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GENERAL INFORMATION -- MODEL IDENTIFICATION

VT - VY COMMODORE

	ECOTEC V6	Supercharged V6 Sequential	179kW V8	195kW V8	Gen III LS1 V8
Engine:					
Bore (mm):	97	97	102	102	99.0
Stroke (mm):	86	97	77	77	92.0
Capacity (cm3):	3791	3791	4987	4987	5665
Compression Ratio:	9.4:1	8.5:1	8.8:1	8.8:1	10.1:1
Recommended Octane	91	95 - Altern 91	91	91	91
VT Models (first release)					
Power (DIN):	147kW@5200rpm	171kW@5200rpm	179kW@4800rpm	195kW@200rpm	220kW@5000rpm
Torque (DIN):	304Nm@3600rpm	375Nm@3000rpm	400@3600rpm	430Nm@3600rpm	446Nm@4400rpm
VX Models (first release)					
Power (DIN):	152kW@5200rpm	171kW@5200rpm			225kW@5000rpm 235kW@5200rpm
Torque (DIN):	304Nm@3600rpm	375Nm@3000rpm			446Nm@4400rpm 465Nm@4400rpm
VY Models (first release)					
Power (DIN):	152kW@5200rpm	171kW@5200rpm			225kW@5000rpm 235kW@5200rpm 245kW@5600rpm
Torque (DIN):	304Nm@3600rpm	375Nm@3000rpm			446Nm@4400rpm 465Nm@4400rpm 465Nm@4000rpm
Fuel System:	EFI	EFI	Sequential EFI	Sequential EFI	Sequential EFI
Fuel Economy:(Litres/100km) (VT Exect and SS)					
Manual City:	11.0H/way: 7.2		City: 14.0H/way: 9.0		City: 13.0H/way: 7.4
Automatic	City: 12.0H/way: 7.2	City: 13.5H/way: 7.8	City: 15.0H/way: 9.0		City: 13.0H/way: 8.

Transmission Ratios:

Manual transmission:

V6 - Getrag 260:5-Speed		V8 - Getrag 290:5-Speed		V8 - Tremec T56:6-Speed	
1st:	3.83	First:	3.55	1st:	2.66
2nd:	2.20	2nd:	2.04	2nd:	1.78
3rd:	1.40	3rd:	1.40	3rd:	1.30
4th:	1.00	4th:	1.00	4th:	1.00
5th:	0.81	5th:	0.75	5th:	0.74
				6th:	0.60

Automatic transmission:

4L-60E4-Speed	
1st:	3.06
2nd:	1.63
3rd:	1.00
4th:	0.70

Differential Ratio: 3.08:1 Gen III: 3.46:1

Fuel Tank Capacity (Litres): 75 Litres LPG Tank: 60

Track (mm): **Sedan** & **Wagon:** Front / Rear: 1569 / 1587

Turning Circle (m): **Sedan:** 11.0 **Wagon:** 11.1

Exterior Dimensions: **Length:** Sedan: 4884 / Wagon: 5042 **Width:** Sedan: 1842 / Wagon: 1847

Towing Capacity: Holden rated: 1200kg, 1590kg & 2100kg (subject to state regulations and towbar design)

Kerb Weight (kg): Exect. Sedan: 1551 Exec. Wagon: 1611 Sedan: 1643 Wagon: 1702

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TUNE-UP & MAINTENANCE

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SERVICE OPERATIONS

LUBRICATION

CHECK OIL LEVEL

The oil level should be between the L & F marks on the oil dipstick, when the engine is at operating temperature. Inspect for leakage, and fill oil up to the F mark if level is low. Do Not fill oil level above the full mark on the dipstick.

OIL CAPACITY: V6 & V6 Supercharged

Drain & Refill:

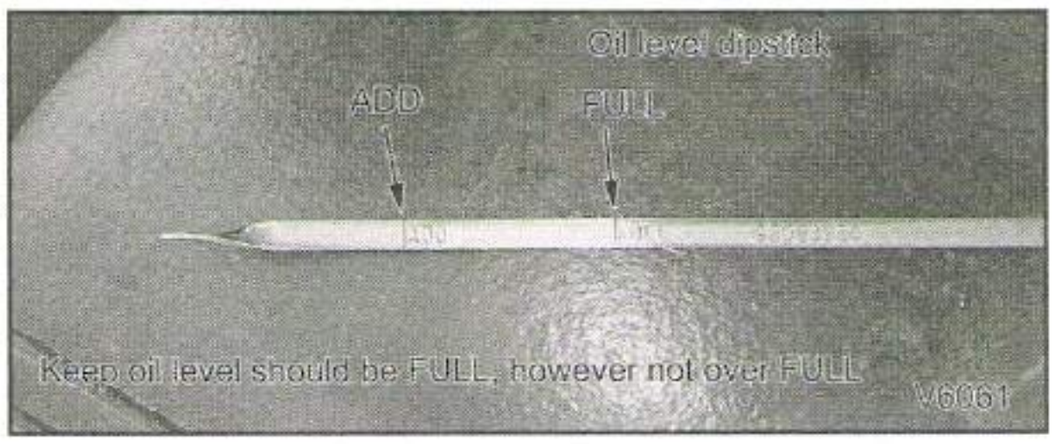
w/o Oil Filter:	4.0L
w/ Oil Filter:	4.3L

OIL CAPACITY: VT SerI V8

Drain & Refill:

w/o Oil Filter:	4.8L
w/ Oil Filter:	5.1L

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OIL CAPACITY: Gen III - 5.7 V8

Drain & Refill:

w/o Oil Filter: 4.7L

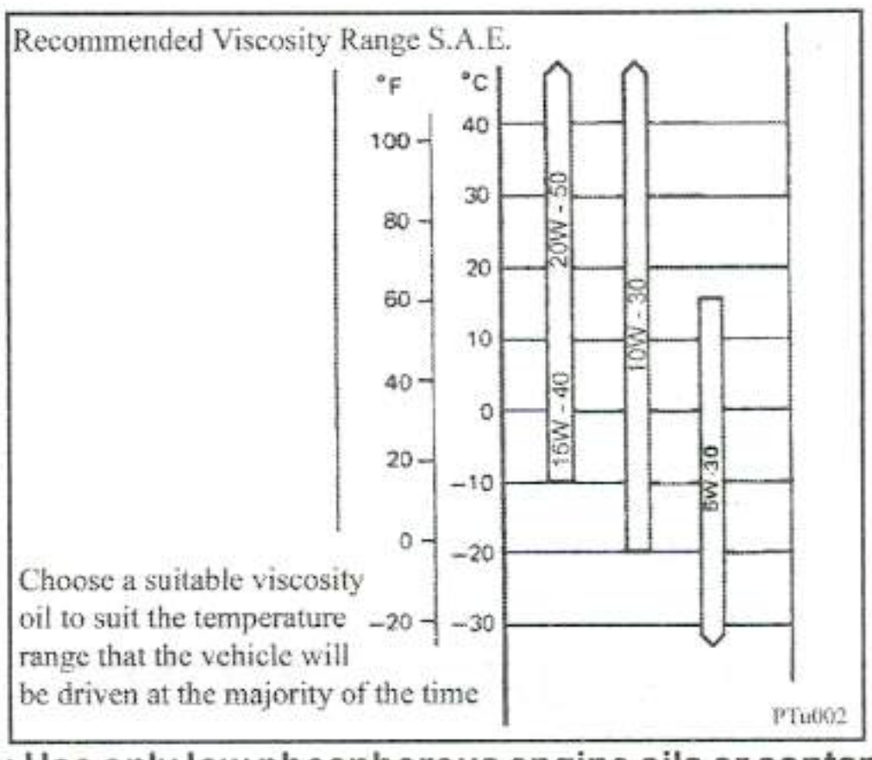
w/ Oil Filter: 5.0L

Oil Specification

V6 & 5.0 litre V8

Use classification SG or SH, viscosity grade 20w/50 for general use and high ambient temperatures. If using vehicle for prolonged periods in snow areas use viscosity grade of 15w/40, this will assist engine starting.

Gen III 5.7 V8 engine. Use classification SJ - GF2 viscosity grade 10w-30



Note: Use only low phosphorous engine oils or contamination of catalytic convertor may result.

Oil Pressure

Check oil pressures with engine at operating temperature and oil at correct level on the dipstick.

1. Remove the oil pressure switch/gauge sender unit

2. Fit the oil pressure gauge adapter and pressure gauge

3. Start engine and allow to idle, check the pressure gauge reading and take note of pressure

Oil Pressure:

V6 & V6 Supercharged @ 1850 rpm or above - 375 kpa

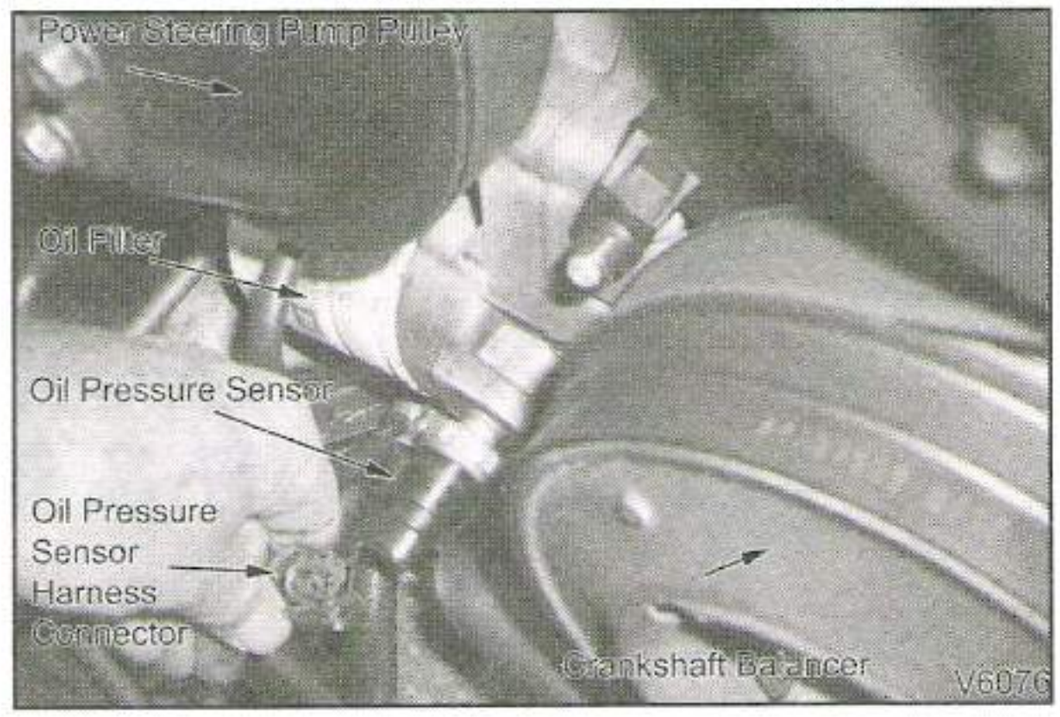
VT Ser I V8 @ idle - 500 rpm - 48 kpa

VT Ser I V8 @ 2000 rpm - 276-414 kpa

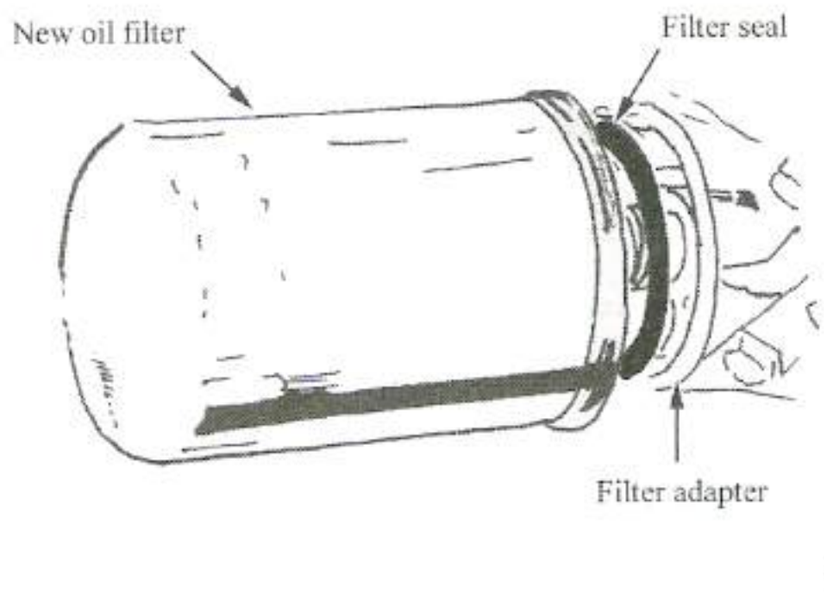
Gen III V8 @ 1,000 rpm 50 kPa (Minimum, Hot)

Gen III V8 @ 2,000 rpm 125 kPa (Minimum, Hot)

Gen III V8 @ 4,000 rpm 165 kPa (Minimum, Hot)



OIL FILTER



The oil filter should be replaced every 10,000 km or 6 months which ever occurs first, or when the engine oil is contaminated in any way.

Replacement

1. Unscrew the oil filter with a suitable oil filter wrench, then remove and discard the filter

2. Make sure that the seal is fitted correctly in the recess in the new oil filter

a) Pour some clean engine oil into the filter, until level is approximately 2 cms below top of filter

b) Smear some engine oil over the filter seal

c) Screw the filter into place until the seal contacts mating surface of adaptor, then tighten through a further 2/3 of a turn.

3. Clean any excess oil from filter and adaptor

a) Check oil level, then start the engine and check for oil leaks

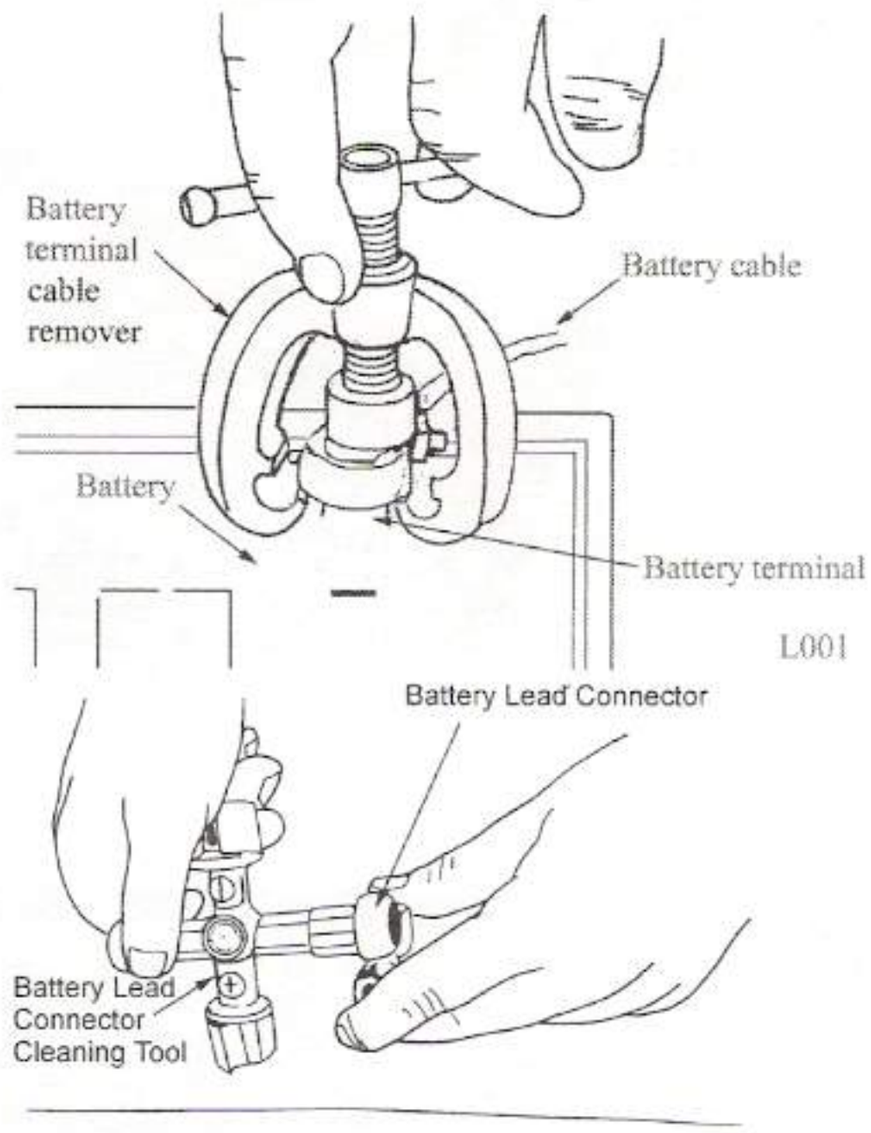
b) Repair as required

Note: After running the engine, the oil level must be checked

BATTERY INSPECTION

Check the battery terminals for corrosion and poor contact with battery posts, repair as required. Check battery electrolyte levels, top up if required using distilled water.

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Clean battery lead connectors to ensure a good contact between the battery and battery lead. L003

Testing Electrolyte Levels

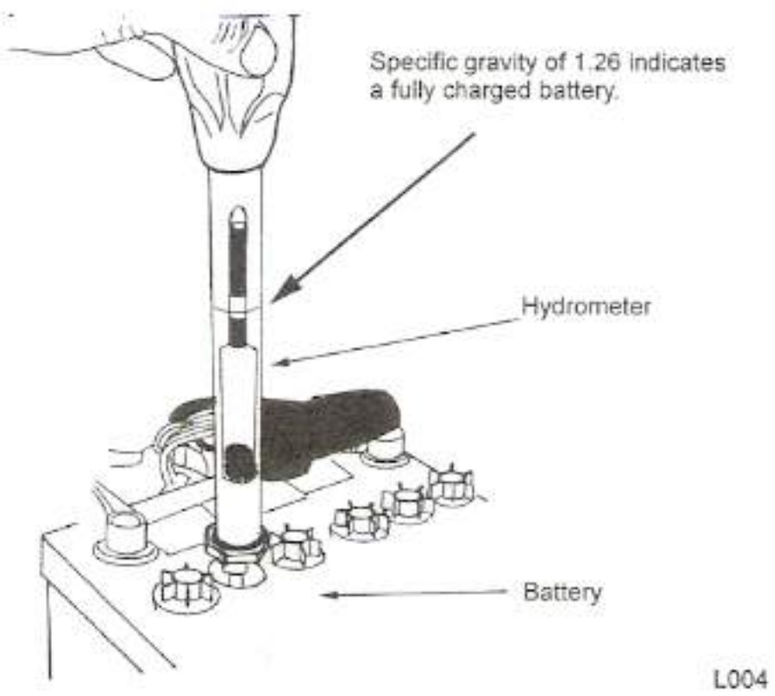
The electrolyte levels of the battery should be checked at regular intervals using a hydrometer. The hydrometer measures the specific gravity of the electrolyte in the battery which relates to the amount of sulphuric acid that is held in suspension in the electrolyte. The state of battery charge and condition can be determined by the specific gravity reading obtained.

Using Hydrometer

1. Top up all battery cells to the correct level

2. Place the end of the hydrometer into one of the cells and draw the electrolyte in and out several times

a) Draw sufficient electrolyte into the hydrometer to fill the hydrometer and then remove the hydrometer from the battery cell



b) Check the reading indicated on the hydrometer scale and note down

c) Check all other cells in the same way and note specific gravity of each cell

If the specific gravity is less than 1.210 the battery should be charged.

A specific gravity reading of more than 0.25 variation between cells indicates a possible faulty battery, charge the battery and recheck readings replace battery if required.

Battery Charging

1. Disconnect both of the battery terminals

2. Remove the battery cell covers

a) Connect the battery charger and preferably charge the battery on slow charge rate for at least 8 hrs

3. Check the specific gravity readings once the battery and been fully charged

Warning: Batteries release explosive gasses when being charged, keep any ignition source away from battery and only charge batteries in a well ventilated area

HYDROMETER READINGS CHART	
Specific Gravity	Charge Level
1.240 to 1.260	100%
1.210 to 1.240	75%
1.180 to 1.210	50%
Below 1.130	Battery Discharged

tu022

COOLING SYSTEM

The cooling system is designed to use a coolant solution containing a mixture of ethylene glycol - (antifreeze), corrosion inhibitors and water. The use of glycol raises the boiling point and therefore increases the cooling system efficiency. The coolant is made up of a solution of 50% ethylene glycol antifreeze/inhibitor (Holden Specification: HN2043) and 50% clean water.

Note: Do Not fill the cooling system with straight water as damage to the engine may result.

Coolant Concentration

Checking the concentration of the coolant is critical to maintain the efficient operation of the cooling system and longevity of the engine. The coolant concentration can be checked using a suitable hydrometer.

Testing Concentration Level

1. Make sure cooling system is at or around the current ambient temperature

2. Remove the radiator cap and insert the hydrometer into the radiator

a) Fill the hydrometer with coolant and remove from the

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radiator
b) Check the coolant concentration reading on the hydrometer
3. If coolant percentage is to low more antifreeze/inhibitor will have to be added to the radiator
a) Drain some of the coolant out of the radiator and top up with the correct amount of antifreeze/inhibitor.

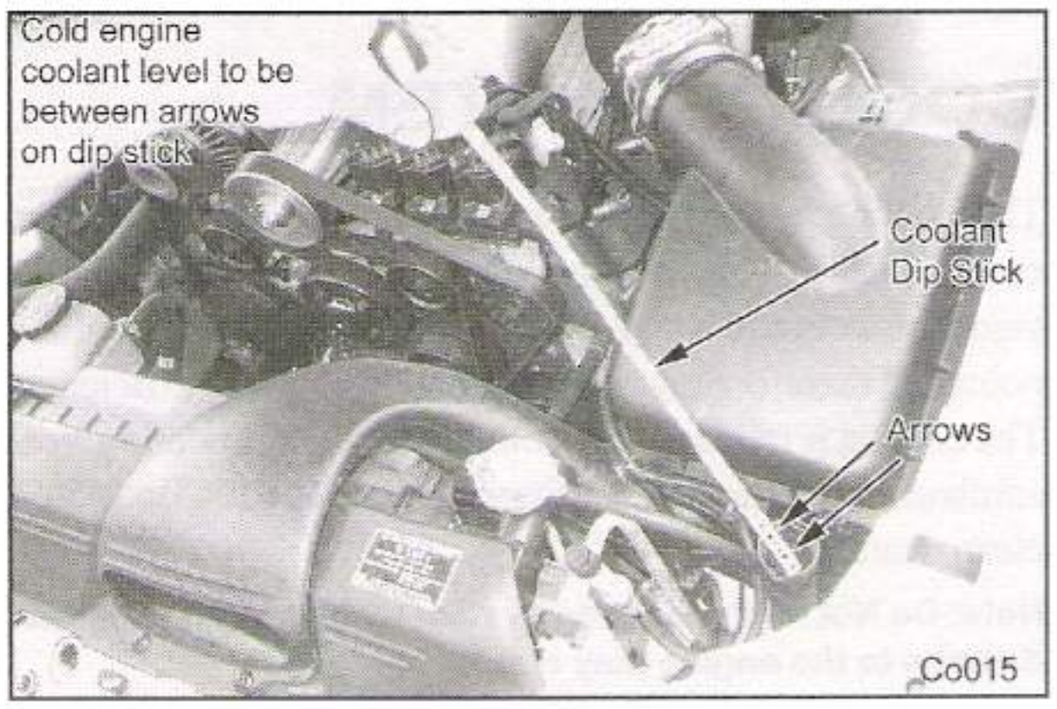
Hydrometer Reading %	Antifreeze/inhibitor to Add
0	6.0
5	5.7
10	5.3
15	4.9
20	4.5
25	4.0
30	3.4
35	2.8
40	2.0
45	1.1
50	0

tu023

Coolant Level Check

All V6 and VT Ser 1 V8

1. The coolant level is inspected by checking the coolant reservoir, check dip stick.



2. Also remove radiator cap to check coolant level, the coolant level MUST be to the top of the radiator neck.

Tip: It is possible for the coolant reservoir to have the correct reading on the dip stick and the water level in the radiator to be low.

Note: Only remove radiator cap if the cooling system is cold

The coolant level should be in between the indicator arrows on the dipstick at the coolant recovery tank.

Gen 111 V8

The coolant level is inspected by checking the coolant



reservoir. The coolant level should be in between the indicator lines on the side of the coolant recovery tank.

Radiator Cap



Note: Only remove radiator cap if the cooling system is cool.

Note: Depending on the engine temperature the level will vary

If removing the radiator cap when the engine is cold, the coolant level should be to the top of the radiator filler.

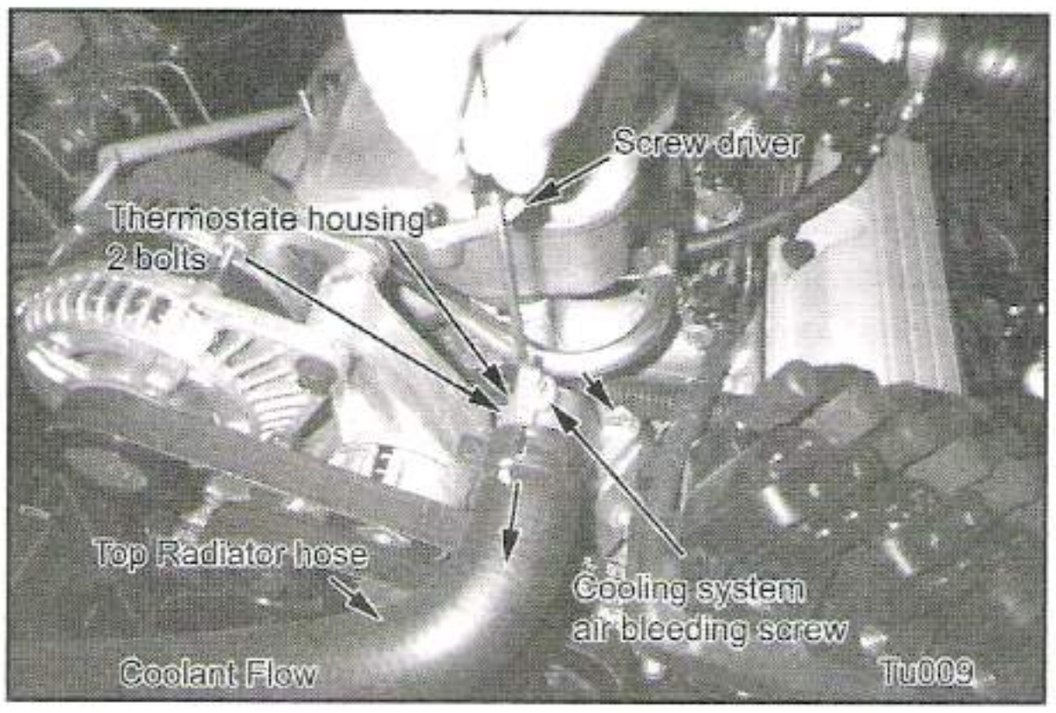
Coolant System Refill

If the cooling system needs to drained, the following instructions should be followed when refilling the cooling system, to ensure that no air locks are left in the cooling system.
1. Adjust heater control to maximum.
2. Have a coolant mixture consisting of 50% ethylene glycol antifreeze/inhibitor and 50% water on hand to fill system.

Note: Do not combine different types of antifreeze or corrosion inhibitors as they may be incompatible. If a different type has been used in the cooling system rinse the system with clean water.

3.a) Remove radiator cap and fill cooling system with as much coolant mixture as possible.
b) [V6 - models] Loosen air bleeding screw to allow air from engine block, when all air is removed and coolant flows from bleeder screw, tighten screw.
[Gen III V8] models do not require to have the cooling system bleed as they have a bleed pipe at the top of each cylinder head.
c) Refit the radiator cap
4. Loosen the upper radiator hose clamp at the coolant outlet

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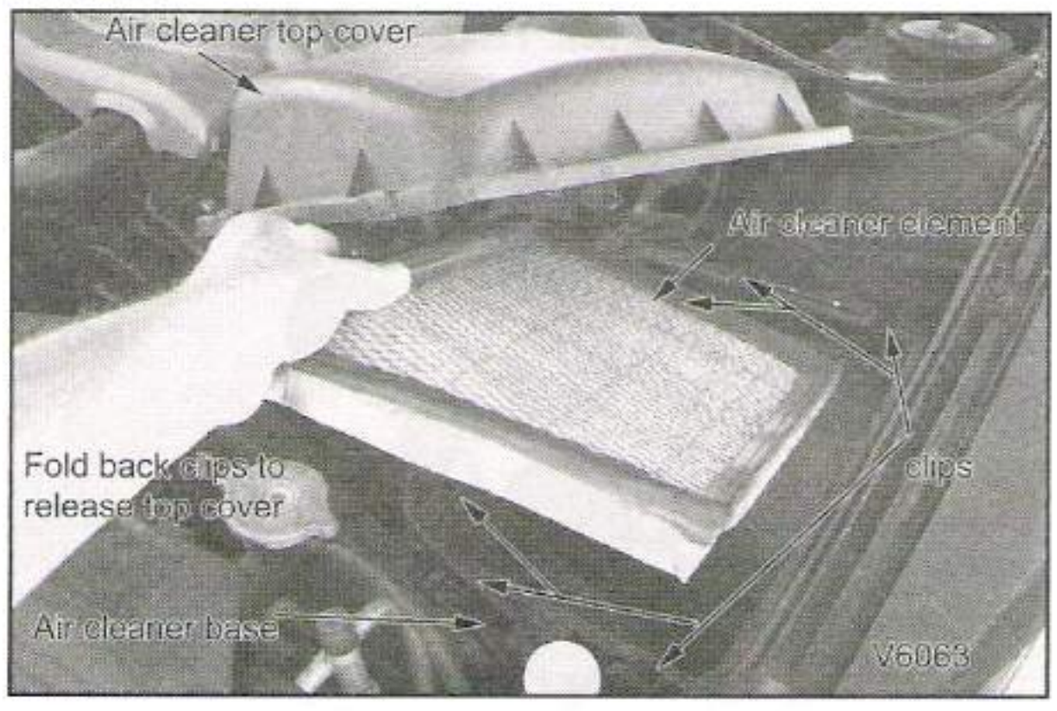


on the engine and remove the hose.
a) Hold the hose upward and pour coolant into the open end of hose until coolant runs out of outlet on engine
b) Quickly fit the hose to the coolant outlet and refit hose clamp
c) Fill the coolant reservoir to approximately 25 mm above the indicator arrows
5. Start engine and run it at 2000 rpm for 10 minutes to open thermostat and purge air from system. Fill reservoir tank to between the arrow indicators on the dipstick
6. Check coolant level when engine has cooled down and top up to correct level as required

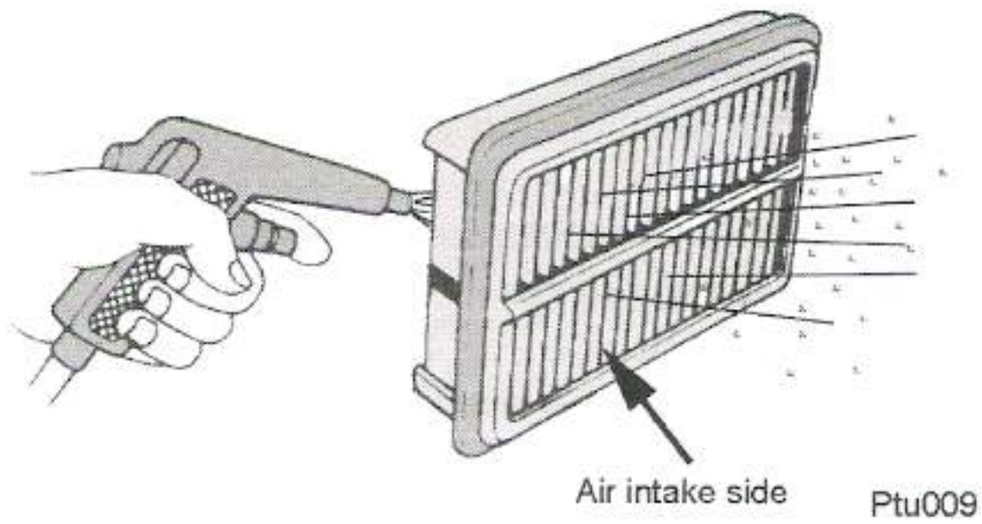
COOLANT CAPACITY
V6 & V8 - 12 litres

AIR FILTER

Inspect & Clean
Remove the air filter element and inspect to ensure it is not excessively dirty, damaged or contaminated with oil. If the element is contaminated with oil, replace it with a new element.



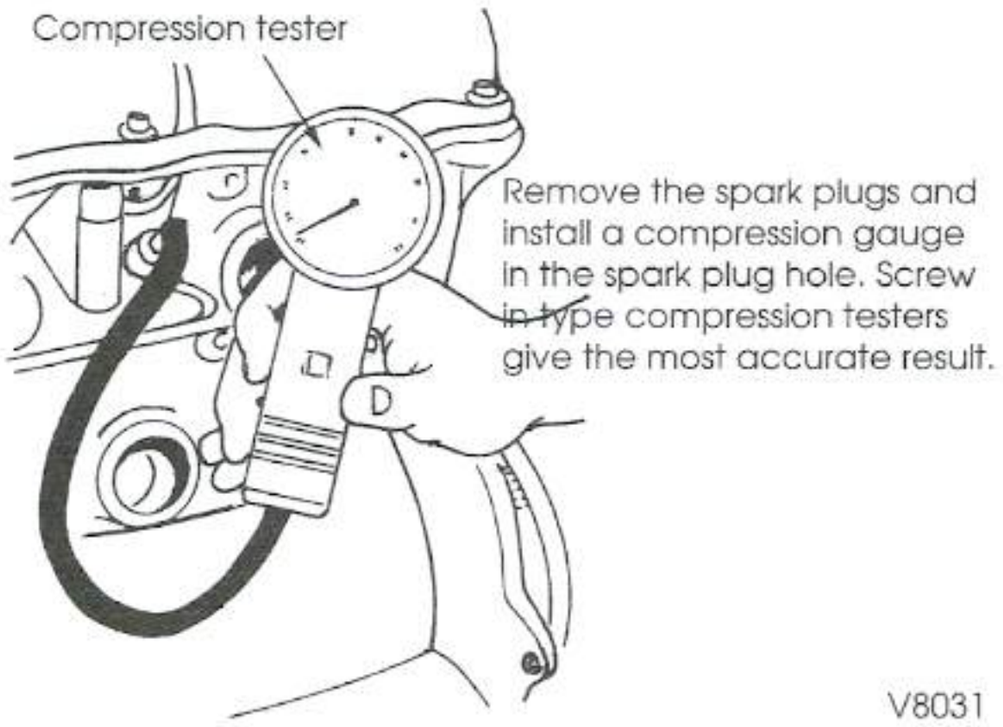
Thoroughly clean the element housing of any dirt, dust oil or any other contaminants. Use compressed air to blow any dust particles out of the filter element, blow from the inside of the element to the outside. Thoroughly clean the outside of the element from the outside.



Ptu009

COMPRESSION CHECK

1. Make sure of the following before checking compression pressures:
a) Engine is at operating temperature
b) Battery is at or near full charge
c) Remove the spark plugs
d) Disconnect the EFI relay (located in the engine bay) and fuse No.F14 (located in the underdash fuse panel
2. Install suitable compression tester into spark plug hole
a) Depress the accelerator fully and crank the engine at 250 rpm or greater, until the gauge reading stabilises



V8031

b) Take note of the gauge reading
3. Check all remaining cylinders
If compression reading on one or more cylinders is low, pour a small amount of oil into the cylinder through the spark plug hole and check compressions again

COMPRESSION TEST RESULTS
NORMAL :- Compression builds up quickly and evenly on each cylinder.
PISTON RINGS:- Compression low on 1st stroke, tending to build up on following strokes, but does not reach normal. Improves considerably with addition of oil.
VALVES:- Low on 1st stroke and does not tend to build up on following strokes. Does not improve much with oil added.
HEAD GASKET:- If cylinder compression in any 2 adjacent cylinders is low and if adding oil does not help increase compression gauge readings, cylinder head gasket has blown out.

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Specifications

V6 & V6 Supercharged: Variation between highest and lowest reading should be less than 70%.
Minimum - 689 kpa

VT Ser I V8: Variation between highest and lowest readings should be less than 138 kpa
Minimum - 650 kpa

Gen III V8: The lowest rreading should not be less than 70% of the highest reading.
Minimum - 690 kpa

DRIVE BELTS

V6 & V6 Supercharged

Both the V6 & V6 Supercharged engines utilise a single drive belt or serpentine belt to drive all of the auxiliary components ie; alternator, water pump, power steering etc.



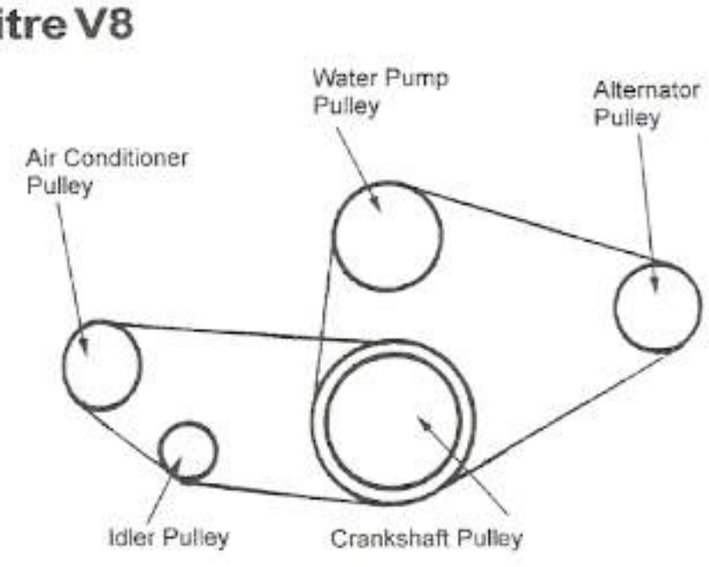
Replacement

Use a 15mm ring spanner to release the tension on serpentine belt by turning belt tensioner idler pulley anticlockwise. Remove the serpentine belt. Fit new serpentine belt using reverse procedure.

V6 and Gen III engines have a belt tension indicator, which will show on the third mark if the belt is streched more than allowed.

Note: Ensure that ribs on serpentine belt are correctly aligned with pulley grooves when reinstalling

5.0 Litre V8



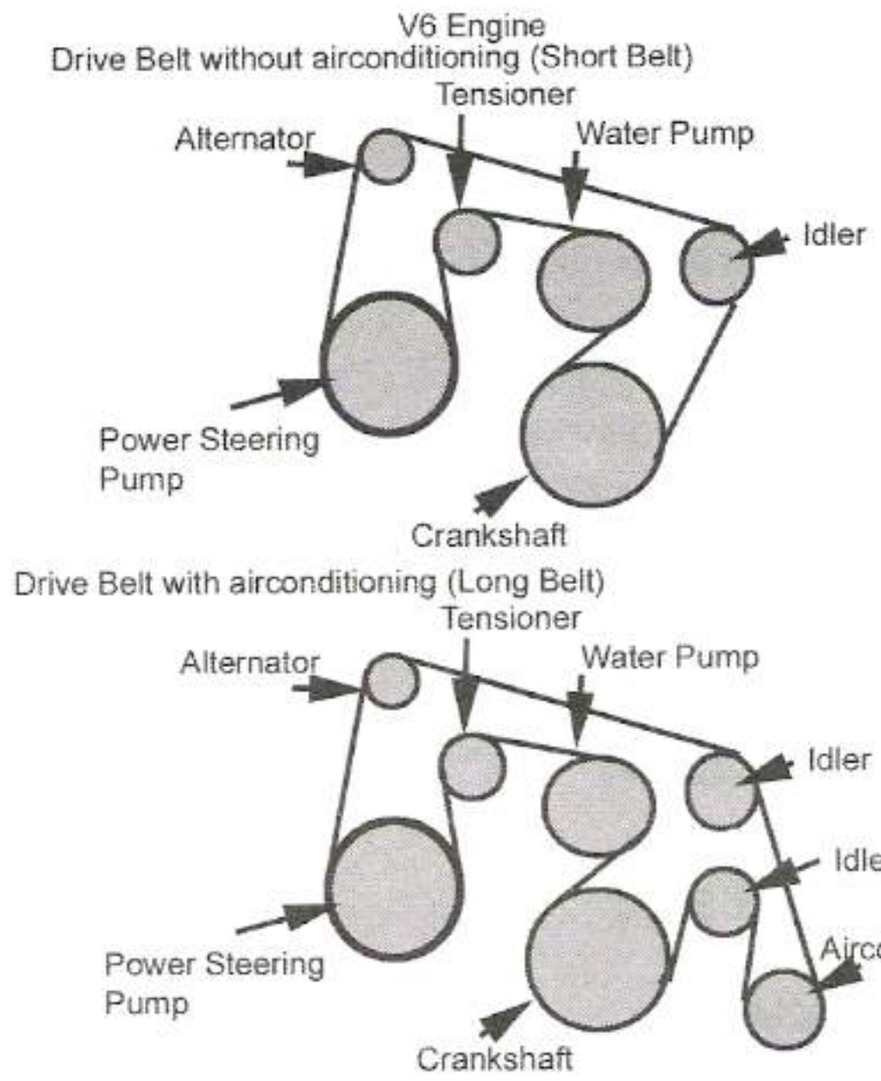
The V8 engine uses a conventional drive belt setup ie; separate belts for the air conditioner, alternator etc.

Replacement

Release tension of the belts by loosening the alternator, air conditioner, power steering pump adjustment bolts. Remove drive belts from drive pulleys. Replace belts, taking care the belts are fitted correctly. Tension belts by adjusting and tightening alternator, air conditioner etc.

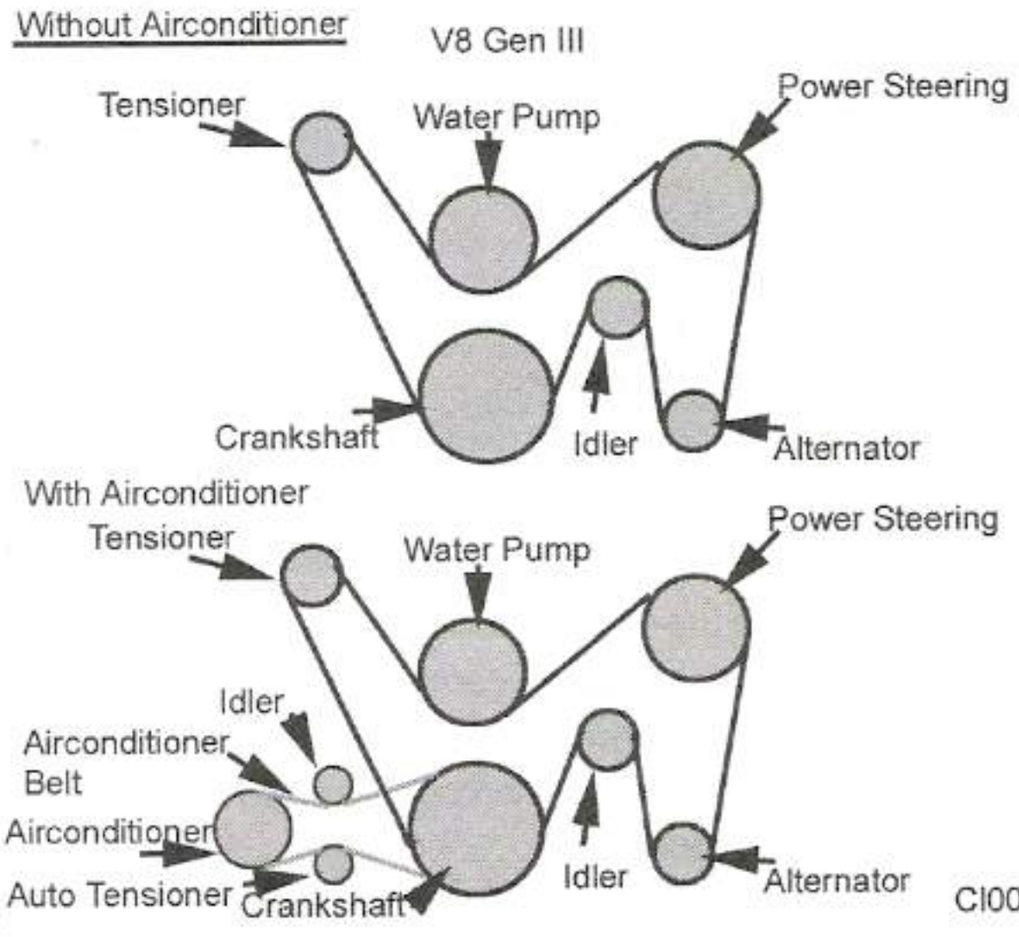
Gen III, V6 and V6 Supercharged

Both the V6 & Gen III engines utilise a single drive belt to drive all of the auxiliary components ie; alternator, water pump, power steering etc.

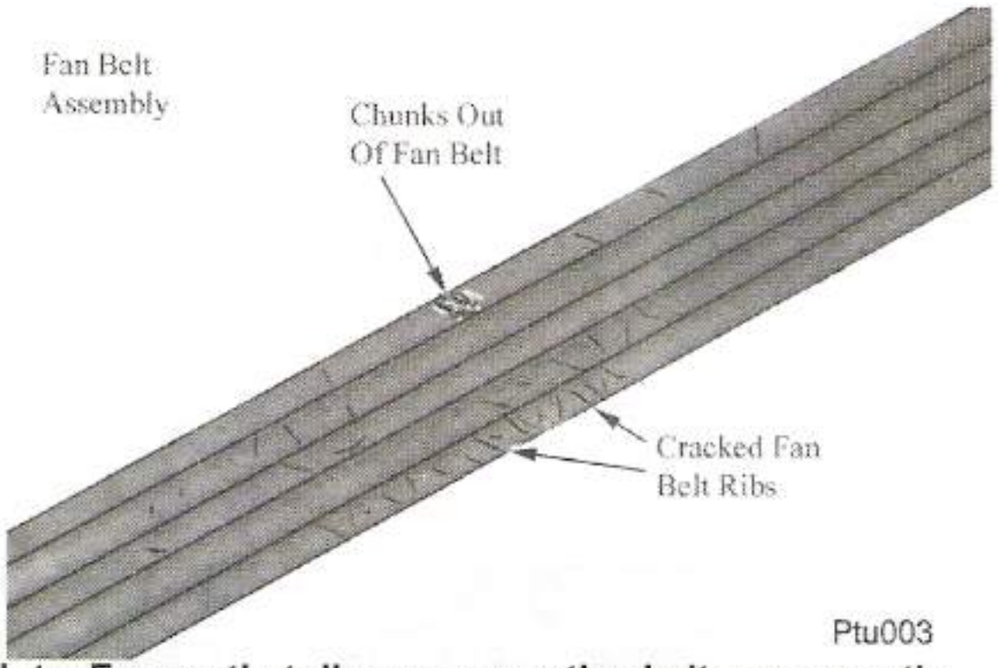


Replacement

Use a 15mm ring spanner to release the tension on serpentine belt by turning belt tensioner idler pulley anticlockwise. Remove the serpentine belt. Fit new serpentine belt using reverse procedure.



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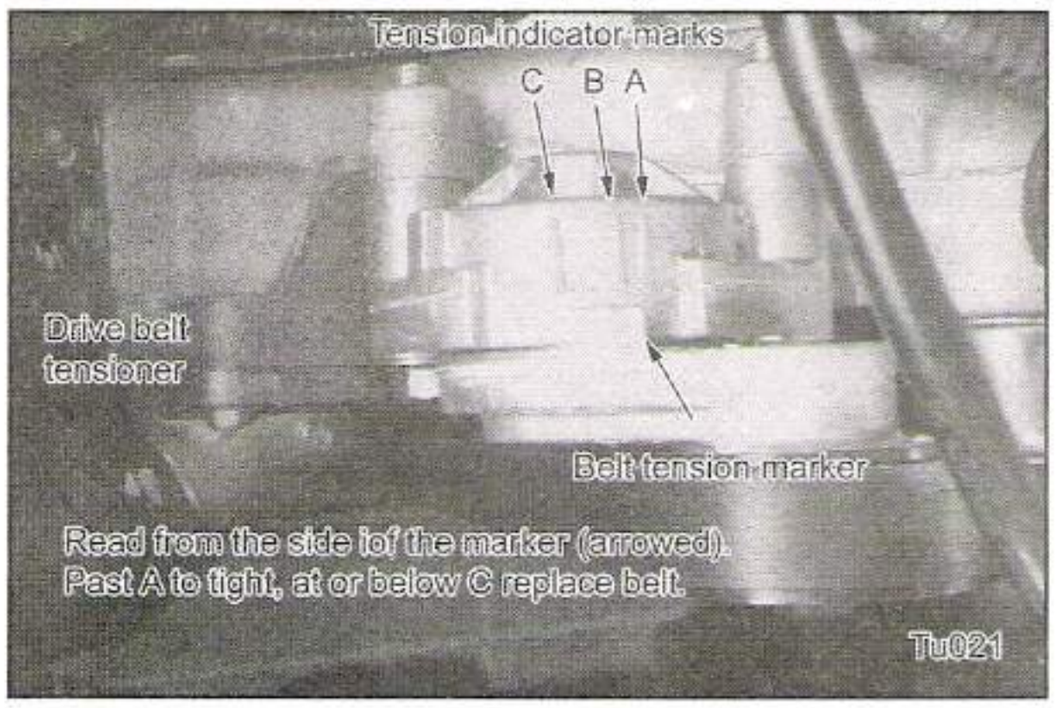
Note: Ensure that ribs on serpentine belt are correctly aligned with pulley grooves when reinstalling

Drive Belt Wear

1. NEW BELT: - No cracks or chunks.
2. MODERATELY USED BELT: - Few cracks, some wear on surfaces. Replacement not required.
3. SEVERELY USED BELT:- Several cracks per 25 mm Should be replaced before failure occurs.
4. FAILED BELT:- Separation of belt material from backing

Note: Some belt squeal when the engine is started or stopped is possible and has no effect on durability of drive belt

V6 and Gen III engines have a belt tension indicator, which will show on the third mark if the belt is streched more than allowed. (V6 see a previous illustration). Gen III read from the side iof the marker (arrowed). Past A to tight, at or below C replace belt.



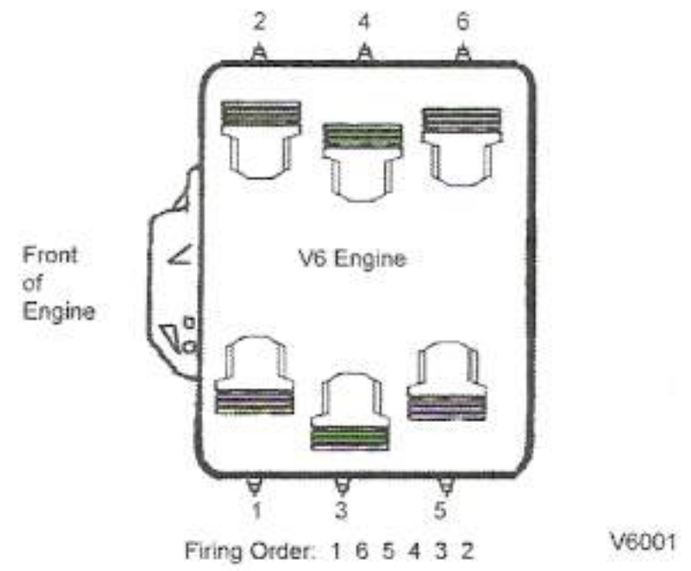
VALVE CLEARANCES

Both the V6 & V8 engines use hydraulic lifters and the valve clearances are not adjustable.

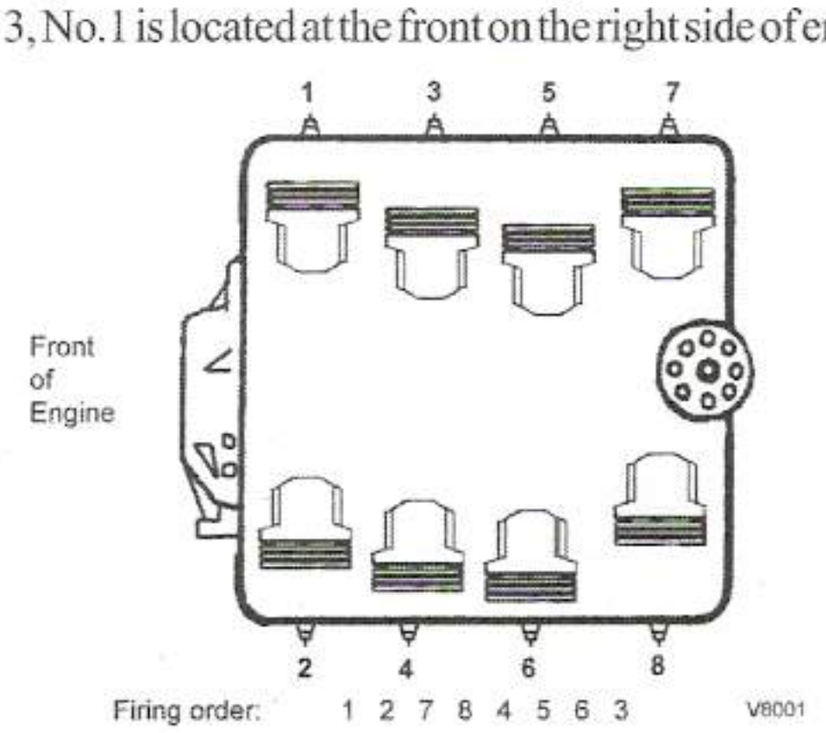
IGNITION

FIRING ORDER

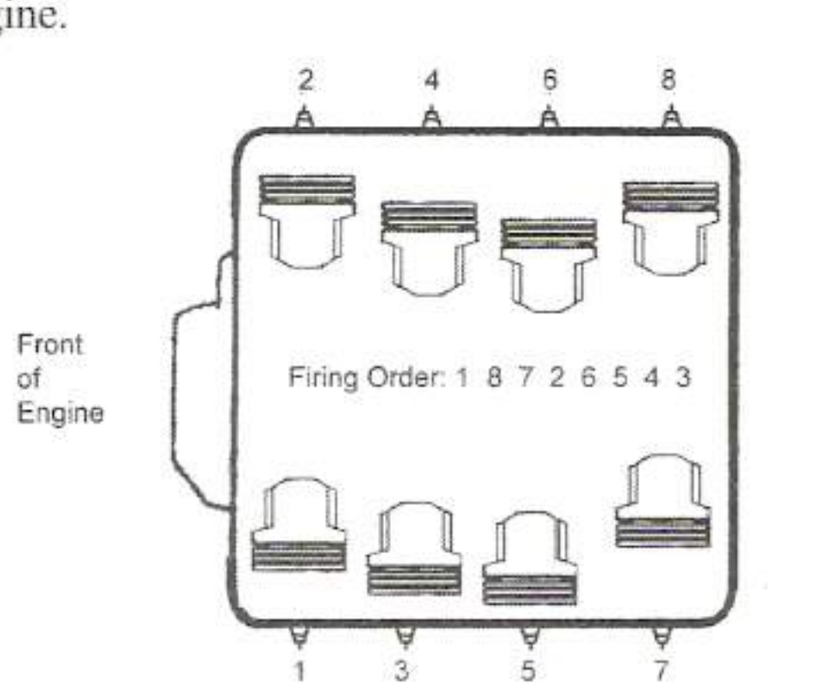
The firing order of both V6 engines 1 - 6 - 5 - 4 - 3 - 2, No.1 cylinder is located at the front of the engine on the left side



The firing order of the 5.0 Litre V8 engine is 1 - 2 - 7 - 8 - 4 - 5 - 6 - 3, No.1 is located at the front on the right side of engine.



The firing order of the 5.7 Litre GenIII V8 engine is 1 - 8 - 7 - 2 - 6 - 5 - 4 - 3, No.1 is located at the front on the left side of engine.



HIGH TENSION LEADS

1. Carefully Remove High Tension Lead by Rubber Boot from spark plugs and distributor or coil pack.
**** Pulling on or bending the cords may damage the conductor inside.***
2. Check the resistance of all high tension leads
Check that the resistance does not exceed the maximum using an ohmmeter.

V6 & V6 Supercharged

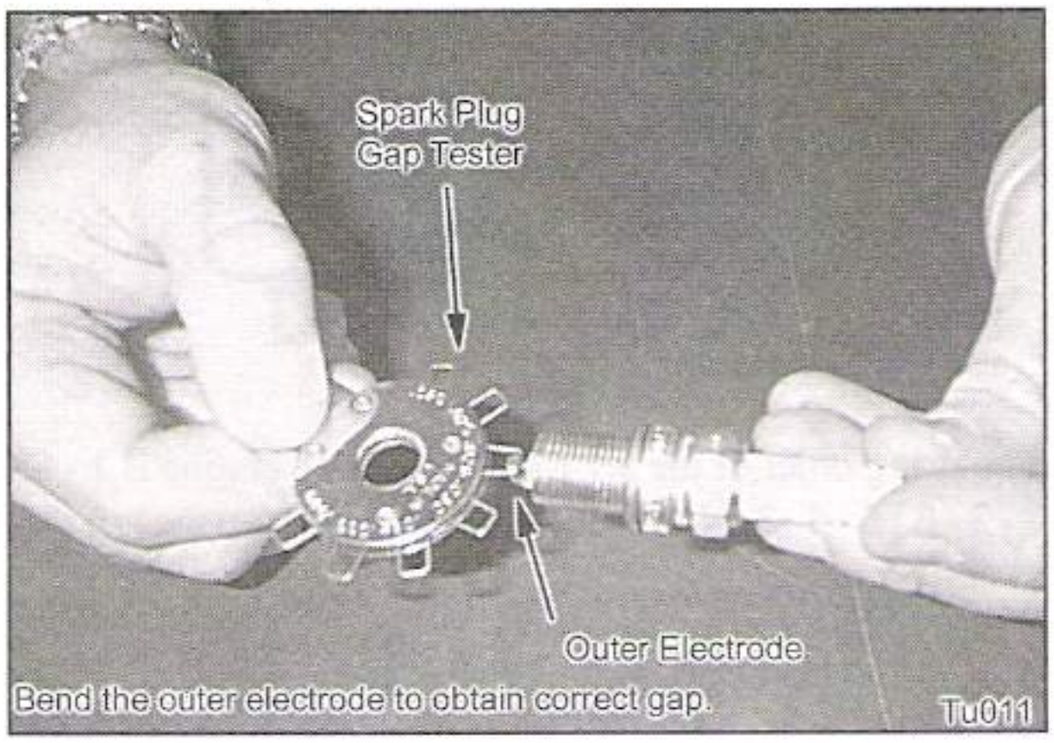
Resistance - Leads 1, 3 & 5 less than 10000 ohms
- Leads 2, 4 & 6 less than 17000 ohms

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VT SerI V8
Spark Plug Leads - Maximum Resistance: 25000 ohms
Coil Lead - Maximum Resistance: 6000 ohms
Gen III 5.7 Litre V8
See diagnostic charts for ignition problems.
Inspect the terminals, and replace the high tension lead and if more than maximum specified.

SPARK PLUGS

1. Remove, Clean & Inspect Spark Plugs.
a) Clean the spark plugs with a spark plug cleaner or wire brush
b) Examine the spark plugs for electrode wear, thread damage and insulator damage. Replace the plugs if worn or damaged.
2. Adjust Electrode Gap. Gently bend the outer electrode to obtain the correct electrode gap
Electrode Gap:



V6 & V6 Supercharged - 1.5 mm
5.0 Litre V8 - 1.0mm +/- 0.05
5.7 Litre Gen III V8 - 1.5 mm
Spark Plug Type:
V6 - Original Equipment: NGK - BPR6EFS-15
V6 Supercharged - Original equipment: AC 41-919
5.0 Litre V8 - Original equipment: NGK - BPR6EF
5.7 Litre Gen III V8 - Original equipment: AC 41-952
3. Refit spark plugs and tighten to correct torque
Specified Torque:

V6 & V6 Supercharged:	15-25Nm
5.0 Litre V8:	15-25Nm
5.7 Litre V8:	15Nm

4. Refit spark plug leads and any previously removed parts.

IGNITION TIMING

V6 & V6 Supercharged

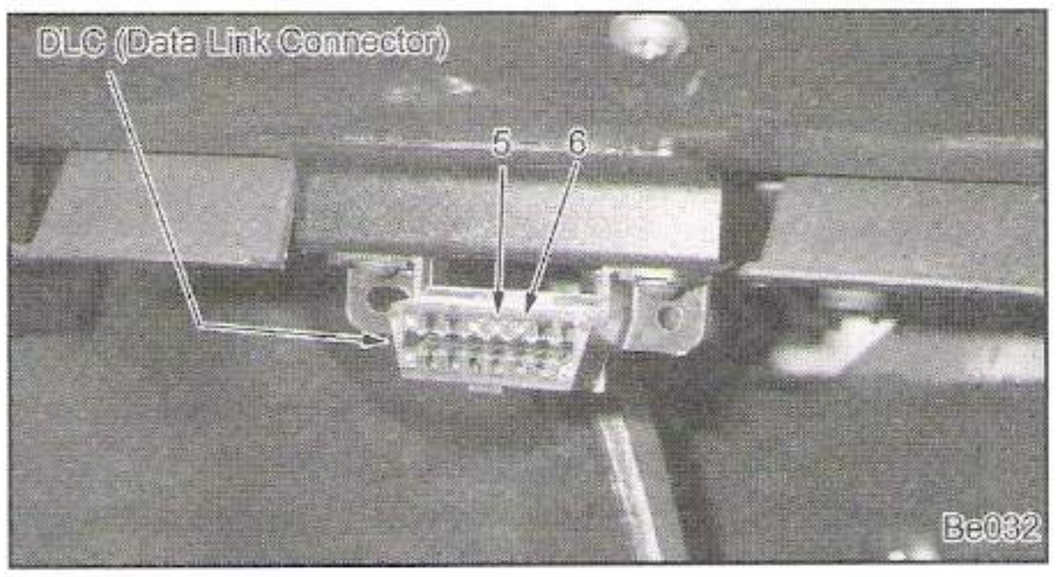
The ignition timing is not manually adjustable on either of these engines and is controlled by the PCM.
Base Ignition Timing (Bypass mode) - 10^0 BTDC
Operating Ignition Timing - 13^0 BTDC @ idle

5.7 litre Gen III V8

The ignition timing is not manually adjustable on either of these engines and is controlled by the ECM.
Base Ignition Timing - 0^0 BTDC
Operating Ignition Timing - 13^0 BTDC @ idle

5.0 Litre V8

1. Warm the engine up to operating temperature
a) Connect a service wire between terminals 5 and 6 of the



Data Link Connector
b) Connect a suitable timing light
c) Check ignition timing by directing timing light on crankshaft pulley timing marks
2. Adjust the ignition timing if required, by loosening the bolt and nut on the distributor and turn distributor in the desired direction until the timing is set at the specified value
Ignition Timing - 10^0 BTDC @ idle
6. If timing is correct remove service lead from DLC, tachometer and timing light from the engine

GENIII V8

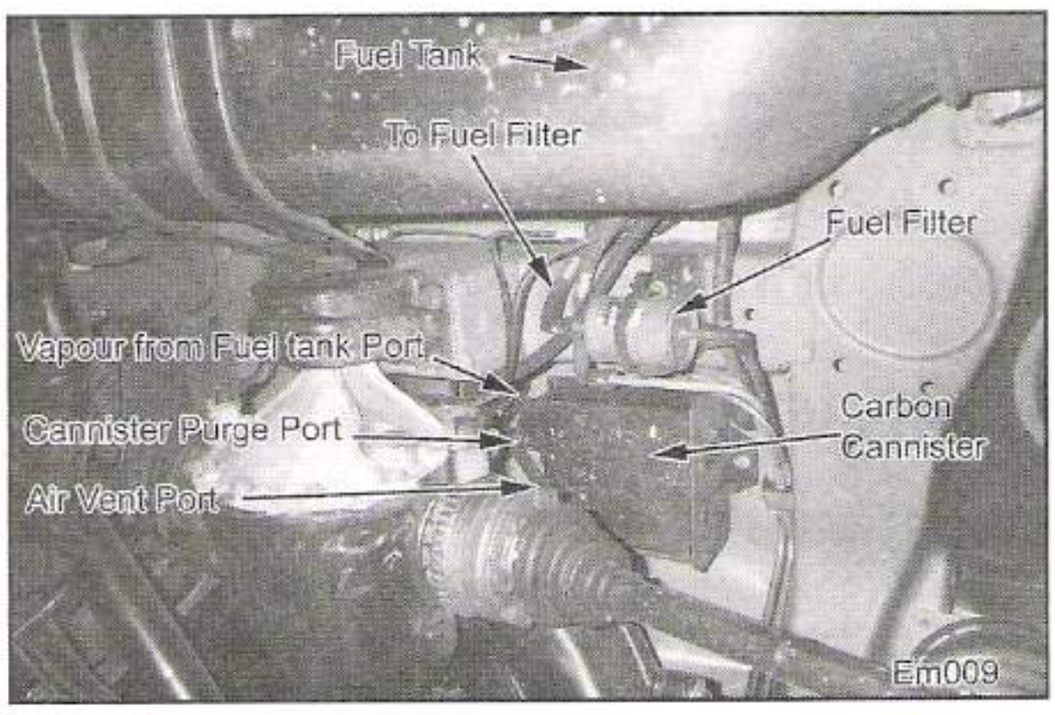
The timing is set by the PCM, no adjustment available.

FUEL

FUEL FILTER

All Models

The fuel filter is located underneath at the rear of vehicle, in

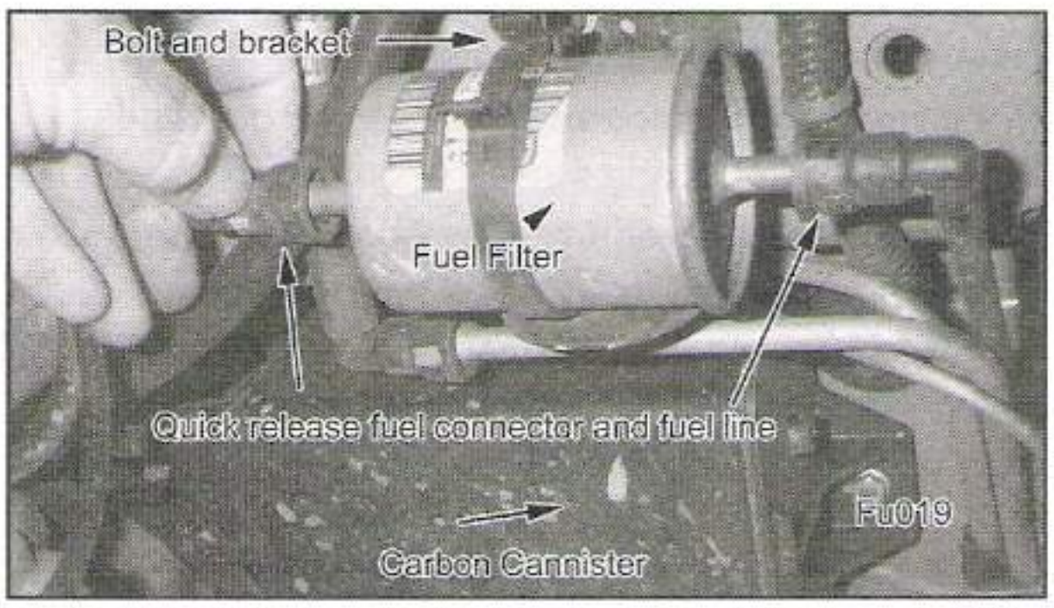


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front of the fuel tank.

Note: Fuel system is under pressure, take care when disconnecting fuel lines

Remove



1. Place a suitable container under the fuel filter
a) Push the hose connector in towards the fuel filter to release any built up pressure in fuel lines
b) Press the tangs on the side of connector in and then pull connector away from the fuel filter
2. Remove the filter by depressing the barbs on the quick release strap

Refit

1. Refit the fuel filter assembly to the vehicle bracket (clip into position)
2. Push fuel lines back into position (make sure lines are securely attached)
3. Start the engine and check fuel system for any leaks, repair as required.

Idle Speed & Air/Fuel Ratio

The idle speed & air/fuel ratio are controlled by the ECU. Readings from various sensors are received by the ECU which in turn calculates the correct adjustments required to maintain the idle speed and air/fuel ratio at optimal levels.
Air / Fuel ratio: 14.7:1

Note: No manual adjustments should be carried out to the idle speed etc or there may be a detrimental effect to engine performance

PROBLEM DIAGNOSIS

See "ENGINE", "EMISSION" and "EFI Fault Diagnosis & ECU Information" Chapters for additional Problem Diagnosis.

COMMON SERVICE POINTS



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EMISSION CONTROL

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General Precautions

Know the importance of periodical maintenance. Every service item in the periodic maintenance list must be performed. Failing to do even one item can cause the engine to run poorly and increase exhaust emissions. Determine if you have an engine or emission system problem.

Engine problems are usually not caused by the emission control systems. When troubleshooting, always check the engine and the ignition system first. Check hose and wiring connections first. The most frequent cause of problems is simply a bad wiring or vacuum hose connection. Always make sure that all connections are secure and correct.
Observe the following precautions to avoid damage to the parts:

- To disconnect vacuum hoses, pull on the end, not the middle of the hose.
- To pull apart electrical connectors, pull on the end, not the middle of the wiring loom.
- Be careful not to drop electrical components, such as sensors or relays. If they are dropped on a hard surface, they should be replaced and not reused.
- When steam cleaning an engine, protect the distributor, crank sensor, coil, air filter, air intake etc.
- Never use an impact wrench to remove or install thermo switches, thermo sensors or other sensors.
- When checking continuity at a wire connector, insert the tester probe carefully to prevent terminals from bending.
- When using a vacuum gauge, never force the hose onto a connector that is too large. Use a step-down adaptor instead. Once the hose has been stretched, it may leak.

When disconnecting vacuum hoses, use tags to identify hoses and mark how they should be reconnected. After completing a job, double check that the vacuum hoses are properly connected.

When replacing components use a new component if a second-hand component cannot be tested.

If the vehicle is to be jacked up only at the front or rear end, be sure to block the wheels. After the vehicle is jacked up always support it on stands. It is extremely dangerous to do any work on the vehicle raised on a jack alone, even for jobs that can be finished quickly.

Disconnect the battery cable from the negative terminal of the battery to make work safer when replacing electrical parts or working on parts near an electrical source.

Catalytic Convertors

WARNING: If large amounts of unburnt fuel flow into the catalytic converter, it may overheat and create a fire hazard

To prevent this, observe the following precautions:
1. Use only unleaded petrol
2. Avoid prolonged idling
Avoid running the engine at fast idle speed for more than 10 minutes and at idle speed for more than 20 minutes.
3. Avoid spark jump test
a) Perform spark jump test only when absolutely necessary and as quickly as possible
b) Never race the engine while testing
4. Avoid prolonged engine compression measurement.
Engine compression tests must be made as quickly as possible.
5. Do not run engine when fuel tank is nearly empty.
This may cause the engine to misfire and create an extra load on the catalytic converter.
6. Avoid coasting with ignition turned off and prolonged engine braking.

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7. Do not dispose of used catalytic converter along with parts contaminated with petrol or oil.

Emission Control Systems

PCV Valve (positive crankcase ventilation)

The positive crankcase ventilation valve is located in the inlet manifold. During normal driving conditions excess vapours from the crankcase are drawn into the inlet manifold via the P.C.V valve. These vapours are then delivered into the inlet manifold plenum chamber and into the combustion chamber to be burnt.

Fresh air is drawn into the crankcase through a breather hose connected to the throttle body.

The quality or smoothness of the engine idle is maintained by the restriction of flow by the P.C.V. valve when inlet manifold vacuum is high.

All V6 engines

Remove

1. Remove the engine cover 4 dome nuts

2. Loosen the 2 bolts for the PCV valve cover

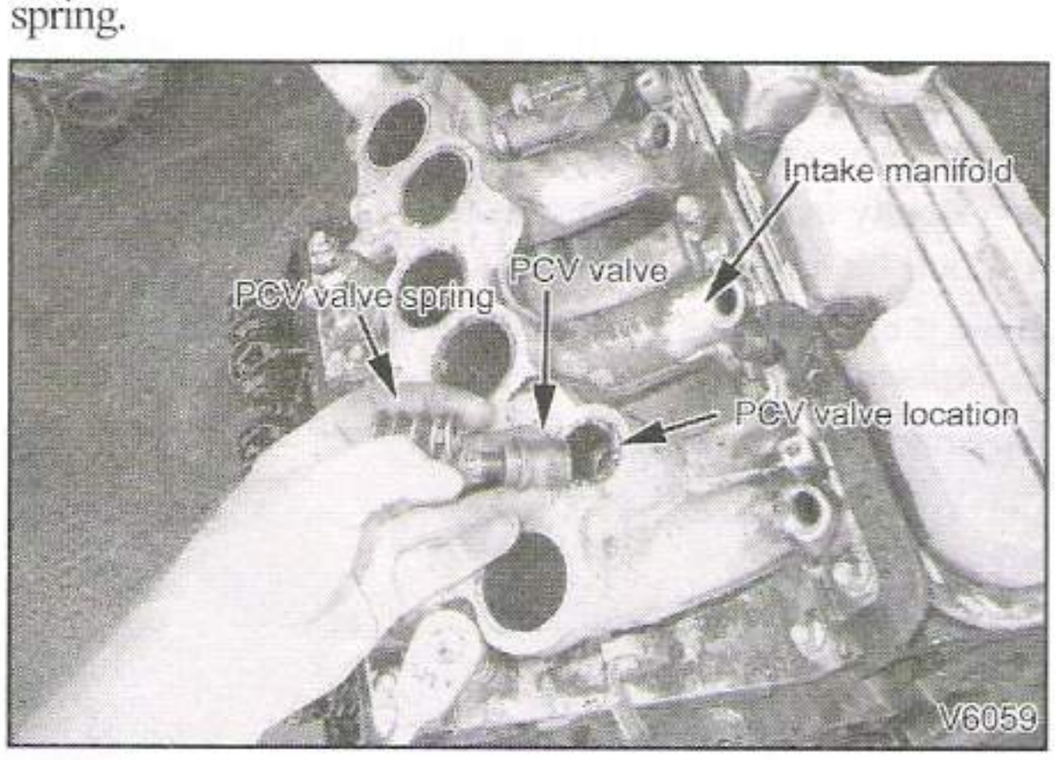
a) Hold down the cover and remove the 2 bolts

b) Remove cover, spring and 'O' ring

Install

1. Fit new 'O' ring

2. Fit the P.C.V. valve back into position along with the spring.



3. Fit a new gasket, position the cover and fit 2 bolts torque to specifications

Torque: 4-6Nm

4. Refit the engine cover 4 dome nuts

Inspection

1. The P.C.V. valve is located in the inlet manifold plenum

a) To check the valve for blockage - shake the valve and listen for a rattle from the needle inside, if no rattle replace the valve

Note: P.C.V. valve is non-serviceable and must be replaced if found to be defective

2. Check the fresh air intake hose fitted to the throttle body

a) Check hose for cracks and correct fit to connectors, repair or replace as required

b) Check passages for blockage, clean out if required

3. To test the operation of the P.C.V. valve V6 engines, remove the dipstick from tube

a) Use a good quality vacuum gauge with a scale of at least 0 to -4kpa and connect to the dipstick tube

** Ensure a tight seal between vacuum gauge and dipstick tube*

c) Start engine and allow to idle for a couple of minutes, check vacuum gauge reading

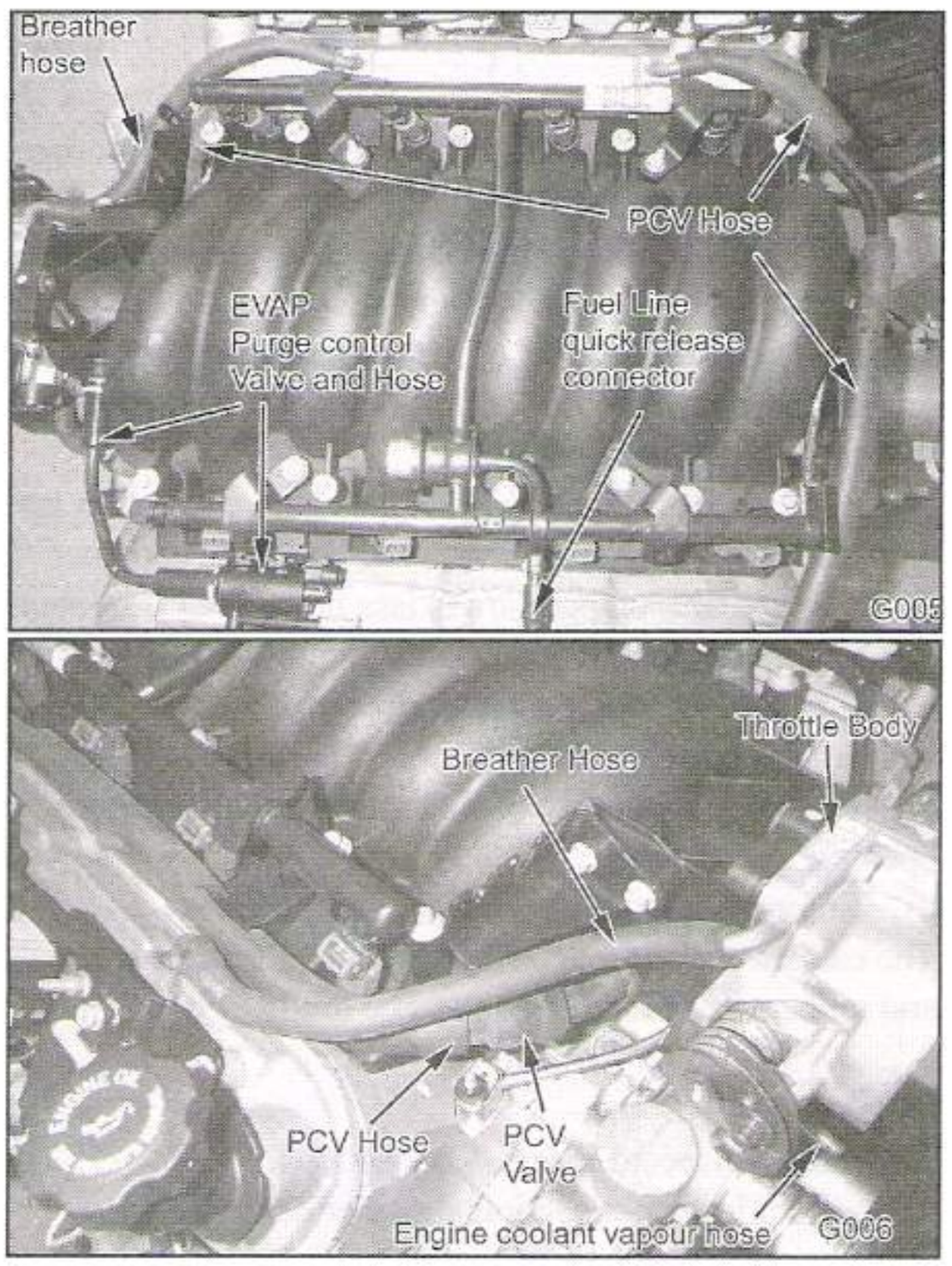
Vacuum Specification: -0.2 - -1.00kpa

d) If vacuum reading is within this range P.C.V valve is functioning correctly

PCV Valve Gen 111 V8

The PCV valve is located between the throttle body and hose connected to the front of the right side rocker cover.

Inspection



1. Low air pressure should be able to pass from the rocker cover side of the PCV vlave to the throttle body side.

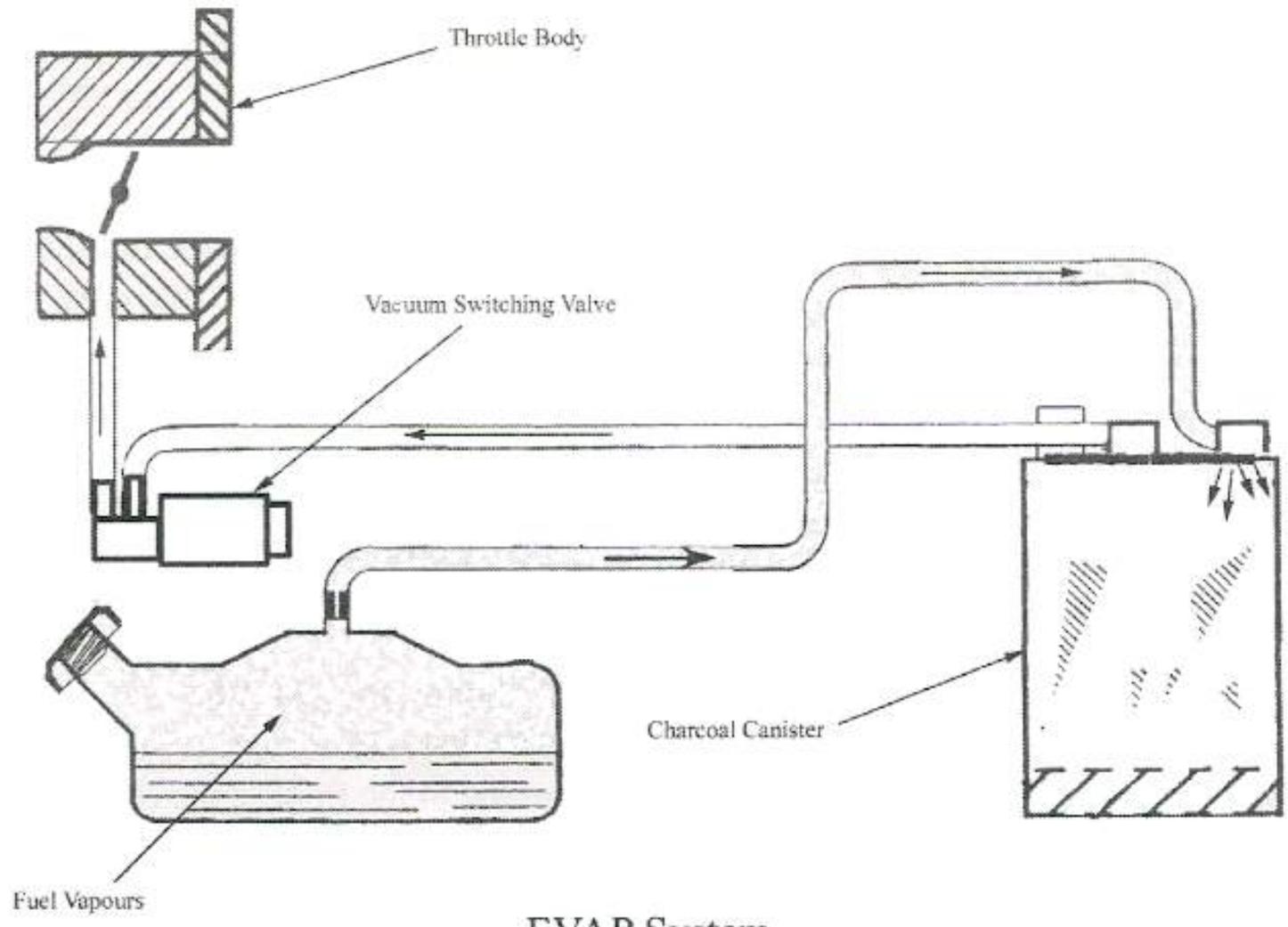
2. Low air pressure should not pass from throttle body side to the rocker cover side of the PCV valve.

3. Replace if not PCV valve if faulty.

EVAP (evaporative emission control)

The Evaporative Emission Control System (EECS) is required to prevent the escape of fuel vapours to the atmosphere by venting them to the combustion chamber to be

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EVAP System

Em005

burnt. The VT ECCS uses a charcoal canister type storage. Fuel vapours are transferred from the fuel tank to the canister and are stored there while the vehicle is not operating. Once the engine is running the vapours are purged to the intake manifold and become part of the combustion process. The fuel cap is not vented to atmosphere but does contain a vacuum relief & pressure valve.

The PCM controls the purging of the charcoal canister and only allows purging if the following conditions are met.

a) The coolant temperature is less than 20°C, 3 minutes and 10 seconds after engine start.

b) The coolant temperature is greater than 800C, 5 seconds after engine start.

c) Engine is not in decel fuel cutoff mode and throttle opening is less than 92%

d) Engine is operating in closed loop mode.

The canister should be checked at regular service intervals and replaced as a unit if found to be faulty.

Inspection

1. Visually Inspect Lines & Connections.

a) Look for loose connection, kinks or damage.



Fi005

2. Visually Inspect Fuel Tank.

a) Look for deformation, cracks or fuel leakage.

3. Visually Inspect Fuel Filler Cap.

a) Look for a damaged or deformed gasket and cap.

b) If necessary, repair or replace the cap.

Carbon Canister

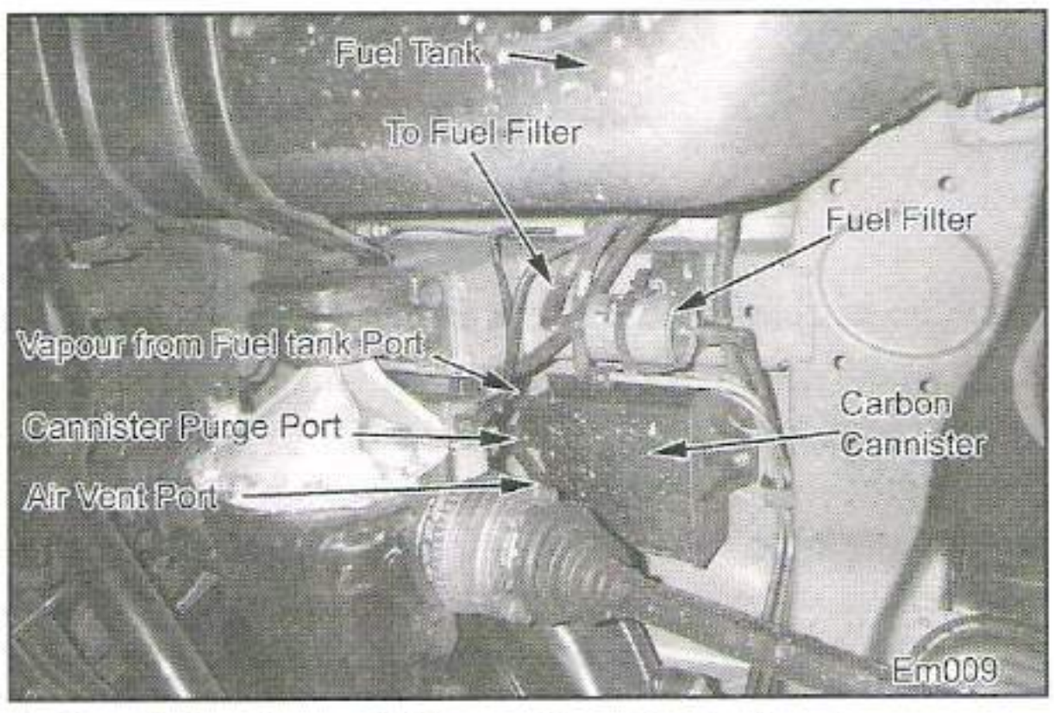
The carbon cannister is rectangler and located under the vehicle near the fuel filter.

1. Remove carbon canister

2. Visually inspect carbon canister

a) Look for cracks or damage

Note: If canister has been flooded with fuel it will have to be replaced



3. Check for clogged filter and stuck check valve

a) Using low-pressure compressed air (1.96kpa, 20gf/cm², 0.28psi), blow into fuel tank port and check that the air flows without resistance from the other pipes

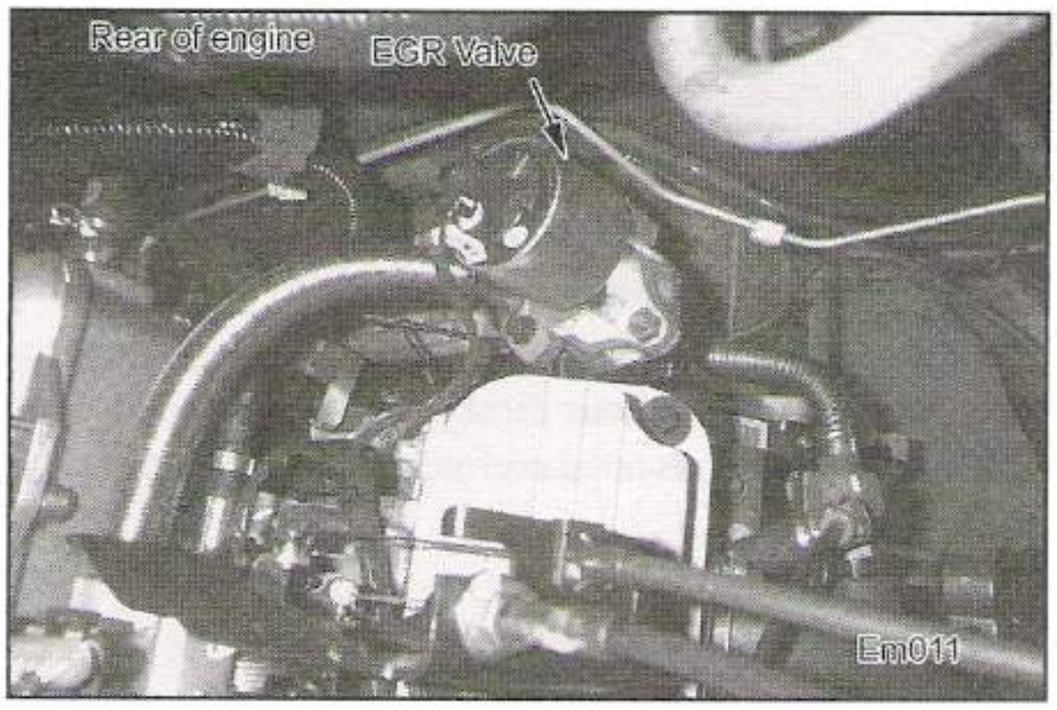
b) Apply vacuum to cannister purge port (1.96kpa, 20gf/cm², 0.28psi). Check that the vacuum does not decrease

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when other ports are blocked, vacuum should decrease when port fuel tank port is released
** If a problem is found, replace the charcoal canister*
4. Install Carbon Canister

EGR (exhaust gas recirculation)

Non Supercharged V6



The non-supercharged V6 engine is fitted with an EGR system . The system is designed to lower the NOx (Oxides of Nitrogen) emission levels. The V6 engine uses a linear EGR valve which is used to feed small amounts of exhaust gas back into the engine independent of engine manifold vacuum. This dilutes the air/fuel ratio which also lowers the combustion temperatures.
The linear EGR valve is controlled by the PCM allowing accurate supply of exhaust gas to the engine. During operation the pintle of the linear EGR valve is controlled by the PCM which monitors pintle position via a feedback signal.
The linear EGR valve is activated if the following conditions are met:
1. Engine is at operating temperature
2. Above idle speed
The sensors listed below are monitored by the PCM and adjustments to the pintle position are made accordingly.
1. Engine coolant temperature sensor (ECT
2. Mass air flow sensor (MAF)
3. Throttle position sensor (TP)
4. Engine RPM

Refer: 'Diagnostics Chapter for service operations'

Remove
1. Remove the engine cover 4 dome nuts
2. Disconnect the electrical connector at the linear EGR valve
3. Remove the EGR valve and gasket 2 nuts

Install
1. Clean gasket sealing areas and fit a new gasket
2. Fit the EGR valve into position and secure with 2 nuts and torque to specifications
Torque: 20-27Nm
3. Refit the previously disconnected electrical connector and engine cover 4 dome nuts

O_2 - Oxygen Sensor

Description

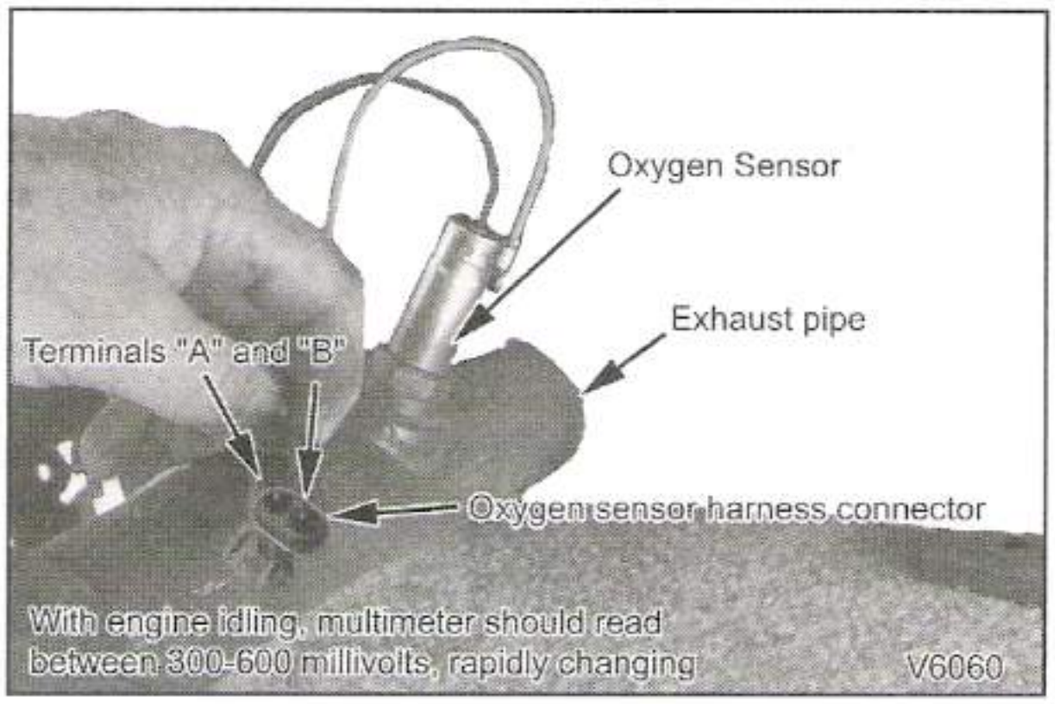
The O_2 or oxygen sensors are the key to maintaining correct fuel air ratio levels while the engine is running in closed loop mode. The V6 supercharged engine and the V8 engines use two heated O_2 sensors and the V6 non-supercharged engine uses two un-heated sensors, these heated sensors have an internal heating element which helps to get the sensor to operating temperature at a reduced amount of time. This enables fuel control to start quicker when closed loop mode is reached.
The sensors are located in the exhaust engine pipes, one for each cylinder bank.
Both types of sensor are fitted with a zirconia element that when heated to temperatures above 360^0 C will produce a voltage depending on the amount of O_2 surrounding the tip. Once the PCM detects a voltage change in the range between 300-600millivolts closed loop mode can be enabled allowing the air/fuel ratio to be controlled by the PCM.

Oxygen Sensor Operation Test

Before carrying out the following test ensure that the engine is at operating temperature.

Non-Supercharged V6 (without Heater)

1. Disconnect the electrical connector at the LH sensor
2. Connect a multimeter set to read millivolts across the sensor terminals A & B
3. With the engine idling check that the voltage reading on the multimeter rapidly changes between 300-600millivolts



4. Carry out the same test on the RH sensor.
** If not OK remove the sensor and check for contaminants, clean or replace as required*

V8 and Supercharged V6 Engines (with Heater)

1. Disconnect the electrical connector at the LH sensor
2. Connect a multimeter set to read millivolts across the sensor terminals A & C
3. With the engine idling check that the voltage reading on the multimeter rapidly changes between 300-600millivolts

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4. Carry out the same test on the RH sensor.
** If not OK remove the sensor and check for contaminants, clean or replace as required*

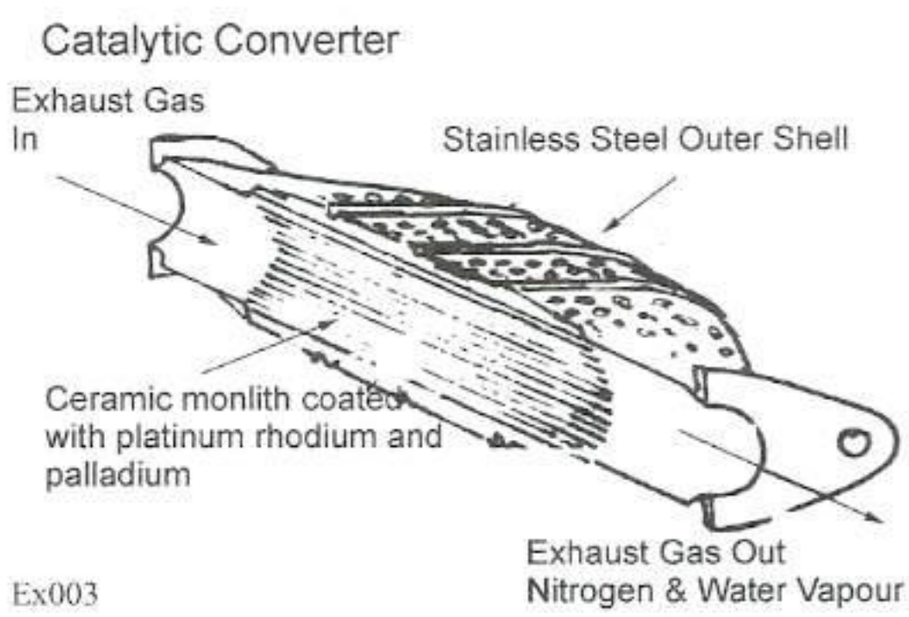
Sensor Heater Test (Supercharged V6)

1. Disconnect the electrical connector at the LH sensor
2. Connect a test light across terminals B and D, wiring harness side.
3. Turn on the ignition and check that the test light illuminates
** If test light does not illuminate refer to diagnostics chapter*
4. Use a multimeter set to measure resistance and measure the resistance across terminals B and D at the sensor
Resistance: 3.5-13.2 ohms
*If not within specified range replace the O_2 Sensor
5. Repeat above tests for the RH O_2 sensor

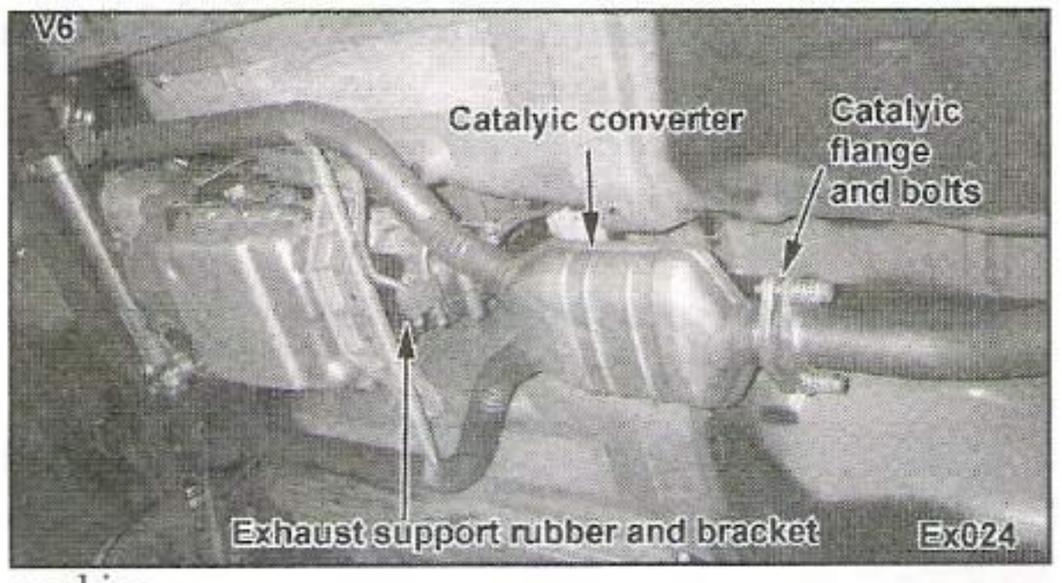
Catalytic Convertor

Description

The catalytic converter fitted to the Commodore is a three-way catalytic convertor and is similar in appearance to a muffler. This type of convertor is referred to as a three-way



convertor because it simultaneously converts CO-(Carbon Dioxide), HC-(Hydrocarbons) and NOx-(Oxides of Nitrogen) to harmless natural gasses. Inside the steel housing, the converter comprises of ceramic monolith which is surrounded by a mat, this prevents the monolith from contacting the inner casing. The surfaces of the ceramic monolith contain Rhodium, Palladium and Platinum which are exposed to exhaust gases. This creates the chemical reaction necessary to oxidize CO, HC and NOx to harmless CO_2 and O_2.
The catalytic converter normally operates at approximately 600°C. The catalytic material is very sensitive to the effects of a rich or lean fuel mixture which causes the temperature of the converter to rise rapidly to the temperature at which the ceramic material melts.
The catalytic converter is also sensitive to the use of leaded petrol. This causes deposits to form in the converter which restrict the exhaust flow and prevent the catalyst from



working.
WARNING: *Excessively rich or lean fuel mixture can cause sudden failure of the catalytic converter*
The use of unleaded petrol results in black tail pipe deposits rather than the grey colour most people are familiar with. The black colour does not therefore, indicate a state of poor engine tune.

Problem Diagnosis

Leaking exhaust gases!

1. Leaks at pipe joints
a) Torque U-bolt nuts and joint bolts.
2. Damaged or improperly installed converter gaskets.
a) Replace gasket as necessary.
3. Burned or rusted-out exhaust pipe or muffler
a) Replace component as necessary.

Exhaust noises!

1. Leaks at manifold or pipe connections
a) Torque clamps at leaking connections, or replace gasket.
2. Burned or blown-out pipe or muffler
a) Replace pipe/muffler assembly as necessary.
3. Exhaust manifold cracked or broken
a) Replace manifold.

Loss of engine power, hesitation, surging, bad fuel economy, stalling / hard starting!

1. Clogged catalytic converter (may result from serious engine malfunction or wrong fuel).
a) Replace catalytic converter.
2. Crushed pipe work
a) Replace pipe work.

Internal rattling in exhaust!

1. Dislodged turning tubes and/or baffles in muffler
a) Replace muffler.
2. Catalytic converter monolith has crumbled and pieces blown into muffler
a) Replace catalytic converter assembly and affected muffler

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V6 ENGINE MAINTENANCE & REBUILD

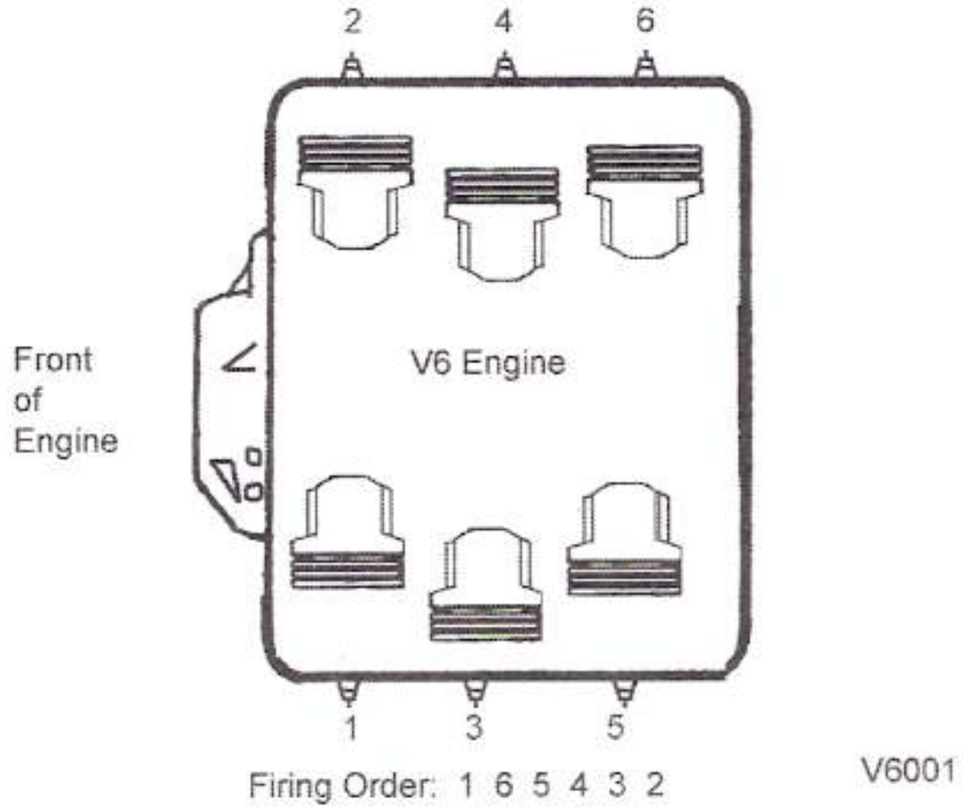
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GENERAL DESCRIPTION

The engine is a 90⁰ "V" 6 cylinder 3.8 litre (3.791cc) . Each camshaft is supported by 4 journals and operate two valves per cylinder, that is 6 valves per head.
The cylinder block made of cast iron, with standard bore of 96.52mm and a stroke of 86.36mm, with a 9.35:1 compression ratio.
The cylinder numbering is as illustrated, from the front of the engine, left side 1-3-5 and right side 2-4-6. Firing order is 1-6-5-4-3-2. Four main bearings support the crankshaft.



The engine has two aluminium heads with a fuel injector for each cylinder which is incorporated into the heads.

ENGINE SERIAL NUMBER

Engine No. Location: On left-hand side engine block casting, at the front below and behind the water pump outlet.

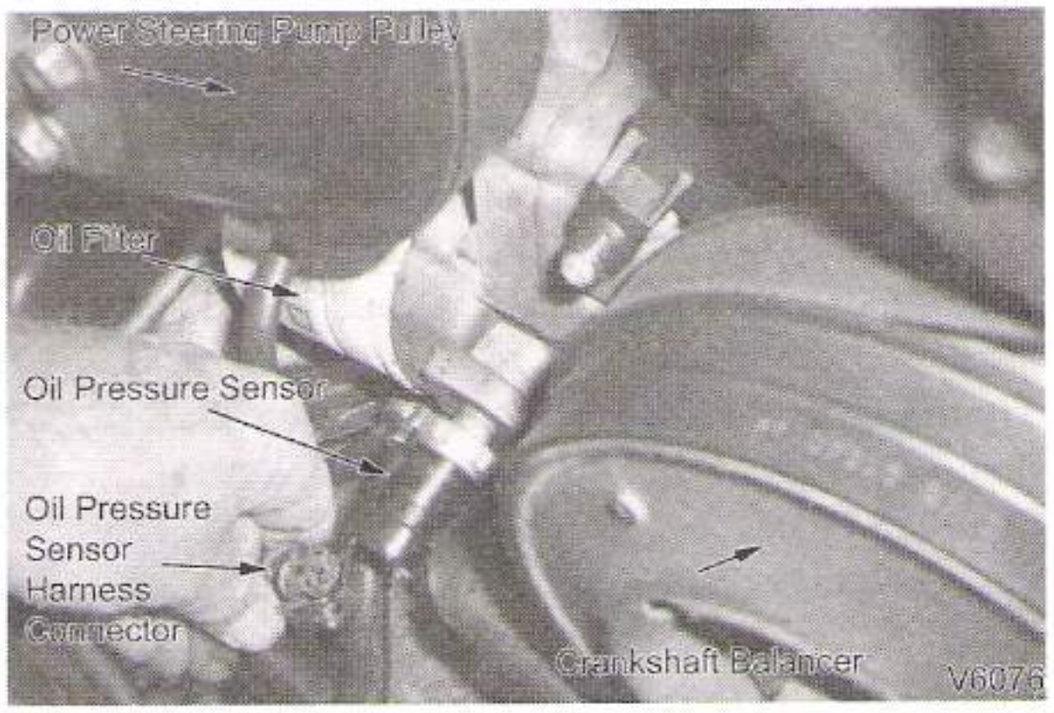
MAINTENANCE HINTS

1.(a) When any internal engine parts are serviced, care and cleanliness are important.
(b) An engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in thousandths of a millimetre.
(c) Friction areas should be coated liberally with engine oil during assembly to protect and lubricate the surfaces on initial operation.
(d) Proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure and is considered standard workshop practice.
2. When valve train components are removed for service, they should be kept in order and should be installed in the same locations (with the same mating surfaces) as when removed.
3. Battery terminals should be disconnected before any major work is begun. If not, damage to wiring harnesses or other electrical components could result.
4. When raising or supporting the engine for any reason, do not use a jack under the oil pan. There are small clearances between the oil pan and the suction pipe screen, so jacking may cause the oil pan to be bent against the screen, with damage being done to the oil suction pipe assembly.
5. If the air flow ducting is removed or disconnected, the intake opening should be covered to avoid accidental entrance of foreign material (which could follow the intake passage into a cylinder and cause extensive damage when the engine is started).

GENERAL MAINTENANCE

CHECKING ENGINE OIL PRESSURE

1. With engine at operating temperature and disconnect wiring harness connector from oil pressure sender unit.
2. Loosen and remove oil pressure sender unit from oil filter adaptor.
3. Install a suitable oil pressure gauge assembly into oil filter adaptor oil pressure sender unit hole.
4. Start engine and check oil pressure reading with engine running under no load.
Oil pressure@1850 rpm plus: 375kPa(min).
5.(a) After completing test, apply LOCTITE 242 sealant or equivalent to sender unit threads.
(b) Install and torque sender unit.
Oil Pressure Sender Unit
Torque: 12-14 Nm.
(c) Install wiring harness connector, start engine and check for oil leaks.



OIL FILTER

* The oil filter should be replaced every 10,000 Kilometres or 6 months which ever occurs first, or when the engine oil is contaminated in any way.

Replacement

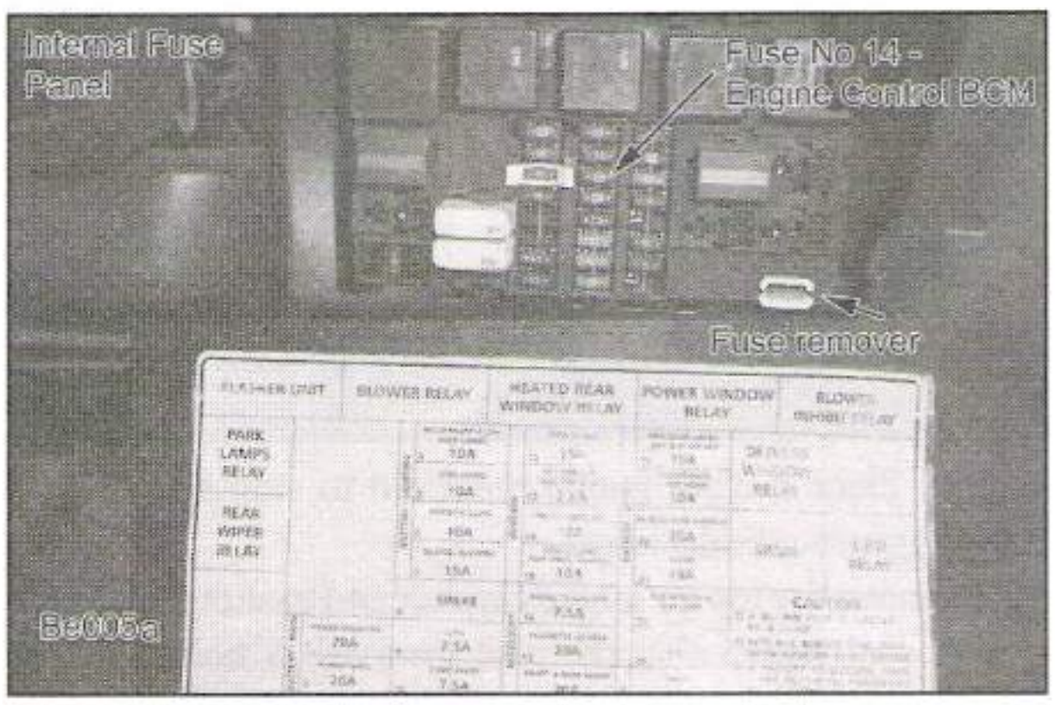
1. Unscrew oil filter with a suitable oil filter wrench, then remove and discard.
2. (a) Make sure seal is placed correctly in recess in new filter.

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(b) Pour some clean engine oil into filter until level is approximately 2 cms (1.0 in) below top of filter.
3. (a) Apply a thin film of engine oil over new filter seal.
(b) Screw filter into place until seal contacts mating surface of adaptor, then tighten through a further 2/3 of a turn.
4. (a) Clean any excess oil from filter and adaptor.
(b) Check oil level, then start engine and check for oil leaks.
(c) Repair as necessary.
* After running the engine, the oil level must be rechecked and oil added as necessary, to compensate for oil used to refill the oil filter.

COMPRESSION CHECK

1. Make sure of the following:
(a) Engine is at operating temperature;
(b) Battery is at (or near) full charge;
(c) Spark plugs are removed;
(d) Remove the fuse number F14 (Engine Cont. BCM), located drivers side lower dash. This fuse stops fuel and ignition functioning during engine cranking.



2. (a) Install suitable compression tester into spark plug hole, screw in type are more accurate. Depress accelerator pedal to fully open position and crank engine.
(b) Read compression gauge indication.
3. Check remaining cylinders.
Minimum Specified Comp: 689kPa.
Variation between cylinders:
not less than 70% of highest test
* If cylinder compression in 1 or more cylinders is low, pour a small amount of engine oil into the cylinders through the spark plug holes and test compression.

Compression Test Results

NORMAL Compression builds up quickly and evenly on each cylinder.
PISTON RINGS Compression low on 1st stroke, tending to build up on following strokes, but does not reach normal. Improves considerably with addition of oil.
VALVES Low on 1st stroke and does not tend to build up on following strokes. Do not improve much with addition of oil.
HEAD GASKET If cylinder compression in any 2 adjacent cylinders is low (and if adding oil does not help compression), cylinder head gasket has blown out.

DRIVE BELTS

Inspection

* Some belt squeal when the engine is started or stopped is possible and has no effect on durability of drive belt.

Visual Inspection

* Condition of the belt is best judged by twisting the belt so as to see the both surfaces.

Stages of Belt Wear:

1. NEW BELT: No cracks or chunks.
2. MODERATELY USED BELT: Few cracks; some wear on surfaces. Replacement not required.
3. SEVERELY USED BELT: Several cracks per inch. Should be replaced before chunking occurs.
4. FAILED BELT: Separation of belt material from backing (chunking). Replace belt immediately.

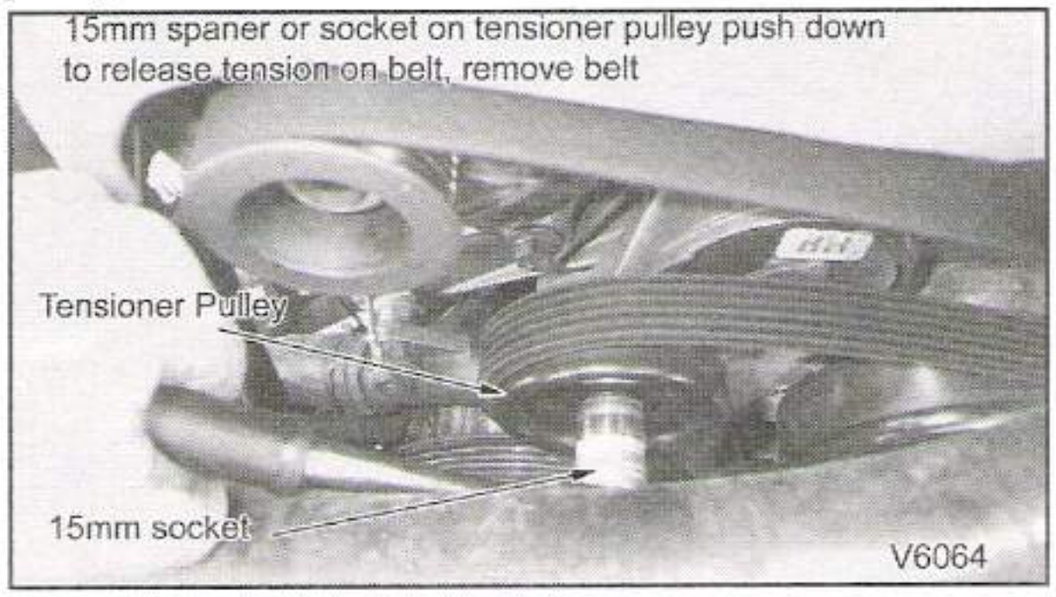
Replacement

Use a 15mm ring spanner togrip the belt tensioner pulley, turn the spanner anti-clockwise with force to move tensioner pulley. Remove belt or install belt, release pressure on ring spanner to take tension up on belt.

DRIVE BELT TENSIONER

Remove

1. Remove the engine top cover 4 nuts.
2. Use a 15mm ring spanner togrip the belt tensioner pulley, turn the spanner anti-clockwise with force to move tensioner pulley, remove belt.



3. Disconnect the earth lead from the battery.
4. Remove the alternator.
5. Disconnect the heater hoses from the heater inlet and outlet at the belt tensioner.
6. Remove the heater inlet casting, 2 nuts, pull away from front of engine. Discard "O" ring.
7. Remove the belt tensioner 2 studs.

Install

1. Install belt tensioner and gasket, 2 studs.
Drive Belt Tensioner Studs: 40-60Nm
2. Install the heater inlet casting, 2 nuts, fit a new "O" ring, coat with petroleum jelly.
Heater Inlet Casting Nuts: 18-25Nm

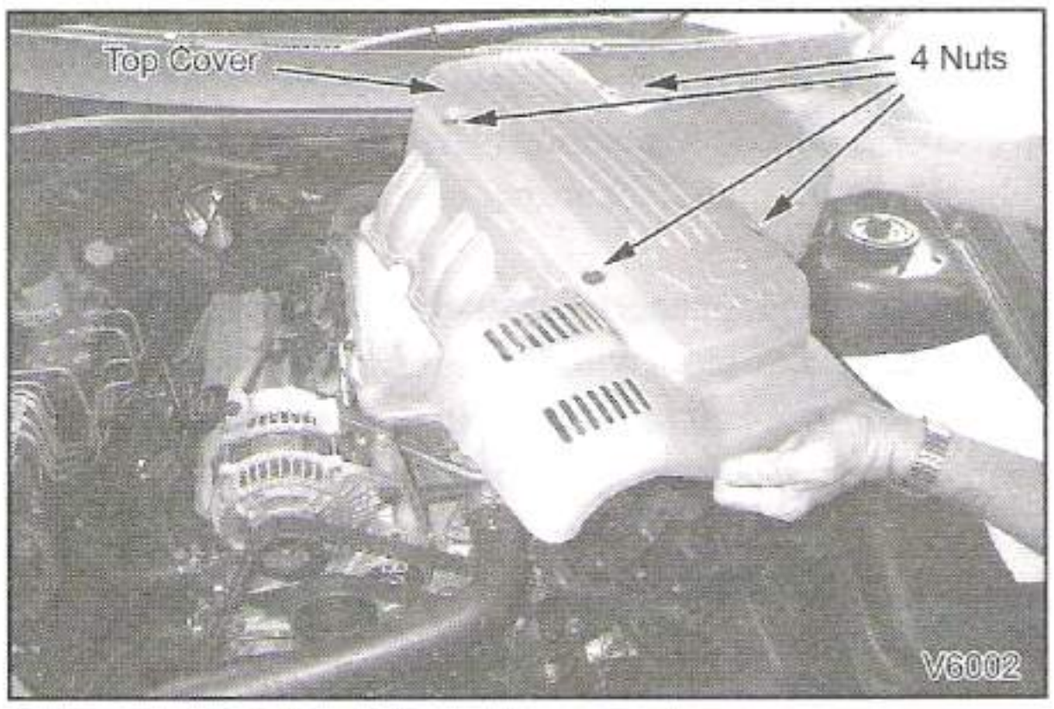
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3. Connect the heater hoses to the heater inlet and outlet at the belt tensioner, refill the cooling system.
4. Replace the alternator.
5. Connect the earth lead from the battery.
6. Use a 15mm ring spanner togrip the belt tensioner pulley, turn the spanner anti-clockwise with force to move tensioner pulley. Install belt, release pressure on ring spanner to take tension up on belt.
7. Replace the engine top cover 4 nuts.

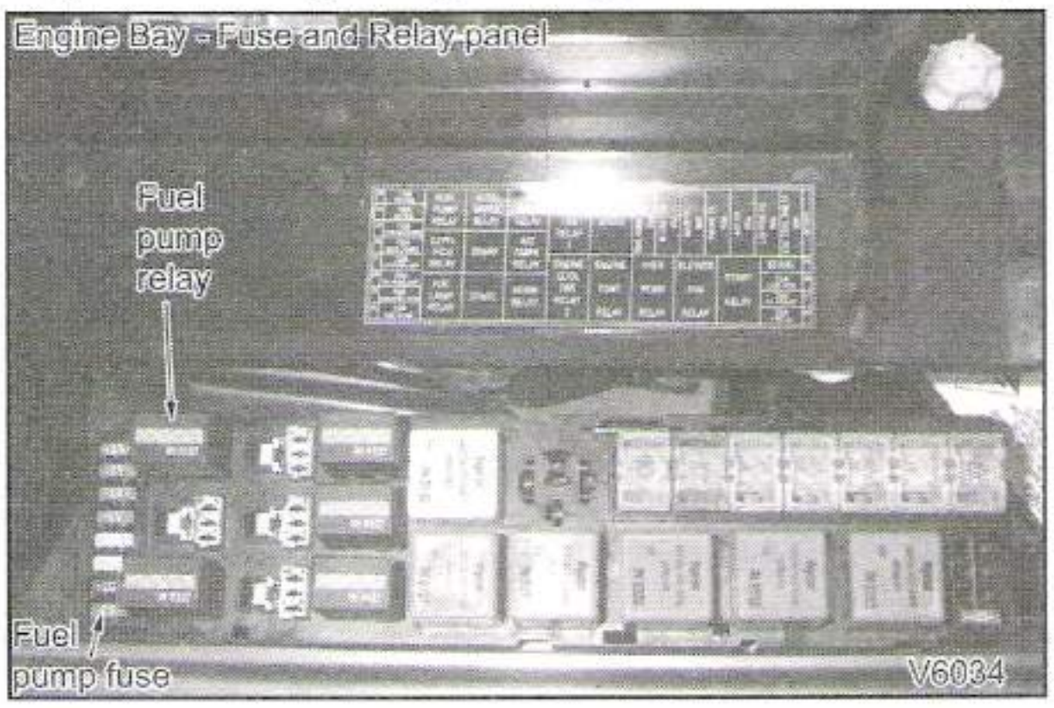
INTAKE MANIFOLD and FUEL RAIL ASSEMBLIES

Remove

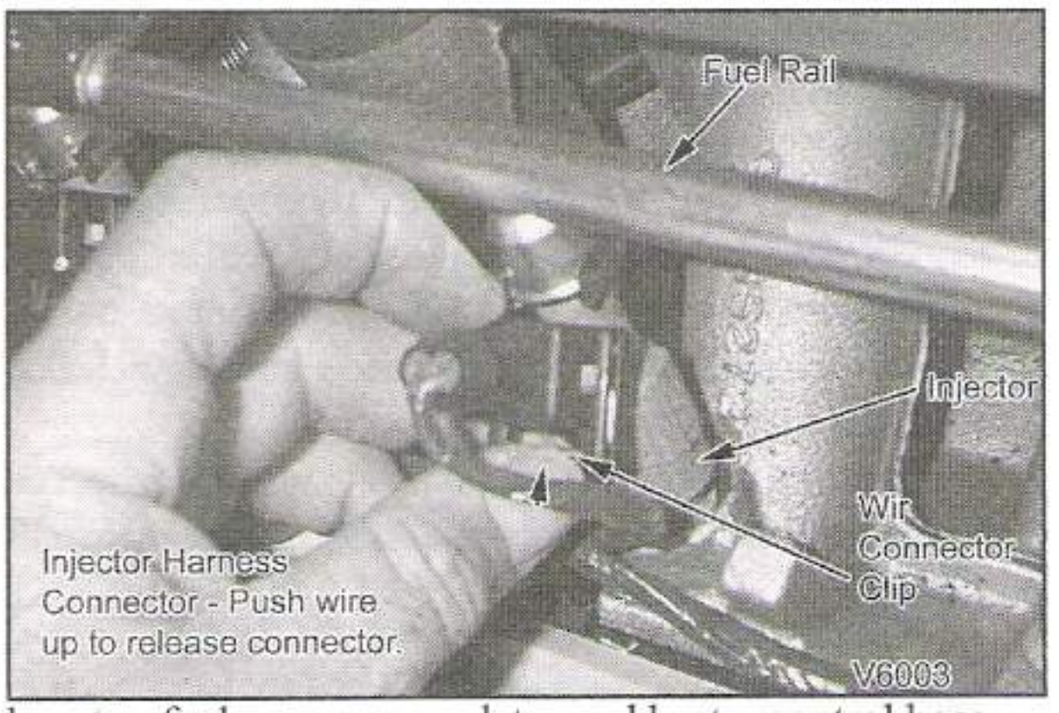
1. Remove the engine top cover 4 nuts.



2. Depresserize the fuel injection system, (remove fuel pump relay located in engine bay, start engine allow to idle to stall).



3. Disconnect the earth lead from the battery.
4. Drain coolant from engine at radiator lower hose.
5. Remove air cleaner to intake chamber tube with MAF sensor, disconnect MAF wiring connector.
6. Remove alternator and wiring connectors, label connectors to help assembly.
7. Remove front drive belt tensioner as previously described.
8. Disconnect the fuel and return pipes at the quick release connector at the rear of engine on firewall.
9. Detach throttle cable at the throttle body, 3 nuts
10. Disconnect wiring connectors, at TPS wiring plug, IAC wiring connector, Injectors, 3 vacuum hoses for brake



booster, fuel pressure regulator and heater control hose.
11. Remove the top air intake chamber cover and gasket, 8 bolts.

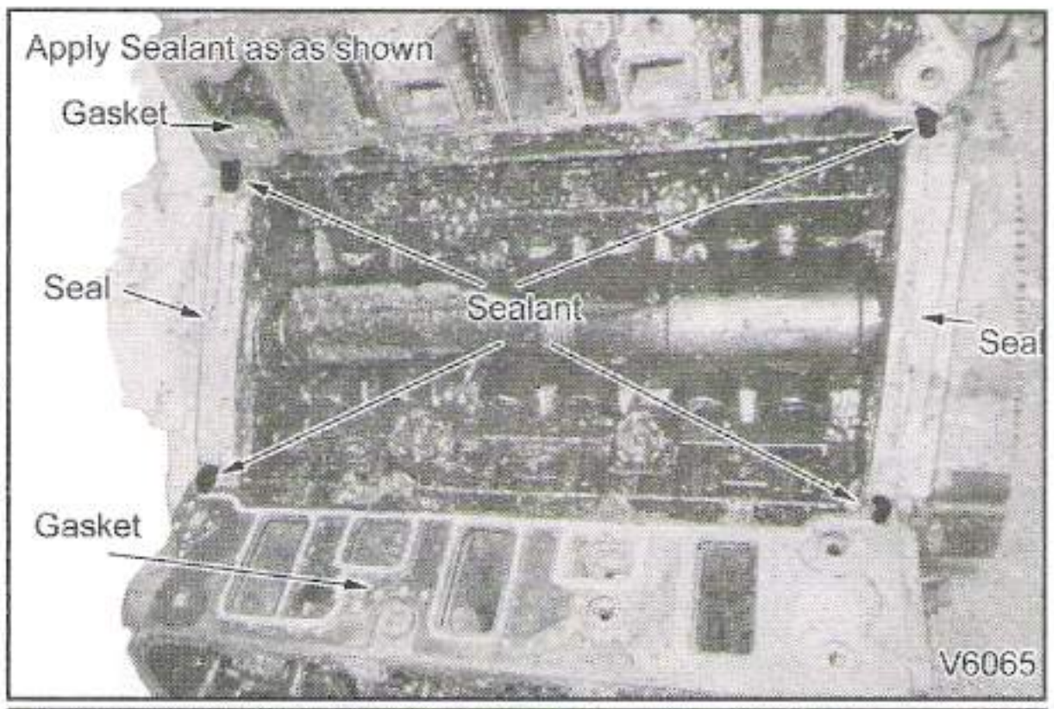


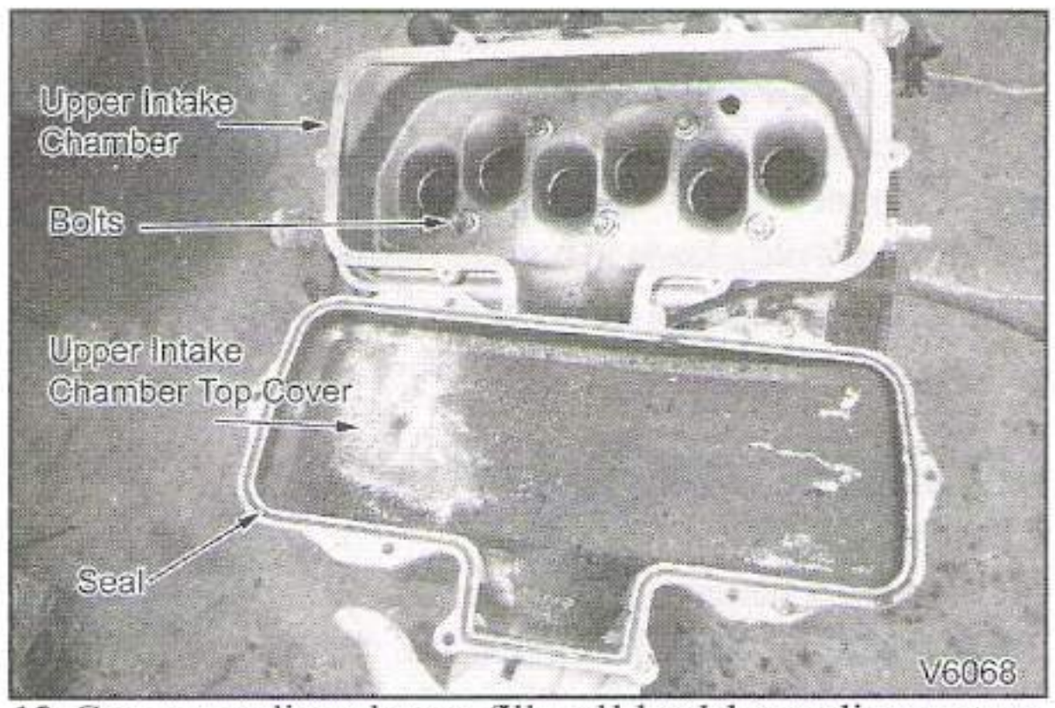
Hint: Place a cloth inside manifold to stop any objects dropping into cylinder inlets.
12. Remove the top air intake camber and gasket seal (leave gasket seal inserted in the seal groove), 5 bolts (do not completely remove 5 bolts), and fuel rail and injectors.
13. If necessary dismantle throttle body from top intake manifold and remove fuel pressure regulator hose.
14. Separate the fuel rails and injectors.
15. Remove the lower intake manifold, gaskets and seals, 12 bolts.

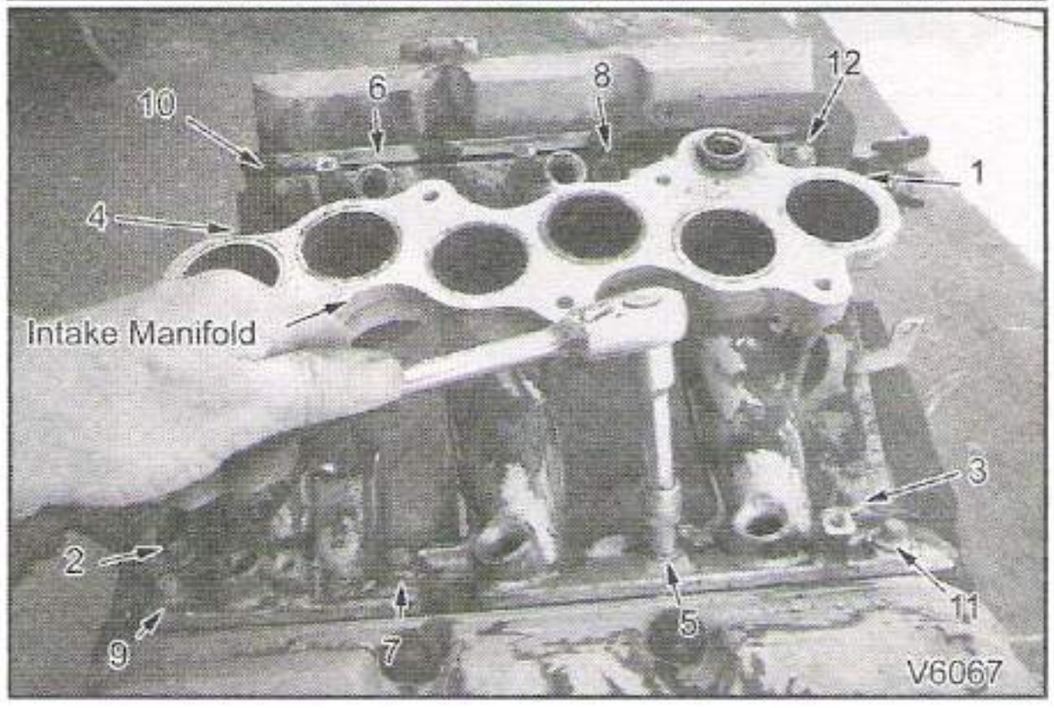
Install

1. Clean mating surfaces of the cylinder heads and the manifold.
2. Use a straight edge to check the surface of the intake manifold and intake chambers matching surfaces, if over maximum warpage specification, machine the surface or replace the manifolds.
Intake Manifold and Intake Chambers Maximum Warpage: 0.10mm (0.0039in)
3. The P.C.V. valve is located in the intake manifold, remove and check it is not clogged, wash and reinstall.
4. Install new intake manifold gaskets and seals, apply RTV 732 sealant to the 4 ends of the 2 seals where they contact the intake manifold gaskets.
5. Install the intake manifold. Using Loctite 242 to coat the threads of all 12 bolts, install bolts tighten to specification, in

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sequence shown.

Intake Manifold Attaching Bolts : 12-18Nm

6. Install the fuel rail and injectors and top intake manifold.

(a) Install a new "O" ring into each injector position of the manifold.

(b) Install the spacers onto the bolts which support the fuel rail.

(c) If the injectors have been removed from the fuel rail. Install the injectors into the fuel rail, make sure that the injector turn freely in the fuel rail.

(d) Install the top intake manifold chamber, 5 bolts.

(e) Tighten the fuel rail and top intake manifold bolt to specification.

Fuel Rail and Top Intake Manifold bolts: 10-14Nm

7. Install new "O" rings and the air intake chamber, tighten to specification.

Air Intake Chamber Bolts: 10-14Nm

8. Replace the top air intake chamber cover and gasket.

9. Install fuel and fuel return lines at the quick release connections, on the firewall.

10. Install the engine wiring loom and connectors, attach the 6 fuel injector wiring connectors, water temperature sensor at the front of the engine, water temperature gauge sender unit, TPS and IAC connectors to the throttle body. 3 vacuum hoses for brake booster, fuel pressure regulator and heater control hose.

Connect the hoses to the throttle body if removes, crankcase vent hose and emission control hose, if removed.

11. Connect the accelerator cable and bracket, 3 nuts.

12. Install air duct tube between air cleaner and throttle body.

13. Connect radiator hoses, fill and bleed the cooling system.

14. Replace air cleaner to intake chamber tube with MAF sensor, connect MAF wiring connector.

15. Replace alternator and wiring connections.

16. Replace drive belt tensioner.

17. Replace fuse14, reconnect earth to battery.

18. Install top engine cover, 4 nuts.

EXHAUST MANIFOLDS

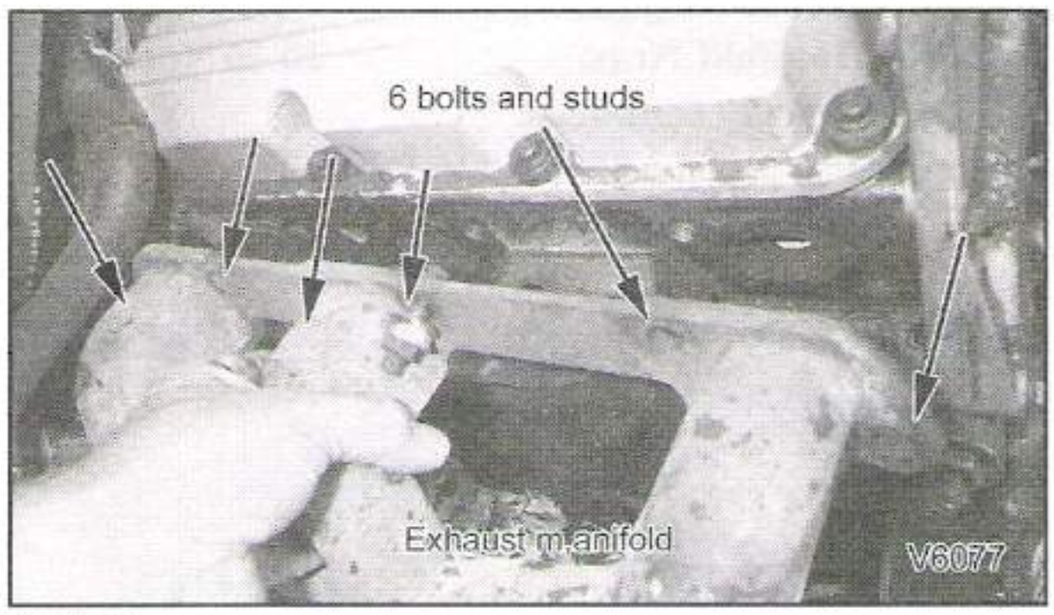
Remove

1. Remove the bolts attaching the exhaust pipe to the exhaust manifolds.

2. Unplug spark plug leads and position them out of the way.

3. [Left side manifold] Remove the air cleaner to intake chamber tube with MAF sensor, disconnect MAF wiring connector.

4. Remove the lock washers, 6 nuts, studs and bolts each side as required attaching each manifold to the cylinder head, remove manifolds. (left side the oil dip stick and bracket is attached to the manifold



Install

1. Install gasket to cylinder heads, to align the gasket, install four guide studs in the cylinder head. Place the gasket on the studs. Place the manifold on the studs. Install the bolts on the lower holes, remove the guide studs, install the upper bolts Gradually tighten the bolts to specification. Install lock washers. Apply Kopr-Kote or similar anti-seize to threads of bolt and studs.

Exhaust Manifold Studs, 1 Bolt: 25-35Nm

Exhaust Manifold Nuts: 20-27Nm

2. Tighten the manifold flange to exhaust pipe nuts to specification. Apply Kopr-Kote or similar anti-seize to threads

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of studs.

Exhaust Pipe Flange to Exhaust Manifold: 18-35Nm

3. Replace air cleaner to intake chamber tube with MAF sensor, connect MAF wiring connector.

4. Plug spark plug leads in correct position.

Hint: Coil pack has the cylinder number stamped on it for the spark plug lead.

ROCKER COVERS AND/OR SEALS

Remove

1. Disconnect battery negative terminal.

2. [Left side manifold] Remove the air cleaner to intake chamber tube with MAF sensor, disconnect MAF wiring connector. Remove nuts attaching the dip stick tube, remove dip stick tube

3. Remove spark plug leads.

4. (a) Remove rocker cover to cylinder head bolts and remove rocker cover from cylinder head.

(b) If replacing rocker cover seal, remove seal from recess in rocker cover to cylinder head.

Install

1. (a) Install new gasket seal in rocker cover recess.

(b) Install rocker cover and gasket assembly.

* Make sure gasket is correctly installed in rocker cover.

2. Install rocker cover to cylinder head and torque bolts to specification.

Rocker Cover Bolts Torque: 7-11Nm

3. Plug spark plug leads in correct position.

Hint: Coil pack has the cylinder number stamped on it for the spark plug lead.

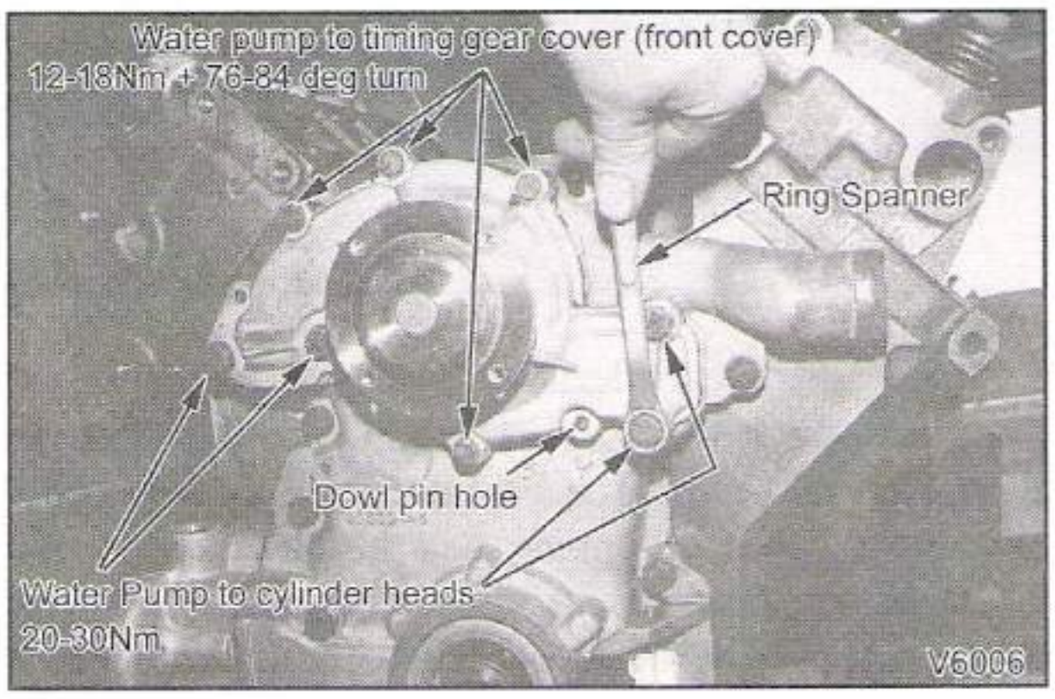
4. Replace air cleaner to intake chamber tube with MAF sensor, connect MAF wiring connector. Replace dipstick tube and nuts attaching the dip stick tube.

Exhaust Manifold Nuts: 20-27Nm

5. Connect battery earth lead.

6. Start engine and check for oil leaks.

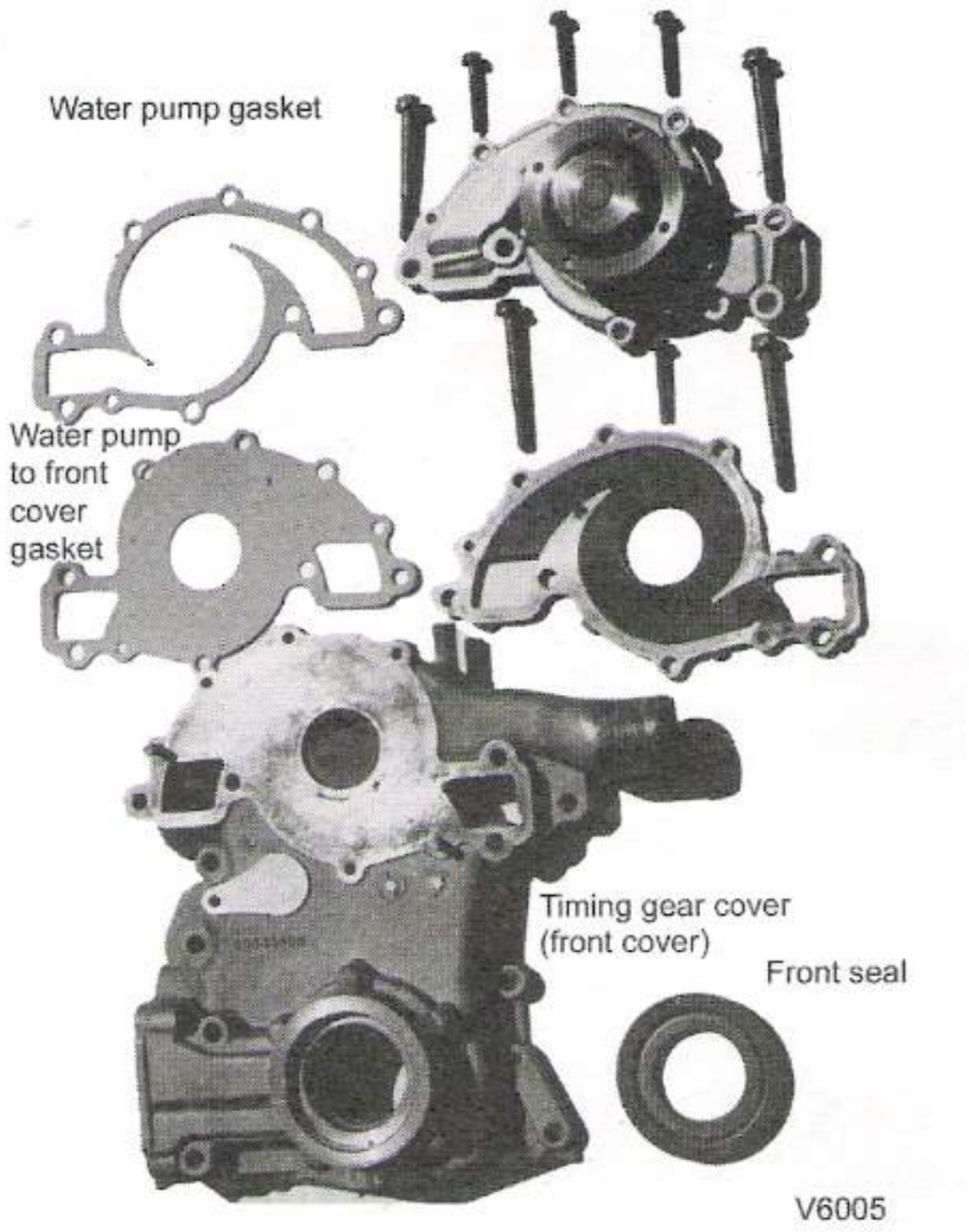
WATER PUMP



Remove

1. Disconnect battery earth lead.

2. Drain coolant from engine at radiator lower hose and remove top radiator hose, remove drive belt.



3. Remove alternator and drive belt tensioner.

4. Remove the water pump pulley, 4 bolts.

5. Remove water pump and gasket.

Install

1. Install water pump and new gasket with sealant, tighten bolts to specification.

Water Pump to Timing Gear Cover Bolts: 12-18Nm plus 76-84deg turn

Water Pump to Cylinder Head Bolts: 20-30 Nm

2. Install water pump pulley, 4 bolts.

3. Install drive belt tensioner, alternator, radiator hoses.

4. Refill and bleed cooling system.

5. Connect earth to battery.

TIMING GEAR COVER, OIL PUMP

Remove fan and front drive belt assembly if not removed.

Remove

1. Disconnect battery earth lead.

2. Drain coolant from engine at radiator lower hose and remove top radiator hose, drive belt assembly.

3. Remove the crankshaft balancer pulley bolt, use a pulley remover to remove the pulley.

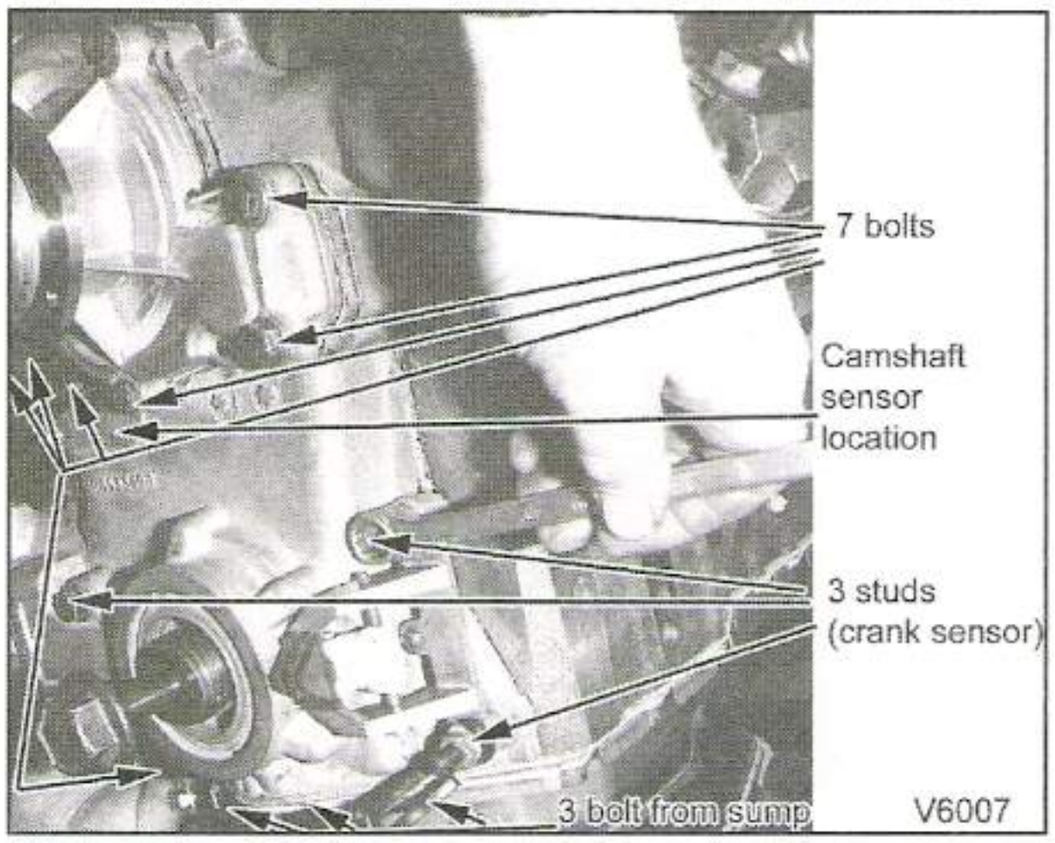
4. Remove the water pump pulley, 4 bolts.

5. Unplug spark plug leads from coil pack, remove coil pack and idler pulley, 3 bolts.

6. Remove wiring loom from crankshaft sensor, oil pressure sensor and camshaft sensor.

7. Remove the crankshaft sensor, 3 bolts, take care, lever sensor off with a screw driver if necessary.

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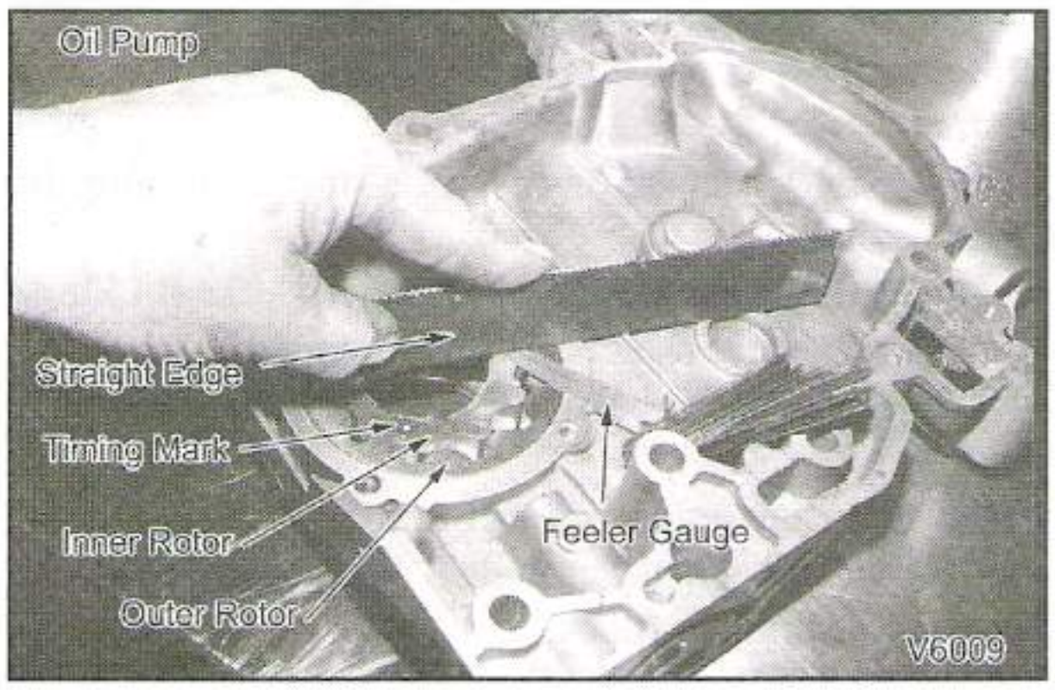
8. Remove power steering pump pulley and bolts.
9. Disconnect battery earth loom.
10. Disconnect the auto trans cooler pipes to the radiator.
11. Remove the beaming brace from the front of the sump area.
12. a) Remove the 3 bolts at the front of the sump to timing gear cover.
b) Loosen sump bolts to engine block.
13. Remove the timing gear cover and gasket, 7 bolts and 3 studs.
Note: The water pump and camshaft sensor are removed with the timing gear cover and will only need separating if necessary.

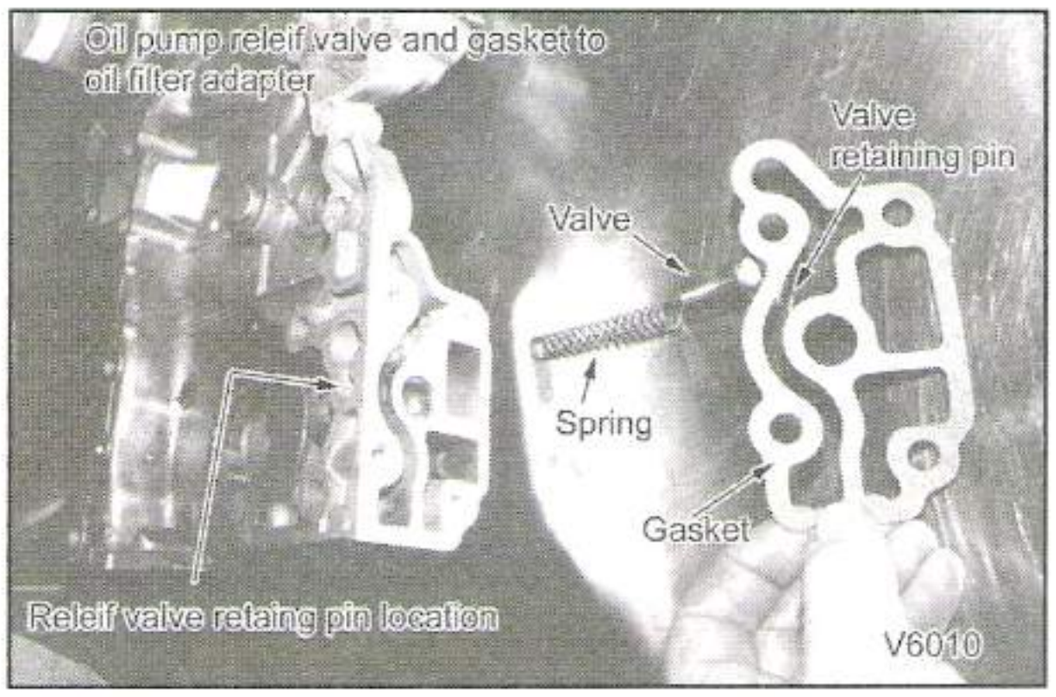
Oil Pump

14. Remove oil filter.
15. Remove the oil filter adapter and gasket, 4 bolts. The oil pressure regulator spring and valve will also be released.
16. Remove the oil pump rear cover from inside the timing gear cover, 5 screws (Torx T30).
17. Remove front oil seal with a seal remover tool or screw driver.

Clean and Inspect

Clean any sludge from inside oil pump and around oil pump rotors. Inspect the inside of the pump housing and the outer gear and inner rotor for damage or excessive wear.
Install the outer gear and the inner rotor shaft assembly with





the timing marks on the gear and rotor towards the pump cover. Inspect clearances of outer gear and rotor gear, replace if not within specification.

Inner gear tip to outer rotor tip specified clearance:
Max: 0.22mm

Outer rotor to pump housing clearance: 0.05-0.13mm

The inner rotor and outer gear are serviced as an assembly. One part should not be replaced without replacing the other. Check the clearance between the oil pump cover and gear / rotor is within specification with a straight edge.

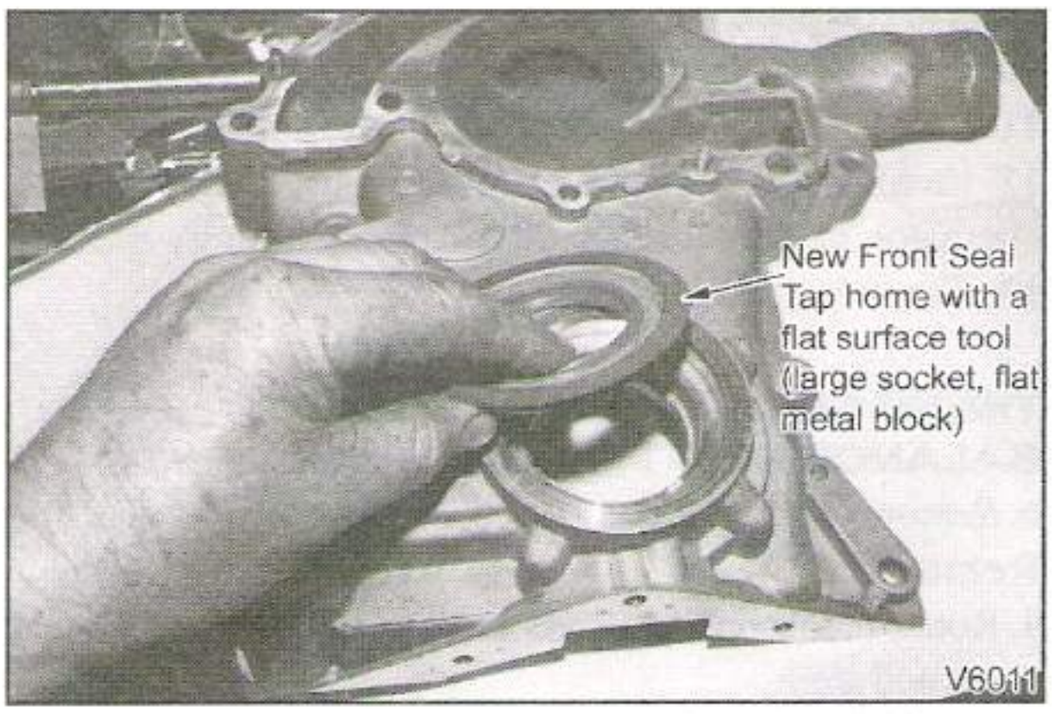
Oil Pump Cover Clearance: 0.025-0.089mm

Check the clearance between the oil pressure relief valve and bore is within specification.

Oil Pressure Releif Valve Clearance:0.038-0.076mm

Install

1. Install a new front seal into the timing gear cover, use a seal insertion tool or a large socket that is the correct size.



2. Install the oil pump gear and rotor into the timing gear cover, install cover and 5 screws, (Torx T30).

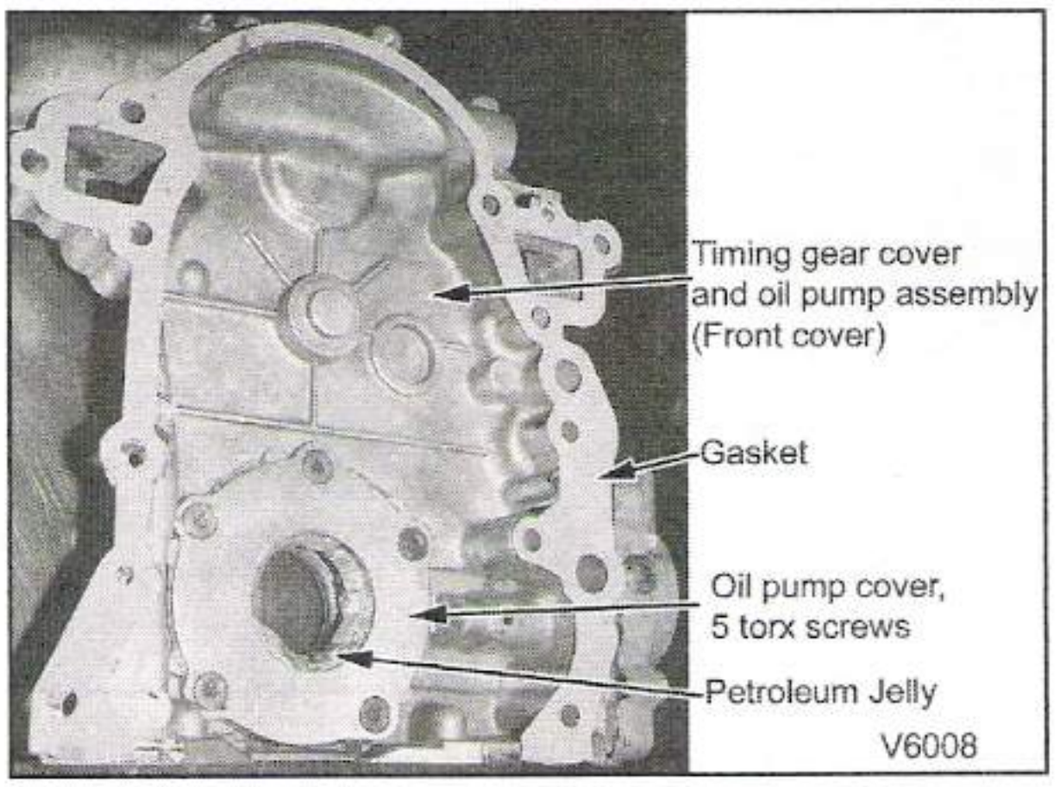
Oil Pump Cover Screws: 8-14Nm

Note: Inner gear chamfered edge is facing towards the engine block.
#Tip: Fill in around oil pump rotor and gear with petroleum jelly.

3. Install oil pressure regulator spring and valve, oil filter adapter and new gasket with sealant, 4 bolts. Use Loctite 242 on the thread of the long bolt.

Oil Filter Adapter Bolts: 23-35Nm

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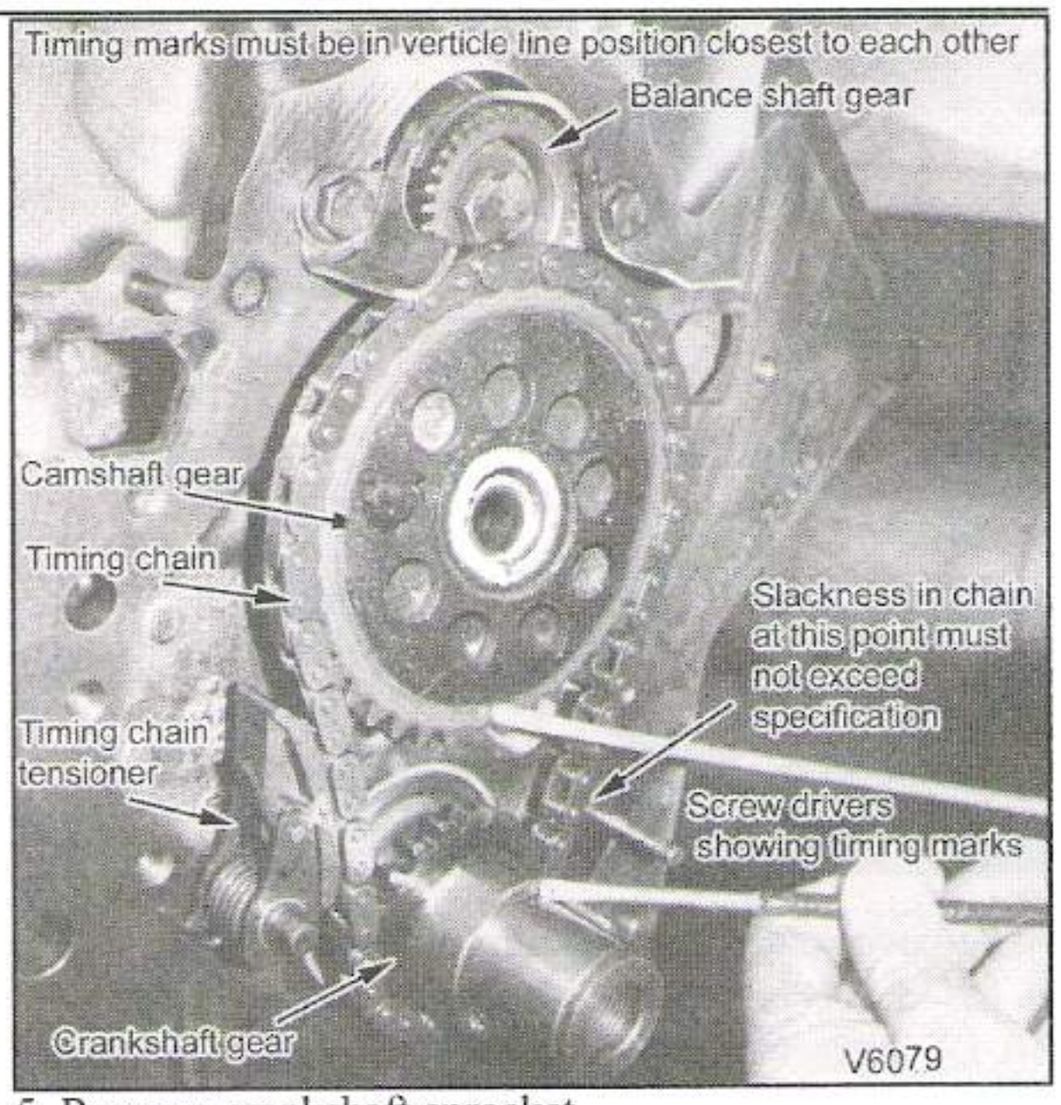
4. Install water pump and camshaft sensor and new gaskets with sealant to timing gear cover if removed.
Install the timing gear cover, 7 bolts, 3 studs. apply Loctite 242 to threads of timing cover bolts to engine block.
Timing Gear Cover Bolts: 20-30Nm
5. Install the crankshaft balancer pulley.
Crank Shaft Balancer Pulley Bolt: 270-325Nm
6. Install crankshaft sensor to timing gear cover, make sure the puller and sensor do not contact.
Crank Shaft Sensor Bolts: 20-30Nm
7. Install the 5 bolts at the front of the sump to the timing gear cover, tighten the remaining sump bolts to specification.
Sump Bolts Torque: 12-16Nm
8. Replace wiring looms and connect connectors and battery earth loom.
9. Replace coil pack and idler pulley, 3 bolts, plug spark plug leads to coil pack.
10. Replace power steering pump pulley and bolts.
11. Replace auto trns pipes to radiator, if applicable.
12. Install water pump pulley, 4 bolts, drive belt tensioner, alternator, radiator hoses refill and bleed cooling system.
13. Connect earth to battery.

TIMING GEAR, CHAIN, CAMSHAFT, BALANCE SHAFT and BEARINGS

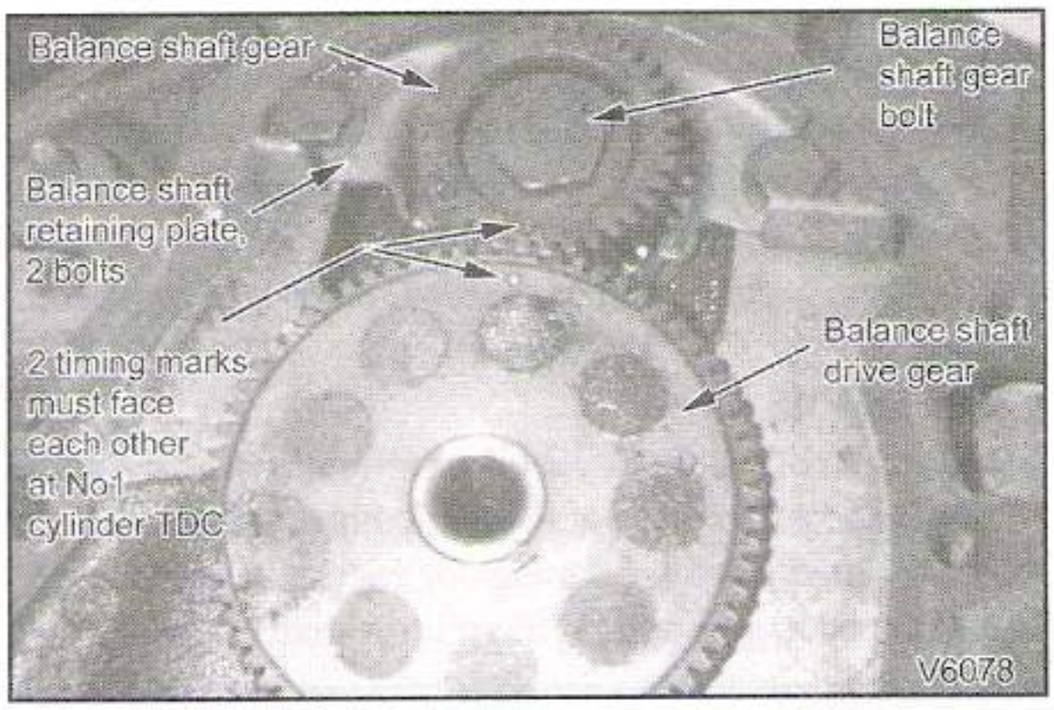
Remove Timing Gear Cover as described above.

Remove

1. Rotate crankshaft to T.D.C. No1, the timing marks on the gears will align.
2. Check timing chain slack for specification, as shown.
Timing Chain Maximum Slackness: 25.4mm
3. Remove camshaft sprocket 3 bolts, if necessary install crankshaft balancer and hold with a tool to stop crankshaft rotating, if sump off jam crankshaft with a block of wood.
4. Remove camshaft sprocket and chain, if crankshaft has rotated during removal make sure engine is at T.D.C. No1 with timing marks as shown before removing sprocket and chain, this helps in assembly.
Tip: It may be easier to remove camshaft sprocket, timing chain and crankshaft sprocket at same time.



5. Remove crankshaft sprocket.
6. Remove chain dampener.
7. Remove balance shaft if required.
a) Remove balance shaft drive gear and key from camshaft, take note of timing marks on balance shaft drive gear and driven gear.
b) Remove the balance shaft retaining plate, 2 bolts.
c) Lever balance shaft out with 2 screws drivers or levers from behind drive gear, if the balance shaft will not release. Remove driven gear and screw in a slide hammer to front of balance shaft.

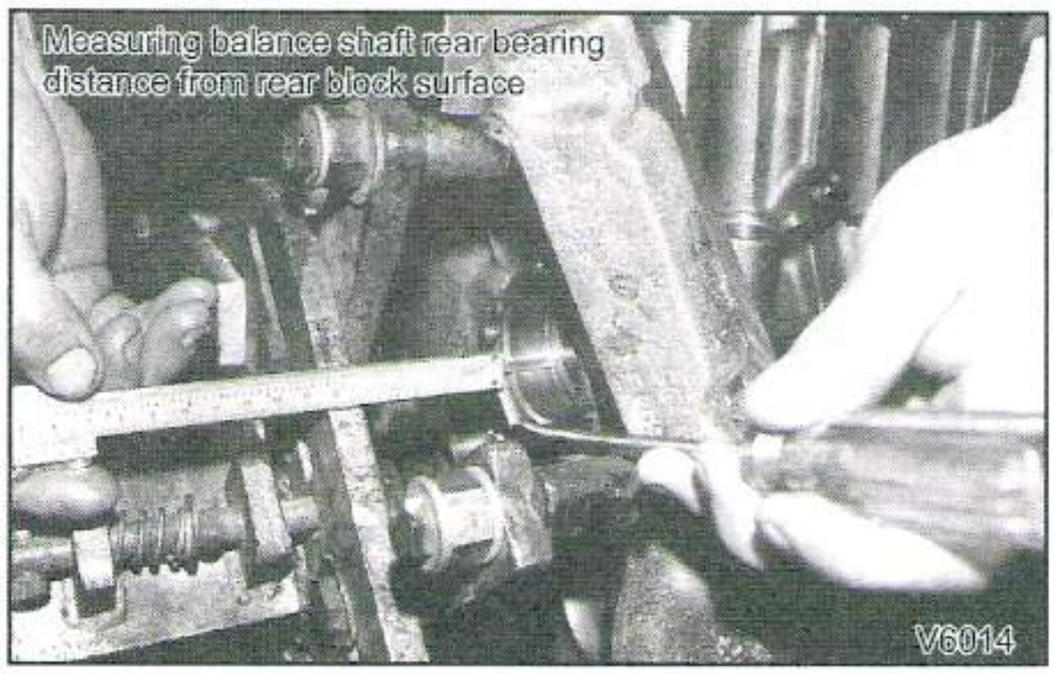


d) Remove balance shaft gear bolt and gear from balance shaft.
e) Check oil clearance of balance shaft rear bearing for specification.
Balance Shaft Rear Bearing Clearance: 0.025-0.130mm
8. Replace balance shaft bearings if required.
a) If balance shaft rear bearing needs to be replaced, remove rear oil seal retainer.
b) Use a special tool (camshaft bearing removal/installing tool) insert through balance shaft bearings and pull the bearing free from the block.
c) Clean bearing bore, coat new bearing in new engine oil, use

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the same tool fro removing the bearing to install the new bearings, pull into place.

Note: Rear balance shaft bearing is to be 0.99 to 1.49mm in from the rear oil seal retainer face of the cylinder block.



d) Only if required press front bearing from balance shaft, press a new bearing in to place.

9. Camshaft

Check Camshaft Lift.

a) Camshaft in engine.

With valve rocker gear removed, setup a dial gauge on top of the pushrods. Rotate the camshaft to measure camshaft for specified lift, see specification below.

b) Camshaft removed from engine, see clean and inspect.

Remove

Camshaft sprocket has been removed as above.

a). Remove valve pushrods and lifters.

b) Remove the sprocket key from the front of the camshaft if loose.

c) Remove the camshaft thrust plate, 2 Torx T30 screws.

d) Gently pull the camshaft from the engine, do not damage lobes and bearings while removing.

Clean and Inspect Camshaft.

1. Clean camshaft thoroughly using a suitable cleaning solution. Wash with clean water or steam.

2. Check camshaft bearing journals for overheating, damage or wear, lobes for damage or wear, with excessive wear the hardened surface will be damaged or removed (never reuse a camshaft with hardened lobe surface damaged).

3. Inspect camshaft journal diameter with micrometer.

Replace camshaft, if journals are not as specified.

Camshaft Journal Diameter: 46.858 - 46.893 mm

4. Camshaft in "V" block, inspect camshaft lobes for specified height.

Replace camshaft, if journals are not as specified.

Camshaft Specified Lift;

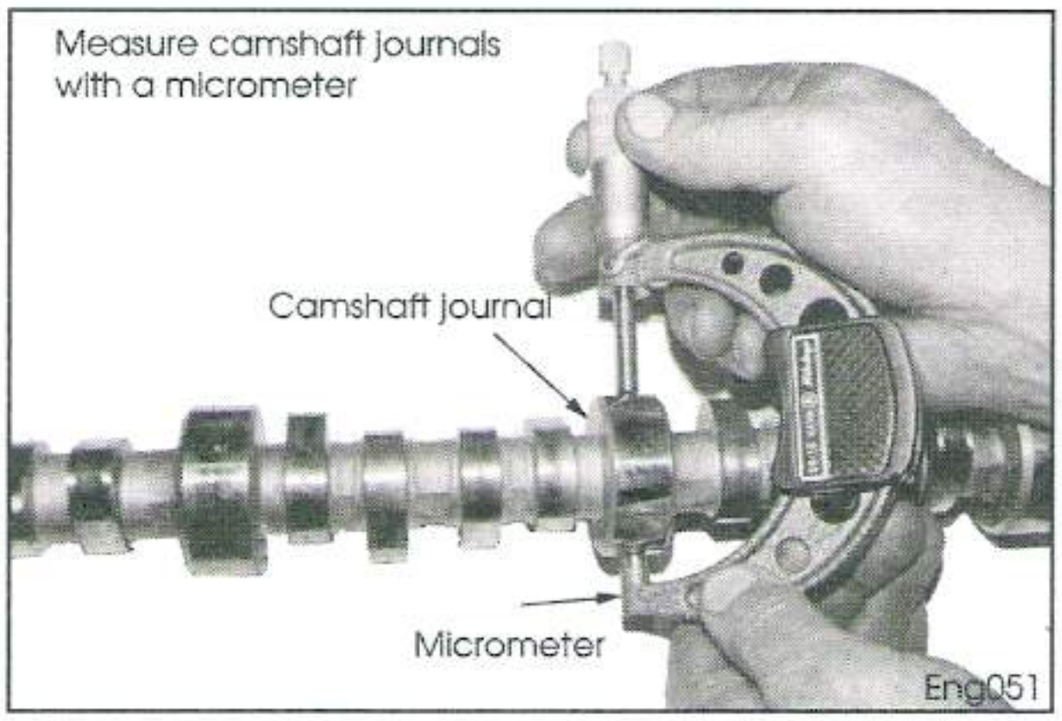
Inlet Lobe: 6.56 mm

Outlet Lobe: 6.48mm

(b) Position camshaft on "V' blocks and check runout of centre camshaft journal.

Camshaft Centre Max. Runout: 0.06mm.

Installation

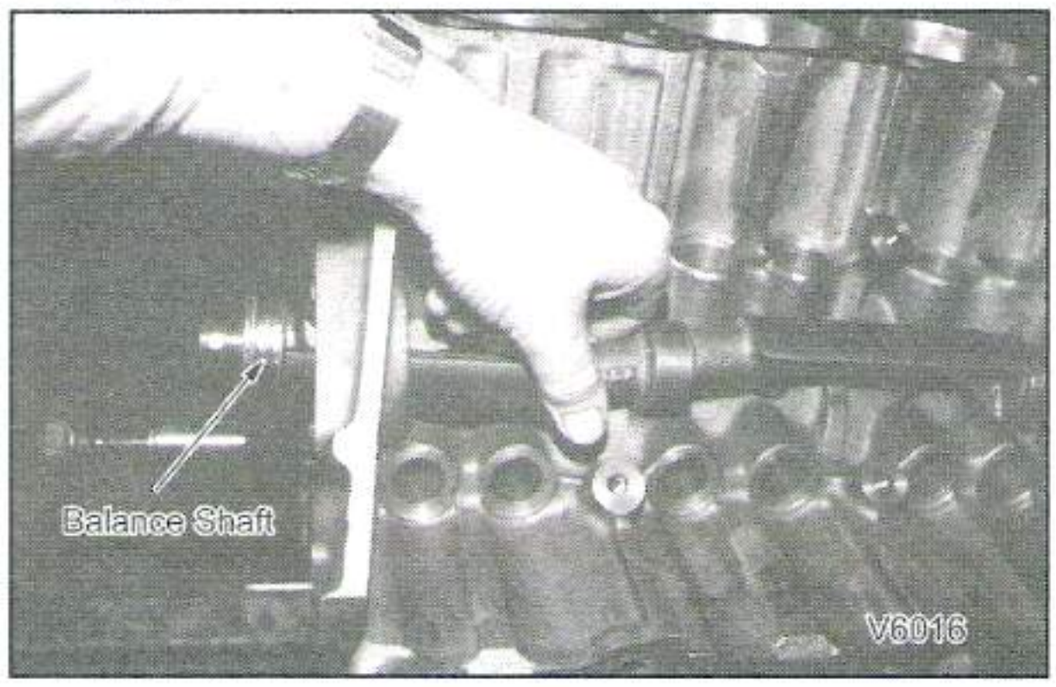


The crankshaft must be at TDC compression No1 cylinder.

1. a) Install balance shaft driven gear to balance shaft, if necessary, align the slot in the back of gear with pin of balance shaft, apply loctite 242 to the thread of the bolt, tight to specification.

Balance Shaft Gear bolt:18-26Nm plus 67^0-73^0 turn

b) Install balance shaft, molybdenum base grease to balance bearings journal surface.



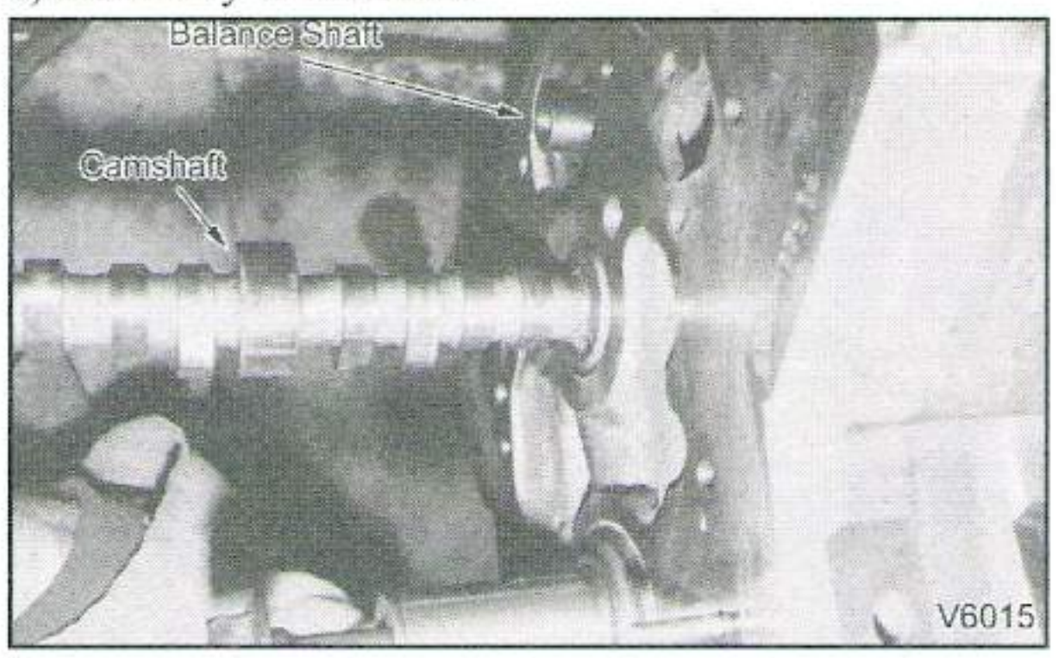
2. Camshaft

a) Gently slide the camshaft into the cylinder block, do not damage lobes and bearings while installing.

b) Apply (Lubrizol 6612) molybdenum base grease to camshaft bearings and lobes, install the camshaft thrust plate, 2 Torx T30 screws, apply loctite 242 to threads of screws.

Thrust Plate Torx T30 Screws: 12-19Nm.

c) Install key to camshaft.



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d) Align balance shaft drive gear with key in camshaft, install gear and bolt. Timing marks must be aligned, as shown on 2 pages back.

3. Temporarily install crankshaft sprocket, align onto key, the sprocket timing mark should be in the vertical position.

4. Install timing chain dampner, spring locates in cylinder block hole. Tighten dampner bolt.

Timing Chain Dampner Bolt: 16-28Nm

5. Install camshaft sprocket to camshaft, temporarily installed, rotate the camshaft, the timing marks of the crankshaft sprocket and camshaft sprocket must be towards each other. Ensure the camshaft sensor magnet is installed to the camshaft sprocket.

Check timing alignment marks shown 2 pages back.

6. Remove camshaft sprocket.

7. Install the timing chain around the camshaft sprocket, slide the camshaft sprocket and chain into place while installing chain the crankshaft sprocket as the timing chain dampner is pulled back to allow the chain into place. As previously the camshaft sprocket must be aligned with the key in the camshaft.

Install camshaft sprocket and bolt, apply loctite 242 to the thread of the bolt, tight to specification.

Camshaft Sprocket Bolt: 90-110Nm plus 86^0-94^0 turn

Timing marks must be aligned.

8. Apply clean engine oil to timing chain and all gears and sprockets.

9. Install hydraulic lifters and pushrods, apply (Lubrizol 6612) molybdenum base grease to contact surfaces of lifters and pushrods.

Install timing chain cover, head rocker gear as described.

VALVE LIFTERS

The cylinder head rocker gear, intake manifold and pushrods must be removed to allow valve lifters to be removed and installed.

Remove

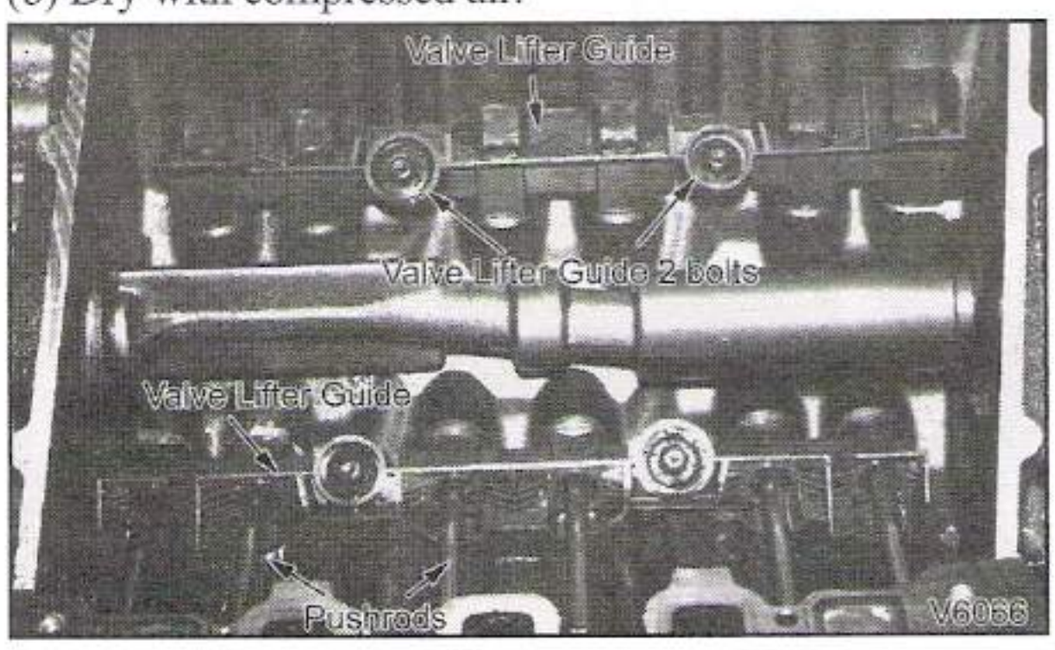
Make sure that all valve train components are kept in order so they can be installed in their original locations.

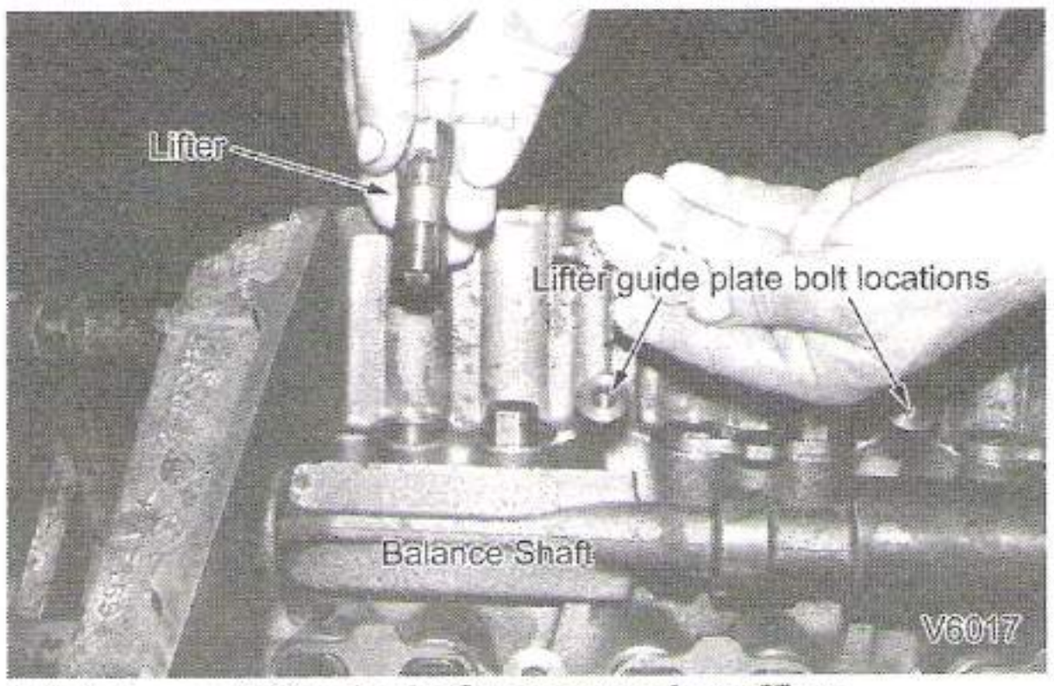
1. Remove the valve lifter guide, 2 bolts per guide, remove lifters by hand.

Clean & Inspect

1. (a) Clean all parts in a suitable cleaning fluid.

(b) Dry with compressed air.





2. (a) Inspect lifter body for wear and scuffing.

(b) Also inspect lifter bore in block.

3. The lifter can be dismantled and cleaned by removing spring clip in base, allow components to drop down. Clean then reassemble.

The unit must be replaced if there is any damage or excessively worn.

Installation

1. Make sure lifter bodies and lifter bores are clean insert lifters into the same bore they were removed from, lubricate lifter bodies and bores with Lubrizol 6612

2. Install lifter guide plates and bolts.

Lifter Guide Plate Bolts: 26 - 34Nm

CYLINDER HEAD and VALVE ASSEMBLIES

**Make sure that all valve train components are kept in order so they can be installed in their original locations.*

Remove

1. Depressurize fuel system, (remove fuel pump relay located in engine bay, start engine allow to idle to stall).

2. Disconnect battery negative terminal.

3. Drain coolant from engine at radiator lower hose and remove top radiator hose.

4. a) Remove the power steering pump and fan bracket.

b) Remove alternator, remove alternator support bolts, then remove support assembly.

c) Remove the drive belt and drive belt tensioner as previously described.

d) Remove coil pack and spark plug leads.

5. Remove intake manifold assembly as described.

Main points listed below.

(a) Remove air cleaner to intake chamber tube.

(b) Separate the top air intake chamber from the lower intake manifold, remove the fuel rails and injectors.

(c) Remove intake manifold and 2 gaskets 2 seals.

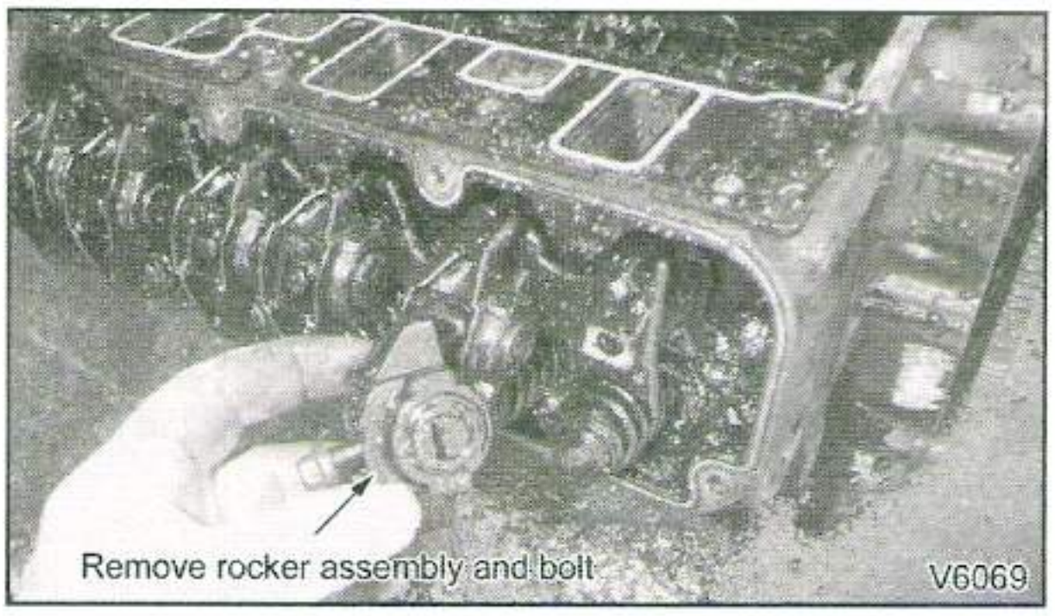
6. Remove the exhaust manifolds as described in this chapter.

7. Remove the 4 bolts securing the each rocker cover, rocker cover and gasket as previously described in this chapter.

8. a) Remove the rocker assembly bolts from each head, lift rocker assembly and rocker arm retainer from heads.

b) Remove push rods.

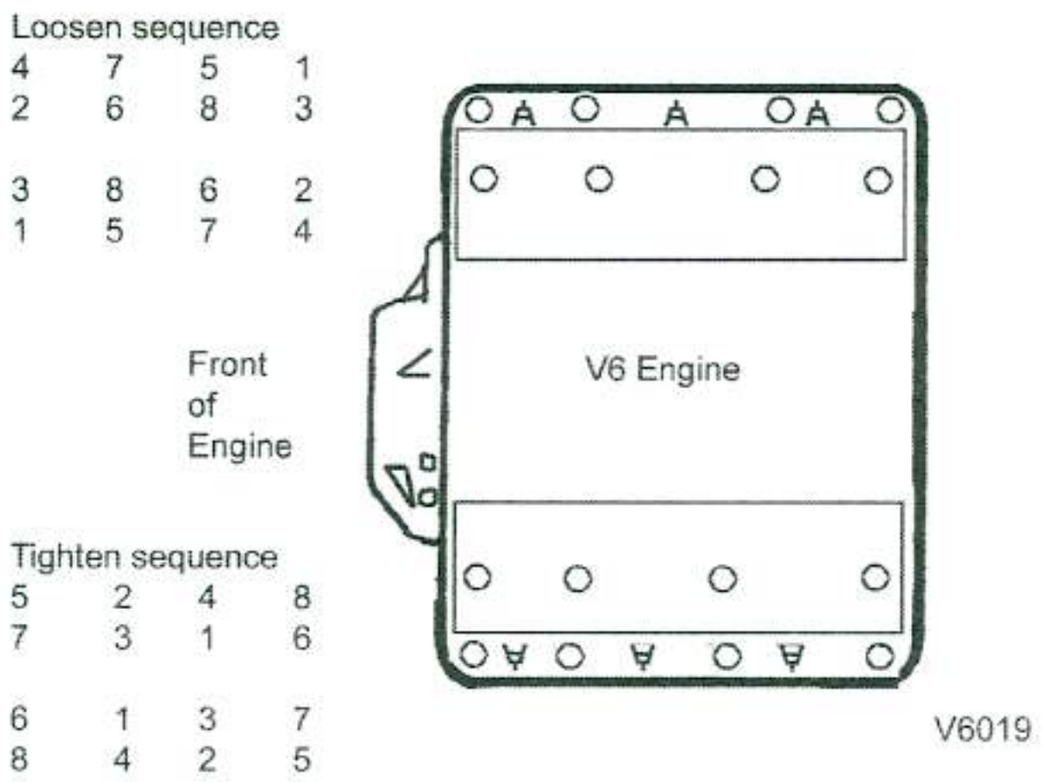
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c) Remove the valve lifters either by hand or use a screw driver with a bent end to help.

**Make sure that all valve train components are kept in order so they can be installed in their original locations.*

9. Remove the cylinder heads, 8 bolts in the sequence shown, loosen bolts gradually.



Remove the heads.

10. Lift the cylinder heads and gaskets from the engine block.

CYLINDER HEAD RECONDITIONING

** Make sure that all valve train components are kept in order so that they can be installed in their original locations.*

Dismantle

1. Compress valve springs in turn with a spring compressor and remove valve collets.

2. Remove the following:

(a) Valve spring caps, springs, valve stem oil seals and valve spring seats.

(b) Valves from cylinder head.

Caution: *Take care removing valves out of guides, because if the valve ends are burred due to lifter wear or dirt in the guide, will damage guide. Remove burrs with an oil stone or fine file.*

3. Replace all welsh plugs, use sealant as plugs are replaced.

CYLINDER HEAD RECONDITIONING

Clean

1. (a) Remove all carbon deposit from combustion chambers, valve ports, etc., with a rotating drill mounted wire brush.

* Do not use a wire brush on any gasket sealing surface.

(b) Clean cylinder head gasket surface of cylinder head.

2. Thoroughly clean valve guides with a suitable cleaning solvent and a fine brass wire brush.

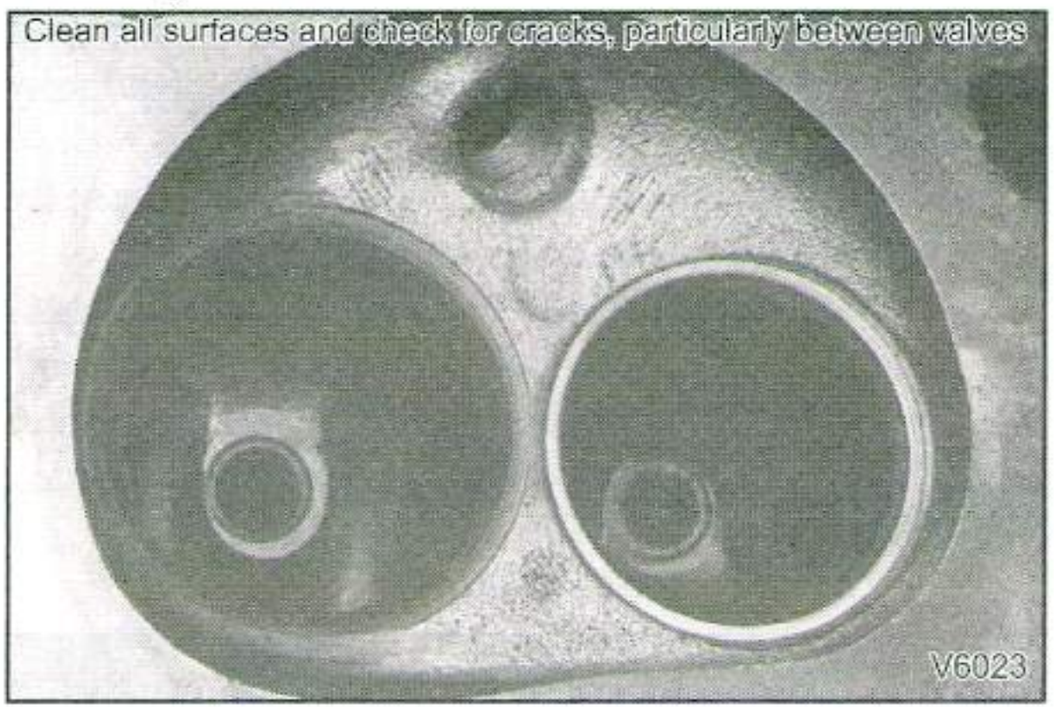
3. Clean valve heads with a drill and wire brush or buffing wheel.

* Do not scratch the valve stem.

4. Wash all components in a suitable cleaning solvent and air dry with dry compressed air.

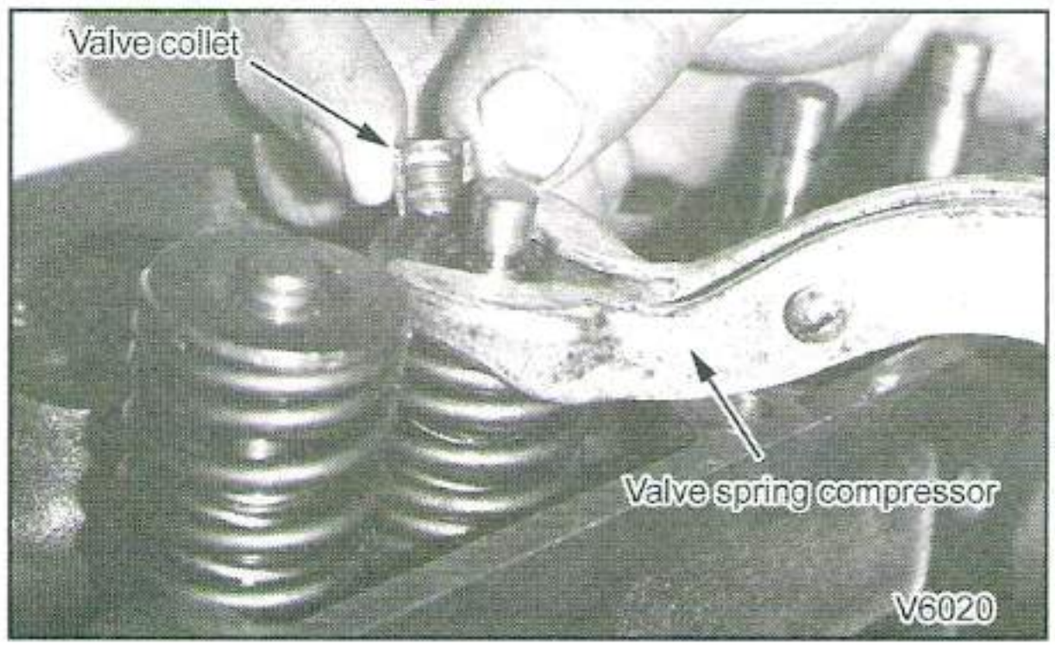
Cylinder Head Inspection

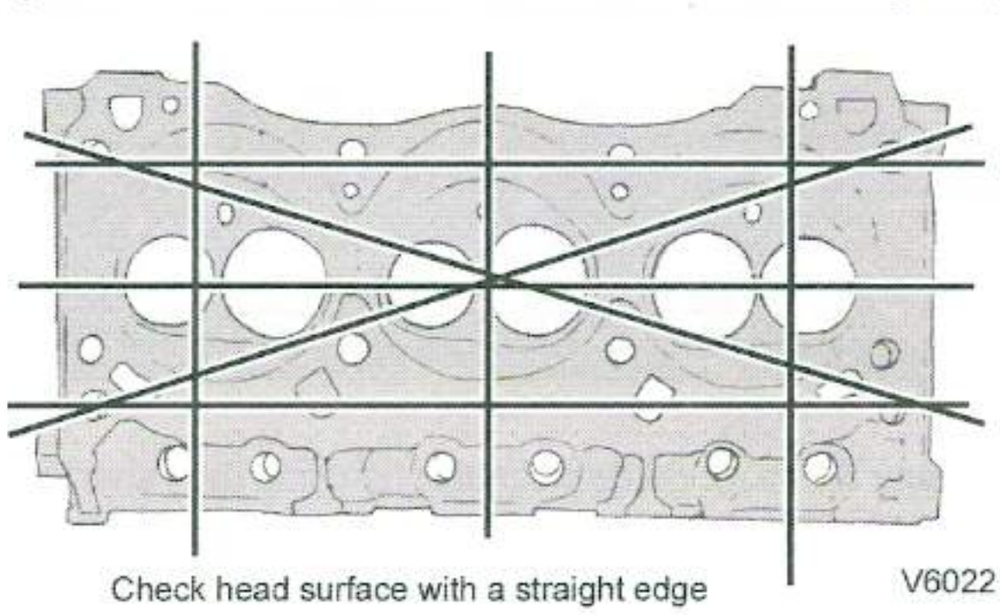
1. Cylinder heads should be inspected for cracks in valve seats, between valve seats, between valve seats and spark plug hole and combustion chambers, and for external cracks to water jackets.



2. Check cylinder head deck surface for corrosion.

3. With a straight edge and feeler gauge, check cylinder head deck, intake and exhaust manifold surfaces for distortion. Cylinder head deck surface should be checked diagonally,





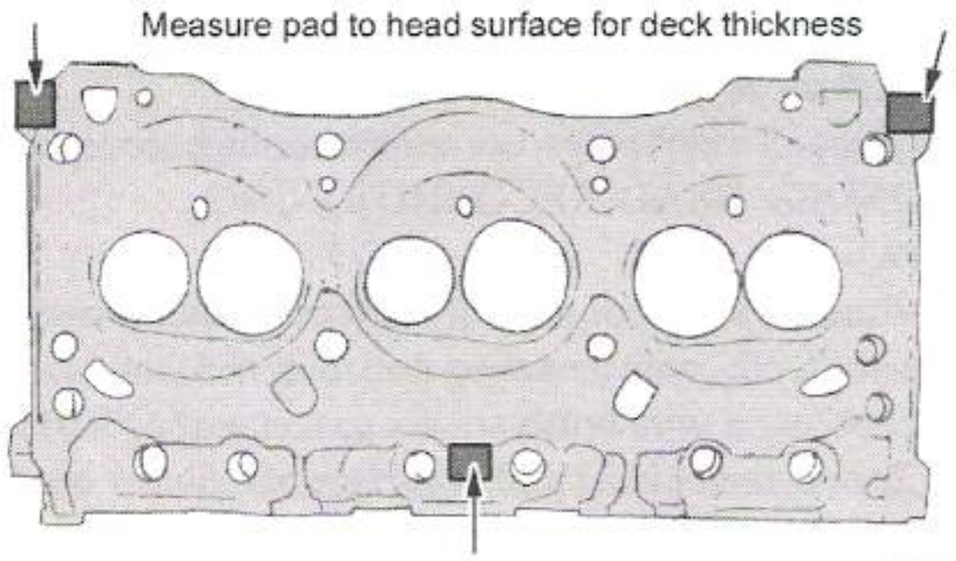
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longitudinally and transversely.

*** Check thickness of cylinder head deck surface:**

Standard head deck thickness: 1.372-1.676mm

Minimum head deck thickness: 1.12mm



Head to block surface: If more than .25mm must be removed from any surface, replace cylinder head.

Tip: Machining 0.15mm from the head surface reduces each combustion chamber by 1.00cc.

* Head to manifold surface if more than .25mm must be removed from any surface, replace cylinder head.

VALVE GUIDES

Clearance Checking

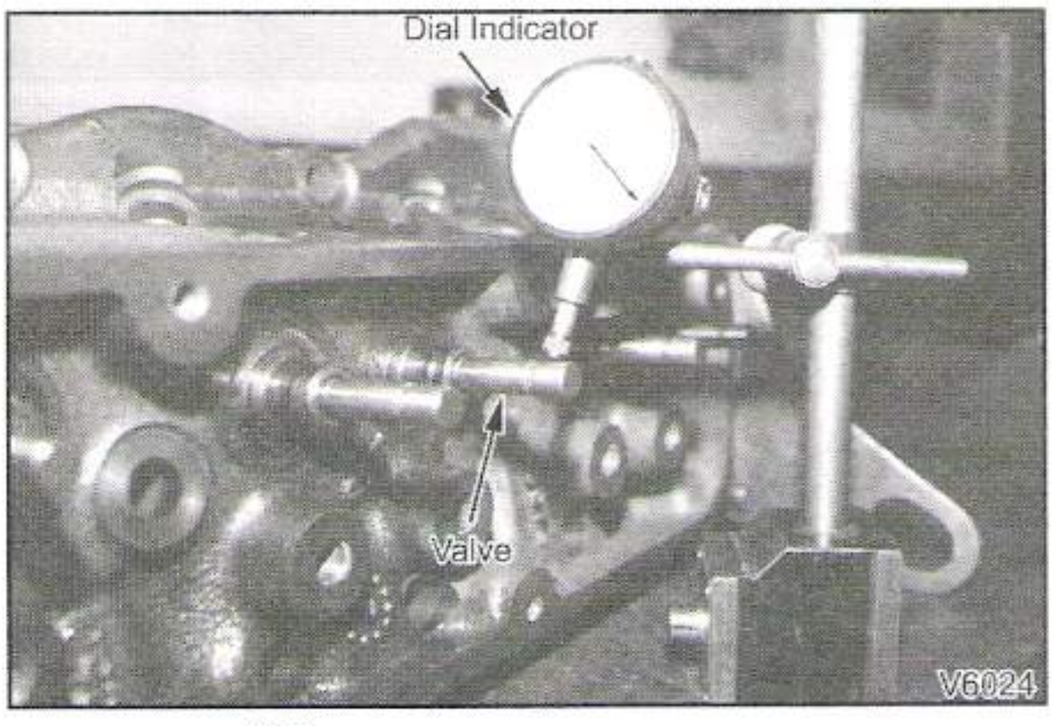
1. If valve stem to guide bore clearance is past maximum tolerance, it could cause lack of power, rough idling and noisy valve operation.

2. Insufficient clearance can cause noise and sticking of the valve and will cause uneven operation of engine.

3. Valve stem clearance can be checked with a dial indicator attached to side of head or stell table top, insert valve into valve guide, measure side movement 8-12mm above valve guide. If not within specification try a new valve or guide.

Valve Side Movement Intake & Exhaust:

0.043-0.25mm



OR

Measure the valve guide clearance by using the valve from that guide, if the clearance is over specified, measure using a new valve, it is better to replace the valve instead of the valve guide, providing clearance is within specification.

Specified Valve Guide Clearance:

New Inlet: 0.033-0.066mm

New Outlet: 0.036-0.074mm

Over size valves are available. Ream valve guide to 0.254mm oversize if necessary, to obtain specified diameter.

Valve Guide to Valve Clearance: Max: 0.18mm

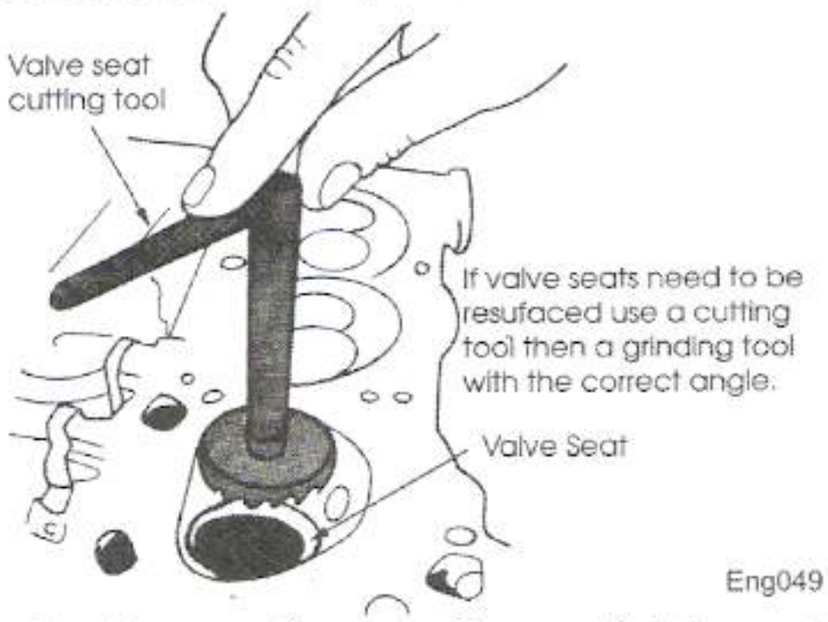
Oversize valves are identified by a "10" mark at the top of the valve.

VALVE SEATS

1. Valve seats must be reconditioned to allow the seating of the valves must be perfect for the engine to deliver the power and performance its develops.

2. Good contact between each valve and its seat in the head is imperative to ensure that the heat in the valve head will be properly carried away.

3. There are several different types of machinery available for reconditioning valve seats. The recommendations of the manufacturer of the equipment being used should be carefully followed to attain proper results.



4. Check valve seats for any evidence of pitting or damage at valve contact surface. If pitting is evident, the valve seats will need to be reconditioned.

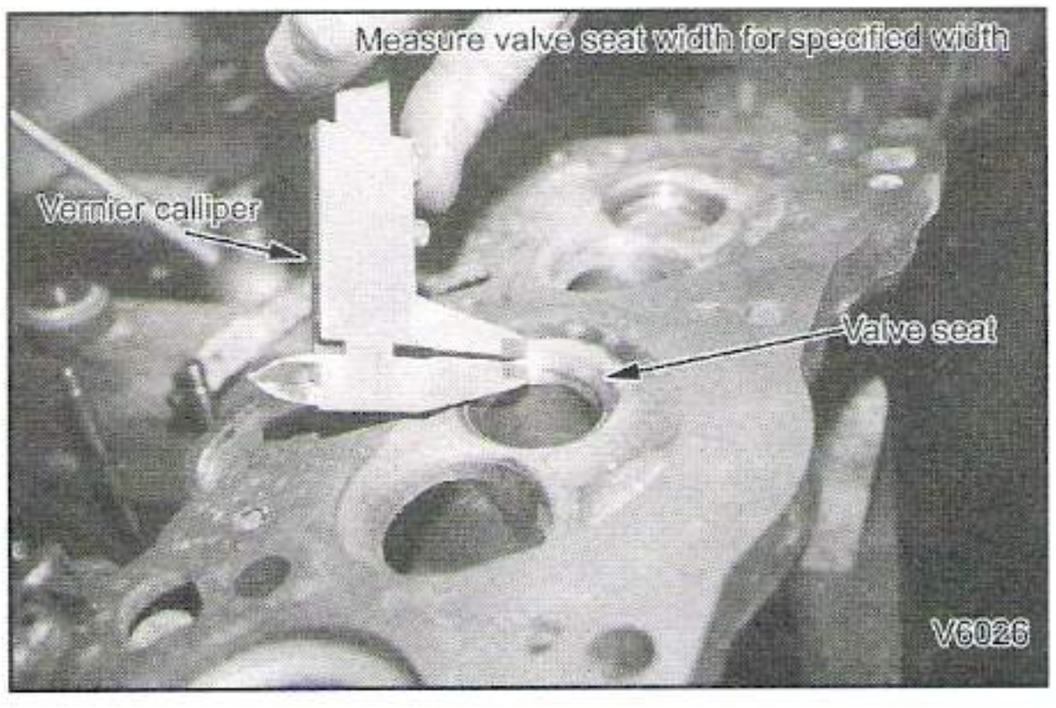
* Because the valve guide serves to support and centre the valve seat grinder, it is essential that the valve guide is serviced before reconditioning the valve seats.

*** Valve seat angles are 45^0**

*** Valve seat width:**

Exhaust 2.16mm

Intake 1.78mm



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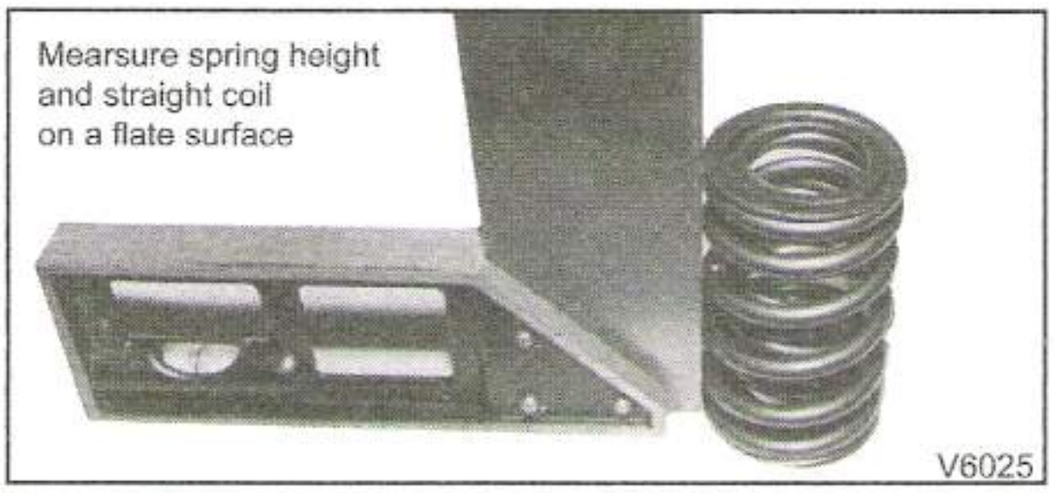
5. If the seat is too wide after grinding, it may be narrowed by using a 250° or 60° grinding stone. The 25° stone will lower the seat and the 60° stone will raise the seat.
6. If the valves seats are reconditioned, the valves must also be reconditioned (refer VALVES) or replace valves as necessary.

REPLACING VALVE SEAT

1. Using a lathe, turn down the out side diameter of a valve head so it fill fit neatly into inside of the valve seat.
2. Cover the head that surrounds the valve seat with an inflammable paste, such as soap paste. This will stop damage from weld spatter.
3. Weld a continuous run of weld around the edge of the valve, so it is welded to the inside of the valve seat.
4. Lift the head so the top of the valve can be tapped to free the valve seat.
5. Slide the machined valve and valve seat out of the head.
6. Machine the head as the new valve seat is over size by 0.38mm diameter and depth.
7. The new valve seat should not to be hit or forced into the head as this will cause damage to the seat and head.
8. Place the new valve seat in liquid nitrogen or dry ice so the seat will shrink in size.
9. Carefully place the valve seat into position with an old valve (converted into a special tool as shown in diagram) positioned through the seat into the valve guide. Gently tap the special tool to position and centre the valve seat.

VALVE SPRINGS

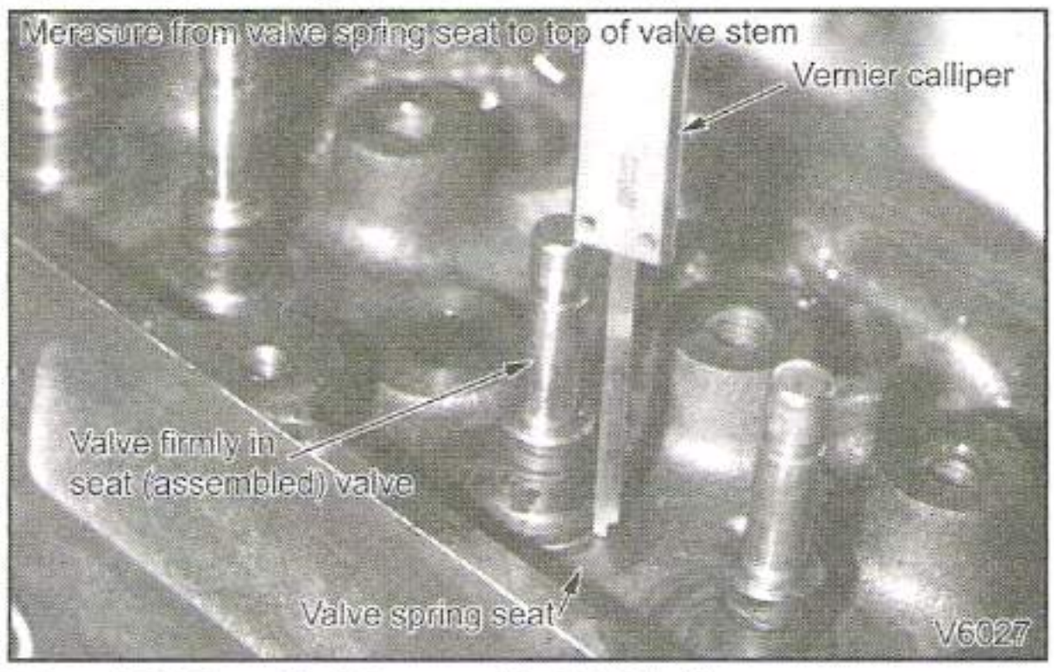
1. Check valve spring surfaces, valve spring seat and valve cap for wear or gouging. Replace components as necessary.
2. (a) Check spring ends. If they are not parallel, the spring is bent.
(b) Replace valve springs that do not meet specification.



Maximum allowable variance in spring end length: 1.60 mm, while rotating spring on level desk.
3. (a) Check valve spring load with a spring tester.
(b) Springs should be compressed to the specified height and checked against specifications.
Valve spring compressed height/load:
Compressed height: 970-1059Nm@32.4mm
Compressed height: 316-351Nm@43.7mm
(c) Replace any valve spring if not to specification.

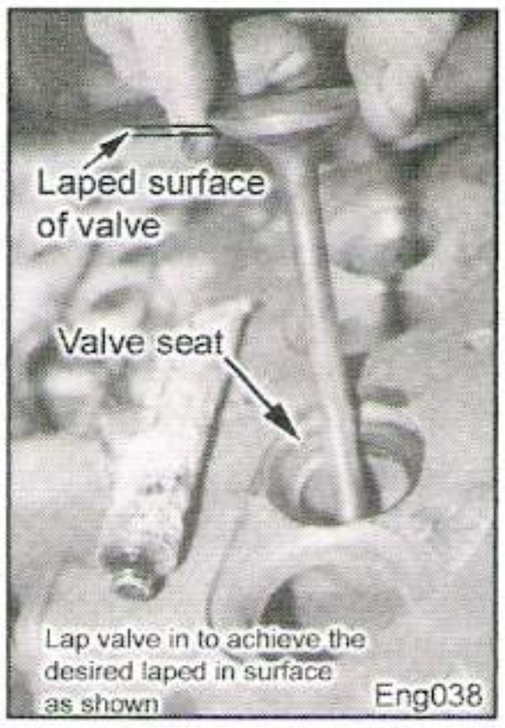
VALVES

1. (a) The valve stem should be inspected for burrs and scratches. (Burrs and minor scratching may be removed with an oil stone.)
(b) Valves that have excessive stem wear or that are warped should be replaced.
(c) The valve stem tip should be inspected for wear. The valve tip may be reconditioned by grinding.
(d) Follow the grinder manufacturers instructions. Make sure the new tip surface is at right-angles to the valve stem.
(e) Do not grind valve below minimum specified height. Install valve into guide, hold tight into valve seat, measure the top of the valve tip to the valve spring seat.



Fitted Valve Height: 49.22-50.49mm
2. Inspect valve stem collet groove for damage.
3. (a) Check valve face for burning or cracking.
(b) If pieces have broken off, inspect corresponding piston and cylinder head area for damage.
4. (a) Inspect valve stem for straightness and valve head for bending or distortion using 'V' blocks.
(b) Bent or distorted valves must be replaced.
5. Valves with pitted or grooves faces can be reconditioned with a valve refacing machine, ensuring correct relationship between head and stem.
Valve face angle: 45°.
* If pitting or grooving is so deep that refacing would result in a 'knife' edge at the valve head, the valve must be replaced.
* Measure valve margin after refacing valves. If margin is less than minimum specified, the valve must be replaced.
Minimum valve head margin thickness: 0.63mm
6. Lightly lap reconditioned valves into valve seat.
* New valves must not be lapped. Lapping destroys the protective coating on the valve face.
7. After refacing or installing a new valve, check for correct seating as follows:
(a) Lightly coat valve face with bearing blue.
(b) Insert valve and rotate about 1/6 of a revolution.
(c) Remove valve and check for full contact with seat.
i) If partial contact is indicated, insert valve again and turn through a full revolution.
ii) If blue on seat indicates full contact, reface valve.

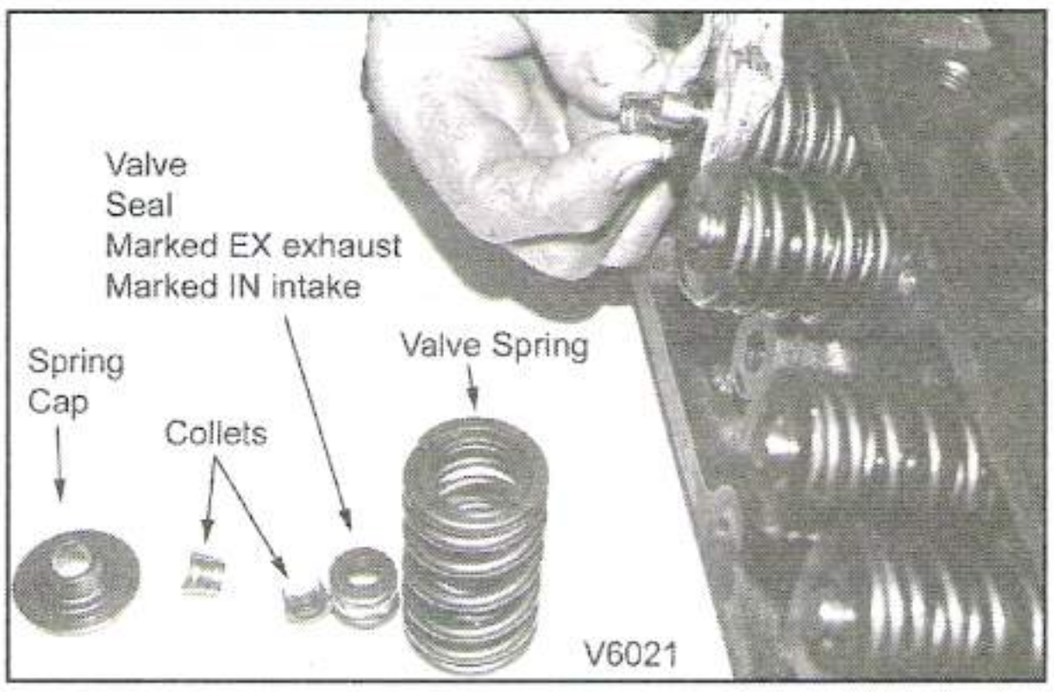
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iii) If partial contact is still indicated, regrind cylinder head valve seat.
(d) Clean all traces of bearing blue from valves and seats.

CYLINDER HEAD ASSEMBLE

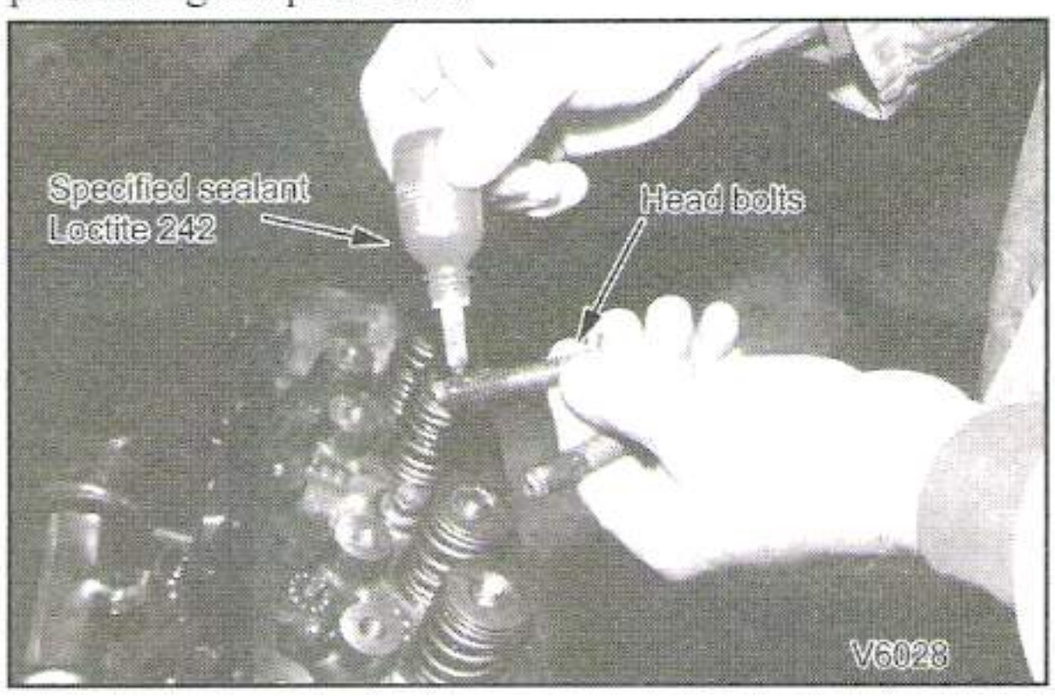
1. Dry and clean all components thoroughly.
2. Using clean engine oil, lubricate valve stems and valve guides thoroughly.
3. Make sure that seals fully seat on top of guide, install new valve stem oil seals.
Intake oil seal has a "IN" on the seal. Exhaust oil seal has a "EX" on the surface.



4. Install valves in corresponding guides.
5. Install the valve spring seat over the valve guide onto the cylinder head.
6. Place valve springs and cap over valve stem.
7. Using a suitable spring compressor, compress valve springs.
* Excess compression could cause spring cap to damage valve stem oil seal, ensure to compress valve springs only enough to install valve collets.
8. Install valve collets, making sure that they locate accurately in groove in top end of valve stem. Release the valve spring compressor slowly ensuring that the collets sit properly. Grease may be used to hold collets in place.
Tap the top of the valve tip to ensure the spring and collets are seated properly.

INSTALL

**Make sure that all valve train components are kept in order so they can be installed in their original locations*
1. Place dowel pins into block, place head gasket in position over dowel pins on cylinder block.
Gaskets are identified with L cut out for left side - a 5 mm hole for right side.
Arrow faces up and to the front of the engine.
2. (a) Carefully guide cylinder head into place over dowel pins and gasket.
(b) Coat threads of cylinder head bolts with LOCTITE 242 sealant or equivalent and tighten with finger, remove dowel pins during this procedure.



** It is a good preventative move to install new cylinder head bolts. This may avoid pulling down the engine again with blown head gasket due to stretched head bolts.*
3. Tighten the head bolts to the following sequence and in the order shown in previous illustration.
* It is important to follow the given procedure to avoid head gasket failure and possible engine damage.
Cylinder Head Bolt Torque: 34Nm
Tighten a further 90⁰ turn of each bolt in sequence (if torqued to 90Nm during this step, do not tighten any further)
Tighten a further 90⁰ turn of each bolt in sequence for the second time.
Note: If cylinder head bolts do not torque to first

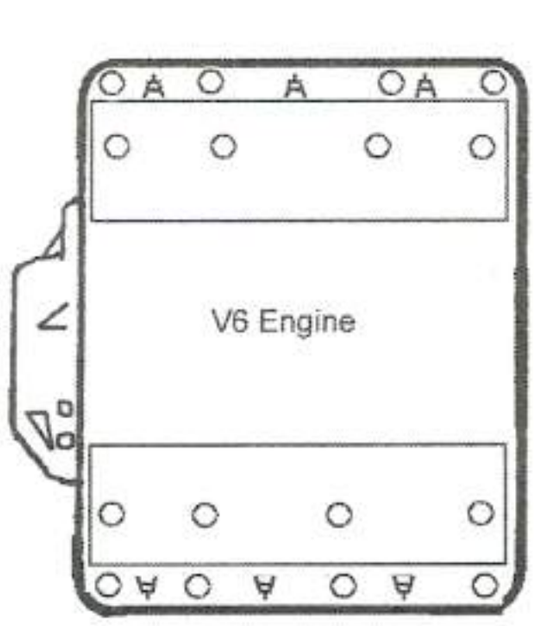
Loosen sequence

4	7	5	1
2	6	8	3
3	8	6	2
1	5	7	4

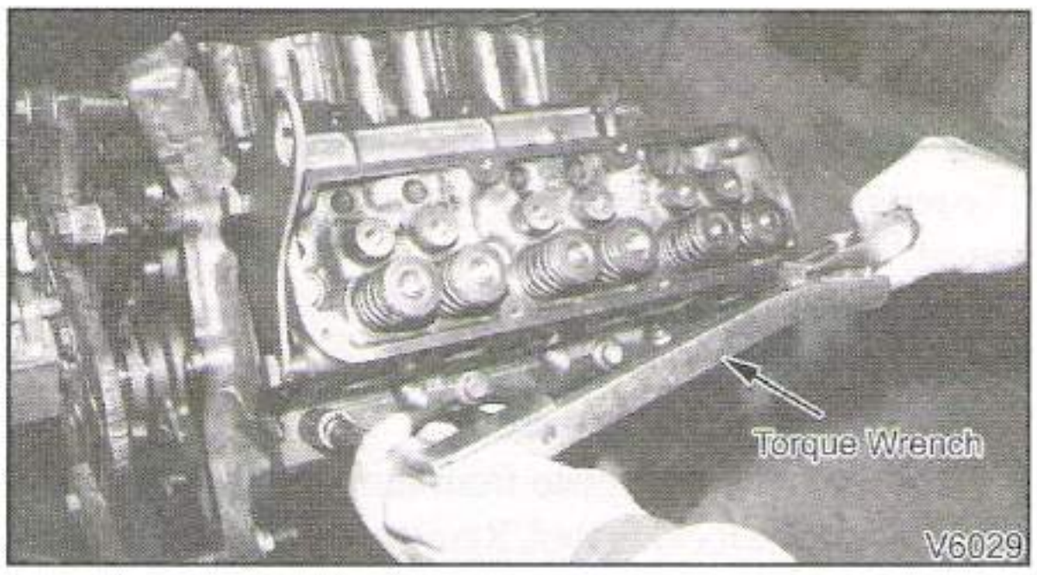
Front of Engine

Tighten sequence

5	2	4	8
7	3	1	6
6	1	3	7
8	4	2	5



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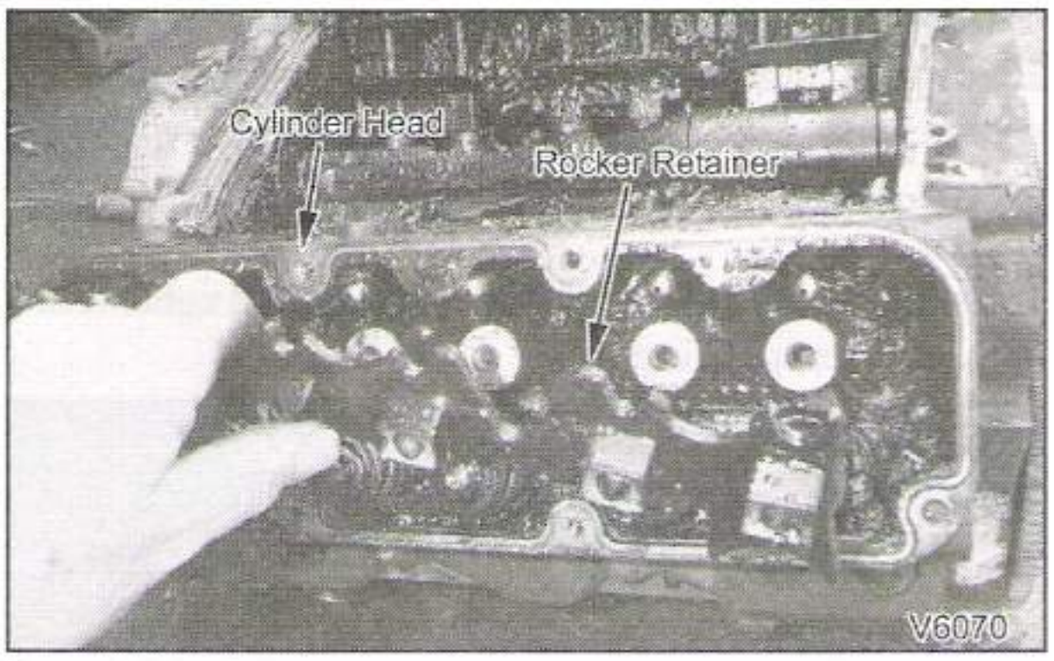
specification, replace bolt.
#Hint: After tightening to first specification, paint dot on bolt head to front of engine. After each tightening sequence, check all paint marks have rotated 90 degrees.

4. Install valve lifters into block if not already installed. Install valve lifter guide plates.

Valve Lifter Guide Plates: 26-34Nm

5. Install the push rods to the original positions.

6. Install rocker arm retainer and rocker assembly, and bolts. Tighten to specification.



Step 1 Rocker Assembly Bolts: 11-19Nm

Step 2 Tighten a further 87-93 deg turn

7. Install rocker covers and gasket as previously described, tighten to specification.

Rocker Cover Nuts Torque: 7-11Nm

8. Install exhaust manifolds as previously described in this chapter.

9. Install intake manifold, fuel injectors, air intake chambers as previously described in this chapter.

10. Install drive belt tensioner, drive belt, alternator as described.

11. Reconnect radiator hoses, refill and bleed cooling system.

VALVE STEM OIL SEALS

Replacement

1. Disconnect battery earth lead.

2. Remove the following:

a) Rocker cover as previously described in this chapter.

b) Remove rocker assembly for relevant cylinder/s

c) Spark plug leads from spark plugs.

d) Spark plug from relevant cylinder and screw air adaptor into spark plug hole.

3. Apply air pressure to hold valves in closed position.

4. Remove the valve spring assembly for relevant valves.

5. a) Compress valve spring with valve spring compressor.

b) Remove valve collets.

*Before installing valve spring compressor, it may be necessary to tap top of valve cap with a soft-faced hammer to overcome the binding of the valve collets in the valve spring cap.

6. a) Remove spring cap, spring and valve compressor as an assembly.

b) Remove and discard old valve stem oil seal.

7. Install new valve stem oil seal and make sure the seal fully seats on top of the valve guide.

* Make sure the correct type of seal is fitted to the appropriate valve, based on part No.

8. a) Install spring, cap and valve compressor as an assembly on the valve stem.

b) Install valve collets and slowly release spring compressor, then remove spring compressor.

c) Disconnect air line to special tool.

9. Install the following:

a) Rocker assembly as previously described in this Chapter.

b) Rocker cover as previously described in this Chapter.

10. Remove special tool and install and torque spark plug.

Spark Plug Torque Specification: 15-25Nm

11. Install spark plug leads and battery earth lead.

12. Start engine and check for oil leaks and valve train noise.

CRANKSHAFT BALANCER

Remove

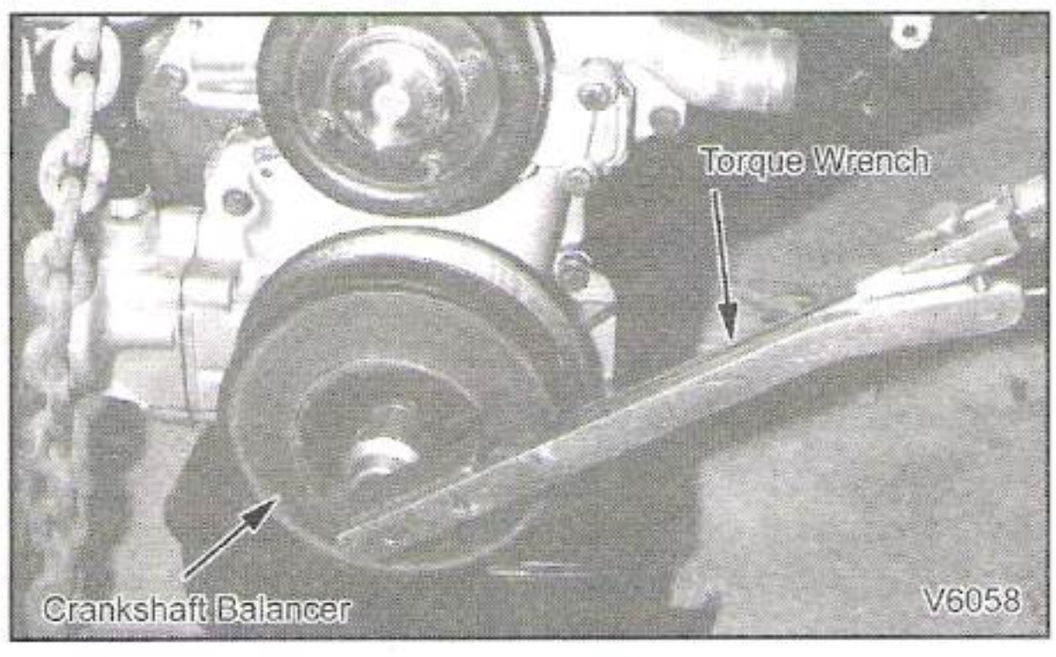
1. Disconnect battery negative terminal and remove drive belt.

2. Manual Transmission: Pull park brake fully on, chock rear wheel and transmission in gear.

Automatic Transmission: Remove starter motor, use a large screw driver or similar to lock ring gear from turning thereby stopping engine turning over.

3. Loosen and remove balancer retaining bolt.

4. Remove balancer from crankshaft with pulley puller.



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Install

1. Using engine oil, lubricate front seal surface of balancer.

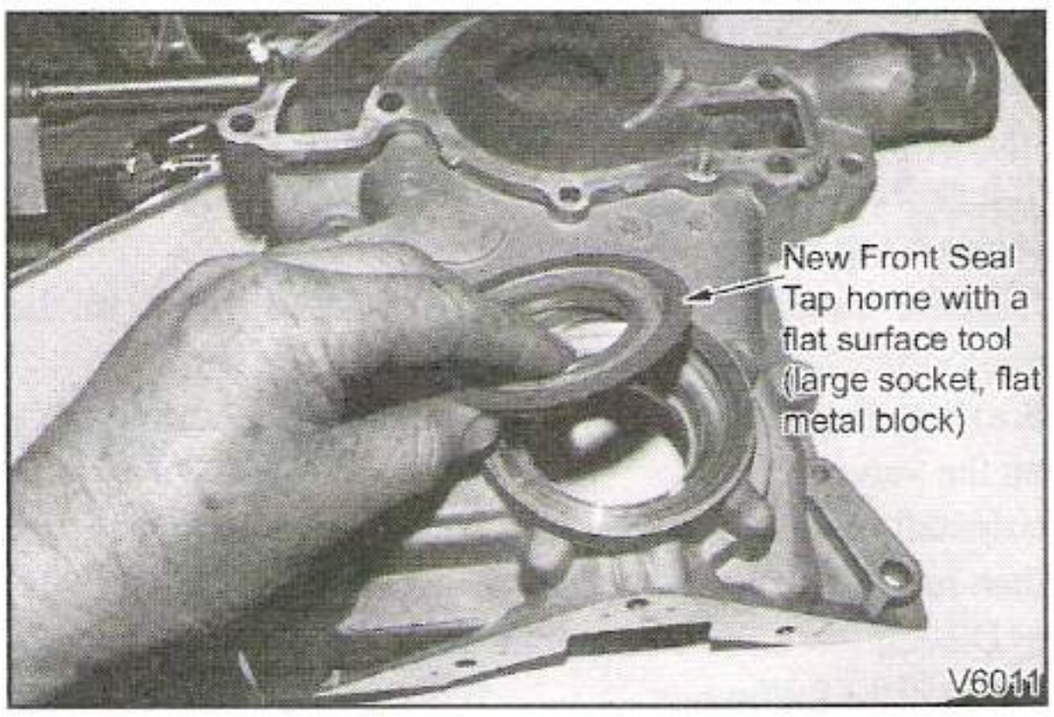
2. Install balancer, engaging key on crankshaft with slot in balancer.

3. Install the crankshaft pulley, tighten attaching bolt to specification.

Crankshaft Pulley Attaching Bolt: 270-325Nm

4. Install and inspect drive belt operation.

FRONT OIL SEAL



Replacement

1. Disconnect battery earth lead.

2. Remove the following:

a) Drive belt assembly as previously described in this chapter.

b) Crankshaft balancer as previously described.

3. Use a seal remover or screw driver to remove the old oil seal.

4. Lubricate the seal lips with petroleum jelly, use a seal replacement tool to replace seal or a suitable object such as a large socket of the correct size. Tape into place with a soft hammer.



5. Install crankshaft balancer.

6. Install drive belt assembly.

FLYWHEEL/DRIVEPLATE

Remove

Before removal of flywheel/driveplate take note of the location of paint alignment marks on flywheel and pressure plate, before removing clutch pressure plate, the driveplate and torque converter make sure they have paint aligning marks.

If not visible, scribe aligning marks on all parts.

1. To remove transmission refer to particular chapter in this manual.

2. Vehicles with manual transmission:

Remove the clutch pressure plate and driven plate as per "Clutch" section in this manual.

3. Block flywheel driveplate from turning, using a screw-driver or suitable locking tool. Remove flywheel/driveplate crankshaft bolts and flywheel/driveplate.

Inspection.

The flywheel and flexplate are purposely out of balance and no attempt should be made to re-balance these as an individual unit.

1. Check flywheel/driveplate ring gear for badly worn, damaged or cracked teeth.

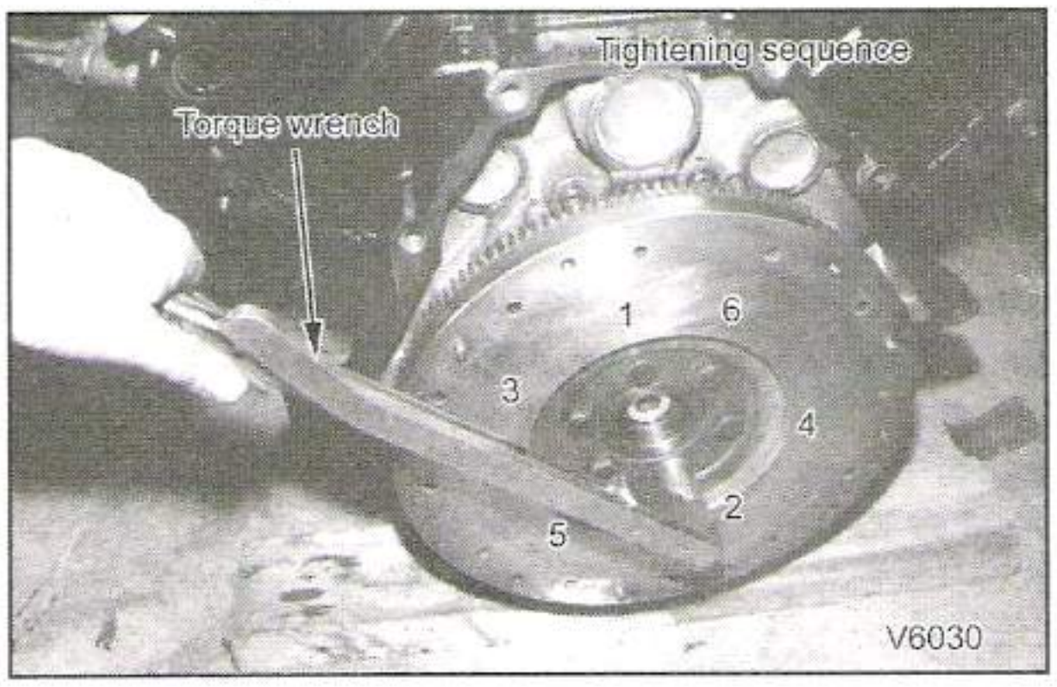
If needed, replace flywheel ring gear or driveplate, for details refer to **"ring gear"** section in this chapter.

Check starter motor pinion gear for damage, if ring gear teeth are damaged replace pinion gear, for details refer to **"Starting System chapter".**

2. Inspect crankshaft and flywheel/driveplate matching surfaces for burrs. Using a fine mill file remove burrs if present.

Install

1. Install flywheel/driveplate to crankshaft, and tighten bolts to the correct specification.



Flywheel / Driveplate Bolt Specification:

1st Step - 18-22 Nm

2nd Step - Turn bolts an extra 47-53 degress

2. Mount a dial indicator on the rear of cylinder block for vehicles with automatic transmission. Inspect flexplate runout at the torque converter mounting bolt holes. Runout should not exceed the following specifications.

Flexplate Runout: 0.38 mm max.

Try to correct by tapping high side with a mallet if runout exceeds specification. Replace driveplate if this condition can not be corrected.

3. Inspect starter motor function.

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RING GEAR

Replacement.

The ring gear is welded to the driveplate and is serviced only as an assembly for vehicles with automatic transmission. Therefore must be replaced as a complete unit.

For vehicles with manual transmission, the ring gear is a shrink fit on the flywheel flange, and if damaged, can be removed and replaced.

Replacement techniques are as follows:

1. To remove flywheel refer to FLYWHEEL/DRIVEPLATE section in this manual for details.

2. To remove ring gear drill a hole between two ring gear teeth and split gear at this point using a chisel.

3. Make sure that there are no foreign matter or burrs on new ring gear and flywheel matching surface. Remove burrs using a fine mill file (if present).

4. Heat and shrink a new gear in place as follows:

(a) Using an emery cloth, polish several spots on ring gear.

(b) Using a hot plate or a slow moving torch, heat ring gear until the polished spots turn blue (approximately 220 degrees Celsius).

* Heating the ring gear in excess of 427 degrees Celsius will destroy ring gear heat treatment.

(c) Quickly place ring gear in position against shoulder of flywheel using 2 pairs of pliers. Allow ring gear to cool slowly until it contracts and is firmly held in place.

5. Install flywheel, tighten bolt to specification.

Flywheel / Driveplate Bolt Specification:

1st Step - 18-22 Nm

2nd Step - Turn bolts an extra 47-53 degress

SPIGOT BEARING

Before removing clutch/pressure plate, take note of the position of the paint aligning marks on flywheel and pressure plate. If marks are not visible, scribe aligning marks on both parts.



Replacement.

1. To remove clutch pressure plate and driven plate as described in this manual.

2. To remove spigot bearing use a Slide hammer.

3. Use a piloted screwdriver to replace spigot bearing. Place new bearing on pilot of tool with radius in bore of bearing next to shoulder on tool. Drive bearing into crankshaft to the dimension as shown in the diagram. Use thin film of SAE 90 gear oil to lubricate the bearing.

4. Install clutch assembly and transmission.

ENGINE REBUILD.

ENGINE ASSEMBLY.

Remove

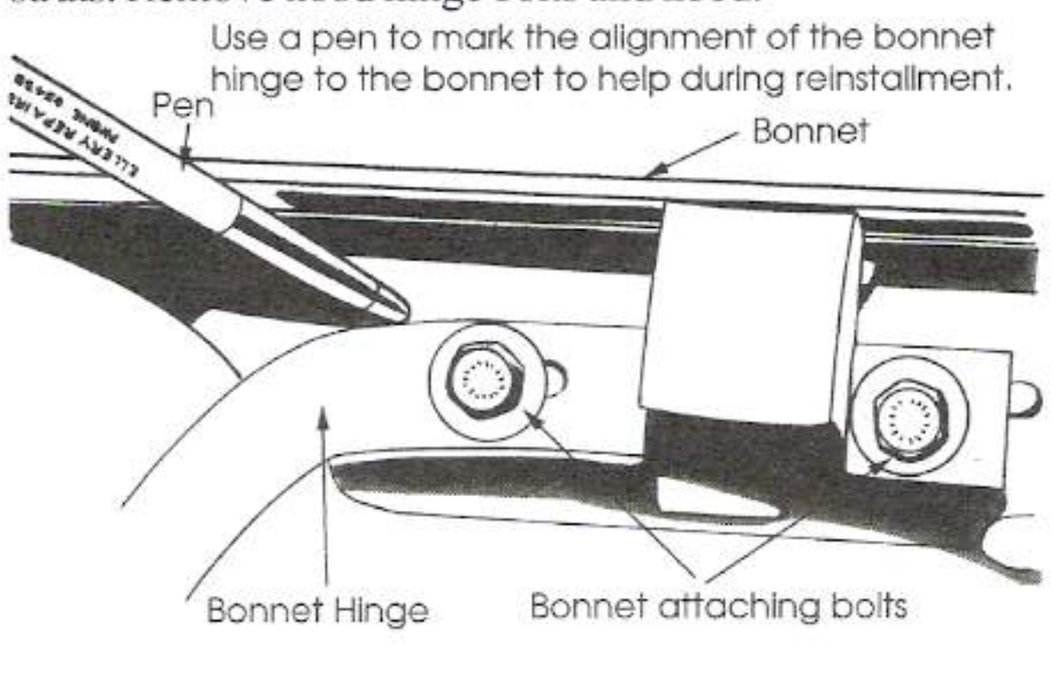
1. Depresserize the fuel injection system, (remove fuel pump relay located in engine bay, start engine allow to idle to stall).

2. Disconnect battery leads.

3. Remove bottom radiator hose from radiator to allow coolant to drain, and disconnect radiator hoses from engine.

4. Drain engine oil sump.

5. Using a felt tipped pen mark engine hood to hinge positions. Disconnect windshield washer hose. Disconnect hood gas struts. Remove hood hinge bolts and hood.



6. To remove cooling fan and radiator assembly refer to "Cooling systems" chapter section for details.

7. Disconnect heater supply and return hoses from engine heater pipe connections, including heater bypass pipe on the side of the block.

8. Disconnect main wiring harness from engine and battery harness.

9. Unclip engine harness, sensors and sender units.

10. To remove power steering pump (if applicable) refer to **Power Steering** section for details.

11. Disconnect air cleaner to air intake chamber tube.

12. Disconnect throttle cable from throttle linkage and mounting bracket.

13. Remove fuel supply and return lines from fuel rail and pressure regulator.

14. Disconnect emission control canister hoses from throttle body connections, and separate canister lines from fuel rail clips if a canister is fitted.

15. Disconnect brake booster hose from engine vacuum connections.

16. Fully raise vehicle and place on safety stands.

17. To remove tail shaft refer to "Propeller shafts and

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universal joints" chapter for details. Place a suitable plug in end of transmission.

18. Disconnect engine exhaust pipes from manifold assemblies.

19. To disconnect gear shift control from transmission refer to MANUAL TRANSMISSION or AUTOMATIC TRANSMISSION sections for details.

20. Disconnect clutch slave cylinder (for vehicles with manual transmission only) for details refer to CLUTCH section.

21. Disconnect speedo or wiring harness connector from speedometer sender at transmission.

Manual Transmission: Disconnect transmission harness from backup lamp switch.

Automatic Transmission: Disconnect transmission harness from solenoid.

22. Raise engine slightly to take weight off mounts by attaching an appropriate lifting hook and chain to engine lifting brackets if fitted. Care must be taken not to damage engine components with rope or chain while lifting engine.

23. Remove engine front mounting from mounting brackets.

24. Disconnect wiring harness connector from compressor clutch for vehicles with air conditioning.

25. Raise engine slightly and remove air compressor from engine mount bracket mounting bolts. Tie compressor back way from the engine.

26. Raise engine with front tilted upwards and a floor jack supporting rear of transmission assembly, make sure that engine exhaust manifolds, starter motor or transmission do not rest on steering gear.

* Do not allow engine to swing forward and damage air conditioning condenser (on vehicles with air conditioning condenser fitted at front) or optional transmission cooler.

27. Separate engine and transmission assemblies if necessary. Refer to MANUAL TRANSMISSION or AUTOMATIC TRANSMISSION for details.

Dismantle.

1. Mount engine assembly in an appropriate engine stand.

2. Remove the following parts:

(a) Starter motor.

(b) Drive belt to water pump, alternator etc.

(c) Alternator and brackets.

3. Remove the following parts as previously described or about to be described, in this chapter.

(a) Air intake chambers and intake manifold.

(b) Rocker covers.

(c) Exhaust manifold manifolds.

(d) Oil filter.

(e) Crankshaft balancer.

(f) Timing chain cover.

Rotate the crankshaft clockwise (it may be necessary to temporally install the crankshaft balancer pulley bolt) so the crankshaft is at TDC/ compression on number 1 cylinder. Check that alignment mark on crankshaft sprocket and the camshaft gears are aligned, 2 dots facing each other, if not it may be necessary to rotate the crankshaft a further 360 degrees.

(j) Timing chain, camshaft gear.

(j) Cylinder head assemblies.

(k) Engine sump.

(l) Oil pump suction pipe and screen.

(m) Flywheel/flexplate.

(n) Engine rear bearing retainer plate.

(o) Crankshaft,

(p) Piston and connecting rod assemblies.

Assembly.

Assembly techniques for each part are outlined in this section under their particular headings.

1. Make sure that all bolts and nuts are tightened as specified.

2. Use specified engine lubricant and coolant when refilling.

3. Inspect transmission fluid level, add lubricant as required.

4. Inspect for fuel, coolant, oil and exhaust leaks. Repair as required.

5. Check engine hood alignment.

OIL PAN (SUMP) & GASKET.

Remove

1. Drain oil from oil pan.

2. Remove the dip stick.

3. Remove end of engine beaming brace plate.

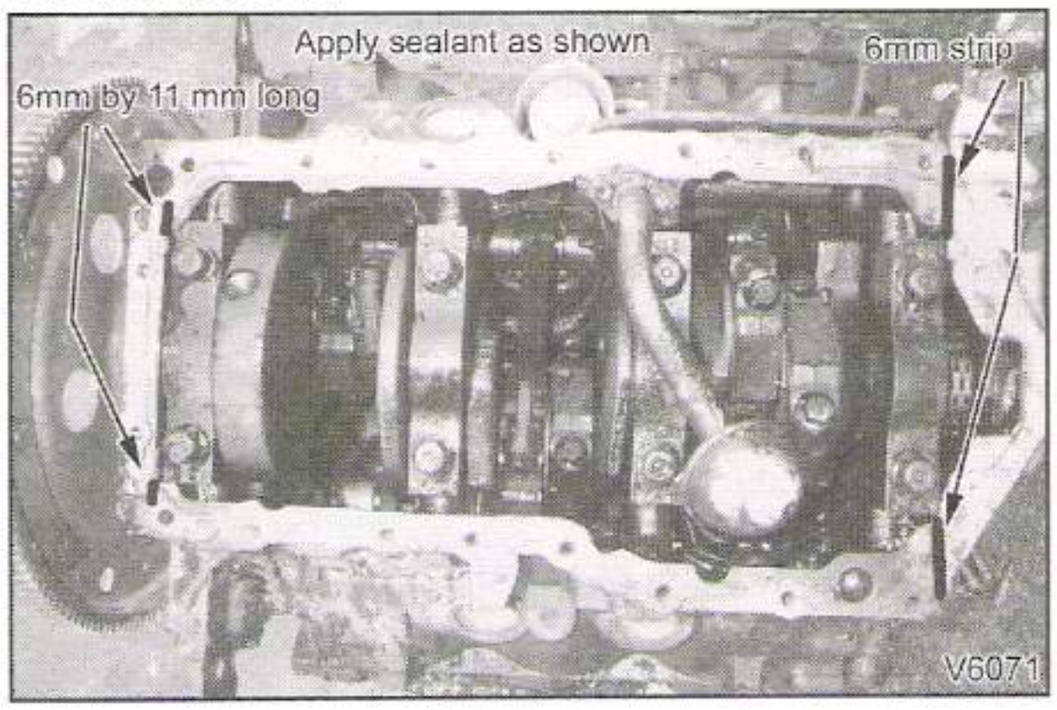
4. Remove oil pan bolts, oil pan and seal, dispose of oil seal.

* Do not reuse the formed rubber oil pan seal.

Install

1. Clean all matching surfaces of oil pan and cylinder block thoroughly.

2. Apply sealant (Loctite 514) to the engine block at the front and rear as shown.



3. Install new gasket onto oil pan, aligning oil pan bolt holes with the holes in gasket.

4. Install oil pan and gasket to crankcase, and tighten as specified.

Oil Pan (Sump) Bolt Specification: 12-16Nm

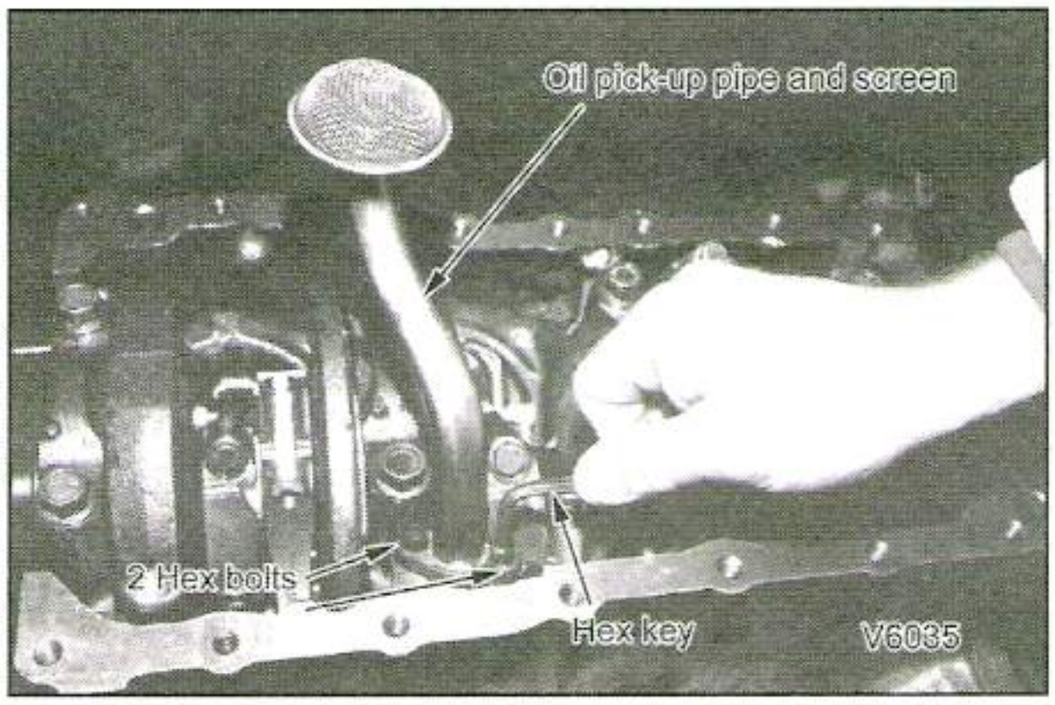
5. Install end of engine rear brace plate, tighten bolts to specification.

End of Engine Rear Brace Plate to Sump: 20-25Mm

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5. Make sure oil pan drain plug is tightened as specified, use a new drain plug seal.
Oil Pan (Sump) Drain Plug Specification: 40-50Nm
6. Replace dip stick.
7. Refill oil pan with the correct amount of engine oil as specified.
Lubricant Quantity Specification:
With out new oil filter: 4.0 Litres
With new oil filter: 4.3 Litres
Lubricant Quality: SAE 15W-40, 20W-40 or 20W-50
Engine Oil Grade API grade: SG or SH
8. Start engine and inspect for oil leaks. Repair as required.
9. Stop engine and check oil level on dip stick.

OIL PUMP SUCTION PIPE AND SCREEN.



Remove
1. Drain oil from oil pan (Sump).
2. To remove oil pan (Sump) refer to "Oil pan (Sump)& Gasket" in this section.
3. Remove the 2 bolts securing suction pipe and oil strainer to the engine block.
Install
1. Make sure that the screen is cleaned of any foreign matter.
2. Clean suction pipe and oil pump cover surfaces.
3. Install the 2 bolts securing suction pipe and oil strainer to the engine block. Use a new "O" ring seal, install and tighten bolts as specified.
Suction Pipe and Strainer Bolts: 8-12Nm
4. Install oil pan and seal to crankcase, and tighten as specified.
Oil Pan (Sump) Bolt: 12-16Nm
5. Make sure oil pan drain plug is tightened as specified.
Oil Pan (Sump) Drain Plug Specification: 40-50Nm
6. Refill oil pan with the correct amount of engine oil as described in the **Oil Pan (Sump)** section.
7. Start engine and inspect for oil leaks. Repair as required.
8. Stop engine and check oil level on dip stick.

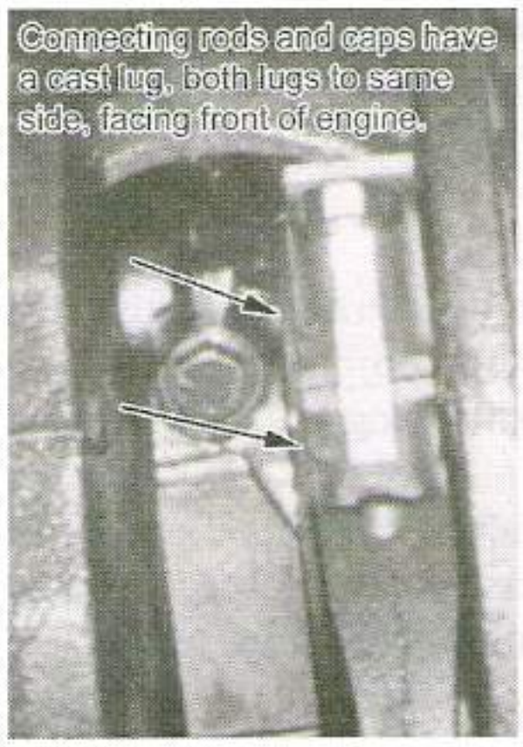
PISTON AND CONNECTING ROD ASSEMBLY.

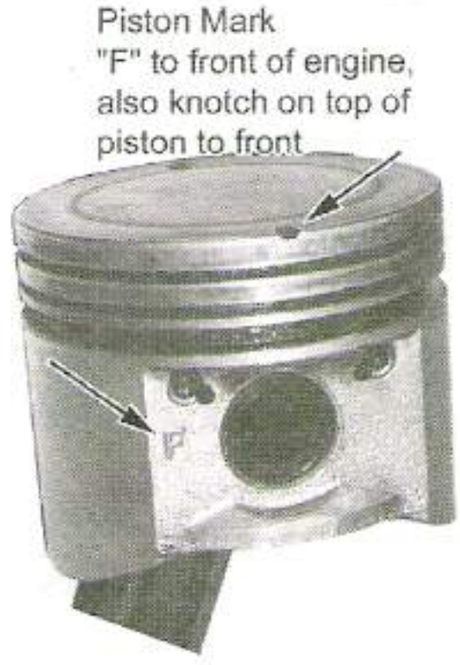
Piston and connecting rod assemblies can be removed while the engine remains in the vehicle.



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If the cylinder bore requires machining, remove the engine assembly as described in ENGINE ASSEMBLY section, remove piston and connecting rod, replace pistons and rings in oversize sets.
Piston and cylinder bore condition must be taken into consideration when fitting new pistons. Production and service pistons have the same nominal weight and can be intermixed without affecting engine balance. If needed, used pistons may be fitted selectively to any cylinder of the engine, providing they are in good condition.
Piston pin assemblies and ring sets are available in oversize.
Remove
1. Disconnect battery negative terminal.
2. Remove cylinder heads as described in CYLINDER HEAD section.
3. To remove oil pan (sump) refer to OIL PAN (SUMP) section
4. Remove oil pump suction pipe and screen refer to OIL PUMP SUCTION PIPE AND SCREEN section.
5. Inspect cylinder bores above piston ring travel. If bores are worn so that a ridge or similar exists.
Turn crankshaft so that piston is at bottom of stroke and cover piston with a cloth to collect cuttings.
Remove the ridge with a ridge remover, this is to be done for each cylinder.
6. Using a punch and hammer, an etching marker, felt tipped

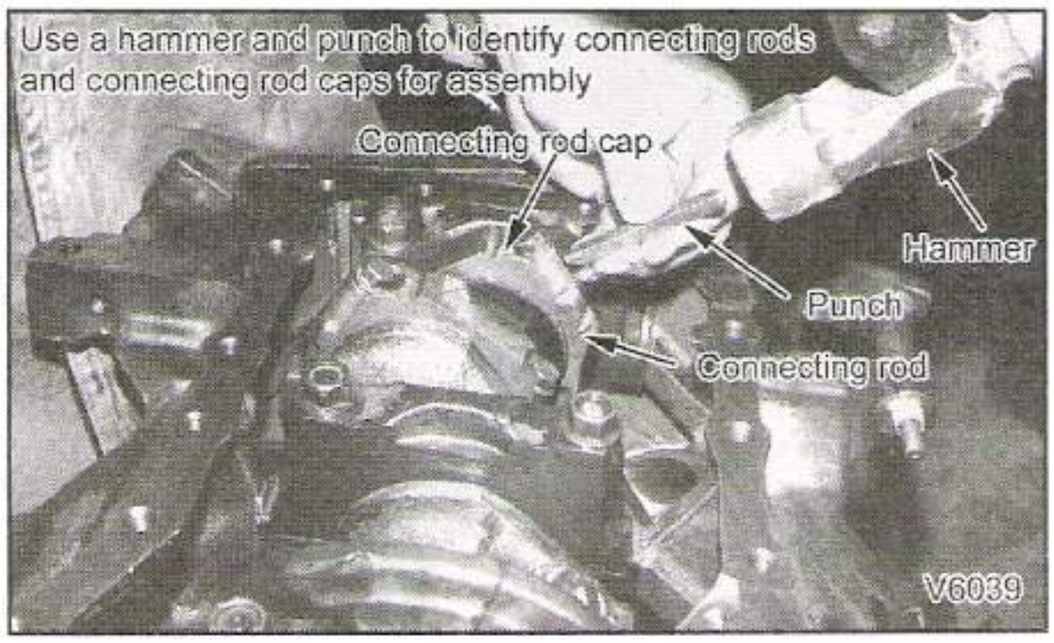




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pen or hammer and punch, mark all connecting rods, caps and pistons to indicate cylinder identification.



7. Remove rod assemblies and piston as follows,
(a) With connecting rod crankshaft journal straight down (Bottom Dead Centre), remove connecting rod cap bolts and remove cap with bearing shell.
(b) Push piston and connecting rod from cylinder using a long guide. Remove guides and install cap and bolts to connecting rod.



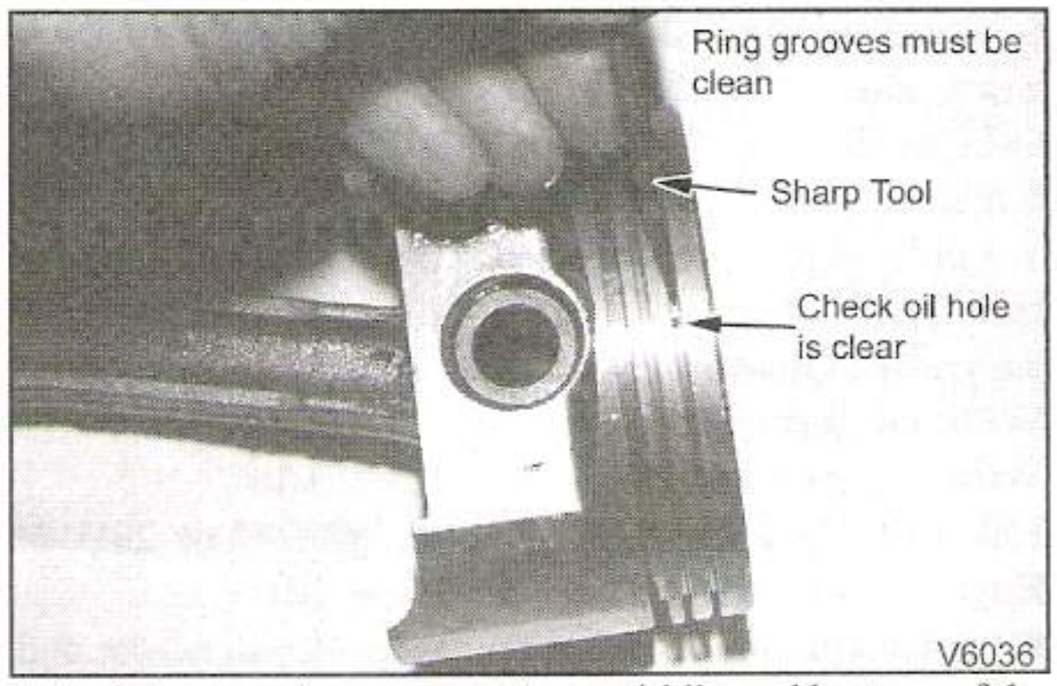
8. Remove all other piston and connecting rod assemblies using the same procedure.

Dismantle.

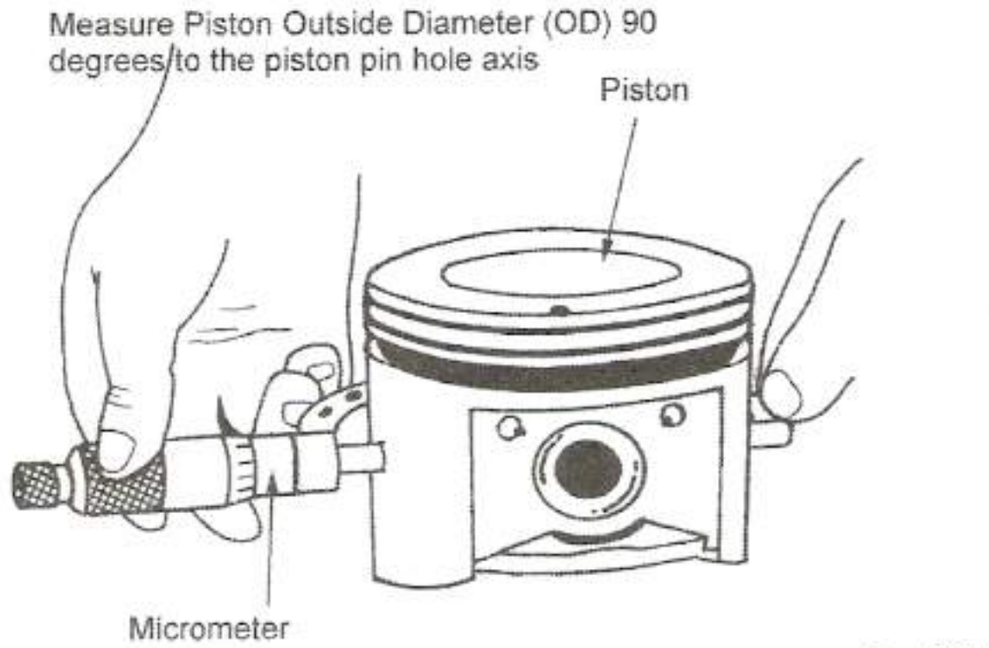
1. Expand and slide piston rings off to remove and dispose of them.
* Worn rings may have sharp edges ensure to take care when removing piston rings.
2. Piston pin can now be removed if required as follows:
a) Remove the piston pin retaining "C" clip.
b) Push or press the piston pin from the piston and connecting rod assembly.

Inspection.

1. Thoroughly clean carbon from piston heads and from ring grooves using a suitable tool (old piston ring) and remove any gum or varnish from piston skirts using a suitable cleaning solvent.
2. Check cylinder walls for ridges, roughness, grooves or scoring which indicates excessive wear. Inspect cylinder bores for taper and possible out-of-round using an accurate



cylinder measuring gauge at top, middle and bottom of the bore, both parallel and at right angles to the centreline of engine. Refer to "Cylinder block" section for details.
3. Examine piston skirt thoroughly for scored or rough surfaces, cracks in skirt or crown of piston, chipping, broken ring lands or uneven piston wear which would cause rings to seat improperly or have excessive clearance in piston ring grooves. Pistons must be replaced if faulty or damaged.
Pistons are cam ground, which means the diameter at right angles to the piston pin is greater than the diameter parallel to the piston pin. When a piston is checked for size, it must be done at points 90° to the piston bore. (Measure *39mm down from piston top)*



Piston Size Standard: 96.482-96.497mm
Available in 0.508mm oversize
4. Check piston pin bores and piston pins for wear. Piston pins and piston pin bores must be free of scuffing or varnish when being measured. Use a micrometer to measure the piston pin, and a dial bore gauge or an inside micrometer to measure piston pin bore.
Piston and pin should be replaced if not as specified.
Piston Pin Clearance
: in Piston 0.002-0.013mm
: in Connecting Rod 0.007-0.022mm
5. Remove bearing shells from connecting rod, install cap and bolts. Tighten bolts as specified.
6. Place connecting rod assembly on a checking fixture and inspect rod for twist or bend.
Replace if twisted or bent, do not attempt to straighten rod.

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Inspect new connecting rods by the same procedure before using them.

Connecting Rod Alignment Max. Specification

Bend 0.020mm per 25.4mm

Twist 0.038mm per 25.4mm

7. Check outside of connecting rod bearing shells and internal diameter of the connecting rod big end for wear, indicating high spots in rod big end.

8. Remove cap bolts and measure bolts for stretching by comparing them with a new bolt, if stretched, replace.

Assembly and Installation.

1. Using engine oil, lubricate piston pin and piston pin bore.

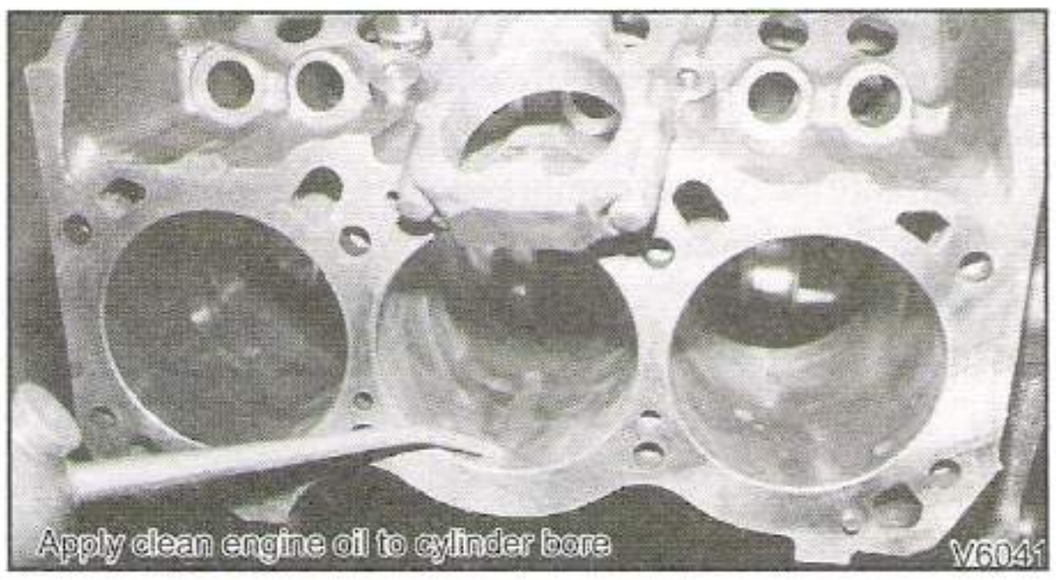
Tip: Check piston notch and connecting rod casting lug, to ensure they are assembled correctly.

2. Install "C" piston pin retaining clip.

3. Press piston pin into place, until piston pin bottoms, install other "C" piston pin retaining clip.

4. To install piston rings refer to "PISTON RINGS" section.

5. Make sure connecting rod bearing shells, pistons, cylinder bores and crankshaft journals are totally clean, then, using clean engine oil, coat cylinder bores and all bearing surfaces.



6. Position the crankshaft journal at its lowest point, before installation of a piston and rod assembly in its bore.

7. Remove bearing cap, and with bearing upper shell seated in to connecting rod, install the guide tool (length of air hose) onto connecting rod bolts.

Guides hold upper bearing shell in position and protect crankshaft journal from damage during the installation of connecting rod and piston assembly.

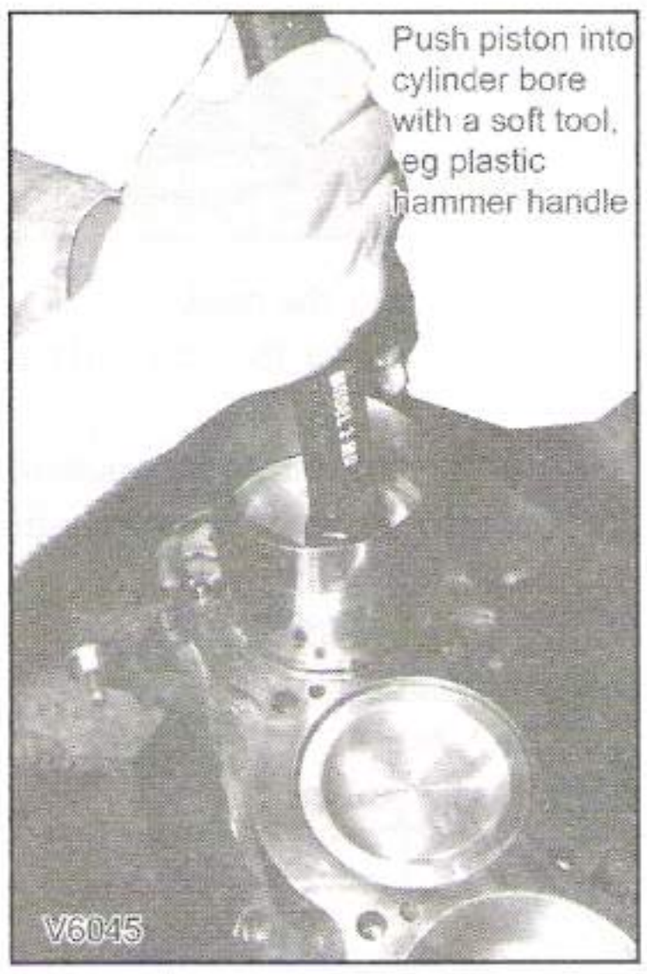
Note: *Check piston notch is to front of engine.*

8. Make sure piston ring gaps are separated as described in PISTON RINGS section.

9. Using clean engine oil, lubricate piston and rings. With a suitable ring compressor, compress rings. Install each piston and connecting rod assembly into its cylinder bore.

10. Lightly tap piston into its bore, using a hammer handle, while holding ring compressor firmly against cylinder block until all piston rings have entered bore.

11. Push the piston down bore until connecting rod seats against the crankshaft journal.



12. Remove connecting rod guides. Install bearing cap and lower bearing shell assembly. Install cap bolts and tighten and then loosen one full turn. Then tighten again as specified.

Connecting Rod Cap Bolt Specification:

24-30Nm. Plus 47^0-53^0 Turn

13. Turn crankshaft to make sure crankshaft and connecting rod can move freely. If crankshaft binds, check bearing cap to rod orientation again and bearing clearance or connecting rod alignment.

14. Measure side clearance between crankshaft journal and connecting rod.

Connecting Rod to crankshaft end clearance:

0.10-0.50mm

If side clearance is not as specified, to check bearing clearance refer to CONNECTING ROD BEARING section, or connecting rod alignment.

15. Install remaining piston and connecting rod assemblies using the same procedure.



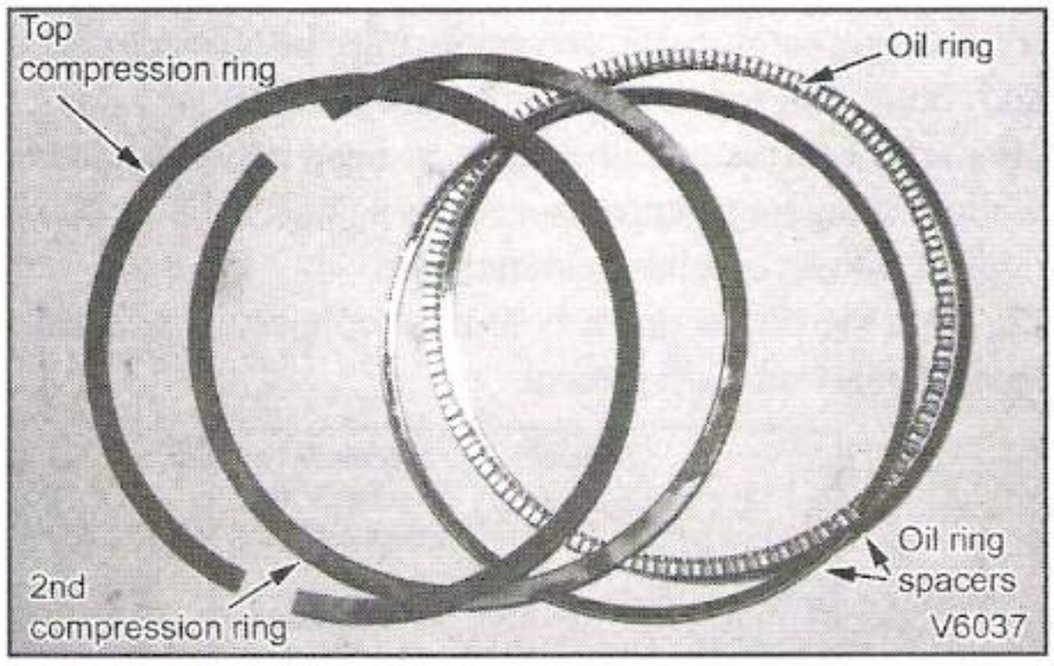
PISTON RINGS.

Install

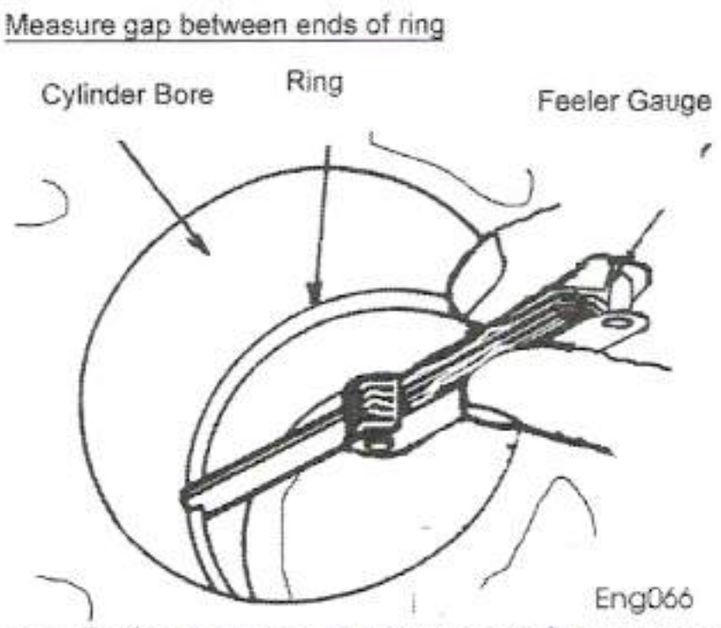
* The pistons have three ring grooves (two compression rings and one oil ring set). The top compression ring is a molybdenum filled, balanced section and barrel lapped type. The second ring is an inverted torsional taper faced type. The oil ring set consists of three pieces, comprising two segments and a spacer.

1. Measure the end gap of the rings to be installed. Install the ring in relevant cylinder bore, then use the head of a piston,

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press ring down evenly into the bore.
* By using the piston as above, the ring will be square with cylinder wall.
* Ensure not to distort the ring during this operation, as it could brake or it may bind in the piston ring groove after the engine is assembled. Measure each ring separately in the cylinder in which it is going to be installed.



2. Using a feeler gauge, measure gap between ends of ring.

Top Compression Ring End Gap Specification:
0.305-0.559mm

Remove ring and try another, if the gap between the ends of a compression ring is below specification. The ring gap may be enlarged by filing.

Second Compression Ring End Gap Specification:
0.762-1.016mm

3. Inspect gap between ends of each oil control ring segment.

Oil Ring Steel Rail Gap Specification:
0.254-0.762mm

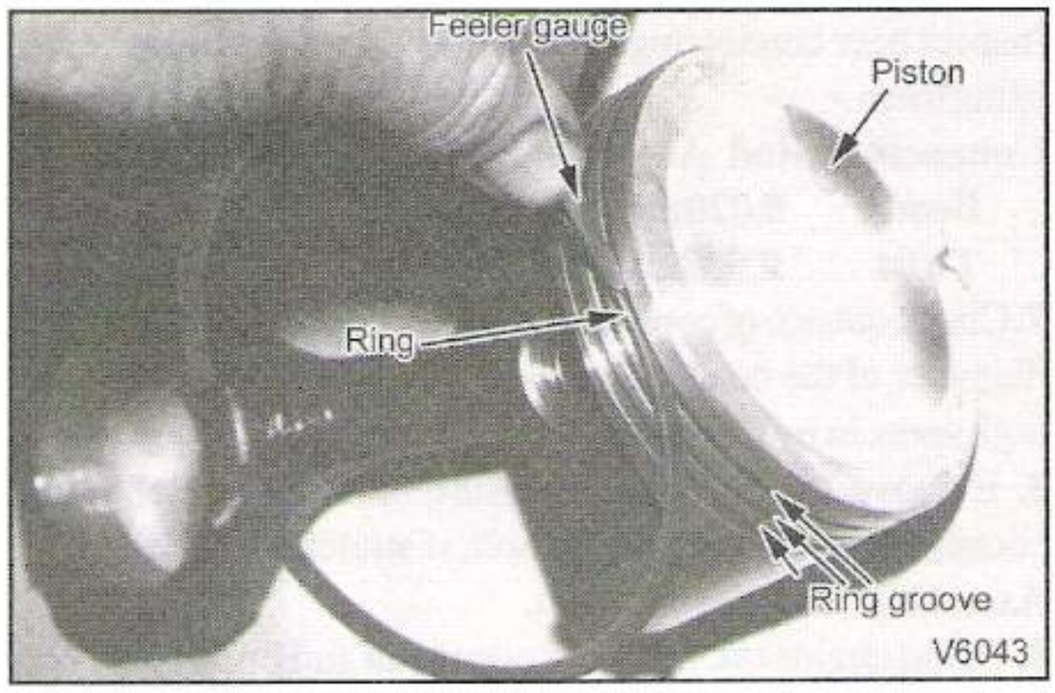
4. Carefully remove all traces of carbon from ring grooves in piston and check grooves for any chips or burrs that might cause ring to bind when fitting.

5. Fit the outer surface of each compression ring into the correct piston ring groove and roll ring around the piston groove to ensure that ring is free. Measure ring to piston groove side clearance.

Piston Ring Side Clearance:

Top Ring:	**0.039-0.079mm**
Second Ring:	**0.039-0.079mm**
Oil Ring:	**0.023-0.201mm**

Try another ring if it is too tight. If no ring can be found that fits the specification, the ring may be ground to size using

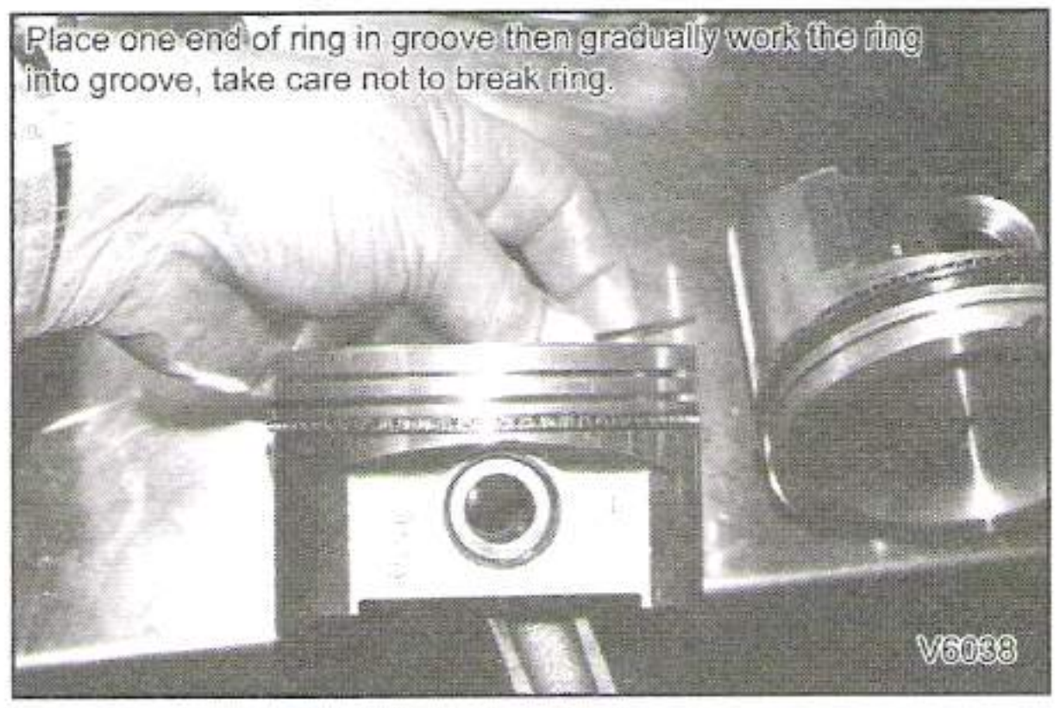


emery paper placed on a piece of glass.
If using a new piston, try another piston.
* High spots in the ring groove may be cleaned up with careful use of a fine file, do not try to cut the piston ring groove.

6. Install oil ring spacer into the bottom piston ring groove.
* The ends of the oil ring spacer butt against each other.

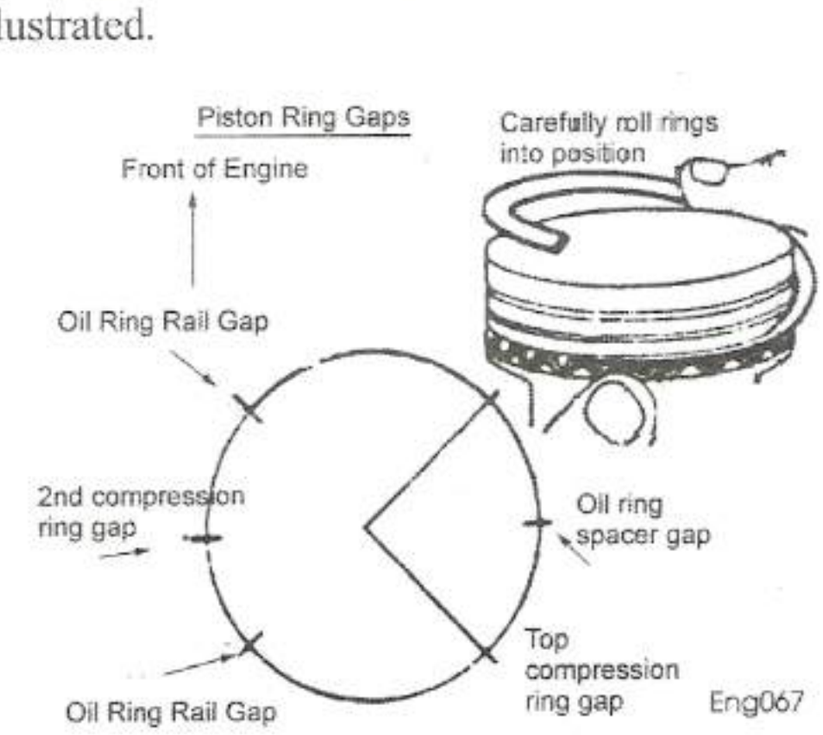
7. Install one steel ring from top of piston down into oil ring groove and install remaining steel ring from bottom of piston up into the oil ring groove.

8. Install compression rings in second and first ring grooves of each piston.
* Make sure the correct compression ring are installed in the first and second grooves, and the correct way up.



Top ring: either way upwards.
2nd ring: has a dot, this must face upwards.

9. Do a final test of ring fit in piston grooves. Separate ends as illustrated.



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* Do not install piston with ring gaps in line, as this will allow blow by at this point.

CONNECTING ROD BEARINGS

Each connecting rod bearing consists of 2 bearing halves or shells which are interchangeable in the rod and cap.
When the shells are in place, the ends extend slightly beyond the parting surfaces of the rod and cap. When the rod bolts are tightened, the shells are tightly clamped in place to ensure positive seating and to prevent rotation.
The connecting rod bearings are of the precision insert type and do not use shims for adjustment. The ends of the bearing shells must never be filed flush with parting surface of rod or cap.

Inspection and Replacement.

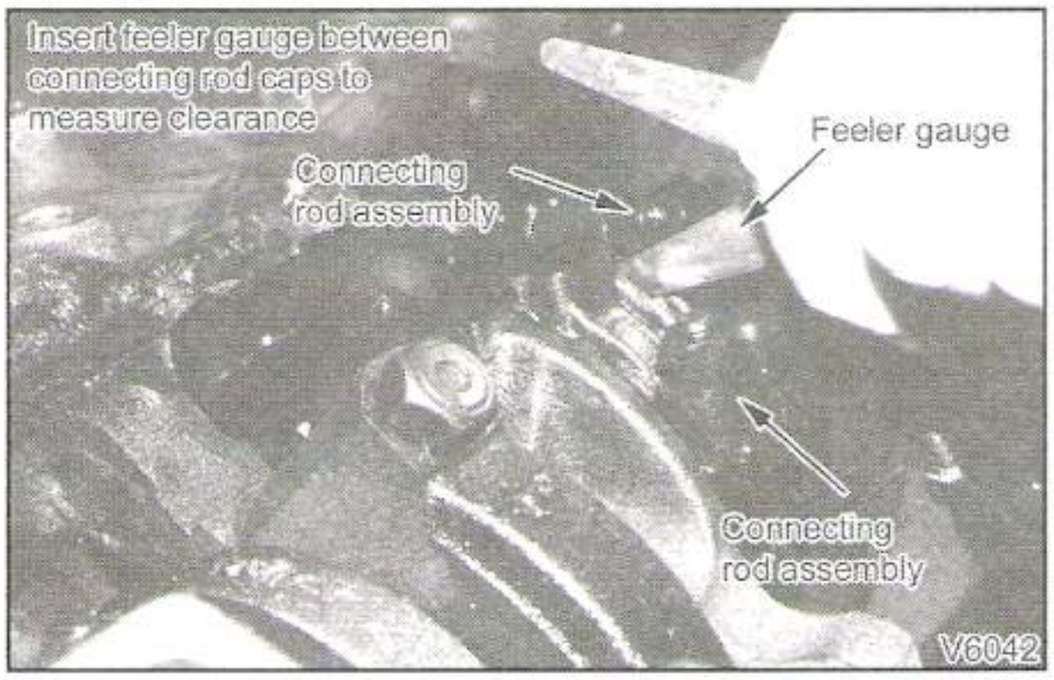
Connecting rod bearings can be replaced without removing the rod and piston assembly from the engine.

1. Disconnect battery earth lead and remove spark plugs.

2. To remove oil pan (Sump) refer to OIL PAN (SUMP) AND SEAL section for details.

3. To remove oil pump suction pipe and screen refer to OIL PUMP SUCTION PIPE AND SCREEN section.

4. Check connecting rod thrust clearance on each journal, if not within specification, replace with new connecting rod. Check clearance specification again if not within specification, replace crankshaft.

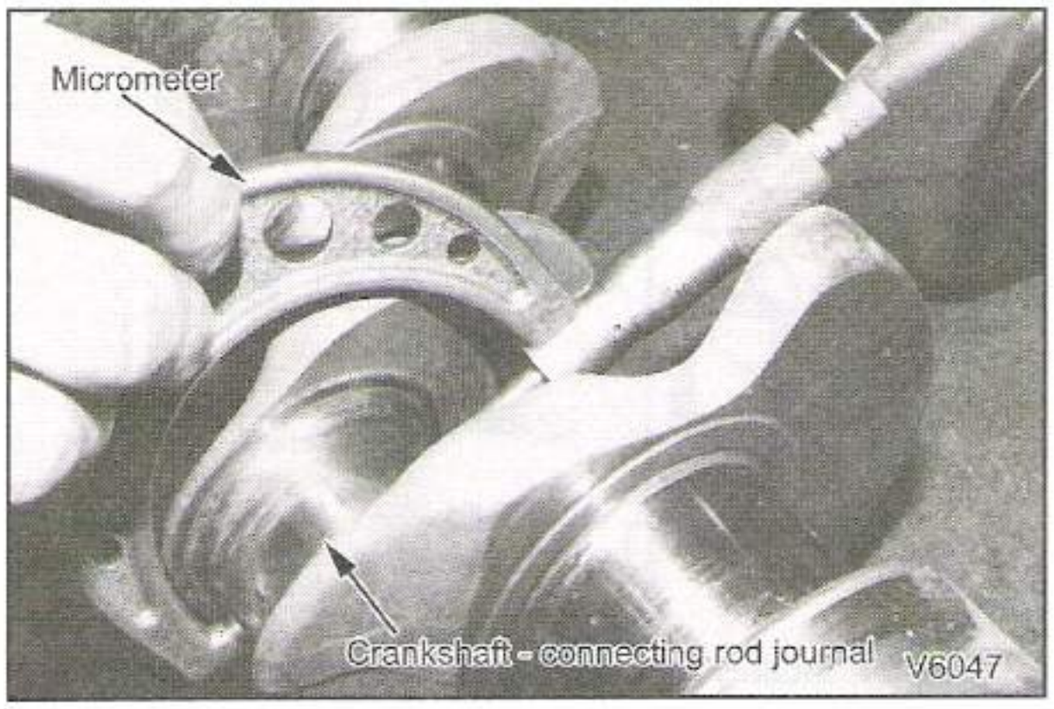


Connecting Rod to crankshaft end clearance:
0.10-0.50mm

5. Using a punch and hammer, an etching marker or felt tipped pen, mark connecting rods and caps to indicate cylinder number and an arrow pointing towards the front of the engine.

6. Remove connecting rod cap securing nuts and remove cap and lower bearing shell, the lower shell may still be on the journal.

7. Push piston and connecting rod up cylinder bore, use a hammer handle or similar to avoid damaging the bearing shell or crankshaft journal. The connecting rod will then be free from crankshaft journal. Remove bearing shell from connecting rod.



8. Clean crankshaft journal and measure for out of round or taper using a micrometer. Replace crankshaft, if not as specified in CRANKSHAFT section.

Connecting Rod Journal:	**57.115-57.147 mm**
Out of round:	**0.0008 mm max**
Taper:	**0.008 mm max**

9. Clean the bearing shell inner and outer surfaces of oil.

10. Inspect inner surface of bearing shells for gouges, wear or embedded foreign matter.
If particles are found, determine its nature and source.
Inspect outer surface of bearing shell for surface wear (indicates movement of shell in cap or high spot in surrounding material), looseness or turning (flattened tangs and wear grooves in shell), or overheating (discoloration of shell either side).
The crankshaft may be bent or have tapered bearing journals if uneven side to side wear is found. If necessary, remove crankshaft, refer to "Crankshaft" section and inspect crankshaft.
* Bearing failure, other than normal wear, should be examined carefully to determine cause.

11. Install bearing shells in original positions in connecting rod and cap if inspection reveals that crankshaft is OK.

12. Push connecting rod down onto crankshaft to allow the upper bearing to be seated against crankshaft journal.

13. Place a section of plastigage across the width of bearing journal, parallel to crankshaft centreline.
Tip: Make sure plastigage is not placed across the oil hole in journal.

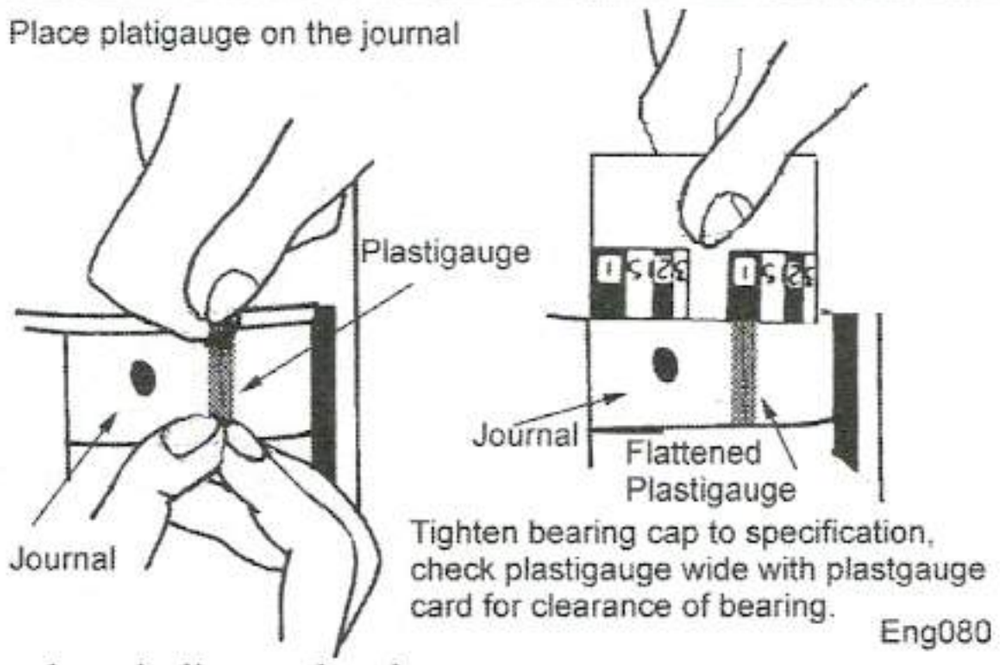
14. Install connecting rod caps to their original position as described in step 6. Tighten bolts as specified.
* Make sure that crankshaft does not rotate with plastigage installed.

Connecting Rod Cap Bolt Specification:
24-30Nm. Plus 47^0-53^0 Turn

15. Remove the connecting rod cap bolts, and cap. Inspect the flattened plastigage it will stick to either the crankshaft or bearing shell in cap.

16. Comparing width of flattened plastigage at widest point with graduation on plastigage envelope, to determine the bearing clearance. The number on the graduation scale of the

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envelope indicates the clearance.
Clearance between connecting rod bearings and crankshaft must not exceed specification.

Connecting Rod Bearing Clearance: 0.023-0.053mm

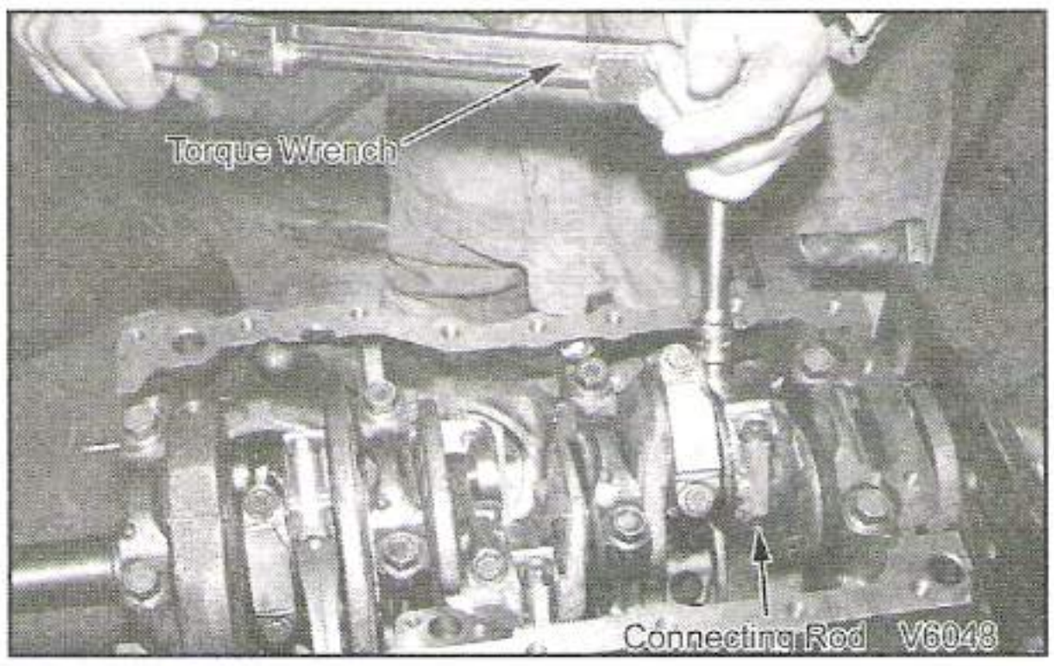
17. Make sure that connecting rod cap bolt threads and connecting rod threads are clean. Apply some new engine oil to the cap bolt threads.

* Before final installation of cap bolts, determine if bolts have stretched by measuring, then comparing with a new bolt. Replace bolt/s if necessary.

18. Install bearing shells in connecting rod and cap making sure notches in the shells match up with the recesses in connecting rod and cap.

Inspect clearance of new bearing using plastigage as previously described.

19. Remove all remains of plastigage from journal and shells after measuring. Using clean engine oil to lubricate bearing shells and journal. Arrow points towards the front of the engine. Install connecting rod caps to their original position as described in step 6. Tighten bolts and then loosen one full turn. Finally tighten cap bolts as specified.



Connecting Rod Cap Bolt Specification:

24-30Nm. Plus 47⁰-53⁰ Turn

20. After the bearing shells have been installed and cap bolts tightened, it should be possible to slide connecting rod backwards and forwards on crankshaft journal to allow end clearance. The crankshaft must turn without binding.

Connecting Rod to crankshaft end clearance:

0.10-0.50mm

If connecting rod binds on the crankshaft journal, loosen and retighten the bearing cap bolts.

If connecting rod still cannot be moved or crankshaft binds, inspect bearing cap is installed correctly, bearing clearance or connecting rod alignment.

21. Install oil pump suction pipe and screen as described.

22. Install the engine sump with new gasket and sealant.

CRANKSHAFT.

Remove

* To check bearing clearance before removing crankshaft from crankcase refer to "connecting rod bearings" and "main bearings" section.

1. When engine is removed from vehicle and mounted on an engine stand, remove oil sump.

2. Remove flywheel/driveplate.

3. Remove oil pump suction pipe and screen and remove crankshaft balancer refer.

4. Remove timing chain cover.

5. Remove crankshaft sprocket.

6. Remove spark plugs.

7. Using a punch and hammer or an etching marker or felt tipped pen to mark connecting rod caps to indicate cylinder number and arrow to point towards front of engine.

8. Remove connecting rod caps and nuts and push the connecting rods away from crankshaft.

9. Using a punch and hammer or an etching marker or felt tipped pen to mark connecting rod caps to indicate cylinder number and arrow to point towards front of engine.

10. Remove main bearing cap bolts and main bearing caps.

11. Lift crankshaft from cylinder block.

12. Remove key from front end of crankshaft, if needed, using a suitable punch and hammer.

Clean, Inspection and Installation.

1. Using a suitable cleaning solvent, pressure wash crankshaft and dry with compressed air.

2. Check crankshaft oil passages for obstructions.

3. Check all bearing journals and thrust surfaces for: gouges, overheating (discoloration), cracks, grooving, chips and roughness.

The crankshaft must be machined or replaced if it has any burned spots, cracks or sever gouging. Slight roughness may be removed using a fine polishing cloth soaked in clean engine oil. Burrs may also be removed using a fine oil stone.

4. Check connecting rod and main bearing shells as described for embedded foreign material, then try to determine its source.

5. Using a micrometer measure bearing journals for taper, excessive wear or out-of-round.

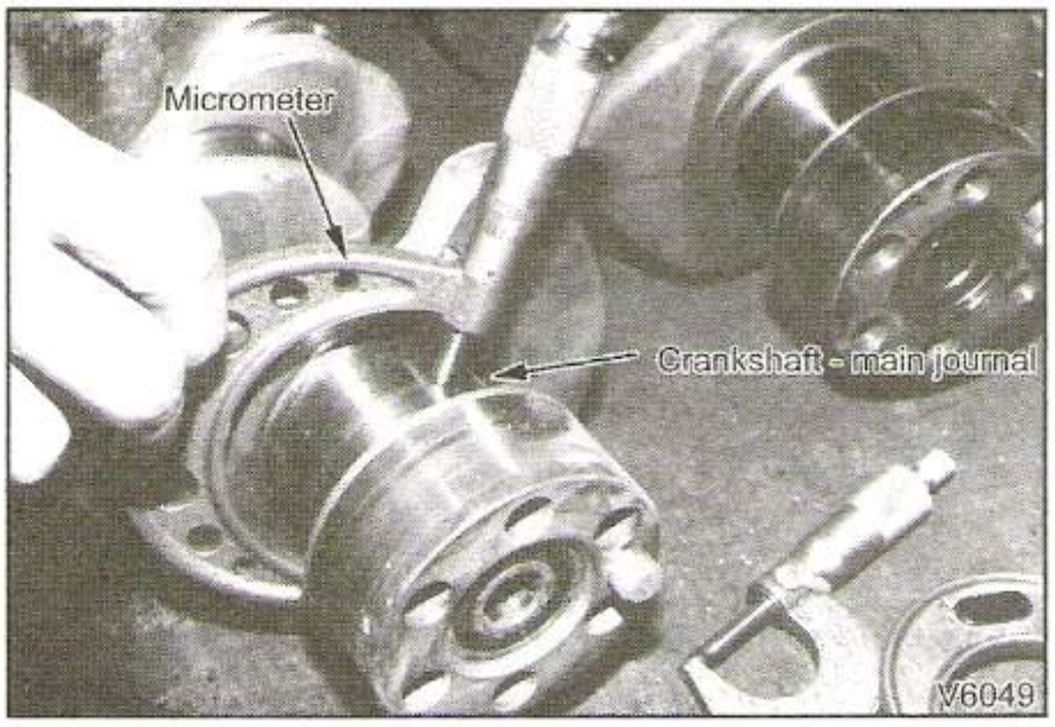
Main Bearing Journal Diameter

Standard Size:	**63.470-63.495mm**
Taper:	**0.008mm max.**
Out-Of-Round:	**0.008mm max.**

Connecting Rod Journal Diameter

Standard Size:	**57.117-57.147mm**
Taper:	**0.008mm max.**

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Out-Of-Round: **0.008mm max.**

6. Inspect crankshaft for run-out by fitting front and rear main bearing journals in a set of "V" blocks and checking other journals with a dial gauge.

Crankshaft Runout Specification: **0.008mm max.**

7. Place a dial gauge indicator at the end of the crankshaft, on the rear flange to inspect rear flange runout. Make sure that crankshaft is thrust forward against a block of wood or on the "V" blocks so there is no possible movement of the crankshaft affecting dial gauge reading.

Crankshaft Rear Flange Runout: **0.05mm**

8. If not as specified, replace crankshaft.

9. Ensure all traces of sealant are cleaned from rear main bearing cap and crankcase.

MAIN BEARINGS.

Crankshaft main bearing journals have 2 bearing halves (shells) which are not the same and not interchangeable in the bearing cap or engine block. The upper (engine block) shell is grooved to supply oil to the bearing, while the lower (into bearing cradle) shell is not grooved. The 2 bearing shells must not be interchanged. The No.2. bearing has flanges to take end thrust.

The main bearings are of the precision insert type and do not require reaming to size or utilize shims for adjustment.

Standard size and 0.0254mm undersize main bearing shells are available.

Bearing shells are stamped with the part number, the number of the bearing shells can be identified, see chart below.

Bearing(Main) Upper and lower	*Standard size*	*0.0254mm undersize*
1	*12537031*	*12537032*
2	*12537033*	*12537034*
3	*18017988*	*18017989*
4	*12537172*	*12537173*

When shells are fitted in engine block and bearing cap, the ends extend slightly past the parting surfaces, when cap bolts are tightened the shells clamp tightly into place, ensuring firm seating and to prevent the bearing from turning.

The ends of the bearing shells must never be filed flush with surfaces of engine block or bearing caps.

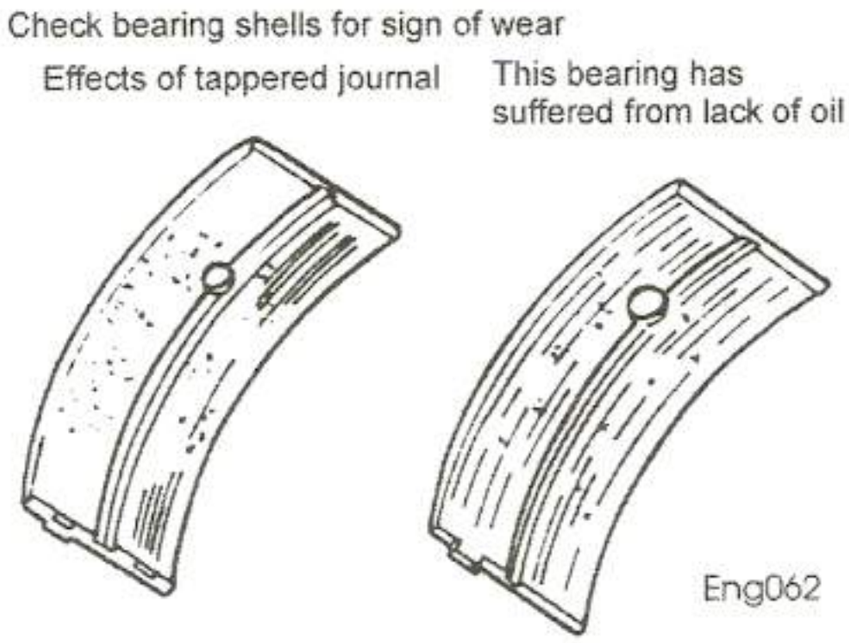
Bearing Inspection and Installation.

1. Check lower bearing shells and crankshaft journals. If the journal surface is ridged or heavily scored, replace crankshaft.

Tip: It is wise to new bearing shells when an engine is pulled down.

Inspect inner surface of bearing shells for gouges, wear or foreign material. Any foreign material found, the type and source should be found. Inspect outer surface of bearing shells for surface wear, this would indicate movement of bearing shell or high spot in surrounding material, looseness, rotation is indicated by flattened tangs and wear grooves, and overheating discolours the bearing metal.

Inspect thrust surfaces of thrust bearing for grooving or wear. Grooves are caused by irregularities in the crankshaft thrust surfaces or particles in the oil.



If the lower bearing shells and crankshaft journals are satisfactory, inspect bearing clearance

2. Inspect bearing tolerances, wipe oil from crankshaft journal, inner and outer surfaces of lower bearing shell. Install bearing shell in original position in bearing cap.

3. Place a section of plastigage across full width of crankshaft journal, parallel to crankshaft centreline.

* Make sure plastigage will is not across an oil hole in journal.

4. Install bearing cap assembly and bolts.

* Install bearing cap assembly by loosely installing cap bolts and then lightly tap bearing cap into position, in order to prevent the possibility of cylinder block and or main bearing cap damage.

* Do not pull the bearing cap into place with the bearing cap bolts.

5. Tighten bearing cap to approx. 70Nm, then loosen cap bolts a full turn.

* Ensure that crankshaft does not rotate with plastigage installed.

Main Bearing Cap Bolt Torque:

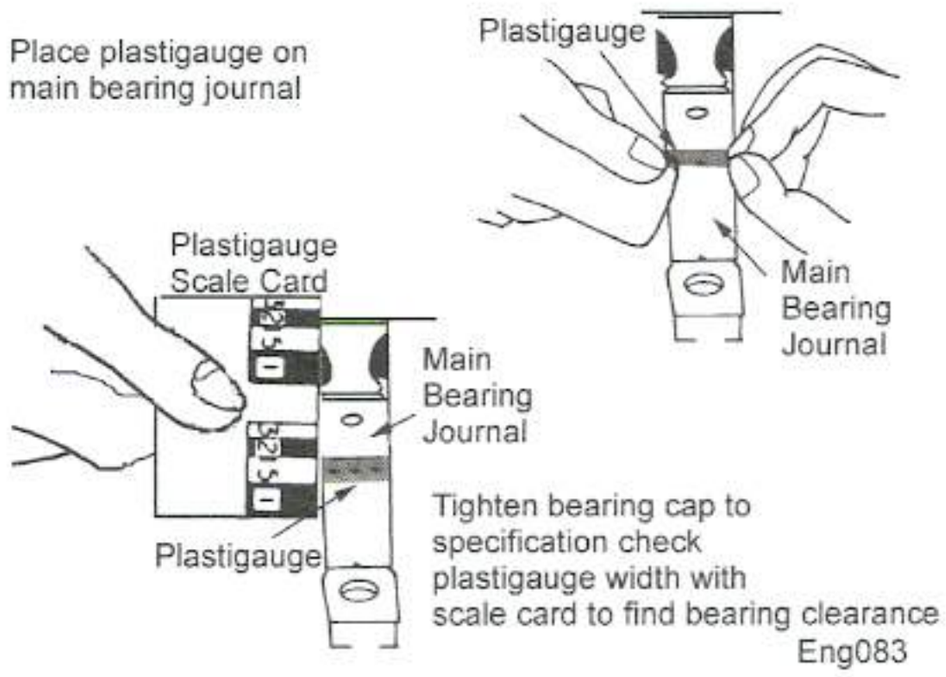
Step 1: tight to 20Nm then to 40Nm

Step 2: tighten a further 35^0 plus 35^0 plus 35^0

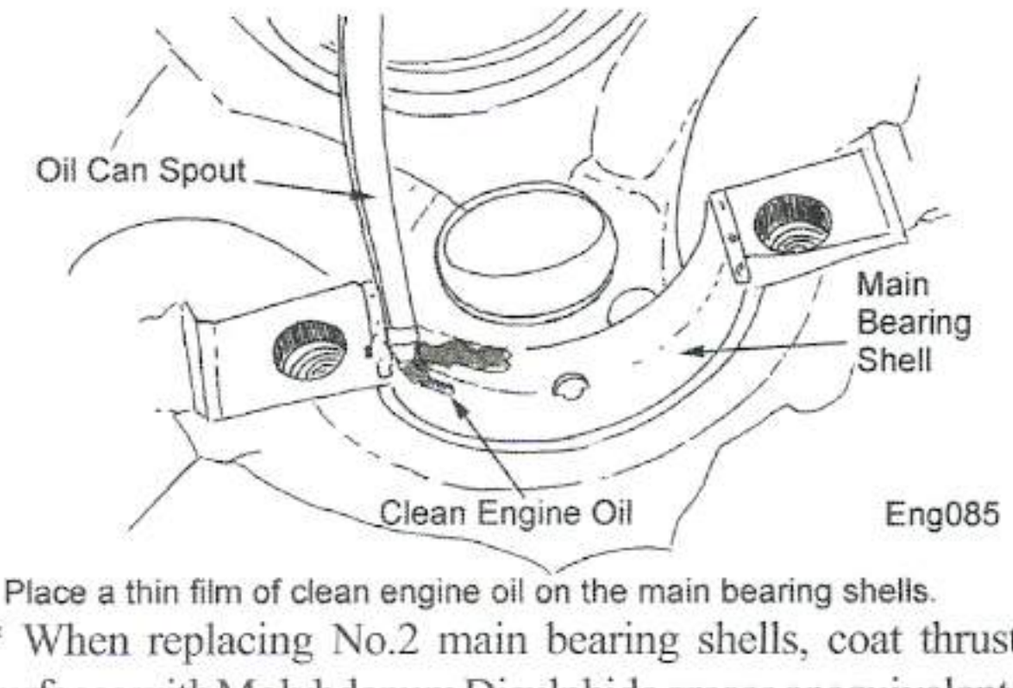
Step 3: Torque side bolts 12-18Nm plus 42^0-48^0

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6. Remove bearing cap and bolts. Check flattened plastigage sticking to either crankshaft or bearing shell in bearing cap.
7. Check bearing clearance by comparing width of flattened plastigage at widest point with scale on plastigage envelope. The graduated number on the envelope indicates the clearance.
Main bearing and crankshaft journal clearance should not exceed specification.



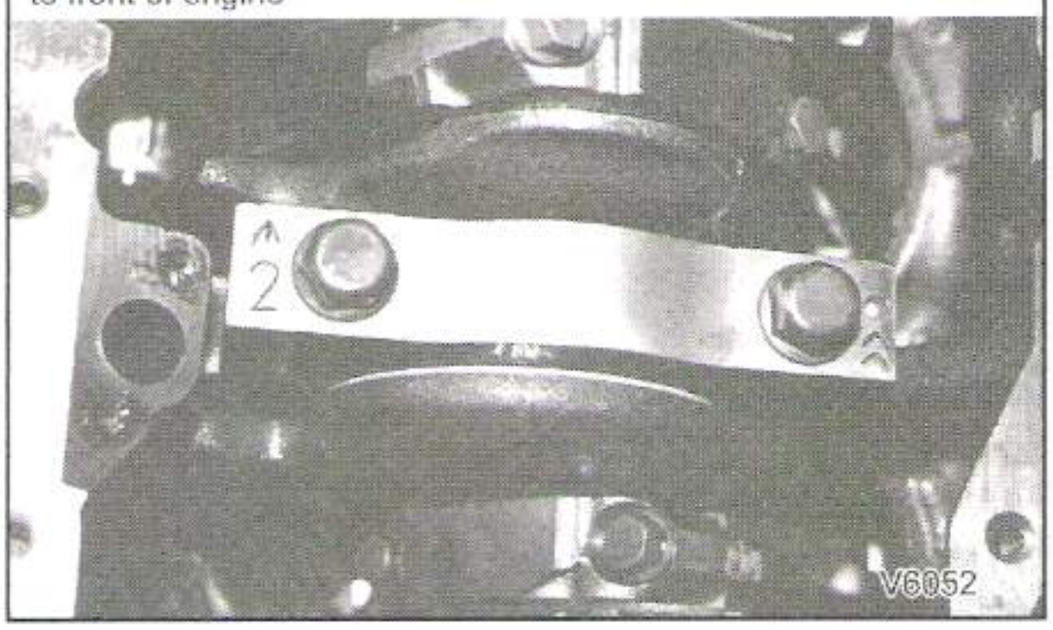
Main Bearing Clearance: 0.023-0.053mm
* This check does not show any indication of crankshaft journal taper or out of round.
To measure taper, out of round or undersized, the crankshaft should be removed from the engine block as previously described.
8. It is advisable to install new bearing shells if bearing clearance exceeds specification and re-check clearance.
#If lower bearing is standard size, install a 0.254 mm undersized shell and check clearance again.
Replace crankshaft if clearance is still not as specified. Apply a thin film of engine oil to the main bearing shells.
9. Install new bearing upper shells in cylinder block, making sure notches in bearings line up with recesses in block. Bearing shells are marked with the part number.
[Crankshaft in engine] Insert un-notched end of shell between crankshaft journal and notched side of crankcase.
Note: If crankshaft is still in engine the place bearing shell on journal and push around journal into place. Installing a cotter pin into the oil hole of the crankshaft, then rotate crankshaft correct way carefully, the cotter pin will roll the bearing shell into place. Do not force shaft when shall is in place.
* Make sure that the correct bearing shell is fitted between the crankcase journal and crankcase.
10. Sit crankshaft in place in main bearing upper shells in crankcase. Ensure not to damage crankshaft thrust bearing surfaces at No.2 main bearing
11. Install lower bearing shells in bearing cap cradle assembly, making sure the notches in the shells line up with the recesses in the caps and correct bearing is installed in the appropriate cap. Lower shells are not grooved and are available in either undersized or standard size.
12. Using engine oil, lubricate journal and bearing shells.



Place a thin film of clean engine oil on the main bearing shells.

* When replacing No.2 main bearing shells, coat thrust surfaces with Molybdenum Disulphide grease or equivalent.
13. Make sure that main bearing cap bolt threads and cylinder block threads are clean and dry. Apply some engine oil to the cap bolt threads.
* Arrow on the main bearing cap must face or point to the front of the engine.

No 2 Main Bearing Cap, number on left side, arrows must point to front of engine



* Before final installation of cap assembly bolts, determine if bolts have stretched by measuring with a new bolt. Replace bolts as needed.
* If the thrust bearing washer is disturbed or replaced, coat the surface using Molybdenum Disulphide Grease.

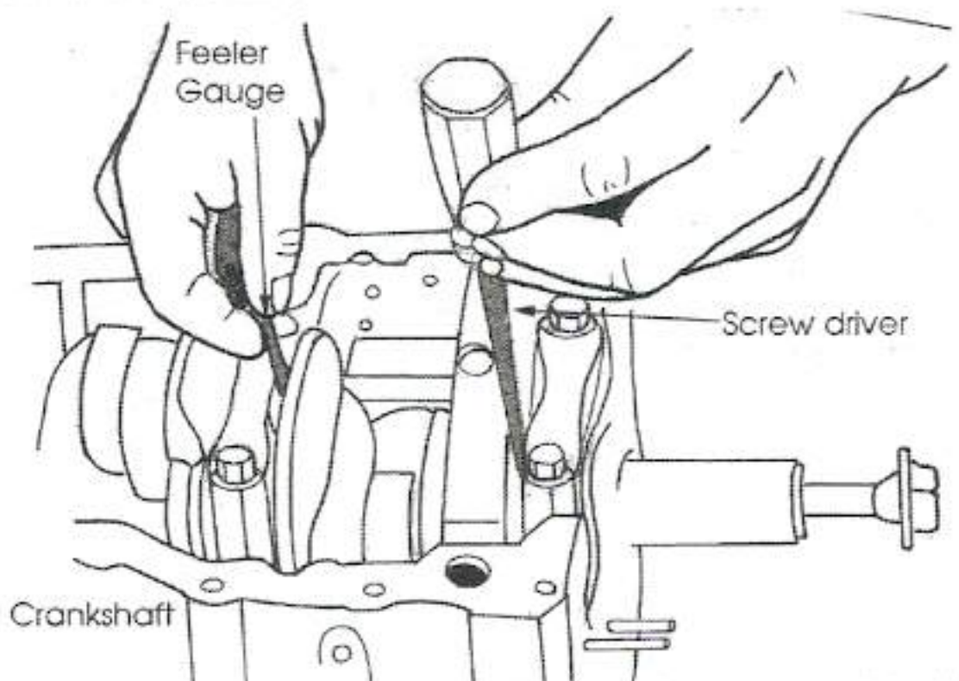


14. Install bearing cap assembly and tighten all bearing cap bolts to the correct specification.
Main Bearing Cap Bolt Torque:
Step 1: tight to 20Nm then to 40Nm
Step 2: tighten a further 35^0 plus 35^0 plus 35^0
Step 3: Torque side bolts 12-18Nm plus 42^0-48^0

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* To eliminate the possibility of cylinder block or bearing cap assembly damage, install bearing caps by installing cap bolts loosely and then lightly tap the bearing cap assembly into position using a soft faced hammer. Do not pull the cap assembly into place by using the bearing cap bolts.

15. Use a feeler gauge to measure crankshaft end float between front of No.2 main bearing thrust washer and crankshaft thrust faces, you will need to force crankshaft forward to do this.



Use a screw driver against main bedrings to move crankshaft backwards and forwards to measure endfloat with a feeler gauge. Eng061

Crankshaft End Float Specification: 0.08-0.28 mm

16. Pull connecting rods up to crankshaft journals, using guide pin tools. Inspect connecting rod bearing clearances, if needed, refer to "Connecting rod bearing" section for details.

17. Turn crankshaft and it should turn without binding. If binding, inspect orientation of bearing cap, correct fitting of bearing shells or bearing clearance.

18. Install oil pump suction pipe and screen.

19. Install oil pan (sump) and gasket

20. Install flywheel/drive plate, tighten bolts to specification.

Flywheel / Driveplate Bolt Specification:

1st Step - 18-22 Nm

2nd Step - Turn bolts an extra 47-53 degress

21. Using the correct amount of engine oil refill the oil pan.

REAR MAIN OIL SEAL

Replace

1. Disconnect battery negative terminal.

2. Remove transmission, as described under "Manual transmission" and "Automatic Transmission" in this manual.

3. Remove flywheel/driveplate, as described in "Flywheel/driveplate" in this manual.

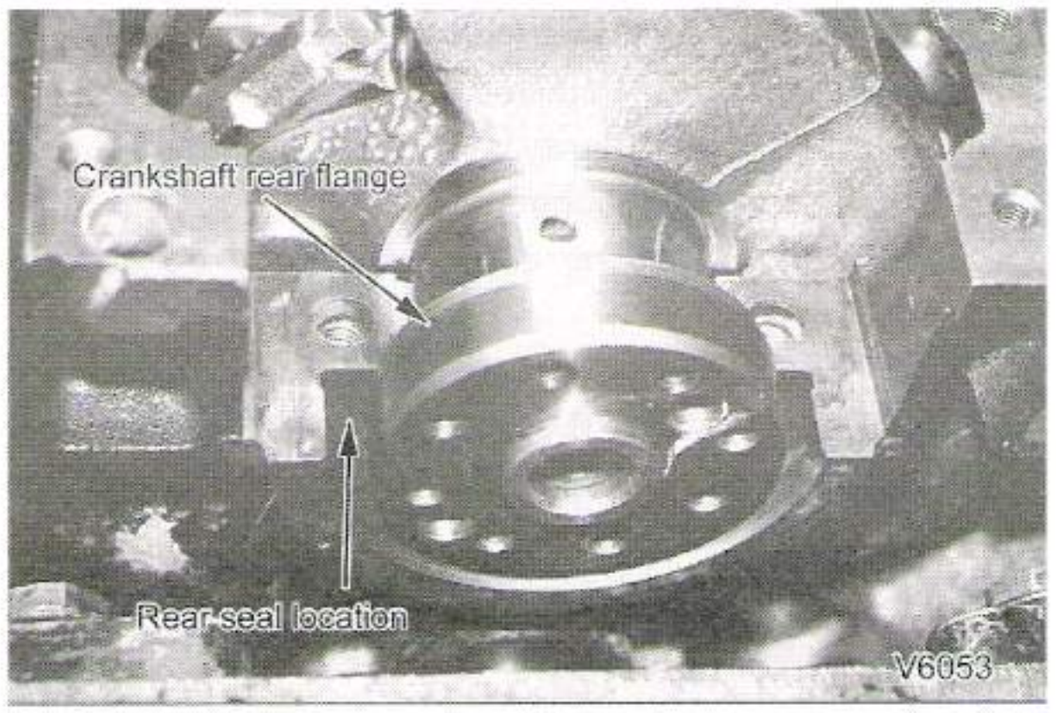
4. a) Position a soft metal (eg brass aluminium or similar) to protect the end of the crankshaft surface.

b) Pry the old seal out with a screw driver or strong lever.

c) Clean seal groove with a cloth.

d) Install new seal with a seal installer, ensure the seals lips are not pulled back or crooked.

Note The oil seal is not to have more than 0.250mm run out, measure from rear flange surface, several plces.



5. Clean flywheel/drive plate attaching bolt threads in rear of crankshaft using a thread tap.

Install new flywheel/flexplate and attaching bolts, tighten bolts to the correct torque specification.

Flywheel / Driveplate Bolt Specification:

1st Step - 18-22 Nm

2nd Step - Turn bolts an extra 47-53 degress

6. Reinstall transmission, check engine and transmission lubricant levels.

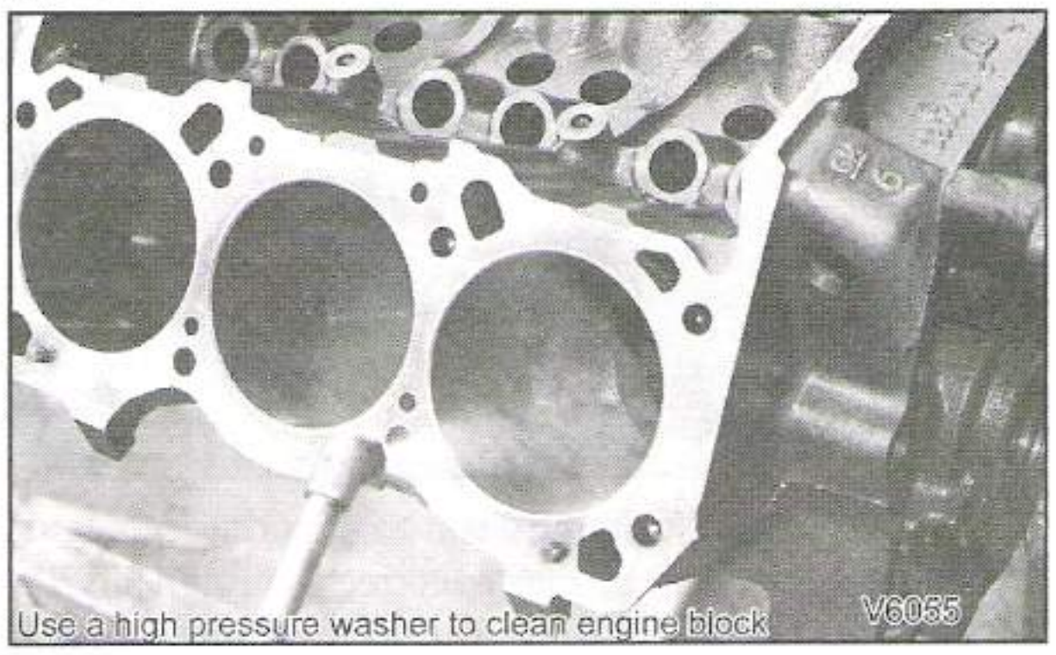
7. Road-test vehicle and check for lubrication leaks.

CYLINDER BLOCK.

Inspection.

1. Mount the block in an engine stand.

2. Pressure wash the block and clean all cylinder block gasket surfaces.



Use a high pressure washer to clean engine block

3. If required remove all coolant jacket welsh plugs, oil gallery screw plugs.

Tip: It is a good practise to remove coolant welsh plugs.

4. Clean cylinder block thoroughly using a suitable cleaning solution. Flush with clean water or steam. Spray or wipe cylinder bores and machined surfaces using engine oil.

* Caustic cleaning solutions destroy all bearing and alloy materials. All bearing and alloy parts if not removed before cleaning must be replaced.

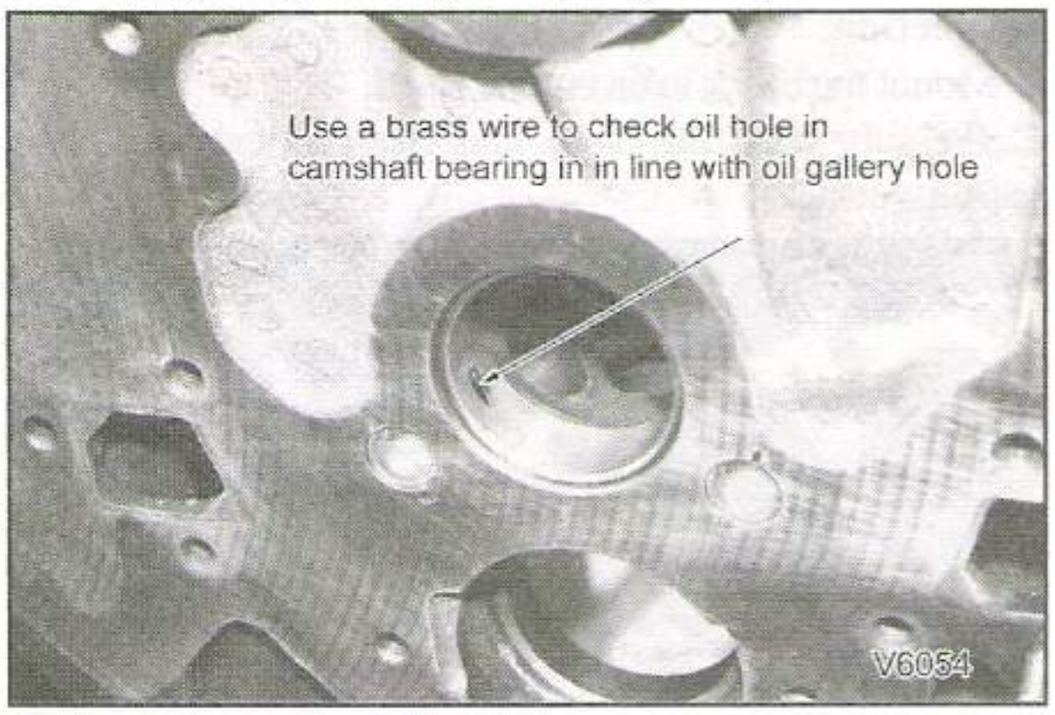
Do not use caustic solutions to clean bearing material or alloy parts.

5. Check all oil passages for obstructions.

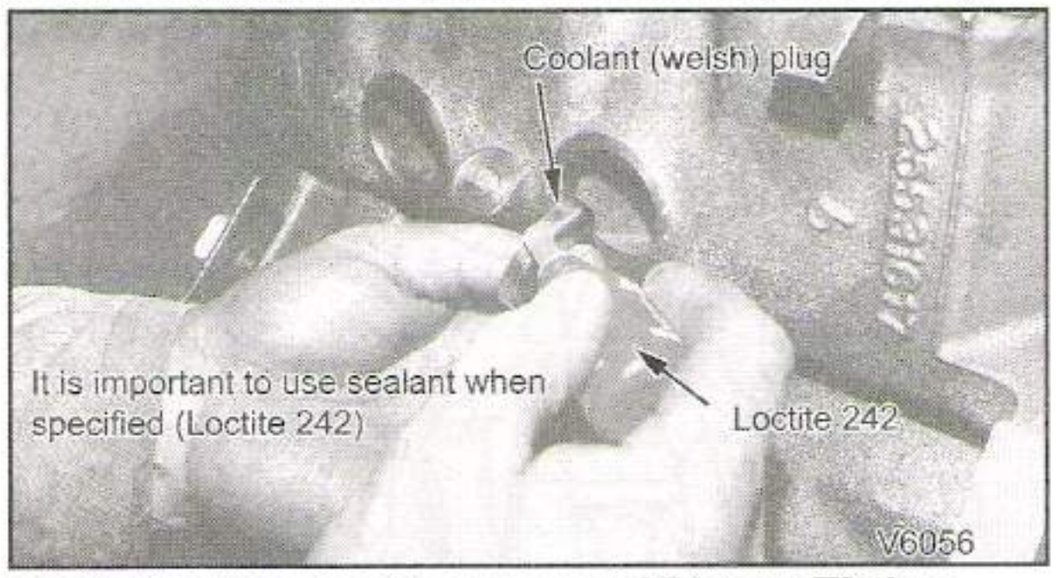
Tip: Use a 22 gauge rifle cleaning rod and brush.

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6. Using a straight edge and feeler gauge, inspect cylinder block deck surface for flatness.
If any distortion or irregularity is less than specified, cylinder block surface may be machined.
Tip: Install main bearing caps and torque before machining.
Cylinder Block Deck Surfaces Flatness: 0.013mm per 25.4mm or a Max 0.08mm for complete surface.
Replace cylinder block if irregularity or distortion is more than specified.
7. Replace camshaft bearings if necessary.
a) Use a special tool (camshaft bearing removal/installing tool) insert through camshaft bearings, install washer and nut to tool, and pull the bearings free from the block, one at a time.
b) Clean bearing bore, coat new bearing in new engine oil, use the same tool for removing the bearings to install the new bearings, pull into place, one at a time.
Tip: The bearings for journals Nos 1 & 4 are the same with 2 oil holes and an oil slot each. Journal Nos 2 & 3 are the same with 1 oil hole each.
Note: Oil slots in bearings for journals 1 & 4 face either end of engine, 1 slot faces to front, 4 slot faces to rear.
Note: Check with a brass wire or similar that the oil holes allow oil to feed from the block, the oil holes and block oil gallery must give a free flow of oil.



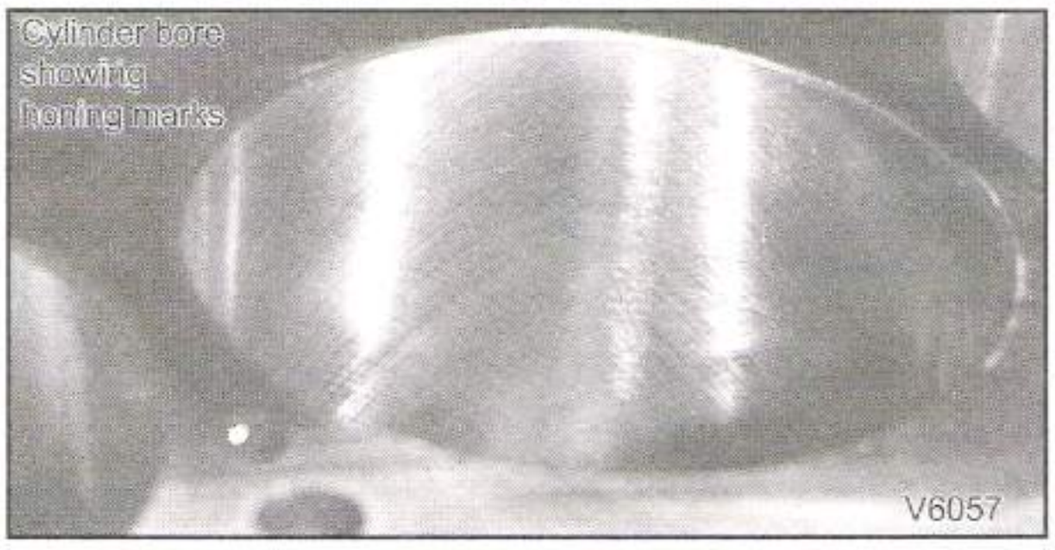
8. Check oil sump and timing chain cover surfaces for burrs or damage. Minor damage may be corrected using a fine file.
10. If needed, clean all threaded holes using a suitable threaded tap or drill out and install thread insert.
11. Measure cylinder bore walls for taper, oversize and out-of-round.
Cylinder Bore (Standard): 96.507 - 96.533mm
Taper: Max 0.013mm
Out of Round: Max 0.010mm
If cylinder bore is worn over maximum limits, the block may be rebored, honed and oversize pistons installed.
12. Install main bearing caps (without bearings) and tighten as described in main bearing section and measure crankshaft bearing bore.
Crankshaft Bearing Bore Out-of-Round:Max 0.008mm
If not within specification replace block, any minor high spots may be filled with a fine fill.
13. Measure camshaft bearing bore.
Camshaft Bearing Bore Out-of-Round:Max 0.0013mm
If not within specification replace block, any minor high spots may be filled with a fine fill.
14. If coolant and oil gallery plugs were removed when dismantling, install using specified sealant (Loctite 242).



Cylinder Reconditioning and Piston Fitting.

It will be necessary to smooth bores to fit new pistons, if one or more cylinder bores are scored, rough or worn beyond limits.
It is not be necessary to rebore all cylinders to the same oversize, to maintain engine balance, if some cylinders require reboring. All oversize OEM pistons are the same weight as standard size pistons.
Do not try to machine oversize pistons to fit cylinder bores, this will destroy the surface treatment of the piston and affect the weight. Install the smallest possible oversize OEM pistons and the cylinder bores should be honed to size for proper clearances.
Measure all new pistons at right angles to the piston pin bore, as described in piston section, before the honing or reboring operation is started.
Honing is recommended for trueing bore if cylinder bore wear does not exceed specification. The bore should be corrected up by boring and then hone finished, if wear or out-of-round exceeds specification.
All crankshaft bearing caps must be installed and torqued to specification when reboring cylinder bores, this help prevent distortion of bores in final assembly.
Leave 0.020 mm on the diameter for final honing to give the required specified clearance when taking the final cut.
Follow the Hone Manufacturers recommendations when honing, cleaning and lubrication of the honing stones. Noting the following points.
Hone through the entire length of the cylinder bore at the rate of approximately 60 cycles per minute. This will achieve the desired 45° cross hatch appearance on cylinder walls which will help ensure minimum oil consumption and maximum ring life.
Each piston must be fitted individually to the bore in which it will be installed and marked to ensure correct assembly during the final honing. After the final honing and before the piston is inspected for fit, each cylinder bore must be washed

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and dried thoroughly to remove all traces of abrasive and then allowed to cool. Apply clean engine oil to cylinder bores. The pistons and cylinder block must be at a common temperature before inspecting.

The glazed cylinder walls should be slightly dulled when new piston rings are installed without reboring cylinders, but without increasing the bore diameter, by means of the finest grade of stone in a cylinder hone.

Proceed as follows to inspect piston to cylinder bore.

1. Using a clean cloth wipe cylinder walls and pistons and apply clean engine oil to cylinder bores.

2. Measure the bore accurately using an inside micrometer.

3. Measure piston diameter 39mm from top of piston, subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.

Piston to Bore Clearance: **0.010-0.051mm**

4. Identify each piston with cylinder number to which it will be installed, then proceed to hone other cylinders and fit pistons.

**Handle the pistons with care, do not attempt to force the piston through the cylinder bore until cylinder has been honed to the correct size. Pistons can be damaged through careless handling.

Problem Diagnosis.

Problems and Possible Causes.

Problems should be corrected, when proper diagnosis is made, by repair, adjustment or part replacement as needed. Refer to the correct section in this manual.

High Oil Loss

(1) Tighten bolts and/or replace gaskets and seals as required for external leaks.

(2) Check oil with car on a level surface and allow adequate drain down time to ensure a correct reading of dipstick.

(3) Towing or continuous high speed driving will normally cause oil consumption to increase.

(4) PCV system failure.

(5) Use recommended S.A.E viscosity for current temperatures. Refer to "tune-up and maintenance" for details on correct oil viscosity.

(6) Valve guides and/or valve stem seals worn, or seals omitted. Ream guides and install oversize service valves and/or new valve stem seals.

(7) Allow enough time for the piston rings to seat. Replace worn or broken rings as needed, if rings have been incorrectly installed, worn or broken, or not seated.

(8) Piston incorrectly installed or misfited.

Gaskets.

(1) Incorrectly tightened fasteners or damaged/dirty threads.

(2) Worn or damaged gasket (cracking or porosity).

(3) Fluid pressure/level too high.

(4) Incorrect sealant used (when required)

Inspection of Seals.

(1) Damaged seal bore (burred, nicked, scratched)

(2) Worn or loose bearing which causes excessive seal wear.

(3) Worn or damaged seal or incorrect installation.

(4) Fluid pressure/level too high.

Oil Leak Investigation

Oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the required parts.

(1) Determine whether the fluid is transmission lubricant, engine oil, power steering fluid etc.

(2) Run the car at normal operating temperature and park the car over a large sheet of paper. After a few minutes, you should be able to find the approximate location of the leak by drippings on the paper.

(3) Use a degreaser or steam to clean the area of the leak, drive the car for a few kilometres. Then visually inspect the suspected part for signs of an oil leak.

Black Light and Dye Method.

There are many dye and light kits available for finding leaks.

(a) Pour required amount of dye into leaking part.

(b) Operate the car under normal operating conditions as instructed in the kit.

(c) Shine the light in the suspected area. The dyed fluid will appear as a yellow path leading to the problem.

Low Oil Pressure

(1) Blocked oil filter.

(2) Incorrect oil viscosity for expected temperature, or oil diluted with moisture or unburnt fuel mixtures.

(3) Excessive bearing clearance.

(4) If the oil level is low, fill to mark on dipstick.

(5) Oil pump dirty/worn, or oil pump suction pipe screen blocked, or hole in oil pump suction pipe.

(6) Incorrect or failing oil pressure sender.

Engine Knocks

WHEN ENGINE COLD AND CONTINUES KNOCKING FOR TWO OR THREE MINUTES

Increases with torque

(1) Tighten or replace as required if drive pulleys or balancer are loose or broken.

(2) Replace piston if clearance from piston to bore is excessive. (Cold engine piston knock usually disappears when the cylinder is grounded out. Cold engine piston knock

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which disappears in 1.5 min. can be considered acceptable.)
(3) Connecting rod bent.

HEAVY KNOCK WITH TORQUE APPLIED

(1) Replace parts as required of pulley hub or balancer broken.
(2) Loose torque converter to flexplate bolts.
(3) Check if exhaust system contacting under-body.
(4) Cracked flexplate/flywheel.
(5) Main bearing clearance or connecting rod bearing clearance excessive.

Light Knock while Hot

(1) Inspect fuel quality if pre-ignition or spark knock.
(2) Loose torque converter to flexplate bolts.
(3) Connecting rod clearing clearance excessive.

KNOCKS ON FIRST START-UP ONLY LASTING A FEW SECONDS

(1) Incorrect oil viscosity. Install correct oil viscosity for expected temperatures.
(2) Hydraulic lifter bleed down.
Some valves will be open when the engine is stopped. Spring force against lifters will tend to bleed lifter down. Only if the problem is consistent should repairs be attempted.
(3) Replace crankshaft thrust bearing shells if excessive crankshaft end float.
(4) Replace worn parts if front main bearing clearance is excessive.

Hydraulic Valve Lifters

The lifters are extremely simple in design and rarely need attention, readjustments are not required and servicing requires only that care and cleanliness be exercised whilst handling the parts. Using a piece of garden hose near the end of each intake and exhaust valve with the other end of the hose to the ear, is the easiest method for locating a noisy valve lifter. Using this method, the sound is localised, which makes it easier to find out which lifter is faulty. Or place a finger on the face of the valve spring retainer. If the lifter is not functioning correctly, a definite shock will be felt when the valve returns to its seat.

Specifications

General

Engine:	60^0 "V" 6 cylinder 3.8 litre (3.791cc)
Bore:	96.52mm
Stroke:	86.36mm.

The cylinder numbering is from the front of the engine, left side 1-3-5 and right side 2-4-6.

Firing order:	1-6-5-4-3-2.
Compression Ratio:	9.35:1
Cylinder Specified Compression:	
Minimum Specified Comp:	689kPa.
Variation between cylinders:	
	not less than 70% of highest test

Lubrication

Lubricant Quantity Specification:	
With out new oil filter:	4.0 Litres
With new oil filter:	4.3 Litres
Lubricant Quality:	SAE 15W-40, 20W-40 or 20W-50
Engine Oil Grade API grade:	SG or SH
Oil pressure@1850 rpm plus:	375kPa(min)
Oil Pressure Switch	
Light On:	less than 41.4 kPa
Light Off:	more than 13.8kPa

Inlet Manifold

Intake Manifold and Intake Chambers Maximum Warpage: 0.10mm (0.0039in)

Oil Pump:

Inner gear tip to outer rotor tip specified clearance:	
Max:	0.22mm
Outer rotor to pump housing clearance:	0.05-0.13mm
Oil Pump Cover Clearance:	0.025-0.089mm
Balance Shaft Rear Bearing Clearance:	0.025-0.130mm

Camshaft

Camshaft Journal Diameter:	46.858 - 46.893 mm
Camshaft Specified Lift;	
Inlet Lobe:	6.56 mm
Outlet Lobe:	6.48mm
Camshaft Centre Max. Runout:	0.06mm.
Timing Chain Maximum Slackness:	25.4mm

Cylinder Heads

Standard head deck thickness:	1.372-1.676mm
Minimum head deck thickness:	1.12mm

* Valve seat angles are 45^0 - VT, later models 46^0.
* Valve seat width:

Exhaust	2.16mm
Intake	1.78mm

Valve Guide

Specified Valve Guide ID:	
New Inlet:	0.033-0.066mm
New Outlet:	0.036-0.074mm
Valve Guide to Valve Clearance:	
Max: 0.18mm	

Valves

Head Diameter - Inlet:	45.59 - 45.85mm
Head Diameter - Exhaust:	38.48 - 38.74mm
0.25mm Oversize available	
Stem Diameter - Inlet:	7.955-7.968mm
Stem Diameter - Exhaust:	7.948-7.965mm
Fitted (not installed) Valve Height:	49.22-50.49mm
Valve face angle:	45°.
Minimum valve head margin thickness:	0.63mm

Valve Springs

Maximum allowable variance in spring end length: 1.60 mm, while rotating spring on level desk.
Valve spring Installed Height - Cylinder head to top of spring: 49.2 - 50.5mm

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Valve spring compressed height/load:
Compressed height: 970-1059Nm@32.4mm
Compressed height: 316-351Nm@43.7mm

Piston

Piston Size Standard: 96.482-96.497mm
Available in 0.508mm oversize
Piston Pin Clearance
: in Piston 0.002-0.013mm
: in Connecting Rod 0.007-0.022mm

Piston Rings

Top Compression Ring End Gap Specification: 0.305-0.559mm
Second Compression Ring End Gap Specification:
0.762-1.016mm
Oil Ring Steel Rail Gap Specification:
0.254-0.762mm
Piston Ring Side Clearance:
Top Ring: 0.039-0.079mm
Second Ring: 0.039-0.079mm
Oil Ring: 0.023-0.201mm

Connecting Rod

Connecting Rod Alignment Max. Specification
Bend 0.020mm per 25.4mm
Twist 0.038mm per 25.4mm
Connecting Rod to crankshaft end clearance: 0.10-0.50mm

Crankshaft

Automatic and Manual transmissions use the same crankshaft.
Main Bearing Journal Diameter
Standard Size: 63.470-63.495mm
Taper: 0.008mm max.
Out-Of-Round: 0.008mm max.
Connecting Rod Journal Diameter
Standard Size: 57.117-57.147mm
Taper: 0.008mm max.
Out-Of-Round: 0.008mm max.
Crankshaft Runout Specification: 0.008mm max.
Crankshaft Rear Flange Runout: 0.05mm

Bearing(Main) Upper and lower	*Standard size*	*0.0254mm undersize*
1	*12537031*	*12537032*
2	*12537033*	*12537034*
3	*18017988*	*18017989*
4	*12537172*	*12537173*

Main Bearing Clearance: 0.023-0.053mm
Flexplate Runout: 0.38 mm max.

Cylinder Block

Cylinder Block Deck Surfaces Flatness: 0.013mm per 25.4mm or a Max 0.08mm for complete surface
Cylinder Bore (Standard): 96.507 - 96.533mm
Taper: Max 0.013mm
Out of Round: Max 0.010mm
Crankshaft Bearing Bore Out-of-Round:Max 0.008mm
Camshaft Bearing Bore Out-of-Round:Max 0.0013mm
Piston to Bore Clearance: 0.010-0.051mm

Torque Wrench Spec

Oil Pressure Sender Unit: 12-14 Nm.
Drive Belt Tensioner Studs: 40-60Nm
Heater Inlet Casting Nuts: 18-25Nm
Exhaust Manifold Studs, 1 Bolt: 25-35Nm
Exhaust Manifold Nuts: 20-27Nm
Exhaust Pipe Flange to Exhaust Manifold: 18-35Nm
Rocker Cover Bolts Torque: 7-11Nm
Water Pump to Timing Gear Cover Bolts:
12-18Nm plus 76-84deg turn
Water Pump to Cylinder Head Bolts: 20-30 Nm
Oil Pump Cover Screws: 8-14Nm
Oil Filter Adapter Bolts: 23-35Nm
Oil Pump Cover Screws: 8-14Nm
Oil Filter Adapter Bolts: 23-35Nm
Timing Gear Cover Bolts: 20-30Nm
Crank Shaft Balancer Pulley Bolt:270-325Nm
Crank Shaft Sensor Bolts: 20-30Nm
Sump Bolts Torque: 12-16Nm
Balance Shaft Gear bolt:18-26Nm plus 67^0-73^0 turn
Camshaft Thrust Plate Torx T30 Screws: 12-19Nm
Timing Chain Dampner Bolt: 16-28Nm
Camshaft Sprocket Bolt: 90-110Nm plus 86^0-94^0 turn
Cylinder Head Bolt Torque: 34Nm
Tighten a further 90^0 turn of each bolt in sequence (if torqued to 90Nm during this step, do not tighten any further)
Tighten a further 90^0 turn of each bolt in sequence for the second time.
Valve Lifter Guide Plates: 26-34Nm

Upper inlet manifold to lower inlet manifold bolts: 15-20 Nm
Fuel Rail and Top Intake Manifold bolts: 15-20Nm
Rocker Assembly
Step 1 Rocker Assembly Bolts: 11-19Nm
Step 2 Tighten a further 87-93 deg turn
Spark Plug Torque Specification: 15-25Nm
Crankshaft Pulley Attaching Bolt: 270-325Nm
Flywheel / Driveplate Bolt Specification:
1st Step - 18-22 Nm
2nd Step - Turn bolts an extra 47-53 degress
Oil Pan (Sump) Bolt Specification: 12-16Nm
Suction Pipe and Strainer Bolts: 8-12Nm
End of Engine Rear Brace Plate to Sump: 20-25Mm
Oil Pan (Sump) Drain Plug Specification: 40-50Nm
Connecting Rod Cap Bolt Specification:
24-30Nm. Plus 47^0-53^0 Turn
Main Bearing Cap Bolt Torque:
Step 1: tight to 20Nm then to 40Nm
Step 2: tighten a further 35^0 plus 35^0 plus 35^0
Step 3: Torque side bolts 12-18Nm plus 42^0-48^0

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"Holden - V8 - VT Series1" ENGINE MAINTENANCE & REBUILD

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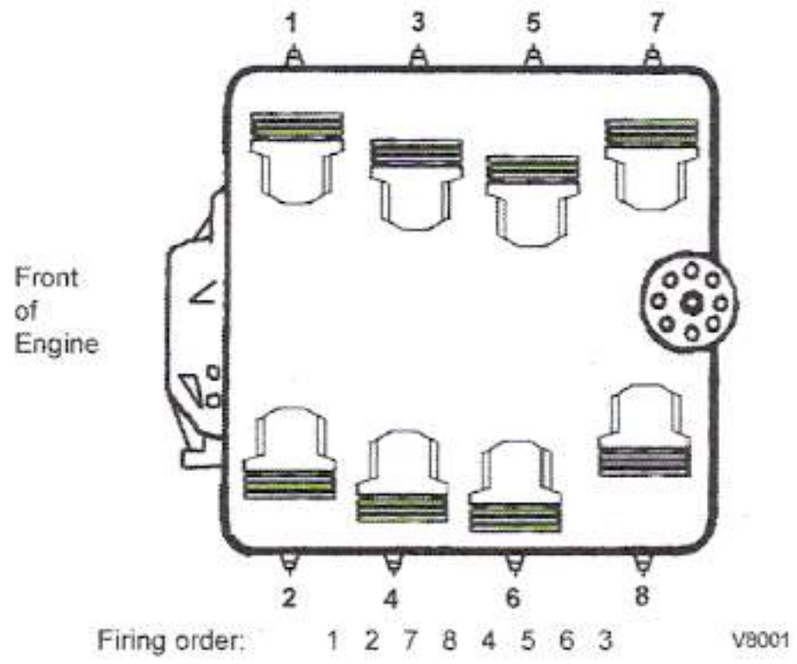
GENERAL DESCRIPTION

The engine is a 90⁰ "V" 8 cylinder 5.0 litre (4987cc) 5.7 (5737cc) litre. Each camshaft is supported by 5 journals and operate 2 valves per cylinder, that is 8 valves per head.



The cylinder block made of cast iron, with standard bore of 101.6mm and a stroke of 76.835mm, with a 8.8:1 compression ratio.

The cylinder numbering is as illustrated, from the front of the engine, left side 1-3-5-7 and right side 2-4-6-8. Firing order is 1-2-7-8-4-5-6-3. Five main bearings support the crankshaft.



The engine has two cast iron heads with a fuel injector for each cylinder which is incorporated into the heads.

ENGINE SERIAL NUMBER

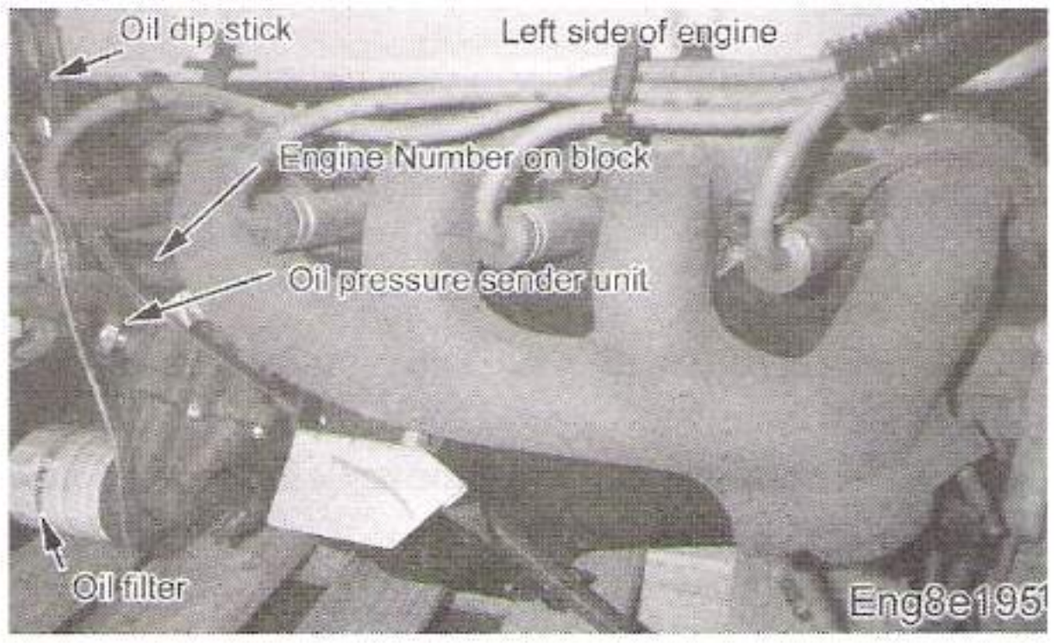
Engine No. Location: On left-hand side engine block casting, close to the dip stick.

MAINTENANCE HINTS

1.(a) When any internal engine parts are serviced, care and cleanliness are important.

(b) An engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in thousandths of a millimetre.

(c) Friction areas should be coated liberally with engine oil during assembly to protect and lubricate the surfaces on initial operation.



(d) Proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure and is considered standard workshop practice.

2. When valve train components are removed for service, they should be kept in order and should be installed in the same locations (with the same mating surfaces) as when removed.

3. Battery terminals should be disconnected before any major work is begun. If not, damage to wiring harnesses or other electrical components could result.

4. When raising or supporting the engine for any reason, do not use a jack under the oil pan. There are small clearances between the oil pan and the suction pipe screen, so jacking may cause the oil pan to be bent against the screen, with damage being done to the oil suction pipe assembly.

5. If the air flow ducting is removed or disconnected, the intake opening should be covered to avoid accidental entrance of foreign material (which could follow the intake passage into a cylinder and cause extensive damage when the engine is started).

GENERAL MAINTENANCE

CHECKING ENGINE OIL PRESSURE

1. With engine at operating temperature and disconnect wiring harness connector from oil pressure sender unit.

2. Loosen and remove oil pressure sender unit from oil filter adaptor.

3. Install a suitable oil pressure gauge assembly into oil filter adaptor oil pressure sender unit hole.

4. Start engine and check oil pressure reading with engine running under no load.

Oil pressure@ 500 rpm plus: Min 48kPa.
Oil pressure@ 2000 rpm plus: 276-414kPa.

5.(a) After completing test, apply LOCTITE 242 sealant or equivalent to sender unit threads.

(b) Install and torque sender unit.

Oil Pressure Sender Unit Torque: 12-14 Nm.

(c) Install wiring harness connector, start engine and check for oil leaks.

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OIL FILTER

* The oil filter should be replaced every 10,000 Kilometres or 6 months which ever occurs first, or when the engine oil is contaminated in any way.

Replacement

1. Unscrew oil filter with a suitable oil filter wrench, then remove and discard.
2. (a) Make sure seal is placed correctly in recess in new filter.
(b) Pour some clean engine oil into filter until level is approximately 2 cms (1.0 in) below top of filter.
3. (a) Apply a thin film of engine oil over new filter seal.
(b) Screw filter into place until seal contacts mating surface of adaptor, then tighten through a further 2/3 of a turn.
4. (a) Clean any excess oil from filter and adaptor.
(b) Check oil level, then start engine and check for oil leaks.
(c) Repair as necessary.
* After running the engine, the oil level must be rechecked and oil added as necessary, to compensate for oil used to refill the oil filter.

COMPRESSION CHECK

1. Make sure of the following:
(a) Engine is at operating temperature;
(b) Battery is at (or near) full charge;
(c) Spark plugs are removed;
(d) Remove fuse number 14, located on the lower dash fuse panel, drivers side. This fuse stops the fuel and ignition functioning during engine cranking.



Fuse and Relay identification panel in cabin (lower dash) Be004

2. (a) Install suitable compression tester into spark plug hole, screw in type are more accurate. Depress accelerator pedal to fully open position and crank engine.
(b) Read compression gauge indication.
3. Check remaining cylinders.
Variation between cylinders: 142kPa.
* If cylinder compression in 1 or more cylinders is low, pour a small amount of engine oil into the cylinders through the spark plug holes and test compression.

Compression Test Results

NORMAL Compression builds up quickly and evenly on each cylinder.
PISTON RINGS Compression low on 1st stroke, tending to build up on following strokes, but does not reach normal. Improves considerably with addition of oil.
VALVES Low on 1st stroke and does not tend to build up on following strokes. Do not improve much with addition of oil.
HEAD GASKET If cylinder compression in any 2 adjacent cylinders is low (and if adding oil does not help compression), cylinder head gasket has blown out.

DRIVE BELTS

Inspection

* Some belt squeal when the engine is started or stopped is possible and has no effect on durability of drive belt.

Visual Inspection

* Condition of the belt is best judged by twisting the belt so as to see the both surfaces.

Stages of Belt Wear:

1. NEW BELT: No cracks or chunks.
2. MODERATELY USED BELT: Few cracks; some wear on surfaces. Replacement not required.
3. SEVERELY USED BELT: Several cracks per inch. Should be replaced before chunking occurs.
4. FAILED BELT: Separation of belt material from backing (chunking). Replace belt immediately.

Replacement

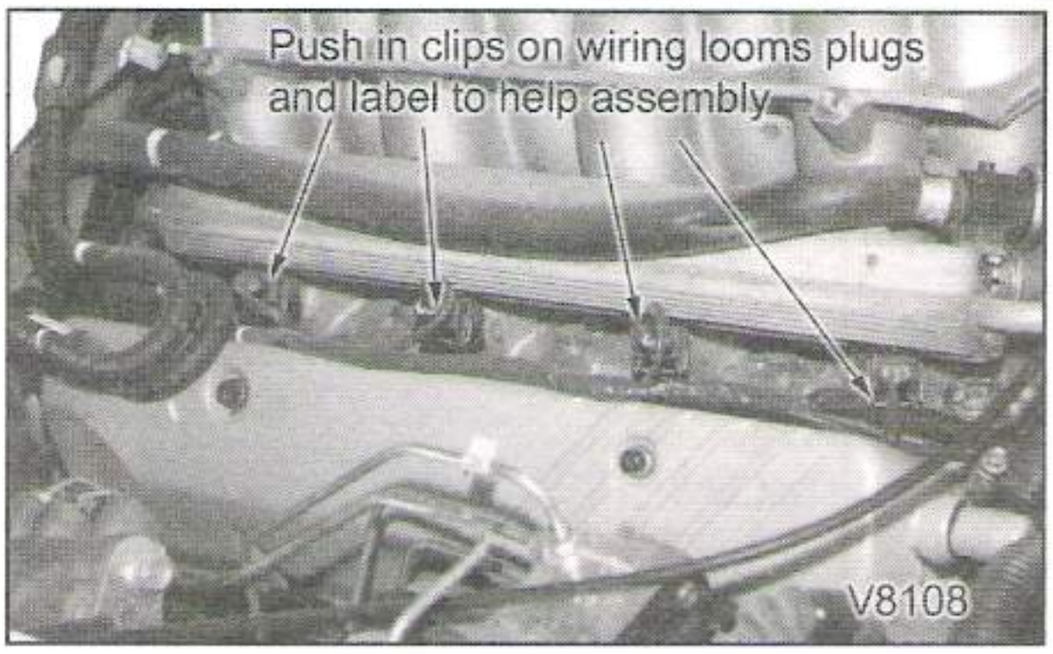
Use a ring spanner to loosen alternator bolts thereby loosening belt tension. Remove belt or install belt, pull back on alternator (or use a screw driver levering alternator to add tension) tighten alternator bolts.
Power steering belt loosen power steering pump to release belt tension and remove belt. Install belt pull back on power steering pump (or use a screw driver levering pump to add tension) tighten pump bolts.
Air-conditioner compressor belt, adjust belt tension to release or gain belt tension during remove and install belt.

INTAKE MANIFOLD and FUEL RAIL ASSEMBLIES

Remove

1. Remove the engine 3 top covers, 5 screws.
2. Depresserize the fuel injection system, remove fuel pump relay, start motor allow to idle until stall.
3. Disconnect the earth lead from the battery.
4. Drain coolant from engine at radiator lower hose, remove upper radiator hose from thermostat housing.
5. Remove air cleaner to throttle body duct and PCV hose at the left side rocker cover. Disconnect the carbon canister
6. Remove alternator and wiring connectors, label connectors to help assembly.
7. At the front of the intake manifold. Remove electrical connectors to temperature sensor, MAF vacuum hose, fuel pressure regulator vacuum hose. Disconnect the coolant by-pass hose to the inlet manifold.
8. At the rear of the inlet manifold remove the vacuum hoses

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for the heater controls and brake booster.

9. Disconnect the fuel and return pipes at the fuel rail and pressure regulator.

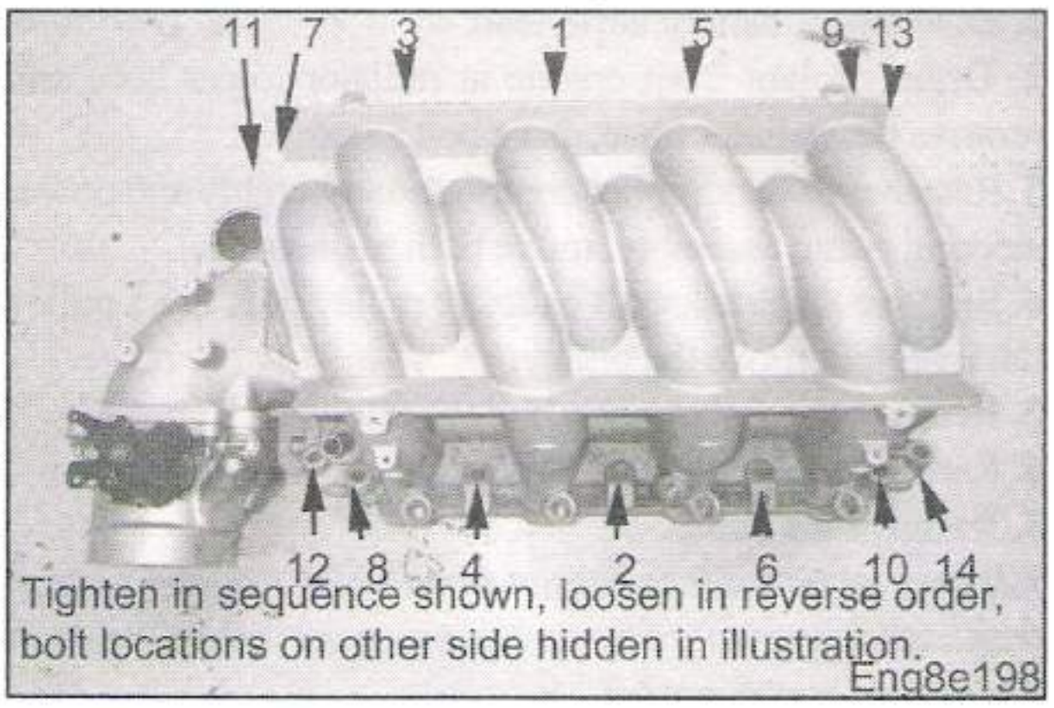
10. Remove coil, 1 bolt. Remove distributor cap and spark plug leads as an assembly.

11. Detach throttle cable at the throttle body, throttle cable plate - 3 bolts. Disconnect the IAC and TPS connectors at the throttle body.

12. If necessary dismantle throttle body from intake manifold.

13. Separate the fuel rails and injectors from the inlet manifold if necessary.

14. Remove the intake manifold, gaskets and seals, 14 bolts.



Install

1. Clean mating surfaces of the cylinder heads and the manifold.

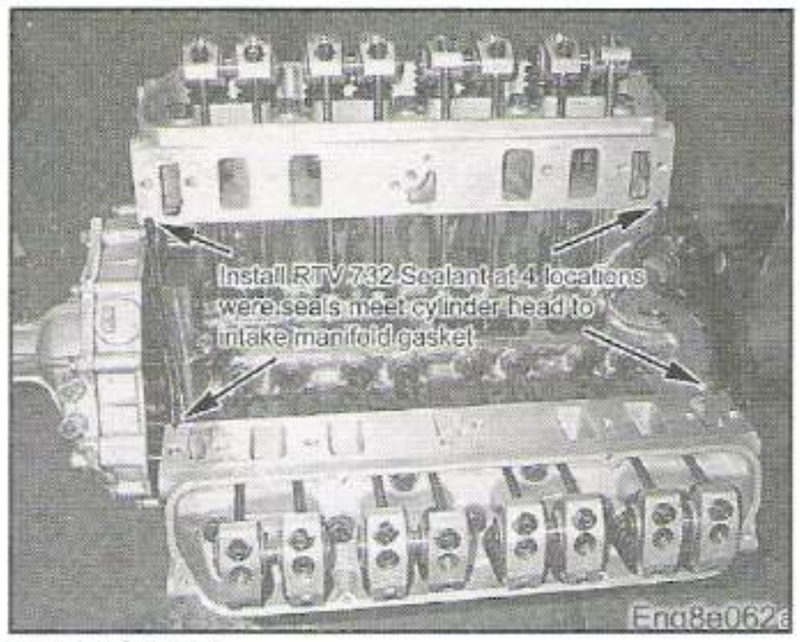
2. Use a straight edge to check the surface of the intake manifold and intake chambers matching surfaces, if over maximum warpage specification, machine the surface or replace the manifolds.

Intake Manifold and Intake Chambers Maximum Warpage: 0.10mm (0.0039in)

3. The P.C.V. valve is located in the intake manifold, remove and check it is not clogged, wash and reinstall.

4. Install new intake manifold gaskets and seals, apply RTV 732 sealant to the 4 ends of the 2 seals where they contact the intake manifold gaskets.

5. Install the intake manifold. Using Loctite 242 to coat the threads of all 12 bolts, install bolts tighten to specification, in



sequence shown

Intake Manifold Attaching Bolts :

Step 1: 12-17Nm, Step2: 34-41

6. Install the fuel rail and injectors and top intake manifold.

(a) Install a new "O" ring into each injector position of the manifold.

(b) Install the spacers onto the bolts which support the fuel rail.

(c) If the injectors have been removed from the fuel rail. Install the injectors into the fuel rail, make sure that the injector turn freely in the fuel rail.

(d) Tighten the fuel rail to intake manifold bolts to specification.

Fuel Rail and Top Intake Manifold bolts: 12-14Nm

7. Install fuel and fuel return lines at the rear of the engine.

8. Install the engine wiring loom and connectors, attach the 9 fuel injector wiring connectors, water temperature sensor at the front of the engine, water temperature gauge sender unit, TPS and IAC connectors to the throttle body. 3 vacuum hoses, and brake booster, fuel pressure regulator.

Connect the hoses to the throttle body, P.C.V. hose to rocker cover and carbon canister.

9. Connect the accelerator cable and bracket, 3 nuts.

10. Install air duct tube between air cleaner and throttle body.

11. Connect radiator hoses, fill and bleed the cooling system.

12. Replace air cleaner to intake manifold duct.

13. Replace alternator and wiring connections.

14. Replace drive belt.

15. Replace relay for fuel pump, reconnect earth to battery.

16. Install top engine covers, 5 screws.

EXHAUST MANIFOLDS

Remove

1. Remove the bolts attaching the exhaust pipe to the exhaust manifolds.

2. Unplug spark plug leads and position them out of the way.

3. Bend the lock plate tabs so the nuts, studs and bolts each side can be removed.

4. Remove manifolds. (left side the oil dip stick and bracket is attached to the manifold

Install

1. Install gasket to cylinder heads, to align the gasket, install four guide studs in the cylinder head. Place the gasket on the

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studs. Place the manifold on the studs. Install the bolts on the lower holes, remove the guide studs, install the upper bolts Gradually tighten the bolts to specification. Apply Kopr-Kote or similar anti-seize to threads of bolt and studs.

Exhaust Manifold Studs and Bolts: 20-28Nm
Exhaust Manifold Nuts: 15-20Nm

2. Tighten the manifold flange to exhaust pipe nuts to specification. Apply Kopr-Kote or similar anti-seize to threads of studs.

Exhaust Pipe Flange to Exhaust Manifold: 15-35Nm

3. Plug spark plug leads in correct position.

ROCKER COVERS AND/OR SEALS

Remove

1. Remove spark plug leads.

2. (a) Remove rocker cover to cylinder head bolts and remove rocker cover from cylinder head.

(b) If replacing rocker cover seal, remove seal from recess in rocker cover to cylinder head.

Install

1. (a) Install new gasket seal in rocker cover recess.

(b) Install rocker cover and gasket assembly.

* Make sure gasket is correctly installed in rocker cover.

2. Install rocker cover to cylinder head and torque bolts to specification.

Rocker Cover Bolts Torque: 3-6Nm

3. Plug spark plug leads in correct position.

4. Start engine and check for oil leaks.

WATER PUMP

Remove

1. Disconnect battery earth lead.

2. Drain coolant from engine at radiator lower hose and remove top radiator hose, remove drive belt.

3. Remove alternator and drive belt tensioner.

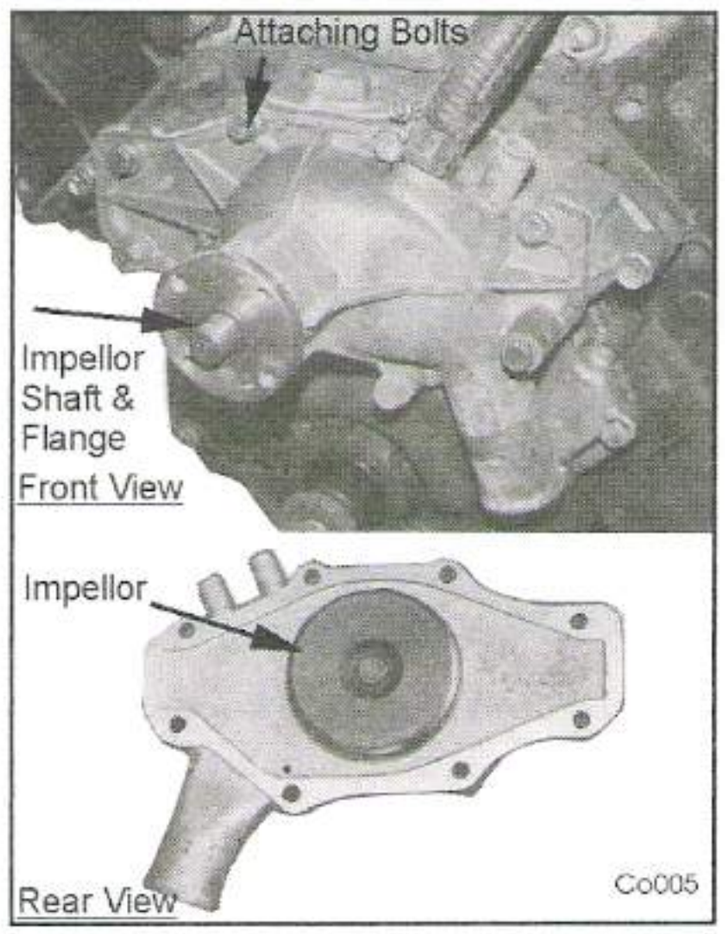
4. Remove the water pump pulley, 4 bolts.

5. Remove water pump and gasket.

Install

1. Install water pump and new gasket with sealant, tighten bolts to specification.

Water Pump Bolts: 23-30Nm



2. Install water pump pulley, 4 bolts.

3. Install drive belt.

4. Refill and bleed cooling system.

5. Connect earth to battery.

TIMING CHAIN COVER

Remove front drive belt assembly if not removed.

Remove

1. Disconnect battery earth lead.

2. Drain coolant from engine at radiator lower hose and remove top radiator hose, drive belt assembly.

3. Remove air conditioner compressor assembly and power steering pump assembly, move both to one side.

4. Remove the crankshaft balancer pulley bolt, use a pulley remover to remove the pulley.

5. Remove the water pump pulley, 4 bolts.

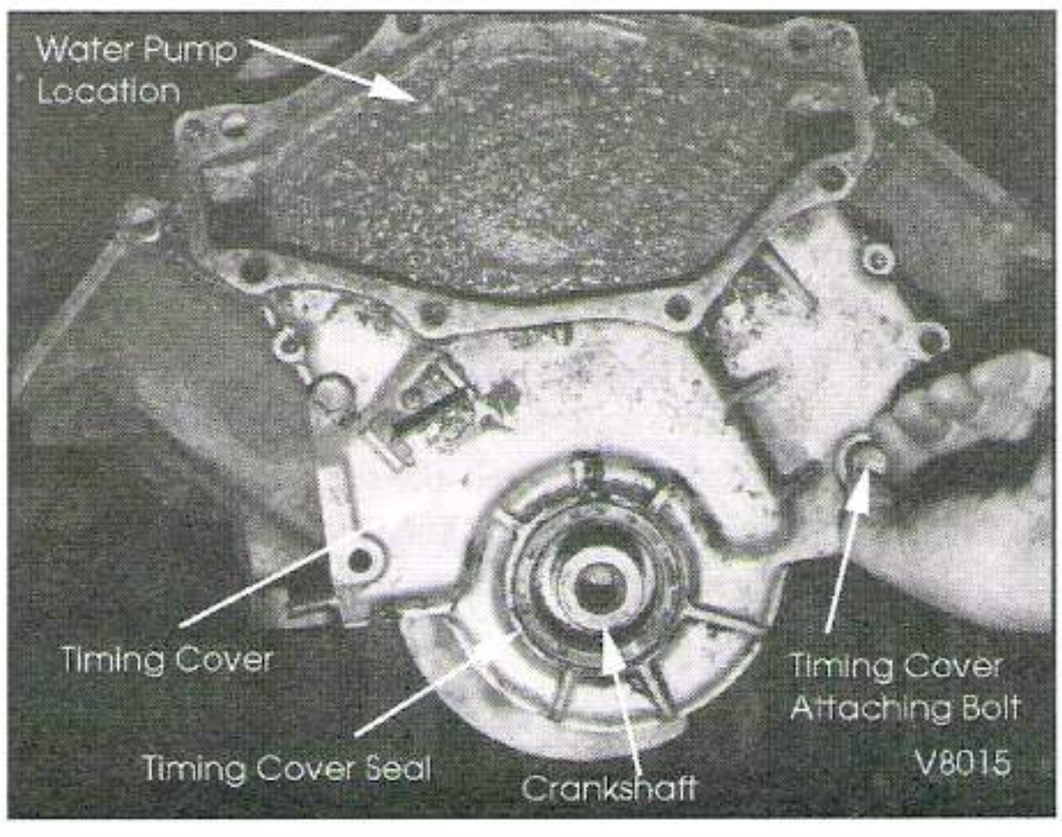
6. Remove idler pulley for drive belt.

7. Remove the sump.

It may be possible to loosen sump bolts, remove bolts at front allowing to remove timing gear cover without damaging sump gasket.

8. Remove the timing gear cover, water pump and gasket.

Install



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1. Install a new front seal into the timing gear cover, use a seal insertion tool or a large socket that is the correct size.
2. Install water pump and timing gear cover with new gaskets.
Install the timing gear cover, apply Loctite 242 to threads of timing cover bolts to engine block.
Timing Gear Cover Bolts: 23-30Nm
3. Install the crankshaft balancer pulley.
Crank Shaft Balancer Pulley Bolt: 270-325Nm
4. Install the bolts at the front of the sump to the timing gear cover, tighten the remaining sump bolts to specification.
Sump Bolts Torque: 8-10Nm
5. Install the crankshaft balancer pulley bolt
Crankshaft Balancer Pulley Bolt: 190-200Nm
6. Install idler pulley for drive belt.
7. Install the water pump pulley, 4 bolts.
8. Install air conditioner compressor assembly and power steering pump assembly.
9. Install drive belts and tension.
10. Refill coolant.
11. Reconnect battery.

TIMING CHAIN, CAMSHAFT and BEARINGS

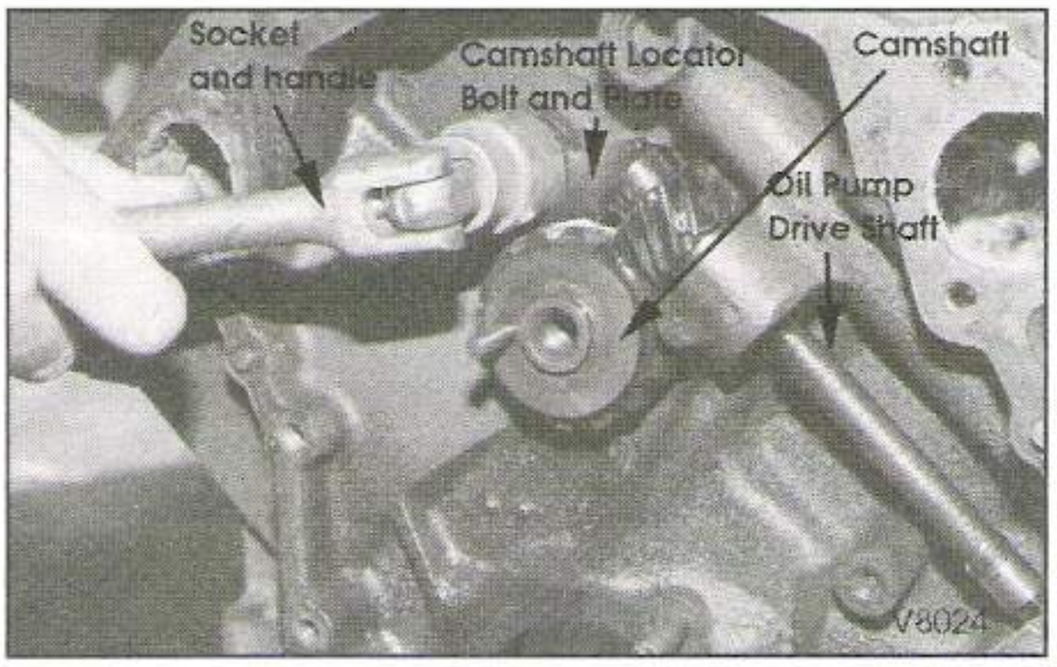
Remove Timing Chain Cover as described above.

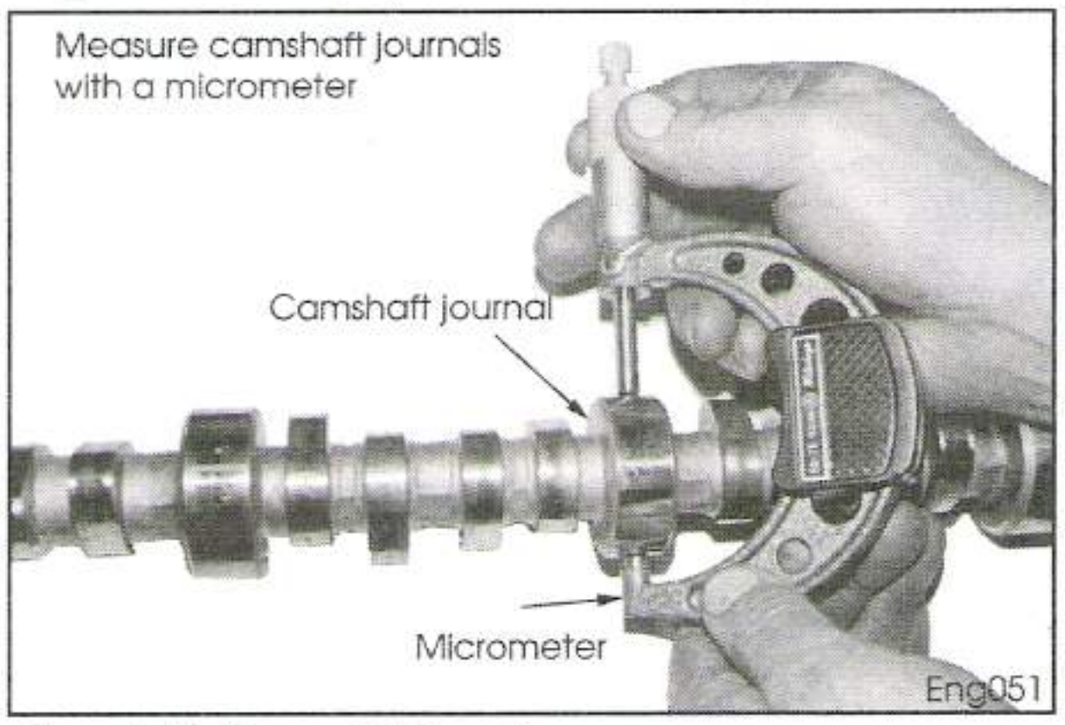
Remove

1. Rotate crankshaft to T.D.C. No4, the distributor rotor will be pointing towards No 4 spark plug lead in the distributor cap, both valves for No 4 cylinder will be closed.
2. Check timing chain alignment marks, the silver links will be opposite the alignment marks on the crankshaft sprocket and camshaft gear.
3. Remove camshaft sprocket bolt, if necessary install crankshaft balancer and hold with a tool to stop crankshaft rotating, if sump off jam crankshaft with a block of wood.
4. Remove camshaft gear, crankshaft sprocket and chain, if crankshaft has rotated during removal make sure engine is at T.D.C. No4 with timing marks as shown before removing sprocket and chain, this helps in assembly.
Tip: Remove camshaft sprocket, timing chain and crankshaft sprocket at same time.
5. Use a pair of multigrips to pull chain oiling nozzle out, check it is not blocked, clean and install so that the nozzle protrudes 22.6 mm.
6. Remove the camshaft locator and bolt, and oil pump drive gear.
7. Camshaft
a). Remove valve pushrods and lifters.
b) Gently pull the camshaft from the engine, do not damage lobes and bearings while removing.

Clean and Inspect Camshaft.

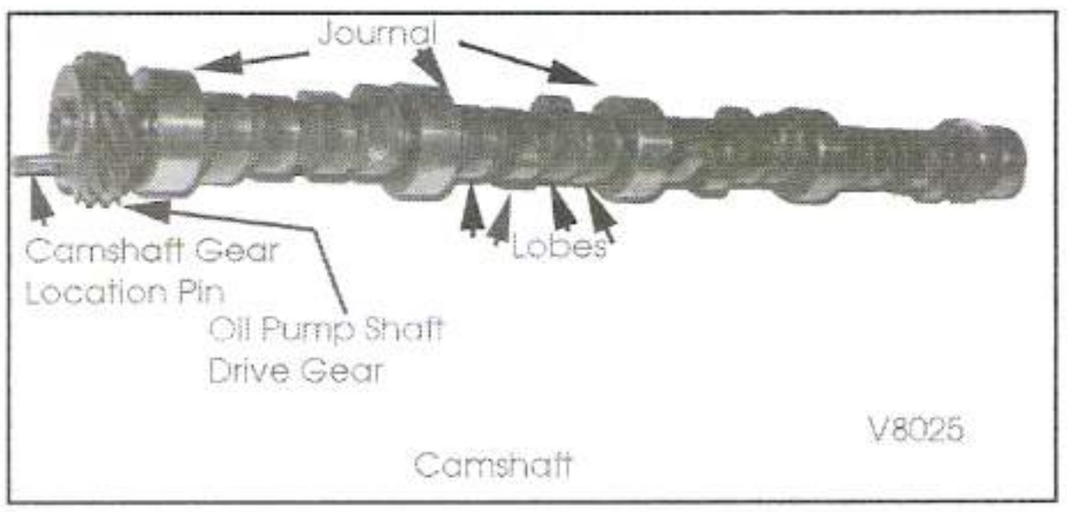
1. Clean camshaft thoroughly using a suitable cleaning solution, wash with clean water or steam.
2. Check camshaft bearing journals for overheating, damage or wear, lobes for damage or wear, with excessivre wear the hardened surface will be damaged or removed (never reuse a camshaft with hardened lobe surface damaged).
3. Inspect camshaft journal diameter with micrometer. Replace camshaft, if journals are not as specified.





Camshaft Journal Diameter:

No1 & 2 : 47.960 - 47.978 mm
No3 & 4 : 47.452 - 47.478 mm
No5: 40.107 - 40.132 mm



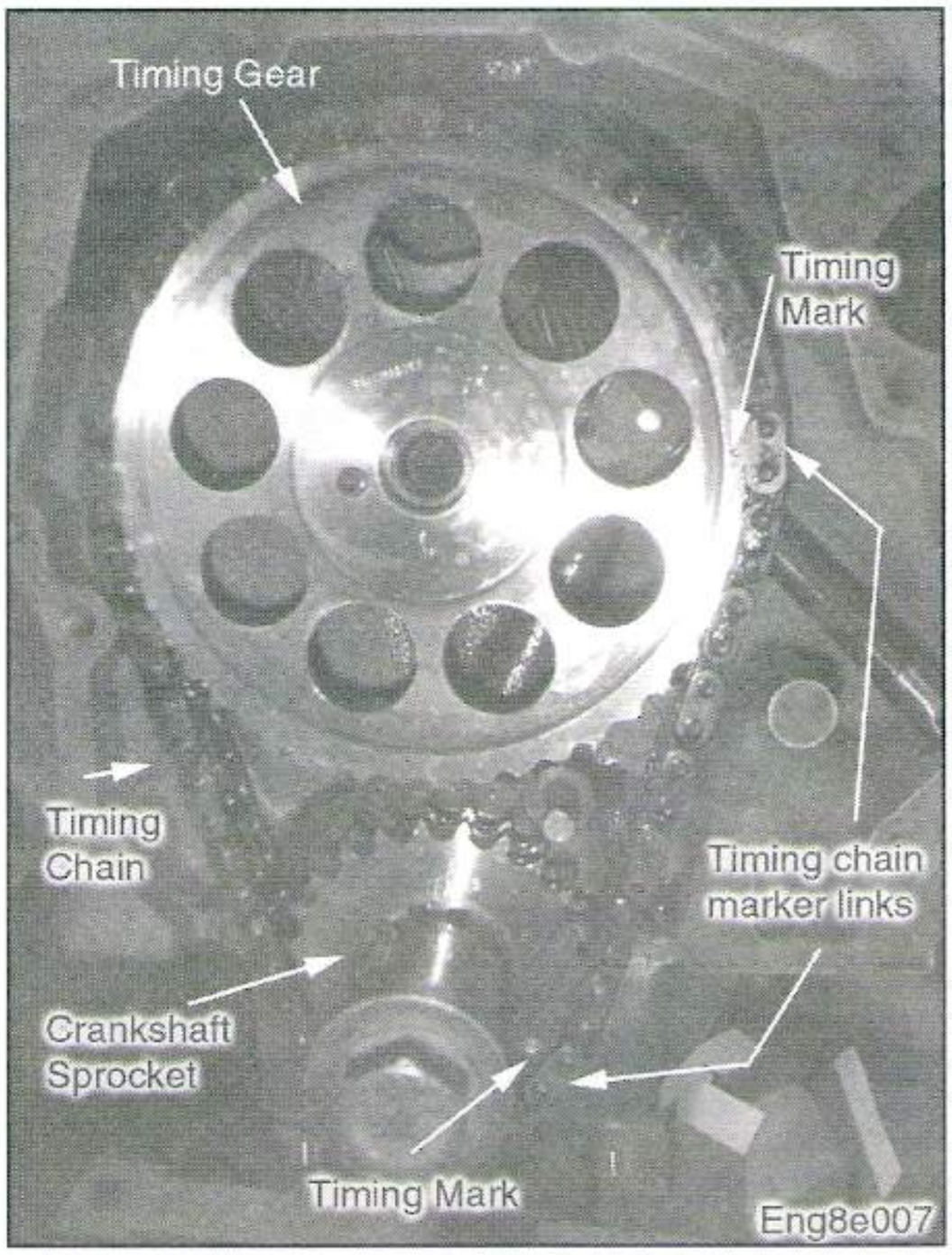
Installation

1. Camshaft
a) Gently slide the camshaft into the cylinder block, do not damage lobes and bearings while installing.
b) Apply (Lubrizol 6612) molybdenum base grease to camshaft bearings and lobes.
2. Install the camshaft locator plate.
Camshaft Locator Plate bolt: 68-81Nm.
3. Install camshaft gear to camshaft, timing chain and crankshaft sprocket as an assembly. The timing marks of the crankshaft sprocket and camshaft gear must be aligned with

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the silver links of the timing chain.



4. Apply clean engine oil to timing chain and all gears and sprockets.

5. Install hydraulic lifters and pushrods, apply (Lubrizol 6612) molybdenum base grease to contact surfaces of lifters and pushrods.

Install timing chain cover, head rocker gear as described.

VALVE LIFTERS

The cylinder head rocker gear, intake manifold and pushrods must be removed to allow valve lifters to be removed and installed.

Remove

Make sure that all valve train components are kept in order so they can be installed in their original locations.

1. Remove the valve lifters either by hand or use a screw driver with a bent end to help.

Clean & Inspect

1. (a) Clean all parts in a suitable cleaning fluid.

(b) Dry with compressed air.

2. (a) Inspect lifter body for wear and scuffing.

(b) Also inspect lifter bore in block.

3. The lifter can be dismantled and cleaned by removing spring clip in base, allow components to drop down. Clean then reassemble.

The unit must be replaced if there is any damage or excessively worn.

Tip: Ther base of the lifter should be slightly convex in shape. If the lifter is damaged it is quite often more economical to purchase a new one.

Installation

1. Make sure lifter bodies and lifter bores are clean insert lifters into the same bore they were removed from.

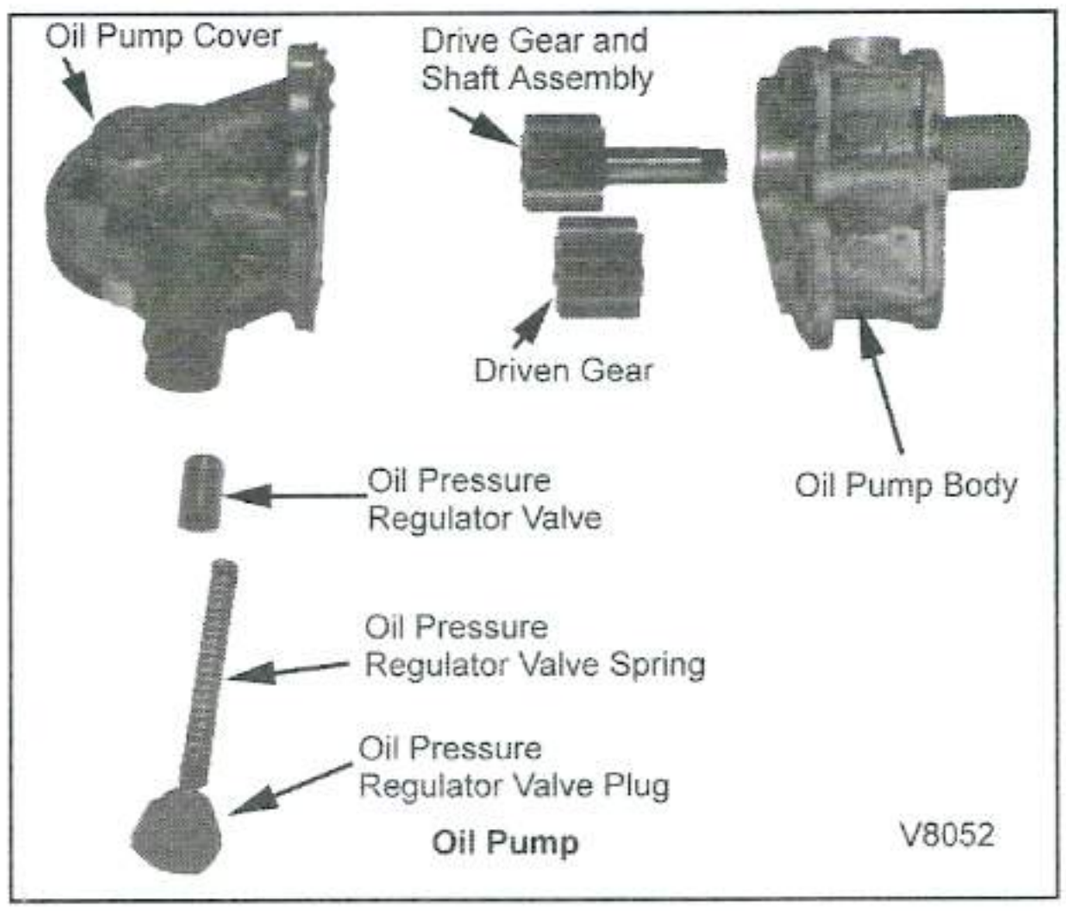
OIL PUMP

1. Remove oil filter.

2. Remove the oil pump and filter adapter and gasket, 4 bolts.

3. Remove the oil pump cover and regulator, 3 bolts .

4. Remove the gears and shaft, use a marker pen to have an alignment marks to help with installation.



Clean and Inspect

Clean any sludge from inside oil pump and around oil pump gears. Inspect the inside of the pump housing and the gears for damage or excessive wear.

Install the gears and the shaft. Check the clearance between the oil pump housing and gears is within specification with a steel ruler, the gears should protrude out from the housing.

Oil Pump Gear Protrusion: 0.051-0.153mm

Measure the pump shaft length from the cut away section to the end of the gear.

Oil Pump Shaft Assembly Length: 68.96 - 69.22mm

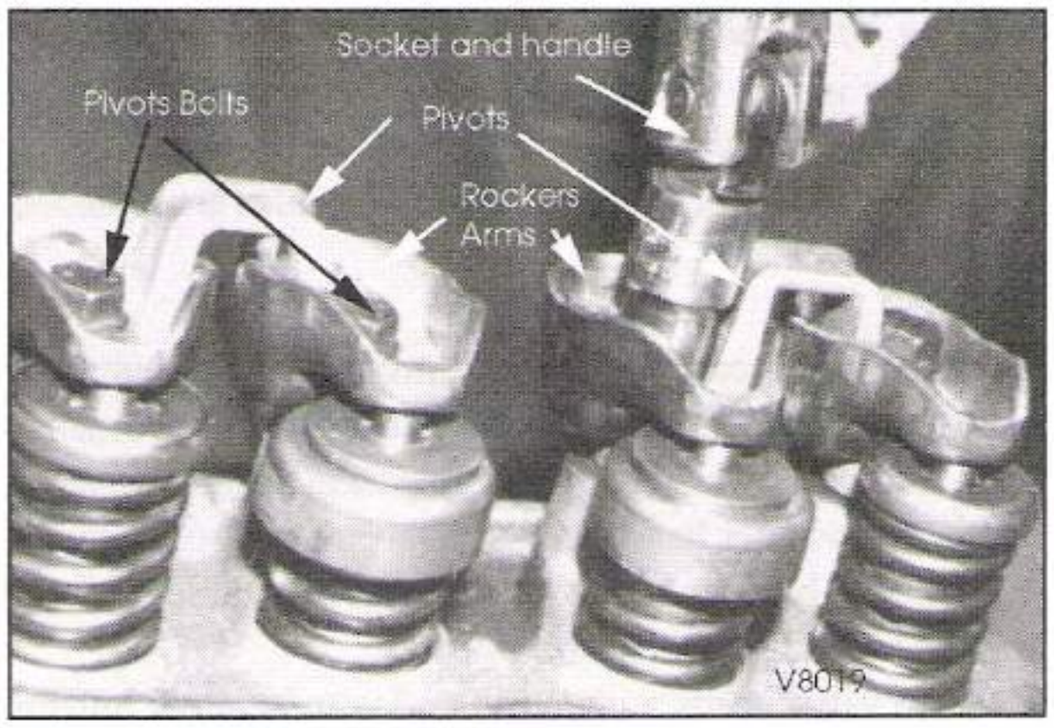
Check oil pump gear back lash, specified length.

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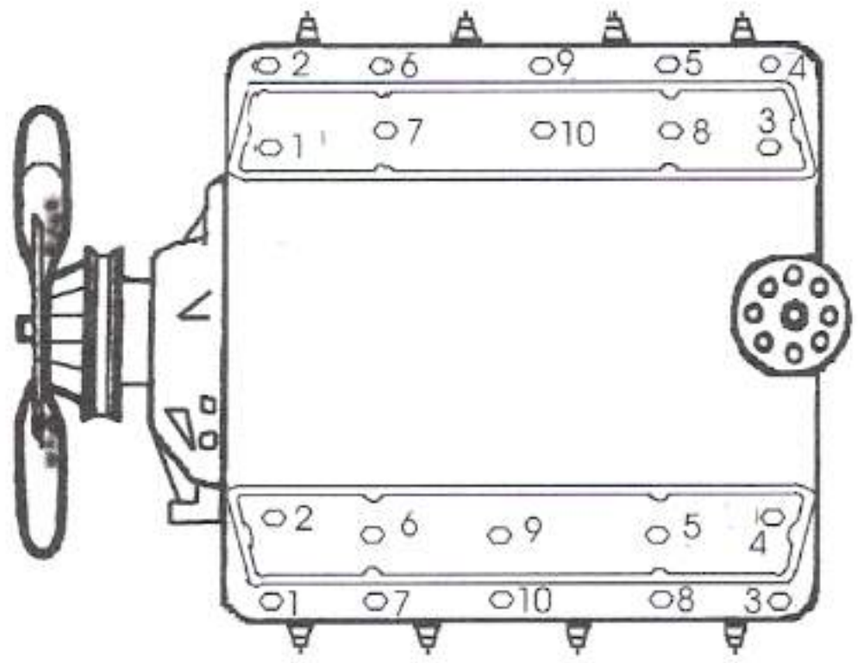
Oil Pump Gear Backlash: 0.229 - 0.381mm
Check the oil pressure releif valve and bore is within clean and the releif spring is not broken. Check spring length.
Oil Pressure Releif Valve Spring:
Free Length: 82.5 mm
Load of 4.76kg: 63.5mm
Install
1. Install pressure regulator spring and valve, tighten plug.
Oil Pump Regulator Plug: 34-41Nm
2. Install gears and shaft using alignment marks from dismantle, apply new engine oil to gears and shaft, new gasket, install cover / regulator, 3 bolts.
#Tip: 2/3 Fill a new oil filter and install to filter adapter, install 2 of the oil pump cover bolts loosely, add new engine oil to oil pump, finish installing cover and 3rd bolt, tighten.
Oil Pump Cover / Regulator 3 Bolts: 5-8Nm
3. Install the oil pump and 4 bolts, do not allow oil from oil pump to spill out.
Oil Pump bolts: 23-30Nm
#Tip: The oil pump can be primed by removing the oil pressure switch.

CYLINDER HEAD and VALVE ASSEMBLIES

**Make sure that all valve train components are kept in order so they can be installed in their original locations.*
Remove
1. Depressurize fuel system as described
2. Disconnect battery negative terminal.
3. Drain coolant from engine at radiator lower hose and remove top radiator hose.
4. a) Remove the power steering pump and lay to one side.
b) Remove alternator, remove alternator support bolts, then remove support assembly.
c) Remove distributor cap and spark plug leads.
5. Remove intake manifold and throttle body assembly as described.
Main points listed below.
(a) Remove air cleaner to intake chamber tube.
(b) Remove the fuel rails and injectors.
(e) Remove intake manifold and 2 gaskets 2 seals.
6. Remove the exhaust manifolds as described in this chapter.
7. Remove the 8 bolts securing the each rocker cover, rocker cover and gasket as previously described in this chapter.
8. a) Remove the rocker assembly bolts from each head, lift rocker assemblies and rocker arm pivots from heads.
b) Remove push rods.
c) Remove the valve lifters either by hand or use a screw driver with a bent end to help.
**Make sure that all valve train components are kept in order so they can be installed in their original locations*
9. Remove the cylinder heads, 10 bolts in the sequence shown, loosen bolts gradually.



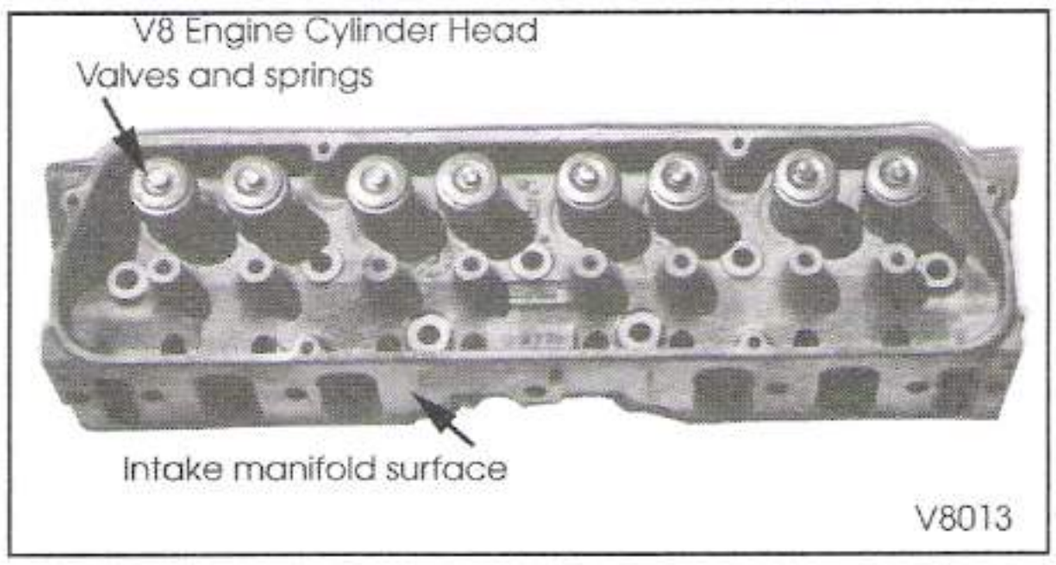
Loosen cylinder head bolts in this order



V8011

Remove the heads.
10. Lift the cylinder heads and gaskets from the engine block.

CYLINDER HEAD RECONDITIONING



** Make sure that all valve train components are kept in order so that they can be installed in their original locations.*
Dismantle
1. Compress valve springs in turn with a spring compressor and remove valve collets.
2. Remove the following:
(a) Valve spring caps, springs, valve stem oil seals and valve spring seats.
(b) Valves from cylinder head.
Caution: *Take care removing valves out of guides,*

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because if the valve ends are burred due to lifter wear or dirt in the guide, will damage guide. Remove burrs with an oil stone or fine file.

3. Replace all welsh plugs, use sealant as plugs are replaced.

Clean

1. (a) Remove all carbon deposit from combustion chambers, valve ports, etc., with a rotating drill mounted wire brush.

* Do not use a wire brush on any gasket sealing surface.

(b) Clean cylinder head gasket surface of cylinder head.

2. Thoroughly clean valve guides with a suitable cleaning solvent and a fine brass wire brush.

3. Clean valve heads with a drill and wire brush or buffing wheel.

* Do not scratch the valve stem.

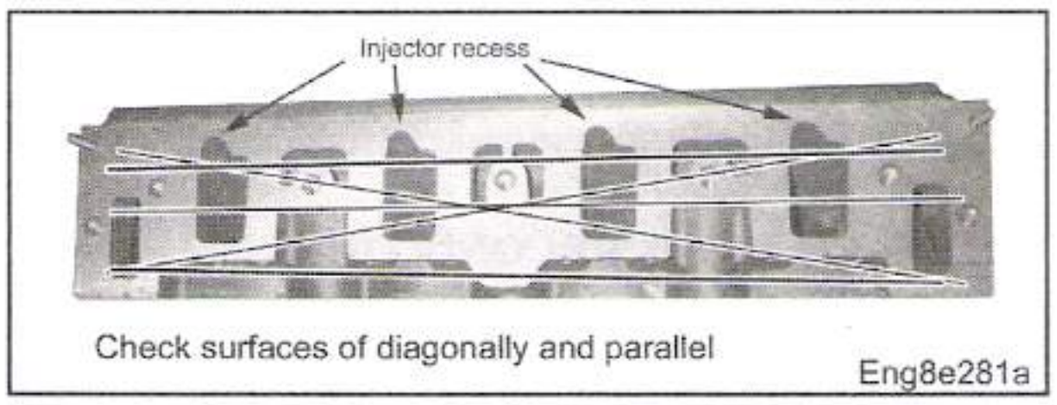
4. Wash all components in a suitable cleaning solvent and air dry with dry compressed air.

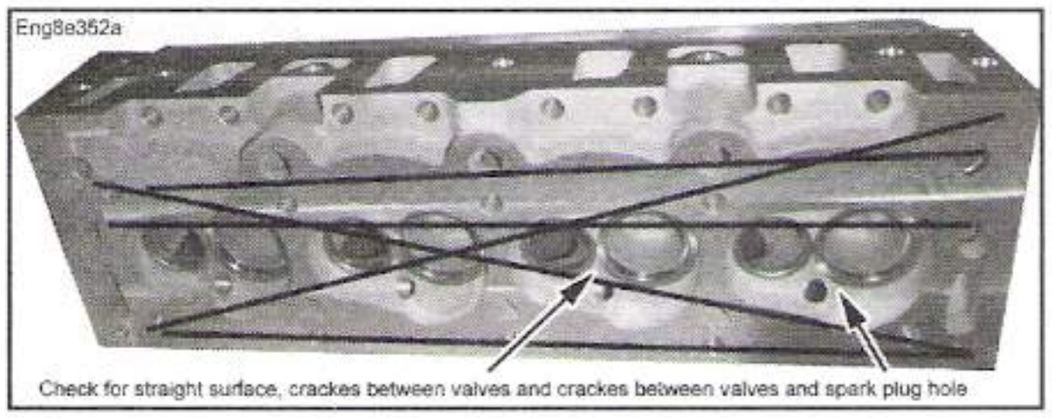
Cylinder Head Inspection

1. Cylinder heads should be inspected for cracks in valve seats, between valve seats, between valve seats and spark plug hole and combustion chambers, and for external cracks to water jackets.

2. Check cylinder head deck surface for corrosion.

3. With a straight edge and feeler gauge, check cylinder head deck, intake and exhaust manifold surfaces for distortion. Cylinder head deck surface should be checked diagonally, longitudinally and transversely.

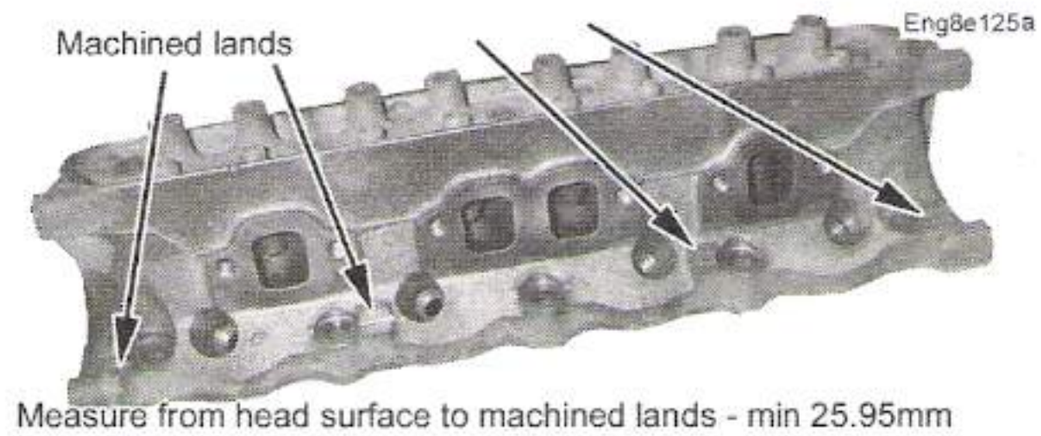




Head Surface maximum Distortion: 0.10mm

* Check thickness of cylinder head deck surface.

Minimum head deck thickness: 25.95mm



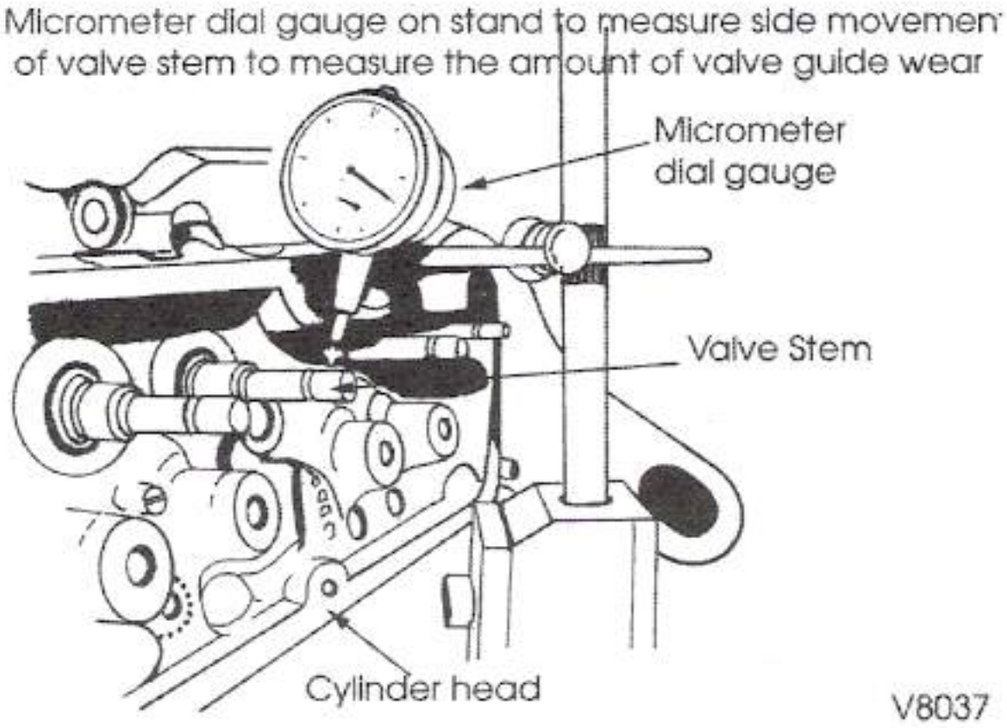
VALVE GUIDES

Clearance Checking

1. If valve stem to guide bore clearance is past maximum tolerance, it could cause lack of power, rough idling and noisy valve operation.

2. Insufficient clearance can cause noise and sticking of the valve and will cause uneven operation of engine.

3. Measure the valve guide clearance by using the valve from that guide. Install a dial indicator on top of the head so the with the valve lowered 1.5mm from the valve seat, the sideways movement of the top of the valve can be measured.



If the clearance is over specified, measure using a new valve, it is better to replace the valve instead of the valve guide, providing clearance is within specification.

Specified Valve Movement in Valve Guide:

Inlet maximum: 0.094mm

Outlet maximum: 0.119mm

Valves with over size stems are available, 0.04, 0.08, 0.20, 0.38 and 0.76mm. Ream valve guide to obtain specified diameter.

VALVE SEATS

1. Valve seats must be reconditioned to allow the seating of the valves must be perfect for the engine to deliver the power and performance its develops.

2. Good contact between each valve and its seat in the head is imperative to ensure that the heat in the valve head will be properly carried away.

3. There are several different types of machinery available for reconditioning valve seats. The recommendations of the manufacturer of the equipment being used should be carefully followed to attain proper results.

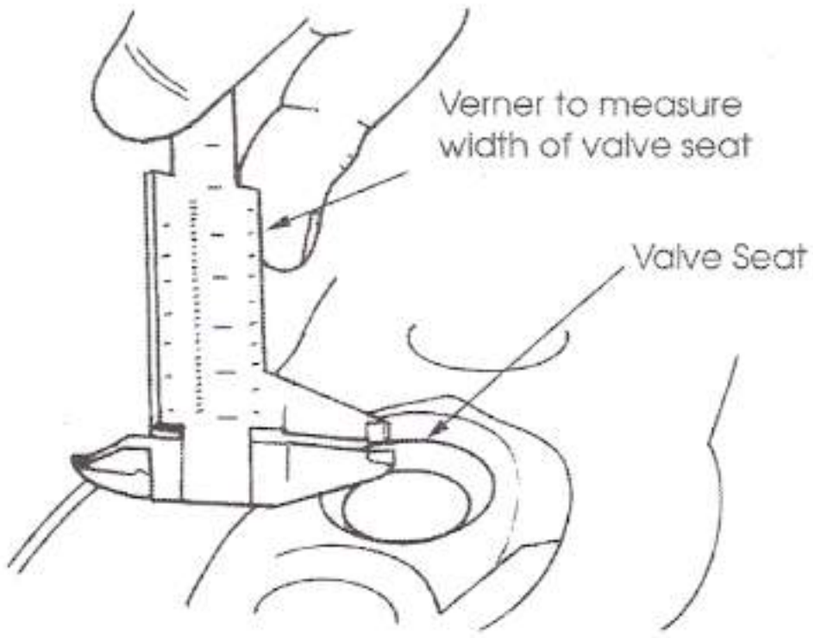
4. Check valve seats for any evidence of pitting or damage at valve contact surface. If pitting is evident, the valve seats will need to be reconditioned.

* Because the valve guide serves to support and centre the valve seat grinder, it is essential that the valve guide is serviced before reconditioning the valve seats.

* **Valve seat angles are 46^0.**

* **Valve seat width:**

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Valve seat must be specified width V8029

Exhaust 0.97-1.35mm
Intake 0.90-1.30mm

5. If the seat is too wide after grinding, it may be narrowed by using a 30° or 60° grinding stone. The 30° stone will lower the seat and the 60° stone will raise the seat.

6. If the valves seats are reconditioned, the valves must also be reconditioned (refer VALVES) or replace valves as necessary.

VALVE SPRINGS

1. Check valve spring surfaces, valve spring seat and valve cap for wear or gouging. Replace components as necessary.

2. (a) Check spring ends. If they are not parallel, the spring is bent.

(b) Replace valve springs that do not meet specification.

Maximum allowable variance in spring end length: 1.60 mm, while rotating spring on level desk.

Valve Spring Free Length: 51.56mm approximately

3. (a) Check valve spring load with a spring tester.

(b) Springs should be compressed to the specified height and checked against specifications.

Valve spring compressed height/load:

Compressed height: 338-373Nm@45.2mm

(c) Replace any valve spring if not to specification.

VALVES

1. (a) The valve stem should be inspected for burrs and scratches. (Burrs and minor scratching may be removed with an oil stone.)

(b) Valves that have excessive stem wear or that are warped should be replaced.

(c) The valve stem tip should be inspected for wear. The valve tip may be reconditioned by grinding.

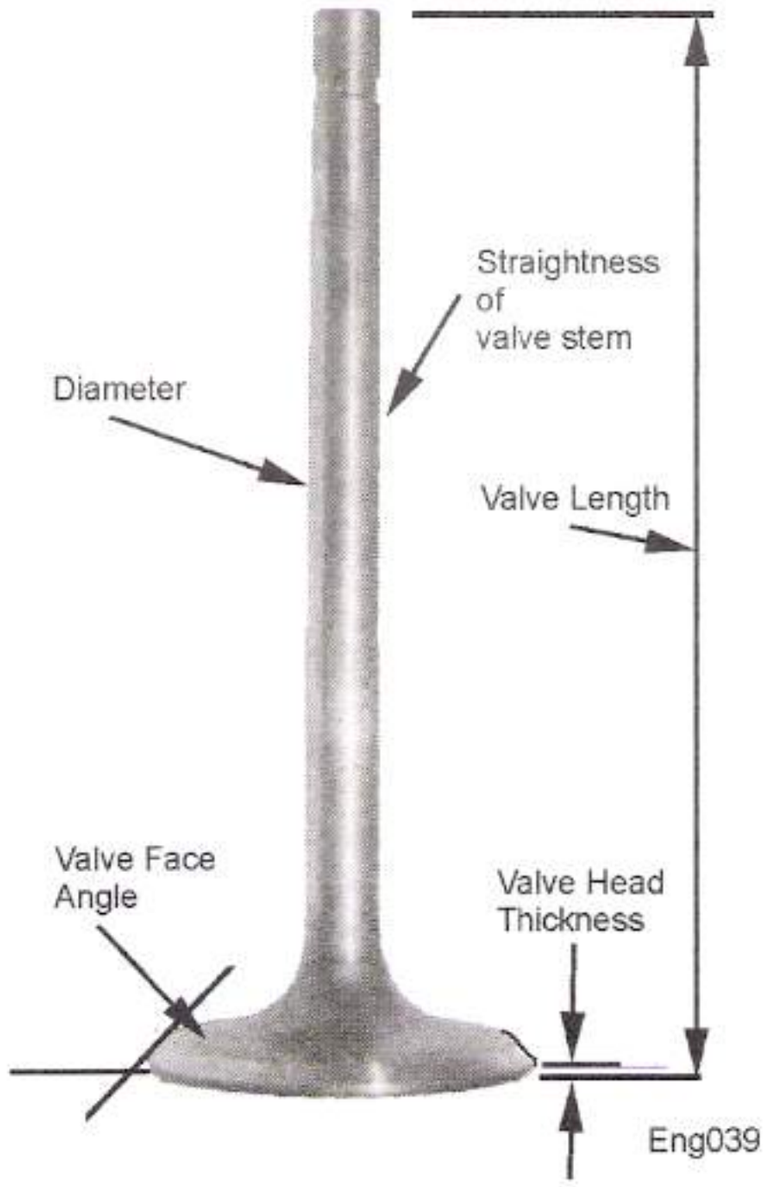
(d) Follow the grinder manufacturers instructions. Make sure the new tip surface is at right-angles to the valve stem.

(e) Do not grind valve below minimum specified height. Install valve into guide, hold tight into valve seat, measure the top of the valve tip to the valve spring seat.

Fitted Valve Maximum Height: 54.37mm

2. Inspect valve stem collet groove for damage.

3. (a) Check valve face for burning or cracking.



(b) If pieces have broken off, inspect corresponding piston and cylinder head area for damage.

4. (a) Inspect valve stem for straightness and valve head for bending or distortion using 'V' blocks.

(b) Bent or distorted valves must be replaced.

c) Measure valve stem diameter if out of specification replace, see also valve guides for oversize valve stems.

Inlet valve stem dia: 8.661 - 8.679mm
Exhaust valve stem dia: 8.66 - 8.68mm

5. Valves with pitted or grooves faces can be reconditioned with a valve refacing machine, ensuring correct relationship between head and stem.

Valve face angle: 45°.

* If pitting or grooving is so deep that refacing would result in a 'knife' edge at the valve head, the valve must be replaced.

* Measure valve margin after refacing valves. If margin is less than minimum specified, the valve must be replaced.

Minimum valve head margin thickness: 0.63mm

6. Lightly lap reconditioned valves into valve seat.

* New valves must not be lapped. Lapping destroys the protective coating on the valve face.

7. After refacing or installing a new valve, check for correct seating as follows:

(a) Lightly coat valve face with bearing blue.

(b) Insert valve and rotate about 1/6 of a revolution.

(c) Remove valve and check for full contact with seat.

i) If partial contact is indicated, insert valve again and turn through a full revolution.

ii) If blue on seat indicates full contact, reface valve.

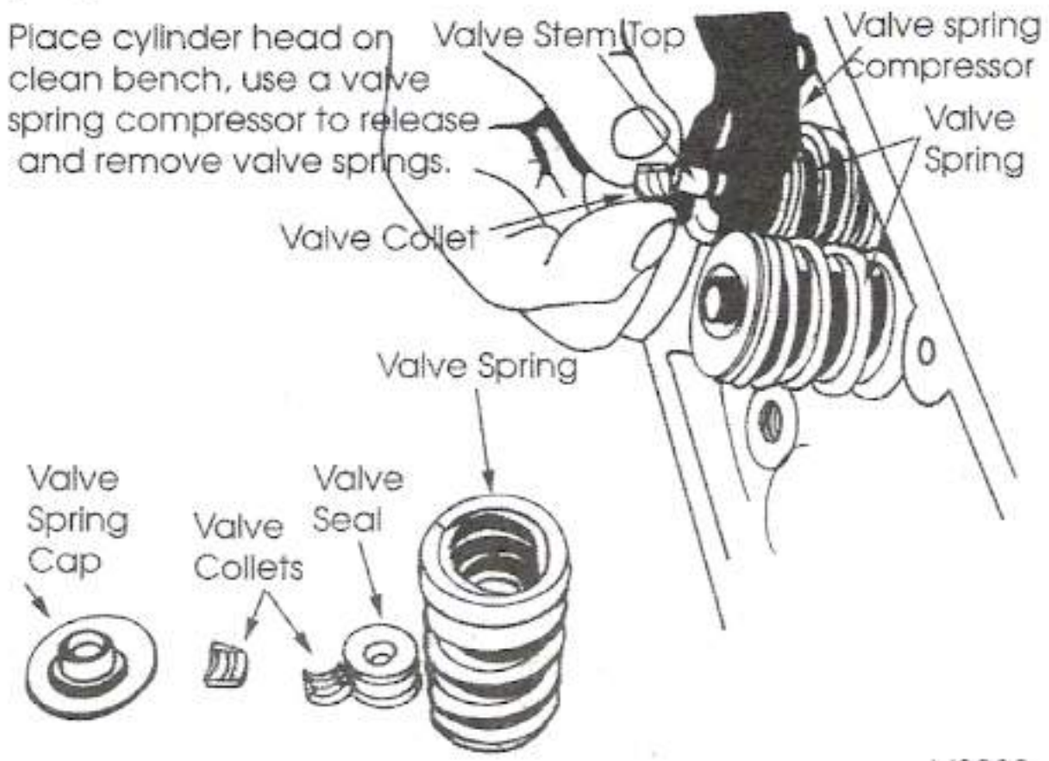
iii) If partial contact is still indicated, regrind cylinder head

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valve seat.
(d) Clean all traces of bearing blue from valves and seats.

CYLINDER HEAD ASSEMBLE

1. Dry and clean all components thoroughly.
2. Using clean engine oil, lubricate valve stems and valve guides thoroughly.
3. Make sure that seals fully seat on top of guide, install new valve stem oil seals.
4. Install valves in corresponding guides.
5. Install the valve spring seat over the valve guide onto the cylinder head.
6. Place valve springs and cap over valve stem.
7. Using a suitable spring compressor, compress valve springs.



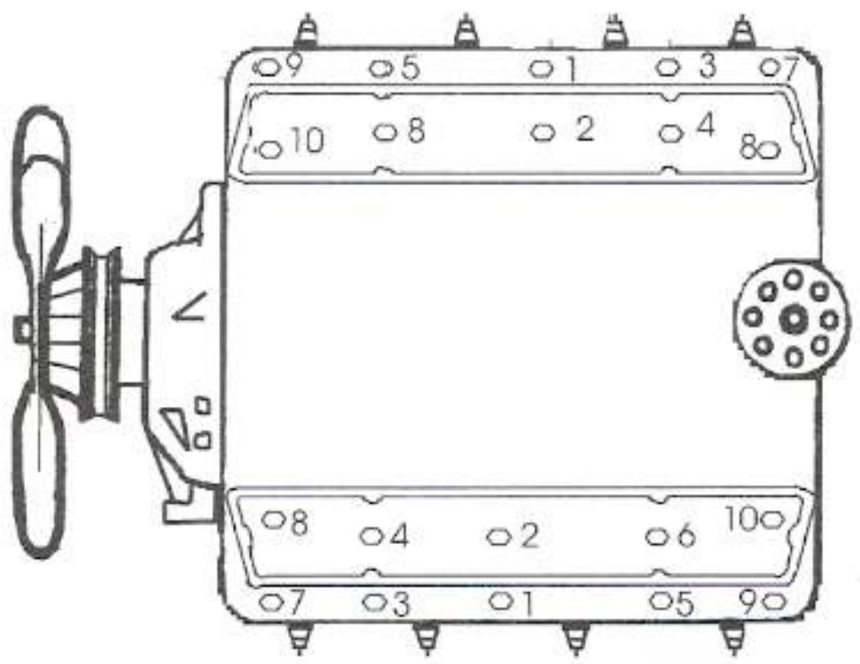
V8033

* Excess compression could cause spring cap to damage valve stem oil seal, ensure to compress valve springs only enough to install valve collets.
8. Install valve collets, making sure that they locate accurately in groove in top end of valve stem. Release the valve spring compressor slowly ensuring that the collets sit properly. Grease may be used to hold collets in place.
Tap the top of the valve tip to ensure the spring and collets are seated properly.

INSTALL

**Make sure that all valve train components are kept in order so they can be installed in their original locations*
1. Place dowel pins into block, place head gasket in position over dowel pins on cylinder block.
Gaskets must have the "Top" facing up.
2. (a) Carefully guide cylinder head into place over dowel pins and gasket.
(b) Coat threads of cylinder head bolts with LOCTITE 242 sealant or equivalent and tighten with finger, remove dowel pins during this procedure.
3. Tighten the head bolts to the following sequence and in the order shown in previous illustration.
* It is important to follow the given procedure to avoid head gasket failure and possible engine damage.

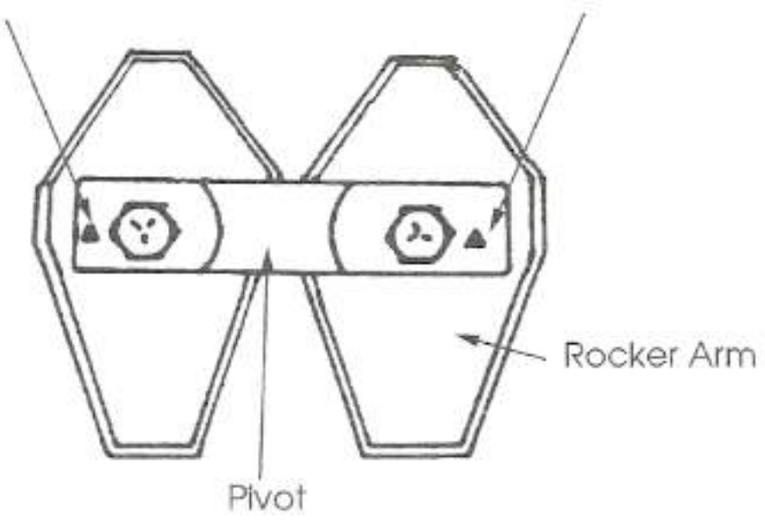
Tighten Cylinder Heads in this order



V8012

Step 1-Cylinder Head Bolt Torque: 50-55Nm
Step 2-Cylinder Head Bolt Torque: 77-83Nm
4. Install valve lifters into block if not already installed. Install valve lifter guide plates and retainer plate.
Valve Lifter Guide Plates: 26-34Nm
5. Install the push rods to the original positions.
6. Install rocker arm retainer and pivot assembly, and bolts. Tighten to specification.

Ensure the arrows on the rocker arm pivot point towards the center of the engine



V8010

Rocker Pivot Bolts: 24-32Nm
Step 2 Tighten a further 87-93 deg turn
7. Install rocker covers and gasket as previously described, tighten to specification.
Rocker Cover Nuts Torque: 3-6Nm
8. Install exhaust manifolds as previously described in this chapter.
9. Install intake manifold, fuel injectors, air intake chambers as previously described in this chapter.
10. Install drive belt, alternator as described.
11. Reconnect radiator hoses, refill and bleed cooling system.

VALVE STEM OIL SEALS

Replacement
1. Disconnect battery earth lead.

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2. Remove the following:
a) Rocker cover as previously described in this chapter.
b) Remove rocker assembly for relevant cylinder/s
d) Spark plug leads from spark plugs.
e) Spark plug from relevant cylinder and screw air adaptor into spark plug hole.
3. Rotate crankshaft so both valves are shut for the cylinder that correlates with the valve you are working on.
Apply air pressure to hold valves in closed position.
4. Remove the valve spring assembly for relevant valves.
5. a) Compress valve spring with valve spring compressor.
b) Remove valve collets.
*Before installing valve spring compressor, it may be necessary to tap top of valve cap with a soft-faced hammer to overcome the binding of the valve collets in the valve spring cap.
6. a) Remove spring cap, spring and valve compressor as an assembly.
b) Remove and discard old valve stem oil seal.
7. Install new valve stem oil seal and make sure the seal fully seats on top of the valve guide.
* Make sure the correct type of seal is fitted to the appropriate valve, based on part No.
8. a) Install spring, cap and valve compressor as an assembly on the valve stem.
b) Install valve collets and slowly release spring compressor, then remove spring compressor.
c) Disconnect air line to special tool.
9. Install the following:
a) Rocker assembly as previously described in this Chapter.
b) Rocker cover as previously described in this Chapter.
10. Remove special tool and install and torque spark plug.
Spark Plug Torque Specification: 15-25Nm
11. Install spark plug leads and battery earth lead.
12. Start engine and check for oil leaks and valve train noise.

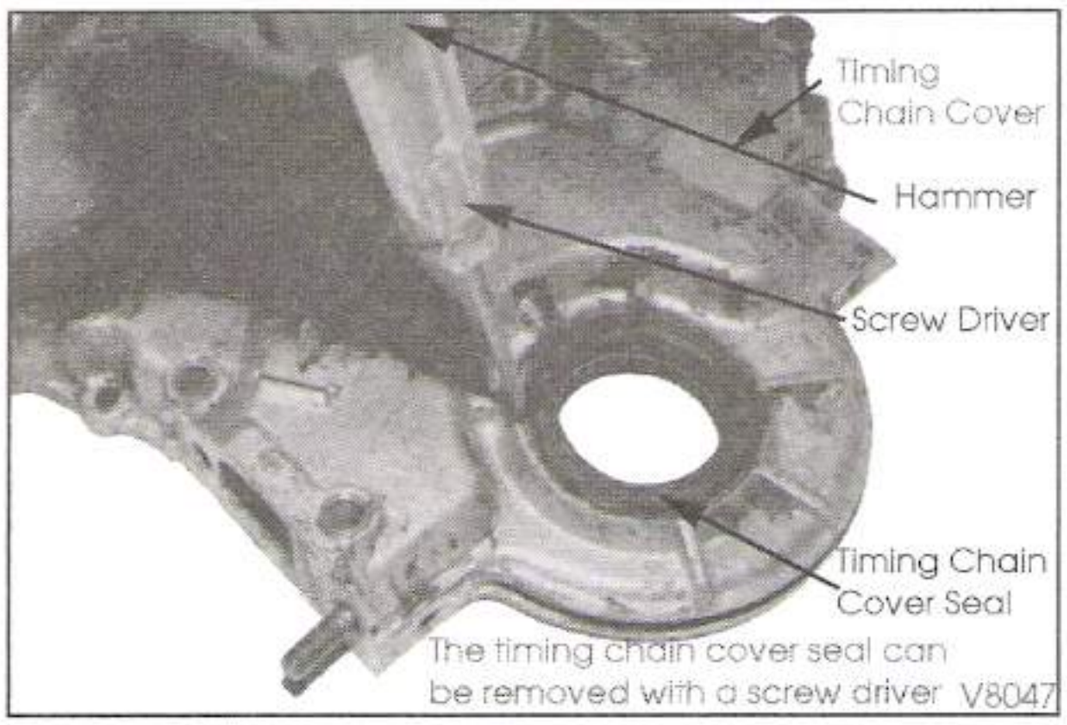
CRANKSHAFT BALANCER



Remove
1. Disconnect battery negative terminal and remove drive belt.
2. Manual Transmission: Pull park brake fully on, chock rear wheel and transmission in gear.
Automatic Transmission: Remove starter motor, use a large screw driver or similar to lock ring gear from turning thereby stopping engine turning over.
3. Loosen and remove balancer retaining bolt.
4. Remove balancer from crankshaft with pulley puller.
Install
1. Using engine oil, lubricate front seal surface of balancer.
2. Install balancer, engaging key on crankshaft with slot in balancer.
3. Install the crankshaft pulley, tighten attaching bolt to specification.
Crankshaft Pulley Bolt: 190 Nm minimum
4. Install and inspect drive belt operation.

FRONT OIL SEAL

Replacement

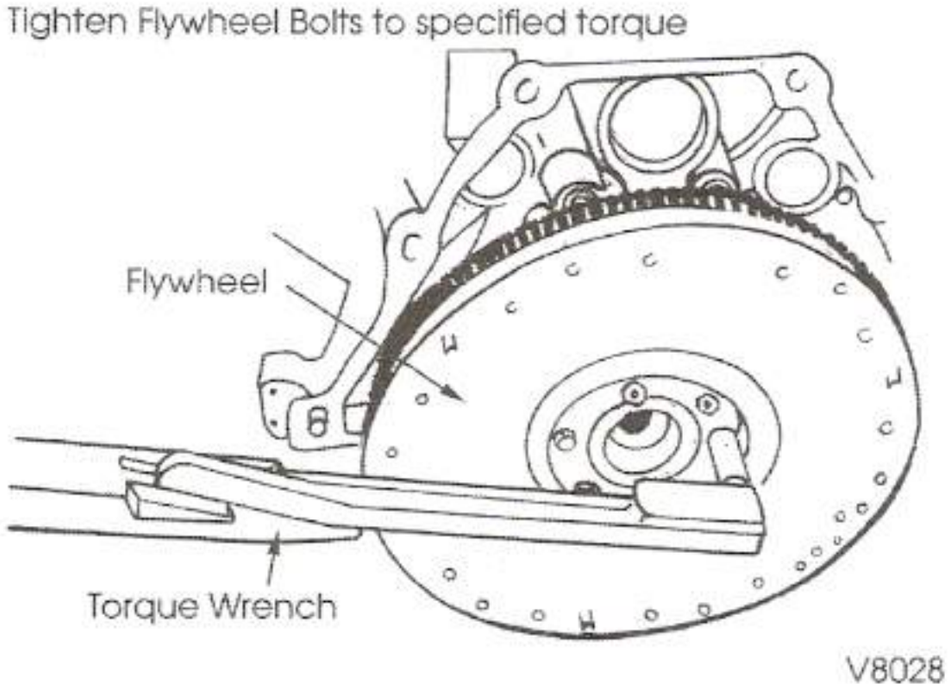


1. Disconnect battery earth lead.
2. Remove the following:
a) Drive belt assembly as previously described in this chapter.
b) Crankshaft assembly as previously described.
3. Use a seal remover or screw driver to remove the old oil seal.
4. Lubricate the seal lips with petroleum jelly, use a seal replacement tool to replace seal or a suitable object such as a large socket of the correct size. Tape into place with a soft hammer.
5. Install crankshaft balancer.
6. Install drive belt assembly.

FLYWHEEL/DRIVEPLATE

Remove
Before removal of flywheel/driveplate take note of the location of paint alignment marks on flywheel and pressure plate, before removing clutch pressure plate, the driveplate and torque converter make sure they have paint aligning marks.
If not visible, scribe aligning marks on all parts.
1. To remove transmission refer to particular chapter in this manual.

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2. Vehicles with manual transmission:
Remove the clutch pressure plate and driven plate as per "Clutch" section in this manual.
3. Block flywheel driveplate from turning, using a screw-driver or suitable locking tool. Remove flywheel/driveplate crankshaft bolts and flywheel/driveplate.

Inspection.

The flywheel and flexplate are purposely out of balance and no attempt should be made to re-balance these as an individual unit.
1. Check flywheel/driveplate ring gear for badly worn, damaged or cracked teeth.
If needed, replace flywheel ring gear or driveplate, for details refer to **"ring gear"** section in this chapter.
Check starter motor pinion gear for damage, if ring gear teeth are damaged replace pinion gear, for details refer to **"Starting System chapter".**
2. Inspect crankshaft and flywheel/driveplate matching surfaces for burrs. Using a fine mill file remove burrs if present.

Install

1. Install flywheel/driveplate to crankshaft, and tighten bolts to the correct specification.
Flywheel / Driveplate Bolt: 81-88 Nm
2. Mount a dial indicator on the rear of cylinder block for vehicles with automatic transmission. Inspect flexplate runout at the torque converter mounting bolt holes. Runout should not exceed the following specifications.
Flexplate Runout: 0.38 mm max.
Try to correct by tapping high side with a mallet if runout exceeds specification. Replace driveplate if this condition can not be corrected.
3. Inspect starter motor function.

RING GEAR

Replacement.

The ring gear is welded to the driveplate and is serviced only as an assembly for vehicles with automatic transmission. Therefore must be replaced as a complete unit.
For vehicles with manual transmission, the ring gear is a shrink fit on the flywheel flange, and if damaged, can be removed and replaced.
Replacement techniques are as follows:
1. To remove flywheel refer to FLYWHEEL/DRIVEPLATE section in this manual for details.
2. To remove ring gear drill a hole between two ring gear teeth and split gear at this point using a chisel.
3. Make sure that there are no foreign matter or burrs on new ring gear and flywheel matching surface. Remove burrs using a fine mill file (if present).
4. Heat and shrink a new gear in place as follows:
(a) Using an emery cloth, polish several spots on ring gear.
(b) Using a hot plate or a slow moving torch, heat ring gear until the polished spots turn blue (approximately 220 degrees Celsius).
* Heating the ring gear in excess of 427 degrees Celsius will destroy ring gear heat treatment.
(c) Quickly place ring gear in position against shoulder of flywheel using 2 pairs of pliers. Allow ring gear to cool slowly until it contracts and is firmly held in place.
5. Install flywheel, tighten bolt to specification.
Flywheel / Driveplate Bolt: 81-88 Nm

SPIGOT BEARING

Engines with manual transmissions have spigot bearings. Before removing clutch/pressure plate, take note of the position of the paint aligning marks on flywheel and pressure plate. If marks are not visible, scribe aligning marks on both parts.

Replacement.

1. To remove clutch pressure plate and driven plate as described in this manual.
2. To remove spigot bearing use a Slide hammer.
3. Use a piloted screwdriver to replace spigot bearing. Place new bearing on pilot of tool with radius in bore of bearing next to shoulder on tool. Drive bearing into crankshaft to the dimension as shown in the diagram. Use thin film of SAE 90 gear oil to lubricate the bearing.
4. Install clutch assembly and transmission.

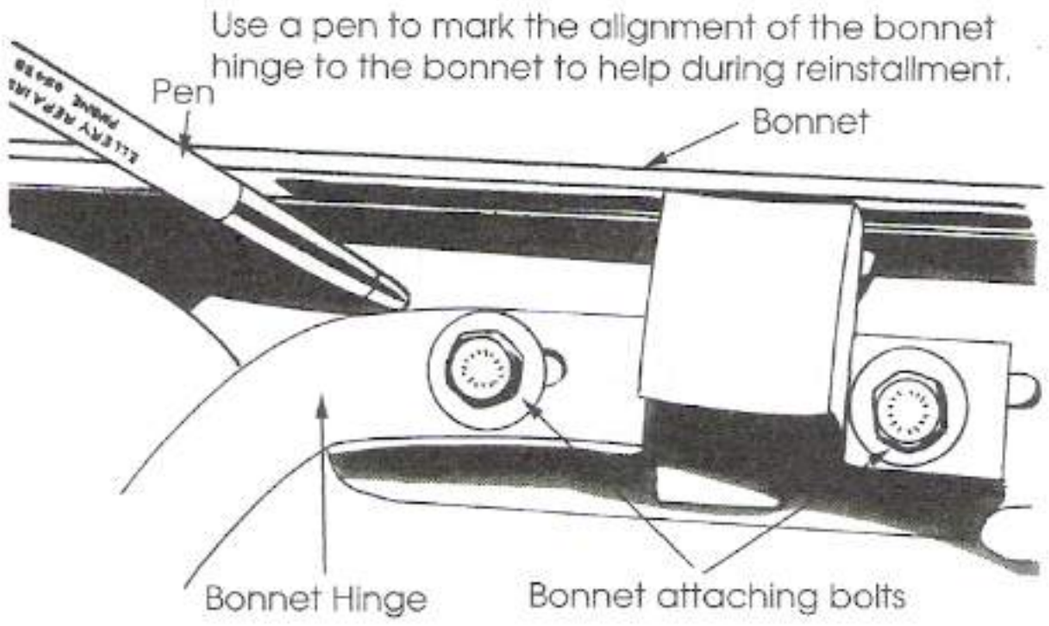
ENGINE REBUILD.

ENGINE ASSEMBLY.

Remove

1. Depressurise the fuel system as described in EFI chapter.
2. Disconnect battery leads
3. Remove bottom radiator hose from radiator to allow coolant to drain, and disconnect radiator hoses from engine.
4. Drain engine oil sump.
5. Using a felt tipped pen mark engine hood to hinge positions. Disconnect windshield washer hose. Disconnect hood gas struts. Remove hood hinge bolts and hood.
6. To remove cooling fan and radiator assembly refer to

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"Cooling systems" chapter section for details.
7. Disconnect heater supply and return hoses from engine heater pipe connections, including heater bypass pipe on the side of the block.
8. Disconnect main wiring harness from engine and battery harness.
9. Unclip engine harness, sensors and sender units.
10. To remove power steering pump (if applicable) refer to **Power Steering** section for details.
11. Disconnect air cleaner to air intake chamber tube.
12. Disconnect throttle cable from throttle linkage and mounting bracket.
13. Remove fuel supply and return lines from fuel rail and pressure regulator.
14. Disconnect emission control canister hoses from throttle body connections, and separate canister lines from fuel rail clips if a canister is fitted.
15. Disconnect brake booster hose from engine vacuum connections.
16. Fully raise vehicle and place on safety stands.
17. To remove tail shaft refer to "Propeller shafts and universal joints" chapter for details. Place a suitable plug in end of transmission.
18. Disconnect engine exhaust pipes from manifold assemblies.
19. To disconnect gear shift control from transmission refer to MANUAL TRANSMISSION or AUTOMATIC TRANSMISSION sections for details.
20. Disconnect clutch slave cylinder (for vehicles with manual transmission only) for details refer to CLUTCH section.
21. Disconnect speedo or wiring harness connector from speedometer sender at transmission.
Manual Transmission: Disconnect transmission harness from backup lamp switch.
Automatic Transmission: Disconnect transmission harness from solenoid.
22. Raise engine slightly to take weight off mounts by attaching an appropriate lifting hook and chain to engine lifting brackets if fitted. Care must be taken not to damage engine components with rope or chain while lifting engine.
23. Remove engine front mounting from mounting brackets.
24. Disconnect wiring harness connector from compressor clutch for vehicles with air conditioning.
25. Raise engine slightly and remove air compressor from engine mount bracket mounting bolts. Tie compressor back way from the engine.
26. Raise engine with front tilted upwards and a floor jack supporting rear of transmission assembly, make sure that engine exhaust manifolds, starter motor or transmission do not rest on steering gear.
* Do not allow engine to swing forward and damage air conditioning condenser (on vehicles with air conditioning condenser fitted at front) or optional transmission cooler.
27. Separate engine and transmission assemblies if necessary. Refer to MANUAL TRANSMISSION or AUTOMATIC TRANSMISSION for details.

Dismantle.

Dismantle techniques for each part are outlined in this section under their particular headings.
1. Mount engine assembly in an appropriate engine stand.
2. Remove the following parts:
(a) Starter motor.
(b) Drive belt to water pump, alternator etc.
(c) Alternator and brackets.
3. Remove the following parts as previously described or about to be described, in this chapter.
(a) Air intake chambers and intake manifold.
(b) Rocker covers.
(c) Exhaust manifold manifolds.
(d) Oil filter.
(e) Crankshaft balancer.
(f) Timing chain cover.
Rotate the crankshaft clockwise (it may be necessary to temporally install the crankshaft balancer pulley bolt) so the crankshaft is at TDC/ compression on number 4 cylinder, as previously described. Check that alignment mark on crankshaft sprocket and the camshaft gears are aligned, 2 dots facing each other, if not it may be necessary to rotate the crankshaft a further 360 degrees.
(g) Timing chain, camshaft gear.
(h) Cylinder head assemblies.
(i) Engine sump.
(j) Oil pump suction pipe and screen.
(k) Flywheel/flexplate.
(l) Engine rear bearing retainer plate.
(m) Crankshaft,
(n) Piston and connecting rod assemblies.

Assembly.

Assembly techniques for each part are outlined in this section under their particular headings.
1. Make sure that all bolts and nuts are tightened as specified.
2. Use specified engine lubricant and coolant when refilling.
3. Inspect transmission fluid level, add lubricant as required.

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4. Inspect for fuel, coolant, oil and exhaust leaks. Repair as required.
5. Check engine hood alignment.

OIL PAN (SUMP) & GASKET.

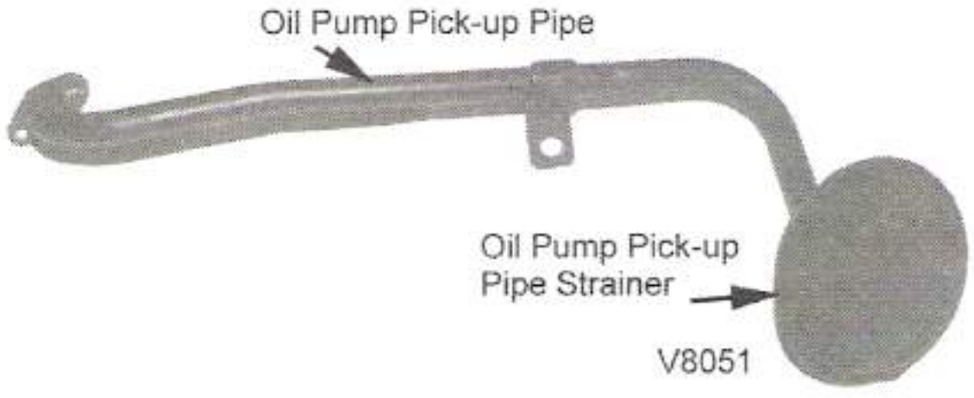
Remove

1. Drain oil from oil pan.
2. Remove the dip stick.
3. Remove starter motor if necessary to gain access to sump bolts.
Tip: You can use a tube spanner to remove bolts instead of removing starter motor.
4. Remove oil pan bolts, oil pan and seal, dispose of oil seal.
* Do not reuse the formed rubber oil pan seal.

Install

1. Clean all matching surfaces of oil pan and cylinder block thoroughly.
2. Apply sealant (Loctite 514) to the engine block and front timing chain cover.
3. Install new gasket onto oil pan, aligning oil pan bolt holes with the holes in gasket.
4. Install oil pan and gasket to crankcase, and tighten as specified.
Oil Pan (Sump) Bolt Specification: 8-11Nm
5. Make sure oil pan drain plug is tightened as specified, use a new drain plug seal.
Oil Pan (Sump) Drain Plug Specification: 30-60Nm
6. Replace dip stick.
7. Replace starter motor if removed.
8. Refill oil pan with the correct amount of engine oil as specified.
Lubricant Quantity Specification:
With out new oil filter: 4.8 Litres
With new oil filter: 5.1 Litres
Lubricant Quality: SAE 15W-40, 20W-40 or 20W-50
Engine Oil Grade API grade: SG or SH
9. Start engine and inspect for oil leaks. Repair as required.
10. Stop engine and check oil level on dip stick.

OIL PUMP SUCTION PIPE AND SCREEN.



Remove

1. Drain oil from oil pan (Sump).
2. To remove oil pan (Sump) refer to "Oil pan (Sump)& Gasket" in this section.
3. Remove the 2 bolts securing suction pipe and oil strainer to the engine block.

Install

1. Make sure that the screen is cleaned of any foreign matter.
2. Clean suction pipe and oil pump cover surfaces.
3. Install the bolts securing suction pipe and oil strainer to the engine block. Use a new "O" ring seal, install and tighten bolts as specified.
Suction Pipe and Strainer Bolts: 8-11Nm
4. Install oil pan and seal to crankcase, and tighten as specified.
Oil Pan (Sump) Bolt: 8-11Nm
5. Make sure oil pan drain plug is tightened as specified.
Oil Pan (Sump) Drain Plug Specification: 30-60Nm
6. Refill oil pan with the correct amount of engine oil as described in the **Oil Pan (Sump)** section.
7. Start engine and inspect for oil leaks. Repair as required.
8. Stop engine and check oil level on dip stick.

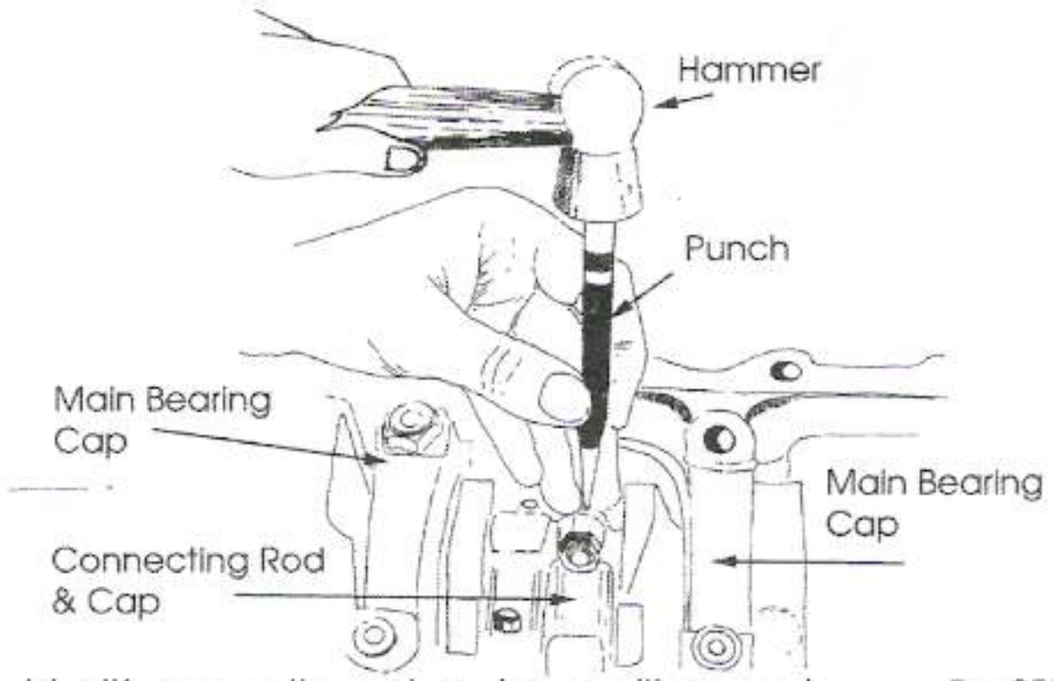
PISTON AND CONNECTING ROD ASSEMBLY.

Piston and connecting rod assemblies can be removed while the engine remains in the vehicle.
If the cylinder bore requires machining, remove the engine assembly as described in ENGINE ASSEMBLY section, remove piston and connecting rod, replace pistons and rings in oversize sets.
Piston and cylinder bore condition must be taken into consideration when fitting new pistons. Production and service pistons have the same nominal weight and can be intermixed without affecting engine balance. If needed, used pistons may be fitted selectively to any cylinder of the engine, providing they are in good condition.
Piston pin assemblies and ring sets are available in oversize.

Remove

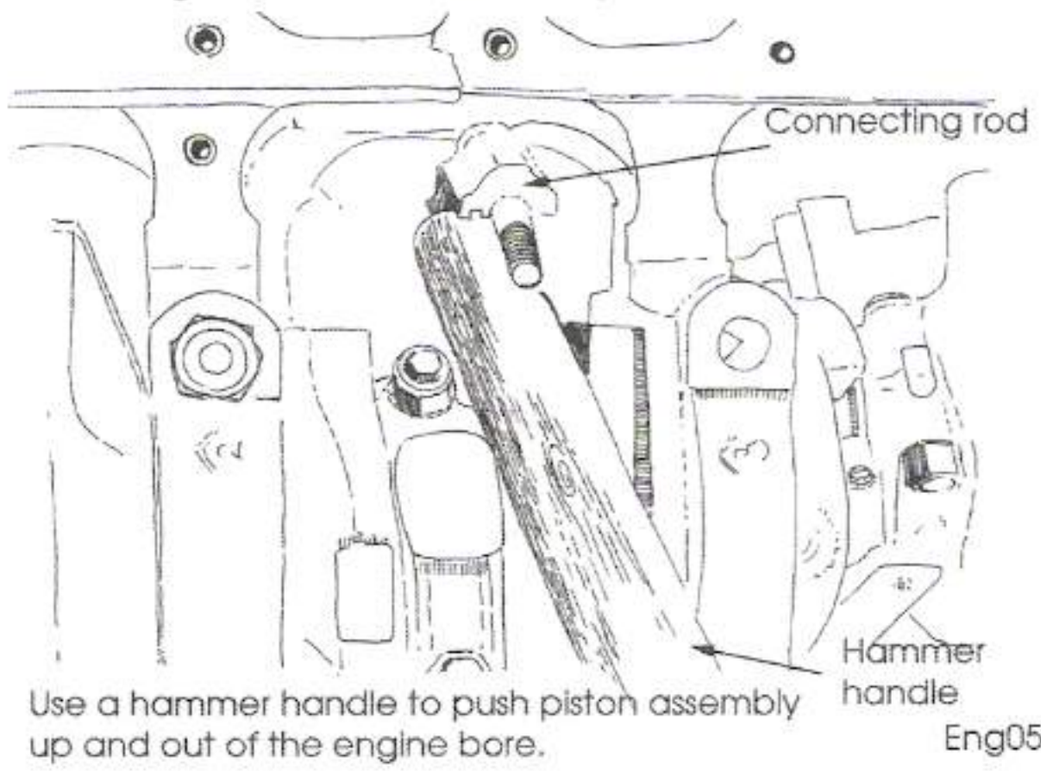
1. Disconnect battery negative terminal.
2. Remove cylinder heads as described in CYLINDER HEAD section.
3. To remove oil pan (sump) refer to OIL PAN (SUMP) section
4. Remove oil pump suction pipe and screen refer to OIL PUMP SUCTION PIPE AND SCREEN section.
5. Inspect cylinder bores above piston ring travel. If bores are worn so that a ridge or similar exists.
Turn crankshaft so that piston is at bottom of stroke and cover piston with a cloth to collect cuttings.
Remove the ridge with a ridge remover, this is to be done for each cylinder.
6. Using a punch and hammer, an etching marker, felt tipped pen or hammer and punch, mark all connecting rods, caps and pistons to indicate cylinder identification.
7. Remove rod assemblies and piston as follows,
(a) With connecting rod crankshaft journal straight down (Bottom Dead Centre), remove connecting rod cap bolts and remove cap with bearing shell, install a short piece of hose on bolt thread to protect crankshaft.

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Identify connecting rods and caps with a punch Eng055

(b) Push piston and connecting rod from cylinder using a hammer handle or similar. Remove bolt protection hose and install cap and bolts to connecting rod.



Use a hammer handle to push piston assembly up and out of the engine bore. Eng056

8. Remove all other piston and connecting rod assemblies using the same procedure.

Dismantle.

1. Expand and slide piston rings off to remove and dispose of them.

* Worn rings may have sharp edges ensure to take care when removing piston rings.

2. Push or press the piston pin from the piston and connecting rod assembly.

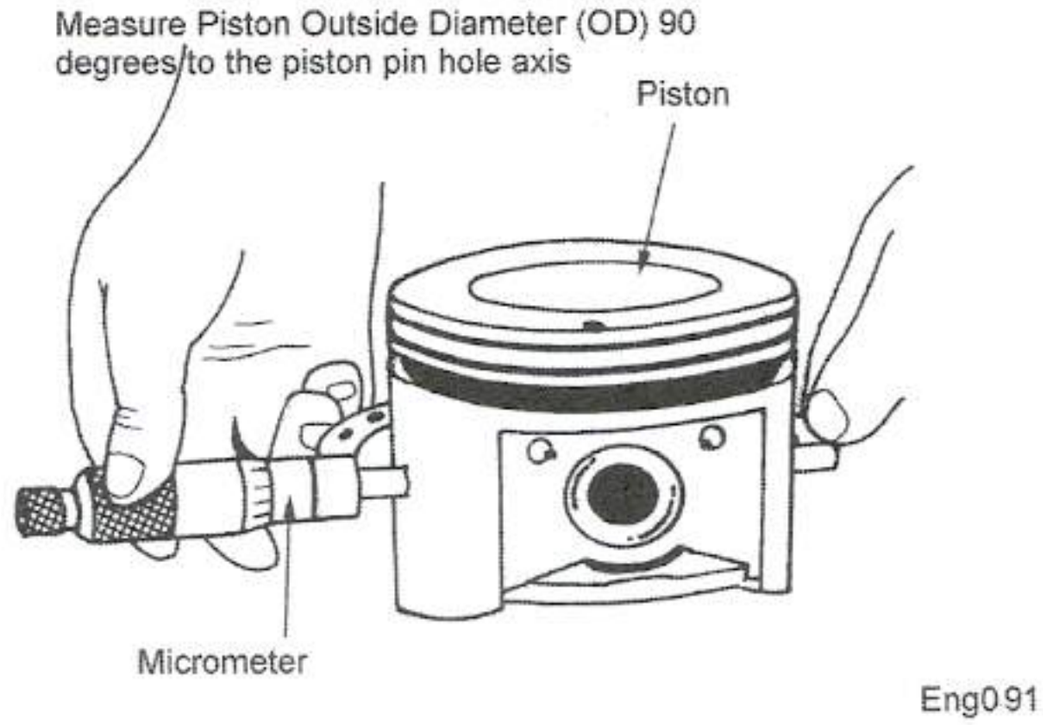
Inspection.

1. Thoroughly clean carbon from piston heads and from ring grooves using a suitable tool (old piston ring) and remove any gum or varnish from piston skirts using a suitable cleaning solvent.

2. Check cylinder walls for ridges, roughness, grooves or scoring which indicates excessive wear. Inspect cylinder bores for taper and possible out-of-round using an accurate cylinder measuring gauge at top, middle and bottom of the bore, both parallel and at right angles to the centreline of engine. Refer to "Cylinder block" section for details.

3. Examine piston skirt thoroughly for scored or rough surfaces, cracks in skirt or crown of piston, chipping, broken ring lands or uneven piston wear which would cause rings to seat improperly or have excessive clearance in piston ring grooves. Pistons must be replaced if faulty or damaged.

Pistons are cam ground, which means the diameter at right angles to the piston pin is greater than the diameter parallel to the piston pin. When a piston is checked for size, it must be done at points 90° to the piston bore. (Measure *65mm down from piston top)*



Eng091

Piston Size Standard: 101.572- 101.648mm
Available in 0.508mm oversize

4. Check piston pin bores and piston pins for wear. Piston pins and piston pin bores must be free of scuffing or varnish when being measured. Use a micrometer to measure the piston pin, and a dial bore gauge or an inside micrometer to measure piston pin bore.

Piston and pin should be replaced if not as specified.

Piston Pin Clearance

: in Piston	**0.0038 - 0.0064mm**
: in Connecting Rod	**0.0203 - 0.0406mm**

5. Remove bearing shells from connecting rod, install cap and bolts. Tighten bolts as specified.

6. Place connecting rod assembly on a checking fixture and inspect rod for twist or bend.

Replace if twisted or bent, do not attempt to straighten rod. Inspect new connecting rods by the same procedure before using them.

Connecting Rod Alignment Max. Specification

Bend	**0.020mm per 25.4mm**
Twist	**0.038mm per 25.4mm**

7. Check outside of connecting rod bearing shells and internal diameter of the connecting rod big end for wear, indicating high spots in rod big end.

8. Remove cap bolts and measure bolts for stretching by comparing them with a new bolt, if stretched, replace.

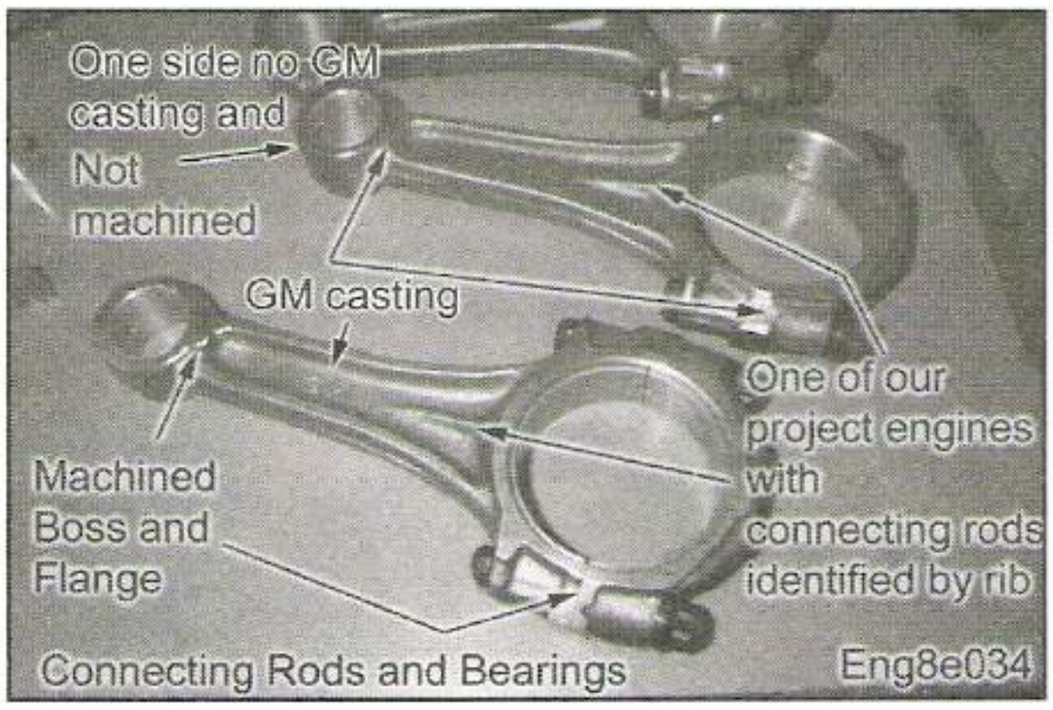
Assembly and Installation.

1. Using engine oil, lubricate piston pin and piston pin bore.

Note: The "GM" casting and connecting rod for cylinders 1357 faces the front of the engine, and for cylinders 2468 the "GM" faces the rear of the engine.

The notch on the top of the piston faces the front of the engine.

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2. Heat the connecting rod and piston pin to deg 280°C, use a heat crayon to indicate heat.

3. Assemble piston to connecting rods, while using a press to press piston pin into place, using a guide tool the pin will stop at the guide.

Caution: Use heat insulating gloves during this process.

4. To install piston rings refer to "PISTON RINGS" section.

5. Make sure connecting rod bearing shells, pistons, cylinder bores and crankshaft journals are totally clean, then, using clean engine oil, coat cylinder bores and all bearing surfaces.

6. Position the crankshaft journal at its lowest point, before installation of a piston and rod assembly in its bore.

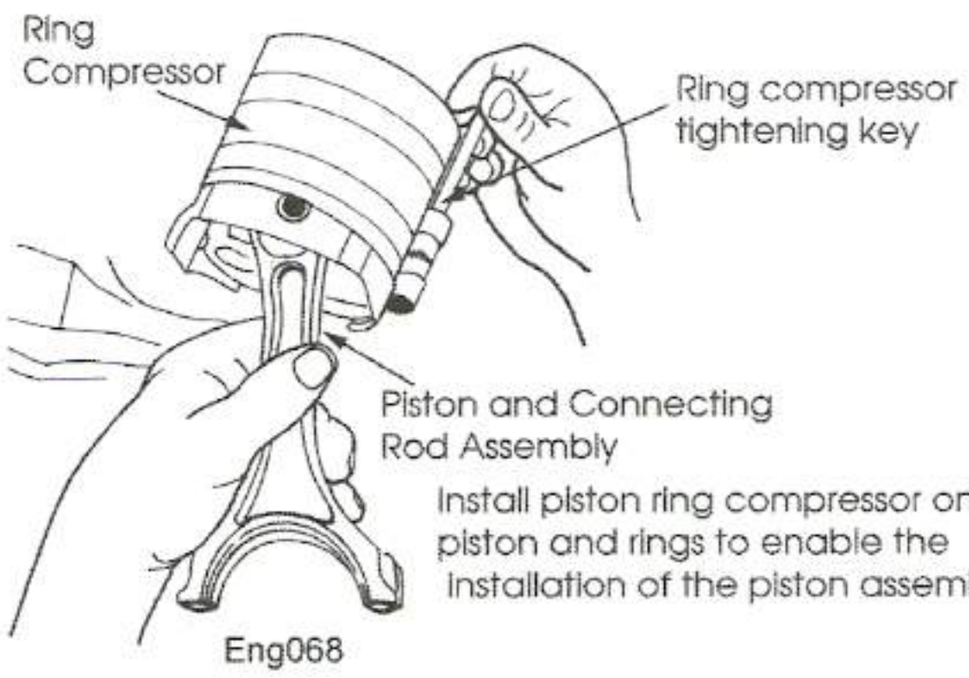
7. Remove bearing cap, and with bearing upper shell seated in to connecting rod, install the guide tool (length of air hose) onto connecting rod bolts.

Guides hold upper bearing shell in position and protect crankshaft journal from damage during the installation of connecting rod and piston assembly.

Note: *Check piston notch is to front of engine.*

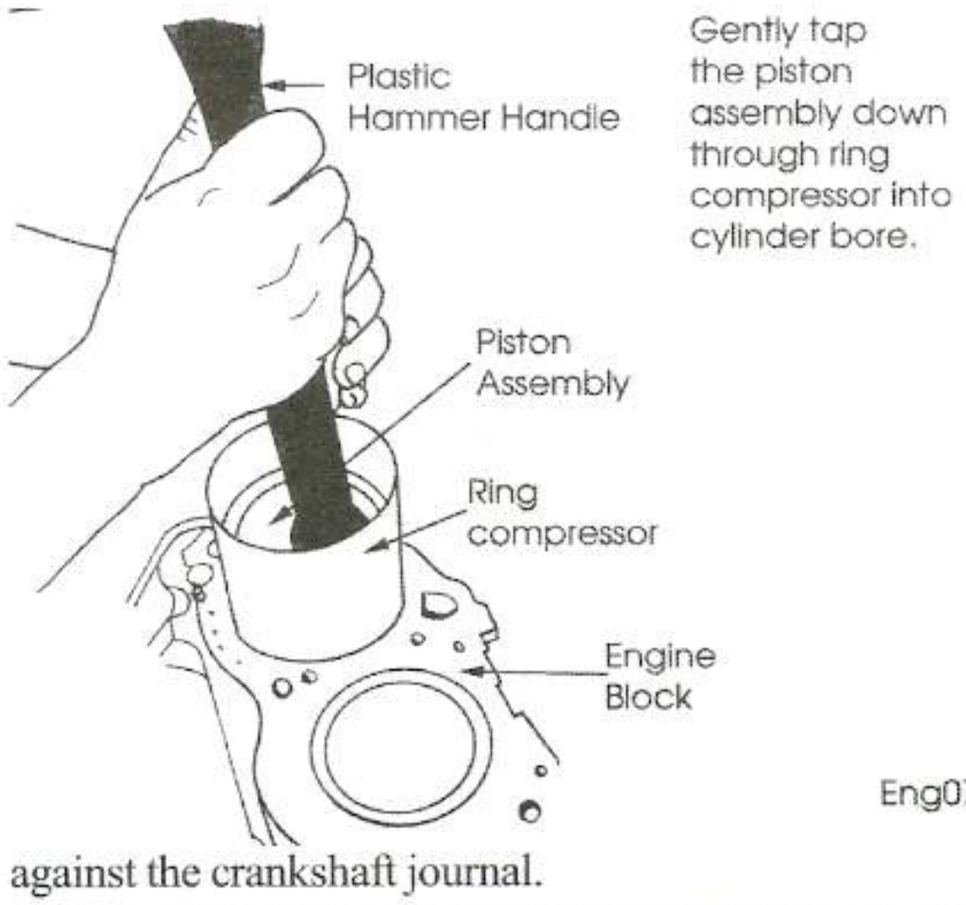
8. Make sure piston ring gaps are separated as described in PISTON RINGS section.

9. Using clean engine oil, lubricate piston and rings. With a suitable ring compressor, compress rings. Install each piston and connecting rod assembly into its cylinder bore.



10. Lightly tap piston into its bore, using a hammer handle, while holding ring compressor firmly against cylinder block until all piston rings have entered bore.

11. Push the piston down bore until connecting rod seats against the crankshaft journal.



12. Remove connecting rod guides. Install bearing cap and lower bearing shell assembly. Install cap bolts and tighten and then loosen one full turn. Then tighten again as specified.

Connecting Rod Cap Bolt: 56-64Nm.

13. Turn crankshaft to make sure crankshaft and connecting rod can move freely. If crankshaft binds, check bearing cap to rod orientation again and bearing clearance or connecting rod alignment.

14. Measure side clearance between crankshaft journal and connecting rod.

Connecting Rod to crankshaft end clearance:

0.203-0.356mm

If side clearance is not as specified, to check bearing clearance refer to CONNECTING ROD BEARING section, or connecting rod alignment.

15. Install remaining piston and connecting rod assemblies using the same procedure.

PISTON RINGS.

Install

* The pistons have three ring grooves (two compression rings and one oil ring set). The top compression ring is a molybdenum filled, balanced section and barrel lapped type. The second ring is an inverted torsional taper faced type. The oil ring set consists of three pieces, comprising two segments and a spacer.

1. Measure the end gap of the rings to be installed. Install the ring in relevant cylinder bore, then use the head of a piston, press ring down evenly into the bore.

* By using the piston as above, the ring will be square with cylinder wall.

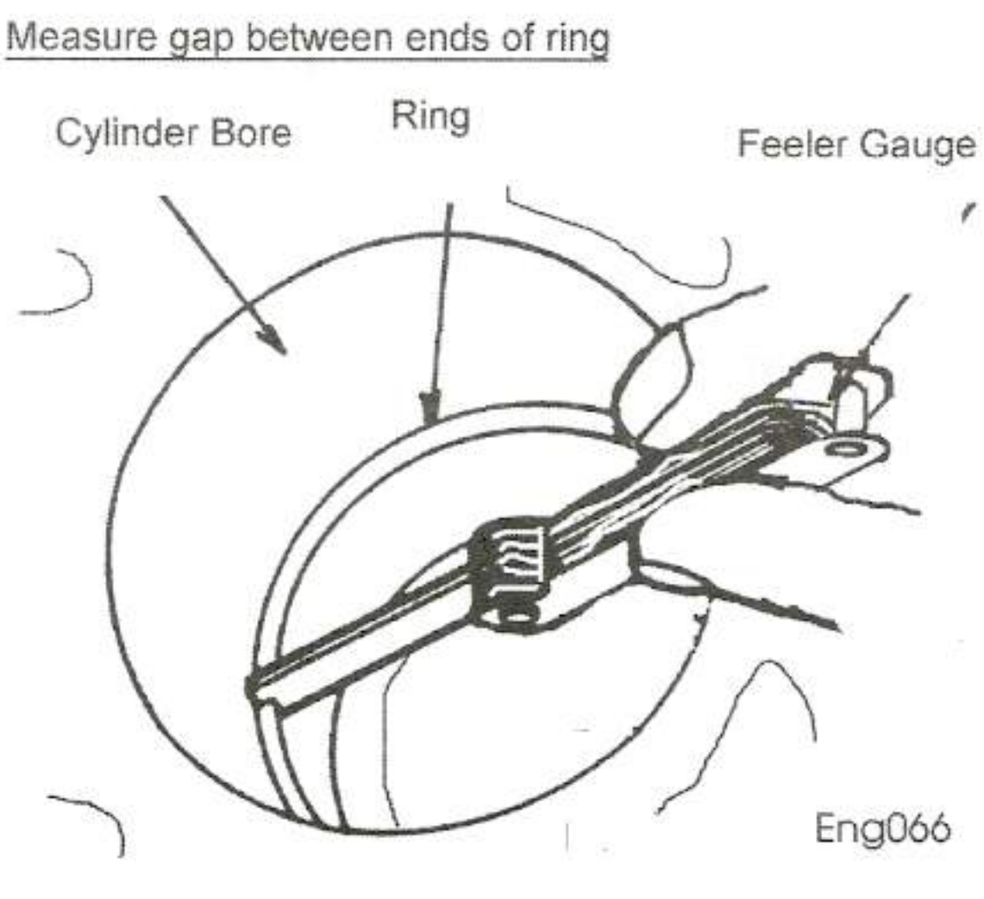
* Ensure not to distort the ring during this operation, as it could brake or it may bind in the piston ring groove after the engine is assembled. Measure each ring separately in the cylinder in which it is going to be installed.

2. Using a feeler gauge, measure gap between ends of ring.

Top Compression Ring End Gap Specification:

0.279-0.553mm

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Remove ring and try another, if the gap between the ends of a compression ring is below specification. The ring gap may be enlarged by filing.

Second Compression Ring End Gap Specification:
0.254-0.508mm

3. Inspect gap between ends of each oil control ring segment.

Oil Ring Steel Rail Gap Specification:
0.38-1.39mm

4. Carefully remove all traces of carbon from ring grooves in piston and check grooves for any chips or burrs that might cause ring to bind when fitting.

5. Fit the outer surface of each compression ring into the correct piston ring groove and roll ring around the piston groove to ensure that ring is free. Measure ring to piston groove side clearance.

Piston Ring Side Clearance:

Top Ring:	**0.03-0.08mm**
Second Ring:	**0.03-0.08mm**
Oil Ring:	**0.023-0.201mm**

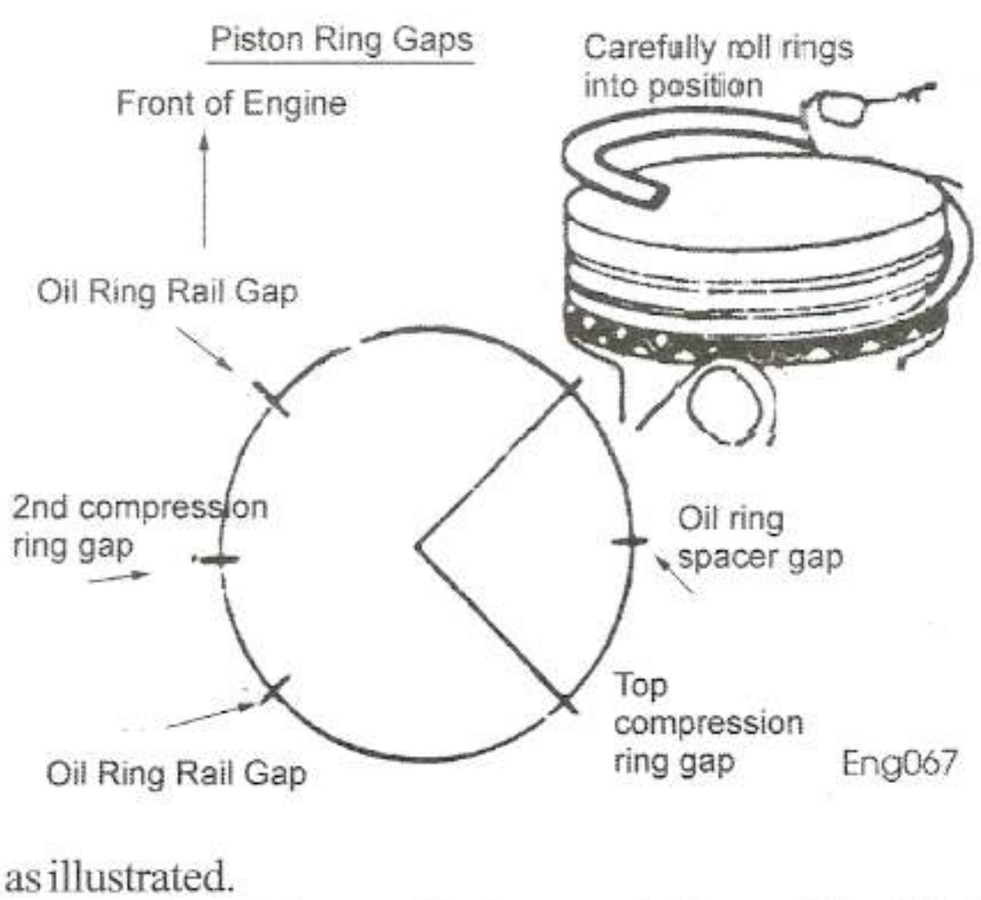
Try another ring if it is too tight. If no ring can be found that fits the specification, the ring may be ground to size using emery paper placed on a piece of glass.
If using a new piston, try another piston.
* High spots in the ring groove may be cleaned up with careful use of a fine file, do not try to cut the piston ring groove.

6. Install oil ring spacer into the bottom piston ring groove.
* The ends of the oil ring spacer butt against each other.

7. Install one steel ring from top of piston down into oil ring groove and install remaining steel ring from bottom of piston up into the oil ring groove.

8. Install compression rings in second and first ring grooves of each piston.
* Make sure the correct compression ring are installed in the first and second grooves, and the correct way up.
Top ring: either way upwards.
2nd ring: has a dot, this must face upwards.

9. Do a final test of ring fit in piston grooves. Separate ends



as illustrated.
* Do not install piston with ring gaps in line, as this will allow blow by at this point.

CONNECTING ROD BEARINGS

Each connecting rod bearing consists of 2 bearing halves or shells which are interchangeable in the rod and cap.
When the shells are in place, the ends extend slightly beyond the parting surfaces of the rod and cap. When the rod bolts are tightened, the shells are tightly clamped in place to ensure positive seating and to prevent rotation.
The connecting rod bearings are of the precision insert type and do not use shims for adjustment. The ends of the bearing shells must never be filed flush with parting surface of rod or cap.

Inspection and Replacement.
Connecting rod bearings can be replaced without removing the rod and piston assembly from the engine.

1. Disconnect battery earth lead and remove spark plugs.

2. To remove oil pan (Sump) refer to OIL PAN (SUMP) AND SEAL section for details.

3. To remove oil pump suction pipe and screen refer to OIL PUMP SUCTION PIPE AND SCREEN section.

4. Check connecting rod thrust clearance on each journal, if not within specification, replace with new connecting rod. Check clearance specification again if not within specification, replace crankshaft.

Connecting Rod to crankshaft end clearance:
0.203-0.356mm

5. Using a punch and hammer, an etching marker or felt tipped pen, mark connecting rods and caps to indicate cylinder number and an arrow pointing towards the front of the engine.

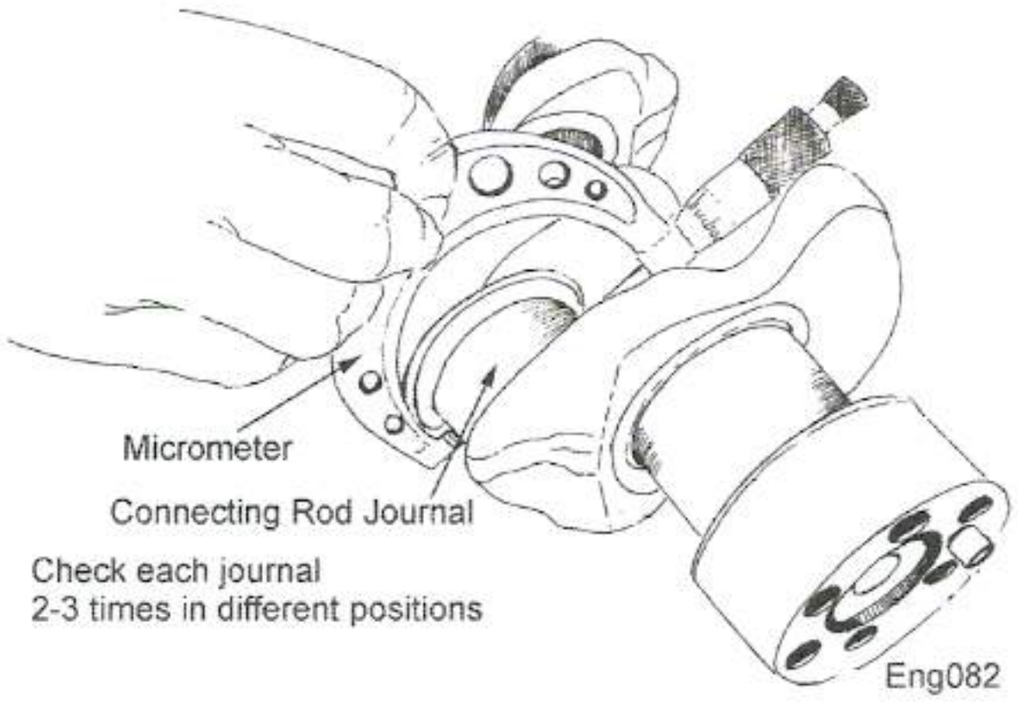
6. Remove connecting rod cap securing nuts and remove cap and lower bearing shell, the lower shell may still be on the journal.

7. Push piston and connecting rod up cylinder bore, use a hammer handle or similar to avoid damaging the bearing shell

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or crankshaft journal. The connecting rod will then be free from crankshaft journal. Remove bearing shell from connecting rod.

8. Clean crankshaft journal and measure for out of round or taper using a micrometer. Replace crankshaft, if not as specified in CRANKSHAFT section.



Connecting Rod Journal: **53.950 - 53.975 mm**
Out of round: **0.0381 mm max**
Taper: **0.0381 mm max**

9. Clean the bearing shell inner and outer surfaces of oil.

10. Inspect inner surface of bearing shells for gouges, wear or embedded foreign matter.

If particles are found, determine its nature and source.

Inspect outer surface of bearing shell for surface wear (indicates movement of shell in cap or high spot in surrounding material), looseness or turning (flattened tangs and wear grooves in shell), or overheating (discoloration of shell either side).

The crankshaft may be bent or have tapered bearing journals if uneven side to side wear is found. If necessary, remove crankshaft, refer to "Crankshaft" section and inspect crankshaft.

* Bearing failure, other than normal wear, should be examined carefully to determine cause.

11. Install bearing shells in original positions in connecting rod and cap if inspection reveals that crankshaft is OK.

12. Push connecting rod down onto crankshaft to allow the upper bearing to be seated against crankshaft journal.

13. Place a section of plastigage across the width of bearing journal, parallel to crankshaft centreline.

Tip: Make sure plastigage is not placed across the oil hole in journal.

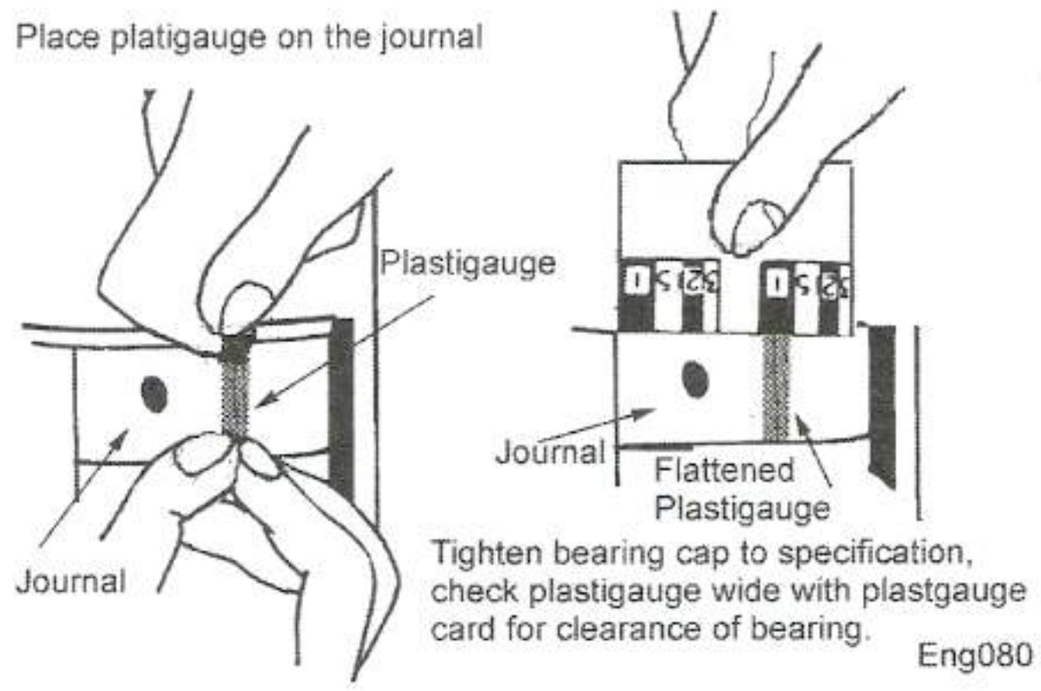
14. Install connecting rod caps to their original position as described in step 6. Tighten bolts as specified.

* Make sure that crankshaft does not rotate with plastigage installed.

Connecting Rod Cap Bolt: **56-64Nm.**

15. Remove the connecting rod cap bolts, and cap. Inspect the flattened plastigage it will stick to either the crankshaft or bearing shell in cap.

16. Comparing width of flattened plastigage at widest point



with graduation on plastigage envelope, to determine the bearing clearance. The number on the graduation scale of the envelope indicates the clearance.

Clearance between connecting rod bearings and crankshaft must not exceed specification.

Connecting Rod Bearing Clearance: 0.018 - 0.056
Maximum: 0.09 mm

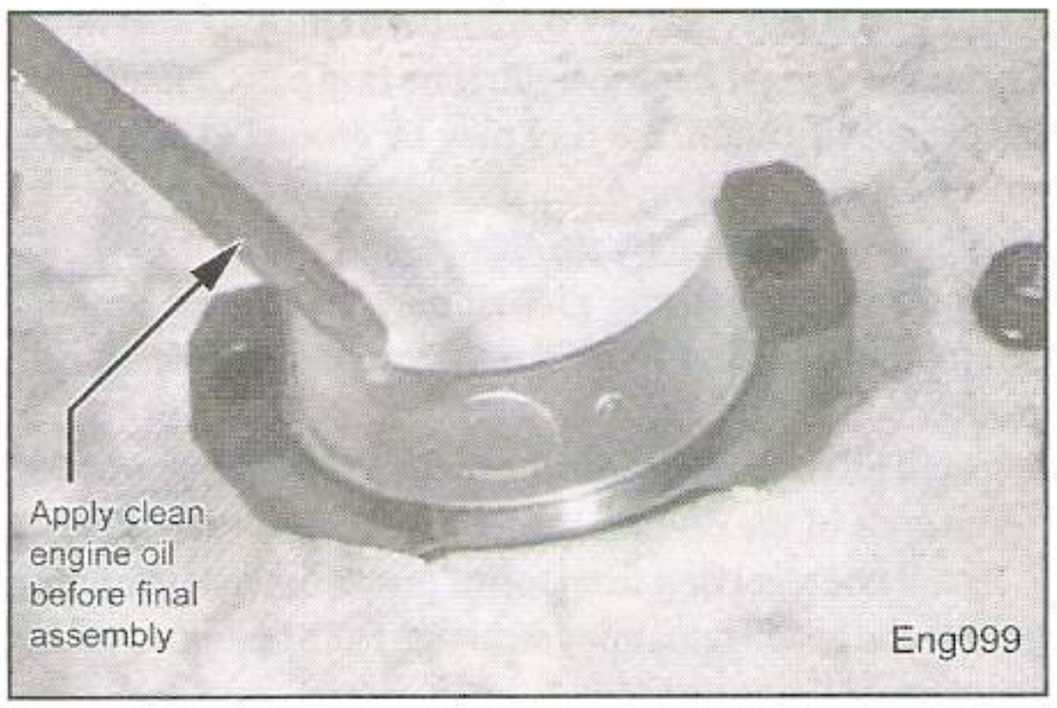
17. Make sure that connecting rod cap bolt threads and connecting rod threads are clean. Apply some new engine oil to the cap bolt threads.

* Before final installation of cap bolts, determine if bolts have stretched by measuring, then comparing with a new bolt. Replace bolt/s if necessary.

18. Install bearing shells in connecting rod and cap making sure notches in the shells match up with the recesses in connecting rod and cap.

Inspect clearance of new bearing using plastigage as previously described.

19. Remove all remains of plastigage from journal and shells after measuring. Using clean engine oil to lubricate bearing shells and journal. Arrow points towards the front of the



engine. Install connecting rod caps to their original position as described in step 6. Tighten bolts and then loosen one full turn. Finally tighten cap bolts as specified.

Connecting Rod Cap Bolt: **56-64Nm.**

20. After the bearing shells have been installed and cap bolts tightened, it should be possible to slide connecting rod backwards and forwards on crankshaft journal to allow end

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clearance. The crankshaft must turn without binding.

Connecting Rod to crankshaft end clearance:
0.203-0.356mm

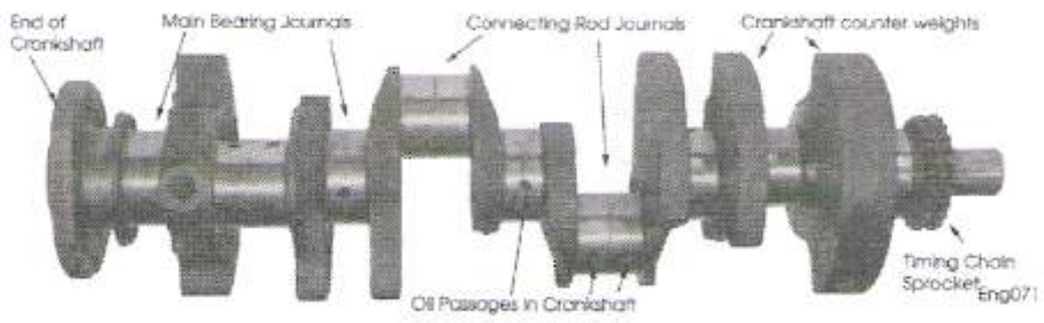
If connecting rod binds on the crankshaft journal, loosen and retighten the bearing cap bolts.

If connecting rod still cannot be moved or crankshaft binds, inspect bearing cap is installed correctly, bearing clearance or connecting rod alignment.

21. Install oil pump suction pipe and screen as described.

22. Install the engine sump with new gasket and sealant.

CRANKSHAFT.



Remove

* To check bearing clearance before removing crankshaft from crankcase refer to "connecting rod bearings" and "main bearings" section.

1. When engine is removed from vehicle and mounted on an engine stand, remove oil sump.

2. Remove flywheel/driveplate.

3. Remove oil pump suction pipe and screen and remove crankshaft balancer refer.

4. Remove timing chain cover.

5. Remove crankshaft sprocket.

6. Remove spark plugs.

7. Using a punch and hammer or an etching marker or felt tipped pen to mark connecting rod caps to indicate cylinder number and arrow to point towards front of engine.

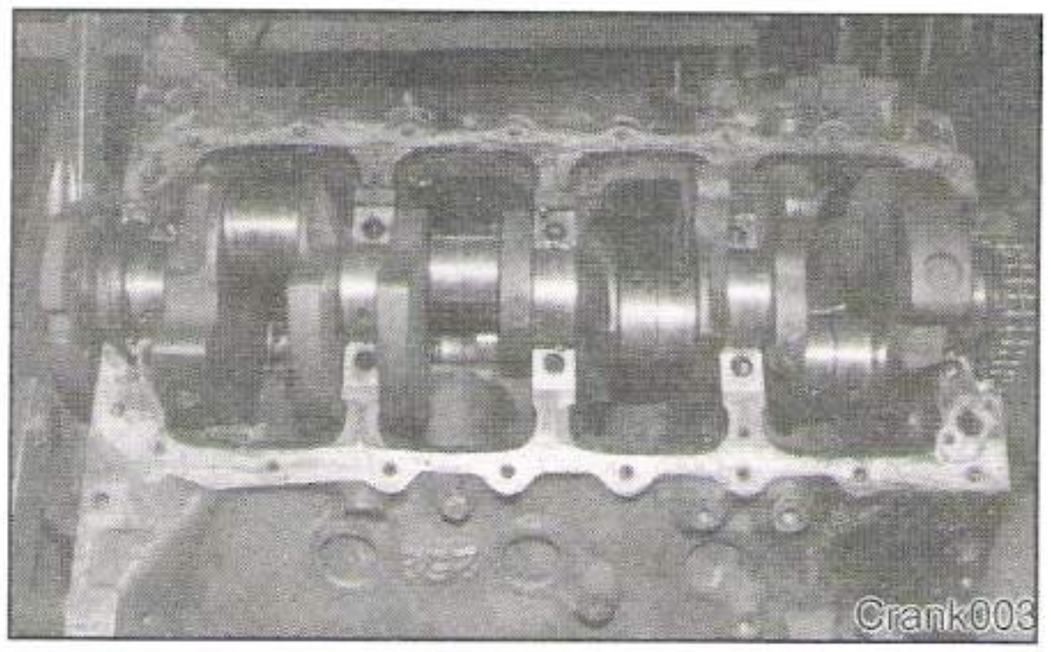
8. Remove connecting rod caps and nuts and push the connecting rods away from crankshaft.

9. Using a punch and hammer or an etching marker or felt tipped pen to mark connecting rod caps to indicate cylinder number and arrow to point towards front of engine.

10. Remove main bearing cap bolts and main bearing caps.

11. Lift crankshaft from cylinder block.

12. Remove key from front end of crankshaft, if needed, using a suitable punch and hammer.



Clean, Inspection and Installation.

1. Using a suitable cleaning solvent, pressure wash crankshaft and dry with compressed air.

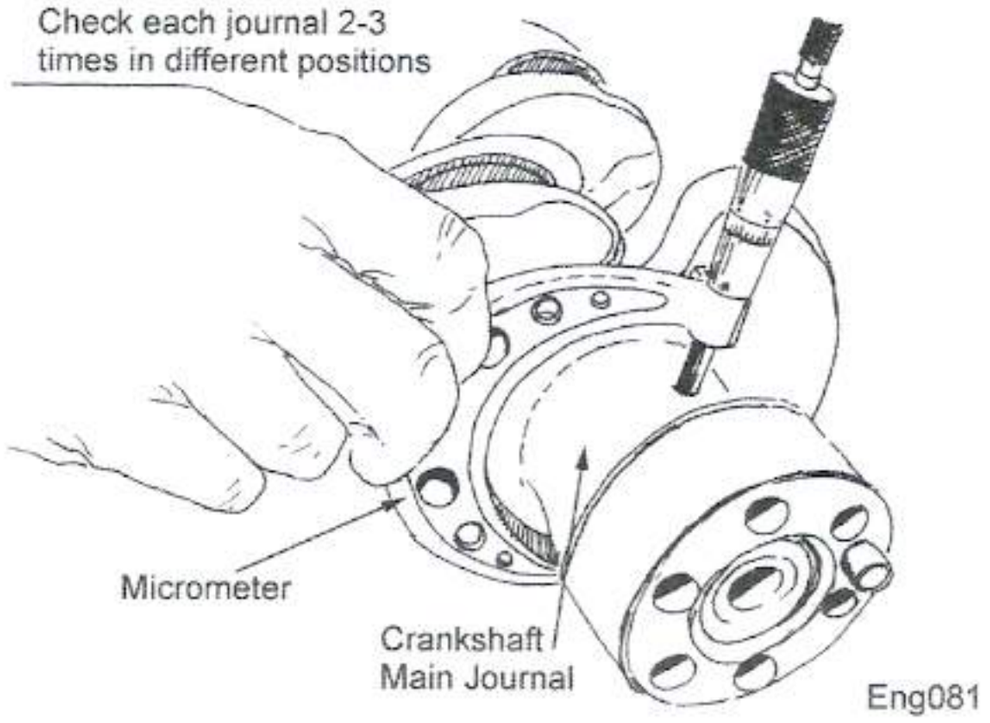
2. Check crankshaft oil passages for obstructions.

3. Check all bearing journals and thrust surfaces for: gouges, overheating (discoloration), cracks, grooving, chips and roughness.

The crankshaft must be machined or replaced if it has any burned spots, cracks or sever gouging. Slight roughness may be removed using a fine polishing cloth soaked in clean engine oil. Burrs may also be removed using a fine oil stone.

4. Check connecting rod and main bearing shells as described for embedded foreign material, then try to determine its source.

5. Using a micrometer measure bearing journals for taper, excessive wear or out-of-round.



Main Bearing Journal Diameter	
Standard Size:	**60.90 - 60.93 mm**
Taper:	**0.0254 mm max.**
Out-Of-Round:	**0.0254 mm max.**
Connecting Rod Journal:	**53.950 - 53.975 mm**
Out of round:	**0.0381 mm max**
Taper:	**0.0381 mm max**

6. Inspect crankshaft for run-out by fitting front and rear main bearing journals in a set of "V" blocks and checking other journals with a dial gauge.

Crankshaft Runout Specification: 0.03mm max.

7. Place a dial gauge indicator at the end of the crankshaft,

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on the rear flange to inspect rear flange runout. Make sure that crankshaft is thrust forward against a block of wood or on the "V" blocks so there is no possible movement of the crankshaft affecting dial gauge reading.

Crankshaft Rear Flange Runout: 0.05mm

8. If not as specified, replace crankshaft.

9. Ensure all traces of sealant are cleaned from rear main bearing cap and crankcase.

MAIN BEARINGS.

Crankshaft main bearing journals have 2 bearing halves (shells) which are not the same and not interchangeable in the bearing cap or engine block. The upper (engine block) shell is grooved to supply oil to the bearing, while the lower (into bearing cradle) shell is not grooved. The 2 bearing shells must not be interchanged. The No.5. bearing has flanges to take end thrust.

The main bearings are of the precision insert type and do not require reaming to size or utilize shims for adjustment.

Standard size and 0.001, 0.002, 0.010, 0.020, 0.030mm undersize main bearing shells are available.

When shells are fitted in engine block and bearing cap, the ends extend slightly past the parting surfaces, when cap bolts are tightened the shells clamp tightly into place, ensuring firm seating and to prevent the bearing from turning.

The ends of the bearing shells must never be filed flush with surfaces of engine block or bearing caps.

Main bearing caps have an arrow pointing towards the front of the engine and number cast into the bearing ,this indicates the number of the bearing cap from the front.

Bearing Inspection and Installation.

1. Check lower bearing shells and crankshaft journals. If the journal surface is ridged or heavily scored, replace crankshaft.

Tip: It is wise to new bearing shells when an engine is pulled down.

Inspect inner surface of bearing shells for gouges, wear or foreign material. Any foreign material found, the type and source should be found. Inspect outer surface of bearing shells for surface wear, this would indicate movement of bearing shell or high spot in surrounding material, looseness, rotation is indicated by flattened tangs and wear grooves, and overheating discolours the bearing metal.

Inspect thrust surfaces of thrust bearing for grooving or wear. Grooves are caused by irregularities in the crankshaft thrust surfaces or particles in the oil.

If the lower bearing shells and crankshaft journals are satisfactory, inspect bearing clearance

2. Inspect bearing tolerances, wipe oil from crankshaft journal, inner and outer surfaces of lower bearing shell.

Install bearing shell in original position in bearing cap.

3. Place a section of plastigage across full width of crankshaft journal, parallel to crankshaft centreline.

* Make sure plastigage will is not across an oil hole in journal.

4. Install bearing cap assembly and bolts.

* Install bearing cap assembly by loosely installing cap bolts and then lightly tap bearing cap into position, in order to prevent the possibility of cylinder block and or main bearing cap damage.

* Do not pull the bearing cap into place with the bearing cap bolts.

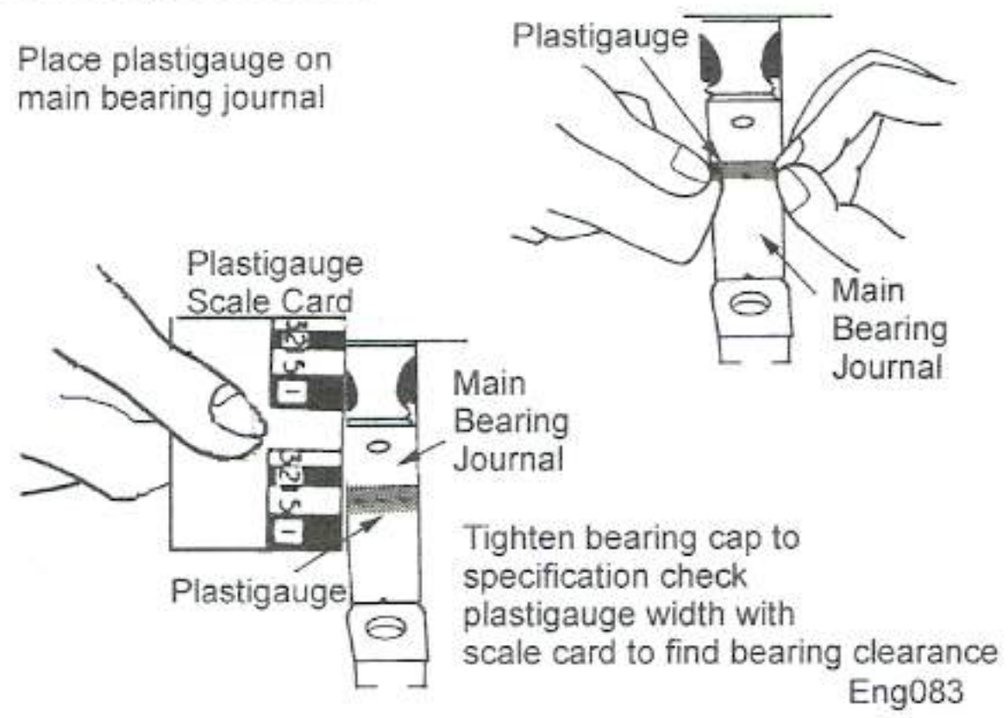
* Ensure that crankshaft does not rotate with plastigage installed.

Main Bearing Cap Bolt Torque: 81-95Nm

5. Remove bearing cap and bolts. Check flattened plastigage sticking to either crankshaft or bearing shell in bearing cap.

6. Check bearing clearance by comparing width of flattened plastigage at widest point with scale on plastigage envelope. The graduated number on the envelope indicates the clearance.

Main bearing and crankshaft journal clearance should not exceed specification.



Main Bearing Clearance: 0.020 - 0.061 mm

Maximum: 0.100 mm

* This check does not show any indication of crankshaft journal taper or out of round.

To measure taper, out of round or undersized, the crankshaft should be removed from the engine block as previously described.

7. It is advisable to install new bearing shells if bearing clearance exceeds specification and re-check clearance.

#If lower bearing is standard size, install an undersized shell and check clearance again.

Replace crankshaft if clearance is still not as specified. Apply a thin film of engine oil to the main bearing shells.

8. Install new bearing upper shells in cylinder block, making sure notches in bearings line up with recesses in block.

Bearing shells are marked with the part number.

[Crankshaft in engine] Insert un-notched end of shell between crankshaft journal and notched side of crankcase.

Note: If crankshaft is still in engine the place bearing shell on journal and push around journal into place. Installing a cotter pin into the oil hole of the crankshaft, then rotate crankshaft correct way carefully, the cotter pin will roll the bearing shell into place. Do not force shaft when shall is in place.

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* Make sure that the correct bearing shell is fitted between the crankcase journal and crankcase.

9. Sit crankshaft in place in main bearing upper shells in crankcase. Ensure not to damage crankshaft thrust bearing surfaces at No.5 main bearing

10. Install lower bearing shells in bearing cap cradle assembly, making sure the notches in the shells line up with the recesses in the caps and correct bearing is installed in the appropriate cap. Lower shells are not grooved and are available in either undersized or standard size.

11. Using engine oil, lubricate journal and bearing shells.

* When replacing No.5 main bearing shells, coat thrust surfaces with Molybdenum Disulphide grease or equivalent.



12. Make sure that main bearing cap bolt threads and cylinder block threads are clean and dry. Apply some engine oil to the cap bolt threads.

* Arrow on the front of the main bearing caps must face or point to the front of the engine.

* Before final installation of cap assembly bolts, determine if bolts have stretched by measuring with a new bolt. Replace bolts as needed.

* If the thrust bearing washer is disturbed or replaced, coat the surface using Molybdenum Disulphide Grease.

13. Install rear main bearing seal as described under "Rear Main Oil Seal".

14. Apply a thin bead of sealer to rear main bearing cap and mating surface on crankcase.

13. Install bearing cap assembly and tighten all bearing cap bolts to the correct specification.

Main Bearing Cap Bolt Torque: 81-95Nm

* To eliminate the possibility of cylinder block or bearing cap assembly damage, install bearing caps by installing cap bolts loosely and then lightly tap the bearing cap assembly into position using a soft faced hammer. Do not pull the cap assembly into place by using the bearing cap bolts.

14. Use a feeler gauge to measure crankshaft end float between front of No.5 main bearing thrust washer and crankshaft thrust faces, you will need to force crankshaft forward to do this.

Crankshaft End Float Specification:

New bearings: 0.051 - 0.153 mm
Maximum: 0.25 mm

15. Pull connecting rods up to crankshaft journals, using guide pin tools. Inspect connecting rod bearing clearances, if needed, refer to "Connecting rod bearing" section for details.

16. Turn crankshaft and it should turn without binding. If binding, inspect orientation of bearing cap, correct fitting of bearing shells or bearing clearance.

17. Install oil pump suction pipe and screen.

18. Install oil pan (sump) and gasket

19. Install flywheel/drive plate, tighten bolts to specification.

Flywheel / Driveplate Bolt: 81-88 Nm

20. Using the correct amount of engine oil refill the oil pan.

REAR MAIN OIL SEAL

Replace in Vehicle

1. Remove sump.

2. Remove rear main bearing cap.

3. Remove old seal from bearing cap and measure the length of the seal. Cut two pieces of new seal 2.0mm longer than the piece removed.

4. Use a piece of oxy welding rod to make a tool as shown.

5. Force special tool up into old seal in engine block to push the old seal around into the groove. With pliers grab the old seal, which is now partly out of seal groove and pull seal out.

6. Use a new cut seal, apply a suitable adhesive to seal and force into seal groove packing the seal with special tool as in point 4. Cut seal off at bearing mating surface once seal has fully filled seal groove.

7. Install another new half seal in bearing cap after applying the same type of cyanoacrylate adhesive as above in point number 6, to bearing cap seal groove. Roll seal into groove with wooden hammer handle.

8. Trim ends of seal flush with bearing cap surface. Apply a silastic type of sealant to the trimmed ends of the seal, this will help the seal to become oil proof.

9. Install rear main bearing cap and tighten bolts to specified torque.

Rear main bearing cap bolt torque 81 - 95 Nm

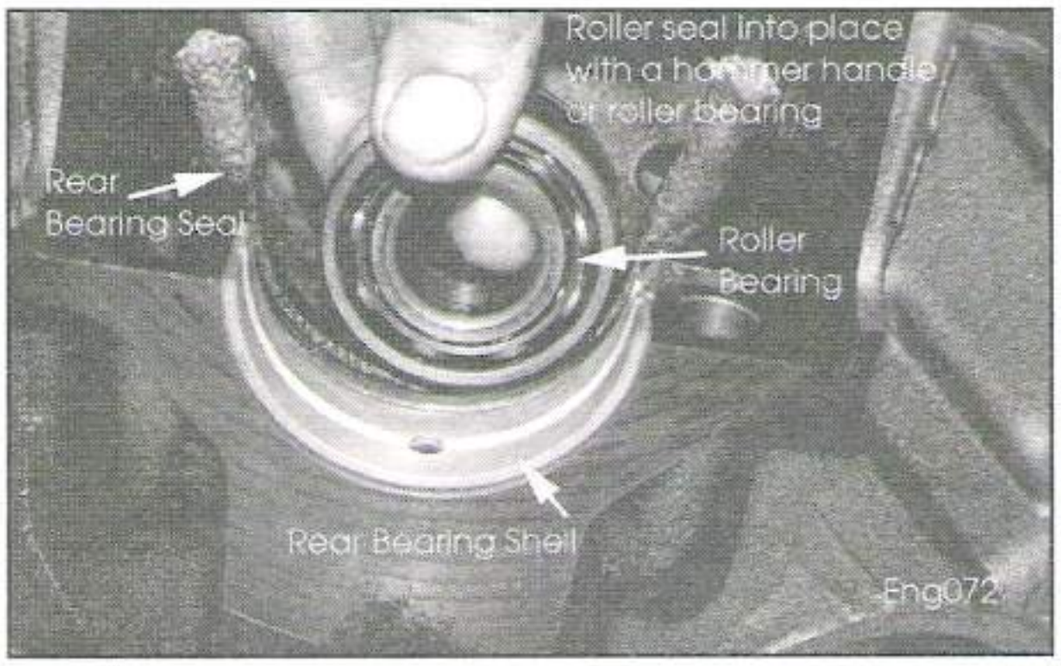
10. Install engine sump.

REPLACE

1. Remove crankshaft, as described in this chapter.

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2. Remove old rear main bearing oil seal from crankcase and rear main bearing cap. Clean seal groove.
3. Cut new seals 5.0mm longer than old seals removed.
4. Apply adhesive to bearing cap and crankcase seal grooves.
5. Install new seals in bearing cap and crankcase using a wooden hammer handle or old roller bearing to roll in new seal. Trim seal ends level with bearing cap and crankcase. Apply sealant such as, Silastic sealer to the cut ends of the seals.

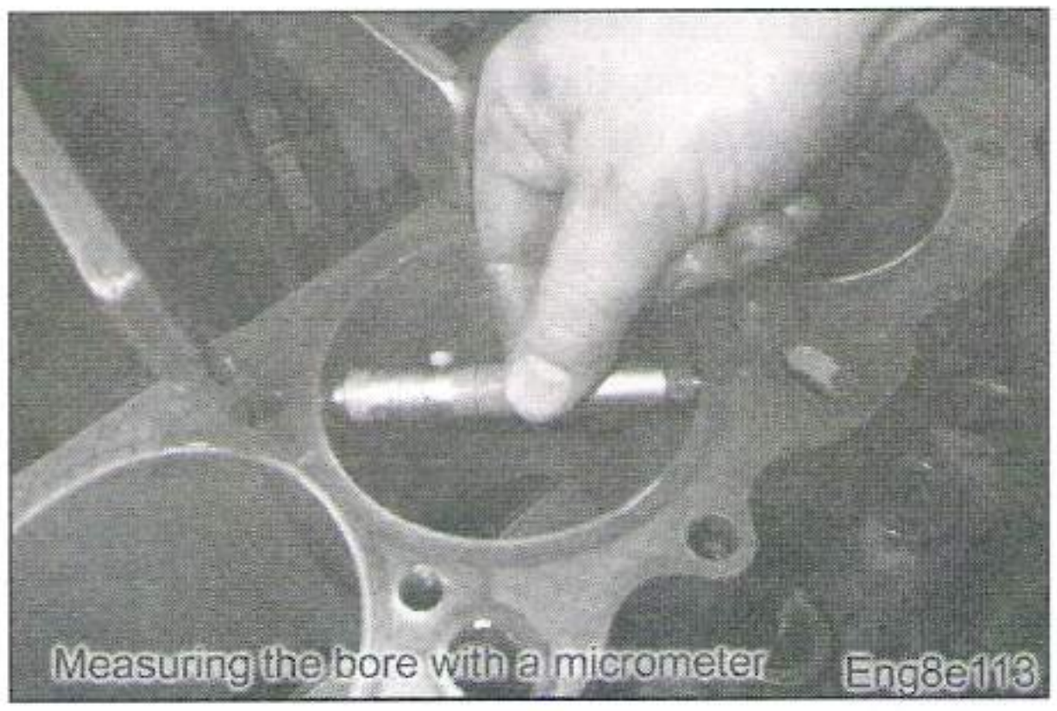


6. Apply thin bead of sealer to cap and mating surface on crankcase .
7. Install crankshaft.
8. Install rear main bearing cap and tighten bolts to specified torque.
Rear main bearing cap bolt torque: 81 - 95 Nm
9. Install engine sump.

CYLINDER BLOCK.

Inspection.
1. Mount the block in an engine stand.
2. Pressure wash the block and clean all cylinder block gasket surfaces.
3. If required remove all coolant jacket welsh plugs, oil gallery screw plugs.
Tip: It is a good practise to remove coolant welsh plugs.
4. Clean cylinder block thoroughly using a suitable cleaning solution. Flush with clean water or steam. Spray or wipe cylinder bores and machined surfaces using engine oil.
* Caustic cleaning solutions destroy all bearing and alloy materials. All bearing and alloy parts if not removed before cleaning must be replaced.
Do not use caustic solutions to clean bearing material or alloy parts.
5. Check all oil passages for obstructions.
Tip: Use a 22 gauge rifle cleaning rod and brush.
6. Using a straight edge and feeler gauge, inspect cylinder block deck surface for flatness.
If any distortion or irregularity is less than specified, cylinder block surface may be machined.
Tip: Install main bearing caps and torque before machining.

Cylinder Block Deck Surfaces Flatness: 0.013mm per 25.4mm or a Max 0.08mm for complete surface.
Replace cylinder block if irregularity or distortion is more than specified.
7. Replace camshaft bearings if necessary.
a) Use a special tool (camshaft bearing removal/installing tool) insert through camshaft bearings, install washer and nut to tool, and pull the bearings free from the block, one at a time.
b) Clean bearing bore, coat new bearing in new engine oil, use the same tool for removing the bearings to install the new bearings, pull into place, one at a time.
8. Check oil sump and timing chain cover surfaces for burrs or damage. Minor damage may be corrected using a fine file.
10. If needed, clean all threaded holes using a suitable threaded tap or drill out and install thread insert.
11. Measure cylinder bore walls for taper, oversize and out-of-round.



Cylinder Bore (standard):		**101.60 - 101.676mm**
Out of Round:	**Max**	**0.025mm**
Used:	**Max**	**0.08mm**
Taper:	**Max**	**0.013mm**
Used:	**Max**	**0.130mm**

If cylinder bore is worn over maximum limits, the block may be rebored, honed and oversize pistons installed.
14. If coolant and oil gallery plugs were removed when dismantling, install using specified sealant (Loctite 242).

Cylinder Reconditioning and Piston Fitting.

It will be necessary to smooth bores to fit new pistons, if one or more cylinder bores are scored, rough or worn beyond limits.
It is not be necessary to rebore all cylinders to the same oversize, to maintain engine balance, if some cylinders require reboring. All oversize OEM pistons are the same weight as standard size pistons.
Do not try to machine oversize pistons to fit cylinder bores, this will destroy the surface treatment of the piston and affect the weight. Install the smallest possible oversize OEM pistons and the cylinder bores should be honed to size for proper clearances.
Measure all new pistons at right angles to the piston pin bore,

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as described in piston section, before the honing or reboring operation is started.
Honing is recommended for trueing bore if cylinder bore wear does not exceed specification. The bore should be corrected up by boring and then hone finished, if wear or out-of-round exceeds specification.
All crankshaft bearing caps must be installed and torqued to specification when reboring cylinder bores, this help prevent distortion of bores in final assembly.
Leave 0.020 mm on the diameter for final honing to give the required specified clearance when taking the final cut.
Follow the Hone Manufacturers recommendations when honing, cleaning and lubrication of the honing stones. Noting the following points.
Hone through the entire length of the cylinder bore at the rate of approximately 60 cycles per minute. This will achieve the desired 45° cross hatch appearance on cylinder walls which will help ensure minimum oil consumption and maximum ring life.


Cylinder bores that are scored or grooved should be refinished by honing.
Cylinder bore. Eng074

Each piston must be fitted individually to the bore in which it will be installed and marked to ensure correct assembly during the final honing. After the final honing and before the piston is inspected for fit, each cylinder bore must be washed and dried thoroughly to remove all traces of abrasive and then allowed to cool. Apply clean engine oil to cylinder bores. The pistons and cylinder block must be at a common temperature before inspecting.
The glazed cylinder walls should be slightly dulled when new piston rings are installed without reboring cylinders, but without increasing the bore diameter, by means of the finest grade of stone in a cylinder hone.
Proceed as follows to inspect piston to cylinder bore.
1. Using a clean cloth wipe cylinder walls and pistons and apply clean engine oil to cylinder bores.
2. Measure the bore accurately using an inside micrometer.
3. Measure piston diameter 65mm from top of piston, subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.
Piston to Bore Clearance: 0.020-0.036mm
4. Identify each piston with cylinder number to which it will be installed, then proceed to hone other cylinders and fit pistons.

**Handle the pistons with care, do not attempt to force the piston through the cylinder bore until cylinder has been honed to the correct size. Pistons can be damaged through careless handling.

Problem Diagnosis.

Problems and Possible Causes.
Problems should be corrected, when proper diagnosis is made, by repair, adjustment or part replacement as needed. Refer to the correct section in this manual.
High Oil Loss
(1) Tighten bolts and/or replace gaskets and seals as required for external leaks.
(2) Check oil with car on a level surface and allow adequate drain down time to ensure a correct reading of dipstick.
(3) Towing or continuous high speed driving will normally cause oil consumption to increase.
(4) PCV system failure.
(5) Use recommended S.A.E viscosity for current temperatures. Refer to "tune-up and maintenance" for details on correct oil viscosity.
(6) Valve guides and/or valve stem seals worn, or seals omitted. Ream guides and install oversize service valves and/or new valve stem seals.
(7) Allow enough time for the piston rings to seat. Replace worn or broken rings as needed, if rings have been incorrectly installed, worn or broken, or not seated.
(8) Piston incorrectly installed or misfited.
Gaskets.
(1) Incorrectly tightened fasteners or damaged/dirty threads.
(2) Worn or damaged gasket (cracking or porosity).
(3) Fluid pressure/level too high.
(4) Incorrect sealant used (when required)
Inspection of Seals.
(1) Damaged seal bore (burred, nicked, scratched)
(2) Worn or loose bearing which causes excessive seal wear.
(3) Worn or damaged seal or incorrect installation.
(4) Fluid pressure/level too high.
Oil Leak Investigation
Oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the required parts.
(1) Determine whether the fluid is transmission lubricant, engine oil, power steering fluid etc.
(2) Run the car at normal operating temperature and park the car over a large sheet of paper. After a few minutes, you should be able to find the approximate location of the leak by drippings on the paper.
(3) Use a degreaser or steam to clean the area of the leak, drive the car for a few kilometres. Then visually inspect the suspected part for signs of an oil leak.
Black Light and Dye Method.

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There are many dye and light kits available for finding leaks.
(a) Pour required amount of dye into leaking part.
(b) Operate the car under normal operating conditions as instructed in the kit.
(c) Shine the light in the suspected area. The dyed fluid will appear as a yellow path leading to the problem.

Low Oil Pressure

(1) Blocked oil filter.
(2) Incorrect oil viscosity for expected temperature, or oil diluted with moisture or unburnt fuel mixtures.
(3) Excessive bearing clearance.
(4) If the oil level is low, fill to mark on dipstick.
(5) Oil pump dirty/worn, or oil pump suction pipe screen blocked, or hole in oil pump suction pipe.
(6) Incorrect or failing oil pressure sender.

Engine Knocks

WHEN ENGINE COLD AND CONTINUES KNOCKING FOR TWO OR THREE MINUTES
Increases with torque
(1) Tighten or replace as required if drive pulleys or balancer are loose or broken.
(2) Replace piston if clearance from piston to bore is excessive. (Cold engine piston knock usually disappears when the cylinder is grounded out. Cold engine piston knock which disappears in 1.5 min. can be considered acceptable.)
(3) Connecting rod bent.

HEAVY KNOCK WITH TORQUE APPLIED

(1) Replace parts as required of pulley hub or balancer broken.
(2) Loose torque converter to flexplate bolts.
(3) Check if exhaust system contacting under-body.
(4) Cracked flexplate/flywheel.
(5) Main bearing clearance or connecting rod bearing clearance excessive.

Light Knock while Hot

(1) Inspect fuel quality if pre-ignition or spark knock.
(2) Loose torque converter to flexplate bolts.
(3) Connecting rod clearing clearance excessive.

KNOCKS ON FIRST START-UP ONLY LASTING A FEW SECONDS

(1) Incorrect oil viscosity. Install correct oil viscosity for expected temperatures.
(2) Hydraulic lifter bleed down.
Some valves will be open when the engine is stopped. Spring force against lifters will tend to bleed lifter down. Only if the problem is consistent should repairs be attempted.
(3) Replace crankshaft thrust bearing shells if excessive crankshaft end float.
(4) Replace worn parts if front main bearing clearance is excessive.

Hydraulic Valve Lifters

The lifters are extremely simple in design and rarely need attention, readjustments are not required and servicing requires only that care and cleanliness be exercised whilst handling the parts. Using a piece of garden hose near the end of each intake and exhaust valve with the other end of the hose to the ear, is the easiest method for locating a noisy valve lifter. Using this method, the sound is localised, which makes it easier to find out which lifter is faulty. Or place a finger on the face of the valve spring retainer. If the lifter is not functioning correctly, a definite shock will be felt when the valve returns to its seat.

Specifications

General

Engine:	90^0 "V" 8 cylinder	
Capacity	5.0 litre (49881cc)	5.7 litre
Bore:	101.6mm	
Stroke:	76.835mm	

The cylinder numbering is from the front of the engine, left side 1-3-5-7 and right side 2-4-6-8. Firing order is 1-2-7-8-4-5-6-3.

Compression Ratio:	8.8:1
Taxable horsepower (RAC or SAE)	51.2
Power:	180kW @ 4800 rpm
Torque:	400Nm @ 3600 rpm
Compression (Hot cranking)	To be within 142 kPa
Bore and stroke (nominal)	101.6 x 76.835 mm

Lubrication

Lubricant Quantity Specification:	
With out new oil filter:	4.8 Litres
With new oil filter:	5.1 Litres
Lubricant Quality:	SAE 15W-40, 20W-40 or 20W-50
Engine Oil Grade API grade:	SG or SH
Oil pressure@ 500 rpm plus:	Min 48kPa.
Oil pressure@ 2000 rpm plus:	276-414kPa.
Oil Pressure Releif Valve Spring:	
Free Length:	82.5 mm
Load of 4.76kg:	63.5mm
Oil Pump Gear Protrusion:	0.051-0.153mm
Oil Pump Shaft Assembly Length:	68.96 - 69.22mm
Oil Pump Gear Backlash:	0.229 - 0.381mm

Head

Head Surface maximum Distortion:	0.10mm
Minimum head deck thickness:	25.95mm

Intake Manifold and Intake Chambers Maximum Warpage: 0.10mm (0.0039in)

Camshaft

Camshaft Journal Diameter:

No1 & 2 :	47.960 - 47.978 mm
No3 & 4 :	47.452 - 47.478 mm
No5:	40.107 - 40.132 mm

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Valve Guide

Specified Valve Movement in Valve Guide:

Inlet maximum:	0.094mm
Outlet maximum:	0.119mm

Valve

Valves with over size stems are available, 0.04, 0.08, 0.20, 0.38 and 0.76mm.

* Valve seat angles:	46^0.
* Valve seat width:	
Exhaust	0.97-1.35mm
Intake	0.90-1.30mm
Fitted Valve Maximum Height:	54.37mm
Inlet valve stem dia:	8.661 - 8.679mm
Exhaust valve stem dia:	8.66 - 8.68mm
Valve face angle:	45°.
Minimum valve head margin thickness:	0.63mm

Valve Spring

Maximum allowable variance in spring end length: 1.60 mm.

Valve Spring Free Length:	51.56mm approx
Valve spring compressed height/load:	
Compressed height:	338-373Nm@45.2mm

Piston and Connecting Rod

(Measure 65mm down from piston top)

Piston Size Standard:	101.572- 101.648mm
Available in 0.508mm oversize	
Piston Pin Clearance	
: in Piston	0.0038 - 0.0064mm
: in Connecting Rod	0.0203 - 0.0406mm
Connecting Rod Alignment Max. Specification	
Bend:	0.020mm per 25.4mm
Twist:	0.038mm per 25.4mm
Connecting Rod to crankshaft end clearance:	0.203-0.356mm

Piston Rings

Ring End Gap Specification:

Top Compression:	0.279-0.553mm
Second Compression:	0.254-0.508mm
Oil Ring Steel Rail:	0.38-1.39mm
Piston Ring Side Clearance:	
Top Ring:	0.03-0.08mm
Second Ring:	0.03-0.08mm
Oil Ring:	0.023-0.201mm

Crankshaft

Main Bearing Journal Diameter	
Standard Size:	60.90 - 60.93 mm
Taper:	0.0254 mm max.
Out-Of-Round:	0.0254 mm max.
Connecting Rod Journal:	53.950 - 53.975 mm
Out of round:	0.0381 mm max
Taper:	0.0381 mm max
Main Bearing Clearance:	0.020 - 0.061 mm
Maximum:	0.100 mm
Connecting Rod Bearing Clearance:	0.018 - 0.056
Maximum:	0.09 mm

Crankshaft End Float Specification:

New bearings:	0.051 - 0.153 mm
Maximum:	0.25 mm

Engine Block

Cylinder Bore (standard):	101.60 - 101.676mm
Out of Round:	Max 0.025mm
Used:	Max 0.08mm
Taper:	Max 0.013mm
Used:	Max 0.130mm

Cylinder Block Deck Surfaces Flatness:

0.013mm per 25.4mm or a Max 0.08mm for complete surface.

Torque Wrench Spec

Oil Pressure Sender Unit Torque:	12-14Nm
Intake Manifold Attaching Bolts :	
Step 1:	12-17Nm
Step2:	34-41Nm
Fuel Rail and Top Intake Manifold bolts:	12-14Nm
Exhaust Manifold Studs and Bolts:	20-28Nm
Exhaust Manifold Nuts:	15-20Nm
Exhaust Pipe Flange to Exhaust Manifold:	15-35Nm
Rocker Cover Bolts Torque:	3-6Nm
Timing Gear Cover Bolts:	23-30Nm
Water Pump Bolts:	23-30Nm
Crank Shaft Balancer Pulley Bolt:	270-325Nm
Sump Bolts Torque:	8-10Nm
Crankshaft Balancer Pulley Bolt:	190-200Nm
Oil Pump Regulator Plug:	34-41Nm
Oil Pump Cover / Regulator 3 Bolts:	5-8Nm
Oil Pump bolts:	23-30Nm
Cylinder Head Bolts	
Step 1 Torque:	50-55Nm
Step 2 Torque:	77-83Nm
Valve Lifter Guide Plates:	26-34Nm
Rocker Pivot Bolts:	
Step 1:	24-32Nm
Step 2:	Tighten a further 87-93 deg turn
Crankshaft Pulley Bolt:	190 Nm minimum
Flywheel / Driveplate Bolt:	81-88 Nm
Oil Pan (Sump) Bolt Specification:	8-11Nm
Oil Pan (Sump) Drain Plug Specification:	30-60Nm
Suction Pipe and Strainer Bolts:	8-11Nm
Connecting Rod Cap Bolt:	56-64Nm.
Main Bearing Cap Bolt Torque:	81-95Nm

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5.7 Litre V8 "Gen III" ENGINE MAINTENANCE & REBUILD

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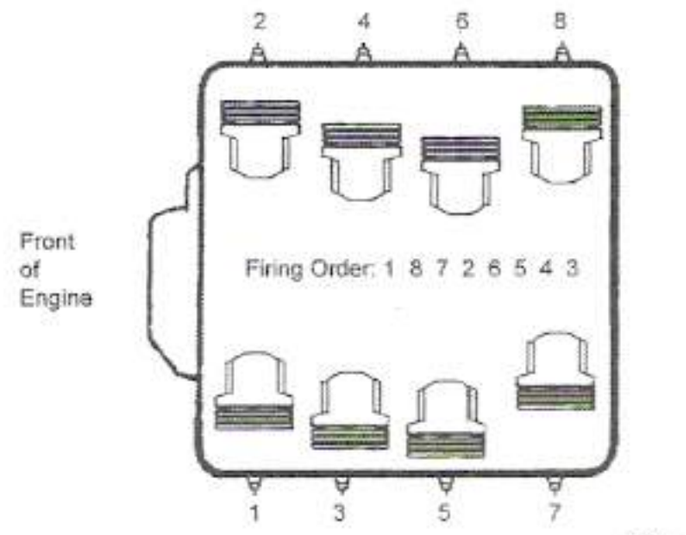
GENERAL DESCRIPTION

The engine is a 90⁰ "V" 8 cylinder 5.7 litre (5,667cc) . The camshaft is supported by 5 journals and operate two valves per cylinder, that is 8 valves per head, these valves are set at 15⁰ to the cylinder bore.

The cylinder block made of aluminium, with standard bore of 99.0mm and a stroke of 92.0mm, cast iron bore liners, 6 bolts per main bearing cap.

The engine has a 10.1:1 compression ratio.

The cylinder numbering is as illustrated, from the front of the engine, left side 1-3-5-7 and right side 2-4-6-8 . Firing order is 1-8-7-2-6-5-4-3. Four main bearings support the crankshaft.

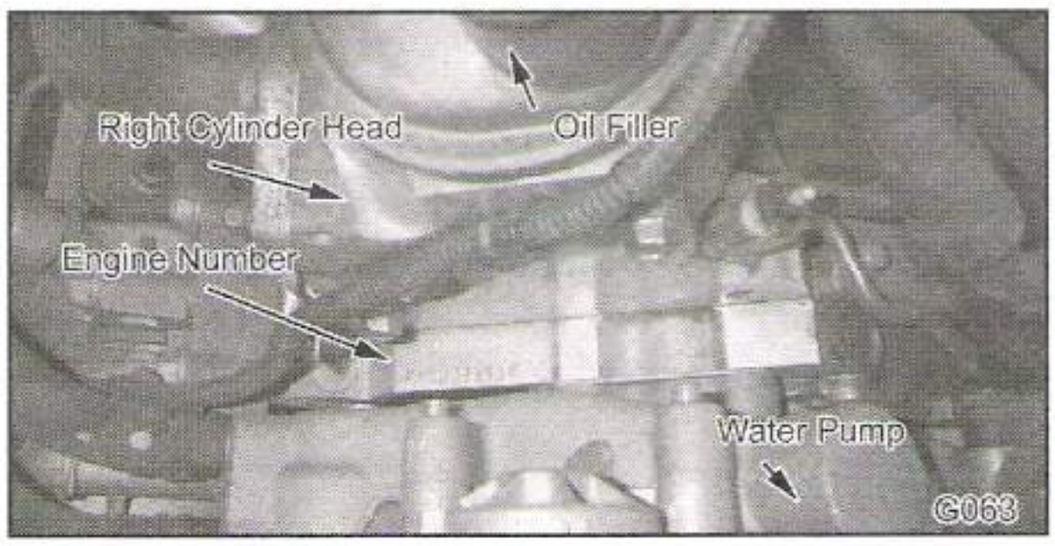


The engine has two aluminium heads with a fuel injector for each cylinder which is incorporated into the heads.

ENGINE SERIAL NUMBER

Engine No. Location: at the front on right-hand side of the engine block.

The first digits are , then the first 2 digits shown the year of manufacture. The next 3 numbers are the date of manufacture (Julian date), then followed by a 4 numbers being the build number for the day.



MAINTENANCE HINTS

1.(a) When any internal engine parts are serviced, care and cleanliness are important.

(b) An engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in thousandths of a millimetre.

(c) Friction areas should be coated liberally with engine oil during assembly to protect and lubricate the surfaces on initial operation.

(d) Proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure and is considered standard workshop practice.

2. When valve train components are removed for service, they should be kept in order and should be installed in the same locations (with the same mating surfaces) as when removed.

3. Battery terminals should be disconnected before any major work is begun. If not, damage to wiring harnesses or other electrical components could result.

4. When raising or supporting the engine for any reason, do not use a jack under the oil pan. There are small clearances between the oil pan and the suction pipe screen, so jacking may cause the oil pan to be bent against the screen, with damage being done to the oil suction pipe assembly.

5. If the air flow ducting is removed or disconnected, the intake opening should be covered to avoid accidental entrance of foreign material (which could follow the intake passage into a cylinder and cause extensive damage when the engine is started).

6. Aluminium and steel (and other metals) expand at different rates with temperature, therefore do attempt to remove bolts and threaded components when the engine block is 50⁰C. Otherwise the threads will be damaged.

GENERAL MAINTENANCE

CHECKING ENGINE OIL PRESSURE

1. With engine at operating temperature.

2. Remove oil filter and attach an after market adapter to the oil filter adapter with a pressure gauge.

3. Start engine and check oil pressure reading with engine running under no load.

Oil pressure@1000 rpm plus: 45kPa(min).
Oil pressure@2000 rpm plus: 125kPa(min).
Oil pressure@4000 rpm plus: 165kPa(min).

3. After completing test, install the oil filter.

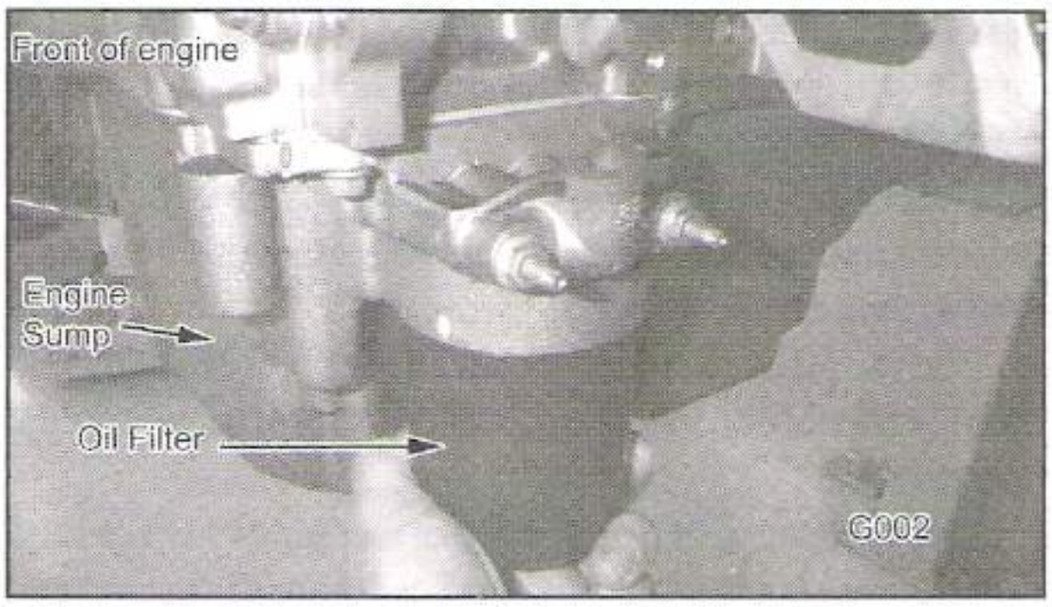
4. Only use specified oil type.

Specified oil type: 10W-30 SJ GF2

OIL FILTER

* The oil filter should be replaced every 10,000 Kilometres or 6 months which ever occurs first, or when the engine oil is contaminated in any way.

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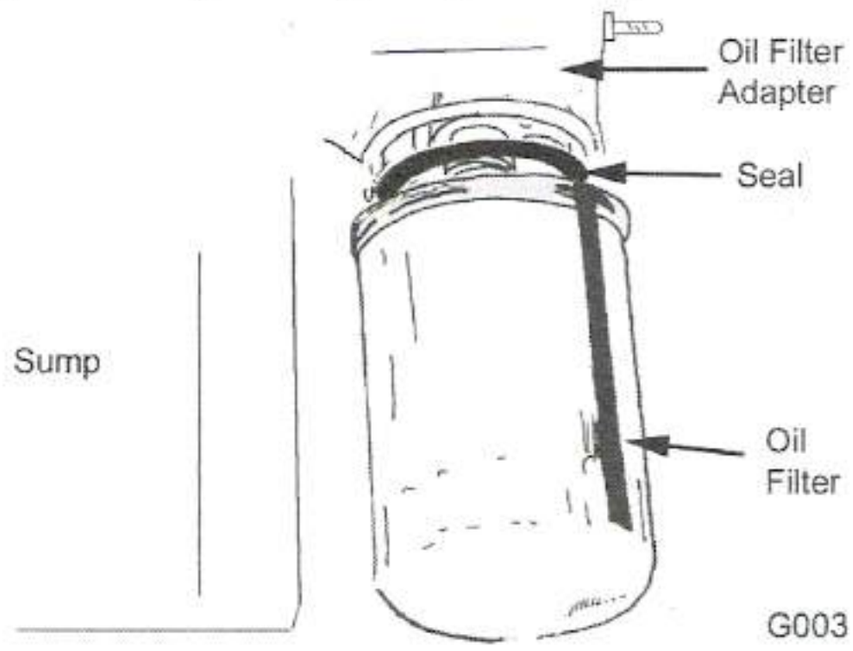


Replacement

1. Unscrew oil filter with a suitable oil filter wrench, then remove and discard.

2. (a) Make sure seal is placed correctly in recess in new filter.

(b) Pour some clean engine oil into filter until level is approximately 2 cms (1.0 in) below top of filter.



3. (a) Apply a thin film of engine oil over new filter seal.

(b) Screw filter into place until seal contacts mating surface of adaptor, then tighten through a further 2/3 of a turn.

4. (a) Clean any excess oil from filter and adaptor.

(b) Check oil level, then start engine and check for oil leaks.

(c) Repair as necessary.

* After running the engine, the oil level must be rechecked and oil added as necessary, to compensate for oil used to refill the oil filter.

COMPRESSION CHECK

1. Make sure of the following:

(a) Engine is at operating temperature;

(b) Battery is at (or near) full charge;

(c) Spark plugs are removed;

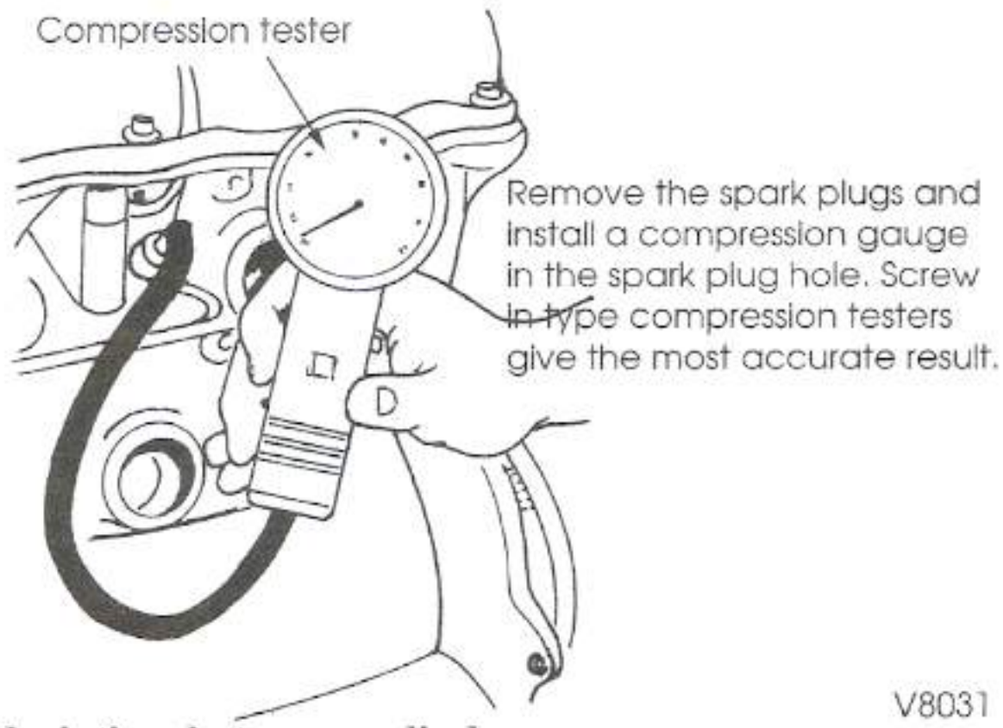
(d) Remove the EFI relay, located in the engine compartment. This relay stops fuel and ignition functioning during engine cranking.

2. (a) Install suitable compression tester into spark plug hole, screw in type are more accurate. Depress accelerator pedal to fully open position and crank engine.

(b) Read compression gauge indication.

3. Check remaining cylinders.

Minimum Specified Comp: 690kPa.



Variation between cylinders:

not less than 70% of highest test

* If cylinder compression in 1 or more cylinders is low, pour a small amount of engine oil into the cylinders through the spark plug holes and test compression.

Compression Test Results

NORMAL Compression builds up quickly and evenly on each cylinder.

PISTON RINGS Compression low on 1st stroke, tending to build up on following strokes, but does not reach normal. Improves considerably with addition of oil.

VALVES Low on 1st stroke and does not tend to build up on following strokes. Do not improve much with addition of oil.

HEAD GASKET If cylinder compression in any 2 adjacent cylinders is low (and if adding oil does not help compression), cylinder head gasket has blown out.

DRIVE BELTS

Inspection

* Some belt squeal when the engine is started or stopped is possible and has no effect on durability of drive belt.

Visual Inspection

* Condition of the belt is best judged by twisting the belt so as to see the both surfaces.

Stages of Belt Wear:

1. NEW BELT: No cracks or chunks.

2. MODERATELY USED BELT: Few cracks; some wear on surfaces. Replacement not required.

3. SEVERELY USED BELT: Several cracks per inch. Should be replaced before chunking occurs.

4. FAILED BELT: Separation of belt material from backing (chunking). Replace belt immediately.

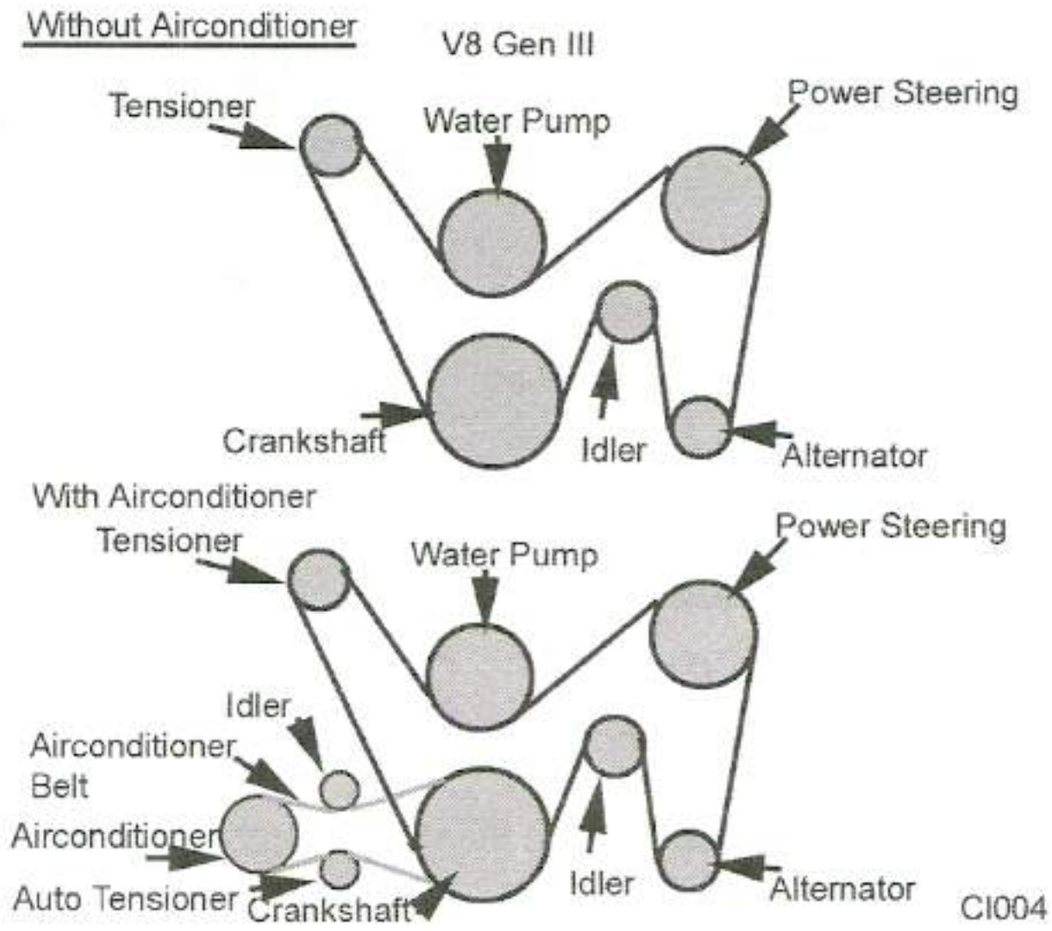
Replacement

Remove engine top cover, 4 nuts.

Use a 15mm ring spanner to grip the belt tensioner pulley, turn the spanner clockwise with force to move tensioner pulley. Remove belt or install belt, release pressure on ring spanner to take tension up on belt.

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DRIVE BELT TENSIONER



Remove

1. Remove the engine top cover 4 nuts.

2. Use a 15mm ring spanner to grip the belt tensioner pulley, turn the spanner clockwise with force to move tensioner pulley, remove belt.

3. Remove the belt tensioner, 2 bolts.



Install

1. Install belt tensioner, 2 bolts.

Drive Belt Tensioner Bolts: 40-60Nm

2. Use a 15mm ring spanner to grip the belt tensioner pulley, turn the spanner clockwise with force to move tensioner pulley. Install belt, release pressure on ring spanner to take tension up on belt.

3. Replace the engine top cover 4 nuts.

INTAKE MANIFOLD, FUEL RAIL, VAPOUR VENT PIPE ASSEMBLIES, ENGINE VALLEY COVER and KNOCK SENSORS

Remove

1. Remove the engine top cover 4 nuts.

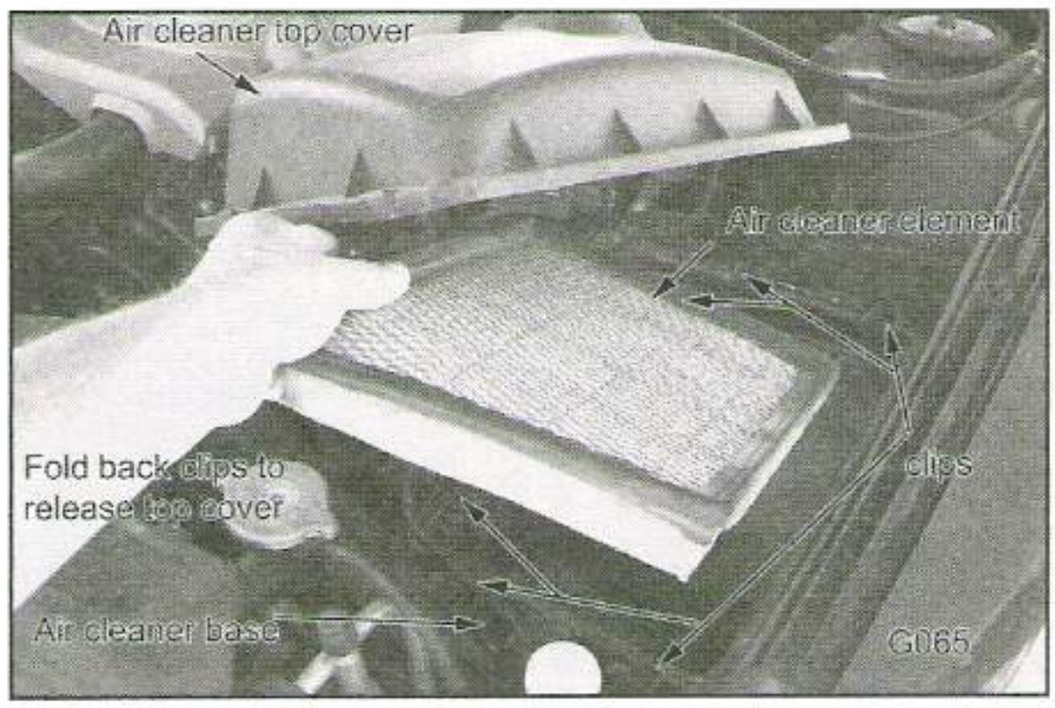
2. Depressurise the fuel injection system, remove fuel pump relay, idle engine until stops.

3. Disconnect the earth lead from the battery.

4. Drain coolant from engine at radiator lower hose.



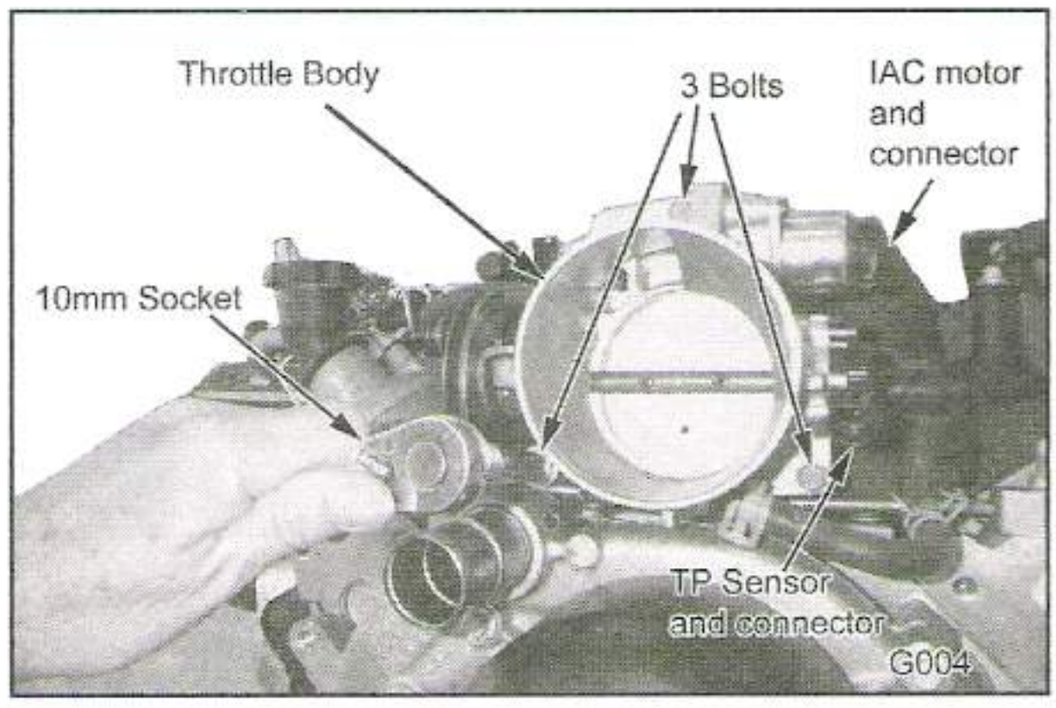
5. Remove air duct between air cleaner to MAF sensor and air cleaner.



6. Disconnect the fuel and return pipes at the quick release connector at the rear of engine on firewall.

7. Detach throttle cable at the throttle body, and brackets.

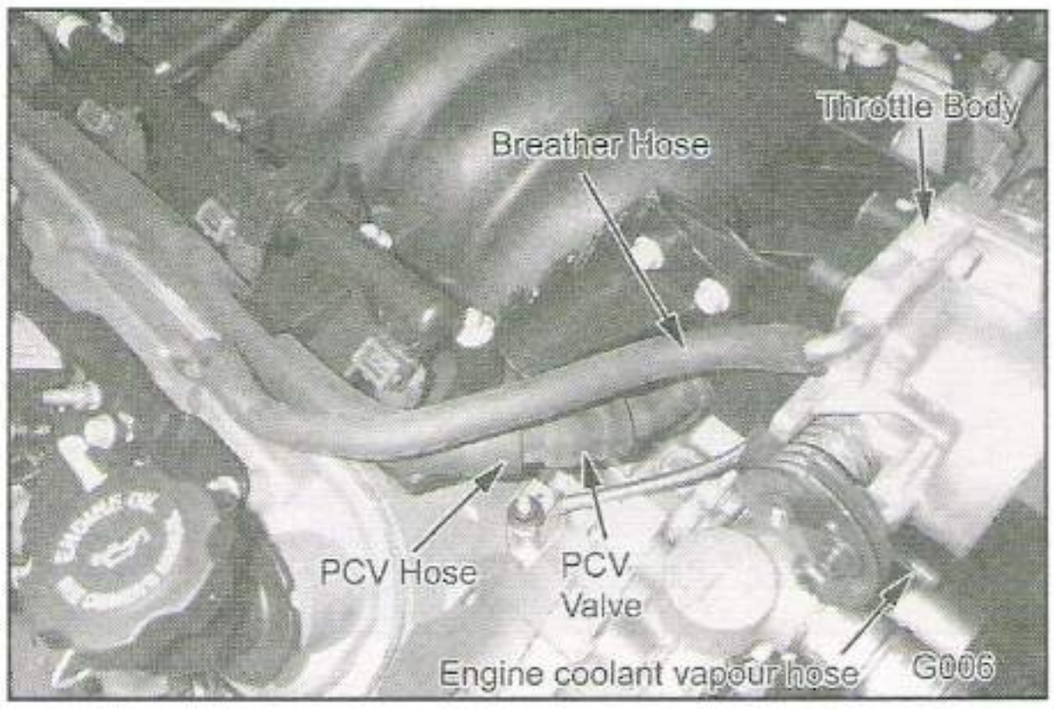
8. Disconnect wiring connectors, at TPS wiring plug, IAC wiring connector, injectors, disconnect the coil harness connectors left and right side, unclip harness from the fuel rail.



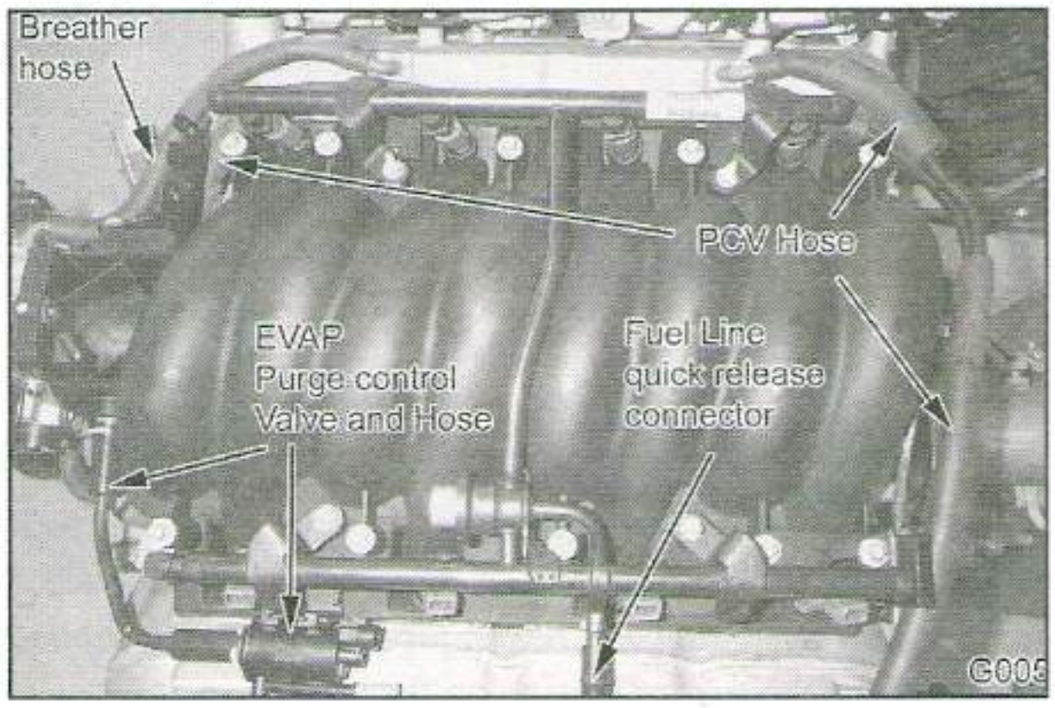
9. Remove the breather hose from the rocker cover to the throttle body, right side.

10. Remove the PCV hose from the rear of left rocker cover, rear of right rocker cover and throttle body.

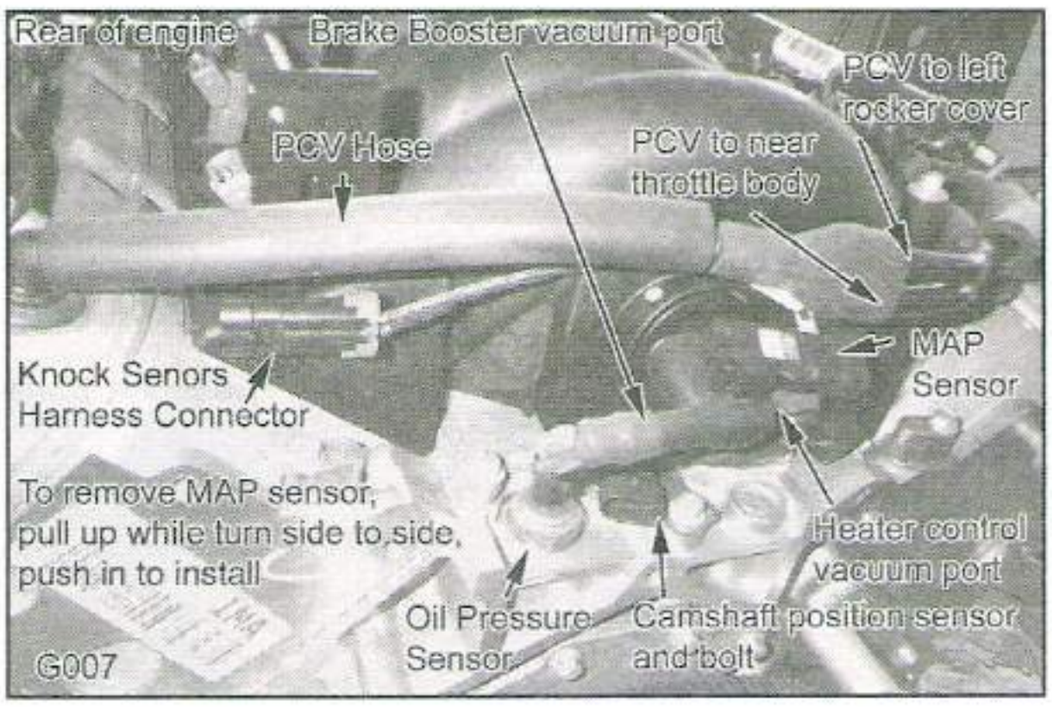
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11. a) Remove the carbon (EVAP) canister vapour hose from the throttle body, remove EVAP purge valve and bracket from the intake manifold.



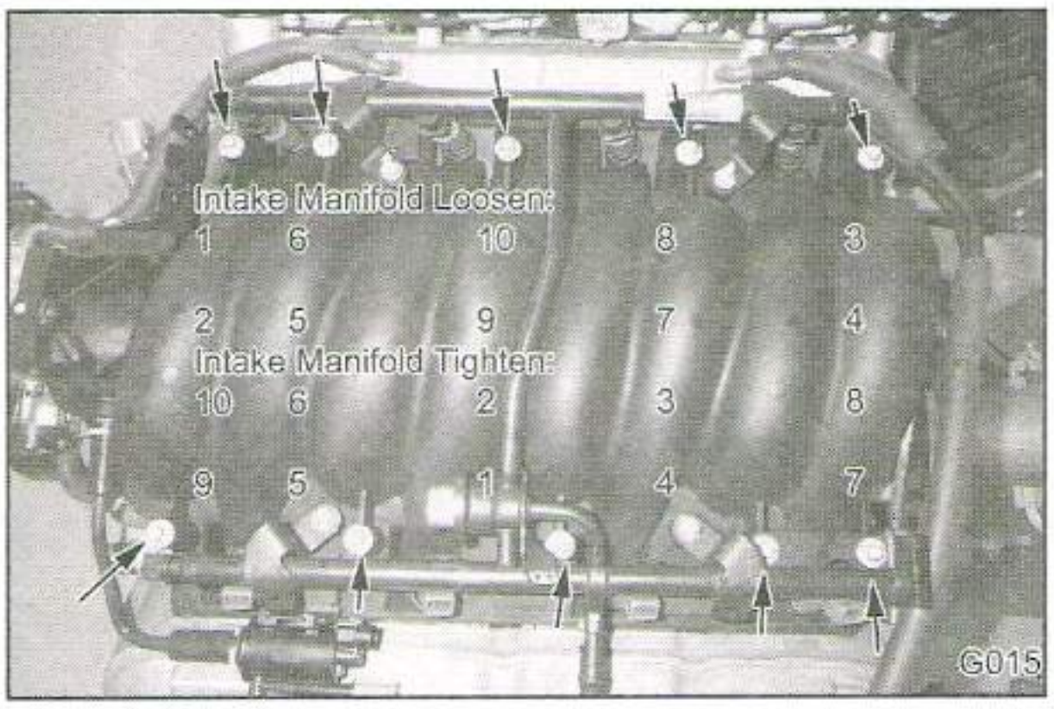
b) Remove 3 vacuum hoses the brake booster, fuel pressure regulator and heater control hose.



12. a) Remove the fuel rail, 4 nuts.
b) Loosen and remove the intake manifold 10 bolts in order shown, remove fuel rail bracket at rear.
Remove intake manifold assembly, it may be necessary to bump the manifold to release the seals and gasket.
Hint: Place cloths in cylinder port intakes to stop any objects dropping into cylinders.

13. If necessary dismantle throttle body, 3 bolts, from intake manifold, if not already removed.

14. If necessary remove fuel rail, 4 nuts, 4 studs, separate the fuel rails and injectors.

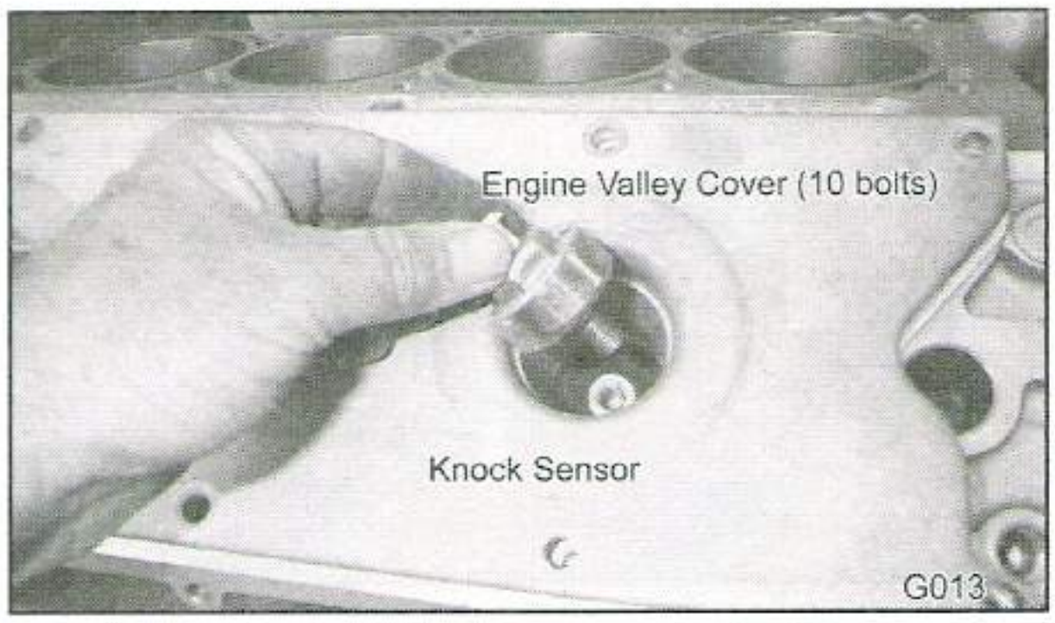


15. Unfasten the knock sensor electrical harness from the vent vapour pipe.

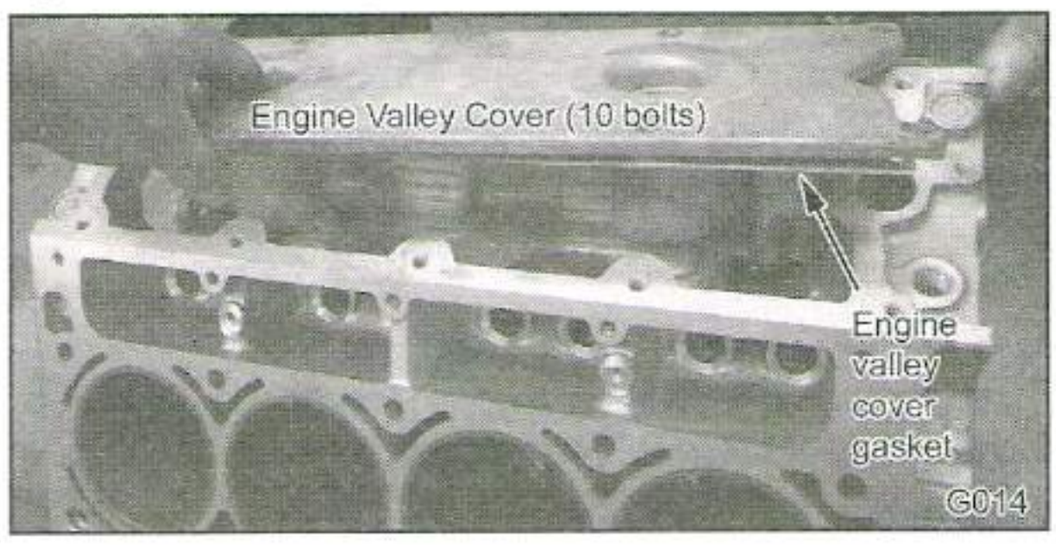
16. Remove the 4 studs from the vapour vent pipe, remove pipe and gaskets.
Tip: Identify the location of studs while removing.

17. Remove the knock sensor harness, disconnect the harness connector, lift the sensor plugs from the valley cover enough to release the harness connector to each sensor, unclip from each sensor, then remove harness.

18. Using a 22mm socket, remove each sensor.
Tip: Use a deep socket to get a good grip of the sensor.



19. Remove the valley cover and gasket, 10 bolts.
Tip: Clean and inspect valley cover for damage.



Install

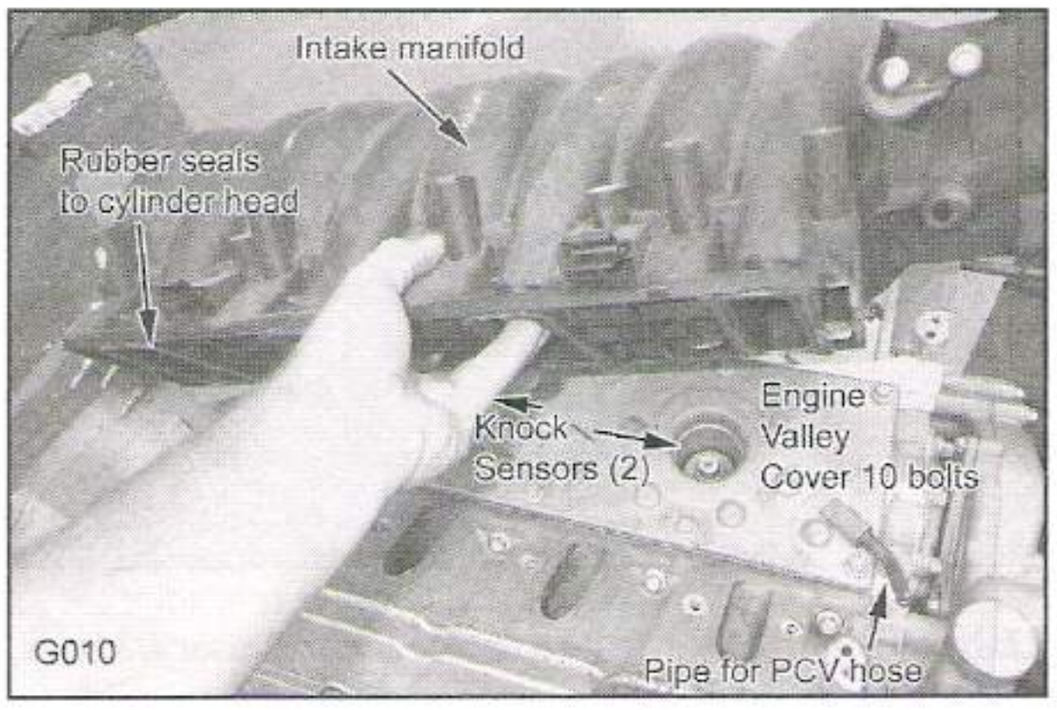
1. Install the valley cover with a new gasket, tight to specification.

Engine Valley Cover Bolts: 25Nm

2. Install senors with new seals, tighten.

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Knock Sensor Tighten: 20Nm

3. Install the knock sensors harness with new seals, apply new engine oil to the seals.

4. Install new gaskets to the vapour vent pipe, then install pipe and gaskets to the engine, 4 studs tighten to specification.

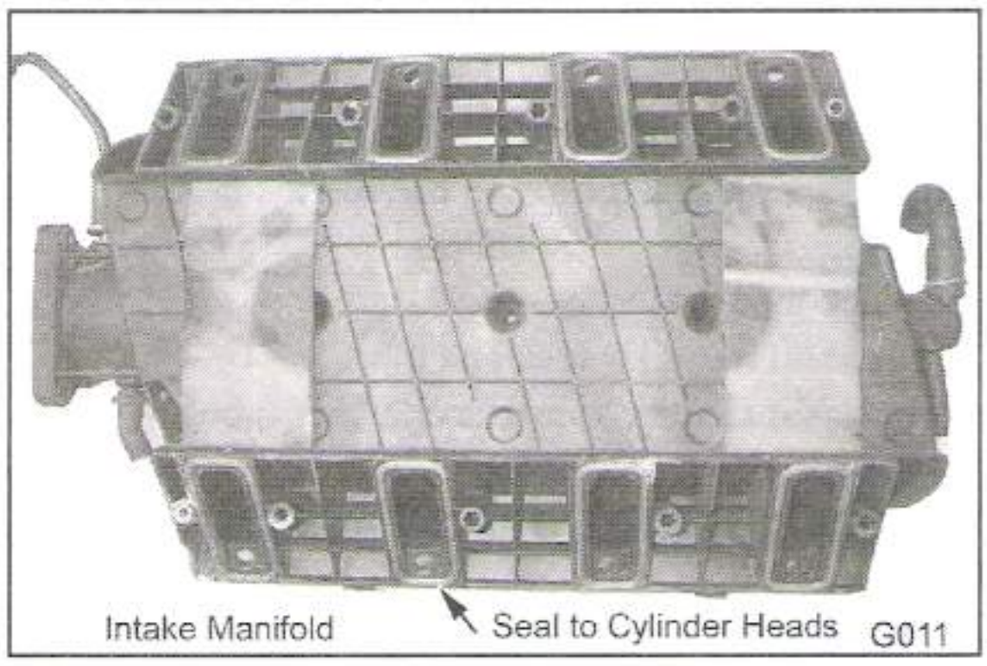
Replace studs to their original position.

Vapour Vent Pipe Studs: 12Nm

5. Secure the knock sensor harness onto the vapour vent pipe.

6. Clean mating surfaces of the cylinder heads and the manifold.

7. Use a straight edge to check the surface of the intake manifold and intake chambers matching surfaces, if over maximum warpage specification, replace the manifolds.



Intake Manifold and Intake Chambers Maximum Warpage: 0.50mm

8. Install new intake manifold gaskets and seals.

9. Install the intake manifold. Using Loctite 242 to coat the threads of all 10 cleaned bolts, install bolts tighten to specification, in sequence shown on previous page.

Note: Install fuel rail bracket at rear of intake manifold to bolt.

Intake Manifold Attaching Bolts :

Step 1: 5Nm

Step 2: 8Nm

10. Install fuel injectors and fuel rail.

a) Install the fuel rail and injectors to 4 studs. Using Loctite 242 to coat the threads of all 4 cleaned studs if removed, install studs tighten to specification.

Fuel Rail Studs: 8-12Nm

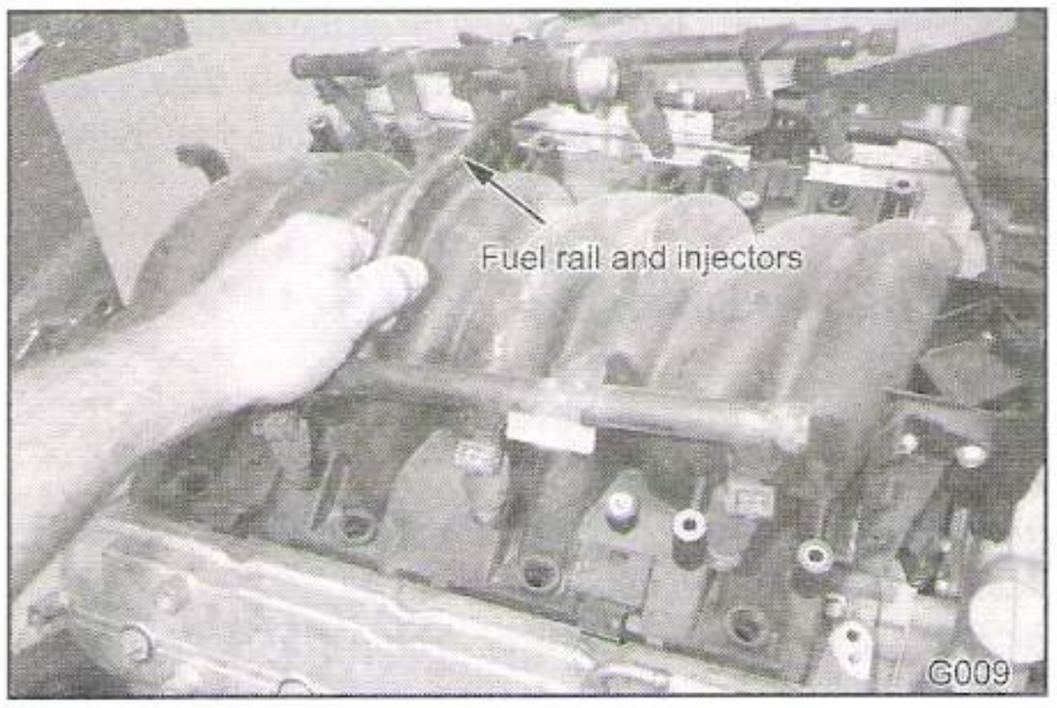
b) Install a new "O" ring into each injector position of the manifold.

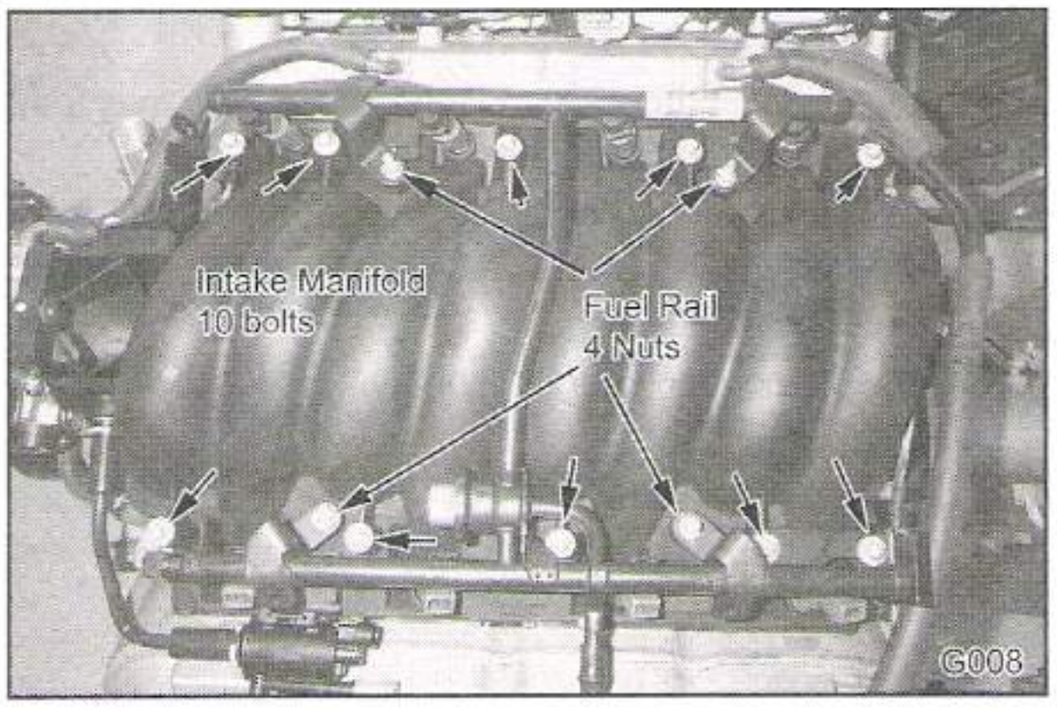
(c) If the injectors have been removed from the fuel rail. Install the injectors into the fuel rail, make sure that the injector turn freely in the fuel rail.

d) Tighten the fuel rail 4 nut. Using Loctite 242 to coat the threads of all 4 cleaned studs, install nuts tighten to specification.

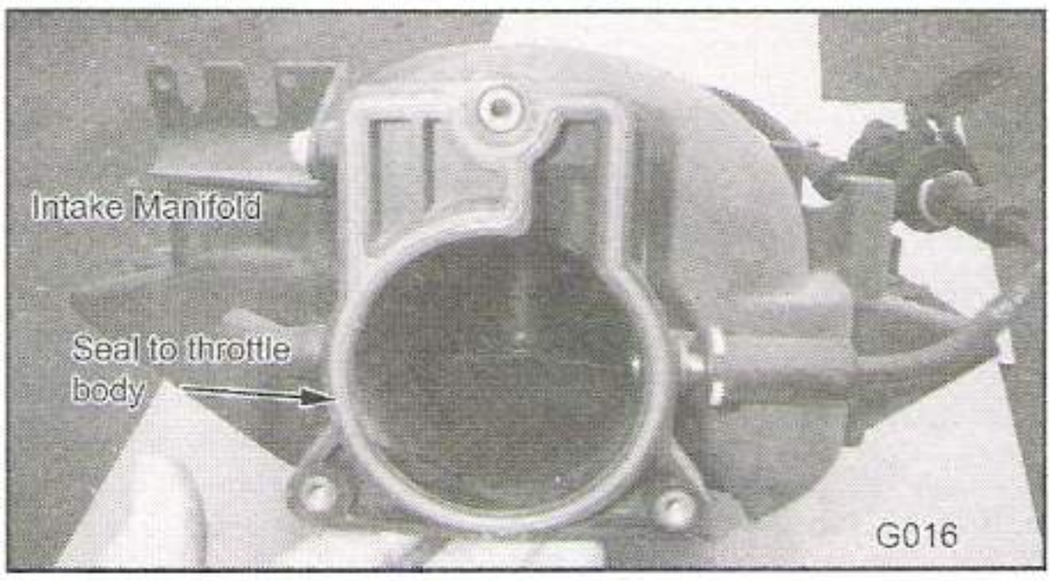
Fuel Rail Nuts: 8-12Nm

11. Install fuel and fuel return lines at the quick release connections.





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12. Install throttle body with a new seal in necessary, 3 bolts, tight to specification.

Throttle Body Bolts: 12Nm

13. Install the engine wiring loom and connectors, attach the 8 fuel injector wiring connectors,

14. Connect the accelerator cable and brackets, cruise control if required. Each cable has a hand operated adjuster, adjust cables so there is no slack, the cam begins to move.

15. Replace the carbon (EVAP) canister vapour hose to the throttle body, replace EVAP purge valve and bracket from the intake manifold..

16. Replace the breather hose from the rocker cover to the throttle body, right side.

17. Replace the PCV hose to the rear of left rocker cover, rear of right rocker cover and throttle body.

18. Connect wiring connectors, at TPS wiring plug, IAC wiring connector, injectors, connect the coil harness connectors left and right side, reclip harness to the fuel rail.

19. Connect radiator hoses, fill and bleed the cooling system.

20. Replace air cleaner/MAF to throttle body tube.

21. Replace relay for fuel pump, reconnect earth to battery.

22. Install top engine cover, 4 nuts.

EXHAUST MANIFOLDS

Remove

1. Remove the engine cover, 4 nuts.

Tip: To make job easier:

a) Remove air duct between the throttle body and the MAF at the air cleaner.

b) Remove temperature sensor front of left side.

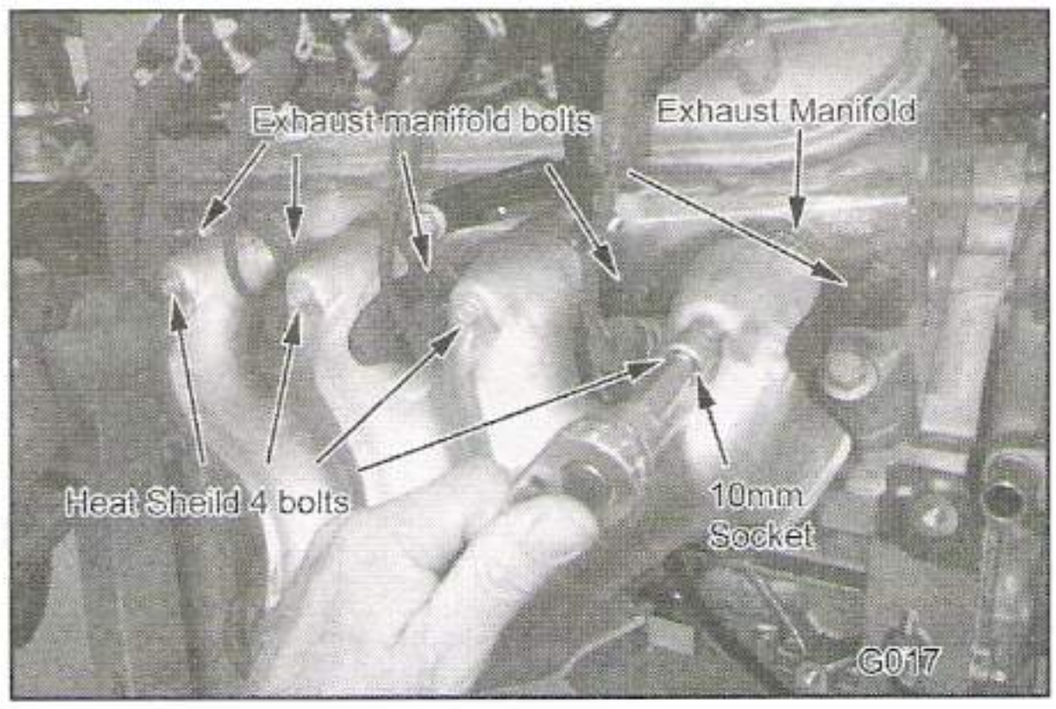
2. Remove spark plugs, heads must be cooler than 500C to stop thread damage.

3. Remove oil level dip stick and tube, place cloth over hole to stop foreign matter falling into sump.

4. Remove the oxygen sensors from the exhaust pipes, under the vehicle, other wise when the pipes drop the sensor or wiring could be damaged.

5. Remove the nuts attaching the exhaust pipe to the exhaust manifolds.

6. Remove the bolts each side as required attaching each manifold to the cylinder head, remove manifolds and gaskets.



Install

1. Install gasket to cylinder heads, to align the gasket, install four guide studs in the cylinder head. Place the gasket on the studs. Place the manifold on the studs. Install the some of the bolts, remove the guide studs, install the other bolts Gradually tighten the bolts to specification. Install lock washers. Apply loctite 242 to the threads of the bolts, do not apply loctite to the first 3 threads.

Exhaust Manifold Bolts:

Step 1: 15Nm

Step 2: 25Nm

2. Tighten the manifold flange to exhaust pipe nuts to specification. Apply Kopr-Kote or similar anti-seize to threads of studs.

Exhaust Pipe Flange to Exhaust Manifold: 20-35Nm

3. Install oxygen sensors if removed and tighten.

Oxygen Sensors Tighten: 41Nm

4. Plug spark plug and leads in correct position.

Spark Plug: 15Nm

5. Replace temperature sensor.

6. Replace oil level dip stick and tube.

7. Replace air cleaner to intake chamber tube.

ROCKER COVERS AND/OR SEALS

Remove

1. Depressurise the fuel system.

2. Disconnect battery negative terminal.

3. Remove the engine cover, 4 nuts.

4. [Left side manifold] Remove the air cleaner to throttle body intake duct.

5. [Right side] Remove the breather hose from the throttle body to the rocker cover.

6. Disconnect the spark plug leads.

7. Disconnect the fuel line to the fuel rail.

8. Disconnect and remove the EVAP purge control valve.

9. Remove the coils and bracket each side.

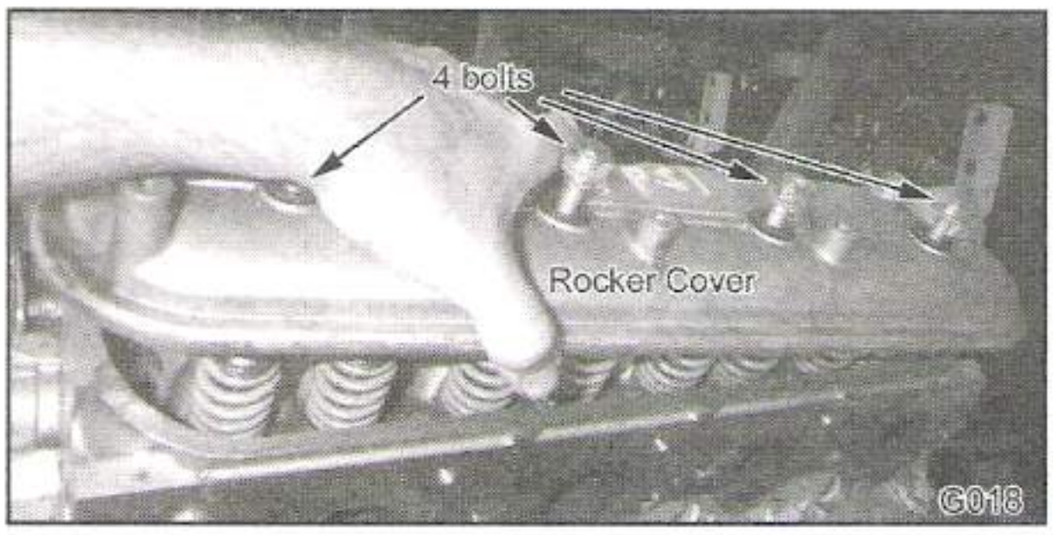
a) Disconnect the locking tab for the main ignition coil connector, disconnect the main connector.

b) Remove 1 stud, carefully lift and remove coils.

10. Remove rocker covers.

a) Remove rocker cover to cylinder head bolts and remove

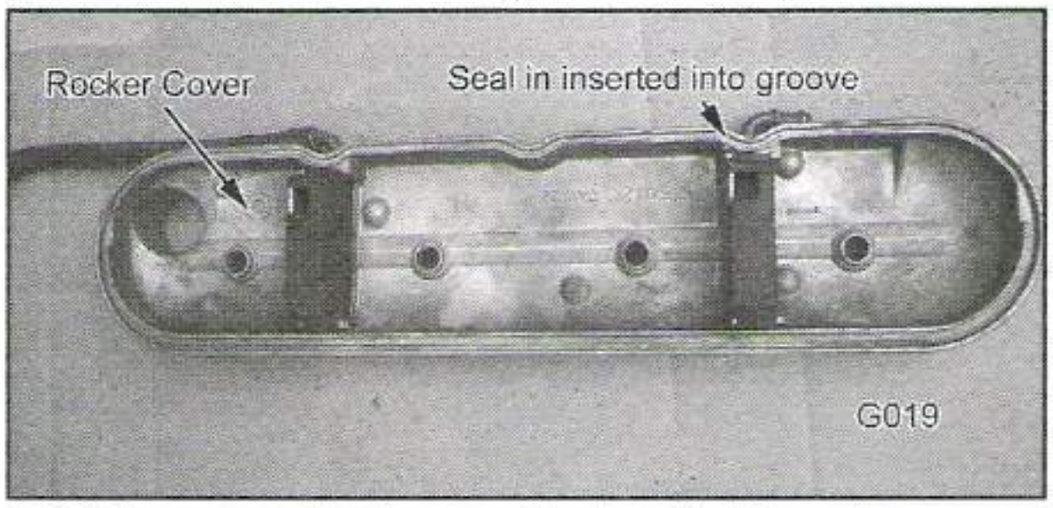
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rocker cover from cylinder head.
b) If replacing rocker cover seal, remove seal from recess in rocker cover to cylinder head.

Install

1. (a) Install new gasket seal in rocker cover recess.
(b) Install rocker cover and gasket assembly.

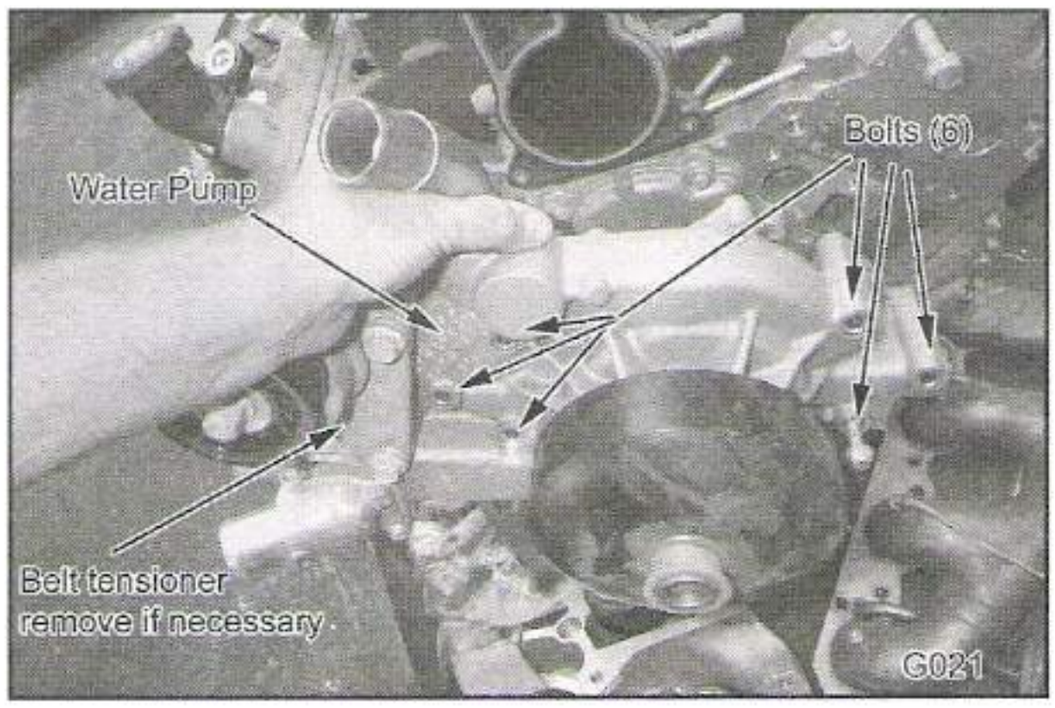


* Make sure gasket is correctly installed in rocker cover.
2. Install rocker cover to cylinder head and torque bolts to specification.
Rocker Cover Bolts Torque: 12Nm
3. Replace the coils and bracket each side.
a) Carefully position coils and bracket to the rocker cover, replace and tighten stud.
b) Connect the main connector, connect the locking tab for the main ignition coil connector.
4. Replace and connect the EVAP purge control valve.
5. Connect the fuel line to the fuel rail.
6. Connect the spark plug leads.
7. [Right side] Replace the breather hose from the throttle body to the rocker cover.
8. [Left side manifold] Replace the air cleaner to throttle body intake duct.
9. Install the engine cover, 4 nuts.
10. Replace the Fuel Pump relay if not replaced
11. Connect battery negative terminal.

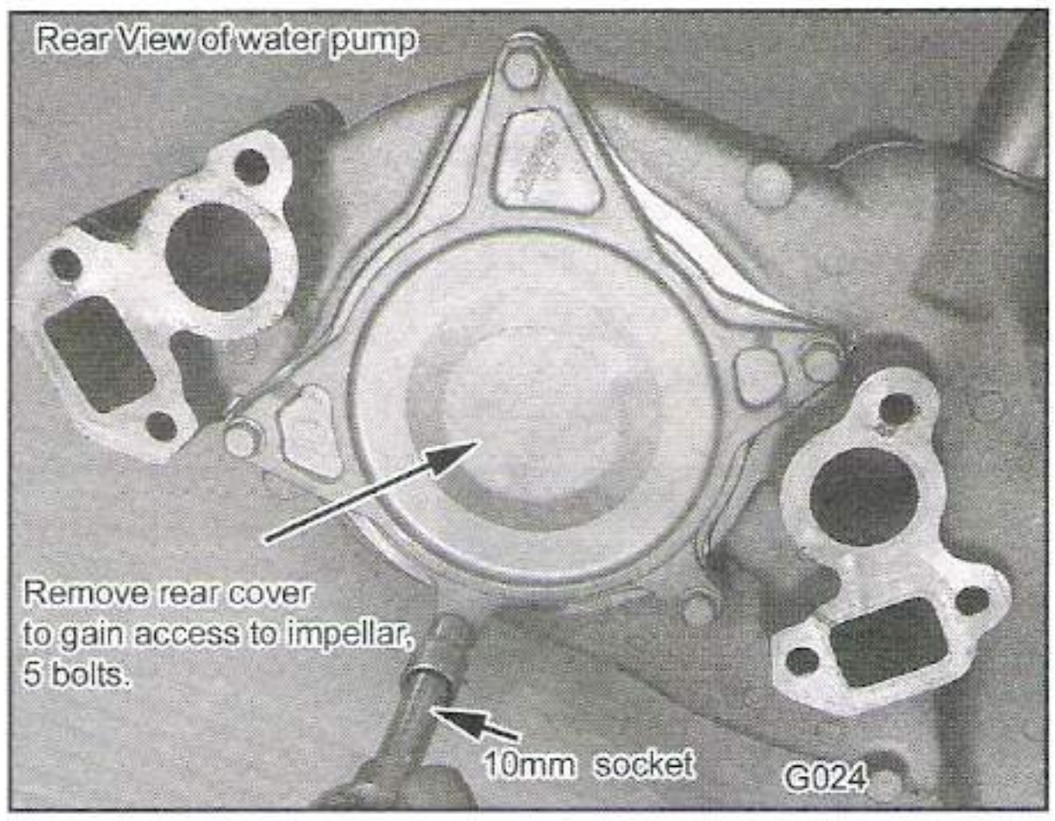
WATER PUMP

Remove

1. Disconnect battery earth lead.
2. Remove engine cover, 4 nuts.
3. Loosen the water pump pulley bolts before removing drive belt.
4. Remove drive belt.
5. Drain coolant from engine at radiator lower hose and remove two heater hoses.



6. Remove the drive belt tensioner if necessary, 2 bolts.
4. Remove the water pump, 6 bolts.
5. Remove water pump and 3 gaskets.
Note: The water pump is not a serviceable unit, if faulty replace.
Note: The water pump has a rear cover, with an "O" ring this "O" ring can be replaced if the pump is leaking. Rear cover bolts tighten to 13-15Nm



Install

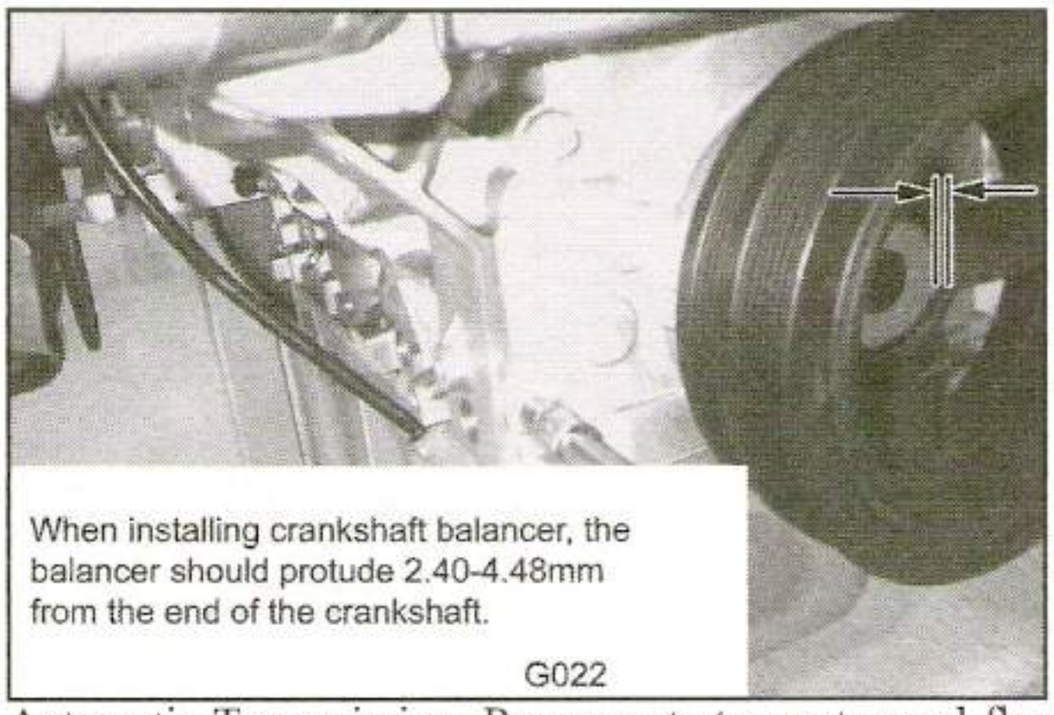
1. Install water pump and 3 new gaskets with sealant, tighten bolts to specification.
Water Pump Bolts: Step1: 15Nm, Step2:30Nm
2. Install water pump pulley bolts.
3. Install drive belt tensioner.
Drive Belt Tensioner Bolts: 40-60Nm
4. Install heater hoses and radiator hose.
5. Refill and bleed cooling system.
6. Install engine cover, 4 nuts.
7. Connect earth to battery.

CRANKSHAFT BALANCER

Remove

1. Disconnect battery negative terminal and remove drive belts, remove radiator if necessary.
2. Manual Transmission: Pull park brake fully on, chock rear wheel and transmission in gear.

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Automatic Transmission: Remove starter motor and fly-wheel side dust cover. Use a large screw driver or similar to lock ring gear from turning thereby stopping engine turning over.

3. Loosen and remove balancer retaining bolt.

4. Remove balancer from crankshaft with pulley puller.

Install

1. Using engine oil, lubricate front seal surface of balancer.

2. Install balancer, engaging key on crankshaft with slot in balancer. Use a tool to press balancer onto crankshaft to specified position.

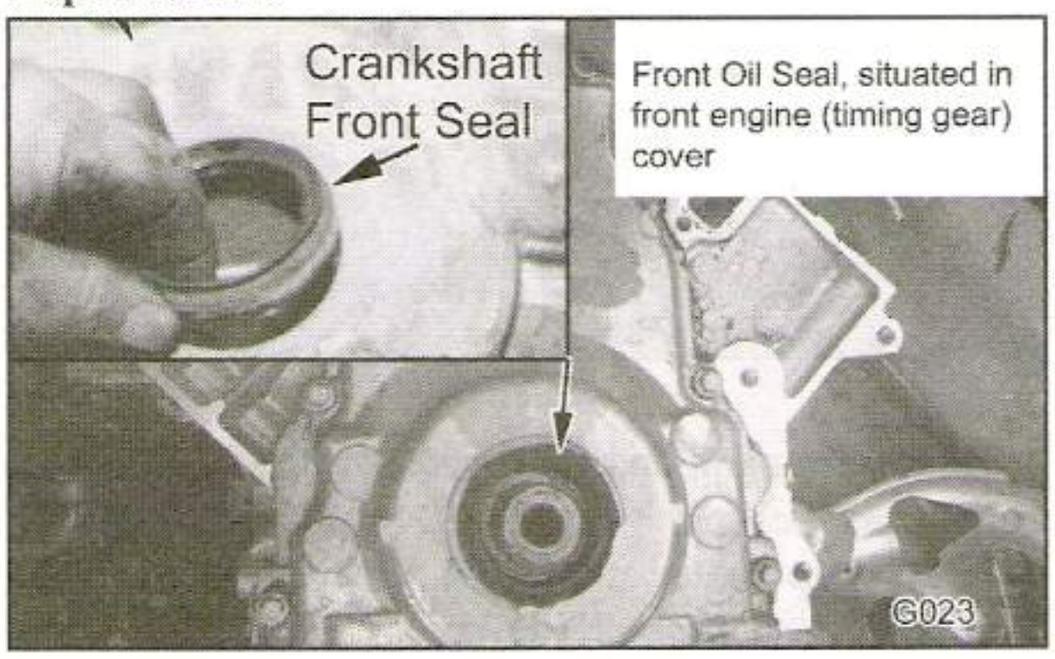
3. Install the balancer bolt, tighten to specification.

Crankshaft Balancer Bolt: 330Nm

4. Inspect and install drive belt operation.

FRONT OIL SEAL

Replacement



1. Disconnect battery earth lead.

2. Remove the following:

a) Drive belt assembly as previously described in this chapter.

b) Crankshaft balancer as previously described.

3. Use a seal remover or screw driver to remove the old oil seal.

4. Lubricate the seal lips with petroleum jelly, use a seal replacement tool to replace seal or a suitable object such as a large socket of the correct size. Tape into place with a soft hammer.

5. Install crankshaft balancer.

6. Install drive belt assembly.

FRONT COVER (TIMING GEAR COVER), OIL PUMP

Remove fan and front drive belt assembly if not removed.

The sump needs to be removed, it is suggested that the engine is removed to allow removal and installation of the sump.

Remove

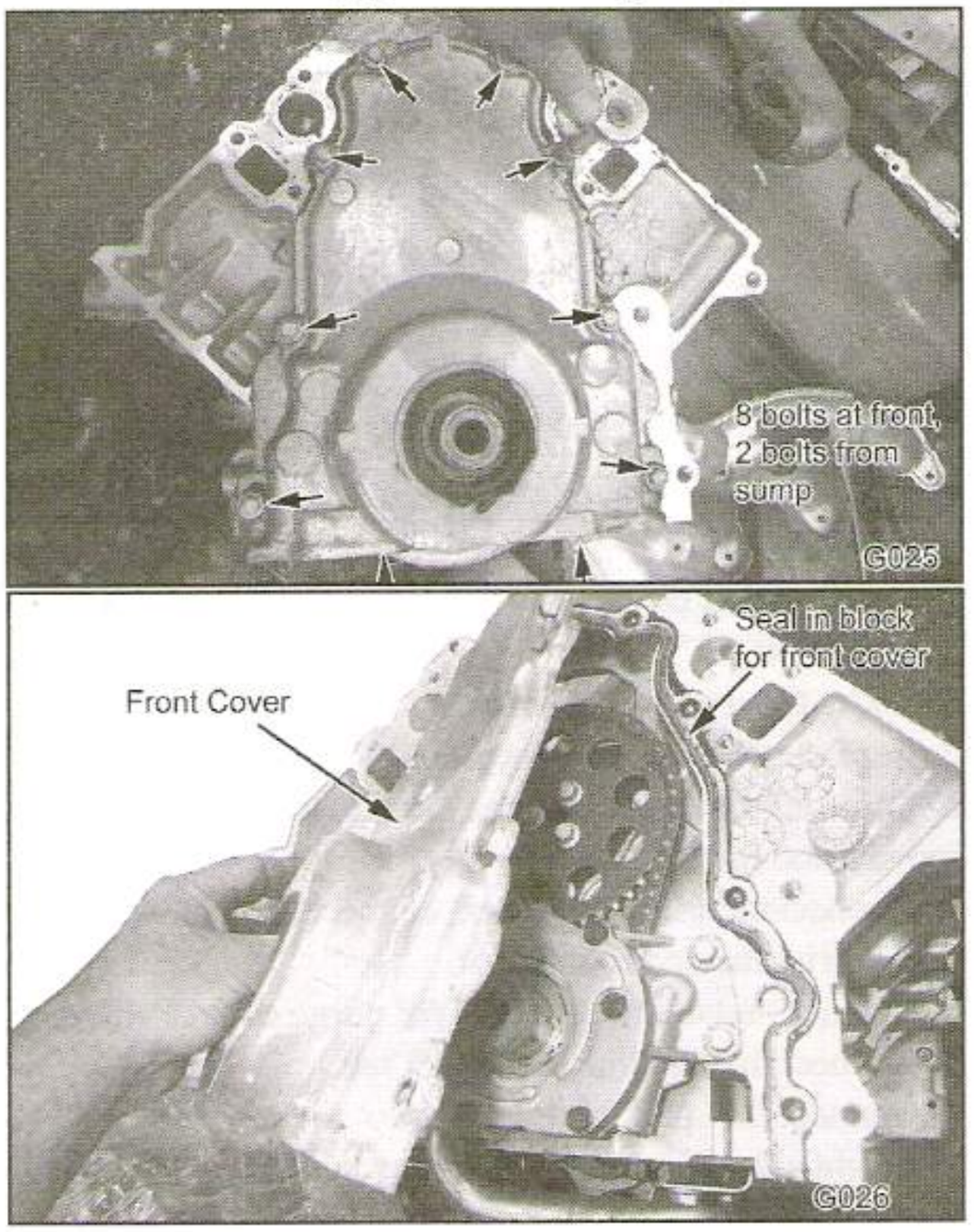
1. Disconnect battery earth lead.

2. Drain coolant from engine at radiator lower hose and remove top radiator hose, drive belt assembly.

3. Remove the crankshaft balancer pulley bolt, use a pulley remover to remove the pulley.

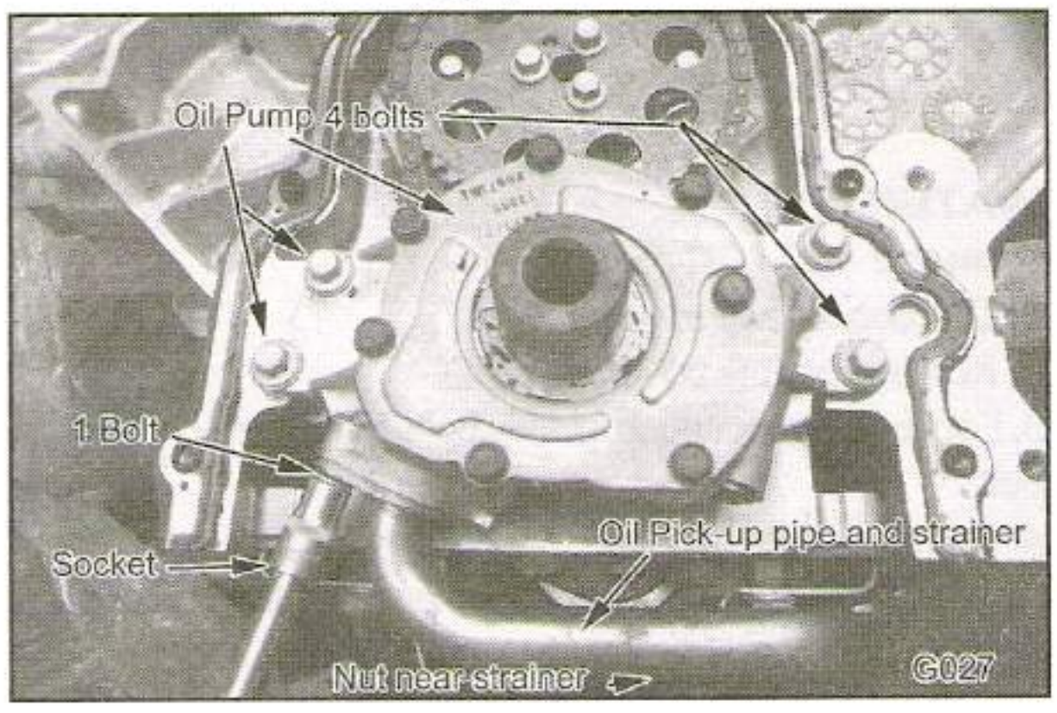
4. Remove the sump bolts, and remove sump.

5. Remove the timing gear cover and gasket, 8 bolts.

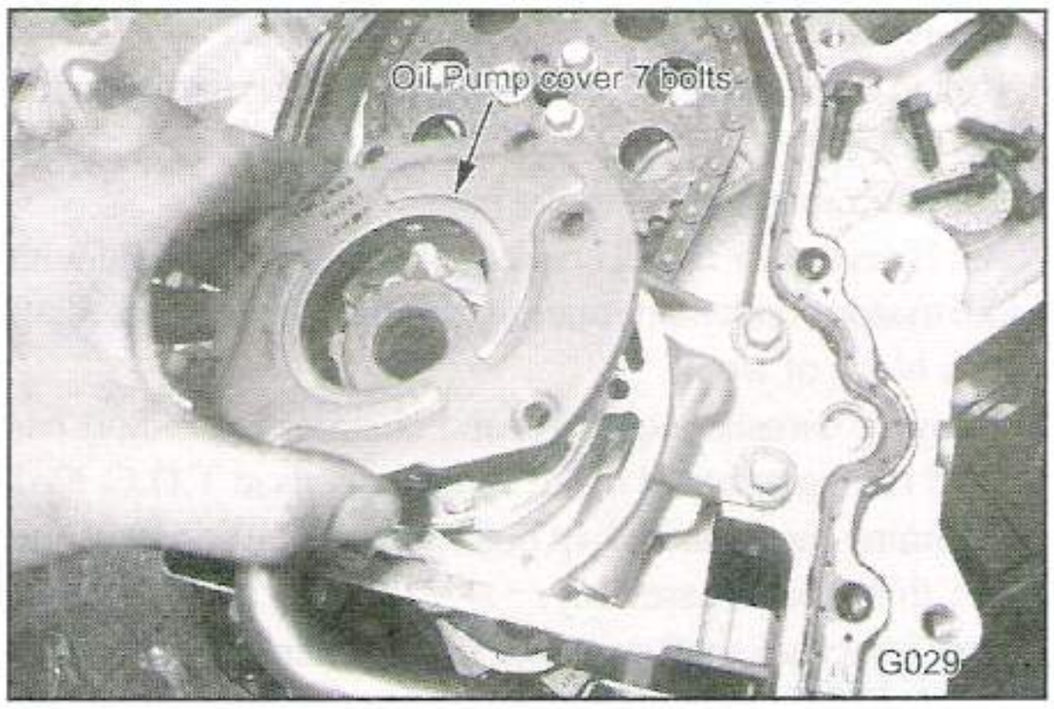


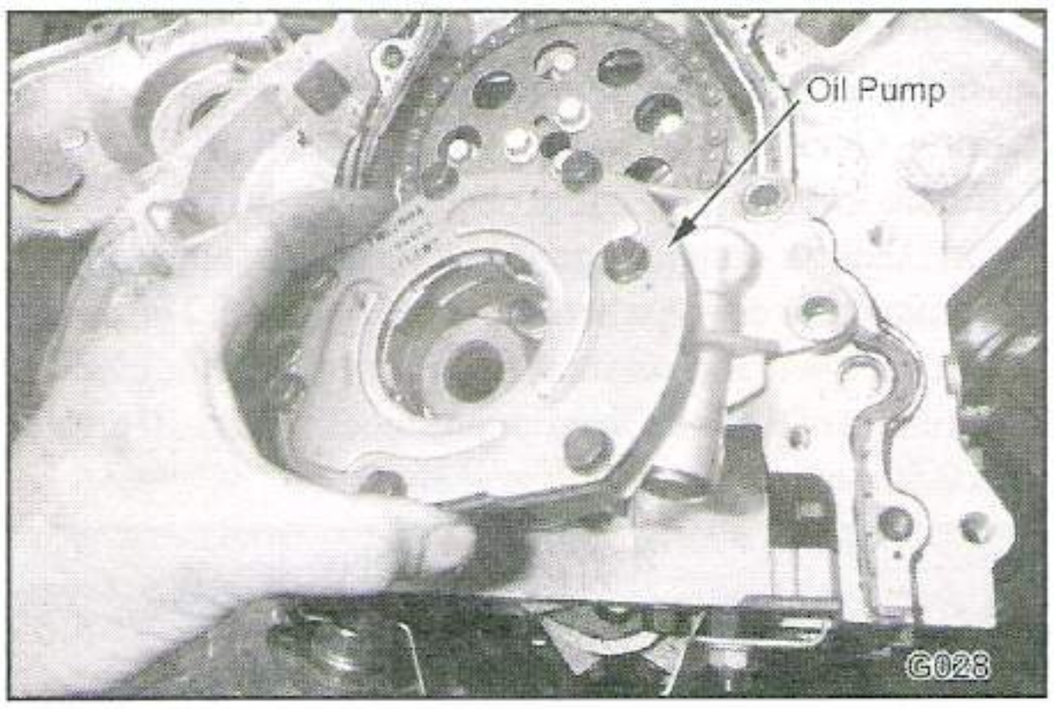
Oil Pump (the pump cover can be removed with pump on cylinder block)

6. Remove the oil pick-up pipe and screen, 1 nut and 1 bolt.



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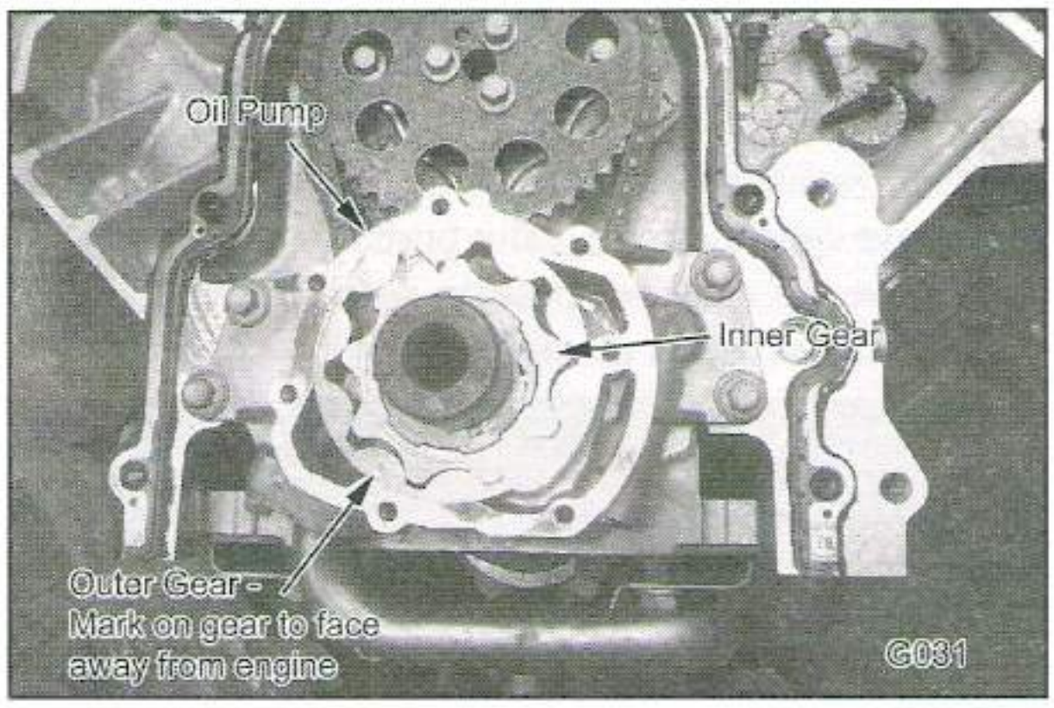




7. Remove the oil pump from the front of the engine block, 4 bolts.
8. Remove the oil pump cover, 7 bolts.
9. Use a marker to place alignment marks on oil pump gears, if removing gears.
10. Remove oil pressure relief valve, plug, spring and valve.

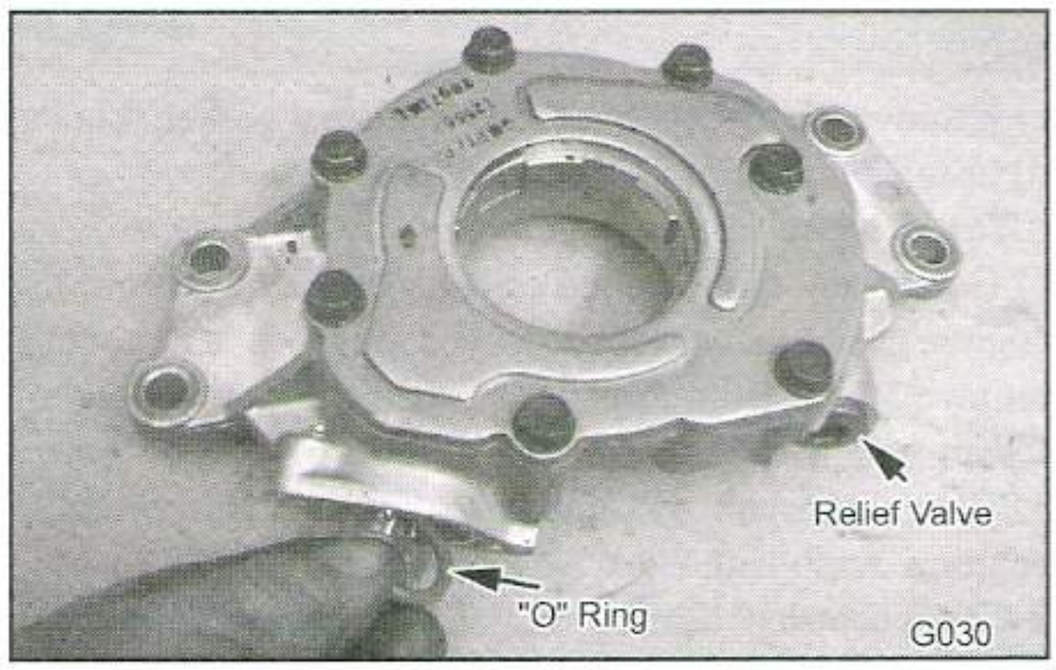
Clean and Inspect

Clean any sludge from inside oil pump and around oil pump gears. Inspect the inside of the pump housing and the outer gear and inner gear for damage or excessive wear. One part should not be replaced without replacing the other.



The outer gear has a mark which faces the oil pump cover. Check the clearance between the oil pressure relief valve and bore.
Replace "O" for oil pick-up pipe now or during assembly.

Install

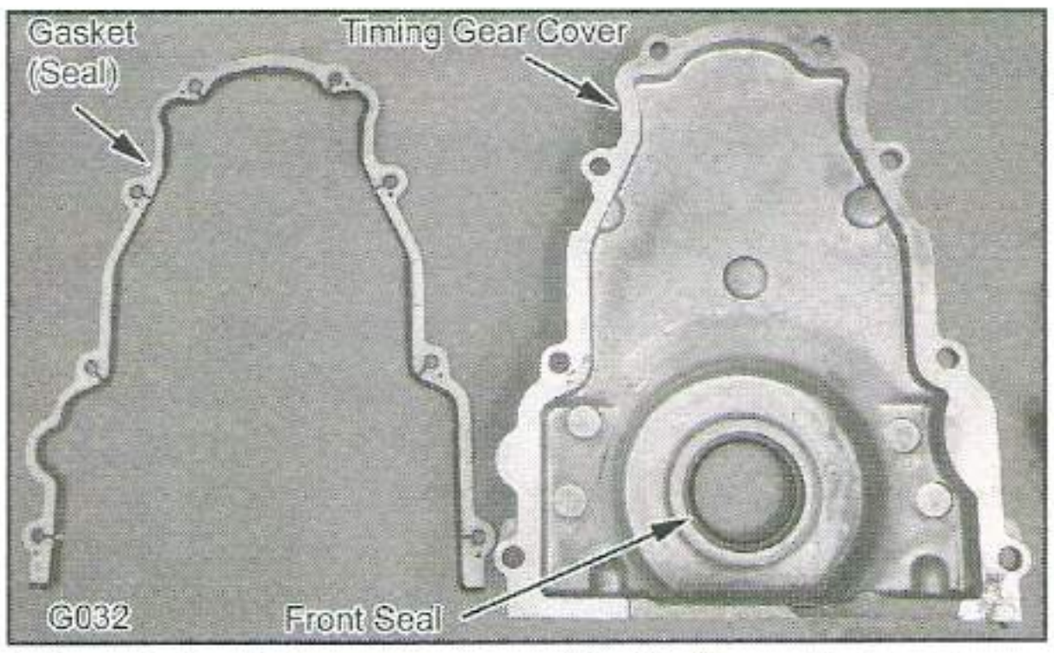


Oil Pump

1. Install the oil pump gears into the oil pump taking note of the alignment marks, install cover and 7 bolts.
Oil Pump Cover Screws: 12Nm
#Tip: Fill in around oil pump gears with petroleum jelly and engine oil.
Tip: Install a new spring to oil pressure relief valve during assembly.
2. Install oil pressure regulator valve, new spring and plug.
Oil Pressure Relief Valve Plug: 12Nm
3. Install the oil pump to the front of crankshaft sprocket and the engine block, 4 bolts.
Oil Pump Bolts: 25Nm
4. Install the oil pick-up pipe and screen, use a new "O" ring, 1 nut and 1 bolt.
Oil Pick-up Tube and Screen Bolt: 12Nm
Oil Pick-up Tube and Screen Nut: 25Nm

Timing Gear Cover

5. Install a new front seal into the timing gear cover, use a seal inserting tool or a large socket that is the correct size.



6. Install the timing gear cover, 8 bolts, finger tight only.
#Note: There are 2 special tools Nos J 41480 and J41475 to ensure the timing cover is aligned to help prevent oil leaks. The tool which is plate that bolts to the bottom of the engine block and lower timing cover, (sump bolt holes) tighten to 25Nm. The other tool fits over the front of the crankshaft is located by hand, this centralises the timing cover, so the front seal will not leak.

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Once timing gear cover has been centralised, tighten timing gear cover bolts to specification

Timing Gear Cover Bolts: 25Nm

7. Before installing the sump check as below.

#Note: Using a straight edge, check surfaces of engine block and timing gear cover, where the sump bolts too. The timing gear cover lower surface must flush with the engine block or a maximum of 0.50mm from engine block surface. If greater than 0.50mm replace timing gear cover.



Install sump with a new gasket, tighten bolts.

Sump Bolts to Engine Block: 25Nm

Sump Bolt to Timing Gear Cover: 25Nm

8. Install crankshaft balancer as described.

Crankshaft Balancer Bolt: 330Nm

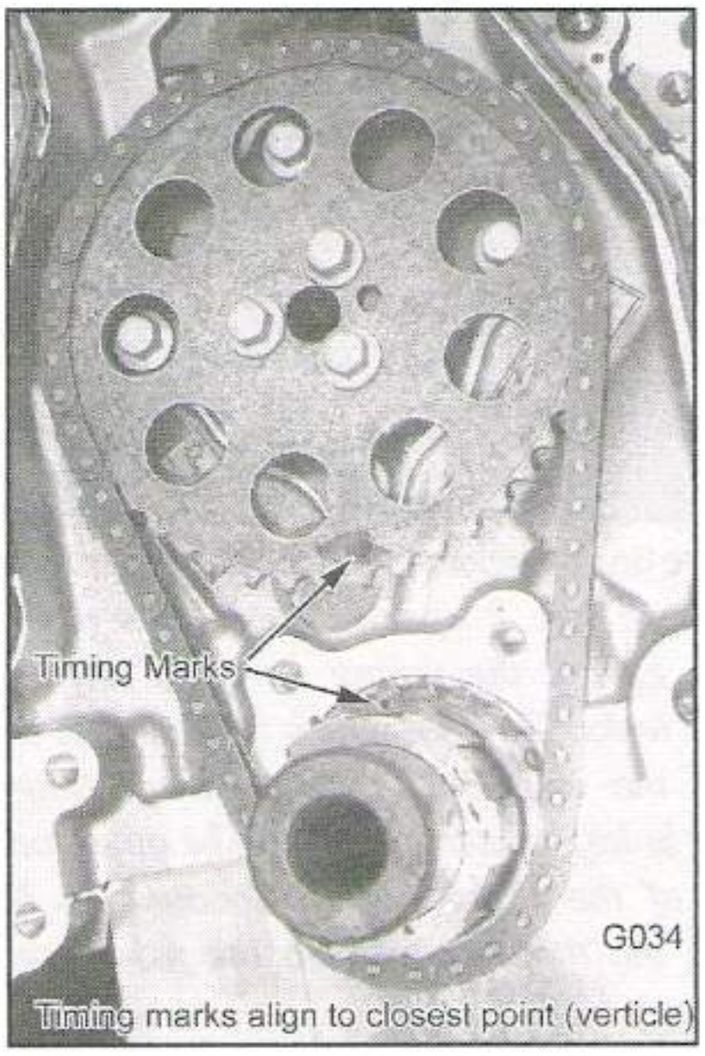
9. Replace auto trns pipes to radiator, if applicable.

10. Install water pump pulley, drive belt tensioner, alternator, radiator hoses refill and bleed cooling system.

11. Connect earth to battery.

TIMING CHAIN, GEAR, CAMSHAFT

Remove Timing Gear Cover and Oil Pump as described above.



Remove

1. Rotate crankshaft to T.D.C. No1, the timing marks on the gears will align.

3. Remove camshaft sprocket bolts.

Note: If necessary install crankshaft balancer and hold with a tool to stop crankshaft rotating, if sump off jam crankshaft with a block of wood.

4. Remove camshaft sprocket and chain, if crankshaft has rotated during removal make sure engine is at T.D.C. No1 with timing marks as shown before removing sprocket and chain, this helps in assembly.

5. Remove crankshaft sprocket, use a puller or(special tool Nos J 41558, J41816-2 and J 8433-1).

6. Camshaft

Check Camshaft Lift.

a) Camshaft in engine.

With valve rocker gear removed, setup a dial gauge on top of the pushrods. Rotate the camshaft to measure camshaft for specified lift, see specification below, replace if not within specification.

Specified Camshaft Lobe Lift Intake: 7.43mm

Specified Camshaft Lobe Lift Exhaust: 7.43mm

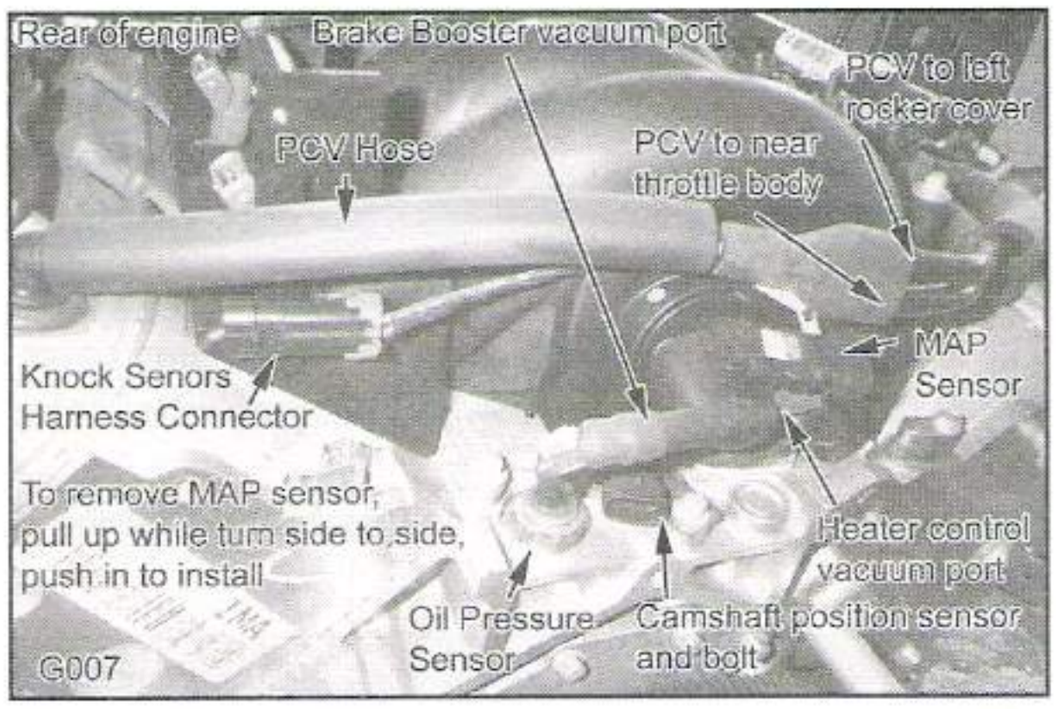
b) Camshaft removed from engine, see clean and inspect.

Remove

Camshaft sprocket has been removed as above, the camshaft can be removed with camshaft sprocket installed, by rotating camshaft and sprocket to align camshaft retainer bolts with holes in camshaft sprocket

a) Remove cylinder heads, valve pushrods and lifters.

b) Remove the camshaft position sensor, 1 bolt, located above camshaft at rear of engine valley.



c) Remove the camshaft retainer plate and gasket, 4 bolts.

d) Install 3 bolts into front of camshaft.

Tip: 3 of the water pump bolts.

c) Gently pull and turn the camshaft to remove from the engine, do not damage lobes and bearings while removing, remove 3 bolts from front of camshaft.

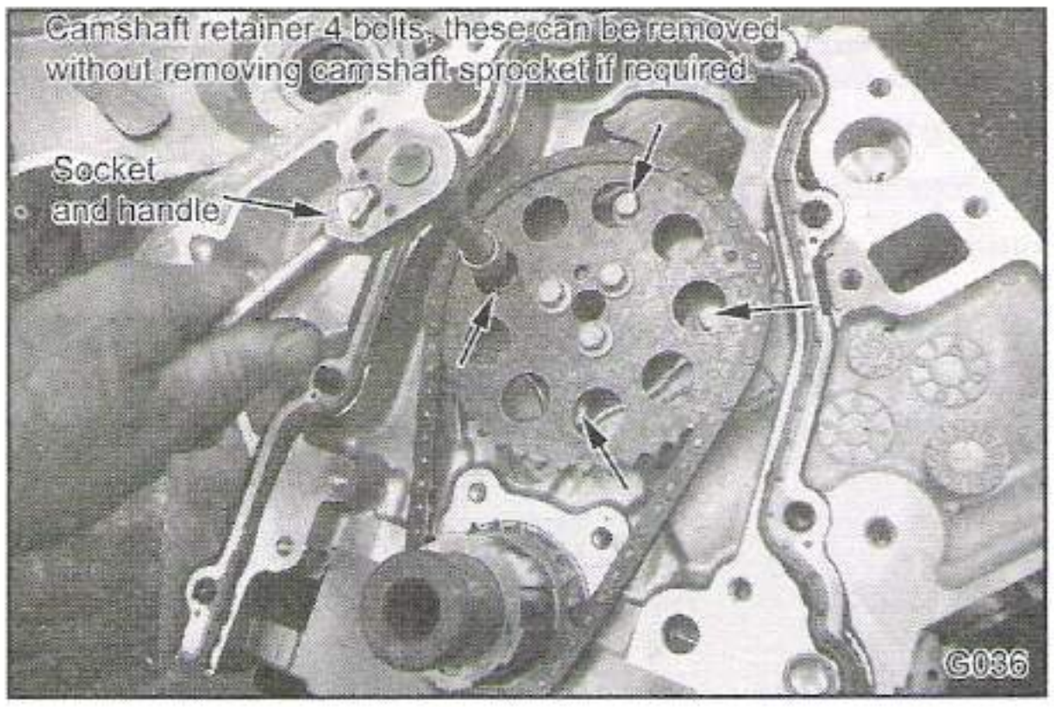
Clean and Inspect Camshaft.

1. Clean camshaft thoroughly using a suitable cleaning solution. wash with clean water or steam.

2. Check camshaft bearing journals for overheating, damage

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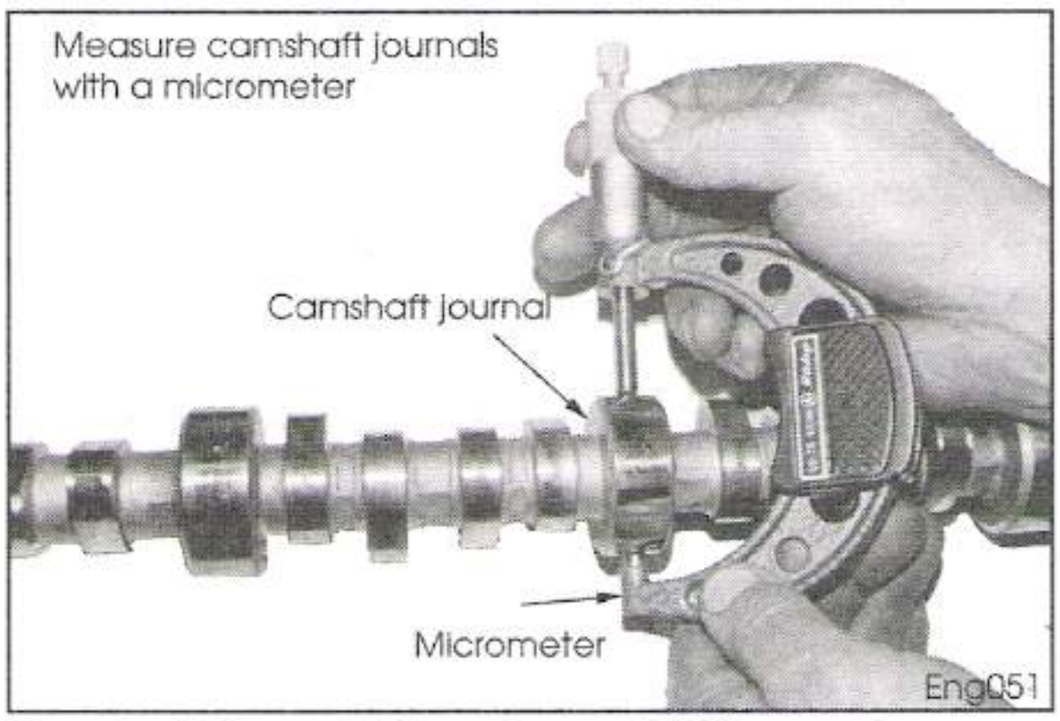




or wear, lobes for damage or wear, with excessive wear the hardened surface will be damaged or removed (never reuse a camshaft with hardened lobe surface damaged).

3. Inspect camshaft journal diameter with micrometer.

Replace camshaft, if journals are not as specified.



Camshaft Journal Diameter: 54.99mm min

4. Inspect camshaft lobes for specified height, using a micrometer.

Replace camshaft, if journals are not as specified.

Camshaft Lobe Specified Height;

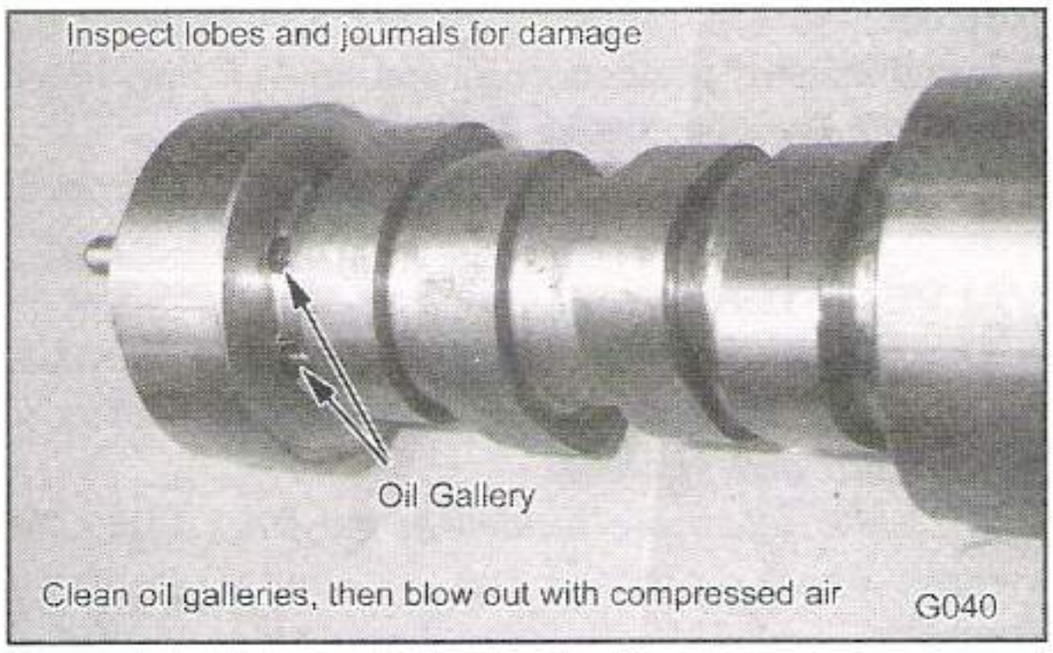
Inlet Lobe: 46.67 mm

Outlet Lobe: 46.67 mm

(b) Position camshaft on "V' blocks and check runout of centre camshaft journal.

5. Inspect camshaft retainer plate for wear, replace if necessary.

Camshaft Centre Max. Runout: 0.05mm.



Installation

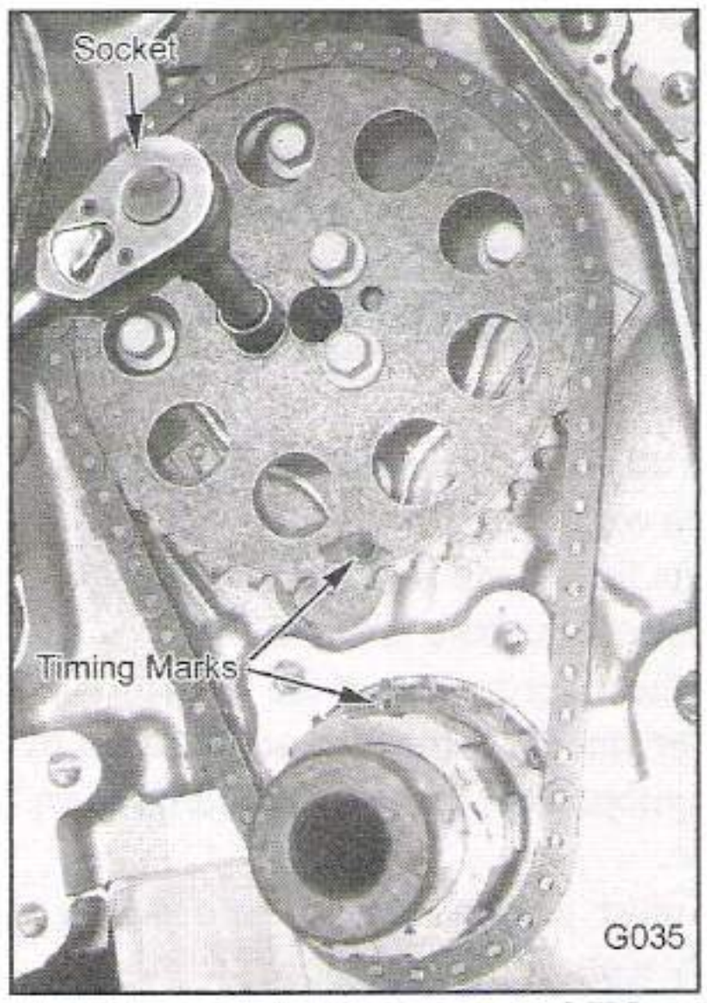
The crankshaft must be at TDC compression No1 cylinder.

1. Camshaft

a) Gently slide the camshaft into the cylinder block, do not damage lobes and bearings while installing.

b) Apply (Lubrizol 6612) molybdenum base grease to camshaft bearings and lobes, install the camshaft.

c) Install the camshaft retainer , 4 bolts, apply loctite 242 to threads of bolts.



Camshaft Retainer Plate Bolts: 25Nm.

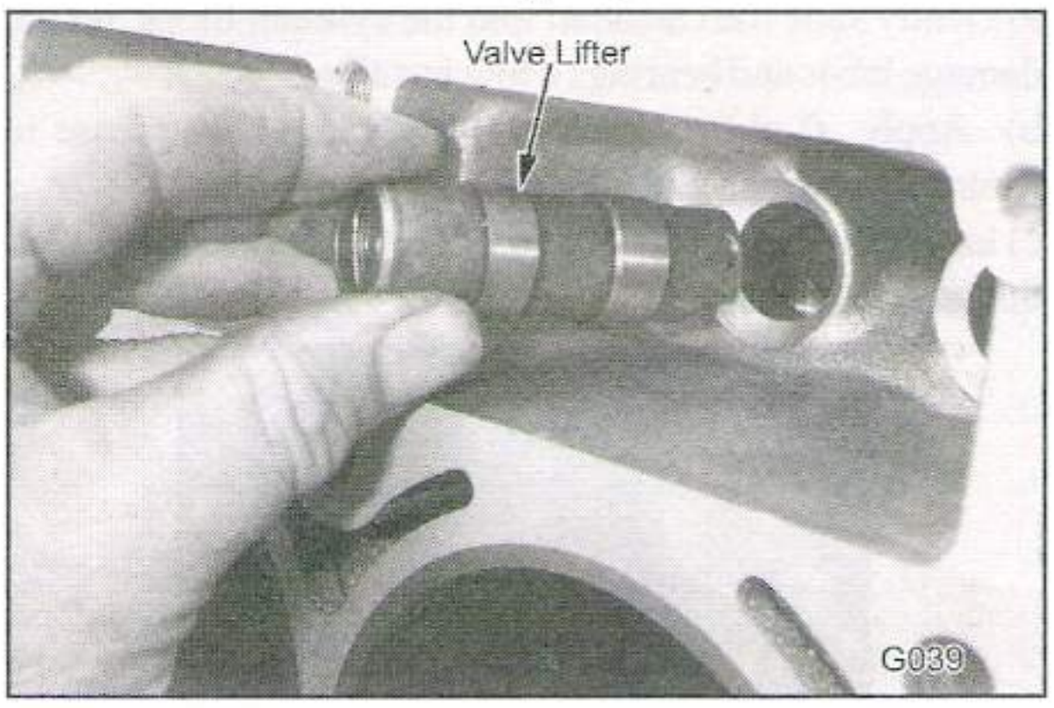
2. Install crankshaft sprocket, align onto key, the sprocket timing mark should be in the vertical position.

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3. Install camshaft gear to camshaft, install gear and chain, rotate the camshaft, the timing marks of the crankshaft sprocket and camshaft gear must be towards each other.
The camshaft gear must fit over the alignment pin
4. Install camshaft gear bolts, apply loctite 242 to the thread of the bolts, tight to specification.
Camshaft Gear Bolts: 35 Nm
Timing marks must be aligned.
5. Apply clean engine oil to timing chain, gear and sprocket.
6. Install hydraulic lifters and pushrods, apply (Lubrizol 6612) molybdenum base grease to contact surfaces of lifters and pushrods.
7. Install camshaft position sensor and new "O" ring, 1 bolt.
Camshaft Position Sensor Bolt: 25Nm
Install timing gear cover, head rocker gear as described.

VALVE LIFTERS

The cylinder head and rocker gear, intake manifold and pushrods must be removed to allow valve lifters to be removed and installed.
The valve lifters are located in the block under the cylinder heads.
Remove
Make sure that all valve train components are kept in order so they can be installed in their original locations.
1. Remove the cylinder heads.
2. Remove the valve lifter support plate, bolt and lifters.



Clean & Inspect
1. a) Clean all parts in a suitable cleaning fluid.
b) Dry with compressed air.
2. a) Inspect lifter body for wear and scuffing.
b) Also inspect lifter bore in block.
c) Inspect the roller surface of the lifter.
3. The lifter can be dismantled and cleaned by removing spring clip in top, allow components to drop down. Clean then reassemble.
The unit must be replaced if there is any damage or excessively worn.
4. Inspect lead down rate, use a lifter tester (tool no 6A23). The lifter should lead down to 0.125 on the tester scale in a time of 10 to 30 seconds, make sure the lifter is full of oil or testing fluid.
Installation
Make sure lifter bodies and lifter bores are clean insert lifters into the same bore they were removed from.
1. Install lifters and support plate, 2 bolts.
Valve Lifter Guide Plate Bolts: 12Nm
2. Install cylinder heads as described.

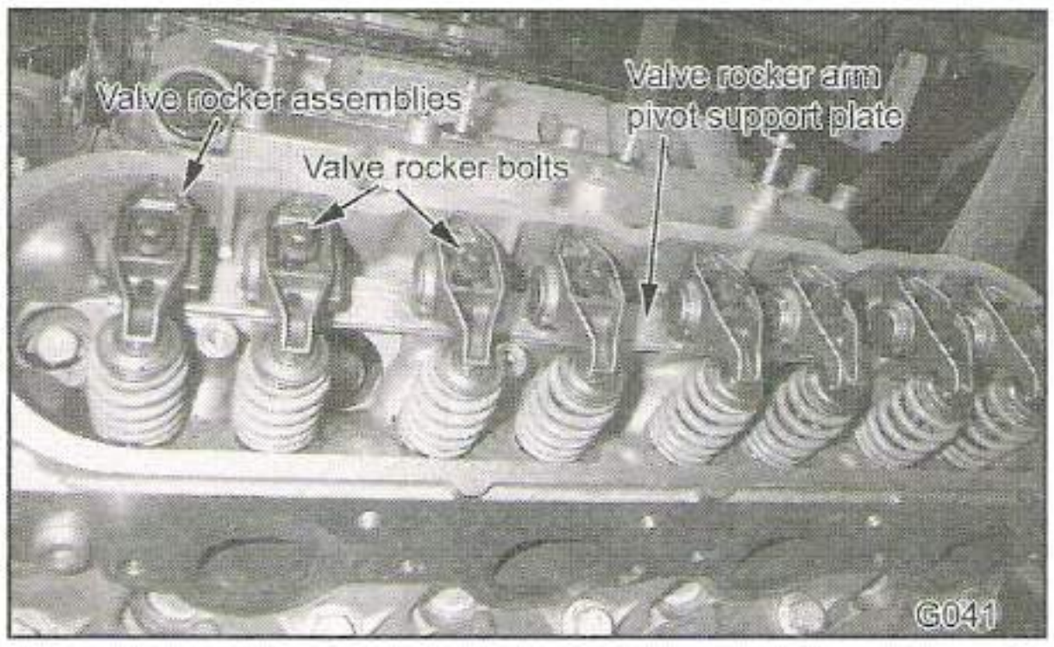
CYLINDER HEAD and VALVE ASSEMBLIES

**Make sure that all valve train components are kept in order so they can be installed in their original locations.*
Remove
1. Depressurize fuel system, remove fuel pump relay idle until stall.



2. Disconnect battery negative terminal.
3. Drain coolant from engine at radiator lower hose and remove top radiator hose.
4. a) Remove the power steering pump and lay to one side (if necessary disconnect the hoses to pump).
b) Remove alternator, remove alternator support bolts, then remove support assembly.
c) Remove the drive belt and drive belt tensioner as previously described.
d) Remove spark plug leads.
5. Remove intake manifold assembly as described.
Main points listed below.
a) Remove air cleaner to intake chamber tube.
b) Remove intake manifold, remove the fuel rails and injectors.
c) Remove vapour vent pipe.
6. Remove the exhaust manifolds as described in this chapter.
7. Remove the 4 bolts securing the each rocker cover, rocker cover, coils and gasket as previously described in this chapter.
8. a) Remove each roller rocker and bolt, lift roller rocker assembly and identify for assembly.
b) Remove the roller rocker pivot support plate from each head.

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c) Remove push rods.

**Make sure that all valve train components are kept in order so they can be installed in their original locations*

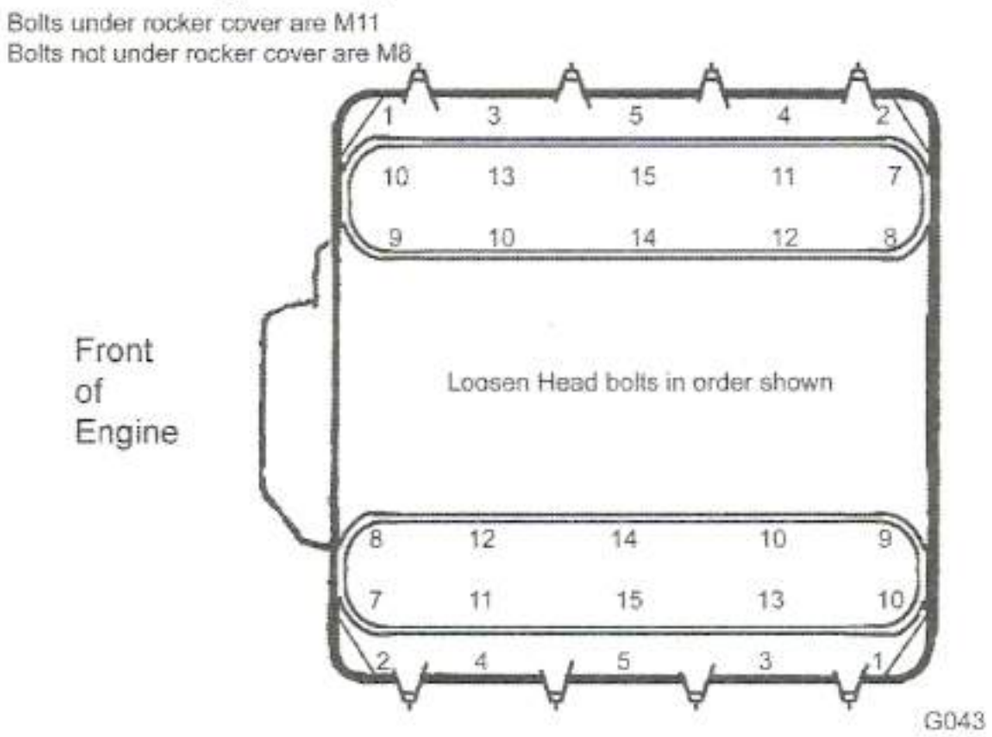
9. Remove the cylinder heads.

a) Remove the powertrain earth strap to the front of right head, back of left head and harness on rear of left head.

b) Remove the auto trans dip stick support bolt at rear of right head.

c) Remove the 5 smaller bolts, outside to center, each head.

d) Remove the 10 cylinder head bolts in the sequence shown, loosen bolts gradually, discard these bolts.



Tip: Take note of the location of the 2 short head bolts.

Tip: Obtain new cylinder head bolts, as once used the bolts stretch.

d) Lift the cylinder heads and gaskets from the engine block.

10. Remove the valve lifters and valve lifter plate, 2 bolts.

CYLINDER HEAD RECONDITIONING

** Make sure that all valve train components are kept in order so that they can be installed in their original locations.*

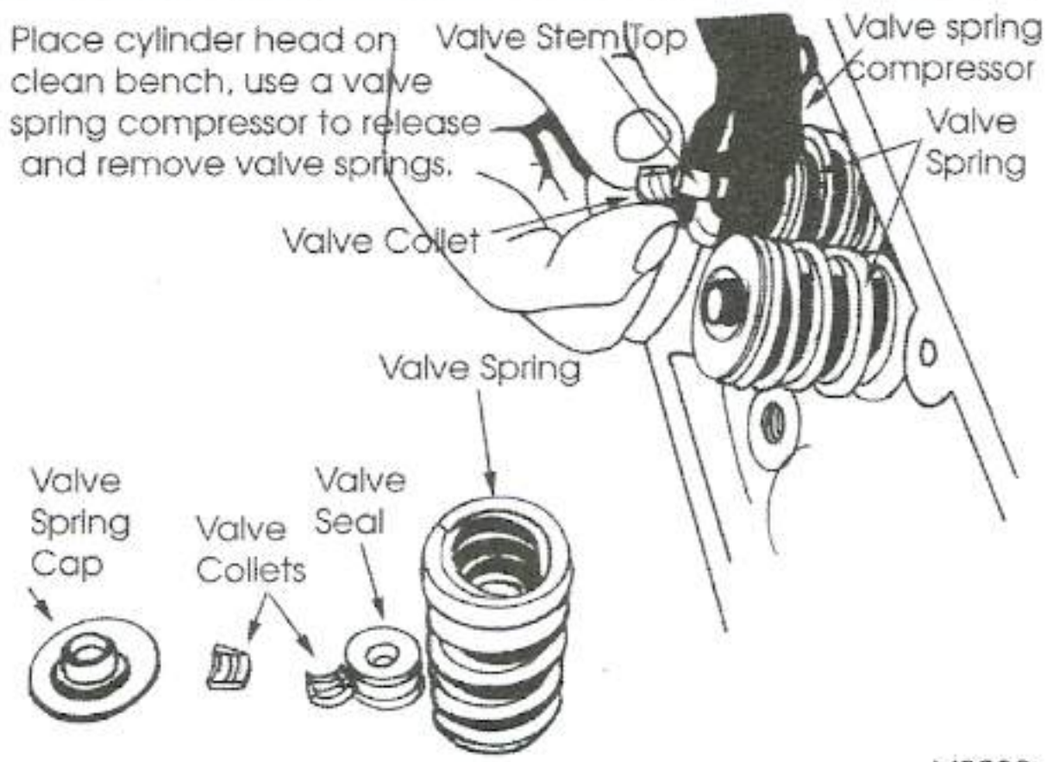
Dismantle

1. Compress valve springs in turn with a spring compressor and remove valve collets.

2. Remove the following:

(a) Collets, valve spring caps, springs, valve stem oil seals and valve spring seats.

(b) Valves from cylinder head.



Caution: *Take care removing valves out of guides, because if the valve ends are burred due to lifter wear or dirt in the guide, will damage guide. Remove burrs with an oil stone or fine file.*

3. Replace all welsh plugs, use sealant as plugs are replaced.

Clean

1. (a) Remove all carbon deposit from combustion chambers, valve ports, etc., with a rotating drill mounted wire brush.

* Do not use a wire brush on any gasket sealing surface.

(b) Clean cylinder head gasket surface of cylinder head.

2. Thoroughly clean valve guides with a suitable cleaning solvent and a fine brass wire brush.

3. Clean valve heads with a drill and wire brush or buffing wheel.

* Do not scratch the valve stem.

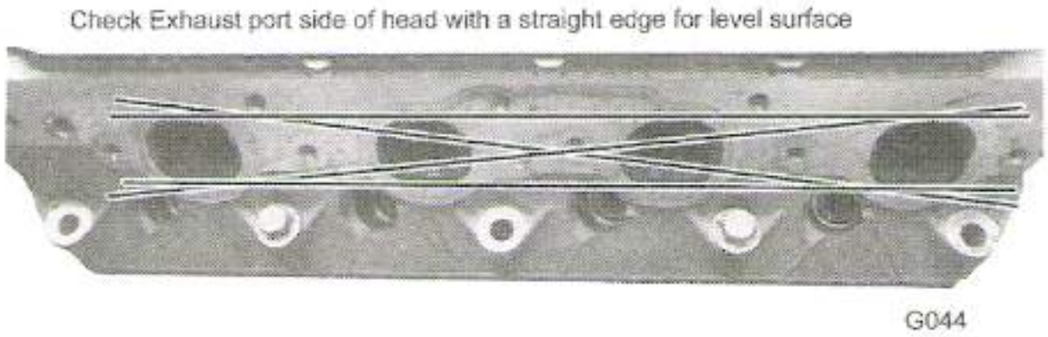
4. Wash all components in a suitable cleaning solvent and air dry with dry compressed air.

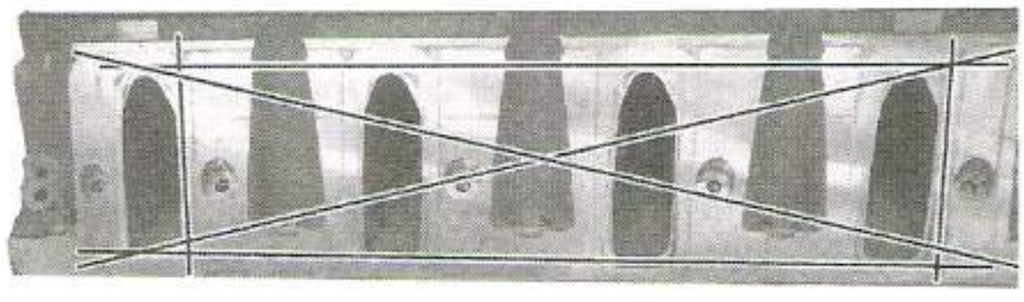
Cylinder Head Inspection

1. Cylinder heads should be inspected for cracks in valve seats, between valve seats, between valve seats and spark plug hole and combustion chambers, and for external cracks to water jackets.

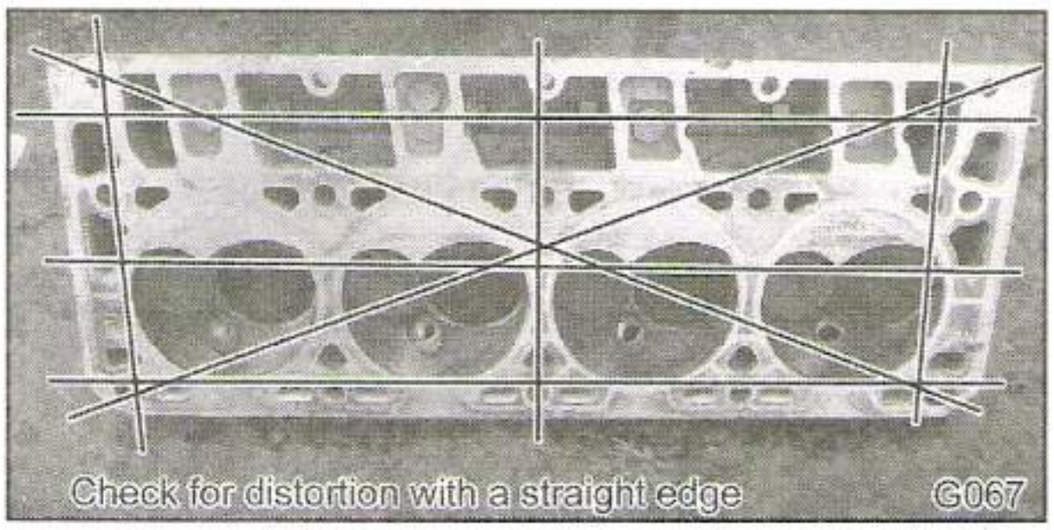
2. Check cylinder head deck surface for corrosion.

3. With a straight edge and feeler gauge, check cylinder head deck, intake and exhaust manifold surfaces for distortion, if distortion is greater than specified, machine surface.

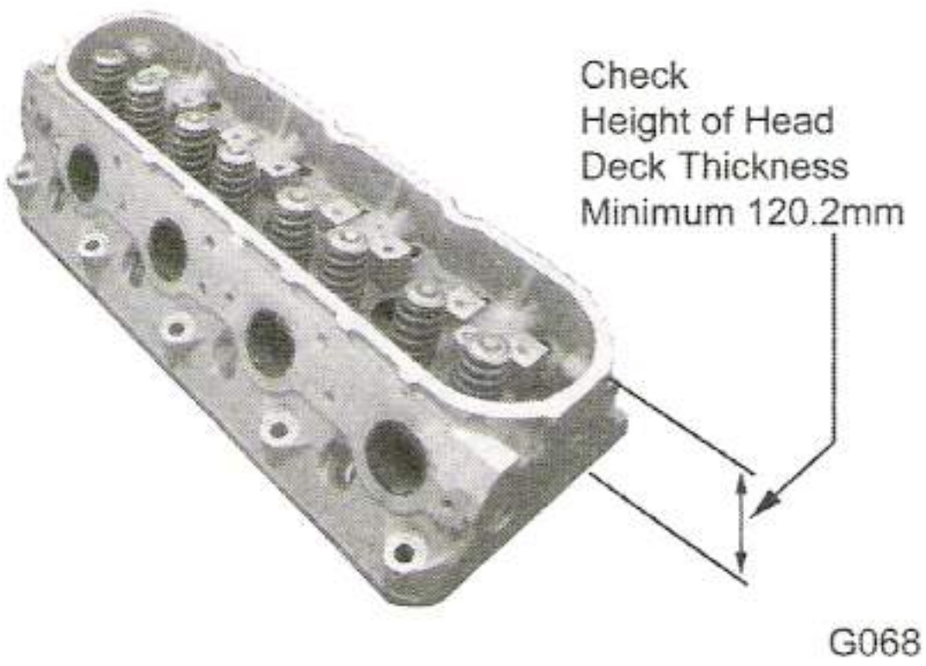




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Maximum Cylinder Head Distortion: 0.22mm
Cylinder head surface should be checked diagonally, longitudinally and transversely.
*** Check thickness of cylinder head deck surface:**
Minimum head deck thickness: 120.2mm

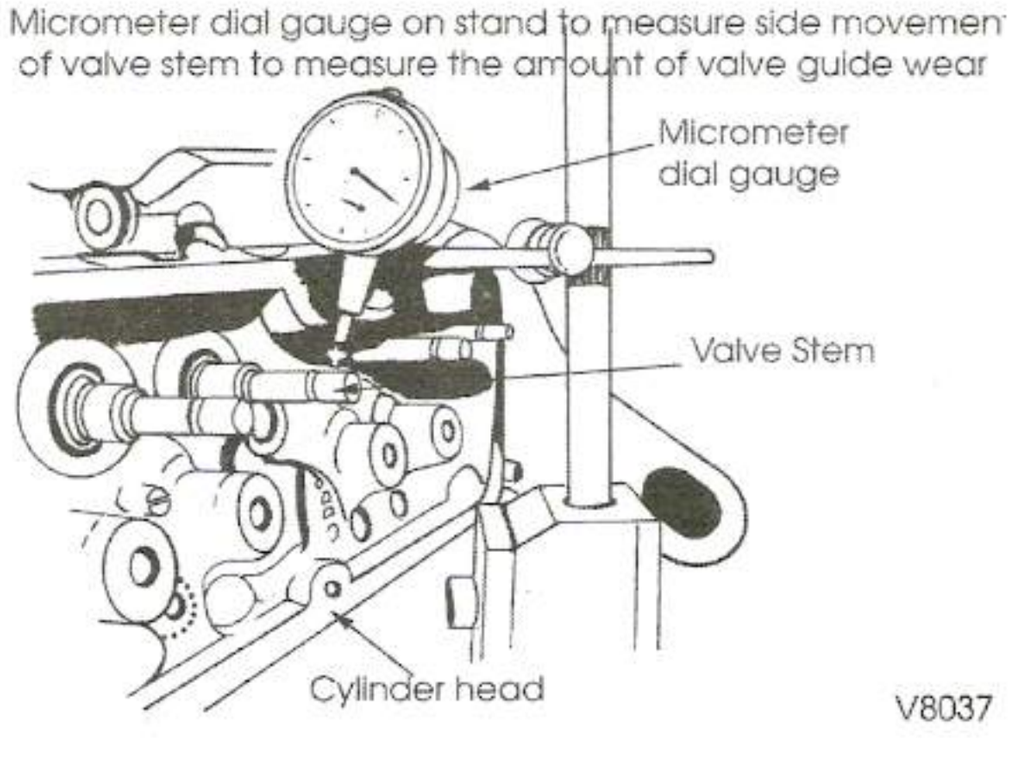


Tip: Machining 0.15mm from the head surface reduces each combustion chamber by approximately 1.00cc.

VALVE GUIDES

Clearance Checking

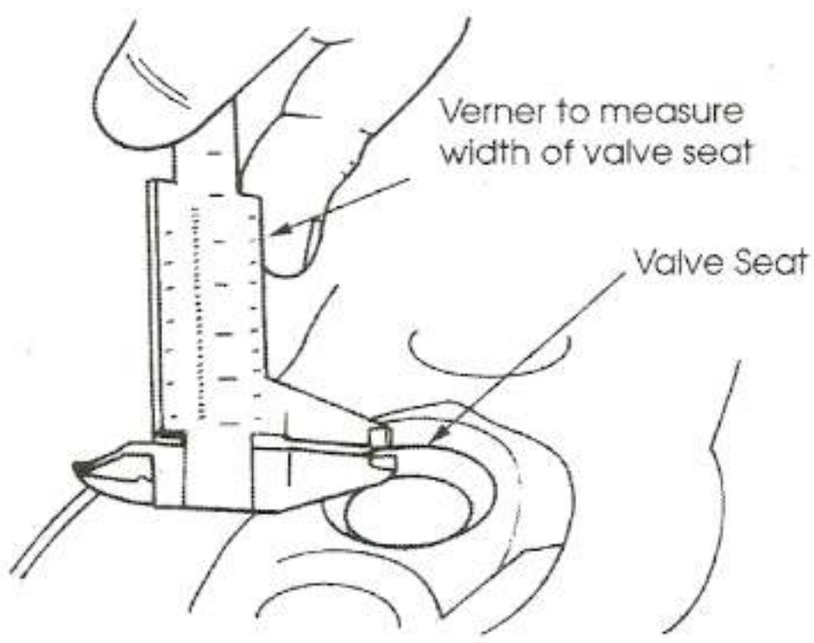
1. If valve stem to guide bore clearance is past maximum tolerance, it could cause lack of power, rough idling and noisy valve operation.
2. Insufficient clearance can cause noise and sticking of the valve and will cause uneven operation of engine.
3. Valve stem clearance can be checked with a dial indicator attached to side of head or stell table top, insert valve into valve guide, measure side movement 8-12mm above valve guide. If not within specification try a new valve or guide.
3. Measure the valve guide clearance by using the valve from that guide, if the clearance is over specified, measure using a new valve, it is better to replace the valve instead of the valve guide, providing clearance is within specification.
4. Valve stem clearance can be checked with a dial indicator attached to side of head or stell table top, insert valve into valve guide, measure side movement 8-12mm above valve guide. If not within specification try a new valve or guide.
Specified Maximum Valve Guide Clearance as above: 0.093mm



Tip: Try an oversize valve.
Replace cylinder head if valve guide clearance is over maximum as described above.

VALVE SEATS

1. Valve seats must be reconditioned to allow the seating of the valves must be perfect for the engine to deliver the power and performance its develops.
2. Good contact between each valve and its seat in the head is imperative to ensure that the heat in the valve head will be properly carried away.
3. There are several different types of machinery available for reconditioning valve seats. The recommendations of the manufacturer of the equipment being used should be carefully followed to attain proper results.
4. Check valve seats for any evidence of pitting or damage at valve contact surface. If pitting is evident, the valve seats will need to be reconditioned.
* Because the valve guide serves to support and centre the valve seat grinder, it is essential that the valve guide is serviced before reconditioning the valve seats.



*** Valve seat angles are 46^0.**
*** Valve seat width:**
Exhaust 1.78mm
Intake 1.02mm
5. If the seat is too wide after grinding, it may be narrowed by using a 250° or 60° grinding stone. The 25° stone will lower

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the seat and the 60° stone will raise the seat.
6. If the valves seats are reconditioned, the valves must also be reconditioned (refer VALVES) or replace valves as necessary.

REPLACING VALVE SEAT

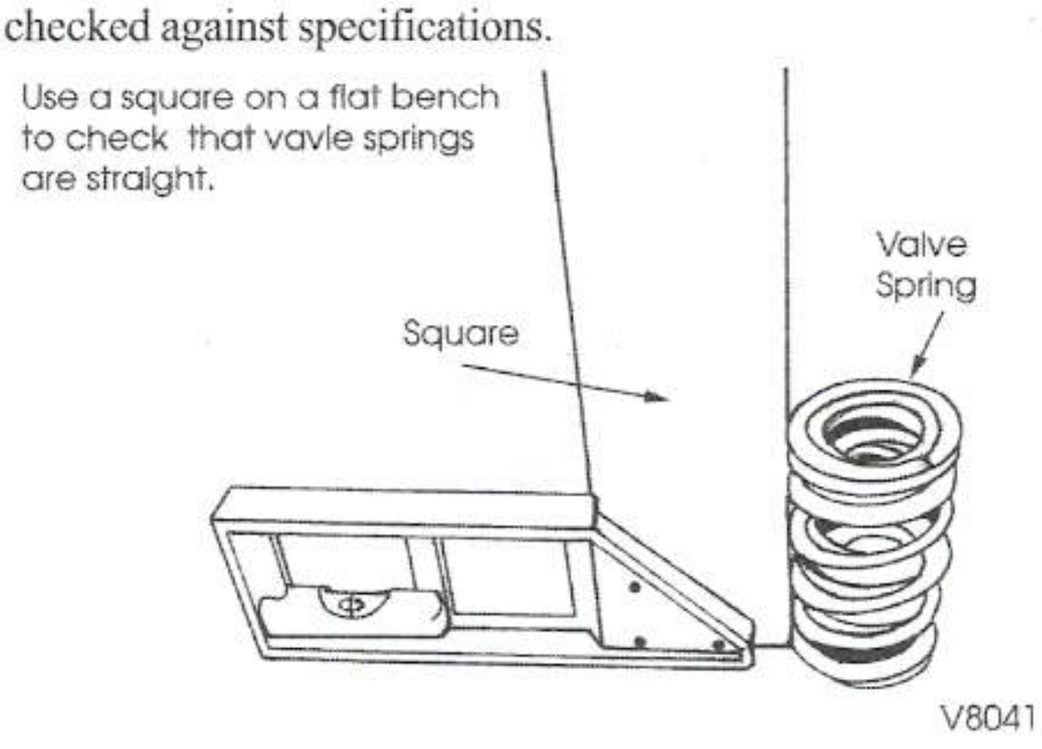
1. Using a lathe, turn down the out side diameter of a valve head so it fill fit neatly into inside of the valve seat.
2. Cover the head that surrounds the valve seat with an inflammable paste, such as soap paste. This will stop damage from weld spatter.
3. Weld a continuous run of weld around the edge of the valve, so it is welded to the inside of the valve seat.
4. Lift the head so the top of the valve can be tapped to free the valve seat.
5. Slide the machined valve and valve seat out of the head.
6. Machine the head as the new valve seat is over size by 0.38mm diameter and depth.
7. The new valve seat should not to be hit or forced into the head as this will cause damage to the seat and head.
8. Place the new valve seat in liquid nitrogen or dry ice so the seat will shrink in size.
9. Carefully place the valve seat into position with an old valve (converted into a special tool as shown in diagram) positioned through the seat into the valve guide. Gently tap the special tool to position and centre the valve seat.

VALVE SPRINGS

1. Check valve spring surfaces, valve spring seat and valve cap for wear or gouging. Replace components as necessary.
2. (a) Check spring ends. If they are not parallel, the spring is bent.
(b) Replace valve springs that do not meet specification.
Maximum allowable variance in spring end length: 1.60 mm, while rotating spring on level desk.
(c) Measure valve spring height for specification, replace if necessary.

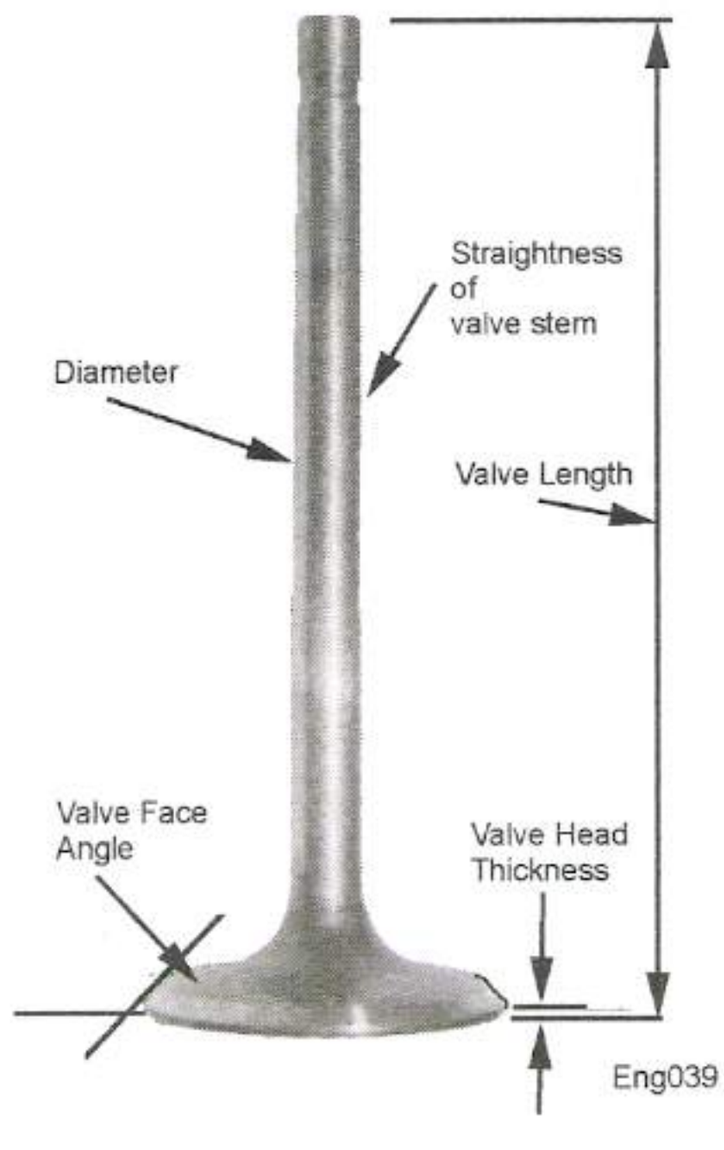
Valve Spring Intake Free Height:	**52.9mm**
Valve Spring Exhaust Free Height:	**52.9mm**

3. (a) Check valve spring load with a spring tester.
(b) Springs should be compressed to the specified height and checked against specifications.



Valve spring compressed height/load:
Compressed height: 310Nm@45.75mm min
Compressed height: 980Nm@33.55mm min
(c) Replace any valve spring if not to specification.

VALVES

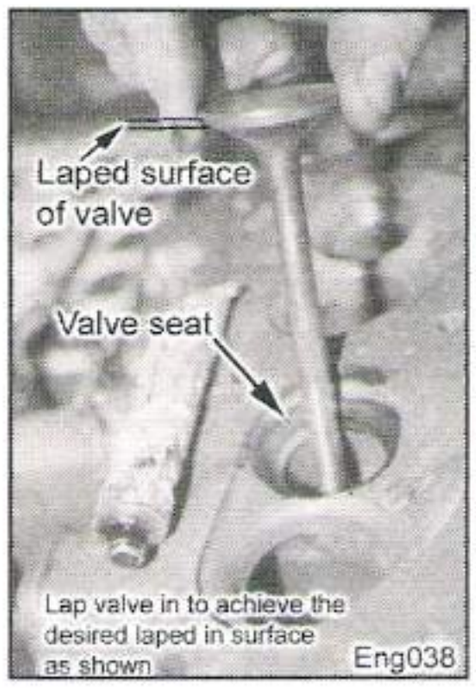


1. (a) The valve stem should be inspected for burrs and scratches. (Burrs and minor scratching may be removed with an oil stone.)
(b) Valves that have excessive stem wear or that are warped should be replaced.
(c) The valve stem tip should be inspected for wear. The valve tip may be reconditioned by grinding.
(d) The valve stem should be inspected for wear. Replace if not within specification.

Valve Stem Diameter:	**7.955-7.976mm**
Mim Dia:	**7.950mm**

(e) Follow the grinder manufacturers instructions. Make sure the new tip surface is at right-angles to the valve stem.
2. Inspect valve stem collet groove for damage.
3. (a) Check valve face for burning or cracking.
(b) If pieces have broken off, inspect corresponding piston and cylinder head area for damage.
4. (a) Inspect valve stem for straightness and valve head for bending or distortion using 'V' blocks.
(b) Bent or distorted valves must be replaced.
5. Valves with pitted or grooves faces can be reconditioned with a valve refacing machine, ensuring correct relationship between head and stem.
Valve face angle: 45°.
* If pitting or grooving is so deep that refacing would result in a 'knife' edge at the valve head, the valve must be

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replaced.

* Measure valve margin after refacing valves. If margin is less than minimum specified, the valve must be replaced.

Minimum valve head margin thickness: 0.63mm

6. Lightly lap reconditioned valves into valve seat.

* New valves must not be lapped. Lapping destroys the protective coating on the valve face.

7. After refacing or installing a new valve, check for correct seating as follows:

(a) Lightly coat valve face with bearing blue.

(b) Insert valve and rotate about 1/6 of a revolution.

(c) Remove valve and check for full contact with seat.

i) If partial contact is indicated, insert valve again and turn through a full revolution.

ii) If blue on seat indicates full contact, reface valve.

iii) If partial contact is still indicated, regrind cylinder head valve seat.

(d) Clean all traces of bearing blue from valves and seats.

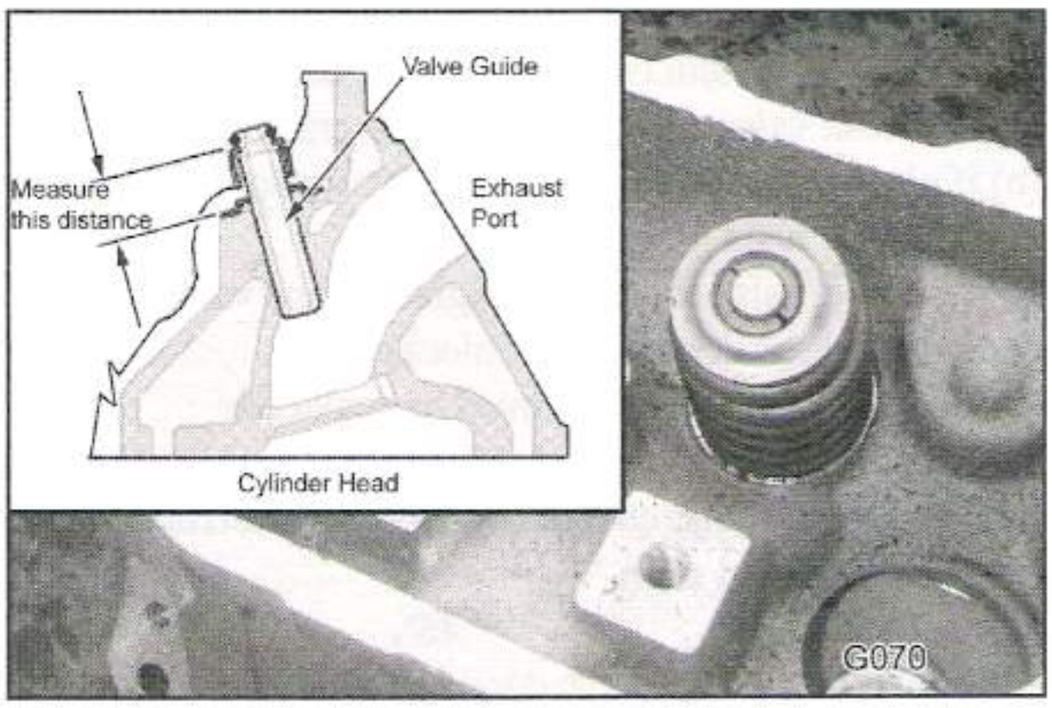
CYLINDER HEAD ASSEMBLE

1. Dry and clean all components thoroughly.

2. Using clean engine oil, lubricate valve stems and valve guides thoroughly.

3. Make sure that oil seals fully seat on top of guide, install new valve stem oil seals, lubricate oil seals with clean engine oil.

The oil seal should be at the specified height above the valve spring seat when installed correctly, 18.1 to 19.1mm.



4. Install valves in corresponding guides.

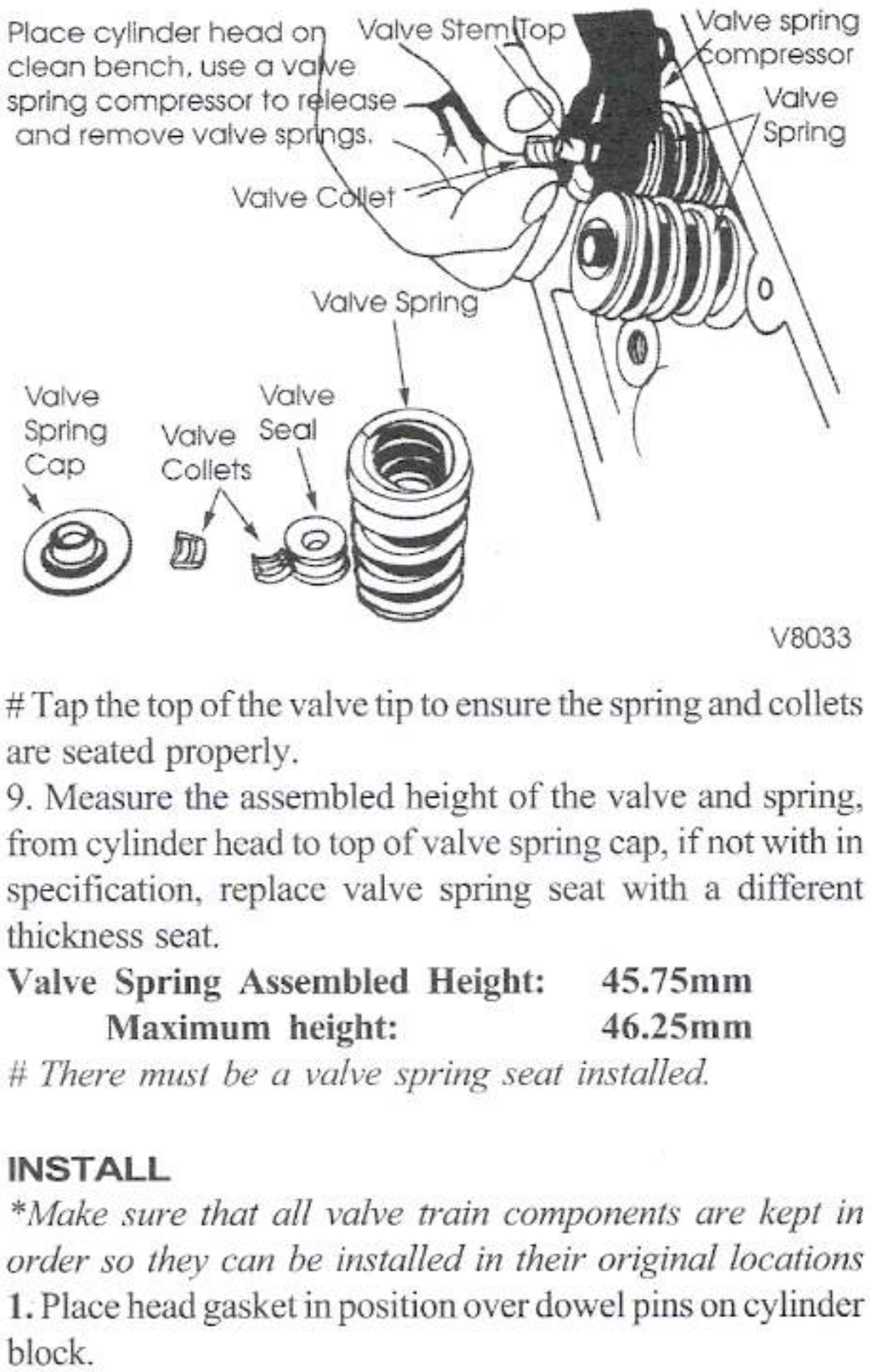
5. Install the valve spring seat over the valve guide onto the cylinder head.

6. Place valve springs and cap over valve stem.

7. Using a suitable spring compressor, compress valve springs.

* Excess compression could cause spring cap to damage valve stem oil seal, ensure to compress valve springs only enough to install valve collets.

8. Install valve collets, making sure that they locate accurately in groove in top end of valve stem. Release the valve spring compressor slowly ensuring that the collets sit properly. Grease may be used to hold collets in place.



Tap the top of the valve tip to ensure the spring and collets are seated properly.

9. Measure the assembled height of the valve and spring, from cylinder head to top of valve spring cap, if not with in specification, replace valve spring seat with a different thickness seat.

Valve Spring Assembled Height: 45.75mm

Maximum height: 46.25mm

There must be a valve spring seat installed.

INSTALL

**Make sure that all valve train components are kept in order so they can be installed in their original locations*

1. Place head gasket in position over dowel pins on cylinder block.

The tab on the head gasket is closest to the front of the cylinder block, same both sides.

Later gaskets will fit to either side.

Do not use any sealant on head gasket..

2. a) Carefully guide cylinder head into place over dowel pins and gasket.

b) Coat threads of the 5 small head bolts (M8) with LOCTITE 242 sealant or equivalent and tighten with finger.

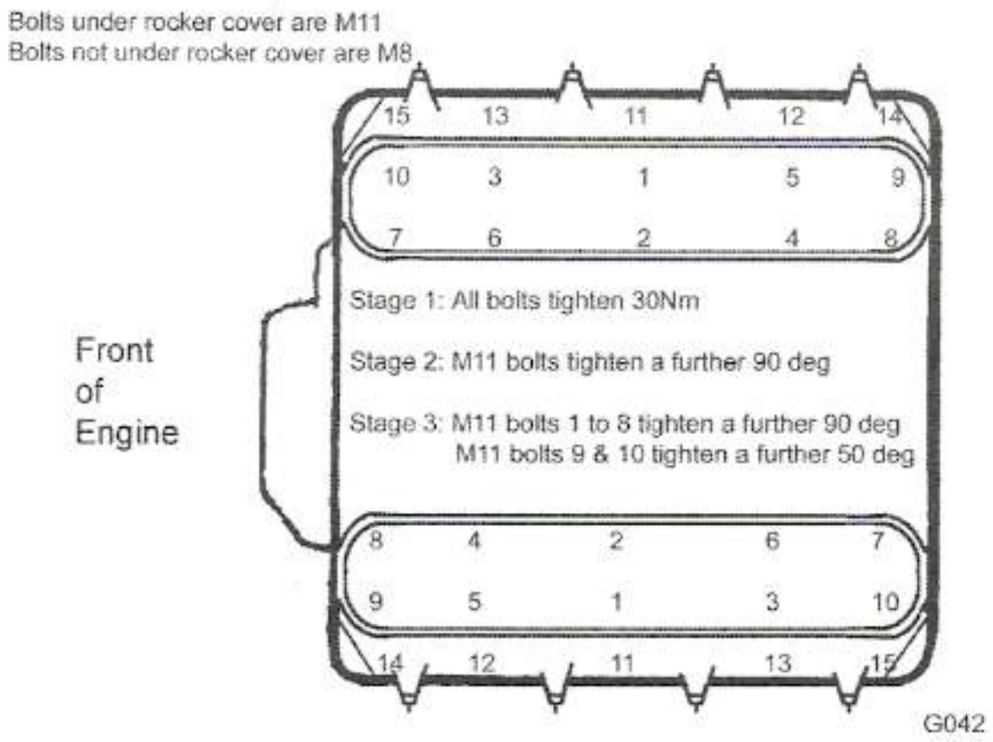
c) Install new cylinder head bolts (M11) with no sealant.

** Use new cylinder head bolts. This may avoid pulling down the engine again with blown head gasket due to*

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stretched head bolts.

3. Tighten the head bolts to the following sequence and in the order shown in previous illustration.



* It is important to follow the given procedure to avoid head gasket failure and possible engine damage.

Cylinder Head Bolt Torque:

Step1: All bolts M11 and M8: 30Nm
Step2: M11 bolts tighten a further 90⁰ turn
Step3: M11 bolts 1-8 tighten a further 90⁰ turn
Step3: M11 bolts 9&10 tighten a further 50⁰ turn

#Hint: After tightening to first specification, paint dot on bolt head to front of engine. After each tightening sequence, check all paint marks have rotated as required

4. Install valve lifters and valve lifter guide plate, 2 bolts.

Valve Lifter Guide Plate Bolts: 12Nm

5. Install the push rods to the original positions.

6. Install roller rocker arm pivot plate and rocker assembly, and bolts. Tighten to specification.

Rocker Assembly Bolts: 30Nm

7. Install rocker covers and gasket as previously described, tighten to specification.

Rocker Cover Nuts Torque: 12Nm

8. Install exhaust manifolds as previously described in this chapter.

9. Install intake manifold, fuel injectors, etc as previously described in this chapter.

10. Install drive belt tensioner, drive belt, alternator as described in this chapter.

11. Reconnect radiator hoses, refill and bleed cooling system.

VALVE STEM OIL SEALS

Replacement

1. Disconnect battery earth lead.

2. Remove the following:

a) Rocker cover as previously described in this chapter.
b) Remove rocker assembly for relevant cylinder/s
d) Spark plug leads from spark plugs.
e) Spark plug from relevant cylinder and screw air adaptor into spark plug hole.

3. Apply air pressure to hold valves in closed position.

4. Remove the valve spring assembly for relevant valves.

5. a) Compress valve spring with valve spring compressor.
b) Remove valve collets.

*Before installing valve spring compressor, it may be necessary to tap top of valve cap with a soft-faced hammer to overcome the binding of the valve collets in the valve spring cap.

6. a) Remove spring cap, spring and valve compressor as an assembly.
b) Remove and discard old valve stem oil seal.

7. Install new valve stem oil seal and make sure the seal fully seats on top of the valve guide and valve spring seat.

** Lubricate oil seals with clean engine oil.*

The oil seal should be at the specified height above the valve spring seat when installed correctly, 18.1 to 19.1mm.

Illustration previously shown.

8. a) Install spring, cap and valve compressor as an assembly on the valve stem.
b) Install valve collets and slowly release spring compressor, then remove spring compressor.
c) Disconnect air line to special tool.

9. Install the following:

a) Rocker assembly as previously described in this Chapter.
b) Rocker cover as previously described in this Chapter.

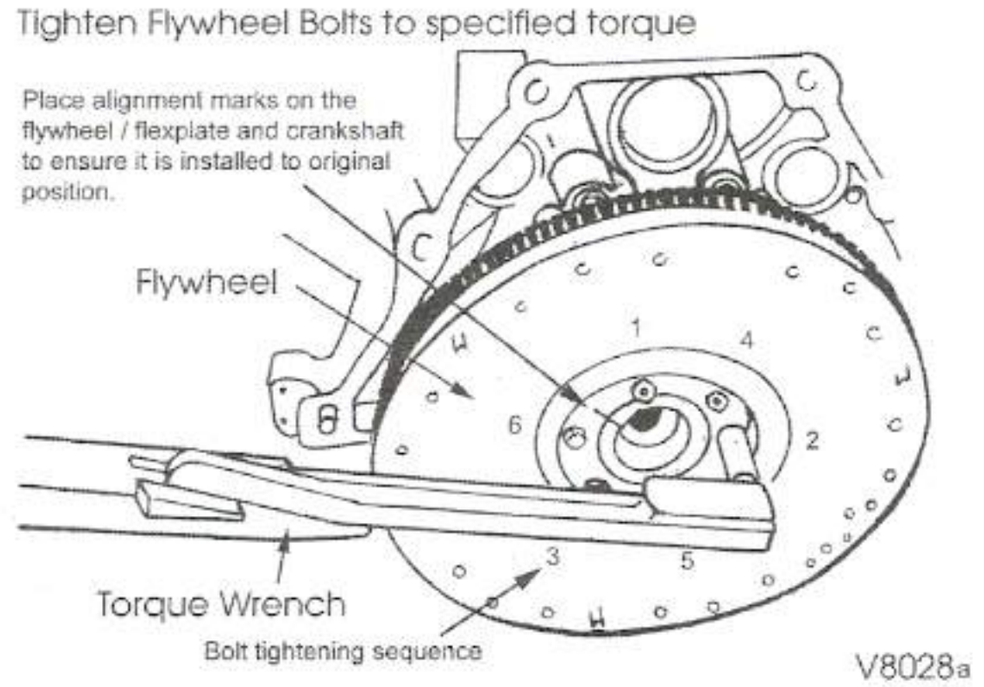
10. Remove special tool and install and torque spark plug.

Spark Plug Torque Specification: 20Nm

11. Install spark plug leads and battery earth lead.

12. Start engine and check for oil leaks and valve train noise.

FLYWHEEL/FLEXPLATE

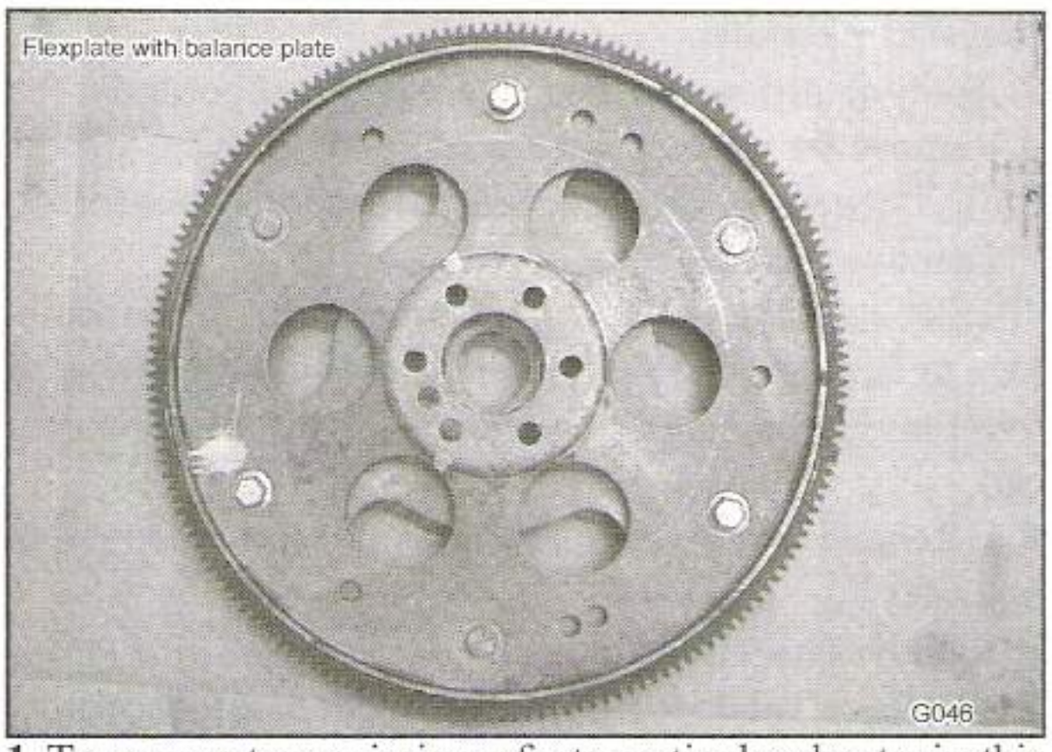


Remove

Before removal of flywheel/flexplate take note of the location of paint alignment marks on flywheel and pressure plate, before removing clutch pressure plate, the driveplate and torque converter make sure they have paint aligning marks.

Important: If not visible, scribe aligning marks on all parts, the flywheel is balanced and must be installed to correct position. If fitting a new flywheel, take note of balance weight position locations of old flywheel.

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1. To remove transmission refer to particular chapter in this manual.
2. Vehicles with manual transmission:
Remove the clutch pressure plate and driven plate as per "Clutch" section in this manual.
3. Block flywheel / flexplate from turning, using a screw-driver or suitable locking tool. Remove flywheel/flexplate crankshaft bolts and flywheel/flexplate.

Inspection.

The flywheel and flexplate are purposely out of balance and no attempt should be made to re-balance these as an individual unit.
1. Check flywheel/flexplate ring gear for badly worn, damaged or cracked teeth.
If needed, replace flywheel ring gear or driveplate, for details refer to **"ring gear"** section in this chapter.
Check starter motor pinion gear for damage, if ring gear teeth are damaged replace pinion gear, for details refer to **"Starting System chapter".**
2. Inspect crankshaft and flywheel/flexplate matching surfaces for burrs. Using a fine mill file remove burrs if present.

Install

1. Install flywheel/flexplate to crankshaft, and tighten new bolts to the correct specification and in correct sequence.
Note: The bolts will pull the flywheel/flexplate to crankshaft surface.

Flywheel / Flexplate Bolt Specification:

Step 1: Tighten firmly
Step 2: 50 Nm
Step 3: 100Nm

2. Mount a dial indicator on the rear of cylinder block for vehicles with automatic transmission. Inspect flexplate runout at the torque converter mounting bolt holes. Runout should not exceed the following specifications.

Flexplate Runout: 0.38 mm max.

Try to correct by tapping high side with a mallet if runout exceeds specification. Replace driveplate if this condition can not be corrected.
3. Inspect starter motor function.

RING GEAR

Replacement.

The ring gear is welded to the driveplate and is serviced only as an assembly for vehicles with automatic transmission. Therefore must be replaced as a complete unit.
For vehicles with manual transmission, the ring gear is a shrink fit on the flywheel flange, and if damaged, can be removed and replaced.

Replacement techniques are as follows:

1. To remove flywheel refer to FLYWHEEL/DRIVEPLATE section in this manual for details.
2. To remove ring gear drill a hole between two ring gear teeth and split gear at this point using a chisel.
3. Make sure that there are no foreign matter or burrs on new ring gear and flywheel matching surface. Remove burrs using a fine mill file (if present).
4. Heat and shrink a new gear in place as follows:
(a) Using an emery cloth, polish several spots on ring gear.
(b) Using a hot plate or a slow moving torch, heat ring gear until the polished spots turn blue (approximately 220 degrees Celsius).
* Heating the ring gear in excess of 427 degrees Celsius will destroy ring gear heat treatment.
(c) Quickly place ring gear in position against shoulder of flywheel using 2 pairs of pliers. Allow ring gear to cool slowly until it contracts and is firmly held in place.
5. Install flywheel, tighten bolt to specification.

Flywheel / Driveplate Bolt Specification:

Step 1: Tighten firmly
Step 2: 50 Nm
Step 3: 100Nm

SPIGOT BEARING and CRANKSHAFT REAR OIL GALLERY PLUG

Before removing clutch/pressure plate, take note of the position of the paint aligning marks on flywheel and pressure plate. If marks are not visible, scribe aligning marks on both parts.

Replacement.

1. To remove clutch pressure plate and driven plate as described in this manual.
2. To remove spigot bearing use a Slide hammer.
3. Check crankshaft rear oil gallery plug, if it damaged, leaking or loose, remove and tap home a new plug to depth specified.

Crankshaft Rear Oil Gallery Plug Depth:

31.2-31.6mm

Note: apply loctite 242 to the new plug as you install it.
3. Use a piloted screwdriver to replace spigot bearing. Place new bearing on pilot of tool with radius in bore of bearing next to shoulder on tool. Drive bearing into crankshaft to the dimension as shown in the diagram. Use thin film of SAE 90 gear oil to lubricate the bearing.
4. Install clutch assembly and transmission.

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ENGINE REBUILD.

ENGINE ASSEMBLY.

Remove

1. Depressurise the fuel system, remove fuel pump relay, idle engine until stops.
2. Disconnect battery leads
3. Remove bottom radiator hose from radiator to allow coolant to drain, and disconnect radiator hoses from engine.
4. Drain engine oil sump.
5. Using a felt tipped pen mark engine hood to hinge positions. Disconnect windshield washer hose. Disconnect hood gas struts. Remove hood hinge bolts and hood.
6. To remove cooling fan and radiator assembly refer to "Cooling systems" chapter section for details.
7. Disconnect heater supply and return hoses from engine heater pipe connections, including heater bypass pipe on the side of the block.
8. Disconnect main wiring harness from engine and battery harness.
9. Unclip engine harness, sensors and sender units.
10. To remove power steering pump (if applicable) refer to **Power Steering** section for details.
11. Disconnect air cleaner to air intake chamber tube.
12. Disconnect throttle cable from throttle linkage and mounting bracket.
13. Remove fuel supply and return lines from fuel rail and pressure regulator.
14. Disconnect emission control canister hoses from throttle body connections, and separate canister lines from fuel rail clips if a canister is fitted.
15. Disconnect brake booster hose from engine vacuum connections.
16. Fully raise vehicle and place on safety stands.
17. To remove tail shaft refer to "Propeller shafts and universal joints" chapter for details. Place a suitable plug in end of transmission.
18. Disconnect engine exhaust pipes from manifold assemblies.
19. To disconnect gear shift control from transmission refer to MANUAL TRANSMISSION or AUTOMATIC TRANSMISSION sections for details.
20. Disconnect clutch slave cylinder (for vehicles with manual transmission only) for details refer to CLUTCH section.
21. Disconnect speedo or wiring harness connector from speedometer sender at transmission.
Manual Transmission: Disconnect transmission harness from backup lamp switch.
Automatic Transmission: Disconnect transmission harness from solenoid.
22. Raise engine slightly to take weight off mounts by attaching an appropriate lifting hook and chain to engine lifting brackets if fitted. Care must be taken not to damage engine components with rope or chain while lifting engine.
23. Remove engine front mounting from mounting brackets.
24. Disconnect wiring harness connector from compressor clutch for vehicles with air conditioning.
25. Raise engine slightly and remove air compressor from engine mount bracket mounting bolts. Tie compressor back way from the engine.
26. Raise engine with front tilted upwards and a floor jack supporting rear of transmission assembly, make sure that engine exhaust manifolds, starter motor or transmission do not rest on steering gear.
* Do not allow engine to swing forward and damage air conditioning condenser (on vehicles with air conditioning condenser fitted at front) or optional transmission cooler.
27. Separate engine and transmission assemblies if necessary. Refer to MANUAL TRANSMISSION or AUTOMATIC TRANSMISSION for details.

Dismantle.

1. Mount engine assembly in an appropriate engine stand.
2. Remove the following parts:
a) Starter motor.
b) Drive belt to water pump, alternator etc.
c) Alternator and brackets.
3. Remove the following parts as previously described or about to be described, in this chapter.
a) Air intake chambers and intake manifold.
b) Rocker covers.
c) Exhaust manifold manifolds.
d) Oil filter.
e) Crankshaft balancer.
f) Timing chain cover.
Rotate the crankshaft clockwise (it may be necessary to temporally install the crankshaft balancer pulley bolt) so the crankshaft is at TDC/ compression on number 1 cylinder. Check that alignment mark on crankshaft sprocket and the camshaft gears are aligned, 2 dots facing each other, if not it may be necessary to rotate the crankshaft a further 360 degrees.
g) Timing chain, camshaft gear.
h) Cylinder head assemblies.
i) Engine sump.
j) Oil pump suction pipe and screen.
k) Flywheel/flexplate.
l) Engine rear bearing retainer plate.
m) Crankshaft,
n) Piston and connecting rod assemblies.

Assembly.

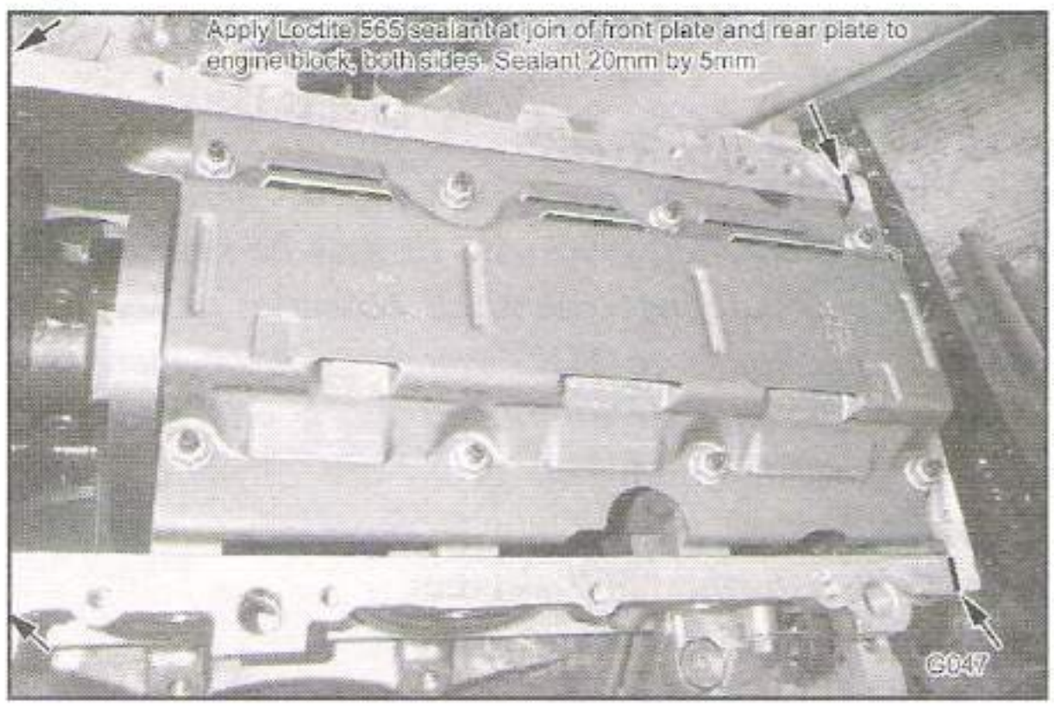
Assembly techniques for each part are outlined in this section under their particular headings.
1. Make sure that all bolts and nuts are tightened as specified.
2. Use specified engine lubricant and coolant when refilling.
3. Inspect transmission fluid level, add lubricant as required.
4. Inspect for fuel, coolant, oil and exhaust leaks. Repair as

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required.
5. Check engine hood alignment.

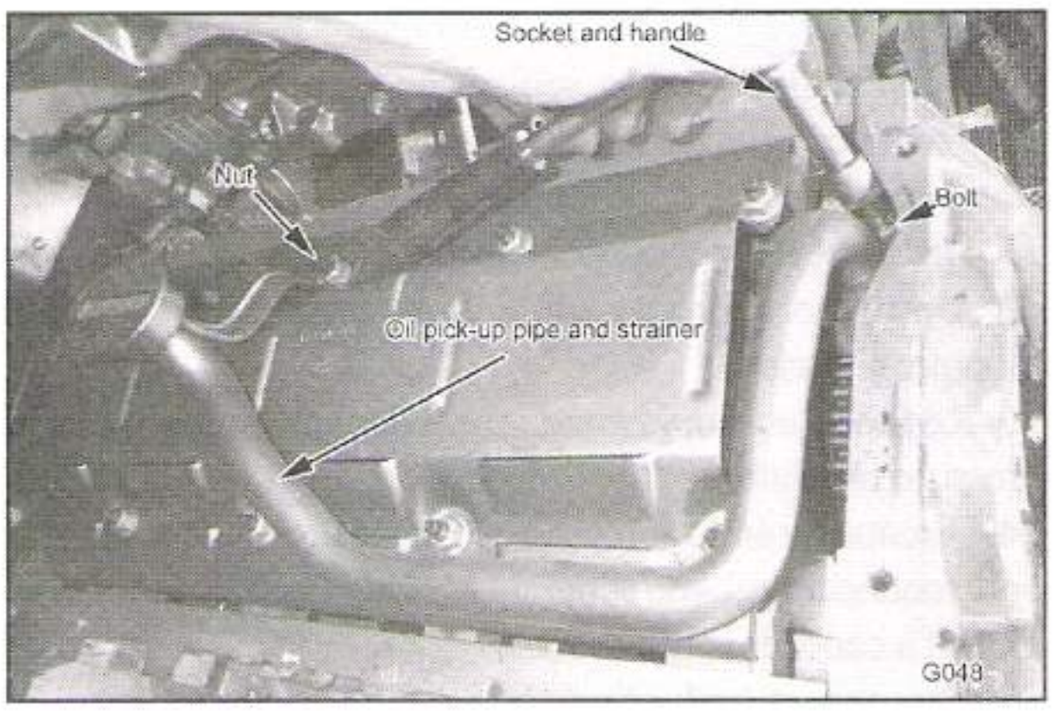
OIL PAN (SUMP) & GASKET.

Note: The oil pan incorporates the oil filter, oil baffle,
Remove
1. Drain oil from oil pan.
2. Remove the dip stick.
3. Remove the left and right rear cover plates, 1 bolt each.
4. Remove oil pan bolts, oil pan and gasket.
Note: Only replace gasket if necessary.
The gasket is riveted to the oil pan, it will be necessary to drill out gasket rivets, dispose of gasket. Cover any holes to stop drill shavings from entering holes.
When a new gasket if fitted it is not necessary to reinstall the rivets.
5. If necessary remove oil transfer pipes nuts and 1 bolt, remove oil transfer pipe.
6. Remove oil baffle , 6 bolts if necessary for washing.
Install
1. Install oil baffle if removed, 6 bolts.
Oil Baffle Bolts: 12Nm
1. Clean all matching surfaces of oil pan and cylinder block thoroughly.
2. Assembly oil transfer pipes if removed, apply loctit 242 to threads.
2. Apply sealant 20mm long and 5mm dia (Loctite 565) to the engine block at the front and rear as shown.



3. Install new gasket if necessary onto oil pan, aligning oil pan bolt holes with the holes in gasket.
4. Install oil pan and gasket to crankcase, and tighten as specified. The oil holes in the oil pan and engine block must be aligned with the gasket. Ensure the rear of the oil pan and engine block surfaces are aligned.
Install bolts to timing gear cover and rear cover first to help keep oil holes aligned.
Oil Pan (Sump) to Timing Gear Cover: 25Nm
Oil Pan (Sump) to Rear Covers: 12Nm
Check clearance of oil pan to engine block, if not as specified loosen bolts and try again.
Note: The oil pan must not protrude past the rear of the engine block.
Maximum oil pan to rear of engine block clearance: 0.25mm
Install remaining oil pan bolts.
Oil Pan (Sump) Bolt Specification: 12-16Nm
5. Make sure oil pan drain plug is tightened as specified, use a new drain plug seal.
Oil Pan (Sump) Drain Plug Specification: 25Nm
6. Replace dip stick.
Tip: Ensure oil filter is installed.
7. Refill oil pan with the correct amount of engine oil as specified.
Specified oil type: 10W-30 SJ GF2
Lubricant Quantity Specification:
With out new oil filter: 4.7 Litres
With new oil filter: 5.0 Litres
8. Start engine and inspect for oil leaks. Repair as required.
9. Stop engine and check oil level on dip stick.

OIL PUMP SUCTION PIPE AND SCREEN.

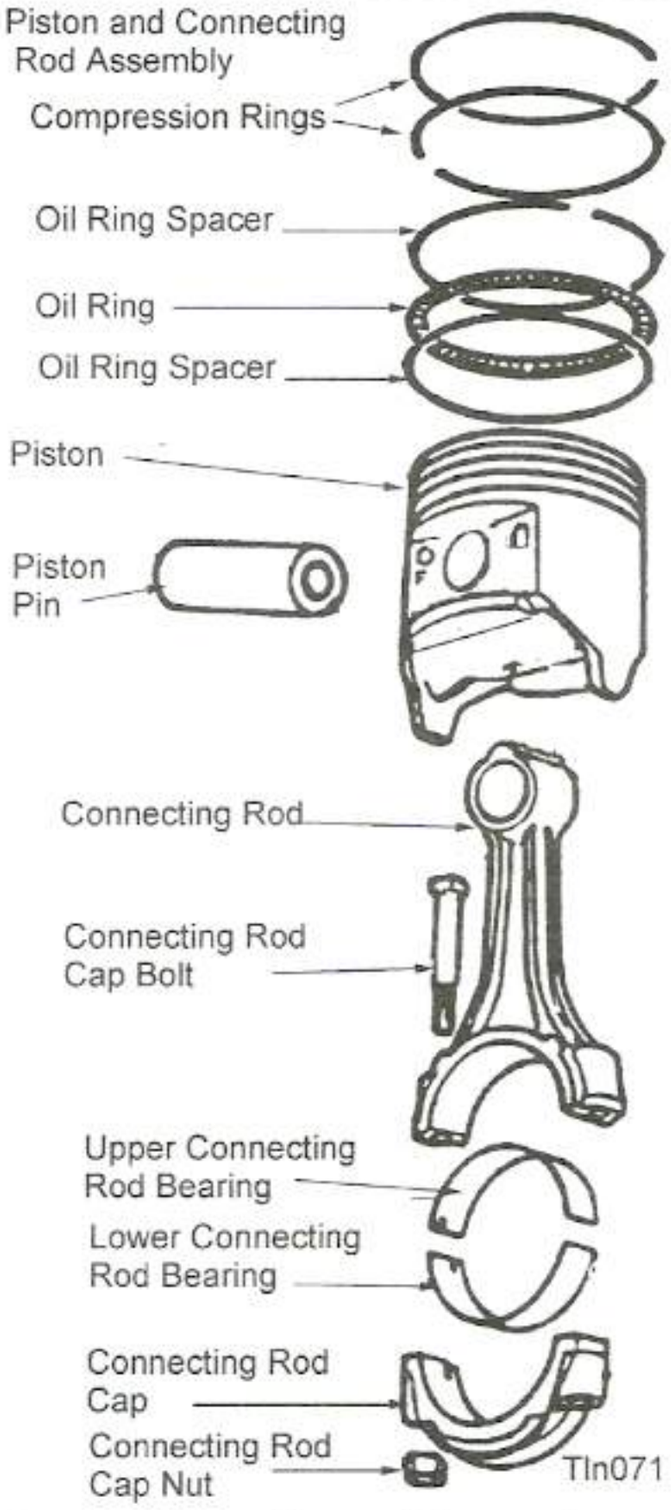


Remove
1. Drain oil from oil pan (Sump).
2. To remove oil pan (Sump) refer to "Oil pan (Sump)& Gasket" in this section.
3. Remove the 1 bolt, 1 nut securing suction pipe and oil strainer to the engine block.
Install
1. Make sure that the screen is cleaned of any foreign matter.
2. Clean suction pipe and oil pump cover surfaces.
3. Install the 1 bolt, 1 nut securing suction pipe and oil strainer to the engine block. Use a new "O" ring seal, install and tighten bolts as specified.
Oil Pick-up Tube and Screen Bolt: 12Nm
Oil Pick-up Tube and Screen Nut: 25Nm
4. Install oil pan and seal to crankcase as described, and tighten as specified.
Oil Pan (Sump) Bolt: 25Nm
5. Make sure oil pan drain plug is tightened as specified.
Oil Pan (Sump) Drain Plug Specification: 25Nm
6. Refill oil pan with the correct amount of engine oil as described in the **Oil Pan (Sump)** section.

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7. Start engine and inspect for oil leaks. Repair as required.
8. Stop engine and check oil level on dip stick.

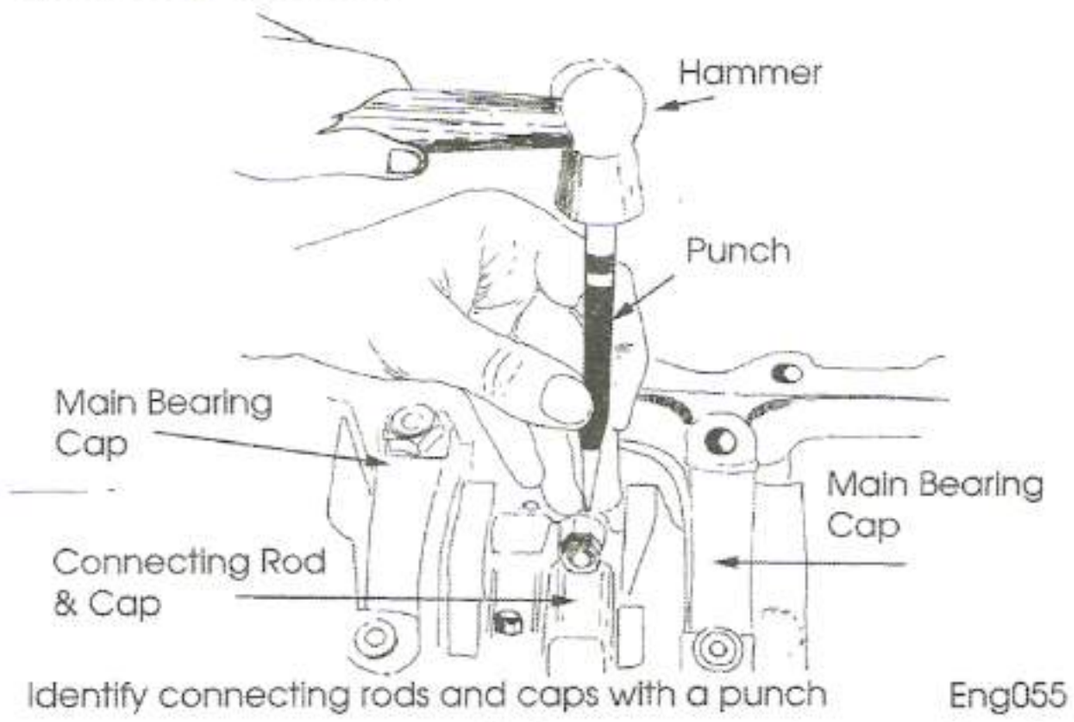
PISTON AND CONNECTING ROD ASSEMBLY.



Piston and connecting rod assemblies can be removed while the engine remains in the vehicle.
If the cylinder bore requires machining, remove the engine assembly as described in ENGINE ASSEMBLY section, remove piston and connecting rod, replace pistons and rings in oversize sets.
Piston and cylinder bore condition must be taken into consideration when fitting new pistons. Production and service pistons have the same nominal weight and can be intermixed without affecting engine balance. If needed, used pistons may be fitted selectively to any cylinder of the engine, providing they are in good condition.
Piston pin assemblies and ring sets are available in oversize.

Remove

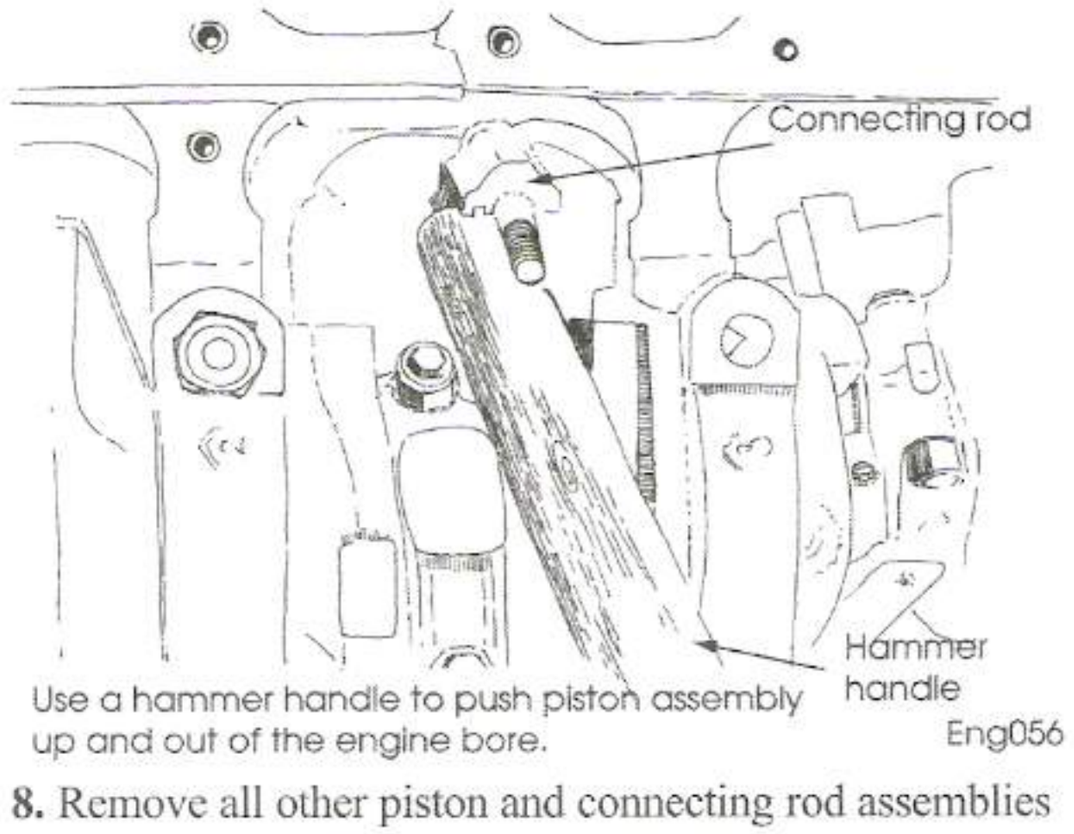
1. Disconnect battery negative terminal.
2. Remove cylinder heads as described in CYLINDER HEAD section.
3. To remove oil pan (sump) refer to OIL PAN (SUMP) section
4. Remove oil pump suction pipe and screen refer to OIL PUMP SUCTION PIPE AND SCREEN section.
5. Remove the oil splash guard, nuts attached to main bearing studs.
6. Inspect cylinder bores above piston ring travel. If bores are worn so that a ridge or similar exists.
Turn crankshaft so that piston is at bottom of stroke and cover piston with a cloth to collect cuttings.
Remove the ridge with a ridge remover, this is to be done for each cylinder.
6. Using a punch and hammer, an etching marker, felt tipped pen mark all connecting rods, caps and pistons to indicate cylinder identification.



Identify connecting rods and caps with a punch Eng055

Tip: It is not recommended to use a punch to mark side of connecting rod and cap as this could distort connecting rod or cap.

7. Remove rod assemblies and piston as follows,
(a) With connecting rod crankshaft journal straight down (Bottom Dead Centre), remove connecting rod cap bolts and remove cap with bearing shell.
(b) Push piston and connecting rod from cylinder using a long guide. Remove guides and install cap and bolts to connecting rod.



Use a hammer handle to push piston assembly up and out of the engine bore. Eng056

8. Remove all other piston and connecting rod assemblies using the same procedure.

Dismantle.

1. Expand and slide piston rings off to remove and dispose of them.
* Worn rings may have sharp edges ensure to take care when removing piston rings.
2. Piston pin can now be removed as follows:

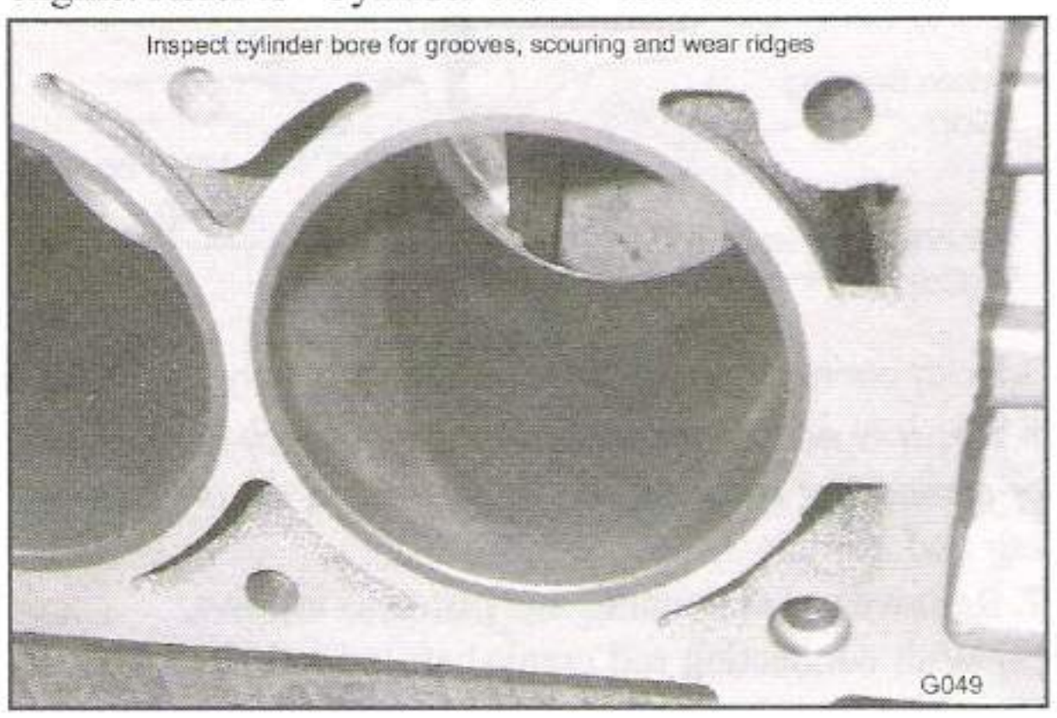
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a) Remove the piston pin retaining "C" clip.
b) Push or press the piston pin from the piston and connecting rod assembly.

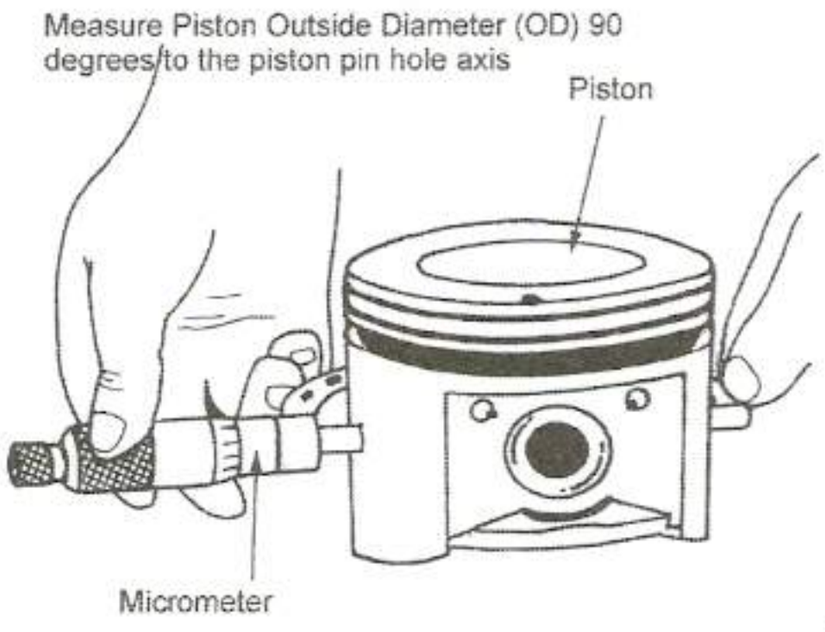
Inspection.

1. Thoroughly clean carbon from piston heads and from ring grooves using a suitable tool (old piston ring) and remove any gum or varnish from piston skirts using a suitable cleaning solvent.

2. Check cylinder walls for ridges, roughness, grooves or scoring which indicates excessive wear. Inspect cylinder bores for taper and possible out-of-round using an accurate cylinder measuring gauge at top, middle and bottom of the bore, both parallel and at right angles to the centreline of engine. Refer to "Cylinder block" section for details.



3. Examine piston skirt thoroughly for scored or rough surfaces, cracks in skirt or crown of piston, chipping, broken ring lands or uneven piston wear which would cause rings to seat improperly or have excessive clearance in piston ring grooves. Pistons must be replaced if faulty or damaged.
Pistons are cam ground, which means the diameter at right angles to the piston pin is greater than the diameter parallel to the piston pin. When a piston is checked for size, it must be done at points 90° to the piston pin bore. (Measure *11mm up from base of skirt)*



Piston Size Standard: 98.964-98.982mm
Maximum Variation: 0.018 mm
Oversize (0.25 mm) pistons are available.

4. Check piston pin bores and piston pins for wear. Piston pins and piston pin bores must be free of scuffing or varnish when being measured. Use a micrometer to measure the piston pin, and a dial bore gauge or an inside micrometer to measure piston pin bore.
Piston and pin should be replaced if not as specified.

Piston Pin Clearance
: in Piston 0.010-0.020mm
: in Connecting Rod 0.020-0.043mm

5. Remove bearing shells from connecting rod, install cap and bolts. Tighten bolts as specified.

6. Place connecting rod assembly on a checking fixture and inspect rod for twist or bend.
Replace if twisted or bent, do not attempt to straighten rod. Inspect new connecting rods by the same procedure before using them.

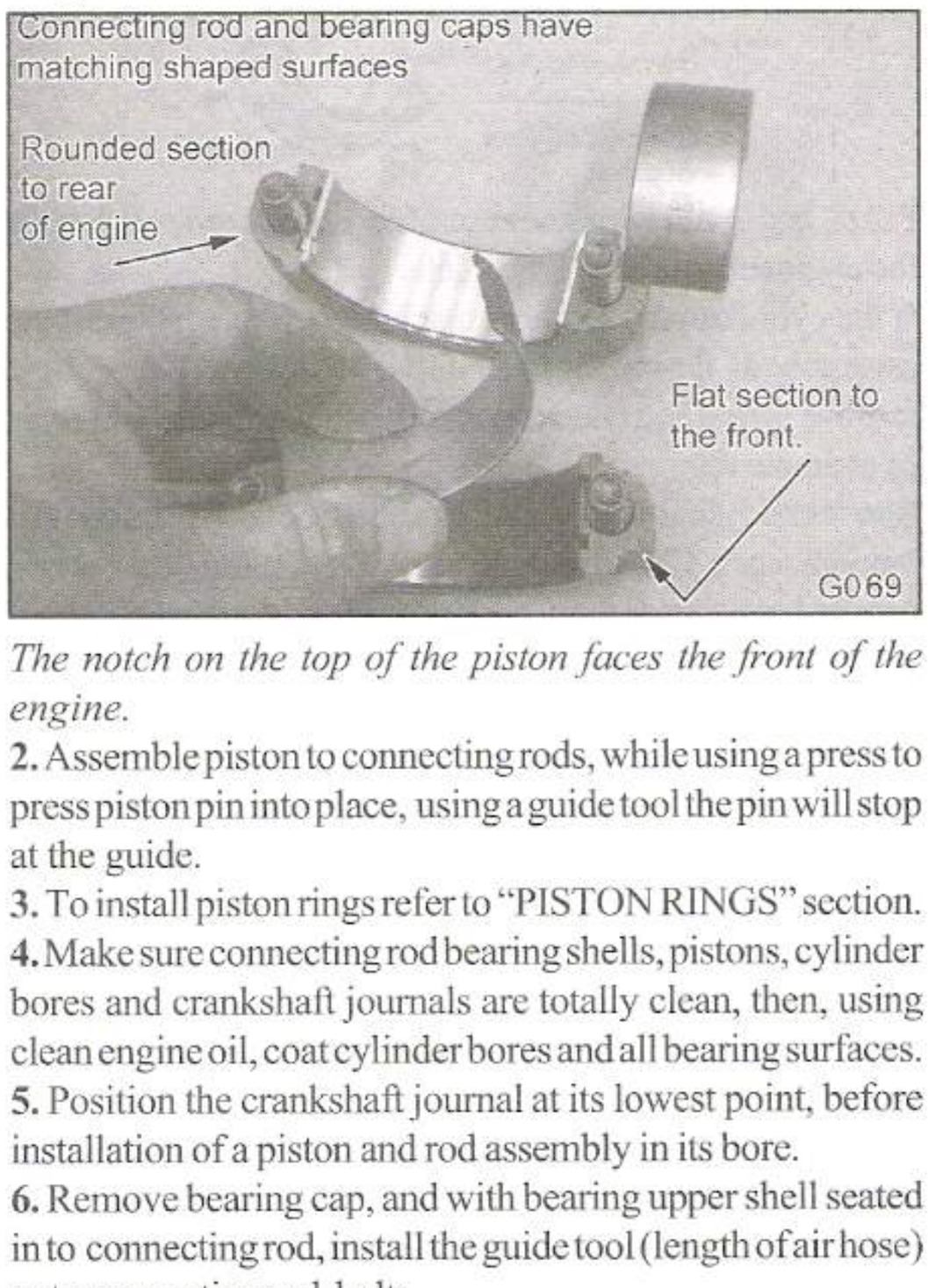
Connecting Rod Alignment Max. Specification
Bend: 0.020mm
Twist: 0.010

7. Check outside of connecting rod bearing shells and internal diameter of the connecting rod big end for wear, indicating high spots in rod big end.

8. Remove cap bolts and measure bolts for stretching by comparing them with a new bolt, if stretched, replace.

Assembly and Installation.

1. Using engine oil, lubricate piston pin and piston pin bore.
Tip: The connecting rod flat surface near bolts faces to the front.



The notch on the top of the piston faces the front of the engine.

2. Assemble piston to connecting rods, while using a press to press piston pin into place, using a guide tool the pin will stop at the guide.

3. To install piston rings refer to "PISTON RINGS" section.

4. Make sure connecting rod bearing shells, pistons, cylinder bores and crankshaft journals are totally clean, then, using clean engine oil, coat cylinder bores and all bearing surfaces.

5. Position the crankshaft journal at its lowest point, before installation of a piston and rod assembly in its bore.

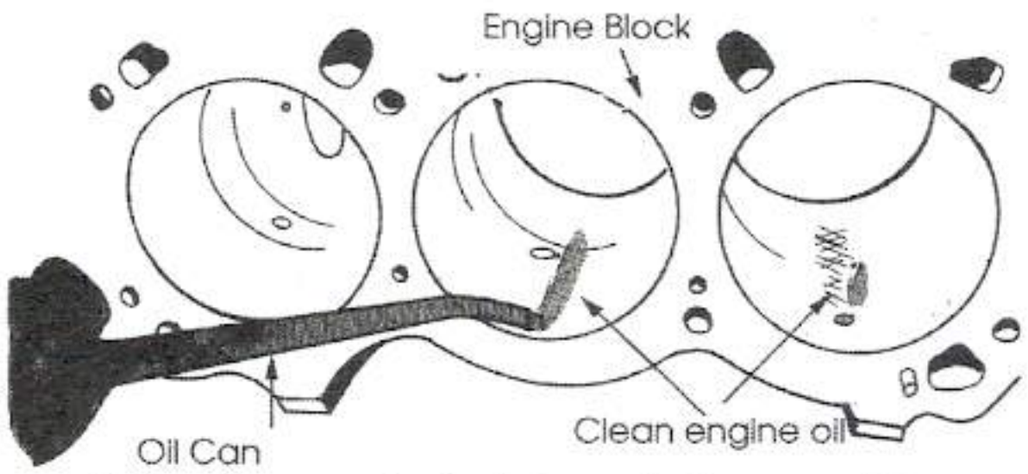
6. Remove bearing cap, and with bearing upper shell seated in to connecting rod, install the guide tool (length of air hose) onto connecting rod bolts.

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Guides hold upper bearing shell in position and protect crankshaft journal from damage during the installation of connecting rod and piston assembly.

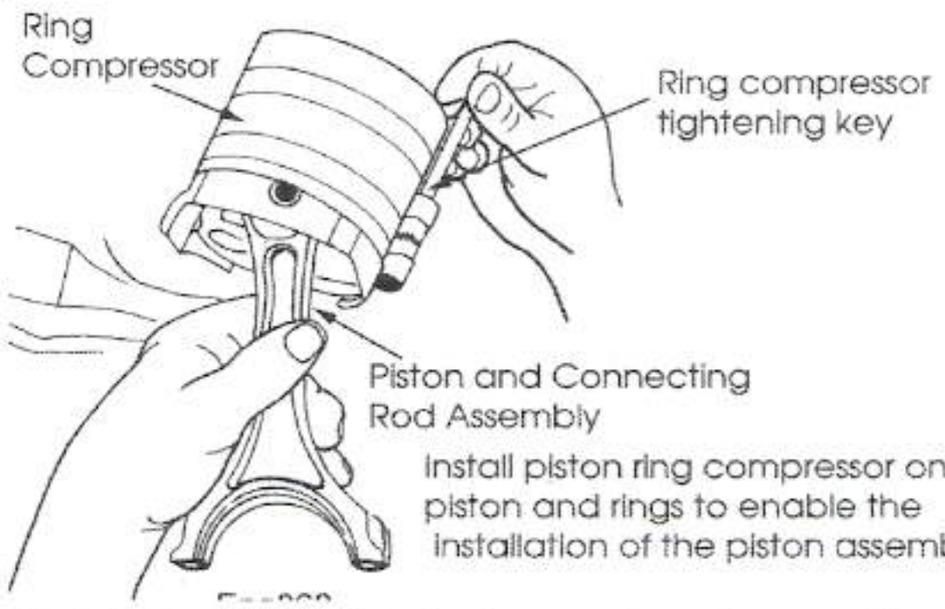
Note: *Check piston casting lug is to front of engine.*

7. Make sure piston ring gaps are separated as described in PISTON RINGS section.

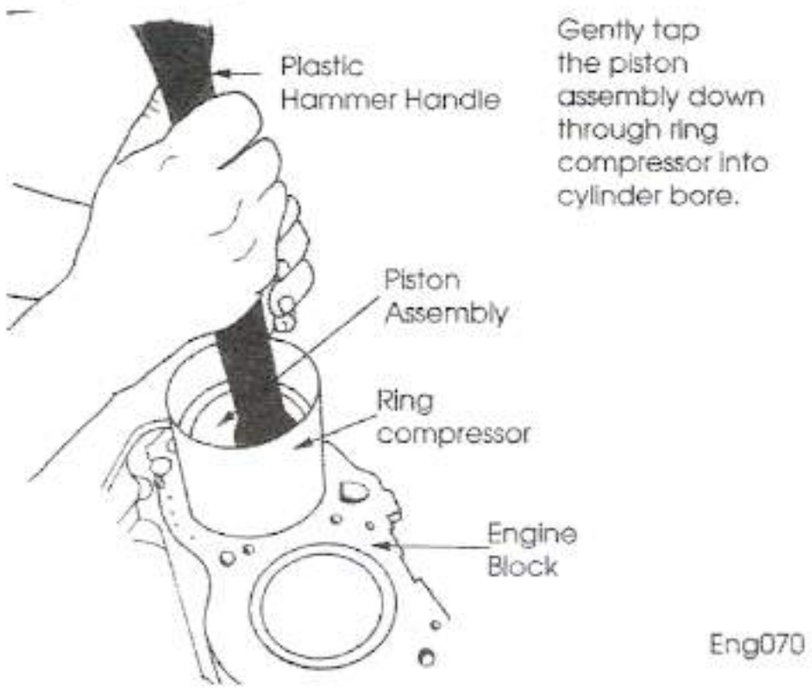


Oil the pistons and cylinder bores before assembly Eng057

8. Using clean engine oil, lubricate piston and rings and cylinder bores. With a suitable ring compressor, compress rings. Install each piston and connecting rod assembly into its cylinder bore.



9. Lightly tap piston into its bore, using a hammer handle, while holding ring compressor firmly against cylinder block until all piston rings have entered bore.



10. Push the piston down bore until connecting rod seats against the crankshaft journal.

11. Remove connecting rod guides. Install bearing cap and lower bearing shell assembly. Install cap bolts and tighten and then loosen one full turn. Then tighten again as specified.

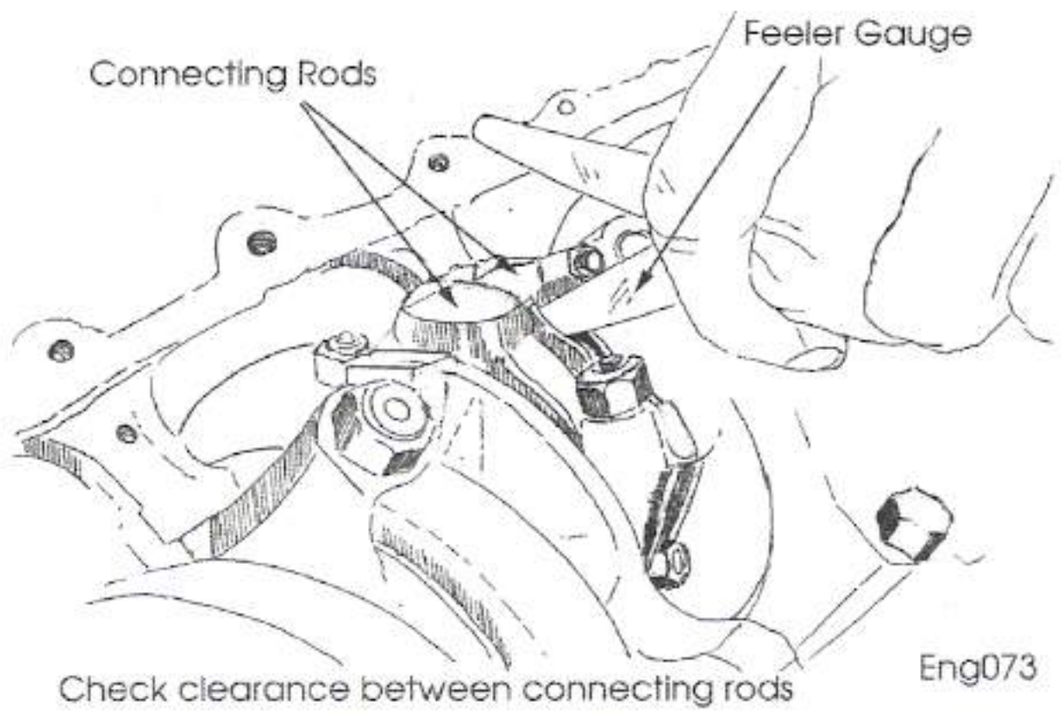
Connecting Rod Cap Bolt Specification:

Step 1: 20Nm.

Step 2: Plus 60⁰ Turn

12. Turn crankshaft to make sure crankshaft and connecting rod can move freely. If crankshaft binds, check bearing cap to rod orientation again and bearing clearance or connecting rod alignment.

13. Measure side clearance between crankshaft journal and connecting rod.



Check clearance between connecting rods Eng073

Connecting Rod to Crankshaft End Clearance:

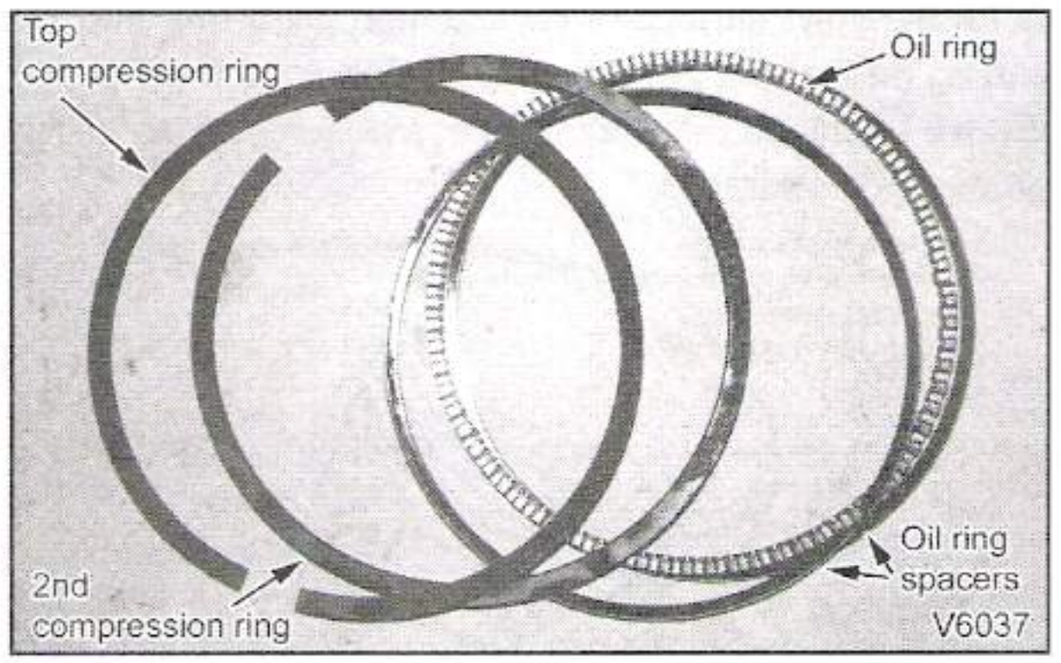
0.11-0.51mm

If side clearance is not as specified, to check bearing clearance refer to CONNECTING ROD BEARING section, or connecting rod alignment.

14. Install remaining piston and connecting rod assemblies using the same procedure.

PISTON RINGS.

Install



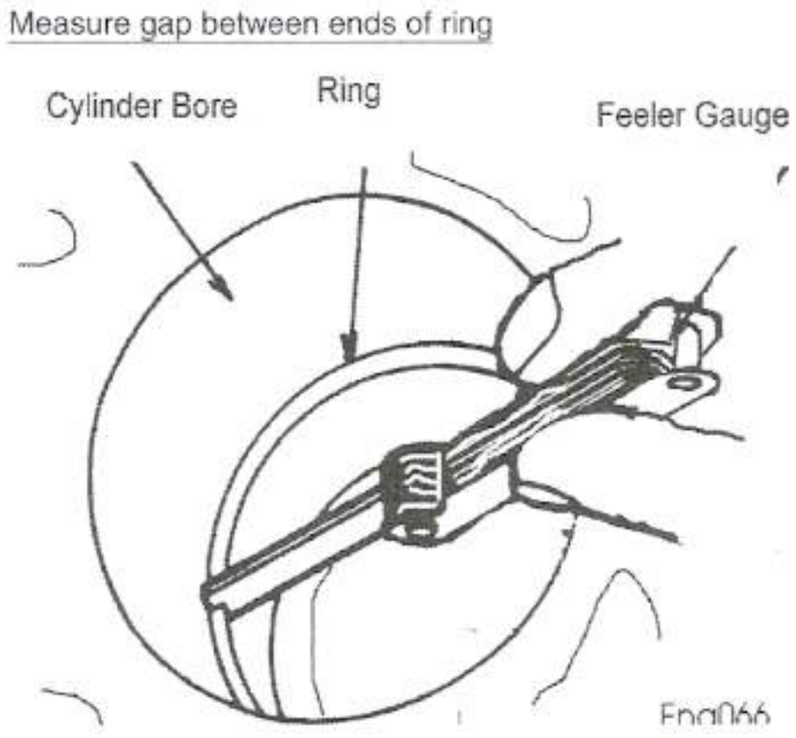
* The pistons have three ring grooves (two compression rings and one oil ring set). The top compression ring is a molybdenum filled, balanced section and barrel lapped type. The second ring is an inverted torsional taper faced type. The oil ring set consists of three pieces, comprising two segments and a spacer.

1. Measure the end gap of the rings to be installed. Install the ring in relevant cylinder bore, then use the head of a piston, press ring down evenly into the bore.

* By using the piston as above, the ring will be square with cylinder wall.

* Ensure not to distort the ring during this operation, as it could brake or it may bind in the piston ring groove after the engine

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is assembled. Measure each ring separately in the cylinder in which it is going to be installed.

2. Using a feeler gauge, measure gap between ends of ring.

Top Compression Ring End Gap Specification:
0.230-0.380mm

Remove ring and try another, if the gap between the ends of a compression ring is below specification. The ring gap may be enlarged by filing.

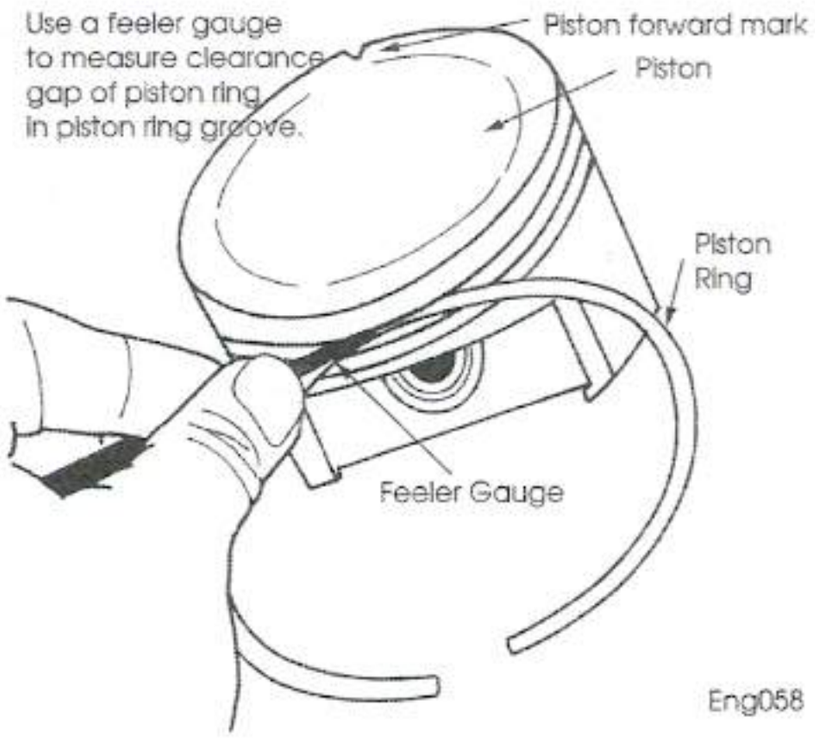
Second Compression Ring End Gap Specification:
0.440-0.640mm

3. Inspect gap between ends of each oil control ring segment.

Oil Ring Steel Rail Gap Specification:
0.180-0.690mm

4. Carefully remove all traces of carbon from ring grooves in piston and check grooves for any chips or burrs that might cause ring to bind when fitting.

5. Fit the outer surface of each compression ring into the correct piston ring groove and roll ring around the piston groove to ensure that ring is free. Measure ring to piston groove side clearance.



Piston Ring Side Clearance:

Top Ring:	**0.040-0.085mm**
Second Ring:	**0.040-0.080mm**
Oil Ring:	**0.010-0.220mm**

Try another ring if it is too tight. If no ring can be found that fits the specification, the ring may be ground to size using emery paper placed on a piece of glass.

If using a new piston, try another piston.

* High spots in the ring groove may be cleaned up with careful use of a fine file, do not try to cut the piston ring groove.

6. Install oil ring spacer into the bottom piston ring groove.

* The ends of the oil ring spacer butt against each other.

7. Install one steel ring from top of piston down into oil ring groove and install remaining steel ring from bottom of piston up into the oil ring groove.

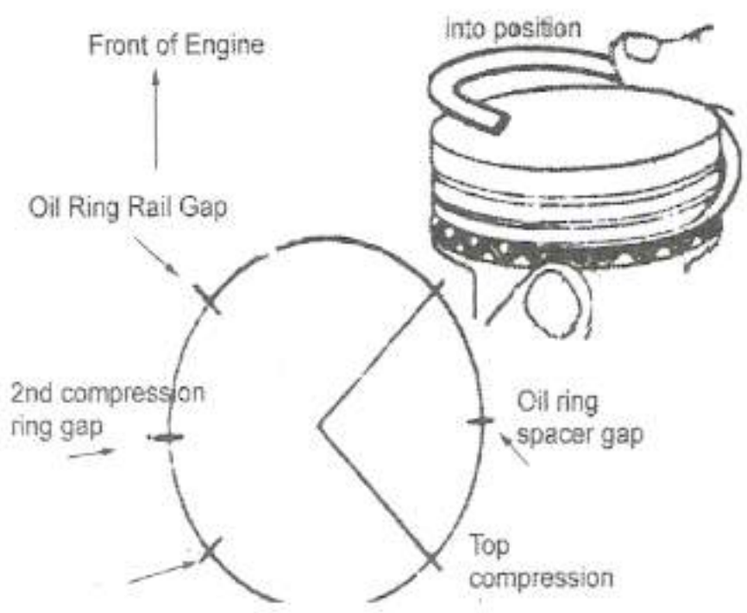
8. Install compression rings in second and first ring grooves of each piston.

* Make sure the correct compression ring are installed in the first and second grooves, and the correct way up.

Top ring: either way upwards.

2nd ring: has a dot, this must face upwards.

9. Do a final test of ring fit in piston grooves. Separate ends as illustrated.



* Do not install piston with ring gaps in line, as this will allow blow by at this point.

CONNECTING ROD BEARINGS

Each connecting rod bearing consists of 2 bearing halves or shells which are interchangeable in the rod and cap.

When the shells are in place, the ends extend slightly beyond the parting surfaces of the rod and cap. When the rod bolts are tightened, the shells are tightly clamped in place to ensure positive seating and to prevent rotation.

The connecting rod bearings are of the precision insert type and do not use shims for adjustment. The ends of the bearing shells must never be filed flush with parting surface of rod or cap.

Inspection and Replacement.

Connecting rod bearings can be replaced without removing the rod and piston assembly from the engine.

1. Disconnect battery earth lead and remove spark plugs.

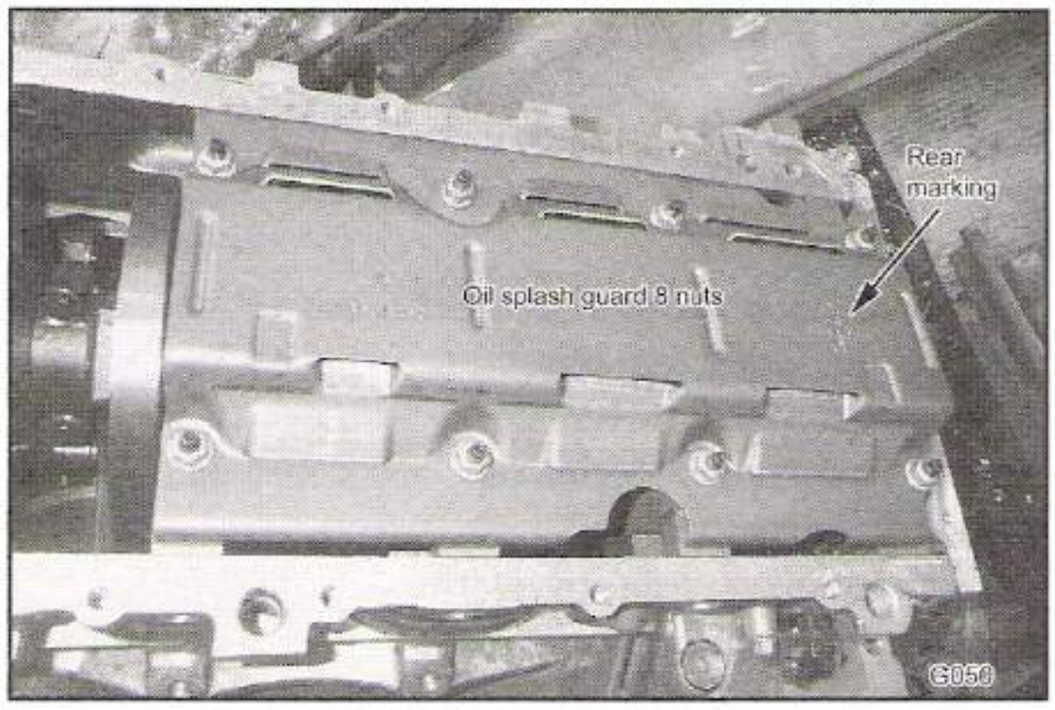
2. To remove oil pan (Sump) refer to OIL PAN (SUMP) AND SEAL section for details.

3. To remove oil pump suction pipe and screen refer to OIL PUMP SUCTION PIPE AND SCREEN section.

4. Remove oil splash guard.

5. Check connecting rod thrust clearance on each journal, if not within specification, replace with new connecting rod.

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Check clearance specification again if not within specification, replace crankshaft.

Connecting Rod to crankshaft end clearance:
0.11-0.51mm

6. Using a punch and hammer, an etching marker or felt tipped pen, mark connecting rods and caps to indicate cylinder number and an arrow pointing towards the front of the engine.

Tip: It is not recommended to use a punch to mark side of connecting rod and cap as this could distort connecting rod or cap.

7. Remove connecting rod cap securing nuts and remove cap and lower bearing shell, the lower shell may still be on the journal.

8. Push piston and connecting rod up cylinder bore, use a hammer handle or similar to avoid damaging the bearing shell or crankshaft journal. The connecting rod will then be free from crankshaft journal. Remove bearing shell from connecting rod.

9. Clean crankshaft journal and measure for out of round or taper using a micrometer. Replace crankshaft, if not as specified in CRANKSHAFT section.

Connecting Rod Journal: **53.318-53.338 mm**
Minimum used: **53.308 mm**
Out of round: **0.005 mm max, used max: 0.01mm**
Taper: **0.008 mm max, used max: 0.01mm**

10. Clean the bearing shell inner and outer surfaces of oil.

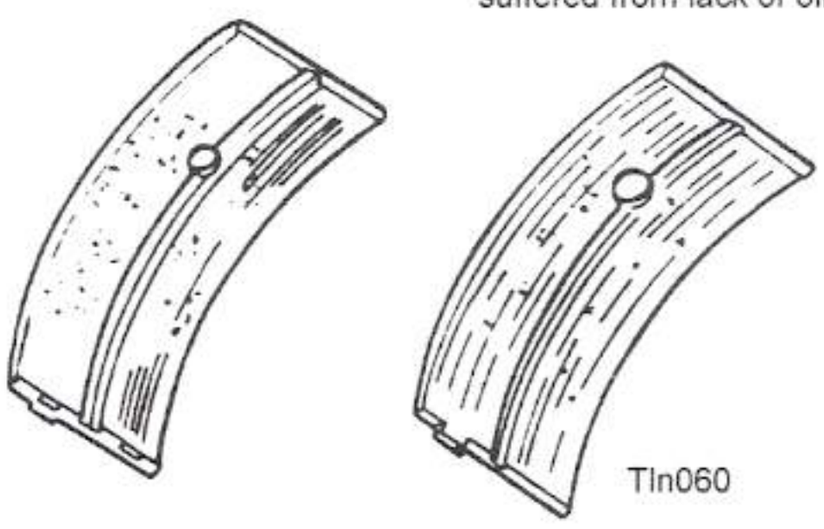
11. Inspect inner surface of bearing shells for gouges, wear or embedded foreign matter.

If particles are found, determine its nature and source.

Check bearing shells for sign of wear

Effects of tappered journal

This bearing has suffered from lack of oil



Inspect outer surface of bearing shell for surface wear (indicates movement of shell in cap or high spot in surrounding material), looseness or turning (flattened tangs and wear grooves in shell), or overheating (discoloration of shell either side).

The crankshaft may be bent or have tapered bearing journals if uneven side to side wear is found. If necessary, remove crankshaft, refer to "Crankshaft" section and inspect crankshaft.

* Bearing failure, other than normal wear, should be examined carefully to determine cause.

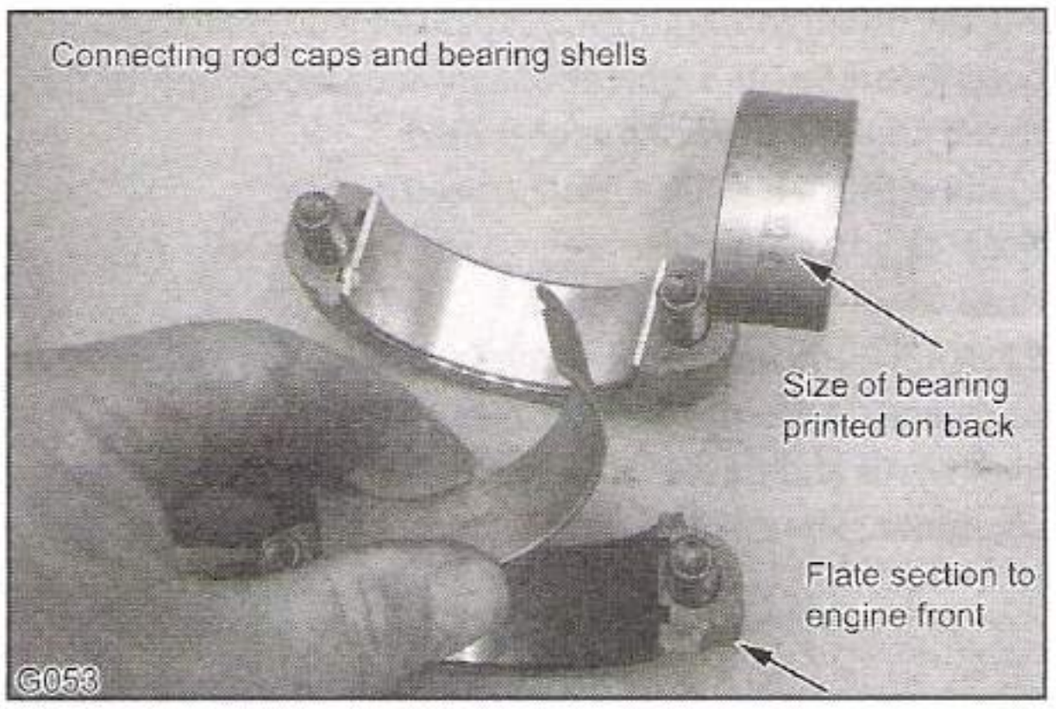
12. Install bearing shells in original positions in connecting rod and cap if inspection reveals that crankshaft is OK.

13. Push connecting rod down onto crankshaft to allow the upper bearing to be seated against crankshaft journal.

14. Place a section of plastigage across the width of bearing journal, parallel to crankshaft centreline.

Tip: Make sure plastigage is not placed across the oil hole in journal.

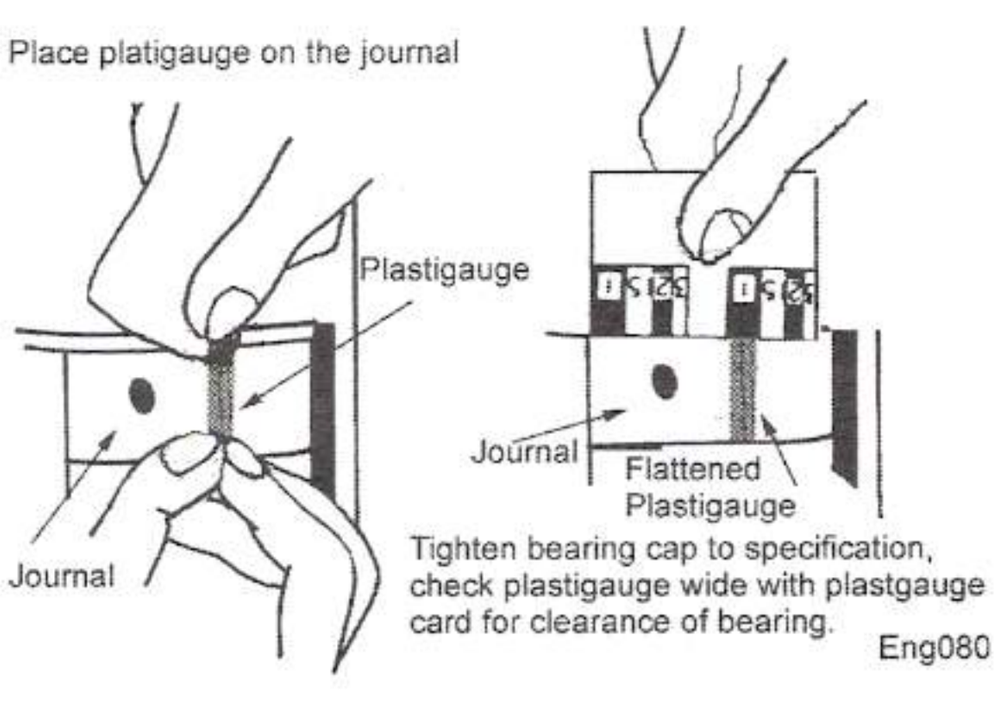
15. Install connecting rod caps to their original position as described in step 6. Flate surface to front of engine. Tighten bolts as specified.



* Make sure that crankshaft does not rotate with plastigage installed.

Connecting Rod Cap Bolt Specification:
Step 1: **20Nm.**
Step 2: **Plus 60⁰ Turn**

16. Remove the connecting rod cap bolts, and cap. Inspect the flattened plastigage it will stick to either the crankshaft or



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bearing shell in cap.

17. Comparing width of flattened plastigage at widest point with graduation on plastigage envelope, to determine the bearing clearance. The number on the graduation scale of the envelope indicates the clearance.

Clearance between connecting rod bearings and crankshaft must not exceed specification.

Connecting Rod Bearing Clearance: 0.015-0.076mm

18. Make sure that connecting rod cap bolt threads and connecting rod threads are clean. Apply some new engine oil to the cap bolt threads.

* Before final installation of cap bolts, determine if bolts have stretched by measuring, then comparing with a new bolt. Replace bolt/s if necessary.

19. Install bearing shells in connecting rod and cap making sure notches in the shells match up with the recesses in connecting rod and cap.

Inspect clearance of new bearing using plastigage as previously described.

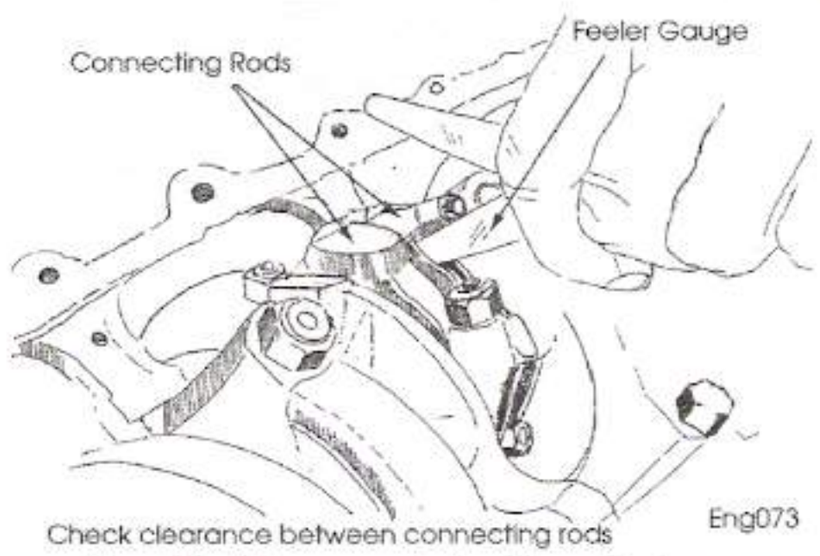
20. Remove all remains of plastigage from journal and shells after measuring. Using clean engine oil to lubricate bearing shells and journal. Arrow points towards the front of the engine. Install connecting rod caps to their original position as described in step 6. Tighten bolts and then loosen one full turn. Finally tighten cap bolts as specified.

Connecting Rod Cap Bolt Specification:

Step 1: 20Nm.

Step 2: Plus 60⁰ Turn

21. After the bearing shells have been installed and cap bolts tightened, it should be possible to slide connecting rod backwards and forwards on crankshaft journal to allow end clearance. The crankshaft must turn without binding.



Connecting Rod to crankshaft end clearance: 0.11-0.51mm

If connecting rod binds on the crankshaft journal, loosen and retighten the bearing cap bolts.

If connecting rod still cannot be moved or crankshaft binds, inspect bearing cap is installed correctly, bearing clearance or connecting rod alignment.

22. Install oil pump suction pipe and screen as described.

23. Install the engine sump with new gasket and sealant.

CRANKSHAFT.

Remove

* To check bearing clearance before removing crankshaft from crankcase refer to "connecting rod bearings" and "main bearings" section.

1. When engine is removed from vehicle and mounted on an engine stand, remove oil sump.

2. Remove flywheel/driveplate.

3. Remove oil pump suction pipe and screen and remove crankshaft balancer refer.

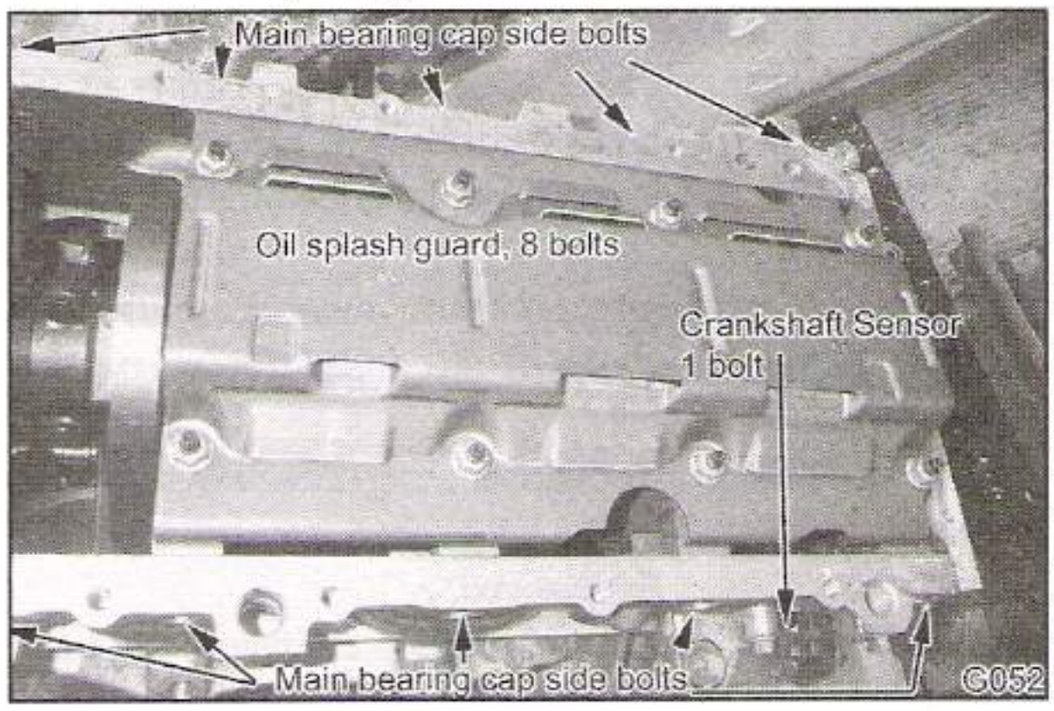
4. Remove timing chain cover.

5. Remove crankshaft sprocket.

6. Remove spark plugs.

7. Remove crankshaft sensor, located near rear of block, right side, 1 bolt.

8. Remove oil splash guard, 8 bolts



9. All main bearing caps are numbered, (1 to 4 on one side while rear bearing cap number on opposite side) if the engine has been rebuilt and numbers are not in sequence. Using a punch and hammer or an etching marker or felt tipped pen to mark connecting rod caps to indicate cylinder number and arrow to point towards front of engine.

Tip: It is not recommended to use a punch to mark side of connecting rod and cap as this could distort connecting rod or cap.

10. Remove connecting rod caps and nuts and push the connecting rods away from crankshaft.

11. Using a punch and hammer or an etching marker or felt tipped pen to mark main bearing caps, place an arrow to point towards front of engine.

12. Remove main bearing cap bolts, 6 bolts per main bearing cap (2 on side of block) and main bearing caps.

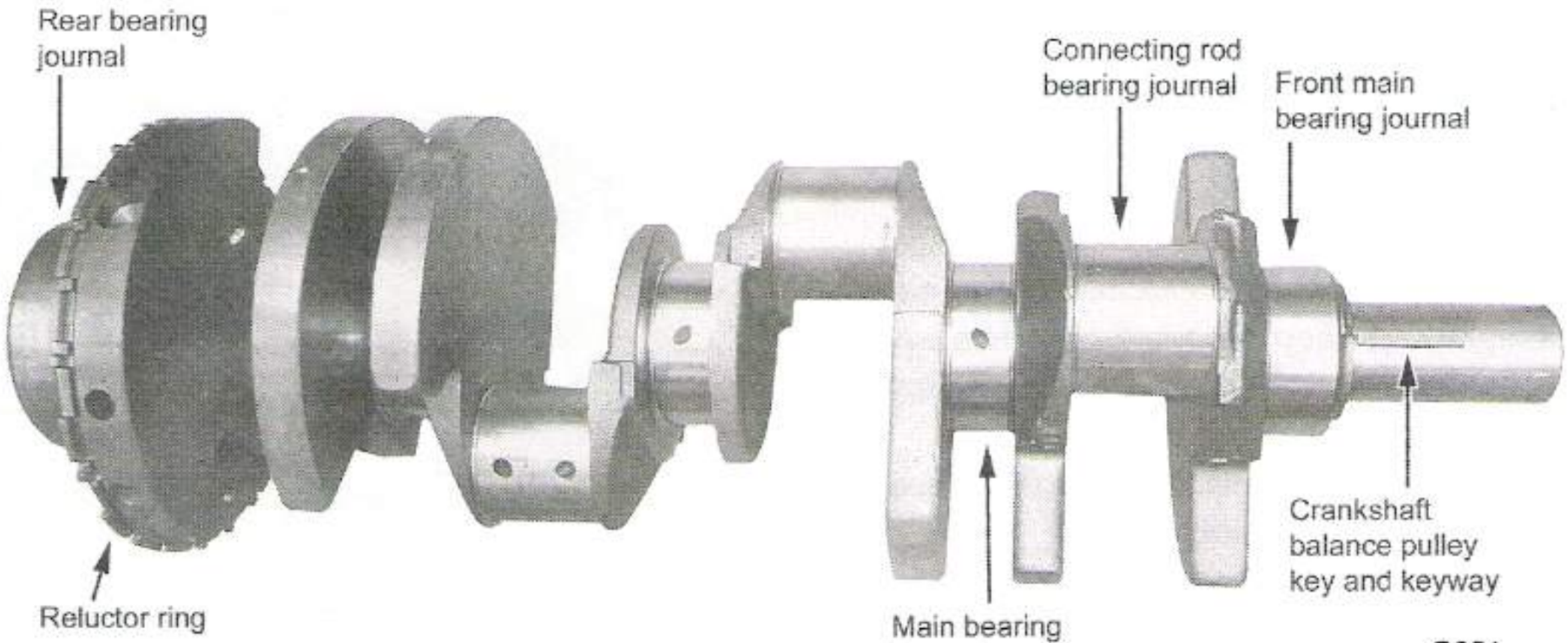
Tip: There is a tool, straight plate bolted with 2 bolts to the 2 center bolt holes with a slide hammer available to remove caps.

13. Lift crankshaft from cylinder block.

Note: The crankshaft has a reluctor ring near the rear main bearing, place the crankshaft between blocks to make sure the reluctor ring is not damaged.

14. Remove key from front end of crankshaft, if needed, using a suitable punch and hammer.

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Clean and Inspection.

1. Using a suitable cleaning solvent, pressure wash crankshaft and dry with compressed air.

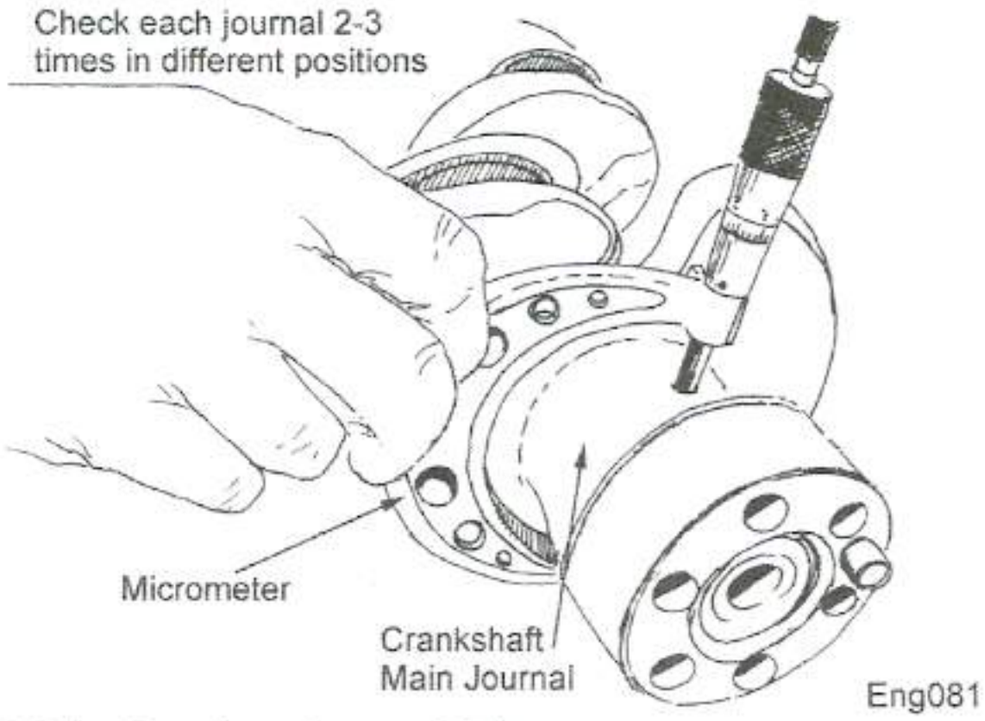
2. Check crankshaft oil passages for obstructions.

3. Check all bearing journals and thrust surfaces for: gouges, overheating (discoloration), cracks, grooving, chips and roughness.

The crankshaft must be machined or replaced if it has any burned spots, cracks or sever gouging. Slight roughness may be removed using a fine polishing cloth soaked in clean engine oil. Burrs may also be removed using a fine oil stone.

4. Check connecting rod and main bearing shells as described for embedded foreign material, then try to determine its source.

5. Using a micrometer measure bearing journals for taper, excessive wear or out-of-round.



Main Bearing Journal Diameter

Standard Size: 64.993-65.007mm

Taper: 0.010mm used: 0.020mm max.

Out-Of-Round: 0.003mm used: 0.008mm max.

Connecting Rod Journal: 53.318-53.338 mm

Minimum used: 53.308 mm

Out of round: 0.005 mm max, used max: 0.01mm

Taper: 0.008 mm max, used max: 0.01mm

6. Place a dial gauge indicator at the end of the crankshaft, on the rear flange to inspect rear flange runout. Make sure that crankshaft is thrust forward against a block of wood or on the "V" blocks so there is no possible movement of the crankshaft affecting dial gauge reading.

Crankshaft Rear Flange Runout: 0.05mm

7. Place a dial gauge indicator at the reluctor ring, 1.0 mm below the tooth diameter. Make sure that crankshaft is thrust forward against a block of wood or on the "V" blocks so there is no possible movement of the crankshaft affecting dial gauge reading.

Crankshaft Reluctor Ring Runout: 0.250mm

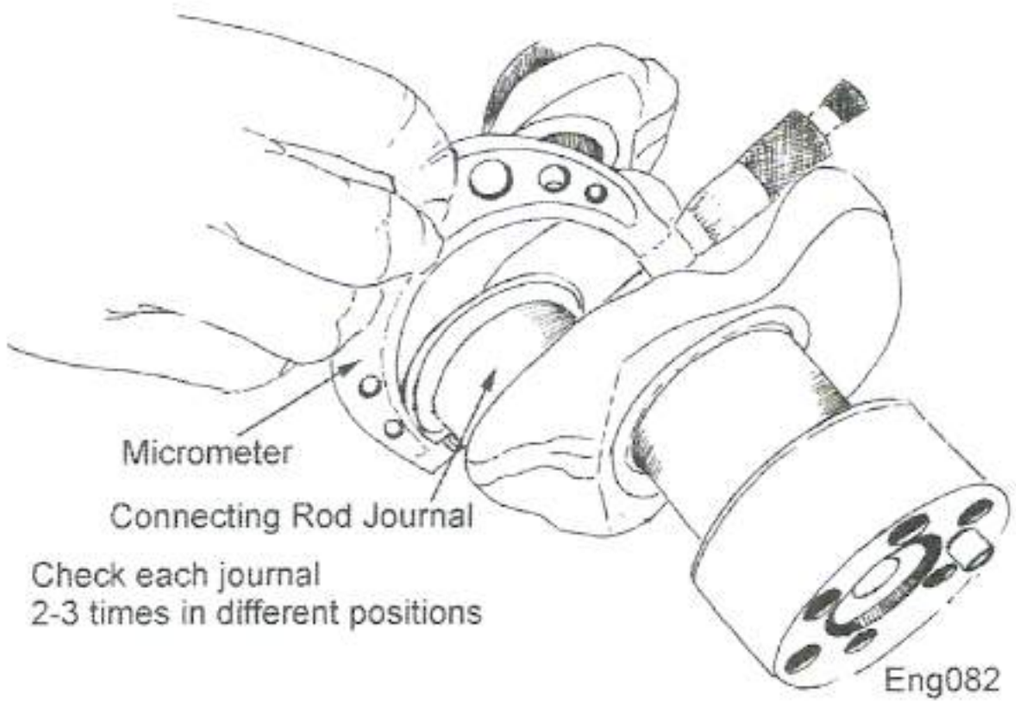
8. If not as specified, replace crankshaft.

9. Ensure all traces of sealant are cleaned from rear main bearing cap and crankcase.

10. Check crankshaft rear oil gallery plug, if it damaged, leaking or loose, remove and tap home a new plug to depth specified.

Crankshaft Rear Oil Gallery Plug Depth: 31.2-31.6mm

Note: apply loctite 242 to the new plug as you install it.



MAIN BEARINGS.

Crankshaft main bearing journals have 2 bearing halves (shells) which are not the same and not interchangeable in the bearing cap or engine block. The upper (engine block) shell is grooved to supply oil to the bearing, while the lower (into bearing cradle) shell is not grooved. The No3 bearing shells

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must not be interchanged, the No.3. bearing has flanges to take end thrust.

The main bearings are of the precision insert type and do not require reaming to size or utilize shims for adjustment.

Standard size and 0.0254mm undersize main bearing shells are available.

When shells are fitted in engine block and bearing cap, the ends extend slightly past the parting surfaces, when cap bolts are tightened the shells clamp tightly into place, ensuring firm seating and to prevent the bearing from turning.

The ends of the bearing shells must never be filed flush with surfaces of engine block or bearing caps.

Bearing Inspection.

1. Check lower bearing shells and crankshaft journals. If the journal surface is ridged or heavily scored, replace crankshaft.

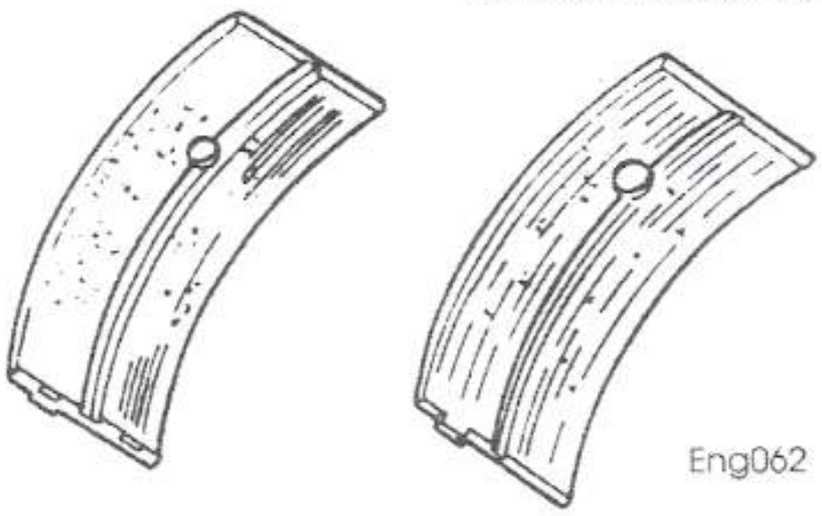
Tip: It is wise to new bearing shells when an engine is pulled down.

Inspect inner surface of bearing shells for gouges, wear or foreign material. Any foreign material found, the type and source should be found. Inspect outer surface of bearing shells for surface wear, this would indicate movement of bearing shell or high spot in surrounding material, looseness, rotation is indicated by flattened tangs and wear grooves, and overheating discolours the bearing metal.

Check bearing shells for sign of wear

Effects of tappered journal

This bearing has suffered from lack of oil



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Inspect thrust surfaces of thrust bearing for grooving or wear. Grooves are caused by irregularities in the crankshaft thrust surfaces or particles in the oil.

If the lower bearing shells and crankshaft journals are satisfactory, inspect bearing clearance

2. Inspect bearing tolerances, wipe oil from crankshaft journal, inner and outer surfaces of lower bearing shell. Install bearing shell in original position in bearing cap.

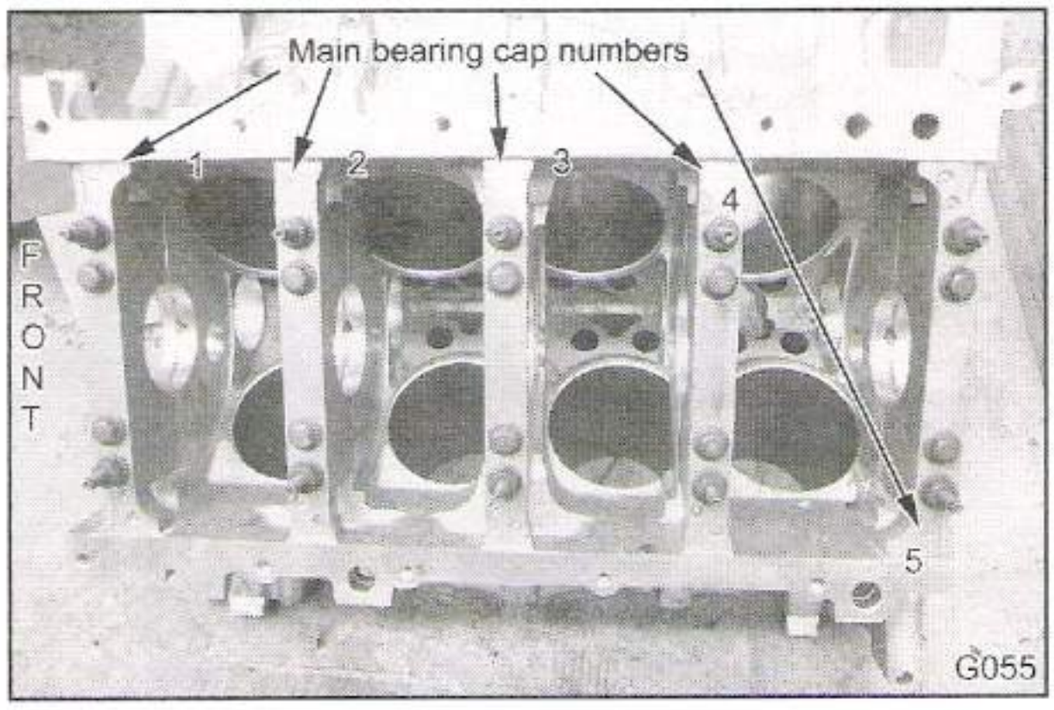
3. Place a section of plastigage across full width of crankshaft journal, parallel to crankshaft centreline.

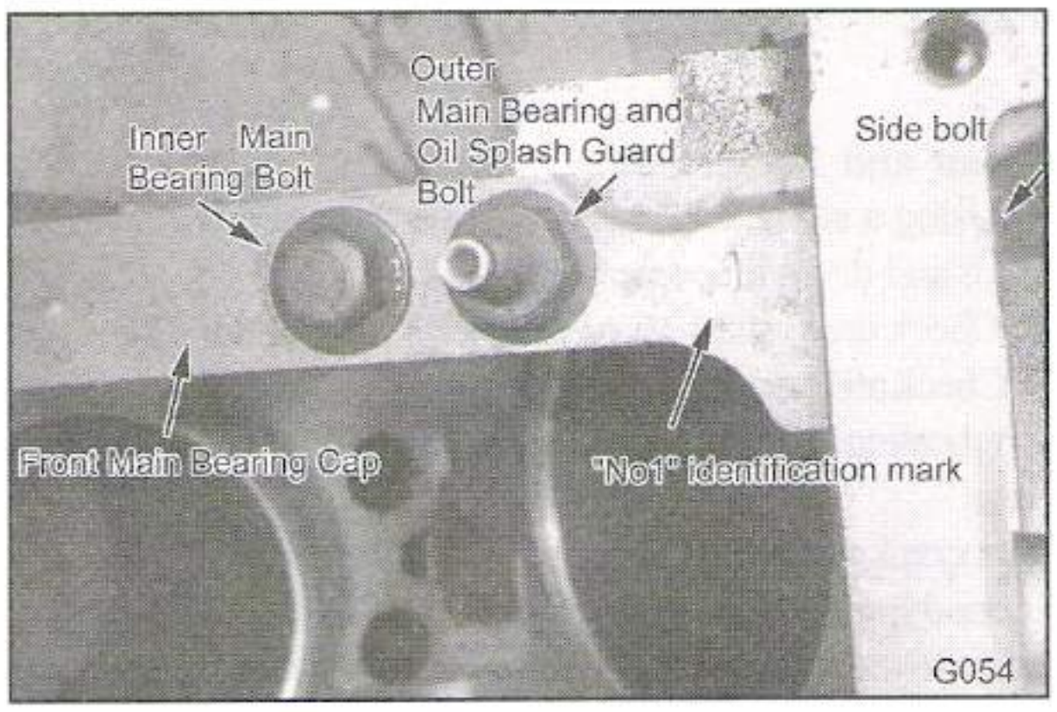
* Make sure plastigage will is not across an oil hole in journal.

4. Install bearing cap assembly and bolts.

* Install bearing cap assembly by loosely installing cap bolts and then lightly tap bearing cap into position, in order to prevent the possibility of cylinder block and or main bearing cap damage.

* Do not pull the bearing cap into place with the bearing cap bolts.





5. Tighten bearing caps to specification.

* Ensure that crankshaft does not rotate with plastigage installed.

Main Bearing Cap Inner and Outer Bolts:

Step1: 20Nm

Main Bearing Cap Inner Bolt Torque:

Step 2: tighten a further 80⁰

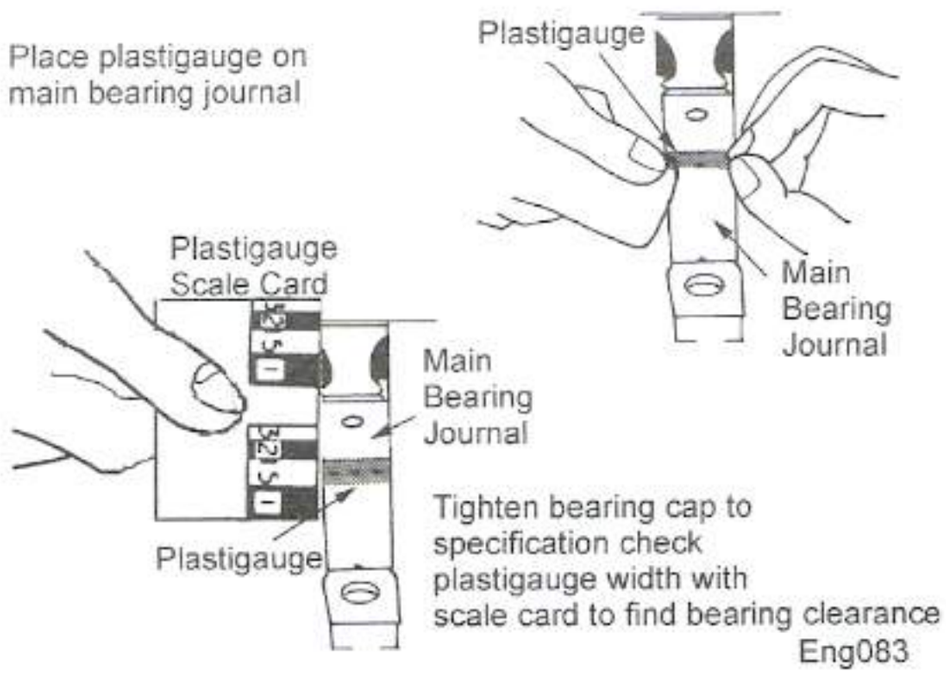
Main Bearing Cap Outer Bolt Torque:

Step 2: tighten a further 53⁰

Main Bearing Cap Side Bolt Torque: 25Nm

6. Remove bearing cap and bolts. Check flattened plastigage sticking to either crankshaft or bearing shell in bearing cap.

7. Check bearing clearance by comparing width of flattened plastigage at widest point with scale on plastigage envelope. The graduated number on the envelope indicates the clearance.



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Main bearing and crankshaft journal clearance should not exceed specification.

Main Bearing Clearance: 0.018-0.025mm
Max 0.054mm

If over 0.025mm remove crankshaft and mic journal.

* This check does not show any indication of crankshaft journal taper or out of round.

To measure taper, out of round or undersized, the crankshaft should be removed from the engine block as previously described.

8. It is advisable to install new bearing shells if bearing clearance exceeds specification and re-check clearance.

#If lower bearing is standard size, install a 0.254 mm undersized shell and check clearance again.

Replace crankshaft if clearance is still not as specified. Apply a thin film of engine oil to the main bearing shells.

9. Install new bearing upper shells in cylinder block, making sure notches in bearings line up with recesses in block.

Bearing shells are marked with the part number.

[Crankshaft in engine] Insert un-notched end of shell between crankshaft journal and notched side of crankcase.

Note: If crankshaft is still in engine the place bearing shell on journal and push around journal into place. Installing a cotter pin into the oil hole of the crankshaft, then rotate crankshaft correct way carefully, the cotter pin will roll the bearing shell into place. Do not force shaft when shall is in place.

* Make sure that the correct bearing shell is fitted between the crankcase journal and crankcase.

10. Sit crankshaft in place in main bearing upper shells in crankcase. Ensure not to damage crankshaft thrust bearing surfaces at No.3 main bearing

11. Install lower bearing shells in bearing cap cradle assembly, making sure the notches in the shells line up with the recesses in the caps and correct bearing is installed in the appropriate cap. Lower shells are not grooved and are available in either undersized or standard size.

12. Using engine oil, lubricate journal and bearing shells.

* When replacing No.3 main bearing shells, coat thrust surfaces with Molybdenum Disulphide grease or equivalent.

13. Make sure that main bearing cap bolt threads and cylinder block threads are clean and dry. Apply some engine oil to the cap bolt threads.

* Arrow on the main bearing cap must face or point to the front of the engine.

* Before final installation of cap assembly bolts, determine if bolts have stretched by measuring with a new bolt. Replace bolts as needed.

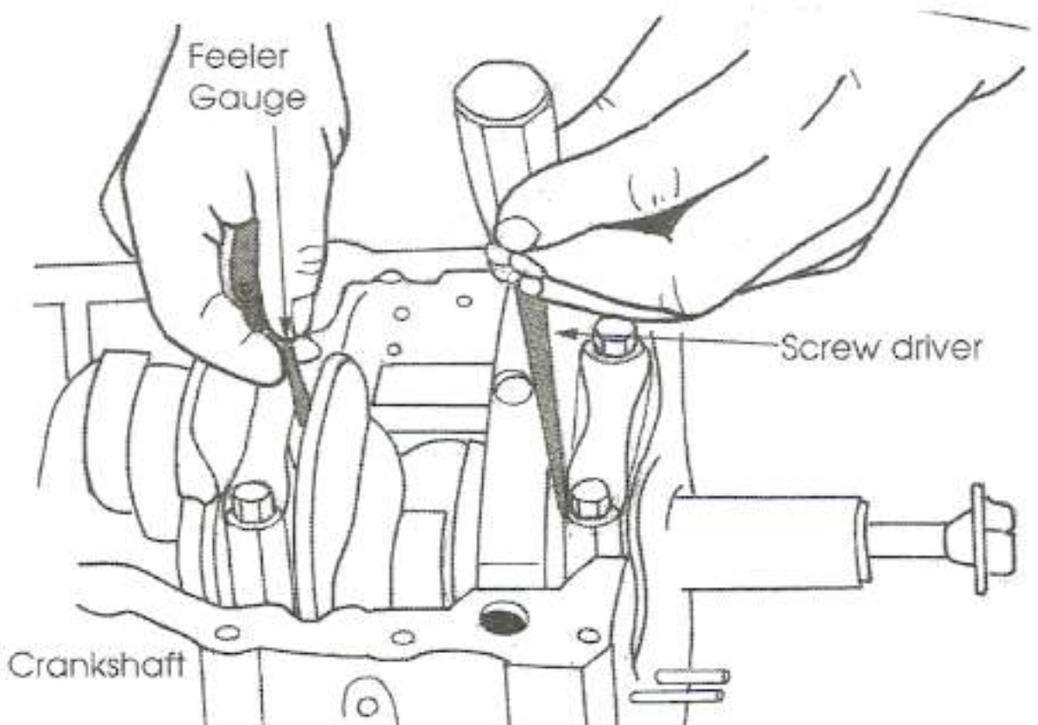
* If the thrust bearing washer is disturbed or replaced, coat the surface using Molybdenum Disulphide Grease.

14. Install bearing cap assembly and tighten all bearing cap bolts to the correct specification.

Main Bearing Cap Inner and Outer Bolts:
Step1: 20Nm
Main Bearing Cap Inner Bolt Torque:
Step 2: tighten a further 80⁰
Main Bearing Cap Outer Bolt Torque:
Step 2: tighten a further 53⁰
Main Bearing Cap Side Bolt Torque: 25Nm

* To eliminate the possibility of cylinder block or bearing cap assembly damage, install bearing caps by installing cap bolts loosely and then lightly tap the bearing cap assembly into position using a soft faced hammer. Do not pull the cap assembly into place by using the bearing cap bolts.

15. Use a feeler gauge to measure crankshaft end float between front of No.3 main bearing thrust washer and crankshaft thrust faces, you will need to force crankshaft forward to do this.



Use a screw driver against main bedrings to move crankshaft backwards and forwards to measure endfloat with a feeler gauge. Eng061

Crankshaft End Float Specification: 0.040-0.20 mm

16. Pull connecting rods up to crankshaft journals, using guide pin tools. Inspect connecting rod bearing clearances, if needed, refer to "Connecting rod bearing" section for details.

17. Turn crankshaft and it should turn without binding. If binding, inspect orientation of bearing cap, correct fitting of bearing shells or bearing clearance.

18. Install crankshaft sensor, 1 bolt.

Crankshaft Sensor Bolt: 25Nm

19. Install oil splash guard, oil pump suction pipe and screen.

20. Install oil pan (sump) and gasket

21. Install flywheel/drive plate, tighten bolts to specification.

Flywheel / Driveplate Bolt Specification:
Step 1: Tighten firmly
Step 2: 50 Nm
Step 3: 100Nm

22. Using the correct amount of engine oil refill the oil pan.

REAR MAIN OIL SEAL / REAR COVER

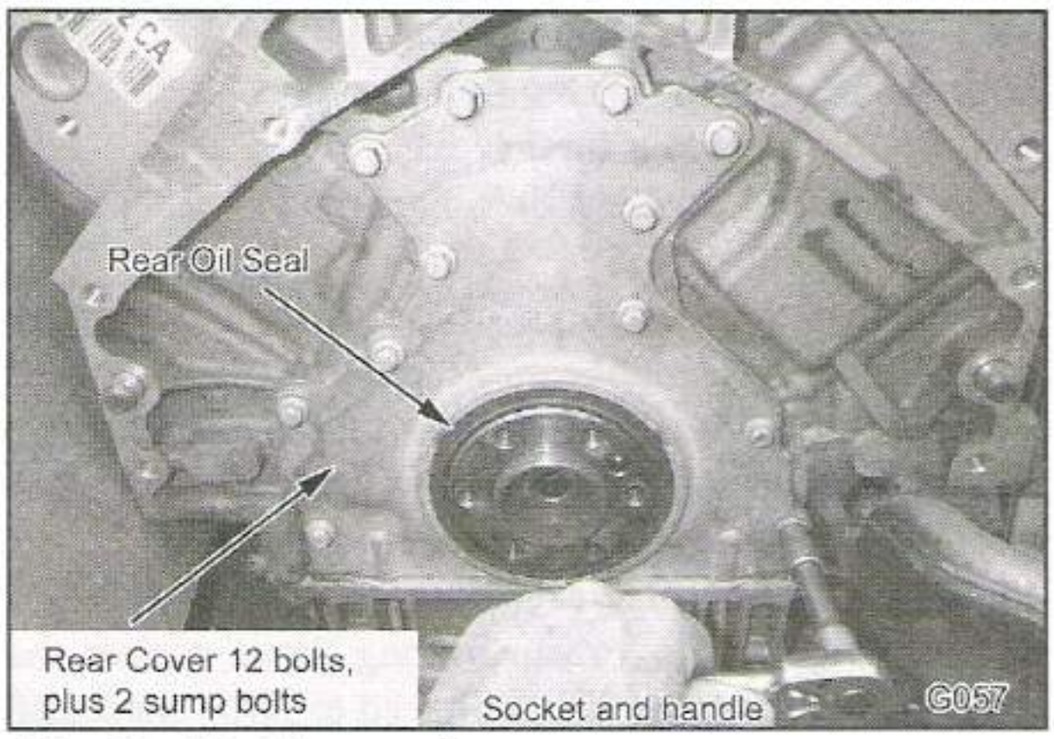
Replace

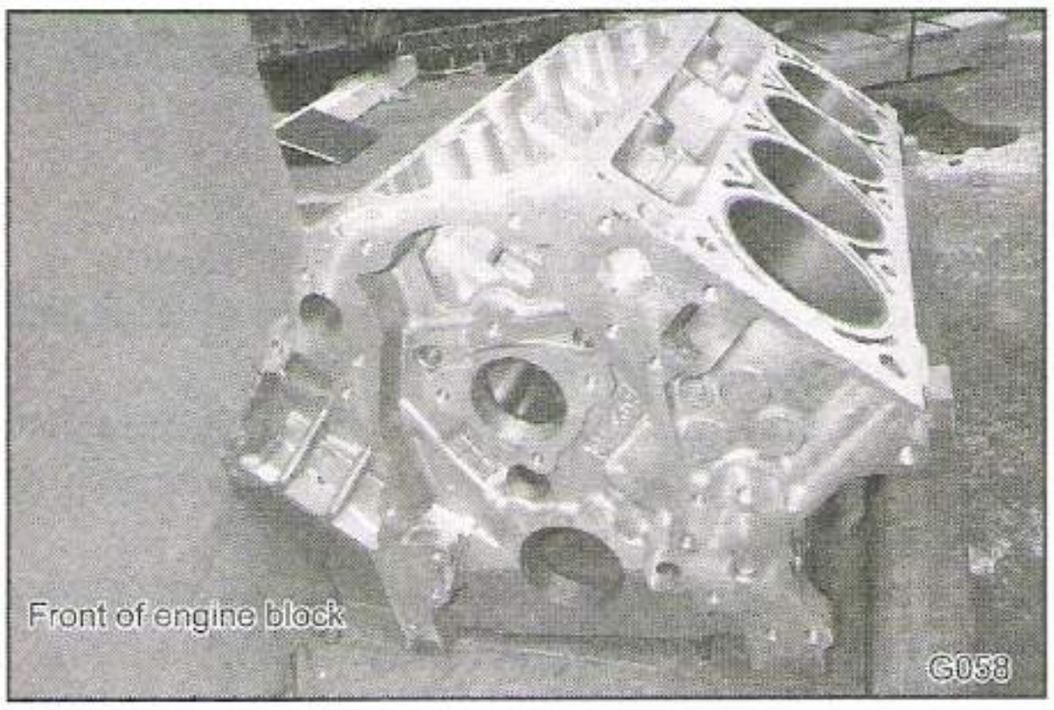
1. Disconnect battery negative terminal.

2. Remove transmission, as described under "Manual transmission" and "Automatic Transmission" in this manual.

3. Remove flywheel/driveplate, as described in "Flywheel/

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driveplate" in this manual.

4. Remove rear cover, 12 bolts and gasket, (plus 2 sump bolts).

5. a) Pry the old seal out with a screw driver or strong lever.

b) Clean seal groove with a cloth.

Note: the rear main oil seal is replaced once the rear cover has been installed.

Note: The rear main oil seal is not renewed once removed.

6. a) Install rear cover and new gasket, use a tool to center the rear cover with sump holes, this ensures the rear main oil seal is centrally located.

b) Install the 12 bolts and tighten, (plus 2 sump bolts).

Rear Cover Bolts: 25Nm

c) Remove tool and check with a straight edge that the rear cover is within specification of the lower level of cylinder block.

Rear Cover Alignment to Cylinder Block: less than 0.25mm

Note: Rear cover must not protrude lower than cylinder block.

7. Install new seal with a seal installer, ensure the seals lips do not get caught on the edge and peel back.

Lubricate the seal lips with new engine oil.

8. Clean flywheel/drive plate attaching bolt threads in rear of crankshaft using a thread tap.

Install new flywheel/flexplate and attaching bolts, tighten bolts to the correct torque specification.

Flywheel / Driveplate Bolt Specification:

Step 1: Tighten firmly
Step 2: 50 Nm
Step 3: 100Nm

9. Reinstall transmission, check engine and transmission lubricant levels.

10. Road-test vehicle and check for lubrication leaks.

CYLINDER BLOCK.

Inspection.

1. Mount the block in an engine stand.

2. Pressure wash the block and clean all cylinder block gasket surfaces.

3. If required remove all coolant drain plugs, 1 on right, 3 on left sides.

Tip: It is a good practise to remove coolant plugs.

4. Clean cylinder block thoroughly using a suitable cleaning solution. Flush with clean water or steam. Spray or wipe cylinder bores and machined surfaces using engine oil.

* Caustic cleaning solutions destroy all bearing and alloy materials. All bearing and alloy parts if not removed before cleaning must be replaced.

Do not use caustic solutions to clean bearing material or alloy parts.

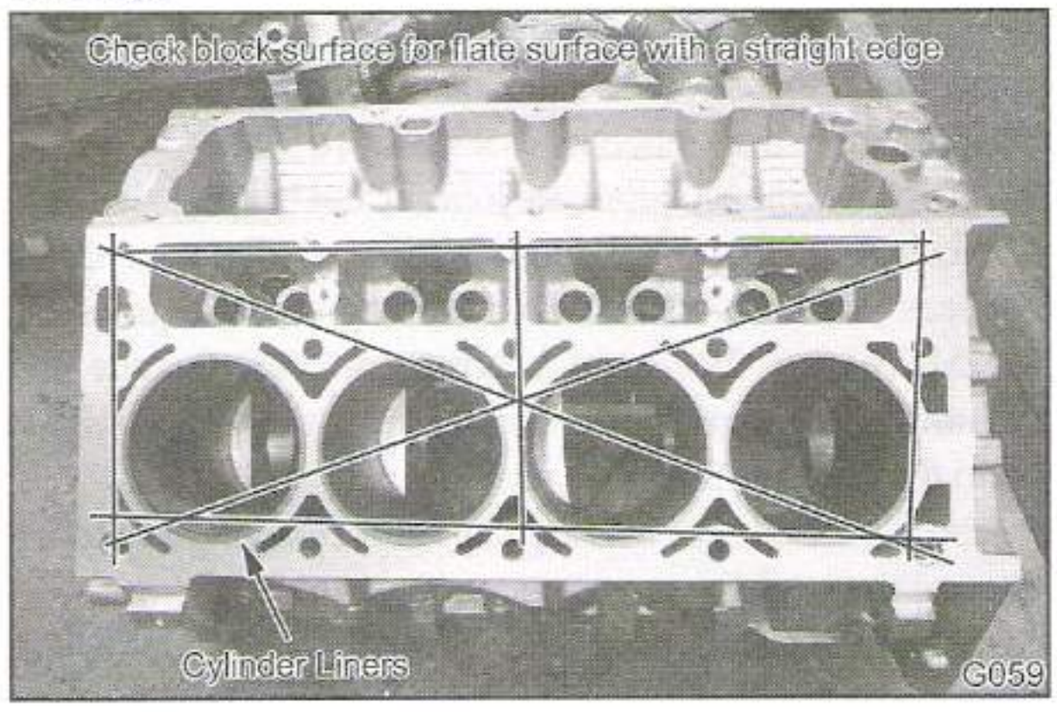
5. Remove front and rear oil gallery plugs. Check all oil passages for obstructions.

Tip: Use a 22 gauge rifle cleaning rod and brush.

6. Using a straight edge and feeler gauge, inspect cylinder block deck surface for flatness.

If any distortion or irregularity is less than specified, cylinder block surface may be machined.

Tip: Install main bearing caps and torque before machining.



Cylinder Block Deck Surfaces Flatness: 0.011mm per 150mm or a Max 0.22mm for complete surface.

Replace cylinder block if irregularity or distortion is more than specified.

7. Replace camshaft bearings if necessary.

a) Use a special tool (camshaft bearing removal/installing tool) insert through camshaft bearings, install washer and nut to tool. and pull the bearings free from the block, one at a time.

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b) Clean bearing bore, coat new bearing in new engine oil, use the same tool for removing the bearings to install the new bearings, pull into place, one at a time.

Tip: The bearings must have the oil slots aligned with the oil feed hole in the block

Use a marker pen and mark the rear of the bearing 180⁰ from the join in the bearing.

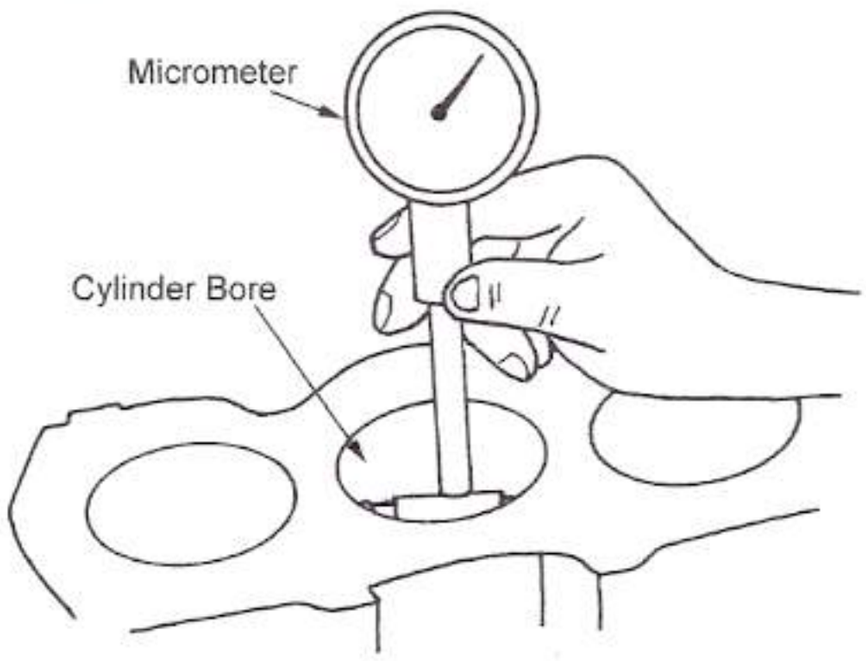
The join goes the bottom of the engine.

Note: Check with a brass wire or similar that the oil holes allow oil to feed from the block, the oil holes and block oil gallery must give a free flow of oil.

8. Check oil sump and timing chain cover surfaces for burrs or damage. Minor damage may be corrected using a fine file.

10. If needed, clean all threaded holes using a suitable threaded tap or drill out and install thread insert.

11. Measure cylinder bore walls for taper, oversize and out-of-round.



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Cylinder Bore (Standard): 99.00 - 99.018mm
Taper: Max 0.018mm
Out of Round: Max 0.018mm

If cylinder bore is worn over maximum limits, the block may be rebored, honed and oversize pistons installed.

12. Install main bearing caps (without bearings) and tighten as described in main bearing section and measure crankshaft bearing bore.

Main Bearing Bore Dia: 69.69.871-69.889mm
Crankshaft Bearing Bore Out-of-Round: Max 0.050mm

If not within specification replace block, any minor high spots may be filled with a fine file.

13. Measure camshaft bearing bore.

Camshaft Bearing Bore Dia: 55.063-55.088 mm

If not within specification replace block, any minor high spots may be filled with a fine file.

14. Measure valve lifter bore.

Valve Lifter Bore Dia: 21.417-21.443 mm

15. If coolant and oil gallery plugs were removed when dismantling, install using specified sealant (Loctite 242).

Cylinder Reconditioning and Piston Fitting.

It will be necessary to smooth bores to fit new pistons, if one or more cylinder bores are scored, rough or worn beyond limits.

It is not be necessary to rebore all cylinders to the same oversize, to maintain engine balance, if some cylinders require reboring. All oversize OEM pistons are the same weight as standard size pistons.

Do not try to machine oversize pistons to fit cylinder bores, this will destroy the surface treatment of the piston and affect the weight. Install the smallest possible oversize OEM pistons and the cylinder bores should be honed to size for proper clearances.

Measure all new pistons at right angles to the piston pin bore, as described in piston section, before the honing or reboring operation is started.

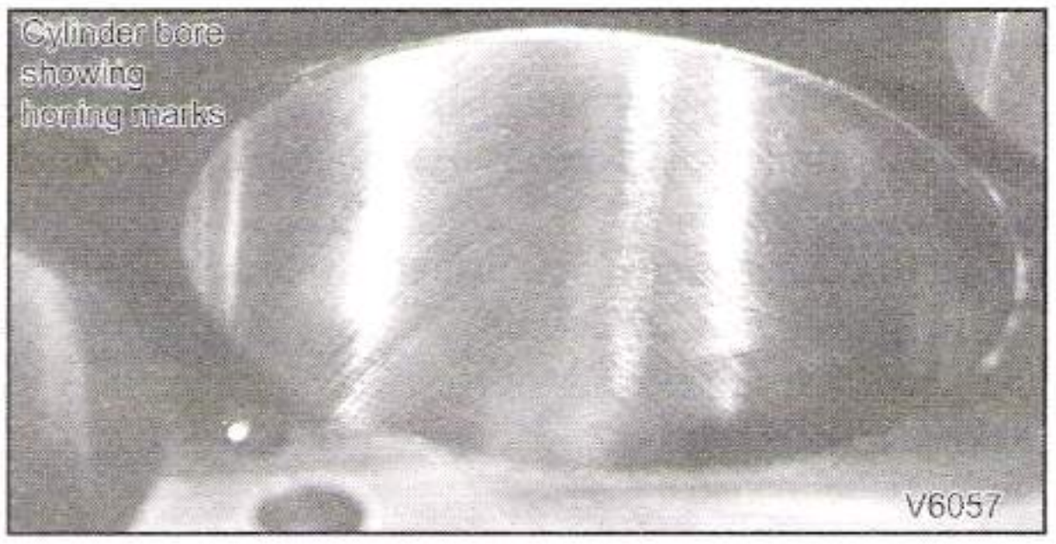
Honing is recommended for trueing bore if cylinder bore wear does not exceed specification. The bore should be corrected up by boring and then hone finished, if wear or out-of-round exceeds specification.

All crankshaft bearing caps must be installed and torqued to specification when reboring cylinder bores, this help prevent distortion of bores in final assembly.

Leave 0.020 mm on the diameter for final honing to give the required specified clearance when taking the final cut.

Follow the Hone Manufacturers recommendations when honing, cleaning and lubrication of the honing stones. Noting the following points.

Hone through the entire length of the cylinder bore at the rate of approximately 60 cycles per minute. This will achieve the desired 45° cross hatch appearance on cylinder walls which will help ensure minimum oil consumption and maximum ring life.



Each piston must be fitted individually to the bore in which it will be installed and marked to ensure correct assembly during the final honing. After the final honing and before the piston is inspected for fit, each cylinder bore must be washed and dried thoroughly to remove all traces of abrasive and then allowed to cool. Apply clean engine oil to cylinder bores. The pistons and cylinder block must be at a common temperature before inspecting.

The glazed cylinder walls should be slightly dulled when new piston rings are installed without reboring cylinders, but without increasing the bore diameter, by means of the finest grade of stone in a cylinder hone.

Proceed as follows to inspect piston to cylinder bore.

1. Using a clean cloth wipe cylinder walls and pistons and

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apply clean engine oil to cylinder bores.
2. Measure the bore accurately using an inside micrometer.
3. Measure piston diameter 39mm from top of piston, subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.
Piston to Bore Clearance: 0.010-0.051mm
4. Identify each piston with cylinder number to which it will be installed, then proceed to hone other cylinders and fit pistons.
**Handle the pistons with care, do not attempt to force the piston through the cylinder bore until cylinder has been honed to the correct size. Pistons can be damaged through careless handling.

Problem Diagnosis.

Problems and Possible Causes.
Problems should be corrected, when proper diagnosis is made, by repair, adjustment or part replacement as needed. Refer to the correct section in this manual.
High Oil Loss
(1) Tighten bolts and/or replace gaskets and seals as required for external leaks.
(2) Check oil with car on a level surface and allow adequate drain down time to ensure a correct reading of dipstick.
(3) Towing or continuous high speed driving will normally cause oil consumption to increase.
(4) PCV system failure.
(5) Use recommended S.A.E viscosity for current temperatures. Refer to "tune-up and maintenance" for details on correct oil viscosity.
(6) Valve guides and/or valve stem seals worn, or seals omitted. Ream guides and install oversize service valves and/or new valve stem seals.
(7) Allow enough time for the piston rings to seat. Replace worn or broken rings as needed, if rings have been incorrectly installed, worn or broken, or not seated.
(8) Piston incorrectly installed or misfited.
Gaskets.
(1) Incorrectly tightened fasteners or damaged/dirty threads.
(2) Worn or damaged gasket (cracking or porosity).
(3) Fluid pressure/level too high.
(4) Incorrect sealant used (when required)
Inspection of Seals.
(1) Damaged seal bore (burred, nicked, scratched)
(2) Worn or loose bearing which causes excessive seal wear.
(3) Worn or damaged seal or incorrect installation.
(4) Fluid pressure/level too high.
Oil Leak Investigation
Oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the required parts.
(1) Determine whether the fluid is transmission lubricant, engine oil, power steering fluid etc.
(2) Run the car at normal operating temperature and park the car over a large sheet of paper. After a few minutes, you should be able to find the approximate location of the leak by drippings on the paper.
(3) Use a degreaser or steam to clean the area of the leak, drive the car for a few kilometres. Then visually inspect the suspected part for signs of an oil leak.
Black Light and Dye Method.
There are many dye and light kits available for finding leaks.
(a) Pour required amount of dye into leaking part.
(b) Operate the car under normal operating conditions as instructed in the kit.
(c) Shine the light in the suspected area. The dyed fluid will appear as a yellow path leading to the problem.
Low Oil Pressure
(1) Blocked oil filter.
(2) Incorrect oil viscosity for expected temperature, or oil diluted with moisture or unburnt fuel mixtures.
(3) Excessive bearing clearance.
(4) If the oil level is low, fill to mark on dipstick.
(5) Oil pump dirty/worn, or oil pump suction pipe screen blocked, or hole in oil pump suction pipe.
(6) Incorrect or failing oil pressure sender.

Engine Knocks
WHEN ENGINE COLD AND CONTINUES KNOCKING FOR TWO OR THREE MINUTES
Increases with torque
(1) Tighten or replace as required if drive pulleys or balancer are loose or broken.
(2) Replace piston if clearance from piston to bore is excessive. (Cold engine piston knock usually disappears when the cylinder is grounded out. Cold engine piston knock which disappears in 1.5 min. can be considered acceptable.)
(3) Connecting rod bent.
HEAVY KNOCK WITH TORQUE APPLIED
(1) Replace parts as required of pulley hub or balancer broken.
(2) Loose torque converter to flexplate bolts.
(3) Check if exhaust system contacting under-body.
(4) Cracked flexplate/flywheel.
(5) Main bearing clearance or connecting rod bearing clearance excessive.

Light Knock while Hot
(1) Inspect fuel quality if pre-ignition or spark knock.
(2) Loose torque converter to flexplate bolts.
(3) Connecting rod clearing clearance excessive.
KNOCKS ON FIRST START-UP ONLY LASTING A FEW SECONDS
(1) Incorrect oil viscosity. Install correct oil viscosity for expected temperatures.
(2) Hydraulic lifter bleed down.

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Some valves will be open when the engine is stopped. Spring force against lifters will tend to bleed lifter down. Only if the problem is consistent should repairs be attempted.
(3) Replace crankshaft thrust bearing shells if excessive crankshaft end float.
(4) Replace worn parts if front main bearing clearance is excessive.

Hydraulic Valve Lifters

The lifters are extremely simple in design and rarely need attention, readjustments are not required and servicing requires only that care and cleanliness be exercised whilst handling the parts. Using a piece of garden hose near the end of each intake and exhaust valve with the other end of the hose to the ear, is the easiest method for locating a noisy valve lifter. Using this method, the sound is localised, which makes it easier to find out which lifter is faulty. Or place a finger on the face of the valve spring retainer. If the lifter is not functioning correctly, a definite shock will be felt when the valve returns to its seat.

Specifications

General

Engine: 90^0 "V" 8 cylinder 5.7 litre (5,667cc)
Bore: 99.0mm
Stroke : 92.0mm
The cylinder numbering is as illustrated, from the front of the engine, left side 1-3-5 -7 and right side 2-4-6-8.
Firing order: 1-8-7-2-6-5-4-3
Compression ratio: 10.1:1
HSV C4B (300kW)
Compression ratio: 95.5:1
Cylinder Specified Compression:
Minimum Specified Comp: 690kPa.
Variation between cylinders:
not less than 70% of highest test

Lubrication

Engine Oil Grade API grade: 10W-30 SJ GF2
Lubricant Quantity Specification:
With out new oil filter: 4.7 Litres
With new oil filter: 5.0 Litres
Oil pressure@1000 rpm plus: 45kPa(min).
Oil pressure@2000 rpm plus: 125kPa(min).
Oil pressure@4000 rpm plus: 165kPa(min).

Camshaft

Camshaft Lobe Specified Height;
Inlet Lobe: 46.67 mm
Outlet Lobe: 46.67 mm
Specified Camshaft Lobe Lift Intake: 7.43mm
Specified Camshaft Lobe Lift Exhaust: 7.43mm
Camshaft Journal Diameter: 54.99mm min
Camshaft Centre Max. Runout: 0.05mm.

Cylinder Head

* Check thickness of cylinder head deck surface:
Minimum head deck thickness: 1.20.2mm
* Valve seat angles are 46^0.
* Valve seat width:
Exhaust 1.78mm
Intake 1.02mm
Note: The HSV C4B (300kW) engine has specific cyl;inder head.

Valve Spring

Maximum allowable variance in spring end length: 1.60 mm, while rotating spring on level desk.
Valve Spring Intake Free Height: 52.9mm
Valve Spring Exhaust Free Height: 52.9mm
Valve spring compressed height/load:
Compressed height: 310Nm@45.75mm min
Compressed height: 980Nm@33.55mm min
Valve Spring Assembled Height: 45.75mm
Maximum height: 46.25mm
There must be a valve spring seat installed.
Note: The HSV C4B (300kW) engine has specific valve springs.

Valves

Valve Stem Diameter: 7.955-7.976mm
Mim Dia: 7.950mm
Valve face angle: 45°.
Minimum valve head margin thickness: 0.63mm
Note: The HSV C4B (300kW) engine has specific valves.

Piston and Rings

Piston Size Standard: 98.964-98.982mm
Maximum Variation: 0.018 mm
Oversize (0.25 mm) pistons are available.
Piston to Bore Clearance: 0.010-0.051mm
Piston Pin Clearance
: in Piston 0.010-0.020mm
: in Connecting Rod 0.020-0.043mm
Top Compression Ring End Gap Specification:
0.230-0.380mm
Second Compression Ring End Gap Specification:
0.440-0.640mm
Oil Ring Steel Rail Gap Specification:
0.180-0.690mm
Piston Ring Side Clearance:
Top Ring: 0.040-0.085mm
Second Ring: 0.040-0.080mm
Oil Ring: 0.010-0.220mm
Note: The HSV C4B (300kW) engine has specific pistons.

Connecting Rod

Connecting Rod Alignment Max. Specification
Bend: 0.020mm
Twist: 0.010

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Connecting Rod to Crankshaft End Clearance:
0.11-0.51mm
Connecting Rod Bearing Clearance: 0.015-0.076mm
Note: The HSV C4B (300kW) engine has specific connecting rod bolts.

Crankshaft

Connecting Rod Journal: 53.318-53.338 mm
Minimum used: 53.308 mm
Out of round: 0.005 mm max, used max: 0.01mm
Taper: 0.008 mm max, used max: 0.01mm
Main Bearing Journal Diameter
Standard Size: 64.993-65.007mm
Taper: 0.010mm used: 0.020mm max.
Out-Of-Round: 0.003mm used: 0.008mm max.
Connecting Rod Journal: 53.318-53.338 mm
Minimum used: 53.308 mm
Out of round: 0.005 mm max, used max: 0.01mm
Taper: 0.008 mm max, used max: 0.01mm
Crankshaft Rear Oil Gallery Plug Depth:
31.2-31.6mm

Flexplate Runout: 0.38 mm max.

Maximum oil pan to rear of engine block clearance:
0.25mm
Intake Manifold and Intake Chambers Maximum Warpage:
0.50mm

HSV C4B CAMSHAFT SPECIFICATION
INTAKE EXHAUST
Camshaft C4B LS1 (HSV 195i & 300kW)
Intake Lobe Lift: 8.331mm (0.327")
Exhaust Lobe Lift: 8.356mm (0.329")
Duration at 1.27mm (0.050") lift:
Intake: 184.7°
Exhaust: 189.0°
Duration:
Intake: 278.8°
Exhaust: 283.0°
Valve Timing at 1.27mm (0.050") lift:
Open: Intake 25.1° ATDC
Exhaust 31.3° BBDC
Close Intake 29.8° ABDC
Exhaust 22.3° BTDC

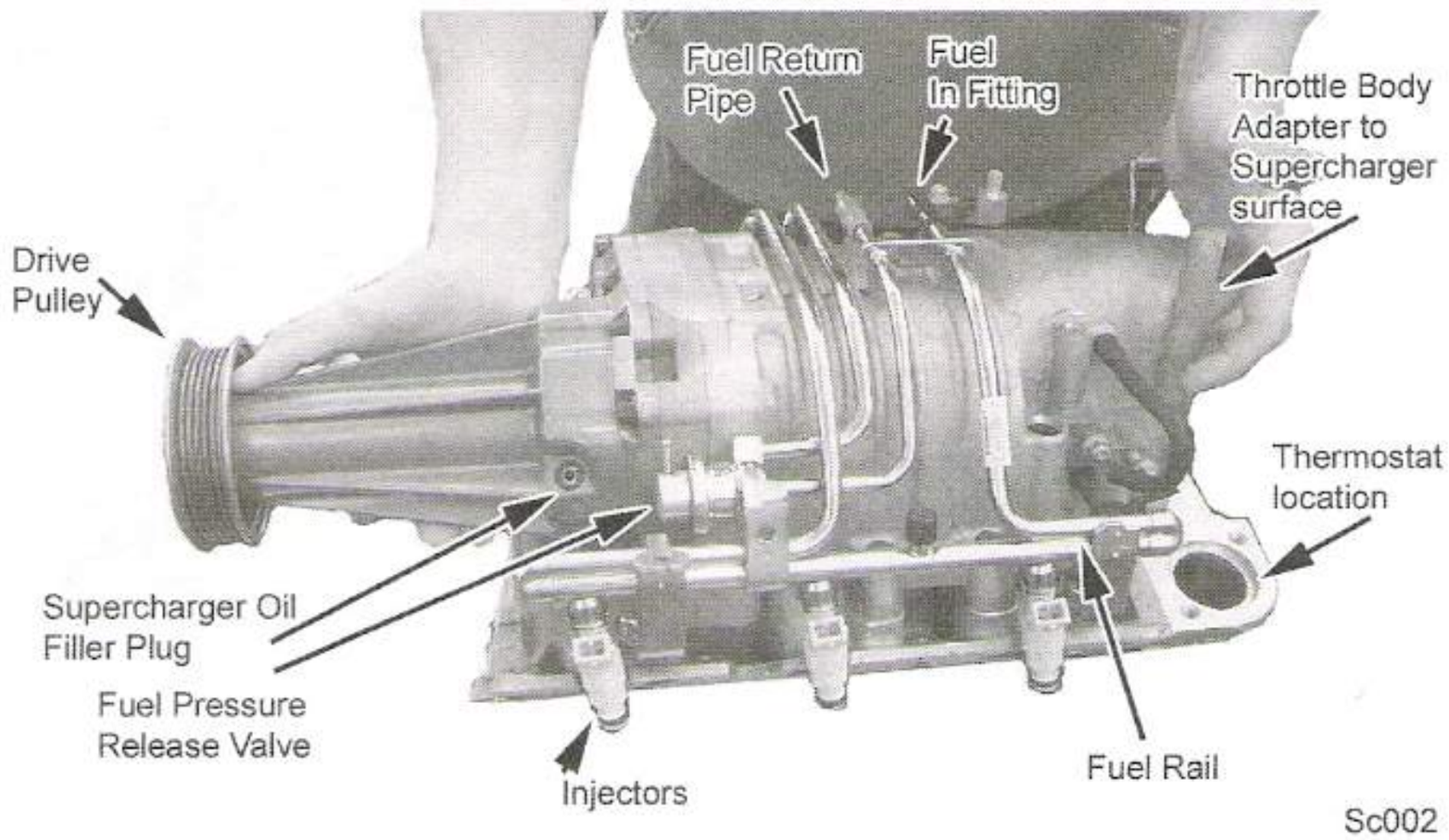
Torque Wrench Spec

Drive Belt Tensioner Bolts: 40-60Nm
Engine Valley Cover Bolts: 25Nm
Knock Sensor Tighten: 20Nm
Vapour Vent Pipe Studs: 12Nm
Intake Manifold Attaching Bolts :
Step 1: 5Nm
Step 2: 8Nm
Fuel Rail Studs: 8-12Nm
Fuel Rail Nuts: 8-12Nm
Throttle Body Bolts: 12Nm
Exhaust Manifold Bolts:
Step 1: 15Nm
Step 2: 25Nm
Exhaust Pipe Flange to Exhaust Manifold: 20-35Nm
Oxygen Sensors Tighten: 41Nm
Spark Plug: 15Nm
Rocker Cover Bolts Torque: 12Nm
Water Pump Bolts: Step1: 15Nm, Step2:30Nm
Water Pump Pulley Bolts: 15Nm
Crankshaft Balancer Bolt: 330Nm

Oil Pump Cover Screws: 12Nm
Oil Pressure Relief Valve Plug: 12Nm
Oil Pump Bolts: 25Nm
Oil Splash Guard Nuts: 25Nm
Oil Pick-up Tube and Screen Bolt: 12Nm
Oil Pick-up Tube and Screen Nut: 25Nm
Timing Gear Cover Bolts: 25Nm
Sump Bolts to Engine Block: 25Nm
Sump Bolt to Timing Gear Cover: 25Nm
Connecting Rod Cap Bolt Specification:
Step 1: 20Nm.
Step 2: Plus 60^0 Turn
HSV 300kW engine
Connecting Rod Cap Bolt Specification:
Step1: 30-35Nm
Step 2: 65-70Nm.
Main Bearing Cap Inner and Outer Bolts:
Step1: 20Nm
Main Bearing Cap Inner Bolt Torque:
Step 2: tighten a further 80^0
Main Bearing Cap Outer Bolt Torque:
Step 2: tighten a further 53^0
Main Bearing Cap Side Bolt Torque: 25Nm
Crankshaft Sensor Bolt: 25Nm
Flywheel / Driveplate Bolt Specification:
Step 1: Tighten firmly
Step 2: 50 Nm
Step 3: 100Nm
Rear Cover Bolts: 25Nm

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SUPER CHARGER V6



Sc002

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General Information

The V6 supercharged engine uses a positive displacement, two counter rotating rotors in a housing mounted on the top of the engine. The suoercharger develops maximum boost from 50-70kPa, the boosted air pressure is available at all of the rpm range, when not required the boosted air is recirculated by the bypass valve through the bypass passage between the lower intake manifold and inlet of supercharger.

The bypass valve has a spring keeping it closed and a vacuum actuator valve that opens it with increased vacuum. The closed valve allows boost air pressure to be used by the engine, the open valve allows boost air pressure to recirculate. The rotors are driven by the front drive belt, rotors are supported by ball bearings at the front and sealed roller bearings at the rear.

On Vehicle Tests

1. The drive belt tensioner indicator must be within the tension range as per the marks on the belt tensioner.
2. Oil level shouldbe checked at regular maintenance service checks.

Note: The engine must be cool ($2^1/_2$-3 hours after engine sut down) before checking supercharger oil level, otherwise oil lose will occur and possible hot oil spray from plug hole could burn you.

a) Remove oil plug, oil level should at the lower threads of the plug. (use a 3/16 allen key)

b) Top oil level by using specified oil.

Supercharger Oil:

GM Part No 12345982 Synthetic Oil

c) Replace oil plud and tighten.

Supercharger Oil Plug: 10Nm

3. Excessive oil leak at front seal, behind drive pulley.

Tip: It is acceptable for a small weep at this seal, but not excessive weeping.

Maintenance

Supercharger

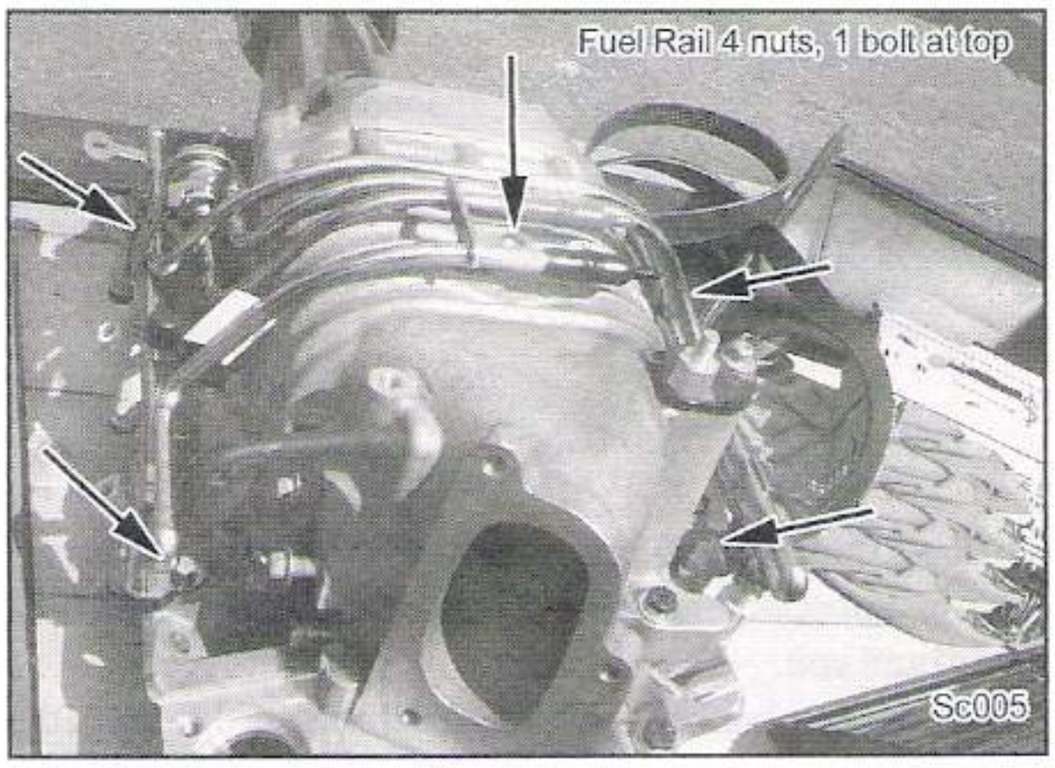
Remove

1. Remove engine cover, 4 nuts.
2. Disconnect wiring loom connectors, for MAF - air flow meter, IAT - air flow meter, TP - throttle body, IAC throttle body.
3. Remove the drive belt from the supercharger pulley.
4. Disconnect acellerator cable and cruise control if applicable.
5. Remove duct between air cleaner and throttle body.
6. Remove attaching bolts for boost solenoid wiring and rear

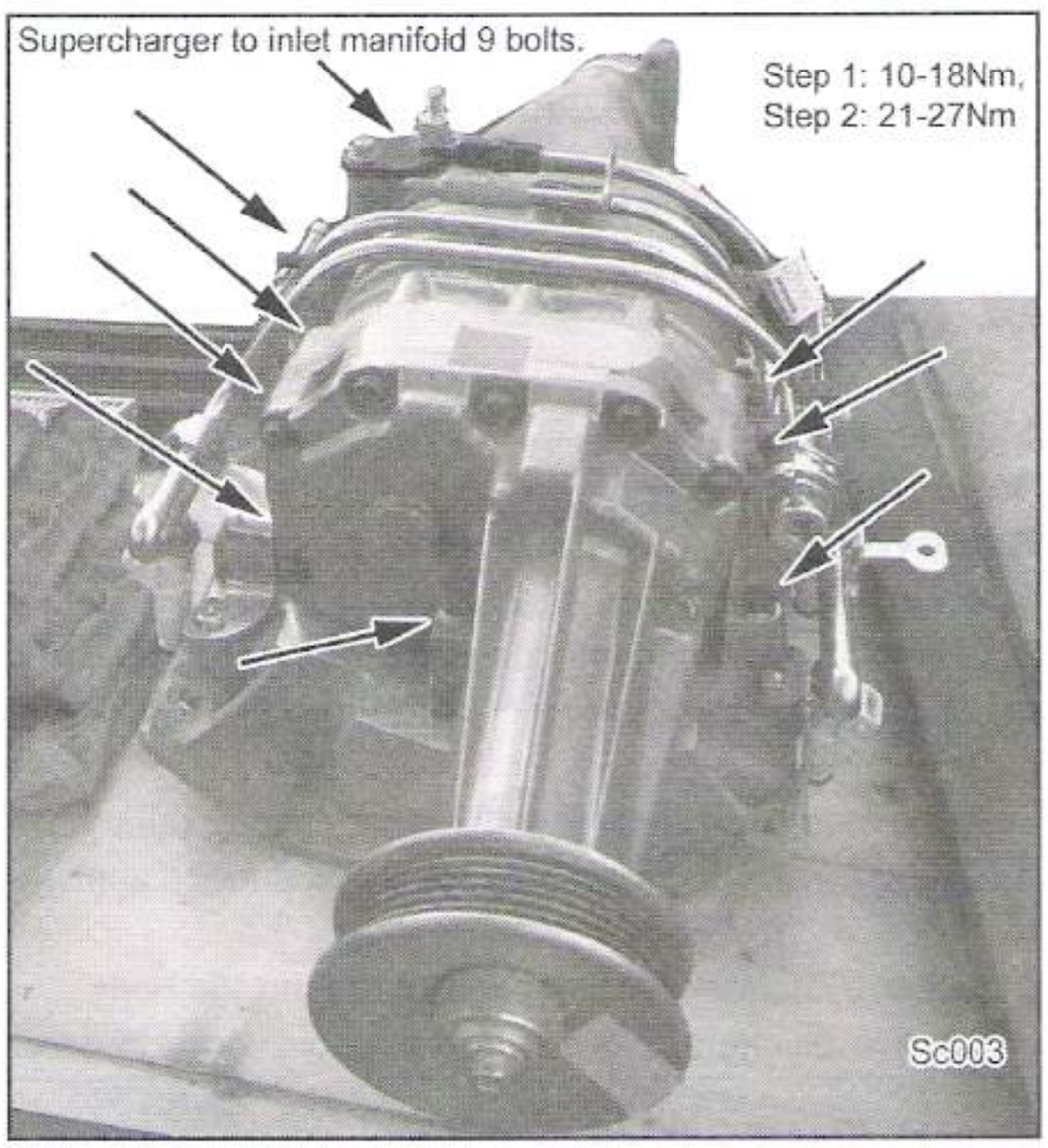


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cover, disconnect wiring harness.
7. Depressurise fuel system as described in EFI chapter.
8. Disconnect and label for assembly vacuum hoses to throttle body, boost solenoid, heater, fuel pressure regulator and engine vent.
9. Remove alternator bracket.
10. Remove fuel rail, disconnect injector connectors.



11. Remove supercharger, 9 bolts, discard gasket and "O" rings.



Install
1. Install supercharger, 9 bolts, new gasket and "O" rings, tighten bolts.
Supercharger bolts:
Step 1: 10-18Nm, Step2: 21-27Nm
2. Install fuel rail, 4 nuts 1bolt. Connect injector connectors.
3. Connect the vacuum hoses for the boost control solenoid, and the engine cover back bracket.
4. Connect vacuum hoses to fuel pressure regulator, engine vent.
5. Install throttle body and duct between throttle body and air



cleaner.
6. Install the acellerator cable and cruise control.
7.Install the drive belt from the supercharger pulley.
8. Reconnect wiring loom connectors, for MAF - air flow meter, IAT - air flow meter, TP - throttle body, IAC throttle body.
9. Install engine cover, 4 nuts.
10. Connect the battery, turn ignition key ON and check for leaks as fuel system repressurises.

Supercharged Model Modifications

Front drive belt and pulleys.
Supercharged models have two drive belts, one standard belt plus a belt for the supercharger.
Front drive belt tensioner and Idler pulleys.
Superchraged models have an extra tensioner fitted, and two additional idler pulleys are required. A wider crankshaft balancer pulley with different specifications is also required.
Balance shaft.
The supercharged models have a balance shaft without grooves in the balancer weights and also the end of the balance shaft has 4 oil holes instead of 3.
Camshaft sprocket.
Camshaft sprocket has triangular holes while the standard camshaft sprocket has round holes.
Piston Pin.
The piston pin is alarger diemeter (23mm) and therefore the piston and connectind rod is also different.
Piston.
The piston pin is alarger diemeter (23mm) and therefore the piston and connectind rod is also different.
Connecting rods.
The piston pin is alarger diemeter (23mm) and therefore the piston and connectind rod is also different. Also the centers of the piston pin and bigend are at a different distance.
Cylinder Heads.
The cylinder heads have been altered due to the injectors in the cylinder heads.
Cylinder head gaskets.
Supercharged models have special head gaskets due the revised heads, also the gaskets are made of a different composition.

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Camshaft Sprocket
A modified camshaft sprocket is used, this can be identified by the trianglur holes in the sprocket.
Fuel Injectors
Higher volume fuel injectors are fitted to supercharged models.
Fuel Rail
A different fuel rail is used for the supercharged models.
Inlet manifold



The lower inlet manifold is different due to the supercharger fitted to the inlet manifold and the injectors fitted into the heads.
Rocker covers.
The supercharged models need different rocker covers due to the extra clearnace needed by the injectors.
Throttle Body Adapter
A special throttle body adapter is used between the throttle body and the supercharger.
Coolant Outlet and Thermostat Housing.
Coolant outlet to the radiator is located at the rear of the inlet manifold, therefore a different coolant outlet and thermosata housing is used.
Flexiplate
The superchargered models have an extra counter weight on the flexiplate.
Crankshaft Balancer
A different crankshaft balancer is necessary because of the extra drive belt fitted, also the balancer is specifically designed for the supercharged engine.
Coil Pack Bracket and Spark Plug leads.
Supercharged models have a different coil pack bracket, therefore the spark plug leads are also different and in a different position.
Spark Plugs
The spark plugs are a different heat catagory.
Engine Management - PROM
The engine management PROM is different.

Problem Solving

Roughtidling

* Check and clean engine breather (crankcase ventilation valve.
* Throttle body or adapter bolts loose.
* Supercharger bolts loose.
* See other problem solving diagnosis sysptoms under EFI and Ignition.

Noisy Supercharger

* Low oil level of supercharger.
* Worn internal gears
* Worn bearings.
* Drive belt stretched.
* Loose pulleys.
* Worn or frayed drive belt.

Excessive Oil Leak

* Front seal of supercharger.
* Worn supercharger shaft at front seal.
* Cracked supercharger housing.

Specifications

* Engine Capacity:	3791cc
Engine Compression Ratio:	8.5:1
* Bore:	96.5 mm
* Stroke:	86.3 mm
* Taxable H.P.RAC OR SAE:	34.6
Power DIN:	171 kw @ 5200rpm
Torque DIN:	375 Nm @ 3000rpm

* Same as standard V6 engine

Torque Specifications Nm

Drive belt tensioner bolt:	40 - 50
Drive belt tensioner pulley bolt:	40 - 50
Drive belt idler pulley bolt:	40 - 60
Drive belt idler pulley bracket bolt:	25 - 35
Supercharger bolts:	
Step 1:	10-18
Step2:	21-27
Supercharger oil filler plug:	10
Engine dress cover attaching nut:	4.0 - 6.0
Engine top cover bracket bolt,nut:	15 - 20
Coil pack bolts:	40 - 50
Throttle body adaptor bolts:	20 - 28
Throttle body nuts:	15 - 20
Crankshaft balancer bolt:	270 - 325
Bypass valve actuator bolts:	26
Bypass harness bolt:	15 - 20
Boost reduction solenoid bolt:	30 - 40
Fuel rail bolt:	20 - 30
Fuel rail nuts:	8.0 - 12
Radiator inlet pipe attaching bolt:	20 - 27
Bypass actuator solenoid valve bolts:	30 - 40

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STARTING SYSTEM

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General Information

The starting system is made up of the following components, battery, starter motor, ignition switch, inhibitor switch-(automatic transmission only), theft deterrent engine crank switch and related wiring.

The starter motor fitted to the V6 and the V8 is a series parallel wound, four pole, four brush type. The V6 starter motor uses a planetary gear drive train-(*the armature rotates the drive assembly at a reduced speed of approximately 3.36:1*). The armature shaft is supported at both ends by oil absorbent sintered metal bushes.



New Bosch V6 stater motor - superseeds earlier models, almost none maintenance, when faulty replace with a new unit. St026

A new Bosch V6 stater motor - superseeds earlier models, almost none maintenance, when faulty replace with a new unit. It has become almost cheaper to replace than repair th estarter motor.

Starter Motor Tests

To perform the following tests the starter motor will have to be removed from the vehicle.

Solenoid Switch Tests

Pull-In Test

1. Remove the nut and washer from terminal 'M'

a) Remove the braided cable from terminal 'M'

2. Connect test leads as per diagram and check that the solenoid pulls the drive assembly outwards

**If drive assembly does not move replace the solenoid*

Hold-Out Test

1. Connect the test leads as for pull-in test

2. Disconnect the negative lead from terminal 'M'

3. Check that the drive assembly stays in the out position

**If drive does not stay in the out position replace the solenoid*

Drive Assembly Return Test

1. Test leads still connected as at the end of the hold-out test

2. Remove the earth cable connected to the starter housing

3. The drive assembly should return to the in position

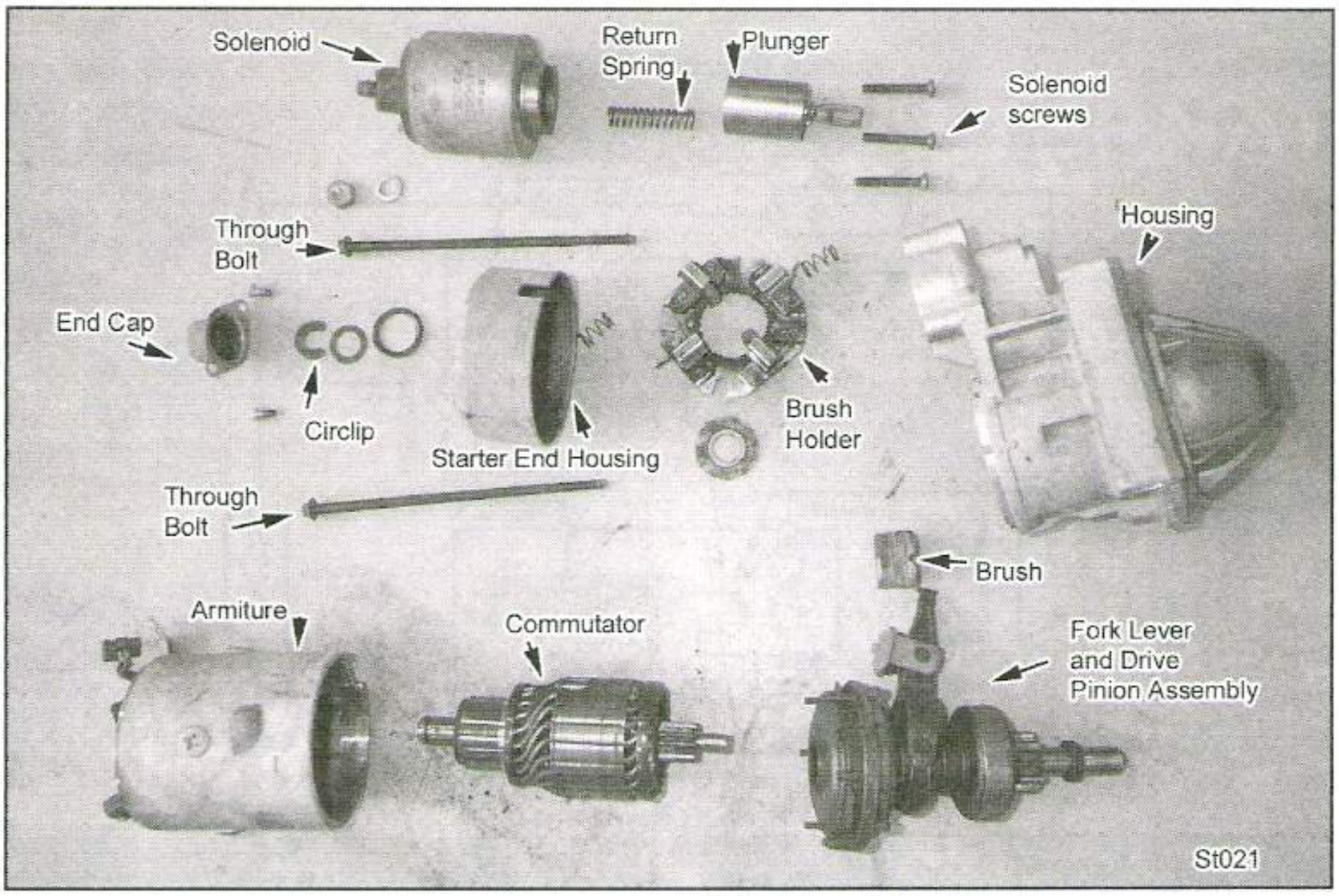
**If drive does not stay in the out position replace the solenoid*

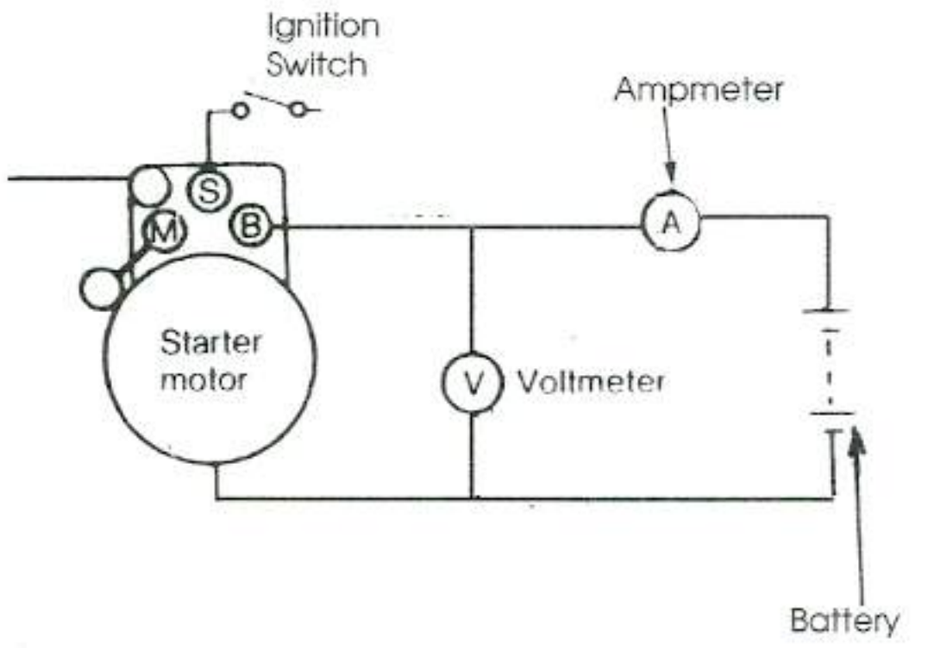
NO LOAD TEST

Check the armature is not seized before performing a NO LOAD TEST. Pry the pinion in a counter clockwise direction with a screwdriver. If the armature will not rotate freely, Do Not perform the No Load Test.

Clamp starter motor securely to test bench and make connections. Close the switch and compare the RPM, current,voltage

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readings with the following specifications.

V6 Engine -

Armature R.P.M:	5300 rpm
Starter Current:	125 amps
Voltage:	11.5 volts

VT Ser I V8 Engine -

Armature R.P.M:	6500 rpm
Starter Current:	70 amps (max)
Voltage:	12 volts

Gen III V8 Engine -

Armature R.P.M:	2500 rpm
Starter Current:	90 amps
Voltage:	11.0 volts

Note: Check **Problem Solving & Diagnosis** if the 'No Load test' indicates that the starter motor is defective.

Major Maintenance

Remove

1. Disconnect the battery negative and positive terminals

VT Ser I V8 Engine

a) Remove the L.H. side engine pipe to manifold bolts 2

b) Loosen and remove the 2 bolts attaching the engine pipe to the catalytic convertor.

Gen III I V8 Engine

a) Remove the R.H. side engine pipe to manifold bolts 2

b) Loosen and remove the 2 bolts attaching the engine pipe to the catalytic convertor.

c) Mark for assembly and loosen steering shaft lower universal joint at steering rack, remove universal from steering rack.

d) Remove the starter motor heat shield.

V6 and V8

2. Loosen and remove the starter motor to engine block, 2 bolts.

3. Lower the starter motor and disconnect the connectors from terminals '50' and '30'

a) Remove the starter motor assembly from the vehicle

Dismantle

1. Remove nut and washer from the solenoid field coil terminal, then separate the lead from the terminal, remove the two solenoid retaining screws

2. Scribe match marks on the solenoid switch and drive end housing.

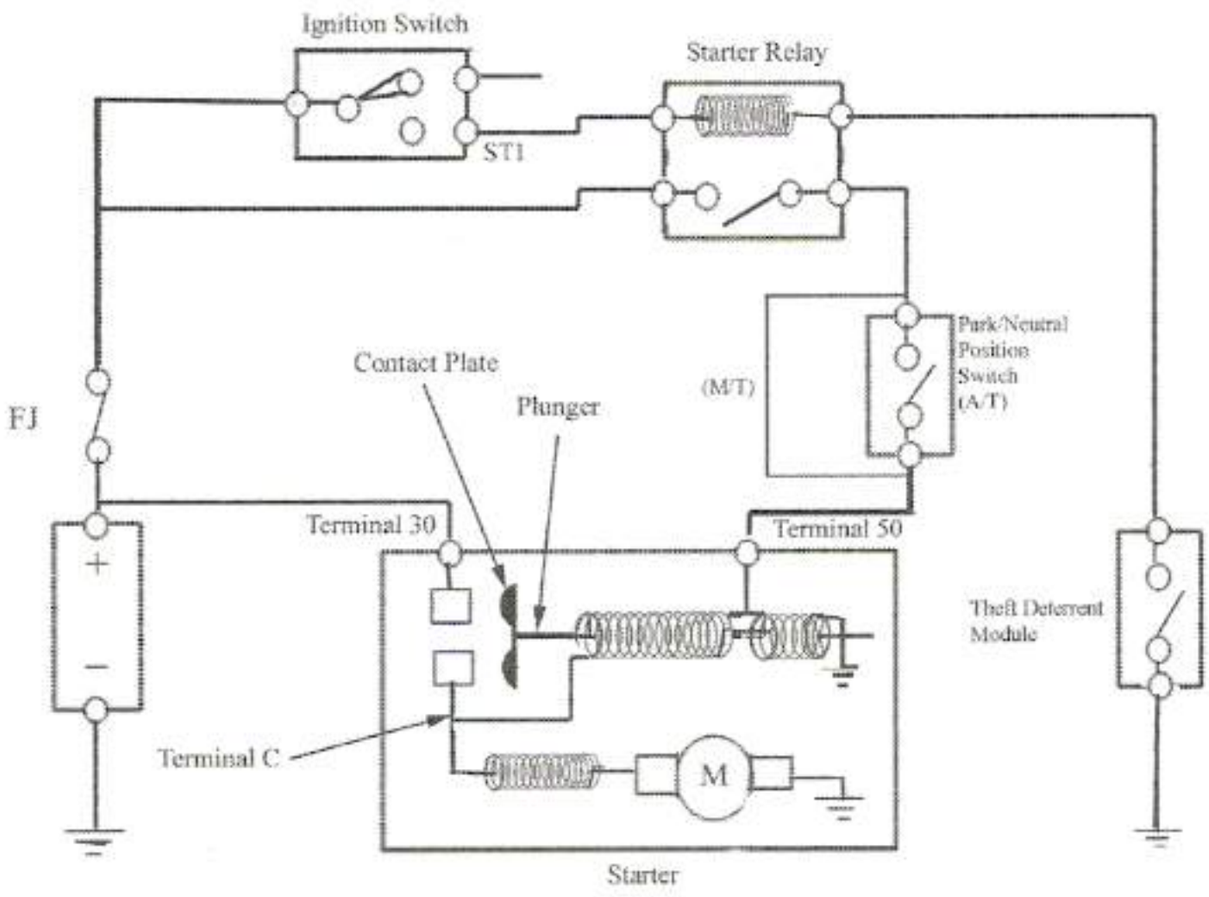
a) Remove 3 bolts securing solenoid switch to drive end housing (V8 - 2 bolts)

b) Remove the solenoid switch assembly, taking care not to

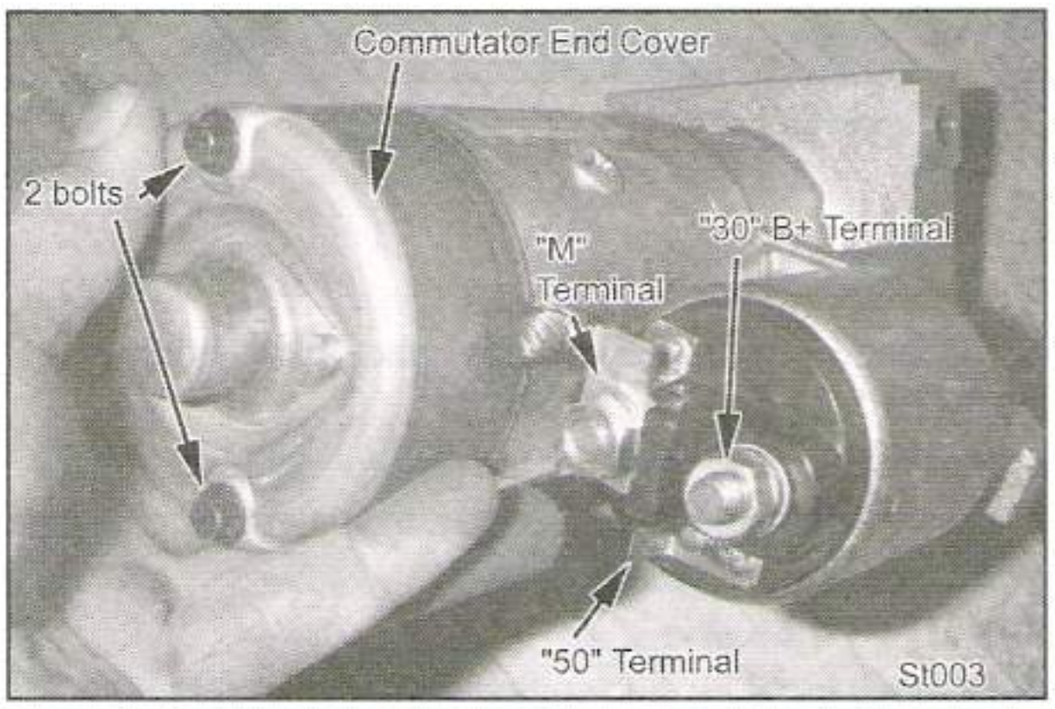
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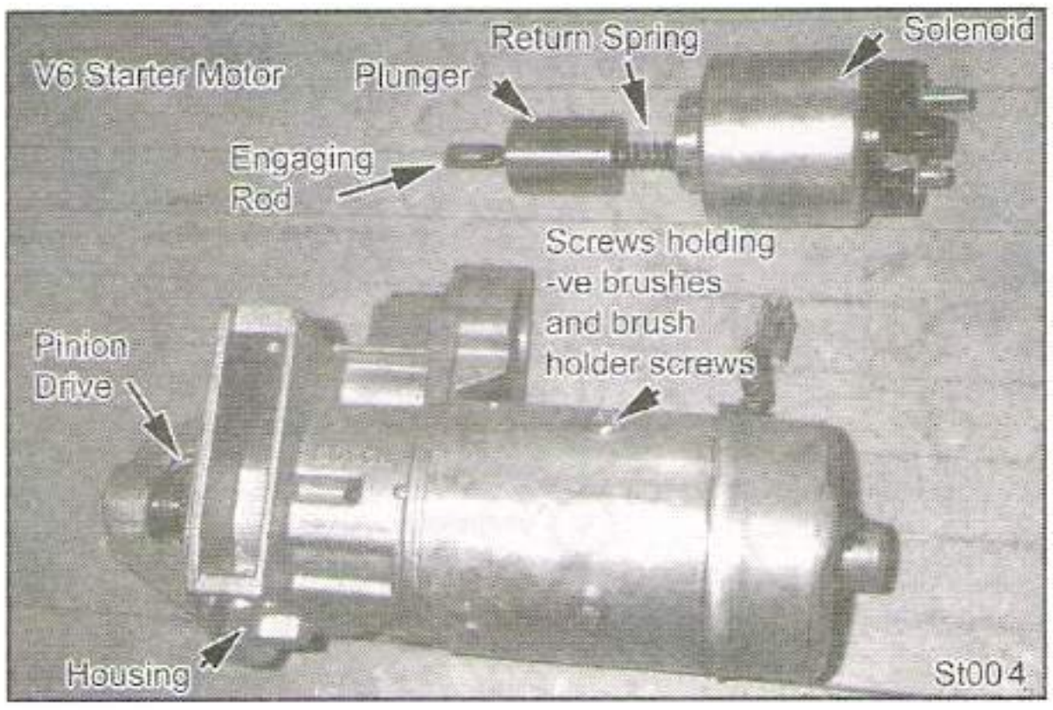
lose the plunger return spring

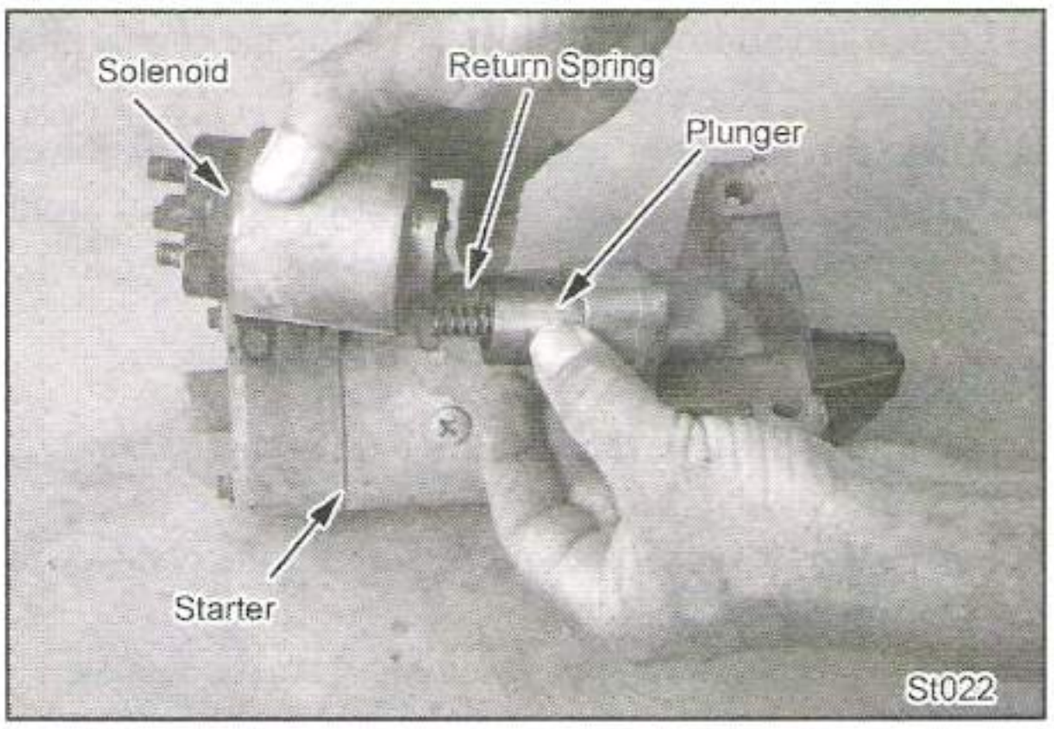
Starting System Circuit Diagram



Sto13







c) Lift the plunger off the drive fork and remove from starter

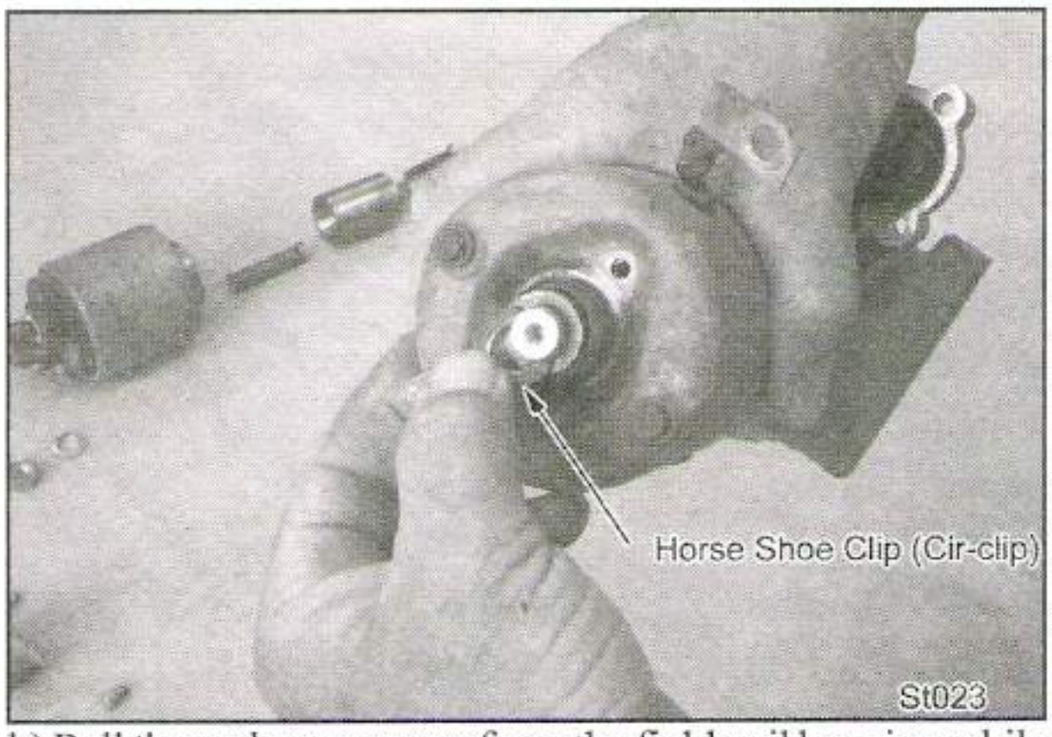
3. Scribe match marks on the drive end housing, field coil housing and the commutator housing end cover

4. Loosen and remove the 2 bolts that secure the commutator end cover and filed coil housing to the drive end cover

5. Remove the commutator end cover, field coil housing and armature as an assembly from the drive end housing

6. Remove 2 screws securing the dust cover to the commutator end cover

a) Remove the horse shoe clip (cir-clip) and any shims from the end of the armature

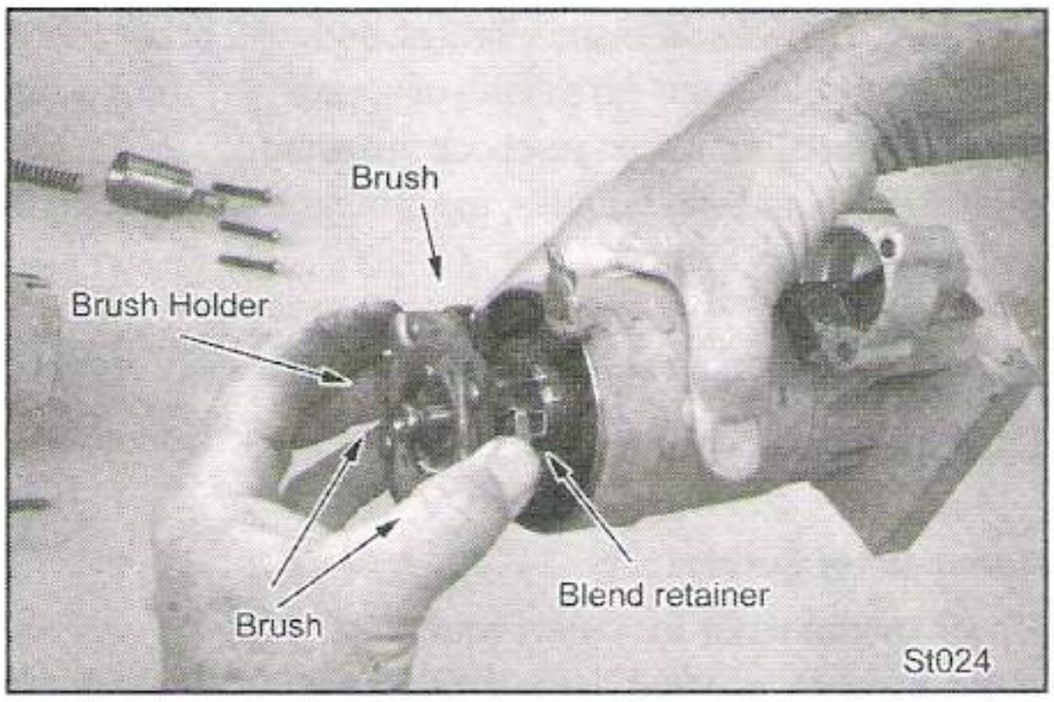


b) Pull the end cover away from the field coil housing while holding the field coil braided wire to the housing

c) Carefully bend back all of the brush retainers and remove the brushes

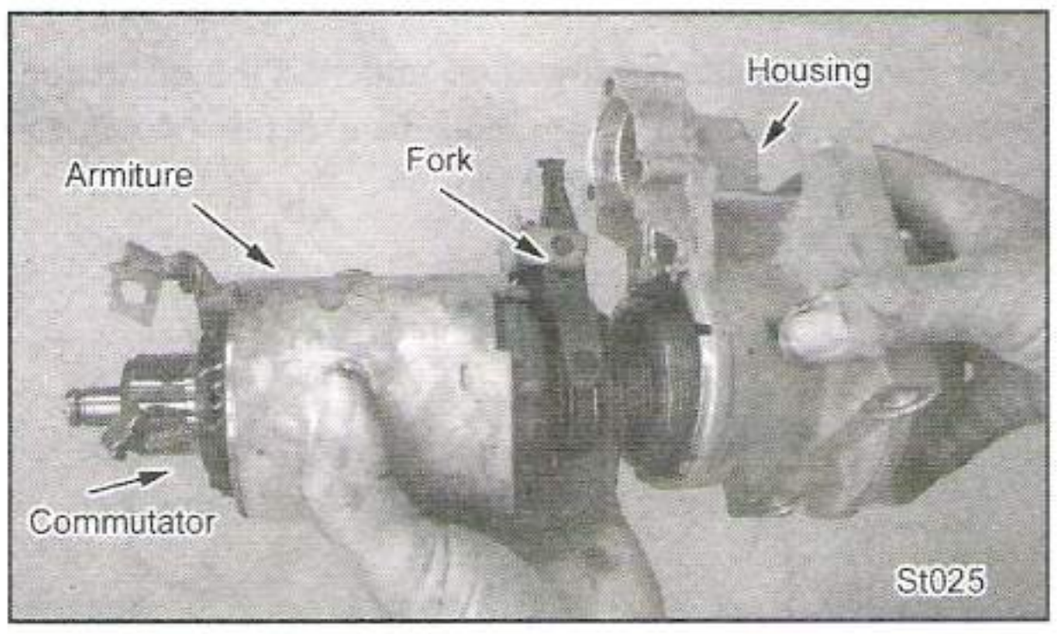
Note: Take care not to loose the brush springs

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d) Remove the brush holder from the commutator.

7. Remove the armature from the field coil housing (commutator)



8. Remove the sealing rubber from the drive end housing

a) V6 - Remove the planetary drive assembly and fork lever from the drive end housing

Assembly

1. Assembly is the reverse of the disassembly operation, noting the following. Lubricate drive end, pinion and commutator end bushes with clean engine oil. Lightly coat armature shaft bearing surfaces and helical splines, drive assembly internal splines and engaging clutch contact surfaces with Molybdenum Disulphide grease.

2. Care must be taken that these gears and bearings are installed correctly: refer Diagram

With the starter motor assembled, a No Load Test should be conducted.

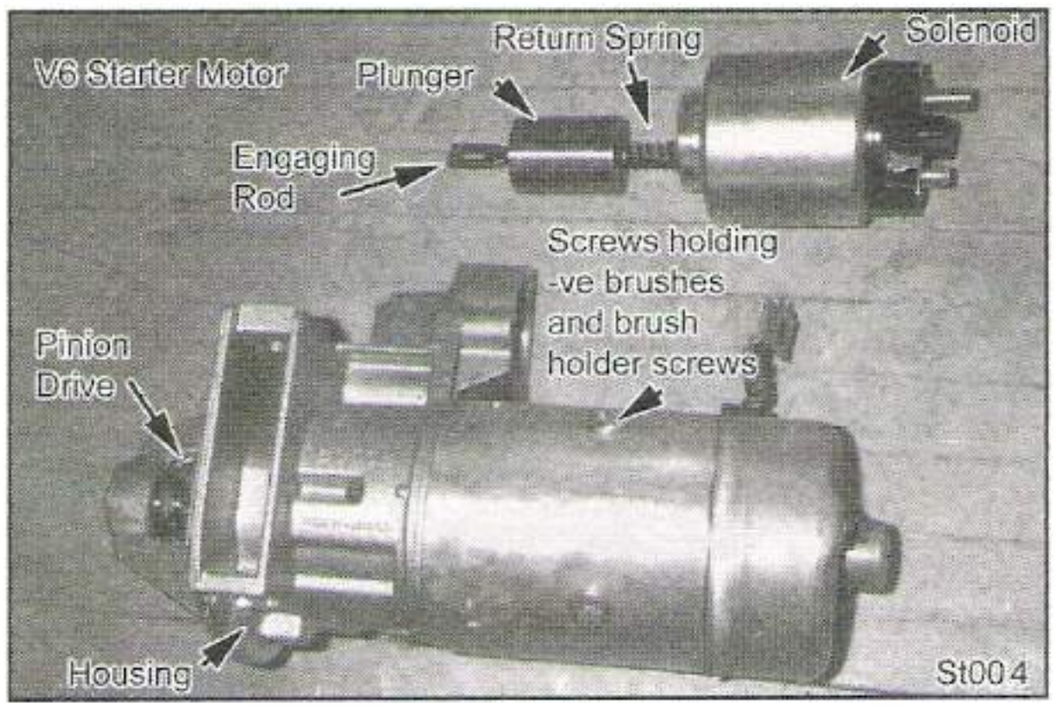
Failure of starter motor to perform according to the No Load specification may be due to tight or dirty bushes or high resistance connections. Rectify any faults found.

Installation

1. Place the starter assembly and start the starter retaining bolts, progressively tighten to specification.

2. Reconnect the starter cable from battery and wiring to switch. Connect the battery earth cable.

3. V8 engines- fit the engine pipe back into position, Gen III install heat shield and steering shaft universal joint, match marks made during removal.



Component Checking

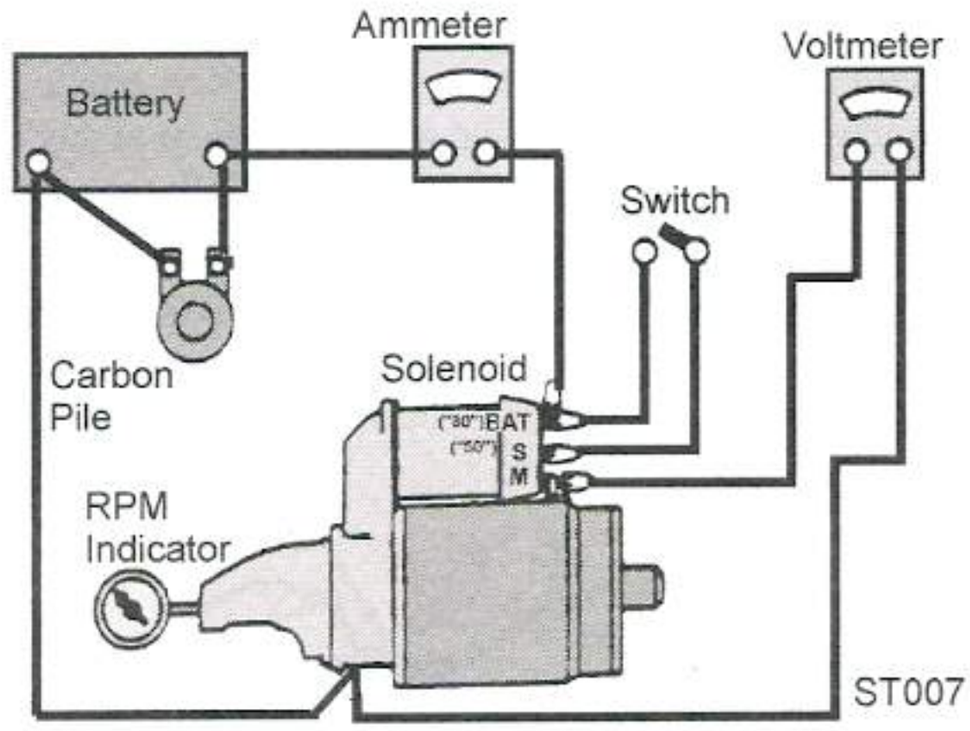
Cleaning and Inspection

With the starter motor completely disassembled, all components should be cleaned and inspected. Wash components except the armature and field coils in a suitable cleaning agent.

CAUTION: Do not clean armature or field coils with cleaning solvent as damage to the insulation could occur. Clean armature and field coils carefully using compressed air

Field Coils

1. Connect a 12 volt powered DC. test lamp or ohmmeter between field coil winding connection and a positive brush. The lamp will illuminate or the meter will show a reading to indicate continuity, if the field coil circuit is serviceable. Repeat on remaining positive brush.



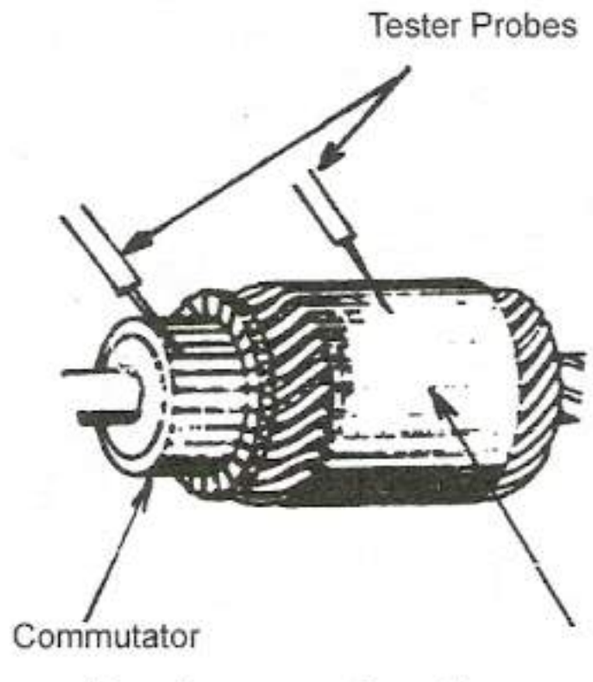
2. Make sure brushes are not touching the field coil housing, then connect a 12 volt powered test lamp or ohmmeter between field coil winding connection and field coil housing. The lamp will not illuminate or the ohmmeter will not show a reading, if winding insulation is satisfactory.

3. Visually inspect field coil windings for signs of insulation breakdown and/or burns.

4. Remove and replace defective field coil with an approved pole shoe screwdriver.

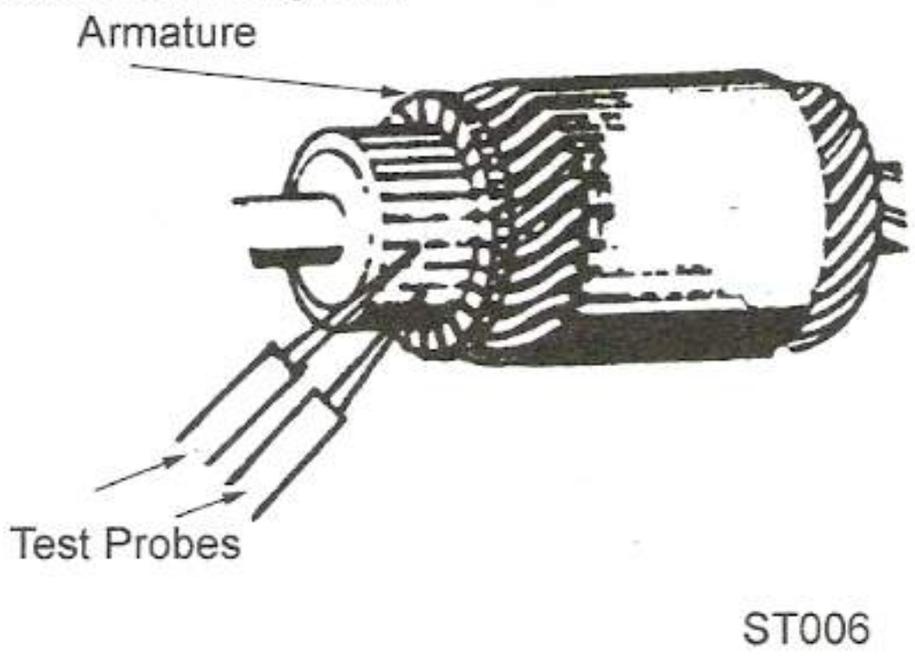
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Armature Insulation Test



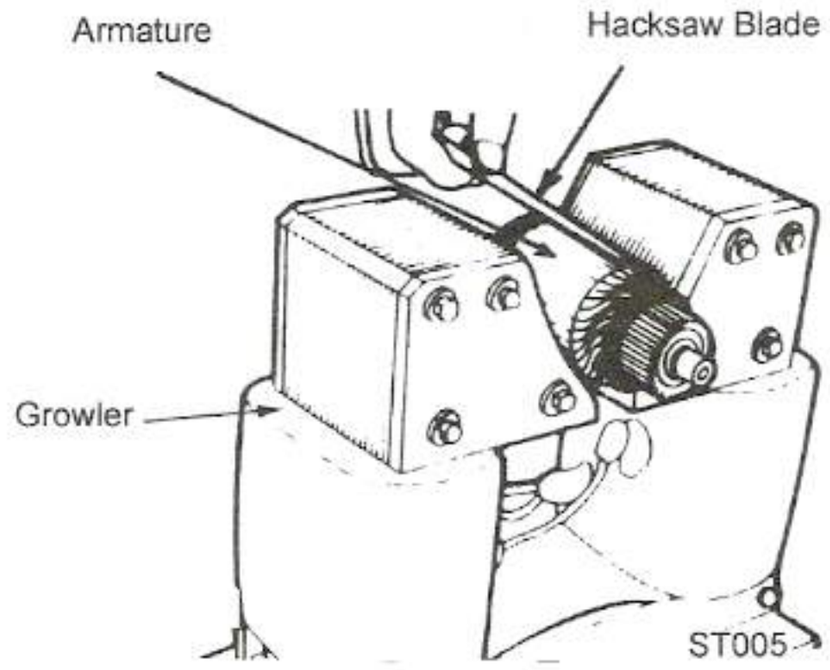
Connect a 12 volt powered test lamp or ohmmeter between the armature core and a commutator segment. If lamp illuminates, armature is grounded and should be replaced. Repeat procedure on the remaining commutator segments.

Armature Continuity Test



Using an Ohmmeter or 12 volt powered test lamp. Touch one probe onto a commutator segment, then touch the remaining probe to an adjacent segment, repeat procedure on each adjacent set of segments. If any adjacent set of segments indicates continuity (test lamp illuminates), the armature windings are shorted, armature to be replaced.

Armature Short Test



Test armature for short circuits on a growler.
Place armature on growler and switch on growler. Hold a hacksaw blade approx. 6 mm above armature core and rotate armature. If hacksaw blade vibrates, undercut between the commutator segments (to a depth of approx. 0.7 mm) using a suitable small file, then re-check armature.
If hacksaw blade still vibrates, the armature is short circuit and must be replaced.

Armature to Commutator Leads

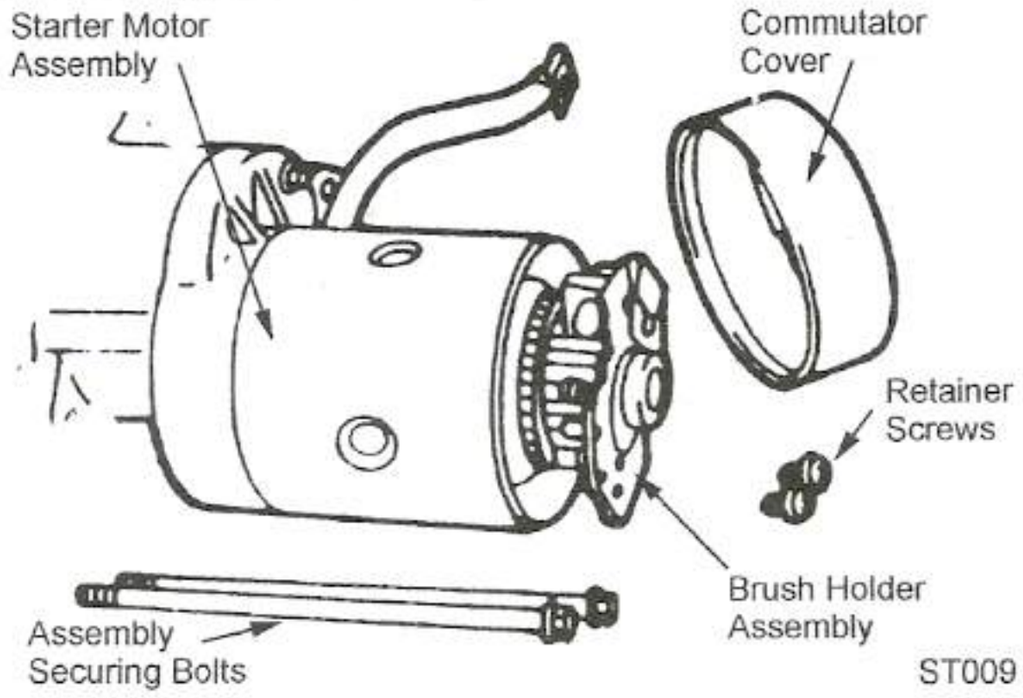
Examine, re-solder or replace if required.

Commutator Surface

Check commutator for out-of-round.
If the armature is otherwise satisfactory but commutator is worn, burnt, out-of-round, or has high insulation between the segments, the commutator should be machined.

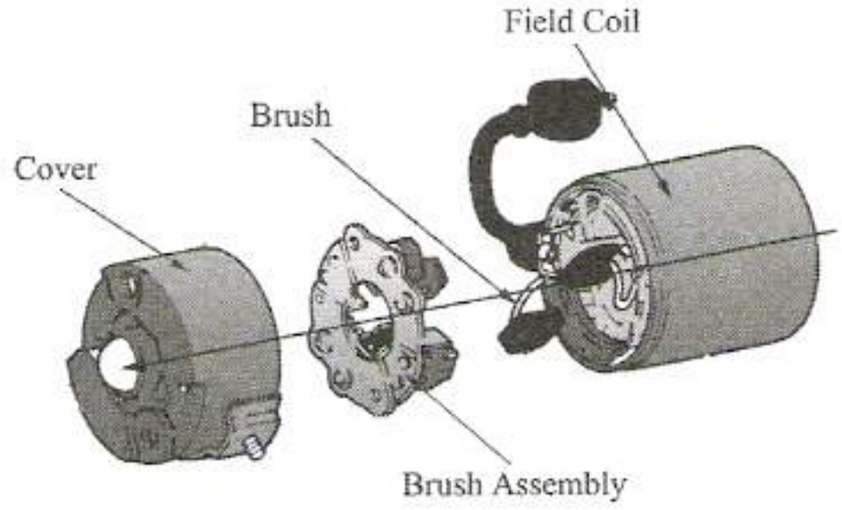
Commutator Diameter

After machining the commutator, undercut the insulation, between the commuter segments to a depth of approx. 0.7mm using a suitable small file.



After undercutting, clean all dirt and debris from the segment slots, and lightly polish commutator with fine emery cloth to remove any burrs left by the undercutting procedure. Clean commutator and armature thoroughly with compressed air.

Brushes



Make sure that brushes slide smoothly in their respective holders, brush connections are good and brushes are clean and not chipped.

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If required replace brushes as follows:

Positive Brushes

Cut brush lead at field coil, dispose of brush and spring. Clean field coil terminal and any remaining section of the brush lead, 'Tin' the field coil terminal.

Note: Replacement brushes have ends of leads 'tinned'

Hold the new brush lead in place on the field coil terminal, using a pair of pliers. Solder brush lead to field coil end.
** When soldering the new brush lead into place, don't allow the solder to run to far up the lead.*

Negative Brushes

Cut brush lead at the brush holder terminal. Dispose of brush and spring. Clean the brush holder terminal, and any remaining section of the brush lead. Clean remaining brush lead on brush holder. 'Tin' brush holder terminal. Hold new brush lead in place on the brush holder terminal, using a pair of pliers. Solder brush lead to brush holder.
** When soldering the new brush lead into place, do not allow the solder to run to far up the lead.*

Test brushes as follows:

Brush Holder Assembly

Using an Ohmmeter, check insulation between the replaced brush holders and earth. If continuity exists, replace holder assembly. Check continuity between negative brushes and earth. If continuity does not exist, replace holder assembly. Check the condition of the positive brush spring tabs. Where tabs are weak, broken or if the tabs have been bent open more than twice before, replace brush holder assembly.

Drive Assembly Check

Examine pinion gear for burrs and worn or chipped teeth. Check operation of pinion, the pinion gear should rotate free and smooth in relation to the pinion housing when turned in a clockwise direction, but not rotate when turned in a counter clockwise direction.

Bushes

Check fit of armature shaft in commutator end cover and drive end housing. If bushes are excessively worn, the starter motor is likely to operate inefficiently and/or the armature may foul on field coil poles.
To remove bushes, support the commutator end cover or drive end housing (as appropriate), carefully tap bush out using a suitable mandrel.

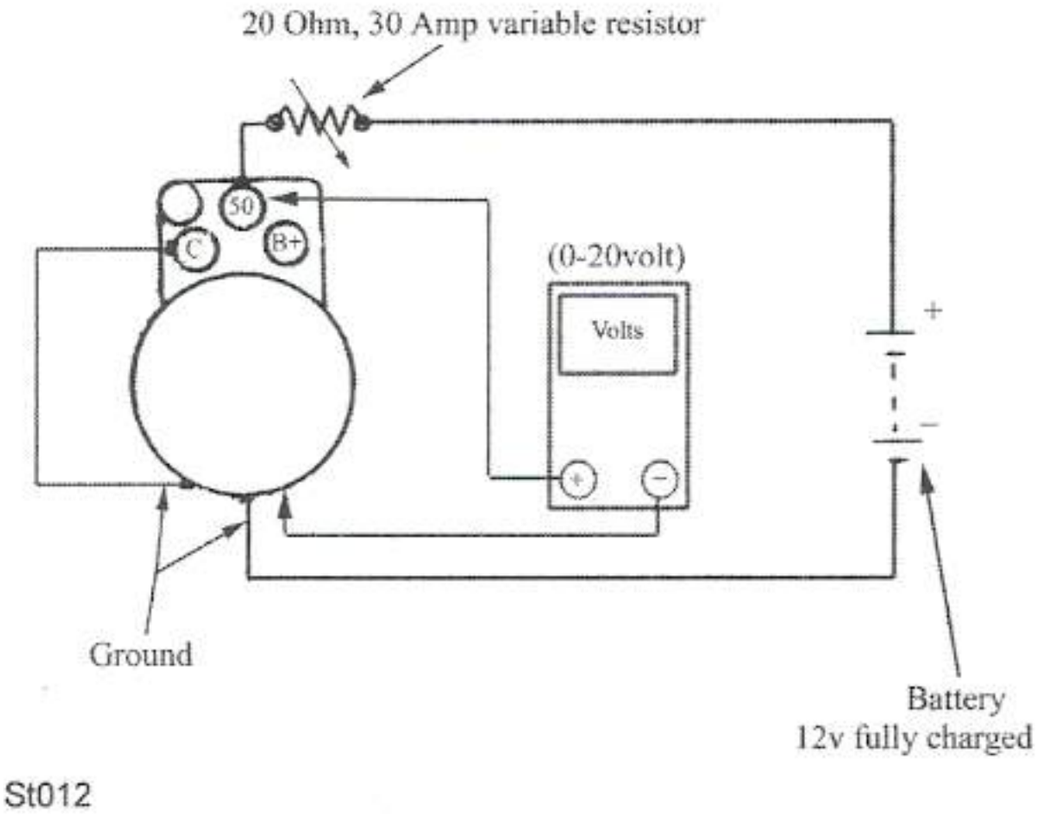
Note: If new bushes are to be installed, they must be soaked in clean engine oil for one hour prior to installation

To install new bushes, press or tap into place with a suitable shouldered mandrel.
Do not ream bushes after they have been installed as self lubricating qualities of the bush will be diminished.

Solenoid

The following tests require a 20 Ohm, 30 amp variable resistor, a voltmeter (0-20 volt scale) and a fully charged 12V battery.
Tests are to be carried out quickly so that the results are not affected by increasing temperature. Test cables are required to be at least 10 gauge.

1. Connect a variable resistor in series with the battery positive terminal and the solenoid '50' terminal, then adjust the maximum resistance.
a) Connect a jumper lead from battery negative terminal to a good ground on the solenoid housing.
b) Connect a jumper lead from solenoid field coil terminal to a good ground on solenoid housing.
c) Connect the voltmeter positive lead to solenoid '50' terminal and negative lead to a good ground on solenoid housing.



2. Slowly adjust variable resistor until solenoid plunger 'pulls in' and note voltmeter reading.
a) Quickly adjust variable resistor to minimum resistance. Full voltage is therefore applied to saturate the magnet core. Immediately detach jumper lead from solenoid field coil terminal.
b) Slowly adjust variable resistor until solenoid plunger springs out, and note voltmeter reading.

Note: If solenoid does not operate within voltage limits, replace solenoid. Measurements at 20° C.

Pull-In Voltage:	3.0-6.5 volts
Hold-In Voltage:	0.2-2.0 volts

Battery Inspection

Testing Battery Electrolyte Levels

A hydrometer should be used to determine the specific gravity of battery electrolyte. The reading obtained indicates amount of unused sulphuric acid remaining in electrolyte and state of charge of battery.
The reading obtained will vary in relation to the temperature of the electrolyte. As the temperature rises the density of the electrolyte decreases and the specific gravity falls. As the

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temperature falls the density increases and the specific gravity rises.

Using the Hydrometer

1. Liquid level of battery cell should be at normal height and electrolyte should be thoroughly mixed with any battery water which may have just been added by charging battery before taking hydrometer readings.
2. Draw electrolyte in and out of hydrometer barrel several times to bring temperature of hydrometer float to that of the acid in the cell.
3. Draw sufficient electrolyte into hydrometer barrel with the pressure bulb fully expanded to lift float so that it does not touch the sides, bottom or top of barrel.
4. Read the hydrometer with the hydrometer in a vertical position.

Test Result Indications

Electrolyte specific gravity	Battery Charge Level.
1.240 to 1.260	100%
1.210 to 1.240	75%
1.180 to 1.210	50%
Below 1.130	Discharged.

Battery Charging

A battery should be charged if the specific gravity is less than 1.210. If there is more than 0.25 specific gravity variation between cells then a fault is most likely with the battery itself.
If battery charge is low and battery is serviceable, check alternator operation and all electrical connections.

Problem Solving & Diagnosis

PROBLEM

Speed low.

FAULT

Check battery electrolyte specific gravity.
Check battery terminal for corrosion or loose fitting.

PROBLEM

Speed, torque and current consumption low.

FAULT

High resistance in motor. Check field to terminal connection, condition of bushes and their connections and check brushes for dirty or burnt commutator.

PROBLEM

Speed and torque low, current consumption high.

FAULT

Tight or worn bearings, bent armature shaft, insufficient end play, armature fouling pole shoe, short-circuited armature, earthed armature or field coil.

PROBLEM

Speed and current consumption high, torque low.

FAULT

Short circuit windings in field coils.

PROBLEM

Armature does not rotate, no current consumption.

FAULT

Open circuit armature, field coils or solenoid. If commutator is badly burned, there may be poor contact between brushes and commutator, owing to excessively worn or sticking brushes.

PROBLEM

Armature does not rotate, high current consumption.

FAULT

Earthed field winding or short-circuited solenoid. Armature physically prevented from rotating.

PROBLEM

Excessive arcing at commutator.

FAULT

Defective armature windings, sticking brushes or dirty commutator.

PROBLEM

Armature rotates but pinion does not mesh with ring gear.

FAULT

Pinion bearing fouled, burred, damaged ring gear or broken pinion teeth.

SPECIFICATIONS

Bosch DV Four Pole, Four Brush & Planetary drive train - V6 Engine	
Number of pinion teeth	9
No Load Test	
Ampere	12 amps or less @ 11.5V
Rpm	5300 rpm or more
Lock Test	
Max Current	740 amps
Volts	4 volts
Torque	20 Nm
Solenoid Test (Removed)	
Pull-In Voltage	7.8 volts @ 20°C
Hold-In winding resistance	1.16-1.3 ohms @ 20°C
Pull-In winding resistance	0.248-0.281 ohms @ 20°C
Armature End Play	0.05-0.30mm
Armature Out of Round - max	0.5mm
Commutator Out of Round- max	0.1mm
Commutator Diameter	31.2mm
Depth of Undercut	0.8mm
Brush Min Length	7mm
Field Coil Resistance	1 Megohm or greater

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Bosch Four Pole, Four Brush - VT Set I V8 Engine

Number of pinion teeth	9
No Load Test	
Ampere	70 amps or less @ 12V
Rpm	6500 rpm or more
Lock Test	
Max Current	525 amps
Volts	7 volts
Torque	23 Nm
Solenoid Test (Removed)	
Pull-In Voltage	8 volts @ 20°C
Hold-In winding resistance	1.16-1.3 ohms @ 20°C
Pull-In winding resistance	0.248-0.281 ohms @ 20°C
Armature End Play	0.05-0.30mm
Armature Out of Round - max	0.5mm
Commutator Out of Round- max	0.05mm
Commutator Diameter	33.5mm
Depth of Undercut	0.7mm
Brush Min Length	13mm
Field Coil Resistance	1 Megohm or greater

Bosch Four Pole, Four Brush - Gen III V8 Engine

Number of pinion teeth	10
No Load Test	
Ampere	90 amps or less @ 11V
Rpm	2500 rpm or more
Lock Test	
Max Current	760 amps
Volts	4 volts
Torque	19.5 Nm
Solenoid Test (Removed)	
Pull-In Voltage	8 volts @ 20°C
Hold-In winding resistance	1.70-3.0 ohms @ 20°C
Pull-In winding resistance	0.98 ohms @ 20°C
Armature End Play	0.05-0.20mm
Armature Out of Round - max	0.1mm
Commutator Out of Round - max	0.1mm
Commutator Minimum Diameter	28.4mm

Torque Specifications

Through Bolts	6.6-9.6 Nm
Pole Screws	30-60 Nm
Solenoid Bolts	4.5-6.0 Nm
Starter to Block	40-60 Nm
Engine Pipe to Flange	15-35 Nm
Engine Pipe to Convertor	30-50 Nm

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ALTERNATOR SYSTEM

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General Information

The V6 engine uses the Bosch KC-A Compact 100 amp or 90 amp alternator. This alternator is a 3 phase type incorporating a rotor with 6 pole pairs and is fitted with 2 cooling fans.
V6 Police pack and WH with option T82 are fitted with Mitsubishi 120 amp alternator
The VT Ser I V8 engine is equipped with Bosch 120 amp alternator. This alternator is 3 phase type incorporating a rotor which is of 12 pole construction and also utilises two internal cooling fans.
Gen III V8 engines are equipped with a Mitsubishi 140 amp alternator.

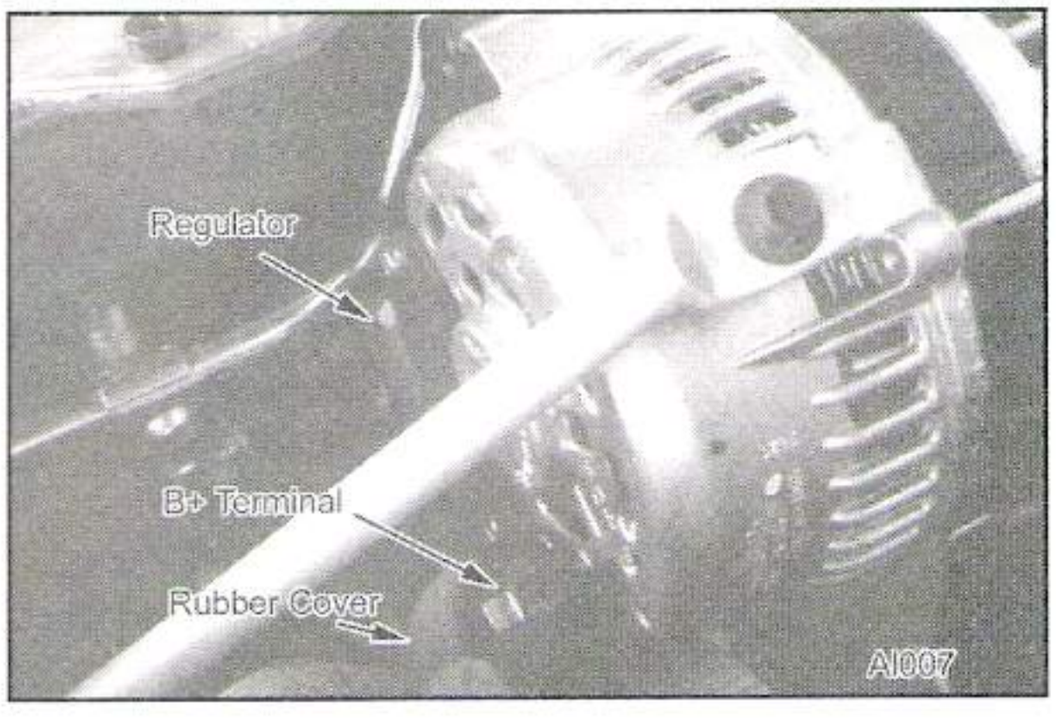
When the engine is operating with the ignition switch turned on, a flow of electrical current passes through the rotor coil wiring which energises the rotating electromagnet (the rotor). The spinning of the rotor causes the stator windings to cut the magnetic lines of force of the rotor, this creates an AC current voltage in the stator windings.
Rectifiers convert the AC current to DC current at the output terminal, rectifiers also stop the current flowing back through the alternator from the battery.

On Vehicle Tests

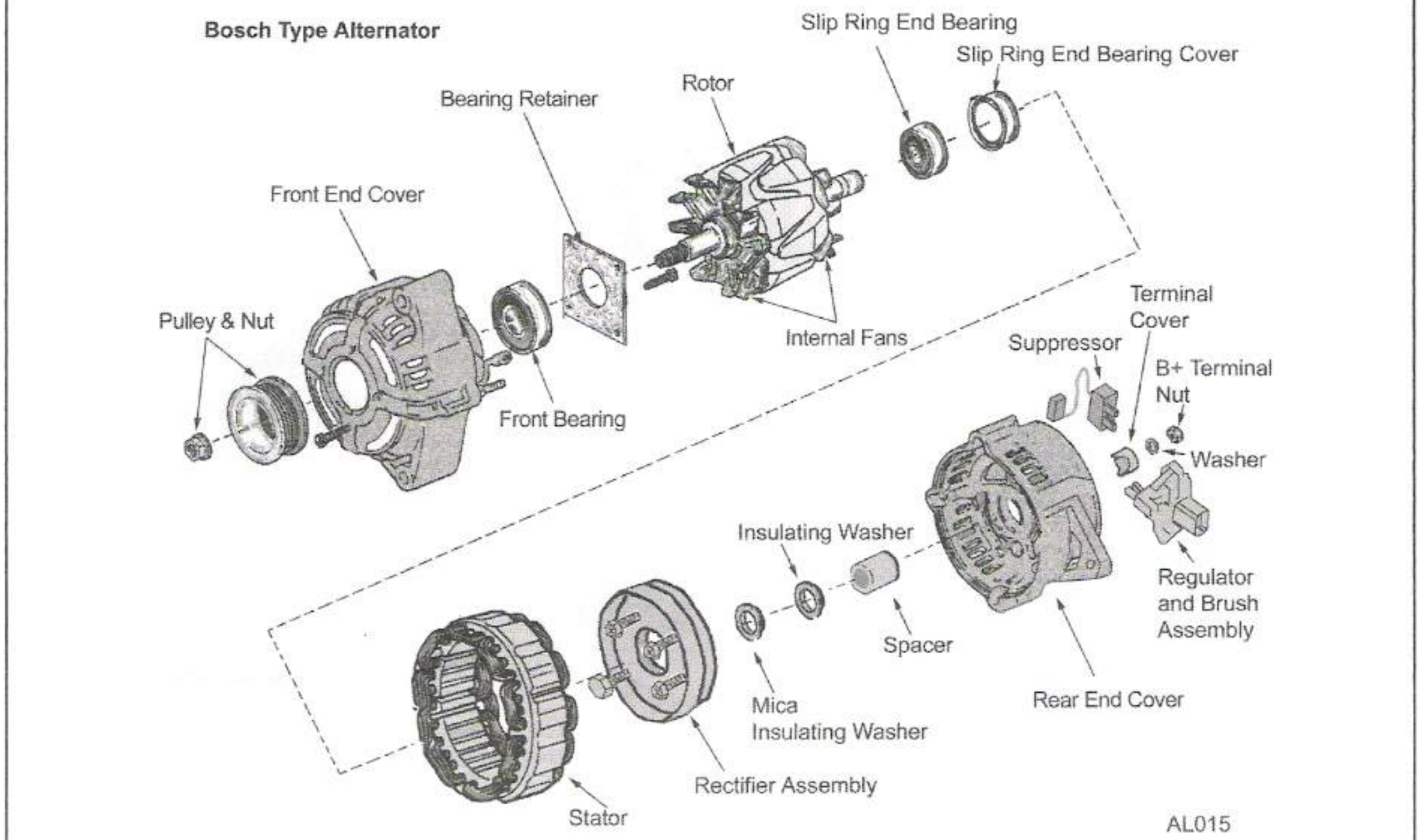
Before carrying out on vehicle tests check:
1. The alternator indicator light is operating, if it is not the test results will be inaccurate.
2. The battery must be fully charged.
3. Engine must be at normal operating engine temperature.
4. Engine idle must be within specification.

Alternator Operating Test

1. Make sure all electrical equipment is turned off, and the ignition system is in off position. Disconnect battery earth cable at battery.
2. Detach alternator positive lead from the 'B+' alternator terminal.



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3. Connect positive lead of an ohmmeter (0-100 Amp scale) to the alternator 'B+' terminal, and the negative ohmmeter lead to the disconnected alternator positive lead.

4. Connect positive lead of a voltmeter (0-20 Volt scale minimum) to the alternator 'B+' terminal, and negative voltmeter lead to a good ground on alternator body.

5. Insulate the alternator positive lead terminal to prevent contact with any metal part of the vehicle. If the terminal is grounded, damage to the charging circuit will result when the battery is reconnected.

6. Connect battery earth cable. Connect an electrical load instrument to the battery, this should have a power consumption of 8 to 10 amps.

If you do not have an instrument for this turn on lights and other known power rated accessories to obtain power consumption of 8-10 amps.

7. Start engine and check alternator output against rated output.

Charge Rates:

V6 Engine:

Standard Amperage - 10A or less
Standard Voltage - 14.2-14.6v @25°C (77°F)

VT Ser I **V8 Engine:**

Standard Amperage - 10A or less
Standard Voltage - 14.25-14.55v @25°C (77°F)

V8 Gen III Engine:

Standard Amperage - 5 A or less
Standard Voltage - 14.1-14.7v @25°C (77°F)

If alternator doesn't provide rated output, it should be disassembled and inspected for faults.

When the Alternator Output Check is completed, to prevent excessive battery discharge occurring, the engine should be returned to idle speed and the loading device detached from battery terminals.

Detach the battery earth cable at battery, remove bolt and ohmmeters, then reconnect the alternator positive lead (red wire) to the alternator 'B+' terminal. Connect battery earth cable to the battery.

Charging Circuit Voltage Drop Test

With normal connections made at alternator, charging circuit can be checked for voltage drop as follows:

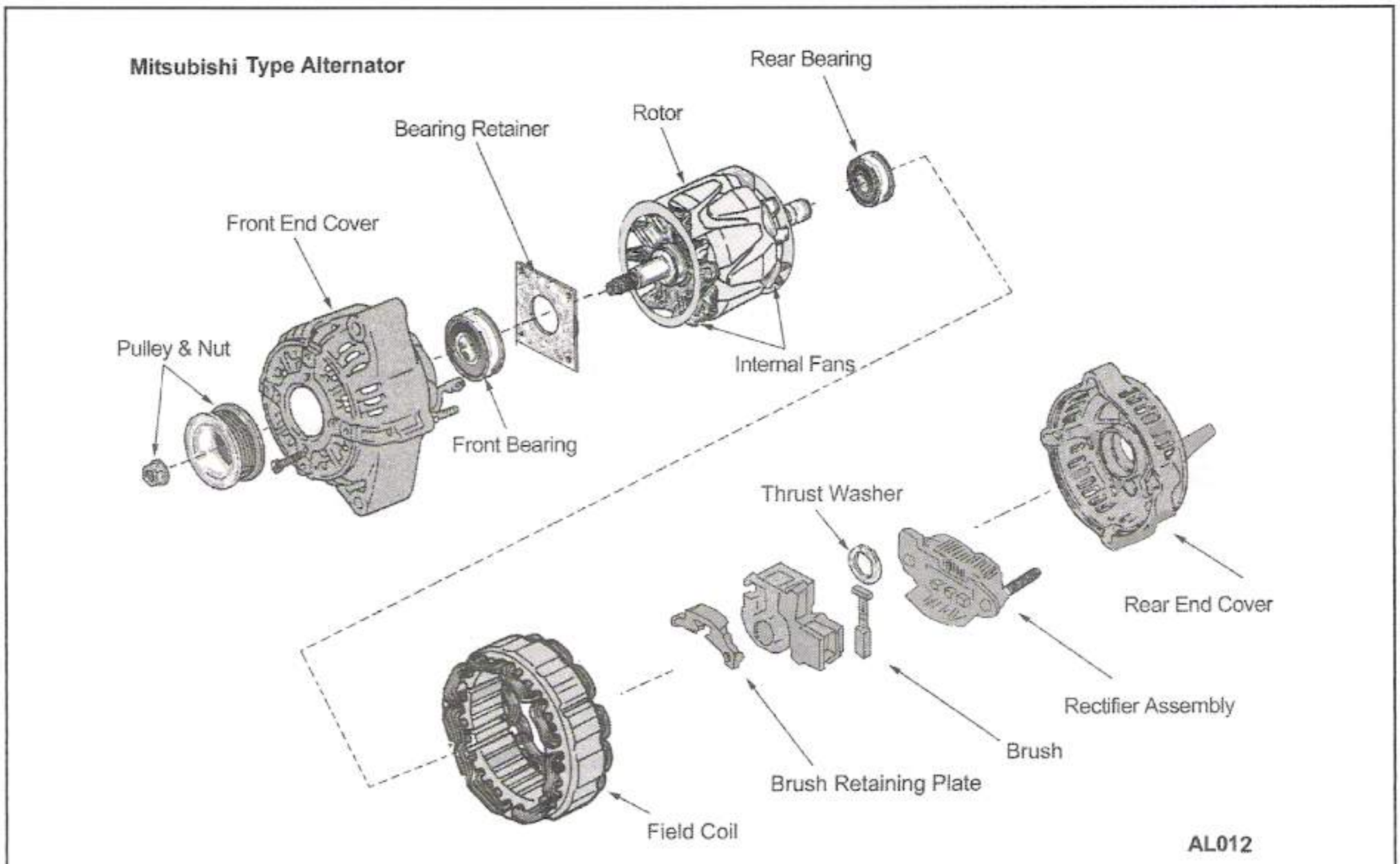
1. Connect positive lead of a low range voltmeter at the alternator 'B+' terminal and the negative voltmeter lead to the battery positive terminal.

2. Start engine, switch on headlamps, then increase engine speed to approx. 2500 RPM and note voltmeter reading.

3. Stop engine and transfer voltmeter connections, negative lead to alternator body and the positive lead to battery negative terminal. Start and operate the engine at approx. 2000 RPM and again note voltmeter reading.

4. If readings exceed 0.5 volts on positive side and 0.25 volts on negative side, there is a high resistance in charging circuit which must be traced and corrected. Stop engine, detach the voltmeter.

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Maintenance

Remove

V6 - Engine

1. Detach battery earth cable at battery

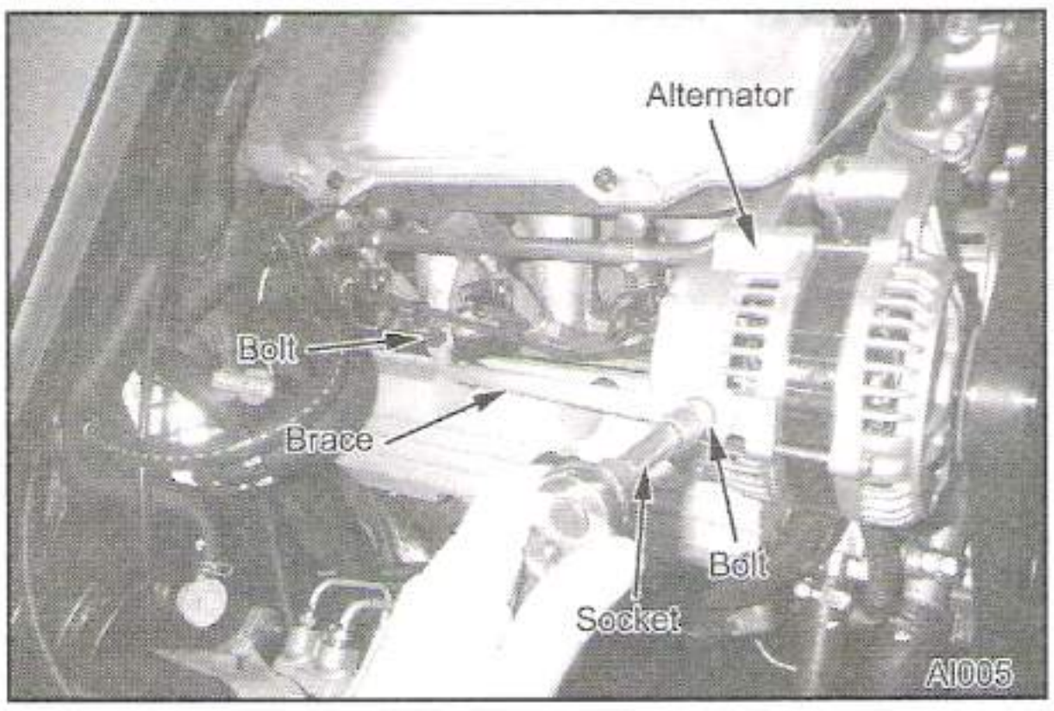
a) Remove the engine cover 4 dome nuts

2. Use a 15 mm ring spanner to release the serpentine belt tensioner

a) Remove the serpentine belt

3. Pull back the B+ terminal cover and remove the nut, washer and positive wire

4. Remove the brace attaching bolts 2 and remove brace.



5. Loosen upper and lower alternator attaching bolts

a) Remove the upper bolt

b) Hold the alternator and remove the lower bolt and alternator assembly

c) Disconnect the regulator electrical connector

V8 - Engine

1. Disconnect the battery negative terminal

a) Loosen the alternator drive belt idler pulley nut

b) Loosen idler pulley adjusting bolt enough to allow belt removal

2. Loosen the upper and lower alternator mounting bolts

a) Disconnect the electrical connector at the regulator

b) Undo and remove the positive lead nut, washer and lead

3. Remove the lower mounting bolt

a) Hold the alternator and remove the upper mounting bolt and the alternator assembly

Dismantle V6 & V8

1. Scribe a match mark on the housing and stator frame

2. Loosen and remove the 2 regulator/brush assembly mounting screws

a) Carefully remove the regulator/brush assembly

Note: Take care not to damage the brushes

3. Loosen and remove the 4 through bolts

4. Carefully separate the slip ring end housing and stator as an assembly from the rotor / drive end housing

Note: Take care not to damage stator wires

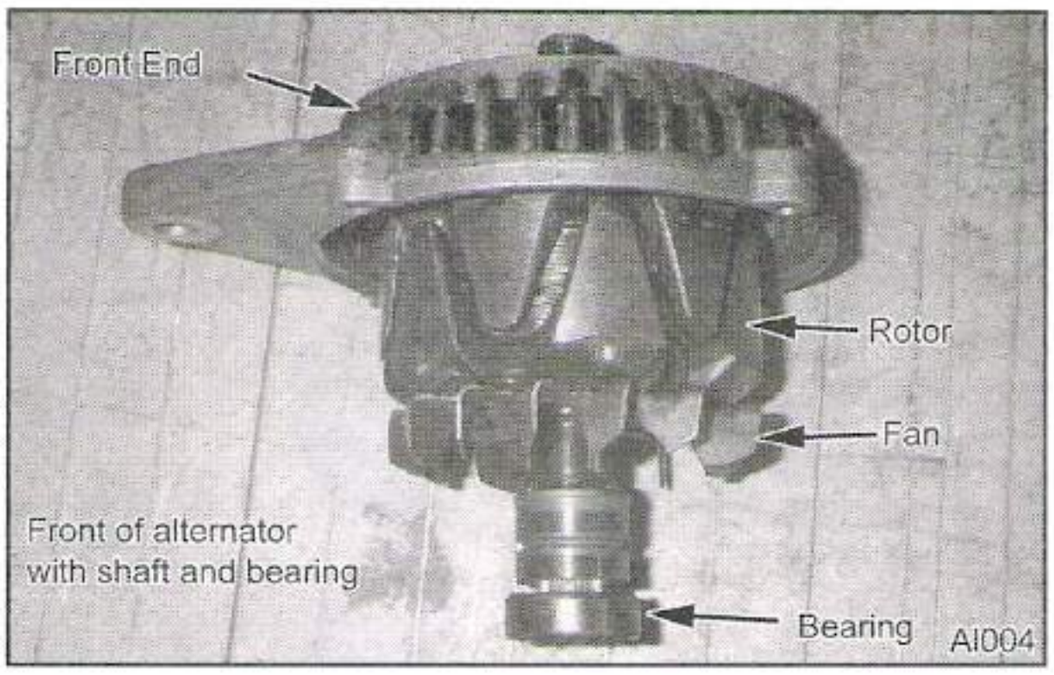
5. Fit an 8 mm Allen key to the drive pulley shaft and mount the Allen key in a vice

a) Use a 24 mm ring spanner to loosen the pulley mounting nut

b) Remove the nut and pulley etc from the drive shaft

Warning: Never mount the drive pulley in a vice to loosen

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the mounting nut or damage will occur

6. Loosen and remove the bearing retainer 4 screws

a) Push the rotor shaft and front bearing from the drive end housing

Assemble V6 & V8

1. Fit new drive end bearing into drive end housing

a) Position the bearing retainer plate and fit 2 screws

Torque: 2.1-3.0Nm

2. Insert a new slip ring bearing into the Bosch special tool -9981 066 600

a) Fit the rotor into special tool so as the slip ring side of shaft is seated in the new bearing

b) Fit the drive end housing onto the special tool

c) Insert the special tool mandrel into the drive end housing and carefully press the bearings into correct position

2. Fit the drive pulley, washer and nut

a) Fit an Allen key 8 mm to the end of drive shaft and secure in a vice

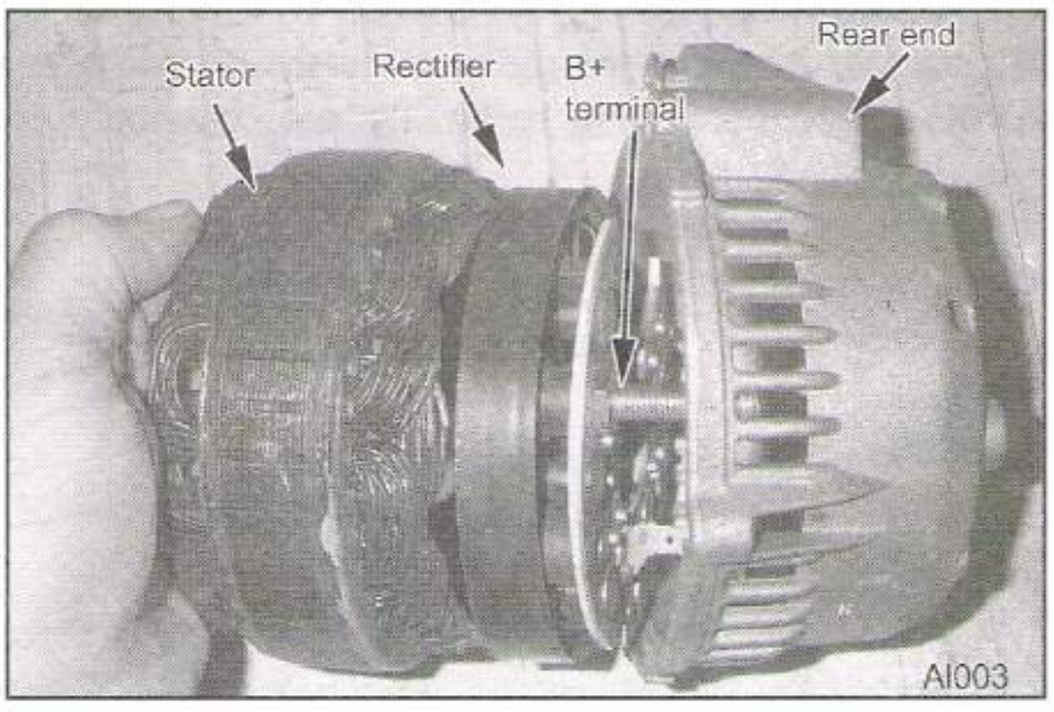
b) Tighten the drive shaft nut to specified torque

Torque: 54-68Nm

3. Apply heatsink compound to both sides of new rectifier positive heatsink mica washers

a) Fit the mica washers into position in the slip ring end housing

b) Fit the rectifier assembly into the slip ring end housing



c) Fit insulator, flat, wave washers and nut to the B+ terminal finger tight

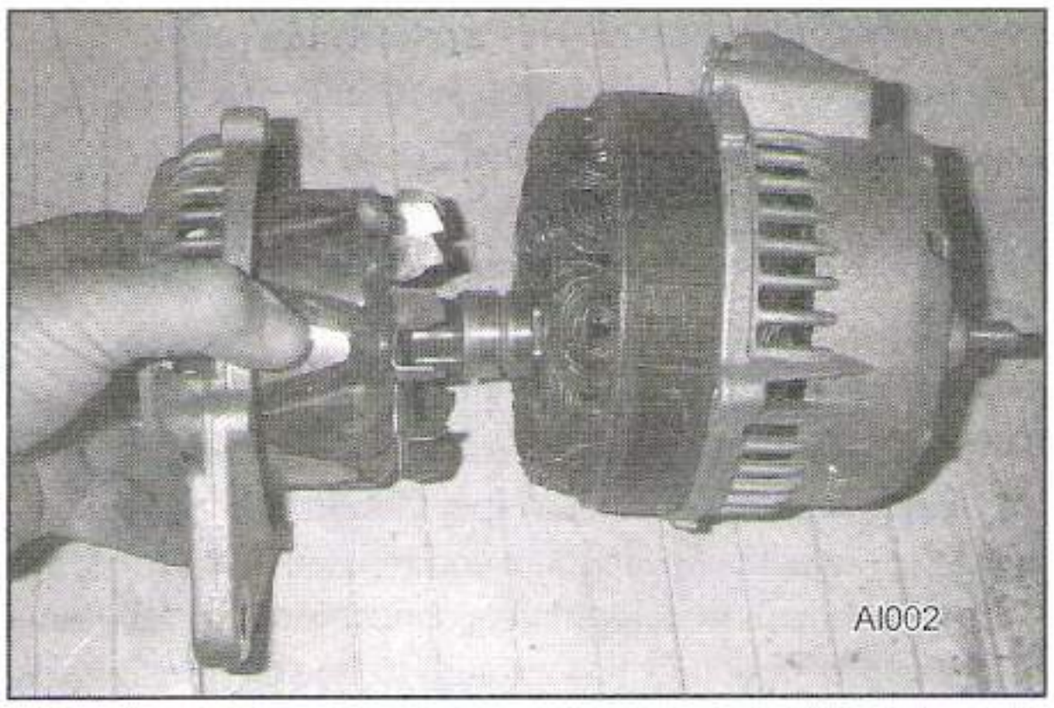
d) Fit the rectifier mounting screws and tighten to specification

Torque: 1.6-2.3 Nm

e) Tighten the B+ terminal nut to specifications

Torque: 7.5-8.5 Nm

4. Assemble the rotor and drive end housing into the stator and slip ring end housing, taking care to align match marks made on disassembly



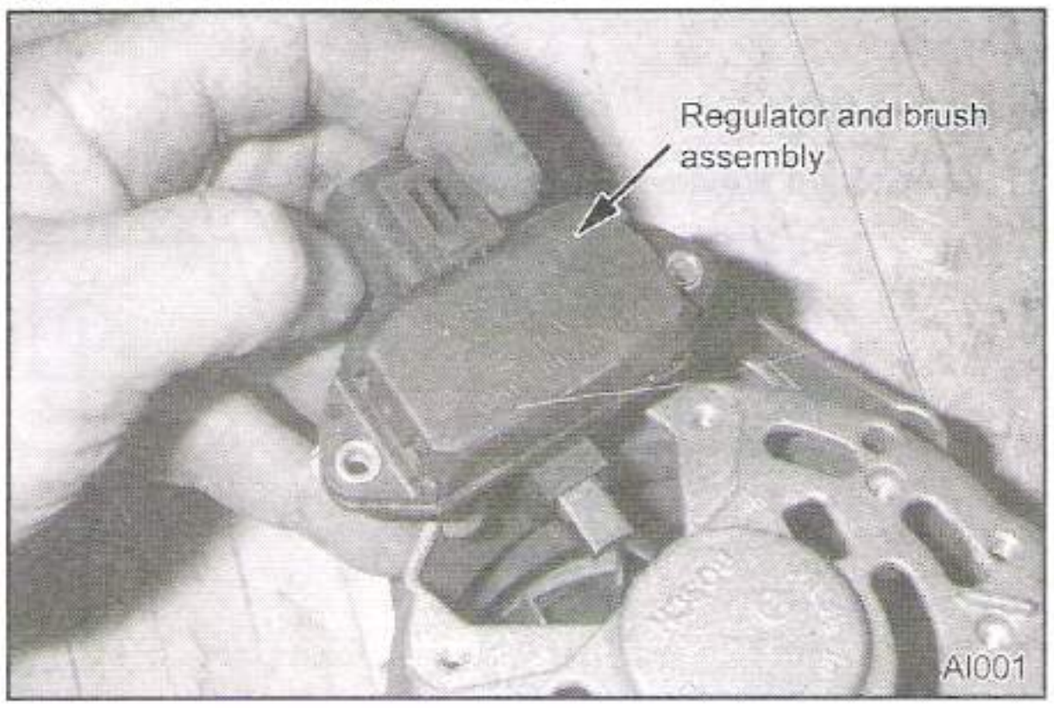
5. Fit the 4 through bolts and tighten to specification

Torque: 3.8-5.5 Nm

Note: ensure that all housings are seated correctly

6. Carefully install the brush/regulator assembly into position

a) Fit 2 screws and tighten to specifications



Toque: 1.6-2.3 Nm

7. Check that the rotor rotates freely

Installation

1. Install alternator in the reverse order of the removal instructions

2. Connect battery earth cable at battery

3. Check the alternator operation, charge rate etc.

Component Checking

Clean and Inspect

With alternator completely disassembled, clean and inspect all components. Wash the components, (excluding stator), rotor, rectifier and regulator in a suitable cleaning agent. Don't clean stator or rotor windings with cleaning solvents as

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damage to the insulation may result.

Rectifier Assembly

The rectifier can't be overhauled, and is serviced as an assembly only.

1. Using a powered DC. test lamp (of less than 24 volts) or ohmmeter, touch probes to terminal thread and rectifier frame. Reverse probe connections and repeat test to check that current has passed in one direction only.

2. Repeat procedure with probes on negative side of rectifier.

Note: Test lamp or ohmmeter will show a short circuit if any one diode is grounded

3. Replace the rectifier assembly if required found to be faulty

Brush Gear

1. Measure length of brushes installed in the voltage regulator. Replace brushes if not at specified length.

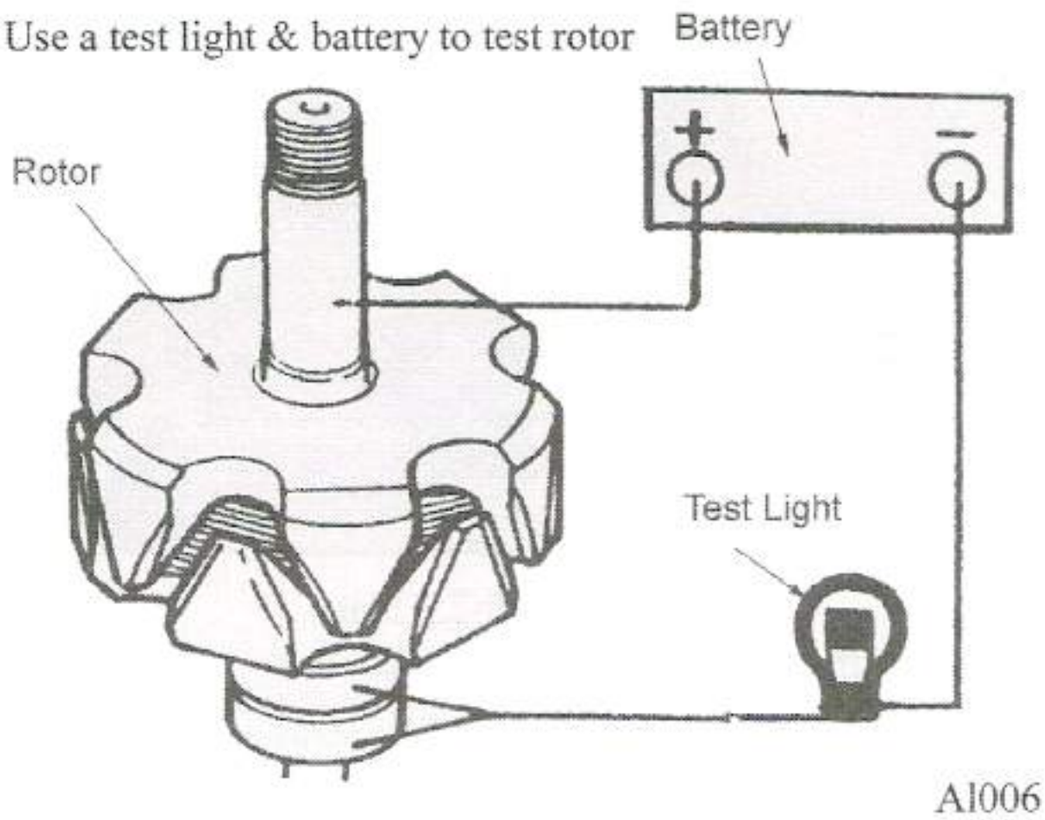
2. Inspect brushes for damage and replace if required, unsolder brush leads from regulator connections, carefully bend back the retaining lugs just enough to free the brush leads. Remove and dispose of the brushes and springs.

3. Place silicon tubing over brush leads, install new brush springs over brush leads, then install brushes into regulator and carefully solder leads to connections.

4. Bend the retaining tabs back into the original places and check that the brushes are free and move smoothly in and out of holder.

Rotor Insulation Test

Use a test light & battery to test rotor

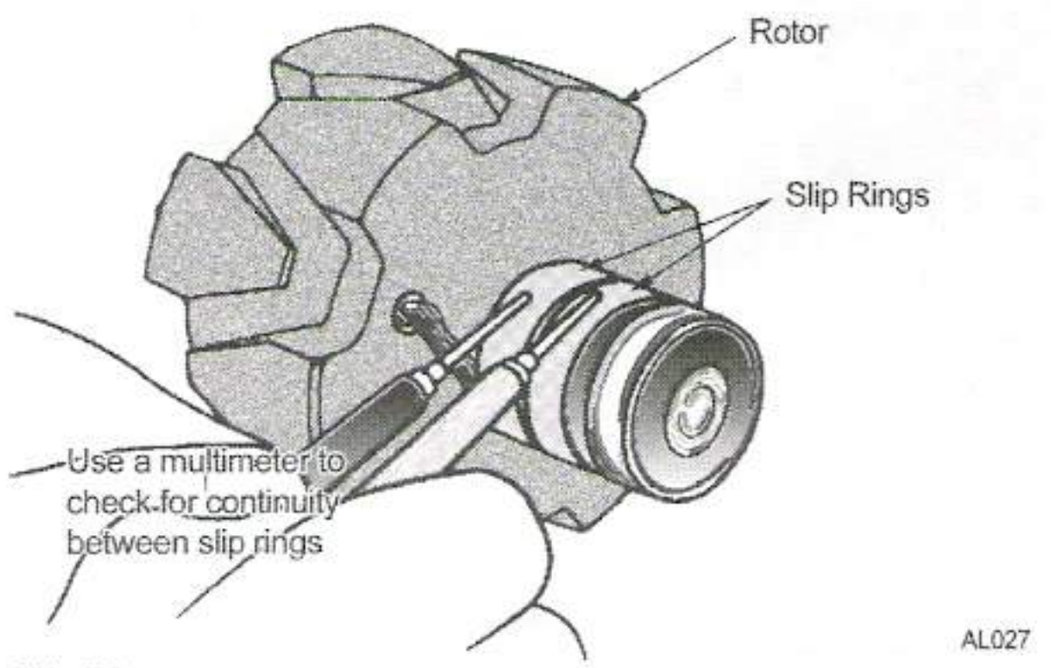


Al006

Check insulation between slip rings and rotor core and shaft, using an ohmmeter or test light. If continuity exists, replace rotor.

Rotor Open Circuit Test

Connect ohmmeter probes to slip rings and measure resistance of rotor windings. Replace the rotor if the resistance is not within the specifications



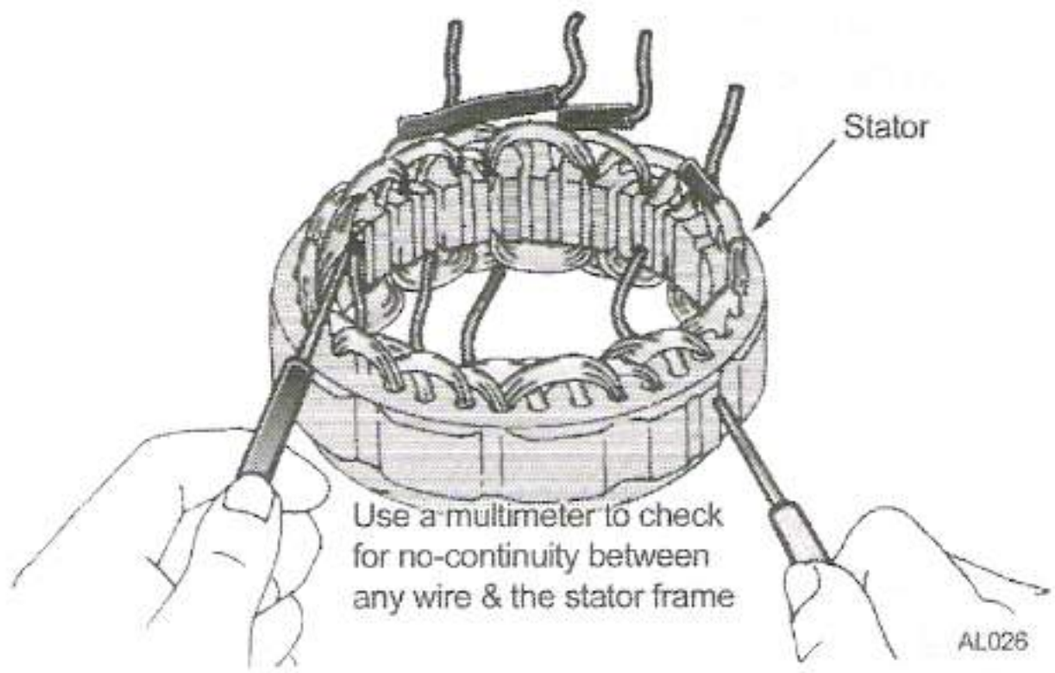
Slip Rings

Check slip rings for wear or damage and polish with emery cloth until smooth or replace rotor as necessary

Bearings

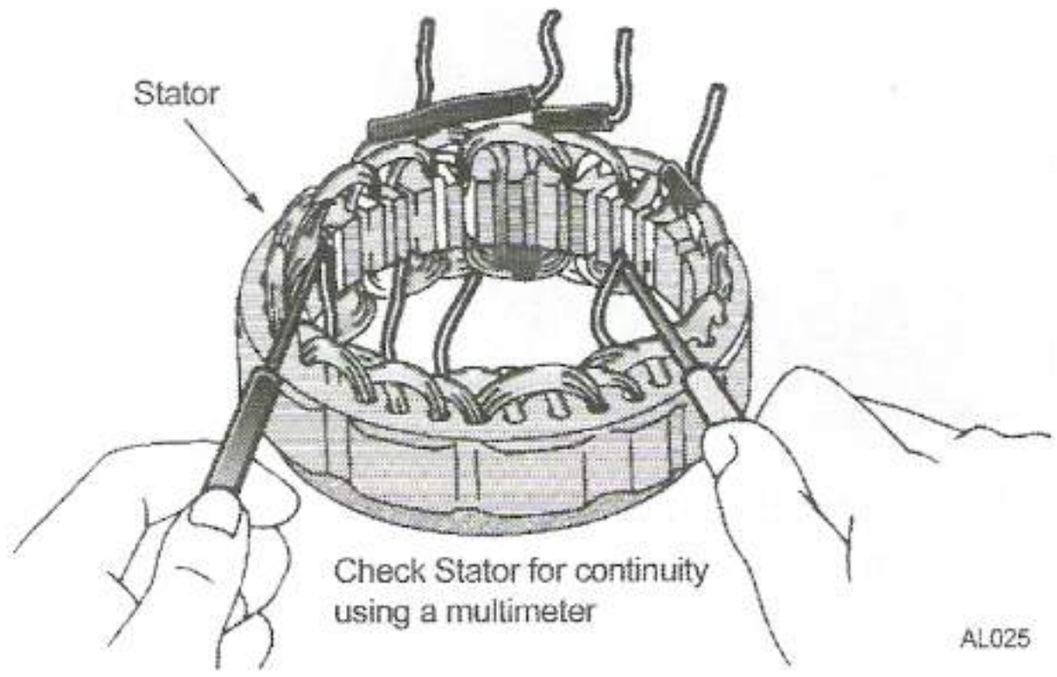
Examine the bearings for evidence of overheating, cracks or other damage. Check bearings for operation that is free and smooth.. Check bearing bores in drive end slip ring end plates for wear. If bearing outer race is allowed to rotate in its bore, it will cause ovality of the bore and a lip will form in the bore. If the bearings are serviceable, pack bearings with grease. Replace damaged bearings if required.

Stator Insulation Test



Connect an ohmmeter to any stator lead and the stator frame. If there is no-continuity this indicates that the stator winding is OK, if there is continuity replace the stator assembly.

Stator Open Circuit Test



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Connect ohmmeter to any two stator leads and check for continuity, repeat the operation on remaining stator leads. Replace the stator if any two leads do have continuity.

Problem Solving & Diagnosis

Battery Will Not Charge

* Battery cells not faulty
* Battery terminals dirty or loose
* Battery acid level low
* Battery acid specific gravity specification of 1.230
* Loose or corroded connection in charging circuit
* Faulty generator
* Faulty voltage regulator

Indicator Light Stays Off

* Globe broken or blown
* Defective regulator
* Defective Wiring
* Open circuit in rotor winding

Indicator Light Stays On

* Positive diode failure
* Defective voltage regulator
* Faulty alternator
* B + cable off or broken
* Battery Overcharged

Noisy Alternator

* Worn bearings
* Loose alternator drive pulley
* Open or shorted diodes
* Open or shorted Stator winding
* Generator mounting brackets loose
* Worn or frayed drive belt

Battery Overcharges

* Battery acid specific gravity not correct
* Shorted battery cell
* Faulty voltage regulator
* Short circuit in rotor winding

Alternator Not Charging

* Faulty regulator
* Brushes worn or sticking
* Brush springs broken or lost tension
* Faulty rectifiers
* Open circuit in stator wiring, charging circuit or field circuit
* Loose drive belt

Specifications

Battery

Specific Gravity @ 20°C: 1.25-1.29

Alternator

Type		
All	V6	Bosch KC-A 100 amp
VT Series 11	V6 (some models)	Bosch KC-A 90 amp
Police Pack all models	V6	Mitsubishi 120 amp
WH with T82 option	V6	Mitsubishi 120 amp
VT Series 1	V8	Bosch 120 amp
Gen 111	V8	Mitsubishi 140 amp

Rotor Coil Resistance:

V6 Bosch - 2.47-2.73 ohms
V8 Bosch - 2.3 ± 0.115 ohms
V8 Mitsubishi - 1.7-2.1 ohms

Stator Coil Resistance:

Bosch	100 amp - 0.058-0.063 ohms
Bosch	90 amp - 0.027 ± 0.0027 ohms
Bosch	120 amp - 0.015 ± 0.00015 ohms
Mitsubishi	140 amp - negligible

Brush Exposed Length:

Bosch V6	New	12 mm
	Min	3.8 mm
Bosch V8	New	9.3 mm
	Min	3.8 mm
Mitsubishi V8	New	18.5 mm
	Min	5.0mm

Regulator

Regulating Voltage:

VT & WH-V6	14.2-14.6 v
VX, VU, VY & WH 11 - V6	14.35-14.65 v*
VT Ser1 V8	14.25-14.55 v
Gen 111 V8	14.1-14.7 v

*same alternator as VT, different regulator.

Torque Specifications

Through Bolts: ..... 3.8-5.5 Nm
Front Bearing Retainer Plate: ..... 2.1-3.0 Nm
Drive Pulley: ..... 54-68 Nm
Regulator Assembly: ..... 1.6-3.2 Nm
B+ Terminal Nut: ..... 7.5-8.5 Nm
Rectifier Plate: ..... 2.2-3.2 Nm

V6 Engine

Support Mounting Bolt: ..... 20-34 Nm
Alternator to Belt Tensioner: ..... 20-34 Nm

VT Ser I V8 Engine

Bracket to Head Bolts: ..... 46-60 Nm
Idler Pulley Nut: 35-65
Alternator to Bracket Nut: ..... 20-45 Nm

Gen III V8 Engine

Alternator to Drive Belt Tensioner Bolts: 40-50 Nm
Alternator Support Brace Bolts: ..... 20-30 Nm

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COOLING SYSTEM

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General Description

All models both V6 & V8 use a aluminium core crossflow design radiator. The side tanks are made of plastic and a high temperature rubber seal is used between the side tanks and the radiator core. Tanks are held in position with clinch tabs that are part of the core. Vehicles equipped with automatic transmission have coolers located in both of the side tanks. Two electric fans are fitted to the inside of the radiator and are controlled by the P.C.M which uses inputs from various sensors to determine if the fans should be turned on.
Water passing down through radiator is cooled by air flow through radiator fins.

Note: The correct concentration of recommend coolant/ inhibitor must be maintained in the cooling system.

The radiator cap is a pressure sealing type. It incorporates two valves; a pressure release valve and a vacuum released valve, and has two functions:

1. To increase pressure in cooling system and thus raise boiling point of coolant.
2. In conjunction with the coolant recovery bottle, to maintain the coolant in radiator at maximum level.

The coolant recovery bottle is connected to radiator filler neck by a plastic tube. The system operates in the following manner.
As the coolant is heated it expands and pressure in the system increases. When pressure reaches a predetermined point pressure release valve in radiator cap opens and coolant is forced out of radiator and into recovery bottle.
As engine cools the coolant contracts thus creating a vacuum in radiator. The vacuum release valve in radiator cap opens and coolant is drawn back into radiator.

Note: Coolant recovery system will not operate if the cooling system has an air leak.

The water pump is a centrifugal type pump. It is mounted at the front of the motor and is belt driven by a pulley mounted to crankshaft.
The thermostat is a wax pellet type and incorporated in system to ensure quick engine warm up and to keep the engine at the optimum operating temperature.
A common misconception is that by removing the thermostat the engine will run cooler, this is incorrect, as it can quite often increase the running temperature and induce overheating.

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The thermostat acts as a restrictor as well as to stop coolant flow in a cold engine, if you remove the restriction of the coolant flow, fast flowing coolant does not have time to disperse the stored heat from the engine therefore causing the engine to run hotter.

COOLANT

The V6 & V8 engines have a large number of components made of aluminium alloys, this makes it essential that an effective coolant/inhibitor additive is maintained in the cooling system.

As a general rule coolant manufactured by different companies should not be mixed even if the coolant is the same colour.

Glycol coolant has several properties other than antifreeze, it will help lubricate various valves in the cooling system, thermostat slides and water pump seal surfaces.

Glycol will also raise the boiling point of coolant.

GLYCOL BOILING POINT CHART

Kpa Pressure	PSI Pressure	33% Glycol	55% Glycol
0	0	04.5oC	108.5oC
25	3.7	110.5oC	114.0oC
50	7.4	116.5oC	119.5oC
75	11.0	121.0oC	125.0oC
100	14.7	125.0oC	129.0oC
150	22.1	132.5oC	136.0oC
200	26.4	139.0oC	142.5oC

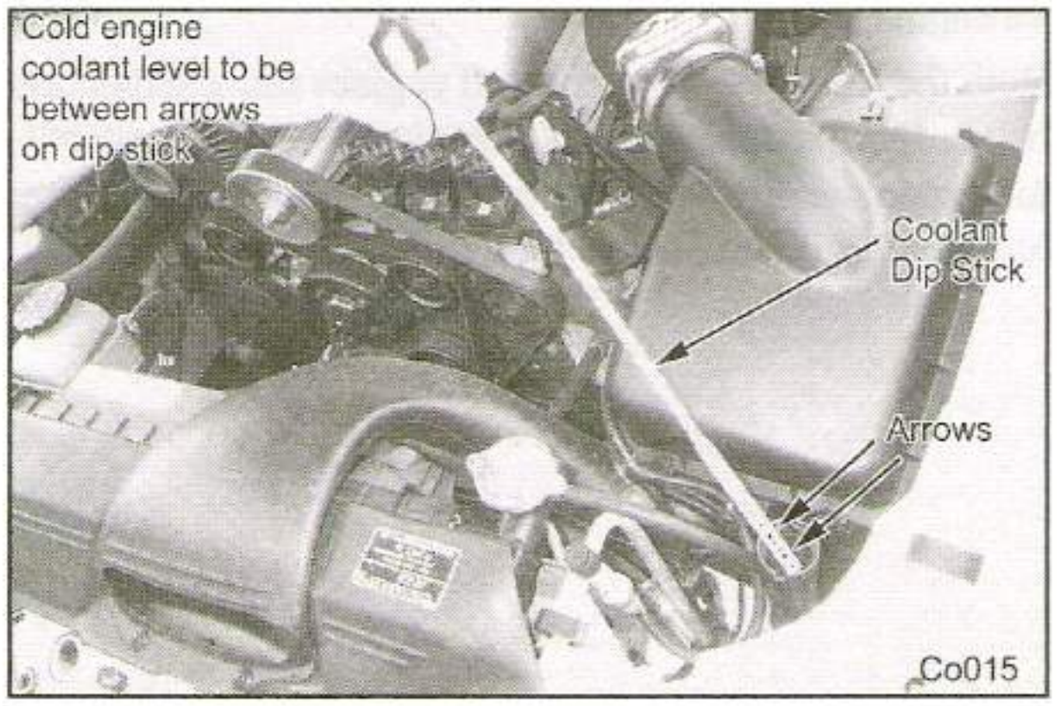
General Maintenance

Coolant Level Check

All V6 and VT Ser 1 V8

1. The coolant level is inspected by checking the coolant reservoir, check dip stick.
2. Also remove radiator cap to check coolant level, the coolant level MUST be to the top of the radiator neck.

Tip: It is possible for the coolant reservoir to have the correct reading on the dip stick and the water level in the radiator to be low.





Note: Only remove radiator cap if the cooling system is cold

The coolant level should be in between the indicator arrows on the dipstick at the coolant recovery tank.

Gen 111 V8

The coolant level is inspected by checking the coolant reservoir. The coolant level should be in between the indicator lines on the side of the coolant recovery tank.

Note: GenIII has an engine coolant level switch, which is located in the bae of the coolant reservoir. It can not be serviced and the coolant reservoir and switch are a none serviceable unit.



Note: Only remove radiator cap if the cooling system is cool.

Note: Depending on the engine temperature the level will vary

If removing the radiator cap when the engine is cold, the coolant level should be to the top of the radiator filler.

Radiator Cap Pressure Test



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1. Remove the radiator cap
2. Use water to clean cap seals and vacuum relief valve. Following manufacturer's directions, install cap on a pressure test unit.
3. Depress the plunger of test unit pump slowly until highest reading is achieved on gauge.
4. This reading should lie within the specification for the cap being tested. Repeat test several times.
5. If gauge reading is not within specification replace cap.

Draining / Filling Cooling System

Drain

WARNING: Under no circumstances should the radiator cap be completely removed prior to the pressure in the cooling system being relieved

Allow the engine to cool before attempting to remove the radiator cap. Place a rag over the radiator cap and slowly release to the first stop and allow pressure to release. Detach lower radiator hose from radiator to allow coolant to drain from the system.

V6

To drain block remove knock sensors from both sides of engine block.

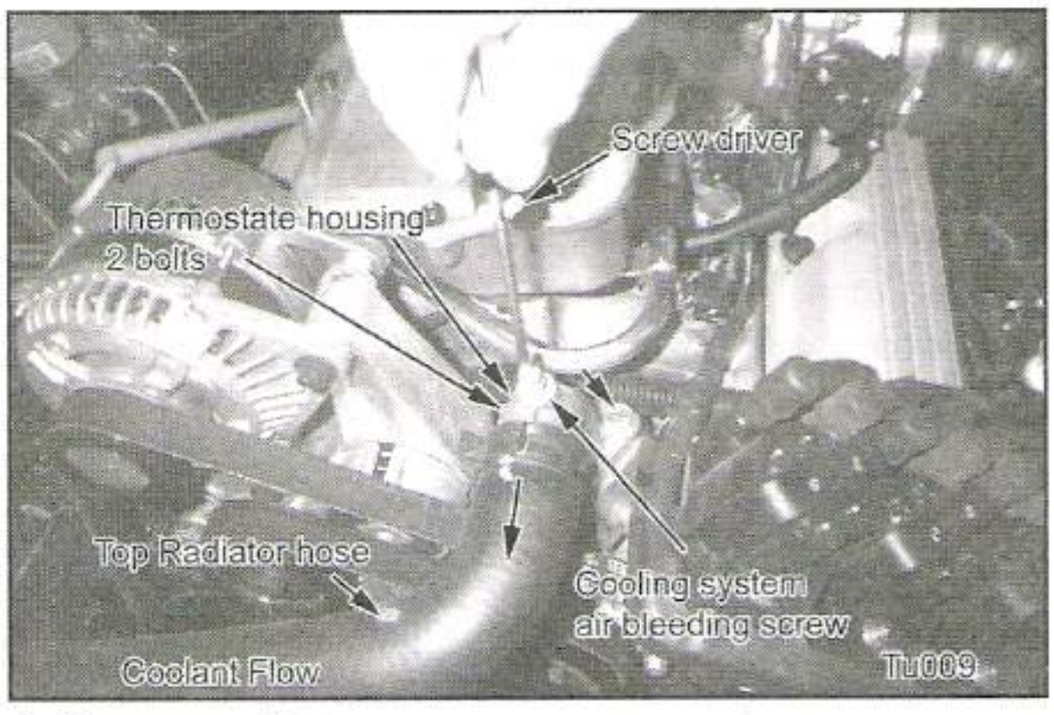
Refill

If the cooling system has been drained, the following instructions should be followed when refilling the cooling system, to ensure that no air locks are left in the cooling system.

1. Adjust heater control to maximum.
2. Have a coolant mixture consisting of 50% ethylene glycol antifreeze/inhibitor and 50% water on hand to fill system.

Note: Do not combine different types of antifreeze or corrosion inhibitors as they may be incompatible. If a different type has been used in the cooling system rinse the system with clean water.

3. Loosen air bleeding screw to allow air from engine block, when all air is removed and coolant flows from bleeder screw, tighten screw.



4. Remove radiator cap.

a) Use a rediator hose with a narrow diameter that can be forced in to the top of the radiator neck, approx 25 cm long.

b) Fill cooling system until coolant fllows from bleeder plug hole, install bleeder plug and tighten when all air has been allowed to escape, with as much coolant mixture as possible.

c) Remove hos efrom radiator neck.

d) Refit the radiator cap.

Without narrow hose fitted to radiator neck

3. Remove radiator cap and fill cooling system with as much coolant mixture as possible.

a) Refit the radiator cap

4. Loosen the upper radiator hose clamp at the coolant outlet on the engine and remove the hose.

a) Hold the hose upward and pour coolant into the open end of hose until coolant runs out of outlet on engine

b) Quickly fit the hose to the coolant outlet and refit hose clamp

c) Fill the coolant reservoir to approximately 25 mm above the indicator arrows.

5. Start engine and run it at 2000 rpm for 10 minutes to open thermostat and purge air from system. Fill reservoir tank to between the arrow indicators on the dipstick
6. Check coolant level when engine has cooled down and top up to correct level as required

Coolant Capacity

V6 & V8 - 12 litres

Drive Belts

Check tension of drive belt to make certain it's within specifications if it's noisy. Check for misaligned pulleys. If drive belt is worn or frayed, replace it using following procedures.

Belt Adjustment

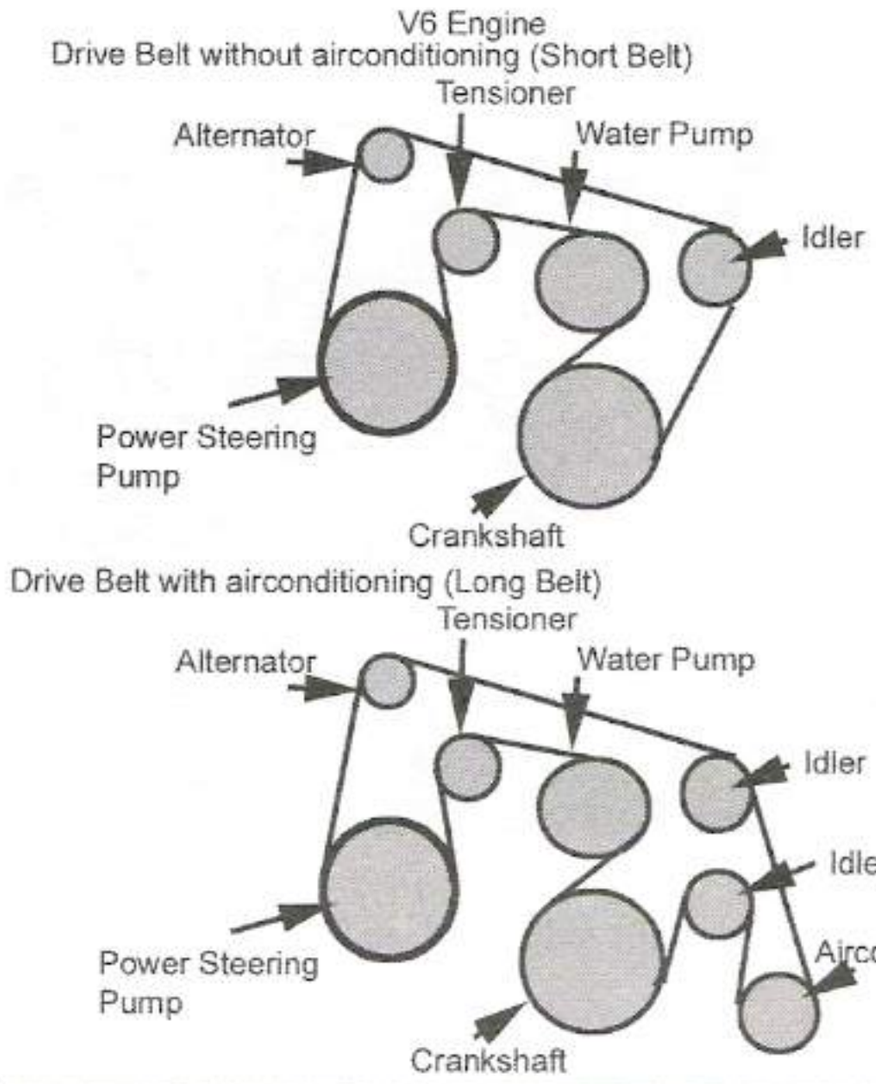
Drive belts should be properly adjusted at all times. A loose drive belt will cause incorrect operation of driven components. A belt that's too tight places severe strain on driven components, bearings etc. Drive belts that are properly tensioned minimize noise and prolong the belt's service life. Any belt that is operated for a minimum of 10 minutes is considered a used belt and when adjusted it must be adjusted to the reset tension shown in the specifications.

Belt Tension and Adjustment

V6 Engine

Both the V6 & V6 supercharged engines use a serpentine belt to dive the various components ie: water pump, alternator, power steering etc. The serpentine belt is self adjusting but should still be checked for wear and correct alignment.

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Belt Tension

Check the belt tensioner alignment marks. When the alignment marks are at the minimum tension range the serpentine belt should be replaced. 'refer to diagram'

VT Ser 1 V8 Engine

Apply a thumb pressure of 100N (10kg) to the midpoint of the longest convenient span of belt, and noting the belt deflection as shown, check the tension of the belt.

Alternator to Water Pump

New Belt Deflection: ..... 7-8 mm
Used Belt Deflection: ..... 9-10 mm

Power Steering Pump

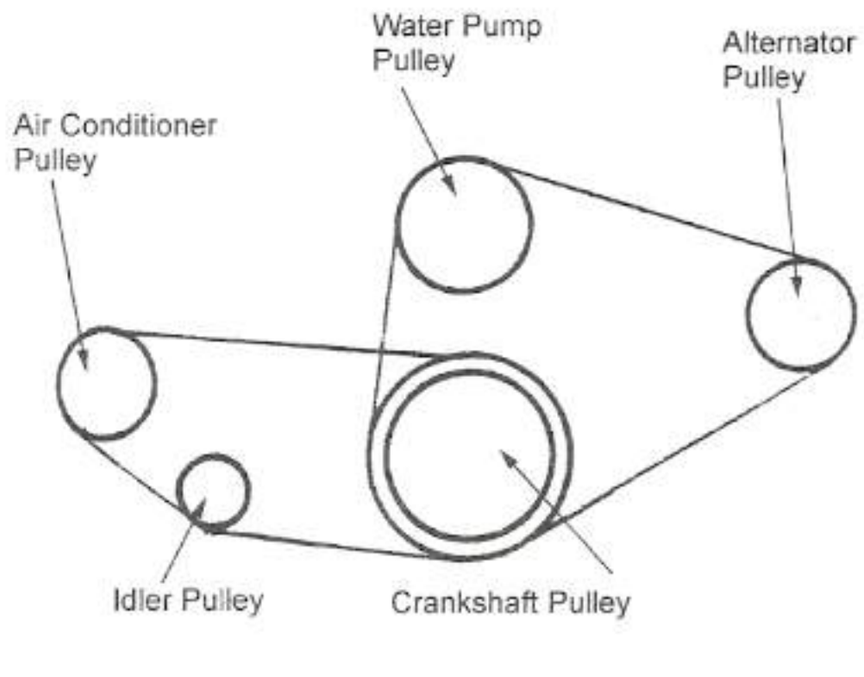
New Belt Deflection: ..... 8-9 mm
Used Belt Deflection: ..... 10-11 mm

Air Conditioning

New Belt Deflection: ..... 8-9 mm
Used Belt Deflection: ..... 10-11 mm

Adjusting Alternator/Water Pump Belt

1. Loosen alternator mounting bolts and belt idler pulley nut
2. Turn adjusting bolt on the idler pulley to achieve correct belt



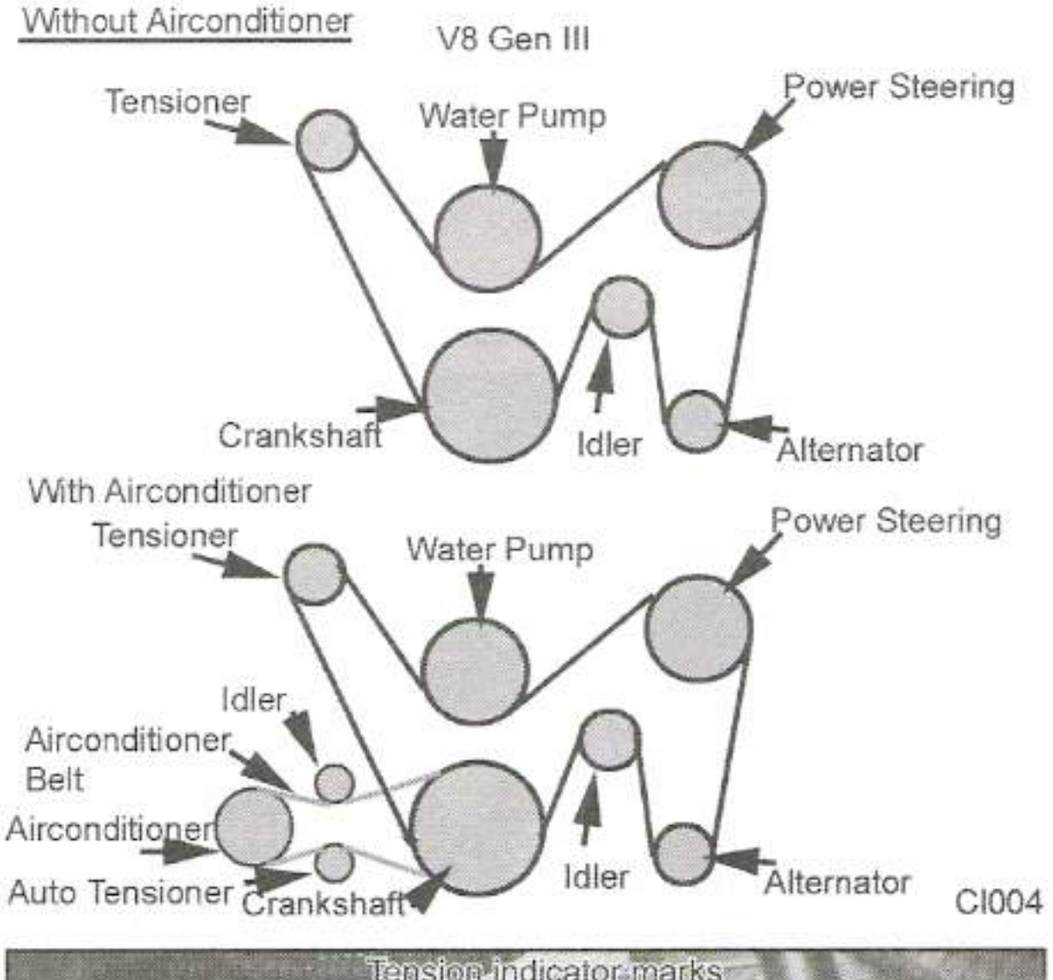
tension
3. Tighten mounting bolts and idler pulley nut.

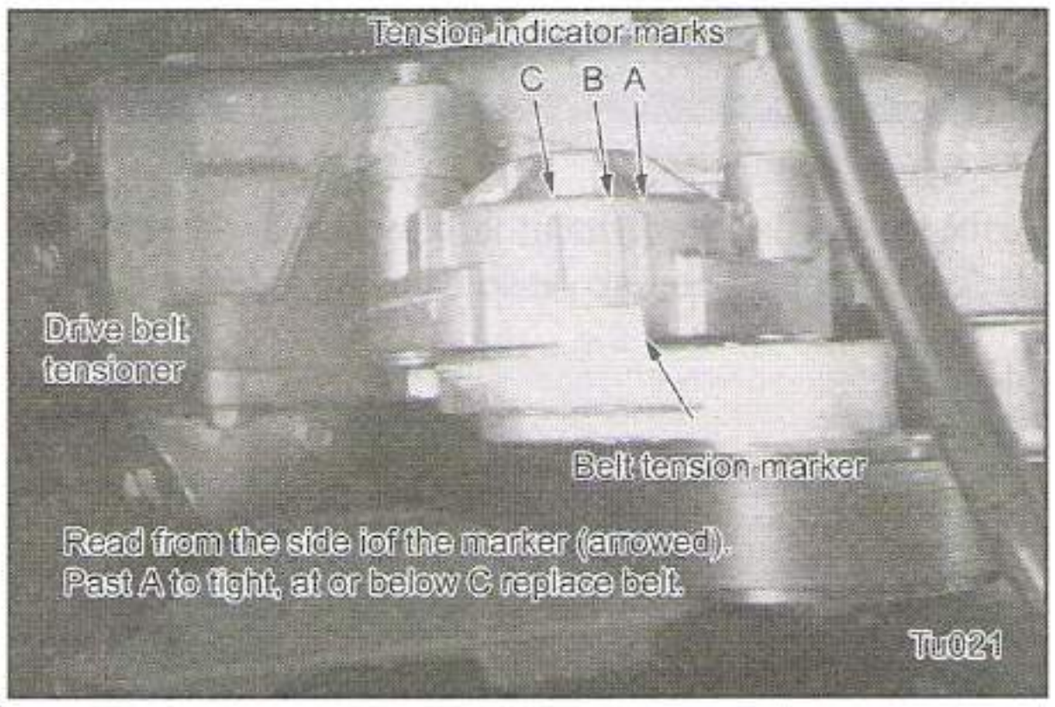
Gen 111 V8

Gen 111 V8 engines use a serpentine belt to dive the various components ie: water pump, alternator, power steering etc. The serpentine belt is self adjusting but should still be checked for wear and correct alignment.

Belt Tension

Check the belt tensioner alignment marks. When the alignment marks are at the minimum tension range the serpentine belt should be replaced.





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Radiator Hose Replacement

Radiator hoses should be replaced whenever they become cracked, rotted or have a tendency to collapse.

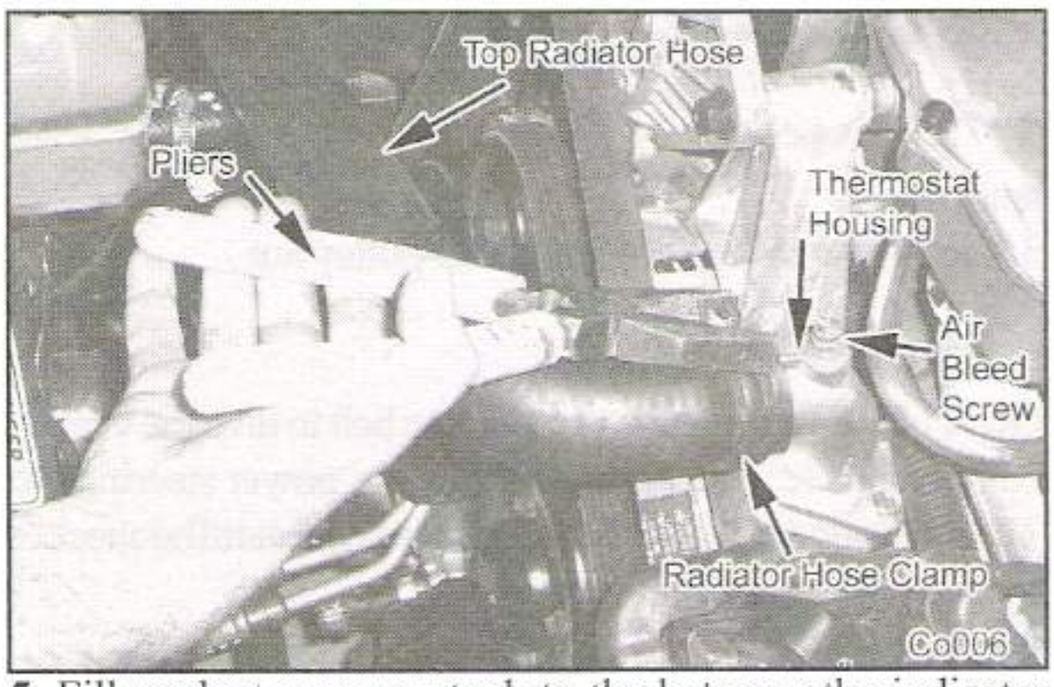
Drain the cooling system, refer to previous chapter.

1. Loosen the clamps at each end of hose to be removed.

2. Slide hose off radiator connection and the cylinder head water outlet or water pump connection.

3. Position clamps and hoses so they do not rub or contact any metal surface, otherwise they will soon deteriorate and fail.

4. Tighten clamps.



5. Fill coolant recovery tank to the between the indicator arrows on the dipstick

6. Fill and bleed the cooling system as previously described.

Note: Install hose clamps as close as possible to the bead on inlet and outlet pipes.

Coolant Temperature Sensor

The coolant temperature sensor is located:

All V6:

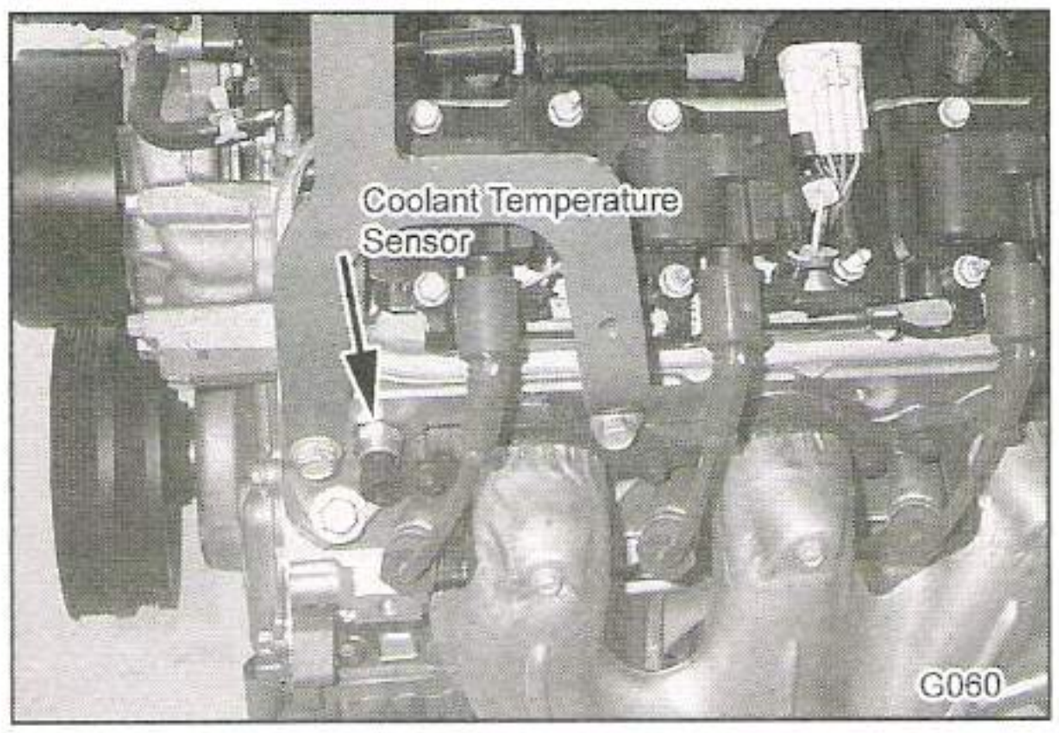
In the inlet manifold, below thermostat housing.



VT Ser 1 V8 Engines:

At the front of the intake manifold closest to the throttle body flange, PCM temperature sensor is along side to the left.

Gen 111 V8 engines:



At the front of the left side head, in front of the exhaust outlets.

Thermostat

The thermostat is mounted in the block and is a wax pellet type. The thermostat is normally closed but when the engine starts to reach operating temperature the wax in the thermostat heats up and expands which overcomes the spring pressure and allows the thermostat to open and the coolant to start flowing through the cooling system.

Note: For operating temperatures, refer to specifications.

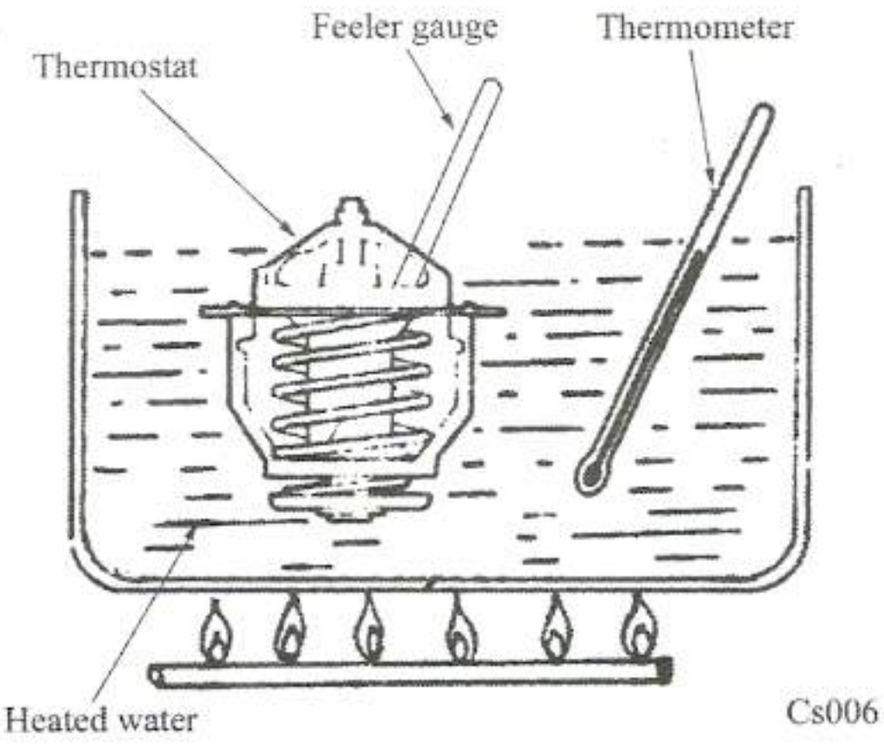
Check a used thermostat before reinstalling it following the procedure under "Thermostat Test" in the preceding pages. Don't attempt to repair thermostat. It should be replaced if not operating properly.

Remove

1. Remove lower radiator hose and drain cooling system below level of coolant outlet housing.

2. Reinstall hose for all V6 and VT Ser 1 V8.

3. [All V6 and VT Ser 1 V8] Remove coolant outlet housing (top hose) retaining bolts and slide housing (with hose attached) to one side.



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[Gen 111 V8] Remove coolant inlet housing (lower hose) retaining bolts.

4. Remove thermostat and gasket

Thermostat Test

Test used thermostats before installing them in engine.

1. Remove thermostat and immerse it in boiling water.

2. Remove when open and place a .05 mm feeler gauge in throat of thermostat and allow thermostat to cool and clamp on feeler gauge.

3. Suspend thermometer into container of cool water and heat water.

4. When thermostat opens and drops off feeler gauge, note temperature.

Note: Check specifications for correct operating temperature

Install

1. Clean outlet and thermostat housing.

2. Coat a new gasket with water proof gasket sealant and fit to thermostat.

3. Install thermostat and thermostat housing and bolts.

4. Fill system as previously described.

5. Run engine and test for water leaks.

Water Pump

Description

A centrifugal-type water pump is situated on the front of the cylinder block. A vane-type impeller provides coolant through centrifugal movement to the water pump outlet port. Remove and discard a pump if it is found faulty, as it is of a sealed unit type which is unable to be repaired.

Remove

Remove the engine trim covers V8 models only.

1. Disconnect the lower radiator hose from the water pump to empty the coolant

2. Loosen the water pump pulley bolts 4

All V6 Engine

3. Remove the serpentine belt as previously described.

VT Ser 1 V8 Engine

3. Remove all of the drive belts 'refer to drive belt chapter'

4. Disconnect the two heater by-pass hoses

Gen 111 V8 Engine

3. Remove the serpentine belt as previously described.

4. Remove the serpentine belt tensioner, 2 bolts.

All

5. Remove the water pump pulley bolts and remove pulley

6. Loosen and remove all water pump mounting bolts

a) Remove the water pump assembly

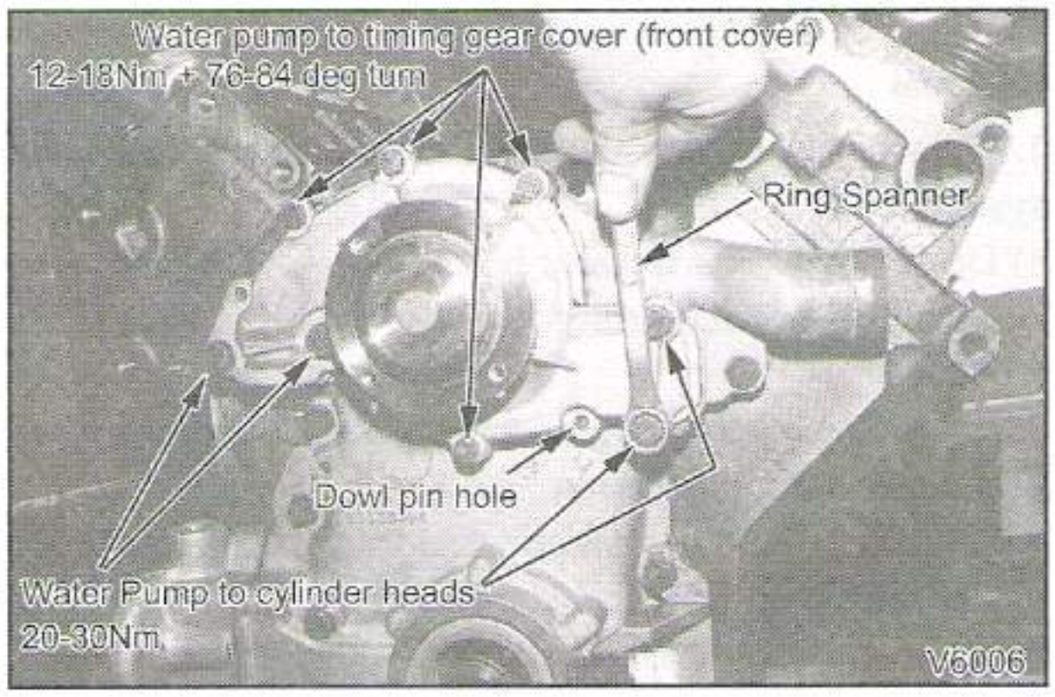
Clean and Inspection

Gen 111 V8 water pump has a rear cover that cane be removed to clean and inspect pump for corrision. If cover is removed a new "O" ring must be installed, tighten cover bolts to 13-15Nm.

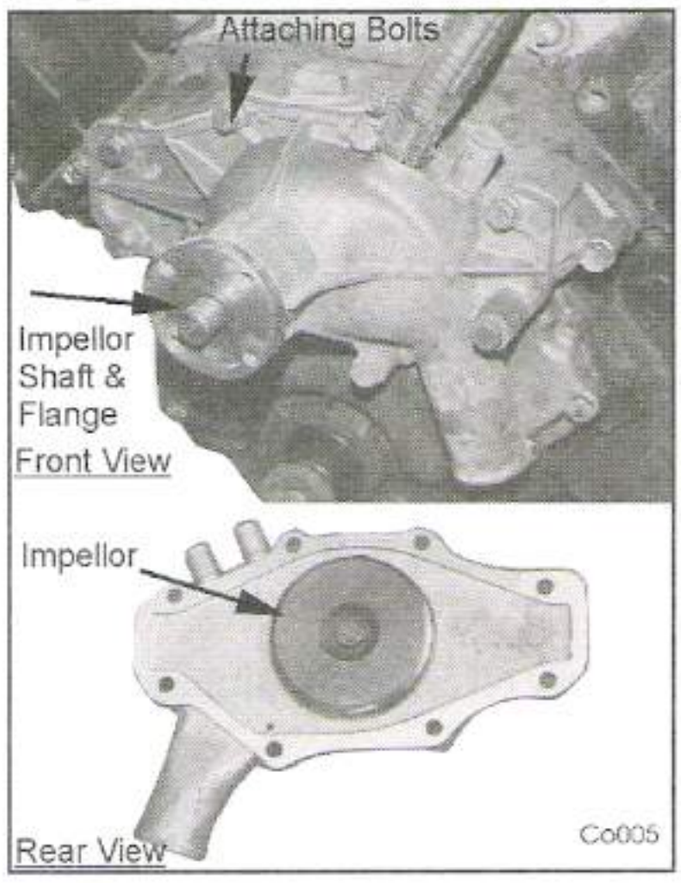
Install

1. Clean the pump and cylinder block mating surfaces and place a new gasket coated with water resistant sealer.

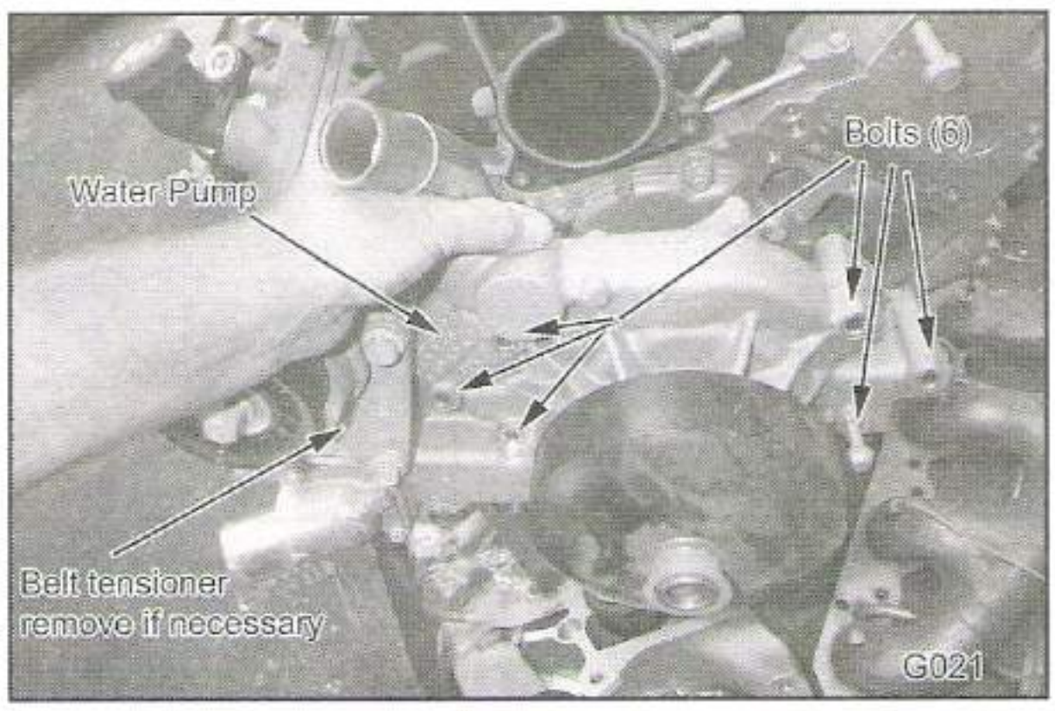
2. Install the water pump on the cylinder block Install the bolts and tighten to specification.



Torque:
V6 Water Pump to Front cover:12-18 Nm+76-84⁰ turn
Water Pump to Cylinder Heads: 20-30 Nm



VT Ser 1 V8 Engine - 23-30 Nm



Gen 111 V8Step1: 15Nm Step2: 25Nm

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3. [Gen 111 V8]Reinstall Belt tensioner and tighten bolts to specification.

Belt Tensioner: Step1: 15Nm Step2: 25Nm

4. Replace and tension the drive belts.

5. Fill the cooling system and pressure test for leaks

Radiator

Removal

1. Detach the lower radiator hose to empty the cooling system.

a) Detach the upper radiator hose.

2. Detach the coolant reservoir hose from the side of the radiator

3. Detach the oil cooler lines at the radiator - vehicles fitted with automatic transmission.

4. Remove the cold air intake duct and radiator shroud 4 clips

a) Disconnect all electrical connectors

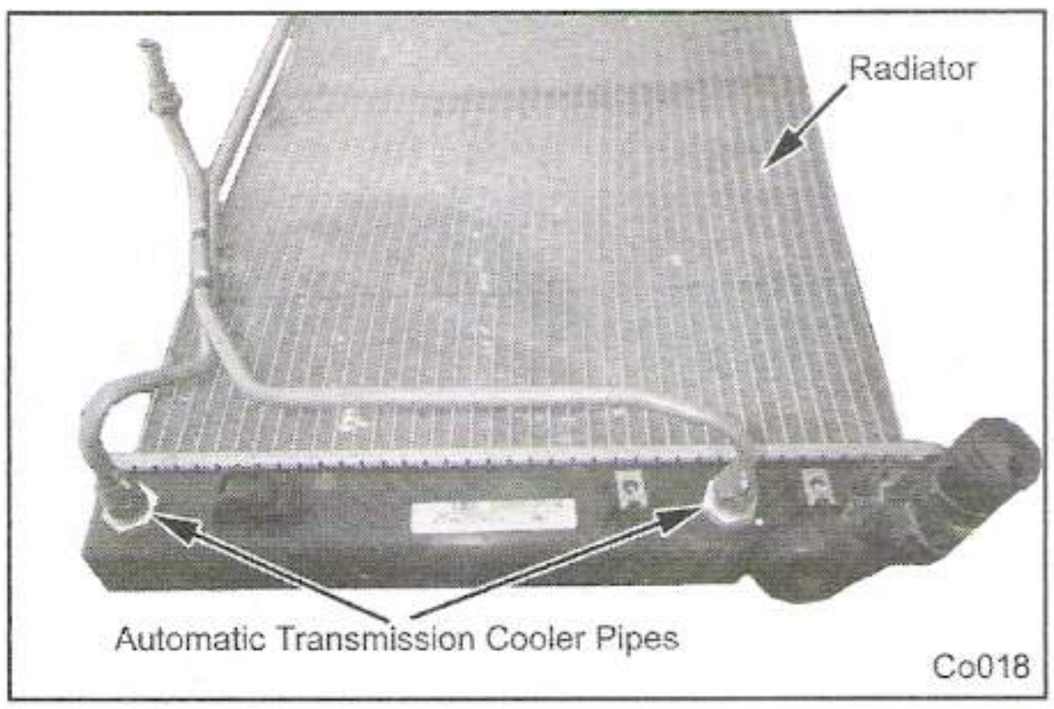
5. Use a screwdriver to remove the 2 radiator retainer clips.



6. Carefully lift the radiator from the vehicle

Install

1. If required replace oil cooler line fittings at radiator - auto trans vehicles only



2. Position the radiator in the vehicle and refit the 2 retainer clips

3. Refit the cold air intake duct and radiator shroud 4 clips

a) Connect the electrical connectors

4. Fit the upper and lower radiator hoses

a) Fit the coolant reservoir hose

5. Connect the transmission cooler hoses if quipped with auto trans

a) Refill the cooling system

b) Pressure test system and rectify any leaks

Coolant Reservoir Tank

Removal

1. Remove the dipstick

2. Remove the reservoir hose

3. Loosen and remove the 3 bolts that secure the reservoir to vehicle chassis

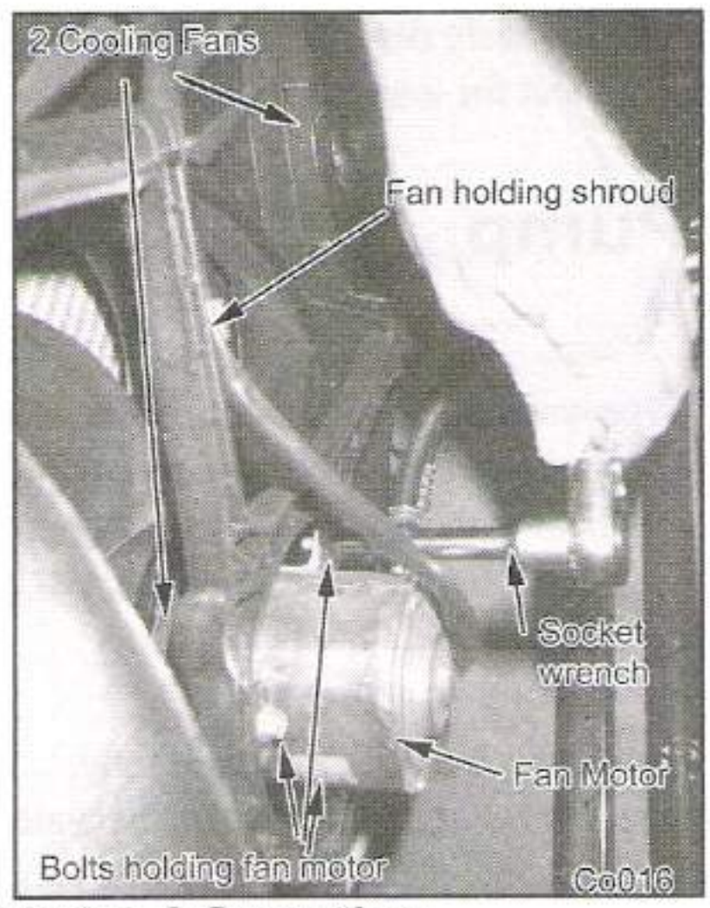
4. Remove the reservoir from underneath the vehicle

Install

1. Fit the reservoir into position and secure with 3 bolts

2. Connect the hose and refill reservoir to correct level

Electric Cooling Fans



Description & Operation

All vehicles are fitted with twin electric cooling fans. The fans can operate at either low or high speed. Operation of the fans is controlled solely by the P.C.M. if certain sensor parameters and vehicle conditions are met the fans will be turned on by the P.C.M in either the low or high speed modes. refer to diagnostics chapter for more information.

Remove

1. Disconnect the battery earth lead

a) Remove the power steering reservoir refer 'Power Steering' chapter

2. Disconnect the electrical connectors at the fans

3. Loosen and remove the 4 attaching bolts

4. Remove the fans and shroud assembly from the vehicle

Install

1. Position the fans and shroud against the radiator

2. Fit the 4 attaching bolts and tighten

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3. Reconnect the electrical connectors
4. Fit the power steering reservoir into position
a) Connect the battery earth lead

Cooling Fan Electronics

COOLING FAN HIGH SPEED
The fan high speed relay is activated through the PCM, by data from the "engine coolant temperature" (ECT) sensor. The high speed fan will turn "on" via the relay only if the low speed fan is "on" for 2 seconds and the conditions listed below are active.
- BCM Code DTC 92 is active.
- Temperature codes DTC 14, 15, 16, or 17 are active.
- Engine coolant temperature is over 104^0 C.

The air conditioner can cause the high speed fan to be activated. If the A/C refrigerant pressure is over 2600 kPa the A/C pressure sensor will via the PCM activate the high speed fan. If the low speed fan was off when the high speed fan was activated the high speed fan will start 5 seconds after the low speed fan is activated.
If both fans are on, the high speed fan will turn off when:
- Coolant temperature is less than 990 C.
- A/C does not activate the fan.
- A/C does try to activate the fan however the A/C pressure is under 2300 kPa.

Problem Solving & Diagnosis

Quick Reference Diagnosis Chart

Engine Overheats

Loss of coolant
Belt tension incorrect.
Radiator fins obstructed.
Thermostat stuck closed, or otherwise defective.
Cooling system passage blocked by rust, scale or other foreign material.
Water pump inoperative.
Fan drive clutch defective.
Ignition initial timing incorrect.

Engine Fails to Reach Normal Operating Temperature or has Wrong Indicated Temperature

Thermostat stuck open or of incorrect heat range.
Temperature sending unit defective (causing gauge to indicate low engine temperature).
Temperature gauge defective (not indicating true engine temperature) or incorrectly installed.

Loss of Coolant

Leaking radiator, or transmission oil cooler
Leaking coolant supply tank
Loose or damaged hose connections
Cylinder head gasket defective
Improper tightening of cylinder head bolts
Cylinder block or head core plunge leaking
Cracked or warped cylinder head or block
Cracked intake manifold
Heater hose or engine hose with minor fault allowing water to leak
Heater hose or engine hose not sealed correctly, or hose clamp not tight enough

Testing

Visual Inspection

Check for leakage at:
1. All hoses and hose connections.
2. Radiator seams and radiator core.
3. All engine core plugs and drain plugs.
4. Edges of cooling system gaskets.
5. Transmission oil cooler.
6. Vehicle heating system components.
7. Water pump.
8. Examine all dipstick for evidence of engine oil contaminated with coolant.
9. Check supply tank for evidence of oil coolant (leakage at transmission oil cooler).

Thermostat Test

Thermostat Removed:
Detach the thermostat and place it in boiling water. Remove when open and place a 0.05 mm feeler gauge in the throat of the thermostat and allow the thermostat to cool and clamp on the feeler gauge.
Suspend a thermometer into a container of cool water and heat the water.
Suspend the thermostat by the feeler gauge into the container of warming water. When the thermostat opens and drops off the feeler gauge, note the temperature.

Specifications

Coolant Capacity:
V6 - V8 Engines - 12 Litres
Recommended Coolant Type:
HN2043 or equivalent (6 Litres required for refill)
Thermostat starts to open:
All V6 and VT Ser 1 V8 ..... 89-93^{0}C
Fully Open: ..... less than 103^0 C
Gen 111 ..... 86^{0}C
Fully Open: ..... less than 100^0 C
Radiator Cap Pressure: ..... 100 kpa

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IGNITION SYSTEM

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General Description

The V6 and Gen 111 V8 engines are equipped with a high energy 'distributor less' Direct Ignition System or D.I.S. This system uses a waste spark method of distributing the spark. Cylinders are paired with their opposing cylinder, one cylinder is on compression and the opposing one will be on exhaust stroke. The cylinder on the compression stroke will receive the majority of the voltage to fire the spark plug.
The D.I.S system uses the following components, an electronic coil, ignition module, dual crank angle sensors, camshaft position sensor, electronic spark control system E.S.C, spark plugs and is controlled by the powertrain control module P.C.M.
The VT Ser 1 V8 engine uses a hall gap type distributor in the ignition system, ignition timing is controlled by the P.C.M. Components used are distributor, ignition trigger module, ignition coil, spark plugs and leads.

V6 and GennIII V8 - Ignition Components

Crankshaft Position Sensor

The crankshaft position sensor is mounted on the front of the engine near the crankshaft balancer. The sensor incorporates two Hall effect sensors and a center mounted magnet. Interrupter rings are fitted to the crankshaft balancer and pass through the crankshaft position sensor causing pulses to be sent to the P.C.M which calculates the engine r.p.m. and crankshaft position.

Electronic Spark Control

The ESC receives pulses from the knock sensors to detect the amount of engine detonation that is occurring the ESC process the signal into a command signal and uses this to control the electronic spark timing (EST).

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Spark Plugs & Leads
The spark plug leads are made of a carbon impregnated core encased in an 8 mm diameter silicone cover. Resistor type, copper cored spark plugs are used. Always replace spark plugs with the correct type and heat range.

Ignition Module
The ignition module controls the primary coil circuits, turning them on and off. Spark timing is controlled if engine r.p.m. is below 450 and if the P.C.M. by-pass circuit is open or earthed.



Ignition Coils
There is a coil pack consisting of 3 coils, each coil supplies spark to two cylinders the ignition module is mounted under the coil packs.

VT Ser 1 V8 - Ignition Components

Distributor
The distributor function is to direct the ignition voltage to the correct cylinder through the spark plug lead and spark plug. Incorporated in the distributor are two Hall effect sensors. One sensor provides the P.C.M. with a crankshaft reference signal, the other sensor is used to provide a camshaft reference signal to the P.C.M. via the ignition trigger module.

Ignition Trigger Module
The purpose of the ignition trigger module is to provide an interface between the Hall effect sensors, P.C.M. and the ignition coil. The ignition trigger module collects the signals from the Hall effect sensors and converts them into a format that the P.C.M. is able to use. The P.C.M. calculates engine r.p.m. and crank angle position using the pulses provided to it by the ignition trigger module.

Ignition Coil
The ignition coil is of a special type designed to suit the electronic control module and medium energy ignition system.

Note: Do Not replace the coil with any other type of coil or damage to electronic components may result

Spark Plugs & Leads
The spark plug leads are made of a carbon impregnated core encased in an 8 mm diameter silicone cover. Resistor type, copper cored spark plugs are used. Always replace spark plugs with the correct type and heat range.

Precautions

Extremely high voltages are produced on both the primary and secondary circuits of the ignition system fitted, take care when working with any of the ignition circuits to avoid injury.

- Do Not disconnect the spark plug leads while the engine is running or damage may occur to the electronic circuits of the ignition system.
- Make sure that the ignition is turned off before disconnecting or removing any of the ignition components
- Never disconnect the battery while the engine is running or damage to electronic components will result.

On Vehicle Inspection

Spark Test
When checking for ignition spark always use a spark tester or a spark plug fitted to the plug lead to be tested. Check if sparks occurs while engine is being cranked, if it does not, perform the following tests.

Note: Do not crank engine for more than 5 - 10 seconds at a time, to prevent to much fuel from being injected into the cylinder.

V6 and Supercharged V6 Spark Test Chart
SPARK TEST
** BAD **
CHECK RESISTANCE OF HIGH TENSION LEADS.
OK then
CHECK POWER SUPPLY TO IGNITION COIL
1. Ignition switch turn to ON
2. Ensure that there is battery voltage at ignition coil positive (+) terminal.
BAD
CHECK WIRING BETWEEN IGNITION SWITCH TO IGNITION COILS
OK then
CHECK RESISTANCE TO IGNITION COILS
Primary coil resistance: 0.3-1.5 ohms @ 20-30^{0}C
Secondary coil resistance: 5000-7000 ohms @ 20-30^{0}C
BAD
REPLACE THE IGNITION COIL/S
OK then
INSPECT CRANKSHAFT POSITION SENSOR

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Visually inspect sensor, remove crankshaft balancer and inspect vanes for physcial damage

REPLACE CRANKSHAFT SENSOR

INSPECT CAMSHAFT SENSOR

Inspect sensor wiring connector

OK then

CHECK IGNITION signal from ECM

see Fault Diagnositic Codes 41 and 42

Check fuses 34 and 35 as they supply current to the ignition and fuel injection system.

BAD

REPLACE ECM

OK then

CHECK wiring circuits from ECM to Coil

VT Ser I V8 Test Chart

SPARK TEST

** BAD **

CHECK RESISTANCE OF HIGH TENSION LEAD.

OK then

CHECK POWER SUPPLY TO IGNITION COIL

1. Ignition switch turn to ON

2. Ensure that there is battery voltage at ignition coil positive (+) terminal.

BAD

CHECK WIRING BETWEEN IGNITION SWITCH TO IGNITION COIL

OK then

CHECK RESISTANCE TO IGNITION COIL

Primary coil resistance (cold): 0.67-1.05 Ohms.

Primary coil resistance (hot): 0.85-1.23 Ohms.

BAD

REPLACE THE IGNITION COIL

OK then

CHECK RESISTANCE OF VVT SENSOR

check between terminals

Resistance (cold): 835-1400 ohms

BAD

REPLACE CRANKSHAFT SENSOR

OK then

CHECK RESISTANCE OF CRANKSHAFT POSITION SENSOR +ve and -ve

Resistance (cold): 1630-2740 ohms

BAD

REPLACE CRANKSHAFT SENSOR

OK then

CHECK IGT signal from ECM

see page 413 codes 351 to 356

BAD

REPLACE ECM

OK then

CHECK wiring from ECM to Coil

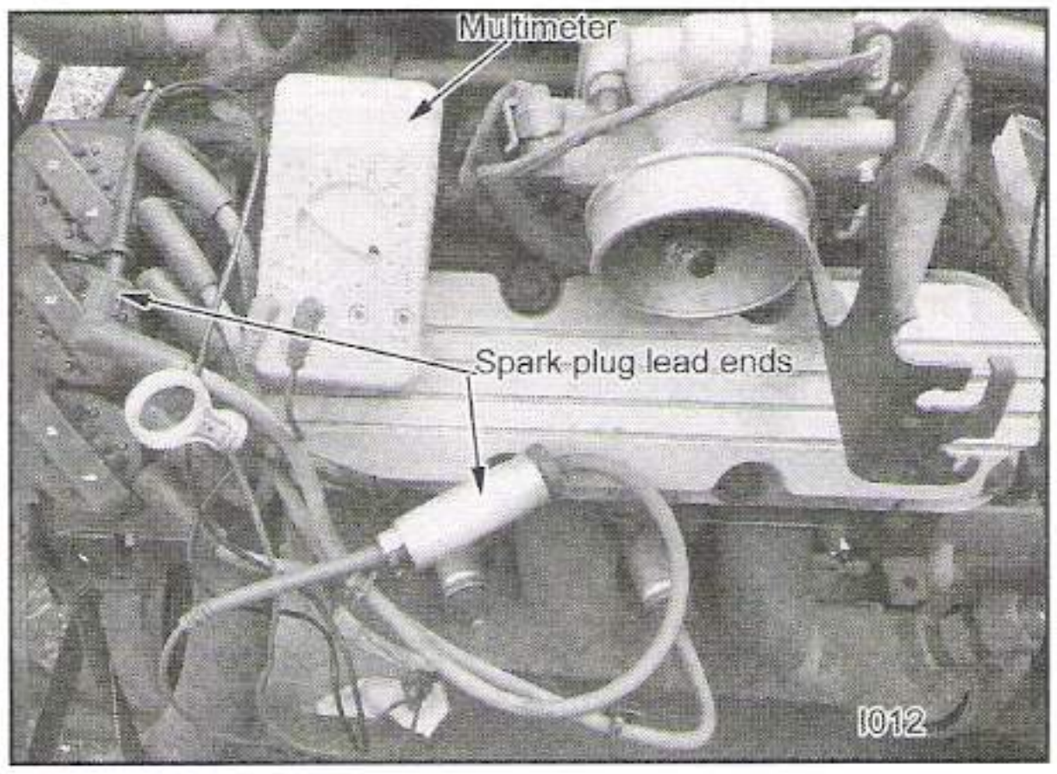
High Tension Leads

Inspection

1. Remove high tension leads.

Note: Grip the rubber insulator as pulling on or bending the leads can cause damage to the lead

2. Check Resistance of High Tension Lead. Using an ohmmeter, ensure that the resistance does not exceed the maximum, if it does, examine the terminals, and replace the high tension lead as required.



Maximum Lead resistance:

V6 Engine -	L.H. Side Less than 10000 ohms
	R.H. Side Less than 27000 ohms
V6 Supercharged -	L.H. Side Less than 10000 ohms
	R.H. Side Less than 17000 ohms
VT Ser I V8 Engine -	Less than 25000 ohms
Gen III V8 Engine-	Less than 700 ohms

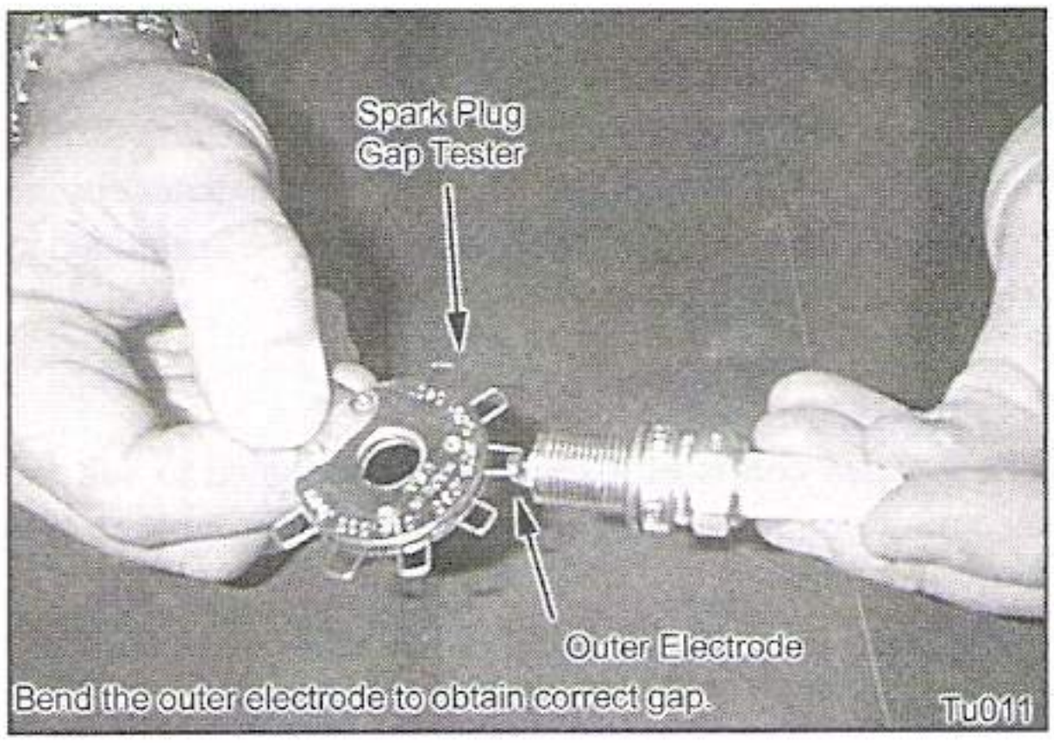
Spark Plugs

Clean & Inspect Spark Plugs

a) Clean the spark plugs with a spark plug cleaner or wire brush..

b) Examine the spark plugs for electrode wear, thread damage and insulator damage. Replace the plugs if worn or damaged.

c) Adjust Electrode Gap - Gently bend the outer electrode to obtain the correct electrode gap.



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Spark Plug Type:
V6 - NGK BPR6EFS-15
Electrode Gap: ..... 1.5 mm
V6 Supercharged - AC41-919
Electrode Gap: ..... 1.5 + 0 - 0.5 mm
VT Ser I V8 - NGK BPR6EFAC41-952
Electrode Gap: ..... 1.0 ± 0.05 mm
Gen III I V8 - AC41-952
Electrode Gap: ..... 1.5 ± 0.05 mm

Precautions

Cleaning: Only clean spark plugs using a commercial type plug cleaner and only when absolutely necessary. Never use a wire brush to clean spark plugs.
Electrode Adjustment: New spark plugs can have the electrode gap adjusted if required. If the electrode gap on a used spark plug is outside specification then the spark plug must be replaced - *Do Not Adjust the electrode gap on a used spark plug.*

Check Spark Plug Condition

A visual inspection of the spark plug can indicate how the spark plug is firing and buring fuel, below are some examples of conditions seen on spark plugs.



Correct heat range, slight brown or grey colouration of electrodes



Operating colder than recommended, fuel not buring correct so carbon deposits build up.



Indications of a hot plug causing pre-ignition, the electrodes are buring away, plus blistering of the centre insulation.

Eng8e241e

Ignition Timing

Inspect

The ignition timing on the V6, V6 Supercharged and Gen III V8 engines is not manually adjustable.

V8 VT Series 1 Engine

1. Warm up the engine to operating temperature
a) Connect a tachometer and timing light

Note: Timing light must be suitable for use with semiconductor type ignition systems

b) Ground the DLC diagnostic request mode terminal - 'connect terminals 5 & 6 on the data link connector'
2. Check timing using timing light, at timing marks on the balancer and timing cover
3. Loosen distributor bolt and adjust timing if required
Ignition Timing:
10^0 BTDC @ Idle
4. Remove the timing light, tachometer and service wire from the 'Data Link Connector'

V6 and V6 Supercharged

Ignition Timing

Inspect

The ignition timing is set by PCM. with data from the crankshaft sensor and camshaft sensor.
The ignition timing on the V6, V6 Supercharged engines are not manually adjustable. The ignition module operates in 2 modes, 1 (Bypass) while engine is cranking and the other (Electronic Spark Timing) while engine is running.
Bypass mode is activated while engine is cranking upto 450rpm, while in this mode the ignition timing is set at 10 deg advanced. Once the engine fires the ignition module switches to Electronic Spark Timing (EST) this is set by the PCM, however if there is a problem the PCM will revert the ignition mode back to Bypass (advanced by 10 deg) the engine may stop running in this mode. The engine should resart and operate in Bypass mode.
The PCM sets the ignition timing according to data from many sensors, however there are three main data readings that have a real effect on the timing, that is Mass Air Flow (MAF), engine revs (rpm) and engine temperature.
Timing
Base Ignition Timing (Bypass mode) - 10^0 BTDC
Operating Ignition Timing - 13^0 BTDC @ idle
Check chart below for a guide to PCM effect on timing.

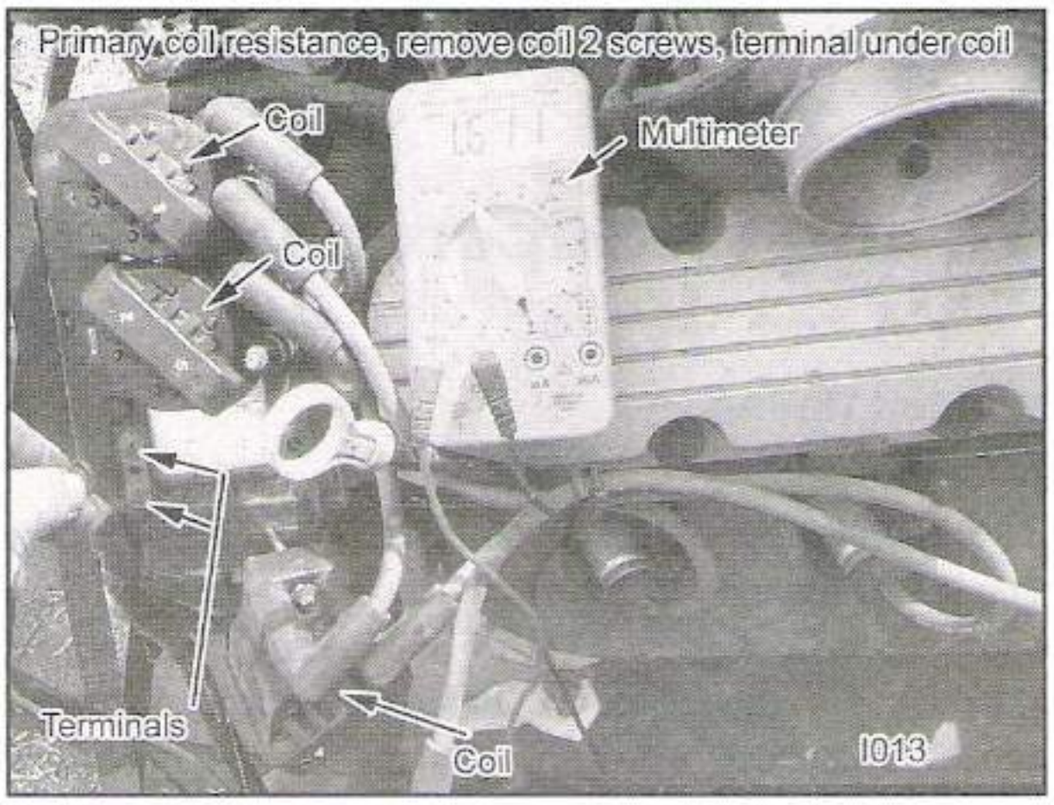
Guide to engine timing conditions

Condition	Timing
Low MAF - engine not under load	more advanced
High MAF - engine operating loaded	less advanced
High rpm	more advanced
Low rpm	less advanced
Engine cold	more advanced
Engine hot	less advanced

Inspection of Ignition Coils

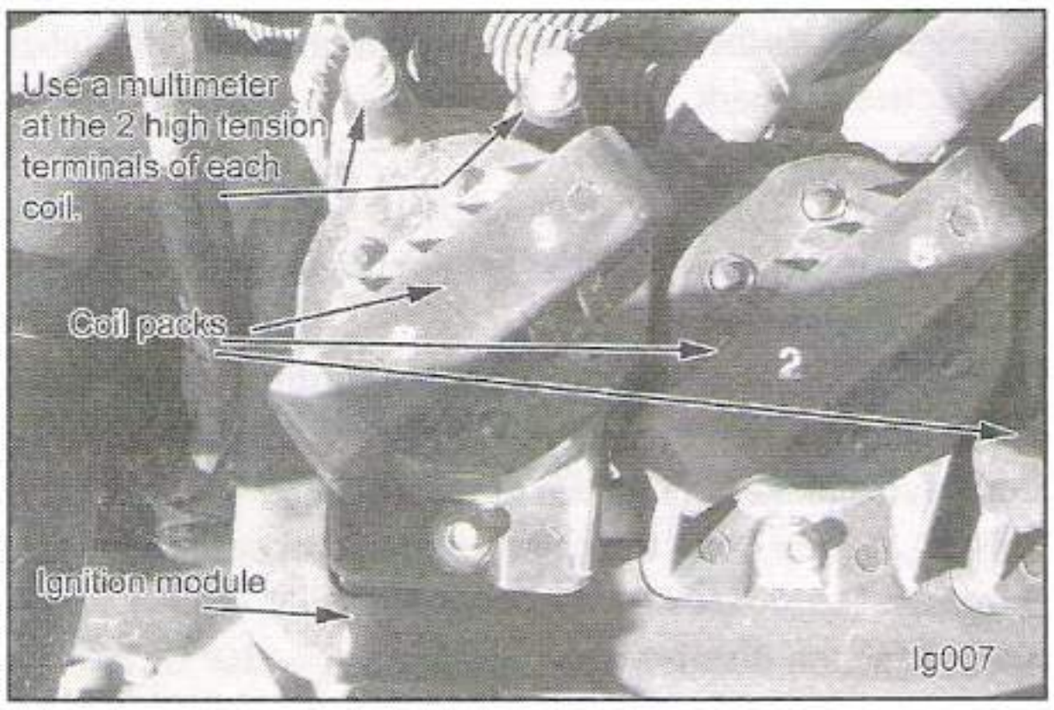
1. Remove High Tension Leads
a) Loosen the coil mounting screws 2
b) Remove screws and coil
2. Check Primary Coil Resistance.
a) Measure the resistance between the positive (+) and negative (-) terminals using an ohmmeter. Replace if not within specification.

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Primary coil resistance: 0.3-1.5 ohms @ 20-30°C

3. Check Secondary coil Resistance.



a) Measure the resistance across the high-tension terminals on top of coil.

Secondary coil resistance: 5000-7000 ohms @ 20-30°C

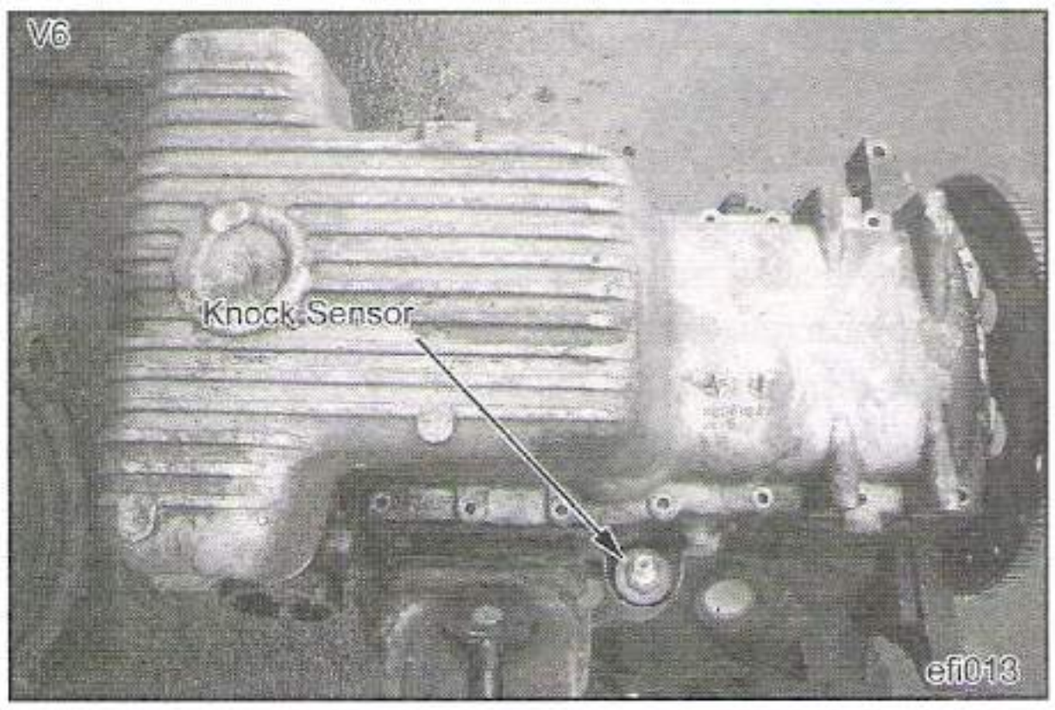
Note: Replace the ignition coil if not to specifications

Knock Sensor and Test

Remove

1. Disconnect battery terminals.

2. Remove the knock sensor heat shield bolts and heat shield.

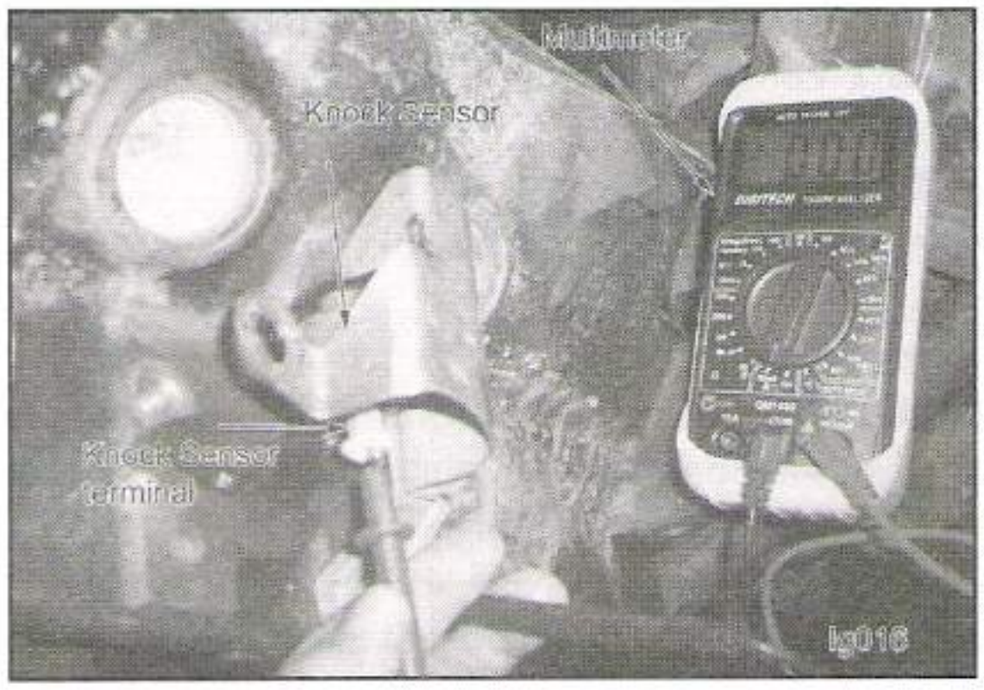


3. Remove the harness connector.

4. Remove the knock sensor.

Test

Measure the resistance between the terminal and earth, using an ohmmeter. The sensor can be tested on the vehicle.



Knock Sensor (cold): 50,000 ohms.

Measure the AC voltage back probe the harnes connector and earth, using an ohmmeter, with ignition ON.

Knock Sensor (igniton ON): 1.3 mVAC.

If not as specified replace sensor.

Install

1. Install the knock sensor, use a sealant on thread. Tighten to specification.

Knock Sensor Sealant: Loctite 242

#Tip: Do not over tighten, can damage sensor.

Knock Sensor: 16-22Nm

2. Replace the knock sensor harness connector.

3. Replace knock sensor heat shield, tight bolts to psecification.

Knock Sensor Heat Shield Bolts: 25-35Nm

4. Reconnect battery terminals.

Ignition Module and Test

Note: The ignition module operates in 2 modes, 1 (Bypass) while engine is cranking and the other (Electronic Spark Timing) while engine is running.

See codes DTC 41 and 42.

See direct Ignition System Check

Remove

1. Disconnect battery terminals.

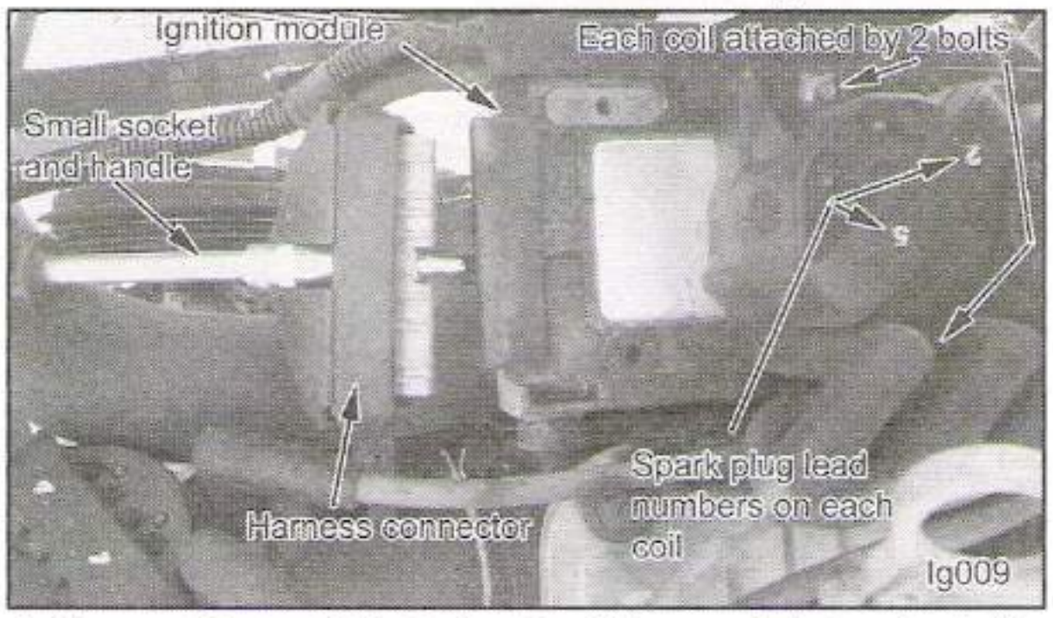
2. Remove the coil pack as described.

Test



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1. Connect the battery terminals.
2. Use a test light to check performance of ignition module.
3. At each coil contects two terminals on the ignition module.

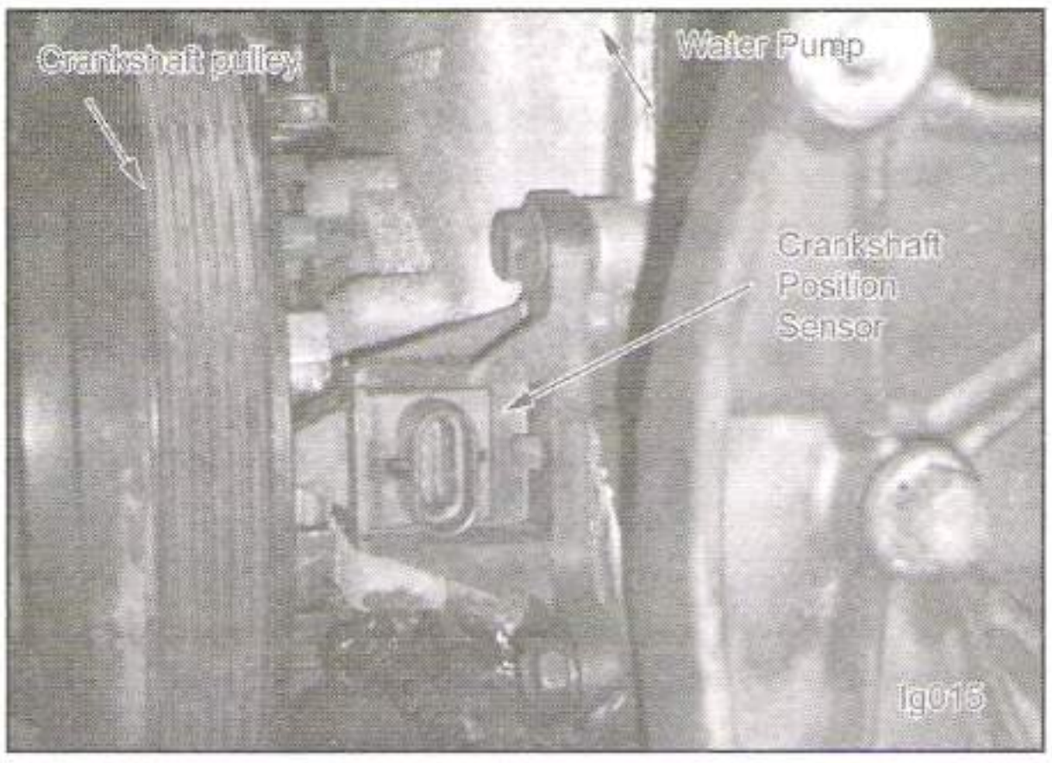


4. Connect the test light to the 2 ignition module terminals for a coil.
5. Ignition ON and crank engine, the test light should flash as the engine is cranking.
6. Repeat this test for each pair coil contacts.
7. If the light does not flash on each pair of contacts replace ignition module.

Install

1. Disconnect battery terminals.
2. Replace the coil pack.
3. Reconnect battery terminals.

Crankshaft Position Sensor and Test

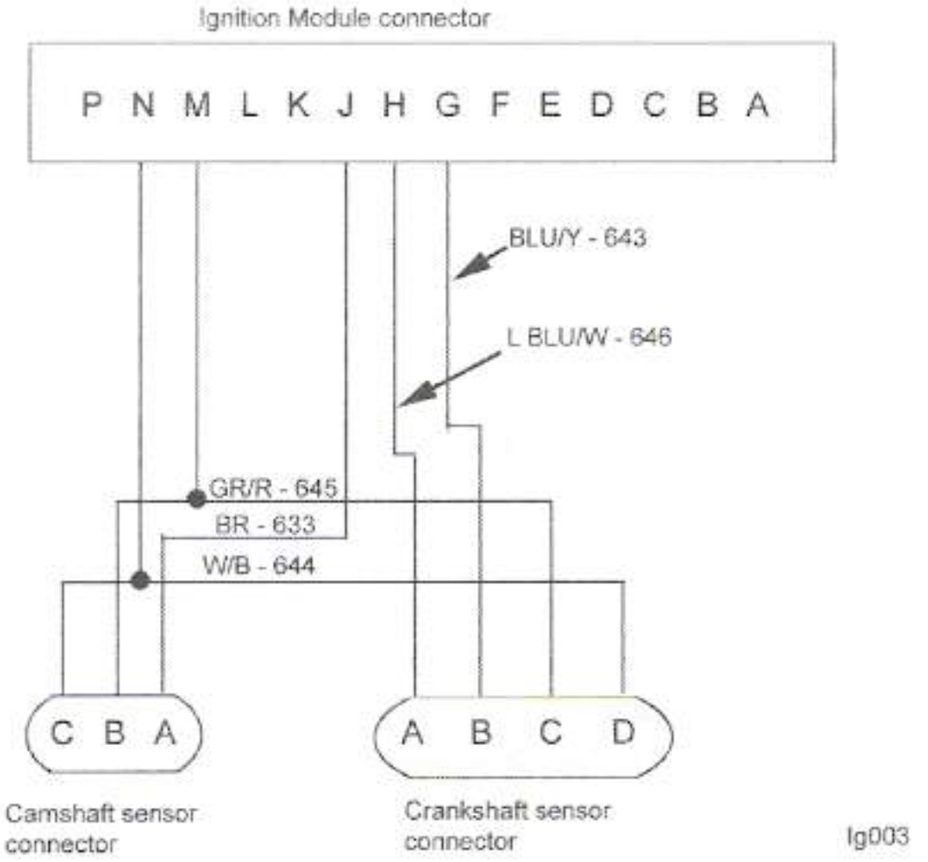


Remove

1. Disconnect battery terminals.
2. Remove the crankshaft position sensor loom connector bolt and connector.
4. Remove the crankshaft position sensor, 2 bolts

Test at the Ignition Module Harness Connector

1. Turn ignition OFF.
2. Use electrical wire or paper clips to form jumper wires and terminal extenders.
3. Form a narrow U to use as a jumper wire at the ignition module harness connector, jumper terminals "N" and "P" together.
4. Insert a straightened wire or paper clip into harness

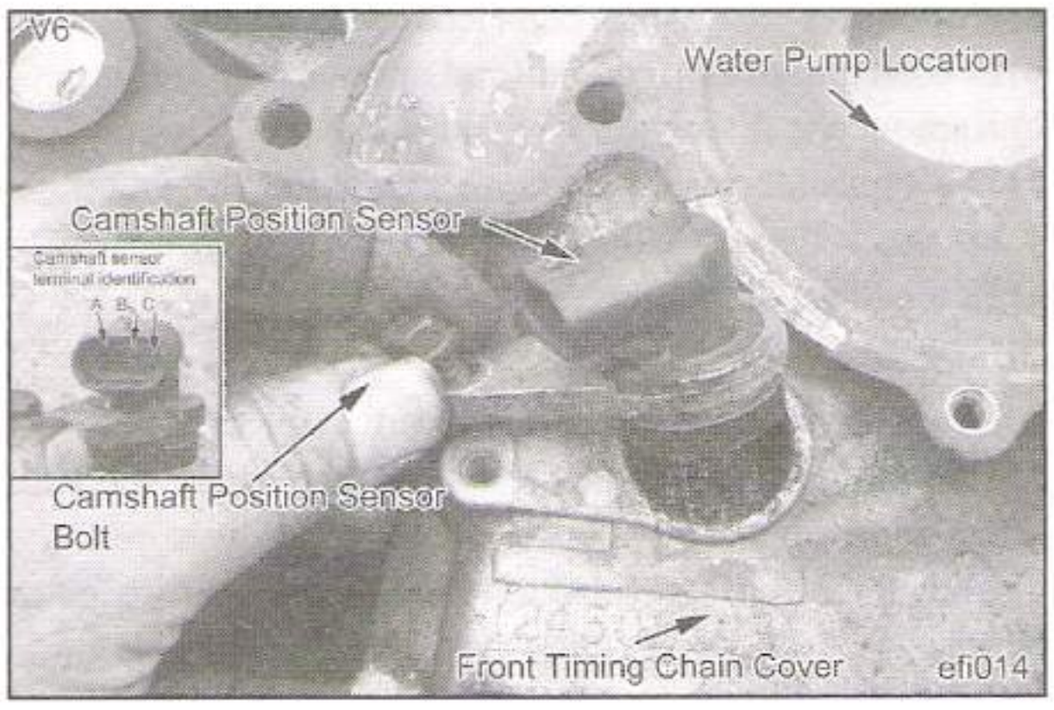


connector terminal "M" and jumper to earth.
• Ensure that the Two paper clips and/or jumper leads Do Not Touch.
5. Connect a test light to ignition module harness connector terminal "H" and +ve 12 volts.
6. Turn ignition ON.
7. Using a long handle 28 mm socket to slowly turn the engine over at the crankshaft balancer one revolution.
8. The test light should flash as the 3X interrupter blades pass through the sensor air gap.
9. If the test light does not flash, check the 4 wiring circuits between the crankshaft position sensor and the ignition module, if all are correct replace crankshaft position sensor.

Install

1. Install the crankshaft position sensor,2 bolts. Tighten bolts top specification.
Crankshaft Sensor Bolt: 20-30 Nm
2. Replace the crankshaft position sensor loom
3. Reconnect battery terminals.

Camshaft Position Sensor and Test



Remove

1. Disconnect battery terminals.
2. Disconnect the harness connector.
3. Remove the camshaft position sensor, 1 bolt.

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Install

1. Install the camshaft position sensor, 1 bolt. Tighten bolt top specification.

Camshaft Sensor Bolts: 8-12 Nm

2. Reconnect the electrical harness connector.

3. Reconnect battery terminals.

VT Ser I V8 Engine Only

Coil and Test

1. Remove High Tension Lead & disconnect the primary electrical connector

2. Check Primary Coil Resistance.

a) Measure the resistance between the positive (+) and negative (-) terminals using an ohmmeter. Replace if not within specification.

Primary coil resistance: 0.42-0.47 ohms @ 20-30°C

3. Check Secondary coil Resistance.

a) Measure the resistance between the positive (-) and high-tension terminal, using an ohmmeter.

Secondary coil resistance: 5940-7260 ohms @ 20-30°C

Note: Replace the ignition coil if not to specifications

Distributor Assembly

Remove

Turn the engine over by hand until it is at T.D.C. on the compression stroke on No.1 cylinder. Remove distributor assembly from the engine

1. Loosen and remove the engine trim covers

a) Remove the fuel pump relay

b) Start engine and allow to idle until fuel supply remaining in fuel lines is used, turn off ignition switch

2. Disconnect the battery negative cable

a) Disconnect the fuel supply hose and tie up out of the way

3. Disconnect all high tension leads at spark plugs and coil

a) Disconnect the ignition coil electrical connector

b) Loosen the ignition coil bolt and remove the ignition coil

c) Remove the distributor cap and leads

d) Disconnect the electrical connector at the distributor

4. Loosen and remove the distributor retaining bolt

a) Remove the distributor assembly

Dismantle

1. Disconnect the wiring harness from connector

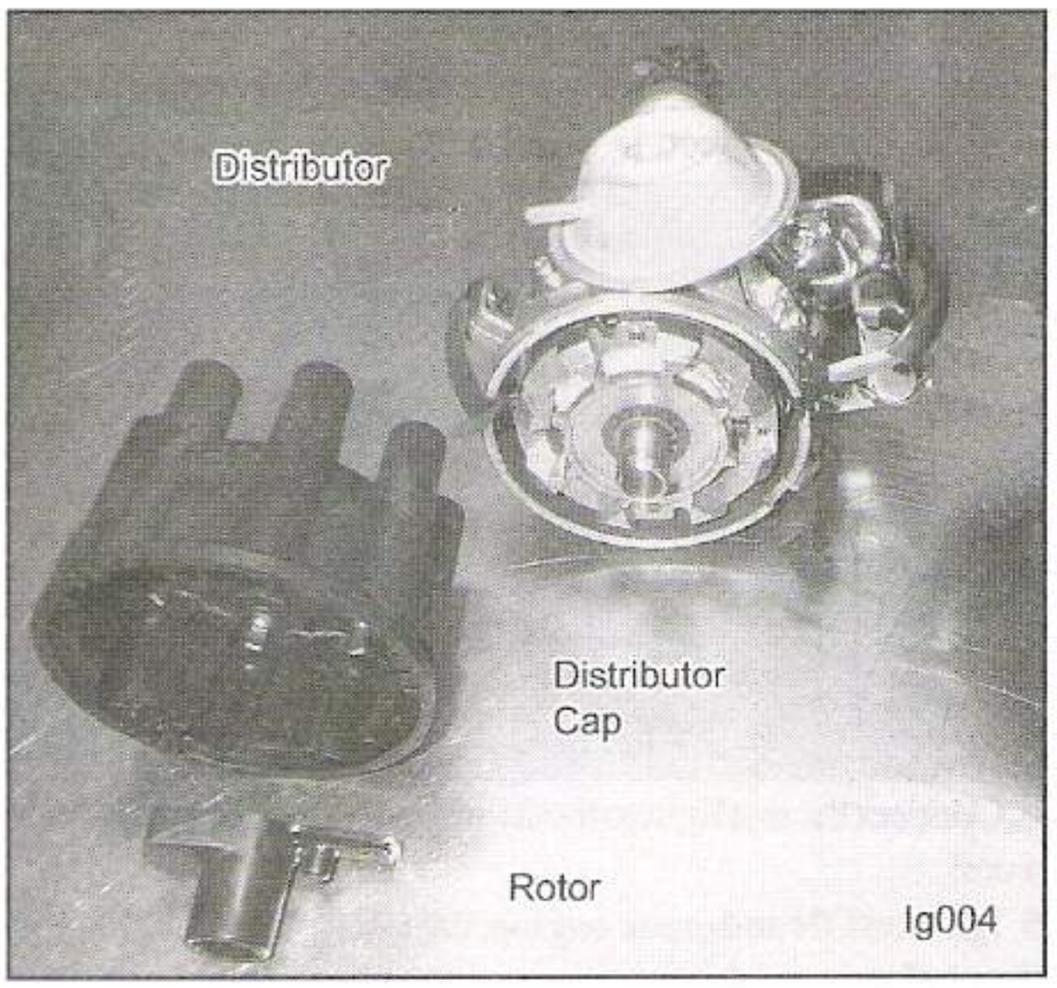
2. Loosen and remove the 2 screws that secure the Hall effect sensor plate

a) Slide the electrical connector block from the distributor housing

3. Support the distributor driven gear in a wooden v-block and using a pin punch, knock out the roll pin

a) Slide the driven gear and thrust washers off the shaft

4. Carefully push the shaft assembly out of the distributor



housing

5. Remove the lower circlip from the shaft, slide the sensor plate and plastic bush downward to remove

6. Remove both the upper and lower circlips from the toothed disc

a) Use a suitable length sleeve and hammer to carefully drive the disc off the shaft

Note: Do Not damage the toothed disc or it will have to bel replaced

Assembly

1. Lightly coat the distributor shaft bushes with high temperature grease

2. Carefully drive the toothed disc into position on the shaft

a) Fit both the upper and lower circlips

3. Slide the sensor plate onto the shaft and fit the circlip

4. Fit the shaft assembly back into the distributor housing

a) Fit the thrust washers onto the shaft and refit the driven gear onto shaft aligning roll pin holes

b) Support the driven gear using a wooden v-block

c) Use a pin punch and hammer to drive the roll pin into the driven gear and shaft

5. Fit the electrical connector into position in the distributor housing

a) Fit the 2 sensor plate screws and tighten

b) Connect the distributor harness to the electrical connector

Installation

1. Turn engine over until No.1 Cylinder is at TDC/Compression.

a) Remove No.1 spark plug

b) Place your finger over the hole of the No.1 spark plug and turn the crankshaft slowly clockwise by hand to TDC, pressure will be felt on your finger.

2. Position the rotor so that it is about 40° before the No. 1

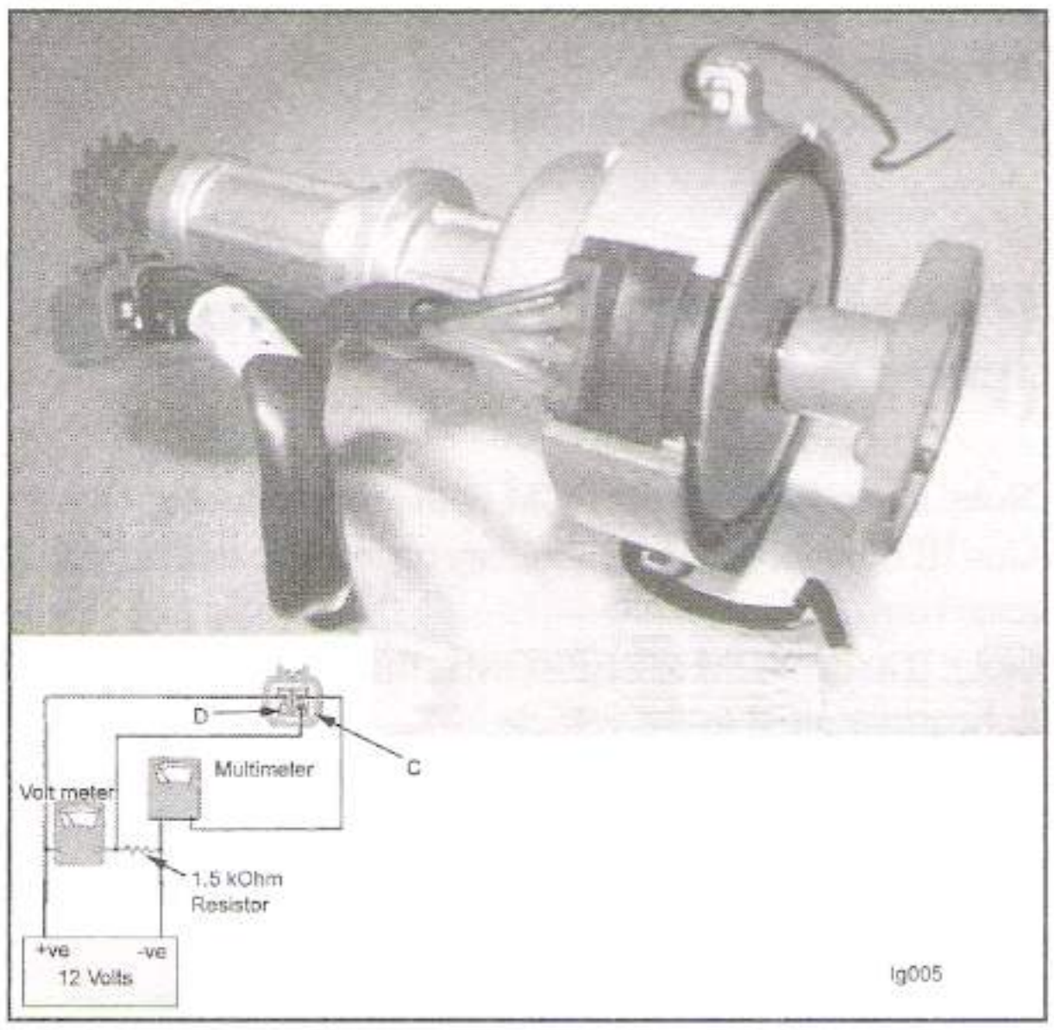
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cylinder mark on the distributor
a) Fit distributor into block when fully installed rotor should be aligned with the No.1 mark on distributor
b) Fit the distributor clamp and bolt and tighten by hand
c) Refit distributor cap, leads, coil and electrical connectors etc.
d) Connect the battery negative lead and refit the fuel pump relay
4. Check the ignition timing and adjust as previously described, tighten distributor clamp bolt when timing is set correctly.

Distributor Tests (removed from engine)

Crankshaft reference sensor test

1. Remove the distributor cap and rotor
2. Rotate the distributor shaft until a trigger vane (toothed disc) is just outside the Hall effect sensor air gap
3. Connect an ammeter, voltmeter, 1.5 kohm resistor and a 12 v power source as shown in diagram, with probe X to terminal C.



4. The voltmeter should read 400 mV or less and the ammeter less than 20 mA @ 24°C
5. Rotate the distributor shaft until any trigger vane (toothed disc) is within the Hall effect sensor air gap
a) The voltmeter should now give a reading of 11.0 V the ammeter should read less than 20 mA @ 24°C

Note: If values are not as specified replace the Hall effect sensors

Camshaft position sensor and Test

1. Rotate the distributor shaft until the trigger vane of the disc is outside the air gap of the Hall effect sensor
2. Connect an ammeter, voltmeter, 1.5 kohm resistor and a 12 v power source as shown in diagram, with probe X to terminal D
3. The voltmeter should read 400 mV or less and the ammeter should show a value of less than 20 mA @ 24°C
4. Rotate the distributor shaft until the trigger vane is within the Hall effect sensor air gap
a) The voltmeter should now give a reading of 11.0 V the ammeter should read less than 20 mA @ 24°C

Note: If values are not as specified replace the Hall effect sensors

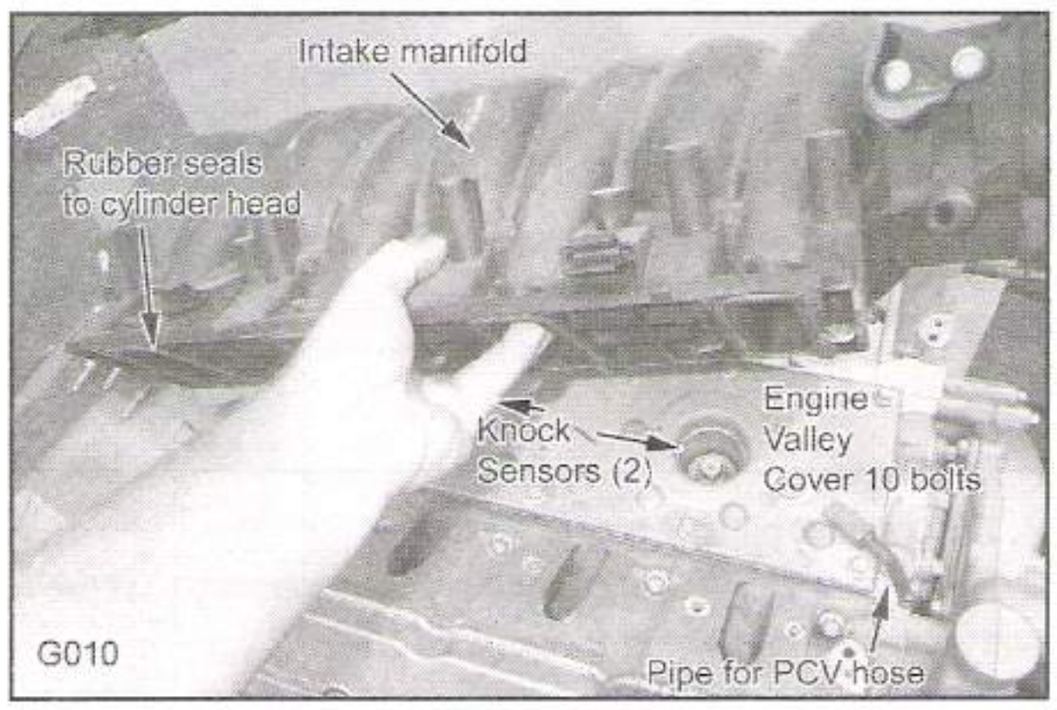
Gen III V8

Ignition Timing

Inspect

The ignition timing is set by PCM. with data from the crankshaft sensor, camshaft sensor and feed through the ignition module.
The PCM adjusts the ignition timing according to data from the engine coolant temperature sensor, air intake temperature sensor, mass air flow sensor, transmission fluid temperature switch, knock sensor, throttle position sensor, vehicle speed sensor.
The ignition timing on the Gen III V8 engines are not manually adjustable, therefore there are no timing marks on the crankshaft balancer.

Knock Sensor



Knock Sensor is located under intake manifold, see GenIII engine chapter for removal and installation.

Test

Measure the resistance between the terminal and earth, using an ohmmeter. The sensor can be tested on the vehicle.
Knock Sensor (cold): 50,000 ohms.
If not as specified replace sensor.

Ignition Coils and Ignition Module

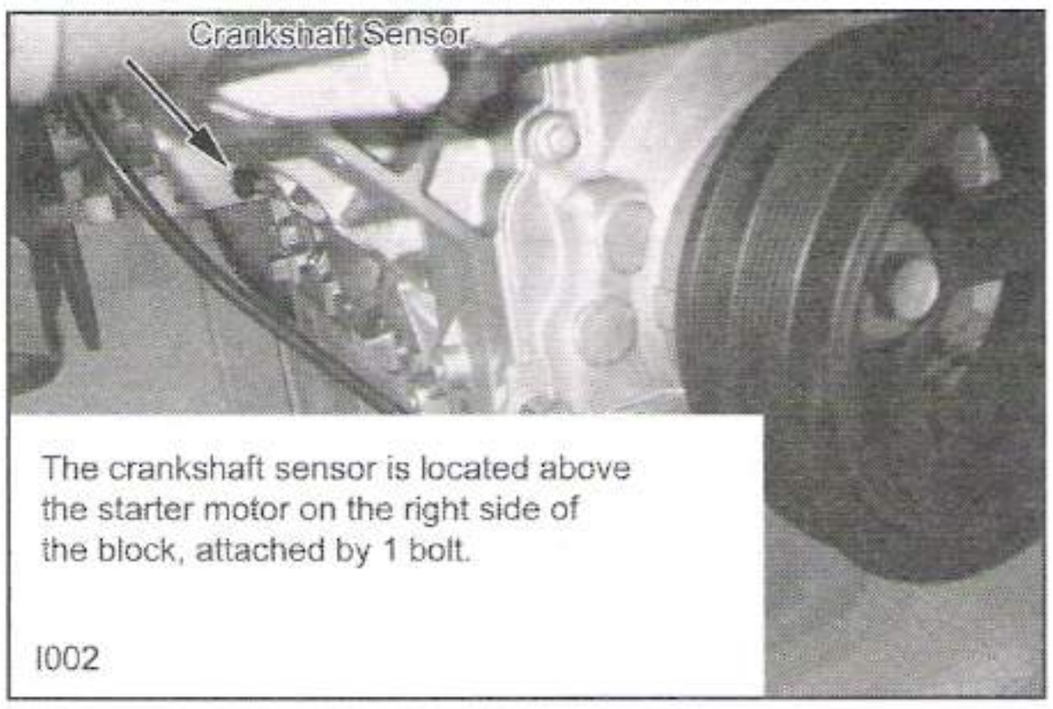
Note: The ignition module operates in 2 modes, 1 (Bypass) while engine is cranking and the other (Electronic Spark Timing) while engine is running.

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See codes DTC 41 and 42.
See direct Ignition System Check
Remove
1. Disconnect battery terminals.
2. Remove the engine top cover, 4 nuts.
3. Disconnect the ignition coil / module harnes connector, the connector has a securing tab to be removed.
4. Disconnect the coil spark plug leads and coil harness connector.
5. Remove the coils / modules, 2 bolts.
Test
See Diagnostic codes for testing proceedues.
Install
1. Install coils / modules, 2 bolts.
Coil / Module Bolt Torque: 12Nm
2. Connect the coil spark plug leads and coil harness connector.
3. Reconnect the ignition coil / module harnes connector, the connector has a securing tab to be inserted.
4. Replace the engine top cover, 4 nuts, reconnect battery terminals.

Crankshaft Position Sensor

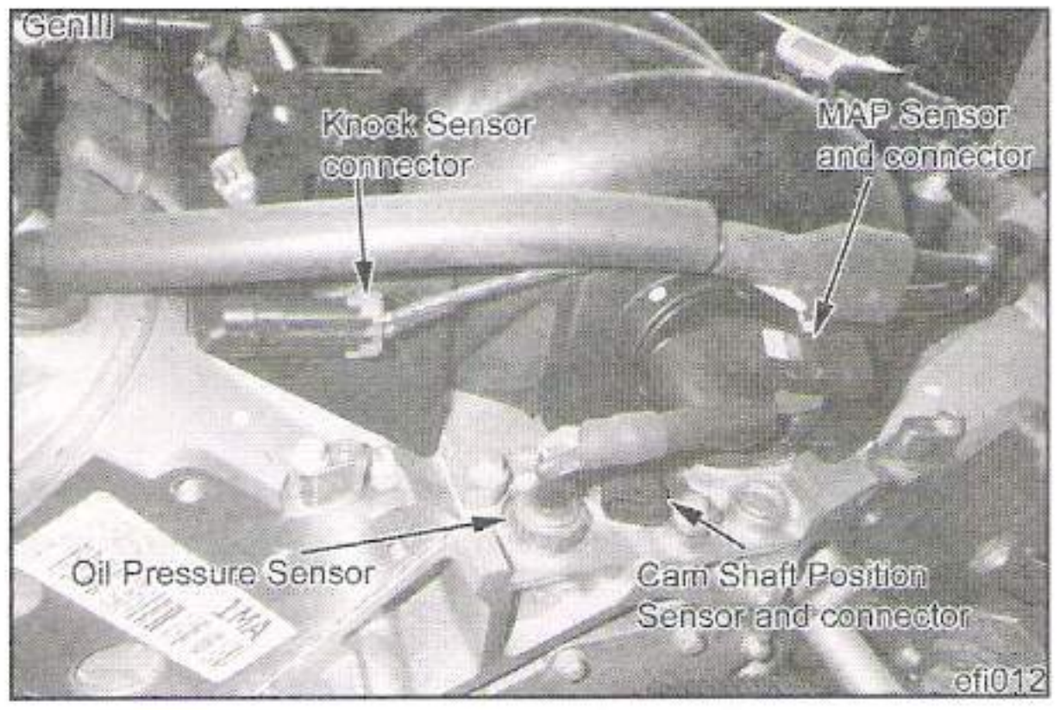
Located above and behind starter motor, rear right side.
Remove



1. Disconnect battery terminals.
2. Remove starter motor (it may not be necessary to remove starter motor, but easier to work with)..
3. Remove the crankshaft position sensor loom connector bolt and connector.
4. Remove the crankshaft position sensor, 1 bolt.
Install
1. Install the crankshaft position sensor, use a new O ring, 1 bolt. Tighten bolts top specification.
Crankshaft Sensor Bolts: 25 Nm
2. Replace the crankshaft position sensor loom
3. Reconnect battery terminals.

Camshaft Position Sensor

Note: It may be necessary to remove the intake manifold, for clearance in removing the camshaft sensor as it is quite long.



Remove
1. Disconnect battery terminals.
2. Disconnect the harness connector.
3. Remove the camshaft position sensor, 1 bolt.
Install
1. Install the camshaft position sensor, 1 bolt. Tighten bolt top specification.
Camshaft Sensor Bolts: 25 Nm
2. Reconnect the electrical harness connector.
3. Reconnect battery terminals.

Powertrain Control Module (PCM)

Note: Do not disconnect PCM with ignition turned ON.
Gen III is located in the enginebay on left side under coolant reservoir.
Note: If a new PCM or EEPROM is fitted the PCM will need to be programed to the vehicle.
Note: Check part numbers as a correct PCM must be fitted to a particlur vehicle to match engine and transmission etc.
Note: A new PCM will not be programed, and can only be programed by using a Tech II tool.
Then an Idle Learn check must be carried out, also a Functional check
Remove.
1. Ignition OFF, disconnect battery,
2. Remove the engine coolant reservoir, disconnect the coolant temperature switch in the base of the reservoir.
3. Remove air cleaner top cover and box.
4. Remove PCM harness connectors.
a) Remove harness top cover.
b) Remove the harnessess by removing the securing screws, then connector.
5. Remove PCM, remove bracket attaching screws, then PCM, the PCM will need to be lifted from the bracket while working the bracket edges.
Install
1. Install PCM bracket, replace attaching screws.

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2. Reconnect PCM harness connectors and the securing screws.
3. Replace the engine coolant reservoir, reconnect the coolant temperature switch in the base of the reservoir.
4. Replace air cleaner top cover and box.
5.Reconnect battery.
6. Carry out the proceedure as described in this chapter.

PCM Programing with Tech II tool

* Ignition ON, fully charged battery.
Tech II tool connected to vehicle DCL (under the dash drivers side), go to "service programming system" (SPS) / program ECU.
If the PCM will not program, replace the PCM and program it.
The PCM must the be security linked to the PIM/BCM with the Tech II tool.

PCM/PIM/BCM Security Link

1. Tech II tool connected to vehicle DCL (under the dash drivers side), go to "body control module" then:
2. Diagnostic/(vehicle model)/Body/Body Control Module/ Security / BCM link to PCM / PIM.
3. Enter type of engine (if a GenIII V8, a TIS programe approve is required to down loaded into the Tech II tool)
4. Link the BCM to the PIM, then the PCM to the PIM will be performed by the Tech II tool.
5. Idle Learn Proceedure will then then be required to obtain IAC position data.
6. Carry out a functional check as described.

Idle Learn Procedure

If the PCM looses power due to battery being disconnected, the "Idle Learn Position" should be performed to obtain a smooth idle.

Automatic transmission vehicles

All accosories turned OFF, ignition OFF, park brake pulled on, jam rear (drive) wheels with blocks .
Start engine.
Select "D' for transmission.
Idle for 10 minutes.
Turn air conditioner ON.
Idle for 10 minutes.
Select "P" for transmission.
Idle engie for 10 minutes.
Turn air conditioner OFF.
Idle for 10 minutes.
Engine OFF for minimum 30 seconds.

Manual transmission vehicles

All accosories turned OFF, ignition OFF, park brake pulled on, jam rear (drive) wheels with blocks .
Select neutral for transmission.
Start engine.
Turn air conditioner ON.
Idle for 10 minutes.
Turn air conditioner OFF.
Idle for 10 minutes.
Engine OFF for minimum 30 seconds.

Functional Check

Clear all diagnostic trouble codes (DTC's).
Carry out the "Powertrain OBD System Check
Start engine and allow to idle for 1 minute.
Check for any diagnostic trouble codes (DTC's).

Powertrain Interface Module (PIM)

The PIM is located behind the passenger side kick panel.

Remove

1. Ignition OFF.
2. Remove side kick panel.
3. Remove PIM from bracket on vehicle panel.
4. Disconnect the PIM harness connector from PIM.

Install

1. Ignition must be OFF.
2. Connect the PIM harness connector from PIM.
3. Install PIM into bracket on vehicle panel.
4. Replace side kick panel.

PCM/PIM/BCM Security Link

1. Tech II tool connected to vehicle DCL (under the dash drivers side), go to "body control module" then:
2. Diagnostic/(vehicle model)/Body/Body Control Module/ Security / BCM link to PCM / PIM.
3. Enter type of engine (if a GenIII V8, a TIS programe approve is required to down loaded into the Tech II tool)
4. Link the BCM to the PIM, then the PCM to the PIM will be performed by the Tech II tool.
5. Idle Learn Proceedure will then then be required to obtain IAC position data.
6. Carry out a functional check as described.

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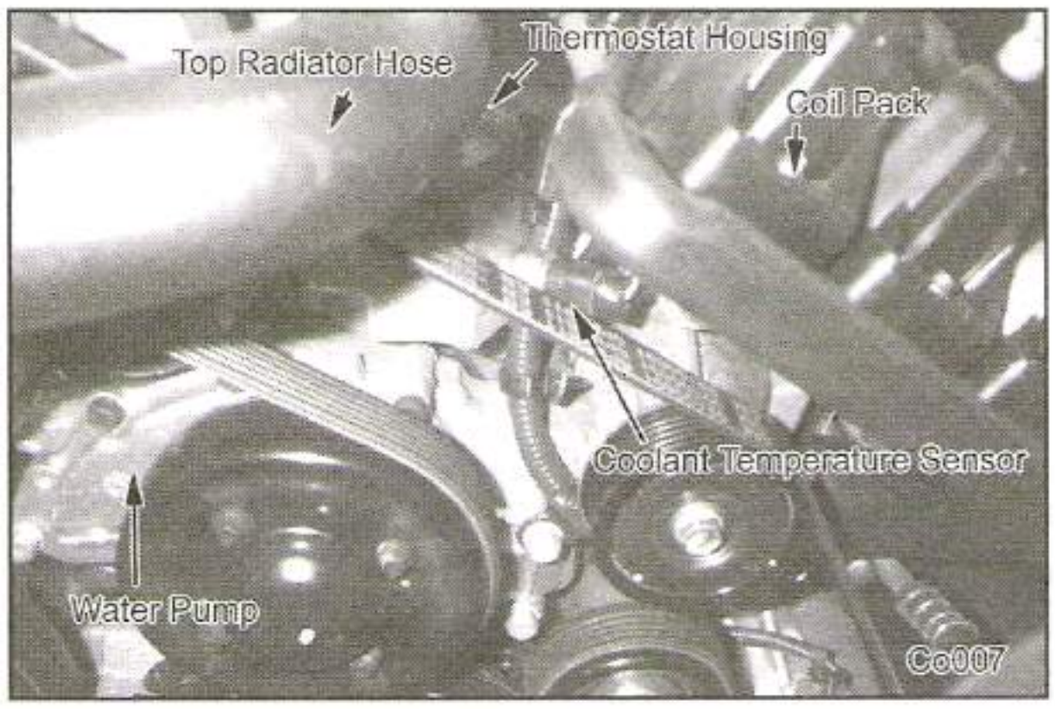
Functional Check

Clear all diagnostic trouble codes (DTC's).
Carry out the "Powertrain OBD System Check
Start engine and allow to idle for 1 minute.
Check for any diagnostic trouble codes (DTC's).

COOLANT TEMPERATURE SENDER

Removal

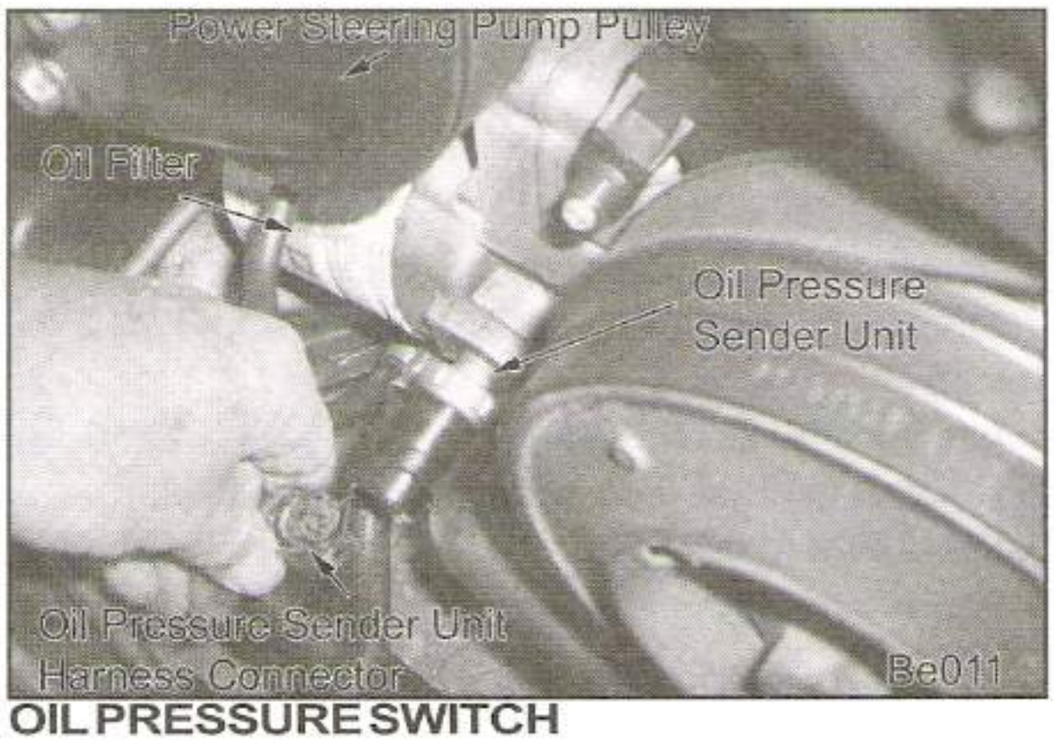
1. Disconnect electrical connector from temperature gauge sender unit.



2. Unscrew and remove temperature gauge sender unit. Note that some coolant will discharge.

Installation

1. Screw in the new temperature gauge sender unit.
2. Reconnect electrical connector to temperature gauge sender unit.



OIL PRESSURE SWITCH

Removal

Disconnect electrical connector from oil pressure switch.
Unscrew switch to remove.

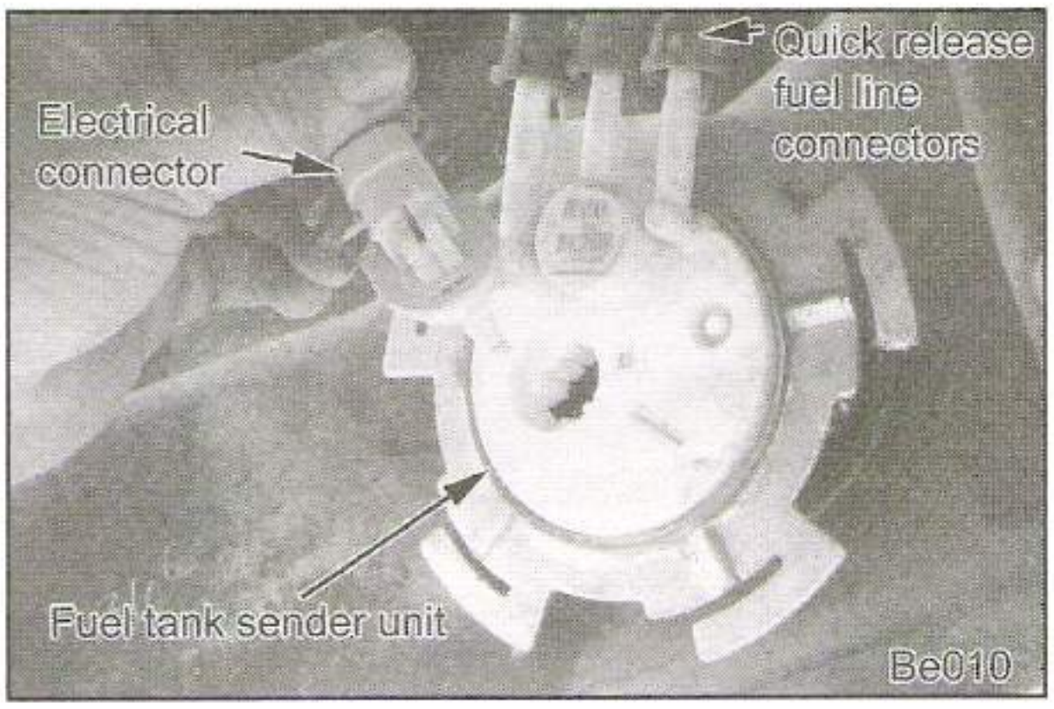
Installation

Install unit, tighten and fit electrical connection.

FUEL GAUGE SENDER

Removal

1. Remove the fuel tank or allow it be lowered by removing the supporting straps and bolts.
2. Disconnect the electrical connections for the fuel gauge



sender unit.
3. Unscrew the lock plate (use a special tool or use a large screw driver and hammer to tap the plate around until loose enought to use your hand) on top of the fuel sender unit then remove unit from the fuel tank.

Installation

1. Clean mating surfaces of sender unit and tank.
2. Install new seal to sender unit then replace gauge sender unit into fuel tank.
3. Install and tighten the locking plate, reconnect electrical connections and check operation.
4. Install the tank to the vehicle.

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Problem Diagnosis.

Also see "Spark Tests" in this chapter, and also see "EFI Fault Diagnosis" chapter.

Problem: Engine will not start or hard to start but cranks OK!
Possible Causes & Remedies:
* Check timing and check DTC codes.
* Ignition coil faulty or igniter faulty. Remedy-Examine coil
* High tension lead faulty. Remedy-Inspect high tension lead.
* Spark plugs faulty. Remedy-Check plugs.
* Ignition wiring disconnected or broken. Remedy-Examine wiring.

Problem: Rough Idle or Stalls!
Possible Causes & Remedies:
* Spark plugs faulty. Remedy-Examine plugs.
* Ignition wiring faulty. Remedy-Examine wiring.
* Check timing and check DTC codes.
* Ignition coil faulty or igniter faulty. Remedy-Inspect coil.
* High tension lead faulty. Remedy-Inspect high tension lead.

Problem: Engine hesitates/poor acceleration!
Possible Causes & Remedies:
* Spark plugs faulty. Remedy-Check plugs.
* Ignition wiring faulty. Remedy-Inspect wiring.
* Check timing and check DTC codes.

Problem: Muffler explosion (after fire) all the time! and Engine back fires
Possible Cause & Remedies:
* Check timing and check DTC codes.

Problem: Poor Fuel Economy!
Possible Cause & Remedies:
* Spark plugs faulty. Remedy-Examine plugs.
* Check timing and check DTC codes.

Problem: Engine overheats!
Possible Cause & Remedies:
* Check timing and check DTC codes.

Specifications

V6 - Engine
Firing Order 1-6-5-4-3-2
Spark Plug
V6 - non supercharged
Type: ..... NGK BPR6EFS-15
Electrode Gap: ..... 1.5 mm
V6 - Supercharged
Type: ..... AC 41-919
Electrode Gap: ..... 1.5 mm + 0 - 0.5 mm
Ignition Coil Resistance
Primary: ..... 0.3-1.5 ohms @ 20-30°C
Secondary: ..... 5000-7000 ohms @ 20-30°C
Ignition Lead Resistance
V6 - non supercharged
Left Hand Side: ..... Less than 10000 ohms
Right Hand Side: ... Less than 27000 ohms
V6 - Supercharged
Left Hand Side: ..... Less than 10000 ohms
Right Hand Side: ... Less than 17000 ohms

VT Ser I V8 - Engine
Firing Order: ..... 1 - 2 - 7 - 8 - 4 - 5 - 6 - 3
Spark Plug
Type: ..... NGK BPR6EF
Electrode Gap: ..... 1.0 ± 0.05 mm
Ignition Coil Resistance
Primary: ..... 0.472-0.47 ohms @ 20-30°C
Secondary: ..... 5940-7260 ohms @ 20-30°C
Spark Plug Lead Resistance
Less than 25000 ohms
Coil Lead Resistance
Less than 6000 ohms
Ignition Timing: . 10° BTDC @ Idle
(transmission in neutral & A/C off)
Connect terminals 5 and 6 of D.L.C.

Gen III V8 - Engine
Firing Order 1-8-7-2-6-5-4-3
Spark Plug
Type: ..... AC 41-952
Electrode Gap: ..... 1.5 mm + 0 - 0.5 mm
Heat Range 2
Ignition Lead Resistance
Maximum ..... Less than 700 ohms

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ELECTRONIC FUEL INJECTION

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General Information

ELECTRONIC FUEL INJECTION (EFI)

The V6 & V8 engines all utilise an Electronic Fuel Injection System. EFI system is basically made up of three subsystems:- Fuel System, Air Induction System and Electronic Control System.

Fuel System

The EFI system requires a supply of fuel at higher pressures than the carburettor type system. The fuel is supplied to the fuel rail by an electric fuel pump, pressure is regulated to a set value. It is then injected into the intake ports by the injectors which are controlled by signals sent from the PCM (Powertrain Control Module).

Air Induction System

The air induction system draws in sufficient air to provide correct fuel/air ratio depending upon varying engine requirements.

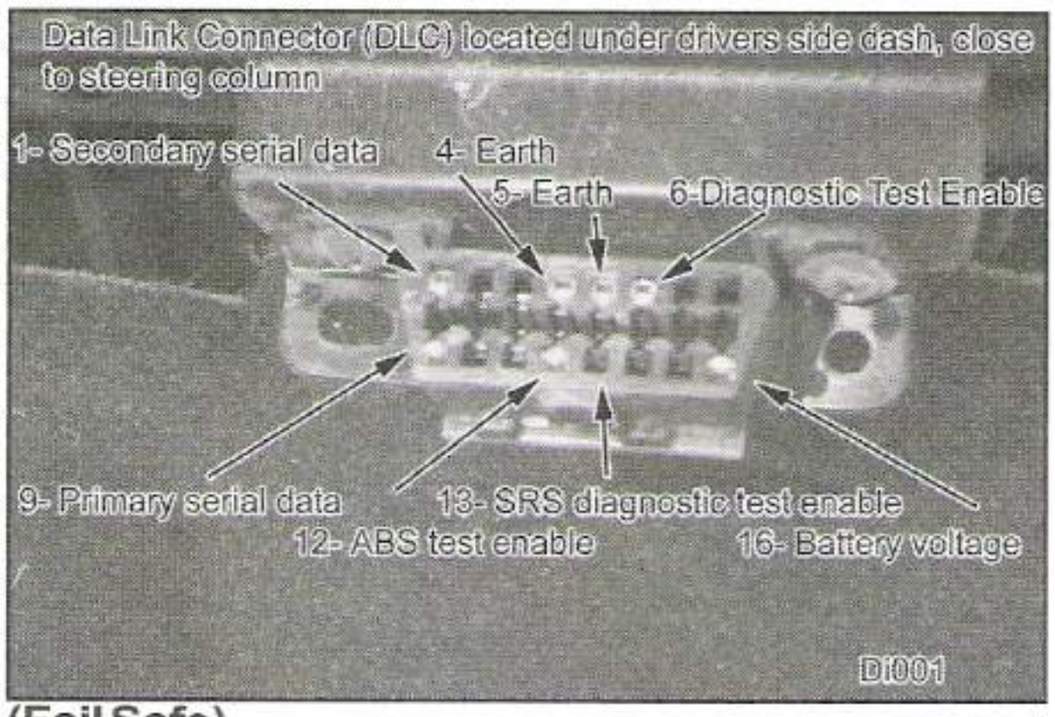
Electronic Control System

The PCM (Powertrain Control Module) employs a microcomputer. All of the data sent to the PCM by sensors such as the intake air volume, intake air temperature, water temperature, engine speed, oxygen sensor and throttle position sensor is read by the PCM. All of this information is then checked against parameters stored in the PCM to decide the optimum amount of fuel to inject and the correct ignition timing for any given situation.

(Diagnosis)

The PCM incorporates a self diagnosis system, if there is a failure in any of the EFI systems a "Check Engine" light will illuminate on the instrument panel. Diagnostic codes can then be read by shorting terminals 5 and 6 of the Data Link Connector, the check engine light will then flash a number of times depending on the code that has been set.

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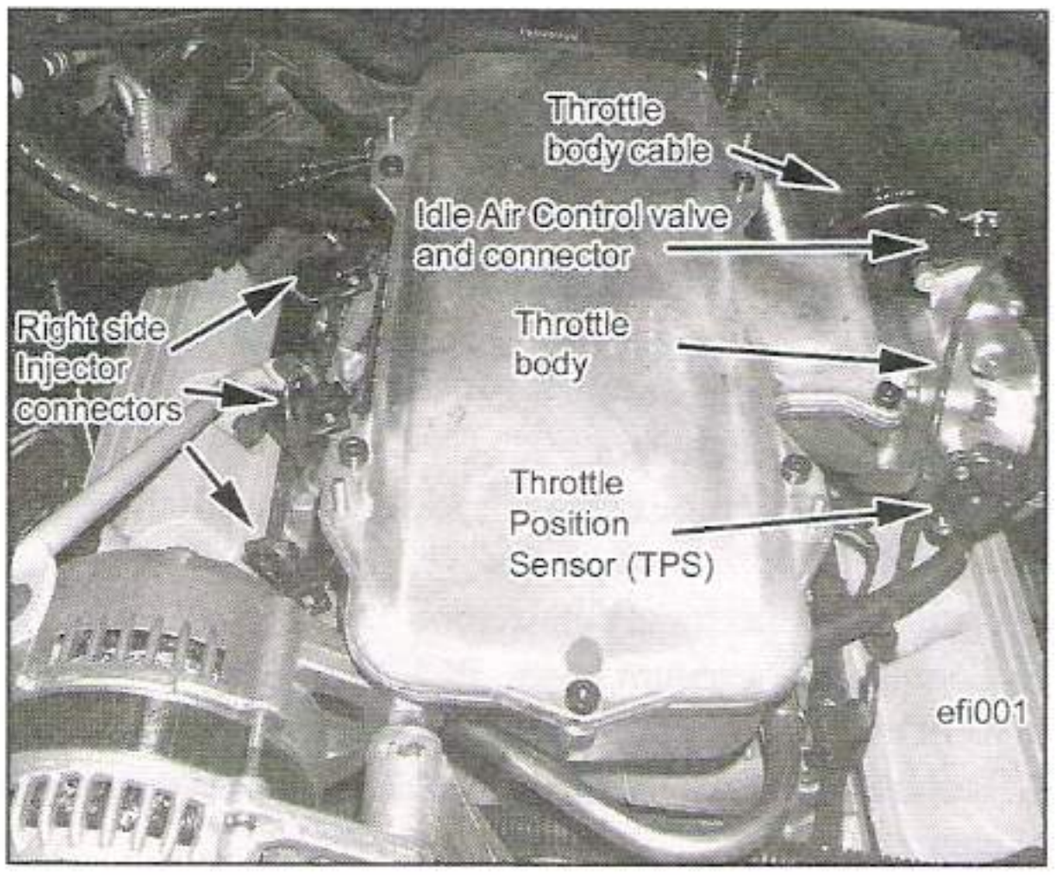
(Fail Safe)

If there should be a problem with the PCM a back up circuit 'Fail Safe' is built into the PCM and it will take over allowing the vehicle to be driven, although drive ability is poor the vehicle should be able to be driven to a location where repairs can be undertaken.

Precautions

1. Before starting any work on the fuel system disconnect the negative battery terminal
2. Keep any sources of ignition away from the work area, DO NOT smoke while working on any of the fuel system components
3. Keep fuel off any rubber or plastic parts to prevent damage
4. Keep the work area clean to prevent any contaminants from entering the fuel system components

On Vehicle Checks



EFI System Check

The EFI system operation can be checked using the 'Check Engine Warning Light', any faults that may have occurred during engine operation will be stored as diagnostic codes. Before staring the diagnostic check make sure the following items are correct:

a) Battery voltage is 11v or more
b) Transmission is in neutral
c) Engine is at normal operating temperature
d) All accessories are off
e) The throttle is closed

Read Diagnostic Codes

Gen III V8 the DTC's must be read with a Tech 2 tool.

All V6 and VT SerI V8

1. To enter diagnostic mode first turn the ignition switch to the ON position
a) Connect terminals 5 and 6 together at the 'Data Link Connector'
2. The 'Check Engine Warning Light' will now start to flash
3. The Code 12 should flash 3 times, this indicates that the PCM diagnostic system is operating correctly, if any other trouble codes are stored they will start to flash from lowest to highest. Each code will be flashed 3 times
a) If more than one code is stored, there is an interval of 2.5 seconds between codes
b) Once all the codes have been displayed, there is a pause for 4.5 seconds and then the light will start to flash the codes again starting with the first code stored
Note: Refer to **'Diagnostics chapter'** for code analysis

Clear DTC's All V6, VT Ser 1 V8 and Gen III V8

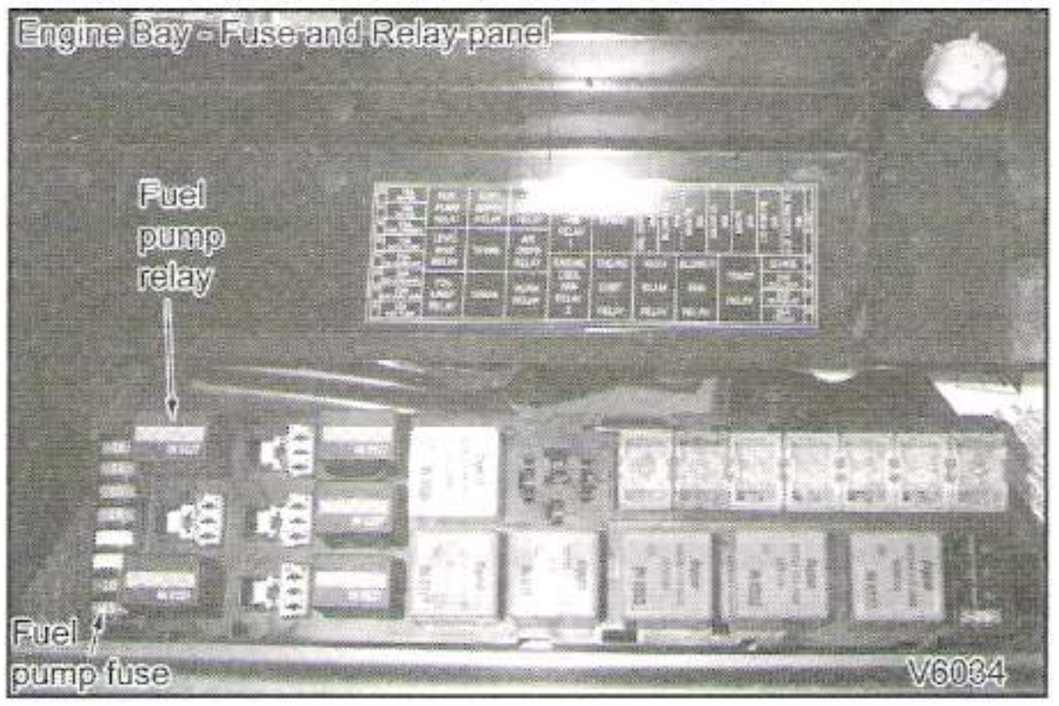
To clear current DTC's disconnect PCM power by turning ignition OFF and disconnecting the battery +ve termnal for atleast 10 seconds, this can also be acheived by removing the "Engine/Cnt BCM" fuse for approximately 30 seconds. The current DTC's will be cleared, however the code history is still stored in the PCM
After repair work has been completed you may wish to clear DTC history, a Tech 2 tool is needed to clear code history.

Note: To help protect the PCM ensure ignition switch is off before disconnecting or connecting PCM power

Once the DTC's have been cleared, take vehicle for a test drive and check that no further DTC's are set. If codes are reset run through diagnostic charts again to rectify problem.

Depressurize Fuel System

1. Remove fuel pump fuse (Fuse No28) or Fuel Pump Relay.

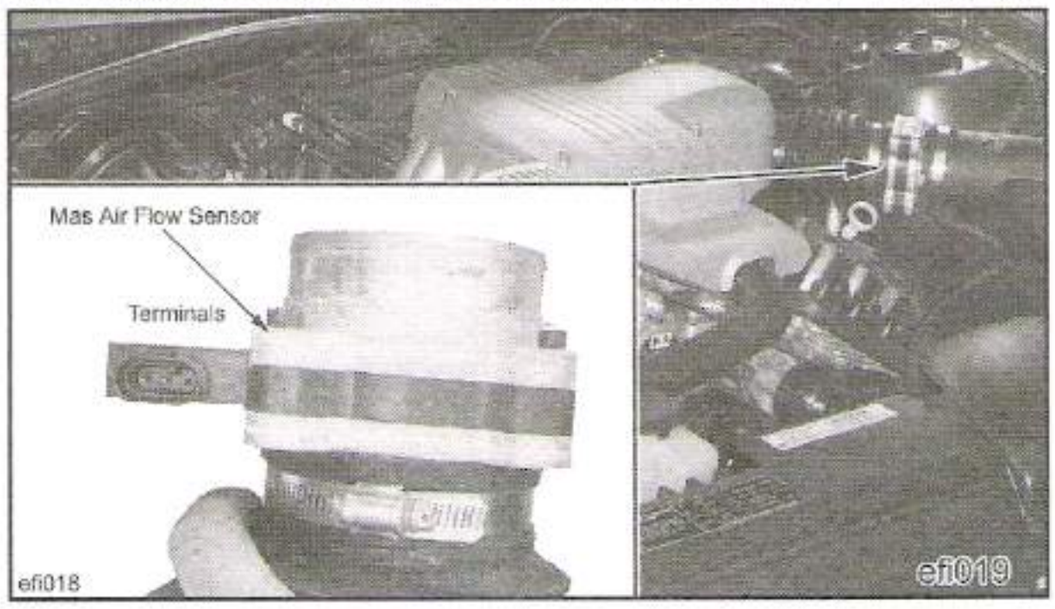


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2. Crank engine or start engine and allow engine to stall.
3. Fuel system has been depressurised.

Mass Air Flow Sensor (MAF)

The Mass Air Flow Sensor or MAF is located in the air intake



ducting (near the air cleaner) between the air cleaner and throttle body.

The MAF uses a heated element placed in the air flow path of the intake air system. The element is maintained at a constant temperature slightly above the ambient temperature. The amount of current required to keep the element at a constant temperature is used by the PCM to calculate the intake air flow.

There are three elements used on the MAF sensor, one is used to measure the ambient temperature and the other two are used as heat sensing elements. As the intake air flows over the heat sensing elements they begin to cool, the current required to keep the elements at a constant temperature is used by the PCM to calculate the amount of fuel to inject into the cylinders.

* If there is a problem with the MAF sensor a DTC 32 will be set, indicating a fault in the circuit. Refer to 'Diagnostics Chapter'

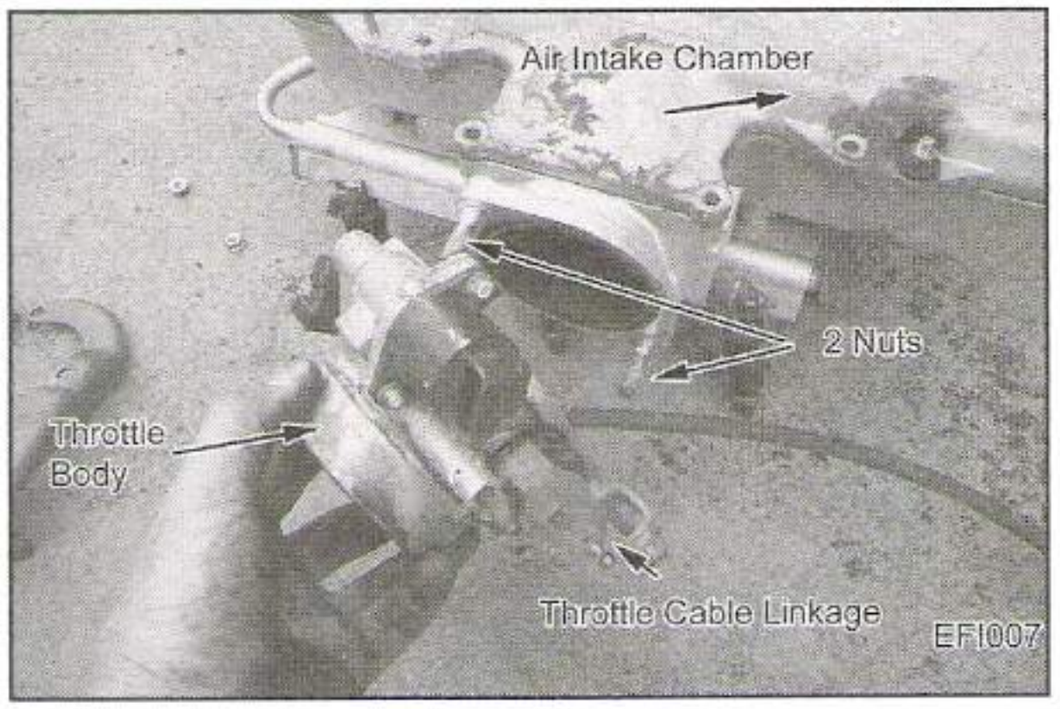
If the MAF sensor is found to be faulty it will have to be replaced as an assembly, no repair is possible.

Note: No adjustments can be made to the MAF sensor

Throttle Body

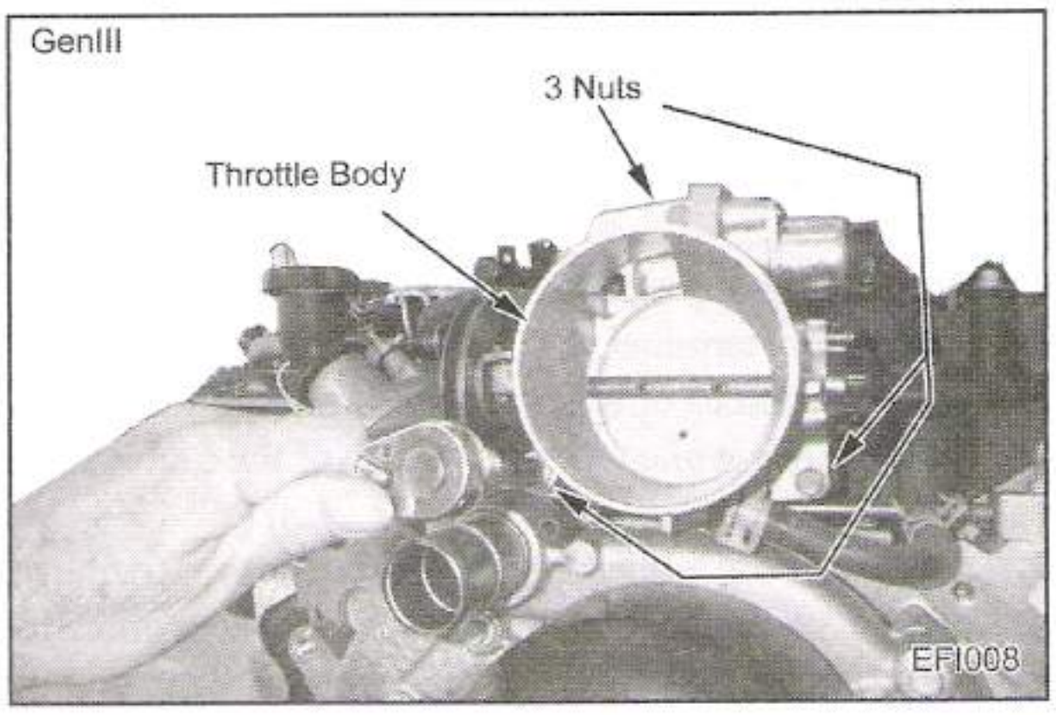
Remove

1. Disconnect the negative battery terminal
2. V6 and Gen 111 V8 - Remove the engine cover 4 dome nuts
   a) VT Ser 1 V8 - Remove the 3 engine trim covers.
3. Loosen the intake duct clamps and remove the duct
4. Disconnect the TPS and IAC electrical connectors at the throttle body
   a) Disconnect the throttle cable from the throttle body butterfly
   b) V6 - Loosen and remove the throttle cable bracket nuts 3
   c) V6 - Remove the bracket and cable from the throttle body
   d) Disconnect the vacuum hoses etc from the throttle body
   e) [Gen 111 engine] Remove the 2 coolant hoses from the throttle body and plug with a rubber stopper.



Remove the evaporative canister purge valve (EVAP) tube from the throttle body.

5. Loosen and remove the [V6- 2] [GenII- 3] throttle body mounting nuts



a) Remove the throttle body and seal

Clean

Clean the throttle body cast parts using a soft brush and carburettor cleaner. Use compressed air to blow out all air ways and passages. To prevent damage, Do Not soak or clean any of the sensors.

Refit

1. Refit the throttle body into position on the inlet manifold, use a new gasket
2. Fit nuts and tighten to specified torque

Torque: ..... 15-18 Nm

3. Connect the throttle cable bracket and connect the cable to butterfly
   a) Connect all electrical connectors
   b) Connect any vacuum hoses, PCV hose etc.
   c) Refit trim/engine covers depending on engine type
4. Start the engine, check for any leaks and correct operation of engine

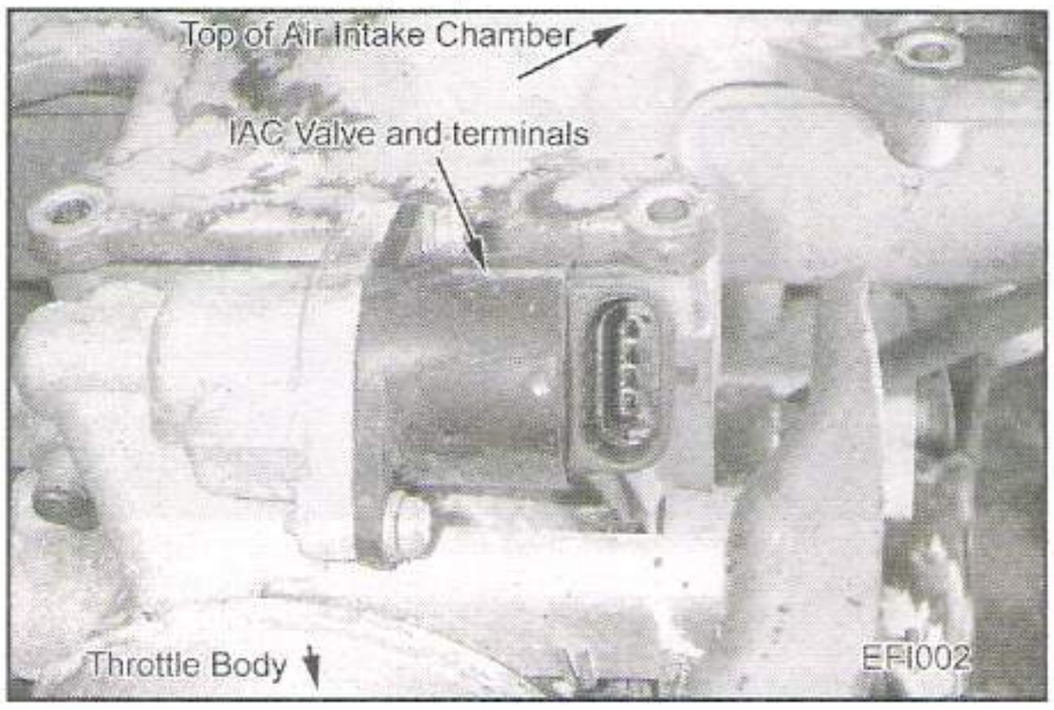
Inspection

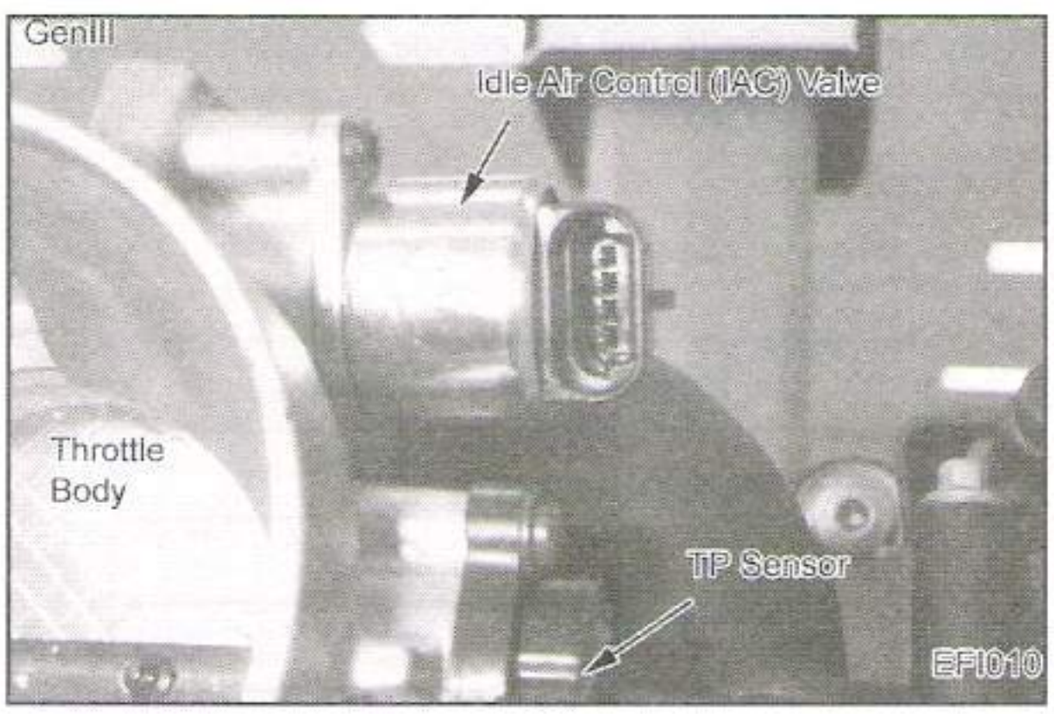
1. Check that the throttle linkage moves freely and is not binding
   a) Check the throttle butterfly shaft for excessive wear in the throttle body - replace throttle body assembly if faulty

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2. Check all ports on the throttle body for blockage and clean as required

Idle Air Control Valve (IAC)





The purpose of the Idle Air Control valve (IAC) is to maintain the correct idle speed depending on engine load and prevent engine stall. The IAC valve has a pintle type valve which is extended or withdrawn depending on signals from the PCM and various sensors. The IAC valve moves in small steps from 0 (fully shut) to 255 (fully open).

The PCM uses signals from the coolant temperature sensor, engine rpm and engine load to determine the correct amount to open or close the IAC pintle valve.

3. If for some reason the IAC should need to be reset ie; battery has been disconnected, IAC connector has been removed. The IAC can be reset by simply starting the engine and allow to idle for at least 5 seconds.

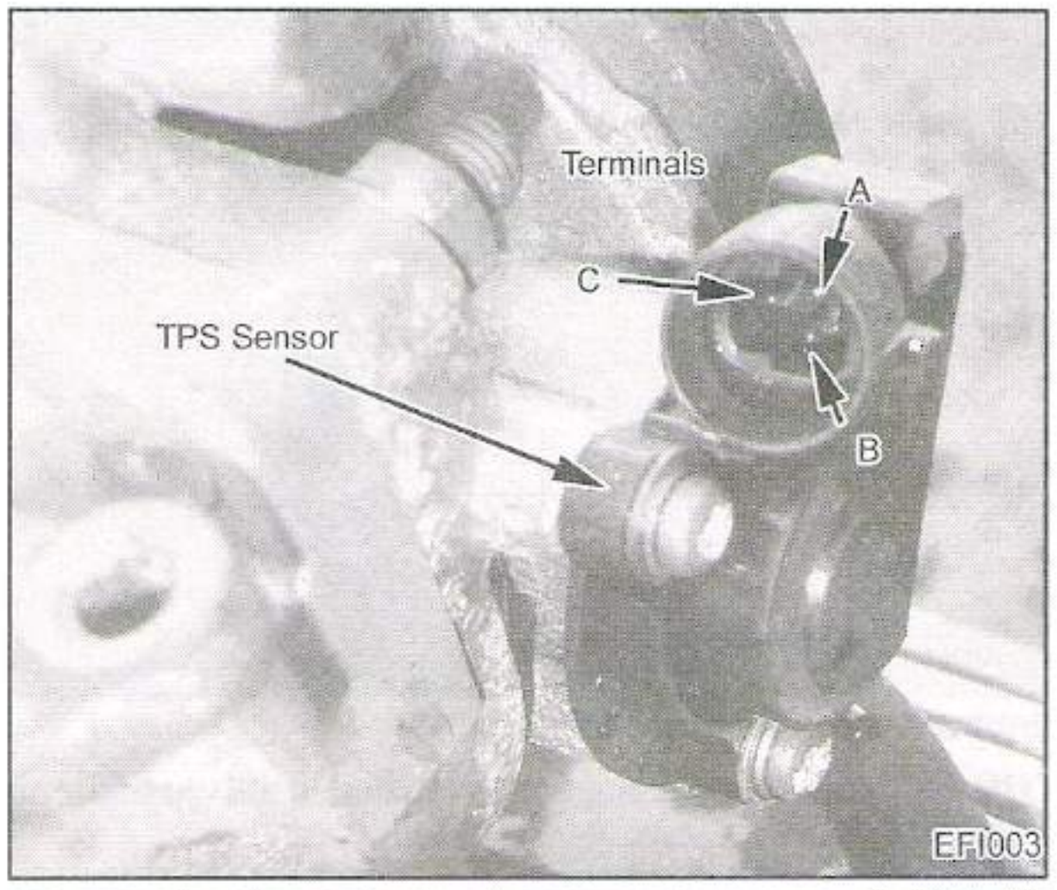
a) Turn the ignition off - the PCM will fully close the IAC valve and store in it's memory this position as 0 steps

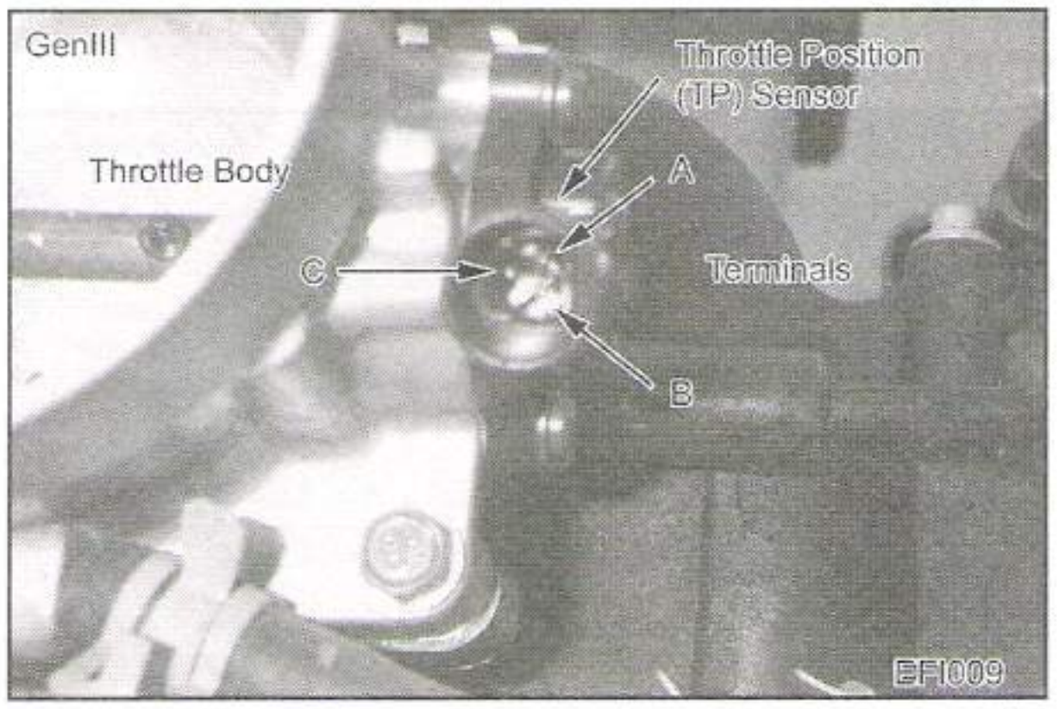
b) Turn the ignition switch to the ON position - the PCM will now fully open the IAC valve and record this position as 255 steps

4. Start the engine and allow to idle, the PCM can now set the IAC valve to the correct position to maintain correct idle depending on coolant temperature, rpm and engine load.

Throttle Position Sensor (TP)

The Throttle Position Sensor (TP) is really just a potentiometer and is turned by the throttle butterfly shaft. The PCM sends a 5 V current to the TP and a signal or voltage is sent to the PCM from the TP depending on the position of the throttle shaft. The PCM uses this information to calculate the exact amount the throttle butterfly is open and this information is used by the PCM to make various calculations as to the amount of fuel to inject etc.





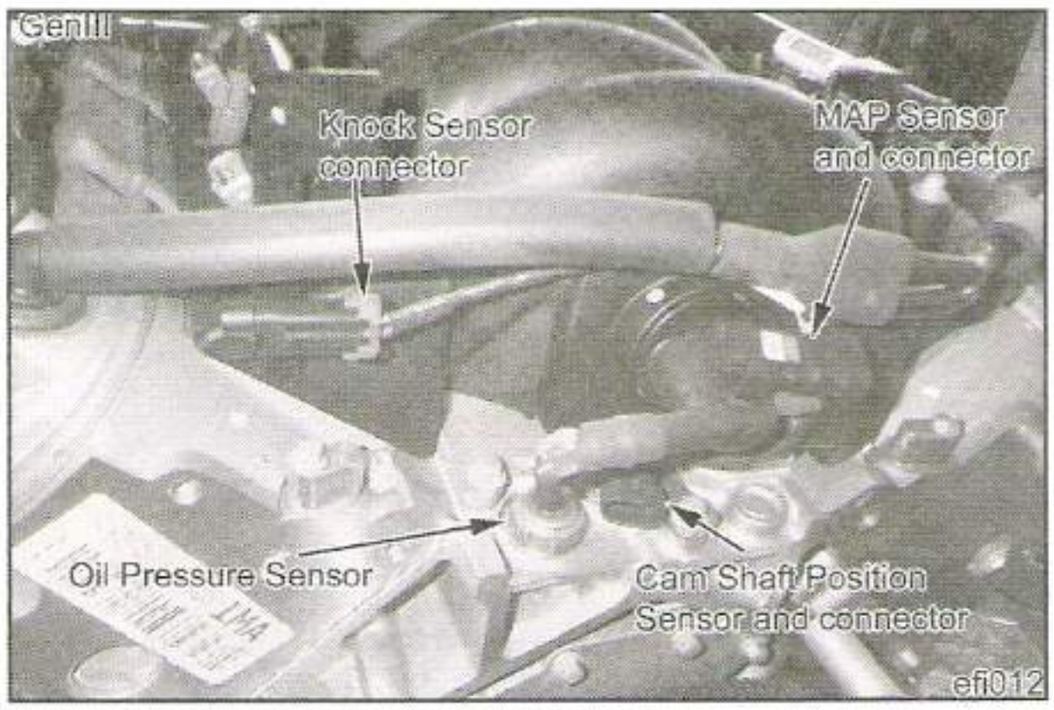
V6 Throttle Position Sensor

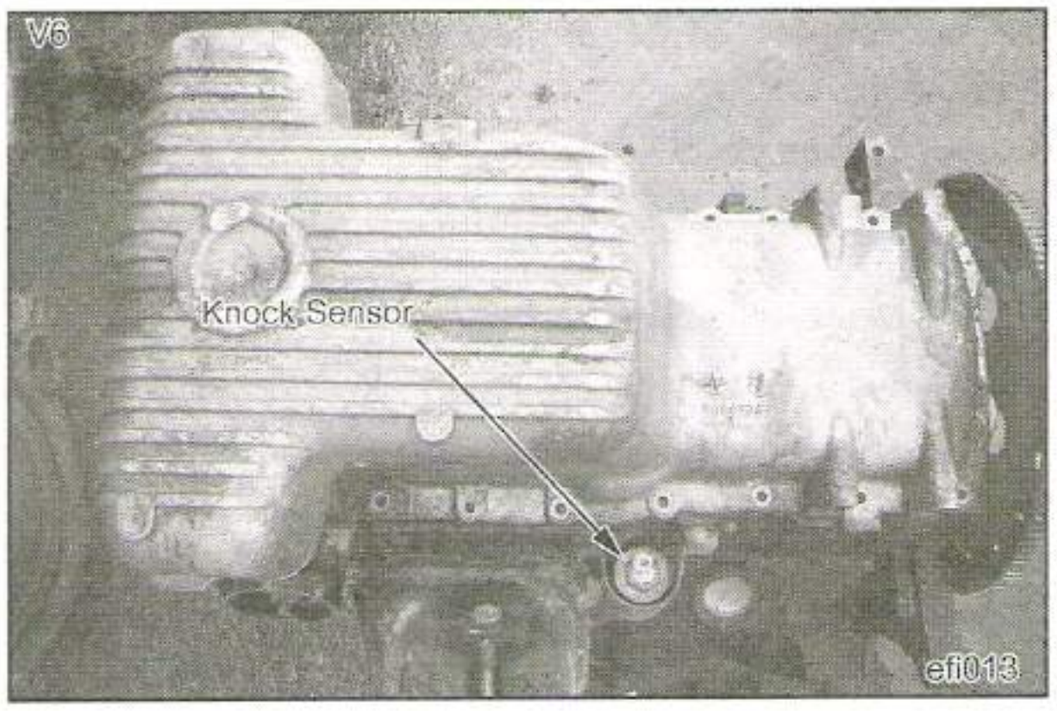
Percentage Open	Engine rpm
20	800
22	1200
27	1600
29	2000
33	2400
37	2800
39	3200
40	3600
41	4000
44	4400

If there is a problem with the TP it will set the diagnostic code 19, 21 or 22 refer to 'Diagnostics Chapter'

Note: The Throttle Position Sensor is not adjustable and if found to be faulty must be replaced as a unit

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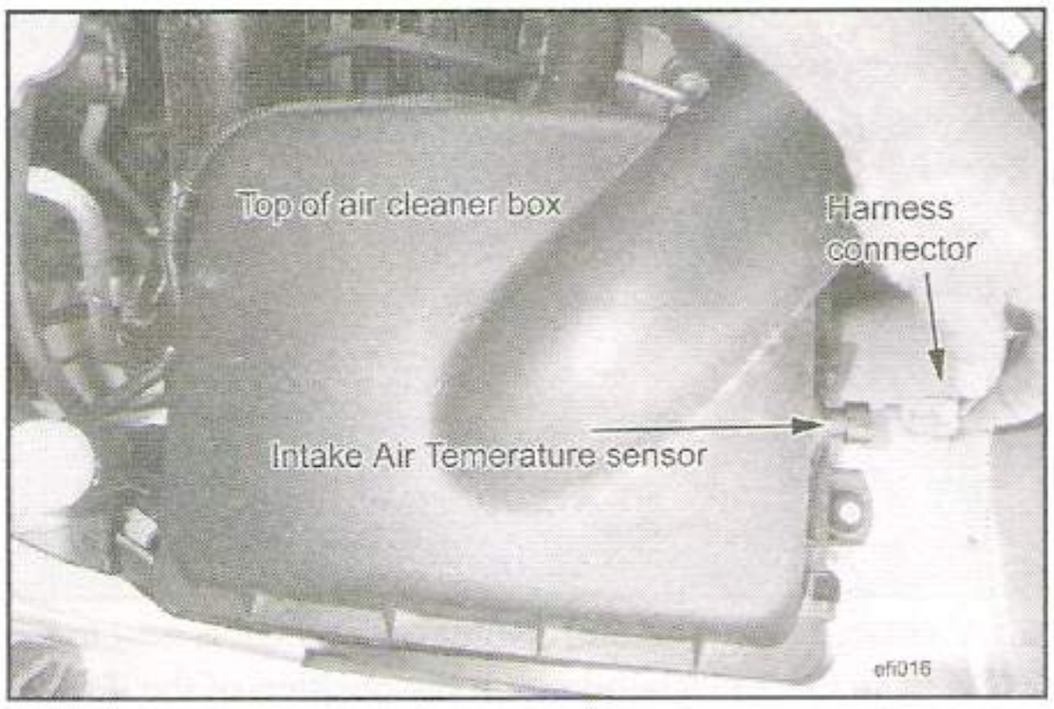


Intake Air Temperature Sensor (IAT)

The IAT sensor and connecotr is located in the top of the air cleaner box.

Remove

1. Disconnect the IAT harness connector.



2. Remove air cleaner box top.
3. Cut the IAT retainer from the air cleaner box top.
4. Remove the IAT sensor.

Install

1. Install the new IAT sensor into top section of air cleaner box, align the retainering tab with the rib moulding on the air cleaner box top. Firmly push the IAT sensor into place.
2. Replace air cleaner box top.
3. Connect the IAT harness connector.

Vehicle Speed Sensor (VSS)

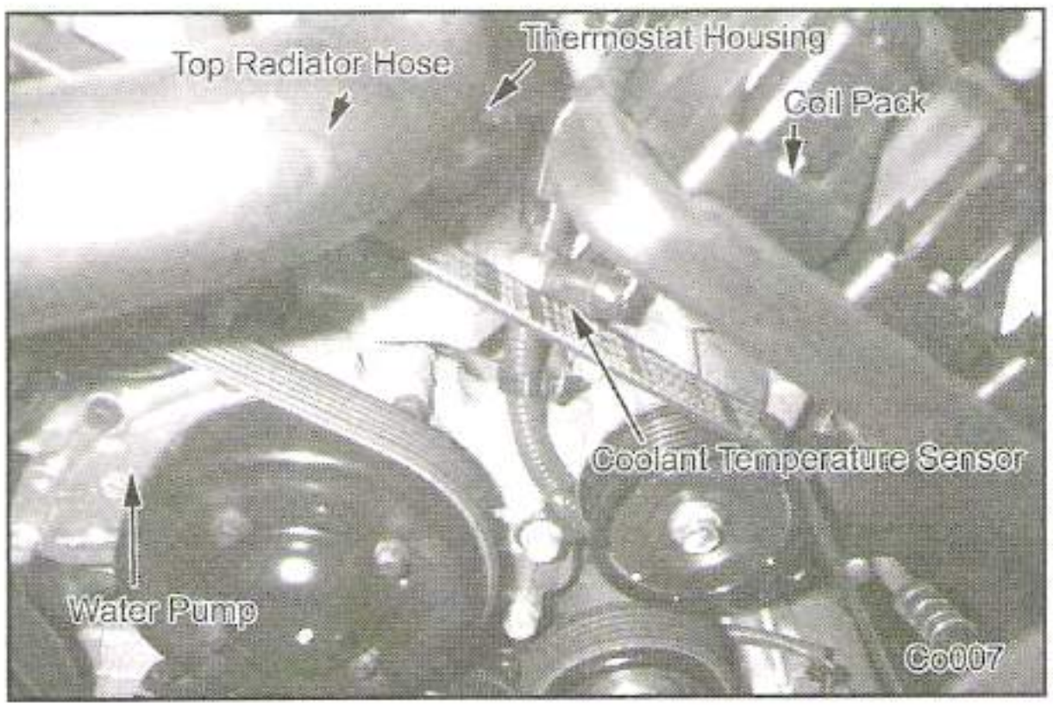
The vehicle speed sensor (VSS) is fitted to the transmission. The purpose of the VSS is provide the PCM with information as to the exact vehicle speed so adjustments to the IAC, injection pulse width and various other fuelling modes can be made. If there is a problem with the VSS or it's circuit it will set a DTC 24 (automatic transmission), DTC 94 (Manual Transmission) refer to 'Diagnostics Chapter'

Note: The Throttle Position Sensor is not adjustable and if found to be faulty must be replaced as a unit.

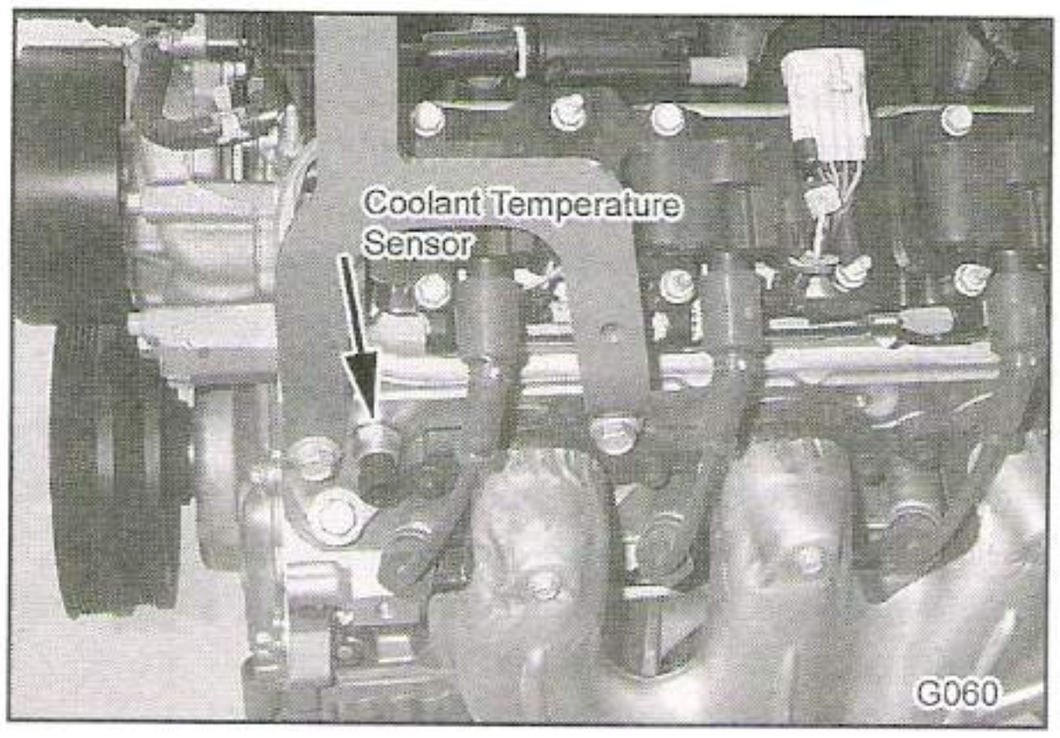
Engine Coolant Temperature Sensor

Use a multimeter to test the engine coolant temperatrure sensor, if faulty replace.

Engine Temp Sensor	
Temperature	**Ohms**
-10	16.320
0	9,517
20	3,555
30	2,268
40	1,483
70	474
90	244
100	180
110	134 ets



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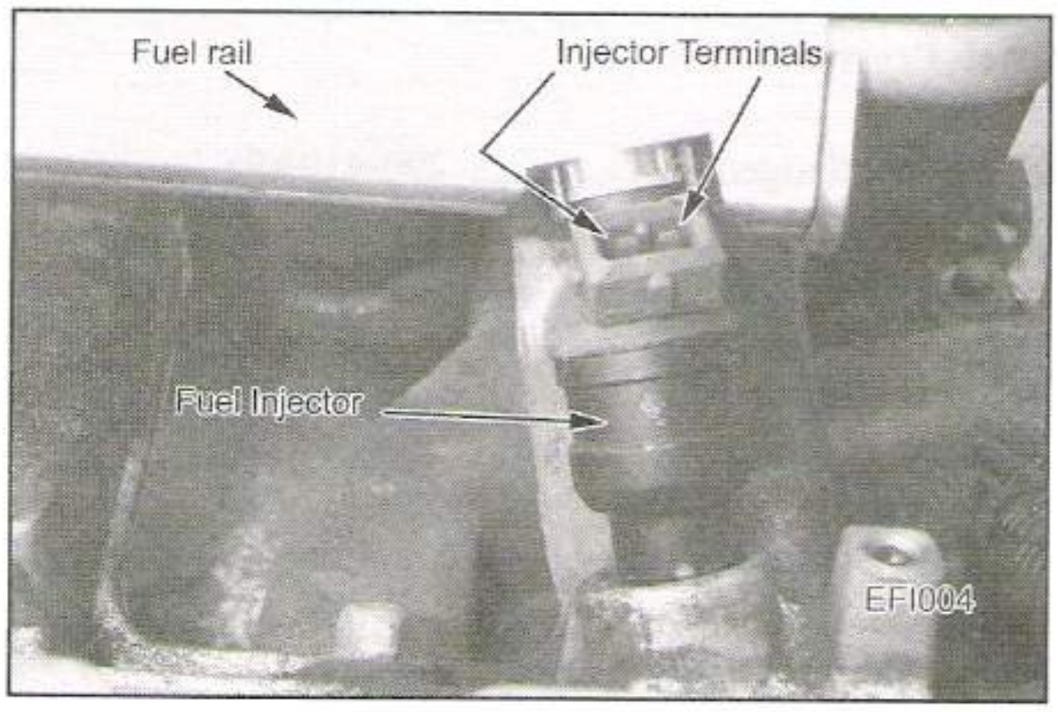
Engine Cover Nuts Torque: 8-12Nm

Injectors

The fuel injectors fitted are electrically operated fuel flow valves. The injectors are controlled by a signal/pulse from the PCM which provides an earth circuit for the injectors. This allows current to flow through the injector electromagnet opening the injector nozzle and allowing fuel to flow into the combustion chamber. The longer the pulse from the PCM the more fuel is injected.

On Vehicle Check

1. Disconnect all of the injector electrical connections and use a multimeter to check the resistance of all injectors



Resistance: ..... 11.8-12.8 ohms @ 20°C

Note: If resistance is not as specified replace the injector

2. Reconnect all of the injector electrical connectors

Remove and Install

1. The fuel pressure in the fuel lines should be relieved before any work is carried out. Thoroughly clean around the injectors before removing so as foreign material does not fall into the cylinders.

a) Remove the fuel pump relay

b) Start engine and allow to idle until fuel supply remaining in fuel lines is used, turn off ignition switch

2. Disconnect the battery negative cable

a) Remove the engine cover/s.

3. Disconnect the throttle cables

4. [V6] Remove the air intake duct

a) Remove the upper intake manifold cover and upper intake manifold refer to 'Engine Chapter'

[Gen 111 V8] Remove the 4 nuts attaching the engine cover brackets to the fuel rail.

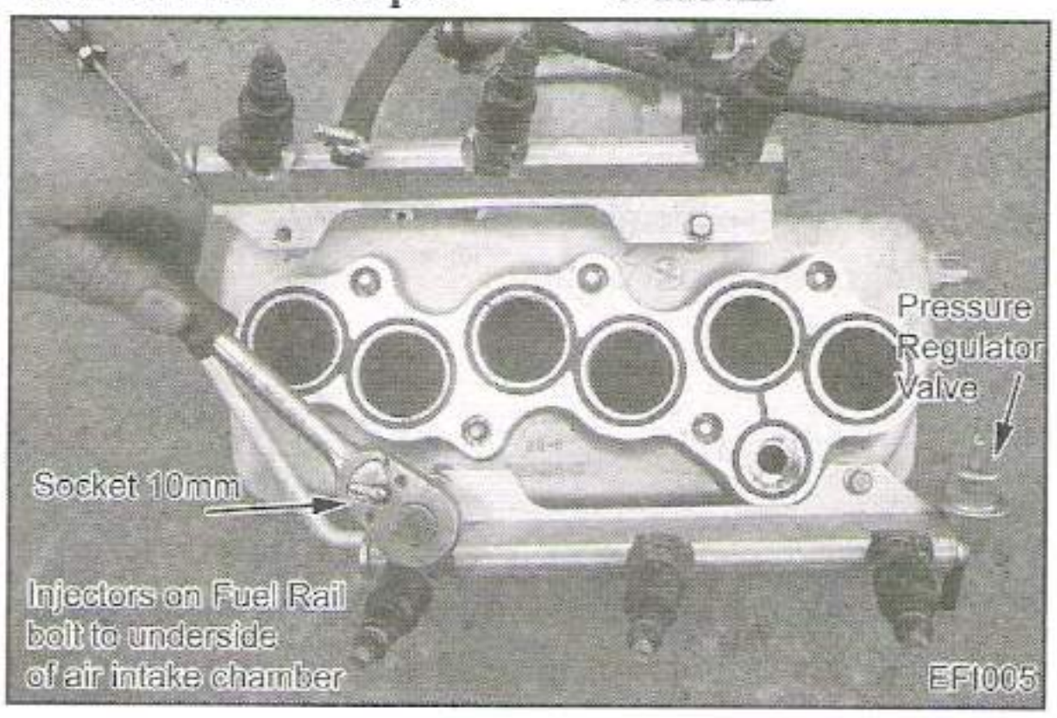
Engine Cover Bracket to Fuel Rail Torque:4-6Nm

5. Disconnect electrical connectors from all of the injectors

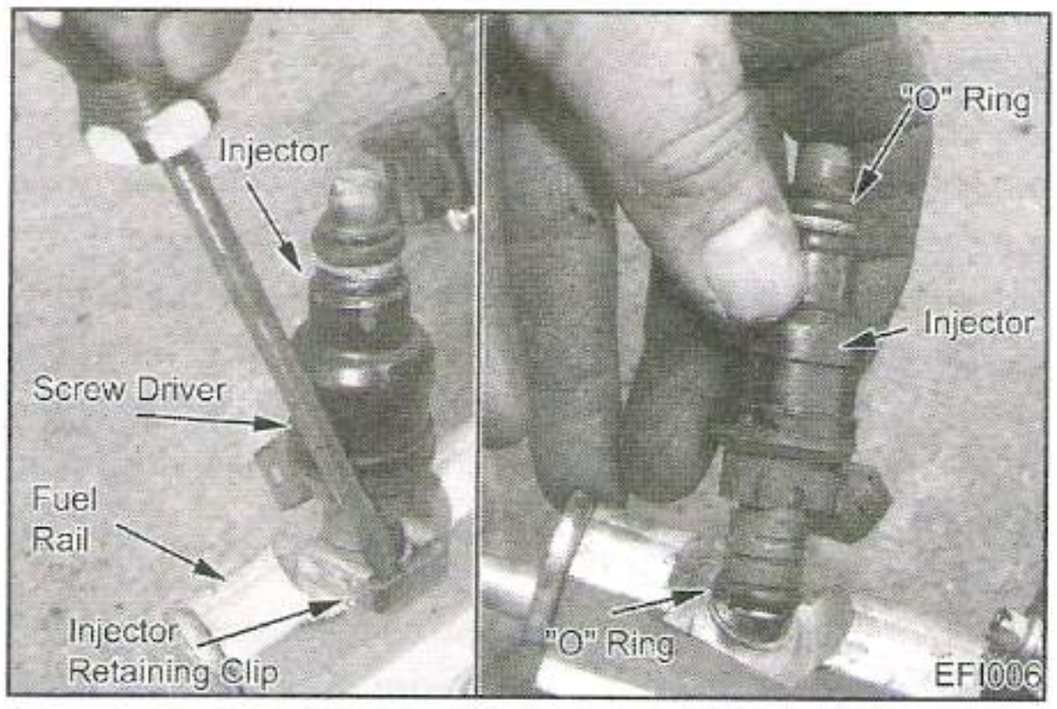
a) Disconnect the fuel rail supply and return hoses

b) Loosen and remove the 4 fuel rail bolts

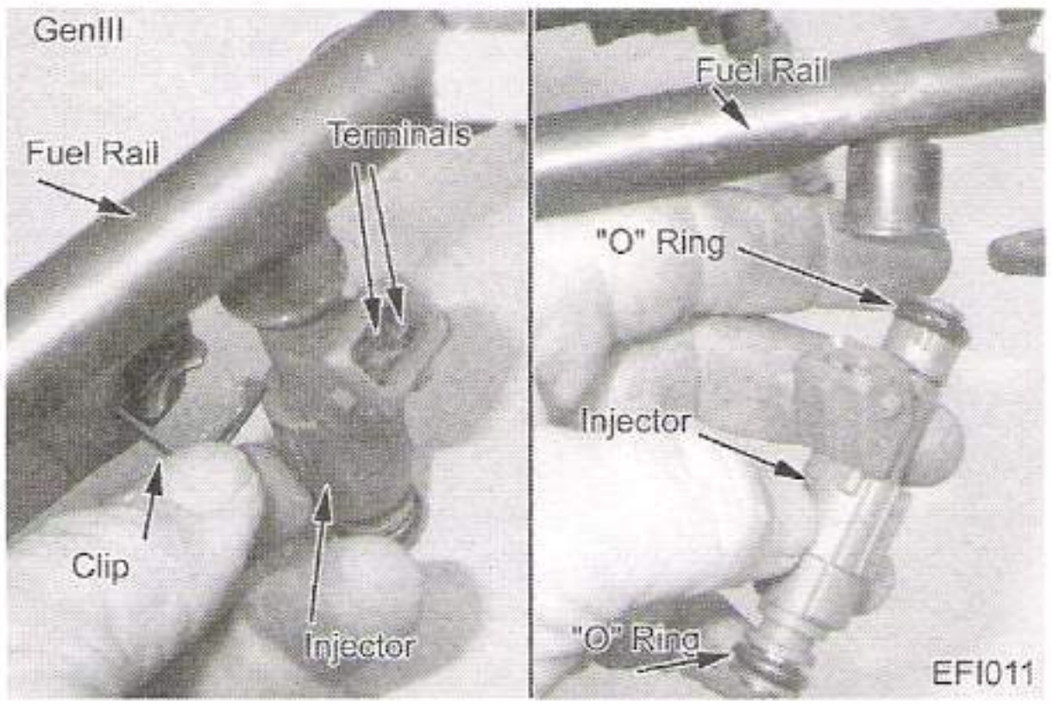
Fuel Rail Bolt Torque: 8-12Nm



6. Lift the fuel rail and injectors out of the lower intake manifold



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7. Remove the clip that secures the injector in the fuel rail and remove all of the injectors

Assembly of injectors, ensure that new 'O' rings and seals are always used if the fuel rail and injectors have been removed for any reason.

Coat the seals lightly with petroleum jelly to assist in installation.

Note: DO NOT drop the injectors when removing from the fuel rail

Fuel Pump

A single high pressure fuel pump which is mounted inside the fuel tank on all vehicles. A pressure regulator is incorporated into the system to maintain the fuel pressure at required level depending on manifold vacuum.

Fuel Pressure:

V6 Engine

None Supercharged: ..... 290-410 kPa

Supercharged: ..... 270-350 kPa

V8 Engine: ..... 270-350 kPa

Any fuel in excess of the injector requirement is sent back to the fuel tank via the fuel return line.

Warning: Do Not work on the fuel pump near any sources of ignition.

ON VEHICLE CHECKS

Pump Operation

Breakdown Hint: *If vehicle will not start, check for fuel pump operation. Turn ignition key ON while you listen for operation of fuel pump. If pump is not heard. Have an assistant turn key ON while you give the bottom of the fuel tank a reasonably hard hit with a rubber hammer, this may cause the fuel pump to start operating, do not turn key OFF, drive to a suitable work area then replace fuel pump.*

1. Check the fuel pump fuse 28 is OK

2. Remove the fuel pump relay and connect terminals 3 & 5 of the relay holder with a jumper wire

a) Connect a test light to the violet wire at the fuel pump connector and other end of test light to earth

3. Get an assistant to turn the ignition switch to the On position, while you watch the test light

Note: Test Light should illuminate and an audible sound should be heard from the fuel pump if it is operating.

4. If the test light illuminates but there is no noise coming from the fuel pump the fuel pump will have to be replaced

a) If the test light does not illuminate then there is a problem in the wiring between the fuel pump and the relay block, check wiring back to relay block and repair as required.

5. Refit the fuel pump relay and connect a test light to terminal 5 on the relay and the other end to earth

a) Turn the ignition switch to the On position

b) The test light should illuminate if not the relay is faulty or there is a circuit problem between the relay and the PCM refer to the 'Diagnostics Chapter'

Fuel Pressure Check

The fuel pressure in the fuel lines should be depressurised before any work is carried out.

a) Remove the fuel pump relay

b) Start engine and allow to idle until fuel supply remaining in fuel lines is used, turn off ignition switch

1. Fit the a fuel pressure gauge and adapters to the incoming fuel line before the fuel pressure regulator.

2. Start the engine and allow to idle

a) Check the fuel pressure gauge reading

Fuel Pressure:

V6 Engine

Non Supercharged: ..... 290-410 kPa

Supercharged: ..... 270-350 kPa

VT Ser 1 V8 Engine: ..... 270-350 kPa

Gen 111 V8 ..... 290-410 kPa

3. If fuel pressure is not as specified check fuel filter, if OK replace fuel pump.

Remove

1. Relieve the fuel pressure in the fuel lines as previously described

2. Disconnect the battery earth cable

3. Remove the fuel tank assembly from the vehicle refer to the 'Fuel Tank Chapter'

4. Remove the fuel sender/pump retaining ring

5. Lift the fuel sender/pump assembly straight up out of the fuel tank

Install

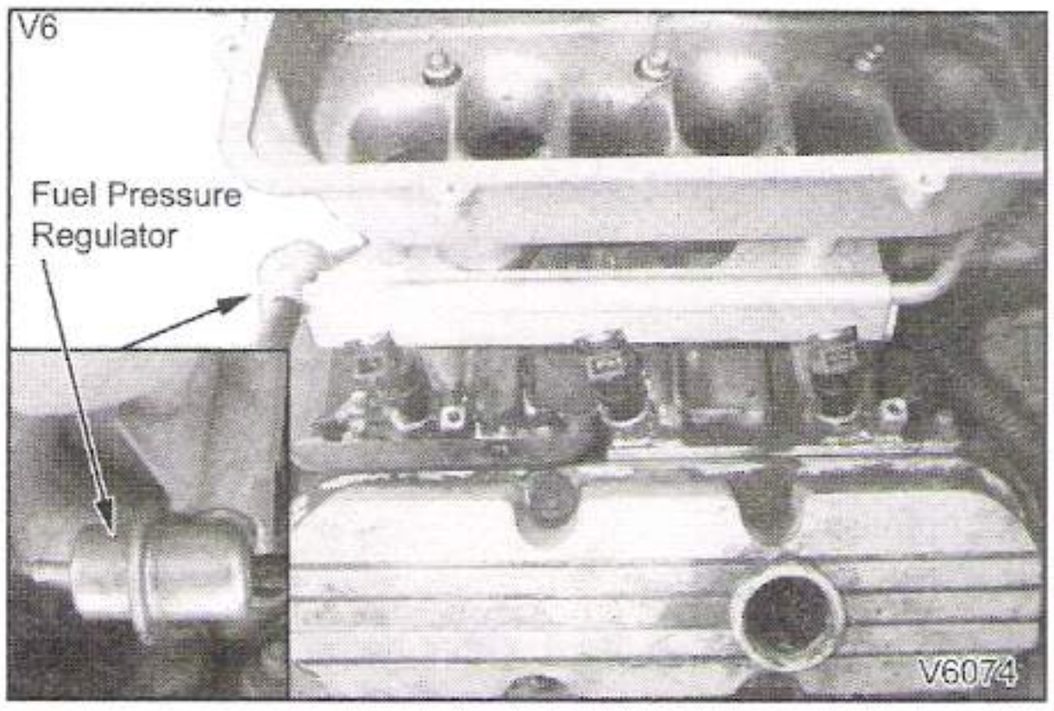
1. Install the fuel sender/pump in the reverse order of the removal procedure taking note to use a new 'O' ring and ensure that assembly is correctly seated before tightening the retaining ring.

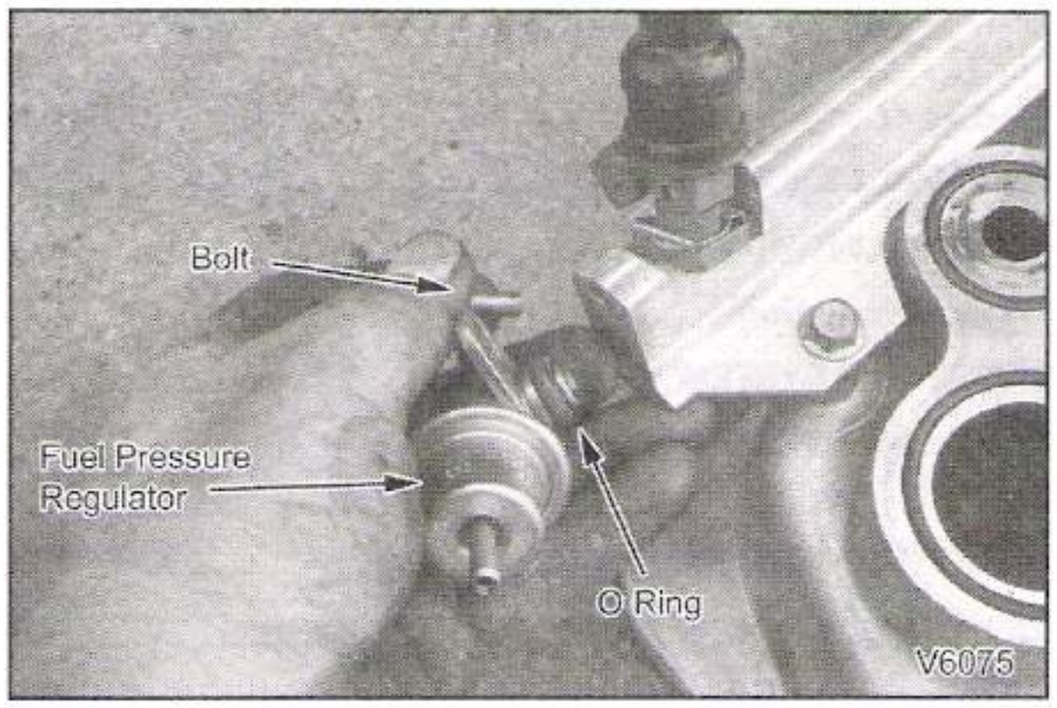
2. Install fuel tank to vehicle.

3. Install fuel tank, reconnect hoses and electrical connector

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Fuel Pressure Regulator





Remove

1. Relieve the fuel pressure in the fuel lines as previously described. (remove fuel pump relay, idel engien to stall)

2. Disconnect the vacuum hose to the fuel pressure regulator.

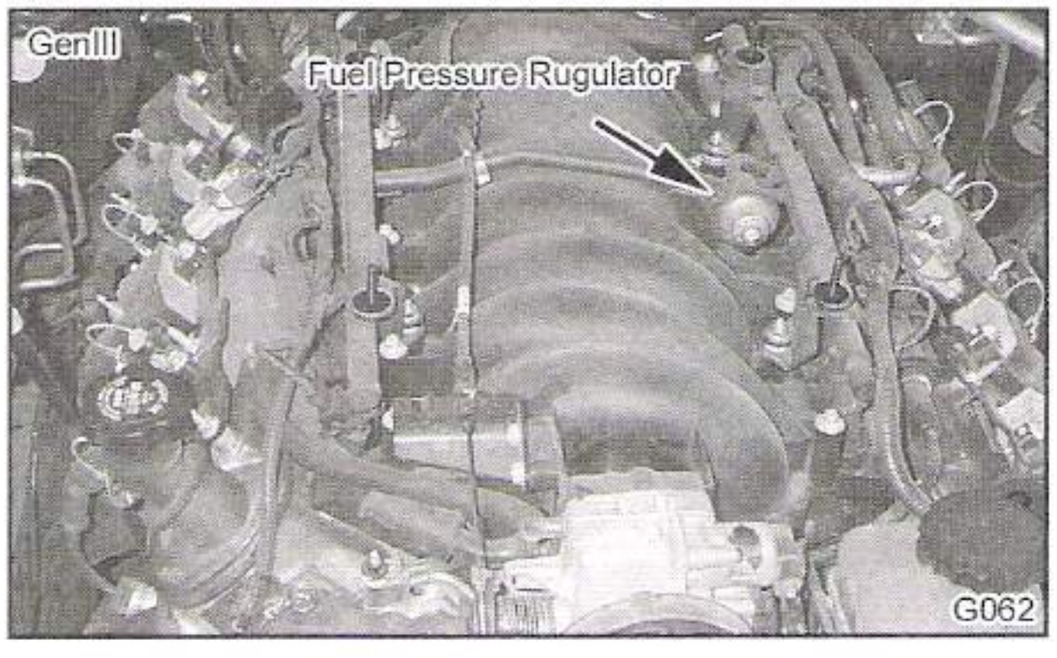
3. Remove the fuel pressure regulator.

Install

1. Install the fuel pressure regulator, use a new "O" ring.

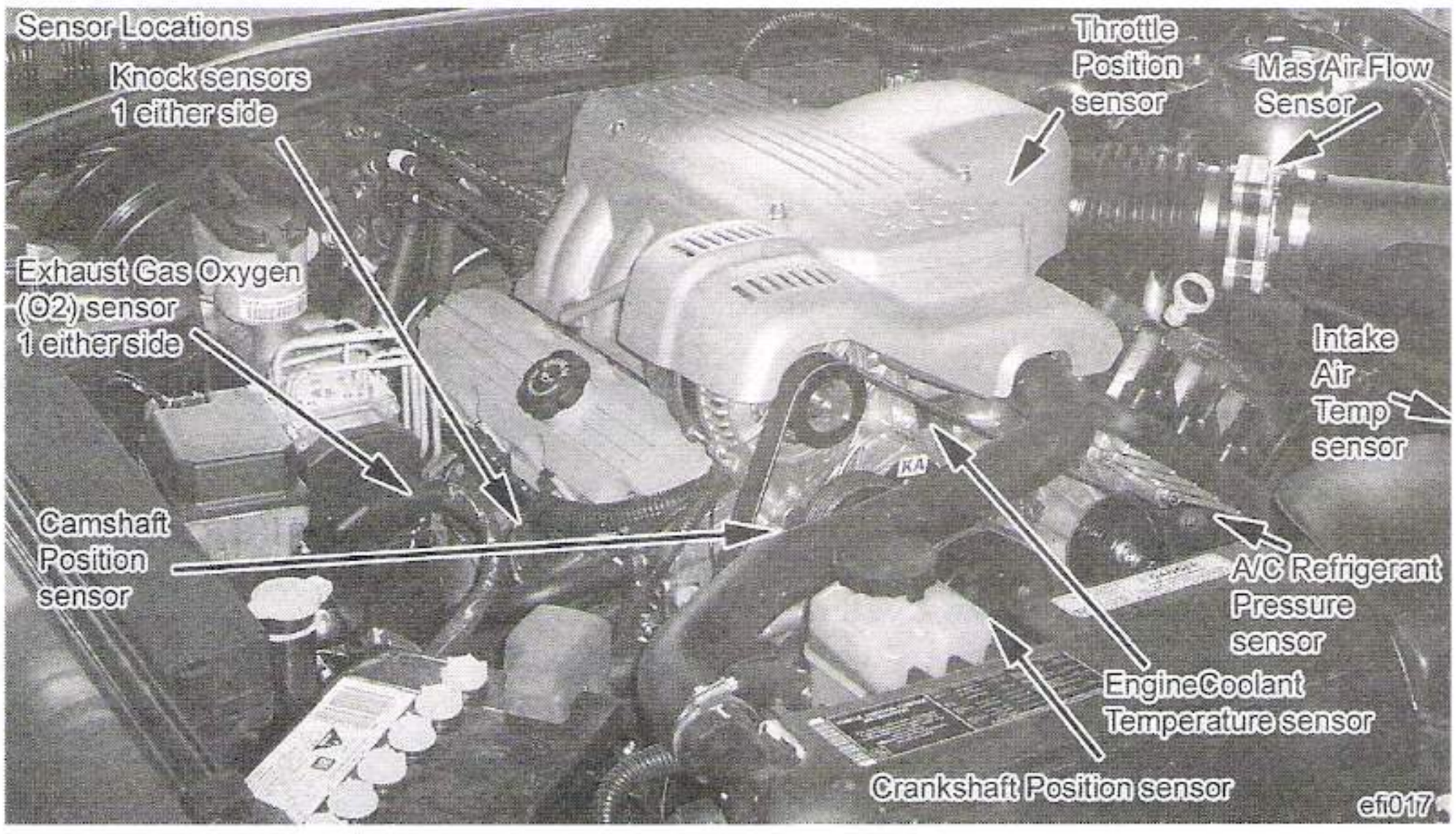
2. Install vacuum hose to fuel pressure regulator.

3. Install fuel tank, reconnect hoses and electrical connector



PROBLEM DIAGNOSIS

For problem diagnosis see "Fault Diagnosis, ECU & Trouble Shooting" chapter.



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CLUTCH

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General Description

V6 - Engine

The V6 engine is equipped with a hydraulically controlled, diaphragm spring clutch pressure plate and a dual mass engine flywheel.

V6 Dual Mass Flywheel

The Dual Mass Flywheel is designed to absorb the vibrations caused by the igniting of the fuel/air mixture as well as any other vibrations that may be caused by the engine. The design of the flywheel is in two halves that are radially joined by springs. One section is bolted directly to the engine crankshaft and the other half is bolted to the clutch pressure plate. The clutch plate is not fitted with torque reaction springs anymore.

Re- Surfacing of the Duel Mass Flywheel is not possible and if the clutch plate surface of the flywheel becomes distorted or excessively worn the flywheel will have to be replaced as a complete unit.

VT Series 1 V8 - Engine

The V8 engine is also fitted with a hydraulically operated clutch using a conventional pressure plate, clutch plate and flywheel.

Gen 111 V8 - Engine

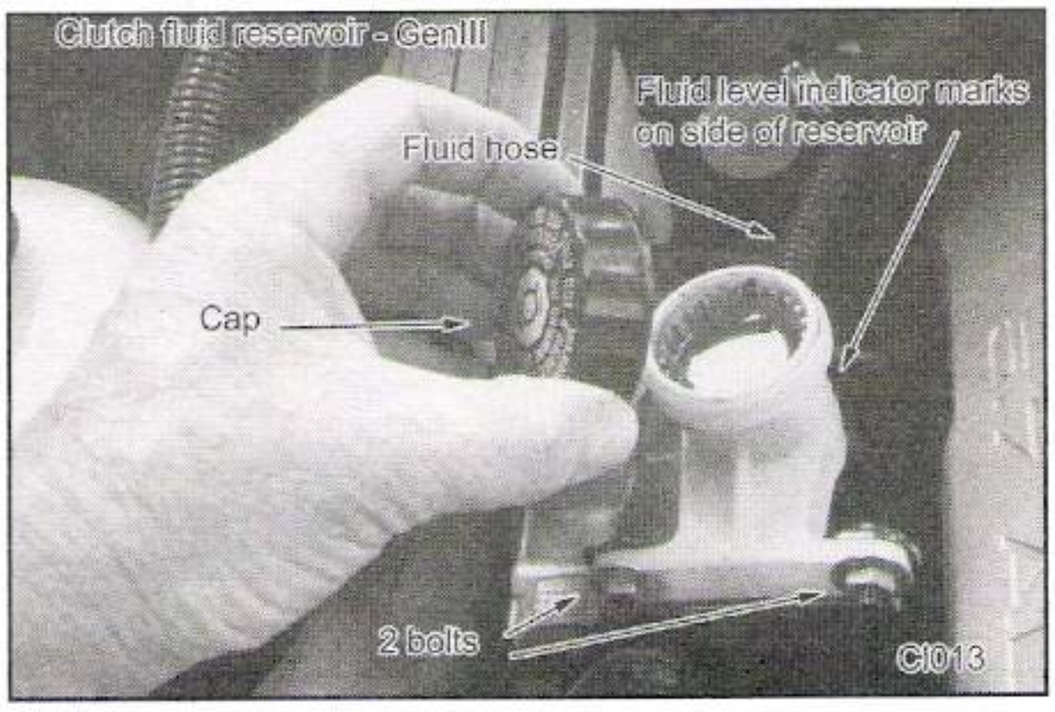
The Gen 111 V8 engine is fitted with a hydraulically operated clutch using an adjusting pressure plate, clutch plate and flywheel, also a self adjusting thrust bearing/slave cylinder is used. These keep the same clutch pedal loading pressure, resulting in no pedal adjustment is necessary.

Minor Maintenance

There are several items which affect good clutch operation, therefore it is necessary before performing any major clutch service, to make preliminary inspections to determine whether the trouble is actually in the clutch.

Visual Inspection

1. Check condition of hydraulic lines and ensure that components are assembled correctly, taking note that the lines do not have sharp bends or are rubbing against other objects.
2. Check level of hydraulic reservoir.
3. Check clutch master cylinder for leaking seals.
4. Check clutch slave cylinder and lines for leaking seals and unions.
5. Check condition of clutch pedal bushes and shaft.
6. Check clutch pedal height and control rod adjustment, as outlined in this chapter.
7. Check condition of all engine and transmission mountings.



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Hydraulic System

Master Cylinder Inspection

1. Check that the level of brake fluid is within the levels marked on the cylinder reservoir.
2. Refill with specified brake fluid.
Clutch fluid specified:
Heavy duty brake fluid - HN 1796
3. Inspect to make sure the air vent in the reservoir cap is clear and air can be blown through it.

Bleed Hydraulic Clutch System

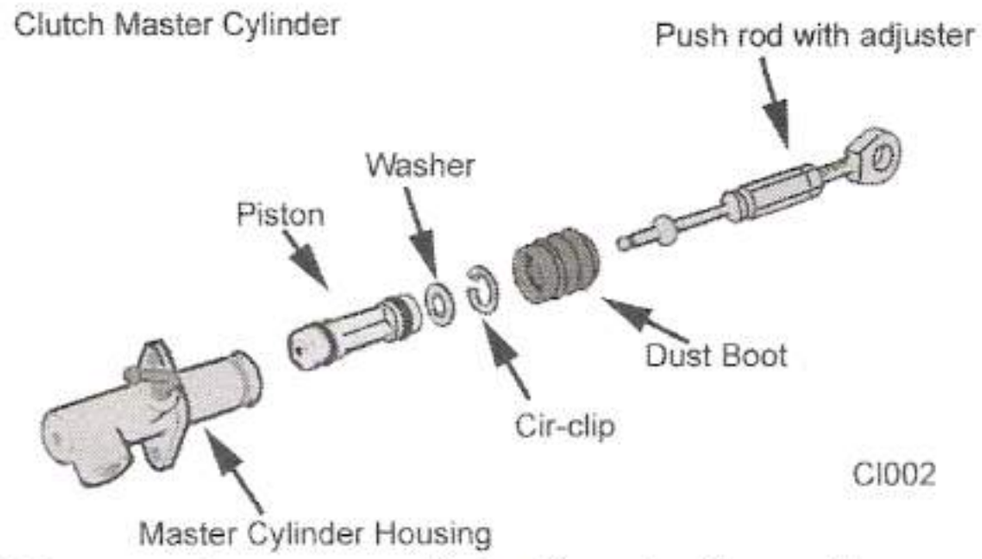
1.[V6 and VT Ser 1 V8] Fit a tube onto the bleed valve located on the slave cylinder with the other end in a container half full of brake fluid.
1.[Gen 111 V8] Loosen bleeder found upper opening in the clutch housing, by using a 11mm socket and extension. Fit a tube onto the bleed valve located on the slave cylinder with the other end in a container half full of brake fluid. (See later illustrations)
2. With an assistant, push down on the clutch pedal several times, push down on the pedal while the bleed valve is loosened just enough to allow brake fluid (and air if present) to bleed out of the hose attached to the bleed valve.
3. Tighten the bleed valve before the clutch is allowed to return to its normal position.
4. Repeat steps 2 & 3 above until the system is free of air. This is detected by having a firm feeling clutch pedal when pushed down.
5. Check the level of the master cylinder reservoir brake fluid, top up to marked levels so as not to allow air to enter the system.
6. Top up master cylinder with specified Brake fluid, do not use fluid bled out of clutch system.
Clutch fluid specified:
Heavy duty brake fluid - HN 1796 (SAE J1704)

Major Repairs

Clutch Master Cylinder

Remove

1. Disconnect the clutch master cylinder to reservoir hose and drain fluid into a suitable container
a) Loosen and remove the clutch master cylinder to slave cylinder line, use a suitable container to drain fluid into
2. Remove the swing down underdash cover drivers side, 2 clips and 1 hinge pin
a) Remove the lower trim panel 3 clips
b) Remove the 7 screws attaching the body control module mounting panel to the dash panel and remove
3. Detach the clutch pedal push rod from the clutch pedal.
4. Remove the two nuts attaching the master cylinder to the fire wall, and bracket (1 bolt).



5. Remove the master cylinder from the fire wall.

Dismantle

1. Pull the boot at the rear of master cylinder towards the end of the push rod
2. Depress the push rod slightly and using circlip pliers remove the circlip and the punch rod
3. Apply a small amount of compressed air to the cylinder assembly to dislodge the piston from the cylinder bore

Assemble

If the master cylinder is dismantled always fit new cups and seals.
1. Fit new cup to the piston and lightly coat with new brake fluid
a) Slide the piston assembly into the cylinder
2. Fit the pushrod and retaining washer into place, then install the retaining clip into the cylinder
3. Fit the boot to the back of the cylinder assembly, ensuring it is installed correctly
a) Check for free operation of push rod / piston assembly within the master cylinder

Install

1. Position the master cylinder to the firewall
2. Fit the 2 mounting nuts, bracket and bolt, torque to specification
Torque: ..... 20-30 Nm
3. Connect the slave cylinder line and tighten
a) Connect the reservoir to cylinder hose
4. Fit the push rod into position on the clutch pedal and fit bush washer and clip
5. Refit all of the previously removed underdash panels etc.
6. Refill the reservoir and bleed the clutch system

Clutch Slave Cylinder [V6 and VT Ser1 V8]

Remove

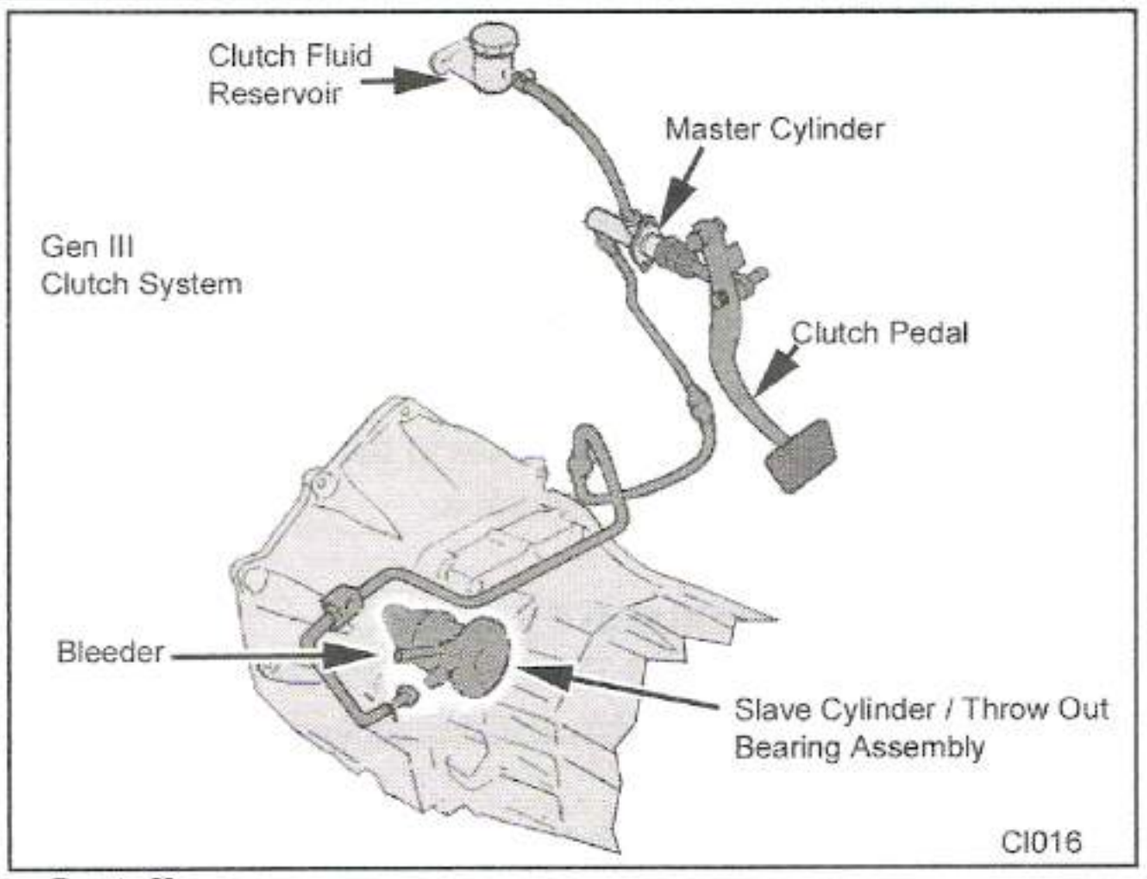
1. Detach the slave cylinder flexible hose from the slave cylinder.
2. Release the slave cylinder from the bell housing assembly 2 nuts

Dismantle & Assemble

1. Withdraw the push rod and dust boot from the assembly
2. Apply air pressure to the cylinder assembly to push the piston from the cylinder bore

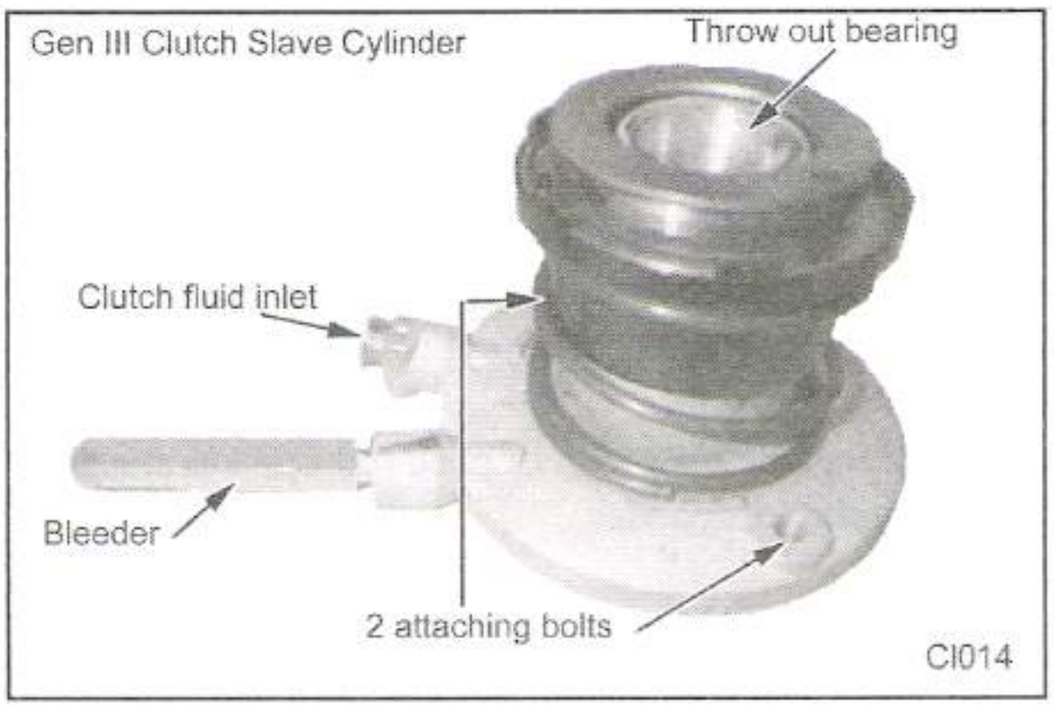
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3. Check piston and cups for wear or damage
a) Inspect the cylinder bore for any score marks, deep scratches or corrosion, hone or replace if required
4. If necessary fit new slave cylinder kit, then coat piston assembly with new brake fluid
5. Slide the piston into the cylinder bore, check pushrod for damage, then fit the pushrod and boot to the assembly
Install
1. Fit the cylinder assembly to the bell housing, ensuring the pushrod is in position correctly
a) Fit the 2 mounting nuts and torque
Torque: ..... 20-25 Nm
2. Connect the flexible hose to the slave cylinder, then bleed the system.

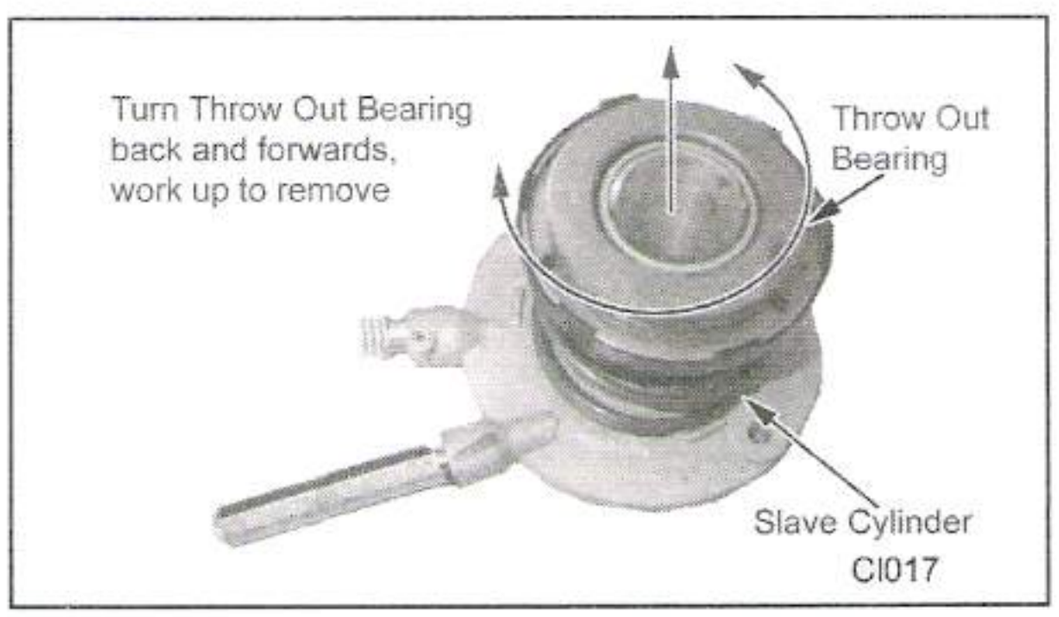


Clutch Slave Cylinder and Thrust Bearing (Throw Out Bearing) Assembly [Gen 111 V8]

The transmission must be separated from the engine.
Remove
1. Detach the slave cylinder pipe from the slave cylinder.
2. Release the slave cylinder from the front of the transmis-



sion (inside the bell housing assembly) 2 bolts.
Dismantle & Inspect
The thrust bearing and spring can be removed from the splined shaft of the slave cylinder. Rotate throw out bearing back and forwards while pulling up to remove.
The slave cylinder is not a serviceable unit, there should be no sign of fluid leakage, replace if necessary.
Spine the thrust bearing to check for noise or a feel roughness while turning, replace if necessary



Install
1. Fit the cylinder assembly to the front of the transmission.
a) Fit the 2 mounting bolts and torque
Torque: ..... 7.5-12.5 Nm
2. Connect the fluid pipe to the slave cylinder, install transmission, then bleed the system.

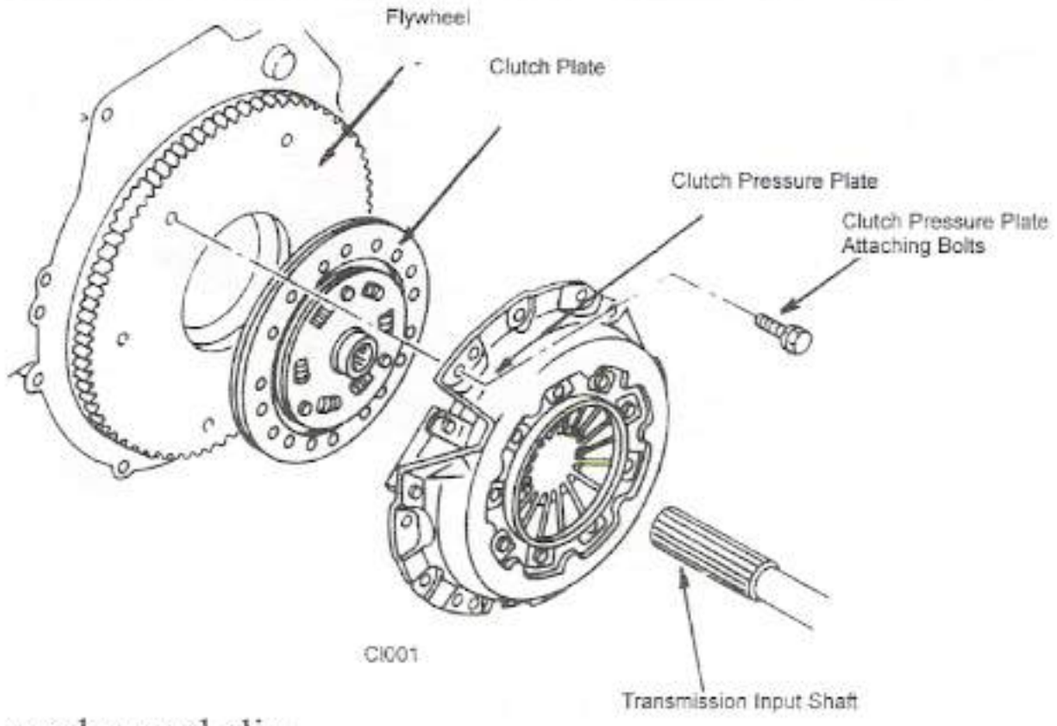
Clutch Pedal Adjustment

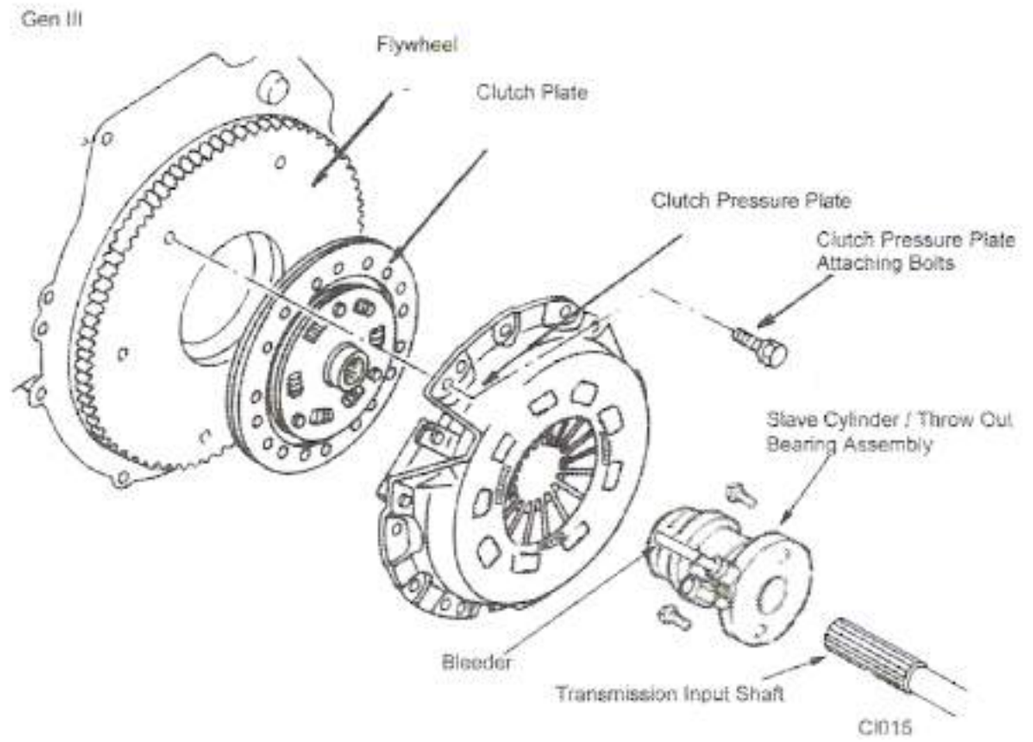
No Clutch pedal adjustment is necessary on Gen 111 V8.
1. Check that the pedal height is adjusted correctly, if incorrect adjust, check from floor pan to top of pedal.
Align clutch pedal height with brake pedal height.
2. Check the pushrod free play.
a) Push rod free play is the amount of clearance between the end of the push rod and the master cylinder piston, adjust push rod lever adjuster if required.
Free Play: ..... 1.0 mm

Clutch Pedal [and Switch]

Disable SRS (Air Bag) system before undertaking any work, then disconnect negative battery terminal. On completion of work reconnect battery negative terminal, activate the SRS (Air Bag) system.
Clutch switch is fitted with some cruise control units
Remove
1. Remove the swing down underdash cover drivers side, 2 clips and 1 hinge pin
a) Remove the lower trim panel 3 clips
b) Remove the 7 screws attaching the body control module mounting panel to the dash panel and remove
2. Remove the fuse panel and body control modual (BCM).
3. Detach the clutch switch wiring connector and remove switch if necessary (turn anti-clockwise and pull out).
4. Detach the clutch pedal push rod from the clutch pedal.
5. Remove the nuts attaching the pedal assembly.
Install
1. Install the pedal assembly and tighten nuts / bolts.
2. Fit the push rod into position on the clutch pedal and fit bush

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washer and clip

3. Install switch (puh in and turn clockwise) if necessary and attach the clutch switch wiring connector.

4. Install fuse panel and body control modual (BCM).

5. Refit all of the previously removed underdash panels etc.

6. Refill the reservoir and bleed the clutch system.

Clutch Assembly

Remove

1. Remove the transmission assembly from the vehicle as described in the 'Transmission Chapter'

2. Mark the relationship between the pressure plate and the flywheel to maintain correct balance on assembly.

3. Loosen all of the pressure plate retaining bolts.

4. Remove all of the bolts, pressure plate and the clutch plate

Inspection

1. Check the clutch disc for run out , and for wear and damage to the surface.

2. The fly wheel needs to be checked for surface damage, like hot spots, cracked surface and glazing, also check for run out.

3. Inspect the clutch release bearing to ensure its not noise or rough.

4. Check the diaphragm spring fingers for damage and wear.

5. If there are any signs of oil on the flywheel or clutch plate, find cause and repair.

Note: Do Not wash the pressure plate assembly, only use compressed air to clean and wear a suitable breathing apparatus

Install

V6 - Engine

1. Using a clutch aligning tool fit the clutch disc into place, then the pressure plate assembly over the top, line up the match marks made on disassembly

Note: Clutch plate is fitted with the offset side of the splined hub facing the flywheel

2. Fit the pressure plate retaining bolts and tighten loosely working from opposite sides

a) Fit the special tool AKM-632-A

b) Apply force to the arm depressing the pressure plate fingers by 18 mm, releasing any pressure on the clutch plate

c) While holding this pressure tighten all of the pressure plate bolts to specified torque

Torque: ..... 28-35 Nm

d) Release the special tool and remove

Note: It is critical that the loading tool is used, otherwise distortion of the pressure plate may result

3. Install the transmission as described in the 'Transmission Chapter'

VT Ser 1 V8 - Engine

1. Using a clutch aligning tool fit the clutch disc into place, then the pressure plate assembly over the top, line up the match marks made on disassembly

Note: Clutch plate is fitted with the offset side of the splined hub facing towards the gearbox

2. Fit the pressure plate retaining bolts and tighten firmly working from opposite sides

a) Check the clutch assembly is aligned correctly, then tension the retaining bolts to specification.

Torque: ..... 41-47 Nm

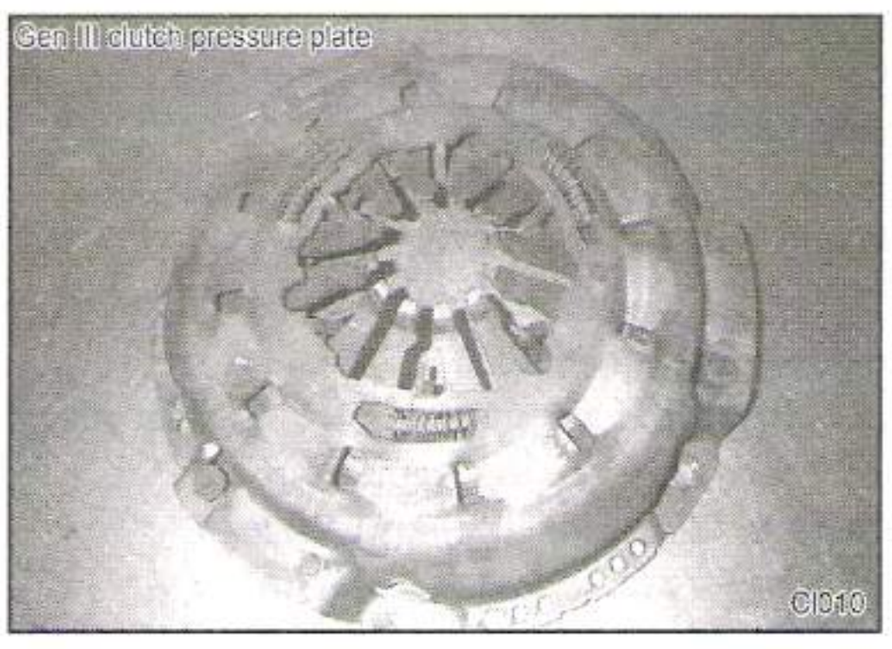
3. Inspect the diaphragm spring finger alignment, adjust as required.

4. Coat the release fork wear points with molybdenum disulphide grease and fit the release fork / release bearing into position on the transmission.

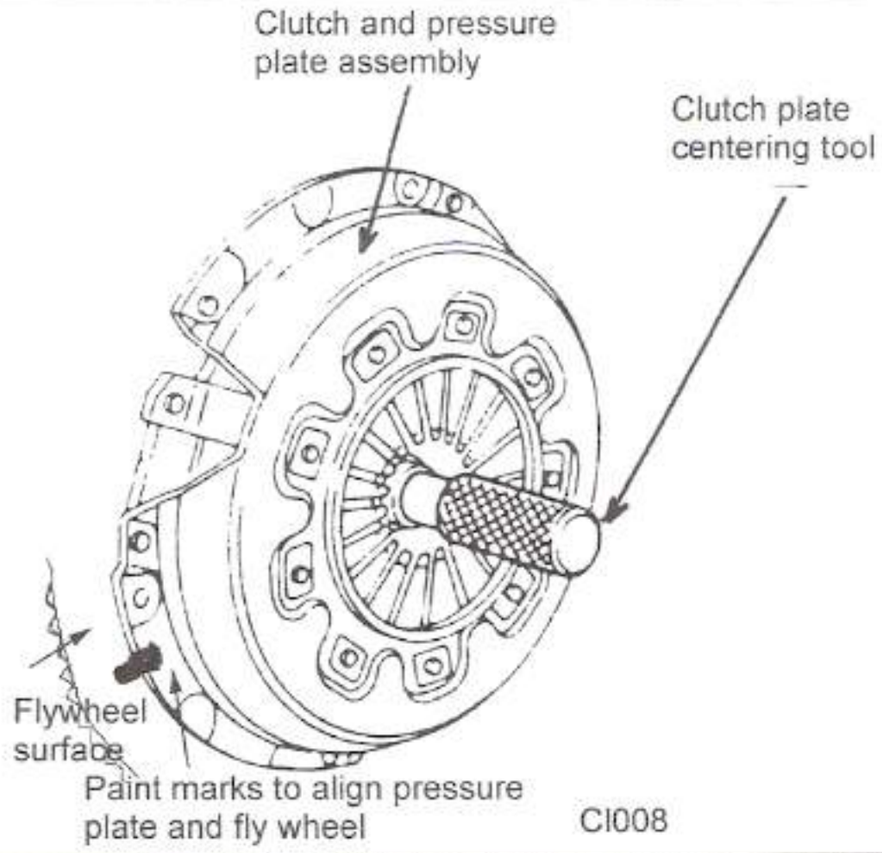
5. Install the transmission as described in the 'Transmission Chapter'

Gen III V8 - Engine

Gen III has a indicator marks, one for new factory setting, center one for a servicable clutch, 3rd mark for clutch



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CI008



CI011

pressure plate needs replacing.

Set Pressure Plate Tension - Note this should not be necessary as pressure plate is preset, and first time used it is set correctly.

1. Use a press with a flat large base, place the clutch plate (offset side of plate facing up, flat side should have flywheel stamped on it this side faces down.

2. Position the pressure plate over the clutch plate, using the press on the diaphragm fingers apply pressure until the tension is released from the clutch plate.

3. The pressure plate has 3 adjusting slots adjacent to the adjusting ring tension springs. Insert a screw driver (easier with 2 screw drivers) rotate the adjusting ring anti clockwise to lock the diaphragm fingers in a loaded situation. Release pressure and remove clutch and pressure plates from press.

Install - Gen III

1. Using a clutch aligning tool fit the clutch disc into place, then the pressure plate assembly over the top, line up the match marks made on disassembly

Note: Clutch plate is fitted with the offset side of the splined hub facing towards the gearbox

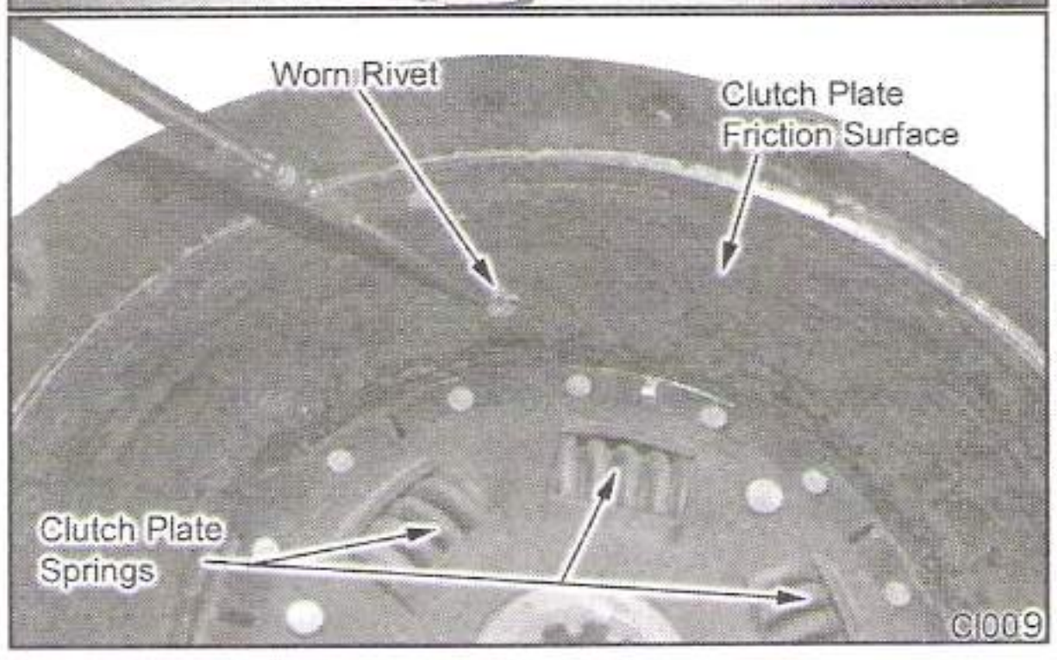
2. Fit the pressure plate retaining bolts and tighten firmly working from opposite sides

a) Check the clutch assembly is aligned correctly, then tension the retaining bolts to specification.

Torque Step 1: ..... 10 Nm
Torque Step 2: ..... 25 Nm
Torque Step 3: ..... 40 Nm



CI005



CI009

Torque Step 4: ..... 50 Nm

3. Coat the release fork wear points with molybdenum disulphide grease and fit the release fork / release bearing into position on the transmission.

4. Install transmission described in "Transmission Chapter'

Problem Diagnosis

Problem: Clutch fails to release (pedal pressured to floor - shift lever does not move freely in and out of reverse gear without gear clash)!

Possible Causes and Remedies:

* Improper pedal travel. Remedy - Adjust pedal height.
* Faulty driven plate. Remedy - Replace plate.
* Fork and bearing not assembled properly. Remedy - Install properly and (very lightly) lubricate fingers at release bearing.
* Driven plate hub binding on main drive gear clutch shaft splines. Remedy - Repair or replace main drive gear and/or drive plate assemblies.
* Driven plate warped or bent. Remedy - Replace driven plate.
* Insufficient brake fluid in master cylinder reservoir. Remedy - Top up reservoir to correct level.

Problem: Slipping!

Possible Causes and Remedies:

* Improper driver operation. Remedy - Observe correct operation.
* Oil soaked driven plate. Remedy - Install new plate and correct leak at its source.
* Worn facing or facing torn from driven plate. Remedy -

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replace plate.
* Warped pressure plate or flywheel. Remedy - Replace pressure plate or flywheel.
* Weak diaphragm spring. Remedy - Replace pressure plate.
* Driven plate not seated in. Remedy - Make 30 - 40 normal starts. *(**Caution**: Do not overheat!)*
* Driven plate overheated. Remedy - Allow to cool and re-check.

Problem: Grabbing (chattering)!

Possible Causes and Remedies:

* Oil on facing; burned or glazed facings. Remedy - Install new driven plate and correct leak at its source.
* Worn splines on main drive gear clutch shaft splines. Remedy - Replace main drive gear assembly.
* Loose engine mountings. Remedy - Tighten or replace mountings.
* Warped pressure plate or flywheel. Remedy - Replace pressure plate or flywheel.
* Burned or smeared resin on flywheel or pressure plate. Remedy - Sand off if superficial. Replace burned or heat-affected parts.

Problem: Rattling - transmission click!

Possible Causes and Remedies:

* Release fork loose. Remedy - Install properly.
* Oil in driven plate damper. Remedy - Replace driven plate and correct leak.
* Driven plate damper spring failure. Remedy - Replace driven plate.

Problem: Noisy!

Possible Causes and Remedies:

* Worn throw-out bearing. Remedy - Replace bearing.
* Fork shaft improperly installed. Remedy - Install properly and lubricate fork fingers at bearing.

Problem: Pedal stays on floor!

Possible Causes and Remedies:

* Binding throw-out bearing. Remedy - Lubricate and free up bearing.
* No brake fluid in master cylinder. Remedy - Top up reservoir and bleed system.
* Spring wear in pressure plate. Remedy - Replace pressure plate.

Problem: Hard pedal effort!

Possible Causes and Remedies:

* Bind in pedal. Remedy-Lubricate bushes and free up.
* Driven plate worn. Remedy - Replace driven plate.

Specifications

Clutch Fluid (Brake Fluid)	**Holden Spec HN 1796**
Clutch Master Cylinder:	**Compensating Port**
Bore Size:	19.05 mm
Nominal Stroke:	30 mm

Clutch Slave Cylinder

VT -VY V6 and VT Series 1 V8

Type:	Side Port Delivery
Bore Size:	V6 - 22.2 mm V8 - 20.6 mm
Available Stroke:	V6 - 25.6 mm V8 - 28.8 mm

V8 Gen 111

Bore Size:	36mm
Available Stroke:	22.8 mm

Clutch Pressure Plate

Type: ..... Belleville Diaphragm

Clutch Driven Plate

Type:Single Plate Dry

Disc Facing:

Outside Diameter:

V6:	240 ± 1.0 mm
VT Ser 1 V8:	266 ± 1.0 mm
Gen 111 V8:	297 ± 1.0 mm

Inside Diameter:

V6:	155 ± 1.0 mm
VT Ser 1 V8:	172 ± 1.0 mm
Gen 111 V8:	198 ± 1.0 mm

Gen 111 V8: Thickness of Disc unit with 10000Nm Load ..... 8.7 ± 0.35 mm

Thrust Bearing

Type:	Ball Race
Lubrication:	Sealed with grease for life

Dual Mass Flywheel (V6 Only)

Type:	Spring dampened internally

Rotational Free Play:

Degrees:	11^0
Distance:	27 mm

Note: Measure at the outer diameter of the secondary side of the flywheel assembly

Clutch Pedal

Pedal Height:	173 mm
Push Rod Free Play:	1 mm

Torque Specifications

Slave Cylinder Nut:	20-25 Nm
Gen 111 V8 Slave Cylinder Bolt:	7.5-12.5 Nm
Master Cylinder Nuts:	20-30 Nm
Clutch Pedal Pivot Bolt:	12-16 Nm

Pressure Plate Bolts

V6:	28-35 Nm
VT Ser1 V8:	41-47 Nm
Gen 111 V8 Step 1:	10 Nm
Gen 111 V8 Step 2:	25 Nm
Gen 111 V8 Step 3:	40 Nm
Gen 111 V8 Step 4:	50 Nm

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AUTOMATIC TRANSMISSION

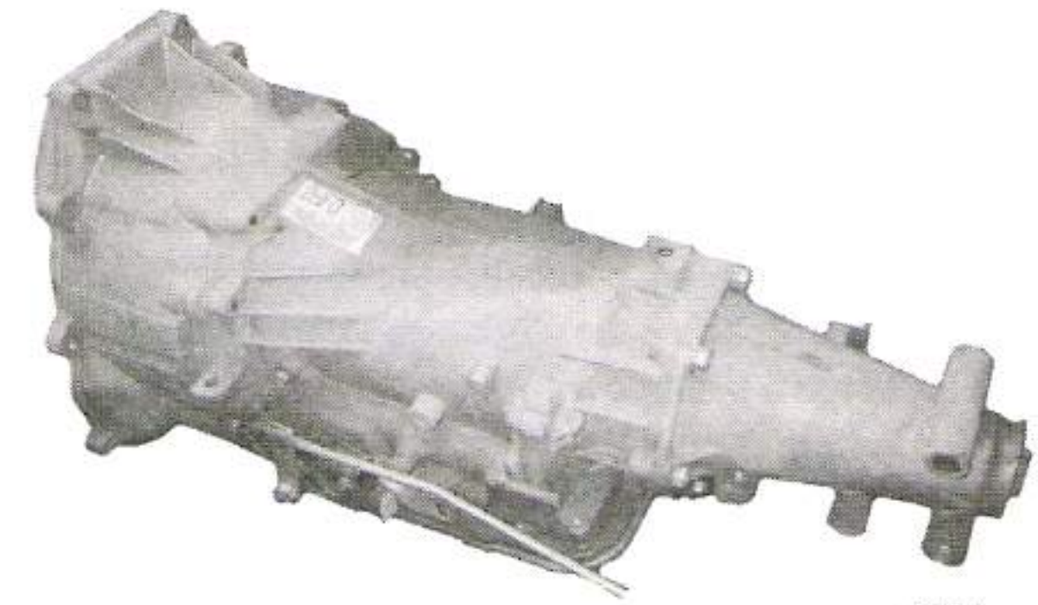
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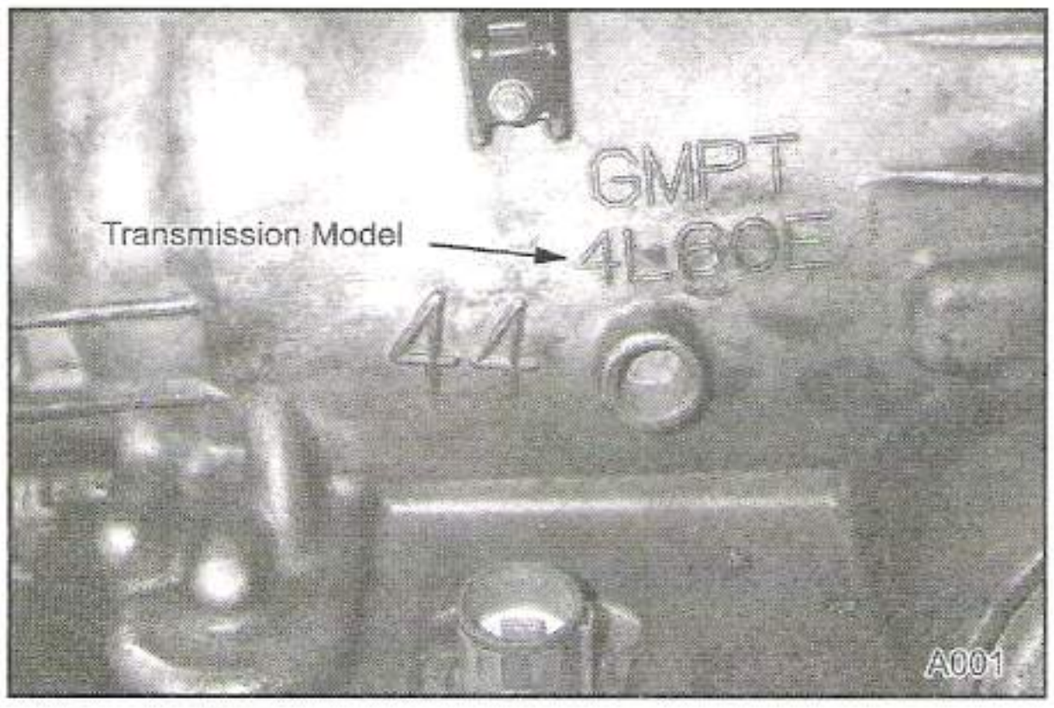
AUTOMATIC TRANSMISSION

Hydra-Matic 4L60-E Automatic Transmission. Which is a 4 speed including an over drive gear plus reverse transmission.



A154

Transmission model is cast on right side of housing.
Transmissions changes are electronically controlled by the Powertrain Control Module (PCM) which adjusts line



pressure to alter shift speed according to engine speed.
The PCM uses electrical current to activate gear change, gear change feel and torque converter clutch apply and release, this is done to give a smooth gear change and to maximise a good ratio of economy and power.
A metal identification plate is attached to the transmission, also the identification is stamped into the rear section of the case near the oil pan
A sticker is located on the upper side of the transmission case for identification of transmission.
This sticker will identify the transmission, with year build and type.
First Number is the last digit in the year.
8 represents 1998
3 letters is the vehicle type HLD.

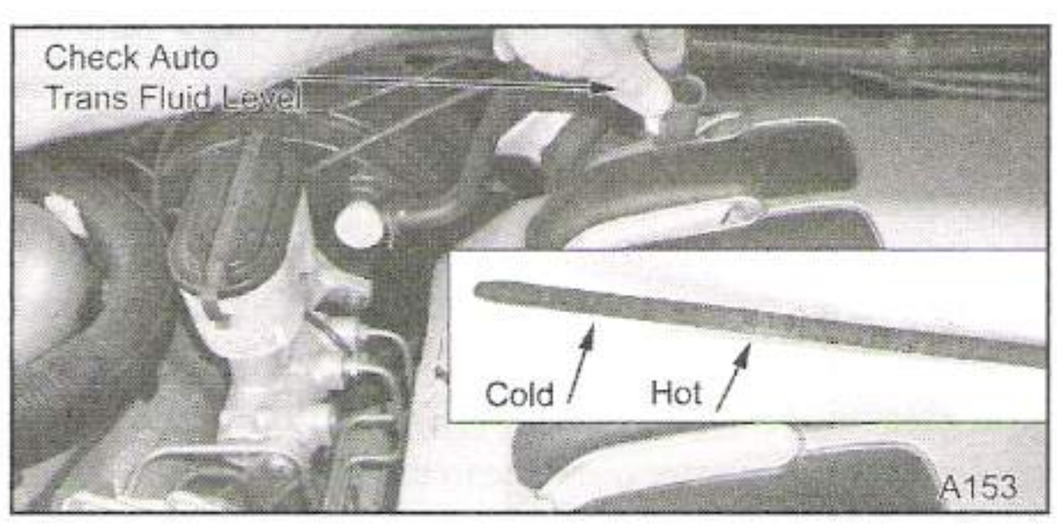
MAINTENANCE

Transmission Fluid Check, Drain and Refill

Normal maintenance and lubrication requirements do not necessitate period automatic transmission fluid changes.



If a major failure, such as a clutch, band, bearing, etc. has occurred, the transmission will have to be removed for repair and the converter replaced.
Automatic transmission fluid is red coloured when new, after use it turns a light brown. Remove the fluid dipstick to check the colour, if the colour is a dark brown and has a burnt type of odour, the fluid should be drained and refilled with new fluid.



When filling a dry transmission and converter do not over fill as foaming can occur, and possibly result in damage to the transmission. Check specifications for the correct volume of fluid. Start the engine, shift the selector lever as described below, and check and add fluid as required.
Following is the procedure for partial drain and refill due to minor repairs.
1. Place a drain pan under transmission. Loosen and remove the screws at rear of the oil pan. Loosen remaining screws and allow fluid to drain. Remove and clean oil pan and screen, dispose of oil pan gasket.
2. Position a new gasket on the oil pan, and install the screen and pan on transmission.
3. Add 3.5 litres of fluid to the transmission through filler tube.
4. Run engine at idle speed until it reaches its normal operating temperature, 3-4 minutes. Do not race the engine.
5. Shift selector lever through all positions then place the lever in `P'.
6. Switch off engine. Remove dipstick, wipe and immediately insert the dipstick all the way into the filler tube then withdraw it and check the fluid level. This procedure must

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be completed within 10 seconds of engine switch off.

Don't Overfill the Transmission.
Check the level of your transmission fluid.
Incorrect transmission fluid level can have the following effects, although they may be attributable to other malfunctions:-
a. No drive in "D", "1", "2", "D (overdrive)" or "R".
b. Slip and squawk or shudder on full throttle starts in "D", "1", "2" "D (overdrive") or "R".
c. Overheating due to high fluid level during sustained high speeds.

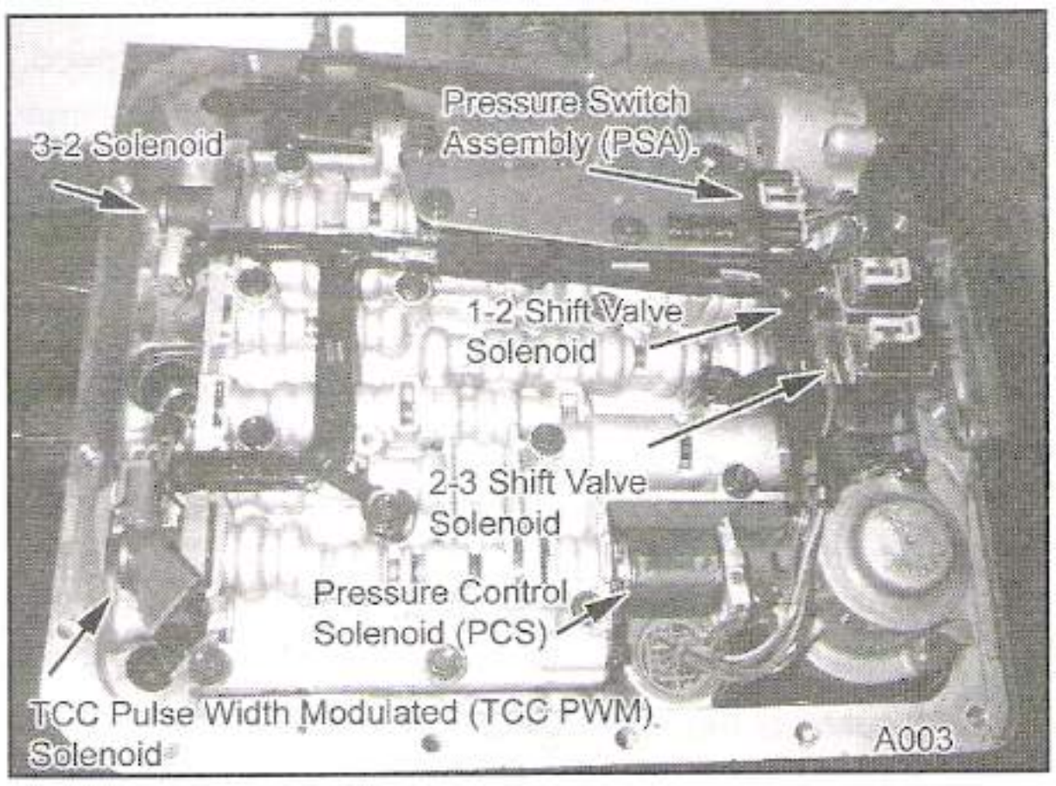
Transmission Fluid Flushing Procedure
When a clutch or band failure or other internal trouble has occurred in the transmission, any metal particles or clutch plate or band material may have been carried into the cooler, this must be removed from the system by flushing the cooler and lines before the transmission is put back into service.
Tip: In no instance should an automatic transmission that has had a clutch or band failure or other internal trouble resulting in contaminated fluid, be put back into service without first flushing the transmission oil cooler.
1. After installing a new or rebuilt automatic transmission and converter assembly in the vehicle. Do not connect cooler return line to the transmission. Position transmission selector lever in the P (park) position and connect cooler inlet (converter out) line to the transmission. Place a pan under the end of the cooler return line that will hold transmission fluid. Do Not Start the Engine.
2. Install an additional 2 litres more than is required (from specifications) of automatic transmission fluid.
3. Start engine and allow it to run at normal idle speed with the selector lever in P, park position.
4. Allow approx. two litres of transmission fluid to drain into the pan placed under the end of the cooler return line.
5. If fluid does not run clean after draining two litres of it through the cooler, turn off engine and add two additional litres of transmission fluid.
6. Repeat Step 3 to 5 until the transmission fluid flowing out of the cooler return line is clean.
7. If there is no fluid flow or the fluid does not flow freely, turn off the engine and detach both cooler lines from the transmission and cooler.
8. Use an air hose with no more than 700 kPa air pressure to reverse flush the cooler lines and the cooler. After reverse flushing, connect both lines at the cooler and the cooler inlet line (converter out) to the transmission.
9. Start the engine and check the fluid flow. If the transmission fluid flows freely, proceed with Steps 3 to 5. If there is no fluid flow, check for pinched cooler lines. If flow is restricted, replace cooler lines and/or the radiator.
10. Don't attempt to correct cooler or cooler line leaks by closing off the lines.

Oil Cooler (In Radiator) Replacement
When fluid leakage is found at the oil cooler, the entire radiator must be replaced.

Power Control Module
The Power Control Module controls and monitors the transmission, similar to the ECM in previous models controlling and monitoring the engine, now the PCM controls and monitors the engine and transmission.
The PCM has a breakdown emergency mode, if the PCM detects certain conditions the transmission will still operate by applying high line pressure. This enables the transmission to be manually operated in R P N 1 2 and in D or 3 the transmission operates in 3. If this occurs the vehicle should be driven only until the transmission can be repaired.

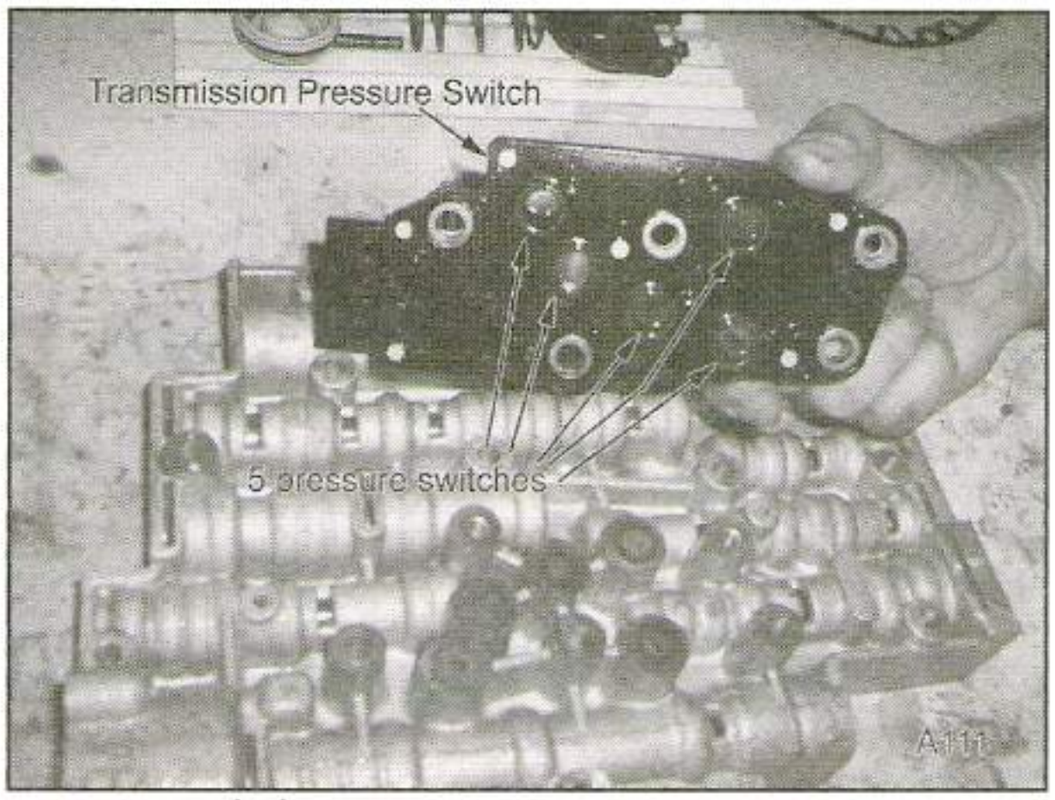
Down and Up Shift
Correct down and up shift is essential for normal service life of transmission and proper gear shift feel and control. Gear sifts are controlled by the (PCM) Power Control Module.
The PCM allows for transmission wear by still functioning with pressure variations from 35kPa below up to 70kPa above standard line pressure.
If the transmission is in economy mode the shifts occur less often provided that the accelerator is not more than 80% depressed.

Electrical Components
Transmission Pressure Switch Assembly
Located in the base of the transmission, on lower section



of the valve body (held by two bolt) with five pressure switches, flat with a wiring loom connecting to other solenoids and speed sensor.
The five pressure switches have electrical current supplied to then, when open the current is stopped, when closed the current is allowed to flow to earth via the

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pressure switch.
When there is no fluid pressure:
Reverse Gear switch is open no current (Of the two furthest switches one closest to 3rd gear switch)
1st Gear switch is open no current (2nd closest to electrical plug).
2nd Gear switch is closed with current (Of the two furthest switches the switch away from other switches).
3rd Gear switch is closed with current (3rd closest to electrical plug).
4th Gear switch is open no current (closest to electrical plug).
Fluid Temperature Sensor located in transmission pressure switch near the 5 pin electrical connection. At room temperature of approx 20Ã–Ã0Ä–ÄC with a 5 volt feed the output should be about 2.50 volts and decreasing voltage as the fluid temperature increases.

Gear Shift Linkage

Remove

1. Place selector lever in the `P' position. Raise vehicle and detach the transmission shift rod from the lower selector lever.
2. Remove the bolt on the bottom of the selector lever, remove transmission control rod and bush from the bottom of the selector lever.
3. Pry the lever consul top from the centre consul.
4. Disconnect the dial indicator light.
5. Remove the 4 nuts (under the floor pan) attaching the lever to floor pan, remove the selector lever and housing.

Install

1. Make sure the bushes are located in the housing and install upper and lower selective levers. Torque the nuts to specification.

Transmission Lever torque: 15-35Nm

2. Install the selector lever housing and lever assembly, install indicator light, install indicator light, center consul.

Selector Lever to floor Pan Nuts torque:12-18 Nm

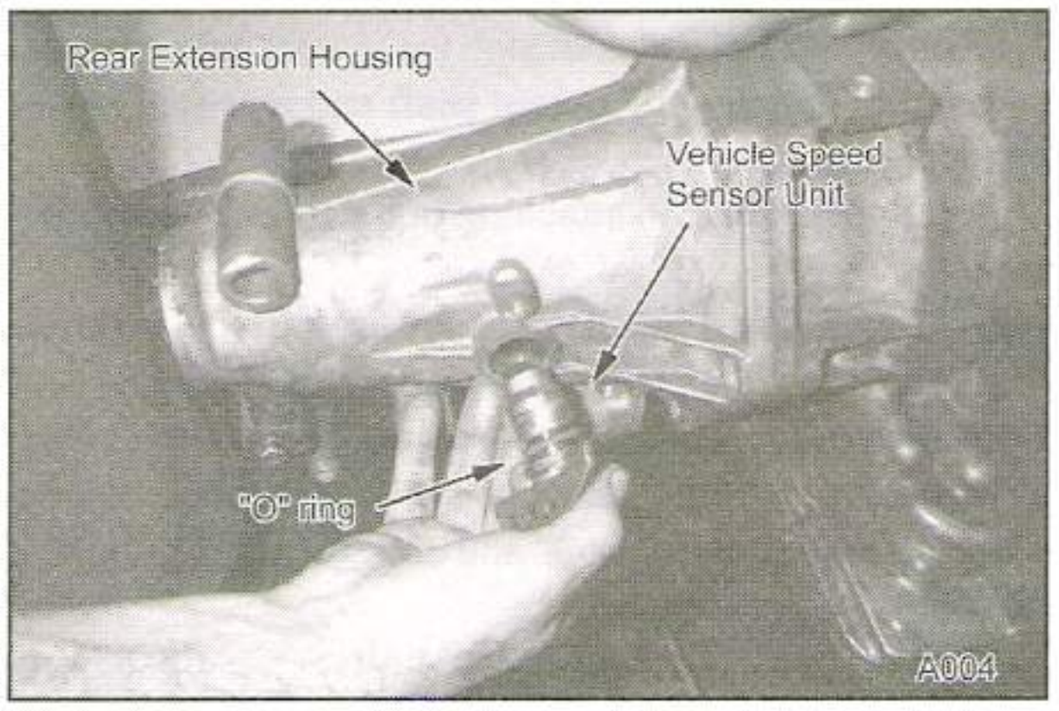
Adjust Gear Shift Lever

1. Loosen selection lever nuts.
(a) Install a new (if necessary) control rod bush on the control rod.
(b) Place transmission in "P" position at transmission.
(c) Place console gearshift lever in "P" position.
(d) Screw trunnion along shifter rod until the trunnion lines up with the bolt hole in the bottom of the gear shift lever.
(c) Install bolt in the selector lever and screw it to the selector rod trunnion. Tighten to specified torque.

Gear Shift Lever Bolt to Rod Trunnion: 15-35Nm

2. Lower vehicle and check transmission operation in each selector lever detent position.

Vehicle Speed Sender Unit (VSS)



Rear Extension and Seal

Note: 1999 on production models the rear extension has 3 internal ribs plus a new rear bush.
Use: The new extension and bush (unit) can be used on earlier 2 piece case transmissions. The extension and bush are not interchangeable (must be as a complete unit).

Remove

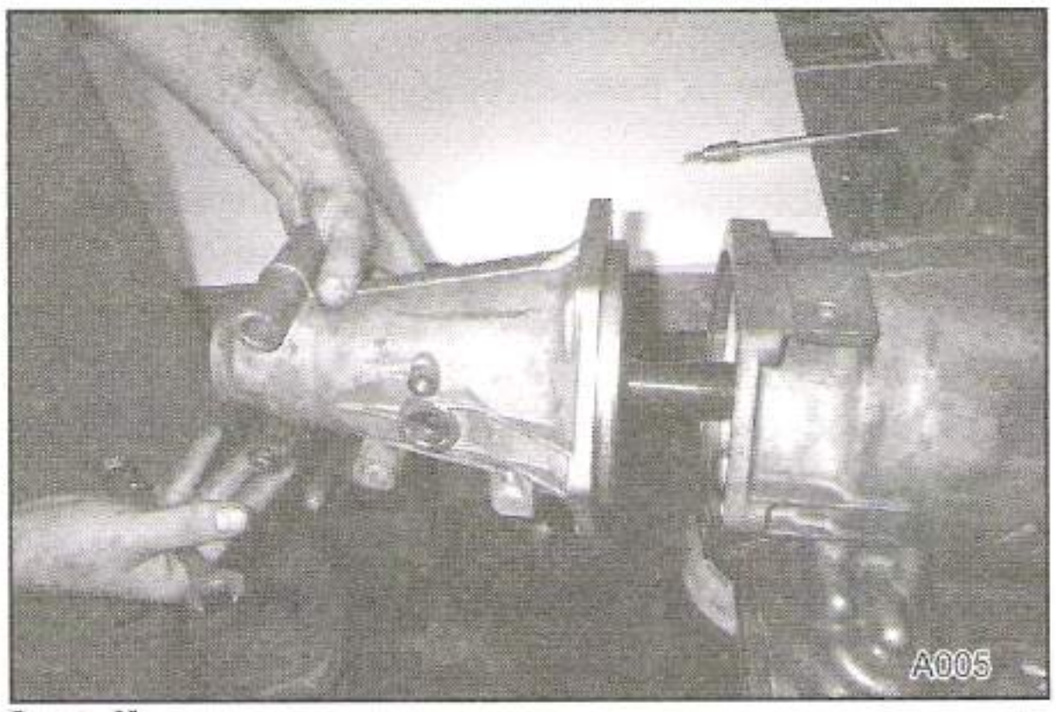
1. Raise back of vehicle. Support transmission.
2. Remove crossmember, 4 bolts, 2 nuts, and rear transmission mount, 2 bolts.
3. Remove the tail shaft.
4. Remove the extension seal as described below.
5. Remove speedo sender unit as described above.
6. Remove the extension attaching bolts.
7. Carefully prize the extension away from the transmission case, take not to damage the output shaft and rear seal cavity moulding.
8. Remove the "O" ring seal between the extension and the case.

If the transmission is to be removed, wrap the output shaft in a clean cloth and tie back to transmission, this will stop shaft from falling out.

Replace Rear Extension Seal

1. Prise seal from housing.
2. Using the seal replacing tool, drive the seal until the seal seats.

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Install

1. Fit a new "O" ring seal between the extension and the case.
2. Carefully install the extension to the transmission case, take not to damage the output shaft and rear seal cavity moulding.
3. Install the extension attaching bolts, tighten to specification.

Rear Extension Housing to Trans bolts: 42-48Nm

4. Replace speedo sender unit as described above.

Speedo Sender Unit Bolt torque: 9-14Nm

5. Install a new rear extension seal as described below.
6. Install rear mount, 2 bolts and crossmember, 4 bolts, 2 nuts.

Rear Mount to Transmission bolts: 50-65Nm
Rear Crossmember bolts: 50-65Nm
Rear Crossmember nuts: 20-30Nm

7. Replace the tail shaft.

Transmission Sump (Oil Pan)

Note: 1999 models on used a deep oil pan, a filter designed for deep oil pan must be used.

Remove

1. Raise vehicle, place a drain pan under the transmission.
2. Loosen and remove the screws at the rear of the oil pan.

Tip: It may be necessary to free oil pan with a screw driver.

Illustration taken with transmission out of vehicle.

3. Loosen the remaining screws and allow the fluid to drain.

CAUTION: The fluid will be very hot if the transmission has just been operated.

4. Remove oil pan securing screws and lower the oil pan carefully, it will still contain a quantity of fluid. Discard this fluid and the oil pan gasket.

Install

1. Clean oil pan, screen and the gasket face of the transmission, remove magnet and clean, then replace magnet.
2. Place a new gasket on the oil pan, and install the filter and pan on the transmission.
3. Tighten oil pan bolts to specification.



Transmission Oil Pan (Sump) bolts: 9.5-13.8Nm

*Don't overfill the Transmission.

TRANSMISSION FLUID FILTER

Remove



Note: 1999 on production models the transmission fluid filter has changed for a deep oil pan, it is now a black plastic filter and must be used with all deep oil pans.

Do not use a shallow oil pan filter with a deep oil pan.

1. Remove transmission oil pan.
2. Pull the filter away from the oil pump, slightly twist the filter as it is removed.

Illustration taken with transmission out of vehicle

3. Use pointy nose pliers or a circlip remover to remove the filter seal, (in extreme cases use a slide hammer) from the oil pump body.

Tip: Cut open filter for inspection of foreign matter.

Install

1. Install a new seal, push down into seat with a screw driver handle or similar.
2. Install new filter into position, push in.
3. Replace oil pan, after cleaning oil pan and magnet.

HSV Modifications

In the HSV VT series of vehicles with 195i engine have a specific Plate Control valve body spacer part No 07B3970101, plus a Valve control assembly with (valve and body) part No 07B3970102.

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Shift patterns have also been modified in the PCM for:
VT Series II 250kw engine.
VX Clubsport 255, Senator 255 Sedan and Estate, Grange 255.
VY Series: engines above 250kw

Major Repairs and Rebuild

Transmission

Remove

1. Detach earth lead from battery.
2. Raise vehicle, if work is to be carried out on the transmission or torque converter when removed from the vehicle, drain transmission fluid.
3. Remove the tail shaft and place a rag plug into rear of transmission to stop oil leakage.
4. Remove rear mounting to extension housing bolts.
5. Remove electrical connectors, speedometer sender unit, disconnect oxygen sensor wiring connectors.
6. Detach the fluid cooler lines from the case. Plug the cooler line connections.
7. Detach the manual linkage rod from the transmission control lever.
8. Remove the cover plate from the front of the converter housing, disconnect the neutral start switch wiring, remove the converter to flywheel attaching nuts.
9. Place a transmission jack to support the transmission and secure the transmission to the jack with a safety chain.
10. Remove the filler tube and plug hole with a rubber plug.
11. Remove the exhaust system bracket, V6 naturally aspirated engines remove exhaust system from manifolds to rear of catalytic converters.
12. Place alignment marks on the cross member and floor pan for reassemble.

Tip: If the crossmember is not aligned during assembly vibration and handling problems could occur. Remove the cross member to body bracket attaching nuts and lower the crossmember.

13. Remove the converter housing lower cover to engine, starter motor will need to be removed. V6 models will need the 2 support braces also removed.
14. Place alignment marks on the torque converter, remove the 3 bolts from the torque converter to the flexiplate. (do not reuse these bolts, replace with new).
15. Hold the converter firmly against the transmission, move the transmission to the rear and lower. Lower transmission slightly, just enough to disconnect wiring connector, squeeze widest outer section to unclip at narrowest section.
16. Secure the converter to prevent it becoming disengaged from the transmission and remove the assembly from under the vehicle, with the aid of the transmission jack.

Install

1. With the converter properly installed on the transmission, position it on the jack and secure with a safety chain. Reconnect transmission wiring loom.
2. Raise the transmission into position. Install the converter housing to the engine attaching bolts. Remove safety chain.
3. Locate the crossmember and mounting and install the crossmember to body bracket nuts. Use alignment marks made during removal.
4. Align the exhaust system bracket, lower the transmission and install the extension housing to mounting bolts.

V6-Torque Converter Housing bolts to Engine: 50-60Nm

V8-Torque Converter Housing bolts to Engine: 30-45Nm

5. Connect fluid cooling lines to the transmission case leaving the unions loose.
6. Loosely assemble the exhaust system bracket to the exhaust pipe flange.
7. Remove jack, tighten exhaust bracket to pipe flange nuts, tighten the fluid cooler lines to case unions.

Fluid Cooler Lines to Trans: 22-24Nm

8. Install the flexiplate to converter attaching new bolts. Install the converter housing cover ,V6 support braces, starter motor.

Torque Converter to Flexiplate bolt torque spec: 60-70Nm

V6-Converter Lower Housing Cover bolts:30-45Nm

V8-Converter Lower Housing Cover bolts: 5-10Nm

9. V6 normally aspirated models install front section of exhaust system.
10. Align the mating marks and install the tail/drive shaft.
11. Connect shift linkage and check adjustment.
12. Reconnect speedo sender unit and oxygen sensor wiring connectors.
13. Reconnect the battery, check fluid level and check the operation of the transmission controls.

1-2 Accumulator Assembly

Note: 11 May 1998 a new type of 1-2 accumulator composite material piston and oval spring was bought into production. These pistons and springs are not interchangeable.

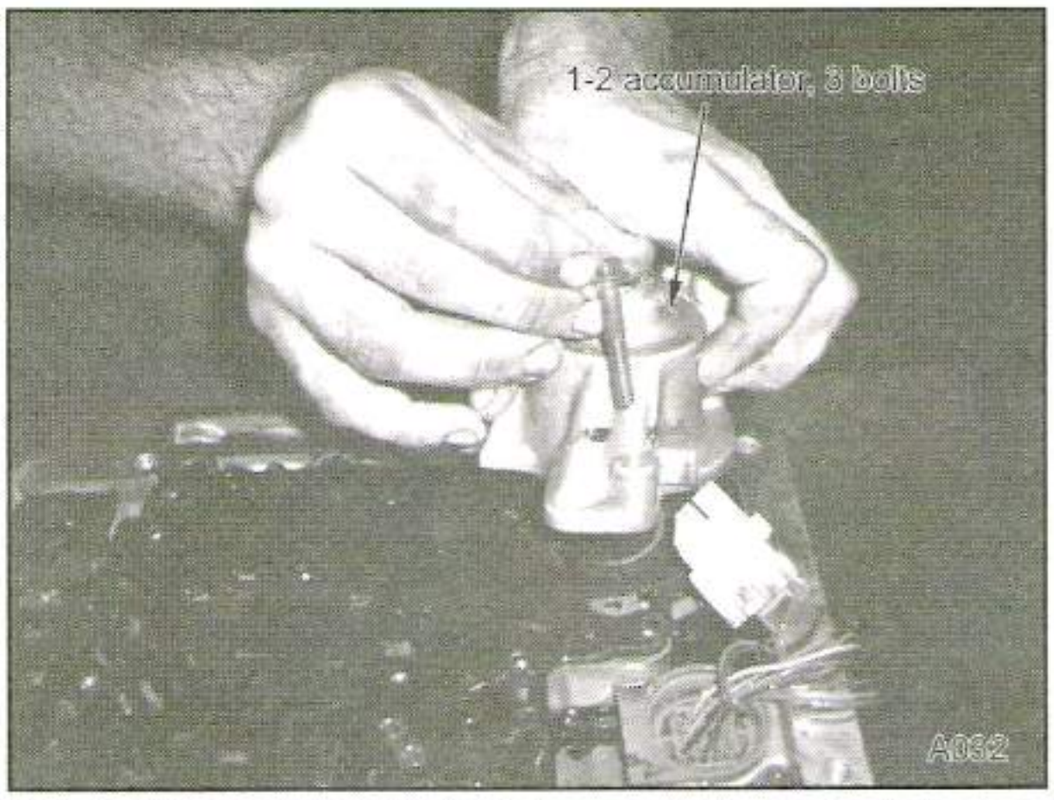
Remove

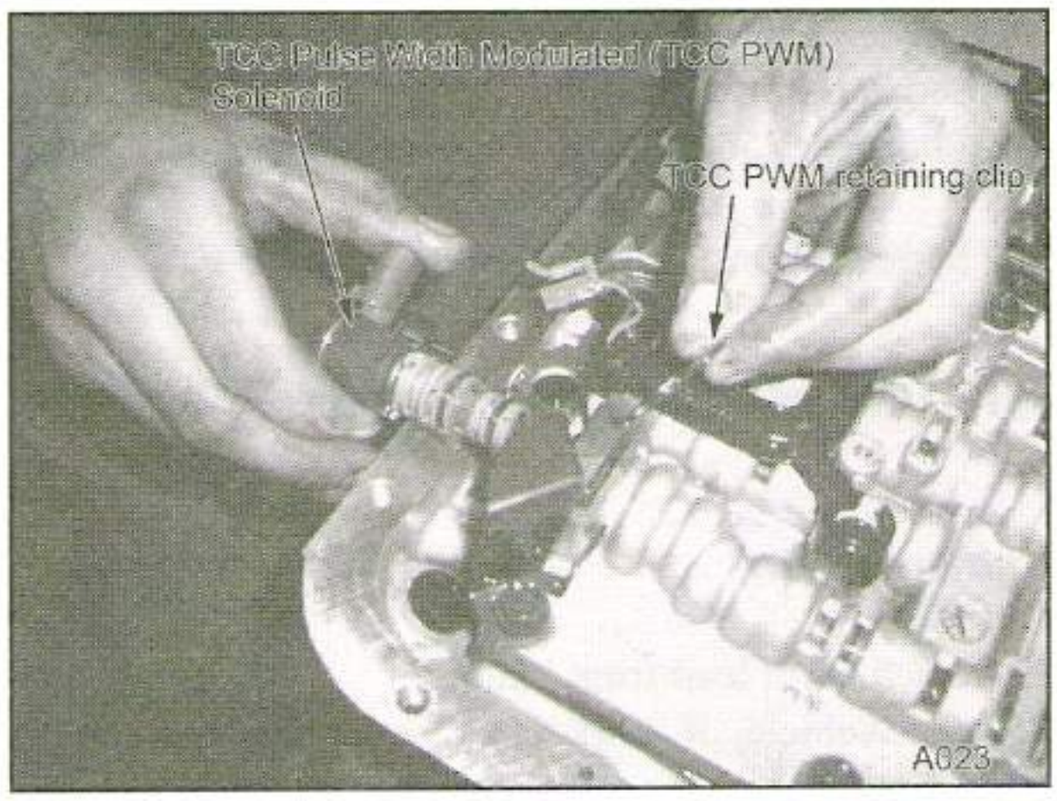
1. Raise vehicle and remove transmission sump and strainer.
2. Remove the accumulator retaining cover (3) bolts with care as there is a spring behind the cover.
3. Remove cover, spring, and seal.
4. Remove the 1-2 accumulator piston it may be necessary to use air pressure through side hole to remove the piston.

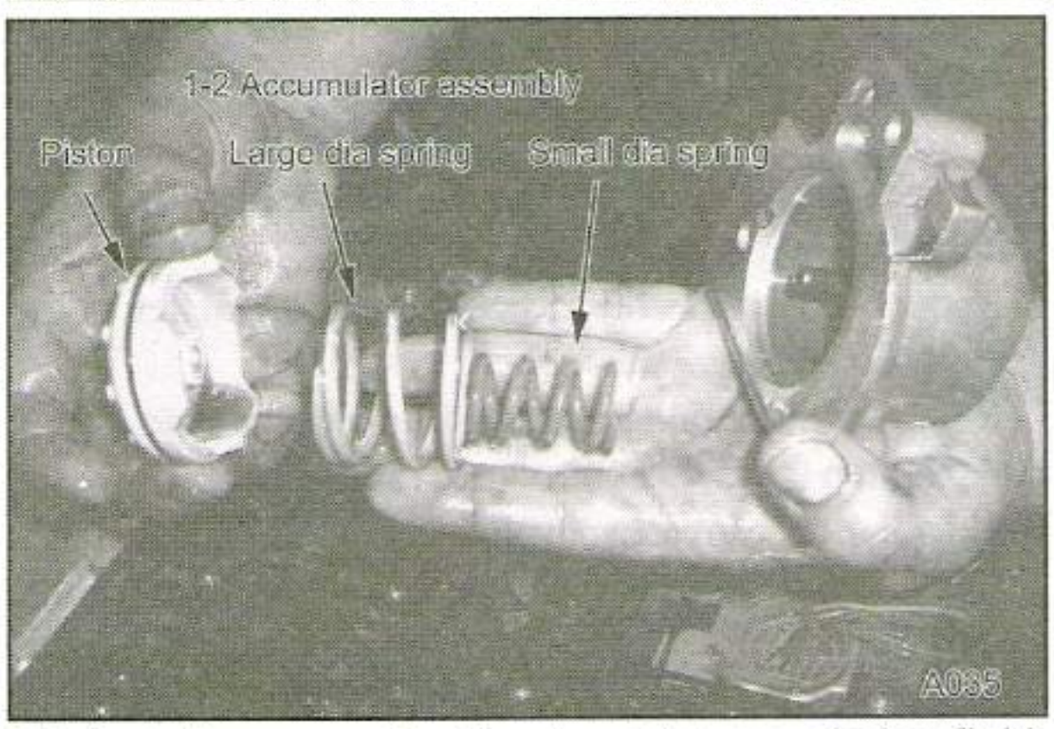
Install

1. Wash with solvent and dry, replace seal with a new seal

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lubricate the new seal with automatic transmission fluid.
2. Install the 1-2 accumulator piston into position.
3. Install new seal and cleaned springs.
4. Install the cover and three bolts. Tighten cover bolts to specification.

Accumulator Cover Bolts: 8-14Nm

6. Replace transmission sump and strainer, tighten sump bolts to specification.

Transmission Oil Pan (Sump) bolts: 9.5-13.8Nm

Control Valve Body & 3-4 Accumulator Assembly

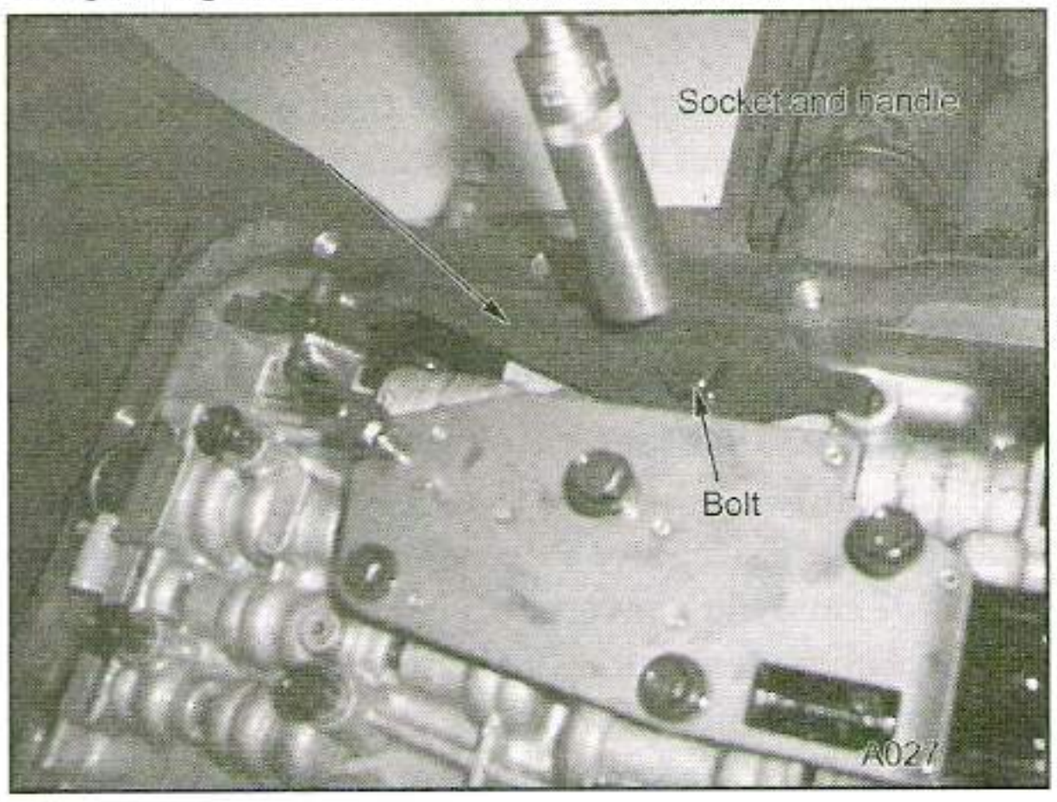
Note: 1999 production a slightly different valve body is used, it takes a round check ball instead of an oval check ball. Do not use an early control valve body on a 1999 and later transmission.

Note: 1999 production a slightly different valve regulator is used, it has a groove on the valve as shown.

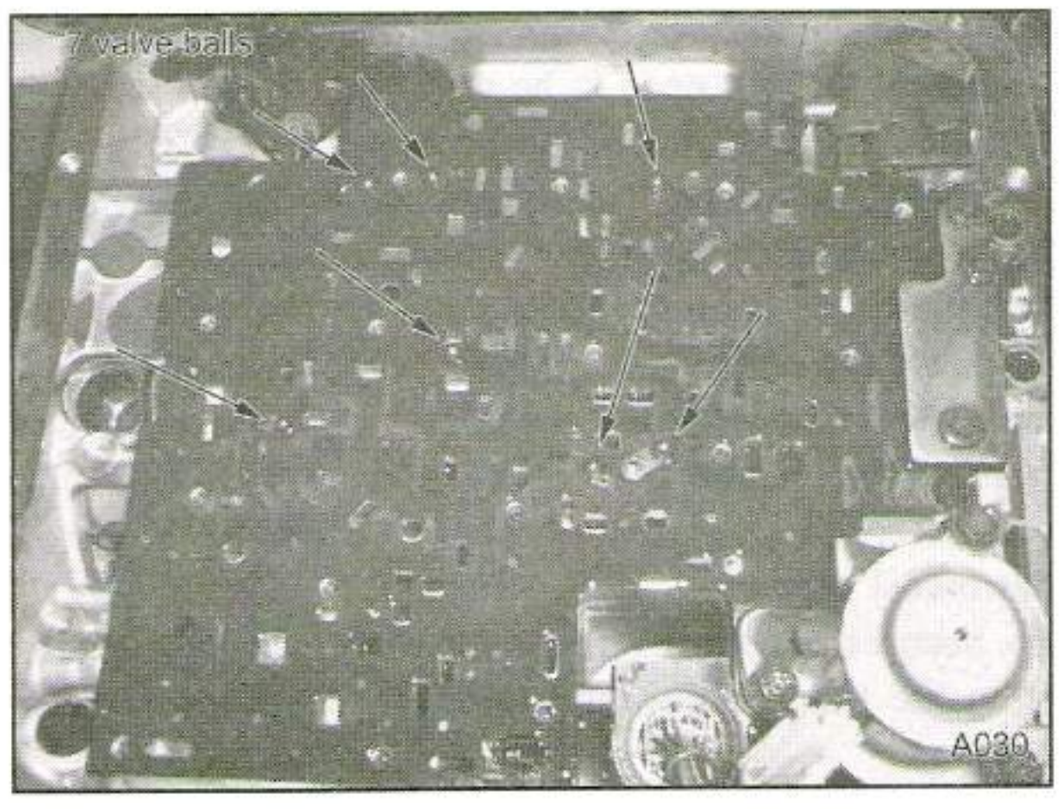
Note: Transmissions fitted to Gen III V8 engine, there is no spring fitted to the 3-4 accumulator piston.

Remove

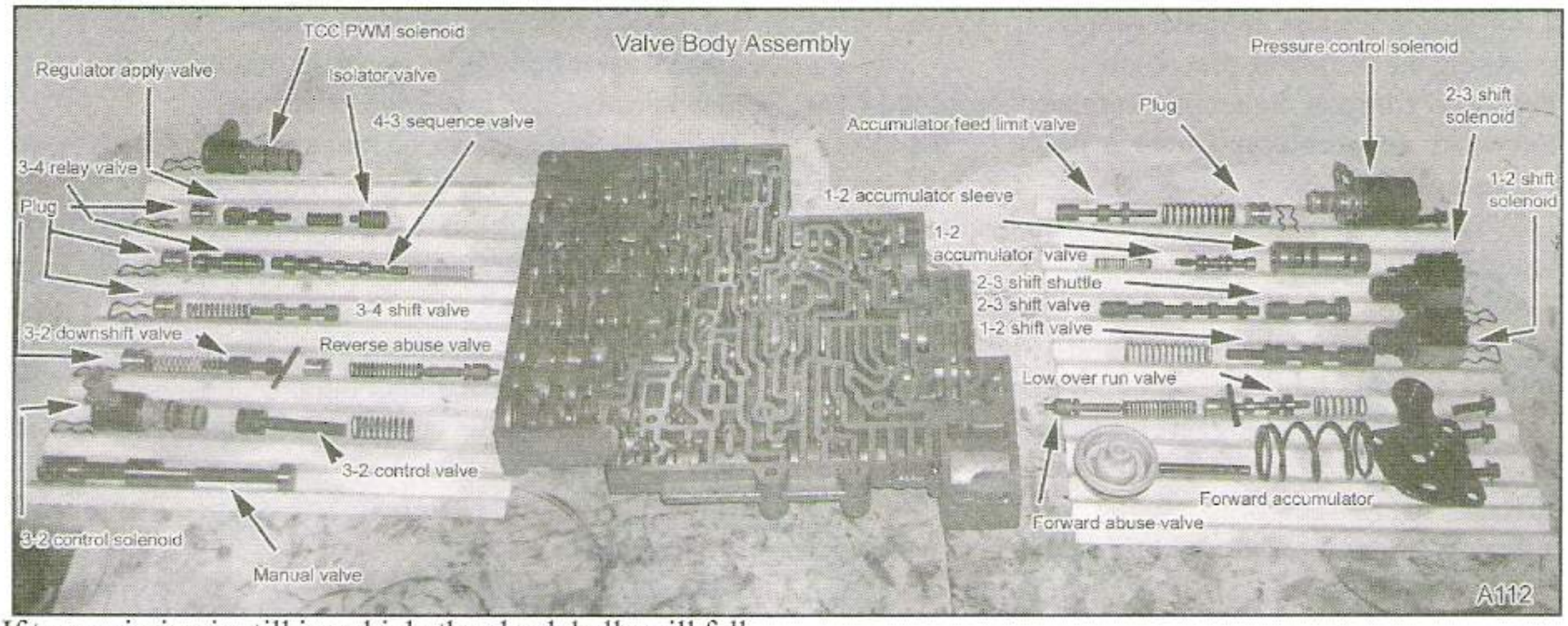
1. Remove transmission is preferable and remove transmission sump.
2. Remove electrical loom connections, label and tie back.
3. Remove electrical switches (solenoids) that are connected to the valve body.
4. Remove the TCC pulse width modulator (PWM) retaining clip and solenoid.
5. Remove the wiring loom (3 bolts) from the valve body.
6. Remove the TCC solenoid assembly from the oil pump, 2 bolts. The valve body needs to be lifted or removed to allow removing of the TCC solenoid.
7. Remove the transmission pressure switch assembly if required, 5 bolts, or only remove 3 bolts shown.
8. Remove detent lever spring, 1 bolt.
9. Remove attaching bolts that hold the control valve body into place, plus 1 bolt holding fluid level dipstick stop.



10. Lift the control valve body taking care with the manual valve link and 7 ball valves.



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If transmission is still in vehicle the check balls will fall down. Hold the control vale body and the manual valve, turn control valve body to disengage manual valve from the manual valve link.

11. Hold the spacer plate, remove the 1-2 accumulator, 3 bolts.

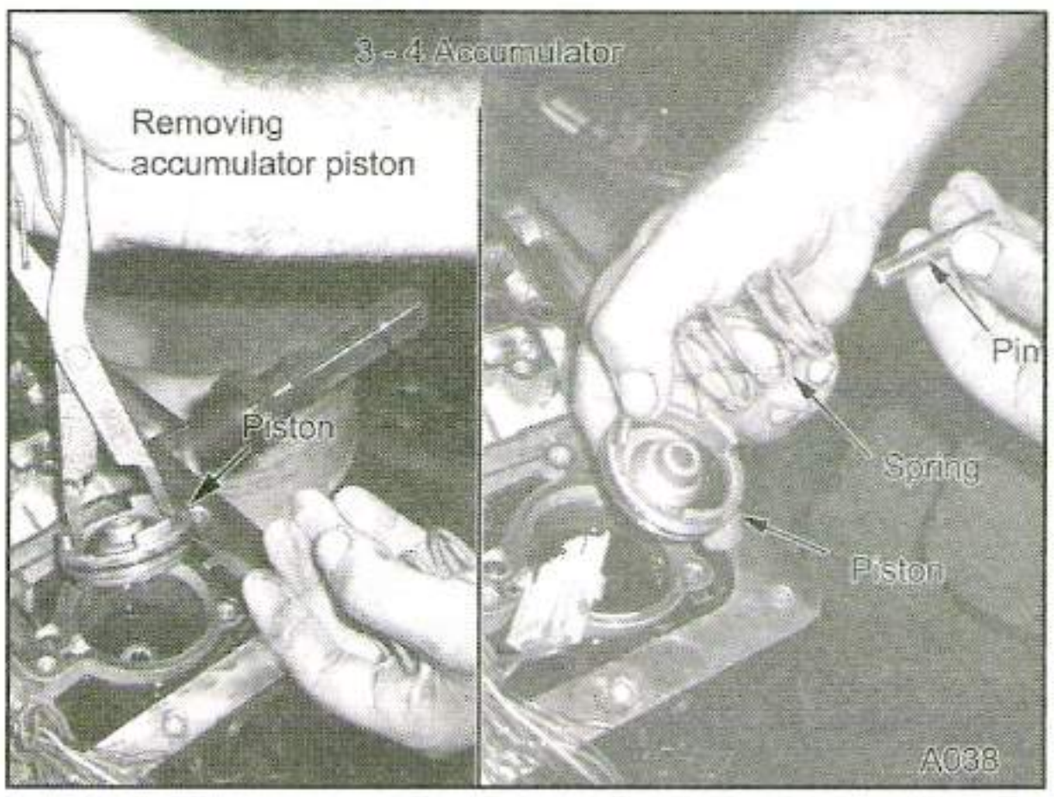
Tip: 3-4 accumulator spring is behind spacer plate.

12. Remove 1-2 accumulator as previously described. With the 1-2 accumulator removed access to 3-4 accumulator is gained by removing gaskets and spacer plate with 2 gaskets, remove with care as there are a spring , seal, pin, piston. Take care as there is 1 ball, ball assembly and orifice cup

13. Remove the spacer plate attaching plate, 3 bolts.

14. Remove large gasket, large plate, large gasket.

15. Remove the 3-4 accumulator spring and tag, remove the 3-4 accumulator piston, pull and turn.



16. Remove the check ball near the 3-4 accumulator location.

Dismantle / Assemble

Note: # Some valves have springs and are spring loaded, when removing pins or clips the valve may spring out.

Keep all components in order of dismantle to help assemble.

1. Remove the pressure control solenoid, bolt, retainer plate. Insert rod to hold spring plug, remove plug retaining clip, remove actuator feed limit valve spring and valve.
2. Remove the 1-2 accumulator sleeve pin and sleeve, valve and spring.
3. Remove the 2-3 shift solenoid retaining clip then solenoid, 2-3 shuttle valve, 2-3 shift valve.
4. Remove the 1-2 shift solenoid retaining clip then solenoid, 1-2 shift valve, 1-2 shift valve spring.
5. Remove the 1-2 accumulator cover (3 bolts), spring, piston, push in plug with small rod to remove the 1-2 accumulator roll pin, remove plug, forward abuse valve spring, valve.
6. Remove the forward accumulator spring, piston and pin. Remove sealing ring from piston.
7. Turn control valve body around to remove other components.
8. Remove the 3-2 control solenoid (retaining clip), valve and spring.
9. Push in the valve plug and remove the retaining clip, spring, 3-2 down shift valve. Use a small rod to push in plug to remove the roll pin for 3-2 down shift valve, remove plug, spring, reverse abuse valve.
10. Push in the 3-4 shift valve plug and remove the retaining clip, spring, 3-4 shift valve.
11. Push in the 3-4 relay valve plug and remove the retaining clip, plug, 3-4 relay valve, 4-3 sequence valve, spring.
12. Push in the regulator apply valve plug and remove the retaining clip, plug, regulator apply valve, isolator valve.
13. Remove the TCC PWM solenoid in not installed until after the TCC solenoid has been installed and bolts tightened to specification as the control valve body is installed into the transmission.

Assemble

Install clips for plugs from the machined side of the valve body, if not the filter will not fit correctly and wiring harness will not fit correctly.

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As this procedure is quite simple, it is a matter of reversing the dismantle procedure.

Pressure Control Solenoid Retainer Bolt: 8-14Nm
Forward Accumulator Cover 3 Bolts: 8-14Nm

Clean and Rebuild

1. Wash the complete valve body with a solvent based liquid and air dry.
2. Remove the pins from the valves shown in diagrams, with care. Remove the springs and valves, wash with solvent and dry, lubricate with auto trans fluid, replace valves and springs making sure the valves move freely. Fit new valves and springs if reconditioning transmission.

Install

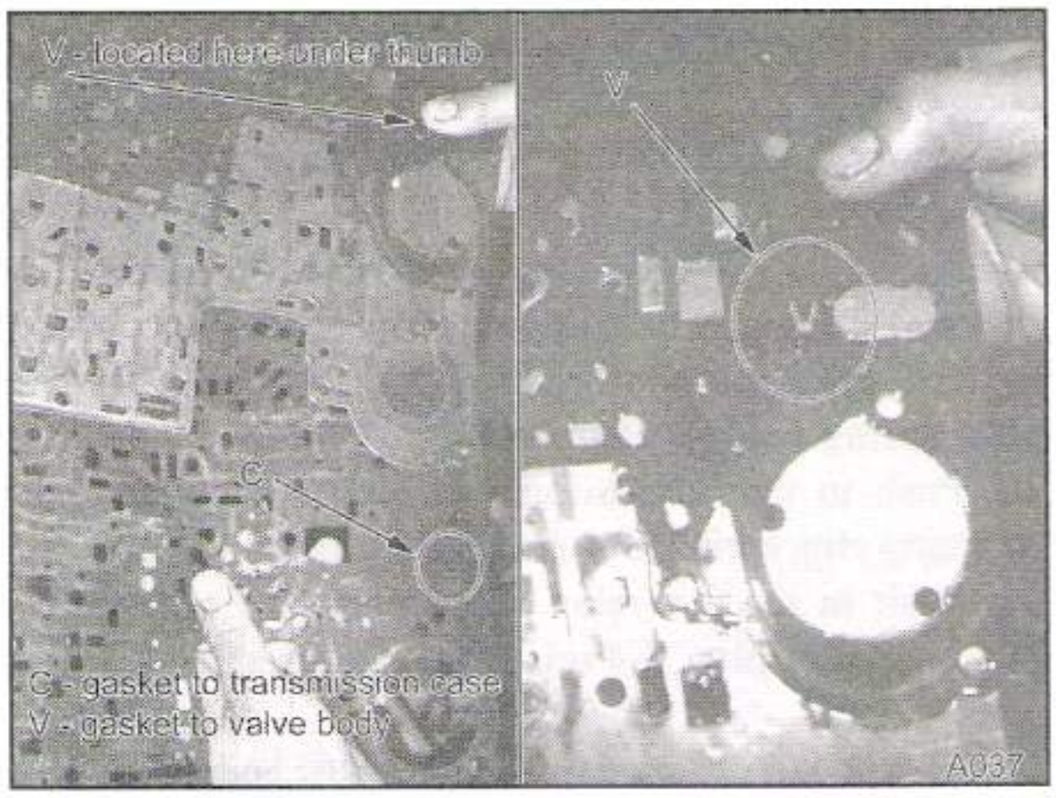
1. Install 3-4 accumulator with care, fit a new seal to the 3-4 accumulator piston, pin into transmission case, piston (3 notches are out of the piston bore).
2. Install 2 guide pins.
3. Install check ball, then spring.

Tip: Use petroleum jelly is used on the balls, they will stay in place while installing the assembly.

Use new gaskets when installing the accumulator and spacer plate. The 2 gaskets (new coated with petroleum jelly) and spacer plate will need to be held in position until the auxiliary valve body and 1-2 accumulator is installed.

Tip: If a new spacer plate is being used, 2 filter screens will need to be fitted, if not present.

Gasket identified with a "C" is installed between transmission case and spacer plate. Gasket identified with a "V" is installed between control valve body and spacer plate.



4. Replace the 1-2 accumulator, 3 bolts.

1-2 Accumulator Bolts : 8-14Nm

5. Install spacer plate and bolt.

Spacer Plate Bolt : 8-14Nm

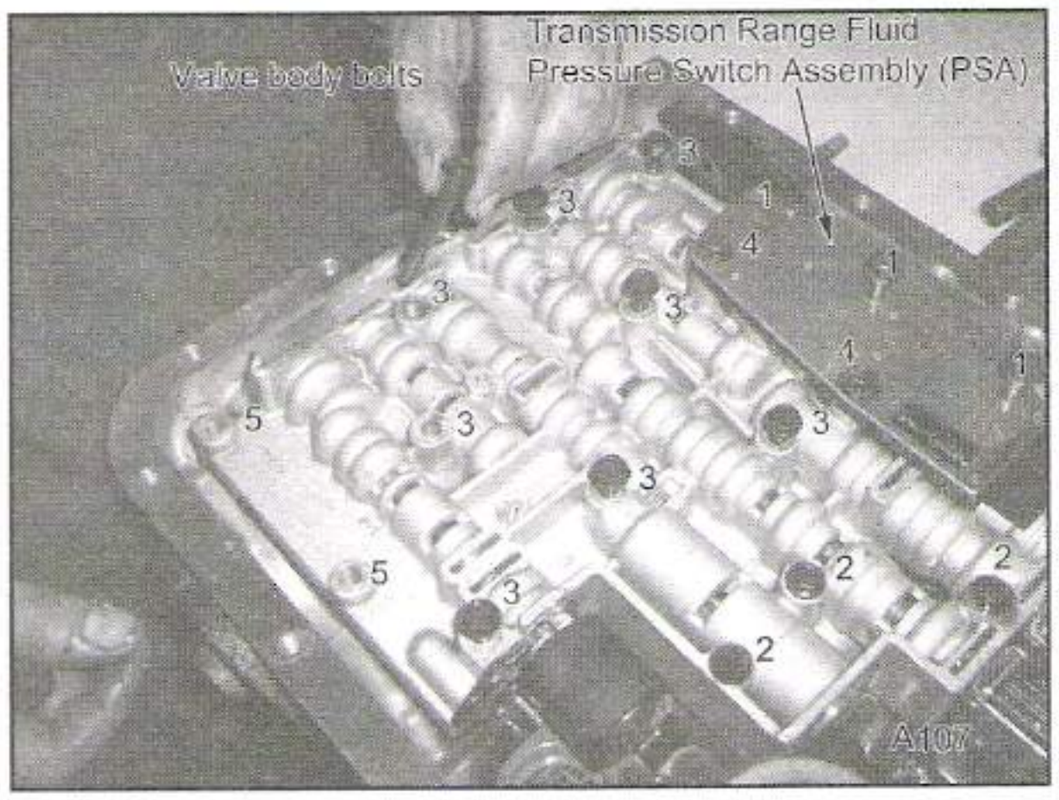
6. Remove guide pins.
7. Assemble control valve body, install the 7 check balls into the underside of the valve body, use petroleum jelly.
8. Place the manual valve link into the inner detent lever.
9. Hold the manual valve link, while turning the control valve body with the other hand. Connect the link with the manual valve body as you keep the manual valve up to the manual valve link, install the valve body.
10. Install the transmission range pressure switch assembly and 5 bolts, finger tight.
11. Install dip stick guide to bolt and install, finger tight.
12. Install detent lever spring and bolt to valve body, finger tight.
13. Replace other attaching bolts that hold the control valve body into place, finger tight.
14. Install the torque converter controller solenoid and new "O" ring.
15. Tighten control valve body bolts to specification in the order shown.

Control Valve Body Bolts: 8-14Nm
Pressure Switch Assembly Bolts : 8-14Nm
Detent Lever Bolt: 20-27Nm

The different bolt sizes are:

Valve body bolt identification and location

ID	Number	Size	Grade
1	3 bolts	1.0mm x 65.0mm	M6
2	3 bolts	1.0mm x 54.4mm	M6
3	8 bolts	1.0mm x 47.5mm	M6
4	2 bolts	1.0mm x 18.0mm	M6
5	2 bolts	1.0mm x 35.0mm	M6
6	3 bolts	1.25mm x 20.0mm	M6



16. Install the torque converter controller PWM solenoid with a new 'O' ring, install retaining clip.
17. Install electrical loom connections, use labels from earlier during removal.
18. Install a new transmission fluid filter.
19. Replace transmission sump and new gasket, tighten to specification.

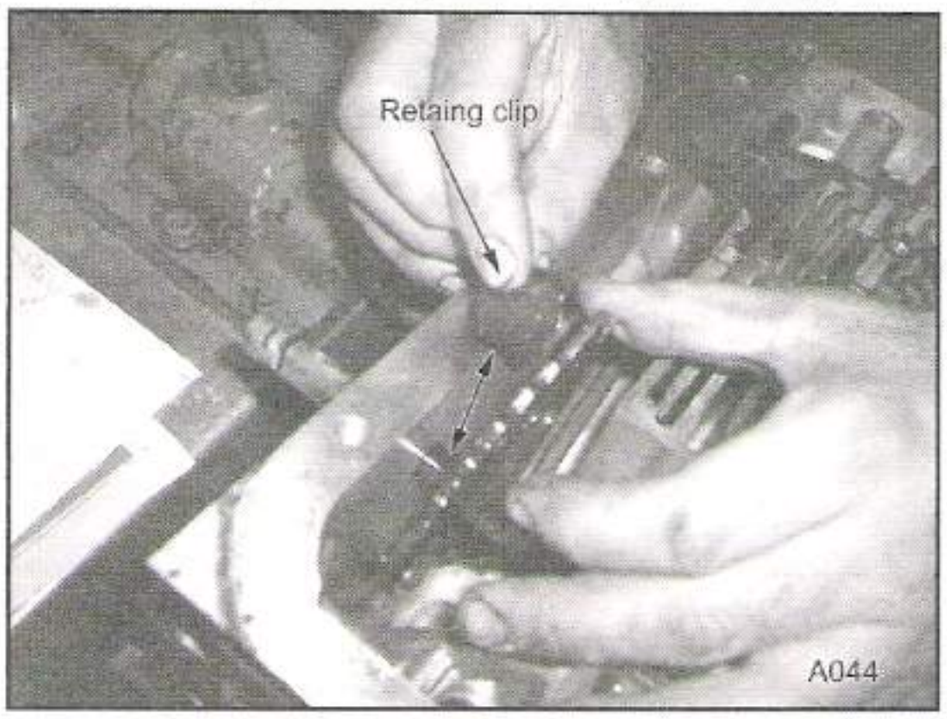
Transmission Sump bolt: 9-14Nm

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Gear Linkage Shaft

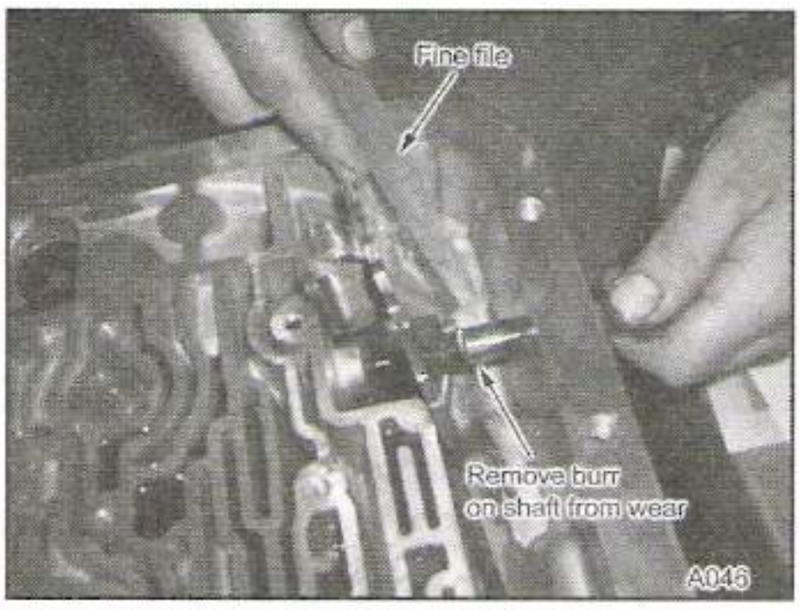
Remove

1. Remove transmission linkage if not removed, transmission oil pan and filter.
2. Remove bolt securing manual detent lever spring.
3. Remove nut attaching the detent lever from the gear linkage shaft.
4. Remove the spacer clip from the gear linkage shaft.



5. Remove the gear linkage shaft.

Tip: If shaft is warn, it may needs smoothing with a fine file. Take care you do not want fine filings in the transmission.



6. Remove seal ring from transmission case.

Install

1. Install "O" ring to transmission case.

Tip: Tap home with a 14mm socket and hammer.

2. Install the gear linkage shaft.
3. Replace the spacer clip to the gear linkage shaft
4. Replace detent lever and nut attaching the detent lever to the gear linkage shaft.

Detent Lever Inner Nut: 27-34Nm

5. Install detent spring lever and bolt.

Detent Lever Spring Bolt: 20- 27Nm

6. Install filter, transmission oil pan and transmission linkage.

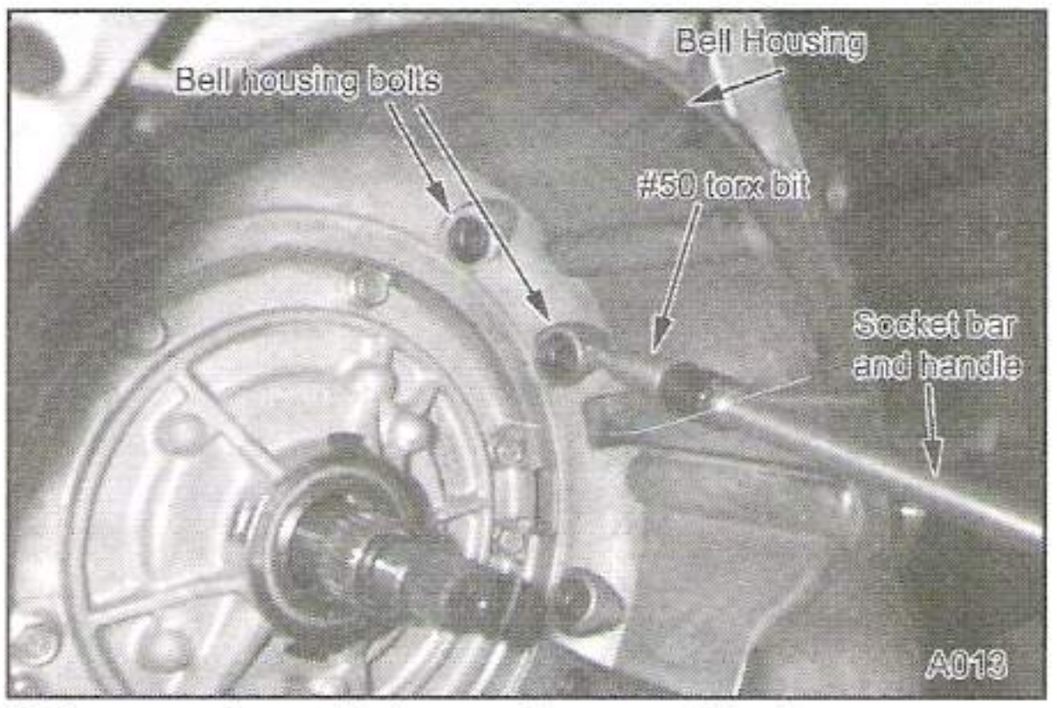
Transmission Rebuild

Dismantle

1. Place the transmission in a suitable clamp or stand so the transmission is stable and safe to work with.
2. Remove the torque converter.



3. Inspect the torque converter collar for damage:
a) Check for cracks near the cut slot section.
b) Inspect for a worn groove.
c) Inspect for seal wear groove.
d) Inspect colour of torque converter, if the side of the torque converter is very dark or near black this is due to over heating.
If any of the conditions have occurred, replace the torque converter, as it is a none repairable unit.
4. Remove the bell housing, size # 50 torx bolts.

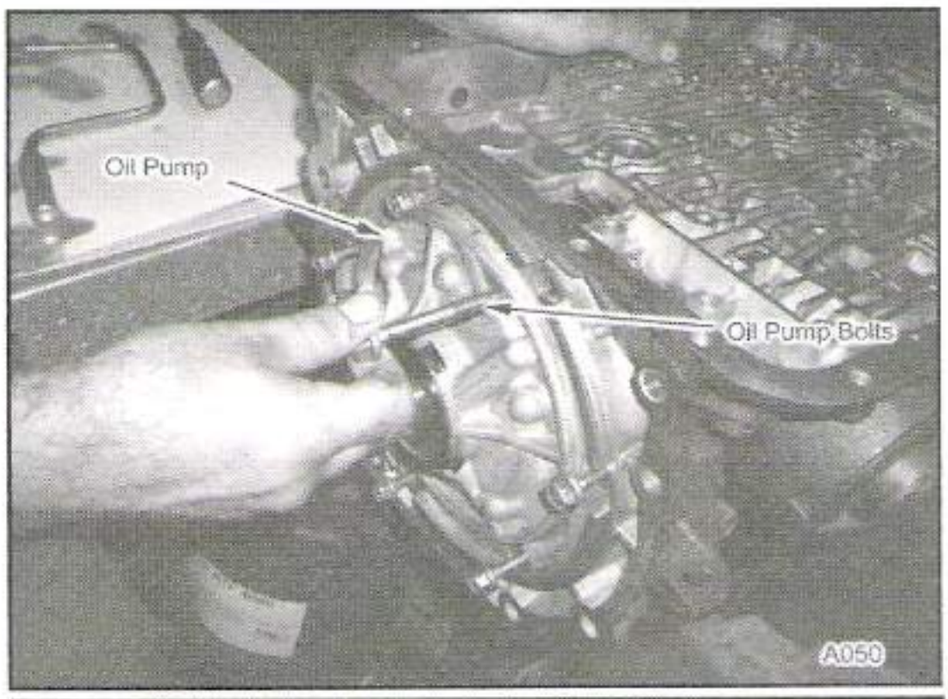


5. Remove the vehicle speed sensor, 1 bolt.
6. Remove the rear extension housing.
Carefully prize the extension away from the transmission case, take not to damage the output shaft and rear seal cavity moulding. Position an oil tray under transmission to catch transmission fluid while removing rear extension.
7. Remove the "O" ring seal between the extension and the case.
8. Remove the "O" ring from the input shaft.

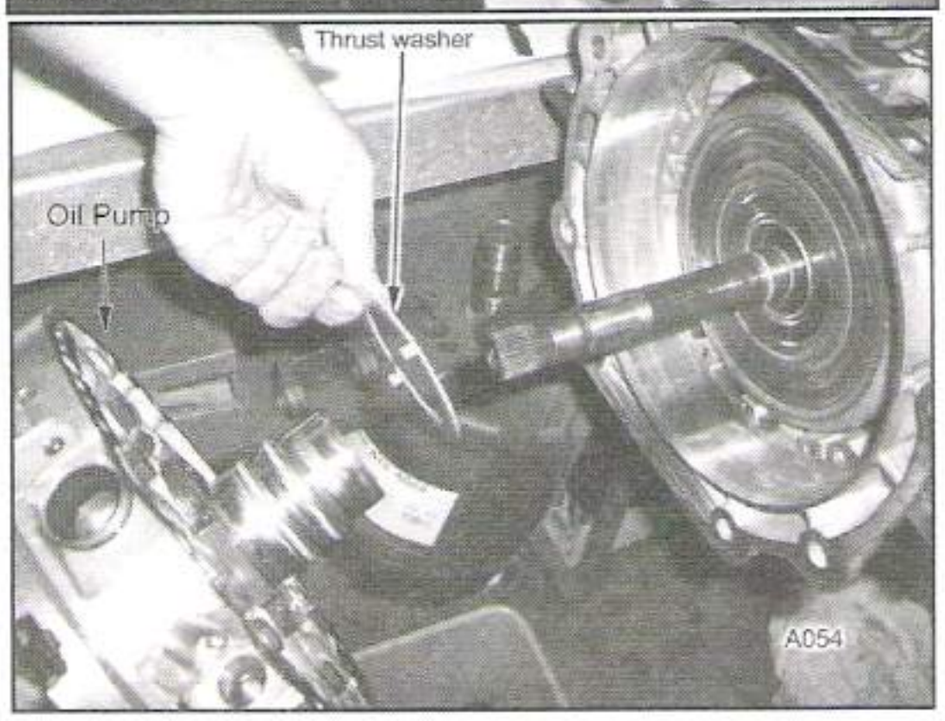
Oil Pump

1. Remove the oil pump attaching bolts from the front of the transmission.
2. Firmly push on the input shaft while using a screw driver to push down the rubber seal, to allow the oil pump to be levered out of the transmission case.
Continue to lever oil pump from transmission case.
5. Remove the oil pump from the input shaft. Take care not to damage the input shaft spline while removing the oil pump.
5. Remove thrust washer.

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6. Remove the transmission case seal and gasket.

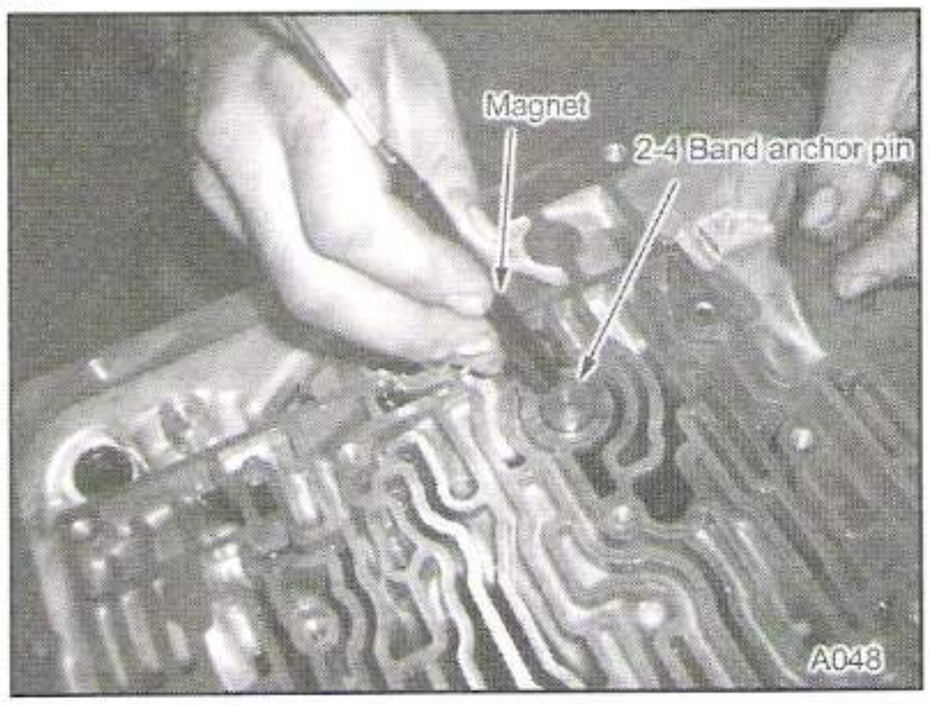
Reverse Input Clutch, Input Clutch, 2-4 Band & Input Gear Set

7. Take hold of the input shaft and gently lift to remove the "reverse input clutch" and "input clutch assembly", remove thrust washer.

Place assembly on a clean bench.

8. Remove the 2-4 band.

a) Remove the 2-4 band support pin and remove the 2-4 band.



b) Remove the 2-4 band from transmission case.



c) Inspect band for cracks, or discolouring.

9. Remove the input sun gear from transmission case.

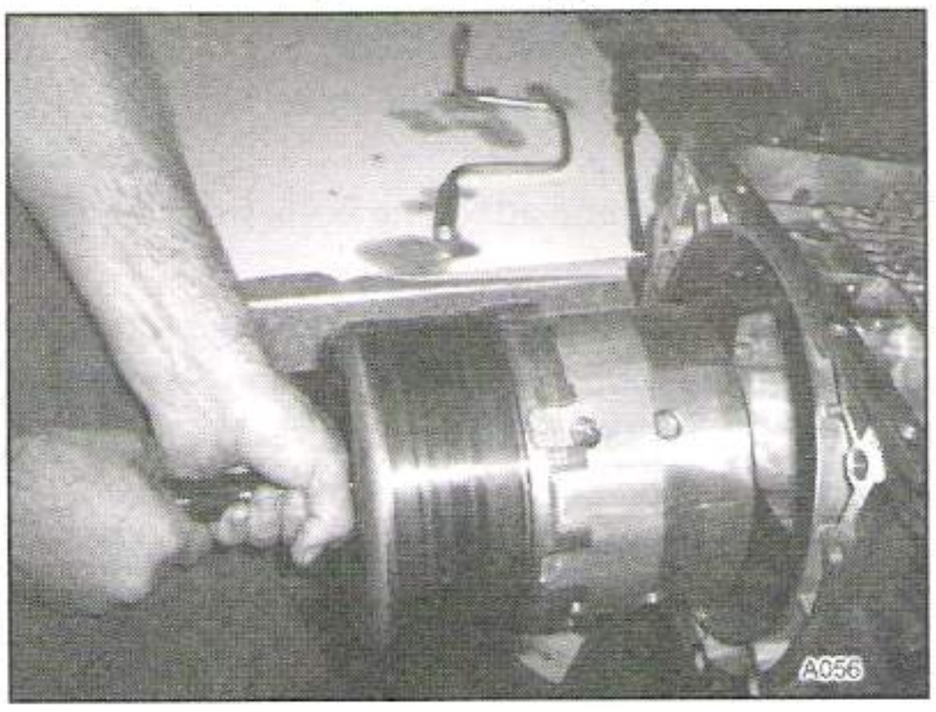
Note: Only pre 1997 the input sungear is now a press fit to the forward sprag inner race.

10. Remove the input shaft retaining circlip (from the front) inside transmission case. The circlip retains the input carrier.



11. Remove input carrier assembly.

12. The thrust bearing is between the input carrier assem-

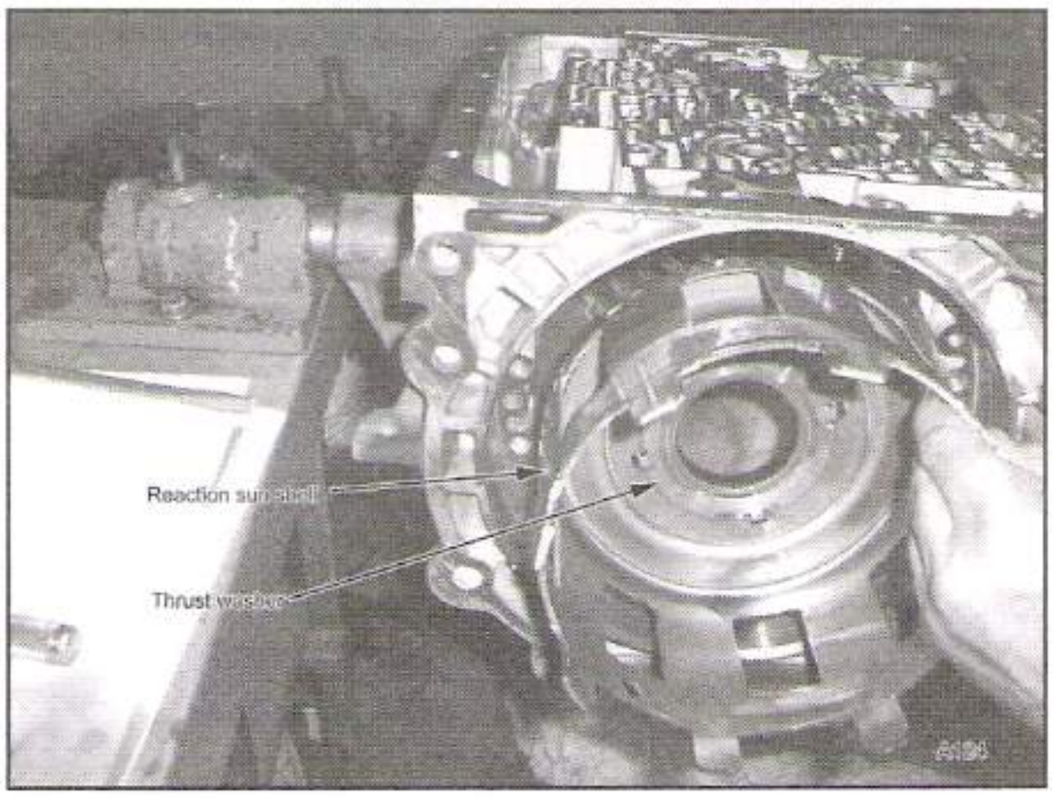


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bly and the input internal gear.
Tip: Remove output shaft later in step 16, however it is possible to remove it now.

Reaction Gear Set

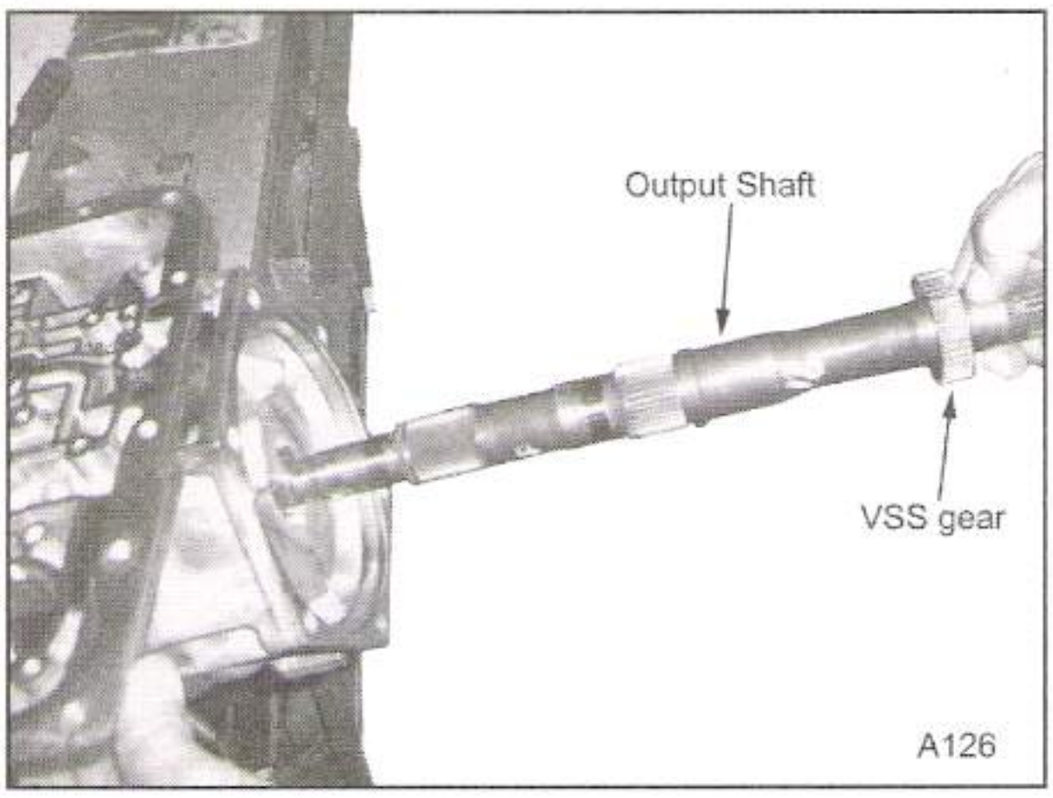
13.The input internal gear and reaction carrier shaft has been removed with input carrier.
14. Remove the reaction sun gear case and thrust washer.



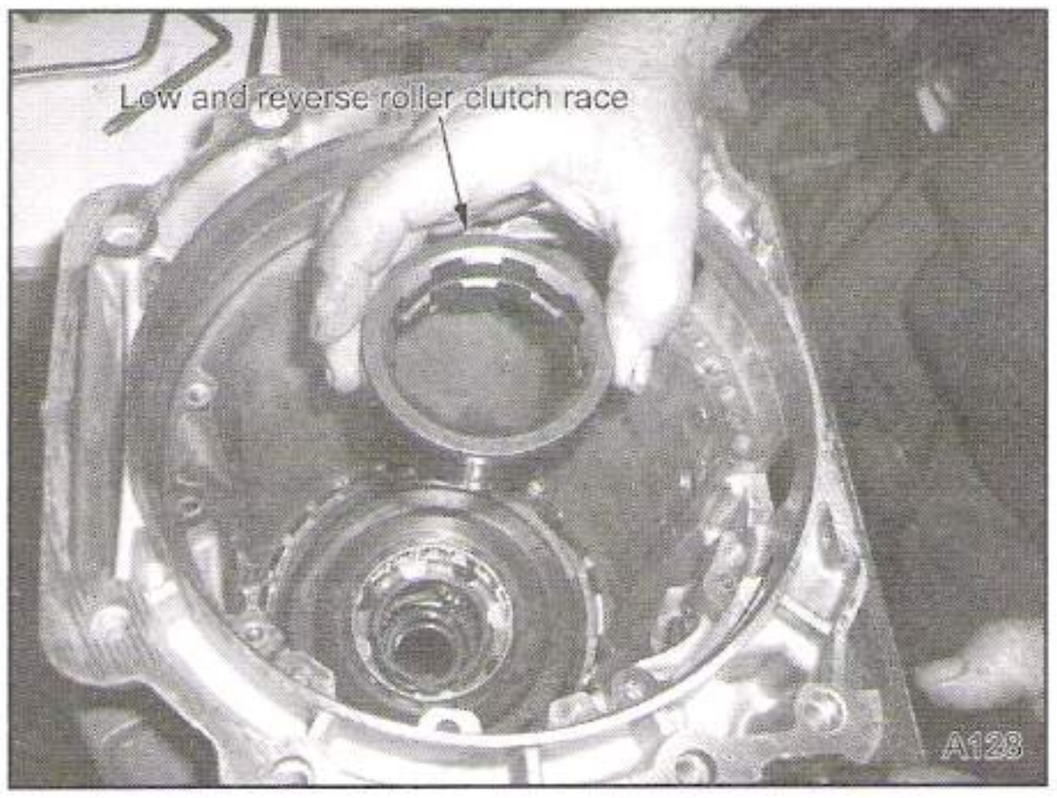
15. Grip the reaction sun gear and remove.



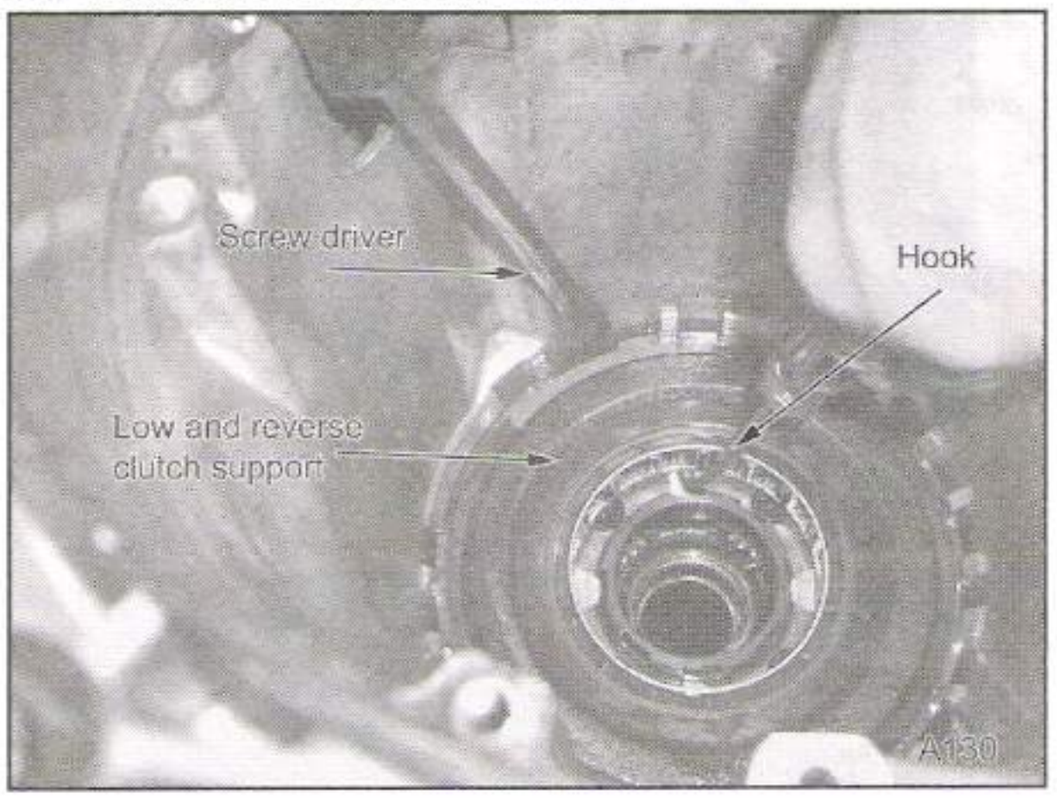
16. Remove the output shaft.
Tip: Do not try to remove speed sensor gear, unless replacing input shaft or the gear has become damaged.



17. Turn transmission case in clamp, remove thrust washer.
18. Hold the low and reverse clutch race, grip the inner surface and turn the race in the "free" direction.

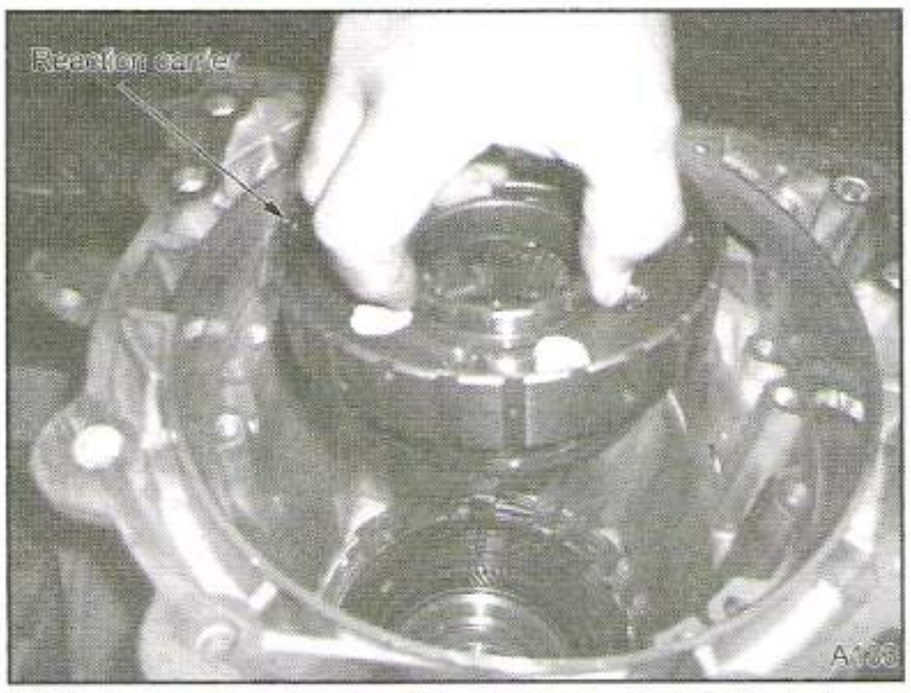


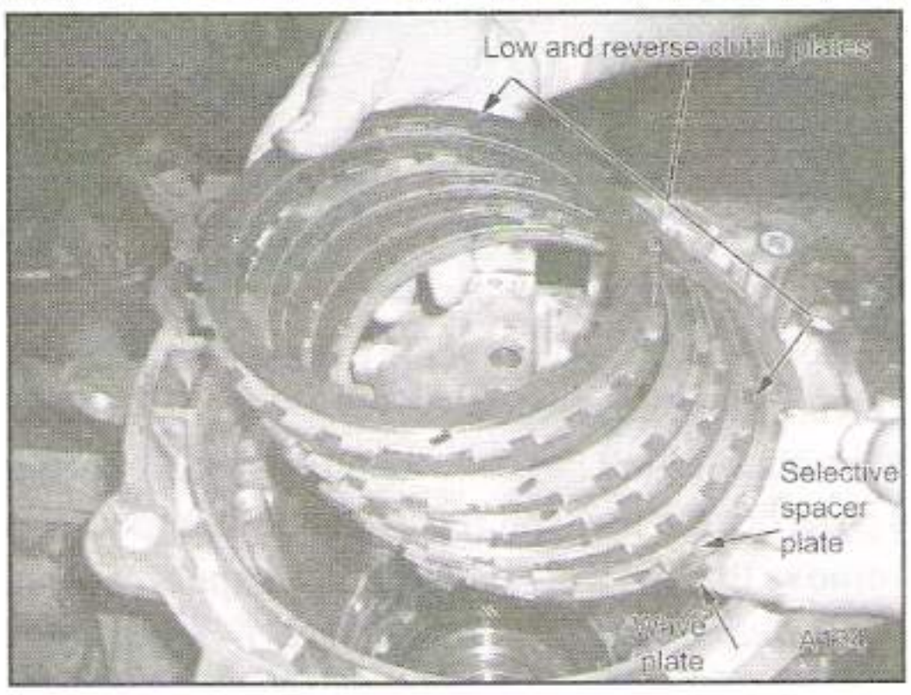
19. Remove the low and reverse to case retaining spring clip, lever free with a screw driver.
20. If the output shaft has been taken out install, then push up to push out the low and reverse clutch support assembly, remove the low and reverse clutch support assembly.
Tip: Use output shaft to push in and free the low and reverse clutch support assembly.
The low and reverse clutch support assembly can be lifted out with a hook and screw driver.



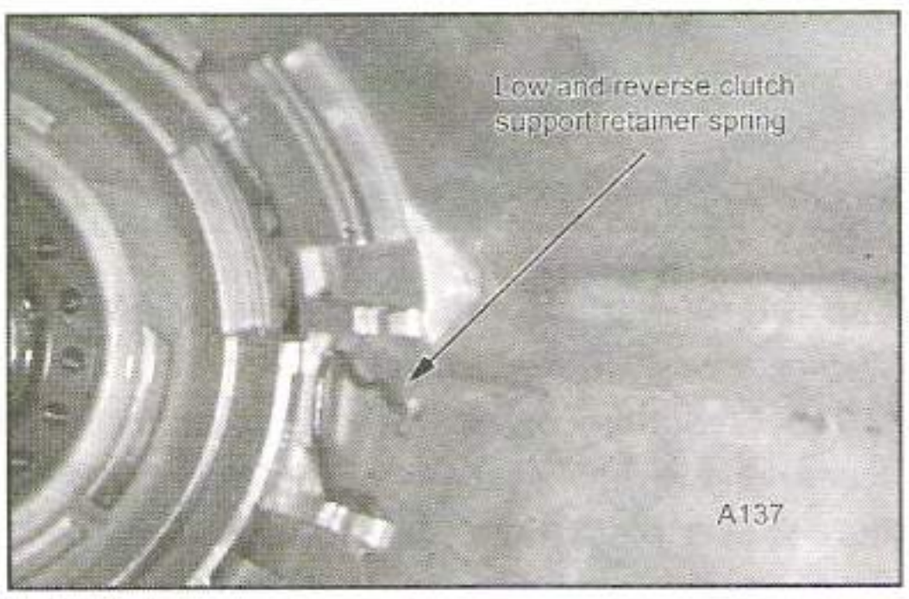
Note: If output shaft is still in transmission, it should now be removed.
21. Lift the reaction carrier from the transmission case.
22. Remove the low and reverse clutch plates, then selective spacer plate, then wave plate.
* Take note of removal procedure to help in assembly.
23. Remove the reaction carrier support thrust bearing, take note of the surface facing up.
Tip: Inside diameter has a lip that faces down.
24. Remove the reaction gear and reaction gear to transmission case bearing from transmission case.
25. Remove the low and reverse support retainer spring

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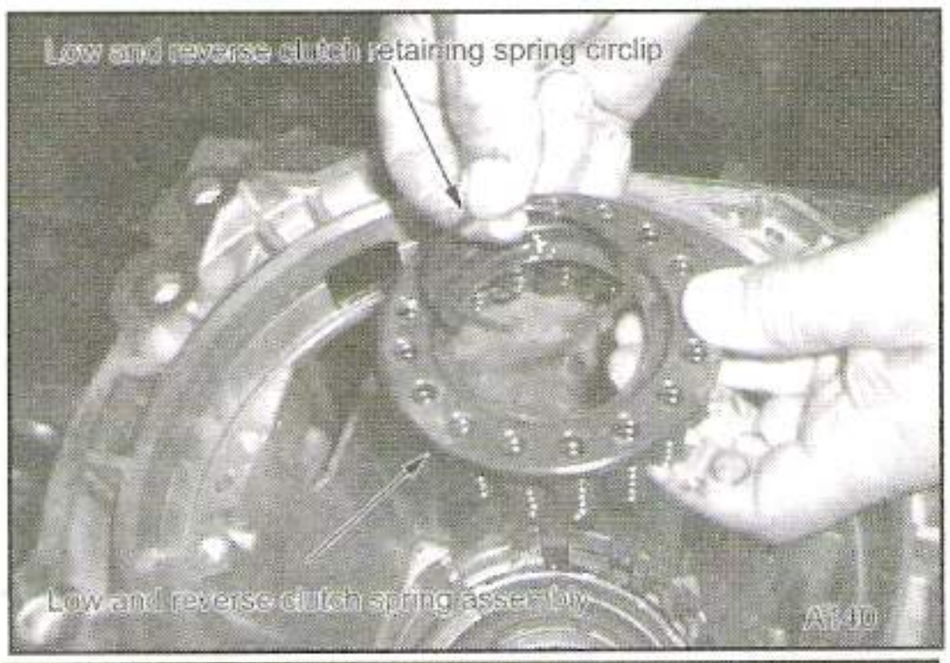




Low and Reverse Clutch Assembly

26. Use a spring compression tool (such as a tool shown or NoJ23327), compress springs and remove the low and reverse clutch retaining spring circlip, clutch spring assembly .

25. Apply low air pressure to transmission case to help





remove clutch piston.

Remove gear shift shaft as previously described if required.

Clean and Inspect

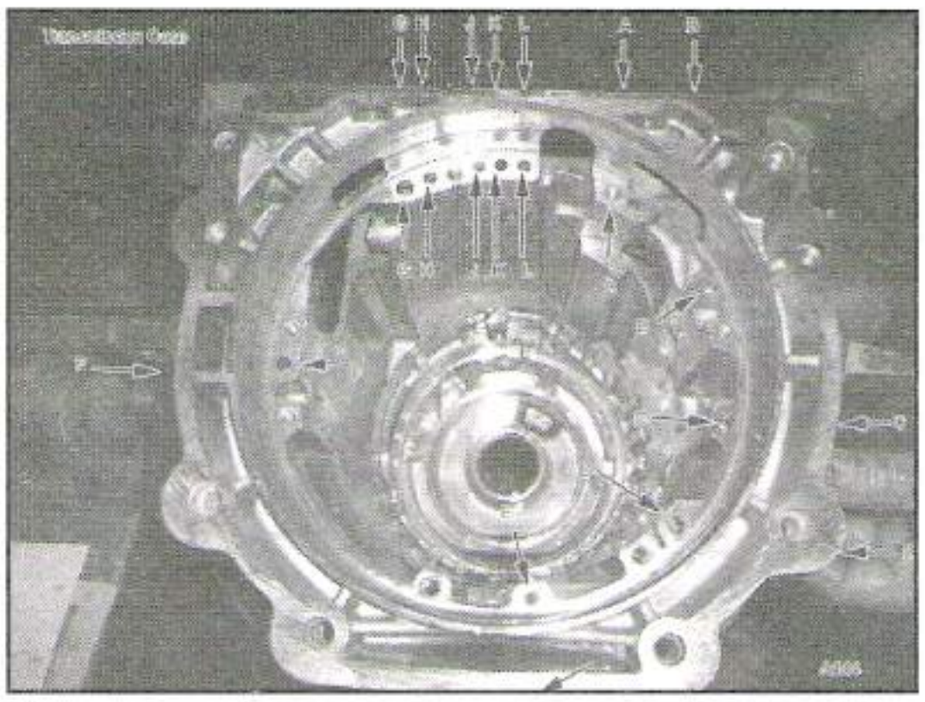
1. Wash parts in a solvent solution and air dry.
2. Inspect for any damage and foreign matter caught on components.
3. Inspect the speed sender unit and gear shift shaft bore for damage and foreign matter.
4. Check all components for cracks or distortion.
5. Blow low pressure air through the oil pump passages in the transmission case, to check for block oil passages.

Transmission Case Oil Passages Test.

Holes	Passage
A	Overrun clutch
B	Torque converter clutch signal
C	Pipe to trans fluid cooler
D	Pipe from trans fluid cooler
E	Vent pipe
F	Line pressure (also to G)
G	Line pressure (also to F)
H	Reverse input clutch
I	3-4 clutch
J	Torque signal
K	Forward clutch feed

6. Inspect 2-4 servo bore for damage or wear, foreign matter.

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7. Inspect 2-4 servo bore for damage or wear, foreign matter.
8. Inspect case rear shaft bushing, if warn replace.

Component Inspection.

3rd Accumulator Retainer and Ball Assembly

1. Inspect ball for rough surface, dirty, foreign matter.
2. Retainer not fitting correctly.
3. Feed passages contaminated and damaged.
4. Inspect that 3rd accumulator ball is effective (inspect for leakage past ball).
a) Install the assembled 2-4 servo components, cover and retaining ring, into 2-4 servo bore.
b) Check for solvent leaks into other than from servo plug.
c) if leakage comes from the 3rd accumulator ball assembly, replace the ball assembly by using an easyout (6.3mm). Install a new 3rd accumulator assembly into the case. The oil feed slots must align with the case, use a 9.5mm dia rod marked at 42mm to tape home the ball assembly.

Low and Reverse Clutch Assembly and Plates



1. Remove the piston "O" ring seals.
Tip: These "O" rings are to be replaced with new "O" rings, but check for damaged, this may help solve a problem.
2. Wash piston in a solvent solution and air dry, inspect for any damage and foreign matter.
3. Inspect spring for damage and out of alignment.
4. Inspect plates for damage and wear. Any showing signs of delamination or heat damage replace.
Tip: It wise to replace plates with a new set if any worm or damage to some plates.
5. Measure plates for spacer plate, use a flat bench top stack plates as they assembled in the transmission, starting with the wave plate.
a) Place a flat light weight (2.0 kilo) on top of the plates.
b) Measure the height of the plates to determine the spacer plate to used from the chart below.
Note: The height of the plates and spacer plate must be between 29.22 to 29.90mm high.

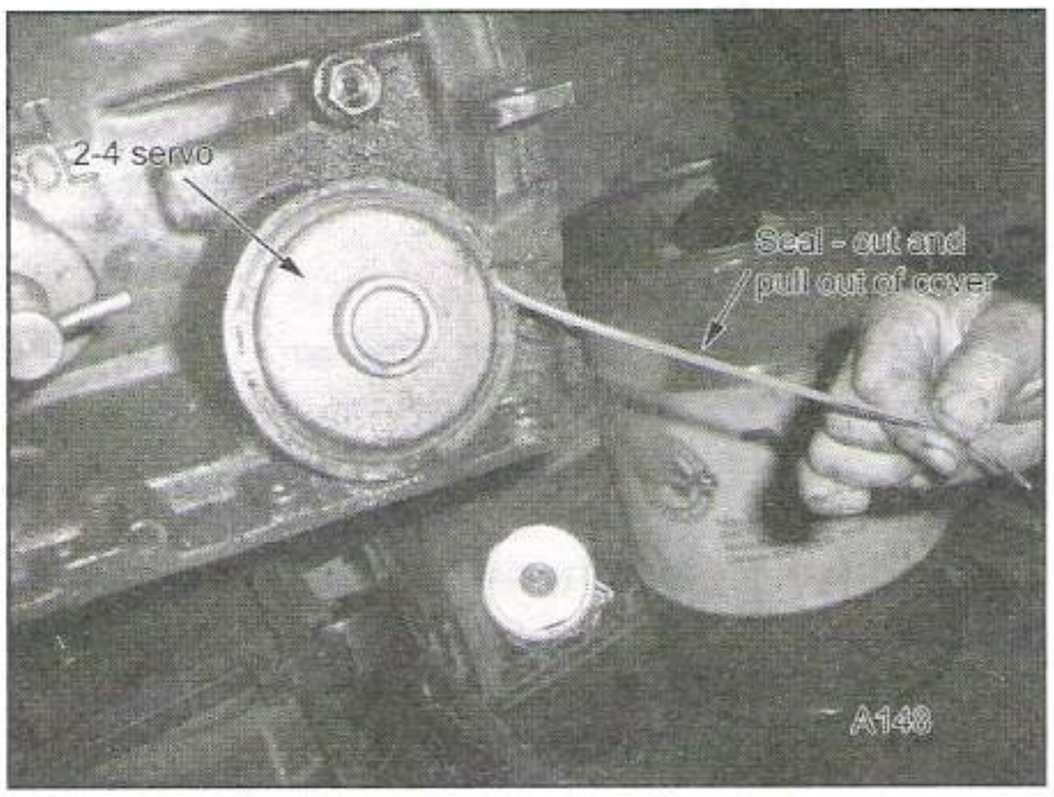
Plate height	Spacer plate ID	Spacer thickness
27.026-27.544mm	1	2.198-2.344mm
27.545-28.065mm	None	1.684-1.829mm
28.066-28.586mm	0	1.168-1.314mm

6. Install the spacer plate between the wave plate and the first fibre laminated plate. The spacer ID to the top.

2-4 Servo

Remove

1. Push the servo cover in and remove the retaining circlip, remove cover and seal.
To remove seal, use a hook to prise out the seal, then cut it, then pull the seal out.



2. Remove piston assemblies and spring from the transmission.
Tip: the 4th apply piston may fall while taking cover off, if make sure the "O" ring groove is not damaged.
3. Separate the 4th (small piston) apply piston from the 2nd apply piston, it may be a loose fit.
4. Remove seals from both pistons.
5. Remove small piston/valve and spring.
5. Wash with a solvent solution and air dry, check for any faults.

Disassemble and Assemble

1. Remove small retaining clip, washer and spring.
2. Remove apply piston pin.

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3. Place a "G" clamp to the 2nd apply piston, remove the retaining ring.
4. Remove "G" clamp, remove cushion spring, tapered cushion spring (tapered cushion spring not fitted to V8 engine transmissions) and retainer

Inspection

1. Wash parts in a solvent solution and air dry.
2. Inspect for any damage and foreign matter caught on components.
3. Inspect the springs for broken sections or out of alignment.
4. Check all components for cracks or distortion.

Install

1. Fit new seals to both pistons and assemble the pistons together.
2. Install pistons and spring (spring first) into transmission.
3. Fit new seal to cover and install, push to allow retaining spring circlip to be fitted.

Reaction Internal Gear and Carrier

1. Inspect reaction internal gear and support to make sure they where correctly installed, check for damaged splines, teeth, and lugs.
2. Inspect bearings from damage: The reaction carrier and thrust bearing. Reaction gear support case bearing surface and thrust bearing.
3. Check the reaction carrier assembly.
a) Pinion excessive end play, end play to be 0.20 - 0.60mm.
b) Pinion teeth damage or wear.
c) Check for any roughness of the carrier assembly turning on its thrust bearing.
d) Replace as a unit if necessary.

Reaction Sun Gear and Shell

1. Check for damage to spline or teeth, loose spring ring. Removing the spring ring may damage spline and teeth so remove only if replacing.
2. Check shell and thrust washer for damage and wear, replace if necessary.

Sun Gear Bush

1. Check sun gear bushing for wear, if worn replace bush with tools to push bush out and new one in.

Input Internal Gear and Output Shaft

1. Remove spring ring to separate reaction carrier shaft and input internal gear.
2. Inspect components for wear, damaged teeth or cracks, if OK reassemble.
2. Check output shaft for worn sections, damaged spline or ring grooves. Replace if necessary.
Tip: Some burrs and at the rear extension seal can be polished off by using a crocus cloth.

Reaction Carrier Shaft Bushes

If bushes are worn.
1. The front bush can be replaced by using a bush remover and slide hammer to remove and bush installer to install new bush.
2. The rear bush can be driven out while the front bush is out and new bush driven in.

Transmission Speed Output Sensor Gear

1. Check for damage to teeth, replace if necessary.
2. Measure the exact distance from the end of the shaft to the gear.
3. Use a puller to puller gear from shaft.
4. Use a tool such as a neat fitting brass tube to hit gear into the exact measured position.

Input Carrier and Sun Gear

Inspect for damage and wear.
a) Pinion excessive end play, end play to be 0.20 - 0.60mm.
b) Pinion teeth damage or wear.
c) Check for any roughness of the pinion spinning.
d) Check carrier assembly by turning it on its thrust bearing.

Replace input sun gear bushes if required

Two bushes are located at either end of inner bore.
Use a driving shaft to press out both bushes, press two new bushes into original location.

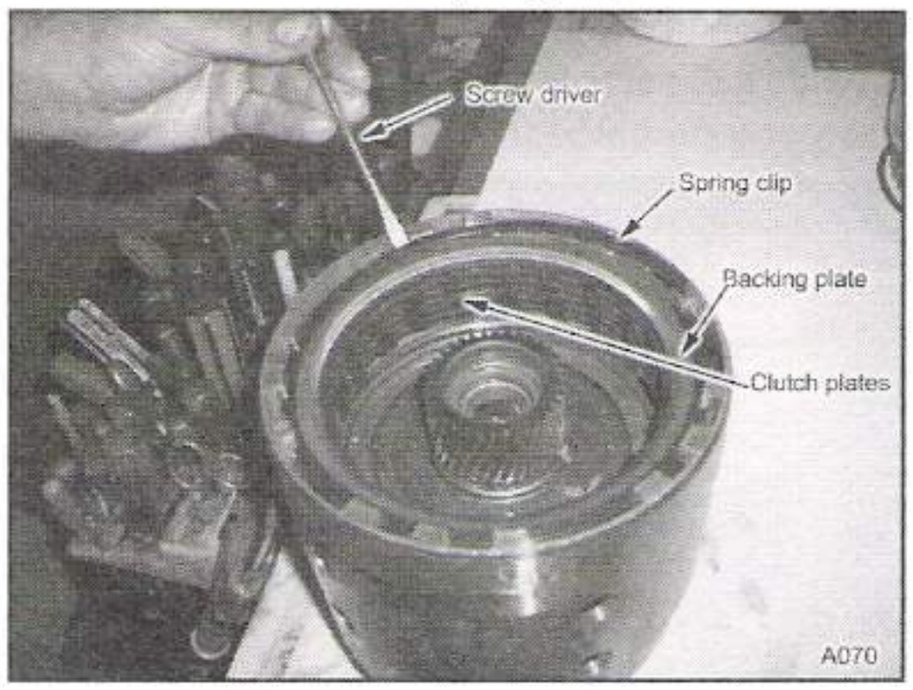
Input Clutch Housing Assembly

1. Remove the reverse input clutch housing drum from the



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input clutch shaft assembly.
2. Remove the thrust bearing and thrust washer.
Tip: Use a magnetic rod to lift thrust washer.
3. Install the input clutch housing in a suitable work bench.
Tip: Cut a hole into the top of the bench allowing the shaft to drop down into the hole.
4. Dismantle the input clutch housing assembly
a) Remove the 3-4 clutch plate retaining spring ring, use a screw driver to remove spring clip.



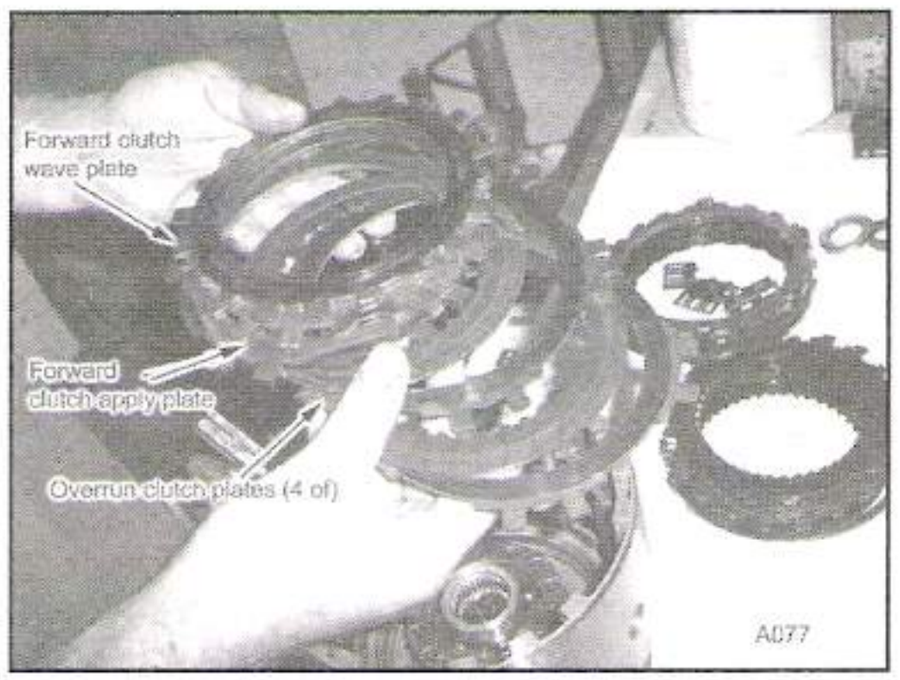
b) Remove the backing plate.
c) Remove the 3-4 clutch boost springs assemblies, 5 of.
d) Remove the 3-4 (11) clutch plates
e) Remove the 3-4 clutch apply plate.



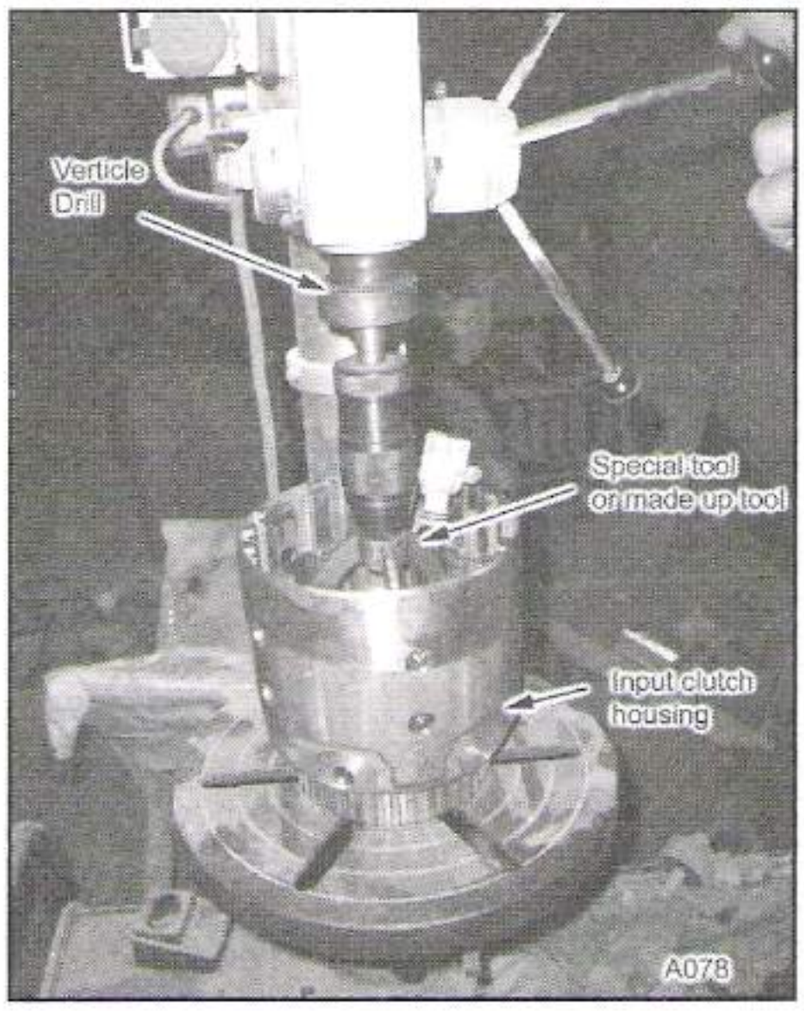
f) Remove the forward clutch backing plate retaining spring clip then the backing plate.
g) Remove the forward clutch sprag as an assembly.
Note: 1999 on models have the sprag retaining ring and input sungear are an assembly.



h) Remove input housing to output shaft seal.
i) Remove the forward clutch plates (10).
j) Remove forward clutch wave plate.
k) Remove the forward clutch apply plate.

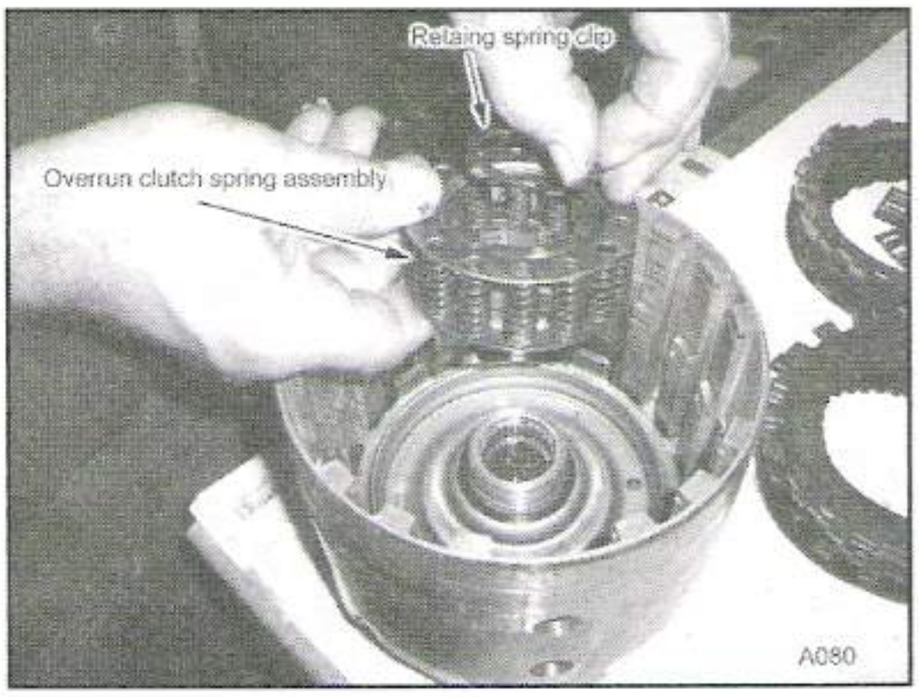


l) Remove overrun plates (4).
5. Use a special press to compress overrun clutch spring assembly to remove retaining spring clip.
Tip: Use a vertical drill as shown.

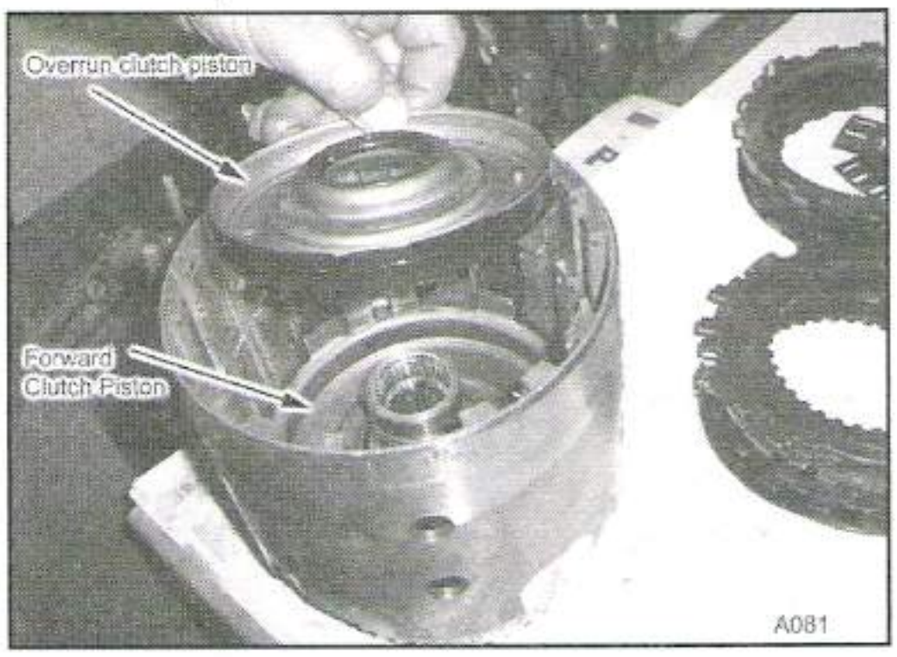


6. Remove overrun clutch spring assembly.

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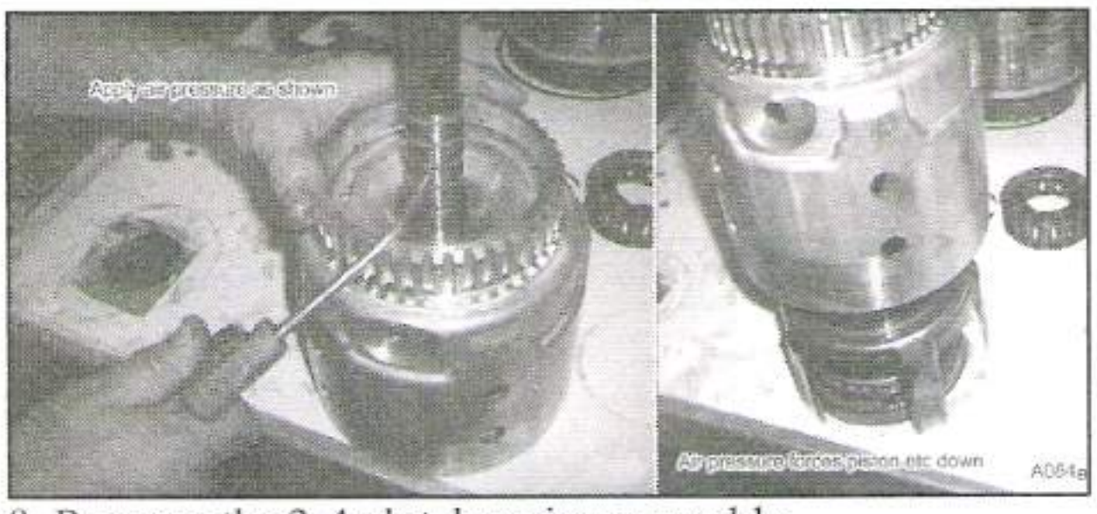


7. Remove the forward clutch piston assembly and the overrun clutch piston.

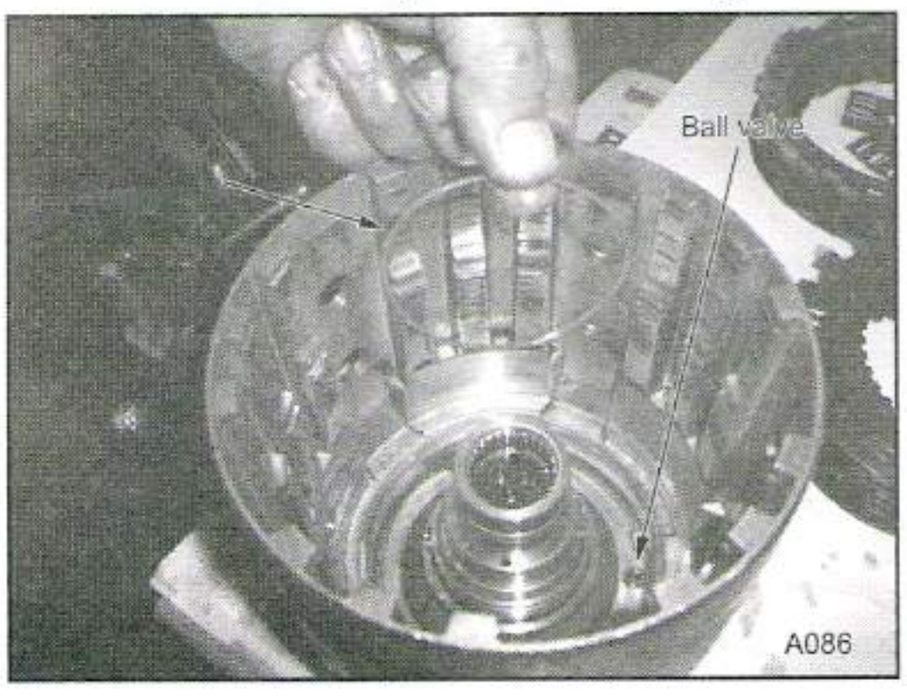


8. Remove the forward clutch housing.

Tip: Use air pressure as shown to help removing items in steps 8, 9 and 10.



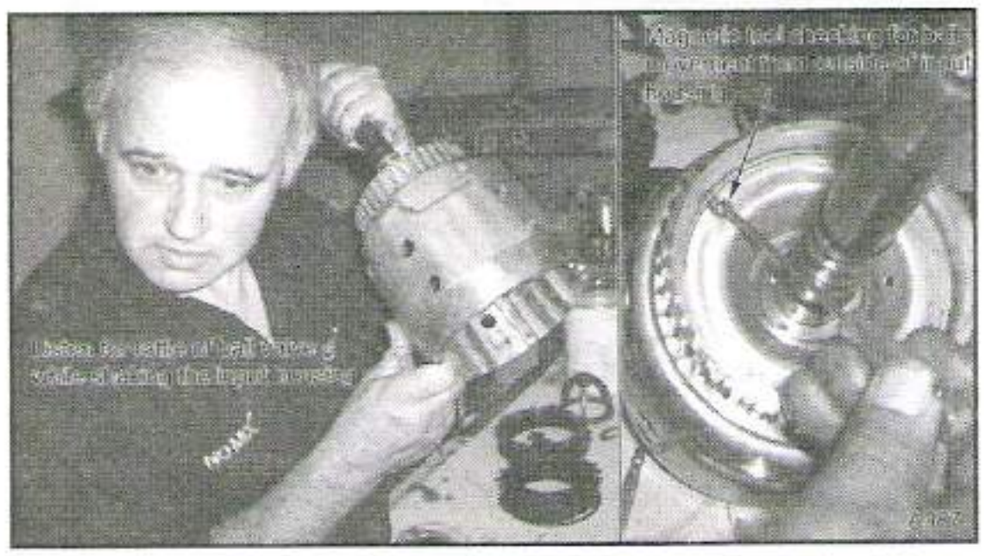
9. Remove the 3-4 clutch spring assembly.
10. Remove the 3-4 clutch apply ring and piston.
11. Remove seal from input clutch housing.



12. Remove and inspect all seals, checking for damage and potential problems.

Inspection of input clutch housing assembly parts

1. Inspect for damage and wear, cracks around hole openings, burrs on any edges. Pistons for porosity, ring grooves, general damage to piston.
2. Inspect springs for damage and out of alignment.
3. Inspect plates for damage and wear, any showing signs of delamination or heat damage replace, check plates lugs for burrs or bending.
4. Make sure ball valve is free, lift up input clutch housing and shake, you should hear it rattle, or use a magnetic tool



to see if the ball moves freely check it from inside and outside housing. It can be checked with solvent for leak test. Replace if necessary remove with 5.7mm (1/4") flat punch, install new check ball assembly, tape home as shown with 5.7mm flat punch.

5. Use air pressure to check 3 turbine shaft ball valves, they must not leak. Hole "A" is an open hole to the output shaft.
6. Orifice cup must be present.
7. Sealing rings on the turbine shaft must spin freely in grooves.
8. Inspect check ball moves freely, use air pressure to as shown to make sure ball moves freely. If not replace by bending out ball retaining lugs remove ball, use an easyout to remove retainer, insert new retainer and ball assembly and tape home 3.0mm below surface with a 9.5mm (3/8") flat punch.
9. Check overrun clutch piston, check inner and outer seals if damaged the piston assembly must be replaced, inspect check ball for free movement.
10. Input sun gear bearing and input housing to output shaft, seal for inspect damage and distortion.

Inspect Assembly

1. Forward sprag clutch.

a) Remove spring clip and overrun clutch hub. Inspect for damage, blocked holes, burrs.

b) Remove forward clutch and outer race. Inspect for damage, splines damaged, burrs and check on flat surface for outer race being flat.

c) Remove sprag retainer and race assembly. Inspect for damage, splines damaged, burrs and check on loose retainer.

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d) Remove sprag retainer rings. Inspect for damage, burrs and check for buckled ring.
e) Remove forward sprag assembly. Inspect for damage, broken or bent rings, burrs and check for missing retaining caps.
Assemble forward sprag clutch assembly.
f) Install the forward sprag assembly into the forward clutch outer assembly.
g) Install a sprag retaining ring and race hub, hold the outer race, recessed surface to the palm of your hand, install retaining ring and race hub from top side, push in and turn anticlockwise.
Note: 1999 on models have the sprag retaining ring and input sungear are an assembly.
h) Install remaining sprag retaining ring (recessed section facing in to sprag).
i) Install overrun clutch hub and retaining spring clip.
Tip: Check assembly so far, position with overrun clutch hub facing up. Overrun clutch hub should turn clockwise and lock when turned anticlockwise.
2. Place input housing on a stand vertically, shaft facing down.
3. **3-4 clutch assembly.**
a) Install a new "O" ring covered in petroleum jelly.
b) New piston inner and outer seal lids to be lubricated.
c) Install 3-4 clutch spring on the 5 pronged 3-4 clutch apply ring.
d) Lubricate the bonded seals on the forward clutch piston, and install into forward clutch housing.
e) Install forward clutch assembly onto 3-4 clutch spring assembly, have the tabs on the forward clutch piston located between the 3-4 clutch apply ring prongs.
f) Temporary install the forward clutch backing plate retaining ring to secure the assembly of the components.
4. Use tool J29883 (sleeve) lubricated, onto input housing.
5. Install 3-4 clutch apply ring / forward clutch assembly into housing and shaft. The forward clutch piston must not separate from the forward clutch housing. Push down on forward clutch assembly, make sure the forward clutch housing is over the "O' ring. This procedure may take some manipulating.
6. Remove special tool J29883 and temporary installed forward clutch backing plate retaining ring.
7. Overrun clutch assembly.
a) Use tool J29883 (sleeve) lubricated, onto input housing.
b) Use petroleum jelly to lubricate the overrun clutch piston inner and outer bonded seals, install piston with hub recess facing up. Remove tool J29883.
Tip: If all components are correctly assembled, overrun piston hub is approx 3mm under spring clip ring groove in input housing hub.
c) Install overrun clutch spring into overrun clutch piston.
8. Install (protection plate tools - J23327 and J25018) use press to compress input housing and shaft assembly.
9. Install spring clip ring, release from press and remove (protection plate tools - J23327 and J25018).
10. Install a new output shaft seal into input housing, lip at top.
11. Install overrun clutch plates, after they have been coated with automatic transmission fluid. Install as shown, steel, composite, steel composite.
Large tab must fit into large groove.
12. Install thrust bearing, apply some petroleum jelly.
13. Align the overrun clutch plate inner tabs.
14. Install and position the forward clutch sprag assembly into the input housing, locating overrun clutch hub into overrun clutch plates.
15. **Forward Clutch Pack**
a) Install forward clutch apply plate to the input clutch housing, note location.
b) Install wave plate to the input clutch housing as shown.
c) Install forward clutch plates, after they have been coated with automatic transmission fluid. Install as shown, steel, composite, steel composite and so on.
d) Install backing plate to the input clutch housing as shown.
e) b) Install retaining spring clip ring.
f) Measure clearance between backing plate and retaining spring clip ring with 2 feeler gauges. clearance gap specification 0.75 to 1.60mm, if not install a new backing plate, see chart.

Forward clutch Backing Plate Chart

Identification	Thickness
A	6.97-7.07
B	6.38-6.48
C	5.79-5.89
D	5.20-5.30
E	4.61-4.71

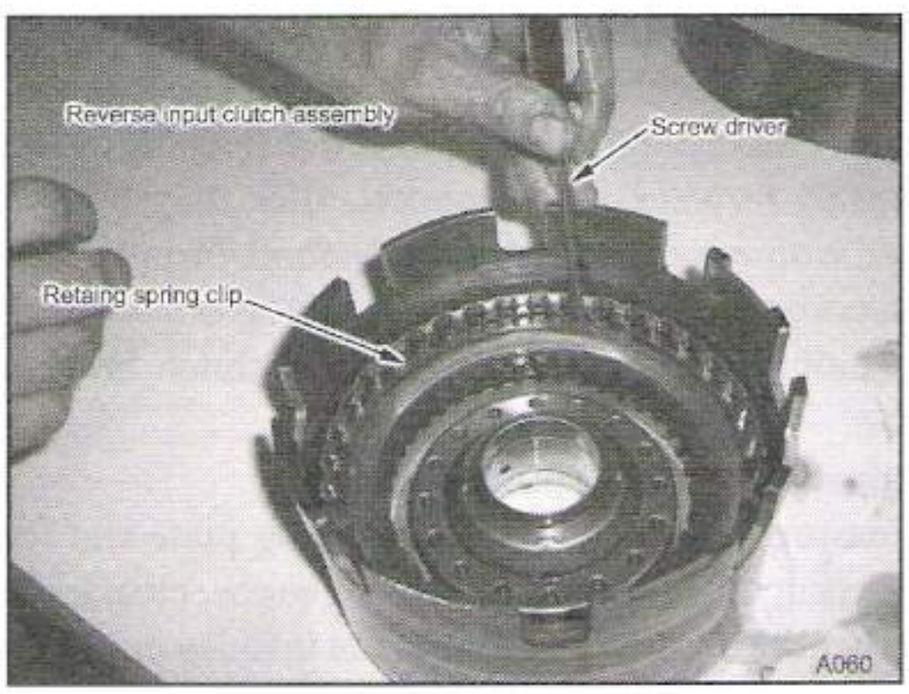
Input Clutch Housing Air Checks
Apply low pressure compressed air to hole shown while holding finger over other hole to test if the overrun clutch applies.
Apply low pressure compressed air to hole shown while holding finger over other hole to test if the 3-4 clutch applies.
If any of the tests fail, disassemble and check again.
16. Install turbine shaft seals, slide seals "O" rings onto shaft and slide down with special tool, remove tool then rings can be sized by placing another special tool (J36418-2A) on shaft and over "O" rings, leave tool on shaft until assembly.

Reverse Input Clutch Assembly
1. Remove backing plate retaining spring clip and backing plate.

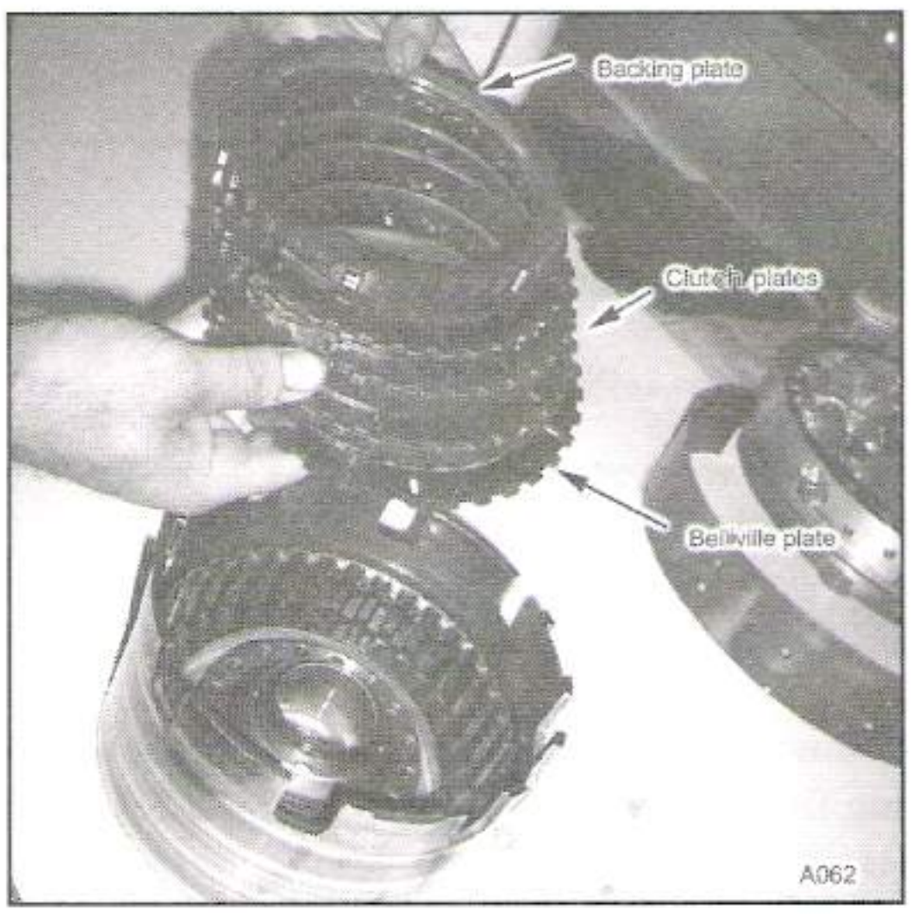
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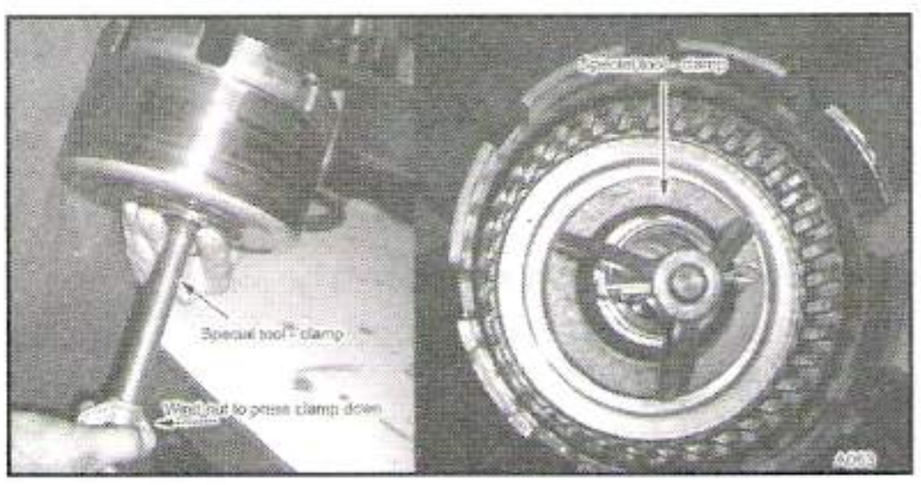
Use screw driver to lever retaining spring clip from drum.



2. Remove clutch plates including the belleville plate.



3. Install (protection plate tools - J23327 and J25018-A) and use press to compress reverse input clutch spring





assembly.

Remove spring clip ring. Remove special tools.

4. Remove piston and seals.

Inspect

1. Inspect for damage and wear, burrs on any edges. Pistons for porosity, ring grooves, general damage to piston.
2. Inspect springs for damage and out of alignment.
3. Inspect plates for damage and wear, any showing signs of delamination or heat damage replace, check plates lugs for burrs or bending.
4. Inspect spring for damage and out of alignment.
5. Inspect the drum surface for flatness, if bulged out or worn groove, drum must be replaced.



Replace reverse input clutch housing bushes if required

Two bushes are located at either end of inner bore.

Use a bush remover with a slide hammer to remove first one, use a shaft to press out other bush, press two new bushes into original location.

Assemble

1. Clean and lubricate piston install 2 new piston seals, lubricated with petroleum jelly.
2. Position plastic protection film 0.01mm thick half way around hub, coat with petroleum jelly.
3. Install piston make sure the seal lips are correct way, install piston side away from plastic first, once piston is in place remove plastic.
4. Install spring., large opening facing up, compress spring down to enable spring assembly retaining spring clip to be installed. Use (protection plate tools - J23327 and J25018-

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A) and use press to compress reverse input clutch spring assembly.
5. Install reverse input clutch plates, after they have been coated with automatic transmission fluid. Install as shown, belleville plate, steel, composite, steel composite.
6. Install backing plate to the reverse input clutch housing, chamfered section facing up, install backing plate retaining spring ring.
7. Measure clearance between backing plate and retaining spring clip ring with 2 feeler gauges, with approximately 10 kg. Load to backing plate, clearance gap specification 1.02 to 1.95mm, if not install a new backing plate, see chart.

Reverse Input Clutch Backing Plate Chart

Identification	Thickness
2	7.249-7.409
3	6.519-6.678
4	5.787-5.947

Reverse Input Clutch Air Checks
Apply low pressure compressed air to hole shown while the drum assembly and thrust washer are on the inverted pump assembly. See if the clutch piston moves, if not try extra air pressure before dismantle and rechecking.

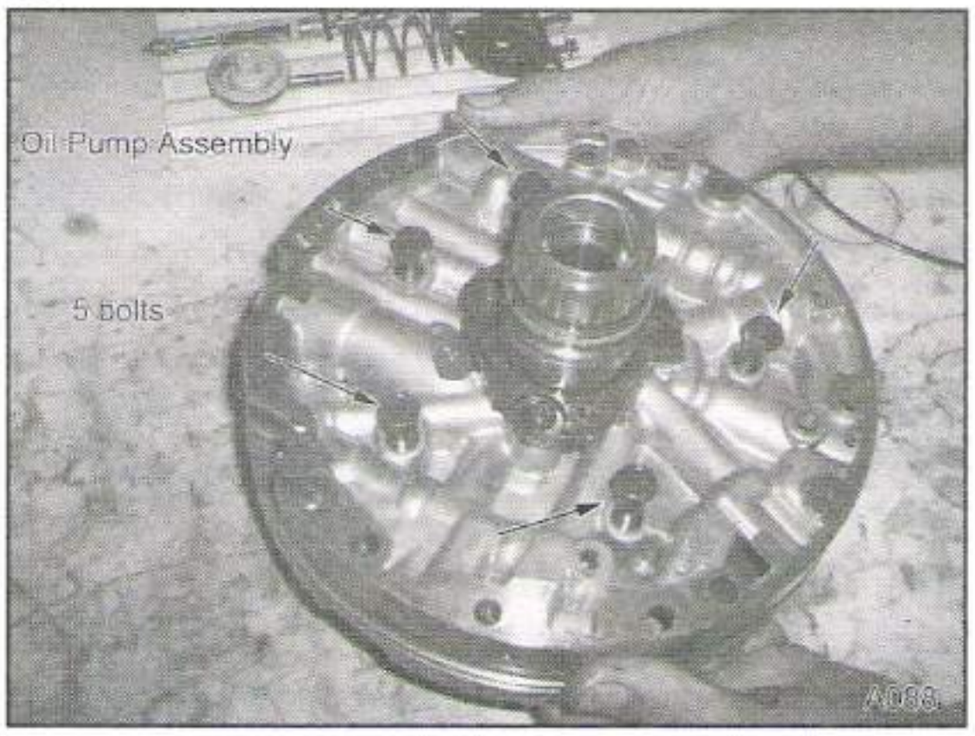
2-4 Band.

Inspection
Inspect band for damage and wear, any sign of delamination or heat damage replace, check edges for burrs or bending.

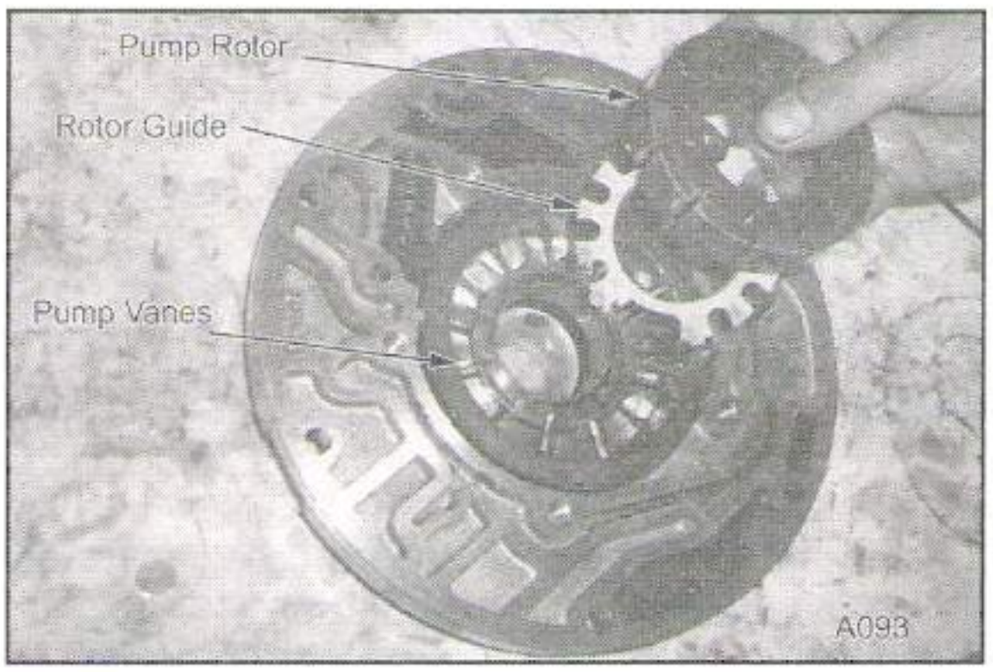
Oil Pump

Note: 1999 production a different pump filter screen is used, it has coarser screen to help the flow of cold transmission fluid. It must be used on all 1999 and later transmissions.

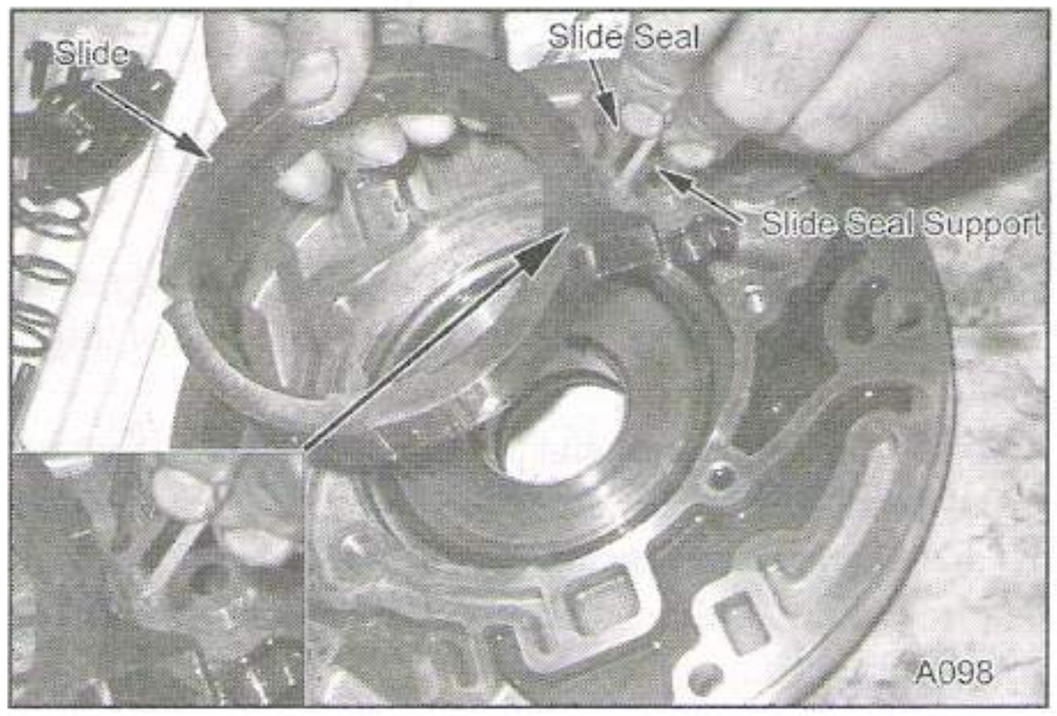
Dismantle
1. Place oil pump on a bench with the stator shaft through a hole.
2. Remove the thrust washer from the reverse input drum and "O" ring (cut O ring to remove) seal. from the pump side.



3. Remove the pump cover from pump body. 5 bolts.
4. Remove the "O" ring seal. from the pump side.
5. Remove from pump:



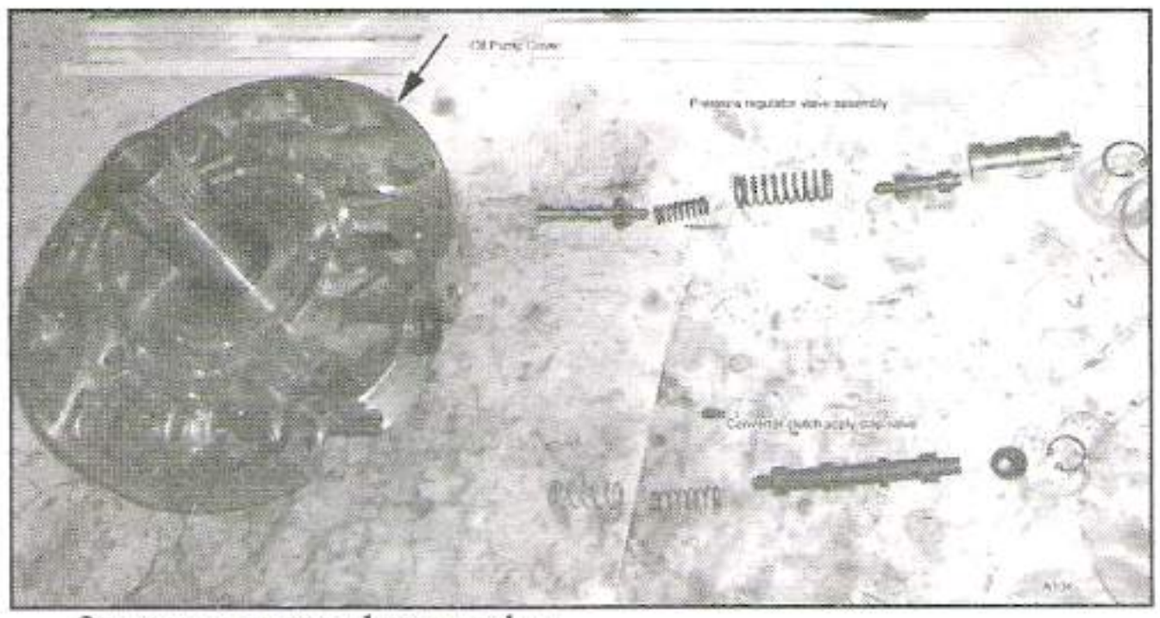
a) Guide ring.
b) Pump rotor, guide ring under pump.
c) Remove pump vanes.
Tip: Take note of which side of vanes is to the pump body.
If you look closely you can see worn edge.
d) Remove pump vane guide ring.
6. Push down on the slide spring assembly remove, use a screw driver to lever out. Take care as spring may catapult out.
7. Remove slide assembly
a) Remove pivot slide pin with a magnetic rod.
b) Remove slide, slide seal and slide seal support.



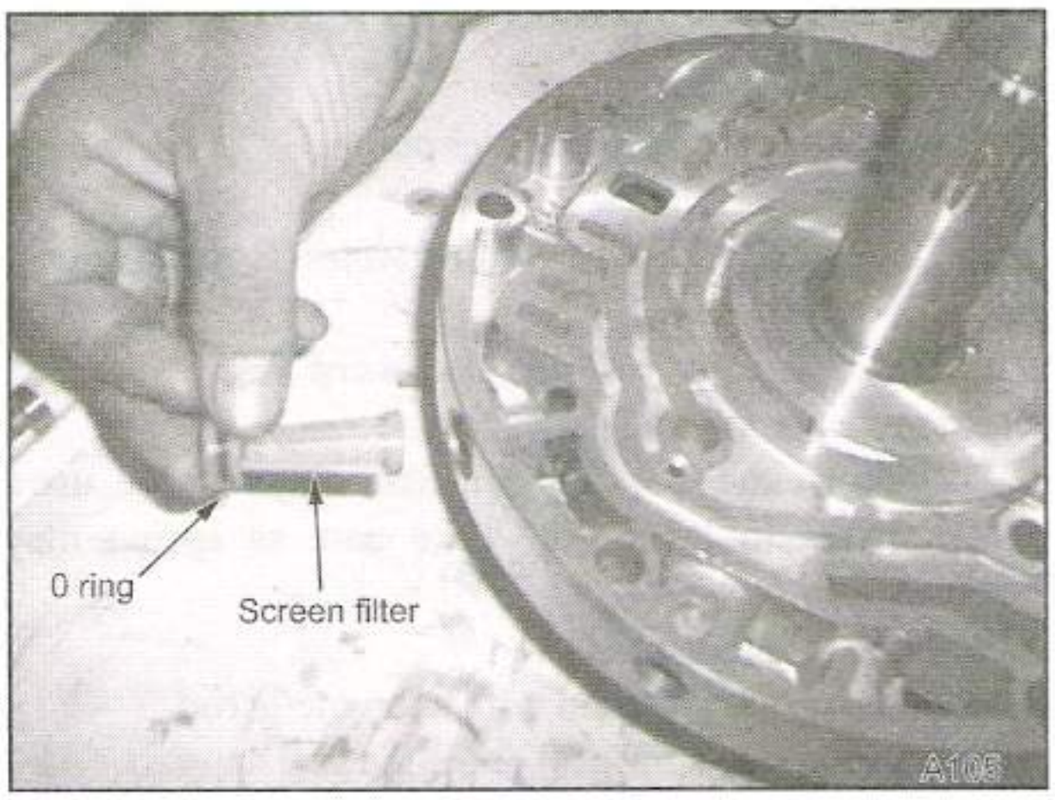
c) Remove slide seal ring and slide seal back-up ring.
d) Remove the slide pivot pin spring with a magnetic rod. pin and back-up seal
8. Remove the helix seal and oil sea from front of oil pump.

Oil Pump Cover
1. Remove the 2 stator seals from the oil pump cover.
2. Push down on the converter clutch apply stop valve with a screw driver, and remove circlip. Release spring carefully. Remove the stop valve, converter clutch apply valve, 2 springs.
3. Push down on the pressure regulator valve with a screw driver, and remove circlip. Release spring carefully. Remove the reverse boost valve sleeve, reverse boost valve,

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2 pressure regulator valve.
4. Remove the pressure release pin, spring and ball.
5. With pointy nose pliers or a screw driver, remove the screen filter and "O" ring from the cover.



Note: 1999 on revised screen fitted, use revised screen on all 1999 on transmissions.

Inspect

1. Wash parts in a solvent solution and air dry.
2. Inspect for damage and wear, burrs on any edges.
3. Inspect valves, springs for damage and out of alignment.
4. Inspect pump rotor and slide for damage, if undue grooves and burrs, check the rotor and slide have the same ID size marks, if not install correct matching ID sizes. The rotor and slide can be carefully honed to remove rough surfaces.

Oil Pump Cover Bush

Inspect bush for damage, replace if necessary.

Remove

Use a press and adapter the correct size (tool J41778-1) to press the pump cavity body bush out.

Install

Use a flat steel plate the correct diameter to use as a bush stop positioned under the pump cavity body, this positions the bush to the correct depth. Press the bush into place with an adapter to the press (tool J41778-1).

Pump Cover Stator Shaft Bushes

Remove

Use a slide hammer and bush removing tool to remove the front stator shaft bush.
Turn the pump cover over to remove the rear stator shaft bush using the same tools.

Install

Use a bush insertion tool the correct diameter (J21465-2) and a press to install front bush, from the front side. Turn pump over to install the rear bush using the same tool and press.

Assemble Oil Pump.

1. Install a new front seal and the seal retainer.
2. Turn pump cover over, coat with petroleum jelly and install a new slide seal backup "O" ring and support ring.
3. Fit the pump slide, align notch and pivot pin hole, install slide seal support and seal into the notch on the pump side. Install the pivot pin spring and pin into position.
4. Compress both slide springs and install, use a feeler gauge blade or flat screw driver to assist in installing springs.

Springs can spring out of pump body, protect yourself.

5. Install the lower valve guide rings into place.
Coat rotor guide with petroleum jelly and install. Install rotor, then rotor vanes, vanes to have wear marks facing the same way as when dismantled (worn surface to pump body - slide).
Install rotor vane guide ring.
6. Assemble pump cover,
a) Place inner and outer springs onto the stem of the converter clutch apply valve and reinstall with valve stop and retaining cir-clip into its groove.
b) Install pressure regulator valve and springs, into oil pump cover. Then assemble the reverse boost valve into the reverse boost valve sleeve, position these into the same bore, compress in and install the retaining cir-clip into groove.
c) Install the pressure relief ball, spring and pin into pump cover.
d) Install cover filter screen and new seal.
e) Install new solid stator shaft oil seals, use an expander, then a sizing tool once seals are in place, leave tool in position until assembly.

Note: If the seals are not compressed and left compressed for sometime before assembly, the seal will be damaged, and it is virtually impossible to assemble.

7. Use a frame to hold the pump body assembly, fit the pump cover to the body, and install the 5 cover bolts finger tight. Align the cover to pump with the aid of a band clamp, do not over tighten. Tighten the 5 cover to pump bolts to specification.

Pump Cover to Body bolt specification: 20-27Nm.

Assemble Transmission

Manual Shaft and Parking

1. Install a ne w manual shaft linkage seal, lubricate with

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transmission fluid and seat correctly with a socket and hammer.

2. Connect the parking pawl actuator to the inner detent lever.

3. Install manual shaft lever, fitting the inner detent lever over the machined section of the shaft. Install shaft nut and tighten to specification.

Manual Shaft Inner Detent Lever Nut: 27-34Nm

4. Replace the manual shaft retainer clip over shaft.

Low and Reverse Clutch Piston

5. Fit new low and reverse piston seals, lubricate the seals with transmission fluid.

6. Install low and reverse piston align piston notch with notch in case. Install clutch spring assembly, flat side facing up, clamp spring assembly down to fit retaining circlip then remove clamp.

7. Install parking pawl and return spring in transmission case. Install parking pawl pivot shaft, make sure it moves freely.

8. Apply sealant (loctite 242) to plug tap home with a hammer and punch.

9. Install park pawl bracket, bolts.

Park Pawl Bracket Bolt: 27-34Nm

Reaction Planetary Gear Set

10. Replace the reaction internal gear bearing, case section into trans case, hold with petroleum jelly. Install the reaction internal gear and thrust bearing.

11. Install the reaction carrier assembly onto thrust bearing.

Low and Reverse Clutch Plates

12. Install the low and reverse clutch plates in the order they where removed.

Plate order: Wave plate, selective plate (as per previous instructions), - composition plate, turbulator steel plate.

Place all composite plates in transmission fluid prior to assembly.

Install plates with notch as shown.

13. Coat the spring with petroleum jelly, and install into the curved section of the transmission case.

14. Install low and reverse roller clutch assembly to the cam and support, fit both retaining spring circlips. Install inner low and reverse clutch race by pushing down and turning anticlockwise.

15. Lift the low and reverse roller clutch inner race up from its normally down position, this will help it grip the support assembly as you install the support assembly. Fit the assembly into transmission with hub facing down, align lug with lug groove in case.

16. Fit inner race into roller assembly, twist and push down until fully seated, check that inner race will turn clockwise freely. Fit small retaining spring between case and case lug and open notch in low and reverse clutch support. Fit retaining ring into transmission case.

Tip: Apply air pressure to duct, low and reverse piston should moved when looked at from the parking pawl position.

Reaction Gear, Input Gear and Output Shaft

17. Install the reaction sun gear and new retaining ring into reaction carrier (helical gear side down), check that gears mesh properly.

18. Install thrust washer into transmission case, make sure the lugs on the thrust washer face down and fit into the inner race of the low and reverse roller clutch.

19. Install bronze thrust washer into reaction sun shell, apply petroleum, the tangs on the thrust washer must go into the holes of the reaction sun shell.

20. Install the reaction sun shell into the transmission onto thrust washer, shell goes over reaction sungear.

21. Install thrust bearing onto reaction carrier shaft, outer section to reaction carrier shaft. Push down and turn to allow the splines of the reaction carrier shaft to align with the splines on the reaction carrier assembly.

23. Install the input carrier into transmission, turn forward and back to align gears and teeth.

24. Install the output shaft, support the end of the shaft with a tool box or home made bracket so it will not fall out. Place the input carrier onto output shaft, then expanding retaining circlip onto the output shaft.

#Tip: Do not over expand circlip, otherwise it may partially expand permanently.

25. Pre 1999 transmissions: Fit input sun gear into input carrier, meshing sun gear into pinion gear.

Note: 1999 on models have the sprag retaining ring and input sungear are an assembly.

Reverse Input clutch, Input Clutch and Input Gear Set

26. Fit end play adjusting thrust washer and bearing on input housing and shaft.

This thrust washer determines the input shaft end play.

#: Inside bearing race upwards (black colour).

Front Input Shaft End Play Thrust Washer

ID Mark	Thrust Washer Thickness
67	1.87-1.97
68	2.04-2.14
69	2.21-2.31
70	2.38-2.48
71	2.55-2.65
72	2.72-2.82
73	2.89-2.99
74	3.06-3.16

Install reverse input clutch assembly onto input housing and shaft assembly, check that lugs align with housing hub. Check that reverse input clutch plate tangs are aligned.

27. Slide reverse input and input clutch assembly with all clutch lugs over internal gear into transmission, when correct the reverse input housing is located below oil pump, machined surface in transmission case.

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The reverse input clutch and reaction sun gear will have around 3.8 mm clearance.

2-4 Band

Replace band if the band material is badly scoured or well worn.

Tip: Turn transmission upside down on bench so oil pan position is upmost.

28. Fit the anchor pin for 2-4 band and the band into transmission. Ensure the pin is fully installed into the band assembly.

Oil Pump

29. Fitting a new gasket and seal to transmission, install temporary guide pins to case.

30. Install the oil pump with thrust washer (apply petroleum jelly to washer. Remove temporary guide pins to fit last 2 bolts,

Tighten bolts around the oil pump, to specified torque. Make sure the input shaft will turn.

Oil Pump bolts torque specification: 20-27Nm

Input shaft must be able to turn by hand, if not dismantle and check assembly, check for thrust washer misaligned.

31. Install torque converter housing to transmission and bolts tighten to specification.

Torque Converter Housing (50+ Torx): 72-78Nm

32. Check end play of input shaft for specified clearance, if not within specification, rectify by installing different end play adjusting thrust washer in chart above.

Input Shaft End Play clearance: 0.13-0.92mm

33. Install the torque converter onto input shaft, after fitting a new "O" ring onto input shaft just below spline.

Tip: Input shafts for V8 and V6 are different, check illustration.

PROBLEM SOLVING AND DIAGNOSIS

Preliminary Checks

When diagnosing transmission problems, first refer to the diagnosis guide for detailed information of the items that could be causing the problem. The following preliminary checks should be made in the order listed.

Check fluid level, check fluid for a burnt clutch plate odour. Check the manual linkage adjustment. Check the accelerator pedal height and down shift linkage.

Check the throttle linkage to make sure of wide open throttle operation, check the engine for proper operation.

Fluid Level Check

Make sure that the vehicle is standing level. Run engine at normal idle speed until the fluid reaches its normal operating temperature.

Clean all dirt from the transmission fluid dipstick cap before removing the dipstick from the filler tube. Remove the dipstick, wipe it clean, and place it to one side.

Shift the selector lever through all positions then place the lever at `P'. Switch off engine. Immediately insert the dipstick all the way into the filler tube then withdraw it and check the fluid level. This Operation Must Be Completed Within 10 Seconds of Engine Switch Off.

If required, add fluid to the transmission through filler tube to raise the fluid level to the `F' (full) mark on the dipstick. Recheck fluid level. Don't Overfill the Transmission.

If it is required to check fluid level when the transmission is cold, when the level should be on `Add' mark, otherwise it will be too high at normal operating temperature when the fluid has expanded. Recheck the level when the gearbox is at normal running temperature.

If the fluid level is to high this will cause the fluid to become more aerated. Aerated fluid will cause low control pressure, and the aerated fluid may be forced out the vent.

Low fluid level can effect the operation of the transmission and may indicate fluid leaks that could cause transmission damage.

Incorrect transmission fluid level can also have the following effects, although they may be attributable to other malfunctions:-

a. No drive in `D', `1', `2' or `R'.

b. Slip and squawk or shudder on full throttle starts in `D' , `1', `2', or `R'.

c. Overheating due to high fluid level during sustained high speeds.

Fluid Leakage Checks

Check speedometer transducer installation at the transmission. Leakage at the oil pan gasket often can be stopped by tightening the attaching bolts to the proper torque. If required, replace gasket. Check fluid filler tube connection at the transmission. If the filler tube O-ring seal is leaking, replace seal.

The transmission fluid is water cooled; check fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear or damage. If leakage can't be stopped by tightening a fitting, replace defective parts.

Check engine coolant in radiator. If transmission fluid is present in coolant, the cooler in the radiator tank is probably leaking.

The cooler can be further checked for leaks by disconnecting the lines at the cooler fitting and apply 500 kPa maximum air pressure to the fittings. The radiator cap must be removed when making this check to relieve the pressure on the exterior side of the cooler. If the cooler is leaking and will not hold this pressure the radiator must be replaced. The cooler can't be replaced separately.

Leakage in the extension housing area may be caused by a worn extension housing bush, seal, drive shaft yoke or the housing to case gasket.

If leakage is found at the manual lever shaft, replace seals that are leaking.

The pressure port plug on the left of the case must also be

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inspected.
Fluid leakage from the converter housing may be caused by engine oil leaking past the rear main bearing or from oil gallery plugs. Be sure to determine the exact cause of the leak.

Fluid Leakage Converter Area

In diagnosing and correcting fluid leaks in the front pump and converter area, use the following operations to assist in locating the exact cause of leakage.
Leakage at the front of the transmission, as evidenced by fluid around the converter housing, may have several sources. By observing it is possible in many instances to pinpoint the source of the leak before removing the transmission from the vehicle.
* Remove converter lower housing cover. Clean off any fluid from the top and bottom of the converter housing, front of the transmission case, and rear face of the engine and engine oil pan. Clean the converter area by washing with suitable nonflammable solvent, and blow dry with compressed air.
* Wash out the converter and front of the flywheel. Blow all washed areas dry with compressed air.
* Run engine until transmission reaches its normal operating temperature. Raise car and run engine at fast idle, then at engine idle, occasionally shifting to drive and reverse ranges to increase pressures within the transmission. Run engine until fluid leakage is evident and the probable source of leakage can be determined.

Manual Linkage Check

Correct manual linkage adjustment is necessary to position the manual valve for proper fluid pressure direction to the different transmission components. Improperly adjusted manual linkage may cause subsequent transmission failure.

Road Test Procedures

Test 1

Check that the starter only operates with the selector in `P' and `N' and that the reversing light only operates in `R'.

Test 2

Apply brakes and, engine idling, select N-D, N-1, N-2, N-R. Transmission engagement should be felt in each position selected.

Test 3

Examine converter stall speed with transmission in `1' after connecting a tachometer to the engine and applying the hand brake. Allow engine and transmission to reach normal operating temperature and then momentarily depress kick-down position, noting the tachometer reading. Don't stall for more than five seconds, otherwise the transmission will overheat.
Check for slip or clutch squawks.

Test 4

With transmission at normal operating temperature, select `D', release the brakes and accelerate with minimum throttle opening checking for 1st to 2nd and 2nd to 3rd changes. At minimum throttle openings the changes may be difficult to detect. To confirm that the transmission is in third gear, select `2' when a 3rd to 2nd change should be felt.

Test 5

Part Throttle Downshift in "D"

At 70-90 km/h in 4th gear, depress the accelerator to the `kick-down' position where transmission should change to 3rd.

Full Throttle Downshift in "D"

* At 70-90 km/h in 4th gear, depress the accelerator to the `kick-down' position where transmission should change from 4th to 2nd.
* At 30 km/h in 3rd gear, depress accelerator to full throttle position. The transmission should change to 1st gear.

Manual Downshift

In "D" accelerate from stop to 40 km/h, shifts 1-2 and 2-3 at low throttle. Foot off the accelerator, manually change to "1st" gear.
Check engine immediately changes to 1st gear.

Test 6

* Stop vehicle, re-start using full throttle acceleration. Check change speeds for 1st to 2nd and 2nd to 3rd: refer shift speed chart in specifications.
* At 65 km/h in 3rd gear, release accelerator.

Check for 3rd to 2nd change and engine braking. Check that the 2nd to 1st change occurs below 30 km/h and for engine braking.

Test 7

Stop vehicle with "1" engaged, release brakes, using full throttle accelerate to 30 km/h (20 mph)). Check for slip and clutch squawk, and no upward changes.

Test 8

Stop and select `R'. Release brakes, using full throttle if possible. Check slip or clutch squawk.

Test 9

Stop vehicle facing downhill with brakes and select `P'. Release brakes and check that the parking pawl holds the vehicle. Apply brakes before disengaging the parking pawl. Repeat with vehicle facing uphill.

Upshift Chart

MODEL- HFD (V6)
Upshift speed chart in power mode

Gear Change	Throttle	Km/h
1-2	Minimum Throttle	20.9
2-3	Minimum Throttle	35.4
3-4	Minimum Throttle	88.5

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Gear Change	Throttle	Km/h
1-2	50% Throttle	51.5
2-3	50% Throttle	91.7
3-4	50% Throttle	205.3

Gear Change	Throttle	Km/h
1-2	100% Throttle	66.8
2-3	100% Throttle	123.1
3-4	100% Throttle	205.3

MODEL- HBD

Upshift speed chart in power mode

Gear Change	Throttle	Km/h
1-2	Minimum Throttle	21.0
2-3	Minimum Throttle	33.8
3-4	Minimum Throttle	88.5

Gear Change	Throttle	Km/h
1-2	50% Throttle	50.0
2-3	50% Throttle	80.5
3-4	50% Throttle	185.1

Gear Change	Throttle	Km/h
1-2	100% Throttle	61.2
2-3	100% Throttle	115.9
3-4	100% Throttle	185.1

Downshift Chart

MODEL- HFD (V6)

Downshift speed chart in power mode

Gear Change	Throttle	Km/h
Gear Change	Throttle	Km/h
4-3	Minimum Throttle	78.9
3-2	Minimum Throttle	32.2
2-1	Minimum Throttle	17.9

Gear Change	Throttle	Km/h
4-3	50% Throttle	96.6
3-2	50% Throttle	61.2
2-1	50% Throttle	17.9

Gear Change	Throttle	Km/h
4-3	100% Throttle	204.5
3-2	100% Throttle	114.3
2-1	100% Throttle	45.9

MODEL- HBD (V8)

Upshift speed chart in power mode

Gear Change	Throttle	Km/h
4-3	Minimum Throttle	78.9
3-2	Minimum Throttle	19.3
2-1	Minimum Throttle	17.7

Gear Change	Throttle	Km/h
4-3	50% Throttle	83.7
3-2	50% Throttle	56.3
2-1	50% Throttle	24.1

Gear Change	Throttle	Km/h
4-3	100% Throttle	177.1
3-2	100% Throttle	106.2
2-1	100% Throttle	45.9

SPECIFICATIONS

Type:	Hydra-Matic 4L60 E
Special Features	Torque converter clutch overdrive
Gear Ratios: Reverse (R)	2.29:1
Drive 4th (D)	0.69:1
Third (3)	1.00:1
Second (2)	1.625:1
First (1)	3.06:1

TORQUE CONVERTER

Number of elements:	3 plus torque converter clutch
Cooling type:	Liquid

Max Torque ratio at stall:

V6	1.63:1 (k=122)
V6 supercharged	1.63:1 (k=133)
V8 VT Ser I	2.15:1 (k=115)
V8 Gen III	1.9:1(k=101)

Nominal dia:

V6 engine	245mm
V6 from 26/2/1999	258mm (same as V6 supercharged)
V6 supercharged	258mm
V8 VT Ser I	298mm
V8 Gen III	300mm

LUBRICANT

Capacity, refill

V6 engine 4.8 litres (total capacity 7.9 litres)

V8 engine 5.0 litres (total capacity 10.6 litres)

Type recommended Dexron Type 111

CLUTCHES and BANDS

2-4 Band

Type	Steel band composition lined
Operation	Servo
Adjustment	Selective fit apply pin:

65.82-66.12mm - 1 groove

67.23-67.53mm - 2 grooves

68.64-68.94mm - no groove

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Reverse Input Clutch

Type	Multiple wet disc.	
Clutch plate	Nnumber	Thickness:
Steel	4	1.892 - 2.045 mm.
Composition	4	1.730 - 1.880 mm.
Belleville	1	2.210 - 2.311 mm.
Backing plate	1	Selective.

Backing plate,

Identification	Thickness
2	7.249 - 7.409 mm.
3	6.519 - 6.678 mm.
4	5.787 - 5.947 mm.

Backing plate travel 1.02 - 1.94 mm

Forward Clutch

Type	Multiple wet disc	
Clutch plates	Number	Thickness:
Steel	5	2.29 mm
Composition	5	1.78 mm
Apply plate	1	4.30 mm
Waved Steel	1	1.79 mm
Backing plate	1	selective

Backing plate

Identification	Thickness
A	6.92 - 7.07 mm
B	6.38 - 6.48 mm
C	5.79 - 5.89 mm
D	5.20 - 5.30 mm
E	4.61 - 4.71 mm

Backing plate travel:

VT (V6 & V8)	0.750 - 1.600 mm
V6 & V6 Supercharged	0.866 – 1.876 mm
GEN III V8	0.866 – 1.876 mm

Overrun Clutch

Type	Multiple wet disc	
Clutch plates	Number	Identification:
Steel	2	2.248-2.4mm
Composition	2	2.03mm

3-4 Clutch

Type	Multiple wet disc	
Clutch plates	Number	Thickness:
Steel	5	2.71mm
Composition	6	2.03mm
Flat apply plate	1	5.60mm
Flat steel (same spline configuration as apply plate)	1	1.78mm
Backing plate	1	Selective

Backing plate

Identification	Thickness
A	5.88-5.68mm
B	4.99-4.76mm
C	4.10-3.90mm

Backing plate travel 0.90-2.10mm

Low and reverse clutch

Type	Multiple wet disc	
Clutch plates	Number	Thickness:
Steel	5	1.75mm
Composition	5	2.25mm
Waved	1	2.43mm
Selective	1	Selective

Selective plate

Identification	Thickness
No identification	1.684-1.829mm
0	1.168-1.314mm
1	2.198-2.344mm
Clutch support	6.655-6.909mm

CLEARANCES

Transmission end play	0.13-0.92mm
Pinion gears end play(all)	0.20-0.60mm
Torque converter end play:	
V6 engines	0-0.5mm
VT Ser I V8 engines	0-0.6mm
Gen lll engines	0-0.5mm

TORQUE SPEC'S Nm

1-2 Accumulator Cover to Case	8-14
Transmission Oil Pan (Sump) bolts:	9.5-13.8
Pressure Control Solenoid Retainer Bolt:	8-14
Forward Accumulator Cover 3 Bolts:	8-14
1-2 Accumulator Bolts :	8-14
Spacer Plate Bolt:	8-14
Control Valve Body Bolts:	8-14
Pressure Switch Assembly Bolts :	8-14
Line Pressure Plug	8-14
Detent Lever Bolt:	20-27
Detent Lever Inner Nut:	27-34
Detent Lever Spring Bolt:	20- 27
Park Pawl Bracket Bolt:	27-34
Oil Pump bolts:	20-27
Fluid Cooler Lines to Trans:	22-24
V6-Torque Converter Housing bolts to Engine:	50-60
V8-Torque Converter Housing bolts to Engine:	30-45
Torque Converter to Flexiplate bolt torque spec:	60-70
V6-Converter Lower Housing Cover bolts:	30-45
V8-Converter Lower Housing Cover bolts:	5-10

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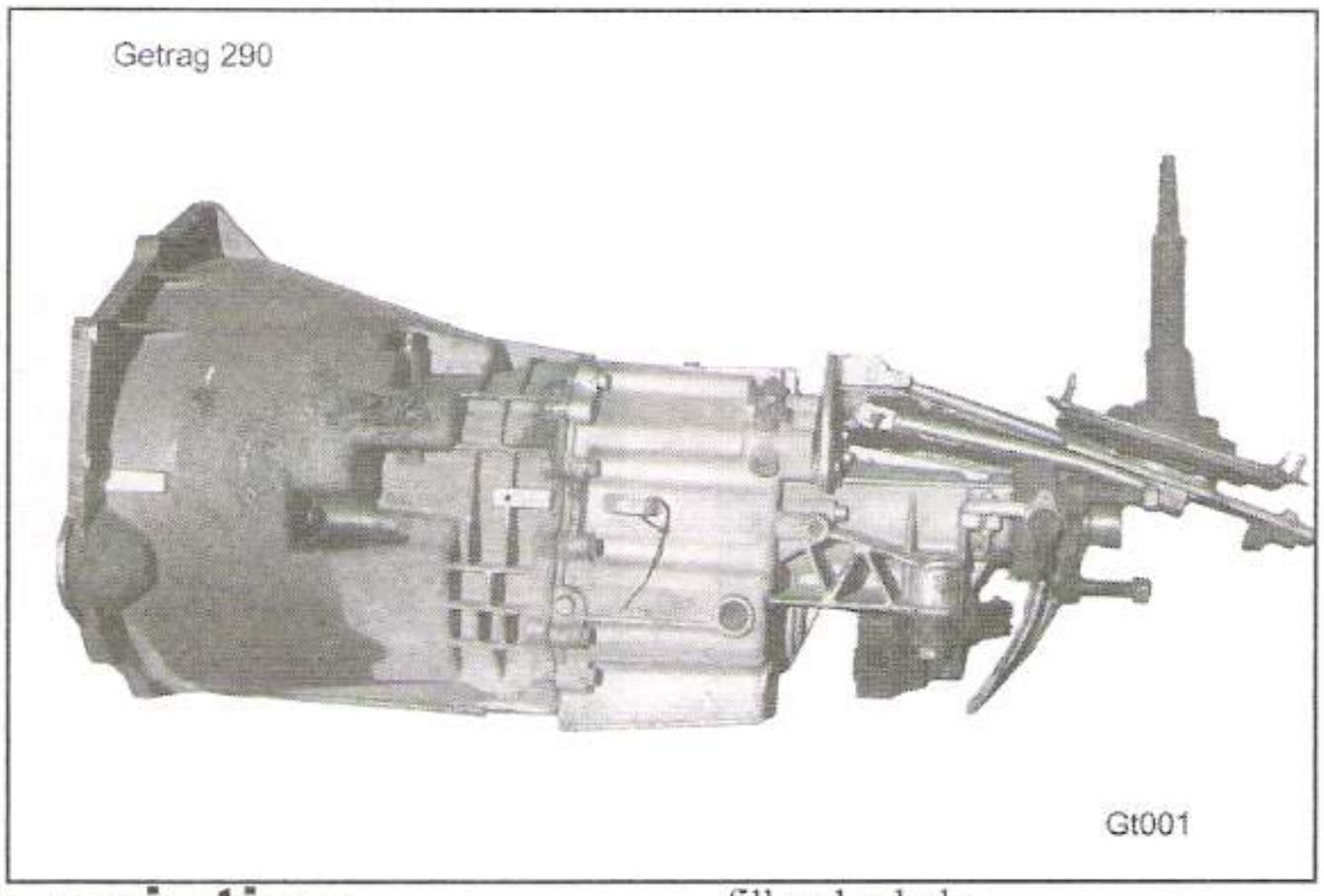
MANUAL TRANSMISSION

V6 - Getrag 260 & V8 - Getrag 290

5 Speed

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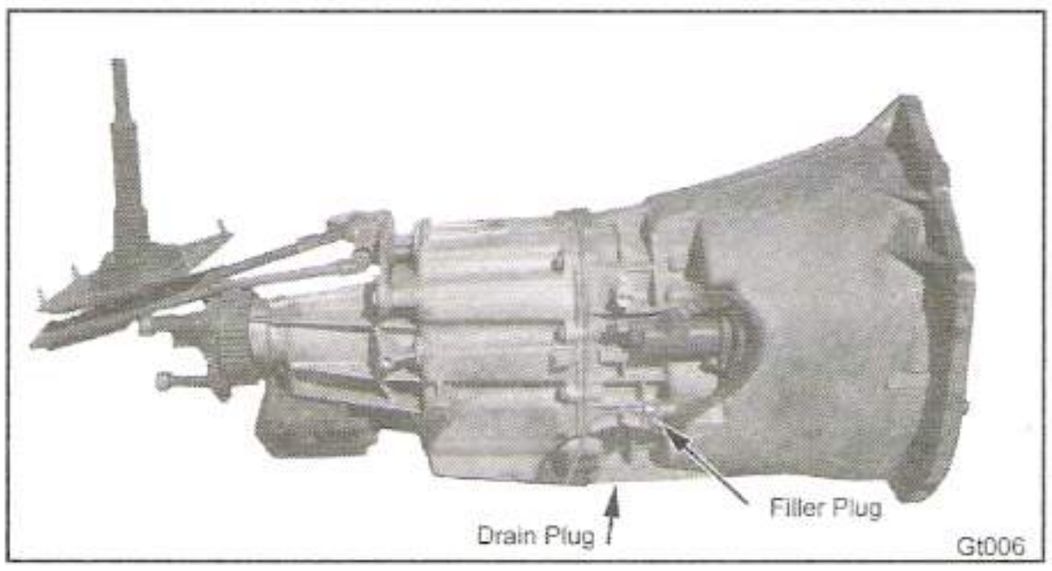


General Description

There are two differentGetrag models of transmission. The V6 equipped vehicle uses the Getrag - Type 260 (option code M35) manual transmission. Vehicles fitted with the V8 engine use the Getrag - Type 290 (option code M34) manual transmission. Both of these transmissions are a 5-speed fully synchronised type. The M34 & M35 transmission are similar in construction, both use a 2-piece transmission case with the clutch housing integrated into the front section of the transmission case. Some of the dismantle and assemble proceedues are the same for the 260 and 290 types.

Maintenance

Drain & Refill Transmission



Position an oil drain tin under the transmission. Loosen the transmission filler plug. Loosen and remove the drain plug from the transmission, if the vehicle has been recently driven take care as the oil could be hot enough to burn skin on contact, when the oil has finished draining from the transmission replace the drain plug and tighten to specification.

Torque: ..... 40-60 Nm

Remove the filler plug, refer to diagram for location. Fill the transmission with the correct amount of specified oil.

Oil Level: Not more than 9 mm below the lower edge of the filler plug hole.

Oil Specification & Capacity

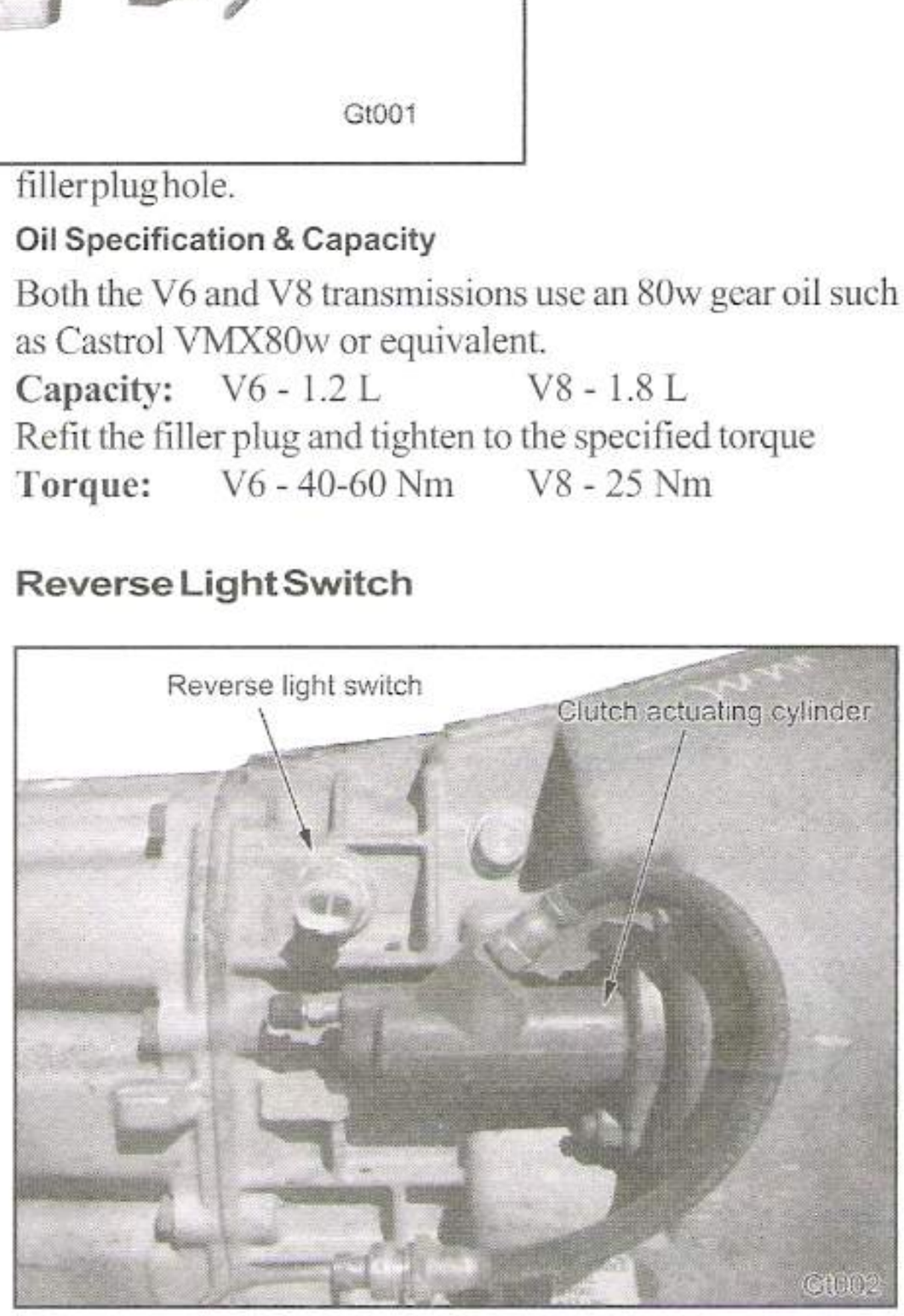
Both the V6 and V8 transmissions use an 80w gear oil such as Castrol VMX80w or equivalent.

Capacity: V6 - 1.2 L V8 - 1.8 L

Refit the filler plug and tighten to the specified torque

Torque: V6 - 40-60 Nm V8 - 25 Nm

Reverse Light Switch



Remove

Detach electrical connector from reverse light switch and using a suitable size spanner, loosen and remove the switch from the transmission case.

Inspection

The reverse light switch can easily be checked using a multimeter. Set the multimeter to measure ohm's, then connect the test leads from the multimeter to the terminals on the switch, if there is continuity when the switch is depressed and no continuity when the switch is released then the operation of the switch is OK, otherwise the switch should be replaced.

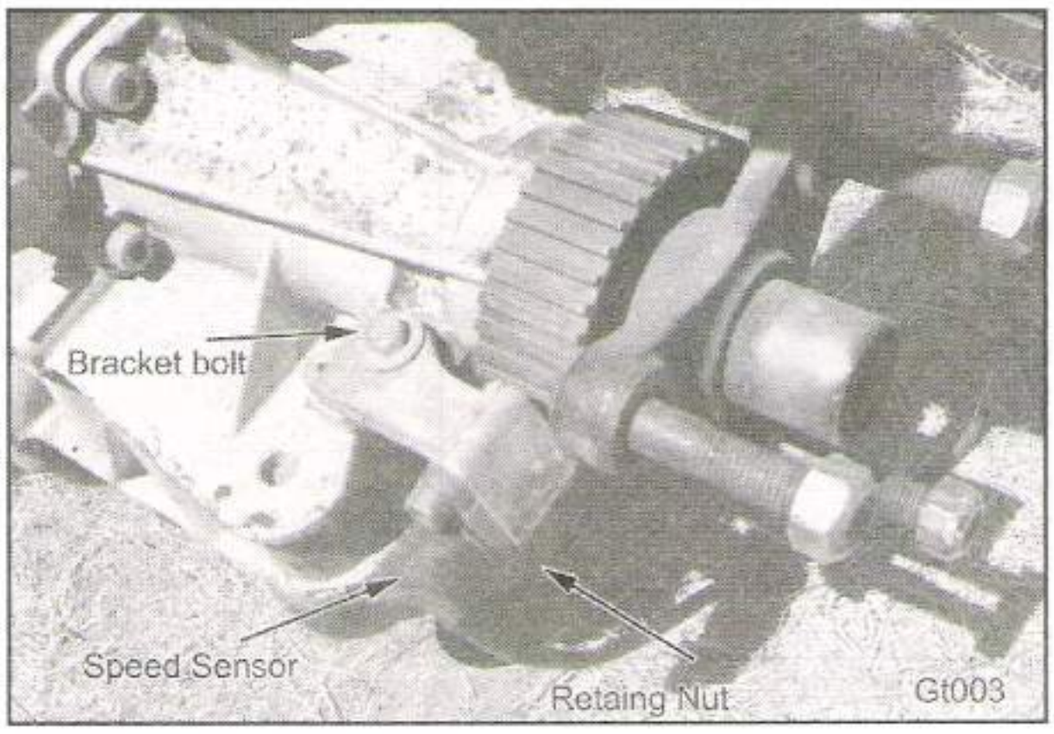
Install

Clean threads of the switch and apply a suitable sealant to

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threads. Install the switch and torque to specification.
Torque: ..... 20 Nm

Vehicle Speed Sensor (VSS)



Remove

1. Detach the electrical connector at the VSS
2. Loosen and remove the VSS bracket mounting bolt V6 or nut if V8
a) Remove the VSS and bracket from the transmission
3. Loosen and remove the Allen head bolt.
a) Remove the VSS from the bracket by twisting the VSS back and forth

Inspection

Refer to the 'Diagnostics' chapter for correct procedure to check the VSS operation.

Install

1. Fit the VSS to the bracket and tighten the bolt to specified torque
Torque: ..... 6-14 Nm
2. Fit the bracket and VSS into position and torque the nut V8 or bolt V6 to the specified torque
Torque: ..... 15-20 Nm
3. Connect the VSS electrical connector

Gearshift Knob & Boot Assembly

Note: The gearshift knob & boot are an assembly and cannot be separated.

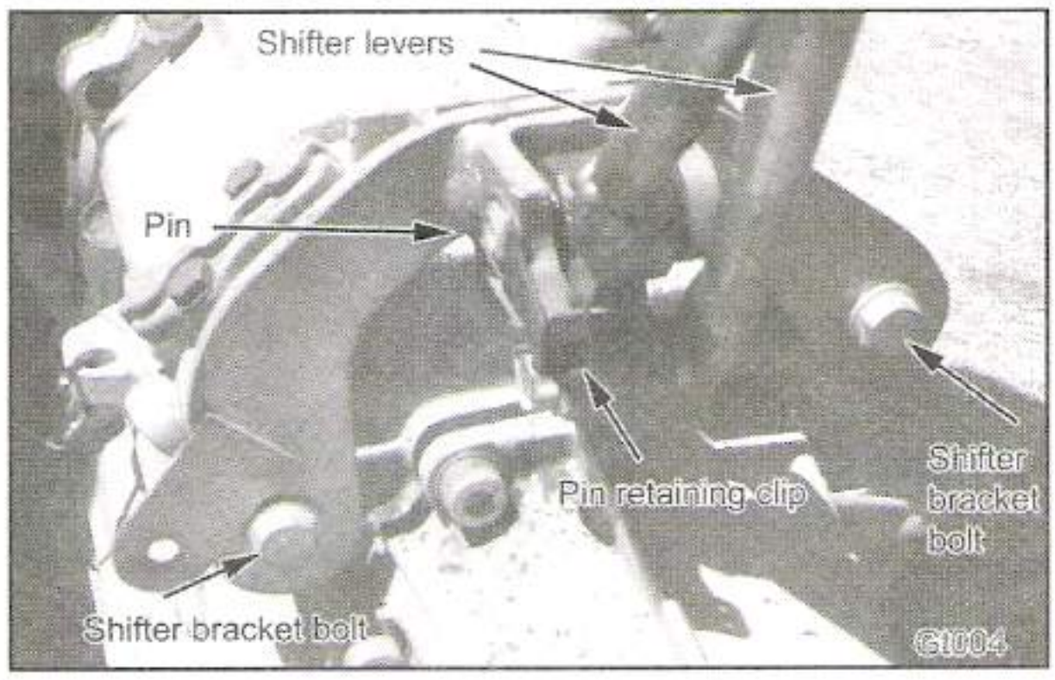
Remove

1. Release the eight boot retainers
2. Lift up the boot and hold of the gear stick with one hand
a) Grasp the gearshift knob with the other hand and while rocking the knob from side to side lift the knob upwards until the retaining claws are released.
b) Lift off the gearshift knob and boot assembly

Install

1. Fit the gearshift knob/boot over the gear stick and push the knob down into position until clips lock into position on shaft
2. Align the 8 boot retainer clips into position on the console and engage each clip into position

Gearshift Lever Assembly



Remove

1. Remove the gearshift knob/boot as previously described
2. Raise the vehicle and position on safety stands
a) Remove the gearshift knob and boot as previously described
3. Mark the position of the crossmember to aid in assembly
a) Support the transmission with a jack
b) Loosen and remove the 4 crossmember to underbody bolts
c) Lower the transmission enough to gain access to the gear shift linkages etc.
4. Remove the shift linkage brace retainer clip and pin
a) Lever the shift linkage brace free of its mount
b) Remove the gearshift rod to transmission clip and disconnect the rod
c) Disconnect the gearshift rod to gearshift clip and disconnect the gearshift rod

Note: Make a note of the orientation of the gearshift rod to aid in assembly.

5. Inside the vehicle loosen and remove the 4 nuts securing the gearshift to the body
a) Loosen and remove the 2 bolts securing the rubber mounted bracket
b) Lower the gearshift assembly and remove from the vehicle

Dismantle

1. Loosen and remove the 2 nuts securing the gearshift brace to the gear shift
a) Remove the gearshift brace
2. Remove the gearshift stick, bearing and end plate'
a) Hold the cover firmly and use a soft faced hammer to tap the top end of the gearshift stick until it is free of the cover
3. Inspect all components for damage and replace as required

Assemble

Assemble the gearshift in the reverse order of removal. Coat the bearing and ball with Lithium grease when assembling. Fit the gearshift lever brace and tighten bolts to specified torque
Torque: 6-14Nm

Install

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1. Fit the gearshift assembly into position from underneath the vehicle
a) Fit the 2 bolts to the brace rubber mounted bracket
2. From inside the vehicle fit the 4 nuts and tighten to specified torque
Torque: ..... 6-14 Nm
a) Tighten the rubber mounting bolts 2 to the same torque
3. Fit the shift rod and install the clip
a) Position the brace rod and fit the pin and clip
4. Jack the transmission up into position and fit the 4 crossmember to underbody bolts.
a) Align the crossmember using the marks made on disassembly
b) Tighten the 4 bolts to the specified torque
Torque: ..... 50-65 Nm
c) Refit the gearshift knob and boot

Major Repairs

Transmission

Remove

1. Disconnect or remove the following:
a) Disconnect the battery terminals
b) Raise vehicle and place on safety stands
c) Drain the gearbox
d) Remove the tailshaft and exhaust engine pipes
2. Detach all of the electrical connectors from the transmission
3. Remove the clutch slave cylinder 2 bolts and tie back out of the way
4. Remove the starter motor refer to 'Starter' chapter
5. Remove the lower flywheel cover

V6 Engine

a) Loosen and remove the transmission to brace bolts 2
b) Undo the 2 cover bolts and remove cover

V8 Engine

a) Loosen and remove the 4 cover bolts
b) Remove the cover
6. Support the engine and transmission assembly with a transmission jack.
a) Mark the position of the crossmember to aid assembly
b) Loosen/remove the crossmember to underbody and crossmember to mount nuts
c) Remove the crossmember
d) Disconnect the gearshift brace and gearshift rod from the transmission
7. Lower the transmission enough to gain access to the clutch housing bolts
a) Loosen and remove the clutch housing bolts
8. Carefully remove the transmission assembly from the vehicle

Install

1. Position transmission on the transmission jack, raise transmission and move it forward on the guide pins until the input shaft splines enter the clutch hub splines and the case is placed against the clutch housing.
2. Install the transmission clutch housing to engine bolts. Tighten all bolts to specification.
Torque: ..... 50-85 Nm
3. Connect the gearshift brace and gearshift rod and clips
a) Connect the electrical connectors etc.
4. Fit the crossmember to the transmission mount 2 nuts
a) Raise the transmission and fit the crossmember to underbody bolts
b) Align the crossmember marks made on disassembly and tighten the crossmember to underbody bolts to specified torque
Torque: ..... 50-65 Nm
c) Tighten the crossmember to engine mount nuts
Torque: ..... 20-30 Nm
5. Fit the lower flywheel cover

V6 Engine

a) Position the cover and fit cover to transmission bolts 2
Torque: ..... 5-10 Nm
b) Fit the cover to transmission brace bolts 2
Torque: ..... 50-85 Nm

V8 Engine

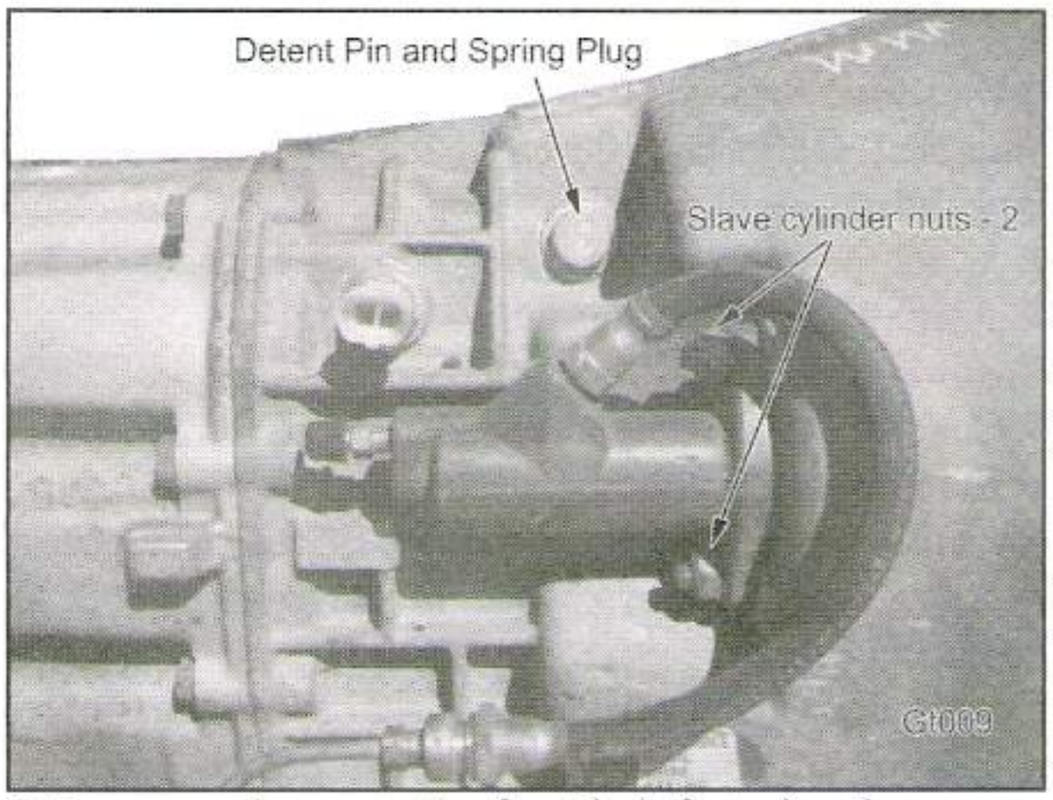
a) Position the cover and fit cover to transmission bolts 4
Torque: ..... 5-10 Nm
6. Refit clutch slave cylinder 2 nuts
Torque: ..... 22 Nm
8. Refit the starter motor etc. refer to 'Starter' chapter
9. Refit tailshaft, exhaust pipes etc. fill transmission with oil.

M35 - 260 Transmission (V6)

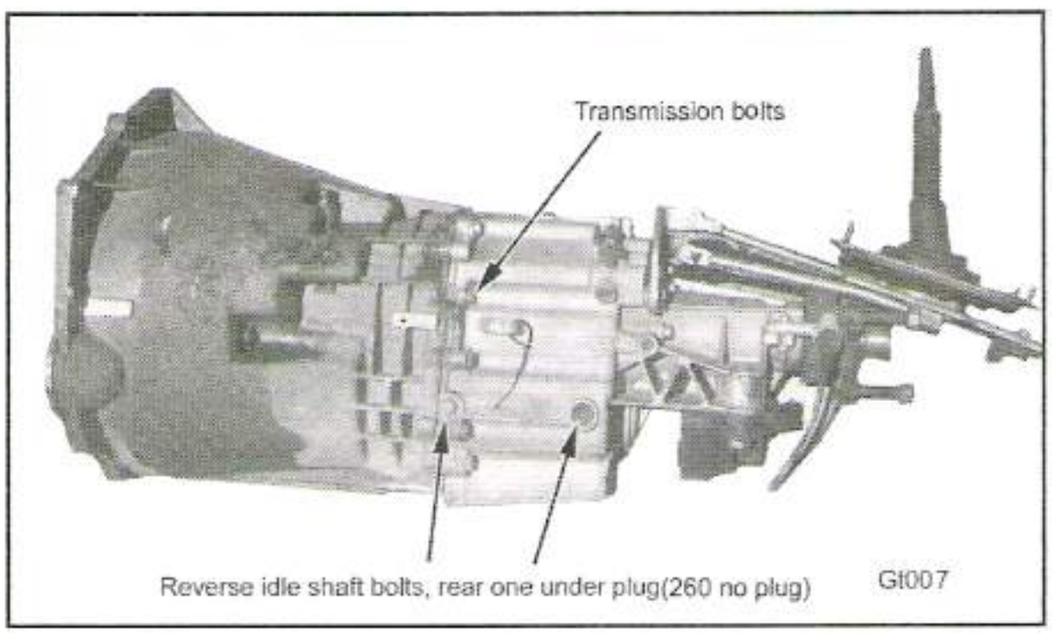
Dismantle

1. Place transmission on a clean bench to enable a complete pull down and rebuild.
2. Disconnect the clutch release lever clip and remove the lever and thrust bearing
3. Loosen and remove the thrust bearing guide bolts
a) Use a soft faced hammer to gently tap the tap the guide and free it from the transmission case
b) Use circlip pliers to remove the snap ring on the front of the input shaft, remove bearing spacer and shims if fitted
4. Remove the speed sensor bracket bolt, cut the wiring harness retaining strap and remove VSS, bracket etc. from the transmission
a) Lever the spring steel retaining ring forward on the selector rod trunnion
b) Use a pin punch and hammer to knock out the trunnion pin
c) Remove the trunnion and retaining ring
d) Remove the reverse light switch
5. Lever the detent cover out of the transmission case and remove the detent pin and spring

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6. Loosen and remove the front bolt fastening the reverse idler gear shaft, L.H. side of transmission case



a) Loosen and remove the transmission case bolts

Note: Take note of the position of the one longer bolt (60 mm) at top of transmission to aid assembly.

7. Fit extractor - special tool AKM-628-A to the front of the transmission case, using the 6 bolts from the throwout bearing guide

a) Tighten the extractor bolt to separate the transmission case sections

Note: It may be necessary to gently tap the transmission case with a soft faced hammer while tightening the extractor, to help break the sealing compound between the case sections.

8. Loosen and remove the rear output shaft flange nut

a) Use a suitable puller to remove the flange from the output shaft

9. Select 4th gear, support the shift selector rod with a block of wood

a) Use a pin punch and hammer to remove the roll pin from the shift finger and shaft

b) Use a soft faced hammer to knock the shift rod rearwards and out of the transmission case

Note: There are 4 rollers fitted to the rear section of the shift rod, take care not to loose them when the rod is knocked out.

10. Remove 2 bolts from the detent cover, remove cover and 3 springs

b) Use a magnet to remove the 3 detent balls

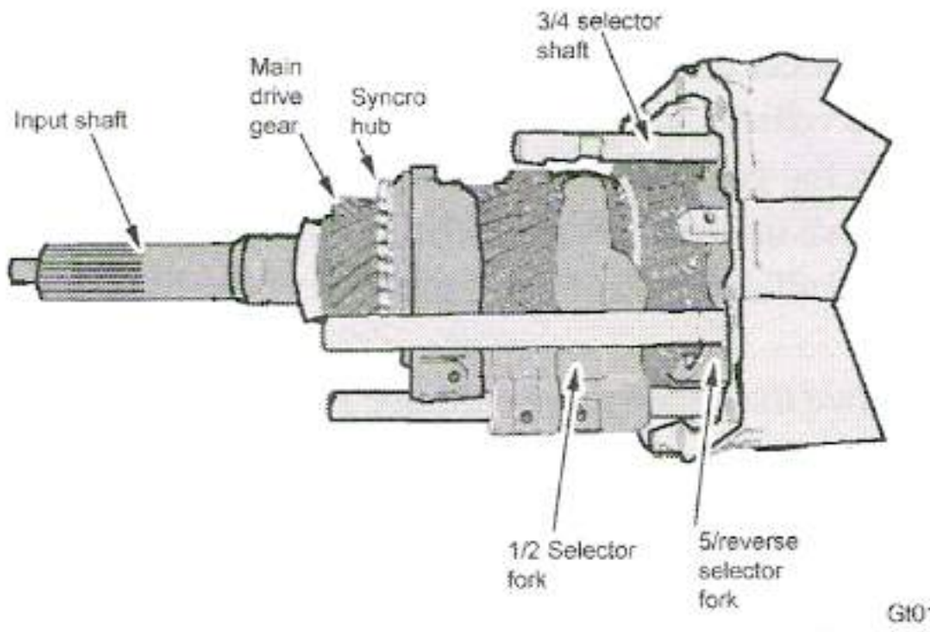
11. Support the 3rd/4th selector rod and knock the pin out of the rod and fork

a) Gently tap the selector rod rearwards to dislodge the expansion plug in the rear of the transmission case

b) Remove the selector rod and interlock pin

12. Remove rear mainshaft bearing plate retaining bolts 3

13. Position the 1st/3nd selector rod/fork into 2nd gear position and the 5th/Reverse selector rod into the reverse gear position

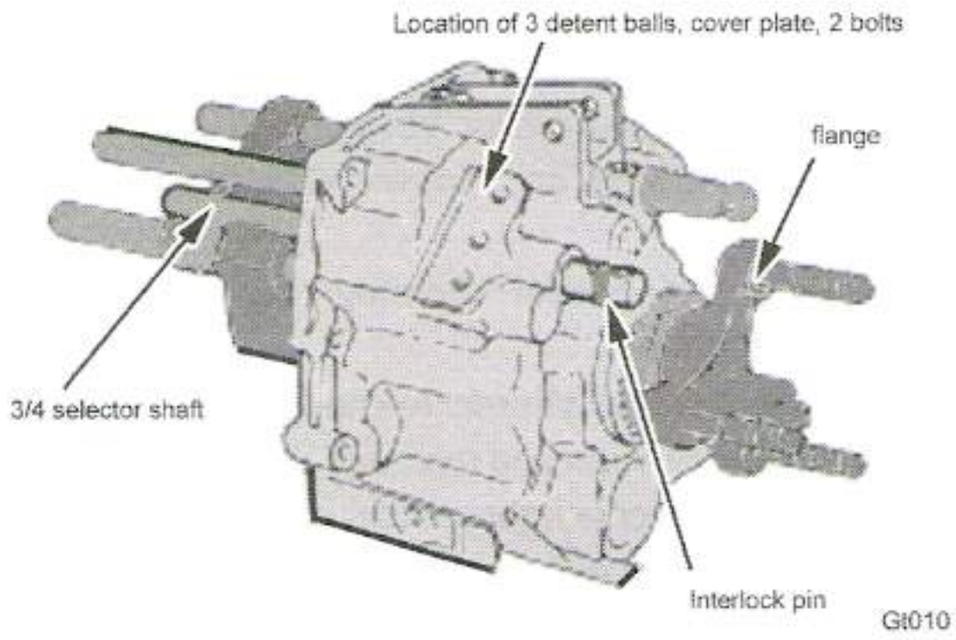


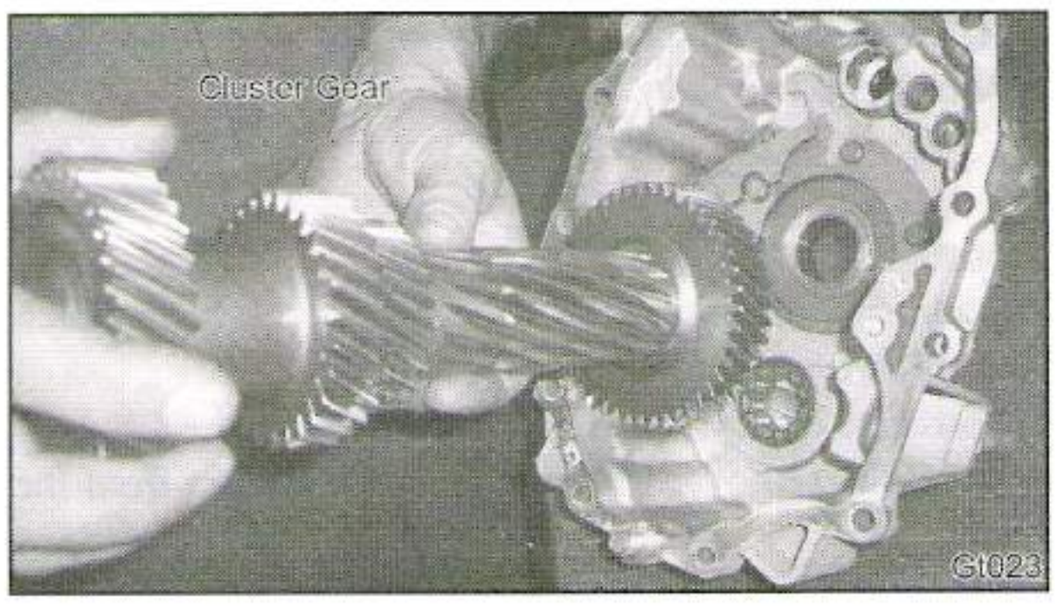
a) Remove the rear bolt from the reverse idler gear thrust plate

b) Remove the reverse idler gear shaft and roller bearing from the case

c) Remove the reverse gear

14. Support the rear transmission case in a press and carefully press the mainshaft out of the case along with the cluster gear, selectors etc. from the case





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Mainshaft

Dismantle

1. Remove the main drive gear and 4th speed gear synchro ring from the mainshaft

2. Remove the snap ring from the end of the mainshaft

a) Fit separator plates under the 2nd speed gear and tighten the bolts

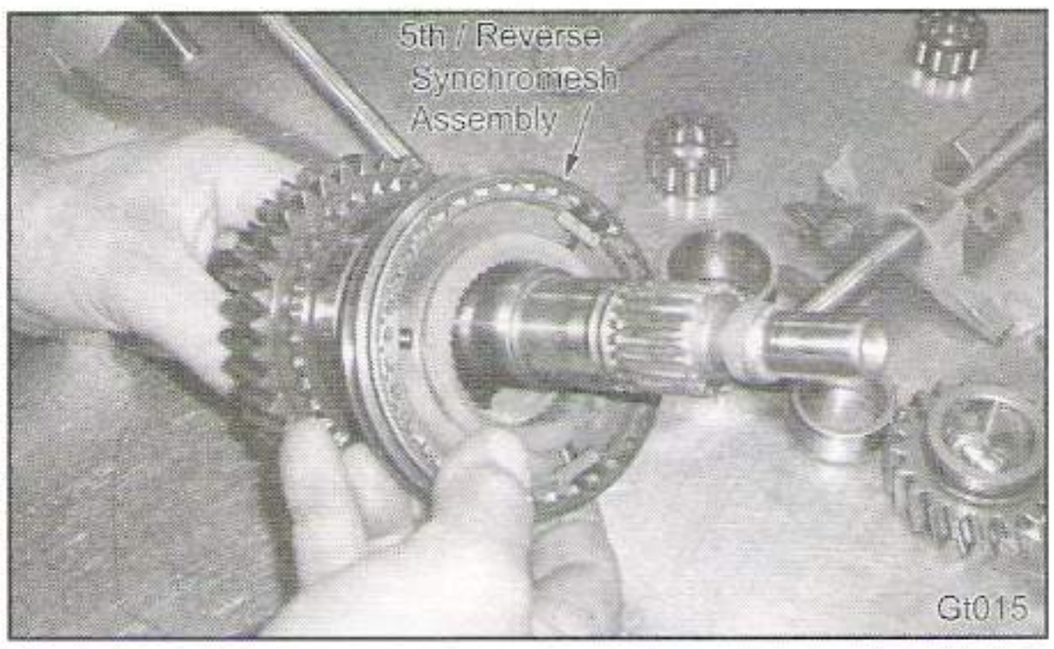
b) Use a press to push the mainshaft out of the 3rd/4th synchro hub assembly, 3rd gear/synchro ring, 3rd gear roller bearing, 2nd gear thrust washer, locating ball, 2nd gear and 2nd gear needle roller bearing.

3. Fit press plates with the flat side under the first speed gear

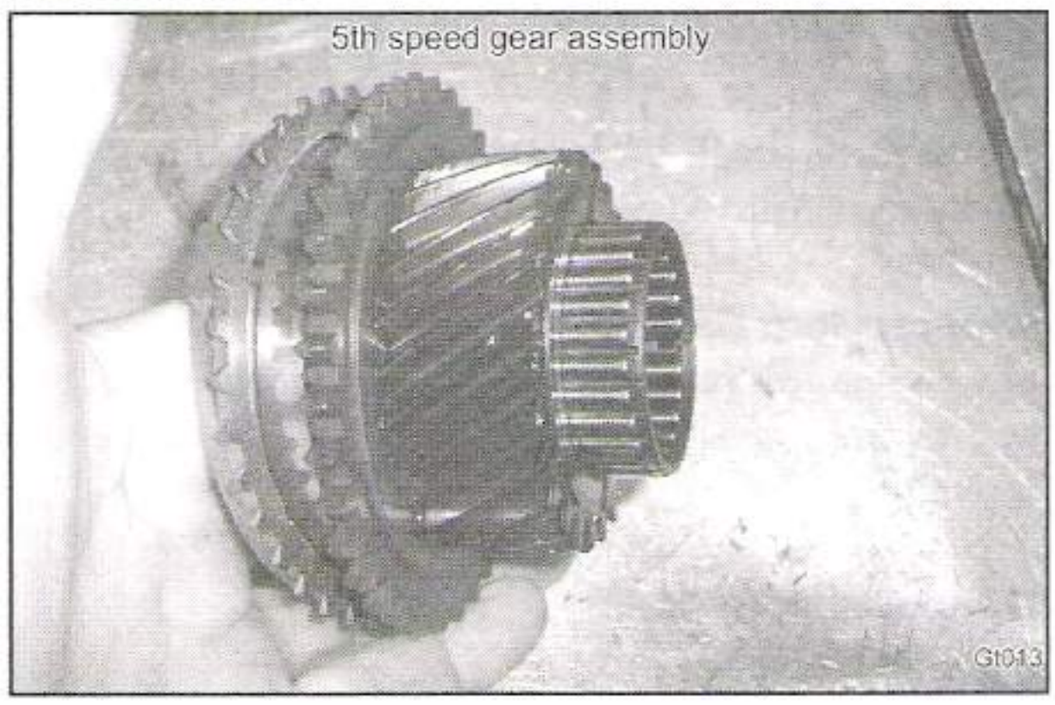
a) Remove the snap ring and press the mainshaft from the 1st/2nd synchro assembly, 1st gear, synchro ring etc.

4. Remove the 5th speed constant mesh gear, synchro ring and needle roller

5. Remove the snap ring from the 5th/Reverse synchro assembly



a) Fit suitable press plates to the 5th/Reverse synchro hub assembly and press mainshaft out of the hub, synchro ring, reverse gear etc.



Assembly

1. Coat the mainshaft, gear bores and needle rollers with transmission lubricant

2. Fit the colour coded needle roller bearing, reverse gear and synchro ring to the mainshaft

Note: Refer to the chart for the correct colour code combinations for the reverse gear needle roller bearing. Combinations preceded with an asterisk are to avoided if possible, but may be used if no other combination is possible.

Color Code Combinations
at018

Mainshaft	Reverse gear	Needle Roller Bearing	
Paint Daub Color	Paint Daub Color	Cage Color	Undersize Dimension
White	Yellow	Green	-0.5 to -0.7
White	White	White	-0.3 to -0.5
White	Green	Red	0 to -0.2
Yellow	Orange	Green	-0.6 to -0.7
Yellow	Yellow	White	-0.3 to -0.5
Yellow	White	Blue	-0.1 to -0.3
*Yellow	Green	Red	0 to -0.2
Orange	Blue	Green	-0.5 to -0.7
Orange	Orange	White	-0.3 to -0.5
Orange	Yellow	Blue	-0.1 to -0.3
*Orange	White	Red	0 to -0.2



3. Heat the 5th/Reverse synchro hub assembly to 100°C

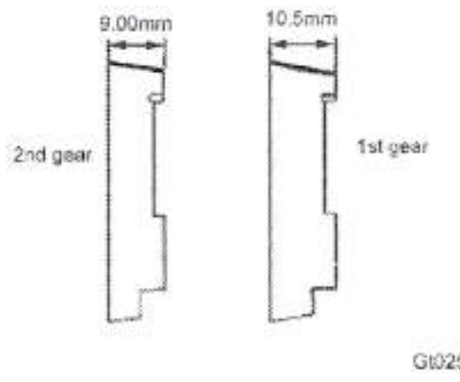
b) Use a press and suitable size sleeve to seat the assembly on the mainshaft, ensure that the synchro hub keys are aligned with the synchro ring cutouts

Note: Ensure that the synchro ring is not jammed on the gear cone before proceeding.

4. Fit the snap ring into position on the mainshaft, snap ring is available in following sizes: 1.8 - 1.85 - 1.9 - 1.95 and 2 mm

5. Fit the 1st speed gear, needle roller, friction ring, cone ring and synchro ring to the mainshaft

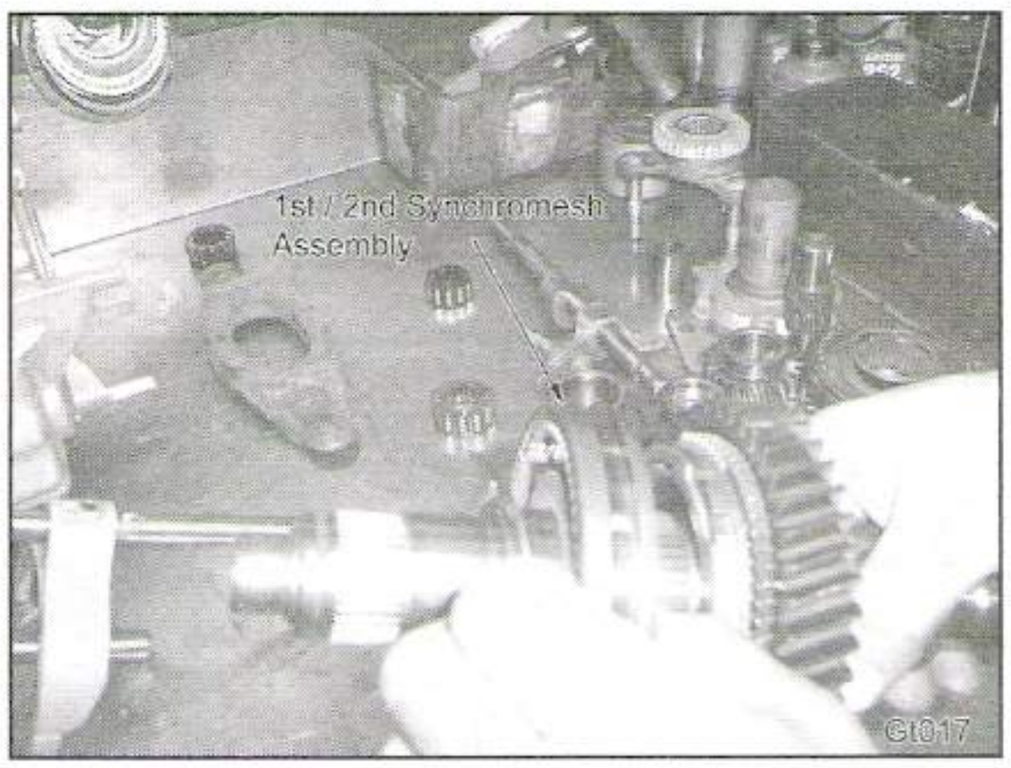
Note: The 1st and 2nd gear cone rings are of different dimensions, ensure the correct ring is used.



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6. Heat the 1st/2nd synchro hub assembly to 100°C



a) Use a heat proof glove and fit the assembly to the mainshaft

Note: The side with the smaller outer surface and the step faces 1st gear.

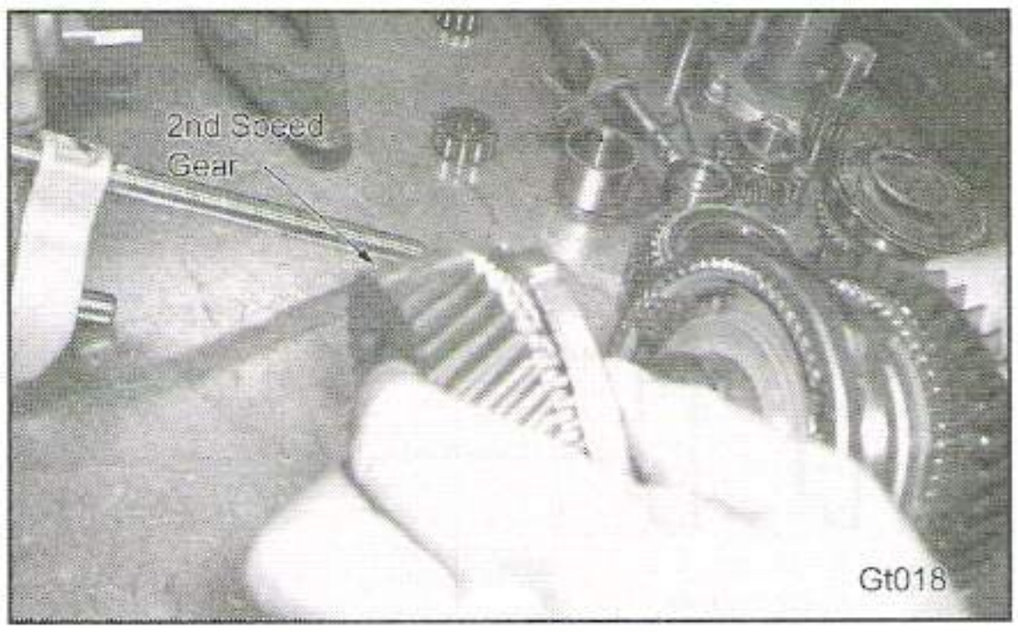
b) Use a suitable size sleeve and press the assembly into position, while lining up the keys and cutouts on the synchro ring

Note: Check the synchro ring for free movement, free up if required.

7. Fit a suitable thickness snap ring to the mainshaft. Available sizes: 1.8 - 1.85 - 1.9 - 1.95 and 2 mm

a) Select a snap ring that gives no clearance between it and the hub.

8. Fit the 2nd speed gear, needle roller, friction cone, cone ring and synchro hub assembly to the mainshaft



9. Fit the small locating ball to the mainshaft and hold in position with petroleum jelly

a) Fit the thrust washer over the locating ball

10. Heat the 3rd speed gear roller bearing sleeve to 80°C

a) Position the sleeve onto the mainshaft, use a press and suitable plates to seat the sleeve on the mainshaft

b) Fit the needle roller bearing, 3rd speed gear and synchro ring onto the mainshaft

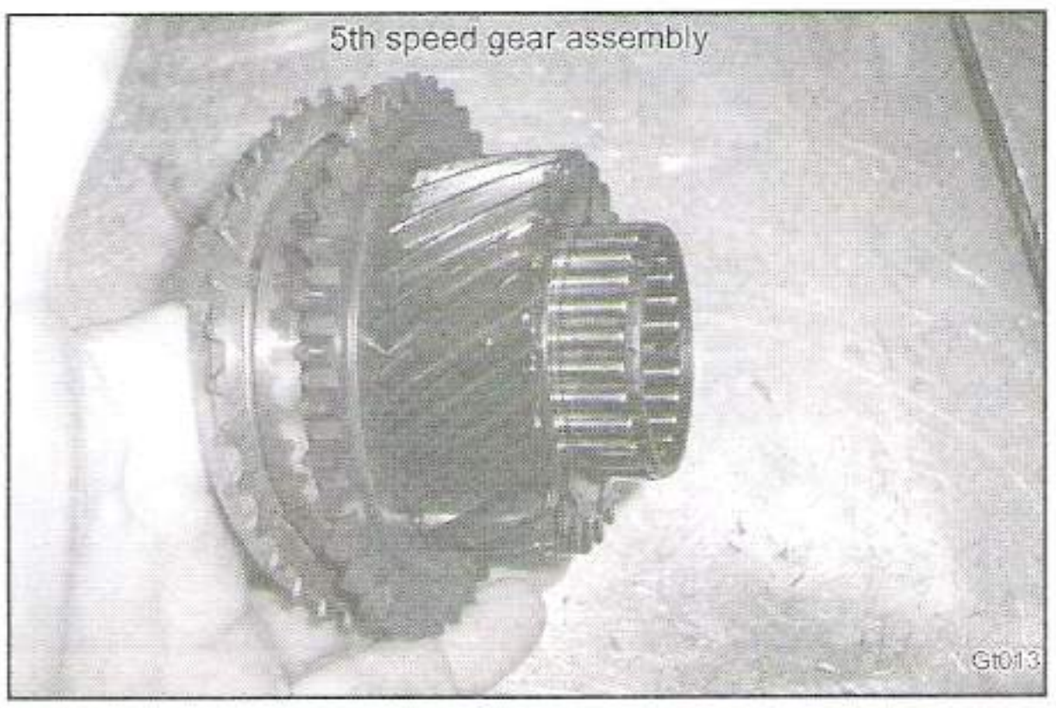
11. Heat the 3rd/4th speed synchro hub to 100°C

Note: The 3rd/4th selector fork offset in the outer sleeve faces away from 3rd gear.

a) Fit the assembly to the mainshaft and use a press and suitable plates to seat the hub on the mainshaft

b) Fit washer and snap ring to the mainshaft, there should be no clearance between the snap ring and the hub. Available sizes: 2.0 - 2.1 - 2.2 - 2.3 - 2.4 and 2.5 mm

12. Fit the 5th gear needle roller, synchro ring and the 5th speed gear.



Maindrive Gear

Dismantle

1. Remove the needle roller bearing from the maindirve gear.

Assemble

1. Coat a new needle roller bearing with petroleum jelly and fit to the main drive gear

Cluster Gear Set

The cluster gear set should not be dismantled. The cluster gear assembly must be replaced as an assembly if found to be faulty.

Revers Idler Shaft

Dismantle

1. Remove the snap ring from the end of the shaft and remove the needle roller bearing. Remove the other snap ring from the shaft.

Assemble

1. Fit a new snap ring to shaft

a) Fit the needle roller assembly to the shaft

b) Fit other snap ring to shaft

Note: Ensure that the snap rings are fitted with the curved ends facing the needle roller bearing.

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Synchromesh Assemblies

Inspection

Before dismantling any of the synchro assemblies mark the relationship between the synchro hub and sleeve. Use a permanent marker or similar. Cover the assembly in a piece of rag and separate the hub from the sleeve, take care not to lose any of the keys, springs or balls.

1. Check the synchro rings for any cracks, deformation or excessive wear.

2. Inspect the synchro hubs, sliding blocks, outer sleeves and springs for any damage.

3. Fit the synchro ring to its respective gear

a) Use a feeler gauge to check the clearance between the ring and gear

Clearances:

4th: ..... 0.82-1.35 mm
3rd: ..... 0.82-1.35 mm
2nd: ..... 0.85-2.25 mm
1st: ..... 0.95-2.35 mm
Reverse: ..... 0.5-0.98 mm
5th: ..... 0.82-1.35 mm

4. Inspect all gears, roller bearings, mainshaft, inner sleeves etc.

Assembly

1. Place the synchro hub on the workbench and use a suitable spacer to raise the hub about 6 mm off the bench

2. Fit the sleeve into position and let it rest on the work bench

3. Fit the 3 keys and springs into position

a) Use a small screwdriver to hold each key upwards and insert the ball into position, release the key

Repeat above for the remaining 2 key/spring combinations.

Assembly for all of the synchro assemblies is basically the same except for the following notes.

Note 1. The single groove on the outer sleeve of the 5th/Reverse synchro outer sleeve faces 5th gear.

Note 2. The offset groove and the step in the outer sleeve of the 1st/2nd gear synchro assembly faces 1st gear.

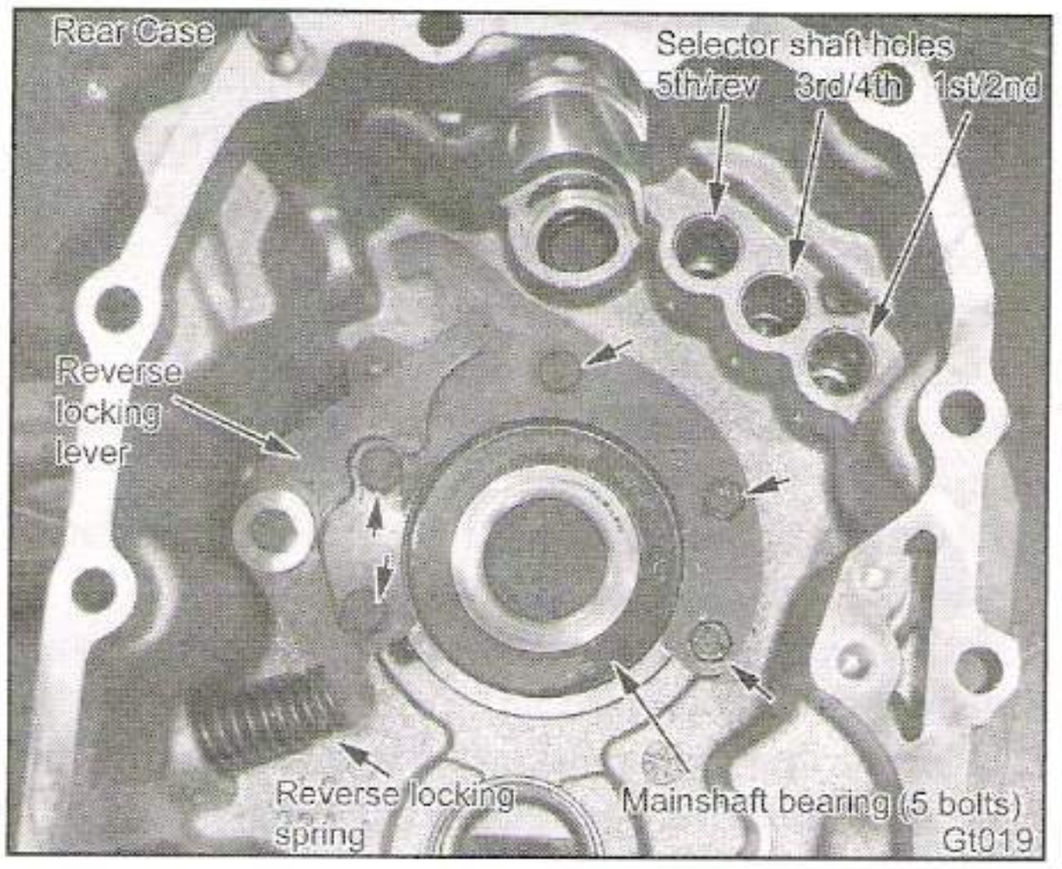
Note 3. The thicker boss of the 3rd/4th synchro assembly hub faces 3rd gear. The offset of the 3rd/4th selector fork groove faces 4th gear.

Transmission Case Inspection

If an aluminium transmission case thread is damaged, service kits may be purchased from local jobbers to service a damaged thread.

Drill out the damaged threads, using same drill size as the thread OD. Tap drilled hole. The tap is marked for the size of the thread being serviced. It cuts a thread large enough for the insert, and after the insert is installed to the original thread size.

Select coil inserting tool. Place insert on the tool and adjust the sleeve to the length of the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert in one-half turn below the face.



Working through the insert, bend the insert tang straight up and down until it breaks off at the notch. Position extractor tool in the insert so that the blade rests against the top coil one-fourth to one-half turn away from the end of the coil. Exert downward pressure on the tool and turn it counter clockwise until the insert is removed.

With insert on tool adjust sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is one-half turn below the face.

Transmission Assembly

1. Position respective synchro assemblies into Reverse and 2nd gear positions

a) Fit all of the shift forks to their synchro sleeves

b) Fit the 5th/Reverse and 1st/2nd shift shafts to the forks using new roll pins

2. Assemble the mainshaft gear set, cluster gear and the selector shafts and forks

a) Heat the inner race of the rear ball race to 80°C

b) Carefully install the assemblies into the transmission rear case, take care to align the shift shafts etc. with their respective bores

c) Move the 5th/Reverse and 1st/2nd gear synchro sleeves into the neutral position

3. Fit the interlock balls to the interlock bore, hold in place with petroleum jelly

a) While holding the transmission case in the upright horizontal position fit the lower interlock ball

b) Insert the 3rd/4th shift shaft into the fork and through into the transmission case.

c) Use a small screwdriver to install the last interlock ball into position and push the shift shaft through the case

d) Insert the interlock pin and move the shift shaft until the roll pin hole is lined up in the selector fork

e) Support the shaft and install a new roll pin

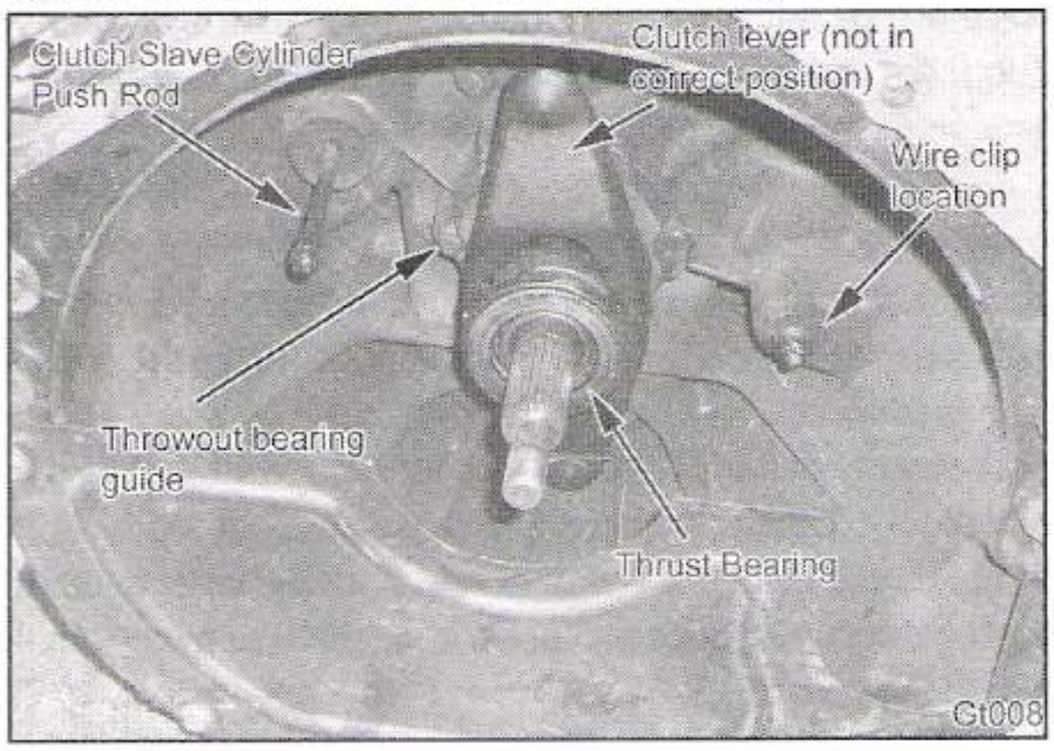
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4. Fit the mainshaft sleeve, toothed ring and flange
a) Hold the flange with special tool KM-620-1-A
b) While holding the flange with the special tool tighten the flange nut until the mainshaft and bearing are correctly seated in the transmission case housing
c) Remove the flange nut, flange and sleeve
5. Lubricate the lip of a new output shaft seal
a) Use a seal installer to fit the new seal to the transmission case
b) Fit the spacer, flange, nut and tighten to specified torque
Torque: ..... 100 Nm
6. Fit the reverse gear into position in the transmission case, with the groove facing forward
a) Lubricate the needle roller on the reverse idler shaft and fit the shaft through the gear, into the transmission case
b) Align the bolt holes in the transmission case and the idler shaft
c) Install the locating bolt in the side of the transmission and tighten to specified torque
Torque: ..... 25 Nm
d) Fit the reverse idler thrust plate and bolt
e) Use a 0.040 mm thick feeler wire in between the thrust plate and the idler gear *(used to centre the thrust plate on the idler gear)*
f) Tighten the mounting bolt to the specified torque
Torque: ..... 25 Nm
7. Coat the gear selector rod with petroleum jelly and insert through the rear of the transmission case into the selector arm
a) Align the roll pin holes and fit a new roll pin
8. Fit the 3 detent balls and springs
a) Coat the threads of the bolts with Loctite 242 or similar and fit the detent cover
b) Tighten the 2 bolts to specified torque
Torque: ..... 10 Nm
9. Lubricate the inner lip of a new gearshift rod seal with transmission oil
a) Slide the seal over the shaft and fit into position
b) Fit the trunnion into position and fit a new roll pin
c) Fit the spring steel cover back into position on the trunnion covering the roll pin
10. Heat the transmission case in the area of the front maindrive bearing to 80°C
a) Install the maindrive bearing into the case using a suitable sleeve and hammer
b) Fit the reverse block into the case using a soft faced hammer
c) Tighten the retaining bolt to the specified torque
Torque: ..... 10 Nm
11. Run a bead of Loctite 574 or similar around the transmission case sealing surfaces
a) Fit the two sections of the transmission case together, aligning the shift rods etc.
b) Fit the tool KM-461 and tighten to seat the bearing on the maindrive shaft
c) Remove the tool and fit a suitable selective washer. Available sizes: 21. - 2.2 - 2.3 - 2.4 and 2.5 mm thickness
Clearance: ..... 0 - 0.09 mm
d) Fit dowel pins and install all of the transmission case bolts and tighten to specified torque
Torque: ..... 25 Nm
12. To determine the correct thickness of shims to fit to the throwout bearing guide use vernier callipers to measure the distance between the front edge of the bearing distance ring and the transmission case - Measurement 'A'
Remove any shims from the throwout bearing guide and measure the depth of the counterbore of the guide - Measurement 'B'
Subtract measurement 'A' from 'B' to obtain the correct thickness of shims to fit to the throwout bearing guide. Shims are available in the following: 0.30 - 0.40 and 0.50 mm thickness.
a) Coat the throwout bearing guide to transmission surface with Loctite 574 or similar and fit to the transmission
b) Fit the bolts and tighten to the specified torque
Torque: ..... 10 Nm
c) Insert the detent pin and spring into the case, ensure that the pin roller is in the horizontal position
d) Coat the plug with Loctite 574 or similar and fit the plug to the transmission case
e) Fit the reverse light switch etc.

M34 - 290 Getrag (V8 eng's)

Dismantle

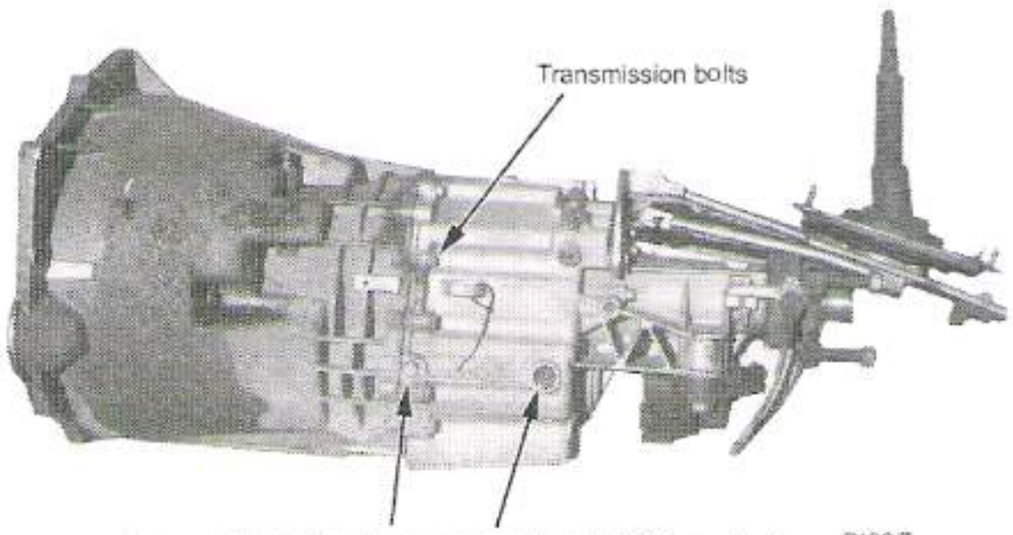
1. Place transmission on a clean bench to enable a complete pull down and rebuild.
2. Disconnect the clutch release lever clip and remove the lever and thrust bearing
3. Loosen and remove the thrust bearing guide bolts
a) Use a soft faced hammer to gently tap the tap the guide and free it from the transmission case
b) Use circlip pliers to remove the snap ring on the front of



the input shaft and remove bearing spacer
4. Remove the gearshift brace bracket 2 bolts
a) Lever the spring steel retaining ring forward on the

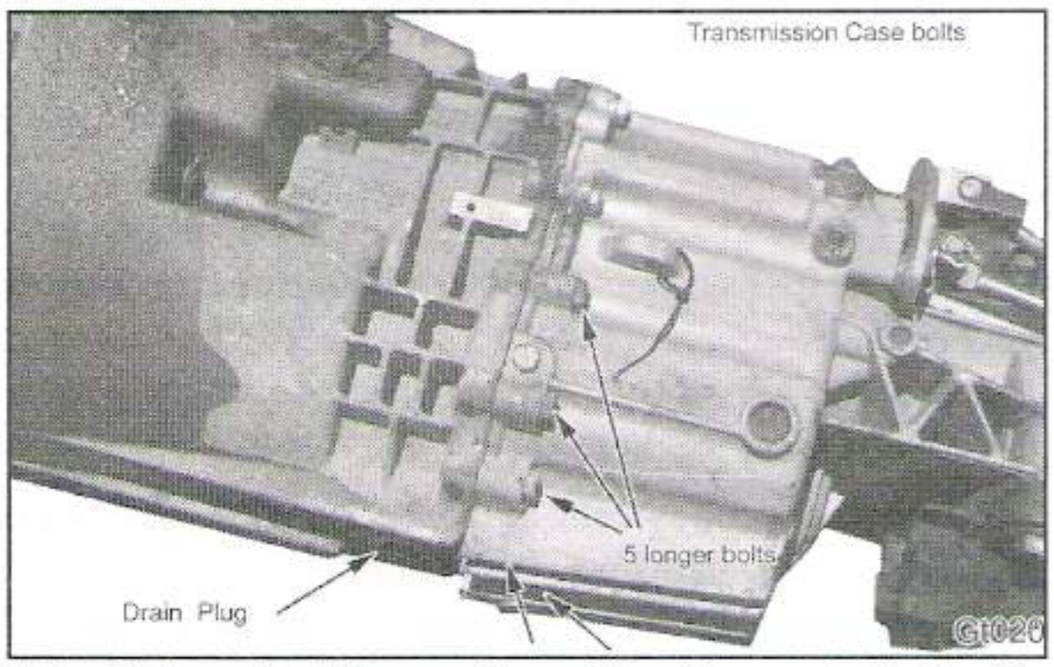
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selector rod trunnion
b) Use a pin punch and hammer to knock out the trunnion pin
c) Remove the trunnion and retaining ring
d) Remove the reverse light switch
5. Lever the detent cover out of the transmission case and remove the detent pin and spring



Reverse idle shaft bolts, rear one under plug(260 no plug) GI007

6. Use a pin punch and hammer to drive the 2 locating dowels into the front section of the transmission case
a) Loosen and remove the transmission case bolts 10

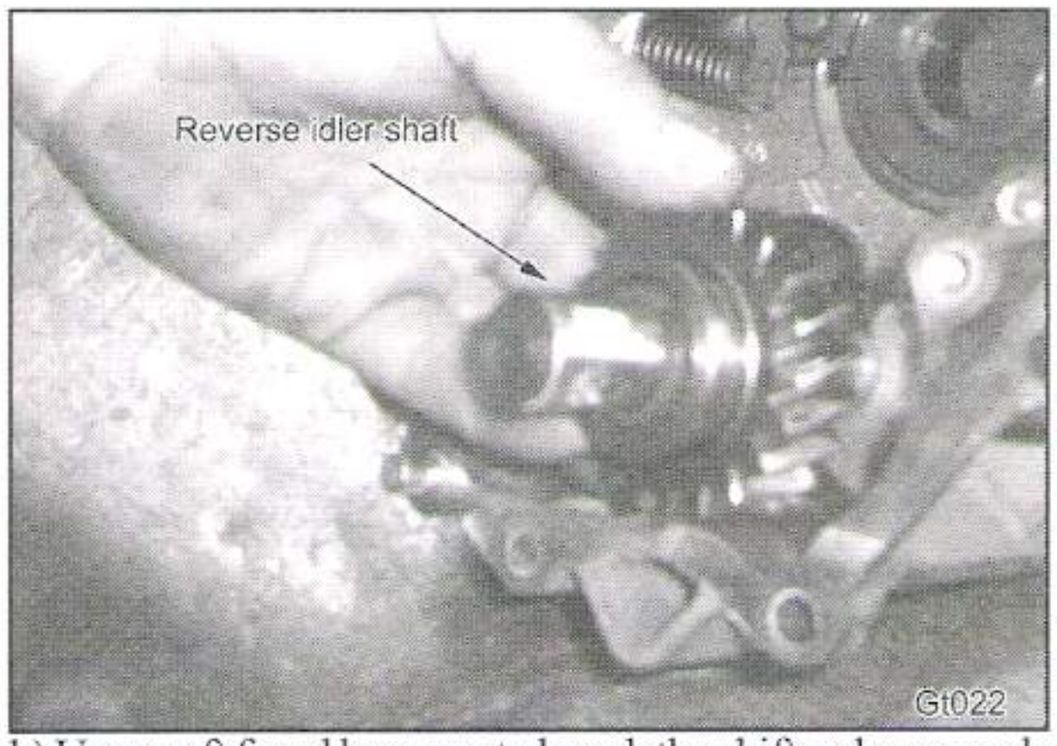


Note: Take note of the position of the 5 longer bolts to aid assembly.

7. Fit extractor - special tool AKM-628-A to the front of the transmission case, using the 6 bolts from the throwout bearing guide
a) Tighten the extractor bolt to separate the transmission case sections

Note: It may be necessary to gently tap the transmission case with a soft faced hammer while tightening the extractor, to help break the sealing compound between the case sections.

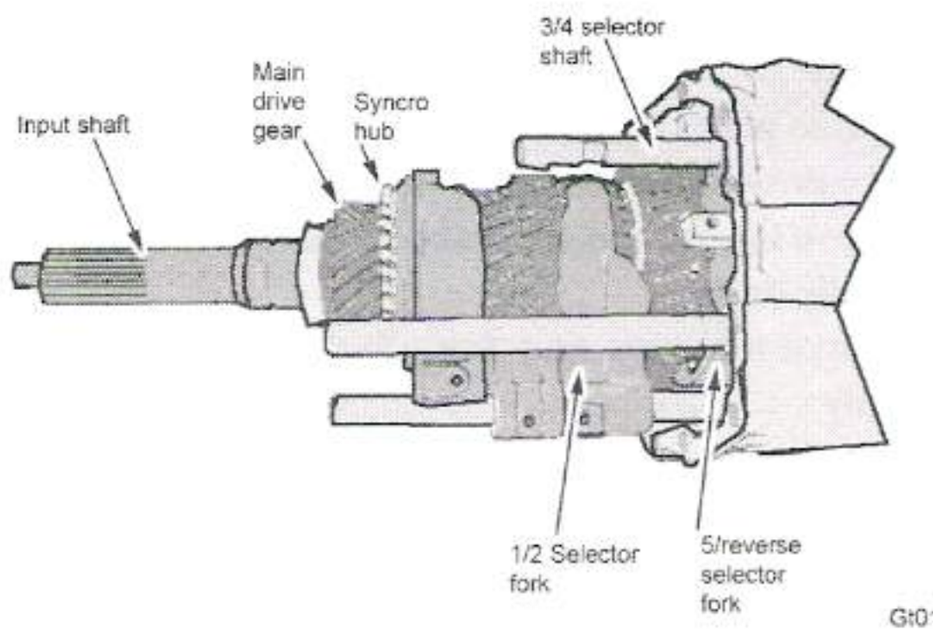
8. Remove the expansion plug located at the L.H. rear of the rear case and remove the reverse idler shaft bolt underneath the plug
a) Loosen and remove the other reverse idler shaft bolt at the L.H. front of the rear case
b) Rotate the reverse idler shaft retainer and then remove the shaft, retainer and needle roller bearing
9. Select 4th gear, support the shift selector rod with a block of wood
a) Use a pin punch and hammer to remove the roll pin from the shift finger and shaft



b) Use a soft faced hammer to knock the shift rod rearwards and out of the transmission case

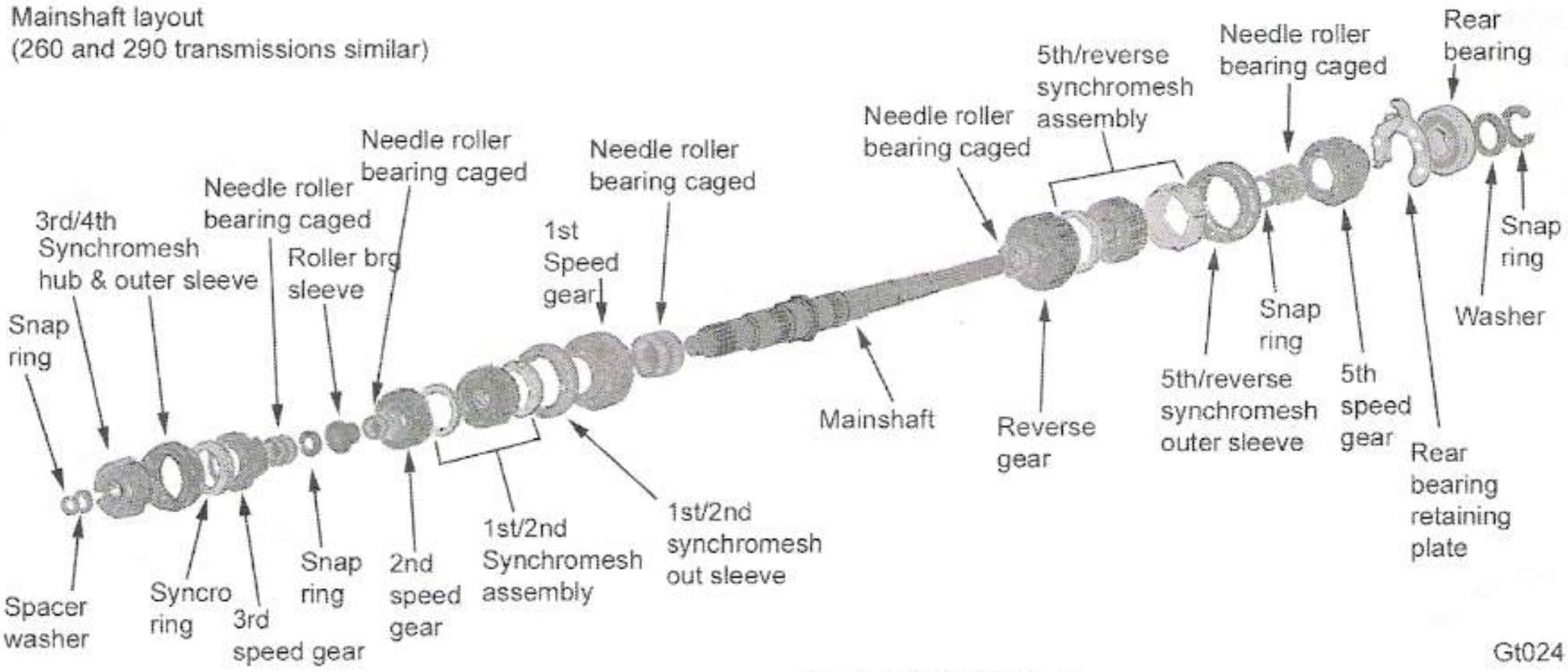
Note: There are 4 rollers fitted to the rear section of the shift rod, take care not to loose them when the rod is knocked out.

10. Loosen and remove the locking lever plug and spring located at the rear of the transmission
a) Remove 2 bolts from the detent cover, remove cover and 3 springs
b) Use a magnet to remove the 3 detent balls and 2 interlock plugs and 2 interlock balls
11. Fit tension loading tool AU462 to the shift lever engaging the lugs with the shift lever
a) Lever the selector rod spring into position on the tool
b) Turn the tool counter-clockwise to tension the spring and lock the tool
c) Use a 6 mm Allen key to remove the gearshift selector rod bush lock bolt
d) Remove the tensioned assembly from the case, take care not to lose the roller from the selector arm pin
12. Remove rear mainshaft bearing plate retaining bolts 3
13. The mainshaft/cluster gear assemblies and selector shaft, forks etc. can now be removed from the case



a) Hold the assembly in the vertical position and use a soft faced hammer to tap the case down and away from the gear sets etc.
b) The mainshaft, counter gear set and the selectors can now be separated from one another

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Mainshaft

Dismantle

1. Remove the main drive gear and 4th speed gear synchro ring from the mainshaft

2. Remove the snap ring from the 3rd/4th gear synchro assembly

a) Fit separator plates under the 3rd speed constant mesh gear and tighten the bolts

b) Use a press to push the mainshaft out of the 3rd speed constant mesh gear, 3rd speed synchro ring and 3rd/4th synchro hub assembly

c) Remove the snap ring and spacer from the rear of the mainshaft

3. Fit press plates to the rear mainshaft bearing

a) Use a press to remove the mainshaft bearing

4. Remove the 5th speed constant mesh gear, synchro ring and needle roller

5. Remove the snap ring from the 5th/Reverse synchro assembly

a) Use two screwdrivers to lever the 5th/Reverse synchro hub assembly from the mainshaft

Note: When separating the synchro hub assembly from the 5th/Reverse gear, take care not to lose any of the 12 x 4 mm balls fitted to the synchro ring.

6. Remove the snap ring from the mainshaft that secures the 2nd speed constant mesh gear

a) Fit press plates under the 1st speed constant mesh gear with the flat side facing the gear

b) Support in a press and carefully press the mainshaft out of the remaining gears

Assembly

1. Coat the mainshaft, gear bores and needle rollers with transmission lubricant

2. Support the mainshaft in the vertical position

a) Fit the 1st gear caged needle roller, 1st gear and synchro ring

b) Fit the 1st/2nd synchro assembly with the outer sleeve marked "First Gear Side" facing 1st gear

c) Use a press and suitable size sleeve to install the synchro hub onto the mainshaft, ensure that the synchro ring slots are aligned with the keys

Note: Ensure that the synchro ring is not jammed on the gear cone before proceeding.

3. Fit the 2nd speed synchro ring, make sure that the ring is aligned correctly with the synchro hub

a) Fit the 2nd speed gear, sleeve etc. into position.

b) Use a press and suitable size sleeve to seat the assembly on the mainshaft

Note: Ensure that the synchro ring is not jammed on the gear cone before proceeding.

4. Fit the snap ring into position on the mainshaft, snap ring is available in following sizes: 2.1 - 2.15 - 2.2 - 2.25 and 2.3 mm

4. Fit the needle roller bearing, 3rd speed constant mesh gear and synchro ring

a) Heat the 3rd/4th speed synchro assembly to approximately 100°C

Note: Use a hotplate to heat the assembly to required temperature.

b) Wearing a heat proof glove position the synchro assembly onto the mainshaft

c) Use a press and suitable size sleeve to fit the assembly into position on the mainshaft, while aligning the synchro ring with the keys

Note: Ensure that the synchro ring is not jammed on the gear cone before proceeding.

5. Fit a snap ring to the mainshaft ensuring that the snap ring is seated correctly and that there is no clearance between the

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snap ring and the synchro hub. Available sizes are: 1.8 - 1.85 - 1.9 - 1.95 - 2.0 mm.

6. Assemble the 12x4 mm balls, synchro ring and reverse gear

a) Fit the 5th/Reverse synchro hub to the reverse gear, ensure that the cutouts on the synchro ring align with the keys on the hub assembly

b) Fit the needle roller bearing to the assembly and then install to the mainshaft

c) Use a suitable size sleeve to sit the 5th/reverse synchro hub on and press the mainshaft into the assembly until seated correctly

Note: Ensure that the synchro ring is not jammed on the gear cone before proceeding.

d) Fit a new snap ring of the correct size to eliminate any clearance between the hub and snap ring. Available sizes: 2.0 - 2.05 - 2.1 - 2.15 and 2.22 mm

7. Fit the needle roller, synchro ring and 5th speed gear into position on the mainshaft

a) Fit the rear bearing retainer plate and a new rear mainshaft bearing

b) Use a suitable size piece of pipe and a press to seat the bearing etc. in the correct position on the mainshaft

c) Fit a suitable thickness snap ring to the mainshaft. Available sizes: 2.0 - 2.1 - 2.2 and 2.3 mm

Maindrive Gear

Dismantle

1. Remove the needle roller bearing from the maindirve gear.

Assemble

1. Coat a new needle roller bearing with petroleum jelly and fit to the main drive gear

Cluster Gear Set

The cluster gear set should not be dismantled. The cluster gear assembly must be replaced as an assembly if found to be faulty.

Reverse Idler Shaft

Dismantle

1. Remove the snap ring from the cut away end of the shaft and remove the needle roller bearing. Remove the thrust washer and locating ball from the shaft.

Assemble

1. Fit a new snap ring to the shaft on the locating ball end of the shaft

a) Fit the locating ball into the recess and coat with petroleum jelly

b) Fit the thrust washer over the shaft and locating ball

c) Fit the needle roller assembly to the shaft

d) Fit new snap ring to shaft

Synchromesh Assemblies

Inspection

Before dismantling any of the synchro assemblies mark the relationship between the synchro hub and sleeve. Use a permanent marker or similar. Cover the assembly in a piece of rag and separate the hub from the sleeve, take care not to lose any of the keys, springs or balls.

1. Check the synchro rings for any cracks, deformation or excessive wear.

2. Inspect the synchro hubs, sliding blocks, outer sleeves and springs for any damage.

3. Fit the synchro ring to its respective gear

a) Use a feeler gauge to check the clearance between the ring and gear

Clearances:

4th:	1.35-1.95 mm
3rd:	1.35-1.95 mm
2nd:	1.35-1.95 mm
1st:	1.35-1.95 mm
Reverse:	1.00-1.95 mm
5th:	1.35-1.95 mm

4. Inspect all gears, roller bearings, mainshaft, inner sleeves etc.

Assembly

1. Place the synchro hub on the workbench and use a suitable spacer to raise the hub about 6 mm off the bench

2. Fit the sleeve into position and let it rest on the work bench

3. Fit the 3 keys and springs into position

a) Use a small screwdriver to hold each key upwards and insert the ball into position, release the key

Repeat above for the remaining 2 key/spring combinations.

Assembly for all of the synchro assemblies is basically the same except for the following notes.

Note 1. The sleeve of the 3rd/4th synchro has a single groove on it, the groove faces 4th gear. The inside hub is symmetrical and has the smallest diameter.

Note 2. 1st/2nd gear synchro outer sleeve and hub are both symmetrical. The outer sleeve has 'First Gear Side' marked on it.

Note 3. 5th/Reverse synchro outer sleeve has a single groove on it and the groove faces toward reverse gear. The reverse synchro ring , containing the 12 x 4 mm balls has a recess machined into the inner side of the outer section.

Transmission Case Inspection

If an aluminium transmission case thread is damaged, service kits may be purchased from local jobbers to service a damaged thread.

Drill out the damaged threads, using same drill size as the thread OD. Tap drilled hole. The tap is marked for the size of the thread being serviced. It cuts a thread large enough for the insert, and after the insert is installed to the original thread size.

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Select coil inserting tool. Place insert on the tool and adjust the sleeve to the length of the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert in one-half turn below the face.
Working through the insert, bend the insert tang straight up and down until it breaks off at the notch. Position extractor tool in the insert so that the blade rests against the top coil one-fourth to one-half turn away from the end of the coil. Exert downward pressure on the tool and turn it counter clockwise until the insert is removed.
With insert on tool adjust sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is one-half turn below the face.

Transmission Assembly

1. Assemble the following special tools, J36515-15, J36515-16 and J36515
2. Assemble the mainshaft gear set, cluster gear, reverse idle gear/shaft and all of the selector shafts and forks

Note: Make sure that all of the synchro hub assemblies are in the neutral position.

a) FIt the assembled parts to the special tool/jig and wrap heavy duty rubber band around the assembly to hold in position
b) Fit two 100 mm length guide studs to the rear bearing retainer plate
3. Preheat the rear bearing counter bore in the transmission case to approximately 80°C using a suitable heat gun
a) Lower the transmission case into position over the gear assemblies etc.
b) Align the mainshaft, selector shafts, guide pins etc. with their respective bores in the transmission case

Note: Make sure that the interlock pin is installed in the hole through the 3rd/4th selector shaft.

c) The transmission case may require gentle tapping with a soft faced hammer to fully seat the rear mainshaft bearing
d) Remove the rubber band, special tools etc.
e) Use the guide pins to seat the bearing retainer in the correct position and fit the 3rd bearing retainer bolt
f) Remove the two guide pins and install the remaining two bolts and tighten all three to the specified torque
Torque: ..... 20 Nm
4. Check that the interlock pin in the 3rd/4th selector shaft is still in the correct position
a) Fit the two interlock balls and two plugs into their respective bores in the transmission case
b) Fit the three detent balls and their pressure springs
c) Fit the cover, apply Loctite 242 or similar to the threads of the 2 bolts and fit into position
d) Tighten bolts to the specified torque
Torque: ..... 10 Nm
5. Clean the threads of the reverse idler gear shaft bolts and apply Loctite 242 or similar
a) Fit the bolts to the shaft, insert a 0.2 - 0.3 mm feeler strip between the thrust washer and the reverse idler gear
b) Tighten the 2 remaining bolts to specified torque
Torque: ..... 25 Nm
6. Insert the pretensioned shift lever assembly into the transmission case, take care not to knock the roller out of position when fitting assembly
a) Apply Loctite 242 or similar to the threads of the shift lever, selector rod bush bolt and install the bolt
b) Tighten to specified torque
Torque: ..... 25 Nm
7. Fit the locking lever spring, plug and guide, tighten to specified torque
Torque: ..... 60 Nm
8. Lubricate the remaining shift rod with petroleum jelly and fit the rod into position through the shift fork etc. into the transmission case
a) Align the holes in the shift rod and fork
b) Use a hammer and punch to install the roll pin while at the same time supporting the shift rod with a block of wood
c) Fit the gearshift trunnion and secure with pin
d) Fit the spring steel cover to the trunnion and rotate until the pin is completely covered
9. Preheat the main drive bearing bore in the front section of the transmission case
a) Coat the contact surfaces of the transmission cases with Loctite 574 or similar, align the selector rods etc, and fit the rear section of the transmission case to the front section
b) Use the special tool KM-461 to pull the input shaft into the front bearing
c) Remove the tool and fit a spacer washer of the correct thickness. Available sizes: 2.10 - 2.20 - 2.30 - 2.40 and 2.50 mm
d) Fit a new plug to the front of the cluster gear bearing opening and seat to the circlip

Note: Place the transmission in neutral and rotate the mainshaft to check that none of the synchro rings have become jammed.

10. Install the 2 dowel pins
a) Fit the longer 45 mm transmission bolts into the correct position as noted on disassembly, followed by the remaining 4 bolts and tighten all of the bolts to the specified torque
Torque: ..... 25 Nm
11. To determine the correct thickness of shims to fit to the throwout bearing guide use vernier callipers to measure the distance between the front edge of the bearing distance ring and the transmission case - Measurement 'A'
Remove any shims from the throwout bearing guide and measure the depth of the counterbore of the guide - Measurement 'B'
Subtract measurement 'A' from 'B' to obtain the correct thickness of shims to fit to the throwout bearing guide. Shims are available in the following: 0.30 - 0.40 and 0.50 mm thickness.

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a) Coat the throwout bearing guide to transmission surface with Loctite 574 or similar and fit to the transmission
b) Fit the bolts and tighten to the specified torque
Torque: ..... 10 Nm
c) Insert the detent pin and spring into the case, ensure that the pin roller is in the horizontal position
d) Coat the plug with Loctite 574 or similar and fit the plug to the transmission case
e) Fit the reverse light switch etc.

PROBLEM DIAGNOSIS

PROBLEM
[Transmission Noisy in Gear]
Possible Cause & Remedy:
* *Lubricant level low or wrong type* - Fill to bottom of filler plug hole with proper lubricant.
* *Transmission to flywheel housing and flywheel housing to engine block bolts loose* - Tighten bolts to specification.
* *Pilot bushing worn or damaged* - Remove transmission. If noise is howling during start-up, check pilot bushing. Check for loose flywheel and housing alignment. Service or replace as required.
* *Improper transmission pilot engagement into flywheel housing* - Replace housing or input shaft bearing retainer as required. Refer to 'Clutch'.
* *Worn or damaged internal components* - Disassemble transmission. Inspect input, output and counter shaft bearings, gear and gear teeth for wear and damage. Service or replace as required.

PROBLEM
[Transmission Shifts Hard]
* *Improper clutch release* - Refer to 'Clutch Section'.
* *Internal shift mechanism binding* - Remove transmission and free up shift mechanism.
* *Synchroniser sleeve to hub fit* - Remove and check for burrs or fit.
* *Binding condition between input shaft and crank shaft pilot bearing* - Check alignment and service as required.
* *Improper Fluid* - Drain and refill with specified fluid to bottom of filler plug hole.

PROBLEM
[Transmission Will Not Shift into One Gear - All Other Gears OK]
* *Floor shift, interference between shift handle and console of floor cut out* - Adjust console or cut out floor pan to eliminate interference.
* *Restricted travel of internal shifter components* - Remove transmission. Inspect shift rail and fork system, synchroniser system and gear clutch teeth for restricted travel. Service and replace as required.

PROBLEM
[Transmission is Locked in One Gear]
* *Internal Shifter components worn or damaged* - Remove transmission. Inspect the problem gear or gearshift rails and fork and synchroniser for wear or damage. Service or replace as required.
* *Selector arm finger broken* - Remove transmission. Replace selector arm assembly.
* *Bent shifter forks at pads and selector slot* - Service or replace as required.

PROBLEM
[Transmission Will Not Shift Into Reverse - all Others OK]
* *Worn or damaged internal components* - Remove transmission. Check for damaged reverse gear train, misaligned reverse relay lever, shift rail and fork system.

Specifications

V6 Engine:

Type: Getrag Type 260-5 speed, 5th overdrive, Option M35

V8 Engine:

Type: Getrag Type 290-5 speed, 5th overdrive, Option M34

Gear Ratios:

M35 Transmission (260)		M34 Transmission (290)	
1st	3.829:1	1st	3.553:1
2nd	2.199:1	2nd	2.041:1
3rd	1.401:1	3rd	1.400:1
4th	1.000:1	4th	1.000:1
5th	0.809:1	5th	0.755:1
Reverse	3.456:1	Reverse	3.553:1

Gear Teeth No.s

M35 Transmission (260)		M34 Transmission (290)	
Maindrive Input Gear	26	Maindrive Input Gear	26
Mainshaft Gears		Mainshaft Gears	
1st	41	1st	42
2nd	37	2nd	37
3rd	30	3rd	32
5th	26	5th	25
		Reverse	42
Reverse Idler Gear	21	Reverse Idler Gear	23
Cluster Gear Input	34	Cluster Gear Input	33
Cluster Gear		Cluster Gear	
1st/Reverse	14	1st/Reverse	15
2nd	22	2nd	23
3rd	28	3rd	29
5th	42	5th	42

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Synchro Assemblies

M35 Transmission (260 Getrag)

Synchro Ring Wear

New Clearance ..... 1.0-1.3 mm

Replace ..... less than 1.0 mm

Synchro Ring Identification

1st & 2nd 040.8.0001.00

3rd & 4th 002.8.0301.00

5th/Reverse 011.8.0331.10

M34 Transmission (290 Getrag)

Synchro Ring Wear

New-All Forward Gears ..... 1.35-1.95 mm

New-Reverse Gear ..... 1.00-1.40 mm

Replace-All Forward ..... less than 1.35 mm

Replace-Reverse ..... less than 1.00 mm

Synchro Ring Identification

All Forward 0058.8.5031.02

Reverse 0058.8.5111.00

End Float Clearances

M35 Transmission (260 Getrag)

Maindrive Gear ..... 0.00-0.09 mm

Cluster Gear ..... 0.13-0.23 mm

M34 Transmission (290 Getrag)

Cluster Gear ..... 0.12-0.22 mm

Reverse Idler Gear ..... 0.05-0.55 mm

Snap Ring Thicknesses

M35 Transmission (260 Getrag)

3rd/4th Synchro Assembly ..... 2.0-2.1-2.2-2.3-2.4-2.5 mm

1st/2nd Synchro Assembly ..... 1.8-1.85-1.9-1.95-2.0 mm

5th/Reverse Synchro Assembly ... 1.8-1.85-1.9-1.95-2.0 mm

M34 Transmission (290 Getrag)

3rd/4th Synchro Assembly ..... 1.80-1.85-1.90-1.95-2.00 mm

2nd Gear Bearing/Thrust Sleeve ... 2.00-2.05-2.10-2.15-2.20 2.25-2.30 mm

5th/Reverse Synchro Assembly ... 2.00-2.05-2.10-2.20-2.30 mm

Rear Mainshaft Bearing ..... 2.00-2.10-2.20-2.30 mm

Spacer/Shim Washer Thickness

M35 Transmission (260 Getrag)

Guide to Input Shaft Bearing ..... 0.3-0.4-0.5 mm

Input Shaft Bearing ..... 2.1-2.2-2.3-2.4-2.5 mm

Cluster Gear End Float 1.0-1.7-1.8-2.0-2.1-2.2-2.2mm

M34 Transmission (290 Getrag)

Maindrive Gear Spacer ..... 2.10-2.20-2.30-2.40-2.50 mm

Maindrive Gear Bearing Shim ..... 0.30-0.40-0.50 mm

Cluster Gear End Float Shim ..... 0.30-0.40-0.50-2.30-2.35-2.40-2.45-2.50 mm

Lubricant

Type

80W Gear Oil, Castrol VMX80W or similar

Capacity

M34 (Getrag 260) Transmission: .... 1.2 Litres

M35 (Getrag 290) Transmission: .... 1.8 Litres

Torque Wrench Specifications

M34 Transmission (260 Getrag)

Filler Plug: ..... 40-60 Nm

Drain Plug: ..... 40-60 Nm

Reverse Switch: ..... 20 Nm

VSS to Bracket Bolt: ..... 6-14 Nm

VSS Bracket to Trans: ..... 15-20 Nm

Flange Nut: ..... 22 Nm

Clutch Housing to Engine Brace: .... 50-85 Nm

Locking Lever Screw Plug: ..... 48 Nm

Trans Rear Case to Front Case: ..... 25 Nm

Reverse Idler Shaft Bolt: ..... 25 Nm

Reverse Idler Thrust Plate Bolt: ..... 25 Nm

Throwout Bearing Guide Bolts: ..... 10 Nm

Reverse Block Bolt: ..... 10 Nm

Rear Trans Case to Adaptor Bolts: .. 20-30 Nm

Rear Engine Mount to Adaptor Bolts: 50-60 Nm

M35 Transmission (290 Getrag)

Filler Plug: ..... 25 Nm

Drain Plug: ..... 40-60 Nm

Reverse Switch: ..... 20 Nm

VSS to Bracket Bolt: ..... 20 Nm

VSS Bracket to Trans: ..... 15-20 Nm

Flange Nut: ..... 22 Nm

Clutch Housing to Engine: ..... 30-45 Nm

Shift Detent Cover Bolts: ..... 10 Nm

Trans Rear Case to Front Case: .... 25 Nm

Reverse Idler Gear Shaft Bolt: ..... 25 Nm

Throwout Bearing Guide Bolts: ..... 10 Nm

Reverse Block Bolt: ..... 10 Nm

Gearshift Brace to Trans Bolt: ..... 15-35 Nm

Rear Trans Adaptor Bolt: ..... 95-115 Nm

Rear Engine Mount to Adaptor: ..... 50-65 Nm

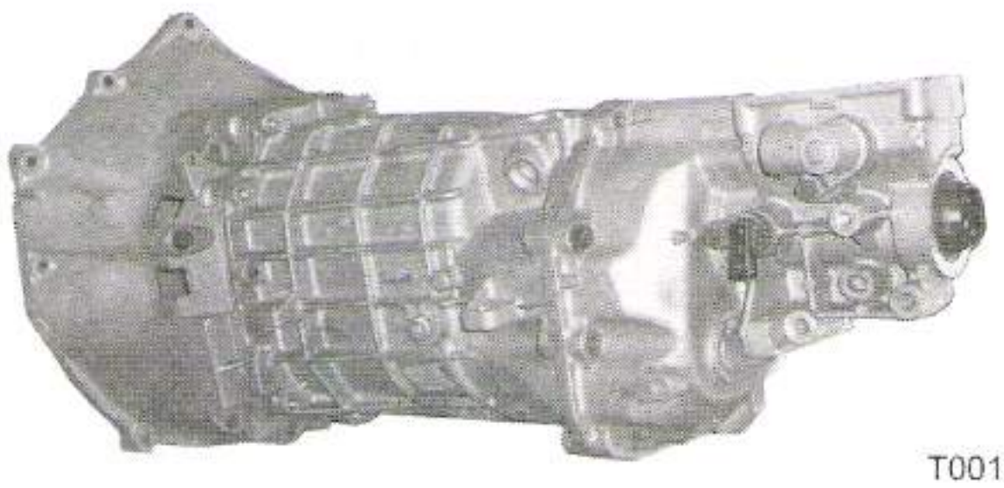
The Getrag 260 V6 manual transmission has a revised vehicle mounting, which includes a new transmission crossmember and rear extension housing casting to reduce gear noise intrusion into the cabin.

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MANUAL TRANSMISSION

Tremec-Type T56 - 6 Speed

Tremec T56



T001

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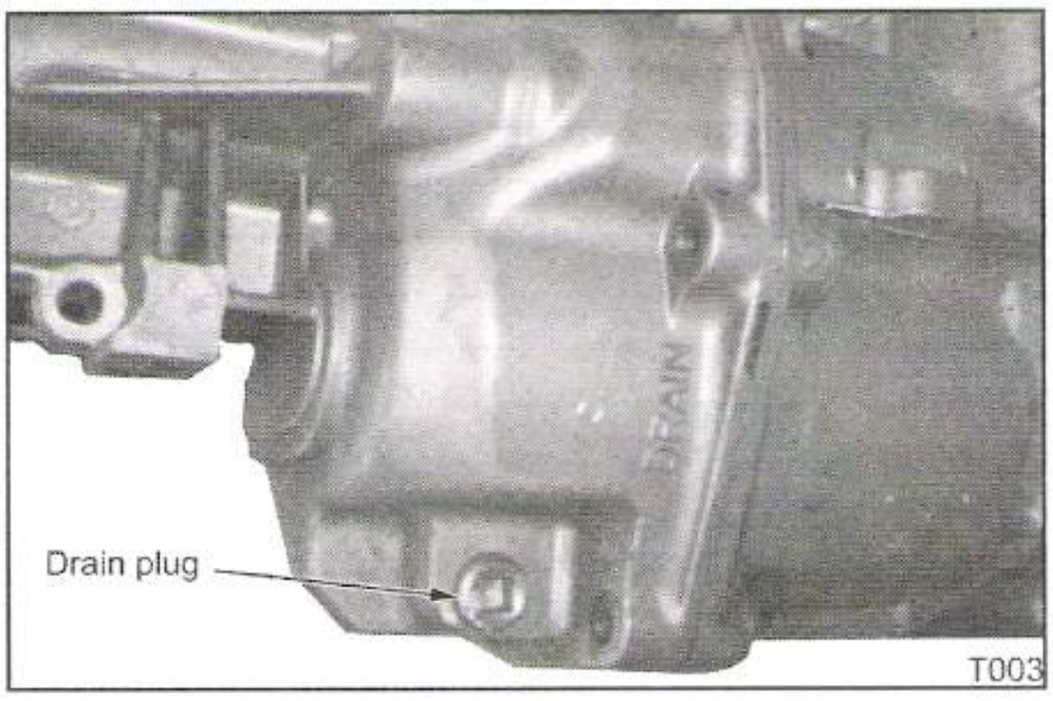
General Description

The Commodore with the Gen III has a 6 speed manual transmission Tremec Type T56 option code MM6 These transmissions are a 6-speed fully synchronised type, with a 3 piece transmission case with the clutch housing as a sperate component of the transmission case. Much of the transmission assembly is attached to the front adapter plate.

Maintenance

Drain & Refill Transmission

1. Position an oil drain tin under the transmission. Loosen the transmission filler plug. Loosen and remove the drain plug from the transmission, if the vehicle has been recently driven take care as the oil could be hot enough to burn skin on contact, when the oil has finished draining from the transmission replace the drain plug and tighten to specification.



Drain Plug: ..... 20-34 Nm

2. Remove the filler plug, refer to diagram for location. Fill the transmission with the correct amount of specified oil.

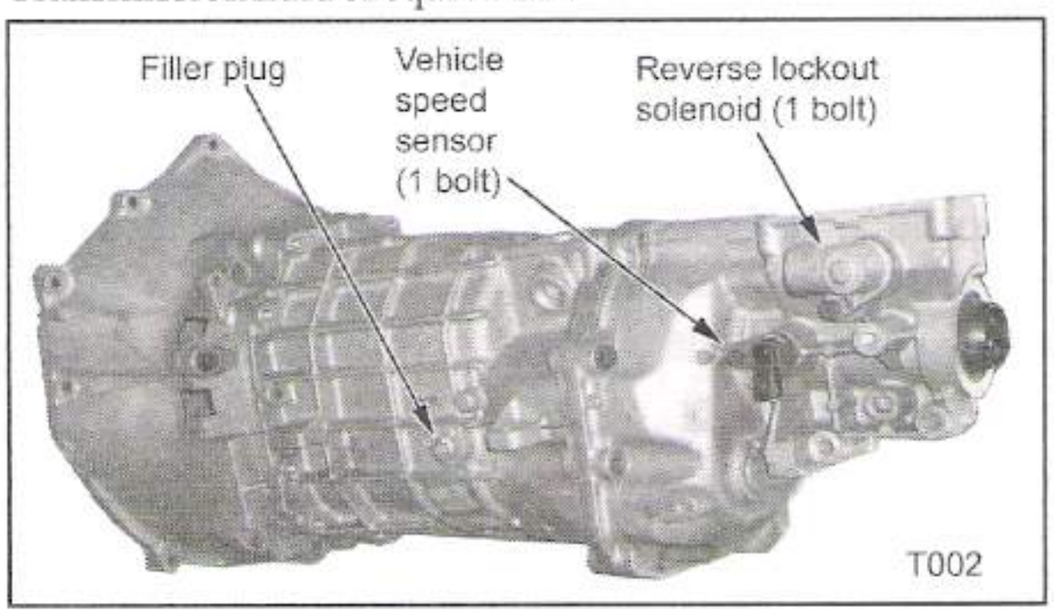
3. Remove reverse light switch, add 0.5 litre of Transmission fluid to reverse light switch hole.

4. Install reverse light switch, tighten, replace electrical wiring.

Oil Level: Oil should almost flow from the filler plug hole.

Oil Specification & Capacity

5. The transmission lubricant is Dexron III Automatic Transmission fluid or equivalent.

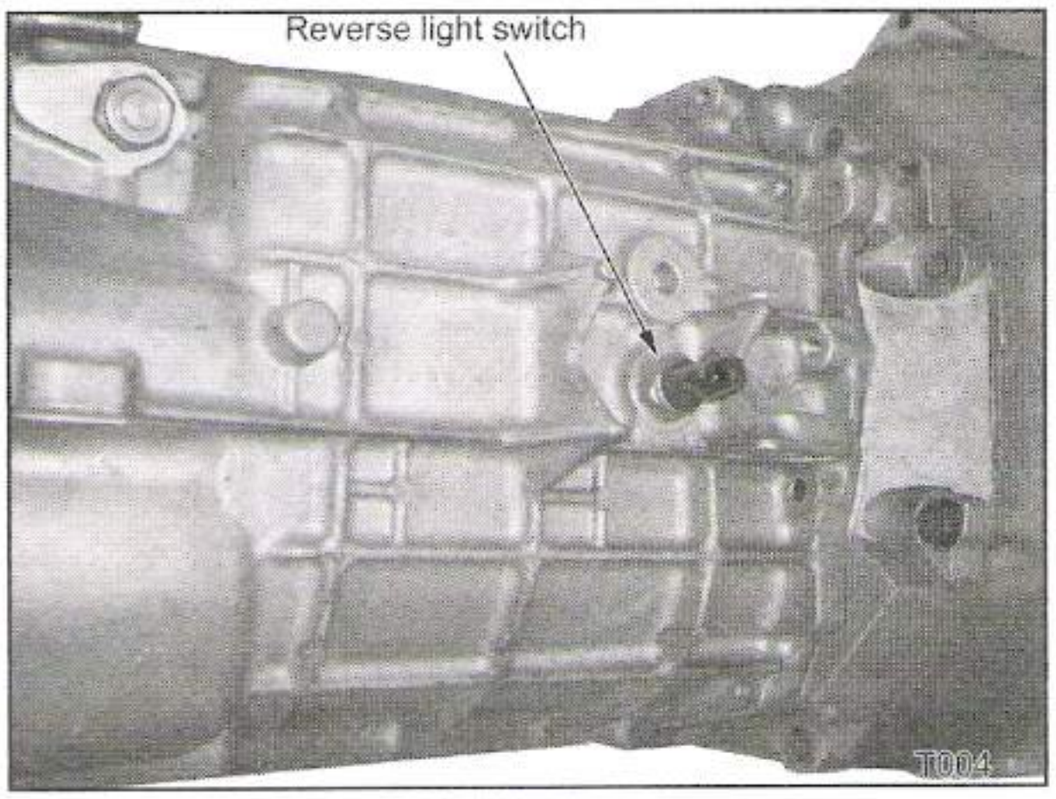


Capacity: approx 4.4 litre

Apply loctite 565 or similar to the filler plug, refit the filler plug and tighten to the specified torque

Filler Plug: 20 - 34 Nm

Reverse Light Switch



Remove

Detach electrical connector from reverse light switch and using a suitable size spanner, loosen and remove the switch from the transmission case.

Inspection

The reverse light switch can easily be checked using a multimeter. Set the multimeter to measure ohm's, then connect the test leads from the multimeter to the terminals on the switch, if there is continuity when the switch is depressed and no continuity when the switch is released then the operation of the switch is OK, otherwise the switch should be replaced.

Install

Clean threads of the switch and apply a suitable sealant to threads. Install the switch and torque to specification.

Torque: ..... 20 -34 Nm

Vehicle Speed Sensor (VSS)

Remove

1. Remove the front exhaust section from the manifolds to the rear of the catalytic converters.

2. Mark the position of the crossmember to aid in assembly

a) Support the transmission with a jack

b) Loosen and remove the 4 crossmember to underbody bolts

c) Lower the transmission enough to gain access to the VSS.

3. Detach the electrical connector at the VSS

4. Loosen and remove the VSS bracket mounting bolt.

a) Remove the VSS and bracket from the transmission

Inspection

Refer to the 'Diagnostics' chapter for correct procedure to check the VSS operation.

Install

1. Fit the bracket and VSS into position and torque the bolt

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to the specified torque
Torque: ..... 8-12 Nm
2. Connect the VSS electrical connector
3. Jack the transmission up into position and fit the 4 crossmember to underbody bolts.
a) Align the crossmember using the marks made on disassembly
b) Tighten the 4 bolts to the specified torque
Torque: ..... 50-65 Nm
4. Re-install the exhaust system section removed.

Reverse Lockout Solenoid

Remove

1. Remove the front exhaust section from the manifolds to the rear of the catalytic converters.
2. Mark the position of the crossmember to aid in assembly
a) Support the transmission with a jack
b) Loosen and remove the 4 crossmember to underbody bolts
c) Lower the transmission enough to gain access to the reverse lockout solenoid.
3. Detach the electrical connector at the reverse lockout solenoid
4. Loosen and remove the reverse lockout solenoid bracket mounting bolt.
a) Remove the reverse lockout solenoid and bracket from the transmission

Inspection

Refer to the 'Diagnostics' chapter for correct procedure to check the reverse lockout solenoid operation.

Install

1. Fit the bracket and reverse lockout solenoid into position and torque the bolt to the specified torque
Torque: ..... 15-20 Nm
2. Connect the reverse lockout solenoid electrical connector
3. Jack the transmission up into position and fit the 4 crossmember to underbody bolts.
a) Align the crossmember using the marks made on disassembly
b) Tighten the 4 bolts to the specified torque
Torque: ..... 50-65 Nm
4. Re-install the exhaust system section removed. Tighten the 6 bolts to the specified torque
Torque: ..... 20-30 Nm

Gearshift Knob & Boot Assembly

Note: The gearshift knob & boot are an assembly and cannot be separated.

Remove

1. Release the eight boot retainers.
2. Lift up the boot and take hold of the gear stick with one hand.
a) Grasp the gearshift knob with the other hand and while moving the knob from side to side lift the knob upwards until the retaining claws are released.
b) Lift off the gearshift knob and boot assembly.

Install

1. Fit the gearshift knob/boot over the gear stick and push the knob down into position until the clips lock into position on the shaft
2. Align the 8 boot retainer clips into position on the console and engage each clip into position

Gearshift Lever Assembly

Remove



1. Remove the gearshift knob/boot as previously described
2. Raise the vehicle and position on safety stands
a) Remove the gearshift knob and boot as previously described
3. a) Remove the lower shift lever cover.
b) Remove the 2 bolts attaching the lever to the transmission shaft lever.
c) Remove gearshift lever.

Install

1. Fit the gearshift assembly into position.
a) Fit the 2 bolts attaching the gear shaft lever and tighten to specified torque
Torque: ..... 15-35 Nm
b) Refit the lower shift lever cover.
2. Refit the gearshift knob and boot

Major Repairs

Transmission

Remove

1. Disconnect or remove the following:
a) Disconnect the battery terminals
b) Raise vehicle and place on safety stands
c) Drain the gearbox
d) Remove the tailshaft and exhaust engine pipes
2. Detach all of the electrical connectors from the transmission

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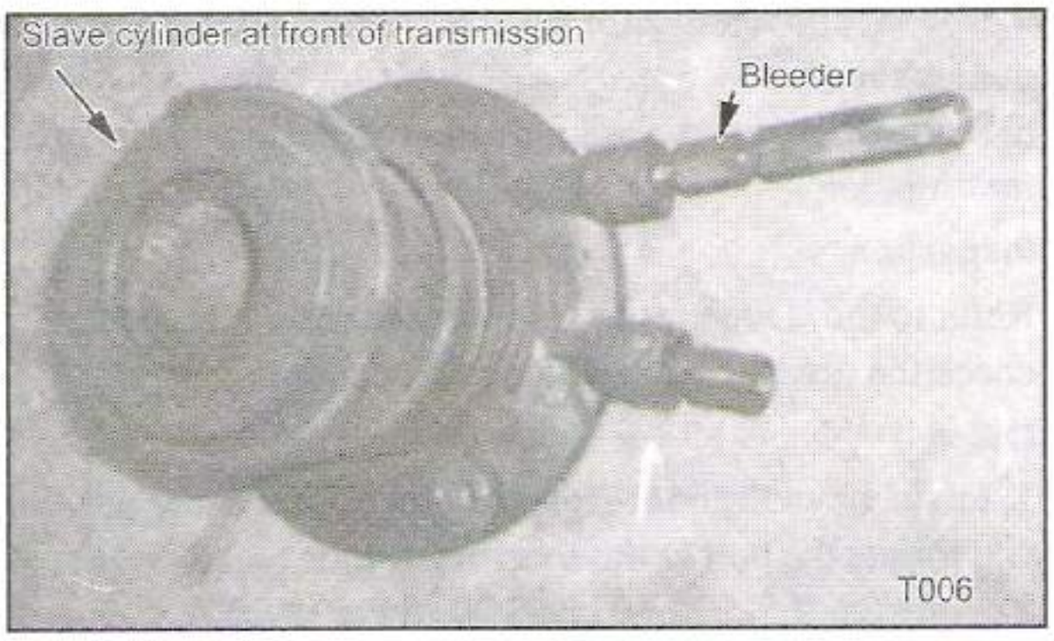
3. Disconnect the clutch fluid hose to transmission clutch fluid pipe, plug the ends of the hose and pipe to stop fluid leaking..
4. Remove the starter motor refer to 'Starter' chapter
5. Remove the lower flywheel cover
a) Remove the side cover plates, 1 bolt each.
6. Support the engine and transmission assembly with a transmission jack.
a) Mark the position of the crossmember to aid assembly
b) Loosen/remove the crossmember to underbody and crossmember to mount nuts
c) Remove the crossmember
d) Disconnect the gearshift brace and gearshift rod from the transmission
7. Lower the transmission enough to gain access to the clutch housing bolts
a) Loosen and remove the clutch housing bolts
8. Carefully remove the transmission assembly from the vehicle. Use a transmission support plate and jack.
a) Move the transmission rearwards to dislodge the alignment pins.
b) Support the transmission to avoid damage to the clutch assembly and transmission input shaft.
c) Turn the transmission to the right 90 deg to allow clearance of the floor pan.
d) Remove transmission by pulling rearwards and lower.

Install

1. a) Install the clutch slave cylinder pipe if removed.
Clutch slave cylinder pipe: 12-14Nm
b) Apply 10% molybdenum grease to clutch throwout bearing face and the splines of the input shaft.
c) Move the gear shift lever to 3rd position to help floor clearance.
2. Position transmission on the transmission jack 90 deg to right off vertical to allow clearance of the floor pan. Raise transmission and move it forward until the input shaft splines enter the clutch hub splines and close to guide pins, rotate to vertical position and fit onto the guide pins and the case is placed against the clutch housing.
3. Install the transmission clutch housing to engine bolts. Tighten all bolts to specification.
Clutch Housing bolts Torque: 40-60 Nm
4. Connect the gearshift brace and gearshift rod and clips
a) Connect the electrical connectors etc.
5. Fit the crossmember to the transmission mount 2 nuts
a) Raise the transmission and fit the crossmember to underbody bolts
b) Align the crossmember marks made on disassembly and tighten the crossmember to underbody bolts to specified torque
Torque: ..... 50-65 Nm
c) Tighten the crossmember to engine mount nuts
Torque: ..... 20-30 Nm
6. Fit the lower flywheel cover
a) Position the side covers, 2 bolts.
Torque: ..... 5-10 Nm
7. Install the catalytic converter bracket, 7 bolts and nuts.
Catalytic Converter Bracket: 40-60Nm
8.# *Hint: this step will correctly align transmission and help to remove any transmission vibration.*
Remove transmission support jack, remove the 4 nuts for the rear mount studs into the crossmember holes.
Loosen the catalytic convert bracket 7 bolts and nuts.
Align the crossmember marks made on disassembly and tighten the crossmember to underbody bolts to specified torque
Torque: ..... 50-65 Nm
Tighten the catalytic converter bracket, 7 bolts and nuts.
Catalytic Converter Bracket: 40-60Nm
9. Refit the starter motor etc. refer to 'Starter' chapter
10. Refit tailshaft, exhaust pipes etc. fill transmission with oil.

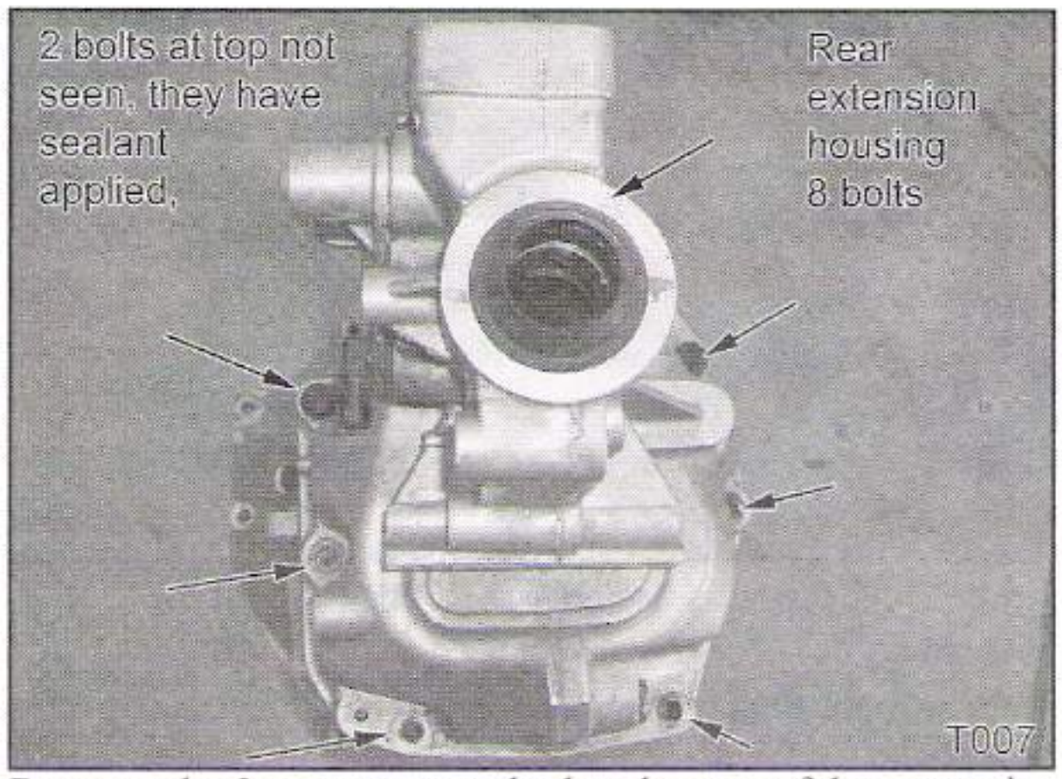
Dismantle

1. Place transmission on a clean bench to enable a complete pull down and rebuild.
2. Loosen and remove the clutch slave cylinder 2 bolts, pipe connection, remove slave cylinder.



3. Remove the clutch housing bolts, disconnect the clutch slave cylinder pipe and remove. Remove the clutch housing. Remove the vent pipe.
4. Remove the reverse light switch
5. *Hint: Place a transmission support plate to the front adapter plate fixed to a bench or strong vice, to help dismantle and assembly.*
a) Select 4th gear, remove the gear shift lever top cover, 4 bolts.
b) Remove the shifter assembly, 4 bolts, tap with soft head hammer if required.
c) Support the shift selector rod with a block of wood
d) Use a pin punch and hammer to remove the roll pin from the shift finger and shaft
e) Remove the finger and inspect bush, if loose replace bush and finger.
6. Remove the rear extension housing, 8 bolts. Tap with a soft hammer and user a lever if necessary to remove the housing.
Transmission ID plate is attached by 1 of these bolts, keep to reinstall.

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Remove the 2 magnets attached to the rear of the transmission case, clean and inspect for metal particles.

7. Speedo pulse ring.

a) Remove spacer ring from main shaft.

b) Use appropriate pliers to remove snap ring from in front of speedo pulse ring.

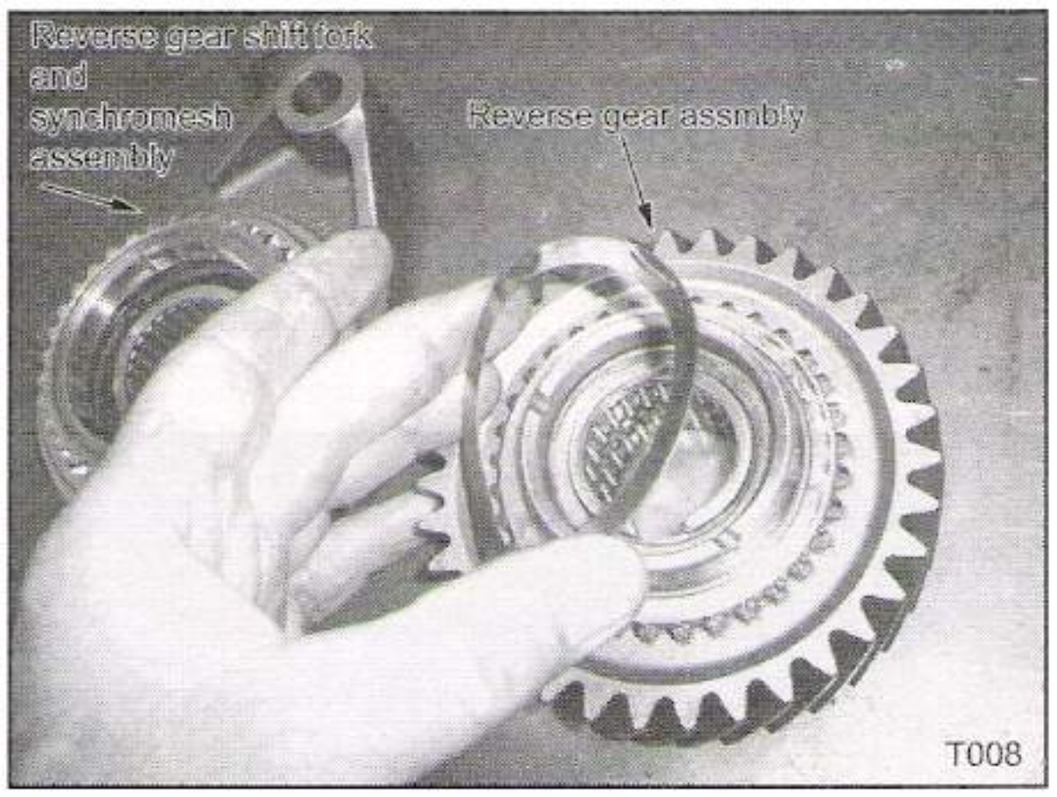
c) Use a puller to remove speedo pulse ring.

d) Use appropriate pliers to remove snap ring from in behind speedo pulse ring.

8. Remove reverse and 5th-6th driven gear.

a) Remove snap ring, spacer, roller bearing race snap ring and thrust washer.

b) Remove the reverse gear and caged roller bearing as a unit.



c) Remove wave washer, reverse gear blocker ring.

d) Remove the circlip from the reverse shift fork shaft.

e) Remove the snap ring from in front of reverse synchromesh ring unit.

f) Slide the reverse synchromesh unit, thrust washer and shift fork as an assembly.

g) Use a puller to remove the 5th-6th driven gear from the main shaft.

9. Remove 5th and 6th drive gears from counter shaft extension.

a) Remove the circlip from the 5th-6th shift fork and shift rail.

b) Remove as an assembly, counter shaft extension shaft, 5th drive gear, shifter fork, snap ring, spacer, 6th gear block ring, 6th drive gear with caged bearing and thrust washer.

10. Remove the front offset shifter finger and transmission case. Place transmission in a vertically position on a bench.

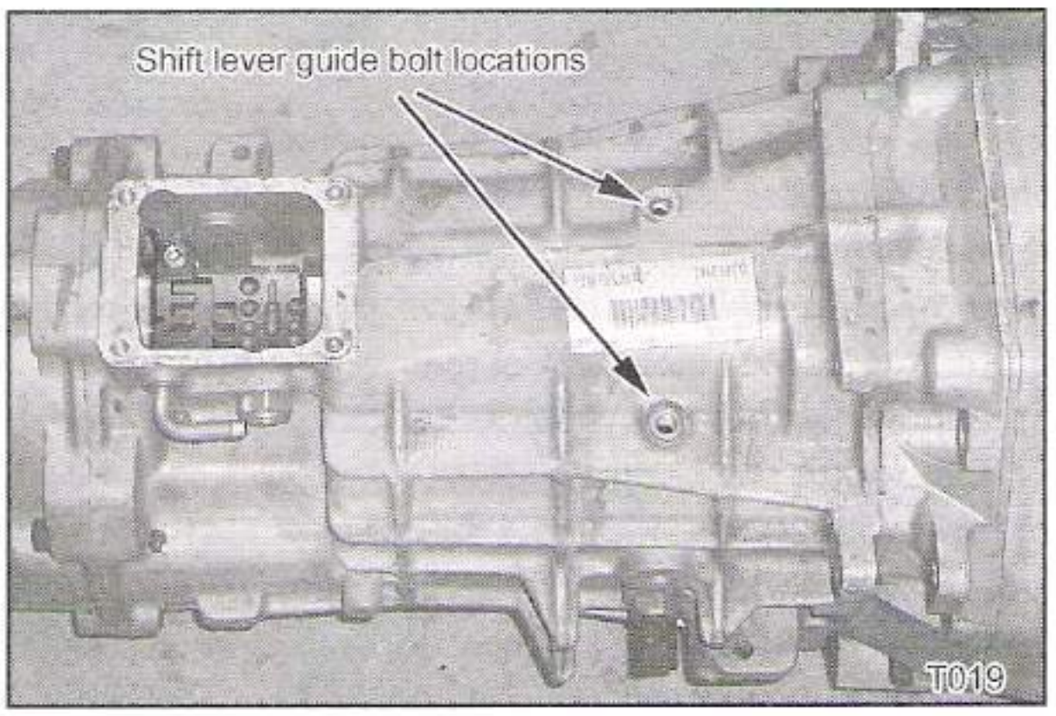
a) Remove the guide plate cover from transmission case, 4 bolts, cut sealant, do not bend cover.

b) Use a pin punch and hammer to remove the roll pin from the shift finger and front offset lever shaft.

c) Remove shift enhancer, 1 bolt.

d) Remove the 2 torx T40 bolts from the outside of the case.

Hint: The torx screws have sealant so may be difficult to remove.



e) Remove the 10 bolts attaching the transmission case to the front adapter plate.

f) Use the moulding provided to lever a screw driver this will assist in breaking the seal between the case and adapter plate, remove case, lift up. Support front offset lever while lifting case.

Hint: Hold the guide plate and front offset lever assembly while lifting, this will help keep the detent ball and spring from falling out.

g) Remove the 2 torx T40 screws from the guide plate, remove plates.

11. Remove assemblies from adapter plate.

a) Remove 5th and 6th shift rail assemblies. Turn the shift levers away from the interlock plate and remove levers and rails from the adapter plate.

b) Move the mainshaft and shift forks to free the counter gear shaft, remove counter gear shaft.

c) Remove the mainshaft and shift forks from the adapter plate as a unit.

d) Remove the input shaft assembly from the adapter plate.

Mainshaft

Dismantle

1. Remove "O" ring from rear of the rear shaft bearing.

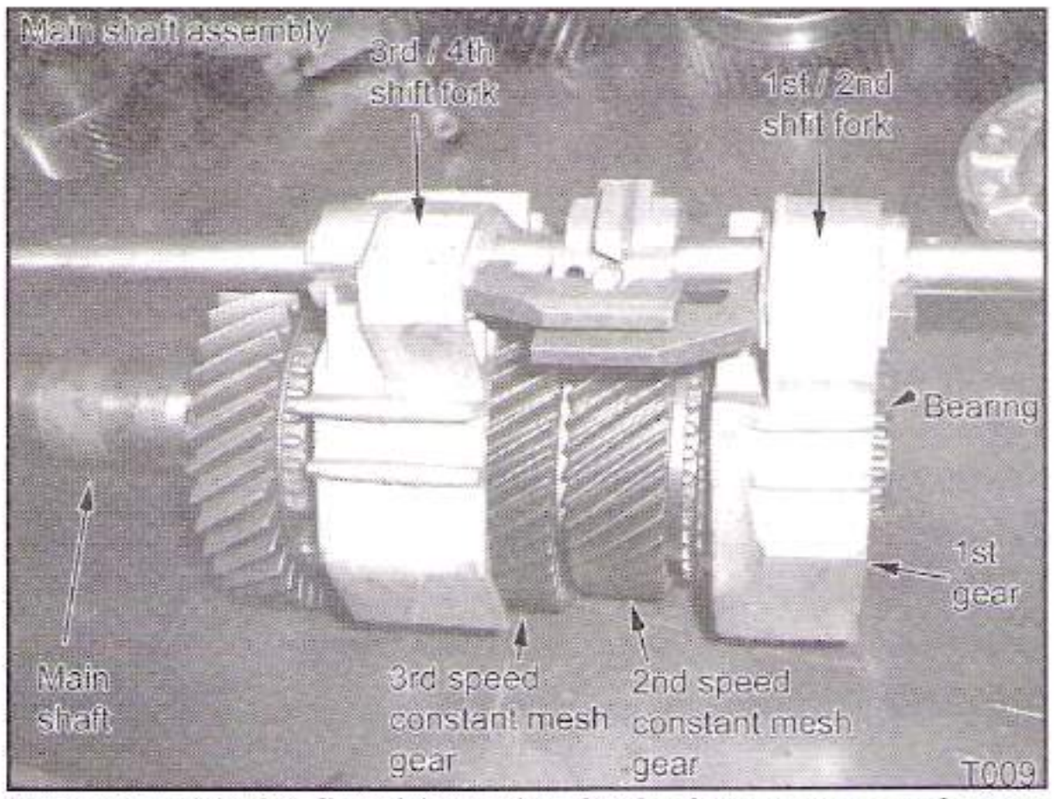
2. Slide the rear bearing from the main shaft.

3. Slide the 1st gear and caged bearing from the mainshaft.

4. Remove the 1st/2nd synchromesh assembly and 2nd gear.

a) Remove snap ring, thrust washer, inner cone, friction cone, blocker ring from the mainshaft.

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b) Press with the flat side under the 2nd constant mesh gear and synchromesh assembly from the mainshaft.

#Note the blocker ring, fricton cone, 2nd speed inner cone, thrust washer are included in the above assembly.

c) Remove caged bearing if not removed with 2nd gear.

5. Remove the 3rd/4th synchromesh and 3rd speed gear.

a) Remove the snap ring.

b) Press with the flat side under the 3rd constant mesh gear and synchromesh assembly from the mainshaft.

#Note the blocker ring, fricton cone, 3rd speed inner cone, thrust washer are included in the above assembly.

c) Remove caged bearing if not removed with 3rd gear.

6. Remove front bearing from main shaft only if necessary, use a press.

Assembly

1. Coat the mainshaft, gear bores and needle rollers with transmission lubricant.

2. Mount the main shaft in a press, clamped under the flange, press a new spigot bearing into place (if removed).

Hint use a 21mm socket as a press tool.

3. Install 3rd gear and 3rd/4th synchromesh assembly.

a) Install 3rd gear caged bearing, 3rd gear, blocker ring, plastic sleeve.

b) Install 3rd/4th synchromesh assembly, use a 47mm ID, 5mm rim tool.

c) Hold the 3rd gear and blocker ring aligned with the synchromesh, make sure the locating dogs align with the synchromesh keys.

4. Install the 2nd gear and synchroniser assembly.

a) Install 2nd gear caged bearing, 2nd gear, blocker ring.

b) Install 1st/2nd synchromesh assembly, use a 50mm ID, 5mm rim tool.

c) Hold the 3rd gear and blocker ring aligned with the synchromesh, make sure the locating dogs align with the synchromesh keys.

Input Shaft

Dismantle

Hint: Remove bearing assembly only if required.

1. Place input shaft in press and press bearing from input



shaft. The bearing is not reusable once pressed off.

Assembly

1. Place input shaft in press and press a new bearing cup onto the shaft.

2. Press a new bearing onto the mainshaft, use a press tool 32mm ID 5mm rim.

Countershaft

Dismantle

Hint: Remove bearing assembly only if required.

1. Rear Bearing: Place countershaft in press and press bearing from countershaft. The bearing is not reusable once pressed off.

2. Front Bearing: Place countershaft in press and press bearing from counter shaft. The bearing is not reusable once pressed off.

Assembly

1. Press a new bearing onto narrow end of shaft. Place countershaft in press and press a new bearing onto the shaft, use a press tool 40mm ID 4mm rim.

2. Press a new bearing onto larger end of shaft. Place countershaft in press and press a new bearing onto the shaft, use a press tool 36mm ID 4mm rim.

Countershaft Extension

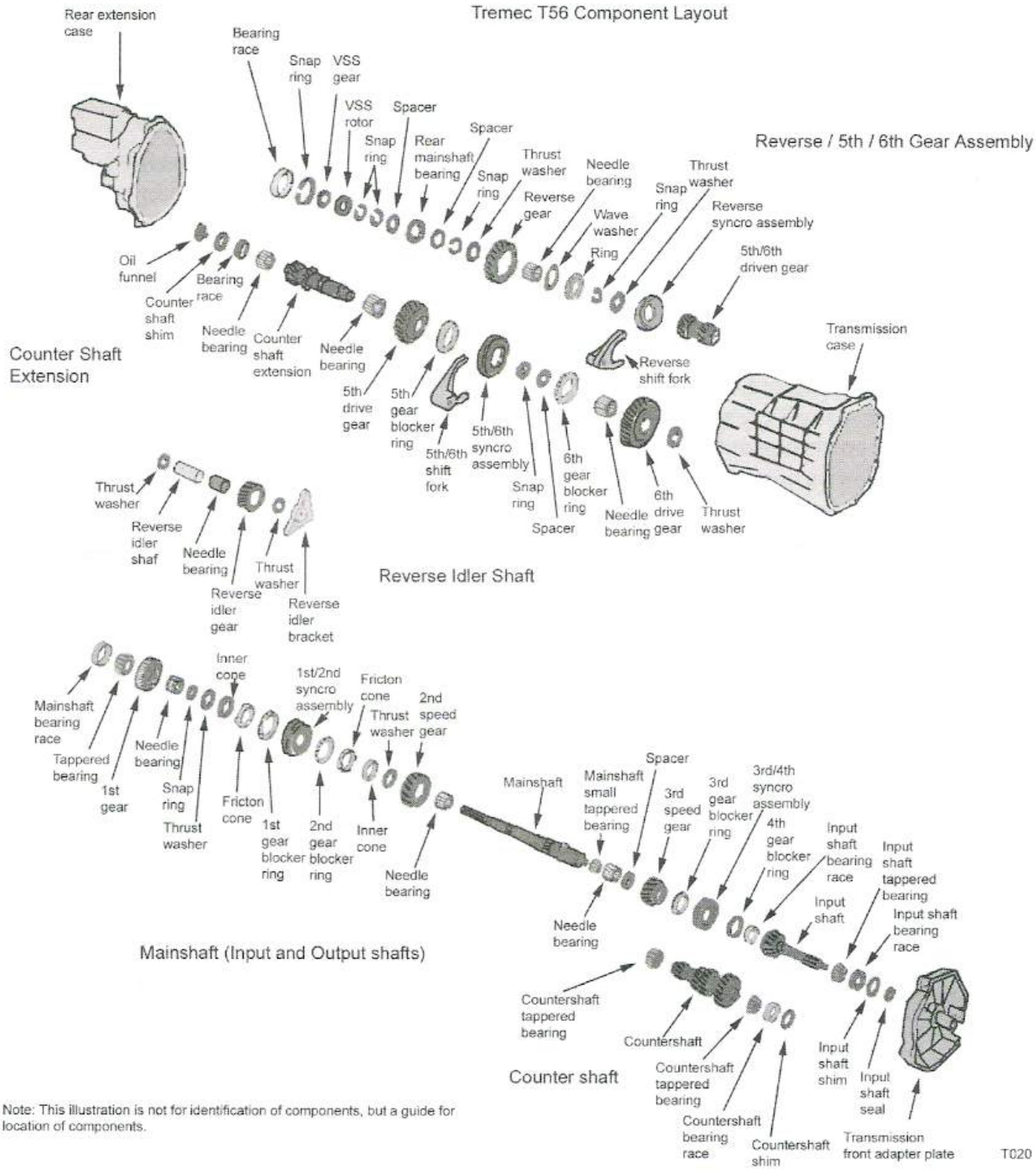


Dismantle

Countershaft extension assembly.

1. Remove the thrust washer, caged bearing, 6th drive gear, 6th gear block ring, spacer

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Note: This illustration is not for identification of components, but a guide for location of components.

2. Remove snap ring retaining 5th/6th gear synchromesh.
3. Press with the flat side under the 5th speed gear and synchromesh assembly from the countershaft.
4. Place countershaft extension in press and press bearing from countershaft extension. The bearing is not reusable once pressed off.
Hint: Remove bearing assembly only if required.

Assemble

1. Place countershaft extension in press and press a new bearing onto the shaft, use a press tool similar to 21mm socket.
2. Slide on these components. caged bearing, 5th gear block ring, 5th/6th synchromesh assembly.
3. Press the assembled countershaft extension into the synchromesh hub.
4. Install the snap ring.
5. Slide on spacer washer, caged bearing, 6th speed blocker ring, 6th speed drive gear. Thrust washer (recessed side towards countershaft gear.)

Synchromesh Assemblies

Inspection

Before dismantling any of the synchro assemblies mark the relationship between the synchro hub and sleeve. Use a permanent marker or similar. Cover the assembly in a piece of rag and separate the hub from the sleeve, take care not to

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lose any of the keys, springs or balls.
Inspect and install
1. Check the synchro rings for any cracks, deformation or excessive wear.
2. Inspect the synchro hubs, sliding blocks, outer sleeves and springs for any damage.
3. Fit the synchro ring to its respective gear.

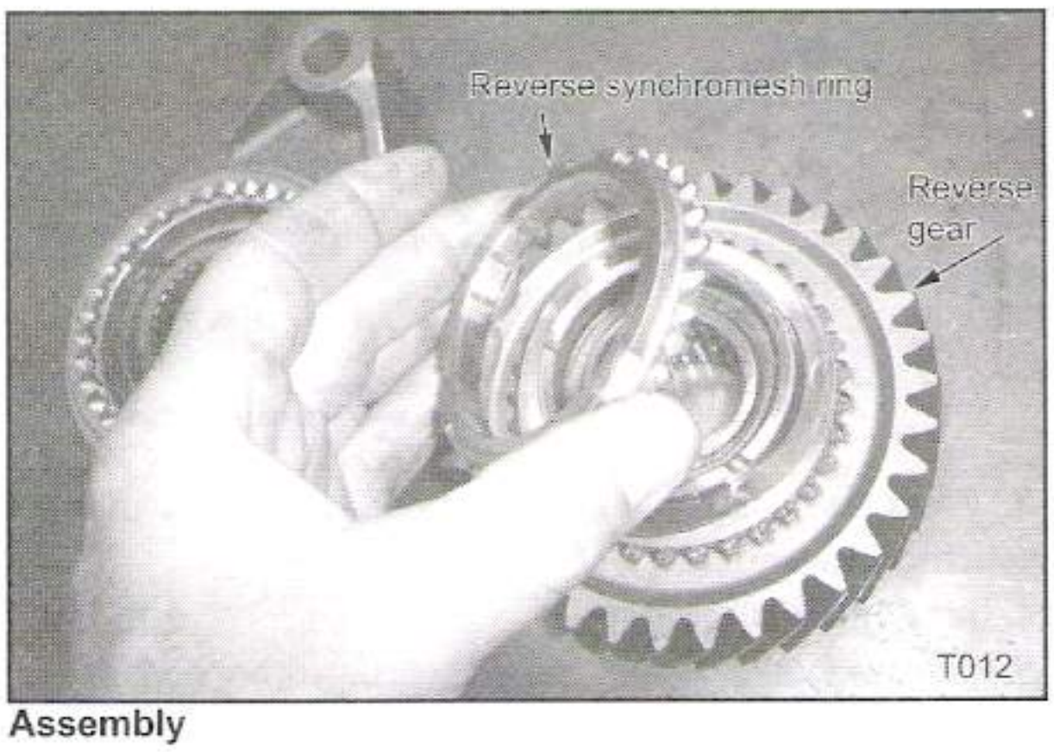
Assembly

1. Place the synchro hub on the workbench and use a suitable spacer to raise the hub about 6 mm off the bench
2. Fit the sleeve into position and let it rest on the work bench
3. Fit the 3 keys and springs into position
a) Use a small screwdriver to hold each key upwards and insert the ball into position, release the key
Repeat above for the remaining 2 key/spring combinations.
Assembly for all of the synchro assemblies is basically the same except for the following notes.

Reverse Synchromesh Assemblies

Dismantle

Before dismantling any of the synchro assemblies mark the relationship between the synchro hub and sleeve. Use a permanent marker or similar. Cover the assembly in a piece of rag and separate the hub from the sleeve, take care not to lose any of the keys, springs or balls.
Inspect and install
1. Check the synchro rings for any cracks, deformation or excessive wear.
2. Inspect the synchro hubs, sliding blocks, outer sleeves and springs for any damage.
3. Fit the synchro ring to its respective gear.



Assembly

1. Place the synchro hub on the workbench and use a suitable spacer to raise the hub about 6 mm off the bench
2. Fit the sleeve into position and let it rest on the work bench
3. Fit the 3 keys and springs into position
a) Use a small screwdriver to hold each key upwards and insert the ball into position, release the key
Repeat above for the remaining 2 key/spring combinations.
Assembly for all of the synchro assemblies is basically the same except for the following notes.

Reverse Idler Gear

Dismantle

1. Remove the idler gear support plate, 3 Torx screws (T40).
2. Remove support plate, thrust washer, idler gear with caged bearing, thrust washer. Remove shaft if required.

Assemble

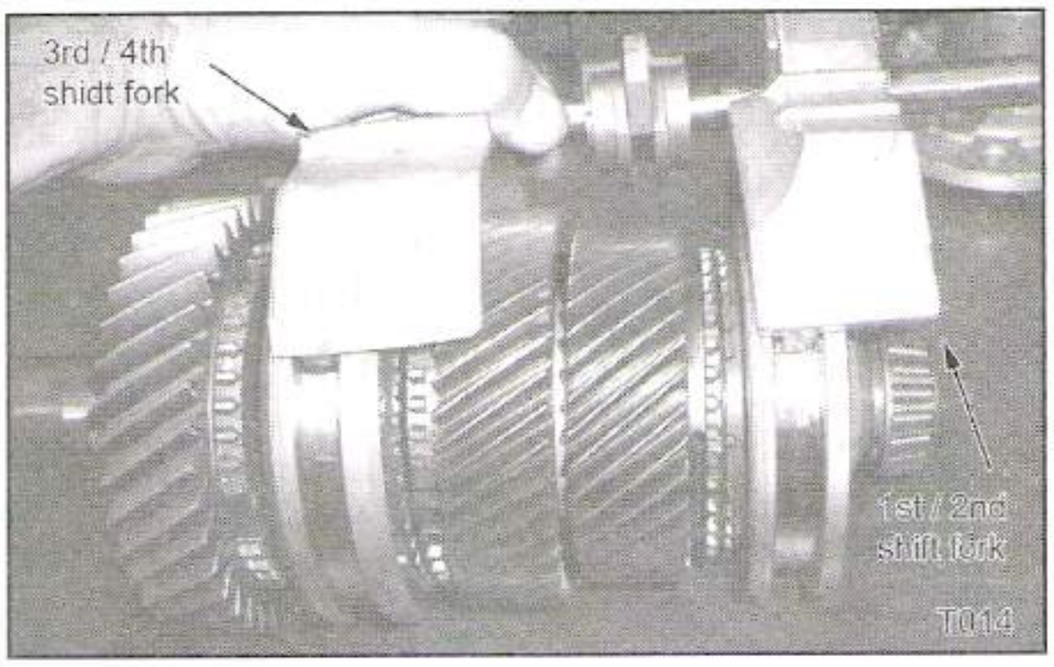
1. Install shaft into extension if removed.
2. Install thrust washer, caged bearing, idler gear, thrust washer and support plate.
3. Install 3 Torx screws with loctite 242 and tighten.

Idler Reverse Gear Plate Torx: 19-30Nm

1st/2nd & 3rd/4th Gear Shift Rail and Forks

Dismantle

1. Turn the interlock plate is free of the shift plate links.
2. Remove the 3rd/4th shift fork from the shift rail.
3. Remove the 1st/2nd shift fork from the shift rail.
4. Slide the interlock plate from the shift rail and punch the roll pin from the selector pin, if necessary.



Assemble

1. Slide the selector pin on the shift rail and punch in the roll pin.
2. Install the interlock plate over the selector pin, push on the 1st/2nd shift fork, fit over shift rail while turning the interlock plate to allow the link to be installed.
3. Install the interlock plate over the selector pin, push on the 3rd/4th shift fork, fit over shift rail while turning the interlock plate to allow the link to be installed.
4. Turn the interlock plate to mesh the two shift fork links.

5th/6th & Reverse Gear Shift Rail and Forks

Dismantle

Tip: Only remove bushes and sleeve from shift rail if replacement is required.

1. Punch the roll pin from the collar and shift rail.
2. Remove the 5th/6th shift rail lever from the shift rail.
3. Punch the roll pin attaching the reverse shift rail lever to the shift rail. Remove the reverse shift lever from shift rail.

Assemble

1. Slide on reverse shift lever and punch in new roll pin.
2. Install 5th/6th shift lever onto shift rail.
3. Install collar, punch a new roll pin in to secure.

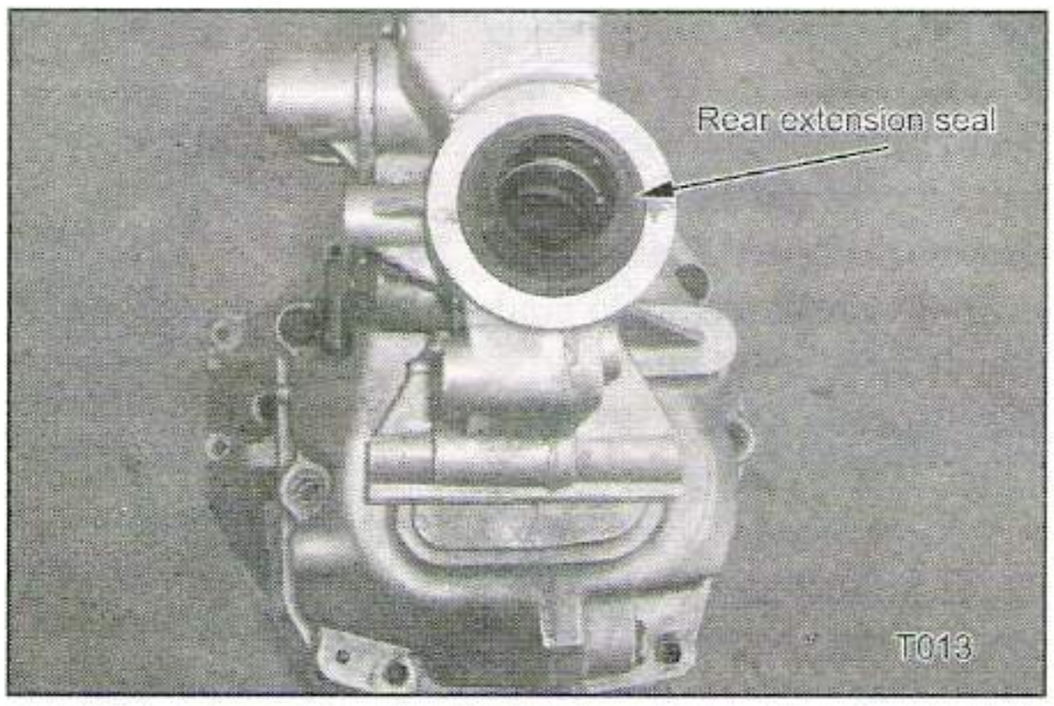
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Rear Extension Housing and Rear Oil Seal

Dismantle

1. Remove the rear oil seal with a screw driver or oil seal remover and discard.
2. Remove by prizing the countershaft gear extension rear bearing cup, shim, and oiler.
3. Remove the mainshaft rear bearing.

a) Remove the snap ring with snap ring pliers, press or punch the bearing cup out.



Assemble

1. Install the mainshaft rear bearing.

a) Press a new bearing cup into place.

b) Install the snap ring.

2. Install the oiler, shim/s and countershaft rear bearing cup.
3. Install a new seal oil, tap home with a seal insertion tool or a flat surface plate.

Transmission Case Inspection

If an aluminium transmission case thread is damaged, service kits may be purchased from local jobbers to service a damaged thread.

Drill out the damaged threads, using same drill size as the thread OD. Tap drilled hole. The tap is marked for the size of the thread being serviced. It cuts a thread large enough for the insert, and after the insert is installed to the original thread size.

Select coil inserting tool. Place insert on the tool and adjust the sleeve to the length of the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert in one-half turn below the face.

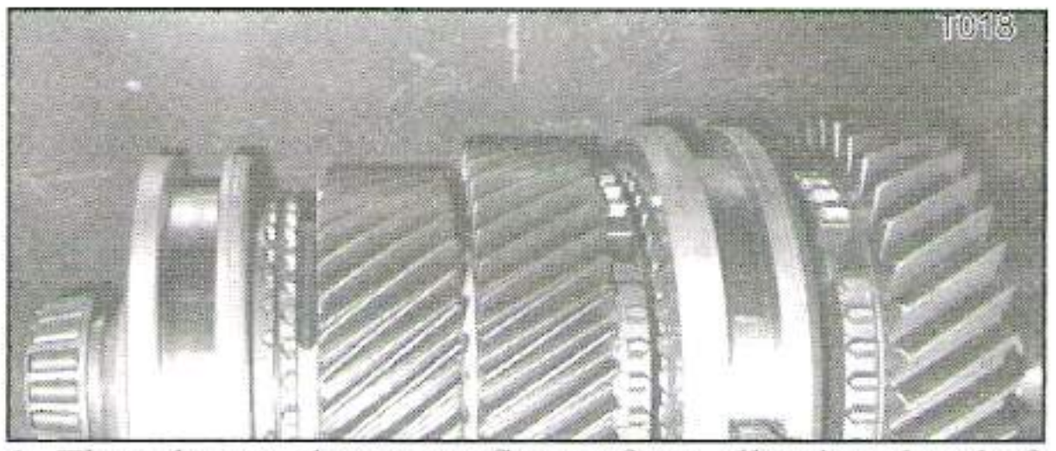
Working through the insert, bend the insert tang straight up and down until it breaks off at the notch. Position extractor tool in the insert so that the blade rests against the top coil one-fourth to one-half turn away from the end of the coil. Exert downward pressure on the tool and turn it counter clockwise until the insert is removed.

With insert on tool adjust sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is one-half turn below the face.

Checking Shim Tolerances

Input Shaft / Mainshaft and Counter shaft

It is easier to assemble the transmission if the adapter is in a suitable holding bracket and vice, to enable the transmission to be rotated.



1. The adapter plate on a flat surface, allowing the shaft assemblies to be installed in a vertical position.
2. Install the input shaft, 4th blocking ring and mainshaft to the bearing cup in the adapter plate.
3. Slightly lift the mainshaft as you install the countershaft into the appropriate front bearing.
4. Install transmission case over the shaft assemblies onto the adapter plate, install 8 bolts and tighten.

Case to Adapter Plate bolts: 30-41Nm

5. Mount a dial indicator at the end of the mainshaft with some free play. Turn transmission 180 deg (upside down), adjust dial indicator to end of mainshaft, lift mainshaft up and down to measure freeplay, specified freeplay.

Mainshaft Freeplay: 0.00-0.05mm

Select a shim from the 37 available between 0.559 - 1.372mm to give specified freeplay.

6. Transmission vertical, move dial indicator to measure the movement of the countershaft. Insert a rod through the adapter plate plug hole to move the countershaft up and down, to allow the freeplay measurement, specified freeplay.

Countershaft Freeplay: 0.00-0.05mm

Select a shim from the 33 available between 0.356 - 1.372mm to give specified freeplay.

Countershaft Extension

#Note: Countershaft freeplay can not be measured until the correct shims have been installed for the mainshaft and countershaft.

1. Transmission vertical, remove case, lift mainshaft enough to allow countershaft to be removed.
2. Remove mainshaft, remove input shaft and blocking ring.
3. Remove the input shaft bearing cup from the adapter plate by hand keeping it straight so it does not jam.
4. Remove the countershaft shaft bearing cup from the adapter plate by hand keeping it straight so it does not jam.
5. Insert the correct shims to obtain the specified tolerance for each shaft.
6. Install the bearing cups for both mainshaft and countershaft.
7. Install the input shaft, 4th blocking ring and mainshaft to the bearing cup in the adapter plate.
8. Slightly lift the mainshaft as you install the countershaft into the appropriate front bearing.

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9. Install transmission case over the shaft assemblies onto the adapter plate, install 8 bolts and tighten.
Case to adapter plate bolts: 30-41Nm
10. Install countershaft extension, make sure the recessed side of the thrust washer is towards the countershaft, and dogs of the extension are fully engaged into those of the countershaft.
11. Install the rear extension housing to the transmission, 8 bolts, tighten to specification.
Rear Extension to Case bolts: 30-4Nm
12. Insert special tool rod J39444-2 through adapter plate hole (remove plug if necessary) and hollow countershaft, screw special tool rod J39444-2 into countershaft.
13. Mount a dial indicator to the adapter plate to measure the movement of the tool rod.
Lift the tool rod up and down to measure freeplay, specified freeplay.
Countershaft Extension Freeplay: 0.05-0.13mm
Select a shim from the 33 available between 0.559 - 1.372mm to give specified freeplay.
Install adapter plug with sealant loctite 565 or similar, tighten.
Adapter countershaft plug: 20-34Nm
14. Remove rear extension. Remove by prizing the countershaft gear extension rear bearing cup, shim/s, and oiler.
15. Install the oiler, shim/s to obtain correct tolerance, and countershaft rear bearing cup.
16. Remove transmission case.
17. Remove the mainshaft and countershaft.

Transmission Assemble

Transmission Case
1. Reinstall the front lever guide plate ("H" pattern in plate to trans rear) to case, 2 torx bolts, tighten.
Shift Guide Plate Torx T40: 16-27Nm

Input Shaft / Mainshaft and Counter shaft and Shift Rails
It is easier to assemble the transmission if the adapter is in a suitable holding bracket and vice, to enable the transmission to be rotated.
Note: Lubricate the gear, shaft and shift assemblies with clean transmission oil before assembly, this is a must.
1. The adapter plate on a flat surface, allowing the shaft assemblies to be installed in a vertical position.
2. Install a new oil seal for the input shaft to the adapter plate.
3. Install the input shaft to the adapter plate.
4. Install blocker rings to input shaft.
5. Install mainshaft with 1st/2nd and 3rd/4th shift shaft and forks.
Tip: The 4th speed blocker rings must be engaged with the synchromesh assembly keys.
6. Install the countershaft to the adapter plate, slightly lift the mainshaft as you install the countershaft into the appropriate front bearing.
7. Install the shift rail assembly for 5th/6th and reverse, align slots of the shift rail levers with interlock plate and selector pin.
8. Apply sealant to adapter plate, loctite "Ultrablack 598" or similar.
Install the case over the mainshaft and shift shaft assemblies.
Push the front offset lever to the detent ball and spring. Hold the detent ball to the guide plate, in "Neutral" position, this will align the front offset lever with the shift shaft.
Gently but firmly press the case over adapter plate guide pins, install 8 bolts and tighten.
Case to Adapter Plate bolts: 30-41Nm
9. Apply thread sealant to guide plate bolts, loctite 242 or similar, install and tighten.
Shift Lever Guide Plate Bolts: 20-34Nm
Tip: If necessary pull down on the 5th/6th and reverse shift shaft to align bolt holes with interlock plate.
10. Align the front offset lever with the hole in the shift shaft, punch in a new roll pin.
#Tip: Insert a small rod into the rear offset lever roll pin hole in the shift shaft. Move the shift shaft through all the detent ball positions to check free movement of the shift selector forks. If this is difficult, the case must be removed to fix the problem and reinstalled.
11. Install shift enhancer, apply sealant loctite 242 or similar, tighten.
Shift Enhancer: 34-48Nm
12. Install front offset lever cover plate, apply sealant loctite "Ultrablack 598" or similar, install 4 bolts and tighten.
Front Offset Lever cover Plate bolts: 15-20Nm
Counter shaft Extension
The countershaft extension should be assembled as previously described.
1. Install to the countershaft extension shaft spacer, 6th gear blocker ring, 6th drive gear, 6th drive gear caged bearing and thrust washer (recessed side of thrust washer to face countershaft).
2. Fit the 5th/6th shift fork to the countershaft extension as shown, install assembly including the shift fork to the countershaft and shift fork over the 5th/6th shift rail lever sleeve.
Turn the countershaft extension back and forward to lock in dog teeth of countershaft extension to mating dogs on the end of the countershaft.
3. Install circlip into groove of 5th/6th shift rail lever sleeve.
5th/6th Driven Gear
Slide the 5th/6th speed driven gear onto the mainshaft. The inner gear splines must align with the mainshaft.
Push or Tap home with a tube that fits over the mainshaft. (there is a special tool J3944-1 and 2 that screws into the mainshaft to press gear home)
Note: Small gear facing inwards, and rotate the 5th and 6th

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drive gears on the countershaft to allow the 5th/6th speed driven gear to be installed.

Reverse Synchromesh Assembly

Install the reverse synchromesh assembly and reverse shift fork. Reverse synchromesh assembly over the mainshaft and reverse shift fork over shift shaft. The synchromesh key retainer must face the 6th speed driven gear.

Install the circlip to the reverse shift fork and shaft.

Reverse Speed Gear

1. Install the reverse gear blocker ring, align with synchromesh keys.
2. Install wave washer, reverse gear caged bearing, reverse gear, thrust washer.
3. Install a new snap ring to secure reverse driven gear.
4. Install spacer, rear mainshaft roller race (bearing), spacer.
5. Install a new snap ring to secure bearing race etc.

Speedometer Pulse Ring

1. Install a new inner snap ring to the main shaft to locate the speedometer pulse ring.
2. Install the speedometer pulse ring onto mainshaft.

Push or Tap home with a tube that fits over the mainshaft. (there is a special tool J3944-1 and 2 that screws into the mainshaft to press gear home)

3. Install a new snap ring to the outer speedometer pulse ring groove, install a new sealing ring to mainshaft.

Rear Extension Housing

Place the transmission horizontal.

1. Position the 2 magnets at the rear of the transmission case.
2. Place the gear shift into 2nd or 4th, shortening the shift rail exposed.
3. Apply sealant loctite "Ultrablack 598" or similar to rear extension housing mating surface, install 8 bolts and tighten.

2 top bolts use loctite 242 or similar thread sealant.

ID plate fits to middle left side bolt.

Rear Extension housing bolts: 30-41Nm

4. Install a new oil seal to rear of rear extension housing, use a seal insertion tool or similar.
5. Slide the offset lever over the shift rail and fix with a new roll pin, punch in.

Apply lithium grease to the bush in the rear offset shift lever.

6. Install shift lever assembly with rubber seal (new if old is damaged), insulating grommets and 4 bolts, tighten.

Shift Lever Assembly bolts: 15-20Nm

7. Install the cover over the shift lever assembly, 4 screws, tighten firmly but not over tight.
8. Install speedometer sensor with a new "O" ring and tighten.

Speedometer Sensor bolt: 8-12Nm

9. Install reverse lockout solenoid with a new "O" ring and tighten.

Reverse Solenoid bolt: 15-20Nm

10. Install reverse light switch and tighten.

Speedometer Sensor bolt: 20-34Nm

11. Install clutch housing, 10 bolts.

Clutch housing bolts: 30-41Nm

PROBLEM DIAGNOSIS

PROBLEM

[Transmission Noisy in Gear]

Possible Cause & Remedy:

* *Lubricant level low or wrong type* - Fill to bottom of filler plug hole with proper lubricant.
* *Transmission to flywheel housing and flywheel housing to engine block bolts loose* - Tighten bolts to specification.
* *Pilot bushing worn or damaged* - Remove transmission. If noise is howling during start-up, check pilot bushing. Check for loose flywheel and housing alignment. Service or replace as required.
* *Improper transmission pilot engagement into flywheel housing* - Replace housing or input shaft bearing retainer as required. Refer to 'Clutch'.
* *Worn or damaged internal components* - Disassemble transmission. Inspect input, output and counter shaft bearings, gear and gear teeth for wear and damage. Service or replace as required.

PROBLEM

[Transmission Shifts Hard]

* *Improper clutch release* - Refer to 'Clutch Section'.
* *Internal shift mechanism binding* - Remove transmission and free up shift mechanism.
* *Synchroniser sleeve to hub fit* - Remove and check for burrs or fit.
* *Binding condition between input shaft and crank shaft pilot bearing* - Check alignment and service as required.
* *Improper Fluid* - Drain and refill with specified fluid to bottom of filler plug hole.

PROBLEM

[Transmission Will Not Shift into One Gear - All Other Gears OK]

* *Floor shift, interference between shift handle and console of floor cut out* - Adjust console or cut out floor pan to eliminate interference.
* *Restricted travel of internal shifter components* - Remove transmission. Inspect shift rail and fork system, synchroniser system and gear clutch teeth for restricted travel. Service and replace as required.

PROBLEM

[Transmission is Locked in One Gear]

* *Internal Shifter components worn or damaged* - Remove transmission. Inspect the problem gear or gearshift rails and fork and synchroniser for wear or damage. Service or replace as required.
* *Selector arm finger broken* - Remove transmission.

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Replace selector arm assembly.
* *Bent shifter forks at pads and selector slot* - Service or replace as required.

PROBLEM

[Transmission Will Not Shift Into Reverse - all Others OK]
* *Worn or damaged internal components* - Remove transmission. Check for damaged reverse gear train, misaligned reverse relay lever, shift rail and fork system.

Specifications

V8 GenIII Engine:

Type: Borg Warner Type T56 with overdirve 5th and 6th gears, 6 speed, Option MM6

Gear Ratios:

MM6 Transmission

1st	2.66:1
2nd	1.78:1
3rd	1.30:1
4th	1.00:1
5th	0.74:1
6th	0.50:1
Reverse	2.90:1

End Float Clearances

Maindrive Gear	0.00-0.05 mm
Countershaft	0.00-0.05 mm
Countershaft	0.05-0.13 mm

Gear Teeth Numbers

MM6

Input Gear	31
Mainshaft Assembly	
1st	39
2nd	43
3rd	37
5th	37
6th	29
Reverse	35
Reverse Idler Gear	23
Countershaft Gear	
1st	17
2nd	28
3rd	33
Countershaft Extension	
5th	58
6th	67
Reverse	14

Synchromesh replacement clearance

All forward gears	less than 0.38 mm
Reverse gear	less than 0.75 mm

M35 Transmission

3rd/4th Synchro Assembly	1.80-1.85-1.90-1.95-2.00 mm
2nd Gear Bearing/Thrust Sleeve	2.00-2.05-2.10-2.15-2.20 2.25-2.30 mm
5th/Reverse Synchro Assembly	2.00-2.05-2.10-2.20-2.30 mm
Rear Mainshaft Bearing	2.00-2.10-2.20-2.30 mm

Lubricant

Type

Dexron III fluid or similar

Capacity

T56 Transmission: 3.9 Litres

Torque Wrench Specifications

Drain Plug:	20-34 Nm
Filler Plug:	20 - 34 Nm
Catalytic Converter Bracket:	40-60Nm
Idler Reverse Gear Plate Torx:	19-30Nm
Case to Adapter Plate bolts:	30-41Nm
Rear Extension to Case bolts:	30-4Nm
Adapter countershaft plug:	20-34Nm
Shift Guide Plate Torx T40:	16-27Nm
Shift Lever Guide Plate Bolts:	20-34Nm
Shift Enhancer:	34-48Nm
Front Offset Lever cover Plate bolts:	15-20Nm
Shift Lever Assembly bolts:	15-20Nm
Speedometer Sensor bolt:	8-12Nm
Reverse Solenoid bolt:	15-20Nm
Speedometer Sensor bolt:	20-34Nm
Clutch housing bolts:	30-41Nm

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TAILSHAFTS & UNIVERSAL JOINTS

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General Description

All of the models, except those fitted with manual transmission, have at each end of the tail shaft a needle roller type universal joint fitted. A slip yoke is fitted to the transmission end and a flange at the rear end. A constant velocity joint is fitted between the two halves of the tail shaft and the tail shaft is supported with a fully sealed ball bearing that is encased in a rubber cover. The centre bearing is mounted in a carrier which is bolted to the vehicle underbody.

Any vehicle fitted with the V6 engine and a manual transmission, uses a rubber coupling at the front of the tailshaft instead of the slip yoke. The coupling is bolted to the transmission output shaft flange.

VT fitted with a V8 engine and a manual transmission uses a hydraulically dampened rubber coupling bolted to the front of the tail shaft, which is inturn bolted to the flange on the transmission output shaft.

VX and WH SerII on had a new different tailshaft with a rubber coupling at the front, connected to a slip yoke near the transmission. [V6 and automatic transmission and Gen III with manual and automatic transmission] plus another coupling bolted to the pinion flange near the differential. V6 models with manual transmissions retains the original type of tailshaft.

Tailshaft

Remove

1. Loosen and remove the exhaust flange bolts at the rear of the catalytic convertor

Note: V6 Supercharged & V8 has 2 convertors fitted, remove bolts from both

2. Remove the 2 rubber exhaust hangers at the rear of the rear muffler - all models

3. Remove the intermediate muffler rubber supports - 2 V6, 4 V6 Supercharged & V8

V8 Engine

4. Remove the vehicle speed sensor mounting bolt 1

a) Tie the VSS to one side out of the way

b) Support the transmission with a suitable jack

c) Scribe a mark around the transmission crossmember mounting spacers

Note: Crossmember alignment is critical to maintain

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vibration free operation.

d) Loosen and remove the crossmember to underbody mounting bolts

e) Lower the transmission enough to facilitate the tail shaft removal

V6 Engine

5. It is recommended that the engine pipes be removed to allow access to the front flexible rubber joint and flange bolts

a) Disconnect both of the O_2 sensor electrical connectors

b) Loosen and remove the exhaust to manifold flange 4 bolts

c) Remove the engine pipe assembly

d) Scribe or paint match marks on the flange and rubber coupling

e) Loosen and remove the 3 nuts (VX on Torx E20 socket) securing the front rubber flange to the rear transmission flange

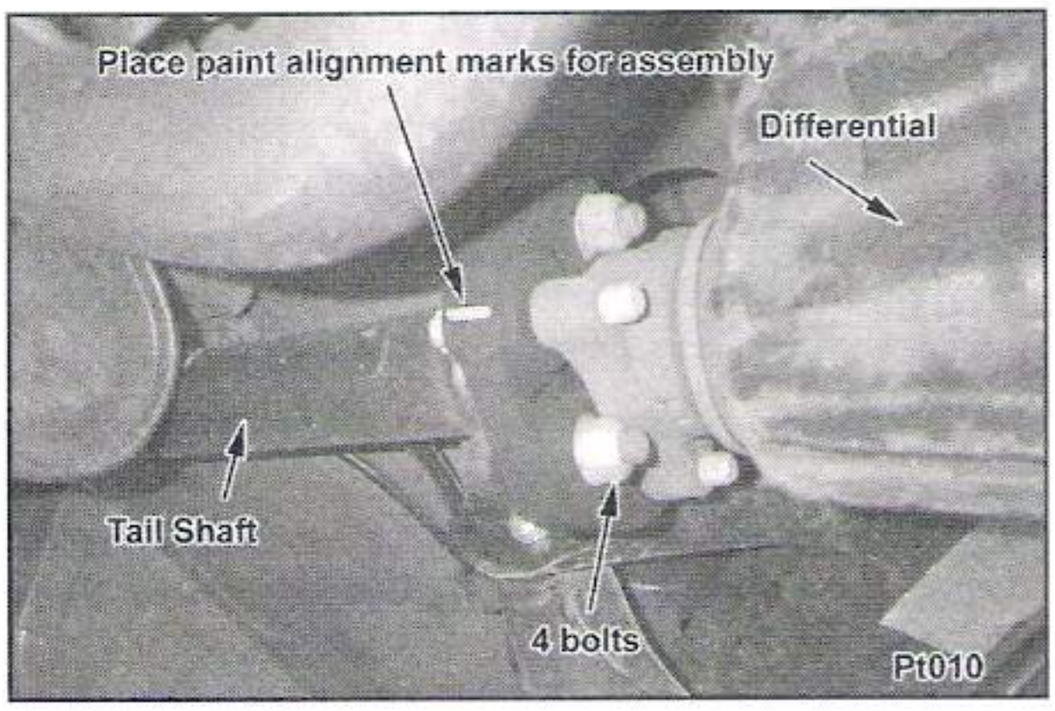
Note: Discard the nuts on removal, new nuts must always be used on installation of rubber flange.

Note: Some VX on models have a sliding front yoke, when tail shaft remove, insert a plug or cloth to stop oil from transmission leaking oil.

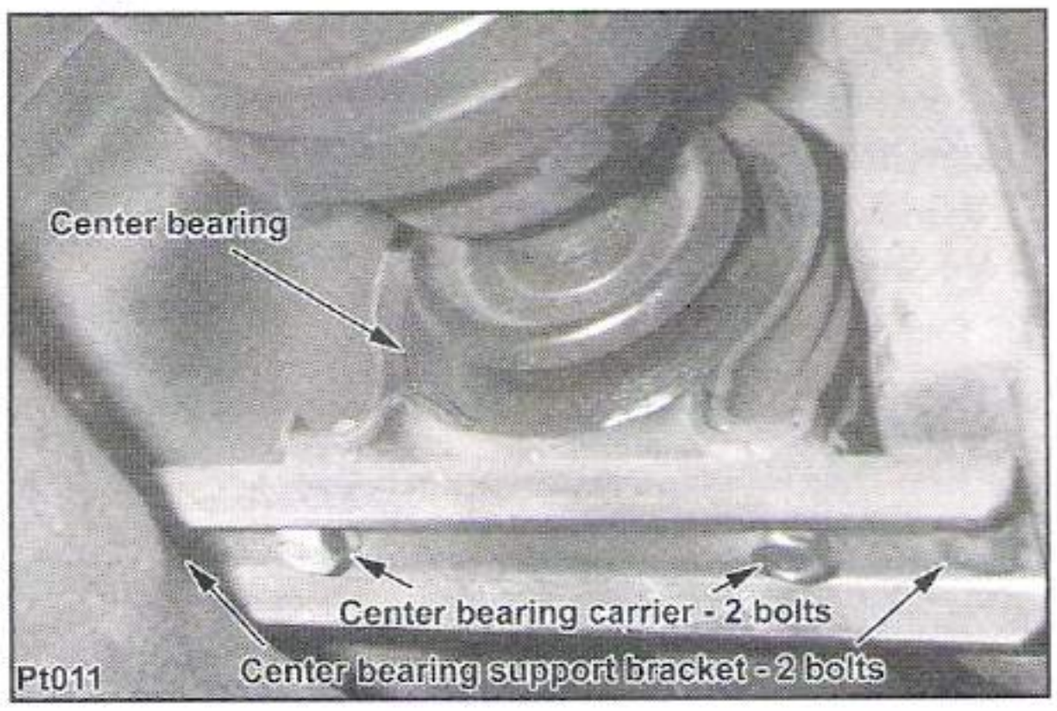
All Models

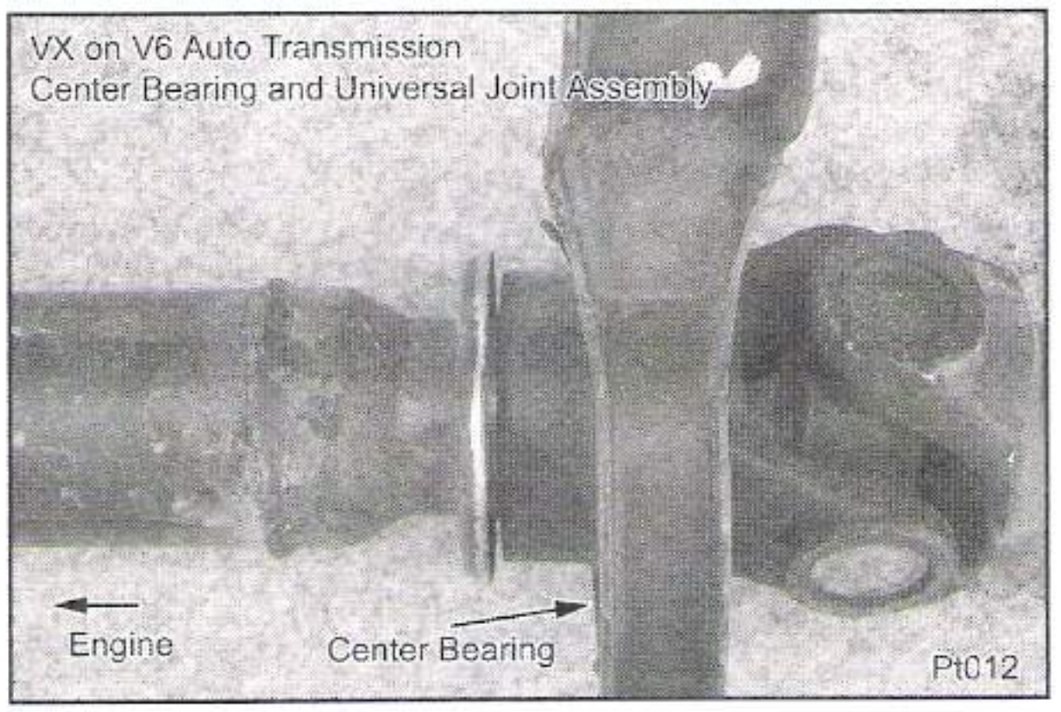
6. Scribe or paint match marks on both of the flanges

a) Loosen and remove the 4 bolts and nuts on the rear tail shaft flange to differential flange



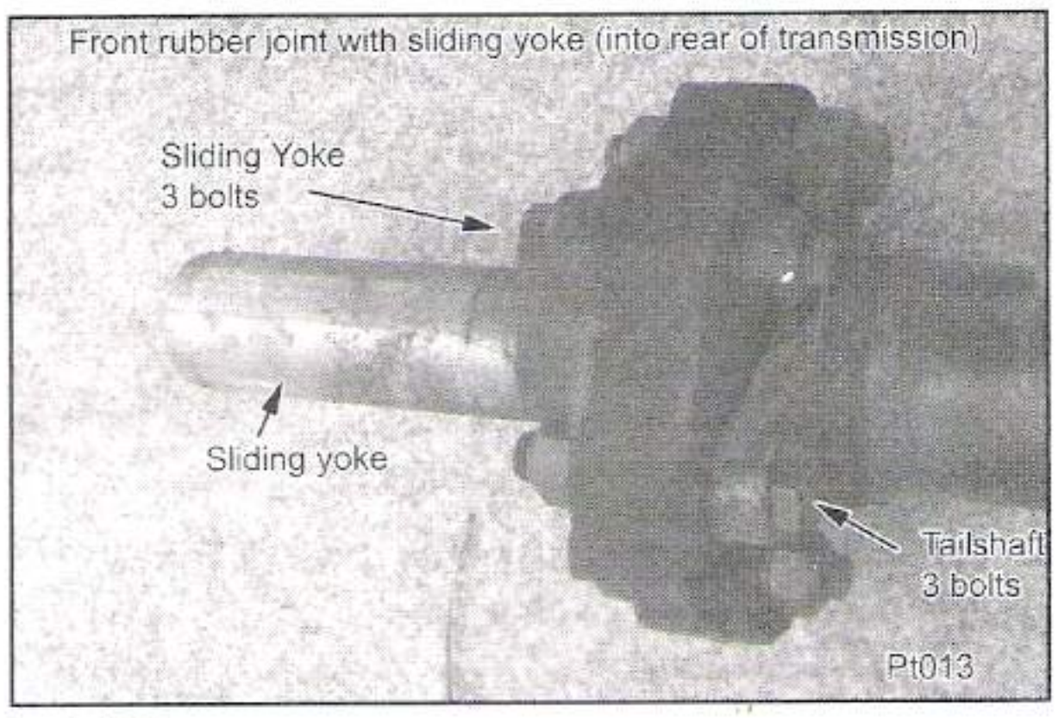
7. Support the tail shaft and loosen and remove the centre bearing carrier bolts 2





a) Remove the tail shaft assembly from the vehicle

Note: On vehicles fitted with the front slip yoke a plug must be fitted to the transmission to prevent loss of fluid.



Installation

1. Lift the tail shaft into position and align the match marks made on removal

2. Fit the 2 bolts to the centre bearing carrier and torque to specification

Torque: ..... 20-35 Nm

3. Fit the 4 rear flange bolts and nuts and torque to specification

Torque: ..... 55-65 Nm

VX on Torque: ..... 105-125 Nm

V8 Engine/Manual Transmission

4. Fit the vehicle speed sensor 1 bolt and torque

Torque: ..... 15-20 Nm

a) Raise the transmission, fit spacers and bolts, tighten to specified torque

Torque: ..... 50-65 Nm

Note: Ensure that the crossmember and spacers are aligned exactly as on removal to prevent excessive vibration.

V6 Engine/Manual Transmission

5. Lightly coat the output shaft spigot with molybdenum disulphide grease before installing the tail shaft into position

a) Fit new nuts to the front rubber coupling/flange and torque to specification

Torque: ..... 74-80 Nm

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6. Refit the exhaust system components previously removed

Note: If the vehicle is fitted with the front slip yoke check the transmission fluid levels and top up if required.

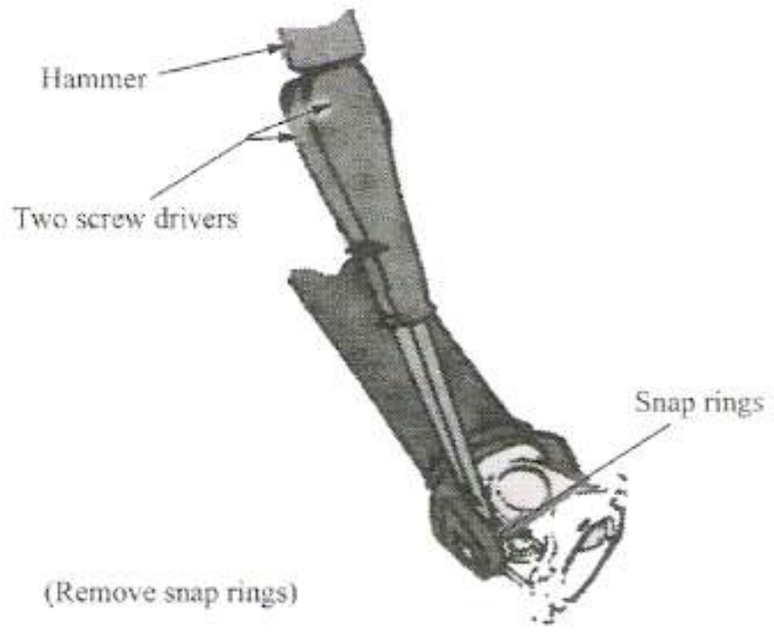
Inspection

1. Raise vehicle and support front and rear axle assembly on safety stands.
2. Measure propeller shaft run out at several points by rotating final drive flange by hand.
3. Remove propeller shaft as described above.
4. Place propeller shaft on "V" blocks, measure run out with micrometer gauge.
5. Measure propeller shaft run out at several points by rotating final drive flange by hand.

Universal Joints

Remove

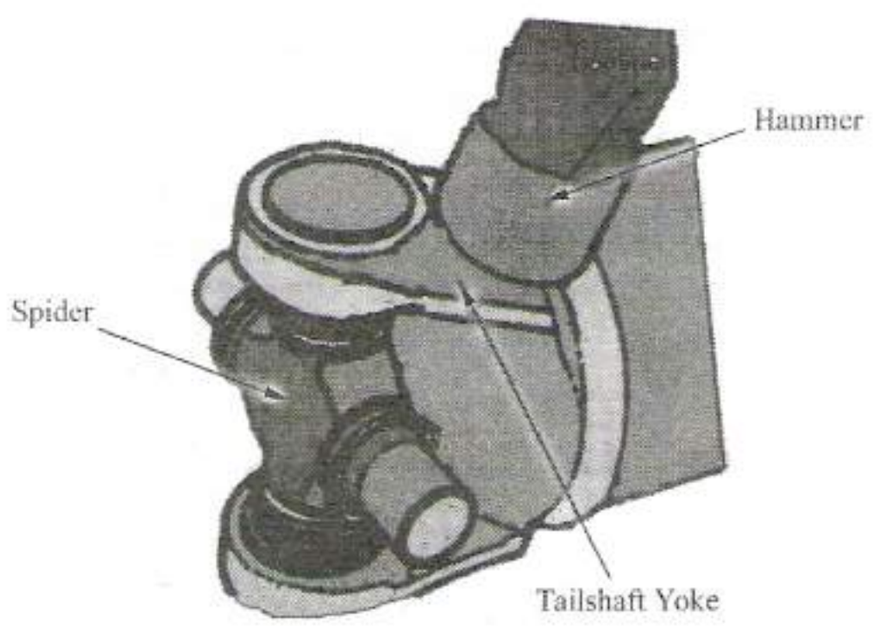
1. Remove the tail shaft as previously described
2. Mount propeller shaft in vice. Remove bearing cap retaining snap rings from grooves at inner ends of bearing caps.
3. Remove bearing caps from ends of the propeller shaft



(Remove snap rings)

Pt005

assembly as follows:
a) Support front universal joint yoke, or rear universal joint flange ears on open jaws of a vice.
b) Tap propeller shaft adjacent to bearing cap with a hammer so that universal joint spider forces bearing cap out.
4. Pull dislodged bearing cap from front universal joint or rear universal joint.
5. Rotate propeller shaft assembly 180° so that ears on opposite side of flange, rest on the vice.
6. Remove 2nd bearing cap from propeller shaft as per Steps 3 and 4.
7. Separate flange from universal joint spider.
8. Remove bearing caps from yoke or flange by resting exposed ends of spider on the vice, and removing bearing caps as previously described.
9. Remove the spider from the yoke or flange.
a) Thoroughly clean yoke or flange and propeller shaft universal joint bearing cap bores.
b) Check bearing cap bores and remove any burrs.

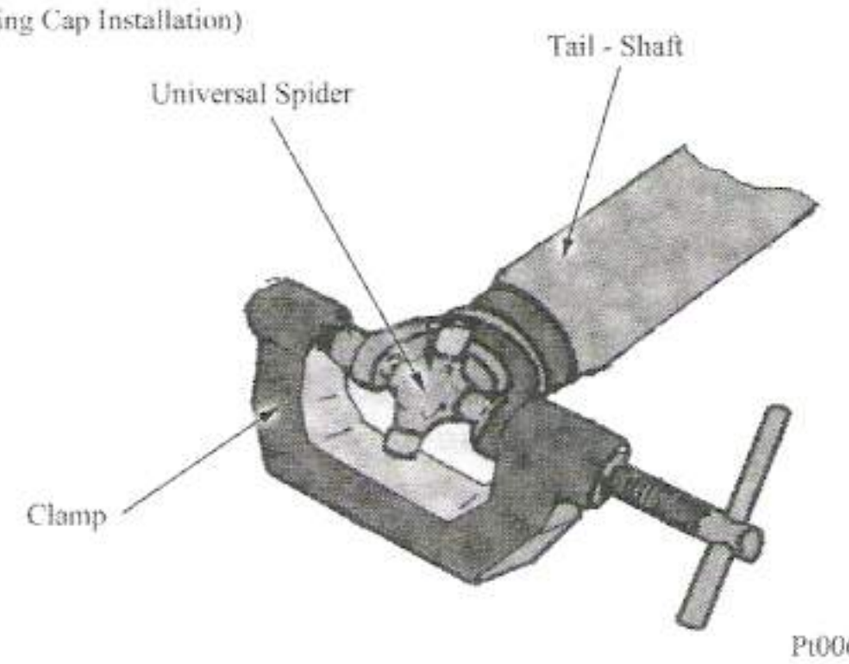


Pt003

Install

Before installing universal joint, note the following:
* Cleanliness is of prime importance to ensure maximum universal joint life.
* Do not allow any needle rollers to become dislodged. Install bearing caps in the upright position.
* Universal joint assemblies are prepackaged with lubricant and do not require any further lubrication.
* Take care not to damage bearing cap seals during installation. Gently ease bearing caps into their bores during assembly.
1. Remove bearing caps from spider.
2. Position spider in yoke or flange. Hold spider to one side in yoke or flange and position a bearing cap on the end of spider.
3. While holding spider in bearing cap, push by hand then use a "G" clamp to push bearing cap into yoke or flange until bearing cap snap ring groove is fully visible. Install snap ring into groove.

(Bearing Cap Installation)



Pt006

4. Turn yoke or flange around and install opposite bearing cap by positioning spider into bearing cap to prevent needle rollers from being dislodged.
5. To fully install 2nd bearing cap, position yoke or flange in vice with 2 of the old universal joint bearing caps. Squeeze new bearing caps into position using the vice jaws or G clamp.
* Ensure that the 2 old bearing caps are positioned centrally on the new bearing caps, and not up against the edge of the

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flange or yoke.
a) Install 2nd snap ring.
6. Install spider and yoke or flange assembly to propeller shaft. Install remaining bearing caps and snap rings as previously described.
7. Tap propeller shaft, yoke and flange ears with a hammer and ensure that all bearing cap snap rings are seated correctly in bearing cap grooves and that universal joints are free to move in all directions.
8. Install propeller shaft as per tail shaft installation section

Flexible Joint

V8 Engine/Manual transmission only

Remove

Raise vehicle and support with safety stands, remove the tail shaft as previously described
1. Scribe match marks to align the slip yoke and tail shaft on assembly
2. Loosen and remove the 3 bolts/nuts securing the tail shaft to the flexible joint
3. Loosen and remove the 3 bolts/nuts securing the flexible joint to the slip yoke
4. Separate the tail shaft and yoke from the flexible rubber joint

Assemble

Assembly is the reverse of the removal procedure, taking care to align the match marks made on removal. The arrow on the rubber flexible joint points towards the tailshaft flange. Tighten the bolts and nuts to the specified torque
Torque: ..... 74-80 Nm
Refit the tail shaft assembly as previously described

Constant Velocity Joint

Remove

1. Raise vehicle and place on safety stands, remove the tail shaft assembly as previously described
2. Scribe match marks on the C.V.Joint and both of the tail shaft sections to assist in alignment on assembly
3. Loosen and remove the 6 Allen head bolts
a) Use a brass drift and hammer to sperate the rear tail shaft section from the C.V. joint
4. Remove the circlip on the front tail shaft
a) Use a hammer and brass drift to carefully knock the dust cover off the C.V. joint
5. Remove the 2 bolts/nuts that secure the carrier to the centre bearing and remove the carrier
6. Fit suitable press plates in between the C.V. joint and the dust cover
a) Position in a press and carefully press the C.V.joint from the tail shaft

Inspection

Clean the C.V. joint with a suitable cleaning solvent and inspect the joint cage, race and ball bearings. Check for pit marks, plating flaking off, excessive wear marks in the cage and races. Replace joint if found to be faulty.

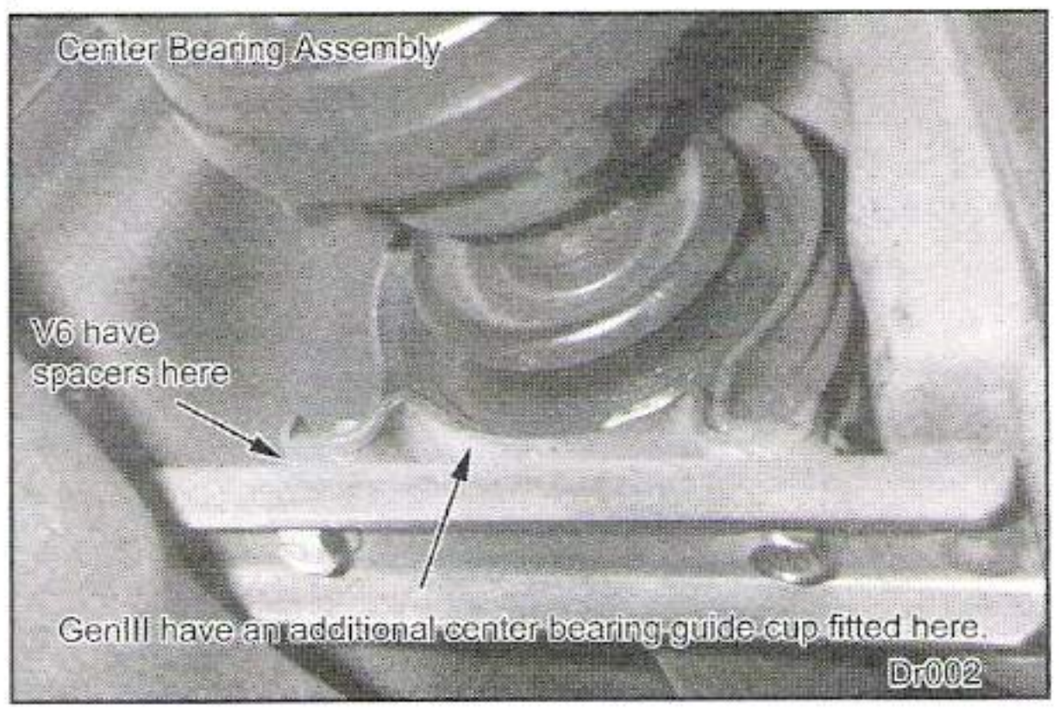
Note: The C.V. joint will have to be replaced as an assembly if found to be faulty.

Assemble

1. Inspect all dust shields for any damage, replace as required
2. Pack the C.V. joint with molybdenum disulphide grease
3. Apply a bead of Loctite 510 High Temperature Gasket Eliminator or similar to the mating surfaces of the dust shield and C.V. joint.
4. Fit the joint into position on the tailshaft, taking care to align the match marks made on removal
a) Use a press an adaptor or socket to press the joint back into position on the tailshaft
b) Fit the C.V. joint retaining circlip to the tailshaft
5. Clean the thread of the 6 Allen head bolts and the companion flange mating surface
a) Apply a light coat of Loctite 510 or similar to the threads of the Allen head bolts and the mating surface of the companion flange
c) Position the two halves of the tailshaft together, taking care to align the match marks made on disassembly
d) Fit the 6 Allen head bolts and tighten to specified torque
Torque: ..... 35-40 Nm
6. Fit the tailshaft assembly to the vehicle as previously described.

Center Bearing

VT ser II Gen III on. - Note:
V6 vehicles have a spacer installed between the transmission support mounting and the extension housing.
Gen III vehicles have the catalytic converter bracket as the spacer required.
The center drive shaft bearing also has spacers and a plate, as shown.
The original spacers must be reinstalled in the original positions.



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Sedans and Station wagons use different width spacers and are not interchangeable.
The centre bearing carrier must be installed with the arrow facing to the front.

Remove

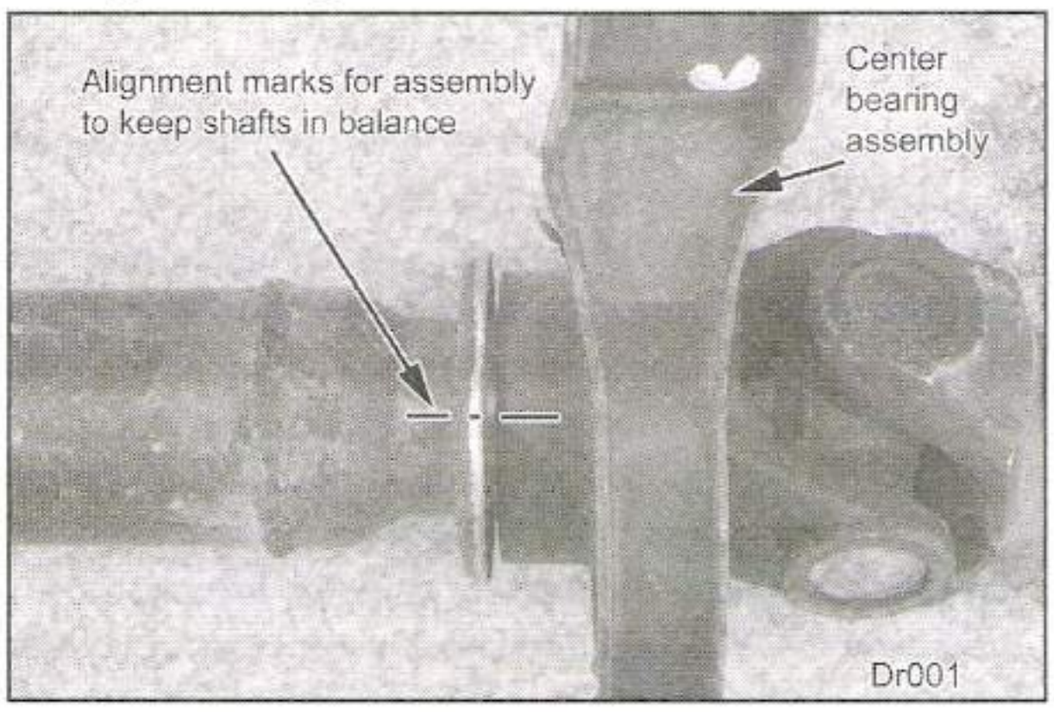
If the centre bearing is removed from the tail shaft for any reason it will have to be replaced. A kit is available containing a new centre bearing, circlips and dust covers.

1. Remove the tail shaft assembly from the vehicle as described previously.

2. [VX on V6 engine, manual transmission]
The 2 piece tail shaft has a sliding spline, covered by a rubber boot, use a felt pen or scriber to align mark the 2 tail shaft sections near the rubber boot before removing, as the 2 tail shaft sections must a assembled correctly in aligned during assembly to keep the tailshaft in balance.

3. Remove the C.V. joint for models with a CV joint, as per previous section

4. Loosen and remove the 2 bolts and nuts that hold the centre bearing carrier together



a) Bend the tangs down on the carrier and separate the carrier halves
b) Spread the carrier lower half and remove from the centre bearing

5. Use a hammer and a punch to remove the front dust cover
a) Remove the centre bearing circlip
b) Fit a set of suitable size press plates to the centre bearing
c) Use a press to remove the bearing assembly from the tail shaft

6. Use a hammer and a punch to remove the rear dust cover

Note: New bearing, dust covers and circlip must be used on assembly.

Assembly

1. Fit a new dust cover to the tailshaft using a suitable size tube and a hammer or press

2. Fit the new centre bearing to the tailshaft using a tube and a press.
a) Fit the circlip the tailshaft
b) Press the rear dust cover carefully into position

Note: Take care not to distort the dust cover and ensure that it is not rubbing on the centre bearing when fully seated.

3. Fit the lower half of the bearing carrier to the bearing
a) Fit the upper half of the carrier to the top half and bend the tangs up to hold the two halves together
b) Fit the 2 bolts and nuts to the carrier and tighten to specification
Torque: ..... 20-25 Nm

4. Refit the C.V. joint for models with a CV joint as previously described

5. Fit the tailshaft assembly to the vehicle.
[VX on V6 engine, manual transmission]
The 2 piece tail shaft has a sliding spline, covered by a rubber boot, align the marks made during removal, place some molybdenum grease on the spline, install a new rubber boot.

Problem Diagnosis

Problem: Vibration!

Possible Causes and Remedies:

* Propeller shaft runout. Remedy - replace propeller shaft.
* Propeller shaft imbalance. Remedy - balance propeller shaft.
* Sleeve yoke spline stuck. Remedy - replace sleeve yoke.
* Excessive wear in C.V. joint or Uni-joints. Replace - worn parts.

Specifications

Tailshaft Runout (Rotational)

Maximum: ..... 0.25 mm
This is best measured accurately on a suitable tail shaft jig, where the tail shaft assembly is correctly supported through its entire length. However if a shaft jig is not available use "V" blocks in preference to checking on vehicle.

Lubricants

Universal Joints: ..... Lithium soap grease
C.V. Joint: ..... Molybdenum Disulphide grease

Sealants

Loctite 510 High Temperature Gasket Eliminator (or equivalent)
Loctite 242 Thread Sealant (or equivalent)

Balance Specification

10 g cm @ 3.000 rpm on turn over.

Note: Low spot is marked with a daub of paint, on tail shaft at the rear universal joint flange

Torque Specifications

Rear uni-joint flange bolts:	55-65 Nm
Bearing Carrier to Body:	20-35 Nm
Flexible Coupling Bolt(Man Tran):	74-80 Nm
C.V. joint Allen head bolts:	35-40 Nm

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Differential & Driveshafts

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General Description

All model vehicles are fitted with independent rear suspension as standard equipment, final drive option code GU4. The V6 has a final drive ratio of 3.08:1, with a ring gear diameter of 190.5 mm. The V6 Supercharged & V8 final drive ratio is 3.07:1, both have a ring gear diameter of 2.05 mm. HSV and V2 Monaro ratio's are listed in specifications. A limited slip differential is available as an option, code G80, regardless of differential ratio.

The differential is of the 4 pinion type and is mounted to a crossmember which is inturn rubber mounted to the vehicle. If any repairs are to be carried out on the differential it should be removed from the vehicle.

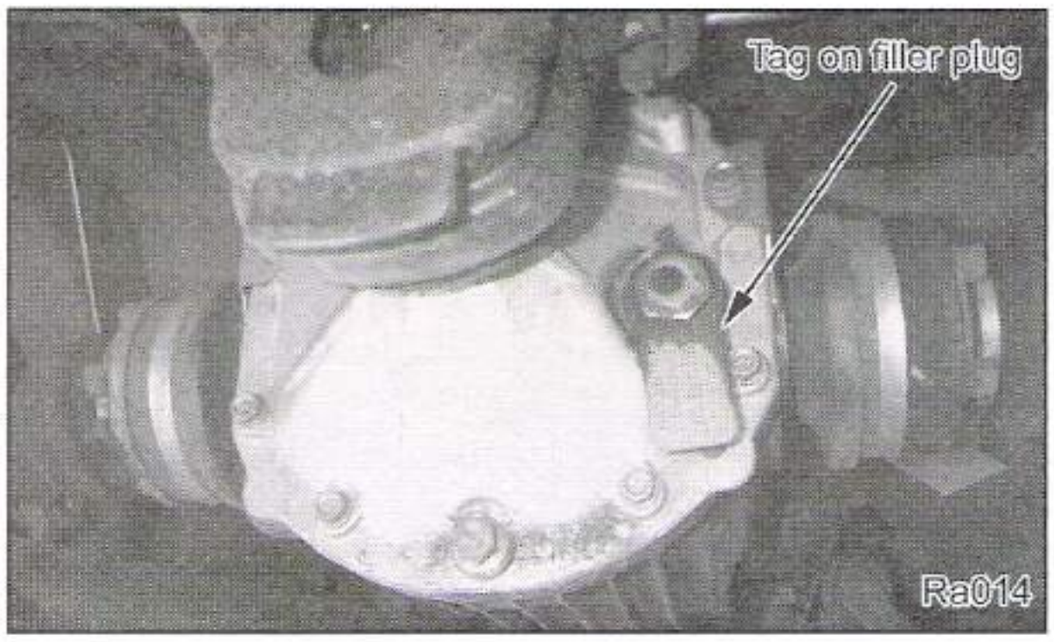
Early 2000 VT series II saw the introduction of an Australian manufactured trailing arm.

Identification

The differential type can be identified by the ID tag fitted to the RHS of the carrier housing and the tag fitted to the filler plug. The ID tag carries the manufactures part number for the differential assembly, final drive ratio and the unit serial number. HSV and Monaro codes list in specifications.

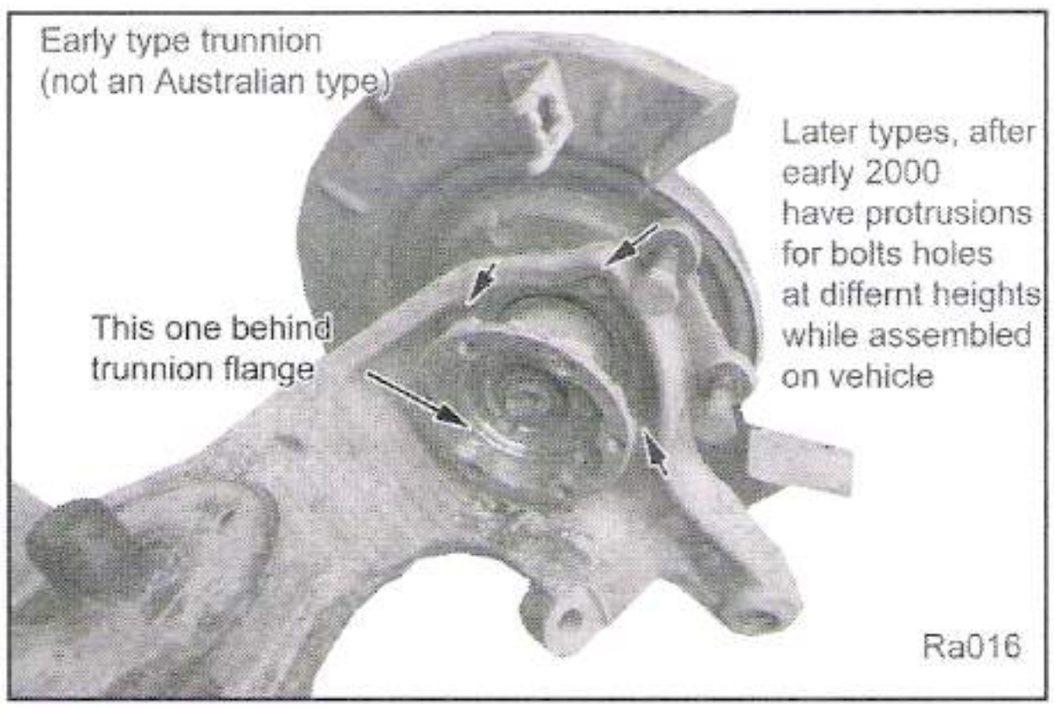
Code Letters		Differential Ass'y Type
Std Brakes	ABS	ra018
BF	BC	Conventional - V6
BD	BE	LSD - V6
BA	BJ	Conventional V8 & V6 - Supercharged
BB	BH	LSD - V8 & V6 Supercharged

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The tag fitted to the filler plug has information about the differential type.

The Australian manufactured trailing arm can be identified by visual inspection, jack-up rear of vehicle, remove rear wheel, brake calliper, disc. Inspect the protrusions of the trailing arm from the rear view. If the protrusions are the same height the trailing arm is the early type. If the trunnion protrusions are at different levels, the trailing arm is of Australian manufacture.



Maintenance

Breather

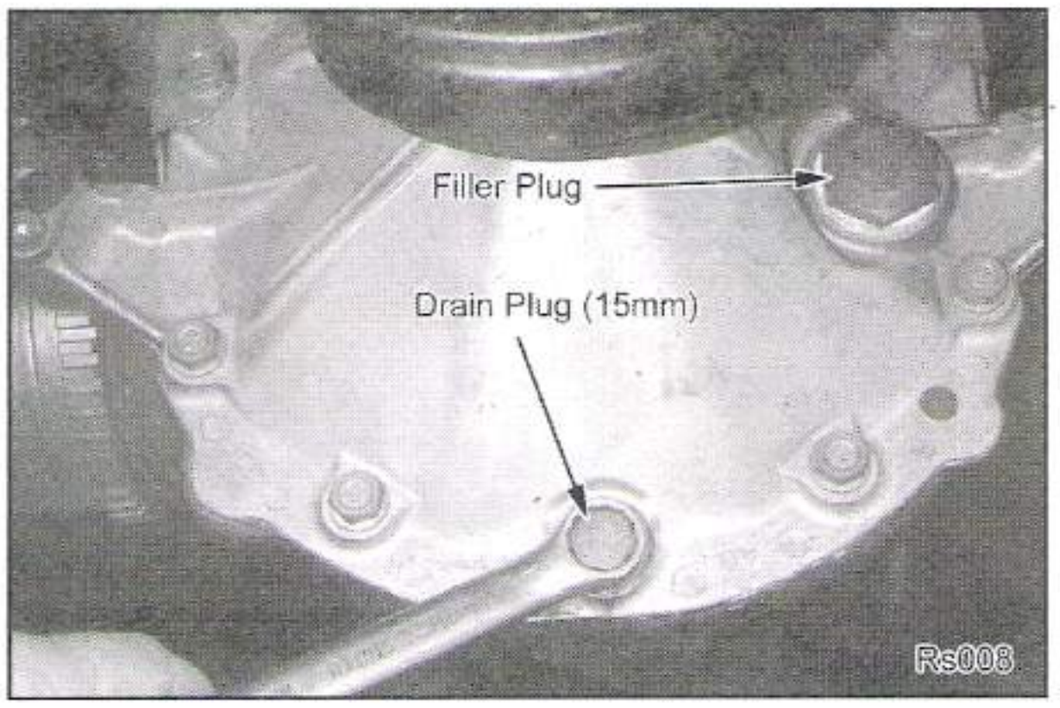
The breather valve should be checked regularly to ensure that the tube is not kinked or damaged, cover rotates freely and that the exhaust port is not restricted or blocked by mud. The top portion of the breather hose should be inserted at least 25 mm into the underbody crossmember hole.

Drain Plug

The drain plug is located in the bottom rear of the differential housing and is fitted with a copper or aluminium sealing washer.

Axle Bearings & Constant Velocity Joints

The drive shaft outer bearings and the constant velocity joint, are lubricated when assembled at the factory and require no periodic maintenance. The CV joint boots should be inspected for any wear or damage. Replace boots if any damage is found.



Differential Carrier Assemblies

Check for lubricant leaks at every maintenance service. If there is evidence of leakage, correct leak and add lubricant as necessary.

Note: At every specified service, check the lubricant level is to the bottom of the filler plug hole, when the rear axle is COLD.

Differential Lubricant Level

1. Ensure vehicle is level.
2. Clean area around filler plug.
3. Remove filler plug at the rear of the differential housing.
4. The lubricant level is to be maintained at the bottom edge of the filler plug hole. Top up the differential with specified lubricant.
5. Inspect filler plug for damage. If OK, refit in axle housing cover. If damaged, replace plug.

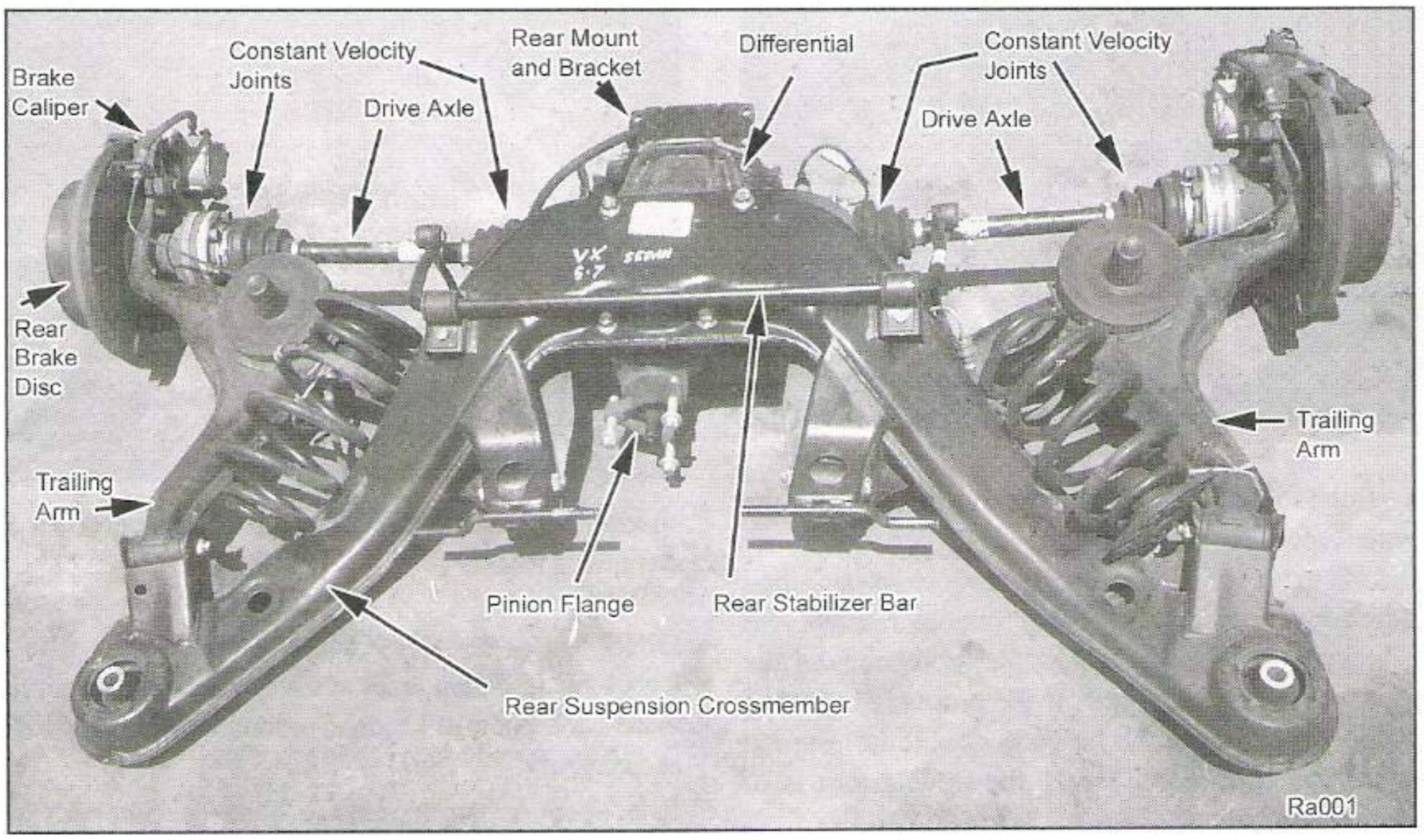
Precautions - L.S.D.

When working on vehicle equipped with a limited slip differential, "Do Not" run the engine with the transmission in gear and only one of the wheels raised off the ground. The driving force transmitted to the wheel on the ground could be enough to allow the vehicle to move.
On car type wheel balancers are not recommended for use with vehicles equipped with a limited slip differential.

Torque Check - L.S.D.

Place the transmission in neutral and leave the ignition turned off, raise one side of the vehicle at the rear and place on safety stand
1. Remove the road wheel, disc brake calliper and disc brake rotor
2. Fit an adaptor such as tool No.7208 (bracket on wheel studs witha nut welded to center of bracket)to the trunnion assembly
3. Using a torque wrench turn the trunnion assembly in a forward direction, the opposite wheel should remain station-

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ary and a torque reading of approximately 70 Nm should be achieved.

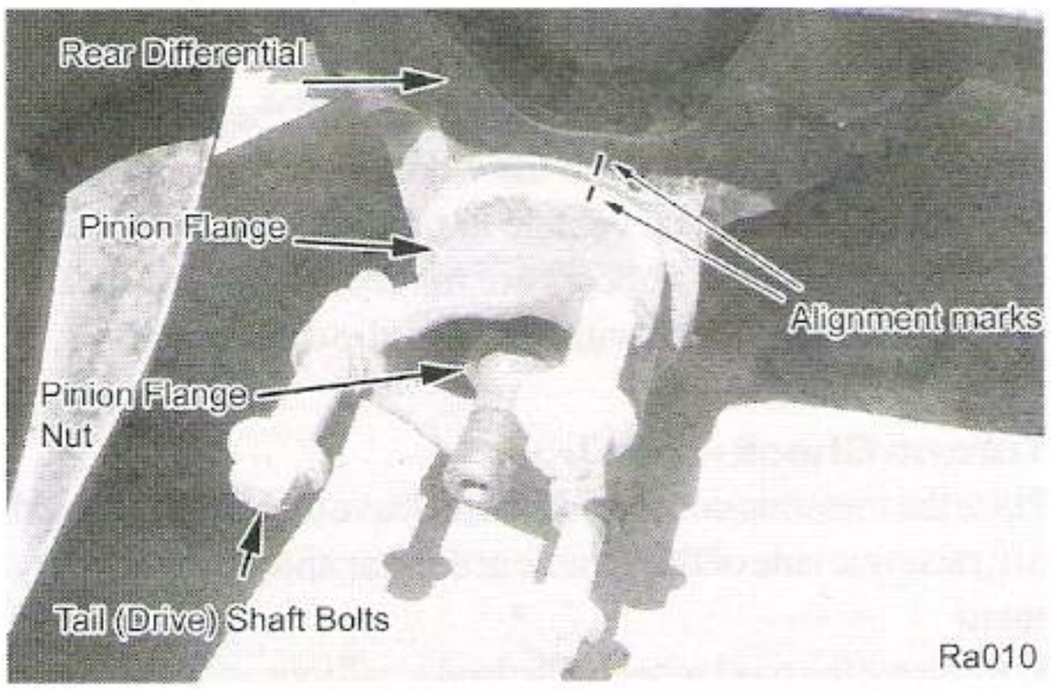
Note: If the torque reading is less than 45 Nm the differential will have to be removed and the internal clutches etc. inspected for possible damage.

4. Refit all previously removed parts.

Minor Repairs

Pinion Oil Seal

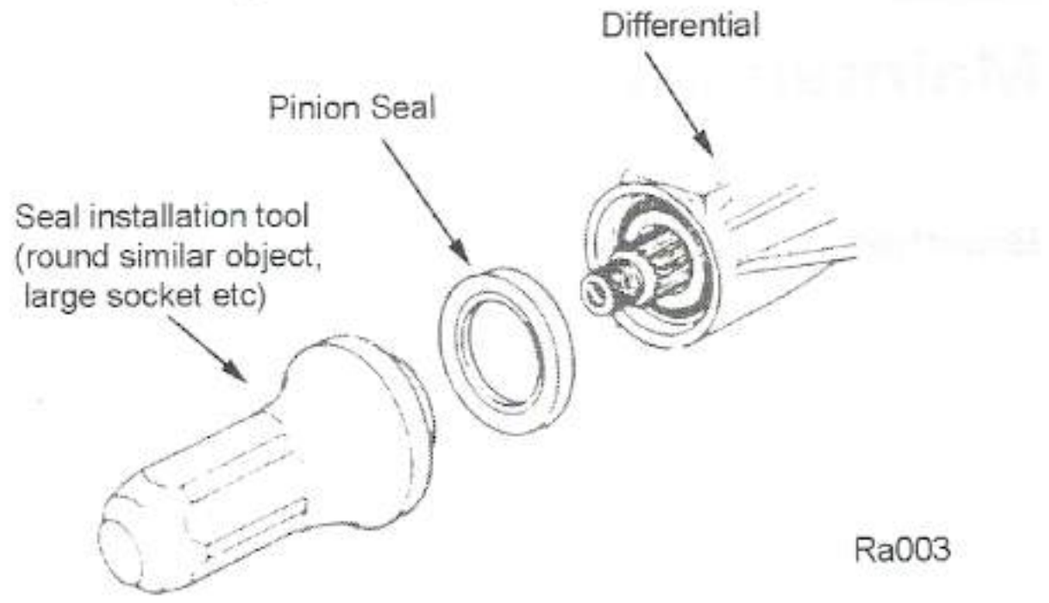
Remove



1. Raise vehicle and support axle assembly on safety stands
2. Disconnect drive shaft from pinion flange
3. Mark the relationship of the nut, flange and pinion, to aid assembly
a) Hold the pinion flange using special tool and remove flange retaining nut
b) Place a drain tray beneath differential carrier housing
4. Remove the pinion flange using a suitable puller
5. Pry pinion oil seal from carrier bore using a seal removing tool
a) Clean the pinion housing etc. of any dirt/oil

Replace

1. Lubricate new pinion oil seal lips with rear axle lubricant. Lightly coat outside of seal shell with a non-hardening gasket cement.
2. Start oil seal in differential carrier housing and drive seal squarely into position. Seal fits flush to 0.25 mm below the carrier housing surface.



3. Ensure that pinion shaft is free from burrs and that flange oil seal surface is free from damage.
4. Coat spline and seal surface of pinion flange with differential gear lubricant, and install flange on pinion shaft splines.

Note: Pinion flange is an interference fit on the pinion shaft splines and should be pulled into place by tightening the retaining nut.

Caution: Do not use force or hammer the new flange on to

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the pinion shaft.

5. Install flange retaining nut and tighten nut until the flange is fully seated and the alignment marks made on disassembly are aligned, hold the flange with a special tool.

Note: Do Not go past the alignment marks anymore than 5^0.

Caution: Should the retaining nut be over-tightened and the pre-load exceeded, it will be necessary to remove the pinion from the carrier to replace the collapsible spacer. Under no circumstances must the retaining nut be backed off to decrease the pre-load setting.

8. Reconnect tail shaft universal joint flange to pinion flange.

9. Check axle lubricant level and top up as required.

Hub Wheel Studs

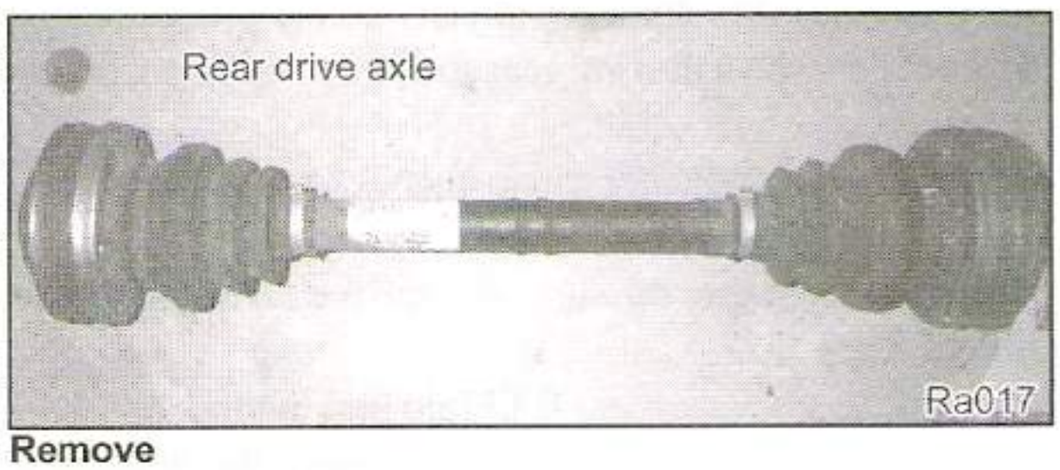
Remove

1. Raise the rear of vehicle and place on safety stands
2. Loosen and remove the road wheel nuts and wheel
3. Loosen and remove the calliper to anchor plate bolts 2
a) Remove the calliper and tie up out of the way, do not allow the calliper to hang from the brake hose.
4. Remove the disc rotor
5. Using special tool, press the wheel stud from the hub

Replace

1. Fit the new wheel stud into the hub
2. Fit special tool to two of the other wheel studs, to hold the hub
a) Fit a suitable nut to the new wheel stud
b) Hold the hub with the special tool and pull the new wheel stud into position by tightening the nut with a spanner
3. Remove the special tool and fit the disc rotor back to the hub
4. Fit the disc brake calliper and tighten the 2 bolts to specified torque
Torque: ..... 70-100 Nm
5. Fit the road wheel and nuts

Drive Shaft Assembly



Remove

1. Raise vehicle and support axle assembly on safety stands
2. Mark the relationship of the driveshaft flanges to the hub and axle flanges
3. Loosen and remove the 6 Allen head bolts at the inner end of the driveshaft
4. Loosen and remove the 6 Allen head bolts at the outer end



of the driveshaft and remove the shaft assembly from the vehicle.

Refit

1. When fitting the driveshaft note that the orientation of the shaft is important
a) The inner driveshaft plunge joint, has one groove and the outer C.V. joint is marked with two grooves
2. Clean the threads of the Allen head bolts and apply Loctite 242 or similar
3. Position the driveshaft and fit the bolts to both ends of the shaft. Tighten all bolts to the specified torque
Torque: ..... Initial -5 0 Nm , plus 60^0-75^0
4. Remove the safety stands and lower vehicle

Inner Axle Shaft Seal

Remove

1. Raise the vehicle and place on safety stands
2. Remove the driveshafts as previously described
3. Fit a suitable slide hammer to the axle flange and remove the axle from the carrier housing

Caution: On V6 non-supercharged, fitted with L.S.D. Do Not rotate the opposite axle shaft as the side gear and clutch cones may become misaligned.

4. Thoroughly clean around the seal housing and using a seal removal tool to dislodge the seal

Replace

1. Inspect the axle seal surface for any nicks or excessive seal damage, replace if required
2. Lightly coat the seal lips and outer surface with lithium soap grease
a) Use a seal installation tool to fully seat the seal in the carrier housing
3. Fit the axle shaft aligning the splines with the side gear
a) Use a soft faced hammer to knock the axle shaft in until the clip on the end of the axle is fully engaged
4. Refit the driveshaft etc.

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Major Repairs

Trailing Arm/Trunnion Flange etc.

Refer to the 'Rear Suspension ' chapter for correct removal/repair operations.

Differential Assembly

Remove

1. Using a floor jack under centre of the axle, jack up vehicle, place safety stands under the body jacking points

2. Loosen the tail shaft retaining bolts from the pinion flange

3. Remove the road wheels

a) Disconnect the exhaust system at the rear of the catalytic convertor and remove the rear sections of exhaust from vehicle

b) Remove the driveshafts as previously described

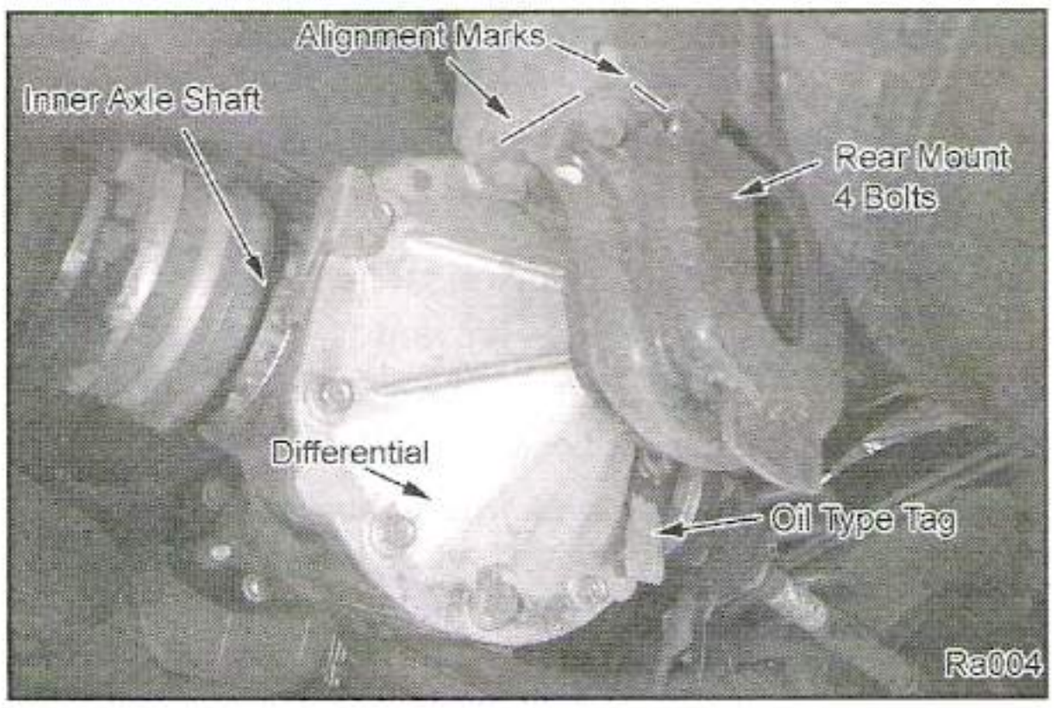
c) Disconnect the handbrake cables from the body mounts

d) Disconnect and remove the breather hose

e) Disconnect the ABS sensor connectors if fitted

4. Use a scriber to mark the position of the differential rear mount to body

a) Support the differential assembly with a jack and loosen and remove the 4 bolts for the rear mount



b) Lower the differential enough to gain access to the 4 upper mounting bolts on top of crossmember, loosen and remove

c) Lower the assembly and remove from the vehicle.

Installation

1. Position the differential assembly on a jack and move under the crossmember

2. Raise the assembly into position on the crossmember, f it the 4 bolts and tighten finger tight (on top of crossmember).

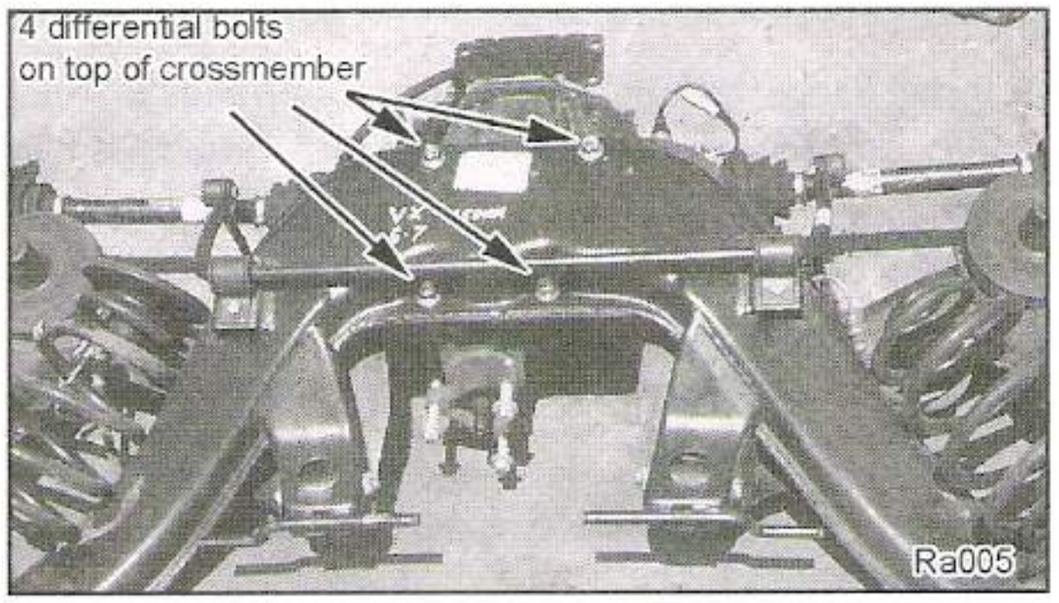
Note: Bolts must be replaced with new bolts once they have been used.

3. Align the differential and crossmember using the marks made on disassembly

a) Tighten bolts to specified torque

Torque: ..... Initial - 90 Nm, plus 30^0-45^0

b) Raise the differential assembly and fit the 4 rear mounting



bolts

c) Align the rear mount with the marks previously made and tighten the 4 bolts to the specified torque

Early trailing Arm type torque: 30-40 Nm

Australian manuf trailing arm type: 30-40Nm plus 55-65 deg turn

4. Refit the driveshafts as per previous section

5. Reconnect the handbrake to underbody mounts

a) Connect the ABS sensors if fitted

b) Refit the tailshaft refer to the 'Tailshaft' chapter

c) Refit the breather hose to the differential and insert other end into the hole in the crossmember

d) Fit the exhaust system components previously removed

6. Refit the road wheels etc. fill or top up the differential oil level as required

7. Using a floor jack under centre of the axle, jack up vehicle, withdraw the safety stands from under the rear body jacking points and place vehicle on the ground..

Differential

Dismantle

1. Remove the carrier assembly from the vehicle as previously described

2. Mount the carrier in a suitable bench jig

3. Loosen and remove the rear cover attaching bolts and side adjuster lock plates

a) Use a soft faced hammer to free the cover from the housing and remove

b) Allow the oil to drain completely before proceeding

4. Visually inspect the ring gear and pinion teeth etc. for any damage

a) Mount a dial indicator gauge on the case with the pointer against the ring gear rear face

b) Turn the ring gear through 360^0 and record the amount of runout if any

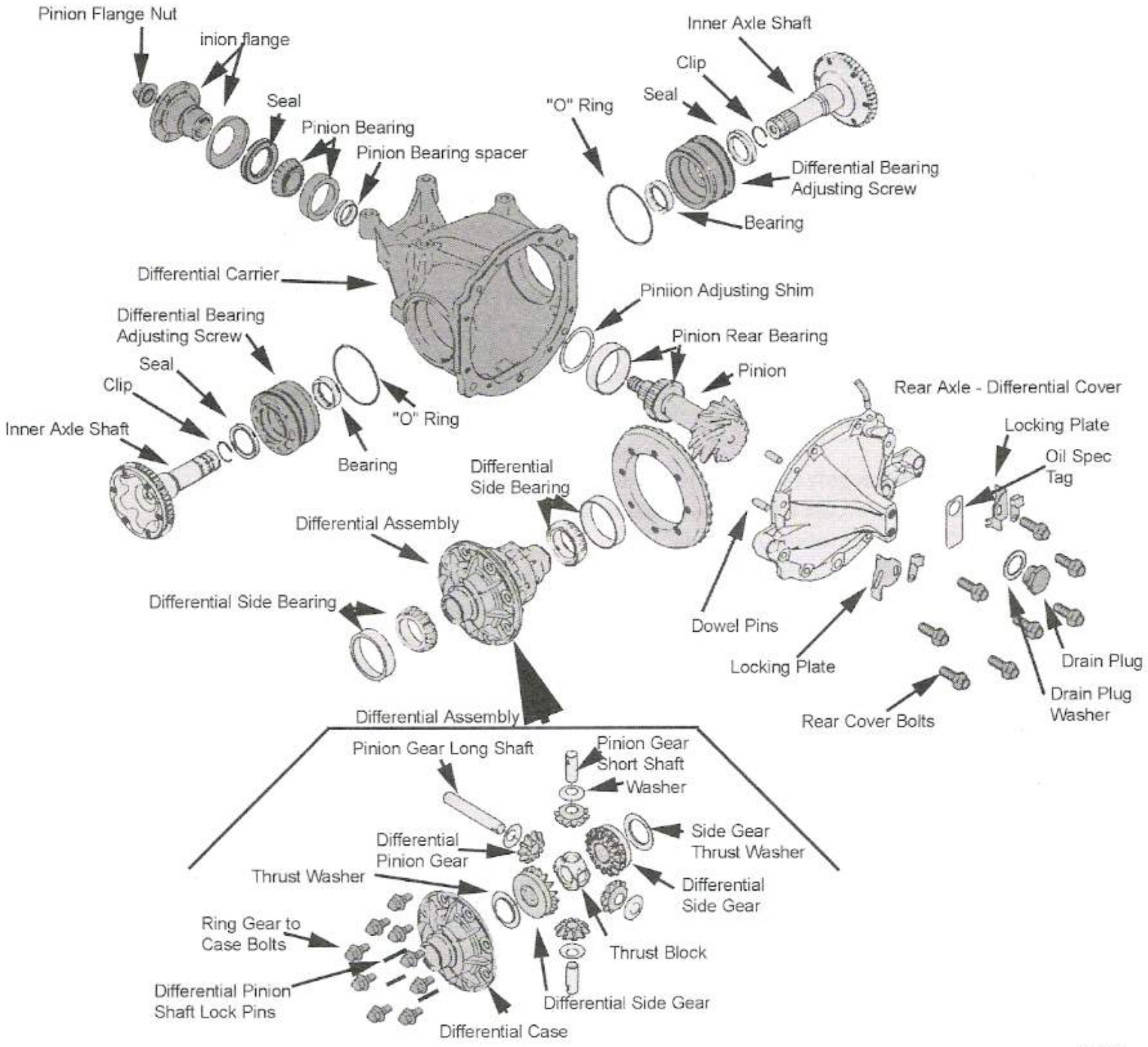
Runout: ..... 0.13 mm maximum

c) Reposition the dial indicator, measure the amount of backlash between the ring gear and the pinion, record for later use

Backlash: ..... 0.10-0.18 mm at tightest point

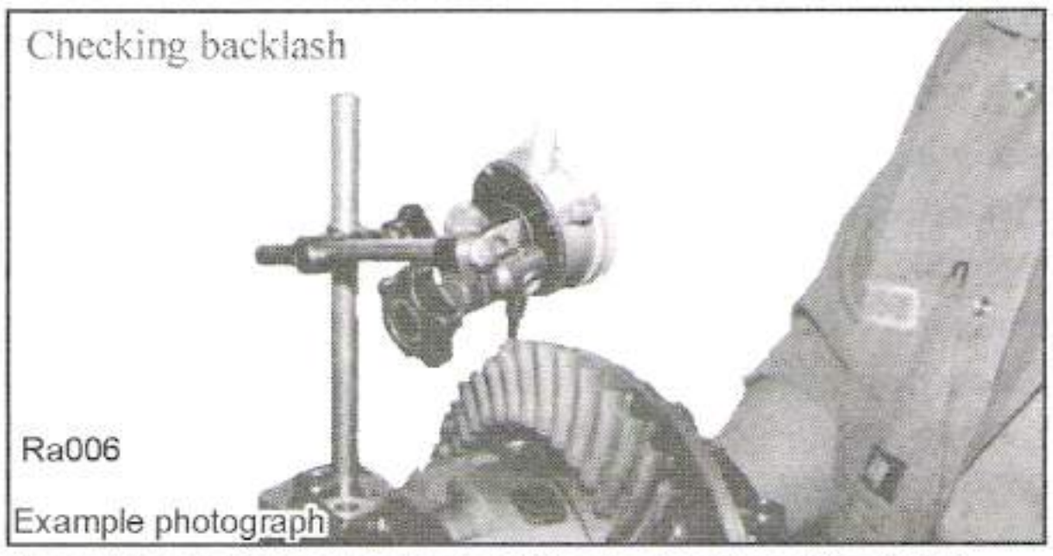
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Differential Assembly (not limited slip)



Ra012

5. Remove the axle shafts refer to previous section



Note: The left hand axle shaft is shorter than the right hand side.

6. If new axle seals are to be fitted, remove them now from the screw adjusters, use a seal removal tool

a) Use tool AU407 to remove the screw adjusters from the carrier housing

b) Remove the differntial carrier from the carrier housing

7. Fit a suitable tool to the pinion flange to hold it, loosen and remove the pinion nut

a) Remove the pinion oil seal from the carrier housing

b) Gently tap the end of the pinion with a soft faced hammer to remove the pinion from the carrier housing

8. Fit suitable plates to the pinion bearing and press the bearing off the pinion

9. Remove the carrier side bearings using the following special tools, E1673MT, E1673B16, E1673N15 assemble and pull the side bearings off the carrier

a) Hold the carrier in a vice using soft jaws, with the ring gear bolts facing up

b) Loosen and remove the ring gear bolts

Note: Ring gear bolts are L.H. thread.

c) Remove the carrier from the vice and place on a bench, wrap a piece of rag around the bottom of the carrier and using a soft faced hammer gently tap the ring gear to free it from

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the carrier

Note: Support the ring gear while tapping it free of the carrier, if the ring gear lands heavily on the bench damage may occur to the ring gear teeth.

10. Use a hammer and pin punch to drive out the carrier retaining pins

a) Mount the carrier in a vice using soft jaws and using a brass drift and hammer drive the long pinion shaft from the carrier

b) Remove the carrier from the vice and using a brass drift tap against the thrust block to separate the two carrier halves

c) Use brass drift and hammer to drive out the short pinion shafts

11. Remove the pinion gears, thrust washers and thrust block from the case.

Inspection

All components should be thoroughly cleaned and blow dried with compressed air. Inspect the case for general soundness and pay particular attention to the following points:

1. If differential case side bearings have been removed, check case journals for damage and that seating surfaces are free form dirt and burrs.

2. The mating surfaces for differential case halves should be clean and free from burrs.

3. The thrust washer surfaces should be examined for excessive wear and should not have any metal surface. Check for specified thickness of thrust washers

4. Inspect the pinion gears, ring gear and the pinion teeth for any chips, cracks or excessive wear patterns.

Note: Replace any components found to be faulty.

Assemble

1. Lightly coat the pinion gears, thrust washers, pinion shafts etc. with specified axle lubricant

2. Fit the pinion gears, thrust washers into their respective carrier halves

3. Install the pinion shafts into the housing enough to allow the thrust washer to sit on the ends

Note: When installing the shafts ensure that the roll pin holes are in the correct aspect to align with the case holes when fully installed.

3. Install the remaining pinion gears, thrust washers into the housing.

a) Tap the shafts in enough to hold the pinion gears

b) Fit the thrust block into position and using a soft faced hammer fully install the shafts

c) Install the shaft retaining pins, pins must protrude 6 mm above the mating surface of the housing

d) Fit the two halves of the housing together, gently tap with a soft faced hammer to seat the top half

4. Heat the ring gear until it is warm, use a hot plate or similar

a) Fit two guide studs to the ring gear and position on the carrier.

b) Fit new bolts to the ring gear and tighten bolts evenly until the ring gear is seated on the carrier housing

c) Tighten the bolts to the specified torque

Torque: ..... 125-150 Nm

Setting Side Bearing Pre-load

5. Use special tool E9277 and apress to install new side bearings to the carrier

6. Use special tool AU409 to seat the screw adjuster in and using a press and adapter AU411 press new cones into the adjuster until the cones are fully seated

a) Fit new 'O' - rings to the screw adjusters and coat with rubber grease or similar

b) Fit the carrier assembly into the differential housing and install the screw adjusters into the housing until the carrier is fully supported, rotate the carrier several times to seat the bearings in the side cones

c) Wrap a piece of string around the carrier and connect the end to a spring balance

d) Tighten the screw adjusters until the correct preload is achieved

Side Bearing Pre-load

New Bearings: ..... 15-35 Nm

Used Bearings: ..... 8-18 Nm

During VX production it is possible to use either Timken" or Koyo" bearings, the preload is listed below.

	Timken	Koyo
New bearings	15 – 35 Nm	8 – 24 Nm
Used bearings	8 – 18 Nm	5 – 13 Nm

e) Use special tool AU407 and a torque wrench to measure the tightening torque of the screw adjusters, record this measurement for later use.

f) Remove the screw adjusters and carrier from the differential housing

Setting Pinion Depth

7. If the pinion and ring gear are to be replaced the pinion depth will have to be checked using a pinion setting gauge.

Note: If a new gear set is installed make sure that the matching numbers are the same on both.

The V6 and V8/V6 Supercharged pinions have different mounting distances (94.49 and 102.50 mm respectively). The following components are also different - bearings, gear sets, carrier assemblies and screw adjusters, Do Not intermix parts.

If new bearings are to be used remove both cones from the housing and install the new cones with no adjusting shim. If original bearings are to be used remove the rear cone and shim, reinstall cone without shim. Coat both the bearings and cones with specified lubricant.

V6 - 3.08:1 Ratio

a) Fit the distance spacer E9300-1to the dummy pinion E9300A, followed by the rear pinion bearing

V8-V6 Supercharged 3.07:1 Ratio

a) Fit the rear bearing to the dummy pinion

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Both

b) Fit the dummy pinion into the differential housing

c) Install the front bearing and thrust collar and nut, tighten the nut until the correct rotational torque is obtained

Rotational Torque

New Bearings: ..... 1.4-2.0 Nm

Used Bearings: ..... 0.7-1.0 Nm

Note: Only use the bearings that will be used on final assembly.

d) Rotate the dummy shaft several times to seat the bearings

e) Fit the arbour tool AU408 into the housing, install the screw adjusters and tighten enough to clamp the arbour into position

f) Use a feeler gauge to measure the clearance between the arbour and the dummy pinion head. 'Record the clearance'

g) The pinion will have a marking etched into its end. If the marking is '0' then a shim the same size as the dimension recorded in step 'f' is required. If the marking is '+2' then the shim required would be equal to 'f' minus the value related to '+2'. refer to the following chart:

h) Remove the dummy pinion and remove the rear bearing

Pinion Marking	Shim Thickness Required
-4	Add 0.10 mm to measurement recorded
-3	Add 0.075 mm to measurement recorded
-2	Add 0.50 mm to measurement recorded
-1	Add 0.025 mm to measurement recorded
0	Measurement recorded
+1	Subtract 0.025 mm from measurement
+2	Subtract 0.050 mm from measurement
+3	Subtract 0.075 mm from measurement
+4	Subtract 0.10 mm from measurement

ra019

cone, fit the shim selected in step above to the rear bearing cone bore in the differential housing and reinstall the cone.

8. Fit the rear pinion bearing to the pinion using a press and suitable sleeve

a) Lubricate the bearings, fit the collapsible spacer to the pinion and install the pinion into the differential housing, fit the front pinion bearing into position

b) Fit the pinion flange and using the original nut tighten until the front bearing is seated on the pinion shaft, remove the nut and use puller to remove the flange

c) Install a new pinion oil seal

Note: Seal fits flush to 0.25 mm below the housing surface.

d) Lubricate the pinion flange seal surface with lubricant and fit to the pinion. Hold the flange with special tool and tighten the new nut while turning the pinion in both directions.

Note: The pinion pre-load will have to be checked frequently fitting a pulley to the flange and using a spring balance and string to measure the rotational torque. Tighten the flange nut until the specified torque is reached.

Pinion Pre-load

New Bearings: ..... 1.4-2.4 Nm

Used Bearings: ..... 0.7-1.2 Nm

During VX production it is possible to use either Timken" or Koyo" bearings, the preload is listed below.

New bearings with pinion oil seal fitted:

Timken ..... 1.4 – 2.4 Nm Koyo ..... 1.5 – 2.1 Nm

New bearings without pinion oil seal fitted:

Timken ..... 1.4 – 2.0 Nm Koyo ..... 1.5 – 1.9 Nm

Used bearings with pinion oil seal fitted:

Timken ..... 0.7 – 1.2 Nm Koyo ..... 0.7 – 1.2 Nm

Used bearings without pinion oil seal fitted:

Timken ..... 0.7 – 1.2 Nm Koyo ..... 0.7 – 1.2 Nm

The torque reading is calculated by multiplying the pulley radius by the spring balance reading. e.g. pulley dia. 152 mm, radius is 76 mm which equals 0.076 m. Spring balance reading is 25 N. Pre-load is equal to 0.076 m x 25 N = 1.9 Nm.

Note: If the flange nut should be over tightened the collapsible spacer will have to be removed and replaced.

Setting Differential Backlash

1. Fit the ring gear carrier assembly into the case

2. Fit the screw adjusters and tighten enough to seat the carrier side bearings

a) Rotate the carrier several times to seat the bearings

b) Fit a dial indicator gauge with the pointer on one of the ring gear teeth

c) Turn the screw adjusters in or out until the backlash is roughly within specification

Backlash: .....0.10-0.18 mm

3. Tighten the screw adjusters to the torque reading previously recorded.

a) Check the backlash against four equally spaced points on the ring gear

b) If the backlash is not within specification back off or tighten the screw adjusters until the specified backlash is achieved.

Backlash: ..... 0.10-0.18 mm at tightest point

Limited Slip Differential

The procedures for dismantling the L.S.D assembly are the same as for the conventional differential except for the internal components of the carrier. Checking the bearing pre-loads, pinion depth, backlash etc. refer to the previous section.

Dismantle

1. Remove the carrier from the differential case as described in the previous section

2. With the ring gear removed loosen and remove the carrier cover bolts

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a) Lift the cover off the carrier, clutch cone may remain in the cover

3. Remove the clutch cone, shim if fitted, side gear and thrust spring plate from the pinion cross shaft

Note: The V8 and V6 Supercharged clutch cones/ side gears are an integral unit and must not be separated from one another.

a) Mark the clutch cones and their corresponding housings, with a daub of paint to assist in assembly

b) Remove the three concentric pre-load springs from the centre of the cross shaft

c) Remove the cross shaft, pinion gears and thrust washers from the carrier

d) Mark the remaining clutch cone and its housing with a daub of paint and remove it from the housing

Inspection

1. The mating surfaces of the carrier case halves should be free of burrs and clean.

2. Check the thrust surfaces of the pinions for excessive wear.

3. Inspect the clutch cone seats for excessive scoring, slight grooves and scratches are permissible.

4. The land surface of the clutch cones heavy spiral, will duplicate the housing surface condition. Excessive wear or damage will require the cones and housing to be replaced.

5. Inspect the pinion cross shaft bores for ovality

6. Inspect the axle splines in the clutch cones for excessive wear

Replace any components found to be faulty.

Assembly

1. Lubricate all of the carrier parts with specified lubricant

V6 - Engine Only

2. Fit the clutch cones and shims if used into their respective housings

a) To check if shims are required, measure the distance from the case mating surface to the flat surface of the clutch cone. record this dimension

b) Using the above measurement select the required shim from the chart below:

Distance Measured	Shim Size Required
32.0-31.84 mm	No Shim Required
32.14-32.04 mm	0.13 mm Shim
32.27-32.17 mm	0.25 mm Shim

ra020

Note: The V8 and V6 Supercharged models do not require shims as the clutch cone and pinion side gear are an integral unit.

3. Mount the L.H. axle shaft in a vice using soft jaws

a) Fit the carrier case over the axle shaft

b) Coat the side gear and clutch cone friction surfaces with a mixture of molybdenum disulphide grease and the specified differential lubricant

V6 Engine

c) Fit the clutch cone over the axle splines and seat it in the housing, fit the shim if required followed by the pinion side gear

V8 & V6 Supercharged Engine

c) Install the clutch/side gear to the housing

4. Fit a thrust spring plate into position (stepped side up) on the pinion side gear

a) Fit the four pinions and thrust washers to the cross shaft

b) Install the pinions and cross shaft to the carrier housing

c) Fit three new concentric differential pre-load springs in the centre of the cross shaft

d) Fit the second thrust spring plate on top of the concentric springs (stepped side towards the springs)

V6 Engine

5. Fit the clutch cone, shim if required followed by the pinion side gear to the case cover

V8 & V6 Supercharged Engine

Install the clutch/side gear to the housing

a) Fit the case cover to the carrier, ensure that the cutout on the cover is aligned with the carrier cutout

b) Install two new cover bolts finger tight and fit the other axle through the side gear/clutch cone

c) Fit the remaining bolts and tighten evenly to the specified torque

Torque: ..... 35-45 Nm

Note: Assemble the rest of the differential following the procedures used for the conventional differential in the previous section.

Ring Gear & Pinion Contact Pattern

Checking Contact Pattern

1. Thoroughly clean ring gear and pinion teeth.

2. Paint ring gear teeth lightly and evenly with gear marking compound of a suitable consistency to produce a contact pattern.

3. Apply a light load to the ring gear using a flat bar or similar

4. Turn the differential through several rotations in both directions

5. Inspect contact pattern produced by above procedure.

General Information

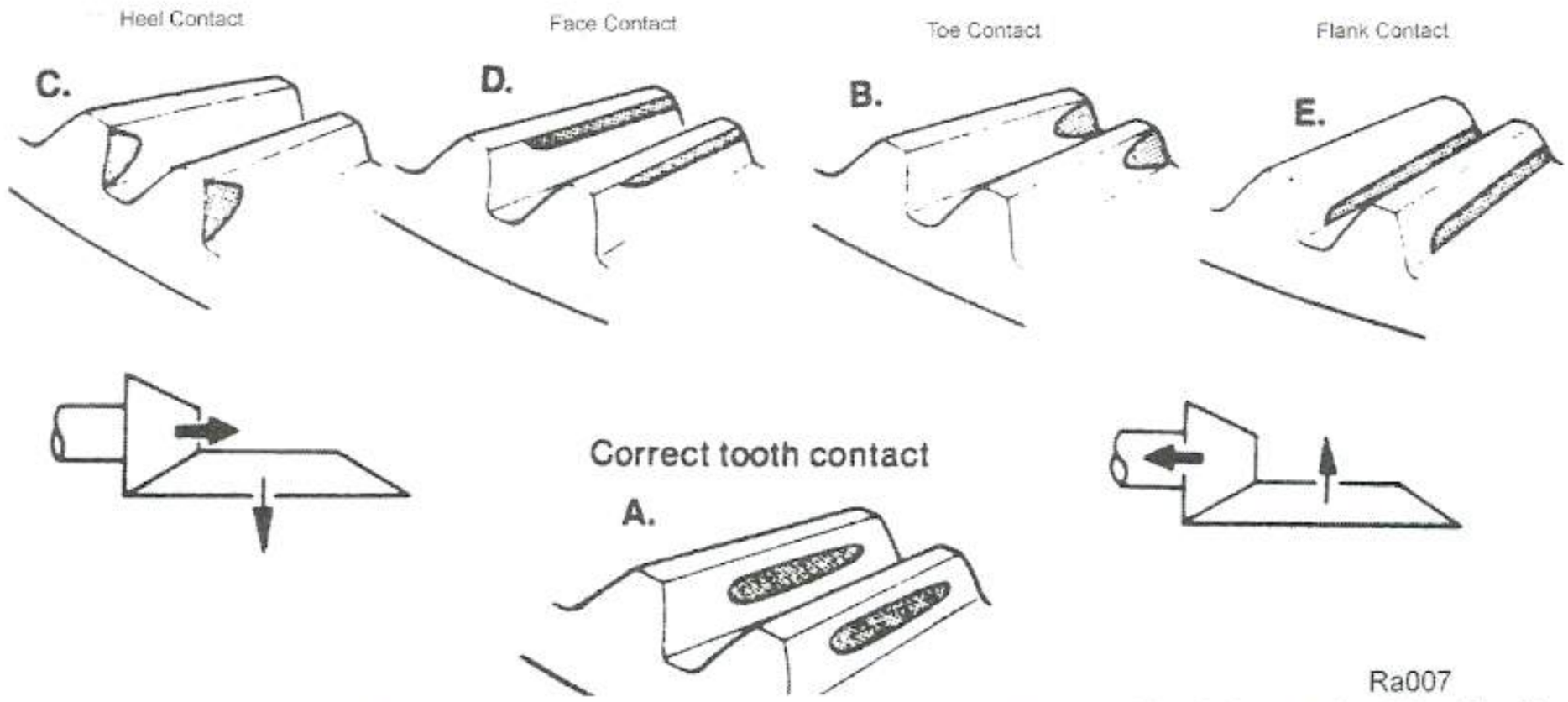
The large end of the tooth is called the 'HEEL' and the small end the 'TOE'

The top of the tooth which is above the pitch line is called the 'FACE' while the area below the pitch line is called the 'FLANK'

The clearance between the pinion and ring gear teeth is referred to as 'BACKLASH'

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GEAR TOOTH CONTACT PATTERNS; Throughly clean ring gear and pinion teeth. Paint ring gear surfaces lightly and evenly with gear marking compound



The figure illustrates correct and incorrect contact patterns. Contact pattern 'A' provides the ideal marking for quietness and long life.

If the pattern shows a toe contact 'B', it indicates not enough backlash. If the pattern shows a flank contact 'E', it indicates that the pinion is in to far. To correct, move the ring gear away from the pinion by increasing the size of the shim on the pinion shaft before the collapsable spacer.

If the pattern shows a heel contact 'C', it indicates too much backlash. To correct a pattern such as 'D', it will be necessary to adjust. To correct, move the ring gear towards the pinion by decreasing the size of the shim on the pinion shaft before the collapsable spacer.

**** moving the pinion 'IN' reduces backlash and moving pinion 'OUT' increases backlash.***

Preffered Contact Patterns

Drive Side:

A central toe contact marking, lengthwise in position and slightly low contact in the profile position. Total length approximately 5/8 of the gear face width. There should be clearance of about 1 mm between the contact marking and the toe and along the top face angle line.

Coast Side:

A centrally located marking, lengthwise in position and slightly high in the profile position. Total length approximately 5/8 of the gear face width. There should be clearance between the contact and the face angle line of the gear.

Acceptable Heel Contact Patterns

Drive Side:

A central face contact marking, lengthwise in position, is shown in figure. This represents the limit of acceptability of the contact marking towards the heel. Marking should fade out at least 5 mm before heel end. A central profile marking position is shown and is acceptable, although low contact marking is preferred.

Coast Side:

The centre of the contact marking is located at 5/8 of the face width from the toe and it does not approach the heel end by less than 5 mm. A high contact marking, as shown in figure, is preferred for coast side contacts which tend to be toward the heel. A central profile marking position is acceptable, providing the pinion face angle edge lines do not appear low on the gear.

Acceptable Toe Contacts:

Drive Side:

The contact markings begin almost at the toe end face and extend in length by approximately half the face width. A slightly low contact marking is shown in figure. This is preferable although a centrally located profile position is acceptable.

Coast Side:

The contact marking being almost at the toe end face and may appear pointed as shown in figure. A square end is equally acceptable. The total length of the contact marking is approximately 1/2 of the face width. A high profile marking position is desirable, although a central profile is acceptable.

After satisfactory contact pattern is acheived, clean ring gear and pinion gear teeth and pour a liberal quantity of rear axle lubricant onto gears and bearings.

a) Turn gears to work lubricant into all surfaces.

Problem Diagnosis

General Problems

The differential is often blamed as being the cause of rear end noise, when in reality, the noise is emanating from some other source, such as tyres, rear wheel bearings, transmission rear bearing (manual transmission), engine noises, muffler roar, automatic transmission etc.

All differentials have some slight humming noise. This will

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vary with the type of body construction, load and tyre pressure.

Noise which emanates from any one of these can quite easily be confused with a differential noise and unless a series of elimination tests are carried out to definitely confirm the real source of the noise, rear axle assemblies may be (and often are) dismantled unnecessarily.

Although not infallible, the following diagnosis guide will assist in locating and defining the different characteristics of the components which could be responsible for a noise.

Road Test

Drive at low speed until thoroughly familiar with vehicle noises, by which time the rear axle should have warmed up. Accelerate gradually from the lowest practical speed in top gear to 100 km/h, noting any noises and the speeds at which they occur. Release the accelerator and without using the brakes, allow the vehicle to lose speed.

Next, allow the vehicle to coast to rest from 100 km/h with the transmission in neutral position. Any noises common to earlier tests may be eliminated as rear axle gear noise, as the rear axle is not under load under these conditions.

Engine noise is gauged by gradually accelerating the engine with the vehicle at rest.

Diagnosis

Consider the following factors when diagnosing bearing condition:

1. General condition of all parts during dismantling and inspection.

2. Note the type of failure.

3. Determine the cause.

4. Make all repairs following recommended procedures.

Problem: Abrasive roller wear!

Possible Cause:

* Pattern on races and rollers caused by fine abrasive.

Remedy:

* Clean all parts and housings.
* Check seals and bearings and replace if leaking, rough or noisy.

Problem: Galling!

Possible Cause:

* Metal smears on roller ends due to overheating lubricant failure or overload.

Remedy:

* Replace bearing, check seals and check for proper lubrication.

Problem: Bent cage!

Possible Cause:

* Cage damage due to improper handling or tool use.

Remedy:

* Replace bearing.

Problem: Abrasive step wear!

Possible Cause:

* Pattern on roller ends caused by fine abrasive.

Remedies:

* Clean all parts and housing.
* Check seals and bearings and replace if leaking, rough or noisy.

Problem: Etching!

Possible Cause:

* Bearing surfaces appear grey (or greyish black) in colour with related etching away of material usually at roller spacing.

Remedy:

* Replace bearings, check seals and check for proper lubrication.

Problem: Indentations!

Possible Cause:

* Surface depressions on race and rollers caused by hard particles of foreign materials.

Remedies:

* Clean all parts and housing and check seals
* Replace bearings if rough or noisy.

Problem: Cage wear!

Possible Cause:

* Wear around outside diameter of cage and roller pockets caused by abrasive materials and inefficient lubrication.

Remedies:

* Replace bearings, check seals
* Check for proper lubrication.

Problem: Misalignment!

Possible Cause:

* Outer race misalignment due to foreign object.

Remedies:

* Clean related parts and replace bearing.
* Make sure races are properly seated.

Problem: Cracked inner race!

Possible Cause:

* Race cracked due to improper fit, cocking, or poor bearing seats.

Remedy:

* Replace bearing and correct bearing seat.

Problem: Fatigue spalling!

Possible Cause:

* Flaking of surface metal resulting from fatigue.

Remedy:

* Replace bearing and clean all related parts.

Problem: Discolouring!

Possible Cause:

* Surface indentations in raceway caused by rollers either under impact loading or vibration while the bearing is not rotating.

Remedy:

* Replace bearing if rough or noisy.

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Specifications

Rear Axle Assembly

Type:

V6 Engine

BTRE - 76 Series

V8 & V6 Supercharged

BTRE - 80 Series

HSV and V2 Monaro code and ratio alterations:

HSV used either LSD or Hydratrak.

Vehicle	Transmission	ID Code	Final drive ratio
VTI Senator 220i / GTS	Manual	BL	3.46
VTI Senator 220i / GTS	Auto	BK	3.07
VT II on LS1 vehicles	Manual	ET	3.73
VT II on GTS	Manual	CK	3.91
VT II	Auto	EH	3.07
Monaro V2 Gen III	Manual	FC	3.46
Monaro V2 Gen III	Auto	FH	3.07
Monaro V6 supercharge	Auto	FH	3.07
Monaro V6 supercharge	Auto	FF	3.07 (no LSD)

Gear Type: Hypoid

Gear Ratio: V6-3.08:1, V8 & V6 Supercharged-3.07:1

No. of Teeth:

V6 Engine	Ring Gear:	37
	Pinion Gear:	12
V8 & V6 Supercharged	Ring Gear:	43
	Pinion Gear:	14

Lubricant:

Capacity: ..... 1.65 Litres

Type

V6 conventional & LSD: Mineral Hypoid Gear Oil, Ampol Gearlube SRD90, BP Limslip 90, Caltex gear Oil LSD, Castrol LSX90, Mobil Lubrite LS90, Shell XD90LS, Valvoline HP Gear Oil LS90 or similar

V8 & V6 Supercharged: Synthetic Hypoid Gear Oil, Ampol Synthetic Gear Oil 80W/140, Caltex Synstar GL 80W/140, Castrol SAF-XA, Mobil Mobilelube SHC 80W-140 ID, Valvoline Synthetic Gear Oil 75W-140 or similar

Carrier gears:

Type: ..... Straight Bevel

V6 Engine:- No. of Teeth	Pinion:	10
	Side Gears:	16
V8 & V6 Supercharged:- No. of Teeth		
	Pinion:	10
	Side Gears:	15

Runout Specifications All:

Trunnion Assembly Hub: 0.16 mm max'

Carrier Assembly (ring gear removed): 0.05 mm max'

Ring Gear Rear Face: 0.13 mm at the tightest point

Backlash Specifications All:

Ring Gear to Drive Pinion: 0.10-0.18 mm at tightest point

LSD torque check:

45 Nm Minimum

Pinion Pre-load

New Bearings: ..... 1.4-2.4 Nm

Used Bearings: ..... 0.7-1.2 Nm

During VX production it is possible to use either Timken" or Koyo" bearings, the preload is listed below.

New bearings with pinion oil seal fitted:

Timken ..... 1.4 – 2.4 Nm

Koyo ..... 1.5 – 2.1 Nm

New bearings without pinion oil seal fitted:

Timken ..... 1.4 – 2.0 Nm

Koyo ..... 1.5 – 1.9 Nm

Used bearings with pinion oil seal fitted:

Timken ..... 0.7 – 1.2 Nm

Koyo ..... 0.7 – 1.2 Nm

Used bearings without pinion oil seal fitted:

Timken ..... 0.7 – 1.2 Nm

Koyo ..... 0.7 – 1.2 Nm

Side Bearing Pre-load

New Bearings:	15-35 Nm
Used Bearings:	8-18 Nm

During VX production it is possible to use either Timken" or Koyo" bearings, the preload is listed below.

	Timken	Koyo
New bearings	15 – 35 Nm	8 – 24 Nm
Used bearings	8 – 18 Nm	5 – 13 Nm

Torque Specifications

Rear Cover Bolts: ..... 23-31 Nm

Filler Plug: ..... 23-31 Nm

Drain Plug: ..... 23-31 Nm

Ring Gear Bolts: ..... 125-150 Nm

LSD Carrier Cover Bolts: .... 35-45 Nm

Drive Shaft to Inner Axle Bolts: 50 Nm + 60°-75°

Trunnion to Driveshaft Nut: . 295-305 Nm

Diff' to Crossmember Bolts: 90 Nm + 30°-45°

Early type (upto approx Jan 2000)

Rear Mount to Underbody:

Early type (upto approx Jan 2000) 30-40 Nm

Aust manuf type (after approx Jan 2000) 30-40 Nm plus 55°-65° turn

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STEERING

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STEERING

Minor Maintenance

Steering Gear Lubrication

The rack and pinion steering gears are lubricated by a semi-liquid grease.

The correct amount of grease can only be applied during a steering gear rebuild and therefore check and top-up is not a maintenance service operation.

Specified Lubricant:
EP Semi Fluid Lithium Base O Grease
Specified Amount: 50 Grams

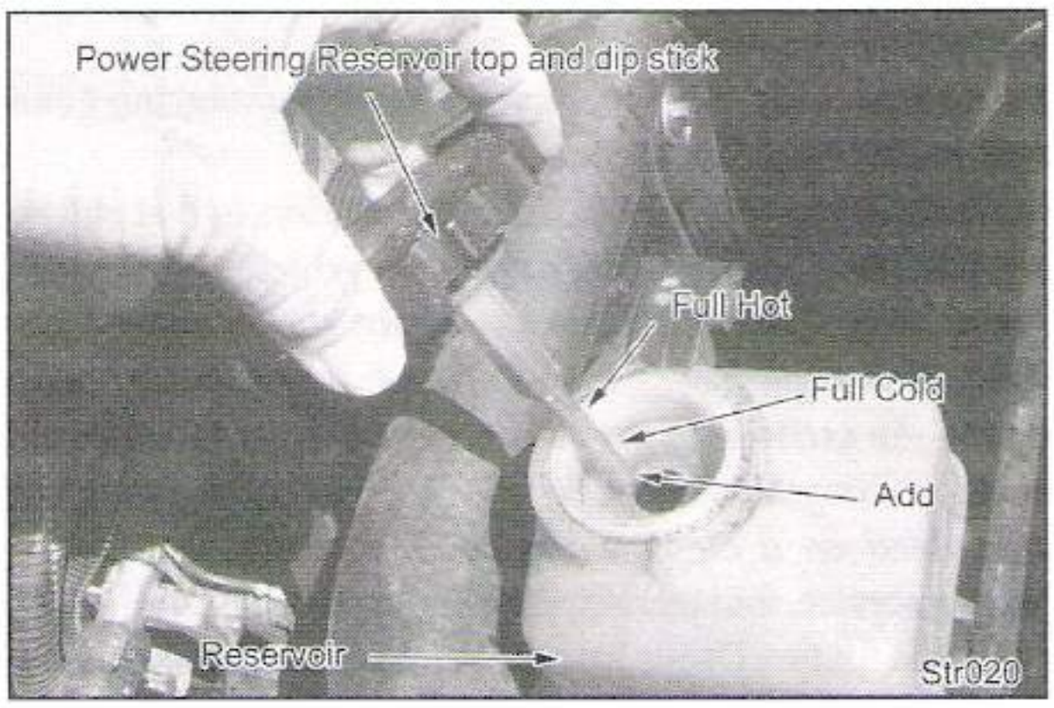
Fluid Contamination

If the power steering fluid has been contaminated, the power steering lines should be flushed and the steering pump, reservoir, rack and pinion gear must be removed, dismantled, cleaned, assembled, and installed as described in this chapter.

Power Steering Pump Fluid Level

Run the engine until the fluid is at normal operating temperature, (74-80 degrees Celsius). Turn the steering wheel from lock to lock several times then turn off the engine.

Check the fluid level in the pump reservoir by the dip stick. If required top-up the fluid to the 'HOT' mark on the dip stick with the specified fluid. DON'T OVERFILL.



Gen III V8 engines have a visual inspection at the side of the fluid reservoir.

Specified Fluid:
Dexron III Automatic Transmission Fluid
Specified Fluid Capacity: 650 ml

Drive Belt

V6 and V8 - Replacement and adjustment of belt tension. See drive belt section in "Tuning and Maintenance" chapter.

Rack and Pinion

All rack and pinion adjustments must be performed with the rack and pinion removed from the vehicle.

Pinion Bearings

There is no adjustment possible on the pinion bearings. If considered that there is extreme free play in the pinion bearings, then the bearings should be replaced.

Centralising the Rack

When vehicle is travelling straight ahead it is vital that the rack bar is positioned centrally within its ratio pattern.

The rack bar is in the straight ahead position when the distance between the housing lock stop face and the inner face of the tie rod ball joint is equal for both locks. This distance can be set by rotating the pinion to the halfway position of its total lock to lock rotation.

When the rack is in the straight ahead position, the input shaft must be in the position as shown on next page. Input shaft square back must be 16^0 from the centre line of the steering rack.

If the position is at any other angle, then the pinion is displaced by one or more teeth and must be corrected before the gear is installed in the vehicle.

Bleeding the System

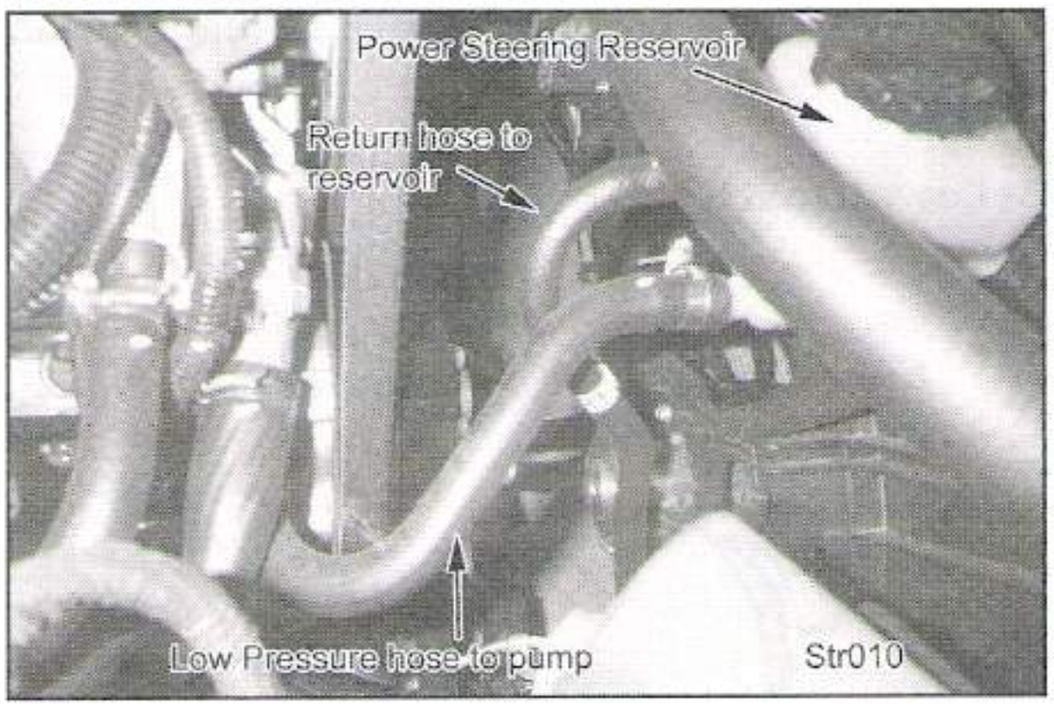
After any repairs are carried out on the steering gear, pump or lines the following start up operation must be used.

1. Fill reservoir to the 'cold' level with the specified fluid.
2. Start engine and run for 2 or 3 seconds to circulate the fluid, top up reservoir.
3. Repeat step 2 until the fluid level remains constant.
4. Idle engine and turn steering wheel quickly to lightly contact each stop three times, stop engine and top up reservoir.

Power Steering Pump Hoses and Tubes

Remove

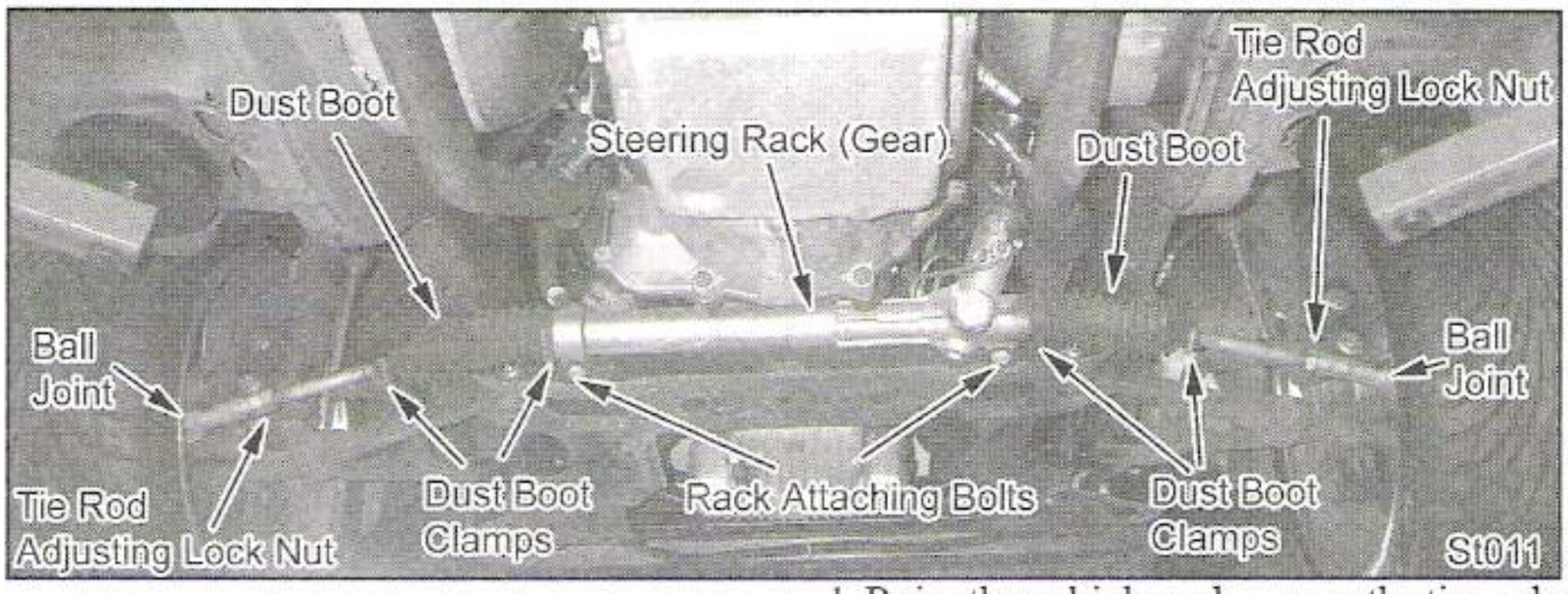
1. Disconnect the tubes from the steering gear valve housing and drain the fluid into a container.
2. Disconnect the fluid return hose and the pressure tube from the pump.
3. Remove the tubes and hoses from the vehicle.



Install

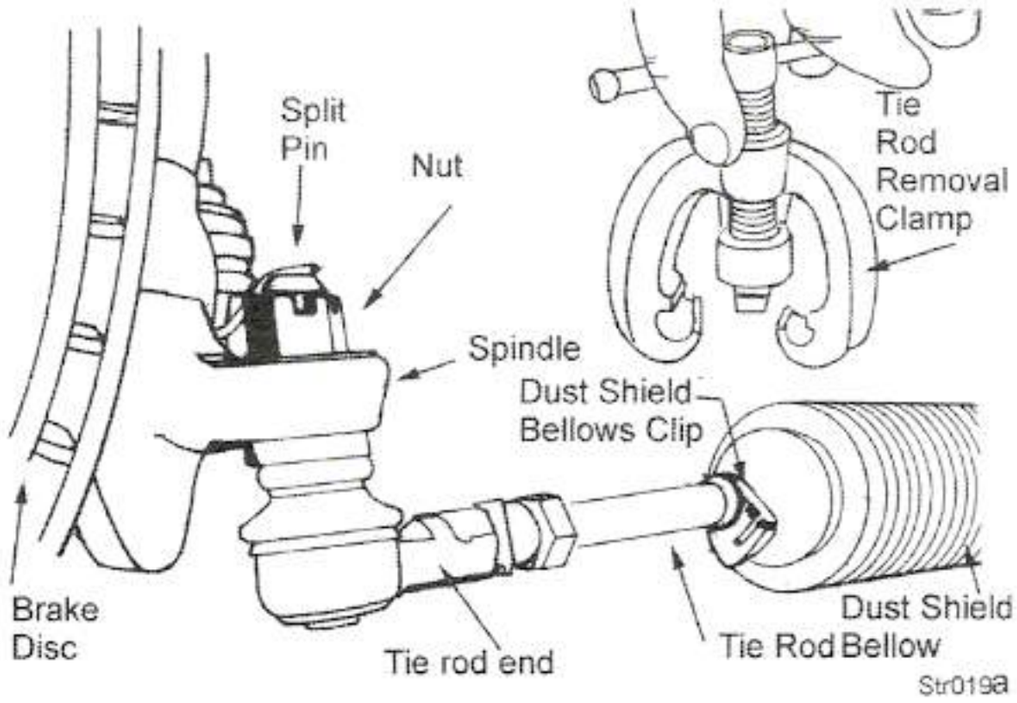
1. Install the tubes to the steering gear valve housing.
2. Install the fluid return hose and the pressure tube to the pump.

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3. Fill the reservoir with the specified power steering fluid.

Tie Rod Ball Joint



Remove

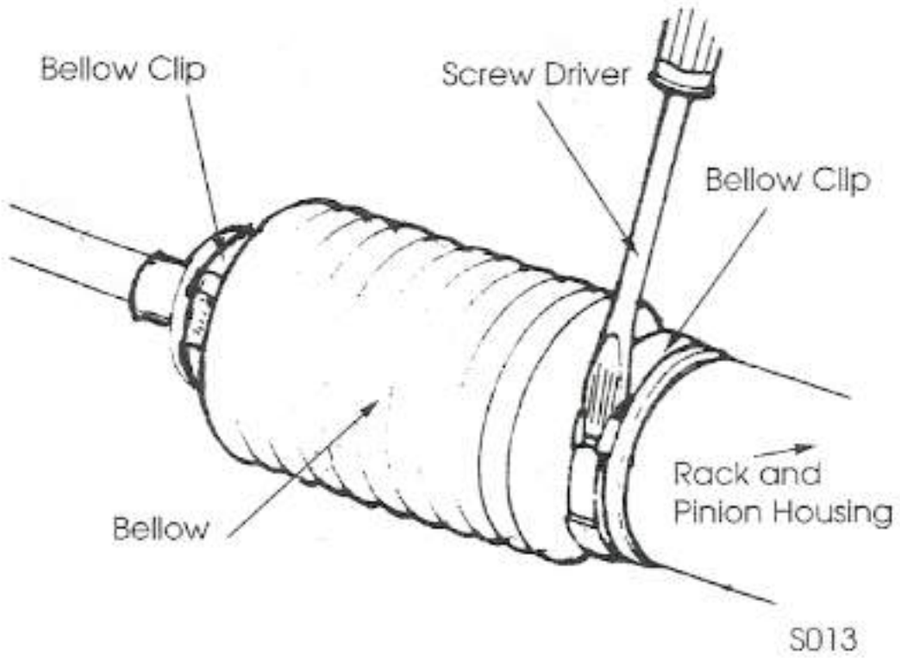
1. Raise vehicle, loosen tie rod end locknut 1/4 of a turn.
2. Loosen tie rod end stud nut and free the stud taper in the spindle using a tie rod removal clamp or Tool No. 9A-10.
3. Remove nut and disconnect the tie rod end from the spindle, hold tie rod and unscrew tie rod end.

Install

1. Hold tie rod and screw the end onto the rod until it locks tightly.
2. Locate tie rod end stud in the spindle, install and tighten the nut. Pin the nut.
3. Lower the vehicle and check the toe-in, tighten tie rod end lock nut.

Bellows (Dust Boot)

Remove



1. Raise the vehicle and remove the tie-rod end as previously described.
2. Remove tie rod end locknut, and remove the clips with a screw driver from the bellows then remove the bellows from the gear.

Install

1. Install the bellows on the gear, install the bellows clips but don't tighten the small clip.
2. Install the locknut and tie rod end, don't tighten the locknut.
3. Lower the vehicle and check the toe-in, tighten the small bellows clip and the tie-rod end locknut.

MAJOR REPAIRS & REBUILD

Rack & Pinion Steering Gear

Note: the steering gear is slightly different from VT Ser I to VTSerII and later.

*** All repairs must be performed with the steering gear removed from the vehicle.**

Right or Left hand of the steering gears refers to that end as viewed from the drivers position in the vehicle.

CAUTION: It is most important that the steering gear parts are kept free from dirt and foreign particles, hence, the exterior of the steering gear assembly must be cleaned completely before the gear is dismantled or assembled on a clean work bench.

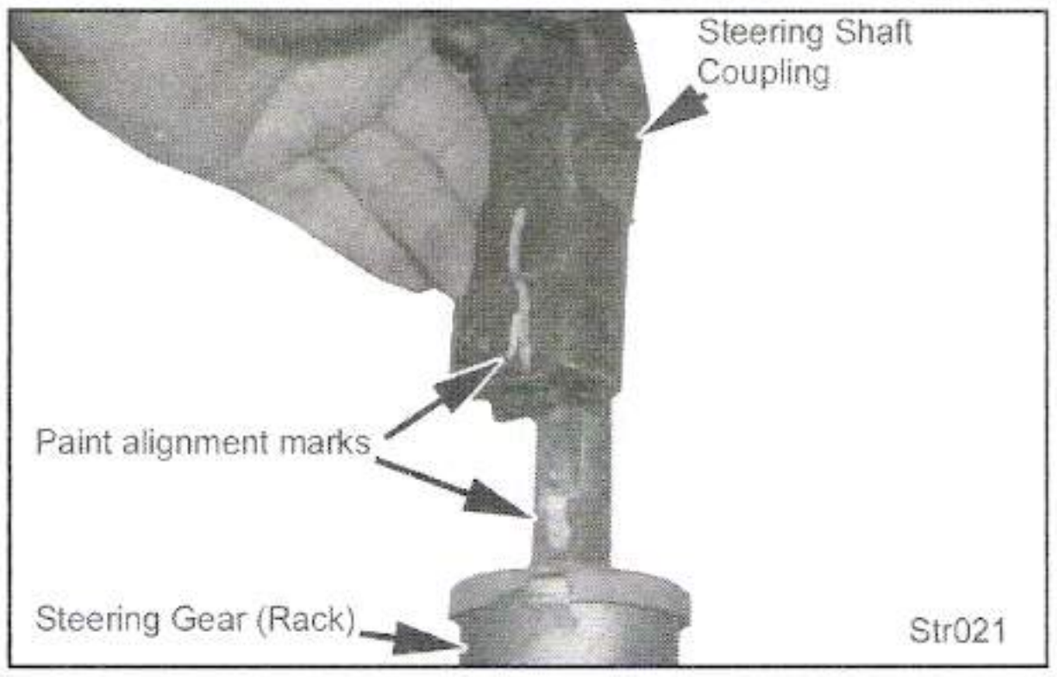
During service, the steering gear should preferably be held in a suitable fixture. Do not grip the general housing in a vice as this could cause deformation and cracking of the thin aluminium section resulting in binding or failure of the gear.

Steering Gear

Remove

1. Place a drain pan under the steering.
2. Disconnect the pump to steering gear hydraulic lines at the gear using a six point tube nut wrench.
3. Loosen the clamp bolt at the upper end of the coupling shaft. Place alignment marks on coupling and steering shaft to help assembly. Remove the bolt from the clamp at the lower end of the coupling shaft. Slide the coupling shaft upwards until it is clear of the steering gear input shaft.
4. Raise the vehicle supporting it under the body side rails, loosen the tie rod end stud nuts and free the tie rod end stud tapers in the wheel spindles. Remove the nuts and detach

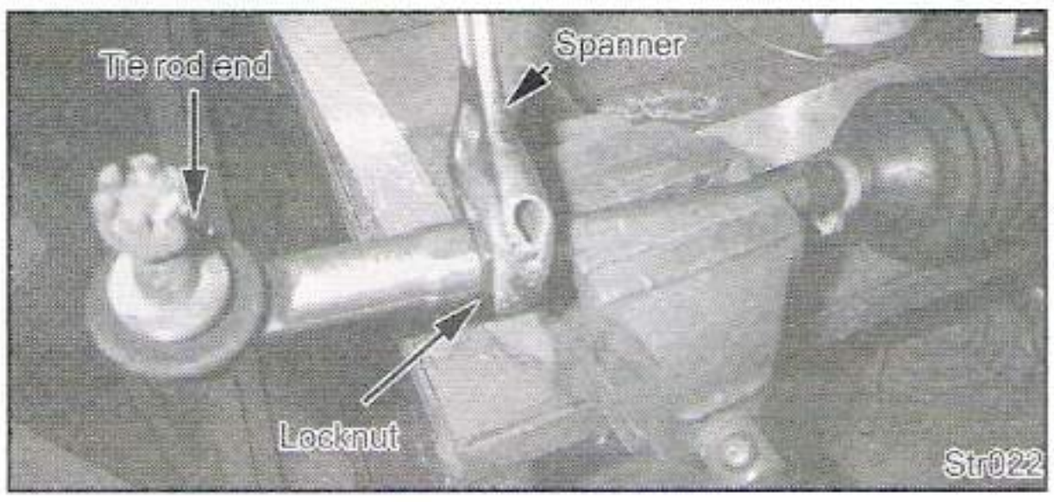
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the tie rod ends from the spindles.

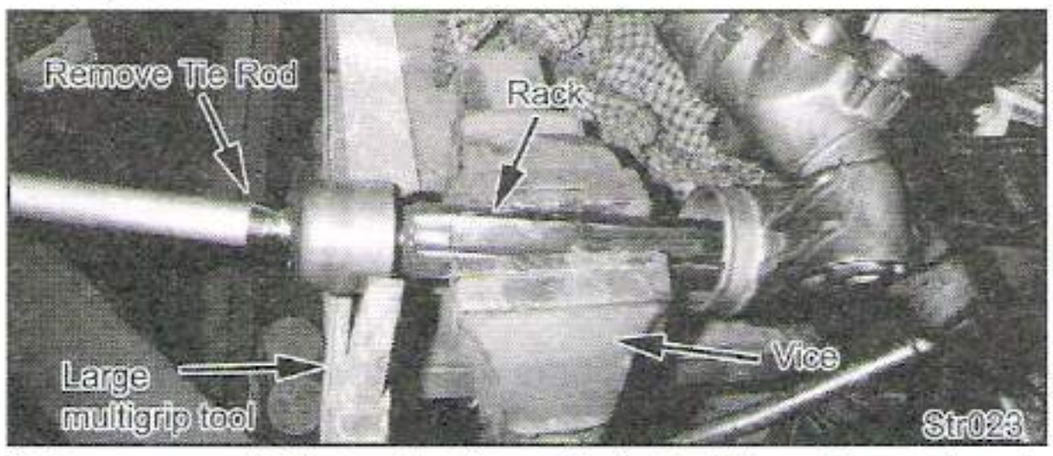
5. Remove the two bolts attaching the steering gear assembly to the sub-frame and remove the gear from the vehicle.

Dismantle



1. Remove the tie rod ends and bellows as previously described. Turn the gear to full left lock.

2. Hold the exposed tooth end of the rack in the vice equipped with protective jaws.



3. Loosen and tighten the tie rod joint ball housing, to break the seal. Unscrew the tie rod assembly from the rack.

4. Remove the gear from the vice and rotate the pinion enough to expose the left hand tab washer. Remount the assembly in the vice gripping the exposed rack.

5. Remove the left hand tie rod assembly as in Step 3. Remove the gear housing assembly from the vice and remount it by gripping the left hand mounting boss.

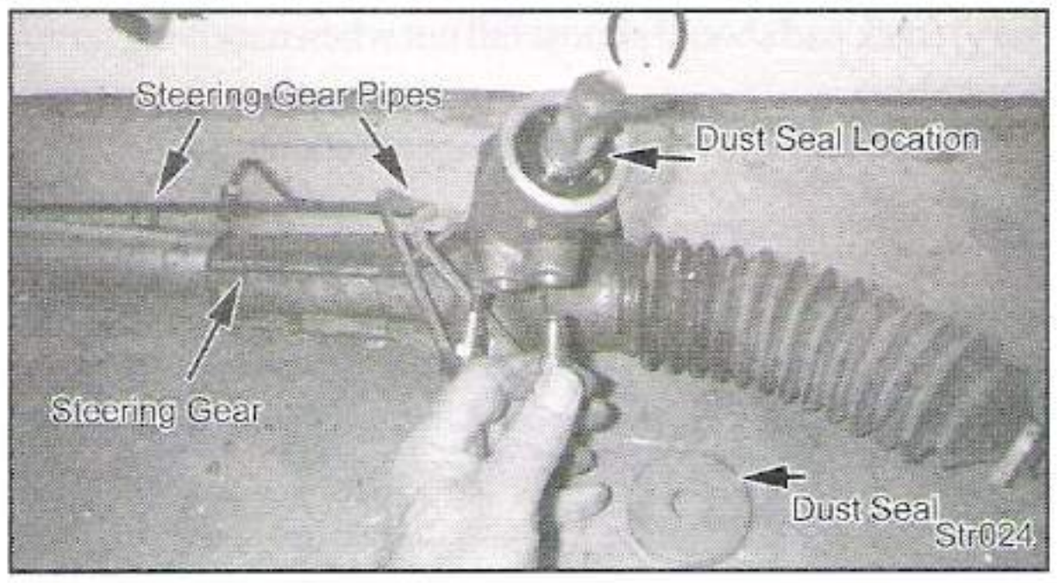
6. Disconnect the fluid transfer pipes from the valve housing and the gear housing.

7. Remove the dust seal from the housing.

8. [VT Ser I] Remove the two valve housing attaching screws (5mm allen key) and pull the valve housing from the input shaft.

a). Remove and dispose of the 'O' ring seal from the spigot on the rack housing.

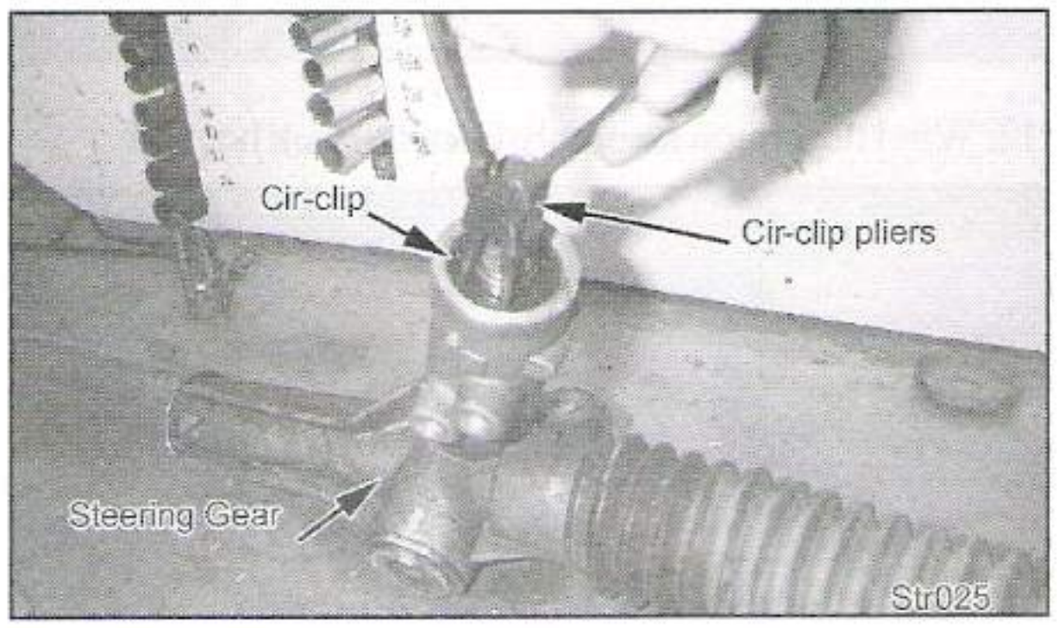
b). Drive the valve seal and bearing from the valve housing.



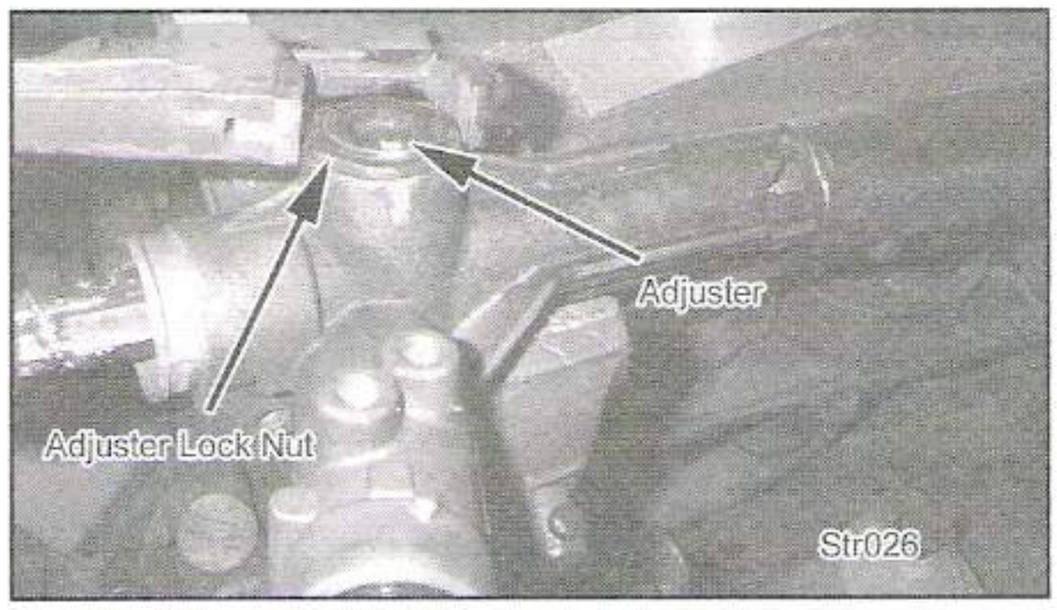
Tip: The inner needle bearing may fall out.

8. [VT Ser II and later]

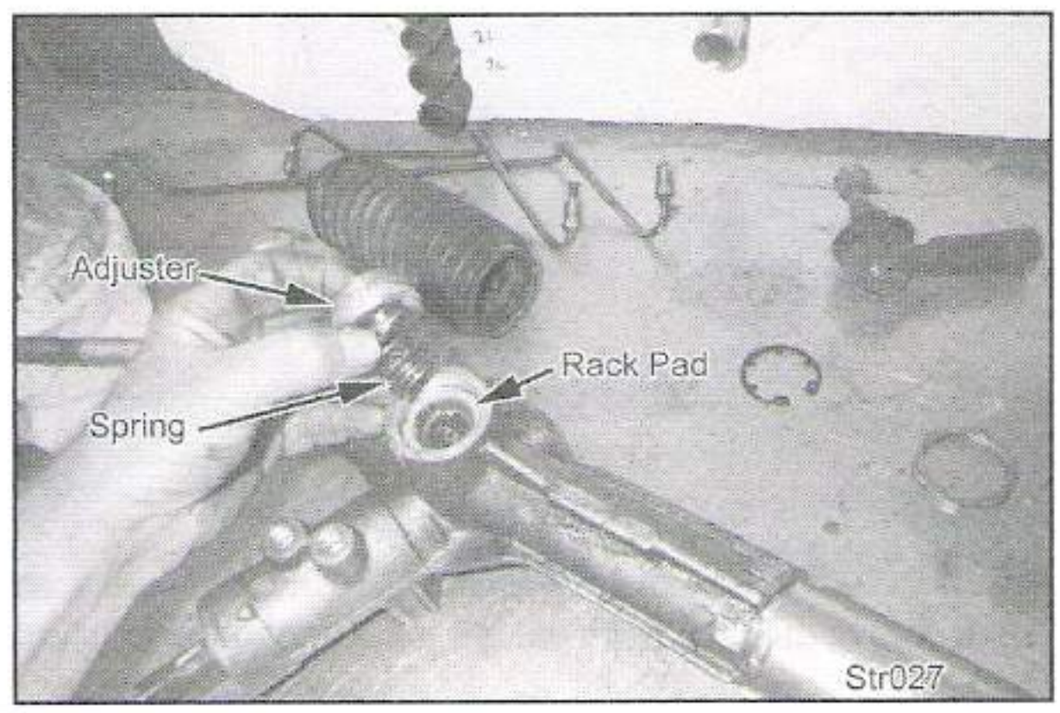
Remove the circlip, from the valve housing.



9. Release the rack pad adjuster locknut with Holden Tool No. AU301 or suitable multigrips, turn the gear to the full right hand lock.

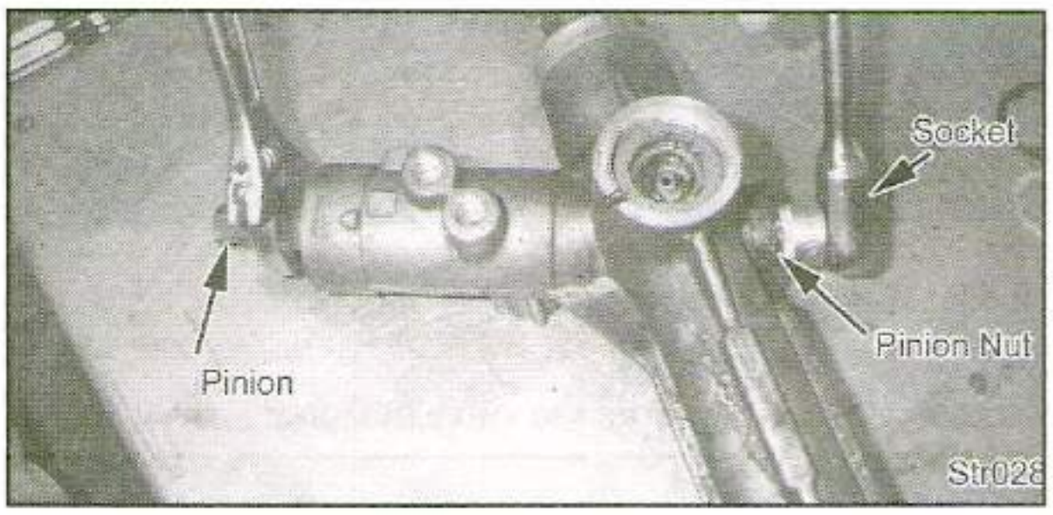


10. Remove the rack pad adjuster screw, spring and rack pad assembly (Holden Tool No. AU211 will help but not neces-

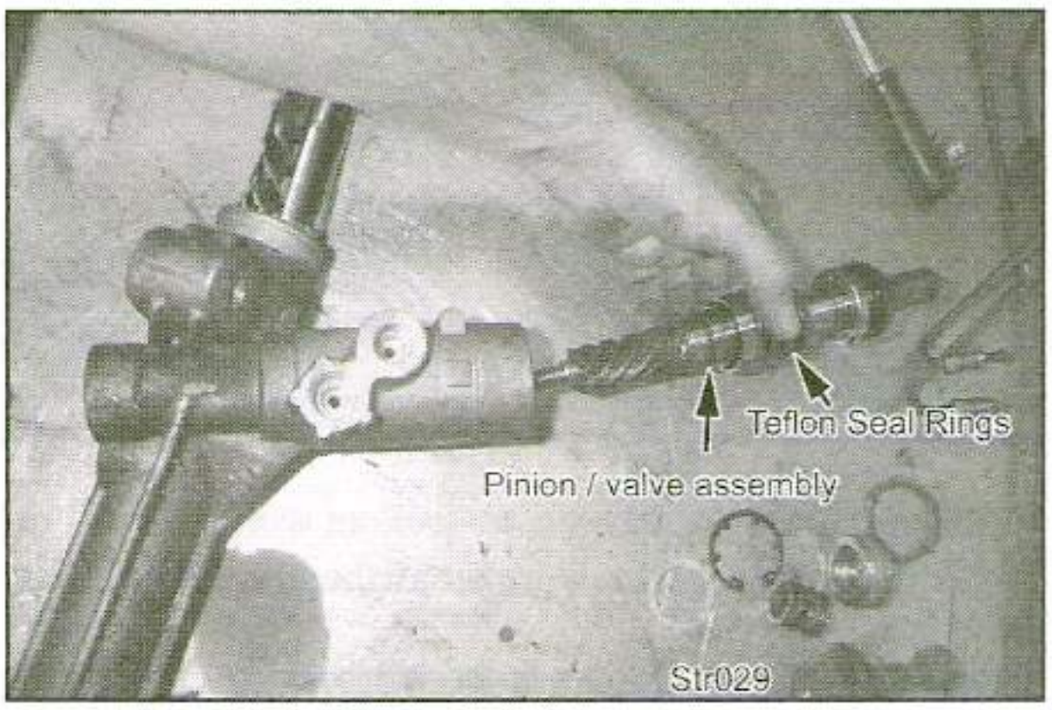


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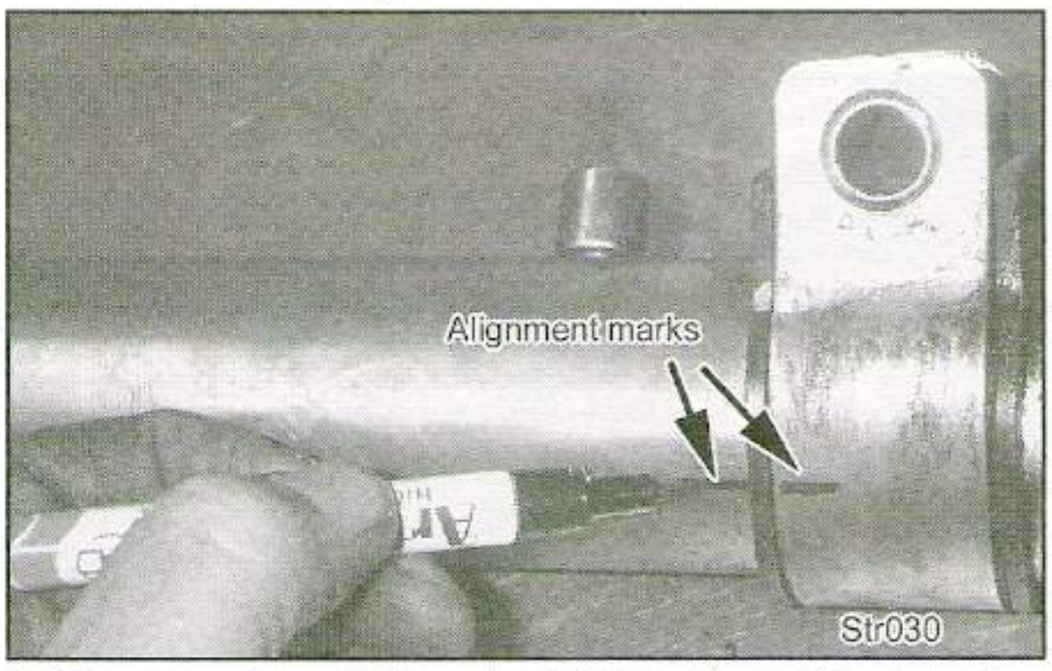
sary) (rack pad should almost fall out when removing pinion assembly).
11. Remove the lower pinion bearing retaining screw from the housing.
12. Remove the lower pinion bearing retaining nut from the pinion.



12. Wind the pinion assembly from the rack housing.

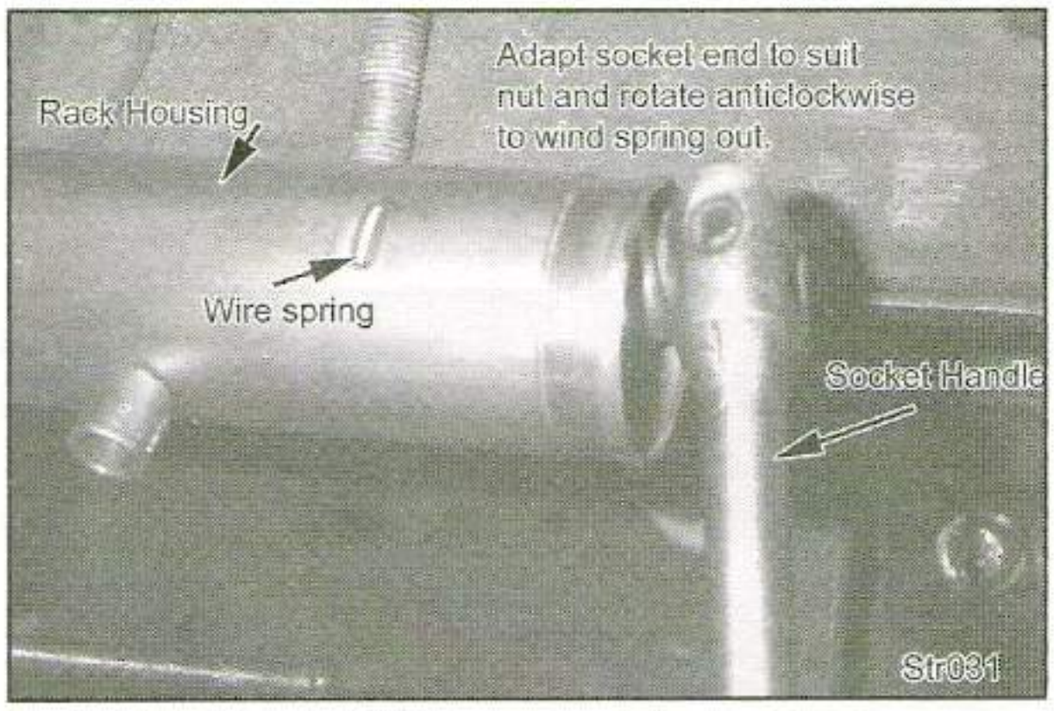


13. Remove and dispose of the Teflon sealing rings from the valve sleeve.
This is best achieved by cutting them diagonally with a sharp knife taking care not to scratch the grooves or subsequent leakage will result.
*The Pinion Assembly Must Not Be Further Dismantled.
14. Remove the pinion seal and bearings from the housing. Discard the seal.
15. Place alignment marks on rack mounting bracket and remove by using a screw driver to lever and work the bracket from the rack housing.



16. Remove the rack from the left hand end of the housing.

* The inner rack seal and back up ring together with the rack bearing will be removed on the rack, therefore some resistance will be encountered when the rack contacts these items.
Remove the rack bearing from the rack bar.
17. Rotate the piston in a anticlockwise direction to release the lock wire.
18. Remove the piston from the rack bar.
19. Remove the spring wire from the rack bar, use a screw driver to lever end of spring wire up and wind the rack bar anticlockwise to remove spring wire..



20. Remove the inner rack seal and retaining ring from the rack bar.
21. Remove the Teflon ring and rubber ring from the piston outside diameter.
22. Remove the 'O' ring from the inside diameter of the piston.
23. Remove the 'O' ring from the outside diameter of the rack bearing.
24. Remove the rack seal from the end of the rack bearing taking care not to damage the bearing or seal diameters.

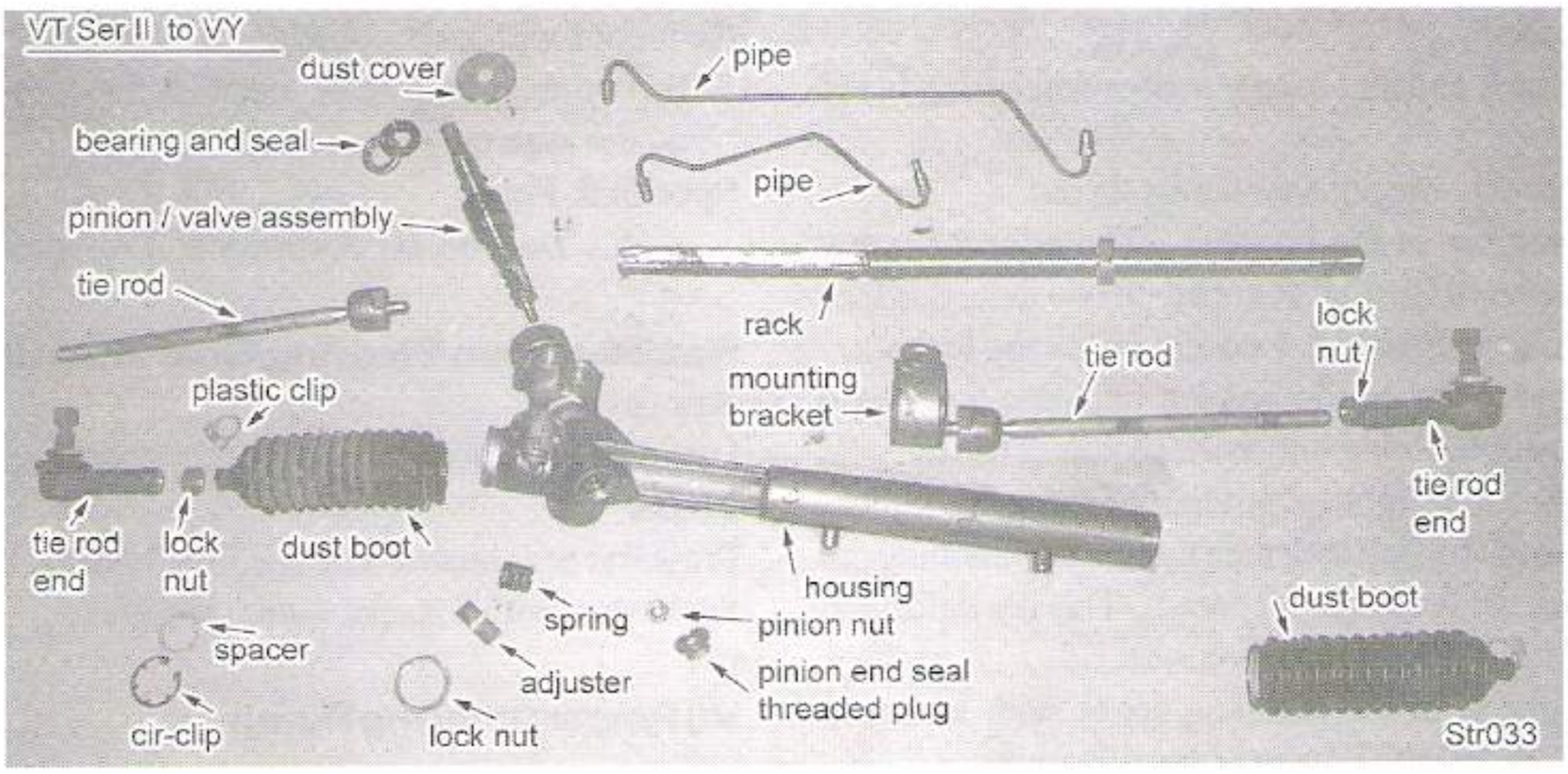
Clean and Inspect.

1. Wash all parts in a cleaning solvent and blow off with air.
2. Examine the rubber bellows thoroughly for damage and deterioration, replace if required, dispose of all seals.
3. Inspect pinion bearings for signs of brinnelling, damage and wear, examine pinion for signs of tooth wear or damage.
4. Examine rack for signs of wear or damage to the teeth, rack pad faces and bush journal.
5. Inspect housing for wear or damage in the pinion bearing bores, seal bores, power bore and lock stop faces.
6. Inspect the rack pad for damage or excessive wear, examine the valve housing and bearing for any wear or damage. Then examine the valve sleeve for any wear or damage.

Assembly

1. Install the upper pinion bearing into the rack housing using a bearing insertion tool. Examine the pinion seal.
2. Install the lower pinion bearing into the rack housing using retaining screw to push it into place. Leave the retaining screw in position until the pinion is installed.

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3. Assemble the 'O' ring and the Teflon ring into the groove in the outer diameter of the piston.
4. Position the piston assembly into the tapered sleeve, for 5 minutes to shrink the Teflon ring back to its operating dimension.
* Both the inner and outer rack seals have a tapered nylon ring installed in a recess in a rear face of the seal. The rings must be installed with the taper towards the spring loaded seal slip. Make sure that the tapered ends of the rings are correctly seated.
5. Assemble the seal back up ring and inner rack seal onto the rack bar. Make sure the spring loaded sealing lip is facing the left hand end of the rack. Take care when passing the seal over the piston circlip grooves.
6. Place the piston on the rack bar tapered face first. Locate the short leg of the lock wire in the hole in the lock ring groove of the rack with the long leg of the wire pointing to the right. Slide the piston over the lock wire so that the wire is located in the slot in the piston face.
7. Rotate the piston in a clockwise direction to wind the wire into the locking groove on the inner diameter of the piston. When fully home approx 2mm of wire should protrude into the piston slot to aid in possible future removal of the piston.
8. Install the 4 Teflon seal rings into the grooves of the valve sleeve. It will be necessary to expand the rings, so that they can be easily fitted into the sleeve grooves. The rings may be more easily worked if they are warmed in hot water.
9. When the rings are fitted into the grooves place the assembly into a cylinder type clamp for 5 minutes to shrink the rings to their operating dimension.
10. Liberally smear the rack teeth and journal with specified grease.

Specified Lubricant:

EP Semi Fluid Lithium Base O Grease

Smear the rack seals and bearing with specified power steering fluid.

Specified Fluid:

Dexron 11 Automatic Transmission Fluid

11. Install the rack bar into the housing, rack teeth first, from the left hand end. Take care not to damage the piston seal on the internal threads in the housing.
12. Align the teeth with the pinion bore to facilitate the fitting of the pinion. Do not press the inner rack seal into its bore at this time. Install the rubber sealing on the outside diameter of the rack bearing.
13. Assemble the outer rack seal into the end of the rack bearing with the sealing lip toward the bearing bore. Check that the nylon ring is in its place in the rear face of the seal.
14. Install the rack bearing assembly onto the rack bar and press it into the housing, install the rack bearing retaining screw with Holden tool No AU305. Tighten to specification.

Rack Bearing Lock Nut specified torque: 55-60Nm.

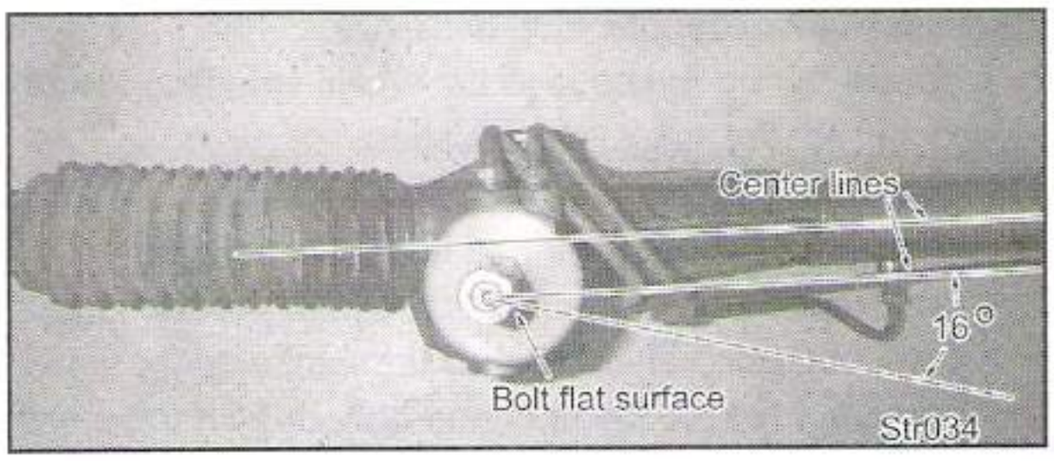
15. Press the rack bar towards the right hand end of the housing until the resistance of the inner rack seal is felt, continue pressing until the seal is lightly bottomed out. The end of the rack bar should now be 0.9-3.4 mm below the outer face of the rack bearing locknut. Insert 50 grams of specified grease into the pinion bore.

Specified Lubricant:

EP Semi Fluid Lithium Base O Grease

16. Centralise the rack (the distance from the housing lock stop face to the end of the rack bar is the same on both sides).
17. Maintaining the rack in its central position insert the pinion.

Input shaft square back 16^0 from the centre line of the steering rack.



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* The pinion will rotate 90 degrees anticlockwise as it meshes with the rack teeth.
18. Install the rack pad and insert, washer and spring in the housing.
19. Apply loctite to the adjuster screw thread.
Install the assembly in the housing. The adjuster screw locknut has the word 'Inside' stamped on one face, this face must be towards the housing. Loosely install the locknut.
20. Remove the lower pinion bearing retaining screw and install the bearing retaining nut on the pinion. Turn the gear to the full left lock then tighten the retaining nut on the pinion. Turn the gear to the full left lock then tighten the retaining nut to 55 Nm. Pack the bearing with grease. This is a deformed thread locknut and should not be reused.
21. Coat the thread of the retaining screw with loctite or equivalent and install and tighten to specification.
Retaining Screw: 55-60Nm
22. Install a new 'O' ring onto the spigot of the rack housing.
23. Install the valve seal in the valve housing.
24. Install the valve bearing, wide flange toward the seal.
25. [VT Ser I] a) Slide the valve housing over the valve sleeve and locate it on the spigot of the rack housing. Be careful not to damage the Teflon sleeve seals during this process.
b). Install the valve housing retaining screws and tighten to specification.
Valve Housing Retaining Screws: 5-6Nm
26 [VT Ser II and later] Install bearing cover and cir-clip.
27. Fit new 'O' rings to the oil transfer pipes and connect the pipes to the valve housing and rack housing. Tighten the tube nuts to specification.
Fluid Transfer Tube Nuts: 15-25Nm
Adjust the rack pad as described under adjustments.
28. Install the tie rods, and rotate the gear to the full left lock and hold the tooth end of the rack bar in a vice equipped with protective jaws. Place a tab washer on the end of the rack bar with the tabs located in the slot on the bar and screw in the tie rod. Tighten the tie rod ball joints to specification.
Tie Rod Ball Joints: 90-100Nm
29. Remove the gear from the vice and rotate the pinion enough to expose the left hand end of the rack bar. Mount the assembly in the vice gripping the exposed teeth of the rack.
30. Repeat number 28, then install the bellows and tie rod ends as previously described.

Install
1. Position the steering gear assembly on the sub-frame, install and tighten the attaching bolts.
2. Connect the tie rod ends to the wheel spindles, install, tighten and pin the nuts to specification.
Tie Rod Ball Joint Ends: 50-85Nm
Centralize the steering gear and lower the vehicle.
3. Align the splines on the coupling shaft joint with the splines on the steering gear valve and slide the shaft onto the valve. Install and tighten the lower clamp bolt, tighten the upper clamp bolt.
4. Connect the hydraulic lines to the steering gear and tighten the unions with a six point tube nut wrench.
5. Top up the pump reservoir with the specified fluid and bleed the system.
Specified Fluid:
Dexron III Automatic Transmission Fluid

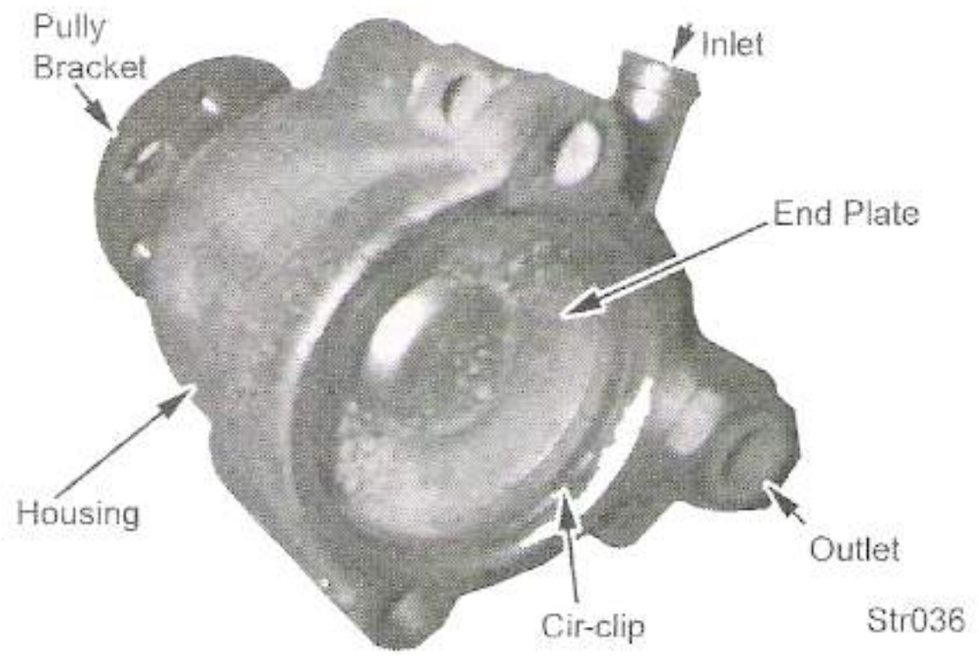
Rack & Pinion Steering Gear Mounting Bushes

Remove
Using a press, press the bushes from the rack housing.
Install
Press the new bushes into the rack housing after smearing the bushes with a soapy water solution.

V6 Power Steering Pump.

Power Steering Pump Hoses and Tubes

1. Remove fluid from power steering pump reservoir.
2. Detach hoses from pump.
3. Disconnect hose at rack and pinion steering gear housing.

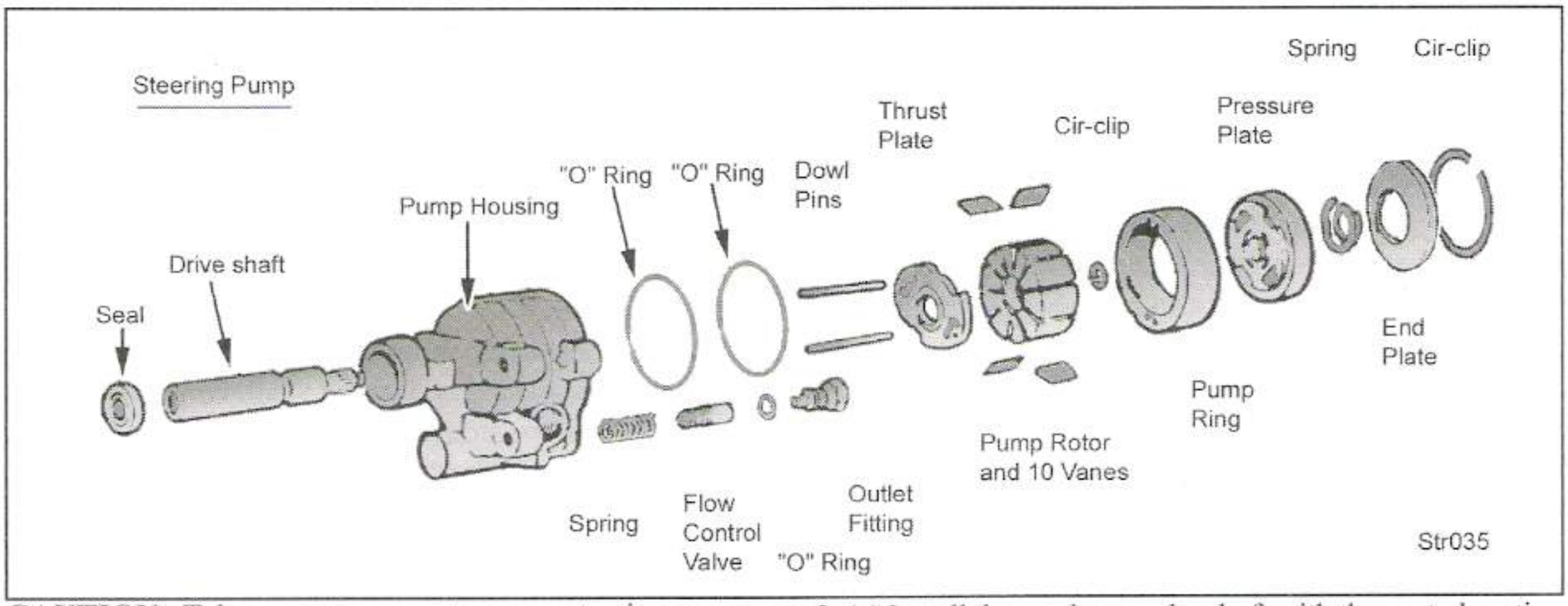


Install
1. Replace hose to rack and pinion steering gear housing, do not tighten the connector.
2. Lower vehicle, replace teflon seal on pump pressure hose union, and install hose to the power steering pump.
Power Steering Clamp Nut: 50-102Nm
3. Raise vehicle, tighten hose connection.
Power Steering Clamp Nut: 50-102Nm
* Refill power steering pump with specified fluid.
Specified Fluid:
Dexron III Automatic Transmission Fluid

Power Steering Pump & Reservoir

Remove
1. Using an 18mm spanner, engaged in the drive belt tensioner to relieve tension and remove the serpentine drive belt.
2. Remove the power steering pump pulley.
3. Remove fluid from pump reservoir using a syringe or siphon hose.
4. Loosen the pump pressure line connector and disconnect pressure line. Detach return line.

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CAUTION: Take care to prevent power steering pump fluid loss by plugging connections.

5. Remove pump from retaining bracket.

Dismantle

1. Remove pump pulley if not removed.
2. Remove outlet fitting, flow control valve, and flow control spring from pump.
3. Remove pump reservoir as outlined.
4. Place pump assembly in a bench vice.
5. Remove end plate retaining ring, compress ring by pushing a punch in through the hole in the pump housing, remove ring with a screwdriver, take care as the end plate is spring loaded.
6. Remove end plate, spring and "O" ring from pump housing.
7. Remove pump from vice and remove flow control valve and spring.
8. Tap pump shaft if necessary to remove shaft, pump ring, rotor assembly and thrust plate. Dismantle this assembly.
9. Remove rotor vane, rotor and retaining ring and "O" ring.
10. Remove dowel pins and remove shaft seal with a screw driver.

Clean and Inspect.

Steering Pump

The following precautions must be observed when servicing the power steering pump:

1. Use a clean work bench and tools, thoroughly clean exterior of the unit with solvent. Drain as much fluid from the pump as possible.
2. If only reservoir is to be removed, clean as outlined, Do not use cleaning solvents on the seal.

Steering Pump-Reservoir

Take following precautions when servicing the power steering pump reservoir:

* Use a clean work bench and tools, plug the inlet and outlet openings of the pump with plugs or masking tape, thoroughly clean the exterior of the pump with solvent

Assemble

1. Install new shaft seal make sure the seal is seated properly, replace dowl pins.
2. Install new pressure plate "O" ring into pump body.
3. (a) Install thrust plate on the shaft with the ported section facing the spline end of the shaft.

(b) Replace the rotor on the shaft, countersunk end facing thrust plate.

(c) Install new shaft retaining ring, tap the ring into position with the help of a socket.

(d) Install this assembly into the pump body, fit the dowel pins into the thrust plate.

4. Install pump ring (use two small holes) onto dowel pins, have the arrow facing up.
5. Fit the pump vanes into the rotor grooves.
6. Replace the pressure plate, narrow slots fit onto dowel pins, fit the spring onto the plate.
7. Install new end plate "O" ring, end plate and retaining ring.
8. Fit the flow control spring and plunger into pump body.
9. Replace the outlet fitting with a new "O" ring and tighten the fitting to specification.

Outlet Hose Fitting: 50-100Nm

Install

1. Position pump in mounting bracket, and install return line and torque hose clamp.

Power Steering Pump Bolts: 40-55Nm

2. Install pump reservoir screws and torque to specification.

Power Steering Pump Reservoir Bolts specified torque: 3-7Nm

3. Install pressure hose connector..

Pump Fluid Line specified torque: 40-55Nm

4. Install the pump pulley and tighten to specification.

Power Steering Pump Pulley Bolts: 20-30Nm

5. Install the serpentine drive belt.

* Make sure belt is correctly engaged on pulley ribs.

6. Fill power steering pump reservoir with specified fluid.

Specified Fluid:

Dexron III Automatic Transmission Fluid

7. Crank engine over without starting to prime pump.

V8 Power Steering Pump.

The power steering pump is a constant displacement vane type providing hydraulic pressure for the steering system. The housing and internal parts of the pump are inside the

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reservoir so the pump parts operate submerged in oil. The reservoir is sealed against the pump housing, leaving the housing face and the shaft hub exposed. The reservoir has a filler neck with a cap.
Start-Up Procedure
(After Pump, Steering Box or Line Repair)
1. Fill reservoir to the cold level with specified fluid.
2. Let engine run for one or two seconds to circulate fluid.
Top up reservoir
3. Repeat number 2 until reservoir level remains full.
4. Idle engine and turn steering wheel rapidly to momentarily contact each lockstop 3 times, stop engine and top up reservoir.

Pump Drive Belt VT Ser 1 V8

Remove

Loosen the idler pulley locknut and release the belt tension. Remove the belt.

Install

Position the belt over the pulleys and adjust the tension as previously described.

Pump Drive Belt Gen III V8

Remove / Install

Using an 18mm spanner, engaged in the drive belt tensioner to relieve tension and remove or install the serpentine drive belt.

Outlet Fitting Flow Control Valve and Spring

Remove

1. Disconnect the fluid return hose at the reservoir and drain the fluid into a container.
2. Disconnect the pressure hose from the outlet fitting using a ring spanner to prevent damage to the tube nut.
3. Remove the outlet fitting, the flow control valve and the spring. Dispose of all seals. It may be necessary to use a magnet to withdraw the flow control valve.

Install

1. Lubricate seals with power steering fluid prior to installation.
2. Install the spring and the flow control valve. The screened end is towards the spring. Install the outlet fitting.
3. Connect the pressure hose to the outlet fitting and tighten using a ring spanner.
4. Install the fluid return hose to the reservoir. Fill the reservoir with the specified power steering fluid.

Power Steering Pump Pulley

Remove

1. With the pump removed from the vehicle, drain as much fluid as possible through the filler tube.
2. Install pulley remover tool on the pulley hub, and place the tool and pump in a vice.
3. Hold the pump and rotate the tool nut counterclockwise to remove the pulley. Do not apply in and out pressure on the pump shaft. Pressure will damage the internal thrust areas and the snap ring and groove, remove the tool.

Rotor Shaft Seal

Remove

1. Remove the pump pulley from the rotor shaft, place the pump assembly in a holding fixture, with the pulley end of the shaft uppermost.
2. Clean any rust or dirt from the pulley end of the rotor shaft.
3. To prevent scoring of the rotor shaft, wrap 10mm shim stock (free of burrs) around the shaft and push the shim stock into the ID of the seal until it contacts the bushing.
4. Using a sheet metal punch, or similar tool, carefully pierce the metal portion of the seal body face, and pry the old seat out.

*** Do not damage the bushing, housing or the rotor shaft.**

Install

1. Remove the shim stock from the rotor shaft, and place the new rotor shaft seal on the seal protector with the metal backing facing the pulley end of the shaft.
2. Place the seal protector tool and the rotor shaft seal on the rotor shaft.
3. Using seal installation Tool and a plastic or rubber mallet, tap on the end of the tool until the seal is seated in the housing.
4. Remove the tools and install the pulley on the rotor shaft.

Power Steering Pump - GenIII

1. Use a clean work bench and tools.
2. Clean the exterior of the unit with solvent. Drain as much fluid as possible
3. Do not use solvent on seals.

Remove

1. Disconnect the pressure and return lines from the pump and plug them to prevent loss of fluid or entrance of dirt into the system. Remove the drive belt.
2. Remove the two bolts securing the front mounting bracket to the cylinder head. Remove the nut attaching the pump to the rear bracket and remove the pump, remove the front mounting bracket from the pump.

Dismantle

1. Remove any corrosion from the shaft to prevent damage to the shaft bushing when the shaft is being removed.
2. Clamp the hub or pump in a vice so the extending portion of the shaft points down. Do not clamp the pump too tightly or bearing damage may result.
3. Remove the pressure union, O-ring assembly, and the mounting bolt from the back of the reservoir. Dispose of all seals and O-rings.
4. Rock the reservoir slightly back and forth to unseat the O-ring seal. Remove the reservoir. Remove and dispose of the O-ring.
5. Remove the bolt and pressure union seals from the counterbored spaces in the pump housing. Discard the seals. Remove the magnet.

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6. Rotate the end plate retaining ring so that one end of the ring is over the hole in the housing. Insert a small punch in the 3mm diameter hole in the housing side opposite the flow control valve hole. Compress the retaining ring with the punch and remove the ring by twisting a screwdriver under the ring.
7. Remove the end plate. The end plate is spring loaded and will generally sit above the housing level for easy removal. If the plate sticks, rock back and forth lightly to free it.
8. Remove the pressure plate spring, remove the end plate O-ring seal.
9. Remove the pump from the vice and turn it over allowing the flow control valve, its spring, and the dowel pins to fall out. Do not disassemble the flow control valve. Service it as a unit.
10. Tap very lightly on the end of the shaft until the pressure plate, cam ring, vanes, rotor and shaft fall free.
11. Remove the retaining ring by clamping the shaft in a soft-jawed vice and prying the ring off the shaft. Do not damage the shaft with the vice jaws. Dispose of the retaining spring.
12. Remove the rotor and thrust plate from the shaft, remove the pressure plate seal from the housing bore and dispose of. Hold the housing in a vice and remove the shaft seal using a suitable puller. Removal will destroy the seal.

Clean and Inspect

Steering Pump

The following precautions must be observed when servicing the power steering pump:

Use a clean work bench and tools, thoroughly clean exterior of the unit with solvent. Drain as much fluid from the pump as possible.

Steering Pump-Reservoir

Take following precautions when servicing the power steering pump reservoir:

* Use a clean work bench and tools, plug the inlet and outlet openings of the pump with plugs or masking tape, thoroughly clean the exterior of the pump with solvent

Assemble

1. Clean all metal parts with solvent, lubricate all parts with Power Steering Fluid M2C163A prior to assembly.
2. Clamp the end hub of the housing in a vice with the pump chamber uppermost. Do not clamp too tightly or the bearing may be damaged.
3. Install a new pressure plate O-ring seal in the third groove from the rear of the housing. Install both dowel pins.
4. Install the thrust plate on the drive shaft with the ports toward the splined end of the shaft.
5. Install the rotor on the shaft with the counterbored end toward the thrust plate.
6. Clamp the shaft in a soft-jawed vice. Install a new retaining ring on a splined end of the shaft by sliding it down over the shaft until it seats in the ring groove. Use the round wire ring from the retaining ring service kit. Do not damage the shaft.
7. Insert the shaft in the housing. Lubricate shaft with power steering fluid, and make certain the thrust plate slides properly on the dowel pins.
8. Install the cam ring on the dowel pins with the rotation arrow toward the rear of the housing.
9. Install the vanes into the rotor slots. Be sure the vanes slide freely.
10. Lubricate the pressure plate to prevent damage to the pressure plate O-ring seal.
11. Install the pressure plate on the dowel pins with the circular spring depression toward the rear of the housing. The narrow slots in the plate should engage the dowel pins. To seat pressure plate press it about 1.2mm over the O-ring.
12. Lubricate a new end plate o-ring and install it in the second groove from the rear of the housing.
13. Install the pressure plate spring in the groove in the pressure plate.
14. Lubricate the end plate to prevent damage to the o-ring, and press it into the housing with a press or a 'G' clamp. Press the end plate only far enough to allow installation of the retaining ring. Release the press or 'G' clamp.
15. Install the end plate retaining ring. Release the press or 'G' clamp.
16. Position the control valve spring in its hole and insert the control valve with the screened end towards the front of the housing.
17. Install new mounting bolt and pressure union seals in the countersunk holes. Lubricate a new reservoir O-ring seal and install it on the housing.
18. Lubricate the inside edge of the reservoir and install it on the housing. Align the holes in the reservoir and housing. Replacement reservoirs do not have an identification number. If a new reservoir is installed imprint the model number of the defective reservoir on the new part for future identification.
19. Insert the mounting bolt and tighten to specification.

Reservoir Bolt specified torque: 35-80Nm

20. Lubricate a new O-ring and install it on the pressure union in the groove next to the head hex. Insert the pressure union in the flow control valve hole in the back of the reservoir and tighten to specification.
21. Install a new seal.
22. Install the pulley.

Install

1. Install the front mounting bracket on the pump. Position the pump on the rear mounting bracket and install the nut and bolts tighten to specification.

Power Steering Pump Bolt: 20-28Nm

2. Install and adjust the drive belt.
3. Install the pressure hose to the pump fitting.

Tighten the tube nut with a tube nut wrench rather than with an open end wrench.

Press Hose Fitting: 40-55Nm

3. Install the return hose to the pump, fill the pump with the specified fluid and carry out the start up procedure.

Specified Fluid:

Dexron III Automatic Transmission Fluid

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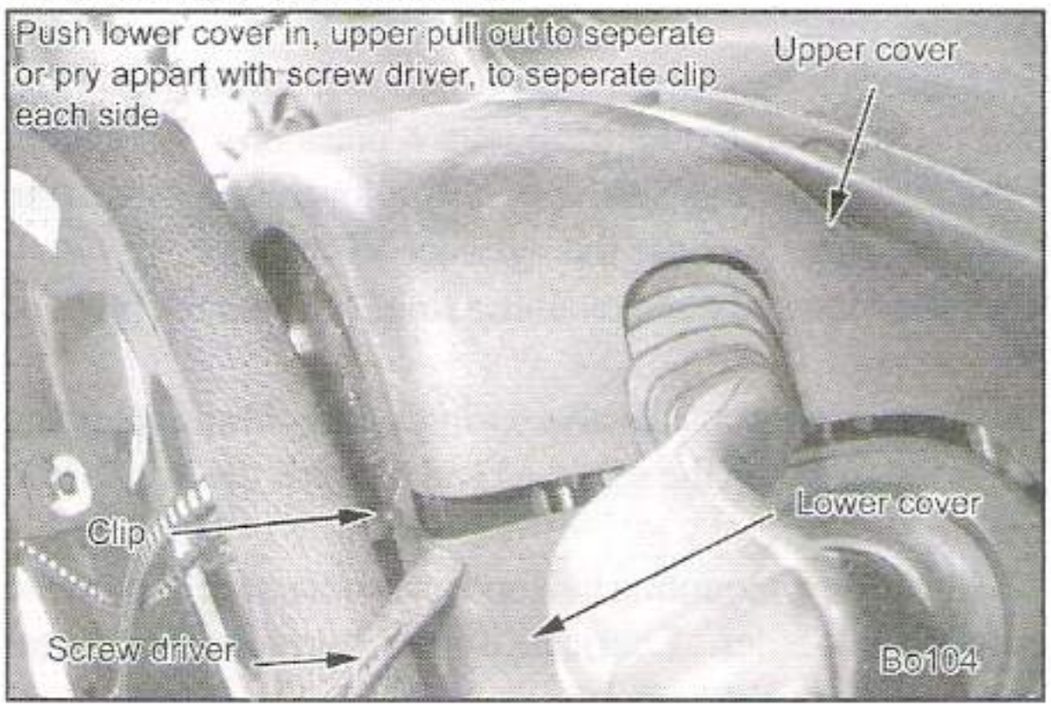
STEERING COLUMN

Steering Column

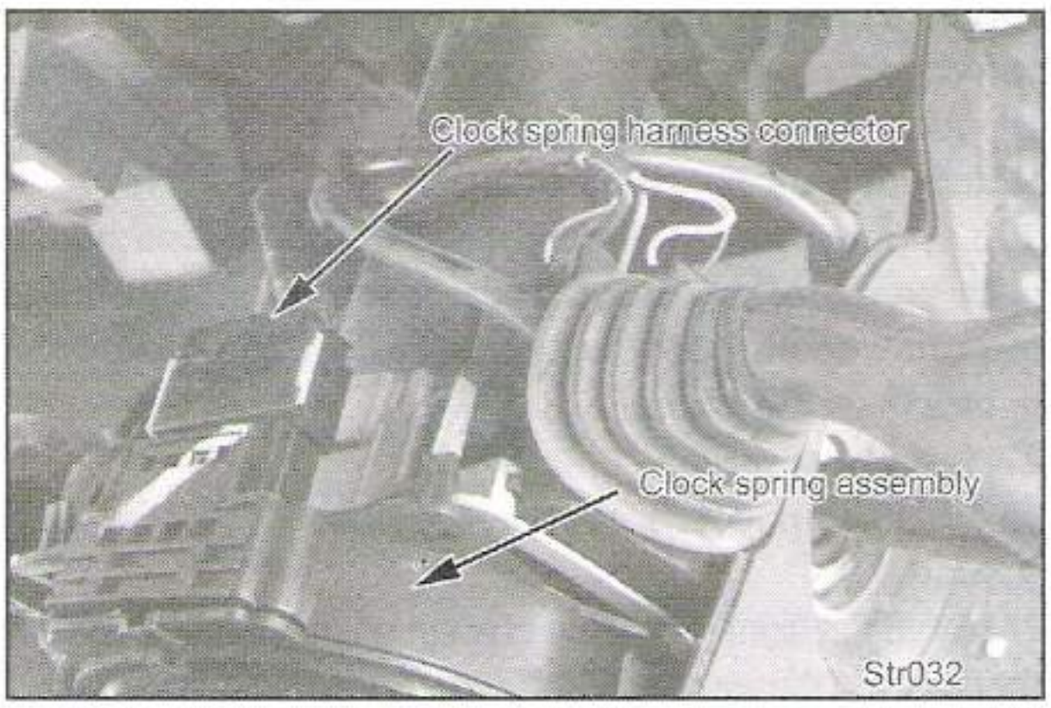
** CAUTION: The vehicle may be fitted with SRS (Safety Air Bag), the SRS must be made inoperative, other wise it could cause harm to the repairer. See SRS Chapter

Briefly

1. Disconnect battery earth terminal.
2. Turn the ignition key to the LOCK position
3. Remove drivers lower dash panel, remove fuse number 26.
4. Remove upper steering column trim, pull upper section banck, use your finger to on the lower section to push inand force forward to release clip.



5. Disconnect the harness connecter to the clock spring assembly, slide the yellow connector lock to the left then pull on the connector to separate.



Steering Column Lock.

Note: The steering column lock is a manufactured component of the steering column, if the lock is faulty the steering column must be replaced.

Steering Column Upper or Lower Bearing

Note: The upper and lower steering column bearing is a manufactured component of the steering column, if the bearing is faulty the steering column must be replaced.

Steering Shaft Universal Coupling

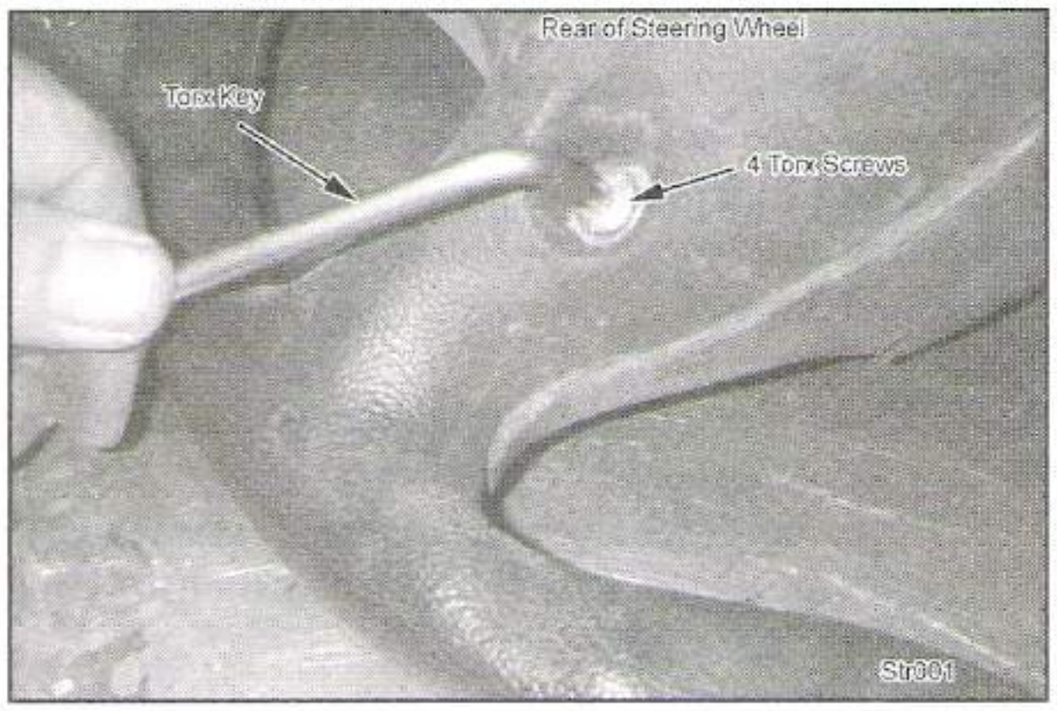
Note: The steering shaft universal coupling is a component of the steering column, if the universal coupling is faulty the steering column must be replaced.

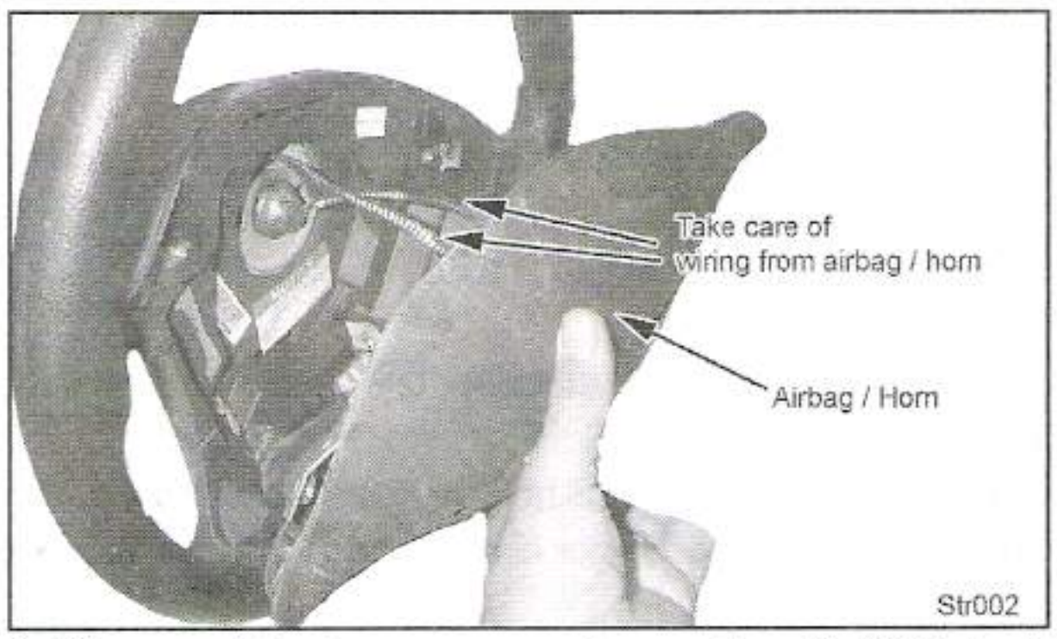
Steering Wheel

Remove

1. Remove the horn pad, 4 screws Torx T30H. Lift the pad / air bag from the steering wheel.

CAUTION: Carry removed air bag with opening side facing away from you. Do not support air bag by wiring. Store or position air bag on a flat stable bench with opening side facing up. Do not store in a confine area. There is danger zone of several meters from the air bag.



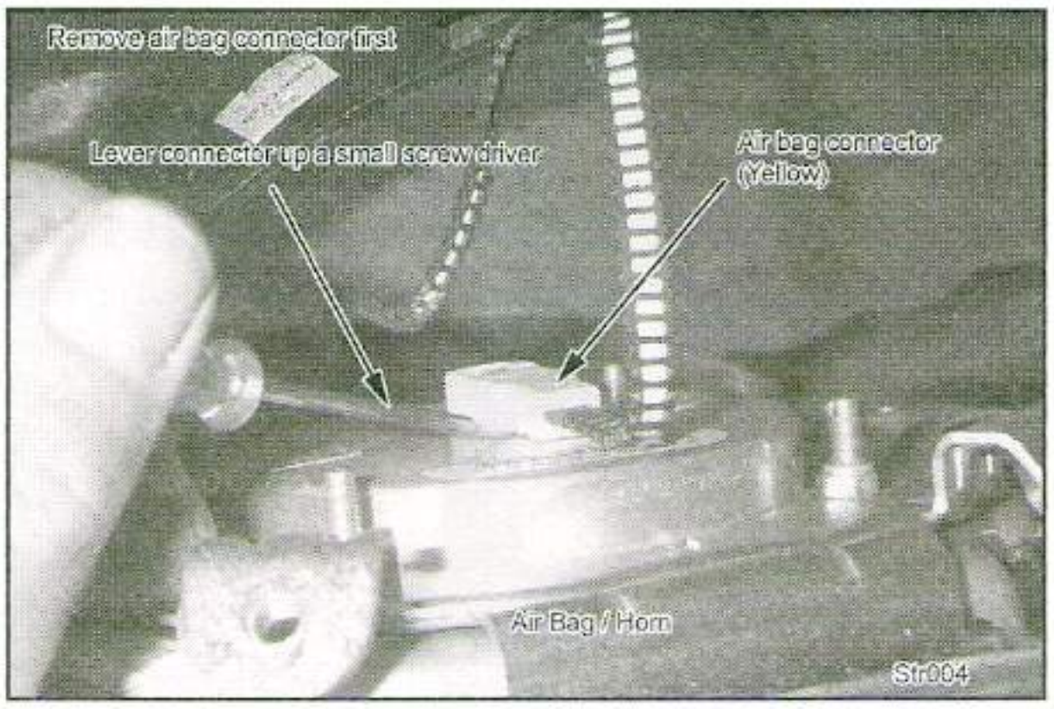


2. Disconnect the harness connectors, yellow first (Air bag) then other 1 or 2 connectors.

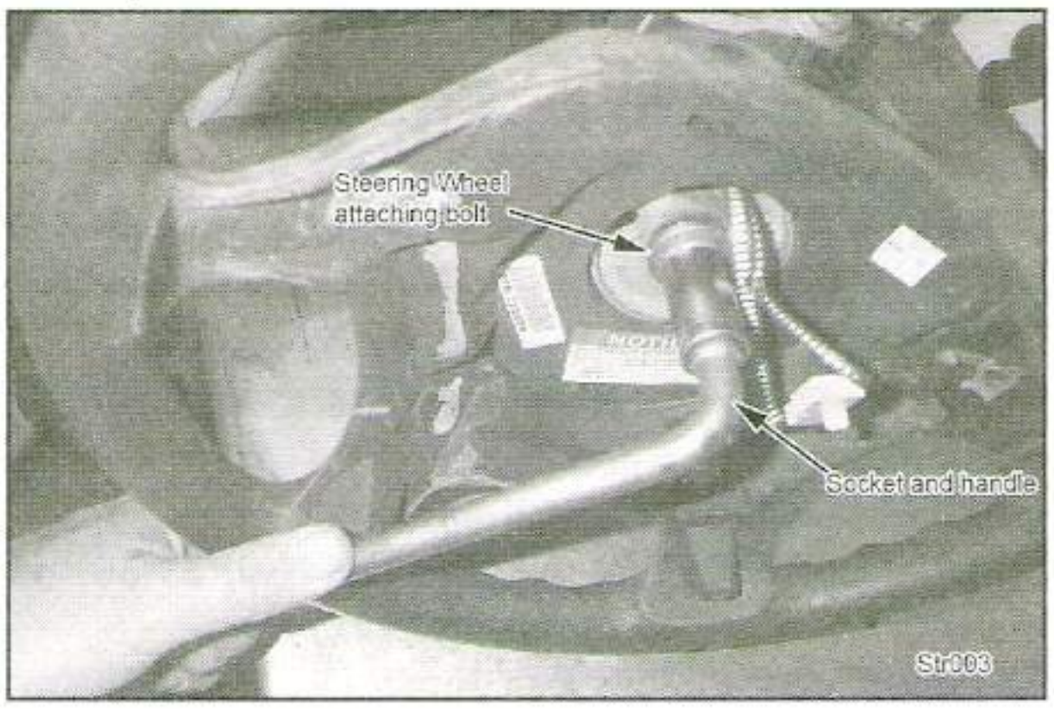
Tip: Take care when removing stero harness connector as it could cause a malfunction of the stero controls

The steering column, which includes a combination ignition steering-ignition lock is of the collapsible type to lessen the possibility of injury to the driver of the vehicle, should the vehicle be involved in an accident.

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3. Remove steering wheel attaching torx E20 bolt (not a 12 point socket - a 5/8 socket may help), thump the steering wheel from the back to loosen or if necessary use a puller.
Note: Do not strike the shaft with a hammer as this will damage the bearing, you may need to use a steering wheel puller.



Install

1. Install the steering wheel to the steering column, take note of the alignment marks.

Steering Wheel Torx E20 bolt torque: 40-50Nm

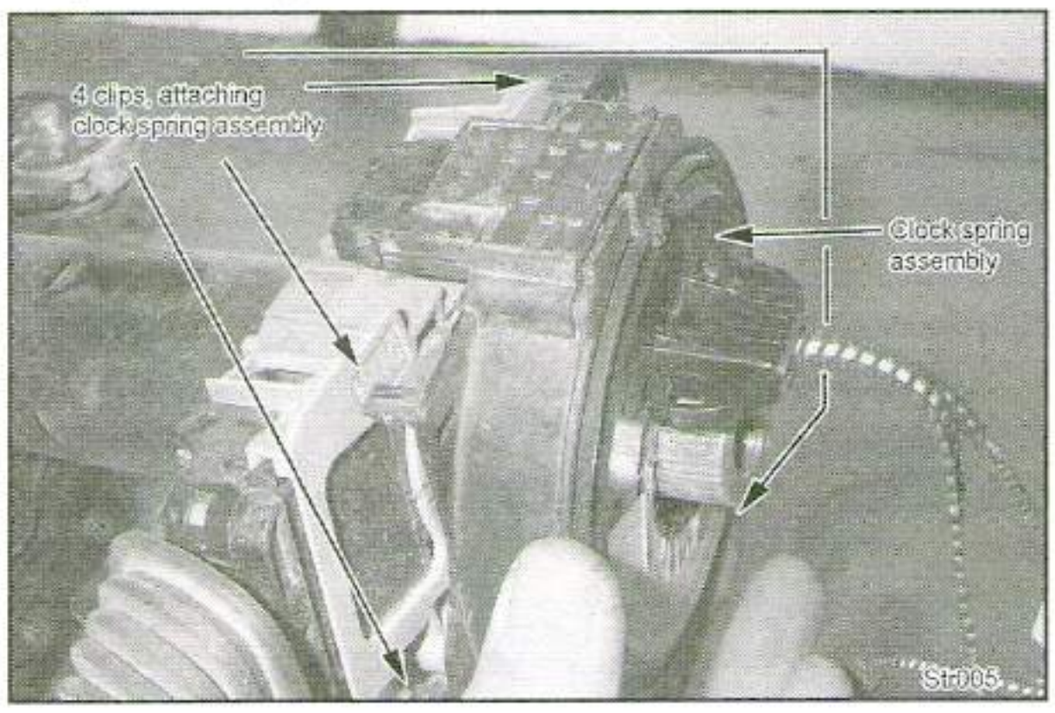
2. Make sure the earth strap is still disconnected from the battery. Replace horn / air bag, connect the wiring connectors. Install the 4 screws at the rear of the horn pad, T30H screws at the back of steering wheel.
3. Reconnect the harness connector behind the steering wheel, replace the upper and lower steering column trims.
4. Install the lower trim panel.

Steering Column and Ignition Lock

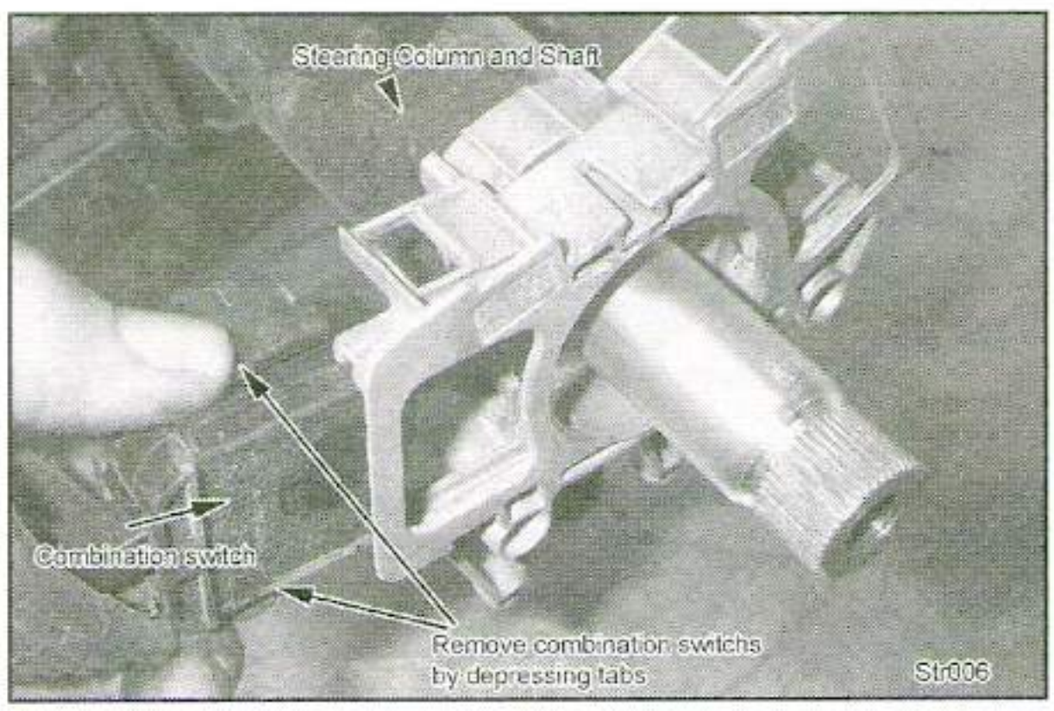
Tip: Position the front wheels pointing straight ahead, steering wheel in centralised position.

Remove

1. Disconnect the earth battery terminal.
2. Remove the lower dash right side panel by gripping with fingers and pulling down to free clips. Remove lower hinge pins.
3. Remove the center lower dash trim, 13 screws. (air conditioner sensor 2 screws, if fitted)
4. Remove the lower right support panel VT Ser1-5 screws, VT Ser II on remove the 2 rivets and for Auto trans remove plastic plug.
5. Remove the fuse and body control module trim screws, leave the diagnostic link connector attached. Allow trim, place to one side, tie back if necessary.
6. Remove the upper steering column trim, push lower trim in at side join, pull upper trim up and forward to release clip.
7. Remove 1 screw from lower steering column trim, push trim forward to release clips and feed ignition key light surround around ignition lock as the lower trim is removed.
8. Remove the steering wheel as described.
a) Use a screw driver to unclip the wiring harness, lift harness away from the steering column.
9. Remove clock spring assembly, 4 clips, lift tang up and pull away, 1 or 2 clips at a time.



10. Remove the combination switch assemblies from the top of the steering column.
a) Unclip the wiper / washer switch and remove, push-in on the tabs to release switch.

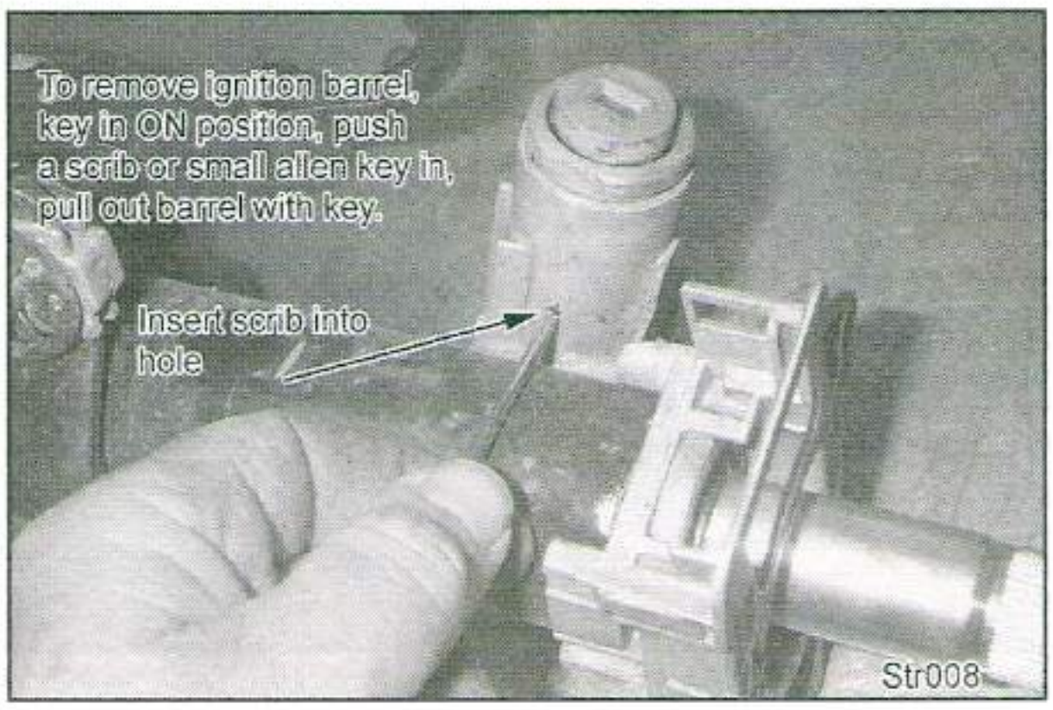


b) Unclip the turn indicator switch and remove, push-in on the tabs to release switch.
11. Remove remote key sensor and ignition key light.
a) Pull remote key sensor from ignition lock, disconnect wiring and remove key light.
b) Disconnect earth to ignition lock, 1 screw.
12. Remove ignition key barrel if required.
a) Use an allen key (2.5mm) or piece of wire to push in the

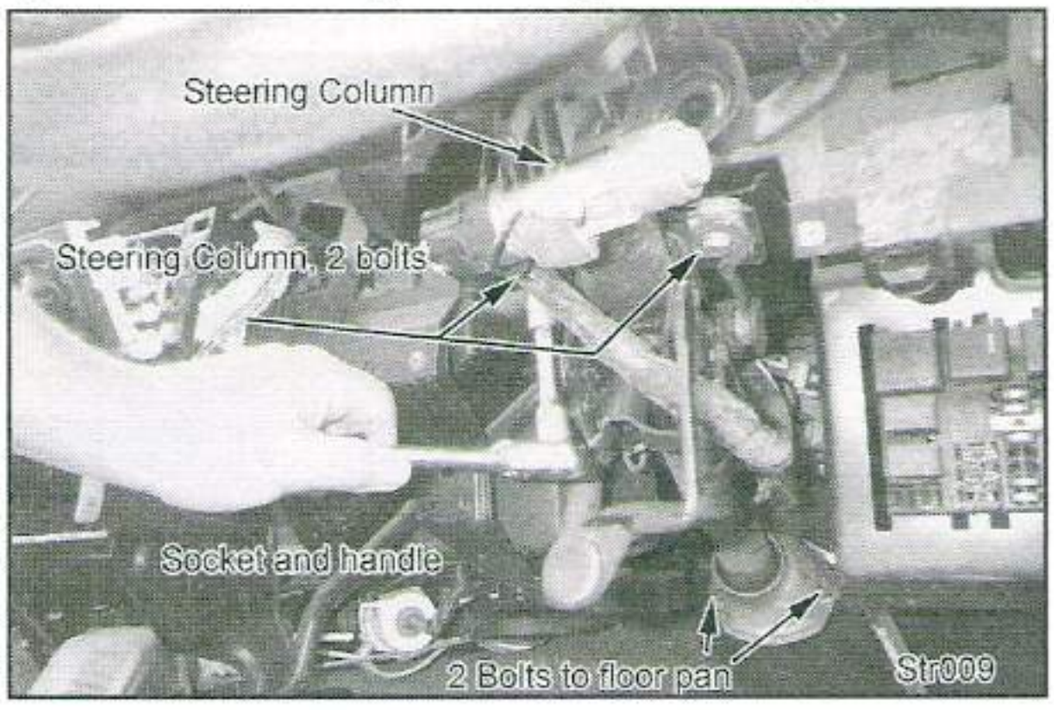
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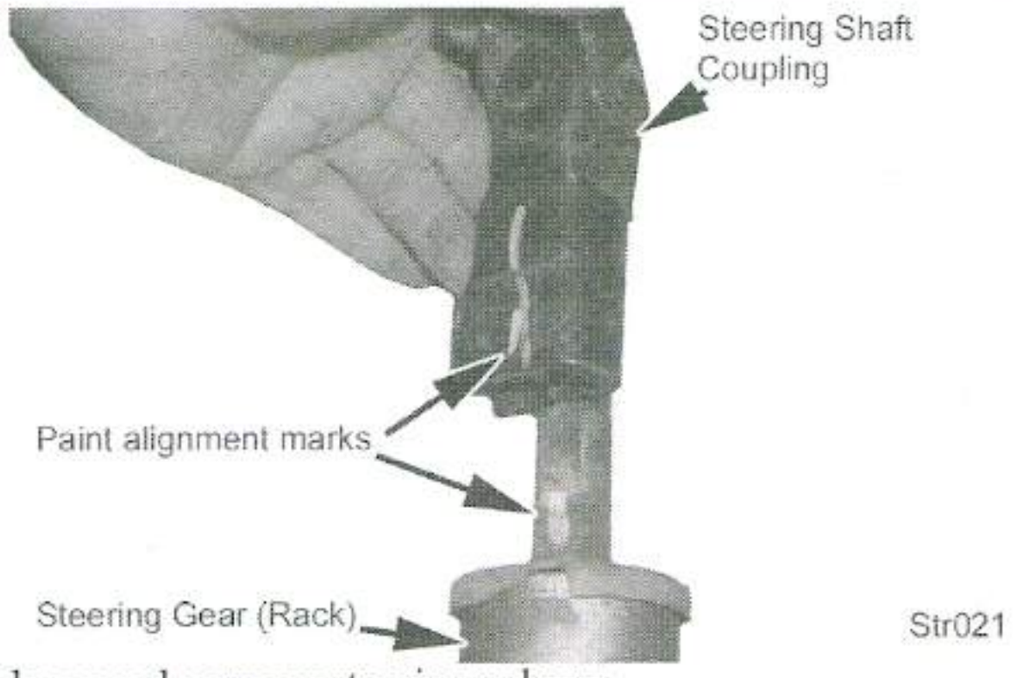
spring loaded catch of the ignition barrel.
b) Key in ON position.
c) Push wire into hole to uncatch barrel, pull on key to remove barrel.



13. Steering column.
a) Loosen the steering column upper attaching bolts



b) Remove the nut and pin from the steering column shaft universal at the steering rack input shaft.
Use a marker pen to place alignment marks on the universal coupling and the steering rack.
c) Use a screw driver to unclip retaining clip to the steering rack.
d) Pull shaft from rack.
e) Remove the steering column floor pan 2 nuts.
f) Remove the upper steering column bolts that have been



loosened, remove steering column.

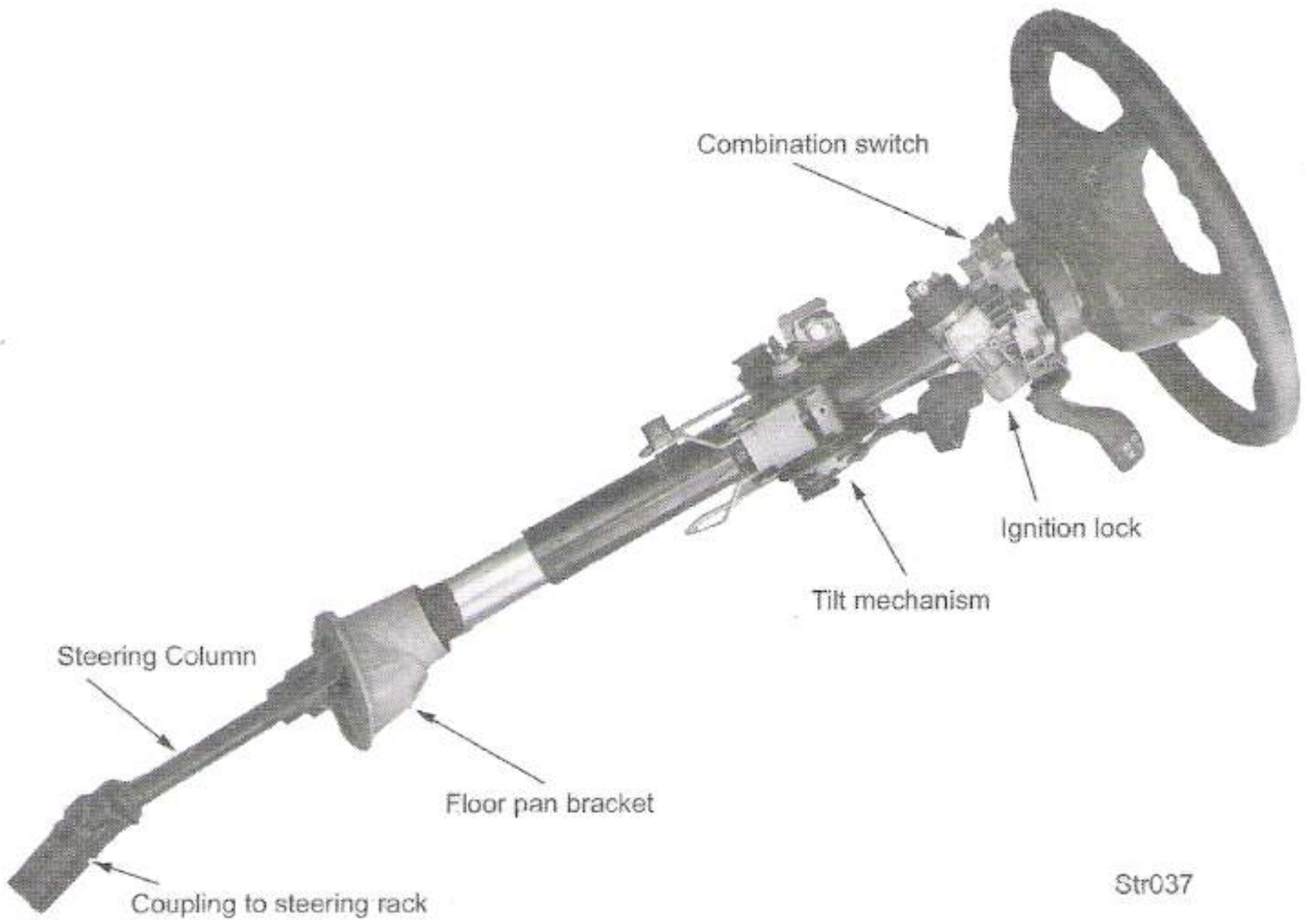
CHECKING CONDITION of STEERING COLUMN

To ascertain if the steering column has been damaged due to an accident the steering column must be inspected.
Check that the mounting lugs to the attaching bracket, also if control springs have been damaged.
Check that the shaft does not feel difficult or hard turn.
If there are any faults replace then steering column assembly.

Install

1. Steering column.
a) Position steering column into vehicle, apply a bead of sealant around base plate of steering column to floor pan. (RTV732 - Loctite). Install upper bolts do not tight.
b) Slide shaft universal coupling onto rack. align marks to ensure the steering wheel is centralised. Make sure the retaining clip is in place. Install pin and nut, tighten.
Steering Universal Coupling Pin and Nut: 23-30Nm
c) Install 2 nuts to floor pan and tighten.
Steering Column Floor Pan Nuts: 15-30Nm
d) Tighten the 2 bolts to the upper sterring column.
Steering Column Upper Bolts: 15-30Nm
2.Install ignition key barrel if required.
a) Key in ON position.
b) Push barrel into place until you feel the spring catch clip in.
3. Install remote key sensor and ignition key light.
a) Connect earth to ignition lock, 1 screw.
b) Position remote key sensor to ignition lock, connect wiring and remove key light.
4. Install the combination switch assemblies to the top of the steering column.
a) Position wiring harness to steering column, clip into place.
b) Push in the turn indicator switch and make sure tabs lock in.
c) Push in the wiper / washer switch and make sure tabs lock in.
5. Install clock spring assembly, 4 clips, lift tang up and push in, 1 or 2 clips at a time.
Note: The clock spring unit must be centralised (the green tab fully visible) before installation. To centralise the unit hold in your hand, squeeze the central clips rotate the center unit until it stops, then turn back approx 2.5 turns until he green tab

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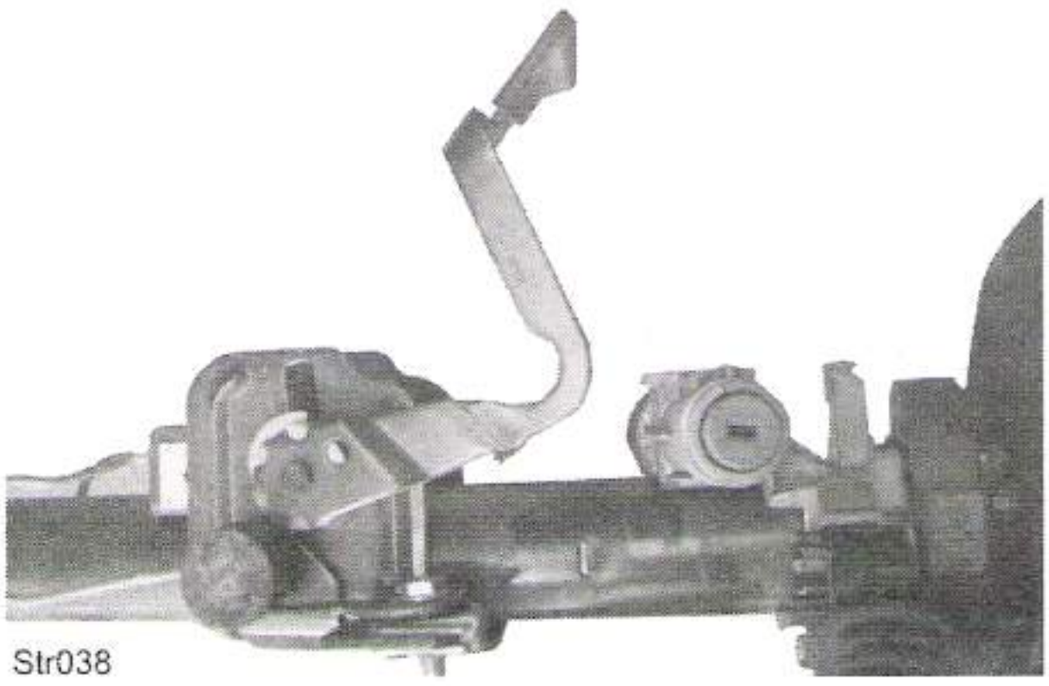
Str037

is fully visible, release central tabs.
6. Install the steering wheel as described.
7. Install and pull back to clip in base of lower steering column trim, feed ignition key light surround around ignition lock as the lower trim is installed, install 1 screw.
8. Install the upper steering column trim, push upper trim down to clip in place.
9. Install the fuse and body control module trim and screws.
10. Install the lower right support panel VT Ser1-5 screws, VT Ser II on 2 rivets and for Auto trans remove plastic plug.
11. Install the center lower dash trim, 13 screws. (air conditioner senser 2 screws, if fitted)
12. Install the lower dash right side panel by gripping with hands and fitting hinge pins, push in clips.
13. Connect the earth battery terminal.

Tilt Steering Unit

Remove.

1. Either remove the steering column as previously described, or remove surrounding trim.



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2. Unlock tilt mechanism by operating handle.
3. Remove the nut cover, nut, bearing and washer.
4. Grip handle and release the tilt unit, pull handle from steering column, this releases the inner cam.

Install

1. Slide tilt handle rod into tilt mechanism of steering column, position inner cam is install at the same time
2. Install washer, nut - tighten and nut cover to end of tilt handle rod.

Tilt Handle Rod Nut: Until a force of 80Nm is required to lock tilt mechanism with handle.

POWER STEERING FLUID PRESSURE TESTS

Test 1 provides a means of determining whether the power steering system hydraulic parts are faulty. If test 1 results in readings indicate faulty hydraulic operation, test 2 will identify the faulty part. Before performing hydraulic circuit test, carefully check drive belt tension, condition of driving pulley and fluid level.

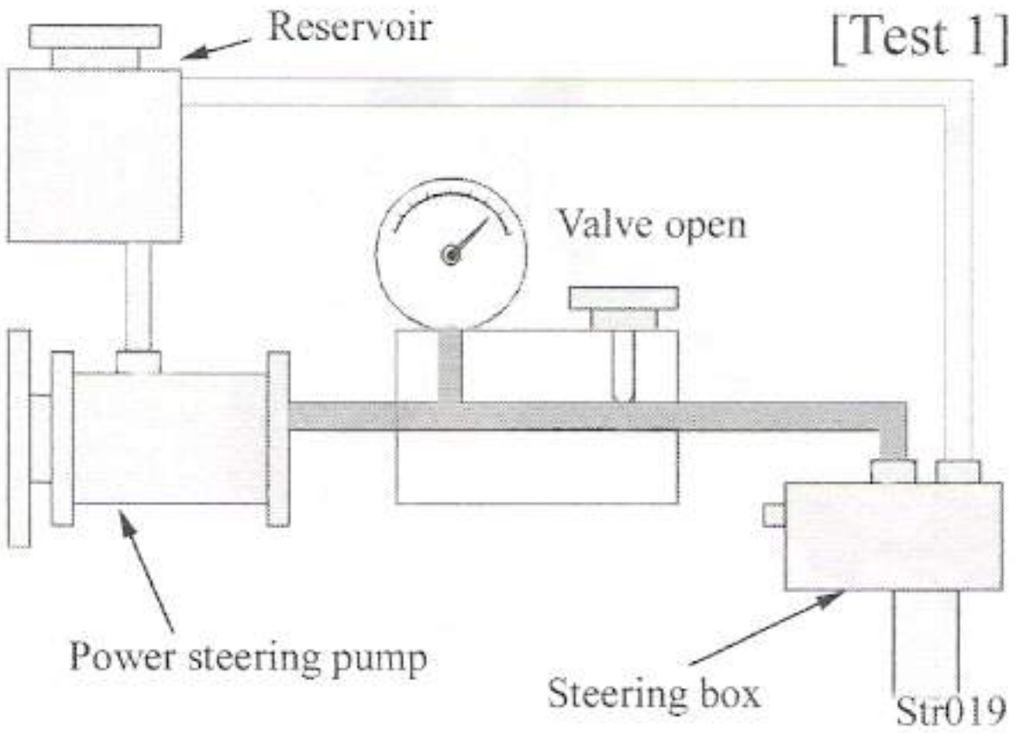
The engine should be at normal operating temperature. Front tyres at correct pressure. The engine must be operating at idle RPM.

Connect a pressure gauge and valve (valve position between pump and pressure gauge) assembly in the high pressure hydraulic line between the pump and steering gear. Remove the high pressure line at the steering pump, install the valve then pressure gauge, reinstall the hose to the pressure gauge.

* Refill the power steering system with fluid to the correct level.

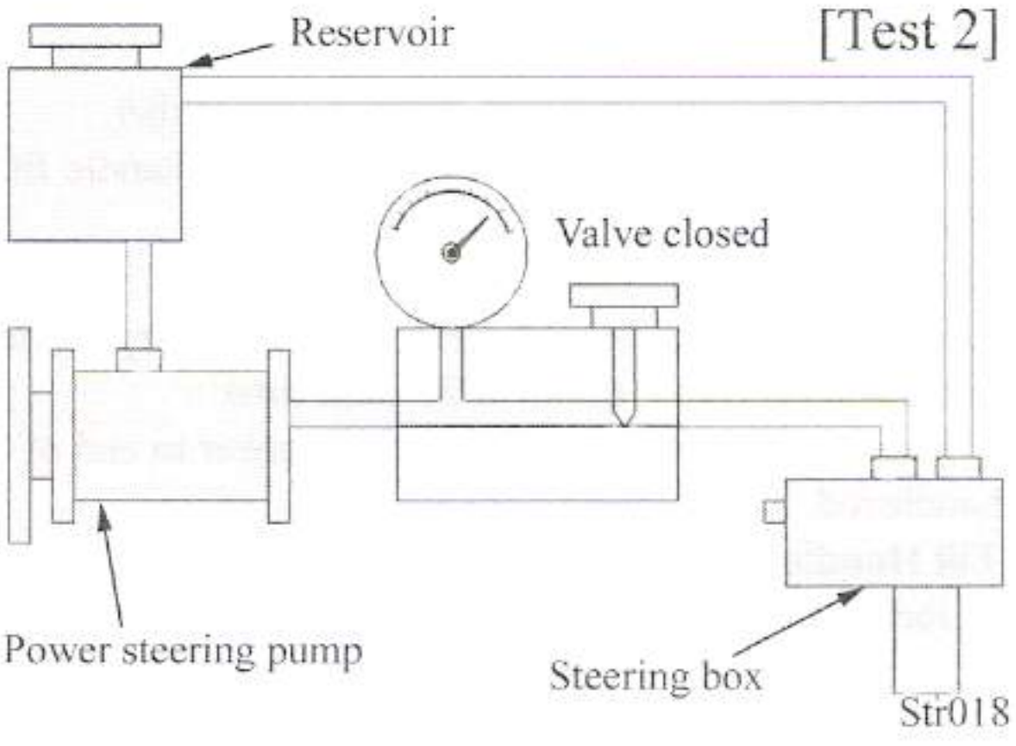
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Test 1 - Hydraulic Circuit Open



1. Engine idling over, valve open so fluid can run through pressure gauge, turn the steering wheel so the steering is fully turned.
2. Pressure should be at or marginally above 9250kPa , if not check for faulty components.

Test 2 - Hydraulic Circuit Closed



1. Engine idling over, valve open so fluid can run through pressure gauge, turn the valve so it is closed for a second or two, just long enough to read pressure then open valve again.
* Low pressure that is less than 7580Pa for V6 or 8270 kPa for V8 engines.
- Check for faulty pump.
* Low pressure that is less than 8270Pa for V6 or 8960 kPa for V8 engines.
- Check for damaged hoses or faulty hose connections.
- Flow control valve stuck or inoperative.
* High pressure that is over 8500kPa - V6, 9300 kPa - V8
- Check for hoses that are blocked or kinked causing

Problem Diagnosis.

Problem: Hard Steering

Possible Causes & Remedies:

* Tyres incorrectly inflated. Remedy-Inflate tyres to correct pressure.
* Insufficient lubricant. Remedy-Lubricate suspension and steering linkage.
* Excessive caster. Remedy-Check front wheel alignment.
* Steering system joints worn. Remedy-Replace steering system joints.
* Lower arm ball joints worn. Remedy-Replace lower arm ball joints.
* Steering column binding. Remedy-Inspect steering column.
* Steering gear out of adjustment or broken. Remedy-Adjust or repair steering gear.
* Power steering belt loose. Remedy-Adjust belt.
* Fluid level in reservoir low. Remedy-Check reservoir.
* Power Steering unit faulty. Check power steering unit.

Power Steering Unit Checks

* Check fluid level on cap dip stick.
* Loose drive belt.
* Drive belt slipping.
* High internal leakage.
* Insufficient pump pressure.
* Sticky flow control valve.
* Steering column to rack & pinion connection may not be correctly aligned.

If none of the above problems are found, carry out a pressure test as described in this Chapter, for other possible causes such as.

* Control valve problems.
* Pump pressure not as specified.
* Steering pump bypass of fluid.

Problem: Poor return

Possible Causes & Remedies:

* Tyres incorrectly inflated. Remedy-Inflate tyres to correct pressure.
* Insufficient lubricant. Remedy-Lubricate suspension and steering linkage.
* Wheel alignment incorrect. Remedy-Check front wheel alignment.
* Steering column binding. Remedy-Inspect steering column.
* Steering gear out of adjustment or broken. Remedy-Adjust or repair steering gear.

Problem: Excessive Play

Possible Causes & Remedies:

* Front wheel bearing worn. Remedy-Replace front wheel bearing.
* Main shaft yoke or intermediate shaft yoke worn. Remedy-Replace main shaft or intermediate shaft.
* Lower arm ball joints worn. Remedy-Replace lower arm ball joints.
* Steering system joints worn. Remedy-Replace steering system joints.
* Steering gear out of adjustment or broken. Remedy-Adjust or repair steering gear.

Problem: Abnormal Noise !

Possible Causes & Remedies:

* Steering linkage loose. Remedy-Tighten steering linkage.
* Steering system joints worn. Remedy-Replace steering system joints.

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* Steering gear out of adjustment or broken. Remedy-Adjust or repair steering gear.

Problem: Drive Belt Squeal

Possible Causes & Remedies:

* Loose drive belt
* Drive belt slipping
* Drive belt badly worn
* Drive belt has a glazed surface

Problem: Noise from Power Steering Pump

Possible Causes & Remedies:

* Excessive back-pressure in hoses or steering gear caused by restriction.
* Scored pressure plate, thrust plate or rotor.
* Extreme wear of pump ring and vanes.
* Vanes not installed correctly.

Problem: Miscoloured Power Steering Fluid

Possible Causes & Remedies:

* Power steering fluid has air mixed with it. Check pump for problem and repair.

Problem: Steering pump pressure not as specified.

Possible Causes & Remedies:

* Pump has not been correctly assembled.
* Internal components of pump are extremely worn.
* Control valve problems.
* Pump pressure not as specified.
* Steering pump internal bypass of fluid.

Leaking Pump Remedies

* Check oil level - if leakage persists with the level correct and cap tight, replace the cap because of poor cap ventilation.
* Replace drive shaft seal. Make certain that drive shaft is clean and free of pitting in seal area.
* Replace reservoir O-ring seal.
* Torque hose fitting nut to 40 - 54 Nm. If leakage persists, replace O-ring seal.
* Torque outlet fitting to 75 Nm. If leakage persists, replace O-ring seal.
* Torque hose fitting nut to 48 Nm. If leakage persists, replace connector and reface the tube flare. If nut threads are damaged, replace nut.
* Replace O-rig seal.

Specifications

STEERING GEAR

Steering Gear Type:	
Power Steering	Rack & pinion with integral power cylinder & rotary valve mechanism - variable ratio.
No. of Steering Wheel Turns Lock to Lock:	3

POWER STEERING PUMP	Make: Saginaw
Type: V6 & V8 Gen III	"N"Series vane type
V8 VT Ser I	"P" Series vane type
Pressure at idle:	
V6	7580-8270 kPa
V8 all V8's	8270-8960 kPa
Drive:	Pulley
Nominal Travell of Rack	164mm
Lubrication (Power Steering):	
Hydraulic Dexron II Automatic Transmission Fluid	
Fluid Capacity:	Approx 650 mls.
Drive Belt Tension:	
V6	Belt Self Adjusting
V8	Ser I - New Belt57 kg
- Used Belt*	34 kg

* Belt is considered "used" after 10 minutes running

V8 Gen III	Belt Self Adjusting

Toe-in Specification (all models):

Toe-in (total)	0°10'+/- 0°10' (2.0+/-1.0mm)
Toe-in (per wheel)	0°5'+/- 0°05' (1.0+/- 0.5 mm)

Specified Grease for Rack & Pinion Steering Gear Unit: EP Semi Fluid Lithium Base O Grease

Specified Locking Compound:

Power Steering: Loctite 242 or equivalent.

Torque Specifications Nm

Steering Column

Upper Column Mounting Bolt:	15-30
Lower Column to Floor Pan Nut:	15-30
Lower coupling to rack pinion Pin Nut:	23-30
Steering Wheel Nut:	40-50
Horn Bar & Air Bag to Steering Wheel Screw	10-14

Rack & Pinion Steering Gear

Steering Rack attaching bolts:	40-50
Steering fluid lines to flare nut:	25-35
Pinion Lower Bearing Retaining Nut:	35-45
Pinion Lower Retaining Screw:	55-60
Valve Housing Retaining Screw:	5-6
Rack Adjusting Screw Lock Nut:	55-65
Rack Adjusting Screw:	10-12 then loosen 20°-28°
Tie Rod End Locking Nut:	50-85
Tie Rod End Castellated Nut:	50-85
Tie Rod to Rack:	90-100

Power Steering Pump

V6

Pump to Mounting Bracket:	30-40
Pulley Retaining Bolt:	20-30
Fluid Outlet Fitting:	50-102
Reservoir Attachment Screw:	3-7

V8 VT Ser I

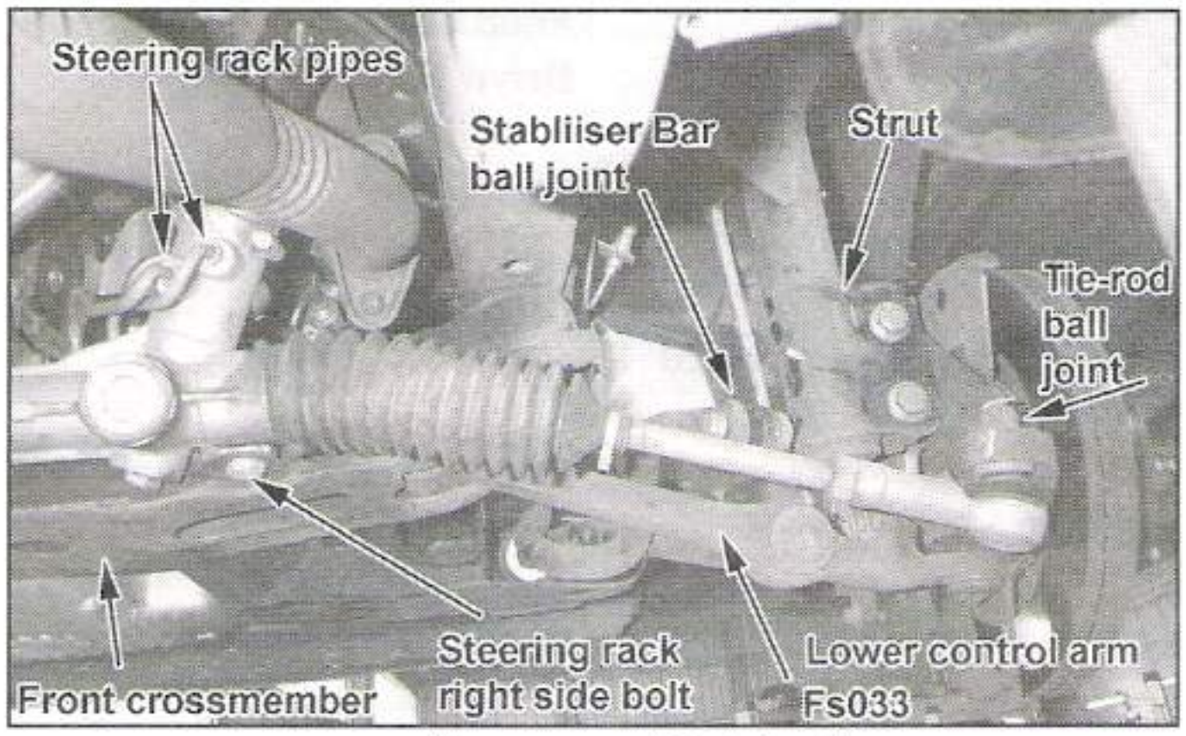
Pump to Mounting Bracket & Adjusting Nut:	35-65
Fluid Outlet Fitting:	50-102
Fluid Outlet Tube Fitting:	25-35
Reservoir Attaching Bolts:	35-80

V8 Gen III

Pump to Cylinder Head Bolt:	20-35
Fluid Outlet Flare Nut :	25-35
Outlet Fitting:	50-102
Reservoir Attaching Bolts:	50

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FRONT SUSPENSION



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Minor Maintenance

Front Wheel Alignment

The tie rods, part of the steering rack assembly, are adjustable to permit the setting of toe-in and wheel lock angles.

Don't attempt to carry out alignment checks without first making a preliminary check of the serviceability of the front end components.

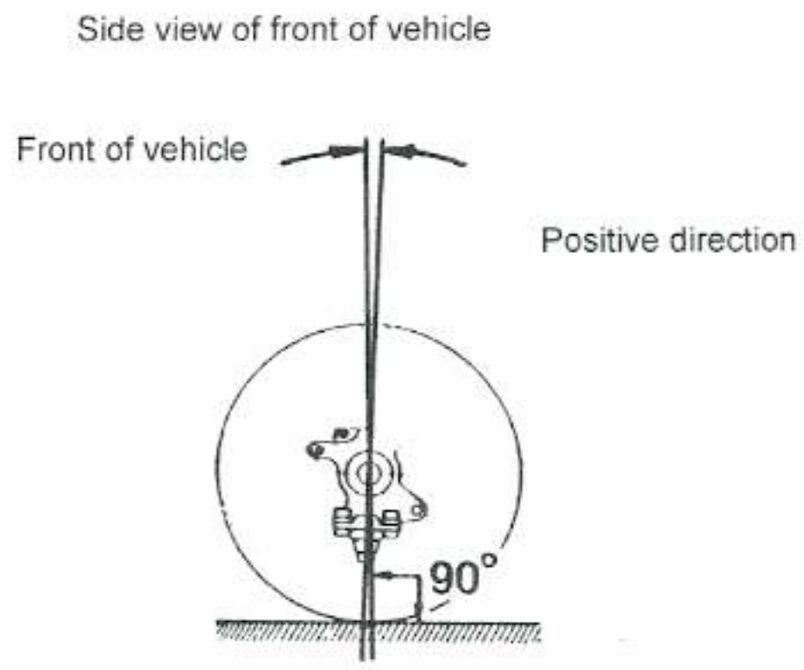
Front Wheel Alignment Check

Equipment Installation

Install the wheel alignment equipment on the vehicle and follow the installation, inspection and operating instructions provided by the equipment manufacturer.

Equipment used for front wheel alignment inspection must be accurate. Controlled body height spacers are used when checking camber and caster. The spacers should be omitted when checking toe-in and wheel lock angles. Vehicles with rear IRS must have the rear IRS aligned before aligning the front suspension.

Caster



Caster angle side view Fs006

Check the caster angle at each front wheel.

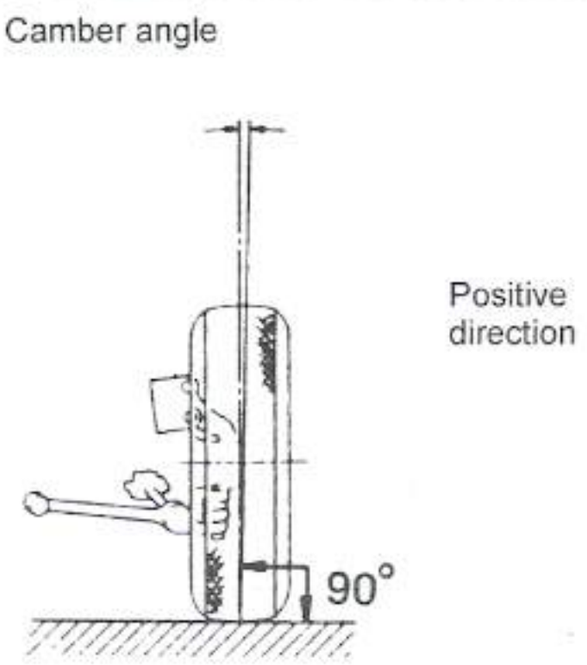
Caster is the forward or rearward tilt of the top of the wheel spindle. If the spindle tilts to the rear, caster is positive. If the spindle tilts to the front, caster is negative. The correct angle, or tilt, is specified at the end of the chapter. The maximum difference between both front wheel caster angles should not exceed 1/2 degree.

When carrying out the check of caster angle, it is possible that the strut bushes may not always be under equal compression and therefore, will tend to bias the strut rod in a forward or rearward position, thus affecting the steering caster angle. Therefore it is important whenever the steering caster angle is checked, that the car is bounced up and down to ensure the strut rubbers are not holding the vehicle at an angle before taking gauge readings.

Camber

Check the camber angle at each front wheel.

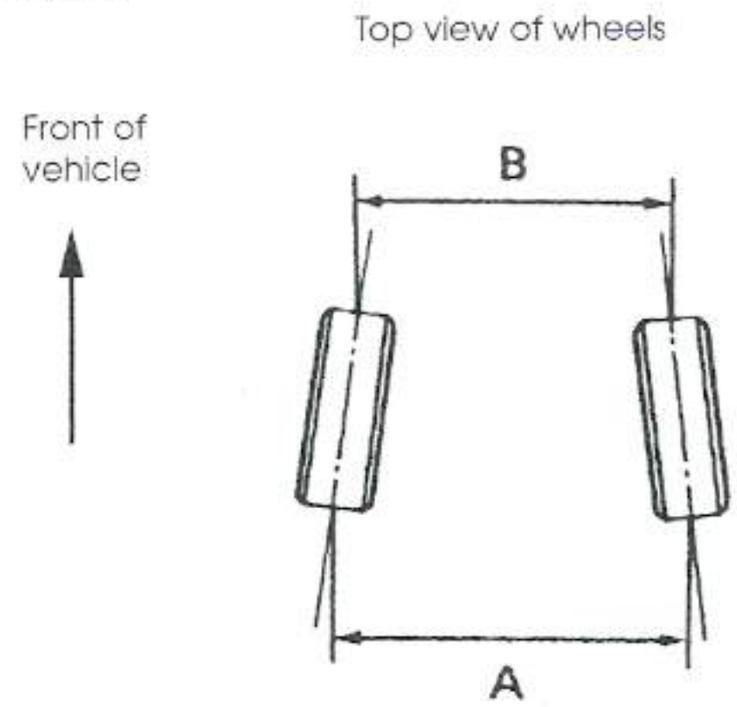
Camber is the amount the front wheels are tilted inboard or outboard at the top. If a wheel tilts outward, camber is negative. The correct camber angle, or outward (positive) tilt,



Camber angle from front Fs007

is specified at the end of the chapter. The maximum difference between both front wheel camber angles should not exceed 3/4 degrees.

Toe-In



Toe-In is "A" minus "B" Fs005

Toe-in is the inward point of both front wheels at the front.

The checking and optimum resetting toe-in specifications are specified at the end of the chapter.

Check the toe-in with the steering wheel in the straight ahead position.

WHEEL ALIGNMENT

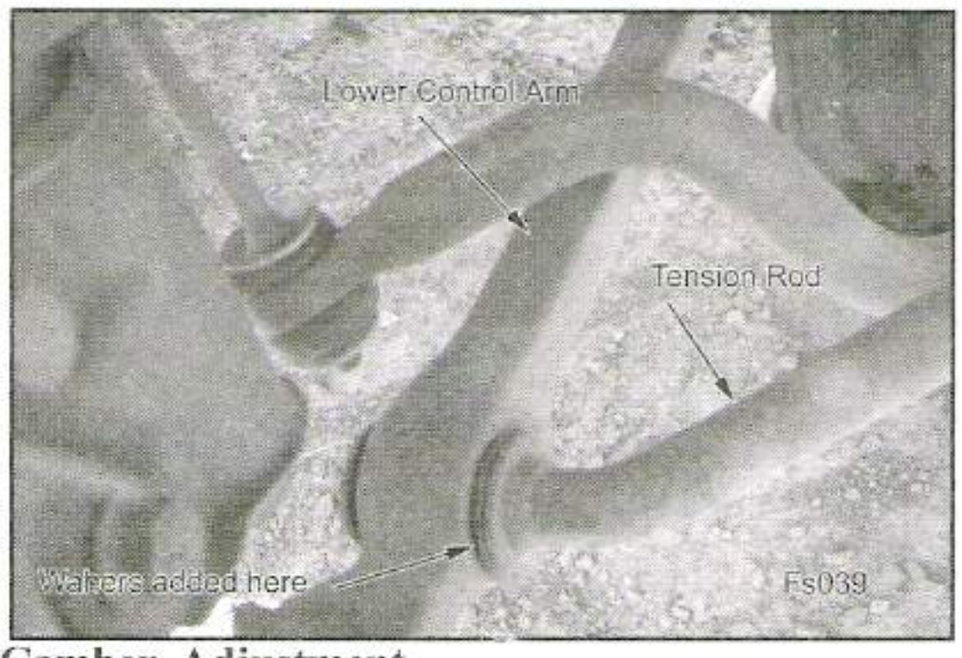
Caster Adjustment

To adjust caster angle, one spacer washer can be added or removed on one tension rod, when adding a washer add to the one with the highest reading.

Caster

VT, VX, WH , VY
Caster at kerb weight 7° 45′ ± 1° 15′
VU (utility)
Caster at kerb weight 5° 45′ ± 0° 30′
HSV - VS
Caster at kerb weight 4° 45′ ± 1° 15′
HSV - VT, VX, WH, VU, VY
Caster at kerb weight 7° 45′ ± 1° 15′

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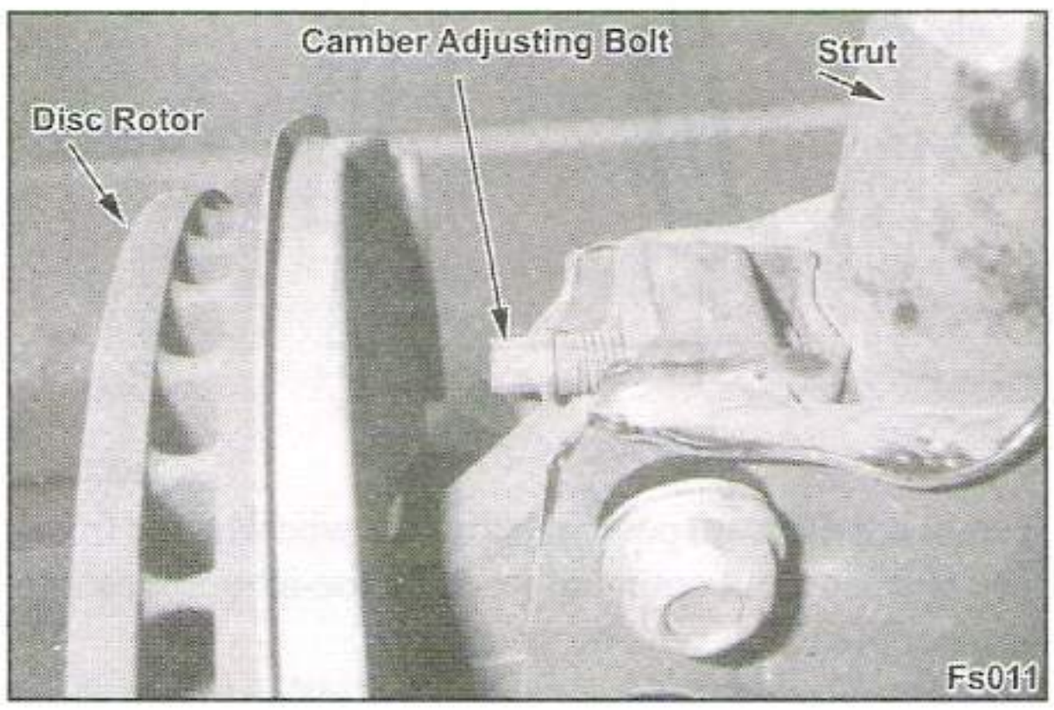


Camber Adjustment

Adjust.

1. The vehicle needs to be lifted and supported so that the front wheels are well clear of floor. Remove front wheels.
2. Remove the two bolts from the lower section of the suspension strut to the front hub and knuckle and install 2 new bolts, tighten only firmly do not torque at this stage.
3. Adjust the camber adjusting bolt to obtain the correct camber adjustment.

Clockwise / In: Reduces the negative camber.



Anticlockwise / Out: Reduces the positive camber.

Camber:

VT Ser I Standard Suspension
-minus 0deg12min +/- 0 deg 12min
VT Ser II, VX, VY and WH Standard Suspension
-minus 0deg12min +/- 0 deg 18min
VU Utility Standard suspension
-minus 0deg00min +/- 0 deg 30min
HSV VS suspension
-minus 0deg25min +/- 0 deg 05min
HSV VT Ser 1 suspension
-minus 0deg48min +/- 0 deg 30min
HSV VT Ser 11 and WH suspension
-minus 0deg30min +/- 0 deg 20min
HSV VX and WH Ser II suspension
-minus 0deg30min +/- 0 deg 20min
HSV VU suspension
-minus 0deg30min +/- 0 deg 20min

4. Tighten the two bolts from the lower section of the suspension strut to the front hub and knuckle. Tighten to specification.

Strut To Front Hub/Knuckle Bolt Torque:
Step One: 85Nm
Step Two: 100Nm
Step Three: Plus 90⁰ Turn

5. Fit wheels and tighten to specification.

Road Wheels Nuts specified torque: 100-125Nm

Toe-In & Steering Wheel Adjustments

Check the steering wheel position when the front wheels are in the straight ahead position. If the steering wheel is not in its correct position, it can be corrected while toe-in is being adjusted.

1. Clean and lubricate the exposed threads on the tie-rods. Loosen the clip on the outer ends of the rack bellows and ensure that the bellows are free on the tie-rods.
2. Hold the tie-rod and loosen the lock nut on each rod.

*** Both rods have right hand threads.**

3. Adjust toe-in. If the steering wheel is in the correct position, lengthen or shorten both rods equally to obtain correct toe-in. If the steering wheel is not in its correct position, make the necessary rod adjustments to obtain the correct toe-in and steering wheel spoke alignment.
4. When the toe-in and steering wheel spoke alignment are both correct tighten the lock nut on each rod.

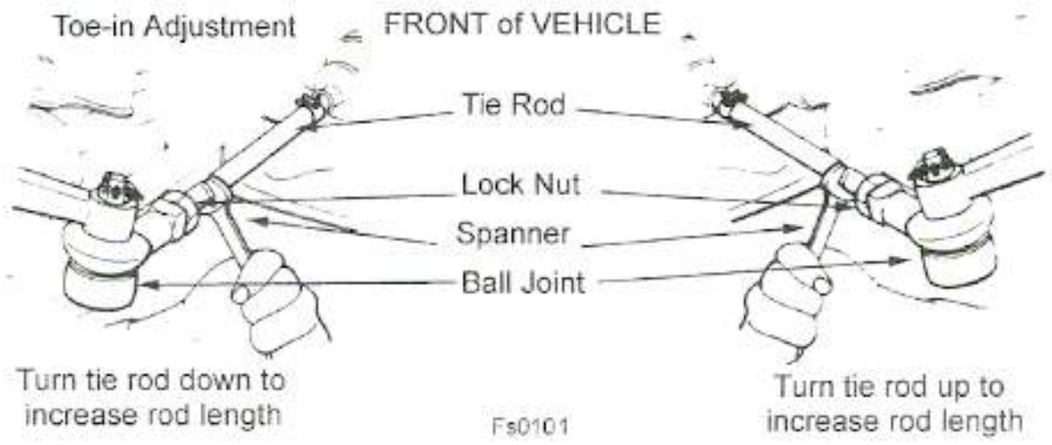
* A maximum of 20mm of thread may be exposed on either rod after the lock nuts have been tightened.

5. Position each tie-rod end ball joint at the centre of its articulation and tighten the clips on the rack bellows.

Toe - in

VT Ser I & II, VX, VY, VU (utility), WH
Toe-in (Deg total) ..... 0deg. 10min +/- 0 deg. 10min
Toe-in (Deg per wheel).....0deg. 5min +/- 0 deg. 05min
HSV VS
Toe-in (Deg total) ..... 0deg. 40min +/- 0 deg. 10min
Toe-in (Deg per wheel).....0deg. 20min +/- 0 deg. 05min
HSV VT Ser 1
Toe-in (Deg total) ..... 0deg. 20min +/- 0 deg. 10min
Toe-in (Deg per wheel).....0deg. 10min +/- 0 deg. 05min
HSV VT Ser 11 and WH, VU
Toe-in (Deg total) ..... 0deg. 10min +/- 0 deg. 10min
Toe-in (Deg per wheel).....0deg. 05min +/- 0 deg. 05min
HSV VX, VY and WH Ser II and VU
Toe-in (Deg total) ..... 0deg. 10min +/- 0 deg. 10min
Toe-in (Deg per wheel).....0deg. 05min +/- 0 deg. 05min

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Front Wheel Lock Angle

When the inside wheel is turned 20 degrees, the turning angle of the outside wheel should be approximately 18.5^0.

If the turning angles are incorrect or uneven when compared. First check the toe-in. If this is correct, examine the tie rods which should be approximately the same length. If they are appreciably different (i.e. 3.0mm) the turning angles will be adversely affected. It should be noted that minor differences in tie rod lengths are acceptable and, in fact, sometimes necessary to compensate for production tolerances in the build up of the suspension and steering assembly. If the toe-in and the tie rod lengths are satisfactory examine the tie-rods for distortion. The tie rod ball joints should also be checked for wear or looseness.

Rear Wheel Alignment Independent Rear Suspension

Camber and Toe-In

Wheel alignment for the independent suspension is nonadjustable, however often the wheel alignment may be incorrect due to mechanical work having been carried out on the vehicle.

When checking for toe-in, one side can often be excessively out while the other side is excessively in, this can be caused be the trailing arms having been tightened when the vehicle was not at kerb height, or the rear crossmember installed when not parallel.

Correct these by, loosen the rear crossmember and trailing arm to crossmember bolts and nuts, bounce the rear of the car at least three times and allow to settle, bounce the car again two/three times and allow to settle, then tighten the bolts and nuts to the correct specification in the order listed below.

Rear Crossmember Front Bolt:
125Nm $+30^0$-40^0 turn
Rear Crossmember Rear bolt to Under Body:
30-40Nm
Trailing Arm to Rear Crossmember Nut: 95-105Nm

Suspension Ride Height - Front and Rear

Loading Requirements

1. Full tank of fuel.
2. Cooling system filled.
3. Crankcase oil at full.
4. Spare wheel and tyre stowed in design position.
5. Front seat one notch forward from rearmost position.

Measuring Procedure

1. Position vehicle on level surface at kerb weight.
2. Roll vehicle at least one wheel revolution backwards or forwards (or both) to allow the vehicle to assume normal attitude.
3. Bounce the front and rear of the vehicle up and down approx. 50mm in each direction.
4. With the parking brake disconnected, push the vehicle front end at the centre of the front bumper evenly down, approx. 25mm, and release slowly.
5. With appropriate instruments measure from the top of the wheel opening arch, to the lowest wheel rim centre line, on both sides and record these measurements.
6. Raise the vehicle front end at the centre of the front bumper evenly, approx, 25mm, and release slowly.
7. Repeat number 5.
8. Average the above measurements for each side and record as front ride heights left and right.

Tip: The right side could be lower by approx 4mm due to the weight of the battery.

9. Repeat operations 4 to 8 at the rear end of the vehicle.

* Suspension ride height specifications for coil springs must be measured after the springs have settled in after operation. When the new springs are fitted a further 6mm may be added to the max. allowable height (refer to table above). Ride height also depends on the options fitted to the base vehicle and the amount of fuel in the fuel tank.

Vehicle Height Variations

Front to Rear	Variation of +/- 20 mm
Side to Side	Variation of +/- 10 mm
Spring Setting	Variation of +/- 5 mm

Wheel Balancing

Ensure wheels are correctly balanced to give correct road handling properties.

Strut

Vehicles are equipped with hydraulic acting struts of the direct-acting type and are nonadjustable but can be refilled, and repaired.

Before replacing a strut, check the strut action as follows.

On Vehicle Tests

1. Bounce the vehicle up and down. If the struts and rear shock absorbers are in good condition the vehicle will immediately settle into a normal position after the car is released.
2. Check the strut to be sure it is securely and properly installed. Check the strut insulators for damage and wear. Replace any defective insulators and tighten attachments to the specified torque.
3. Inspect the strut for evidence of fluid leakage. (A light film

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of fluid on the upper shaft is permissible. Be sure any fluid observed is not from sources other than the strut).
4. Replace the strut if leakage is severe.

Bench Test

1. With the strut right side up (as installed in vehicle), pause for 15 seconds then extend it fully. Then turn the strut upside down, pause for 15 seconds and completely compress it. Repeat this procedure at least three times to ensure that any entrapped air has been expelled. Now place the strut right side up in a vice, and hand stroke the strut. There should be a constant drag during the complete cycle. Any sudden loss of drag indicates air in the system, loss of fluid, or faulty internal valve operation.
2. Extend and compress the strut shaft as fast as possible, using as much travel as possible.
Action should become smooth and uniform throughout each stroke. Higher resistance on extension than on compression is a normal condition. Faint swish noises are also normal.
3. If the action is smooth, but the struts are suspected of being weak, repeat Step 2 on a new strut or the mating strut on the opposite side of the vehicle, and compare results of both tests.

Ball Joint Inspection

1. Raise vehicle.
2. Adjust the wheel bearings as described in this chapter.
3. Hold the tyre at the top and bottom and try to move it in and out.
4. There should be no perceptible movement in either joint. If movement is detected in either joint that joint should be replaced.

Front Wheel Hub Angular Float (Bearing Check)

Inspection

1. Jack the front wheel concerned up, removed wheel trim, wheel nuts and wheel, place alignment mark on disc and wheel for on car balance of wheel.
2. Install flat washers and wheel nut on wheel studs, turn the wheel nuts so the flat surface is against the disc. Tighten nuts to keep the disc tight against the hub.
3. Mount a dial gauge on the strut so the gauge is reading side movement of the brake disc at the top edge.
4. Measure wheel bearing angular float specification, if not with in specification replace hub.
a) Push 10kg force against the lower part of the disc to measure hub float, measure movement and record.
b) Pull 10kg force against the lower part of the disc to measure hub float, measure movement and record.

Bearing Angular Float:

New Bearing: 0.106 mm (0.0042") Max
Used Bearing: 0.213 mm (0.0085") Max

5. Remove dial gauge.
6. Install the wheel and tighten the wheel nuts.
7. Spin wheel to check that the wheel spins freely.
8. Lower front of wheel and tighten to specification.

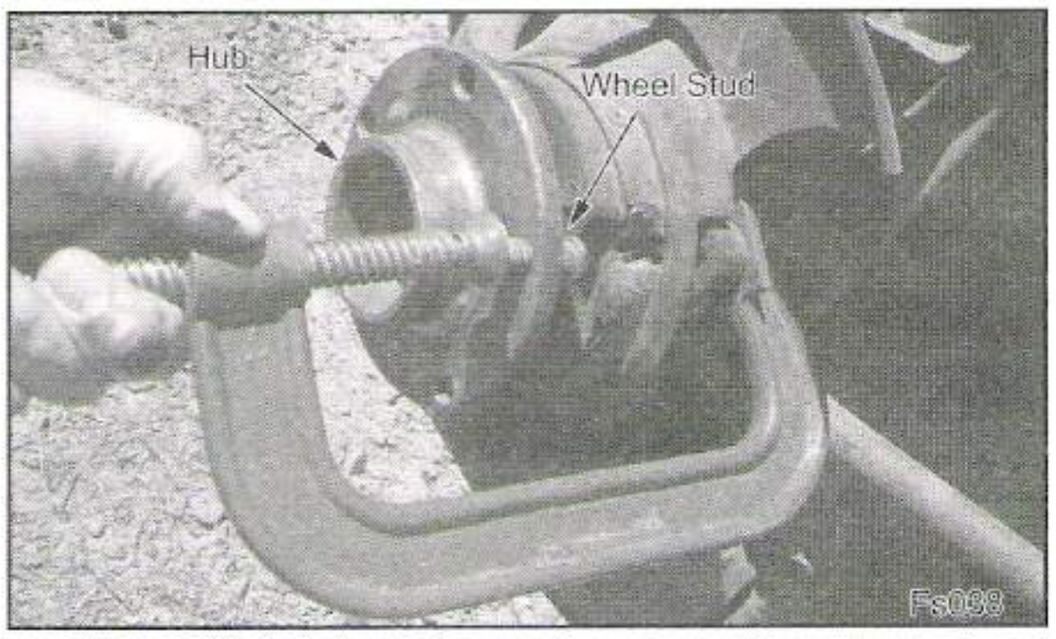
Wheel Attaching Nut: 100-125Nm

Wheel Studs

The wheel studs are pressed from the wheel hub, new studs are pressed into the hub. This can be achieved while the hub is fitted to the vehicle.

Remove

1. Jack the front wheel concerned up, removed wheel trim, wheel nuts and wheel, place alignment mark on disc and wheel for on car balance of wheel.
2. Remove the front brake caliper bracket attaching bolts, lift the caliper off the disc and tie the caliper up. Do not leave the caliper hanging by the brake fluid hose, as this will cause possible hose damage.
3. Take care and slide the front disc off the axle hub.
4. Loosen the brake backing plate, this is attached by rivets around the diameter of the plate to the steering knuckle. Rotate the brake backing plate to allow the removal of the studs.
5. Use a "G" clamp or special tool AJ24292-C which will allow the stud to be forced out at the back of the hub.



Install

1. Fit a new stud, feed stud in from back of hub,
Tip: Use a plate with 2 holes for wheel studs, bolt to hub to stop hub rotating, or special tool KM468
2. Tighten a wheel stud against the hub or washer plate to force the stud into place.
3. Remove plate or tool to stop hub from rotating.
4. Replace the brake back plate, rivets around the diameter of the plate to the steering knuckle.
5. Take care and fit the front disc onto the axle hub.
6. Install front brake caliper, lift the caliper over the disc. Install calliper attaching bolts and tighten to specification.

Front Brake Calliper Bolts: 80-90 plus 40^0 - 50^0 turn

7. Install the wheel and tighten the wheel nuts.
8. Spin wheel to check that the wheel spins freely.
9. Lower front of wheel and tighten to specification.

Wheel Attaching Nut : 100-125Nm

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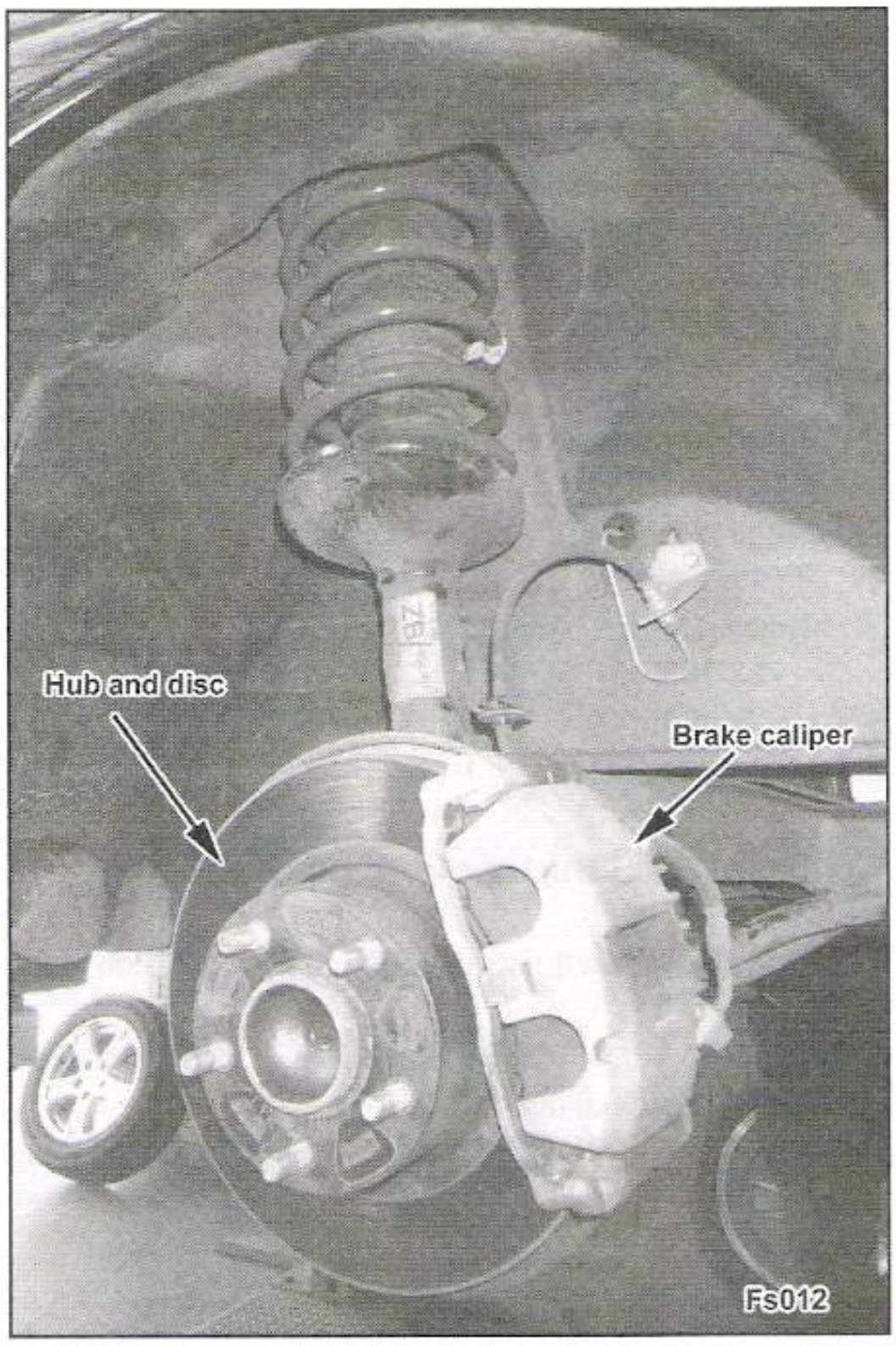
Major Maintenance

Note: At production time of August 12th 1999, serial number L492505 there were alterations too:

Lower control arm ball joint
Steering knuckle
Outer tie rod end

These components are not transferrable back to earlier models unless all 3 components are replaced at the same time.
Working procedures have not changed.
Note: After January 2000 saw the introduction of 2 different bolts for the crossmember to sub frame.

Front Wheel Hub and or Steering Knuckle



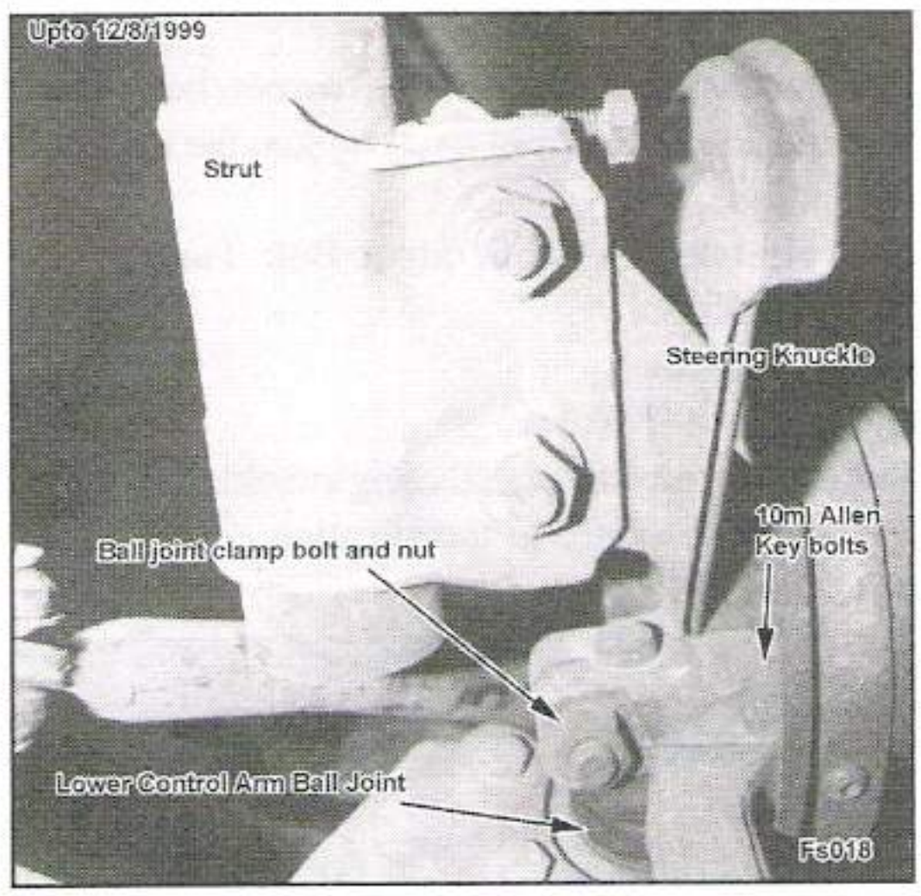
Note: Vehicles with ABS need the correct front hub check with part numbers in brake specifications. The part number is located on the disc edge.

Front Hub Identification	
No ABS	Pt Nos 92033392
ABS or ABS/ETC	Pt Nos RH 92046940, LH 92046941

Remove

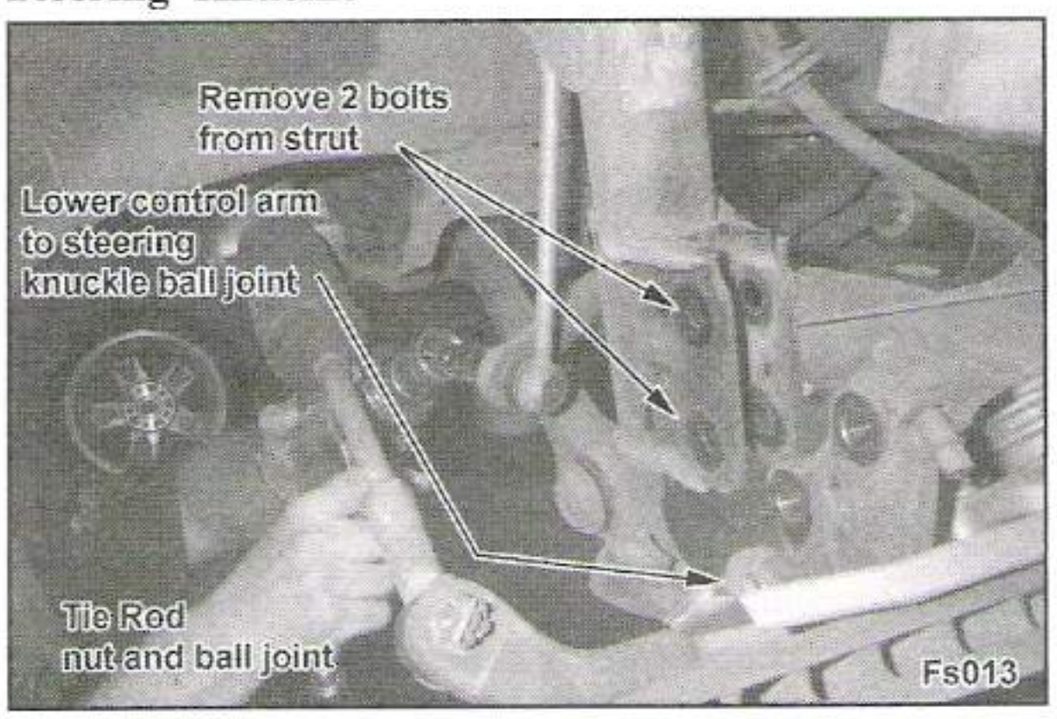
Hub

1. Jack the front wheel concerned up, removed wheel trim, wheel nuts and wheel, place alignment mark on disc and wheel for on car balance of wheel.
2. Remove the front brake caliper bracket attaching bolts, lift



the caliper off the disc and tie the caliper up. Do not leave the caliper hanging by the brake fluid hose, as this will cause possible hose damage.
3. Take care and slide the front disc off the axle hub.
4. If ABS is fitted to the vehicle [VT I: use a 5mm allen key to remove lock screw], gently pull the ABS sensor lead out.
5. Remove the 3 wheel hub to steering knuckle attaching bolts, use a 10mm allen key, if hub is hard to remove replace bolts and tap bolts with hammer to loosen.
Remove Hub

Steering Knuckle



6. If necessary remove the brake back plate, this is attached by rivets around the diameter of the plate to the steering knuckle.
7. Loosen the tie rod end nut and using a taper breaker free the stud taper. Remove the nut and detach the tie rod end from the spindle.
8. [12/8/1999] Remove the bolt from the lower control arm ball joint clamp, [12/8/99 on] This will force the ball joint from the steering knuckle assembly..

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9. Free the lower control arm from the steering knuckle, use a small press and hit with a hammer on the lower control arm.
10. Remove the two bolts attaching steering knuckle (dispose of 2 bolts) to the front strut, remove the steering knuckle.

Install

Steering Knuckle

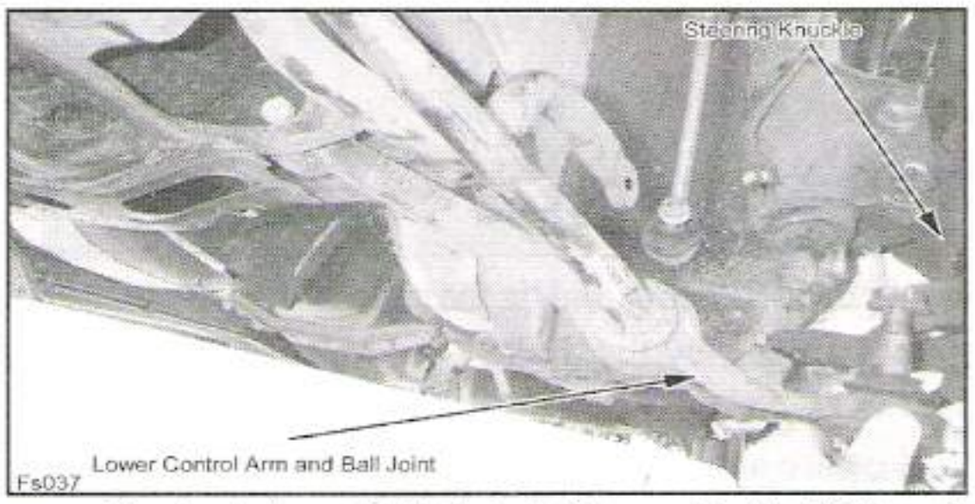
1. Install the steering knuckle and the two new bolts attaching steering knuckle to the front strut, tighten the new bolts to specified torque.

Steering Knuckle to Front Strut Bolt Torque:

Step 1 85Nm
Step 2 100Nm
Step 3 Plus 90⁰ Turn

2. Install the ball joint into the steering knuckle assembly, use a new clamp bolt, tighten to specification.

Upto 12/08/1999



Lower Control Arm Ball Joint Clamp Bolt: 70Nm plus 30⁰-40⁰ turn

After 12/08/1999

Lower Control Arm Ball joint Nut: 50-70Nm

3. If necessary replace the brake back plate, rivets around the diameter of the plate to the steering knuckle.
4. Install the tie rod ball joint to the steering knuckle, install washer, nut torque and fit split pin.

Tie Rod Ball joint Castellated Nut: 58-71Nm

Hub

5. Check surfaces of steering knuckle and hub, clean if necessary.
Check "O" ring on hub, replace if necessary.
6. Install the hub to the steering knuckle. Replace the 3 wheel hub to steering knuckle attaching bolts, use a 10mm allen key, tighten to specification.
Note: If ABS fitted align the steering knuckle hole with the sensor connection on hub during assembly of hub.

Hub to Steering Knuckle Allen Bolts: 100-115Nm

7. If ABS is fitted to the vehicle push sensor lead into place [VT I: use a 5mm allen key to replace lock screw].
8. Take care and fit the front disc onto the axle hub.
9. Install front brake caliper, lift the caliper over the disc. Install calliper attaching bolts and tighten to specification.

Front Brake Calliper Bolts: 80-90 plus 40⁰ - 50⁰ turn

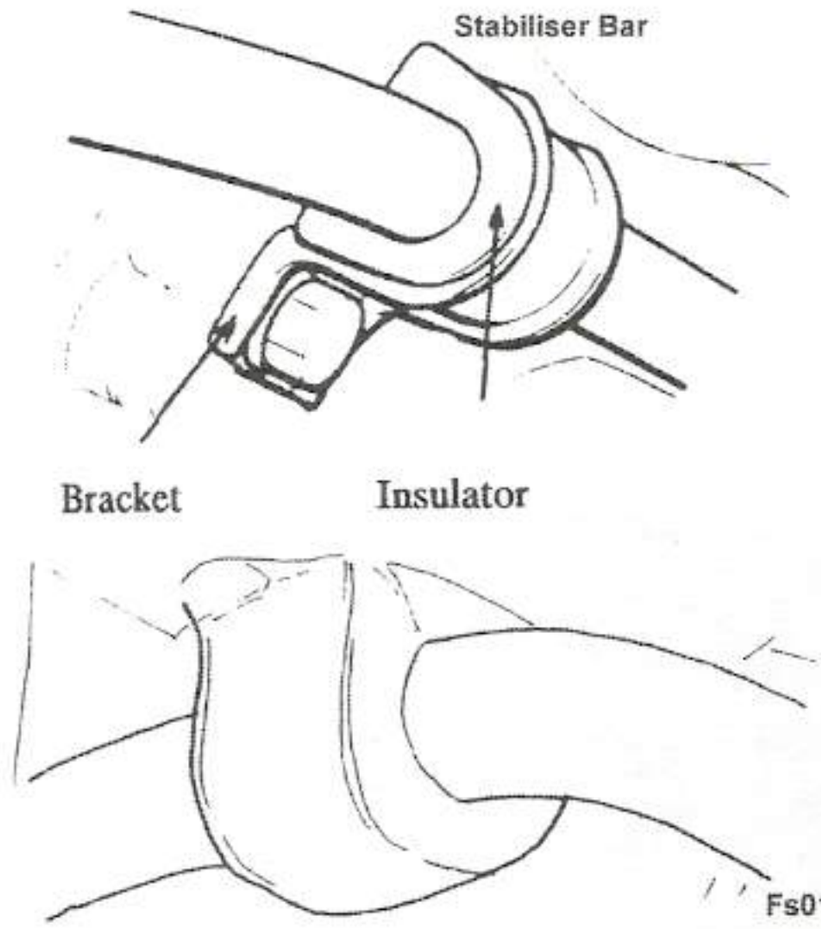
10. Install the wheel and tighten the wheel nuts.
11. Spin wheel to check that the wheel spins freely.
12. Lower front of wheel and tighten to specification.

Wheel Attaching Nut : 100-125Nm

Stabilizer Bar Center Insulators (Front or Rear Bar)

Remove

Remove the hardware and brackets attaching the centre section of the stabilizer bar. Remove the insulators or link ball jointfrom the bar.



Install

1. Position the insulators on the stabilizer bar. Make sure that the links on each end of the bar are located at approx. the same angle relative to the centre line of the vehicle and install the attaching brackets, tighten nuts to specification.

Stabilizer Centre Insulator Bracket Nuts & Bolts: 24-30Nm

VX on: Ball Joint: 45-56Nm

2. Lower the vehicle.

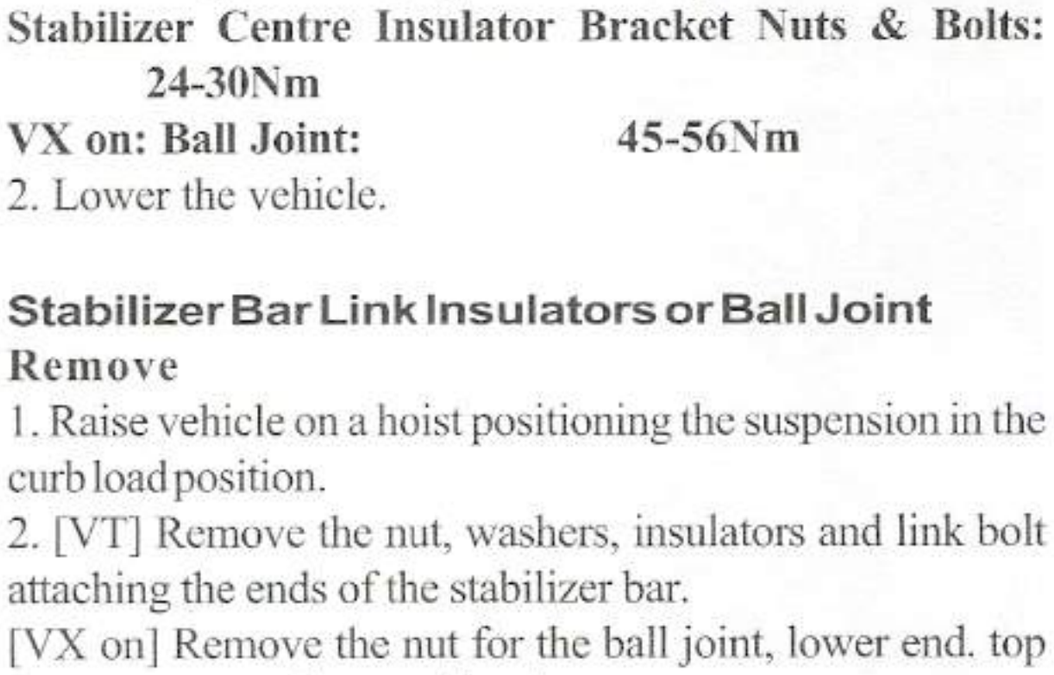
Stabilizer Bar Link Insulators or Ball Joint

Remove

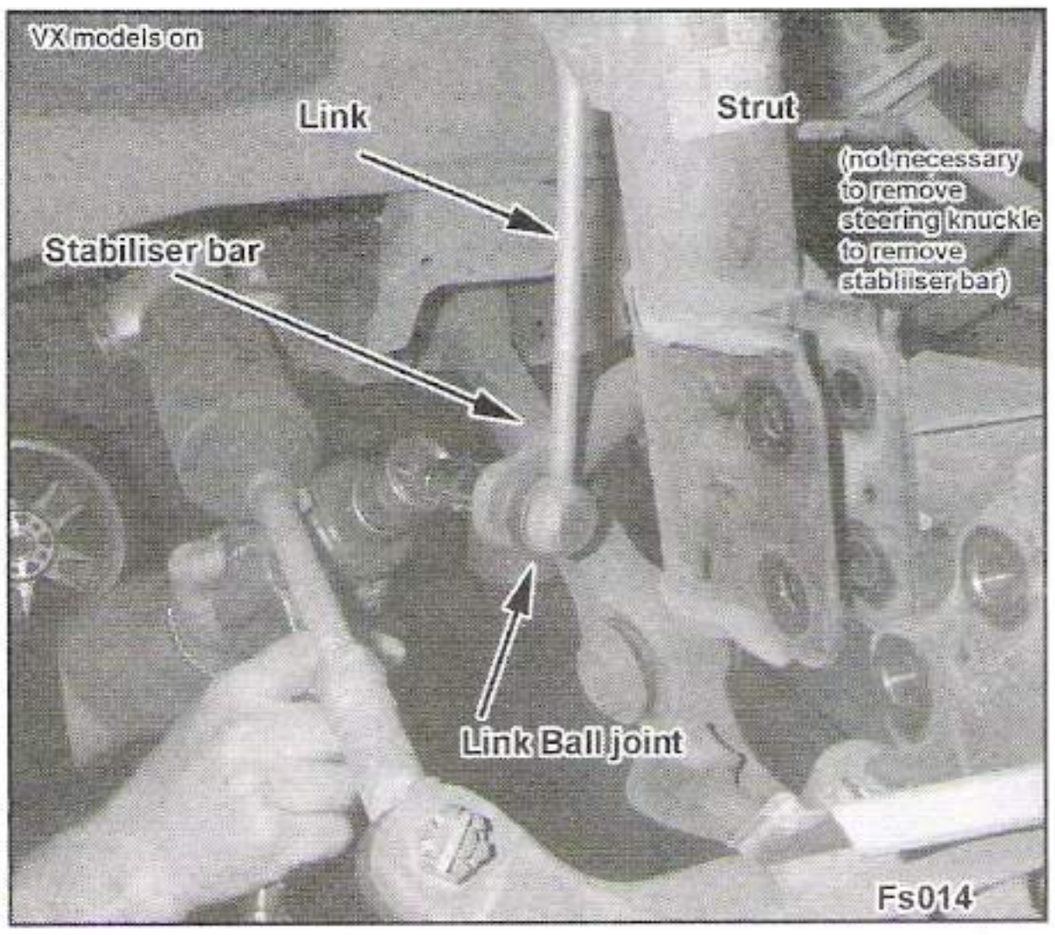
1. Raise vehicle on a hoist positioning the suspension in the curb load position.
2. [VT] Remove the nut, washers, insulators and link bolt attaching the ends of the stabilizer bar.
[VX on] Remove the nut for the ball joint, lower end. top remove nut, washers and insulators.

Install

1. Install the bolt, washers, insulators, spacer and nut as



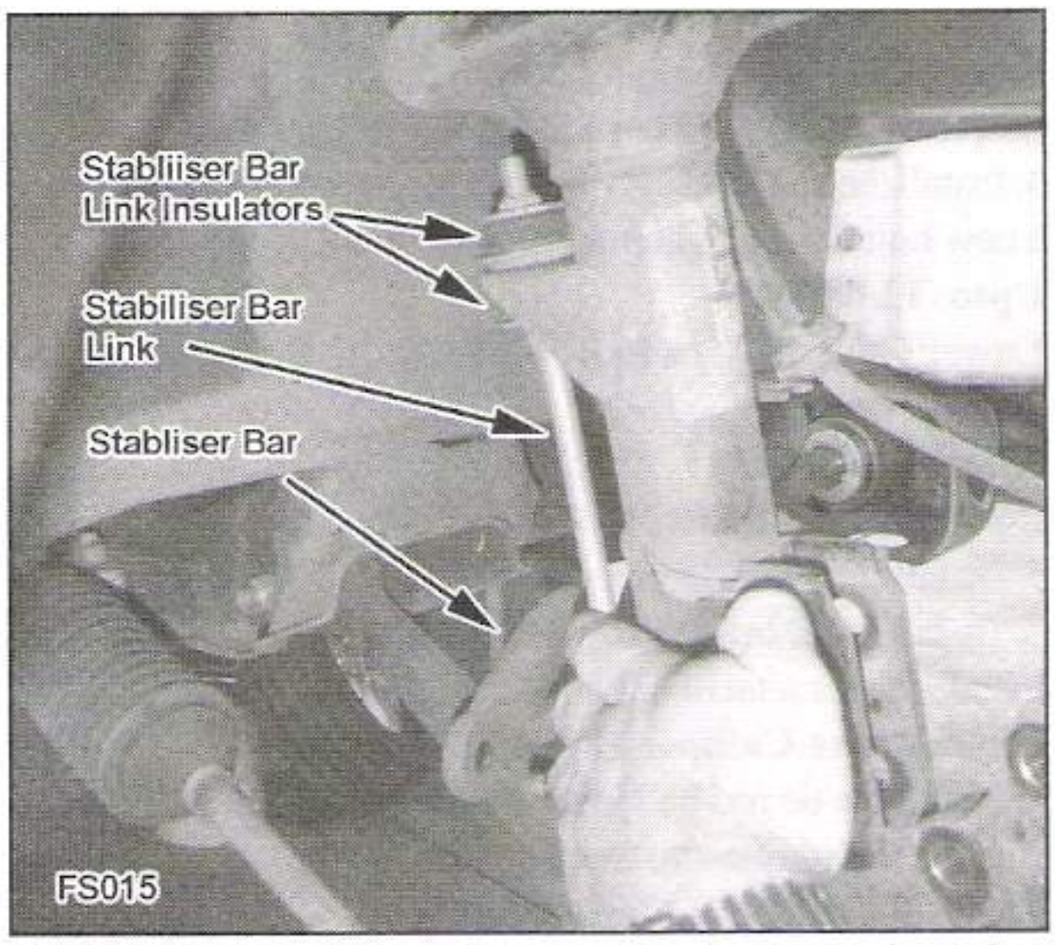
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illustrated.

2.[VT] Make sure that the insulators are correctly located in the respective mounting holes.

[VX on] Install nut to ball joint at lower end, tighten to specification.



Stabilizer Centre Insulator Bracket Nuts & Bolts: 24-30Nm

VX on: Ball Joint: 45-56Nm

Lower vehicle.

Stabiliser Bar - Front or Rear

Remove

Raise the vehicle with the suspension in the curb load attitude. Disconnect the stabilizer bar from each link. Remove both stabilizer bar retaining brackets, and remove the stabilizer bar.

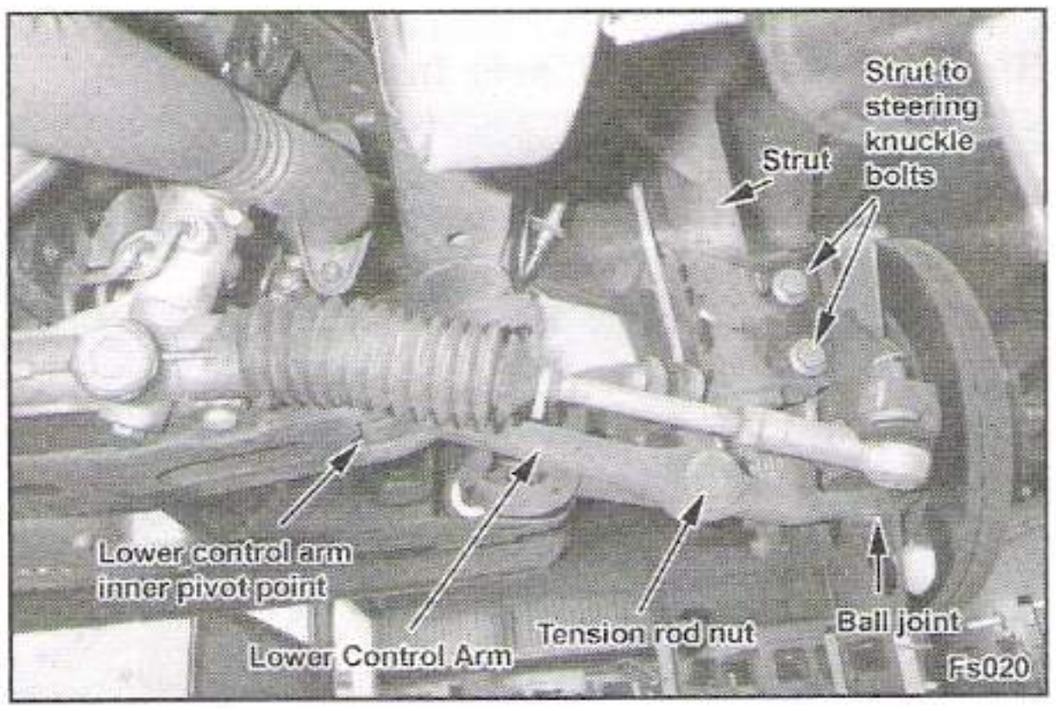
Install

Place the bar in position and install the retaining brackets and the links. Make sure that the insulators on the link are correctly in their respective mounting holes. Tighten the nuts to specification.

Stabilizer Bar Nut specified torque: 13-16Nm

VX on: Ball Joint: 45-56Nm

Front Lower Control Arm / Tension Rod



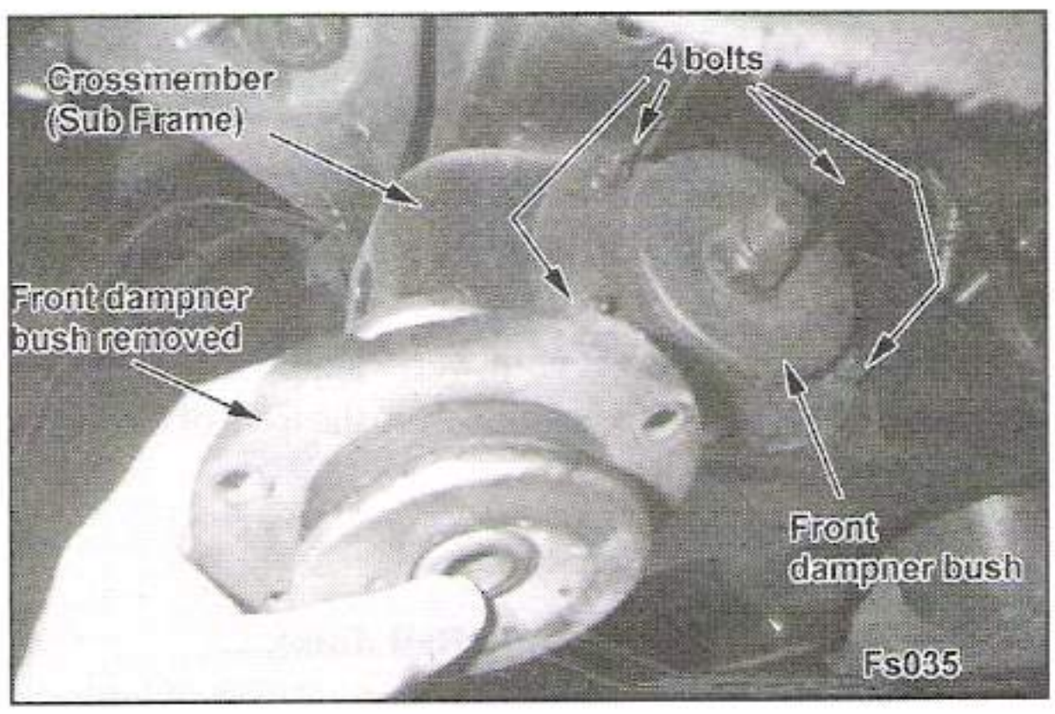
Remove Lower Control Arm Assembly

1. Raise the vehicle and support it under the front crossmember. Then remove the wheel, align mark wheel and hub for assembly.
2. Remove the front brake caliper, tie to one side.
3. Remove back dust shield from hub, drill out 3 rivets.

Removing back dust plate allows clearance to remove ball joint from knuckle.

4. Remove the bolt and nut from the lower control arm ball joint to the steering knuckle. Free the lower control arm from the steering knuckle, use a small press and hit with a hammer on the lower control arm. This will force the ball joint from the steering knuckle assembly.
5. Loosen the tie rod end nut and using a taper breaker free the stud taper. Remove the nut and detach the tie rod end from the spindle.
2. a) Disconnect the tension bar rod from the lower arm.

b) Remove tension bar nut from crossmember, remove tension bar dampner and bush from front crossmember, 4 nuts.



c) Remove tension bar.

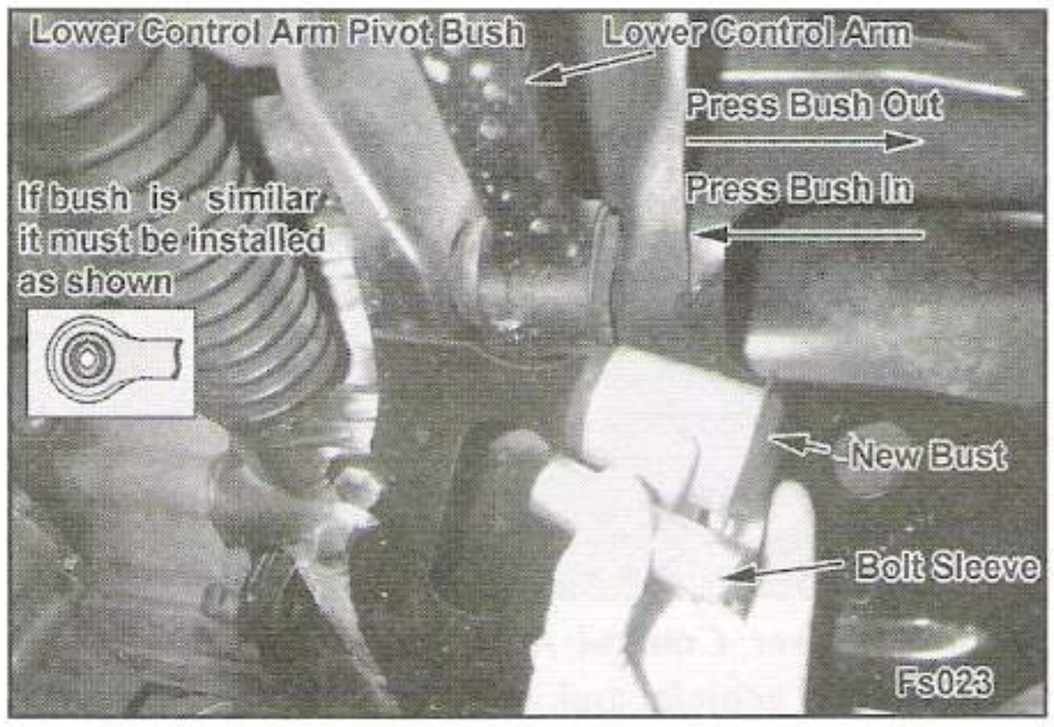
3. Remove the ball joint clamp bolt, dispose of bolt.
4. Remove the nut, (dispose of nut) and bolt from the inside

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of the control arm at the crossmember and free lower control arm.

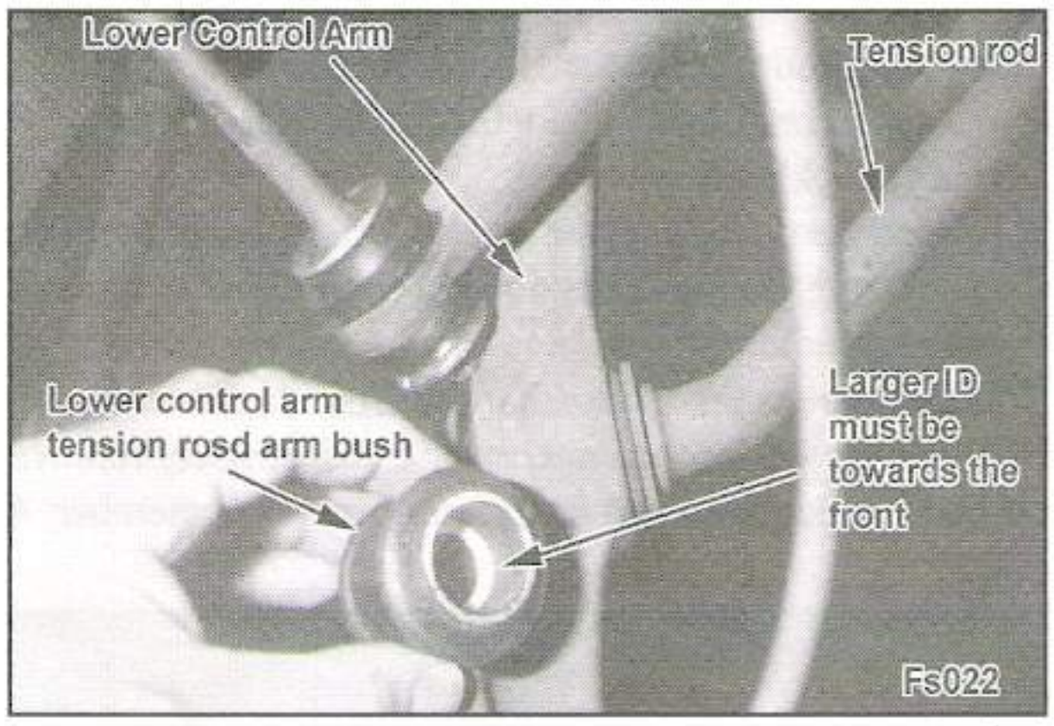
5. Free the control arm from the axle spindle, use a small press and hit with a hammer on the lower control arm. This will force the ball joint from the axle hub assembly.

Replace Lower Control Arm Inside Bushes



Press the bush from the rear side of the control arm.
Fit a new bush, lubricate the bush with soapy water. Press the bush into the control arm from the front side until it is correctly pushed into place. (Special tools AU160-1 and KM157-2 can be used)

Replace Lower Control Arm Tension Rod Bush

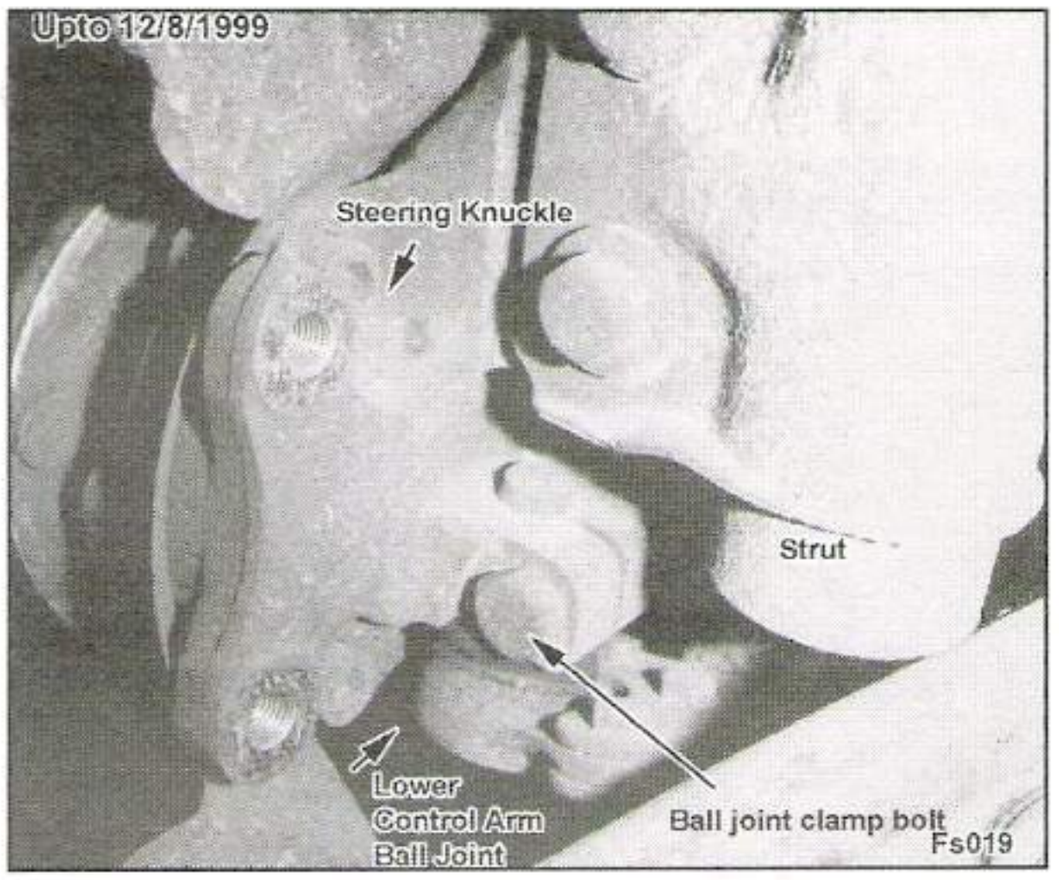


1. Press the lower control arm tension rod bush from the control arm, clean the bush hole if there is any of the old bush present.
2. Lubricate the new bush with warm soapy water.
3. Press the new bush into position from the front of the lower control arm.

Note: Larger ID bush hole to front.

Replace Lower Control Arm Ball Joint.

* The lower control arm and lower control arm ball joint are a none serviceable unit, and must be replaced if the ball joint is faulty.



Install Lower Control Arm Assembly

1. Install tension rod to lower control arm and fit washer and nut, do not tighten.
2. Install tension rod and dampner bush to front crossmember, washer and nut to tension rod, 4 nuts to tension rod dampner bush, do not tighten tension rod nut.

Tension Rod Dampner Bush 4 Nuts: 20-26Nm

3. Install the lower control arm to the crossmember, install bolt and new nut, tighten a little over finger tight.
4. Install the ball joint into the steering knuckle assembly, use a new bolt or nut, tighten to specification.

Upto 12/08/1999

Lower Control Arm Ball Joint Clamp Bolt: 70Nm plus 30^0-40^0 turn

After 12/08/1999

Lower Control Arm Bsll joint Nut: 50-70Nm

5. Install the brake back dust shield to hub, 3 rivets.
6. Install front brake caliper, lift the caliper over the disc. Install caliper attaching bolts and tighten to specification.

Front Brake Calliper Bolts: 80-90 plus 40^0 - 50^0 turn

4. Install the tie rod ball joint to the steering knuckle, install washer, nut torque and fit split pin.

Tie Rod Ball joint Castellated Nut: 58-71Nm

7. Install the wheel and tighten the wheel nuts.
8. Spin wheel to check that the wheel spins freely.
9. Lower front of wheel and tighten to specification.

Wheel Attaching Nut : 100-125Nm

10. Bounce vehicle a few times to allow bushes and dampner to settle in.
11. Tighten lower cross arm at front crossmember.

Lower Control Arm Inside nut spec torque: 95-110Nm

12. Tighten tension rod nut at lower control arm.

Tension Rod at Lower Control Arm Nut: 95-110Nm

13. Tighten tension rod nut at damper in front crossmember.

Tension Rod Nut at Dampner Nut: 140-155Nm

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Strut Top Bearing / Front Spring / Strut Housing.

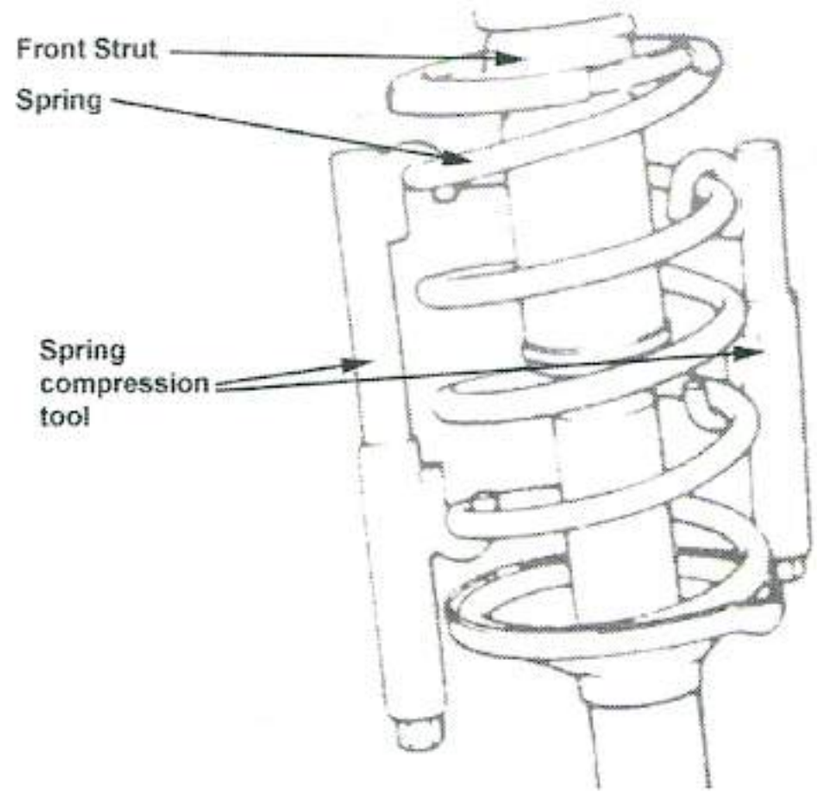
*** Note the complete assembly does not have to be dismantled, if the top bearing or front spring need replacing, only carry out the work needed to achieve the replacement of the faulty part**

Dismantle

Top Bearing

1. Raise the vehicle and support under the body rails, remove the wheel.
2. Fit a spring compression tool to the front spring, compress so that there is no pressure on the top end plate.

Note: If the lower control arm is not seperated from the strut, the spring must be compressed and clamped before



Fs024

the top bearing assembly can be removed.

3. Place alignment marks on the top locating plate, remove nuts and dispose of nuts.

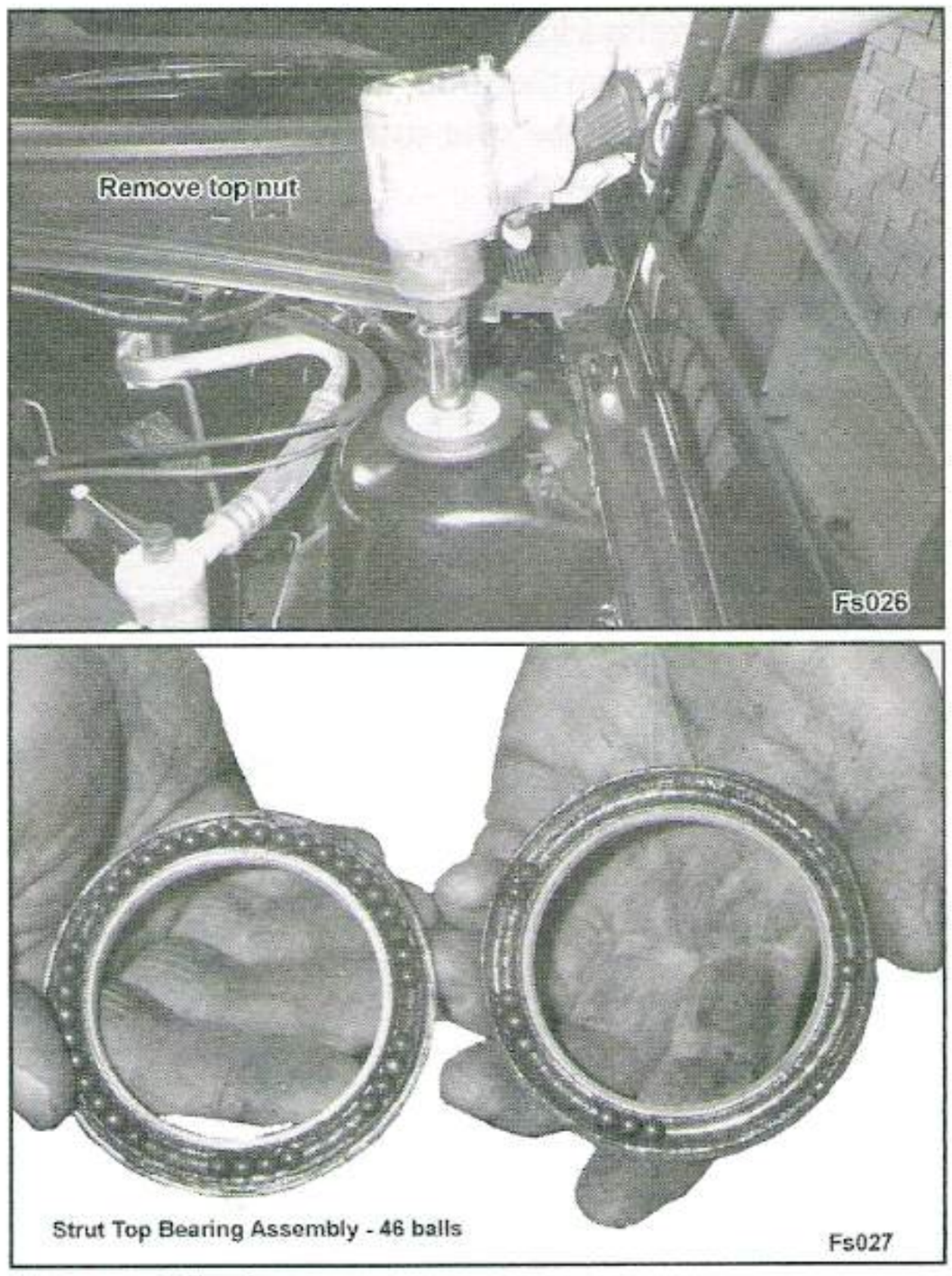
Tip: If removing strut, allow the lower control arm to drop down and remove strut and bearing as an assembly.



Fs025

4. Grip the top of the strut shaft with a 10mm ring spanner, remove top 24mm nut.
5. Remove washer, top strut support, washer, bearing and top spring seat.

Tip: Take note component positions and orientation for assembly

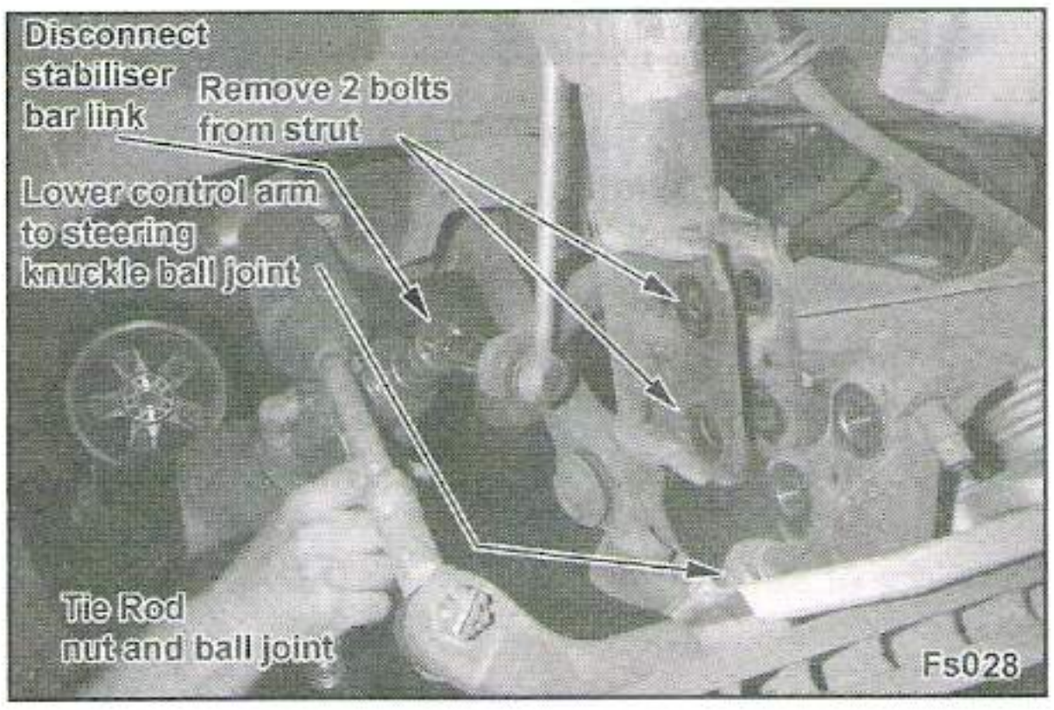


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Strut Top Bearing Assembly - 46 balls
Fs027

Strut and Spring

1. Raise the vehicle and support it under the front crossmember. Then remove the wheel, align mark wheel and hub for assembly.
2. Remove the front brake caliper, tie to one side.
3. Loosen the tie rod end nut and using a taper breaker free the stud taper. Remove the nut and detach the tie rod end from the spindle.
4. Remove the ABS if fitted and loom from the bracket on the strut. Remove the brake hose from the strut, turn plastic clip section, slides out of bracket cut away section.
5. Remove the stabilizer arm stud from the strut bracket, washers, bushes, VX on models disconnect stabiliser bar link ball joint..
6. Place a jack under the lower control arm to support when detached from strut.
7. Remove the two bolts attaching the lower section of the

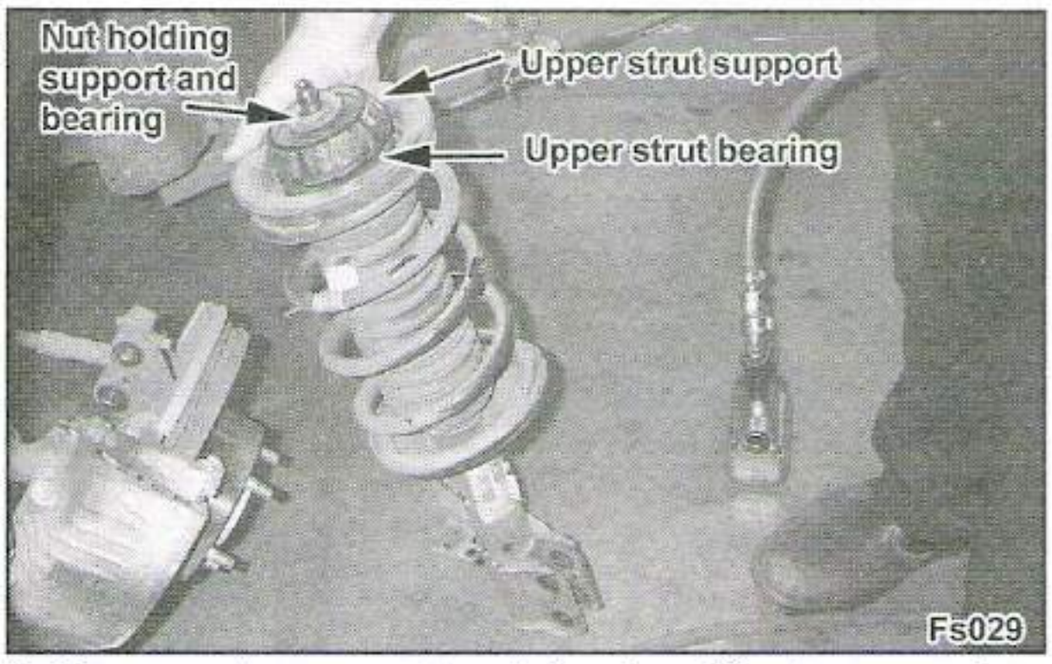


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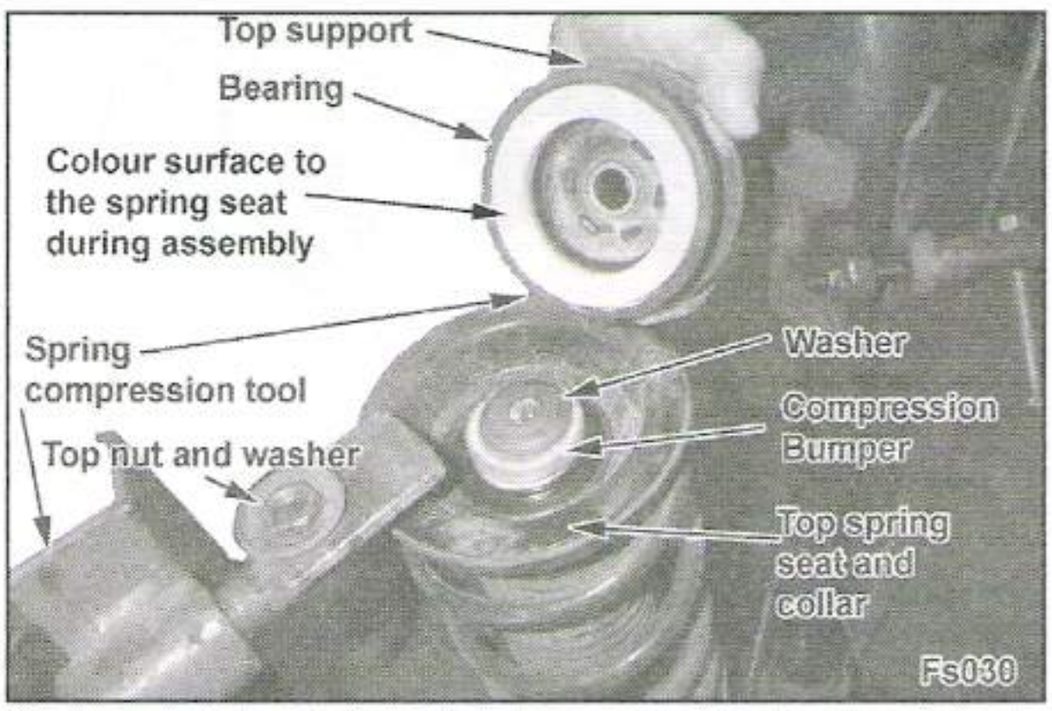
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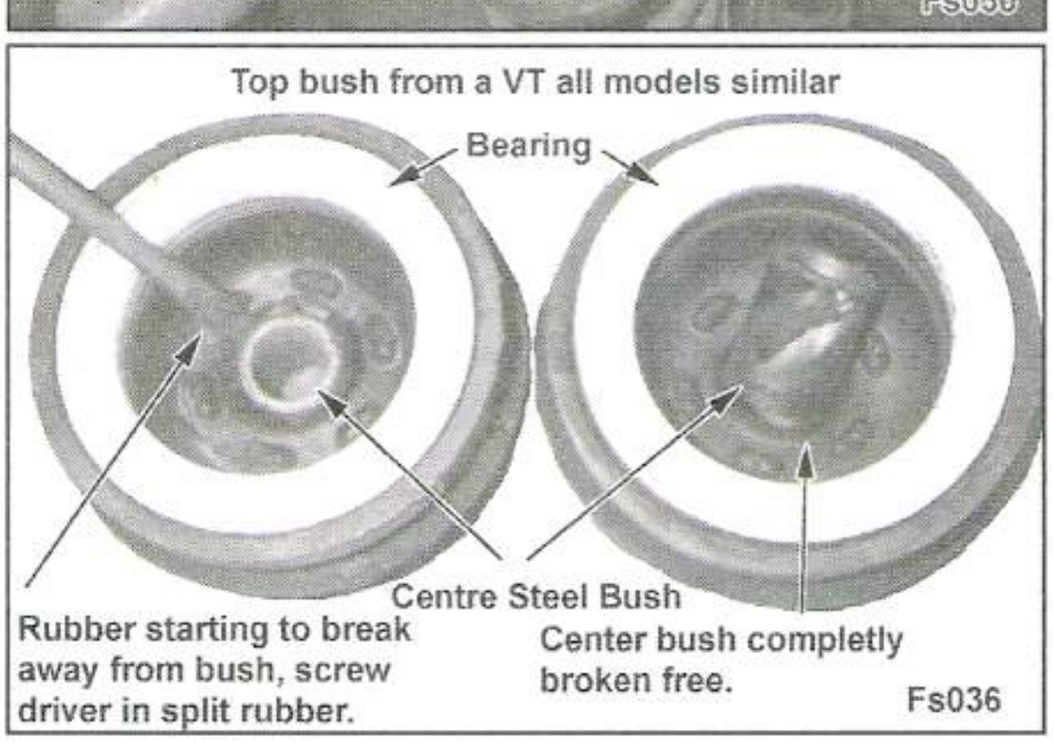
strut to the steering knuckle, remove the steering knuckle and lower control arm from the strut.

8. Lower and remove the strut suspension unit down and away from the strut tower.



9. Remove top support and bearing if not removed as decsribed earlier in this section.



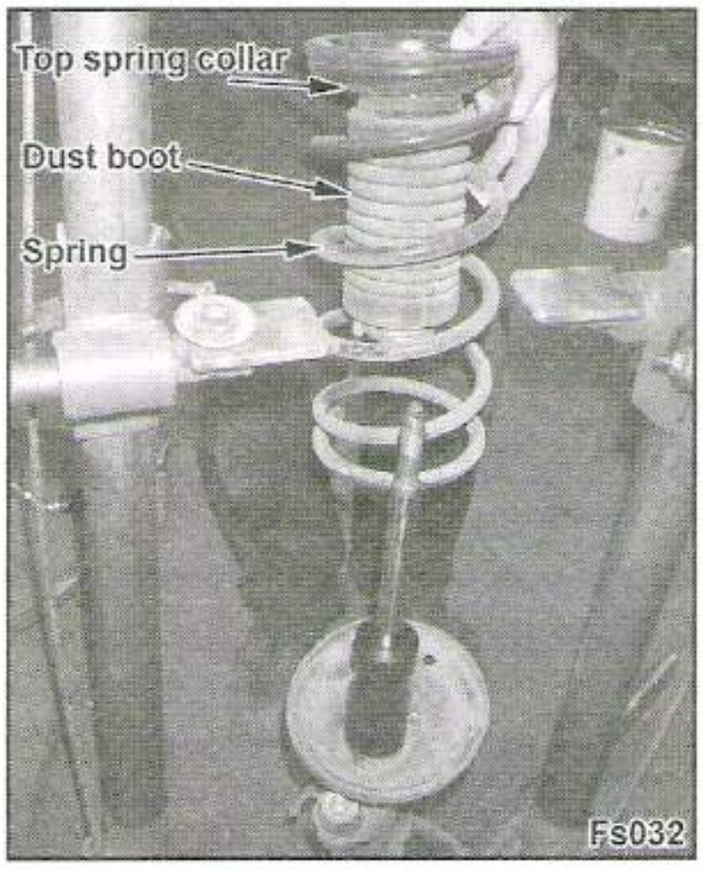


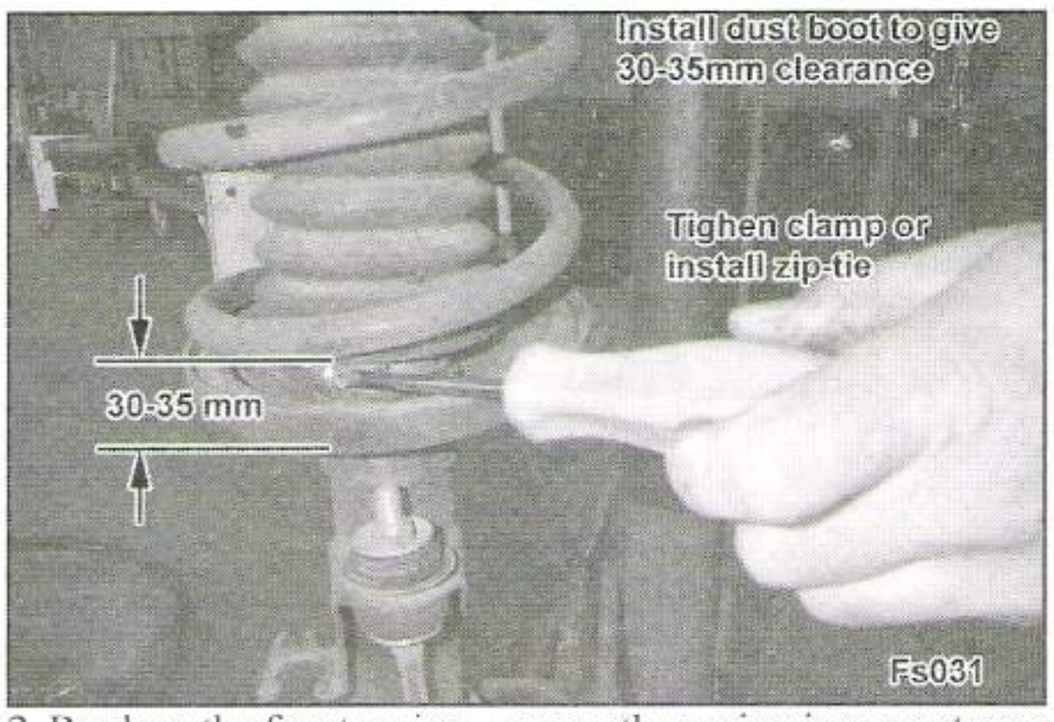
10. Remove the spring and spring insulator as required.

11. Remove rubber bumper, bellow dust boot and clamps.

Assemble and Install

1. Replace the strut dust boot over the shaft and fit the dust boot retaining strap to the top of the strut. Hold the shaft up by temporally and loosely fitting the old top end locking nut, this will stop the shaft top from sliding down into the dust boot. Fit the dust boot lower clamp, is fitted so that there is a clearance of 30 - 35 mm from strut, as shown. Install the rubber bumper.





2. Replace the front spring , ensure the spring is correct way up and the spring is seated into the spring seat of the strut, fit the spring compression tool with care.

3. a) Install the strut assembly with front spring compression tool fitted to the spring on the strut

b) Install the spring insulator to the top of the spring.

4. Pull the shaft of the strut out to full length, remove the temporally fitted old nut, dispose of nut.

5. a) Install top spring seat and bearing.

Tip: The coloured or narrow face of the bearing fits to the spring seat.

Tip: Lower washer concave section faces down, top washer concave section faces up.

b) Install washer and new nut.

6. Install top locating plate with new top nuts.

Strut Top Locating Plate Nuts: 50-60Nm

7. Hold the strut shaft 10mm ring spanner (do not clamp the seal area of the shaft) and tighten the top nut (24mm) to specification.

Top Bearing Retaining Nut: 70-85Nm

8. Replace the stabilizer arm stud to the strut bracket, fitting the washers, bushes and nut, tighten the nut to specification.

Stabilizer Bar Nut s: 7-10Nm

9. Install steering knuckle to strut, install 2 new bolts and nuts, tighten to specification.

Steering Knuckle to Front Strut Bolt Torque:

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Step 1 **85Nm**
Step 2 **100Nm**
Step 3 **Plus 90⁰ Turn**

10. Install the tie rod end to the steering knuckle, install the nut and tighten to specification, fit split pin.

Tie Rod to Steering Knuckle Nut: 60-70Nm

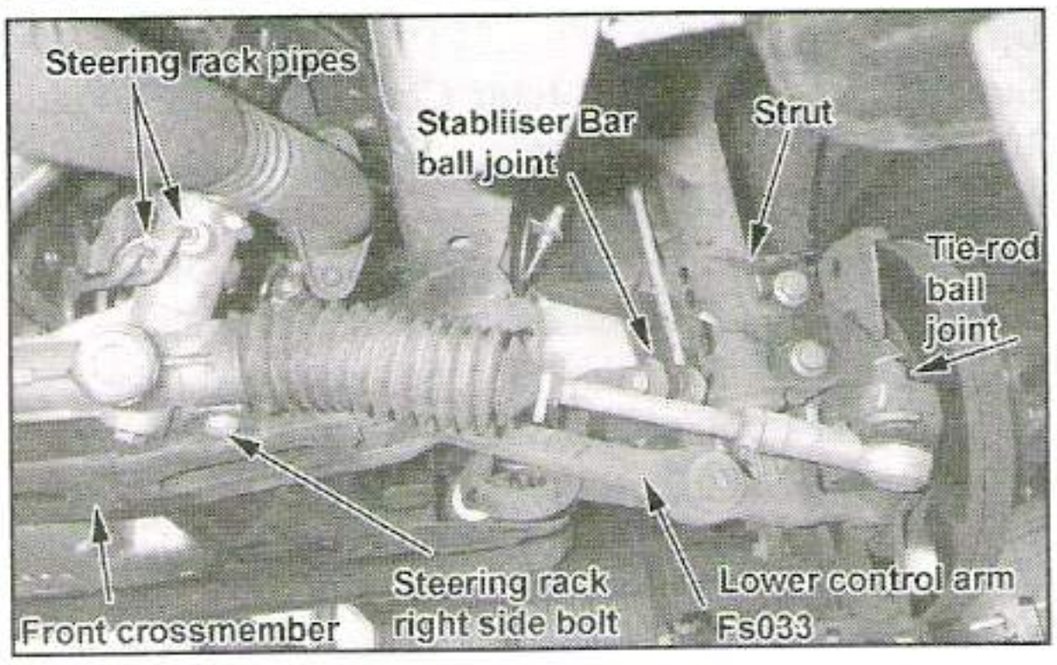
11. Install front brake caliper, lift the caliper over the disc. Install caliper attaching bolts and tighten to specification.

Front Brake Calliper Bolts: 80-90 plus 40⁰ - 50⁰ turn

12. Install ABS sensor wiring connector if required.
13. Replace wheel to hub, tighten nuts, lower vehicle, tighten wheel nuts to specification and road test vehicle.

Wheel Nuts specified torque: 100-125Nm

14. Adjustment of front end of vehicle.



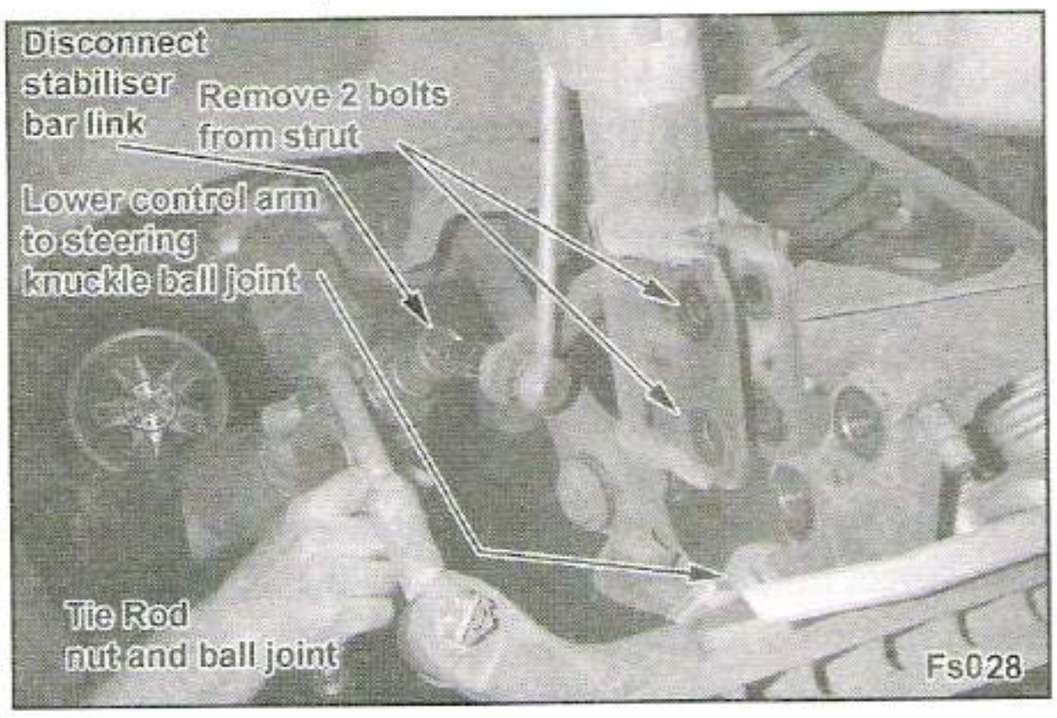
Front Crossmember

Remove

1. Raise the vehicle and support it under the sub frame with jack stands. Then remove the wheel, align mark wheel and hub for assembly.
2. Remove the front brake caliper, tie to one side.
3. Remove back dust shield from hub, drill out 3 rivets.

Removing back dust plate allows clearance to remove ball joint from knuckle.

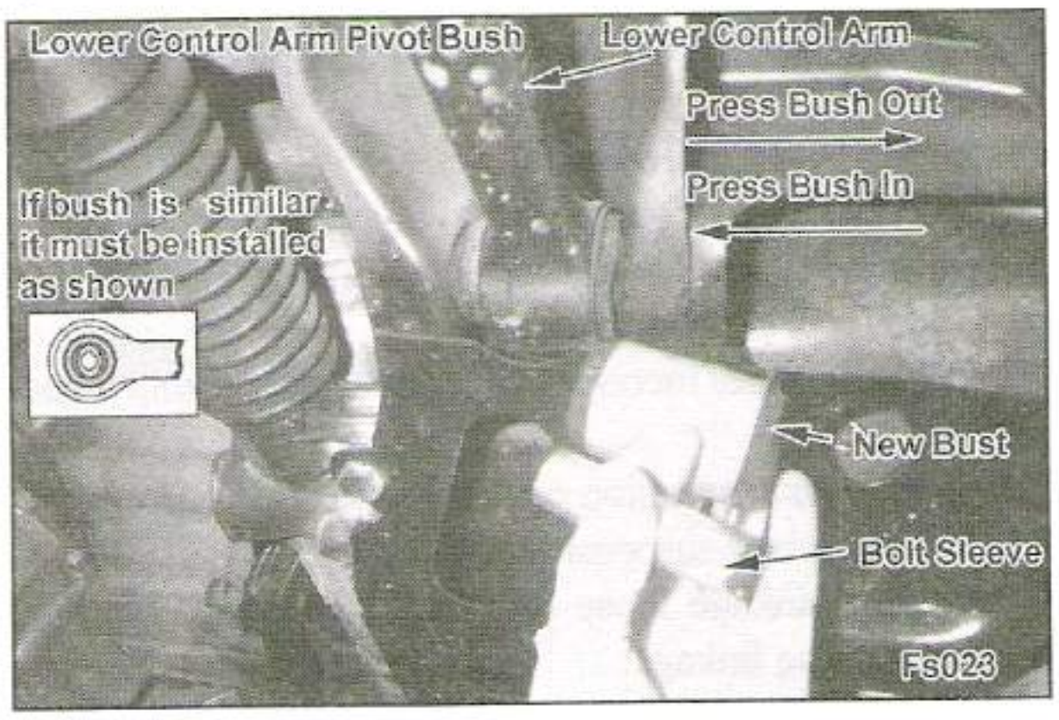
4. Remove the bolt and nut / nut after 12/08/1999 from the lower control arm ball joint to the steering knuckle. Free the lower control arm from the steering knuckle, use a small press and hit with a hammer on the lower control arm. This will force the ball joint from the steering knuckle assembly.



5. Loosen the tie rod end nut and using a taper breaker free the stud taper. Remove the nut and detach the tie rod end from the spindle.
6. Remove the stabiliser bar from the front strut, nut, washers, and bushes.
7. Disconnect and remove the rack and pinion steering gear as described in steering chapter.

a) Place alignment marks on steering shaft to rack and pinion input shaft, loosen universal clamp and slide from input shaft.
b) Remove power steering hoses and plug hoses to stop fluid leak.
c) Remove the bolts attaching the rack and pinion to the crossmember.

8. a) Place a jack and stand under engine, support engine, or attach a block and chain to engine to support engine.
b) V6 Remove engine mount bolts to cylinder head.
V8 - Remove engine mount bolts to crossmember.
9. a) Place alignment marks on crossmember and sub frame to help in assembly and crossmember alignment.
b) Support crossmember, remove bolts attaching the crossmember to the sub frame.
c) Lower crossmember and detach tension rods in necessary, as removing crossmember.
d) Remove stabiliser bar if required.
e) Remove lower control arms if required.



Install

1 a) Install stabiliser bar to crossmember if required.

Stabiliser Bar to Crossmember: 24-30Nm

b) Install crossmember and attach tension rods in necessary.
c) Support crossmember using alignment marks, install bolts attaching the crossmember to the sub frame.

Crossmember to Subframe: 120-125Nm

2. Install engine mount bolts and tighten to specification, release engine weight and allow to be supported on crossmember.
3. Install the rack and pinion steering gear to the front crossmember as described in steering chapter.

Rack and Pinion to Crossmember: 70-85Nm

4. Install stabiliser bar to strut.
5. Install the ball joint into the steering knuckle assembly, use a new bolt / nut, tighten to specification.

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Upto 12/08/1999
Lower Control Arm Ball Joint Clamp Bolt: 70Nm plus 30^0-40^0 turn
After 12/08/1999
Lower Control Arm Bsll joint Nut: 50-70Nm
6. Install the brake back dust shield to hub, 3 rivets.
7. Install front brake caliper, lift the caliper over the disc. Install caliper attaching bolts and tighten to specification.
Front Brake Calliper Bolts: 80-90 plus 40^0 - 50^0 turn
8. Install the tie rod ball joint to the steering knuckle, install washer, nut torque and fit split pin.
Tie Rod Ball joint Castellated Nut: 58-71Nm
9. Install the wheel and tighten the wheel nuts.
10. Spin wheel to check that the wheel spins freely.
11. Lower front of wheel and tighten to specification.
Wheel Attaching Nut : 100-125Nm
12. Bounce vehicle a few times to allow bushes and dampner to settle in.
13. Tighten lower cross arm at front crossmember.
Lower Control Arm Inside nut spec torque: 95-110Nm
14. Tighten tension rod nut at lower control arm.
Tension Rod at Lower Control Arm Nut: 95-110Nm
15. Tighten tension rod nut at damper in front crossmember.
Tension Rod Nut at Dampner Nut: 140-155Nm

PROBLEM DIAGNOSIS

Problem: Wanders/pulls !
Possible Causes & Remedies:
* Tyres worn or improperly inflated. Remedy- Replace tyre or inflate tyres to proper pressure.
* Wheel alignment incorrect. Remedy- Inspect front wheel alignment.
* Front or rear suspension parts loose or broken. Remedy-Tighten or replace suspension parts.
* Steering linkage loose or worn. Remedy-Tighten or replace steering linkage.
* Steering gear out of adjustment or broken. Remedy-Adjust or repair steering gear.

Problem: Bottoming !
Possible Causes & Remedies:
* Vehicle overloaded. Remedy-Inspect loading.
* Shock absorber worn out. Remedy-Replace shock absorber.
* Springs weak. Remedy-Replace spring.

Problem: Sways/pitches !
Possible Causes & Remedies:
* Tyres improperly inflated. Remedy-Inflate tyres to proper pressure.
* Stabiliser bar bent or broken. Remedy-Examine stabiliser bar.
* Strut faulty. Remedy-Replace struts.

Problem: Front Wheel Vibrations !
Possible Causes & Remedies:
* Tyres worn or improperly inflated. Remedy-Replace or inflate tyres to correct pressure.
* Wheels out of balance. Remedy-Balance wheels.
* Shock absorber worn out. Remedy-Replace shock absorber.
* Wheel alignment incorrect. Remedy-Inspect front wheel alignment.
* Ball joints or bushings worn. Remedy-Examine ball joints and bushings.
* Steering linkage loosen or worn. Remedy-Tighten or replace steering linkage.
* Steering gear out of adjustment or broken. Remedy-Adjust or repair steering gear.

Problem: Abnormal Tyre Wear !
Possible Causes & Remedies:
* Tyres improperly inflated. Remedy-Inflate tyres to correct pressure.
* Shock absorbers worn out. Remedy-Replace shock absorber.
* Wheel alignment incorrect. Remedy-Check wheel alignment.
* Suspension parts worn. Remedy-Replace suspension parts.

Problem: Steering Wheel Play !
Possible Causes and Remedies:
* Tyres worn or improperly inflated. Remedy- Replace tyre or inflate tyres to proper pressure.
* Front or rear suspension parts loose or broken. Remedy-Tighten or replace suspension parts.
* Steering linkage loose or worn. Remedy-Tighten or replace steering linkage.
* Faulty control arm ball joints.

Problem: Steering hard when braking !
Possible Causes and Remedies:
* Tyres improperly inflated. Remedy-Inflate tyres to correct pressure.
* Front disc buckled. Remedy - Check and machine or replace front discs.
* Faulty brake pads. Remedy - Replace brake pads.
* Incorrect front wheel alignment. Remedy - Check front wheel alignment and adjust.
* Steering rack and pinion not attached correctly to front frame. Remedy - Check all attachments of steering rack and pinion.

Problem: Vehicle pulls to one side!
Possible Causes and Remedies:
* Suspension parts worn. Remedy-Replace suspension parts.
* Wheel alignment incorrect. Remedy-Check wheel alignment.
* Tyres improperly inflated. Remedy-Inflate tyres to correct pressure.
* Rear axle alignment incorrect or badly worn components. Remedy - Check rear wheel alignment, rear axle bushes and

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IRS vehicles check for correct installation of differential centre to crossmember.

Problem: Steering Excessively Heavy

Possible Causes and Remedies:

* Tyres improperly inflated. Remedy-Inflate tyres to correct pressure.

* Steering rack and pinion not attached correctly to front frame. Remedy - Check all attachments of steering rack and pinion.

* Power Steering Unit faulty. Remedy- Check power system unit and pressure test power steering system.

* Power Steering fluid low. Remedy- Top-up power steering fluid reservoir.

* Steering damaged due to accident. Remedy- Check all components of steering and front suspension.

SPECIFICATIONS

Bearing Angular Float:

New Bearing:	0.106 mm (0.0042") Max
Used Bearing:	0.213 mm (0.0085") Max

Front Hub Identification

No ABS	Pt Nos 92033392
ABS or ABS/ETC	Pt Nos RH 92046940, LH 92046941

Stabiliser Bar

Vehicle	Diameter	Code
V6 Std VT	26.0mm	GE
V8 Std VT Ser I	25.0mm	GF
V8 Std VT Ser II	26.0mm	GE
V6 & V6 S/C "S" models	26.0mm	GE
V8 "SS" models VT	26.0mm	GE
FE2 suspension VT	27.0	GH
VX Std	26.0mm	YB
VX FE2	27.0mm	YA
VU ute & S	26.0mm	YB
VU SS	27.0mm	YA
WH all models	26.0mm	GE
Monaro all models	28.0mm	KA

Mac Pherson Strut	Standard & V5W	FE2
Compression (2/3 compression of bumper)	90mm	80mm
Rebound	110mm	120mm

Front spring

Vehicle	Length	Coils	Code	Pressure
VT Ser 1 and Ser II to January 2000				
V6 Std	444mm	6.05	HN	3700+/-110N@210mm
V6 FE2	341mm	5.25	HJ	3660+/-110N@200mm
V8 Std	376mm	6.12	HS	variable 24-31N/mm
V8 FE2	351mm	5.74	HK	variable 27-35 N/mm
V6 V5W	376mm	6.12	HS	3660+/-100N@230mm
V6s/c & GenIII			HN	as above
V6s/c & GenIII FE2	348mm	5.70	HT	3825+/-100N@194mm
VT Ser II after January 2000, all engines				
Std	444mm	6.05	HN	3700+/-110N@210mm
FE2	341mm	5.25	HJ	3660+/-110N@200mm
V5W	376mm	6.12	HS	3660+/-100N@230mm
VX all engines				
Std	444mm	6.05	HN	3700+/-110N@210mm
FE2	341mm	5.25	HJ	3660+/-110N@200mm
V5W	444mm	6.05	HN	3700+/-110N@210mm
VU utility				
Ute and S	367mm	5.70	JN	3600+/-110N@230mm
SS	358mm	5.25	HJ	3850+/-110N@209mm
WH Statesman				
V6	401-7mm	6.06	JN	3700+/-110N@218mm
WH Caprice				
Gen III	283-7mm	7.78	JN	3700+/-110N@218mm
Monaro				
All models	355mm	5.25	KA	3660+/-110N@200mm

Stabiliser Bar

Vehicle	Diameter	Code
V6 Std VT	26.0mm	GE
V8 Std VT Ser I	25.0mm	GF
V8 Std VT Ser II	26.0mm	GE
V6 & V6 S/C "S" models	26.0mm	GE
V8 "SS" models VT	26.0mm	GE
FE2 suspension VT	27.0	GH
VX Std	26.0mm	YB
VX FE2	27.0mm	YA
VU ute & S	26.0mm	YB
VU SS	27.0mm	YA
WH all models	26.0mm	GE
Monaro all models	28.0mm	KA

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Mac Pherson Strut Identification

	Left Side	Right Side
VT		
Standard	LS	RS
FE2	LT	RT
V5W	LU	RU
VX		
Standard	ZM	ZN
FE2	ZP	ZR
V5W	ZS	ZT
VU Utility		
Ute & S	LS	RS
SS	LT	RT
WH all models	LT	RT
Monaro all models	ZK	ZJ

HSV Models

HSV VT Ser 1 (different stabiliser bar and insulator also)

Suspension Type	Spring	Strut right / left
Sport	03C-970301	03F-970301 / 02
Luxury	03C-970301	03F-970803 / 04
Performance	03C-970701	03F-970701 / 02
Boulevard	03C-671902	03F-741903 / 04

HSV VT Ser II & WH (all stabiliser bar - 03G-970701)

Suspension Type	Spring	Strut right / left
Sport	03C-990601	03F-990601 / 02
Luxury	03C-990601	03F-991601 / 02
Performance	03C-970701	03F-990701 / 02
Grange	03C-970301	03F-991301 / 02

HSV VX & WH ser II

Suspension Type	Spring	Strut right / left
Sport	03C-990601	03F-990601 / 02
Luxury	03C-990601	03F-991601 / 02
Performance	03C-970701	03F-990701 / 02
Prestige	03C-970301	03F-991301 / 02

HSV VU

Suspension Type	Spring	Strut right / left
Maloo	03C-970701	03F-000601 / 02

Vehicle Height Variations

Front to Rear	Variation of +/- 20 mm
Side to Side	Variation of +/- 10 mm
Spring Setting	Variation of +/- 5 mm

Approx Vehicle Height with base options

Vehicle	Trans	Front	Rear
VT Ser I			
Executive	manual	598	562
Berlina	auto	603	586
Calias	auto	609	603
Exec Wagon	manual	603	573
Berlina Wagon	auto	598	582
VT Ser II			
Executive	manual	593	583
Berlina	auto	593	583
Calias	auto	593	583
Exec Wagon	manual	603	573
Berlina Wagon	auto	598	582

VX	Trans	Front	Rear	Suspension
Exec/Berlina	a/m	605	594	Std / V5W
Exec/Berlina	a/m	583	581	FE2
Calias	auto	618	607	Std / V5W
Calias	auto	596	608	FE2
Wagon	a/m	601	583	Std / V5W
Wagon	a/m	586	568	FE2
"S" Pack	a/m	605	603	FE2
"SS" Pack	a/m	611	609	FE2
VU Utility				
Ute V6	a/m	616	641	
Ute V8	a/m	606	641	
S V6	a/m	629	654	
S V8	a/m	619	654	
SS V8	a/m	619	644	
WH Stat	auto	600	595	
WH Cap	auto	597	598	
Monaro V6	a/m	611	609	
Monaro V8	a/m	624	622	

HSV Approx Vehicle Height with base options

Vehicle	Trans	Front	Rear
HSV VT Ser I (+/-5mm)			
Manta, Clubsport Senator			
	a/m	615	605
GTS	a/m	627	612
Estate	a/m	615	605
Maloo	a/m	622	622
Grange	a/m	595	560
HSV VT Ser II and WH Ser I (+/-5mm)			
XU8, Clubsport, Senator			
	a/m	615	605
SV99, GTS	a/m	627	612
Estate	a/m	615	605
Maloo	a/m	622	622
Grange	a/m	595	560

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C'ntd

HSV VX & WH Ser II (+/-5mm)			
XU6, Senatora/m		615	605
Clubsport, R8 & Senator			
	a/m	627	612
GTS	a/m	639	624
Estate	a/m	615	605
Maloo	a/m	627	612
Grange	a/m	627	612
HSV VUI (+/-5mm)			
Maloo	a/m	622	622
Maloo R8	a/m	622	622

Specifications Nm

Strut To Front Hub/Knuckle Bolt Torque:
Step One: 85Nm
Step Two: 100Nm
Step Three: Plus 90^0 Turn
Road Wheels Nuts specified torque: 100-125Nm
Rear Crossmember Front Bolt: 125Nm $+30^0$-40^0 turn
Rear Crossmember Rear bolt to Under Body: 30-40Nm
Trailing Arm to Rear Crossmember Nut: 95-105Nm
Front Brake Calliper Bolts: 80-90 plus 40^0 - 50^0 turn
Tie Rod Ball joint Castellated Nut: 58-71Nm
Hub to Steering Knuckle Allen Bolts: 100-115Nm
Stabilizer Centre Insulator Bracket Nuts & Bolts: 24-30Nm
Stabilizer Bar Nut specified torque: 13-16Nm
VX on Stabliser Bar Ball Joint: 45-56Nm
Tension Rod Dampner Bush 4 Nuts: 20-26Nm
Lower Control Arm Inside nut: 95-110Nm
Tension Rod at Lower Control Arm Nut: **95-110Nm
Tension Rod Nut at Dampner Nut: **140-155Nm
Top Bearing Retaining Nut: **70-85Nm
Strut top Locating Plate Nuts: **50-60Nm
Stabilizer Bar Nuts: 7-10Nm
Stabiliser Bar to Crossmember: 24-30Nm
Crossmember to Subframe: 120-125Nm
Rack and Pinion to Crossmember: 70-85Nm

Lower Control Arm Ball Joint

Upto 12/08/1999
Lower Control Arm Ball Joint Clamp Bolt: **70Nm plus 30^0-40^0 turn

After 12/08/1999
Lower Control Arm Bsll joint Nut: **50-70Nm

** Must use new bolts when replacing components

Caster

VT, VX, WH, VY
Caster at kerb weight 7° 45' ± 1° 15'
VU (utility)
Caster at kerb weight 5° 45' ± 0° 30'
HSV - VS
Caster at kerb weight 4° 45' ± 1° 15'
HSV - VT, VX, VY, WH, VU
Caster at kerb weight 7° 45' ± 1° 15'

Camber:

VT Ser1 Standard Suspension
-minus 0deg12min +/- 0 deg 12min
VT Ser II, VX, VY and WH Standard Suspension
-minus 0deg12min +/- 0 deg 18min
VU Utility Standard suspension
-minus 0deg00min +/- 0 deg 30min
HSV VS suspension
-minus 0deg25min +/- 0 deg 05min
HSV VT Ser 1 suspension
-minus 0deg48min +/- 0 deg 30min
HSV VT Ser 11 and WH suspension
-minus 0deg30min +/- 0 deg 20min
HSV VX, VY and WH Ser II suspension
-minus 0deg30min +/- 0 deg 20min
HSV VU suspension
-minus 0deg30min +/- 0 deg 20min

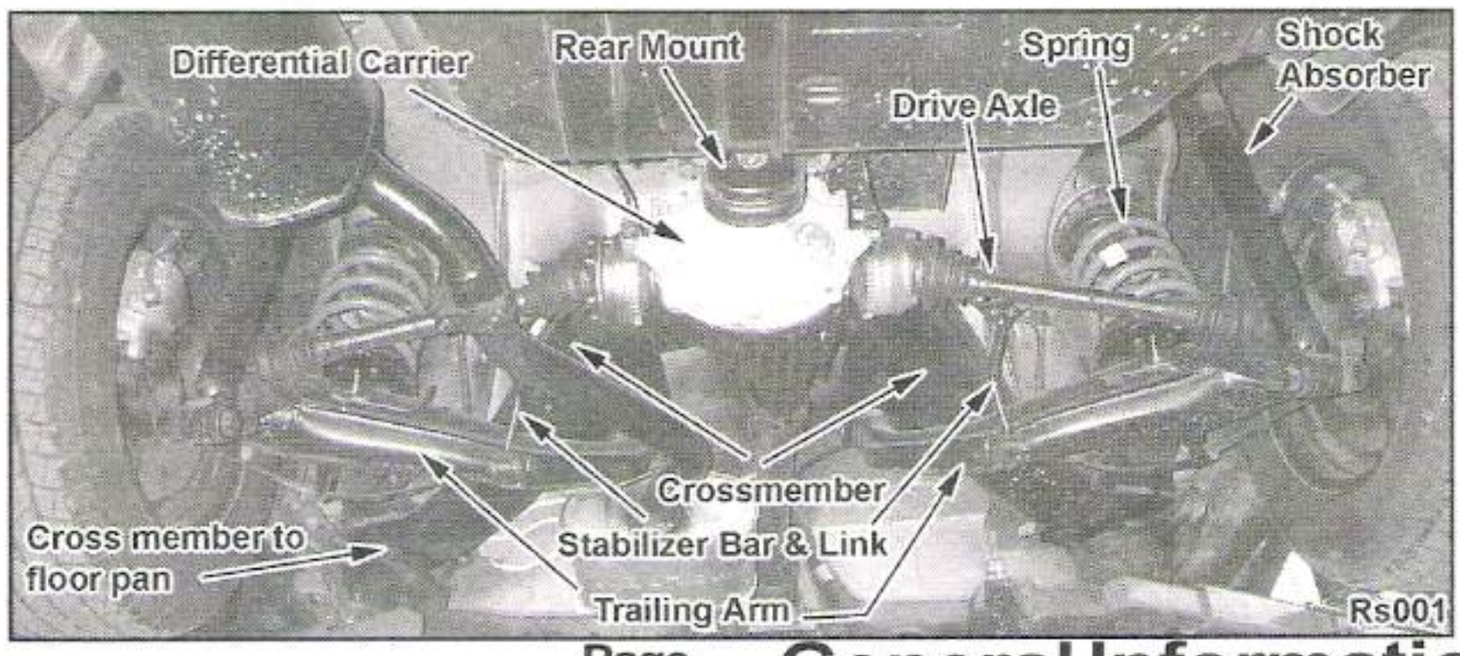
Toe - in

VT Ser I & II, VX,VY, VU (utility), WH
Toe-in (Deg total) ..... 0deg. 10min +/- 0 deg. 10min
Toe-in (Deg per wheel).....0deg. 5min +/- 0 deg. 05min
HSV VS
Toe-in (Deg total) ..... 0deg. 40min +/- 0 deg. 10min
Toe-in (Deg per wheel).....0deg. 20min +/- 0 deg. 05min
HSV VT Ser 1
Toe-in (Deg total) ..... 0deg. 20min +/- 0 deg. 10min
Toe-in (Deg per wheel).....0deg. 10min +/- 0 deg. 05min
HSV VT Ser 11 and WH, VU
Toe-in (Deg total) ..... 0deg. 10min +/- 0 deg. 10min
Toe-in (Deg per wheel).....0deg. 05min +/- 0 deg. 05min
HSV VX, VY and WH Ser II and VU
Toe-in (Deg total) ..... 0deg. 10min +/- 0 deg. 10min
Toe-in (Deg per wheel).....0deg. 05min +/- 0 deg. 05min

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Independent Rear Suspension

I.R.S.

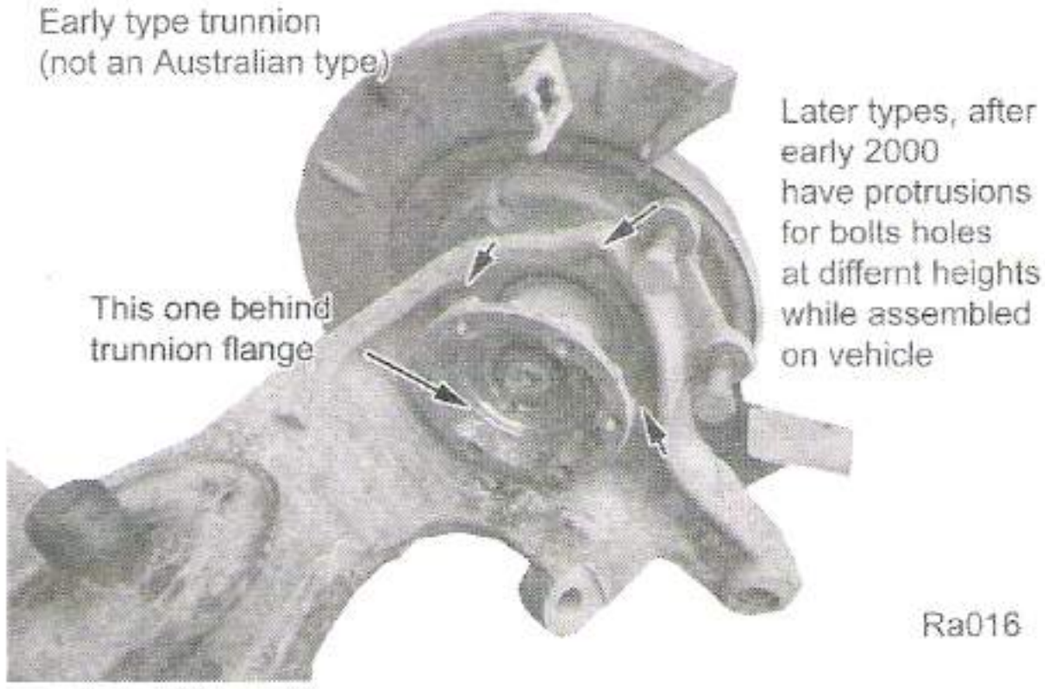


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General Information

The sedans and station wagon are fitted with independent rear suspension as standard equipment. Variable rate minibloc coil springs and double acting shock absorbers are utilised. The rear suspension consists of a crossmember that is attached to the underbody by large volume rubber bushes at both front corners, the rear is attached to the differential assembly which is in turn attached to the underbody through a rubber mount.

An Australian manufactured trailing arm was introduced during VT ser II and can be identified by visual inspection, jack-up rear of vehicle, remove rear wheel, brake calliper, disc. Inspect the protrusions of the trunnion housing from the rear view. If the protrusions are the same height the trailing arm is the early type. If the trailing arm protrusions are at different levels, the trailing arm is of Australian manufacture.



Automatic Level Ride System: This system is electronically controlled using a air compressor, air pump up shock absorbers and a ride height sensor.

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Rear Wheel Alignment

Camber & Toe-in Check

The following items must be inspected before an accurate rear wheel alignment check can be carried out.

1. Tyre pressures are correct and the tyre tread pattern is even and of a roadworthy condition

2. Check the road wheel rim runout, rectify if not to specifications, refer to 'Wheels Tyres' chapter

3. Vehicle must be at curb weight - full tank of fuel, no driver , passengers or luggage.

4. If the vehicle has been raised prior to carrying out the alignment check the springs etc. should be settled by bouncing the rear of the vehicle several times.

Note: The rear wheel alignment is not adjustable and if found to be incorrect the rear suspension components will have to be checked for excessive wear and or accident damage.

HSV vehicles have some different components but in general the same procedures are similar, wheel alignment is also as per Commodore vehicles in chart.

GTS models used a multilink rear suspension. At curb weight, rear toe-in is 0+/-1mm (0^0 +/- $1^0$0'), camber -$1^0$30' to -$2^0$30', torque settings 65Nm.

Maloo vehicles do not have adjustable rear suspension, however at curb weight, rear toe-in is 0+/-1mm ($0^0$00'+/- $0^0$30'), camber -$1^0$00' +/- $0^0$30'.

Rear Wheel Alignment Specifications

Sedan		
cc003	Standard Suspension	FE2 Suspension
Track	1586 mm	1592 mm
Camber	-1°9' to -2°6'	-1°27' to -2°29'
Toe - Degrees per Wheel	VT ser1: -0° 14' to +0°9' VT ser 11 on: -0°27' to +0°19'	VTser1: -0°9' to +0°14' VT ser 11 on: -0°19' to +0°32'
Wagon		
	Standard Suspension	FE2 Suspension
Track	1579 mm	1589 mm
Camber	-1°7' to -1°44'	-1°17' to -2°14'
Toe - Degrees per Wheel	VT ser1: -0° 13' to +0°10' VT ser 11 on: -0°27' to +0°19'	VTser1: -0°5' to +0°18' VT ser 11 on: -0°19' to +0°32'
Variation Side to Side		
Camber	0°35' Maximum	
Toe - in	0°20' Maximum	

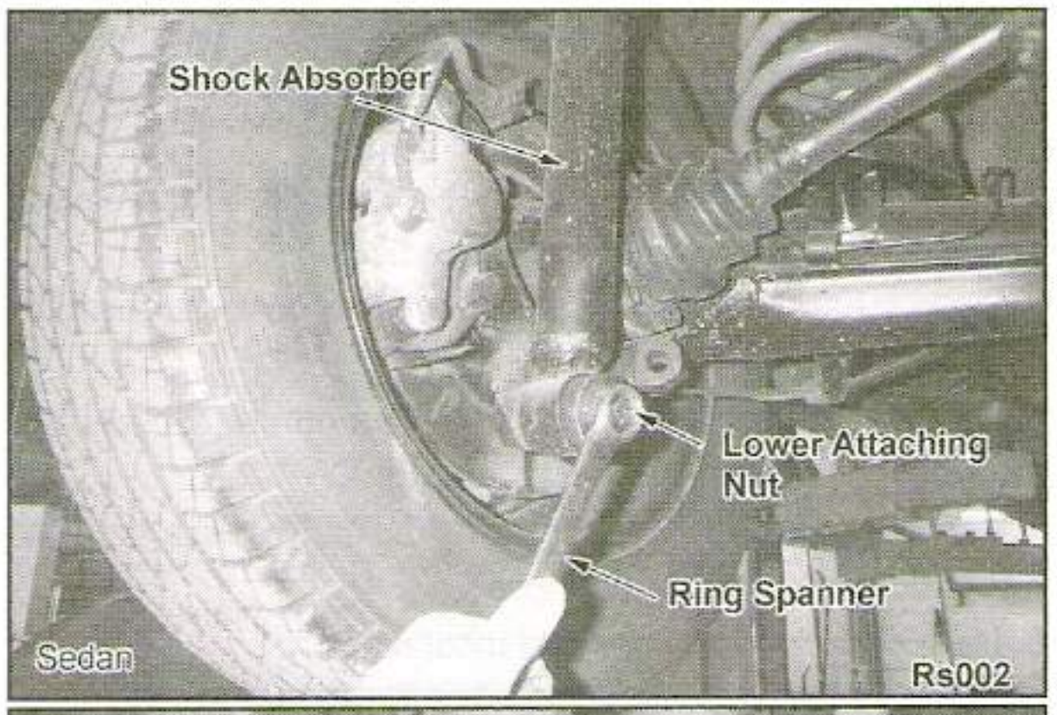
SHOCK ABSORBERS

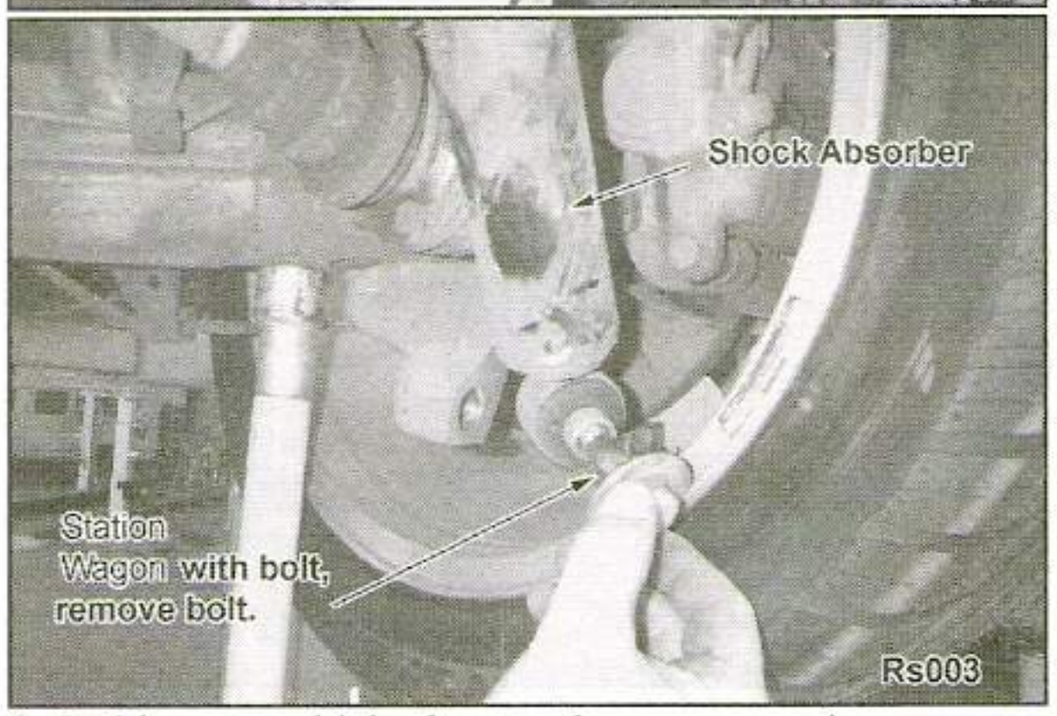
#Note: Automatic Level Ride suspension has air shock absorbers fitted, take this into consideration, discharge and charge air system as required, remove and install air hoses as required, see later in this chapter.

Remove

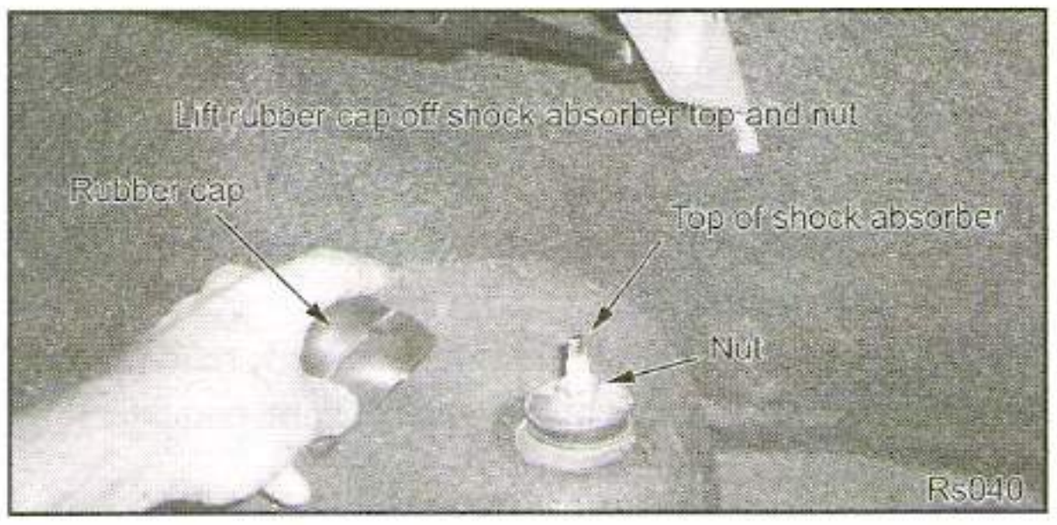
1. Jack up the vehicle and place on safety stands (fit stands under the body rear jacking points)

2. Release the lower nut/bolt attaching the shock absorber to rear suspension trailing arm, remove the bushes and washers. Sedan bolt at rigth angles to wheel, S'wagon bolt parrallel





3. Inside rear vehicle, boot sedans, rear section wagons, remove cover from shock absorber mounting point. Remove the shocker top retaining nut.



4. From under vehicle remove the shocker.

Install

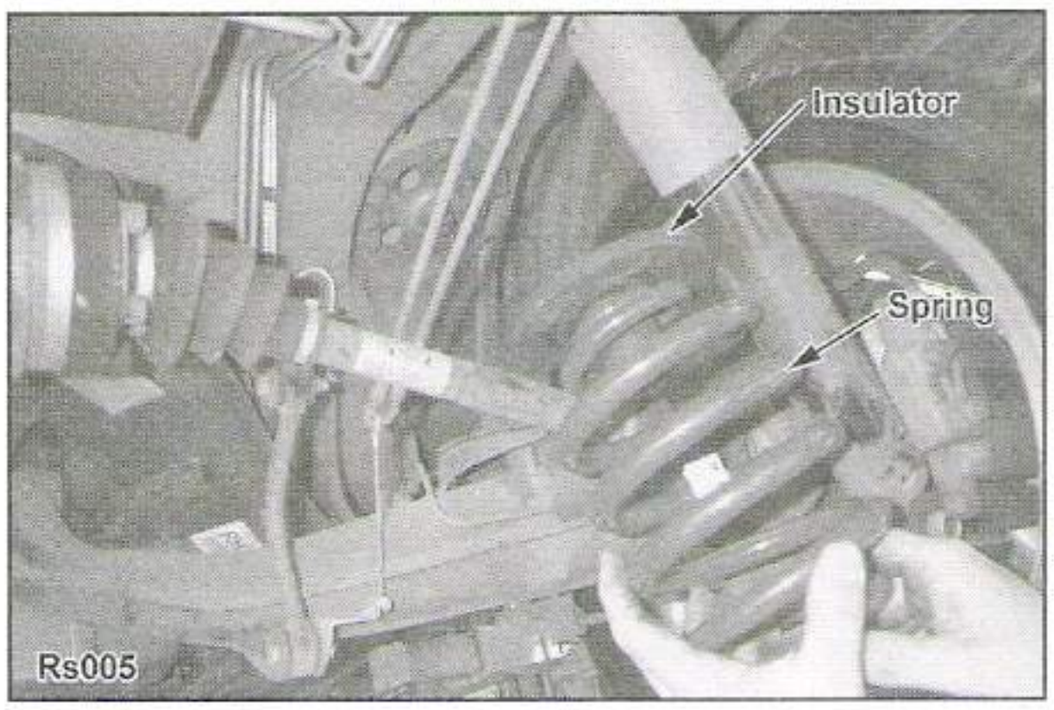
1. Connect the shock absorber to the top mounting bracket, ensure that the washers and rubber bushes are fitted in the

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correct order. Tighten nut to specification.
Sedans, tighten nut until nut is on all of thread.
S'wagons tighten until nut is 15.5-16.0mm from top of shocker bolt.
2. Install the shock absorber, bushes and washers to the trailing arm, tension bolt to specifications.
Shock Absorber Lower Bolt: 105-125Nm
4. Remove jack stands and lower vehicle.

Coil Springs

Remove
1. Using a floor jack under centre of the axle, jack up rear of vehicle. Then place safety stands under the rear body jacking points.
2. Mark relationship of wheels to axle flanges. Remove road wheel attaching nuts and remove wheels.
3. Support axle housing (only . ghtly) under centre with a floor jack.
4. Disconnect shock absorbers at lower mounting points, and also the lateral bar from the differential.
5. Lower the axle housing, checking the brake hoses, if pulled tight, disconnect the brake hoses.
6. Pull out the coil springs and insulators.



Installation
1. Assembly the coil springs with insulator and install to the axle housing spring base.
2. Jack up the axle housing, taking care the springs are fitting into the lower and upper spring seats.
3. Reconnect shock absorbers at lower mounting points and tighten bolt to specification.
4. Connect brake pipe at underbody rear connection. Install brake hose retaining clip (if removed).
5. Replace road wheel taking note of mark made during removal for position of wheel to brake drum, and attaching nuts tighten to specification.
6. Remove safety stands from under the front body jacking points.

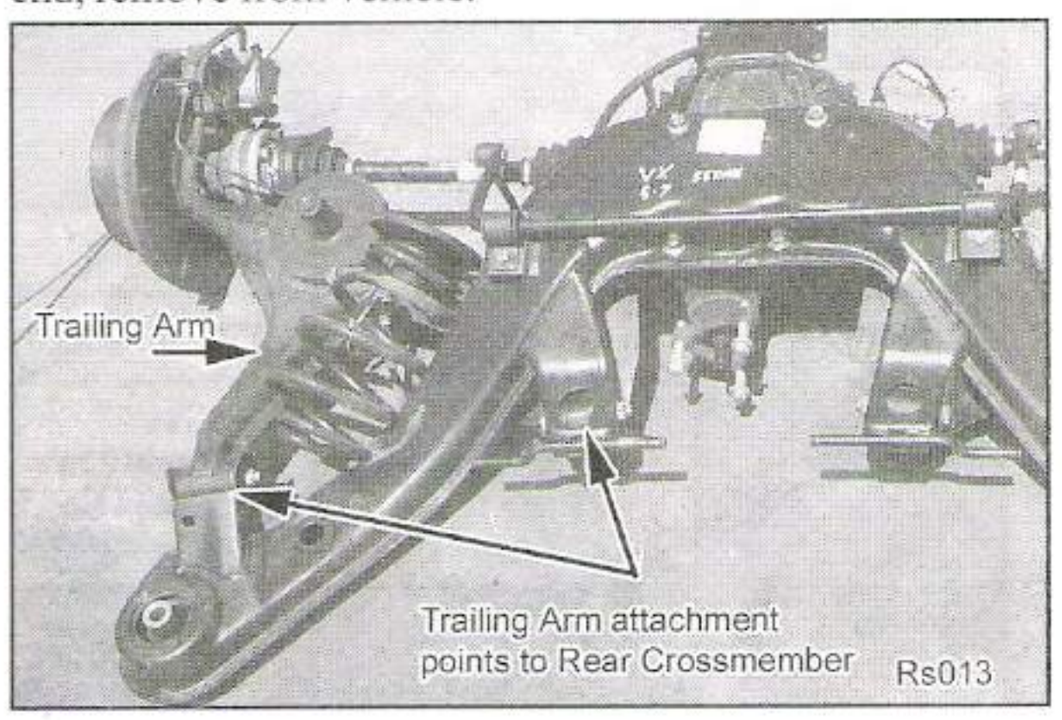
Trailing Arm, Trunnion Assembly including Bearing

Replace bearing only if required or if trunnion assembly is being removed from trailing arm.

Remove
1. Raise vehicle and place safety stands under the rear jacking points.
2. Remove wheel, brake caliper and disc.
3. Disconnect hand brake cable, brake released, undo the support clips to the floor pan, at the cable yoke pull each side cable forward and up to release from yoke.
4. Disconnect the drive shaft at rear of trunnion, 8mm allen key. Lift axle shaft up and support with wire.



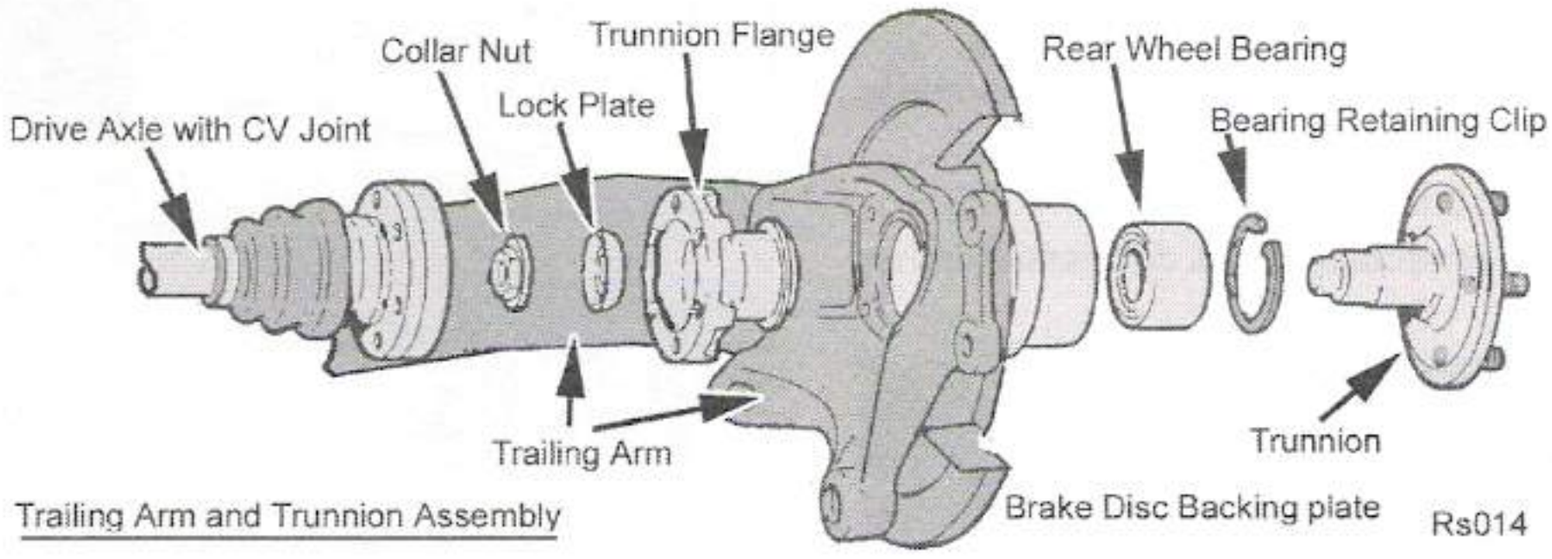
5. Remove shock absorber and coil spring as previously described.
6. Disconnect the stabiliser bar from the trailing arm.
7. If removing the trailing arm, release the bolts retaining the trailing arm to the rear crossmember assembly, and lower the end, remove from vehicle.



Trunnion Assembly including Bearing's
Note: Only replace bearing if faulty

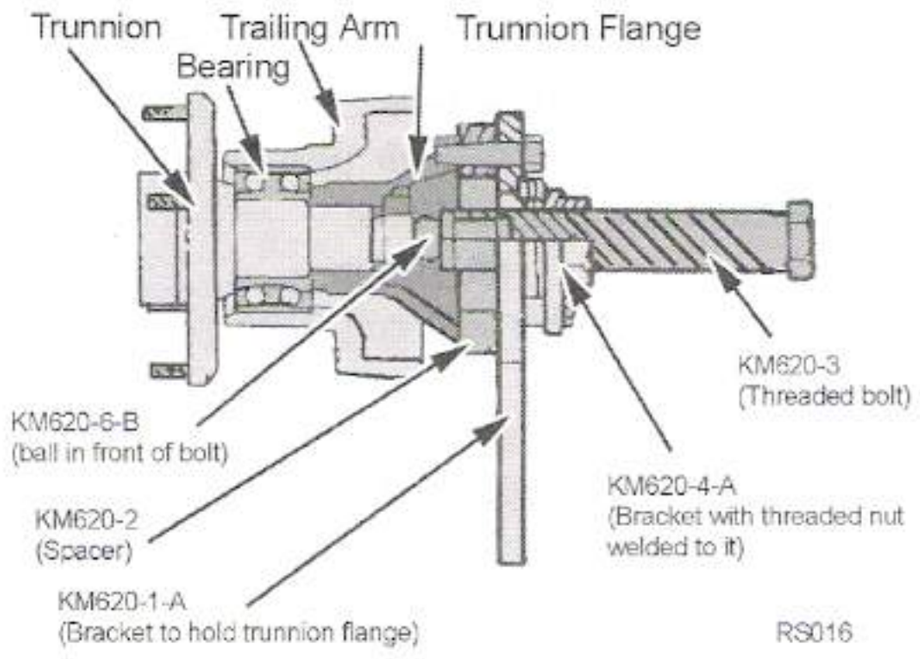
Remove
1. Use special tools KM620-1-A KM620-2 (bracket and spacer), and bolt them the back of the trunnion using 3 axle shaft bolts.
2. Supporting the trailing arm , grip the special tools in a vice, remove collar nut and lock plate.
3. Use special tools KM620-5-B (lubricate ball end), KM620-4-A and KM620-3, bolt KM620-4-A to KM620-1-A.(threaded bolt with ball end to screw through bracket to press trunnion assembly from flange)

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Trailing Arm and Trunnion Assembly

4. Assemble and bolt special tool KM620-2 and a spacer ring to the trunnion.
5. With the vice griping KM620-1-A rotate the KM620-3 to free (press) the flange from the trunnion.



6. Remove backing plate from the trailing arm, use a torx bit.
7. Use 3 bolts and bolt special tool KM620-7 (3 sections) and KM620-4-A to the rear of the backing plate. KM620-3 and KM620-5-B to KM620-7.
8. With the vice griping KM620-1-A rotate the KM620-3 to free (press) the bearing from the trunnion. Remove special tools
9. Use snap ring pliers to remove bearing retaining snap ring from the trailing arm.
10. Position special tool KM620-6 to rear of bearing in trailing arm, install KM620-1-A with other tools previously assembled to it, at rear also.
11. With a vice griping KM620-1-A rotate the KM620-3 to free (press) the bearing from the trailing arm. Remove special tools

Inspection

Clean surfaces of trailing arm and trunnion that come into close contact and the bearing contact surfaces, check for burrs etc. Apply a thin layer of Molybond HE50 or similar to bearing surfaces and bore surfaces..

Install

1. Mount KM620-8-A onto KM620-3, stepped surface away from trunnion bearing. Mount KM620-8-A to new bearing and install into trailing arm bearing bore. Grip KM620-3 and KM620-1-A, screw in KM620-4-A, this will press the bearing into the trailing arm. Remove special tools and install retaining ring.
2. Mount KM620-9-A onto KM620-3, stepped surface away from trunnion bearing. Mount KM620-1-A to KM620-3. Grip KM620-3 and KM620-9-A, screw in KM620-3, this will press the trunnion into the trailing arm bearing. Remove special tools.
4. Use special tools KM620-1-A KM620-2, and bolt them the back of the trunnion using 3 axle shaft bolts. Install KM620-4-A, ball bearing plus KM620-3 installed to KM620-1-A. Apply specified differential carrier lubricant to flange splines. Tighten KM620-3 to trunnion. Grip KM620-3 and KM620-4-A, screw in KM620-3, this will press the trunnion flange on top trunnion. Remove special tools.
5. Install a new collar nut to trunnion, use KM620-1-A and KM620-2 to grip trunnion while tighten nut.

Collar Nut to Trunnion Assembly: 295-3-5Nm

6. Install a new lock plate over collar nut, punch into place with a $1^1/4$" socket.
7. Install drive shaft velocity joint to trunnion flange and plates, 6 bolts, tighten.

Drive Shaft Constant Velocity Joint to Trunnion Flange Bolts: 50Nm plus 60^0-75^0 tighten.

8. Install disc backing plate to trailing arm, 2 short bolts to top with washers in machined out surface. 2 longer hex head bolts, installed in lower holes, apply loctite 242 or similar to longer bolts, tighten.

Backing Plate -Upper Shorter bolts: 70-80Nm
Backing Plate - Lower Hex Head bolts: 85-90Nm

9. Install brake disc, install brake caliper, tighten bolts.

Brake Disc Caliper bolts: 70-100Nm

10. Install shock absorber, stabiliser bar link and wheel as previously described.

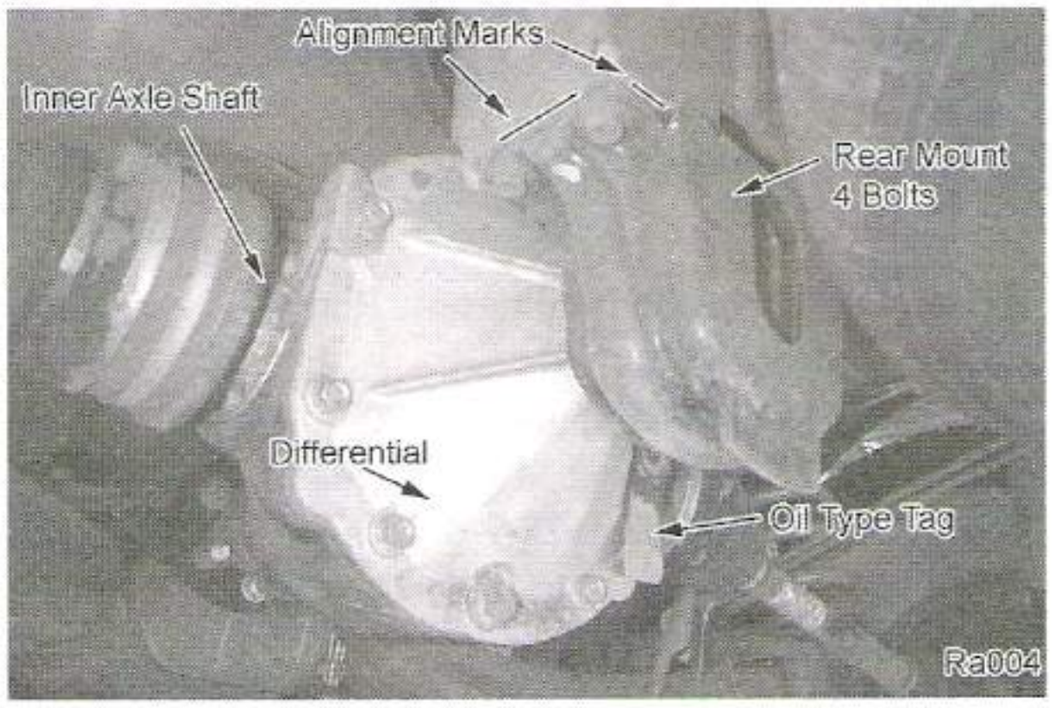
Rear Suspension (rear crossmember) Assembly

Remove

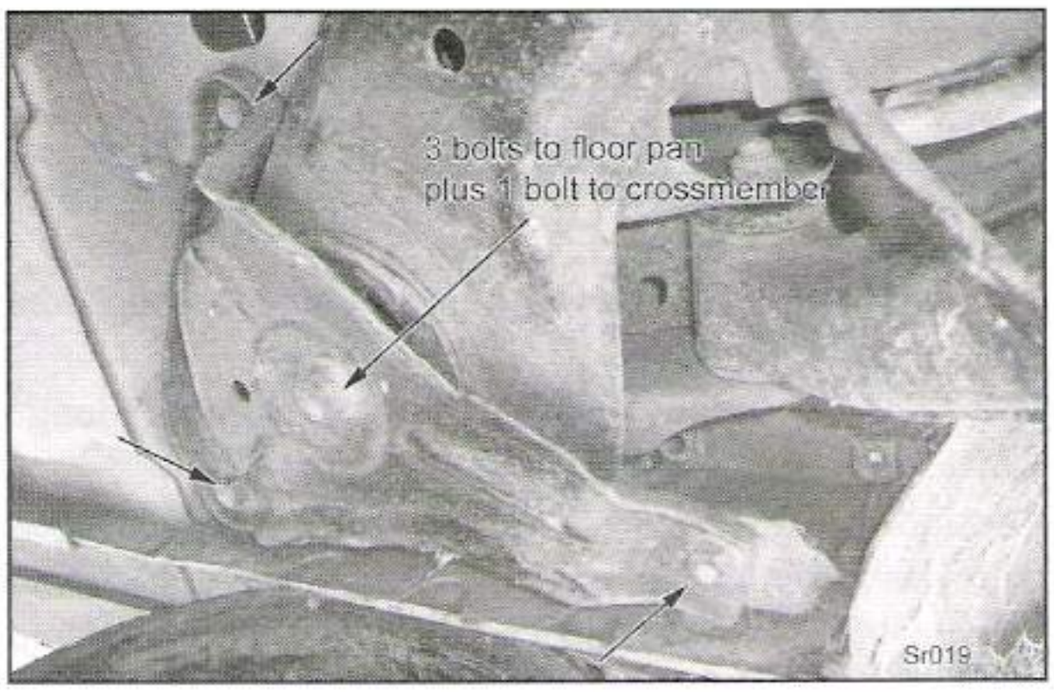
1. Raise vehicle and place safety stands under the rear jacking points.
2. Remove wheels.
3. Disconnect hand brake cable, brake released, undo the support clips to the floor pan, at the cable yoke pull each side

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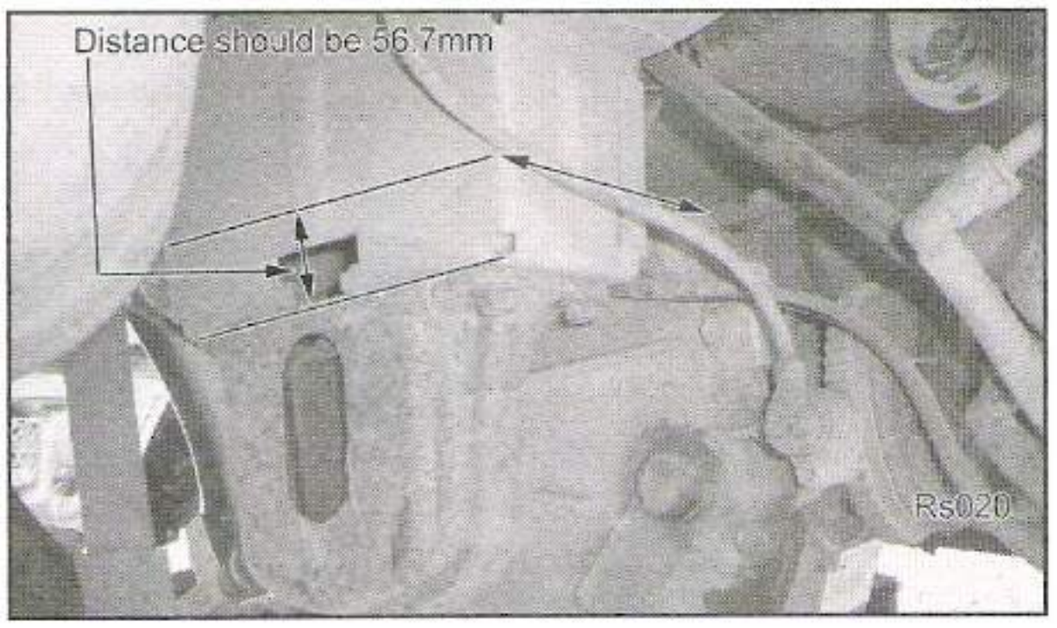
cable forward and up to release from yoke.
4. Disconnect the tail shaft at the differential carrier.
5. Remove shock absorber and coil spring as previously described.
6. Disconnect brake flexible lines, at floor pan.
7. Use a felt pen, scribe or similar to mark differential carrier rear mount to body.



8. Use jack to support differential carrier, remove rear mount bolts and lower differential carrier and rear crossmember
9. Use a jack to support front sections of rear crossmember. Remove the 3 brace bolts and 1 crossmember mounting bolt at the front of each crossmember side, retaining the rear crossmember to the floor pan, lower crossmember.



Install
1. Position rear crossmember under vehicle.
2. Lift front arms of crossmember into place, install 1 bolt plus 3 brace bolts each side, tighten but only firmly.
3. Lift differential carrier and rear mount to mounting position on under body, align marks made during removal. Install new bolts, but do not tighten.
#Note: The rear suspension must be aligned to the center of the vehicle (there is a special tool for this). If not correctly realigned the steering could be affected, plus the rear tyres will wear uneven.
Differential carrier must be parrell (within 1.0mm) to the crossmember, measure from the mounting section to top of crossmember, should be 56.7mm..



NEW Differential Carrier Rear Mount bolts: 30-40Nm
4. Lower the vehicle from the stands, then bounce the rear of the vehicle to allow the suspension to position itself.
5. Tighten 1 front crossmember and 3 brace bolts to specification.
Rear Crossmember Front bolt:
125Nm plus 30^0-40^0 turn
Rear Crossmember Brace bolts:
60-70Nm
6. Replace shock absorber and coil spring as previously described
7. Reconnect the tail shaft at the differential carrier.
8. Connect hand brake cable, brake released, at the cable yoke push each side cable forward and down to install to yoke, install cable clips.
9. Connect brake flexible lines, at floor pan, bleed brakes.
10. Install wheels.
Road Wheel Nuts torque: 95-105Nm

Trailing Arm Rear Bushes

Remove
1. Remove trailing arm.
2. Cut the inner flange off the rubber bush, press the bush outwards for each bush.
Install
1. Clean bush hole of trailing arm, place bush in soapy water, press bush into place inwards.
2. Install trailing arm.

Trailing Arm Front Bushes

Remove
1. On vehicle lower trailing arm, support trailing arm with a safety stand.
2. Install a bolt from top, screw into plate lower side of bush, use a bearing puller to press bush out top of trailing arm.
Install
1. Clean bush hole of trailing arm, place bush in soapy water, press bush into place from lower side, a special tool can be made with a plate under bush, plate on top of arm, bolt through bush press bush into arm.

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2. Install front of trailing arm as described in this chapter.

Stabilizer Bar / Bushes

Note: If replacing bushes for stabiliser bar consider changing bushes with stabiliser bar on vehicle.
Note: To remove stabiliser bar differential carrier needs to be lowered as does the rear suspension crossmember.
#The differential carrier will need to be realigned.

Remove

1. Use a felt pen, scribe or similar to mark differential carrier rear mount to body.
2. Use jack to support differential carrier, remove rear mount bolts and lower differential carrier and rear crossmember, to allow access to stabiliser bar brackets. Remove bracket bolts.
3. Remove stabiliser bar link from trailing arms, 1 bolt each side.
4. To remove bushes from stabiliser bar, press inner steel sleeve from bush then cut or lever bush from bar.

Install

1. Lubricate bush with petroleum jelly, press or push bush into stabiliser bar. Press inner steel sleeve into bush.
2. Install stabiliser bar to vehicle, connect to links but do not tighten bolts, install stabiliser brackets to rear crossmember, tighten bolts.

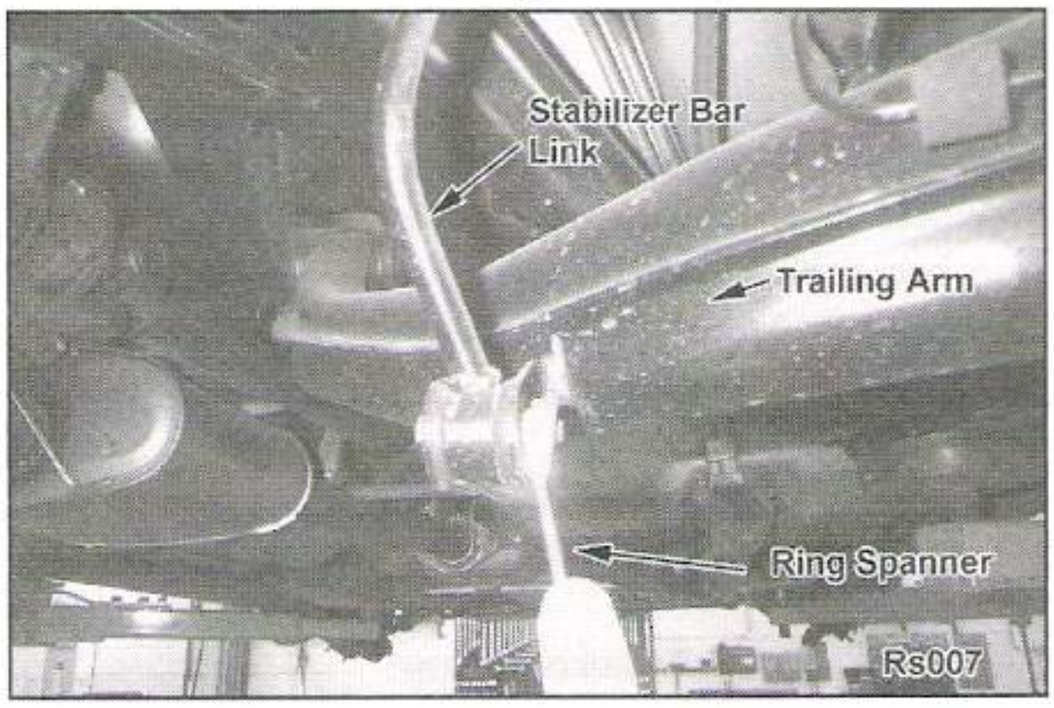
Stabiliser Bar Brackets to Rear Crossmember bolts: 18-26Nm

3. Lift differential carrier and rear mount to mounting position on under body, align marks made during removal. Install new bolts, but do not tighten.

#Note: The rear suspension must be aligned to the center of the vehicle (there is a special tool for this). If not correctly realigned the steering could be affected, plus the rear tyres will wear uneven.

NEW Differential Carrier Rear Mount bolts: 30-40Nm

4. Lower the vehicle from the stands, then bounce the rear of the vehicle to allow the suspension to position itself.



5. All stabilizer bar mounting and retaining bolts will require tensioning to specifications.

Stabiliser Bat to Link Bolts: 95-105Nm

Automatic Level Ride System

Maintenance

Normal inspection at service intervals should include checking for wiring looms and their connectors plus checking air hoses for rubbing, fouling and their connections.
Charging Air System
During maintenance or service work, if air pressure top the shock absorbers is lost. Do not lower vehicle until air pressure has been restored.

System Shutdown and Reset.

System deactivates under certain conditions.
The compressor timer will deactivate the system if the compressor has been running for more than 4.5 minutes.
The exhaust solenoid timer will deactivate the system if the exhaust solenoid has been operating for more than 4.5 minutes.
Reset the timers by turning the ignition system "on", turn it "off" for 60 seconds, turn ignition "on"

Air Leak Checking

If air is suspected of leaking from a particular location, apply some soapy warm water solution to location and check for bubbles

Charging Air System

During maintenance or service work, if air pressure to the shock absorbers is lost. Do not lower vehicle until air pressure has been restored.

Charge Air System

Turn the ignition "on", disconnect the lower end of the sensor adjustable link. Lift link until the compressor starts, hold link there for 30 seconds, this will restore sir pressure to the shock absorbers. Turn ignition "off", check air system for cause of air loss, repair and recharge air system if necessary.

Depressurising Air System

During maintenance or service work, if air pressure to the shock absorbers is lost. Do not lower vehicle until air pressure has been restored.

Depressurise Air System

Rear of vehicle jack up, supported on safety stands.
Turn the ignition "on", disconnect the lower end of the sensor adjustable link. Lower link until the exhaust solenoid activates, hold link there for 30 seconds or until air stops exhausting, lift link to normal position. Turn ignition "off", recharge system before lowering vehicle.

Compressor

Remove

1. Raise vehicle and support on safety stands.

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2. Discharge air system as described above.
3. Disconnect the wiring loom connector.
4. Support compressor by hand, remove 3 bolts, disconnect "T" hose piece by turn "T" joint 90 deg and pulling away from compressor. Remove compressor.
5. Remove dust shield, 3 bolts.
6. Remove filter form hose, blow through filter to check for blockage, replace if OK, if block install a new filter.

Install

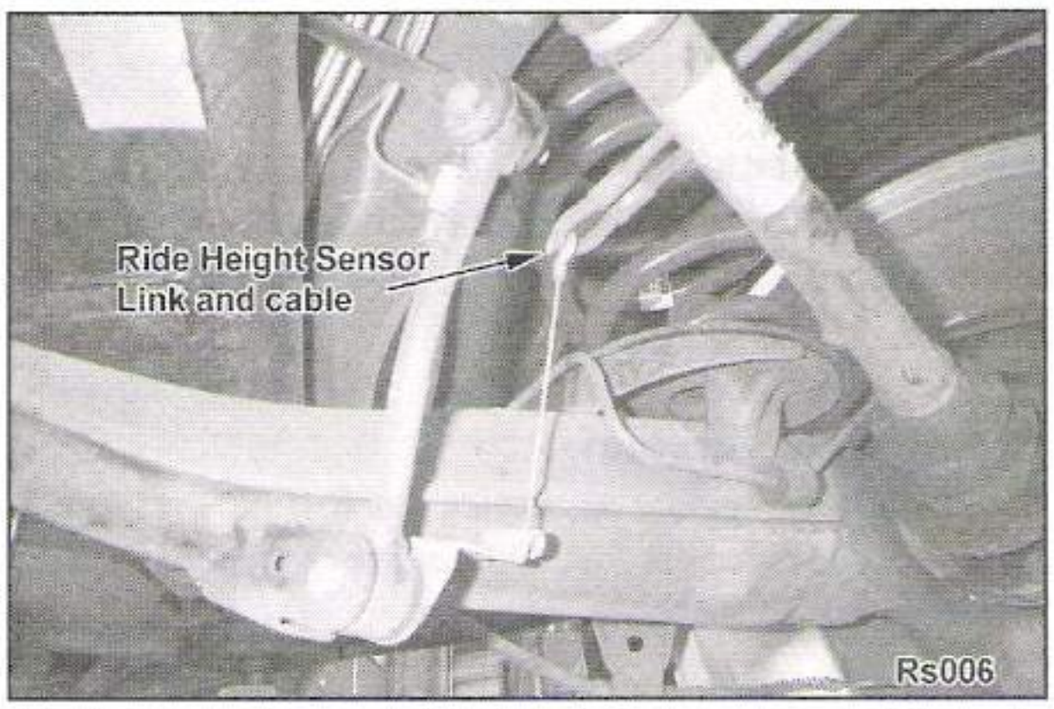
Tip: If new rear suspension longitudinal or crossmembei has been replaced new holes may need to be drilled. shown below.

1. Install dust shield to compressor.
2. Lift compressor into place install "T" joint, push in and turn 90 deg. Install compressor 3 attaching bolts.

Rear Suspension Compressor bolts: 4-5Nm

3. Reconnect the wiring loom connector.
4. Charge air system as described above.
6. Lower vehicle and test drive.

Ride Height Sensor and Height Link



Remove

1. Disconnect negative lead from battery to stop activating air system.
2. Raise vehicle and support on safety stands.
3. Disconnect the wiring loom connector.
4. Disconnect the ride height link nearest to sensor. Remove adjustable link, 1 bolt, if required.



5. Remove sensor, 1 bolt to crossmember. Remove bracket, nuts.
6. If sensor is faulty, replace.

Install

1. Install sensor to bracket, attach nuts and tighten.
2. Install sensor and bracket to rear crossmember, install bolt and tighten.

If new crossmember has been installed fit a new nut cage to crossmember in hole provided.

Sensor to Crossmember bolt: 15-30Nm

3. Connect the adjustable ride height link nearest to sensor. Install adjustable link if required, 1 bolt.

Sensor Link to Stabiliser Bar:95-105Nm

PROBLEM DIAGNOSIS

Testing Shock Absorbers!

* This test procedure is not for gas pressurised shock absorbers.

1. Clamp shock absorber by its bottom mount in a vice.

2. Slowly pump shock absorber up and down the full stroke at least six times before checking its resistance.

3. Pump shock absorber by hand at various rates of speed and observe resistance.

* When extending the shock absorber, the resistance should be marginally greater than when collapsing the unit. The resistance should be consistent throughout both strokes and there should be no 'slack' spots.

* 'Slack' spots indicate either loss of oil or valve not seating.

4. It is normal to detect a hissing noise (orifice swish).

Replace shock absorber if listed conditions occur:

a) A skip or lag at reversal near mid-stroke.
b) A seize (except at either extreme end of travel).
c) A noise such as a grunt or squeal after completing one full stroke in both directions.
d) A clicking noise at fast reversal.
e) Fluid leakage.

Automatic Ride Height

* Vehicle should readjust to correct height within 20 seconds from being either loaded or unloaded.

Compressor Motor Not Operating

Reset system as described.
Motor OK

Motor not going.

Check and replace "FJ" fuse in engine bay
Motor OK

Motor not going

Check and replace fuses F24 & F15 passenger compartment.
Motor OK

Motor not going

Disconnect wiring connector at sensor, ignition "on", short

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pins 3 & 4 is motor running, also check voltage at compressor connector pins B & D.
Motor OK (Check for damaged loom or connectors, also carry out height sensor test A.)

12 volts/ Motor not going / Low volts

Replace motor
Check for damaged loom or connectors.

Exhaust Solenoid Not Operating
(If solenoid OK it should click)
Reset system as described.
Solenoid OK

Solenoid not clicking.

Check and replace "FQ" fuse in engine bay
Solenoid OK

Solenoid not clicking.

Check and replace fuses F6 & F15 passenger compartment.
Solenoid OK

Solenoid not clicking.

Disconnect wiring connector at sensor, ignition "on", short pins 2 & 4 is solenoid clicking, also check voltage at compressor connector pins A & C.
Solenoid OK (Check for damaged loom or connectors, also carry out height sensor test B.)

12 volts/ Solenoid not clicking / Low volts

Replace compressor assembly
Check for damaged loom or connectors.

Compressor not going

Check voltage at compressor connector pins B & D.
12 Volts (Replace height sensor -Check for intermittent fault)

Low volts

Check for damaged loom or connectors.

Height Sensor Test A (Compressor)
Vehicle will not level correctly
Reset system as described.
Compressor OK

Compressor not going.

Disconnect sensor link and lift sensor arm 45 deg, ignition "on" wait for 20 seconds.
Compressor OK (check compressor is running and pumping, if OK replace sensor) (if compressor is not pumping but motor running, check air filter)

Compressor not going

Check voltage at compressor connector pins B & D.
12 Volts (Replace height sensor -Check for intermittent fault)

Low volts

Check for damaged loom or connectors.

Height Sensor Test B (Exhaust solenoid)
(If solenoid OK it should click)
Reset system as described.
Solenoid OK

Solenoid not clicking.

Disconnect sensor link and lower sensor arm 45 deg, ignition "on" wait for 20 seconds.
Solenoid OK (check solenoid is clicking if OK replace sensor)

Solenoid not clicking.

Check and replace fuses F6 & F15 passenger compartment.
Solenoid OK

Solenoid not clicking.

Compressor not going

Check voltage at compressor connector pins A & C.
12 Volts (Replace height sensor -Check for intermittent fault)

Low volts

Check for damaged loom or connectors.

Torque Specifications

Shock Absorber Top Nut:
Sedans, tighten nut until nut is on all of thread.
S'wagons tighten until nut is 15.5-16.0mm from top of shocker bolt.
Shock Absorber Lower Bolt: 105-125Nm
Trunnion Collar Nut to Trunnion Assembly:
295-3-5Nm
Drive Shaft Constant Velocity Joint to Trunnion Flange Bolts: 50Nm plus 60^0-75^0 tighten.
Rear Brake Backing Plate -Upper Shorter bolts:
70-80Nm
Rear Brake Backing Plate - Lower Hex Head bolts:
85-90Nm
Rear Crossmember Front bolt: 125Nm plus 30^0-40^0 turn
Rear Crossmember Brace bolts: 60-70Nm
Front Trailing Arm Front bolt: 125Nm plus 30^0-40^0 turn
Front Trailing Arm Brace bolts: 60-70Nm
Trailing Arm Rear bolts: 95-105Nm
Stabiliser Bar Brackets to Rear Crossmember bolts:
18-26Nm
Rear Suspension Compressor bolts: 4-5Nm
Sensor to Crossmember bolt: 15-30Nm
Sensor Link to Stabiliser Bar: 95-105Nm

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BRAKE SYSTEM

DESCRIPTION AND OPERATION

The front and rear brakes are caliper and disc operation, while the hand brake via a lever and cable, uses brake pads to apply a clamping force on the rear drum/discs.

The master cylinder has a tandem back-up cylinder system to prevent brake failure. The PBR back-up master cylinder is a compensating type featuring a "fast fill" system. The primary and secondary pistons each operate a separate hydraulic system connecting one front and one, diagonally opposite, rear brake.

The master cylinder also incorporates the proportioning valves and a brake failure warning lamp switch.

The master cylinder is assisted by the function of vacuum operated brake booster. The brake booster is a self-contained vacuum-hydraulic braking unit mounted on engine side of the dash panel.

The brake booster is of the vacuum suspended type which utilizes engine intake manifold vacuum and atmospheric pressure for its power. The booster unit is to be exchanged when found to be defective.

Utilities have a load sensing proportioning valve fitted to the vehicle, above the rear axle, connected to the panhard rod via a spring lever and chain. This valve monitors the vehicle load, if it is fully loaded the rear brakes will receive gull brake line pressure, lightly loaded the rear brakes receive lower pressure. Utilities do not have the normal proportional valve but a low pressure warning valve instead. Utilities do not have a booster.

ABS brake systems are designed to stop wheel lockup when brakes are applied at full pressure. Wheel lockup can cause the driver to loose some control over the steering of the vehicle. Also wheel lockup can lengthen the vehicle stopping distance.

ABS systems use a different master cylinder, it has only two pipes connected and the reservoir is a greenish colour.

OPERATION

Initial pedal travel produces pressure in large diameter primary piston bore which closes the fast fill flap valve to prevent fluid entering the reservoir port. This high volume, low pressure fluid flows over primary piston primary cup into smaller bore to cater for low pressure brake displacement, ie. caliper piston movement.

With further movement pressure in large bore increases until, at a predetermined point the ball in the fast fill valve unseats preventing additional pressure rise and allowing fluid to flow from large bore into reservoir port.

At this stage the small diameter bore section operates as a conventional tandem master cylinder to produce high line pressurise with minimal piston travel.

As primary piston returns on release of brake pedal, fluid recuperation, from reservoir to large and small diameter bores, occurs through the replenishing holes in the fast fill valve.

With the primary piston fully returned, the compensating port in the master cylinder is uncovered, thus fluid returning from the caliper pistons can flow into the reservoir through the compensating passage in the master cylinder and relieve all pressure in the brake system.

The vacuum assisted brake booster is fitted between the brake pedal and brake master cylinder and supplements the driver's pedal effort. It derives power from permanent use of depression or vacuum existing in intake manifold of engine and controlled application of atmospheric pressure. Engine intake manifold vacuum is relayed to the unit through a hose fitted with a vacuum check valve.

In the case of engine failure and consequent loss of engine vacuum, two application of brakes are possible by using vacuum retained in the power unit. In case of complete vacuum loss, brakes can be applied in the conventional manner, although more effort is required.

When the brake pedal is applied, brake fluid is displaced into the caliper bore moving the piston outwards. This action forces the inner pad assembly against the disc. The resultant reaction forces the caliper body and outboard pad assembly inwards against the disc.

The piston seal retracts the piston a small amount allowing the pads to clear the disc, when brake pedal is released.

ABS system uses electrical sensors at each wheel to detect the rotation of wheels, three independent systems one for each front wheel and one for the two back wheels.

As a wheel is slowing down compared to others wheels the control unit via a solenoid valve attached to each of the three systems alters the brake fluid pressure to stop wheel lockup.

ABS (Anti-locking Braking System) monitors the wheel revolutions and brake line fluid pressure, then adjusts fluid pressure to stop wheel lock-up during braking. This reduces the stopping distance while braking.

ABS/ETC system is an Anti-locking Braking System (ABS) and an Electronic Traction Control system (ETC). The ETC system controls the engine and braking system under conditions when 1 or more wheels loose traction with the road surface (which can occur during start off, cornering and braking) by limiting the amount of traction lose. ETC helps to give the driver more control over the vehicle therefore making driving safer.

ROUTINE MAINTENANCE

ABS

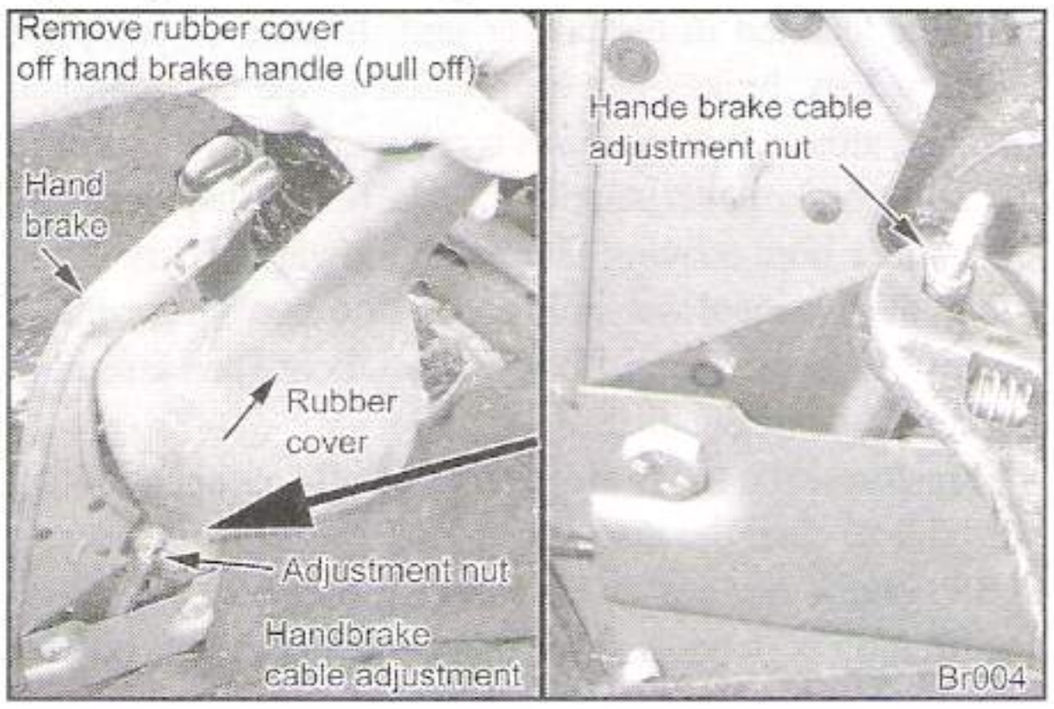
If any component that forms part of the ABS or ABS/ETC (if fitted), is disturbed during service operations, it is important that the complete ABS or ABS/ETC **system** is checked, using the procedure as detailed in the Brake and ABS chapters.

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Hand Brake Cable

Check and Adjustment

Place the transmission in neutral.
Jack the rear of the vehicle and place on safety stands. DO NOT START ENGINE.
Place safety blocks both sides of both front wheels.
Pull the hand brake lever up until there is sufficient resistance that the hand brake should be fully functional (this should be approximately 4-6 clicks from fully down).
Check the back wheels for resistance, there should be enough resistance that the wheels are impossible to turn by hand.
If the rear wheels can be rotated tighten the adjustment nut at the handbrake handle (pull rubber handbrake protector cover to adjust nut) to 2Nm, check rear wheels, tighten the adjusting nut further if required.

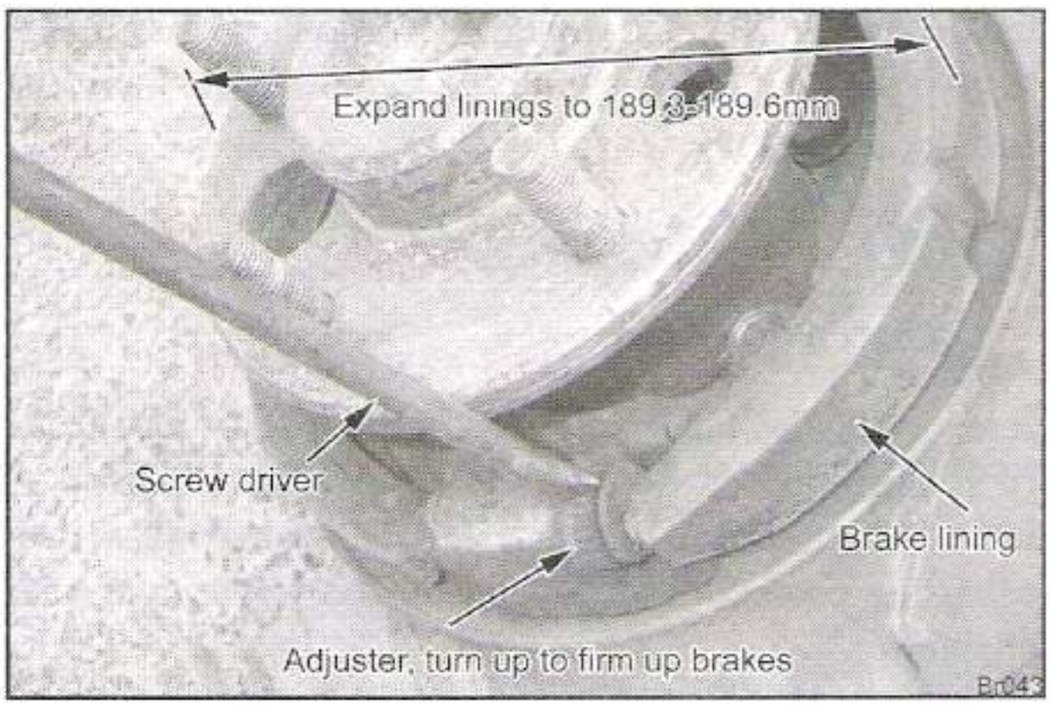


Release hand brake lever and check the back wheels for resistance, there should not be any resistance.

Hand Brake

Adjustment of hand brake

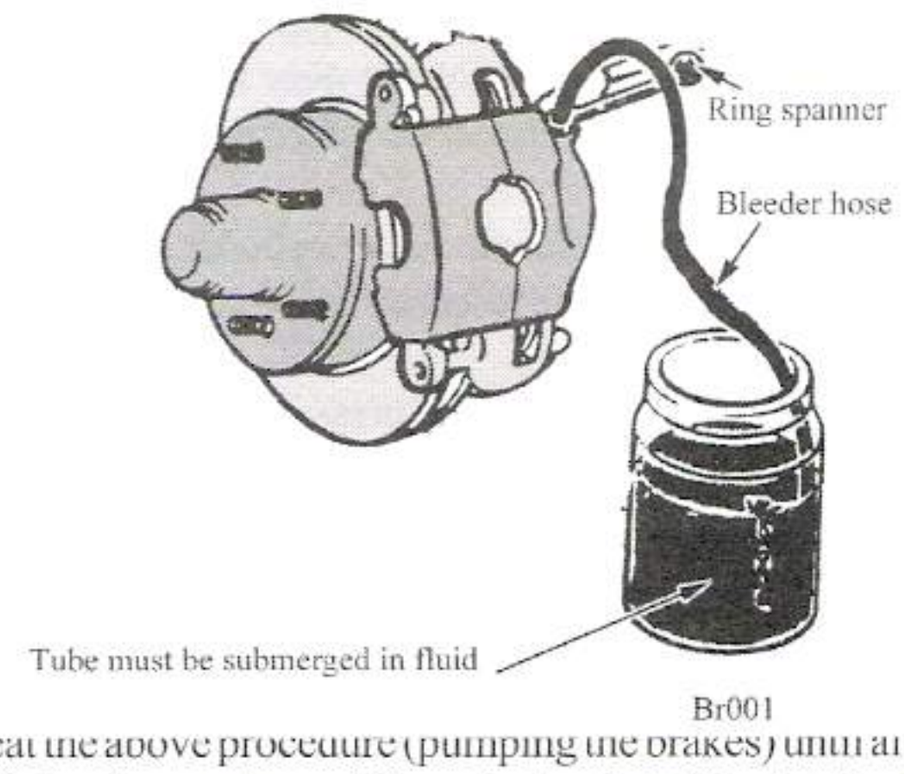
1. Place the transmission in neutral.
2. Jack the rear of the vehicle and place on safety stands. DO NOT START ENGINE.
3. Place safety blocks both sides of both front wheels.
4. Ensure the hand brake handle is not pulled up.
5. Remove rear wheels, make alignment marks with wheel to disc, disc to axle.



6. Remove hand brake adjustment access hole plug, 1 of 2.
7. Tighten adjuster screw until wheel is locked.
8. Loosen adjuster screw 3-5 clicks, check that wheel will freely rotate.
9. Adjust hand brake cable if required as previously described.
10. Install back wheels, remove safety stands, lower back wheels.

Bleeding the Brake System

Clean dust grease and foreign matter from the brake bleeding valves on all four calipers.
At the back left wheel prepare to start bleeding the brake system. Always bleed the caliper with the longest length of brake fluid pipe first, this to help ensure there are no air traps in the brake pipe system.
Use a ring spanner on the bleeder valve, then connect a clear plastic tube to the end of the bleeder valve, insert the other end of the plastic bleeder hose into a clean container half filled with clean brake fluid.
Have an assistant press the brake pedal 3 or 4 times and hold his foot on the pedal, this is pumping the brakes. After your assistant has pumped the brakes, with his/her foot still on the pedal, loosen the bleeder valve with the ring spanner approximately half a turn. This will allow fluid and air to pass out of the bleeder valve through the bleeder hose into the container with the brake fluid. When the assistants foot on the brake pedal has travelled to the floor, tighten the bleeder valve before the assistant allows the pedal to rise from the floor, otherwise old fluid and air will be sucked back into the brake system. Check the level of the master cylinder and keep topping it up with fluid otherwise air will enter the system.



Repeat the above procedure (pumping the brakes) until all of the air has been released from the back left brake bleeder valve. Tighten the bleeder valve, remove the hose and spanner.
Repeat the bleeding procedure on the right rear wheel, left front wheel then right front wheel.
Then repeat the pumping and bleeding procedure on the left back wheel and right back wheel, this is to ensure the pedal will not be spongy.

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Check the level of the master cylinder.

*** Do not use the old brake fluid as a top up into the master cylinder.**

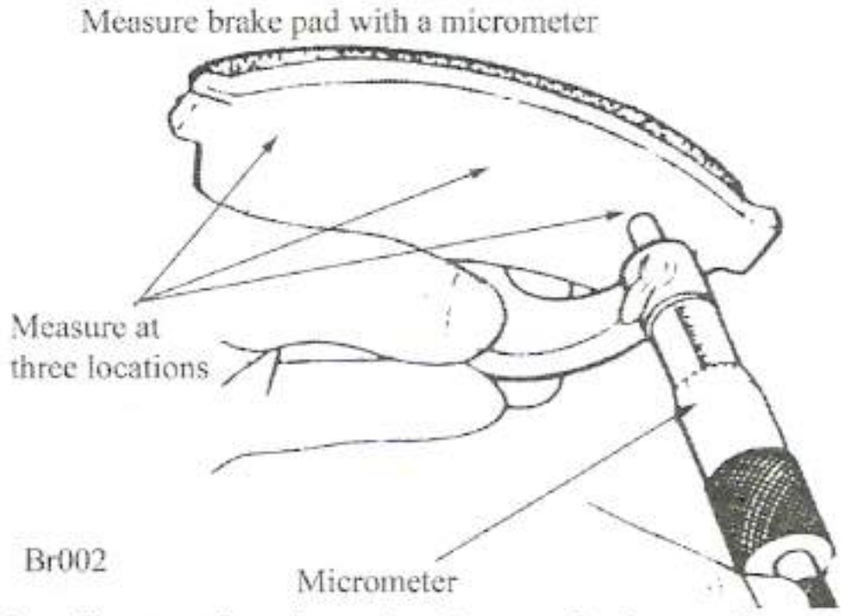
Checking Brake Lines, Hoses and Linings

Raise the rear of vehicle, position on safety stands and remove rear wheels. Inspect braking disc, linings and caliper. Check all brake tube connection for possible leaks and flexible hoses for deterioration. Install new flexible hoses if required.

Note: Ensure hose is not twisted more than 15° after final fitting.

If a brake pad lining has worn to the minimum specification, replace both inboard and outboard pads. It is necessary that both rear wheel sets be replaced whenever a respective brake pad is worn beyond specifications or damaged.

Brake Pad Wear



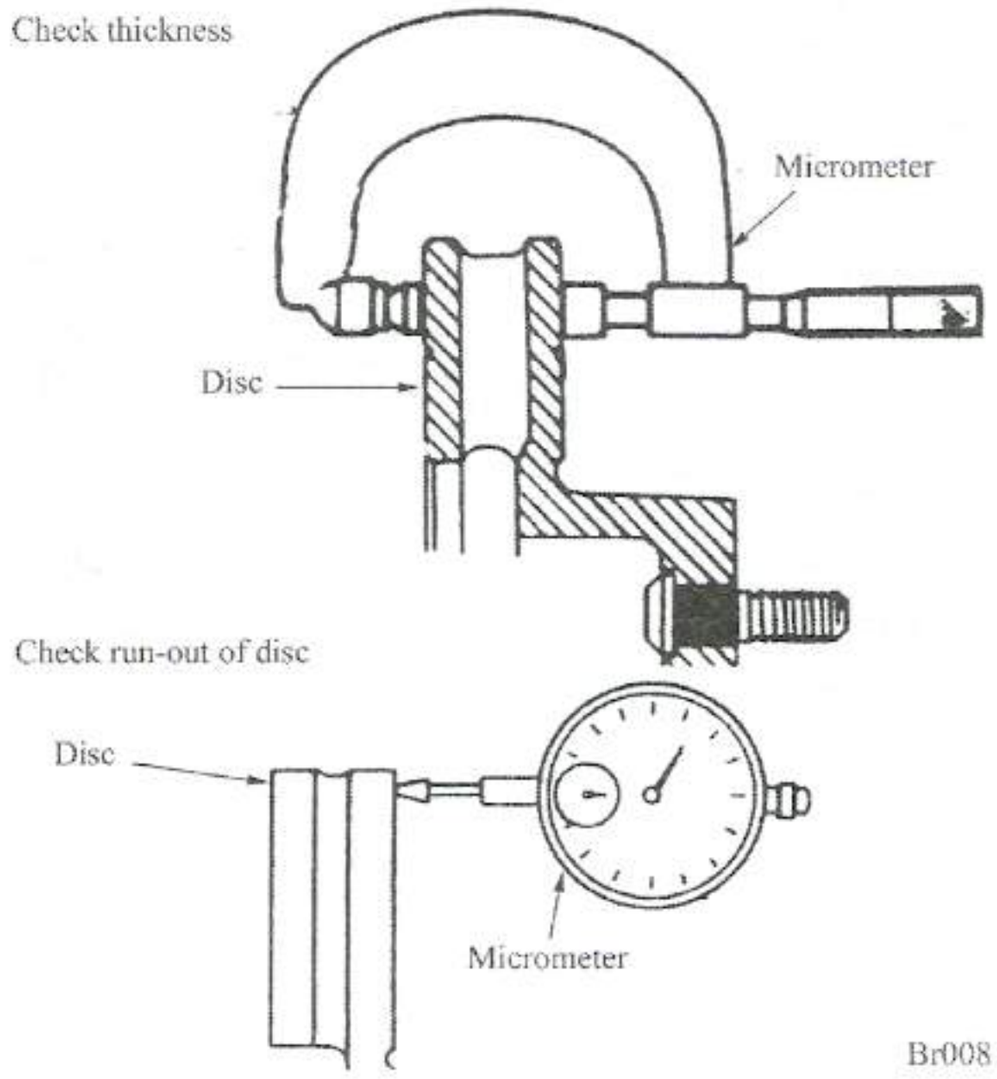
If a visual inspection doesn't adequately determine condition of lining, a physical check will be necessary. To check amount of lining wear, remove brake pad assemblies (see "Pad Replacement"). Three thickness measurements with a micrometer should be taken across the centre of each pad assembly; one reading at each end and one in the centre.

Brake Roughness

The most common cause of brake roughness (or chatter) with disc brakes is excessive disc face run-out. This is easily checked with a dial indicator. If measurement is out of specification, disc must be resurfaced or replaced.

Maximum Disc Runout specification: 0.05mm
Minimum Disc Thickness is stamped on Hub: e.g. 25.00mm

Other less prevalent causes of roughness can be the use of some type of nonstandard lining material and extreme abrasion of the disc faces. Vehicles which stand unused for periods of time in areas of high humidity or salt air may incur rust on the disc which could cause a temporary brake surge and roughness. Normally, however, this condition should correct itself after a short period of usage. If rust is severe enough, roughness will not clear up and the disc must be resurfaced or replaced.



Disc Brake Service Precautions

Grease and any foreign material must be kept off caliper assembly and surfaces of braking disc during service procedures. The braking disc and caliper should be handled, avoiding deformation of the disc and scratching or nicking of the pad linings.

If inspection reveals square sectioned caliper piston seal is worn or damaged, it should be replaced immediately.

During removal and installation of a wheel and tyre assembly, use care not to strike the caliper.

Before vehicle is moved after any brake service work, obtain a firm brake pedal by using correct bleeding procedures.

Dragging the brakes (common result of left foot application on vehicles with automatic transmission) should be avoided during vehicle operation.

As brake pad lining wears, reservoir level will go down. If fluid has been added between relines, then reservoir overflow may occur when piston is pushed back into new lining position. Overflow can be avoided by removing a small amount of fluid from reservoir.

Hydraulic System Failure Warning Switch (Differential Switch)

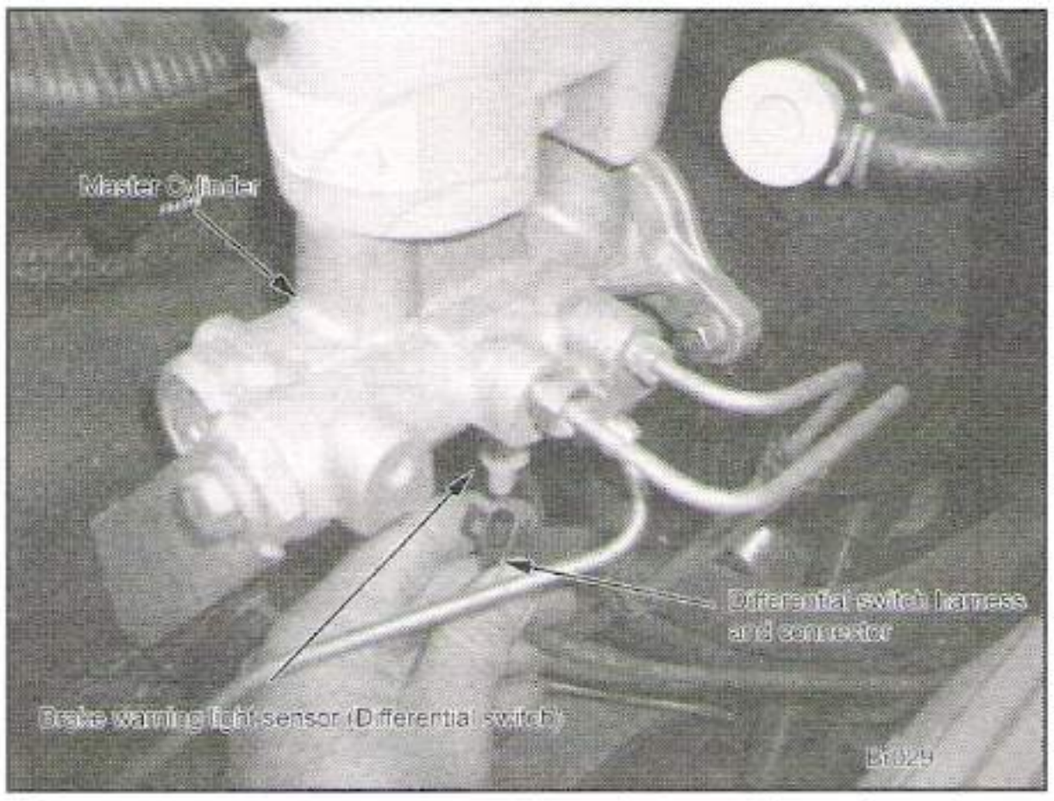
The differential switch located in the master cylinder, is used to warn the vehicle operator that one of the hydraulic systems has failed, by turning on the brake warning light.

A failure in one circuit doesn't result in an entire brake system failure.

As pressure in one circuit falls, the uneven pressure on the spool valve forces the valve to move and contact switch terminal thus lighting the brake and failure warning light on instrument cluster.

The warning lamp switch spool valve is self neutralising, thus

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it is not necessary to remove the switch to allow the valve to centralise.

After working on the master cylinder, pump brake hard to turn off the brake warning light.

Proportioning Valve

Proportioning valves are fitted into the master cylinder. Their purpose is to regulate the amount of fluid pressure transmitted to the rear hydraulic circuits thus preventing premature rear wheel "lock-up" resulting in improved braking and steering control under braking.

The valves contain a stepped piston working against a pre-loaded spring and poppet valve. This allows the front and rear hydraulic pressure to increase at the same rate until the piston overcomes the spring force. At this point the piston will begin to move across to the poppet valve, thus restricting the pressure increase to the rear brakes.

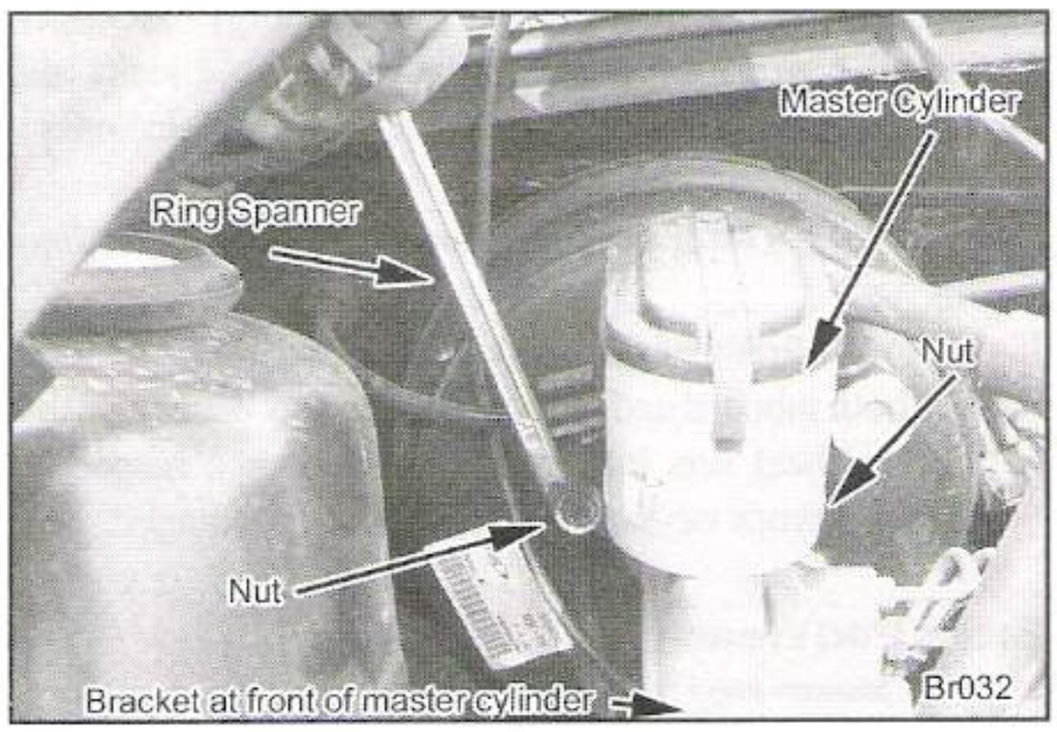
MAJOR REPAIRS

Master Cylinder

Remove

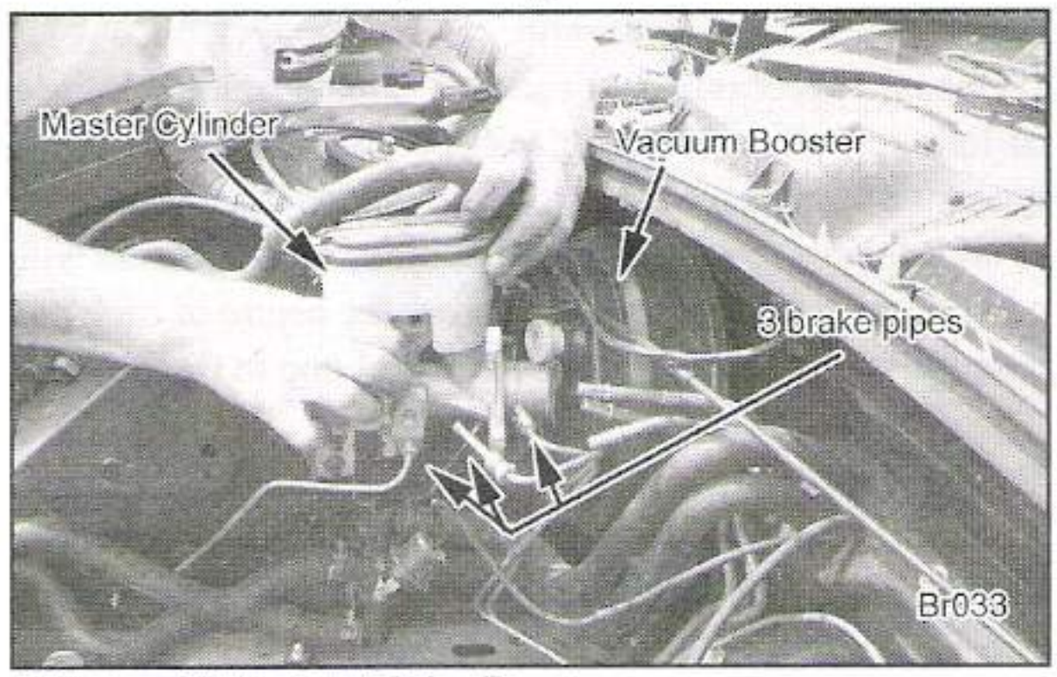
1. Remove master cylinder cap and syphon fluid from reservoir, replace master cylinder cap.
2. Remove the brake tubes from the outlet ports of the master cylinder. Disconnect the plug from the warning light switch.
3. Remove the master cylinder support stay from the suspension tower.
4. Remove two nuts and two lock washers attaching the master cylinder to the brake booster assembly. Slide the master cylinder forward and upward from the vehicle.





Note: The 'crack' pressure of the proportioning valve is stamped on the front of the master cylinder body, and it is important that, if a cylinder needs replacing, a cylinder the same must be used.

5. Take care not to disturb the pushrod and not to depress the brake pedal after the cylinder is removed, or when removing the master cylinder. Failure to observe this may result in the reaction disc becoming dislodged inside the booster.

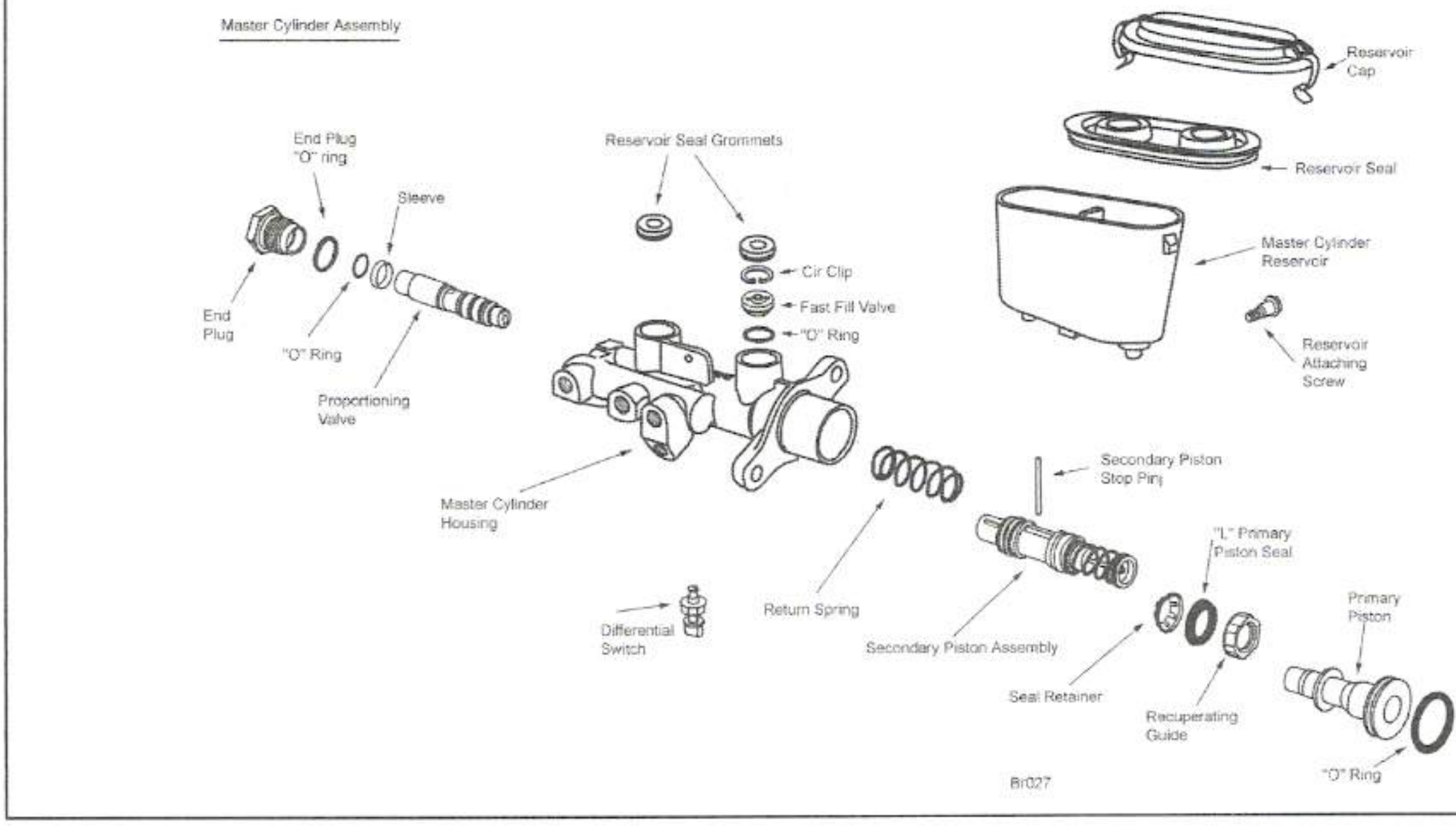


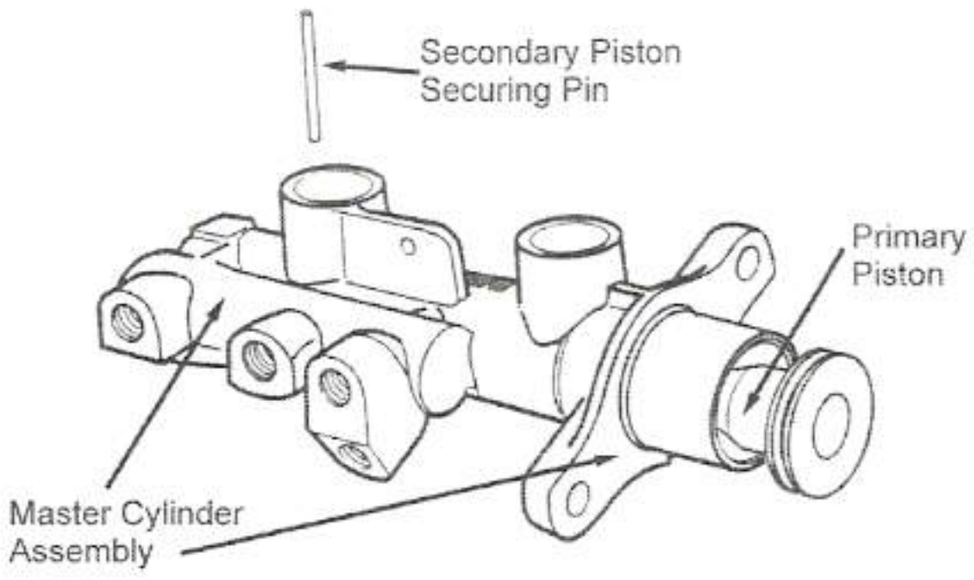
Master Cylinder Main Bore

Dismantle

1. Place the master cylinder on a clean bench, any dirt that may enter the unit, could cause a brake failure. Unclip the reservoir cap and remove. Empty fluid from reservoir.
2. Unscrew reservoir to body retaining bolt located at bottom of reservoir. Separate by hand, the plastic reservoir from aluminium body. Remove the reservoir sealing grommets.
3. Turn master upside down, press the primary piston in until it bottoms, this should allow the secondary piston stop piston to fall out of the reservoir port.
4. Carefully remove primary piston assembly from main bore of master cylinder.
6. Remove secondary piston and return spring by using

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compressed air or lightly tapping the open end of the cylinder bore squarely onto a soft piece of wood.

Note: Caged spring on secondary piston has been set to a predetermined length-Do not attempt to adjust the spring or remove the caged spring.

6. Remove the seal retainer, seal and recuperating guide from the primary piston.

7. Remove all rubber seals from both pistons taking extreme care not to damage pistons.

Fast-Fill Valve

Using circlip pliers, remove circlip retaining the fast-fill valve in the primary reservoir port of the cylinder.

Turn master cylinder upside down to allow this valve to fall out. It may be necessary to lightly tap cylinder on piece of wood to assist valve removal. Remove the 'O' ring from bottom of the bore.

Brake Warning Switch Section

Unscrew the plastic brake warning switch from the master cylinder body. Ensure electrical earthing spring remains on plunger. Carefully withdraw spool assembly from bore, using long nose pliers. Carefully remove both 'O' rings and washers from spool.

Proportioning Valve

Unscrew and remove the hexagon fitting located at the flange end of the cylinder.

Caution: Hold firmly with one hand during this operation to ensure the internal parts do not spring out.

The "O" rings, seal, proportioning piston should be removed. However, if these parts remain in the bore, lightly tap the body on a piece of wood to remove.

Remove proportioning spring from bore. Remove proportioning spring location washer from bottom of proportioning bore. Separate proportioning piston, seal block and poppet sub assembly from hexagon fitting.

Inspection

Inspect the master cylinder bores for signs of etching, pitting or scoring and if in poor condition, replace the cylinder assembly.

DO Not Hone This Cylinder.

Wash all internal parts in clean brake fluid and inspect the parts for excessive wear damage. Place all parts on clean pan or paper prior to assembly.

Master Cylinder Main Bore Assembly

1. Lubricate internal parts and master cylinder bore with clean, recommended brake fluid from sealed container, or special PBR Brake lubricant.

2. Install the "O" ring onto the end of the primary piston.

3. a) Install primary recuperating guide onto the other end of piston.

b) Then the "L" seal with sealing lip facing away from recuperating guide already assembled.

c) Then the seal retainer in fitted to the primary piston, use a small screw driver or scribe to align the retainer legs into

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the groove in the primary piston.
Note: Care should be taken to avoid damage to piston or cup seal.
4. Install the 2 "L" seals to the secondary piston.
5. Install the return spring, small diameter end onto the end of the secondary piston.
6. *# The main bore is 'stepped'.*
The secondary piston retaining pin must be installed through the reservoir port as during dismantle ,ensure the slot for the retaining pin is aligned so the pin can be installed through the reservoir port.
a) While holding the cylinder in a horizontal position with the reservoir port facing up, carefully install the secondary piston, return spring end first, through the large bore and into smaller bore until the spring 'bottoms'.
b) Fully stroke secondary piston and while held at the bottom of the bore install retaining pin, through the reservoir port hole.
c) Install the primary piston, upto the caged spring of the secondary piston.

Proportioning Section

7. Before assembly, lubricate bore and valve with clean recommended brake fluid.
Install new "O" rings to the proportional valve.
8. Install proportioning valve into bore, capped end first, make sure it bottoms into bore.
9. Install new "O" ring onto end plug, screw in and tighten.
Master Cylinder Proportioning Valve End Plug: 25-30Nm

Differential Warning Switch Section

10. Ensure the conical electrical earthing spring is installed on switch plunger.
11. Install electrical switch and tighten to a torque of 2 Nm.
*** Electrical spring must remain attached to plunger when switch is held vertically. Small end of spring may need to be closed down to give required attachment.**

Fast Fill Valve

12. Install new "O" ring to base of fast fill bore.
13. Install fast fill valve, 6 dimples face into bore.
13. Install retaining circlip.

Reservoir

14. Lightly smear reservoir bores and grommets with clean brake fluid.
15. Assemble grommets into reservoir bores to locate against the shoulder in each bore. Assemble reservoir into grommets.
16. Push on reservoir to align the retaining screw hole in the reservoir and cylinder body, then assemble retaining screw.
Master Cylinder Reservoir Retaining Screw: 4-5 Nm.
Both holes must be aligned to avoid cross threading.
17. Push cap and seal assembly onto reservoir and secure by pressing clip at each end location on reservoir lugs.

Install

1. Position the master cylinder assembly over the booster push rod and onto the two studs on the booster assembly.
2. Install the attaching nuts and lock washers and torque them to specifications.
Master Cylinder Attaching Nuts: 15-20Nm
3. Install master cylinder support stay and nuts.
Master Cylinder support Stay Nuts: 15-20Nm
4. Install the front and rear brake tubes to the master cylinder outlet fittings.
5. Fill the master cylinder with the specified brake fluid to the level marked on the side of the dual reservoirs.
6. Bleed the brake system. Operate the brake several times, check for external hydraulic leaks.

VACUUM BRAKE BOOSTER

On Vehicle Test

Check the hydraulic brake system for leaks or insufficient fluid.
With the transmission in neutral, stop the engine and apply the parking brake. Depress the brake pedal several times to exhaust all vacuum in the system. With the engine shut off and all vacuum in the system exhausted, depress the pedal, and hold it in the applied position. Start the engine. If the vacuum system is operating, the pedal will tend to fall away under foot pressure and less pressure will be required to hold the pedal in the applied position. If no action is felt, the vacuum booster system is not functioning.
Remove the vacuum hose from the brake booster check valve connection. Manifold vacuum should be available at the check valve end of the hose with the engine at idle speed and the transmission in neutral. Operate the engine a minimum of 10 seconds at fast idle. Stop the engine and let the vehicle stand for 10 minutes; then, depress the brake pedal. The pedal feel (brake application) should be the same as that noted with the engine operating. If the pedal feels hard (no power assist), replace the brake booster.
If the brake pedal movement feels spongy, bleed the hydraulic system to remove air from the system.

Removal

** Operate the brake pedal several times without the engine running to exhaust the vacuum from the booster.*
1. Remove the master cylinder as previously described.
Tip: It is not necessary to disconnect the brake lines.
2. Disconnect the manifold vacuum hose from the booster unit.
3. Inside the vehicle below the instrument panel, disconnect the booster push rod from the brake pedal assembly. Remove the flat plate clip, washer, push rod, washer from the brake pedal pin.
4. Remove the booster from the fire wall attaching nuts, located under dash at top of pedal assembly.
5. In the engine bay remove the booster assembly.

Install

1. Check the booster mounting gaskets.
2. Mount the booster to the fire wall, inserting the push rod

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and boot through the hole in the fire wall. Loosely install the booster to dash panel attaching nuts.

Booster to Fire Wall Nuts: 20-25Nm

3. Install the brake push rod to the brake pedal, washers and flat clip.
4. Connect the manifold vacuum hose to the booster.
5. Install the master cylinder and torque the attaching nuts

Master Cylinder Attaching Nuts: 15-20Nm.

Disc Brakes

Disc Pads Replace

Remove

1. Remove one half of the total fluid capacity, if the reservoir is near full. Keep the top of the reservoir on a loose fit, to allow air movement in top of reservoir and loosly on to stop brake fluid from splashing out as pistons are pushed in.

Do not remove the brake line or completely empty the reservoir or it will be necessary to bleed the hydraulic system. Discard the brake fluid.

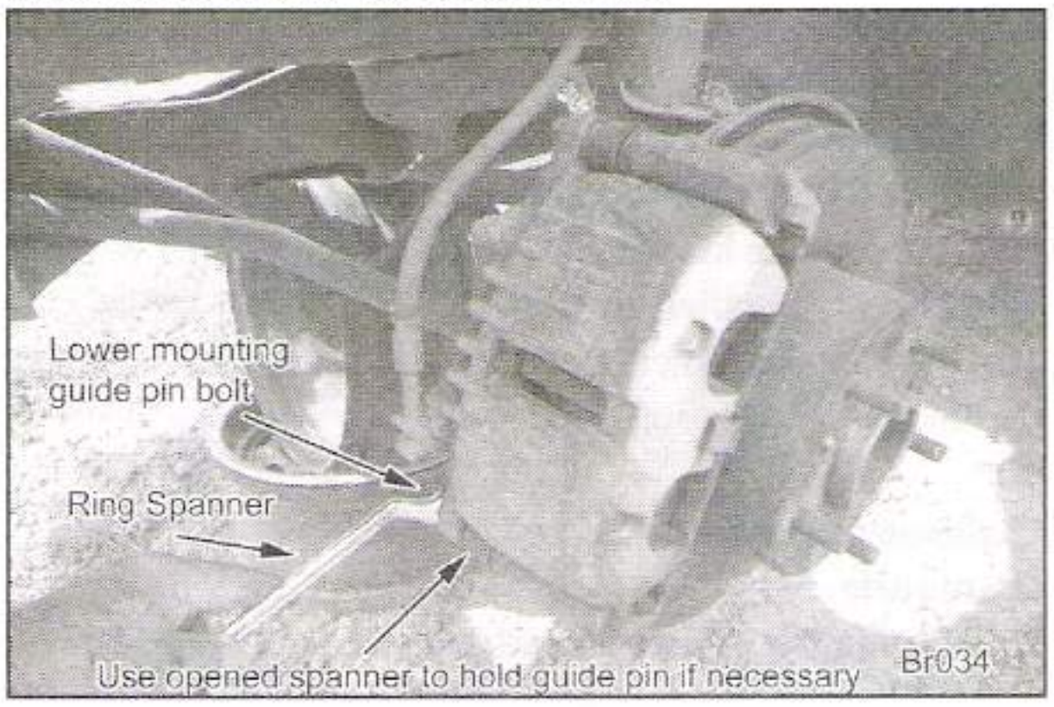
Tip: Removal of the fluid is necessary to prevent reservoir overflow when the caliper piston is pushed back in its bore during pad replacement.

Tip: It is not necessary to disconnect the brake hose at the caliper for pad replacement.

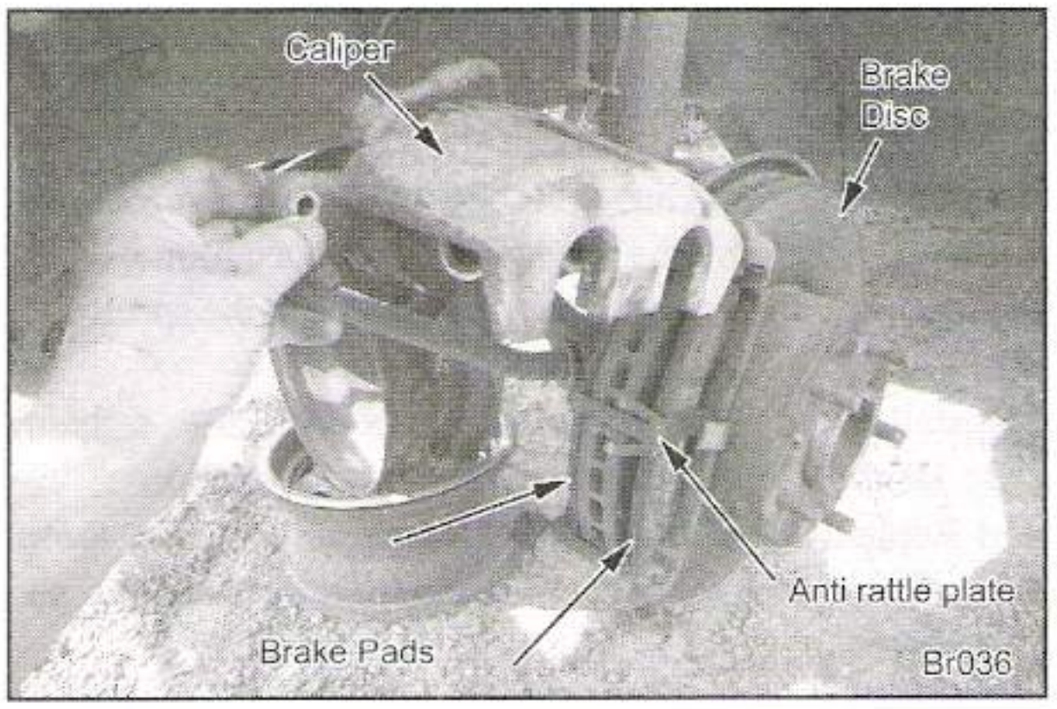
2. Remove the wheels. If more than one brake requires service, work on only one brake at a time. Pad assemblies must always be replaced as sets either front or rear.
3. Install "G" clamp to caliper, screw in until the piston bottoms.

Note: Front caliper 2 "G" clamps. Rear caliper 1 "G" clamp.

4. With an open ended spanner hold guide pin, use ring spanner to remove the lower mounting guide pin bolt which holds the caliper to the caliper frame.



5. Sswing the caliper up from the disc and caliper frame,. this will allow the removal of the disc pads.





Install

1. Push piston into the caliper bore until it bottoms if not carried out as in "step 3", using a suitable "G" clamp.



2. **Front Brakes**

a) Remove the protective paper back from the new inner pad and install disc pad into caliper frame.

b) Install the outer pad into the caliper, install so a section of the steel spring will be on top of the inner pad when assembled.

c) Fold down the caliper into position so that the centre finger will engage with the caliper frame.

2. **Rear Brakes**

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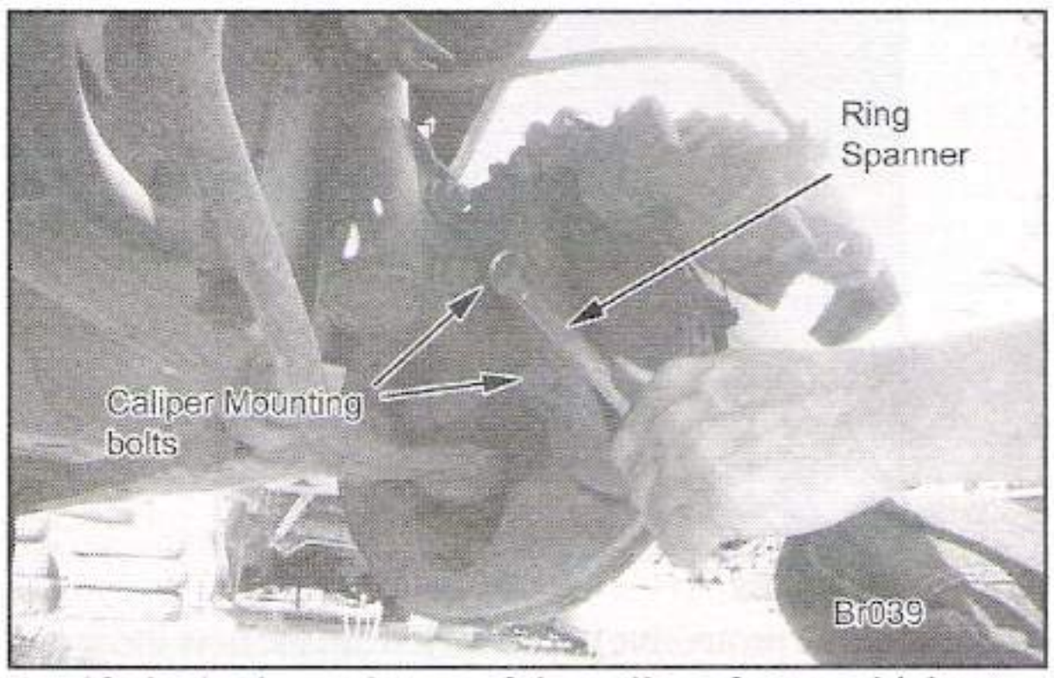
Note: Both calipers have a shim that must be fitted with the disc pads.

a) Install the inner pad and half shim into the caliper frame.
b) Install the outer pad and full shim into the caliper frame, the outer pad is held by the fingers of the caliper frame.
c) Fold down the caliper into position so that the spring clip is on the caliper frame.
3. Install a new guide pin to the caliper and frame, tighten.
Disc Brake Caliper Guide Pin: 30-34Nm
4.a) Replenish the brake fluid in the master cylinder. Pump the brake pedal several times to position the shoe and pad assemblies.
b) Front pads only: Press brake pedal and hold down for 5-10 seconds to allow disc to stick to caliper pistons.
5. Top up master cylinder with new brake fluid, and check brake pedal travel.
6. Install wheel, lower vehicle, tighten wheel nuts.
Road Wheel Nuts: 100-125Nm

Front and Rear Brake Calipers and Disc Pads

Remove

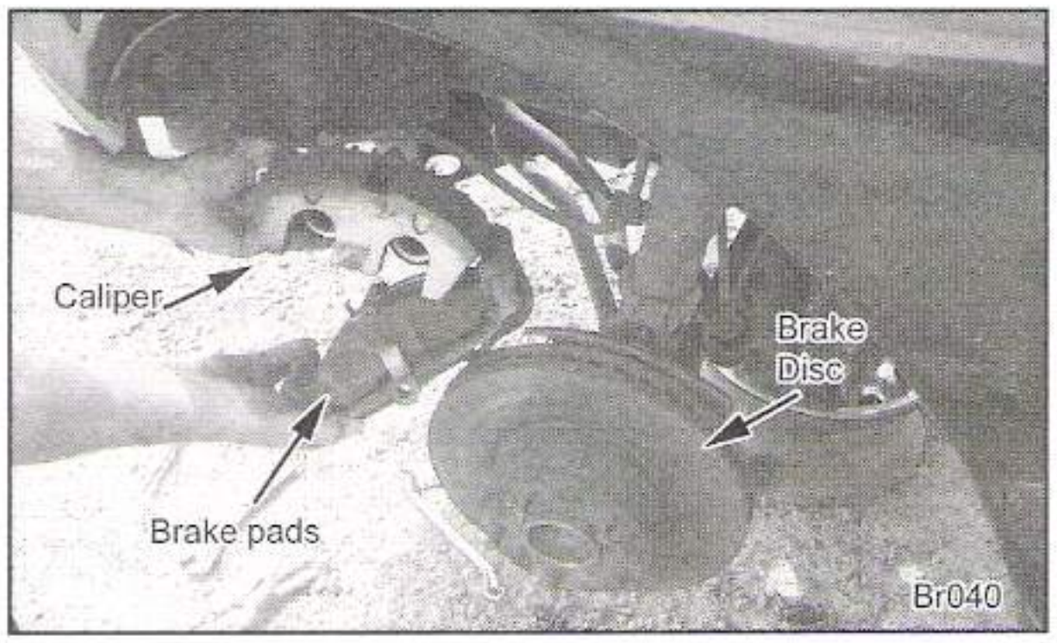
1. Remove one half of the total fluid capacity. Do not remove the brake line or completely empty the reservoir or it will be necessary to bleed the hydraulic system. Discard the brake fluid.
*** Removal of the fluid is necessary to prevent reservoir overflow when the caliper piston is pushed back in its bore during pad replacement.**
2. Remove front wheels. If more than one brake requires service, work on only one brake at a time. Pad assemblies must always be replaced in both brakes.
3. Remove the two mounting bolts which attach the caliper, lift the caliper radially away from the disc. It is not necessary to disconnect the brake hose at the caliper unless you wish to remove the caliper from the vehicle.



4. Lift the brake pads out of the caliper frame which were either side of the disc rotor.
5. Remove the guide pin bolts holding the caliper to the caliper frame, separate the caliper and caliper frame. Dispose of guide pin bolts.

Install

1. Install caliper frame and 2 bolts.



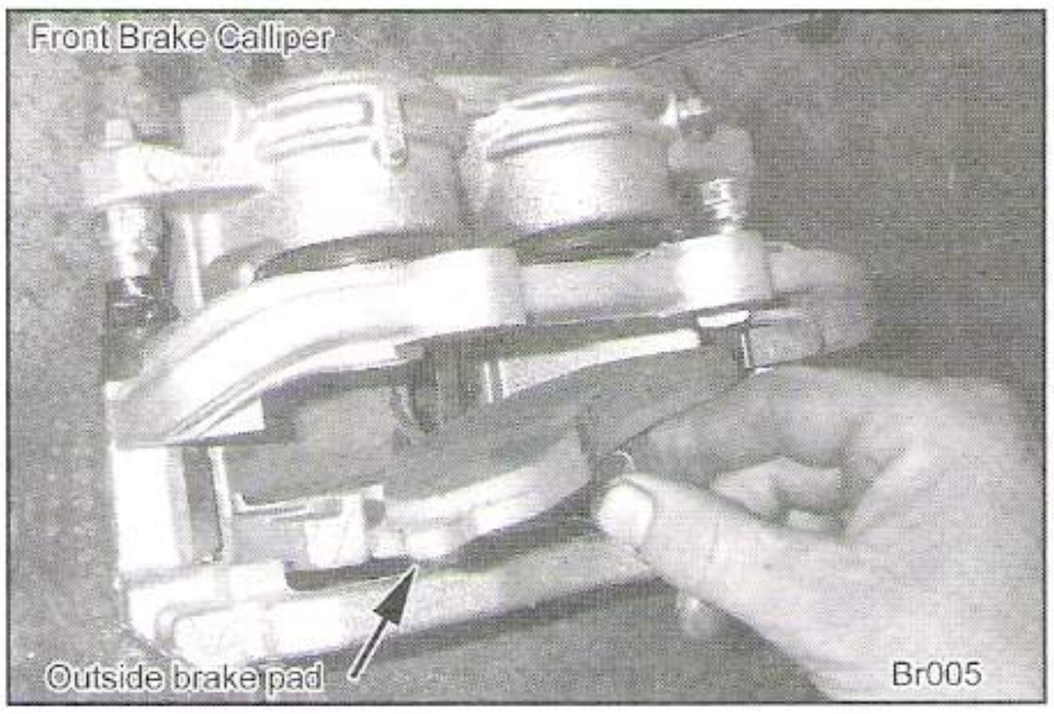
Front Brake Caliper Frame Bolts:
80-90Nm plus 40^0-50^0 turn
Rear Brake Caliper Frame Bolts: 70-80Nm
2. Push piston into the caliper bore (by hand if the caliper has been overhauled), or by using two suitable "G" clamps. Retract the pistons slowly to permit the piston to move in the seal. If the pistons are not sufficiently retracted the spacing between the linings is inadequate to permit the pad and caliper assembly to be mounted over the rotor.
3. Front Brakes: Remove the protective paper back from the new inner pad and install disc pad into caliper frame.
4. Slide the outboard pad into the caliper.
5. Position caliper correctly over rotor and slide straight into position until caliper head bolt holes align with their respective holes on the caliper frame.
6. Install a new guide pin to the caliper and frame, tighten.
Disc Brake Caliper Guide Pin: 30-34Nm
7. Install brake hose to caliper in necessary.
Brake hose to Caliper Union: 32-37Nm
8. Replenish the brake fluid in the master cylinder. Pump the brake pedal several times to position the shoe and pad assemblies.
Front Brakes: Press brake pedal and hold down for 5-10 seconds to allow disc to stick to caliper pistons.
9. Check for leakage of fluid at all connections under pedal pressure. Check fluid level, install wheel and tighten wheel nuts, tighten nuts to specification.
Wheel Nut specified torque: 100-125Nm
10. Road test the vehicle and make several light stops to seat the linings.

Caliper Overhaul

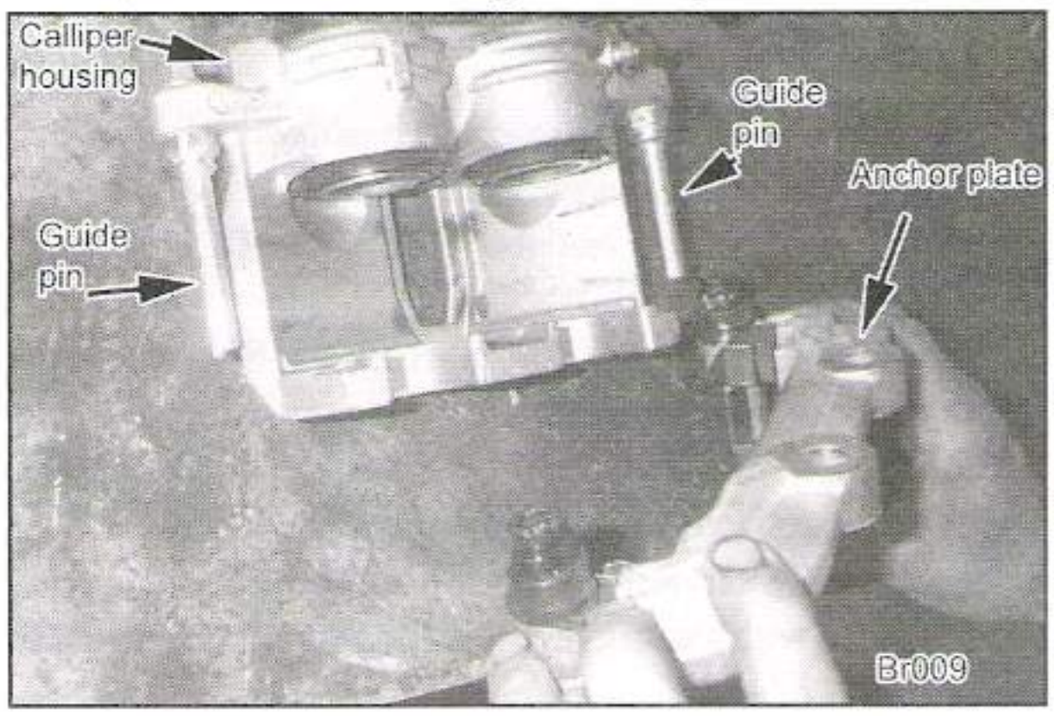
Dismantle

1. Position the caliper assembly in a vice equipped with padded jaws, remove brake pads. Unscrew the two guide pins and boots from the caliper body.

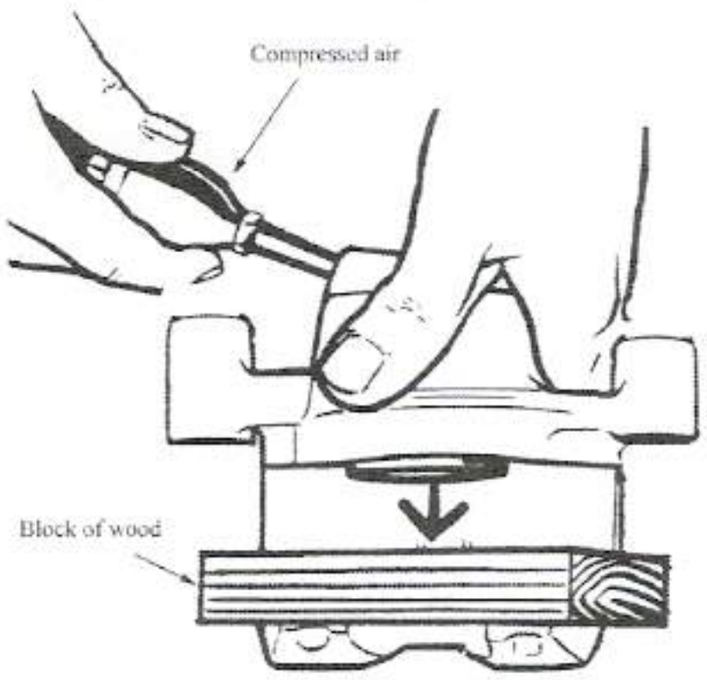
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Caution: Do not hit the guide pins with a hammer to loosen, as this will damage the caliper.



2. Remove piston by carefully gradually increasing compressed air at the fluid inlet port of the caliper until the piston is forced out of the bore. A block of wood or hardboard or a wad of cloth located in the position of the outboard pad will guarantee the piston is not damaged.



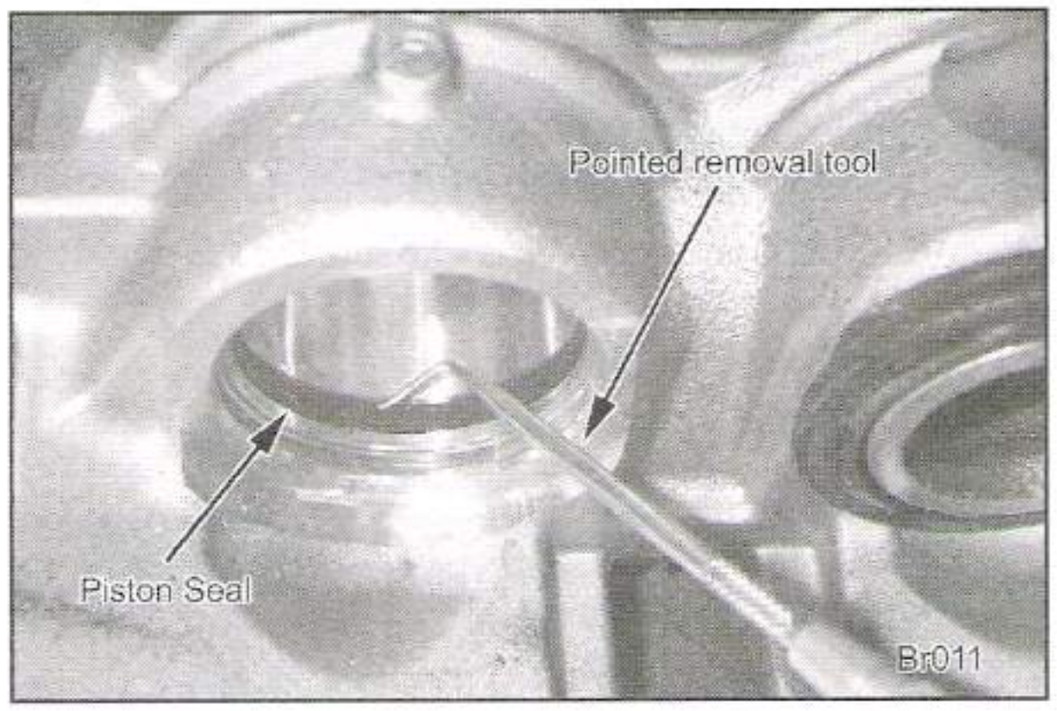
Caution: Keep fingers from the inside of caliper when removing the piston using air pressure.

Note: Calipers with twin pistons will need the second piston to griped with an expanding pair of pliers to grip the inside of the piston to twist and pull piston out, position first piston just in bore, place a piece of wood in the caliperto stop it from coming out .



3. While the piston slides out, the I.D. of the rubber boot in the groove of the piston should stretch out around the large portion of the piston allowing the piston to slide out and be removed.

4. Remove the boot out of cylinder groove and dispose of it. Using a small pointed wood or plastic tool remove the piston seal from its groove in the cylinder bore and dispose of the seal, be careful not to damage the seal seat.



5. Clean and inspect all parts as described below.

Clean and Inspect

1. Wash all parts with methylated spirits and dry with compressed air or lint free cloth.
2. Blow out the caliper bore and all drilled passages with compressed air.
3. Inspect the piston for scoring, pitting, corrosion or areas where the chrome plating has worn off. If damage is present replace piston.
4. Inspect the caliper bore for scoring, pitting, corrosion or damage and replace the caliper if any of these factors are present.
5. If light scuff marks exist on the piston or in the caliper bore, rub down lightly by hand with '600' wet and dry paper and thoroughly rinse with methylated spirits.
The caliper must not be honed.
6. Inspect all other components and replace if wear or damage exists.

Assembly

1. Position caliper assembly on a clean bench area with the open end of cylinder up.
2. Dip new piston seal in clean disc brake fluid and install in

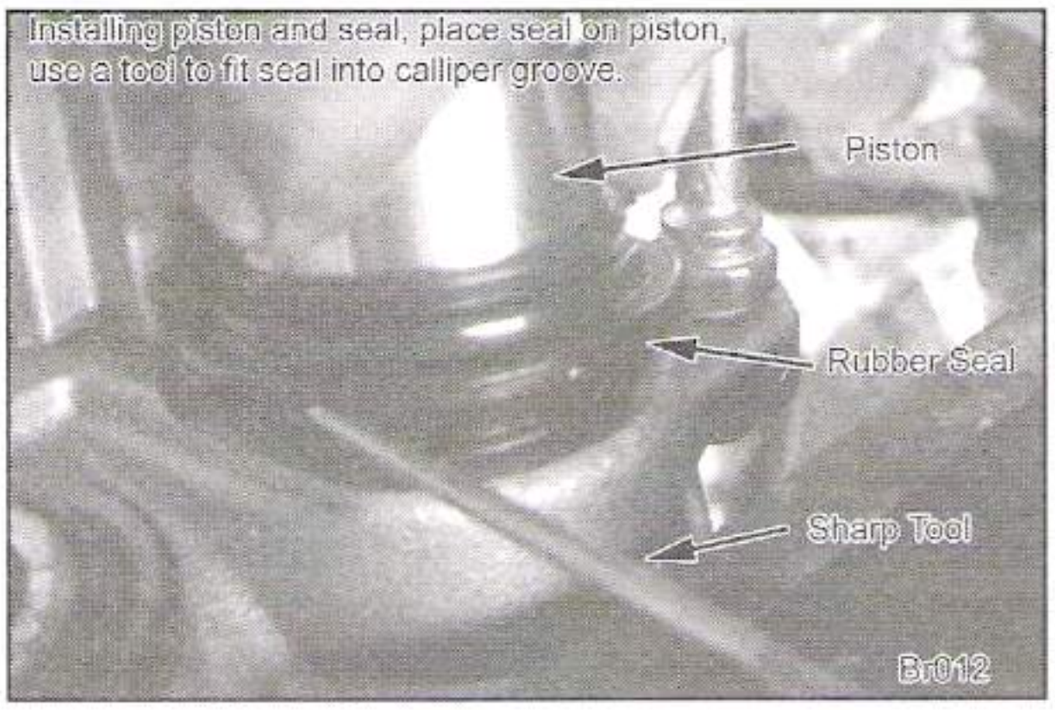
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cylinder groove. Place seal in the groove and gently work around cylinder bore with a finger until the seal is properly seated. Check to be sure the seal is not twisted or rolled in its groove.

3. Coat piston boot in rubber grease. Place piston boot over end of piston. Liberally coat the outside diameter of piston with rubber grease.

4. Locate boot into groove in caliper body. Start this procedure at the rear of the body and gradually feed boot around groove until completely assembled.

5. Lubricate inside of calliper head guide pin bores with



approved Dow Corning No44, make sure the slider and pin re lubricated and move freely.

6. Fit the caliper to the anchor plate.

7. Tighten the guide pins bolts to specification, use a spanner to hold guide pins while tightening the guide pin bolts.

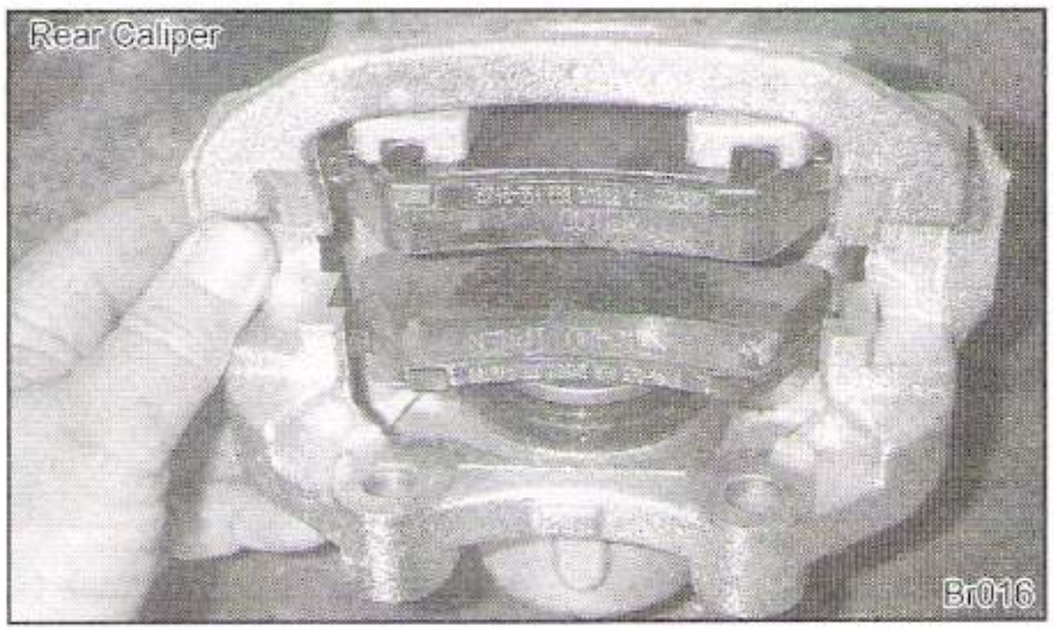


Disc Brake Caliper Guide Pin: 30-34Nm

8. Install the brake hose to the caliper, if applicable.

Brake hose to Caliper Union: 32-37Nm

9. Install the bleeder screw valve.



Brake Discs / Front Shield and Rear Brake Shield

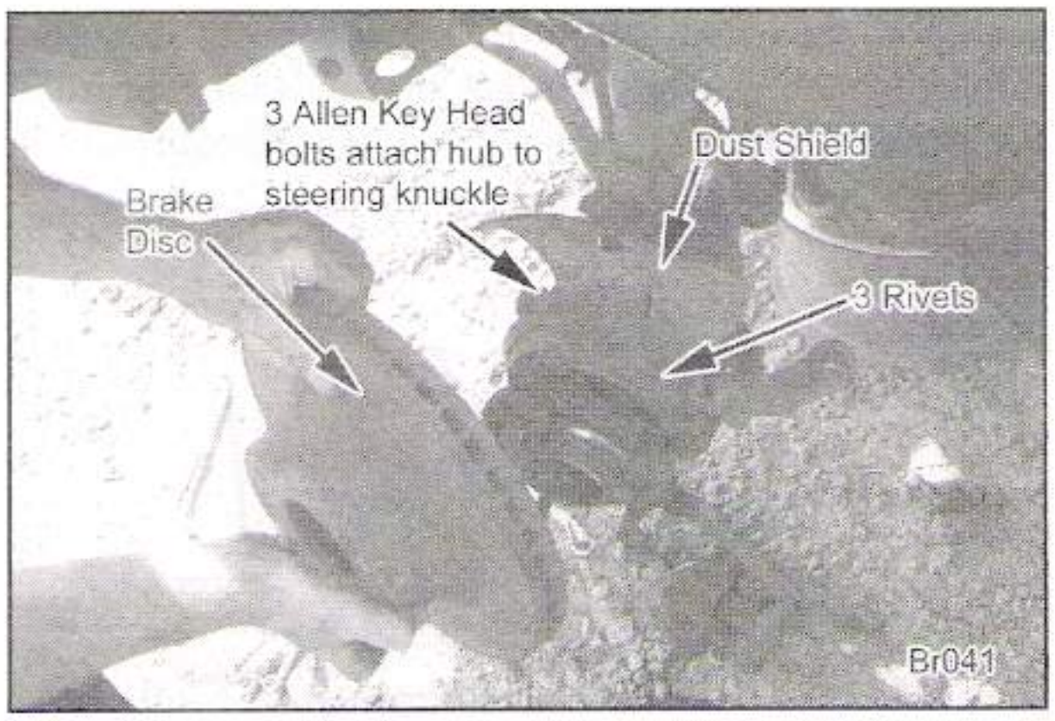
Note: The front disc should have alignment marks to the hub if not place alignment for assembly to stop possibility of disc run out and brake shudder.

Remove

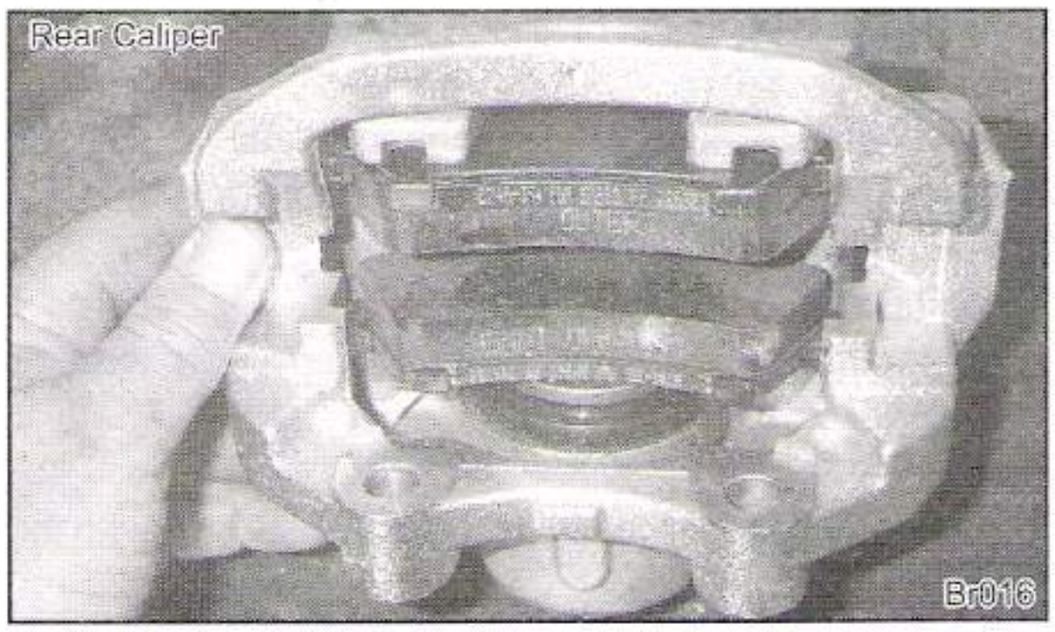
1. [Rear Disc] Park brake control released, disconnect the park brake cable at the equaliser if necessary to remove disc.

2. Remove the caliper assembly as described in this chapter. There is no need to disconnect the brake hose, if the caliper does not require servicing. Place the caliper out of the way, and support it with a wire to avoid damaging the caliper or the hose.

3. Lift the brake disc from the front hub.



4. [Front brake disc shield]





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a) Remove the 3 wheel hub to steering knuckle attaching bolts, use a 10mm allen key, if hub is hard to remove replace bolts and tap bolts with hammer to loosen.
b) Remove Hub
c) Remove the disc shield from the front hub, attached by 3 rivets.
5. [Rear Brake shield]
a) Disconnect brake caliper hose at brake pipe, remove clip holding brake pipe to backing plate, remove brake pipe from backing plate.
b) Disconnect hand brake cable from hand brake actuator at rear of backing plate.
c) Remove trailing arm trunnion flange and trunnion as described in "Rear Axle" chapter.
d) Remove hand brake shoes as described in this chapter.
e) Remove the 4 bolts attaching the backing plate, 2 torx bolts and 2 15mm bolts.

Install

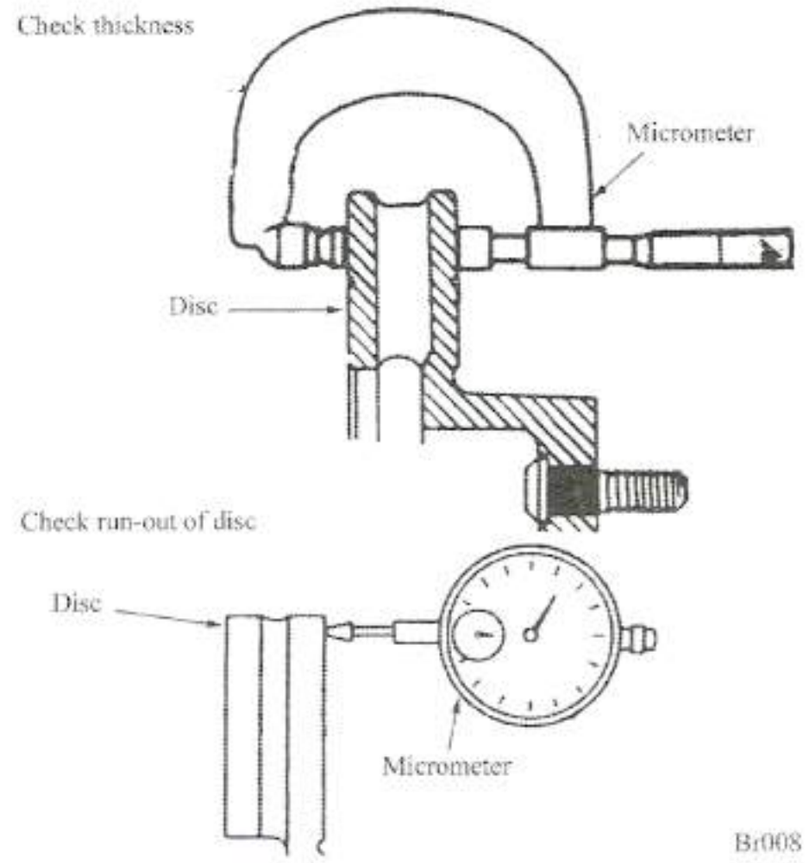
1. [Front disc shield] a) If necessary replace the brake back plate, rivets around the diameter of the plate to the steering knuckle.
b) Check surfaces of steering knuckle and hub, clean if necessary. Check "O" ring on hub, replace if necessary.
c) Install the hub to the steering knuckle. Replace the 3 wheel hub to steering knuckle attaching bolts, use a 10mm allen key, tighten to specification.
Note: If ABS fitted align the steering knuckle hole with the sensor connection on hub during assembly of hub.
Hub to Steering Knuckle Allen Bolts: 100-115Nm
d) If ABS is fitted to the vehicle push sensor unit lead into place [VTI: use a 5mm allen key to replace lock screw].
2. [Rear Brake shield]
a) Install the backing plate and 4 bolts attaching the backing plate, 2 torx bolts and 2 15mm bolts.
Rear Brake Backing Plate 2 torx bolts: 70-80Nm
Rear Brake Backing Plate 2 15mm bolts: 85-90Nm
b) Install hand brake shoes as described in this chapter.
c) Install trailing arm trunnion flange and trunnion as described in "Rear Axle" chapter.
d) Connect hand brake cable from hand brake actuator at rear of backing plate.
e) Connect brake caliper pipe to backing plate, insert clip, connect brake hose to brake pipe.
3. Take care and fit the disc onto the axle hub. Align with alignment marks
4. Install front brake caliper, lift the caliper over the disc. Install calliper attaching bolts and tighten to specification.
Front Brake Caliper Bolts: 80-90 plus 40^0 - 50^0 turn
Rear Brake Caliper Bolts: 70-100
5. [Rear Disc] Park brake, re-connected the park brake cable at the equaliser if necessary.
6. Install the wheel and tighten the wheel nuts.
7. Spin wheel to check that the wheel spins freely.
8. Lower front of wheel and tighten to specification.
Wheel Attaching Nut : 100-125Nm
9. Adjust the park brake in required.

Disc Inspection and Machining

The finished braking surfaces of the rotor must be flat and parallel within 0.05mm.

Disc Flatness, bolt sides:	**0.05mm max**
Disc surfaces parallel:	**within 0.08mm**
Disc thickness variation:	**0.005mm max**

Check disc runout with a dial gauge.



Disc Runout:
Front: 0.04mm max and 0.03mm every 30 deg of disc.
Rear: 0.05mm max and 0.03mm every 30 deg of disc
Overall thickness across braking surfaces after machining must not be less than specified minimum as marked on disc.
Front: Disc minimum thickness spec: marked on disc
Rear: Disc minimum thickness spec: 13.9mm
After machining there must be a 45 deg chamfer by 1.0mm deep at the out edge of the disc.
The chamfer must be between 1.3min and 2.5mm max from the bake pad surface, to help prevent heat stress cracking.

Hand Brake Lever Assembly

Remove

1. Disconnect the hand brake front cable from the relay



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equaliser beneath the vehicle.
2. Remove the lever rubber cover from inside the vehicle.
3. Remove the two bolts attaching the lever to the transmission tunnel.

Install

1. Replace the hand brake lever assembly to the vehicle, and attach to the transmission tunnel and tighten the attaching bolts.

Hand Brake Attaching Bolts: 20-25Nm

2. Install the dust cover to the hand brake lever.
3. Reconnect the hand brake cable to the equaliser.

Hand Brake Shoes Replace and Adjust

1. Remove the rear disc as previously described.
2. Release the upper and lower hand brake shoe springs. Grip the shoes at the base, force up to push the end of the shoe from the actuating pin and the shoes from the retaining clip.
3. Manipulate the shoes around the axle trunnion to remove, release spring from back shield with a screw driver.
4. The adjuster and pins can be removed, however to remove other components the backing shield must be removed.
5. Before installing shoes, apply molybdenum grease to adjuster and pins, screw adjust in before installing new shoes.
6. Connect one end of the shoe to the adjuster pin, move the shoe to engage the other end to the other pin.
7. Locate each shoe to the spring clip on the backing plate.
8. With both shoes firmly attached measure the distance across the shoe lining material, use the adjuster to achieve the specified distance.

Hand Brake Shoe Diameter: 189.3 - 189.6 mm

9. Install brake disc, caliper and wheel as previously described.
10. Adjust hand brake and cable as previously described.

Problem Diagnosis and Tests

Preliminary Tests

Fluid Level

Check the fluid level in the brake master cylinder reservoirs before performing the test procedures.
If necessary, top up the master cylinder reservoirs to the level indicated on the side of the reservoir.

Brake Pedal Clearance Check

The brake system is designed to permit full stroke of the master cylinder when the brake pedal is fully depressed. There is no need for brake pedal clearance adjustment. With the brake master cylinder outlet lines disconnected and the brake pedal fully depressed, the centre of the top surface of the brake pedal pad should be 25mm from the floor surface. If the pedal height is below specification make the necessary repairs.

Hydraulic System Test

Turn the engine off and exhaust all vacuum from the booster system by depressing the brake pedal several times, before performing this test.
Depress the brake pedal and hold it in the applied position. If the pedal gradually falls away under this pressure, the hydraulic system is leaking. Check all tubing, hoses, and connections for leaks.
If the brake pedal movement is spongy, bleed the hydraulic system to remove air from the brake system.

SPECIFICATIONS

Brake Fluid

Brake fluid spec. ..... HMC - HN 1796

Master Cylinder

Main Bore Diameter (Heavy duty) ID 25.4mm
Stroke 28.5mm
Crack point(stamped on end of master cylinder) 3.1 MPa

Disc Brake Calipers - PBR

Bore Diameter (FRONT) twin 42.0mm
Bore Diameter (REAR) 40.5mm

Front Brake Disc

Disc Diameter: 296.0mm
Disc Flatness, bolt sides: 0.05mm max
Disc surfaces taper: within 0.08mm
Disc thickness variation: 0.005mm max
Disc Runout:
0.04mm max and 0.03mm every 30 deg of disc.
Thickness (New) 28.05mm
Minimum Disc Thickness is stamped on Hub:
e.g. 25.00mm

After machining there must be a 45 deg chamfer by 1.0mm deep at the out edge of the disc.
The chamfer must be between 1.3min and 2.5mm max from the bake pad surface, to help prevent heat stress cracking.

Rear Brake Disc

Disc Diameter: 286.0mm
Disc thickness variation: 0.013mm max
Disc Runout:
0.05mm max and 0.03mm every 30 deg of disc
Assembled Disc to Trunnion Hub Runout:
0.08mm max
Trunnion Indicated Runout 0.06mm max
Thickness (New) 15.9 mm
Disc minimum thickness spec: 13.9mm
Drum Diameter (New) 190.0 mm
Hand Brake Shoe Diameter: 189.3 - 189.6 mm

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After machining there must be a 45 deg chamfer by 1.0mm deep at the out edge of the disc.
The chamfer must be between 1.3min and 2.5mm max from the bake pad surface, to help prevent heat stress cracking.

Disc Pads
Lining Wear Limit 1.0 mm
IRS - ABS Sensor Air Gap specification. 0.3-1.3mm
BRAKE FLUID
Brake fluid spec. ..... HMC - HN 1796

ABS
IRS - ABS Sensor Air Gap specification 0.3-1.3mm

Front Wheel Hub	No Teeth	ID	Cover Colour
With IRS Diff	48	LH48 / RH48	Light Grey

HSV
HSV vehicles have several braking system options including the systems fitted to GMH vehicles, some of the differences are listed below

VT Performance Brake System

Standard on GTS and Senator 220i vehicles.
Optional on other HSV VT models listed in the
Major components of the VT Performance System are:
Front ventilated disc:
330mm x 32mm, (PN 05A-970701).
Front Caliper Assemblies:
Twin piston floating of 40.5mm diameter,
(PNs LH 05A-970705, RH 05A-970706).
Caliper Mounting Brackets:
(PNs LH 05A-970713, RH 05A-970714).
Front Brake Hose:
(PNs LH 05F-970702, RH 05F-970701).
Rear ventilated disc:
315mm x 18mm, (PN 05B 970701).
Rear Caliper:
Single piston floating of 45mm diameter
(PNs LH 05B-970705, RH 05B-970706).
Rear brake hose: (05F-970703).
Brake Pad material: BM962 front and rear.

VT Premium Brake System

Standard on VT Blueprint models
Major components of the VT Premium System are:
Front ventilated disc:
Cross drilled Disc of 343mm x 32mm,
(PN 05A-970712)
Front Caliper Assemblies:
Four piston opposed Caliper Assembly - 2 pistons of 38.1mm and 2 pistons of 41.3mm diameter,
(PNs 05A-970710 and 05A-970711)
Rear ventilated disc:
Cross drilled brake disc 315mm X 18mm
(PN 05B-970701)
Rear Caliper:
four piston opposed Caliper Assembly with piston size of 28.57mm diameter
(PNs 05B-970709 and 05B-970710)
Brake Pad material: PX987, front and rear.

HSV - VS Premium Brake System

Standard on Grange 215i Sedans
Major components of the VT Premium System are:
Front ventilated disc: 328mm x 28mm
(PNs LH 05A-970732, RH 05A-970731)
Rear ventilated disc: 280mm x 20mm
Front Caliper Assemblies: Twin piston.
(PNs LH 05A-121918, RH 05A-121917)
Front caliper mounting brackets and bolts.
Front brake hose assembly
Rear Caliper: Large diameter single piston
(PNs LH 05B-211918, RH 05B-211917)
Rear brake hoses
Brake Pad material: BM 962 brake pads

VT2 Performance Brake System

Major components of the VT2 Performance System are:
Front ventilated disc: 330mm x 32mm.
Front Caliper Assemblies:
Twin piston floating of 40.5mm diameter.
(PNs LH 05A-970732, RH 05A-970731).
Bracket Caliper Mounting:
(PNs LH 05A-970713, RH 05A-970714).
Front Brake Hose: (PN 05F-970706/7).
Rear ventilated disc:
315mm x 18mm, (PN 05B 970701).
Rear Caliper:
Single piston floating of 45mm diameter. (Standard VX rear caliper)
Rear brake hose: (05F-970703).
Brake Pad material:
Front JBINF-42
Rear BM962.

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VT2 Premium Brake System

Major components of the VT2 Premium System are:
Front ventilated disc:
Cross drilled Disc of 343mm x 32mm,
(PN 05A-970712)
Front Caliper Assembly:
Four piston opposed - 2 pistons of 38.1mm and 2 pistons of 41.3mm diameter.
(PNs LH 05A-970719, RH 05A-970718)
Front brake hose: (PN 05F-970706/7).
Rear ventilated disc:
Cross drilled brake disc 315mm X 18mm
(PN 05B-970701)
Rear Caliper Assemblies
Four piston opposed with piston size of 28.57mm diameter. (PNs LH 05B-970715 , RH05B-970714)
Rear brake hose: (PN 05F-970704).
Brake Pad material: PX1387, front and rear.

VX and WH Performance Brake System

Major components of the VX Performance System are:
Front ventilated disc:
Grooved disc of 330mm x 32mm.
Front Caliper Assemblies:
Twin piston floating of 40.5mm diameter.
(PNs LH 05A-970732, RH 05A-970731).
Caliper Mounting Brackets:
(PNs LH 05A-970713, RH 05A-970714).
Front Brake Hose: (PN 05F-970706/7).
Rear ventilated disc:
Grooved disc of 315mm x 18mm.
Rear Caliper Assemblies:
Single piston floating of 45mm diameter. (Standard VX rear caliper)
Rear brake hose: (05F-970703).
Brake Pad material:
Front JBINF-42
Rear BM962

VX and WH Premium Brake System

Major components of the VX Premium System are:
Front ventilated disc:
Cross drilled Disc of 343mm x 32mm.
Front Caliper Assemblies:
Four piston opposed - 2 pistons of 38.1mm and 2 pistons of 41.3mm diameter.
(PNs LH 05A-970719, RH 05A-970718)
Front brake hose: (PN 05F-970706/7).
Rear ventilated disc:
Cross drilled brake disc 315mm x 18mm
Rear Caliper Assemblies:
Four piston opposed, with piston size of 28.57mm diameter. (PNs LH 05B-970715 , RH05B-970714)
Brake Pad material: PX1387, front and rear.
Rear brake hose: (PN 05F-970704).

VU Performance and Premium Brake System

Major components of these system are the same as the VX systems.
The Maloo standard brake system is the same as the GMHA Police brake system.

HSV DISC MINIMUM THICKNESS

VS PREMIUM	
Front Disc minimum thickness spec:	20.0mm
Rear Disc minimum thickness spec:	18.0mm
VT I & II, VX, WH PREMIUM	
Front Disc minimum thickness spec:	30.0mm
Rear Disc minimum thickness spec:	16.0mm
VT I & II, VX, WH PERFORMANCE	
Front Disc minimum thickness spec:	30.0mm
Rear Disc minimum thickness spec:	16.0mm

TORQUE LIMITS Nm

Master Cylinder Proportioning Valve End Plug:	25-30
Master Cylinder Reservoir Retaining Screw:	4-5
Master Cylinder Attaching Nuts:	15-20
Master Cylinder support Stay Nuts:	15-20
Booster to Fire Wall Nuts:	20-25
Master Cylinder Attaching Nuts:	15-20
Disc Brake Caliper Guide Pin:	30-34
Road Wheel Nuts:	100-125
Front Brake Caliper Frame Bolts:	80-90Nm plus 40^0-50^0 turn
Rear Brake Caliper Frame Bolts:	70-80
Disc Brake Caliper Guide Pin:	30-34
Brake hose to Caliper Union:	32-37
Hub to Steering Knuckle Allen Bolts:	100-115
Rear Brake Backing Plate 2 torx bolts:	70-80
Rear Brake Backing Plate 2 15mm bolts:	85-90
Front Brake Caliper Bolts:	80-90 plus 40^0 - 50^0 turn
Rear Brake Caliper Bolts:	70-100
Hand Brake Attaching Bolts:	20-25
ABS Modulator Attaching Nuts:	5-12
Sensor Retaining Bolt VT SerI:	8-14

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ABS & ABS / ETC System

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DESCRIPTION AND OPERATION

ABS system uses electrical sensors at each wheel to detect the rotation of wheels, three independent systems one for each front wheel and one for the two back wheels.
As a wheel is slowing down compared to others wheels the control unit via a solenoid valve attached to each of the three systems alters the brake fluid pressure to stop wheel lockup.
ABS (Anti-locking Braking System) monitors the wheel revolutions and brake line fluid pressure, then adjusts fluid pressure to stop wheel lock-up during braking. This reduces the stopping distance while braking.
ABS/ETC system is an Anti-locking Braking System (ABS) and an Electronic Traction Control system (ETC). The ETC system controls the engine and braking system under conditions when 1 or more wheels loose traction with the road surface (which can occur during start off, cornering and braking) by limiting the amount of traction lose. ETC helps to give the driver more control over the vehicle therefore making driving safer.
Gen III V8 powered vehicles have a throttle relaxer unit located on the firewall. Consisting of a motor and 3 pulleys, center pulley for throttle cable, outside pulley for cruise control cable and inside pulley for a cable from the throttle relaxer to the throttle body. The relaxer unit is controlled by a control module located behind the passenger side kick trim inside the cabin. DTC for the throttle relaxer control module are stored in the ABS & ABS / ETC control module.

ROUTINE MAINTENANCE

ABS

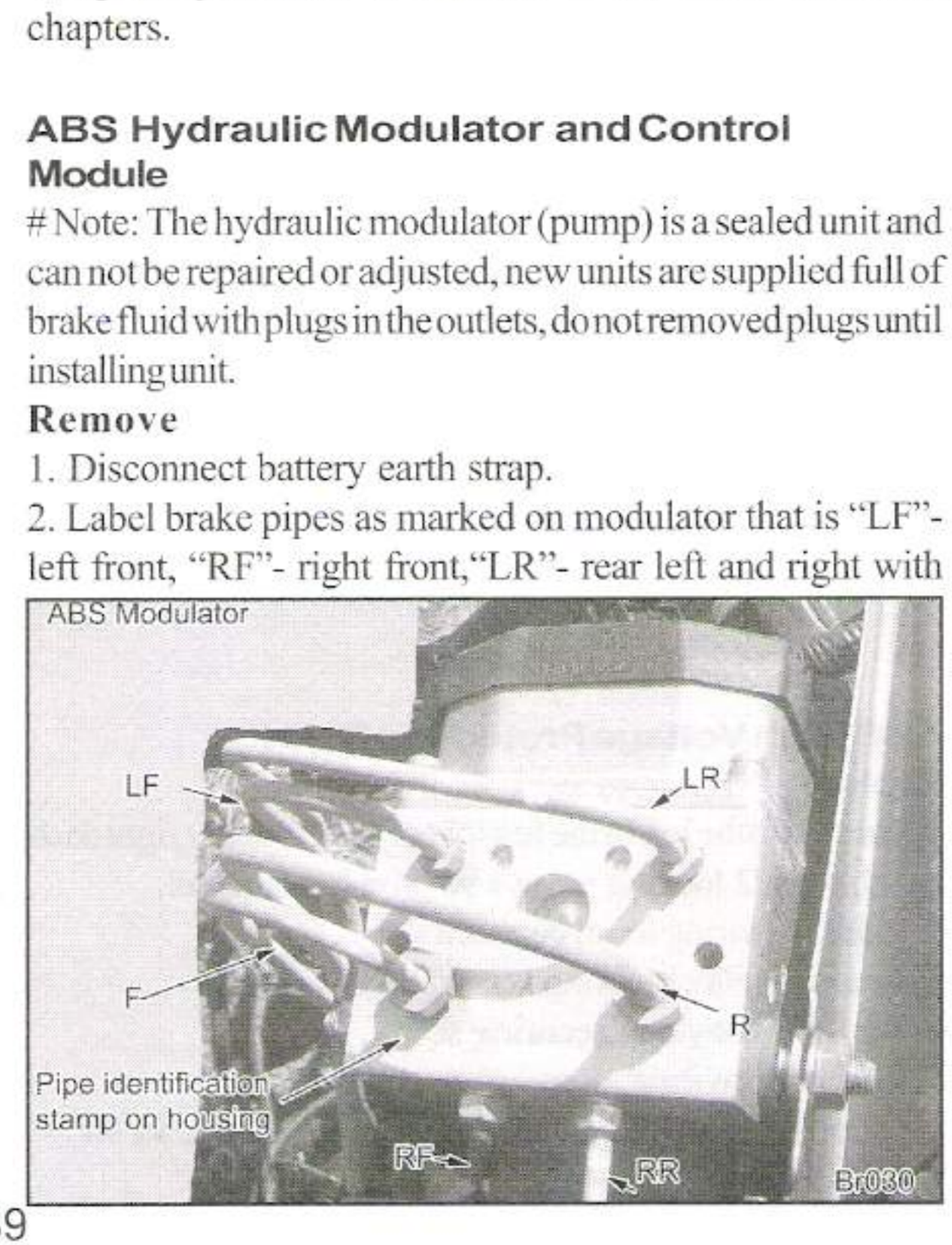
If any component that forms part of the ABS or ABS/ETC (if fitted), is disturbed during service operations, it is important that the complete ABS or ABS/ETC system is checked, using the procedure as detailed in the Brake and ABS chapters.

ABS Hydraulic Modulator and Control Module

Note: The hydraulic modulator (pump) is a sealed unit and can not be repaired or adjusted, new units are supplied full of brake fluid with plugs in the outlets, do not removed plugs until installing unit.

Remove

1. Disconnect battery earth strap.
2. Label brake pipes as marked on modulator that is "LF"- left front, "RF"- right front,"LR"- rear left and right with



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ABS, left rear only with ABS/ETC, "RR"-rear right brakes (ETC only), "F"-master cylinder front, "R"-master cylinder rear.

3. Remove brake pipes, fluid will weep from pipes so place a cloth underneath the modulator.

4. Pull the connector release pin out to release the modulator wiring loom, remove earth strap.



5. Remove 2 mounting nuts and washers, lift unit up and slide out, take care of insulators when lifting out.

6. Separate control module from hydraulic modulator, 6 T-20H Torx screws.

7. Remove spring spacer between control unit and hydraulic modulator.

Install

1. Replace spring spacer between control unit and modulator, outer ends face away from hydraulic modulator.

2. Install control module to hydraulic modulator, 6 T-20H Torx screws.

Control Module to Hydraulic Modulator Screws:3Nm

3. Install modulator and control unit.

(a) Fit insulators to unit, slide unit in and down.

(b) Fit 2 washers and nuts and tighten to specification.

ABS Modulator Attaching Nuts Torque: 5-12Nm

4. Install brake fluid pipes to modulator as per labels, that is "LF"-left front, "RF"-right front, "LR"- left rear right brakes "RR"-rear right brakes (ETC only), "F"-master cylinder front, "R"-master cylinder rear.

5. Replace modulator wiring loom and earth strap.

6. Connect battery earth terminal.

7. Bleed brake system as per normal at wheels.

ABS High Voltage Protection Relay

Replace

1. Located to the left of the fuse panel behind lower right dash panel. Turn 2 locking screws 90⁰ and lower panel.

2. Remove wiring loom connector.

3. Remove relay securing screw, lift out relay.

4. Replace relay and securing screw.

5. Reconnect wiring loom.

6. Lift lower dash panel into place, turn lock screws 90⁰.

Traction Control Switch VT

Remove

1. Lift transmission shift lever center console trim with a screw driver to help unclip tabs.

2. Use a screw driver to push in tabs on switch under console trim to release switch.

3. Disconnect wiring leads, remove switch.

Install

1. Feed wiring through console trim, connect wires to switch.

2. Push the switch into place, until the switch locks into the trim.

3. Replace trim, push firmly into place until tabs lock in.

Traction Control Switch VX on

Remove

1. Remove the instrument cluster surround trim.

a) Lever trim away from dash to allow the removal of harness connector to the different switches.

b) Remove the instrument cluster surround trim.

2. Push the trac control switch tabs in to allow the switch to be removed.

Test

Use an ohm meter to test for continuity between terminals with switch pushed in, if continuity exists, replace switch.



Terminals	Switch pushed IN
1 - 2	no continuity
1 - 5	no continuity
2 - 5	no continuity

Replace if not as specified

Install

1. Position the switch into the instrument cluster trim and push switch in until it locks in place.

2. Position the trim close enough to the dash to allow the

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harness connectors to fitted the switches.

Pulse Rings / Hubs

Front Pulse Rings and Hub

Front hubs for ABS incorporate the pulse rings, there to replace front pulse rings replace front hub as described in "Front Suspension" chapter "Front Wheel Hub and or Steering Knuckle".

Note: Vehicles with ABS need the correct front hub check with part numbers in specifications.

Rear Pulse Rings - IRS differential

Replace

Remove axle drive shaft as described in "Rear Axle" chapter.

1. As the pulse ring and the inner axle are one unit, use a slide hammer to remove inner axle and pulse ring.
2. Install inner axle shaft, align spring clip and diff cone, then tap into place.
3. Install axle drive shaft as described in "Rear Axle" chapter.

Speed Sensor

Front Wheel

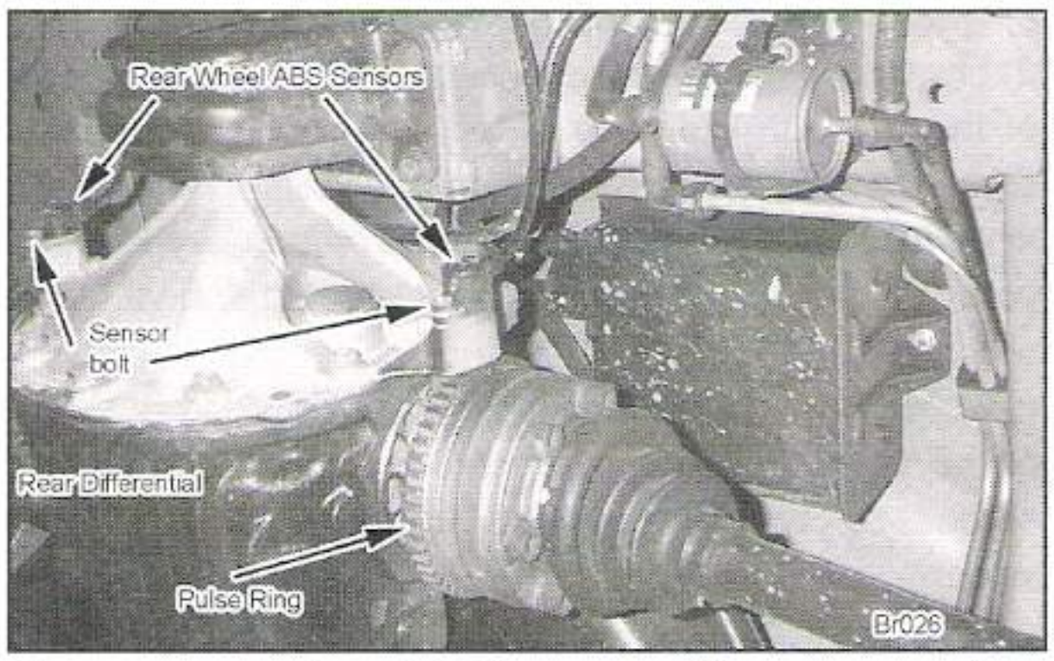
The front wheel ABS or ABS / ETC speed sensor is part of the front wheel hub for removal and installation see "Front Wheel Hub and or Steering Knuckle" in "Front Suspension" chapter.

Rear Wheel IRS

Remove

1. Disconnect sensor harness connector, up on floor pan above differential
2. Unclip sensor lead from differential carrier.
3. Remove the sensor retaining bolt (5mm allen key), remove sensor, do not loose shims if fitted.

Install



Clean sensor and apply high temp melting grease such as Dow Corning FB 180 on surface contacting mounting bracket.

Slide in sensor, fit original shims. Fit retaining bolt and tighten to specification.

Sensor Retaining Bolt Specified Torque: 8-14Nm

Adjust

Use shims to adjust the air gap of the sensor to pulse ring within specification.

IRS - ABS Sensor Air Gap specification. 0.3-1.3mm

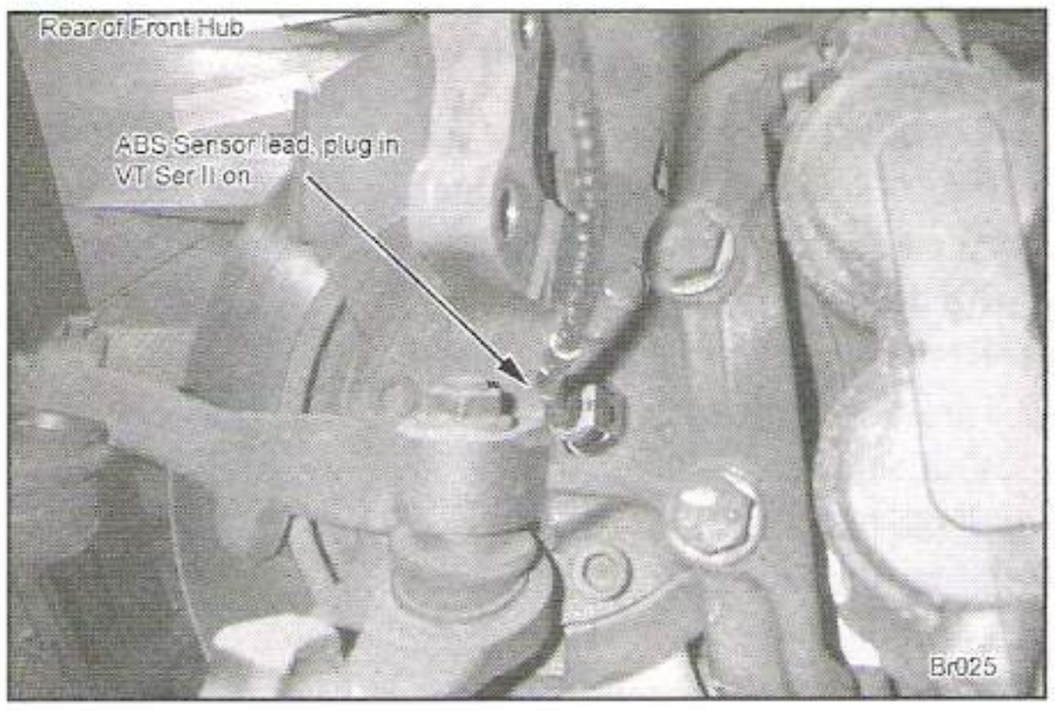
Speed Senor Lead

Front Speed Sensor Lead and Rear Wheel Conventional Diff

Remove

1. Disconnect sensor harness connector, [left side inside engine bay, near suspension tower] [right side near ABS unit] [rear wheel up on floor pan above differential] use a small screw driver to lever apart connector if necessary.
2. Unclip sensor lead from inner fender panel.
3. [VT I: Remove the sensor lead retaining bolt (5mm allen key)], remove sensor lead separate lead from sensor.

Test



Use an ohm meter to test sensor lead for continuity, if the lead does not test infinity on each separate wire, replace.

Install

1. Fit new "O" ring slide in sensor. Fit retaining bolt and tighten to specification. Connect lead to sensor

VT I: Sensor Lead Retaining Bolt: 8-14Nm

2. Clip sensor lead to inner fender panel.
3. Reconnect sensor lead to harness. [Left side inside engine bay, near suspension tower] [right side near ABS unit] [rear wheel up on floor pan above differential].

Throttle Relaxer Control Module

Remove

1. Disconnect battery earth cable,
1. Remove passenger side kick trim, throttle relaxer control module is located with the ECU and PCM
2. Disconnect harness connector to throttle relaxer control module, by lifting the connector locking lever and pulling the connector from the module.
3. Remove control module by using a screw driver to lever the lower part of the module away from the body panel, pull module way and down to free tabs

Install

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1. Replace control module slide module in and up at the top of the module, push lower section in to body to clip in tabs. .
2. Connect wiring harness to module, pull down connector locking lever.
3. Replace passenger side kick trim.
4. Reconnect battery earth cable, turn ignition ON ABS and ABS / ETC lights should glow for 2-5 seconds then turn off, If the lights continue to glow check operational chart in the "ABS & ABS / ETC" chapter..

Throttle Relaxer Unit

Remove

1. Remove cover.
2. Remove the cables connected to the pulley's.
3. Remove the electrical connection.
4. Remove the 2 attaching nuts to the fire wall.

Install

1. Install unit to firewall, 2 nuts.
2. Connect wiring connector.
3. Connect cables to the pulley's, center pulley for throttle cable, outside pulley for cruise control cable and inside pulley for a cable from the throttle relaxer to the throttle body.

Adjustment of Throttle Cables

1. Remove engine top cover, 4 nuts.
2.Throttle is fully closed, no weight on accelerator pedal.
3. Cable adjuster unlocked, pull back on accelerator cable until the throttle cam starts to move.
4. Move the accelerator cable towards the throttle cam until the throttle cam is back at rest, lock the cable locking lever.
Note: A small amount of slack for the inner cable is ideal.
5. If you have a TECH 2 instrument check throttle reads 100% when fully open and zero when the cable has no tension on it.
6. Install engine top cover, 4 nuts.

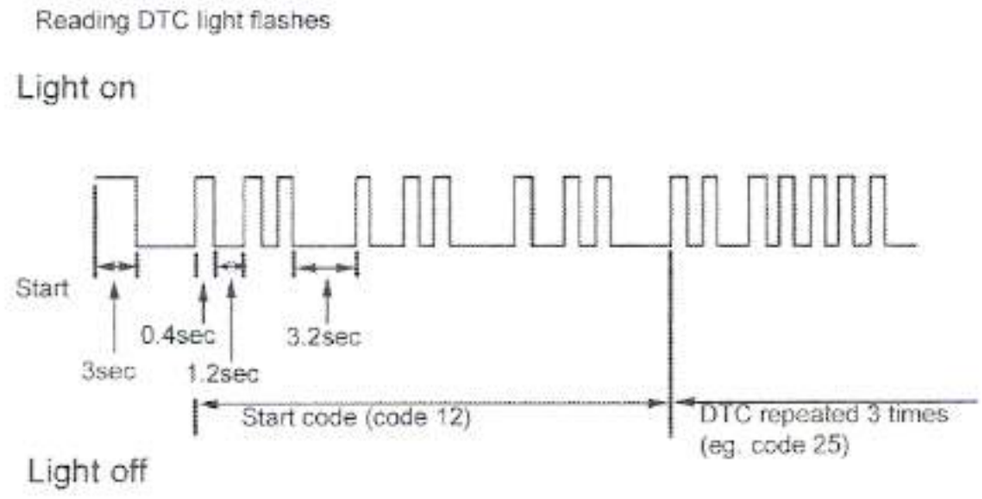
ABS and ABS/ETC Self Diagnosis

The ABS or ABS/ETC control module will set a fault codes if one is detected, the control module is capable of storing 3 fault codes at any one time.
If a fault is detected and still occurring the ABS or ABS/ETC warning light will glow, however if the fault is corrected the light will not glow but the fault code will be stored in the control module until cleared.
The ABS control module can set 21 fault codes, while the ABS/ETC control module can set 29 fault codes.

Reading ABS and ABS/ETC Fault Codes

There are 2 methods of reading these codes:
1. Read flashes of the ABS warning light.
OR
2. Use a TECH 2 tool connected to the DLC connector.

1. Read flashes of the ABS warning light.



D25a

Vehicle stationary, short the DLC terminal number 12 (blue/black wire) terminal to earth terminal number 5 (black wire), turn ignition switch ON. After approx. 3 seconds the ABS warning light will start to flash codes. DTC code 12 will start the process, this code will flash 3 times, then each code stored will flash 3 times. The code display flashing will continue to repeat starting with code 12 while the DLC terminal 12 is earthed.
Note: Fault codes 41, 42, 45, 46, 47, 48, 55, 56, 61 and 63 will not flash the ABS warning light.

and read the flashes of the ABS warning light.

2. Connect a TECH 2 Instrument

Connect a TECH 2 instrument to the DLC and read codes as per instrument instructions and menu.

Clearing ABS or ABS/ETC DTC Codes

There are 3 methods of clearing codes.
Note: All codes must be displayed before the codes can be cleared.

1. Diagnostic Request Line Procedure

a) Ignition OFF
b) At the DLC short out terminals 12 (blue/black) to terminal 5 (black) with a test wire.

c) Ignition ON, this will display all codes.
d) Once all codes have been displayed. Disconnect an end of the test wire from one of the terminals, for approx. 1 second, then connect again for at least 1 second. Repeat the disconnect and reconnect 2-3 times within a 10 second period. Leave the test wire connected after the final reconnection.
c) Check the ABS warning (read out) light, code 12 should be the only code flashing. Leave code flashing for at least 15 seconds before turning ignition OFF and disconnecting test wire.
If codes other than code 12 were flashing at the end of step (e) the codes have not been cleared. Repeat procedures (a) to (e).

2. Using a TECH 2 Instrument

a) Connect a TECH 2 instrument and clear codes as per instructions from menu.
b) Check codes have been cleared.

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	ABS, ABS/ETC Operational Test		
No	Test	Yes	No
1	Visual inspection	Go to test 2	Perform visual inspection
2	Check brake warning light, turn key to ON then to Start. Is light ON?	Go to test 3	Check warning lamp circuit sec 12c
3	Turn ignition OFF. check ABS or ABS & TRAC OFF light. Lights should glow for 3-5 seconds, 2 seconds if engine is started.	Go to test 7	Go to test 4
4	Connect TECH 2 to DLC, dial Chasis / ABS/ETC, press CONFIRM. Screen should indicate system information.	Go to test 5	Check DTC 72, serial data fault.
5	Use TECH 2 to check for diagnositc fault codes.	Go to test 6	Check warning light fault chart.
6	Use TECH 2 to check for ignition cycles, are they zero?	Check ABS / ABS/ETC diagnostic chart	Check for intermittent faults.
7	Perform road test, to 35km/h plus. Does ABS light turn on.	Go to test 5	Go to test 8
8	While road testing did the brake warning light turn on?	Check brake system	Go to test 10
9	While road testing did brake system perform OK?	Go to test 10	Check brake system
10	Connect TECH 2, Ignition on. Check for ABS history DT codes.	Check DTC codes faults	Check for intermittent faults. ABSoperatCk

3. Ignition Cycle Default

The fault code will be erased if there are 100 ignition cycles without the problem resetting the code fault. The ignition cycle counter will then return to zero.

Intermittent Fault Check

Intermittent Fault Check Chart

1	Wiring harness connectors not connected properly
2	Damaged terminal in a harness connector
3	Wire to terminal connection damaged
4	Visually inspect speed sensors for loosens or contamination.
5	Speed sensor harness near spark plug leads ABS and ABS/ETC system is very sensitive, there fore check!
6	Check installation of accessories such as Radio/CD, Phone, Driving lights.
7	Faulty spark plug leads, check resistance

The basic brake system is the same except for the speed senors and ABS / ABS/ETC unit is installed.

Problem Diagnosis

ABS Operational Check Chart 293

Visual Inspection chart 294

ABS Codes and Possible Faults 295

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ABS, ABS/ETC Visual Inspection		
Component	Inspection	Action
Wheel / Tyres	Are the wheels and tyres recommended size?	Install recommended wheels and tyres
Brake Fluid	Check fluid level	Top up if required
Master cylinder and booster	Correct installation?	Install correctly
Hydraulic modulator	External leaking	Tighten fittings or replace modulator
Parking brake	Operating and releasing?	Correct and adjust if necessary
ABS fusable link in engine bay	Blown link	Replace link and correct problem
ABS fuse (No 27 passenger compartment)	Blown fuse	Replace fuse and correct problem
Warning light fuse (No 13 passenger compartment)	Blown fuse	Replace fuse and correct problem
Stop light fuse (No 5 passenger compartment)	Blown fuse	Replace fuse and correct problem
ABS ABS/ETC module wiring harness connector	Inspect	Disconnect and connect, repair if required
Main harness to front wheel speed sensor connectos	Inspect	Disconnect and connect, repair if required
Hydraulic modulator harness connector	Inspect	Disconnect and connect, repair if required
Main wiring harness connector to body harness	Inspect	Disconnect and connect, repair if required
4 wheel speed sensor connectors	Inspect ABSvisinspt	Disconnect and connect, repair if required

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			ABS and ABS/ETC - Diagnostic Code Faults with possible causes.
DTC	ABS or ABS/ETC	DTC Fault	Possible causes and actions
12	Both	DTC start up code	
21	Both	Front right wheel speed sensor faulty signal	* Jack up wheel, ignition ON, back probe wiring connectors(YE71), circuit 872 and 873, check for pulse and check if pulse alters with speed of wheel. * Damaged sensor or pulse ring - replace * Check wiring and connecors, circuit 872 (white) and 873 (red), for continuity - repair as necessary. * Connect TECH 2 check for faulty control module - replace control module
23	Both	Front right wheel speed sensor short or open circuit	* Check wiring and connecors, circuit 872 (white) and 873 (red), for continuity - repair as necessary. * Check resistance of sensor on lead at connector(YE71), should be 1600-1800ohms - if not replace sensor and lead. * Disconnect control module connector (YE98 & YE71) check for open or short - replace if necessary * Connect TECH 2, recheck for code - replace control module
25	Both	Front left wheel speed sensor faulty signal	* Jack up wheel, ignition ON, back probe wiring connectors(YE71), circuit 830 (Brown) and 833(Grey), check for pulse and check if pulse alters with speed of wheel.. * Damaged sensor or pulse ring - replace * Check wiring and connectors, circuit 830 (brown) and 833 (grey), for continuity - repair as necessary. * Connect TECH 2 check for faulty control module - replace control module
27	Both	Front left wheel speed sensor short or open circuit	* Check wiring and connecors, circuit 830(brown) and 833 (grey), for continuity - repair as necessary. * Check resistance of sensor on lead at connector(YE71), should be 1600-1800ohms - if not replace sensor and lead. * Disconnect ABS control module connector (YE98 & YE71) check for open or short - replace if necessary * Connect TECH 2, recheck for code - replace control module
28	Both	Wheel speed sensot frequency incorrect	* Visual check front sensor wiring and connectors - replace if required. * Check between ABS terminals and connector (YE98) at module for continiuty - repair as required * Check wiring as per codes 23, 27, 33 and 37 - repair as required
31	Both	Rear right wheel speed sensor faulty signal	* Jack up wheel, ignition ON, back probe wiring connectors(YR34), circuit 882 (black) and 883(blue), check for pulse and check if pulse alters with speed of wheel. * Damaged sensor or pulse ring - replace * Check wiring and connecors, circuit 882 (black) and 883 (grey), for continuity - repair as necessary. * Connect TECH 2 check for faulty control module - replace control module
33	Both	Rear right wheel speed sensor short or open circuit	* Check wiring and connecors, circuit 882 (black) and 883 (grey), for continuity - repair as necessary. * Check resistance of sensor on lead at connector(YR34), should be 1600-1800ohms - if not replace sensor and lead. * Disconnect control module connector (YE98 & YR34) check for open or short - replace if necessary * Connect TECH 2, recheck for code - replace control module
35	Both	Rear left wheel speed sensor faulty signal	* Jack up wheel, ignition ON, back probe wiring connectors(YR34), circuit 884 (voilet) and 885(yellow), check for pulse and check if pulse alters with speed of wheel. * Damaged sensor or pulse ring - replace * Check wiring and connecors, circuit 884 (voilet) and 885 (yellow), for continuity - repair as necessary. * Connect TECH 2 check for faulty control module - replace control module

ABSdtcodes1

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			ABS and ABS/ETC - Diagnostic Code Faults with possible causes.
DTC	ABS or ABS/ETC	DTC Fault	Possible causes and actions
37	Both	Rear left wheel speed sensor short or open circuit	* Check wiring and connecors, circuit 884 (voilet) and 885 (yellow), for continuity - repair as necessary. * Check resistance of sensor on lead at connector(YR34), should be 1400-1760ohms - if not replace sensor and lead. * Disconnect control module connector (YE98 & YR34) check for open or short - replace if necessary * Connect TECH 2, recheck for code - replace control module
41	Both	Front right inlet valve solenoid	* Codes 41 to 56 are all solenoid faults. * Check for codes between 41 and 56, they may have a common fault * Check for constant approx 12 volts at ABS control module connector (YE98) terminals 17 and 18, circuit 23(red), if not - repair short or open in circuit 23 * Ignition ON, Check for constant approx 12 volts at ABS control module connector (YE98) terminals 15 and circuit 885(red), if not - repair short or open in circuit 885 including fuse F27 * Check for continuity at ABS control module connector (YE98) terminal 16 circuit 154(black/orange) and ABS bracket (E2) in engine bay, if not - repair open in circuit 154 * Check for continuity at ABS control module connector (YE98) terminal 19 circuit 150(black) and earth (E3) in engine bay, - if continuity try a new modulator and control module - if no continuity repair open in circuit 150
42	Both	Front right outlet valve solenoid	As for DTC 41
45	Both	Front left inlet valve solenoid	As for DTC 41
46	Both	Front left outlet valve solenoid	As for DTC 41
47	ABS/ETC	Priming valve solenoid	As for DTC 41
48	ABS/ETC	Switiching valve solenoid	As for DTC 41
51	ABS/ETC	Rear right inlet valve solenoid	As for DTC 41
52	ABS/ETC	Rear right outlet valve solenoid	As for DTC 41
55	ABS	Rear axle inlet valve solenoid	As for DTC 41
55	ABS/ETC	Rear left inlet valve solenoid	As for DTC 41
56	ABS	Rear axle outlet valve solenoid	As for DTC 41
56	ABS/ETC	Rear left outlet valve solenoid	As for DTC 41

ABSdtcodes2

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			ABS and ABS/ETC - Diagnostic Code Faults with possible causes.
DTC	ABS or ABS/ETC	DTC Fault	Possible causes and actions
61	Both	Pump motor or relay faulty	* Check if common power supply fault to control module and hydraulic modulator * Check hydraulic modulator harness connector - if OK next step - if not OK repair and recheck. * Use TECH 2 tool to activate hydraulic modulator - replace modulator if not operating. * Check for constant approx 12 volts at ABS control module connector (YE98) terminals 17 and 18, circuit 23(red), if not - repair short or open in circuit 23 * Ignition ON, Check for constant approx 12 volts at ABS control module connector (YE98) terminals 15 and circuit 885(red), if not - repair short or open in circuit 885 including fuse F27 * Check for continuity at ABS control module connector (YE98) terminal 16 circuit 154(black/orange) and ABS bracket (E2) in engine bay, if not - repair open in circuit 154 * Check for continuity at ABS control module connector (YE98) terminal 19 circuit 150(black) and earth (E3) in engine bay, - if continuity try a new modulator and control module - if no continuity repair open in circuit 150
62	ABS/ETC	RPM signal incorrect	* Check for continuity at ABS control module connector (YE98) terminal 30 circuit 121(brown/red) and DIS module connector (YE57) terminal E (brown) - if continuity try a new control module - if no continuity repair open in circuit 121
63	Both	Valve solenoid relay circuit faulty	* Connect TECH 2 to check operation of valve * Check for constant approx 12 volts at ABS control module connector back probe (YE98) terminals 17 and 18, circuit 23(red), if not - repair short or open in circuit 23 * Ignition ON, Check for constant approx 12 volts at ABS control module connector back probe (YE98) terminals 15 and circuit 885(red), if not - repair short or open in circuit 885 including fuse F27 * Check for continuity at ABS control module connector (YE98) terminal 16 circuit 154(black/orange) and ABS bracket (E2) in engine bay, if not - repair open in circuit 154 * Check for continuity at ABS control module connector (YE98) terminal 19 circuit 150(black) and earth (E3) in engine bay, - if continuity try a new modulator and control module - if no continuity repair open in circuit 150
67	Both	Stop light switch vircuit faulty	* Check for approx 12 volts at ABS control module connector back probe (YE98) terminals 14, circuit 20(blue/red) with brakes applied - if not - if continuity try a new control module - if not check brake lights operate * Check brake lights glow when brakes applied - if yes go to next step check circuit 20 - if no below, check circuit 840 * Disconnect control modual connector (YE98) and stop light switch connector (YB161). Check for continuity at ABS control module connector (YE98) terminal 14 circuit 20(blue/red) and stop light switch connector (YB161) - if yes check all harnesses and connectors - if not repair open in circuit 20 * Check, back probe for battery volts at stop light switch connector (YB161) circuit 840(orange/blue) and earth - if yes check circuit 20 below - if not repair short or open in circuit 840 including fuse F5 * Check, back probe for battery volts at stop light switch connector (YB161) circuit 20(blue/red) and earth - if yes system is OK - if not repair stop light switch
71	Both	Control modual internal fault	* Check and repair any other DTC faults * Road test check for DTC 71 - if so continue steps below. - if not check for intermitant faults caused by faulty harness or connectors * Disconnect control modual connector (YE98). Ignition ON. Check for battery voltage at ABS control module connector (YE98) between terminals 15 and 19 - if yes continue steps below - if not check voltage and earth to control module as in these charts, then recheck. * Check for intermitant faults caused by faulty harness or connectors. * Check for all DTC's, clear and recheck if DTC 71 still present - if yes try a new control module - if no system OK ABSdtcodes3

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			ABS and ABS/ETC - Diagnostic Code Faults with possible causes.
DTC	ABS or ABS/ETC	DTC Fault	Possible causes and actions
72	ABS/ETC	Data fault	* Check and repair any other DTC faults * Road test check for DTC 72 - if so continue steps below. - if not check for intermitant faults caused by faulty harness or connectors * Did TECH 2 communicate with ABS control module - if not try a new ABS control module * Did TECH 2 communicate with Body control module - if not try a new Body control module * Are there other data faults for other control modules - if so check cxircuit 1220 * Check for open or short in circuit 1220 (green/white wire) between Body control module and other control modules - repair as required * Disconnect Body control modual connector (YB164) or (YB175) and ABS/ETC control module connector (YB98). Check for continuity between (YB164) terminal 3 or (YB175) terminal 9 and ABS/ETC control module connector (YE98) terminal 11 circuit 1220 (green/white) - if yes try a new ABS/ETC control module - if not repair circuit 1220 between body control module and ABS/ETC control module
73	ABS/ETC	Requested torque circuit fault	* Ignition ON, Check for 95-105Hz and 4.2-4.8 volts at ABS/ETC control module connector back probe (YE98) terminals 13 circuit 1426 (orange/white) to earth - if OK got to next step. - if not try a new ABS/ETC control module * Ignition ON, Check for 95-105Hz and 0.1-1.0 volts at PCM connector back probe (YB194) terminals F7 circuit 1427 (blackwhite) to earth - if OK got to next step. - if not try a new PCM * Ignition ON, Check for 95-105Hz and 0.1-1.0 volts at ABS/ETC control module connector back probe (YE98) terminals 27 circuit 1427 (black/white) to earth - if OK got to next step. - if not repair short or open in circuit 1427, then recheck * Road test, recheck for DTC 73 with TECH 2 - if so try a new ABS/ETC control module - if no DTC73 check for intermittant fault
74	ABS/ETC	Actual torque circuit fault	* Ignition ON, Check for 95-105Hz and 0.1-1.0 volts at ABS/ETC control module connector back probe (YE98) terminal 27 circuit 1427 (black/white) to earth - if OK got to last step - if not go to next step * Ignition ON, Check for 95-105Hz and 0.1-1.0 volts at PCM connector back probe (YB194) terminals F7 circuit 1427 (blackwhite) to earth - if OK repair short or open in circuit 1427 - if not go to next step * Ignition ON, Check for 95-105Hz and 4.2-4.8 volts at PCM connector back probe (YB193) terminals C11 circuit 1426 (orange/white) to earth - if OK try a new PCM - if not go to next step * Ignition ON, Check for 95-105Hz and 4.2-4.8 volts at ABS/ETC control module connector back probe (YE98) terminal 13 circuit 1426 (orange/white) to earth - if OK repair short or open in circuit 1426 - if not try a new ABS/ETC control module * Road test, recheck for DTC 74 with TECH 2 - if so try a new ABS/ETC control module - if no DTC74 check for intermittant fault
78	ABS/ETC	Incorrect optional coding	* Check that the correct ABS/ETC control module and associated modules are for this vehicle - if OK go to next satep - if not replace with correct module * Check with TECH 2 for other DTC's - if sorepair faults and clear codes - if not go to steps below. * Check with TECH 2 for other DTC's and DTC 78 - if codes are present try a new control module - if not check for intermittant faults.
85	Both	Voltage to low	* Check with TECH 2 for above10 volts at body control module with engine idling - if above 10 volt and no other DTC check for other problems - if not above 10 volts go to next step. * Check battery terminal voltage if not above 10 volts - if 10 or more volts go to next step - if not check alternator system * Disconnect control modual connector (YE98). Ignition OFF. Check for battery voltage at ABS control module connector (YE98) between terminal 15 - if yes continue to next step - if not check and repair for open or short in circuit 855 (red wire) and fuse F27 * Check for faulty connection between ABS/ETC control module and circuit 855 - if faulty repair - if not faulty try a new ABS/ETC control module

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			ABS and ABS/ETC additional Gen III - Diagnostic Code Faults with possible causes.
DTC	ABS or ABS/ETC	DTC Fault	Possible causes and remedies
58	Both	Throttle Relaxer PWM Interface Fault	* Check for resistance of 0 - 5 ohms at throttle relaxer control module connector, disconnect, (YE170) terminals 28, circuit 750 (black/red) and earth at engine block - if OK go to next step, - if not repair short or open in circuit 750 * Check for resistance of 0 - 5 ohms at throttle relaxer control module connector, disconnect, (YE170) terminals 55, circuit 750 (black/red) and earth at engine block - if OK go to next step, - if not repair short or open in circuit 750 * Ignition ON, Connector (YE170) still disconnected. Check for constant approx 12 volts at throttle relaxer control module terminals 1 and 28 - if OK go to next step, - if not repair circuit 855 * Check for open or short at ABS control module connector (YE98) terminal 13 circuit 1426 (orange/white) and connector (YE170) terminal 37, both connectors disconnected - if OK go to next step. - if not repair open or short in circuit 1426. * Check for open or short at ABS control module connector (YE98) terminal 27 circuit 1427 (blacke/white) and connector (YE170) terminal 35, both connectors disconnected - if OK and problem still exists replace throttle relaxer control modualp. - if not repair open or short in circuit 1426
62	Both	RPM Signal Fault	* Disconnect engine connector (YE112) and ABS/ETC control module connector (YE98). Check for continuity between (YE112) and ABS/ETC control module connector (YE98) terminal 30 circuit 121 (brown) - if OK and problem still exists try a new ABS/ETC control module - if not repair circuit 121 between engine connector and ABS/ETC control module
64	Both	Throttle Relaxer Control Module Position Fault	* Check for other DTC fault codes - if other codes repair other code problems first - if no other codes go to next step * Disconnect throttle relaxer connectorr (YB170),throttle position sensor harness connector (YE30) and PCM harness connector (Y120). Check for resistance of 0-5ohms between (YB170) terminal 40 and throttle position sensor connector (YE30) terminal C circuit 417 (blue) - if OK go to next step - if not repair circuit 417 between connectors YB170 and YE30. * Disconnect throttle relaxer connectorr (YB170),throttle position sensor harness connector (YE30) and PCM harness connector (Y120). Check for resistance of 0-5ohms between (YB170) terminal 41 and throttle position sensor connector (YE30) terminal A circuit 416 (grey) - if OK go to next step - if not repair circuit 416 between connectors YB170 and YE30 * Disconnect throttle relaxer connectorr (YB170),throttle position sensor harness connector (YE30) and PCM harness connector (Y120). Check for resistance of 0-5ohms between (YB170) terminal 43 and throttle position sensor connector (YE30) terminal B circuit 452 (black/yellow) - if OK and fault stillexists try a new throttle relaxer control module - if not repair circuit 452 between connectors YB170 and YE3

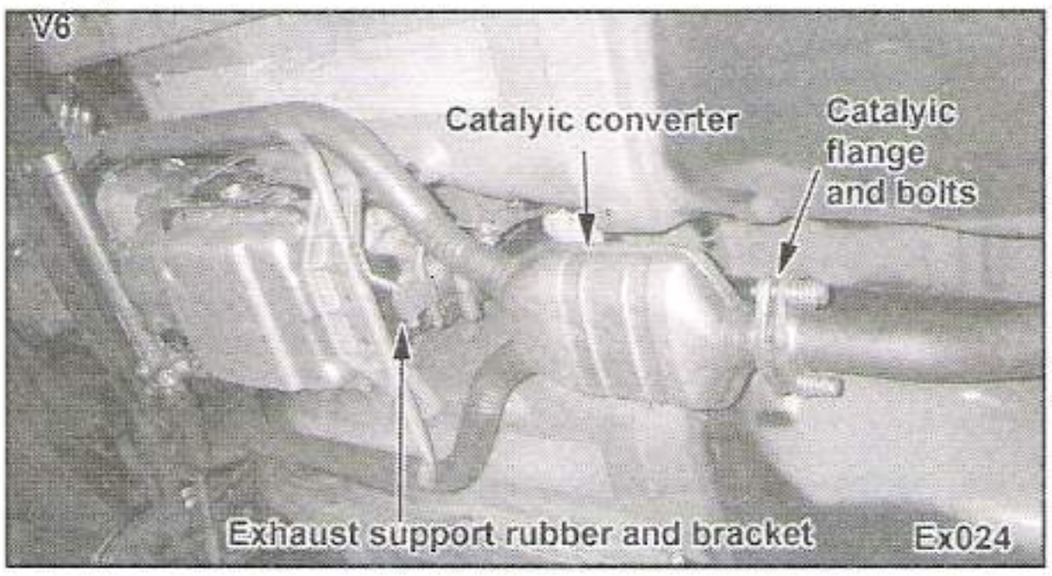
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			ABS and ABS/ETC additional Gen III - Diagnostic Code Faults with possible causes.
65	Both	Throttle Relaxer Motor Fault	* Check for resistance of 0 - 5 ohms at throttle relaxer control module connector, disconnect, (YE170) terminals 28, circuit 750 (black/red) and earth at engine block - if OK go to next step, - if not repair short or open in circuit 750 * Check for resistance of 0 - 5 ohms at throttle relaxer control module connector, disconnect, (YE170) terminals 55, circuit 750 (black/red) and earth at engine block - if OK go to next step, - if not repair short or open in circuit 750 * Connector (YE170) disconnected. Check for constant approx 12 volts at throttle relaxer control module terminal 51 and 28 - if OK go to next step, - if not repair circuit 490 and fuse F36 * Connector (YE170) disconnected. Check for constant approx 12 volts at throttle relaxer control module terminal 24 and 28 - if OK go to next step, - if not repair circuit 490 and fuse F36 * Ignition OFF, disconnect throttle relaxer connector (YE127), remove all cables from throttle relaxer pulleys then turn pulleys and allow to return to pulley stop repeat this 2-3 times, check for 0.5 - 10 ohms resistance between connector (YE127) terminals A and B - if OK go to next step - if not OK try a new throttle relaxer assembly. * Disconnect throttle relaxer control module connector (YB170) and throttle relaxer connector (YE127) . Check for resistance of 0-5ohms between (YB170) terminal 22 and throttle relaxer connector (YE127) terminal A circuit 456 (red/white) - if OK go to next step - if not repair circuit 456 * Disconnect throttle relaxer control module connector (YB170) and throttle relaxer connector (YE127) . Check for resistance of 0-5ohms between (YB170) terminal 49 and throttle relaxer connector (YE127) terminal A circuit 456 (red/white) - if OK go to next step - if not repair circuit 456 * Disconnect throttle relaxer control module connector (YB170) and throttle relaxer connector (YE127) . Check for resistance of 0-5ohms between (YB170) terminal 26 and throttle relaxer connector (YE127) terminal B circuit 466 (red/black) - if OK go to next step - if not repair circuit 466 * Disconnect throttle relaxer control module connector (YB170) and throttle relaxer connector (YE127) . Check for resistance of 0-5ohms between (YB170) terminal 53 and throttle relaxer connector (YE127) terminal B circuit 466 (red/black) - if OK go to next step - if not repair circuit 466 * Disconnect throttle relaxer control module connector (YB170) . Check for infinite resistance between (YB170) terminal 28 circuit 750 (black/red) and terminal 22 circuit 456 (red/white) - if OK go to next step - if not repair circuit 456 * Disconnect throttle relaxer control module connector (YB170) . Check for infinite resistance between (YB170) terminal 28 circuit 750 (black/red) and terminal 26 circuit 466 (red/black) - if OK go to next step - if not repair circuit 466 * Disconnect throttle relaxer connector (YE127) . Ignition ON. Check for greater than 1volt at (YB170) terminal A circuit 456 (red/white) - if more than 1 volt repair short in circuit 456 - if not go to next step * Disconnect throttle relaxer control module connector (YB170) and throttle relaxer connector (YE127).. Ignition ON. Check for greater than 1volt at (YE127) terminal B circuit 466 (red/blacke) - if more than 1 volt repair short in circuit 466 - if no try a new throttle relaxer control module
66	Both	Throttle Relaxer Control Fault	* Check operation of all cables, make sure none are binding or stiff. * Check operation of throttle pulley's, remove cables move pulley's make sure they return to the stop. * Check for any PCM DTC faults, repair and clear faults if required * * Ignition ON, Check voltage at ABS/ETC control module connector back probe (YE98) terminal 27 circuit 1427 (black/white) to earth, move throttle, throttle closed should rerad approx 1 volt, throttle wide open should read approx 10 volts - if so try anew ABS/ETC control module. - if not try a new throttle relaxer control module

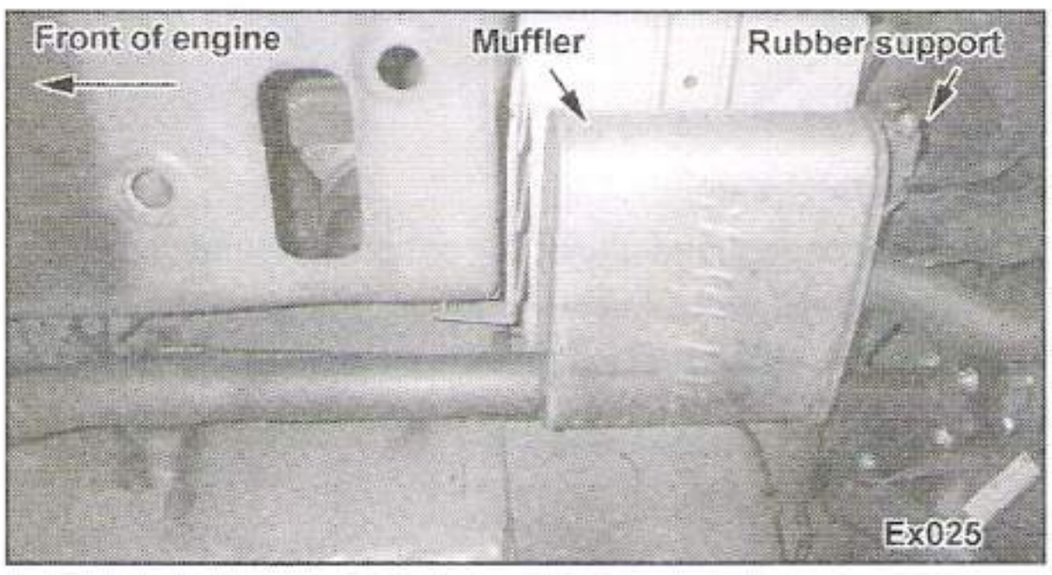
EXHAUST SYSTEM

GENERAL DESCRIPTION - V6

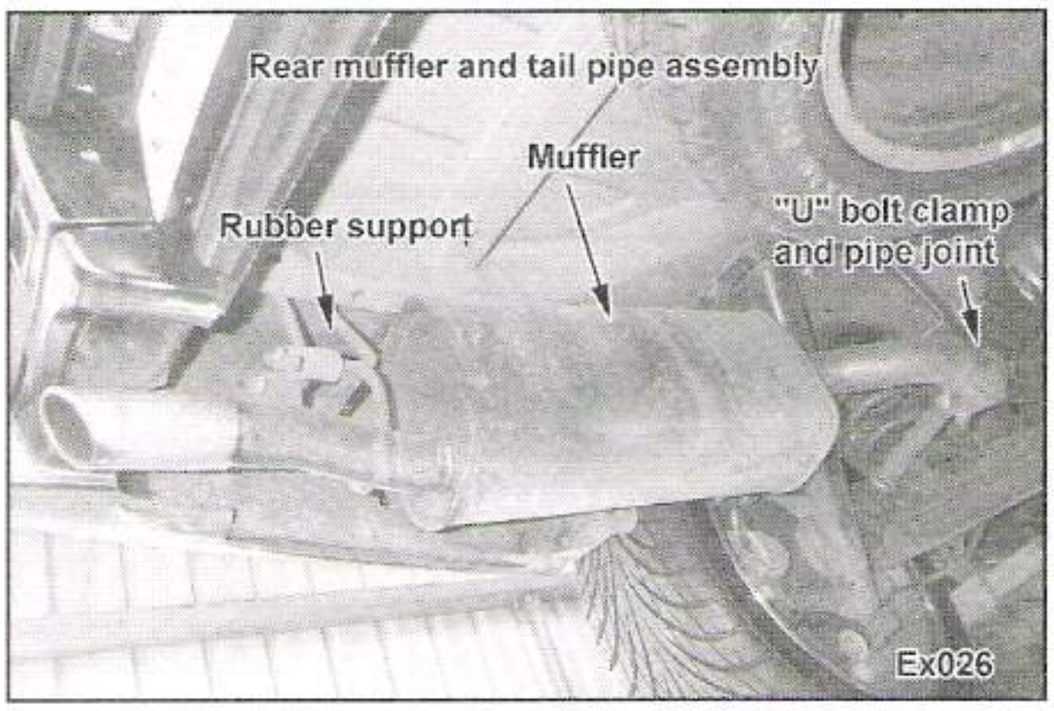
V6 engines are fitted with a single pipe exhaust system, dual pipes from the engine to the catalyic converter then to a single pipe. Supported by a rubber insulator at the rear of the transmission, at the end of the muffler and at the rear of the tail pipe.



Exhaust manifolds are connected to a split system front pipe which feeds into one pipe just before the catalytic converter joining flange. After the catalytic converter a centre pipe and muffler assembly is bolted via a flange, this assembly takes the exhaust fumes towards the rear of the car.



A tail pipe fits onto the centre pipe, this pipe goes over the differential and has a muffler just prior to the back bumper bar assembly. It is this pipe and muffler assembly which most frequently requires replacing due to condensation and rust



within the muffler. Each type of body style has its own specific tail pipe and muffler assembly.

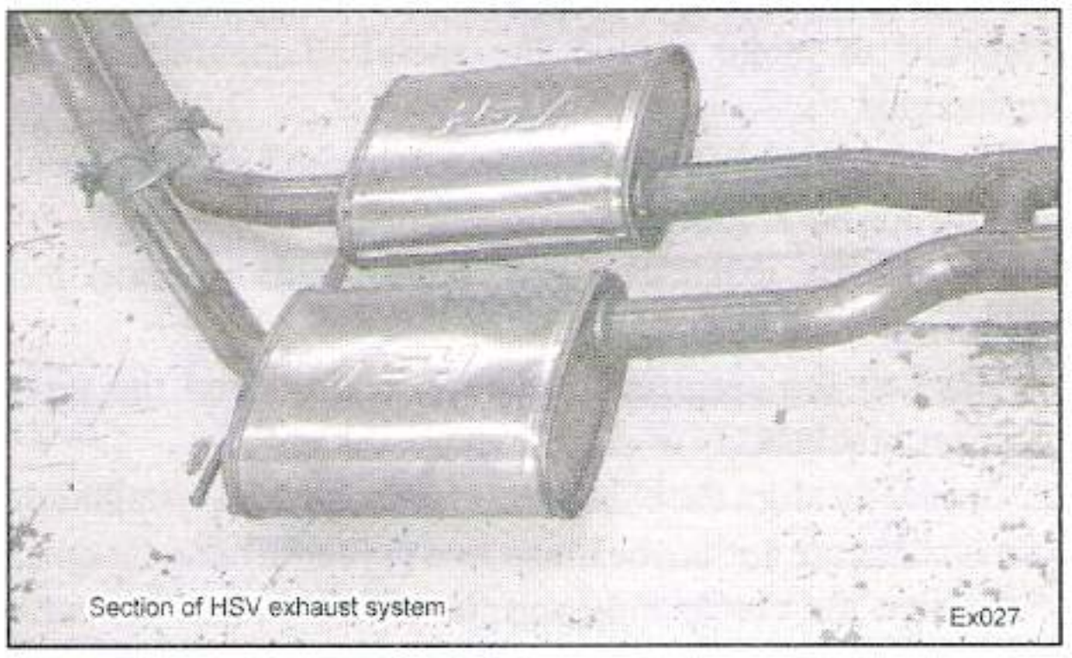
GENERAL DESCRIPTION - V8

VT SerI V8 pwered vehicles have a split system to the rear pipe and muffler.

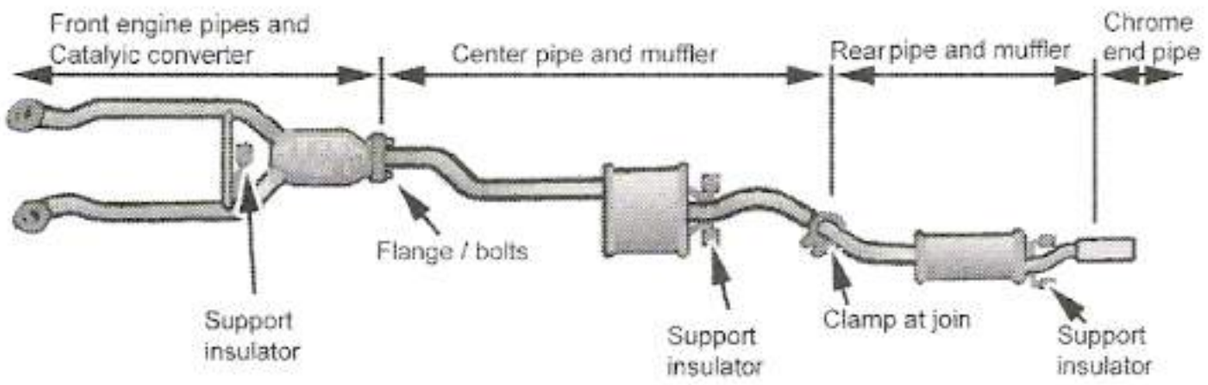
V8 Gen III have a similar system to VT SerI, however there are differences.

GENERAL DESCRIPTION - HSV

HSV Vehicles have their own seperate exhaust systems, including special mufflers and exhaust pipes.

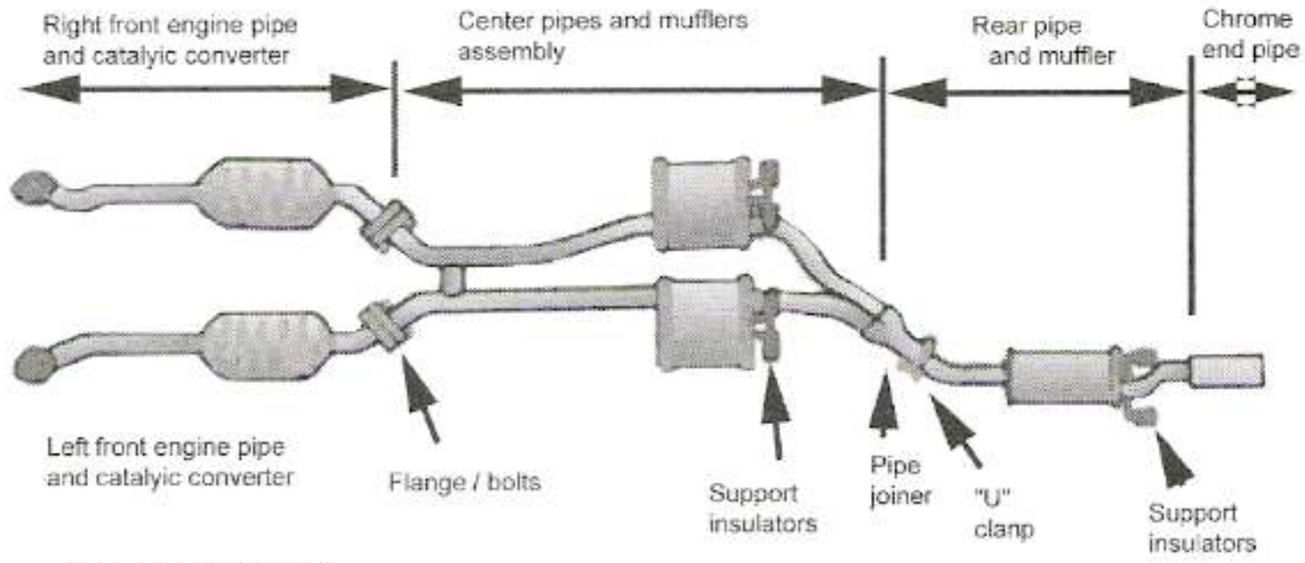


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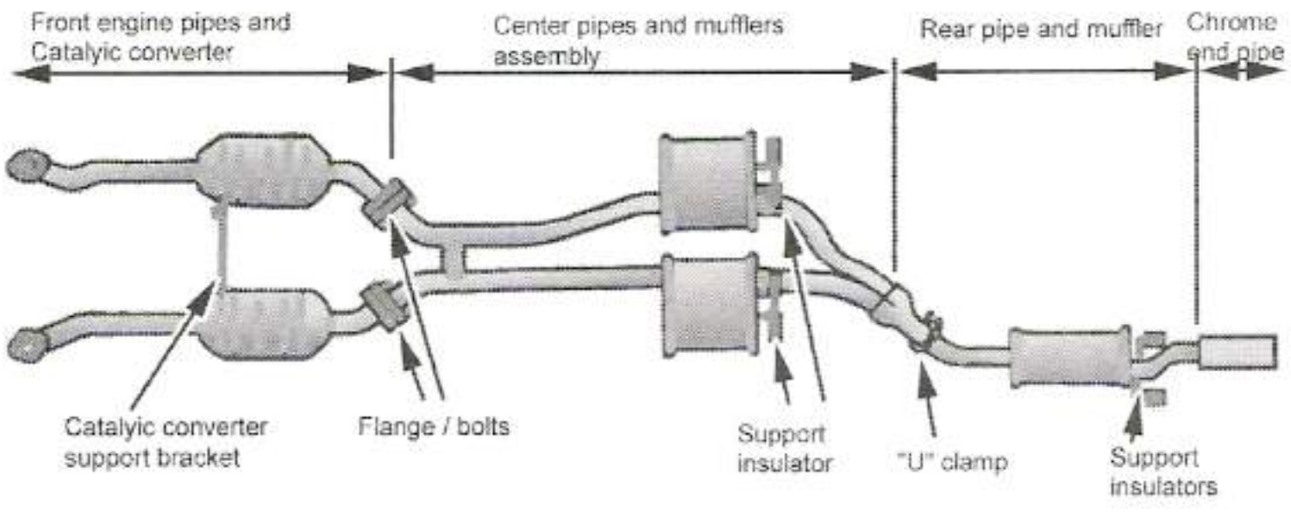
V6 Engines

Ex020



Supercharged V6 and V8

Ex021

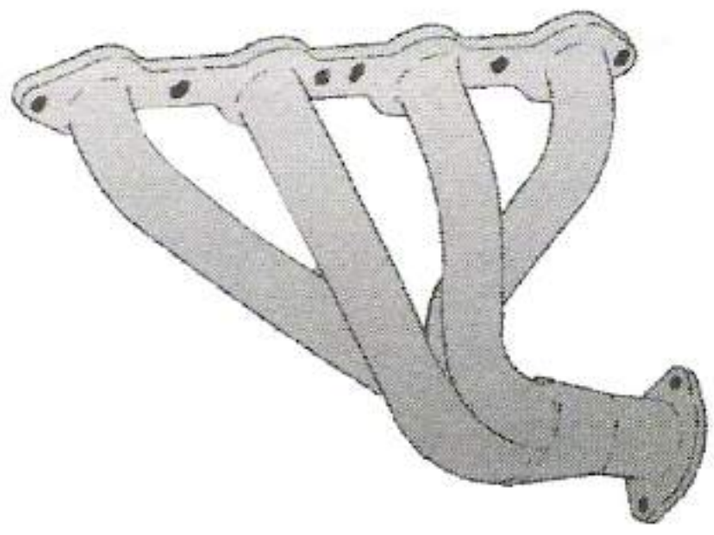


V8 Gen III

Ex022

These components can be ordered through HSV or specail GM Holden suppliers.

HSV - one of the header designs fitted to LS1 (GenIII) engines (left side)



Ex023

MAINTENANCE

Exhaust System Alignment

The exhaust system must not have any leaks, binds, grounding and excessive vibration. If these occur they are usually caused by: loose, broken or improperly aligned clamps, insulators or brackets or improperly connected pipes. Any of these mentioned could alter the clearances of the exhaust system components. If any of these conditions occur, the exhaust system components must be checked, adjusted or replaced to make certain the specified clearances are maintained.

All the pipe joints have a peg and a notch which must be equal to gain correct alignment.

To adjust the exhaust system components perform the following procedure:

1. Slacken the securing hardware, clamps and the pipe support brackets.
2. Gradually align the exhaust system so that all installation dimensions are within the limits and tighten all attachments.

* Tighten the clamp nuts and the exhaust manifold nuts evenly and alternately.

3. Start the engine and check the exhaust system for leaks.

* Mufflers, inlet pipes and outlet pipes, brackets, clamps and insulators should be replaced if they are defective or become badly corroded. Do not attempt repair of theses parts.

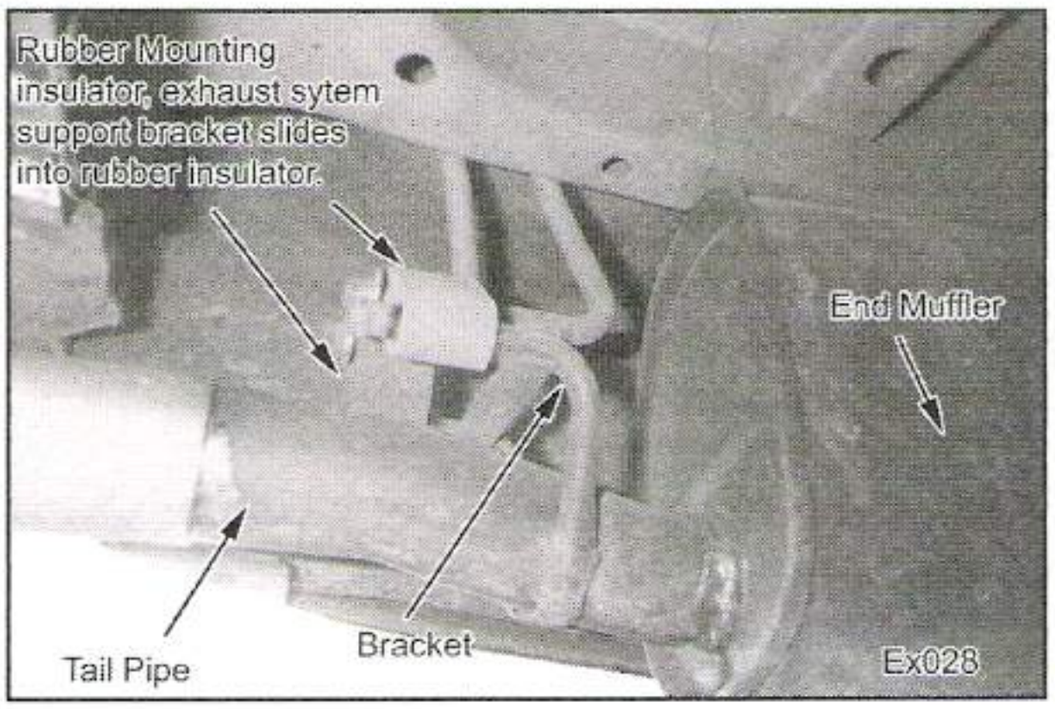
INSPECTION

Exhaust System

Inspection

Check the inlet pipe. Outlet pipe, and muffler for cracked joints, broken welds and corrosion damage (holes) that would cause a leaking exhaust system. Check the clamps, brackets

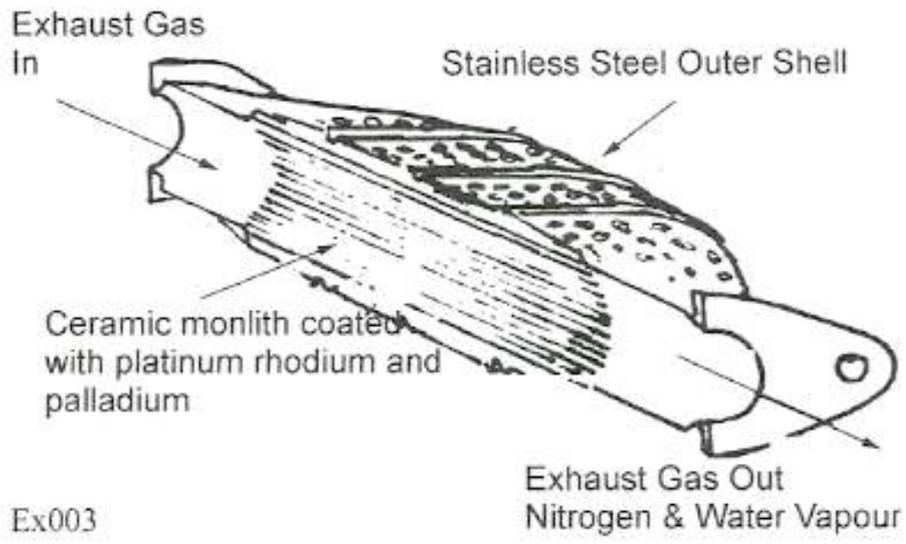
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and insulators for cracks and stripped or badly corroded bolt threads. When pipe clamp(s) are eased , and/or removed to replace a pipe or muffler, replace the clamp(s), if there is reasonable doubt that its service life is limited.

CATALYTIC CONVERTER

Catalytic Converter



Catalytic converters and mufflers look very similar. Except a catalytic converter when operating properly will covert carbon monoxide and hydrocarbons, that is exhaust gas into carbon dioxide which is a harmless gas that is present in our environment.

The outside consists of a stainless steel housing, the converter internal components consist of a ceramic monolith which has small holes to allow the exhaust gasses to flow through. The converter housing has gauze packed in between the housing and the honeycombed ceramic monolith. (this creates the chemical reaction necessary to oxidize carbon monoxide and hydrocarbons to harmless carbon dioxide).

The catalytic converter normally operates at approximately 600°C. The catalytic material is very sensitive to the effects of a rich or lean fuel mixture which causes the temperature of the converter to rise rapidly to the temperature at which the ceramic material melts.

Caution: *Excessively rich or lean fuel mixture can cause sudden failure of the catalytic converter.*

The catalytic converter is also sensitive to the use of leaded petrol. This causes deposits to form in the converter which restrict the exhaust flow and prevent the catalyst from working.

* The use of unleaded petrol results in black tail pipe deposits rather than the grey colour most people are familiar with. The black colour does not therefore, indicate a state of poor engine tune.

Problem Diagnosis

Problem: Leaking exhaust system!

Possible Causes and Remedies:

* Leaks at exhaust pipe joins. Remedy - Check for broken or loose clamps or clamp nuts and joint bolts.
* Gaskets damaged. Remedy - Replace gasket.
* Muffler, catalytic converter or exhaust pipe burnt out or rusted out. Remedy - Replace faulty items.

Problem: **Excessive noise!**

Possible Causes and Remedies:

* Muffler, catalytic converter or exhaust pipe burnt out or rusted out. Remedy - Replace faulty items.
* Leaks at exhaust pipe joins. Remedy - Check for broken or loose clamps or clamp nuts and joint bolts.
* Gaskets damaged. Remedy - Replace gasket.
* Exhaust manifold loose at cylinder head. Remedy - Torque exhaust studs or replace if necessary.

Problem: Poor fuel economy!

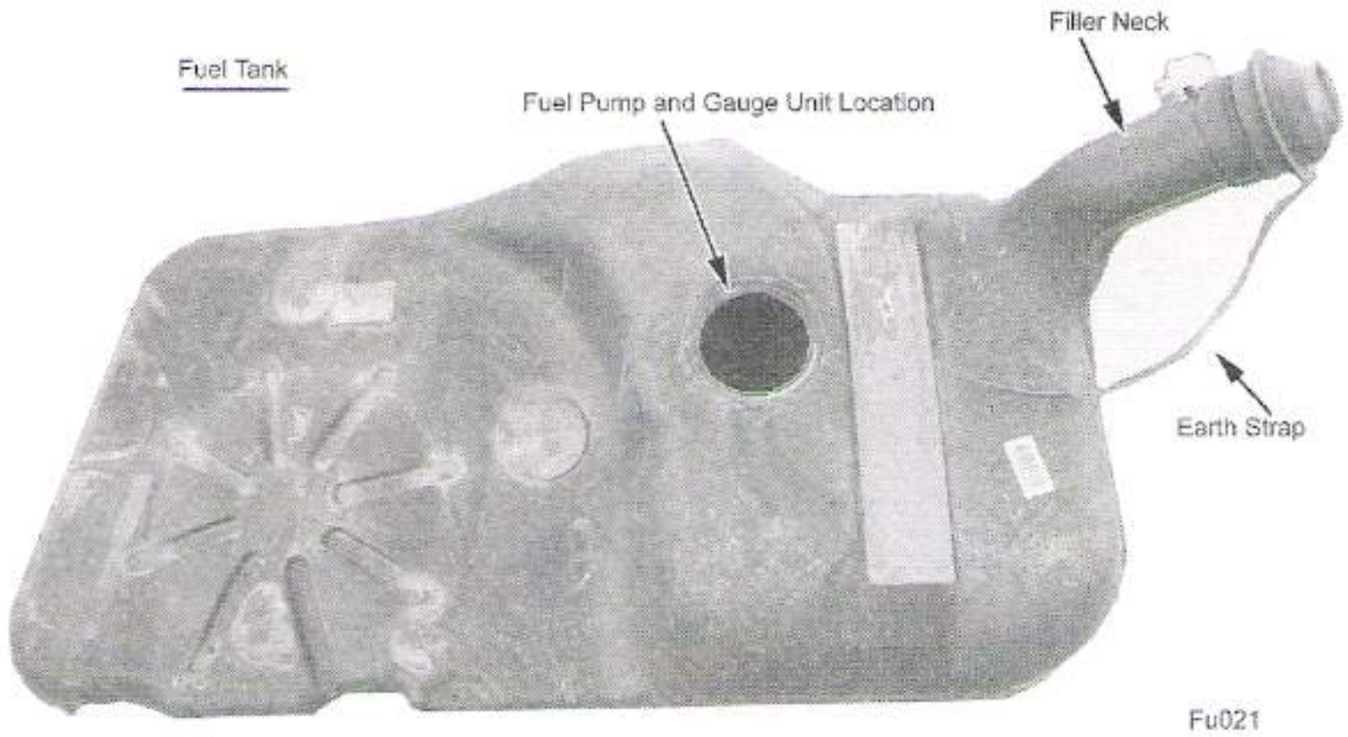
Possible Causes and Remedies:

* Blocked catalytic converter. Remedy - Replace catalytic converter.
* Exhaust pipe damaged. Remedy - Replace exhaust pipe.

Torque Specifications Nm

V6 Exhaust manifold to cylinder head studs	40 - 60
V8 Exhaust manifold to cylinder head studs	20 - 28
V6 and V8 engines	
Oxygen sensors	38 - 46
Front exhaust pipe flange to exhaust manifold flange	20 - 35
Catalytic converter flange to exhaust pipe bolts	30 - 50
Exhaust clamp nuts	20 - 30
Tailpipe bracket to rear hanger bolts	20 - 25

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FUEL TANK

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GENERAL INFORMATION

Therfuel tank is located at the rear of the vehicle, it is constructed of a multi-layered carbonate materail. The filler neck has a overflow vent back to the tank. The fuel pump is located in the fuel tank in a combination fuel pump, filter, feul gauge sender unit.

FUEL PUMP

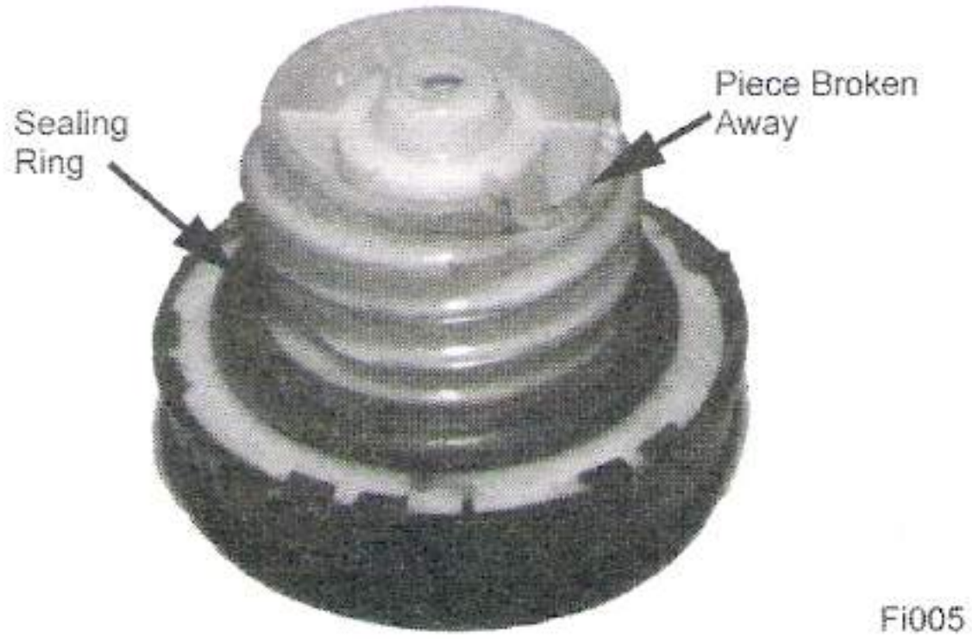
Roller vane-type fuel feed pump installed integral with the riser pipe and fuel gauge sender unit inside the fuel tank.
Station Wagon models use a low pressure priming pump within the fuel tank and an additional high pressure pump in the fuel feed line. The additional external pump is mounted in an insulated bracket to reduce noise transmission. The electrical leads to the tank mounted pump are spliced to accommodate extension leads to the additional pump.

UNLEADED FUEL - FUEL FILLER NECK

Vehicles have a fuel filler neck to help prevent the fuel tank being filled with leaded or LRP petrol, the fuel filler neck has a built-in re-stricter and deflector. The opening in the re-stricter will only admit the smaller unleaded petrol nozzle spout and must be fully inserted to by pass the deflector.
Attempted refuelling with a leaded or LRP petrol nozzle or failure to fully insert the unleaded petrol nozzle will result in petrol splashing back out of the filler neck.

FUEL FILLER CAP

The fuel filler caps are designed to screw into place and seal tight on the filler neck. The fuel filler cap is require to withstand pressure, as the fuel vaporizes the tank pressure increases, the pressure is released through the fuel tank breather hose, which runs to the carbon canister.
The fuel filler cap is required to prevent the vapour from escaping to the atmosphere, this is to comply with pollution laws, therefore any raw fuel vapour must be burnt.



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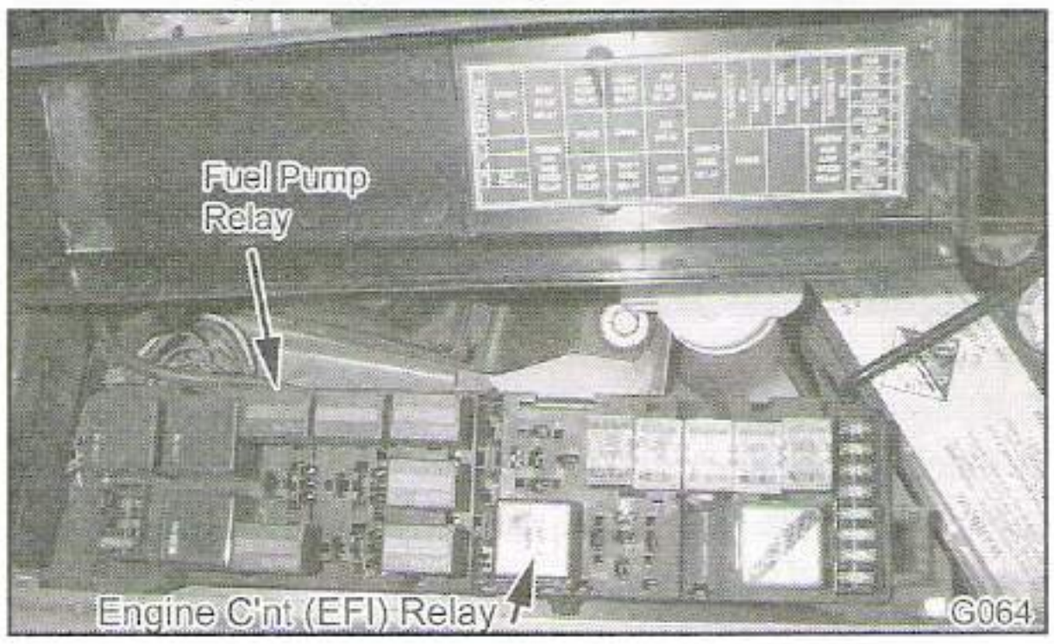
SERVICE OPERATIONS

FUEL TANK All Sedans and Station Wagons

Syphon fuel from tank with a commercial syphon hose.

Remove

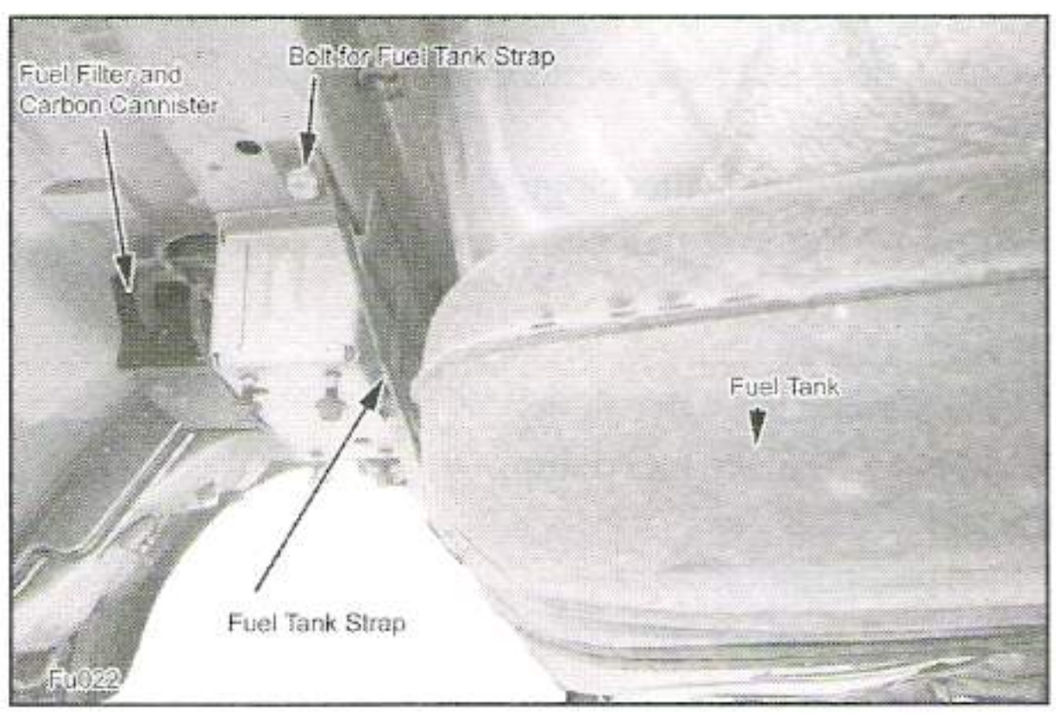
1. Depressurise the fuel system, (remove fuel pump relay located in engine bay, start engine allow to idle to stall).



2. Disconnect fuel tank electrical harness connector.
a) Remove inner fender guard from under right rear fender, 3 screws.
b) Pull connector from attaching clip, disconnect harness connector by pressing on locking tab at rear of connector.
3. Disconnect fuel filter and carbon canister return line quick release fittings.
Push in on line, depress side tabs, then pull on line to separate.
4. Disconnect other fuel and vapour lines.
Tip: Label fuel and vapour lines to help in installation.
5. Remove earth wire attached to fuel tank attaching strap clip/washer,
6. Drain the tank with a commercial syphon hose.
7. Support fuel tank with suitable jack. Locate a block of wood between the jack and tank to prevent tank damage.
8. Remove the bolts securing the tank to the body and lower tank.

Install

1. Lift the tank into position and install the bolts securing the tank to the body. Make sure insulation at top of tank is in place.



Fuel Tank Support Strap Bolts: 15-25Nm

2. Connect earth electrical connector to fuel tank strap washer / clip.
3. Reconnect fuel lines to filter and canister vapour, pushin, quick release types plus other fuel and vapour lines removed..
4. Connect fuel tank electrical harness connector.
a) Connect harness connector by pressing together, then slide onto attaching clip.
b) Replace inner fender guard from under right rear fender, 3 screws.
5. Replace fuel pump fuse
6. Add fuel to fuel tank

FUEL TANK Utility

Remove

1. Depressurise the fuel system, (remove fuel pump relay located in engine bay).
2. Disconnect fuel tank electrical harness connector.
a) Inside the utility tray area, remove the left side panel at the back of the cabin, remove the left side front floor panel to access the tank, panels attached by screws.
b) Pull connector from attaching clip, disconnect harness connector by pressing on locking tab at rear of connector.
3. Disconnect fuel feed and fuel return lines quick release fittings.
Push in on line, depress side tabs, then pull on line to separate.
Fuel return hose has a white marker near to pof tank.
Tip: Label fuel and vapour lines to help in installation.
4. Disconnect other fuel and vapour lines.
Tip: Label fuel and vapour lines to help in installation.
5. Remove earth wire attached to fuel tank attaching strap clip/washer,
6. Remove the fuel gauge sender unit and drain the tank with a commercial syphon hose.
7. Remove the bolts securing the tank to the body and lift from floor of utility tray.

Install

1. Position and install the tank and bolts securing the tank to the body. Make sure insulation washers are in place.

Fuel Tank Support Strap Bolts: 25-30Nm

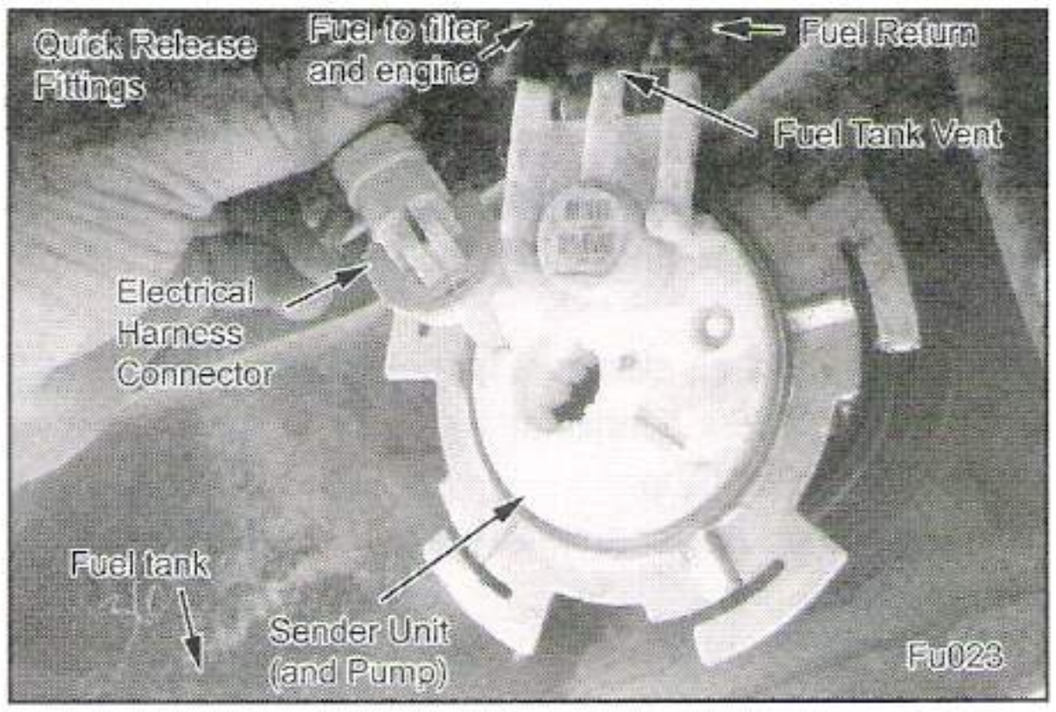
2. Reconnect fuel lines, pushin, quick release types plus other fuel and vapour lines removed..
3. Connect fuel tank electrical harness connector.
4. Replace ute tray liner panels, install screws and tighten.
5. Replace fuel pump fuse and reconnect the battery negative cable.
6. Add fuel to fuel tank

FUEL GAUGE SENDER UNIT / FUEL PUMP / INTANK FILTER

Remove

1. Remove fuel tank as previously described.
2. Remove the gauge unit by turning anti-clockwise to allow

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the unit to lifted from the tank.
Turn the sender unit with a special tool No J39765 or a large pair of multigrips.
Tip: The sender unit may spring up.
3. Remove sender unit and seal from tank, take care not to damage the float and arm.

Install

1. Clean mating surfaces of gauge unit and tank.
2. Install seal to fuel gauge tank unit.
3. Carefully fit fuel sender tank unit into the tank and turn clockwise to secure.
Turn the sender unit with a special tool No J39765 or a large pair of multigrips.
4. Install fuel tank as previously described.

FUEL GAUGE SENDER UNIT

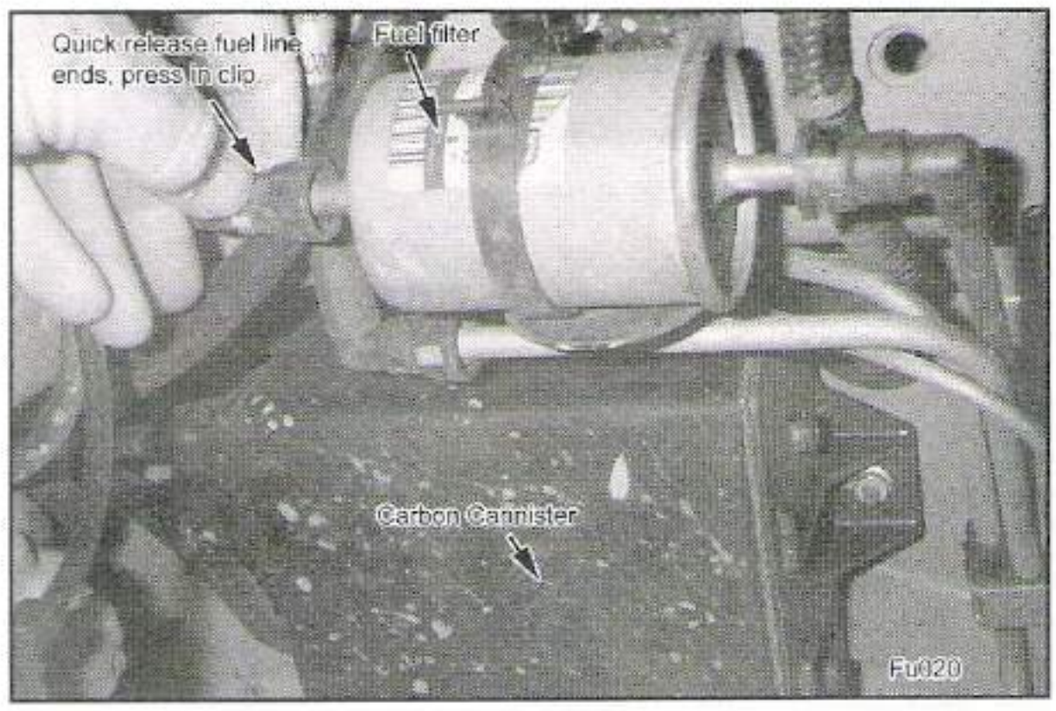
Dismantle

1. Remove sender unit / fuel pump as previously described.
2. Remove to cover.
a) Remove red locking tab with a small screw driver.
b) Press connector lock (Grey) to remove the top cover.
c) Disconnect the wire connector from the fuel pump.
d) Release the 2 spring wires from the side of pump housing.
3. Remove sender unit locking tab, push tab down with a small screw driver blade.
4. Use pointy nose pliers to release sender lock.

Assemble

1. Fit sender unit and press tabs into place.
2. Replace sender unit locking tab, push tab down into place.
3. Replace top cover
a) Replace the 2 spring wires to the side of pump housing.
b) Connect the wire connector to the fuel pump.
c) Press the top cover into place make grey tab locks in to place
d) Replace red locking tab
4. Install fuel gauge sender unit as previously described.

INLINE FUEL FILTER



Remove

1. Relieve fuel pressure as described earlier.
2. Place a container under the fuel line at the rear of the vehicle near the fuel tank, release the fuel hose clamps attached to the fuel filter.
3. Allow the excess fuel to drain into the container.
4. Remove filter clamp bolt and remove the filter.

Install

1. Check for the direction flow arrow on the side of the fuel filter, the arrow must point towards the front of the vehicle.
2. Slide the fuel clamps onto the fuel hoses allowing plenty of space for the filter inlet and outlet tubes to be inserted in to the hoses, slide the hoses onto the filter tubes and position the clamps in the correct position as shown.
3. Replace filter clamp and bolt and tighten to specification.
Filter clamp bolt specification: 20-25Nm
4. Before starting engine carry out fuel system leak test, by inserting the fuel pump fuse removed to depressurise the system, turn ignition key on, let fuel pump operate until stops. Check for leaks.

PROBLEM DIAGNOSIS

Problem: Fuel Delivery Pressure Low!
Possible Cause:
* Twisted or leaking fuel line.
Remedy: *Check fuel lines for leaks as described in installation of fuel tank.
* Check hose and pipe connections.
Possible Cause:
* Fuel pump gauze filter clogged.
Remedy: * Remove fuel pump and check condition of fuel pump gauze.
Possible Cause:
* Fuel pump relief valve faulty.
Remedy: * Replace fuel pump.
Possible Cause:
* Fuel pump faulty.
Remedy: * Replace fuel pump.

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Possible Cause:
* In line filter blocked.
Remedy: * Replace in line filter near fuel tank.
Problem: Fuel Delivery Pressure High!
Possible Cause:
* Fuel pump relief valve faulty.
Remedy: * Replace fuel pump.

Problem: No fuel at Fuel Rail
Possible Cause:
* Kinked fuel line.
Remedy: * Check fuel hoses and lines replace if necessary.
Possible Cause:
* In line fuel filter blocked.
Remedy: * Replace in line filter near fuel tank.
Possible Cause:
* Fuel pump relief valve faulty.
Remedy: * Replace fuel pump.
Possible Cause:
* Fuel pump in operative.
Remedy: * See below.

Problem: Fuel Pump Not Operating!
Possible Cause:
* Fuel pump faulty.
Remedy: * Test fuel pump.
Possible Cause:
* Wiring looms or connections faulty.
Remedy: * Check wiring with test light or multimeter replace as required.
Possible Cause:
* Fuel pump control unit faulty.
Remedy: * Replace control unit.

Problem: Fuel Pump Not Operating
Tip: If the fuel pump will not start to pump when the ignition is turned ON, you may be able to start fuel pump. This is a get home or to your garage proceedure.
1. Turn ignition ON and try to start engine.
2. Use an assistant to hit the base of the fuel tank with a rubber hammer or your hand, while still trying to start engine. (This will send a shock wave through the fuel that may be enough to turn the fuel pump impellar and activate the fuel pump.)
3. Do not turn engine off as this method may only work once or twice in the final stages of the fuel pump becoming completely inoperative.
4. As soon as possible, replace fuel pump with a new pump

SPECIFICATIONS

Fuel Tank Capacity

Sedans and Station Wagons	75 Litres
Utility	70 Litres
Fuel Pump V6 & VT I-V8	1.6l/sec @ 350 +/- 5kPa
Fuel Pump V6 supercharged	2.5l/sec @410 +/- 5kPa
Fuel Pump V8 Gen III	400 +/- 50kPa

TORQUE SPEC Nm

Fuel Tank Strap Bolts	15 - 25
Fuel Attaching bolts:	25-30
Fuel Pipe Hose Clamps	0.5 - 3.0
Utility Tank Mounting Bolts	6-65
Filter Bracket	5-8Nm

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WHEELS AND TYRES

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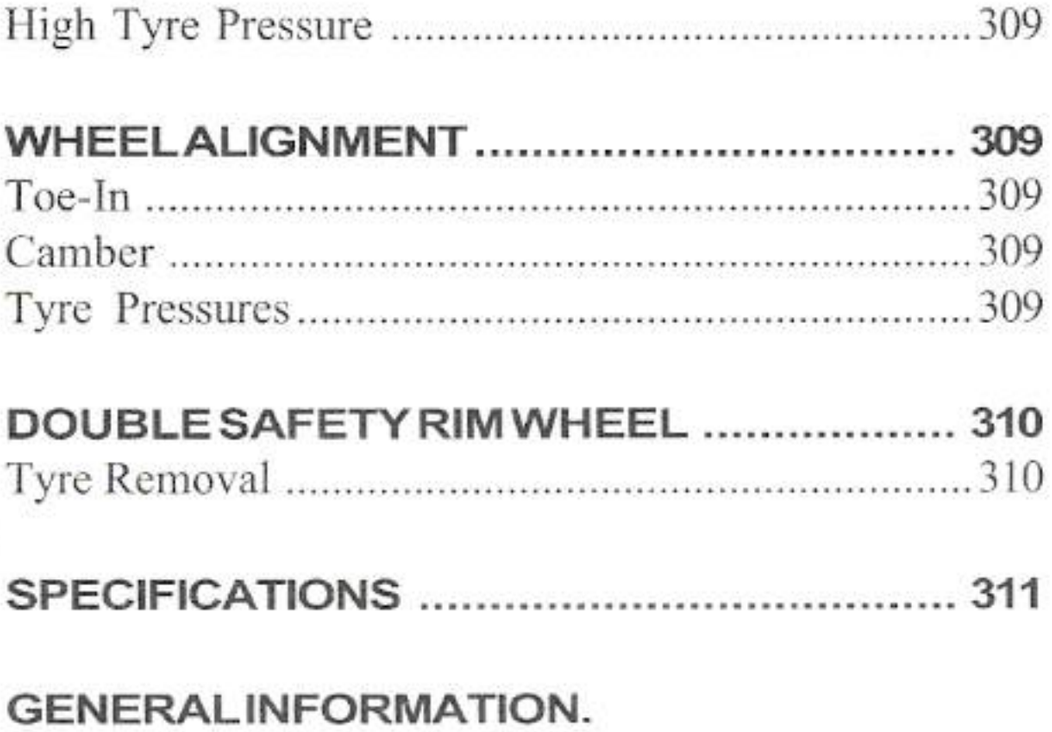
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GENERAL INFORMATION.

When installing a wheel ensure that as the road wheel attaching nuts are gradually tightened in the order shown.



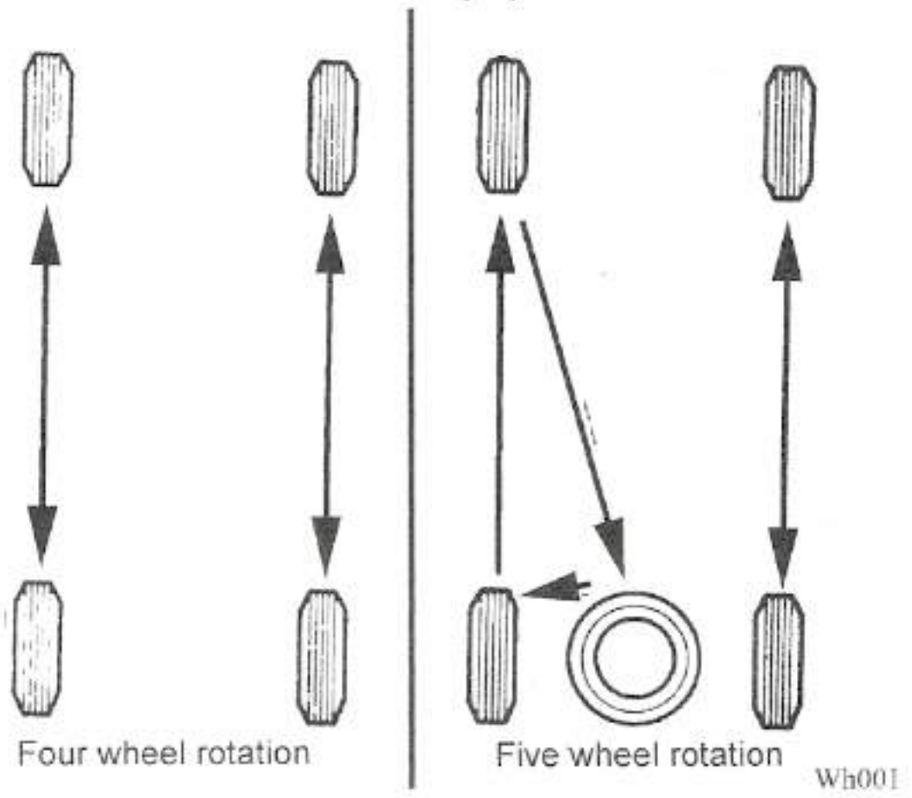
Tyre rotation as shown will help correct uneven tyre wear, it is also recommended that the wheels are balanced at the time of tyre rotation.

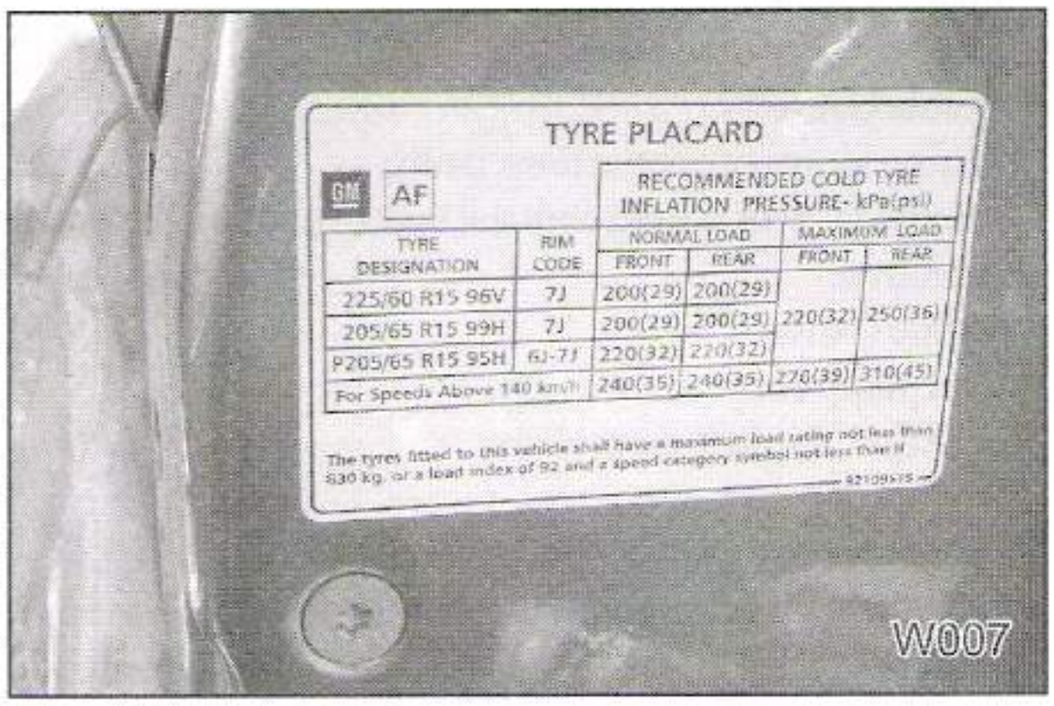
The tyres fitted as original equipment have been selected for safety, handling and comfort characteristics. Therefore when replacing any tyres it must be noted that a tyre of a lesser rating must not be used.

Wheel and tyre specifications are displayed on a decal fitted on the inside of the glove box or drivers door opening.

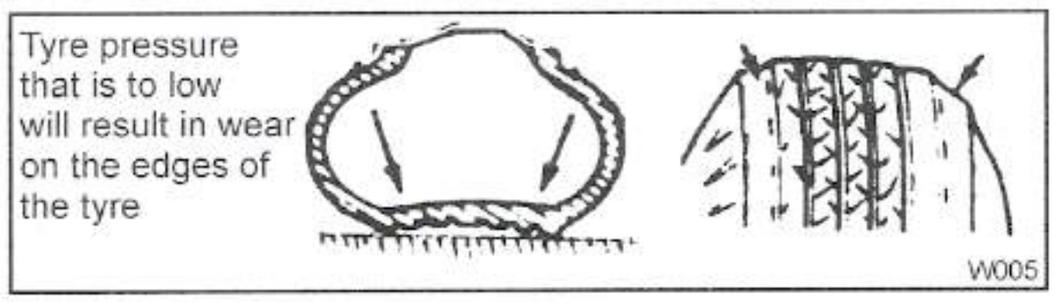
Inflation Pressure

Tyre inflation pressures should be checked with the tyres cold. Never reduce tyre pressure when the tyres are hot.





Low Tyre Pressure

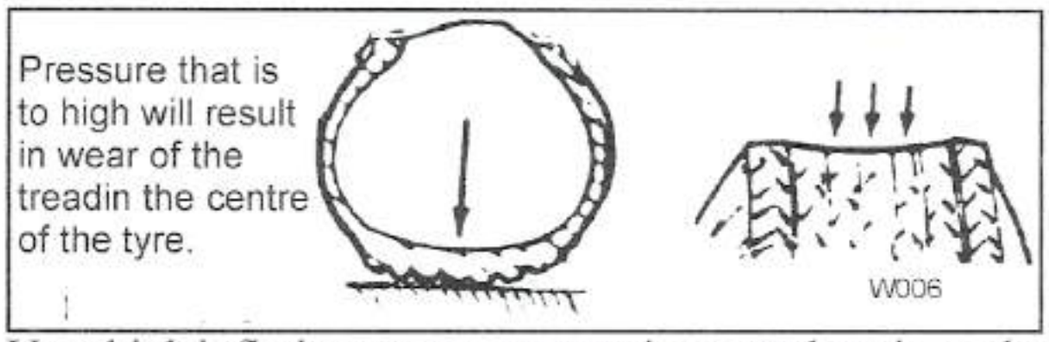


Low tyre pressure is a common fault affecting tyre life. While driving in normal conditions a tyre flexes as it rolls along the road and this flexing in turn generates heat. If the tyre is correctly inflated this heat buildup is not detrimental to the tyre. However an under inflated tyre flexes far more than normal resulting in greater heat generation. Under these conditions the temperature of the tyre can rise to a point where the rubber compounds that bind the tyre together are softened and weakened. In extreme conditions this may result in the tread separating

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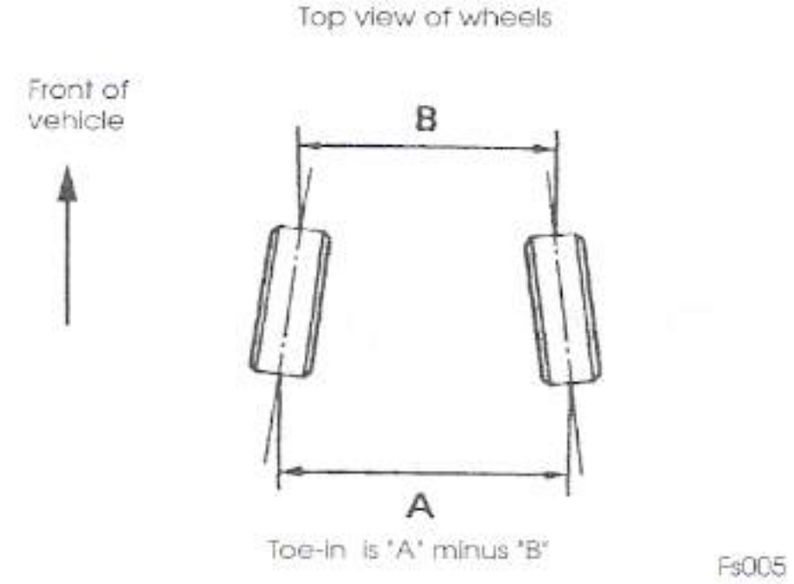
from the casing or the plies separating from each other. Under inflation also reduces tyre life by causing excessive wear on the tyre edges.
Overloading has the same effect as under inflation causing excessive tyre flexing and subsequent heat generation. Tyre damage and wear is accelerated if the vehicle is driven at high speed or in an overloaded condition.

High Tyre Pressure
High tyre inflation pressure can result in damage to the casing and further reduces tyre life by causing excessive wear at the centre of the tyre tread.



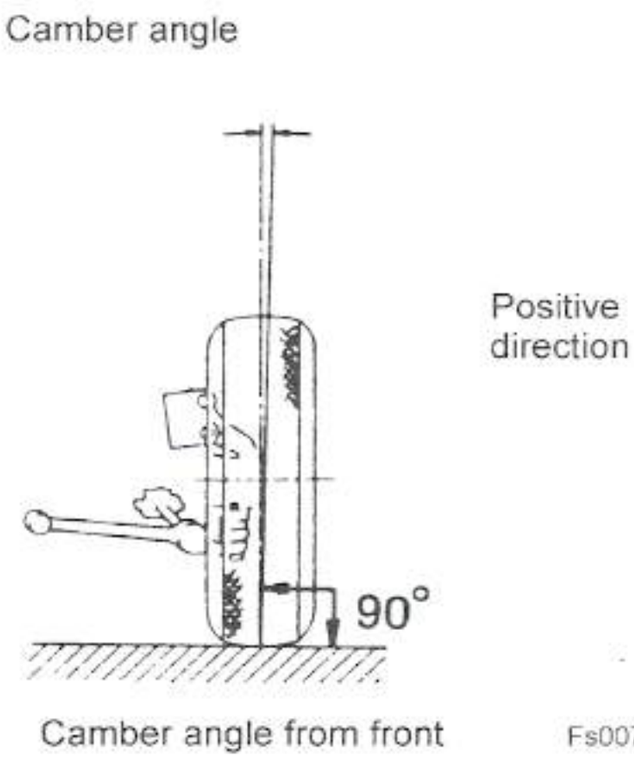
Very high inflation pressure exerts increased strain on the casing which subsequently reduces resistance to impact shocks. Since the tyre tread is stretched tight, tread cracks can rapidly develop and the tread is likely to crack.

Wheel Alignment
Toe-In



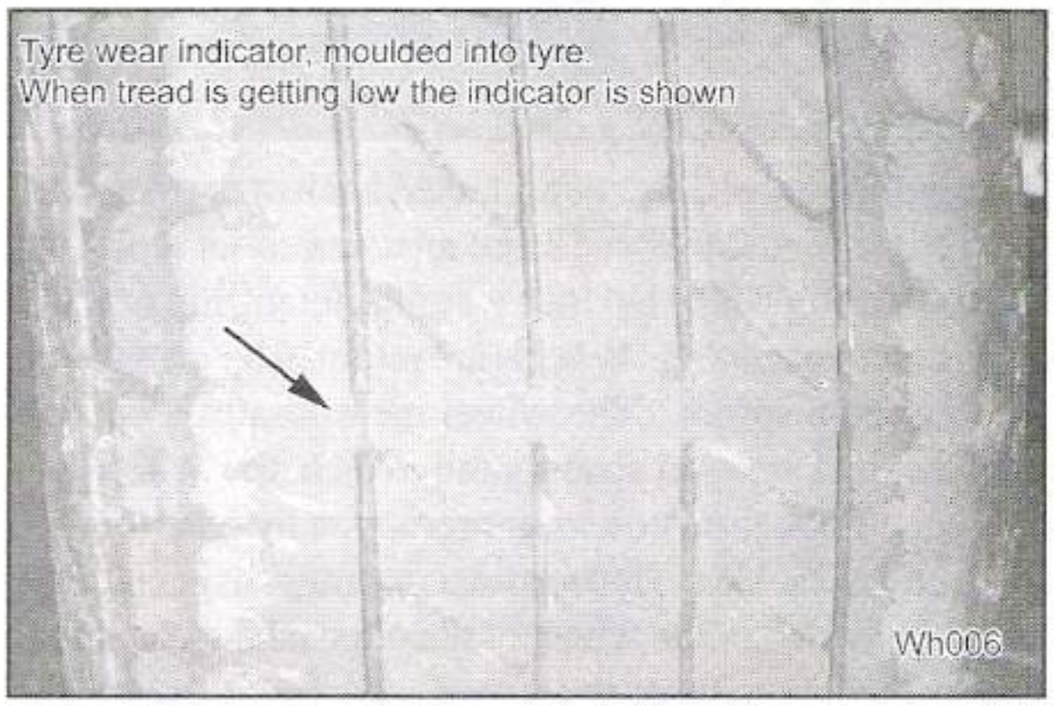
Toe-in setting is an important factor in tyre life. Excessive toe-in results in tapered or feathered wear on the outside edge of the tyre while excessive toe-out has the same result on the inside edge. Under these conditions the tyre is dragged along the road instead of rolling freely.
Check Front Suspension chapter for specifications and the correct procedure for adjusting toe-in.

Camber
Excessive wheel camber either positive or negative, results in one side of the tyre wearing faster than the other. Wheel camber is adjustable, the setting may alter as a result of damage to the front end. In this event the damaged components must be replaced, and camber adjusted as described in Front Suspension chapter.
It is essential that the recommended inflation pressures are always maintained as described previously. Radial ply tyres may appear under-inflated at the correct recommended pressures. This is normal and they should never be inflated beyond the recommended pressures.



Tyre Pressures
The tyre pressures quoted are cold pressures. In this context, the tyre temperature is considered 'hot' after extended motoring at speed. Under certain extreme conditions of operation a tyre may require up to one hour before it can be considered 'cold', i.e. not warm to touch, which is usual after operation.

Tyre Wear
Tyres should be routinely checked for wear, there are special patterns that appear when the tyre tread is low as shown below. Also the depth of tread can be checked with a tyre tread depth gauge.



If regular wear is noticed, check the front wheel hubs and front suspension ball joints for excess play and also check the front suspension geometry.
Hint: Tyres driven with 3/4 recommended air pressure have only 1/2 of the suggested tyre life.
Hint: Friction is proportional to velocity cubed. Double your driving speed, 8 times the tyre wear, or driving speed increased from 100 km/h to 120 km/h doubles tyre wear.

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Spare Wheel

The spare wheel is located in the floor of the boot. To remove spare wheel, open boot, lift back boot floor carpet, remove spare wheel cover (boot floor section). Unscrew spare wheel securing bolt, lift spare wheel out. When replacing spare wheel make sure the bolt securing the spare wheel is hand tight, this will stop rattles and also secure the wheel in case of an accident.

Steel Wheels

Steel wheels are usually standard equipment.

The press on type wheel trims are removed by inserting the small end of the wheel nut spanner or screw driver inside the outer edge of the trim and progressively prying the trim off. To install the trim, position trim on the wheel and using a rubber mallet or your hand gently knock the trim onto the wheel, hitting on the outer edge.

The wheel nuts are conventional wheel nuts.

Aluminium Wheels



Alloy wheel with center hub cover removed Wh005

The aluminium wheels are protected against corrosion by special coating. Care must be taken when either replacing a tyre or fitting wheel balance weights not to chip or score the protective coating. Wheels are retained by nuts which incorporate a spigot. The wheel incorporates a captive steel conical tapered insert onto which the wheel nut tightens. The centre covers are removed by inserting the small end of the wheel nut spanner or screw driver into the recess provided in the wheel at the edge of the cover and prying the cover from the wheel. To install, place the centre cover in the correct location in the wheel and hand press the cover into the wheel.

Double Safety Rim Wheel

A new snap in valve should be fitted, when fitting a new tubeless tyre. The valve is made to last the life of the tyre, but beyond that time fatigue of the valve body rubber is likely to impair the air seal of the rim hole.

The tyre can be ascended or descended on a machine. A machine should always be used on aluminium alloy wheels. Make sure that the outer side of the wheel is positioned upward.

Tyre Removal

1. It is OK to use tyre levers on steel wheels using the following operation.

Deflate tyre completely once valve cap and core are deflated, break loose the tyre beads from the wheel, using the bead loosening tool.

2. Remove the wheel weights (if fitted).

* With the outer side of the wheel upward, insert two tyre irons about 200mm apart between the tyre outer bead and the wheel rim. Use only tyre irons with rounded edges or irons designed for dismounting tubeless tyres.

* Lever the tyre bead over the hub cap with one iron and hold it in this position. Pry the rest of the bead over the rim with the over iron. Take small 'bites' with the iron around the tyre in order to avoid damaging the sealing surface on the tyre bead.

* Stand the wheel and tyre upright with the tyre inner bead in the drop centre well at the bottom of the wheel. Position the tyre between the bead and the edge of the wheel rim, and pry the wheel out of the tyre.

Tyre Valve

A periodical check should be made of the tyre valve, remove valve cap, place some saliva on your finger and wipe over valve insert opening.

If there is a slow air pressure leak a bubble will develop. If so replace old valve with a new valve.

SPECIFICATIONS

Tyres with a code ending in H have a speed rating of 210km/h.

Tyres with a code ending in V have a speed rating of 240km/h

* Cold Tyre Pressure kPa upto 3 passengers - higher pressure for heavier loads or higher than average speeds

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VT Ser I

Model	Wheel Size	Tyre	Cold Air Pressure*	
Exec	Steel 6.0J x 15	P205/65 - R15 92H	200	200
Berlina	Alloy 6.0J x 15	P205/65 - R15 92H	200	200
S	Alloy 7.0J x 16	P225/50 - R16 92H	200	200
SS	Alloy 8.0J x 17	P235/45 - R17 92H	200	200
Calais	Alloy 7.0J x 16	P215/60 - R16 92H	180	180

VT Ser II

Model	Wheel Size	Tyre	Cold Air Pressure*	
Exec & Acclaim	Steel 6.0J x 15	P205/65 - R15 92H	220	220
Exec Gen III	Steel 6.0J x 15	P225/60 - R15 96V	200	200
Berlina V6	Alloy 6.0J x 15	P205/65 - R15 95H	200	200
Berlina V8	Alloy 6.0J x 15	P225/60 - R15 96V	200	200
S	Alloy 7.0J x 16	P225/50 - R16 92V	200	200
S	Alloy 8.0J x 17	P235/45 - R17 92V	200	200
SS	Alloy 8.0J x 17	P235/45 - R17 92V	200	200
Calais	Alloy 7.0J x 16	P225/60 - R16 95V	180	180

WH Ser I & II

Model	Wheel Size	Tyre	Cold Air Pressure*	
Statesman	Alloy 7.0J x 16	P225/55 - R16 95V	180	180
Caprice	Alloy 7.0J x 16	P225/55 - R16 95V	180	180

VX Ser I & II

Model	Wheel Size	Tyre	Cold Air Pressure*	
Exec & Acclaim	Steel 6.0J x 15	P205/65 - R15 95H	220	220
Exec Gen III	Steel 6.0J x 15	P225/60 - R15 96V	200	200
Berlina V6	Alloy 6.0J x 15	P205/65 - R15 95H	220	220
Berlina V8	Alloy 6.0J x 15	P225/60 - R15 96V	200	200
S V6	Alloy 7.0J x 16	P225/50 - R16 92V	200	200
SS V8 GenIII	Alloy 8.0J x 17	P235/45 - R17 93V	200	200
Calais	Alloy 7.0J x 16	P225/55 - R16 95V	180	180
Police Pack	Steel 7.0J x 15	P225/60 - R16 96V	200	200
Taxi Pack	Steel 7.0J x 15	P205/65 - R16 99H	200	200

VY Ser I & II

Model	Wheel Size	Tyre	Cold Air Pressure*	
Exec & Acclaim	Steel 6.0J x 15	P205/65 - R15 95H	220	220
Exec Gen III	Steel 6.0J x 15	P225/60 - R15 96V	200	200
Berlina V6	Alloy 6.0J x 15	P205/65 - R15 95H	220	220
Berlina V8	Alloy 6.0J x 15	P225/60 - R15 96V	200	200
S V6	Alloy 7.0J x 16	P225/50 - R16 92V	200	200
SS V8 GenIII	Alloy 8.0J x 17	P235/45 - R17 93V	200	200
Calais	Alloy 7.0J x 16	P225/55 - R16 95V	180	180
Police Pack	Steel 7.0J x 15	P225/60 - R16 96V	200	200
Taxi Pack	Steel 7.0J x 15	P205/65 - R16 99H	200	200

VU Utility Ser I & II

Model	Wheel Size	Tyre	Cold Air Pressure*	
Utility	Steel 7.0J x 15	P205/65 - R15 99H	200	200
S	Alloy 7.0J x 16	P225/55 - R16 95V	200	200
SS	Alloy 8.0J x 17	P235/45 - R17 93V	200	200

Monaro Ser I & II

Model	Wheel Size	Tyre	Cold Air Pressure*	
CV6	Alloy 8.0J x 17	P235/45 - R17 93V	200	200
CV8	Alloy 8.0J x 18	P235/40 - R1891 W	230	230
Spare CV6 & CV8	4T x 15	T135/90D15	420	420

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WINDSCREEN WIPERS & WASHERS

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DESCRIPTION

The front wiper motor is a two speed type and incorporates a parking switch which is activated when wipers are switched off.

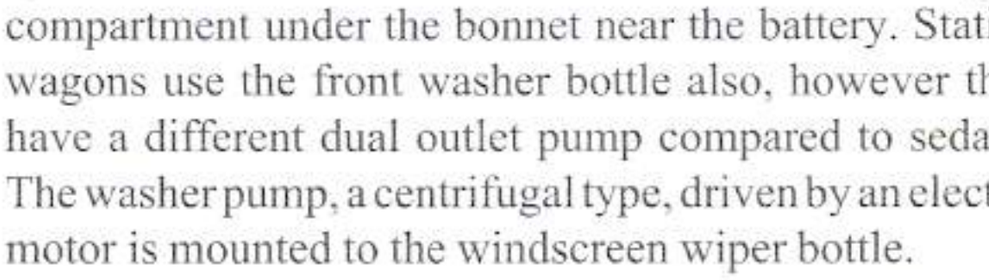
The intermittent wiper action is controlled from in the BCM. On higher series BCM the intermittent wiper varies with vehicle speed and can also be controlled by the wiper control switch.

The windscreen washer bottle filler is located in the engine compartment under the bonnet near the battery. Station wagons use the front washer bottle also, however they have a different dual outlet pump compared to sedans. The washer pump, a centrifugal type, driven by an electric motor is mounted to the windscreen wiper bottle.

Control switches for high speed, low speed, intermittent operation and the windscreen washer switches are mounted on the side of the steering column.

WIPER ARM

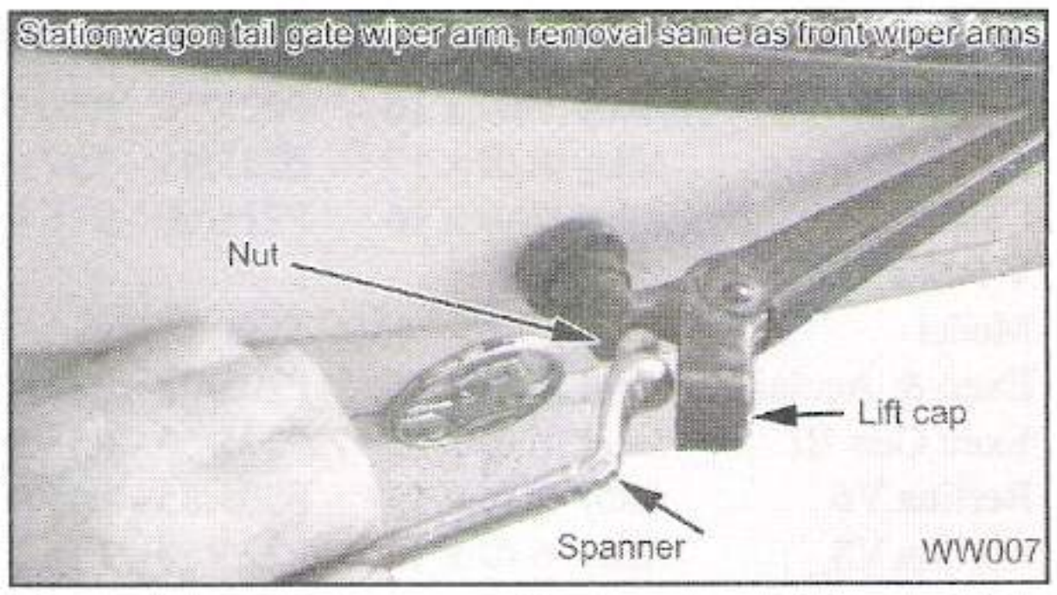
Note: The front wiper arms can be identified by a "D" for drivers side and "P" for passenger side, stamped on underside of wiper arms.



Moulded in underside of wiper arm - RHD D ww015

Remove

1. The wiper arms are a press on fit then secured with a nut.



(a) Remove wiper arm attaching nut cover, then attaching nut.

b) Place a screw driver under the arm with a cloth between the body and screwdriver to prevent damage to paint work, gently lever the arm from the drive shaft, and remove arm.

3. Remove wiper blade from arm if required, unclipping the wiper locking device and slide the wiper away from the arm.

Install

1. Install the wiper blade onto the wiper arm.

Clip the wiper onto the arm.

2. Install wiper arm assembly onto spline so that the blade is positioned "Normal Stopping Position" as shown on windshield and shown in later illustration.

3. Press the arm onto the shaft ensuring the arm is fully seated on the shaft in the correct position.

4. Install attaching nut, tighten, then install nut cover which is a push on fit.

Front Wiper Arm Attaching Nut: 20-25 Nm
Rear Wiper Arm Attaching Nut: 6-14 Nm

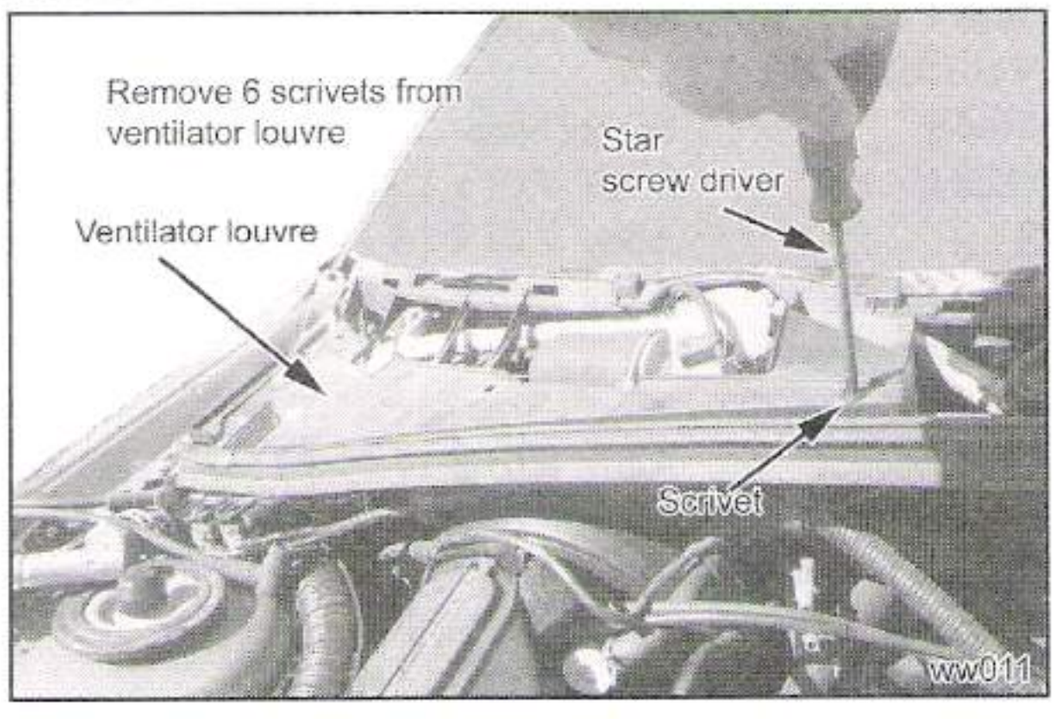
FRONT WIPER MOTOR & LINKAGE

Remove

1. Remove wiper arms from the linkage.

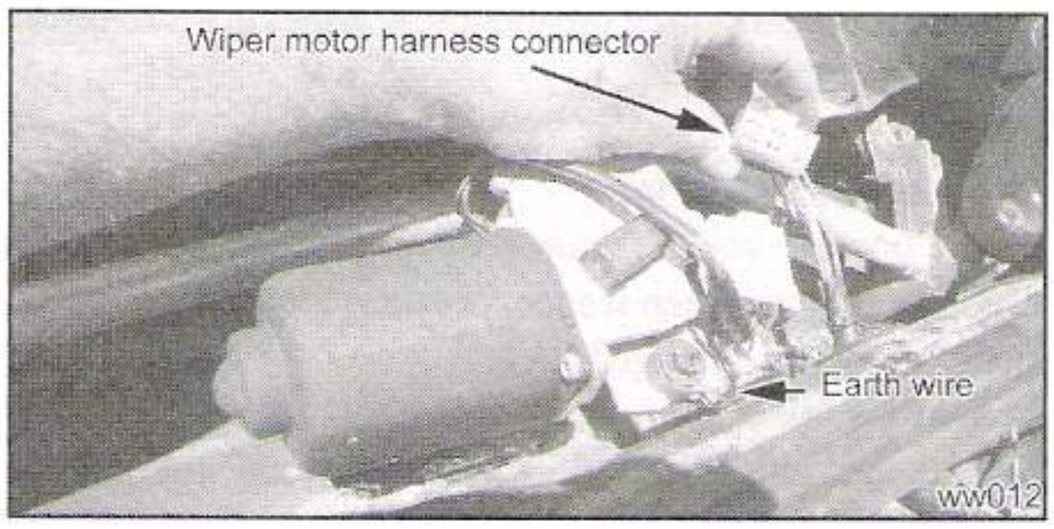
2. Remove engine bonnet.

3. Remove plenum top ventilator louvre, 6 scrivets, right side first, pull away and up from windscreen to free louvres.



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4. Remove the plenum water deflector, 10 scrivets, pull forward and up to remove.
5. The wiper motor and linkage is secured by 5 bolts.
a) Disconnect the motor electrical connector.



b) Remove the 5 bolts.



c) Disconnect the motor from the wiper link and then remove the motor.
6. Separate the linkage from the motor if necessary, 2 screws.

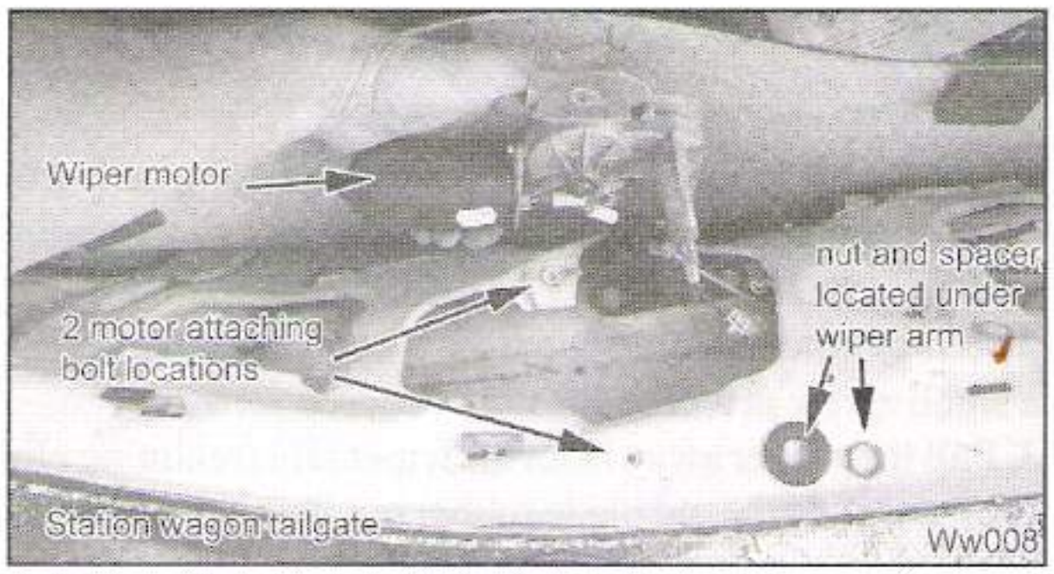
Install

1. Replace the linkage assembly to the wiper motor if required, 2 screws.
Wiper Linkage to Motor: 7-9 Nm
Motor Crank to Linkage Bolt: 16-20 Nm
2. Install the wiper motor and linkage assembly, 5 bolts.
Wiper Motor to Plenum: 4-6 Nm
Connect the electrical connector.
3. Replace the plenum water deflector, tabs fit under windscreen, 10 scrivets.
4. Replace both of the ventilator louvres, tabs fit under windscreen, 6 scrivets.
5. Install engine bonnet.
6. Replace the wiper arms and check operation for correct position of wiper arm

REAR DOOR WIPER MOTOR

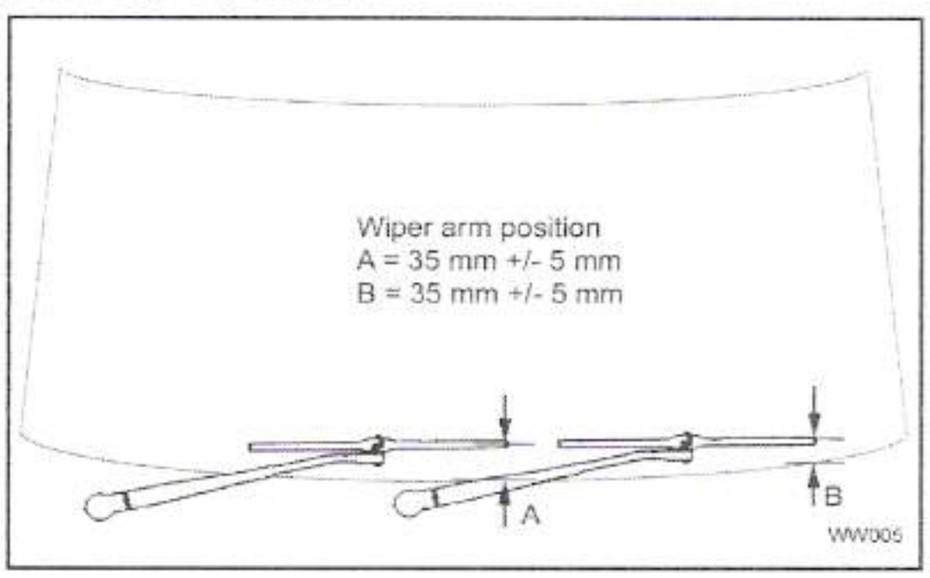
Remove

1. Remove wiper arm from motor.
a) Open nut cover.
b) Remove nut and wiper arm.
c) Remove the spacer.
2. Open the rear door to access the inside and remove the following.
a) Remove the assist grip.
b) Remove the inside door handle bezel.
c) Remove the window top trim panels - pull push clips.
d) Remove lower trim panel held by clips, then dust cover.
** use screwdriver or similar to pry trim panel clips free*
3. The rear wiper motor and linkage can now be removed.
a) Disconnect wiper motor electrical connector.
b) Remove 2 bolts on wiper motor mount.
c) Remove wiper motor assembly from door.



Install

1. Refit wiper motor into position.
a) Install the 2 bolts and torque to specifications.
Rear Wiper Motor Securing bolts: 6-14 Nm
b) Connect electrical connector.
2. Refit the door trim panels, inside handle bezel and assist grip.
3. The rear wiper arm can now be installed
a) Refit spacer.
b) Operate wiper motor, switch off and allow to park in correct position.
c) Refit wiper arm and nut, torque to specifications.



REPLACE WIPER BLADES

Wiper insert rubbers deteriorate as a result of environmental conditions, such as atmospheric pollution and road grime, temperature extremes and natural ageing of rubber.
It is therefore recommended that wiper inserts are replaced every twelve months or as required.

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Wiper Blade Insert Assembly (metal backing)

1. Lift the blade away from the windscreen as far as it will go, so the wiper arm is held into position by its own spring tension.

2. Remove the wiper blade from the wiper arm on early models remove the two attaching screws. Later models Unclip the wiper locking device, remove the locking clip and slide the wiper away from the arm.



3. Remove the retaining clip from the wiper and slide the old rubber blade out from the wiper assembly.

4. Slide the wiper insert assembly into position, install the metal retaining clip.

5. Install the wiper onto the wiper arm.
Clip the wiper onto the arm.

Wiper Blade (Rubber insert only)

1. Lift the blade away from the windscreen as far as it will go, so the wiper arm is held into position by its own spring tension.

2. Remove the retaining clip from the end of the wiper, use a small screw driver to lift tab.

3. Pull the rubber away from the wiper arm (retaining clip end) and slide the old blade rubber out from the other end of the wiper.

4. Slide the new rubber wiper insert into position from the outside end of the arm, lock into place with the metal retaining tab.

Checking Wiper Arm to Windscreen Alignment

This check should be performed if wiper inserts are in good operating condition.

1. Operate wipers and then, by turning ignition switch off, position wipers at approximately 30° into the arc of the wiper.

2. Remove wiper blade and check that end of wiper arm is square to windscreen.

3. If arm is not square, gently twist end of arm to achieve correct alignment.

4. Refit wiper blades.

5. Turn ignition switch on and allow wiper arms to return to normal position.

Windshield Washer

Don't operate washer motor for more than 20 seconds continuously or when washer bottle is empty as motor or pump could be damaged.

Washer Liquid

Fill washer unit with either water or water and a small amount of detergent, this will help remove road grim such as oil and insects.

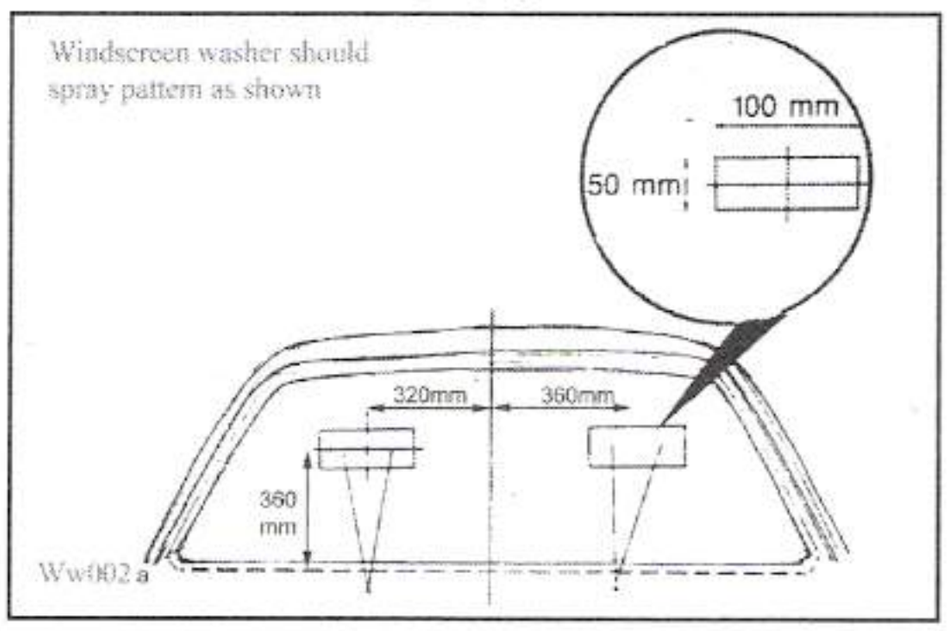
** do not use too much detergent as this will obscure vision on the windscreen.*

Blocked Washer Nozzle

If the nozzles become blocked remove the hose from the back of the washer nozzle and use air pressure to blow the foreign matter from the nozzle. Reconnect the hose to the nozzle and test washer unit.

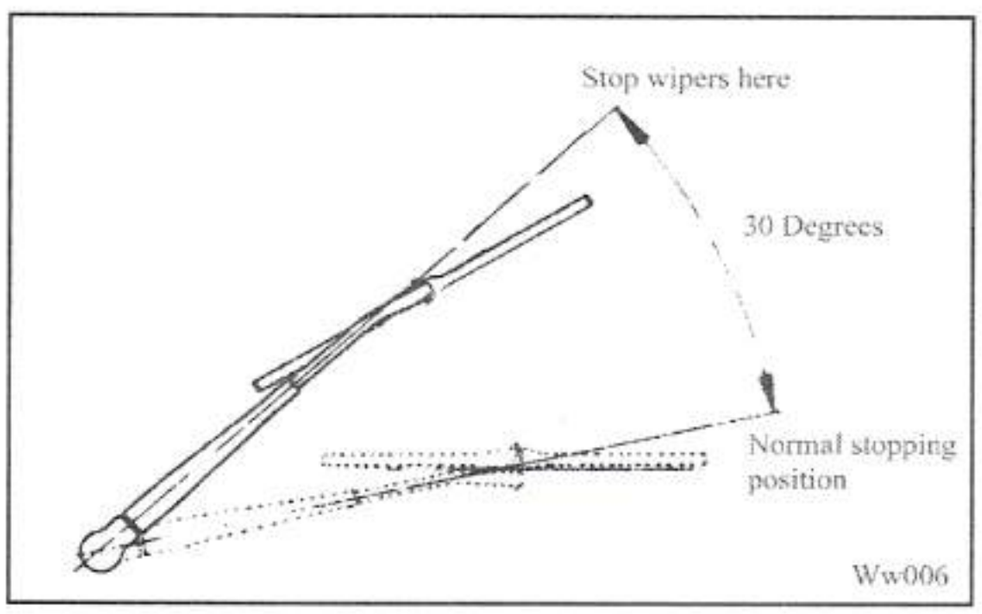
Washer Nozzle Adjustment

1. Check washer fluid spray pattern is as shown.



2. If adjustment is necessary use a metal wire or pin 1.0 mm or less in diameter inserted in nozzle hole, turn nozzle to direct spray at the desired angle.

3. If insufficient washer fluid is supplied check system for clogged, bent or crushed hoses.



Torque Specifications

Front Wiper Arm Attaching Nut:	20-25 Nm
Rear Wiper Arm Attaching Nut:	6-14 Nm
Wiper Linkage to Motor:	7-9 Nm
Motor Crank to Linkage Bolt:	16-20 Nm
Wiper Motor to Plenum:	4-6 Nm
Rear Wiper Motor Securing bolts:	6-14 Nm

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HEATING, AIR CONDITIONING & ELECTRONIC CLIMATIC CONTROL (ECC)

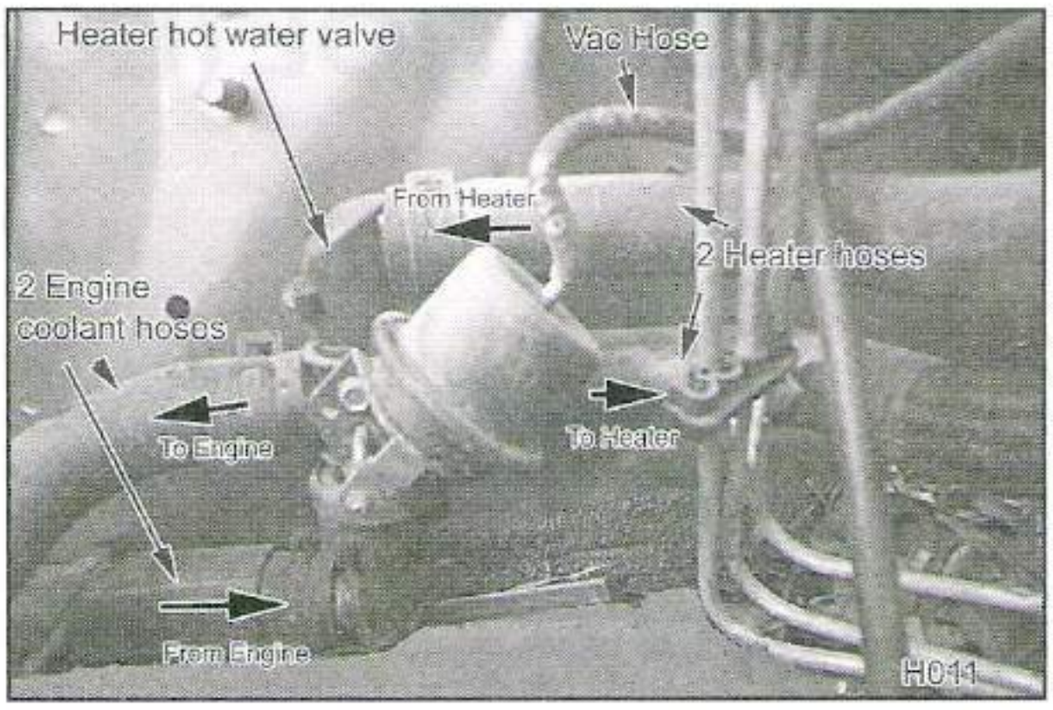
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HEATING

HEATER WATER VALVE



Remove

1. Remove the water hose from the engine block and allow the water to drain, remove radiator cap to help drain.
2. Remove the other heater valve hoses.
3. Remove the vacuum hose from the heater water valve.
4. Remove the water valve attaching bolt, remove the water valve.

Install

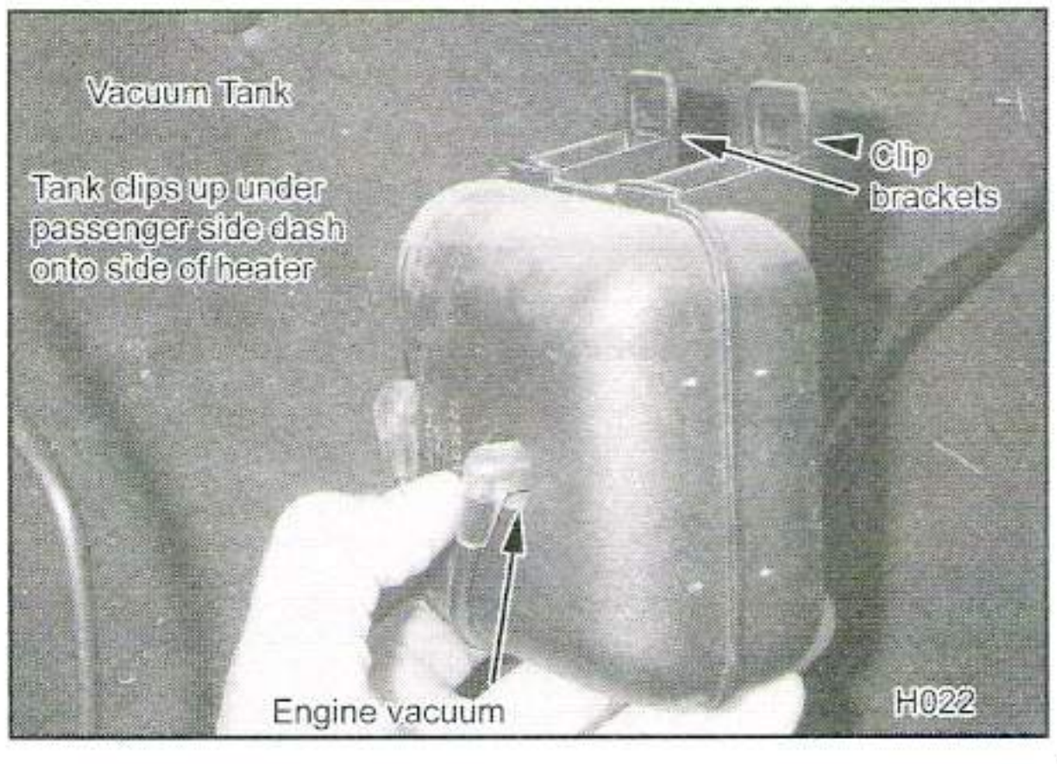
1. Replace the water valve attaching bolt securing the water valve to engine panel.
2. Replace the heater hoses and vacuum line to the water valve assembly.

BLEEDING AIR FROM HEATER CORE

1. Disconnect the heater core outlet hose at the heater control valve connection (top hose that leads to the heater control valve).
2. Any trapped air should be allowed to flow out.
3. Connect the hose to the heater control valve, when a continuous flow of coolant is obtained from the hose.

VACUUM TANK

Located on the left side of the heater/airconditioning unit under the dash, behind the glove box.



Remove

1. Disconnect the vacuum hoses to the vacuum tank.
2. Remove the 1 attaching screw of the vacuum tank to the air-condition unit.
3. Remove the vacuum tank, pull down and away to dislodge tabs.

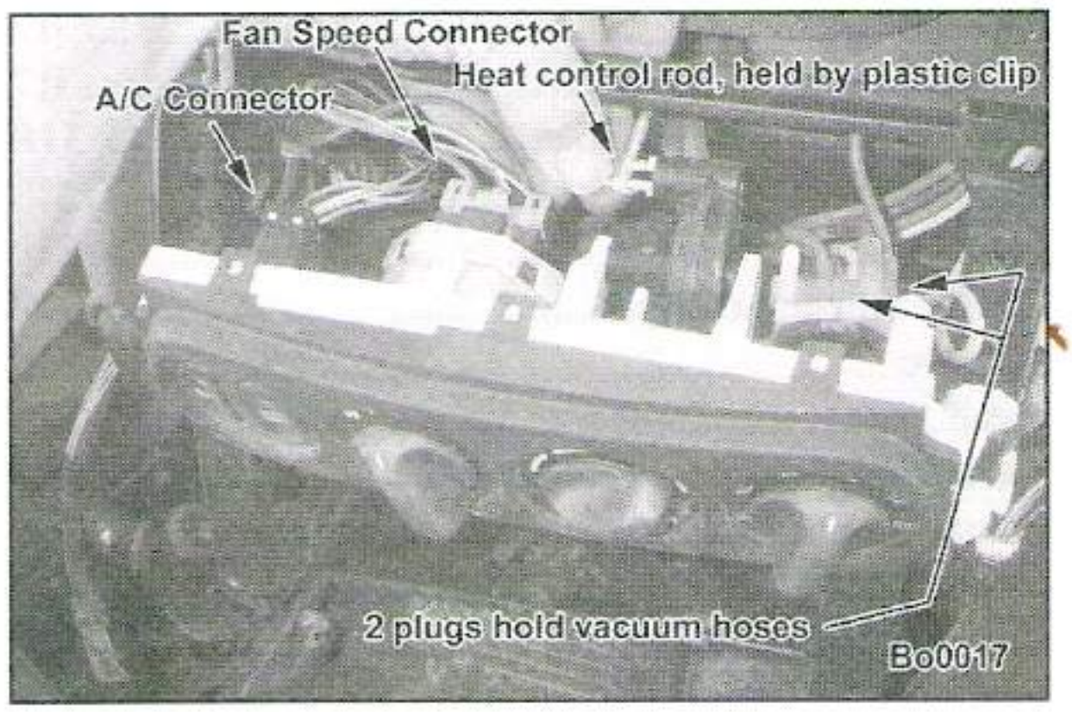
Install

1. Install the vacuum tank, push in to airconditioning unit then up to secure top tabs.
2. Replace the I attaching bolt of the vacuum tank to the body panel.
3. Connect the vacuum hoses to the vacuum tank.

HEATER and AIR CONDITIONER CONTROLS

Remove

1. Disconnect the battery.
2. Remove the centre transmission consol trim as described in body chapter.
3. Remove the radio and instrument facia as described in body chapter.
4. Remove the heater / air-conditioner controls (2 screws) lift the control unit enough to allow the wiring connectors and vacuum hose connectors to be removed from the controls.



Tip: Remove the 2 hose plugs (2 T15 torx screws) not the hoses from the plugs, label hoses and identify the vacuum ports which the particular hoses belong too as a precaution. This is to help during installation of the heater control switch.

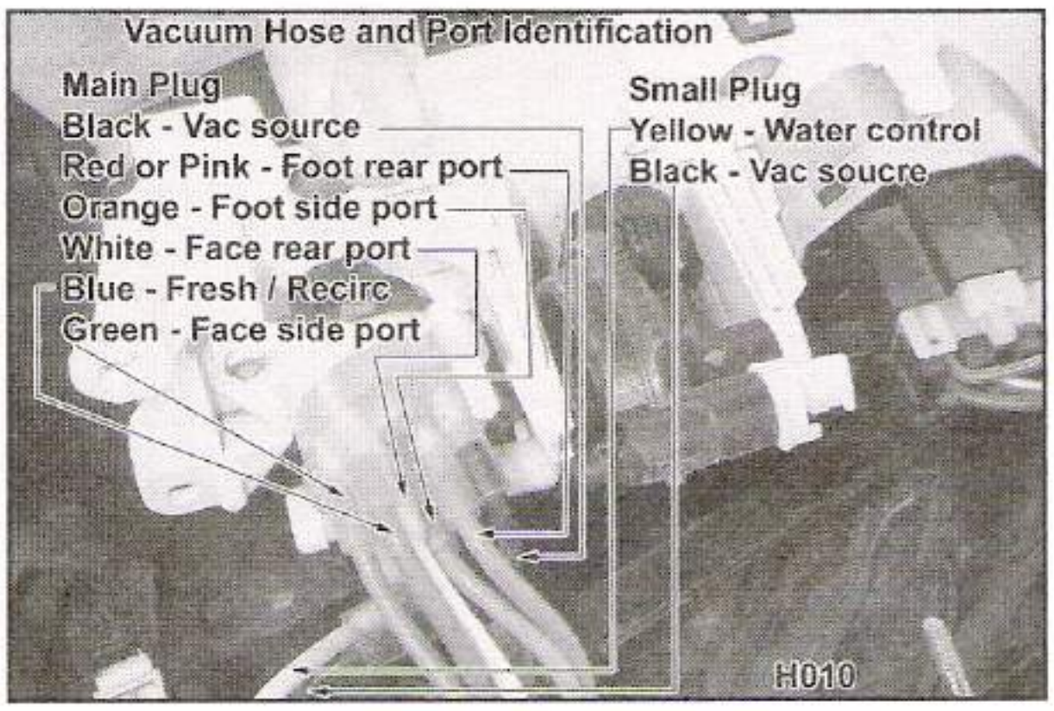
Install

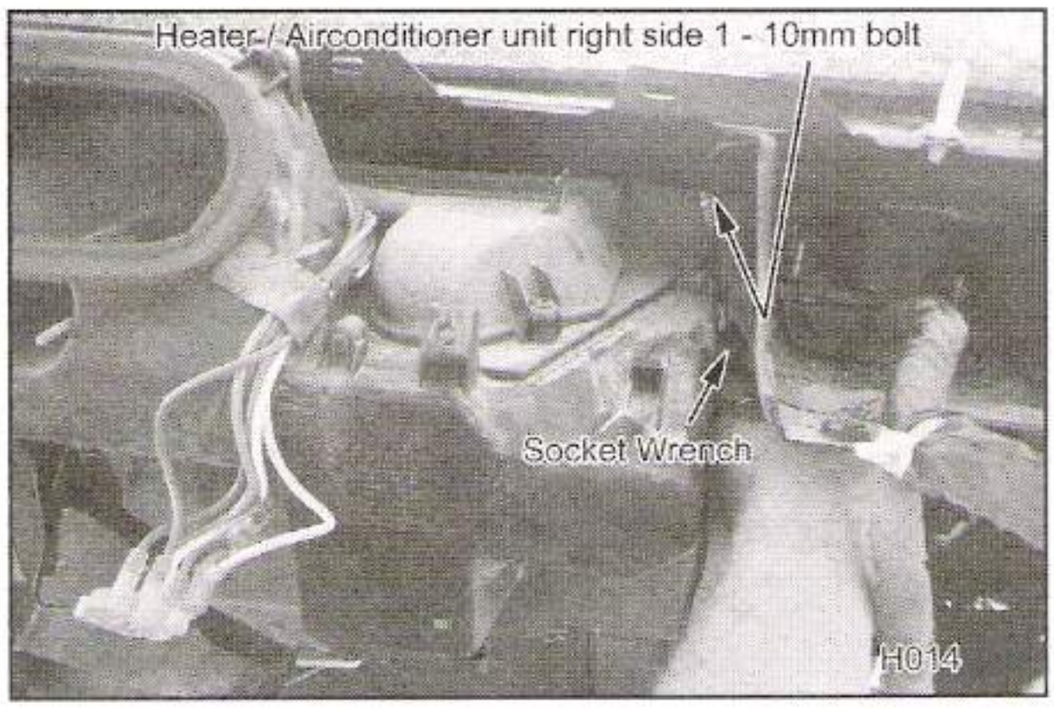
1. Connect the heater / air-conditioner wiring loom connectors and connect vacuum hose plugs, use the labels made during removal to identify the correct hoses for the ports.
2. Replace the radio and instrument facia and radio as previously described.
3. Replace the centre transmission console trim as described earlier.
4. Reconnect the earth cable to the battery.

DASH PANEL ASSEMBLY

**** WARNING: Deactivate air bag system before carrying out any work on steering column or dash - as**

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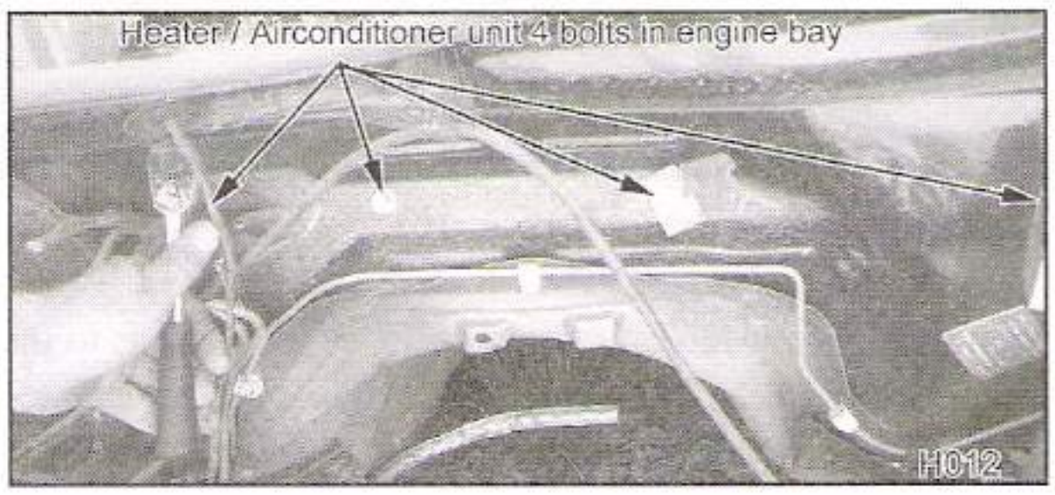


described in SRS chapter.
Remove as described in the "Body" chapter.

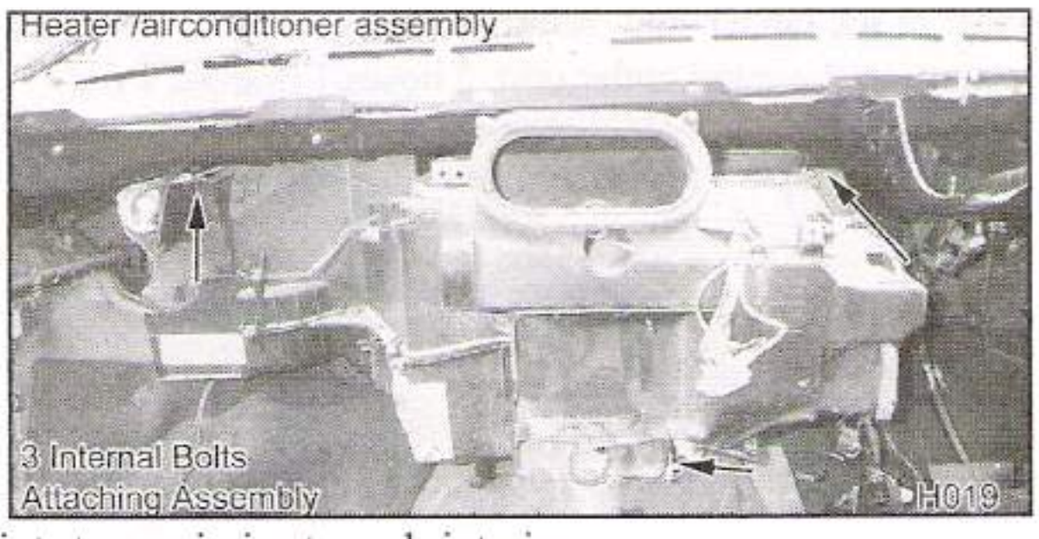
HEATER UNIT

Remove

1. Drain sufficient coolant from radiator so as coolant will not flow into the vehicle.
2. Remove the dash panel as described in "Body " chapter.
3. Disconnect both coolant hoses from the heater core.
4. Disconnect electrical wiring connectors to the fan etc.
5. Remove the vacuum hoses, label hoses and identify the vacuum ports which the particular hoses belong too. This is to help during installation of the heater control switch.
6. Remove the screws attaching the vents and demister ducting, and remove these items.
7. Remove the 4 bolts - in engine bay,



3 bolts in cabin:- 1 bolt right side - interior, 1 bolt front of unit

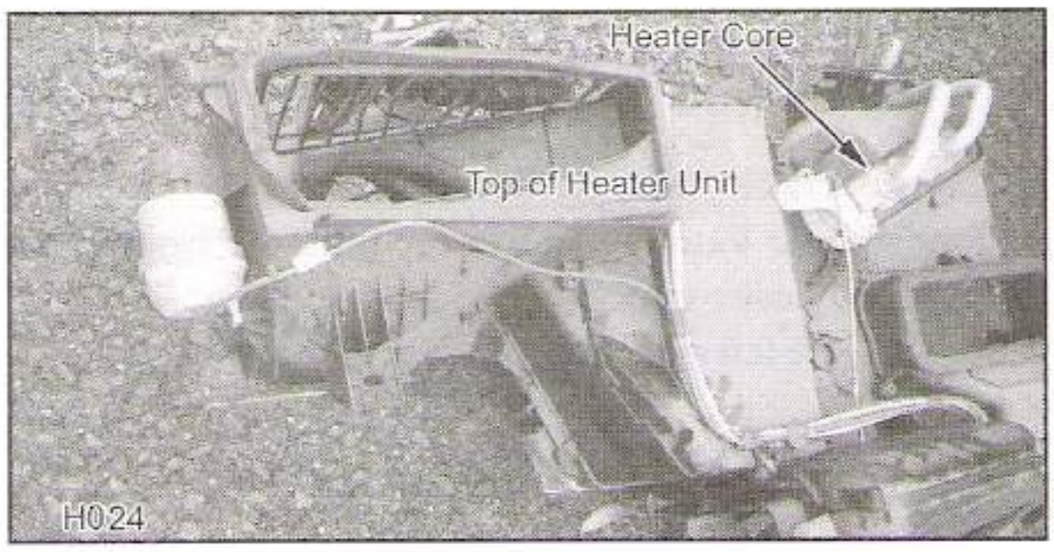


into transmission tunnel - interior,
1 bolt in center of unit, to bracket on floor pan,
1 bolt left side on top air box into top dash support beam - interior. securing the heater / air conditioner case.



8. Remove the heater assembly from the vehicle.

Install

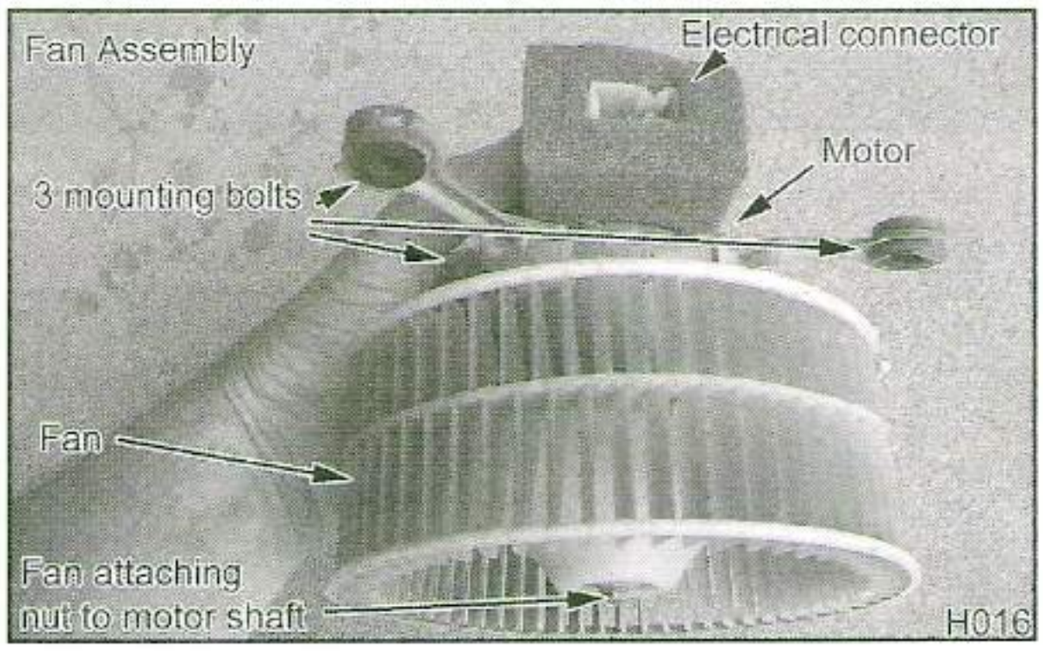


1. Position the heater assembly into the vehicle and up to the front panel and fasten the heater with the four washers and screws.
2. Connect the heater / air-conditioner wiring loom connectors and connect vacuum hoses, use the labels made during removal to identify the correct hoses for the ports.
2. Install the 4 - in engine bay, 1 right side - interior, 1 front of unit into transmission tunnel - interior, 1 left side on top air box into top dash support beam - interior. Screws securing the heater / air conditioner case
3. Connect the water hoses.

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4. Remove the screws attaching the vents and demister ducting, and remove these items.
5. Install the instrument panel as described earlier in this chapter.
6. Top up radiator with specified coolant.
7. Bleed the heater system of any air locks, as described earlier in this chapter.
8. Check the operation of the heater.

FAN MOTOR ASSEMBLY



Remove

1. Gain access to the base of the heater unit, remove heater if necessary.
2. Remove the left side foot well upper panel.
3. Remove the four (4) screws securing the heater base cover to the heater unit.
4. Disconnect the electrical connection.
5. Remove the 3 screws securing the fan and fan motor to the heater case.

Install

1. Secure the motor to the heater case. Install the 3 securing screws.
2. Connect the electrical connection.
3. Replace the four (4) screws securing the heater base cover to the heater unit.
4. Replace the left side foot well upper panel.

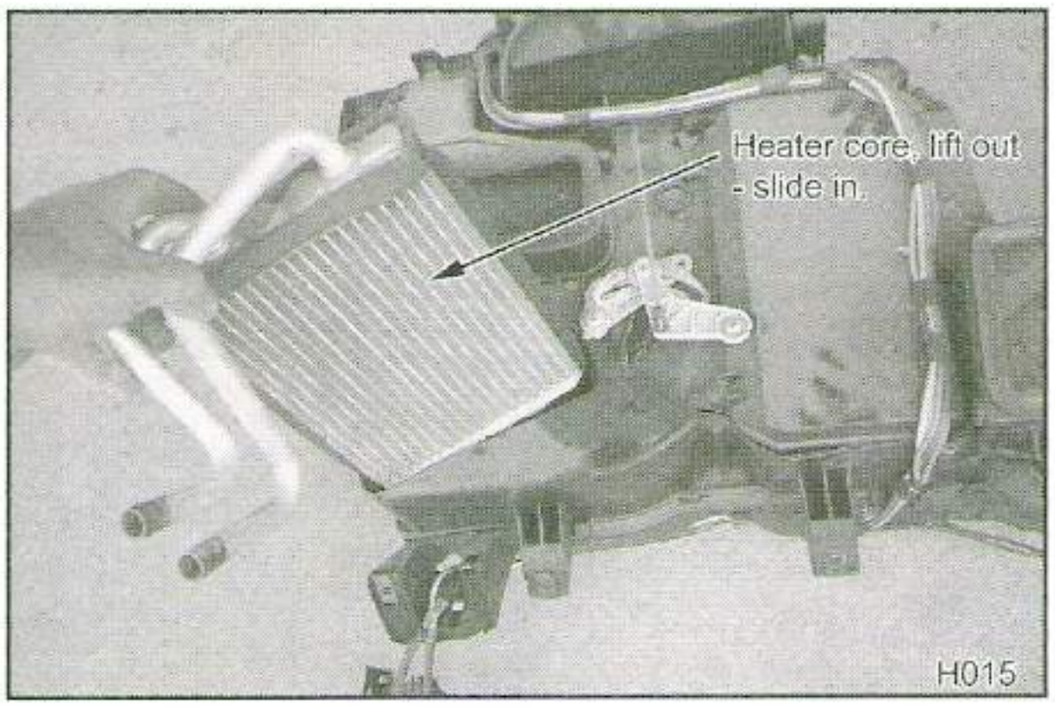
HEATER CORE AND PIPE

Remove

1. Drain coolant from cooling system, remove lower radiator hose.
2. Gain access to the heater unit, remove heater if necessary.
3. Disconnect coolant hoses to heater core.
4. Remove plastic heater core pipe retainer.
5. Lift the heater core from the heater unit, take care not to damage core fins and pipes.

Install

1. Install heater core and pipes taking care not to damage the sealing strips and heater core.
2. Replace plastic heater core pipe retainer.
3. Install coolant hoses, fill cooling system, and check for coolant leaks.



VACUUM ACTUATORS

Remove

1. Disconnect the vacuum hose/s.
2. Remove 2 securing screws of the actuator.
3. Disconnect actuator arm from the control lever.

Install

1. Connect actuator arm from the control lever.
2. Replace 2 securing screws of the actuator.
3. Connect the vacuum hose.

Fresh Air / Air Recirculation



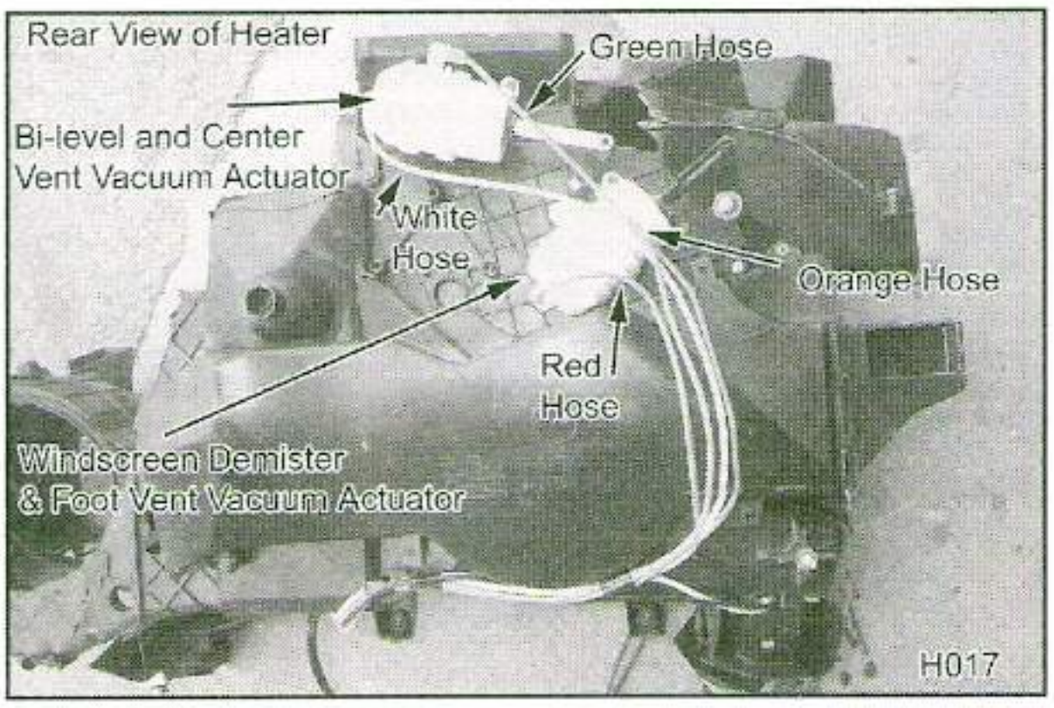
Left side above vacuum tank

Bi-level and Center Vent

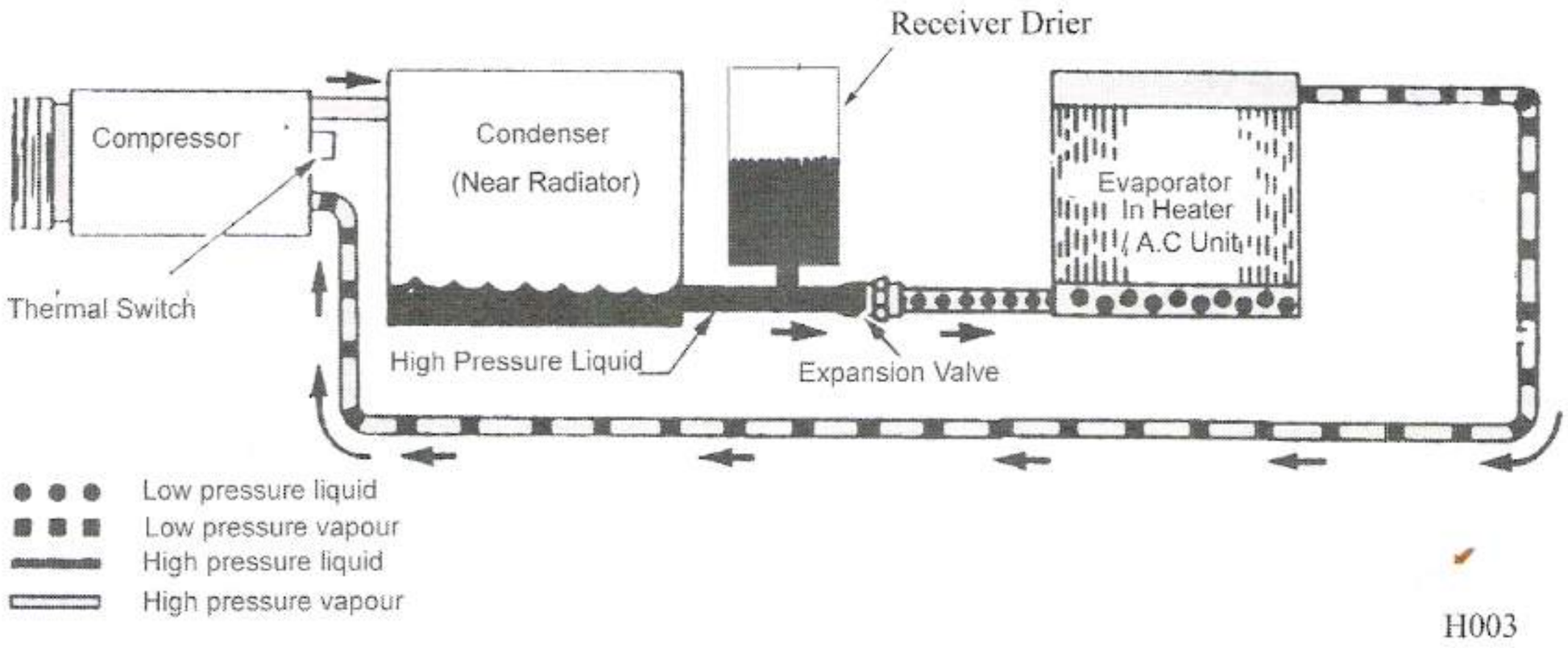
Remove heater / airconditioning unit or gain access to the base of the heater unit, remove the right side center facia extension. Located under unit, 2 hoses 1 green, 1 white.

Windscreen Demister and Foot Air

Remove heater / airconditioning unit or gain access to the base of the heater unit, remove the right side center facia extension. Located under unit, 2 hoses 1 orange, 1 red.



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AIR CONDITIONING

GENERAL INFORMATION

The following information provides basic service operations for the air conditioning system, including the compressor.

REFRIGERANT CIRCUIT

The refrigerant circuit below is schematic of the major components.

A compressor, condenser, expansion tube, evaporator, and an accumulator.

The engine RPM is higher on air conditioned models so as not to drop to low at idle during system operation. When the ignition is turned off and the air conditioning has been operating, a faint sound of liquid flowing for 30-60 seconds maybe heard. This is the refrigerant in the system continuing to flow until high side and low side pressures equalize.

SERVICE OPERATIONS

COMPRESSOR BELT TENSION & ADJUSTMENT

VT Ser I V8 Engine

Inspect the condition of the air compressor belt.

COMPRESSOR DRIVE BELT TENSION

NEW		USED	
*8-10 MM	64kg	*9-11 MM	43kg

* Belt deflection in mm when a force is applied in the area shown in diagram.

ADJUST.

V6 Engines and V8 Gen III:

Automatic tensioner should take into consideration belt wear.

Turn the automatic adjuster idler pulley mounting stud to adjust tension. Check belt wear reference marks on tensioner. Install a new belt if tension is not within reference marks.

VT Ser I V8 Engine:

Using a ring spanner or socket, loosen off the compressor idler pulley assembly. Pull on the idler pulley to tighten the belt, tighten the compressor idler pulley nut.

Torque idler pulley nut to 40-60 Nm when the correct tension has been achieved.

COMPRESSOR

V6 and VT V8 Ser I compressor: Sanden

V8 Gen III compressor: Harrison V5

* Where a failure has occurred that may have resulted in foreign material in the system, the system must be flushed using Refrigerant R-134a.

Note; Refrigerant R134a and R12 compressor oil must not be mixed.

* The compressor is a sealed unit, and the only serviceable sections are the port sealing washers and compressor control valve.

* All compressor removal and install operations, except belt replacement, can only be performed only after the unit has been discharged.

Storage of compressor

The port protection plate should be fitted to keep compressor free from moisture and foreign material if it is necessary to store a serviced compressor.

Remove

1. Discharge the air conditioning service system, and remove refrigerant lines from compressor.
2. [V6 engines and V8 Gen III] Remove front belt, insert a socket drive into belt tensioner rotate anti-clockwise to release tension, remove belt.

[VT Ser I - V8] Loosen compressor mounting bolts, belt adjuster, remove drive belt and disconnect electrical connector.

3. Disconnect electrical connector.
4. Remove compressor mounting [V6 1 bolt and 2 nuts] [VT Ser I V8 - 3 bolts] [V8 Gen III - , remove compressor from

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the vehicle.

Install

1. Install new compressor and [VT SerI V8 fit drive belt]. Torque compressor mounting bolts to specification.

Air-conditioner Compressor V6:	40-60Nm
Air-conditioner Compressor VT Ser I V8:	40-60Nm
Air-conditioner Compressor V8 Gen III:	40-60Nm

2. Connect electrical connector.
3. [V6 engines and V8 Gen III] Remove front belt, insert a socket drive into belt tensioner rotate anti-clockwise to release tension, replace belt.

[VT Ser I - V8] Adjust drive belt to specification with idler pulley. Install refrigerant hoes, and connect clutch wire.

3. Charge the air conditioning system.

COMPRESSOR OIL LEVEL and OIL REPLACEMENT

The compressor has a specified oil and only this oil should be used when adding or changing oil.

Compressor Specified oil:	**Harrison PAG**
Compressor Specified oil capacity:	**220cc ****

Compressor oil level is not a routine type of maintenance check and this would only occur when a break down of the air conditioning system has occurred, thus resulting in oil spillage from broken component or hose fracture.

1. The compressor must be removed to allow a through inspection.
2. New compressor being fitted or servicing used compressor. Remove the drain plug to allow all oil to drain into a container. Measure the amount of oil drained, this will help in determining the amount to be used refilling compressor. Also it will help find the possible fault of the air conditioning unit.
3. Once all oil has drained from the compressor flush any excess oil using a commercial air compressor flushing fluid.
4. Add oil to the compressor via the inlet and outlet hose fittings of the compressor.
5. Replace O ring seals to the suction hose. Tighten the hose connections to specification.

Hose Connections specified torque: 20-30 Nm.

6. Install the compressor.

Oil replacement guide when components have been replaced.

If replacing condenser - add approx. 40ml.
If replacing a pipe or hose - add approx. 40ml.
If replacing evaporator - add approx. 50ml.
Filter Drier Receiver (FDR) - add approx. 15ml.
The FDR must be replaced whenever the system has been opened to the atmosphere for repair.

COMPRESSOR CONTROL VALVE

Remove

1. Discharge the refrigerant from A/C system following recommended EPA procedure, observing safety precautions.
2. From under vehicle remove the "cir-clip that holds the control valve in place.
3. Remove the control valve with pliers. Have the replacement valve to install to avoid loss of oil.

Install

1. Install new control valve, lubricated with oil from compressor.
2. Install cir-clip, ensure it has seated correctly.
3. To check for leaks, evacuate and charge the refrigerant system following the recommended procedures and safety precautions.

REFRIGERANT (A/C) LINES

Removal

1. Discharge the refrigerant from A/C system following recommended EPA procedure, observing safety precautions.
2. Remove the A/C line using a back-up spanner on each fitting.

Install

1. Install new A/C line with protective caps installed.
2. Using new O-rings lubricated with clean refrigerant oil, connect the A/C line into the system. Use two wrenches when tightening the fittings to specification.
3. To check for leaks, evacuate and charge the refrigerant system following the recommended procedures and safety precautions.

EVAPORATOR CORE

Remove

1. Discharge refrigerant from air conditioning system.
2. Remove the dash assembly as described in "Body" chapter.
3. Disconnect the heater ducting and remove from vehicle.
4. Remove the air conditioner/heater assembly as described in heater section. Taking care not to damage the thermostat (held by 2 screws) and thermostat capillary tube.
5. *Heater Core*

a). Remove plastic heater core pipe retainer.
b). Remove the core top securing bracket, 1 screw.
c). Lift the heater core from the heater unit, take care not to damage core fins and pipes.

Air Conditioner Evaporative Core

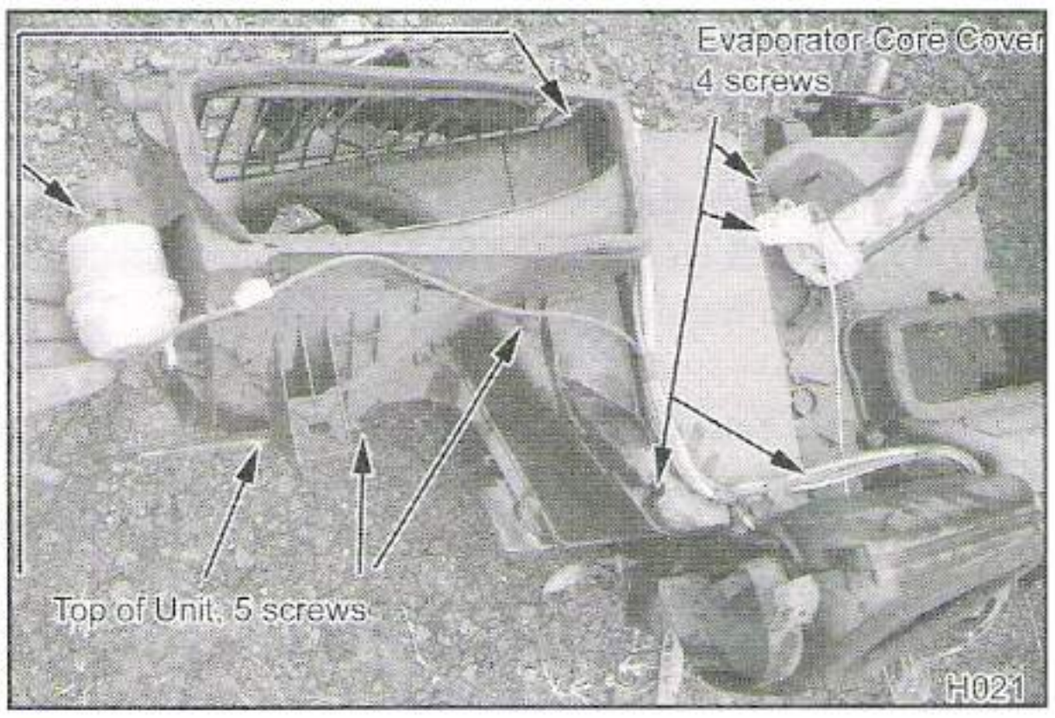
a) Disconnect the vacuum hose from the fresh air actuator.
b) Remove the 5 screws holding the fresh air housing to the top of the heater/airconditioning unit, separate top unit.
c) Remove the evaporator core cover, 4 screws.
d) Remove the evaporator core, take care not to damage core fins and pipes.

Install

1. *Heater Core*

a) Install heater core and pipes taking care not to damage the sealing strips and heater core.
b). Replace the core top securing bracket, 1 screw.

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c). Replace plastic heater core pipe retainer.

Air Conditioner Evaporative Core

a) Install the evaporator core, taking care not to damage the sealing strips and core.

b) Replace the evaporator core cover, 4 screws.

c) Replace the fresh air housing to the top of the heater/ airconditioning unit, 5 screws holding the fresh air housing.

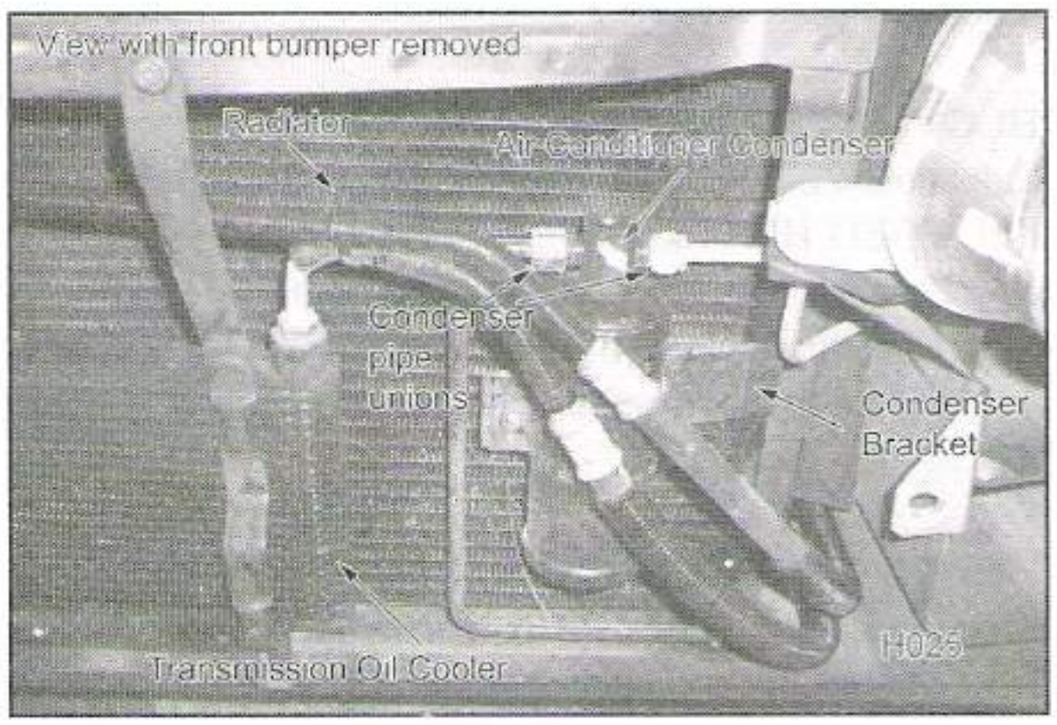
d) Connect the vacuum hose from the fresh air actuator.

2. Connect the heater ducting to the heater assembly.

3. Replace the heater assembly as described in the heater section. Taking care not to damage the thermostat (held by 2 screws) and thermostat capillary tube.

4. Install dash assembly as described in "Body" chapter.

CONDENSER and FDR Unit



Remove

1. Discharge the refrigerant system. Remove the radiator as described in the 'Cooling' chapter, or remove front bumper assembly as described in the "body" chapter.

2. On vehicles fitted with a transmission cooler, remove transmission oil cooler. Remove the attaching bolts and position the transmission oil cooler clear of working area.

3. Disconnect the filter drier receiver (FDR) outlet. Disconnect the discharge pipe from the condenser. (Use a back up spanner to prevent damage when loosening and tightening fittings).

5. [Vehicles with ECC] Disconnect the ambient temperature sensor at the top right side of the condenser.

6. Disconnect the FDR inlet pipe, remove FDR from bracket.

7. Lift condenser towards engine and up to remove.

Install

1. Install the FRD unit to the vehicle, connect the inlet pipe with a new "O" ring.

FRD Pipe Fitting: 7.5-12.5Nm

2. Install the condenser to the vehicle.

3. Oil condenser line 'O' ring and fittings with refrigerant oil and torque nuts to specifications.

Condenser Pipe Fitting: 7.5-12.5Nm

4. Install the FRD inlet pipe with a new "O" ring.

FRD Pipe Fitting: 7.5-12.5Nm

5. Install the transmission oil cooler (where fitted).

6. Evacuate and charge the system with refrigerant R134a.

7. Install the radiator as described in "Cooling" chapter.

THERMAL EXPANSION VALVE (TXV)



Remove

1. Discharge the refrigerant system.

2. Remove the front TXV pipe retaining plate, 1 bolt.

3. Pull pipes from TXV unit, discard "O" rings.

4. Remove the 2 torx screws attaching the TXV unit to the firewall, remove TXV unit, discard "O" rings.

Install

1. Install TXV unit with new "O" rings, install 2 torx screws and tighten.

TXV torx screws: 4.0-4.5 Nm

2. Install the 2 pipes to the TXV unit, new "O" rings.

3. Install the front TXV pipe retaining plate, 1 bolt.

TXV Front Pipe Retaining Plate: 7.5-12.5Nm

HEATER & AIRCONDITIONING SWITCH

See "Heater & Airconditioning Switch" earlier in this chapter under Heater section.

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PROBLEM SOLVING AND DIAGNOSIS

HEATING TROUBLE DIAGNOSIS GUIDE

Condition - Insufficient, Erratic, No Heat or Demist

CAUSE: Low radiator coolant due to coolant leaks.
ACTION: Check supply tank cap pressure. Replace if below minimum pressure. Fill to level. Pressure test for engine cooling system and heater system leaks. Service as required.
CAUSE: Low radiator coolant due to engine overheating.
ACTION: Remove bugs, leaves, etc. from radiator or condenser fins. Check for: Loose drive belt, sticking thermostat, incorrect ignition timing, water pump impeller damage, and restricted cooling system. Service as required.
CAUSE: Loose drive belt.
ACTION
Replace if cracked or worn and/or adjust belt tension.
CAUSE: Thermostat.
ACTION: Check coolant temperature at supply tank. If under 77 degrees Celsius replace thermostat.
CAUSE: Plugged or partially plugged heater core.
ACTION: Clean and back flush engine cooling system and heater core.
CAUSE: Loosely or improperly adjusted control cables.
ACTION: Adjust to specifications.
CAUSE: Vacuums hoses crossed, collapsed, or kinked.
ACTION: Check to see if door vacuum motors respond properly to movements of the Control Knobs. Visually check vacuum hoses, and service as required.
CAUSE: Air flow control doors sticking or blinding.
ACTION: Check if door vacuum motors or cable operated blend door respond properly to movements of Control Knobs. Detach vacuum motor arm from door crank arm and move crank arm by hand, if hesitation in movement is noticed. Repair sticking or binding door as required.
CAUSE: Vacuum motor diaphragm or hose leaks.
ACTION: Detach each multiple vacuum connection from the switch and check each connector opening with hand operated vacuum pump. If one line leaks vacuum, test motor by itself prior to replacing. Service vacuum hose(s), or replace vacuum motor as required.
***It is normal for the orange line not to hold vacuum unless the engine temperature is greater then 101°C.**
Turquoise and black lines have multiple terminations.
CAUSE: Ticking heater water valve.
ACTION: Vacuum check with hand vacuum pump. Replace if required.
CAUSE: Kinked, clogged, collapsed, soft, swollen, or decomposed engine cooling system or heater system hoses.
ACTION: Replace damaged hoses and back flush engine cooling system, then heater system, until all particles have been removed.
CAUSE: Blocked air inlet.
ACTION: Check cowl air inlet for leaves, foreign material, etc. Remove as required.

Condition - Too Much Heat

CAUSE: Loose or improperly adjusted control cables.
ACTION: Adjust as specified.
CAUSE: Sticking water valve.
ACTION: Vacuum check with hand vacuum pump. Replace if required.
CAUSE: Vacuum not available to close water valve.
ACTION: Check vacuum system with hand vacuum pump from control connector (turquoise line). Service tubing, or replace damaged component as required.

Condition - Air Flow Changes Direction When Vehicle is Accelerated

CAUSE: Vacuum system leak.
ACTION: Check vacuum system with hand vacuum pump for the switch connector. Service tubing, or replace damaged components as required.
CAUSE: Faulty vacuum check valve.
ACTION: Replace.
TEST

LOOSE MOTOR FAN TEST

Turn on the fan switch, if only a hum is heard, the fan is loose on the motor.

BLOWER SWITCH TEST

Substitute a blower switch for the suspected switch.

PLUGGED HEATER CORE TEST

Make certain the control knob is set at 'HOT'. Temporarily remove the outlet hose from the heater core (the hose may be detached from the heater in engine compartment), whilst the engine is running.

HEATER WATER VALVE TESTS

Prior to testing, check for proper coolant level, coolant temperature, and drive belt tension. Also check for coolant leaks or plugged hoses or heater core. Correct any defects before proceeding with the tests.

VACUUM TESTS

1. Disconnect the vacuum line and attach a vacuum pump to the vacuum switch connection.
2. The arm of the vacuum motor should move freely in both directions without sticking, when the vacuum is applied and released.
3. Make sure there is full travel of the arm. This can be checked by pushing the arm manually to make sure the valve

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is fully seated.
4. Check for any possible leak of the vacuum diaphragm.
5. The motor should be replaced if it does not operate as described.

VACUUM HOSE & CONNECTION TESTS

Start the engine and move the control knobs slowly from one position to another, to test the A/C-heater control system. As a control knob is moved from one position to another a momentary hiss should be heard indicating that vacuum is available at the switch assembly. A continuous hiss indicates that there is a leak somewhere in the system. This does not necessarily indicate that the leak is at the switch assembly. Check for a kinked, pinched or disconnected vacuum supply hose, if a momentary hiss cannot be heard when a control knob is moved from one position to another. **Inspect the check valve between the intake manifold and the vacuum reservoir to be sure it is working properly.**
Vacuum is available at the switch assembly, if a momentary hiss can be heard when a control knob is moved from one position to another. With the blower on HI, cycle the switch through each position and check the location(s) of the discharge air. The air flow schematic and vacuum control chart gives the vacuum motors applied for each position of a control switch along an air flow system. The air flow diagram shows the position of each door when vacuum is applied and, their "no" vacuum position. The air flow for each position of a control switch can be determined with the chart.
If a vacuum motor fails to operate, the motor can be readily found because the air flow will be incorrect.
Check the operation of the motor with a vacuum pump, if the vacuum motor is inoperative. The vacuum hose is probably pinched, kinked, disconnected or has a hole in it if the vacuum motor operates properly.

REFRIGERANT SYSTEM PRESSURE EVALUATION

*Normal system conditional requirements must be maintained to properly evaluate refrigerant pressures.

HIGH Pressure at Accumulator Inlet
Suction pressure: Normal to High:
Problem component: Heater water valve - Insufficient Closure/ Evaporator - Expansion Valve - Sticking Open.
HIGH Pressure at Accumulator Inlet
Suction pressure: Normal:
Problem: Air in refrigerant system. Refrigerant - Overcharge.
HIGH Pressure at Accumulator Inlet
Suction pressure: Low
Problem component: Receiver/drier, Liquid line, TXV Valve - Restriction after high pressure service access valve.
HIGH Pressure at Accumulator Inlet
Suction pressure: Low
Problem component: Receiver/Dryer - Restriction. A/C Liquid Line - Restriction.
NORMAL to HIGH Pressure at Accumulator Inlet
Suction pressure: High
Problem component: CONDENSER - Inadequate Air Flow (Bent Fins, Debris, Loose Radiator Drive Belt, Slipping Fan Clutch).
NORMAL to HIGH Pressure at Accumulator Inlet
Suction pressure: Normal to High
Problem : Humidity well above normal.
NORMAL to HIGH Pressure at Accumulator Inlet
Suction pressure: Normal
Problem component: Excessive Refrigerant Oil.
NORMAL - ERRATIC Pressure at Accumulator
Suction pressure: Normal to Erratic:
Problem component: Moisture in Refrigerant system - Affects Expansion Valve.
NORMAL - LOW Pressure at Accumulator Inlet
Suction pressure: Normal
Problem component : Evaporator - Restriction, Inadequate Air Flow - Reset Blower to Conditional Requirement and/or Confirm Blower Condition.
LOW Pressure at Accumulator Inlet
Suction pressure: High
Problem component: Compressor - Damaged
LOW Pressure at Accumulator Inlet
Suction pressure: Low
Problem component: Evaporator - Iced up, Expansion Valve - Sticking open, Refrigerant Leak and/or Undercharge, Compressor-to-Condenser A/C Line - Restriction.

COMPRESSOR DIAGNOSIS

Problem: Oil Leaks
Remedy: Inspect for leaks.
Oil leaks do not necessarily indicate leaking refrigerant, check for oil leaks around the following components:
- Shaft seal, leak test see area between clutch and compressor.
- Hose fittings.
- Compressor housing.

Thoroughly clean around compressor and components with detergent and hot water, starting detection procedures. Follow supplier instructions for the proper techniques to be used for 'ELECTRONIC' Leak Detectors.
Another useful test is a soap bubble test. Apply a soapy mixture around all joints or possible leak areas, start air conditioner and turn on to high operation, check for bubbles. If bubbles are found at any section or joint where the soapy solution was applied it will indicate a leak requiring repair.
Problem: Bearing Noise
Remedy: Carry out the following procedure: Remove belt. Disengage clutch. Rotate rotor pulley by hand. Listen for bearing noise. Feel for hard spots. If excessive, repair or replace compressor.

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* All compressors have operating noise, this should not be mistaken for a faulty compressor.
Problem: Suspect bearing or seal failure.
Remedy: Discharge the system, disengage clutch, rotate front plate by hand. While rotating, if severe rough spots or 'catches' are felt, repair or replace the compressor.
Problem: Compressor noise.
Remedy: Visual inspection of:
Broken or loose bolts at compressor and engine fixing points - replace and/or torque bolts to specifications.
Loose or bent engine crankshaft pulley - repair or replace.
Broken bracket and/or compressor body mounting - replace broken component.
Oil level - insufficient oil can cause unusual noise.
Drive belt not at correct tension.
Generator bearing noisy - replace.
Water pump bearing noisy - replace.
Loose engine mounting bolts - re-torque.
Low refrigerant charge. Low charge can be determined by low suction pressure together with low head pressure.

Electronic Climate Control (ECC)

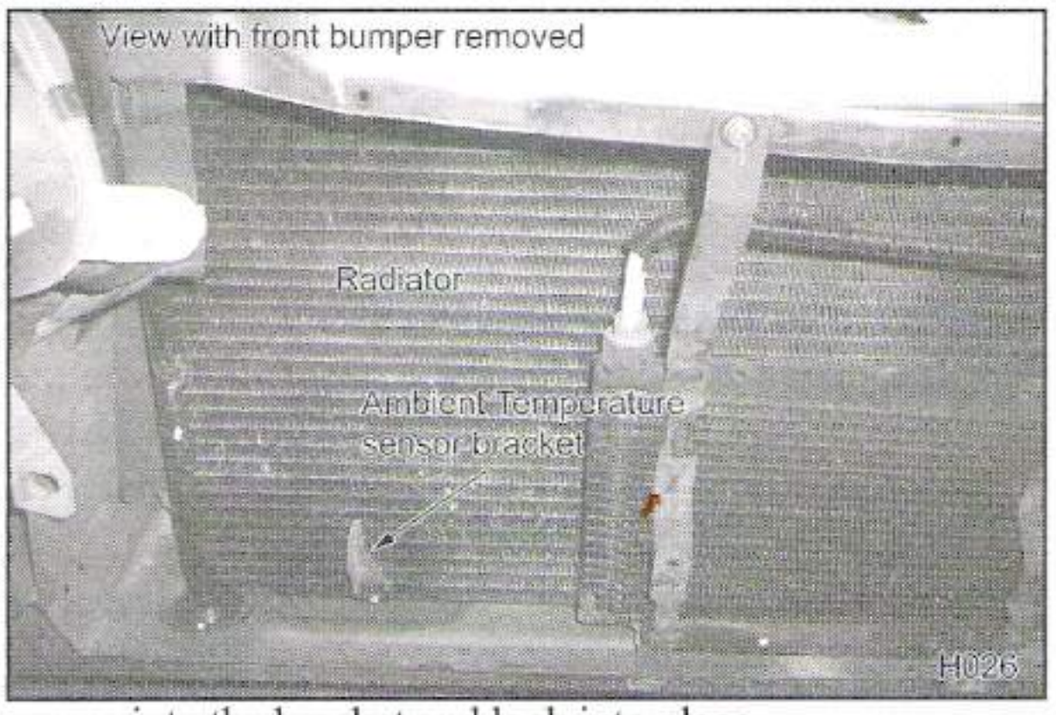
Electronic climate control system is designed to use sensors in conjunction with the air conditioning system to maintain an even inside temperature in the vehicle. This system can be either a single zone or a dual zone.
The ECC has a control module that uses input information from sensors and the PCM and BCM as well as various sensors.
Sensors used are:

In car temperature.
Outside ambient temperature.
Evaporator temperature.
Coolant temperature
Solar

The ECC can operate in Auto mode 23°C or a temperature set by the driver. When in Auto mode the green LED will glow.
If a sensor has an electrical fault the "X" will glow at the right side of the ECC module LCD display.

Ambient Temperature Sensor

The ambient temperature sensor is located in front of the A/C condensor, near the right side.
Remove
1. Work through the opening of the front grille, disconnect the wiring connector..
2. Unclip the sensor with a small screw driver from the bracket and remove.
Install
1. Work through the opening of the front grille, push the



sensor into the bracket and lock into place.
2. Connect the wiring connector.
Test

Ambient Temperature Sensor (wires black/yellow - light green/black)

Amb't air	°C Resistance	Amb't air	°C Resistance
10	9715-10193	40	2610-2717
20	6107-6389	50	1767-1836
30	3943-4115	60	1201-1291

Evaporator Air Temperature Sensor (wires white - blue/black)

The evaporator air temperature sensor is located on top of the A/C unit near the aspirator venturi.
Test

Evaporative Air Temperature Sensor (wires white - blue / black)

Evap. air	°C Resistance	Evap. air	°C Resistance
10	3600-4050	35	1330-1470
15	2950-3250	40	1140-1260
20	2320-2625	45	950-1050
25	1990-2200	50	850-950
30	1675-1850		

In Car Temperature Sensor.

The in car temperature sensor is located on the dash panel behind the left side of the steering wheel.
Remove
1. Remove the centre transmission consol, pry up with a screw driver.
2. Remove the radio and instrument facia as described in body chapter.
3. Remove the in car sensor (2 screws), disconnect the wiring connectors.
Install
1. Replace the in car sensor (2 screws), connect the wiring

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connectors.
2. Replace the radio and instrument facia and radio as previously described.
3. Replace the centre transmission console trim, push into place, firmly.

Test

In Car Temperature Sensor (wires black/yellow - blue/black)

°C in Car	Resistance	°C in Car	Resistance
10	5477-5856	35	1746-1857
15	4310-4583	40	1410-1508
20	3416-3612	45	1145-1231
25	2725-2865	50	935-1010
30	2175-2299		



Aspirator Tube

The aspirator tube is located on top of the A/C unit, this tube sucks air to the in car temperature sensor when the fan starts to operate.

Remove

1. Remove the centre transmission consol, pry up with a screw driver.
2. Remove the radio and instrument facia as described in body chapter.
3. Remove the in car sensor (2 screws), disconnect the wiring connectors.
4. Unclip and remove the aspirator tube from behind the in-car temperature sensor and from on top of the A/C unit.

Install

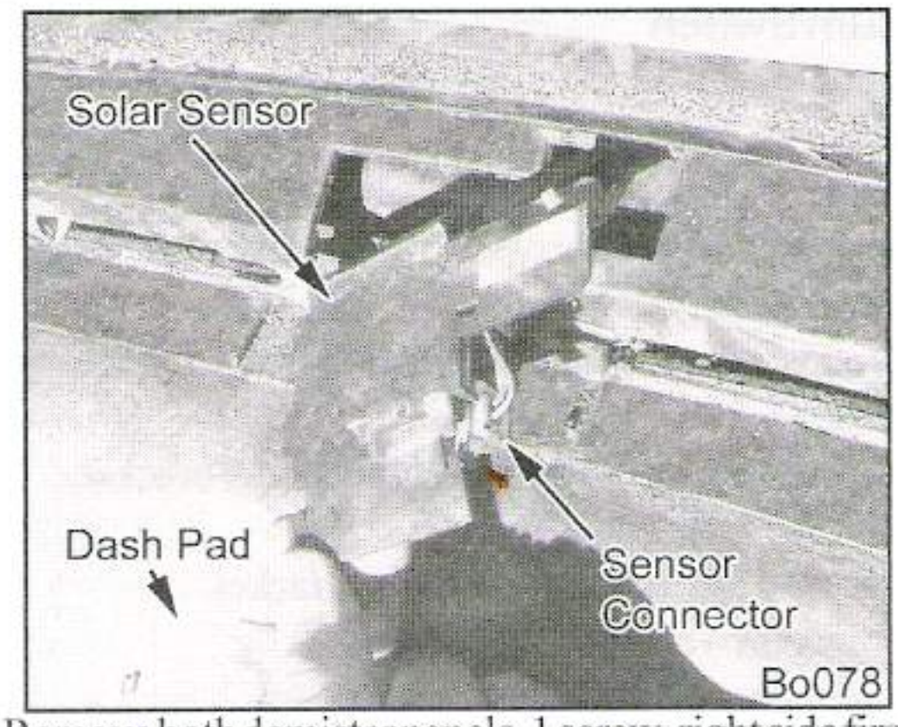
1. Replace the aspirator tube to the top of the A/C unit and behind the in car temperature sensor, clip into place.
2. Replace the in car sensor (2 screws), connect the wiring connectors.
3. Replace the radio and instrument facia and radio as previously described.
4. Replace the centre transmission console trim, push into place, firmly.

Solar Sensor

The solar sensor is located in the center of the demister vent at the center of the windscreen.

Remove

1. Remove both dash end covers, 3 screws.

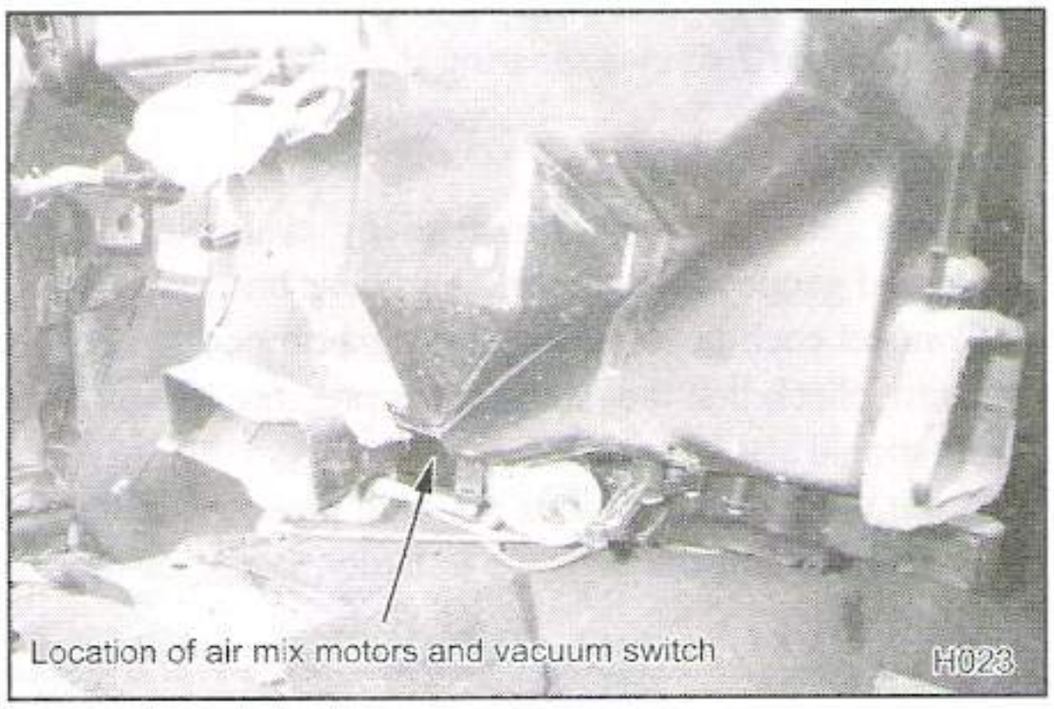


2. Remove both demister panels, 1 screw, right side first, take care of the solar sensor.
3. Grip the solar sensor, lift up to release the lower section, then push down to release the sensor tabs, disconnect the wiring connector and remove.

Install

1. Position the sensor, reconnect the wiring connector.
2. Push the sensor into place, and firmly press so the locking tabs go into place.
3. Remove both demister panels, 1 screw, left side first.
4. Remove both dash end covers, 3 screws.

Air Mix Motors



The air mix motors are located under the A/C unit, they operate the vent doors to mix air flows. A single zone ECC has one motor while the dual zone ECC has two motors.

Remove

1. Gain access to the base of the heater unit, remove heater if necessary.
2 Disconnect the electrical connection to the motor/s.
3. Remove the 3 screws securing the air mix motor/s to the heater case.

Install

1. Secure the motor to the heater case. Install the 3 securing screws.
2. Connect the electrical connection.
3. Replace the heater unit.

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Vacuum Switch

A vacuum switch is located between the 2 vacuum actuators under the A/C unit

Remove

1. Gain access to the base of the heater unit, remove the right side center facia extension.
2. Disconnect the vacuum hoses, label for assistance during assembly.
3. Remove the vacuum switch, clipped into bracket.

Install

1. Secure the vacuum switch to the bracket.
2. Connect the vacuum hoses.
3. Replace the right side center facia trim.

Vacuum Solenoid Pack & Vacuum Hose Check

The vacuum pack is located near the rear of the A/C fan housing, this pack uses electrical current from the ECC module to activate the vacuum actuators giving greater control over the air movement.

Remove

1. Gain access to the base of the heater unit, remove heater if necessary.
2. Remove the left side foot well upper panel.
3. Remove the four (4) screws securing the heater base / fan cover to the heater unit.
4. Disconnect vacuum hoses bracket to the solenoid pack, push on fit, and the electrical connection.
5. Remove the 2 screws securing the solenoid pack to the heater case.

Vacuum hose check

1. Use a hand operated commercially available vacuum pump and gauge unit at the vacuum hose bracket.
2. Connect each hose port to the vacuum pump, create a vacuum, check that the gauge holds pressure, the air flow doors should also operate.
3. If the vacuum pump does not hold pressure, either the vacuum hose and the actuator is faulty, repair or replace faulty section.

Vacuum Hose Identification Chart

Colour	Actuator
Black	Vacuum Source
Blue	Recirculating / Fresh
Orange	Foot well / Windscreen Demister
White	Center Vent
Red	Floor
Green	Bi-level

Install

1. Replace the solenoid pack to the heater case, 2 screws.
2. Connect vacuum hoses bracket to the solenoid pack, push on fit, and the electrical connection.
3. Replace the heater base / fan cover to the heater unit, 4 screws.
4. Replace the left side foot well upper panel.

Vacuum Circuit

See schematic drawing this chapter for circuit.

EEC Module and Control Globe - Commodore

Remove

1. Disconnect the battery.
2. Remove the centre transmission consol trim, pry up with a screw driver.
3. Remove the radio and instrument facia as described in body chapter.
4. Remove the ECC module (2 screws) lift the control unit enough to allow the wiring connectors to be removed from the ECC.

Globe Replacement

1. Separate the 2 sections of the ECC, 5 screws.
2. Use a small flat screw driver, insert it into the globe holder, turn anticlockwise until the holder hits a stop, careful remove globe holder
3. Replace globe, insert globe holder in position, use the screw driver to rotate clockwise to lock in globe holder.
4. Assemble 2 sections of ECC, 5 screws.

Install

1. Connect the ECC loom connectors.
2. Replace the radio and instrument facia and radio as previously described.
3. Replace the centre transmission console trim as described earlier.
4. Re-connect the earth cable to the battery.

EEC Module and Control Globe - Statesman and Captirce

Remove

1. Disconnect the battery.
2. Remove the centre transmission consol trim as described in body chapter.
3. Remove the radio and instrument facia as described in body chapter.
4. Remove the EEC controls (2 screws) lift the control unit enough to allow the wiring connectors to be removed from the controls.

Install

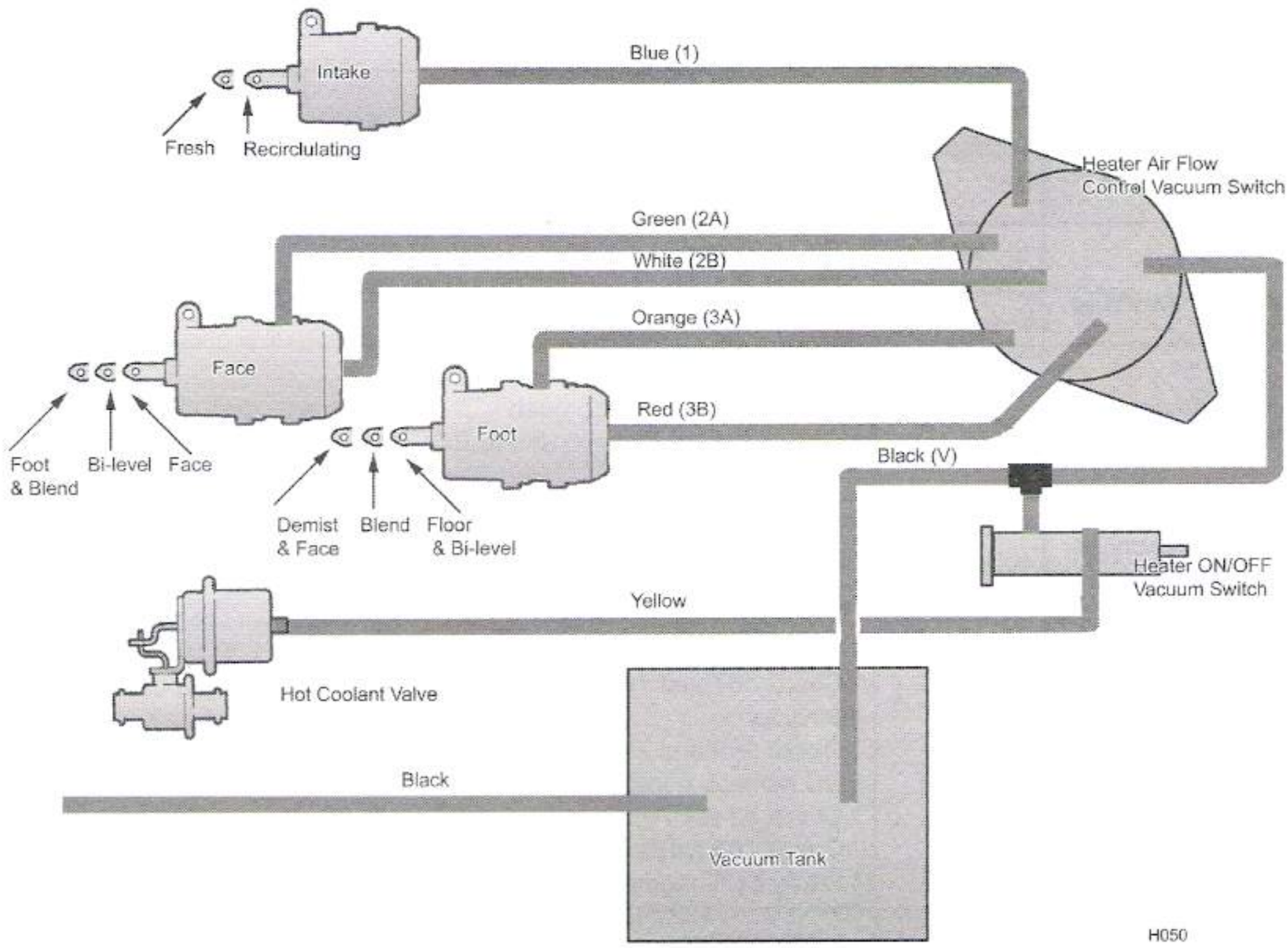
1. Connect the EEC wiring loom connectors.
2. Replace the radio and instrument facia and radio as previously described.
3. Replace the centre transmission console trim as described earlier.
4. Reconnect the earth cable to the battery.

ECC Diagnosis

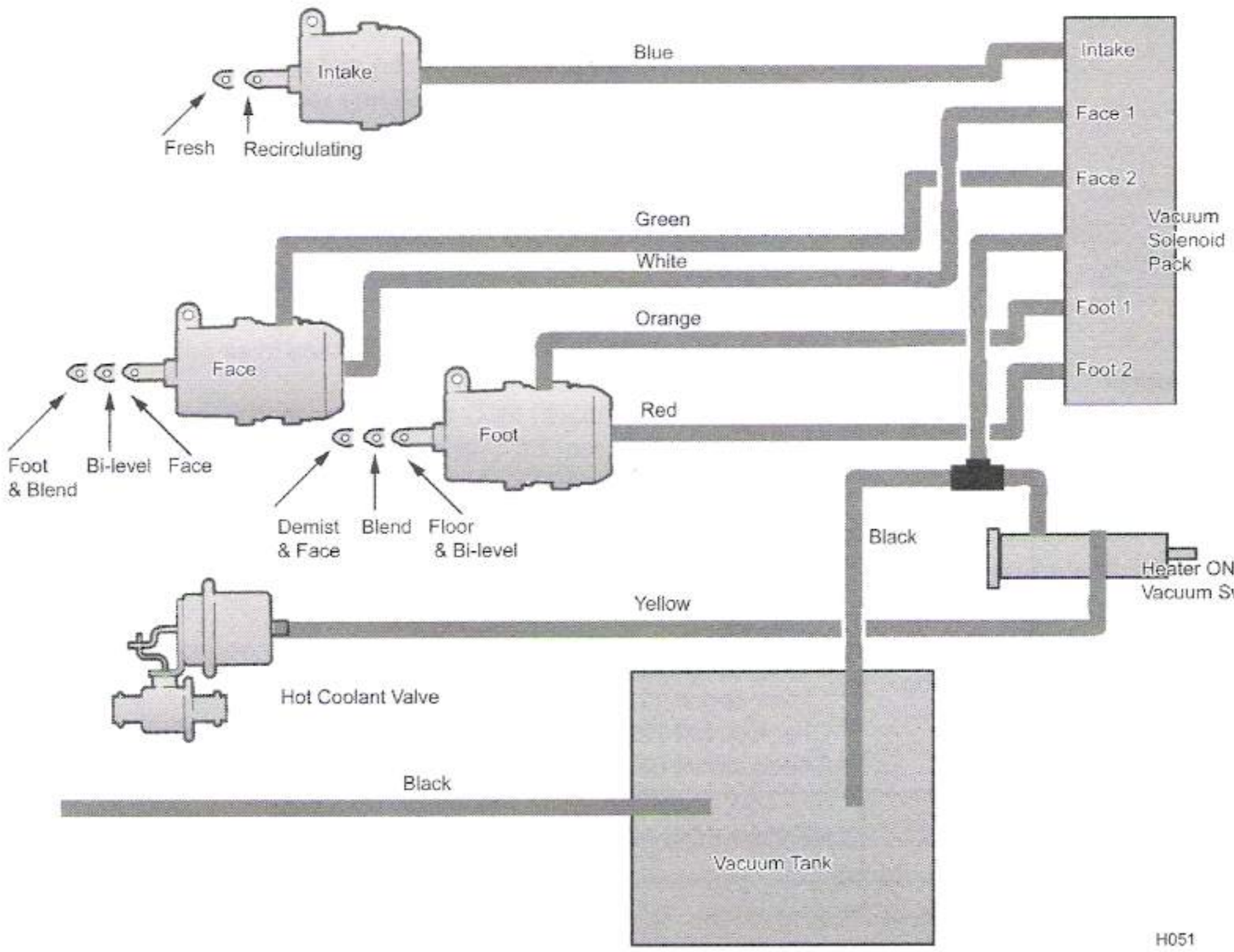
The ECC diagnosis needs a TECH 2 or similar instrument connected to the DLC terminal (located drivers side under dash panel).

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HEATER and AIR CONDITIONING - VACUUM HOSES SCHEMATIC



ECC AIR CONDITIONING - VACUUM HOSES SCHEMATIC



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			Electronic Climate Control DTC codes
DTC	Senor	Fault	Possible Causes
13	Ambient Air Temperature (ATS)	Signal voltage to high	* Faulty sensor * Circuit 155 (ATS earth) open * Circuit 735 (light green) (ATS to ECC module) faulty * Faulty ECC module
14	Ambient Air Temperature (ATS)	Signal voltage to low	* Faulty sensor * Circuit 735 (light green) (ATS to ECC module) faulty * Faulty ECC module
15	In Car Temperature (ITS)	Signal voltage to high	* Faulty sensor * Circuit 155 (ITS earth) open * Circuit 734 (blue/black) (ITS to ECC module) faulty * Faulty ECC module
16	In Car Temperature (ITS)	Signal voltage to low	* Faulty sensor * Circuit 734 (blue/black) (ITS to ECC module) faulty * Faulty ECC module
17	Evaporative Air Temperature (ETS)	Signal voltage to high	* Faulty sensor * Circuit 367 and 763 short - should be no resistance at ECC harness connector * Circuit 188 and 763 short - should not be lass than 4.0ohms resistance at ECC harness contector * Circuit 62 (tan) (ETS to ECC module) faulty * Circuit 783 (white/black) (ETS to ECC module) faulty * Faulty ECC module
18	Evaporative Air Temperature (ETS)	Signal voltage to low	* Faulty sensor * Circuit 783 (white/black) ETS to ECC module short * Faulty ECC module
19	Solar	Signal voltage faulty	* Faulty sensor * With sunlight on senor, cover (0.5volts) and uncover sensor (5.0 volts) check circuit 272 (yellow black) for altering voltage. - faulty sensor or circuit 272 * Circuit 272 open or short between BCM and solar sensor. * Circuit 740 (orange / black) short - should have battery voltage. * Circuit 271 (brown / green) BCM to solar sensor, check for short or open. * Faulty BCM
21	Air Mix Motor - Drivers Side (SZ-DZ)	Motor Not Operating	* Motor faulty * Motor receiving 0.6 to 3.4 volts with alteration in air mixture, circuits 184 (black) and 186 (red). * Check circuit 184 (black) ECC to motor for short or open. * Check circuit 186 (red) ECC to motor for short open. * Check circuit 188 (white) ECC to motor for short open * Check circuit 62 (tan) ECC to motor for short open
24	Air Mix Motor - Passenger Side (DZ)	Motor Not Operating	* Motor faulty * Motor receiving 0.6 to 3.4 volts with alteration in air mixture, circuits 224 (brown) and 223 (blue). * Check circuit 224 (brown) ECC to motor for short or open. * Check circuit 223 (blue) ECC to motor for short open. * Check circuit 222 (yellow/blue) ECC to motor for short open * Check circuit 62 (tan) ECC to motor for short open
37	ECC control module	Internal failure	* Replace ECC after testing with TECH 2 or similar ECCdtc

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BODY

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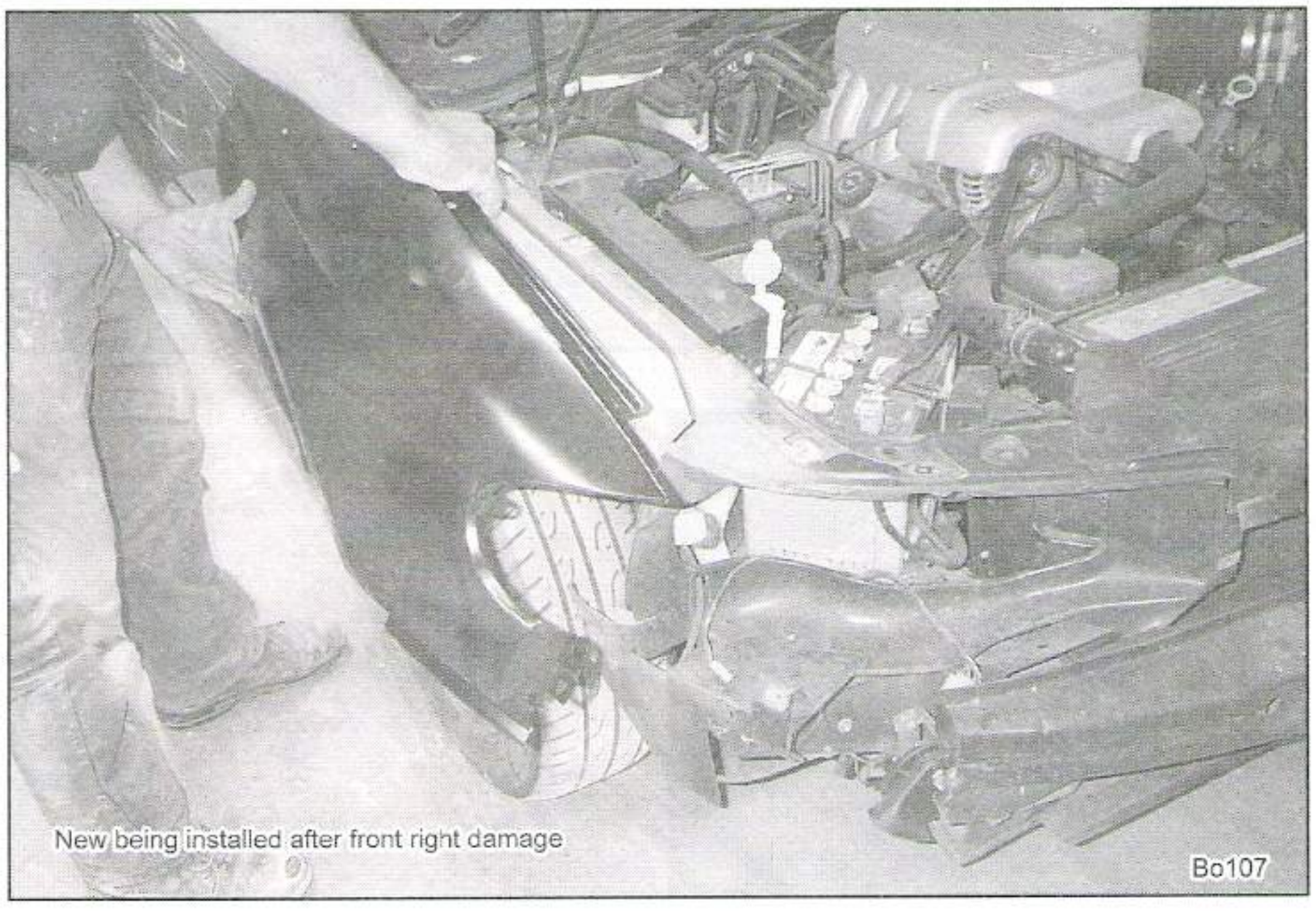
GENERAL INFORMATION

The body incorporates a floor pan frame as the basic construction. The body doesn't have a frame but it's assembled by spot welding panels together. This construction results in a lightweight body which will not bend, buckle or vibrate with normally accepted road use, and minor impact.

After a collision it's advisable to check the body alignment. The reinforced box sections of the front lower structure and strut mountings in the fender splash shields ahead of the fire wall are the ones that will most likely be damaged. These areas in front of the fire wall carry the front suspension, support the engine and the front body panels.

The box sections of the body should also be inspected as these sections support the doors and help in providing protection to the driver and passenger in case of a collision. The door pillars, sills and roof rails provide added strength to floor pan and the general body components.

If replacing body panels it is advisable that these panels be perfectly aligned, if they can not be panel beaten or repaired so they align it is advisable that the panels be replaced with another panel either new or second hand in very good repair. As these panels help give strength to the vehicle body.



New being installed after front right damage

Bo107

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FLOOR PAN / CHASSIS ALIGNMENT

Body alignment may be checked accurately by the following method:

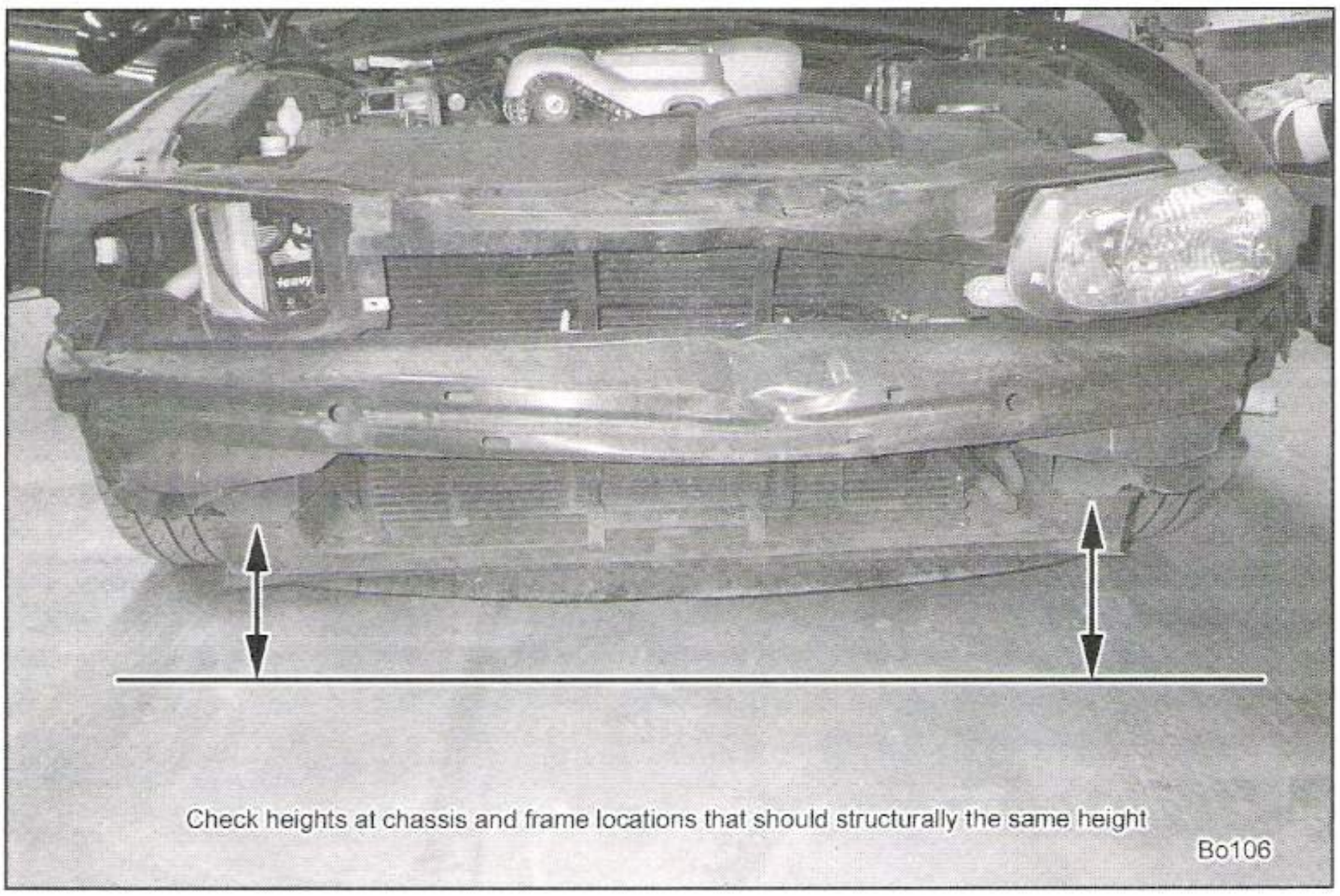
Compare the dimensions made on both sides of vehicle. All dimensions must be measured at the welded joints of the body to ensure uniform measurements or from the centre of holes if measuring from the center of a hole in the body or floor pan / chassis.

[Check Horizontal Plane]

To check the chassis in the horizontal plane, take several measurements, both along the length of the chassis and diagonally across the chassis, the measurements are then compared and if any are not the same the chassis is out of alignment in the horizontal plane. To ensure that measurements are uniform, all dimensions must be taken from the centre point of body mounting holes, shackle bolt holes etc. If dimensions are found to be suspect the vehicle may have to be taken to a body shop to have the chassis aligned correctly.

[Vertical Plane]

The chassis should also be checked for alignment in the vertical plane, A1 and B1 diag:- B-003. The vehicle should be parked on a flat surface and measurements taken from points along the length of the chassis down to the floor, a plum bob can be used along with a piece of chalk to mark the point of contact of the plum bob on the floor, then use a tape measure to accurately take measurements from the marks on the floor to the centre point of shackle bolts etc. To ensure that measurements are uniform, all dimensions must be taken from the centre point of body mounting holes, shackle bolt holes etc. If the measurements are then compared and found not to be the same this indicates that the chassis is twisted. If any twisting of the chassis is found the vehicle will need to taken to a body shop to have the problem rectified by straightening on a chassis rack.



Check heights at chassis and frame locations that should structurally the same height

Bo106



Bo151

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CENTER CONSOLE

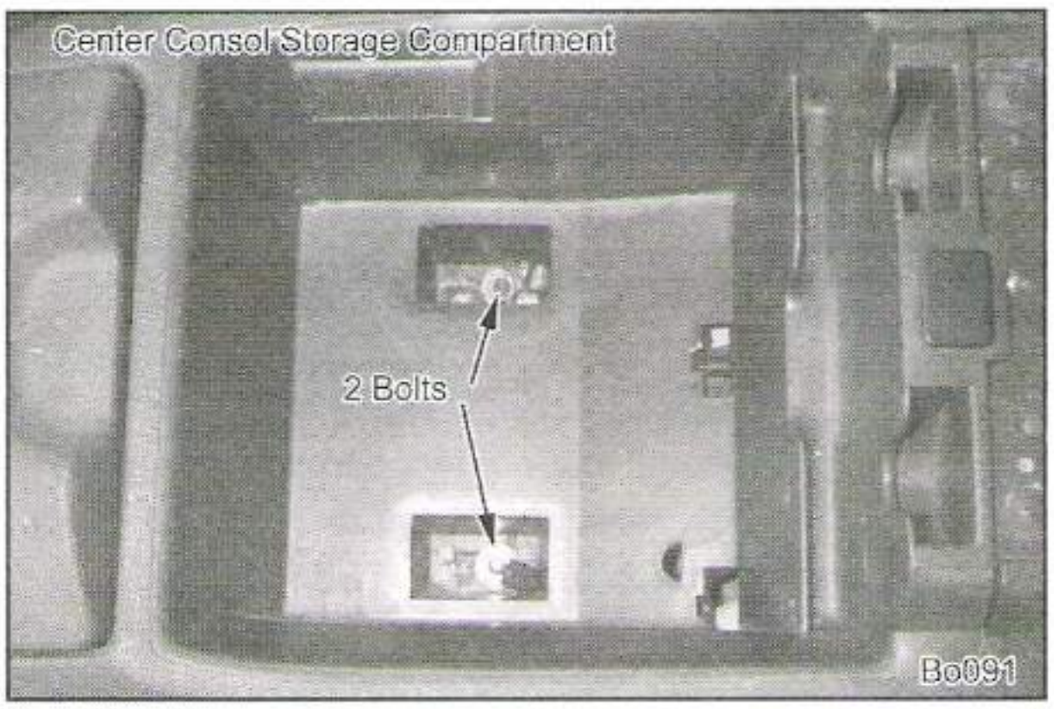
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Replace	332



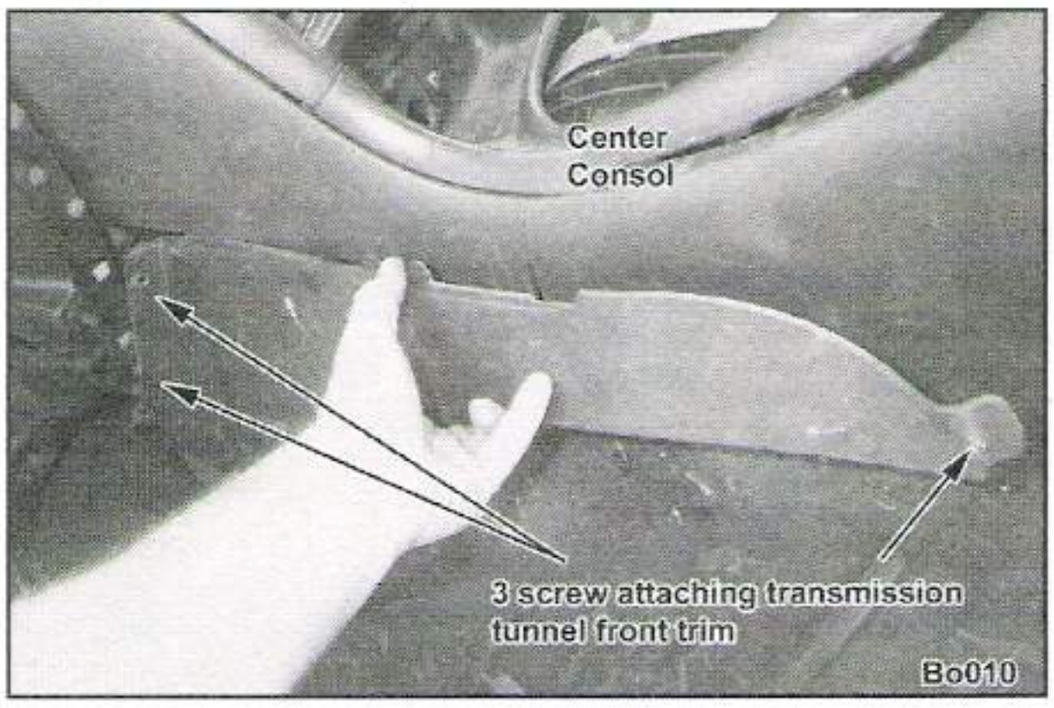
CENTRE CONSOLE

Remove

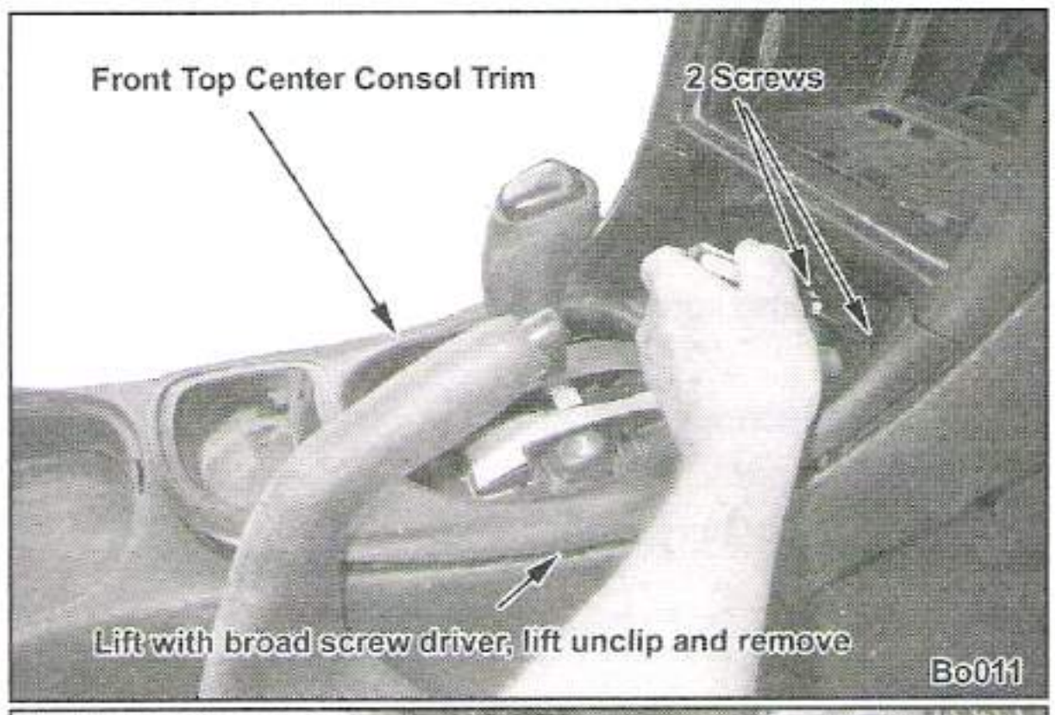
1. Remove the 2 console attaching nuts in the console storage compartment (under the carpet).



2. Remove screws attaching console to transmission tunnel, 4 screws.
3. Remove the 2 screws holding the transmission tunnel front trim, remove trim if required.



4. Automatic Transmissions: "With a screw driver unclip the top selector panel from the under the centre dash panel and console, lift the selector panel, remove the knob retaining screw.
Manual Transmission: Unscrew the gear knob from the gear lever, lift gear shift rubber boot.
Remove the gear knob plastic trim, disconnect any electrical connections that may be present for accessories (power windows) and lights.



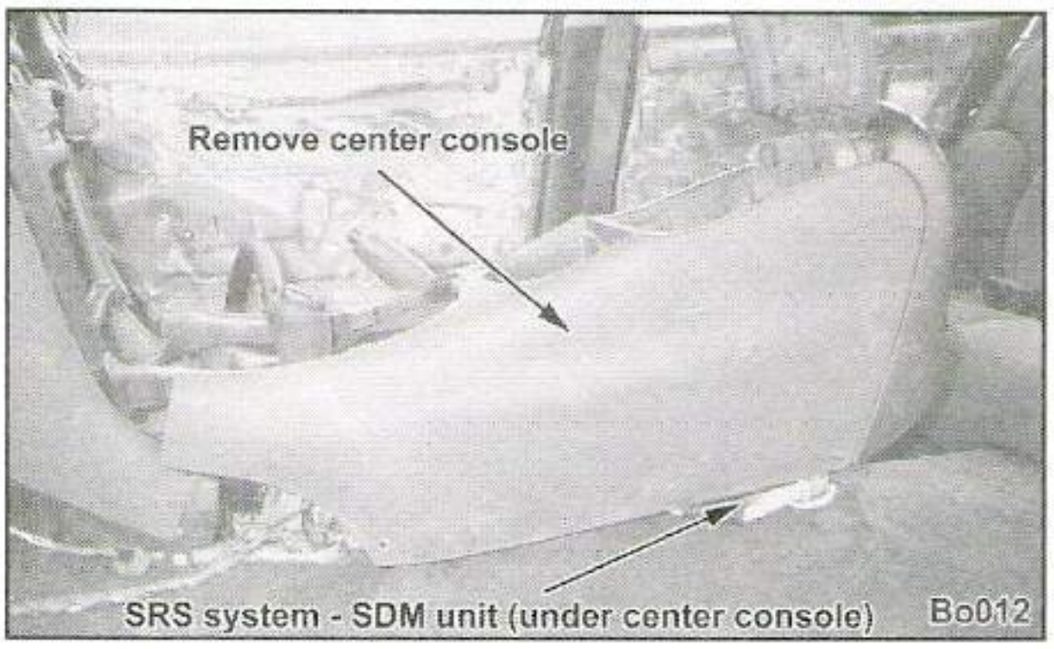


5. Remove the console front top section by removing rubber insert then 2 screws at the front with a star screw driver.
6. Remove the 2 screws attaching the center console to the dash panel. Carefully remove the centre console by lifting up at the rear to help clear the bolts into the storage compartment, then slide back and up to free console.

Install

1. Carefully lower and move the centre console forward over and down installing over the 2 bolts into the storage compartment and gear shift handle.
2. Connect any electrical connections that are present.
3. Ensure the console is correctly positioned and install the 2 screws to the dash panel.
4. Install the console top section and 2 attaching screws at the front of the console with a star screw driver, reconnect electrical connectors to power windows etc..
5. Install the 2 nuts in the storage compartment and carpet section that was removed.

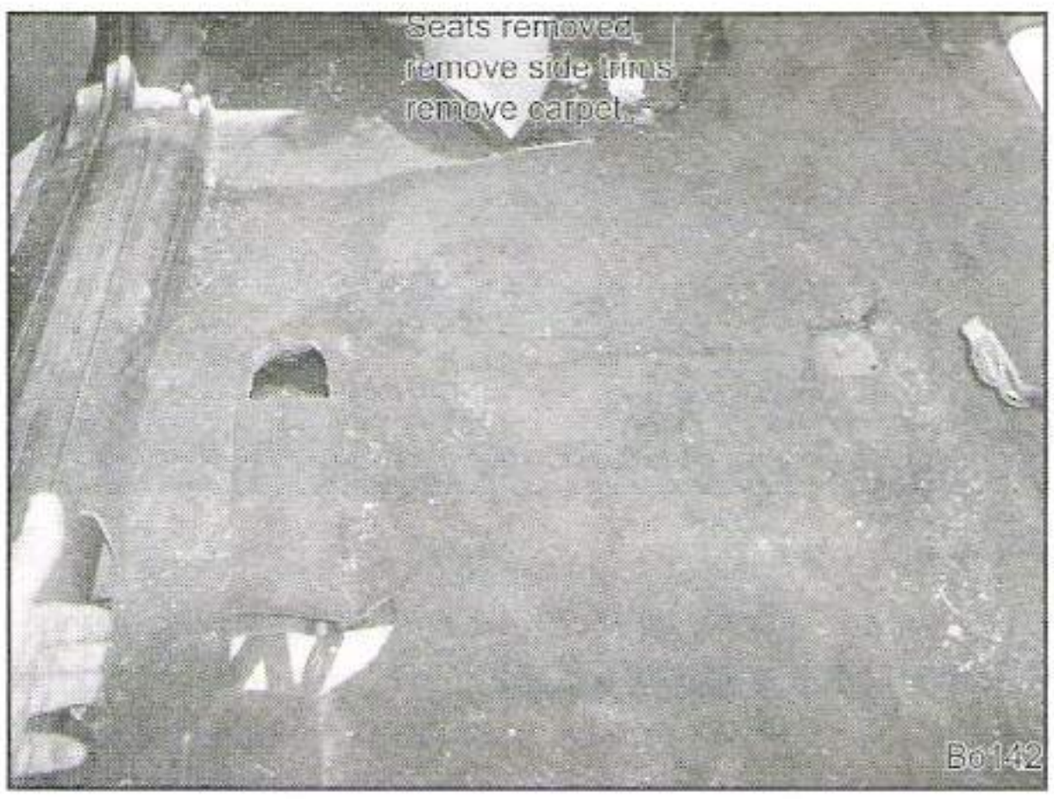
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6. Automatic Transmission:
Fit the selector top panel over the gear lever handle and clip into position.
Manual Transmission:
Ensure the rubber boot is properly located in the console moulding, fit the boot on the gear lever and screw the knob into place making sure that the writing is facing the correct way.
7. Install the screws attaching the center console to the transmission tunnel.
8. Connect the battery earth cable.

FLOOR CARPET - INTERNAL

Replace



Remove the seats from inside the vehicle.
Remove side trims around door openings if replacing.
Note: It is possible to lever up trims around door openings to remove carpet and install the new carpet. However installation is easier with the trims removed.

CARPET - BOOT / STATION WAGON REAR

Replace

Remove fir-tree clip and remove carpet. When isatlling the new carpet the fir-tree clips wil be reusable if care is taken.

Dash and Instrument Panel

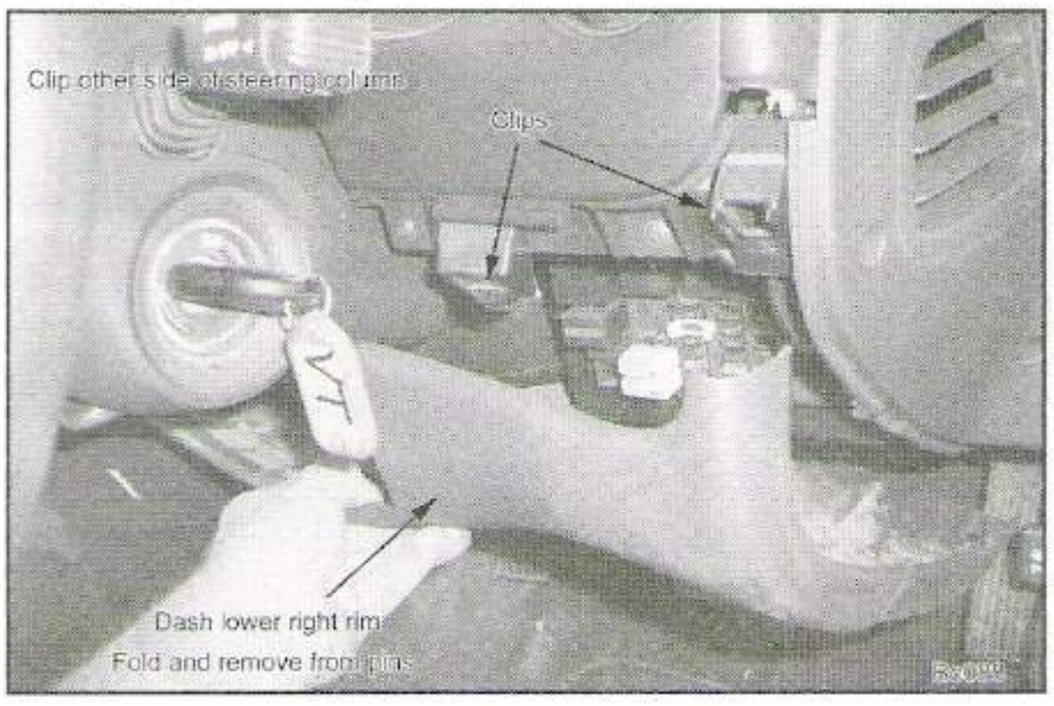
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*** WARNING: De-activate air bag system before carrying out any work on steering column or dash. Reactivate when all work is finished*

DASH LOWER PANEL - RIGHT HAND SIDE

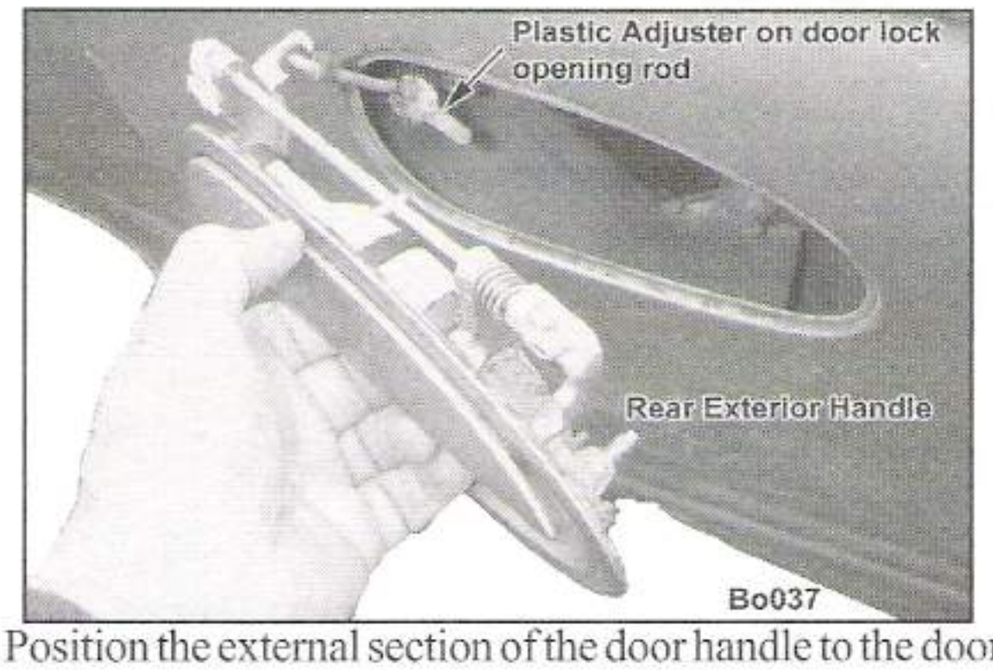
Remove

1. Grip right side of panel and pull out from dash until clip is



free. Grip the center and left side of the panel, pull out and down until all 3 clips are free.
2. Fold panel down, use a flat screw driver to pry the left side hinge pin out. Slide panel free from right side hinge.

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1. Position the external section of the door handle to the door panel, insert the internal components within the door.
2. Inside the door at the back of the exterior door handle,
3. Connect the door lock actuating rod from the door handle to the door lock actuator.
Note: There is a plastic adjusting nut on the base of the rod.
4. Install the handle assembly to the door, tighten the attaching nuts.
5. Replace the water/dust protection cover, carefully, glue back into position if necessary.
6. Install spacer on window regulator shaft.
7. Carefully position the door trim on to the door aligning the retainers with the retainer holes in the door shell.

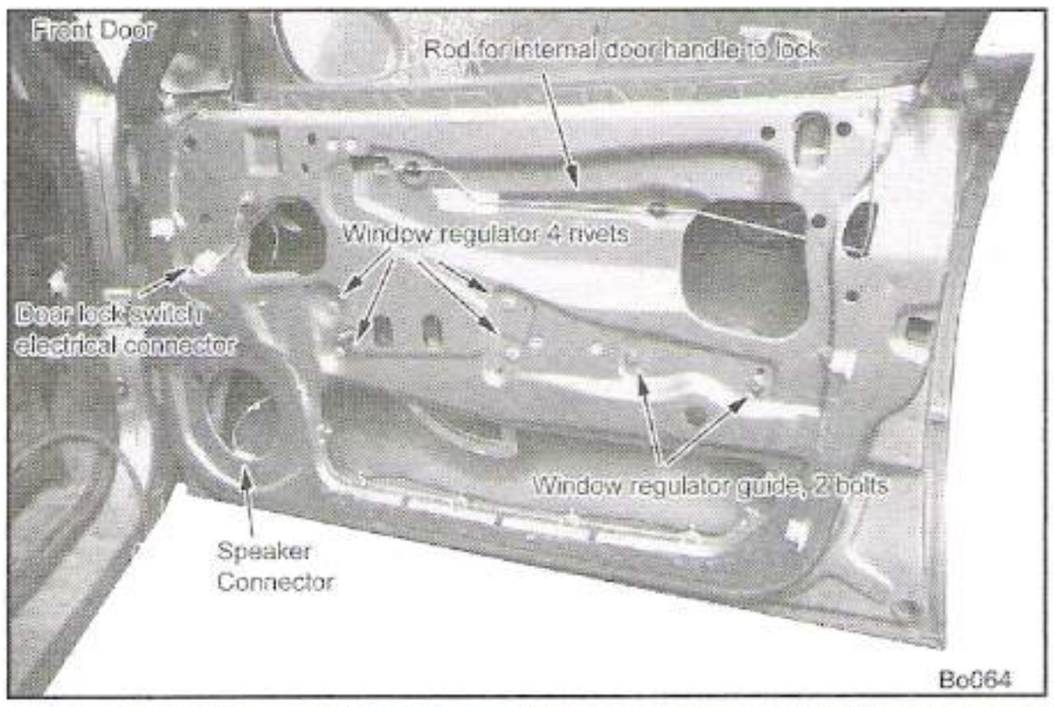
FRONT DOOR WINDOW GLASS and REGULATOR

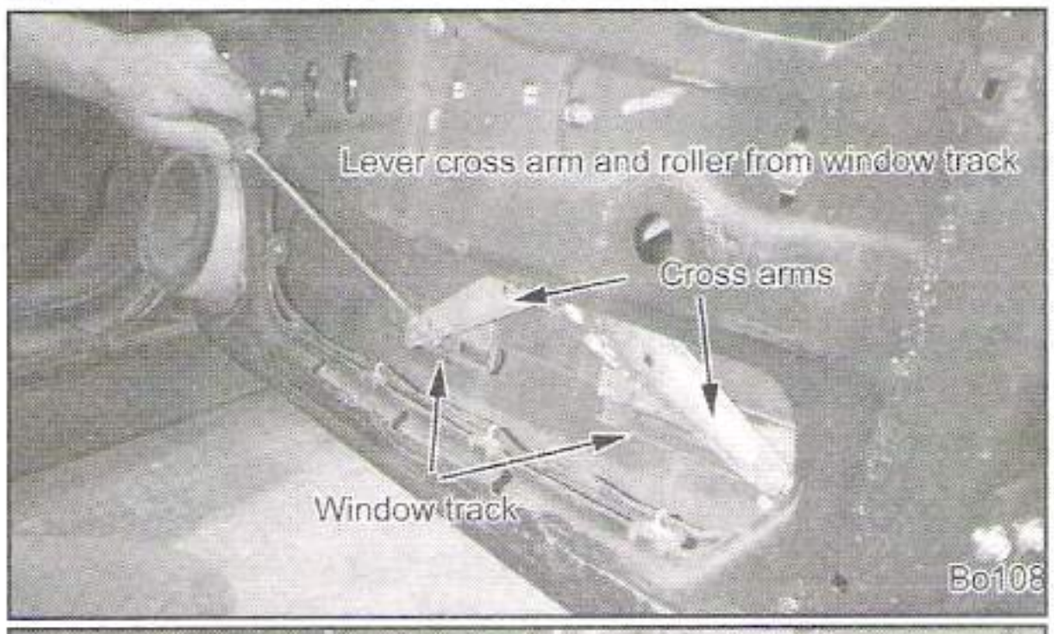
Remove

1. Remove the inner door trim as previously described.
Remove the mirror cover. Pull cover off and back to free the cover from the centre support.
2. Remove the external mirror, 3 screws.
3. Remove the radio speaker, 3 screws.
4. Remove the front weather strip only with window half way down.
5. Remove the weather end cap, pry from door.
6. Remove the water/dust protection cover carefully so it can be glued back into position.
7. Remove the front window channel,
1 bolt and cap at top of window channel.
Tip: Bolt has a loose nut which may fall into door shell.
2 bolts attach the channel to the door shell, push channel to front of door.
8. Remove the window regulator guide rail, 2 bolts.
9. Electronically operated window regulator, disconnect wiring connector.
10. Remove the window runners and window trim on door.
Lever the cross arm runners out of window guide rails.
11. Tilt the glass forward and remove the glass upwards through the glass opening, from the outside of the door.
12. Remove the window regulator assembly.

Install

1. Install the glass in through the glass opening, from outside of the door, tilt the glass forward and slide down.
2. Install window regulator, 4 pop rivets.

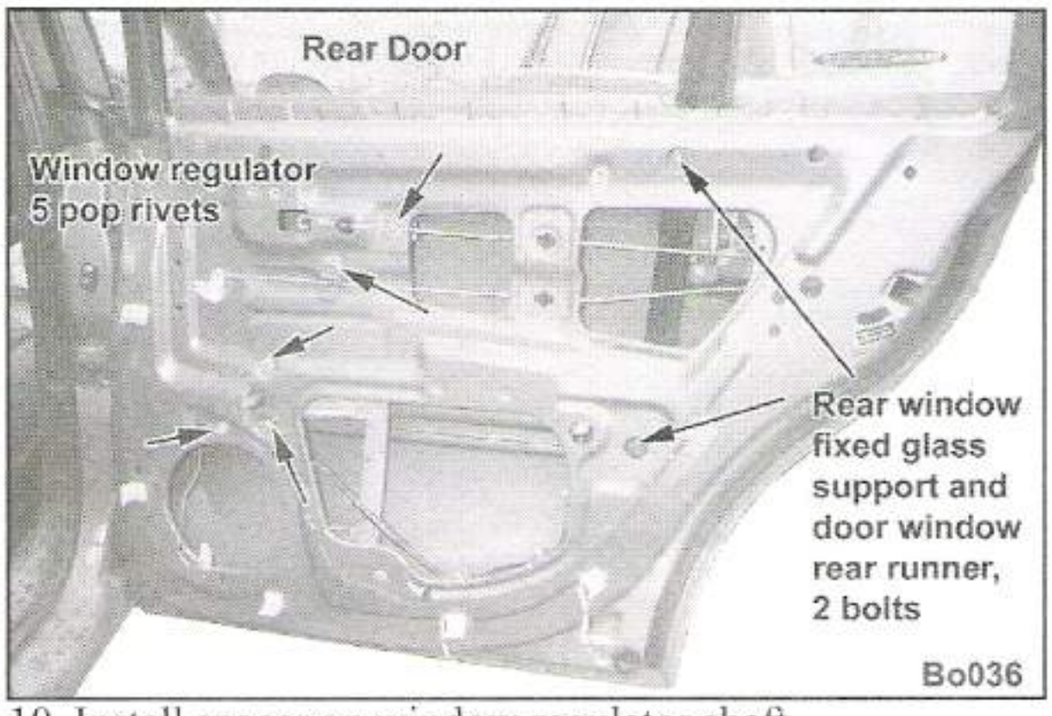






8. Install the window regulator guide rail, 2 bolts.
3. Slide the window side ways to fit the rollers into the roller channels fit roller stops.
4. Replace the front window channel, 2 bolts for the channel, channel top and bolt and nut on top section of channel.
5. Install weather strip end cap, and weather strip to front channel.
6. Check that the glass runs freely in runs.
Adjustment: First pull the glass tightly into the window rear run channel, to adjust the window glass. Then moving the window regulator cam down to remove excess clearance and at the same time maintaining a horizontal attitude, tighten the adjusting screws. Remove any excess clearance that may be apparent in the front window run channel by moving the run channel towards the window glass.
7. Electronic window regulator: Connect wiring connector.
8. Install radio speaker and wiring connector.
9. Replace the water/dust protection cover, carefully glue back into position if necessary.

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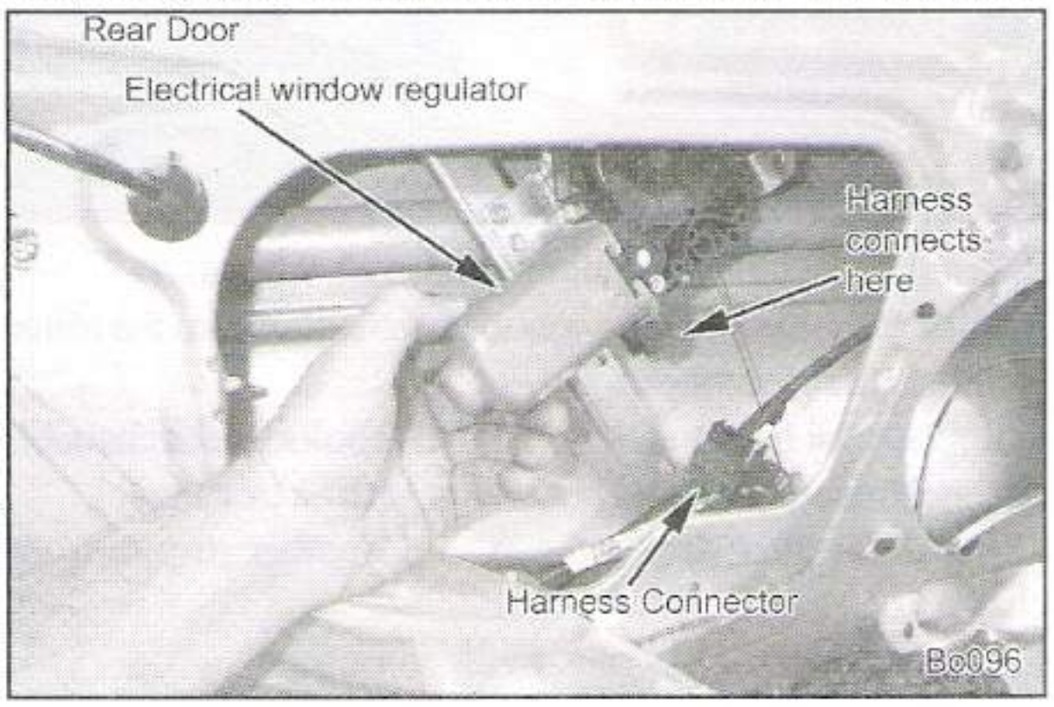


10. Install spacer on window regulator shaft.
11. Install external mirror 3 screws and wiring connector.
12. Carefully position the door trim on to the door install and install window regulator handle as previously described.
13. Install external mirror cover.

REAR DOOR WINDOW GLASS and REGULATOR

Remove

1. Remove the inner door trim as previously described.
2. Remove the radio speaker if fitted, 3 screws.
3. With the window down, remove the weather strip from the rear guide rail.
4. Remove the guide rail, 2 screws at top of door and 2 bolts on door shell, pull guide rail out and up.
5. Remove the water/dust protection cover carefully so it can be glued back into position.
6. Electronically operated window regulator, disconnect wiring connector.
7. Have someone support the window, drill out the 5 pop



rivets supporting the window regulator.
Slide runners out of window guide rails.
8. Tilt the glass forward and remove the glass upwards through the glass opening, from the outside of the door.
9. Remove the window regulator assembly.

Install

1. Install the glass in through the glass opening, from outside of the door, tilt the glass forward and slide down.
2. Install window regulator, 5 pop rivets. Slide the regulator runners into the roller channels fit roller stops.



3. Install the rear guide rail, 2 screws at top of door and 2 bolts on door shell. Install weather strip.
4. Check that the glass runs freely in runs.

Adjustment: First pull the glass tightly into the window front run channel, to adjust the window glass. Then moving the window regulator down to remove excess clearance and at the same time maintaining a horizontal attitude, tighten the adjusting screws of the rear channel.

5. Electronic window regulator: Connect wiring connector.
6. Install radio speaker and wiring connector.
7. Replace the water/dust protection cover, carefully glue back into position if necessary.
8. Install spacer on window regulator shaft.
9. Install inner door trim as previously described.

REAR DOOR FIXED WINDOW GLASS

Remove

1. Remove door window as described above
2. Remove the rear guide rail, 2 screws at the top and 2 bolts in the door shell. Remove or ease forward the rubber seal, guide rail and fixed glass.
7. Prise out the fixed glass panel

Install

1. Slide the glass into position, gently tap the glass home with a rubber mullet.
2. Replace the rubber seal between the fixed glass and the window channel
3. Replace the rear window and guide rail guide rail, 2 screws to the top of the guide rail, 2 bolts to the door shell.
4. Replace the door components as described under "Rear door window glass and regulator" above.



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2. Remove the transmission console similar to earlier description, however lift top trim, to unclip.
3. Remove the radio / cassette unit, use special tool or 2 pieces of "U" shaped wire.



4. Remove the screws at lower section of center dash /heater control trim. Remove top insert.
5. Remove center surround trim, clips and screws.
6. Remove the steering column covers, 1 screw in lower cover. Push lower cover into dash while lifting upper cover, then pull upper cover out. Pull lower cover free while carefully spreading cover over ignition switch.
7. Remove the drivers side lower dash trim, 5 screws.
8. Remove the 7 screws attaching the facia in position.

Install

1. Install the facia in position and install the 7 screws.
2, Install the drivers side lower dash trim, 5 screws.
3. Install the steering column covers, 1 screw in lower cover. Push lower cover into dash while lifting upper cover, then pull upper cover out.
5. Install the center surround trim, center/heater controls facia.
6. Connect the radio wiring loom connector and antenna to radio. Replace radio install the radio by firmly pushing in to the dash facia.
7. Replace the center console as described in this chapter.
8. Re-connect the earth cable to the battery.



DASH PANEL ASSEMBLY

** WARNING: De-activate air bag system before carrying out any work on steering column or dash. Re-activate when fall work is finished

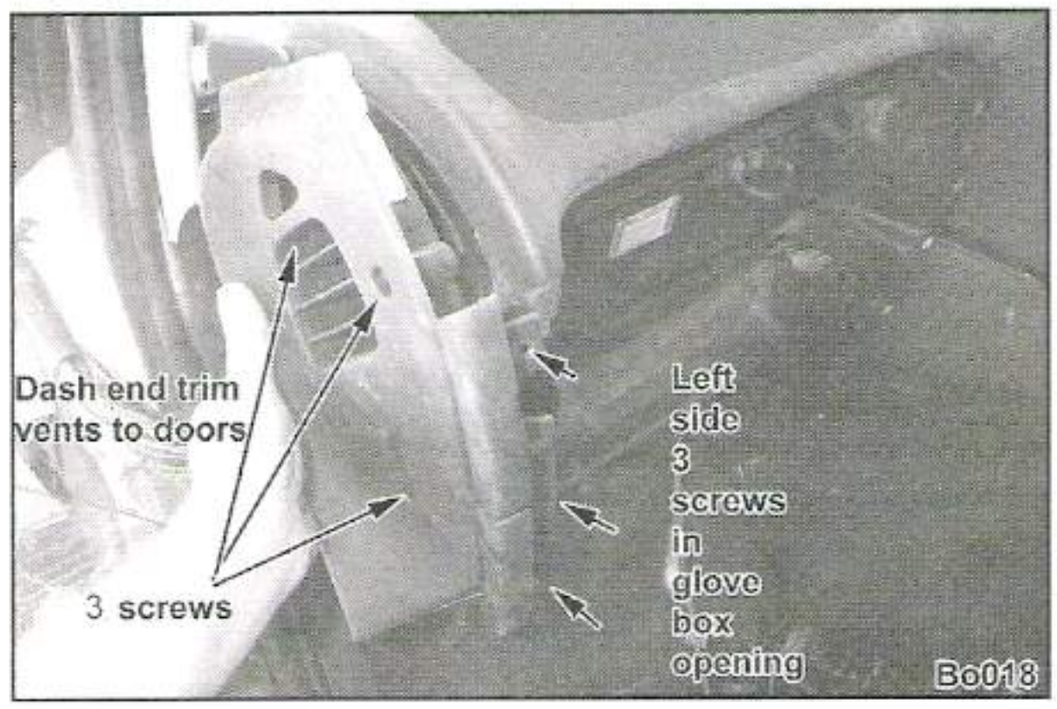
* Tip: Disconnect and remove the PCM to alleviate any damage to the PCM

Remove

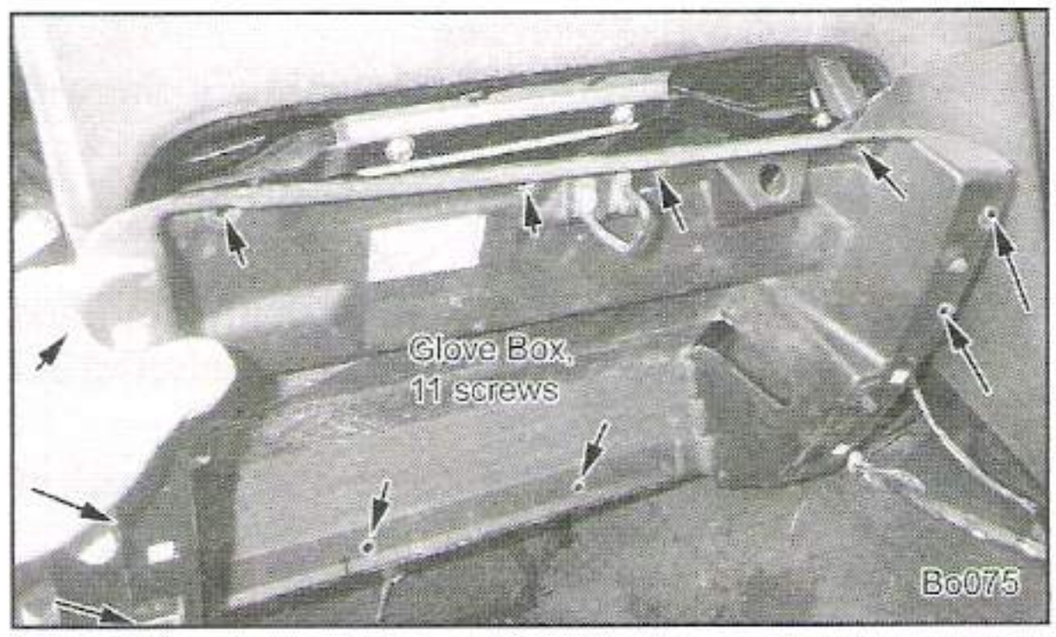
1. Disconnect the battery.
2. Remove the centre transmission console as described earlier.
3. Remove the radio and instrument facia as described earlier.
4. Remove the heater / air conditioning controls as described.
5. Remove the instrument cluster as described.



6. Remove the dash end trims (vent to doors) each side has 3 screws. Left side has an additional trim 3 screws.



7. Remove glove box, 11 screws.

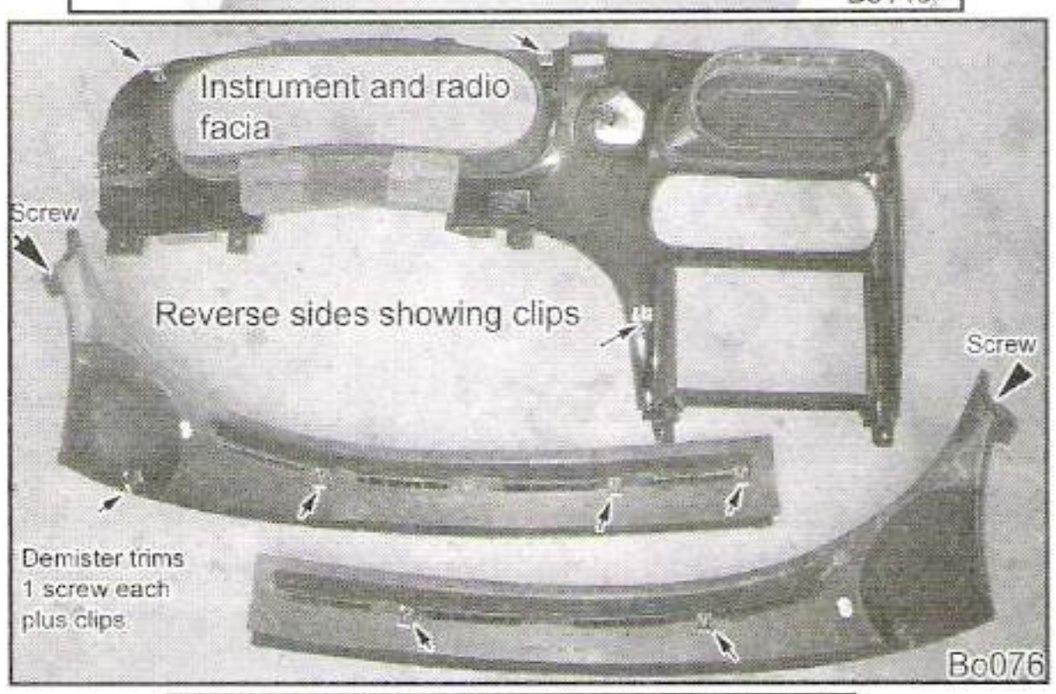


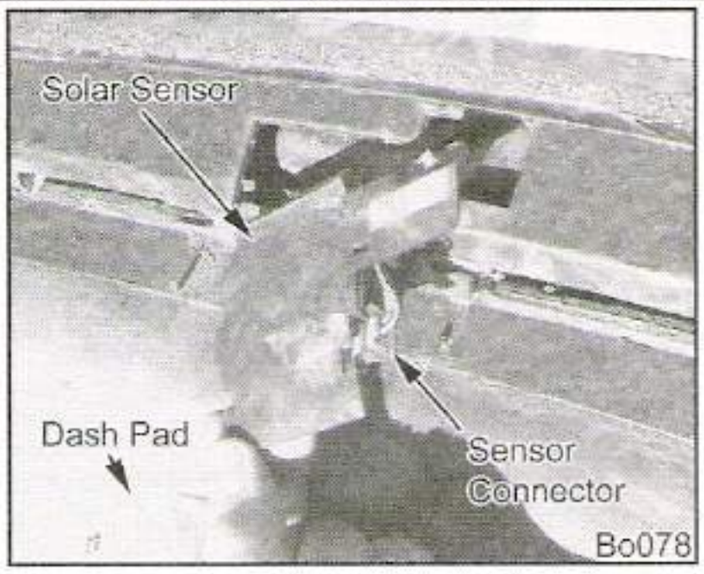
8. Remove the side kick trim on either side, 2 screws each side.

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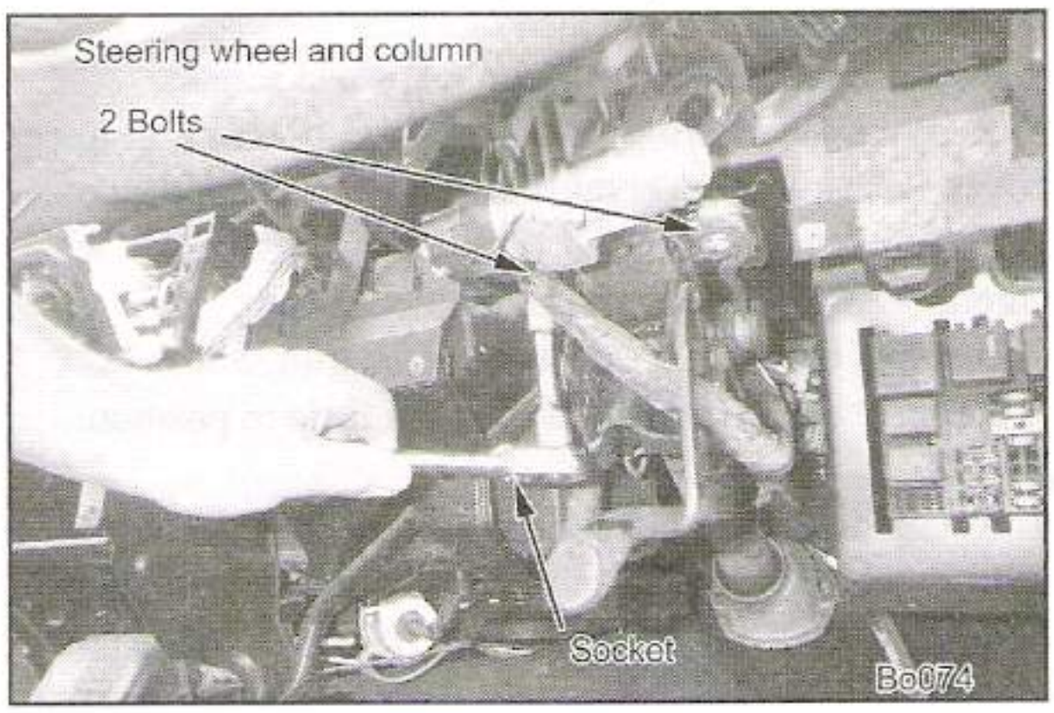
9. Remove the drivers side electrical harness connectors located behind drivers side kick trim.
10. Disconnect and remove the Body Control Module) BCM from behind dash drivers Side. Slide unit forward off support lugs.
11. Remove the demister trim, 2 piece, 1 screw each trim.

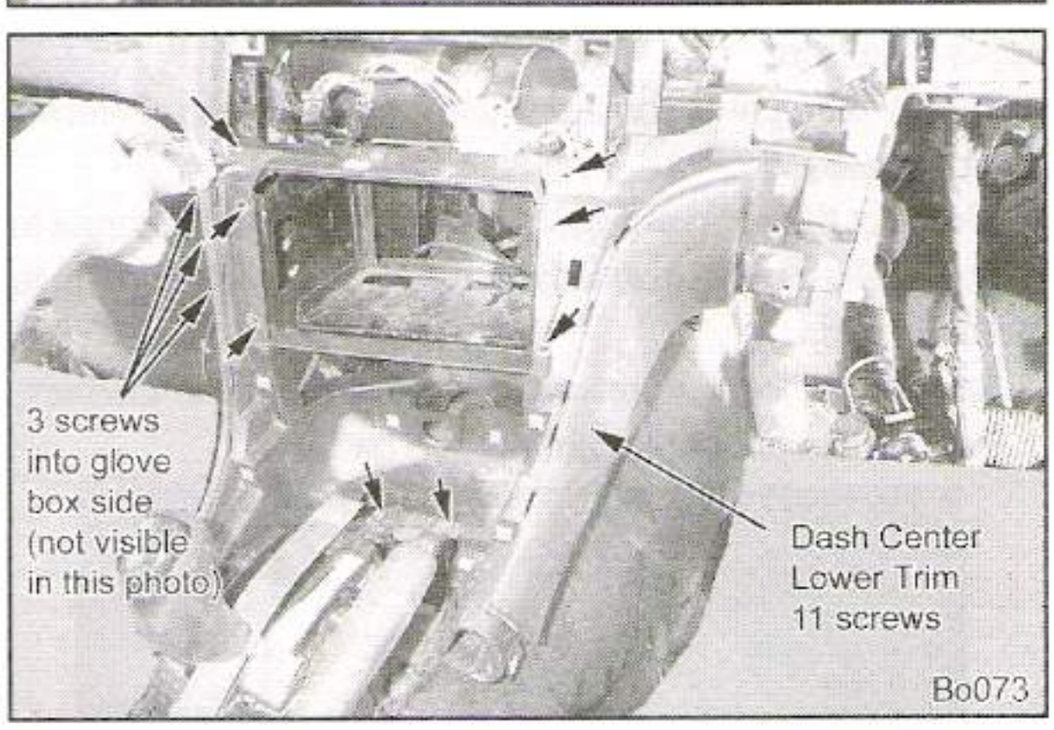






12. Disconnect the solar sensor, slide out of position.
13. Remove the diagnostic connector below the steering column 2 screws, wiring connector.
14. Remove the lower dash right side panel by gripping with fingers and pulling down to free clips.
15. Remove / Lower steering column and wheel.
Also Steering chapter.
a) Remove the steering shaft and universal from the rack and pinion. (Use paint as an alignment marks on the universal and steering rack shaft) if removing.
b) Remove horn / air bag 4 T30H torx screws from back of steering wheel
CAUTION: Carry removed air bag with opening side facing away from you. Do not support air bag by wiring. Store or position air bag on a flat stable bench with opening side facing up. Do not store in a confine area. There is danger zone of several meters from the air bag.
Remove wiring connectors from horn, air bag, radio controls if fitted (the radio control connector needs to handled with care).
c) Remove steering wheel attaching torx E20 bolt (not a 12 point socket), thump the steering wheel from the back to loosen or if necessary use a puller.
d) Remove the steering column support bracket 2 bolts.
e) Disconnect the steering column wiring loom connectors.
f) Remove the 2 nuts attaching the steering column to the floor and 2 bolts attaching the column to the dash frame.
16. Remove the lower right support panel VT Ser1-5 screws, VT Ser II on remove the 2 rivets and for Auto trans remove plastic plug..
17. Remove the center lower dash trim, 11 screws. (air conditioner senser 2 screws, if fitted)



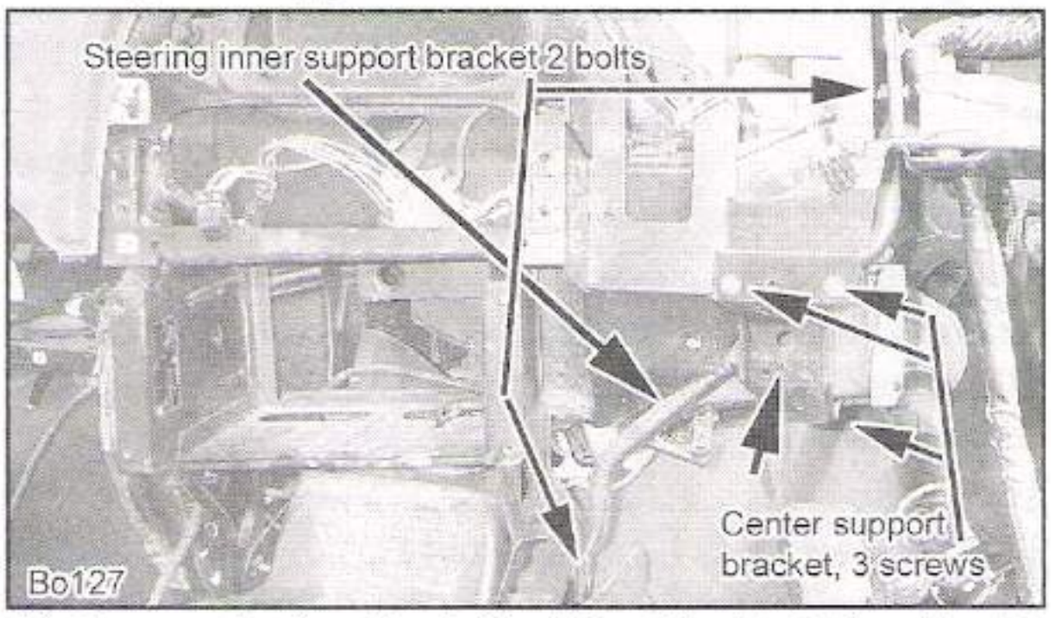


9. Remove air duct behind center lower dash trim.

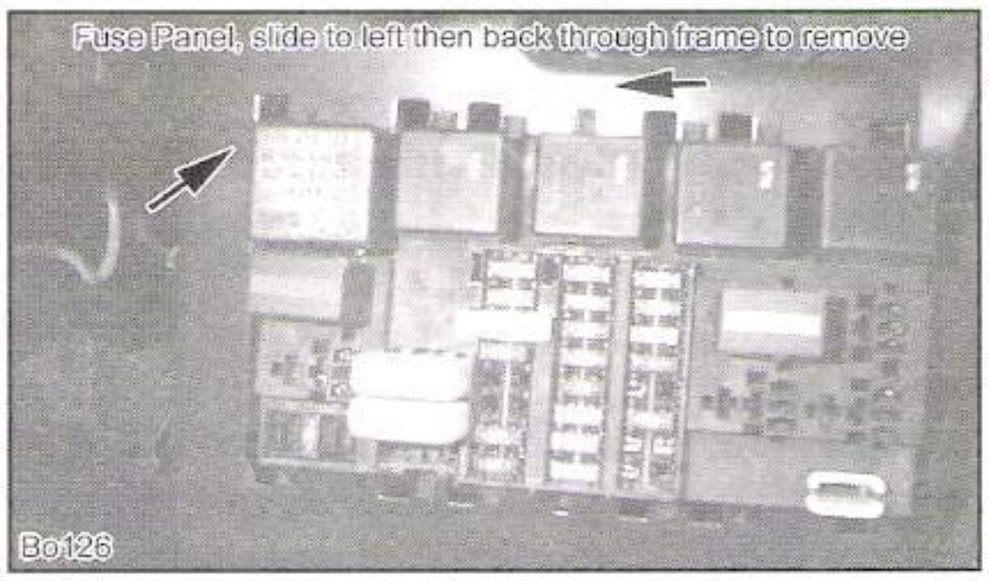


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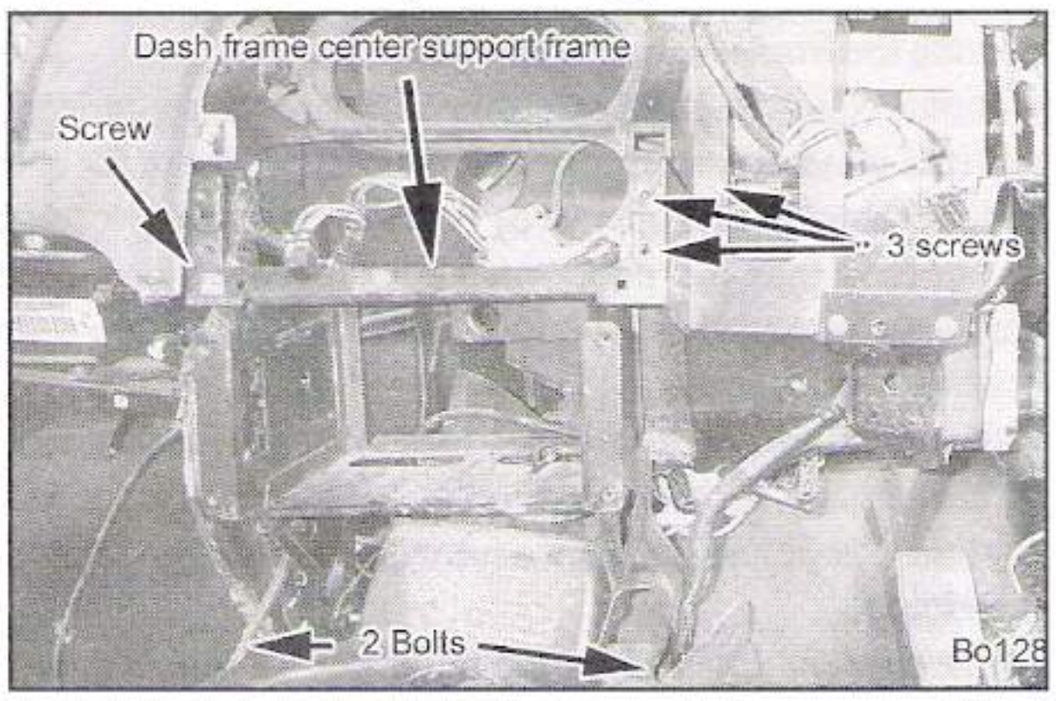
18. Remove the center support bracket 3 screws, and steering inner support bracket 2 bolts.



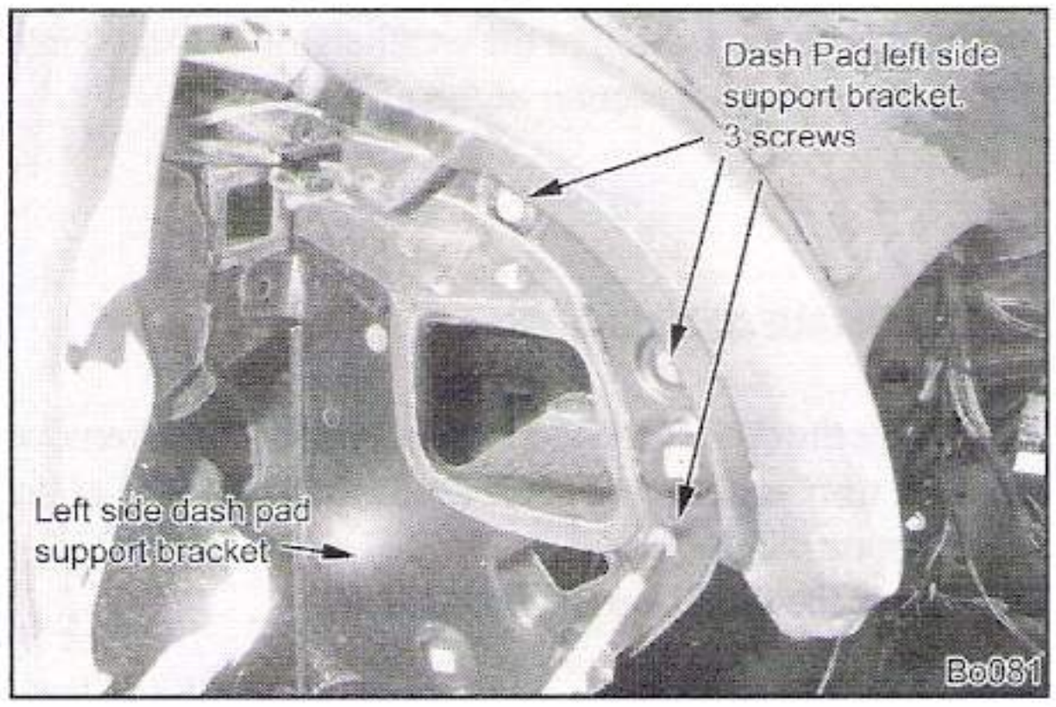
19. Remove the fuse block (Push fuse block to left and back).

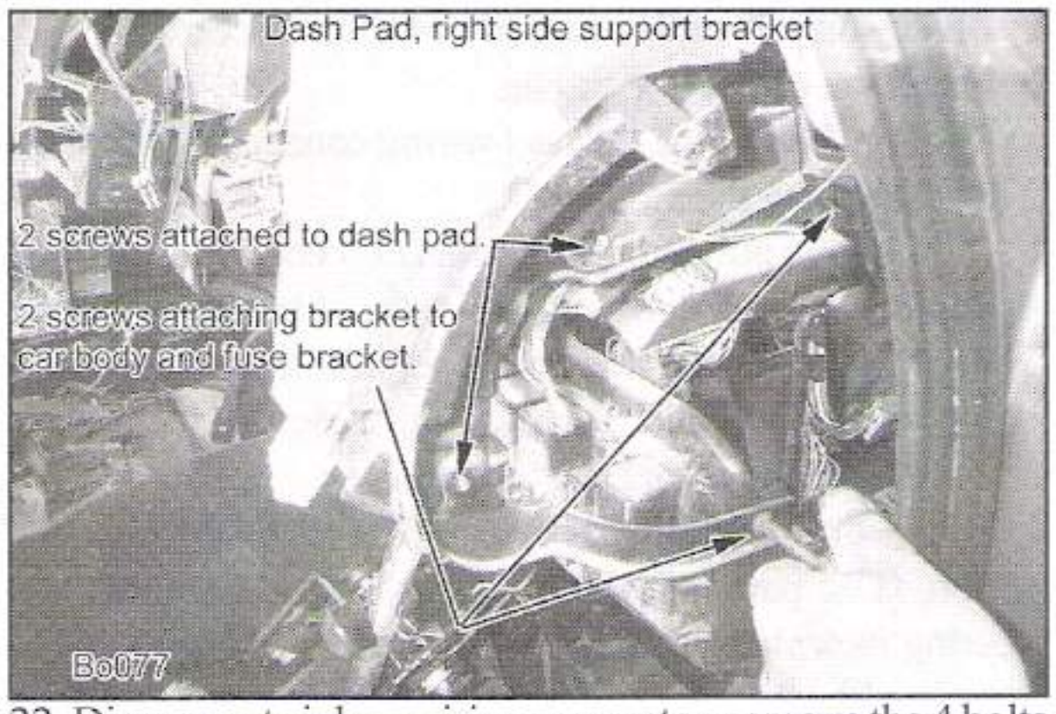


20. Remove the dash frame center support frame 2 bolts to floor, 1 screw left side, 3 screws right side.

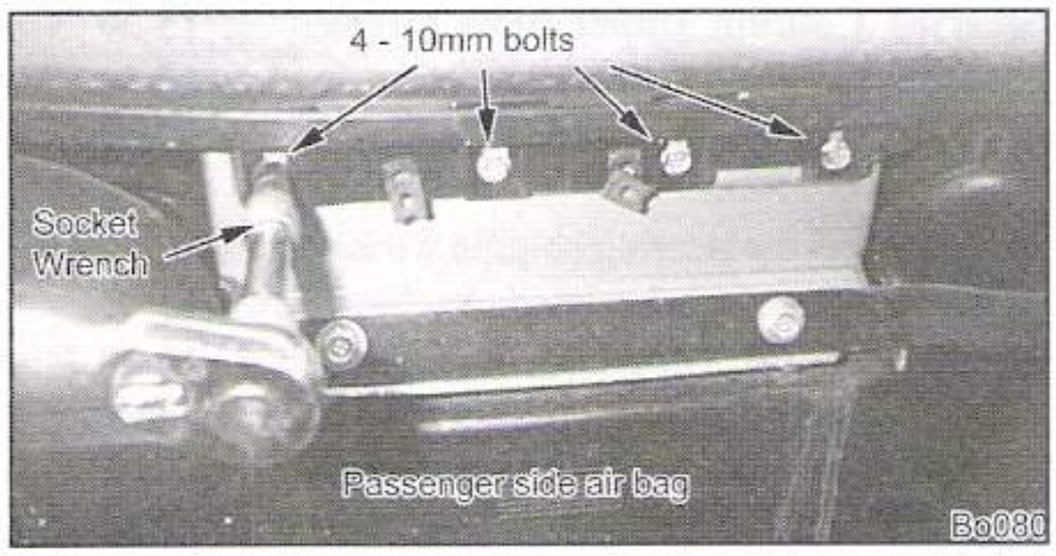


21. Remove the 4 screws from the left side support bracket, 2 screws from right side support bracket..





22. Disconnect air bag wiring connector, remove the 4 bolts attaching the dash pad to the passenger air bag.





23. Remove wiring looms if required.

a) Disconnect the radio aerial connections behind the left side kick panel position.

b) Remove the wiring loom holder, 1 bolt and nut, then pull sideways to disconnect clip.

c) Disconnect the heater /air conditioner wiring connectors.

d) Disconnect loom connector at the fire wall and remove.

24. Disconnect the accelerator cable from the pedal and throttle body if required.

Install

1. Reconnect the accelerator cable to pedal and throttle body.

2. Install wiring looms if required.

a) Connect the radio aerial connections behind the left side kick panel position.

b) Install loom and connect loom connector at the fire wall.

c) Replace the wiring loom holder, 1 bolt and nut, push sideways to lock in clip.

d) Connect the heater /air conditioner wiring connectors.

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e) Make sure all earth straps are connected correctly.
3. Install the passenger air bag.
a) Position the air bag, connect wiring connector, install the 2 nuts attaching the airbag.
b) Replace the airbag support bracket 5 bolts.
4. Replace the left side support bracket 4 bolts.
5. Replace the dash frame center support frame 2 bolts to floor, 1 screw left side, 3 screws right side.
6. Install steering wheel and column.
a) Install the steering shaft and universal to the rack and pinion. (Use paint alignment marks on the universal and steering rack shaft) if removed.
Steering Shaft Universal pin and nut torque:23 - 30Nm
b) Replace the 2 nuts attaching the steering column to the floor and 2 bolts attaching the column to the dash frame.
Steering Column Upper bolts torque: 15-30 Nm
Steering Column to the floor nuts torque: 15-30 Nm
c) Replace the steering column support bracket 2 screws 2 bolts.
d) Reconnect the steering column wiring loom connectors.
e) Replace steering wheel and attaching torx bolt.
Steering Wheel Torx E20 bolt torque: 15-30 Nm
f) Replace horn / air bag, connect the wiring connectors, 4 T30H screws at the back of steering wheel.
7. Install the fuse block bracket and fuse block (Push fuse block from back to front, then push right) 2 bolts.
8. Install the center support bracket 3 screws
9. Install the lower right support panel VT Ser1-5 screws, VT Ser II on install the 2 rivets and for Auto trans install plastic plug..
10. Install dash lower right trim, position and push firmly into place.
11. Install the center lower dash trim, 13 screws. (Air conditioner senser 2 screws, if fitted)
12. Install the dash top panel/instrument cluster top cover by removing the 5 screws and plugs.
13. Install the top forward dash trim from air vents, screw either side.
14. Install the diagnostic connector below the steering column 2 screws, wiring connector.
15. Install the drivers side electrical harness connectors located behind drivers side kick trim.
Install and connect the Body Control Module) BCM behind dash drivers side. Slide onto support lugs.
16. Install the PCM (location left side behind kick panel) and wiring connectors.
17. Install the side kick panels 2 screws each.
18. Install the heater / air conditioning controls as described
19. Install the instrument cluster as described.
20. Install the radio and instrument facia as described earlier.
21. Install the centre transmission console as described earlier.
22. Install the side kick trim on either side, 2 screws each side.
23. Reconnect the battery

Front and Rear Door Assemblies

Subject **Page**

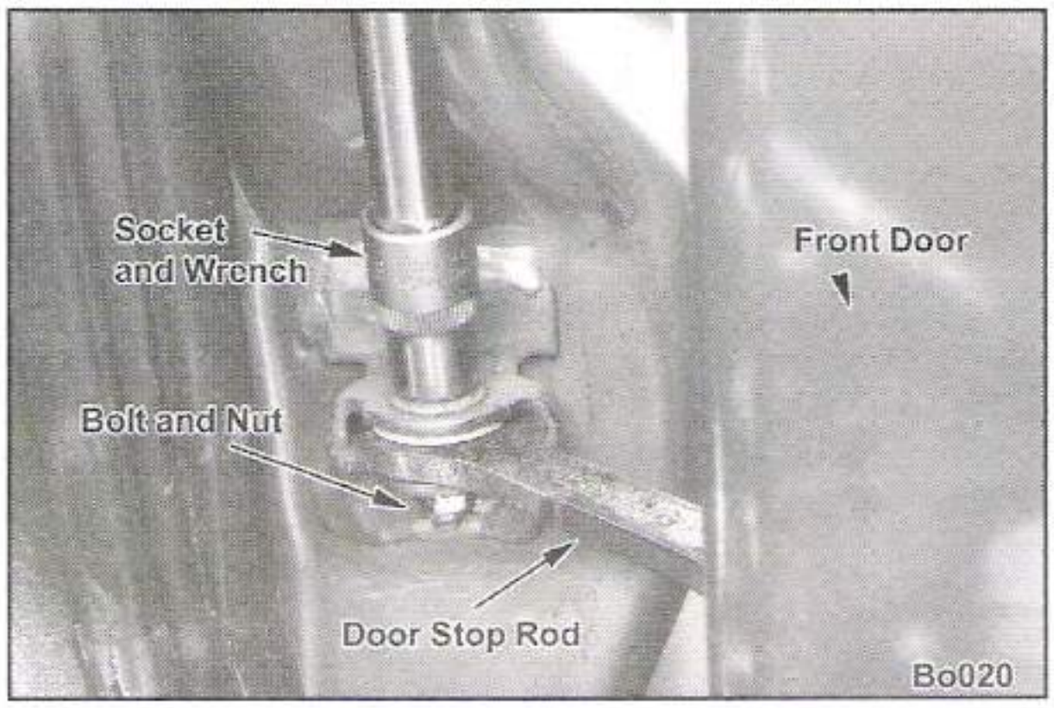
Front & Rear Doors 339
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Description
Doors consist of a pressed inner door panel and an outer panel which is spot welded and folded on to the inner panel. The inner panel incorporates a strengthened section to protect passengers from a possible collision.
A mechanical cross over lever system of window regulators attached to the glass lifter channels and door inner panels operate the front and rear door sliding windows.
Optional equipment of electric motors for operating the front and rear windows are standard equipment on Statesman and Calais. Door handles operate by lifting an external lever that is recessed into the door panel for safety reasons. The handles operate the fork type door locks in conjunction with door lock striker bolts.
Front doors have an external key lock, and a push pull button lock internally for the base models such as Executive and Berlina. Calais and Statesman have electronically operated door locks.
Drain holes are located on the underside of the all doors, which drain water away from the door to stop rust. These holes should be checked and cleared periodically.
Door weatherstrips are attached to the doors by push fit fasteners. The top section of the weatherstrip is locked into place by the channel section of the upper door.

FRONT & REAR DOORS

Remove
1. Remove the door and window regulator handles, remove the door trim and disconnect the harness connector at the body support pillar.
2. Remove the door stop rod bolt and nut.

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3. Support the door with an assistant or a car jack with soft padding support the base of the door.



4. Remove the door hinge pin protection caps, squeeze lower section of pin and tap up and, drive the hinge pin out.

Install

1. Support the door with an assistant or use wood blocks or car jacks with soft padding support the base of the door.
2. Use a hammer, drive the hinge pin into position. Apply dry lube grease to the hinge pin.
3. Replace the door hinge pin protection caps.
4. Replace the door stop rod bolt and nut.
4. If required, connect the wiring loom connectors that may be present for such items as radio speakers, electric mirrors, electric windows and electric door locks, replace the door trim and replace the door and window handles

DOOR ALIGNMENT

The door to the body alignment is set accordingly and maintained at the lock striker adjustment as described later in this section.

To correct door sag the lock striker can be adjusted.

WINDOW REGULATOR HANDLE

Remove

1. Use window regulator handle removing tool or make one out of a flat piece of heavy sheet metal similar to the tool shown below.
2. Align the tool with the handle as shown and push in firmly so as to remove the spring clip.
3. Remove the handle, taking care not to loose the spring clip, and plastic washer.



Install

1. Position the plastic washer over the regulator spline shaft.
2. Install the spring clip on the handle.
3. With the window wound fully up:

Tip: Front Doors: Position handle so it is pointing up towards the front corner of the door.

Tip: Rear Doors:

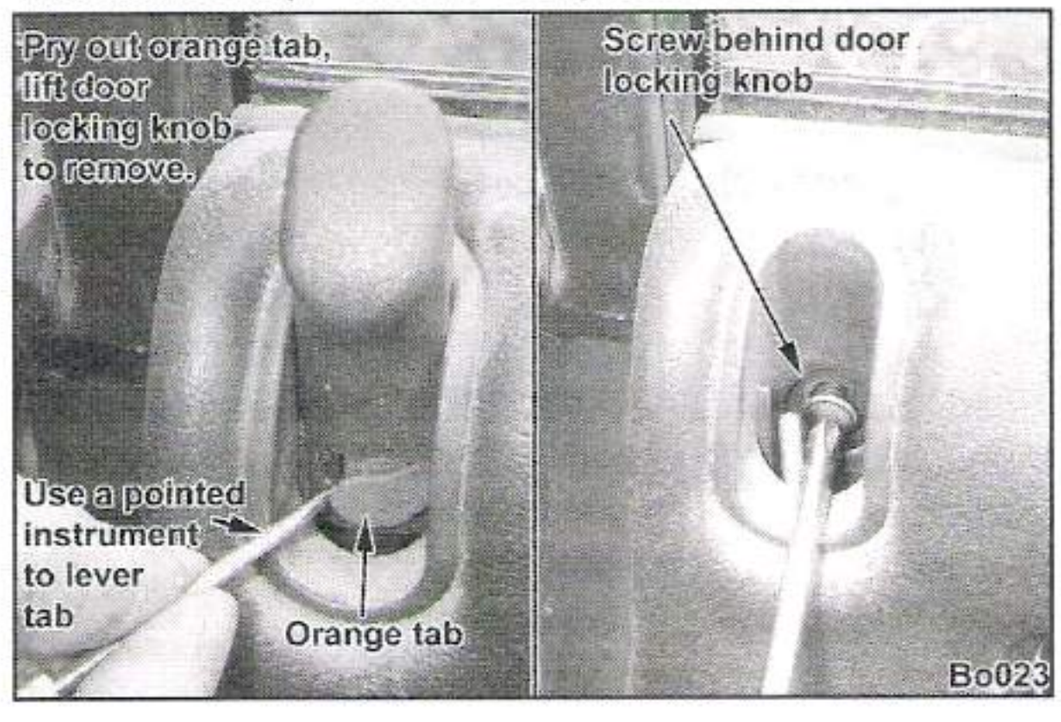
Position the handle horizontally, so it is pointing towards the front of the vehicle.

4. Firmly push the window regulator handle on to the spline so the spring clip locks the handle into position.

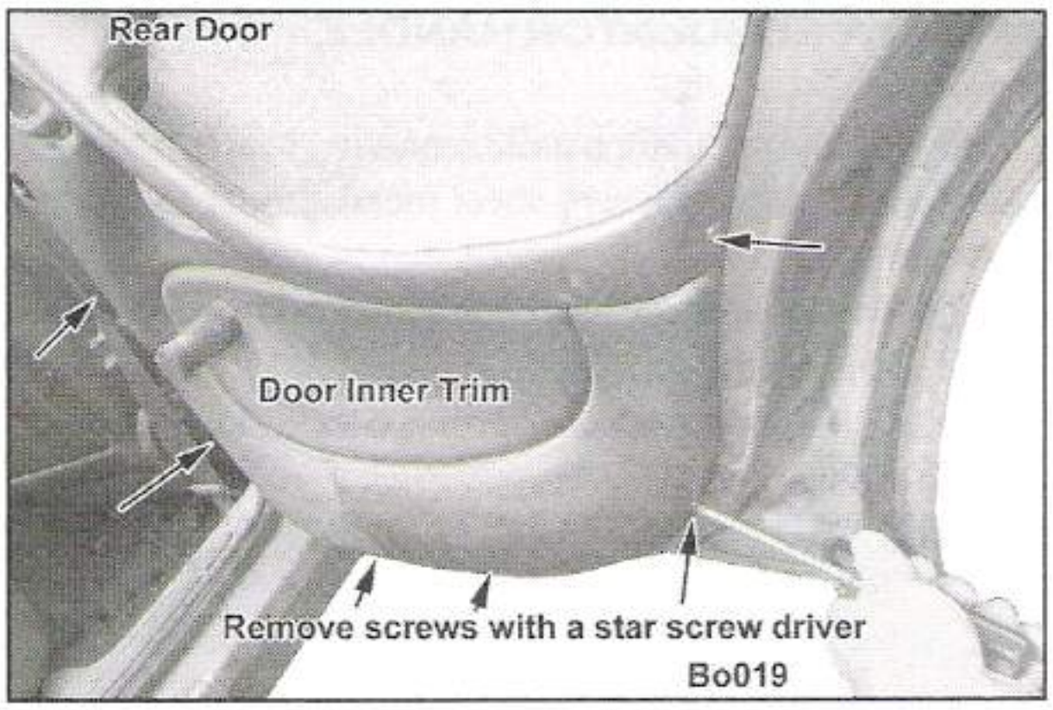
DOOR INNER TRIM PANEL

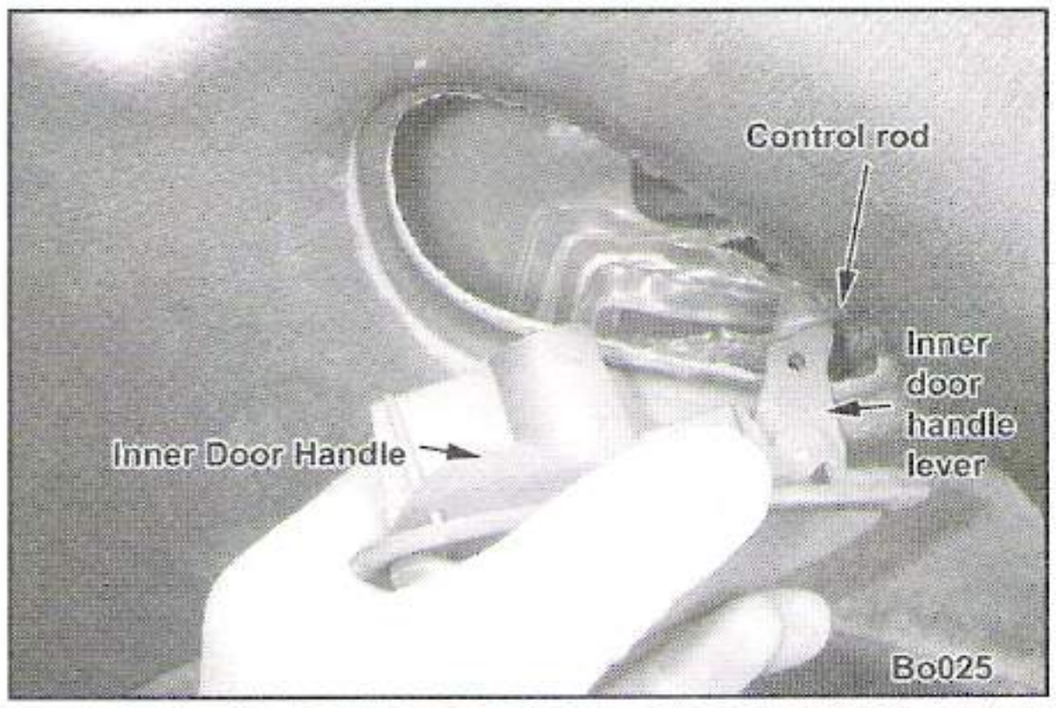
Remove

1. Remove window regulator, as previously described.
2. Use the pointed instrument to remove the locking knob red/ orange tab. The red section fixes the locking knob to the door lock rod. Lift the locking knob off the locking rod
3. Remove the locking knob plastic surround, 1 screw.
4. Remove the (7 - front, 6 - rear) screws from the base and



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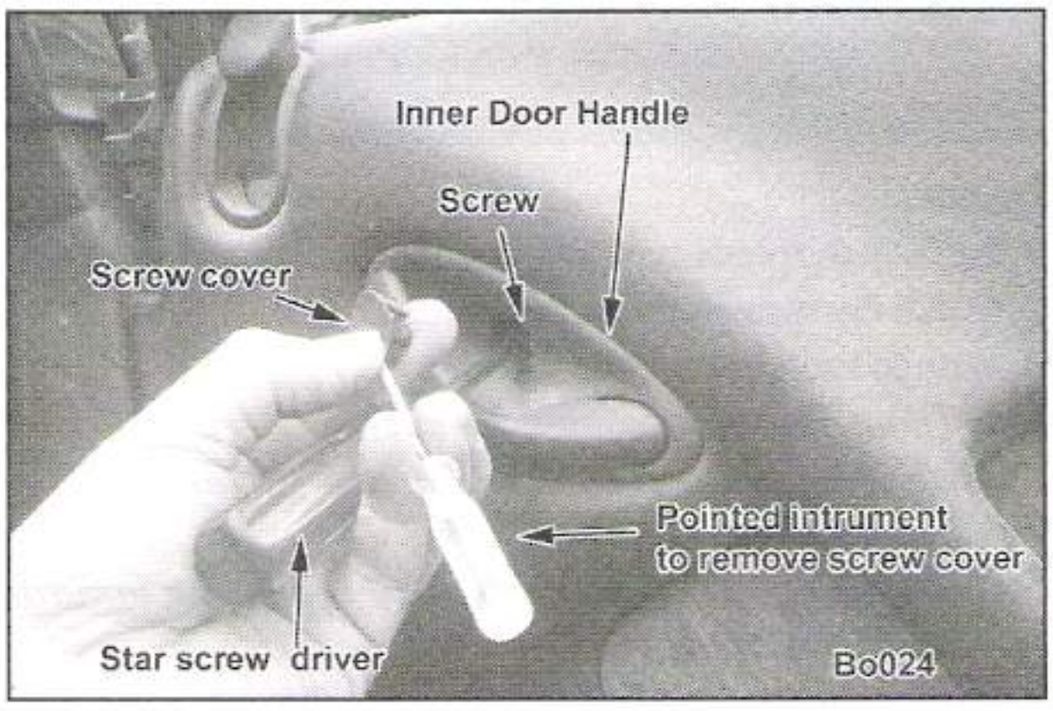




sides of the trim.

5. Remove the mirror cover on front doors. Pull cover off and back to free the cover from the centre support.

6. Remove the inner door control handle and plastic surround, pry out screw cover and remove screw.



Pull remote control assembly to the front, unclip lever from rod, and remove.

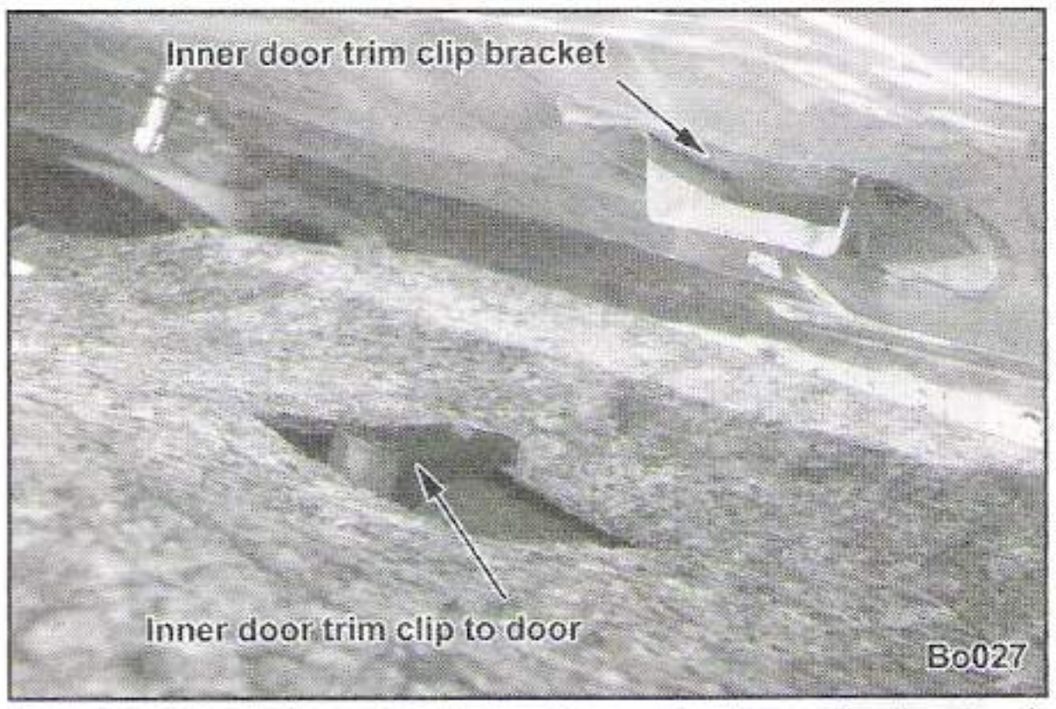
7. Push the center of the trim in near the arm rest, then lift (tap up with hand) door inner trim up to remove. A clip is located behind the center of the inner door trim.



8. Disconnect all electrical connectors to switches and lights on the trim.

Install

1. Place trim close to door and connect wiring connectors.



2. Carefully position the door trim on the door aligning back of the inner trim with the clip bracket on the door shell.

3. Once the door trim is in position fit the attachments back, such as window regulator handle, door handle (pull rod forward, position door handle lever behind rod, fit handle in position) and screw on mouldings, plus push the mirror cover into place.

4. Replace the screws (7 - front, 6 - rear) from the base of the trim..

5. Position door locking knob over rod into correct position, then push in orange retaining clip.

LOCK STRIKER

Remove

1. Mark the striker position on the body panel with a pencil or felt pen, this will help when installing the striker to its correct position.

2. Remove the attaching screws and remove the striker assembly taking care not to loose any shims that may be under the striker.

Install

1. Place the striker and shims against the body panel aligning the striker with the pen marks from the removal.

2. Install the attaching screws and tighten to specification.

Striker Attaching Screw specified torque: 8-18 Nm

3. Check adjustment of the striker.

Adjust

To correct the door sag the lock striker can be adjusted, either horizontally or vertically to align the striker with the lock. To

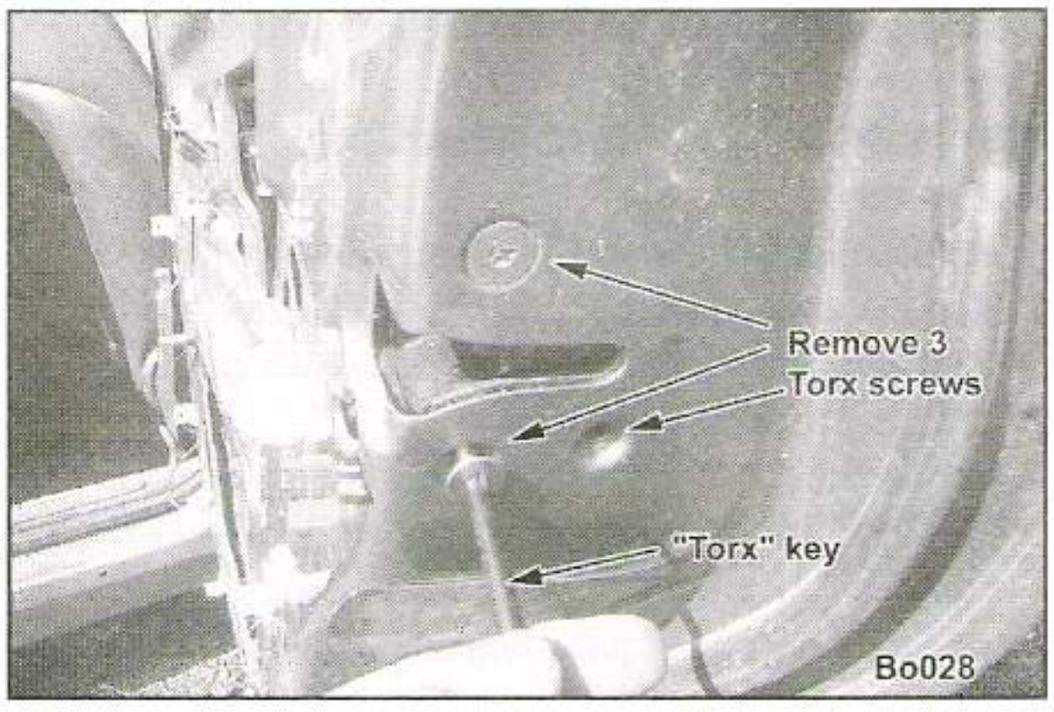
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get the clearance between the lock striker and lock the lock striker should be shimmed. Clean the lock jaws and the striker area and apply a thin layer of grease to the lock striker, to check this clearance. A measurable pattern will result as the door is opened and closed. To provide a flush fit at the door and the pillar or quarter panel move the striker assembly laterally.

FRONT and REAR DOOR LOCK ASSEMBLY

Remove

1. Remove the inner door trim as previously described.
2. Remove the spacer to the window regulator handle.
3. Remove the inner trim clip, 2 screws.
4. Remove the 6 retaining brackets, by removing the attaching clip.
5. Remove or peel back the water/dust protection cover carefully so it can be glued back into position.

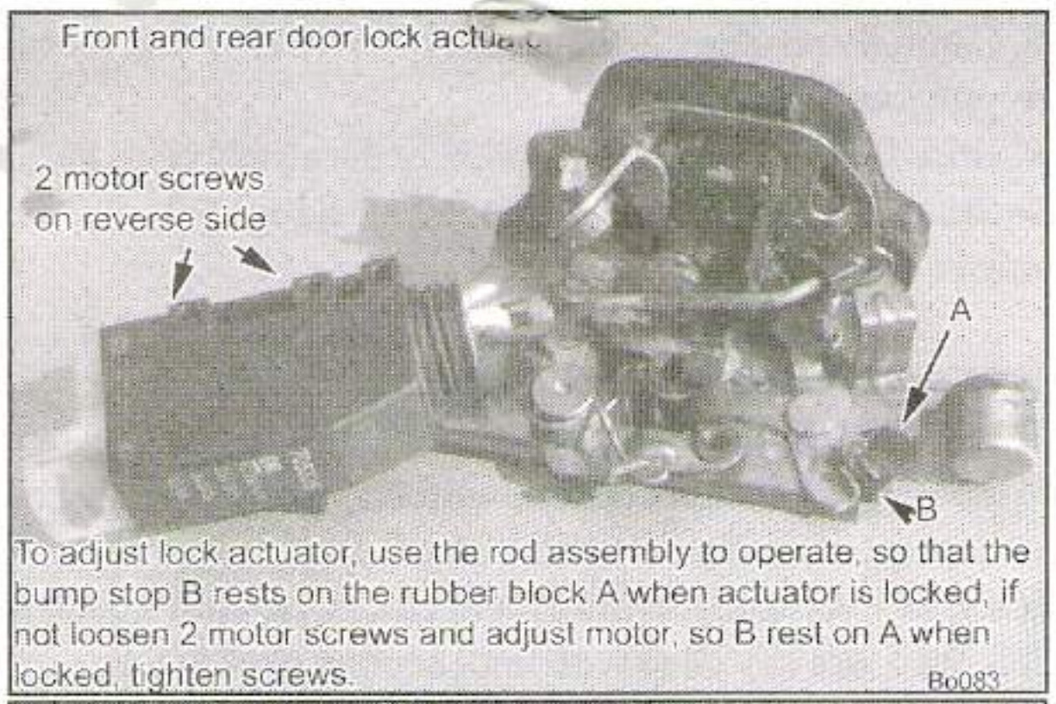


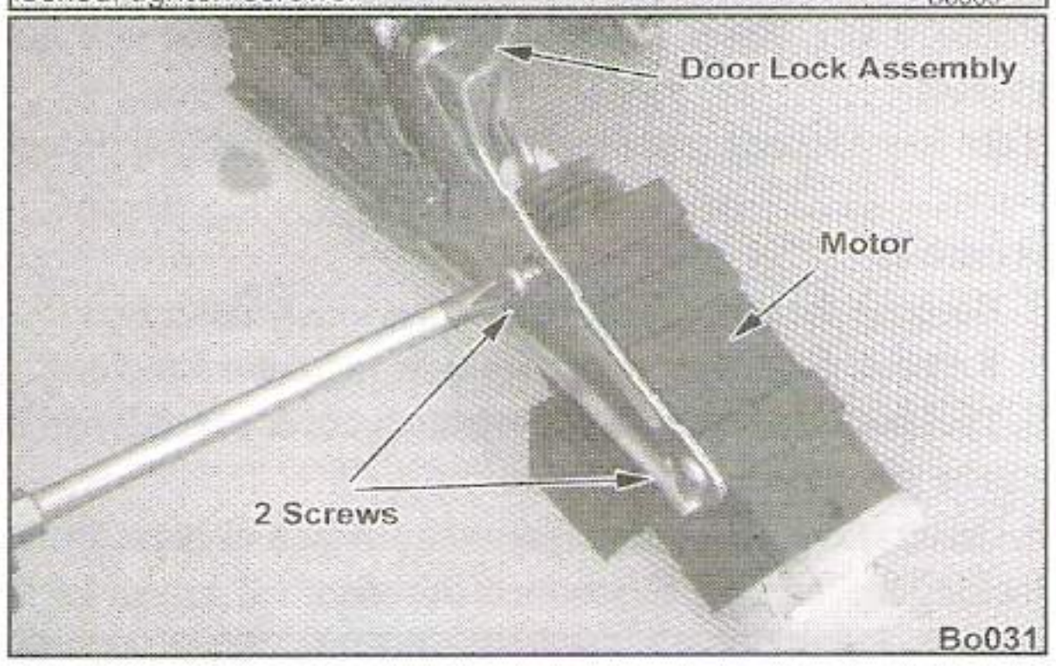
6. Remove the 3 torx screws attaching the lock to the door shell.
7. Remove the electrical connector at the base of the door lock.
8. Unclip the retainer clips on the outer door handle and lock cylinder control rod, rod from internal locking button and the internal door handle rod. Disconnect these rods and label if you feel it is necessary to help in installation.



Inspect and Adjust Lock

If the lock is not operating correctly, such as not locking or unlocking, no deadlock, lock motor is oscillating.

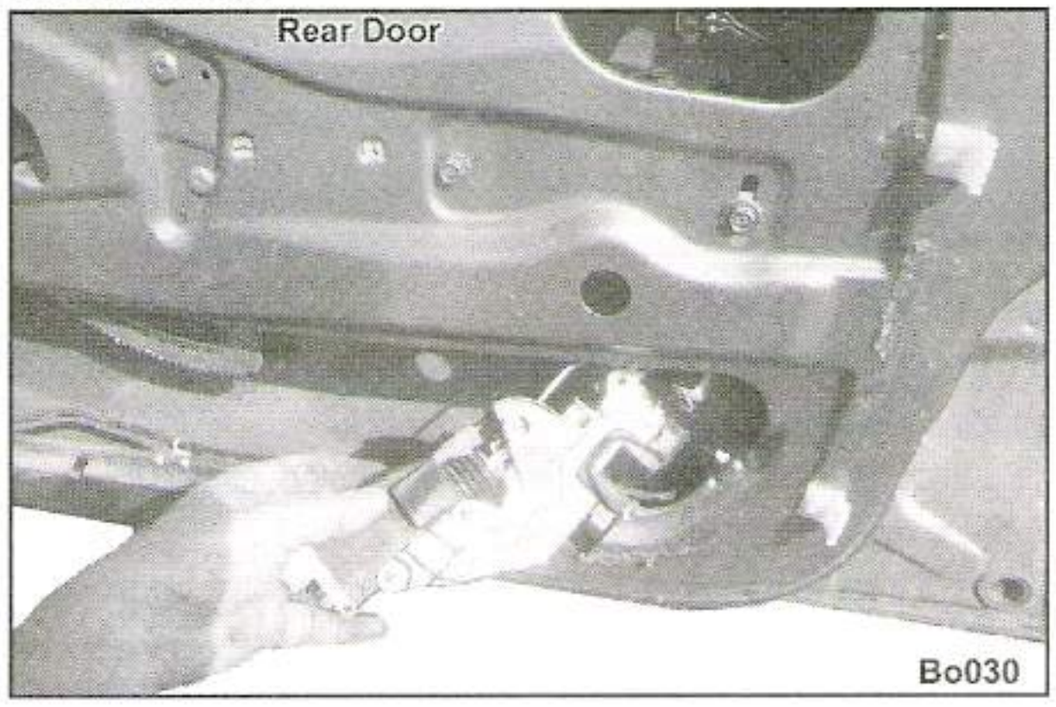




Check the locking lever is resting on the rubber pad, operate the inner locking knob locking rod. If not, loosen the loosen the 2 motor screws, adjust motor to locking assembly until lever rest on rubber block, tighten motor 2 screws.

Install

1. Fit outer door handle and lock cylinder control rod to the lock assembly.



2. Install the lock assembly to the door, tighten the attaching screws.
3. Fit and clip the retainer clips on the rod from internal locking button and the internal door handle rod.
4. Replace the water/dust protection cover carefully, glue back into position if necessary.
5. Install spacer to window regulator shaft.
6. Install the 6 inner door trim bracket to the door shell, replace clip.
7. Replace the center inner trim clip to door shell, 2 screws.

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8. Carefully position the door trim on to the door and install as previously described.
9. Once the door trim is in position fit the attachments back, such as window regulator handle, door locking knob, plus the mirror cover and screw for front doors.

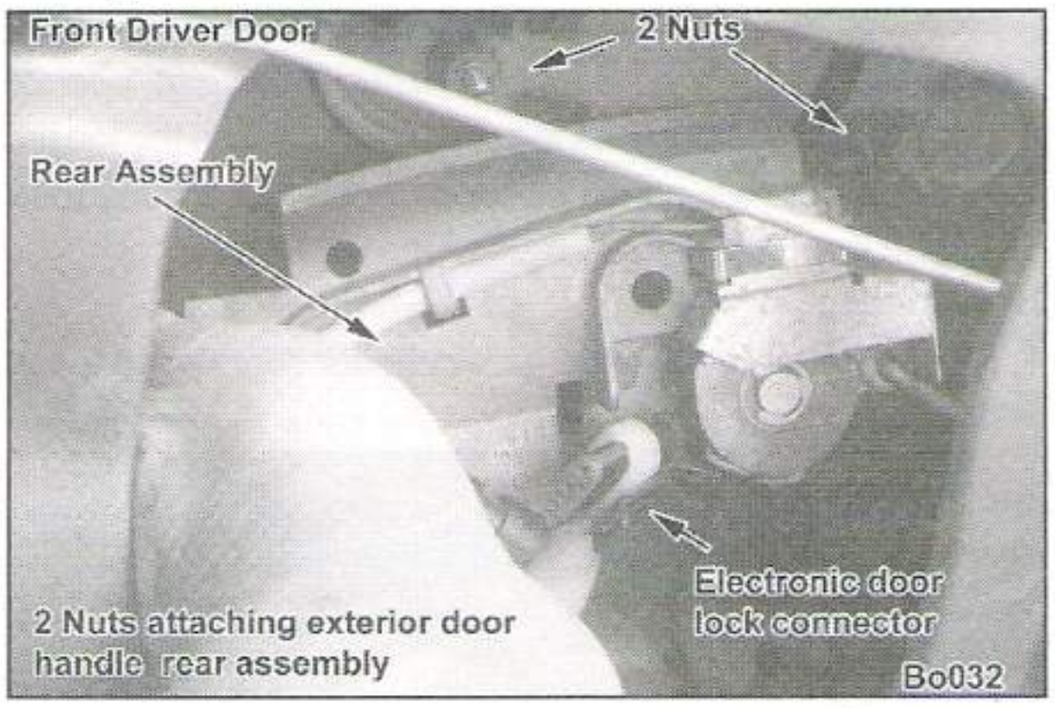
FRONT EXTERIOR HANDLE

Reset Key Lock Cylinder

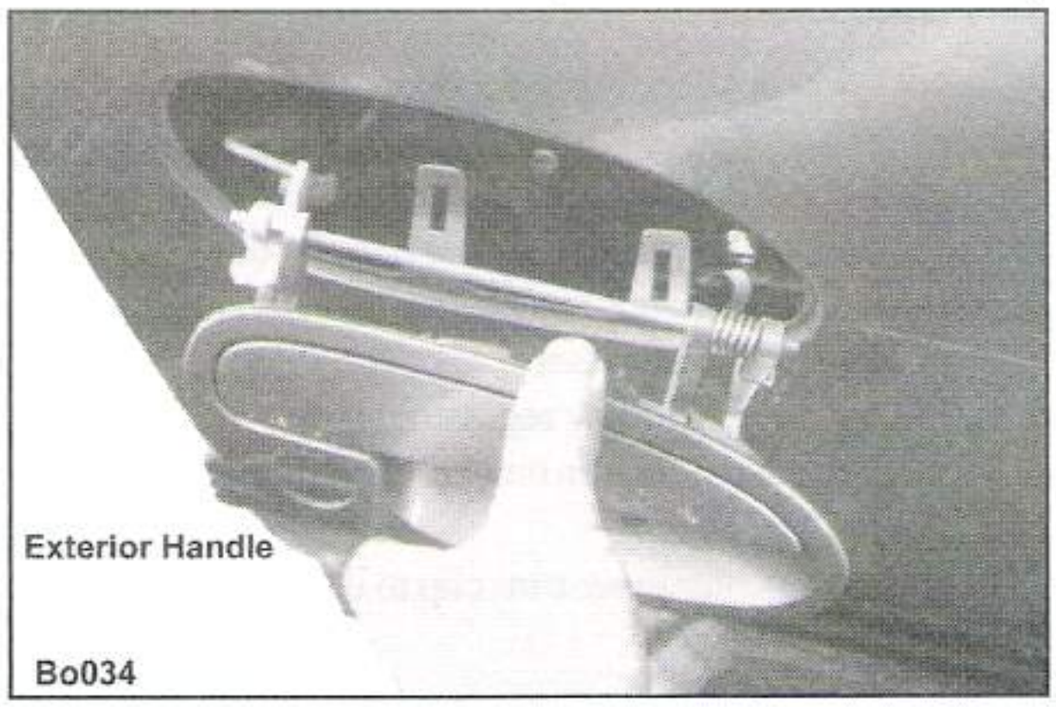
If the key lock does not operate correctly due to a wrong key or key not correctly inserted.
Insert key vertically, turn key anti clockwise until a click is felt, then turn key clockwise until another click is felt.
Remove key, insert key and check operation, if still not correct.
Turn key 180 deg anti clockwise and repeat above procedures.

Remove

1. Remove the inner door trim as previously described.
2. Remove the spacer to the window regulator handle.
3. Peel back the water/dust protection cover carefully so it can be glued back into position.
4. Drivers door: Disconnect the rod from the lock barrel to the locking mechanism. Disconnect the electrical connector to



the outer door handle..
5. Remove the 2 door external handle attaching nuts, remove rear assembly.
6. Disconnect the door lock actuating rod from the door handle to the door lock actuator.
Note: There is a plastic adjusting nut on the base of the rod.
7. Remove the external section, use a screw driver to unclip the 2 plastic tabs, withdraw the internal components from within the door.



Install

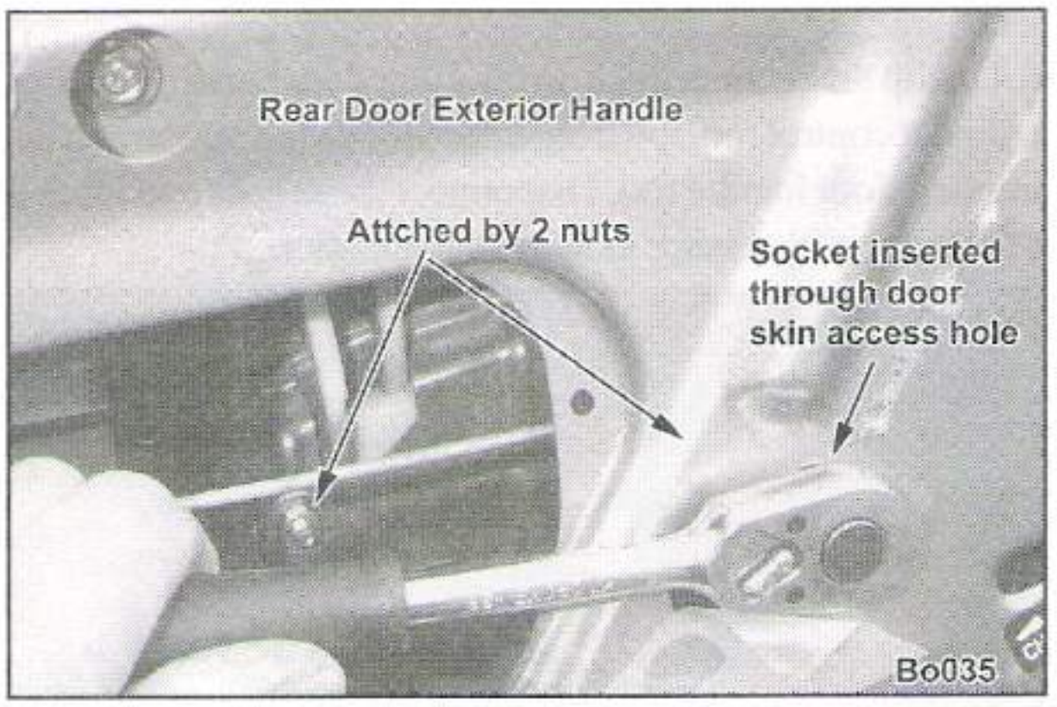
1. Position the external section of the door handle to the door panel, insert the internal components within the door.
2. Inside the door at the back of the exterior door handle,
3. Connect the door lock actuating rod from the door handle to the door lock actuator.
Note: There is a plastic adjusting nut on the base of the rod.
4. Fit outer door handle and lock cylinder control rod to the lock assembly.
5. Install the handle assembly to the door, tighten the attaching nuts.
6. Replace the water/dust protection cover, carefully, glue back into position if necessary.
7. Install spacer on window regulator shaft.
8. Carefully position the door trim on to the door aligning the retainers with the retainer holes in the door shell.

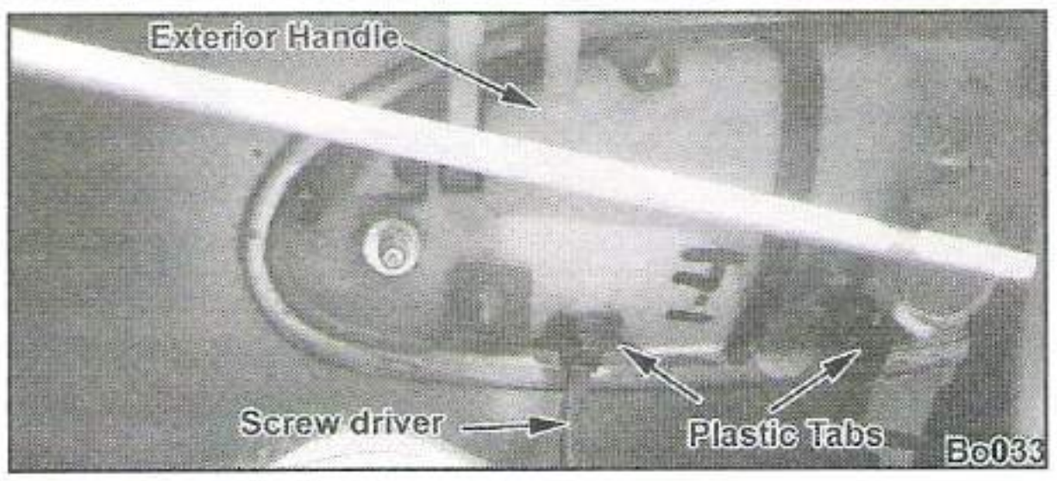
REAR DOOR EXTERIOR HANDLE

Remove

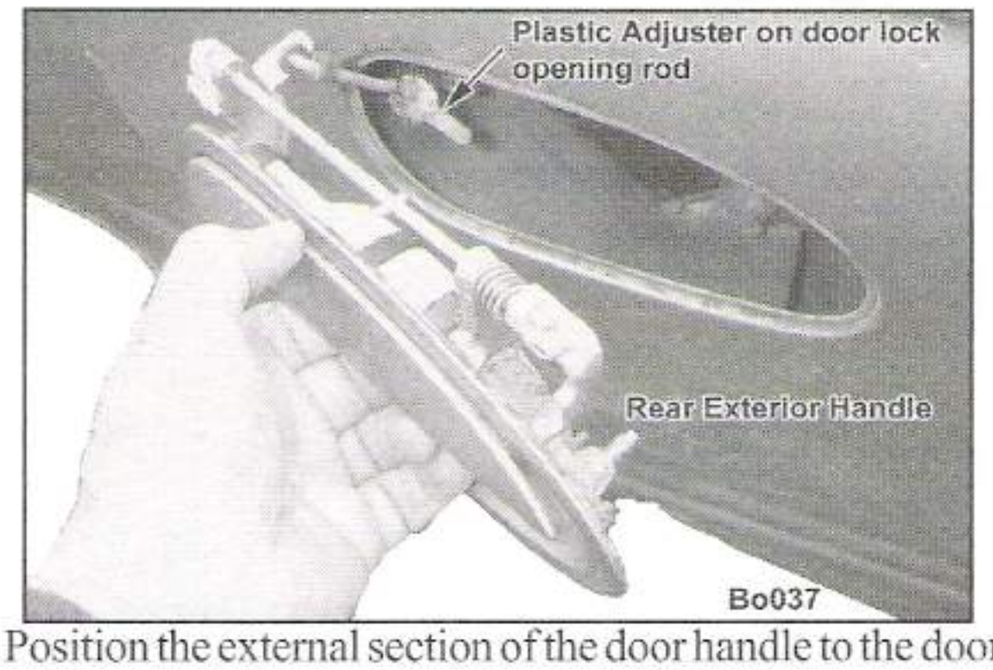
1. Remove the inner door trim as previously described.
2. Remove the spacer to the window regulator handle.
3. Peel back the water/dust protection cover carefully so it can be glued back into position.
4. Remove the 2 door external handle attaching nuts.
5. The door handle has actuating rod from the door handle to the door lock actuator.
Note: There is a plastic adjusting nut on the base of the rod.
6. Remove the external section, use a screw driver to unclip the 2 plastic tabs, withdraw the internal components from within the door.

Install





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1. Position the external section of the door handle to the door panel, insert the internal components within the door.
2. Inside the door at the back of the exterior door handle,
3. Connect the door lock actuating rod from the door handle to the door lock actuator.
Note: There is a plastic adjusting nut on the base of the rod.
4. Install the handle assembly to the door, tighten the attaching nuts.
5. Replace the water/dust protection cover, carefully, glue back into position if necessary.
6. Install spacer on window regulator shaft.
7. Carefully position the door trim on to the door aligning the retainers with the retainer holes in the door shell.

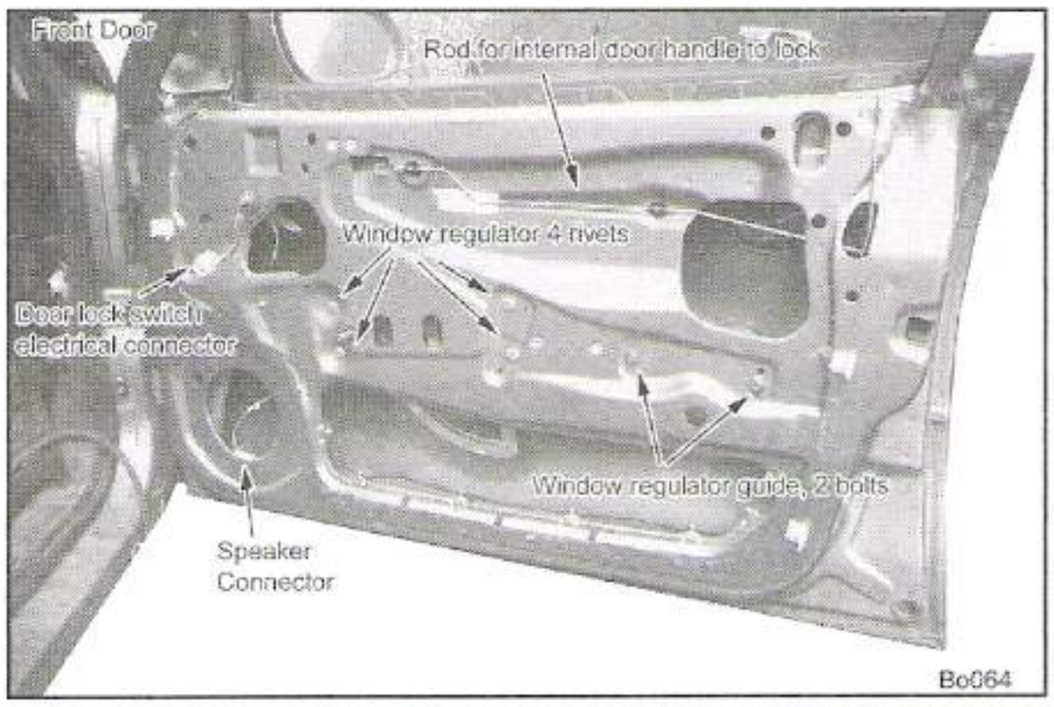
FRONT DOOR WINDOW GLASS and REGULATOR

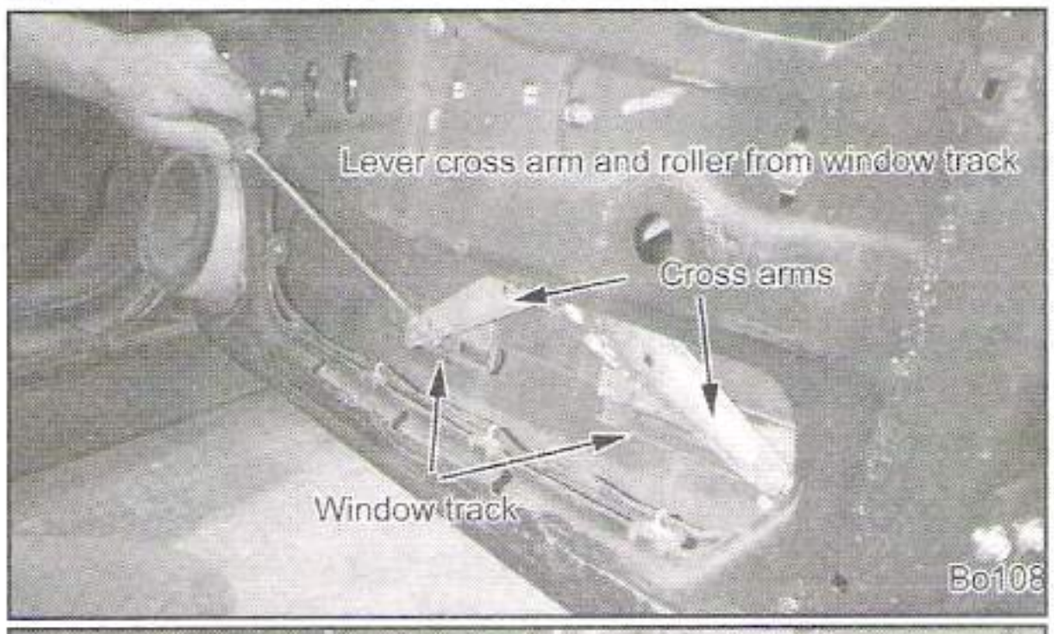
Remove

1. Remove the inner door trim as previously described.
Remove the mirror cover. Pull cover off and back to free the cover from the centre support.
2. Remove the external mirror, 3 screws.
3. Remove the radio speaker, 3 screws.
4. Remove the front weather strip only with window half way down.
5. Remove the weather end cap, pry from door.
6. Remove the water/dust protection cover carefully so it can be glued back into position.
7. Remove the front window channel,
1 bolt and cap at top of window channel.
Tip: Bolt has a loose nut which may fall into door shell.
2 bolts attach the channel to the door shell, push channel to front of door.
8. Remove the window regulator guide rail, 2 bolts.
9. Electronically operated window regulator, disconnect wiring connector.
10. Remove the window runners and window trim on door.
Lever the cross arm runners out of window guide rails.
11. Tilt the glass forward and remove the glass upwards through the glass opening, from the outside of the door.
12. Remove the window regulator assembly.

Install

1. Install the glass in through the glass opening, from outside of the door, tilt the glass forward and slide down.
2. Install window regulator, 4 pop rivets.

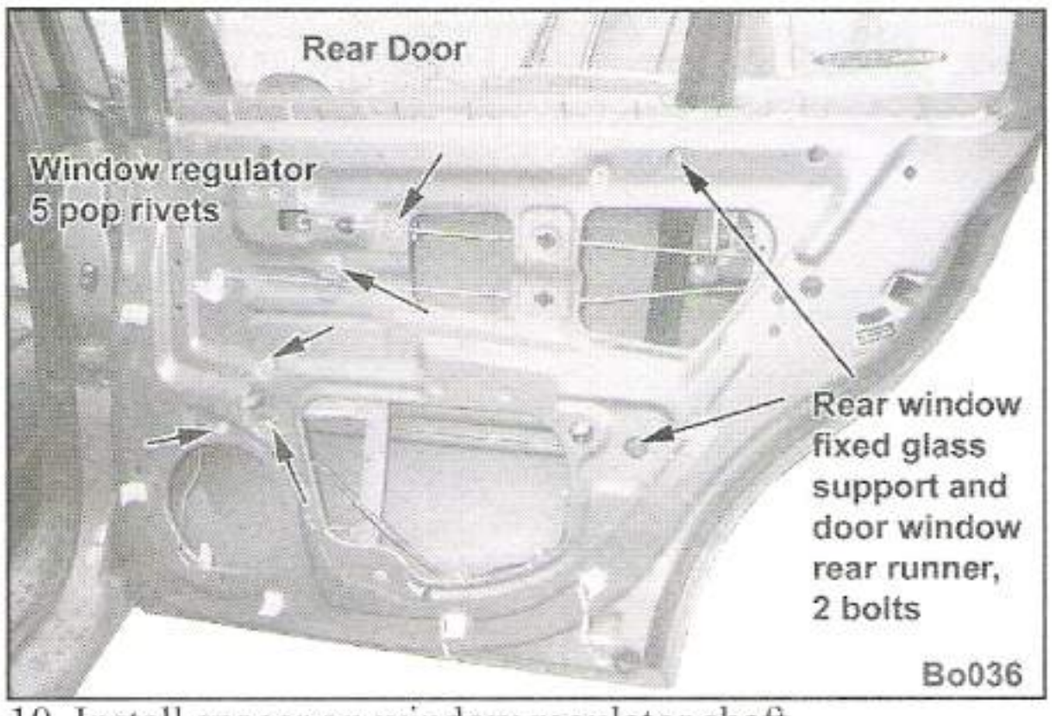






8. Install the window regulator guide rail, 2 bolts.
3. Slide the window side ways to fit the rollers into the roller channels fit roller stops.
4. Replace the front window channel, 2 bolts for the channel, channel top and bolt and nut on top section of channel.
5. Install weather strip end cap, and weather strip to front channel.
6. Check that the glass runs freely in runs.
Adjustment: First pull the glass tightly into the window rear run channel, to adjust the window glass. Then moving the window regulator cam down to remove excess clearance and at the same time maintaining a horizontal attitude, tighten the adjusting screws. Remove any excess clearance that may be apparent in the front window run channel by moving the run channel towards the window glass.
7. Electronic window regulator: Connect wiring connector.
8. Install radio speaker and wiring connector.
9. Replace the water/dust protection cover, carefully glue back into position if necessary.

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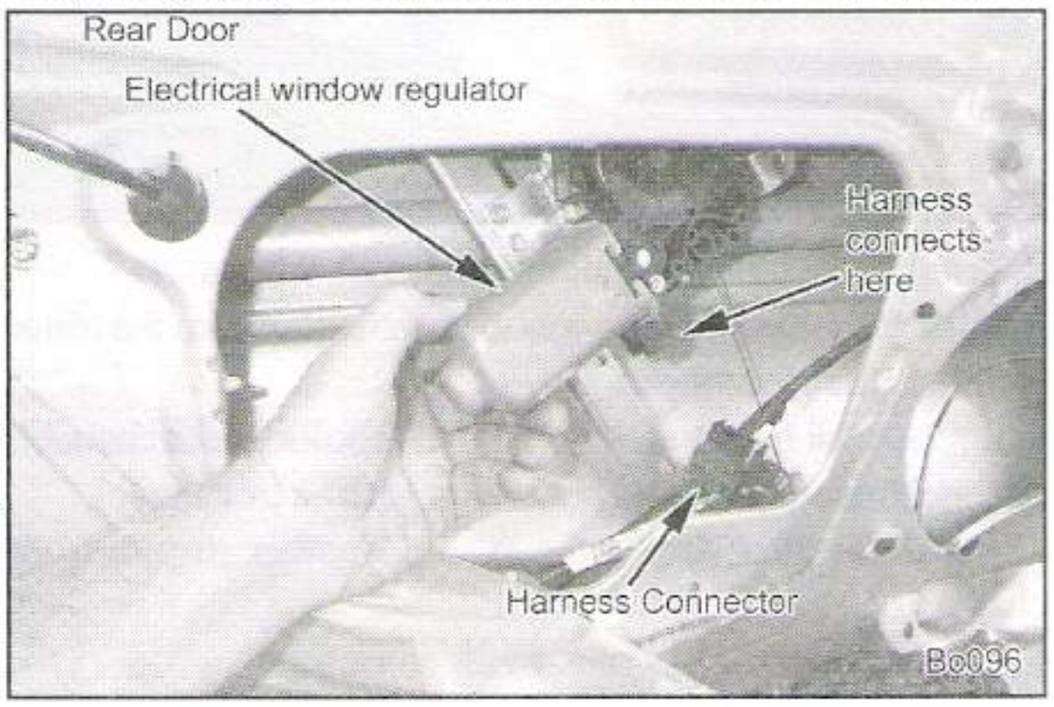


10. Install spacer on window regulator shaft.
11. Install external mirror 3 screws and wiring connector.
12. Carefully position the door trim on to the door install and install window regulator handle as previously described.
13. Install external mirror cover.

REAR DOOR WINDOW GLASS and REGULATOR

Remove

1. Remove the inner door trim as previously described.
2. Remove the radio speaker if fitted, 3 screws.
3. With the window down, remove the weather strip from the rear guide rail.
4. Remove the guide rail, 2 screws at top of door and 2 bolts on door shell, pull guide rail out and up.
5. Remove the water/dust protection cover carefully so it can be glued back into position.
6. Electronically operated window regulator, disconnect wiring connector.
7. Have someone support the window, drill out the 5 pop



rivets supporting the window regulator.
Slide runners out of window guide rails.
8. Tilt the glass forward and remove the glass upwards through the glass opening, from the outside of the door.
9. Remove the window regulator assembly.

Install

1. Install the glass in through the glass opening, from outside of the door, tilt the glass forward and slide down.
2. Install window regulator, 5 pop rivets. Slide the regulator runners into the roller channels fit roller stops.



3. Install the rear guide rail, 2 screws at top of door and 2 bolts on door shell. Install weather strip.
4. Check that the glass runs freely in runs.

Adjustment: First pull the glass tightly into the window front run channel, to adjust the window glass. Then moving the window regulator down to remove excess clearance and at the same time maintaining a horizontal attitude, tighten the adjusting screws of the rear channel.

5. Electronic window regulator: Connect wiring connector.
6. Install radio speaker and wiring connector.
7. Replace the water/dust protection cover, carefully glue back into position if necessary.
8. Install spacer on window regulator shaft.
9. Install inner door trim as previously described.

REAR DOOR FIXED WINDOW GLASS

Remove

1. Remove door window as described above
2. Remove the rear guide rail, 2 screws at the top and 2 bolts in the door shell. Remove or ease forward the rubber seal, guide rail and fixed glass.
7. Prise out the fixed glass panel

Install

1. Slide the glass into position, gently tap the glass home with a rubber mullet.
2. Replace the rubber seal between the fixed glass and the window channel
3. Replace the rear window and guide rail guide rail, 2 screws to the top of the guide rail, 2 bolts to the door shell.
4. Replace the door components as described under "Rear door window glass and regulator" above.



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Radio - Stereo System

There are four main levels of audio/stereo systems fitted to the vehicles. The standard radio/tape player then a radio/tape player/CD for base range vehicles, the Mid range system and Hi range system fitted to Berlina models. Then a high range fitted to Calais models. The different models are fitted as standard equipment to the various range models, however the higher range radio's are an option with some models. The base range unit is a radio/cassette unit and does not have a power antenna.

AUDIO UNIT - Radio/Cassette/CD - All

Remove

1. Using the special two pronged tools, insert the tools in each side of the bezel unit until they lock.

Note: *Two pieces of wire can also be used such as a metal coat hanger.*

2. Move the tools outwards and pull the audio unit rearward.

3. Disconnect the electrical connections and antenna lead.

4. Fully remove unit from vehicle.

Install

1. Connect electrical and antenna connectors to audio unit.

2. Position unit into opening in dash and slide inwards, ensuring rear support peg engages with the mounting bracket.

3. Fully slide unit into dash until it snaps into position.

4. Enter radio security code and check for correct operation.

COMPACT DISC STACKER

Remove

1. Open the boot and remove the inner trim panel from the right hand side rear quarter panel.

2. Disconnect the electrical connection.

3. Remove the 4 screws holding the CD stacker into the CD stacker holder.

4. Remove CD changer and bracket from vehicle.

Install

1. Install the CD stacker into the holder, 4 screws.

2. Reconnect the electrical connection.

3. Replace the rear quarter inner trim panel.

4. Check for correct operation.

SUBWOOFER AMPLIFIER

Remove

1. Open the rear boot and remove the inner trim panel from the left hand side rear quarter panel.

2. Disconnect the electrical harness connector.

3. Remove the 4 screws attaching the amplifier to the side panel, and remove amplifier from vehicle.

Install

1. Install the amplifier into position and install 4 screws.

2. **R**econnect the electrical connector.

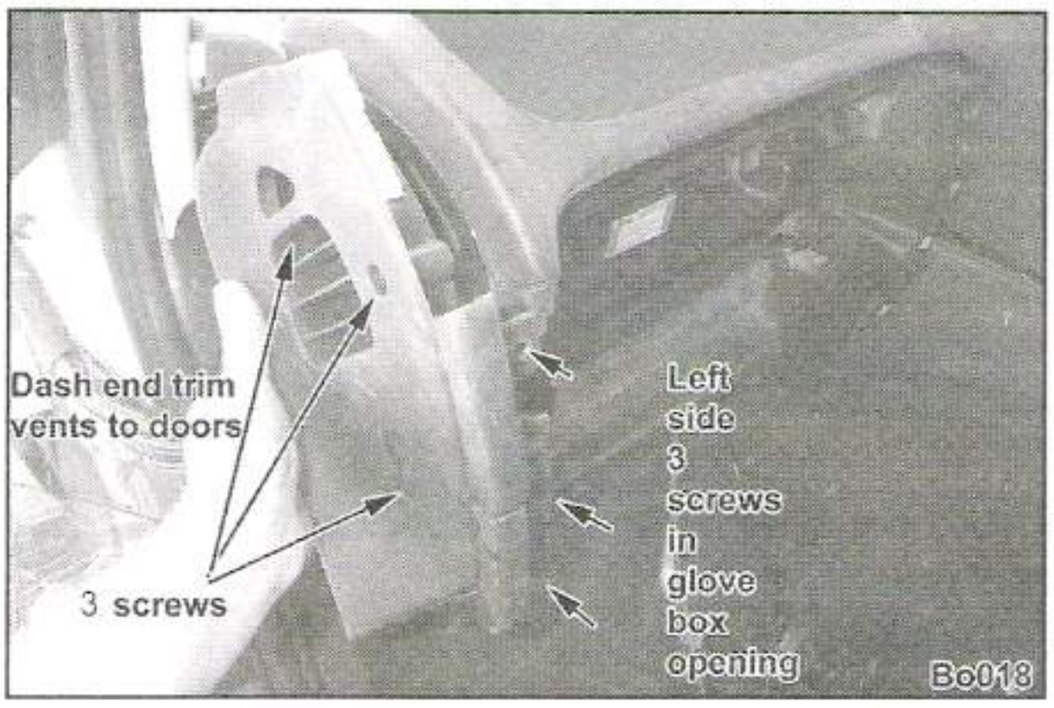
3. Replace the rear quarter inner trim panel.

4. Check for correct operation.

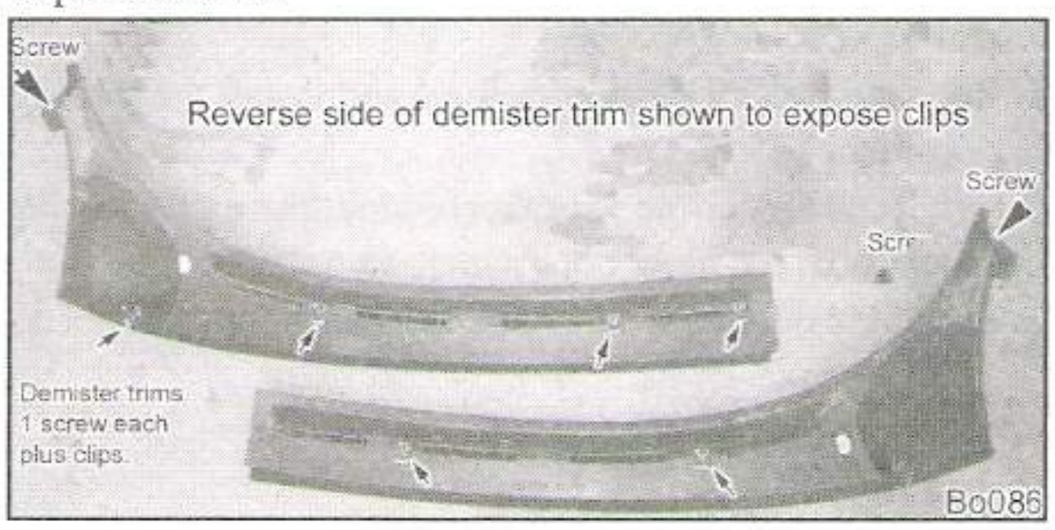
FRONT SPEAKERS -Dash Panel.

Remove

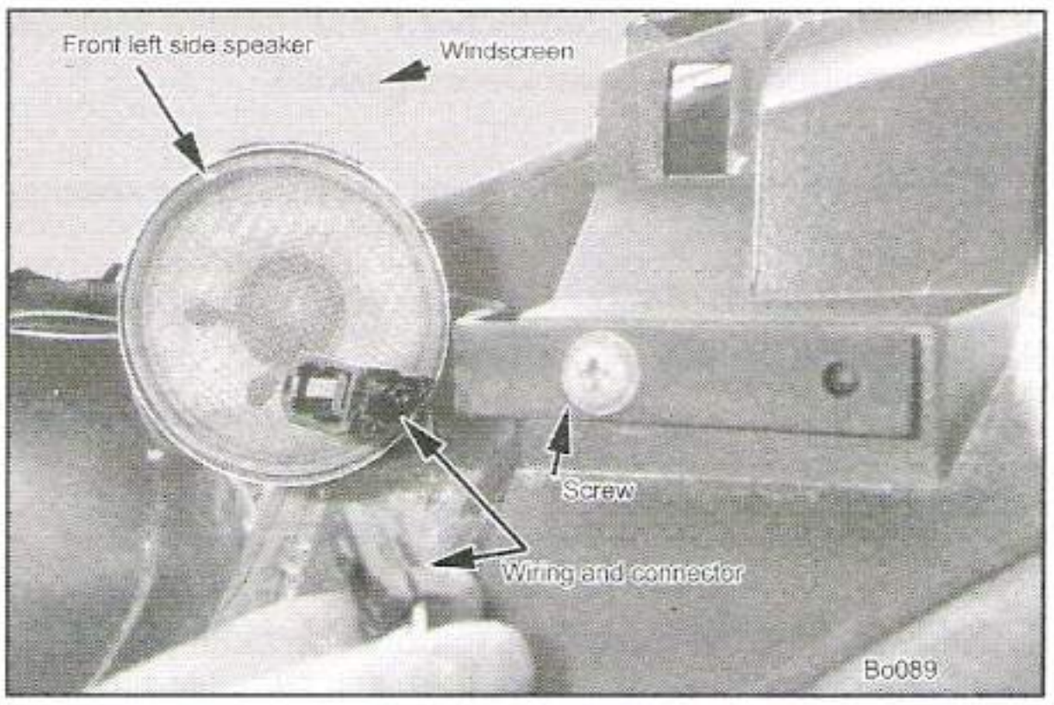
1. Remove the dash end trims (vent to doors) each side has 3 screws. Left side has an additional trim 3 screws.



2. Remove the demister trim, 2 piece, 1 screw each trim, plus clips as shown.



3. Disconnect the speaker each side, screw and wiring connector.



Install

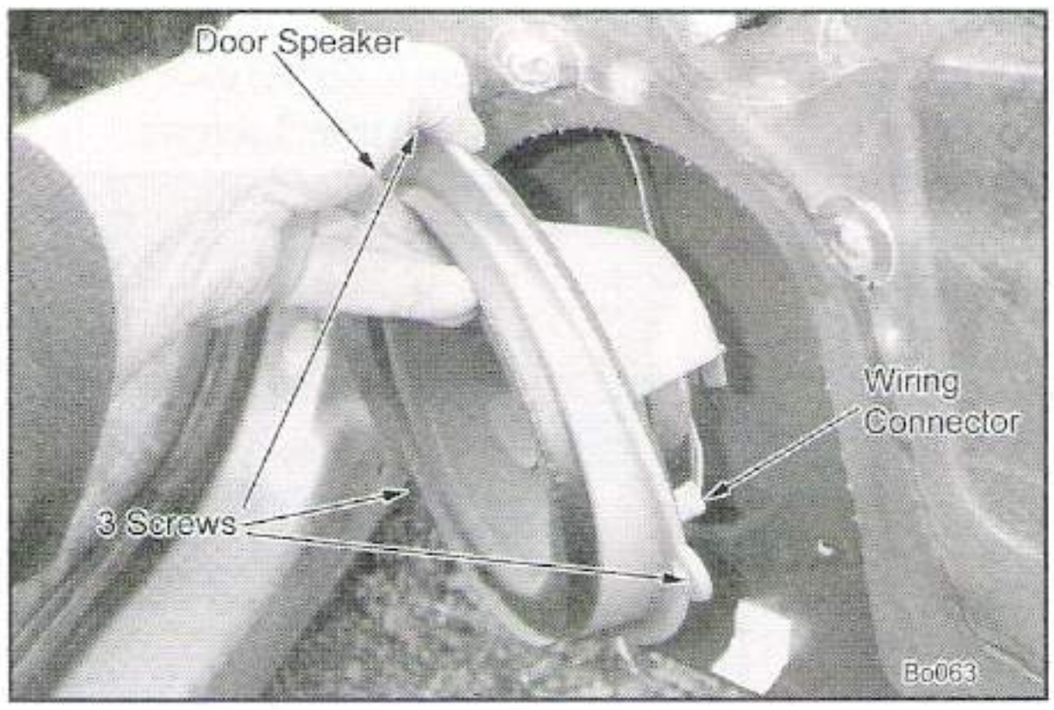
1. Install the speaker each side, bolt and wiring connector.

2.Install the demister trim, 2 piece, 1 screw each trim, plus clips.

3. Install the dash end trims (vent to doors) each side has 3 screws. Left side has an additional trim 3 screws.

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FRONT DOOR SPEAKERS



Remove

1. Remove the door trim as described in the body chapter.
2. Remove the three screws retaining the speaker to the inner door panel and partially remove speaker.
3. Disconnect electrical connections and remove speaker.

Install

1. Reconnect electrical connections and install the speaker into position.
2. Install and tighten the 3 speaker retaining screws, securing the speaker to the inner door panel.
3. Install the door trim panel as described in body chapter.

REAR DOOR SPEAKERS

Remove

1. Remove the door trim as described in the body chapter.
2. Remove the three screws retaining the speaker to the inner door panel and partially remove speaker.
3. Disconnect electrical connections and remove speaker. (See illustration under Front Door Speaker)

Install

1. Reconnect electrical connections and install the speaker into position.
2. Install and tighten the 3 speaker retaining screws, securing the speaker to the inner door panel.
3. Install the door trim panel as described in body chapter.

SUBWOOFER SPEAKERS - Sedan

Remove

1. Inside the boot compartment, remove the under trim to the rear parcel shelf.
2. Disconnect the center saftey belt anchor point and feed through the rear parcel shelf.
3. Remove the rear parcel shelf, 3 screws, 2 fir tree fastners.
a) The anchor point for the child restraunt will need to be removed.
4. Remove the four screws securing the speaker unit to the rear parcel shelf panel.
5. Partially remove speaker, disconnect electrical connections from speaker and fully remove speaker from vehicle.

Install

1. Reconnect electrical connections to speaker and install speaker to parcel shelf.
2. Install and tighten the four speaker retaining screws.
3. Replace the rear parcel shelf and saftey belt, child restraunt anchor point.
4. Test operation of speaker.

STEERING WHEEL RADIO CONTROLS

** CAUTION: The vehicle may be fitted with SRS (Safety Air Bag), the SRS must be made inoperative, other wise it could cause harm to the repairer. See SRS Chapter Briefly

1. Disconnect battery earth terminal.
2. Turn the ignition key to the LOCK position
3. Remove drivers lower dash panel, remove fuse number 26.
4. Remove upper steering column trim, pull upper section banck, use your finger to on the lower section to push inand force forward to release clip.
5. Disconnect the harness connecter to the clock spring assembly, slide the yellow connector lock to the left then pull on the connector to separate.

The steering column, which includes a combination ignition steering-ignition lock is of the collapsible type to lessen the possibility of injury to the driver of the vehicle, should the vehicle be involved in an accident.

CAUTION: Carry removed air bag with opening side facing away from you. Do not support air bag by wiring. Store or position air bag on a flat stable bench with opening side facing up. Do not store in a confined area. There is danger zone of several meters from the air bag.

Remove

1. Remove the horn pad, 4 screws Torx T30H. Lift the pad / air bag from the steering wheel.
2. Disconnect the harness connectors, yellow first (Air bag) then other 1 or 2 connectors. The horn and radio connectors are black.

Tip: Take care when removing stero harness connector as it could cause a malfunction of the stero controls.

Install

1. Position horn bar to steering wheel. Connect the harness connectors, yellow last (Air bag) then other 1 or 2 connectors. The horn and radio connectors are black.
2. Install horn bar and 4 Torx screws.

REAR SPEAKERS - Utility

Remove

1. Remove the rear quarter interior trim panel from vehicle cabin.
2. Remove the three screws securing the speaker to the rear quarter panel.
3. Partially remove speaker, disconnect the electrical connections from speaker and fully remove speaker.

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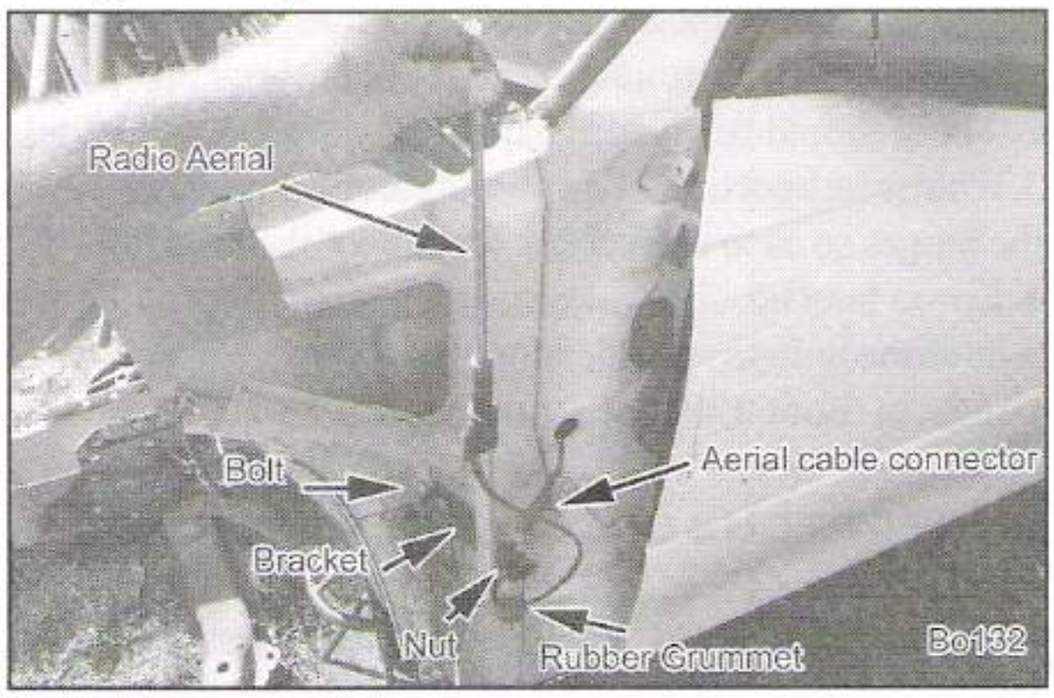
Install

1. Reconnect electrical connections to speaker and install speaker to quarter panel.
2. Install and tighten the three speaker retaining screws.
3. Replace rear quarter inner trim panel (refer body chapter).
4. Test operation of speaker.

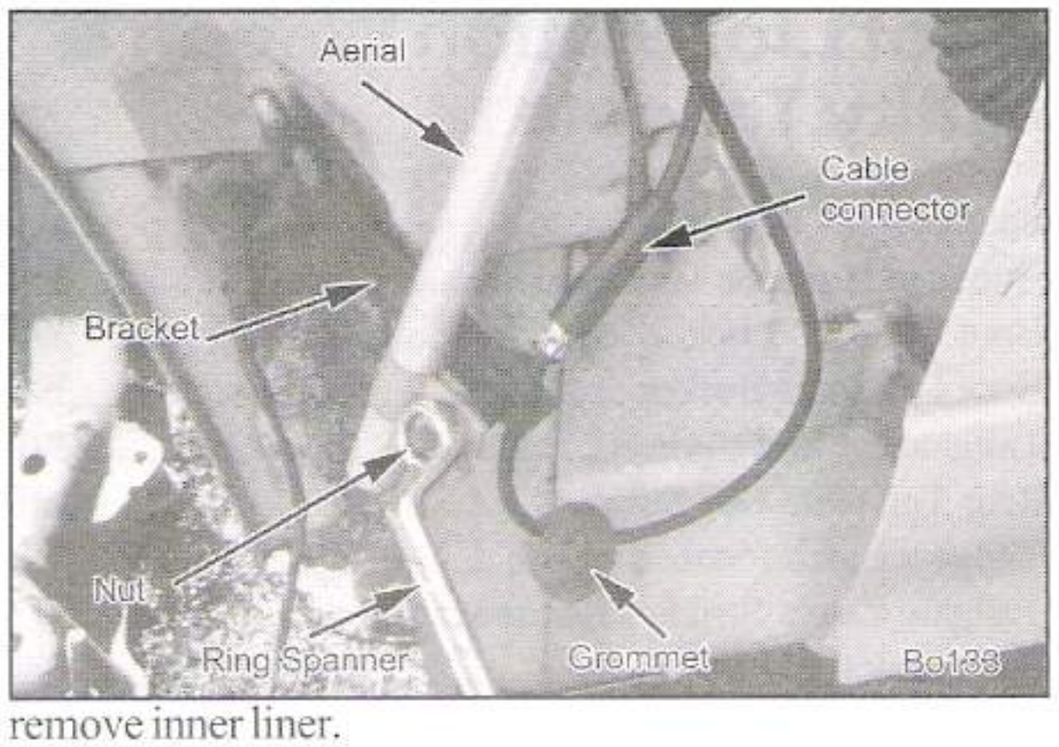
MANUAL/POWER AERIAL

Remove

1. Disconnect aerial cable from cable connecting link located behind the side trim kick panel, also disconnect electrical connections for power aerial.
Note: the cable can also be disconnected by pulling cable through rubber grommet)



2. Remove tabs/nuts/screws securing fender inner liner and remove inner liner.

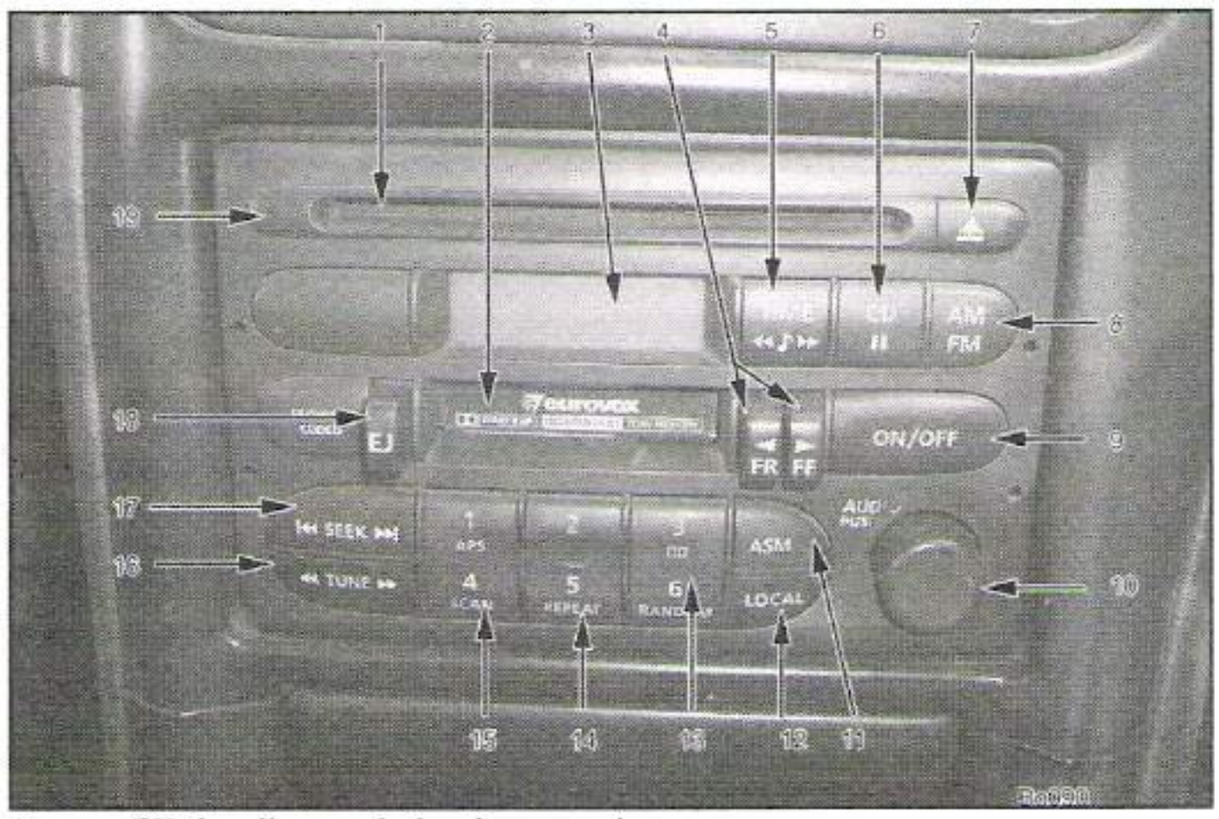


3. Push aerial down to fully closed position.
4. Disconnect earth lead terminal by removing retaining screw.
5. Support aerial and remove the nut attaching aerial bracket to panel.
6. Remove antenna cable grommet from panel.
7. Withdraw aerial down through bezel and remove, complete with cable and grommet.

Installation

1. Ensure aerial cable is routed correctly.
2. Apply sealant around lower mounting bracket to provide water tight seal.
3. Install aerial bracket and securing nut.
4. Connect aerial cable in cabin and install side kick panel.

Base model Radio/Tape/CD



1 CD loading and ejection opening
2 Cassette loading and ejection opening
3 LCD unit display
4 Tape - Fast forward and fast reverse.
- Press both together for tape program selector
5 Time / Frequency priorty selection
Radio / Tape monitor
6 CD - On / Pause selector
7 CD - Eject cd
8 Radio - AM / FM selector
9 All - ON / OFF switch
10 All- Volume, Bass, Treble, Fader, Balance
11 Radio - Automatic Station Memory Store
12 Radio - Local / Distance selector
13 Radio - Memory button 3 and 6
Tape - Dolby B NR button
CD - Random play
14 Radio - Memory button 2 and 5
CD - Track repeat
15 Radio - Memory button 1 and 4
Tape - Automatic Program Search
CD - Track scan
16 Radio - Tune
CD - Fast forward / Repeat within track
17 Radio - Seek Tuning
CD - Track selection
18 Eject cassette
19 Security light indicator

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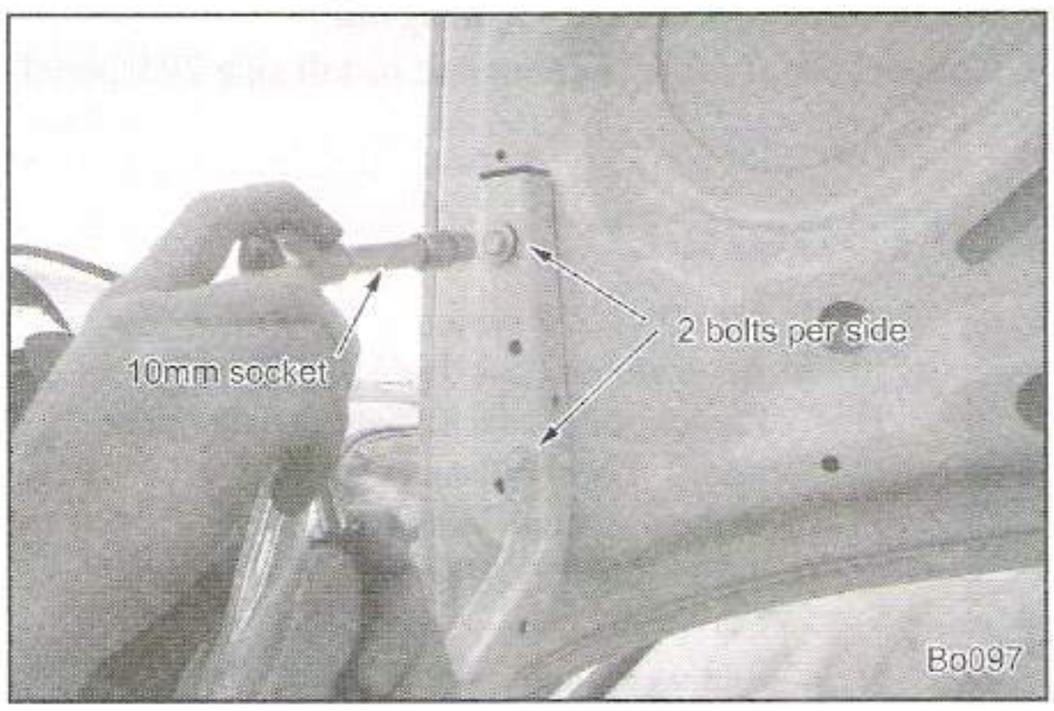
Boot Lid, Station Wagon & Utility Tailgate

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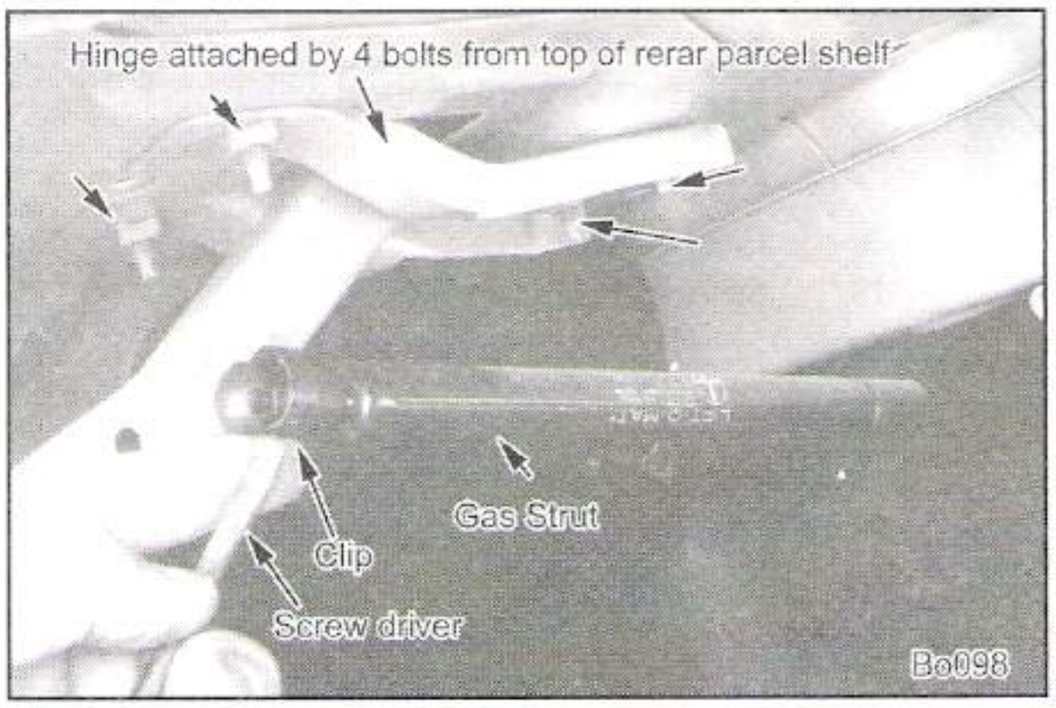
BOOT LID and HINGES

Remove

1. Prop the boot lid open. For reference when refitting the hinge, mark the hinge position of the boot lid with a felt pen.
2. Remove boot lid inside lining, 17 clips.
3. Use a felt pen marker to mark location of hinge to boot lid, for installation.
4. Place a cover under the hinge end of the boot lid to prevent paint damage, when the hinge bolts are removed.
5. Remove the hinge to the boot lid 2 bolts each hinge.



6. Remove the boot lid.
7. Remove the gas strut from the hinge, use a screw driver to lever out clip, push on fit both ends.



8. Remove the hinge attaching bolts and remove the hinge.

Install

1. Replace the hinge. Replace the hinge attaching bolts and tighten to specification.

Hinge - Body Bolts torque: 15-30 Nm

2. Install the boot lid to the hinge, taking note of the felt marks made during removal. Install bolts and tighten to specification

Hinge to Boot Lid Bolts torque: 15-30 Nm

3. Install gas strut to hinge and body bolt, push on fit.
4. Take the door safety prop and the protection cover off. Close the lid and check alignment. After any necessary adjustments tighten the hinge attaching nuts.
5. Open and install boot lid lining 17 clips.

Adjust

1. Loosen slightly the hinge to boot lid bolts, gently close the lid and check the surrounding edges of the boot lid.
2. There should be an even gap on all sides of the boot lid.
3. If not raise boot lid and firmly but carefully move the lid on the hinges so as to correct the position of the boot lid.
4. Lower boot lid, check clearance gaps, if correct lift lid and tighten the bolts to specification.

Hinge to Boot Lid bolts torque: 15-30 Nm

BOOT CATCH & LOCK

Remove

1. Open the boot lid and remove boot lid inside lining, 17 clips.
2. Remove the lock actuating rod from the key lock.
3. Remove the key lock retaining clip, slide sideways, remove the key lock.
4. Remove the latch,
- loosen the 2 screws, push actuator from latch, disconnect wiring connector.
- remove the cable from the latch.
5. Remove the latch, 2 screws.

Install

1. Replace the latch 2 screws and rod assembly.
2. Push the lock cylinder into the opening in the boot lid, slide clip in under lock tabs to fix lock in place.
3. Install the wiring harness connector.
4. Replace the actuator, 2 screws .
5. Replace the boot lid liner, 17 clips.

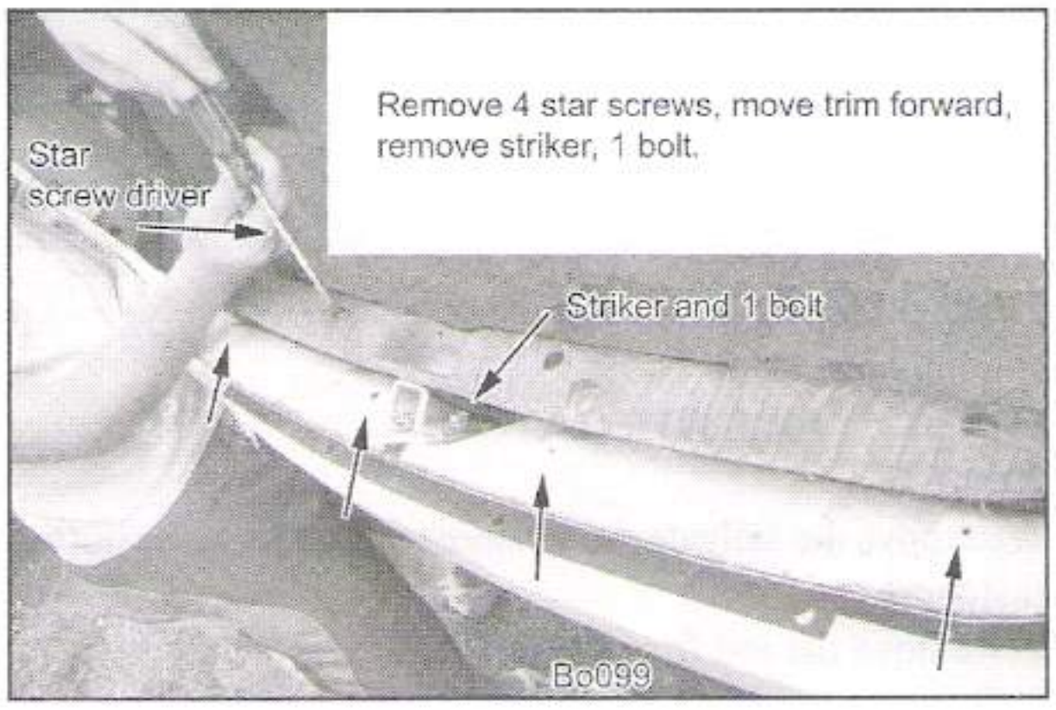
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BOOT LID CATCH STRIKER

Remove

Remove 4 star screws in trim, move trim forward.

1. For reference when refitting the striker, mark the striker position to the boot panel with a felt pen.
2. Remove the one bolt and remove the striker clamping plate.
3. Remove the striker.



Install

1. Replace the striker taking note of the position of the felt pen markings made during removal.
2. Install the clamping plate and bolt, tighten to specification.

Striker Bolt specified torque: 15-35 Nm

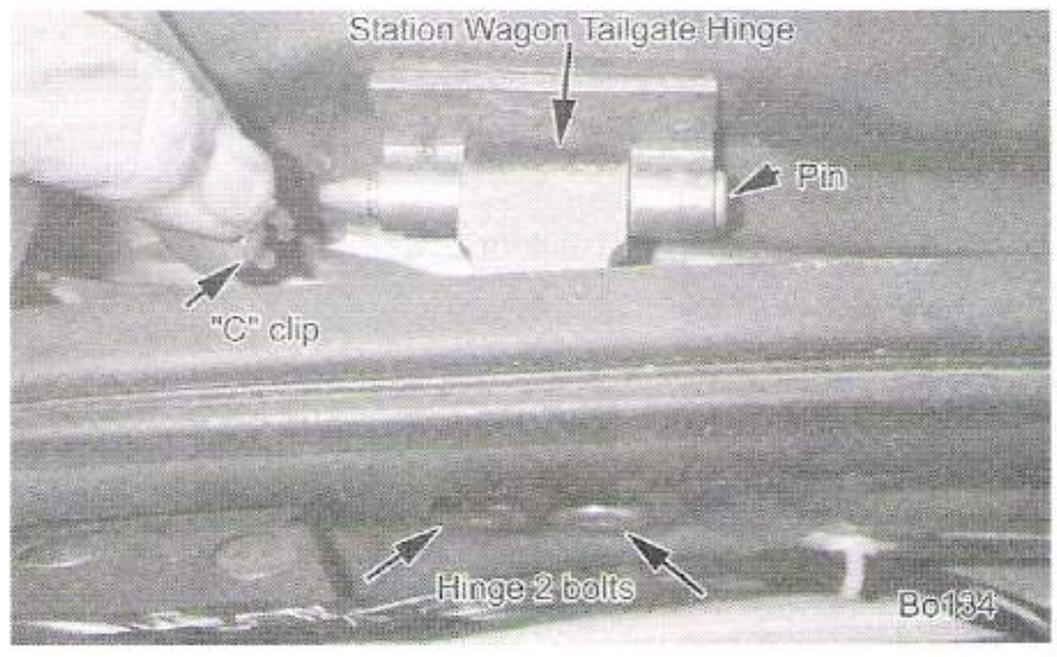
TAILGATE STATION WAGON and STRUTS

Remove

1. Remove the station wagon trim panel, drivers side.
2. Disconnect the 2 electrical wiring connectors, push wiring grommet and connectors through body opening..
3. Prop the tail gate open.
4. Pry the lower gas strut retaining clip from the ball on the prop mounting stud, slide the prop sideways to disengage.
5. Pry the upper gas strut retaining clip from the ball on the prop mounting stud, slide the prop sideways to disengage, remove the gas strut.
6. Have assistant hold the tailgate, remove "C" clip, using a narrow punch and punch the hinge pin out from the hinge.

Install

1. Have assistant hold tailgate, position the tail to correct position and punch hinge pin into hinge, fit retaining "C" clip.



2. Connect the gas strut to the strut support ball of the body and tailgate..
4. Install the wiring loom and connect the rear tailgate wiring loom connectors.
5. Replace the station wagon interior trim panel.

TAILGATE STATION WAGON - Inner Trim

Remove

1. Remove the high stop light cover, 2 scrivets.
2. Remove the rear tailgate interior 2 top trim panels, 1 scrivet each.
3. Remove the upper tailgate trim, 7 clips and pin, pry away from tailgate.
4. Remove tailgate handle, pry off with a screw driver.
5. Use a flat clip removing tool to remove tailgate inner trim, 14 clips.

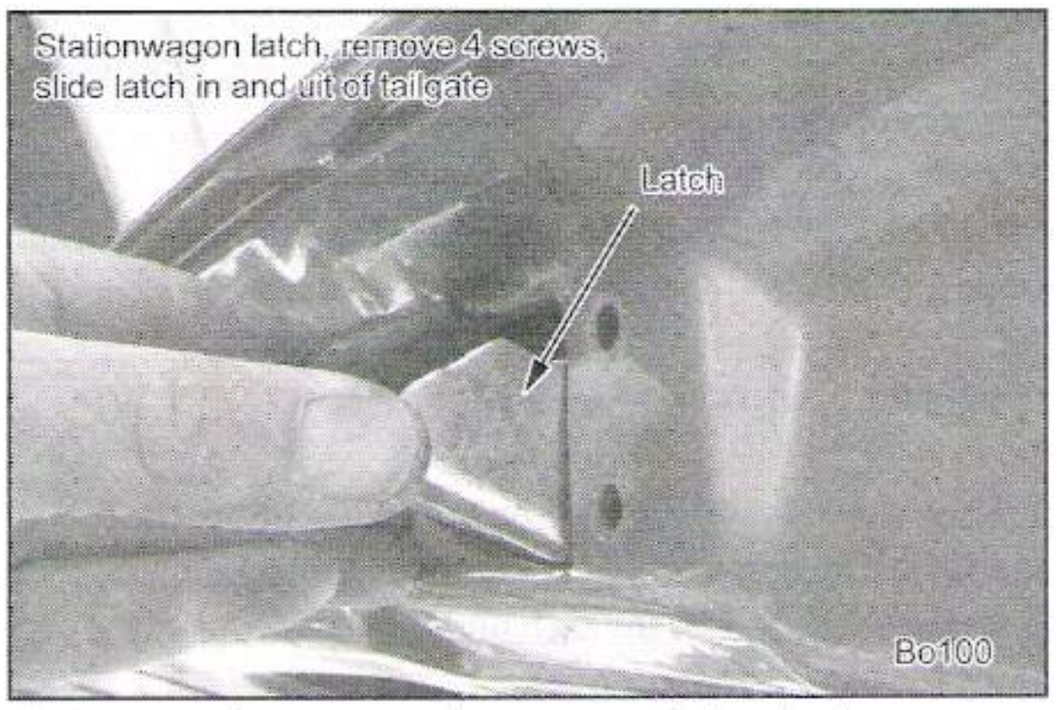
Install

1. Install lower trim, position and push in 14 clips.
2. Install tailgate handle, push in fit.
3. Install the upper tailgate trim, 7 clips and pin, push into place on tailgate.
4. Install the rear tailgate interior 2 top trim panels, 1 scrivet each.
5. Install the high stop light cover, 2 scrivets.

TAILGATE CATCH STATION WAGON - Latch, Lock and Actuator

Remove

1. Remove the rear tailgate interior lower trim panels, prise out the fasteners.
2. Remove the rod from the lower latch to the external push button assembly.
3. Remove the latch, 4 screws, securing the catch to the tailgate.
4. Inside the tailgate disconnect the rod from the external push button to the actuator.
5. Remove the external push button assembly, 2 nuts.



6. Remove the actuator, 2 screws and electrical connector.

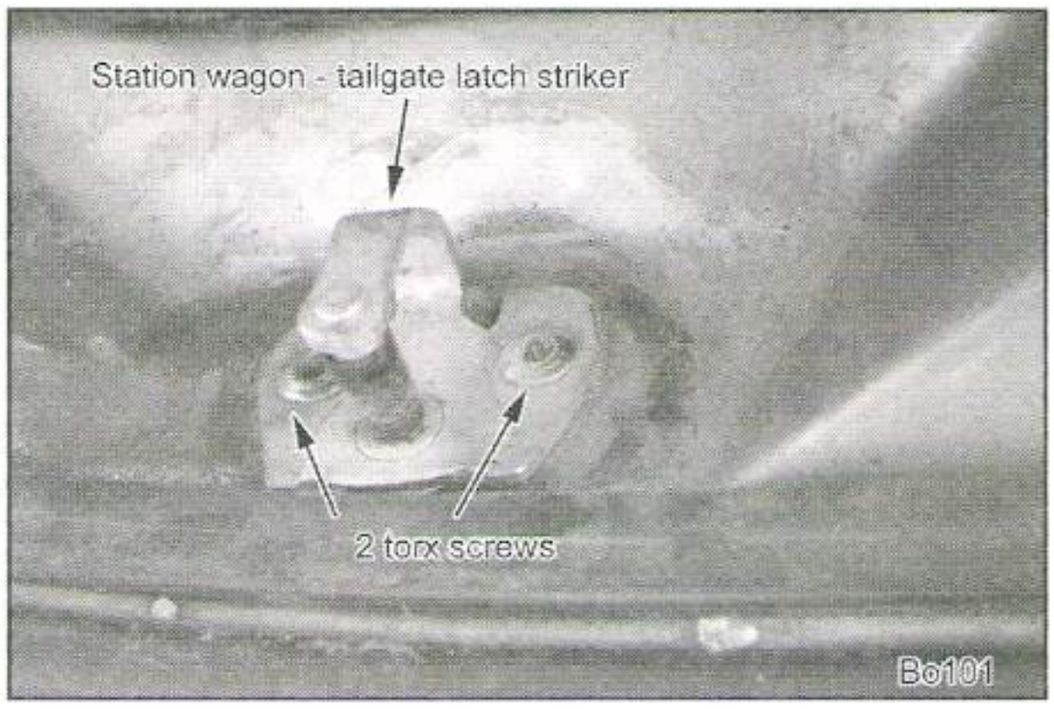
Install

1. Install the actuator, 2 screws and electrical connector.
2. Install the external push button assembly, 2 nuts.

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3. Inside the tailgate connect the rod from the external push button to the actuator.
4. Install the latch, 4 screws, securing the catch to the tailgate.
5. Reconnect the rod from the lower latch to the external push button assembly.
6. Install the rear tailgate interior lower trim panels, push in the fasteners.

TAILGATE CATCH STRIKER - STATION WAGON



Remove

1. For reference when refitting the striker, mark the hinge position of the boot lid with a felt pen.
2. Remove the two torx screws and remove the striker clamping plate.
3. Remove the striker.

Install

1. Replace the striker taking note of the position of the felt pen markings made during removal.
2. Install the striker plate and torx screws, tighten to specification.

Striker bolt specified torque: **15-30 Nm**

FUEL TANK CAP LID

Remove

Open the fuel tank cap lid, take the hinge out, remove the screws and remove the cap lid.

Install

Install the fuel tank cap lid and hinge into the correct position, fit and tighten the securing screws.

UTILITY TAILGATE and HINGES

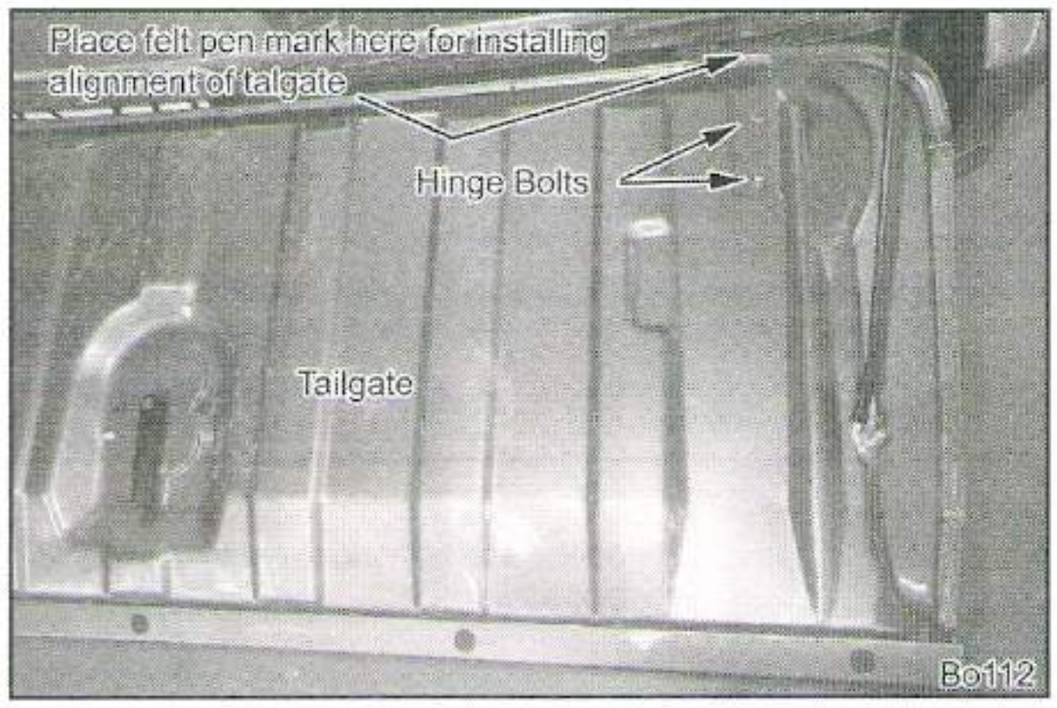
Remove

1. Drop the tailgate. For reference when refitting the hinge, mark the hinge position of the tailgate with a felt pen.
2. Remove the 2 bolts for each hinge, slide the tailgate away from the hinges and remove.

Install

1. Replace the tailgate and slide in the hinge. Replace the hinge attaching bolts and tighten to specification.

Ute Tailgate Hinge Bolts: **15-30 Nm**

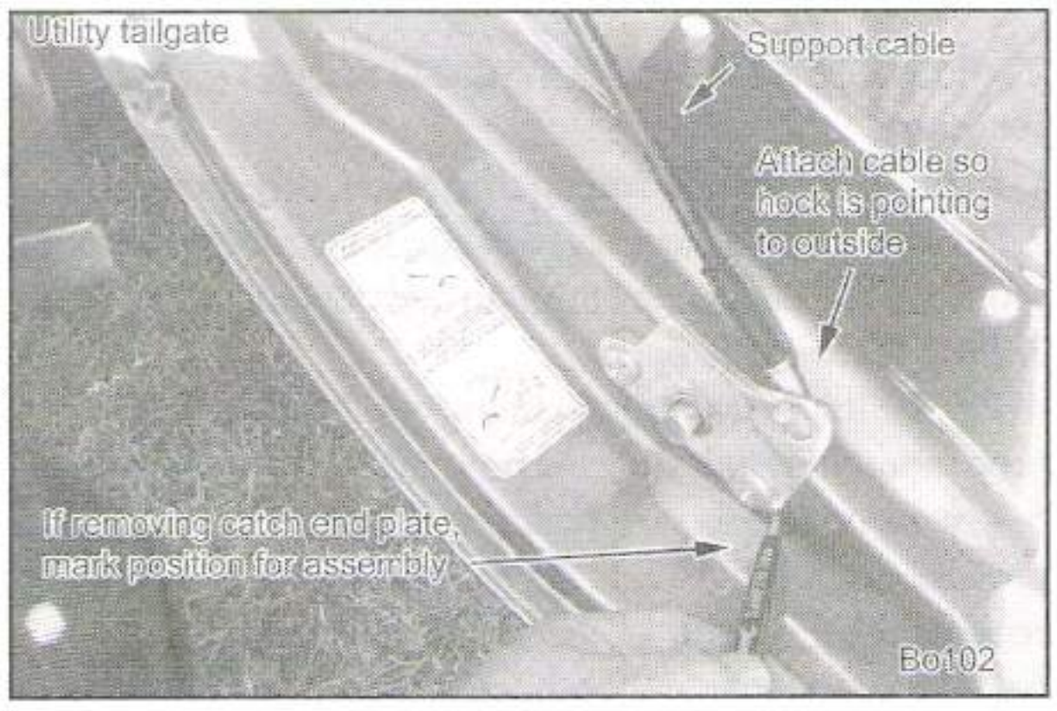


2. Check closing position of the tailgate to the body.

UTILITY TAILGATE CATCH

Remove

1. Remove the tailgate catch handle and panel, prise out the fasteners.
2. Remove the rod from the handle to theside catches.
3. Remove the latch, 4 screws, securing the catch to the tailgate.
4. Inside the tailgate disconnect the rod from the external push button to the actuator.
5. Remove the external push button assembly, 2 nuts.
6. Remove the actuator, 2 screws and electrical connector.



Install

1. Install the actuator, 2 screws and electrical connector.
2. Install the external push button assembly, 2 nuts.
3. Inside the tailgate connect the rod from the external push button to the actuator.
4. Install the latch, 4 screws, securing the catch to the tailgate.
5. Reconnect the rod from the lower latch to the external push button assembly.
6. Install the rear tailgate interior lower trim panels, push in the fasteners.

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Fixed Window Glass

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GENERAL INFORMATION

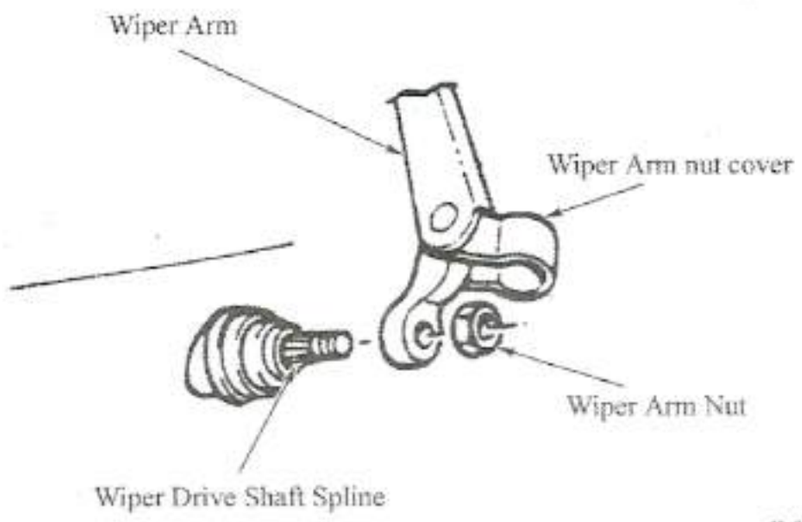
The windscreen is a laminated type of glass which has a plastic lamination between two layers of safety glass. If struck hard enough it will crack into a large section enabling the driver to stop the vehicle safely. The vehicle manufacture fitted windscreen and rear windows are held in position by a compound adhesive. Service kits for replacement windows use a thermo electric butyl tape.

WINDSCREEN

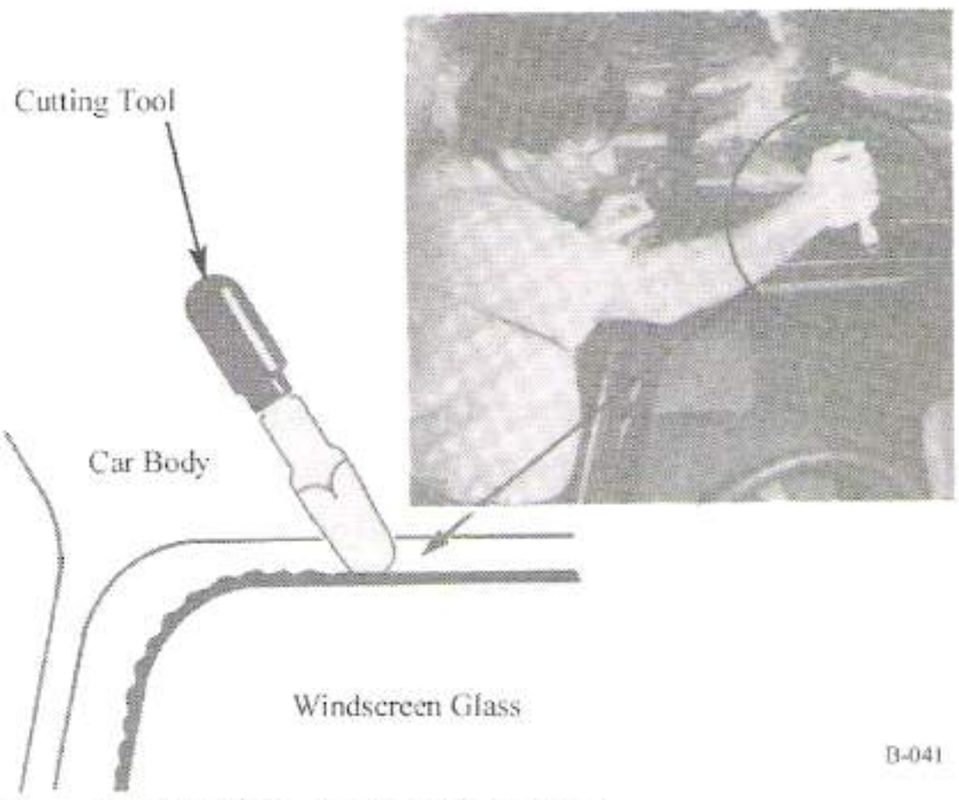
Take care not to damage solar temperature sensor, located in front of dash panel almost against windscreen.

Remove

1. Remove windscreen wiper arms.



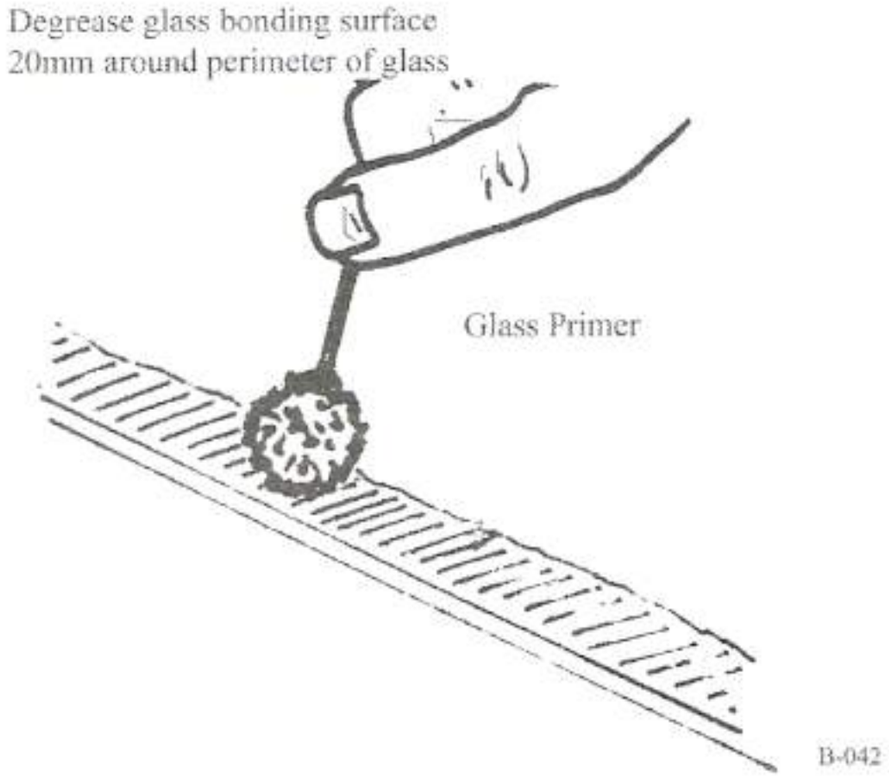
2. Remove the windscreen washer nozzles, i screw each.
3. Remove the two fire wall cover in front of windscreen, 6 scrivets.
4. Remove the water deflector in the firewall plenum chamber, 10 scrivets.
5. Taking care remove the windscreen external moulding, start at a lower corner and work around the window.
6. Remove the internal dash end caps and top front moulding,



as described in "Dash Panel" section.
7. Apply cloth tape around opening perimeter of windscreen to protect paint finish.
8. Using a sharp blade instrument such as a Windscreen removal blade. Lubricate the blade with soapy water, cut the urethane from centre top inside the vehicle. These blades can be used with an air tool or manual handle, it may be necessary to use long blades to work down behind the dash panel.
OR
Use piano wire to cut the windscreen from the body
9. Cutting from the top, then down each side, easing glass forward to an upright position and cutting through bottom material.
10. If glass is to be reused, remove old adhesive with a suitable knife being careful not to damage glass surface.
11. Trim excess sealant from the external edge of the windscreen
12. Cut sealant away from the pinchweld, so the new glass and sealant has an even surface to bond too. Remove as much adhesive, from body flange as possible without damaging paint finish or flange on body..

GLASS PREPARATION

1. Degrease glass bonding surface 20 mm around perimeter of glass, using an oil free cleaning solvent.
2. Apply a thin coating of glass primer around glass on bonding surface. Allow to dry for 10-15 minutes. NB: The



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primed surface must not be touched, if this occurs it must be primed again.
3. Bare end of butyl tape to copper wire core for 30 to 40 mm. Remove cloth only for a further 30 to 40 mm.
4. Starting in bottom corner of glass, position tape with cloth facing inwards. NB: Excessive deformation of butyl tape is to be avoided.
5. With butyl tape positioned around window bare copper wire and remove cloth as previously described.
6. Position ends of tape together and keep copper wires well separated. Don't twist two ends of tape together, they must be pressed against each other.

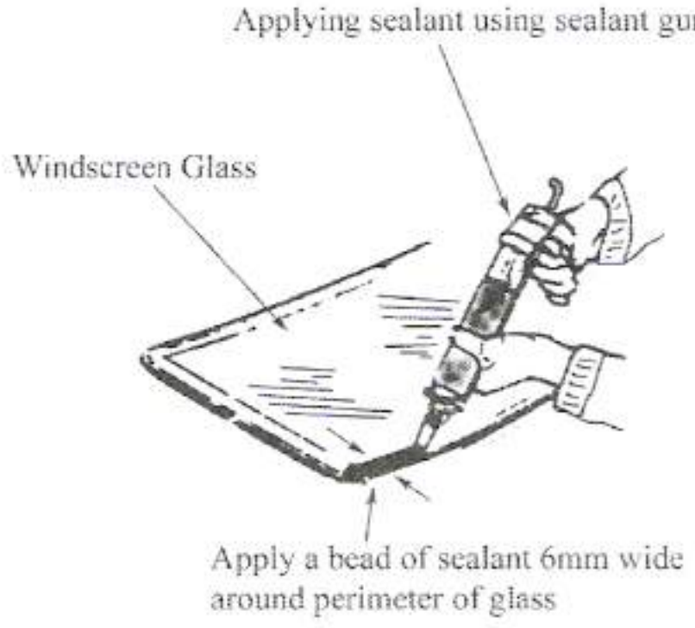
BODY OPENING PREPARATION

1. Clean fence flange and any remaining adhesive with cleaning solvent and allow to dry for 5 to 10 minutes.
2. Apply body primer over metal flange to give a total "blacked-out" appearance. Allow to dry for 10 minutes, refer below.
3. Fit moulding retainers.

GLASS FITMENT

Installing Windscreen using Sealant

1. Using a flat blade or automatic applicator, apply a smooth continuous bead of urethane/silicon adhesive, between the centre and outer edge, around contact area of the entire perimeter of the body opening. The silicon should have an average size of 6 mm in diameter.



There are urethane window replacement kits for various windows. Follow the steps provided with the replacement kits.
2. Install the windshield, using small blocks of wood or plastic to help keep the glass at the correct height. When the glass is in the correct position, masking tape can be used to hold the glass in position. Press windshield gently until the glass is fitted into the correct position.
3. If any areas have gaps or the sealant is not visible. Apply extra sealant using a trowel or flat blade knife, or smooth existing sealant.
4. After the sealant has partly dried, 2 to 4 hours depending on conditions. Test the glass perimeter for leaks with a low pressure water hose. If any leaks are found, apply extra sealant using a trowel or flat blade knife, or smooth existing sealant.
5. Clean off any excess urethane/silicon using commerical cleaning fluid or methylated spirits.

INSTALL WINDSCREEN COMPONENTS

Install the windscreen components in the following order.
- Windscreen moulding.
- Front demister grille, dash end caps.
- Interior rear vision mirror.
- water deflector in the firewall plenum chamber, 10 scrivets.
- two fire wall cover in front of windscreen, 6 scrivets.
- windscreen washer nozzles.
- windscreen wiper arms.

REAR WINDOW

Remove

1. Disconnect rear window defogger wiring.
2. Remove rear pillar trims and rear parcel shelf.
3. Remaining procedure is same as windscreen removal.

GLASS AND BODY PREPARATION

Procedure is same as windscreen section.

GLASS FITMENT

1. Glass bonding is carried out using procedure detailed in Windscreen section.
2. Install following items reversing removal procedure:
- Rear window lower moulding.
- Headlining rear trim.
- Rear pillar trims
- Rear parcel shelf.
3. Connect rear window defogger wiring.

REAR DOOR FIXED WINDOW GLASS



See Front and Rear door Assemblies.

REAR QUARTER PANEL WINDOW-S'WAGON

Remove

1. Remove the door opening external moulding, screws and clips.
2. Remove the quarter window frame from the vehicle, 13 nuts.

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3. Carefully remove the glass and from the vehicle.

Install

1. Carefully position the glass and frame into the vehicle.
2. Install the rear quarter window retaining nuts.

Tip: Do not tighten until the door opening moulding is installed..

3. Replace the door opening external moulding, screws and clips.

TAILGATE WINDOW-STATION WAGON

Remove

1. Remove tail gate window wiper arm and blade assembly.
2. Remove high mounted rear stop light and wiring connections.
3. Disconnect rear window defogger wiring.
4. Remove rear window internal moulding.
5. Remove the external dust deflector, 3 nuts, 2 screws.
6. Carefully cut out the tailgate window.

* It is not necessary to remove all traces of original urethane. However, any original urethane remaining must be smooth and firm.

Glass installation procedure

See "Windscreen Install" for installation procedure.

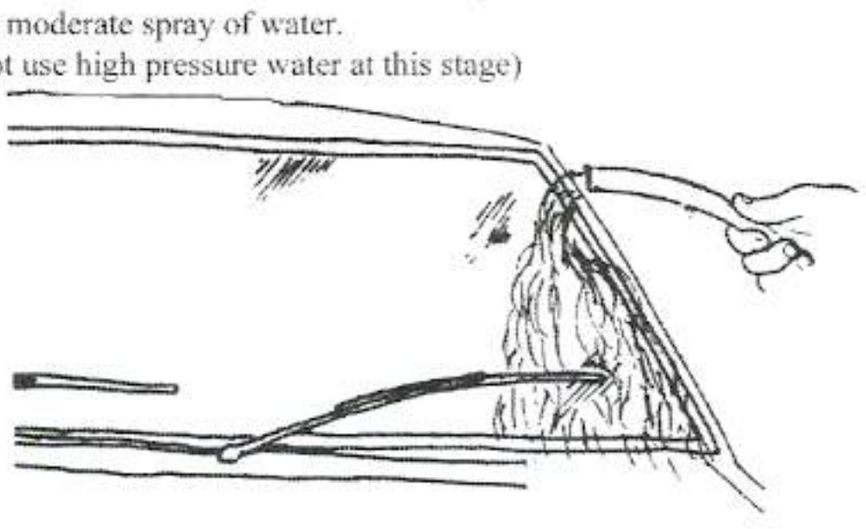
Install

1. Replace tail gate window wiper arm and blade assembly.
2. Replace the window washer nozzle.
3. Replace high mounted rear stoplight and wiring connections.
4. Install rear window internal moulding.
5. Connect rear window defogger wiring.
6. Replace the external dust deflector, 3 nuts, 2 screws.

WATER LEAK SEALING

1. If any areas have gaps or the sealant is not visible. Apply extra sealant using a trowel or flat blade, or smooth existing sealant.
2. After the sealant has partly dried, 3/4 to 11/2 hours depending on conditions. Test the glass perimeter for leaks with a low pressure water hose. If any leaks are found, apply extra sealant using a trowel or flat blade knife, or smooth existing sealant.
3. Clean off any excess urethane/silicon using commerical cleaning fluid or methylated spirits.

Water test the window after 20-30 minutes,
using a moderate spray of water.
(Do Not use high pressure water at this stage)

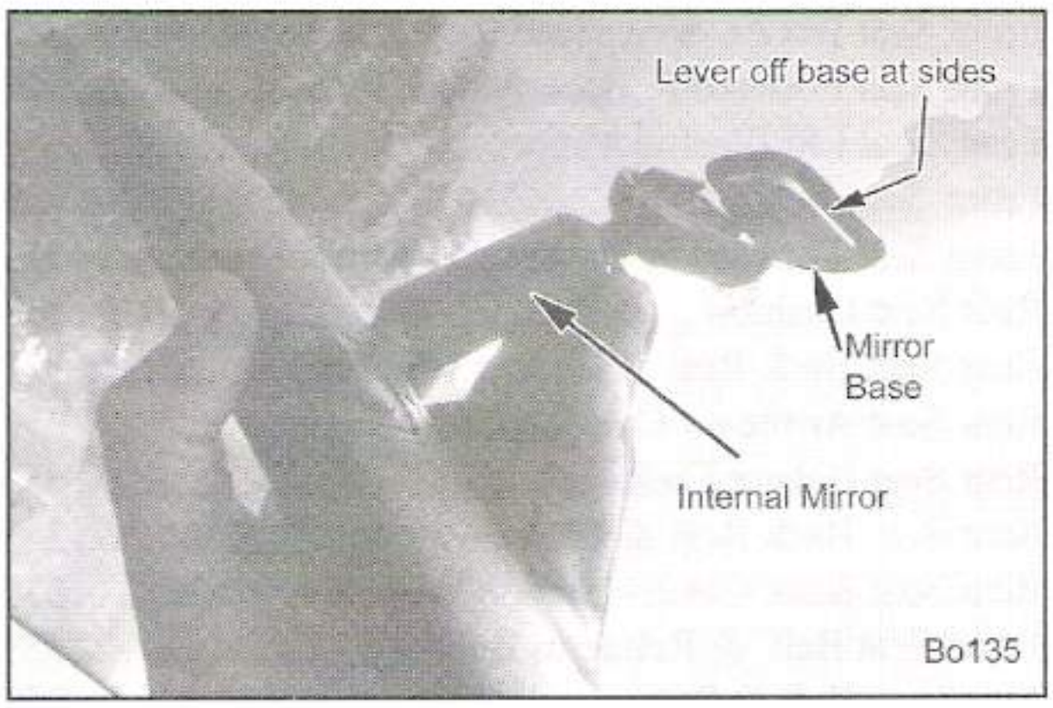


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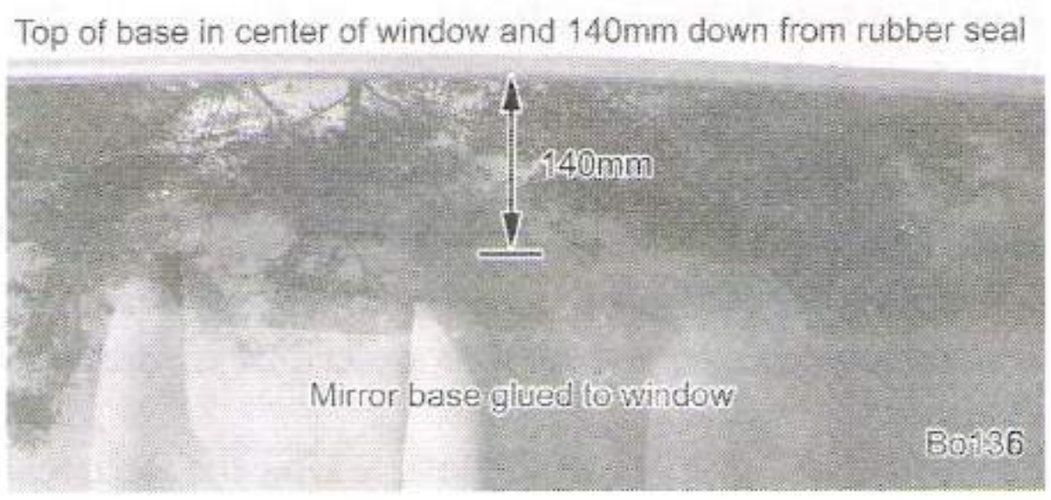
INTERIOR MIRROR

Remove

1. Remove by using a small screw driver to lever mirror away from base.



The base is glued to wind screen.



Install

1. Attach mirror base to windscreen in position shown.
2. Install the mirror to the mirror base, push on..

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Front & Rear Seats / Seat Belts

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Rear Seat Belt & Retractor Buckle - side Sedan	359
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Rear Seat Belt & Retractor Buckle - side S'wagon	359
Rear Seat Belt & Buckle - center S'wagon	360

FRONT SEATS , SIDE AIR BAGS and SEAT BELT BUCKLE & PRE-TENSIONER

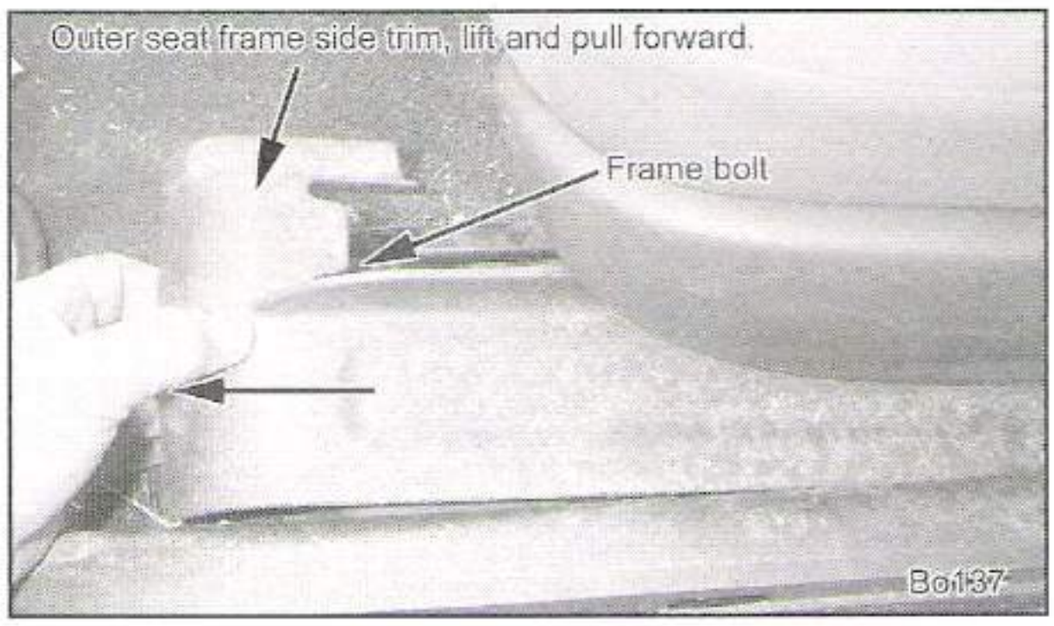
Warning the SRS (air bag and seat belt pre-tensioner) system must be de-activated as described in the SRS chapter.

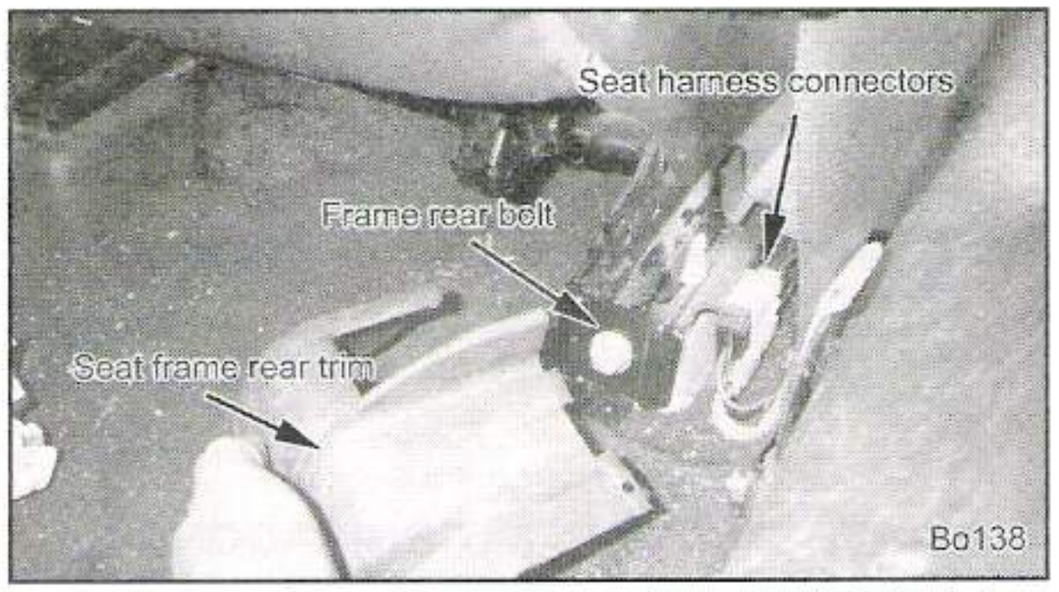
Warning the air bag can still inflate after the electrical system has been disconnected.

Also described in "SRS" chapter.

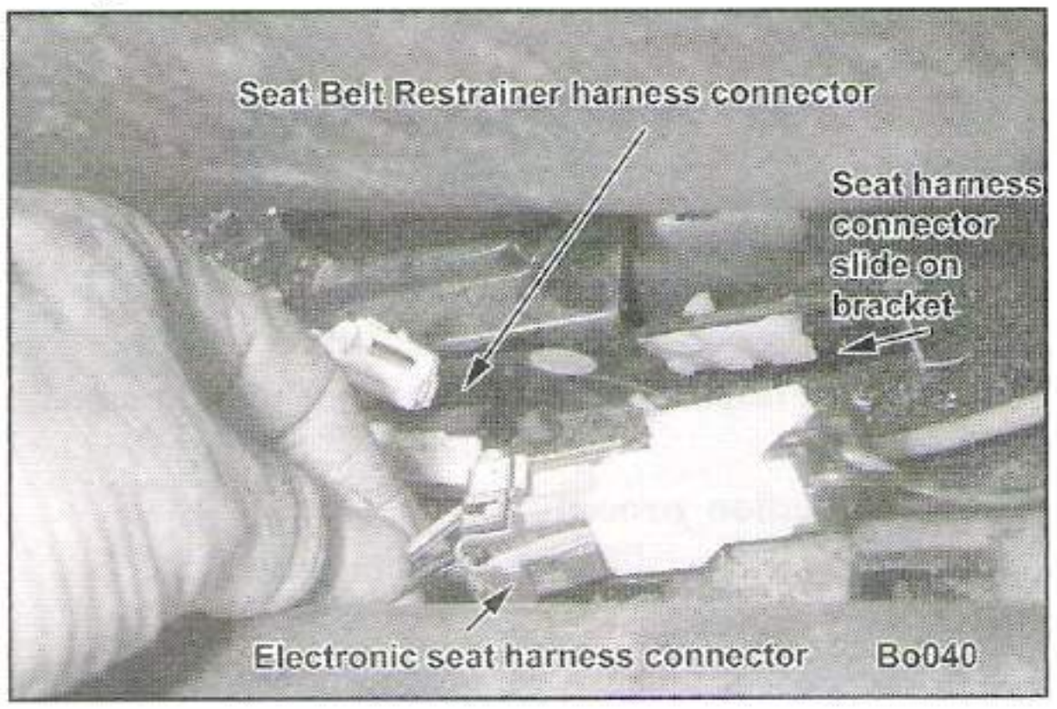
Remove

1. Remove the outer seat frame cover trim, 1 screw, use a screw driver to lever forward, pull forward and up off clips. Remove the 2 rear, 2 front rail covers by prying up and off.





2. Disconnect the seat belt pre-tensioners and side air bag wiring harness connectors.



3. Remove the bolts attaching the front end and rear end of the seat frame to floor.

4. Remove the seat taking care not to damage any of the internal upholstery or internal lining.



5. Connect the seat belt pre-tensioners and side air bag wiring harness connectors.

Dismantle

1. Remove the seat recliner knob and shaft, pull out, seats with electric 4 way adjustment, pry off with a screw driver.

2. Remove the front seat side trim

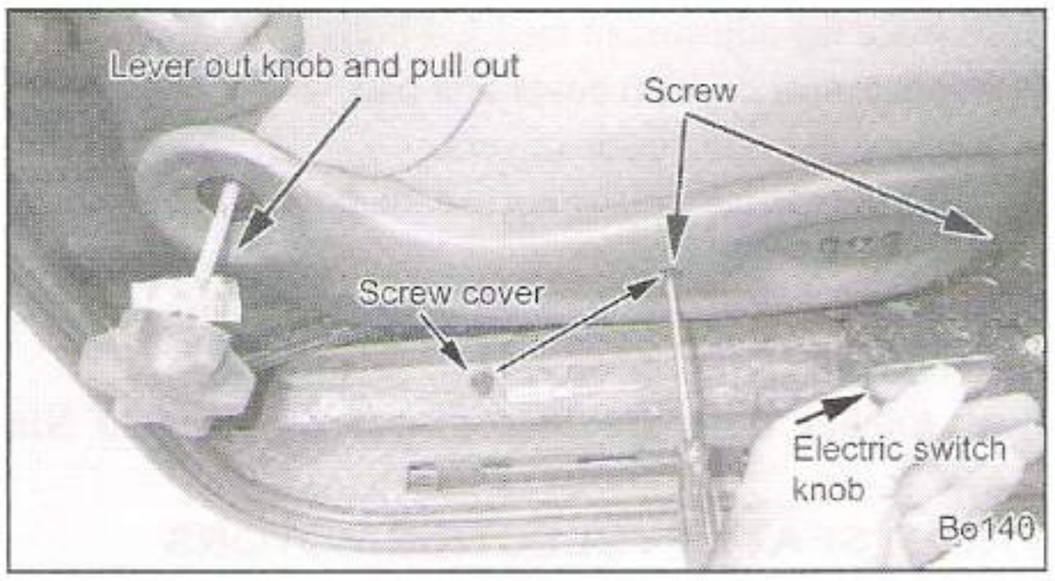
a) Remove the front and side screw.

b) Remove the trim side screw fastener, turn anti-clockwise, remove screw behind fastener.

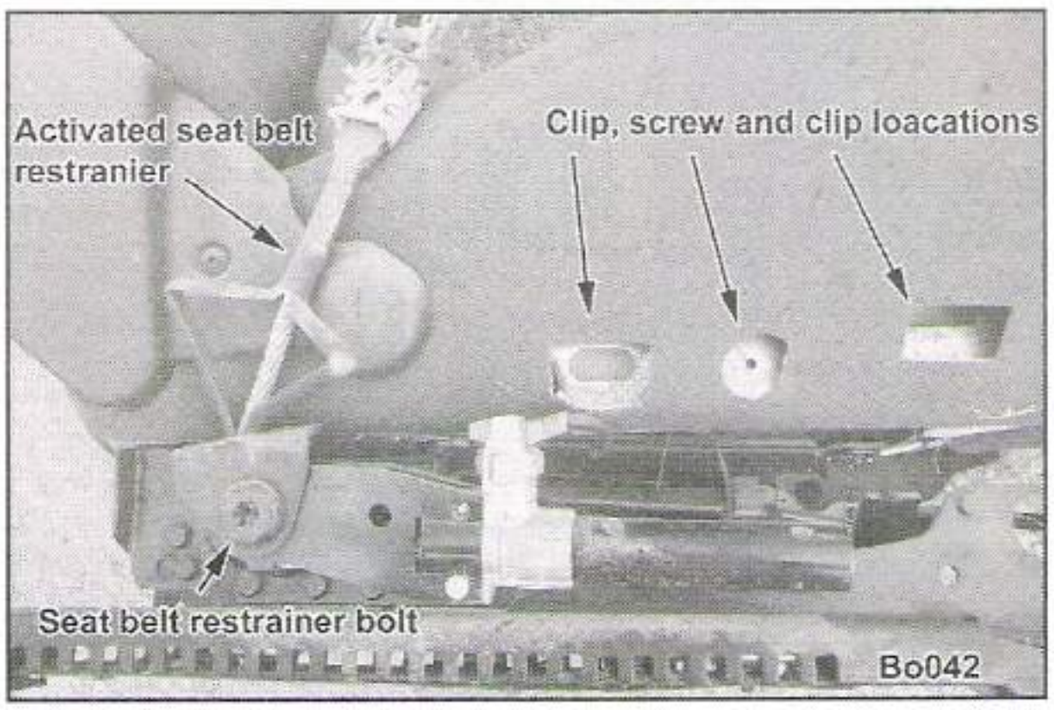
c) Remove side trim, from under seat squeeze the 2 retaining clips in the center of trim.

d) Disconnect the seat adjuster wiring harness connector,

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behind trim.



3. Seat with electric 4 way adjustment.
a) Remove inner cover, 1 screw.
4. Remove seat back cover.
a) Use a screw driver up behind cover to push up and pry the 2 retaining clips away from seat frame.
b) If the seat has lumber support, pull the edges of the back cover out to reveal circlip, push circlip out with 2 screw drivers, release the lumber support adjuster from spline.
c) Pull down on back cover to release from seat assembly.
5 Remove head rest.
a) Squeeze the base of the head rest rod sleeves, located in seat frame under rear upholstery, push up to release head rest sleeves from seat frame.
6. Remove seat back rest upholstery.
a) At the rear of the seat lift and peel back the upholstery from the 4 wrap around locations.
b) The lower one first, 2 sides then top.
c) Remove the upholstery and padding from the seat assembly.
7. Remove the side air bag.
a) Remove the 2 nuts.
b) Cut the plastic ties of the wiring harness and disconnect the wiring connectors.
Tip: Take note or mark the harness and tie locations for assembly.
c) Remove the air bag.
8. Remove seat belt buckle and pre-tensioner.
a) Remove seat cushion upholstery and pad from seat frame.
b) Remove seat cushion frame from seat floor frame and guide rails, 4 bolts.
c) Remove pre-tensioner and buckle, 1 bolt.

Assemble

1. Install seat belt buckle and pre-tensioner.
a) Install pre-tensioner and buckle, 1 bolt.
Side Air Bag Nuts: 45 Nm
b) Install seat cushion frame to seat floor frame and guide rails, 4 bolts.
Seat Cushion Frame to Seat Guide Rails bolts: 27 Nm
c) Install seat cushion upholstery and pad from seat frame.
2. Install the side air bag.
a) Install the air bag and the 2 nuts.
Side Air Bag Nuts: 5-6 Nm
b) Install the wiring harness, connect the wiring connectors use plastic ties to hold harness in place.
Tip: Use the same harness rout and tie locations for assembly as original to ensure the wiring system is not damaged now or later.
3. Install seat back rest upholstery.
a) Install the upholstery and padding to the seat assembly.
b) At the rear of the seat lift and peel around the upholstery from the 4 wrap around locations.
c) The top one first, 2 sides then lower.
4. Install the head rest and sleeves by pushing into place.
5. Install seat back cover.
a) Push the back cover into place locking in the top tabs.
b) If the seat has lumber support, position the lumber support adjuster to allow the circlip to be installed, push circlip in place, then release cover sides.
c) Push on the 2 rear retaining clips to lock in place.
6. Seat with electric 4 way adjustment, install inner cover, 1 screw.
7. Install the front seat side trim.
a) Position trim near seat and connect the seat adjuster wiring harness connector, behind trim.
b) Install side trim, push home the 2 retaining clips in the center of trim.
c) Install the front and side screw, install the trim side screw fastener, turn clockwise.
8. Install the seat recliner knob and shaft into position.

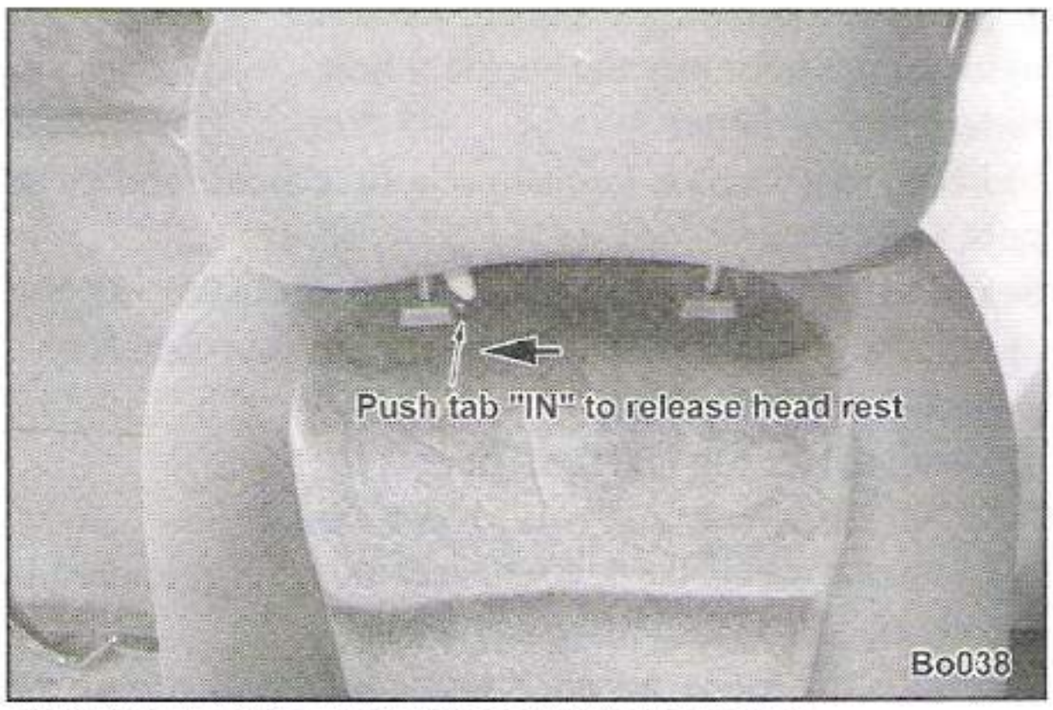
Install

1. Install the seat taking care not to damage any of the internal upholstery or internal lining.
2. Install the seat and frame, tightening the attaching bolts to specification.
Seat Anchor Bolts specified torque: 35-50 Nm
3. Connect the seat belt pre-tensioners and side air bag wiring harness connectors.
4. Install the outer seat frame cover trim, lower into place and push back to lock in, install 1 screw.
Replace the 2 rear rail covers by pushing into place.

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FRONT HEAD SUPPORT

Front seat head supports are retained by single pushing tab as shown. To remove push in on tab, remove head rest.



FRONT SEAT BACK COVER, HEAD SUPPORT SLEEVES & LUMBER KNOB

Remove

1. Remove lumber support knob, push seat cover in to reveal circlip, push circlip out with 2 screw drivers.
2 Push a large screw driver up the inside of the seat back cover while pulling out on seat rear cover to release the 2 retaining clips.
3. Pull down on the seat rear cover to unclip at the top and remove.
4. Squeeze the base of the head support sleeves and push up to release from seat frame.

Install

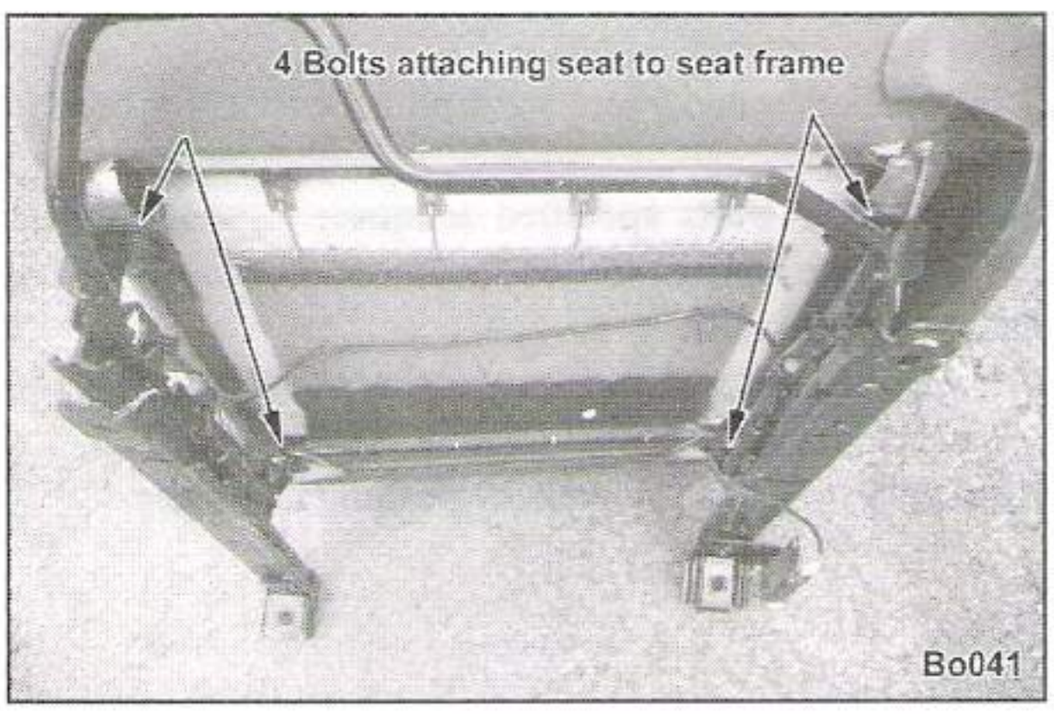
1. Install and push in the head support retaining sleeves.
2. Place the seat rear cover in position, push up to locate into the 2 top clips.
3. Push in the 2 retaining clips near the base of the cover.
4. Install lumber knob and circlip.

FRONT SEAT FORWARD & BACK TRACK

Remove

1. Remove the front seat assembly as previously described.
2. Remove the side plastic covers as previously described.
3. Remove the seat cushion cover and pad.
4. Remove the 4 bolts.

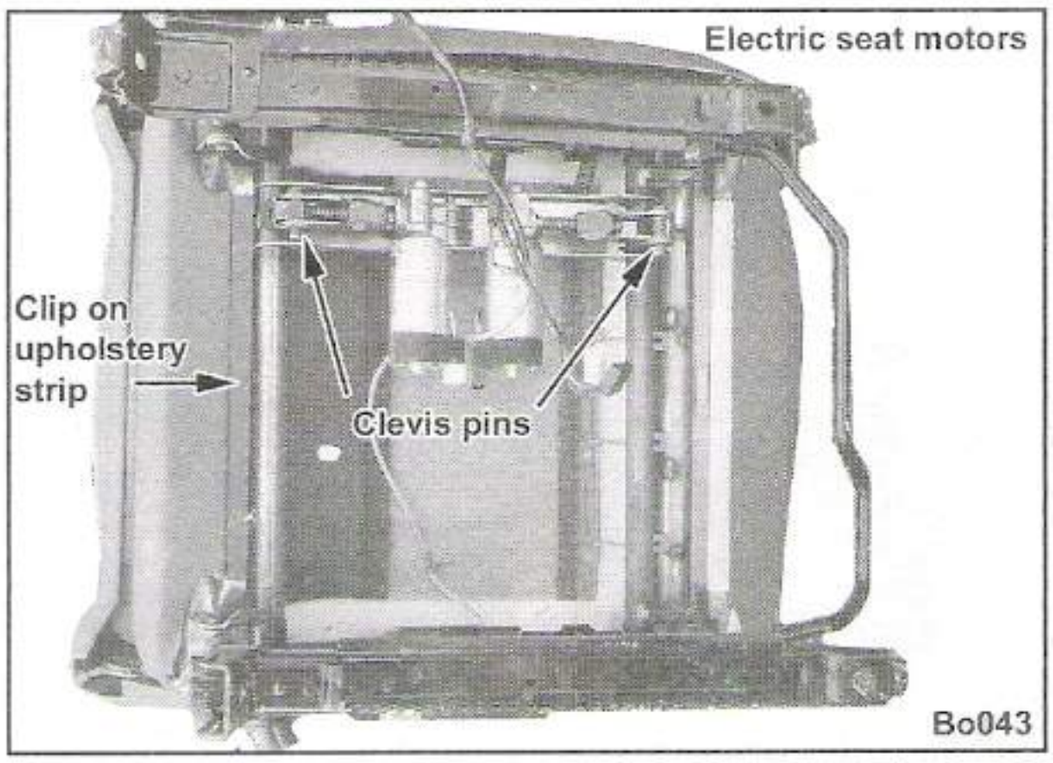
Install



1. Replace the adjustment tracks, 4 bolts.
2. Replace seat cushion cover and pad.
2. Replace the side plastic covers.
3. Install the seat taking care not to damage any of the internal upholstery or internal lining.
4. Install the seat assembly, tightening the attaching bolts to specification.

Seat Anchor Bolts specified torque: 35-50 Nm

FRONT SEAT LIFT ELECTRIC MOTORS



Remove

1. Remove the front seat as described.
2. Cut wiring loom tie straps.

Tip: Take note of the position for assembly, if in wrong position seat might not operate correctly, or cause an electrical short.

3. Motor required, file retaining burr off the clevis pin, use a punch to remove pin.
4. Use a punch to remove the small clevis pin from the seat cross support and motor assembly.
5. Remove motor.

Install

1. Position motor.
2. Use a punch to install the small clevis pin through the seat cross support and motor assembly.
3. Replace large clevis pin and use a punch to burr end of pin.
4. Install wiring loom and tie straps.
6. Install the seat assembly, tightening bolts to specification.

Seat Anchor Bolts specified torque: 35-50 Nm

FRONT SEAT FORWARD/BACK ELECTRIC MOTORS

Remove

1. Remove the front seat as described.
2. Unclip the motor assembly from the seat frame, then lever the motor out of the frame.
3. Disconnect drive cables from each end of motor.
4. Remove motor.

Install

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1. Position motor.
2. Connect drive cables to motor ends.
3. Push motor into place tap in with a rubber hammer, make sure clips lock in. Replace large clevis pin and use a punch to burr end of pin.
4. Install the seat assembly, tightening bolts to specification.

Seat Anchor Bolts specified torque: 35-50 Nm

REAR SEAT CUSHION - Sedan and Station Wagon



Remove

1. Lift front of seat to expose the pull down handles at either side of transmission tunnel, to release the seat cushion catch eiterh side.
2. Remove the seat taking care not to damage any of the internal upholstery or internal lining.

Install

1. Replace the seat into the vehicle taking care not to damage any of the internal upholstery or internal lining.
2. Fit the cushion section into place with the back of the cushion in under the back section.
3. Push down hard on the front of the cushion, pull down on handle to help lock into place.

REAR SEAT BACK REST (3 Sections) - Sedan



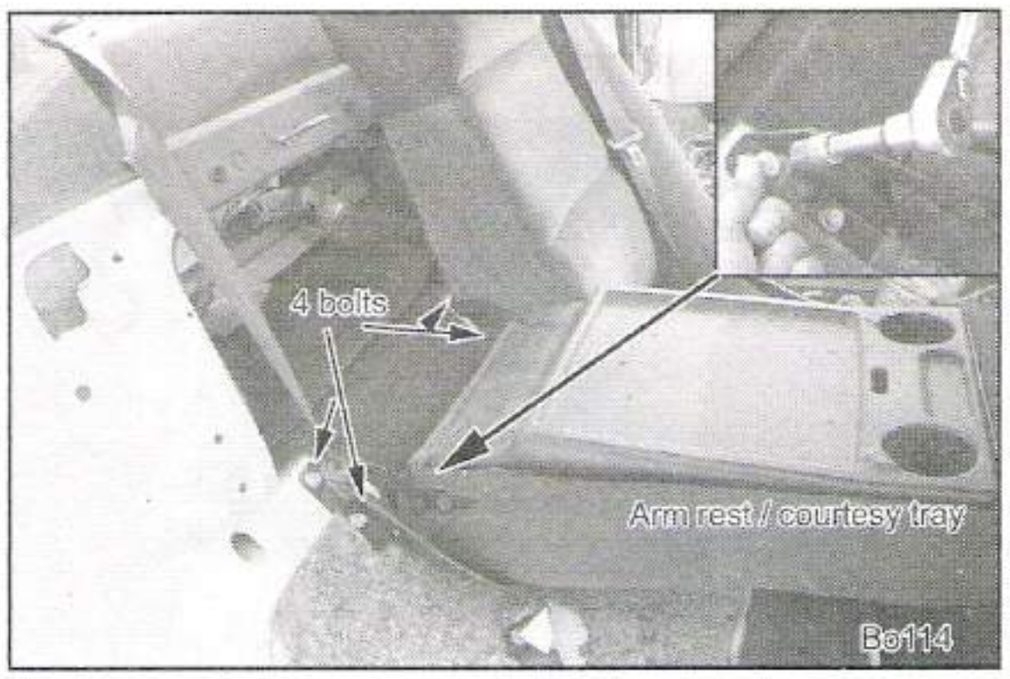
Remove

1. Remove the cushion as described above.
2. Unlock and lower the center section.
3. Remove the 2 bolts attaching the back rest to the floor pan.
4. Lift the back rest frame from the hooks on the body panel near the parcel shelf.
5. Remove the seat taking care not to damage any of the internal upholstery or internal lining.
6. Remove the center section, 4 bolts.

Install

1. Replace the center back rest into the vehicle, install 4 bolts.
2. Replace left and right back rest seat frame to the retaining brackets attached to the rear compartment body panel near the parcel shelf.
3. Install two bolts securing the seat back frame to the rear floor pan.
4. Fit the cushion section into place as described previously.

REAR SEAT ARMREST / COURTESY TRAY



Remove

Fold down arm rest, remove 4bolts that attach the arm rest to the rear seat back panel, lift armrest out the rear back rest panel.

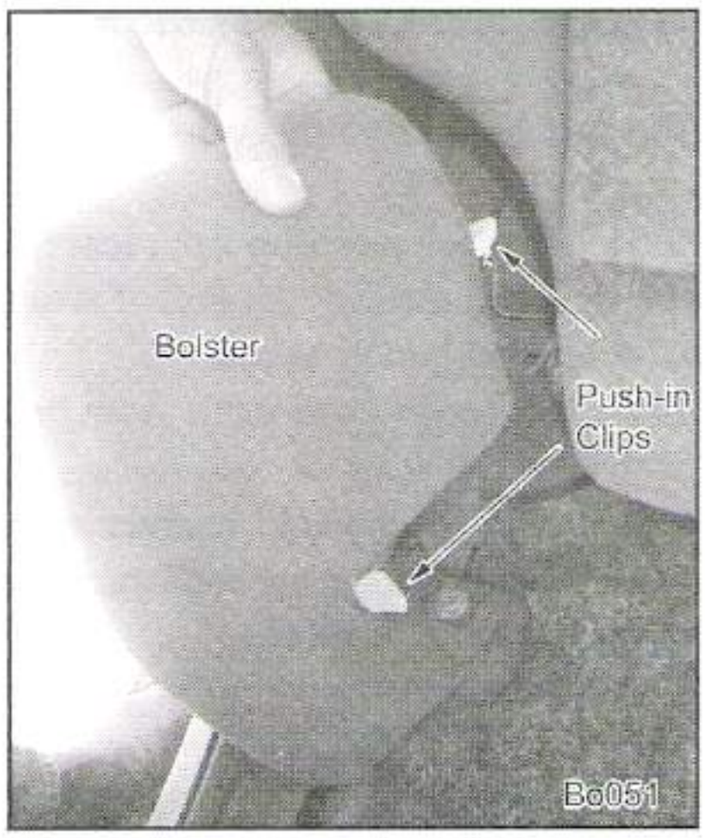
Install

Fit armrest assembly to seat opening, replace 4 bolts securing rear seat armrest to rear seat back rest panel.

REAR SEAT BOLSTER - Station Wagon

Remove

Grip bolstter at base and side, pull bolster straight out to free the bolster from clips.



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Install

Fit bolster into position with clips aligned, push in firmly to lock into position.

REAR SEAT BACK REST (2 Sections) - Station Wagon

Remove

1. Remove the cushion as described.
2. Remove the center seat belt / seat frame attaching bolt.
3. Unlock and lower the rear seat back rest assembly.
4. Remove the bolster cushions each side. Use pliers to squeeze and release each top clip. Remove bolster by sliding forward to release lower guide.
5. The back rest must be lowered, use a screw drivers to release clip on side of back rest.
6. Lift back rest up and pull towards the side of vehicle to release other side from pin.



Install

1. Replace the center back rest into the vehicle, in lowered position, lock in retaining pin on one side, use a screw driver to lever other clip into place.
2. Replace left and right bolster pads, push clip and guide into place.
3. Raise the back rest and lock into place.
4. Install the center bolt and seat belt buckles.
5. Fit the cushion section into place as described previously.

REAR SEAT BACK CATCH - Station Wagon

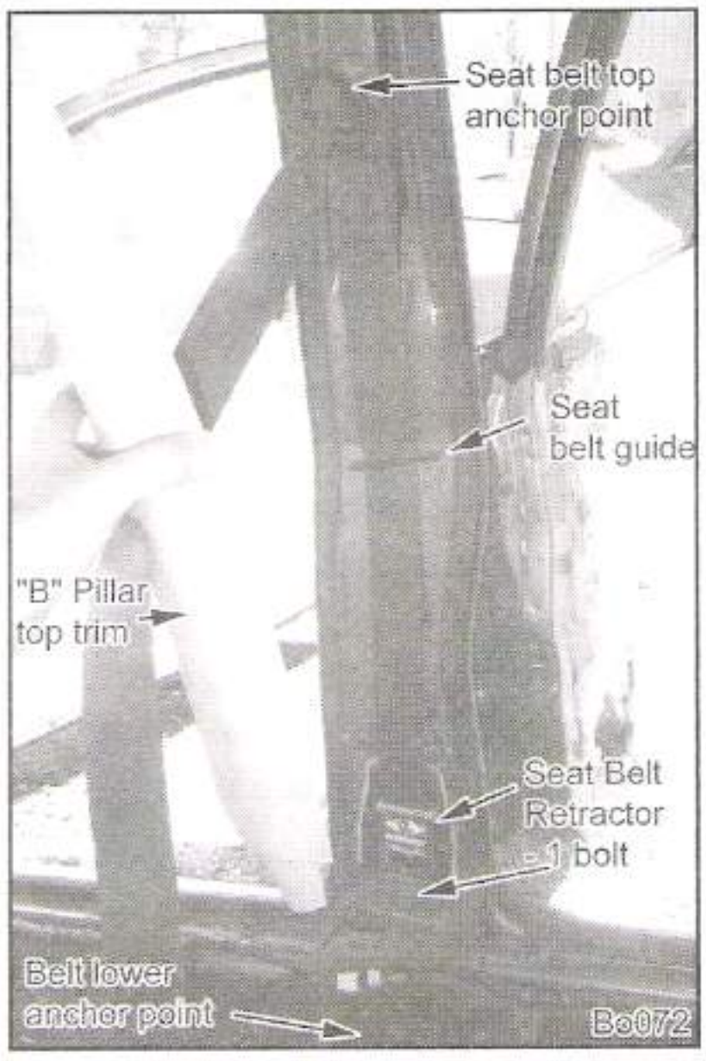
Remove

1. Remove the seat back from the vehicle as previously described.
2. Remove and unclip back covering from seat frame.
3. Use a screw driver in through the end of seat frame to release back rest locking button, two tangs
4. Left side back rest: Lever outer cable from bracket, lift inner cable from lever pin.
Use a screw driver to lever cable retainer and locking actuator from frame, if retaining tangs are damaged the cable and retainer will need to be replaced.
5. Remove the lock actuator from back of seat back rest, drill out 4 pop rivets.
6. Use a hex key to remove the lock link 2 screws, slide lock link from seat frame.

Install

1. Slide lock link from seat frame, use a hex key to fix the lock link 2 screws into place.
2. Replace the lock actuator to back of seat back rest, 4 pop rivets.
3. Left side back rest: Replace cable to lever, position inner cable over lever pin, position outer cable into bracket.
Push the cable retainer into locking actuator of frame, if retaining tangs are damaged the cable and retainer will need to be replaced.
4. Push locking button into seat frame.
5. Replace back rest covering.
6. Install back rest to vehicle.

FRONT SEAT BELT and RETRACTOR, BUCKLE (Check "Internal Trim" this chapter)



Remove

1. Remove the seat outer rail cover as described earlier.
2. Remove the lower anchor, plastic bolt cover from the bolt securing the seat belt to centre pillar, remove the bolt and belt upper support.
3. Remove seat belt buckle and tensioner, disconnect wiring connector, adjust seat back as far as possible remove the attaching bolt to the frame.
3. Remove the scuff panel at doorway, plastic centre (B) pillar lower trim. Remove pillar upper trim 3 screws, carefully remove centre pillar trim, feed belt and lower anchor through trim. Remove the top anchor guide, 1 bolt.
4. Remove the seat belt retractor by removing the attaching bolt to the centre pillar. Remove the retractor and belt.

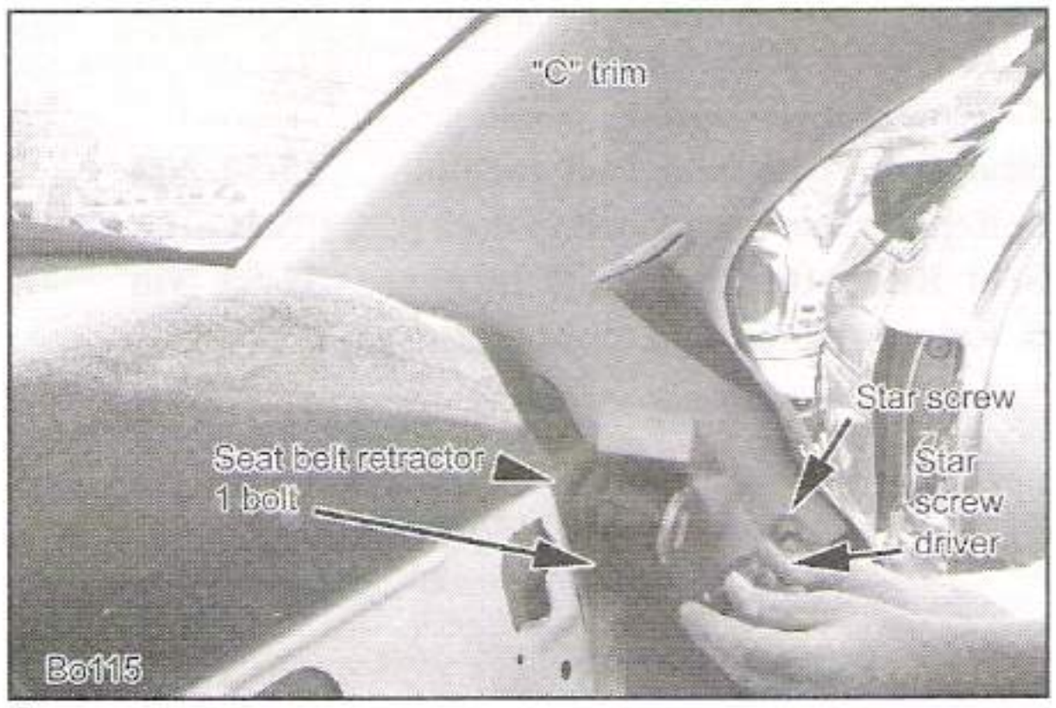
Install

1. Install bolt securing front seat belt retractor to centre pillar.

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Seat Belt Attaching Bolts torque: 35-50 Nm
2. Replace top anchor / guide, 1 bolt.
Seat Belt Attaching Bolts torque: 35-50 Nm
3. Replace centre pillar trim. Replace sections of front and rear door windlacing and seal adjacent to centre pillar lower trim. Replace pillar trim retainers.
4. Replace bolt and seat belt lower anchor, 1 bolt, replace cover.
Seat Belt Attaching Bolts torque: 35-50 Nm
5. Replace seat belt buckle and tensioner, connect wiring connector, 1 bolt to the frame.
Seat Belt Buckle Bolt torque: 45 Nm

REAR SEAT BELT AND BUCKLE - Sides - Sedan (Check "Internal Trim" this chapter)

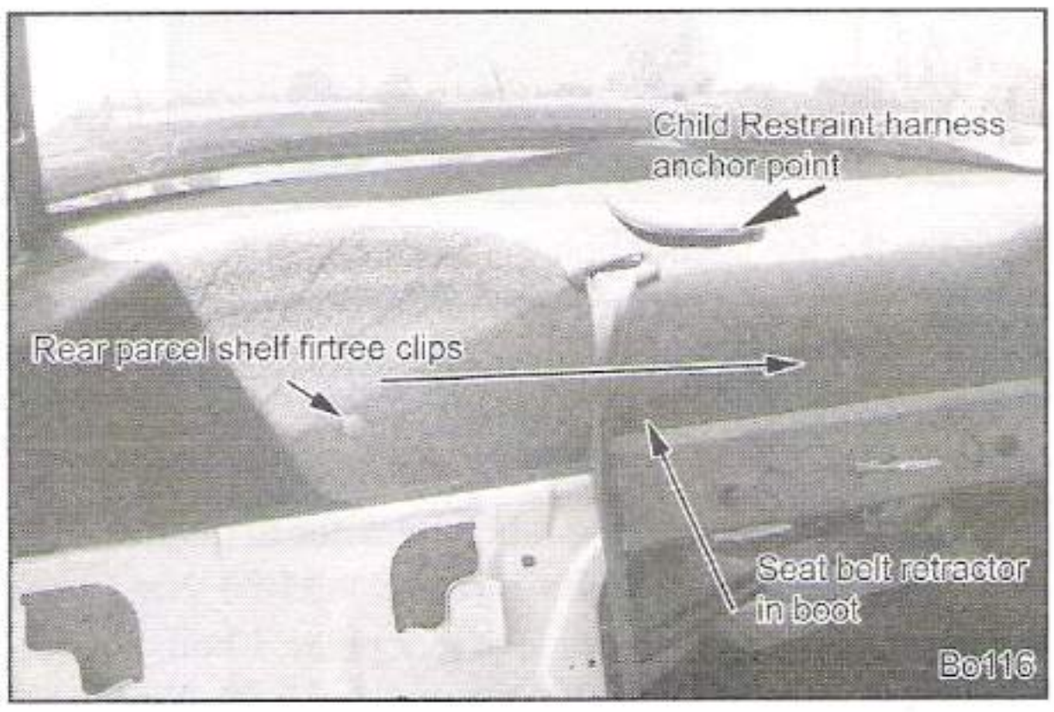


Remove
1. Remove rear seat cushion and bolster as described.
2. Remove bolt securing rear seat belt buckle and belt to the floor pan of the vehicle.
3. Remove the plastic belt escutcheon from the "C" pillar trim, 2 screws in grip handle, 1 screw in "C" trim, then gently prise away with small screw driver.
Feed belt and anchor through "C' trim if necessary.
Remove the top anchor bolt.
4. Remove the seat belt retractor assembly from the quarter panel, 1 bolt. Remove the belt and retractor from the vehicle.
5. Remove buckle and anchor bolt.
Install
1. Replace bolt securing seat belt retractor to quarter
Seat Belt Attaching Bolts torque: 35-50 Nm
2. Replace top anchor / guide to rear pillar, 1 bolt.
Seat Belt Attaching Bolts torque: 35-50 Nm
3. Feed belt lower anchor and escutcheon through "C" pillar trim.
Replace "C" pillar trim and escutcheon to trim.
4. Replace seat buckle belt to floor pan, 1 bolt.
Seat Belt Attaching Bolts torque: 35-50 Nm
3. Replace rear seat cushion and back assemblies as described above.

REAR SEAT BELT & BUCKLE - Center-Sedan

There is a child seat anchor point in the rear parcel shelf, under a cover. (Remove nut from inside boot)

Remove
1. Remove rear seat cushion as described.
2. Remove bolt securing rear seat belt buckle and belt to the floor pan of the vehicle.
3. Remove the lower anchor, 1 bolt.
4. Unlock and lower seat back rest.
Remove the plastic belt escutcheon from the parcel shelf trim
Remove the parcel shelf trim as described in "Interior Trim".
Feed belt escutcheon, belt and anchor through parcel shelf trim.
5. Remove the seat belt retractor assembly from the parcel shelf panel, 1 bolt, remove belt and retractor from the vehicle.

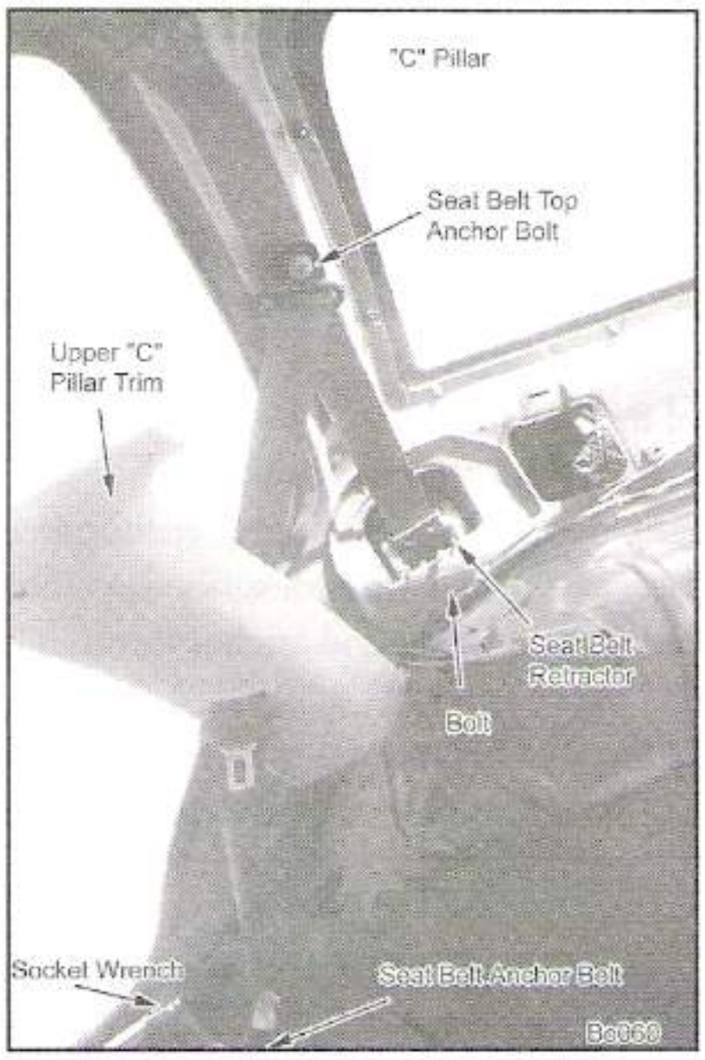


Install
1. Replace bolt securing seat belt retractor to parcel shelf panel.
Seat Belt Attaching Bolts torque: 35-50 Nm
2. Feed belt lower anchor and escutcheon through parcel shelf trim.
Replace parcel shelf trim and escutcheon to trim.
3. Replace lower anchor, 1 bolt.
Seat Belt Attaching Bolts torque: 35-50 Nm
4. Replace seat buckle belt to floor pan, 1 bolt.
Seat Belt Attaching Bolts torque: 35-50 Nm
5. Raise back rest and replace rear seat cushion.

REAR SEAT BELT AND BUCKLE - Sides - Station Wagon (Check "Internal Trim" this chapter)

Remove
1. Remove rear seat cushion and bolster as described.
2. Remove bolt securing rear seat belt buckle and belt to the floor pan of the vehicle.
3. 1) Remove the "C" pillar lower trim, 1 screw.
2) Remove back quarter window lower trim..
3) Remove the plastic belt escutcheon from the "C" pillar trim, 2 screws then gently prise away with small screw driver..
Feed belt and anchor through "C' trim if necessary.

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Remove the top anchor bolt.
4. Remove the seat belt retractor assembly from the quarter panel, 1 bolt. Remove the belt and retractor from the vehicle.
5. Remove buckle and anchor bolt.

Install

1. Replace bolt securing seat belt retractor to quarter
Seat Belt Attaching Bolts torque: 35-50 Nm
2. Replace top anchor / guide to rear pillar, 1 bolt.
Seat Belt Attaching Bolts torque: 35-50 Nm
3. Feed belt lower anchor and escutcheon through "C" pillar trim.
Replace "C" pillar trim and escutcheon to trim.
4. Replace seat buckle belt to floor pan, 1 bolt.
Seat Belt Attaching Bolts torque: 35-50 Nm
3. Replace rear seat cushion and back assemblies as described above.

REAR SEAT BELT & BUCKLE - Center- Station Wagon

Remove

1. Remove rear seat cushion as described.
2. Remove bolt securing rear seat belt buckle and belt to the floor pan of the vehicle.
3. Remove the lower anchor, 1 bolt.
4. Unlock and lower seat back rest, remove if necessary.
Remove the back rest cover and pad.
Remove the top guide, 2 bolts, feed belt and anchor through guide.
Remove the seat belt retractor assembly from the back rest frame, 1 nut, remove belt and retractor from the seat.

Install

1. Replace nut securing seat belt retractor to seat frame.
Seat Belt Attaching Bolts torque: 35-50 Nm



2. Feed belt lower anchor and belt through top guide.
Replace top guide to seat trim, 2 bolts.
Seat Belt Guide Bolts torque: 20-22 Nm
3. Replace seat back rest.
4. Replace lower anchor, 1 bolt.
Seat Belt Attaching Bolt torque: 35-50 Nm
5. Replace seat buckle belt to floor pan, 1 bolt.
Seat Belt Attaching Bolts torque: 35-50 Nm
6. Raise back rest and replace rear seat cushion.

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INTERIOR TRIM

Subject	Page
Headlining Trim	361
Quarter Window Trim Panel - Sedan	362
Rear Parcel Shelf	362
side Scuff Panels	362
Front Side Kick Panels	362
Station Wagon Rear Trim	363
Hand Grip	364



HEADLINING and INTERNAL TRIM

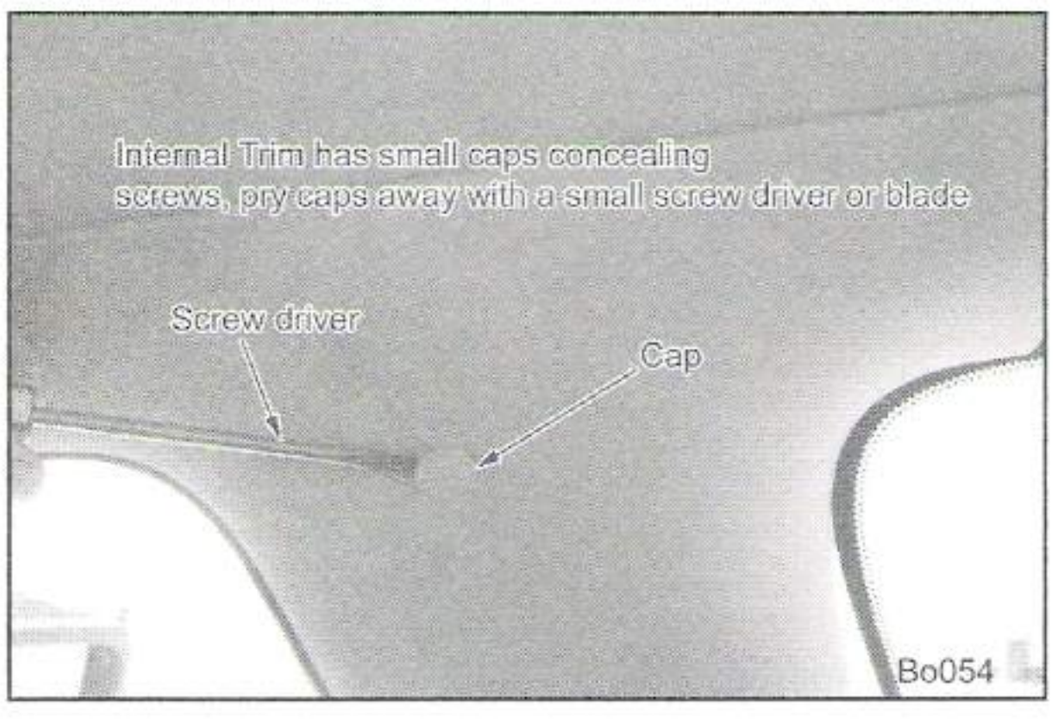
Check this section for detailed procedures for some of the trim panels

Remove

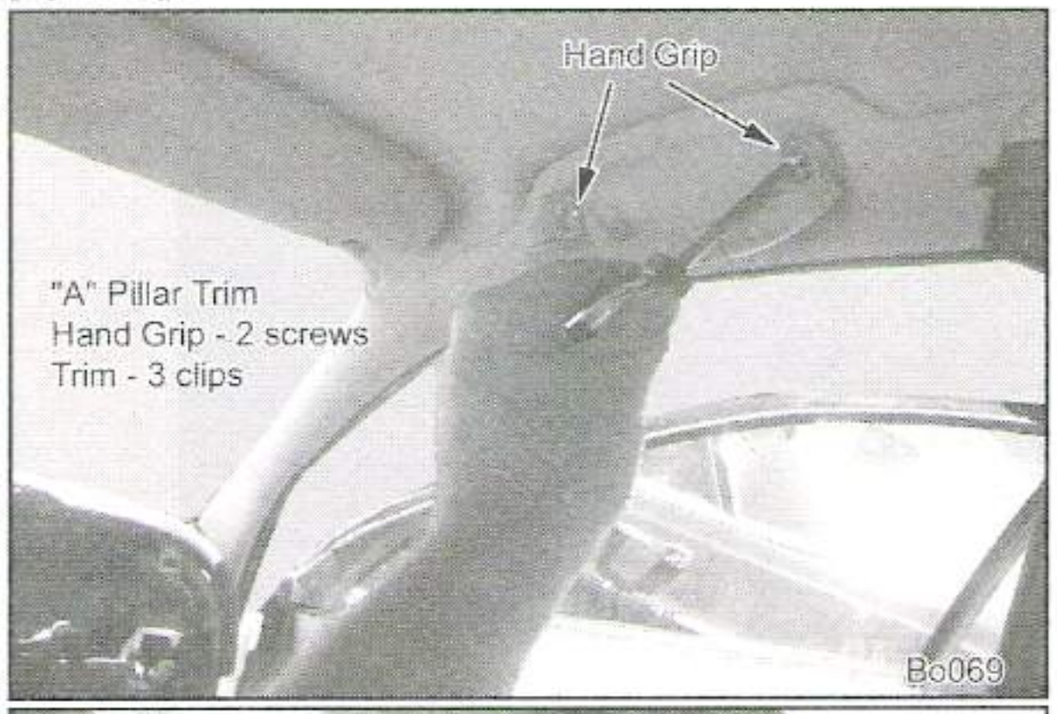
1. Remove the scuff panels from each side..
2. Remove the centre ("B") pillar moulding, lower trim 2 clips, top trim 3 screws..



3. Remove the centre ("B") pillar moulding, top trim 3 screws.



4. Remove the "A" pillar trim, hand grip (2 screws), 3 clips, pry away.





5. Remove the sun visors, and supporting grips attached to the roof.



6. Remove the internal roof light, disconnect wiring connector.
7. Adjust the seats so that both front seat backs are in the reclined position.
8. Sedans: Pry off the back trim above rear window, 4 clips.

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9. Remove the rear quarter "C" pillar trim, 1 scrivet, 5 clips.
Station Wagon: Pry off the back trim near tailgate, 4 clips.
Remove "C" pillar small trim, 2 screws 1 clip.



Remove top "C" pillar trim, 1 screw, 6 clips.
Remove side window lower trim, 1 screw, 4 clips.
Remove "D" pillar trim, 1 screw, 6 clips.
9. Sedan: Open front passenger and rear drivers side doors, work around the head lining, ease down and out rear door.
Station Wagon: Remove fir-tree fasteners, lower head lining, remove through tailgate opening.

Install

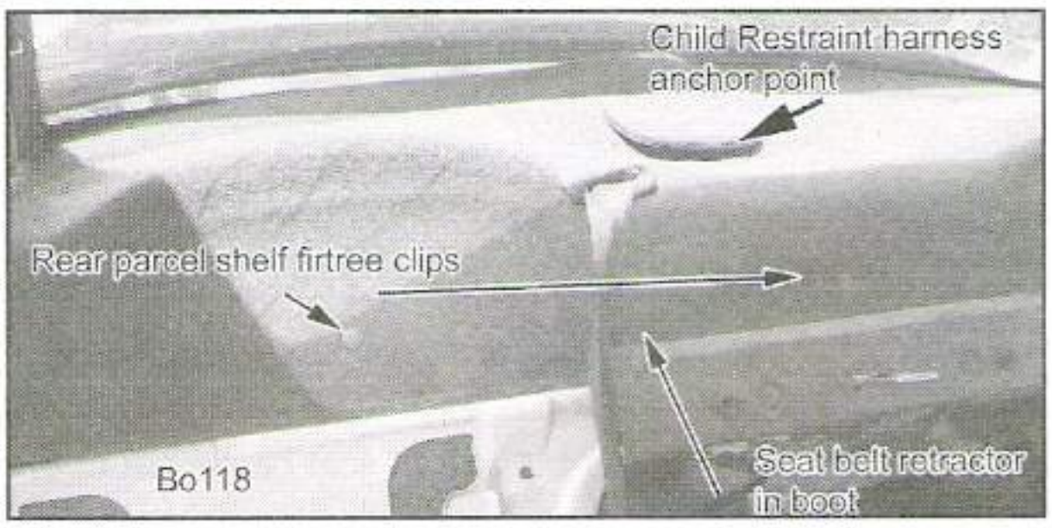
Install taking note of the different procedures.

QUARTER WINDOW TRIM PANEL - Sedan

Check earlier under "Head Lining and Trim" and "Rear Seal Belt" section.

REAR PARCEL SHELF

Check "Rear Seat Belt" section.



Remove

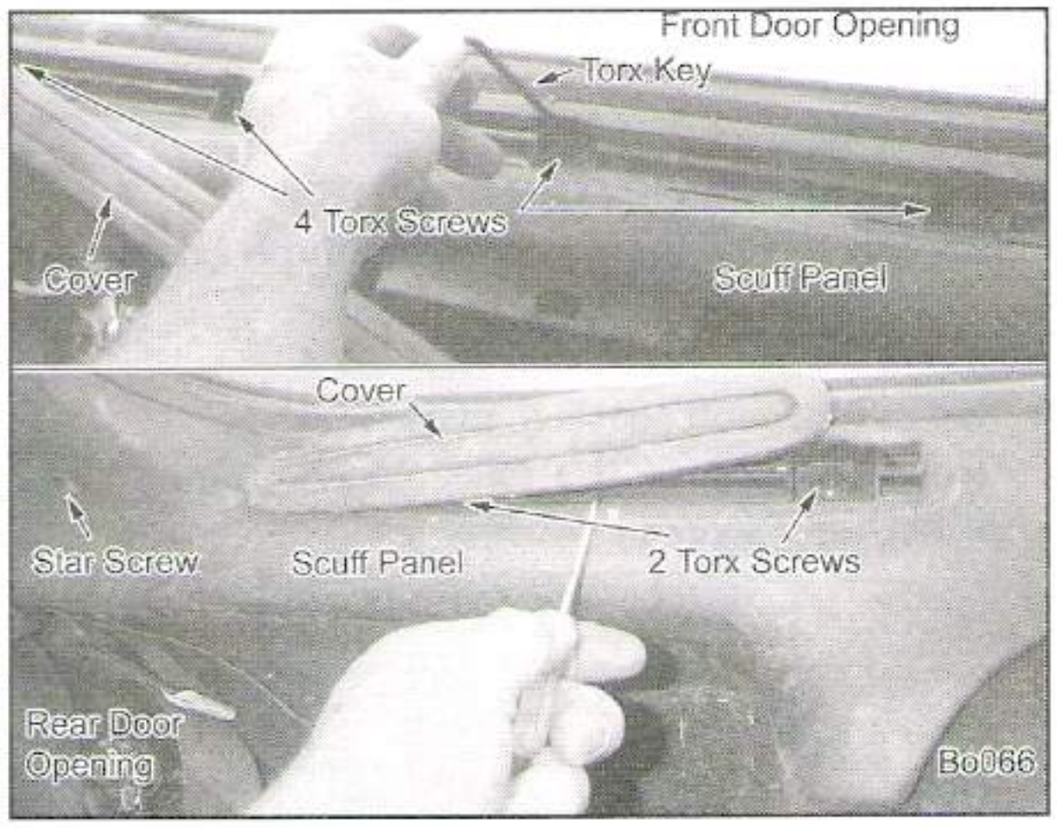
1. The rear seat cushion and back rest as described in this chapter.
2. Remove the child seat anchor point, (nut inside boot).
3. Remove the 3 screws and 2 fir-tree clips, (The fir-tree clips may come out as lifting parcel shelf trim, but take care).
4. Feed seat belt and anchors through trim..

Install

1. Position parcel in place, feed seat belt and anchor through the trim.
2. Push in the 2 fir-tree fasteners, install 3 screws.
3. Install child seat anchor.

SIDE SCUFF PANELS

Remove



1. Pry out covers with a sharp tool or screw driver.
2. Remove the 6 torx screws and 1 star screw.
3. Remove the side scuff covers

Install

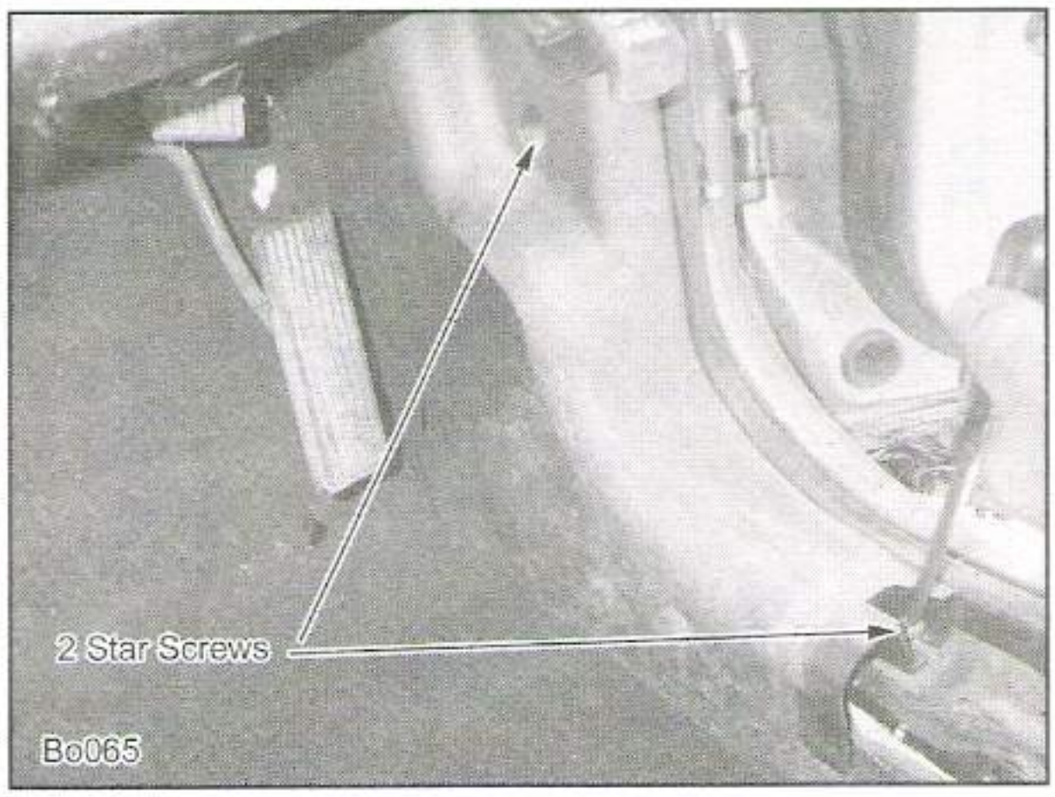
1. Position the side rocker cover in position.
2. Install the 6 torx screws and 1 star screw, push in covers.

FRONT SIDE KICK PANELS

Remove

1. Remove the 2 screws. (The side rocker panel will need to be removed for acess to one of the screws).

Install



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1. Position the side kick panel into place.
2. Install the 2 screws.

STATION WAGON REAR TRIM

Remove

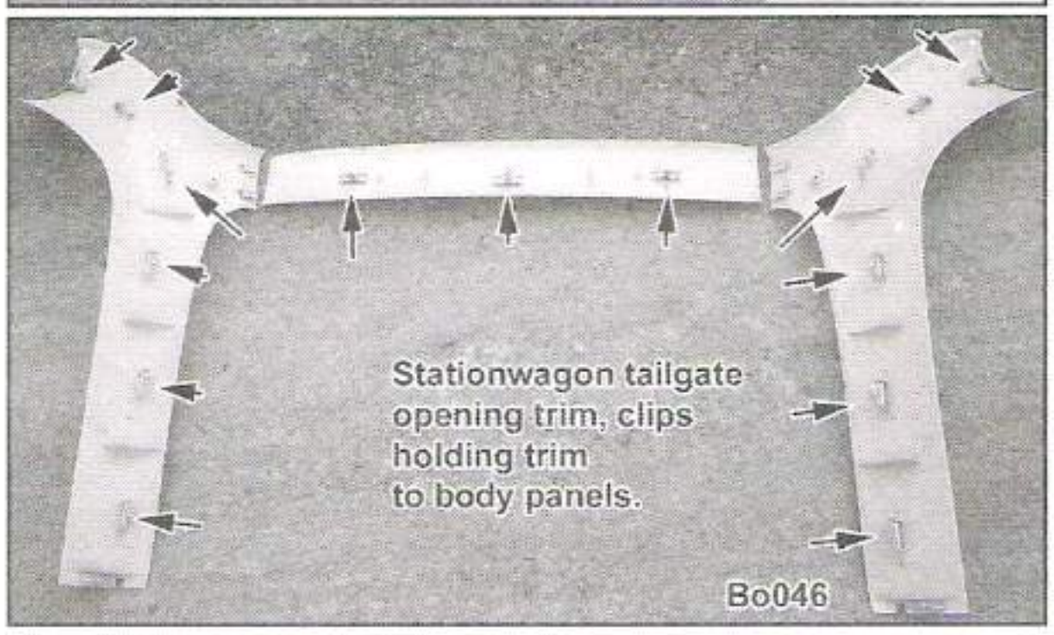
Carpet:

Lift to remove the carpet.

Tailgate opening.

Trim is in 3 sections start at side trim and lever away from body, pull out to unclip.





Rear Quater Window Lower Trim:

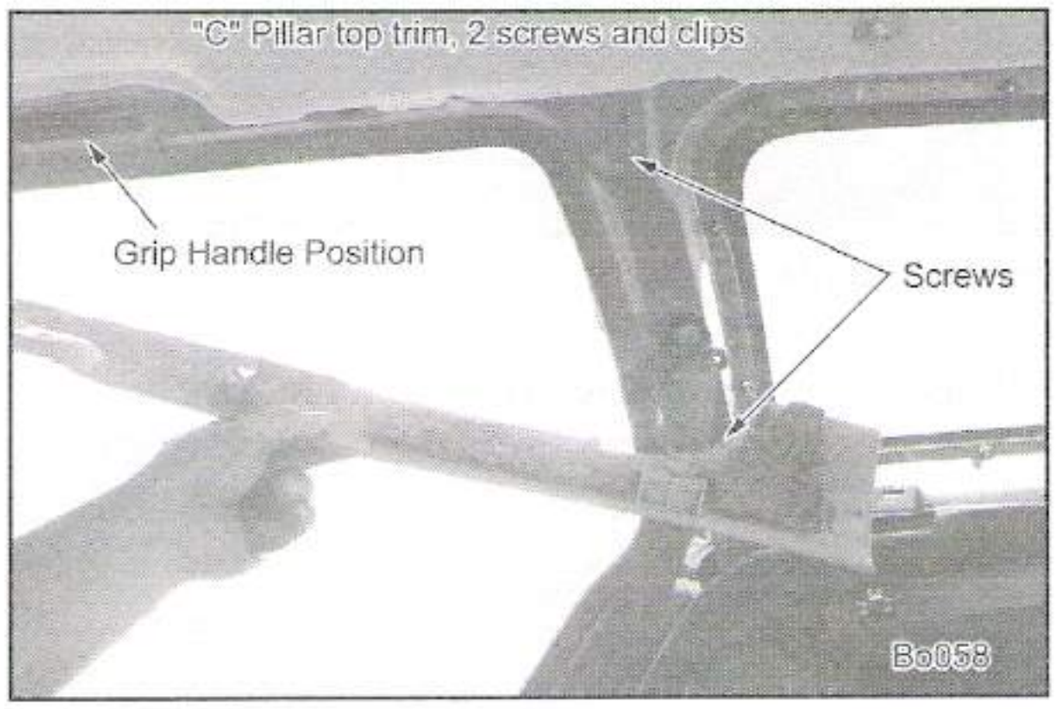
Remove the rear quarter window lower trim, 2 screw, 4 clips

Rear Quater Window Lower Trim:

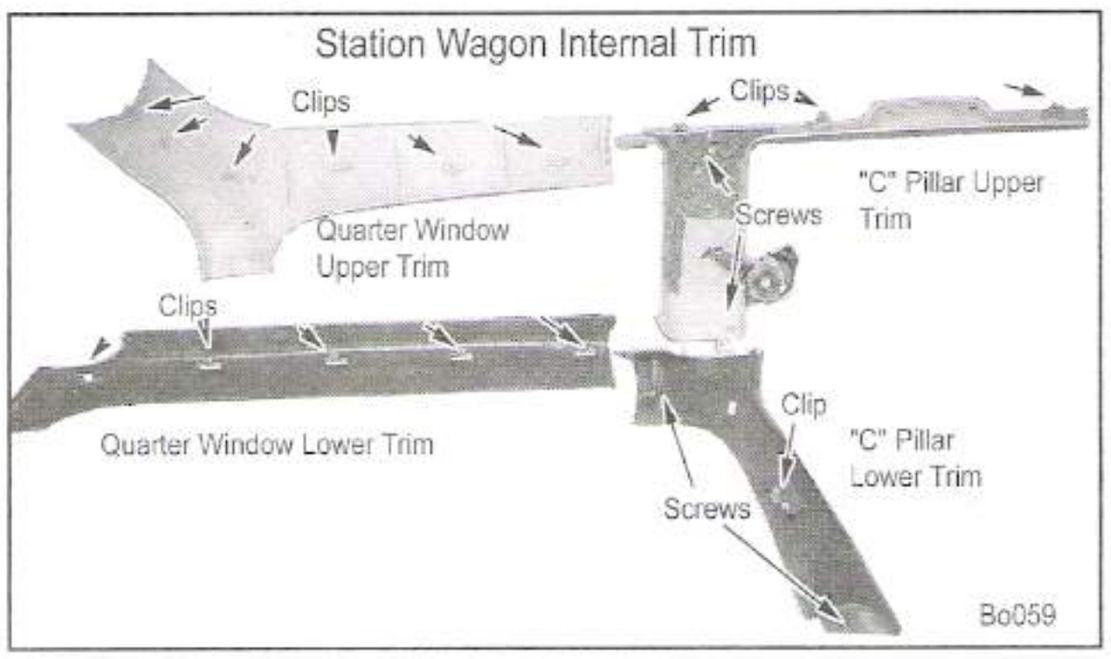
Remove the rear side trim, 7 fasteners.

Rear "C' Pillar:

1. Remove back quarter window lower trim..
2. Remove the "C" pillar lower trim, 2 screws.
3. Remove the "C" pillar top trim, remove grip handle 2 screws, 2 screws then gently prise away with small screw driver..

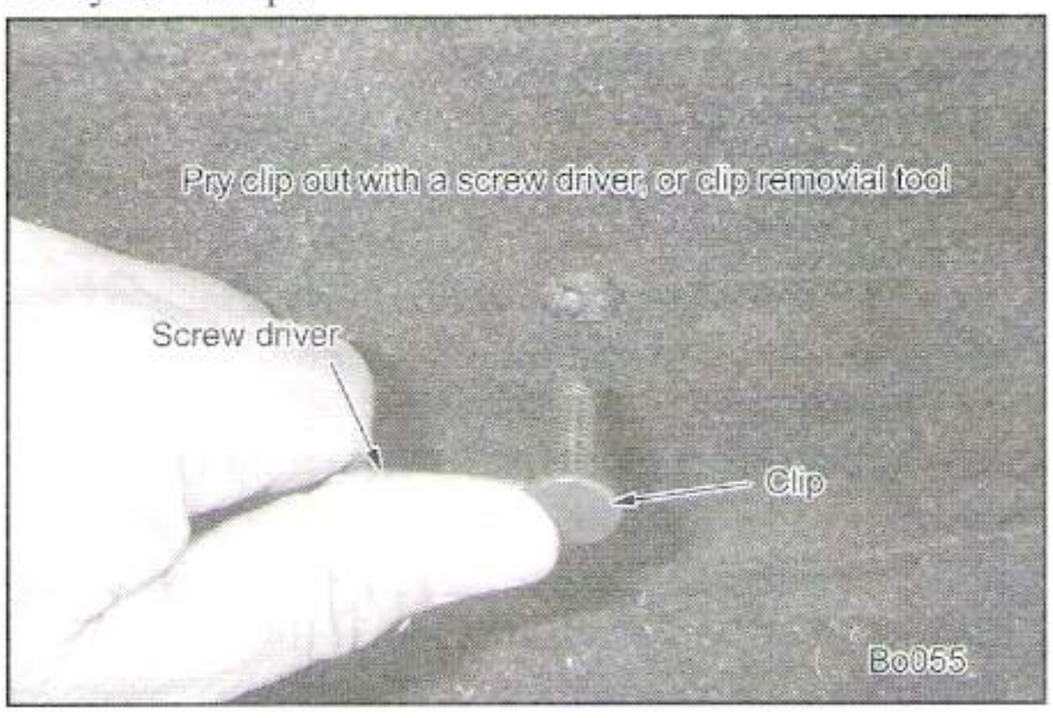


Feed belt escutcheon, belt and anchor through "C' trim. Remove the top anchor bolt.



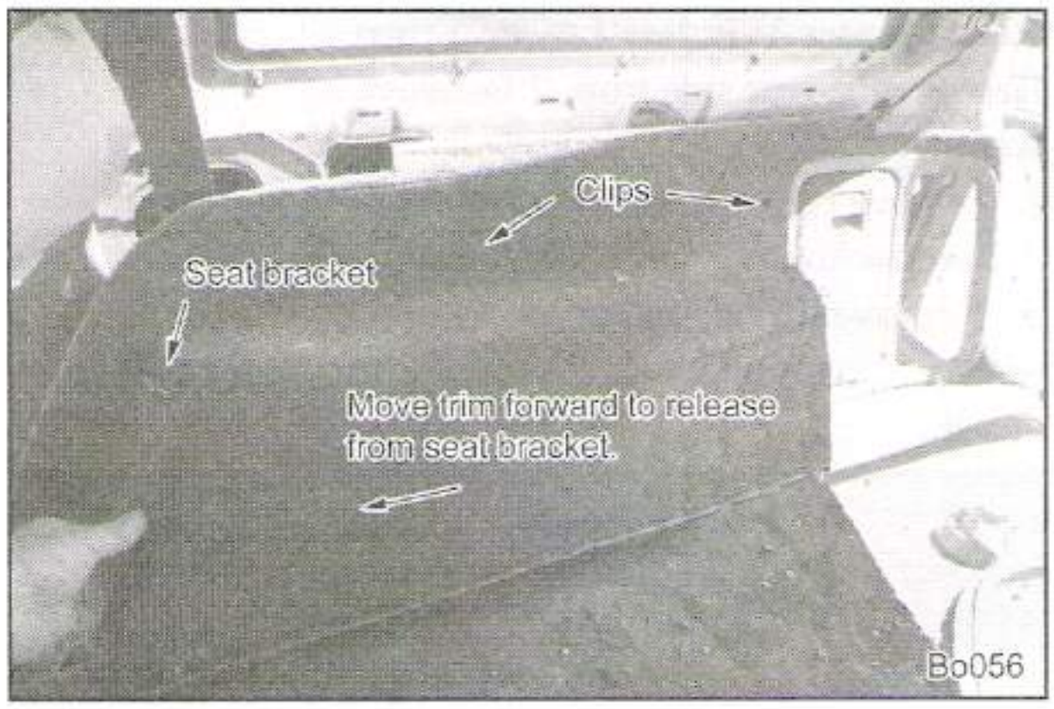
Rear Side Trim:

1. Fold down rear seat, lift back carpet section.
2. Pry out 2 clips.



3. Move side trim forward to move past rear seat positioning bracket.

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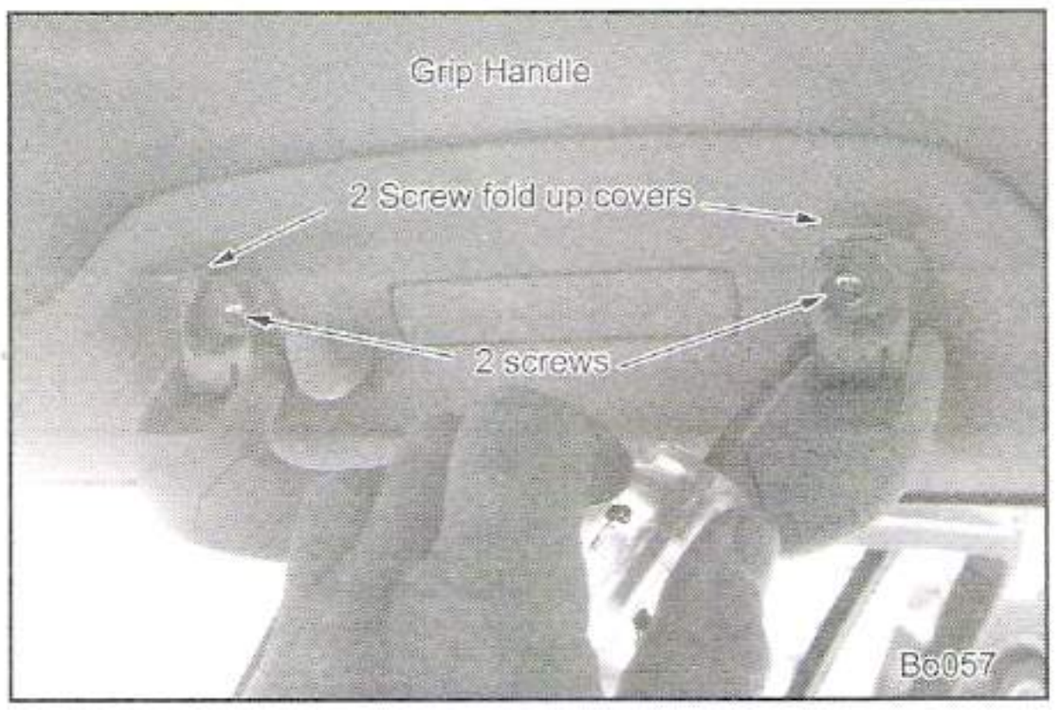


1. Installation of the carpet assembly involves lifting the front and rear of the carpet to get the correct location of the carpet edges and firm pressing down on the carpet to obtain correct location.
2. Sedans, replace the shock absorber covers, push on fit.
3. Replace the weather strip and retainers to fix the carpet on the boot floor and sides.

HAND GRIP

Remove

Lift the 2 screw covers, remve 2 screws remove grip.



Install

Postion handle, install 2 screws, fold down screw covers.

FLOOR CARPET - INTERNAL

Remove

1. Remove the transmission console as described above.
2. Remove the front seat assemblies and rear seat cushion assembly.
3. Remove the side panel covers and foot rest.
4. Lift carpet taking care not to damage carpet as sealant will need to be worked free.

Install

1. Use a suitable sealant to fix carpet into place, carefully replace carpet.
2. Install seat assemblies as described in seat section.
3. Install centre console as described above.

CARPET - BOOT / STATION WAGON REAR

Remove

1. Lift the weather strip to free the carpet on the boot floor.
2. Sedans, pry the shock absorber covers off.
3. Remove any carpet retainers with a large flat screw driver
4. Lift the front and rear of the carpet during removal taking care not to damage the carpet or body.

Install

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PAINT & EXTERIOR BADGES

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Trim and Mouldings	366

BODY MAINTENANCE

EXTERNAL PAINT

Acrylic Enamel Paints

This range of paints have a harder surface, and hold a higher gloss surface for metallic colours than the ordinary enamels, provided the paint surface is maintained. This enamel also has the property of good smoothness.

Below are repair guide lines for acrylic enamel paints:

Polishing Paint:

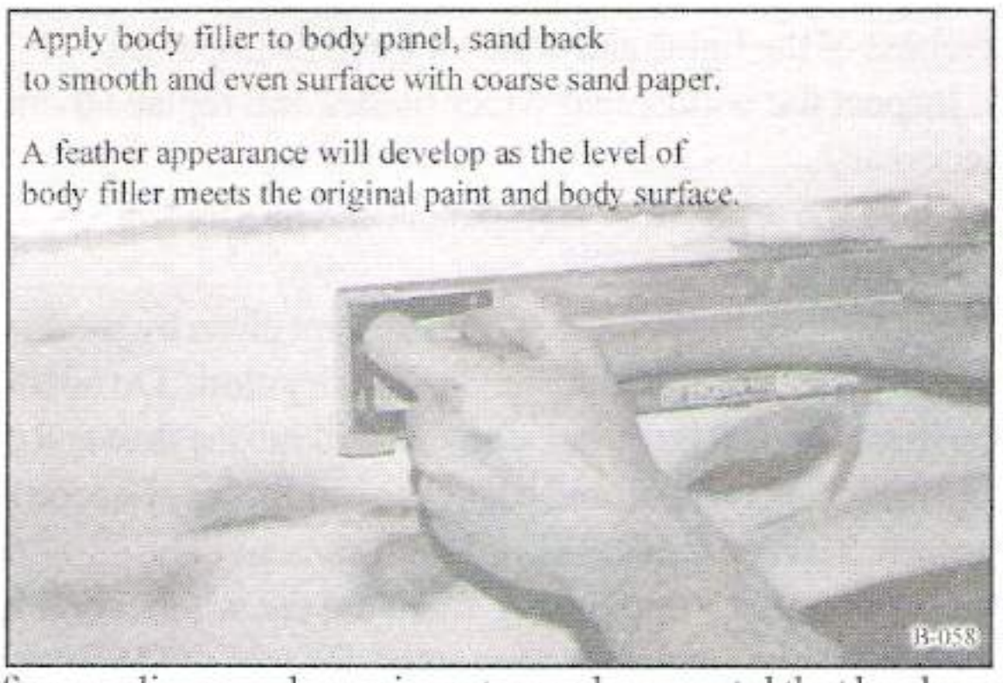
Minor paint runs, scratches, dry over spray and orange peel can be eradicated by machine or hand polishing or by both sanding and polishing without the necessity of repainting. If repairing this type of defect treat the entire panel as, spot repairs will leave a blemish appearance and should be attempted only in areas that do not have large areas of paint. When polishing follow the guide lines below. Lightly sanding using 1200 wet and dry paper with water or mineral spirits as a lubricant removing the defect. Using a brush apply medium grit machine polishing compound to the painted surface. Use a polisher or drill and polishing wheel and woollen pad, polish the entire panel, do not hold the polisher in the one position as this will leave cut marks in the paint surface. Change woollen pad, then with a clean lambs wool pad buff the entire panel. Acrylic enamel paints need a light polishing to improve their gloss, as age and weathering can remove the lustre from the paint surface.

Painting Panels:

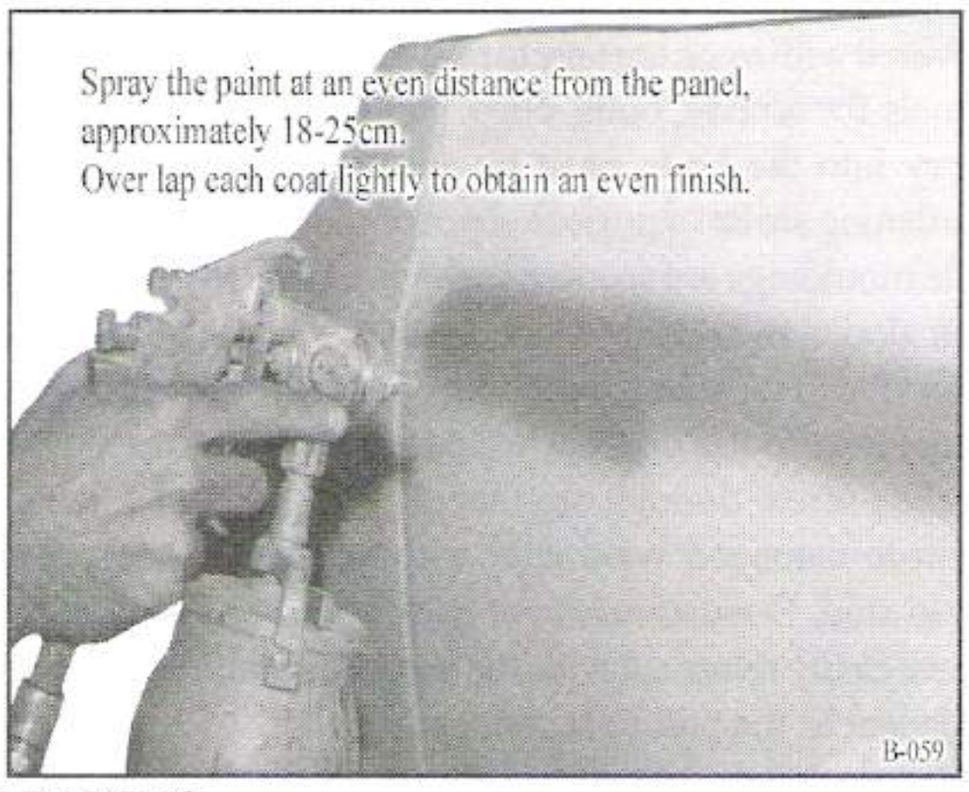
Painting with either conventional air drying or low bake enamels, or with acrylic lacquers acrylic enamels can be used to repair damage to panels. Often a better colour match can be obtained by repainting metallic colours with acrylic lacquer, both the original paint surface and the repaired surface can be polished at the same time to provide a good surface. Air dry acrylic lacquer will provide better service-ability than air dry enamels. "Remove wax, polish or grease with a silicone remover when using any one of the three types of repair materials over acrylic enamel. Using No. 800 grit paper thoroughly sand off the original finish. If trims and mouldings are not removed, care should be taken to ensure that paint surfaces near trim and mouldings, are thoroughly sanded in order to provide adhesion of the repair top coat. Areas sanded to the base metal should be treated with an acid cleaner to give a good surface.



If panels have been damaged, the paint should be removed, the damaged section panel beaten to the correct shape. Body filler and putty are applied, then the repaired section filed and sanded back with coarse paper such as No 120 grit paper to start with. Then use No 360 or 420 grit paper before moving to No 600 grit paper to obtain a good finish.



After sanding, apply a primer to any bare metal that has been exposed. Sand the primer surfaces with No. 800 wet and dry paper with water before applying paint. The lacquer or enamel used should be thinned with thinners as recommended by the supplier of the paint.



CLEANING

Regular maintenance throughout the life of a car, is recommended to help the appearance of the paint surface and the general appearance of the vehicle. The following steps are

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suggested as a guide for regular body maintenance:

1. Wash the car, chamois dry exterior and vacuum the interior thoroughly.
2. Inspect openings for water leaks and seal where necessary. Repair all loose weatherstrips which are still useable.
3. Replace any door or boot lid weatherstrips which are unfit for service. Apply silicone lubricant to the weatherstripping.
4. Replace all cracked, fogged, or chipped glass, the effectiveness of the lights and windows will be impaired.
5. Inspect the windshield wiper blades and replace them if necessary.
6. Clean the seats, door trim panels and headlining.

Exterior Cleaning

The outside of the vehicle should be kept clean by washing. Never wipe the painted surface with a dry cloth. Do not dust the finish when it is dry because this will rub the dust and dirt into the baked enamel, and it leaves a sandpaper effect on the surface. To keep the finish bright and attractive and eliminate the necessity of using polish, wash the car whenever it has accumulated a moderate amount of dirt and road grime.

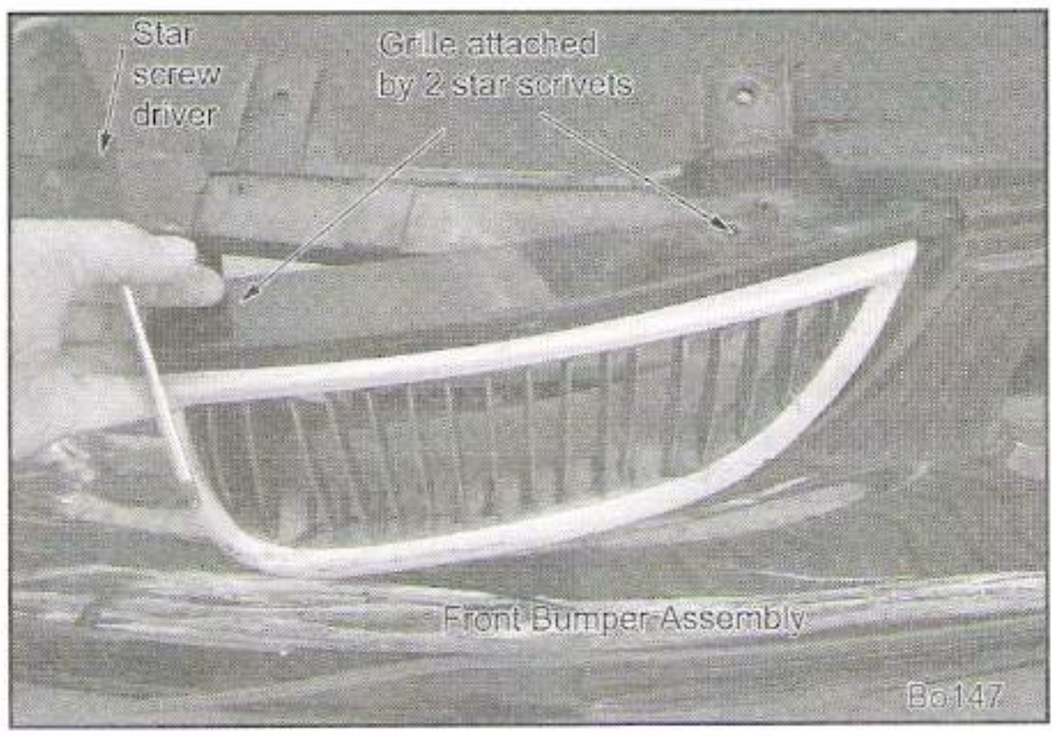
Trim and Mouldings

Trim mouldings and name badges are held into place by clips, fasteners, retainers, bushes, nuts and contact adhesive. When removing or installing exterior mouldings, care should be exercised. Finishes adjacent to the moulding should be covered with masking tape to prevent damage. Holes in body panels for screws, bolts, clips, etc; that could permit water entry into the body must be adequately sealed with non hardening sealer or presealed screws, nuts or clips. The body side mouldings are secured to the front fender and front and rear doors with double sided adhesive tape and urethane adhesive. If replacing moulding clips drill a small hole in the panel next to the original weld stud location. Insert a self-sealing screw through original clip and into outer panel, or replace damaged weld stud with self-sealing screw-type weld stud. Bonded adhesive nameplates and emblems are more easily removed with the use of heat lamps positioned adjacent to the part to be removed.

* Ensure that the heat lamps are not too close or the heat too intense to adversely effect paint finish. When installing these adhesive bonded trims and mouldings to the panel, thoroughly clean the panel and ensure the panel temperature is at least 21 degrees Celsius otherwise the bonding may not be satisfactory.

FRONT GRILLE

Front Grille



* Executive, Berlina, Calais & Utility models have the grille mouldings incorporated into the bumper assembly

Remove

1. Lift the bonnet open.
2. Remove the 4 screws at top of the grille moulding.
3. Lift two piece grille trim away from bumper moulding.

Install

1. Position the grille insert or inserts into bumper bar between the head lights, push grille inserts firmly into place.
2. Replace the two small bolts at the top of the grille insert.
3. Close the bonnet.

Front Grille Statesman and Caprice

* Statesman and Caprice models have the grille mouldings incorporated onto the bonnet assembly

Remove

1. Lift the bonnet open.
2. Remove 7 nuts attaching front grille to grille bracket.

Install

1. Install the front grille to the grille bracket, install and tighten the 7 nuts.
2. Close the bonnet and check for clearance of grille.

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FRONT FENDERS & BONNET

Subject	Page
Front Fender	411
Bonnet	411
Bonnet Locking Centralising Pin	412
Bonnet Secondary Catch	412
Bonnet Release Cable Assembly	427

The floor pan and cabin, is welded together to make a very strong structure, therefore front and back panels are either bolted or welded to this structure.

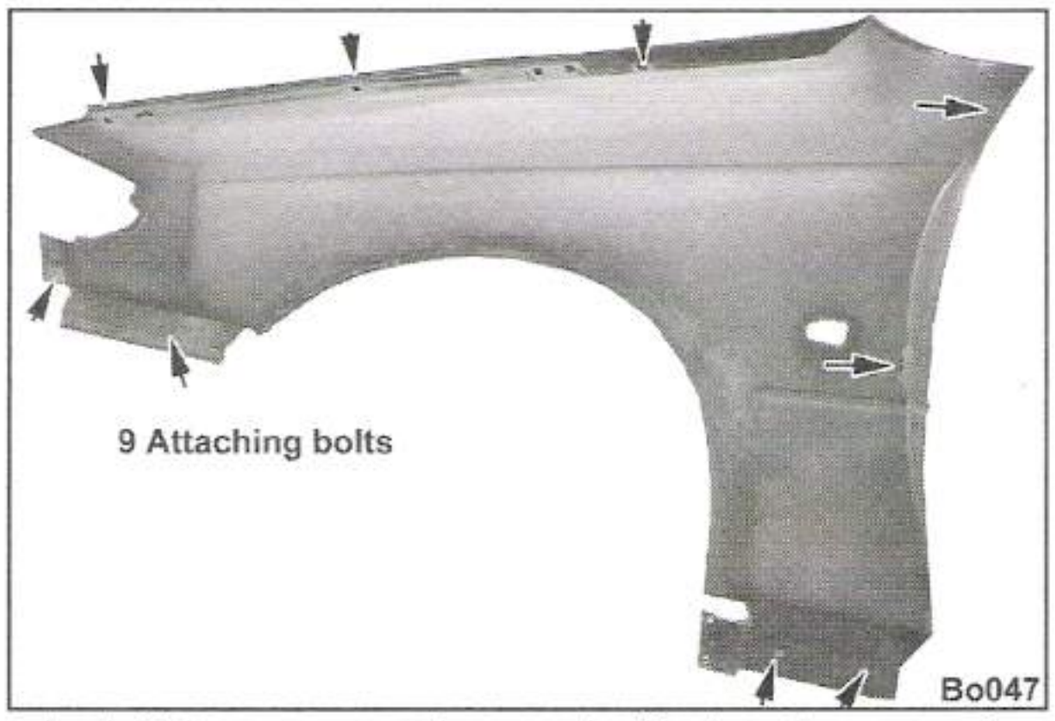
Panels that are attached to the front consist of engine bonnet, front fender and front end panel, into which, headlights are fitted. The engine bonnet assembly is hinged from the fire wall and is supported in open position by two gas operated struts.

The bonnet lock release lever, mounted beneath the right hand side of the instrument panel, controls the bonnet lock release spring. The engine bonnet, when released from the locked position, engages a secondary safety catch which can be released by inserting fingers beneath the leading edge of the engine bonnet.

FRONT FENDER - same for Statesman / Caprice.

Remove

1. Remove the 4 screws and 2 plastic split screws attaching the front fender liner, remove the liner
2. Remove the radio antenna if one is fitted.
3. Disconnect lower ends of the bonnet gas struts.
4. Remove the front bumper bar assembly.
5. The front fenders are attached by 9 self tapper bolts. 3 at top, 2 under front bumper, near front door, 2 behind front



wheel. Take care not to damage the fender when removing.

Install

1. Place the front fender into position insert the bolt and washer assemblies to secure the lower and upper part of the fender then the rear section of the fender. Do not tighten the screws until the fender has been aligned so that it fits into the correct position with the other body panels.
2. Install the front bumper bar assembly.
3. Replace the radio antenna if one is fitted.
4. Replace the front fender liner.



Bonnet - same for Statesman / Caprice.

Remove

1. Lift the bonnet open. For reference when refitting the hinge, mark the hinge position with a felt pen.



2. Place a cover on the front fenders to prevent damage.
3. Disconnect windshield washer tube.
4. Have an assistant to hold bonnet, remove gas struts.
5. Remove the bolts attaching the hinges to the bonnet.
6. Remove the bonnet.
7. If necessary remove hinge from body by removing attaching bolts

Install

1. Replace the hinge. Replace the hinge attaching bolts and tighten to specification.

Hinge to Body bolts torque: 15-20 Nm

2. Install the bonnet to the hinge, taking note of the felt marks made during removal. Install bolts to specification.

Hinge to Bonnet bolts torque: 15-20 Nm

3. Reconnect the hose to the windscreen washer.
4. Take the bonnet safety prop and the protection cover off. Close the bonnet and check alignment. After any necessary adjustments tighten the hinge attaching nuts.

Adjust

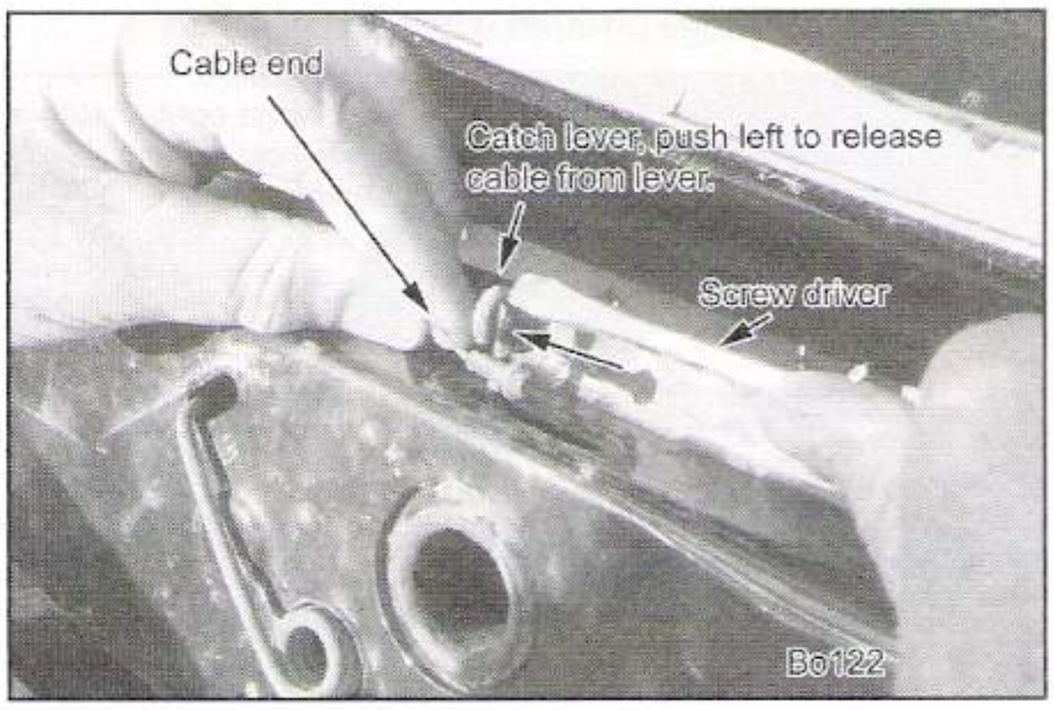
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1. Loosen slightly the hinge to bonnet bolts, gently close the bonnet and check the surrounding edges of the bonnet.
2. There should be an even gap on all sides of the bonnet.
3. If not raise bonnet and firmly but carefully move the bonnet on the hinges, correct the position of the bonnet.
4. Lower bonnet, check clearance gaps, if correct lift bonnet and tighten the bolts to specification.
5. Front height adjust is by 2 adjusters on the bonnet, screw in or out to achieve correct adjustment.

Bonnet Release Cable Assembly - same for Statesman / Caprice.

Remove

1. Pull the bonnet release lever, release the bonnet onto the second catch
2. Remove the right side lick panel as described in "Internal Trim" section.
3. Remove the cable, bracket and lever as an assembly, Pull assembly back to unclip, then pull into vehicle.
4. Lift and prop the bonnet open.
5. Push the bonnet catch back and disengage the cable.



6. Remove the clip bolt and plastic straps securing cable to the front panels.
7. Inside the vehicle pull the outer and inner cable into the vehicle.

Install

1. Feed the outer and inner cable through the fire wall from the inside the vehicle into the engine compartment.
2. Inside the vehicle, connect the cable to the release lever and lever assembly.
3. Install the right side kick panel.
4. At the front of the vehicle, fit the cable to the securing clip and fit new plastic straps, securing the cable to the front end panel assembly.
5. Push the hood catch back and install the cable end fitting.
6. Check the operation of the bonnet catch before closing the bonnet.

Bonnet Locking Centralising Pin

Remove, Adjust or Install

1. Open the bonnet.
2. Loosen the lock nut at the base of the centralising pin (the pin can be screwed out and removed at this stage).
3. If installing a new pin, screw the pin approx 1/4 of the length of the pin, tighten the locknut.
4. Apply a thin coat of grease onto the centre of the end section of the pin, lower centralising pin on to the catch, lift the bonnet and check the catch for location of grease.
5. Loosen the centralising pin lock nut adjust the pin to the correct location, tighten locknut.
6. Repeat steps 4 & 5 until the pin is centralised.
7. Close bonnet fully and check for operation of catch.
8. Check for bonnet height, loosen the centralising pin locknut, screw the pin clockwise or anti-clockwise to adjust the height of the front of the bonnet.

Bonnet Secondary Catch

Remove

1. Remove the retaining pin supporting the catch and spring.
2. Remove the catch taking care not to loose the spring.

Install

1. Replace the spring and catch in the correct position.
2. Install the retaining pin.

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BUMPER BARS

Subject **Page**

Front Bumper Bar 368
Rear Bumper Bar - Sedan 368
Rear Bumper Bar - Stationwagon 369
Rear Bumperette Utility 369

FRONT BUMPER BAR - same for Statesman / Caprice.

Remove electrical connectors from lights if fitted.

Remove

1. Remove the 2 scrivets behind number plate, in top of air duct.
2. Remove the 2 bolts each side in wheel arch.
3. Lift the bonnet, remove the 3 bolts in the radiator support panel.
4. Remove the 2 bolts under the bumper at the front.

S & SS Models: Have a larger moulding on the lower section, with 2 brackets under the front.

Remove the bolts attaching the bumper support bars to the front chassis rail, have an assistant hold the bumper bar.

5. Remove the front bumper bar assembly.

Install

1. Position the front bumper bar assembly onto the front of the vehicle, it may be necessary to use an assistant to hold the bumper bar.
2. Install the bolts attaching the bumper support bars to the front chassis rail, sides and front fender..

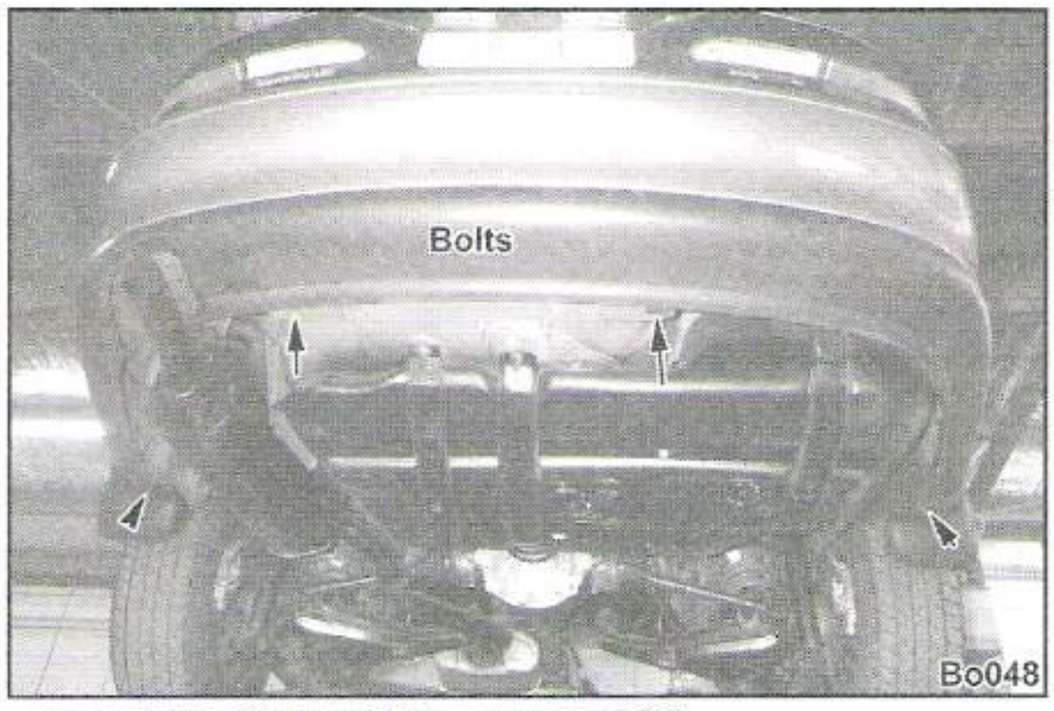
REAR BUMPER BAR - Sedan

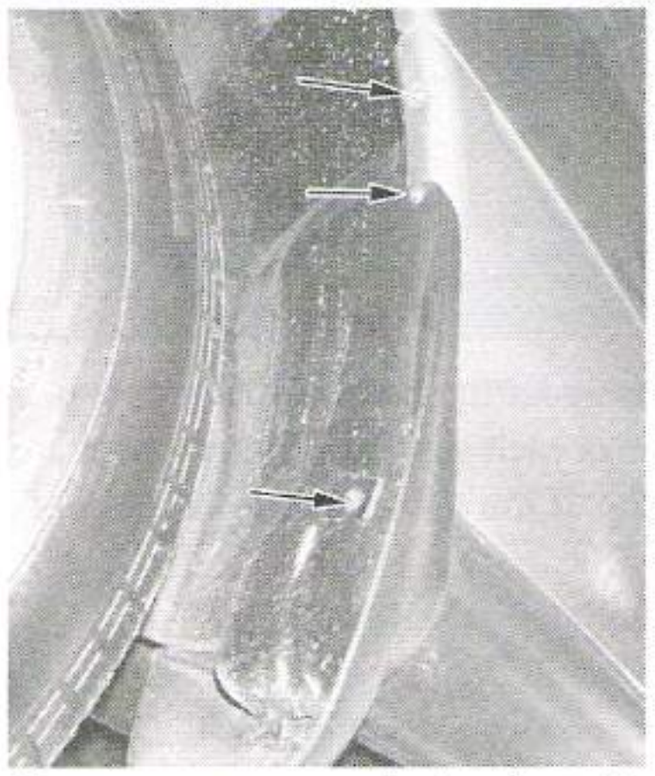
Remove

1. Remove the number plate light from the rear bumper bar with a screw driver. Remove electrical connectors.
2. Remove the bolts attaching the bumper to the body section 2 under bumper, 3 screws at each wheel arch, 1 behind mud flap.
3. Open boot remove boot inner liner each side, remove 2 nuts each side.

Not for Statesman & Caprice: Remove 2 nuts under each tail light from inside boot.

Other bolts nuts inside boot.





4. Boot open, remove the 4 scrivets from boot opening.

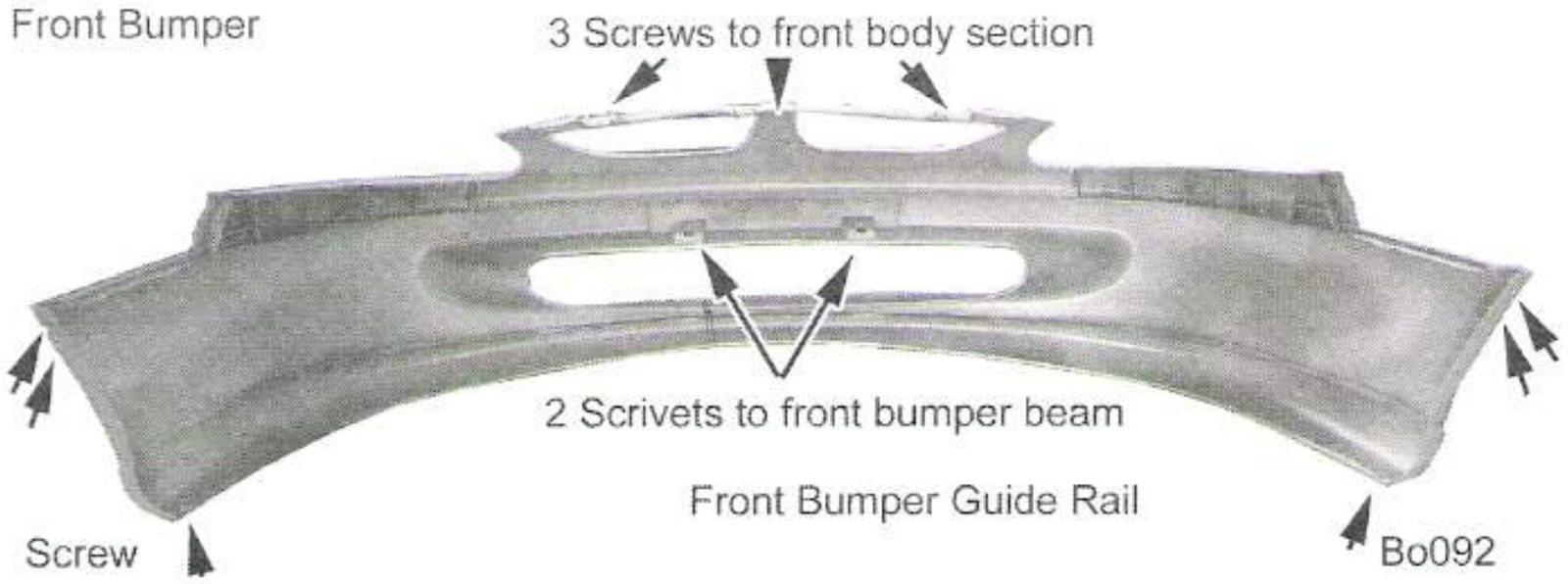
It will be necessary to use an assistant to hold the bumper bar.

S & SS Models: Remove the lower bracket, 4 scrivets.

Remove the bolts from inside wheel arch, 2 each side.

Install

1. Position the rear bumper bar assembly onto the rear of the vehicle, it will be necessary to use an assistant. Push the clips either side onto clip bracket firmly.
2. Remove the bolts attaching the bumper to the body section 2 under bumper, 3 screws at each wheel arch, 1 behind mud flap.
3. Install bolts attaching bumper under the rear of boot. Install the bolt at wheel arch (2) and near boot opening (4).
4. Replace the nuts inside the boot



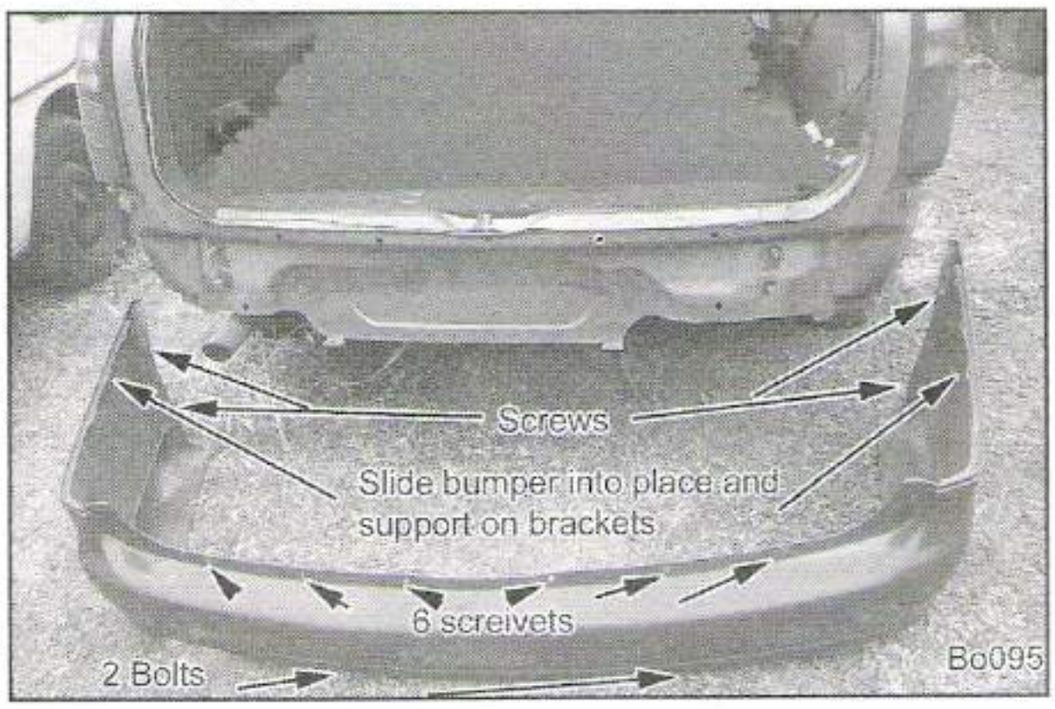
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5. Replace the number plate light to the rear bumper bar, push fit. Replace the electrical connectors.

REAR BUMPER BAR - Station Wagon

Remove

1. Open tail gate, remove 6 scrivets.



2. Remove the 2 bolts under the center of the bumper.
3. Remove the 2 screws each side behind the wheel arch.
4. Slide bumper back off the vehicle with the help of an assistant
5. Remove the rear bumper bar assembly.

Install

1. Position the rear bumper bar assembly onto the rear of the vehicle, it will be necessary to use an assistant to hold the bumper bar.
2. Install the 2 bolts attaching the bumper support bars to the rear chassis panel.
3. Install the 2 screws each side behind the wheel arch.
4. Open tail gate, install 6 scrivets.

REAR BUMPERETTE - Utility

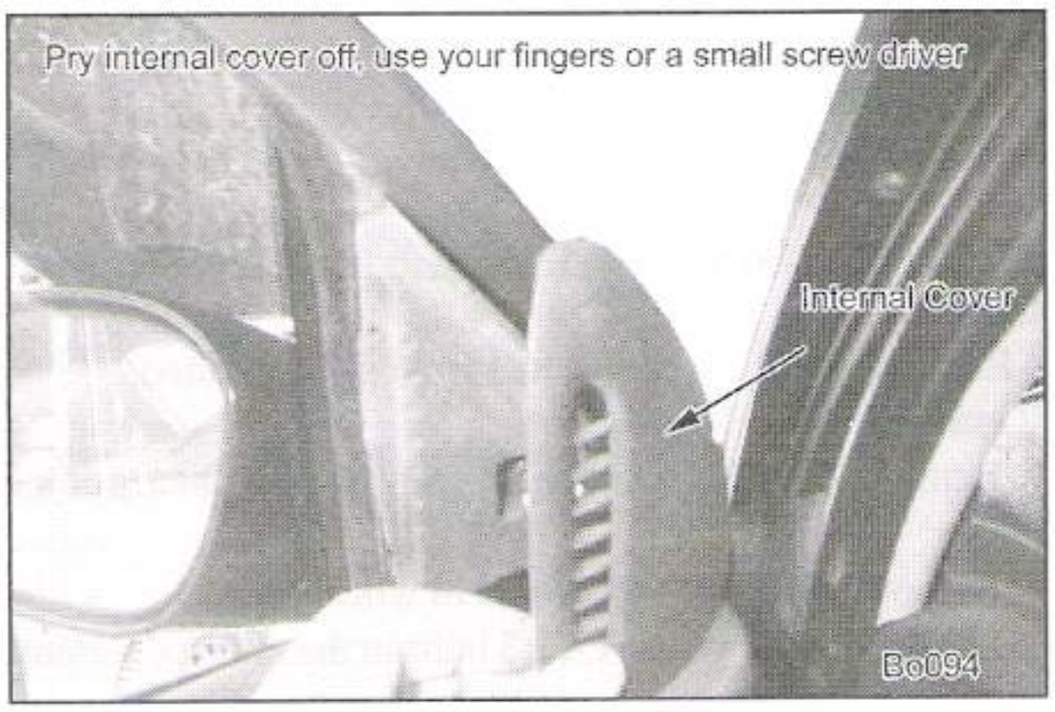
Remove

1. Pry the reflectors away from the bumper to gain access to the bumper attaching bolt.
2. Remove the bolts attaching the bumper. 1 up from the reflector hole. The bolts under bumper, 2 inside wheel arch.
3. Remove the rear bumperette assembly.

Install

1. Position the rear bumperette assembly onto the rear of the vehicle.
2. Install the bolts attaching the bumper. 1 up from the reflector hole. The bolts under bumper, 2 inside wheel arch.
3. Replace the bolt behind reflector, then install reflectors into the bumperette moulding.

Front Door Mirror



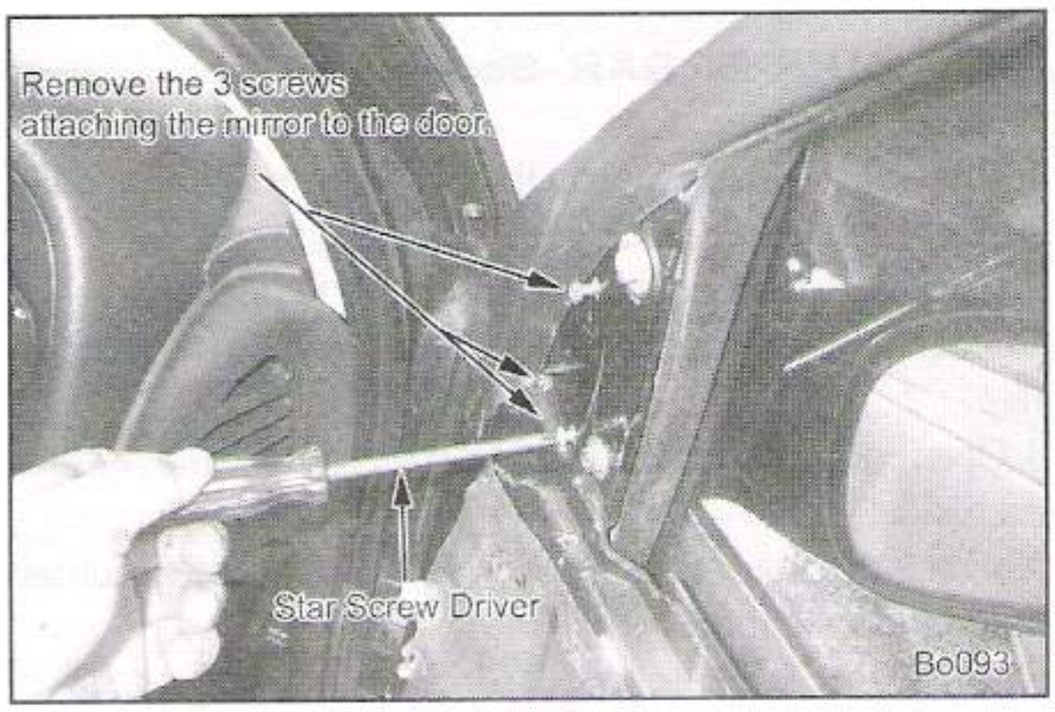
Front Door Mirrors

Remove

1. Remove the internal cover on front doors, which conceals the attaching screws.
2. Remove the 3 screws attaching the mirror to the door frame.
3. Disconnect the mirror harness connector, remove mirror, it may be necessary to remove door internal trim to acess the window harness connector.

Install

1. Position mirror to door, connect wiring harness.
2. Install 3 screws attaching mirror.



3. Push the internal cover into place.

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SUPPLEMENTAL RESTRAINT SYSTEM (SRS)

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SUPPLEMENTAL RESTRAINT SYSTEM (SRS)

WARNING

The air bag must be deactivated before any maintenance is carried out on the air bag, dash, steering wheel, steering column or other vehicle components that could cause an injury to the person or other persons while maintenance is being carried out.

WARNING

If the horn pad air bag assembly or the steering wheel and steering column assembly has been removed from the vehicle, the components must be left so if the air bag inflates there will be no damage to people.

The air bag needs a radius of 1 meter clearance all the way around it in case of sudden inflation.

Do not position the assembly with the air bag facing down as it will catapult the assembly into the air. Position the assembly so the air bag faces either up or off on an angle which will not cause the assembly or other objects to fly through the air if the air bag inflates.

DESCRIPTION.

Air bag safety system is designed to give protection to the driver and the passenger only if there is an air bag fitted to the passenger side of the vehicle. The air bag should only activate if the vehicle is involved with a 45 kmh or faster collision with a stationary object regardless of the speed of your vehicle or the other vehicle.

The air bag safety system and seat belt pre-tensioners are activated by a Sensing and Diagnostic Module (SDM) situated under the center console on the floor pan.

The air bag system is designed to activate if the vehicle has made an impact with an object directly in front or 30 degrees to either side of straight ahead. On impact the air suddenly inflates to protect the driver and (if installed) passenger from causing them selves an injury on the horn pad on the steering wheel and (if installed) dash as they are jolted forward. Soon after the impact and the inflation of the air bag the air bag will slowly deflate.

The seat belt pre-tensioners system and air bag system is automatic, the SRS can activate the pre-tensioners only or both the pre-tensioners and the air bag system. The SRS will only activate with a front on or 30^0 either side of front, it is not designed to activate with a rear collision, side on or roll over.

DEACTIVATE AIR BAG ELECTRICAL SYSTEM

Warning the air bag can still inflate after the electrical system has been disconnected.

1. Turn ignition off, with steering wheel locked, remove ignition keys this will ensure steering wheel is locked.
2. Lift bonnet and disconnect both negative and positive battery terminals.
3. Wait for at least 10 seconds.

ACTIVATE AIR BAG ELECTRICAL SYSTEM

1. Connect all wiring harness connectors.
2. Lift bonnet and connect both negative and positive battery terminals.
3. Turn ignition ON, check the SRS warning light on the dash, it should glow for approx. 5 seconds while the SDM runs a system check, then turn off.

Note: If the SRS light does not turn off and an audible warning sound is heard or the SRS light flashes after 2 seconds from turning off there is a fault with the SRS system.

Sensing and Diagnostic Module (SDM)

The SDM is located under the center console assembly (below the storage compartment). To remove the SDM the center console must be removed.

The SDM is a self contained unit with out other sensors,

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except for systems with side air bags, it senses a crash and should define between sudden braking and a crash. In a crash situation it deploys the air bags and front seat belt pre-tensioners.

Side air bags have a sensor bolted to each side "B" pillar, down low at the retracting seat belt unit.

Initially a SDM 6.2 version system, 3 and 4 loop system was fitted. 1998 August the system was updated to version 8.0 and 8.01. Version 8.0 is 2, 3 or 4 loop system. Version 8.01 is a 6 loop system, the 6 loop system allows for front air bags, seat belt pre-tensioners and side air bags.

There are 4 different SDM units used with version 8.0 and 8.1 systems, if replacing the SDM a compatible SDM must be installed.

A 2 loop SDM system fitted when seat belt pre-ternsioners only used.

A 3 loop SDM system fitted when seat belt pre-ternsioners and driver air bag only used.

A 4 loop SDM system fitted when seat belt pre-ternsioners, driver air bag and passenger air bag only used.

A 6 loop SDM system fitted when seat belt pre-ternsioners, driver air bag, passenger air bag and side air bags are used.

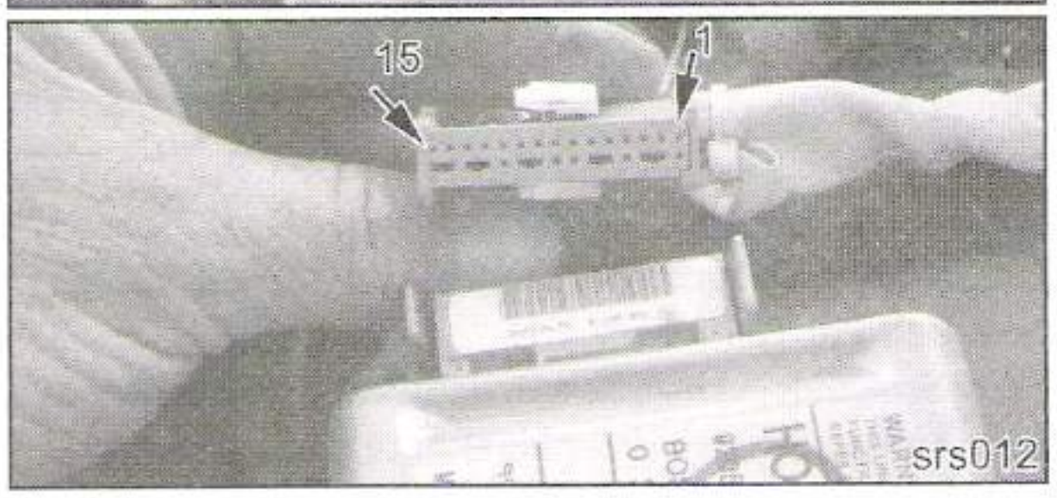
The SDM version 6.2 has 15 terminals to the SDM, looking at the SDM terminals left to right us the SDM Terminal Chart below for identification.

SDM Version 6.2 Terminal Identification Chart

Term' No	Terminal Function	Circuit	Colour
1	Left side pre-tensioner +ve	351	BLU/B
2	Left side pre-tensioner -ve	352	R/B
3	Right side pre-tensioner +ve	353	BR/W
4	Right side pre-tensioner -ve	354	Y/R
5	Ignition	739	P/B
6	Free		
7	Free		
8	Earth		
9	Serial Data	1220	G/W
10	Driver air bag +ve	347	W
11	Driver air bag -ve	348	G
12	Free		
13	Passenger air bag +ve	349	Y/B
14	Passenger air bag -ve	350	GY/B
15	Free		

Note: Circuit 1220 between BCM and SDM is white / green, while the circuit between BCM and other control modules is green / white.





The SDM version 8.0 and 8.1 has 19 terminals to the SDM, looking at the SDM terminals left to right use the SDM Terminal Chart below for identification.

SDM Version 8.0 and 8.1 Terminal Identification Chart

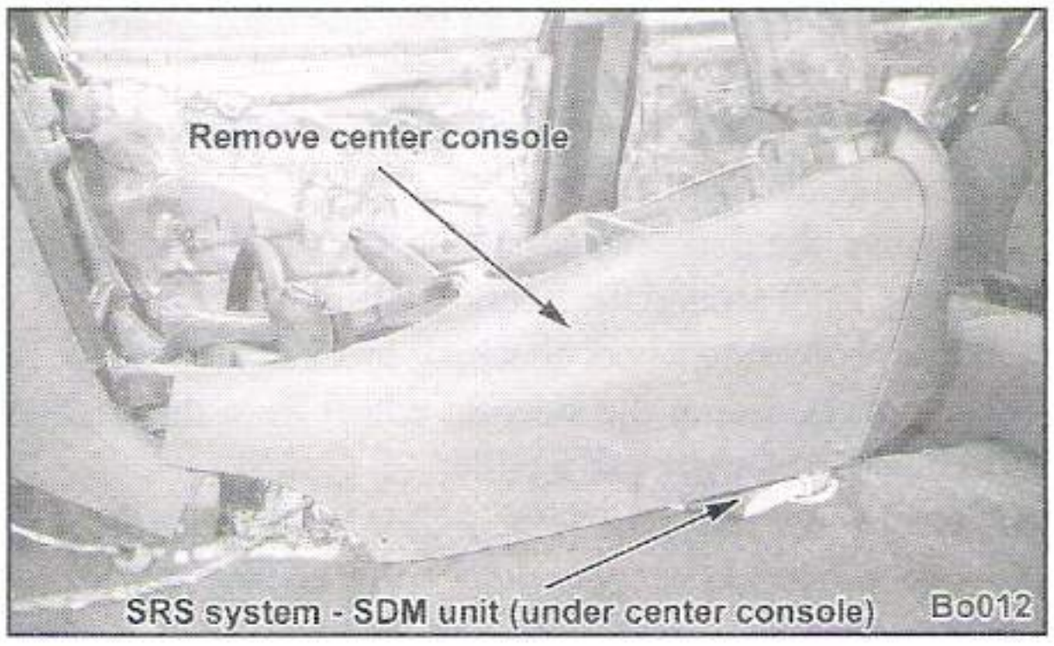
Term' No	Terminal Function	Circuit	Colour
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2	Left side pre-tensioner -ve	352	R/B
3	Right side pre-tensioner +ve	353	BR/W
4	Right side pre-tensioner -ve	354	Y/R
5	Ignition	739	P/B
6 & 7	Free		
8	Earth	305	B
9	Serial Data	1220	W/G
10	Driver air bag +ve	347	W
11	Driver air bag -ve	348	G
12	Free		
13	Passenger air bag +ve	349	Y/B
14	Passenger air bag -ve	350	GY/B
15	Free		
16	Left/right side air bag +ve *	385	Y/G
17	Left/right side air bag -ve *	386	BR/G
18	Right/left side air bag +ve *	387	Y/W
19	Right/left side air bag -ve *	388	BR/W
20	Left side peripheral acceleration sensor +ve	392	Y/BLU
21	Right side peripheral acceleration sensor +ve	407	GY/W
33	Left side peripheral acceleration sensor -ve	393	BR/B
34	Right side peripheral acceleration sensor -ve	408	LBLU

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Terminal 1 to 14 version 8.0 only
Note: Circuit 1220 between BCM and SDM is white / green, while the circuit between BCM and other control modules is green / white.
* At the start of VT SerII circuit 385 and 386 became right side and circuits 387 and 388 became left side

Remove

1. Deactivate the SRS system.
Warning the air bag can still inflate after the electrical system has been disconnected.



a) Turn ignition off, with steering wheel locked, remove ignition keys this will ensure steering wheel is locked.
b). Lift bonnet and disconnect both negative and positive battery terminals.
c). Wait for at least 10 seconds.
2. Remove the center console as described in the "body" chapter.
3. Disconnect the SDM harness connector.
a) Lift the connector lever.



b) Pull harness connector from the SDM.
4. Remove the SDM from the floor pan, 3 bolts, (Torx T30H).

Install

1. Replace the SDM from the floor pan, 3 bolts, (Torx T30H), there is an earth strap under one of the torx bolts.
SDM to Floor Pan bolts: 7-11Nm
2. Connect the SDM harness connector, lock connector lever down.
3. Install center console as described in the "Body" chapter.
4. Activate the SRS system, as described in this chapter.
a) Connect both battery terminals.
b) Turn ignition on and observe the SRS warning light.

DRIVERS AIR BAG

De-activate the SRS system as previously described.

Remove

Warning: The air bag can still activate after the electrical system has been disconnected.
Note: The air bag and horn pad is not a repairable component, therefore it must be replaced if faulty.
1. De-activate the SRS as previously described.
2. Remove the 4 torx screws attaching the horn pad and air bag to the steering wheel.
3. Carefully move horn pad and air bag assembly away from the steering wheel to allow disconnecting the wiring connectors. Care should be taken, if there are stero controls on the horn pad, the stero will no function correctly if the wiring connector is damaged..
4. Gently lift the horn bar and air bag assembly away from the steering wheel and out the vehicle.

Install

1. Make sure the battery has both negative and positive terminals disconnected. Ignition system is turned off and the steering wheel is in locked position.
2. Gently position the horn bar and air bag assembly into the vehicle, near the steering wheel so the electrical connections can be reconnected. Care should be taken, if there are stero controls on the horn pad, the stero will no function correctly if the wiring connector is damaged.



3. Replace the 4 torx screws attaching the horn pad and air bag to the steering wheel, tighten to specification.
Horn Pad & Air Bag Screws: 10-15Nm
4. Activate the electrical system of the air bag as previously described.

PASSENGER AIR BAG

De-activate the SRS system as previously described.

Remove

Warning: The air bag can still activate after the electrical system has been disconnected.
Note: The air bag is not a repairable component, therefore must be replaced if faulty.
1. De-activate the SRS as previously described.

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2. Remove the dash pad assembly as described in the "Body' chapter.
3. Disconnect the wiring connector (YB200) to the passenger air bag.
4. Remove the 2 nuts attaching the air bag to the dash support.



5. Carefully move air bag assembly away from the vehicle.

Install

1. Make sure the battery has both negative and positive terminals disconnected. Ignition system is turned off and the steering wheel is in locked position.
2. Gently position the air bag assembly into the vehicle, near the installation location so the electrical connections can be reconnected.
3. Install the air bag and 2 nuts, tighten to specification.

Passenger Air Bag Nuts: 15-25Nm

4. Install the dash pad assembly as described in the "Body " chapter.
5. Activate the electrical system of the air bag as previously described.

AIR BAG CLOCK SPRING COIL ASSEMBLY

CAUTION: Carry removed air bag with opening side facing away from you. Do not support air bag by wiring. Store or position air bag on a flat stable bench with opening side facing up. Do not store in a confine area. There is danger zone of several meters from the air bag

Note: The clock spring must be centralised. During any maintenance work on the steering column when the air bag clock spring coil is to be removed or replaced, the front wheels must be pointing straight ahead. The steering wheel must be centred, the steering wheel/column must be locked with the key removed and the air bag electrical system deactivated.

Note: The air bag clock spring coil assembly is not a repairable component, therefore it must be replaced if faulty.

Tip: See Steering chapter, steering wheel removal.

Remove

Warning the air bag can still activate after the electrical system has been disconnected.

1. Deactivate the electrical system of the air bag as described above.(Lift bonnet and disconnect both negative and positive battery terminals. Wait for at least 10 seconds., ignition keys removed).
2. Center the clock spring. The steering wheel must be centred, the steering wheel/column must be locked with the key removed
3. Remove the 4 torx screws attaching the horn pad and air bag to the steering wheel.
4. Carefully move the horn pad and air bag assembly away from the steering wheel. Care should be taken. Disconnect wiring connectors. The stero will not function correctly if the wiring connector is damaged..
5. Gently lift the horn bar and air bag assembly away from the steering wheel and out the vehicle.
6. Mark the exact location of the steering wheel in relation to the steering shaft and column.
7. Remove the 3 screws attaching the clock coil spring assembly from around the steering wheel nut.
8. Remove steering wheel attaching torx E20 bolt (not a 12 point socket), thump the steering wheel from the back to loosen or if necessary use a puller.

Note: Do not strike the shaft with a hammer as this will damage the bearing, you may need to use a steering wheel puller.

9. Remove clock spring assembly, 4 clips, lift tang up and pull away, 1 or 2 clips at a time.
10. Remove the lower dash right side panel by gripping with fingers and pulling down to free clips. Remove lower hinge pins.
11. Lower steering column as far it will go.
12. Remove the upper steering column trim, push lower trim in at side join, pull upper trim up and forward to release clip.
13. Remove 1 screw from lower steering column trim, push trim forward to release clips and feed ignition key light surround around ignition lock as the lower trim is removed.
14. Remove clock spring assembly, 4 clips, lift tang up and pull away, 1 or 2 clips at a time.

Install

Note: The clock spring must be centralised if it was not centralised by having the steering wheel in the straight ahead position, steering locked and keys removed. (See this chapter for "Clock Spring Centering")

1. Replace clock spring assembly, locate into position, work carefully to lock clips into place, 4 clips, lift tang up and push in, 1 or 2 clips at a time.

Note: The clock spring unit must be centralised (the green tab fully visible) before installation. To centralise the unit hold in your hand, squeeze the central clips rotate the center unit until it stops, then turn back approx 2.5 turns until he green tab is fully visible, release central tabs.

2. Install the steering wheel to the steering column, take note of the alignment marks.

Steering Wheel Torx E20 bolt torque: 40-50Nm

3. Make sure both terminals are still disconnected from the battery. Replace horn / air bag, connect the wiring connectors. Install the 4 screws at the rear of the horn pad, T30H

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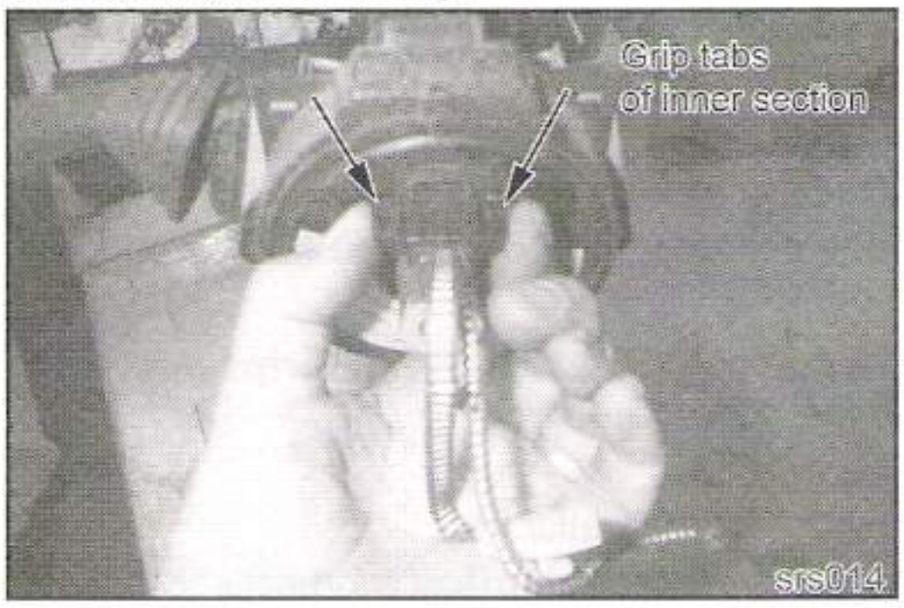
screws at the back of steering wheel.
4. Reconnect the harness connector behind steering wheel.
5. Install the lower trim panel.
6. Install and pull back to clip in base of lower steering column trim, feed ignition key light surround around ignition lock as the lower trim is installed, install 1 screw.
7. Install the upper steering column trim, push upper trim down to clip in place.
8. Install the lower dash right side panel by gripping with hands and fitting hinge pins, push in clips.
9. Connect the earth battery terminal.

CLOCK SPRING CENTERING

The clock spring must be centralised if it is to be reused and the spring was not centralised before removal, other wise the clock spring will be damaged when the vehicle is used.
1. Grip the outer clock spring housing in your hand.



2. With your other hand hold the 2 locking tabs of the inner section. Turn the inner section of the clock spring assembly clockwise until you feel a stop.



3. Turn the inner section approx 2.5 turns until you see the green section in the slot above the 2 locking tabs, release the



tabs so the inner section is locked into the outer housing.

SEAT BELT PRE-TENSIONERS

The pre-tensioner is part of the front seat / seat belt buckle assembly.

FRONT SEATS , SIDE AIR BAGS and SEAT BELT BUCKLE & PRE-TENSIONER

Warning the SRS (air bag and seat belt pre-tensioner) system must be de-activated as described in the SRS chapter.
Warning the air bag can still inflate after the electrical system has been disconnected.
Also described in "Body" chapter.

Remove

1. Remove the outer seat frame cover trim, 1 screw, use a screw driver to lever forward, pull forward and up off clips. Remove the 2 rear rail covers by prying up and off.
2. Disconnect the seat belt pre-tensioners and side air bag wiring harness connectors.



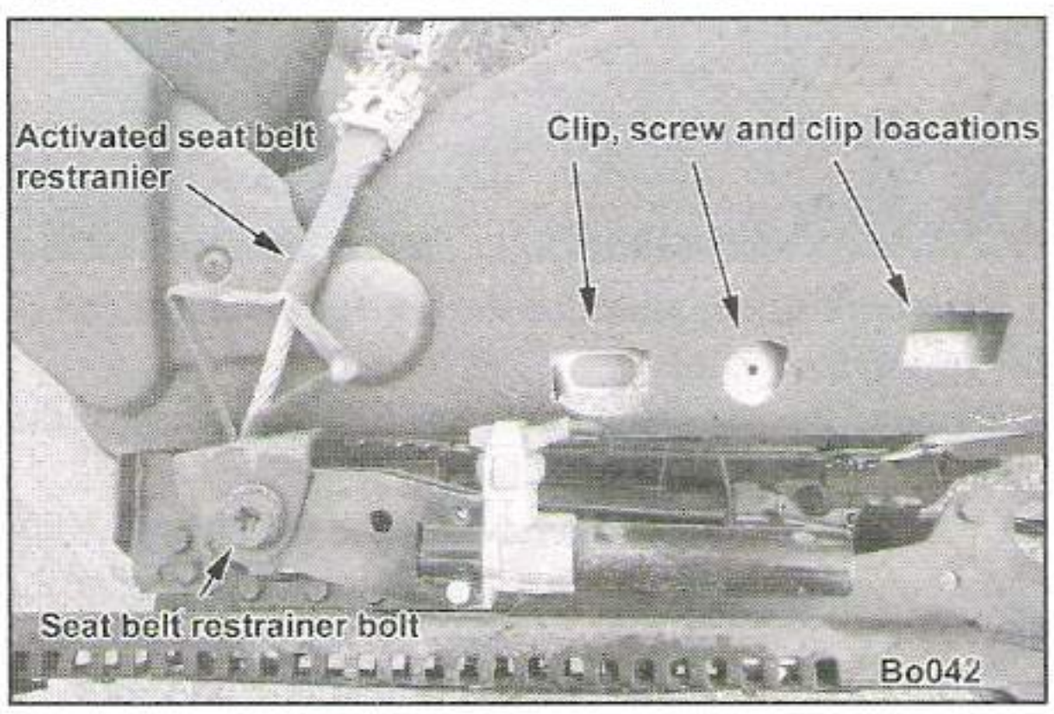
3. Remove the bolts attaching the front end and rear end of the seat frame to floor.
4. Remove the seat taking care not to damage any of the internal upholstery or internal lining.
5. Connect the seat belt pre-tensioners and side air bag wiring harness connectors to a dummy connector to ensure their are no shorts

Dismantle

1. Remove the seat recliner knob and shaft, screw out, seats with electric 4 way adjustment, tap the recliner shaft from the seat, towards the outside.
2. Remove the front seat side trim
a) Remove the front and side screw.
b) Remove the trim side screw fastener, turn anticlockwise, remove screw behind fastener.
c) Remove side trim, from under seat squeeze the 2 retaining clips in the center of trim.
d) Disconnect the seat adjuster wiring harness connector, behind trim.
3. Seat with electric 4 way adjustment.
a) Remove inner cover, 1 screw.
4. Remove seat back cover.

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a) Use a screw driver up behind cover to push up and pry the 2 retaining clips away from seat frame.
b) If the seat has lumber support, pull the edges of the back cover out to reveal circlip, push circlip out with 2 screw drivers, release the lumber support adjuster from spline.
c) Pull down on back cover to release from seat assembly.
5 Remove head rest.
a) Squeeze the base of the head rest rod sleeves, located in seat frame under rear upholstery, push up to release head rest sleeves from seat frame.
6. Remove seat back rest upholstery.
a) At the rear of the seat lift and peel back the upholstery from the 4 wrap around locations.
b) The lower one first, 2 sides then top.
c) Remove the upholstery and padding from the seat assembly.
7. Remove the side air bag.
a) Remove the 2 nuts.
b) Cut the plastic ties of the wiring harness and disconnect the wiring connectors.
Tip: Take note or mark the harness and tie locations for assembly.
c) Remove the air bag.
8. Remove seat belt buckle and pre-tensioner.
a) Remove seat cushion upholstery and pad from seat frame.
b) Remove seat cushion frame from seat floor frame and guide rails, 4 bolts.
c) Remove pre-tensioner and buckle, 1 bolt.



Assemble
1. Install seat belt buckle and pre-tensioner.
a) Install pre-tensioner and buckle, 1 bolt.
Side Air Bag Nuts: 45 Nm
b) Install seat cushion frame to seat floor frame and guide rails, 4 bolts.
Seat Cushion Frame to Seat Guide Rails bolts: 27Nm
c) Install seat cushion upholstery and pad from seat frame.
2. Install the side air bag.
a) Install the air bag and the 2 nuts.
Side Air Bag Nuts: 5-6Nm
b) Install the wiring harness, connect the wiring connectors use plastic ties to hold harness in place.
Tip: Use the same harness rout and tie locations for assembly as original to ensure the wiring system is not damaged now or later.
3. Install seat back rest upholstery.
a) Install the upholstery and padding to the seat assembly.
b) At the rear of the seat lift and peel around the upholstery from the 4 wrap around locations.
c) The top one first, 2 sides then lower.
4. Install the head rest and sleeves by pushing into place.
5. Install seat back cover.
a) Push the back cover into place locking in the top tabs.
b) If the seat has lumber support, position the lumber support adjuster to allow the circlip to be installed, push circlip in place, then release cover sides.
c) Push on the 2 rear retaining clips to lock in place.
6. Seat with electric 4 way adjustment, install inner cover, 1 screw.
7. Install the front seat side trim.
a) Position trim near seat and connect the seat adjuster wiring harness connector, behind trim.
b) Install side trim, push home the 2 retaining clips in the center of trim.
c) Install the front and side screw, install the trim side screw fastener, turn clockwise.
8. Install the seat recliner knob and shaft into position.
Install
1. Install the seat taking care not to damage any of the internal upholstery or internal lining.
2. Install the seat and frame, tightening the attaching bolts to specification.
Seat Anchor Bolts specified torque: 35-50 Nm
3. Connect the seat belt pre-tensioners and side air bag wiring harness connectors.
4. Install the outer seat frame cover trim, lower into place and push back to lock in, install 1 screw.
Replace the 2 rear rail covers by pushing into place.

SIDE AIR BAG SENSORS (Peripheral Acceleration Sensor)

Remove
1. Remove the "B" pillar trim.
a) Pry the trim out at the top (half way up the "B" pillar), there are 2 clips located there to disengage.
b) Lift the trim up and away from the pillar to disengage the lower section of the trim.
2. Remove the inner door opening kick panel.
a) Pry up the inserts to reveal the screws.
b) Remove the inner door opening kick panel 7 screws.
c) Lift and remove the inner door opening kick panel.
3. Remove the outer seat frame cover trim, 1 screw, use a screw driver to lever forward, pull forward and up off clips.
Remove the 2 rear rail covers by prying up and off.
4. Disconnect the side air bag sensor harness connector.
5. Remove the side air bag sensor, 1 bolt.

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Install

1. Install the side air bag sensor, 1 bolt.

Side Air Bag Sensor bolt: 35-50 Nm

2. Connect the side air bag sensor harness connector.
3. Install the outer seat frame cover trim, lower into place and push back to lock in, install 1 screw.

Replace the 2 rear rail covers by pushing into place.

4. Replace the inner door opening kick panel.

a) Position the inner door opening kick panel.
b) Install the inner door opening kick panel 7 screws
c) Position and push down the inserts covering the screws.

5. Install the "B" pillar trim.

a) Position the trim, lower section in place, then gently position the top section and push on clip section to lock clips in place.

DISPOSAL of AIR BAG and PRE-TENSIONER

The air bag assembly, passenger or driver side should not be disposed of unless the air bag has been deployed. It is advisable to wear safety glasses while working with the disposal of an air bag or pre-tensioner. If the air bag has not been deployed in an accident it will have to be deployed before the assembly can safely be disposed of. The following procedure must be adhered to in order to safely deploy the air bag:

* Never connect any electrical current to the air bag or pre-tensioner other wise it may activates.

Air bag still fitted to vehicle

**** passenger side air bag should not be deployed in the vehicle unless vehicle is going to be scrapped***

1. Disconnect the air bag connector.

2. Connect the special tool connector to the air bag to be deployed.

3. Run the wires from the air bag to the special tool and connect.

**** a distance of at least 10m (33ft) from vehicle is recommended***

4. Close all of the vehicle windows and doors, take care not to damage special tool wires.

5. Connect special battery and switch tool to an independent battery.

6. Insure that no one is within 10m (33ft) of the vehicle and then deploy the air bag by turning on the activation switch on the special tool.

**** Note that the air bag will be extremely hot after deployment, leave to cool down for at least 30 minutes before attempting removal***

7. The air bag assembly can now be safely disposed of.

Air bag removed from vehicle

1. The air bag assembly should be tied with wire to an old tyre or wheel and have at least 2 tyres above and below, all tyres should then be tied together with wire.

2. Connect the special tool connector to the air bag to be deployed.

3. Run the wires from the air bag to the special tool and connect.

**** a distance of at least 10m (33ft) from vehicle is recommended***

4. Connect special battery and switch tool to an independent battery.

5. Insure that no one is within 10m (33ft) of the vehicle and then deploy the air bag by turning on the activation switch on the special tool.

Pre-Tensioner

1. Disconnect the wiring harness from the pre-tensioner.

2. Connect special tool to an independent battery.

3. The pre-tensioner assembly should be tied with wire to an old tyre or wheel and have at least 1 tyre above and below, all tyres should then be tied together with wire.

3. Connect the special tool connector to the pre-tensioner to be deployed.

4. Run the wires from the pre-tensioner to the battery special tool and connect.

**** a distance of at least 10m (33ft) from pre-tensioner is recommended***

5. Insure that no one is within 10m (33ft) of the pre-tensioner deploy the pre-tensioner by turning on the activation switch on the special tool

Wiring Repairs for SRS system

The SRS system is very sensitive to wiring resistance etc, if any wiring is to be repaired. The wire should be joined with a splice type join of the same wire gauge. Consider replacing the loon section connector to connector. There is a wiring kit available GM part No J38125-A which contains sealed splices etc.

SRS Warning Light

The globe for the SRS warning light can be replaced as described in globe replacement in the "Body Electrical" chapter.

SRS Component Replacement

Due to the sensitive nature of the SRS system and diagnostic codes. Components from another vehicle should not be reused, replace with components for your particular vehicle build type.

Trouble Shooting and Diagnosis

Carry out a circuit check to ensure the SDM diagnostic codes (SDM dtc's) are correct before reading dtc's

Diagnostic Codes - Reading and Clearing

The SRS diagnostic codes need a Tech 2 or similar tool connected to the diagnostic link connector (DLC) to read the fault codes and clear codes.

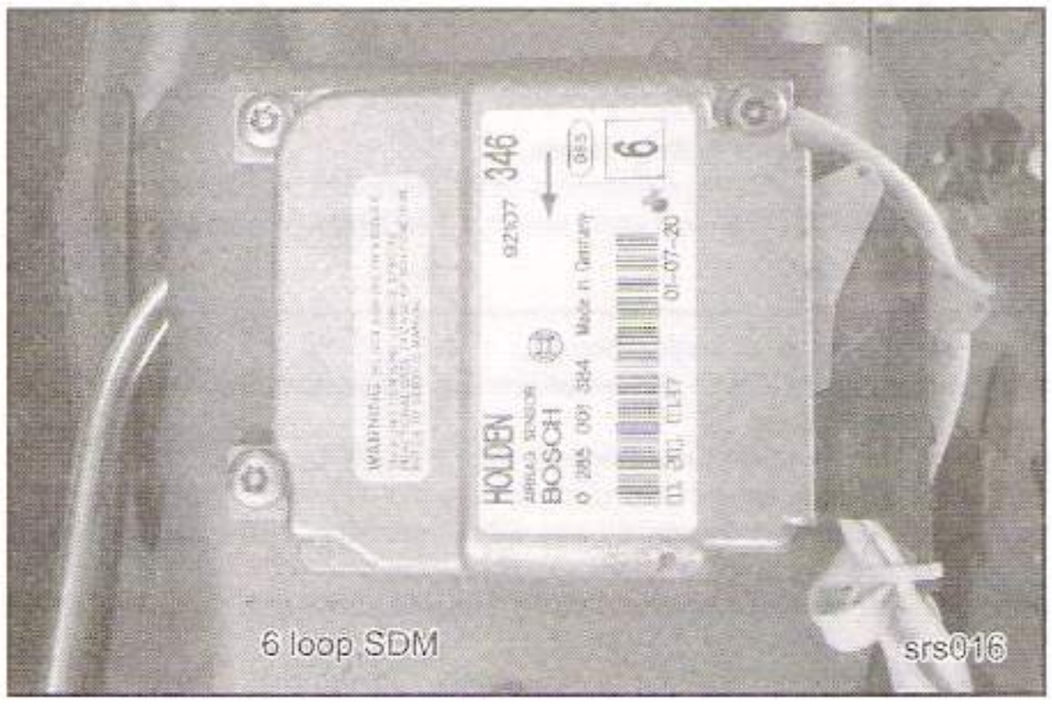
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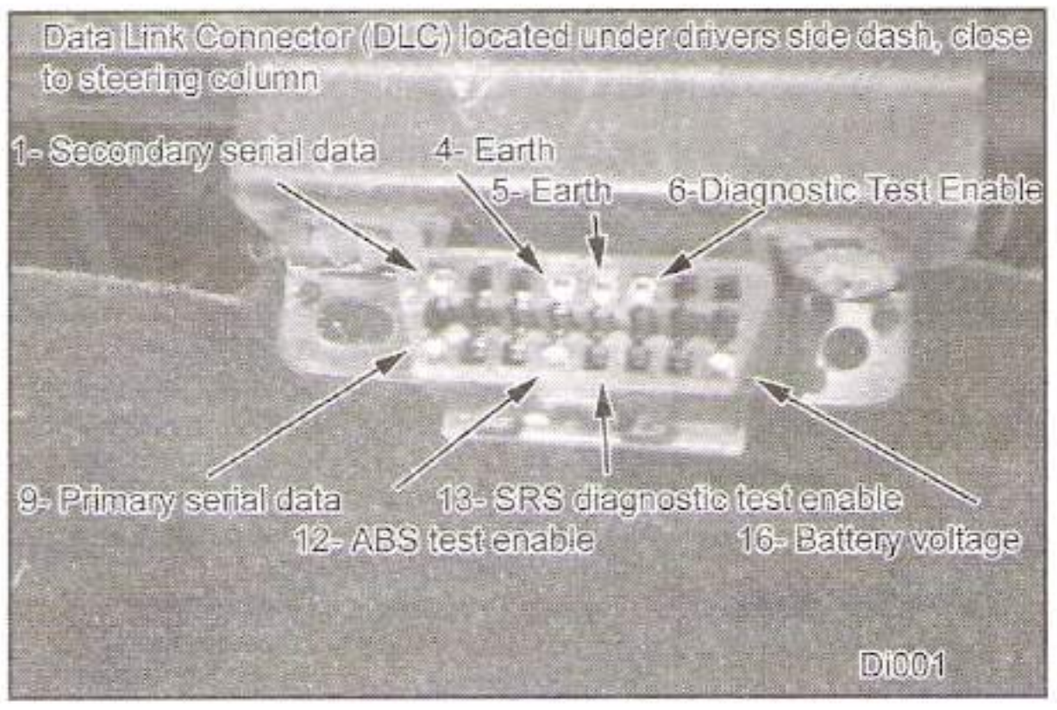
	SRS - Diagnositc Circuit Check		
	Check Proceedure	OK	Not OK
1	* Ignition ON, check action of SRS warning light, does it glow * Did the the SRS warning light go out after 4-5 seconds?	Go to next test If yes, system reports no faults.	Check globe - replace if necessary Go to next test.
2	* Connect Tech 2 instrument or similar and select SRS system, turn ignition ON, does it display SDM part No.	Go to test 4.	Go to next test..
3	* Check Tech 2 or similar fare there any SRS dtc's (coded faults) present.	If so check and repair dtc faults.	Light did not go out - check " SRS warning light glows with no DTC's stored" chart.
4	* Turn ignition OFF, then back ON and start engine straight immediately	Did it start without any delay.	If not check PCM for dtc faults.
5	* Check fuse No 26 (SDM)	If OK go to next test.	If not OK check and repair circuit 739-pink / black, replace fuse .
6	* Ignition ON disconnect the SDM harness connector, measure voltage between Terminal 5 (circuit 739, pink / black) and earth, is battery voltage present.	If OK go to next test	If not check and repair circuit 739 pink / black wire.
7	* Ignition OFF, check coninuity between SDM earth at earth strap and a known good earth.	If OK go to next test	If not repair earth.
8	* Disconnect SDM harness connector, check circuit 1220 green / white for continuity between (SDM connector YB190 terminal 9) and BCM connector (YB164-terminal 3 low series) (YB175-terminal 9 high series), back probe.	If coninuity OK - replace SDM	If no continuity go to next test.
9	* Disconnect SDM harness connector and BCM connector. Check for continuity between (SDM connector YB190 terminal 9) and BCM connector (YB164-terminal 13 low series) (YB175-terminal 3 high series),	If coninuity OK - replace BCM	If no continuity repair circuit 1220 between SDM and BCM SRScircuit

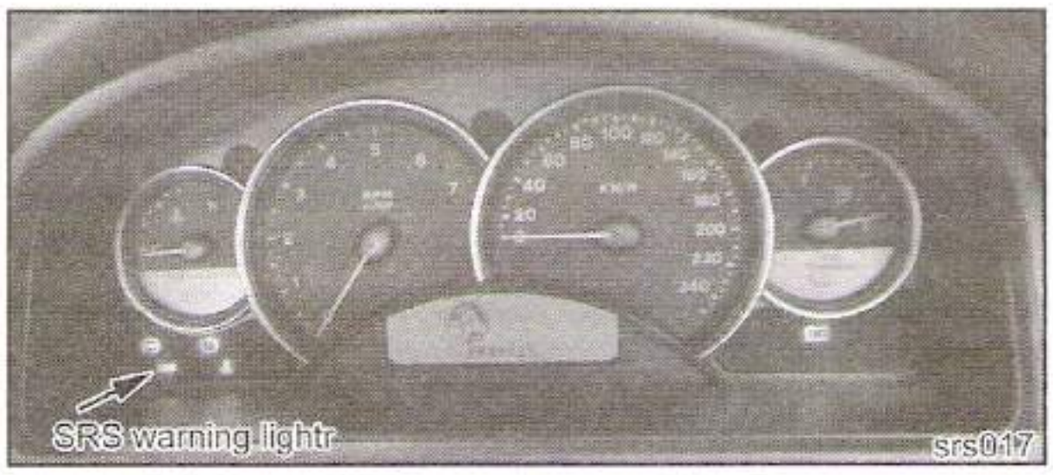
	SRS - Warning light not operating		
	Check Proceedure	OK	Not OK
1	Ignition ON, check action of SRS warning light, does it glow		Check globe and globe socket - replace if necessary
2	Ignition ON, check action of ABS warning light, does it glow for approx. 5 seconds then go off.	Go to next test.	Check globe and globe socket - replace if necessary. Go to test 3.
3	Checked SRS and ABS globe and socket, check operation of both with test leads, both are OK. Do globes function when instrument cluster is re-installed?		Go to next test.
4	Remove instrument cluster. Ignition ON. Check for battery voltage between instrument cluster connector terminal 19, (circuit 44- pink / blue) and a good earth.	Check instrument cluster circuits - repair or replace if necessary.	Check for faulty fusible link (FJ) and fuse No 13. Check circuit 44 (pink / blue) from ignition switch to instrument cluster connector.
5	Connect Tech 2 instrument or similar, with Tech 2 turn SRS light ON.	If light OK, replace SDM	If no light go over tests 1 to 4 SRSnowarnlit

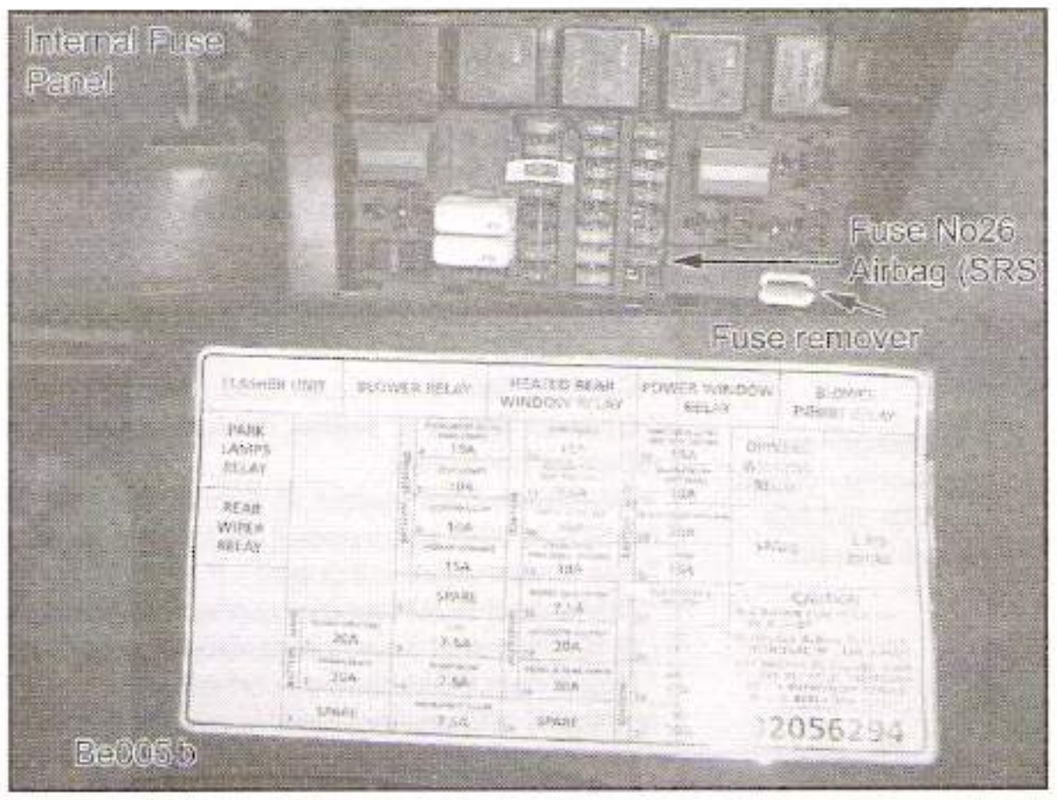
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	SRS warning light ON no dtc's		
	Checking proceedure	OK	Not OK
1	* Carry out a diagnostic circuit check?	Go to next test	If not - do a diagnostic circuit check
2	* Did the the SRS warning light go out after 4-5 seconds?	If yes, system reports no faults.	Could be intermittent fault.
3	* Connect Tech 2 instrument or similar and test for serial data	Go to next test.	Not OK - program instruments.
4	* Check Tech 2 or similar for battery voltage	Go to test 7	Not OK - check alternator output - repair if necessary, go to next test.
5	* Disconnect SDM harness connector at SDM. * Start engine, turn on lights or a load on battery system. * Check terminal 5 (circuit 739 - (circuit to fuse 26)) and a good earth, with a volt meter should read approx. alternator output voltage.	Go to next test	Not OK - check and repair circuit 739.
6	* Check that SDM earth has continuity. with earth under SDM Torx bolt.(Use Tech 2 or similar)	Try a new SDM and check earth circuit	Check and repair earth connection
7	* With a Tech 2 or similar check that energy reserve is OFF.	Go to next test	If not go back and check alternator output at test 5.
8	* With Tech 2 or similar check to see if SRS units, air bag and pre-tensioner are deployed, is it Yes?	Try a new SDM and retest.	Check Air bag deployment under BCM diagnosis SRSlitONnodtc's









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		SRS - Diagnostic Code Faults with possible causes. SDM Version 6.2 only
DTC	DTC Fault	Possible causes and actions
13	Drivers air bag - circuit 347 or 348 has short to earth	## Connector to air bag YB147 has an inbuilt capacitor, use service holes for testing circuits. * Connect Tech 2 or similar, is fault still current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. # Use caution with air bag as described in this chapter. * Deactivate SRS, Install a dummy air bag (tool No SD28280B), reconnect battery. Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, near steering column and clock spring, did code set again, repair as necessary. Did fault disappear when dummy air bag was fitted, if so replace original air bag witha new one. # Use caution with air bag as described in this chapter. * Original air bag fitted, connect Tech 2 or similar, check "drivers air bag loop resistance". It should be approx. 2.2ohms - if not go to next test. # Use caution with air bag. * Install a dummy air bag (tool No SD28280B) to connector YB147, connect Tech 2 or similar, check "drivers air bag loop resistance". Does it read approx. 3.0ohms - if so replace original air bag with a new one. # Use caution with air bag. * Disconnect SDM harness connector and connector from dummy air bag (tool No SD28280B), check circuit 347 (white wire), SDM connector (YB190) terminal 10 and Drivers air bag inflation module connector (YB147) for short to earth. If shorted repair circuit. If not shorted go to next test. * Disconnect SDM harness connector and connector from dummy air bag (tool No SD28280B), check circuit 348 (green wire), SDM connector (YB190) terminal 11 and Drivers air bag inflation module connector (YB147) for short to earth. If shorted repair circuit. If not shorted try a new SDM.
14	Drivers pre-tensioner - circuit 353 or 354 has short to earth.	## Connector to air bag YB209 has an inbuilt capacitor, use service holes for testing circuits. * Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. * Connect Tech 2 or similar, check "drivers pre-tensioer loop resistance". It should be approx. 2.2ohms - if not go to next test. * Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. * Deactivate SRS system as described in this chapter. Disconnect the driver pre-tensioner harness connector (YB209), connect tool No SD28280B) to connector YB209, connect Tech 2 or similar, check "drivers pre-tensioner loop resistance". Does it read approx. 3.0ohms - if so replace original pre-tensioner with a new one. * Disconnect SDM harness connector and connector from tool No SD28280B, check circuit 353 (brown/white wire), SDM connector (YB190) terminal 3 and pre-tensioner connector (YB209) for short to earth. If shorted repair circuit. If not shorted go to next test. * Disconnect SDM harness connector and connector from pre-tensioner, check circuit 354 (yellow/red wire), SDM connector (YB190) terminal 4 and pre-tensioner connector (YB209) for short to earth. If shorted repair circuit. If not shorted try a new SDM
15	Drivers air bag - circuit 348 has short to 12 volts (battery power).	## Connector to air bag YB147 has an inbuilt capacitor, use service holes for testing circuits. * Deactivate the SRS system. Remove air bag assembly. Disconnect SDM connector YB190, reconnect battery. Check circuit 348 (green wire) terminal 11 and circuit 347 (white wire) terminal 10 for short to battery voltage. If shorted repair circuit. If not shorted replace SDM.
16	Drivers pre-tensioner - circuit 353 has short to 12 volts (battery power).	## Connector to air bag YB209 has an inbuilt capacitor, use service holes for testing circuits. * Deactivate the SRS system. Remove pre-tensioner harness connector (YB209) disconnect SDM connector YB190, reconnect battery. Check circuit 353 (brown/white wire) terminal 3 and circuit 354 (yellow / red wire) terminal 4 for short to battery voltage. If shorted repair circuit. If not shorted replace SDM.
23	Passenger air bag - circuit 349 or 350 has short to earth	## Connector to air bag YB208 has an inbuilt capacitor, use service holes for testing circuits. * Connect Tech 2 or similar, is fault still current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. # Use caution with air bag as described in this chapter. * De-activate SRS, install a dummy air bag (tool No SD28280B), reconnect battery. Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, near steering column and clock spring, did code set again, repair as necessary. Did fault disappear when dummy air bag was fitted, if so replace original air bag with a new one. # Use caution with air bag as described in this chapter. * Original air bag fitted, connect Tech 2 or similar, check "passenger air bag loop resistance". It should be approx. 2.2ohms - if not go to next test. # Use caution with air bag. * Install a dummy air bag (tool No SD28280B) to connector YB208, connect Tech 2 or similar, check "drivers air bag loop resistance". Does it read approx. 3.0ohms - if so replace original air bag with a new one. # Use caution with air bag. * Disconnect SDM harness connector and connector from dummy air bag (tool No SD28280B), check circuit 349 (yellow / black wire), SDM connector (YB190) terminal 13 and passenger air bag inflation module connector (YB208) for short to earth. If shorted repair circuit. If not shorted go to next test. * Disconnect SDM harness connector and connector from dummy air bag (tool No SD28280B), check circuit 350 (grey / black wire), SDM connector (YB190) terminal 14 and passenger air bag inflation module connector (YB208) for short to earth. If shorted repair circuit. If not shorted try a new SDM.
24	Passenger pre-tensioner - circuit 351 or 352 has short to earth.	## Connector to air bag YB209 has an inbuilt capacitor, use service holes for testing circuits. * Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. * Connect Tech 2 or similar, check "passenger pre-tensioer loop resistance". It should be approx. 2.2ohms - if not go to next test. * Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. * Deactivate SRS system as described in this chapter. Disconnect the driver pre-tensioner harness connector (YB209), connect tool No SD28280B) to connector YB209, reconnect battery, connect Tech 2 or similar, check "passenger pre-tensioner loop resistance". Does it read approx. 3.0ohms - if so replace original pre-tensioner with a new one. * Disconnect SDM harness connector and connector from tool No SD28280B, check circuit 351 (blue/brown wire), SDM connector (YB190) terminal 3 and pre-tensioner connector (YB209) for short to earth. If shorted repair circuit. If not shorted go to next test. * Disconnect SDM harness connector and connector from pre-tensioner, check circuit 352 (red/black wire), SDM connector (YB190) terminal 4 and pre-tensioner connector (YB209) for short to earth. If shorted repair circuit. If not shorted try a new SDM SRScodes1

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		SRS - Diagnostic Code Faults with possible causes. SDM Version 6.2 only
DTC	DTC Fault	Possible causes and actions
25	Passenger air bag - circuit 349 or 350 has short to 12 volts (battery power).	## Connector to air bag YB208 has an inbuilt capacitor, use service holes for testing circuits. * Deactivate the SRS system. Remove air bag assembly. Disconnect SDM connector YB190, reconnect battery. Check circuit 349 (yellow / black wire) terminal 13 and circuit 350 (grey/black wire) terminal 14 for short to battery voltage. If shorted repair circuit. If not shorted replace SDM.
26	Passenger pre-tensioner - circuit 351 or 352 has short to 12 volts (battery power).	## Connector to air bag YB208 has an inbuilt capacitor, use service holes for testing circuits. * Deactivate the SRS system. Remove pre-tensioner harness connector (YB209) disconnect SDM connector YB190, reconnect battery. Check circuit 351 (blue/blacke wire) terminal 1 and circuit 352 (red/black wire) terminal 2 for short to battery voltage. If shorted repair circuit. If not shorted replace SDM.
31	Drivers air bag has open circuit 347 or 348, loop capacitance too low.	* Connect Tech 2 or similar, is fault still current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. # Use caution with air bag as described in this chapter. * De-activate SRS, install a dummy air bag (tool No SD28280B), reconnect battery. Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, near steering column and clock spring, did code set again, repair as necessary. Did fault disappear when dummy air bag was fitted, if so replace original air bag with a new one. # Use caution with air bag as described in this chapter. * De-activate SRS, disconnect clock spring coil connector YB149, reconnect battery. Connect Tech 2 or similar short together terminal 7 (white - circuit 347 & 8 (green - circuit 348) is fault current or history. If current go to next test, if history replace clock spring coil assembly. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check clock spring coil connector terminal 7 (white - circuit 347 & terminal 10 of SDM connector YB190 for an open circuit. If OK go to next test, if open circuit repair circuit. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check clock spring coil connector terminal 8 (green - circuit 348 & terminal 11 of SDM connector YB190 for an open circuit. If OK try a new SDM, if open circuit repair circuit.
32	Drivers air bag has short circuit 347 or 348, loop capacitance too high.	* Connect Tech 2 or similar, is fault still current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. # Use caution with air bag as described in this chapter. * De-activate SRS, install a dummy air bag (tool No SD28280B), reconnect battery. Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, near steering column and clock spring, did code set again, repair as necessary. Did fault disappear when dummy air bag was fitted, if so replace original air bag with a new one. # Use caution with air bag as described in this chapter. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check clock spring coil connector terminal 7 (white - circuit 347 & terminal 10 of SDM connector YB190 for a short circuit. If OK go to next test, if short circuit repair circuit. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check clock spring coil connector terminal 8 (green - circuit 348 & terminal 11 of SDM connector YB190 for a short. If OK try a new SDM, if short circuit repair circuit.
33	Passenger air bag has open circuit 349 or 350, loop capacitance too low.	## Connector to air bag YB208 has an inbuilt capacitor, use service holes for testing circuits. * Connect Tech 2 or similar, is fault still current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. # Use caution with air bag as described in this chapter. * De-activate SRS, install a dummy air bag (tool No SD28280B) to passenger air bag connector YB208, reconnect battery. Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. Did fault disappear when dummy air bag was fitted, if so replace original air bag with a new one. # Use caution with air bag as described in this chapter. * De-activate SRS, disconnect connector YB200, reconnect battery. Connect Tech 2 or similar short together both terminals of YB200, is fault current or history. If current go to next test, if history replace harness between air bag and connector YB200. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check connector YB200 yellow/black wire - circuit 349 & terminal 13 of SDM connector YB190 for an open circuit. If OK go to next test, if open circuit repair circuit. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check connector YB200 grey / black - circuit 350 & terminal 14 of SDM connector YB190 for an open circuit. If OK try a new SDM, if open circuit repair circuit.
34	Passenger air bag has short circuit 349 or 350, loop capacitance too high.	## Connector to air bag YB208 has an inbuilt capacitor, use service holes for testing circuits. * Connect Tech 2 or similar, is fault still current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. # Use caution with air bag as described in this chapter. * De-activate SRS, install a dummy air bag (tool No SD28280B) to passenger air bag connector YB208, reconnect battery. Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, near steering column and clock spring, did code set again, repair as necessary. Did fault disappear when dummy air bag was fitted, if so replace original air bag with a new one. # Use caution with air bag as described in this chapter. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check wiring circuits between SDM connector YB190 and air bag module connector. YB190 circuit 349 (yellow / black) connector terminal 13 and circuit 350 (grey / black) connector terminal 14 of SDM connector YB190 for a short to earth. If OK go try a new SDM, if short circuit repair circuit. SRScodes2

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		SRS - Diagnostic Code Faults with possible causes. SDM Version 6.2 only
DTC	DTC Fault	Possible causes and actions
35	Driver seat belt pre-tensioner open circuit 353 or 354, loop capacitance too low.	## Connector to air bag YB209 has an inbuilt capacitor, use service holes for testing circuits. * Connect Tech 2 or similar, is fault still current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. # Use caution with air bag as described in this chapter. * De-activate SRS, install a dummy air bag (tool No SD28280B) to driver pre-tensioner connector YB209, reconnect battery. Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. Did fault disappear when dummy air bag was fitted, if so replace original pre-tensioner with a new one. # Use caution with air bag as described in this chapter. * De-activate SRS, disconnect connector YB207 (next to drivers seat), reconnect battery. Connect Tech 2 or similar short together both terminals of YB207, is fault current or history. If current go to next test, if history replace harness between pre-tensioner and connector YB207. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check connector YB207 brown / white wire - circuit 353 & terminal 3 of SDM connector YB190 for an open circuit. If OK go to next test, if open circuit repair circuit. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check connector YB207 yellow / red - circuit 354 & terminal 4 of SDM connector YB190 for an open circuit. If OK try a new SDM, if open circuit repair circuit.
36	Drivers seat belt pre-tensioner short circuit 353 or 354, loop capacitance too high.	## Connector to air bag YB209 has an inbuilt capacitor, use service holes for testing circuits. * Connect Tech 2 or similar, is fault still current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. # Use caution with air bag as described in this chapter. * De-activate SRS, install a dummy air bag (tool No SD28280B) to passengerpre-tensioner connector YB209, reconnect battery. Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. Did fault disappear when dummy air bag was fitted, if so replace original pre-tensioner with a new one. # Use caution with air bag as described in this chapter. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check wiring circuits between SDM connector YB190 and pre-tensioner module connector YB209. Circuit 353 (brown / white) connector terminal 3 and circuit 354 (yellow / red) connector terminal 4 of SDM connector YB190 for a short to earth. If OK go try a new SDM, if short circuit repair circuit.
37	Passenger seat belt pre-tensioner open circuit 351 or 352, loop capacitance too low.	## Connector to air bag YB209 has an inbuilt capacitor, use service holes for testing circuits. * Connect Tech 2 or similar, is fault still current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. # Use caution with air bag as described in this chapter. * De-activate SRS, install a dummy air bag (tool No SD28280B) to driver pre-tensioner connector YB209, reconnect battery. Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. Did fault disappear when dummy air bag was fitted, if so replace original pre-tensioner with a new one. # Use caution with air bag as described in this chapter. * De-activate SRS, disconnect connector YB207 (next to drivers seat), reconnect battery. Connect Tech 2 or similar short together both terminals of YB207, is fault current or history. If current go to next test, if history replace harness between pre-tensioner and connector YB207. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check connector YB207 blue / black wire - circuit 351 & terminal 1 of SDM connector YB190 for an open circuit. If OK go to next test, if open circuit repair circuit. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check connector YB207 red / black - circuit 352 & terminal 2 of SDM connector YB190 for an open circuit. If OK try a new SDM, if open circuit repair circuit.
38	Passenger seat belt pre-tensioner short circuit 351 or 352, loop capacitance too high.	## Connector to air bag YB209 has an inbuilt capacitor, use service holes for testing circuits. * Connect Tech 2 or similar, is fault still current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. # Use caution with air bag as described in this chapter. * De-activate SRS, install a dummy air bag (tool No SD28280B) to passengerpre-tensioner connector YB209, reconnect battery. Connect Tech 2 or similar, is fault current, if not might be intermittent, check and move harness connectors, did code set again, repair as necessary. Did fault disappear when dummy air bag was fitted, if so replace original pre-tensioner with a new one. # Use caution with air bag as described in this chapter. * De-activate SRS, disconnect SDM connector YB190, use an ohmmeter to check wiring circuits between SDM connector YB190 and pre-tensioner module connector YB209. Circuit 351 (blue / black) connector terminal 1 and circuit 352 (red / black) connector terminal 3 of SDM connector YB190 for a short to earth. If OK go try a new SDM, if short circuit repair circuit.
53	Vehicle configuration mismatch	* This code will set when a SDM has been fitted to a vehicle that has the wrong configuration of pre-tensioners and air bags that the SDM was intended for. Check SDM label and part number.
55	SDM internal failure	* Repalce SDM with a new SDM of the correct configuration. SRScodes3

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		SRS - Diagnostic Code Faults with possible causes. SDM Version 8.0 & 8.1
DTC	DTC Fault	Possible causes and actions
17	Driver air bag circuit short to battery.	## Connector YB147 to air bag has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness. * Short in either circuit 347 (white) YB189/YB190 terminal 10 and/or circuit 348 (green) YB189/YB190 terminal 11 has shorted to battery voltage. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag will operate with this fault.
18	Driver air bag circuit short to earth.	## Connector YB147 to air bag has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Short in either circuit 347 YB189/YB190 terminal 10 and/or circuit 348 YB189/YB190 terminal 11 has shorted to earth. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag will operate with this fault.
19	Driver air bag circuit capacitance to high.	## Connector YB147 to air bag has an inbuilt capacitor, use service holes for testing circuitss. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 347 YB189/YB190 terminal 10 and/or circuit 348 YB189/YB190 terminal 11. * Most likley capacitor in YB147 faulty, replace YB147 harness (from clock spring to air bag) and clock spring assembly. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag may not operate with this fault.
20	Driver air bag circuit capacitance to low.	## Connector YB147 to air bag has an inbuilt capacitor, use service holes for testing circuitss. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 347 YB189/YB190 terminal 10 and/or circuit 348 YB189/YB190 terminal 11. * Most likley capacitor in YB147 faulty, replace YB147 harness (from clock spring to air bag) and clock spring assembly. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag may not operate with this fault.
21	Driver air bag circuit resistance to high.	## Connector YB147 to air bag has an inbuilt capacitor, use service holes for testing circuitss. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 347 YB189/YB190 terminal 10 and/or circuit 348 YB189/YB190 terminal 11, have an open circuit or the air bag is faulty, resistance is over 8.4ohms. Install special tool SD28280B instead of air bag to determine if the fault is in the air bag, replace if faulty. * Disconnect clock spring connector and short terminals 7 and 8, if fault becomes history, replace clock spring assembly. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag may not operate with this fault.
22	Driver air bag circuit resistance to low.	## Connector YB147 to air bag has an inbuilt capacitor, use service holes for testing circuitss. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 347 YB189/YB190 terminal 10 and/or circuit 348 YB189/YB190 terminal 11, have a short circuit or the air bag is faulty, resistance is less than 1.0ohms. Install special tool SD28280B instead of air bag to determine if the fault is in the air bag, replace if faulty. * Disconnect clock spring connector, if fault becomes history and code 21 is present, replace clock spring assembly. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag may not operate with this fault.
247	Drivers air bag circuit power error	## Connector YB147 to air bag has an inbuilt capacitor, use service holes for testing circuitss. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 347 YB189/YB190 terminal 10 and/or circuit 348 YB189/YB190 terminal 11, clock spring or the air bag may be faulty, another code may also be set. Repair the fault for the other code and check if 247 is still present, if so try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag may not operate with this fault. SRScodesVer8-1

Note: See earlier section in this chapter for SDM and wiring connector information.

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		SRS - Diagnostic Code Faults with possible causes. SDM Version 8.0 & 8.1
DTC	DTC Fault	Possible causes and actions
33	Passenger air bag circuit short to battery.	## Connector YB208 to air bag has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness. * Short in either Circuit 349 (yellow/black) YB189/YB190 terminal 13 and/or circuit 350 (grey / black) YB189/YB190 terminal 14 has shorted to battery voltage. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag will operate with this fault.
34	Passenger air bag circuit short to earth.	## Connector YB208 to air bag has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Short in either Circuit 349 (yellow/black) YB189/YB190 terminal 13 and/or circuit 350 (grey / black) YB189/YB190 terminal 14 has shorted to earth. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag will operate with this fault.
35	Passenger air bag circuit capacitance to high.	## Connector YB208 to air bag has an inbuilt capacitor, use service holes for testing circuitss. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 349 (yellow/black) YB189/YB190 terminal 13 and/or circuit 350 (grey / black) YB189/YB190 terminal 14. * Most likley capacitor in YB208 faulty, replace YB208 connector and harness to SRS harness. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag may not operate with this fault.
36	Passenger air bag circuit capacitance to low.	## Connector YB208 to air bag has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 349 (yellow/black) YB189/YB190 terminal 13 and/or circuit 350 (grey / black) YB189/YB190 terminal 14. * Most likley capacitor in YB208 faulty, replace YB208 connector and harness to SRS harness. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag may not operate with this fault.
37	Passenger air bag circuit resistance to high.	## Connector YB208 to air bag has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 349 (yellow/black) YB189/YB190 terminal 13 and/or circuit 350 (grey / black) YB189/YB190 terminal 14, have an open circuit or the air bag is faulty, resistance is over 8.4ohms. Install special tool SD28280B instead of air bag to determine if the fault is in the air bag, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag may not operate with this fault.
38	Passenger air bag circuit resistance to low.	## Connector YB208 to air bag has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 349 (yellow/black) YB189/YB190 terminal 13 and/or circuit 350 (grey / black) YB189/YB190 terminal 14, have a short circuit or the air bag is faulty, resistance is less than 0.6ohms. Install special tool SD28280B instead of air bag to determine if the fault is in the air bag, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag may not operate with this fault.
247	Passenger air bag circuit power error	## Connector YB208 to air bag has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 349 (yellow/black) YB189/YB190 terminal 13 and/or circuit 350 (grey / black) YB189/YB190 terminal 14, or the air bag may be faulty, another code may also be set. Repair the fault for the other code and check if 247 is still present, if so try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The air bag may not operate with this fault.

Note: See earlier section in this chapter for SDM and wiring connector information.

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		SRS - Diagnostic Code Faults with possible causes. SDM Version 8.0 & 8.1
DTC	DTC Fault	Possible causes and actions
49	Left seat, seat belt pre-tensioner circuit short to battery.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness. * Short in either circuit 351 (blue / black) YB189/YB190 terminal 1 and/or circuit 352 (red / black) YB189/YB190 terminal 2 has shorted to battery voltage. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner will operate with this fault.
50	Left seat, seat belt pre-tensioner circuit short to earth.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Short in either circuit 351 (blue / black) YB189/YB190 terminal 1 and/or circuit 352 (red / black) YB189/YB190 terminal 2 has shorted to earth, test circuits with a multimeter. * Install special tool SD28280B instead of pre-tensioner to determine if the fault is in the pre-tensioner, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner will operate with this fault.
51	Left seat, seat belt pre-tensioner circuit capacitance to high.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 351 (blue / black) YB189/YB190 terminal 1 and/or circuit 352 (red / black) YB189/YB190 terminal 2. * Most likley capacitor in YB209 faulty, replace YB209 connector and harness to SRS harness. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner may not operate with this fault.
52	Left seat, seat belt pre-tensioner circuit capacitance to low.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 351 (blue / black) YB189/YB190 terminal 1 and/or circuit 352 (red / black) YB189/YB190 terminal 2. * Most likley capacitor in YB209 faulty, replace YB209 connector and harness to SRS harness. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner may not operate with this fault.
53	Left seat, seat belt pre-tensioner circuit resistance to high.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 351 (blue / black) YB189/YB190 terminal 1 and/or circuit 352 (red / black) YB189/YB190 terminal 2, have an open circuit or the pre-tensioner is faulty, resistance is over 8.4ohms for more than 3-5 seconds. Install special tool SD28280B instead of pre-tensioner to determine if the fault is in the pre-tensioner, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner may not operate with this fault.
54	Left seat, seat belt pre-tensioner circuit resistance to low.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 351 (blue / black) YB189/YB190 terminal 1 and/or circuit 352 (red / black) YB189/YB190 terminal 2, have a short circuit or the air bag is faulty, resistance is less than 0.6ohms for more than 3-5 seconds. Install special tool SD28280B instead of pre-tensioner to determine if the fault is in the pre-tensioner, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner may not operate with this fault.
247	Left seat, seat belt pre-tensioner circuit power error	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 351 (blue / black) YB189/YB190 terminal 1 and/or circuit 352 (red / black) YB189/YB190 terminal 2, or the pre-tensioner may be faulty, another code may also be set. Repair the fault for the other code and check if 247 is still present, if so try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner may not operate with this fault. SRScodesVer8-3

Note: See earlier section in this chapter for SDM and wiring connector information

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		SRS - Diagnostic Code Faults with possible causes. SDM Version 8.0 & 8.1
DTC	DTC Fault	Possible causes and actions
65	Right seat, seat belt pre-tensioner circuit short to battery.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness. * Short in either circuit 353 (brown / white) YB189/YB190 terminal 3 and/or circuit 354 (yellow / red) YB189/YB190 terminal 4 has shorted to battery voltage. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner will operate with this fault.
66	Right seat, seat belt pre-tensioner circuit short to earth.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Short in either circuit 353 (brown / white) YB189/YB190 terminal 3 and/or circuit 354 (yellow / red) YB189/YB190 terminal 4 has shorted to earth, test circuits with a multimeter. * Install special tool SD28280B instead of pre-tensioner to determine if the fault is in the pre-tensioner, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner will operate with this fault.
67	Right seat, seat belt pre-tensioner circuit capacitance to high.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 353 (brown / white) YB189/YB190 terminal 3 and/or circuit 354 (yellow / red) YB189/YB190 terminal 4. * Most likley capacitor in YB209 faulty, replace YB209 connector and harness to SRS harness. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner may not operate with this fault.
68	Right seat, seat belt pre-tensioner circuit capacitance to low.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 353 (brown / white) YB189/YB190 terminal 3 and/or circuit 354 (yellow / red) YB189/YB190 terminal 4. * Most likley capacitor in YB209 faulty, replace YB209 connector and harness to SRS harness. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner may not operate with this fault.
69	Right seat, seat belt pre-tensioner circuit resistance to high.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 353 (brown / white) YB189/YB190 terminal 3 and/or circuit 354 (yellow / red) YB189/YB190 terminal 4, have an open circuit or the pre-tensioner is faulty, resistance is over 8.4ohms for more than 3-5 seconds. Install special tool SD28280B instead of pre-tensioner to determine if the fault is in the pre-tensioner, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner may not operate with this fault.
70	Right seat, seat belt pre-tensioner circuit resistance to low.	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 353 (brown / white) YB189/YB190 terminal 3 and/or circuit 354 (yellow / red) YB189/YB190 terminal 4, have a short circuit or the air bag is faulty, resistance is less than 0.6ohms for more than 3-5 seconds. Install special tool SD28280B instead of pre-tensioner to determine if the fault is in the pre-tensioner, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner may not operate with this fault.
247	Right seat, seat belt pre-tensioner circuit power error	## Connector YB209 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 353 (brown / white) YB189/YB190 terminal 3 and/or circuit 354 (yellow / red) YB189/YB190 terminal 4, or the pre-tensioner may be faulty, another code may also be set. Repair the fault for the other code and check if 247 is still present, if so try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The pre-tensioner may not operate with this fault. SRScodesVer8-4

Note: See earlier section in this chapter for SDM and wiring connector information

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		SRS - Diagnostic Code Faults with possible causes. SDM Version 8.0 & 8.1
DTC	DTC Fault	Possible causes and actions
81	Left side, side air bag circuit short to battery.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness. * Short in either circuit 385 (yellow / green) YB189/YB190 terminal 16 and/or circuit 386 (brown / green) YB189/YB190 terminal 17 has shorted to battery voltage. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag should operate with this fault.
82	Left side, side air bag circuit short to earth.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Short in either circuit 385 (yellow / green) YB189/YB190 terminal 16 and/or circuit 386 (brown / green) YB189/YB190 terminal 17 has shorted to earth, test circuits with a multimeter. (Air bag loop on Tech 2 should read 1.6 to 6.4 ohms) * Install special tool AU485 instead of air bag to determine if the fault is in the pre-tensioner, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag should operate with this fault.
83	Left side, side air bag circuit capacitance to high.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 385 (yellow / green) YB189/YB190 terminal 16 and/or circuit 386 (brown / green) YB189/YB190 terminal 17. * Most likley capacitor in YB201 faulty, replace YB201 connector and harness to SRS harness. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag may not operate with this fault.
84	Left side, side air bag circuit capacitance to low.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 385 (yellow / green) YB189/YB190 terminal 16 and/or circuit 386 (brown / green) YB189/YB190 terminal 17. * Most likley capacitor in YB201 faulty, replace YB201 connector and harness to SRS harness. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag may not operate with this fault.
85	Left side, side air bag circuit resistance to high.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 385 (yellow / green) YB189/YB190 terminal 16 and/or circuit 386 (brown / green) YB189/YB190 terminal 17, have an open circuit or the air bag is faulty, resistance is over 8.4ohms for more than 3-5 seconds. Install special too AU485 instead of air bag to determine if the fault is in the air bag, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag may not operate with this fault.
86	Left side, side air bag circuit resistance to low.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 385 (yellow / green) YB189/YB190 terminal 16 and/or circuit 386 (brown / green) YB189/YB190 terminal 17, have a short circuit or the air bag is faulty, resistance is less than 0.6ohms for more than 3-5 seconds. Install special tool AU485B instead of air bag to determine if the fault is in the air bag, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag may not operate with this fault.
247	Left side, side air bag circuit power error	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 385 (yellow / green) YB189/YB190 terminal 16 and/or circuit 386 (brown / green) YB189/YB190 terminal 17, or the air bag may be faulty, another code may also be set. Repair the fault for the other code and check if 247 is still present, if so try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag may not operate with this fault. SRScodesVer8-5

Note: See earlier section in this chapter for SDM and wiring connector information

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		SRS - Diagnostic Code Faults with possible causes. SDM Version 8.0 & 8.1
DTC	DTC Fault	Possible causes and actions
97	Right side, side air bag circuit short to battery.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness. * Short in either circuit 388 (brown / white) YB189/YB190 terminal 19 and/or circuit 387 (yellow / white) YB189/YB190 terminal 18 has shorted to battery voltage. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag should operate with this fault.
98	Right side, side air bag circuit short to earth.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Short in either circuit 388 (brown / white) YB189/YB190 terminal 19 and/or circuit 387 (yellow / white) YB189/YB190 terminal 18 has shorted to earth, test circuits with a multimeter. (Air bag loop on Tech 2 should read 1.6 to 6.4 ohms) * Install special tool AU485 instead of air bag to determine if the fault is in the pre-tensioner, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag should operate with this fault.
99	Right side, side air bag circuit capacitance to high.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 388 (brown / white) YB189/YB190 terminal 19 and/or circuit 387 (yellow / white) YB189/YB190 terminal 18. * Most likley capacitor in YB201 faulty, replace YB201 connector and harness to SRS harness. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag may not operate with this fault.
100	Right side, side air bag circuit capacitance to low.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 388 (brown / white) YB189/YB190 terminal 19 and/or circuit 387 (yellow / white) YB189/YB190 terminal 18. * Most likley capacitor in YB201 faulty, replace YB201 connector and harness to SRS harness. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag may not operate with this fault.
101	Right side, side air bag circuit resistance to high.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 388 (brown / white) YB189/YB190 terminal 19 and/or circuit 387 (yellow / white) YB189/YB190 terminal 18, have an open circuit or the air bag is faulty, resistance is over 8.4ohms for more than 3-5 seconds. Install special too AU485 instead of air bag to determine if the fault is in the air bag, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag may not operate with this fault.
102	Right side, side air bag circuit resistance to low.	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 388 (brown / white) YB189/YB190 terminal 19 and/or circuit 387 (yellow / white) YB189/YB190 terminal 18, have a short circuit or the air bag is faulty, resistance is less than 0.6ohms for more than 3-5 seconds. Install special tool AU485B instead of air bag to determine if the fault is in the air bag, replace if faulty. * Last resort try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag may not operate with this fault.
247	Right side, side air bag circuit power error	## Connector YB201 to pre-tensioner has an inbuilt capacitor, use service holes for testing circuits. * Check for intermittant fault by inspecting for loose/faulty connectors and harness * Circuit 388 (brown / white) YB189/YB190 terminal 19 and/or circuit 387 (yellow / white) YB189/YB190 terminal 18, or the air bag may be faulty, another code may also be set. Repair the fault for the other code and check if 247 is still present, if so try a new SDM. * The SRS warning light will glow until the code is cleared from the SDM history. * The side air bag may not operate with this fault. SRScodesVer8-6

Note: See earlier section in this chapter for SDM and wiring connector information

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		SRS - Diagnostic Code Faults with possible causes. SDM Version 8.0 & 8.1
DTC	DTC Fault	Possible causes and actions
129	Left side, side air bag sensor wiring fault.	* Check for intermittant fault by inspecting for loose/faulty connectors and harness * Check for a short to earth in circuit 392 (yellow / blue) YB189/YB190 terminal 20. * Install an operating air bag sensor (right side?) to see if fault still present. * Last resort try a new SDM. * If the fault clears the SRS warning light will glow until the end of the ignition cycle. * The side air bag may not operate with this fault.
130	Right side, side air bag sensor wiring fault	* Check for intermittant fault by inspecting for loose/faulty connectors and harness * Check for a short to earth in circuit 407 (grey / white) YB189/YB190 terminal 21. * Install an operating air bag sensor (left side?) to see if fault still present. * Last resort try a new SDM. * If the fault clears the SRS warning light will glow until the end of the ignition cycle. * The side air bag may not operate with this fault.
131	Left side, side air bag sensor communication fault	* Check for intermittant fault by inspecting for loose/faulty connectors and harness * Check for an open circuit 392 (yellow / blue) YB189/YB190 terminal 20 and/or circuit 393 (brown / black) YB189/YB190 terminal 33. * Install an operating air bag sensor (right side?) to see if fault still present. * Last resort try a new SDM. * If the fault clears the SRS warning light will glow until the end of the ignition cycle. * The side air bag may not operate with this fault.
132	Right side, side air bag sensor communication fault	* Check for intermittant fault by inspecting for loose/faulty connectors and harness * Check for an open circuit 407 (grey / white) YB189/YB190 terminal 21 and/or circuit 408 (light blue) YB189/YB190 terminal 34. * Install an operating air bag sensor (left side?) to see if fault still present. * Last resort try a new SDM. * If the fault clears the SRS warning light will glow until the end of the ignition cycle. * The side air bag may not operate with this fault.
133	Left side, side air bag sensor identification problem.	* The left side, side air bag sensor is not compatibly with the SDM, replace the sensor. * Last resort try a new SDM. * If the fault clears the SRS warning light will glow until the end of the ignition cycle * The side air bag may not operate with this fault.
134	Right side, side air bag sensor identification problem.	* The right side, side air bag sensor is not compatibly with the SDM, replace the sensor. * Last resort try a new SDM. * If the fault clears the SRS warning light will glow until the end of the ignition cycle * The side air bag may not operate with this fault.
135	Left side, side air bag sensor internal problem.	* The left side, side air bag sensor is not functioning correctly, replace the sensor. * Last resort try a new SDM. * If the fault clears the SRS warning light will glow until the end of the ignition cycle * The side air bag may not operate with this fault.
136	Right side, side air bag sensor internal problem.	* The right side, side air bag sensor is not functioning correctly, replace the sensor. * Last resort try a new SDM. * If the fault clears the SRS warning light will glow until the end of the ignition cycle * The side air bag may not operate with this fault.
161	SRS configuration wrong	* This code will set when a SDM has been fitted to a vehicle that has the wrong configuration of pre-tensioners and air bags that the SDM was intended for. Check SDM label and part number. SRScodesVer8-7

Note: Circuit 1220 between BCM and SDM is white / green, while the circuit between BCM and other control modules is green / white.

* At the start of VT SerII circuit 385 and 386 became right side and circuits 387 and 388 became left side.

VT Series II SDM version 8.1 connector has 8 shorting busbar links. When testing the circuits with the connector disconnected from the SDM, you wil need to open the busbar link by inserting an electrical 3.0mm spade terminal into the busbar to open the circuits.

BusBar Link	Terminal	Circuit
G	1 & 2	Left side pre-tensioner
H	3 & 4	Right side pre-tensioner
I	10 & 11	Driver air bag
J	13 & 14	Passenger air bag
K	16 & 17	left side, side air bag
L	18 & 19	Right side, side air bag

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BODY ELECTRICAL

BATTERY 390
LIGHTS 392
FUSES and RELAYS 400
BODY CONTROL MODULE (BCM) 401
SWITCHES and HORN 402
WIPER and WASHERS 405
CRUISE CONTROL 408
ELECTRIC MIRRORS 409
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ELECTRIC SEATS 413
FUEL GAUGE 413
TRIP COMPUTER SWITCH 414
CIGARETTE LIGHTER/POWER SOCKET 414
REAR WINDOW DEMISTER 415
FRONT & REAR EXTERNAL DOOR LOCK 416

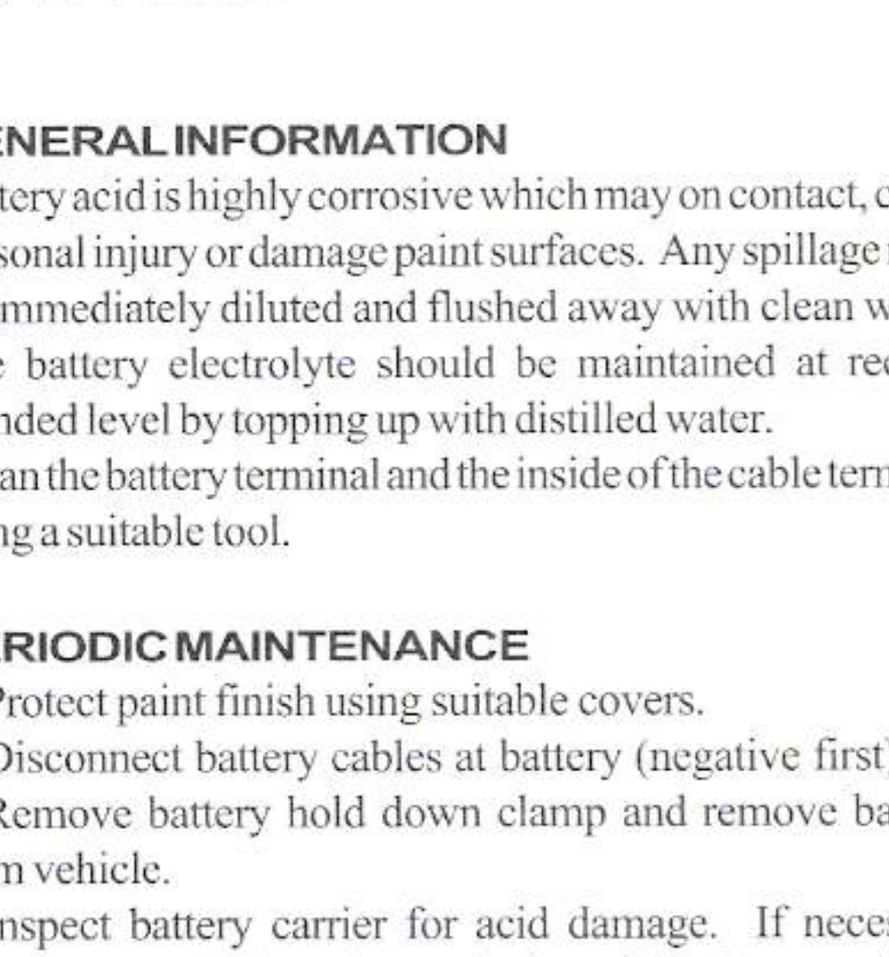
BATTERY

GENERAL INFORMATION

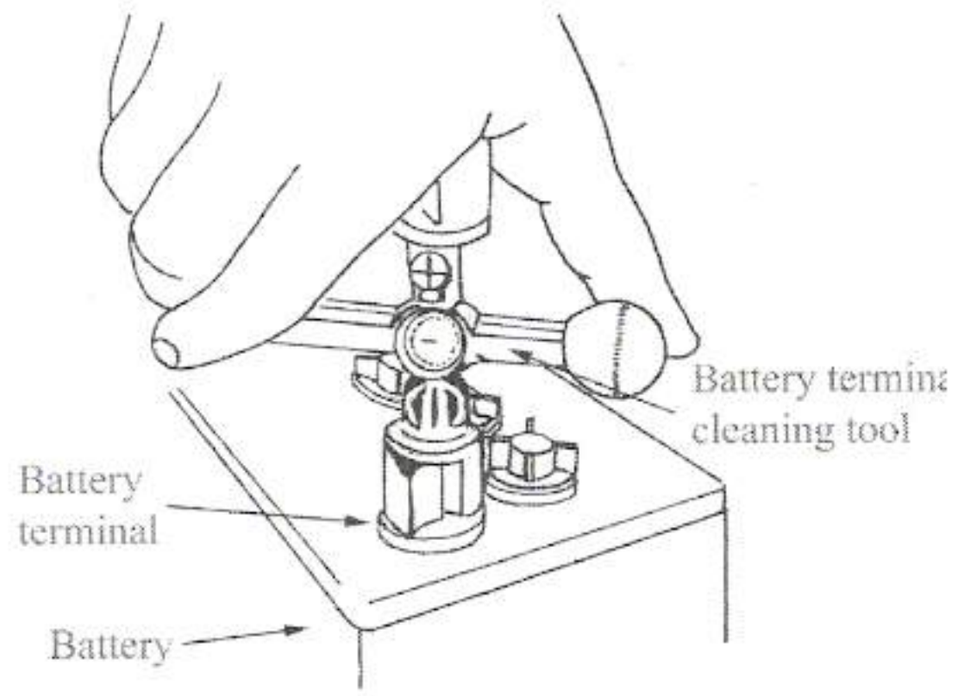
Battery acid is highly corrosive which may on contact, cause personal injury or damage paint surfaces. Any spillage must be immediately diluted and flushed away with clean water. The battery electrolyte should be maintained at recommended level by topping up with distilled water.
Clean the battery terminal and the inside of the cable terminal using a suitable tool.

PERIODIC MAINTENANCE

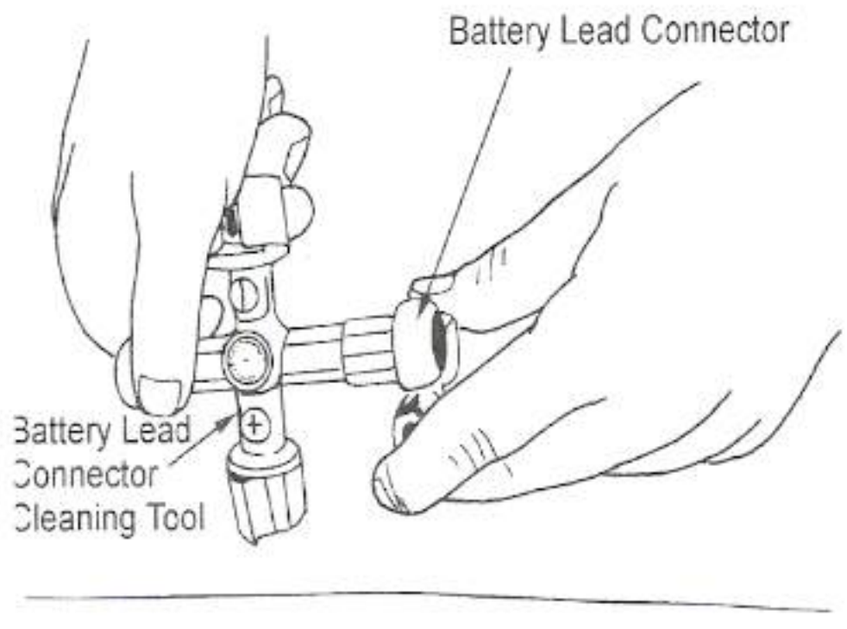
1. Protect paint finish using suitable covers.
2. Disconnect battery cables at battery (negative first).
3. Remove battery hold down clamp and remove battery from vehicle.
4. Inspect battery carrier for acid damage. If necessary remove corrosion by using a solution of bicarbonate of soda in warm water and scrubbing area with a stiff brush, taking care to avoid spreading corrosion residue, and flush area with clean water. Damaged areas should be repainted to avoid further corrosion.
5. Clean battery cover by same method.
* Do not allow any cleaning solution or water to enter battery cells as this will dilute electrolyte.
6. Check battery cables for damage and fraying and replace if necessary.
7. Clean battery terminals. If necessary remove corrosion by using a solution of bicarbonate of soda in warm water and scrubbing area with a stiff brush, taking care to avoid spreading corrosion residue, and flush area with clean water.
8. Check battery case, cover and vents for damage.
9. Install battery and hold down clamp. Do not overtighten



L001



Clean terminals & battery posts to ensure a good contact between battery & terminals L00



Clean battery lead connectors to ensure a good contact between the battery and battery lead. L003

hold down clamp as this could crack case.
10. Connect battery cables and tighten to specifications.
Tighten Battery Terminal: 6-8Nm
* Ensure battery polarity is not reversed.
11. Coat terminals with light mineral grease to avoid corrosion.

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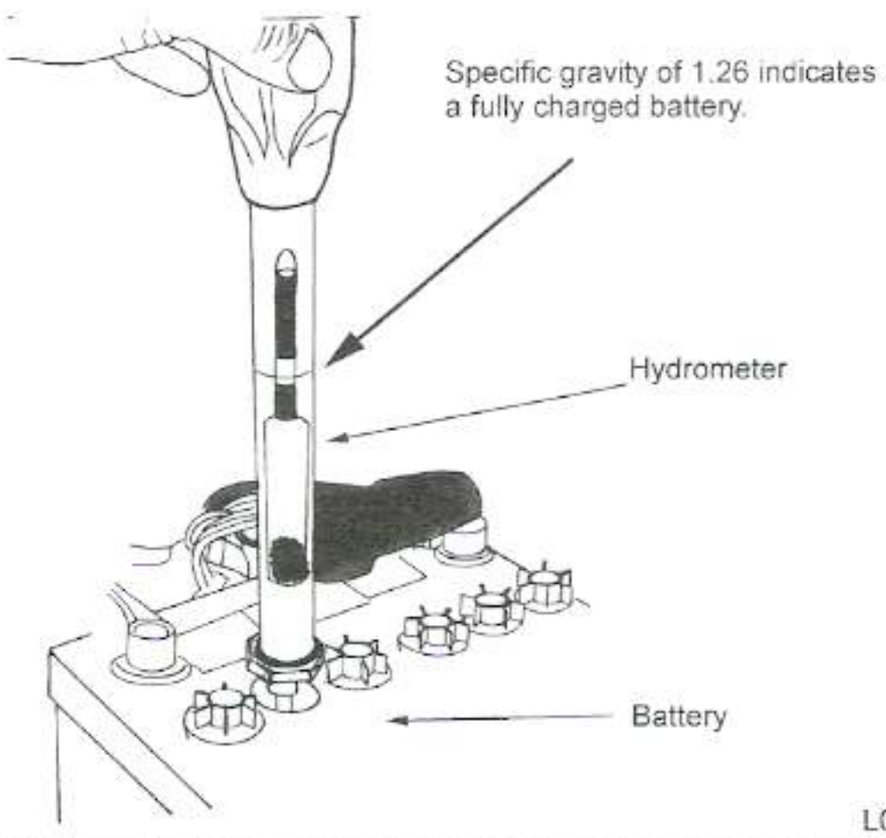
TESTING BATTERY ELECTROLYTE (ACID)

A hydrometer should be used to determine the specific gravity of battery electrolyte. The reading obtained indicates amount of unused sulphuric acid remaining in electrolyte and state of charge of battery.

The reading obtained will vary in relation to the temperature of the electrolyte. As the temperature rises the density of the electrolyte decreases and the specific gravity falls. As the temperature falls the density increases and the specific gravity rises.

USING THE HYDROMETER

1. Liquid level of battery cell should be at normal height and electrolyte should be thoroughly mixed with any battery water which may have just been added by charging battery before taking hydrometer readings.
2. Draw electrolyte in and out of hydrometer barrel several times to bring temperature of hydrometer float to that of the acid in the cell.



L004

3. Draw sufficient electrolyte into hydrometer barrel with the pressure bulb fully expanded to lift float so that it does not touch the sides, bottom or top of barrel.
4. Read the hydrometer with the hydrometer in a vertical position.

TEST RESULT INDICATIONS

Electrolyte specific gravity	Battery Charge Level.
1.240 to 1.260	100%
1.210 to 1.240	75%
1.180 to 1.210	50%
Below 1.130	Completely discharged.

A battery should be charged if the specific gravity is less than 1.210.

If there is more than 0.25 specific gravity variation between cells then a fault is most likely with the battery itself.

If battery charge is low and battery is serviceable, check alternator operation and all electrical connections.

BATTERY CHARGING

WARNING: When batteries are being charged explosive gas mixture forms beneath the cover of each cell.

* Do not smoke near batteries on charge or which have recently been charged.
* Do not break live circuit at terminals of batteries on charge. A spark will occur where the live circuit is broken. Keep all open flames away from battery.

NB: Fast charging will provide sufficient charge after one hour to enable the battery and alternator to carry electrical load however, whenever possible, slow charging is preferable.

FAST CHARGING

Fast charging a battery in the vehicle is not recommended, however if this procedure is used it is most important that the battery is disconnected.

NB: A battery will be irretrievably damaged if following precautions are not taken.

1. Battery electrolyte temperature must NEVER exceed 45°C.

If this temperature is reached, battery should be cooled by reducing charging rate or remove battery from circuit.

2 . As batteries approach full charge electrolyte in each cell will begin to gas or bubble. Excessive gassing must not be allowed.

3. Do not fast charge longer than one hour. If battery does not show a significant change in specific gravity after one hour of "FAST" charge, the slow charge method should be used.

SLOW CHARGING

Many discharged batteries can be brought back to good condition by slow charging; especially batteries that are sulphated. Battery should be tested with a hydrometer and a record kept of the readings taken at regular intervals throughout the charge. When a cell has a specific gravity reading that is 0.25 or more below other cells, that cell is faulty and battery should be replaced.

Safe slow charging rates can be calculated by allowing one ampere per positive plate per cell i.e. 4 amperes for a 9 plate battery and 5 amperes for an 11 plate battery.

The average time required to charge a battery by the slow charge method at normal rates is from 12 to 16 hours, however, when a battery continues to show an increase in specific gravity, battery charge should be continued even if it takes 24 hours or more. Watch the temperature of batteries carefully and if temperature of any one of them reaches 43°C, lower the charging rate.

Battery will be fully charged when it is gassing freely and when there is no further rise in specific gravity after three successive readings taken at hourly intervals. Make sure hydrometer readings are corrected for temperature.

Many batteries can be brought back to a useful condition by slow charging at half the normal charging rate from 60 to 100 hours. This long charging cycle is necessary to reconvert crystalline lead sulphate in to active materials.

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LIGHTS

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HEADLIGHT GLOBE REPLACEMENT

CAUTION:

Never touch bulb with bare hands while they are illuminated, or immediately after turning them off. Never hold halogen bulb with bare hands, dirty gloves, etc., or premature bulb failure will occur. If the glass surface is dirty, be sure to clean it with alcohol, and install after air drying thoroughly.

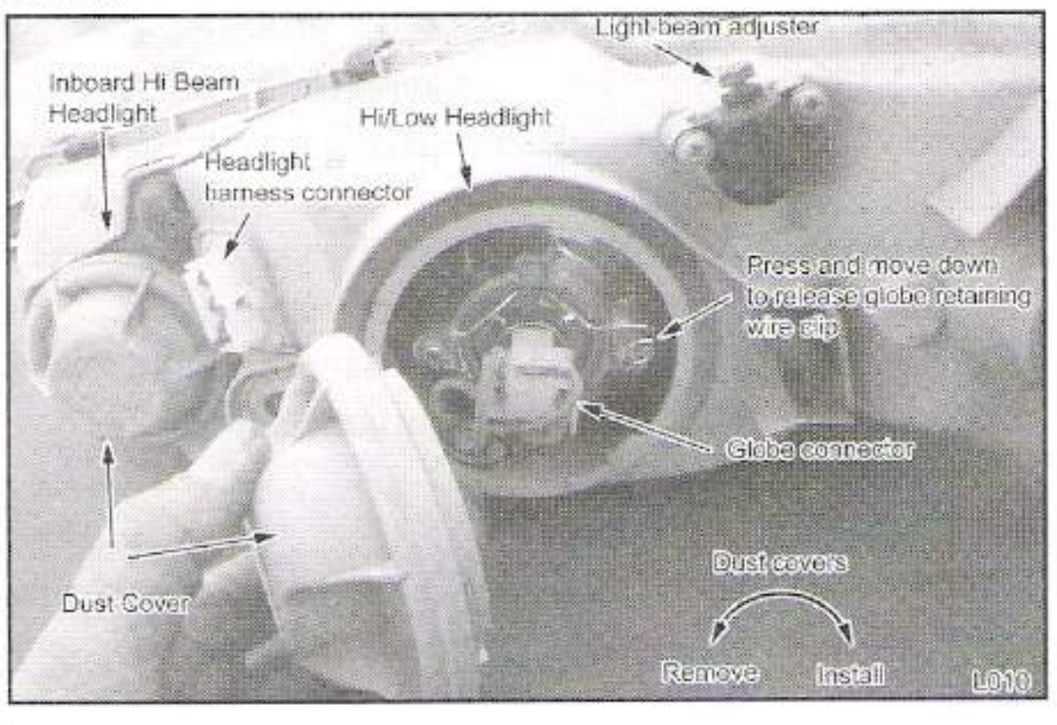
Left side, the battery will need to be moved back for V6 models and battery removed for V8 models.

Headlight Hi/Low Globe (Monaro Low Globe)

Left side, the battery will need to be moved back for V6 models and battery removed for V8 models.

Remove

1. Twist back cover anticlockwise to unlock and remove cover.



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2. Pull wiring connector from globe.
3. Unclip globe retaining wire clip (push in and slightly anticlockwise), to remove globe.
Monaro: Push in and turn anticlockwise to remove globe.

Install

1. Check that the specified globes are used to replace the old globe, align metal tangs of globe to correct tang slots..

Headlight Globe Hi/Low Specification: 60/55W
Monaro " " Low " " : 55W

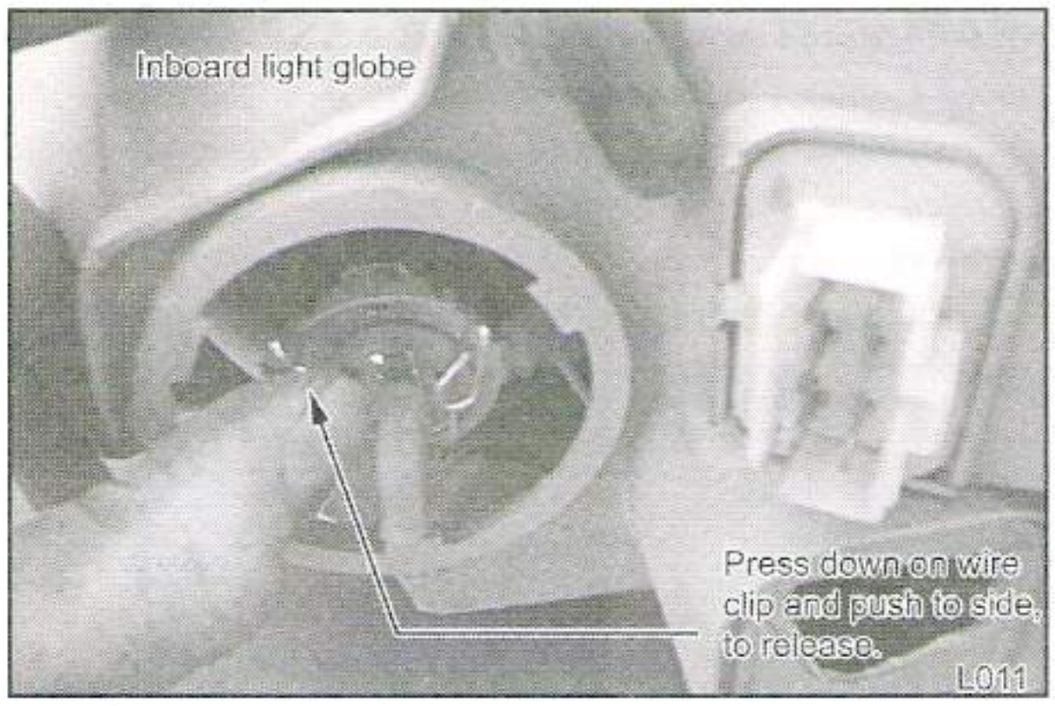
Monaro: Push globe in and turn clockwise.
Clip the globe wire clip in to place (push in, and slightly clockwise). Connect wiring connector.
2. Install back cover, check rubber seal is in place, twist cover clockwise to lock on. Check the cover is correctly installed to prevent water and dust entry.
3. Check headlight pattern after globe replacement.

Headlight Hi Beam - Inboard Globe

Left side, the battery will need to be moved back for V6 models and battery removed for V8 models.

Remove

1. Twist back cover anticlockwise to unlock and remove cover.
2. Pull wiring connector from globe.
3. Unclip globe retaining wire clip (push in and slightly anticlockwise), to remove globe.



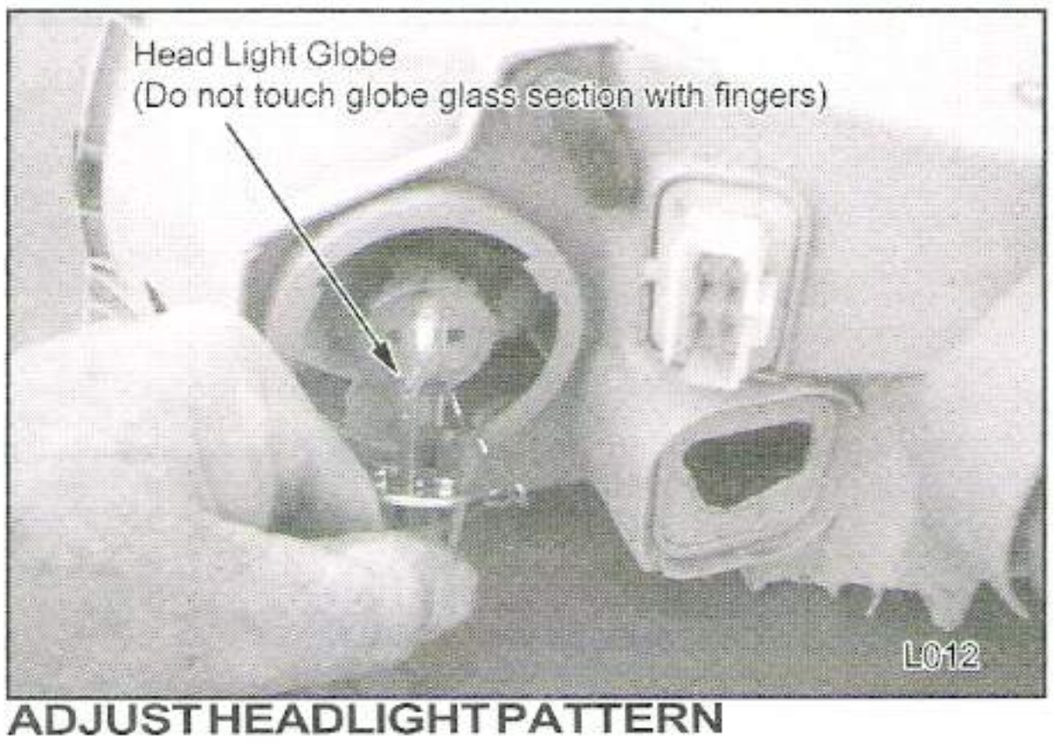
Monaro: Globes are a turn anticlockwise and remove fit.

Install

1. Check that the specified globes are used to replace the old globe.

Headlight Globe Specification: 55W
Monaro " " " : 65W

2. Clip the globe wire clip in to place (push in, and slightly clockwise).
GenIII: Globe is a push in and turn clockwise fit.
Connect wiring connector.
3. Install back cover, check rubber seal is in place, twist cover clockwise to lock on. Check the cover is correctly installed to prevent water and dust entry.
4. Check headlight pattern after globe replacement.



ADJUST HEADLIGHT PATTERN

Always adjust headlight pattern according to the state laws and regulations.
Before adjusting headlight take note of the following procedure:
1. Ensure tyres are inflated correctly.
2. Clean headlight lenses.
3. Check the vehicle is positioned on a level floor.
"4. Bounce vehicle to ensure vehicle is at normal height..
Place sufficient weight in vehicle to simulate full load conditions (1 litre of fuel = 0.72 kg).

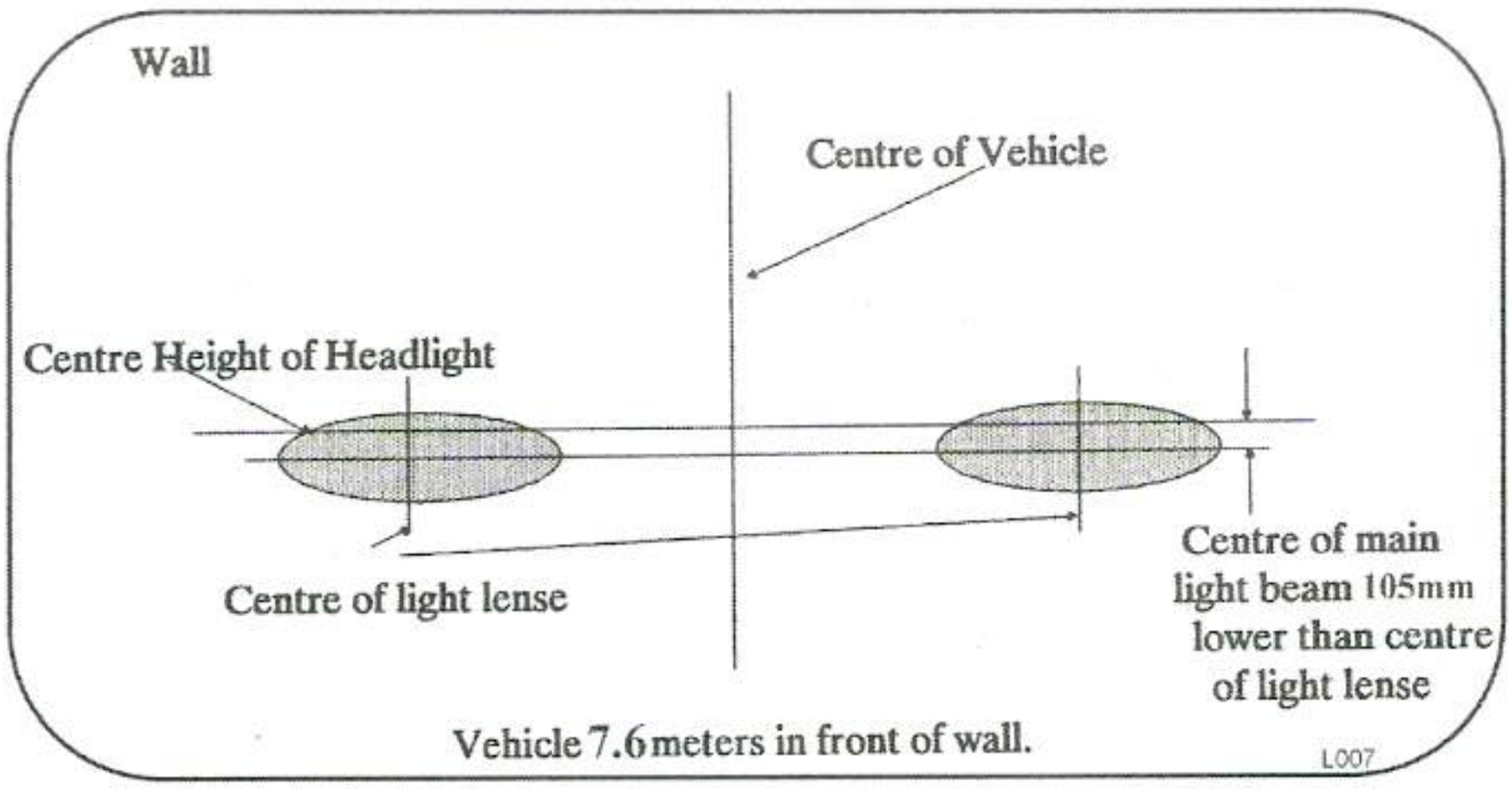
ADJUSTMENT

Adjusting screws are located at rear of headlight assembly in engine compartment under bonnet.
Adjust VERTICALLY with star screw driver at inside adjuster. HORIZONTAL adjustment with star screw driver at outside adjuster.



Adjust vertically and horizontally by using a wall.
1. Manufacture an aiming target on a light colored wall as shown.
2. With vehicle up against wall, align vehicle centre line with centre line of screen.
3. With vehicle up against wall, mark head light height and centre of light lense on wall.
4. Place vehicle 7.6 meters in front of screen ensuring the vehicle is aligned with vehicle centre line mark on screen.
5. Switch headlights onto low beam and aim outer lights.
a. Adjust the height of the light beam turn the inside adjuster.

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b. Adjust the light beam laterally, turn the outside adjuster.
6. Switch headlights onto high beam, mask outer lights and aim inner lights.
a. Adjust the height of the light beam turn the inside adjuster.
b. Adjust the light beam laterally turn the outside adjuster.

PARK LIGHT GLOBE

Replace

1. Twist back cover of headlight assembly anticlockwise to unlock and remove. (As for headlight globe)
2. Remove the parking light globe and socket by pulling back on the socket firmly.

Tip: It is best to remove the head light globe for accesssibility or use pointy nose pliers.

3. Replace the globe with a globe of the same wattage.



4. Install the socket into headlight assembly.
5. Install back cover, twist cover clockwise to lock on. Check the cover is correctly installed to prevent water entry.

FRONT TURNING INDICATOR LIGHT GLOBE

Replace

1. Turn globe and socket anticlockwise to remove socket from back of light reflector.
2. Remove globe from socket.
3. Replace globe with a similar wattage globe.
4. Install socket, turn clockwise to fix socket into place.

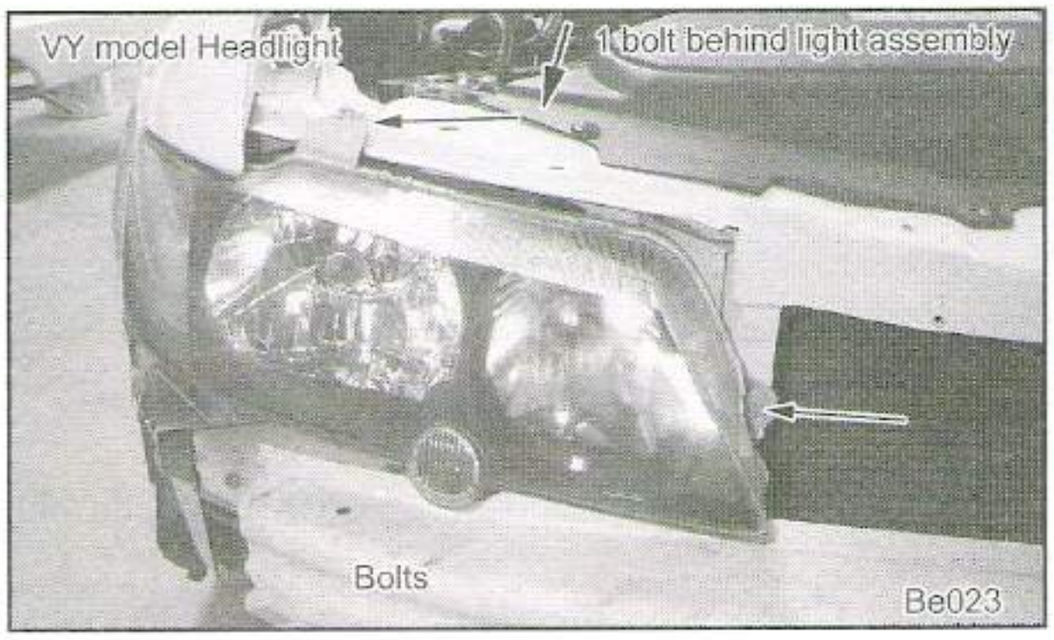


HEADLIGHT and INDICATOR ASSEMBLY

Tip: VT model with care it may not be necessary to remove bumerbar and grille assembly, if it needs to be removed see body chapter.

Remove

1. Lift bonnet to gain access to the back of the light assembly.



2. Gen III: Remove radiator top cover, 4 screws.
3. Push in connector locking tab on the underside of the wiring loom connector, pull connector apart. Remove the turning indicator globe.
4. Remove two screws at back of light assembly, 1 screw at top of assembly.
Monaro: 3 screws, 1 at back, 1 at inside and 1 at top.
5. Gently remove the light from the body of the car.

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Install

1. Install the headlight assembly into the body of the vehicle.
2. Replace the 3 screws to the light assembly.
3. Connect both the headlight and turning indicator wiring loom.
4. GenIII: Install radiator top support cover, 4 screws.
5. Check operation of all the lights.
6. Check headlamp aim.

FOG LIGHT ASSEMBLY and GLOBE

Remove

1. In wheel arch, disconnect wiring loom connector to fog light.
2. Behind bumper bar remove the 3 screws attaching the light to the bumper bar, remove the fog light..
3. Remove two screws attaching the light lense.
4. Gently remove the light from the fog light body.
5. Remove wiring connector, spring clip, globe if necessary.

Install

1. Install a new globe of necessary, clip in spring clip, connect wiring connector.
2. Install the light assembly into the body of the fog light.
3. Replace the fog light to the rear of the front bumper, install 4 screws to the light assembly.
5. Connect the fog light wiring loom, inside the wheel arch.
6. Check operation of all the lights.

MONARO - FOG LIGHT and GLOBE

Remove

1. Remove the air intake grille from bumper assembly.
2. Remove light retaining rim, 1 screw at front.
3. Remove light, unclip globe retaining spring clip, remove globe, disconnect globe wire connector.

Install

1. Install a new globe if necessary, clip in spring clip, connect wiring connector.
2. Install the light assembly into the body of the fog light, install retaining rim, 1 screw.
3. Check operation of all the lights.

FOG/CORNERING LIGHT ASSEMBLY and GLOBE STATESMAN and CAPRICE

Statesman and Caprice globes are a turn and remove globe at rear of light.

Remove

1. Disconnect the wiring connector.
2. Remove the 3 screws at the rear of the bumper assembly, keep cournering light to one side and remove fog light.

Install

1. Install fog light, 3 screws.
2. Connect wiring connector and test lights.

FOG LIGHT ADJUSTMENT

Check fog light aim, vertical adjuster is at top of light, there is no horizontal adjustment.
Statesman and Caprice adjuster is at back of fog light.

SIDE INDICATOR ASSEMBLY and GLOBE



Remove

1. Remove inside wheel arch liner.
2. Grip light assembly, push to front of vehicle while pulling light from fender.
3. Pull globe and wiring assembly from light. Remove the turning indicator globe if necessary.

Install

1. Replace globe if necessary, install the globe assembly to the light.
2. Install light to fender, then pull back to rear to lock light into place.
3. Check operation of the lights.

LICENCE PLATE LIGHT - Sedan VT and VX Berlina

Remove

1. Use a small screw driver to remove both lenses from the boot light assembly, 2 screws.
2. Disconnect the light wiring loom and globe from the light.
3. Remove globe from the light if necessary.

Install

1. Install light into light assembly by pushing in.
2. Install the 2 lenses and 2 small screws, ensure the rubber seal is in place.

LICENCE PLATE LIGHT - Sedan VX sedan except Berlina, VY Sedans and Station Wagons

Replace

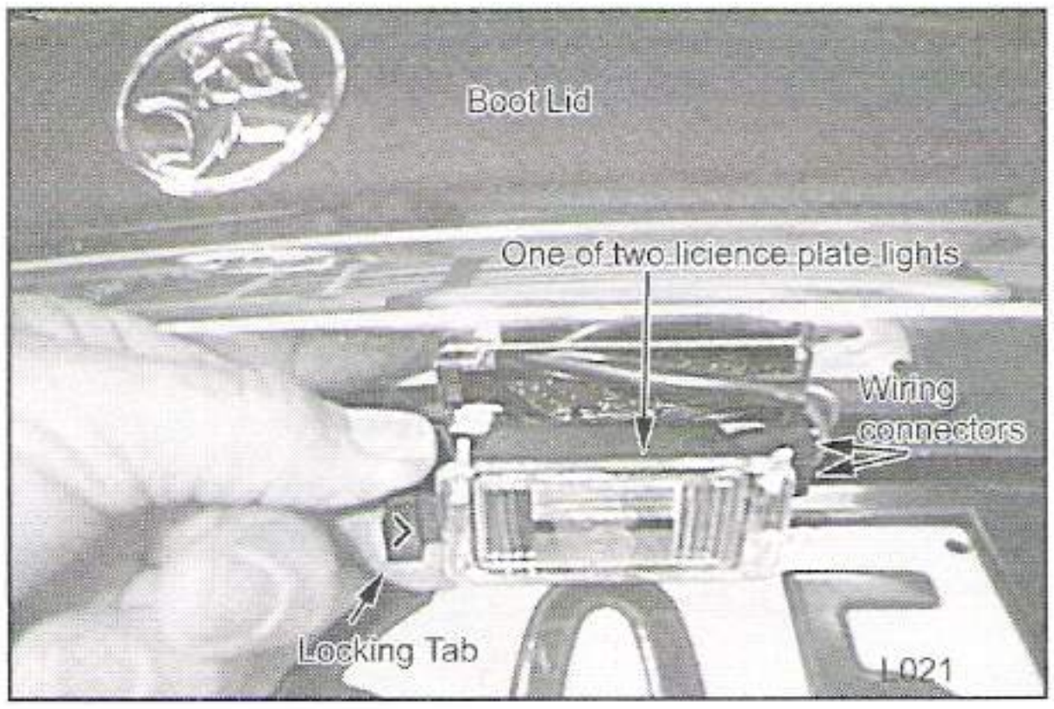
Replacement of Globes

1. Slide the locking tab to remove both light glass lenses.
2. Install new globes of the same wattage if required.
3. Replace the lenses, lock in locking tabs.

Remove

1. Open the tailgate and prize the inside trim from the tailgate.
2. Disconnect the wiring loom connectors and with the light lenses removed as when replacing globe, remove the light

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assembly.

Install

1. Install the light assembly into position, lock in locking tabs.
2. Connect the wiring loom inside tailgate.
3. Replace tailgate lining.

REVERSE R LIGHT - STATESMAN / CAPRICE

Remove

1. Open the boot and prize the inside trim from the boot lid.
2. Remove globes if necessary, push and turn and release.
3. Disconnect the wiring loom connectors, remove the 6 nuts attaching the light, remove the light assembly.

Install

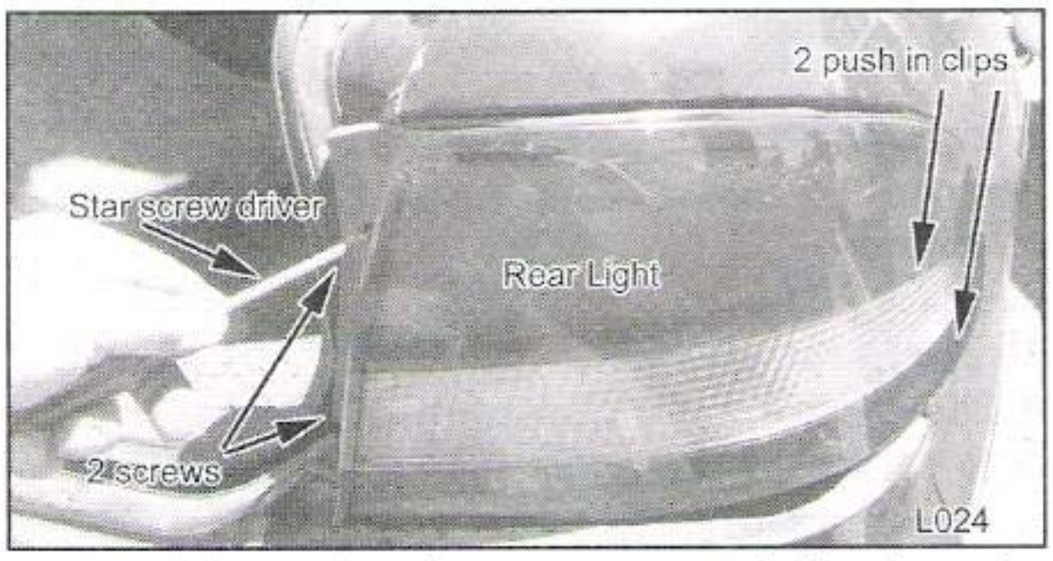
1. Install the light assembly into position and seal, install the 6 attaching nuts.
2. Connect the wiring loom inside boot lid.
3. Replace boot lid lining.

REAR PARK LIGHT, TURNING INDICATOR & STOP LIGHT - SEDAN

Tip: Calais rear light and harness is different to other models.

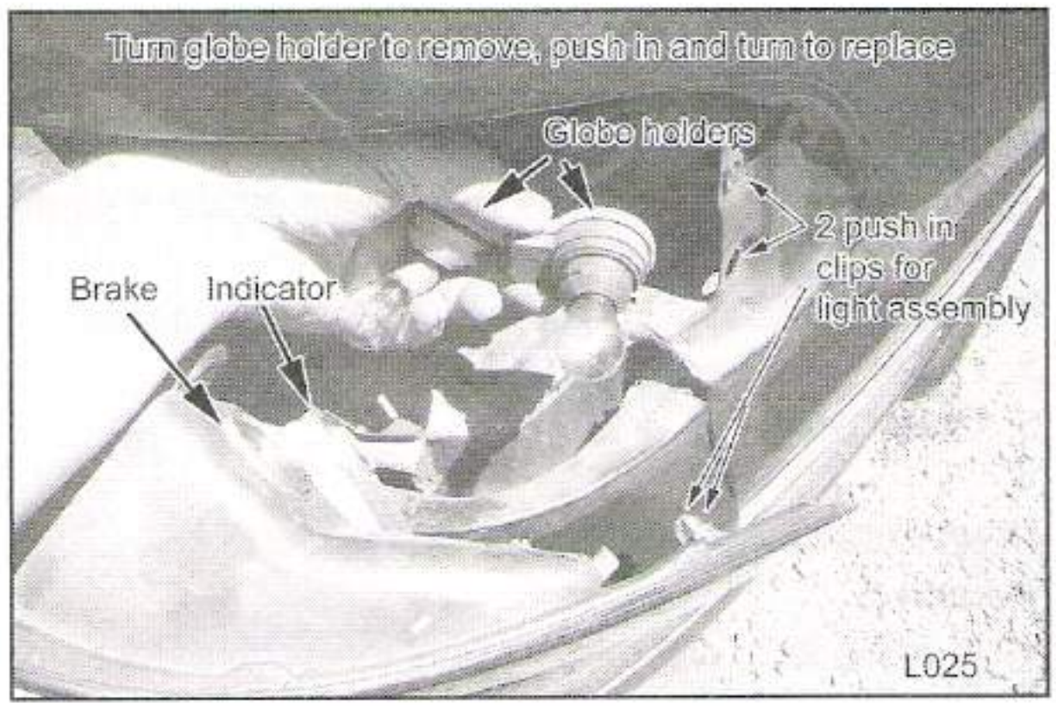
Remove

1. Open the boot.
2. Remove the 2 star screws attaching the the light to the body, of the outboard of the light is attached by push-in lockingpins.



3. The globes and sockets are connected directly to the wiring loom, remove the globes and sockets from the rear of the light assembly.

Replacement of Globes

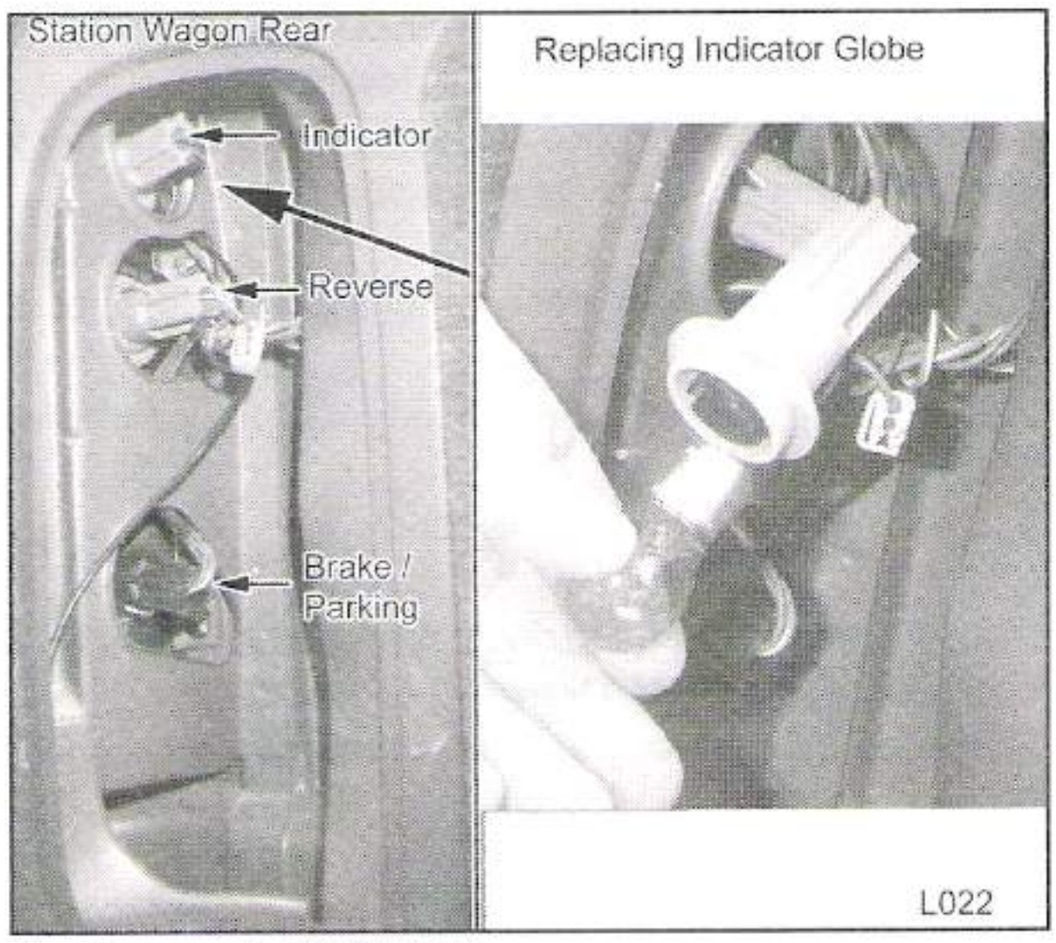


1. Turn the faulty globe and socket anticlockwise to remove the socket from the back of the light assembly
2. Remove the globe from the light socket.
3. Replace the globe with one of the same wattage.
4. Install the socket and new globe into the light assembly, turn clockwise to lock into place.
5. Inspect the lights.

Install

1. Install the light sockets and lock into place by turning the socket clockwise.
2. Install the light assembly to the rear fender panel, push in the locating pins, install the 2 screws.
3. Check the function of the lights.

REAR PARK LIGHT, TURNING INDICATOR & STOP LIGHT - Station Wagon & Utility



Replacement of Globes

1. Open tailgate, remove trim behind light, turn the faulty globe and socket anticlockwise to remove the socket from the back of the light assembly
2. Remove the globe from the light socket.
3. Replace the globe with one of the same wattage.
4. Install the socket and new globe into the light assembly, turn clockwise to lock into place.

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5. Inspect the lights.

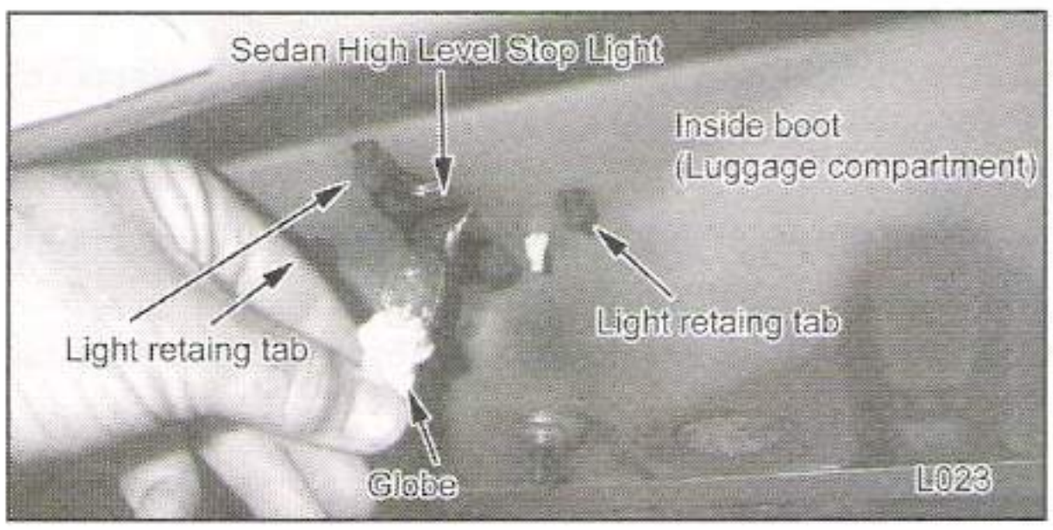
Remove

1. Lift tailgate or drop utility tailgate, remove trim behind light assembly.
2. Remove the 4 nuts attaching the light assembly to the back panel, remove the light assembly.
3. Either : Remove the globes and sockets from the rear of light assembly or unplug light wiring loom from main loom.

Install

1. Replace any faulty globes with one of the same wattage.
2. Install the light assembly into the back panel.
3. Install the socket and new globe into the light assembly, turn clockwise to lock into place or connect light wiring to main loom..
4. Check the function of the lights.
5. Close the tailgate.

HIGH MOUNT STOP LIGHT - Sedan



Remove

1. Open the boot and turn globe anti-clockwise to remove globe.
2. From inside boot use pliers to squeeze retaining tabs, then push tabs up. Inside vehicle pull stop light up and forward to release light.

Install

1. Inside vehicle, postion light near rrar window, push back and down to push in retainig tabs
Install light and wiring , 3 screws.
2. Replace globe from inside the boot.

HIGH MOUNT STOP LIGHT - Sedan

S, SS and HSV Sedans

Remove

1. Open the boot and prize the inside trim from the boot lid.
2. Disconnect the wiring loom connector to the stop light.
3. Remove the 4 nuts attaching the air spoiler to the boot, remove the air spoiler.
4. Stop light has a plate taped (double sided tape) over 3 screws, remove plate with blade or screw driver.
5. Remove the 3 screws and remove light and wiring.

Install

1. Install light and wiring , 3 screws.
2. Install screw cover plate, double sided tape.
3. Install the air spoiler assembly into position and seal, install the 4 attaching nuts.
4. Connect the wiring loom inside boot lid.
5. Replace boot lid lining.

STATESMAN / CAPRICE HIGH MOUNT STOP LIGHT

Replace globe from inside boot, turn and release globe socket.

Remove

1. Open the boot and remove globe from under parcel shelf.
2. Disconnect the wiring loom connector to the stop light.
3. Inside the sedan remove roof lining and parcel shelf trim as described in body chapter.
3. Remove light by pulling light from retaining clips.

Install

1. Install light, push down firmly.
2. Install parcel shelf and roof lining trim as described in body chapter.
3. Inside the boot install the globe and connect wiring connector.

MONARO HIGH MOUNT STOP LIGHT

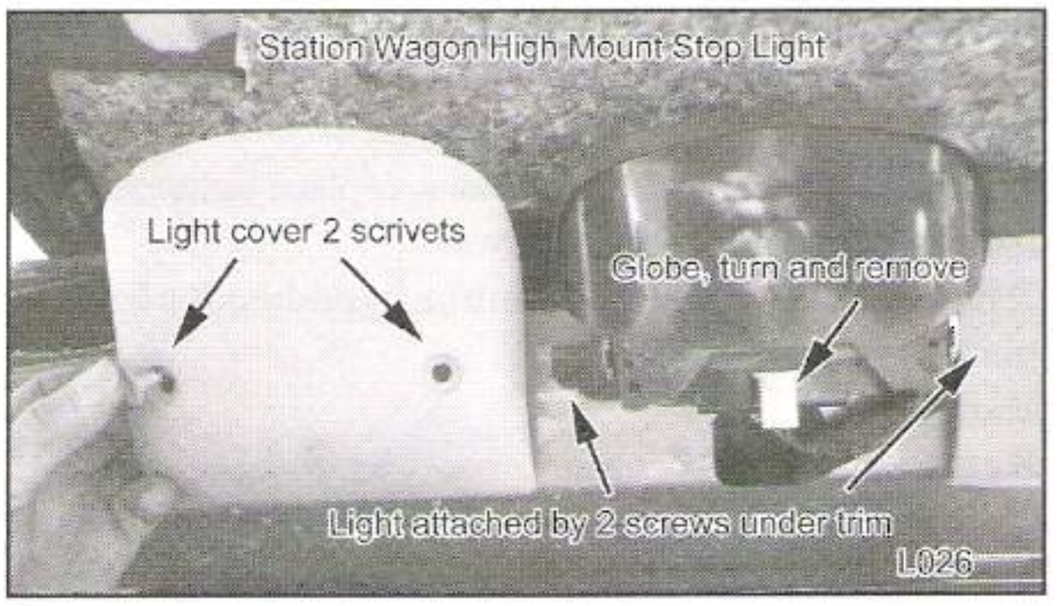
Remove

1. Open the boot and unclip the 2 front tabs of the stop light.
2. Inside the sedan, grip the sides of the light and lift / pull back the light to release 2 tabs at the rear of the light.
3. Disconnect the wiring loom connector to the stop light.
4. To remove the LED light use a thin blade to pry one end free gently move LED out of light assembly.

Install

1. Install LED into position, firmly press home.
2. Install light into place and push down and back towards the rear window to lock in back tabs.
3. Press down on front of light assembly to position, from inside boot clip down tabs.

STATION WAGON HIGH MOUNT STOP LIGHT



Remove

1. Remove the rear cover of light - 2 scrivets.
2. Remove globe socket by turning, remove globe if necessary.
3. Remove the light reflector by removing attaching screws if necessary.

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Install

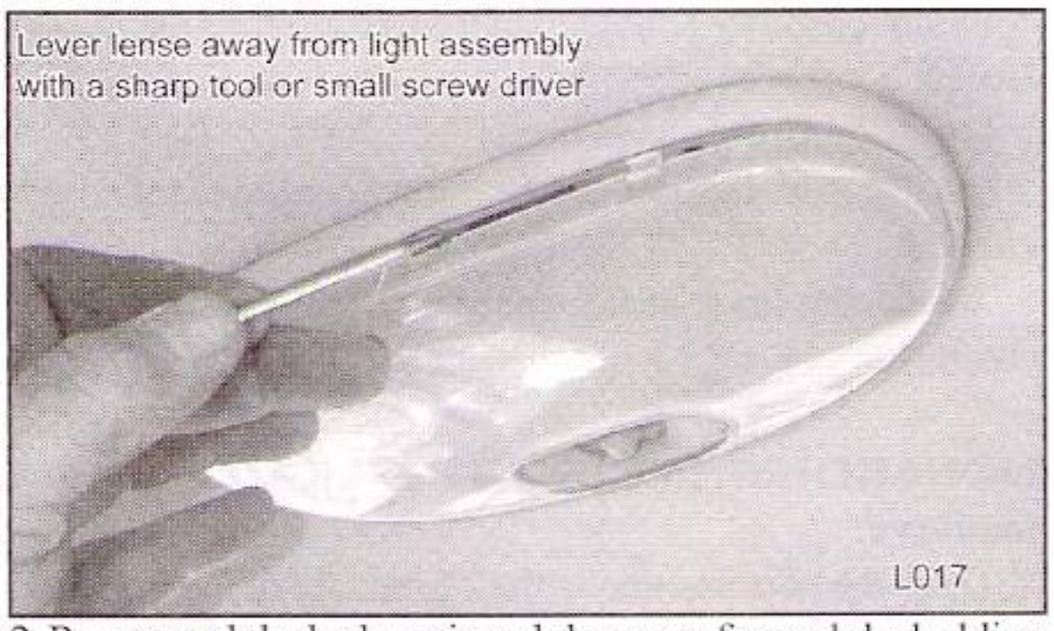
1. Replace the light reflector if removed tighten attaching screws.
2. Insert new globe if necessary into socket.
3. Replace light socket, turn to lock into place and replace rear cover, 2 scrivets

INTERNAL LIGHTS

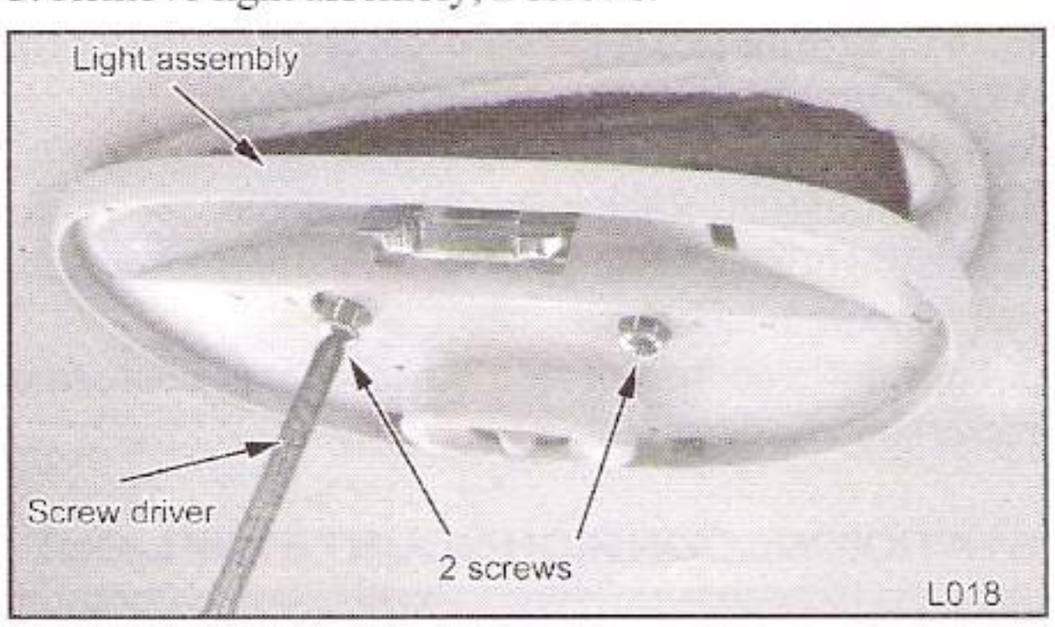
Roof Light

Remove

1. Remove the light lens by using a blade or small screw driver to pry lense and globe from light base, remove globe by bending back globe tab.



2. Remove globe by levering globe away from globe holding connectors.
3. Remove light assembly, 2 screws.



4. Remove the electrical connections from the light.

Install

1. Install the electrical connections, replace light assembly into position, install the 2 screrws.
2. Fix light and lens into position trim by pushing the light into place.

Door Lights

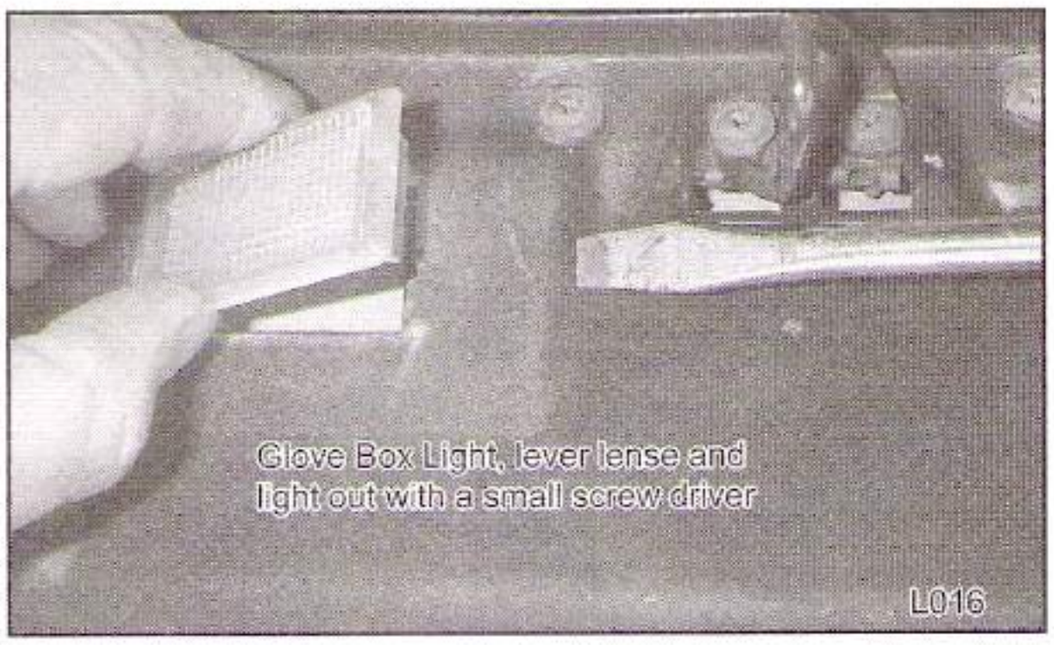
Remove

1. Remove the light lens by using a blade or small screw driver to pry lense and globe from light base, remove globe by bending back globe tab.
2. Remove globe by levering globe away from lense socket.
3. Remove the electrical connections from the light.

Install

1. Install the electrical connections, replace light assembly into door trim, install the electrical connections.
2. Fix light and lens into door trim by pushing the light into place.

Glove Box Light



Remove

1. Remove the light lens by using a blade or small screw driver to pry lense and globe from light base, remove globe by bending back globe tab.
2. Remove globe by levering globe away from lense socket.
3. Remove the electrical connections from the light.

Install

1. Install the electrical connections, replace light assembly into position, install the electrical connections.
2. Fix light and lens into position trim by pushing the light into place.

Boot Light

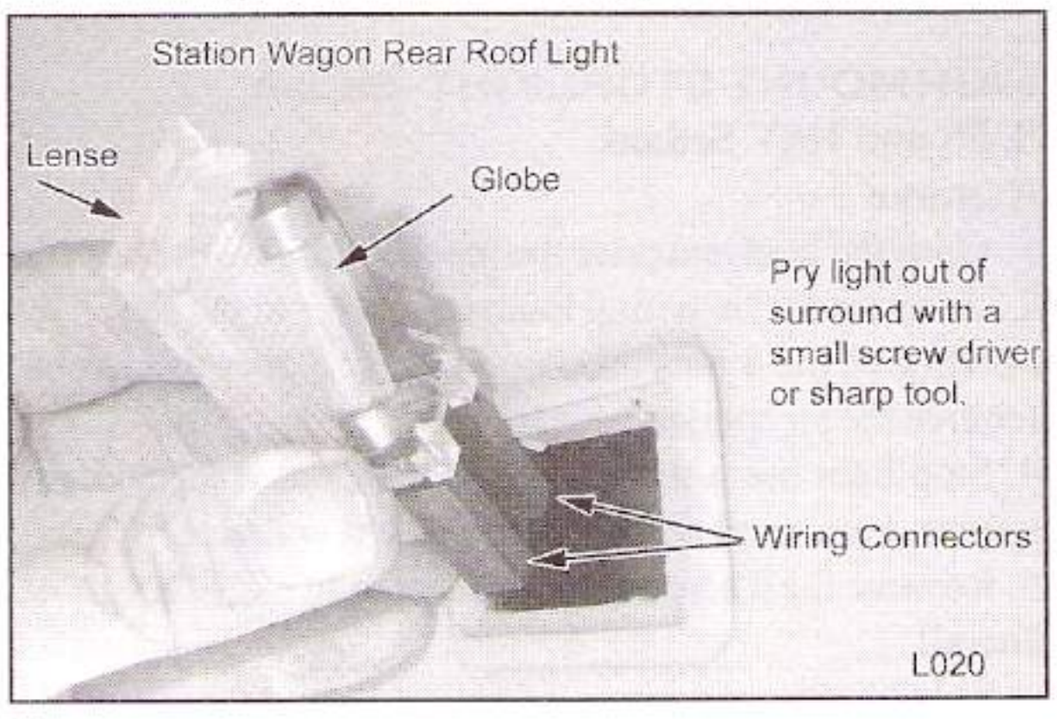
Remove

1. Remove the light lens by using a blade or small screw driver to pry lense and globe from light base, remove globe by bending back globe tab.
2. Remove globe by levering globe away from lense socket.
3. Remove the electrical connections from the light.

Install

1. Install the electrical connections, replace light assembly into position, install the electrical connections.
2. Fix light and lens into position trim by pushing the light into place.

Station Wagon Rear Internal Light



Remove

1. Remove the light lens by using a blade or small screw driver to pry lense and globe from light base, remove globe

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by bending back globe tab.
2. Remove globe by levering globe away from lense socket.
3. Remove the electrical connections from the light.

Install

1. Install the electrical connections, replace light assembly into position, install the electrical connections.
2. Fix light & lens into position by pushing the light into place.

Center Console Storage Compartment Light

Remove

1. Remove the light lens by using a blade or small screw driver to pry lense and globe from light base, remove globe by bending back globe tab.
2. Remove globe by levering globe away from lense socket.
3. Remove the electrical connections from the light.

Install

1. Install the electrical connections, replace light assembly into position, install the electrical connections.
2. Fix light and lens into position trim by pushing the light into place.

Rear Reading Light

Remove

1. Remove the light lens by using a blade or small screw driver to pry lense and globe from light base, remove globe by bending back globe tab.
2. Remove globe by levering globe away from lense socket.
3. Remove the electrical connections from the light.

Install

1. Install the electrical connections, replace light assembly into position, install the electrical connections.
2. Fix light and lens into position trim by pushing the light into place.

Calais Vanity Light

Tip: Mirror will break if care is not taken, 7 years bad luck.

Remove

Remove the light lens by using a blade or small screw driver to pry lense from light base, remove festoon globe by pulling from socket.

Install

Install the globe if necessary, push into place lense firmly.

Automatic Gear Shift Light

Remove center console gear shift surround.

Replace

Remove the light by turning anticlockwise, disconnect wiring connector. Replace globe if necessary. Install light and turn clockwise to lock into place.

Statesman / Caprice Front Dome Light

Remove

1. Remove the light lens by using a blade or small screw driver to pry lense and globe from light base, remove globes if necessary.
2. Reading light globes have a small cover to be levered off.
3. Remove the electrical connections from the light.

Install

1. Install the electrical connections, replace light assembly into position, install the electrical connections.
2. Fix light and lens into position trim by pushing the light into place.

INSTRUMENT CLUSTER, SWITCH AND WARNING LAMP CLUSTER ILLUMINATION

Instrument illumination and warning lamp bulbs are a push fit into sockets which twist.



Globe at rear of instrument cluster, turn to remove, push in and turn for installation.

Be031

Specifications

LIGHT	WATT	GLOBE
HEADLIGHTS		
Sedan / Wagon		
Hi/Lo Beam (Outboard)	60/55	H4
Inboard High Beam	55	H1
Monaro		
Low Beam Outboard	55	
Inboard High Beam	65	
FOG LIGHTS		
Sedan/ Wagon	27	H27W/2
Monaro	55	H3
PARK LIGHTS (Front)	5	Wedge
INDICATOR (Front)	21	Offset Pin (Orange)
INDICATOR (side)	5	Wedge
INDICATOR (Rear)	21	Offset Pin (Silver)
BACK-UP LIGHTS	21	Parallel Pin
STOP/TAIL LIGHTS	21/5	Parallel Pin
LICENCE PLATE LIGHTS	5	Wedge
INSTRUMENT CLUSTER ILLUMINATION LIGHTS	3.6/5	Wedge
INSTRUMENT CLUSTER WARNING LIGHTS	1.2	Wedge
TRIP COMPUTER LIGHT	1.2	Wedge
REAR COMPARTMENT LIGHTS	10	Festoon
DOME LIGHT	10	Festoon
FRONT READING	5	Parallel Pin
REAR READING	5	Festoon
GLOVE BOX	5	Festoon
FRONT FOOTWELL LAMPS	2.7	Wedge
FRONT VANITY MIRROR	1.2	Wedge
DOOR COURTESY	5	Festoon
CONSOLE BIN	5	Festoon
CENTRE HIGH MOUNT STOP	LED	Assembly
CIGAR LIGHTER	1.2	Wedge
IGNITION LOCK	1.2	Wedge

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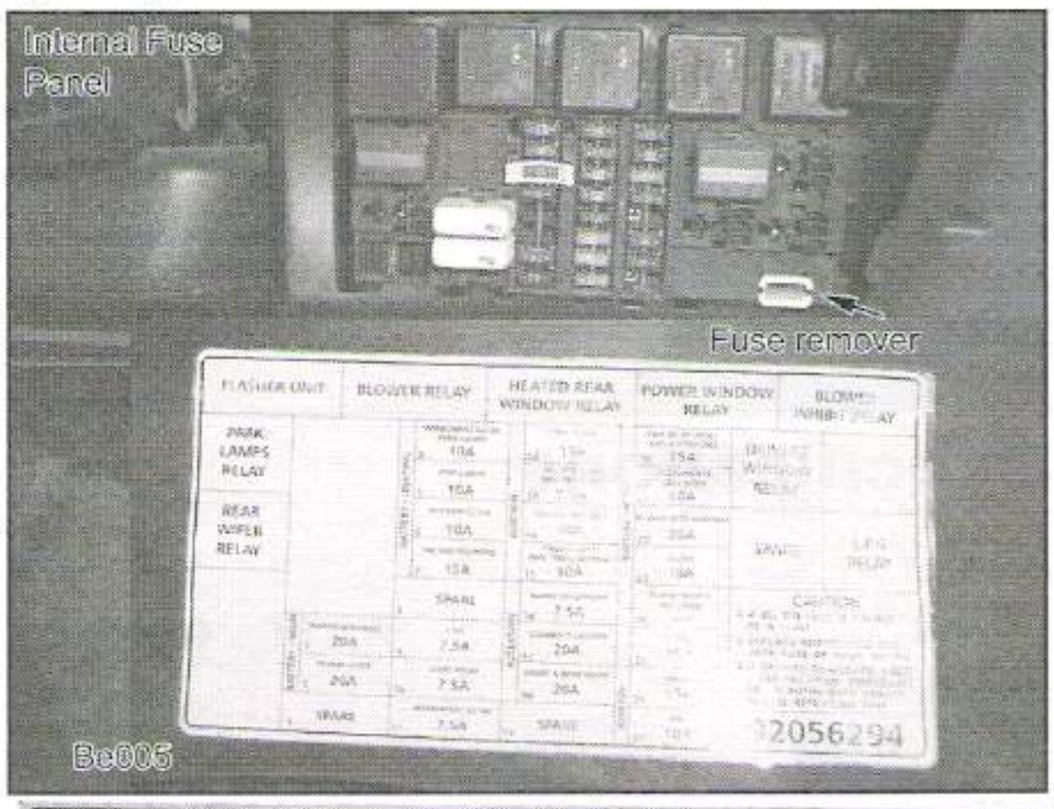
FUSES and RELAYS

Subject **Page**

Fuses 400
Relays 400

Fuses

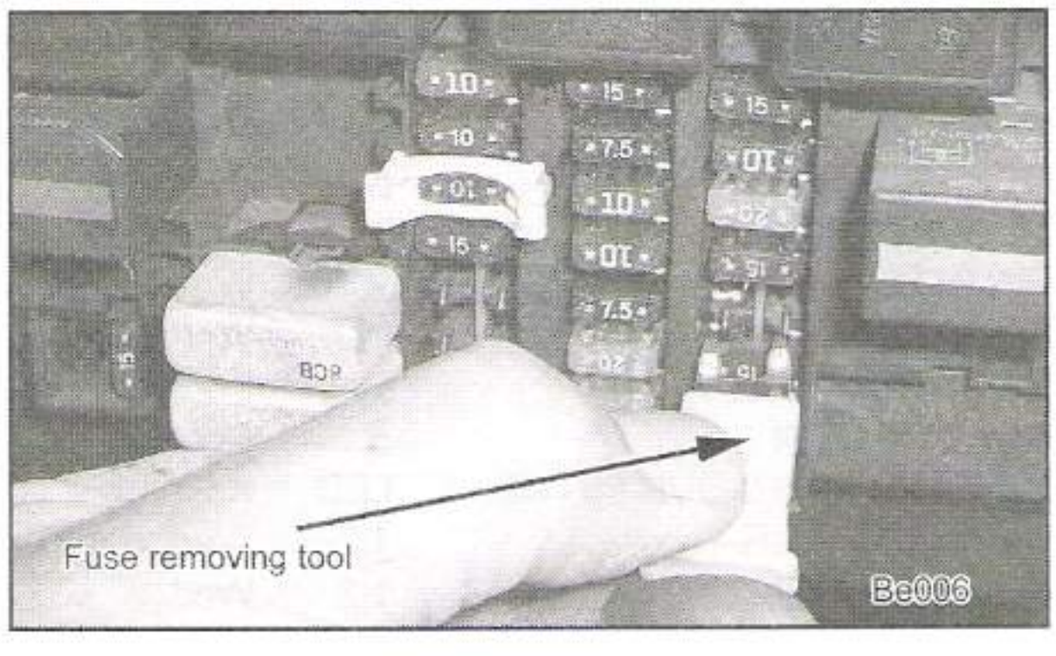
The main fuse box is located below the instrument panel on the drivers door side of the steering column. Access is gained by lifting the lower dash trim down.



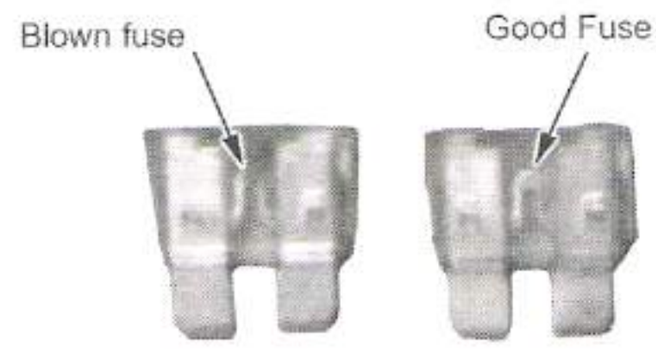


Fuse and Relay identification panel in cabin (lower dash) Be004

The engine comparment fuse box is located near the battery in the engine bay.
Fuses are miulti coloured to easily identify the fuse capacity.
The fuse capacity is also printed on the fuse. There is a fuse removing tool located in the fuse panel, slide the tool over the fuse required and pull out.



Fuses are identified with a label showing which circuit they belong to, as an example "wipers".
Inspection of fuses is achieved by removing the suspected fuse abd examining the element in the fuse for a break., this can also be tested with a multimeter for countinuity.



EI005

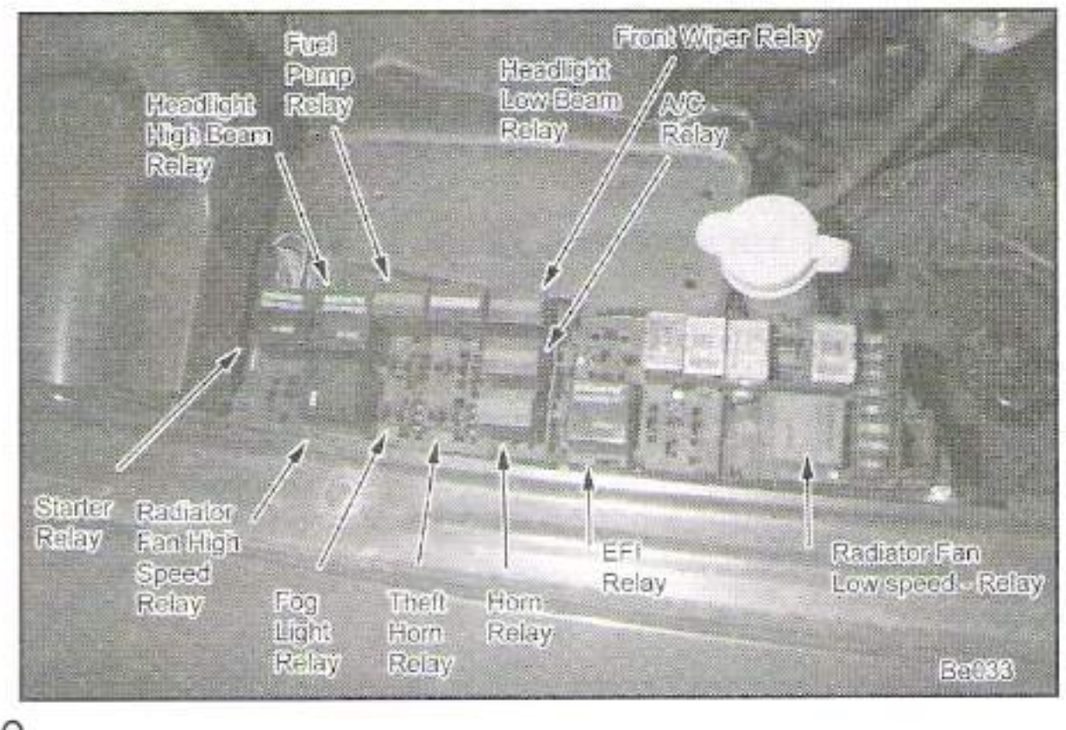
Note: Always repalce blown fuses with fuses of the same rating, if another fuse failure occurs, the circuit must be checked to find the cause of the fuse failure, once the fault has been corrected replace the fuse, with the correct rating.

Fuse Indentification Chart

Amp Rating (amps)	Fuse Colour
3	Violet
5	Tan
7.5	Brown
10	Red
15	Blue
20	Yellow
25	White
30	Green

Relays

Relays are located in two locations. Below the instrument panel on the drivers door side of the steering column. Access is gaine dby lifting the lower dash trim down. The engine comparment relays are llocated near the battery with the fuses in the engine bay.
Relays capacity is printed on the relay..
Relays are identified with a label showing which circuit they belong to, as an example "rear wiper relay".
Note: Always repalce faulty relays with relays of the same rating.



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Body Control Module -BCM

General Information

There are four different types of body control module (BCM) fitted to differnt luxury level vehicles. A "LOW" type (vehicles without power windows) and a "MID" (vehicles with power windows) fitted to Executive, Acclaim, S & SS models. A "LUX" type fitted to Berlina and high model Calais vehicles and "HIGH" type fitted to Statesman and Calais. When replacing a BCM, it must be replaced by one of the same type, BCM can be identified by label as shown.



BCM is fitted in the cabin fuse panel, as shown.



BCM functions	Low	Mid	Lux	Hi
Central door locking	Y	Y Y	Y	
Boot release	Y	Y Y	Y	
Elect window	N	Y Y	Y	
Elect radio antenna	N	N Y	Y	
Internal doom light	Y	Y Y	Y	
Rear light failure warning light	N	N N	Y	
Wiper speed variable action	N	N Y	Y	
Wiper fixed dwell action	Y	Y N	N	
S'wagon rear wiper control	N	Y Y	N	
Speed sensitive power steering	N	N N	A	
Instrument light dimming	N	N Y	Y	
Automatic lights OFF	Y	Y Y	Y	
Twilight lights ON	N	N N	Y	
Anti theft	N	N Y	Y	
Engine disable	Y	Y Y	Y	
Radiator low speed fan	Y	Y Y	Y	
Priority key system	N	N N	Y	
Cruise control interface	Y	Y Y	Y	
SRS shut down	Y	Y Y	Y	
Serial data interface	Y	Y Y	Y	
Heated rear window control	Y	Y N	N	
Air conditioning interface	Y	Y N	N	

Y: Yes capable N: Not capable

BCM Identification

The different BCM units can be identified by the label. Identification is tied to the digets of the part number on label

BCM Identification

Vehicle Model	Series	LevelID
VT Series I		
Exec, Acc, S and SS	Low 1	688 - LOW
" " "	Low 1	686 - MID
Berlina	High 2	687 - LUX
Calais	High 3	685 - HI
VT Series II		
Exec, Acc, S and SS	Low 1	315 - LOW
" " "	Low 1	313 - MID
Berlina	High 2	314 - LUX
Calais	High 3	312 - HI
VX Series I		
Exec, Acc, S and SS	Low 1	315 - LOW
" " "	Low 1	313 - MID
Berlina	High 2	314 - LUX
Calais	High 3	418 - HI
VX Series II		
Exec, Acc, S and SS	Low 1	20 - LOW
" " "	Low 1	21 - MID
Berlina	High 2	- LUX
Calais	High 3	- HII
VY Series I		
Exec, Acc, S and SS	Low 1	20 - LOW
" " "	Low 1	21 - MID
Berlina	High 2	- LUX
Calais	High 3	- HII
VY Series II		
Exec, Acc, S and SS	Low 1	20 - LOW
" " "	Low 1	21 - MID
Berlina	High 2	- LUX
Calais	High 3	- HII
VU Series I		
Utility	Low 1	315 - LOW
VU Series II		
Utility	Low 1	315 - LOW
S and SS	Low 1	20 - LOW
WH Series I & II		
WH Series I	High 3	312 - HI
WH Series II	High 3	418 - HI
Monaro		
V2 - CV6	Low 1	21 - MID
V2 - CV8	High 3	17 - HI - PS

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Switches and Horn

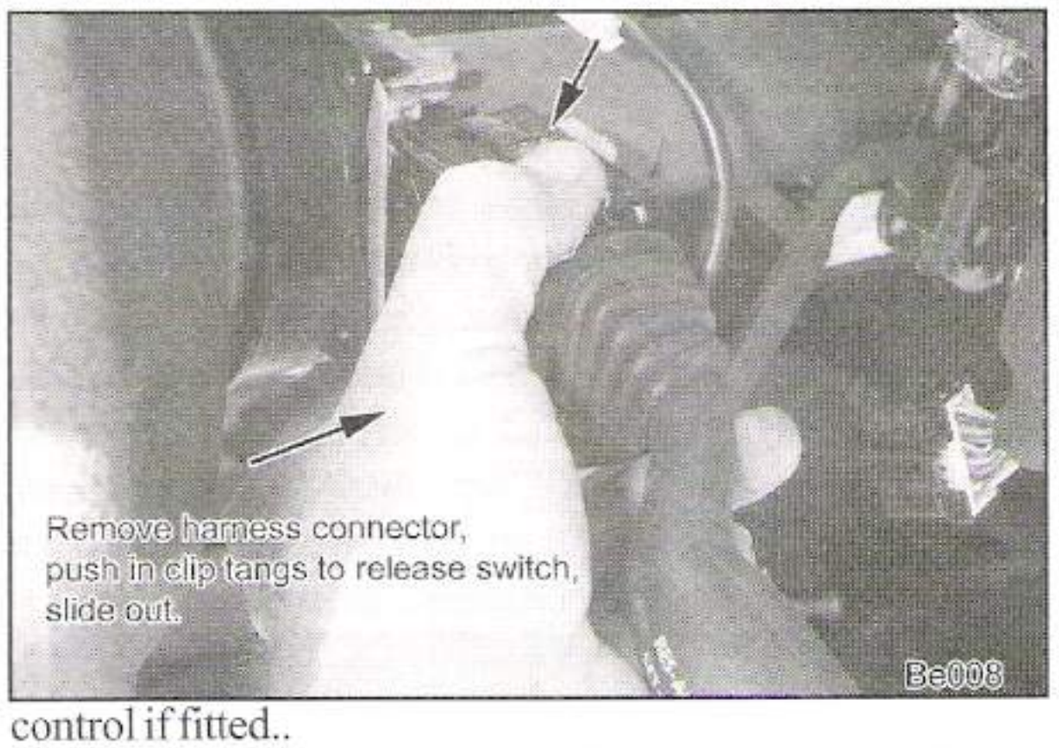
Subject	Page
Head Light, Indicator & Wiper/Washer Combination Switch	402
Remove	402
Install	403
Cruise Control Switch	**403**
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Install	403
Ignition Switch Assembly	**403**
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Install	403
Vehicle Speedo Sensor	**403**
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HEADLIGHT, TURN SIGNAL & CRUISE CONTROL COMBINATION SWITCH

** CAUTION: The vehicle may be fitted with SRS (Safety Air Bag), the SRS must be made inoperative, other wise it could cause harm to the repairer. See SRS Chapter

Remove

1. Disconnect battery earth terminal.
2. Turn the ignition key to the LOCK position
3. Remove drivers lower dash panel, *remove fuse number 26.*
4. Remove upper steering column trim, pull upper section back, use your finger on the lower section to push in and force forward to release clip.
5. Remove lower steering column trim, 1 screw, then pull trim back to driver to unclip.
6. Disconnect wiring harness connector to switch and cruise

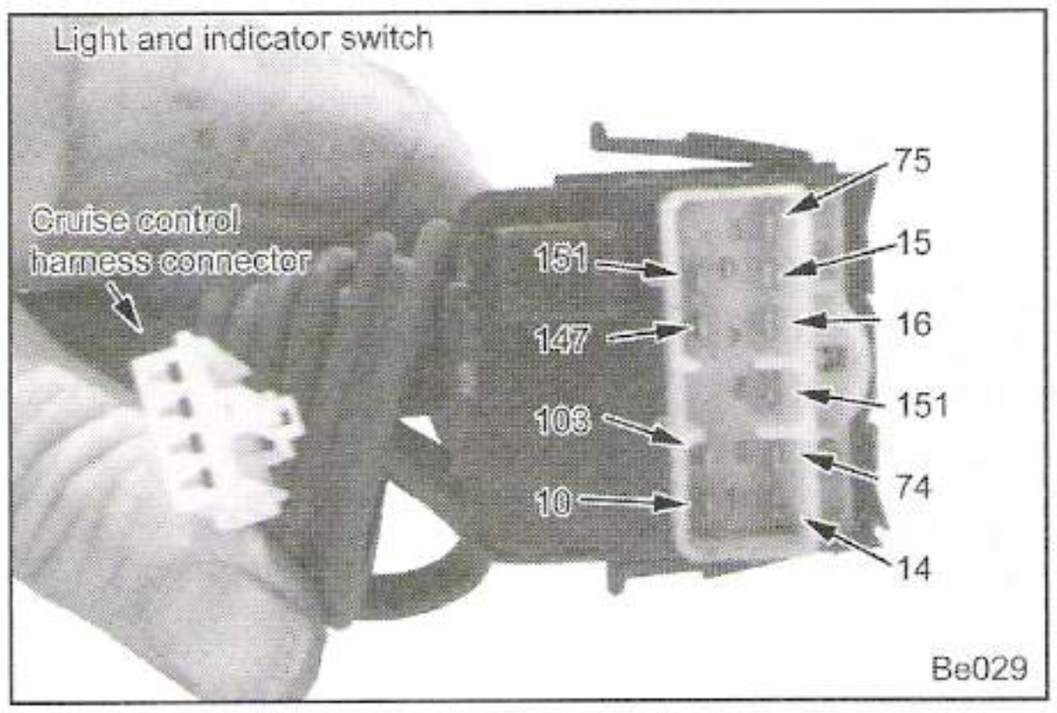


control if fitted..

7. Remove light switch arm by lifting clip tangs to release, remove wiring harness connector.

Test

1. Test the switch with a mulimeter at terminals for values as listed in chart. If results not as indicated replace switch.



Headlight and Turning Indicator Switch

Terminal	Switch	Result
Parking Light contacts		
151 - 75	Right	Continuity
151 - 74	Left	Continuity
Turn Indicator contacts		
16 - 15	Neutral	Open circuit
16 - 14	Neutral	Open circuit
16 - 15	Right indication	Continuity
16 - 14	Left indication	Continuity
Headlight Flash contacts		
151 - 10	Flash lights	Continuity
151 - 10	Hi beam or neutral	Open circuit
Headlight High Beam contacts		
147 - 10	Flash or neutral	Continuity
147 - 10	High Beam	Continuity
147 - 103	Neutral	Continuity
147 - 103	High Beam	Open circuit
147 - 103	Flash	Continuity

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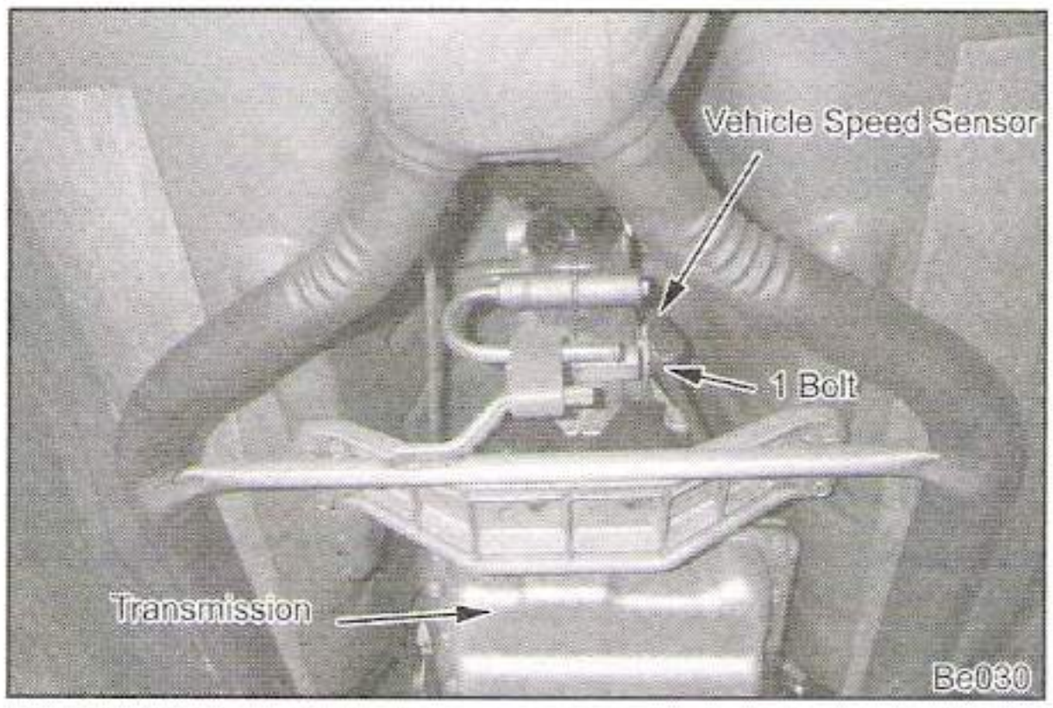
Install

1.Install light switch arm by connecting wiring harness connector, lifting clip tangs to install switch into position.
2. Install lower steering column trim into position push push to lock in, install 1 screw.
3. Install upper steering column trim, push upper section in towards dash to clip into place.
4. Install fuse number 26, install drivers lower dash panel.
5. Connect battery earth terminal.

VEHICLE SPEED SENSOR

Remove

1. Disconnect the electrical wiring to the sensor.
2. Remove the one bolts attaching the sensor to the rear of the transmission, remove the sensor.



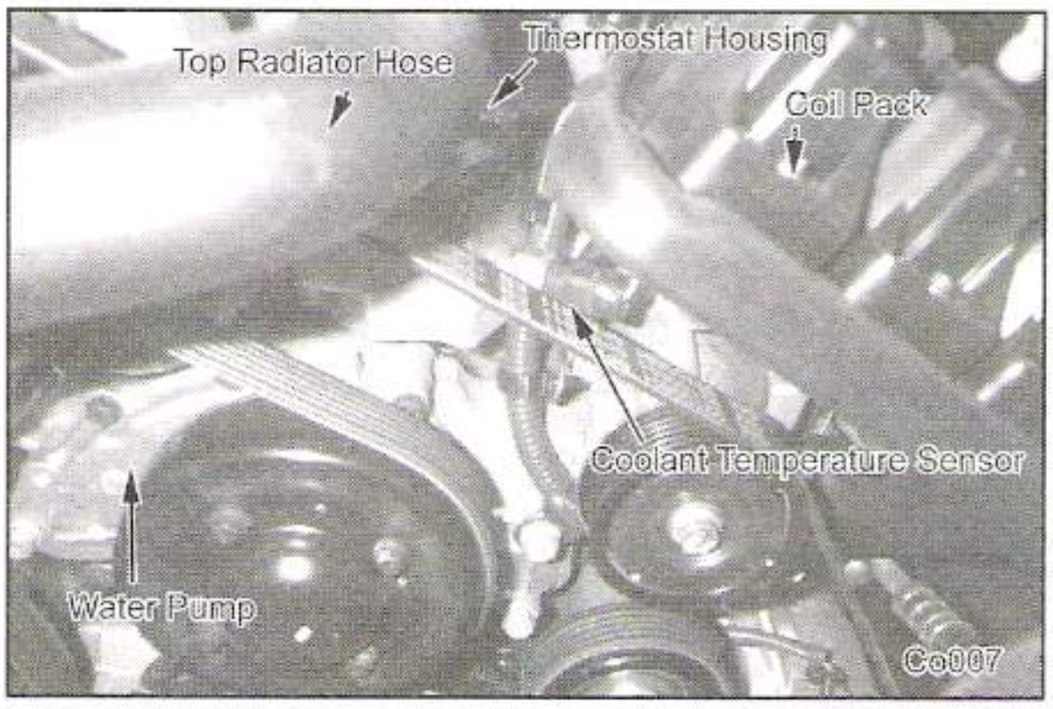
Install

1. Install the sensor to the transmission and tighten two bolts.
2. Reconnect the electrical wiring to the sensor.

COOLANT TEMPERATURE SENDER

Removal

1. Disconnect electrical connector from temperature gauge sender unit.
2. Unscrew and remove temperature gauge sender unit. Note that some coolant will discharge.



Installation

1. Screw in the new temperature gauge sender unit.
2. Reconnect electrical connector to temperature gauge sender unit.

OIL PRESSURE SWITCH



Removal

Disconnect electrical connector from oil pressure switch. Unscrew switch to remove.

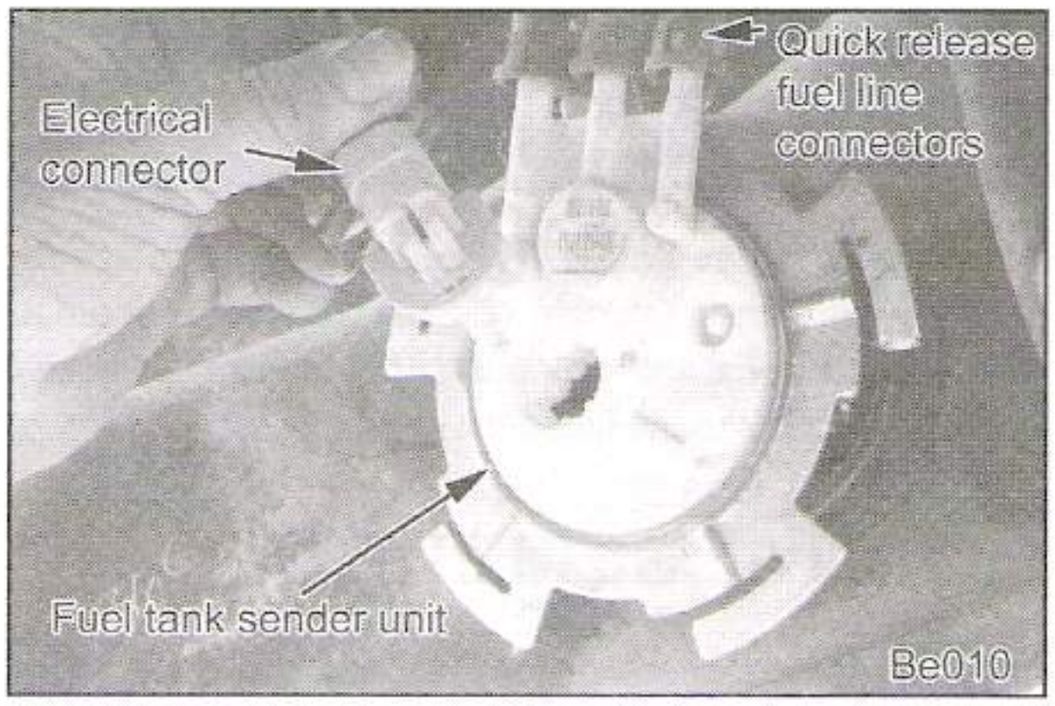
Installation

Install unit, tighten and fit electrical connection.

FUEL GAUGE SENDER

Removal

1. Remove the fuel tank or allow it be lowered by removing the supporting straps and bolts.
2. Disconnect the electrical connections for the fuel gauge sender unit.
3. Unscrew the lock plate (use a special tool or use a large screw driver and hammer to tap the plate around until loose enought to use your hand) on top of the fuel sender unit then remove unit from the fuel tank.



Installation

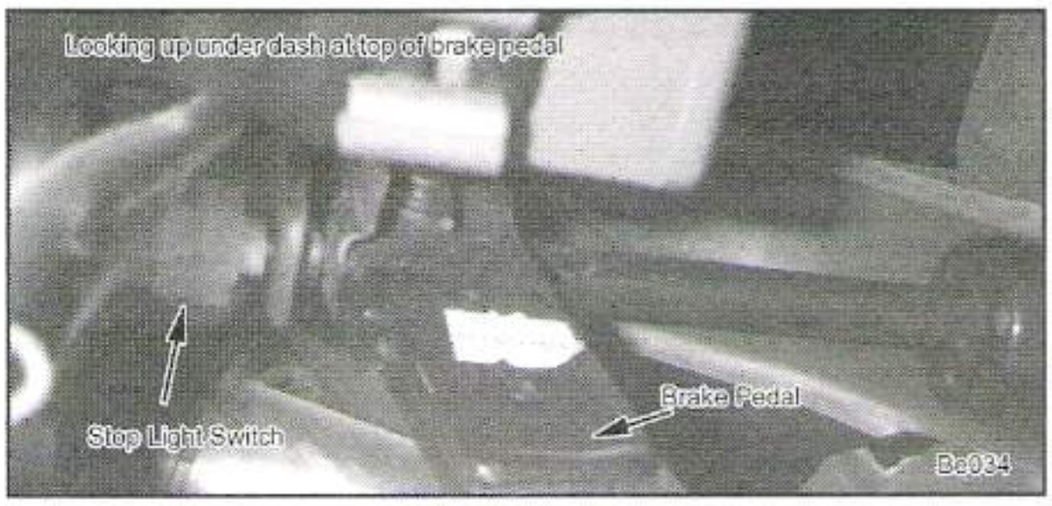
1. Clean mating surfaces of sender unit and tank.
2. Install new seal to sender unit then replace gauge sender unit into fuel tank.
3. Install and tighten the locking plate, reconnect electrical connections and check operation.
4. Install the tank to the vehicle.

STOP LIGHT SWITCH

Removal

1. Disconnect electrical connector from stop light switch located under the dash at the top of the brake pedal.

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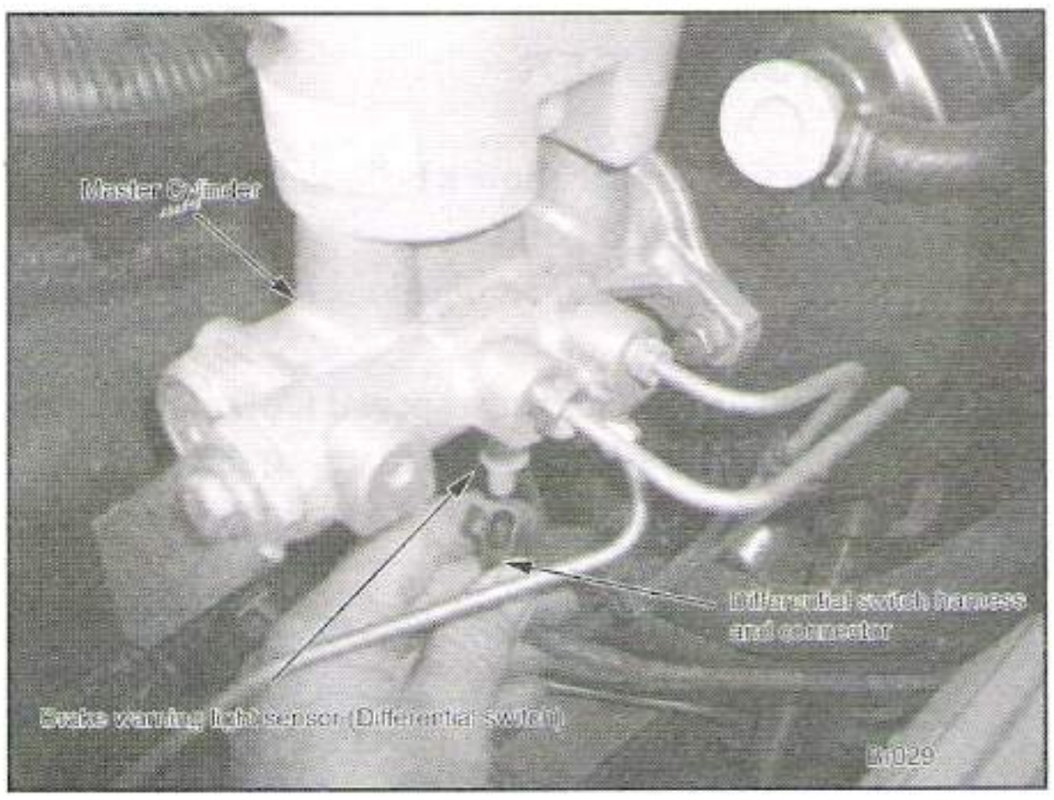
2. Unscrew the lock nut for the brake light switch and remove stop brake switch.

Installation

1. Install the new stop light switch and lock nuts.

2. Reconnect electrical connector to the stop light switch, operate brake pedal and adjust the switch lock nuts to activate the lights when a slight amount of pressure is applied to the pedal.

BRAKE FAILURE SENSOR



If the brake failure sensor (switch) is faulty, replace the warning light sensor (switch) system. The sensor should be able to be removed and replaced without loosing excessive brake fluid or having to bleed the system.

HORN ASSEMBLIES

** CAUTION: The vehicle may be fitted with SRS (Safety Air Bag), the SRS must be made inoperative, other wise it could cause harm to the repairer. See SRS Chapter

HORN/S

Located behind front bumper on chassis, right side.

Calais has a low note additional horn on the left side.

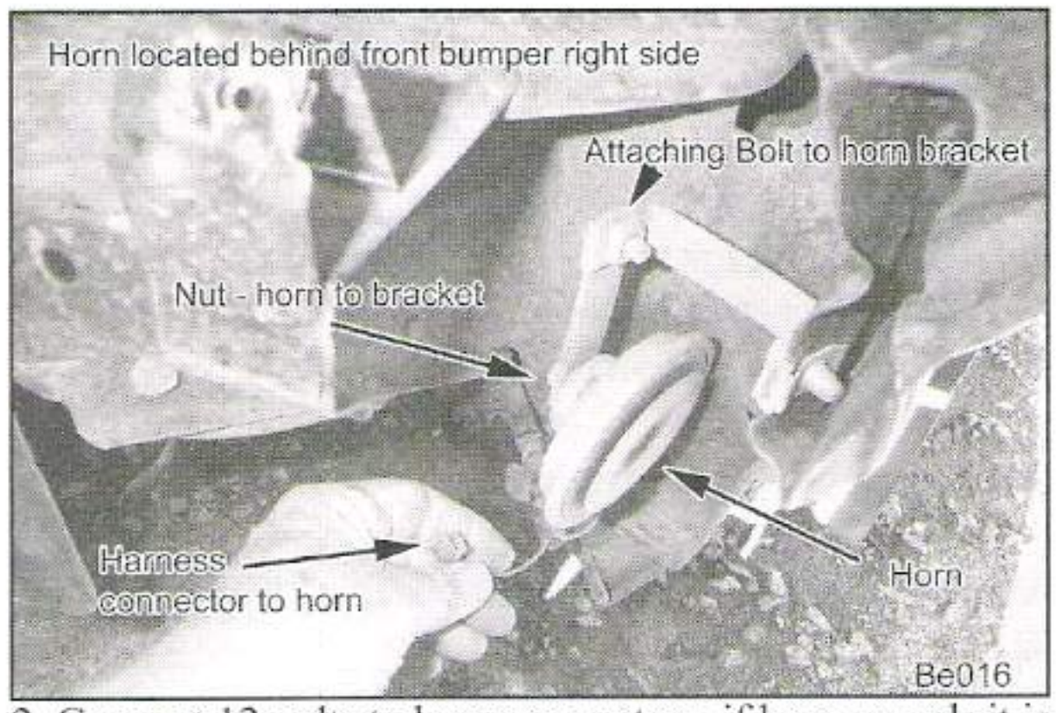
Remove

Disconnect electrical connector(s) from horn(s). Unscrew attaching bolt and remove horn(s).

Test

The horn/s canbe test either on or off the vehicle.

1. Disconnect the wiring connecor to the horn.



2. Connect 12 volts to horn connectors, if horn sounds it is OK, if notreplace.

Install

1. Install horn.

2. Tighten mounting bolts then install front radiator grille if necessary as described in body chapter.

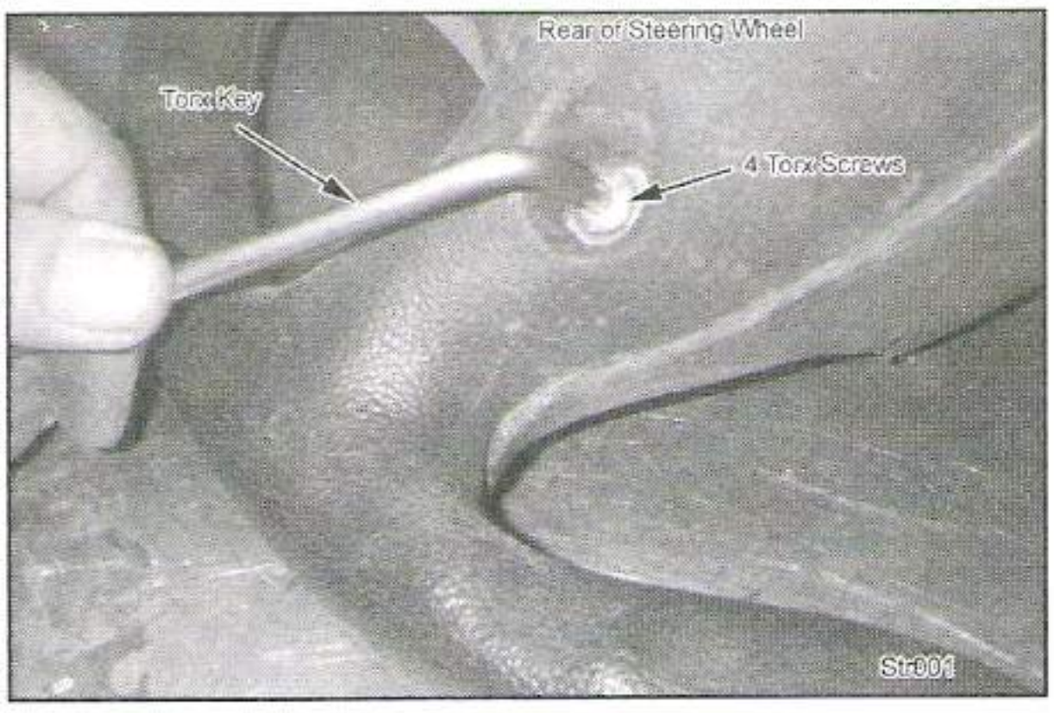
HORN RELAY

The horn relay is located in the fuse / relay panel in the engine compartment.

HORN ACTUATOR

The horn actuator is located in the centre of the steering wheel. To sound the horn the centre of the steering wheel is pushed in towards the steering column.

Remove



1. Remove the horn pad, 4 screws Torx T30H. Lift the pad / air bag from the steering wheel.

CAUTION: Carry removed air bag with opening side facing away from you. Do not support air bag by wiring. Store or position air bag on a flat stable bench with opening side facing up. Do not store in a confine area. There is danger zone of several meters from the air bag.

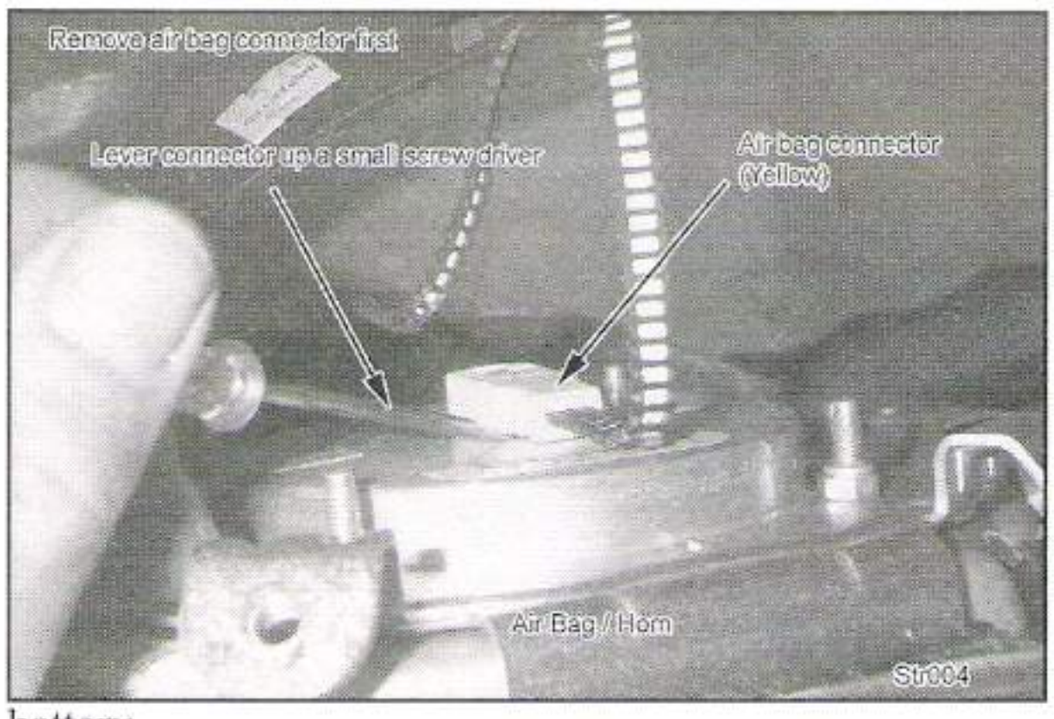
2. Disconnect the harness connectors, yellow first (Air bag) then other 1 or 2 connectors.

Tip: Take care when removing stero harness connector as it could cause a malfunction of the stero controls.

Install

1. Make sure the earth strap is still disconnected from the

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battery.

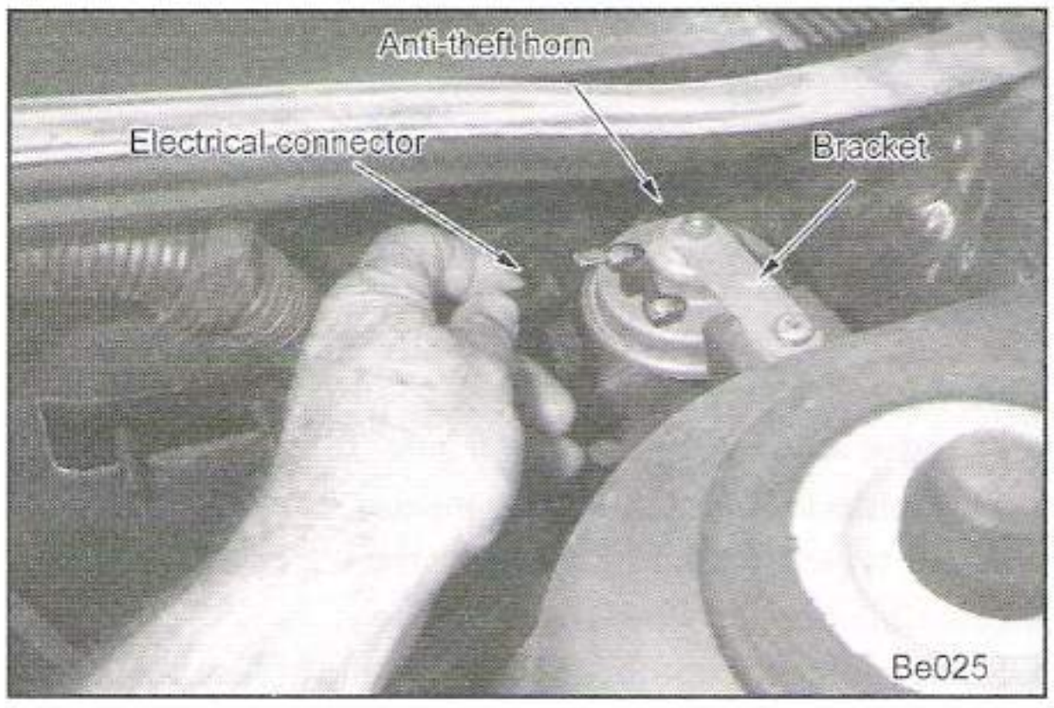
2. Replace horn / air bag, connect the wiring connectors.

3. Install the 4 screws at the rear of the horn pad, T30H screws at the back of steering wheel.

ANTI THEFT HORN

Located in engine bay between suspension tower and firewall.

Remove



Disconnect electrical connector from horn. Unscrew attaching bolt and remove horn.

Install

1. Install horn.

2. Tighten mounting bolts then install harness connector.

TEST ANTI THEFT HORN

1. Disconnect anti theft horn harness at horn.

2. Remove anti theft relay and jumper terminals 3 to 5.

3. Use a test light connected to harness connector terminal to earth.

- If light does not glow, there is fault in the anti theft horn circuit, connector terminal or BCM.
- Activate alarm system, test light should flash.

Note: If the light glows or flashes but horn does not sound when the harness is reconnected, the horn is faulty.

ANTI THEFT HORN RELAY

The horn relay is located in the fuse / relay panel in the engine compartment.

WIPERS and WASHERS

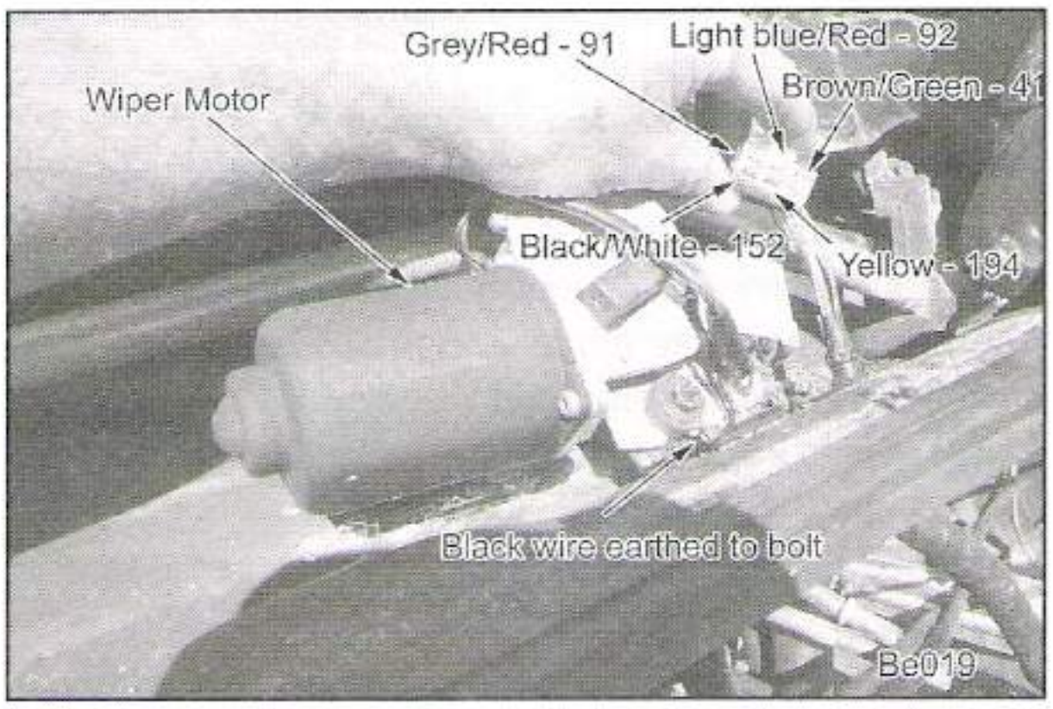
Subject	Page
Front Wiper	405
Station Wagon Rear Wiper	406
Wiper Washer	407
Wiper Washer Switch (Lever)	354

Front Wiper

Test circuits

1. Remove wiper blades and plenum covers..

2. Disconnect wiper harness connector and check circuits for voltage as indicated in chart with a multimeter.



Front wiper motor harness connector - harness side

Ignition is ON or ACC.
Multimeter -ve to connector Black wire (earth)

Circuit	Colour	Purpose	Switch	Result
41	Brown/Green	Power	--	approx 12 v
91	Grey / Red	low speed	Low	approx 12v
91	Grey / Red	Intermitant	INT	approx 12v
92	Light blue /red	high speed	Hi	approx 12v
152	Black / White	earth	--	0 ohms

Ignition is ON or ACC.
Multimeter -ve to connector Yellow wire (circuit 196)

Circuit	Colour	Purpose	Switch	Result
91	Grey / Red	Resistance	OFF	Continuity
91	Grey / Red	Resistance	INT	Continuity
91	Grey / Red	Resistance	LOW	Continuity
91	Grey / Red	Resistance	HIGH	Open circuit

Test Motor Operation

1. Remove wiper blades and plenum (plenum 6 scrivets, water defector 10 scrivets).

2. Disconnect wiper harness connector.

3. At the wiper attaching bolt, earth the wiper motor wire with a jumper wire to a battery -ve.

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4. a) Apply battery +ve to connector terminal for the red wire. The wiper motor should operate, if not replace.
b) Apply battery +ve to connector terminal for the green wire.
The wiper motor should operate at high speed, if not replace.



Wiper Motor connector terminals Be018

Test Motor Park.
1. Remove wiper blades and plenum (plenum 6 scrivets, water defector 10 scrivets).
2. Disconnect wiper harness connector.
3. At the wiper attaching bolt, earth the wiper motor wire with a jumper wire to a battery -ve.
4. a) Apply battery +ve to connector terminal for the red wire. Allow wiper motor to move an arm 50% of travell, then remove battery power from red wire terminal.
Test 1: Apply a test light, one wire to battery +ve the otfer wire to yellow wire terminal.
The light should not glow, if it glows yellow wire has short to earth or wiper motor faulty.
c) Use another jumper lead to red andyellow wire terminals together.
Apply battery =ve power to brown wire, wiper motor shaft should turn back to park position.

Station Wagon Rear Wiper

Test circuits
1. Remove internal trim from tail gate..
2. Disconnect wiper harness connector and check circuits for voltage as indicated in chart with a multimeter.

Rear wiper motor harness connector - harness side

Ignition is ON or ACC, wiper switch OFF

Circuit	Colour	Purpose	Result
41	Brown/White	Power	approx 12 v
391	Grey	Activate motor	0 v

Ignition is ON or ACC, wiper switch ON

Circuit	Colour	Purpose	Result
41	Brown/White	Power	approx 12 v
391	Grey	Activate motor	0 v

Test Motor Operation
1. Remove internal trim from tail gate..
2. Disconnect wiper harness connector.
3. At the wiper attaching bolt, earth the wiper motor brown wire with a jumper wire to a battery -ve.



Be035



Be036

4. Apply battery +ve to connector terminal for the blue wire.
The wiper motor should operate, if not replace.

Test Motor Park
1. Remove internal trim from tail gate..
2. Disconnect wiper harness connector.
3. At the wiper attaching bolt, earth the wiper motor brown wire with a jumper wire to a battery -ve.
4. Short connector terminals for black and blue wires with a jumper wire.
5. Apply battery +ve to connector terminal for the black wire.
The wiper motor should operate.
6. Disconnect jumper wire shorting black and blue wire terminals
The wiper motor should operate until it parks the wiper in the correct position., if not replace.

Wiper Washer

Test circuits
1. Disconnect wiper washer harness connector and check circuits as indicated in chart with a multimeter.

Front Wiper Washer harness connector - harness side

Multimeter +ve to Light Blue wire & -ve to White / Blue wire
Ignition is ON or ACC, wiper lever pulled back

Circuit	Colour	Purpose	Result
94	Light Blue	Power	approx 12 v

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Multimeter to White / Blue and Earth
Wiper lever pulled back

Circuit	Colour	Purpose	Result
494	White / Blue	Earth	0 ohms

Rear Wiper Washer harness connector - harness side

Multimeter +ve to White / Blue wire & -ve to Light Blue wire
Ignition is ON or ACC, wiper switch pushed forward

Circuit	Colour	Purpose	Result
494	White / Blue	Power	approx 12 v

Multimeter to White / Blue and Earth
Wiper lever pulled back

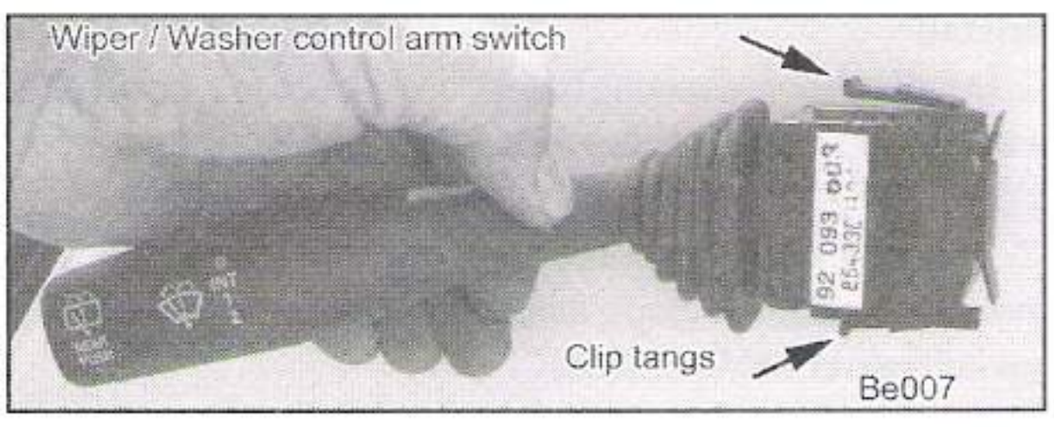
Circuit	Colour	Purpose	Result
94	Light Blue	Earth	0 ohms

Test Pump (located with washer bottle, front behind front bumper. Stationwagon rear,
1. Disconnect wiper washer harness connector and connect 12 volts to the pump terminals.
2. Pump should operate, if reverse 12 volt connection to terminals, if does not operate, replace pump.

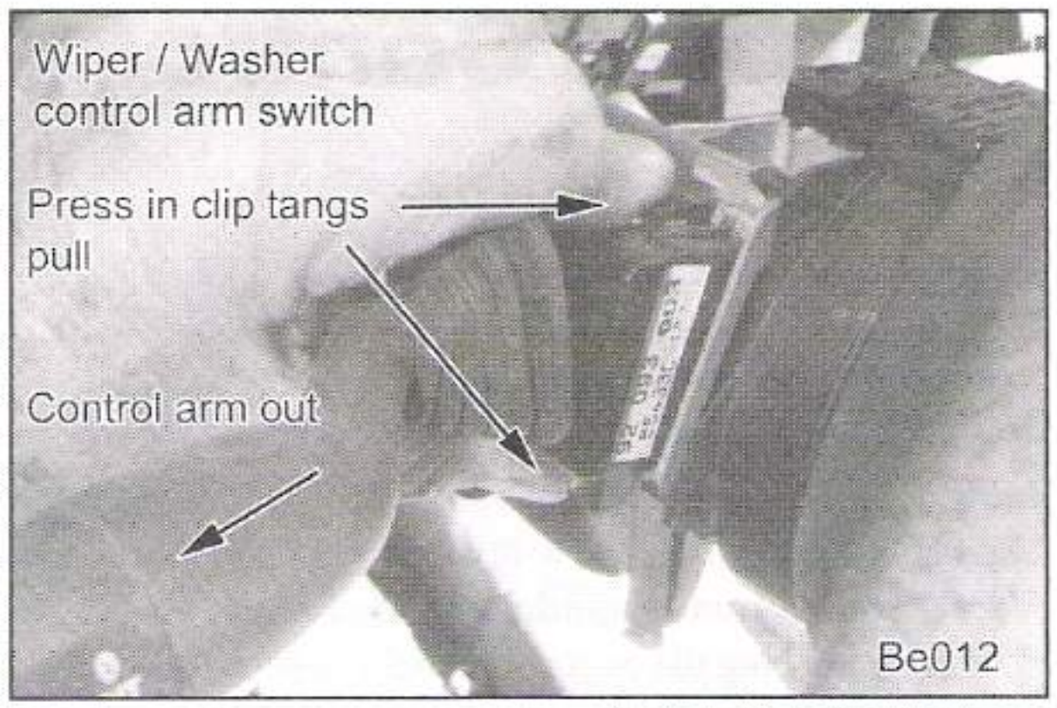
Wiper/Washer Switch (Lever)

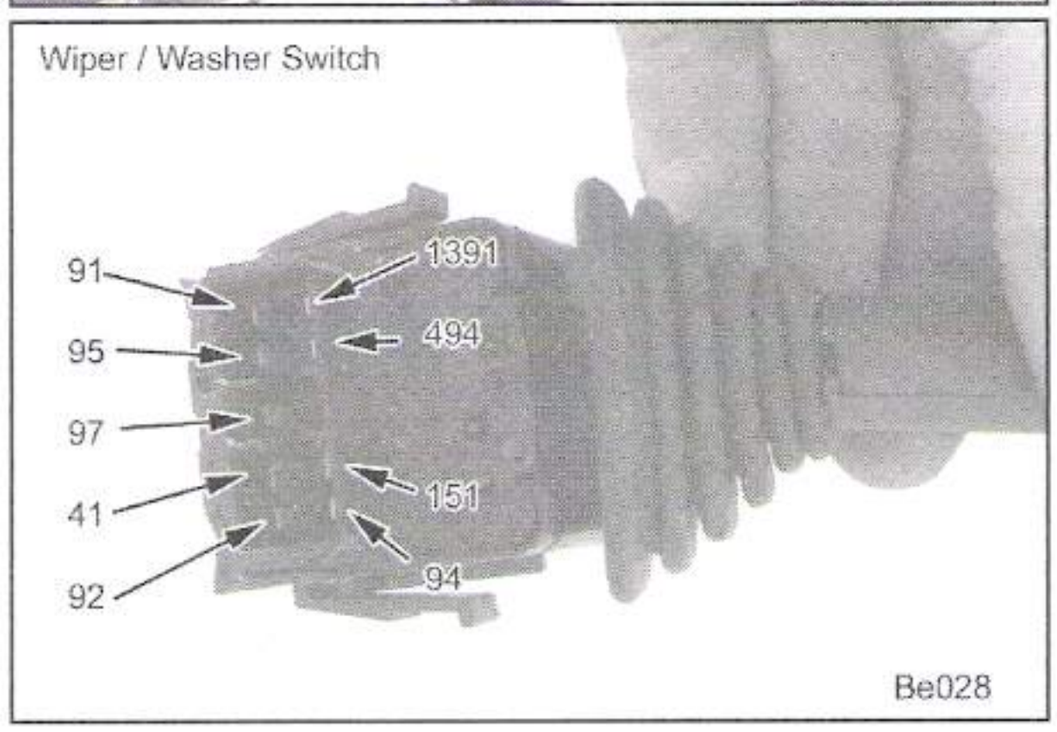
** CAUTION: The vehicle may be fitted with SRS (Safety Air Bag), the SRS must be made inoperative, other wise it could cause harm to the repairer. See SRS Chapter

Remove
1. Disconnect battery earth terminal.
2. Turn the ignition key to the LOCK position
3. Remove drivers lower dash panel, remove fuse number 26.
4. Remove upper steering column trim, pull upper section back, use your finger to on the lower section to push inand force forward to release clip.
5. Remove lower steering column trim, 1 screw, then pull trim back to driver to unclip.
6. Disconnect wiring harness connector, (high series has a wiper dwell harness and connector also).
7. Remove wiper switch arm by lifting clip tangs to release, remove wiring harness connector.



Test
1. Test the switch with a mulimeter at terminals for values as listed in chart.





Terminal	Switch	Result
91 - 95	Off	Continuity
91 -95	Int	Continuity
97 - 41	Int	Continuity
91 - 41	Low speed	Continuity
41 - 92	Hi speed	Continuity
94 - 41	Wash front	Continuity
151 - 494	Wash front	Continuity
41 - 1391	Rear wipe	Continuity
41 - 494	Wash rear	Continuity
41 - 1391	Wash rear	Continuity
94 - 151	Wash rear	Continuity

Dwell Control

Termnals	Result	Position
Betwen Terminals	5.3 kohms	Fully up
Between Terminals	680 ohms	Fully down

Install
1. Install wiper switch arm by connecting wiring harness connector, lifting clip tangs to install switch into position (high series has a wiper dwell harness and connector also).
2. Install lower steering column trim into position push push to lock in, install 1 screw.
3. Install upper steering column trim, push upper section in towards dash to clip into place.
4. Install fuse number 26, install drivers lower dash panel.
5. Connect battery earth terminal.

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Cruise Control

Cruise Control Cable and Module

Remove

1. Remove cable from throttle body.

V6: a) Release inner cable from throttle body linkage, by using a screw driver to release cable end clip, then pry cable end off linkage with a screw driver.

V8:a) Remove front engine dress cover, 1 screw. Loosen the 4 screws attaching the engine top dress cover to allow front cover to be removed.

V8: b) Inner cable is attached to linkage by a stud, nut and clip, use a screw driver to remove clip, remove nut and stud. Seperate inner cable from linkage.



b) Press the outer cable retaining clips to remove cable from bracket.

2. Remove cable from cruise control module.

a) Grip the outer cable near the module, rotate the outer cable into the engine bay, until it unclips from the module.

b) Pull outer cable back to expose the inner cable, lift the inner cable and end ball out of moule motor fitting to release inner cable.

c) Remove cable, unclip from any clips if necessary.

3. Disconnect the wiring harness to the cruise control module.

4. Remove the 3 screws attaching the module to the bracket.

Install

1. Install module and 3 screws attaching the module to the bracket.

2. Connect the wiring harness to the cruise control module.

3.Install cable to cruise control module.

a) Pull outer cable back to expose the inner cable, fit the inner cable and end ball into of moule motor fitting to attach inner cable.

b) Grip the outer cable near the module end, push outer cable to module, rotate the outer cable away from the engine bay, until it locks into the module.

4. Install cable to throttle body.

V6: a) Push inner cable end onto throttle body linkage, lock cable end clip.

V6: b) Position outer cable into bracket, then push locking clip down into bracket.

V8: a) Inner cable is attached to linkage by a stud, nut and clip, connect inner cable to linkage, fit nut and stud. Install clip.

V8: b) Position outer cable into bracket, then push locking clip onto bracket.

5. Position cable, clip into position.

Cruise Control Switch.

Remove and Install

See "HEADLIGHT, TURN SIGNAL & CRUISE CONTROL COMBINATION SWITCH" in this chapter.

Test Cruise Control Switch

Test wiring at harness connector, (backprobe) with a mulimter.

Cruise Control Switch

Wire	Switch Action	Ohms
Red to Grey	ON pushed in.	470w
Blue to Red	SET pushed in.	470w
Red to Green	RES+ pushed in.	470w

Note: Multimeter should read an open circuit when buttons not pushed in.

Brake Release Switch

Tip: If fault finding, make sure brake lights are operating, if repair brake lights firsty.

Remove

1. Remove right lower instrument dash panel trim (RHD) left lower dash panel trim (LHD).

2. Disconnect wiring harness.

3. Pull the switch from the retaing bracket.

Test Brake Release Switch

Switch can be tested while still installed with harness disconnected.

Use an ohmnmeter for testing.

Brake Release Switch - Test between terminals

Pedal not depressed	Continuity
Pedal pressed down	Open circuit

Install

1. Install cylindical retaing bracket if not installed, firmly slide switch into retaining bracket, while holding brake pedal down.

2. Pull on brake pedal onto stop, this will cause a clicking noise, pull till noise stops, then repeat. This is required to seat switch into correct position.

3. Connect harness to switch.

4. Install lower dash panel trim.

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Cruise Control Self Diagnosis

Proceedure	Action	Cruise light	Active light	Purpose
1	Ignition OFF	OFF	OFF	Deactivates any cruise control settings.
2	Depress ON/OFF switch and hold.	OFF	OFF	Starts diagnosis test.
				Note: Switch must be held until proceedure 8
3	Start engine	ON	OFF	
4	Allow 5 seconds	ON	OFF	Allows LOW TRAC warning light to go out if fitted.
5	Depress and hold SET/COAST switch	ON	ON	Testing SET/COAST switch operation
	Release SET/ COAST switch	ON	OFF	
6	Depress & hold RESUME/ACC switch	ON	ON	Testing RESUME/ACC switch operation
	Release RESUME /ACC switch	ON	OFF	
7	Depress and hold brake pedal	ON	ON	Testing release switch of cruise control
	Release brake pedal	ON	OFF	
	Deoress and hold brake pedal	ON	ON	
	Release brake pedal	ON	OFF	
8	Release ON/OFF switch	ON	ON	Begins stage of testing warning lights
9	Depress ON/OFF switch and hold	ON	OFF	Hold switch for completion of next test.
10	Depress and hold brake pedal	OFF	ON	Testing brake light switch A, and input to module, if not operating, repair before continueing
	Release brake pedal	OFF	OFF	
	Depress and hold brake pedal	OFF	ON	
	Releaase brake pedal	OFF	OFF	
11	Release ON/OFF switch	OFF	ON	Beginning next testing stage
12	Depress and hold brake pedal	OFF	OFF	Testing stepper cable and motor
	Crank engine to start	OFF	ON	Stepper motor should stroke and reset.
	Start engine and position in "Drive"	OFF	ON or OFF	
	Tesat drive while watching "Active" light	OFF	Flashing	If does not flash fit a new cruise control module.
13	Stop vehile and position "Park" turn engine OFF	OFF	OFF	Self diagnosis finished and cruise control reset.

ELECTRIC MIRRORS

Test Exterior Mirror

Test circuits

1. Remove mirror from door as described in body chapter.
2. Disconnect mirror harness connector and check circuits as indicated in chart with a multimeter.

Exterior Mirror - Ohms

Terminals	Result
A to B	continuity
A to C	continuity
B to C	continuity

Note: If high resistance ie200ohms or an open circuit is indicated repalce mirror.

3. Apply 12 volts +ve and -ve leads to terminals indicated to test operation of mirror, if results are not as indicated replace mirror.

Exterior Mirror - 12 volts

Left Hand Mirror

Terminals	A	B	C	Result
	-ve	+ve		mirror in
	+ve	-ve		mirror out
	+ve		-ve	mirror up
	-ve		+ve	mirror down

Right Hand Mirror

Terminals	A	B	C	Result
	+ve	-ve		mirror in
	-ve	+ve		mirror out
	+ve		-ve	mirror up
	-ve		+ve	mirror down

Test Exterior Mirror Control Switch

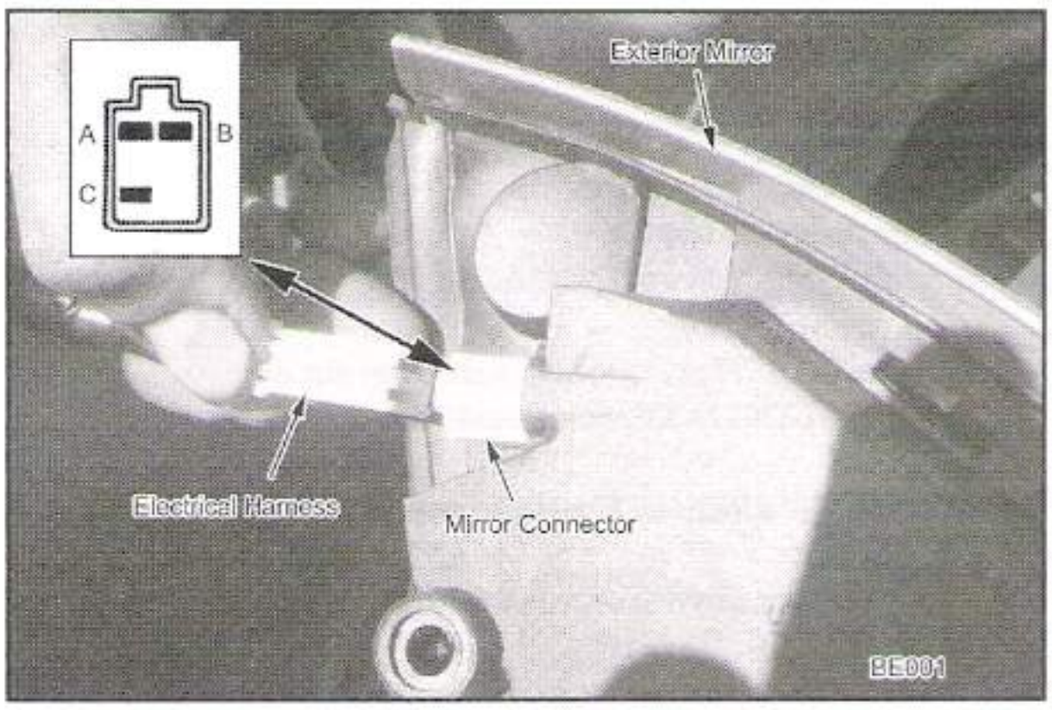
Test circuits

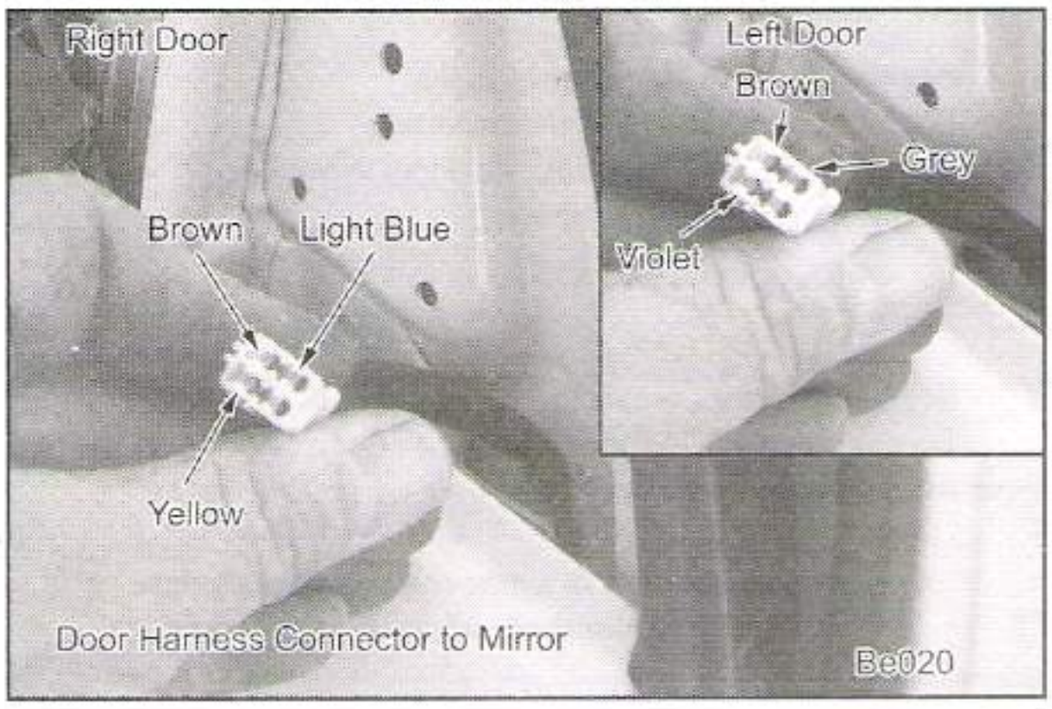
1. Remove inner door trim (as described in "Body" chapter).
2. Disconnect mirror harness connector and check circuits as indicated in chart with a multimeter.

Switch can be either probed at the switch, end of short harness connector between switch and door loom or door loom to mirror connector

If not as indicated replace switch.

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Exterior Mirror Switch - Ohms

Left Hand Mirror

Wire Colour	Operation	Result
Light Green to Black	Out	Continuity
Light Green to Brown	Int	Continuity
Yellow to Black	Up	Continuity
Yellow to Brown	Down	Continuity

Right Hand Mirror

Wire Colour	Operation	Result
Blue to Brown	Out	Continuity
Blue to Black	Int	Continuity
Grey to Black	Up	Continuity
Grey to Brown	Down	Continuity

3. Disconnect mirror harness connector and check circuits as indicated in chart with a multimeter. Connect multimeter then toggle switch to get result in chart
Switch can be either probed at the switch or end of short harness connector between switch and door loom.
If not as indicated replace switch.

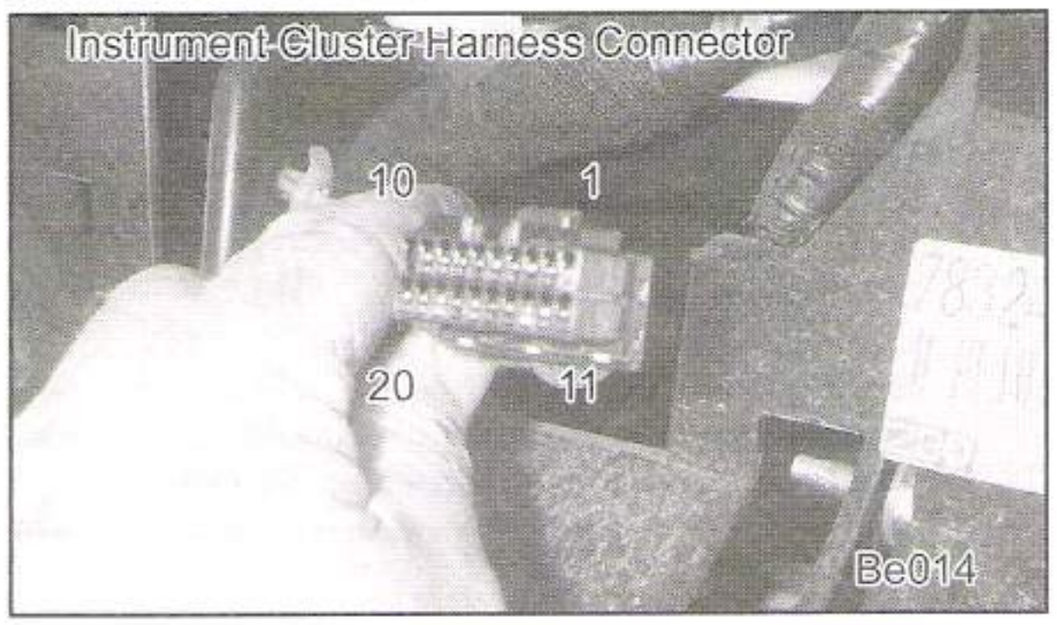
Toggle Exterior Mirror Switch - Ohms

Wire Colour	Direction	Result
Black/Red to Brown	D	Continuity
Black/Red to Black	E	Continuity
Black/Red to Black	F	Continuity
Black/Red to Brown	G	Continuity

Instrument Cluster

GENERERAL INFORMATION

The instrument cluster will need to be removed in order to carry out tests and check wiring, connectors etc. Refer to 'Body Section' for correct removal procedure.
When checking any of the instrument circuits ensure that the test instruments are connected correctly otherwise component damage could occur.
Identification of circuits



20 Pin Connector

Pin	Circuit
1	Right Indicator
2	Cruise control active
3	Fog lights on
4	Parking lights
5	Cluster illumination switch negative
6	Earth
7	High beam indicator
8	Left indicator
9	ABS off
10	LPG fuel activator
11	Low traction
12	Serial data circuit
13	Trip computer switch imput
14	Alternator
15	Brake
16	Fuel activator
17	Speed signal
18	Tachometer signal
19	Ignition
20	Battery +ve

SPEEDOMETER

Before checking the speedometer operation ensure that tyres are inflated correctly and are of the recommended size

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as specified by the manufacturer of vehicle.
The speedometer can be checked for accuracy using a speedometer tester, (compare to another vehicle that has an accurate speedometer) also check the odometer operation and check for pointer vibration or not stoping at 0.
**** if readings are not correct replace speedometer (odometer)***
The instrument cluster system has a self monitoring system with codes for faults.
The instrument clusters are a sealed unit and can not be repaired, if a system check is carried out and a fault is found the instrument cluster must be replaced.

Low Series Instrument Cluster
The high series has 1 display window.
Activate Codes
1.a) Press the "Mode" button and arrow up button at the same time while turning the ignition ON.
Window - The voltage will read v14.25 (battery voltage)
b) Press "Mode" button.
Fuel reading: 00.00 L
c) Press "Mode" button.
INST FUEL 00.00 L/H
d) Press "Mode" button.
TEMP 30^{0}C (temperature from PCM)
e) Press "Mode" button.
000 speed reading.
f) Press "Mode" button.
BV 5.0 (Button voltage)
g) Press "Mode" button
t XX - - (diagnostic code)
h) Press "Mode" button.
Window shows regular information.

---

t - trouble code.
XX - code number
- - (H for active or - inactive)
- - code status (C for active or - inactive

To exit diagnostic mode:
Press the arrow up and arrow down button at the same time

High Series Instrument Cluster
The high series has 3 display windows.
Activate Codes
1. Press the "Mode" button and arrow up button at the same time while turning the ignition ON.
a) Window 2 - The ododmeter will read.
b) The instrument cluster will then give:
Window 1 - a 000 speed reading.
Window 2 - v14.25 (battery voltage)
Window 3 - REMAINING FUEL xxx L (remaining fuel reading)
c) Press "Mode" button.
Window 1 - BV 5.0 (Button voltage)
Window 2 - TEMP 30^{0}C (temperature from PCM)
Window 3 - INST FUEL 00.00 L/H
d) Press "Mode" button.
Window 2 - t XX - - (diagnostic code)
e) Press "Mode" button.
All windows show regular information.

---

t - trouble code.
XX - code number
- - (H for active or - inactive)
- - code status (C for active or - inactive

To exit diagnostic mode:
Press the arrow up and arrow down button at the same time

Trouble Codes

Code Number	Fault
1	Fuel gauge sender, short circuit.
2	Fuel gauge sender, intermittent.
3	Fuel gauge sender, open circuit.
4	LPG gauge sender, open circuit.
5	LPG gauge sender, short circuit.
6	LPG gauge sender, intermittent.
8	ABS, serial data missing.
9	BCM, serial data missing.
10	ECC, serial data missing.
11	PCM, serial data missing.
12	SDM, serial data missing.
13	BCM, no instrument poll.
14	Serial data communication missing.
16	ABS or ABS/ETC.
17	BCM.
18	ECC.
19	PCM.
20	SDM.
24	EE error
25	ROM error
26	Cluster internal fault

Note: code 3 the" Fuel gauge sender, open circuit" will show as "t .

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Radio and Aerial

Aerial Receiption

Test the resistance of antenna with an ohm meter.
Tip: Disconnect battery earth lead as it may interfer with test, even with a none power antenna.

Aerial Test

Action	Result
Aerial cable to body body earth	0.6 ohm
Radio outter cable to body earth	0.3 ohm
Antenna inner cable to antenna	0.4 ohm

Power Aerial

Test Aerial
Test wiring circuits as described in chart, if circuits OK and antenna does not operate properly, check antenna earth. If earth OK replace antenna.
Inspect antenna harness connections.
Tip: If radio receiption is not good check antenna earth.

Power Aerial

White Wire	Red Wire	Result
12 volts	12 volts	Aerial UP
12 volts	0 volts	Aerial DOWN
0 volts	12 volts	Aerial NO movement
0 volts	0 volts	Aerial NO movement

Aerial Earth

Aerial Earth Wire to Vehicle body		1 Watt

Radio / Tape player / CD

Problem Diagnosis

Problem	Possible Cause
No or intermittant power.	Check fuse No 16. Bad coonector connection, partily re move radio unit from dash, disconnect harness and reconnect harness con nector. Check circuit No4 at back of radio harness connector. Check earth circuit 1151. Cellular phone circuit 656 (yellow/black) shorted to earth.
No or poor speaker sound.	Inspect all speaker termianls at rear of speakers. Inspect door harnessess for damage. Correct speakers must be fitted for correct radio range unit. Bad connector connection, partily re move radio unit from dash, disconnect harness and reconnect harness con nector. Faulty speaker, try working speaker.
Weak radio signal.	Damaged antenna, fit a new one. Antenna cable damaged. Alternator and/or coil suppressor faulty Radio or antenna earth. Antenna not extended. Antenna faulty.
Radio setting alter from last time driven or when driveing.	When the vehicle is locked with the remote priorty settings are stored in the BCM. If a different key is used to start the vehicle, the BCM will use settings from the key in use. Remedy: Use the same key to unlock vehicle and start vehicle.
Tape Player, cassettes will not eject	If cassettes do not eject properly the tape player door may be bent, remove unit repair door.
Tape Player, cassettes will not insert.	A foreign object or a cassette in the tape player, try to remove.
Cassette runs slow.	Remove tape, fast forward then fast rewined several times, try again. Faulty tape/cassette.
Tape Player poor sound or tone	Turn ignition and unit off, clean tape player heads with cleaning fluid or metholated spirits.
CD displays "EO1"	Install a loaded CD magazine into change unit.
CD displays	Install a CD into the magazine.

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"EO2".	
CD displays "EO4".	CD dirty or installed upside down.
CD displays "EO8".	CD unit to hot over 55°C, may need repairing.
CD displays "E99".	Hold On/Off knob in for at least 6-7 seconds then reload CD. Remove unit and repair.
CD jumps tracks on rough roads	CD unit has spring adjuster each side the slot must be verticle. Remove unit for repair. Damaged or dirty CD.

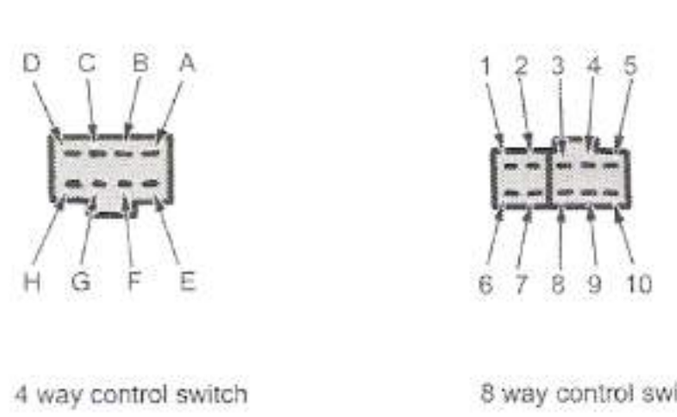


Electric Seats

Test Seat Control Switch - 4 Way & 8 Way

Remove Switch

1. Remove seat as described in Body chapter, seat should be in the highest position.
2. Remove the seat side cover, that is against the transmission tunnel.
a) Use a hammer and ounch drive the recliner shaft towards the other side of the seat by approx 2cm, then remove shaft and knob.
3. Remove the seat trim that is against the door, 1 screw under front section, remove screw plug by turning anticlock-wise 1/4 turn then remove screw behind plug.
4. Remove the front seat side trim
a) Remove the front and side screw.
b) Remove the trim side screw fastener, turn anti-clockwise, remove screw behind fastener.
c) Remove side trim, from under seat squeeze the 2 retaining clips in the center of trim.
d) Disconnect the seat adjuster wiring harness connector, behind trim.
5. Seat with electric 4 way adjustment.
a) Pry the switch away from the back of the seat cover trim clips.
Seat with electric 8 way adjustment.
a) Remove the 3 screws attaching the switch to the back of the seat cover trim.
4 Way Switch
Test terminals as indicated, if result not as shown, replace switch.



Electrical seat control switch terminals

4 way control switch

8 way control switch

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Seat Control Switch 4 - Way

Terminals	Position	Result
3 to 5,6, 7 or 8	Neutral	Continuity
2 to 7	Rear down	Continuity
2 to 6	Rear up	Continuity
2 to 8	Front down	Continuity
2 to 5	Front up	Continuity

8 Way Switch

Test terminals as indicated, if result not as shown, replace switch.

Seat Control Switch 8 - Way

Terminals	Position	Result
8-1 to 8-5	Neutral	Continuity
8-1 to 8-2	Back rest back	Continuity
8-1 to 8-4	Back rest forward	Continuity
8-1 to 8-3	Seat back	Continuity
8-1 to 8-10	Seat forward	Continuity
8-1 to 8-9	Seat down RH front	Continuity
8-1 to 8-6	Seat down LH front	Continuity
8-1 to 8-6	Seat up RH front	Continuity
8-1 to 8-9	Seat up LH front	Continuity
8-1 to 8-8	Seat down RH rear	Continuity
8-1 to 8-7	Seat down LH rear	Continuity
8-1 to 8-7	Seat up RH rear	Continuity
8-1 to 8-8	Seat up LH rear	Continuity

FUEL GAUGE

Gauge Receiver Operation

Test 1: To check the fuel gauge operation disconnect the electrical connector at the sender unit, turn the ignition switch to the on position and check that gauge reads empty.

Test 2: Remove sender unit from tank. Raise the float level while checking the resistance of the unit terminals with an ohm meter. Check with chart below, if not as specified repalce sender unit.

**** It will take a short period of time before readings stabilise***

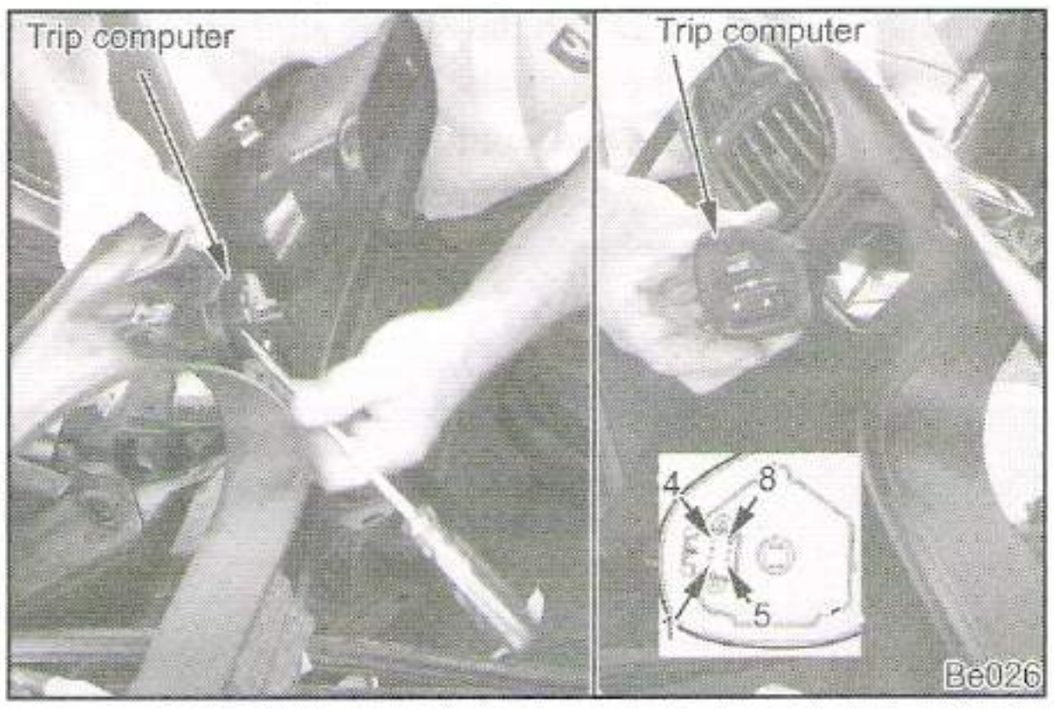
Fuel Gauge Sender Unit

Float level	*Tank level*	*Ohms*
3-10 mm	*Empty*	*37.5 - 42..5*
Half way up	*half full*	*110 - 115*
Up	*Full*	*246.7 - 253.3*

TRIP COMPUTER SWITCH

Remove

1. Remove the instrument panel facia so that the trip computer electrical harness connector can be removed.
2. Squeeze the switch tabs on the rear of the switch, then force switch forward and out,
3. Test the terminals with an ohm meter. Check with chart below, if not as specified replace switch.



Trip Computer Switch

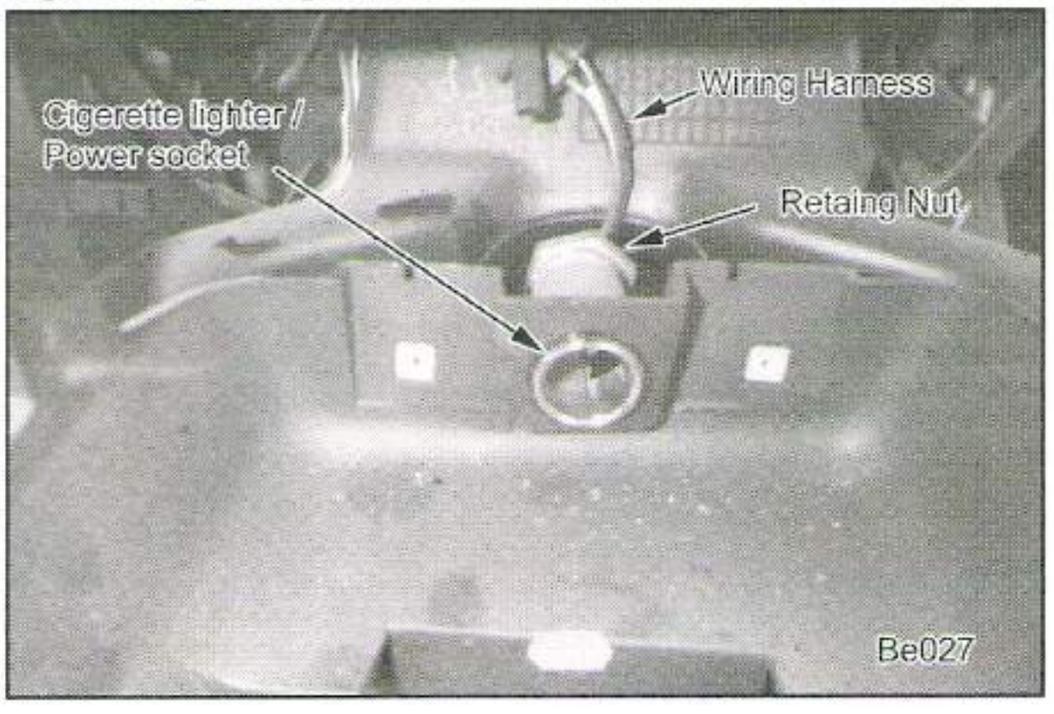
Terminal	Function	Terminal	Function
1	Not used	2	Not used
3	Security LED	4	Not used
5	Encode switch	6	Light eart
7	Light +ve	8	Earth

Button pressed	Terminal	Ohms
Mode	5 to 8	20k
Up	5 to 8	10k
Down	5 to 8	4.99k

CIGARETTE LIGHTER / POWER SOCKET

Remove

1. Remove the dash panel center facia.
2. Disconnect wiring connector.
3. Unscrew the retaining nut at the back of the holder, pull cigarette lighter / power socket out from the front of the facia.



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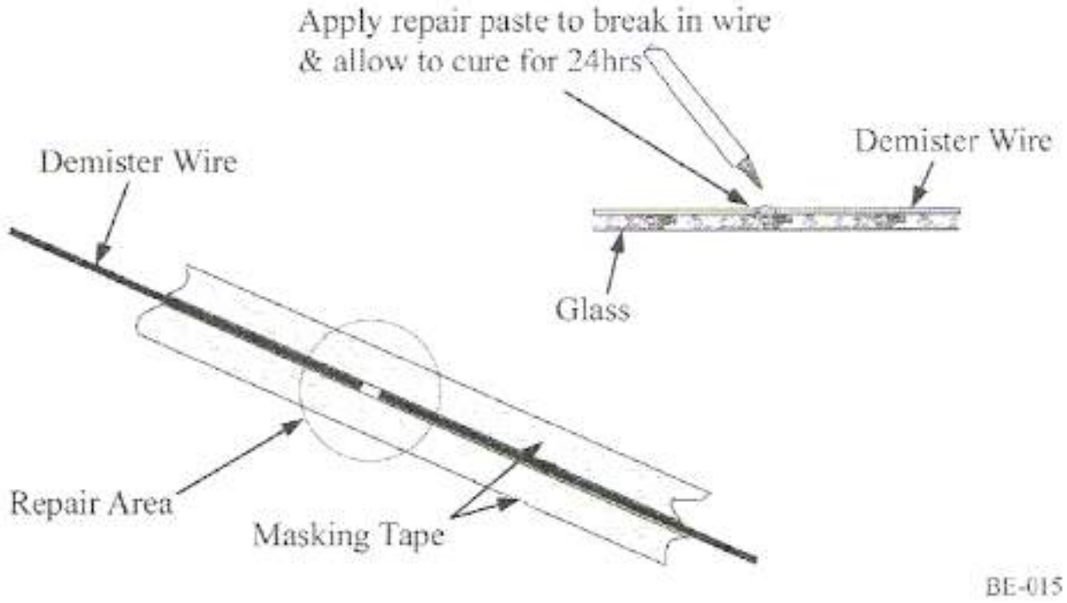
Install

1. Position cigarette lighter / power socket into facia, screw on holder at rear of facia, tighten and connect wiring harness.
2. Repalce dash panel center facia.

REAR WINDOW DEMISTER

General Information

The rear window demister is manually activated and can either be equipped *with a timer that will automatically turn the demister off after a set amount of time, or without a timer and must be manually turned off.*



Repairing Demister Wire

If it is found that one or more of the demister wires are broken they can be repaired with the use of a special electricity conducting paste.

1. Clean the wire and surrounding area with a grease, wax and silicone remover

**** do not use glass cleaners that contain abrasives***

2. Use masking tape along both sides of the wire to be repaired

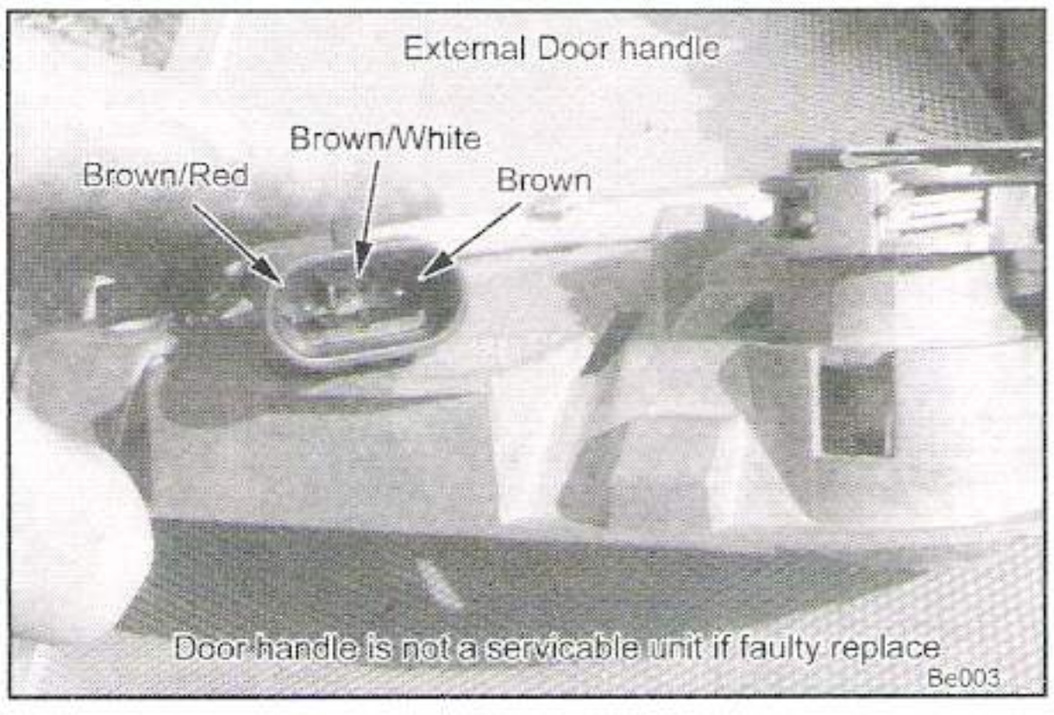
3. Thoroughly mix the repair paste:- Dupont No.4817 or similar

4. Apply a small amount of the paste to the broken area of the wire.

a) After a few minutes carefully remove the masking tape

b) Allow the paste to dry for at least 24 hrs before use

Front and Rear External Door Lock Assembly



Remove the door trim etc refer to 'Body Section', disconnect the electrical connector at the handle check for continuity at the following terminals:

External door handle lock

Wire Colour	Lock	Result
Brown/Red to Brown/White	Normal	Open circuit
Brown/Red to Brown	Normal	Open circuit
Brown/White to Brown	Normal	Open circuit
Brown/Red to Brown	Lock	Continuity
Brown/Red to Brown/White	Lock	Open circuit
Brown/Red to Brown/White	Unlock	Continuity
Brown/Red to Brown	Unlock	Open circuit

Power Window Switch

Remove

1. Lift center console compartment lid.
2. Use your fingers to push in the two tabs of the power window switch as you lift rear of switch with a small screw driver or flate object.
3. Disconnect wiring harnes connector.
4. Test switch as per chart, repalce switch if not as specified.

Tip: Do not have your finger on the printed cirucit as you are testing the switch

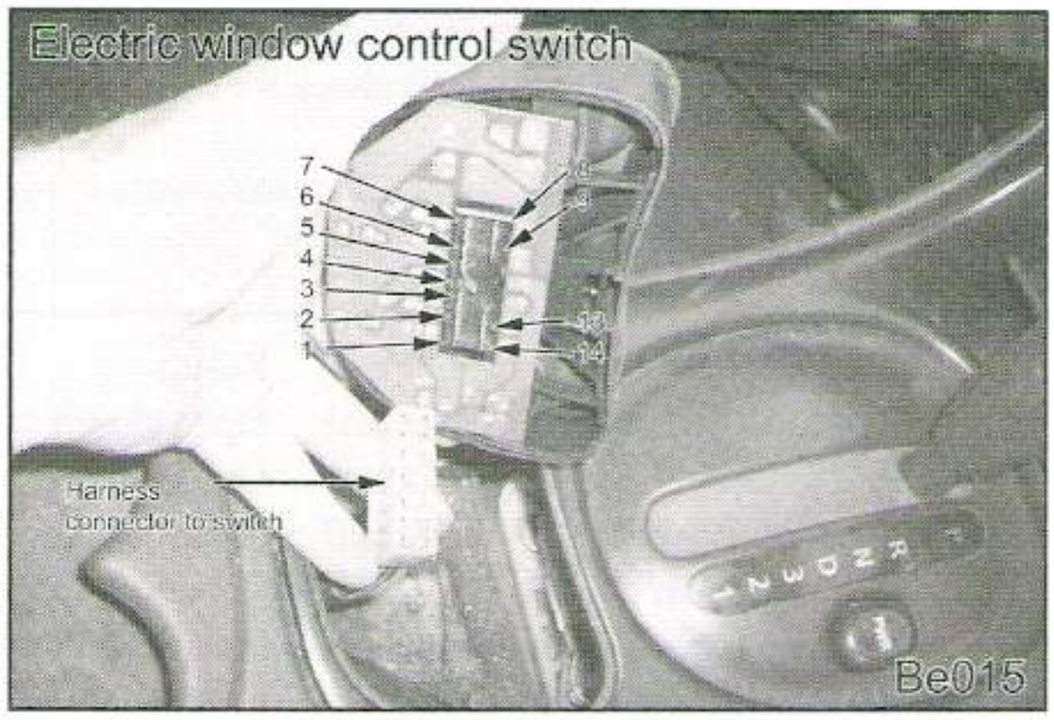
Power Window Switch

Terminal	Switch	Function	Result
4 to 14	LHF Up		Continuity
5 to 1		Neutral	Continuity
5 to 14		Neutral	Continuity
4 to 1		Down	Continuity
4 to 9	RHF Up		Continuity
5 to 8		Neutral	Continuity
5 to 9		Neutral	Continuity
4 to 8		Down	Continuity
4 to 3		LHR Up	Continuity
5 to 2		Neutral	Continuity
5 to 3		Neutral	Continuity
4 to 2		Down	Continuity
4 to 7	RHR Up		Continuity
5 to 6		Neutral	Continuity
5 to 7		Neutral	Continuity
4 to 6		Down	Continuity
4 to 13	Override	In	Open circuit
4 to 13	Override	Out	Continuity

Install

1. Connect harness connector to switch.
2. Position switch and gently but firmly priss switch into position until tabs lock in to place.

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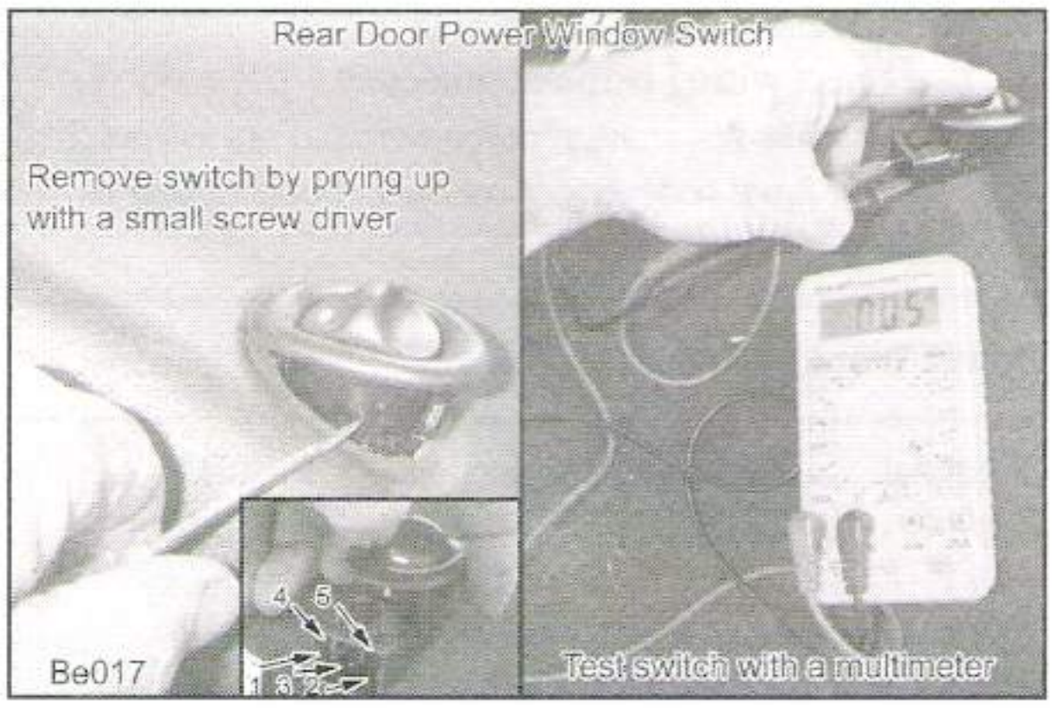


Rear Door Power Window Switch

Remove

1. Use a small screw driver or flat object to pry switch from its position.
2. Disconnect wiring harnes connector.
3. Test switch as per chart, repalce switch if not as specified.

Tip: Do not have your finger on the printed cirucit as you are testing the switch.



Rear Door Power Window Switch

Terminal	Switch Function	Result
1 to 3	Up	Continuity
2 to 4	Up	Continuity
1 to 3	Neutral	Continuity
2 to 5	Neutral	Continuity
1 to 3	Down	Continuity
2 to 5	Down	Continuity

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Fault Diagnosis, PCM & Trouble Shooting Information

Extract Diagnostic Codes without Hand-held Tester (Tech 2 tool)

System Check

The EFI system operation can be checked using the 'Check Engine Warning Light', any faults that may have occurred during engine operation will be stored as diagnostic codes.

Before staring the diagnostic check make sure the following items are correct:

a) Battery voltage is 11v or more

b) Transmission is in neutral

c) Engine is at normal operating temperature

d) All accessories are off

e) The throttle is closed

1. To enter diagnostic mode first turn the ignition switch to the ON position

a) Connect terminals 5 and 6 together at the 'Data Link Connector' (DLC)

2. The 'Check Engine Warning Light' will now start to flash

3. The Code 12 should flash 3 times, this indicates that the PCM diagnostic system is operating correctly.



If any other trouble codes are stored they will start to flash from lowest to highest. Each code will be flashed 3 times

b) If more than one code is stored, there is an interval of 2.5 seconds between codes

c) Once all the codes have been displayed, there is a pause for 4.5 seconds and then the light will start to flash the codes again starting with the first code stored

Clearing DTC's

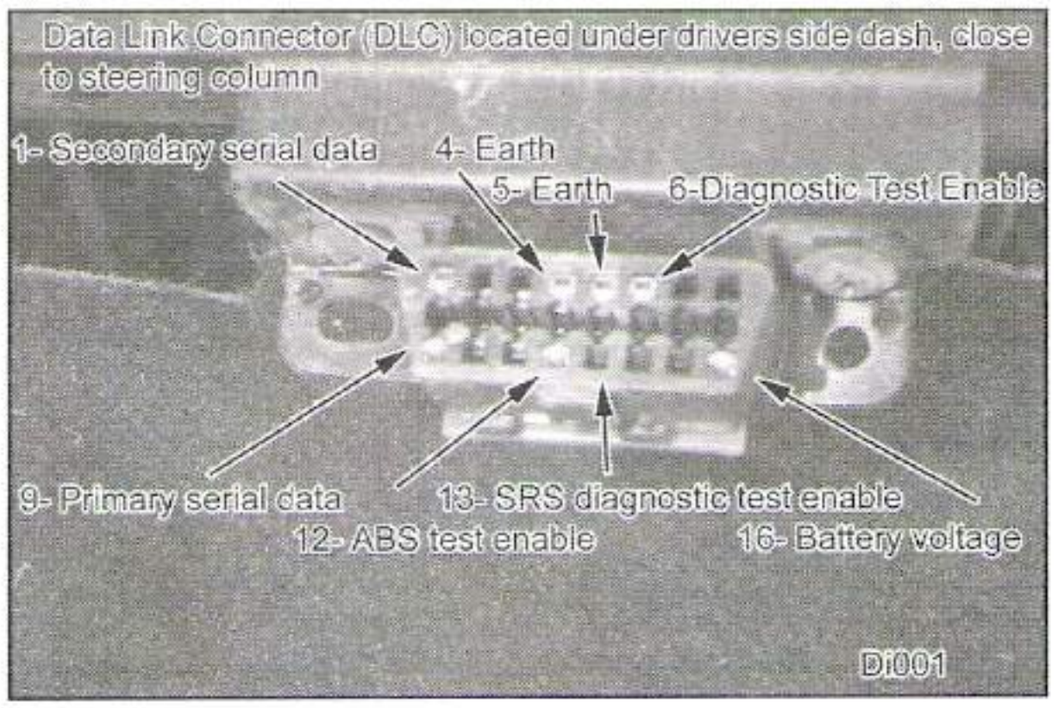
All V6 and VT Ser 1 V8

To clear current DTC's disconnect PCM power by turning ignition OFF and disconnecting the battery +ve termnal for atleast 10 seconds, this can also be acheived by removing the "Engine/Cnt BCM" fuse for approximately 30 seconds. The current DTC's will be cleared, however the code history is still stored in the PCM

After repair work has been completed you may wish to clear DTC history, a Tech 2 tool is needed to clear code history.

Note: To prevent damage to the PCM ensure ignition switch is off before disconnecting or connecting PCM power

Once the DTC's have been cleared, take vehicle for a test drive and check that no further DTC's are set. If codes are reset run through diagnostic charts again to rectify problem.



Checking for Intermittent Faults

Check all wiring connectors for being loose or dirty.

Gently move wiring harness, sensors, components.

Apply moderate heat with a hair drier to faulty component.

Humidity test, by sprinkling water to outside of vehicle.

Apply voltage load to electrical system by turning ON lights, heater fan, etc.

Summary of Fault

Summerise the fault to the vehicle, this may help you pin point the fault.

What were the driving conditions, fast, slow, accellerating, decellerating etc?

What is the problem and when did the problem start?

Where does the problem start to occur and how often?

Powertrain Control Module (PCM)

V8 GenIII Engine

Note: Do not disconnect PCM with ignition turned ON.

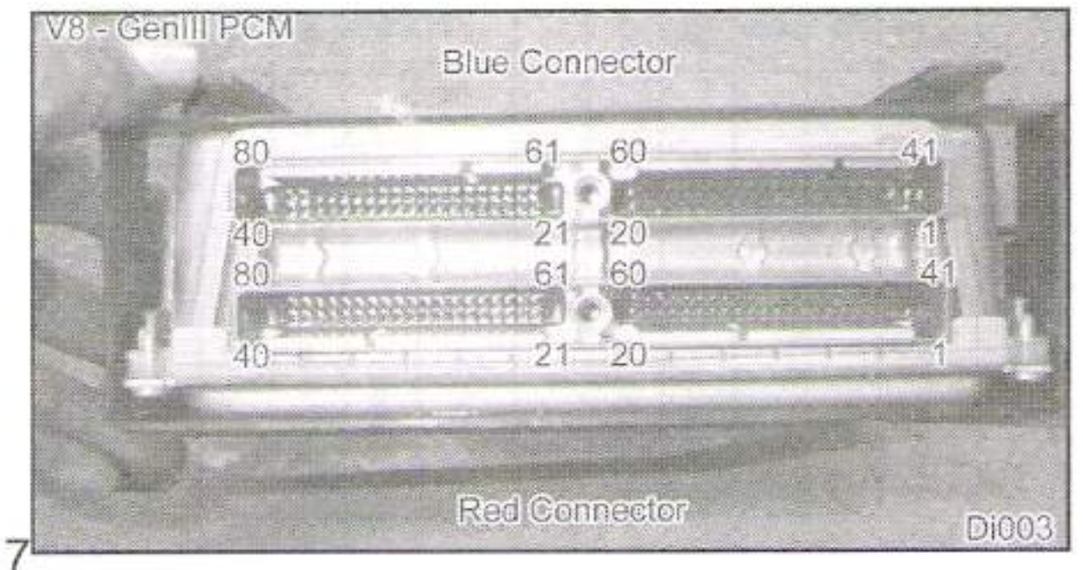
Gen III is located in the enginebay on left side under coolant reservoir.

Note: If a new PCM or EEPROM is fitted the PCM will need to be programed to the vehicle.

Note: Check part numbers as a correct PCM must be fitted to a particlur vehicle to match engine and transmission etc.

Note: A new PCM will not be programed, and can only be programed by using a Tech II tool.

Then an Idle Learn check must be carried out, also a Functional check.



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VT V6, VT Series I V8 and all V6 supercharged					
PCM Connector				**24 Pin Pink Connector**	
ECU Terminal	Terminal ID	Wiring Colour	Circuit	Situation	Voltage Range
Earth	A1	Black/Red	750	PCM earth	less than 0.50
Earth	A2	Black/Red	750	PCM earth	less than 0.50
Serial data	A3	Red/Black	1221	DLC terminal 9 & data	3 to 5
12 volt power	A4	Pink/Black	39	Ignition from fuse F14	12+
Free	A5	--	--	--	--
Fuel Pump	A6	Green/White	465	Fuel pump relay power to fuel pump	12+ while pump operating
TP Sensor	A7	Grey	416	PCM power to TP sensor	5
12 volt power	A8	Orange/black	740	Power to PCM from fuse F31	12+
Free	A9	--	--	--	--
Free	A10	--	--	--	--
Free	A11	--	--	--	--
Free	A12	--	--	--	--
Earth	B1	Black/Red	750	PCM earth	less than 0.50
Earth	B2	Black/Red	750	PCM earth	les than 0.50
Air Conditioner	B3	Green/Black	259	A/C pressure sensor signal to PCM	1-2
Intake air temperature	B4	Brown	472	IAT sensor (temperature) signal to PCM	Aprox. 1.0, varies
Coolant temperature	B5	Yellow	410	ECT sensor (temperature) signal to PCM	Approx. 1.9, varies
Transmission fluid temperature	B6	Black/Yellow	1227	TFT sensor (temperature) signal to PCM	Approx. 1.8, varies
(EGR solenoid for V6) and Air Conditioner	B7	Violet/White	415	PCM power to EGR Solenoid and A/C pressure sensorr	5
12 volt power	B8	Orange/black	740	Power to PCM from fuse F31	12+
Free	B9	--	--	--	--
EGR solenoid VT V8 Ser I and V6 supercharged Free	B10 --	Light Green --	1456 --	EGR pintle valve position signal to PCM --	0.7 --
Throttle position sensor	B11	Blue	417	TPS position signal to PCM	0.25 - 1.25 when test to B1, approx. 4 .0 at full throttle
Fuel injector	B12	Red	481	Injector voltage check to PCM	12+ Vt v6 v8 pcm 24 pin

VT V6, VT Series I V8 and all V6 supercharged					
PCM Connector				**32 Pin Blue Connector**	
ECU Terminal	Terminal ID	Wiring Colour	Circuit	Situation	Voltage Range
V8 supercharged- boost control V8- Fuel injector No6	E1	Yellow	896	Injector control circuit	12+
V6- Fuel injector No 3 V8- Fuel injector No1	E2	Blue	841	Injector control circuit	12+
V6- Fuel injector No 2 V8- Fuel injector No2	E3	Green	842	Injector control circuit	12+
V6- Fuel injector No 5 V8- Fuel injector No4	E4	Brown / Yellow	844	Injector control circuit	12+
V6- Fuel pump V8- Fuel injector No3	E5	Light Blue Violet	411 843	Fuel pump module control driver Injector control circuit	3.0-3.4 engine operating 12+
Automatic transmission shifter	E6	Blue / White	771	Automatic transmission shifter modual terminal A	12+
Automatic transmission shifter	E7	Yellow	772	Automatic transmission shifter modual terminal B	less than 0.50
Automatic transmission shifter	E8	Green / Yellow	773	Automatic transmission shifter modual terminal C	12+
Free	E9				
Free	E10				
Free	E11				
Oil Pressure	E12	Blue	31	Power to oil pressure sensor from PCM	12+ engine operating
Free	E13				
Automatic transmission pressure control solenoid	E14	Grey / Blue	1229	Transmission pressure control signal low	lessthan 0.50 with ignition on, 6.6 engine operating
Automatic transmission pressure control solenoid	E15	Red	1228	Transmission pressure control signal high	1.3 with ignition on and engine operating
Engine coolant temperature and throttle position semsors	E16	Black / Yellow	452	Earth via PCM for ECT and TP sensors	less than 0.50
V6- Fuel Injector No 4 V8- Fuel injector No5	F1	Brown/Yellow	844	Injector control circuit	12+
V6- Fuel Injector No 1 V8- Fuel injector No7	F2	Blue	841	Injector control circuit	12+
V6- Fuel Injector No 6 V8- Fuel injector No8	F3	Yellow	846	Injector control circuit	12+
Air conditioner	F4	Light Green / Black	366	A/C relay terminal 1	12+
Start relay	F5	Grey / Blue	1434	Starter relay terminal 86	less than 0.50
Engine fan high speed	F6	Blue / White	304	Fan relay terminal 86	12 fan off, 0 when fan on
Torque achieved VT V8 Ser I Free	F7	Black / White --------	1427 ------	ABS/TCS modual terminal 27 ----------	0.9 ignition on, 3.6 engine operating ----------
V6- Free Cranking signal	F8	Red / White	806	Power from fuse F10	12 when starter motor operating
Transmission range terminal A	F9	Brown / Yellow	1224	Tranmission pass through terminal N & pressure switch terminal C	12+
Transmission range terminal B	F10	Yellow	1225	Tranmission pass through terminal R & pressure switch terminal E	0
Transmission range terminal C	F11	Green / Yellow	1226	Tranmission pass through terminal P & pressure switch terminal D	12+
Transmission Normal / Power	F12	Blue	774	Normal / Power transmission switch	12 to 0 to 12 as switch is pressed
Free	F13				
DLC terminal 6	F14	White / Black	451	Diagnostic link connector terminal 6	12+
Automatic transmission shifter	F15			Automatic transmission shifter modual terminal A	less than 0.50
Intake air temperature, transmission fluid temperature, EGR, air conditioner pressure sensors	F16	Black	459	Earth via PCM for IAT, TFT, EGR, A/C refrigerant pressure sensors.	less than 0.50 PCM VT v6 v8 32 pin blue

VT V6, VT Series 1 V8 and all V6 supercharged					
PCM Connector				**32 Pin Pink Connector**	
ECU Terminal	Terminal ID	Wiring Colour	Circuit	Situation	Voltage Range
Torque converert clutch	C1	Grey/Red	422	Turn torque converter clutch on and off	12+
1-2 shift solenoid	C2	Light Green	1222	Shift solenoid A terminal B power	12 with ingition ON
2-3 shift solenoid	C3	Yellow/Black	1223	Shift solenoid B terminal B power	12 with ingition ON
Cannister purge valve	C4	Green/Yellow	428	Canister purge solenoid power	12+
Vehicle speed sensor	C5	Violet/White	123	Speed signal from wheel sensor to speedometer	0.1 - 13
Vehicle speed sensor	C6	Blue/White	831	Speed signal from wheel sensor to PCM	0.1 - 13
Idle air control	C7	LIght Blue	441	IAC valve terminal C	-
Idle air control	C8	LIght Blue / Blue	422	IAC valve terminal D	-
Idle air control	C9	LIght Green / Blue	444	IAC valve terminal B	-
Idle air control	C10	LIght Green / White	443	IAC valve terminal A	-
Torque request VT V8 Ser I Free	C11 —	Orange/White —	1426 —	ABS / TCS modula terminal 13 —	4-5 —
Knock sensor	C12	White / Red	815	Knock sensor feed to PCM	1.3 - 25.6m/V (AC)
Transmission 3-2 solenoid	C13	Green / White	897	3-2 solenoid terminal B	12 with ignition ON only
Transmission 3-2 solenoid	C14	Green / White	897	3-2 solenoid terminal B	12 with ignition ON only
Transmission TCC	C15	Brown	418	TCC solenoid terminal B	12+
Transmission TCC	C16	Brown	418	TCC solenoid terminal B	12+
Mass air flow sensor	D1	Brown/White	792	MAF sensor signal to PCM	4.8 - 4.2
Free	D2				
Camshaft position (ignition modual)	D3	Black	630	Camshaft position to PCM from ignition modual terminal F	4.8 (engine operating 4.4)
Crankshaft 18x (ignition modual) VT V8 Ser I Free	D4 —	Light Blue / Black —	647 —	Crankshaft position to PCM from ignition modual terminal C —	5 (engine operating 2.7-3.0) —
Vehicle speed sensor	D5	Tan	832	Vehicle speed sensor signal low	-
Free	D6				
Free	D7				
Free	D8				
Bypass control (ignition modual)	D9	Tan / Black	424	Bypass control to PCM from ignition modual terminal B	4.7 with engine operating
Electronic spark control	D10	White	423	EST ignition modual terminal A	2.0 with engine operating
Reference signal	D11	Black / Red	453	Reference signal low ignition modual terminal L	less than 0.50
Reference signal	D12	Violet	430	Reference signal high ignition modual terminal D	less than 0.50
Oxygen sensor right side	D13	Green / Yellow	1412	O2 RH sensor signal to PCM	450mV
Oxygen sensor right side	D14	Grey / Black	1413	O2 RH sensorearth via PCM	-
Oxygen sensor left side	D15	Violet	412	O2 LH sensor signal to PCM	450mV
Oxygen sensor left side	D16	Violet / Black	413	O2 LH sensorearth via PCM	- V1 v6 v8 pcm 32pink pin

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V6 - VT all Series, V6 Supercharged - VT,VX,VW, VY Monaro, HSV and V8 - VT Series I. DIAGNOSIS CODES

				Diagnostic Codes with trouble shooting	[** All V6 VT Series engines, All V6 supercharged VT,VX,WH, VU, HSV & Monaro and V8 VT Series I] [V6 - All VT Series V6 engines only] [V6S - All V6 supercharged models only] [V8 - All V8 VT series 1 only
Co-de	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure	Trouble Shooting Remedy
13 **	Right side oxygen sensor - no signal	-No 19, 21, 22 DTC codes, 4 conditions below exist for 26 sec - Eng for 4 minutes - Coolant temp is 85 + deg - TP sensor open 15% + -RH O2 sensor 0.410-0.477	ON	#1 Check for poor connection at O2 sensor harness connector. #2 Check O2 sensor wiring harness (PCM side) circuit 1412, is reading over 0.6 volt reading with ingition ON engine not running. #3 Check O2 sensor wiring harness (PCM side) circuit 1412, should give 0.3-0.6 volt reading with ingition ON engine not running.	#1 Fix faulity harness connector. #2 If over 0.6 volt, check circuit 750 for open or faulty circuit, repair. If under 0.6 volt, open or faulty connection in circuit 1412 PCM to O2 sensor. #3 If OK replace PCM. If not OK open or short in circuit 1412 PCM to O2 sensor.
14 **	Engine coolant temperature signal low	- Engine running for 20 + sec - ECT signal less than 0.3 volts	ON	(This code turns the radiator fan ON) #1 Check for intermittent or poor connection of harness to sensor #2 Check engine temperature sensor terminals as in "Body electrical". #3 Check circuit 410 and or sensor for short to earth	#1 Fix faulty harness / connector. #2 Replace sensor if necessary. #3 Repair circuit, replace sensor. If all OK replace PCM
15 **	Engine coolant temperature signal high	- Engine running for 20 + sec - ECT signal more than 4.64 volts	ON	(This code turns the radiator fan ON) #1 Check for intermittent or poor connection of harness to sensor #2 Check engine temperature sensor terminals as in "Body electrical". #3 Check circuit 410 for open to PCM	#1 Fix faulty harness / connector. #2 Replace sensor if necessary. #3 Repair circuit, replace sensor. If all OK replace PCM
16 **	Engine coolant temperature signal erratic	-No 14, 15, 17 DTC codes - Eng running for 11 sec - ECT signal moves greater than 400mV in 200 milliseconds.	OFF	(This code turns the radiator fan ON) #1 Check for intermittent or poor connection of harness to sensor or PCM Also check for small wire strands at connectors. #2 Check condition of sensor and sensor terminals #3 Check PCM, lightly tap PCM, move terminal at PCM, is PCM mounted and earthed correctly.	#1 Fix faulty harness / connector. #2 Replace sensor #3 Remount and earth PCM or replace PCM
17 **	Engine coolant temperature circuit - PCM	- Engine running for 10 + sec and - PCM resistor switches and less 60mV change in ECT signal	OFF	#1 Fault in PCM engine coolant temerature circuit.	#1 Replace PCM
18 **	EGR flow problem (normal asperated vehicles only)	- 700-1100 eng rpm - Eng coolant 85°C + - Veh speed 37k + - IAC signal no change for 5 signals - TP less than 1%	OFF	#1 Visual inspection of EGR components. #2 Remove EGR clean and inspect. #3 Clean EGR ports and install EGR and clear DTC 18, operate vehicle, check for codes	#1 Repair or replace as required. #2 Repair and replace as required. #3 Install EGR
19 **	Throttle Position Sensor not shutting	- Throttle position sensor not closing as per rpm chart (EFI chapter) when MAF is under 301 mg/cyl for 20+sec - Throttle position sensor could be jammed	ON	#1Inspect throttle position butterfly valve and throttle cable for jamming or not closing smoothly.	#1 Repair or replace as necessary
21 **	Throttle Position signal to high	- Throttle position sensor sends an open signal for greater than 2 sec	ON	#1 Inspect harness and connector. #2 TP signal circuit 417 (blue) or circuit 416 (gray short to over 5v) short to voltage. #3 TP earth circuit 452 (blue/yellow) open #4 TP earth circuit 452 (blue/yellow), back probe connector for voltage. #5 TP sensor faulty. #6 PCM faulty	#1 Repair or replace #2 Repair or replace #3 Repair or replace #4 Replace TP sensor for find short in earth circuit 452 #5 Replace #6 Replace VT I DTC's V6 V8 chart I

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				V6 Diagnostic Codes with trouble shooting	[[** All V6 VT Series engines, All V6 supercharged VT,VX,WH, VU, HSV & Monaro and V8 VT Series] [V6 - All VT Series V6 engines only] [V6S - All V6 supercharged models only] [V8 - All V8 VT series 1 only
Co-de	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure	Trouble Shooting Remedy
22 **	Throttle Position signal to low	- Throttle position sensor sends a low (less than 0.2 volts) for greater than 2 sec	ON	#1 Inspect harness and connector. #2 TP test signal voltage, circuit 417 (blue) and circuit 416, should be 4.0 volts or greater. #3 Check circuit 417 for open, short or bad connection. #4 TP signal circuit 417 (blue) probe with 12 volt. Test signal voltage, circuit 417 (blue) and circuit 416, should be 4.0 volts or greater. #5 PCM faulty	#1 Repair or replace #2 Repair or replace #3 Repair circuit 417 if necessary. #4 If OK check and repair circuit 416, if not OK replace throttle position sensor. #5 Replace
23 **	Intake Air Temperatu-re signal to high	- IAT sensor sends a high signal more than 4.9 volts (only if air is below -36^0 C) for greater than 1 sec	OFF	#1 Inspect harness and connector. #2 Check IAT terminal resistance, with chart, under sensors. #3 Check circuit 472 (brown) for open or short. #4 Check for fault code. #5 Faulty PCM	#1 Repair or replace #2 Replace IAT if not as specified. #3 Repair or replace circuit 472. #4 If fault code still present replace IAT sensor. #5 Replace
24 **	Vehicle Speed Sensor	- Low or no signal when engine rpm is high, transmission not in "P" or "N"	ON	#1 Inspect harness and connectors. #2 Ignition OFF, disconnect VSS, trans in neutral, spin back wheels by hand, VSS should generate 0.5 AC volts. #3 Ignition OFF, connect VSS, trans in neutral, disconnect PCM pink connector (32 pin) use an ohmn meter at terminals D5 (tan) and C6 (blu/w), spin back wheels by hand, VSS should generate 0.5 AC volts. #4 Disconnect PCM pink connector (32 pin) use an ohmn meter at terminals D5 (tan) and C6 (blu/w), Mearsure resistance, should be between 1470 - 2820ohms. #5 Disconnect PCM pink connector (32 pin) use an ohmn meter at terminals D5 (tan) and C6 (blu/w), Mearsure resistance, should be less than 250k ohms. #6 Faulty PCM	#1 Repair or replace #2 If OK next step, if not OK go to step #4. #3 If OK next step, if not OK go to step #4. #4 - Ohms over 2820 check for open in circuits 831 & 832, check VSS for terminal damage repair and moisture, replace VSS. - Ohms under 2820 check for short in circuits 831 & 832, check VSS for terminal damage repair and moisture, replace VSS. #5 - Ohms over 250k check for a short to earth in circuits 831 & 832, check VSS for damaged terminals or moisture, replace VSS. - Ohms under 250k check VSS for damaged terminals or moisture, replace VSS. #6 Replace PCM
25 **	Intake Air Temperatu-re signal to low	- IAT sensor sends a low signal less than 0.3 volts (0.3 volts only if air is above 147^0 C) for greater than 1 sec	OFF	#1 Inspect harness and connector. #2 Check IAT terminal resistance, with chart, under sensors. #3 Check circuit 472 (brown) for short to earth or IAT earth. #4 Check for fault code. #5 Faulty PCM	#1 Repair or replace #2 Replace IAT if not as specified. #3 Repair or replace circuit 472. #4 If fault code still present replace IAT sensor. #5 Replace
26 **	Intake Air Temperatu-re signal erratic	- IAT sensor sends a signal indicating 7^0 or more chage in 100 milliseconds. # PCM defaults to 25^{0}C operation with DTC code 26.	OFF	#1 Carry out an intermitant fault inspection on circuits 472 and 469, IAT, connectors associated with these circuits. Disconnect PCM pink connector (32 pin) use an ohmn meter at terminals D5 (tan) and C6 (blu/w), move wires and connectors to check for ohm reading. #2 Check PCM is mounted solidly. #3 Backprobe circuits 472 and 469, lightly tap PCM casing.	#1 Repair or replace faulty components. #2 Tighten PCM bolts. #3 If ohm readings flucuate replace PCM.
28 **	Auto transfluid pressure manual valve position switch assembly.	. A faulty switch assembly signal for 6 sec's or more. # Transmission will only operate in D2 while code 28 is set.	ON	#1 Carry out an intermitant fault inspection on circuits 1224, 1225, 1226, 1227 and 469 #2 Check linkages and adjustment from the transmission lever to the manual valve. #3 If you have a scan tool: Clear codes, eng not running, ignition ON, test voltage for switches A, B & C in all selector position ranges D1, D2, D3, D4, N, R & P, #4 Engine not running, Ing ON, check trans pass through connector at terminals N, P, R for battery + volts. #5 Check that circuits 1224, 1225 & 1226 leading to connector terminals are not shorted between each other. #6 Ignition OFF, remove trans oil pan, disconnect wiring to TFP Valve switch, check circuits for 1224 & 1225 for short to earth.	#1 Repair or replace faulty components. #2 Repair or replace faulty components. #3 If OK go to next step, if not OK go to next step. #4 If OK got to next step, if not OK repair circuits or replace PCM. #5 If faulty repair or replace faulty circuits. #6 If faulty repair or replace faulty circuits. VT I DTC's V6 V8 chart 2

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				V6 Diagnostic Codes with trouble shooting	** All V6 VT Series engines, All V6 supercharged VT,VX,WH, VU, VY, HSV & Monaro and V8 VT Series] [V6 -All VT Series V6 engines only] [V6S - All V6 supercharged models only] [V8 - All V8 VT series 1 only]
Co-de	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure	Trouble Shooting Remedy
29 V6	V6 engine. EGR valve function. (Normal asperated engines only)	EGR valve pintle position sensor	OFF	#1 Ign ON, engine not running, disconnect EGR connector, use a test light to test circuit 435 (violet) to earth. #2 Ign ON, engine not running, back probe circuit 415 (sensor supply volts) (violet/white) for 5 volts. #3 Ign ON, engine not running, back probe circuit 469 (EGR sensor earth) (black) to battery volts. #4 Ign ON, engine not running, use a jumper wire short circuits 469 and 1456 (sensor signal voltage) (light green), back probe circuit 1456 with a volt meter. Does volt meter read 5 volts? #5 Faulty EGR valve. #6 Faulty PCM.	#1 Light glows, check for intermitant fault in circuits or connector. Light does not glow, check circuit 435 and repair. #2 If OK go to next step, if not OK check for open or short in circuit 415. #3 If OK go to next circuit, if not OK check for open in circuit 469 repair as necessary. #4 If OK replace EGR valve, if not OK check for open or short in circuit 1456 (light green), repair or replace if necessary. #5 Replace. #6 Replace.
31 **	Theft deterrent sensor	No theft deterrent signal. Starter operates after a 1 second delay, but engine will not start.	ON	#1 Ign ON use a volt meter check voltage for 3-5 volts at terminal 9 (circuit 1221 (red/black) DLC connector and earth. #2 Faulty PCM.	#1 If OK go to next step, if not OK check for open or short in circuit 1221 #2 Replace.
32 **	Mass Air Flow (MAF) sensor.	Engine running but no MAF signal	ON	#1 Blocked air filter. #2 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a test light to probe sensor harness connector "C" terminal to earth. #3 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a volt meter to probe sensor harness connector "B & C" terminals for 10 volts. #4 Check for intermittent faults. #5 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a volt meter to probe sensor harness connector "A" terminal to earth. #6 Voltage result from above test under 4 volts	#1 Repalce sir filter and clean air filter box. #2 - Light glows, check for intermitant fault in circuits or connector, if no glow check for open or short to earth in circuit 439. - Replace fuse No12 if necessary. #3 If OK go to next step, if not OK check circuit 750 (earth) (balck/red) for fault. #4 Repair iof necessary. #5 - Voltage OK use a scan tool to check MAF for 4-9 grams/second, if not OK go to next step. #6 If under 4 volts, check for open in circuit 750 (earth) (black/red), if over 4 volts repair repair short to circuit 792 (brown/white)
35 **	IAC Vavle sensor.	Idle speed not correct, either to low or to high. This code will not set if odes 19, 21, 22, 23, 25, 26, 36, 72 & 94	OFF	#1 Check for vacuum leak in PCV system or a sticking PCV can give a high idle speed. #2 Throttle linkage and cable may be jamming. #3 Air/fuel ration to lean, low fuel pressure, restricted fuel line flow, contaminated fuel, faulty injector. #4 Air/fuel ration to high, high fuel pressure, faulty injector, O2 sensor not working correctly (maybe silicon contamination). #5 Ign OFF, disconnect IAC valve connector, use an ohm meter to measure resistance between terminals A & B, then C & D. #6 Ign OFF, disconnect IAC valve connector, use an ohm meter to measure resistance between terminals A & D, then B & C. #7 Disconnect the IAC harness connector, ign OFF, probe connector termianls with a test light to earth. #8 Disconnect the IAC harness connector, ign OFF, probe connector termianls with a test light to battery +. #9 Connect IAC harness connector, start and idle engine, back proble all IAC connector terminals, does the test light flash? #10 Check IAC circuits for fault with a digital meter. #11 Faulty IAC Valve. #12 Faulty PCM.	#1 Replace vacuum hoses, clean or replace PCV valve. #2 Repair or replace. #3 Check fuel line pressure, replace fuel filter, clean fuerl system, replace injector. #4 Check fuel line pressure, replace injector, replace O2 sensor. #5 Resistance should be 40-80 ohms, if not replace IAC #6 Resistance should be infinite, if not replace IAC #7 Test light should light on 2 terminals. #8 Test light should light on 2 terminals. #9 Is so, clean IAC passages in IAC and throttle body. If not there may be a loose connector or a faulty PCM. #10 Replace any faulty circuits. # 11 Replace IAC valve. #12 Replace PCM. VT I DTC's V6 V8 chart 3

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				V6 Diagnostic Codes with trouble shooting	[** All V6 VT Series engines, All V6 supercharged VT,VX,WH, VU, HSV & Monaro and V8 VT Series] [V6 -All VT Series V6 engines only] [V6S - All V6 supercharged models only] [V8 - All V8 VT series 1 only]
Co-de	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
36 **	Vacuum Leak	Idle speed is 200rpm higher than desired	OFF	#1 Inspect hoses between the throttle body and MAF sensor for cracks, blockages and misalignment causing blockage. #2 Engine operating listen for air sucking sound around join or possible crack. #3 Remove hoses at intake manifold one at a time, does engine rpm alter. #4 Inspect PCV valve and hoses. #5 Inspect gaskets for throttle body, intake manifold, IAC valve "O" ring. #6 Remove IAC and inspect air ducts. #7 Clear all DTC codes, test drive, is code still present.	#1 Replace if necessary. #2 Replace air hose. #3 If rpm does not alter when hoses is removed, replace that hose. #4 Clean or replace as necessary. #5 Repair as necessary. #6 Clean and re assemble with new "O" ring. #7 If code is still present, recheck all components and/or try a new PCM
41 **	Ignition - Electronic Spark Timing (EST)	Ignition bypass circuit is shorted to battery voltage. OR 2 EST pulses detected by the PCM while engine is start cranking for first 3 crankshaft signals.	ON	#1 Clear code, operate engine did code set again. #2 Disconnect ignition modual connector (14 pin), probe "B" terminal a voltage meter. #3 Disconnect PCM harness connector, ignition ON, probe "B" terminal again, check for 0.5 volts with a voltage meter again. #4 Igntion OFF all connectors connected, use a volt meter, back probe D10 terminal on connector at PCM, ignition ON, start engine, check for 2 volts. #5 Faulty ignition modual.	#1 No code indicates intermitant fault, if code set again proceed with further tests. #2 If voltage is greater than 0.5 go to next step, if voltage is 0.5 or less go test #4. #3 If any voltage is found there is a short to voltage in circuit 424 (tan/black), repair or replace harness. #4 If voltage is approx 2 volts check circuit 423 for open, if not OK check PCM connection or replace PCM. # Replace ignition modual.
42 **	Ignition - Bypass circuit	No EST pulses for 200 milliseconds with engine rpm over 1600 rpm.	ON	#1 Clear code, operate engine did code set again. #2 Disconnect ignition modual connector (14 pin), probe "A" terminal a voltage meter. #3 Disconnect PCM harness connector, ignition ON, probe "A" terminal again check for 0.5 volts with a voltage meter again. #4 Disconnect PCM connectors, ignition OFF, test ignition modual connector circuit 423 (white) with a test light connected to battery voltage. #5 Disconnect ignition modual connector, ignition OFF, test ignition modual connector circuit 424 (tan/black) with a test light connected to battery voltage. #6 Ignition OFF, disconnect PCM connectors check for faulty connection at connectors or open circuit 424. #7 Disconnect PCM connector, all other connectors assembled, ignition ON, test PCM harness connector circuit 423 (white) with an ohm meter to earth. While reading ohm meter connect a test light between PCM harness connector circuit 424 (tan/black).	#1 No code indicates intermitant fault, if code set again proceed with further tests. #2 If voltage is greater than 0.5 go to next step, if voltage is 0.5 or less go test #4. #3 If any voltage is found there is a short to voltage in circuit 423 (white), repair or replace harness, if no voltage replace ignition modual. #4 Test light ON repair short to earth in circuit 423, test light OFF replace PCM. #5 Light ON repair short to earth on circuit 424, test light OFF replace PCM. #6 Repair or replace. #7 If before test light connected less than 300 ohms, with test light connected ohms over 6000 ohms, replace PCM. If the above values are not so replace ignition modual.
43 **	Knock Sensor	No knock sensor for 3 seconds, with warm engine operating over 2000 rpm. (DTC code 43 set only if codes 14, 15, 16, 17, 19, 21, 22 or 93 are not set)	OFF	#1 Ignition ON, back probe PCM connector circuit 815 (white/red) use a volt meter to earth. #2 Ignition OFF, back probe PCM harness connector on circuit 815 (whire/red) to earth with ohm meter. #3 In test #2 no resistance could mean open or short to earth in knock sensor harness, check harness, could also mean open circuit in faulty PCM. #4 All connectors connected, ignition OFF, set back probe PCM connector circuit 815 (white/red) with volt meter set to AC, use a hammer to tap power steering bracket, does the volt meter read 50mV AC?	#1 If any voltage reading, short to voltage, repair or replace knock sensor harness. #2 Resistance should be 50,000 ohms if both knock sensors are OK, 100,000 ohms if one knock sensor OK. No resistance terst #3. #3 Test knock sensor harness for open or short to earth, try a new PCM, replace. #4 If yes check for faulty PCM or bad connector terminals at PCM. If no, replace knock sensor/s. VT 1 DTC's V6 V8 chart 4

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V6 - VT all Series, V6 Supercharged - VT,VX,VW, VY Monaro, HSV and V8 - VT Series I. DIAGNOSIS CODES

				V6 Diagnostic Codes with trouble shooting	[** All V6 VT Series engines, All V6 supercharged VT,VX,WH, VU, HSV & Monaro and V8 VT Series] [V6 -All VT Series V6 engines only] [V6S - All V6 supercharged models only] [V8 - All V8 VT series ! only]
Co-de	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
44 **	Oxygen Sensor (O2) - Right hand	Right hand oxygen sensor has a lean signal. (DTC code 44 set only if codes 23, 25, 26, 33, 34 are not set) (closed loop system activated)	ON	#1 Visually check O2 sensor wire to connector, is it shorting to earth? has the wire broken? #2 Contaminated fuel with water, low fuel pressure, faulty injectors causing lean mixture. #3 Has MAF sensor been worked on or interfered with? #4 Ignition OFF, disconnect PCM connectors, check circuit 1412 for short to earth.	#1 If yes, replace O2 sensor and wire. #2 Replace fuel if contaminated, rectify low fuel pressure or injectors if faulty. #3 Check MAF operation. #4 If OK replace PCM, if not OK repair or replace circuit 1412.
45 **	Oxygen Sensor (O2) - Right hand	Right hand oxygen sensor has a rich signal. (DTC code 45 set only if codes 19, 21, 22 are not set) (closed loop system activated)	ON	#1 Check for high fuel pressure, faulty injector, leaking injector, fuel contaminated oil. # 2 Has MAF sensor been worked on or interfered with? #3 Ignition OFF, test circuit 1412, probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350mV? #4 Ignition OFF, test circuit 1412, probe disconnected PCM connector with volt meter to earth, ignition ON. Is voltage 350mV? #5 Disconnect PCM connectors, ignition OFF, check continuity for circuit 750 PCM connector terminal D14 and engine earth.	#1 Rectify high fuel pressure, replace injector, clean oil. #2 Check MAF operation. #3 If more, go to next test, if less check tests #1 & #2 #4 If more circuit 1412 has short to voltage, repair or replace. #5 If open circuit repair, if not open check PCM earth or replace PCM.
46 **	Distributor Modual	No distributor reference input signal to PCM (DTC code 46 set only if code 32 is not set)	ON	#1 Will engine start? #2 If spark test was OK, ignition OFF, disconnect PCM, use a volt meter to back probe terminal D12 of PCM harness connector to earth, ignition ON, is there 9.5 volts? #3 Same as for test #2 but crank engine is there 2-3 volts.	#1 If started check for intermitant fault, if did not start do an ignition test then check spark at each spark plug with a spark tester. #2 If not replace ignition modual, if 9.5 volts go to test #3 #3 If not 2-3 volts check circuit 430 for bad connection, open or short to earth, or replace ignition modual. If approx 2-3 volts inspect for faulty D12 terminal of PCM connector or replace PCM.
47 V6, V6-S	Ignition Control Modual	PCM has no 18 times signals from hall effect switch	OFF	#1 Ignition ON, engine not running, back probe to check voltage at PCM terminal D4 to earth. #2 Use a volt meter, back probe PCM connector terminal D4 circuit 647 (light blue/black), ignition ON, should read approx 5 volts. #3 Volt meter as for #2, start engine and let idling stabilise, volt meter should read approx. 3 volts. #4 Use a volt meter, disconnect PCM connectors, test voltage at PCM harness connector for terminal D4 circuit 647 (light blue/black), ignition ON, should read approx 5 volts.	#1 If OK go to test #2. If not OK bump engine with starter motor, test again if OK now go to test #2, if not go to test #3 #2 If OK go to test #3. If not OK bump engine with starter motor, test again if OK now go to test #3, if not go to test #4 #3 If OK check for faulty connection at terminal D4 or faulty PCM. If not OK check faulty connections at igntion modual or faulty ignition modual. #4 If approx 5 volts replace PCM. If not approx 5 volts, check circuit 647 (light blue/black) for open or short to earth, if circuit 647 OK replace ignition modual.
48 **	Camshaft Position Sensor	No signal at PCM from Camshaft Position Sensor for 5 seconds.	OFF	#1 Disconnect camshaft position sensor harness connector, ignition ON, check voltage between harness connector terminals "A-B" should be 5-7 volts, and between terminal "B-C" 8-11 volts. #2 All connectors installed, back probe PCM terminals D3 & A1 to check D3 voltage, ignition ON, should be 4.7 volts. (this reading may drop too and hold at 4.4 volts if so continue with test, if drops to approx 4.1 volts camshaft sensor is pulling it low with either a faulty PCM connector or faulty PCM) #3 Disconnect camshaft position sensor harness connector, ignition ON, check voltage at PCM terminal D3 as a test light is connected between earth and camshaft position sensor terminal "A". Voltage shpould drop to 0 volts. #4	#1 If both results are OK go to next test. If "A-B" was low, check for open or short in circuit 633 (brown), if circuit is OK faulty ignition modual connection or faulty ignition modual. If "B-C" was low circuit 644 (white/black) has a fault between splice and camshaft position sensor. If neither test was low, fault in circuit 645 (grey/red) between splice and camshaft position sensor connector. #2 If OK go to #3. If not OK bump engine with starter motor, test again if OK now go to test #3, if not circuit 630 (black) open or short to earth or faulty camshaft position sensor. #3 If it does check for faulty camshaft position sensor connector or faulty camshaft sensor or magnet missing from camshaft. If voltage does not drop faulty ignition control modual. DTC's cont 5

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V6 - VT all Series, V6 Supercharged - VT,VX,VW, VY Monaro, HSV and V8 - VT Series I. DIAGNOSIS CODES

		V6 Engine		Diagnostic Codes with trouble shooting	V6 Eng (VX, WH, VU, Monaro, XY Ser I)
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0560	System voltage	PCM terminal "D16" voltage over 16 volts for more than 108 minutes. (This will cause transmission problems)	ON	#1 Battery voltage should be over 10 volts, start engine, operate engine until warm then run at 2000 rpm for 15 seconds while checking battery voltage should be 13 to 15 volts.	#1 If more than 15 volts, check alternator system. If 13 to 15 volts, check or repalce PCM.
P0561	System voltage	PCM terminal "A4" voltage fluctuates by more then 2.5 volts in a 100 millisecond period	ON	#1 Back probe PCM terminal "D16" (circuit 39 - purple), engine operating, check voltage to earth while moving or handling PCM harness, check for voltage fluctuations with a digital meter.	#1 Check PCM connections for damage or corrision, inspect the PCM mounting, clean terminals with electronic terminal cleaning spray.
P0562	PCM low voltage	Low feed voltage to PCM through circuits 39 and 740. Minimum alters with temperature, min 7.3 volts @ -40°C, 8.6 volts @ 90°C, 10.0 volts @ 150°C	ON	#1 Is the alternator system and battery OK, start engine, load battery by turning on headlights, and heater fan, test battery voltage between battery terminals, should be 13-15 volts at 1500rpm, record voltage. #2 All as for #1 except test voltage by back probing between earth & D16 circuit 39 (pink), earth & A8 circuit 740 (orange/black) and earth & C12 circuit 740 (orange/black after splice orange) of PCM 24 pin connector, voltage should be within 0.5 volt of battery terminal voltage in #1.	#1 If voltage is OK, go to #2, if voltage is not OK, check alternator system, repair, clear codes, run engine and check for code 75 to set again. #2 If voltage is OK, replace PCM, clear codes, check for code 75 to set again. If voltage is not OK which pin has more than 0.5 voltage variation. If pin D16 repair circuit 39 (pink), if pin C12 or D12 repair circuit 740 (orange/black after splice orange).
P0563	System voltage.	PCM terminal "D16" voltage over 19.5 volts for more than 2 seconds. (This will cause transmission problems)	ON	#1 Battery voltage should be over 10 volts, start engine, operate egine until warm then run at 2000 rpm for 15 seconds while checking battery voltage should be 16 volts. #2 Recheck the above test after new PCM installed, voltage should be 13-15.5 volts.	#1 If more than 16 volts, check alternator system. If 15 volts, check or repalce PCM.
P0601	PCM Memory	PCM faulty	ON	#1 As for all tests carry out an On Board Diagnosis test. #2 Replace PCM	#1 If cleared fault go to test #2. #2 The PCM should be replaced even if DTC0601 is in memory.
P0712	PCM	Transmission fluid temperature - low input.	OFF	#1 At the transmission, test resistance between terminals "L and "M" of the pass through connector on the transmission side, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. (see chart in sensors section) GM have a jumper harness J39775 & test adapter kit J35616) #2 Inside transmission, disconnect wiring harness assembly at the TFT sensor, check resistance of TFT sensor, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. #3 Test for short in circuit 1227 (black/yellow).	#1 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range check transmission internal wiring for short to earth or see #2. #2 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range replace TFT sensor, which is included in TLP valve position switch #3 If OK replace PCM, if not OK repair circuit 1227.
P0713	Transmissi-on TFT sensor	Transmission fuild temperature - high input.	OFF	#1 At the transmission, test resistance between terminals "L and "M" of the pass through connector on the transmission side, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. (see chart in sensors section) GM have a jumper harness J39775 & test adapter kit J35616) #2 Inside transmission, disconnect wiring harness assembly at the TFT sensor, check resistance of TFT sensor, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. #3 Test for open or short to earth in circuit 1227 (black/yellow). #4 Test for open circuit 469 (black).	#1 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range check transmission internal wiring for short to earth or see #2. #2 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range replace TFT sensor, which is included in TLP valve position switch #3 If OK go to test #4, if not OK repair circuit 1227. #4 If OK replace PCM, if not OK repair circuit 469 (black).
P0730	Transmissi-on	2-3 Shift solenoid circuit. PCM activates solenoid ON and voltage is above 10-16 volts, usually by a short to voltage. Power supplied by circuit 339 (purple/blue) PCM activates earth by circuit 1223 (yellow/black) to activate 2-3 shift solenoid valve, this valve normally open operates in conjunction with 1-2 shift solenoid valve to allow 4 different shifts.	ON	#2x Circuit 339 (purple/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3x Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "B" Circuit 1223 (yellow/black) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate 2-3 shift solenoid valve ON and OFF, is the test light ON when 2-3 shift solenoid valve ON, then test light OFF when 2-3 shift solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #4 next column) #5 Replace PCM.	#2x If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3x If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 1223 (yellow/black) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on 2-3 shift, if no fault in circuit 1223 replace PCM. If the test light did go ON when valve activtaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "B", if 20-33 ohms, then test resistance between "E" and earth then "B" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms, disconnect internal wiring harness from 2-3 shift solenoid valve, measure the resistance of the terminals to to earth, if now greater than 250 ohms, replace 2-3 shift solenoid, if not greater than 250 ohms replace the transmission internal wiring harness. #5 Clear codes, test drive checking TCC.

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V6 - VT all Series, V6 Supercharged - VT,VX,VW, VY Monaro, HSV and V8 - VT Series I. DIAGNOSIS CODES

				Diagnostic Codes with trouble shooting	[** All V6 VT Series engines, All V6 supercharged VT,VX,W11, VU, HSV & Monaro and V8 VT Series] [V6 -VT Series V6 engines only] [V6S - All V6 supercharged models only] [V8 - All V8 VT series 1 only]
Co-de	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
59 **	Transmissi-on TFT sensor	Transmission fuild temperature - high input.	OFF	#1 At the transmission, test resistance between terminals "L and "M" of the pass thru connector on the transmission side, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. (see chart in sensors section) GM have a jumper harness J39775 & test adapter kit J35616) #2 Inside transmission, disconnect wiring harness assembly at the TFT sensor, check resistance of TFT sensor, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. #3 Test for open or short to earth in circuit 1227 (black/yellow). #4 Test for open circuit 469 (black).	#1 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range check transmission internal wiring for short to earth or see #2. #2 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range replace TFT sensor, which is included in TLP valve position switch #3 If OK go to test #4, if not OK repair circuit 1227. #4 If OK replace PCM, if not OK repair circuit 469.
63 **	Oxygen sensor (O2) Left Hand	No signal left hand oxygen (O2) sensor signal for 4 minutes.	ON	#1 Check for faulty wiring connection at O2 sensor. #2 Ignition ON, engine not running, check voltage of circuit 412 at O2 sensor connector, PCM side, should be 0.3-0.6 volts.	#1 Repair. #2 If 0.3-0.6 volts check for open or bad connection in circuit 750 (black/red) if circuit 750 was OK replace PCM. If not 0.3-0.6 volts check for open or bad connection in circuit 412 (violet) if circuit 412 was OK replace PCM
64 **	Oxygen Sensor (O2) - Left hand	Left hand oxygen sensor has a lean signal. (DTC code 64 set only if codes 23, 25, 26 are not set) (closed loop system activated)	ON	#1 Visually check O2 sensor wire to connector, is it shorting to earth? has the wire broken? #2 Contaminated fuel with water, low fuel pressure, faulty injectors causing lean mixture. #3 Has MAF sensor been worked on or interfered with? #4 Ignition OFF, disconnect PCM connectors, check circuit 412 for short to earth.	#1 If yes, replace O2 sensor and wire. #2 Replace fuel if contaminated, rectify low fuel pressure or injectors if faulty. #3 Check MAF operation. #4 If OK replace PCM, if not OK repair or replace circuit 412.
65 **	Oxygen Sensor (O2) - Left hand	Left hand oxygen sensor has a rich signal. (closed loop system activated (DTC code 65 may be set with high fuel pressure, which could also set code 45)	ON	#1 Check for high fuel pressure, faulty injector, leaking injector, fuel contaminated oil. # 2 Has MAF sensor been worked on or interfered with? #3 Ignition OFF, test circuit 412, probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350mV? #4 Ignition OFF, test circuit 412, probe disconnected PCM connector with volt meter to earth, ignition ON. Is voltage 350mV? #5 Disconnect PCM connectors, ignition OFF, check continuity for circuit 750 PCM connector terminal D15 and engine earth.	#1 Rectify high fuel pressure, replace injector, clean oil. #2 Check MAF operation. #3 If more, go to next test, if less check tests #1 & #2 #4 If more circuit 412 has short to voltage, repair or replace. If low replace PCM. #5 If open circuit repair, if not open check PCM earth or replace PCM.
66 **	Transmissi-on	3-2 Shift solenoid circuit. (Solenoid receives ignition voltage in circuit 339, PCM activates solenoid by providing earth through circuit 687)	ON	#1 If any of DTC codes 67, 81, 82, 83 are set, check fuse No32. #2 Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "S" Circuit 897 (green/white) and "E" circuit 339 (pink/blue) of connector with a test light, ignition ON with a fused jumper wire from earth test PCM terminals C13 and C14. #5 Disconnect harness from 3-2 SS valve assembly, use a multi meter to test resistance between 3-2 SS valve assembly terminals, is resistance 20-32 ohms? #6 Replace transmission internal wiring harness. #7 Repalce 3-2 SS valve assembly. #8 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light is ON when C13 and C14 are earthed, use a multi meter to test resistance between cavity "E" and "S", if 20-32 ohms, then test resistance between "E" and earth then "S" and earth, if both are greater than 250ohm go to terst #5. If the test light was not ON when C13 and C14 are earthed, check circuit 897 (green/white) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on 3-2 shift. #5 If not 20-32 ohms replace 3-2 SS Valve Assembly. If resistance is between 20-32 ohms, check the terminal resistance to earth, if greater than 250 ohms replace transmission internal wiring harness, if not greater than 250 ohms replace 3-2 SS Valve Assembly. #6 Clear codes, test drive checking 3-2 shift. #7 Clear codes, test drive checking 3-2 shift. #8 Clear codes, test drive checking 3-2 shift.

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V6 - VT all Series, V6 Supercharged - VT,VX,VW, VY Monaro, HSV and V8 - VT Series I. DIAGNOSIS CODES

				Diagnostic Codes with trouble shooting	[** All V6 VT Series engines, All V6 supercharged VT,VX,WH, VU, HSV & Monaro and V8 VT Series] [V6 -VT Series V6 engines only] [V6S - All V6 supercharged models only] [V8 - All V8 VT series 1 only]
Co-de	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
67 **	Transmissi-on.	Torque Converter Clutch (TCC) Solenoid. (PCM activates solenoid ON and voltage is above 10-16 volts. OR. PCM activates solenoid OFF and 0 voltage remains)	ON	#1 If any of DTC codes 66, 81, 82, 83 are set, check fuse No32. #2 Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "T" Circuit 422 (grey/red) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate TCC solenoid valve ON and OFF, is the test light ON when TCC solenoid valve ON, then test light OFF when TCC solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #4 next column) #5 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 422 (grey/red) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on TCC, if no fault in circuit 422 replace PCM. If the test light did go go ON when valve activaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "T", if 20-33 ohms, then test resistance between "E" and earth then "T" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms replace the transmission internal wiring harness. #5 Clear codes, test drive checking TCC.
69 **	Transmissi-on.	Torque Converter Clutch (TCC) jamed on. This code will set if DTC codes 19, 21, 22, 24, 28, 67 and 83 are not set, and all conditions below are meet for 4 seconds. [TP is open more than 25%, engine 450rpm +, trans gear D3 or D4, TCC command OFF, trans slip speed b/n -20 to +20rpm]	OFF	#1 The TCC will be jamed ON if the TCC is jamed on because of mechanical fault, the park brake is on, transmission gear position is selected with trnasmission shifter, code 69 is active. #2 Record all codes, the clear codes, is TP operating correctly. #3 Test drive in D4, TP open more than 25%, with a scan tool, test for trans slip speed, does it come within -20 to +20rpm.	#1 Checked which conditions are active, tectify if possible. #2 Check TP is OK, repair if necessary. #3 If trans slip within limits, TCC is jamed on due to mechanical fault, check for converter clutch apply valve is jamed in an apply situation, the TCC solenoid valve has a blocked exhaust and or release duct, valve body gasket is blocking a duct. If fault was one of these clear codes and test drive.
72 **	Vehcile Speed Sensor. (VSS)	Different speeds detected between vehicle speed sensor and PCM of more than 1000rpm in a forward gear or 2048rpm in "P" or "N".	OFF	#1 This code can be set by doing a "wheely" on a loose service then hitting a hard surface such as bitumen, ask driver. #2 Check wiring harness for loose terminals on frayed wires. #3 Check the VSS harness is not near spark-plug lead, this can cause faulse results.	# Clear codes and test drive. #2 Reapir, clear codes, test drive. #3 Re-route wiring harness.
73 **	Transmissi-on	Pressure Control Solenoid (PCS).	OFF	#1 Disconnect trans pass thru connector, test holes "C" circuit 1228 (red) and "D" circuit 1229 (grey/blue) of connector transmission side for resistance of 3-7 ohms. #2 Disconnect trans pass thru connector, test hole "C" circuit 1228 (red) to the case of transmissiion, for resistance of less than 9 ohms. #3 All connectors in place, disconnect PCM blue 32 pin connector, test resistance of terminal E15 to earth, is resistance more than 15 ohm. #4 Faulty PCM.	#1 If the resistance was over 7 ohms or lower than 3 ohms, check auto trans internal harness for open, if so replace, test drive, if harness OK replace PC solenoid valve, test drive. If resistance is within range go to #2. #2 If resistance is less than 9 ohms, test trans internal harness for short to earth, replace if necessary, test drive. If resistance is over 9 ohms, replace PC solenoid valve, test drive. #3 If so test circuits 1228 (red) and 1229 (grey/blue) for an open, repair then test drive. If resistance is under 9 ohms, test circuits 1228 (red) and 1229 (grey/blue) for a short to earth, repair then test drive. #4 Replace and test drive. VT 1 DTC's V6 V8 chart 8

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V6 - VT all Series, V6 Supercharged - VT,VX,VW, VY Monaro, HSV and V8 - VT Series I. DIAGNOSIS CODES

				Diagnostic Codes with trouble shooting	[** All V6 VT Series engines, All V6 supercharged VT,VX,WH, VU, HSV & Monaro and V8 VT Series] [V6 -VT Series V6 engines only] [V6S - All V6 supercharged models only] [V8 - All V8 VT series 1 only]
Co-de	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
75 **	PCM low voltage	Low feed voltage to PCM through circuits 39 and 740. Minimum alters with temperature, min 7.3 volts @ -40°C, 8.6 volts @ 90°C, 10.0 volts @ 150°C	ON	#1 Is the alternator system and battery OK, start engine, load battery by turning on headlights, and heater fan, test battery voltage between battery terminals, should be 13-15 volts at 1500rpm, record voltage. #2 All as for #1 except test voltage by back probing between earth & A4 circuit 39 (purple), earth & A8 circuit 740 (orange/black) and earth & B8 circuit 740 (orange/black) of PCM 24 pin connector, voltage should be within 0.5 volt of battery terminal voltage in #1.	#1 If voltage is OK, go to #2, if voltage is not OK, check alternator system, repair, clear codes, run engine and check for code 75 to set again. #2 If voltage is OK, replace PCM, clear codes, check for code 75 to set again. If voltage is not OK which pin has more than 0.5 voltage variation. If pin A4 repair circuit 39 (pink), if pin A8 or B8 repair circuit 740 (orange/black).
76 **	Fuel Trim	Short term fuel trim (STFT). Fuel trim corrects any variation between right and left cylinders, code will set if differance is more than 63% for 32 seconds, while engine idling.	OFF	#1 Carry out an engine inspection such as dirty or faulty spark plugs, lean or faulty fuel injectors, inlet manifold leaking, exhaust manifold leaking, ensure O2 sensor harnessess are connected to correct sides. #2 If any other DTC codes are set, rectify complaint and clear codes. #3 If you have scan tool test STFT readings, on each engine side.	#1 Repair, clear code, test drive. #2 Test drive. #3 If any variation, see O2 sensor chart under sensors, test O2 sensors, repair and check scan tool readings.
78 **	Fuel Trim	Long term fuel trim (LTFT). Fuel trim corrects any variation between right and left cylinders, code will set if differance is more than 59% for 32 seconds, while engine idling.	OFF	#1 Carry out an engine inspection such as dirty or faulty spark plugs, lean or faulty fuel injectors, inlet manifold leaking, exhaust manifold leaking, ensure O2 sensor harnessess are connected to correct sides. #2 If any other DTC codes are set, rectify complaint and clear codes. #3 If you have scan tool test STFT readings, on each engine side. #4 Perform a fuel system check. #5 Perform an ignition test for Oscilloscope engine. #6 Perform a cylinder compression test on each cylinder.	#1 Repair, clear code, test drive. #2 Test drive. #3 If any variation, see O2 sensor chart under sensors, test O2 sensors, repair and check scan tool readings. #4 Repair if necessary and test drive. #5 Repair if necessary and test drive. #6 Repair if necessary and test drive.
79 **	Transmissi-on	Transmission Fluid Temperature (TFT) to high. TFT reachs 1460C, then stays at 137 or more for atleast 30 minutes, with no code 58, code 58 could set upto 30 minutes after code 79.	ON	#1 If code 58 has set. #2 Check transmission cooler and radiator for poor air flow and debris around radiator and trans cooler, check transmission fluid pipes damaged restricting fuild flow. #3 If you have a scan tool dive if top gear and check if TCC slip is more or less than 20rpm. * Test TFT with a scan tool or install a transmission temperature gauge, to read temperature while driving.	#1 Repair code 58, could also clear code 79. #2 Repair fault. #3 If so see code 67 and 69 trouble shooting. VT 1 DTC's V6 V8 chart 9

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V6 - VT all Series, V6 Supercharged - VT,VX,VW, VY Monaro, HSV and V8 - VT Series I. DIAGNOSIS CODES

		V6 Engine		Diagnostic Codes with trouble shooting	V6 Eng (VX, WH, VU, Monaro, XY Ser I)
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P1627	PCM	Analog to digital information error	ON	#1 Faulty PCM.	#1 Replace PCM.
P1628	Engine coolant temperatu-re circuit - PCM	- Engine running for 10 + sec and - PCM resistor switches and less 60mV change in ECT signal	OFF	This code turns on engine cooling fan. Carry out an On Board Diagnostic test. #1 Fault in PCM engine coolant temerature circuit.	#1 Replace PCM
P1642	LPG	Voltage in circuit 937 (white/green) PCM terminal A3 is to high or to low for over 1 second.	OFF	#1 Disconnect brown PCM connector, ignition ON, test voltage of PCM terminal A3 (circuit 937) and earth, is it battery voltage? #2 Disconnect LPG tank smart unit, ignition ON, test voltage of PCM terminal A3 (circuit 937) and earth, is it 0 voltage? #3 Test conditions below in order listed. - Faulty connection at PCM terminal A3. - Open or short in circuit 937 between LPG Smart Tank Unit and PCM A3 terminal. - Fuse F14 blown. - Open in circuit 750 (brown) (earth for LPG Smart Tank Unit) - Faulty LPG smart Tank Unit. - Faulty PCM	#1 If battery voltage go to test #2. If 0 volts go test #3. #2 If 0 volts, repair damaged A3 terminal. If not 0 volts repair short to battery voltage in circuit 937 #3 - Repair. - Repair or replace. - Repair short to earth in circuit 39 (feed to Fuse 14), replace fuse. - Repair open in circuit 750 (brown). - Replace - Replace
P1643	LPG	Voltage in circuit 1062 PCM terminal E16 is to high or to low for over 1 second.	OFF	#1 Disconnect tan PCM connector, ignition ON, test voltage of PCM terminal E16 (circuit 1062), is it battery voltage? #2 Reconnect PCM connector, engine running, 1500+ rpm, on LPG, test amperage between fuel control valve and earth over a 2-3 minute period, it should be between 0.1 to 1.4 amps of PCM terminal A3 (circuit 937), is it 0 voltage? #3 Test conditions below in order listed. - Faulty connection at PCM terminal A3. - Open or short in circuit 937 between LPG Smart Tank Unit and PCM A3 terminal. - Fuse F14 blown. - Open in circuit 750 (brown) (earth for LPG Smart Tank Unit) - Faulty LPG smart Tank Unit. - Faulty PCM	#1 If battery voltage go to test #2. If 0 volts go test #3. , test for open or short in circuit 937 between LPG Smart Tank Unit and PCM A3 terminal. #2 If 0 volts, repair damaged A3 terminal. If not 0 volts repair short to battery voltage in circuit 937 #3 - Repair. - Repair or replace. - Repair short to earth in circuit 39 (feed to Fuse 14), replace fuse. - Repair open in circuit 750 (brown). - Replace - Replace
P1810	Auto transfluid pressure manual valve position switch assembly.	. A faulty switch assembly signal for 6 sec's or more. # Transmission will only operate in D2 while code 28 is set.	ON	#1 Carry out an intermitant fault inspection on circuits 1224, 1225, 1226, 1227 and 469 #2 Check linkages and adjustment from the transmission lever to the manual valve. #3 If you have a scan tool: Clear codes, eng not running, ignition ON, test voltage for switches A, B & C in all selector position ranges D1, D2, D3, D4, N, R & P. #4 Engine not running. Ing ON, check trans pass through connector at terminals N, P, R for battery + volts. #5 Check that circuits 1224, 1225 & 1226 leading to connector terminals are not shorted between each other. #6 Ignition OFF, remove trans oil pan, disconnect wiring to TFP Valve switch, check circuits for 1224 & 1225 for short to earth.	#1 Repair or replace faulty components. #2 Repair or replace faulty components. #3 If OK go to next step, if not OK go to next step. #4 If OK got to next step, if not OK repair circuits or replace PCM. #5 If faulty repair or replace faulty circuits. #6 If faulty repair or replace faulty circuits.
P1860 **	Transmissi-on	Torque Converter Clutch Pulse Width Modulation solenoid circuit. (PCM activates solenoid ON and voltage is above 10-16 volts. OR. PCM activates solenoid OFF and 0 voltage remains) [TCC PWM solenoid and circuit is operating correctly when the PCM activates the TCC PWM solenoid ON TCC slip speed is between -20 and +20 rpm. When the PCM deactivates the TCC PWM to OFF TCC slip is greater than 50rpm]	OFF	#1 If any of DTC codes P0740, P753, P0758, P0785 are set, check fuse No32. #2 Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wiring harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "U" Circuit 418 (brown) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate TCC PWM solenoid valve ON and OFF, is the test light ON when TCC PWM solenoid valve ON, then test light OFF when TCC PWM solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #4 next column) #5 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 418 (brown) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on TCC PWM, if no fault in circuit 418 replace PCM. If the test light did go ON when valve activtaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "U", if 10-15 ohms, then test resistance between "E" and earth then "U" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms, disconnect internal wiring harness from 1-2 shift solenoid valve, measure the resistance of the terminals to to earth, if now greater than 250 ohms, replace TCC PWM solenoid, if not greater than 250 ohms replace the transmission internal wiring harness. #5 Clear codes, test drive checking TCC.

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V6 - VT all Series, V6 Supercharged - VT,VX,VW, VY Monaro, HSV and V8 - VT Series I. DIAGNOSIS CODES

				Diagnostic Codes with trouble shooting	** All V6 engines and V8 VT Series1, V6-V6 only, V6-SV6 supercharged only, V8-V8 VT series 1 only.
Co-de	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
83 **	Transmissi-on	Torque Converter Clutch Pulse Width Modulation solenoid circuit. (PCM activates solenoid ON and voltage is above 10-16 volts. OR. PCM activates solenoid OFF and 0 voltage remains) [TCC PWM solenoid and circuit is operating correctly when the PCM activates the TCC PWM solenoid ON TCC slip speed is between -20 and +20 rpm. When the PCM deactivates the TCC PWM to OFF TCC slip is greater than 50rpm]	OFF	#1 If any of DTC codes 66, 67, 81, 82 are set, check fuse No32. #2 Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "U" Circuit 418 (brown) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate TCC PWM solenoid valve ON and OFF, is the test light ON when TCC PWM solenoid valve ON, then test light OFF when TCC PWM solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #4 next column) #5 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 418 (brown) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on TCC PWM, if no fault in circuit 418 replace PCM. If the test light did go ON when valve activtaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "U", if 10-15 ohms, then test resistance between "E" and earth then "U" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms, disconnect internal wiring harness from 1-2 shift solenoid valve, measure the resistance of the terminals to to earth, if now greater than 250 ohms, replace TCC PWM solenoid, if not greater than 250 ohms replace the transmission internal wiring harness. #5 Clear codes, test drive checking TCC.
85 **	Transmissi-on	Transmission slippage has been detected by the PCM at more thann 400 rpm with all below, no code 28, throttle is more than 20% open, TF temperature is between 600C and 1500C, TCC is activated ON	OFF	#1 Inspect transmission fluid chart in Transmission chapter. #2 Use a scan tool to verify that the transmission is actually slipping. #3 Check the 1-2 shift solenoid valve for damage, sediment or faulty seals. #4 Inspect the following conditions in order listed: A jammed TCC signal valve in the valve body. Torque converter may have the stator roller clutch not holding or internal damage. Oil Pump may have a jammed converter clutch valve, converter clutch valve assembled wrong way, converter clutch valve retaining ring may not be in the correct position, oil pump gasket not installed correctly, orific cup plugs damaged or faulty, oil pump bolts not tightened correctly. Input shaft and housing turbine "O" ring damaged, turbine retainer and ball assembly damaged or incorrectly assembled. 2-4 band assembly may need replacing or components replaced, check band, anchor pin, 2-4 servo assembly, servo pin, piston and bore, 4th servo piston, band apply pin, servo bore for scoure marks and porosity, servo piston seals and seal grooves, orific cup plug. Forward clutch assembly may need components replaced, check for worn or damaged clutch plates, forward clutch piston, piston seals and seal grooves, input housing to forward clutch lousing "O" ring, forward clutch housing retainer and ball. 3-4 clutch assembly may need components replaced, check for worn or damaged clutch plates, 3-4 clutch piston, piston seals and seal grooves, orific cup plug.	#1 Rectify any problems. #2 If no slipping check for other internal transmission damage. Is the transmission slipping by more than 300 rpm according to the scan tool, if so check the TCC solenoid valve for sediment or faulty seals, if so clean and replace then test to check for slipping. #3 If so clean and repair then test drive to check for slipping. #4 If any components found to be faulty, repair then test drive to check for slipping. VT 1 DTC's V6 V8 chart 11

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V6 - VT all Series, V6 Supercharged - VT,VX,VW, VY Monaro, HSV and V8 - VT Series I. DIAGNOSIS CODES

				Diagnostic Codes with trouble shooting	[** All V6 VT Series engines, All V6 supercharged VT,VX,WH, VU, HSV & Monaro and V8 VT Series] [V6 -VT Series V6 engines only] [V6S - All V6 supercharged models only] [V8 - All V8 VT series 1 only]
Co-de	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
91 **	Quad Driver Surface Modual (QDSM)	QDSM activates upto 4 different devices [relays for: A/C comproessor, Start, Fan high speed and Torque Acheived] as the PCM commands. Code 91 will be present if the engine is operating for 5 seconds or more and the QDSM voltage is not correct.	OFF	#1 Engine running, turn A/C ON does the A/C relay operate, the relay can be activated with key ON and a scan tool, listen or feel relay for operation. #2 Disconnect PCM connector, ignition ON, test for battery voltage at connector harness terminal "F4" A/C relay circuit 366 (light green/blue) to earth. #3 Test for short to earth or open between PCM harness connector terminal "F4" and A/C compressor relay terminal "1" #4 Test relay by activating Start relay with key ON and a scan tool, listen or feel relay for operation, if you have no scan tool go to test #5 then #6. #5 Disconnect PCM connector, ignition ON, test for battery voltage at connector harness terminal "F5" Start relay circuit 1437 (blue) to earth. #6 Test relay by activating High speed Fan relay with key ON and a scan tool, listen or feel relay for operation, if you have no scan tool go to test #7 then #8. #7 Disconnect PCM connector, ignition ON test for battery voltage at connector harness terminal "F6" High Speed Fan relay circuit 304 (blue/white) to earth. #8 Test Torque Achieved circuit 1427 (black/white) between PCM and BCM for short to earth or open, or poor terminal contacts at BCM and PCM.	#1 If the relay is operating go to test #3, if the relay is not operating go to test #2. #2 If no voltage replace A/C relay. If battery voltage check connector terminals or try a new PCM. ##3 If short or open repair circuit. If no short or open go to test #4 #4 If the relay is operating go to test #6, if the relay is not operating check for poor terminal connections, terminals OK then go to test #3. #5 If no voltage replace Start relay. If battery voltage test for open or short bewteen circuit 1437 and circuit to Start relay terminal "86". if no problem go to test #6. #6 If the relay is operating go to test #(17), if the relay is not operating check for poor terminal connections, terminals OK then go to test #3. #7 If battery voltage test for open or short between circuit 304 and circuit to to High speed Fan relay terminal "86", or replace High Speed Fan relay. If no voltage go to test #8 #8 Reapir or replace as necessary.
92 **	Low Speed Fan	No feed back from BCm to PCM from engine cooling fan low speed	OFF	#1 Check is code 31 present. #2 If engine does not start and code 92 is set, test circuit 1221 (red/black) for earth or open. #3 Check for intermittent fault in harness or connectors.	#1 Treat code 31 and test drive. #2 Repair. #3 Repair or replace.
93 **	Signal to Noise Enhancem-ent Filter (SNEF)	Circuit (815) white/red) to knock sensors faulty or knocking noise is longer than expected (more than 10 seconds).	OFF	#1 Listen for mechanical engine noise. #2 Try a new PCM.	#1 If a mechanical noise, repair. # Replace.
94 **	Vehcile Speed Signal (VSS) Manual Transmissi-on	No VSS signal with engine 1400+rpm, throttle closed, low vacuum on MAF (decelerating), in gear and codes 19, 21, 22 or 32 not set.	ON	#1 Place the vehicle on saftey stands with rear wheels off the ground, disconnect the VSS, transmission in neutral, test for 0.5 AC volts from the VSS terminals when spinning the rear wheels by hand. #2 At terminals D5 and C6 of PCM connector still test resistance of both circuits, resistance should be between 1470-2820ohms. If not within ohms go to test #3. If within range, test resistance between C6 and earth, it should be approx 250k ohms. #3 If resistance is not greater than 1470 ohms cehck for open in circuits 831 or 832, repair and test drive. If resistance is more than 2820 ohms, circuits 831 and 832 could be shorted to each other. #4 Faulty PCM	#1 If no A/C volts replace VSS sensor. If 0.5 AC volts, reconnect the VSS connector and disconnect the PCM (pink 32 pin) connector, test terminals D5 circuit 832 (tan) and C6 circuit 831 (blue/white) of the connector for 0.5 AC volts from the VSS terminals, transmission still in neutral, when spinning the rear wheels by hand, if A/C voltage replace the PCM, if no A/C voltage go to test #2. #2 If less than 250k ohms test circuits 831 (blue/white) and 831 (tan) for short to earth, if no short retast from #1 again maybe intermittant. If not less than 250k ohms, may be corroded termianls, faulty connection, broken wire giving an intermittent fault. #3 If circuits are shorted together, replace, test drive. #4 Replace. VT I DTC's V6 V8 chirt 12

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V6 - VT all Series, V6 Supercharged - VT,VX,VW, VY Monaro, HSV and V8 - VT Series I. DIAGNOSIS CODES

				Diagnostic Codes with trouble shooting	[** All V6 VT Series engines, All V6 supercharged VT,VX,WH, VU, HSV & Monaro and V8 VT Series] [V6 -VT Series V6 engines only] [V6S - All V6 supercharged models only] [V8 - All V8 VT series I only]
Co-de	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
95 **	Anti-lock Braking System - Electronic Traction Control (ABS-ET-C)	No 4-5 volts signal received at PCM from circuit 1426 (orange/white) Note: code 95 will disable ETC functions.	ON	#1 Disconnect PCM connector, ignition ON, test for 4-5 volts at PCM connector terminal C11 circuit 1426 (orange/white) to earth. #2 PCM connector connected, disconnect ABS-ECT, ignition ON, test for 4-5 volts at ABS-ECT connector terminal C13 circuit 1426 (orange/white) to earth. #3 Disconnect ABS-ETC modual connector, then disconnect PCM connector, ignition ON, test for voltage at PCM connector terminal C11 circuit 1426 (orange/white) to earth. #4 Replace PCM, clear codes, then test operation of ABS-ETC. Test ABS-ETC: All PCM and ABS-ETC connectors fitted, place the vehicle on saftey stands with rear wheels off the ground, use a volt meter, back probe PCM harness circuit 1427 (orange/white) to earth, start engine, transmission in "P".	#1 If 4-5 volts go to test #2. If no voltage go to test #3. #2 If 4-5 volts check for poor terminal contacts, if contacts OK replace ABS-ECT module. If not 4-5 volts, check for poor terminal contact or open or short in circuit 1426 (orange/white) between PCM and ABS-ETC, repair, if all OK replace PCM. #3 If 0 volts replace ABS-ETC modual. If voltage found locate short to voltage in circuit 1426 (orange/white), clear codes, test drive. #4 Voltage should be 4-5 volts if system working correctly, then shift tranmission into "D" let wheels spin, jab the accelerator pedal, voltage should drop to 1-2 volts if the system is operating correctly. If not operating correctly work through all tests again.
96 **	Air Condition-er (A/C)	AC refrigerant high pressure system sensor feed back is less than 0.2 volt or over 4.9 volts. High speed engine cooling fan will remian on after 5 seconds, until code cleared.	OFF	#1 Use a scan tool, ignition ON, is there 4 volts at A/C pressure sensor. #2 Ignition OFF, use a test light to probe A/C pressure sensor circuit 469 (black) and to B+ #3 Carrying on from test #1, if voltage is 0.2 or lower, disconnect A/C pressure sensor harness connector, at the harness connector with a fused jumper wire, jump circuit 415 (violet/white) to circuit 259 (green/black). Using a scan tool read A/C pressure pressure sensor voltage. #4 Remove jumper wire from test #4, test for voltage between circuit 415 (violet/white) and earth. #5 Test circuit 415 (violet/white) for open or short to earth. #6 Faulty PCM. #7 clear codes, warm engine idling, use scan tool to test voltage of A/C pressure sensor voltage, should be 0.2 to 4.6 volts.	#1 If 4 volts, disconnect A/C pressure sensor harness connector, voltage reading should drop to 0.2 volts, go to test #2. If at 0.2 volts go to test #3. If at any other voltage, go to test x5 #2 If light glows, could be a bad connection at A/C pressure sensor, faulty sensor. If light does not glow, repair open in earth circuit 469 (black) to A/C pressure sensor. #3 If 4.0 volts repalce A/C pressure sensor.. If not at 4.0 volts go to test #4. #4 If not 4.0-5.0 volts repair open in circuit 415 (violet/white). If 4-5 volts work through remaining tests. #5 Repair or replace. #6 Replace PCM then confirm in test #7
97 **	Emmission System	Canister Purge Solenoid circuit fault. QDSM activates upto 4 different devices [canister purge solenoid, being on a QDSM circuit] as the PCM commands.	OFF	#1 Disconnect PCM connector, ignition ON, test voltage at PCM harness connector, circuit 439 (green/yellow) and earth, should be battery voltage. #2 Disconnect PCM connector, disconnect canister purge solenoid, use a multimeter to test voltage between canister purge solenoid driver circuit 428 (green/yellow) and earth, voltage should be 0 volts. #3 Disconnect canister purge solenoid, ignition ON test voltage of ignition feed circuit 439 (purple), should be battery voltage. #4 Test circuit 428 (green/yellow) for bad connections at PCM or canister purge control solenoid,	#1 If battery voltage, switch multimeter to amps, over a 2 minute, amps should vary between 0.1 to 1.5 amps if not go to test #2. If not battery voltage check fuse 33, if blown, repair short to earth in cannister purge solenoid feed circuit 439 (purple), if fuse not blown go to test #3. #2 If not 0 volts, repair short to voltage in purge solenoide driver circuit 428 (green/yellow). If 0 volts, inspect for connector damage from circuit 428 to PCM. #3 If battery voltage, inspect for open or short to earth in circuit 428 (green/yellow) if OK check for poor terminal connection at PCM or canister purge control solenoid if good terminal connections, replace canister purge control solenoid. If not battery voltage, repair open in canister purge control solenoid feed circuit 439 (purple). #4 Repair. VT I DTC's V6 V8 chart 13

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VX, VY, WH, VU, Monaro V6 (not supercharged)					
PCM Connector				**24 Pin Brown Connector**	
ECU Terminal	Terminal ID	Wiring Colour	Circuit	Situation	Voltage Range
3-2 control solenoid	A1	Green / White	897	Tansmission 3-2 control solenoid power	12 with ignition ON
2-3 shift solenoid	A2	Yellow/Black	1223	Shift solenoid B terminal B power	12 with ingition ON
LPG enable	A3	White / Green	937		less than 0.50
Free	A4	–	–	–	–
Earth	A5	Black/Red	750	PCM earth	les than 0.50
Free	A6	–	–	–	–
Mass air flow sensor	A7	Brown/White	792	MAF sensor signal to PCM	4.8 - 4.2
Start relay	A8	Grey / Blue	1434	Starter relay terminal 86	less than 0.50
Air conditioner	A9	Light Green / Black	366	A/C relay terminal 1	12+
Cannister purge valve	A10	Green/Yellow	428	Canister purge solenoid power	12+
Transmission TCC	A11	Brown	418	TCC solenoid terminal B	12+
Torque converert clutch	A12	Grey/Red	422	Turn torque converter clutch on and off	12+
1-2 shift solenoid	B1	Light Green	1222	Shift solenoid A terminal B power	12 with ingition ON
Free	B2	–	–	–	–
Electronic spark control	B3	White	423	EST ignition modual terminal A	2.0 with engine operating
Bypass control (ignition modual)	B4	Tan / Black	424	Bypass control to PCM from ignition modual terminal B	4.7 with engine operating
Earth	B5	Black/Red	750	PCM earth	les than 0.50
Camshaft position (ignition modual)	B6	Black	630	Camshaft position to PCM from ignition modual terminal F	4.8 (engine operating 4.4)
Crankshaft 18x (ignition modual)	B7	Light Blue / Black	647	Crankshaft position to PCM from ignition modual terminal C	5 (engine operating 2.7-3.0)
Torque request	B8	Orange / White	1426	ABS / TCS modula terminal 13	4-5
Reference signal	B9	Violet	430	Crankshaft reference signal high ignition modual terminal D	4.8 with ignition on 2.3 engine running
Reference signal	B10	Black / Red	453	Crankshaft reference signal low ignition modual terminal L	less than 0.50
Torque achieved	B11	Black / White	1427	ABS/TCS modual terminal 27	0.9 ignition on, 3.6 engine operating
Engine fan high speed	B12	Blue / White	304	Fan relay terminal 86	12 fan off, 0 when fan on

PCM Vx v6 24 pin

VX, VY, WH, VU, Monaro V6 (not supercharged)					
PCM Connector				**32 Pin Connector**	
ECU Terminal	Terminal ID	Wiring Colour	Circuit	Situation	Voltage Range
Vehicle speed sensor	C1	Violet/White	123	Speed signal from wheel sensor to speedometer	0.1 - 13
Idle air control	C2	Light Green / Blue	444	IAC valve coil B low terminal C	-
Idle air control	C3	Light Blue / Blue	422	IAC valve coil A low terminal D	-
Idle air control	C4	Light Blue	441	IAC valve coil A high terminal B	-
Idle air control	C5	Light Green / White	443	IAC valve coil B high terminal A	-
Engine coolant temperature and throttle position sensors	C6	Black / Yellow	452	Earth via PCM for ECT and TP sensors	less than 0.50
Throttle position sensor	C7	Blue	417	TPS position signal to PCM	0.25 - 1.25 when test to B1, approx. 4 .0 at full throttle
EGR solenoid	C8	Light Green	1456	EGR pintle valve position signal to PCM	0.7
Oxygen sensor right side	C9	Green / Yellow	1412	O2 RH sensor signal to PCM	450mV
Knock sensor left side	C10	White / Red	815	Knock sensor left side feed to PCM	1.3 - 25.6mV (AC)
Knock sensor right side	C11	White / Red	826	Knock sensor right side feed to PCM	1.3 - 25.6mV (AC)
12 volt power	C12	Orange/black	740	Power to PCM from fuse F31	12+
Serial data	C13	Red/Black	1221	DLC terminal 9 & data	3 to 5
Fuel injector	C14	Red	481	Injector voltage check to PCM	12+
TP Sensor	C15	Grey	416	PCM power to TP sensor	5
EGR solenoid and Air Conditioner	C16	Violet/White	415	PCM power to EGR Solenoid and A/C pressure sensor	5
Vehicle speed sensor	D1	Blue/White-Auto Blue-Manual	831	Speed signal from wheel sensor to PCM	0.1 - 13
Vehicle speed sensor	D2	Tan-Auto Brown-Manual	832	Vehicle speed sensor signal low	-
Oxygen sensor left side	D3	Violet / Black	413	O2 LH sensorearth via PCM	-
Oxygen sensor left side	D4	Violet	412	O2 LH sensor signal to PCM	450mV
Oxygen sensor right side	D5	Grey / Black	1413	O2 RH sensorearth via PCM	-
Intake air temperature, transmission fluid temperature, EGR, air conditioner pressure sensors	D6	Black	469	Earth via PCM for IAT, TFT, EGR, A/C refrgerant pressure sensors.	less than 0.50
Intake air temperature	D7	Brown	472	IAT sensor (temperature) signal to PCM	Aprox. 1.0, varies
Free	D8	–	–	–	–
DLC terminal 6	D9	White / Black	451	Diagnostic link connector terminal 6	12+
Air Conditioner	D10	Green/Black	259	A/C pressure sensor signal to PCM	1-2
Coolant temperature	D11	Yellow	410	ECT sensor (temperature) signal to PCM	Approx. 1.9, varies
12 volt power	D12	Orange	740	Power to PCM from fuse F31	12+
Transmission fluid temperature	D13	Black/Yellow	1227	TFT sensor (temperature) signal to PCM	Approx. 1.8, varies
Free	D14	–	–	–	–
Free	D15	–	–	–	–
12 volt power	A4	Pink	39	Ignition from fuse F14	12+

PCM Vx V6 32 pin

VX, VY, WH, VU, Monaro V6 (not supercharged)					
PCM Connector				**32 Pin Tan Connector**	
ECU Terminal	Terminal ID	Wiring Colour	Circuit	Situation	Voltage Range
Free	E1	--	--	--	--
Fuel Injector No 2	E2	Green	842	Injector control circuit	12+
Free	E3	--	--	--	--
Fuel Injector No1	E4	Blue	841	Injector control circuit	12+
Fuel Injector No 5	E5	Green / Yellow	845	Injector control circuit	12+
Fuel Injector No 6	E6	Yellow	846	Injector control circuit	12+
Earth	E7	Black/Red	750	PCM earth	less than 0.50
Free	E8	--	--	--	--
Automatic transmission pressure control solenoid	E9	Red	1228	Transmission pressure control signal high	1.3 with ignition on, 1.3 with engine operating
Fuel Pump	E10	Green/White	465	Fuel pump relay power to fuel pump	12+ while pump operating
Free	E11	--	--	--	--
EGR control	E12	Violet	435	Control of EGR - emission system	0
Automatic transmission pressure control solenoid	E13	Grey / Blue	1229	Transmission pressure control signal low	lessthan 0.50 with ignition on, 6.8 engine operating
Free	E14	--	--	--	--
Free	E15	--	--	--	--
LPG - FCV	E16	Black / Blue	1062	LPG vehicles only FCV system	12+ for 2 seconds
Fuel Injector No 3	F1	Violet	843	Injector control circuit	12+
Fuel Injector No 4	F2	Brown / Yellow	844	Injector control circuit	12+
Automatic transmission shifter	F3	Blue / White	771	Automatic transmission shifter modual terminal A	12+
LPG vehicles - Fuel	F4	Blue / Orange	936	Fuel on/off switch for LPG vehicles	less than 0.50 volts
Free	F5	--	--	--	--
Automatic transmission shifter	F6	White	776	Automatic transmission shifter PRNDL-terminal P	less than 0.50
Earth	F7	Black/Red	750	PCM earth	less than 0.50
Automatic transmission shifter	F8	Yellow	772	Automatic transmission shifter PRNDL-terminal B	12+
Automatic transmission shifter	F9	Green / Yellow	773	Automatic transmission shifter PRNDL-terminal C	12+
Free	F10	--	--	--	--
Transmission range terminal A	F11	Brown / Yellow	1224	Tranmission pass through terminal N & pressure switch terminal C	12+
Transmission range terminal B	F12	Yellow	1225	Tranmission pass through terminal R & pressure switch terminal E	0
Transmission range terminal C	F13	Green / Yellow	1226	Tranmission pass through terminal P & pressure switch terminal D	12+
Transmission Economy / Power	F14	Blue	774	Normal / Power transmission switch	12 to 0 to 12 as switch is pressed
Oil Pressure	F15	Blue	31	Power to oil pressure sensor from PCM	12+ engine operating
LPG - 12 volt power	F16	Pink/Black	39	LPG vehicles - Ignition from fuse F14	12+ PCM Vx V6 32 pin tan

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V6 - VX, VY, WH, VU (Also corrisponding Monaro and HSV models)

		V6 Engine		Diagnostic Codes with trouble shooting	V6 Eng (VX, WH, VU, Monaro, XY Ser I)
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure	Trouble Shooting Remedy
P0101	Engine Mass Air Flow (MAF) sensor.	Engine running but no MAF signal	ON	#1 Blocked air filter. #2 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a test light to probe sensor harness connector "C" terminal to earth. #3 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a volt meter to probe sensor harness connector "B & C" terminals for 10 volts. #4 Check for intermittent faults. #5 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a volt meter to probe sensor harness connector "A" terminal to earth. #6 Voltage result from above test under 4 volts	#1 Repalce sir filter and clean air filter box. #2 - Light glows, check for intermitant fault in circuits or connector, if no glow check for open or short to earth in circuit 439. - Replace fuse No12 if necessary. #3 If OK go to next step, if not OK check circuit 750 (earth) (balck/red) for fault. #4 Repair if necessary. #5 - Voltage OK use a scan tool to check MAF for 4-9 grams/second, if not OK go to next step. #6 If under 4 volts, check for open in circuit 750 (earth) (black/red), if over 4 volts repair repair short to circuit 792 (brown/white)
P0111	Intake Air Temperat-ure signal erratic	- IAT sensor sends a signal indicating 7° or more chage in 100 milliseconds. # PCM defaults to 25°C operation with DTC code P0111.	OFF	#1 Carry out an intermitant fault inspection on circuits 472 and 469, IAT, connectors associated with these circuits. Disconnect PCM connector use an ohmn meter at terminals circuit 472 D7 (brown) and circuit 469 B6 (black), move wires and connectors to check for ohm reading. #2 Check PCM is mounted solidly. #3 Backprobe circuits 472 and 469, lightly tap PCM casing.	#1 Repair or replace faulty components. #2 Tighten PCM bolts. #3 If ohm readings flucate replace PCM.
P0112	Intake Air Temperat-ure signal to low	- IAT sensor sends a low signal less than 0.3 volts (0.3 volts only if air is above 147° C) for greater than 1 sec # PCM defaults to 25°C operation with DTC code P0112	OFF	#1 Inspect harness and connector. #2 Check IAT terminal resistance, with chart, under sensors. #3 Check circuit 472 (brown) PCM terminal D7 for short to earth or IAT earth. #4 Check for fault code. #5 Faulty PCM	#1 Repair or replace #2 Replace IAT if not as specified. #3 Repair or replace circuit 472. #4 If fault code still present replace IAT sensor. #5 Replace
P0113	Intake Air Temperat-ure signal to high	- IAT sensor sends a high signal more than 4.9 volts (only if air is below -36° C) for greater than 1 sec # PCM defaults to 250C operation with DTC code P0113.	OFF	#1 Inspect harness and connector. #2 Check IAT terminal resistance, with chart, under sensors. #3 Check circuit 472 (brown) for open or short. #4 Check for fault code. #5 Faulty PCM	#1 Repair or replace #2 Replace IAT if not as specified. #3 Repair or replace circuit 472. #4 If fault code still present replace IAT sensor. #5 Replace
P0117	Engine coolant temperatu-re signal low	- Engine running for 20 + sec - ECT signal less than 0.3 volts	ON	(This code turns the radiator fan ON) #1 Check for intermittent or poor connection of harness to sensor #2 Check engine temperature sensor terminals as in "Body electrical". #3 Check circuit 410 (yellow) and or sensor for short to earth	Circuits 410 (yellow) power and 452 (blue/yellow) earth via PCM. #1 Fix faulty harness / connector. #2 Replace sensor if necessary. #3 Repair circuit, replace sensor. If all OK replace PCM
P0118	Engine coolant temperatu-re signal high	- Engine running for 20 + sec - ECT signal more than 4.64 volts	ON	(This code turns the radiator fan ON) #1 Check for intermittent or poor connection of harness to sensor #2 Check engine temperature sensor terminals as in "Body electrical". #3 Check circuit 410 (yellow) for open to PCM	Circuits 410 (yellow) power and 452 (blue/yellow) earth via PCM. #1 Fix faulty harness / connector. #2 Replace sensor if necessary. #3 Repair circuit, replace sensor. If all OK replace PCM
P0121	Throttle Position Sensor not shutting	- Throttle position sensor not closing as per rpm chart (EFI chapter) when MAF is under 301 mg/cyl for 20+sec - Throttle position sensor could be jammed	ON	#1Inspect throttle position butterfly valve and throttle cable for jamming or not closing smoothly.	#1 Repair or replace as necessary.
P0122	Throttle Position signal to low	- Throttle position sensor sends a low (less than 0.2 volts) for greater than 2 sec	ON	#1 Inspect harness and connector. #2 TP test signal voltage, circuit 417 (blue) and circuit 416, should be 4.0 volts or greater. #3 Check circuit 417 for open, short or bad connection. #4 TP signal circuit 417 (blue) probe with 12 volt. Test signal voltage, circuit 417 (blue) and circuit 416, should be 4.0 volts or greater. #5 PCM faulty	#1 Repair or replace #2 Repair or replace #3 Repair circuit 417 if necessary. #4 If OK check and repair circuit 416, if not OK replace throttle position sensor. #5 Replace
P0123	Throttle Position signal to high	- Throttle position sensor sends an open signal for greater than 2 sec	ON	#1 Inspect harness and connector. #2 TP signal circuit 417 (blue) or circuit 416 (gray short to over 5v) short to voltage. #3 TP earth circuit 452 (blue/yellow) open #4 TP earth circuit 452 (blue/yellow), back probe connector for voltage. #5 TP sensor faulty. #6 PCM faulty	#1 Repair or replace #2 Repair or replace #3 Repair or replace #4 Replace TP sensor for find short in earth circuit 452 #5 Replace #6 Replace

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V6 - VX, VY, WH, VU (Also corrisponding Monaro and HSV models)

		V6 Engine		V6 Diagnostic Codes with trouble shooting	V6 Eng (VX, WH, VU, Monaro, XY Ser I)
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure	Trouble Shooting Remedy
P0131	Oxygen Sensor (O2) - Right hand	Right hand oxygen sensor has a lean signal. (closed loop system activated)	ON	#1 Visually check O2 sensor wire to connector, is it shorting to earth? has the wire broken? #2 Contaminated fuel with water, low fuel pressure, faulty injectors causing lean mixture. #3 Has MAF sensor been worked on or interfered with? #4 Ignition OFF, disconnect PCM connectors, check circuit 1412 for short to earth.	#1 If yes, replace O2 sensor and wire. #2 Replace fuel if contaminated, rectify low fuel pressure or injectors if faulty. #3 Check MAF operation. #4 If OK replace PCM, if not OK repair or replace circuit 1412.
P0132	Oxygen Sensor (O2) - Right hand	Right hand oxygen sensor has a rich signal. (closed loop system activated)	ON	#1 Check for high fuel pressure, faulty injector, leaking injector, fuel contaminated oil. # 2 Has MAF sensor been worked on or interfered with? #3 Ignition OFF, test circuit 1412, probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350mV? #4 Ignition OFF, test circuit 1412, probe disconnected PCM connector with volt meter to earth, ignition ON. Is voltage 350mV? #5 Disconnect PCM connectors, ignition OFF, check continuity for circuit 750 PCM connector terminal D5 and engine earth.	#1 Rectify high fuel pressure, replace injector, clean oil. #2 Check MAF operation. #3 If more, go to next test, if less check tests #1 & #2 #4 If more circuit 1412 has short to voltage, repair or replace. #5 If open circuit repair, if not open check PCM earth or replace PCM.
P0134	Right side oxygen sensor - no signal	4 conditions below exist for 26 sec - Eng for 4 minutes - Coolant temp is 85 + deg - TP sensor open 15% + -RH O2 sensor 0.410-0.477	ON	#1 Check for poor connection at O2 sensor harness connector. #2 Check O2 sensor wiring harness (PCM side) circuit 1412, is reading over 0.5 volt reading with ingition ON engine not running. #3 Check O2 sensor wiring harness (PCM side) circuit 1412, should give 0.2 volt reading with ingition ON engine not running.	#1 Fix faulity harness connector. #2 If over 0.5 volt, check circuit 750 for open or faulty circuit, repair. If under 0.4 volt, open or faulty connection in circuit 1412 PCM to O2 sensor. #3 If OK replace PCM. If not OK open or short in circuit 1412 PCM to O2 sensor.
P0151	Oxygen Sensor (O2) - Left hand	Left hand oxygen sensor has a lean signal. (No IAT DTC codes active) (closed loop system activated)	ON	#1 Visually check O2 sensor wire to connector, is it shorting to earth? has the wire broken? #2 Contaminated fuel with water, low fuel pressure, faulty injectors causing lean mixture. #3 Has MAF sensor been worked on or interfered with? #4 Ignition OFF, disconnect PCM connectors, check circuit 412 for short to earth.	#1 If yes, replace O2 sensor and wire. #2 Replace fuel if contaminated, rectify low fuel pressure or injectors if faulty. #3 Check MAF operation. #4 If OK replace PCM, if not OK repair or replace circuit 412.
P0152	Oxygen Sensor (O2) - Left hand	Left hand oxygen sensor has a rich signal. (closed loop system activated (DTC code 65 may be set with high fuel pressure, which could also set code 45)	ON	#1 Check for high fuel pressure, faulty injector, leaking injector, fuel contaminated oil. # 2 Has MAF sensor been worked on or interfered with? #3 Ignition OFF, test circuit 412, probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350mV? #4 Ignition OFF, test circuit 412, probe disconnected PCM connector with volt meter to earth, ignition ON. Is voltage 350mV? #5 Disconnect PCM connectors, ignition OFF, check continuity for circuit 750 PCM connector terminal D3 and engine earth.	#1 Rectify high fuel pressure, replace injector, clean oil. #2 Check MAF operation. #3 If more, go to next test, if less check tests #1 & #2 #4 If more circuit 412 has short to voltage, repair or replace. If low replace PCM. #5 If open circuit repair, if not open check PCM earth or replace PCM.
P0154	Oxygen sensor (O2) Left Hand	No signal left hand oxygen (O2) sensor signal for 4 minutes.	ON	#1 Check for faulty wiring connection at O2 sensor. #2 Ignition ON, engine not running, check voltage of circuit 412 at O2 sensor connector, PCM side, should be 0.3-0.6 volts.	#1 Repair. #2 If 0.3-0.6 volts check for open or bad connection in circuit 750 (black/red) if circuit 750 was OK replace PCM. If not 0.3-0.6 volts check for open or bad connection in circuit 412 (violet) if circuit 412 was OK replace PCM
P0170	Fuel Trim	Long term fuel trim (LTFT). Fuel trim corrects any variation between right and left cylinders, code will set if differance is more than 59% for 32 seconds, while engine idling.	OFF	#1 Carry out an engine inspection such as dirty or faulty spark plugs, lean or faulty fuel injectors, inlet manifold leaking, exhaust manifold leaking, ensure O2 sensor harnessess are connected to correct sides. #2 If any other DTC codes are set, rectify complaint and clear codes. #3 If you have scan tool test STFT readings, on each engine side. #4 Perform a fuel system check. #5 Perform an ignition test for Oscilloscope engine. #6 Perform a cylinder compression test on each cylinder.	#1 Repair, clear code, test drive. #2 Test drive. #3 If any variation, see O2 sensor chart under sensors, test O2 sensors, repair and check scan tool readings. #4 Repair if necessary and test drive. #5 Repair if necessary and test drive. #6 Repair if necessary and test drive. VX-VY1 V6 DTC's chart 2

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V6 - VX, VY, WH, VU (Also corrisponding Monaro and HSV models)

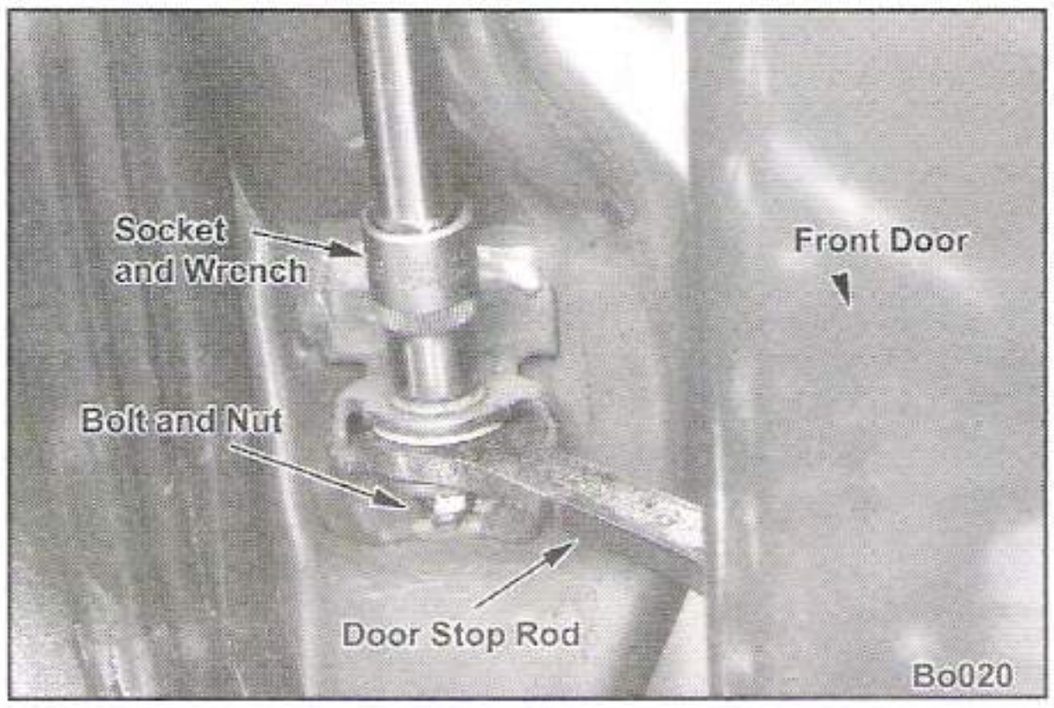
		V6 Engine		V6 Diagnostic Codes with trouble shooting	V6 Eng (VX, WH, VU, Monaro, XY Ser I)
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure	Trouble Shooting Remedy
P0173	Fuel Trim	Short term fuel trim (STFT). Fuel trim corrects any variation between right and left cylinders, code will set if differance is more than 63% for 32 seconds, while engine idling.	OFF	#1 Carry out an engine inspection such as dirty or faulty spark plugs, lean or faulty fuel injectors, inlet manifold leaking, exhaust manifold leaking, ensure O2 sensor harnessess are connected to correct sides. #2 If any other DTC codes are set, rectify complaint and clear codes. #3 If you have scan tool test STFT readings, on each engine side.	#1 Repair, clear code, test drive. #2 Test drive. #3 If any variation, see O2 sensor chart under sensors, test O2 sensors, repair and check scan tool readings.
P0200	Fuel Injector	Injector voltage is more than 2.2 volts different from battery voltage, and DTC code P0561 is not active.	OFF	#1 If codes P0116, P0563, P200 are set, check circuit 451 #2 Use a volt meter, back probe PCM terminal "B12" circuit 481 (red) with +ve lead of meter to PCM terminal "B1", should be within 2.4 volts of battery voltage.	#1 Repair if necessary. #2 If OK replace PCM, if not within voltage range open in circuit 481 between splice and B12 terminal.
P0218	Transmissi-on	Transmission Fluid Temperature (TFT) to high. TFT reachs 1460C, then stays at 137 or more for atleast 30 minutes, with no code P0712, code P0712 could set upto 30 minutes afler code P0218.	ON	#1 If code P0712 has set. #2 Check transmission cooler and radiator for poor air flow and debris around radiator and trans cooler, check transmission fluid pipes damaged restricting fuild flow. #3 If you have a scan tool dive if top gear and check if TCC slip is more or less than 20rpm. * Test TFT with a scan tool or install a transmission temperature gauge, to read temperature while driving.	#1 Repair code P0712, could also clear code P0218. #2 Repair fault. #3 If so see code P0740 and P0741 trouble shooting.
P0325	Signal to Noise Enhancem-ent Filter (SNEF)	Circuits 815 (blue) and 826 (light blue) to knock sensors faulty or knocking noise is longer than expected (more than 10 seconds). Code P0327 and P0332 not activated.	ON	#1 Listen for mechanical engine noise. #2 Try a new PCM.	#1 If a mechanical noise, repair. # Replace.
P0327	Knock Sensor - Left Side	No knock sensor for 3 seconds, with warm engine operating over 1000 rpm. (DTC code P0327 sets only if code P0325 is not set)	ON	#1 Ignition ON, back probe PCM connector circuit 815 (blue) use a volt meter to earth. #2 Ignition OFF, back probe PCM harness connector on circuit 815 (blue) to earth with ohm meter. #3 In test #2 no resistance could mean open or short to earth in knock sensor harness, check harness, could also mean open circuit in faulty PCM. #4 All connectors connected, ignition OFF, back probe PCM connector circuit 815 (blue) with volt meter set to AC, use a hammer to tap power steering bracket, does the volt meter read 50mV AC	#1 If any voltage reading, short to voltage, repair or replace knock sensor harness. #2 Resistance should be approx 100,000 ohms if so knock sensor is OK. No resistance test #3. #3 Test knock sensor circuit 815 (blue) for open or short to earth, try a new PCM, replace. #4 If yes check for faulty PCM or bad connector terminals at PCM. If no replace knock sensor.
P0332	Knock Sensor - Right Side	No knock sensor for 3 seconds, with warm engine operating over 1000 rpm. (DTC code P0327 sets only if code P0325 is not set)	ON	#1 Ignition ON, back probe PCM connector circuit 826 (light blue) use a volt meter to earth. #2 Ignition OFF, back probe PCM harness connector on circuit 826 (light blue) to earth with ohm meter. #3 In test #2 no resistance could mean open or short to earth in knock sensor harness, check harness, could also mean open circuit in faulty PCM. #4 All connectors connected, ignition OFF, back probe PCM connector circuit 826 (light blue) with volt meter set to AC, use a hammer to tap power steering bracket, does the volt meter read 50mV AC	#1 If any voltage reading, short to voltage, repair or replace knock sensor harness. #2 Resistance should be approx 100,000 ohms if so knock sensor is OK. No resistance test #3. #3 Test knock sensor circuit 826 (light blue) for open or short to earth, try a new PCM, replace. #4 If yes check for faulty PCM or bad connector terminals at PCM. If no replace knock sensor.
P0341	Camshaft / Crankshaft	Intermittent signal received at PCM (This may cause the PCM to stop sending injector pulses for a moment, causing the vehicle to hesitate.) If DTC code P0342 is also set trouble shoot code P0342 first.	OFF	#1 Disconnect PCM connectors, ignition ON, check for approx. 5 voltage at PCM harness connector terminal B6 to earth. #2 Disconnect PCM connectors, ignition ON, check for voltage at PCM harness connector terminal B7 to earth while moving all harness going to PCM, does voltage alter. #3 Check intermittent open or short to earth in circuits 643 (blue/white), 644 (white/black), 645 (grey/red), 647 (light blue/black). #4 Check for faulty connections at camshaft sensor and ignition control modual. #5 Check intermittent open or short to earth in circuits 630 (black), 633 (brown), 644 (white/black), 645 (grey/red)	#1 If approx. 5 volts, move all harness going to PCM while watching volt meter, if still at approx 5 volts go to #2. If not OK, bump engine with starter motor, test again if now approx 5 volts, move all harness going to PCM while watching volt meter, if still at approx 5 volts go to #2, if now at 0 volts, check for faulty connections at camshaft position sensor, ignition modual or intermitant open or short to earth in circuits 630, 633, 644 or 645. #2 If voltage does not alter check for faulty connections at PCM, harmonic balancerinterrupter ring vanes damaged or broken off, faulty crank sensor. If voltage alters, check for faulty connection at crankshaft sensor or camshaft sensor or go to test #3. #3 Repair and retest #1 #4 If faulty repair, if connections OK go to test #5. #5 Repair. VX-VY1 V6 DTC's sheet 3

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V6 - VX, VY, WH, VU (Also corrisponding Monaro and HSV models)

		V6 Engine		Diagnostic Codes with trouble shooting	V6 Eng (VX, WH, VU, Monaro, XY Ser I)
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0342	Camshaft Position Sensor	No signal at PCM from Camshaft Position Sensor for 5 seconds.	OFF	#1 Disconnect camshaft position sensor harness connector, ignition ON, check voltage between harness connector terminals "A-B" should be 5-7 volts, and between terminal "B-C" 8-11 volts. #2 All connectors installed, back probe PCM terminals B6 & A5 to check B6 voltage, ignition ON, should be 4.7 volts. (this reading may drop too and hold at 4.4 volts if so continue with test, if drops to approx 4.1 volts camshaft sensor is pulling it low with either a faulty PCM connector or faulty PCM) #3 Disconnect camshaft position sensor harness connector, ignition ON, check voltage at PCM terminal B6 as a test light is connected between earth and camshaft position sensor terminal "A". Voltage shpould drop to 0 volts.	#1 If both results are OK go to next test. If "A-B" was low, check for open or short in circuit 633 (brown), if circuit is OK faulty ignition modual connection or faulty ignition modual. If "B-C" was low circuit 644 (white/black) has a fault between splice and camshaft position sensor. If neither test was low, fault in circuit 645 (grey/red) between splice and camshaft position sensor connector. #2 If OK go to #3. If not OK bump engine with starter motor, test again if OK now go to test #3, if not circuit 630 (black) open or short to earth or faulty camshaft position sensor. #3 If so, check for faulty camshaft position sensor connector or faulty camshaft sensor or magnet missing from camshaft. If voltage does not drop faulty ignition control modual
P0374	Ignition Control Modual	PCM has no 18 times signals from hall effect switch	OFF	#1 Ignition ON, engine not running, back probe to check voltage at PCM terminal D4 to earth. #2 Use a volt meter, back probe PCM connector terminal B7 circuit 647 (light blue/black), ignition ON, should read approx 5 volts. #3 Volt meter as for #2, start engine and let idling stabilise, volt meter should read approx. 3 volts. #4 Use a volt meter, disconnect PCM connectors, test voltage at PCM harness connector for terminal B7 circuit 647 (light blue/black), ignition ON, should read approx 5 volts.	#1 If OK go to test #2. If not OK bump engine with starter motor, test again if OK now go to test #2, if not go to test #3 #2 If OK go to test #3. If not OK bump engine with starter motor, test again if OK now go to test #3, if not go to test #4 #3 If OK check for faulty connection at terminal D4 or faulty PCM. If not OK check faulty connections at igntion modual or faulty ignition modual. #4 If approx 5 volts replace PCM. If not approx 5 volts, check circuit 647 (light blue/black) for open or short to earth, if circuit 647 OK replace ignition modual.
P0400	EGR flow problem (normal asperated vehicles only)	- 700-1100 eng rpm - Eng coolant 85°C + - Veh speed 37k + - IAC signal no change for 5 signals - TP less than 1%	OFF	#1 Visual inspection of EGR components. #2 Remove EGR clean and inspect. #3 Clean EGR ports and install EGR and clear DTC 18, operate vehicle, check for codes	#1 Repair or replace as required. #2 Repair and replace as required. #3 Install EGR
P0405	EGR valve function. (Normal asperated engines only)	EGR valve pintle position sensor	OFF	#1 Ign ON, engine not running, disconnect EGR connector, use a test light to test circuit 435 (violet) to earth. #2 Ign ON, engine not running, back probe circuit 415 (sensor supply volts) (violet/white) for 5 volts. #3 Ign ON, engine not running, back probe circuit 469 (EGR sensor earth) (black) to battery volts. #4 Ign ON, engine not running, use a jumper wire short circuits 469 and 1456 (sensor signal voltage) (light green), back probe circuit 1456 with a volt meter. Does volt meter read 5 volts? #5 Faulty EGR valve. #6 Faulty PCM.	#1 Light glows, check for intermitant fault in circuits or connector. Light does not glow, check circuit 435 and repair. #2 If OK go to next step, if not OK check for open or short in circuit 415. #3 If OK go to next circuit, if not OK check for open in circuit 469 repair as necessary. #4 If OK replace EGR valve, if not OK check for open or short in circuit 1456 (light green), repair or replace if necessary. #5 Replace. #6 Replace.
P0446	Emmission System	Canister Purge Solenoid circuit fault. QDSM activates upto 4 different devices [canister purge solenoid, being on a QDSM circuit] as the PCM commands.	OFF	#1 Disconnect PCM connector, ignition ON, test voltage at PCM harness connector, circuit 439 (green/yellow) and earth, should be battery voltage. #2 Disconnect PCM connector, disconnect canister purge solenoid, use a multimeter to test voltage between canister purge solenoid driver circuit 428 (green/yellow) and earth, voltage should be 0 volts. #3 Disconnect canister purge solenoid, ignition ON test voltage of ignition feed circuit 439 (purple), should be battery voltage. #4 Test circuit 428 (green/yellow) for bad connections at PCM or canister purge control solenoid,	#1 If battery voltage, switch multimeter to amps, over a 2 minute, amps should vary between 0.1 to 1.5 amps if not go to test #2. If not battery voltage check fuse 33, if blown, repair short to earth in cannister purge solenoid feed circuit 439 (purple), if fuse not blown go to test #3. #2 If not 0 volts, repair short to voltage in purge solenoide driver circuit 428 (green/yellow). If 0 volts, inspect for connector damage from circuit 428 to PCM. #3 If battery voltage, inspect for open or short to earth in circuit 428 (green/yellow) if OK check for poor terminal connection at PCM or canister purge control solenoid if good terminal connections, replace canister purge control solenoid. If not battery voltage, repair open in canister purge control solenoid feed circuit 439 (purple). #4 Repair. VX-VY1 V6 DTC's chart 4

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3. Support the door with an assistant or a car jack with soft padding support the base of the door.



4. Remove the door hinge pin protection caps, squeeze lower section of pin and tap up and, drive the hinge pin out.

Install

1. Support the door with an assistant or use wood blocks or car jacks with soft padding support the base of the door.
2. Use a hammer, drive the hinge pin into position. Apply dry lube grease to the hinge pin.
3. Replace the door hinge pin protection caps.
4. Replace the door stop rod bolt and nut.
4. If required, connect the wiring loom connectors that may be present for such items as radio speakers, electric mirrors, electric windows and electric door locks, replace the door trim and replace the door and window handles

DOOR ALIGNMENT

The door to the body alignment is set accordingly and maintained at the lock striker adjustment as described later in this section.

To correct door sag the lock striker can be adjusted.

WINDOW REGULATOR HANDLE

Remove

1. Use window regulator handle removing tool or make one out of a flat piece of heavy sheet metal similar to the tool shown below.
2. Align the tool with the handle as shown and push in firmly so as to remove the spring clip.
3. Remove the handle, taking care not to loose the spring clip, and plastic washer.



Install

1. Position the plastic washer over the regulator spline shaft.
2. Install the spring clip on the handle.
3. With the window wound fully up:

Tip: Front Doors: Position handle so it is pointing up towards the front corner of the door.

Tip: Rear Doors:

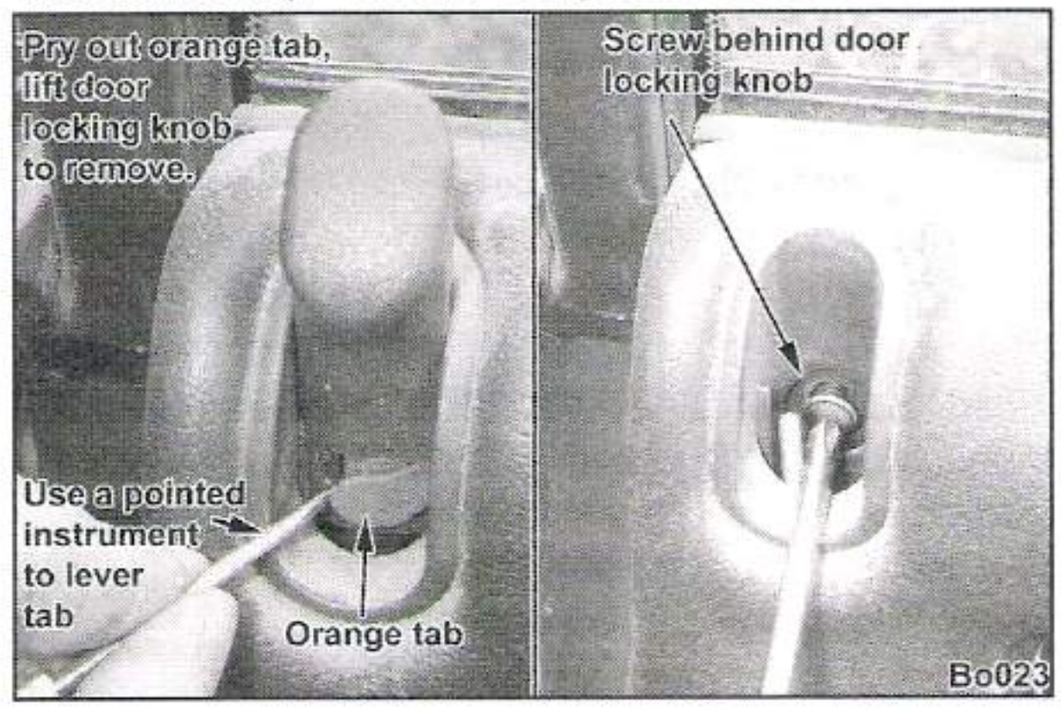
Position the handle horizontally, so it is pointing towards the front of the vehicle.

4. Firmly push the window regulator handle on to the spline so the spring clip locks the handle into position.

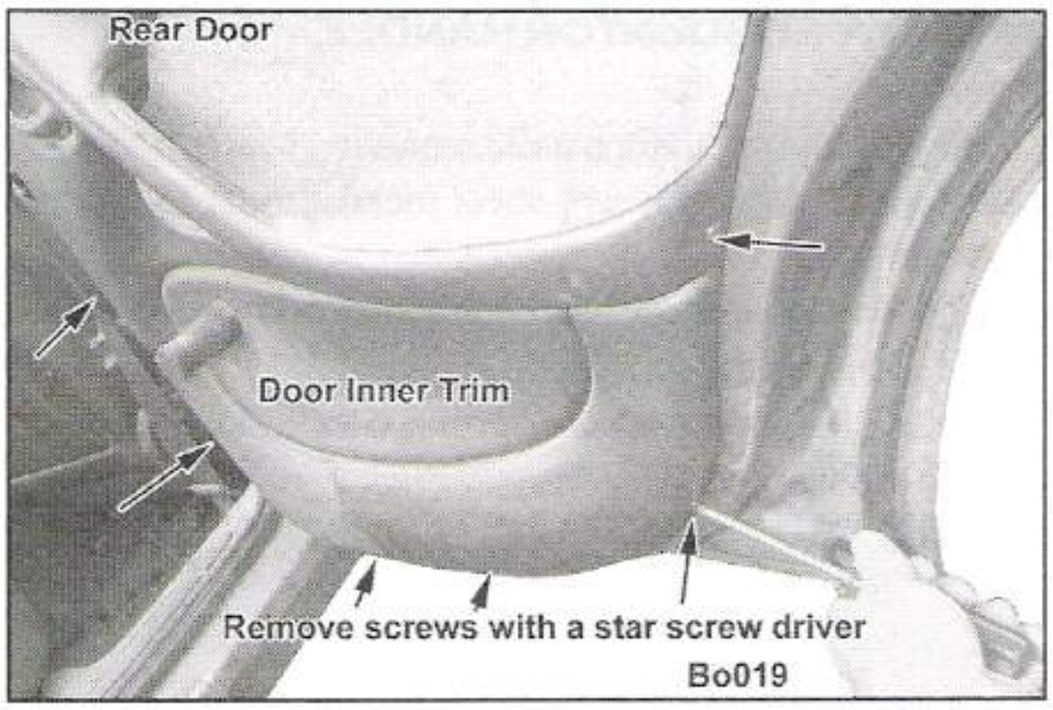
DOOR INNER TRIM PANEL

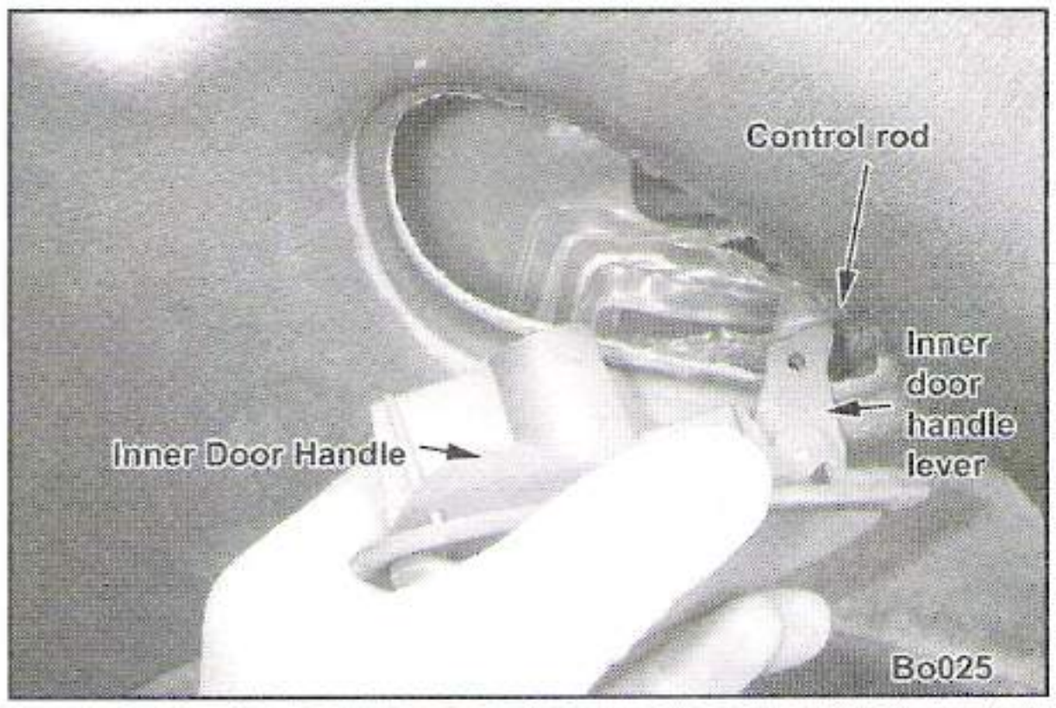
Remove

1. Remove window regulator, as previously described.
2. Use the pointed instrument to remove the locking knob red/ orange tab. The red section fixes the locking knob to the door lock rod. Lift the locking knob off the locking rod
3. Remove the locking knob plastic surround, 1 screw.
4. Remove the (7 - front, 6 - rear) screws from the base and



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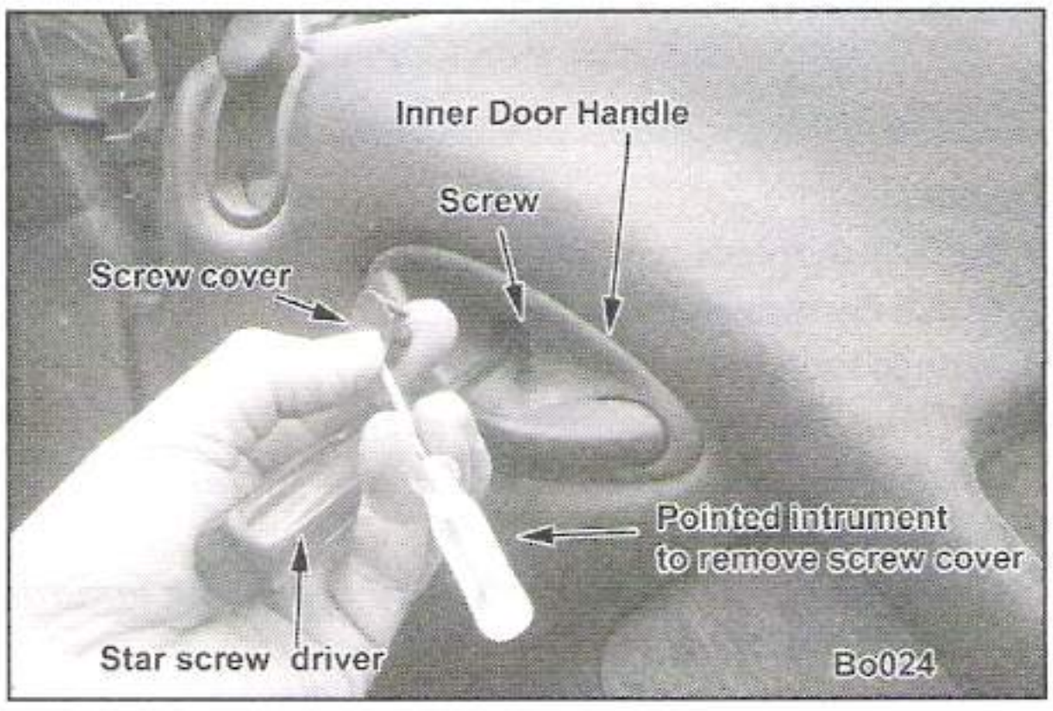




sides of the trim.

5. Remove the mirror cover on front doors. Pull cover off and back to free the cover from the centre support.

6. Remove the inner door control handle and plastic surround, pry out screw cover and remove screw.



Pull remote control assembly to the front, unclip lever from rod, and remove.

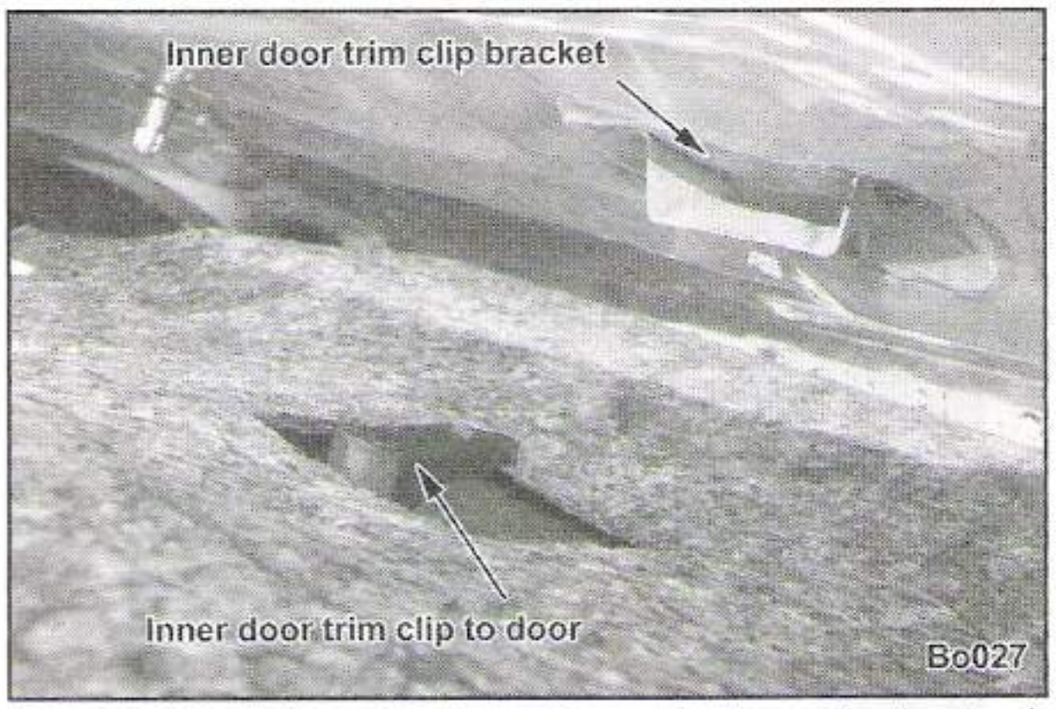
7. Push the center of the trim in near the arm rest, then lift (tap up with hand) door inner trim up to remove. A clip is located behind the center of the inner door trim.



8. Disconnect all electrical connectors to switches and lights on the trim.

Install

1. Place trim close to door and connect wiring connectors.



2. Carefully position the door trim on the door aligning back of the inner trim with the clip bracket on the door shell.

3. Once the door trim is in position fit the attachments back, such as window regulator handle, door handle (pull rod forward, position door handle lever behind rod, fit handle in position) and screw on mouldings, plus push the mirror cover into place.

4. Replace the screws (7 - front, 6 - rear) from the base of the trim..

5. Position door locking knob over rod into correct position, then push in orange retaining clip.

LOCK STRIKER

Remove

1. Mark the striker position on the body panel with a pencil or felt pen, this will help when installing the striker to its correct position.

2. Remove the attaching screws and remove the striker assembly taking care not to loose any shims that may be under the striker.

Install

1. Place the striker and shims against the body panel aligning the striker with the pen marks from the removal.

2. Install the attaching screws and tighten to specification.

Striker Attaching Screw specified torque: 8-18 Nm

3. Check adjustment of the striker.

Adjust

To correct the door sag the lock striker can be adjusted, either horizontally or vertically to align the striker with the lock. To

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V6 - VX, VY, WH, VU (Also corrisponding Monaro and HSV models)

		V6 Engine		Diagnostic Codes with trouble shooting	V6 Eng (VX, WH, VU, Monaro, XY Ser I)
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0740	Transmissi-on.	Torque Converter Clutch (TCC) Solenoid. (PCM activates solenoid ON and voltage is above 10-16 volts. OR. PCM activates solenoid OFF and 0 voltage remains)	ON	#1 If any of DTC codes P0730, P0753, P0785, P1860 are set, check fuse No32. #2 Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "T" Circuit 422 (grey/red) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate TCC solenoid valve ON and OFF, is the test light ON when TCC solenoid valve ON, then test light OFF when TCC solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #4 next column) #5 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 422 (grey/red) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on TCC, if no fault in circuit 422 replace PCM. If the test light did go go ON when valve activaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "T", if 20-33 ohms, then test resistance between "E" and earth then "T" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms replace the transmission internal wiring harness. #5 Clear codes, test drive checking TCC.
P0741	Transmissi-on.	Torque Converter Clutch (TCC) jamed on. This code will set if DTC codes 19, 21, 22, 24, 28, 67 and 83 are not set, and all conditions below are meet for 4 seconds. [TP is open more than 25%, engine 450rpm +, trans gear D3 or D4, TCC command OFF, trans slip speed b/n -20 to +20rpm]	OFF	#1 The TCC will be jamed ON if the TCC is jamed on because of a mechanical fault, the park brake is on, transmission gear position is selected with tmasmission shifter, code 69 is active. #2 Record all codes, the clear codes, is TP operating correctly. #3 Test drive in D4, TP open more than 25%, with a scan tool, test for trans slip speed, does it come within -20 to +20rpm.	#1 Checked which conditions are active, tectify if possible. #2 Check TP is OK, repair if necessary. #3 If trans slip within limits, TCC is jamed on due to mechanical fault, check for converter clutch apply valve is jamed in an apply situation, the TCC solenoid valve has a blocked exhaust and or release duct, valve body gasket is blocking a duct. If fault was one of these clear codes and test drive.
P0748	Transmissi-on	Pressure Control Solenoid (PCS). [electrical current not correct] For DTCP0748 to activate there needs to be no DTC P0562, 10-16 volts, engine operating, at least 0.16 amps between PCS valve return amperage and ideal amperage.	OFF	#1 Disconnect trans pass thru connector, test holes "C" circuit 1228 (red) and "D" circuit 1229 (grey/blue) of connector transmission side for resistance of 3-7 ohms. #2 Disconnect trans pass thru connector, test hole "C" circuit 1228 (red) to the case of transmissiion, for resistance of less than 9 ohms. #3 All connectors in place, disconnect PCM blue 32 pin connector, test resistance of terminal E15 to earth, is resistance more than 15 ohm. #4 Faulty PCM.	#1 If the resistance was over 7 ohms or lower than 3 ohms, check auto trans internal harness for open, if so replace, test drive, if harness OK replace PC solenoid valve, test drive. If resistance is within range go to #2. #2 If resistance is less than 9 ohms, test trans internal harness for short to earth, replace if necessary, test drive. If resistance is over 9 ohms, replace PC solenoid valve, test drive. #3 If so test circuits 1228 (red) and 1229 (grey/blue) for an open, repair then test drive. If resistance is under 9 ohms, test circuits 1228 (red) and 1229 (grey/blue) for a short to earth, repair then test drive. #4 Replace and test drive.
P0753	Transmissi-on	1-2 Shift solenoid circuit. (PCM activates solenoid ON and voltage is above 10-16 volts).	ON	#1 Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #2 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #3 Disconneet trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "A" Circuit 1222 (light green) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate 1-2 shift solenoid valve ON and OFF, is the test light ON when 1-2 shift solenoid valve ON, then test light OFF when 1-2 shift solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #3 next column) #4 Replace PCM.	#1 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #2 If light is on go to next step. If no light repair circuit 339 (purple/blue) clear codes, test drive. #3 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 1222 (light green) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on 1-2 shift, if no fault in circuit 1222 replace PCM. If the test light did go ON when valve activtaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "A", if 20-33 ohms, then test resistance between "E" and earth then "A" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms, disconnect internal wiring harness from 1-2 shift solenoid valve, measure the resistance of the terminals to to earth, if now greater than 250 ohms, replace 1-2 shift solenoid, if not greater than 250 ohms replace the transmission internal wiring harness. #4 Clear codes, test drive checking TCC.

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V6 - VX, VY, WH, VU (Also corrisponding Monaro and HSV models)

		V6 Engine		Diagnostic Codes with trouble shooting	V6 Eng (VX, WH, VU, Monaro, XY Ser I)
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0756	Transmissi-on	1-2 Shift solenoid circuit. (PCM activates solenoid OFF and 0 voltage remains)	ON	#1 If any of DTC codes P0730, P0740, P0753, P0757, P0785, P1860 are set, check fuse No32. #2 Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "A" Circuit 1222 (light green) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate 1-2 shift solenoid valve ON and OFF, is the test light ON when 1-2 shift solenoid valve ON, then test light OFF when 1-2 shift solenoid valve OFF. (If no scan tool available go to "Trouble shooting remedy" #4 next column) #5 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 1222 (light green) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on 1-2 shift, if no fault in circuit 1222 replace PCM. If the test light did go ON when valve activtaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "A", if 20-33 ohms, then test resistance between "E" and earth then "A" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms, disconnect internal wiring harness from 1-2 shift solenoid valve, measure the resistance of the terminals to to earth, if now greater than 250 ohms, replace 1-2 shift solenoid, if not greater than 250 ohms replace the transmission internal wiring harness. #5 Clear codes, test drive checking TCC.
P0757	Transmissi-on	2-3 Shift solenoid circuit. PCM activates solenoid ON and voltage is low. Power supplied by circuit 339 (purple/blue) PCM activates earth by circuit 1223 (yellow/black) to activate 2-3 shift solenoid valve, this valve normally open operates in conjunction with 1-2 shilt solenoid valve to allow 4 different shifts.	ON	#1 If any of DTC codes P0730, P0740, P0753, P0756, P0785, P1860 are set, check fuse No32. #2 Circuit 339 (purple/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "B" Circuit 1223 (yellow/black) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate 2-3 shift solenoid valve ON and OFF, is the test light ON when 2-3 shift solenoid valve ON, then test light OFF when 2-3 shift solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #4 next column) #5 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (purple/blue) clear codes, test drive. #4 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 1223 (yellow/black) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on 2-3 shift, if no fault in circuit 1223 replace PCM. If the test light did go ON when valve activtaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "B", if 20-33 ohms, then test resistance between "E" and earth then "B" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms, disconnect internal wiring harness from 2-3 shift solenoid valve, measure the resistance of the terminals to to earth, if now greater than 250 ohms, replace 2-3 shift solenoid, if not greater than 250 ohms replace the transmission internal wiring harness. #5 Clear codes, test drive checking TCC.
P0785	Transmissi-on	3-2 Shift solenoid circuit. (Solenoid receives ignition voltage in circuit 339, PCM activates solenoid by providing earth through circuit 897)	ON	#1 If any of DTC codes P0740, P0753, P0758, P1860 are set, check fuse No32. #2 Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "S" Circuit 897 (green/white) and "E" circuit 339 (pink/blue) of connector with a test light, ignition ON with a fused jumper wire from earth test PCM terminals C13 and C14. #5 Disconnect harness from 3-2 SS valve assembly, use a multi meter to test resistance between 3-2 SS valve assembly terminals, is resistance 20-32 ohms? #6 Replace transmission internal wiring harness. #7 Repalce 3-2 SS valve assembly. #8 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light is ON when C13 and C14 are earthed, use a multi meter to test resistance between cavity "E" and "S", if 20-32 ohms, then test resistance between "E" and earth then "S" and earth, if both are greater than 250ohm go to terst #5. If the test light was not ON when C13 and C14 are earthed, check circuit 897 (green/white) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on 3-2 shift. #5 If not 20-32 ohms replace 3-2 SS Valve Assembly. If resistance is between 20-32 ohms, check the terminal resistance to earth, if greater than 250 ohms replace transmission internal wiring harness, if not greater than 250 ohms replace 3-2 SS Valve Assembly. #6 Clear codes, test drive checking 3-2 shift. #7 Clear codes, test drive checking 3-2 shift. #8 Clear codes, test drive checking 3-2 shift.

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V6 - VX, VY, WH, VU (Also corrisponding Monaro and HSV models)

				Diagnostic Codes with trouble shooting	**V6 Eng (VX, WH, VU, Monaro, XY Ser I)**
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P1064	Low Speed Fan	No feed back from BCm to PCM from engine cooling fan low speed.	OFF	#1 Check is code DTC 1255 present. #2 If engine does not start and code DTC1064 is set, test circuit 1221 (red/black) for earth or open. #3 Check for intermittent fault in harness or connectors.	#1 Treat code DTC 1255 and test drive. #2 Repair. #3 Repair or replace.
P1116	Engine coolant temperatu-re signal erratic	-No P0117, P0118, P1628 DTC codes - Eng running for 11 sec - ECT signal moves greater than 400mV in 200 milliseconds.	OFF	(This code turns the radiator fan ON) #1 Check for intermittent or poor connection of harness to sensor or PCM Also check for small wire strands at connectors. #2 Check condition of sensor and sensor terminals #3 Check PCM, lightly tap PCM, move terminal at PCM, is PCM mounted and earthed correctly.	Circuits 410 (yellow) power and 452 (blue/yellow) earth via PCM. #1 Fix faulty harness / connector. #2 Replace sensor #3 Remount and earth PCM or replace PCM
P1255	Theft deterrent sensor	No theft deterrent signal. Starter operates after a 1 second delay, but engine will not start.	ON	#1 Ign ON use a volt meter check voltage for 3-5 volts at terminal 9 (circuit 1221 (red/black) DLC connector and earth. #2 Faulty PCM.	#1 If OK go to next step, if not OK check for open or short in circuit 1221 #2 Replace.
P1351	Ignition - Electronic Spark Timing (EST)	Ignition bypass circuit is shorted to battery voltage. OR 2 EST pulses detected by the PCM while engine is start cranking for first 3 crankshaft signals.	ON	#1 Clear code, operate engine did code set again. #2 Disconnect ignition modual connector (14 pin), probe "B" terminal using a voltage meter. #3 Disconnect PCM harness connector, ignition ON, probe "B" terminal again, check for 0.5 volts with a voltage meter again. #4 Igntion OFF all connectors connected, use a volt meter, back probe D10 terminal on connector at PCM, ignition ON, start engine, check for 2 volts. #5 Faulty ignition modual.	#1 No code indicates intermitant fault, if code set again proceed with further tests. #2 If voltage is greater than 0.5 go to next step, if voltage is 0.5 or less go test #4. #3 If any voltage is found there is a short to voltage in circuit 424 (tan/black), repair or replace harness. #4 If voltage is approx 2 volts check circuit 423 (white) for open, if not OK check PCM connection (B3) or replace PCM. # Replace ignition modual.
P1361	Ignition - Bypass circuit	No EST pulses for 200 milliseconds with engine rpm over 1600 rpm.	ON	#1 Clear code, operate engine did code set again. #2 Disconnect ignition modual connector (14 pin), probe "A" terminal a voltage meter. #3 Disconnect PCM harness connector, ignition ON, probe "A" terminal again check for 0.5 volts with a voltage meter again. #4 Disconnect PCM connectors, ignition OFF, test ignition modual connector circuit 423 (white) with a test light connected to battery voltage. #5 Disconnect ignition modual connector, ignition OFF, test ignition modual connector circuit 424 (tan/black) with a test light connected to battery voltage. #6 Ignition OFF, disconnect PCM connectors check for faulty connection at connectors or open circuit 424. #7 Disconnect PCM connector, all other connectors assembled, ignition ON, test PCM harness connector circuit 423 (white) with an ohm meter to earth. While reading ohm meter connect a test light between PCM harness connector circuit 424 (tan/black).	#1 No code indicates intermitant fault, if code set again proceed with further tests. #2 If voltage is greater than 0.5 go to next step, if voltage is 0.5 or less go test #4. #3 If any voltage is found there is a short to voltage in circuit 423 (white), repair or replace harness, if no voltage replace ignition modual. #4 Test light ON repair short to earth in circuit 423, test light OFF replace PCM. #5 Light ON repair short to earth on circuit 424, test light OFF replace PCM. #6 Repair or replace. #7 If before test light connected less than 300 ohms, with test light connected ohms over 6000 ohms, replace PCM. If the above values are not so replace ignition modual.
P1372	No Reference Pulses when Cranking	No crankshaft pulses from ignition module of reference input signal to PCM (DTC code P1372 set only if code P0101 is not set)	ON	#1 Will engine start? #2 If spark test was OK, ignition OFF, disconnect PCM, use a volt meter to back probe terminal B9 of PCM harness connector to earth, ignition ON, is there 9.5 volts? #3 Same as for test #2 but crank engine is there 2-3 volts.	#1 If started check for intermitant fault, if did not start do an ignition test then check spark at each spark plug with a spark tester. #2 If not replace ignition modual, if 9.5 volts go to test #3 #3 If not 2-3 volts check circuit 430 (violet) for bad connection, open or short to earth, or replace ignition modual. If approx 2-3 volts inspect for faulty B9 terminal of PCM connector or replace PCM.
P1571	Anti-lock Braking System - Electronic Traction Control (ABS-ET-C)	No 4-5 volts signal received at PCM from circuit 1426 (orange/white) Note: code 95 will disable ETC functions.	ON	#1 Disconnect PCM connector, ignition ON, test for 4-5 volts at PCM connector terminal C11 circuit 1426 (orange/white) to earth. #2 PCM connector connected, disconnect ABS-ECT, ignition ON, test for 4-5 volts at ABS-ECT connector terminal C13 circuit 1426 (orange/white) to earth. #3 Disconnect ABS-ETC modual connector, then disconnect PCM connector, ignition ON, test for voltage at PCM connector terminal C11 circuit 1426 (orange/white) to earth. #4 Replace PCM, clear codes, then test operation of ABS-ETC. Test ABS-ETC: All PCM and ABS-ETC connectors fitted, place the vehicle on saftey stands with rear wheels off the ground, use a volt meter, back probe PCM harness circuit 1247 (black/white) to earth, start engine, transmission in "P".	#1 If 4-5 volts go to test #2. If no voltage go to test #3. #2 If 4-5 volts check for poor terminal contacts, if contacts OK replace ABS-ECT module. If not 4-5 volts, check for poor terminal contact or open or short in circuit 1426 (orange/white) between PCM and ABS-ETC, repair, if all OK replace PCM. #3 If 0 volts replace ABS-ETC modual. If voltage found locate short to voltage in circuit 1426 (orange/white), clear codes, test drive. #4 Voltage should be 4-5 volts if system working correctly, then shift tranmission into "D" let wheels spin, jab the accelerator pedal, voltage should drop to 1-2 volts if the system is operating correctly. If not operating correctly work through all tests again.

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V6 - VX, VY, WH, VU (Also corrisponding Monaro and HSV models)

		V6 Engine		Diagnostic Codes with trouble shooting	V6 Eng (VX, WH, VU, Monaro, XY Ser I)
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P1627	PCM	Analog to digital information error	ON	#1 Faulty PCM.	#1 Replace PCM.
P1628	Engine coolant temperature circuit - PCM	- Engine running for 10 + sec and - PCM resistor switches and less 60mV change in ECT signal	OFF	This code turns on engine cooling fan. Carry out an On Board Diagnostic test. #1 Fault in PCM engine coolant temerature circuit.	#1 Replace PCM
P1642	LPG	Voltage in circuit 937 (white/green) PCM terminal A3 is to high or to low for over 1 second.	ON	#1 Disconnect brown PCM connector, ignition ON, test voltage of PCM terminal A3 (circuit 937) and earth, is it battery voltage? #2 Disconnect LPG tank smart unit, ignition ON, test voltage of PCM terminal A3 (circuit 937) and earth, is it 0 voltage? #3 Test conditions below in order listed. - Faulty connection at PCM terminal A3. - Open or short in circuit 937 between LPG Smart Tank Unit and PCM A3 terminal. - Fuse F14 blown. - Open in circuit 750 (brown) (earth for LPG Smart Tank Unit) - Faulty LPG smart Tank Unit. - Faulty PCM	#1 If battery voltage go to test #2. If 0 volts go test #3. #2 If 0 volts, repair damaged A3 terminal. If not 0 volts repair short to battery voltage in circuit 937 #3 - Repair. - Repair or replace. - Repair short to earth in circuit 39 (feed to Fuse 14), replace fuse. - Repair open in circuit 750 (brown). - Replace - Replace
P1643	LPG	Voltage in circuit 1062 PCM terminal E16 is to high or to low for over 1 second.	ON	#1 Disconnect tan PCM connector, ignition ON, test voltage of PCM terminal E16 (circuit 1062), is it battery voltage? #2 Reconnect PCM connector, engine running, 1500+ rpm, on LPG, test amperage between fuel control valve and earth over a 2-3 minute period, it should be between 0.1 to 1.4 amps of PCM terminal A3 (circuit 937), is it 0 voltage? #3 Test conditions below in order listed. - Faulty connection at PCM terminal A3. - Open or short in circuit 937 between LPG Smart Tank Unit and PCM A3 terminal. - Fuse F14 blown. - Open in circuit 750 (brown) (earth for LPG Smart Tank Unit) - Faulty LPG smart Tank Unit. - Faulty PCM	#1 If battery voltage go to test #2. If 0 volts go test #3. , test for open or short in circuit 937 between LPG Smart Tank Unit and PCM A3 terminal. #2 If 0 volts, repair damaged A3 terminal. If not 0 volts repair short to battery voltage in circuit 937 #3 - Repair. - Repair or replace. - Repair short to earth in circuit 39 (feed to Fuse 14), replace fuse. - Repair open in circuit 750 (brown). - Replace - Replace
P1810	Auto transfluid pressure manual valve position switch assembly.	. A faulty switch assembly signal for 6 sec's or more. # Transmission will only operate in D2 while code 28 is set.	ON	#1 Carry out an intermitant fault inspection on circuits 1224, 1225, 1226, 1227 and 469 #2 Check linkages and adjustment from the transmission lever to the manual valve. #3 If you have a scan tool: Clear codes, eng not running, ignition ON, test voltage for switches A, B & C in all selector position ranges D1, D2, D3, D4, N, R & P, #4 Engine not running, Ing ON, check trans pass through connector at terminals N, P, R for battery + volts. #5 Check that circuits 1224, 1225 & 1226 leading to connector terminals are not shorted between each other. #6 Ignition OFF, remove trans oil pan, disconnect wiring to TFP Valve switch, check circuits for 1224 & 1225 for short to earth.	#1 Repair or replace faulty components. #2 Repair or replace faulty components. #3 If OK go to next step, if not OK go to next step. #4 If OK got to next step, if not OK repair circuits or replace PCM. #5 If faulty repair or replace faulty circuits. #6 If faulty repair or replace faulty circuits.
P1860 **	Transmission	Torque Converter Clutch Pulse Width Modulation solenoid circuit. (PCM activates solenoid ON and voltage is above 10-16 volts. OR. PCM activates solenoid OFF and 0 voltage remains) [TCC PWM solenoid and circuit is operating correctly when the PCM activates the TCC PWM solenoid ON TCC slip speed is between -20 and +20 rpm. When the PCM deactivates the TCC PWM to OFF TCC slip is greater than 50rpm]	OFF	#1 If any of DTC codes P0740, P753, P0758, P0785 are set, check fuse No32. #2 Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wiring harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "U" Circuit 418 (brown) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate TCC PWM solenoid valve ON and OFF, is the test light ON when TCC PWM solenoid valve ON, then test light OFF when TCC PWM solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #4 next column) #5 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 418 (brown) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on TCC PWM, if no fault in circuit 418 replace PCM. If the test light did go ON when valve activtaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "U", if 10-15 ohms, then test resistance between "E" and earth then "U" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms, disconnect internal wiring harness from 1-2 shift solenoid valve, measure the resistance of the terminals to to earth, if now greater than 250 ohms, replace TCC PWM solenoid, if not greater than 250 ohms replace the transmission internal wiring harness. #5 Clear codes, test drive checking TCC.

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V6 - VX, VY, WH, VU (Also corrisponding Monaro and HSV models)

		V6 Engine		Diagnostic Codes with trouble shooting	V6 Eng (VX, WH, VU, Monaro, XY Ser I)
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P1870	Transmissi-on	Transmission slippage has been detected by the PCM at more thann 400 rpm with all below, no code 28, throttle is more than 20% open, TF temperature is between 600C and 1500C, TCC is activated ON	OFF	#1 Inspect transmission fluid chart in Transmission chapter. #2 Use a scan tool to verify that the transmission is actually slipping. #3 Check the 1-2 shift solenoid valve for damage, sediment or faulty seals. #4 Inspect the following conditions in order listed: A jammed TCC signal valve in the valve body. Torque converter may have the stator roller clutch not holding or internal damage. Oil Pump may have a jammed converter clutch valve, converter clutch valve assembled wrong way, converter clutch valve retaining ring may not be in the correct position, oil pump gasket not installed correctly, orific cup plugs damaged or faulty, oil pump bolts not tightened correctly. Input shaft and housing turbine "O" ring damaged, turbine retainer and ball assembly damaged or incorrectly assembled. 2-4 band assembly may need replacing or components replaced, check band, anchor pin, 2-4 servo assembly, servo pin, piston and bore, 4th servo piston, band apply pin, servo bore for scoure marks and porosity, servo piston seals and seal grooves, orific cup plug. Forward clutch assembly may need components replaced, check for worn or damaged clutch plates, forward clutch piston, piston seals and seal grooves, input housing to forward clutch housing "O" ring, forward clutch housing retainer and ball. 3-4 clutch assembly may need components replaced, check for worn or damaged clutch plates, 3-4 clutch piston, piston seals and seal grooves, orific cup plug.	#1 Rectify any problems. #2 If no slipping check for other internal transmission damage. Is the transmission slipping by more than 300 rpm according to the scan tool, if so check the TCC solenoid valve for sediment or faulty seals, if so clean and replace then test to check for slipping. #3 If so clean and repair then test drive to check for slipping. #4 If any components found to be faulty, repair then test drive to check for slipping. VX-VY1 V6 (P1C) chan 11

PCM Connector - Gen III V8 Engine [80 pin Blue connector]

Terminal	Pin	Wiring Colour	Circuit	Voltage Range
Earth	1	Brown / Red	750	0
Crankshaft positioner sensor ignition feed	2	Light Blue / White	846	12+
Fuel injector No3 power supply	3	Violet	843	12 ignition on, 12 pulsing with engine operating
Fuel injector No2 power supply	4	Green	842	12 ignition on, 12 pulsing with engine operating
Free	5	–	–	-
Free	6	–	–	-
Oil pressure sensor power supply	7	Blue / Yellow	334	5
Throttle position sensor power supply	8	Grey	416	5
Free	9	–	–	-
Free	10	–	–	-
Knock sensor rear signal	11	Light Blue	826	1.3-25.6 mV (AC)
Crankshaft position sensor signal	12	Blue	843	-
Free	13	–	–	-
Free	14	–	–	-
Free	15	–	–	-
Free	16	–	–	-
Automatic Transmission shifter range B input	17	Yellow	1225	12+
Automatic Transmission shifter range C input	18	Grey		12+
Ignition on signal	19	Pink	39	12+
Power from battery, fuse F31	20	Orange	740	12+
Crankshaft position sensor low reference (sensor earth)	21	Light Blue / Black	647	0
Free	22	–	–	-
Free	23	–	–	-
Free	24	–	–	-
Free	25	–	–	-
Heated oxygen sensor (HO2S) bank 2 sensor 1 earth circuit	26	Grey / Black	1413	0
Free	27	–	–	-
Free	28	–	–	-
Heated oxygen sensor (HO2S) bank 1 sensor 1 earth circuit	29	Blue / Black	413	0
Engine coolant lows earth circuit	30	Greeen	69	0
Free	31	–	–	-
Transmission shifter PRNDL terminal A	32	Blue / White	771	12+
Transmission torque convertor clution and cruise control brake switch signal	33	Brown	86	
Transmission shifter PRNDL terminal P	34	White	776	
Free	35	–	–	-
Fuel injector No1 power supply	36	Blue	841	12 ignition on, 12 pulsing with engine operating
Fuel injector No6 power supply	37	Yellow	846	12 ignition on, 12 pulsing with engine operating
Free	38	–	–	-
Free	39	–	–	-
PCM earth	40	Brown / Red	750	0
Crankshaft positioner sensor	41	–	–	-
Free	42	–	–	-
Fuel injector No7 power supply	43	Pink / Black	847	12 ignition on, 12 pulsing with engine operating
Fuel injector No4 power supply	44	Brown / Yellow	844	12 ignition on, 12 pulsing with engine operating
Air conditioner reference power supply	45	Violet / White	415	5
Free	46	–	–	-
Free	47	–	–	-
Manifold absolute pressure sensor reference power supply	48	Violet / White	414	5
Free	49	–	–	-
Free	50	–	–	-
Free	51	Blue	815	1.3-25.6 mV (AC)
Free	52	–	–	-
Auto transmission fluid temperature sensor earth	53	Black / White	1230	0
Manifold absolute pressure sensor earth	54	Black	421	0
Free	55	–	–	-
Free	56	–	–	-
Battery power supply, fuse F31	57	Orange	740	12+
Serial data class II	58	Yellow	1049	0
Free	59	–	–	-
Throttle positioner sensor earth	60	Black / Yellow	452	0
Camshaft positioner sensor reference low (earth)	61	Red / White	832	0
Free	62	–	–	-
Oil pressure sensor earth	63	Green	336	0
Free	64	–	–	-
Free	65	–	–	-
Heated oxygen sensor (HO2S) bank 2 sensor 1high circuit	66	Grey	335	0.350-0.450 ignition on, 0.010-1.000 engine operating
Free	67	–	–	-
Free	68	–	–	-
Heated oxygen sensor (HO2S) bank 1 sensor 1high circuit	69	Violet	412	0.350-0.450 ignition on, 0.010-1.000 engine operating
Free	70	–	–	-
Transmission Power/Economy switch	71	Blue	774	12
Transmission shifter PRNDL terminal B	72	Yellow	772	less than 0.50
Camshaft positioner sensor input signal	73	Brown	833	Approx. 4.8 ignition on, approx. 0.4 engine operating
Engine coolant temperature sensor signal to PCM	74	Yellow	410	Approx. 1.9, varies
Free	75	–	–	-
Fuel injector No5 power supply	76	Blue	845	12 ignition on, 12 pulsing with engine operating
Fuel injector No8 power supply	77	Blue	848	12 ignition on, 12 pulsing with engine operating
Free	78	–	–	-
Transmission 3-2 shift solenoid control	79	Green / White	897	12 with ignition on
Engine coolant temperature sensor earth	80	Grey / Black	455	0

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PCM Connector - Gen III V8 Engine [80 pin Red connector]										
Terminal	**Pin**	**Wiring Colour**	**Circuit**	**Voltage Range**		**Terminal**	**Pin**	**Wiring Colour**	**Circuit**	**Voltage Range**
Earth	1	Brown / Red	750	0		Free	41	--	--	-
Crankshaft positioner sensor ignition feed	2	Light Blue / White	646	12+		Transmission torque converter clutch solenoid control via earth through PCM	42	Grey / Red	422	12+. 0 when torque converter on
Fuel injector No3 power supply	3	Violet	843	12 ignition on, 12 pulsing with engine operating		Air conditioner clutch relay control via earth through PCM	43	Light Green / Black	366	0.1 to 1.0 when clutch relay is on
Fuel injector No2 power supply	4	Green	842	12 ignition on, 12 pulsing with engine operating		Manual transmission, reverse lock out solenoid via earth through PCM (over 8 kpm)	44	Yellow	838	12+ ignition on. Approx 0 when active
Free	5	--	--	-		Free	45	--	--	-
Auto trans, power to pressure control solenoid from PCM	6	Red	1228	12+		Free	46	--	--	-
Free	7	--	--	-		Auto transmission 2-3 shift solenoid control via earth	47	Yellow / Black	1223	12 ignition on. 0 when solenoid on
Auto trans, power to pressure control solenoid from PCM	8	Grey / Blue	1229	12		Auto transmission 1-2 shift solenoid control via earth	48	Light Green	1222	12 ignition on. 0 when solenoid on
Fuel pump relay control from PCM	9	Green / White	465	12+		Free	49	--	--	-
Tachometer output signal to instument cluster	10	Brown	121	varies		Vehicle speed sensor output signal to PCM	50	Violet / White	123	-
Free	11	--	--	-		Auto transmission fluid temperature sensor input	51	Black / Yellow	1227	5 ignition on. less than 5 as temp rises
Free	12	--	--	-		Free	52	--	--	-
Free	13	--	--	-		Electronic traction control retard signal	53	Grey / Black	1687	
Air conditioner refrigerant pressure sensor signal to PCM	14	Green / Black	259	1-2		Free	54	--	--	-
Free	15	--	--	--		Free	55	--	--	-
Free	16	--	--	--		Free	56	--	--	-
Free	17	--	--	-		Air intake temp & air cond. refrig. pressure sensor earth	57	Green / Orange	469	0
Air conditioner clutch and relay situation feed back to PCM	18	Green	59			Oil pressure sensor input signal to PCM	58	Brown / White	331	12
Free	19	--	--	-		Free	59	--	--	-
Vehicle speed sensor low signal to PCM	20	Tan	832	0 AC volts while vehicle is stationary		Ignition reference earth for ignition coils 1, 3, 5 & 7	60	Brown	958	0
Vehicle speed sensor high signal to PCM	21	Blue / White	831	0 AC volts while vehicle is stationary		Ignition reference earth for ignition coils 2, 4, 6 & 8	61	Violet	959	0
Free	22	--	--	--		Transmission shifter PRNDL terminal B	62	Grey	773	12 or 0
Free	23	--	--	--		Transmission range A input	63	Brown / Yellow	1224	12 or 0
Throttle position sensor signal to PCM	24	Blue	417	0.25 - 1.25 when test to pin 1 (earth), approx. 4.0+ at full throttle		Free	64	--	--	-
Air intake temperature sensor input to PCM	25	Brown	472	less than 4.0		Free	65	--	--	-
Cylinder 1 ignition coil control, module terminal G	26	White	971			Cylinder 8 ignition coil control, module terminal G	28	Light Green	976	
Cylinder 7 ignition coil control, module terminal B	27	Yellow	977			Cylinder 2 ignition coil control, module terminal B	28	Light Green	976	
Cylinder 6 ignition coil control, module terminal F	28	Light Green	976			Cylinder 5 ignition coil control, module terminal C	28	Light Green	976	
Cylinder 4 ignition coil control, module terminal C	29	White	974			Cylinder 3 ignition coil control, module terminal F	28	Light Green	976	
Free	30	--	--	-		Free	70	--	--	-
Mass air flow sensor earth signal to PCM	31	Brown / White	792	0.5 to 4.5 depending on air flow		Free	71	--	--	-
Manifold absolute pressure sensor signal to PCM	32	Light Green	432	4+ ignition on 1 to 2 engine at idle		Free	72	--	--	-
Engine radiator fan high speed	33	Blue / White	304	12+ fan not going 0 fan going		Free	73	--	--	-
Emission canister purge solenoid control circuit	34	Green / Yellow	428	12+ if purge control valve is closed 0.50 to 12+ purging		Free	74	--	--	-
Free	35	--	--	-		Free	75	--	--	-
Free	36	--	--	-		Idle air control valve coil B high	76	Light Green / White	443	not relevant
Free	37	--	--	-		Idle air control valve coil B low	77	Light Green / Black	444	not relevant
Free	38	--	--	-		Idle air control valve coil A low	78	Light Blue / Black	442	not relevant
Camshaft sensor ignition feed supply	39	White / Black	631	12+		Idle air control valve coil A high	79	Light Blue	441	not relevant
PCM earth	40	Brown / Red	750	0		Free	80	--	--	-- PCM connector GM red

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Gen III V8 engine models

		Gen III V8 engine		**Diagnostic Codes with trouble shooting**	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure	Trouble Shooting Remedy
P0101	Mass Air Flow (MAF) sensor.	Engine running but MAF signal 50% out from estimated air density for 5+ seconds. Codes P0102, P0103, P0107, P0108, P0121, P0122 & P0123 are not activated	ON	#1 Blocked air filter, vacuum leaks at manifold or throttle body. Oil filler cap not installed correctly, oil dip stick not in correctly. #2 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a test light to probe sensor harness connector "C" terminal to earth. #3 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a volt meter to probe sensor harness connector "B & C" terminals for 10 volts. #4 Check for intermittent faults. #5 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a volt meter to probe sensor harness connector "A" terminal to earth. #6 Voltage result from above test under 4 volts	#1 Replace air filter and clean air filter box, fix vacuum leaks. Fix oil filler cap or oil dip stick. #2 - Light glows, check for intermitant fault in circuits or connector, if no glow check for open or short to earth in circuit 439. - Replace fuse No12 if necessary. #3 If OK go to next step, if not OK check circuit 750 (earth) (black/red) for fault. #4 Repair if necessary. #5 - Voltage OK use a scan tool to check MAF for 4-9 grams/second, if not OK go to next step. #6 If under 4 volts, check for open in circuit 750 (earth) (black/red), if over 4 volts repair short to circuit 792 (brown/white)
P0102	Mass Air Flow (MAF) sensor.	Engine running but MAF signal 50% less from estimated air density for 5+ seconds.	ON	#1 Vacuum leaks at manifold or throttle body. Oil filler cap not installed correctly, oil dip stick not in correctly. #2 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a test light to probe sensor harness connector "C" circuit 439 terminal to earth. #3 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a volt meter to probe sensor harness connector "B & C" terminals for 10 volts. #4 Check for intermittent faults. #5 Ign OFF, engine not running, disconnect MAF sensor connector, ignition ON, use a volt meter to probe sensor harness connector "A" terminal to earth. #6 Voltage result from above test under 4 volts	#1 Fix vacuum leaks. Fix oil filler cap or oil dip stick. #2 - Light glows, check for intermitant fault in circuits or connector, if no glow check for open or short to earth in circuit 439. - Replace fuse No12 if necessary. #3 If OK go to next step, if not OK check circuit 750 (earth) (black/red) for fault. #4 Repair if necessary. #5 - Voltage OK use a scan tool to check MAF for 4-9 grams/second, if not OK go to next step. #6 If under 4 volts, check for open in circuit 750 (earth) (black/red), if over 4 volts repair short to circuit 792 (brown/white)
P0103	Mass Air Flow (MAF) sensor.	Engine running but MAF signal higher than estimated air density for 5+ seconds.	ON	#1 Water contacting the MAF sensor can cause a faulse code to be set. #2 Check for intermittent faults, by moving harness terminals and checking terminal connections. #3 Inspect for MAF wiring harness routed incorrectly near high current and voltage wires, such as ignition, motorand relay wiring. #4 Faulty MAF sensor unit. #5 Faulty PCM.	#1 Check air intake system for signs of water entering system. #2 Repair if necessary. #3 Re-rout wiring harness. #4 Replace MAF sensor unit. #5 Replace PCM.
P0107	Manifold Absolute Pressure (MAP) sensor.	MAP sensor circuit has lower than 0.10 voltage for at least 2 seconds. No TP or ECT codes activated.	ON	#1 Disconnect the MAP harness connector, ignition on, use a volt meter connected to harness connector at voltage circuit 414 (Voilet/white) and earth, is it 5 volts. #2 Ignition off, disconnect MAP sensor connector, use a test light between B+ and circuit 432 (light green). #3 Disconnect the MAP harness connector, ignition on, use a volt meter at MAP terminal B (center terminal) and earth, is it 4-5.5 volts. #4 Engine idling then increase and decrease rpm while backprobing PCM terminal J2-32 (circuit 432, light green) is voltage between 0.10 to 5 volts #5 Ignition off, disconnect MAP sensor connector, use a test light between B+ and circuit 421 (black).	#1 If 5 volts got to test #2. If not at 5 volts, test volts at PCM (blue connector) terminal J1-48 circuit 414 (voilet/white) should be 5 volts, if so open or short in circuit 414, repair, if not 5 volts replace PCM. #2 If light glowed (circuit 432 OK). If does not glow open in circuit 432 (light green) repair circuit. #3 If volts 4-5.5 MAP probably OK, if no volts replace MAP sensor or check MAP sensor terminals. #4 If volts between range MAP sensor OK, if not replace MAP sensor. #5 If light glowed (circuit 421 OK). If does not glow open in circuit 421 (black) repair circuit.
P0108	Manifold Absolute Pressure (MAP) sensor.	MAP sensor circuit has high than 0.10 voltage for at least 2 seconds. No TP or ECT codes activated.	ON	#1 Check vacuum hose from manifold to MAP sensor for blockage or leaks. #2 Disconnect the MAP harness connector, ignition on, use a volt meter connected to harness connector at voltage circuit 414 (Voilet/white) and earth, is it 5 volts. #3 Back probe circuit 421 (black) with a test light to battery voltage, does light glow. #4 Use a multi meter to check continuity of MAP sensor earth circuit 421 through PCM should be approx 5ohms. #5 Faulty MAP sensor.	#1 Replace vacumm hose if necessary. #2 If 5 volts got to test #2. If not at 5 volts, test volts at PCM (blue connector) terminal J1-48 circuit 414 (voilet/white) should be 5 volts, if so open or short in circuit 414, repair, if not 5 volts replace PCM. #3 If no glow, a poor due to either open circuit 421 or faulty terminal connection. #4 If not 5 ohms replace PCM. #5 Replace MAP sensor. DTC's chart Gen III 1

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Gen III V8 engine models

		Gen III V8 engine		**Diagnostic Codes with trouble shooting**	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure	Trouble Shooting Remedy
P0112	Intake Air Temperature signal to low	- IAT sensor sends a low signal less than 0.3 volts (0.3 volts only if air is above 147° C) for greater than 1 sec # PCM defaults to 25°C operation with DTC code P0112	OFF	#1 Inspect harness and connector. #2 Check IAT terminal resistance, with chart, under sensors. #3 Check circuit 472 (brown) PCM terminal D7 for short to earth or IAT earth. #4 Check for fault code. #5 Faulty PCM	#1 Repair or replace #2 Replace IAT if not as specified. #3 Repair or replace circuit 472. #4 If fault code still present replace IAT sensor. #5 Replace
P0113	Intake Air Temperature signal to high	- IAT sensor sends a high signal more than 4.9 volts (only if air is below -36° C) for greater than 1 sec # PCM defaults to 250C operation with DTC code P0113.	OFF	#1 Inspect harness and connector. #2 Check IAT terminal resistance, with chart, under sensors. #3 Check circuit 472 (brown) for open or short. #4 Check for fault code. #5 Faulty PCM	#1 Repair or replace #2 Replace IAT if not as specified. #3 Repair or replace circuit 472. #4 If fault code still present replace IAT sensor. #5 Replace
P0117	Engine coolant temperature signal low	- Engine running for 20 + sec - ECT signal less than 0.3 volts	ON	(This code turns the radiator fan ON) #1 Check for intermittent or poor connection of harness to sensor #2 Check engine temperature sensor terminals as in "Body electrical". #3 Check circuit 410 (yellow) and or sensor for short to earth	Circuits 410 (yellow) power and 452 (blue/yellow) earth via PCM. #1 Fix faulty harness / connector. #2 Replace sensor if necessary. #3 Repair circuit, replace sensor. If all OK replace PCM
P0118	Engine coolant temperature signal high	- Engine running for 20 + sec - ECT signal more than 4.64 volts	ON	(This code turns the radiator fan ON) #1 Check for intermittent or poor connection of harness to sensor #2 Check engine temperature sensor terminals as in "Body electrical". #3 Check circuit 410 (yellow) for open to PCM	Circuits 410 (yellow) power and 452 (blue/yellow) earth via PCM. #1 Fix faulty harness / connector. #2 Replace sensor if necessary. #3 Repair circuit, replace sensor. If all OK replace PCM
P0121	Throttle Position Sensor not shutting	- Throttle position sensor not closing as per rpm chart (EFI chapter) when MAF is under 301 mg/cyl for 20+sec - Throttle position sensor could be jammed	ON	#1Inspect throttle position butterfly valve and throttle cable for jamming or not closing smoothly.	#1 Repair or replace as necessary.
P0122	Throttle Position signal to low	- Throttle position sensor sends a low (less than 0.2 volts) for greater than 2 sec	ON	#1 Inspect harness and connector. #2 TP test signal voltage, circuit 417 (blue) and circuit 416, should be 4.0 volts or greater. #3 Check circuit 417 for open, short or bad connection. #4 TP signal circuit 417 (blue) probe with 12 volt. Test signal voltage, circuit 417 (blue) and circuit 416, should be 4.0 volts or greater. #5 PCM faulty	#1 Repair or replace #2 Repair or replace #3 Repair circuit 417 if necessary. #4 If OK check and repair circuit 416, if not OK replace throttle position sensor. #5 Replace
P0123	Throttle Position signal to high	- Throttle position sensor sends an open signal for greater than 2 sec	ON	#1 Inspect harness and connector. #2 TP signal circuit 417 (blue) or circuit 416 (gray short to over 5v) short to voltage. #3 TP earth circuit 452 (blue/yellow) open #4 TP earth circuit 452 (blue/yellow), back probe connector for voltage. #5 TP sensor faulty. #6 PCM faulty	#1 Repair or replace #2 Repair or replace #3 Repair or replace #4 Replace TP sensor for find short in earth circuit 452 #5 Replace #6 Replace
P0125	Excessive Time to Closed Loop (ECT)	Due to Engine Coolant Temperature sensor feed back an excessive delay occurred for closed Loop operation.	OFF	#1 Is the cooling system operating correctly, thermostate, coolant level, radiator fan. #2 On a cold start, start engine, check operation of coolant temperature gauge (ECT), does it work correctly. #3 Jumper the two ECT sensor wires together, does the temperature gauge read very hot. #4 Faulty ECT sensor. #5 Faulty PCM.	#1 If not repair. #2 If not working, replace coolant temperarue sensor. #3 If not check harness of ECT sensor. #4 Replace ECT sensor. #5 Replace PCM.
P0131	Oxygen Sensor O2 (Heated Oxygen Sensor - HO2S) - Left hand	Left hand (bank 1) oxygen sensor has a lean signal (closed loop system activated) Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1258 are not activated.	ON	#1 Visually check O2 sensor wire to connector, is it shorting to earth? has the wire broken? #2 Contaminated fuel with water, low fuel pressure, faulty injectors causing lean mixture. #3 Has MAF sensor been worked on or interfered with? #4 Ignition OFF, disconnect PCM connectors, check circuit 412 for short to earth.	#1 If yes, replace O2 sensor and wire. #2 Replace fuel if contaminated, rectify low fuel pressure or injectors if faulty. #3 Check MAF operation. #4 If OK replace PCM, if not OK repair or replace circuit 412. DTC's chart Gen III 2

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Gen III V8 engine models

		Gen III V8 engine		Diagnostic Codes with trouble shooting	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure	Trouble Shooting Remedy
P0132	Oxygen Sensor O2 (Heated Oxygen Sensor - HO2S) - Left hand	Left hand (bank 1) oxygen sensor has a rich signal. (closed loop system activated) Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1258 are not activated.	ON	#1 Check for high fuel pressure, faulty injector, leaking injector, fuel contaminated oil. # 2 Has MAF sensor been worked on or interfered with? #3 Ignition OFF, test circuit 412, probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350mV? #4 Ignition OFF, test circuit 412, probe disconnected PCM connector with volt meter to earth, ignition ON. Is voltage 350mV? #5 Disconnect PCM connectors, ignition OFF, check continuity for circuit 750 PCM connector terminal J1-01 and engine earth.	#1 Rectify high fuel pressure, replace injector, clean oil. #2 Check MAF operation. #3 If more, go to next test, if less check tests #1 & #2 #4 If more circuit 412 has short to voltage, repair or replace. #5 If open circuit repair, if not open check PCM earth or replace PCM.
P0133	Oxygen Sensor O2 (Heated Oxygen Sensor - HO2S) - Left hand	Left hand (bank 1) oxygen sensor delayed signal. (closed loop system activated) Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1258 are not activated.	ON	#1 Has the vehicle a leaky exhaust system? #2 Check oxygen sensor, termianls, wiring harness. #3 Ignition OFF, test left bank signal low circuit 412 (violet), probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350-550mV? #4 Faulty oxygen sensor.	#1 If so repair. #2 Repair or replace any damaged components. #3 If not repair circuit 412 or circuit 413 (blue/black) is earthed (repair). If OK go to #4. #4 Repalce oxygen sensor.
P0134	Left side oxygen sensor O2 (Heated Oxygen Sensor - HO2S) - no signal	4 conditions below exist for 26 sec - Eng for 4 minutes - Coolant temp is 85 + deg - TP sensor open 15% + -LH O2 sensor 0.410-0.477 Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1258 are not activated.	ON	#1 Check for poor connection at O2 sensor harness connector. #2 Check O2 sensor wiring harness (PCM side) circuit 412, is reading over 0.5 volt reading with ingition ON engine not running. #3 Check O2 sensor wiring harness (PCM side) circuit 412, should give 0.2 volt reading with ingition ON engine not running.	#1 Fix faulity harness connector. #2 If over 0.5 volt, check circuit 750 for open or faulty circuit, repair. If under 0.4 volt, open or faulty connection in circuit 412 PCM to O2 sensor. #3 If OK replace PCM. If not OK open or short in circuit 412 PCM to O2 sensor.
P0135	Left side oxygen sensor O2 (Heated Oxygen Sensor - HO2S) - no signal	Left hand (bank 1) oxygen sensor heater signal, circuits 439 (power) &750 (earth), (closed loop system activated) Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1258 are not activated.	ON	#1 Check fuse No 33. #2 Check circuit 439 (pink) a test light to earth, ignition ON. #3 Disconnect oxygen sensor connector, measure sensor resistance between circuits 439 and 750 is it bewteen 3.5-14.0ohms?	#1 Replace fuse if necessary. #2 If light does not glow repair circuit 439 (pink). If light glows, use circuit 750 as the earth for the test light earth if the light does not glow, repair circuit 750. #3 If not with range replace oxygen sensor. If within range check and repair connector terminals.
P0151	Oxygen Sensor O2 (Heated Oxygen Sensor - HO2S) - Right hand	Right hand oxygen sensor has a lean signal. (No IAT DTC codes active) (closed loop system activated) Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1258 are not activated.	ON	#1 Visually check O2 sensor wire to connector, is it shorting to earth? has the wire broken? #2 Contaminated fuel with water, low fuel pressure, faulty injectors causing lean mixture. #3 Has MAF sensor been worked on or interfered with? #4 Ignition OFF, disconnect PCM connectors, check circuit 1412 for short to earth.	#1 If yes, replace O2 sensor and wire. #2 Replace fuel if contaminated, rectify low fuel pressure or injectors if faulty. #3 Check MAF operation. #4 If OK replace PCM, if not OK repair or replace circuit 1412.
P0152	Oxygen Sensor O2 (Heated Oxygen Sensor - HO2S) - Right hand	Right hand oxygen sensor has a rich signal. (closed loop system activated (DTC code P0152 may be set with high fuel pressure, which could also set code P0132) Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1258 are not activated.	ON	#1 Check for high fuel pressure, faulty injector, leaking injector, fuel contaminated oil. # 2 Has MAF sensor been worked on or interfered with? #3 Ignition OFF, test circuit 412, probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350mV? #4 Ignition OFF, test circuit 412, probe disconnected PCM connector with volt meter to earth, ignition ON. Is voltage 350mV? #5 Disconnect PCM connectors, ignition OFF, check continuity for circuit 750 PCM connector terminal D3 and engine earth.	#1 Rectify high fuel pressure, replace injector, clean oil. #2 Check MAF operation. #3 If more, go to next test, if less check tests #1 & #2 #4 If more circuit 412 has short to voltage, repair or replace. If low replace PCM. #5 If open circuit repair, if not open check PCM earth or replace PCM. DTC's chart Gen III 3

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Gen III V8 engine models

		Gen III V8 engine		**Diagnostic Codes with trouble shooting**	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0153	Oxygen Sensor O2 (Heated Oxygen Sensor - HO2S) - Right hand	Right hand (bank 1) oxygen sensor delayed signal. (closed loop system activated) Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1258 are not activated.	ON	#1 Has the vehicle a leaky exhaust system? #2 Check oxygen sensor, termianls, wiring harness. #3 Ignition OFF, test right bank signal low circuit 1412 (Grey), probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350-550mV? #4 Faulty oxygen sensor.	#1 If so repair. #2 Repair or replace any damaged components. #3 If not repair circuit 1412 or circuit 1413 (grey/black) is earthed (repair). If OK go to #4. #4 Repalce oxygen sensor.
P0154	Oxygen sensor O2 (Heated Oxygen Sensor - HO2S) Right Hand	No signal left hand oxygen (O2) sensor signal for 4 minutes. Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1258 are not activated.	ON	#1 Check for faulty wiring connection at O2 sensor. #2 Ignition ON, engine not running, check voltage of circuit 1412 at O2 sensor connector, PCM side, should be 0.3-0.6 volts.	#1 Repair. #2 If 0.3-0.6 volts check for open or bad connection in circuit 750 (black/red) if circuit 750 was OK replace PCM. If not 0.3-0.6 volts check for open or bad connection in circuit 1412 (grey) if circuit 1412 was OK replace PCM
P0155	Right side oxygen sensor O2 (Heated Oxygen Sensor - HO2S) - no signal	Right hand (bank 2) oxygen sensor heater signal, circuits 439 (power) &750 (earth), (closed loop system activated) Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1258 are not activated.	ON	#1 Check fuse No 33. #2 Check circuit 439 (pink) a test light to earth, ignition ON. #3 Disconnect oxygen sensor connector, measure sensor resistance between circuits 439 and 750 is it bewteen 3.5-14.0ohms?	#1 Replace fuse if necessary. #2 If light does not glow repair circuit 439 (pink). If light glows, use circuit 750 as the earth for the test light earth if the light does not glow, repair circuit 750. #3 If not with range replace oxygen sensor. If within range check and repair connector terminals.
P0171	Fuel Trim - Left bank lean	Long term fuel trim (LTFT). Fuel trim corrects any variation between right and left cylinders, code will set if left bank is lean for 6+ seconds. Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1111, P1112, P1258 are not activated	ON	#1 Carry out an engine inspection such as dirty or faulty spark plugs, lean or faulty fuel injectors and injector "O" rings, inlet manifold leaking, exhaust manifold leaking, ensure O2 sensor harnessess are connected to correct sides. #2 If any other DTC codes are set, rectify complaint and clear codes. #3 If you have scan tool test STFT readings, on each engine side. #4 Perform a fuel system check. #5 Perform an ignition test for Oscilloscope engine. #6 Perform a cylinder compression test on each cylinder.	#1 Repair, clear code, test drive. #2 Test drive. #3 If any variation, see O2 sensor chart under sensors, test O2 sensors, repair and check scan tool readings. #4 Repair if necessary and test drive. #5 Repair if necessary and test drive. #6 Repair if necessary and test drive.
P0172	Fuel Trim - Left bank rich	Long term fuel trim (LTFT). Fuel trim corrects any variation between right and left cylinders, code will set if left bank is rich for 49+ seconds. Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1111, P1112, P1258 are not activated	ON	#1 Carry out an engine inspection such as dirty or faulty spark plugs, leaking fuel injectors, blocked air intake system, air filter excessively dirty, ensure O2 sensor harnessess are connected to correct sides. #2 If any other DTC codes are set, rectify complaint and clear codes. #3 If you have scan tool test LTFT readings, on each engine side. #4 Perform a fuel system check, looking for oil in fuel, high fuel pressure. #5 Perform a cylinder compression test on each cylinder.	#1 Repair, clear code, test drive. #2 Test drive. #3 If any variation, see O2 sensor chart under sensors, test O2 sensors, repair and check scan tool readings. #4 Repair if necessary and test drive. #5 Repair if necessary and test drive.
P0174	Fuel Trim - Right bank lean	Long term fuel trim (LTFT). Fuel trim corrects any variation between right and left cylinders, code will set if right bank is lean for 6+ seconds. Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1111, P1112, P1258 are not activated	ON	#1 Carry out an engine inspection such as dirty or faulty spark plugs, lean or faulty fuel injectors and injector "O" rings, inlet manifold leaking, exhaust manifold leaking, ensure O2 sensor harnessess are connected to correct sides. #2 If any other DTC codes are set, rectify complaint and clear codes. #3 If you have scan tool test STFT readings, on each engine side. #4 Perform a fuel system check. #5 Perform an ignition test for Oscilloscope engine. #6 Perform a cylinder compression test on each cylinder.	#1 Repair, clear code, test drive. #2 Test drive. #3 If any variation, see O2 sensor chart under sensors, test O2 sensors, repair and check scan tool readings. #4 Repair if necessary and test drive. #5 Repair if necessary and test drive. #6 Repair if necessary and test drive. DTC's chart Gen III 4

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Gen III V8 engine models

		Gen III V8 engine		Diagnostic Codes with trouble shooting	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0175	Fuel Trim - Right bank rich	Long term fuel trim (LTFT). Fuel trim corrects any variation between right and left cylinders, code will set if right bank is rich for 49+ seconds. Codes P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1111, P1112, P1258 are not activated	ON	#1 Carry out an engine inspection such as dirty or faulty spark plugs, leaking fuel injectors, blocked air intake system, air filter excessively dirty, ensure O2 sensor harnessess are connected to correct sides. #2 If any other DTC codes are set, rectify complaint and clear codes. #3 If you have scan tool test LTFT readings, on each engine side. #4 Perform a fuel system check, looking for oil in fuel, high fuel pressure. #5 Perform a cylinder compression test on each cylinder.	#1 Repair, clear code, test drive. #2 Test drive. #3 If any variation, see O2 sensor chart under sensors, test O2 sensors, repair and check scan tool readings. #4 Repair if necessary and test drive. #5 Repair if necessary and test drive.
P0218	Transmissi-on	Transmission Fluid Temperature (TFT) to high. TFT reachs 1460C, then stays at 137 or more for atleast 30 minutes, with no code P0712, code P0712 could set upto 30 minutes after code P0218.	OFF	#1 If code P0712 has set. #2 Check transmission cooler and radiator for poor air flow and debris around radiator and trans cooler, check transmission fluid pipes damaged restricting fuild flow. #3 If you have a scan tool dive if top gear and check if TCC slip is more or less than 20rpm. * Test TFT with a scan tool or install a transmission temperature gauge, to read temperature while driving.	#1 Repair code P0712, could also clear code P0218. #2 Repair fault. #3 If so see code P0740 and P0741 trouble shooting.
P0230	Fuel Pump circuit	The performance of the fuel pump is not correct for 10+ seconds.	ON	#1 Ignition OFF, disconnect PCM red connector, ignition ON, measure amps of circuit 465 (green/white) in connector to battery + for 2 minutes. #2 Ignition OFF, remove fuel pump relay, check resistance of circuit 465 (green/white) to earth is there infinite resistance? #3 Depressurise fuel line, (remove relay, start engien and run till out of fuel). Ignition OFF, remove fuel pump relay, use a test light between earth circuit 152 (black/white) and the control circuit 465 (green/white), ignition ON. #4 Faulty relay. #5 Faulty PCM	#1 If less than 0.75 amps look for terminal damage and frayed wires. If OK go to test #2. #2 If yes replace relay. If not infinate resistance repair short to earth in circuit 465. #3 Test light glows, inspect connections at relay and repair if necessary if connections OK replace relay. Test light does not glow, inspect for open in circuit 152 (black/green) or poor connections in circuit. #4 Replace relay. #5 Replace PCM
P0325	Knock Sensors	Circuits 815 (blue) and 826 (light blue) to knock sensors faulty or knocking noise is longer than expected (more than 10 seconds). Code P0327 and P0332 not activated.	ON	#1 Listen for mechanical engine noise. #2 Try a new PCM.	#1 If a mechanical noise, repair. # Replace.
P0327	Knock Sensor - Left Side	No knock sensor for 3 seconds, with warm engine operating over 1000 rpm. (DTC code P0327 sets only if code P0325 is not set)	ON	#1 Ignition ON, back probe PCM connector circuit 815 (blue) use a volt meter to earth. #2 Ignition OFF, back probe PCM harness connector on circuit 815 (blue) to earth with ohm meter. #3 In test #2 no resistance could mean open or short to earth in knock sensor harness, check harness, could also mean open circuit in faulty PCM. #4 All connectors connected, ignition OFF, back probe PCM connector circuit 815 (blue) with volt meter set to AC, use a hammer to tap power steering bracket, does the volt meter read 50mV AC	#1 If any voltage reading, short to voltage, repair or replace knock sensor harness. #2 Resistance should be approx 100,000 ohms if so knock sensor is OK. No resistance test #3. #3 Test knock sensor circuit 815 (blue) for open or short to earth, try a new PCM, replace. #4 If yes check for faulty PCM or bad connector terminals at PCM. If no replace knock sensor.
P0332	Knock Sensor - Right Side	No knock sensor for 3 seconds, with warm engine operating over 1000 rpm. (DTC code P0327 sets only if code P0325 is not set)	ON	#1 Ignition ON, back probe PCM connector circuit 826 (light blue) use a volt meter to earth. #2 Ignition OFF, back probe PCM harness connector on circuit 826 (light blue) to earth with ohm meter. #3 In test #2 no resistance could mean open or short to earth in knock sensor harness, check harness, could also mean open circuit in faulty PCM. #4 All connectors connected, ignition OFF, back probe PCM connector circuit 826 (light blue) with volt meter set to AC, use a hammer to tap power steering bracket, does volt meter read 50mV AC	#1 If any voltage reading, short to voltage, repair or replace knock sensor harness. #2 Resistance should be approx 100,000 ohms if so knock sensor is OK. No resistance test #3. #3 Test knock sensor circuit 826 (light blue) for open or short to earth, try a new PCM, replace. #4 If yes check for faulty PCM or bad connector terminals at PCM. If no replace knock sensor. DTC's chart GENIII 5

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Gen III V8 engine models

		Gen III V8 engine		Diagnostic Codes with trouble shooting	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0335	Crankshaft Position (CKP) Sensor	No signal from Crankshaft Position (CKP) sensor for 3+ seconds. DTC codes P0101, P0102, P0103, P0341, P0342, P0343 are not activated.	ON	**Caution:** Remove fuses 34 ignition coil and 35 fuel injector feed, to avoid engine firing or excessive fueling. #1 Ignition ON, disconnect the CKP sensor, use a test light between CKP ignition feed circuit 646 (light blue/white) at PCM side of CKP harness connector and earth if light glows earth via the CKP earth circuit 647 (light blue/black). #2 For a very short time connect test light between circuit 646 and CKP signal circuit 643 (blue), does the fuel pump operate? #3 CKP sensor harness connected, disconnect PCM blue connector, use jumper leads to reconnect circuits reference low and ignition feed circuits. Test for 4.0-6.0 volts at CKP signal circuit 643 (blue) while cranking engine. #4 Check CKP sensor for faulty installation, damaged sensor, damaged terminals. #5 Is CKP reluctor wheel for damaged or loose? #6 Excessive crankshaft end play causing the reluctor wheel to run out of alignment.	#1 If light did not glow on an earth, look for open or short in circuit 646. If light did not glow when earth via circuit 647 look for open or bad connections in circuit 647. If light glows when earthed via circuit 647 go to #2. #2 If fuel pump operates check CKP for faulty installation, damaged sensor, damaged terminals, CKP harness to close igniton secondary wiring. If fuel pump does not operate go to #3 #3 If within range replace PCM. If within range check CKP signal circuit 643 (blue) for a fault, open, short to earth or short to voltage, if circuit OK check CKP sensor for damage. #4 Repair or replace. #5 Repair or replace. #6 Repair.
P0336	Crankshaft Position (CKP) Sensor	No signal or signal out of range from Crankshaft Position (CKP) sensor for 1+ seconds.	ON	#1 Inspect for CKP harness to close to: igniton secondary wiring, added on electrical options and wiring, motors etc. #2 Check CKP sensor for faulty installation, damaged sensor, damaged terminals. #3 Inspect CKP harness and circuit 646 (light blue), 643 (blue) and 647 (light blue/black) for damage or damaged terminals at connectors and PCM. #4 Is CKP reluctor wheel for damaged or loose? #5 Excessive crankshaft end play causing the reluctor wheel to run out of alignment.	#1 Re-rout wiring harness. #2 Repair or replace. #3 Repair and replace. #4 Repair or replace. #5 Repair.
P0341	Camshaft Position (CMP) Sensor	Signals from CMP and CKP to PCM are not synchronised for 10+ seconds	ON	#1 Inspect for CMP harness to close to: igniton secondary wiring, added on electrical options and wiring, motors etc. #2 Check CMP sensor for faulty installation, damaged sensor, damaged terminals. #3 Inspect CMP harness and circuit 631 (white/black), 633 (brown) and 632 (red/white) for damage or damaged terminals at connectors and PCM. #4 Is CMP reluctor wheel for damaged or loose? #5 Faulty CMP sensor.	#1 Re-rout wiring harness. #2 Repair or replace. #3 Repair and replace. #4 Repair or replace. #5 Replace.
P0342	Camshaft Position (CMP) Sensor	Signals from CMP are low but should be high for 1+ seconds	ON	#1 Disconnect camshaft position sensor harness connector, ignition ON, check voltage between harness connector terminals "C" to earth should be battery volts, if OK check voltage between terminal "C to B" should also be battery voltage. #2 Ignition OFF, inspect CMP terminals and harness terminals for damage, at PCM connector (same side to makers logo), test CMP signal circuit 633 (brown) at CMP harness connector and PCM connector for continuity should be 0-5ohms. #3 Ignition OFF, inspect CMP terminals and harness terminals for damage, at PCM connector (same side to makers logo), test CMP signal circuit 632 (red/white) at CMP harness connector and PCM connector for continuity should be 0-5ohms. #4 Faulty CMP sensor. #5 Faulty PCM.	#1 If both results are OK go to next test. If "C" to earth was low, check (continuity should be 0-5ohms) for open or short in circuit 631 (white/black), if circuit is OK check for bad connections or terminals at PCM (PCM connector oposite side to makers logo), if all OK, PCM may be faulty. #2 Repair if necessary. #3 Repair if necessary. #4 Replace CMP sensor #5 Replace PCM.
P0343	Camshaft Position (CMP) Sensor	Signals from CMP are high but should be low for 1+ seconds	ON	#1 Disconnect camshaft position sensor harness connector, ignition ON, check voltage between harness connector terminals "C" to earth should be battery volts, if OK check voltage between terminal "C to B" should also be battery voltage. #2 Ignition OFF, inspect CMP terminals and harness terminals for damage, at PCM connector (same side to makers logo), test CMP signal circuit 633 (brown) at CMP harness connector and PCM connector for continuity should be 0-5ohms. #3 Ignition OFF, inspect CMP terminals and harness terminals for damage, at PCM connector (same side to makers logo), test CMP signal circuit 632 (red/white) at CMP harness connector and PCM connector for continuity should be 0-5ohms. #4 Faulty CMP sensor. #5 Faulty PCM.	#1 If both results are OK go to next test. If "C" to earth was low, check (continuity should be 0-5ohms) for open or short in circuit 631 (white/black), if circuit is OK check for bad connections or terminals at PCM (PCM connector oposite side to makers logo), if all OK, PCM may be faulty. #2 Repair if necessary. #3 Repair if necessary. #4 Replace CMP sensor #5 Replace PCM.

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Gen III V8 engine models

		Gen III V8 engine		Diagnostic Codes with trouble shooting	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0351	Ignition circuit No1	Circuit open, shorted or earth for less than 15 seconds.	ON	#1 If all ignition codes are activated. #2 Ignition off, disconnect ignition coil harness, use a multi-meter to test AC Hertz frequency of the ignition control circuit 971 (white), engine at idle rpm, frequency could be 3.0-20Hz. #3 Multi-meter as for last test, measure volts. #4 Clear code, run engine does code reactivate?	#1 Check ignition control circuits earth system for an open. #2 If within range replace ignition coil. If not in range go to #3. #3 If over 1.0 volt, igniton control circuit has short to voltage, repair. If 1.0 volt, igniton OFF, check continuity of ignition control circuit 971 (white) between ignition coil harness connector and PCM red connector, repair if necessary, also check for continuity between ignition control circuit to earth, if so repair circuit also check PCM terminal tension, if loose replace. #4 If so go through tests again checking terminals and poor contections.
P0352	Ignition circuit No2	Circuit open, shorted or earth for less than 15 seconds.	ON	#1 If all ignition codes are activated. #2 Ignition off, disconnect ignition coil harness, use a multi-meter to test AC Hertz frequency of the ignition control circuit 972 (yellow/black), engine at idle rpm, frequency could be 3.0-20Hz. #3 Multi-meter as for last test, measure volts. #4 Igniton OFF, check continuity of ignition control circuit 972 (yellow/black) between ignition coil harness connector and PCM red connector, repair if necessary, also check for continuity between ignition control circuit to earth. #5 Clear code, run engine does code reactivate?	#1 Check ignition control circuits 750 (brown) earth system for an open. #2 If within range replace ignition coil. If not in range go to #3. #3 If over 1.0 volt, igniton control circuit has short to voltage, repair. If 1.0 volt, go to test #4. #4 If so repair circuit also check PCM terminal tension, if loose replace. #5 If so go through tests again checking terminals and poor contections.
P0353	Ignition circuit No3	Circuit open. shorted or earth for less than 15 seconds.	ON	#1 If all ignition codes are activated. #2 Ignition off, disconnect ignition coil harness, use a multi-meter to test AC Hertz frequency of the ignition control circuit 973 (blue), engine at idle rpm, frequency could be 3.0-20Hz. #3 Multi-meter as for last test, measure volts. #4 Igniton OFF, check continuity of ignition control circuit 973 (blue) between ignition coil harness connector and PCM red connector, repair if necessary, also check for continuity between ignition control circuit to earth. #5 Clear code, run engine does code reactivate?	#1 Check ignition control circuits 750 (brown) earth system for an open. #2 If within range replace ignition coil. If not in range go to #3. #3 If over 1.0 volt, igniton control circuit has short to voltage, repair. If 1.0 volt, go to test #4. #4 If so repair circuit also check PCM terminal tension, if loose replace. #5 If so go through tests again checking terminals and poor contections.
P0354	Ignition circuit No4	Circuit open. shorted or earth for less than 15 seconds.	ON	#1 If all ignition codes are activated. #2 Ignition off, disconnect ignition coil harness, use a multi-meter to test AC Hertz frequency of the ignition control circuit 974 (white), engine at idle rpm, frequency could be 3.0-20Hz. #3 Multi-meter as for last test, measure volts. #4 Igniton OFF, check continuity of ignition control circuit 974 (white) between ignition coil harness connector and PCM red connector, repair if necessary, also check for continuity between ignition control circuit to earth. #5 Clear code, run engine does code reactivate?	#1 Check ignition control circuits 750 (brown) earth system for an open. #2 If within range replace ignition coil. If not in range go to #3. #3 If over 1.0 volt, igniton control circuit has short to voltage, repair. If 1.0 volt, go to test #4. #4 If so repair circuit also check PCM terminal tension, if loose replace. #5 If so go through tests again checking terminals and poor contections.
P0355	Ignition circuit No5	Circuit open. shorted or earth for less than 15 seconds.	ON	#1 If all ignition codes are activated. #2 Ignition off, disconnect ignition coil harness, use a multi-meter to test AC Hertz frequency of the ignition control circuit 975 (green), engine at idle rpm, frequency could be 3.0-20Hz. #3 Multi-meter as for last test, measure volts. #4 Igniton OFF, check continuity of ignition control circuit 975 (green) between ignition coil harness connector and PCM red connector, repair if necessary, also check for continuity between ignition control circuit to earth. #5 Clear code, run engine does code reactivate?	#1 Check ignition control circuits 750 (brown) earth system for an open. #2 If within range replace ignition coil. If not in range go to #3. #3 If over 1.0 volt, igniton control circuit has short to voltage, repair. If 1.0 volt, go to test #4. #4 If so repair circuit also check PCM terminal tension, if loose replace. #5 If so go through tests again checking terminals and poor contections.
P0356	Ignition circuit No6	Circuit open. shorted or earth for less than 15 seconds.	ON	#1 If all ignition codes are activated. #2 Ignition off, disconnect ignition coil harness, use a multi-meter to test AC Hertz frequency of the ignition control circuit 972 (yellow/black), engine at idle rpm, frequency could be 3.0-20Hz. #3 Multi-meter as for last test, measure volts. #4 Igniton OFF, check continuity of ignition control circuit 972 (yellow/black) between ignition coil harness connector and PCM red connector, repair if necessary, also check for continuity between ignition control circuit to earth. #5 Clear code, run engine does code reactivate?	#1 Check ignition control circuits 750 (brown) earth system for an open. #2 If within range replace ignition coil. If not in range go to #3. #3 If over 1.0 volt, igniton control circuit has short to voltage, repair. If 1.0 volt, go to test #4. #4 If so repair circuit also check PCM terminal tension, if loose replace. #5 If so go through tests again checking terminals and poor contections. DTC's chart GenIII 7

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Gen III V8 engine models

		Gen III V8 engine		**Diagnostic Codes with trouble shooting**	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0357	Ignition circuit No7	Circuit open. shorted or earth for less than 15 seconds.	ON	#1 If all ignition codes are activated. #2 Ignition off, disconnect ignition coil harness, use a multi-meter to test AC Hertz frequency of the ignition control circuit 977 (yellow), engine at idle rpm, frequency could be 3.0-20Hz. #3 Multi-meter as for last test, measure volts. #4 Igniton OFF, check continuity of ignition control circuit 977 (yellow) between ignition coil harness connector and PCM red connector, repair if necessary, also check for continuity between ignition control circuit to earth. #5 Clear code, run engine does code reactivate?	#1 Check ignition control circuits 750 (brown) earth system for an open. #2 If within range replace ignition coil. If not in range go to #3. #3 If over 1.0 volt, igniton control circuit has short to voltage, repair. If 1.0 volt, go to test #4. #4 If so repair circuit also check PCM terminal tension, if loose replace. #5 If so go through tests again checking terminals and poor contections.
P0358	Ignition circuit No8	Circuit open. shorted or earth for less than 15 seconds.	ON	#1 If all ignition codes are activated. #2 Ignition off, disconnect ignition coil harness, use a multi-meter to test AC Hertz frequency of the ignition control circuit 972 (yellow/black), engine at idle rpm, frequency could be 3.0-20Hz. #3 Multi-meter as for last test, measure volts. #4 Igniton OFF, check continuity of ignition control circuit 972 (yellow/black) between ignition coil harness connector and PCM red connector, repair if necessary, also check for continuity between ignition control circuit to earth. #5 Clear code, run engine does code reactivate?	#1 Check ignition control circuits 750 (brown) earth system for an open. #2 If within range replace ignition coil. If not in range go to #3. #3 If over 1.0 volt, igniton control circuit has short to voltage, repair. If 1.0 volt, go to test #4. #4 If so repair circuit also check PCM terminal tension, if loose replace. #5 If so go through tests again checking terminals and poor contections.
P0443	EGR valve function. (Solenoid circuit)	Solenoid not operating correctly for 10+ senconds	ON	#1 Inspect connections at the solenoid and red PCM connector. #2 Ignition OFF, disconnect red PCM connector, ignition ON use a multi meter to test amps of control circuit 428 (green/yellow) in harness at red PCM connector to earth over a 2 minutes. #3 Disconnect solenoid connector, ignition ON, use a test light between power circuit 439 (pink) and earth, does light glow? #4 Faulty solenoid. #5 Faulty PCM.	#1 Repair or replace if necessary. #2 If 0.75amps test for intermittant fault by checking harness and connectors while watching multimeter. If not 0.75 amps, disconnect EGR solenoid and test resistance between same terminal in red connector to earth, if infinate (very high) replace EGR solenoid, if not infinate check for short to earth or open in circuit 428 (green/yellow) #3 If light does not glow check fuse F33 and circuit 439 (pink) for open or short. If light glows, recheck connectors if OK replace solenoid. #4 Replace solenoid. #5 Replace PCM.
P0481	Radiator Fan (high speed relay circuit).	Fan (high speed) not operating correctly for 10+ senconds	ON	#1 Faulty relay. #2 Inspect connections at the fan high speed relay and red PCM connector. #3 Ignition OFF, disconnect red PCM connector, ignition ON use a multi meter to test amps of control circuit 304 (blue/white) in harness at red PCM connector to earth over a 2 minutes. #4 Remove high speed relay, ignition ON, probe power circuit to relay circuit 740 (orange/black) using a test light to earth, does light glow? #5 From result #3 if light glows, reinstall relay, igniton ON, disconnect red PCM connector, ignition ON use a test wire with a fuse, short control circuit 304 (blue/white) in harness at red PCM connector to earth, does relay operate. #6 Faulty PCM.	#1 Replace relay. #2 Repair or replace if necessary. #3 If 0.75amps test for intermittant fault by checking harness and connectors while watching multimeter. If not 0.75 amps, disconnect relay and test resistance between same terminal in red connector to earth, if infinate (very high) replace relay, if not infinate check for short to earth or open in circuit 304 (blue/white) #4 If light does not glow check fuse F31 and circuit 740 (orange/black) for open or short. If light glows, recheck relay connectors, ignition OFF, go to test #3. #5 If relay operates inspect connections at PCM. If relay does not operate, short to earth or open in circuit 304 (blue/white) #6 Replace PCM DTC's chart GenIII 8
P0506	Idle Speed is low	Idle speed not correct, to low by 100 rpm.This code will not set if codes P0101, P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0171, P0172, P0174, P0175 and P0443 are activated.	ON	#1 Check for vacuum leak in PCV system or a sticking PCV can give a high idle speed. #2 A faulty accessory operating A/C or transmission overloading engine. #3 Air/fuel ration to lean, low fuel pressure, restricted fuel line flow, contaminated fuel, faulty injector. #4 Ign OFF, disconnect IAC valve connector, use an ohm meter to measure resistance between terminals A & B, then C & D. #5 Ign OFF, disconnect IAC valve connector, use an ohm meter to measure resistance between terminals A & D, then B & C. #6 Disconnect the IAC harness connector, ign ON, probe connector termianls with a test light to earth. #7 Disconnect the IAC harness connector, ign OFF, probe connector termianls with a test light to battery +. #8 Connect IAC harness connector, start and idle engine, back proble all IAC connector terminals, does the test light flash? #9 Check IAC circuits for fault with a digital multimeter. #10 Faulty IAC Valve. #11 Faulty PCM.	#1 Replace vacuum hoses, clean or replace PCV valve. #2 Repair or replace. #3 Check fuel line pressure, replace fuel filter, clean fuerl system, replace injector. #4 Resistance should be 40-80 ohms, if not replace IAC #5 Resistance should be infinite, if not replace IAC #6 Test light should light on 2 terminals. #7 Test light should light on 2 terminals. #8 Is so, clean IAC passages in IAC and throttle body. If not there may be a loose connector or a faulty PCM. #9 Replace any faulty circuits. #10 Replace IAC valve. #11 Replace PCM. DTC's chart GenIII 8

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Gen III V8 engine models

		Gen III V8 engine		Diagnostic Codes with trouble shooting	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0507	Idle Speed to High	Idle speed is 100 rpm higher than desired. Code P0507 will not activate if codes P0101, P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0171, P0172, P0174, P0175 and P0443 are activated.	ON	#1 Inspect hoses between the throttle body and MAF sensor for cracks, blockages and misalignment causing blockage. #2 Engine operating listen for air sucking sound around join or possible crack. #3 Remove hoses at intake manifold one at a time, does engine rpm alter. #4 Inspect PCV valve and hoses. #5 Inspect gaskets for throttle body, intake manifold, IAC valve "O" ring. #6 Remove IAC and inspect air ducts. #7 Check IAC circuits for fault with a digital multimeter. #8 Clear all DTC codes, test drive, is code still present.	#1 Replace if necessary. #2 Replace air hose. #3 If rpm does not alter when hoses is removed, replace that hose. #4 Clean or replace as necessary. #5 Repair as necessary. #6 Clean and re assemble with new "O" ring. #7 Repair any faulty circuits. #8 If code is still present, recheck all components and/or try a new PCM
P0522	Engine Oil Pressure	Engine Oil Pressure circuit has low voltage.	ON	#1 Use a scan tool, ignition ON, is there 4 volts at oil pressure sensor. #2 Ignition OFF, use a test light to probe oil pressure sensor earth circuit 335 (green) and to B+ #3 Carrying on from test #1, if voltage is 0.2 or lower, disconnect oil pressure sensor harness connector, at the harness connector with a fused jumper wire, jump circuit 334 (blue/yellow) to circuit 331 (brown/white). Using a scan tool read oil pressure sensor voltage. #4 Remove jumper wire from test #4, test for voltage between circuit 334 (blue/yellow) and earth. #5 Test circuit 334 (blue/yellow) for open or short to earth. #6 Faulty PCM. #7 Clear codes, warm engine idling, use scan tool to test voltage of oil pressure sensor voltage, should be 0.2 to 4.6 volts.	#1 If 4 volts, disconnect A/C pressure sensor harness connector, voltage reading should drop to 0.2 volts, go to test #2. If at 0.2 volts go to test #3. If at any other voltage, go to test x5 #2 If light glows, could be a bad connection at oil pressure or faulty sensor. If light does not glow, repair open in earth circuit 335 (green) to oil pressure sensor. #3 If 4.0 volts replace oil pressure sensor. If not at 4.0 volts go to test #4. #4 If not 4.0-5.0 volts repair open in circuit 334 (blue/yellow). If 4-5 volts work through remaining tests. #5 Repair or replace. #6 Replace PCM then confirm in test #7
P0523	Engine Oil Pressure	Engine Oil Pressure circuit has high voltage.	ON	#1 Use a scan tool, ignition ON, is there 4 volts at oil pressure sensor. #2 Ignition OFF, use a test light to probe oil pressure sensor earth circuit 335 (green) and to B+ #3 Carrying on from test #1, if voltage is 0.2 or lower, disconnect oil pressure sensor harness connector, at the harness connector with a fused jumper wire, jump circuit 334 (blue/yellow) to circuit 331 (brown/white). Using a scan tool read oil pressure sensor voltage. #4 Remove jumper wire from test #4, test for voltage between circuit 334 (blue/yellow) and earth. #5 Test circuit 334 (blue/yellow) for open or short to earth. #6 Faulty PCM. #7 Clear codes, warm engine idling, use scan tool to test voltage of oil pressure sensor voltage, should be 0.2 to 4.6 volts.	#1 If 4 volts, disconnect A/C pressure sensor harness connector, voltage reading should drop to 0.2 volts, go to test #2. If at 0.2 volts go to test #3. If at any other voltage, go to test x5 #2 If light glows, could be a bad connection at oil pressure or faulty sensor. If light does not glow, repair open in earth circuit 335 (green) to oil pressure sensor. #3 If 4.0 volts replace oil pressure sensor. If not at 4.0 volts go to test #4. #4 If not 4.0-5.0 volts repair open in circuit 334 (blue/yellow). If 4-5 volts work through remaining tests. #5 Repair or replace. #6 Replace PCM then confirm in test #7
P0530	Air Condition-er (A/C)	AC refrigerant high pressure system sensor feed back is less than 0.2 volt or over 4.9 volts. High speed engine cooling fan will remian on after 5 seconds, until code cleared.	OFF	#1 Use a scan tool, ignition ON, is there 4 volts at A/C pressure sensor. #2 Ignition OFF, use a test light to probe A/C pressure sensor earth circuit 469 (green/orange) and to B+ #3 Carrying on from test #1, if voltage is 0.2 or lower, disconnect A/C pressure sensor harness connector, at the harness connector with a fused jumper wire, jump circuit 415 (violet/white) to circuit 259 (green/black). Using a scan tool read A/C pressure pressure sensor voltage. #4 Remove jumper wire from test #4, test for voltage between circuit 415 (violet/white) and earth. #5 Test circuit 415 (violet/white) for open or short to earth. #6 Faulty PCM. #7 Clear codes, warm engine idling, use scan tool to test voltage of A/C pressure sensor voltage, should be 0.2 to 4.6 volts.	#1 If 4 volts, disconnect A/C pressure sensor harness connector, voltage reading should drop to 0.2 volts, go to test #2. If at 0.2 volts go to test #3. If at any other voltage, go to test x5 #2 If light glows, could be a bad connection at A/C pressure sensor, faulty sensor. If light does not glow, repair open in earth circuit 469 (green/orange) to A/C pressure sensor. #3 If 4.0 volts repalce A/C pressure sensor.. If not at 4.0 volts go to test #4. #4 If not 4.0-5.0 volts repair open in circuit 415 (violet/white). If 4-5 volts work through remaining tests. #5 Repair or replace. #6 Replace PCM then confirm in test #7

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Gen III V8 engine models

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Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0562	PCM low voltage	Low feed voltage to PCM through circuits 39 and 740. Below 5.0 volts for 5+seconds.	OFF	#1 Is the alternator system and battery OK, start engine, load battery by turning on headlights, and heater fan, test battery voltage between battery terminals, should be 13-15 volts at 1500rpm, record voltage. #2 All as for #1 except test voltage by back probing between earth & J1-19 circuit 39 (pink/black), earth & J1-20 circuit 740 (orange) and earth & J1-57 circuit 740 (orange) after splice orange) of PCM connector, voltage should be within 0.5 volt of battery terminal voltage in #1.	#1 If voltage is OK, go to #2, if voltage is not OK, check alternator system, repair, clear codes, run engine and check for code 75 to set again. #2 If voltage is OK, replace PCM, clear codes, check for code 75 to set again. If voltage is not OK which pin has more than 0.5 voltage variation. If pin J1-19 repair circuit 39 (pink/black), if pin J1-20 or J1-57 repair circuit 740 (orange after splice orange).
P0563	V8 only System voltage.	PCM terminal "J1-19" voltage over 17.0 volts for more than 5 seconds. (This will cause transmission problems)	OFF	#1 Battery voltage should be over 10 volts, start engine, operate engine until warm then run at 2000 rpm for 15 seconds while checking battery voltage should be 16 volts. #2 Recheck the above test after new PCM installed, voltage should be 13-15.5 volts.	#1 If more than 16 volts, check alternator system. If 15 volts, check or replace PCM.
P0601	PCM Memory	PCM faulty	ON	#1 As for all tests carry out an On Board Diagnosis test. #2 Replace PCM	#1 If cleared fault go to test #2. #2 The PCM should be replaced even if DTC P0601 is in memory.
P0602	PCM	PCM not programed for vehicle	ON	#1 Program with applicable software program, carry out an On Board Diagnosis test. #2 Replace PCM	#1 If code still present go to test #2. #2 The PCM should be replaced.
P0608	Vehcile Speed Sensor. (VSS)	Different speeds detected between vehicle speed sensor and PCM for 10+ seconds.	OFF	#1 This code can be set by doing a "wheely" on a loose surface then hitting a hard surface such as bitumen, ask driver. #2 Check wiring harness for loose terminals on frayed wires. #3 Check the VSS harness is not near spark-plug lead, this can cause faulse results. #4 Ignition OFF, disconnect red PCM connector test circuit 831 (blue/white) and earth, it should be battery voltage. #5 Faulty PCM.	#1 Clear codes and test drive. #2 Reapir, clear codes, test drive. #3 Re-route wiring harness. #4 If not inspect for open or short in circuit 831. #5 Replace PCM.
P0654	Tachomet-er	Different rpm detected between engine rpm sensor and PCM for 6+ seconds.	OFF	#1 Ignition OFF, using a volt meter to test for 7-10 volts of circuit 121 (brown) terminal J2-10 of red PCM connector, disconnect PCM connector, ignition ON, test.	#1 If voltage is 7-10 volts, repalce PCM. If voltage is not 7-10 volts check circuit 121 for open, short to voltage or short to earth.
P0705	Transmissi-on Switch	A set of incorrect values for 30+ seconds.	OFF	A scan tool is necessary for most tests, however the 4 way P.R.N.D.L. switch has 4 active circuits with 12 volts plus an earth circuit 750 (black/red) The 4 way switch earths the relative circuits to obtain the correct values. Active circuits listed under "result" column.	Active circuits; Circuit 776 (white) Switch terminal C to PCM terminal J1-34. Circuit 771 (blue/white) Switch terminal A to PCM terminal J1-32. Circuit 772 (yellow) Switch terminal D to PCM terminal J1-72. Circuit 773 (white) Switch terminal B to PCM terminal J1-62
P0706	Transmissi-on Switch	A set of incorrect values for 30+ seconds.	OFF	A scan tool is necessary for most tests, however the 4 way P.R.N.D.L. switch has 4 active circuits with 12 volts plus an earth circuit 750 (black/red) The 4 way switch earths the relative circuits to obtain the correct values. Active circuits listed under "result" column.	Active circuits; Circuit 776 (white) Switch terminal C to PCM terminal J1-34. Circuit 771 (blue/white) Switch terminal A to PCM terminal J1-32. Circuit 772 (yellow) Switch terminal D to PCM terminal J1-72. Circuit 773 (white) Switch terminal B to PCM terminal J1-62
P0711	Transmissi-on fluid temperatu-re (TFT)	Transmission fluid temperature range either has not moved or moved erractly over a given time.	OFF	#1 At the transmission, test resistance between terminals "L and "M" of the pass through connector on the transmission side, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. (see chart in sensors section) GM have a jumper harness J39775 & test adapter kit J35616) #2 Inside transmission, disconnect wiring harness assembly at the TFT sensor, check resistance of TFT sensor, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. #3 Test for short in TFT sensor circuit 1227 (black/yellow) and TFT Sensor earth circuit 1230 (black/white). #4 Faulty TFT sensor.	#1 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range check transmission internal wiring for short to earth or see #2. #2 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range replace TFT sensor, which is included in TLP valve position switch #3 If OK replace PCM, if not OK repair circuit 1227 or circuit 1230. #4 Replace TFT sensor. DTC's chart GenIII 10

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Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0712	PCM	Transmission fluid temperature - low input.	OFF	#1 At the transmission, test resistance between terminals "L and "M" of the pass through connector on the transmission side, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. (see chart in sensors section) GM have a jumper harness J39775 & test adapter kit J35616) #2 Inside transmission, disconnect wiring harness assembly at the TFT sensor, check resistance of TFT sensor, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. #3 Test for short in circuit 1227 (black/yellow). #4 Faulty TFT sensor.	#1 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range check transmission internal wiring for short to earth or see #2. #2 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range replace TFT sensor, which is included in TLP valve position switch #3 If OK replace PCM, if not OK repair circuit 1227. #4 Repalce TFT sensor.
P0713	Transmissi-on TFT sensor	Transmission fuild temperature - high input.	OFF	#1 At the transmission, test resistance between terminals "L and "M" of the pass through connector on the transmission side, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. (see chart in sensors section) GM have a jumper harness J39775 & test adapter kit J35616) #2 Inside transmission, disconnect wiring harness assembly at the TFT sensor, check resistance of TFT sensor, the resistance should be 3088-3942ohms @ 20°C / 159-198ohms @ 100°C. #3 Test for open or short to earth in circuit 1227 (black/yellow). #4 Test for open circuit 1230 (black/white).	#1 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range check transmission internal wiring for short to earth or see #2. #2 If within range, (chart in sensor section) check for terminal damage, wiring damage to PCM. If not within range replace TFT sensor, which is included in TLP valve position switch #3 If OK go to test #4, if not OK repair circuit 1227. #4 If OK replace PCM, if not OK repair circuit 1230 (blackwhite).
P0719	Brake Pedal Switch	Stop light (brake pedal) circuit is normally closed. Stop light circuit open for 15 + minutes and various speeds have been detected.	OFF	#1 Check fuse F31. #2 Disconnect stop light switch, ignition ON, use a test light between circuit 88 (yellow/red) and earth, does light glow. #3 As for #2 but earth via circuit 86 (brown/red) PCM terminal J1-33 and Cruise control modual terminal D. #4 Faulty stop light switch. #5 Faulty PCM.	#1 If blown fuse, replace. (Fuse F31 is connected to other circuits also). #2 If light glows, circuit 88 OK. If light does not glow, repair circuit 88 open or short to earth. ## If light glows, circuit 86 OK. If light does not glow, repair circuit 86 open, repair. #4 Replace stop light switch. #5 Replace PCM.
P0724	Brake Pedal Switch	Stop light (brake pedal) circuit is normally closed. Stop light circuit has a high input.	OFF	#1 Faulty stop light switch. #2 Check circuit 86 (brown/red) for short to earth. #3 Faulty PCM.	#1 Replace stop light switch. #2 Repair circuit 86. #3 Replace PCM. DTC's chart GenIII 11
P0740	Transmissi-on.	Torque Converter Clutch (TCC) Solenoid. (PCM activates solenoid ON and voltage is above 10-16 volts. OR. PCM activates solenoid OFF and 0 voltage remains)	OFF	#1 If any of DTC codes P0730, P0753, P0785, P1860 are set, check fuse No32. #2 Circuit 339 (purple/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra còdes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "T" Circuit 422 (grey/red) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate TCC solenoid valve ON and OFF, is the test light ON when TCC solenoid valve ON, then test light OFF when TCC solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #4 next column) #5 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (purple/blue) clear codes, test drive. #4 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 422 (grey/red) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on TCC, if no fault in circuit 422 replace PCM. If the test light did go go ON when valve activaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "T", if 20-33 ohms, then test resistance between "E" and earth then "T" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms replace the transmission internal wiring harness. #5 Clear codes, test drive checking TCC.
P0742	Transmissi-on.	Torque Converter Clutch (TCC) jamed on. This code will set if codes P0107, P0108, P0122, P0123, P0502, P0503, P740, P1810, P1860 [TP is open 10-45%, engine 300rpm +, trans gear not 1st but in D, trans slip speed b/n -20 to +20rpm in 4 seconds]	ON	#1 The TCC will be jamed ON if the TCC is jamed on because of a mechanical fault, the park brake is on, transmission gear position is selected with trnasmission shifter, code 69 is active. #2 Record all codes, the clear codes, is TP operating correctly. #3 Test drive in D, TP open more than 25%, with a scan tool, test for trans slip speed, does it come within -20 to +20rpm.	#1 Checked which conditions are active, tectify if possible. #2 Check TP is OK, repair if necessary. #3 If trans slip within limits, TCC is jamed on due to mechanical fault, check for converter clutch apply valve is jamed in an apply situation, the TCC solenoid valve has a blocked exhaust and or release duct, valve body gasket is blocking a duct. If fault was one of these clear codes and test drive. DTC's chart GenIII 11

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		GEN III V8 engine		Diagnostic Codes with trouble shooting	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0748	Transmissi-on	Pressure Control Solenoid (PCS). [electrical current not correct] For DTCP0748 to activate there needs to be no DTC P0562, 10-16 volts, engine operating, at least 0.16 amps between PCS valve return amperage and ideal amperage.	OFF	#1 Disconnect trans pass thru connector, test holes "C" circuit 1228 (red) and "D" circuit 1229 (grey/blue) of connector transmission side for resistance of 3-7 ohms. #2 Disconnect trans pass thru connector, test hole "C" circuit 1228 (red) to the case of transmissiion, for resistance of less than 250k ohms. #3 All connectors in place, disconnect PCM connector, test resistance of circuit 1228 (red) and circuit 1229 (grey/blue), is resistance more than 3-7 ohm. #4 All connectors in place, disconnect PCM connector, test resistance of circuit 1228 (red) to earth, is resistance more than 9 ohm. #5 Faulty PCM.	#1 If the resistance was over 7 ohms or lower than 3 ohms, check auto trans internal harness for open, if so replace, test drive, if harness OK replace PC solenoid valve, test drive. If resistance is within range go to #2. #2 If resistance is less than 250k ohms, test circuit 1228 (violet) and 1229 (light blue) for short to earth, replace trans internal harness if required or replace PC solenoid. If resistance is over 9 ohms, replace PC solenoid valve, test drive. #3 If resistance is over 7 ohms test circuits 1228 (red) and 1229 (grey/blue) for an open, repair then test drive. If resistance is under 3 ohms, test circuits 1228 (red) and 1229 (grey/blue) for shorted together, repair then test drive. #4 If resistance is under 9 ohms, test circuits 1228 (red) and 1229 (grey/blue) for a short to earth, repair then test drive. If more than 9 ohms, faulty PCM #5 Replace and test drive.
P0751	Transmissi-on	1-2 Shift Solenoid	ON	#1 Test drive vehicle in "D", did trans shift 1-1-4-4 or 2-2-3-3. #2 Clear codes test drive in D throttle at 20% open, check on correct shift speeds.	#1 If so the internal check hydraulic fluid circuits for damaged seals and damaged shift valve seals. If shift was OK check on correct shift speeds #2 If shifted correctly trans OK. If not correctly go back to test #1. DTC's chart 96
P0753	Transmissi-on	1-2 Shift solenoid circuit. (PCM activates solenoid ON and voltage is above 8-18 volts). PCM commands: Solenoid ON and voltage stays at 12 volts or Solenoid OFF and voltage stays at 0 volts	ON	#1 If codes P0740, P0758, P0785 or P1860 activated. Inspect fuse F32 if blown: Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #2 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (purple/blue) of connector for power use a test light to earth, ignition must be turned ON. (This may cause extra codes to be set) #3 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "A" Circuit 1222 (light green) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate 1-2 shift solenoid valve ON and OFF, is the test light ON when 1-2 shift solenoid valve ON, then test light OFF when 1-2 shift solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #3 next column) #4 Replace PCM.	#1 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #2 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #3 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 1222 (light green) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on 1-2 shift, if no fault in circuit 1222 replace PCM. If the test light did go ON when valve activtaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "A", if 20-33 ohms, then test resistance between "E" and earth then "A" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms, disconnect internal wiring harness from 1-2 shift solenoid valve, measure the resistance of the terminals to to earth, if now greater than 250 ohms, replace 1-2 shift solenoid, if not greater than 250 ohms replace the transmission internal wiring harness. #4 Clear codes, test drive checking TCC.
P0756	Transmissi-on	2-3 Shift solenoid circuit. No codes P0122, P0123, P0502, P0503, P0740, P0742, P0753, P0758, P0785, P1810, P1860 activated. (PCM activates 2-3 solenoid and shift does not occur.)	ON	#1 Test drive vehicle in "D", did trans shift 1-2-2-1 or 4-3-3-4. #2 Clear codes test drive in D at 40% throttle, check on correct shift speeds.	#1 If so the internal check hydraulic fluid circuits for damaged seals and damaged shift valve seals. If shift was OK check on correct shift speeds #2 If shifted correctly trans OK. If not correctly go back to test #1. DTC's chart Gen III 12

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Gen III V8 engine models

		Gen III V8 engine		Diagnostic Codes with trouble shooting	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P0758	Transmissi-on	2-3 Shift solenoid circuit. PCM activates solenoid ON and voltage is high or activates solenoid OFF and voltage is low Power supplied by circuit 339 (purple/blue) PCM activates earth by circuit 1223 (yellow/black) to activate 2-3 shift solenoid valve, this valve normally open operates in conjunction with 1-2 shilt solenoid valve to allow 4 different shifts.	ON	#1 If any of DTC codes P0740, P0753, P0785, P1860 are set, check fuse No32. #2 Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This may cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "B" Circuit 1223 (yellow/black) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate 2-3 shift solenoid valve ON and OFF, is the test light ON when 2-3 shift solenoid valve ON, then test light OFF when 2-3 shift solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #4 next column) #5 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 1223 (yellow/black) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on 2-3 shift, if no fault in circuit 1223 replace PCM. If the test light did go ON when valve activtaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "B", if 20-33 ohms, then test resistance between "E" and earth then "B" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms, disconnect internal wiring harness from 2-3 shift solenoid valve, measure the resistance of the terminals to to earth, if now greater than 250 ohms, replace 2-3 shift solenoid, if not greater than 250 ohms replace the transmission internal wiring harness. #5 Clear codes, test drive checking TCC.
P0785	Transmissi-on	3-2 Shift solenoid circuit. (Solenoid receives ignition voltage in circuit 339, PCM activates solenoid by providing earth through circuit 897) PCM activates solenoid ON and voltage is high or activates solenoid OFF and voltage is low	ON	#1 If any of DTC codes P0740, P0753, P0758, P1860 are set, check fuse No32. #2 Circuit 339 (pink/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "S" Circuit 897 (green/white) and "E" circuit 339 (pink/blue) of connector with a test light, ignition ON with a fused jumper wire from earth test PCM terminals J1-97. #5 Disconnect harness from 3-2 SS valve assembly, use a multi meter to test resistance between valve terminals and earth, is resistance 250k ohms? #6 Replace transmission internal wiring harness. #7 Repalce 3-2 SS valve assembly. #8 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light is ON when C13 and C14 are earthed, use a multi meter to test resistance between cavity "E" and "S", if 20-32 ohms, then test resistance between "E" and earth then "S" and earth, if both are greater than 250ohm go to terst #5. If the test light was not ON when J1-97 are earthed, check circuit 897 (green/white) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on 3-2 shift. #5 If not 250k ohms replace 3-2 SS Valve Assembly. If resistance is greater than 250 ohms replace transmission internal wiring harness. #6 Clear codes, test drive checking 3-2 shift. #7 Clear codes, test drive checking 3-2 shift. #8 Clear codes, test drive checking 3-2 shift.
P0801	Transmissi-on (Manual transmissi-on)	Reverse lock circuit. PCM earths circuit 838 to stop reverse to be engaged when vehicle is traveling over 3 kph. PCM. Code P0801 activates when speed is over 3 kph for 10+ seconds and 838 is not earthed.	OFF	#1 Vehicle up on saftey stands, start engine, engage 1st gear, allow rear wheels to spin at idle 5-15 kph, depress clutch and try to engage reverse. #2 Use a multimeter to measure resistance of circuit 838 in red PCM connector (disconnected) to earth. #3 Vehicle up on saftey stands, ignition ON, engine operating, connect test light to soleniod terminals, spin rear wheels at idle 5-15 kph then below 3 kph. #4 Check power supply with test light between circuit 339 (pink/blue) at solenoid and earth, disconnect solenoid connector, ignition ON, if light does not glow repair circuit 339, if light glows. #5 Faulty solenoid. #6 Faulty PCM.	#1 If reverse was engaged, look for intermittant fault, terminals, damaged wiring. If reverse could not be engaged, disconnect PCM red connector, use a multimeter to measure current between circuit 838 (yellow) and earth over a 2 minute period, is current lower than 1.5 amps but more than 0 amps, if so look for damaged circuit 838, damaged terminals, bad connections at terminals of circuit 838. If current over 1.5 amps got to test #2. #2 If infinite resistance replace solenoid. If not infinite resistance check circuit 838 (yellow) for open or short to earth. #3 If light glows then does not at lower than 3 kph, check solenoid and harness terminals. If light does not glow go to test #4. #4 Reconnect harness, disconnect harness at PCM red connector, probe circuit 838 (yellow) to earth with a fused jumper wire, solenoid should operate, if so check solenoid terminals for intermittant fault, if solenoid does not operate replace solenoid. #5 Replace solenoid. #6 Replace PCM. DTC's chart Gen III 13

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Gen III V8 engine models

		Gen III V8 engine		Diagnostic Codes with trouble shooting	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P1111	Intake Air Temperat-ure, erratic high voltage	IAT sensor sends a high signal Air temp -35°C for 0.3+ seconds. Codes P0101, P0102, P0103, P0117, P0118 are not activated.	OFF	#1 Is code P0113 activated. #2 Use a multimeter to check for intermittent fault, probe PCM connector for circuits 472 (brown) and 469 (green/orange), ignition ON, move and manipulate harness and connectors to see if voltage alters. #3 Faulty IAT sensor	#1 If code P0113 present treat P0113. #2 Repair any faulty harness or connector. #3 Replace IAT.
P1112	Intake Air Temperat-ure, erratic low voltage	IAT sensor sends a high signal Air temp lower than 139°C for 0.3+ seconds. Codes P0101, P0102, P0103, P0117, P0118 are not activated.	OFF	#1 Is code P0112 activated. #2 Use a multimeter to check for intermittent fault, probe PCM connector for circuits 472 (brown) and 469 (green/orange), ignition ON, move and manipulate harness and connectors to see if voltage alters. #3 Faulty IAT sensor	#1 If code P0112 present treat P0112. #2 Repair any faulty harness or connector. #3 Replace IAT.
P1114	Engine Coolant Temperat-ure (ECT) signal erratic low voltage	-No P0117 DTC code - Eng running for 11+ sec - ECT lower than 139°C for 1+ second.	OFF	#1 Is code P0117 activated. #2 Use a multimeter to check for intermittent fault, probe PCM connector for circuits 410 (yellow) and 455 (grey/black), ignition ON, move and manipulate harness and connectors to see if voltage alters. #3 Faulty ECT sensor.	#1 If code P0117 present treat P0117. #2 Repair any faulty harness or connector. #3 Replace ECT sensor.
P1115	Engine Coolant Temperat-ure (ECT) signal erratic high voltage	-No P0117 DTC code - Eng running for 11+ sec - ECT lower than -35°C for 1+ second.	OFF	#1 Is code P0118 activated. #2 Use a multimeter to check for intermittent fault, probe PCM connector for circuits 410 (yellow) and 455 (grey/black), ignition ON, move and manipulate harness and connectors to see if voltage alters. #3 Faulty ECT sensor.	#1 If code P0118 present treat P0118. #2 Repair any faulty harness or connector. #3 Replace ECT sensor.
P1121	Throttle Position Sensor (TP) signal erratic high voltage	TP sensor sends a high signal more than 4.8 volts.	OFF	#1 Is code P0123 activated. #2 Use a multimeter to check for intermittent fault, probe PCM connector for circuits 417 (blue), 416 (grey) and 452 (black/yellow), ignition ON, move and manipulate harness and connectors to see if voltage alters. #3 Faulty TP sensor.	#1 If code P0123 present treat P0123. #2 Repair any faulty harness or connector. #3 Replace TP sensor.
P1122	Throttle Position Sensor (TP) signal erratic low voltage	TP sensor sends a low signal less than 0.2 volts.	OFF	#1 Is code P0122 activated. #2 Use a multimeter to check for intermittent fault, probe PCM connector for circuits 417 (blue), 416 (grey) and 452 (black/yellow), ignition ON, move and manipulate harness and connectors to see if voltage alters. #3 Faulty TP sensor.	#1 If code P0122 present treat P0122. #2 Repair any faulty harness or connector. #3 Replace TP sensor.
P1133	Left side oxygen sensor - (Heated Oxygen Sensor - HO2S)	4 conditions below exist for 26 sec - Eng for 2.0 sec - Coolant temp is 65°C+ - TP sensor open 15% + - Closed loop Moves of rich to lean less than 10 times and lean to rich less than 10 times in 100 seconds.	OFF	Codes P0101, P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1111, P1112, P1258 are not activated. #1 Has the vehicle a leaky exhaust system? #2 Did code P1153 activate? #3 Check oxygen sensor, terminals, wiring harness. #4 Ignition OFF, test left bank signal low circuit 412 (violet), probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350-550mV? #5 Ignition OFF, test left bank signal low circuit 413 (blue/black) and high circuit 412 (violet), PCM side to earth, probe with volt meter, ignition ON. Is voltage 200mV? #6 Faulty oxygen sensor.	#1 If so repair. #2 If code P1153 is present it could be due to contaminated fuel, wrong RTV sealant, engine burning excessive oil, water passing through to exhaust system. #3 Repair or replace any damaged components. #4 If not repair circuit 412 or circuit 413 (blue/black) is earthed (repair). If OK go to #4. #5 If so replace O2 sensor. If not 200mV repair circuit 412 (violet) #6 Replace oxygen sensor.
P1134	Left side oxygen sensor - (Heated Oxygen Sensor - HO2S)	4 conditions below exist for 26 sec - Eng for 2.0 sec - Coolant temp is 65°C+ - TP sensor open 15% + - Closed loop PCM determines the time range for rich to lean and lean to rich moves should be made, if the signals do not come within this range the code is activated.	OFF	Codes P0101, P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1111, P1112, P1258 are not activated. #1 Has the vehicle a leaky exhaust system? #2 Check oxygen sensor, terminals, wiring harness. #3 Did code P1154 activate? Check for contaminated fuel. #4 Ignition OFF, test left bank signal low circuit 412 (violet), probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350-550mV? #5 Ignition OFF, test left bank signal low circuit 413 (blue/black) and high circuit 412 (violet), PCM side to earth, probe with volt meter, ignition ON. Is voltage 200mV? #5 Faulty oxygen sensor.	#1 If so repair. #2 Repair or replace any damaged components. #3 Repair cause of contamination, wrong RTV sealant, engine burning excessive oil, water passing through to exhaust system. #4 If not repair circuit 412 or circuit 413 (blue/black) is earthed (repair). If OK go to #4. #5 If so replace O2 sensor. If not 200mV repair circuit 412 (violet) #6 Replace oxygen sensor. DTC's chart GenIII 14

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Gen III V8 engine models

		Gen III V8 engine		Diagnostic Codes with trouble shooting	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P1153	Left side oxygen sensor - (Heated Oxygen Sensor - HO2S)	4 conditions below exist for 26 sec - Eng for 2.0 sec - Coolant temp is 65°C+ - TP sensor open 15% + - Closed loop Moves of rich to lean less than 30 times and lean to rich less than 30 times in 100 seconds.	OFF	Codes P0101, P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1111, P1112, P1258 are not activated. #1 Has the vehicle a leaky exhaust system? #2 Did code P1133 activate? #3 Check oxygen sensor, terminals, wiring harness. #4 Ignition OFF, test right bank signal low circuit 1412 (grey), probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350-550mV? #5 Ignition OFF, test right bank signal low circuit 1413 (grey/black) and high circuit 1412 (grey), PCM side to earth, probe with volt meter, ignition ON. Is voltage 200mV? #6 Faulty oxygen sensor.	#1 If so repair. #2 If code P1133 is present it could be due to contaminated fuel, wrong RTV sealant, engine burning excessive oil, water passing through to exhaust system. #3 Repair or replace any damaged components. #4 If not repair circuit 1412 or circuit 1413 (grey/black) is earthed (repair). If OK go to #4. #5 If so replace O2 sensor. If not 200mV repair circuit 1412 (grey) #6 Replace oxygen sensor.
P1154	Left side oxygen sensor - (Heated Oxygen Sensor - HO2S)	4 conditions below exist for 26 sec - Eng for 2.0 sec - Coolant temp is 65°C+ - TP sensor open 15% + - Closed loop PCM determines the time range for rich to lean and lean to rich moves should be made, if the signals do not come within this range the code is activated.	OFF	Codes P0101, P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123. P0335, P0336, P0351-P0358, P1111, P1112, P1258 are not activated. #1 Has the vehicle a leaky exhaust system? #2 Check oxygen sensor, terminals, wiring harness. #3 Did code P1134 activate? Check for contaminated fuel. #4 Ignition OFF, test right bank signal low circuit 1412 (grey), probe disconnected O2 connector with volt meter to earth, ignition ON. Is voltage 350-550mV? #5 Ignition OFF, test right bank signal low circuit 1413 (grey/black) and high circuit 1412 (grey), PCM side to earth, probe with volt meter, ignition ON. Is voltage 200mV? #5 Faulty oxygen sensor.	#1 If so repair. #2 Repair or replace any damaged components. #3 Repair cause of contamination, wrong RTV sealant, engine burning excessive oil, water passing through to exhaust system. #4 If not repair circuit 1412 or circuit 1413 (grey/black) is earthed (repair). If OK go to #4. #5 If so replace O2 sensor. If not 200mV repair circuit 1412 (grey) #6 Replace oxygen sensor.
P1258	Engine Coolant Temperat-ure (ECT) to high	If the coolant temperature reaches 132°C the PCM shuts down some of the fuel injectors.	ON	Codes P0117, P0118 are not activated. #1 Is the cooling system operating correctly, thermostate, coolant level, radiator fan. #2 On a cold start, start engine, check operation of coolant temperature gauge (ECT), does it work correctly. #3 Jumper the two ECT sensor wires together, does the temperature gauge read very hot. #4 Faulty ECT sensor. #5 Faulty PCM.	#1 If not repair. #2 If not working, replace coolant temperarue sensor. #3 If not check harness of ECT sensor. #4 Replace ECT sensor. #5 Replace PCM. DTC's chart 12G
P1539	Air Condition-er A/C clutch circuit	A/C clutch circuit has voltage 15 seconds after the PCM turned the A/C clutch off.	OFF	#1 Did code P1546 activate? #2 Check circuit 59 (green) for short to battery voltage. #3 Faulty relay.	#1 If so clear code, remove A/C clutch relay, idle engine for 30+ seconds, did code reactivate, go to test #2. No code P1546 go to test #3. #2 Repair or replace harness. #3 Replace relay.
P1546	Air Condition-er A/C clutch circuit	A/C clutch circuit does not have voltage 5+ seconds after the PCM turned the A/C clutch on.	OFF	#1 Test operation of A/C for several minutes. #2 Ignition OFF, remove A/C relay, ignition ON, probe power circuit with a test light to earth, did light glow? #3 Ignition OFF, remove A/C relay, ignition ON, use a fused jumper wire to short power circuit to A/C clutch circuit 59 (green) did you hear A/C clutch engage and disengage when jumper wire removed? #4 Faulty relay. #6 Faulty PCM.	#1 If operated correctly, check circuits 366 (light green/blue) and 59 (green), terminals for intermittent fault. If did not operate go to test #2. #2 Light glows got to test #3. Light does not glow, check fuse F33, repair power circuit to relay. #3 If A/C clutch engaged with jumper wire replace relay, check relay terminals. If A/C relay did not engage, repair circuit 59 (green) from relay to A/C clutch. #4 Replace relay. #5 Replace PCM.
P1626	Theft deterrent sensor	Engine turns on starter but engine will not start, due to loss of communication between PIM to PCM	ON	#1 Did code P1630 also activate? #2 Disconnect PIM connector check for faulty power circuits 434 (grey) before neutral start switch, circuit 1434 (grey/blue) after switch. #3 Disconnect PIM connector check for faulty earth circuit 750 (black/red). #4 Disconnect PIM connector check for faulty data circuit 1049 (yellow). #5 Faulty PIM. #6 Faulty PCM.	#1 If so go to test #2. #2 Repair circuits 434 or 1434. #3 Repair faulty circuit 750. #4 Repair faulty circuit 1049. #5 Replace PIM. #6 Replace PCM.
P1630	Theft deterrent sensor	Engine turns on starter but engine will not start, due to PCM trying to learn new password from PIM	ON	#1 Did code P1626 also activate? #2 Faulty PIM.	#1 If code P1626 activated treat P1626. #2 Replace PIM. DTC's chart Gen III 15

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Gen III V8 engine models

		Gen III V8 engine		**Diagnostic Codes with trouble shooting**	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P1631	Theft deterrent sensor	Engine turns on starter but engine will not start, due to PCM trying to learn new password from PIM	ON	Warning: Theft deterrent system will not operate while this code is active. #1 This code will activate while PCM is learning new password, to learn a new password and clear code see next column. #2 If engine does not start after #1, are codes P1626, P1630 activated with P1627	#1 Learn mode: Ignition ON, engine OFF for 1hour. Ignition OFF for 30 seconds. Ignition ON, engine OFF for 1hour. Ignition OFF for 30 seconds. Ignition ON, engine OFF for 1hour, or when code P1631 activates. Ignition OFF for 30 seconds. Ignition ON waite for 30 seconds, start engine. #2 Treat codes P1630 and P1631 first.
P1635	PCM	PCM 5 volt circuit No1 not correct. Feeds TP, MAP and Oil pressure sensors.	ON	#1 Remove blue PCM connector, ignition ON, use a volt meter to test PCM terminals to earth: oil pressure sensor circuit 334 (blue/yellow) terminal J1-07, test MAP sensor circuit 414 (violet/white) terminal J1-48, test TP sensor circuit 416 (grey) terminal J1-08. #2 Connect blue PCM connector, ignition ON, use a volt meter to test circuits back probe to earth: oil pressure sensor circuit 334 (blue/yellow) terminal J1-07, test MAP sensor circuit 414 (violet/white) terminal J1-48, test TP sensor circuit 416 (grey) terminal J1-08. #3 Ignition ON, use a test light to test to battery +: oil pressure sensor circuit 334 (blue/yellow) terminal J1-07, test MAP sensor circuit 414 (violet/white) terminal J1-48, test TP sensor circuit 416 (grey) terminal J1-08. #4 Faulty PCM	#1 If 0 volts replace PCM. 1 If all measured at approx 5 volts go to #2 #2 If one or more measured more than 5 volts, check that circuit for a short to battery voltage. (Note: Throttle relaxer module is connected to TP sensor circuit, if TP circuit has a problem also check throttle relaxer circuit.) If all at approx 5 volts go to #3. #3 If light did not glow check for intermittent faults, faulty terminals, faulty harness. If light did glow on any circuit, check that circuit for a short to earth. #4 Repalce PCM.
P1639	PCM	PCM 5 volt circuit No2 not correct. Feeds A/C pressure sensor.	ON	#1 Remove blue PCM connector, ignition ON, use a volt meter to test PCM terminal to earth: test A/C sensor circuit 415 (violet/white) terminal J1-45. #2 Connect blue PCM connector, ignition ON, use a volt meter to test circuit back probe to earth: test A/C sensor circuit 415 (violet/white) terminal J1-45. #3 Ignition ON, use a test light to test to battery +: test A/C sensor circuit 415 (violet/white) terminal J1-45. #4 Faulty PCM	#1 If 0 volts replace PCM. 1 If at approx 5 volts go to #2 #2 If measured more than approx 5 volts, check circuit for a short to battery voltage. If at approx 5 volts go to #3. #3 If light did not glow check for intermittent faults, faulty terminals, faulty harness. If light did glow on circuit, check that circuit for a short to earth. #4 Replace PCM.
P1810	Auto transmissi-on fluid pressure (TFP) manual valve position switch assembly.	A faulty switch assembly signal for 60+ seconds or PCM beleives trans in 2, D or R during engine start for 5+ seconds or PCM beleives trans in P or N when vehicles is travelling in 4th for 10+ seconds. # Transmission will only operate in D2 while code P1810 is set.	ON	#1 Check linkages and adjustment from the transmission lever to the manual valve. #2 If you have a scan tool: Clear codes, eng not running, ignition ON, test voltage for switches A, B & C in all selector position ranges D1, D2, D3, D4, N, R & P, #3 Engine not running, Ing ON, check trans pass through connector at terminals N, P, R for battery + volts. #4 Check that circuits 1224 (brown/yellow), 1225 yellow) & 1226 (grey) leading to connector terminals are not shorted between each other. #5 Ignition OFF, remove trans oil pan, disconnect wiring to TFP Valve switch, check circuits for 1224 & 1225 for short to earth.	#1 Repair or replace faulty components. #2 If OK go to next step, if not OK go to next step. #3 If OK got to next step, if not OK repair circuits or replace PCM. #4 If faulty repair or replace faulty circuits. #5 If faulty repair or replace faulty circuits. DTC's chart GenIII 16

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Gen III V8 engine models

		Gen III V8 engine		Diagnostic Codes with trouble shooting	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
P1860	Transmissi-on	Torque Converter Clutch Pulse Width Modulation solenoid circuit. (PCM activates solenoid ON and voltage is above 10-16 volts. OR. PCM activates solenoid OFF and 0 voltage remains) [TCC PWM solenoid and circuit is operating correctly when the PCM activates the TCC PWM solenoid ON TCC slip speed is between -20 and +20 rpm. When the PCM deactivates the TCC PWM to OFF TCC slip is greater than 50rpm]	OFF	#1 If any of DTC codes P0740, P753, P0758, P0785 are set, check fuse No32. #2 Circuit 339 (purple/blue) may be shorted to earth, inspect trans internal wirning harness for short to earth, check all 5 solenoids for internal short to earth, was a short to earth found. #3 Disconnect trans pass thru connector, at the engine harness connector, test hole "E" Circuit 339 (pink/blue) of connector for power use a test light to earth, ignition must be turned ON. (This will cause extra codes to be set) #4 Disconnect trans pass thru connector, at the engine harness connector, disconnect PCM connector, test hole "U" Circuit 418 (brown) and "E" circuit 339 (pink/blue) of connector with a test light, use scan tool to activate TCC PWM solenoid valve ON and OFF, is the test light ON when TCC PWM solenoid valve ON, then test light OFF when TCC PWM solenoid valve OFF. (If no scan tool available go to "Trouble shoot remedy" #4 next column) #5 Replace PCM.	#1 Replace fuse, go to test #2, if fuse OK go to test #3. #2 If yes clear code, test drive. If no short found check for damaged terminal and wiring harness, corroded terminals etc. #3 If light is on go to next step. If no light repair circuit 339 (pink/blue) clear codes, test drive. #4 If the test light did not go ON when valve activated and OFF when valve was OFF, check circuit 418 (brown) for an open, short to B+ or short to earth, if a fault found repair, clear codes and test drive checking on TCC PWM, if no fault in circuit 418 replace PCM. If the test light did go ON when valve activtaed and OFF when valve was OFF, use a multi meter to test resistance between cavity "E" and "U", if 10-15 ohms, then test resistance between "E" and earth then "U" and earth, if both are greater than 250ohm, check for damaged terminal and wiring harness, corroded terminals etc. If resistance is not greater than 250 ohms, disconnect internal wiring harness from 1-2 shift solenoid valve, measure the resistance of the terminals to to earth, if now greater than 250 ohms, replace TCC PWM solenoid, if not greater than 250 ohms replace the transmission internal wiring harness. #5 Clear codes, test drive checking TCC.
P1870	Transmissi-on	Transmission slippage has been detected by the PCM at more than 400 rpm with all below, no code P0122, P0123, P0502, P0503, P0740, P0753, P0758, P0785, P1860, throttle is more than 20% open, TF temperature is between 600C and 1500C, TCC is activated ON. [4th gear will not be able to be selected]	ON	#1 Inspect transmission fluid chart in Transmission chapter. #2 Use a scan tool to verify that the transmission is actually slipping. #3 Check the 1-2 shift solenoid valve for damage, sediment or faulty seals. #4 Inspect the following conditions in order listed: A jammed TCC signal valve in the valve body. Torque converter may have the stator roller clutch not holding or internal damage. Oil Pump may have a jammed converter clutch valve, converter clutch valve assembled wrong way, converter clutch valve retaining ring may not be in the correct position, oil pump gasket not installed correctly, orific cup plugs damaged or faulty, oil pump bolts not tightened correctly. Input shaft and housing turbine "O" ring damaged, turbine retainer and ball assembly damaged or incorrectly assembled. 2-4 band assembly may need replacing or components replaced, check band, anchor pin, 2-4 servo assembly, servo pin, piston and bore, 4th servo piston, band apply pin, servo bore for scoure marks and porosity, servo piston seals and seal grooves, orific cup plug. Forward clutch assembly may need components replaced, check for worn or damaged clutch plates, forward clutch piston, piston seals and seal grooves, input housing to forward clutch lousing "O" ring, forward clutch housing retainer and ball. 3-4 clutch assembly may need components replaced, check for worn or damaged clutch plates, 3-4 clutch piston, piston seals and seal grooves, orific cup plug.	#1 Rectify any problems. #2 If no slipping check for other internal transmission damage. Is the transmission slipping by more than 300 rpm according to the scan tool, if so check the TCC solenoid valve for sediment or faulty seals, if so clean and replace then test to check for slipping. #3 If so clean and repair then test drive to check for slipping. #4 If any components found to be faulty, repair then test drive to check for slipping.

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Gen III V8 engine models

		Gen III V8 engine		Diagnostic Codes with trouble shooting	
Code	Sensor or Circuit	Conditions	Chk Eng Light	Trouble Shooting Proceedure (test)	Trouble Shooting Remedy (result)
B2002	Low Speed Fan	No feed back from BCM to PCM from engine cooling fan low speed.	OFF	#1 Check is code DTC 1255 present. #2 If engine does not start and code DTC1064 is set, test circuit 1221 (red/black) for earth or open. #3 Check for intermittent fault in harness or connectors.	#1 Treat code DTC 1255 and test drive. #2 Repair. #3 Repair or replace.
B2006	PIM	PIM is not receiving data from PCM	OFF	#1 Inspect data link connector for damage or faulty circuit 1049 (yellow) PCM terminal J1-58, PIM terminal 7. #2 Faulty PCM.	#1 Repair or replace. #2 Replace PCM
B2007	Starter Relay	PIM notes high voltage at starter relay.	OFF	#1 Clear code, start engine, has code B2007 reactivated. #2 Ignition OFF, disconnect PIM connector, use a test light to PIM harness connector for circuit 1434 (grey/blue) to earth, ignition ON. #3 Faulty starter relay. #4 PIM code cleared, try to start engine.	#1 If not reactivated check for intermittent fault, damaged terminals, harness. #2 Light does not glow, clear code, retest. Light glows, remove starter relay, retest, if light glows circuit 1434 or 434 (relay to neutral start switch (grey)) has a short to voltage. #3 Replace relay. #4 If code has reactivated, to a new PIM.
B2009	EEPROM Error	PIM can read EEPROM data correctly.	OFF	#1 Faulty PIM. #2 Other codes activated.	#1 Repalce PIM. #2 Treat other codes then clear them.

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ELECTRICAL WIRING DIAGRAMS

Subject — Page

Wiring Colour Chart **465**

Module & Component Location **466**

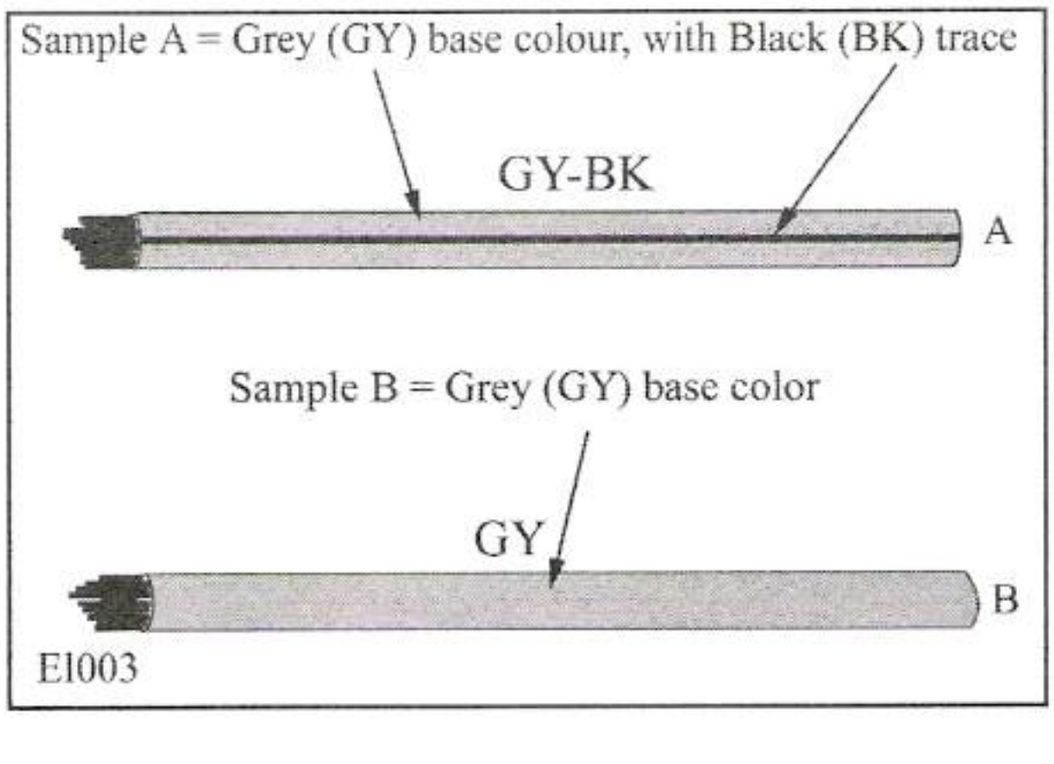
Wiring Diagrams **467**
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Power Train Control Module V6 470
V6 Power Train Control Module 471
Auto Level Ride 471
GEN III Power Train Control Module 472
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Electro-chromatic Interior Mirrors 492
Power Mirrors 492
Supplement Restraint System 492

Wire Colour Chart

All wiring diagrams use a colour coding system to help identify the correct wires or circuit.
The coding system uses alphabetical characters to help identify each wire correctly.

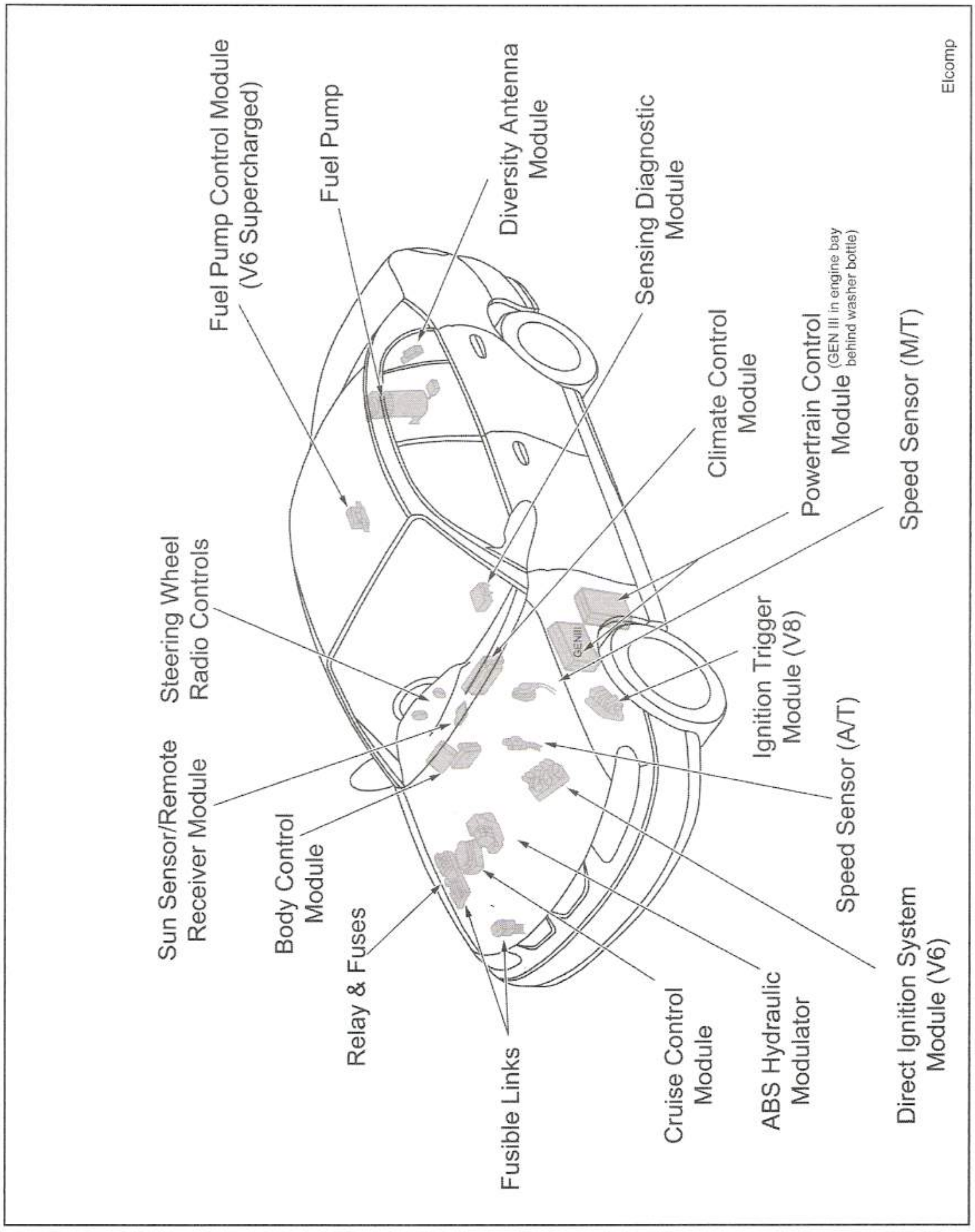
Code	Colour	Code	Colour
BK	Black	**B**	Blue
L	Light blue	**BR**	Brown
G	Dark Green	**LG**	Light Green
T	Tan	**W**	White
R	Red	**P**	Pink
O	Orange	**Y**	Yellow
V	Violet	**GY**	Grey

* The first part of the code indicates the base colour of the wire and the second section of the code indicates the trace (line). Refer to diagram.



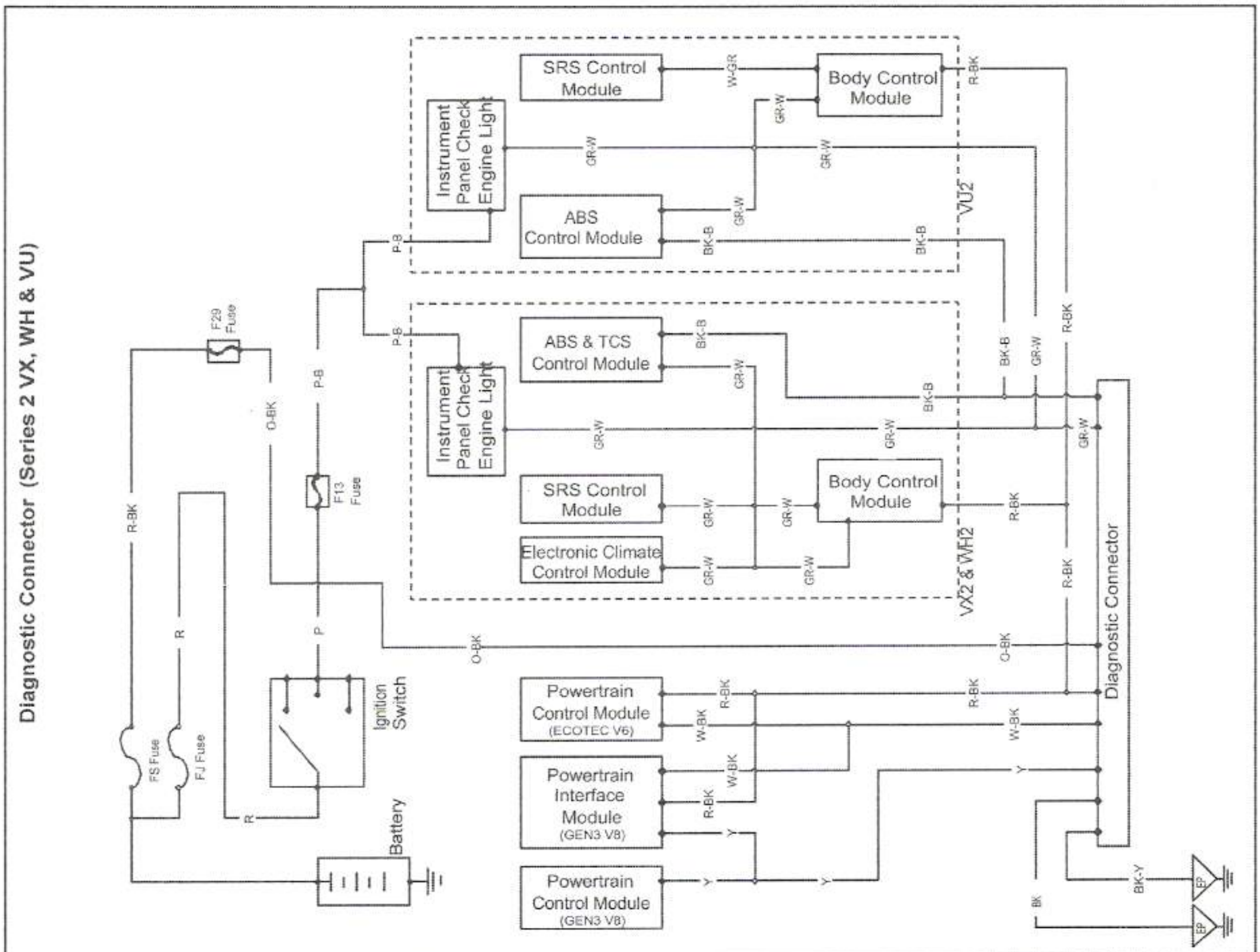
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Module & Component Location

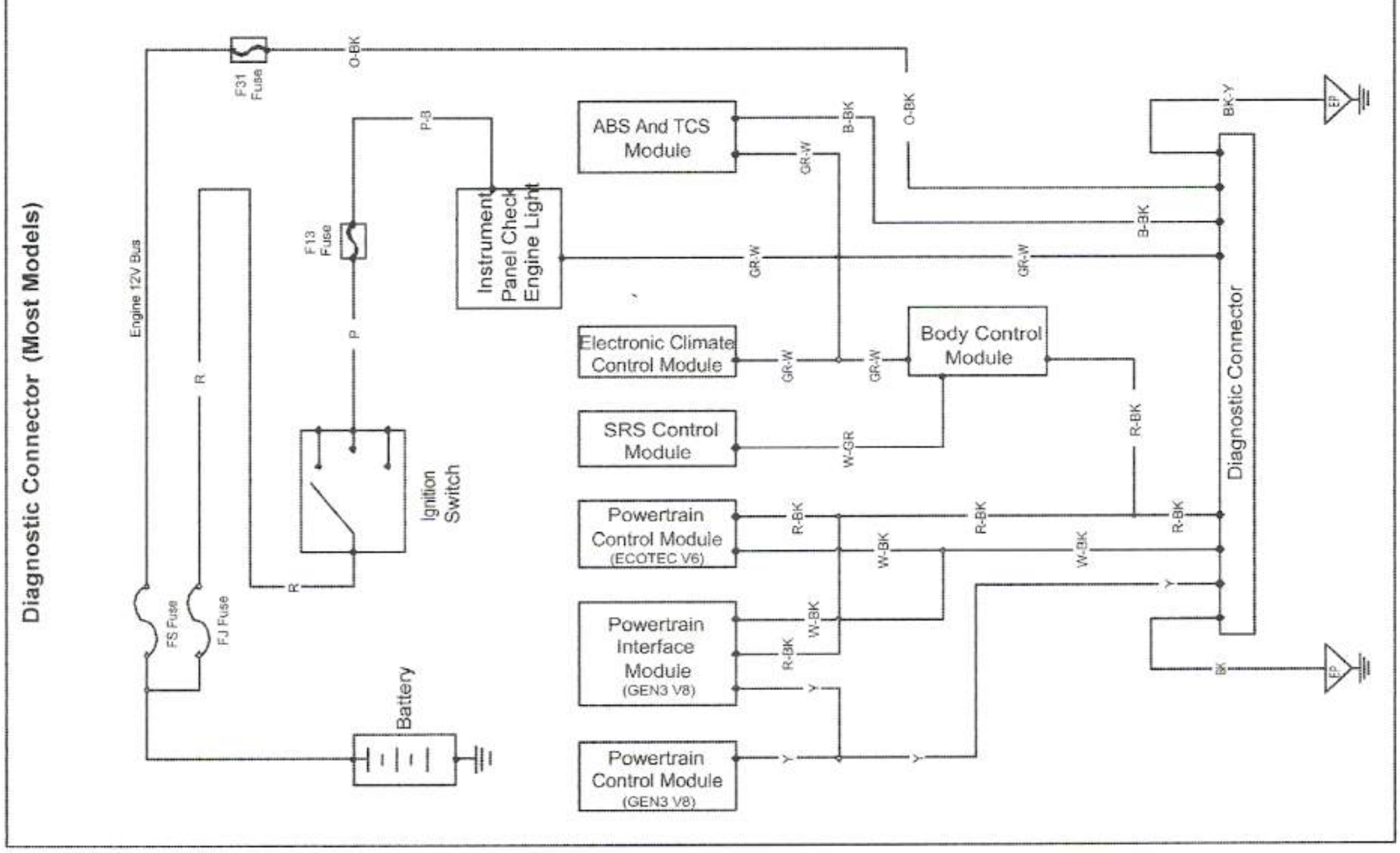


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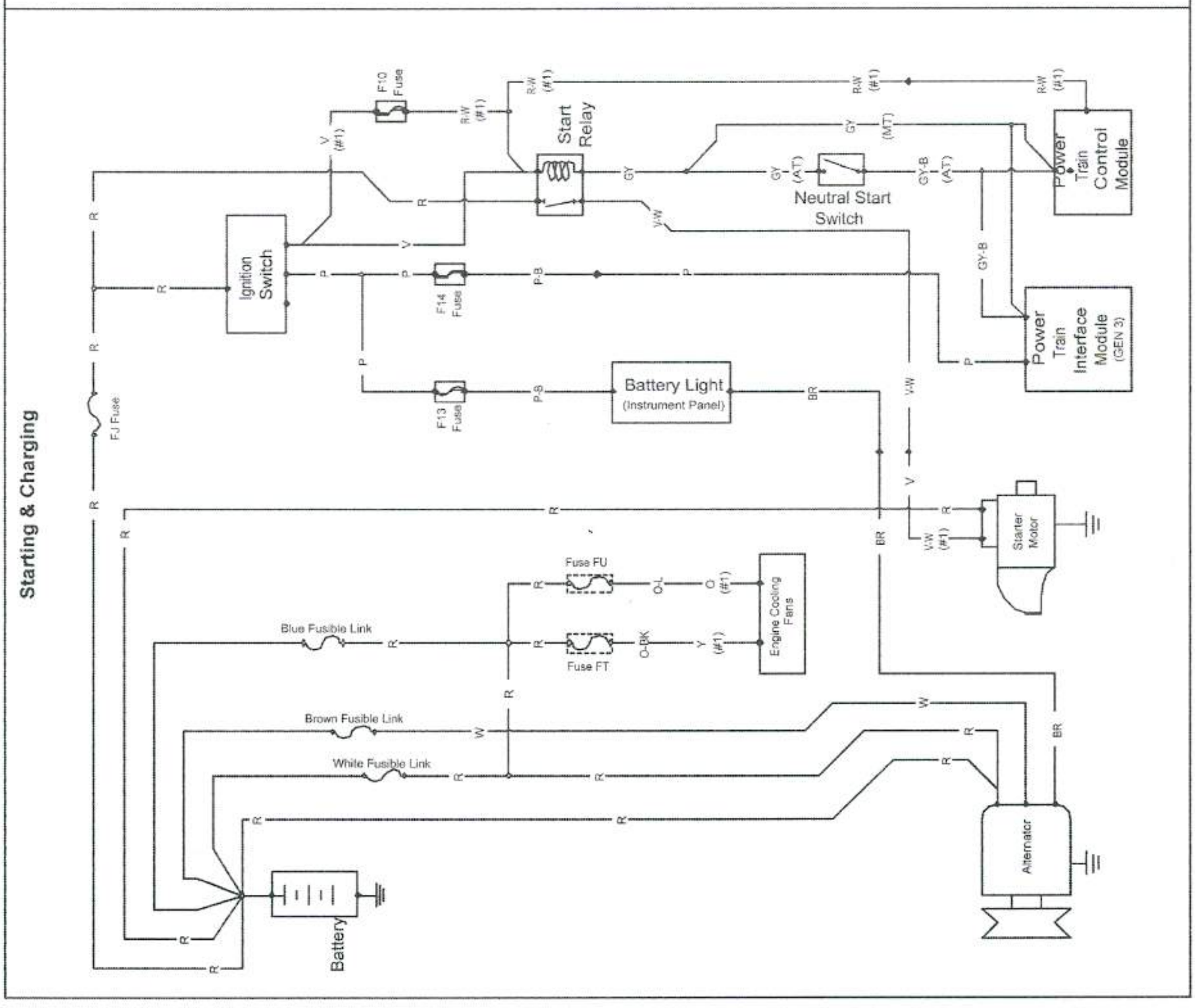
Diagnostic Connector (Series 2 VX, WH & VU)



Diagnostic Connector (Most Models)



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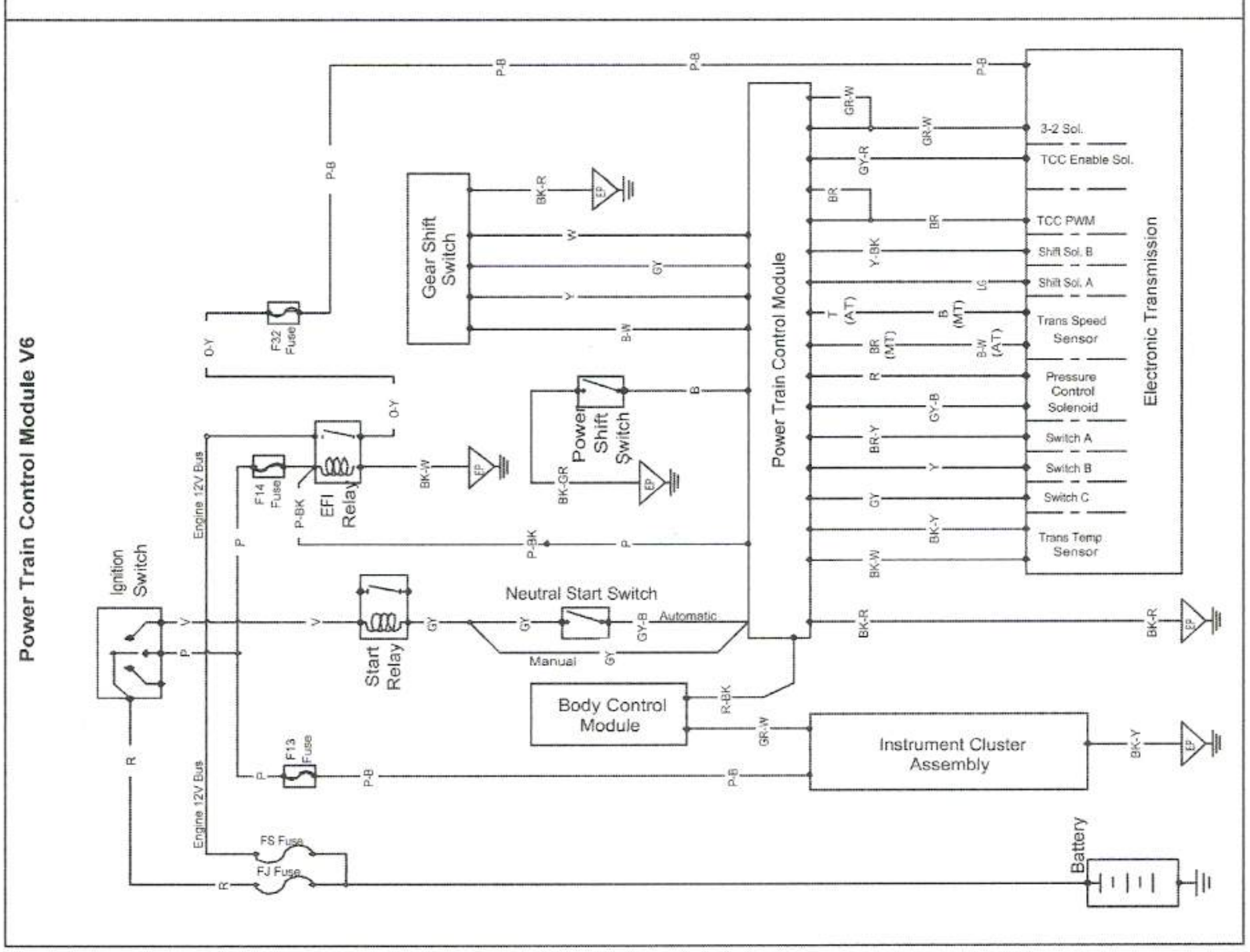
Power Train Control Module V6

Blue Fuseable Link
From Battery
FU Fuse
FT Fuse
O-BK
O-B
GR
B
Injector 6
Injector 5
Injector 4
Injector 3
Injector 2
Injector 1
Camshaft Sensor
Crankshaft Sensor
Direct Ignition Module
Spark Plugs
Engine 12V Bus
Cooling Fan Relay Low
Low Cooling Fan
High Cooling Fan
Cooling Fan Relay High
Body Control Module
A/C Relay
Compressor
EFI Relay
F35 Fuse
F34 Fuse
F33 Fuse
Ignition Switch
F13 Fuse
F14 Fuse
Fuel Pump
F31 Fuse
F28 Fuse
Fuel Pump Relay
FJ Fuse
FS Fuse
From Battery
Instrument Assembly
ABS & TCS Module
Data Link
Body Control Module
Idle Air Control Motor
Cannister Purge
EGR Valve

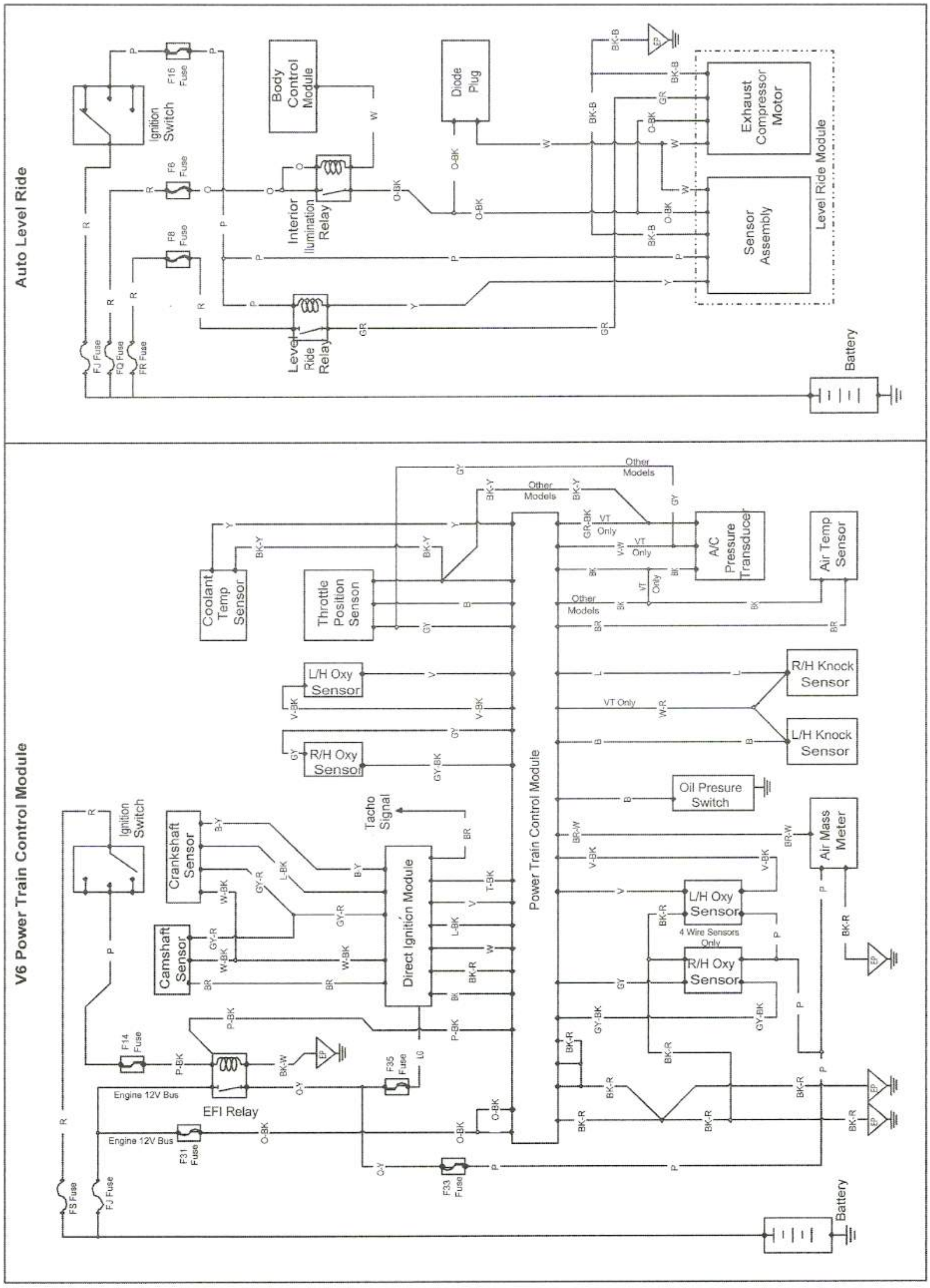
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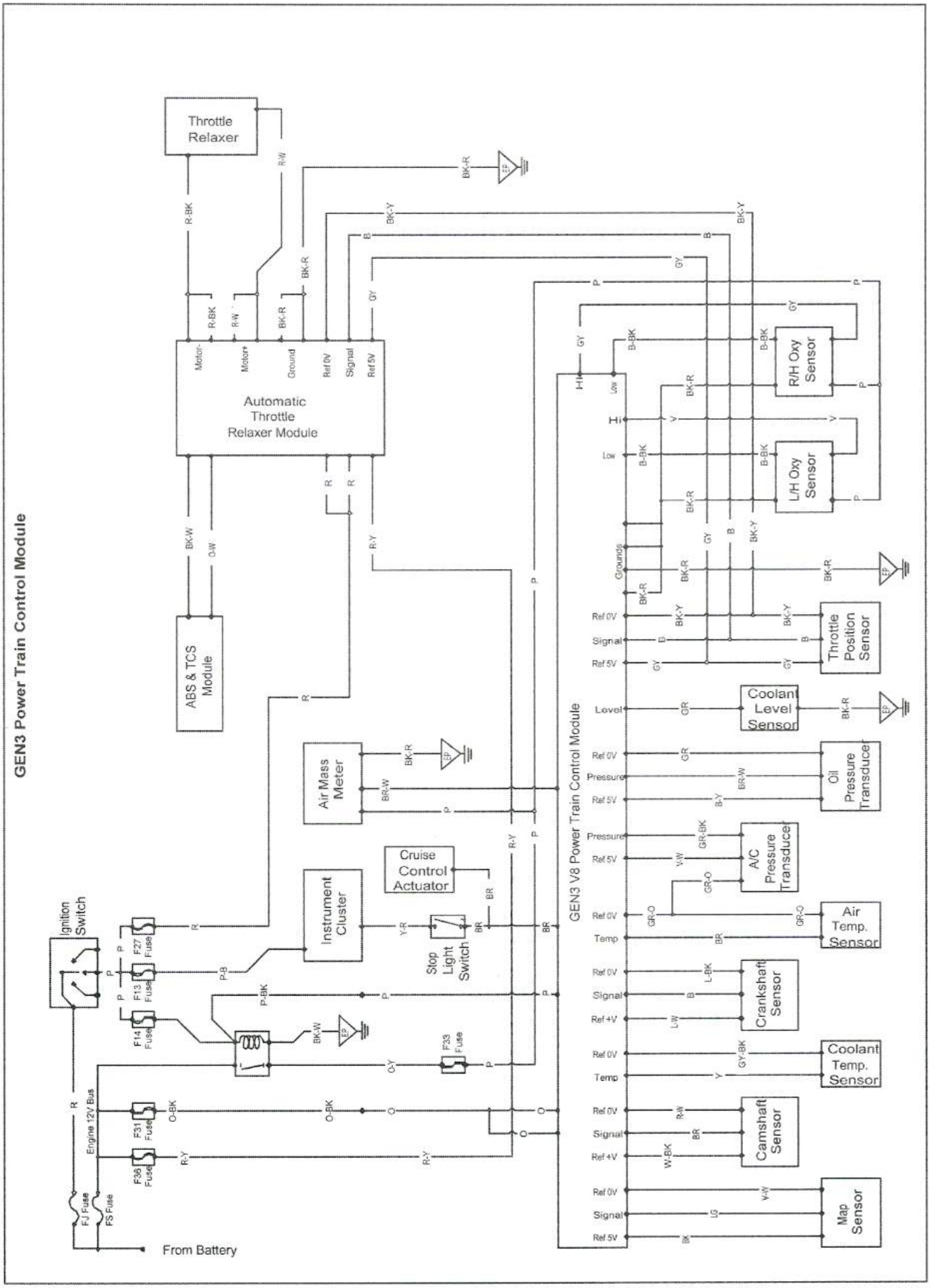
Power Train Control Module V6



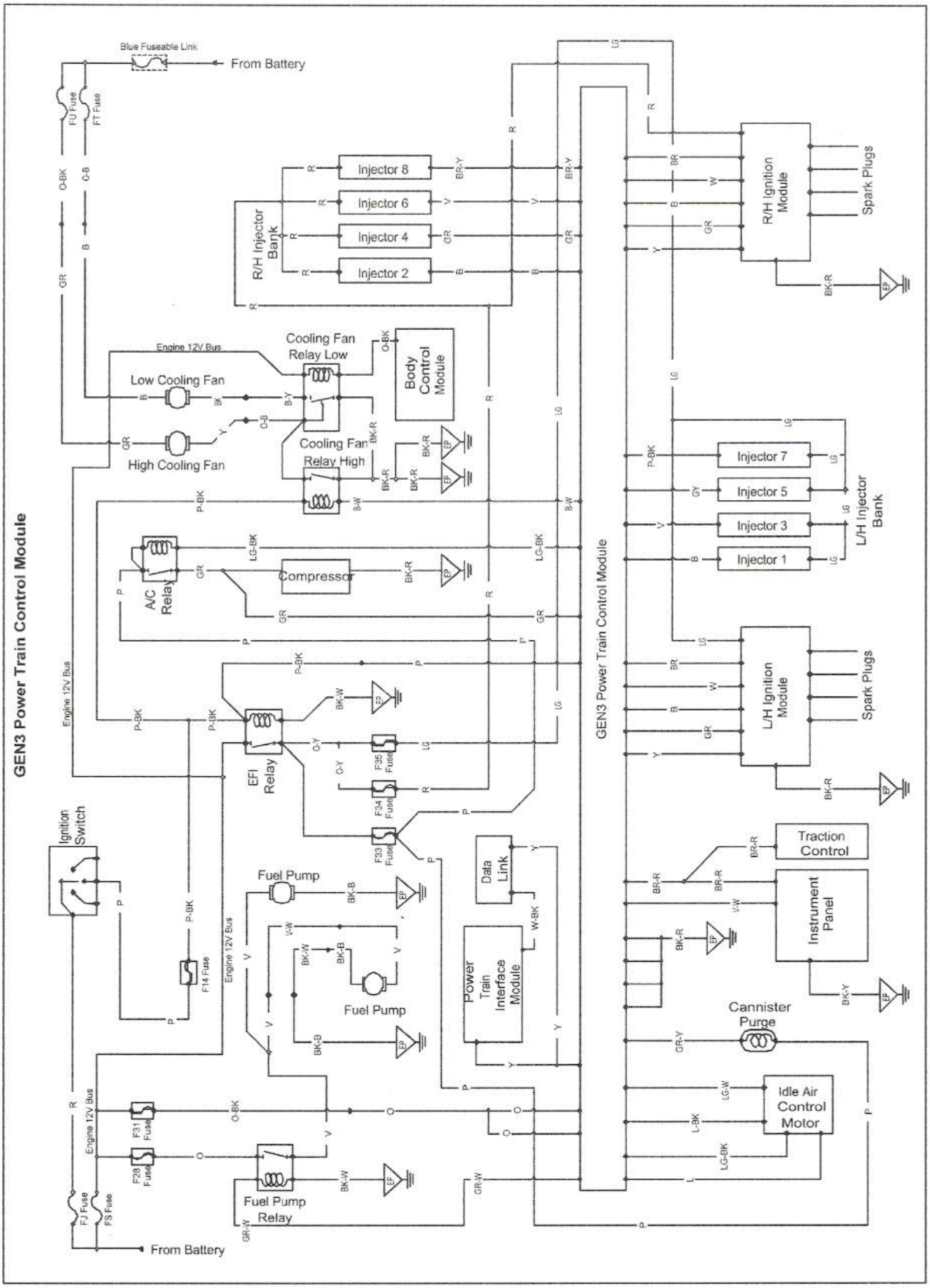
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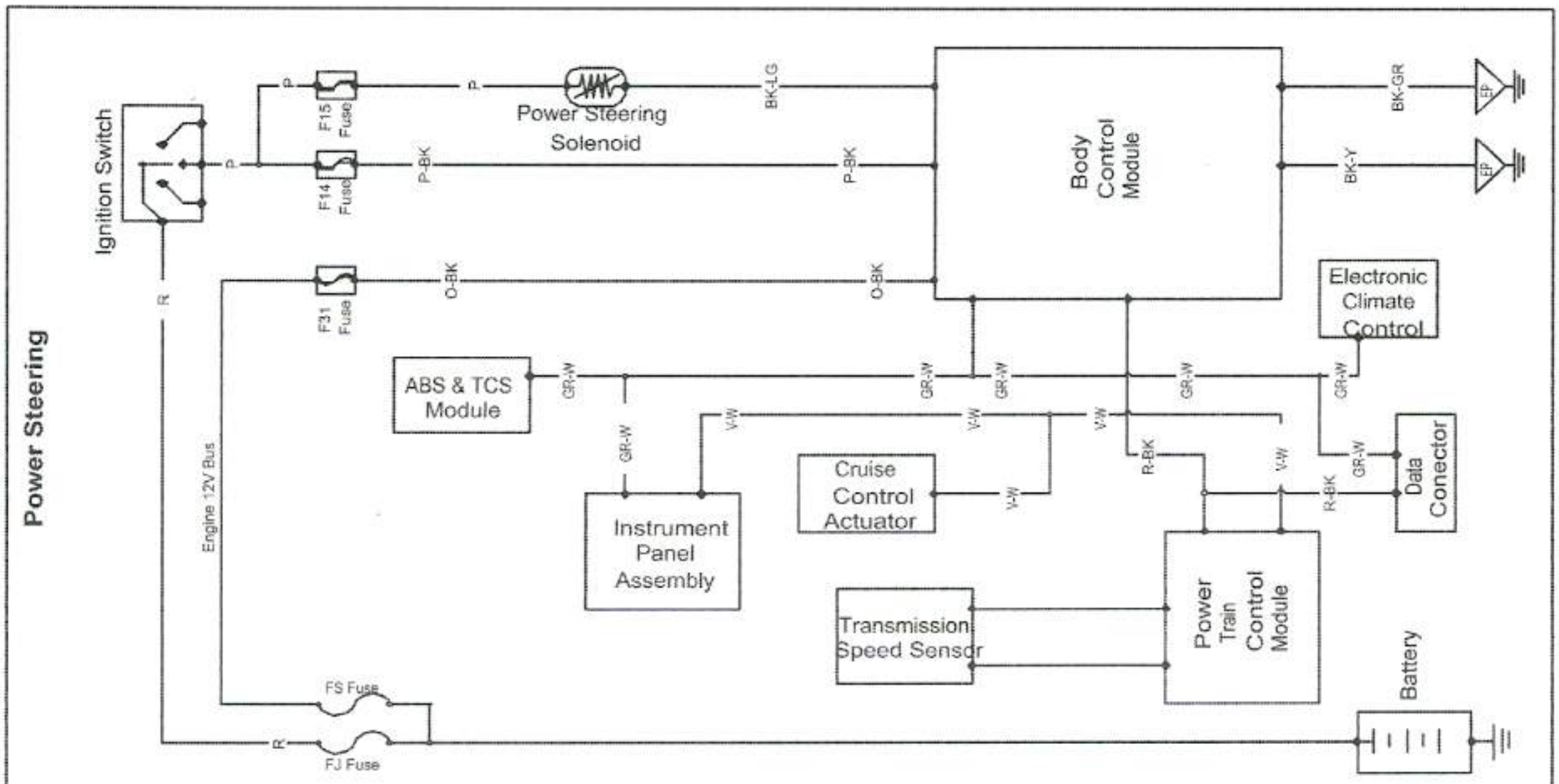
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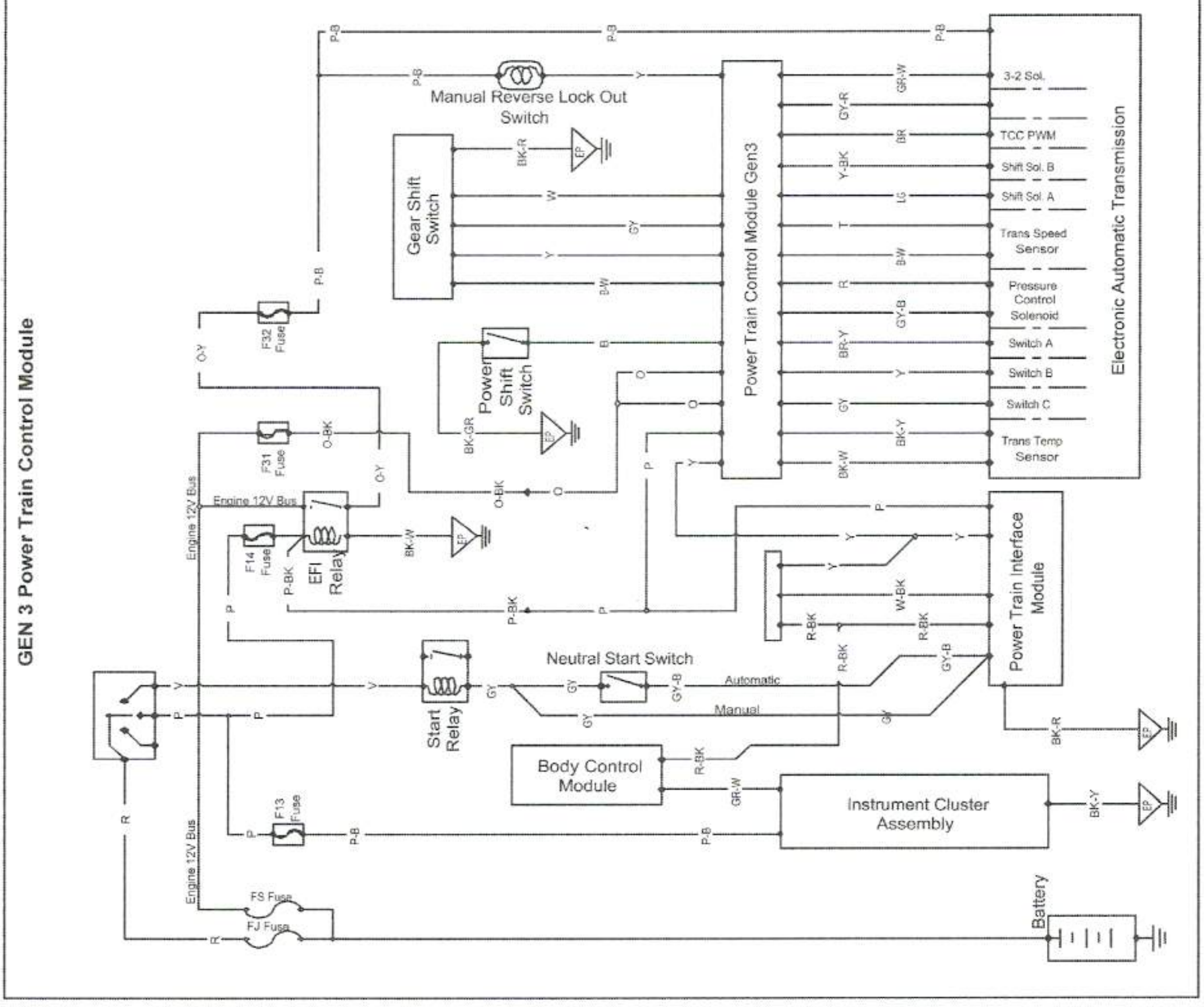
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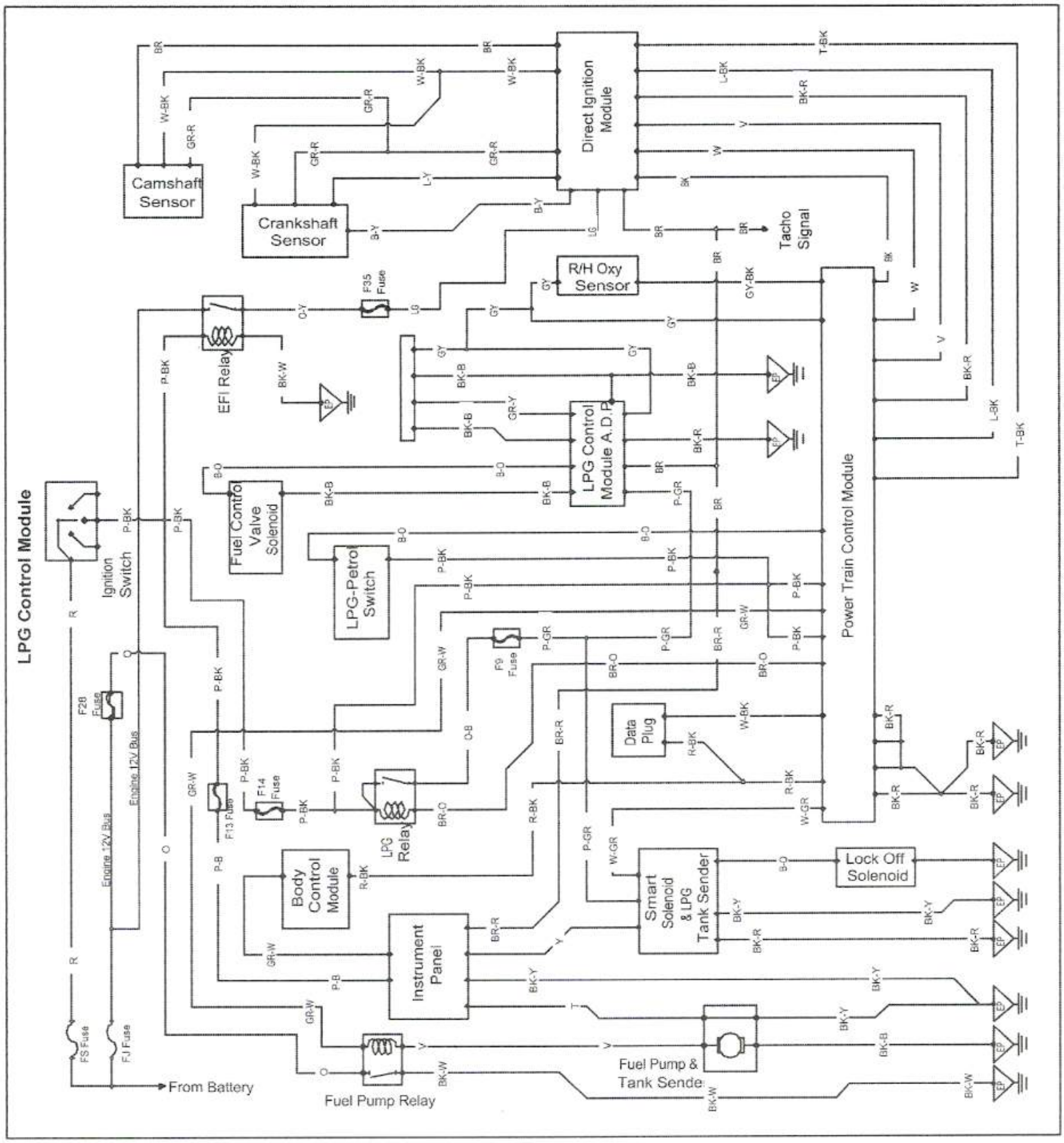
Power Steering



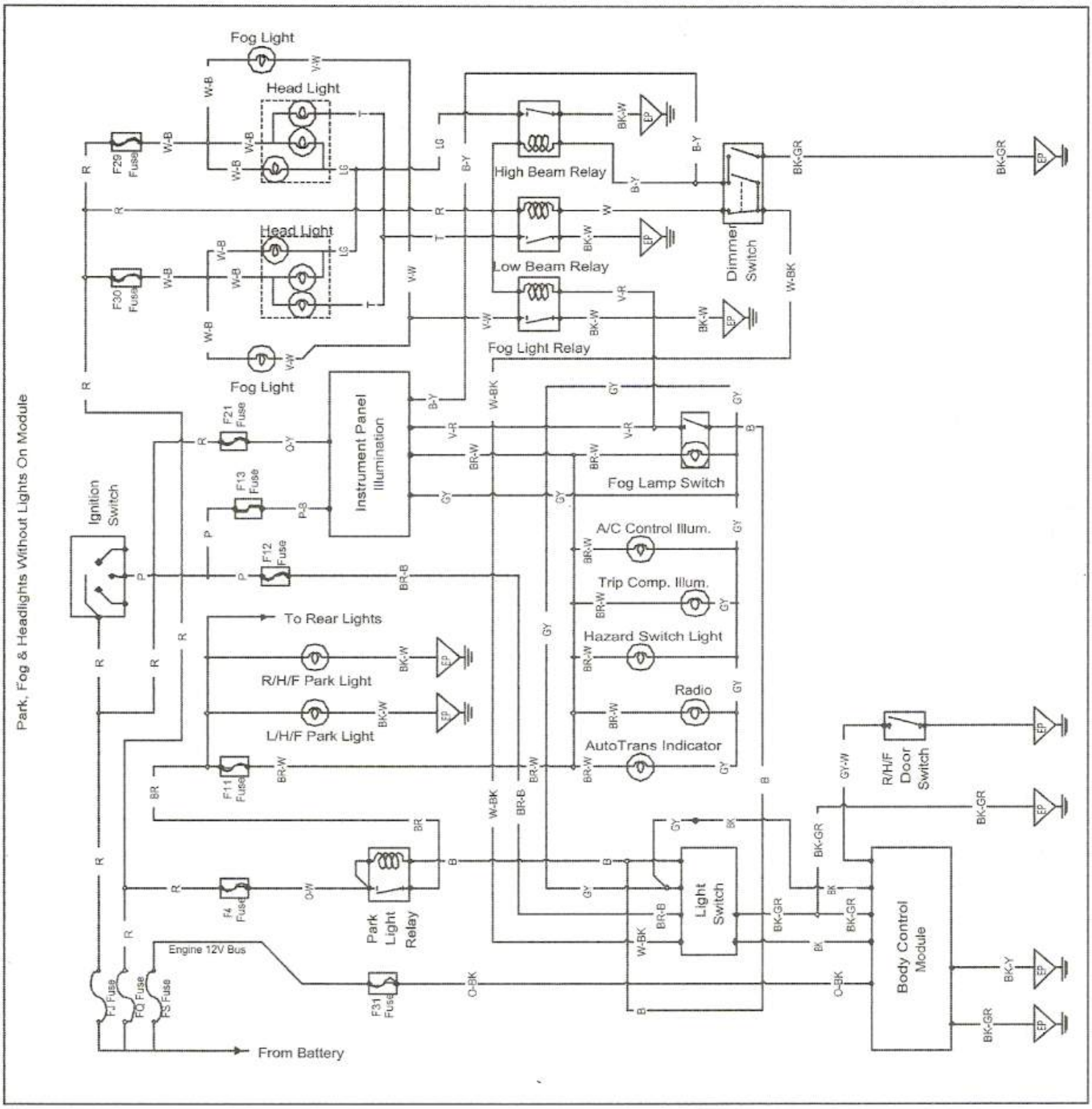
GEN 3 Power Train Control Module



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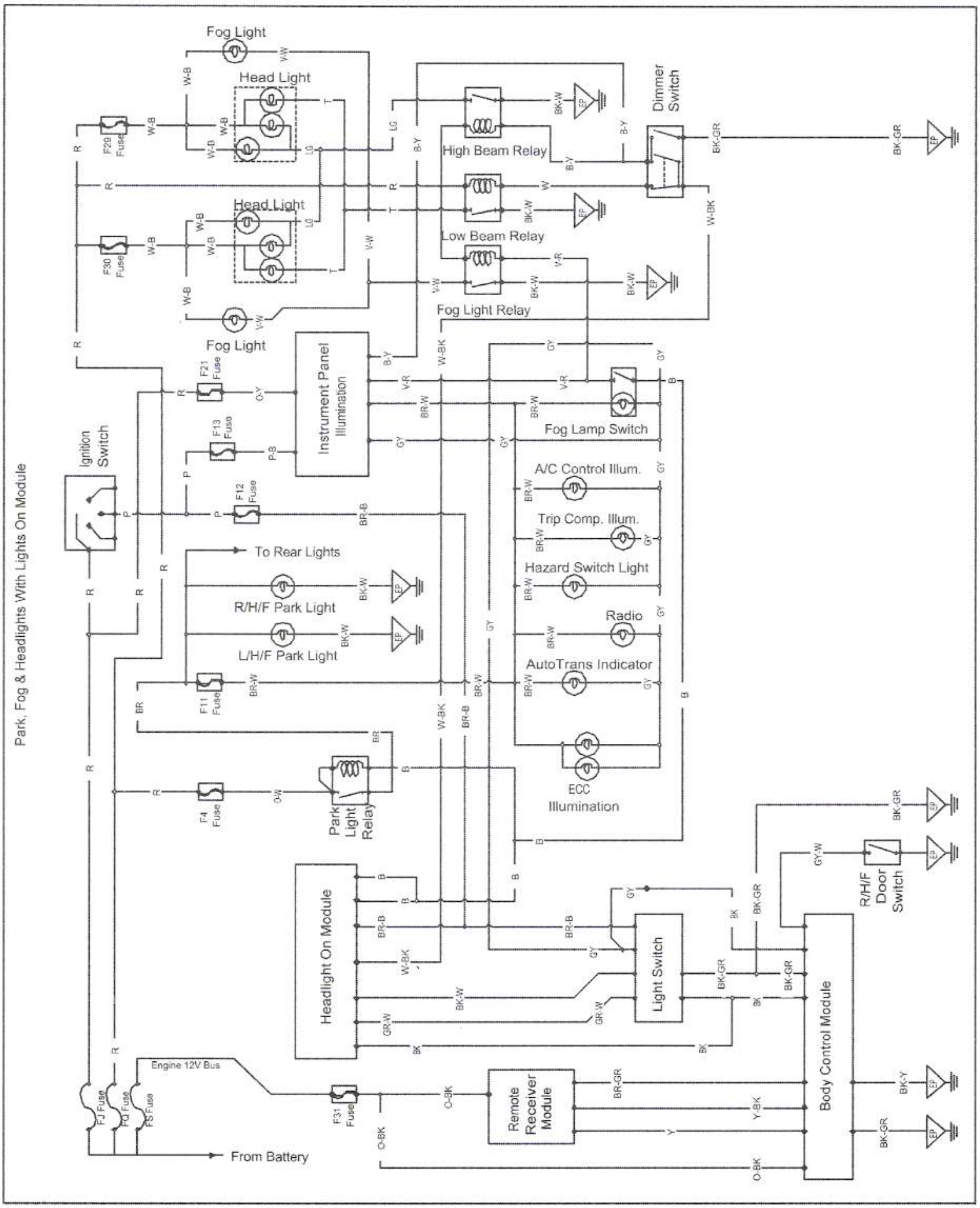


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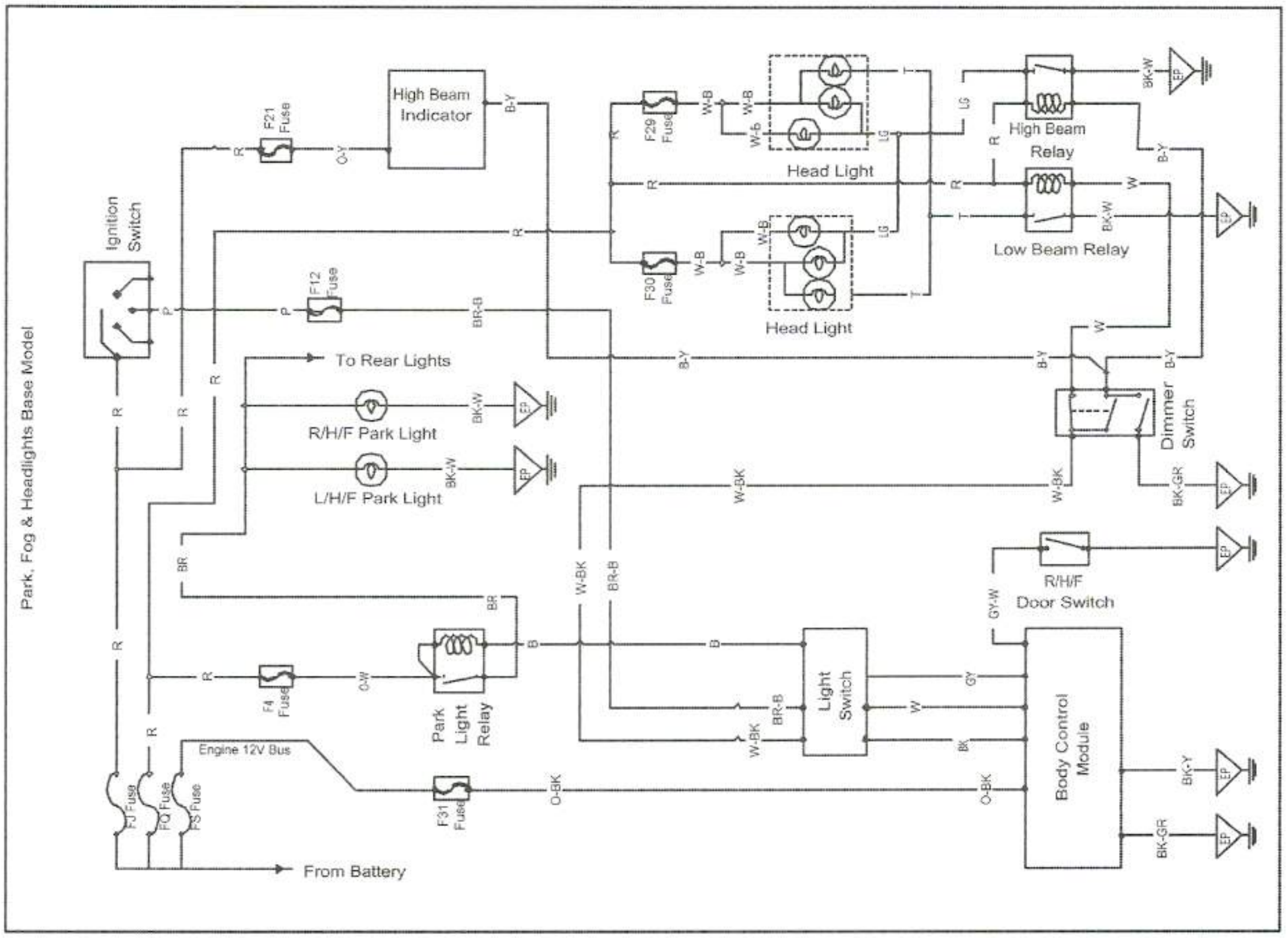


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Park, Fog & Headlights With Lights On Module

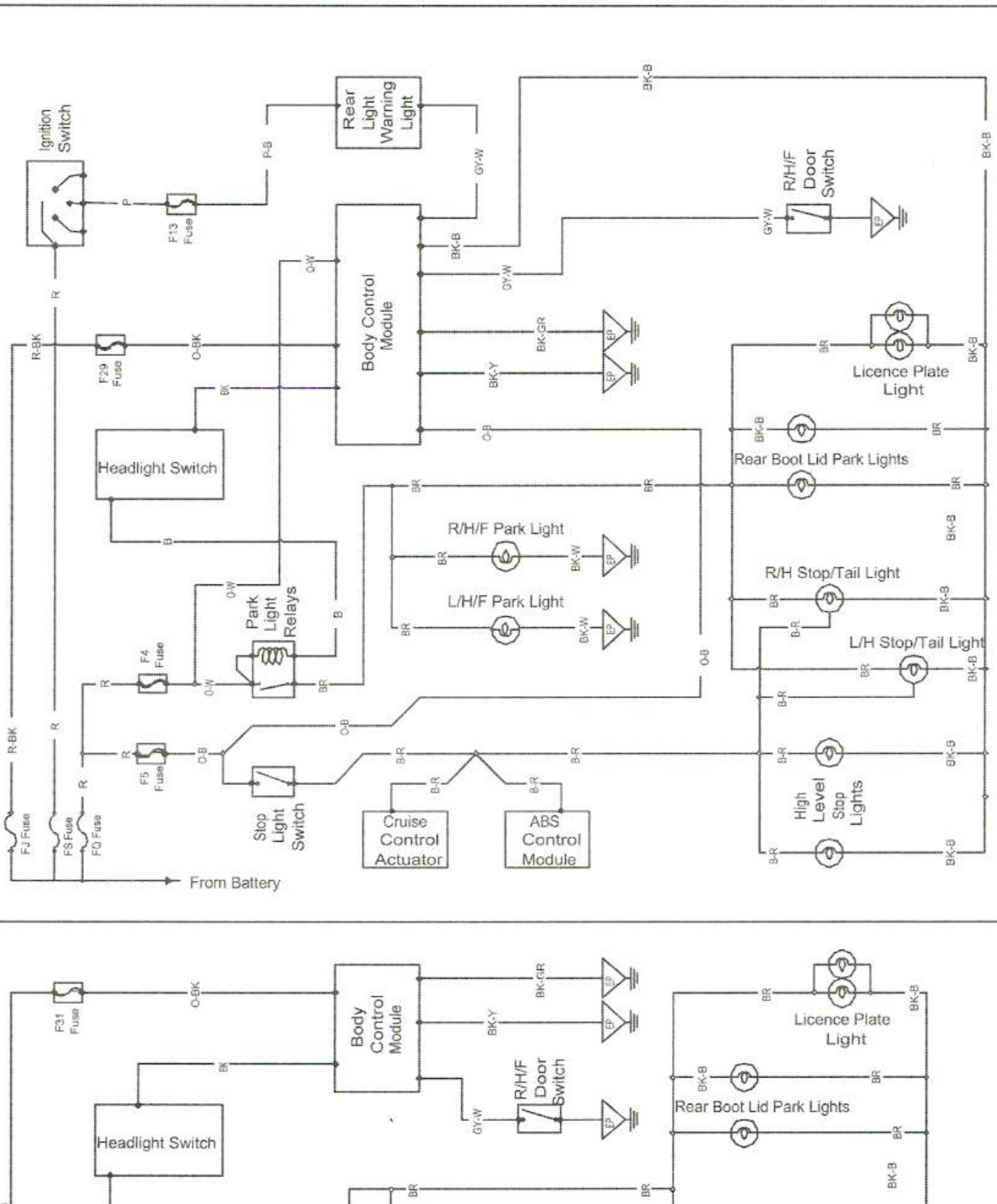


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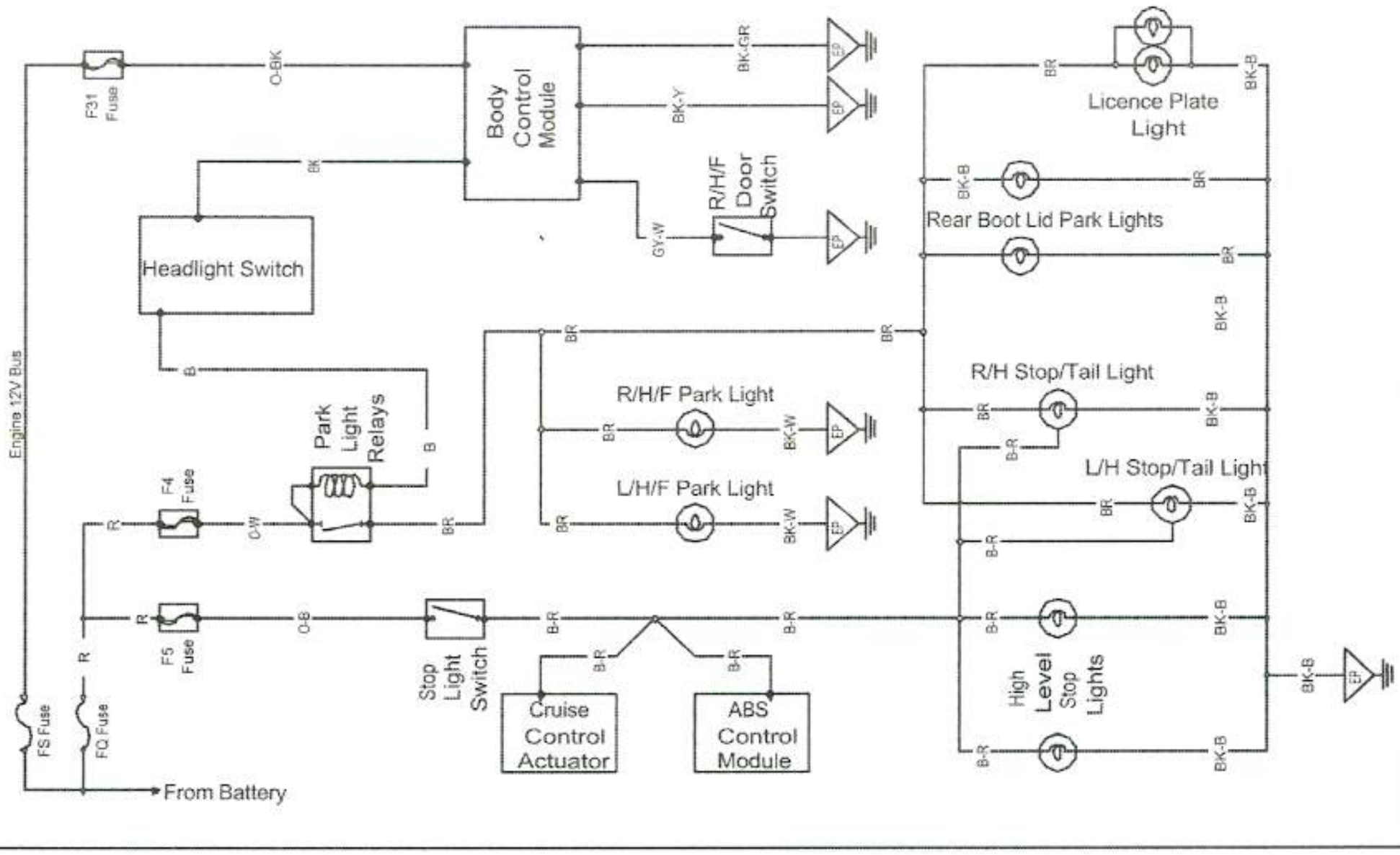


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Stop/Tail & Licence Plate Luxury Models



Stop/Tail & Licence Plate All Models



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Front & Rear Wiper Washer

Ignition Switch

F18 Fuse

Rear Wiper Relay

Rear Wiper Motor

Intermittant Wiper Relay

Front Wiper Motor

Vehicle Speed Sensor

Power Train Control Module

Data Link

Wiper/Washer Switch

Washer Pump

Dwell Control Switch

Engine 12V Bus

FS Fuse

FJ Fuse

F31 Fuse

From Battery

Body Control Module

Turn Signal & Reverse Lights

F31 Fuse Early Models

F29 Fuse Late Models

Turn Signal Switch

Hazard Warning Switch

Hazard/Indicator Relay

Flasher Relay

F7 Fuse

F4 Fuse

Park Light Relay

R/H/F Corner Light

R/H/F Light

R/H Side Light

R/H/R Light

L/H/R Light

L/H Side Light

L/H/F Light

L/H/F Corner Light

Instrument Panel

FQ Fuse

Ignition Switch

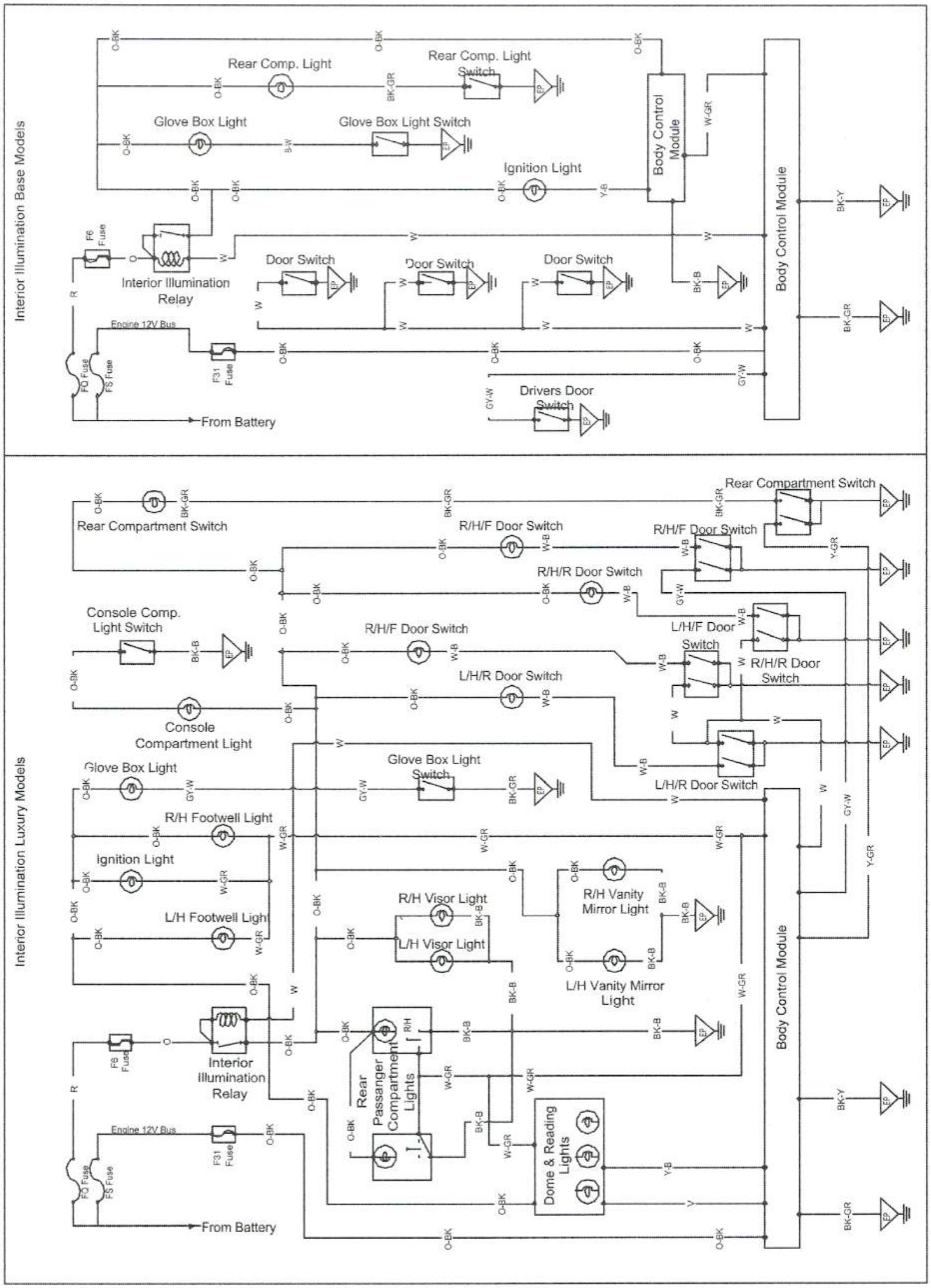
F13 Fuse

To rear Lights

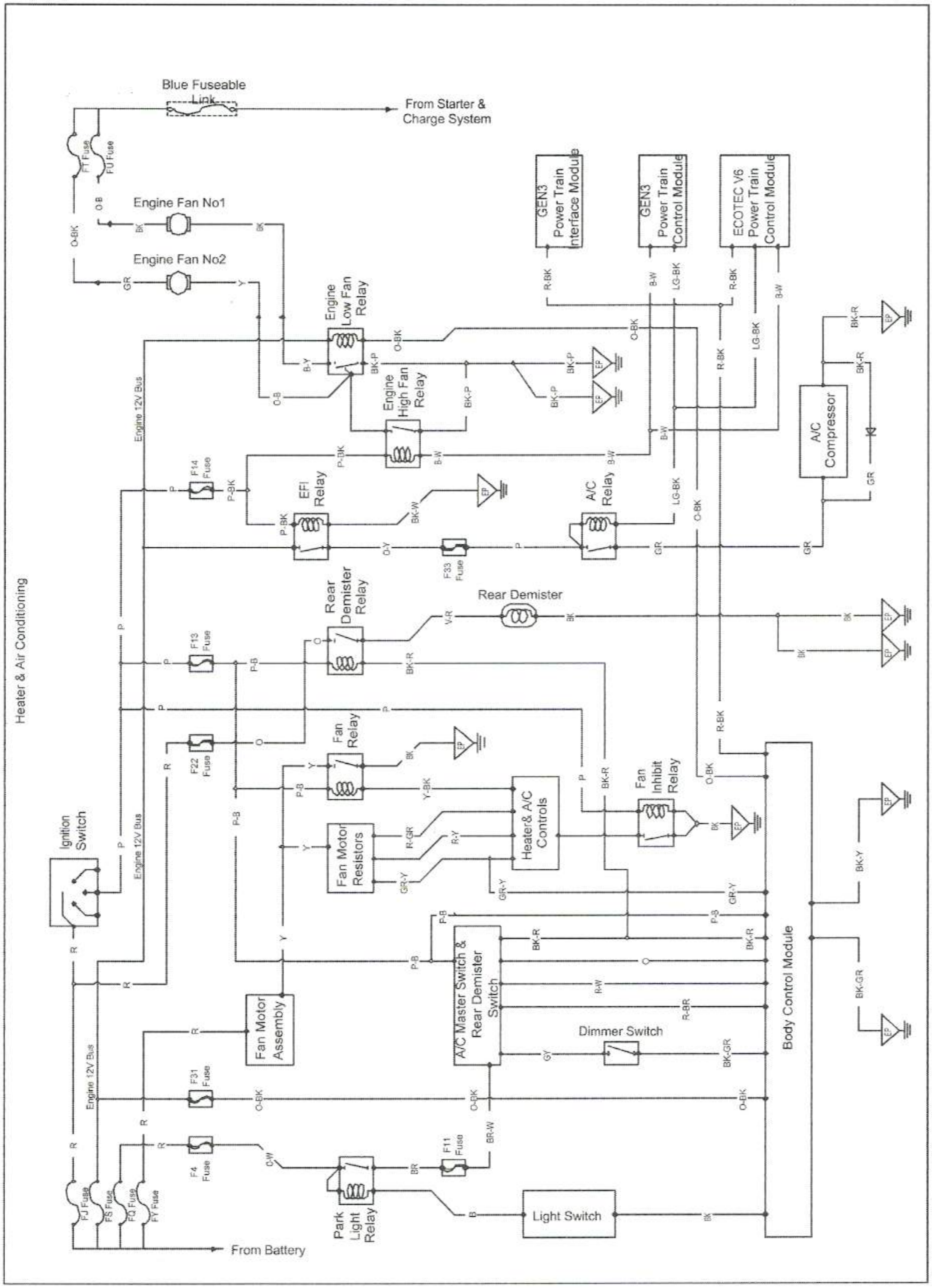
Reverse Light Switch

Reverse Lights

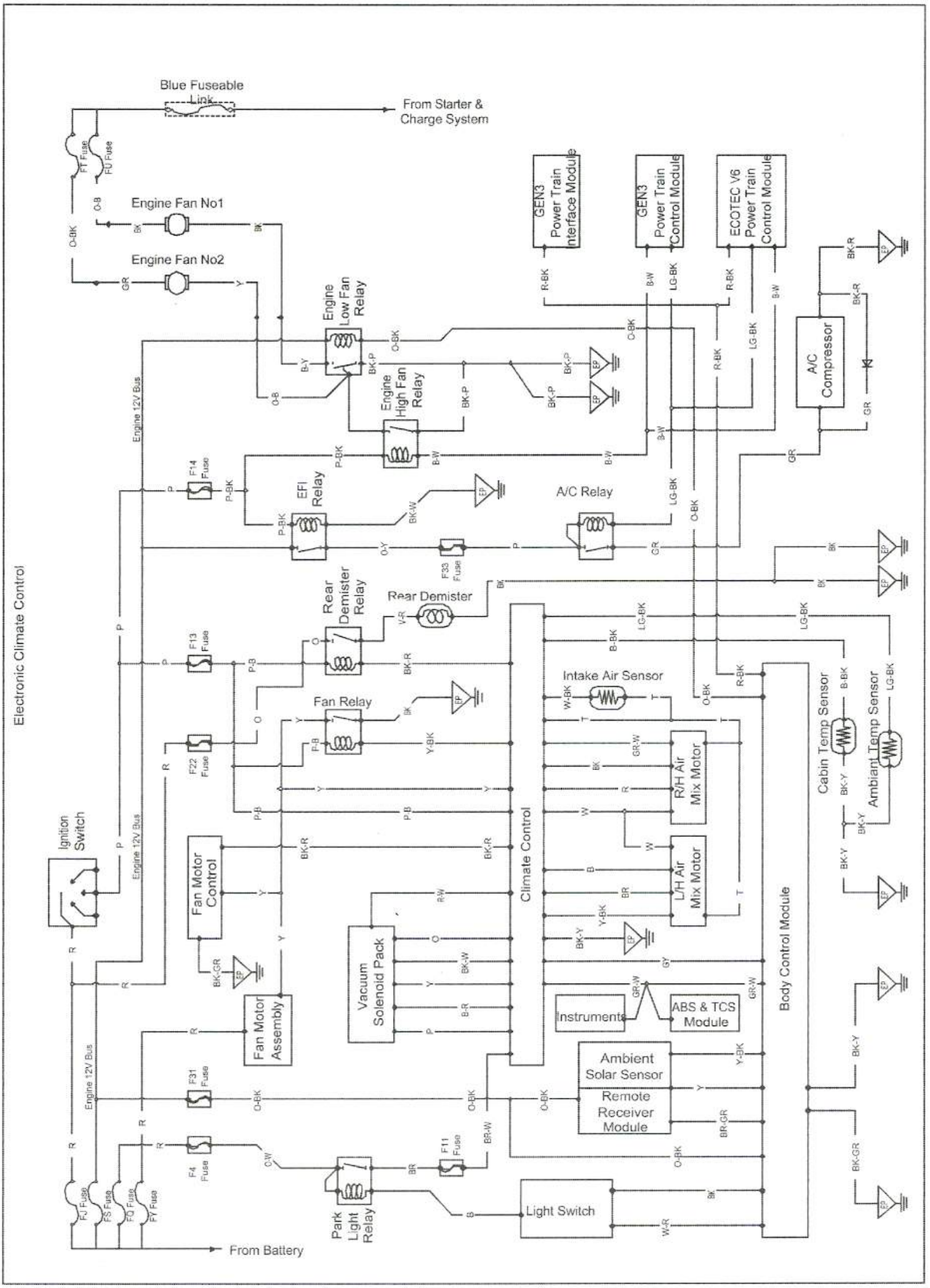
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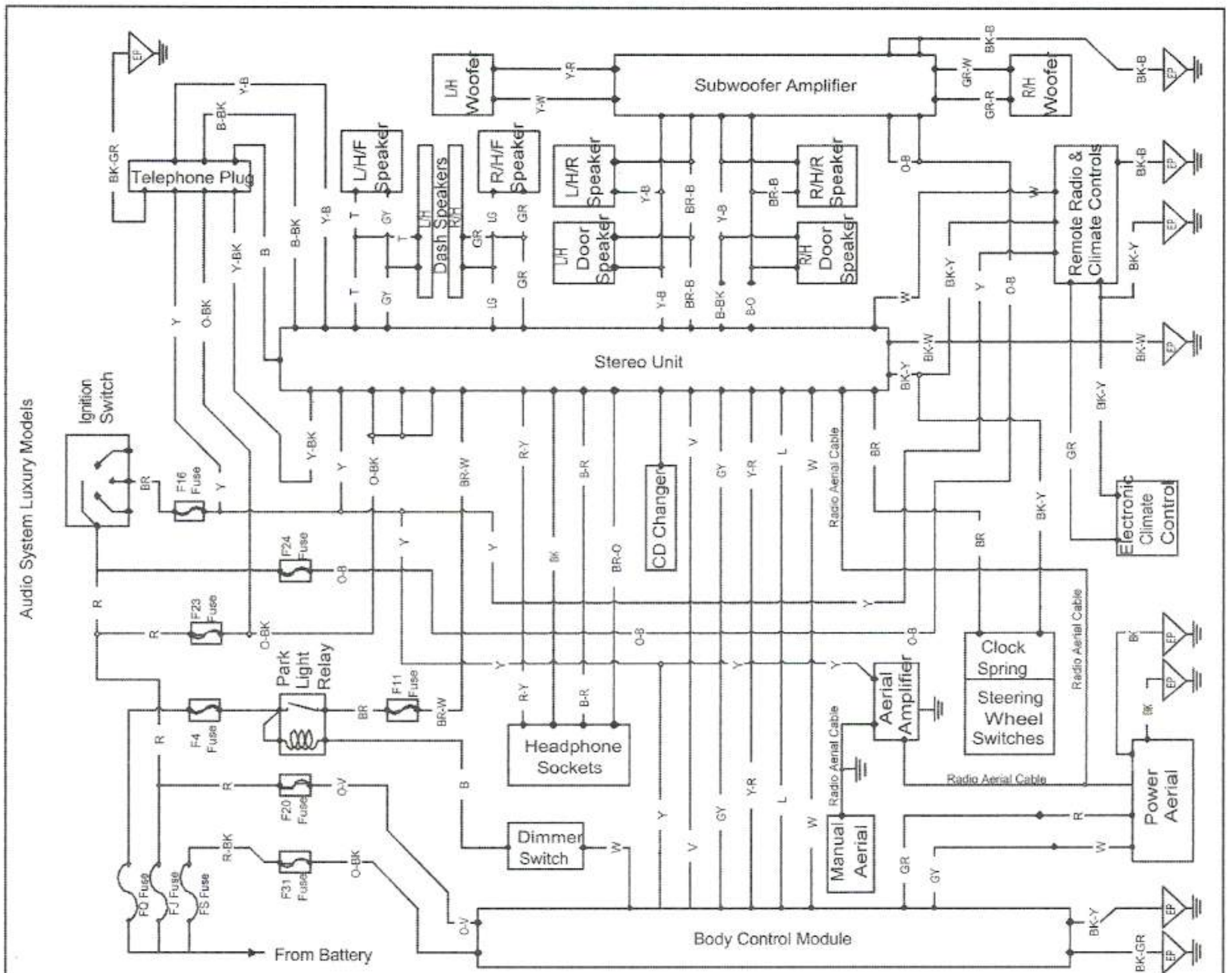


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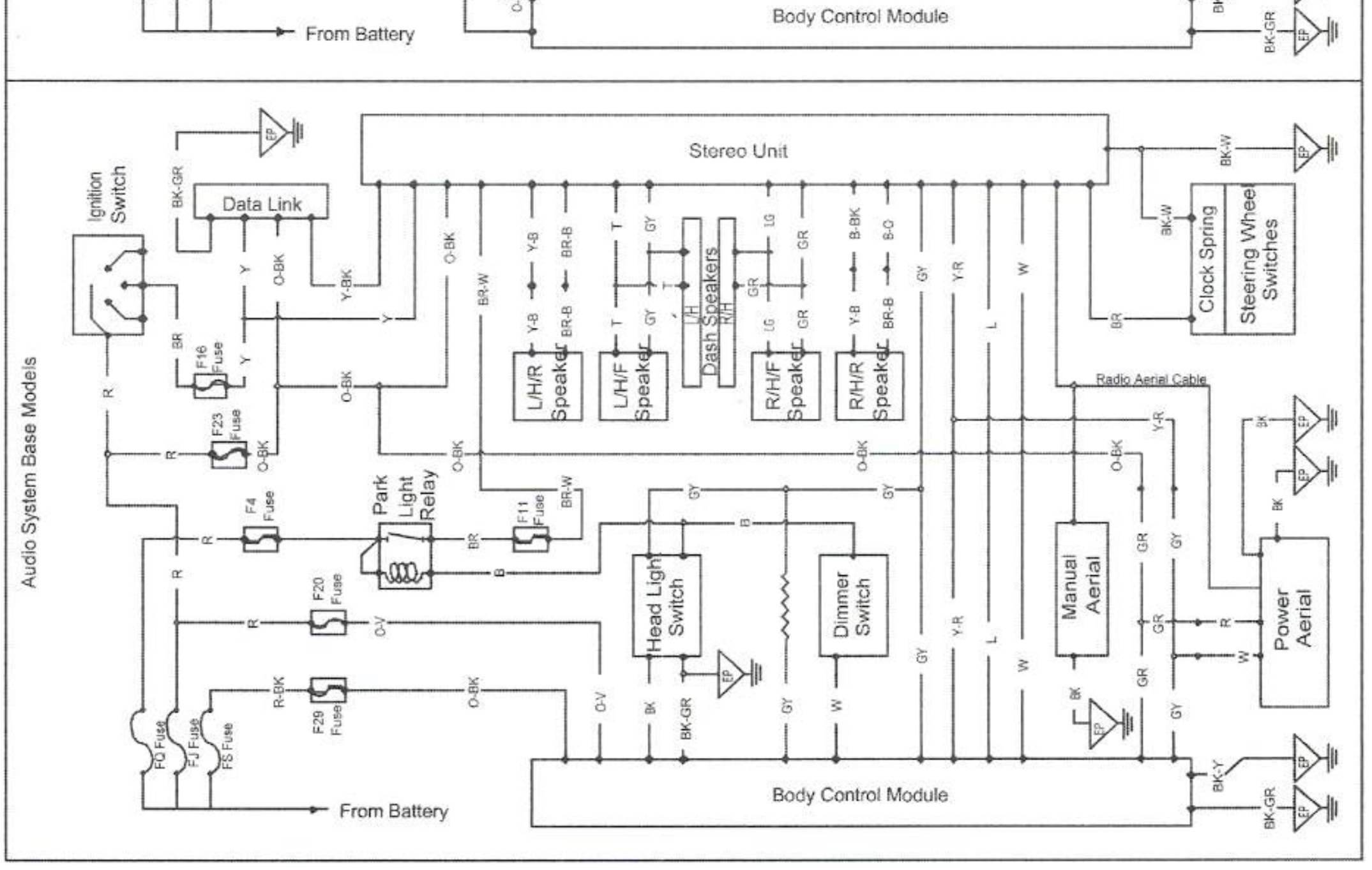


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Audio System Luxury Models

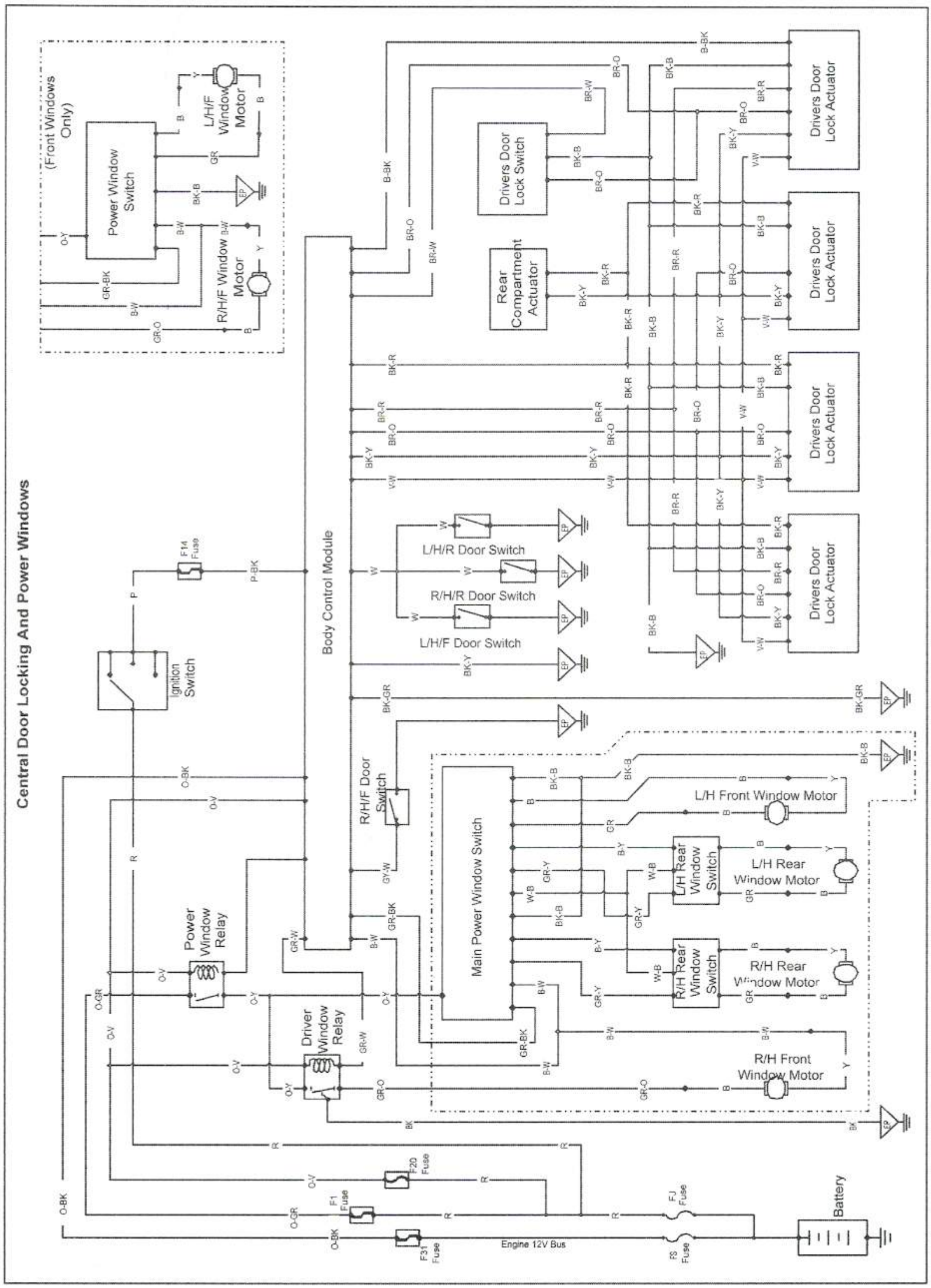


Audio System Base Models



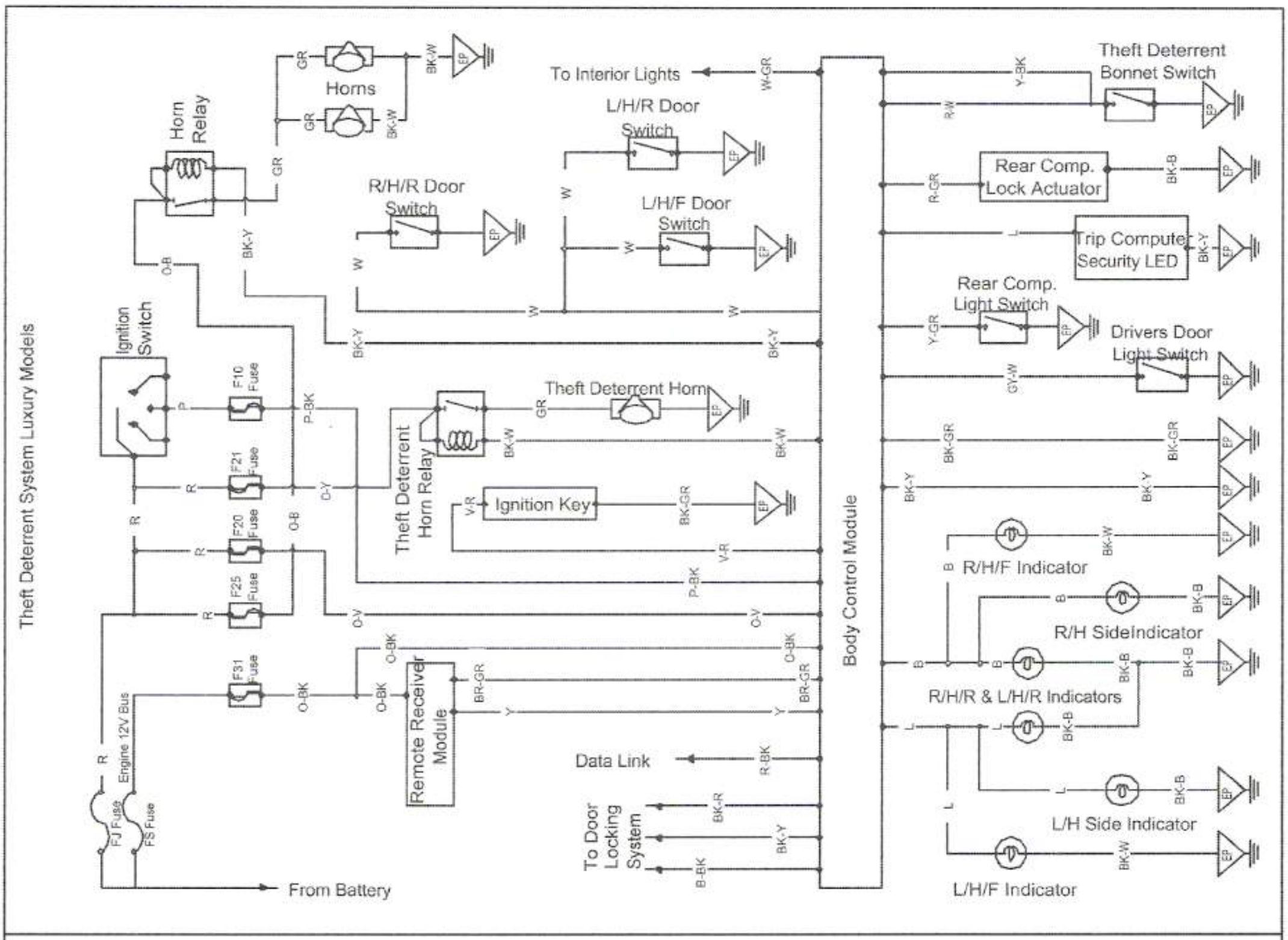
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Central Door Locking And Power Windows

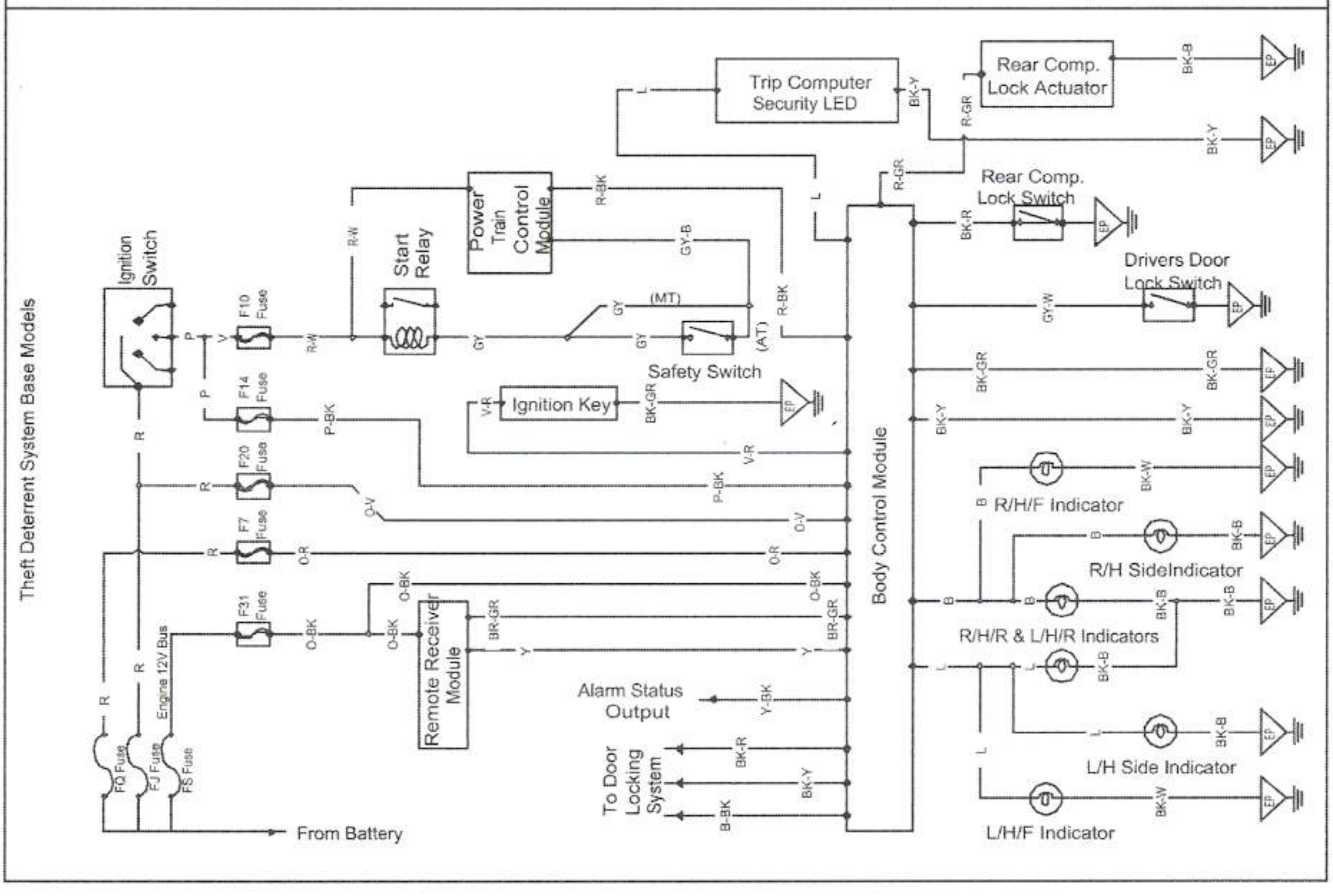


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Theft Deterrent System Luxury Models

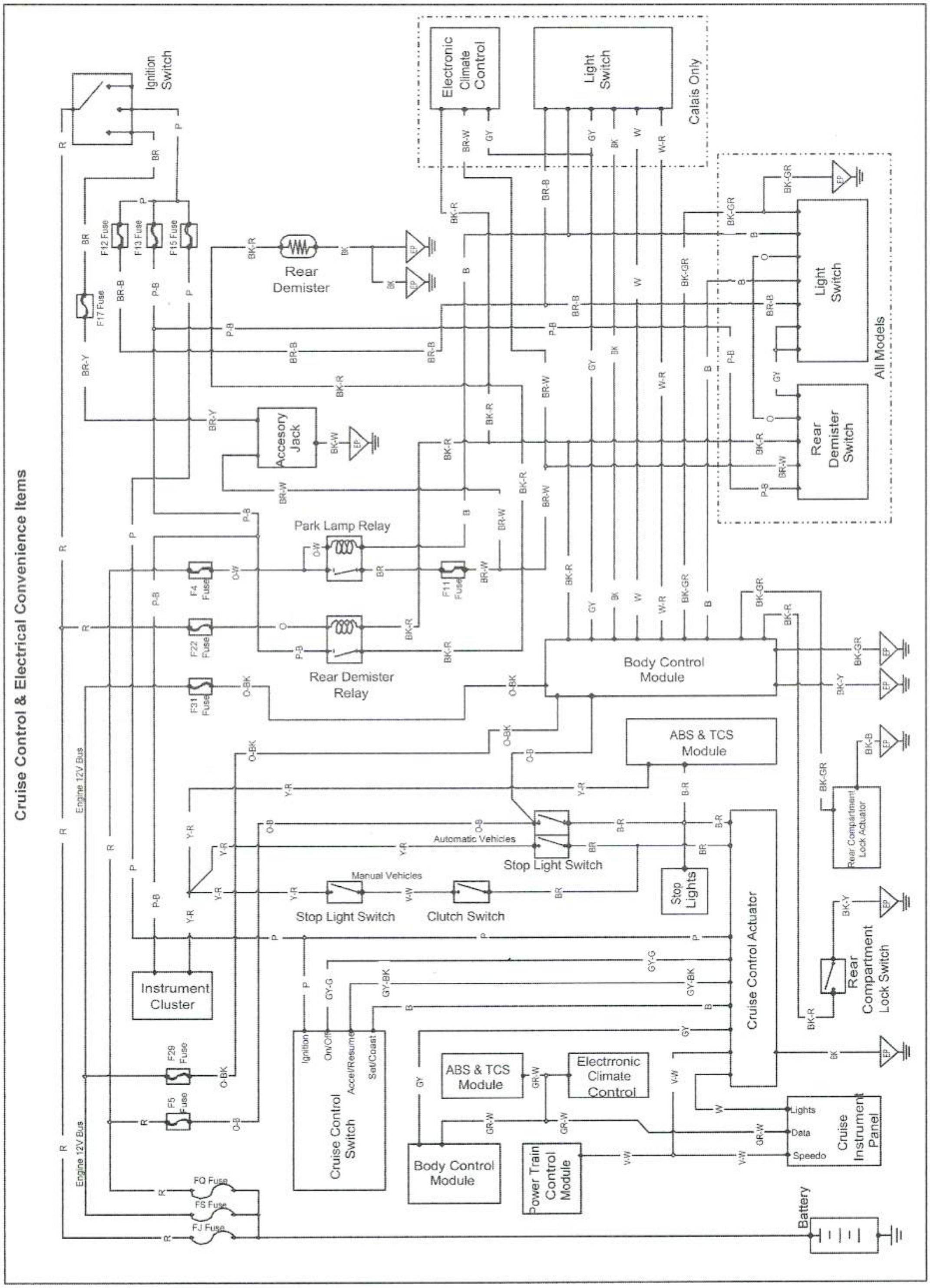


Theft Deterrent System Base Models

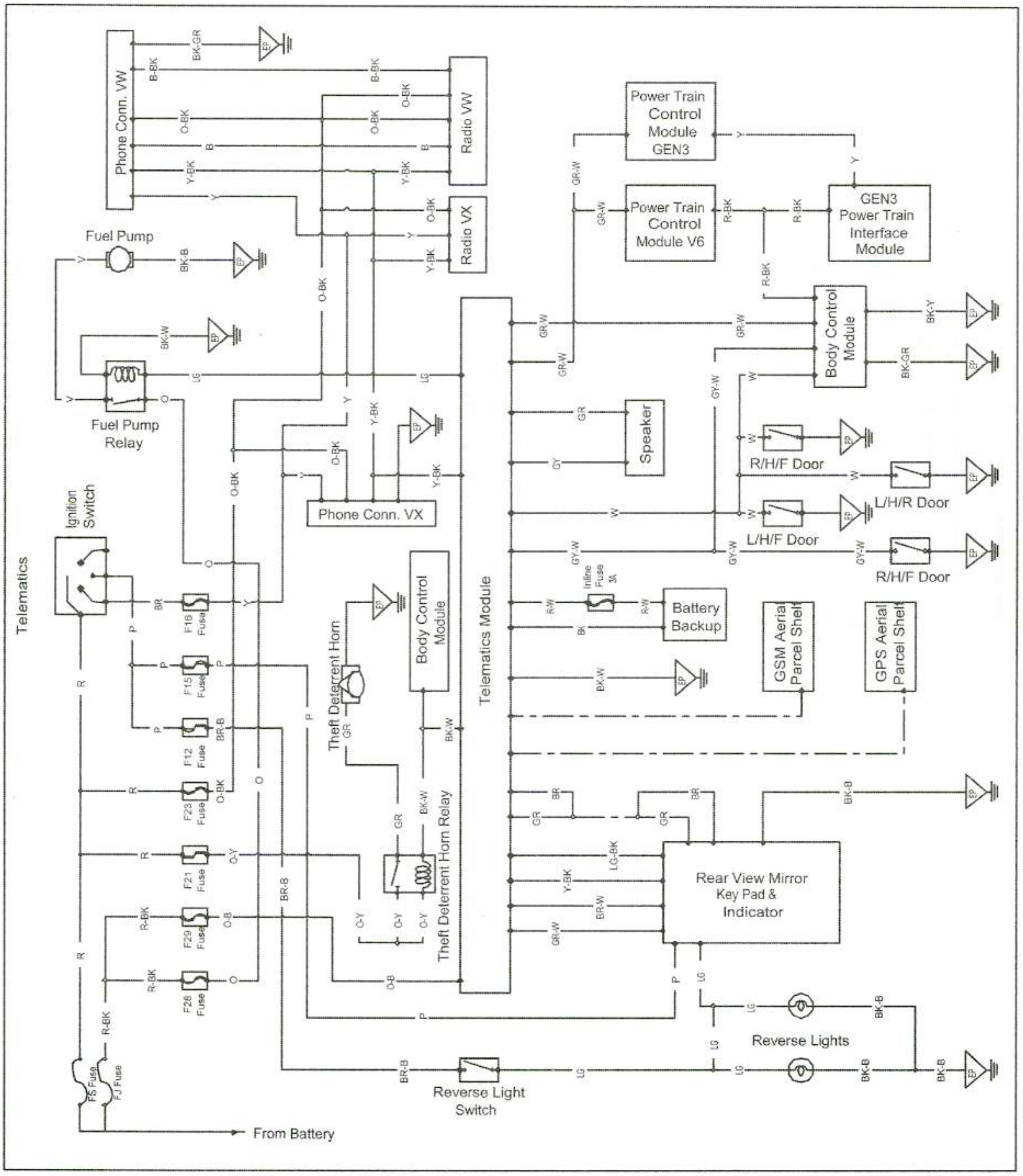


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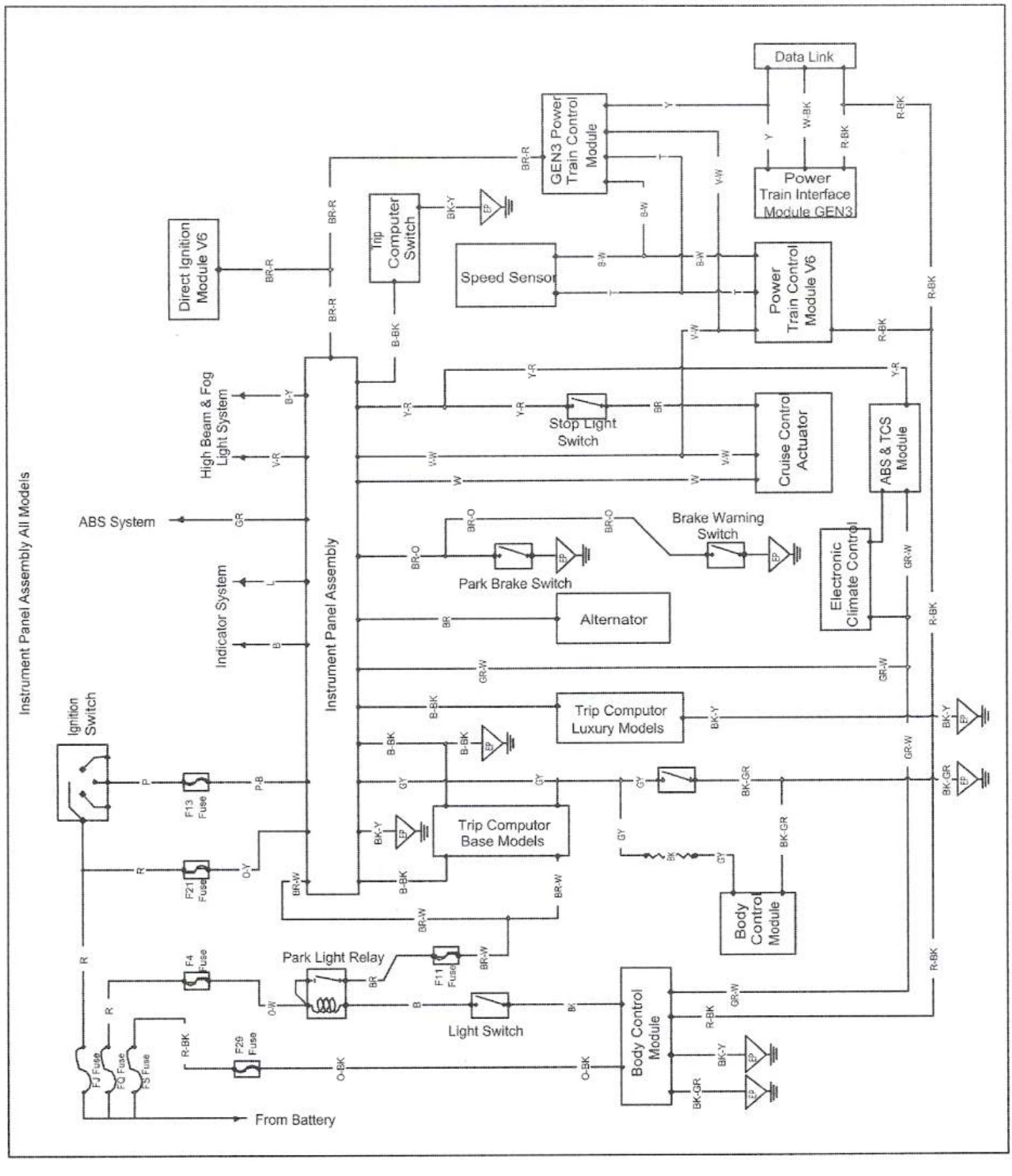
Cruise Control & Electrical Convenience Items



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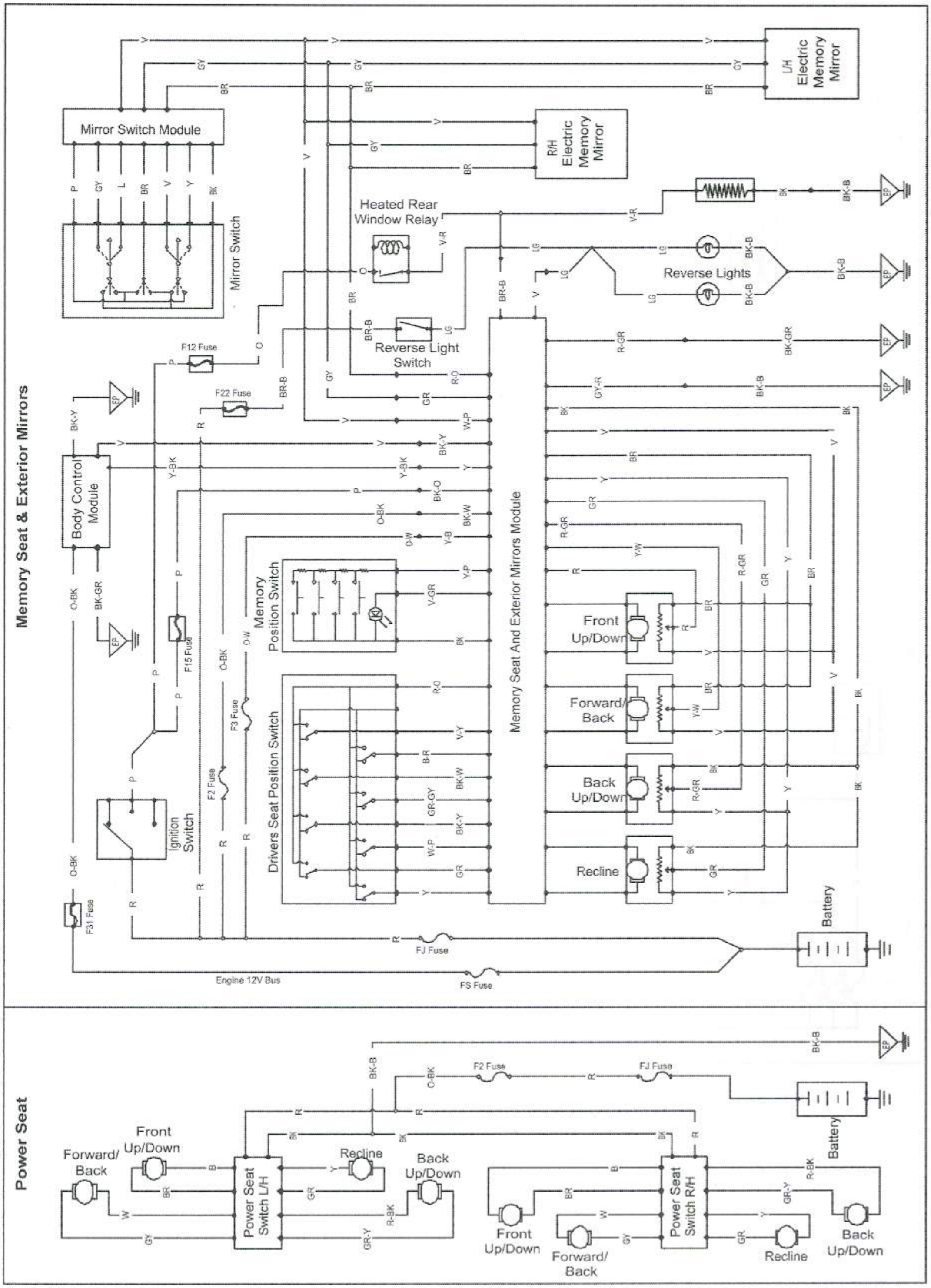


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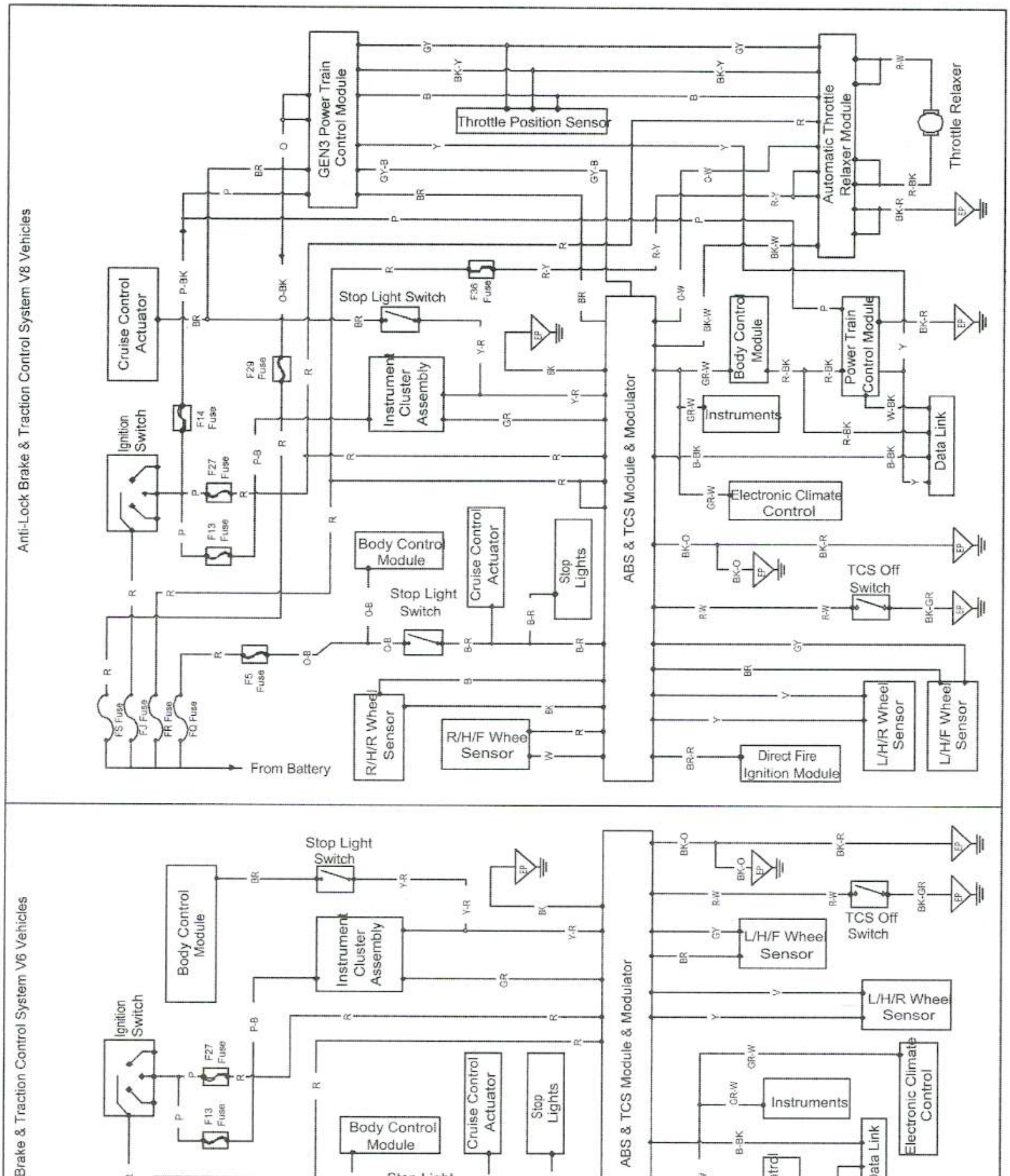
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Memory Seat & Exterior Mirrors

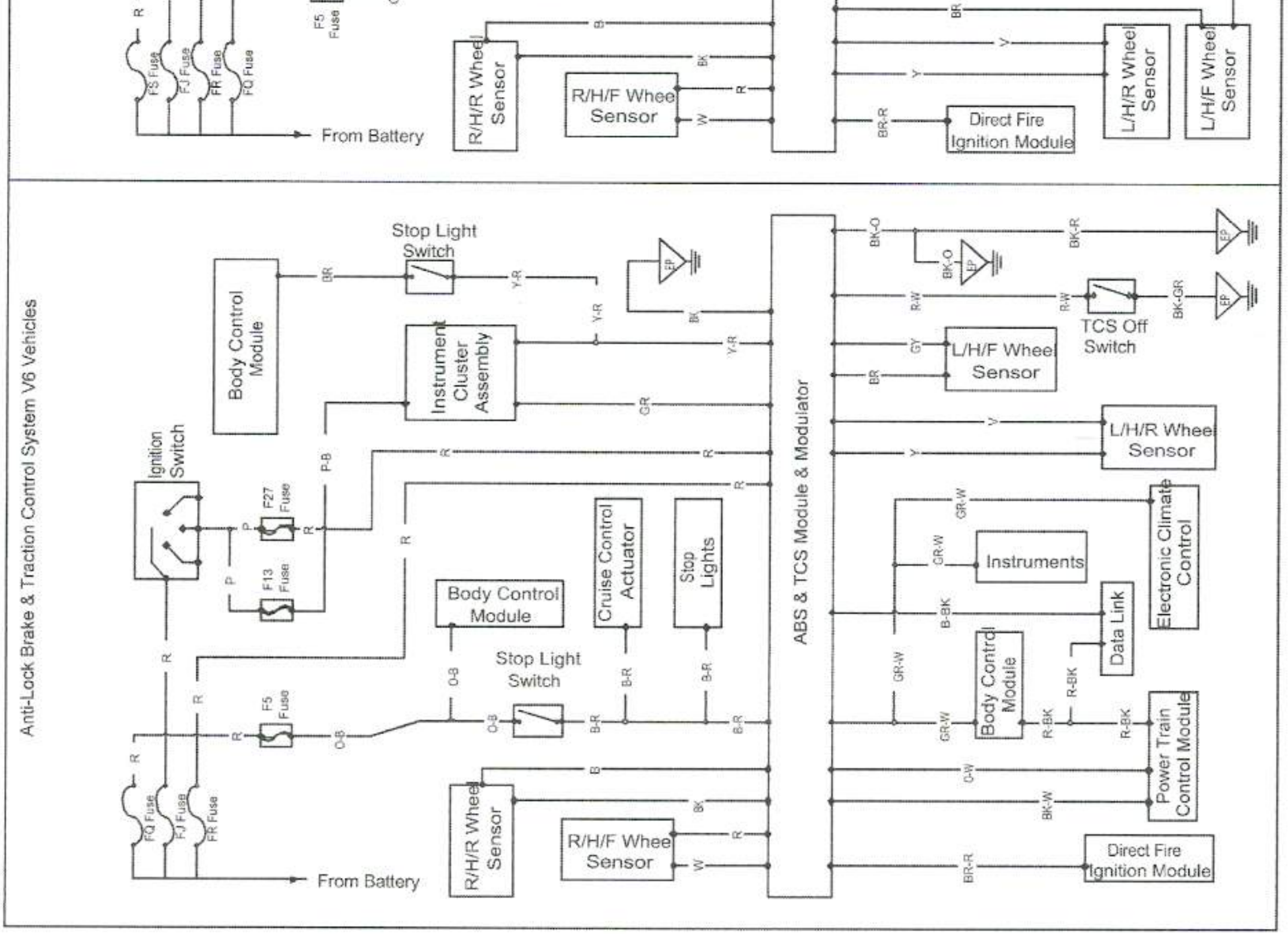


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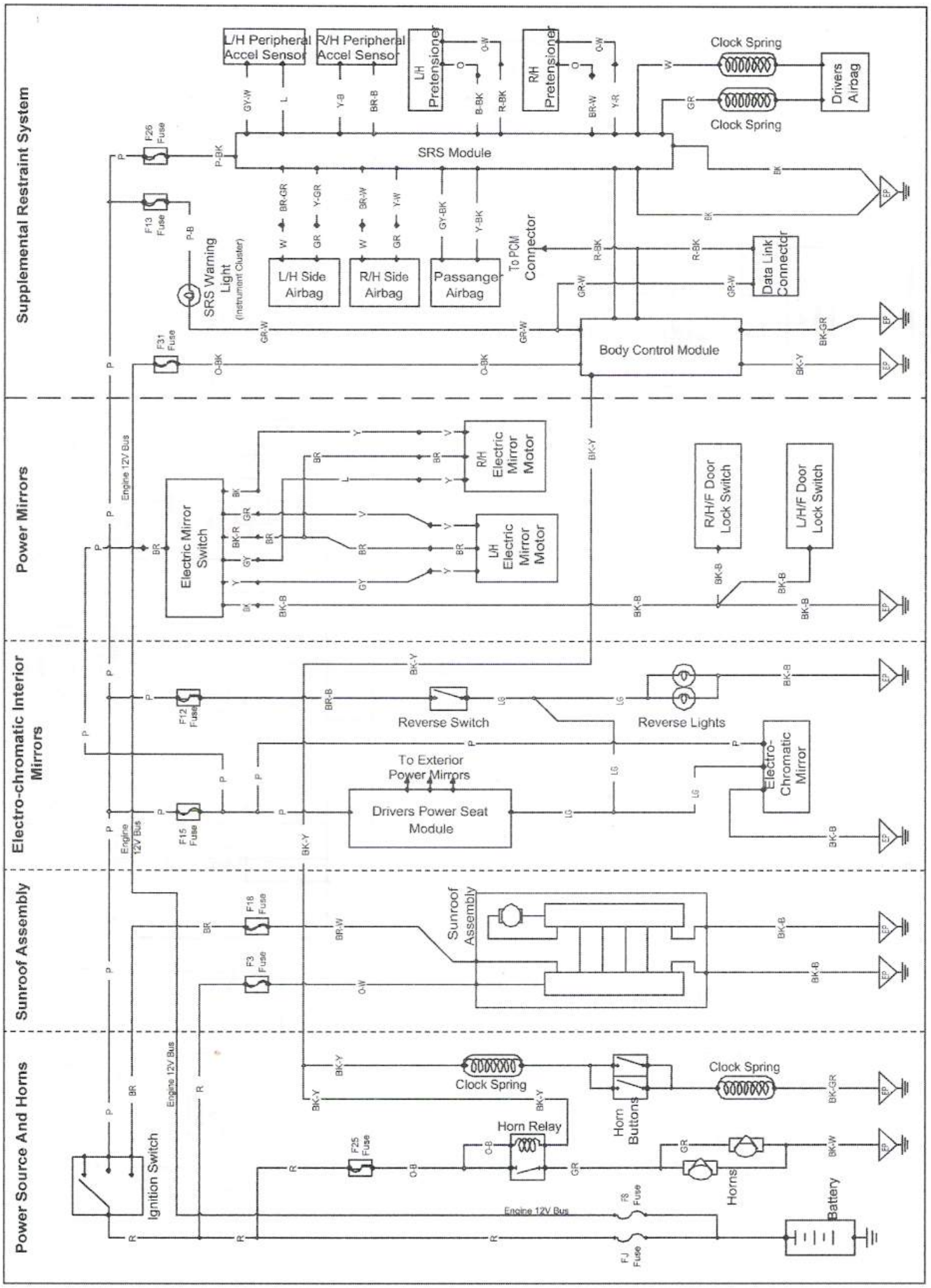
Anti-Lock Brake & Traction Control System V8 Vehicles



Anti-Lock Brake & Traction Control System V6 Vehicles



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