

2-1 [M100] EMISSION CONTROL SYSTEM AND VACUUM FITTING

1. System Application

There are three emission control systems which are as follows:

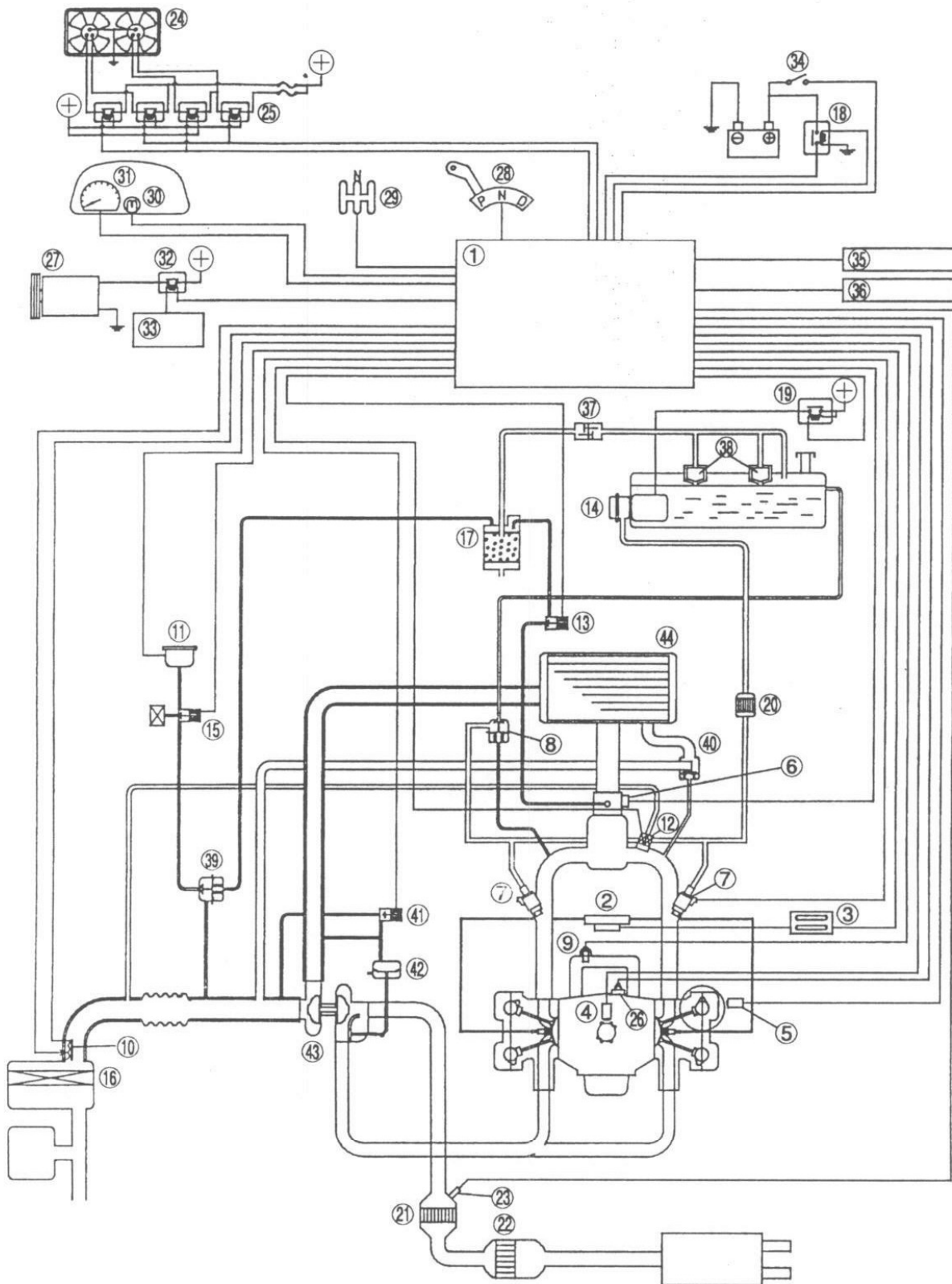
- 1) Crankcase emission control system
- 2) Exhaust emission control system
 - Three-way catalyst system
 - A/F control system
 - Ignition control system
- 3) Evaporative emission control system

Item			Main components	Function
Crankcase emission control system			PCV valve	Draws blow-by gas into intake manifold from crankcase and burns it together with air-fuel mixture. Amount of blow-by gas to be drawn in is controlled by intake manifold pressure.
Exhaust emission control system	Catalyst system*1	Front	Three-way catalyst	Oxidizes HC and CO contained in exhaust gases as well as reducing NOx.
		Rear*2		
	A/F control system		ECM (Engine control module)	Receives input signals from various sensors, compares signals with stored data, and emits a signal for optimal control of air-fuel mixture ratio.
			Oxygen sensor*1	Detects density of oxygen contained exhaust gases.
			Mass air flow sensor (2000 cc model)	Detects amount of intake air.
			Pressure sensor (1600 cc and 1800 cc models)	Detects absolute pressure of intake manifold.
			Intake air temperature sensor (1600 cc and 1800 cc models)	Detects intake air temperature of air cleaner case.
			Throttle position sensor	Detects throttle position.
	Ignition control system		ECM	Receives various signals, compares signals with basic data stored in memory, and emits a signal for optimal control of ignition timing.
			Crankshaft position sensor	Detects engine speed (Revolution).
			Camshaft position sensor (2000 cc model)	Detects reference signal for combustion cylinder discrimination.
			Engine coolant temperature sensor	Detects coolant temperature.
			Knock sensor	Detects engine knocking.
Evaporative emission control system			Canister	Absorbs evaporative gas which occurs in fuel tank when engine stops, and sends it to combustion chambers for a complete burn when engine is started. This prevents HC from being discharged into atmosphere.
			Purge control solenoid valve	Receives a signal from ECM and controls purge of evaporative gas absorbed by canister.

*1 : Except General model

*2 : Except Australia model

2: 2000 cc TURBO MODEL

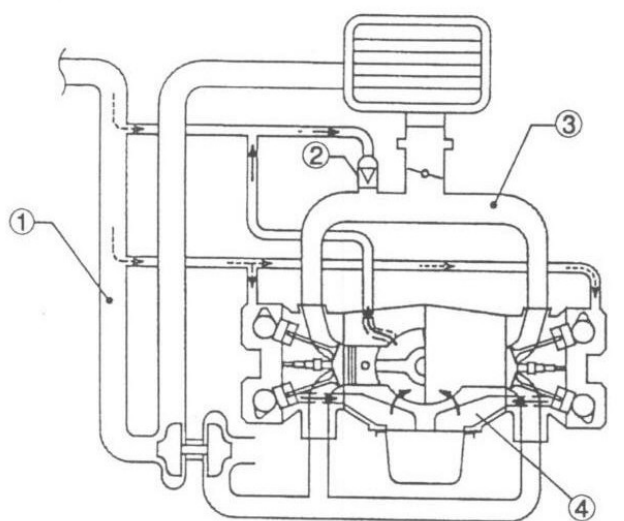


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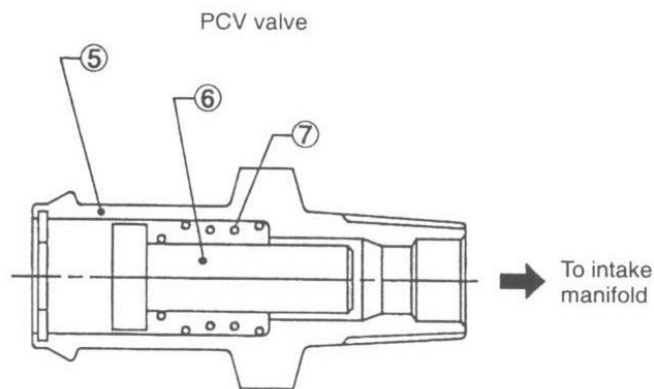
- | | |
|--|--|
| ① Engine control module (ECM) | ②④ Oxygen sensor |
| ② Ignition coil | ②④ Radiator fan |
| ③ Ignitor | ②⑤ Radiator fan relay |
| ④ Crankshaft position sensor | ②⑥ Knock sensor |
| ⑤ Camshaft position sensor | ②⑦ A/C compressor |
| ⑥ Throttle position sensor | ②⑧ Inhibitor switch (AT vehicle only) |
| ⑦ Fuel injectors | ②⑨ Neutral position switch (MT vehicle only) |
| ⑧ Pressure regulator | ③⑩ CHECK ENGINE malfunction indicator lamp (MIL) |
| ⑨ Engine coolant temperature sensor | ③⑪ Tachometer |
| ⑩ Mass air flow sensor | ③⑫ A/C relay |
| ⑪ Pressure sensor | ③⑬ A/C control module |
| ⑫ Idle air control solenoid valve | ③⑭ Ignition switch |
| ⑬ Purge control solenoid valve | ③⑮ Vehicle speed sensor 2 |
| ⑭ Fuel pump | ③⑯ Data link connector |
| ⑮ Pressure sources switching solenoid valve | ③⑰ Tow way valve |
| ⑯ Air cleaner | ③⑱ Fuel cut valve |
| ⑰ Canister | ③⑲ Auxiliary purge control valve |
| ⑱ Main relay | ④① Air vent valve |
| ⑲ Fuel pump relay | ④② Wastegate control solenoid valve |
| ⑳ Fuel filter | ④③ Wastegate controller |
| ㉑ Front catalytic converter | ④④ Turbocharger |
| ㉒ Rear catalytic converter (Except Australia spec. vehicles) | ④⑤ Intercooler |

B: TURBO MODEL

- The positive crankcase ventilation (PCV) system is employed to prevent air pollution which will be caused by blow-by gas being emitted from the crankcase. The system consists of a sealed oil filler cap, rocker covers with fresh air inlet, connecting hoses, PCV valve and an air intake duct.
- At the part throttle, the blow-by gas in the crankcase flows into the intake manifold through the connecting hose of crankcase and PCV valve by the strong vacuum of the intake manifold. Under this condition, the fresh air is introduced into the crankcase through connecting hose of rocker cover.
- At wide open throttle, a part of blow-by gas flows into the air intake duct through the connecting hose and is drawn to the throttle chamber, because under this condition, the intake manifold vacuum is not so strong as to introduce all blow-by gases increasing with engine speed directly through the PCV valve.



- ① Air intake duct
- ② PCV valve
- ③ Intake manifold
- ④ Crankcase



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- ⑤ Case
- ⑥ Valve
- ⑦ Spring

4. Three-way Catalyst

- The basic material of three-way catalyst is platinum (Pt) and rhodium (Rh), and a thin film of their mixture is applied onto honeycomb or porous ceramics of an oval shape (carrier). To avoid damaging the catalyst, only unleaded gasoline should be used.
- The catalyst is used to reduce HC, CO and NO_x in exhaust gases, and permits simultaneous oxidation and reduction. To obtain an excellent purification efficiency on all components HC, CO and NO_x, a balance should be kept among the concentrations of the components. These concentrations vary with the air-fuel ratio.
- The air-fuel ratio needs to be controlled to a value within the very narrow range covering around the stoichiometric mixture ratio to purify the components efficiently.

5. A/F Control System

- The air/fuel control system compensates for the basic amount of fuel injection in response to a signal sent from the oxygen sensor to provide proper feedback control of the mixture. Thus, the theoretical air-fuel ratio is maintained to provide effective operation of the three-way catalyst. The basic amount of fuel injection is preset according to engine speed and loads, as well as the amount of intake air.
- This system also has a “learning” control function which stores the corrected data in relation to the basic amount of fuel injection in the memory map. A new air-fuel ratio correction is automatically added for quick response to the deviation of the air-fuel ratio. Thus, the air-fuel ratio is optimally maintained under various conditions while stabilizing exhaust gases, improving driving performance and compensating for changes in sensors’ performance quality with elapse of time.

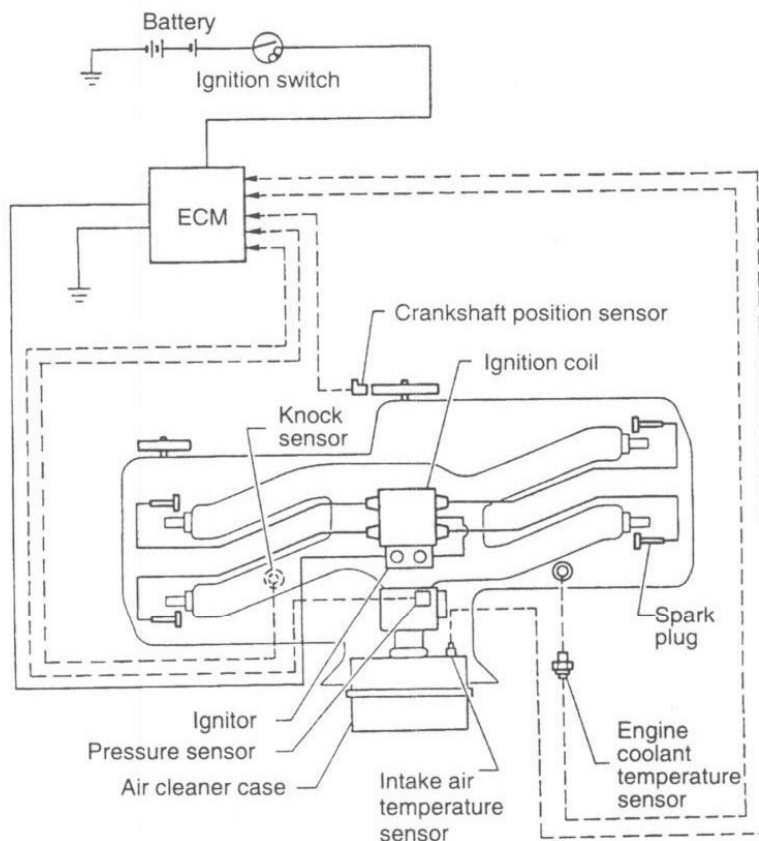
Refer to 2-7 “FUEL INJECTION SYSTEM”.

6. Ignition Control System

A: 1600 cc AND 1800 cc MODEL

- The ignition control system is controlled by the ECM. The ECM determines the optimal ignition timing according to signals sent from various sensors (which monitor the operating conditions of the engine), and sends a signal to the igniters.
- The ECM has a “closed-loop” control function with map which provides superb transient characteristics for responsive ignition timing control.

Refer to 2-7 “FUEL INJECTION SYSTEM”.



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1. Evaporative Emission Control System

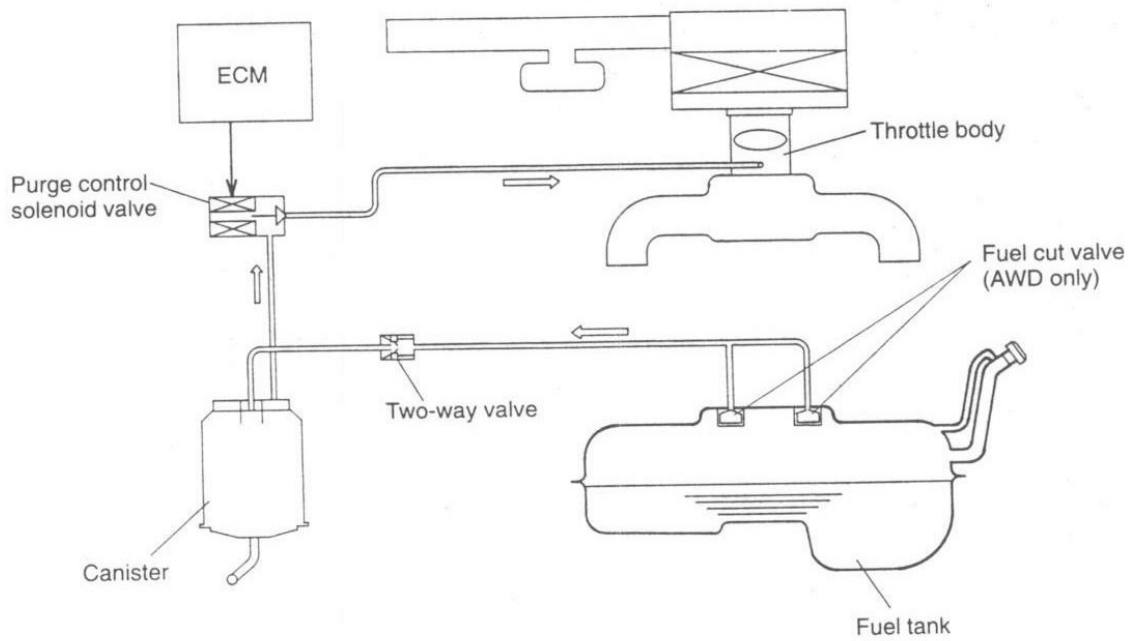
1. GENERAL

The evaporative emission control system is employed to prevent evaporative fuel from being discharged into ambient atmosphere. This system includes a canister, purge control solenoid valve, fuel cut valve, their connecting lines, etc.

Gasoline vapor evaporated from the fuel in the fuel tank is introduced into the canister located in the engine compartment through the evaporation line, and is absorbed on activated carbon in the canister.

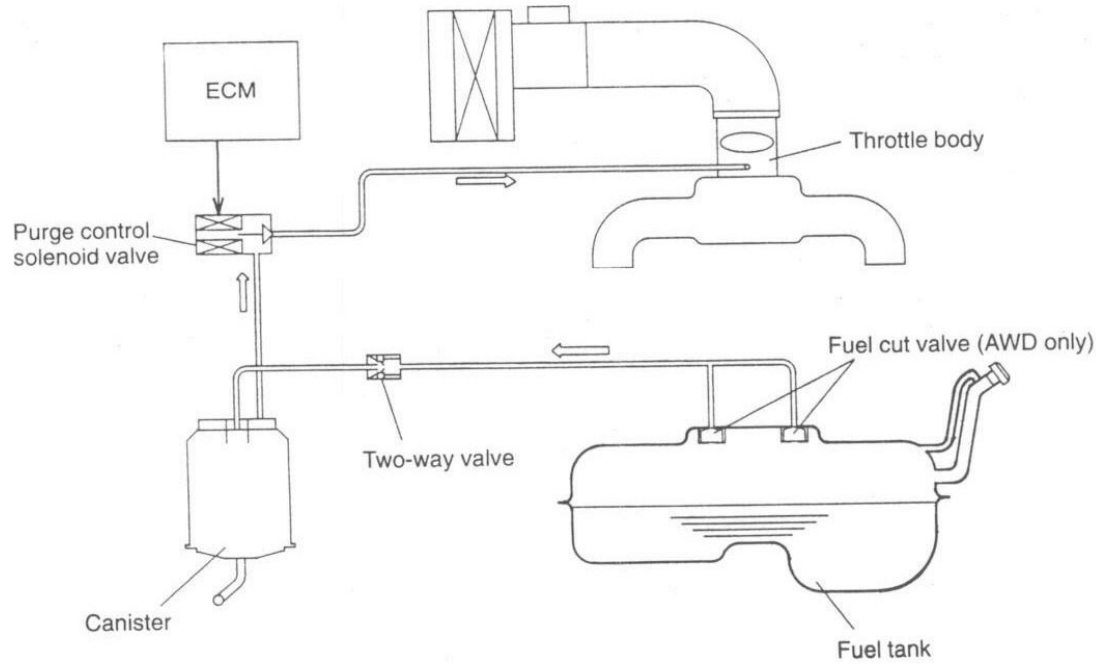
A fuel cut valve is also incorporated on the fuel tank line. The purge control solenoid valve is controlled by the ECM and provides optimal purge control according to the engine condition.

1. 1600 cc AND 1800 cc MODELS



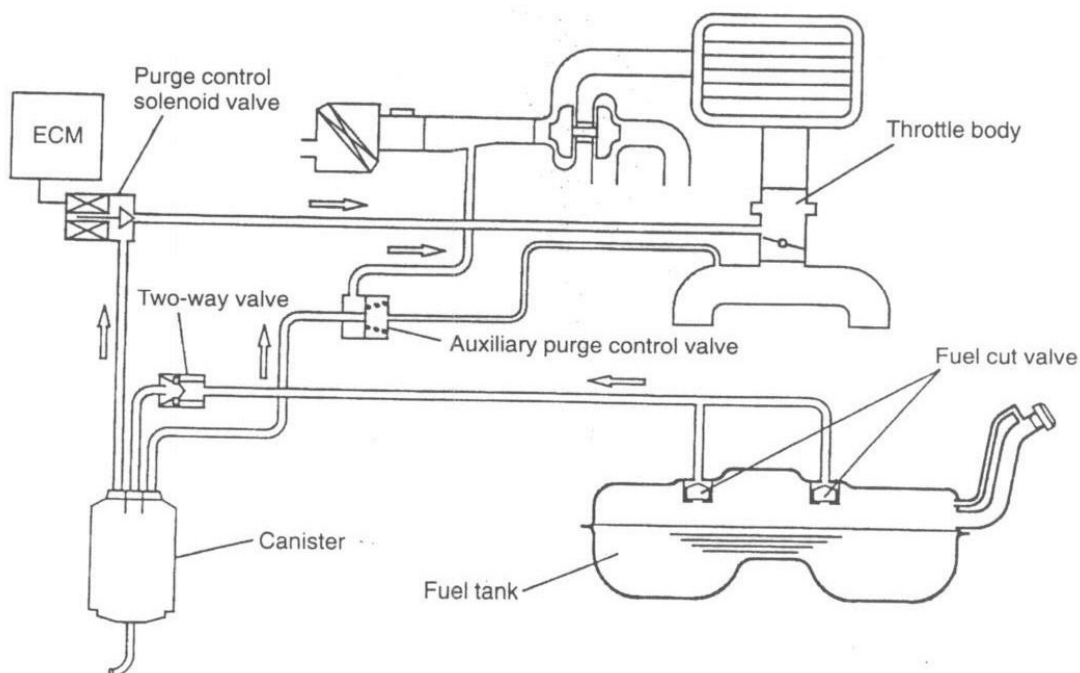
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2. 2000 cc NON-TURBO MODEL



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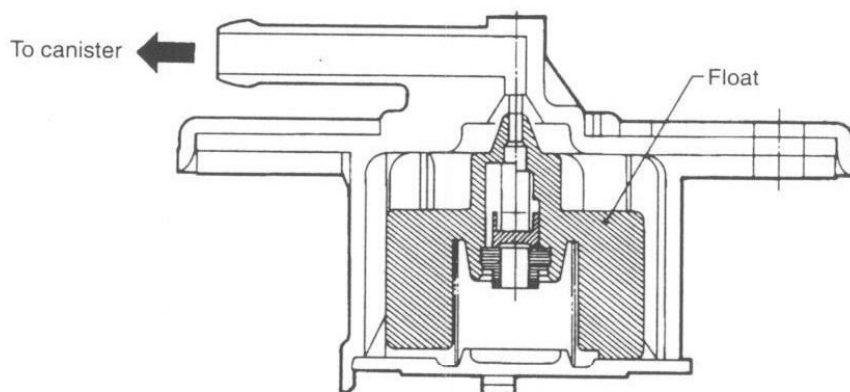
3. 2000 cc TURBO MODEL



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B: FUEL CUT VALVE

On AWD model, the fuel cut valve is built onto the evaporation pipe of the fuel tank cap. The rising level of the fuel from the fuel tank causes the float to move up and close the cap hole so that no fuel can enter during evaporation line.



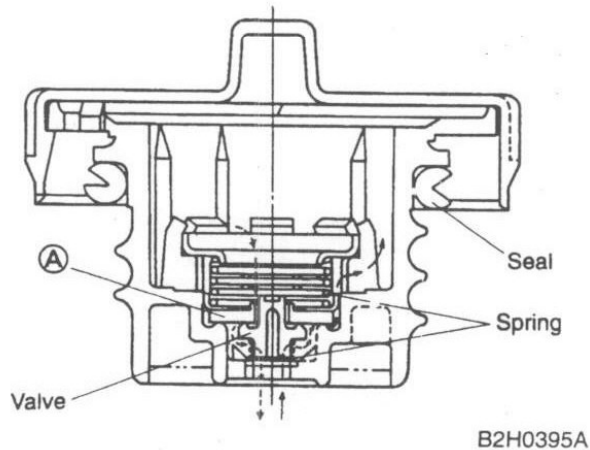
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C: FUEL CAP

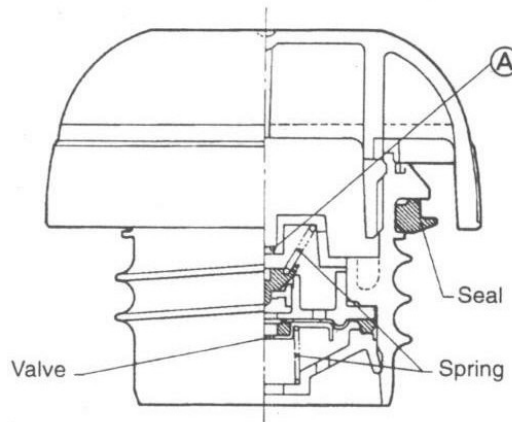
The relief valve is adopted to prevent the development of vacuum in the fuel tank which may occur in case of trouble in the fuel vapor line.

In normal condition, the filler pipe is sealed at ① and at the packing pressed against the filler pipe end. As vacuum develops in the fuel tank, atmospheric pressure forces the spring down to open the valve; consequently air is led into the fuel tank controlling the inside pressure.

1. UNLEADED GASOLINE SPEC. VEHICLES



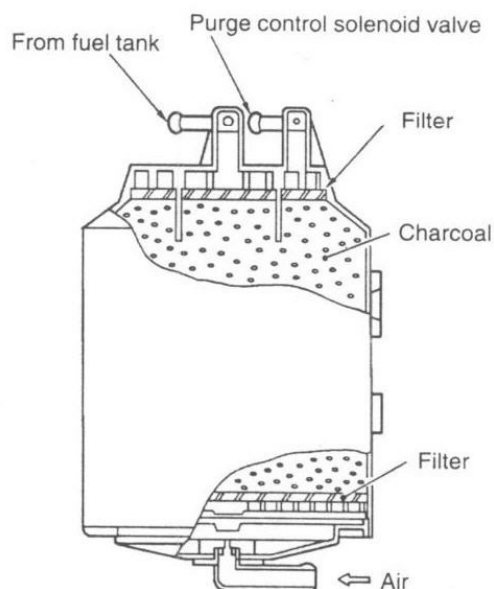
2. LEADED GASOLINE SPEC. VEHICLES



D: CANISTER

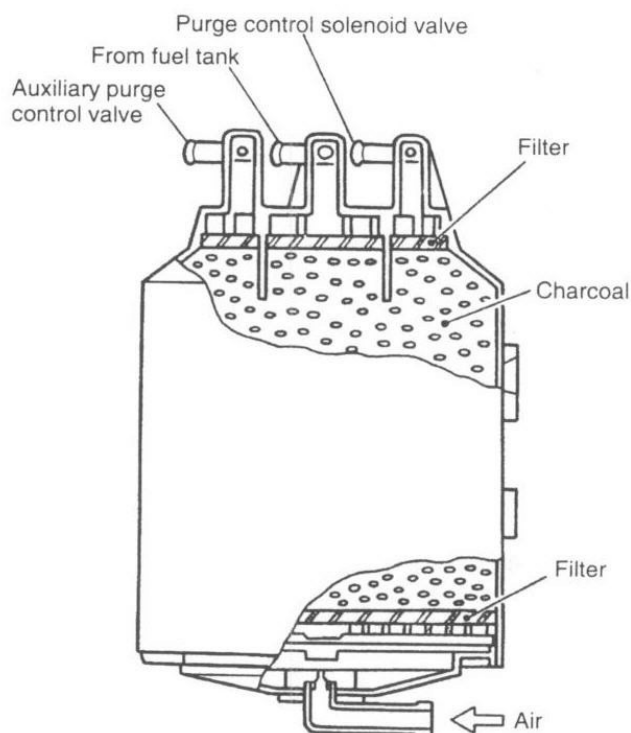
The canister temporarily stores the evaporation gas. When the purge control solenoid valve is opened from a signal sent from the ECM, the evaporation gas is sent into the collector chamber after being mixed with fresh external air.

1. NON-TURBO MODEL



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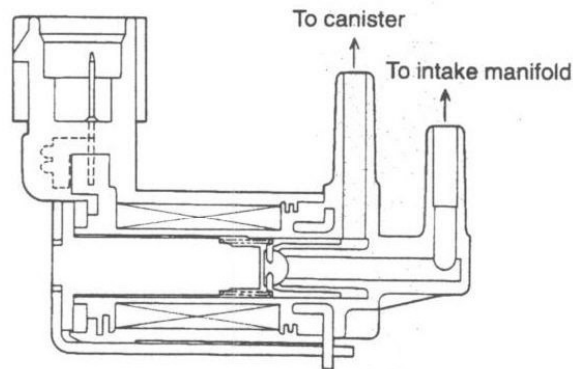
2. TURBO MODEL



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E: PURGE CONTROL SOLENOID VALVE

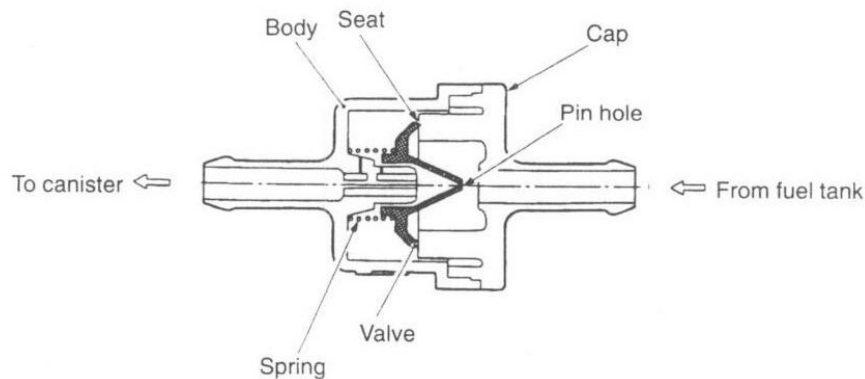
The purge control solenoid valve is on the evaporation line between canister and throttle body. It is built on the inside of intake manifold.



B2H0148

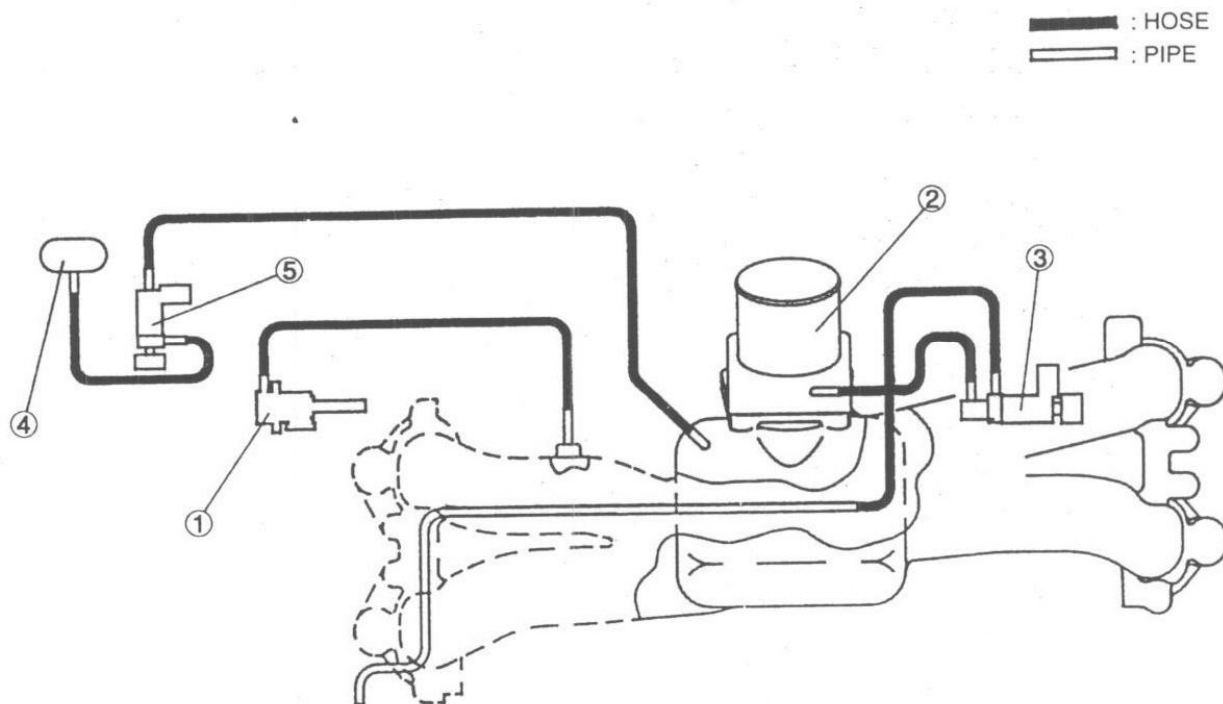
F: TWO-WAY VALVE

- The two-way valve is located in the evaporation line between the fuel tank and canister. When evaporation gas pressure in fuel tank exceeds the specified value, the valve is pressurized to push the spring. This lifts the valve seat so that evaporative gas is discharged to the canister.
- When evaporation gas pressure in fuel tank drops specified value, the valve move to close the valve seat. However, air which enters from the inlet port of the canister is introduced into the fuel tank through the pin hole located at end of the valve.



G2H0003

C: 2000 cc TURBO MODEL



FRONT OF VEHICLE

H2H1856A

- ① Pressure regulator
- ② Throttle body
- ③ Purge control solenoid valve
- ④ Pressure sensor
- ⑤ Pressure sources switching solenoid valve

SERVICE MANUAL



SUBARU IMPREZA



ENGINE SECTION

Technical description

• Mechanism and function

ENGINE (DOHC)

2-3b

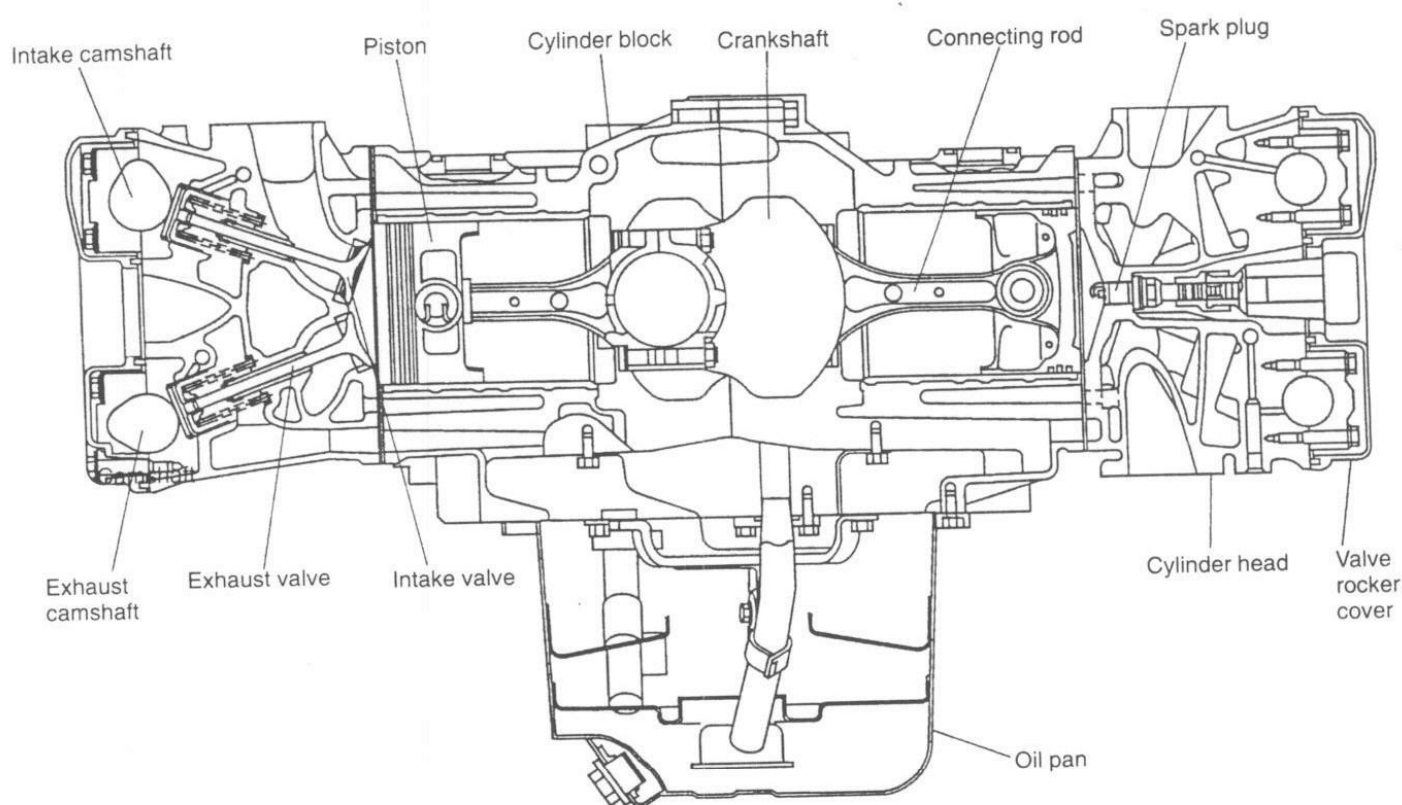
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1. General

The engine is made from aluminum alloy and is horizontally opposed, it is a 4-stroke cycle, water-cooled, DOHC 16-valve, turbocharged engine. The fuel injection system utilizes an MFI design.

A summary of the major construction and function features is as follows:

- The cylinder head is a center-plug type that utilizes pentroof combustion chambers. The four-valve design is provided with two intake valves and two exhaust valves per cylinder. The intake and exhaust ports are arranged in a cross-flow design.
- A single timing belt drives four camshafts on the left and right banks and the water pump on the left bank. Belt tension is automatically adjusted to eliminate maintenance.
- The crankshaft is supported by five bearings to provide high rigidity and strength.
- The cylinder block is made from aluminum diecast which is integrated with cast-iron cylinder liners.



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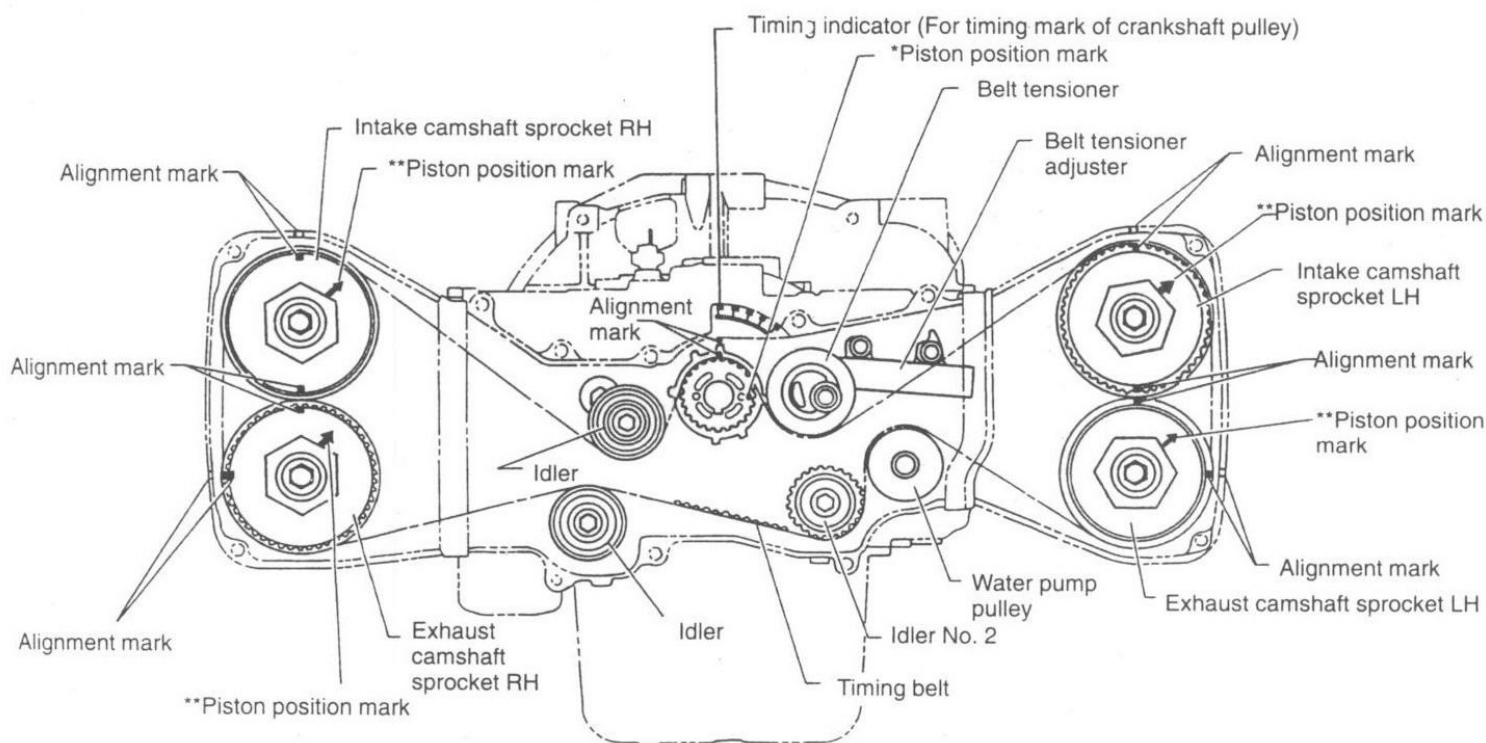
2. Timing Belt

A single timing belt drives four camshafts (intake and exhaust camshafts on each bank). The back of the belt also drives the water pump.

The timing belt teeth have a specially designed round profile to provide quiet operation. The timing belt is composed of a strong and inflexible core wire, a wear-resistant canvas and heat-resistant rubber material.

A hydraulic belt-tensioner adjuster constantly maintains specified belt tension to properly drive the camshafts, as well as to provide a "maintenance-free" advantage.

The camshaft sprocket is made of resin. Compared with the alloy type one, it is lighter in weight.



B2H0716B

NOTE:

*: #1 piston is set at TDC when piston-position mark on crankshaft sprocket is aligned with mark on cylinder block.

**: #1 piston is set at TDC on compression stroke when piston-position mark on camshaft sprocket is facing directly upward.

3. Belt Tensioner Adjuster

The belt tensioner adjuster provides a constant value of tension for the timing belt. Proper belt tension is maintained using an adjuster rod to push the timing belt via tensioner pulley. The location of the tensioner pulley shaft center is offset in relation to the center of the pulley's outside diameter. The adjuster rod provides a rotary movement for the tensioner pulley by both tension of the spring housed in the adjuster.

- Belt tension action

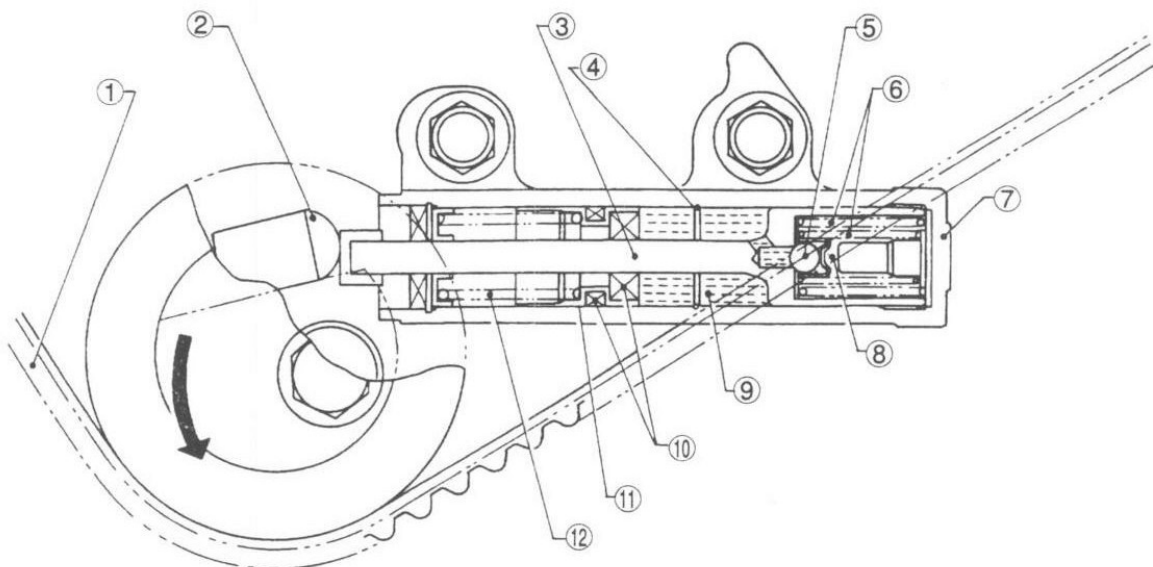
The adjuster rod is moved to the left by the force of the main spring. This causes silicone oil (which is held to constant pressure by compression-spring tension inside the reservoir chamber) to push the check ball so that silicone oil flows into the oil-pressure chamber.

The momentum which forces the adjuster rod out acts upon the tensioner arm so that the pulley is turned counterclockwise. Thus, timing belt tension is properly maintained.

- Balance to belt tension

When the timing belt reaction force is balanced by the main spring tension (to push the adjuster rod), the arm is held stationary to maintain constant belt tension.

When the timing belt reaction force increases to such an extent that the belt will be too tight, a small quantity of oil in the oil-pressure chamber gradually returns to the reservoir chamber via the adjuster body-to-rod clearance. This return of oil continually moves the rod until the reaction force of the timing belt balances with main spring force and oil pressure inside the oil-pressure chamber. Thus, belt tension is constantly maintained.



- ① Timing belt
- ② Tension arm
- ③ Adjuster rod
- ④ Stopper

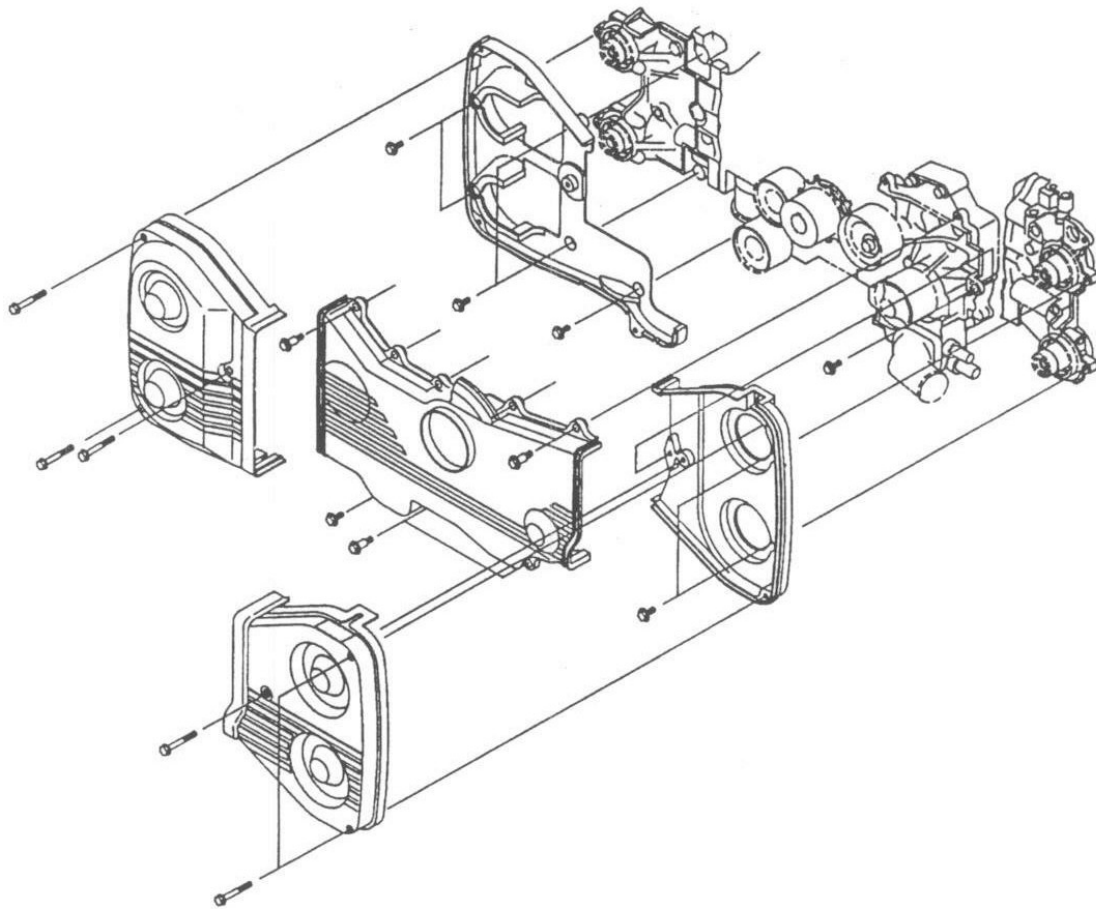
- ⑤ Check ball
- ⑥ Main spring
- ⑦ Adjuster body
- ⑧ Oil pressure chamber

- ⑨ Oil pressure chamber (Silicone oil)
- ⑩ Oil seal
- ⑪ Piston
- ⑫ Compression spring

G2H0015

4. Belt Cover

- The belt cover is made of synthetic resin molding which is lightweight and heat resistant. It has a totally enclosed design that utilizes rubber packing at the mating surface of the cylinder block. This eliminates the chance of dust and liquid from entering the interior.
- A floating design is utilized by placing rubber mounting between the cylinder block and belt cover to prevent the transmission of noise and vibration.
- The front belt cover has a graduated line for ignition-timing confirmation.



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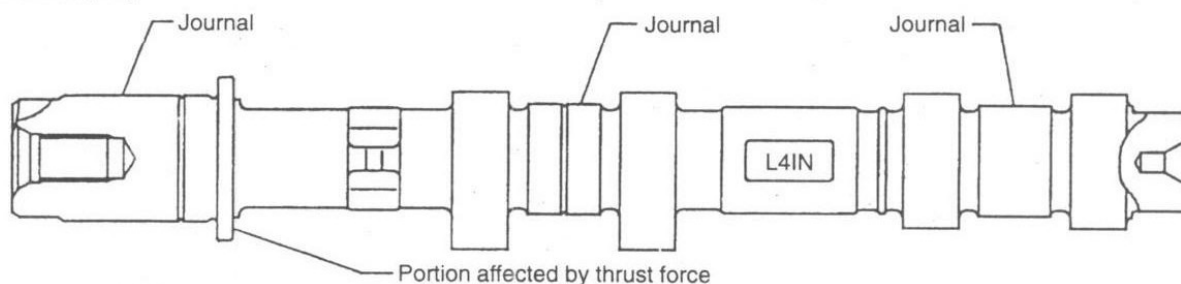
5. Camshaft

The DOHC engine uses four camshafts in all; intake and exhaust camshafts on the RH bank and intake and exhaust camshafts on the LH bank.

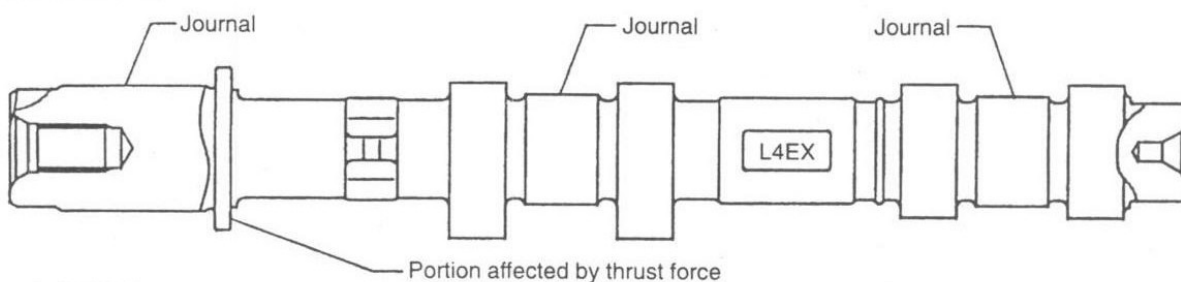
The cam nose part is finished with "chill" treatment to increase wear resistance and anti-scuffing properties.

Each camshaft is supported by three journals with three camshaft caps. Each camshaft flange is supported by a groove provided in the cylinder head to receive thrust force.

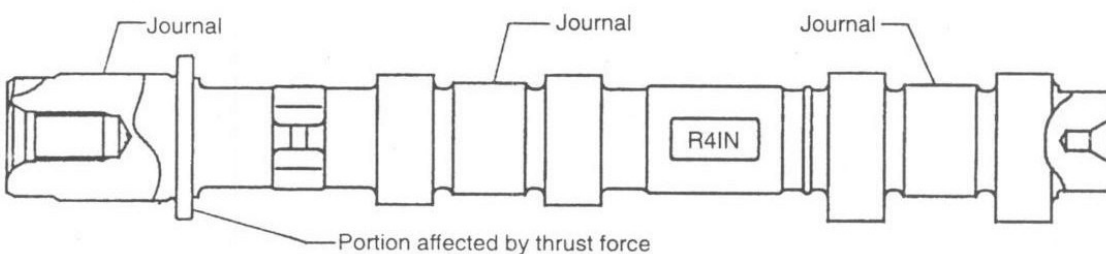
Intake camshaft (LH)



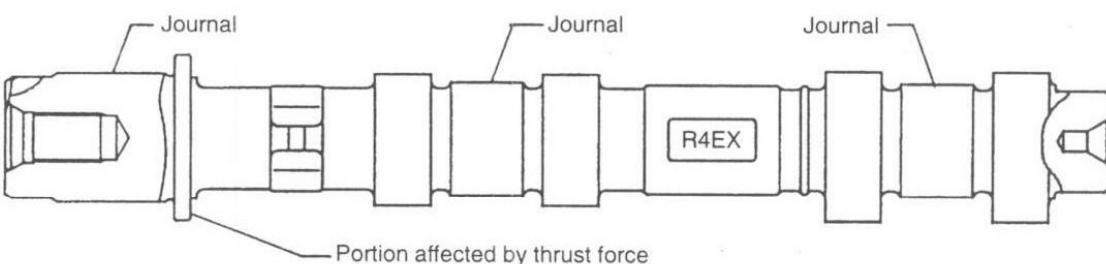
Exhaust camshaft (LH)



Intake camshaft (RH)



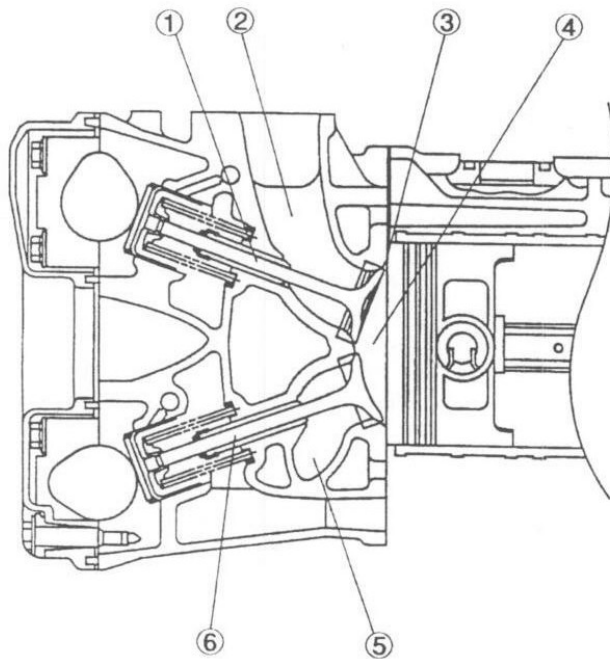
Exhaust camshaft (RH)



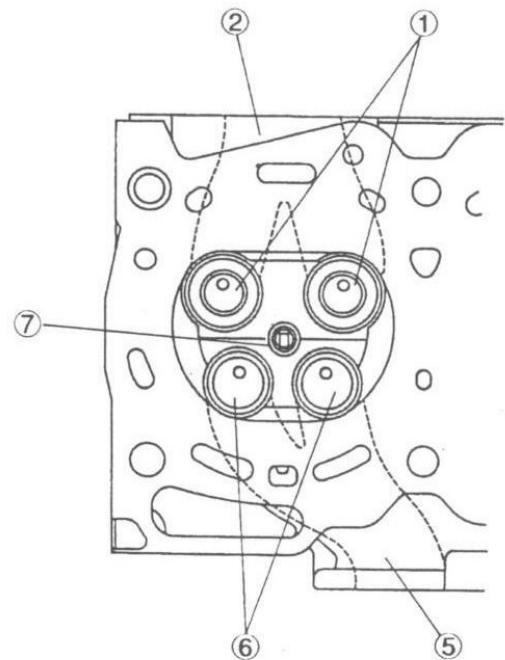
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6. Cylinder Head

- The cylinder head is made from aluminium die casting.
- Combustion chamber in the cylinder head is a compact, pentroof design and spark plug is located at the center of combustion chamber which feature a wide "squish" area for increased combustion efficiency.
- Four valves (two intake and two exhaust), which are arranged in a cross-flow design, are used per cylinder.
- The cylinder head gasket is a metallic one consisting of three layers of the stainless steel sheets. It has better heat resistance and gas sealability and higher reliability.



- ① Intake valve
- ② Intake port
- ③ Squish area
- ④ Combustion chamber



- ⑤ Exhaust port
- ⑥ Exhaust valve
- ⑦ Spark plug

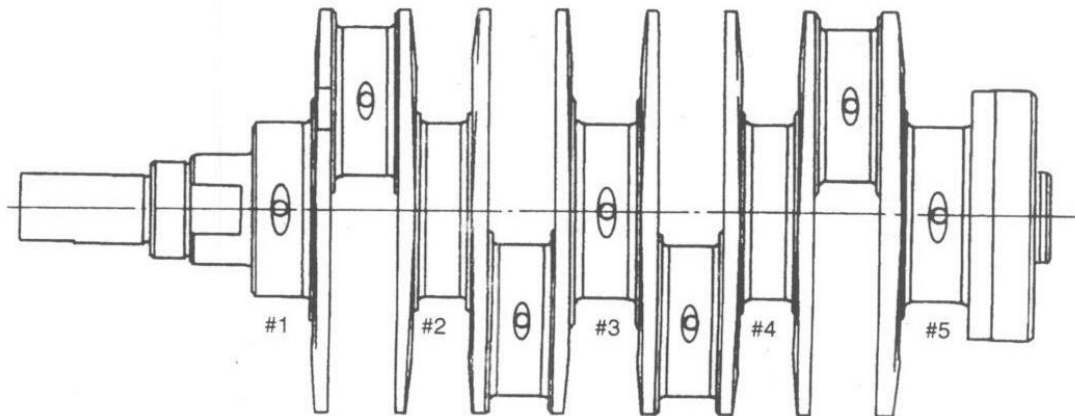
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7. Cylinder Block

- The cylinder block is made from aluminum die casting. The cylinder perimeter has an open-deck design which is lightweight, highly rigid and has superb cooling efficiency.
- The cylinder liners are made from cast iron and are dry types which are totally cast with aluminum cylinder block. Five main journal block designs are employed to increase stiffness and quiet operation.
- The oil pump is located in the front center of the cylinder block and the engine coolant pump is located at the front of the right-cylinder bank. At the rear of the right-cylinder block is a separator which eliminates oil mist contained in the blow-by gas.

8. Crankshaft

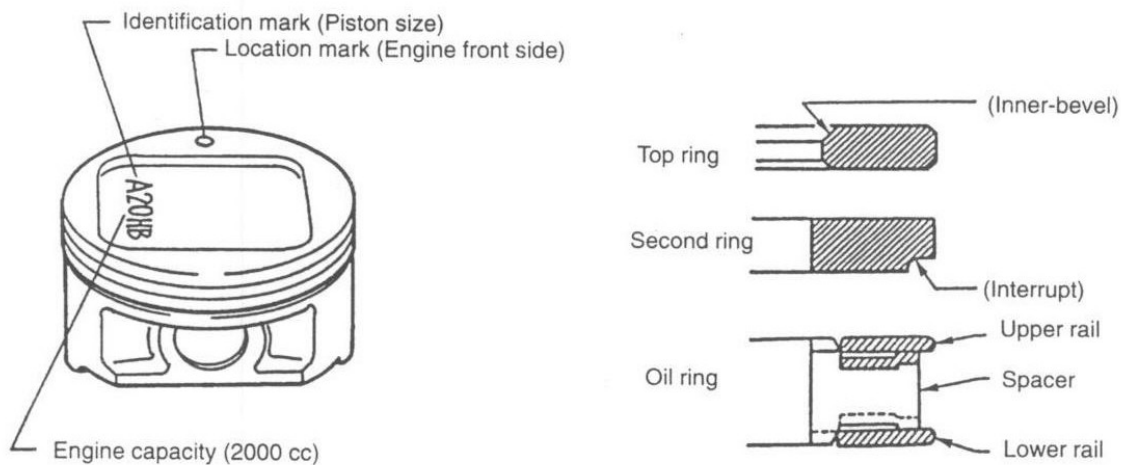
The crankshaft is supported by five bearings to provide high rigidity and strength. The corners of the crankshaft journals and webs, as well as the crank pins and webs, are finished with fillet-roll work to increase stiffness. The five crankshaft bearings are made from aluminum alloy and the No. 3 bearing is provided with a flanged metal to receive thrust force.



G2H0020

9. Piston

- The piston skirt has a “slipper” design to reduce weight and sliding. The oil control ring groove utilizes a slit design.
- The piston pin is located in an offset position. The Nos. 1 and 3 pistons are offset in the lower direction while the Nos. 2 and 4 pistons are offset in the upper direction.
- The piston head is recessed for both the intake and exhaust valves. It also has symbols used to identify the location and the direction of installation.
- Three piston rings are used for each piston—two compression rings and one oil ring. The top piston ring has an inner-bevel design and the second piston ring has an interrupt design to reduce oil consumption.



H2H1725A

ENGINE COOLING SYSTEM

2-5

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1. General

- The engine cooling system consists of a down-flow radiator which features high heat-dissipation performance, an electric motor fan, a water pump, a thermostat, and an engine coolant temperature sensor.
- The reserve tank is designed to eliminate the need for replenishing coolant.
- On models without an air conditioner, the ECM or ECM/TCM sends an ON or OFF switch signal to the radiator fan in response to signals from the engine coolant temperature sensor. On models with an air conditioner, the ECM or ECM/TCM sends ON or OFF (and LO or HI: Turbo model) switch signals to the radiator main fan and sub fan in response to signals from the engine coolant temperature sensor, vehicle speed sensor 2 and A/C switch.

2. Cooling Lines

This cooling system operates in three steps depending on the temperature of the engine coolant flowing through the cooling circuit.

- 1st step ... With thermostat closed

At the engine coolant temperature of below 76°C (169°F), the thermostat remains closed and the engine coolant flows through the bypass and heater circuits.

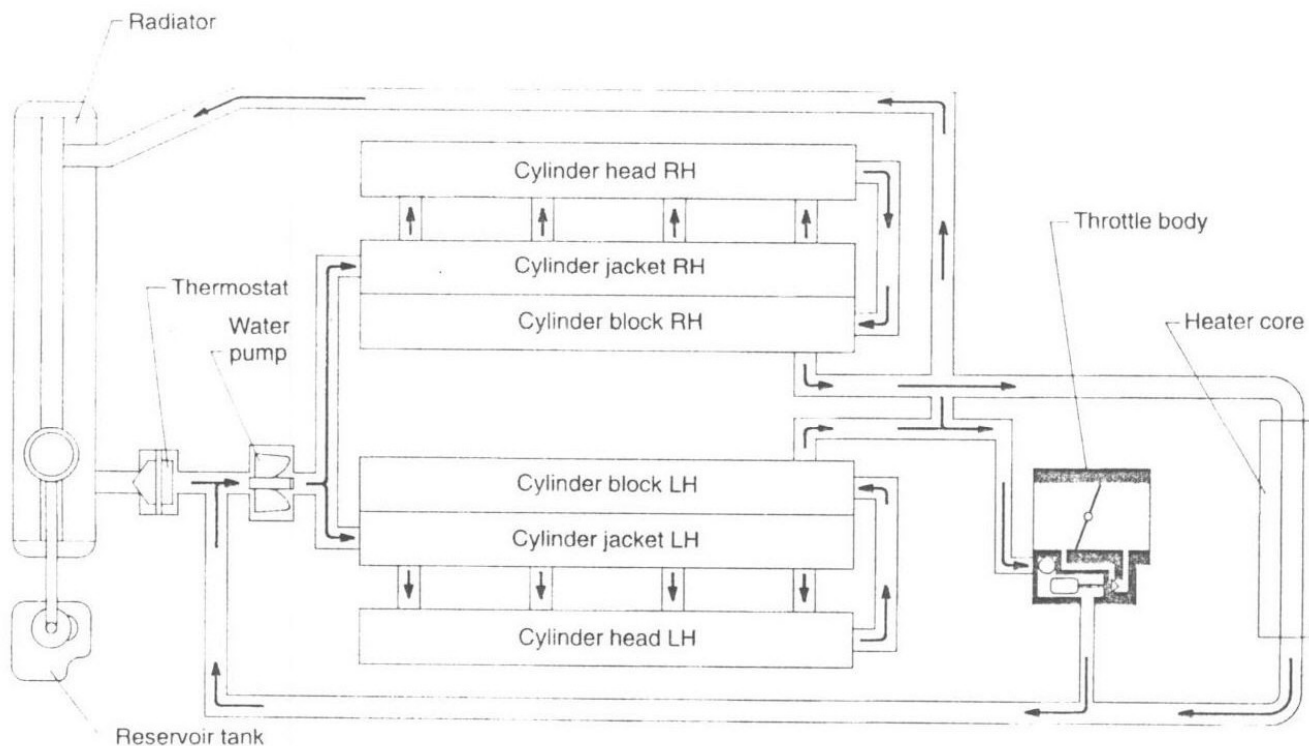
This permits the engine to warm up quickly.

- 2nd step ... With thermostat opened

When the engine coolant temperature is above 76 – 80°C (169 – 176°F), the thermostat opens and the engine coolant flows through the radiator where it is cooled.

- 3rd step ... With radiator fan operating

When the engine coolant temperature rises above 95°C (203°F), the ECM or ECM/TCM sends ON signal to the radiator fan in response to signal from the engine coolant temperature sensor and the radiator fan rotates.

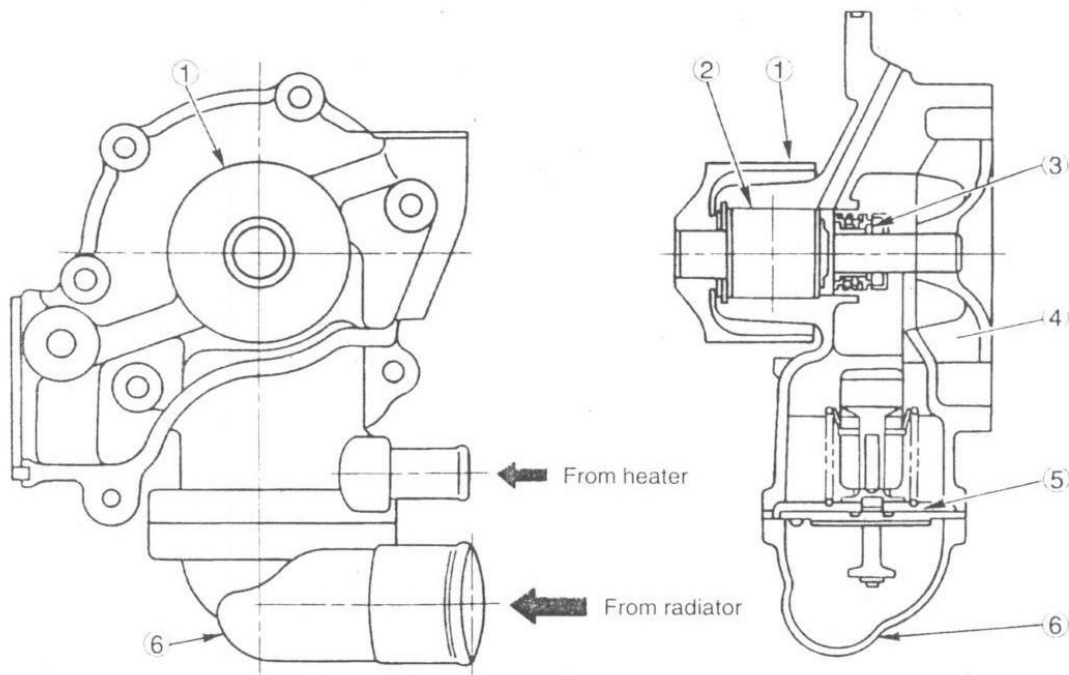


3. Water Pump

A: MECHANISM

The water pump is located on the left front portion of the cylinder block and is driven by the timing belt. The thermostat is built into the engine coolant inlet located on the lower side of the water pump. When the impeller rotates, engine coolant is drawing into the water pump from the lower pipe (which is connected to the radiator hose) via the thermostat. It then flows along the perimeter of the impeller and is delivered to the engine's engine coolant passage.

B: NON-TURBO MODEL



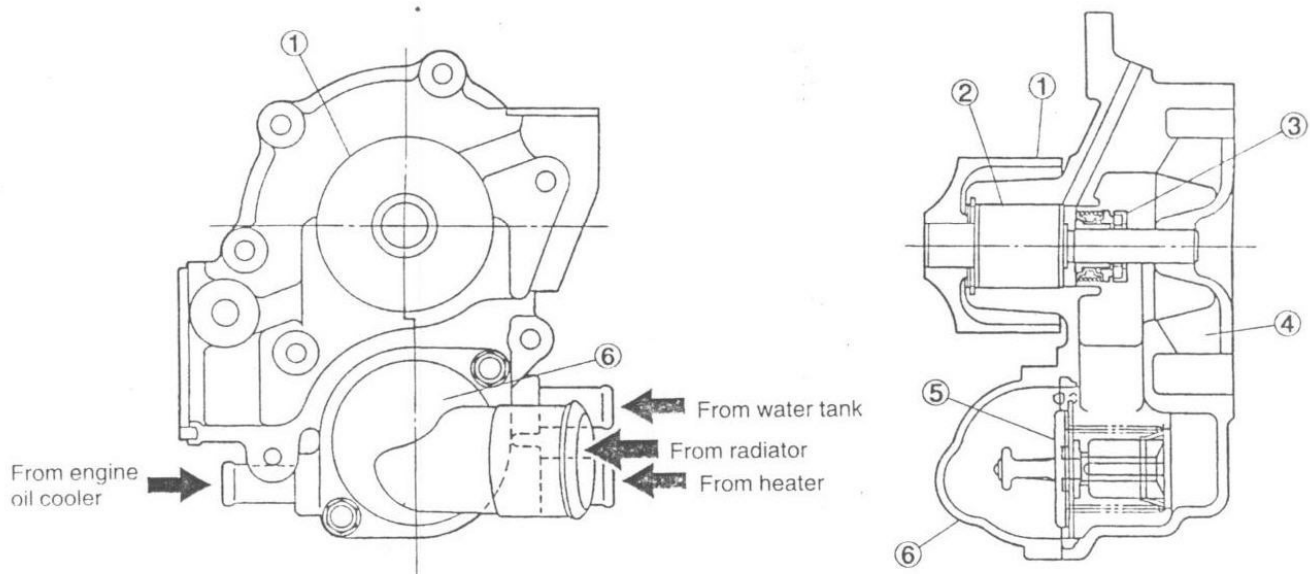
G2H0028

- 1 Pulley
- 2 Ball bearing

- 3 Mechanical seal
- 4 Impeller

- 5 Thermostat
- 6 Thermostat case

C: TURBO MODEL



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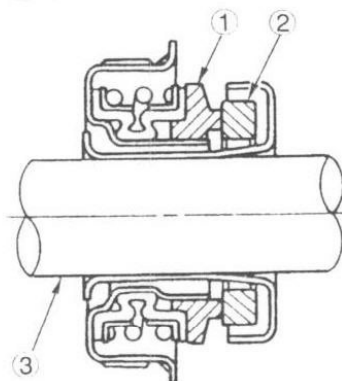
- ① Pulley
- ② Ball bearing

- ③ Mechanical seal
- ④ Impeller

- ⑤ Thermostat
- ⑥ Thermostat case

4. Mechanical Seal

The mechanical seal has its seat pressed into the water pump shaft to form the seal and water pump as a single unit. With this design, the water pump cannot be disassembled.

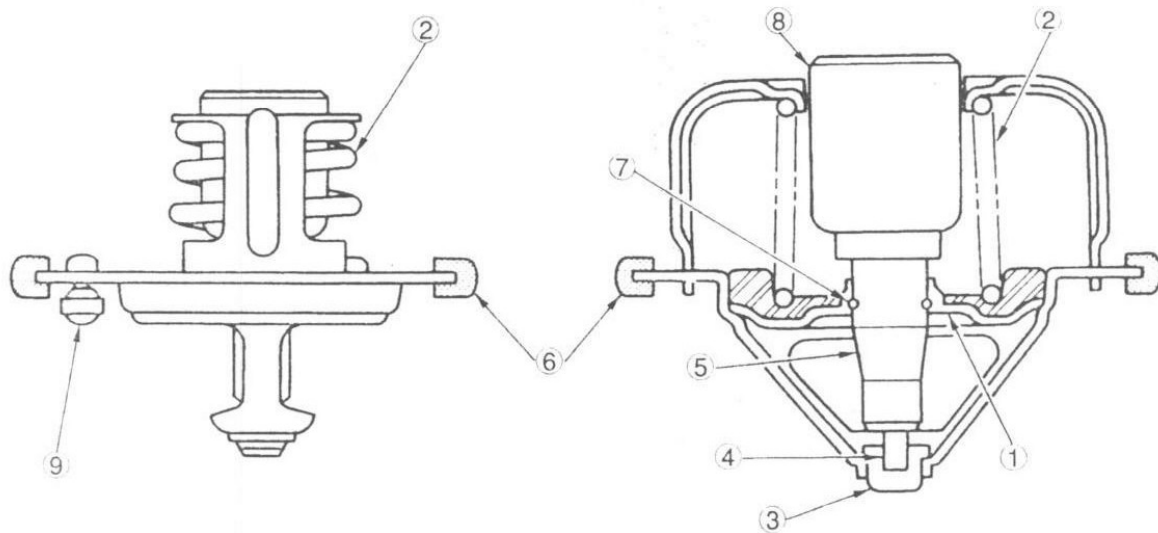


G2H0029

- ① Carbon seal
- ② Ceramics seat
- ③ Water pump shaft

5. Thermostat

The thermostat is powered to open the valve by a totally-enclosed wax pellet which expands with increased temperature. It provides the sure open-close operation of the valve and features high durability.



- 1 Valve
- 2 Spring
- 3 Stopper

- 4 Piston
- 5 Guide
- 6 Gum packing

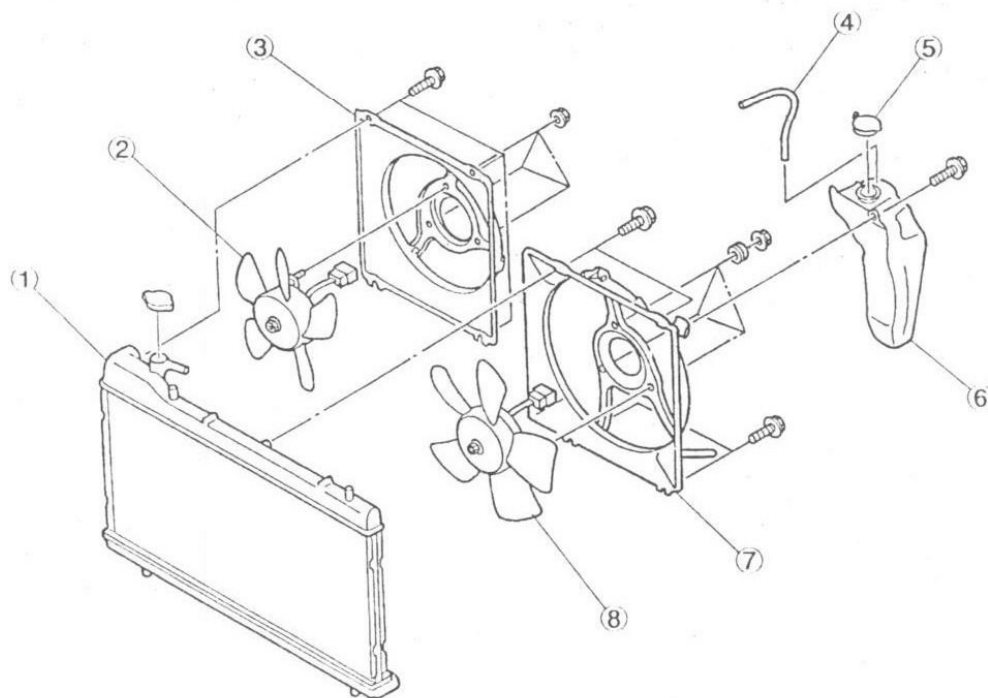
- 7 Stop ring
- 8 Wax element
- 9 Jiggle valve

G2H0030

6. Radiator Fan

A: DESCRIPTION

- The radiator fan is made of plastic. That is installed to the electric motor, and is located onto radiator straight by shroud.
- The vehicle without air conditioning has the radiator main fan only. Thus, the vehicle with air conditioning has the radiator sub fan, too.



H2H1702A

- 1 Radiator
- 2 Radiator sub fan & motor
- 3 Radiator sub fan shroud
- 4 Over flow hose

- 5 Reservoir tank cap
- 6 Reservoir tank
- 7 Radiator main fan shroud
- 8 Radiator main fan & motor

B: FUNCTION**1. WITHOUT A/C MODEL**

The ON-OFF (and Hi-Low: Turbo model) control of the radiator fan is governed by the ECM or ECM/TCM which receives signals sent from the engine coolant temperature sensor.

Non-turbo model

Vehicle speed	Engine coolant temperature		
	Less than 95°C (Less than 203°F)	Between 95 and 99°C (Between 203 and 210°F)	More than 100°C (More than 212°F)
	Operation of radiator main fan	Operation of radiator main fan	Operation of radiator main fan
Less than 19 km/h (Less than 12 MPH)	OFF	ON	ON
Between 20 and 69 km/h (Between 12 and 43 MPH)	OFF	ON	ON
Between 70 and 89 km/h (Between 43 and 55 MPH)	OFF	OFF	ON
More than 90 km/h (More than 56 MPH)	OFF	OFF	ON

Turbo model

Vehicle speed	Engine coolant temperature		
	Less than 92°C (Less than 198°F)	Between 92 and 95°C (Between 198 and 203°F)	More than 96°C (More than 205°F)
	Operation of radiator main fan	Operation of radiator main fan	Operation of radiator main fan
Less than 19 km/h (Less than 12 MPH)	OFF	OFF	Low
Between 20 and 69 km/h (Between 12 and 43 MPH)	OFF	OFF	Hi
Between 70 and 105 km/h (Between 43 and 65 MPH)	OFF	OFF	Hi
More than 106 km/h (More than 66 MPH)	OFF	OFF	Hi

2. WITH A/C MODEL

On models which are equipped with an air conditioning system, the ECM or ECM/TCM receives signals sent from the engine coolant temperature sensor, vehicle speed sensor 2 and A/C switch. These signals simultaneously turn ON or OFF (and Hi or Low: Turbo model) the radiator main fan and radiator sub fan.

Non-turbo model

Vehicle speed	A/C compressor	Engine coolant temperature					
		Less than 95°C (Less than 203°F)		Between 95 and 99°C (Between 203 and 210°F)		More than 100°C (More than 212°F)	
		Operation of radiator fan		Operation of radiator fan		Operation of radiator fan	
		Main	Sub	Main	Sub	Main	Sub
Less than 19 km/h (Less than 12 MPH)	OFF	OFF	OFF	ON	OFF	ON	ON
	ON	ON	ON	ON	ON	ON	ON
Between 20 and 69 km/h (Between 12 and 43 MPH)	OFF	OFF	OFF	ON	OFF	ON	ON
	ON	ON	ON	ON	ON	ON	ON
Between 70 and 89 km/h (Between 43 and 55 MPH)	OFF	OFF	OFF	OFF	OFF	ON	ON
	ON	ON	OFF	ON	ON	ON	ON
More than 90 km/h (More than 56 MPH)	OFF	OFF	OFF	OFF	OFF	ON	ON
	ON	OFF	OFF	ON	OFF	ON	ON

Turbo model

Vehicle speed	A/C compressor	Engine coolant temperature					
		Less than 92°C (Less than 198°F)		Between 92 and 95°C (Between 198 and 203°F)		More than 96°C (More than 205°F)	
		Operation of radiator fan		Operation of radiator fan		Operation of radiator fan	
		Main	Sub	Main	Sub	Main	Sub
Less than 19 km/h (Less than 12 MPH)	OFF	OFF	OFF	OFF	OFF	Low	Low
	ON	Low	Low	Hi	Hi	Hi	Hi
Between 20 and 69 km/h (Between 12 and 43 MPH)	OFF	OFF	OFF	OFF	OFF	Hi	Hi
	ON	Hi	Hi	Hi	Hi	Hi	Hi
Between 70 and 105 km/h (Between 43 and 65 MPH)	OFF	OFF	OFF	OFF	OFF	Hi	Hi
	ON	Low	Low	Low	Low	Hi	Hi
More than 106 km/h (More than 66 MPH)	OFF	OFF	OFF	OFF	OFF	Hi	Hi
	ON	OFF	OFF	Low	OFF	Hi	Hi

1. General

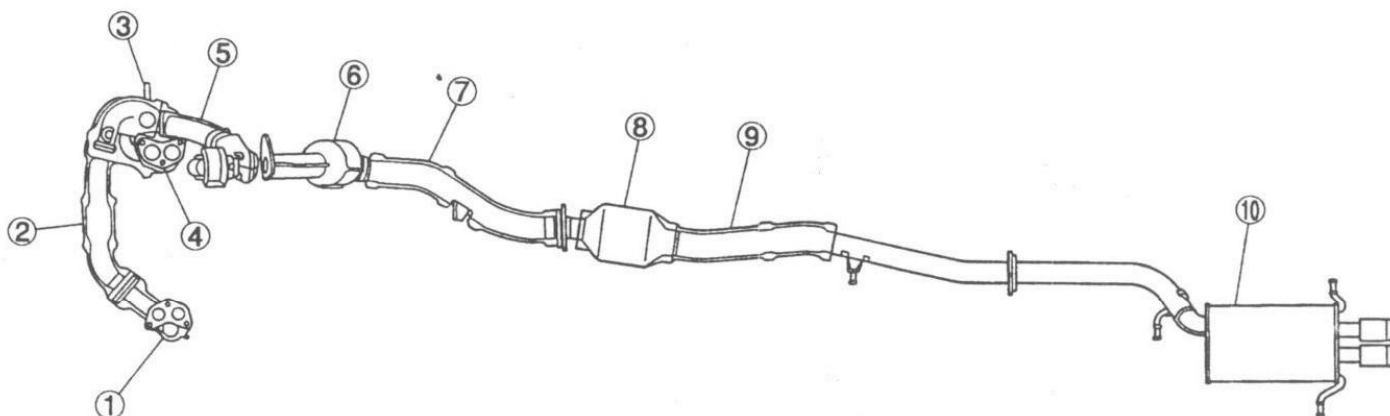
A: NON-TURBO MODEL

- The exhaust system consists of a front exhaust pipe, a front catalytic converter, a center exhaust pipe, a rear exhaust pipe and a muffler. The front catalytic converter is located immediately behind the front exhaust pipe, and the rear catalytic converter is incorporated in the center exhaust pipe.
- *The exhaust system features an improved sound suppression design; the two branches of the front exhaust pipe join at a point almost equal in distance from the engine's exhaust ports and the rear exhaust pipe has a resonance chamber in addition to a muffler of 13 liters (793.3 cu in) capacity.*

B: TURBO MODEL

- The exhaust system consists of a exhaust manifold LH and RH, a front joint pipe, a turbocharger joint pipe, a center exhaust pipe, a rear exhaust pipe and a muffler. The front catalytic converter is incorporated in the center exhaust pipe, and the rear catalytic converter is incorporated in the rear exhaust pipe.
- The exhaust system features an improved sound suppression design; the rear exhaust pipe has a resonance chamber in addition to a muffler of 14 liters (854.3 cu in) capacity.

B: TURBO MODEL



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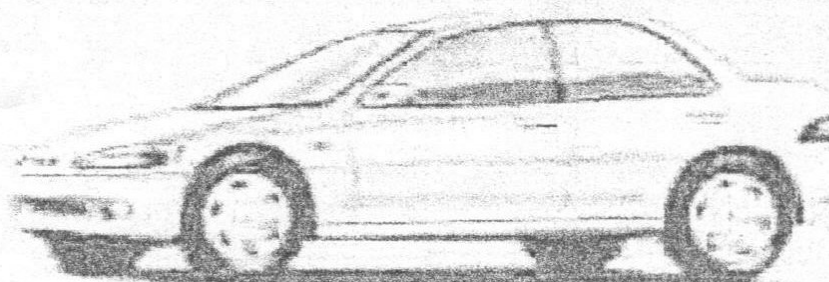
- ① Exhaust manifold LH
- ② Front joint pipe
- ③ Oxygen sensor
- ④ Exhaust manifold RH
- ⑤ Turbocharger joint pipe

- ⑥ Front catalytic converter
- ⑦ Center exhaust pipe
- ⑧ Rear catalytic converter
- ⑨ Rear exhaust pipe
- ⑩ Muffler

SERVICE MANUAL



SUBARU IMPREZA



FUEL INJECTION SYSTEM
(TURBO MODEL)

2-7c

SERVICE MANUAL

• Diagnostics section

FUEL INJECTION SYSTEM [TURBO MODEL]

2-7c

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1. General

- The Multipoint Fuel Injection (MFI) system is a system that supplies the optimum air-fuel mixture to the engine for all the various operating conditions through the use of the latest electronic technology.

With this system fuel, which is pressurized at a constant pressure, is injected into the intake air passage of the cylinder head. The injection quantity of fuel is controlled by an intermittent injection system where the electro-magnetic injection valve (fuel injector) opens only for a short period of time, depending on the quantity of air required for one cycle of operation. In actual operation, the injection quantity is determined by the duration of an electric pulse applied to the fuel injector and this permits simple, yet highly precise metering of the fuel.

- Further, all the operating conditions of the engine are converted into electric signals, and this results in additional features of the system, such as large improved adaptability, easier addition of compensating element, etc.
- The MFI system also has the following features:
 - Reduced emission of harmful exhaust gases.
 - Reduced in fuel consumption.
 - Increased engine output.
 - Superior acceleration and deceleration.
 - Superior startability and warm-up performance in cold weather since compensation is made for coolant and intake air temperature.
 - Suitable to turbocharged engine.

2. Air Line

A: GENERAL

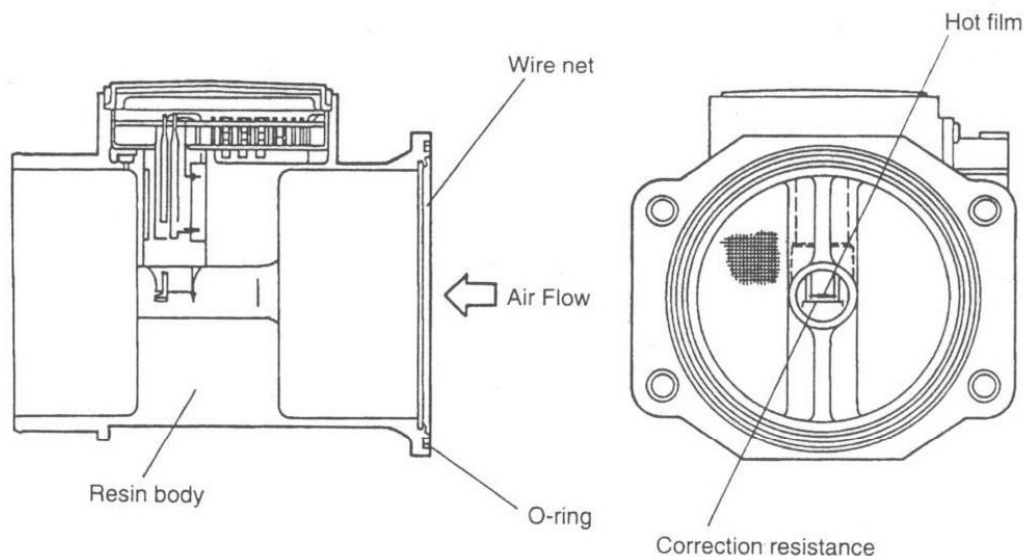
Air which is drawn in and filtered by the air cleaner is metered by the mass air flow sensor. Air is supercharged by the turbocharger and cooled down by the intercooler, and sent to the throttle body. From the throttle body, the air is regulated by the open-close operation of the throttle valve and is delivered to the intake manifold. It is then distributed to the respective cylinders to mix with fuel injected by the fuel injectors. Thus, the air-fuel mixture is delivered into the cylinder. Part of the air branched at the upstream of the throttle body is sent to the idle air control solenoid valve which regulates engine idle speed.

B: MASS AIR FLOW SENSOR

- The MFI system employs a hot-film type mass air flow sensor.

These mass air flow sensors convert the amount of air taken into the engine into an electric signal by utilizing the heat transfer phenomenon between the incoming air and a heating resistor (hot film) located in the air intake.

- The features of these flow sensor types are as follows:
 - High-altitude compensation is made automatically.
 - Quick response.
 - These are no moving parts.
 - They are compact.



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C: THROTTLE BODY

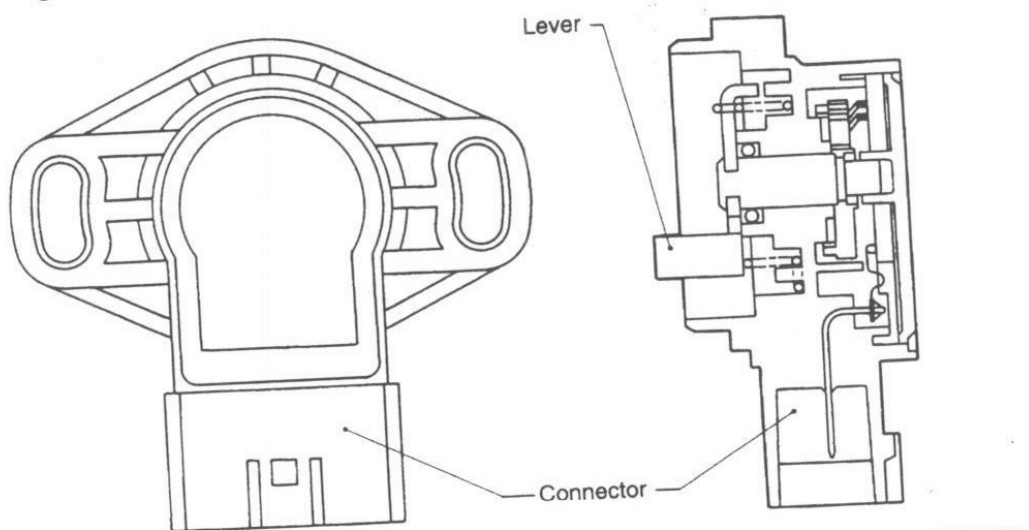
In response to the depressing stroke of the throttle pedal, the throttle body opens/closes its valve to regulate the air volume to be taken in the combustion chamber.

During idling, the throttle valve is almost fully closed and the air flow through the throttle body is less than that passing through the carburetor.

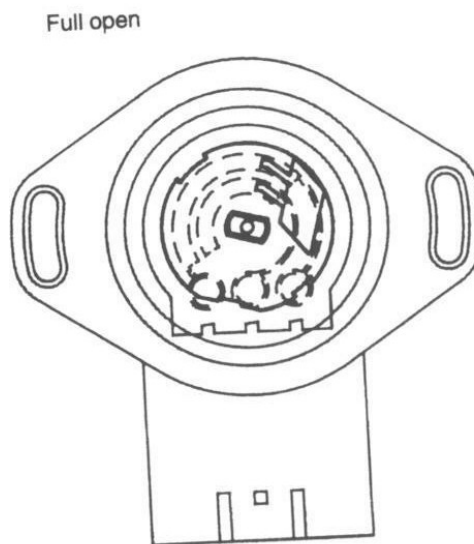
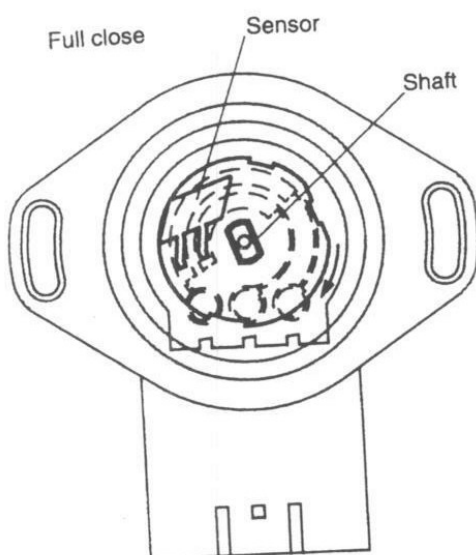
More than half of the air necessary for idling is supplied to the intake manifold via the idle air control solenoid valve.

D: THROTTLE POSITION SENSOR

- A throttle position sensor is provided with a potentiometer which is interlocked with the throttle valve shaft.
- This throttle position sensor sends the ECM a potentiometer output signal corresponding to the opening of the throttle valve. When the level of this signal exceeds a predetermined value, the ECM interprets it as complete closure of the throttle valve and makes a control most suitable for the engine operation with the throttle valve fully closed. For correcting error of this signal, the ECM is provided with a learning function.
- Thus, the ECM precisely controls the air-fuel ratio during acceleration and deceleration as well as engine idling.



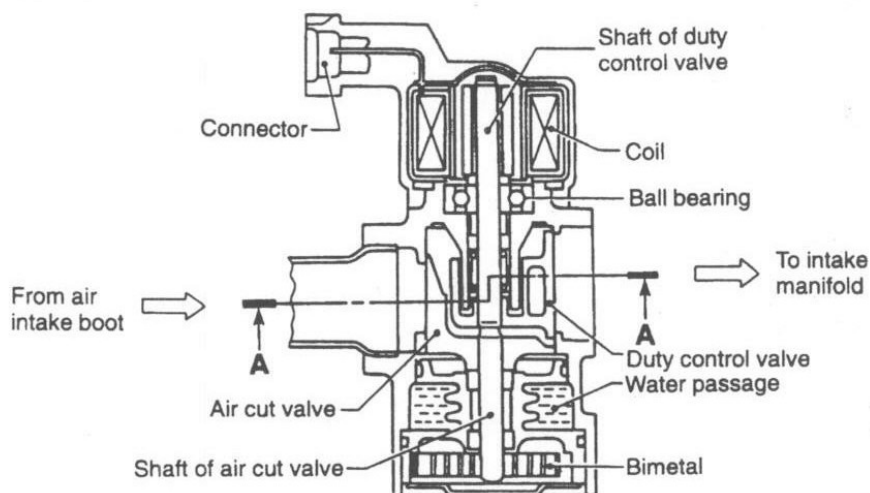
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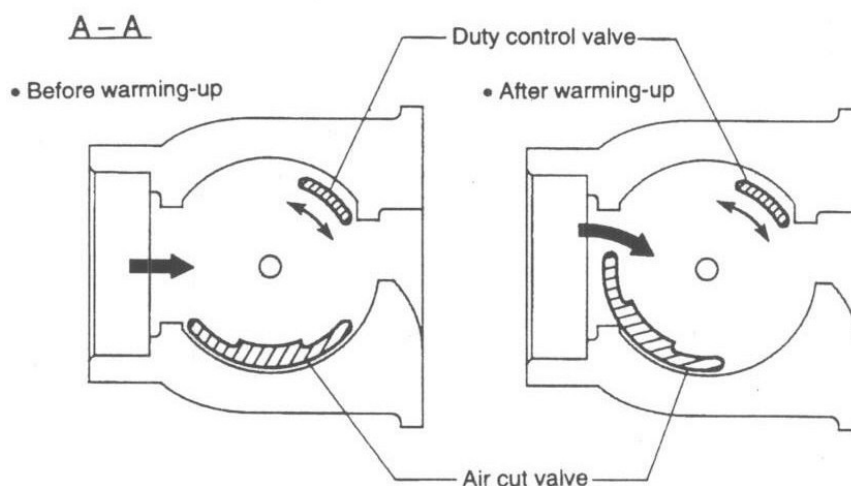
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E: IDLE AIR CONTROL SOLENOID VALVE

- Idle air control solenoid valve consists of an air cut valve, duty control valve, intake air passage and a coolant passage.
- Air cut valve contains a bimetallic substance which responds to coolant temperature, and a duty control valve which is operated by a signal sent from ECM.
- When engine coolant temperature is low, air cut valve is fully opened by the action of the bimetallic substance so that the air flow required for low engine coolant temperatures is maintained.
- ECM controls duty control valve to bring the operating engine speed as close to preset idle speed as possible.



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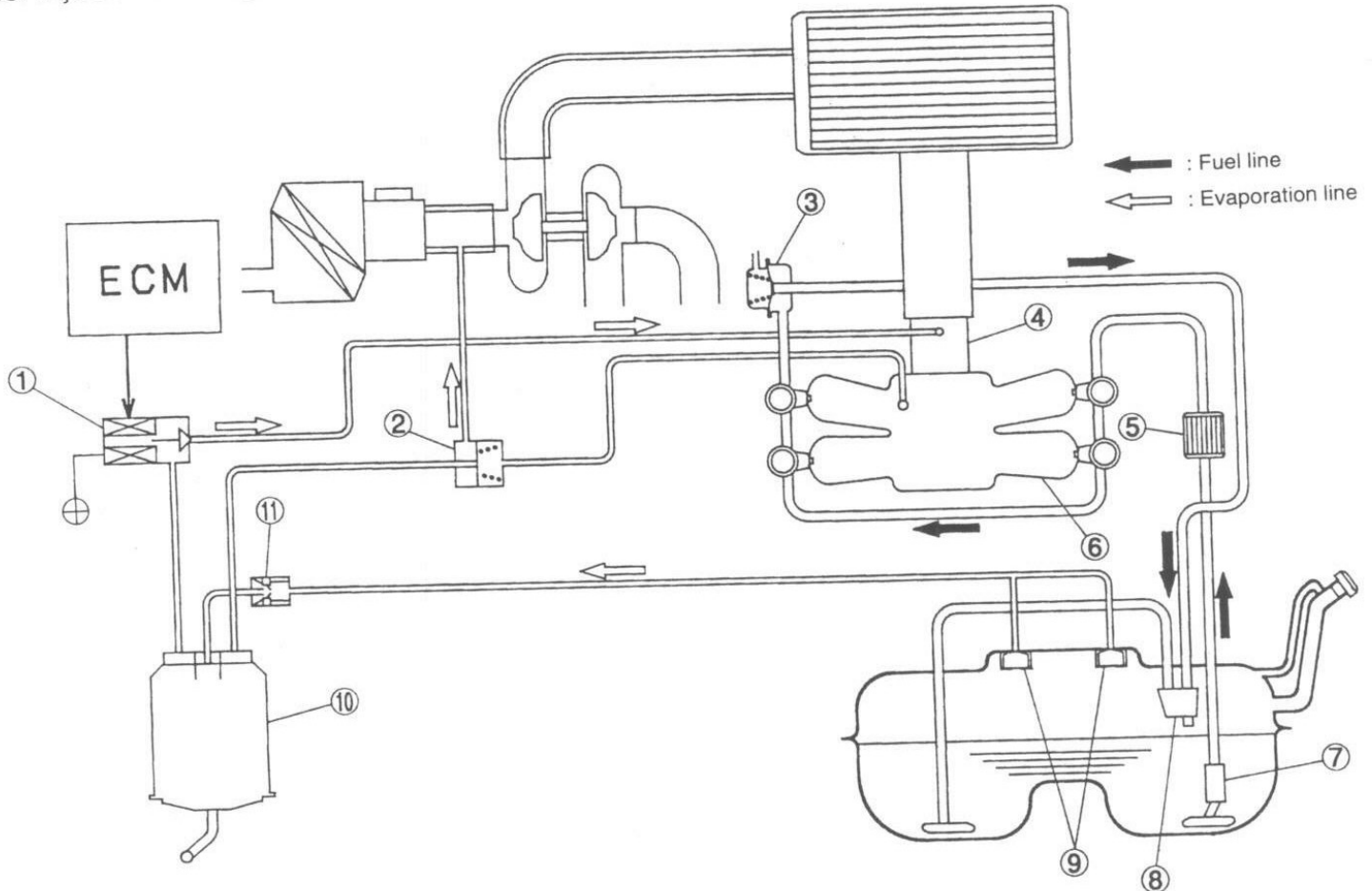


B2H0403A

3. Fuel Line

A: GENERAL

- Fuel pressurized by the fuel pump built into the fuel tank is delivered to fuel injectors by way of the fuel pipe and fuel filter. Fuel is regulated to the optimum pressure level by the pressure regulator on the way to the injectors.
 - From the injectors, fuel is injected into the intake manifold where it is mixed with intake air, and is then delivered to the respective cylinders.
- Fuel injection timing and the amount of fuel injected is regulated by the ECM.



- ① Purge control solenoid valve
- ② Auxiliary purge control valve
- ③ Pressure regulator
- ④ Throttle body
- ⑤ Fuel filter
- ⑥ Intake manifold

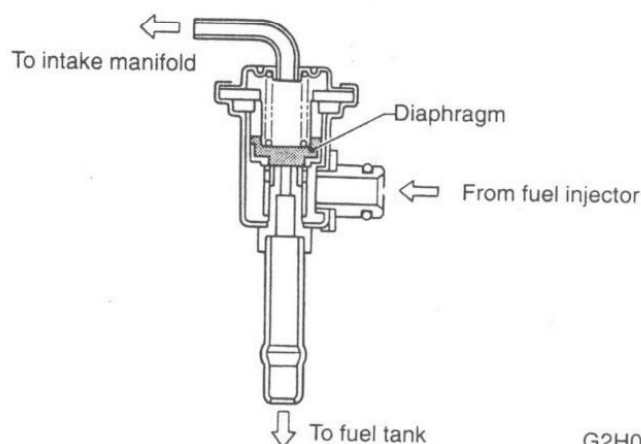
- ⑦ Fuel pump
- ⑧ Jet pump
- ⑨ Fuel cut valve
- ⑩ Canister
- ⑪ Two-way valve

H2H1834A

B: PRESSURE REGULATOR

- The pressure regulator is divided into the fuel chamber and the spring chamber by the diaphragm as illustrated below. Fuel is fed to the fuel chamber through the fuel inlet connected with the injector. A difference in pressure between the fuel chamber and the spring chamber connected with the intake manifold causes the diaphragm to be pushed down, and fuel is fed back to the fuel tank through the return line.

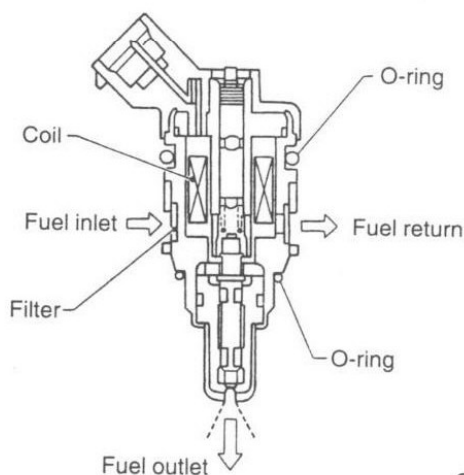
- By returning fuel so as to balance the above pressure difference and the spring force, the fuel pressure is kept at a constant level 299.1 kPa (3.05 kg/cm², 43.4 psi) against the intake manifold pressure.



G2H0678

C: FUEL INJECTOR

- The MFI system employs a gallery type (side-feed type) fuel injector.
- The gallery type fuel injector is installed in the fuel pipe to allow cooling of the injector by the fuel.
- The features of this type of fuel injector are as follows:
 - High heat resistance
 - Low driving noise
 - Easy to service
 - Small size
- The fuel injector injects fuel according to the valve open signal received from the ECM.
- The nozzle is attached on the top of the fuel injector. The ball valve is lifted by the solenoid coil through the plunger on arrival of the valve open signal.
- Since the injection opening, the lifted level of valve and the regulator-controlled fuel pressure are kept constant, the amount of fuel to be injected can be controlled only by the valve open signal from the ECM.

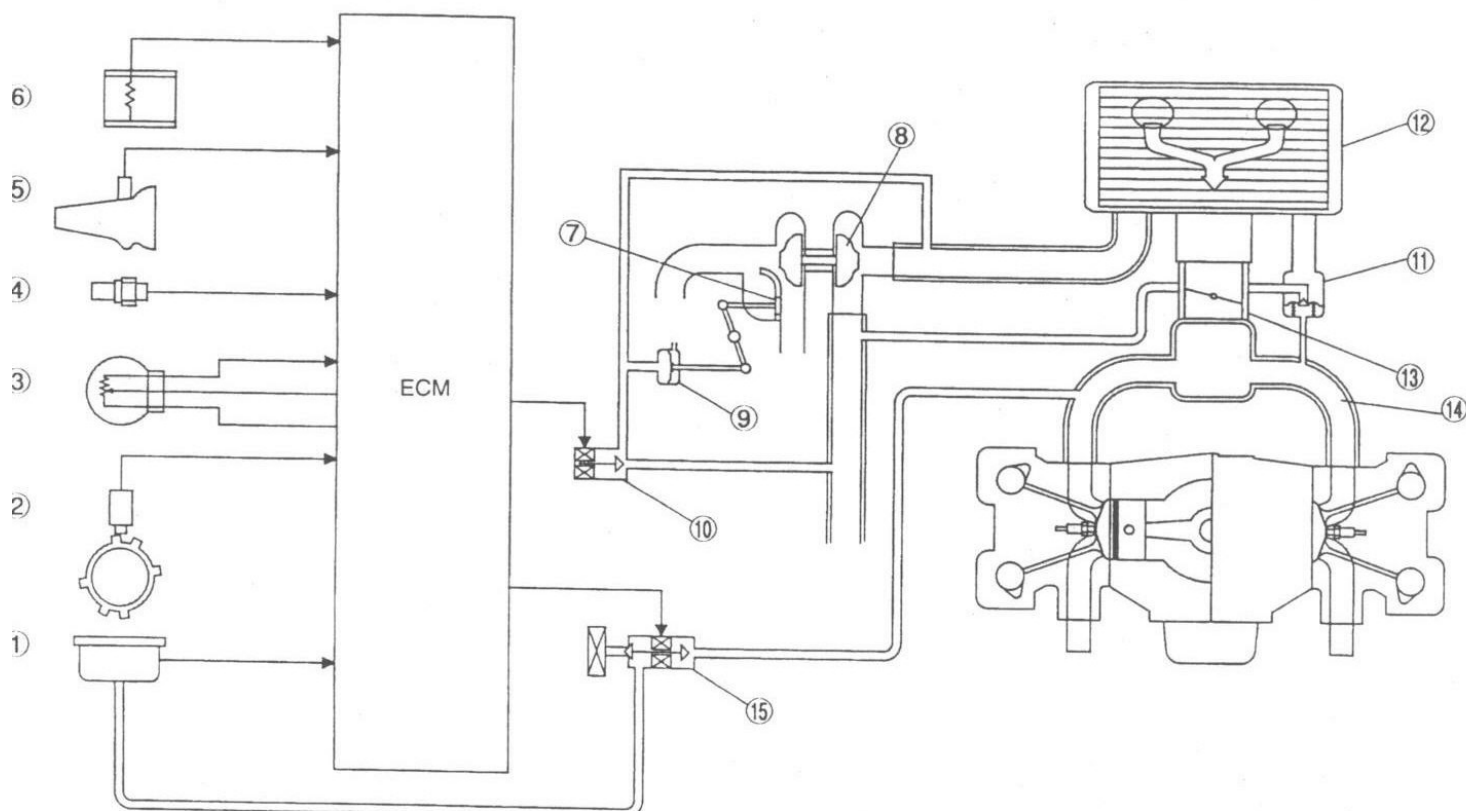


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4. Turbocharger System

A: GENERAL

- This turbocharger system consists of a water-cooled turbocharger, air-cooled intercooler, waste-gate control solenoid valve, pressure sources switching solenoid valve, etc.
- The outlet side turbine, rotated by the energy of exhaust gas it receives, rotates the inlet side turbine. As a result, the intake air is compressed before it is delivered to the intake manifold.
- The intake air, heated when passed through the turbocharger unit, is cooled as it passes through the intercooler.
- This turbocharger system controls supercharging pressure on the basis of the difference from the atmospheric pressure. Even at a high altitude, therefore, the system offers stable performance without being affected by variations in atmospheric pressure.



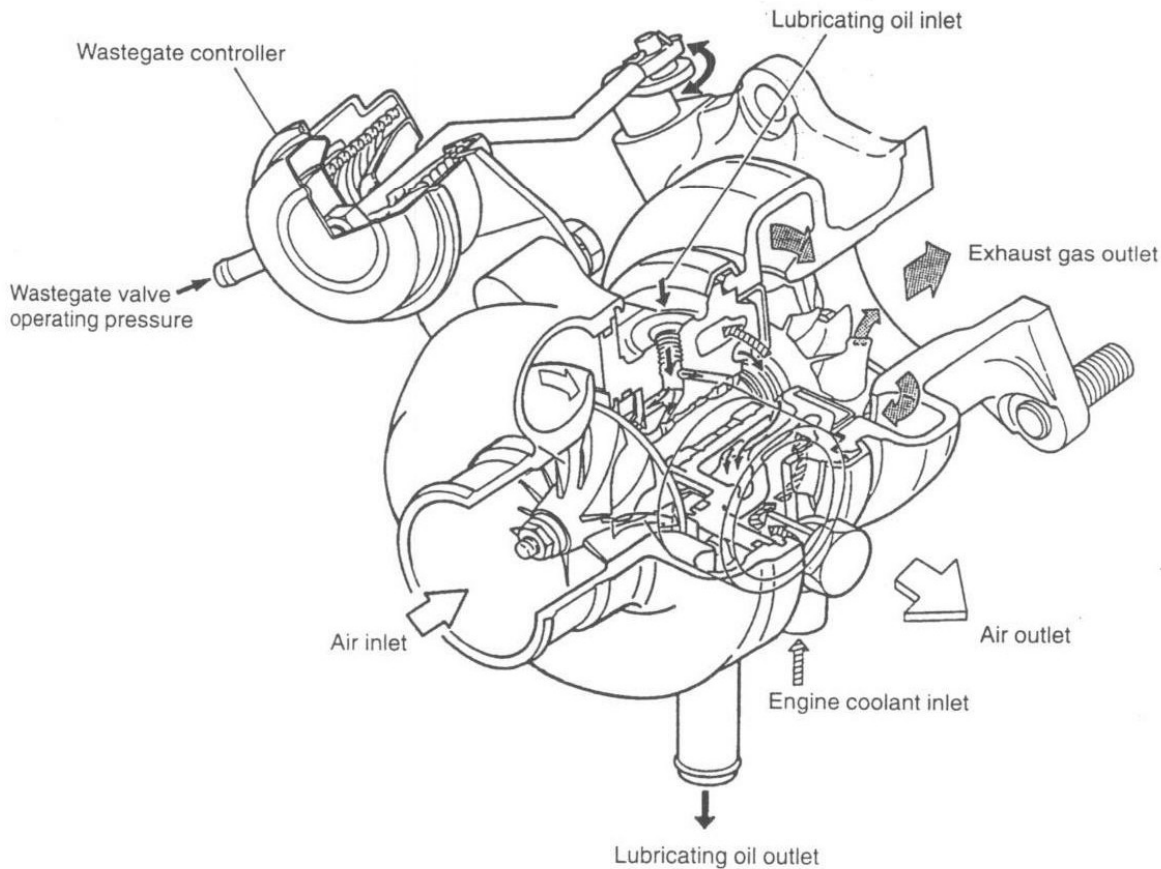
H2H1863A

- ① Pressure sensor
- ② Crankshaft position sensor
- ③ Throttle position sensor
- ④ Engine coolant temperature sensor
- ⑤ Vehicle speed sensor 2
- ⑥ Mass air flow sensor
- ⑦ Wastegate valve
- ⑧ Turbocharger unit

- ⑨ Wastegate controller
- ⑩ Wastegate control solenoid valve
- ⑪ Air by-pass valve
- ⑫ Intercooler
- ⑬ Throttle body
- ⑭ Intake manifold
- ⑮ Pressure sources switching solenoid valve

B: TURBOCHARGER UNIT

The turbocharger is water-cooled, and utilizes a wastegate valve to normalize supercharged pressure. The turbine is constructed of a lightweight, thin walled, and heat-resistant casting. The compressor is a thin wall aluminum alloy casting. The bearing section uses a full-floating metal system.

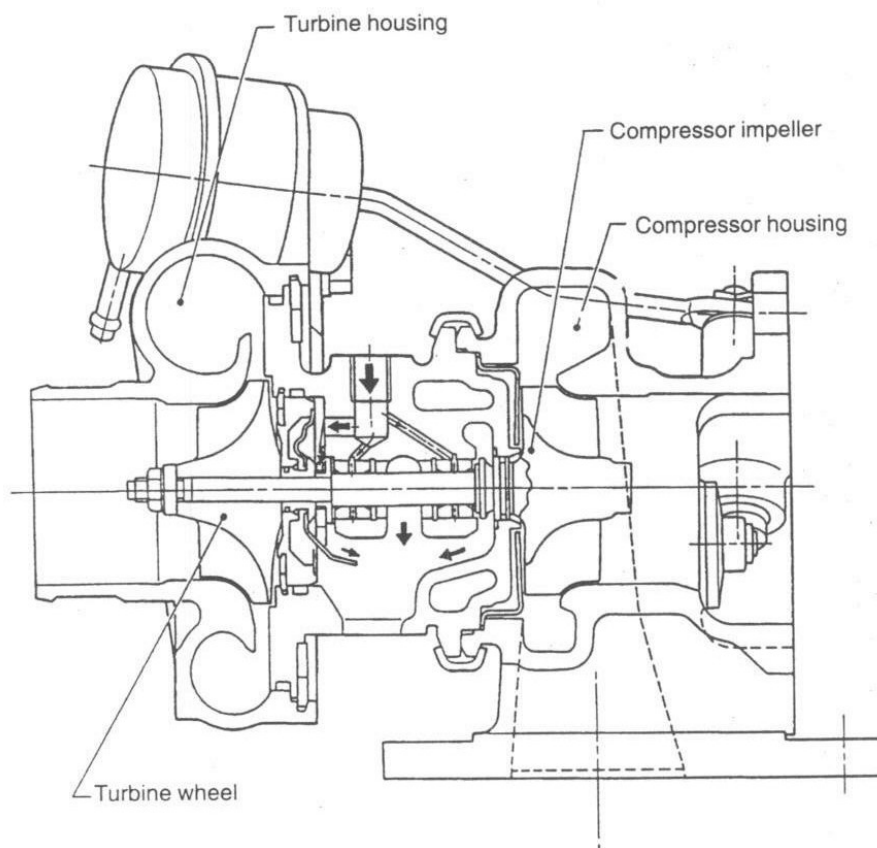


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C: LUBRICATION OF TURBOCHARGER

The turbocharger is lubricated by the engine oil branched out from the oil pump. Since the turbocharger turbine and the compressor shaft reach a maximum of several hundred thousand revolutions per minute, the full-floating type bearings are used to form desirable lubrication films on their inside and outside during running.

Further the oil supplied to the turbocharger also plays an important role of cooling the heat from exhaust gas in the turbine not to propagate to the bearings.



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D: COOLING OF TURBOCHARGER

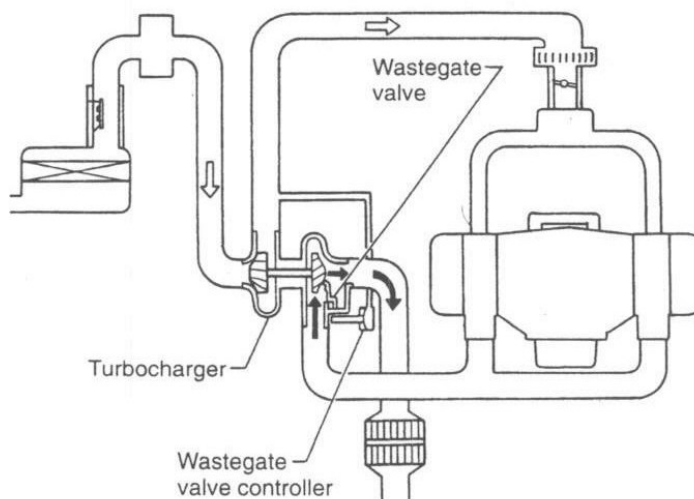
The turbocharger unit is water cooled for higher reliability and durability. The engine coolant from the coolant drain hose under the engine cylinder head is led to the coolant passage, through a pipe, provided in the turbocharger bearing housing. After cooling the bearing housing, the engine coolant is led into the coolant filler tank through a pipe.

E: REGULATION OF SUPERCHARGING PRESSURE

1. BASIC FUNCTION OF THE WASTEGATE VALVE

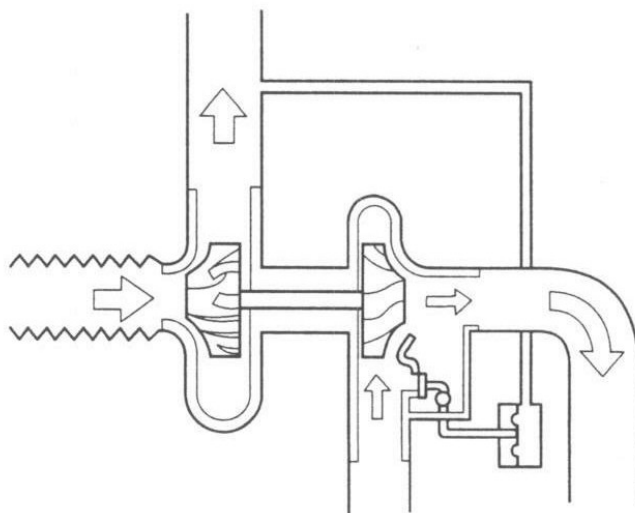
As the engine speed increases with the opening of the throttle valve, the amount of exhaust gas increases. This leads to increase in the rotational speed of turbine (approx. 20,000 to 150,000 rpm), the supercharging pressure and the output.

However, excessive supercharging pressure may cause occurrence of the knocking and heavier thermal load on such a part as piston. In the worst case, the engine may be damaged or broken. To prevent this, the wastegate valve and its controller are equipped. By sensing the supercharging pressure, the wastegate valve restricts it below a predetermined level.



G2H0684

While the supercharging pressure is lower than the predetermined level, the wastegate valve is closed so that all the exhaust gas is carried through the turbine.



G2H0685

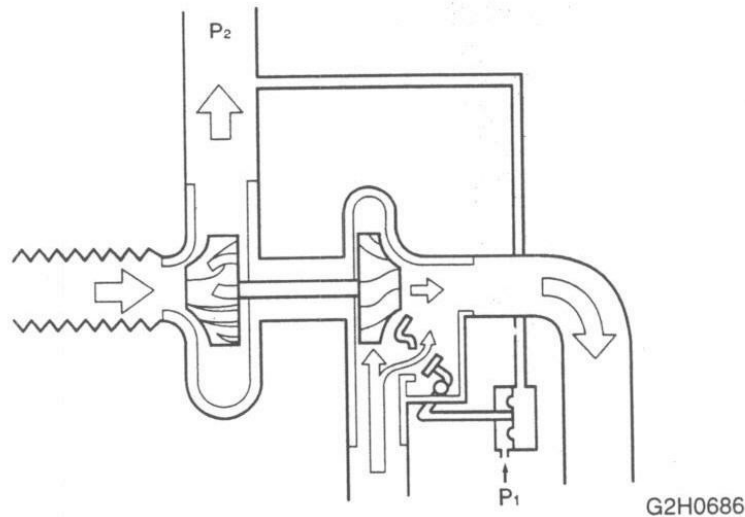
When it reaches the predetermined level, the wastegate controller lets the supercharging pressure to press the diaphragm, causing the linked wastegate valve to open. With the wastegate-valve opened, a part of the exhaust gas is allowed to flow into the exhaust gas pipe by bypassing the turbine.

This decreases the turbine rotating energy to keep the supercharging pressure constant.

It means $P_2 - P_1 = \text{constant}$

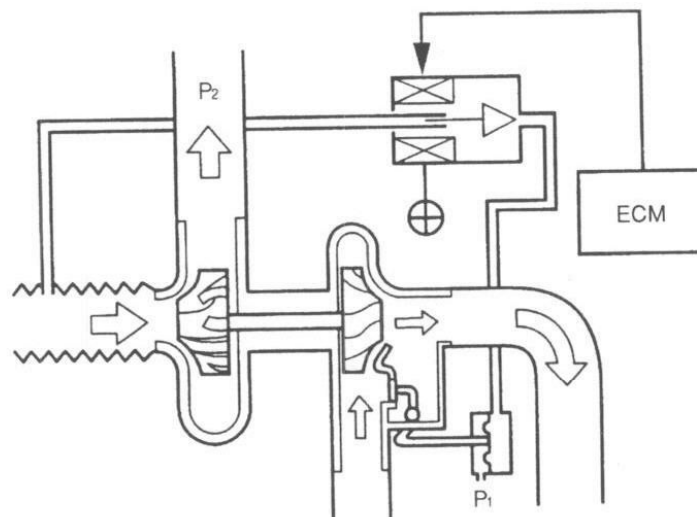
P_1 : Atmospheric pressure

P_2 : Supercharging pressure



2. CONCEPT OF THE WASTEGATE VALVE CONTROL

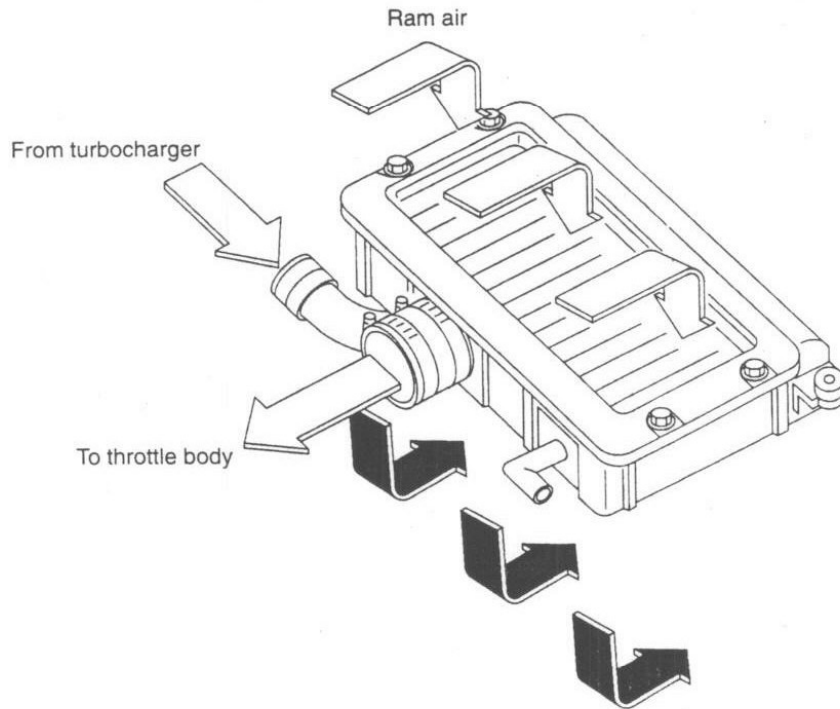
The higher the altitude, the lower the atmospheric pressure (P_1) and supercharging pressure (P_2). The duty solenoid valve acts as a control to maintain maximum supercharging pressure (P_2) under absolute pressure.



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F: INTERCOOLER

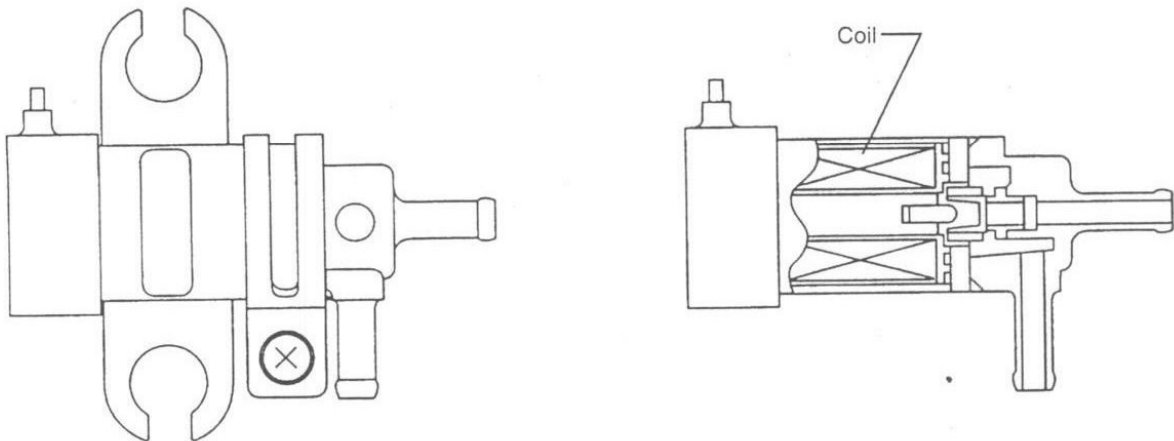
- Since the intake air passed through the turbocharger unit is heated to a very high temperature, the air itself is expanded, resulting in a lower engine charging efficiency. To lower the temperature of the intake air, therefore, the intercooler is provided just before the throttle body.
- The intercooler is an air cooled type. The air delivered from the air duct provided at the engine hood flows through the core and cools the intake air passing through the intercooler.



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G: WASTEGATE CONTROL SOLENOID VALVE

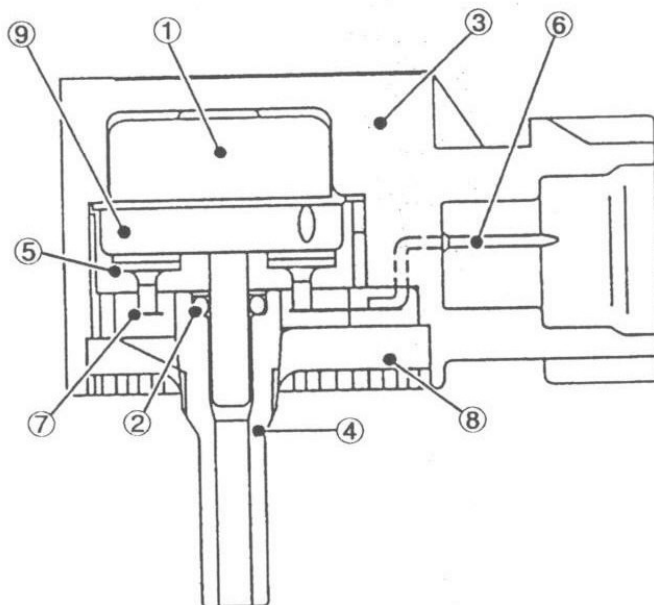
The wastegate control solenoid valve, coupled with the wastegate controller, switches the intake air pressure to be delivered to the wastegate controller in response to a signal from ECM. When the solenoid valve is closed, the intake air pressure upstream of the turbocharger unit is delivered to the wastegate controller. When the solenoid valve is opened, the intake air pressure downstream of the turbocharger unit (supercharged air pressure) is delivered to the wastegate controller.



H2H1868A

H: PRESSURE SENSOR

The pressure sensor alternately receives the intake air pressure in the collector chamber and the atmospheric pressure, converts the pressure values into signals, and sends the signals to ECM. Switchover between the intake air pressure and atmospheric pressure is accomplished by the pressure exchange solenoid valve.

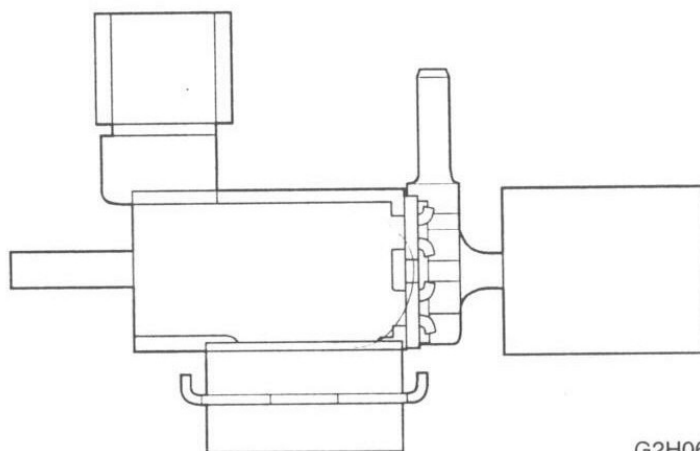


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- | | |
|--------------------|--------------|
| ① Sensor unit | ⑥ Terminal |
| ② O-ring | ⑦ Inner lead |
| ③ Case | ⑧ Resin |
| ④ Pipe | ⑨ Metal lid |
| ⑤ Through capacity | |

I: PRESSURE SOURCES SWITCHING SOLENOID VALVE

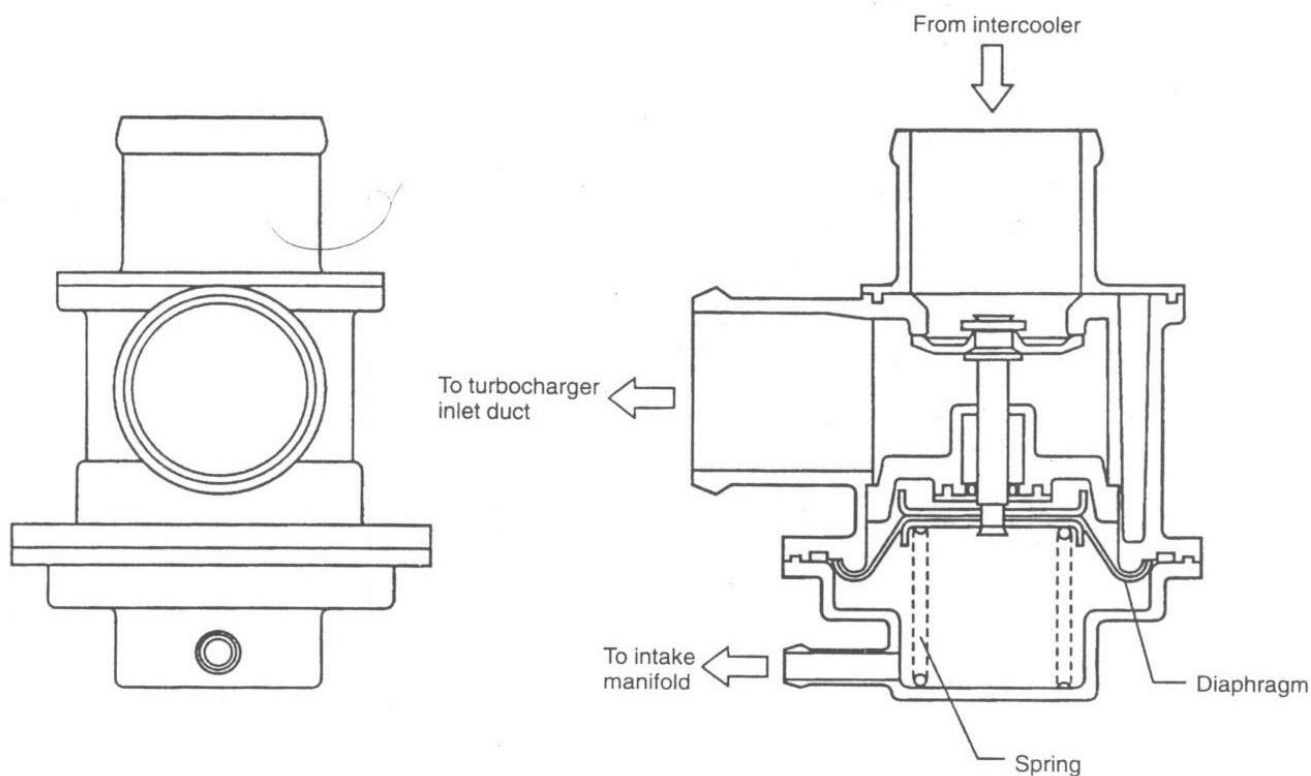
Located at an intermediate point of the line between the collector chamber and pressure sensor, the pressure sources switching solenoid valve switches between the intake air pressure and atmospheric pressure from which the pressure sensor produces signals.



G2H0691

J: AIR BY-PASS VALVE

When a throttle valve is suddenly closed, low air suction noise may occur due to a sudden rise of the air pressure in the passage between the turbocharger and throttle body. To prevent this, an air by-pass valve and air passage are provided. The air by-pass valve, actuated by the vacuum created by a sudden closure of the throttle valve, allows the suction air to by-pass the turbocharger and pass directly upstream, thus lowering the pressure in the air passage.

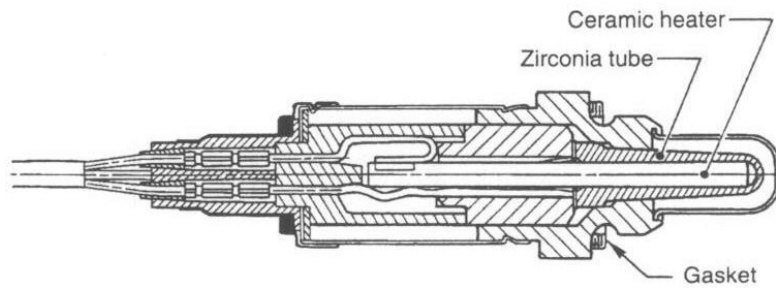


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5. Sensor and Switch

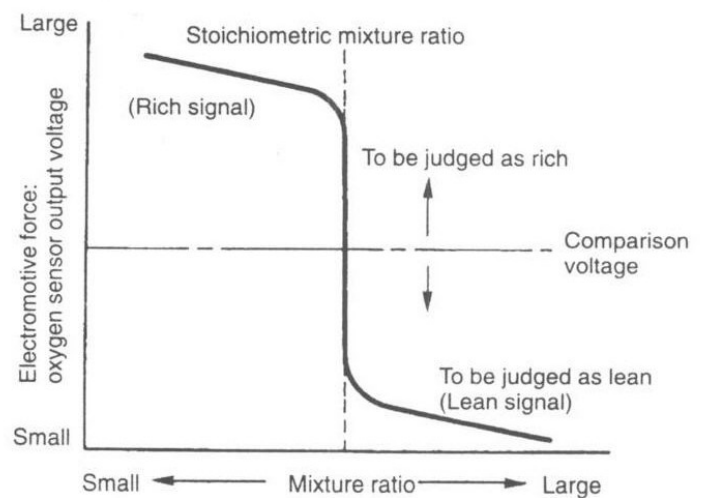
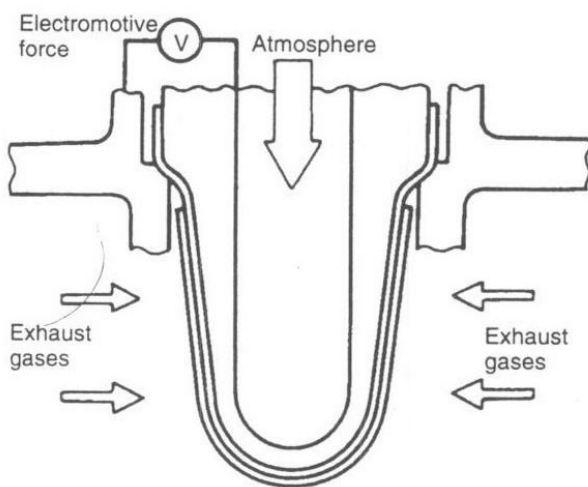
A: OXYGEN SENSOR

- The oxygen sensor is used to sense oxygen concentration in the exhaust gas. If the fuel ratio is leaner than the stoichiometric ratio in the mixture (i.e. excessive amount of air), the exhaust gas contains more oxygen. To the contrary, if the fuel ratio is richer than the stoichiometric ratio, the exhaust gas contains hardly any oxygen.
- Therefore, examination of the oxygen concentration in exhaust gas makes it possible to show whether the air/fuel ratio is leaner or richer than the stoichiometric ratio.
- The oxygen sensor has a zirconia tube (ceramic) which generates voltage if there is a difference in oxygen concentration between the inside and outside of the tube. Platinum is coated on the inside and outside of the zirconia tube for the purpose of catalysis and electrode provision. The hexagon screw on the outside is grounded to the exhaust pipe, and the inside is connected to the ECM through the harness.
- A ceramic heater is employed to improve performance at low temperature.



G2H0037

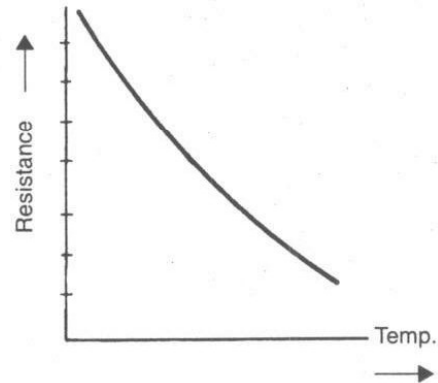
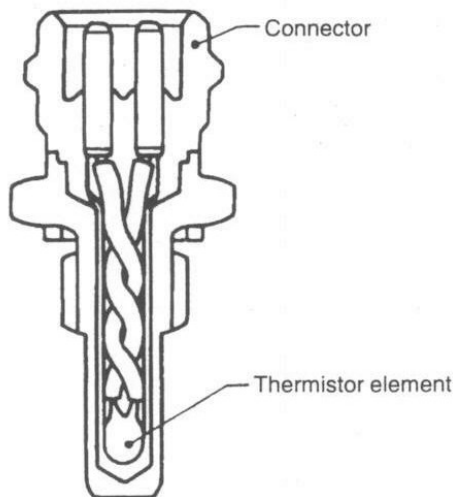
- When rich air-fuel mixture is burnt in the cylinder, the oxygen in the exhaust gases reacts almost completely through the catalytic action of the platinum coating on the surface of the zirconia tube. This results in a very large difference in the oxygen concentration between the inside and outside, and the electromotive force generated is large.
- When a lean air-fuel mixture is burnt in the cylinder, oxygen remains in the exhaust gases even after the catalytic action, and this results in a small difference in the oxygen concentration. The electromotive force is very small.
- The difference in oxygen concentration changes greatly in the vicinity of the optimum air-fuel ratio, and hence the change in the electromotive force is also large. By inputting this information into the MFI control unit, the air-fuel ratio of the supplied mixture can be determined easily. The oxygen sensor does not generate much electromotive force when the temperature is low. The characteristics of the electromotive force stabilize at temperature of approximately 300 to 400°C (572 to 752°F).



G2H0038

B: ENGINE COOLANT TEMPERATURE SENSOR

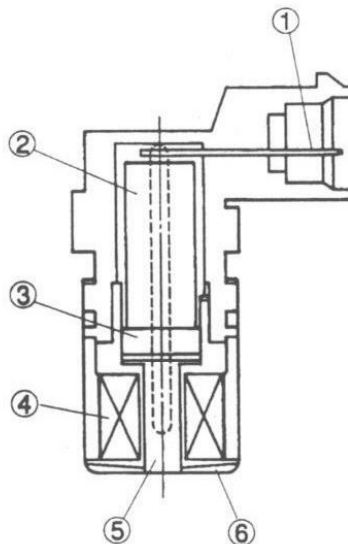
The engine coolant temperature sensor is located on the engine coolant pipe which is made of aluminum alloy. Its thermistor changes resistance with respect to temperature. A engine coolant temperature signal converted into resistance is transmitted to the ECM to control the amount of fuel injection, ignition timing, etc.



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C: CRANKSHAFT POSITION SENSOR

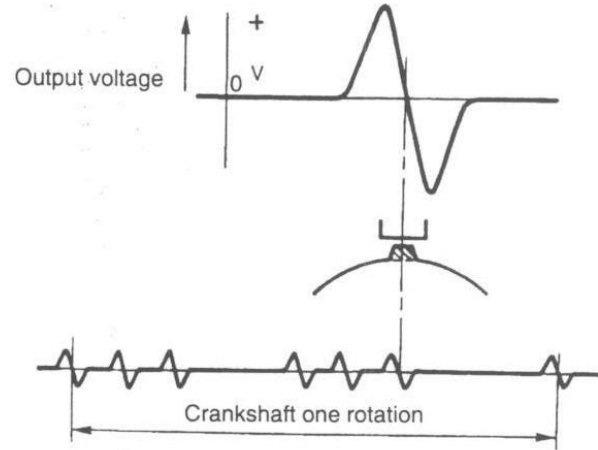
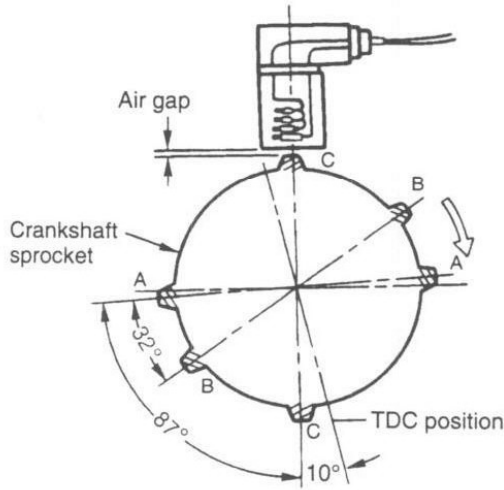
- The crankshaft position sensor is installed on the oil pump, located in the front center portion of the cylinder block, to detect the crankshaft position. It is designed so that the ECM accurately reads the number of pulses which occur when protrusions provided at the perimeter of the crankshaft sprocket (rotating together with the crankshaft) cross the crankshaft position sensor.
- The crankshaft position sensor is a molded type which consists of a magnet, core, coil, terminals, etc.



- | | |
|-------------|---------|
| ① Terminal | ④ Coil |
| ② Yoke core | ⑤ Core |
| ③ Magnet | ⑥ Cover |

B2H0407A

- The crankshaft sprocket is provided with six protrusions. Crankshaft rotation causes these protrusions to cross the crankshaft position sensor so that magnetic fluxes in the coil change with the change in air gap between the sensor pickup and the sprocket. The change in air gap induces an electromotive force which is transmitted to the ECM.

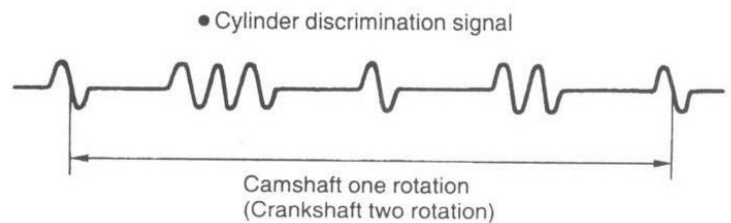
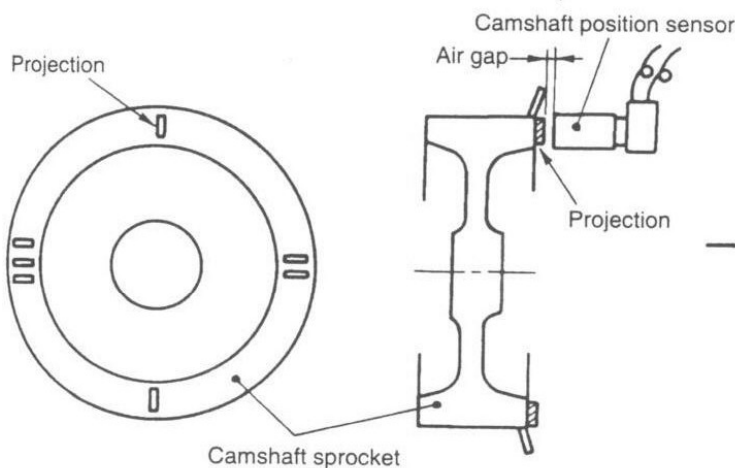


G2H0041

D: CAMSHAFT POSITION SENSOR

- The camshaft position sensor is located on the left-hand camshaft support to detect the combustion cylinder at any one moment.
- It is designed so that the ECM accurately reads the number of pulses which occur when protrusions provided on the back of the LH camshaft-drive sprocket cross the sensor.

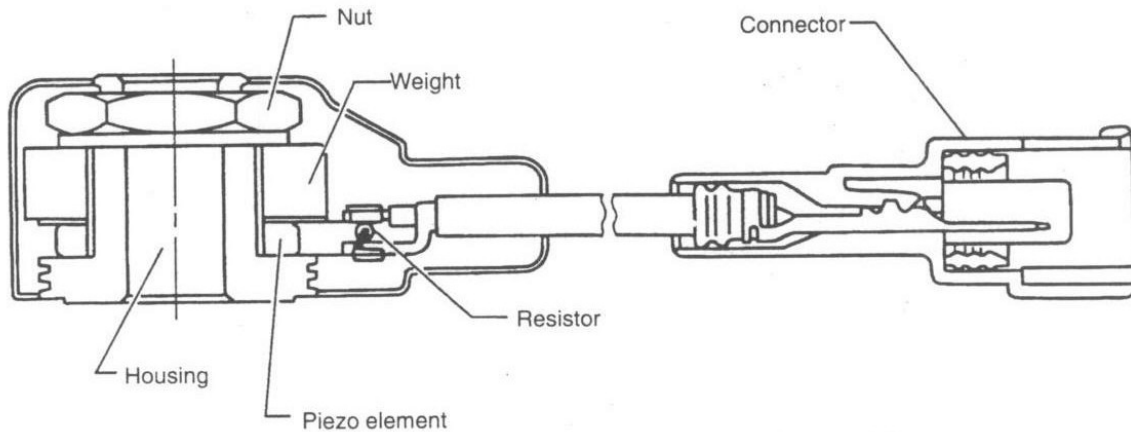
Internal construction and the basic operating principle of the camshaft position sensor are similar to those of the crankshaft position sensor. A total of seven protrusions (one each at two locations, two at one location and three at one location) are arranged in four equal parts of the sprocket, as shown below.



G2H0693

E: KNOCK SENSOR

- The knock sensor is installed on the cylinder block, and senses knocking signals.
- This knock sensor is a piezo-electric type which converts knocking vibrations into electric signals.
- It consists of a piezo-electric element, weight, and case. If knocking occurs in the engine, the weight in the case moves causing the piezo-electric element to generate a voltage.



G2H0681

F: VEHICLE SPEED SENSOR 2

- Vehicle speed sensor 2 is installed onto transmission case, the signal emitted from it is sent to the ECM and speedometer.
- The inner shaft in vehicle speed sensor 2 is connected to speedometer shaft in transmission with plate. The pick-up signal is emitted by rotation of the shaft.

6. Control System

A: GENERAL

The ECM (Engine Control Module) receives signals sent from various sensors and switches to judge the engine operating condition and emits output signals to provide the optimum control and/or functioning of various systems.

Major items governed by the ECM are as follow:

- Fuel injection control
- Ignition system control
- Idle air control
- Wastegate control
- Canister purge control
- Radiator fan control
- Fuel pump control
- Air conditioner cut control
- On-board diagnosis function
- Fail-safe function

B: INPUT AND OUTPUT SIGNALS

	Unit	Function
Input signal	Mass air flow sensor	Detects the amount of intake air.
	Throttle position sensor	Detects the throttle position.
	Oxygen sensor	Detects the density of oxygen in exhaust gases.
	Crankshaft position sensor	Detects engine speed and crankshaft position.
	Camshaft position sensor	Detects relative cylinder position.
	Engine coolant temperature sensor	Detects the coolant temperature.
	Knock sensor	Detects engine knocking.
	Vehicle speed sensor 2	Detects vehicle speed.
	Ignition switch	Detects ignition switch operation.
	Starter switch	Detects the condition of engine cranking.
	A/C switch	Detects the ON-OFF operation of the A/C switch.
	Neutral switch	Detects gear shift in neutral position.
	Pressure sensor	Detects atmospheric pressure and intake manifold pressure.

	Unit	Function
Output signal	Fuel Injector	Inject fuel.
	Ignition signal	Turns primary ignition current ON or OFF.
	Fuel pump relay	Turns the fuel pump relay ON or OFF.
	A/C control relay	Turns A/C control relay ON or OFF.
	Radiator fan control relay	Turns radiator fan control relay ON or OFF.
	Idle air control solenoid valve	Adjusts the amount of idle air flowing through the throttle valve.
	Malfunction indicator lamp	Indicates trouble.
	Purge control solenoid valve	Controls the amount of canister purge through the throttle body.
	Pressure sources switching solenoid valve	Switches pressure detection line between atmospheric pressure and intake manifold pressure.
	Wastegate control solenoid valve	Controls the supercharging pressure.

C: FUEL INJECTION CONTROL

- The ECM receives signals emitted from various sensors to control the amount of fuel injected and the fuel injection timing. Sequential fuel injection control is utilized over the entire engine operating range except during standing starts.
- The amount of fuel injected by the injector valve is dependent upon the length of time it remains open. The optimum fuel injection timing is determined by transmitting a signal to the injector from the ECM according to varying engine operations. Feedback control is also accomplished by means of a learning control. As a result, the fuel injection control system is highly responsive and accurate in design and structure.
- The sequential fuel injection system is designed so that fuel is injected at a specific time to provide maximum air intake efficiency for each cylinder. In other words, fuel injection is completed just before the intake valve begins to open.

1. FUEL INJECTION CHARACTERISTICS

Fuel injection timing is basically expressed as indicated below:

- 1) During engine starts:
Duration of fuel injection = Duration of fuel injection during engine starts
 - 2) During normal operation:
Basic duration of fuel injection x correction factor + voltage correction time
- Basic duration of fuel injection The basic length of time fuel is injected. This is determined by two factors — the amount of intake air detected by the mass air flow sensor and the engine speed (rpm) monitored by the crankshaft position sensor.
 - Duration of fuel injection during engine starts Determined according to the engine coolant temperature detected by a signal emitted from the engine coolant temperature sensor to improve starting ability.
 - Voltage correction time Compensates for the fuel injector's time lag affected by the battery voltage.

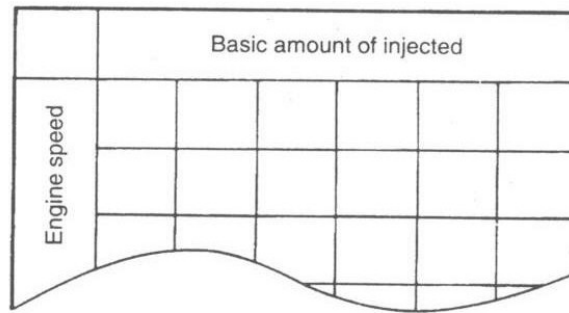
2. CORRECTION COEFFICIENTS

Correction coefficients are used to correct the basic duration of fuel injection so that the air-fuel ratio meets the requirements of varying engine operations.

These correction coefficients are classified as follows:

1) Air-fuel ratio coefficient:

Allotted to provide the optimum air-fuel ratio in relation to engine speed and the basic amount of fuel injected.

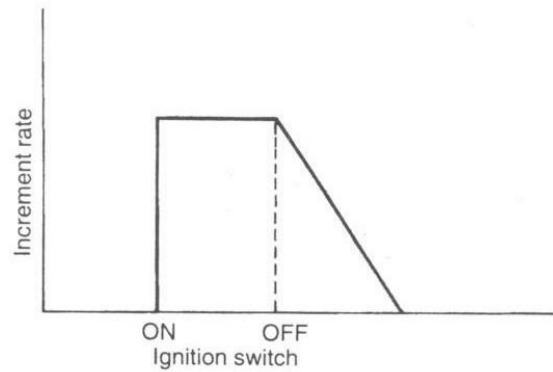


Air-fuel ratio characteristic

G2H0044

2) Start increment coefficient:

Increases the amount of fuel injected only when cranking the engine, which improves starting ability.

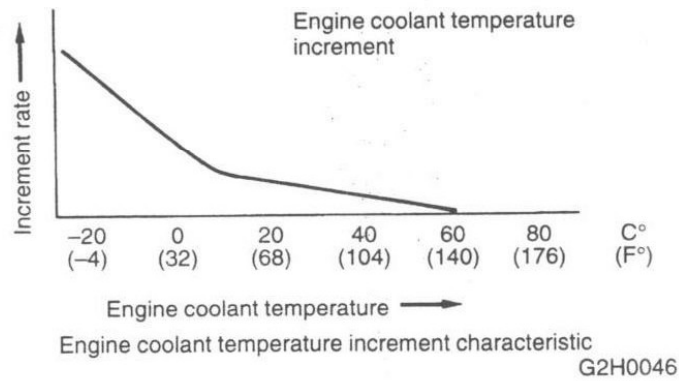


Start increment characteristic

G2H0045

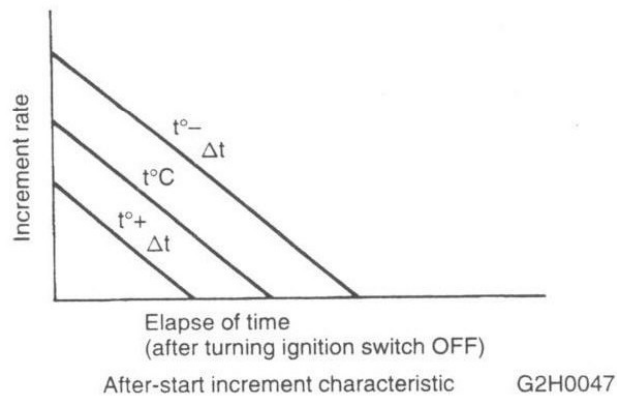
3) Engine coolant temperature increment coefficient:

Used to increase the amount of fuel injected in relation to a signal emitted from the engine coolant temperature sensor for easier starting of a cold engine. The lower the engine coolant temperature, the greater the increment rate.



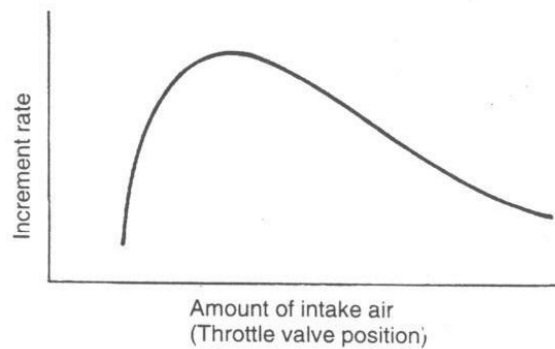
4) After-start increment coefficient:

Increases the amount of fuel injected for a certain period of time immediately after the engine starts to stabilize engine operation.



5) Full increment coefficient:

Increases the amount of fuel injected by a signal emitted from the throttle position sensor in relation to a signal emitted from the mass air flow sensor.

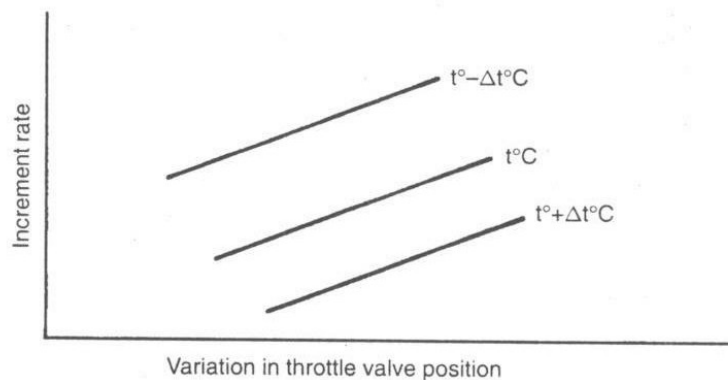


Full increment characteristic

G2H0048

6) Acceleration increment coefficient:

Compensates for time lags of air flow measurement and/or fuel injection during acceleration to provide quick response.

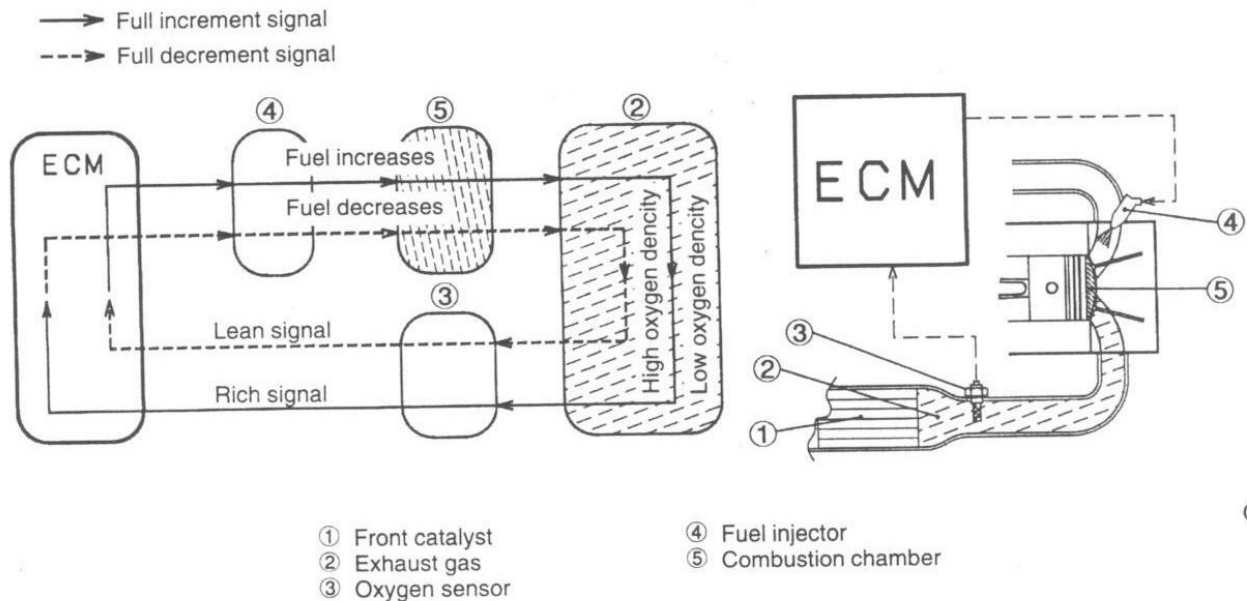


Acceleration increment characteristic

G2H0049

3. AIR-FUEL RATIO FEEDBACK COEFFICIENT "ALPHA"

This feedback coefficient utilizes the oxygen sensor's electromotive force (voltage) as a signal to be entered into the ECM. When low voltage is entered, the ECM judges it as a lean mixture, and when high voltage is entered, it is judged as a rich mixture. In other words, when the air-fuel ratio is richer than the stoichiometric mixture ratio, the amount of fuel injected is decreased. When it is leaner, the amount of fuel injected is increased. In this way, the air-fuel ratio is compensated so that it comes as close to the stoichiometric mixture ratio as possible on which the three-way catalyst acts most effectively. (CO, HC and NOx are also reduced when the air-fuel ratio is close to stoichiometric mixture ratio.)

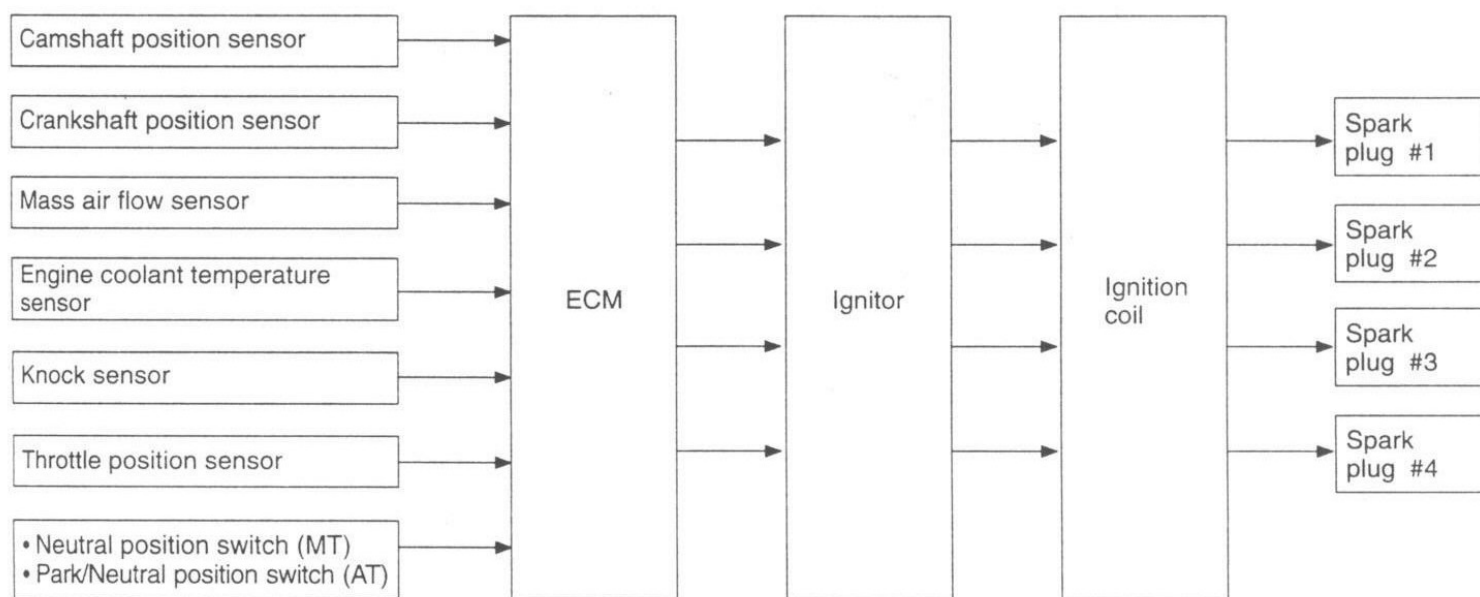


4. LEARNING CONTROL SYSTEM

- In a conventional air-fuel feedback control system, the basic amount of fuel injected (according to engine speed and various loads) is stored in the memory. After the ECM receives a signal emitted from the oxygen sensor, the basic amount of fuel injected is corrected so that it is close to the stoichiometric mixture ratio. This means that the greater the air-fuel ratio is corrected, the lesser the control accuracy.
- In SUBARU engines, however, an air-fuel ratio learning control system constantly memorizes the amount of correction required in relation to the basic amount of fuel to be injected (the basic amount of fuel injected is determined after several cycles of fuel injection), so that the correction affected by feedback control is minimized. Thus, quick response and accurate control of variations in air-fuel ratio, sensors' and actuators' characteristics during operation, as well as in the air-fuel ratio with the time of engine operation, are achieved. In addition, accurate control contributes much to stability of exhaust gases and driving performance.

D: IGNITION SYSTEM CONTROL

- The ECM receives signals emitted from the mass air flow sensor, engine coolant temperature sensor, crankshaft position sensor, camshaft position sensor, etc., to judge the operating condition of the engine. It then selects the optimum ignition timing stored in the memory and immediately transmits a primary current OFF signal to the ignitor to control the ignition timing.
- This system control type features a quick-to-response learning control method by which data stored in the ECM memory is processed in comparison with information emitted from various sensors and switches.
- Thus, the ECM constantly provides the optimum ignition timing in relation to output, fuel consumption, exhaust gas, etc., according to various engine operating conditions, etc.

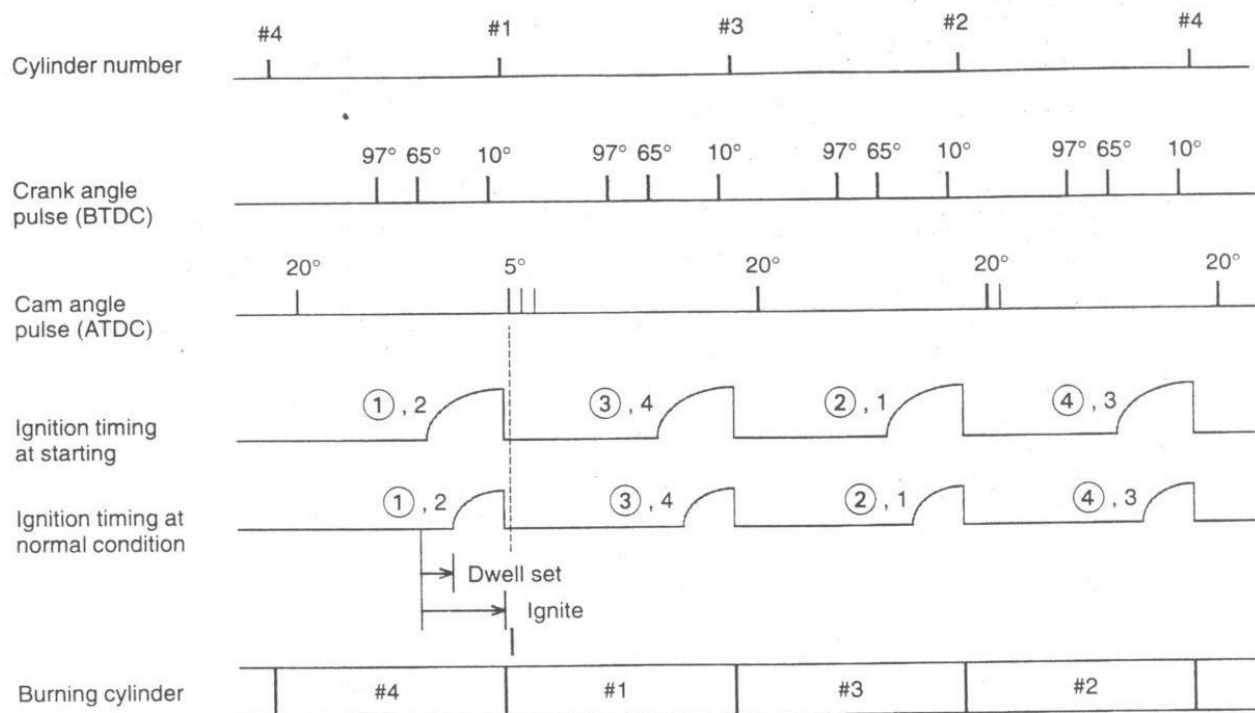


- Ignition control under normal engine conditions

Between the 97° signal and the 65° signal, the ECM measures the engine speed, and by using this data it decides the dwell set timing and ignition timing according to the engine condition.

- Ignition control under starting conditions

Engine speed fluctuates at the starting condition, so the ECM cannot control the ignition timing. When such a condition exists, ignition timing is fixed at 10° BTDC by using the 10° signal.



G2H0051

E: IDLE AIR CONTROL

• The ECM activates the idle air control solenoid valve in advance to control the amount of by-pass air flowing through the throttle valve in relation to signals emitted from the crankshaft position sensor, camshaft position sensor, engine coolant temperature sensor and A/C switch, so that the proper idle speed specified for each engine load is achieved.

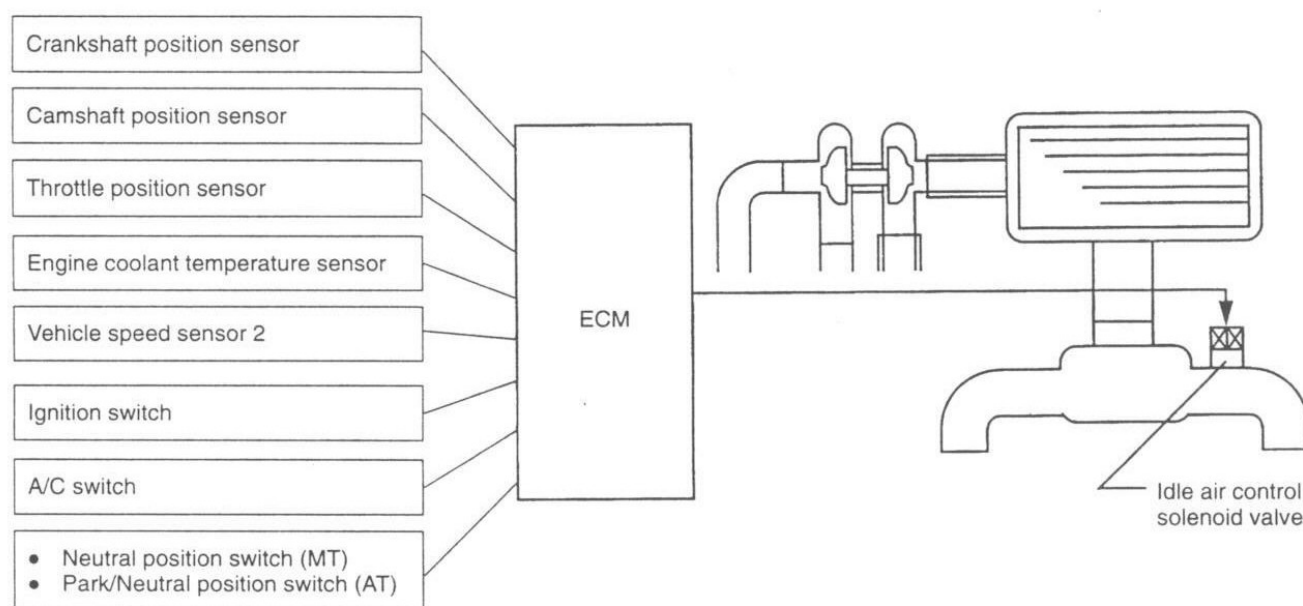
• The idle air control solenoid valve utilizes a duty solenoid design so that the amount of valve "lift" is determined by a certain operating frequency. For this reason, the by-pass air flow is regulated by controlling the duty ratio. The relationship between the duty ratio, valve lift and by-pass air flow is as follows:

Duty ratio (high) → Increases valve lift and by-pass air flow.

Bypass air control features the following advantages:

1. Compensation for engine speed under A/C (air conditioning) system and electrical loads.
2. Increase in idle speed during early stage of warm up period.
3. A dashpot function during the time the throttle valve is quickly closed.
4. Prevention of engine speed variations over time.

Diagram



H2H1871A

F: CANISTER PURGE CONTROL

• The ECM receives signals emitted from the engine coolant temperature sensor, vehicle speed sensor 2 and crankshaft position sensor to control the purge control solenoid. Canister purge takes place during operation of the vehicle except under certain conditions (during idle, etc.).

• The purge line is connected to the throttle chamber to purge fuel evaporation gas from the canister according to the amount of intake air.

G: RADIATOR FAN CONTROL

- The Hi-Low control of the radiator fan is governed by the ECM which receives signals sent from the engine coolant temperature sensor and vehicle speed sensor 2.

Vehicle speed	Engine coolant temperature		
	Less than 92°C (Less than 198°F)	Between 92 and 95°C (Between 198 and 203°F)	More than 96°C (More than 205°F)
	Operation of radiator main fan	Operation of radiator main fan	Operation of radiator main fan
Less than 19 km/h (Less than 12 MPH)	OFF	OFF	Low
Between 20 and 69 km/h (Between 12 and 43 MPH)	OFF	OFF	Hi
Between 70 and 105 km/h (Between 43 and 65 MPH)	OFF	OFF	Hi
More than 106 km/h (More than 66 MPH)	OFF	OFF	Hi

- On models which are equipped with an air conditioning system, the ECM receives signals sent from the engine coolant temperature sensor, vehicle speed sensor 2 and A/C switch. These signals simultaneously turn ON or OFF the radiator main fan and radiator sub fan as well as setting them at "Hi" or "Low" speed.

Vehicle speed	A/C compressor	Engine coolant temperature					
		Less than 92°C (Less than 198°F)		Between 92 and 95°C (Between 198 and 203°F)		More than 96°C (More than 205°F)	
		Operation of radiator fan		Operation of radiator fan		Operation of radiator fan	
		Main	Sub	Main	Sub	Main	Sub
Less than 19 km/h (Less than 12 MPH)	OFF	OFF	OFF	OFF	OFF	Low	Low
	ON	Low	Low	Hi	Hi	Hi	Hi
Between 20 and 69 km/h (Between 12 and 43 MPH)	OFF	OFF	OFF	OFF	OFF	Hi	Hi
	ON	Hi	Hi	Hi	Hi	Hi	Hi
Between 70 and 105 km/h (Between 43 and 65 MPH)	OFF	OFF	OFF	OFF	OFF	Hi	Hi
	ON	Low	Low	Low	Low	Hi	Hi
More than 106 km/h (More than 66 MPH)	OFF	OFF	OFF	OFF	OFF	Hi	Hi
	ON	OFF	OFF	Low	OFF	Hi	Hi

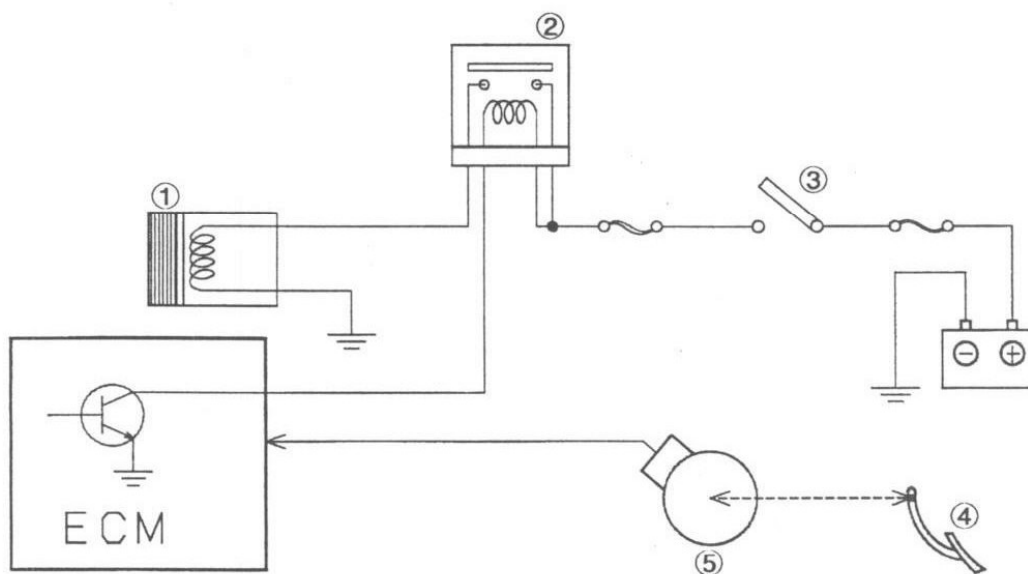
H: FUEL PUMP CONTROL

The ECM receives a signal emitted from the crankshaft position sensor and turns the fuel pump relay ON or OFF to control fuel pump operation. To improve safety, the fuel pump will stop if the engine stalls with the ignition switch ON.

Ignition switch ON	Fuel pump relay	Fuel pump
A certain period of time (after ignition switch is turned ON)	ON	Operates
While cranking the engine	ON	Operates
While engine is operating	ON	Operates
When engine stops	OFF	Does not operate

I: A/C CUT CONTROL

When the ECM receives a "full-open" signal emitted from the throttle position sensor while the air conditioning system is operating, the A/C cut relay turns off for a certain period of time to stop the compressor. This prevents degradation of output during acceleration and stabilizes driveability.



- ① A/C compressor
- ② A/C cut relay
- ③ Ignition switch

- ④ Accelerator pedal
- ⑤ Throttle position sensor

G2H0053

J: POWER SUPPLY CONTROL

- When the ECM receives an ON signal emitted from the ignition switch, current flows through the main relay. This turns the ignition relay ON so that power is supplied to the ignition coil, mass air flow sensor, idle air control solenoid valve, etc.
- Power to the above parts is turned off five seconds after the ECM receives an OFF signal from the ignition switch. The fuel injectors stop fuel injection immediately after the ignition switch is turned OFF because the injection signal is cut off.

7. On-board Diagnosis System

A: GENERAL

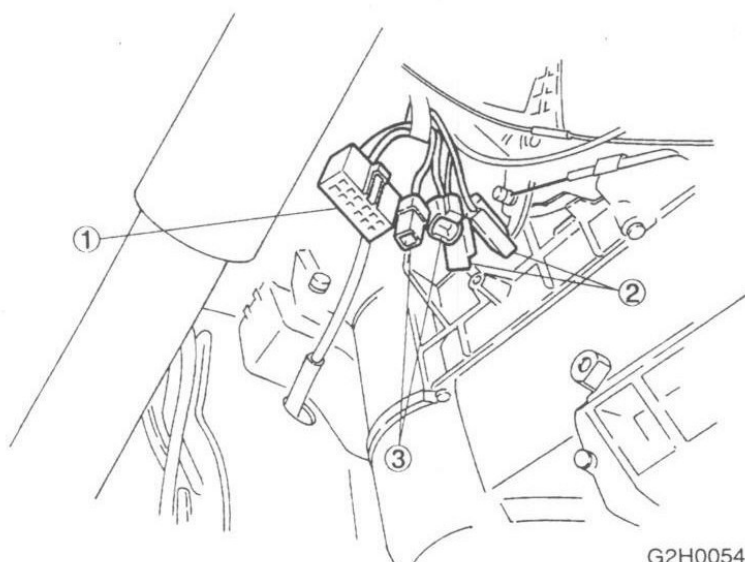
- The on-board diagnosis system detects and indicates a fault in various inputs and outputs of the complex electronic control. The malfunction indicator lamp (CHECK ENGINE light) on the instrument panel indicates occurrence of a fault or trouble.
- Further, against such a failure or sensors as may disable the drive, the fail-safe function is provided to ensure the minimal driveability.

B: FUNCTION OF ON-BOARD DIAGNOSIS

The on-board diagnosis function has four modes: U-check mode, Read memory mode, D-check mode and Clear memory mode. Two connectors (Read memory and Test mode) and a light (CHECK ENGINE light) are used. The connectors are for mode selection and the light monitors, the type of problem.

- Relationship between modes and connectors

Mode	Condition	Read memory connector	Test mode connector
U-check	Ignition ON (engine on)	DISCONNECT	DISCONNECT
Read memory	Ignition ON	CONNECT	DISCONNECT
D-check	Ignition ON (engine on)	DISCONNECT	CONNECT
Clear memory	Ignition ON (engine on)	CONNECT	CONNECT



- ① Data link connector
- ② Test mode connector
- ③ Read memory connector

• U-check mode

The U-check is a user-oriented mode in which only the MFI system components necessary for start-up and drive are diagnosed. On occurrence of a fault, the malfunction indicator lamp (CHECK ENGINE light) is lighted to indicate to the user that the dealer's inspection is necessary. The diagnosis of other parts which do not give significant adverse effect to start-up and drive are excluded from this mode in order to avoid unnecessary uneasiness to be taken by the user.

• Read memory mode

This mode is used by the dealer to read past problems (even when the vehicle's monitor lights are off). It is most effective in detecting poor contact or loose connections of connectors, harnesses, etc.

• D-check mode

This mode is used by the dealer to check the entire MFI system and detect faulty parts.

• Clear memory mode

This mode is used by the dealer to clear the trouble code from the memory after the affected part is repaired.

C: BASIC OPERATION OF ON-BOARD DIAGNOSIS SYSTEM**• NO TROUBLE**

Mode	Read memory connector	Test mode connector	Condition	CHECK ENGINE light
U-check	DISCONNECT	DISCONNECT	Ignition switch ON (Engine OFF)	ON
			Engine ON	OFF
Read memory	CONNECT	DISCONNECT	Ignition switch ON (Engine OFF)	Blink
			Engine ON	ON
D-check	DISCONNECT	CONNECT	Ignition switch ON (Engine OFF)	ON
			Engine ON	OFF → Blink*
Clear memory	CONNECT	CONNECT	Ignition switch ON (Engine OFF)	ON
			Engine ON	OFF → Blink*

• TROUBLE

Mode	Read memory connector	Test mode connector	Condition	CHECK ENGINE light
U-check	DISCONNECT	DISCONNECT	Engine ON	ON
Read memory	CONNECT	DISCONNECT	Ignition switch ON	Trouble code (memory)
D-check	DISCONNECT	CONNECT	Engine ON	Trouble code**
Clear memory	CONNECT	CONNECT	Engine ON	Trouble code**

* When the engine operates at a speed greater than 2,000 rpm for more than 40 seconds, the check engine light blinks. However, when all check items check out "O.K.", even before the 40 seconds is reached, the check engine light blinks.

** When the engine operates at a speed greater than 2,000 rpm for more than 40 seconds, a trouble code is emitted.

D: FAIL-SAFE FUNCTION

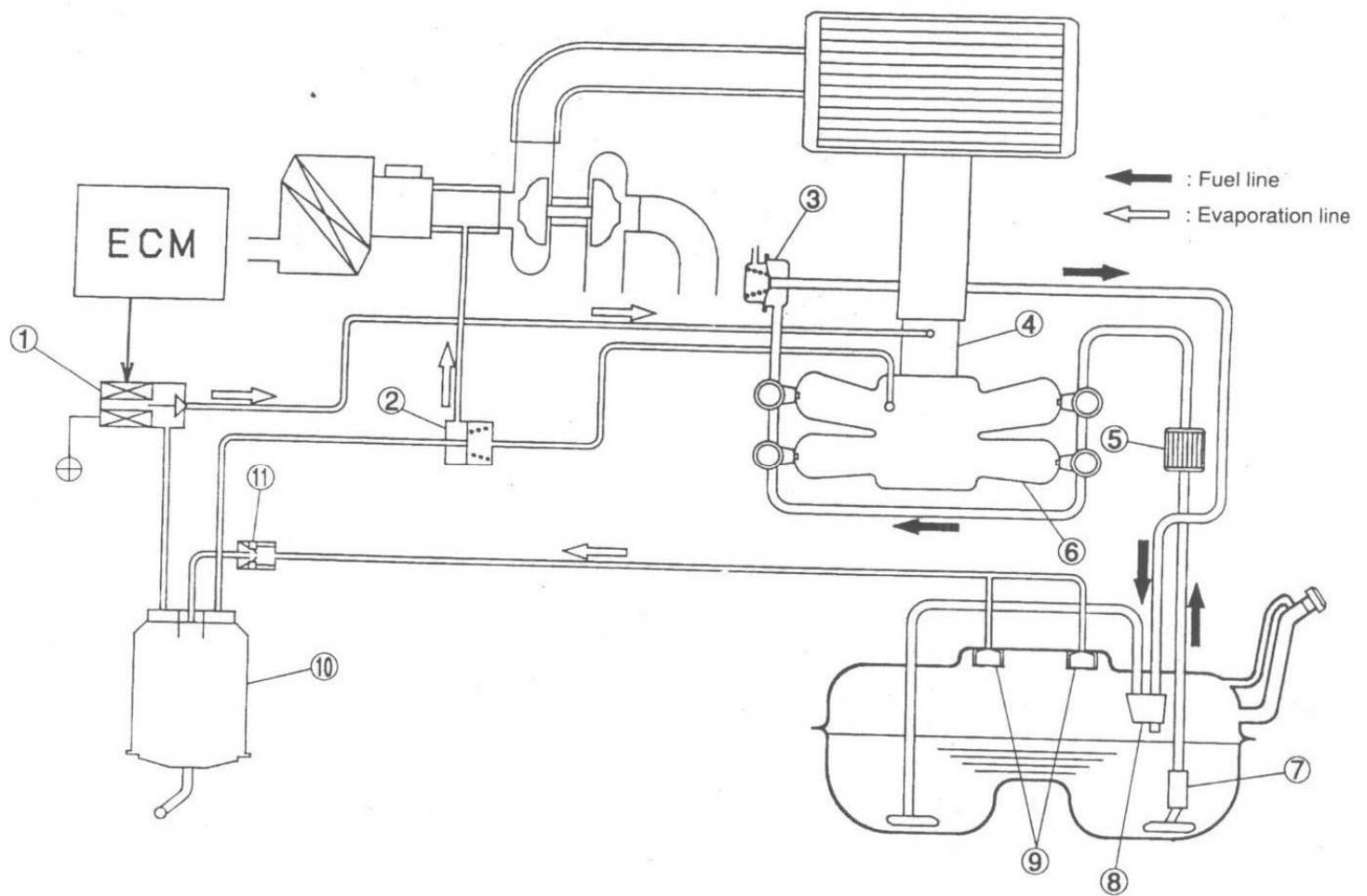
For the part which has been judged faulty in the on-board diagnosis, the ECM generates the associated pseudo signal (only when convertible to electric signal) and carries out the computational processing. In this fashion, the fail-safe function is performed.

E: TROUBLE CODES AND FAIL-SAFE OPERATION

Trouble code	Item	Contents of diagnosis	Fail-safe operation
11	Crankshaft position sensor	No signal entered from crankshaft position sensor, but signal (corresponding to at least one rotation of crankshaft) entered from camshaft position sensor.	—
12	Starter switch	Abnormal signal emitted from starter switch.	Turns starter switch signal OFF.
13	Camshaft position sensor	No signal entered from camshaft position sensor, but signal (corresponding to at least two rotations of camshaft) entered from crankshaft position sensor.	—
21	Engine coolant temperature sensor	Abnormal signal emitted from engine coolant temperature sensor.	Adjusts engine coolant to a specific temperature. Maintains radiator fan "ON" to prevent overheating.
22	Knock sensor	Abnormal voltage input entered from knock sensor.	Sets in regular fuel map, and retards ignition timing by 5°.
23	Mass air flow sensor	Abnormal voltage input entered from mass air flow sensor.	Controls the amount of fuel (injected) in relation to engine speed and throttle valve position.
24	Idle air control solenoid valve	Idle air control valve inoperative. (Abnormal signal produced in monitor circuit.)	Prevents abnormal engine speed using "fuel cut" in relation to engine speed, vehicle speed and throttle valve position.
31	Throttle position sensor	Abnormal voltage input entered from throttle position sensor.	Sets throttle position sensor's voltage output to a fixed value.
32	Oxygen sensor	Oxygen sensor inoperative.	—
33	Vehicle speed sensor 2	Abnormal voltage input entered from vehicle speed sensor 2.	Sets vehicle speed signal to a fixed value.
38	Torque control signal (AT)	Abnormal signal entered from TCM.	—
44	Wastegate control solenoid valve	Solenoid valve inoperative.	Cut off the fuel when throttle valve is fully opened under heavy loads.
45	● Pressure sensor ● Pressure sources switching solenoid valve	Abnormal signal entered from pressure sensor, or pressure exchange solenoid valve inoperative.	Cut off the fuel when throttle valve is fully opened under heavy loads.
51	Neutral position switch (MT)	Abnormal signal entered from neutral position switch.	—
51	Park/Neutral position switch (AT)	Abnormal signal entered from inhibitor switch.	—
53*	Immobiliser system	Faulty immobiliser system.	—

*: Immobiliser system equipped model only

2. TURBO MODEL



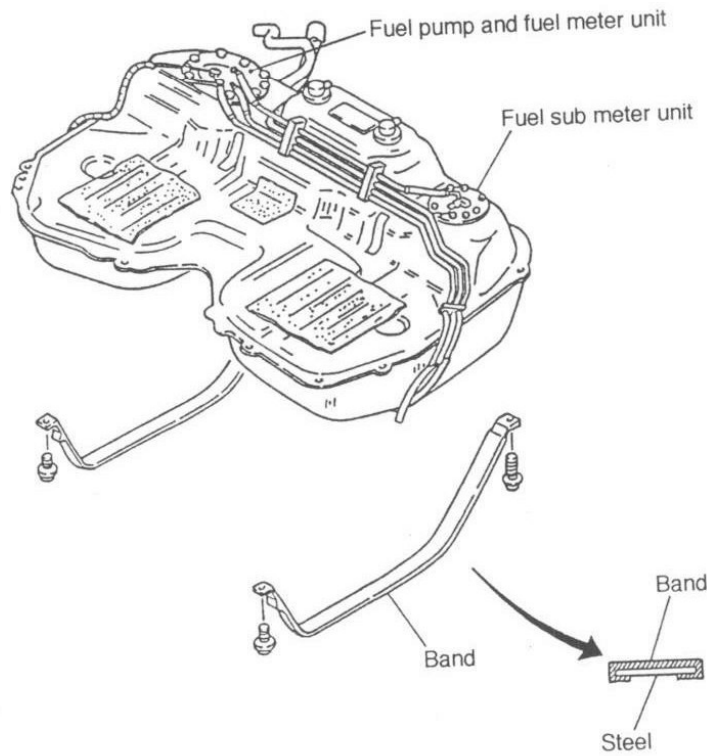
- ① Purge control solenoid valve
- ② Auxiliary purge control valve
- ③ Pressure regulator
- ④ Throttle body
- ⑤ Fuel filter
- ⑥ Intake manifold

- ⑦ Fuel pump
- ⑧ Jet pump
- ⑨ Fuel cut valve
- ⑩ Canister
- ⑪ Two-way valve

H2H1834A

B: TURBO MODEL

- The fuel tank is located under the rear seat and secured with hold down bands. The fuel tank utilizes a dented design to prevent interference with the rear differential.
- The fuel tank has two chambers, and is provided with a suction jet pump which transfers fuel from one chamber to another. Each fuel chamber has a built-in fuel sub meter unit.



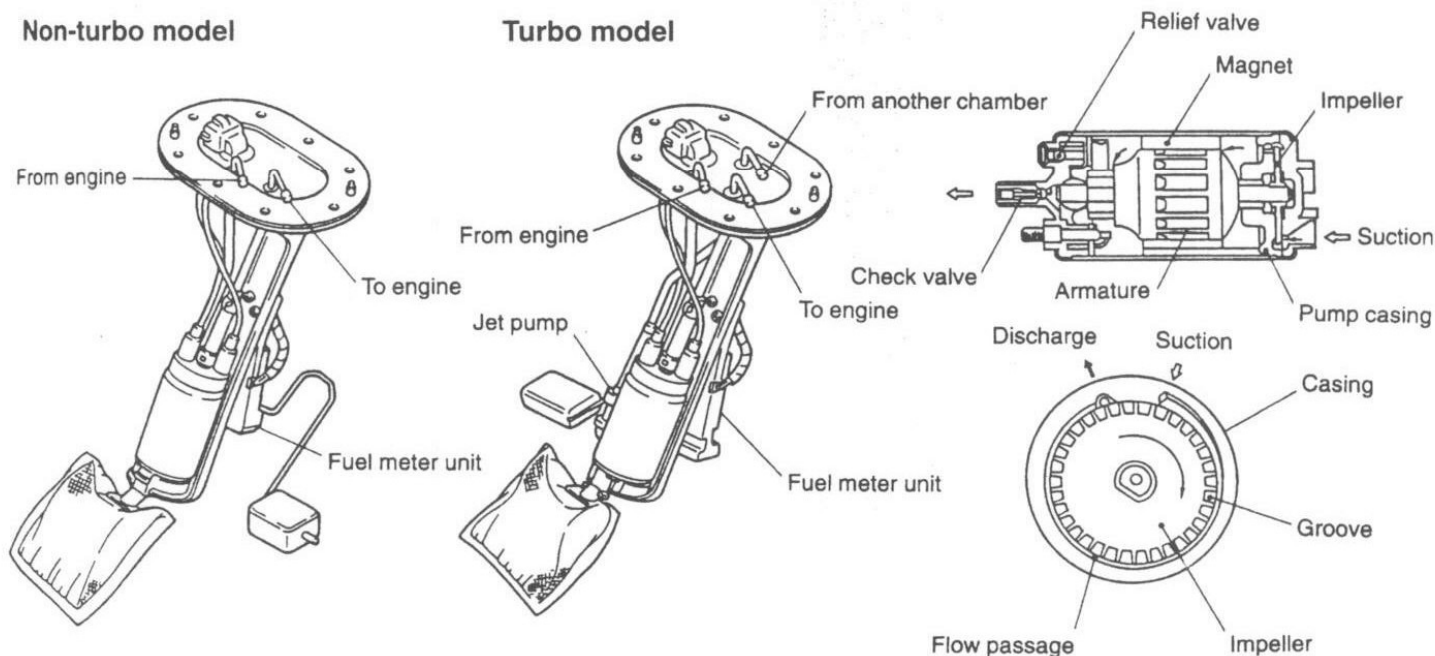
H2H1653A

3. Fuel Pump

The impeller type fuel pump consists of a motor, impeller, pump casing, pump cover, relief valve, check valve and pump filter. It is built into the fuel tank together with the fuel meter unit to provide quiet operation.

Non-turbo model

Turbo model

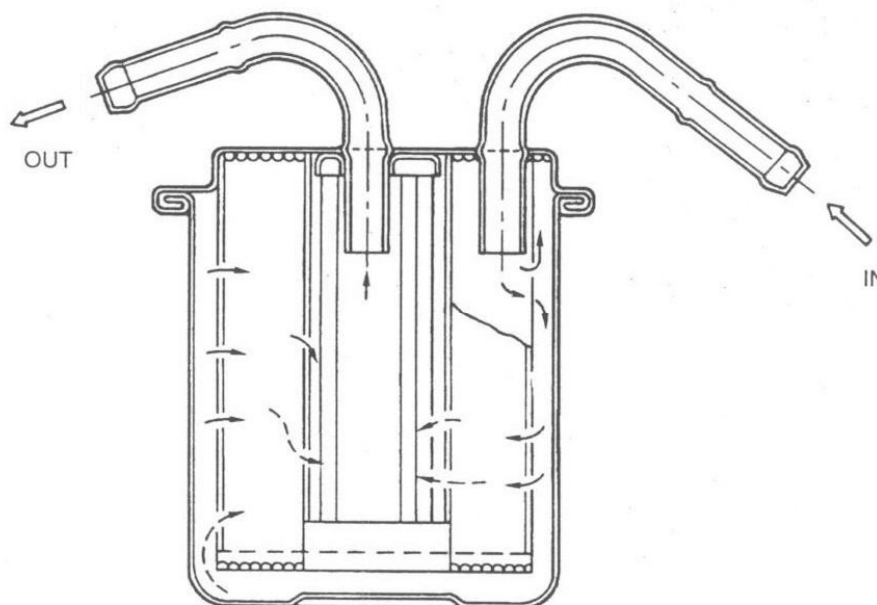


B2H0011B

- When the engine starts, fuel pump relay activates. This operates the motor to rotate the impeller.
- Fuel entering a vane groove of the impeller flows along the fuel passage and into the next vane groove by centrifugal force. During the time fuel flows from one groove to the next, a pressure differential is produced by friction of the flow.
- Thus, fuel pressure increases while the action is described in step 2) above is repeated, and fuel is discharged from the pump casing. Fuel under pressure then passes through the clearance between the armature and the magnet and is discharged from the fuel pump.
- As fuel discharge pressure reaches the specified value, the relief valve opens. This discharges fuel under pressure into the fuel tank. Fuel from the fuel tank then returns to the suction port and passes through the fuel pump. This action of fuel flow is repeated. In this manner, the relief valve prevents an abnormal increase in fuel pressure.
- When the engine and fuel pump stop, spring force acts on the check valve to close the discharge port so that fuel pressure remains in the fuel delivery line.

4. Fuel Filter

The fuel filter utilizes a pressure-withstanding, cartridge design. It has a filter element built into the metal case. With this design, fuel flows from the perimeter of the element to the interior of the filter.



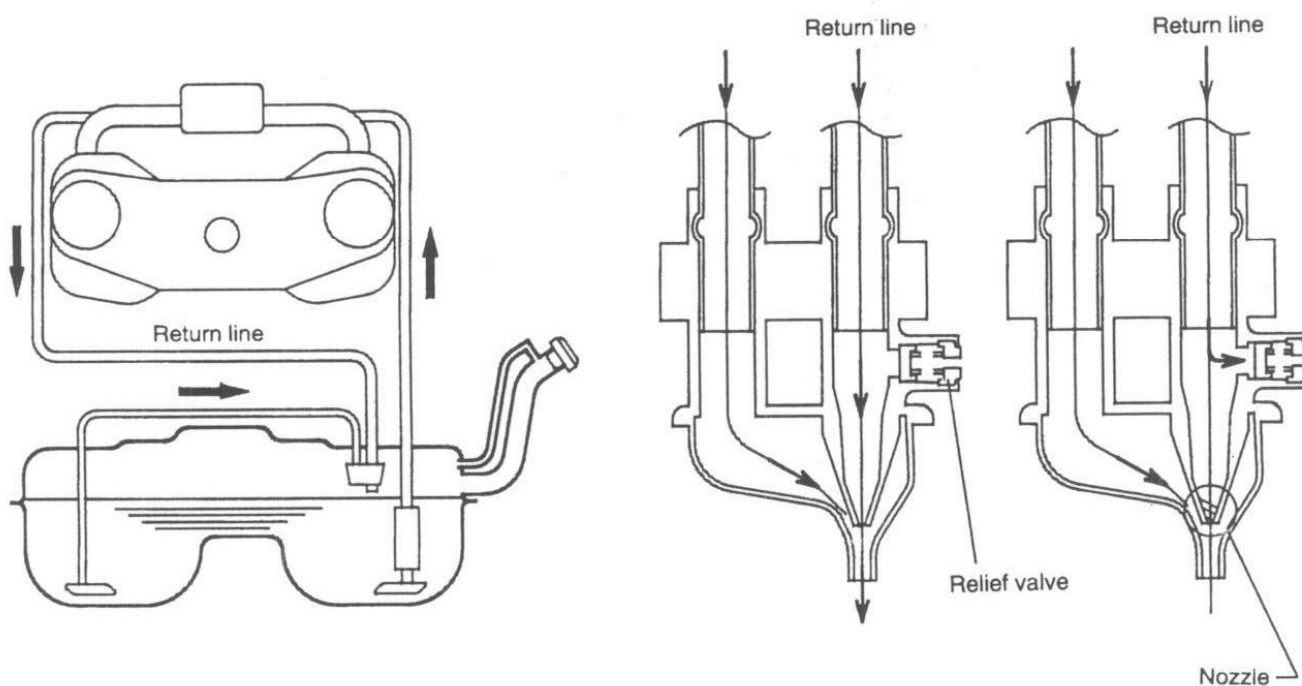
G2H0059

Jet Pump (Turbo model)

The jet pump utilizes the velocity of fuel returning from the engine to produce negative pressure at the jet pump.

This negative pressure allows fuel to be sucked up.

When the return line nozzle is clogged, the fuel sent back through the return line flows back into the fuel tank via the relief valve.



B2H0012A

FUEL INJECTION SYSTEM

[TURBO MODEL] 2-7c

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1. Supplemental Restraint System "Airbag"

Airbag system wiring harness is routed near the engine control module (ECM), main relay and fuel pump relay.

CAUTION:

- All Airbag system wiring harness and connectors are colored yellow. Do not use electrical test equipment on these circuit.
- Be careful not to damage Airbag system wiring harness when servicing the engine control module (ECM), main relay and fuel pump relay.

2. Pre-inspection

Before performing diagnostics, check the following items which might affect engine problems:

1. POWER SUPPLY

- 1) Measure battery voltage and specific gravity of electrolyte.

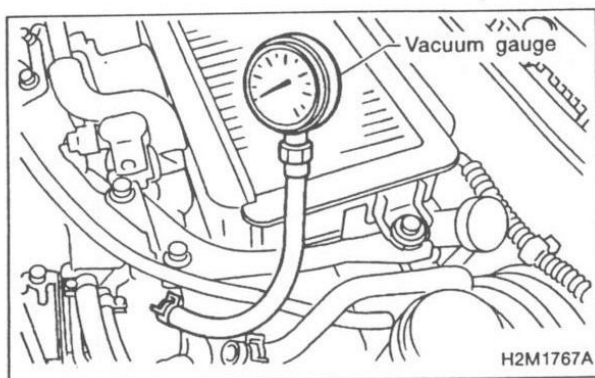
Standard voltage: 12 V

Specific gravity: Above 1.260

- 2) Check the condition of the main and other fuses, and harnesses and connectors. Also check for proper grounding.

2. CAPS AND PLUGS

- 1) Check that the fuel cap is properly closed.
- 2) Check that the oil filler cap is properly closed.
- 3) Check that the oil level gauge is properly inserted.



3. INTAKE MANIFOLD VACUUM PRESSURE

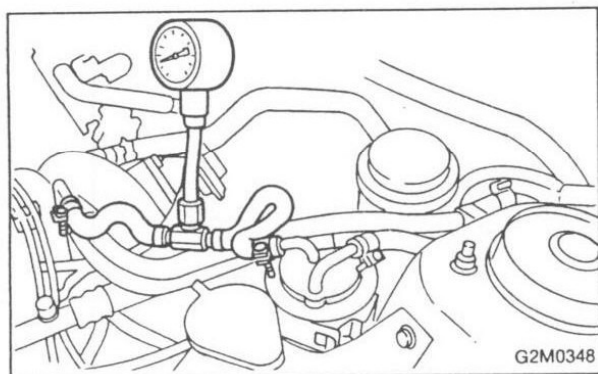
- 1) After warming-up the engine, measure intake manifold vacuum pressure while at idle.

Standard vacuum pressure:

More than -60.0 kPa (-450 mmHg, -17.72 inHg)

< Ref. to 2-2 [W5A0]. >

- 2) Unusual vacuum pressure occurs because of air leaks, fuel or engine problems. In such a case, engine idles roughly.



4. FUEL PRESSURE

- 1) Release fuel pressure.
< Ref. to 2-8 [W1A0]. >
- 2) Connect fuel pressure gauge between fuel filter and hose, and measure fuel pressure at idling.
< Ref. to 2-8 [W2A0]. >

Fuel pressure:

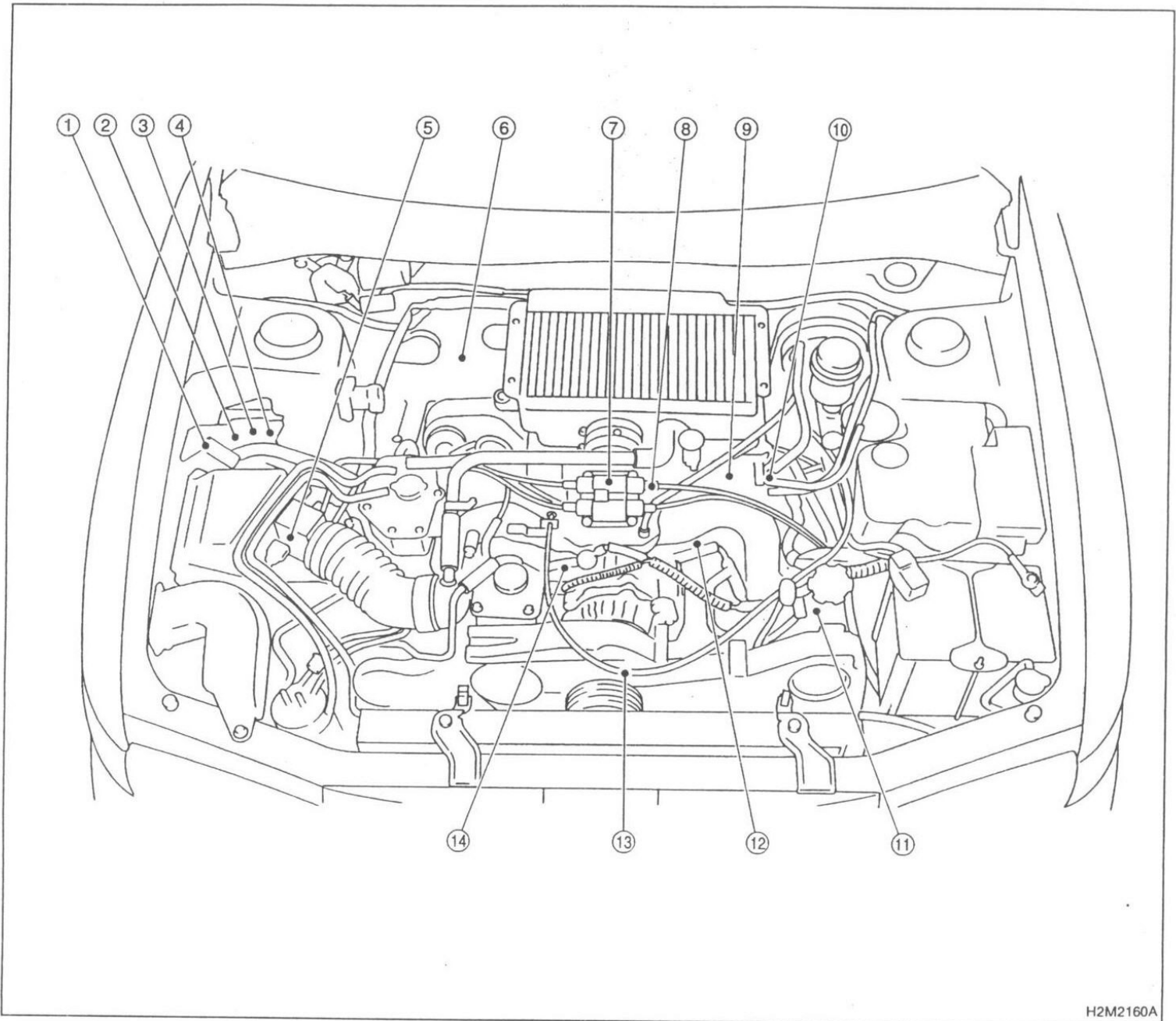
$284 - 314$ kPa ($2.9 - 3.2$ kg/cm², $41 - 46$ psi)

5. ENGINE GROUNDING

Make sure the engine grounding terminal is properly connected to the engine.

3. Electrical Unit Location

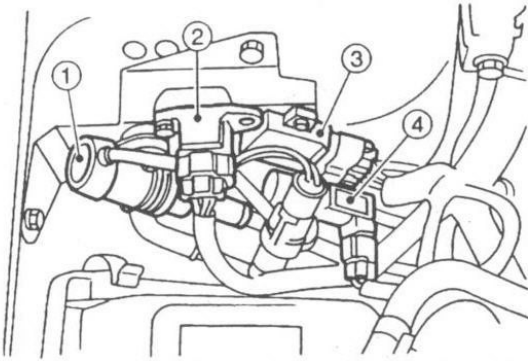
A: SENSOR AND SOLENOID VALVE



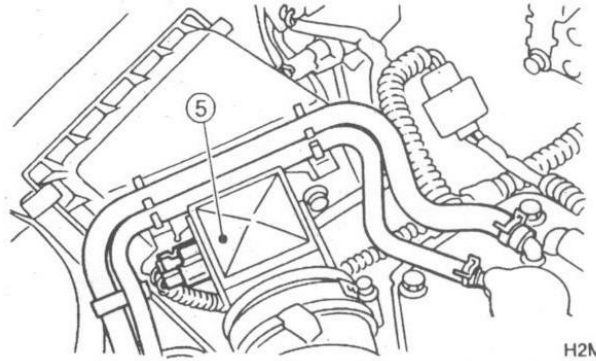
H2M2160A

- ① Wastegate control solenoid valve
- ② Pressure sensor
- ③ Ignitor
- ④ Pressure sources switching solenoid valve
- ⑤ Mass air flow sensor
- ⑥ Vehicle speed sensor 2
- ⑦ Ignition coil

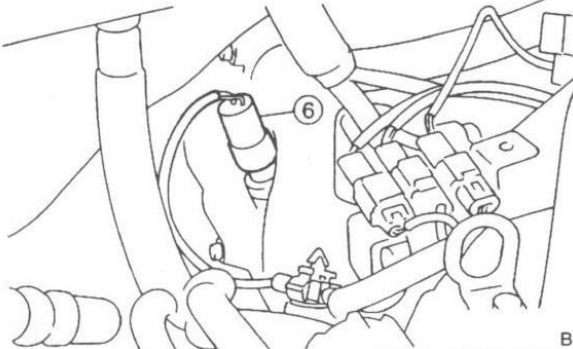
- ⑧ Throttle position sensor
- ⑨ Idle air control solenoid valve
- ⑩ Purge control solenoid valve
- ⑪ Camshaft position sensor
- ⑫ Knock sensor
- ⑬ Crankshaft position sensor
- ⑭ Engine coolant temperature sensor



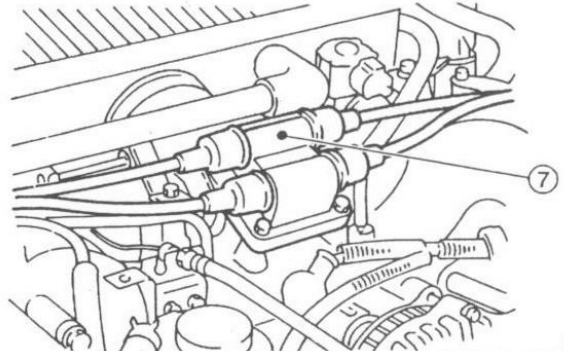
H2M2161A



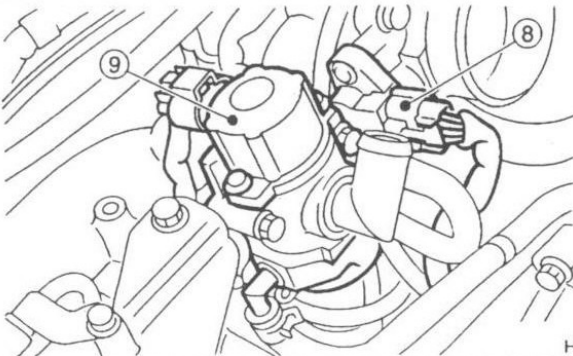
H2M1768C



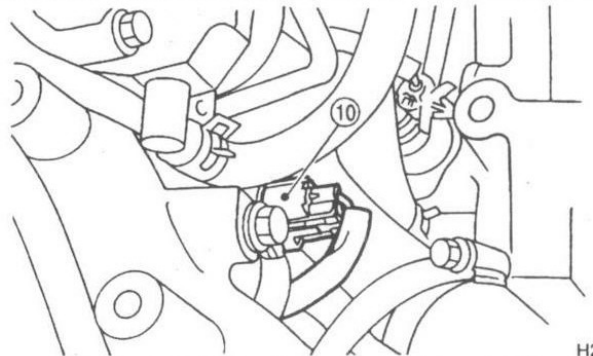
B2M0211D



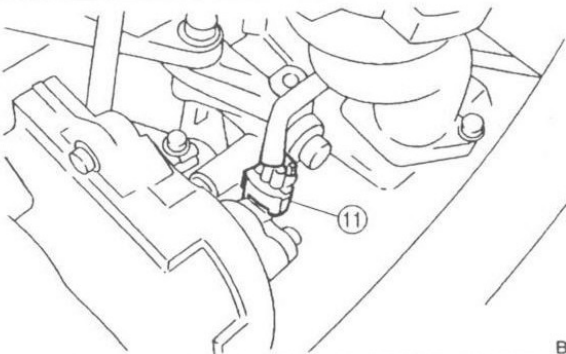
H6M0434D



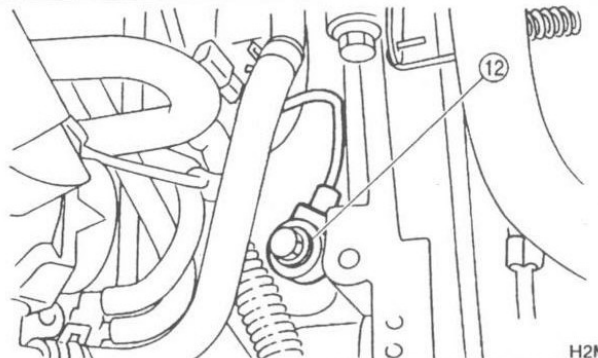
H2M2162A



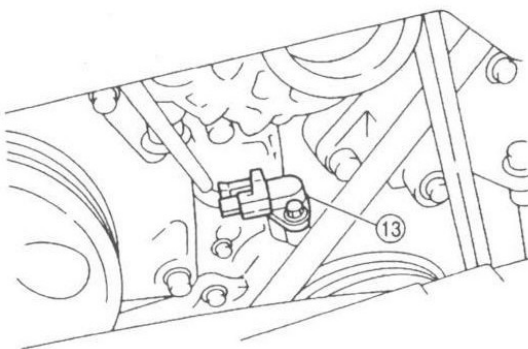
H2M2163A



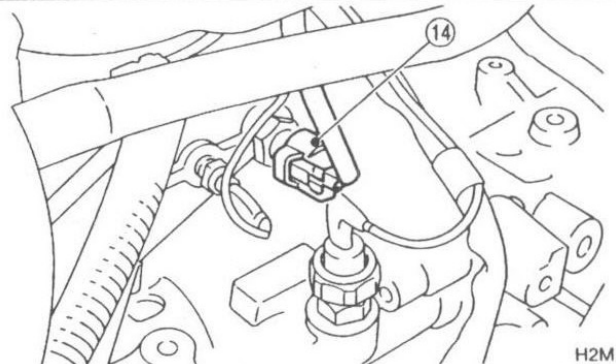
B2M0212C



H2M9999A

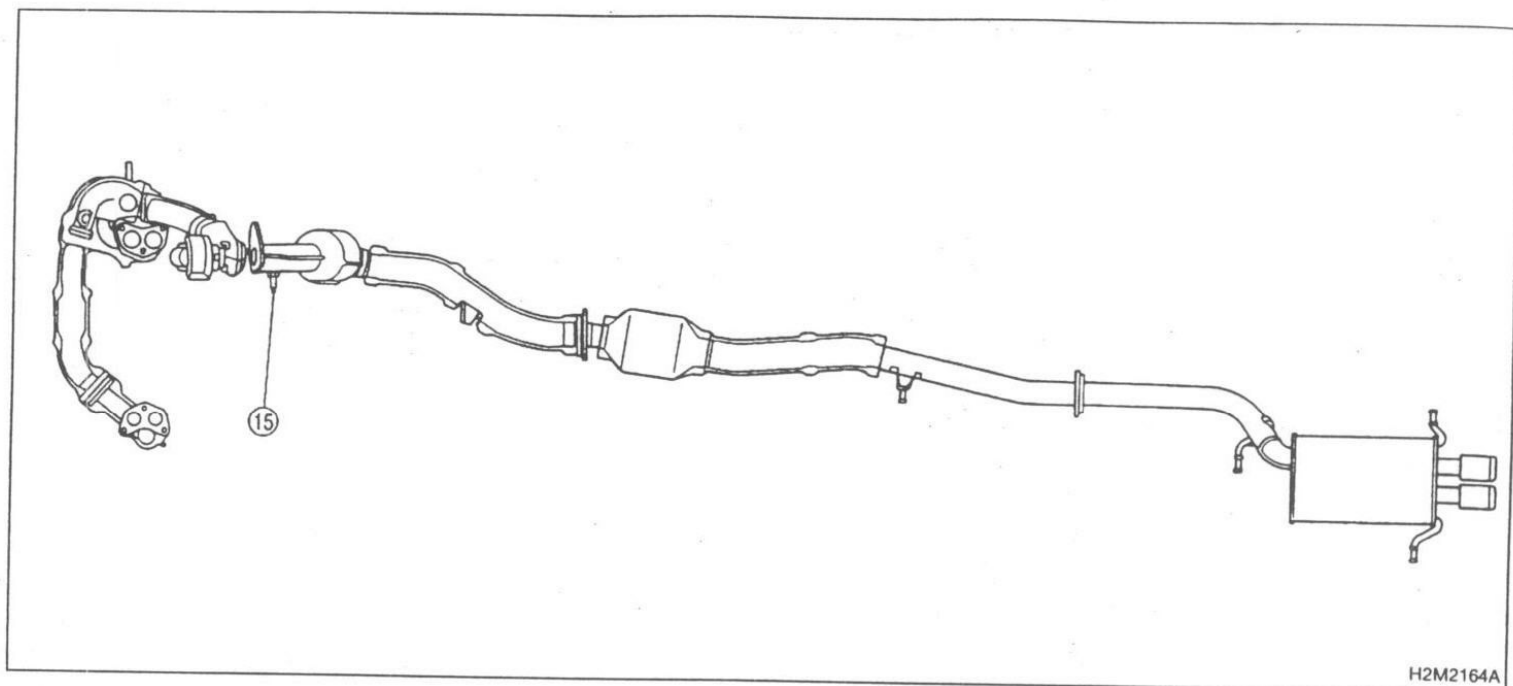


B2M0213G

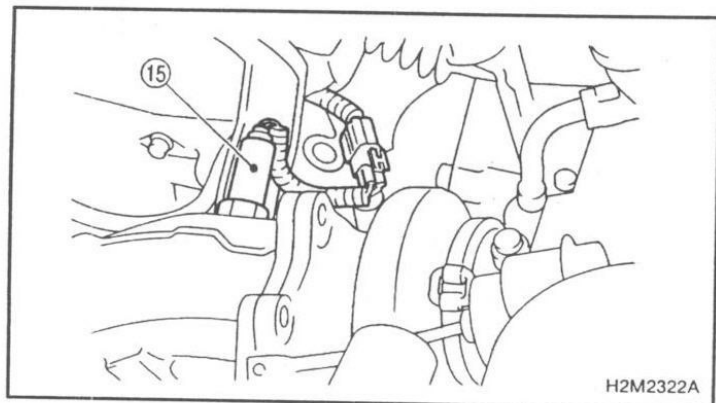


H2M1906B

3. Electrical Unit Location

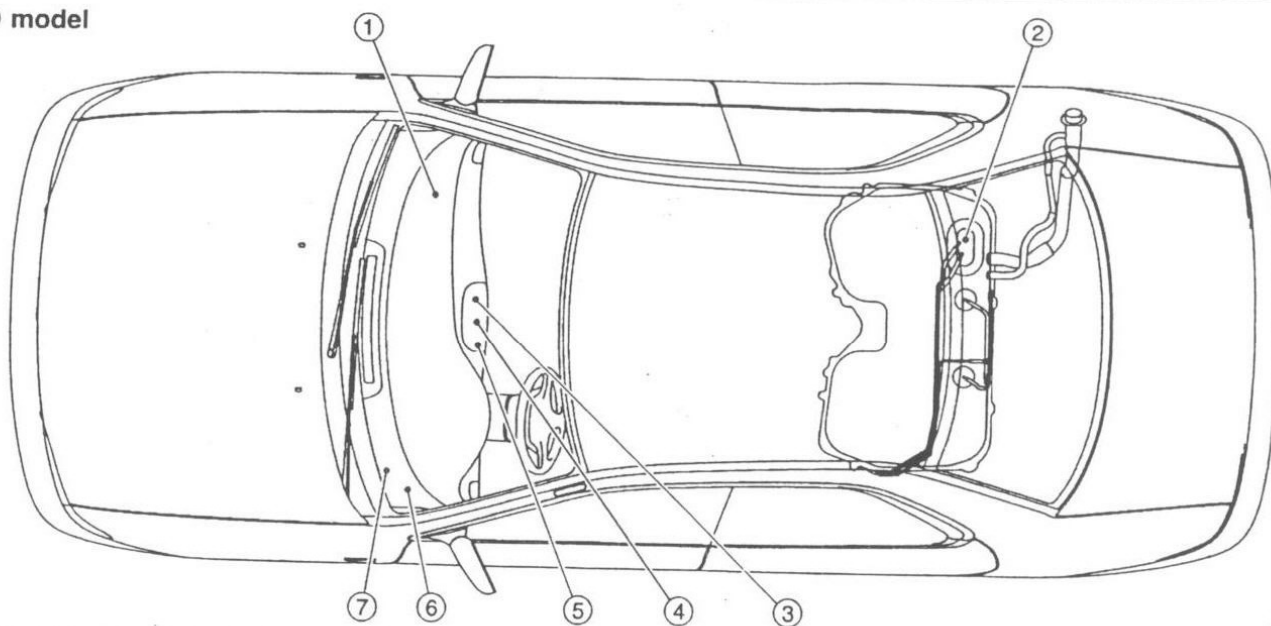


⑮ Oxygen sensor



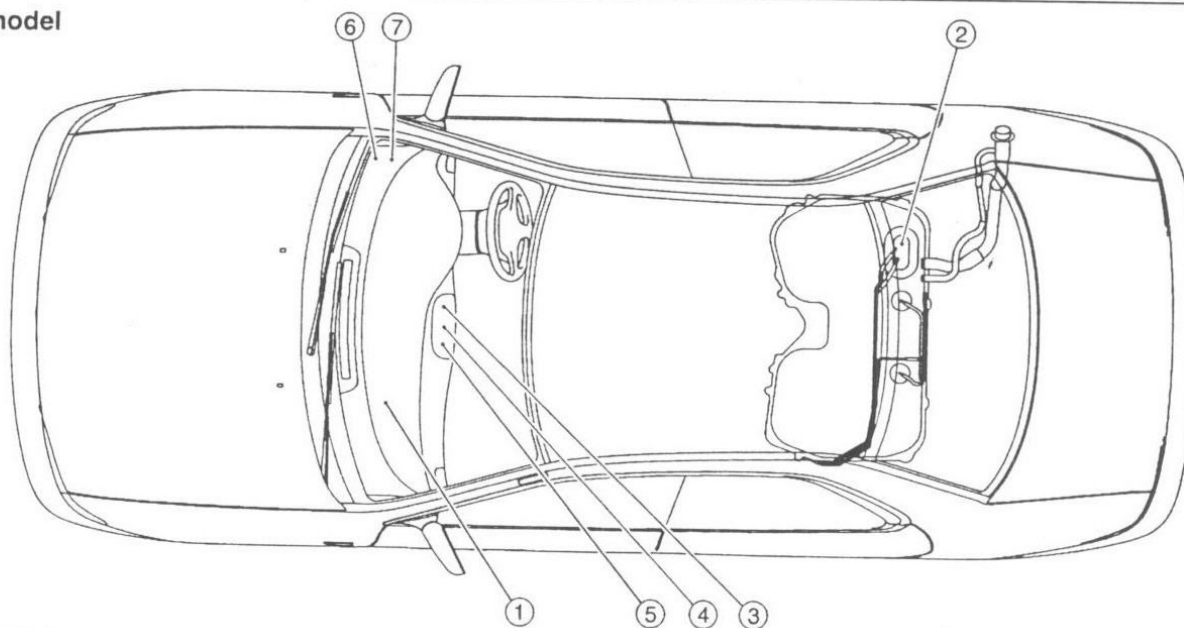
B: MODULE AND RELAY

LHD model



H2M1527B

RHD model

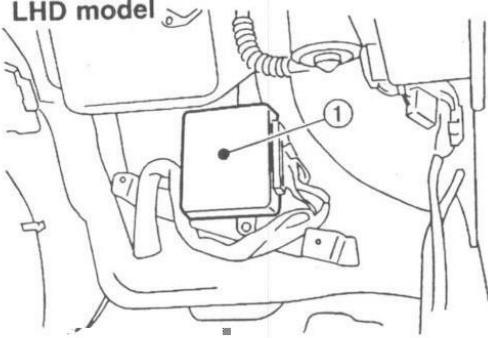


H2M1539B

- ① ECM
- ② Fuel pump
- ③ Read memory connector
- ④ Test mode connector

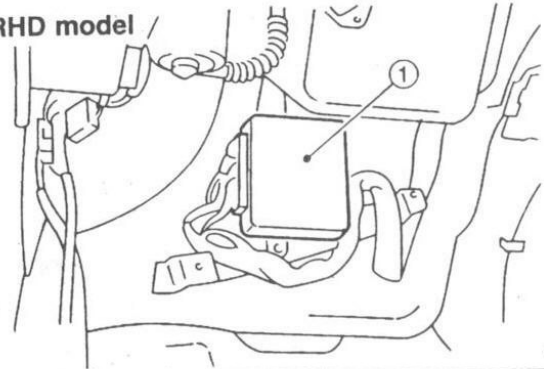
- ⑤ Data link connector
- ⑥ Main relay
- ⑦ Fuel pump relay

LHD model

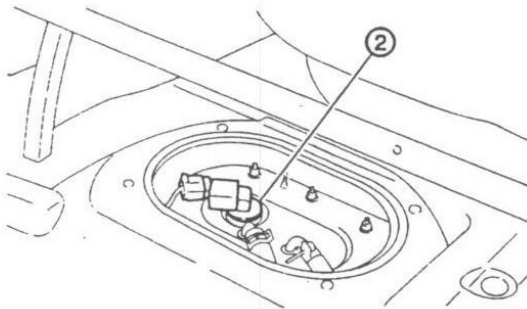


B2M0215B

RHD model

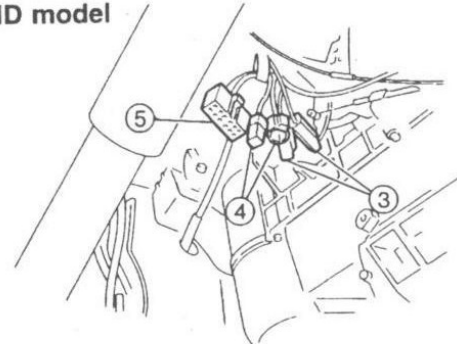


B2M1383A



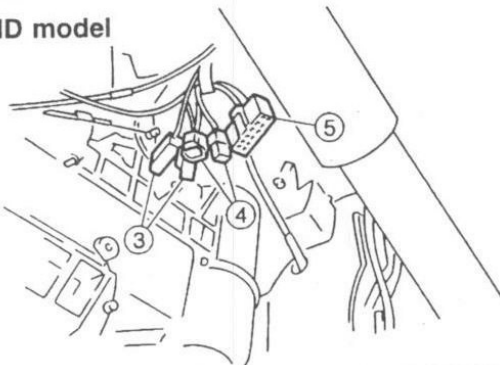
B2M0216A

LHD model



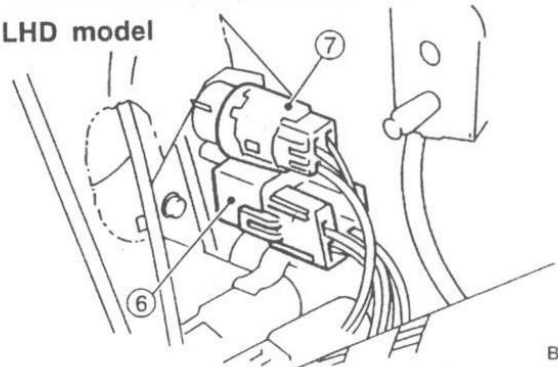
B2M0217B

RHD model



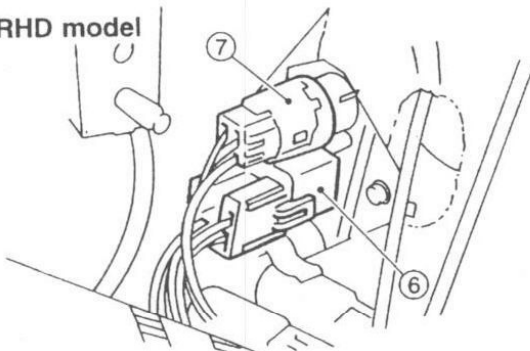
B2M1384A

LHD model



B2M0218D

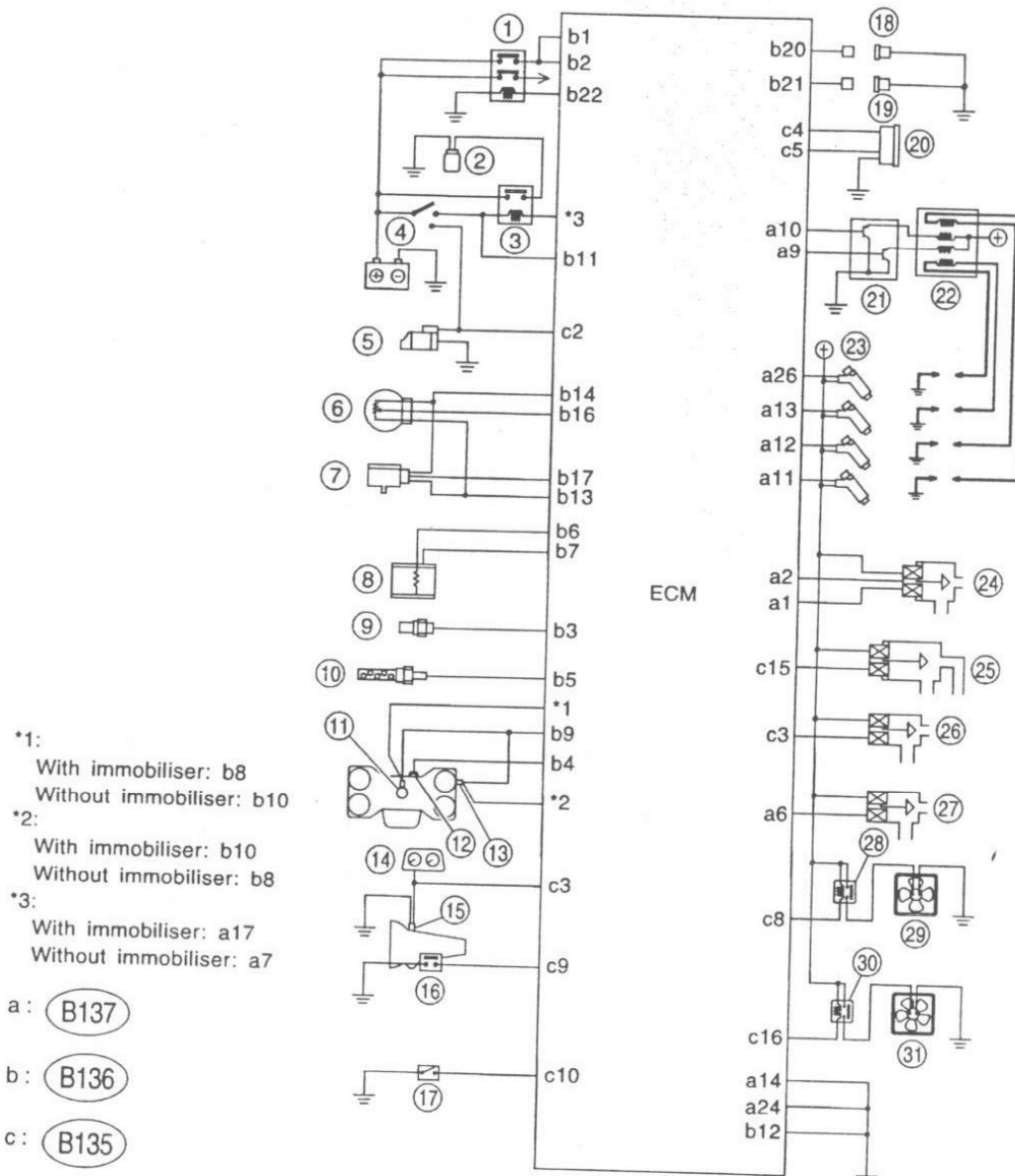
RHD model



B2M0434C

4. Schematic

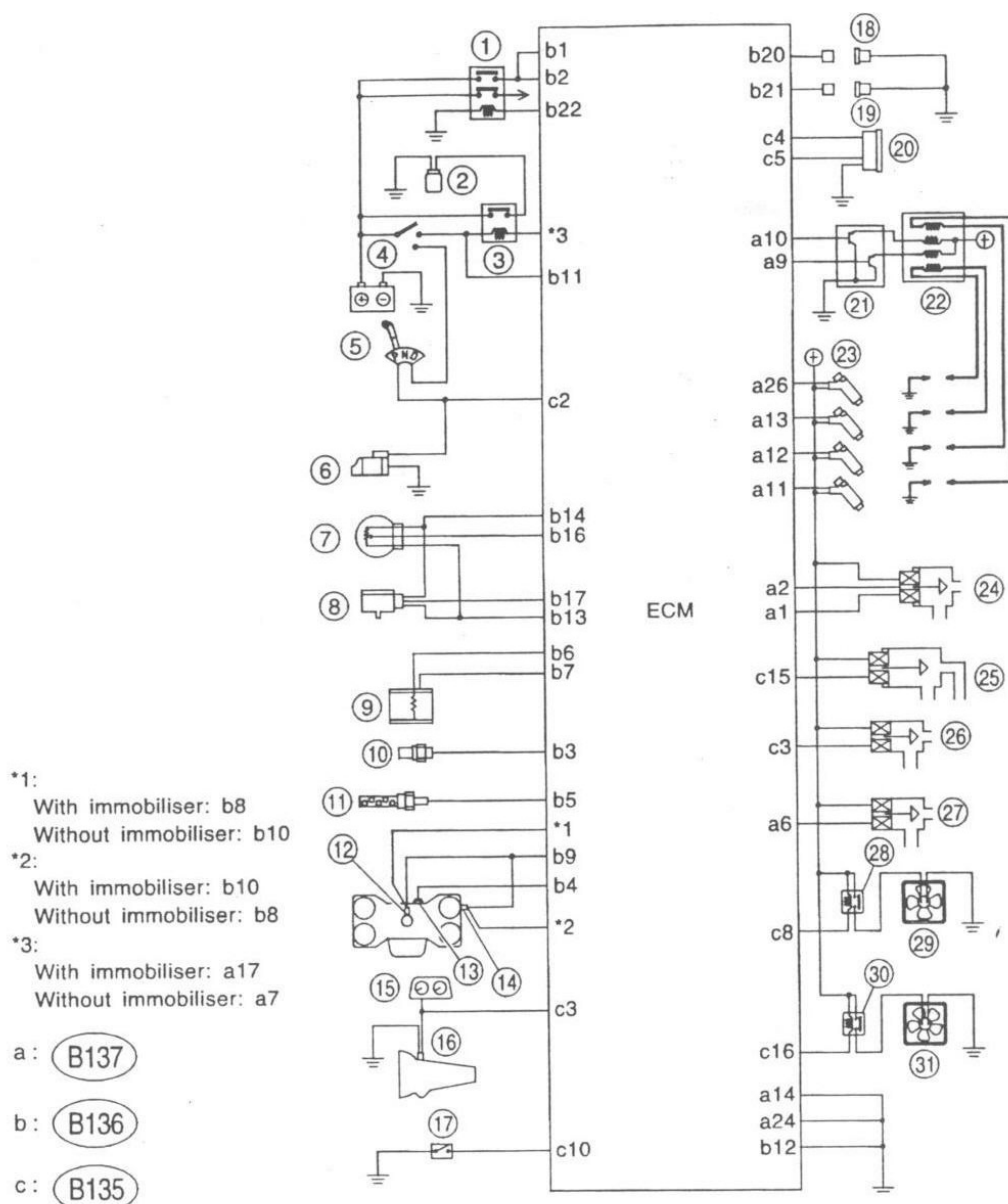
A: MT VEHICLES



H2M2165A

- | | | |
|-------------------------------------|------------------------------|---|
| ① Main relay | ⑪ Crankshaft position sensor | ⑳ Ignition coil |
| ② Fuel pump | ⑫ Knock sensor | ㉑ Fuel injector |
| ③ Fuel pump relay | ⑬ Camshaft position sensor | ㉒ Idle air control solenoid valve |
| ④ Ignition switch | ⑭ Combination meter | ㉓ Purge control solenoid valve |
| ⑤ Starter | ⑮ Vehicle speed sensor 2 | ㉔ Wastegate control solenoid valve |
| ⑥ Throttle position sensor | ⑯ Neutral position switch | ㉕ Pressure sources switching solenoid valve |
| ⑦ Pressure sensor | ⑰ A/C switch | ㉖ Radiator main fan relay |
| ⑧ Mass air flow sensor | ⑱ Read memory connector | ㉗ Radiator main fan |
| ⑨ Engine coolant temperature sensor | ㉒ Test mode connector | ㉘ Radiator sub fan relay |
| ⑩ Oxygen sensor | ㉓ Data link connector | ㉙ Radiator sub fan |
| | ㉔ Ignitor | |

B: AT VEHICLES



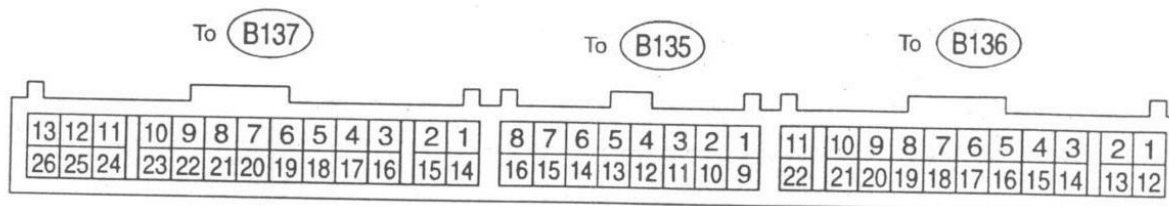
H2M2166A

- ① Main relay
- ② Fuel pump
- ③ Fuel pump relay
- ④ Ignition switch
- ⑤ Park/Neutral position (inhibitor) switch
- ⑥ Starter
- ⑦ Throttle position sensor
- ⑧ Pressure sensor
- ⑨ Mass air flow sensor
- ⑩ Engine coolant temperature sensor

- ⑪ Oxygen sensor
- ⑫ Crankshaft position sensor
- ⑬ Knock sensor
- ⑭ Camshaft position sensor
- ⑮ Combination meter
- ⑯ Vehicle speed sensor 2
- ⑰ A/C switch
- ⑱ Read memory connector
- ⑲ Test mode connector
- ⑳ Data link connector
- ㉑ Ignitor

- ㉒ Ignition coil
- ㉓ Fuel injector
- ㉔ Idle air control solenoid valve
- ㉕ Purge control solenoid valve
- ㉖ Wastegate control solenoid valve
- ㉗ Pressure sources switching solenoid valve
- ㉘ Radiator main fan relay
- ㉙ Radiator main fan
- ㉚ Radiator sub fan relay
- ㉛ Radiator sub fan

5. Control Module I/O Signal



B2M0219F

Content		Connector No.	Terminal No.	Signal (V)		Note
				Ignition SW	Engine ON (Idling)	
				ON (Engine OFF)		
Crankshaft position sensor	Signal (+)	B136	*1	0	±6	Sensor output waveform
	Signal (-)	B136	9	0	0	—
	Shield	B136	13	0	0	—
Camshaft position sensor	Signal (+)	B136	*2	0	±6	Sensor output waveform
	Signal (-)	B136	9	0	0	—
	Shield	B136	13	0	0	—
Mass air flow sensor	Signal	B136	6	0 — 0.3	0.8 — 1.2	—
	Shield	B136	13	0	0	—
	GND	B136	7	0	0	—
Throttle position sensor	Signal	B136	16	Fully closed: 0.5 ± 0.3 Fully opened: 4.3 ± 0.3		—
	Power supply	B136	14	5	5	—
	GND	B136	13	0	0	—
Oxygen sensor	Signal	B136	5	0	Rich mixture: 0.7 Lean mixture: 0	
	Shield	B136	13	0	0	—
Engine coolant temperature sensor	Signal	B136	3	0.6 — 1.0	0.6 — 1.0	After warm-up
	GND	B136	13	0	0	—
Vehicle speed sensor 2		B135	3	0 or 5	0 or 5	"5" and "0" are repeatedly displayed when vehicle is driven.
Starter switch		B135	2	0	0	Cranking: 10 to 14
A/C switch		B135	10	ON: 10 — 13 OFF: 0	ON: 13 — 14 OFF: 0	—
Ignition switch		B136	11	10 — 13	13 — 14	—
Neutral position switch (MT)		B135	9	ON: 5 OFF: 0		Switch is ON when gear is in neutral position.
Park/Neutral position switch (AT)		B135	9	ON: 0 OFF: 5		Switch is ON when shift lever is in "P" or "N" position.
Test mode connector		B136	21	5	5	When connected: 0

*1: With immobiliser: 8
Without immobiliser: 10

*2: With immobiliser: 10
Without immobiliser: 8

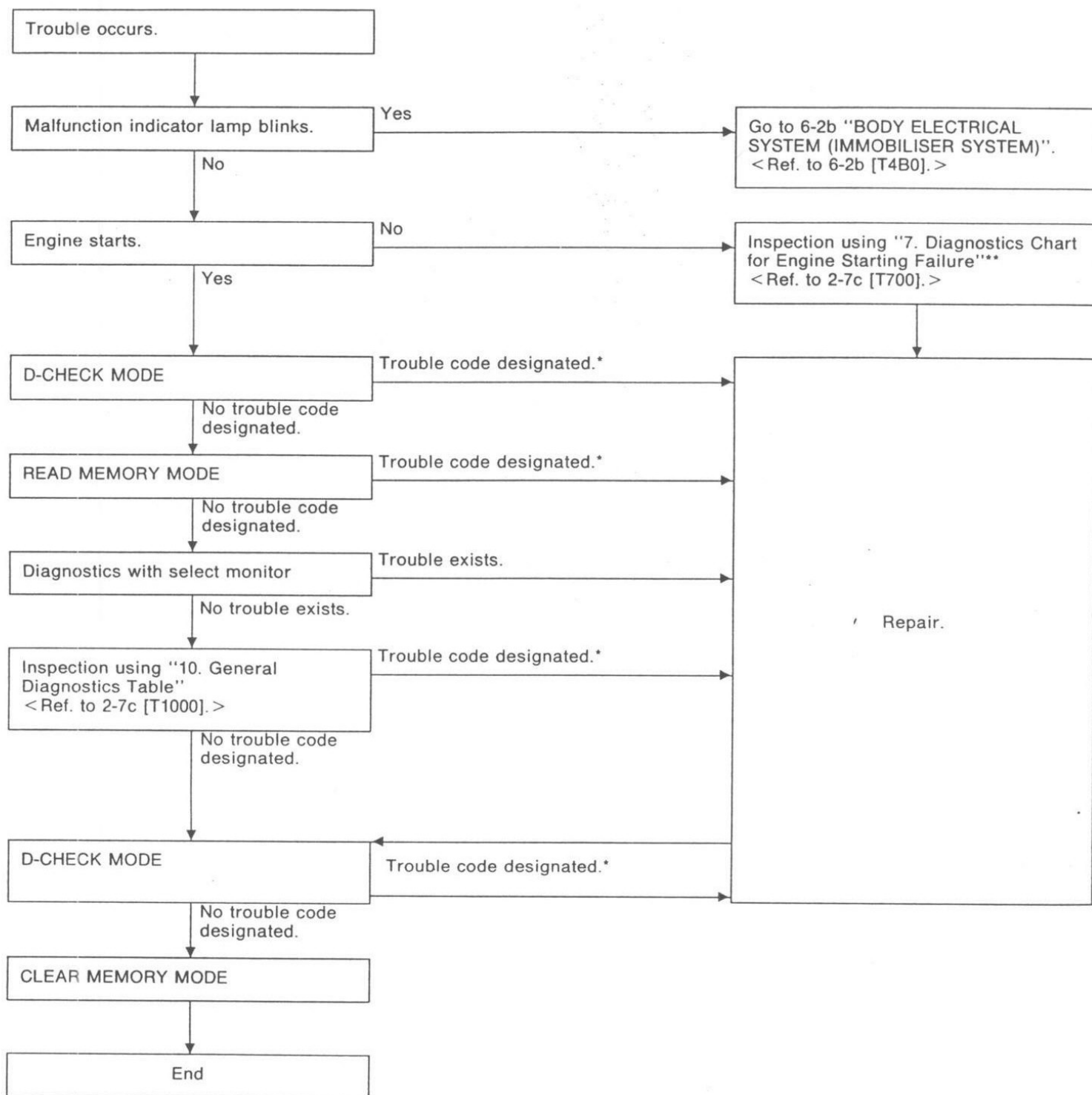
Content		Connector No.	Terminal No.	Signal (V)		Note
				Ignition SW	Engine ON (Idling)	
				ON (Engine OFF)		
Read memory connector		B136	20	5	5	When connected: 0
Back-up power supply		B137	15	10 — 13	13 — 14	—
Control unit power supply		B136	1	10 — 13	13 — 14	—
			2			
Ignition control	# 1, # 2	B137	10	0	3.4, max.	—
	# 3, # 4	B137	9	0	3.4, max.	—
Fuel injector	# 1	B137	26	10 — 13	13 — 14	Waveform
	# 2	B137	13	10 — 13	13 — 14	Waveform
	# 3	B137	12	10 — 13	13 — 14	Waveform
	# 4	B137	11	10 — 13	13 — 14	Waveform
Idle air control solenoid valve	OPEN end	B137	2	—	1, max. — 13, min.	Waveform
	CLOSE end	B137	1	—	13, min. — 1, max.	Waveform
Torque control signal*4		B135	11	0	5	—
Fuel pump relay control		B137	*3	ON: 0 OFF: 10 — 13	0	—
A/C relay control		B137	21	ON: 0 OFF: 10 — 13	ON: 0 OFF: 13 — 14	—
Radiator fan relay 1 control		B135	8	ON: 0 OFF: 10 — 13	ON: 0 OFF: 13 — 14	—
Radiator fan relay 2 control		B135	16	ON: 0 OFF: 10 — 13	ON: 0 OFF: 13 — 14	—
Self-shutoff control		B136	22	10 — 13	13 — 14	—
Malfunction indicator lamp		B137	8	—	—	Light "ON": 1, max. Light "OFF": 10 — 14
Engine speed output		B135	14	—	0 — 13, min.	Waveform
Knock sensor	Signal	B136	4	2.8	2.8	—
	Shield	B136	13	0	0	—
Wastegate control		B137	3	10 — 13	13 — 14	—
Pressure sources switching solenoid valve		B137	6	10 — 13	13 — 14	—
Purge control solenoid valve		B135	15	ON: 0 OFF: 10 — 13	ON: 0 OFF: 13 — 14	—
GND (sensors)		B136	13	0	0	—
GND (injectors)		B137	25	0	0	—
GND (ignition system)		B137	24	0	0	—
GND (power supply)		B137	14	0	0	—
GND (control systems)		B136	12	0	0	—
Select monitor signal		B135	4	—	—	—
			5	—	—	—

*3: With immobiliser: 17
Without immobiliser: 7

*4: AT model only

6. Diagnostics Chart for On-board Diagnosis System

A: BASIC DIAGNOSTICS PROCEDURE



*: When more than one trouble code is out-putted, begin diagnostics with the smallest trouble code number and proceed to the next higher code. After correcting each problem, conduct the D-CHECK and ensure that the corresponding trouble code no longer appears.

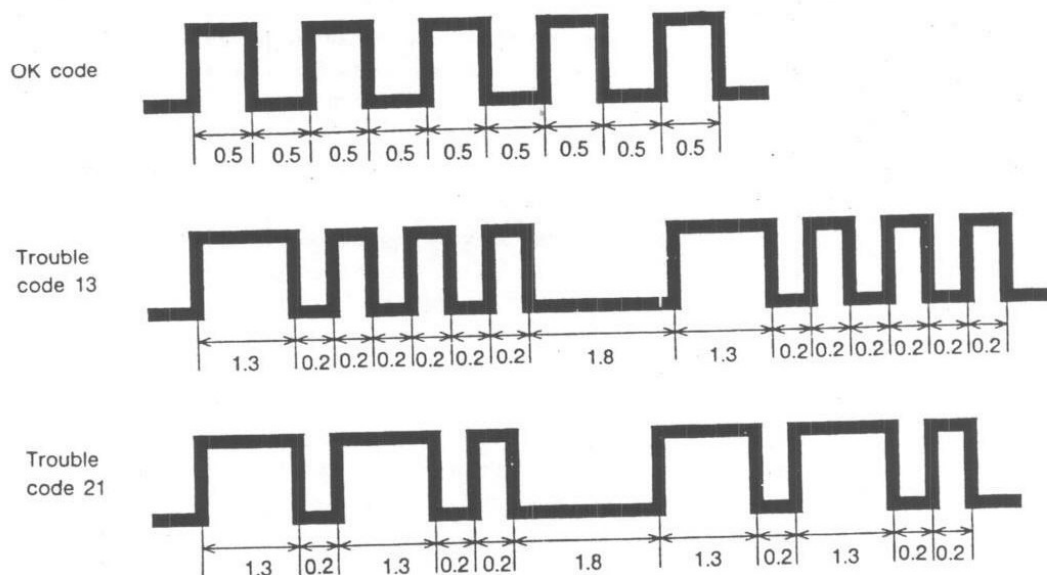
** : When a trouble code is displayed in the READ MEMORY MODE, conduct diagnostics measures which correspond with the code.

CAUTION:

- Check the connector while it is connected unless specified otherwise.
- Be sure to check again from the beginning in order to prevent secondary trouble caused by repair work.

B: TROUBLE CODE**1. HOW TO READ TROUBLE CODE**

The malfunction indicator lamp flashes the code corresponding to the faulty parts. The long segment (1.3 seconds ON) indicates a "ten", and the short segment (0.2 seconds ON) signifies "one". And middle segment (0.5 seconds ON) means OK code.

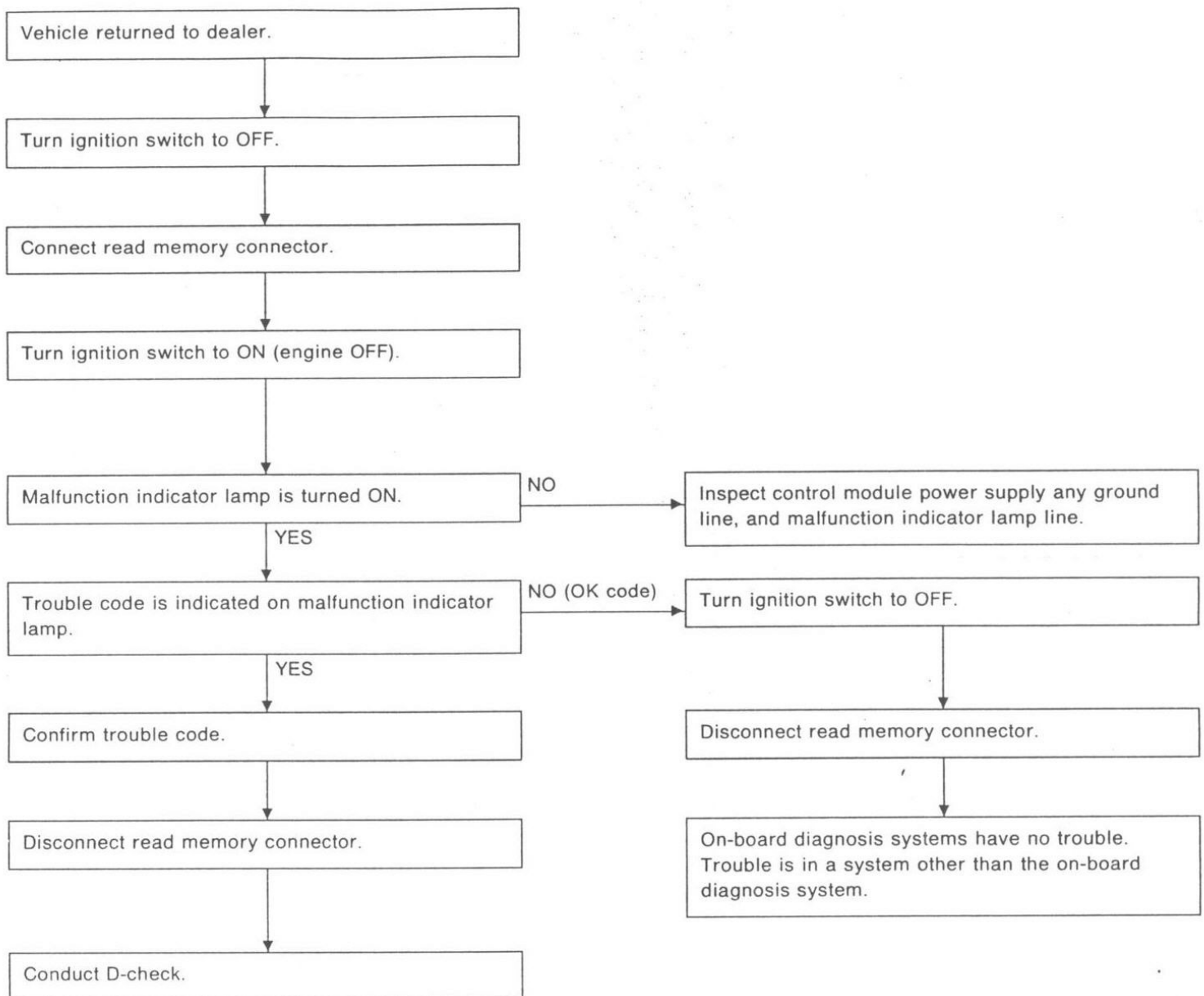


G2M0886

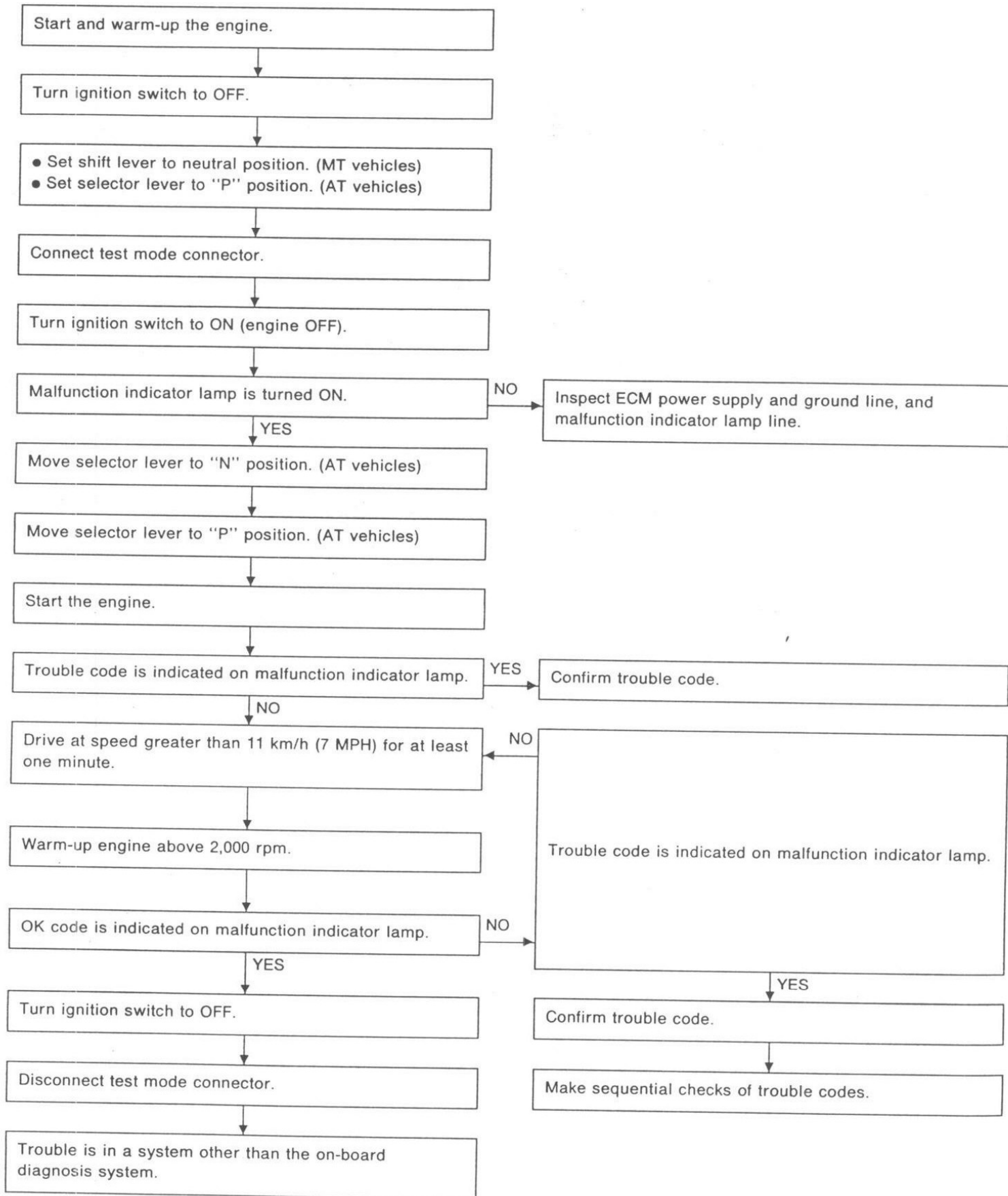
2. LIST OF TROUBLE CODE

Trouble code	Item	Contents of diagnosis
11	Crankshaft position sensor	● No signal entered from crankshaft position sensor when starter switch is ON. ● The harness connector between ECM and crankshaft position sensor is in short or open.
12	Starter switch	● The starter switch signal is abnormal. ● The harness connector between ECM and starter switch is in short or open.
13	Camshaft position sensor	● No signal entered from camshaft position sensor, but signal entered from crankshaft position sensor. ● The harness connector between ECM and camshaft position sensor is in short or open.
21	Engine coolant temperature sensor	● The engine coolant temperature sensor signal is abnormal. ● The harness connector between ECM and engine coolant temperature sensor is in short or open.
22	Knock sensor	● The knock sensor signal is abnormal. ● The harness connector between ECM and knock sensor is in short or open.
23	Mass air flow sensor	● The mass air flow sensor signal is abnormal. ● The harness connector between ECM and mass air flow sensor is in short or open.
24	Idle air control solenoid valve	● The idle air control solenoid valve is not in function. ● The harness connector between ECM and idle air control solenoid valve is in short or open.
31	Throttle position sensor	● The throttle position sensor signal is abnormal. ● The throttle position sensor is installed abnormally. ● The harness connector between ECM and throttle position sensor is in short or open.
32	Oxygen sensor	● The oxygen sensor is not in function. ● The harness connector between ECM and oxygen sensor is in short or open.
33	Vehicle speed sensor 2	● The vehicle speed sensor 2 is not in function. ● The harness connector between ECM and vehicle speed sensor 2 is in short or open.
38	Torque control signal (AT)	● Abnormal signal is entered from TCM. ● The harness connector between ECM and TCM is in short or open.
44	Wastegate control solenoid valve	● The wastegate control solenoid valve is not in function. ● The harness connector between ECM and wastegate control solenoid valve is in short or open.
45	● Pressure sensor ● Pressure sources switching solenoid valve	● The pressure sensor signal is abnormal. ● The pressure sources switching solenoid valve is not in function. ● The intake manifold pressure is not transmitted to pressure sensor. ● The harness connector between ECM and pressure sensor, and pressure sources switching solenoid valve is in short or open.
51	Neutral position switch (MT)	● The neutral position switch signal is abnormal. ● The harness connector between ECM and neutral position switch is in short or open.
	Park/Neutral position switch (AT)	● The park/neutral position switch signal is abnormal. ● The shift cable is connected abnormally. ● The harness connector between ECM and inhibitor switch is in short or open.
53*	Immobiliser system	Faulty immobiliser system. < Refer to 6-2b [T100]. >

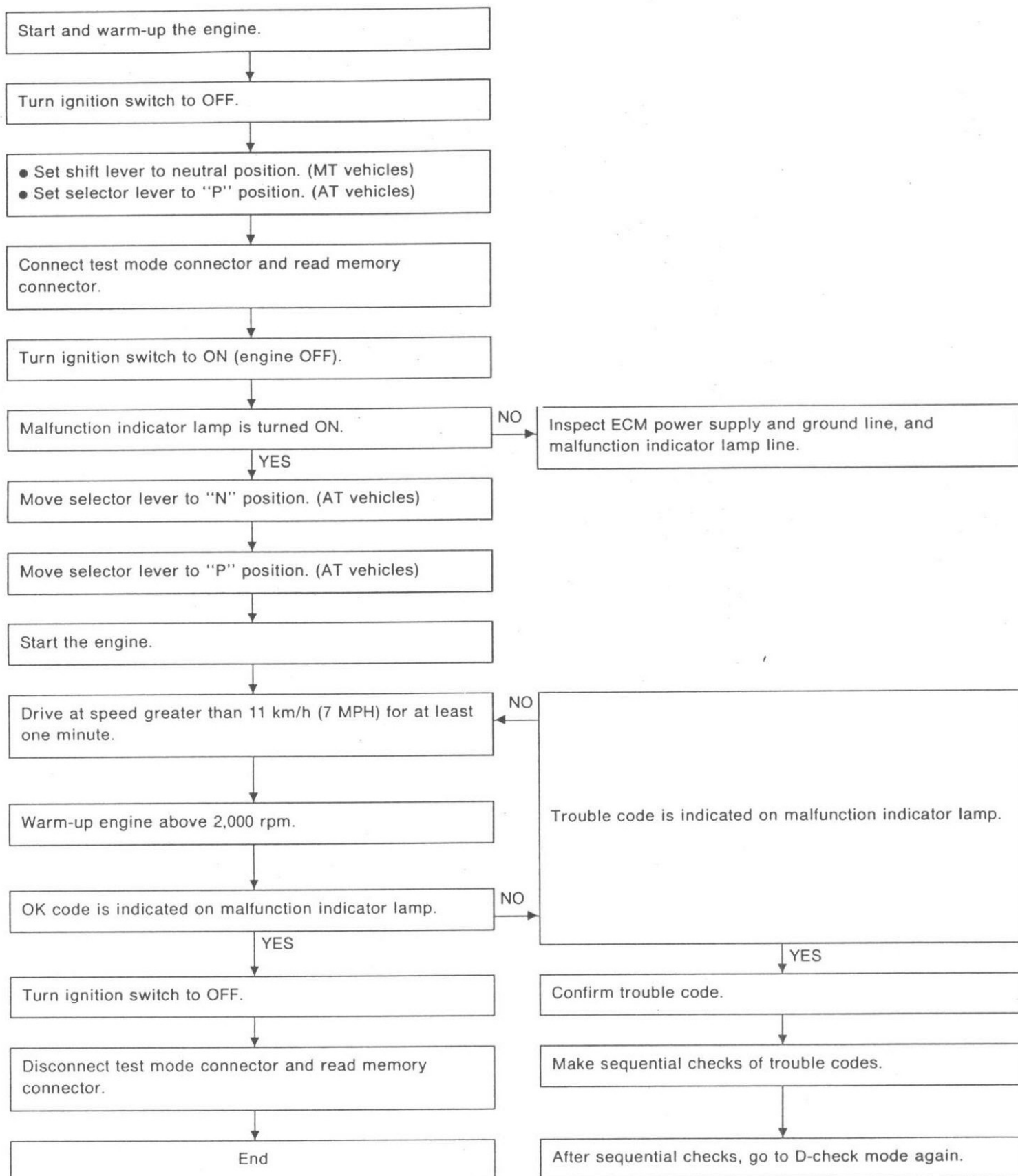
*: Immobiliser system equipped model only

C: READ MEMORY MODE

D: D-CHECK MODE



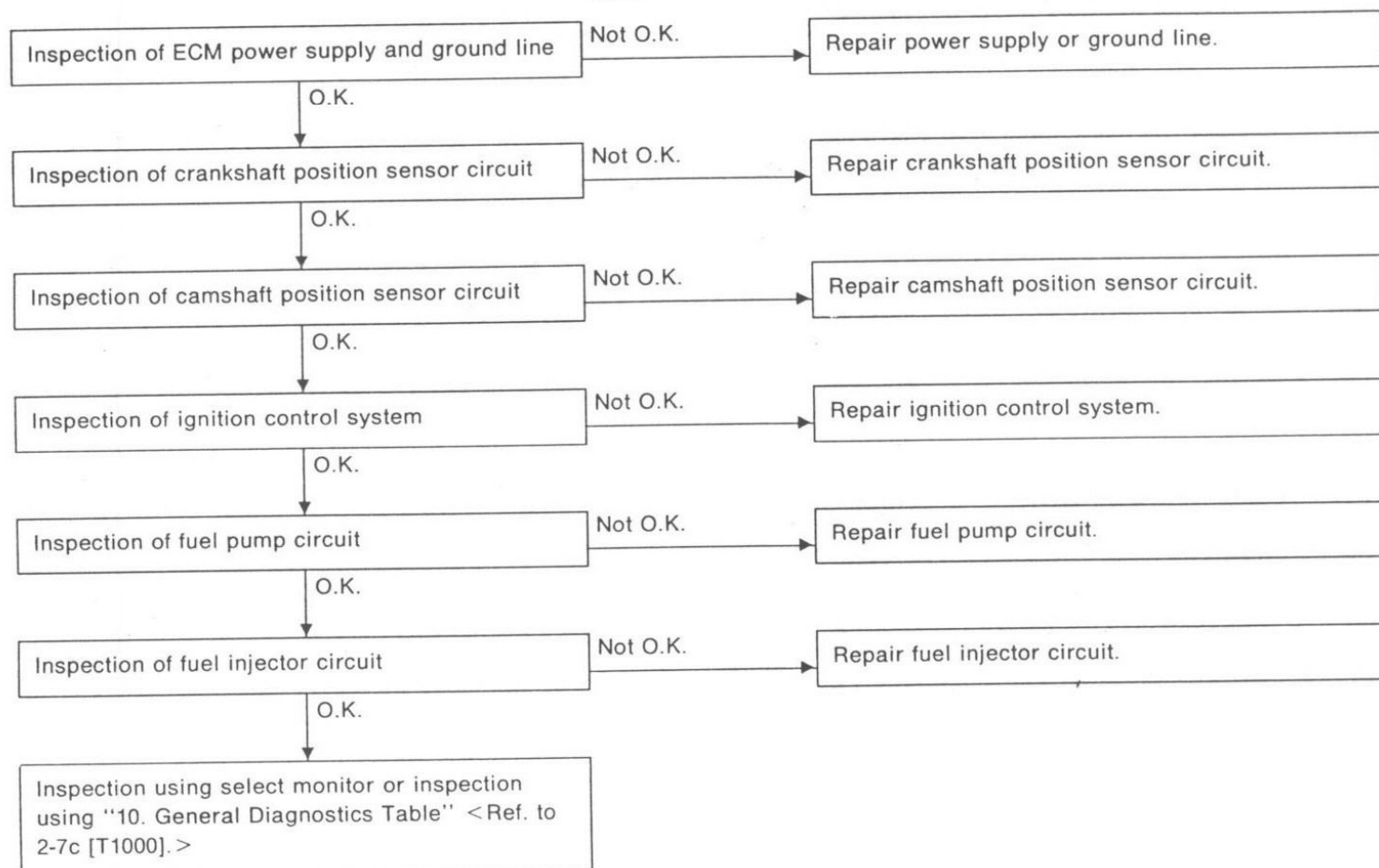
E: CLEAR MEMORY MODE

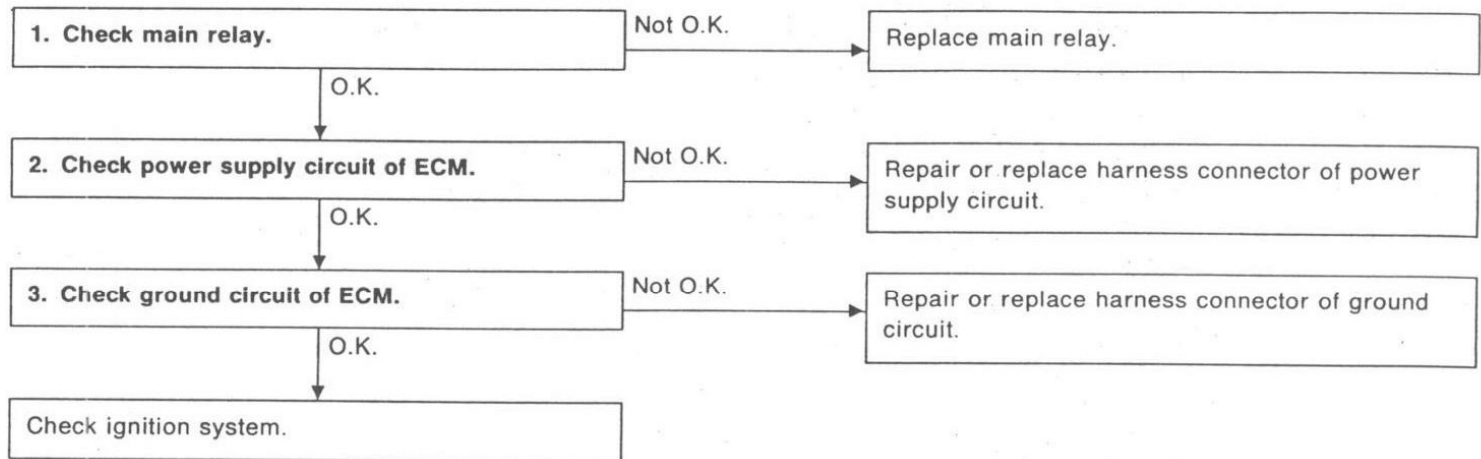
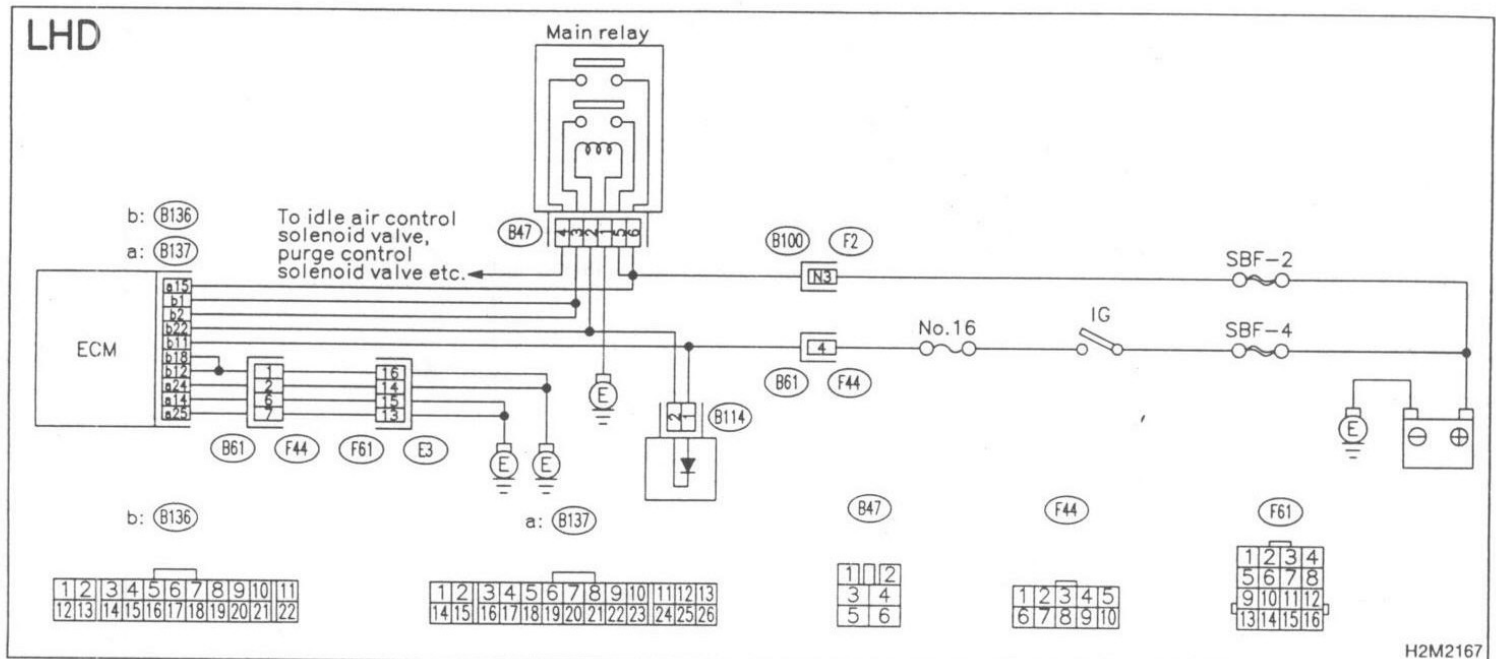


7. Diagnostics Chart for Engine Starting Failure

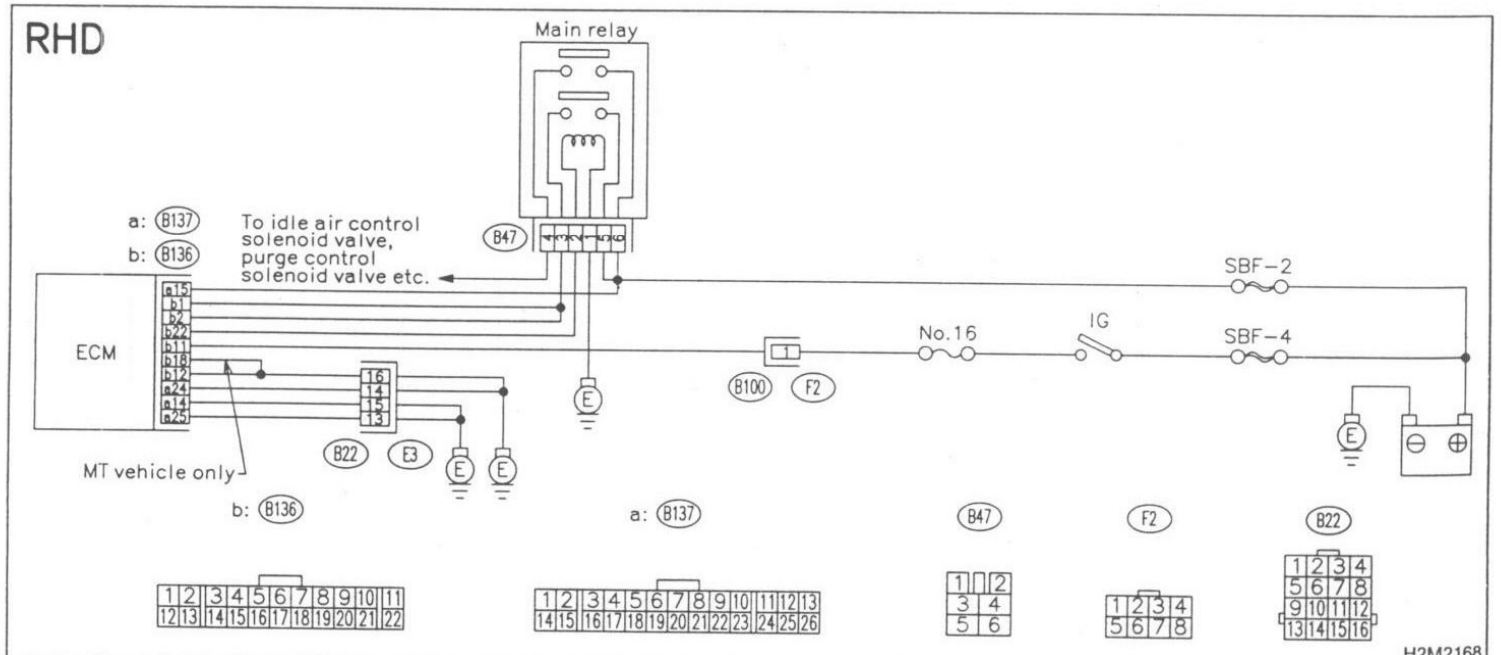
A: BASIC DIAGNOSTICS CHART

When engine cranks but does not start, perform diagnostics in accordance with the following chart.

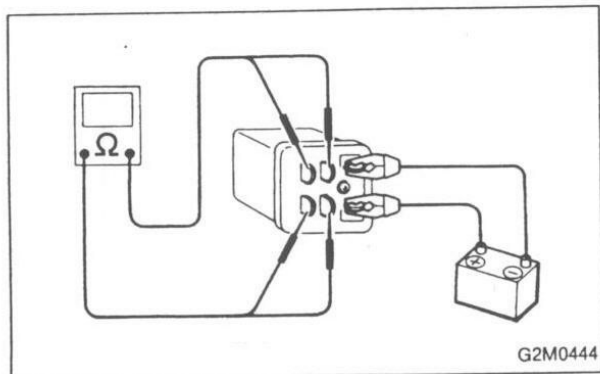


B: CONTROL UNIT POWER SUPPLY AND GROUND LINE**LHD**

H2M2167

RHD

H2M2168



G2M0444

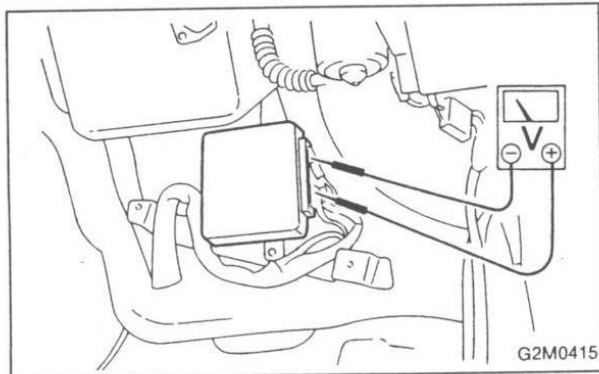
1. CHECK MAIN RELAY.

- 1) Turn the ignition switch to OFF.
- 2) Remove main relay.
- 3) Connect battery to main relay terminals No. 1 and No. 2.
- 4) Measure resistance between main relay terminals.

Terminals / Specified resistance:

No. 3 — No. 5 / Less than 10 Ω

No. 4 — No. 6 / Less than 10 Ω



G2M0415

2. CHECK POWER SUPPLY CIRCUIT OF ECM.

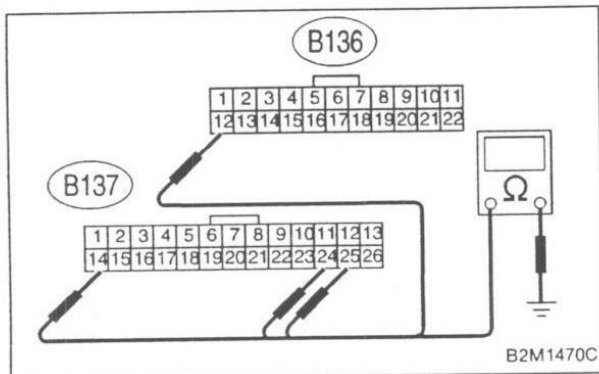
- 1) Install main relay.
- 2) Turn ignition switch to ON.
- 3) Measure power supply voltage between ECM connector terminals and body.

Connector & terminal / Specified voltage:

(B136) No. 1 — (B137) No. 14 / More than 10 V

(B136) No. 2 — (B137) No. 14 / More than 10 V

(B136) No. 11 — (B137) No. 14 / More than 10 V



B2M1470C

3. CHECK GROUND CIRCUIT OF ECM.

- 1) Turn ignition switch to OFF.
- 2) Measure resistance of harness connector between ECM and body.

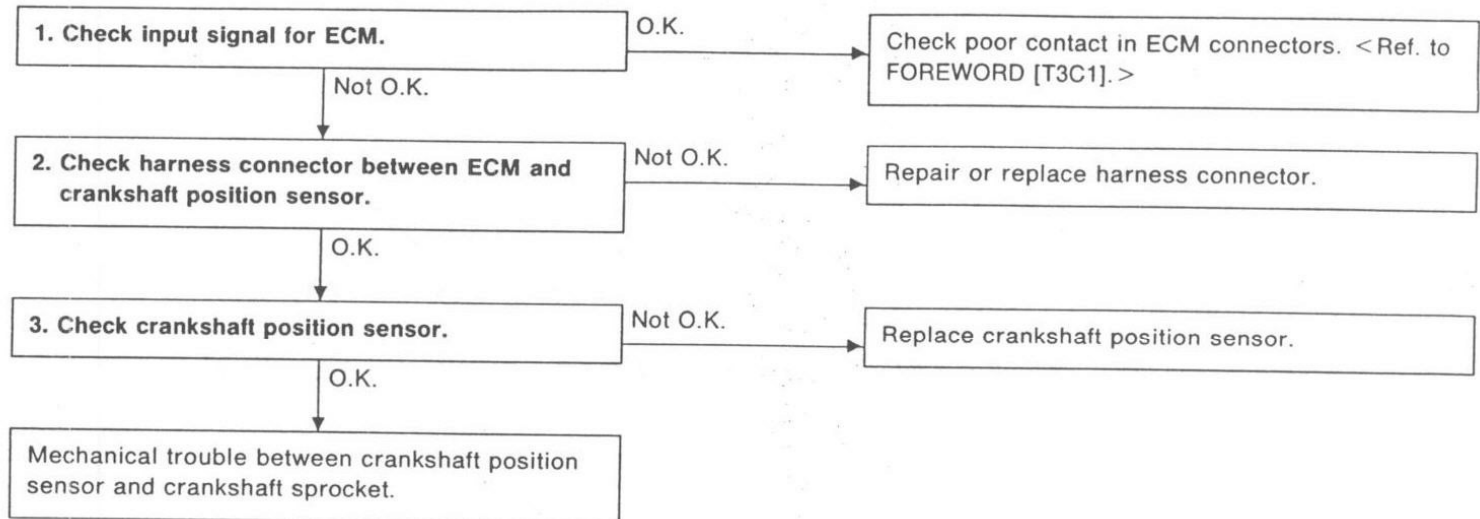
Connector & terminal / Specified resistance:

(B136) No. 12 — Body / Less than 5 Ω

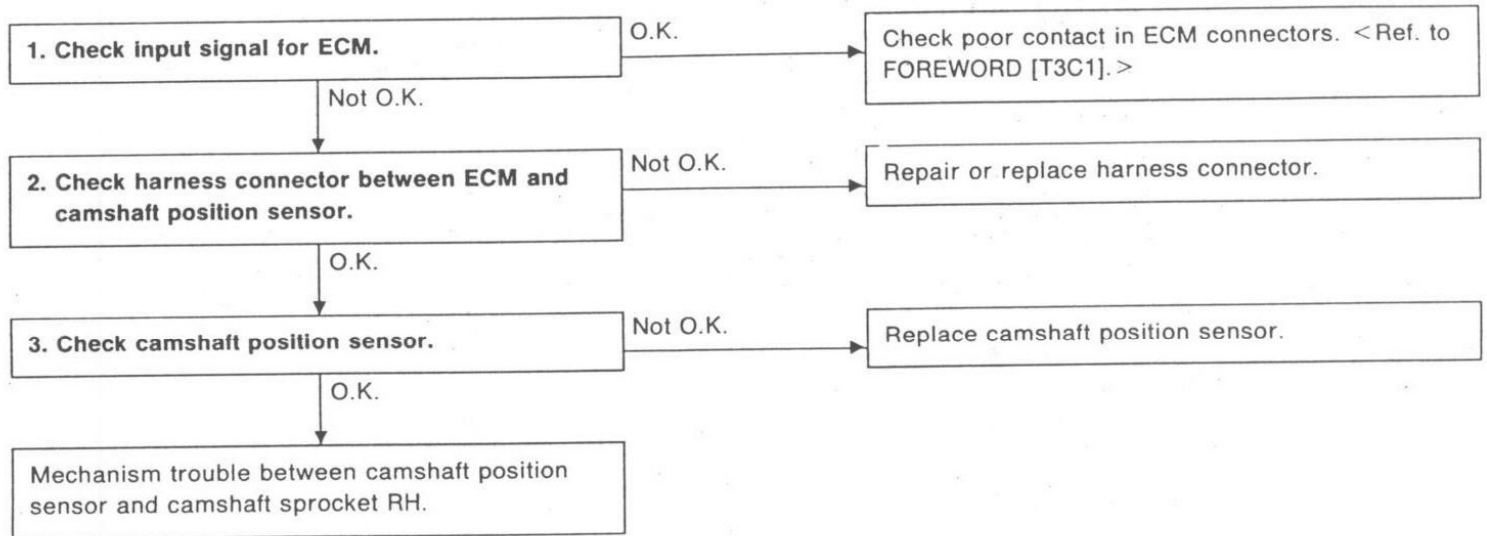
(B137) No. 14 — Body / Less than 5 Ω

(B137) No. 24 — Body / Less than 5 Ω

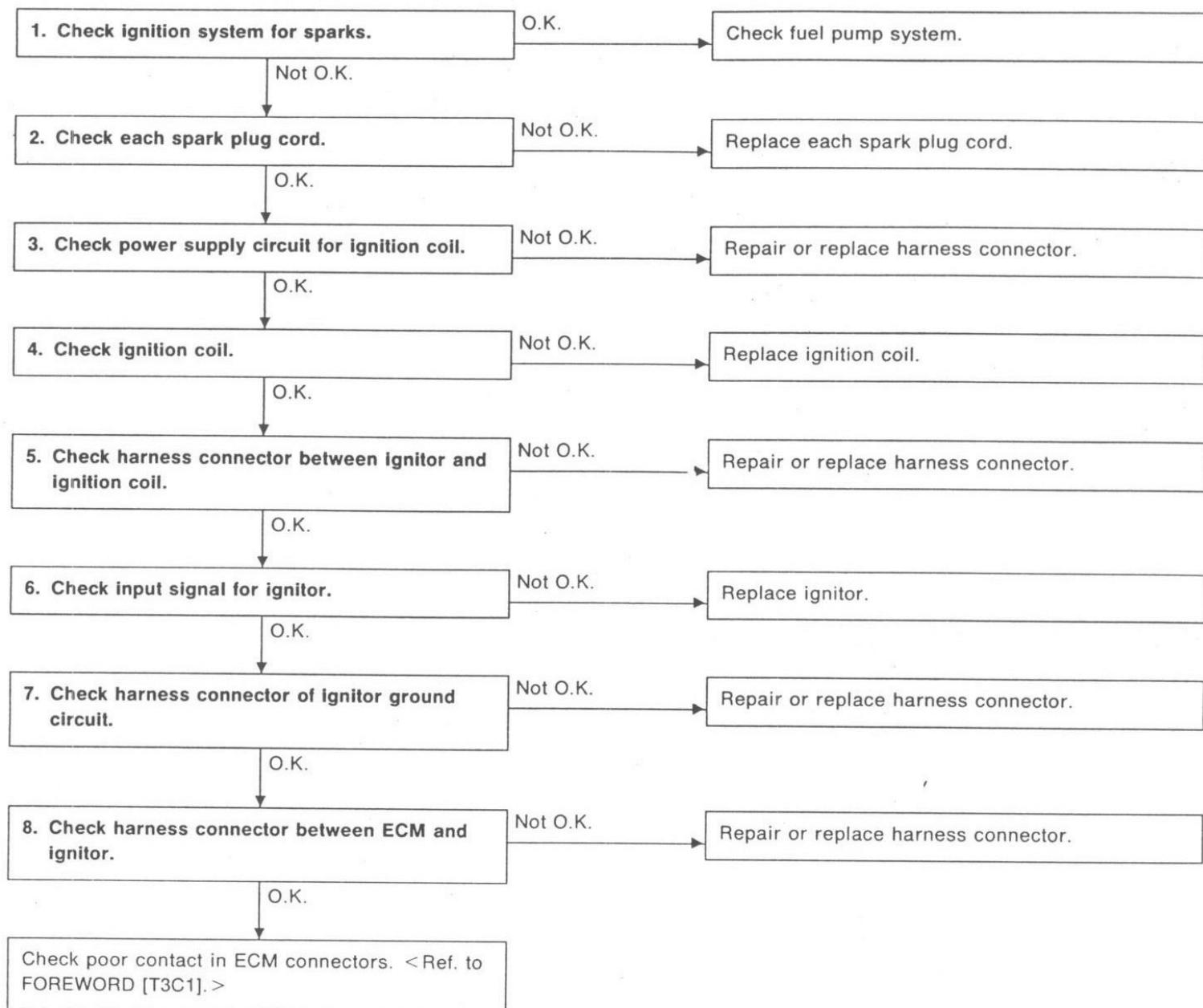
(B137) No. 25 — Body / Less than 5 Ω

C: CRANKSHAFT POSITION SENSOR CIRCUIT**NOTE:**

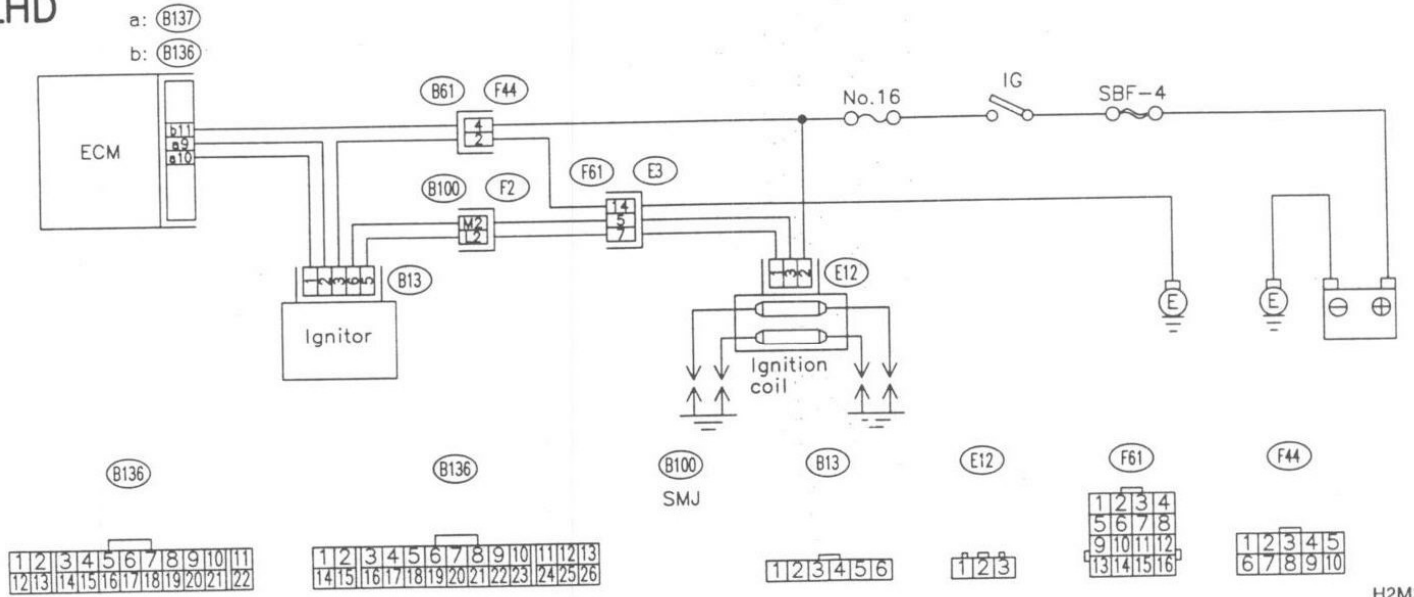
Check crankshaft position sensor circuit.
< Ref. to 2-7c [T8B0]. >

D: CAMSHAFT POSITION SENSOR CIRCUIT**NOTE:**

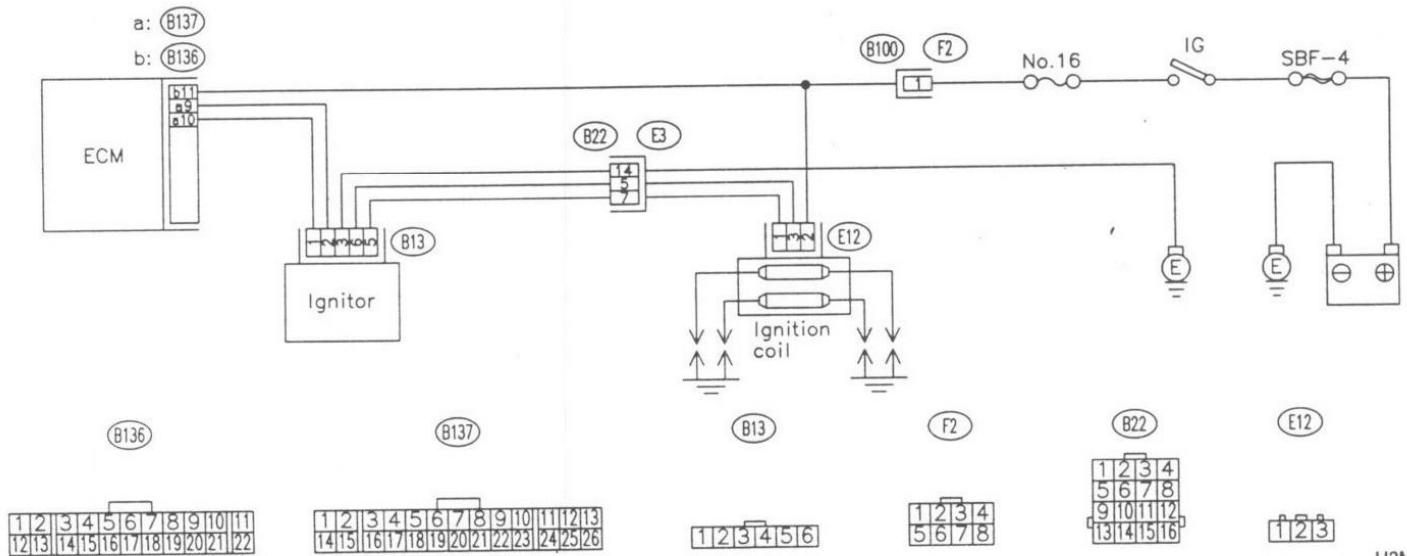
Check camshaft position sensor circuit.
<Ref. to 2-7c [T8D0].>

E: IGNITION CONTROL SYSTEM

LHD



RHD



1. CHECK IGNITION SYSTEM FOR SPARKS.

- 1) Remove plug cord cap from each spark plug.
- 2) Install new spark plug on plug cord cap.

CAUTION:

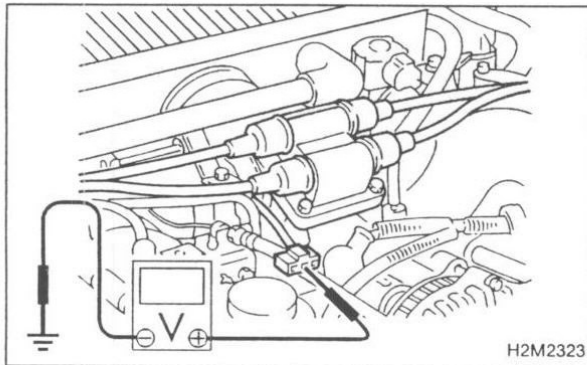
Do not remove spark plug from engine.

- 3) Contact spark plug's thread portion on engine.
- 4) While opening throttle valve fully, crank engine to check that spark occurs at each cylinder.

2. CHECK EACH SPARK PLUG CORD.

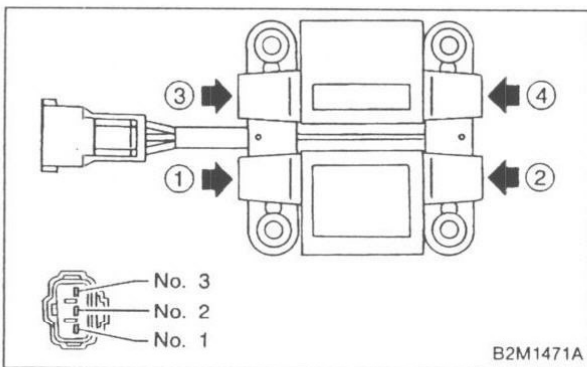
- 1) Remove each spark plug cord.
- 2) Measure resistance of each spark plug cord.

	Resistance value: kΩ
#1 cord	7.40 — 17.27
#2 cord	6.24 — 14.56
#3 cord	6.54 — 15.25
#4 cord	6.59 — 15.37

**3. CHECK POWER SUPPLY CIRCUIT FOR IGNITION COIL.**

- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from ignition coil.
- 3) Turn ignition switch to ON.
- 4) Measure power supply voltage between ignition coil connector terminal and body.

Connector & terminal / Specified voltage:
(E12) No. 2 — Body / More than 10 V

**4. CHECK IGNITION COIL.**

- 1) Measure resistance between ignition coil terminals to check primary coil.

Terminals / Specified resistance:

No. 2 — No. 1 / About 1 Ω

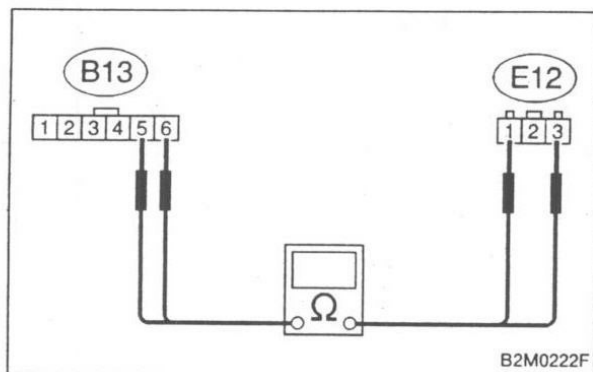
No. 2 — No. 3 / About 1 Ω

- 2) Measure resistance between spark plug cord contact portions to check secondary coil.

Connector & terminal / Specified resistance:

① — ② / 21 ± 3 kΩ

③ — ④ / 21 ± 3 kΩ



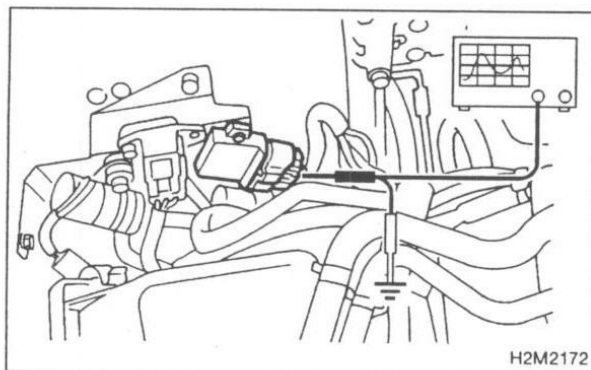
5. CHECK HARNESS CONNECTOR BETWEEN IGNITOR AND IGNITION COIL.

- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from ignitor.
- 3) Measure resistance of harness connector between ignition coil and ignitor.

Connector & terminal / Specified resistance:

(B13) No. 5 — (E12) No. 1 / Less than 1 Ω

(B13) No. 6 — (E12) No. 3 / Less than 1 Ω



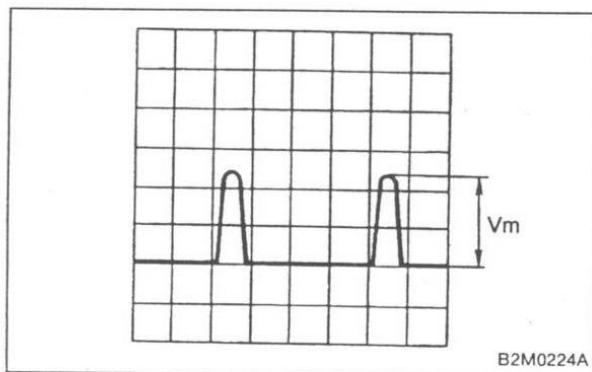
6. CHECK INPUT SIGNAL FOR IGNITOR.

Check if voltage varies synchronously with engine speed when cranking, while monitoring voltage between ignitor connector and body.

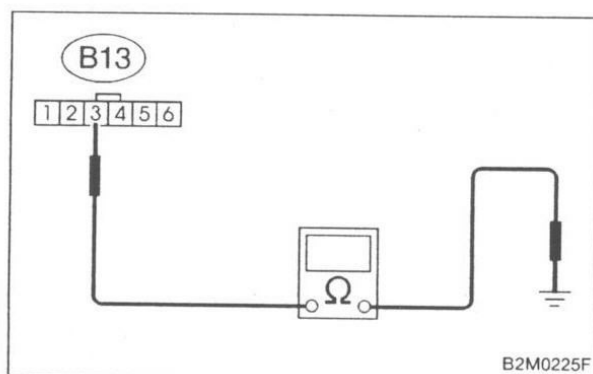
Connector & terminal

(B13) No. 1 — Body

(B13) No. 2 — Body



Specified voltage: More than 10 V

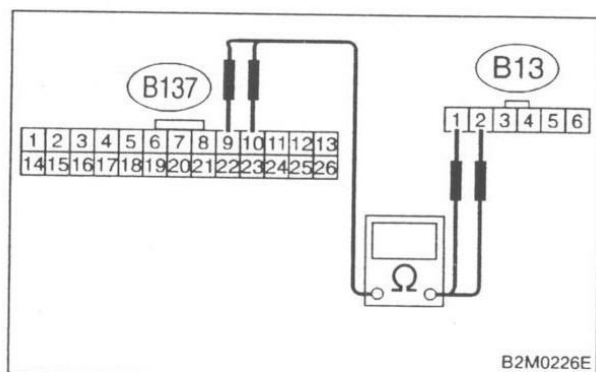


7. CHECK HARNESS CONNECTOR OF IGNITOR GROUND CIRCUIT.

- 1) Turn ignition switch to OFF.
- 2) Measure resistance between ignitor and body.

Connector & terminal / Specified resistance:

(B13) No. 3 — Body / Less than 1 Ω



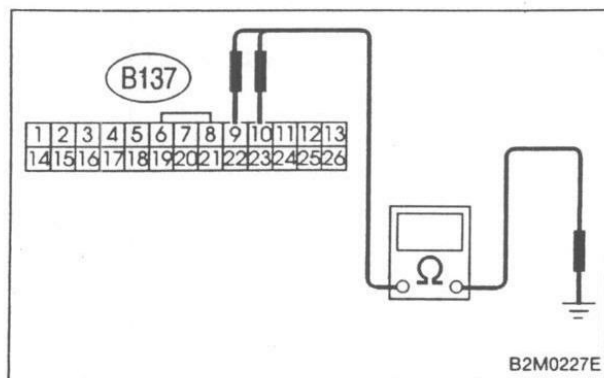
8. CHECK HARNESS CONNECTOR BETWEEN ECM AND IGNITOR.

- 1) Disconnect connector from ECM.
- 2) Measure resistance of harness connector between ECM and ignitor.

Connector & terminal / Specified resistance:

(B137) No. 10 — (B13) No. 1 / Less than 1 Ω

(B137) No. 9 — (B13) No. 2 / Less than 1 Ω



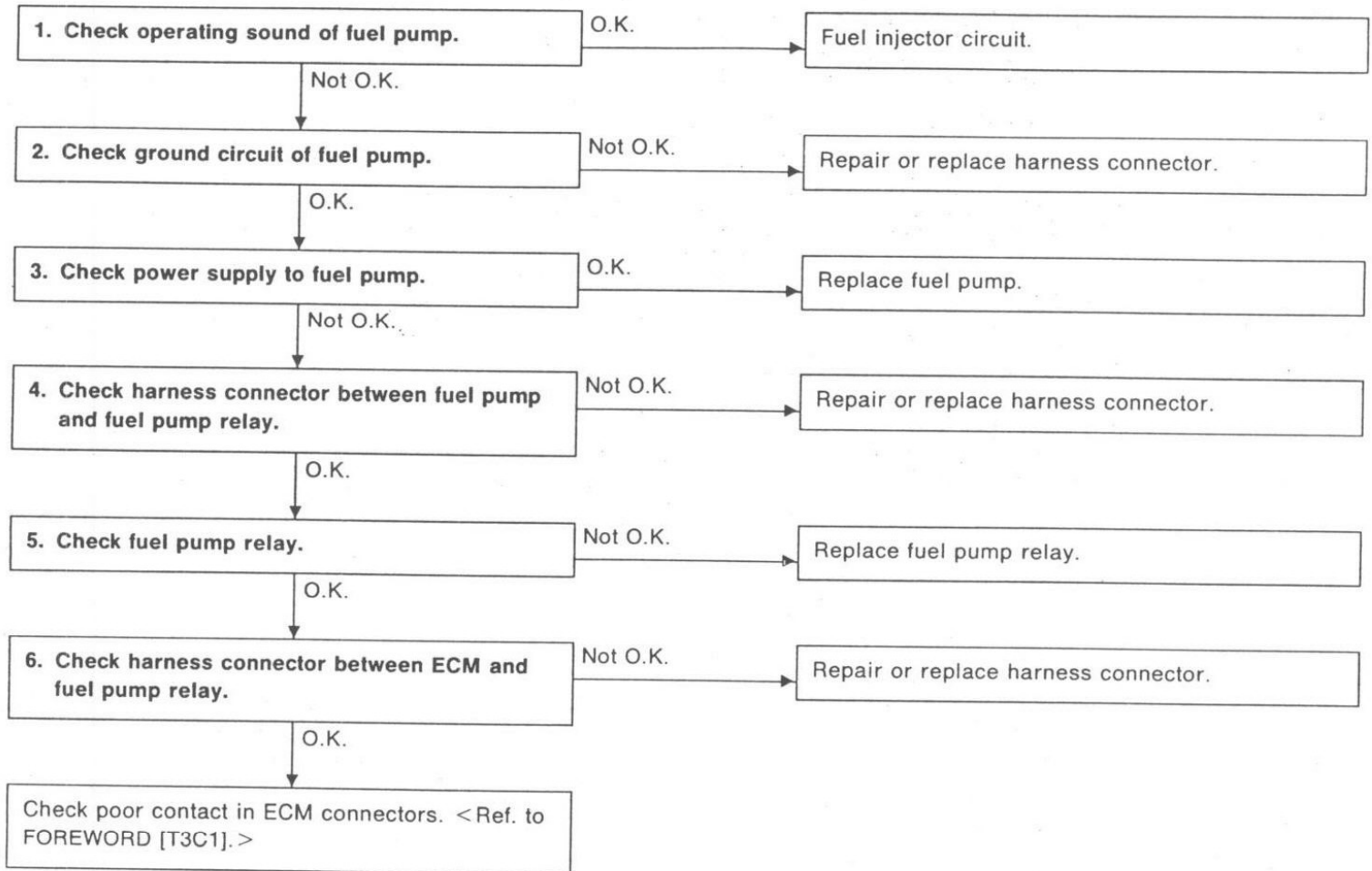
3) Measure resistance of harness connector between ECM and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

(B137) No. 10 — Body / More than 1 MΩ

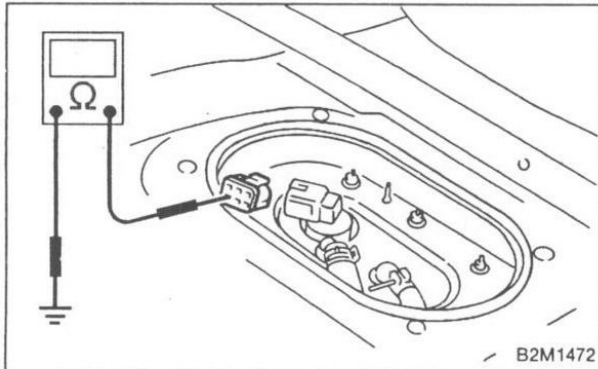
(B137) No. 9 — Body / More than 1 MΩ

F: FUEL PUMP CIRCUIT



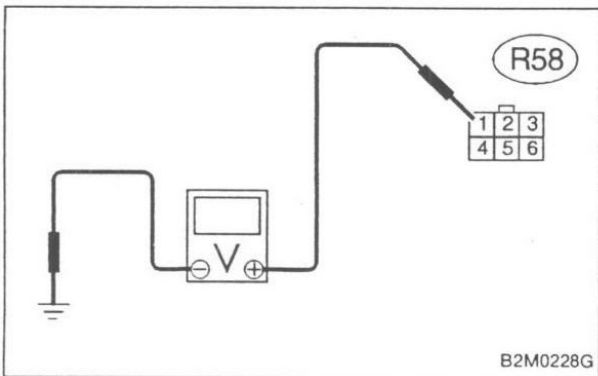
1. CHECK OPERATING SOUND OF FUEL PUMP.

Make sure that fuel pump is in operation for two seconds when turning ignition switch to ON.

**2. CHECK GROUND CIRCUIT OF FUEL PUMP.**

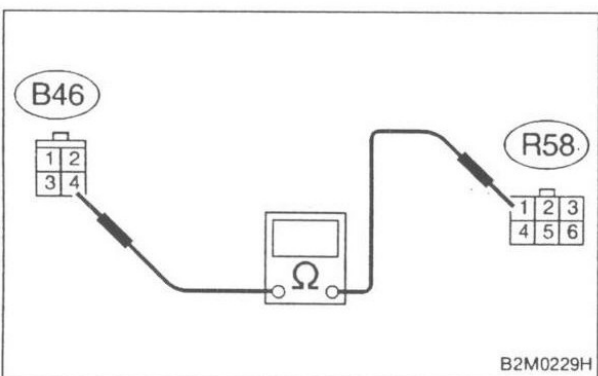
- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from fuel pump.
- 3) Measure resistance of harness connector between fuel pump and body.

Connector & terminal / Specified resistance:
(R58) No. 4 — Body / Less than 5 Ω

**3. CHECK POWER SUPPLY TO FUEL PUMP.**

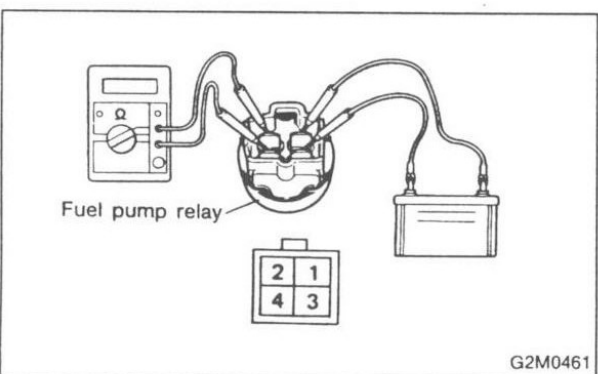
- 1) Turn ignition switch to ON.
- 2) Measure voltage of power supply circuit between fuel pump connector and body.

Connector & terminal / Specified voltage:
(R58) No. 1 — Body / More than 10 V

**4. CHECK HARNESS CONNECTOR BETWEEN FUEL PUMP AND FUEL PUMP RELAY.**

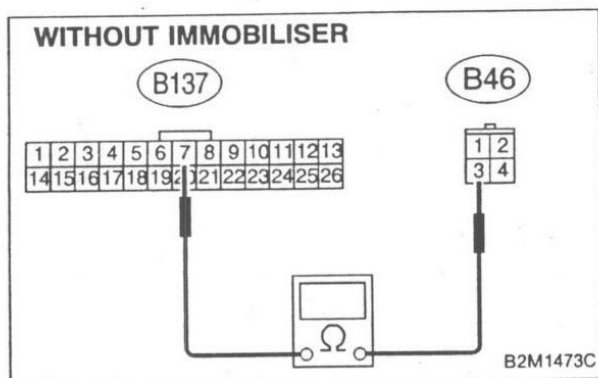
- 1) Turn ignition switch to OFF.
- 2) Measure resistance of harness connector between fuel pump and fuel pump relay.

Connector & terminal / Specified resistance:
(R58) No. 1 — (B46) No. 4 / Less than 1 Ω

**5. CHECK FUEL PUMP RELAY.**

- 1) Disconnect connectors from fuel pump relay and main relay.
- 2) Remove fuel pump relay and main relay with bracket.
- 3) Connect battery to fuel pump relay connector terminals No. 1 and No. 3.
- 4) Measure resistance between connector terminals of fuel pump relay.

Terminals / Specified resistance:
No. 2 — No. 4 / Less than 1 Ω



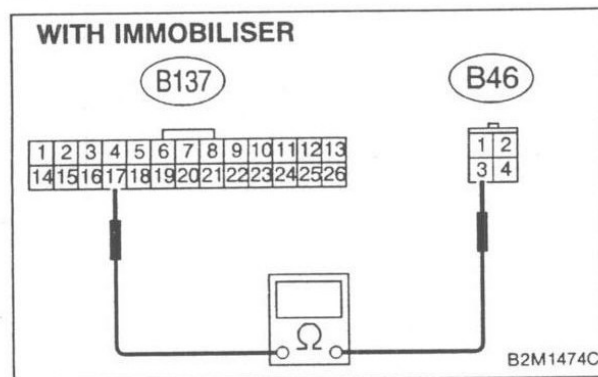
6. CHECK HARNESS CONNECTOR BETWEEN ECM AND FUEL PUMP RELAY.

- 1) Disconnect connectors from ECM.
- 2) Measure resistance of harness connector between ECM and fuel pump relay.

Connector & terminal / Specified resistance:

Without immobiliser:

(B137) No. 7 — (B46) No. 3 / Less than 1 Ω

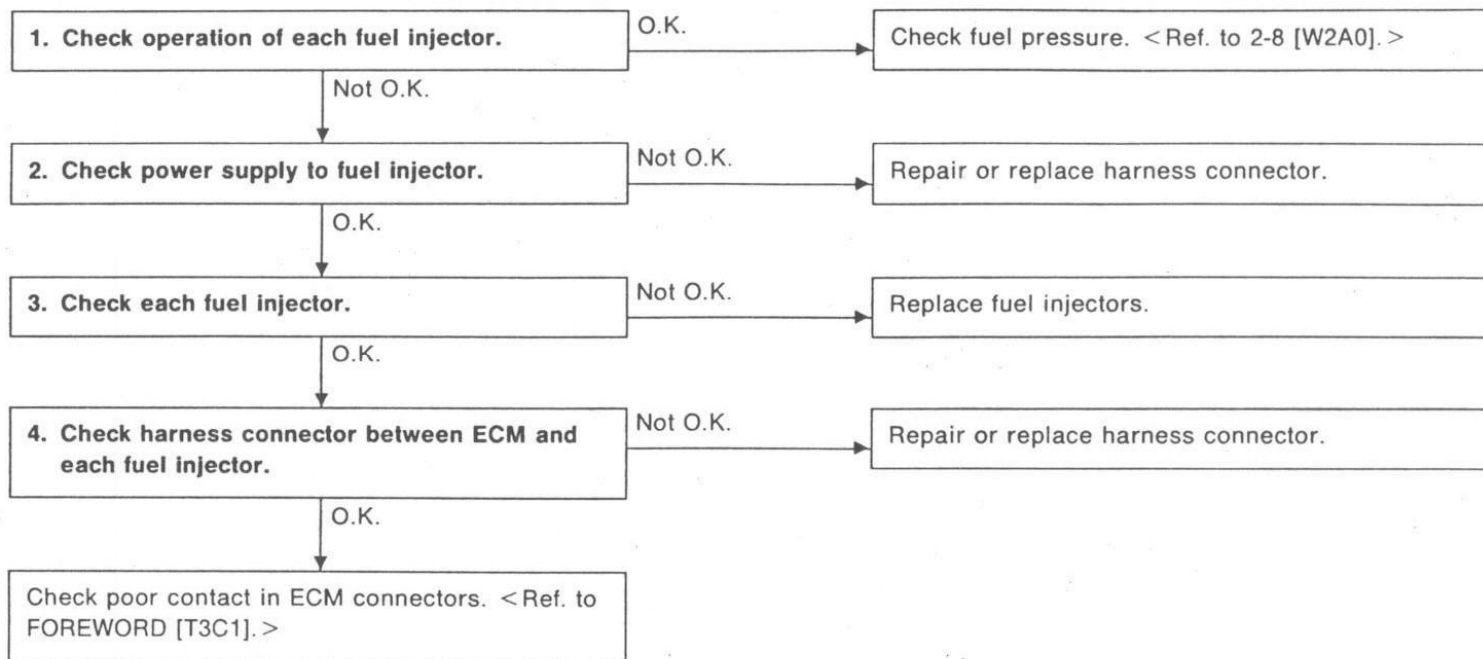


Connector & terminal / Specified resistance:

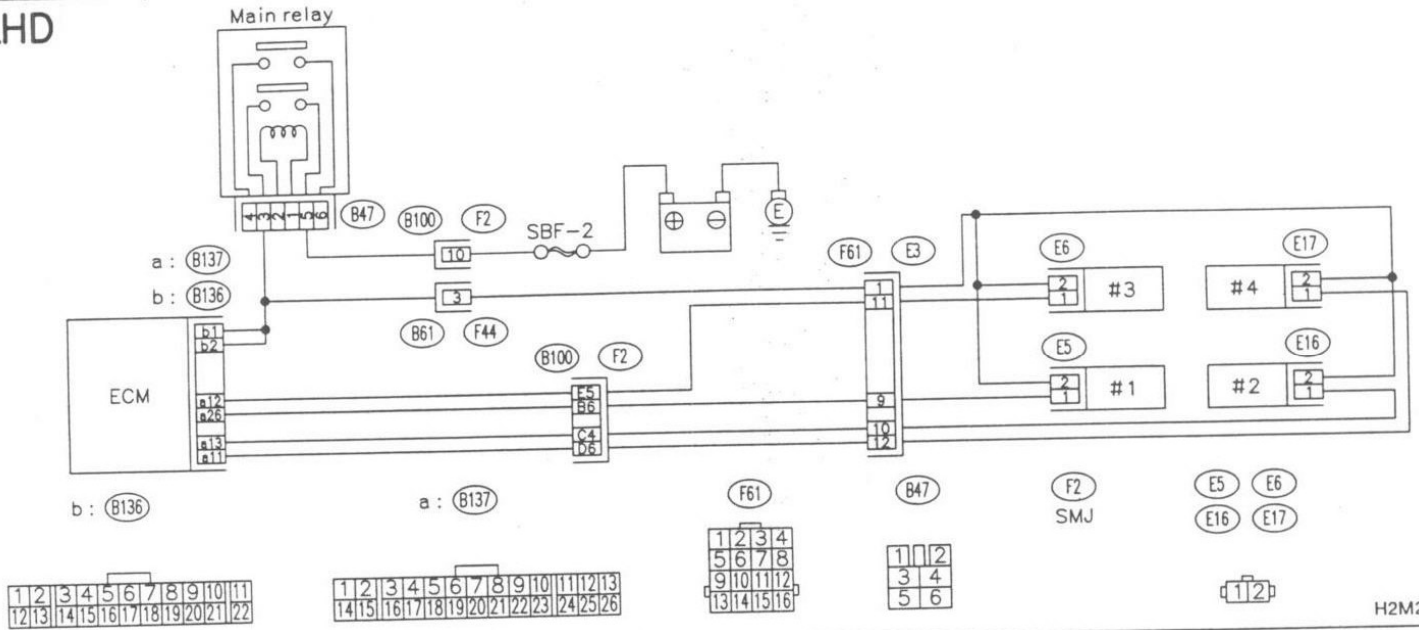
With immobiliser:

(B137) No. 17 — (B46) No. 3 / Less than 1 Ω

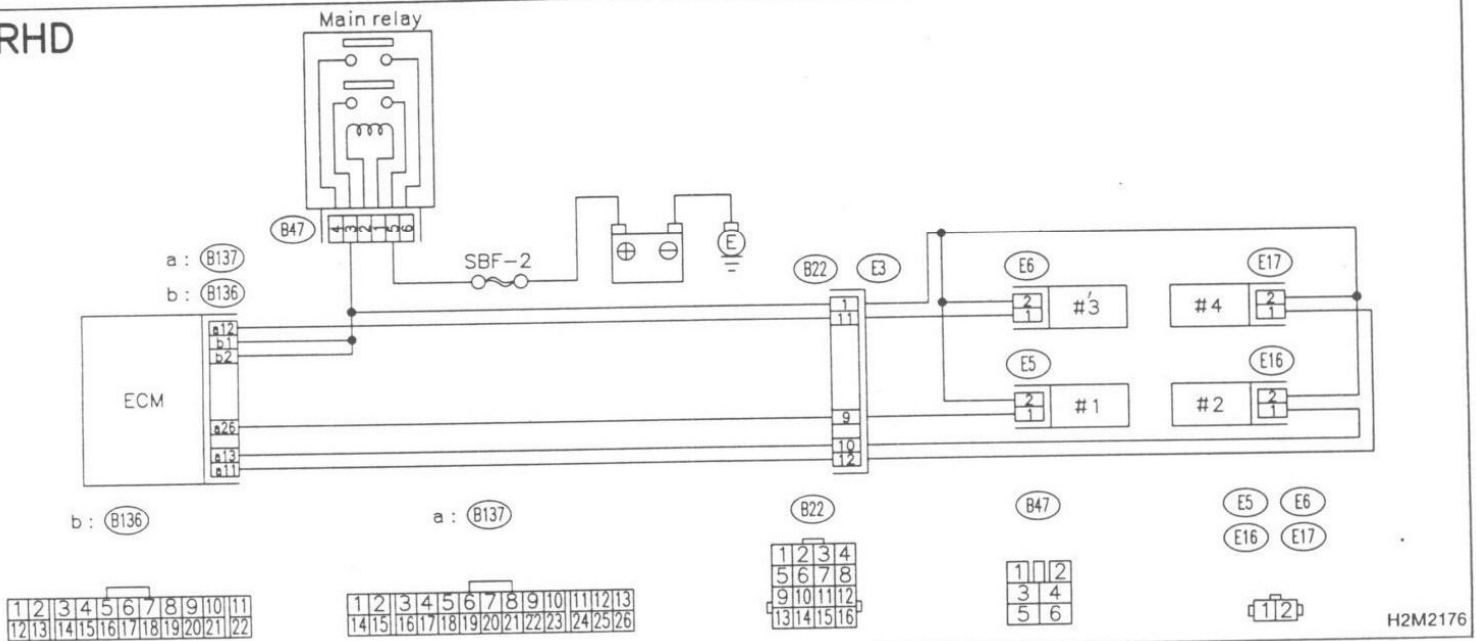
G: FUEL INJECTOR CIRCUIT



LHD

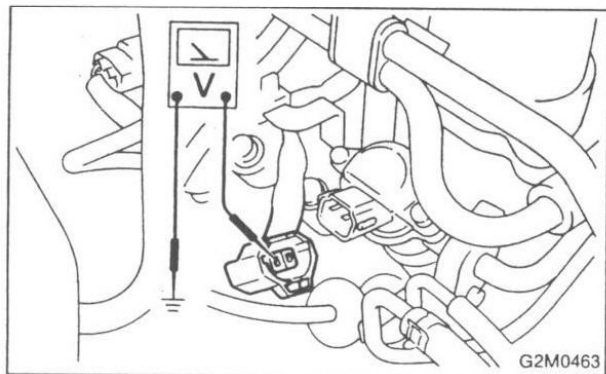


RHD



1. CHECK OPERATION OF EACH FUEL INJECTOR.

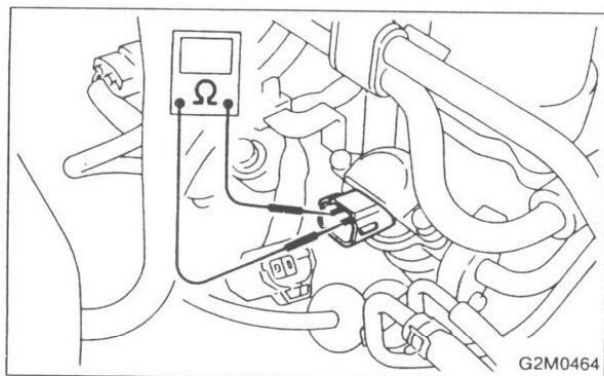
While cranking the engine, check that each fuel injector emits "operating" sound. Use a sound scope or attach a screwdriver to injector for this check.

**2. CHECK POWER SUPPLY TO FUEL INJECTOR.**

- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from each injector.
- 3) Turn ignition switch to ON.
- 4) Measure voltage between each fuel injector connector terminal and body.

Connector & terminal / Specified voltage:

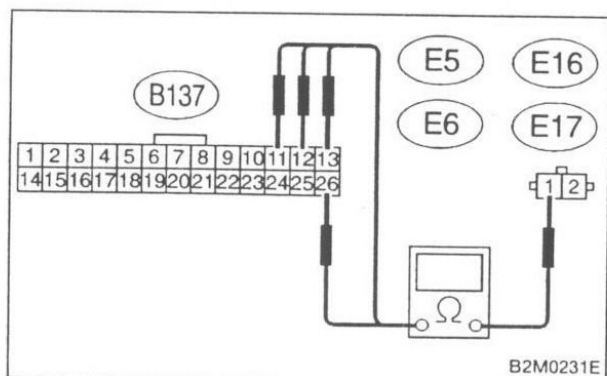
- #1 (E5) No. 2 — Body / More than 10 V
- #2 (E16) No. 2 — Body / More than 10 V
- #3 (E6) No. 2 — Body / More than 10 V
- #4 (E17) No. 2 — Body / More than 10 V

**3. CHECK EACH FUEL INJECTOR.**

Measure resistance between fuel injector terminals.

Terminals / Specified resistance:

- No. 1 — No. 2 / $11.5 \pm 0.5 \Omega$

**4. CHECK HARNESS CONNECTOR BETWEEN ECM AND EACH FUEL INJECTOR.**

- 1) Disconnect connector from ECM.
- 2) Measure resistance of harness connector between ECM and each fuel injector.

Connector & terminal / Specified resistance:

- (B137) No. 26 — (E5) No. 1 / Less than 1 Ω
- (B137) No. 13 — (E16) No. 1 / Less than 1 Ω
- (B137) No. 12 — (E6) No. 1 / Less than 1 Ω
- (B137) No. 11 — (E17) No. 1 / Less than 1 Ω

8. Diagnostics Chart with Trouble Code

A: TROUBLE CODE

Trouble code	Item	Contents of diagnosis	Page
11	Crankshaft position sensor	- No signal entered from crankshaft position sensor when starter switch is ON. - The harness connector between ECM and crankshaft position sensor is in short or open.	40
12	Starter switch	- The starter switch signal is abnormal. - The harness connector between ECM and starter switch is in short or open.	44
13	Camshaft position sensor	- No signal entered from camshaft position sensor, but signal entered from crankshaft position sensor. - The harness connector between ECM and camshaft position sensor is in short or open.	48
21	Engine coolant temperature sensor	- The engine coolant temperature sensor signal is abnormal. - The harness connector between ECM and engine coolant temperature sensor is in short or open.	52
22	Knock sensor	- The knock sensor signal is abnormal. - The harness connector between ECM and knock sensor is in short or open.	56
23	Mass air flow sensor	- The mass air flow sensor signal is abnormal. - The harness connector between ECM and mass air flow sensor is in short or open.	60
24	Idle air control solenoid valve	- The idle air control solenoid valve is not in function. - The harness connector between ECM and idle air control solenoid valve is in short or open.	64
31	Throttle position sensor	- The throttle position sensor signal is abnormal. - The throttle position sensor is installed abnormally. - The harness connector between ECM and throttle position sensor is in short or open.	66
32	Oxygen sensor	- The oxygen sensor is not in function. - The harness connector between ECM and oxygen sensor is in short or open.	70
33	Vehicle speed sensor 2	- The vehicle speed sensor 2 is not in function. - The harness connector between ECM and vehicle speed sensor 2 is in short or open.	74
38	Torque control signal (AT)	- Abnormal signal is entered from TCM. - The harness connector between ECM and TCM is in short or open.	78
44	Wastegate control solenoid valve	- The wastegate control solenoid valve is not in function. - The harness connector between ECM and wastegate control solenoid valve is in short or open.	80
45	- Pressure sensor - Pressure sources switching solenoid valve	- The pressure sensor signal is abnormal. - The pressure sources switching solenoid valve is not in function. - The intake manifold pressure is not transmitted to pressure sensor. - The harness connector between ECM and pressure sensor, and pressure sources switching solenoid valve is in short or open.	82
51	Neutral position switch (MT)	- The neutral position switch signal is abnormal. - The harness connector between ECM and neutral position switch is in short or open.	86
	Park/Neutral position switch (AT)	- The park/neutral position switch signal is abnormal. - The shift cable is connected abnormally. - The harness connector between ECM and inhibitor switch is in short or open.	88
53*	Immobiliser system	Faulty immobiliser system. < Ref. to 6-2b [T100]. >	—

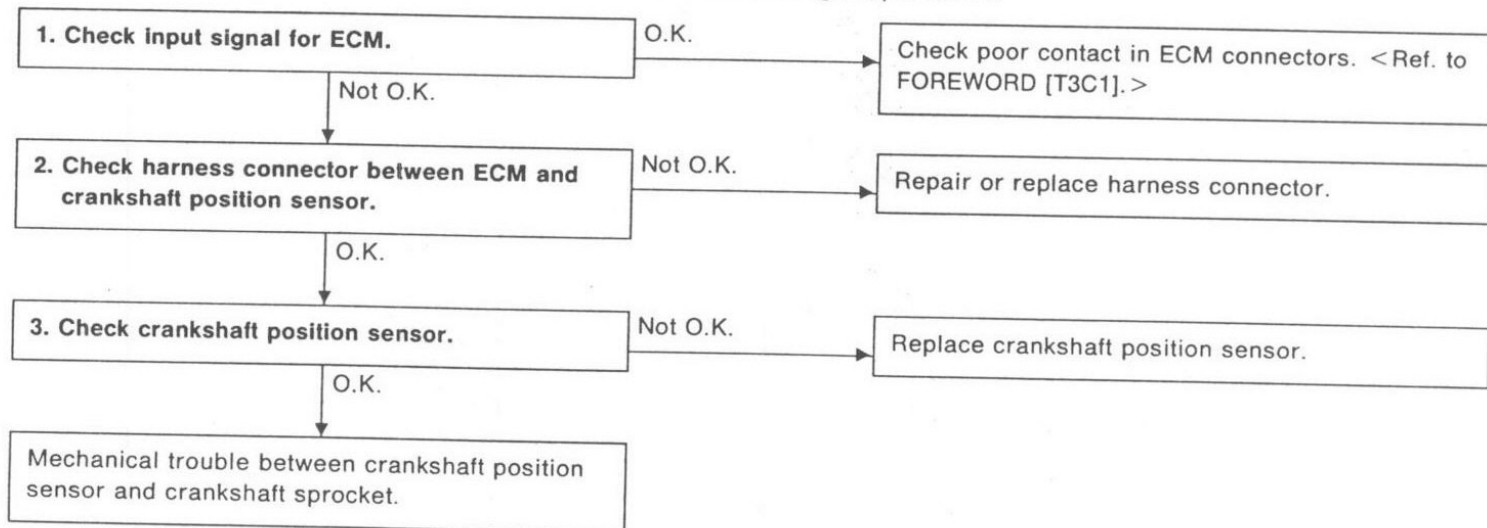
*: Immobiliser system equipped model only

B: TROUBLE CODE (11)**— CRANKSHAFT POSITION SENSOR —****DIAGNOSIS:**

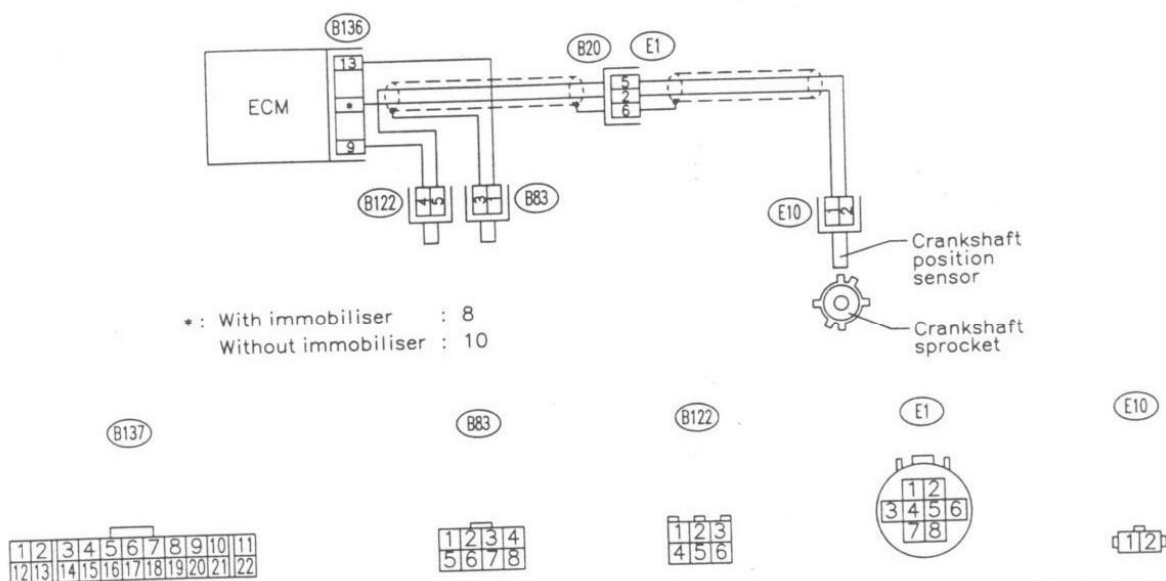
- No signal entered from crankshaft position sensor when starter switch is ON.
- The harness connector between ECM and crankshaft position sensor is in short or open.

TROUBLE SYMPTOM:

- Engine stalls.
- Restarting impossible

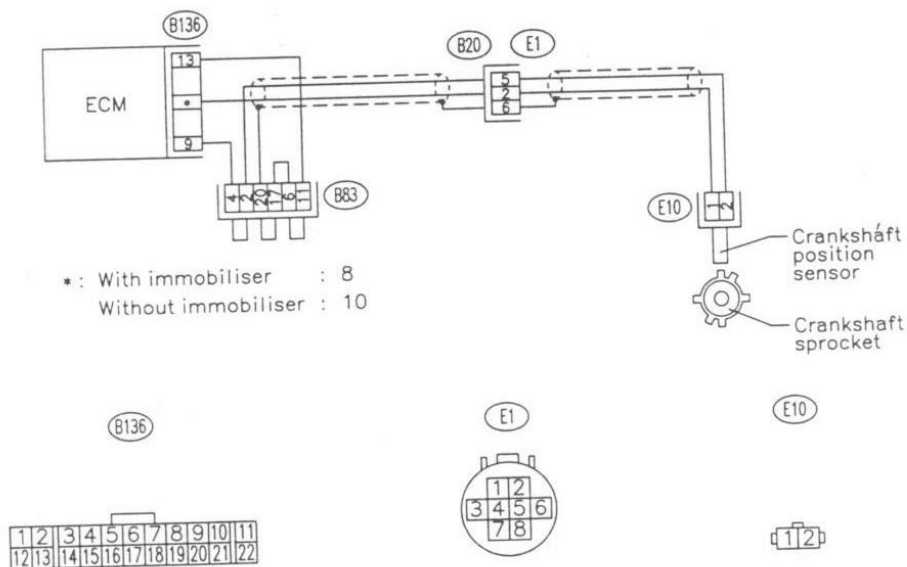


LHD

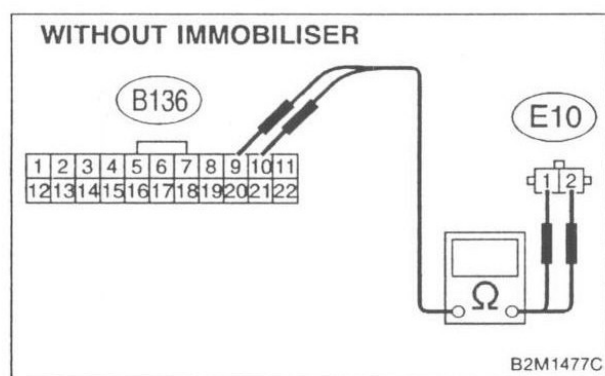
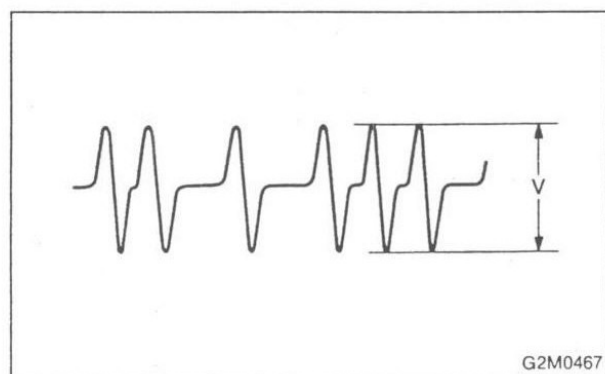
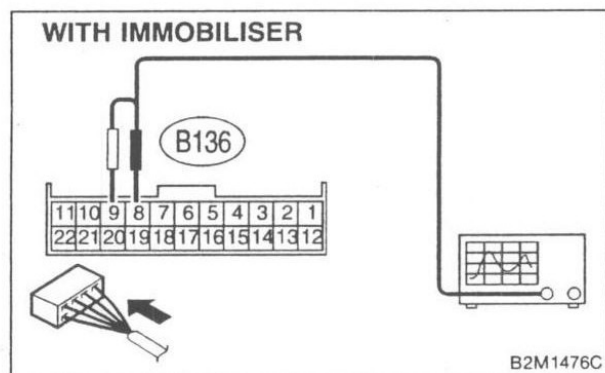
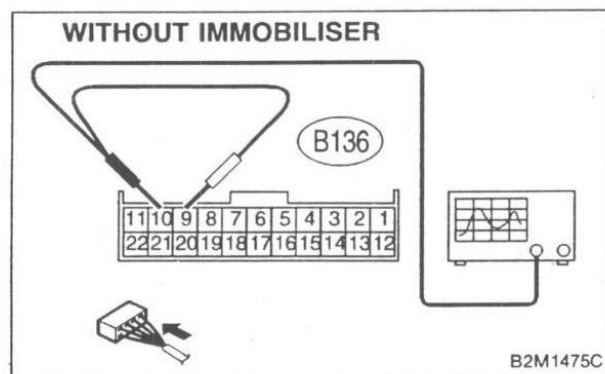


H2M2177

RHD



H2M2178



1. CHECK INPUT SIGNAL FOR ECM.

1) Set the positive (+) probe and earth lead of oscilloscope at ECM connector terminals.

Connector & terminal:

Without immobiliser:

Positive probe; (B136) No. 10

Earth lead; (B136) No. 9

Connector & terminal:

With immobiliser:

Positive probe; (B136) No. 8

Earth lead; (B136) No. 9

2) Measure signal voltage indicated on oscilloscope while cranking the engine.

Specified voltage: More than 400 mV

2. CHECK HARNESS CONNECTOR BETWEEN ECM AND CRANKSHAFT POSITION SENSOR.

1) Turn ignition switch to OFF.

2) Disconnect connectors from ECM and crankshaft position sensor.

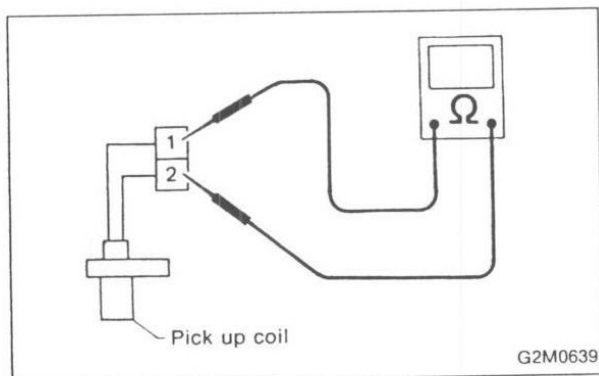
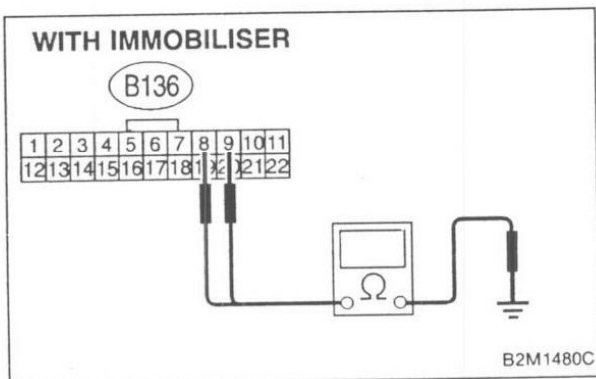
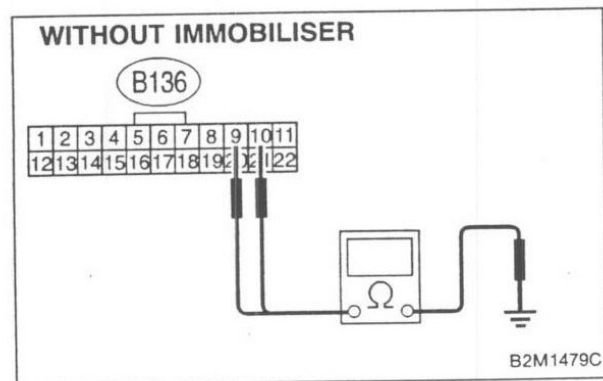
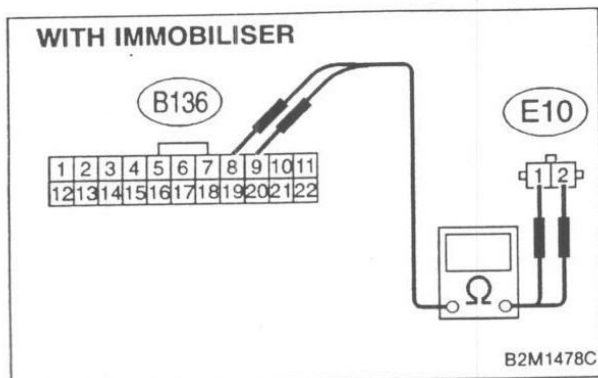
3) Measure resistance of harness connector between ECM and crankshaft position sensor.

Connector & terminal / Specified resistance:

Without immobiliser:

(B136) No. 10 — (E10) No. 1 / Less than 1 Ω

(B136) No. 9 — (E10) No. 2 / Less than 1 Ω



Connector & terminal / Specified resistance:

With immobiliser:

(B136) No. 8 — (E10) No. 1 / Less than 1 Ω

(B136) No. 9 — (E10) No. 2 / Less than 1 Ω

4) Measure resistance of harness connector between ECM and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

Without immobiliser:

(B136) No. 10 — Body / More than 1 M Ω

(B136) No. 9 — Body / More than 1 M Ω

Connector & terminal / Specified resistance:

With immobiliser:

(B136) No. 8 — Body / More than 1 M Ω

(B136) No. 9 — Body / More than 1 M Ω

3. CHECK CRANKSHAFT POSITION SENSOR.

1) Remove crankshaft position sensor.

2) Measure resistance between connector terminals of crankshaft position sensor.

Terminals / Specified resistance:

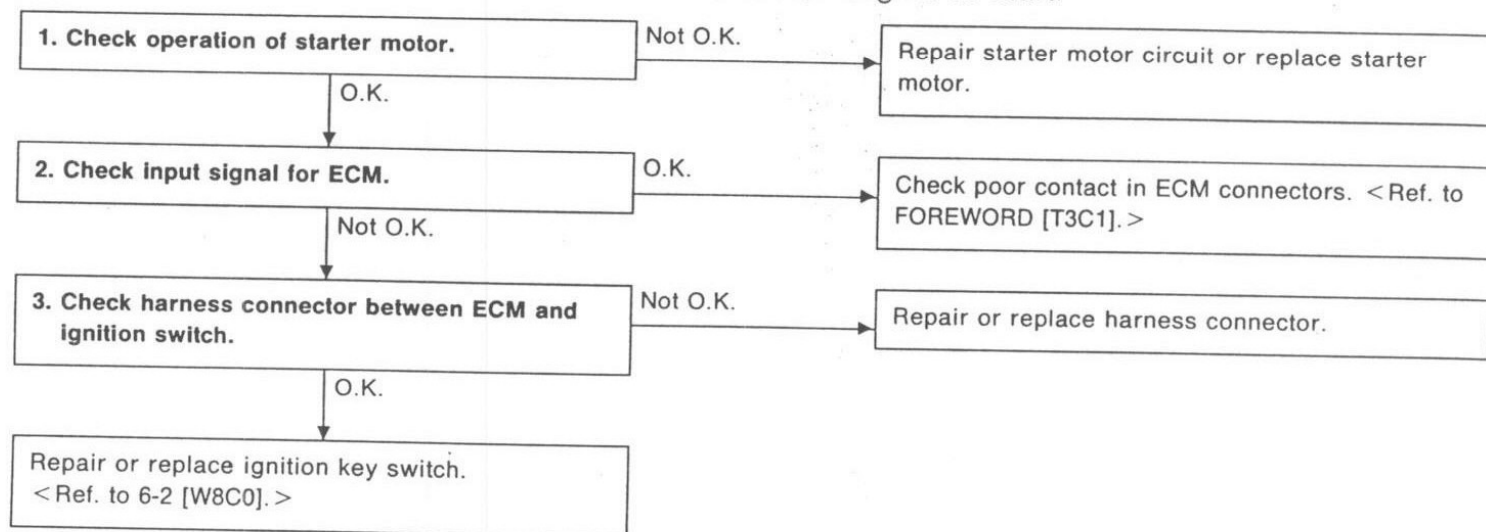
No. 1 — No. 2 / 2,040 $\pm$ 200 Ω

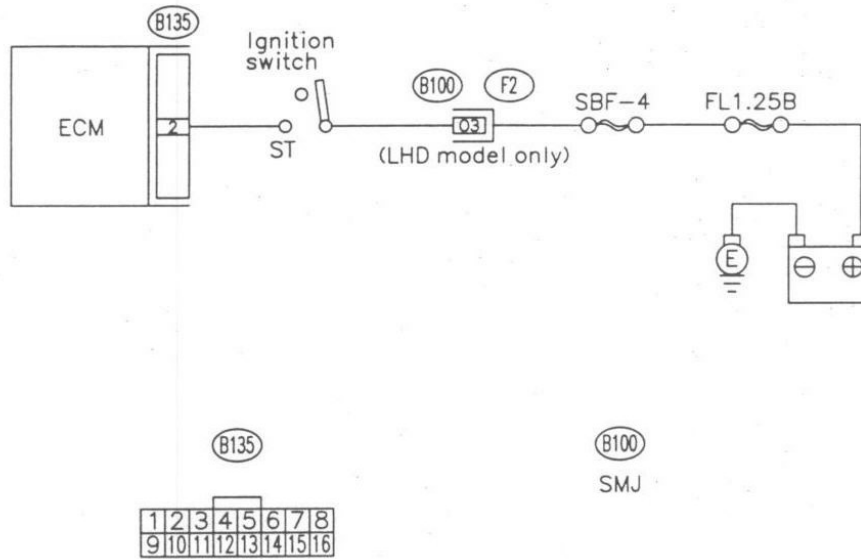
C: TROUBLE CODE (12)**— STARTER SWITCH —****DIAGNOSIS:**

- The starter switch signal is abnormal.
- The harness connector between ECM and starter switch is in short or open.

TROUBLE SYMPTOM:

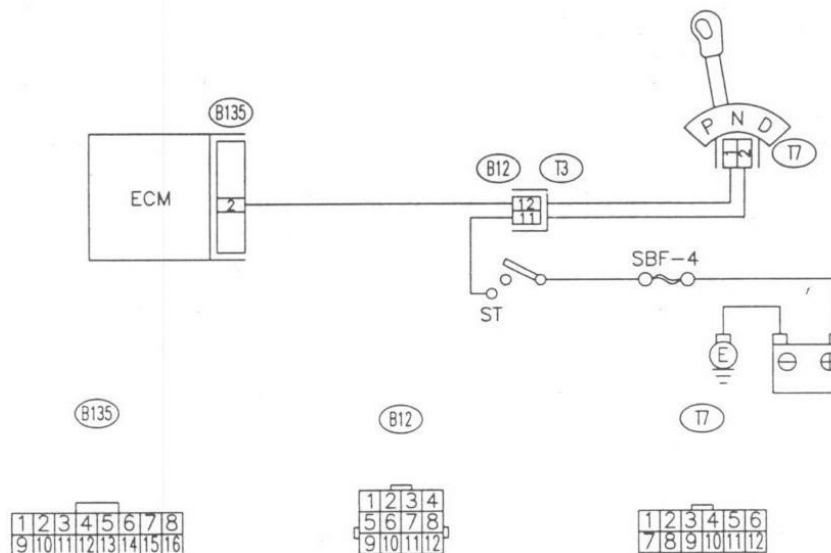
- Failure of engine to start.





H2M2179

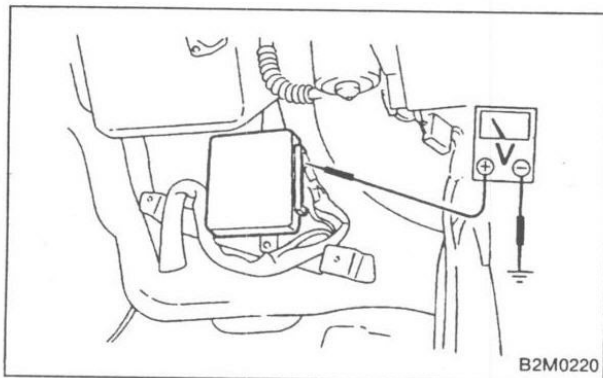
AT



H2M2184

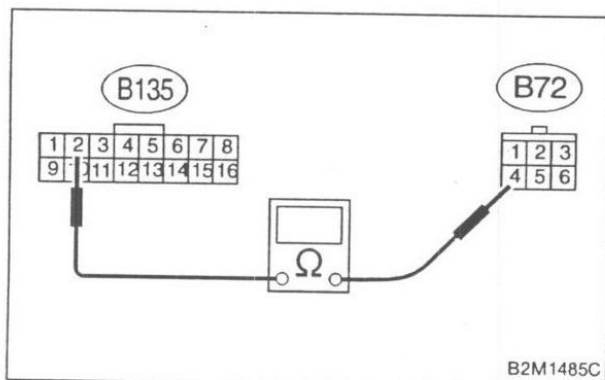
1. CHECK OPERATION OF STARTER MOTOR.

Turn ignition switch to "ST" to ensure that starter motor functions.

**2. CHECK INPUT SIGNAL FOR ECM.**

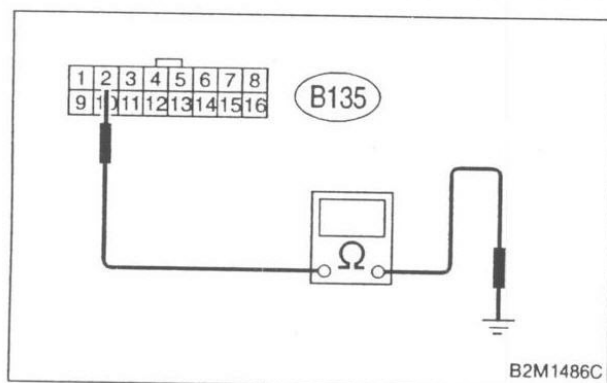
Measure voltage between ECM and body while cranking the engine.

Connector & terminal / Specified voltage:
(B135) No. 2 — Body / More than 9 V

**3. CHECK HARNESS CONNECTOR BETWEEN ECM AND IGNITION SWITCH.**

- 1) Turn ignition switch to OFF.
- 2) Disconnect connectors from ECM and ignition switch.
- 3) Measure resistance of harness connector between ECM and ignition switch.

Connector & terminal / Specified resistance:
(B135) No. 2 — (B72) No. 4 / Less than 1 Ω



- 4) Measure resistance of harness connector between starter motor and body to make sure that circuit does not short.

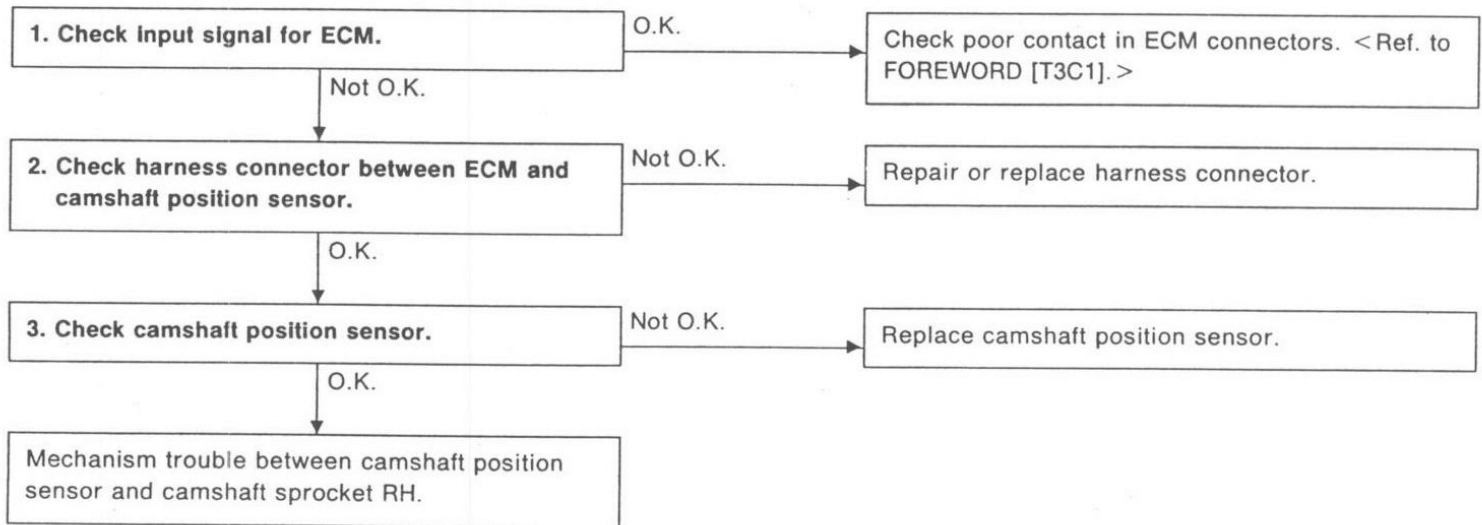
Connector & terminal / Specified resistance:
(B135) No. 2 — Body / More than 1 M Ω

D: TROUBLE CODE (13)**— CAMSHAFT POSITION SENSOR —****DIAGNOSIS:**

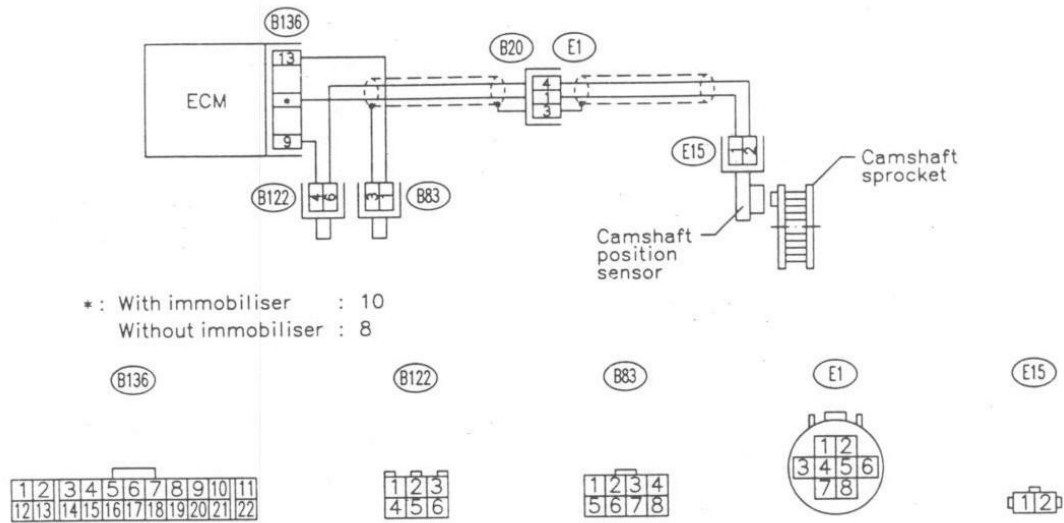
- No signal entered from camshaft position sensor, but signal entered from crankshaft position sensor.
- The harness connector between ECM and camshaft position sensor is in short or open.

TROUBLE SYMPTOM:

- Engine stalls.
- Failure of engine to start.

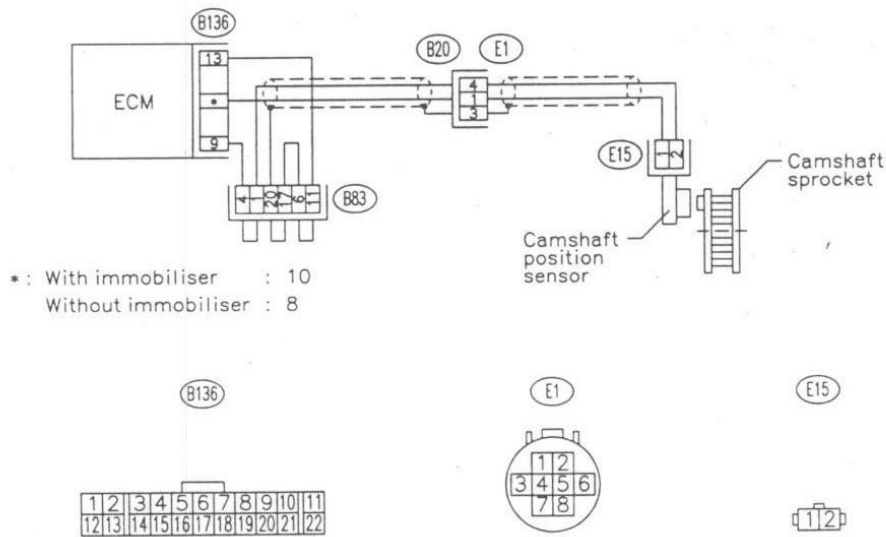


LHD

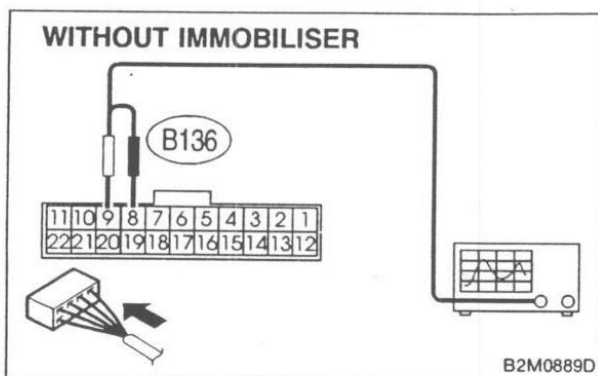


H2M2180

RHD



H2M2181

**1. CHECK INPUT SIGNAL FOR ECM.**

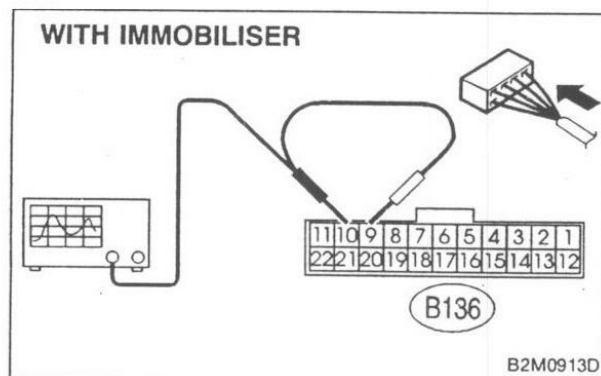
1) Set the positive (+) probe and earth lead of oscilloscope at ECM connector terminals.

Connector & terminal:

Without immobiliser:

Positive probe; (B136) No. 8

Earth lead; (B136) No. 9

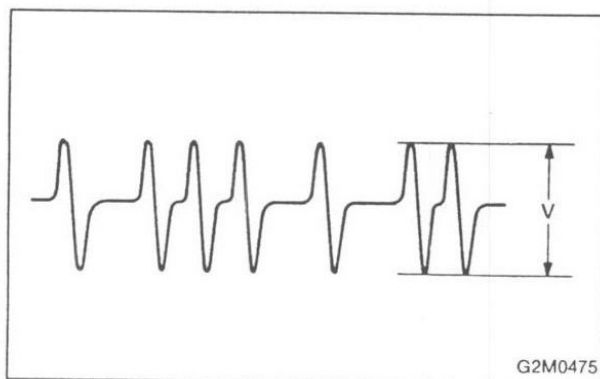


Connector & terminal:

With immobiliser:

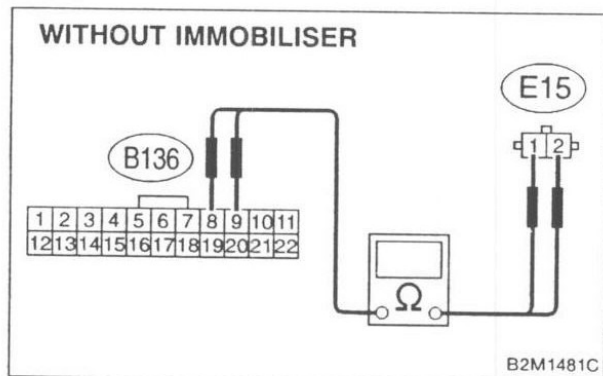
Positive probe; (B136) No. 10

Earth lead; (B136) No. 9



2) Measure signal voltage indicated on oscilloscope, while cranking the engine.

Specified voltage: More than 400 mV

**2. CHECK HARNESS CONNECTOR BETWEEN ECM AND CAMSHAFT POSITION SENSOR.**

1) Turn ignition switch to OFF.

2) Disconnect connectors from ECM and camshaft position sensor.

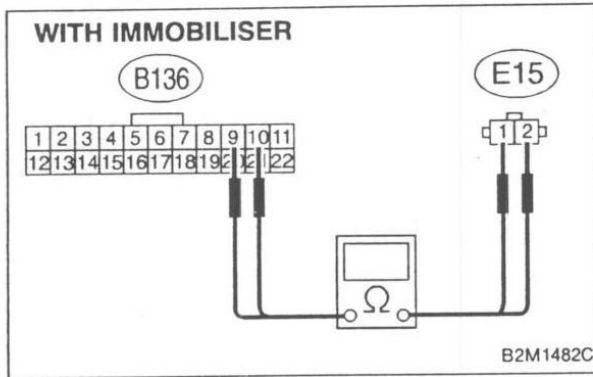
3) Measure resistance of harness connector between ECM and camshaft position sensor.

Connector & terminal / Specified resistance:

Without immobiliser:

(B136) No. 8 — (E15) No. 1 / Less than 1 Ω

(B136) No. 9 — (E15) No. 2 / Less than 1 Ω

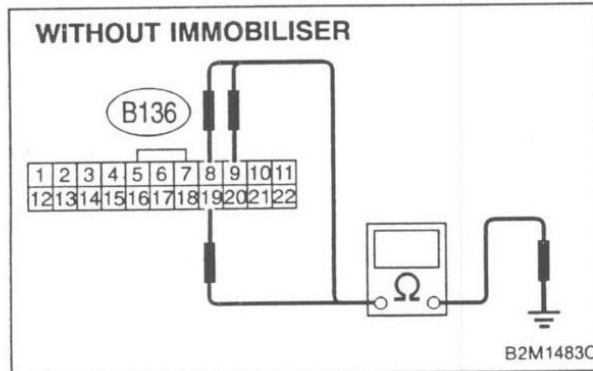


Connector & terminal / Specified resistance:

With immobiliser:

(B136) No. 10 — (E15) No. 1 / Less than 1 Ω

(B136) No. 9 — (E15) No. 2 / Less than 1 Ω



4) Measure resistance of harness connector between ECM and body to make sure that circuit does not short.

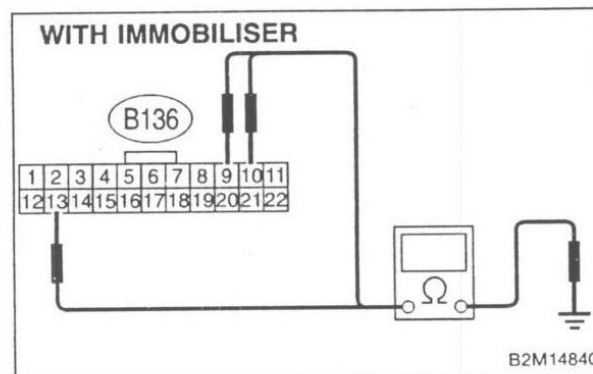
Connector & terminal / Specified resistance:

Without immobiliser:

(B136) No. 8 — Body / More than 1 M Ω

(B136) No. 9 — Body / More than 1 M Ω

(B136) No. 13 — Body / More than 1 M Ω



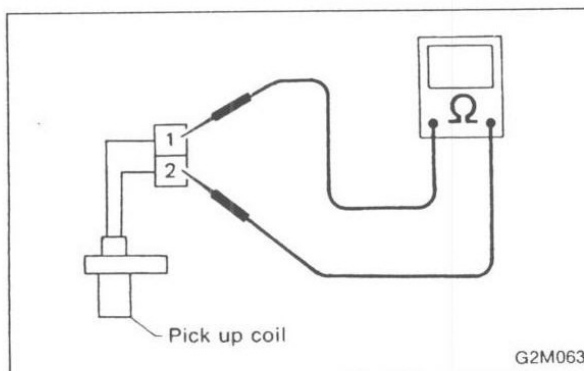
Connector & terminal / Specified resistance:

With immobiliser:

(B136) No. 9 — Body / More than 1 M Ω

(B136) No. 10 — Body / More than 1 M Ω

(B136) No. 13 — Body / More than 1 M Ω



3. CHECK CAMSHAFT POSITION SENSOR.

1) Remove camshaft position sensor.

2) Measure resistance between connector terminals of camshaft position sensor.

Terminals / Specified resistance:

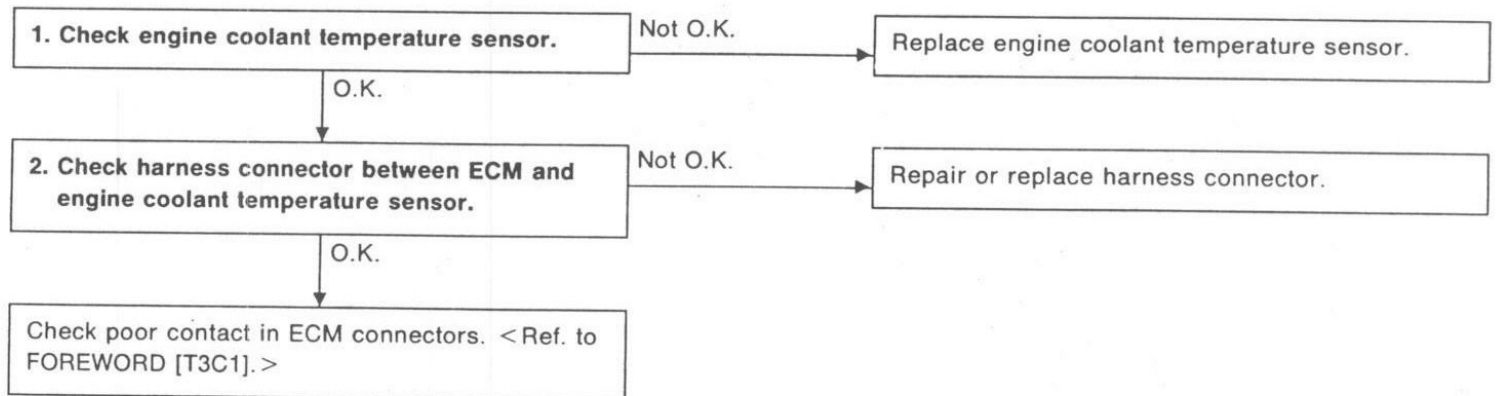
No. 1 — No. 2 / 2,040 $\pm$ 200 Ω

**E: TROUBLE CODE (21)
— ENGINE COOLANT TEMPERATURE
SENSOR —****DIAGNOSIS:**

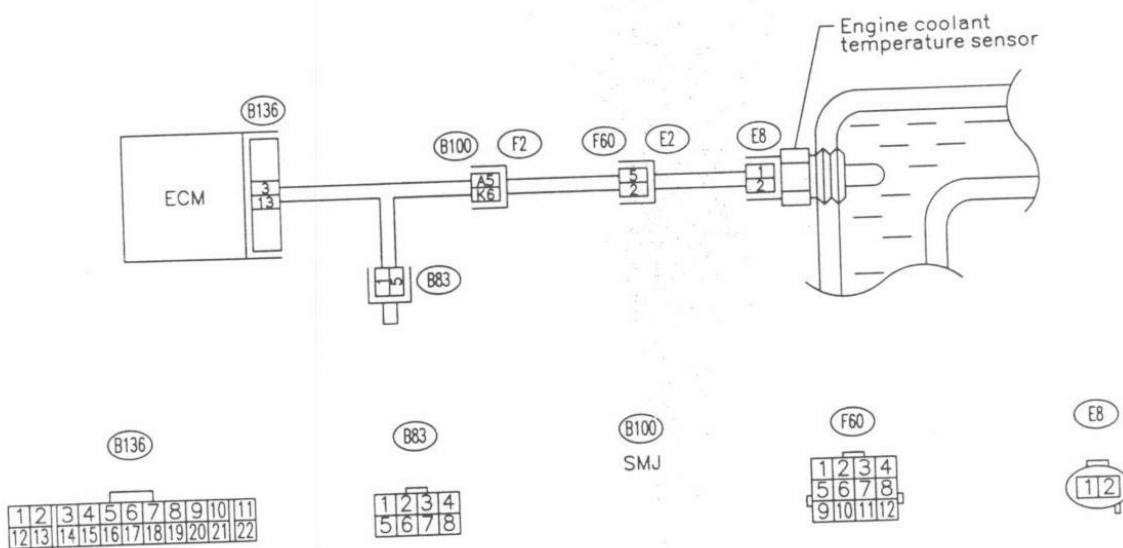
- The engine coolant temperature sensor signal is abnormal.
- The harness connector between ECM and engine coolant temperature sensor is in short or open.

TROUBLE SYMPTOM:

- Hard to start
- Erroneous idling
- Poor driving performance

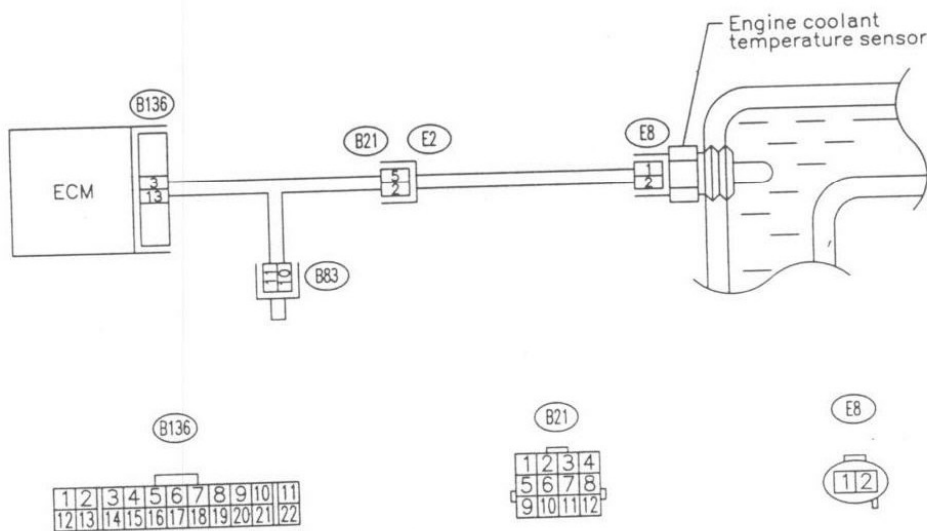


LHD

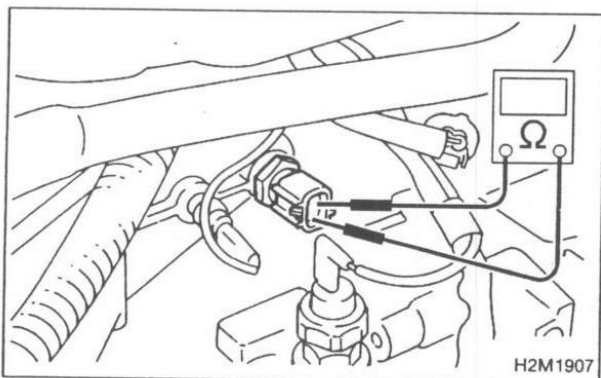


H2M2182

RHD



H2M2183



1. CHECK ENGINE COOLANT TEMPERATURE SENSOR.

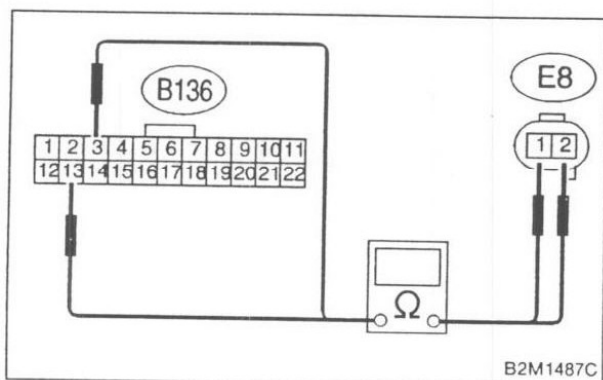
- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from engine coolant temperature sensor.
- 3) Measure resistance between engine coolant temperature sensor terminals.

Terminals / Specified resistance:

No. 1 — No. 2 / $2.5 \pm 0.4 \text{ k}\Omega$ at 20°C (68°F)

No. 1 — No. 2 / $0.37 \pm 0.002 \text{ k}\Omega$ at 80°C (176°F)

No. 1 — No. 2 / $0.25 \pm 0.02 \text{ k}\Omega$ at 90°C (194°F)



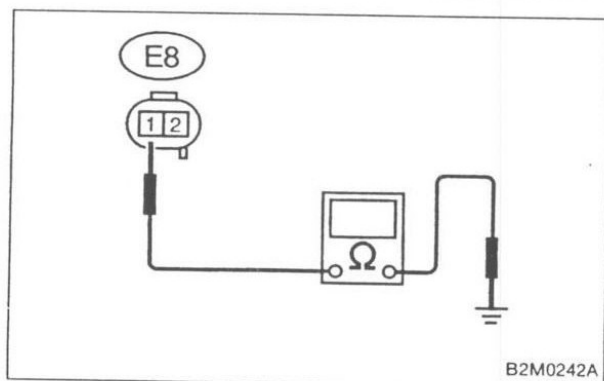
2. CHECK HARNESS CONNECTOR BETWEEN ECM AND ENGINE COOLANT TEMPERATURE SENSOR.

- 1) Disconnect connector from ECM.
- 2) Measure resistance of harness connector between ECM and engine coolant temperature connector.

Connector & terminal / Specified resistance:

(B136) No. 3 — (E8) No. 1 / Less than 1Ω

(B136) No. 13 — (E8) No. 2 / Less than 1Ω



- 3) Measure resistance of harness connector between engine coolant temperature sensor and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

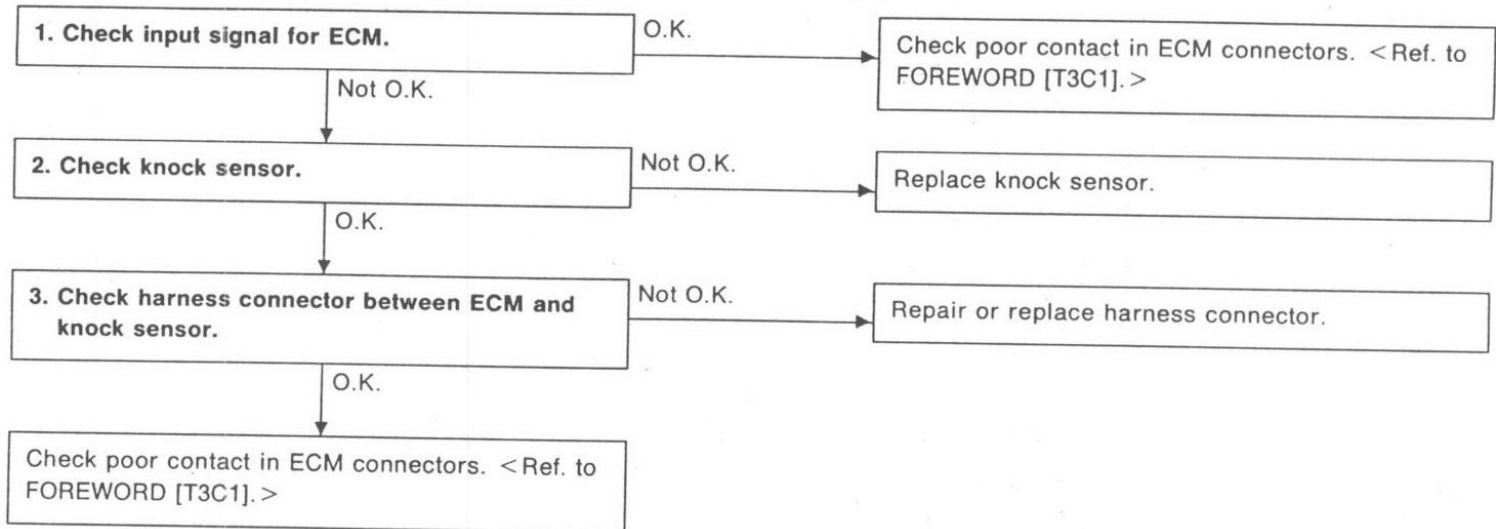
(E8) No. 1 — Body / More than $1 \text{ M}\Omega$

F: TROUBLE CODE (22)**— KNOCK SENSOR —****DIAGNOSIS:**

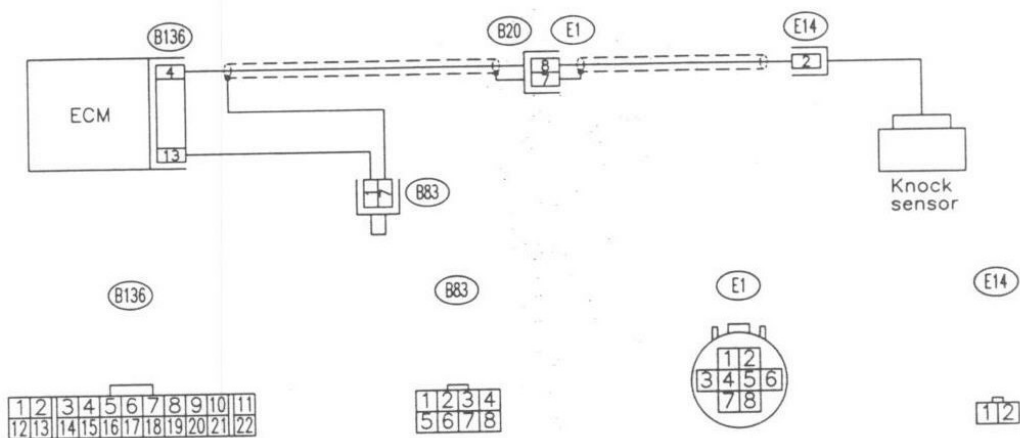
- The knock sensor signal is abnormal.
- The harness connector between ECM and knock sensor is in short or open.

TROUBLE SYMPTOM:

- Poor driving performance

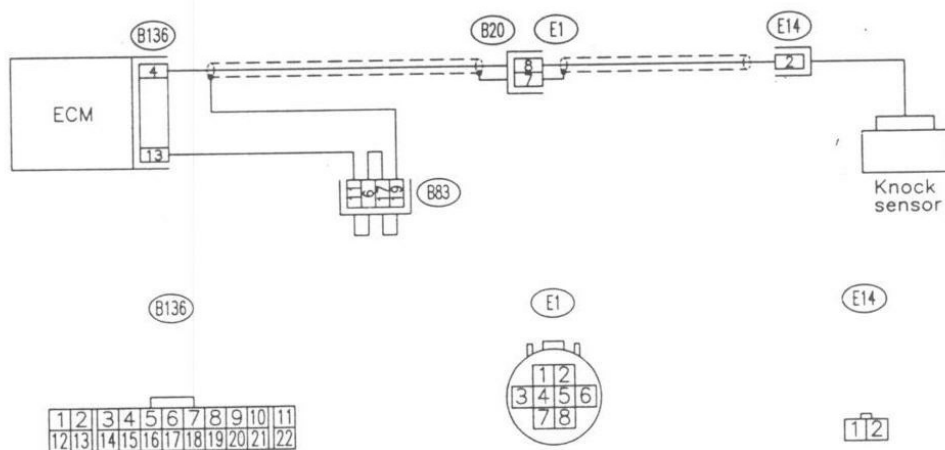


LHD

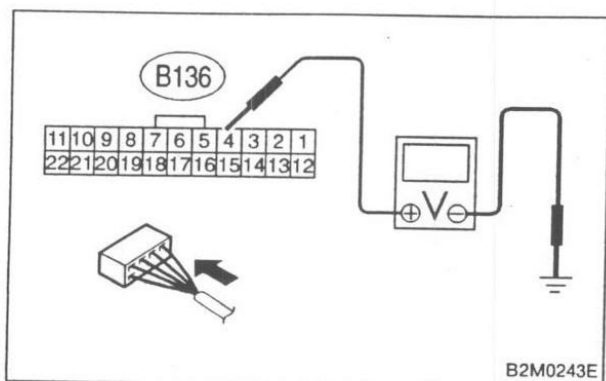


H2M2185

RHD

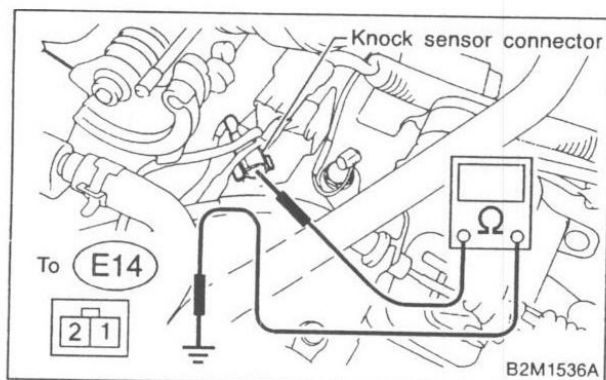


H2M2186

**1. INPUT SIGNAL FOR ECM.**

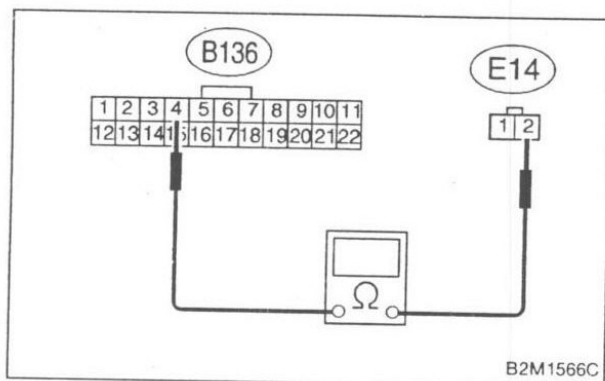
- 1) Turn ignition switch to ON.
- 2) Measure voltage between ECM connector terminal and body.

Connector & terminal / Specified voltage:
(B136) No. 4 — Body / About 2.8 V

**2. CHECK KNOCK SENSOR.**

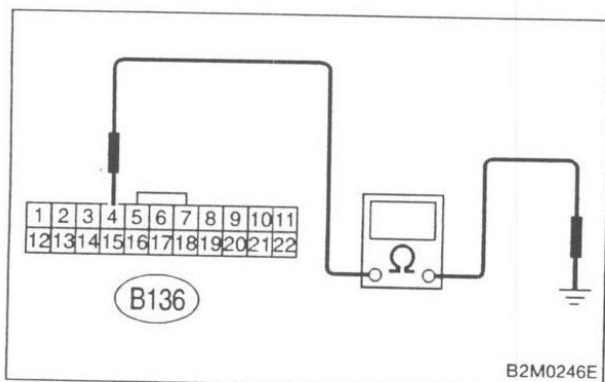
- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from knock sensor.
- 3) Measure resistance between knock sensor terminal and body.

Connector & terminal / Specified resistance:
No. 2 — Body / Approx. 560 k Ω

**3. CHECK HARNESS CONNECTOR BETWEEN ECM AND KNOCK SENSOR.**

- 1) Disconnect connectors from ECM.
- 2) Measure resistance of harness connector between ECM and knock sensor.

Connector & terminal / Specified resistance:
(B136) No. 4 — (E14) No. 2 / Less than 1 Ω



- 3) Measure resistance of harness connector between ECM connector and body to make sure that circuit does not short.

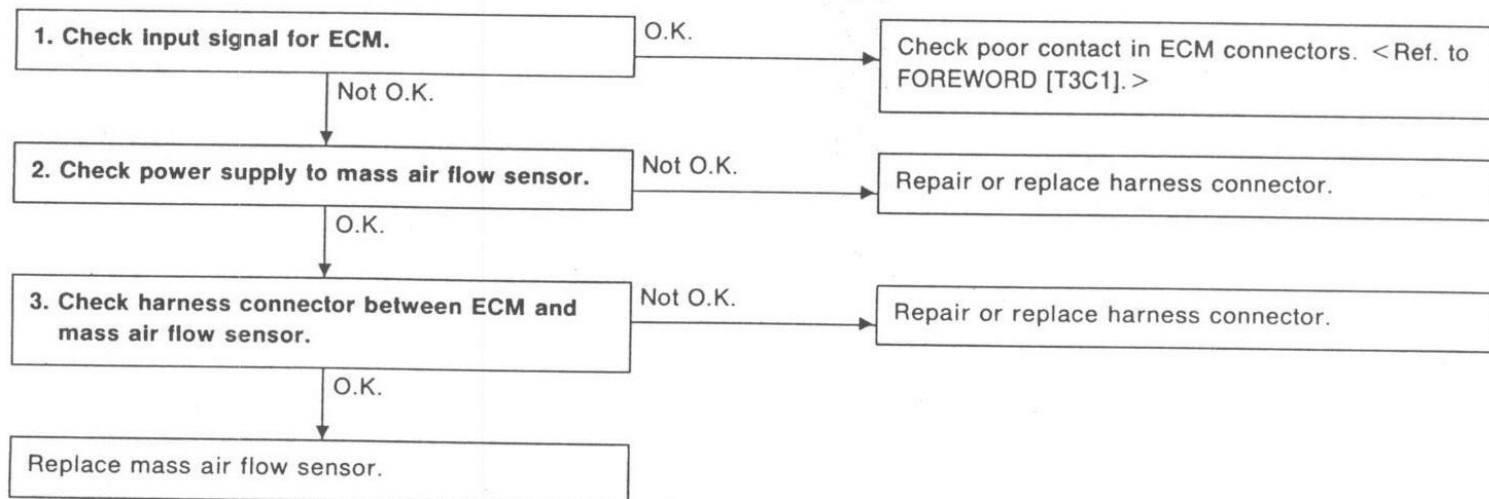
Connector & terminal / Specified resistance:
(B136) No. 4 — Body / More than 1 M Ω

G: TROUBLE CODE (23)**— MASS AIR FLOW SENSOR —****DIAGNOSIS:**

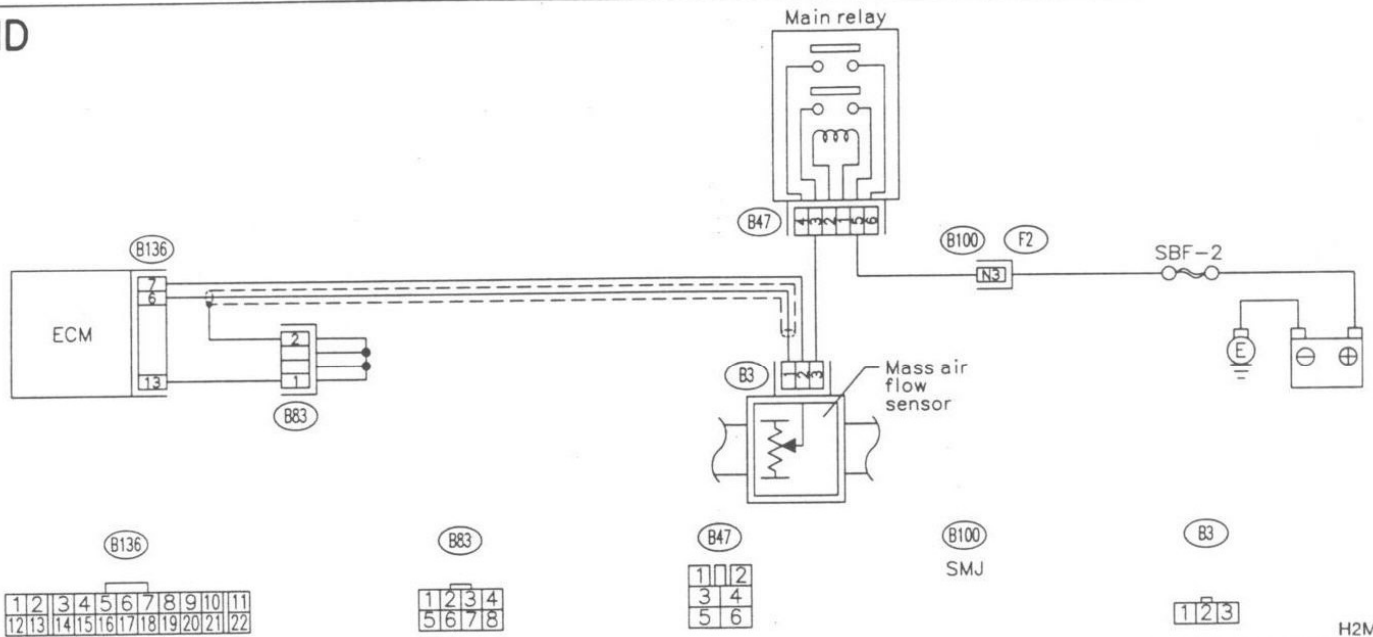
- The mass air flow sensor signal is abnormal.
- The harness connector between ECM and mass air flow sensor is in short or open.

TROUBLE SYMPTOM:

- Erroneous idling
- Engine stalls.
- Poor driving performance

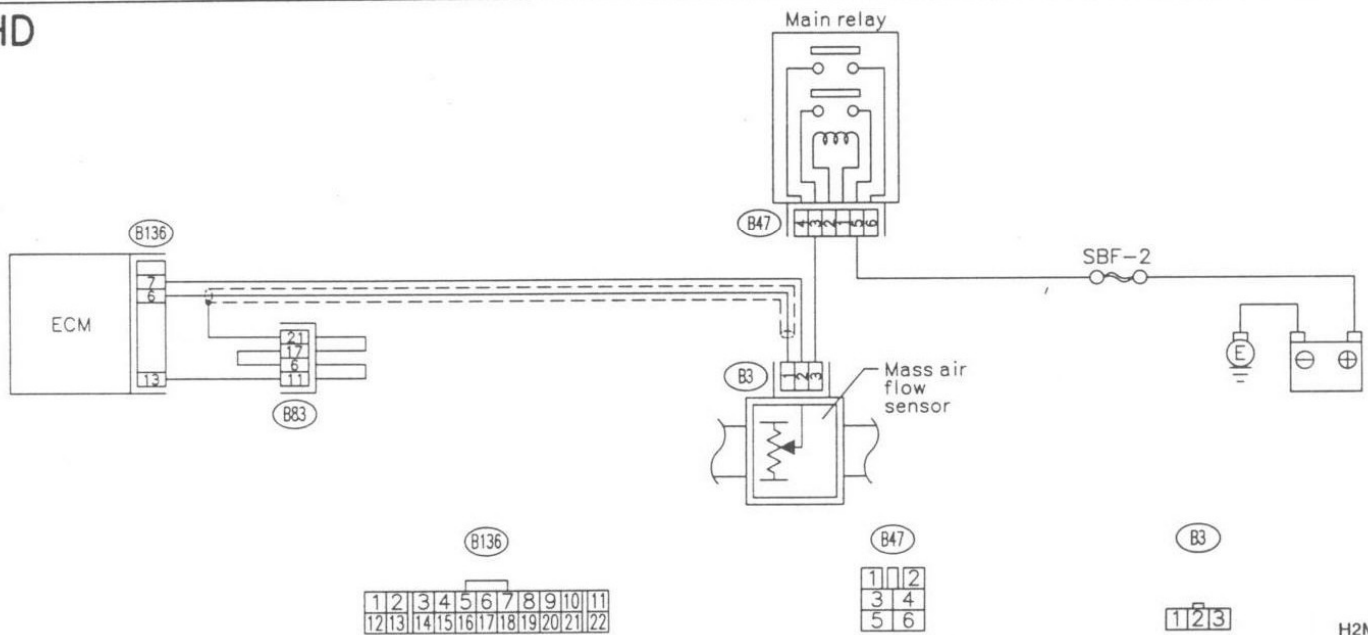


LHD

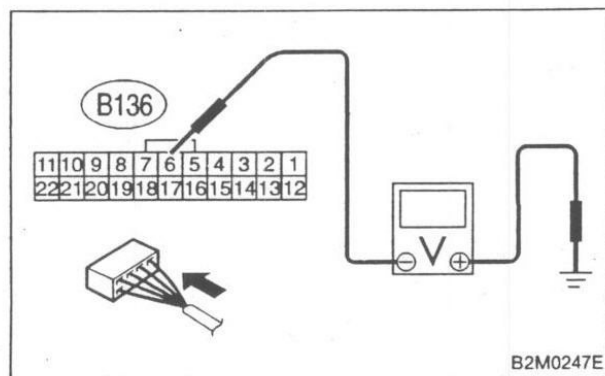


H2M2187

RHD



H2M2188

**1. CHECK INPUT SIGNAL FOR ECM.**

- 1) Turn ignition switch to ON.
- 2) Measure voltage between ECM and body.

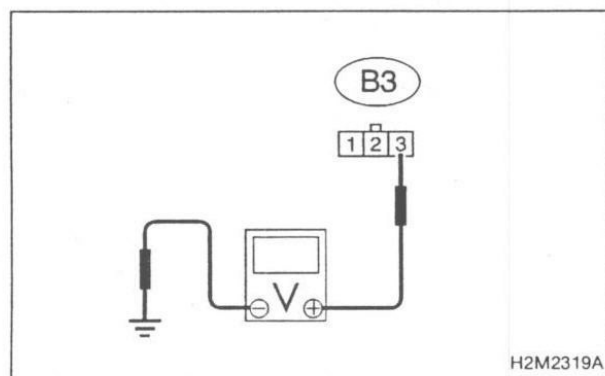
Connector & terminal / Specified voltage:

(B136) No. 6 — Body / 0.26 V

- 3) Start engine, and idle it.
- 4) Measure voltage between ECM and body while engine is idling.

Connector & terminal / Specified voltage:

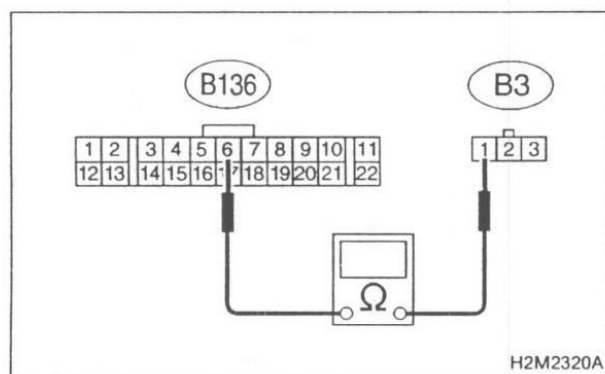
(B136) No. 6 — Body / 1.1 ± 0.3 V

**2. CHECK POWER SUPPLY TO MASS AIR FLOW SENSOR.**

- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from mass air flow sensor.
- 3) Turn ignition switch to ON.
- 4) Measure voltage between mass air flow sensor connector and body.

Connector & terminal / Specified voltage:

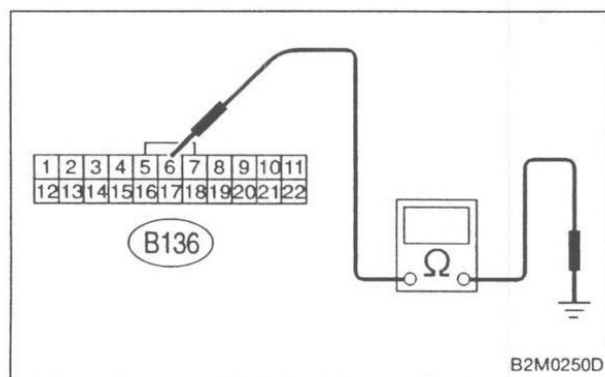
(B3) No. 3 — Body / More than 10 V

**3. CHECK HARNESS CONNECTOR BETWEEN ECM AND MASS AIR FLOW SENSOR.**

- 1) Turn ignition switch to OFF.
- 2) Disconnect connectors from ECM.
- 3) Measure resistance of harness connector between ECM and mass air flow sensor.

Connector & terminal / Specified resistance:

(B136) No. 6 — (B3) No. 1 / Less than 1 Ω



- 4) Measure resistance of harness connector between ECM and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

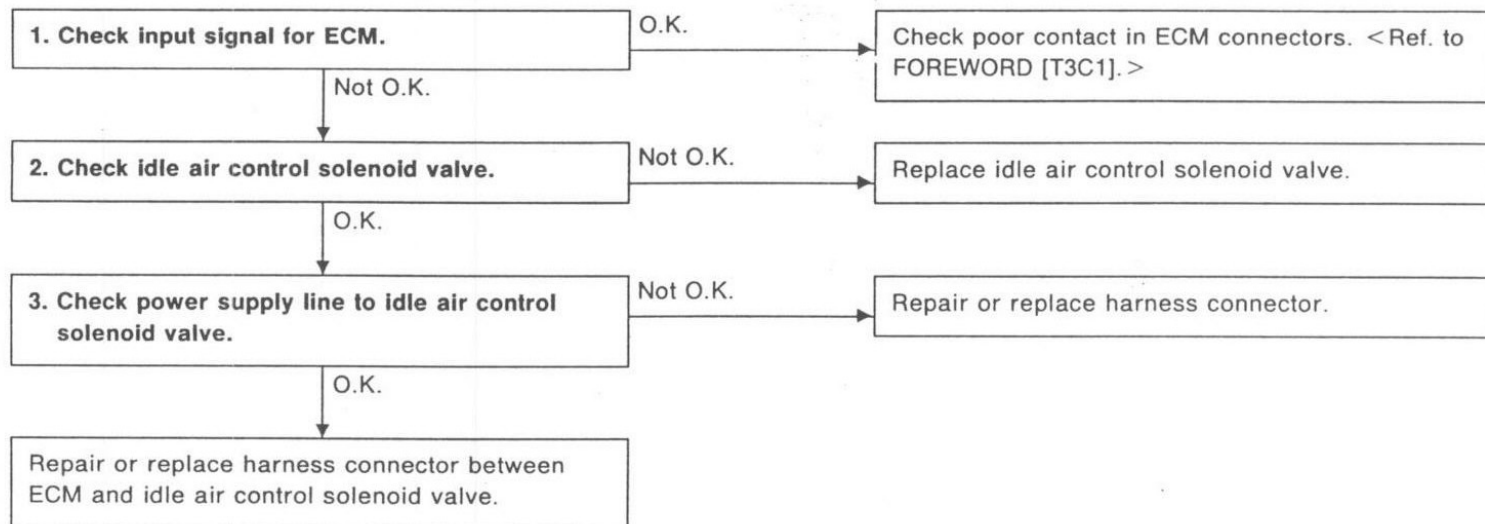
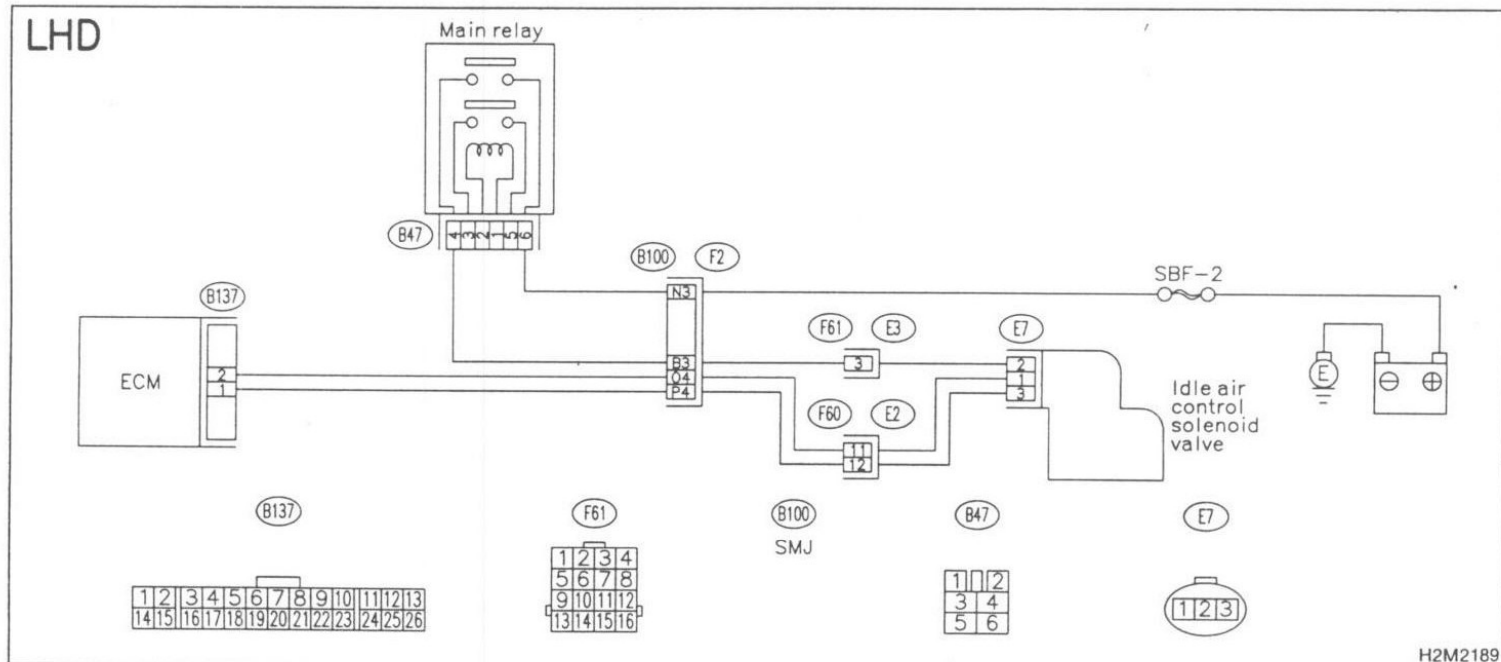
(B136) No. 6 — Body / More than 1 MΩ

H: TROUBLE CODE (24)**— IDLE AIR CONTROL SOLENOID VALVE —****DIAGNOSIS:**

- The idle air control solenoid valve is not in function.
- The harness connector between ECM and idle air control solenoid valve is in short or open.

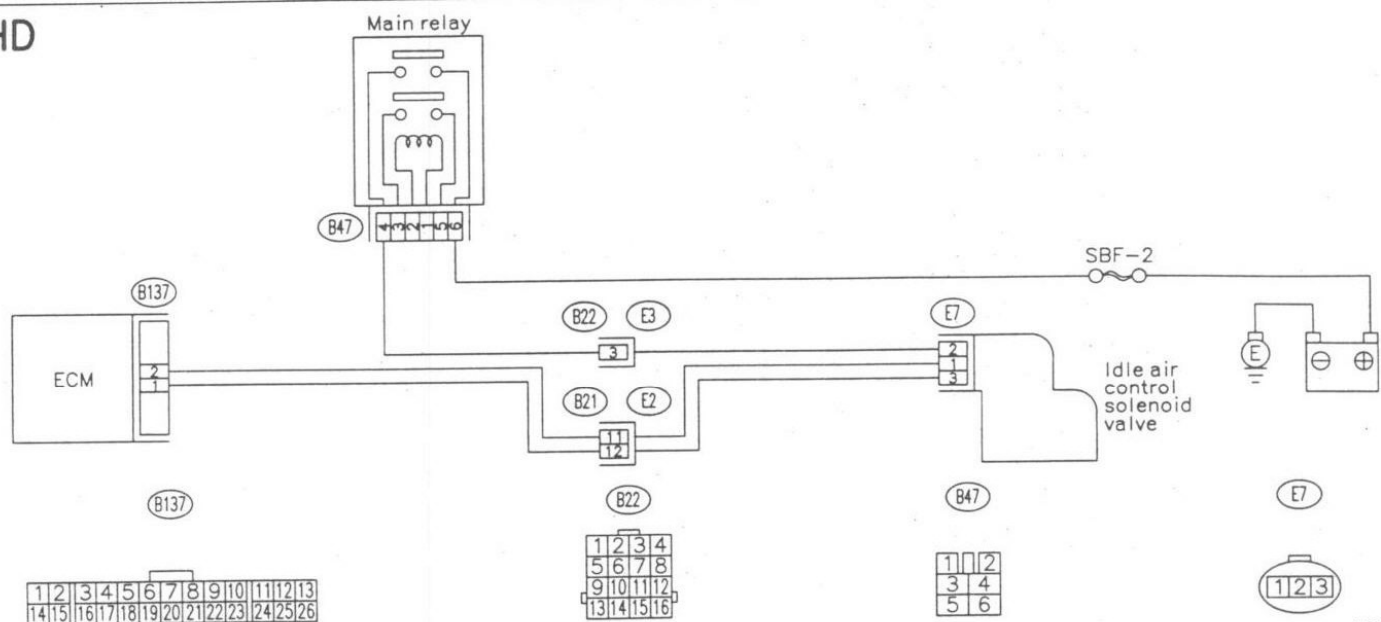
TROUBLE SYMPTOM:

- Erroneous idling
- Engine stalls.
- Engine breathing

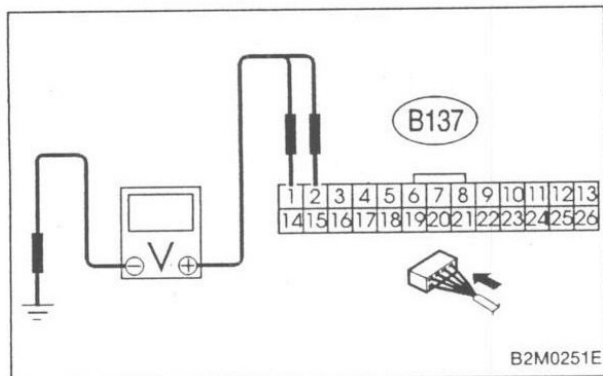
**LHD**

H2M2189

RHD



H2M2190

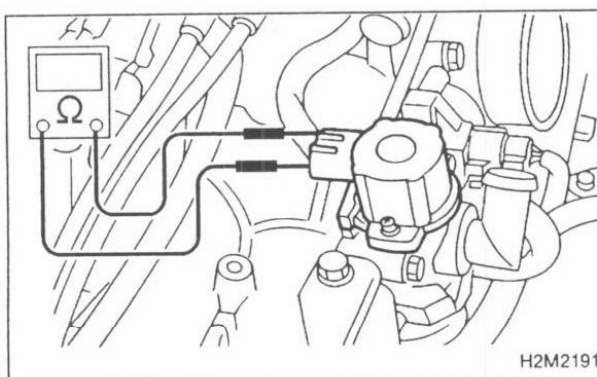


B2M0251E

1. CHECK INPUT SIGNAL FOR ECM.

- 1) Turn ignition switch to ON.
- 2) Measure voltage between ECM and body.

Connector & terminal / Specified voltage:
(B137) No. 1 — Body / More than 10 V
(B137) No. 2 — Body / More than 10 V

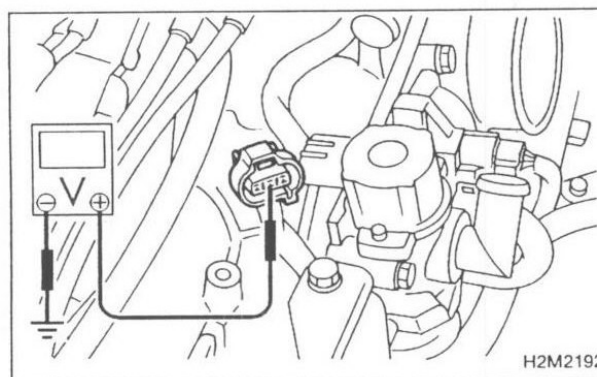


H2M2191

2. CHECK IDLE AIR CONTROL SOLENOID VALVE.

- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from idle air control solenoid valve.
- 3) Measure resistance between solenoid valve terminals.

Terminals / Specified resistance:
No. 1 — No. 2 / $9.5 \pm 1.5 \Omega$
No. 3 — No. 2 / $9.5 \pm 1.5 \Omega$



H2M2192

3. CHECK POWER SUPPLY LINE TO IDLE AIR CONTROL SOLENOID VALVE.

- 1) Turn ignition switch to ON.
- 2) Measure power supply voltage idle air control solenoid valve.

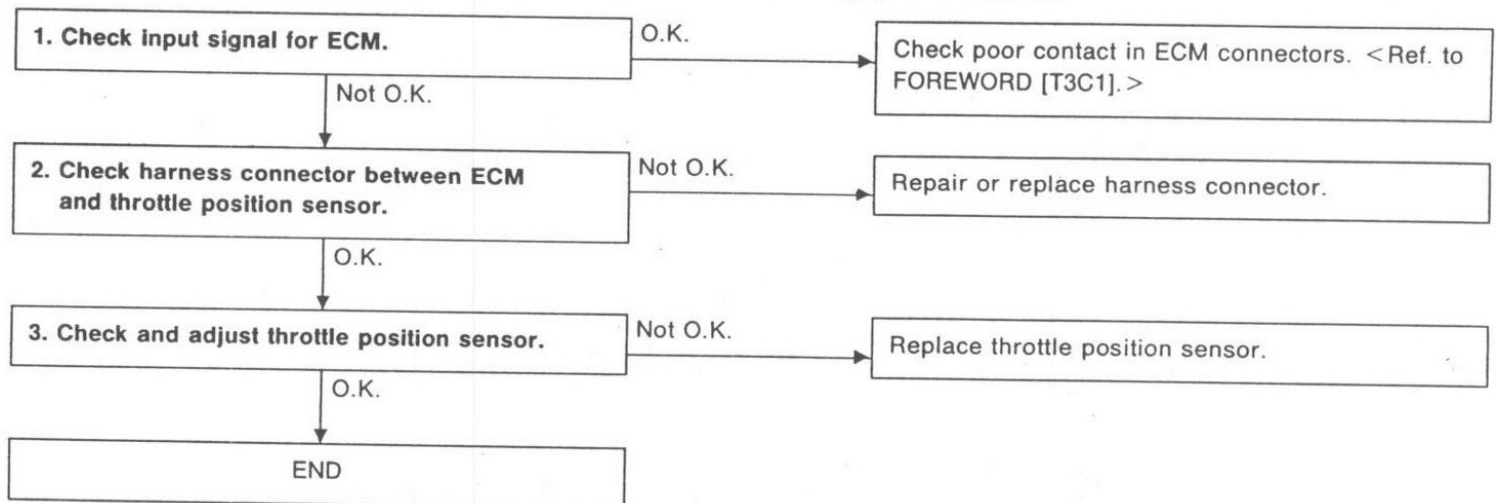
Connector & terminal / Specified voltage:
(E7) No. 2 — Body / More than 10 V

I: TROUBLE CODE (31)**— THROTTLE POSITION SENSOR —****DIAGNOSIS:**

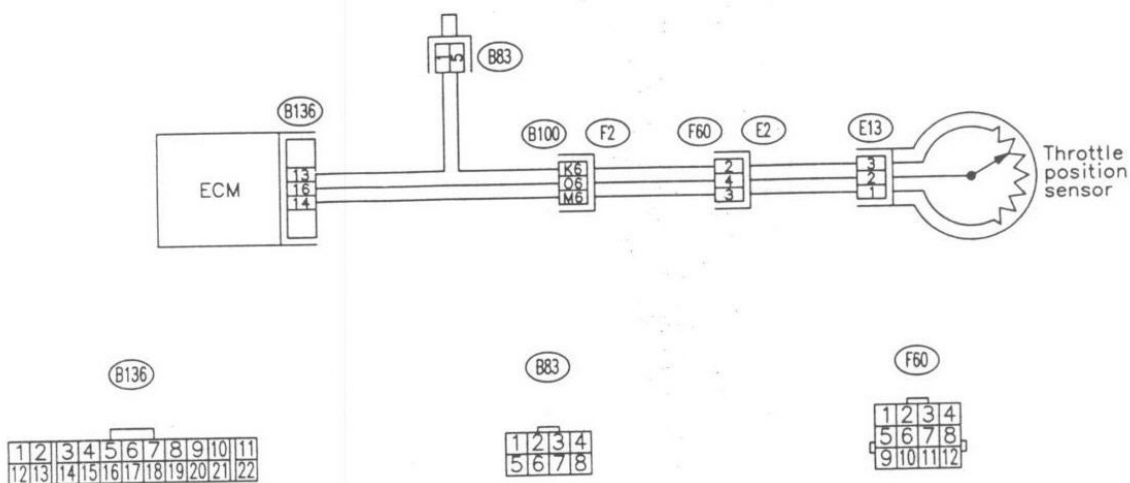
- The throttle position sensor signal is abnormal.
- The throttle position sensor is installed abnormally.
- The harness connector between ECM and throttle position sensor is in short or open.

TROUBLE SYMPTOM:

- Erroneous idling
- Engine stalls.
- Poor driving performance

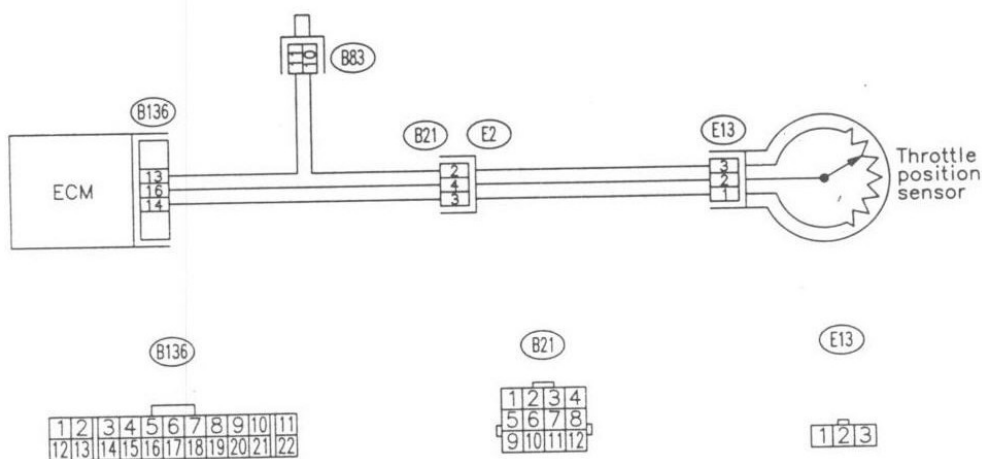


LHD

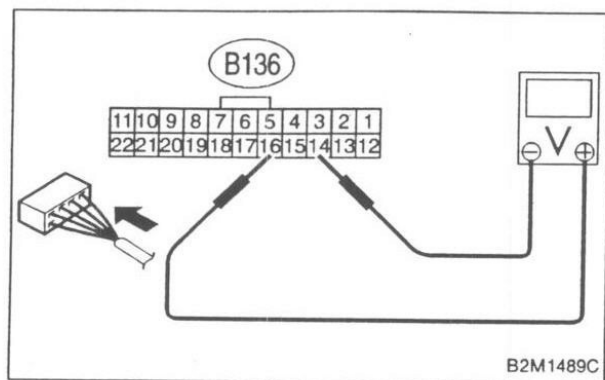


H2M2195

RHD



H2M2196

**1. CHECK INPUT SIGNAL FOR ECM.**

- 1) Turn ignition switch to ON.
- 2) Measure signal voltage between ECM terminals while throttle valve is fully closed.

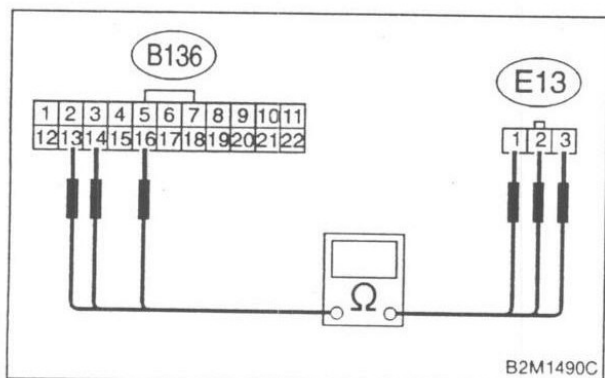
Connector & terminal / Specified voltage:

(B136) No. 16 — (B136) No. 14 / 0.5 ± 0.3 V

- 3) Measure signal voltage between ECM terminals while throttle valve is fully opened.

Connector & terminal / Specified voltage:

(B136) No. 16 — (B136) No. 14 / 4.3 ± 0.3 V

**2. CHECK HARNESS CONNECTOR BETWEEN ECM AND THROTTLE POSITION SENSOR.**

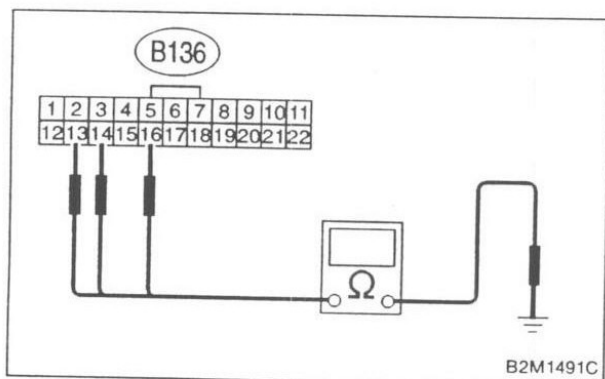
- 1) Turn ignition switch to OFF.
- 2) Disconnect connectors from ECM and throttle position sensor.
- 3) Measure resistance of harness connector between ECM and throttle position sensor.

Connector & terminal / Specified resistance:

(B136) No. 16 — (E13) No. 2 / Less than 1 Ω

(B136) No. 13 — (E13) No. 3 / Less than 1 Ω

(B136) No. 14 — (E13) No. 1 / Less than 1 Ω



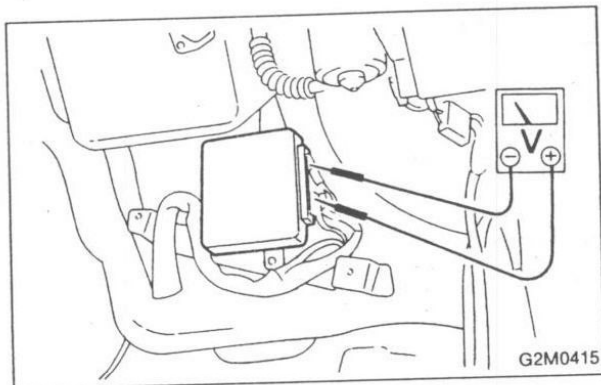
- 4) Disconnect connectors from TCM. (AT vehicle only)
- 5) Measure resistance of harness connector between ECM and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

(B136) No. 16 — Body / More than 1 $M\Omega$

(B136) No. 13 — Body / More than 1 $M\Omega$

(B136) No. 14 — Body / More than 1 $M\Omega$



3. CHECK AND ADJUST THROTTLE POSITION SENSOR.

- 1) Connect all connectors.
- 2) Loosen throttle position sensor installing screws.
- 3) Adjust throttle position sensor while throttle valve is fully opened.

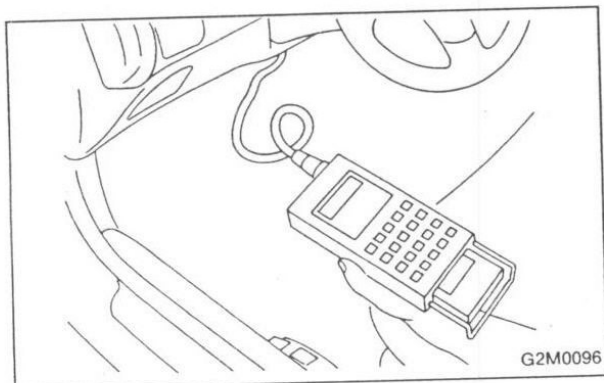
● Using voltage meter:

- (1) Turn ignition switch to ON.
- (2) Adjust throttle position sensor to specified voltage between ECM connector terminals.

Connector & terminal / Specified voltage:

(B136) No. 16 — (B136) No. 14 / 4.3 ± 0.3 V

- (3) Tighten throttle position sensor installing screws.



● Using select monitor:

- (1) Attach select monitor.
- (2) Turn ignition switch to ON.
- (3) Select mode "F07".
- (4) Adjust throttle position sensor to specified data.

Conditions / Specified data:

Throttle valve fully opened / 4.3 ± 0.3 V

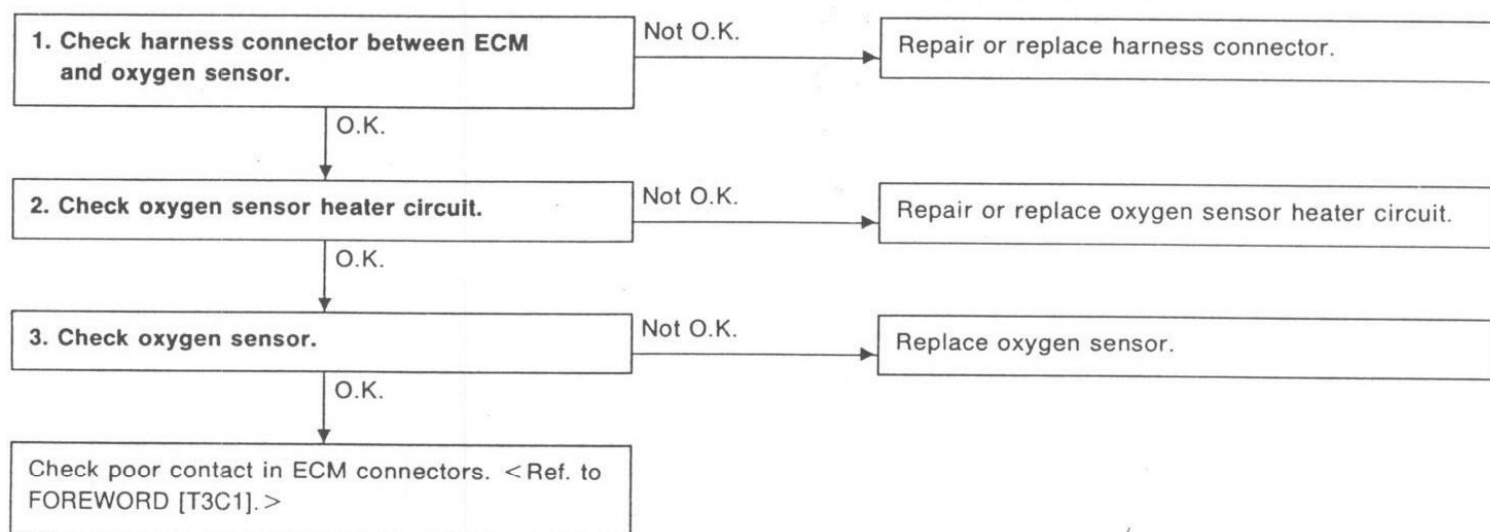
- (5) Tighten throttle position sensor installing screws.

J: TROUBLE CODE (32)
— OXYGEN SENSOR —**DIAGNOSIS:**

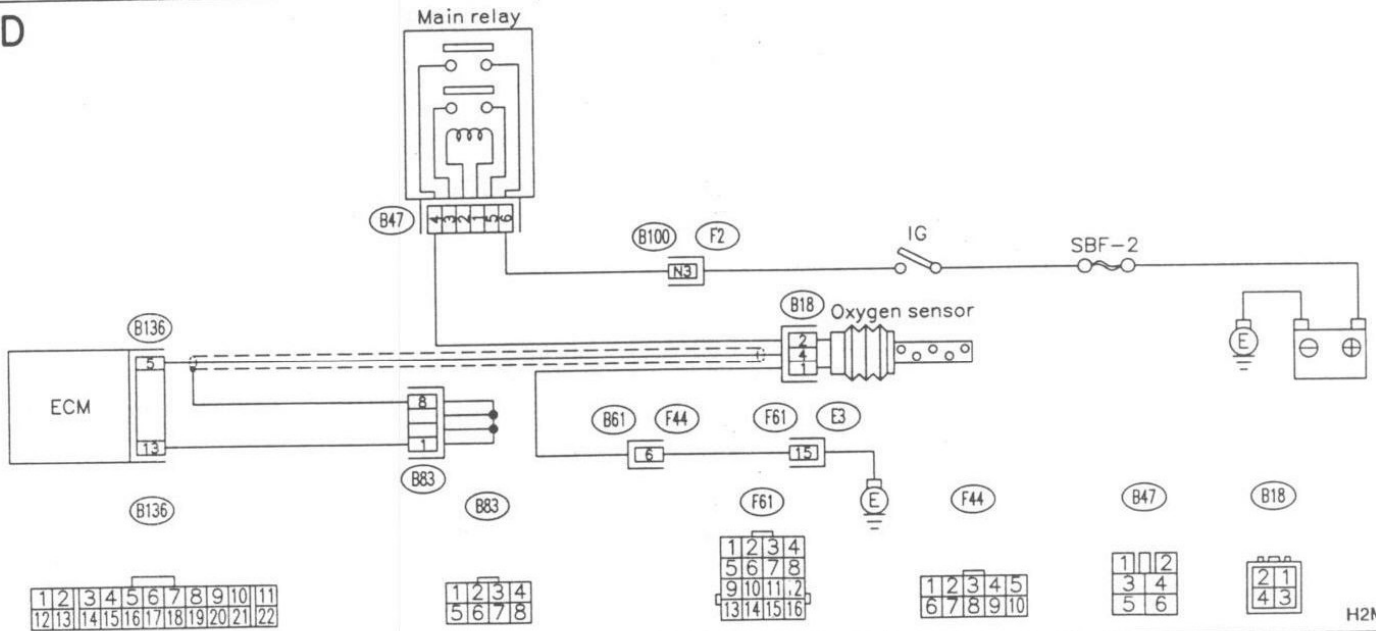
- The oxygen sensor is not in function.
- The harness connector between ECM and oxygen sensor is in short or open.

TROUBLE SYMPTOM:

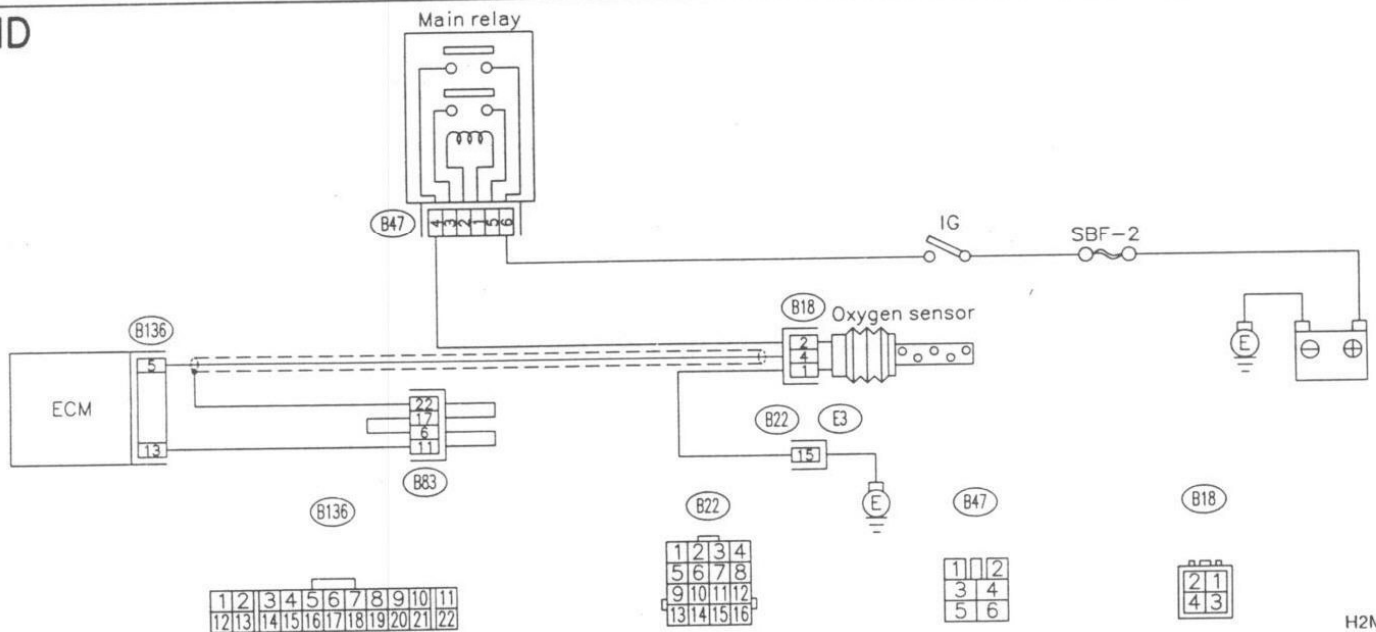
- Failure of engine to start.
- Erroneous idling
- Poor driving performance
- Engine stalls.
- Idle mixture is out of specifications.

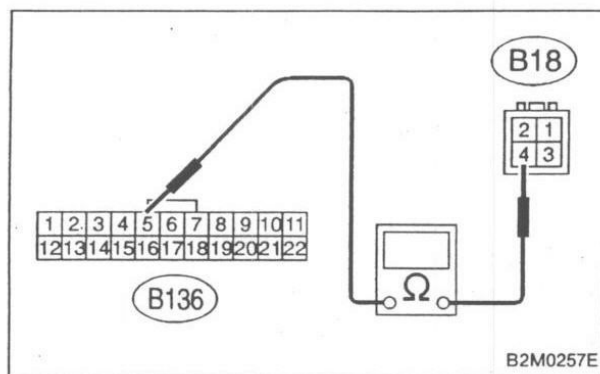


LHD



RHD



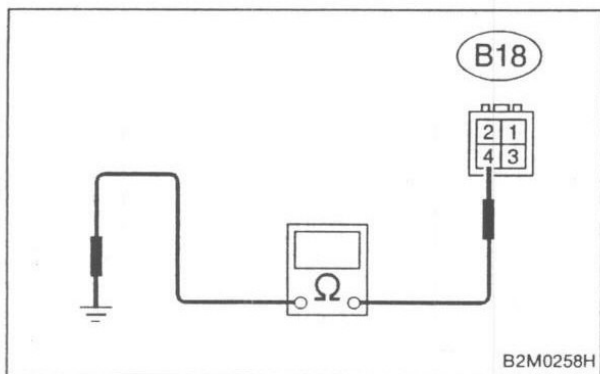


1. CHECK HARNESS CONNECTOR BETWEEN ECM AND OXYGEN SENSOR.

- 1) Disconnect connectors from ECM and oxygen sensor.
- 2) Measure resistance of harness connector between ECM and oxygen sensor.

Connector & terminal / Specified resistance:

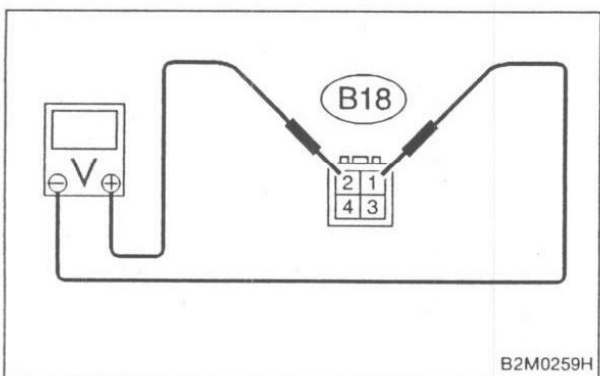
(B136) No. 5 — (B18) No. 4 / Less than 1 Ω



- 3) Measure resistance of harness connector between oxygen sensor and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

(B18) No. 4 — Body / More than 1 M Ω

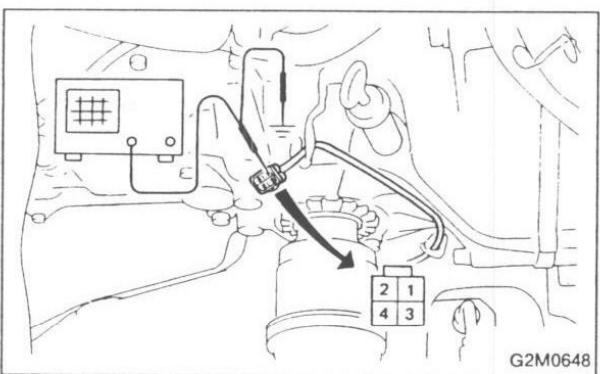


2. CHECK OXYGEN SENSOR HEATER CIRCUIT.

- 1) Connect ECM connectors.
- 2) Turn ignition switch to ON.
- 3) Measure voltage between connector terminals of oxygen sensor.

Connector & terminal / Specified voltage:

(B18) No. 1 — (B18) No. 2 / More than 10 V



3. CHECK OXYGEN SENSOR.

- 1) Connect oxygen sensor.
- 2) Idle engine.
- 3) Disconnect oxygen sensor connector.
- 4) Measure voltage between oxygen sensor terminal and body by using oscilloscope.

Connector & terminal / Specified voltage:

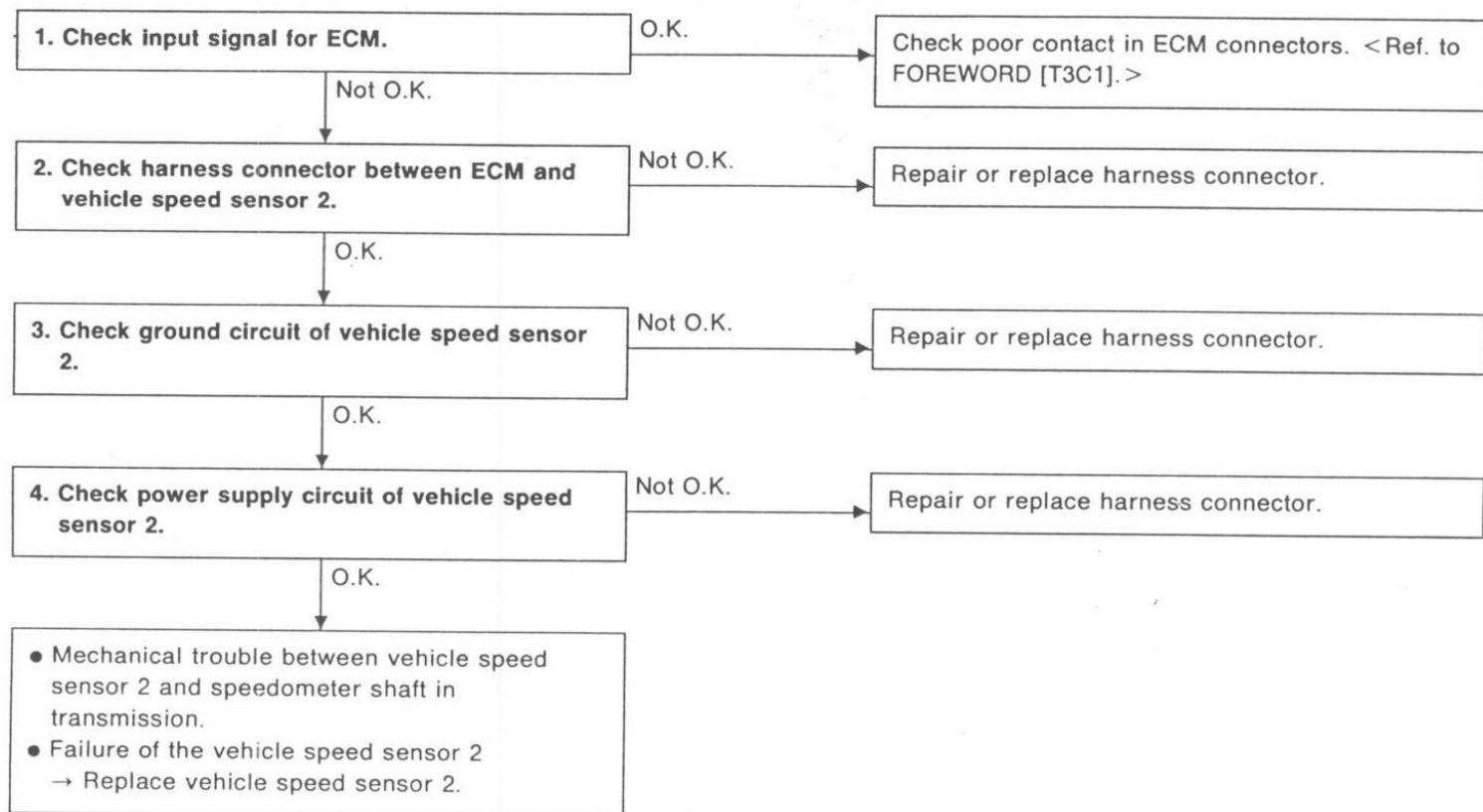
No. 4 — Body / 0.1 — 1.0 V

K: TROUBLE CODE (33)**— VEHICLE SPEED SENSOR 2 —****DIAGNOSIS:**

- The vehicle speed sensor 2 is not in function.
- The harness connector between ECM and vehicle speed sensor 2 is in short or open.

TROUBLE SYMPTOM:

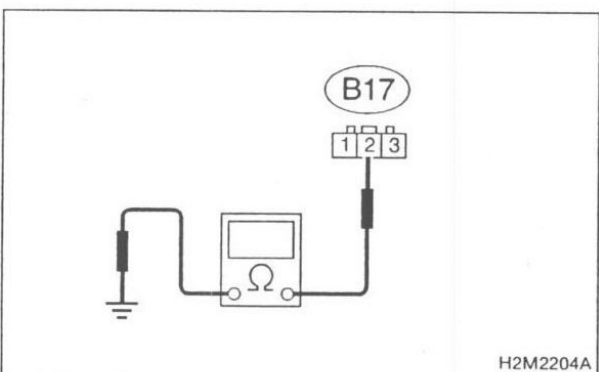
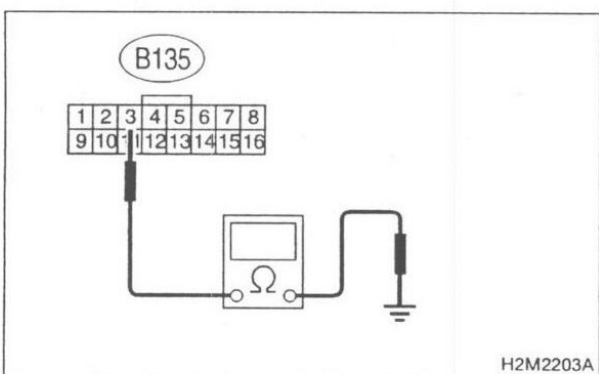
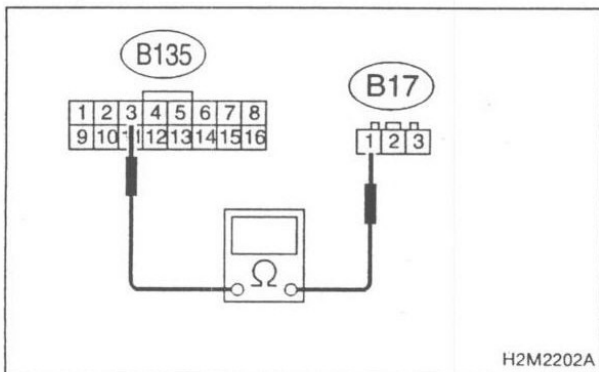
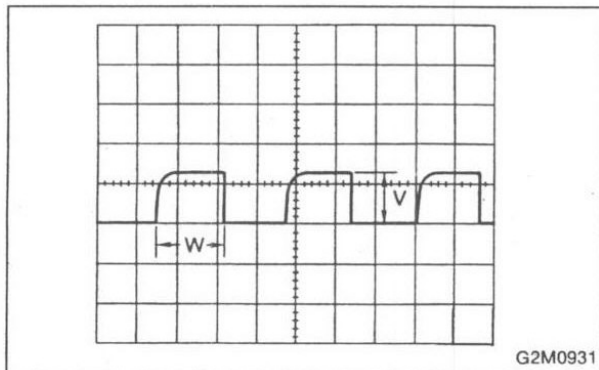
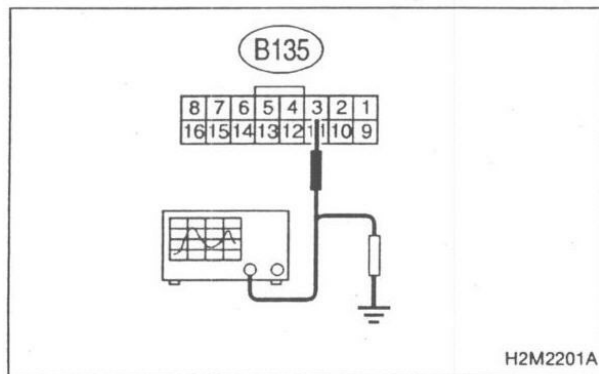
- Erroneous idling
- Engine stalls.
- Poor driving performance



MODEL] [T8K0] 2-7c
8. Diagnostics Chart with Trouble Code

8. Diagnostics Chart with Trouble Code



**1. CHECK INPUT SIGNAL FOR ECM.**

- 1) Lift-up the vehicle, or set the vehicle on free roller.
- 2) Set the positive (+) terminal and earth lead of oscilloscope at ECM connector terminals.

Connector & terminal / (B135) No. 3 — Body

- 3) Start the engine.
- 4) Shift on the gear position, and be constant the vehicle speed.
- 5) Measure signal voltage indicated on oscilloscope.

Specified voltage / More than 3 V

NOTE:

If vehicle speed increases, the width of amplitude (W) decreases.

2. CHECK HARNESS CONNECTOR BETWEEN ECM AND VEHICLE SPEED SENSOR 2.

- 1) Turn ignition switch to OFF.
- 2) Disconnect connectors from ECM and vehicle speed sensor 2.
- 3) Measure resistance of harness connector between ECM and vehicle speed sensor 2.

Connector & terminal / Specified resistance:

(B135) No. 3 — (B17) No. 1 / Less than 1 Ω

- 4) Measure resistance of harness connector between ECM and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

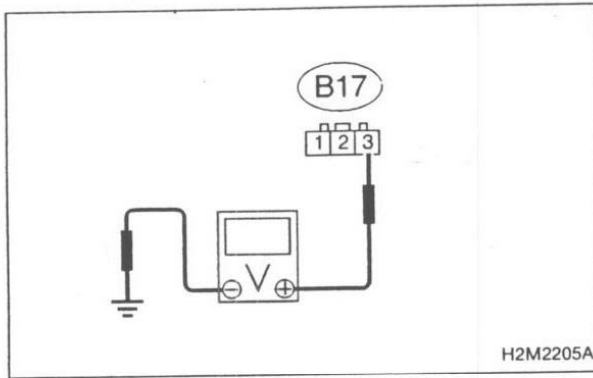
(B135) No. 3 — Body / More than 1 M Ω

3. CHECK GROUND CIRCUIT OF VEHICLE SPEED SENSOR 2.

Measure resistance of harness connector between vehicle speed sensor 2 and body.

Connector & terminal / Specified resistance:

(B17) No. 2 — Body / Less than 5 Ω



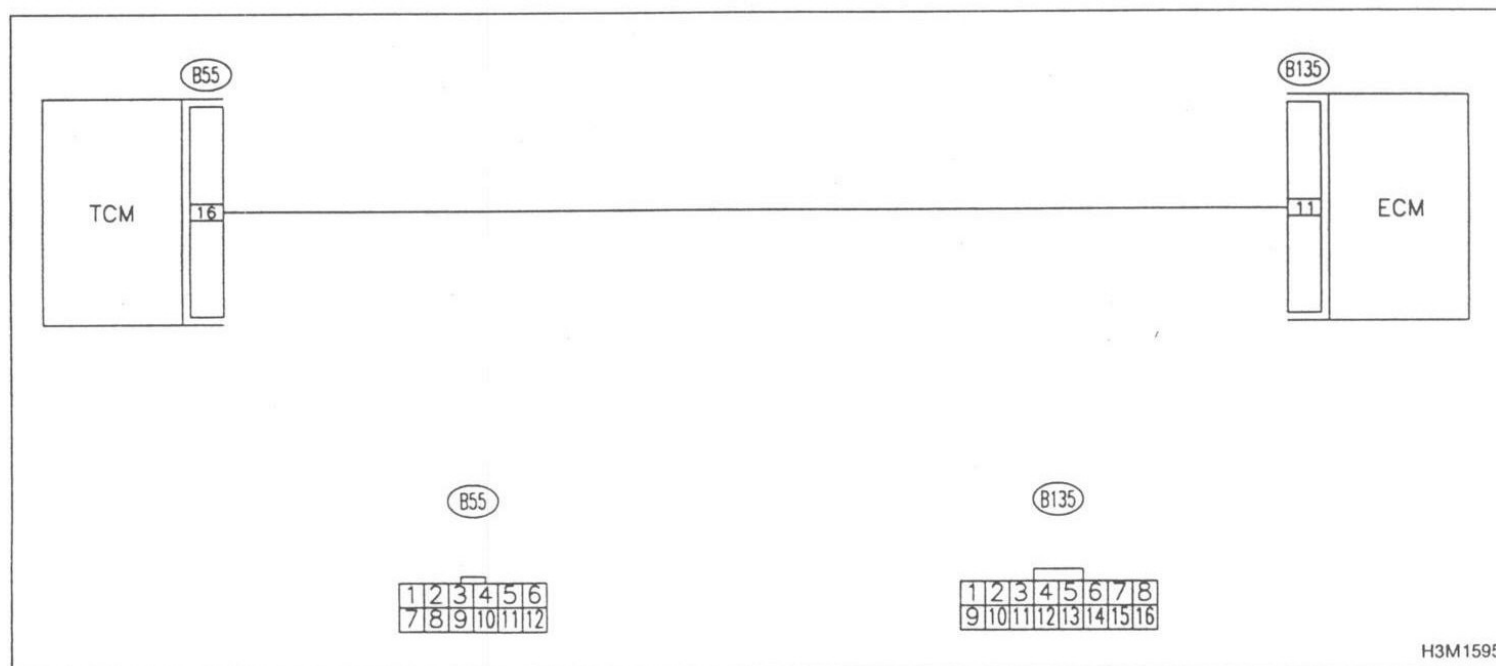
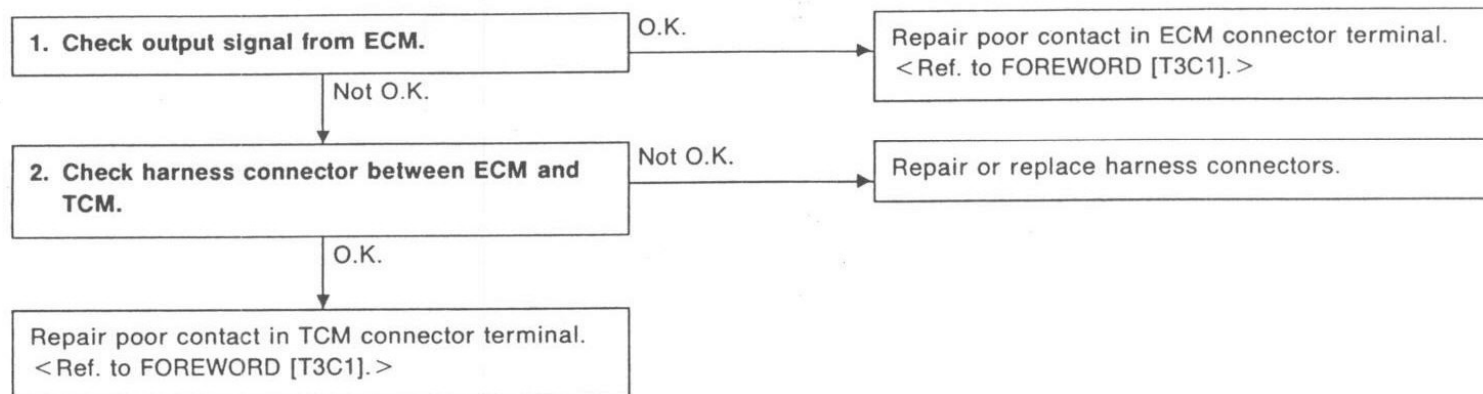
4. CHECK POWER SUPPLY CIRCUIT OF VEHICLE SPEED SENSOR 2.

- 1) Turn ignition switch to ON.
- 2) Measure power supply voltage to vehicle speed sensor 2.

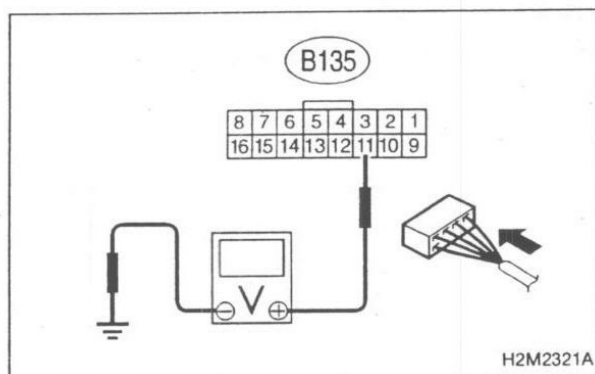
Connector & terminal / Specified voltage:
(B17) No. 3 — Body / $\geq$ More than 0 V

L: TROUBLE CODE (38)**— TORQUE CONTROL SIGNAL —****DIAGNOSIS:**

- Abnormal signal is entered from TCM.
- The harness connector between ECM and TCM is in short or open.



H3M1595

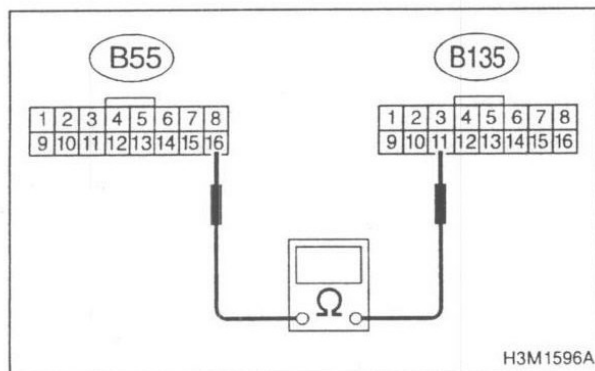


1. CHECK OUTPUT SIGNAL FROM ECM.

- 1) Turn ignition switch to ON.
- 2) Measure signal voltage between ECM and body.

Connector & terminal / Specified voltage:

(B135) No. 11 — Body / 5 ± 1 V

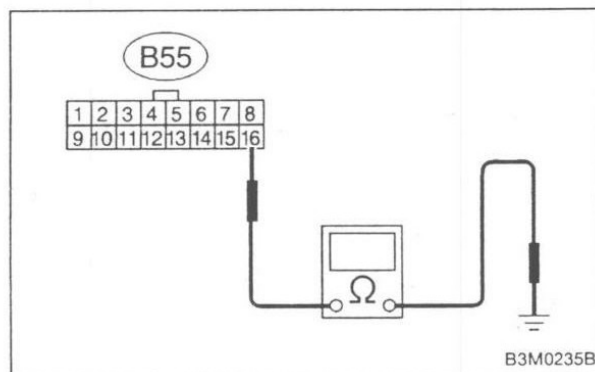


2. CHECK HARNESS CONNECTOR BETWEEN ECM AND TCM.

- 1) Turn ignition switch to OFF.
- 2) Disconnect connectors from TCM and ECM.
- 3) Measure resistance of harness connector between ECM and TCM.

Connector & terminal / Specified resistance:

(B135) No. 11 — (B55) No. 16 / Less than 1Ω



- 4) Measure resistance of harness connector between TCM and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

(B55) No. 16 — Body / More than $1 M\Omega$

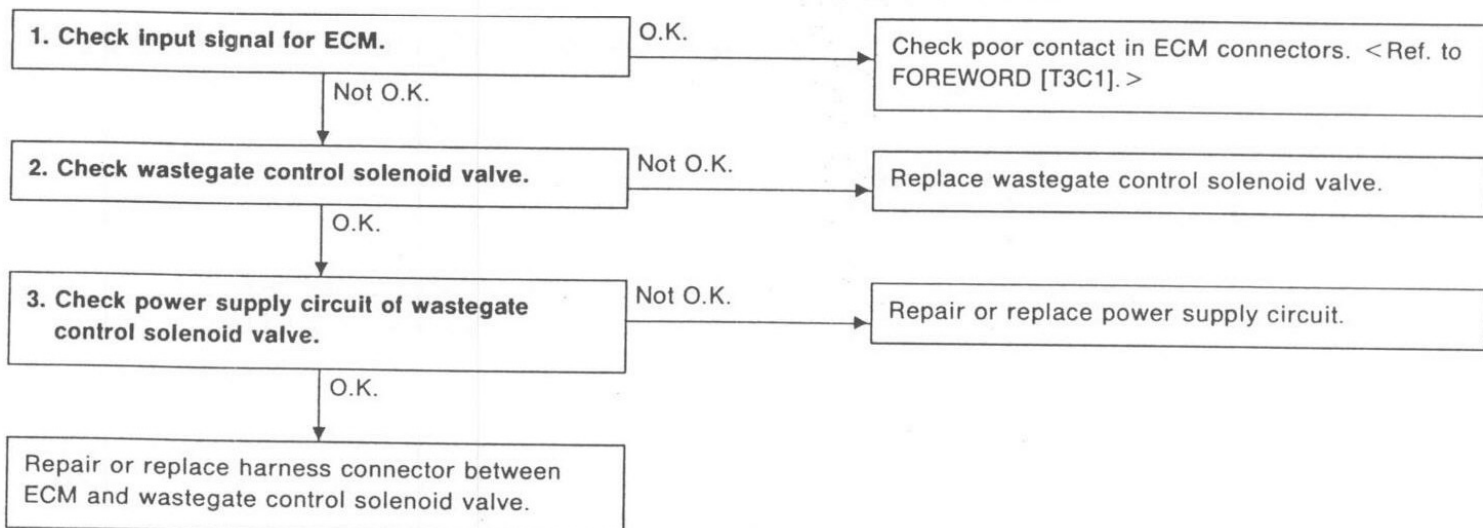
M: TROUBLE CODE (44) — WASTEGATE CONTROL SOLENOID VALVE —

DIAGNOSIS:

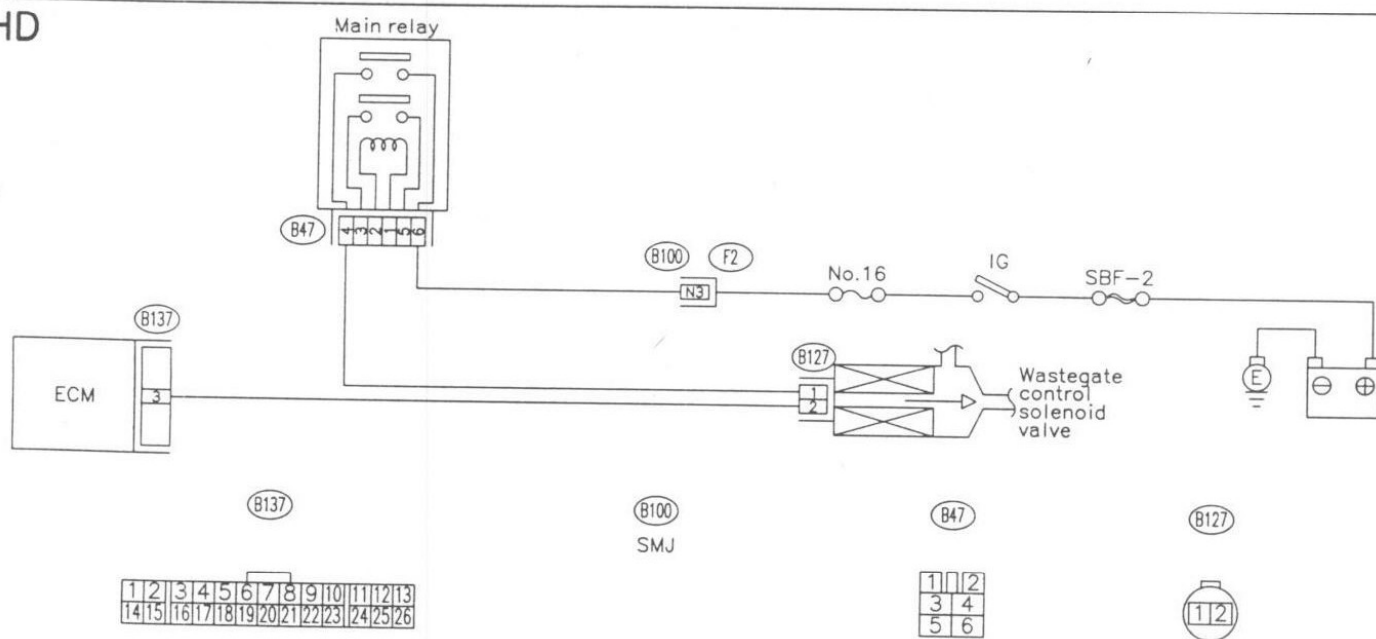
- The wastegate control solenoid valve is not in function.
- The harness connector between ECM and wastegate control solenoid valve is in short or open.

TROUBLE SYMPTOM:

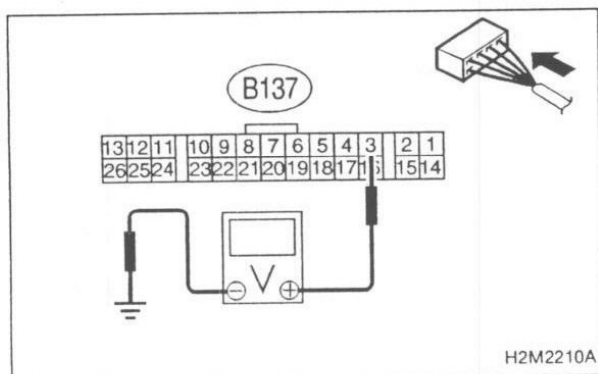
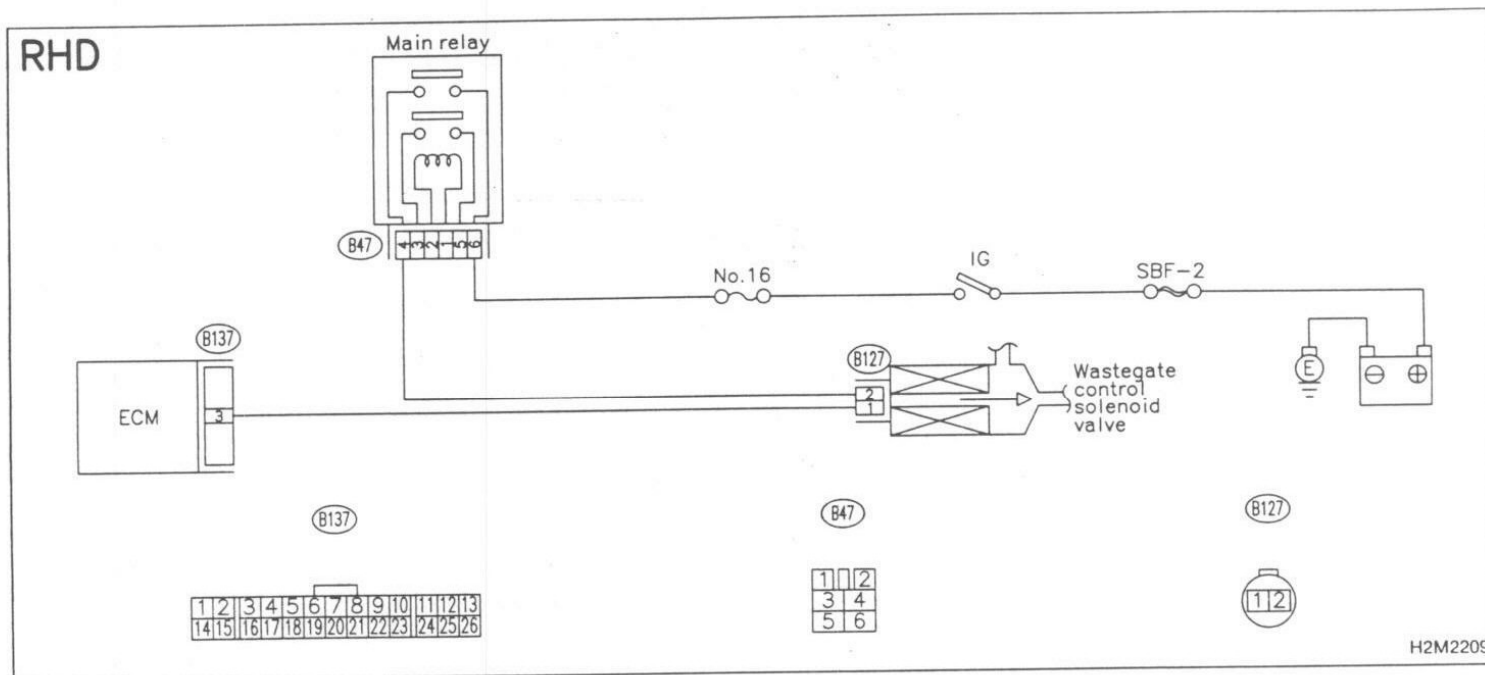
- Poor driving performance



LHD



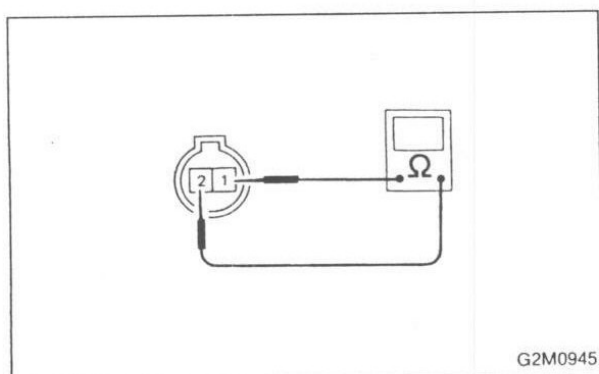
H2M2208



1. CHECK INPUT SIGNAL FOR ECM.

- 1) Turn ignition switch to ON.
- 2) Measure signal voltage between ECM and body.

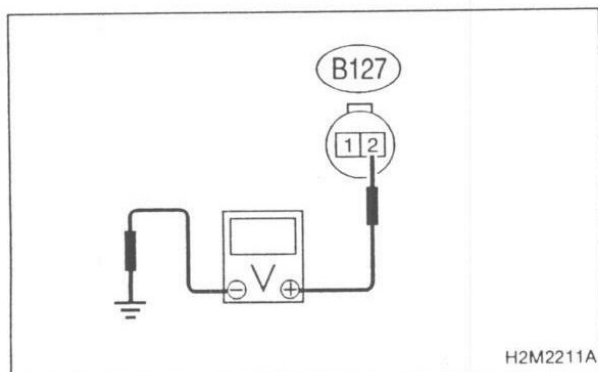
Connector & terminal / Specified voltage:
(B137) No. 3 — Body / More than 10 V



2. CHECK WASTEGATE CONTROL SOLENOID VALVE.

- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from wastegate control solenoid valve.
- 3) Measure resistance between connector terminals of wastegate control solenoid valve.

Terminals / Specified resistance:
No. 1 — No. 2 / 20 Ω



3. CHECK POWER SUPPLY CIRCUIT OF WASTEGATE CONTROL SOLENOID VALVE.

- 1) Turn ignition switch to ON.
- 2) Measure voltage between wastegate control solenoid valve connector and body.

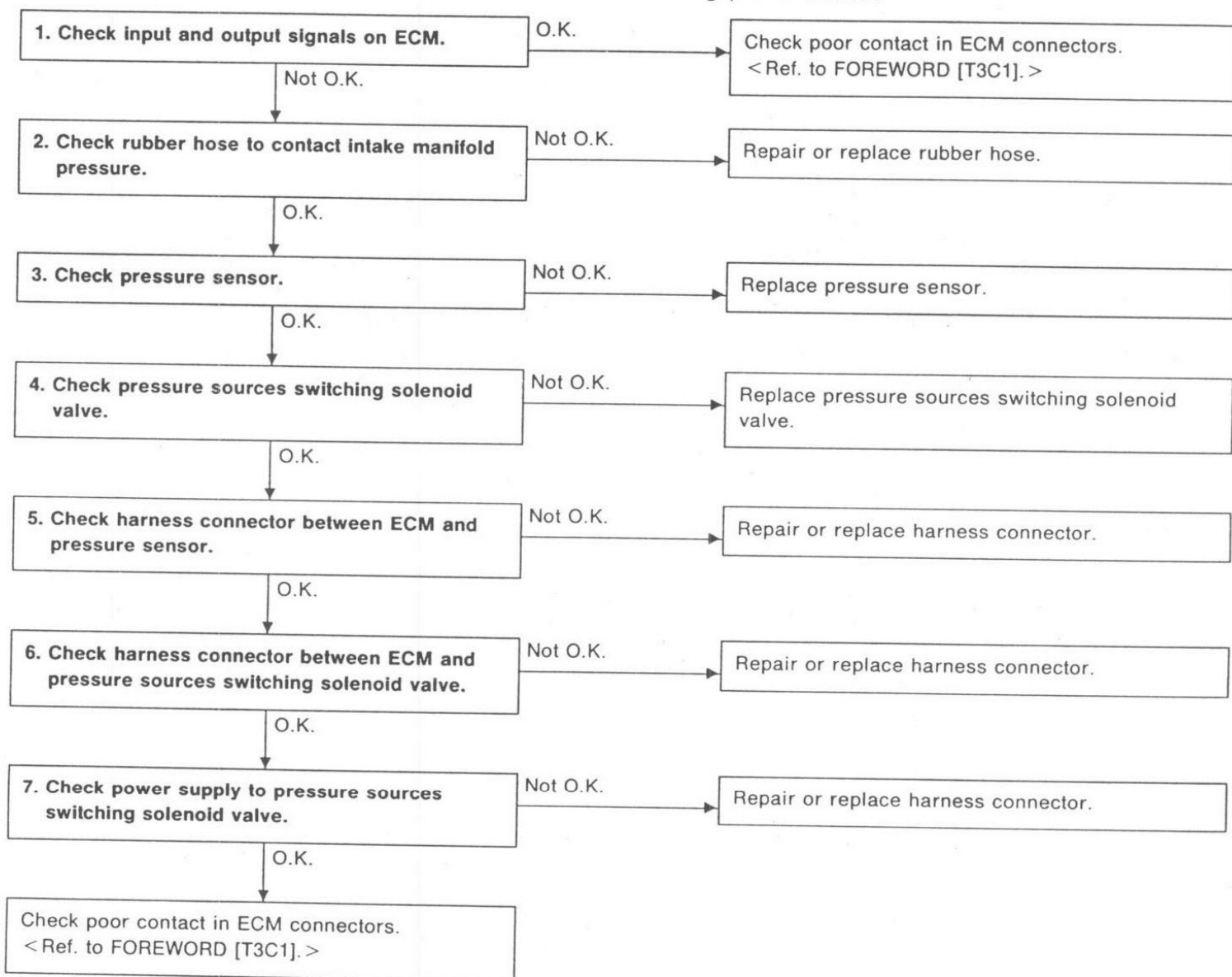
Connector & terminal / Specified voltage:
(B127) No. 2 — Body / More than 10 V

N: TROUBLE CODE (45)**— PRESSURE SENSOR, PRESSURE SOURCES SWITCHING SOLENOID VALVE —****DIAGNOSIS:**

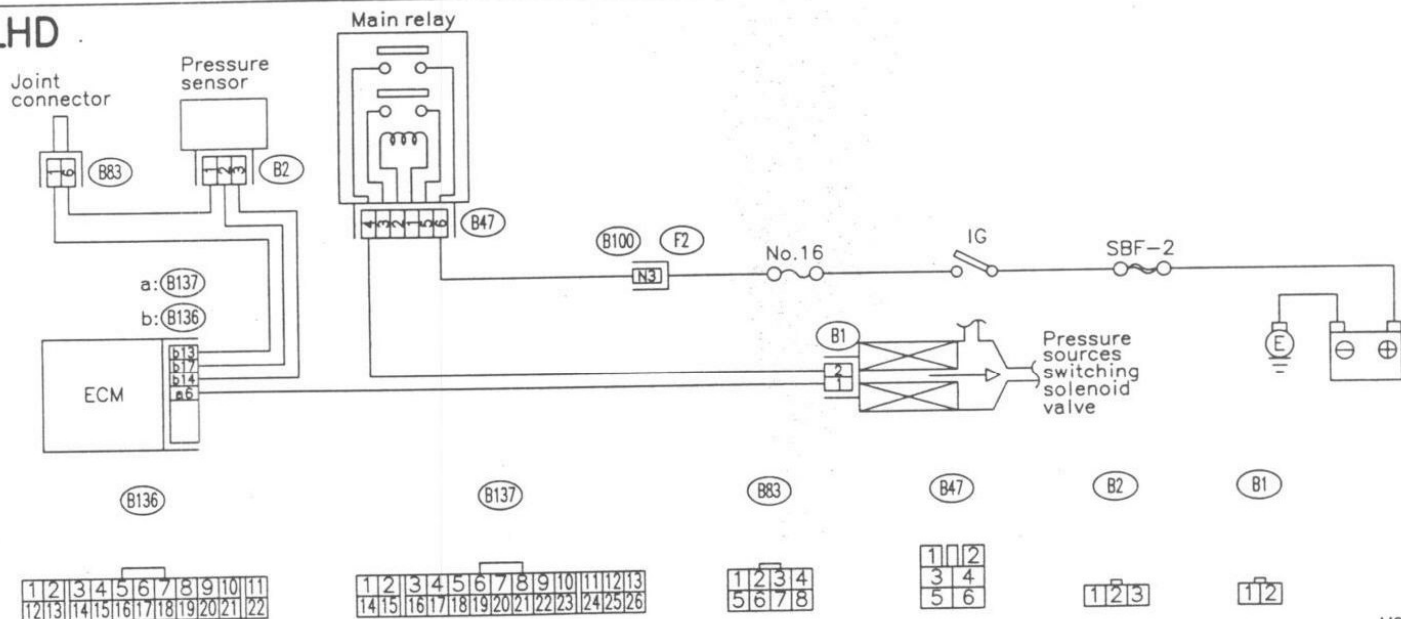
- The pressure sensor signal is abnormal.
- The pressure sources switching solenoid valve is not in function.
- The intake manifold pressure is not transmitted to pressure sensor.
- The harness connector between ECM and pressure sensor, and pressure sources switching solenoid valve is in short or open.

TROUBLE SYMPTOM:

- Poor driving performance

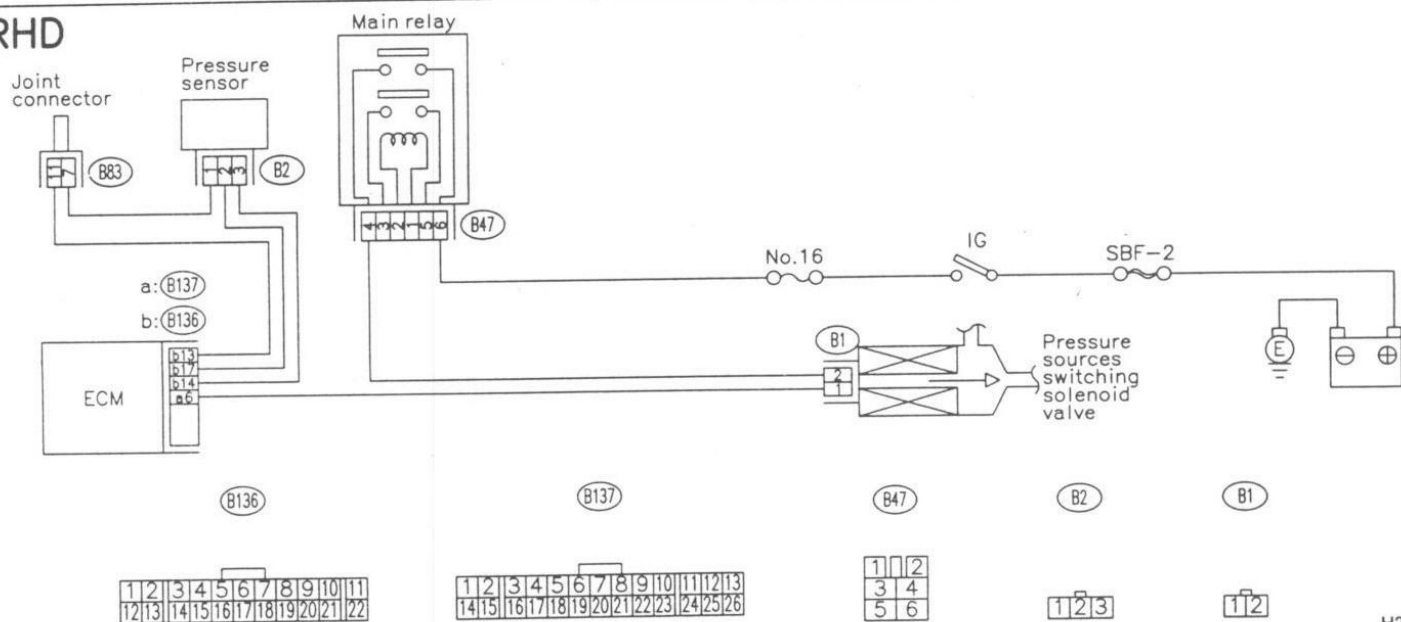


LHD

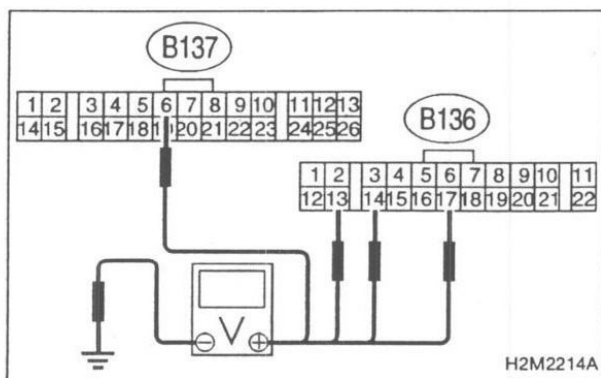


H2M2212

RHD



H2M2213

**1. CHECK INPUT AND OUTPUT SIGNALS ON ECM.**

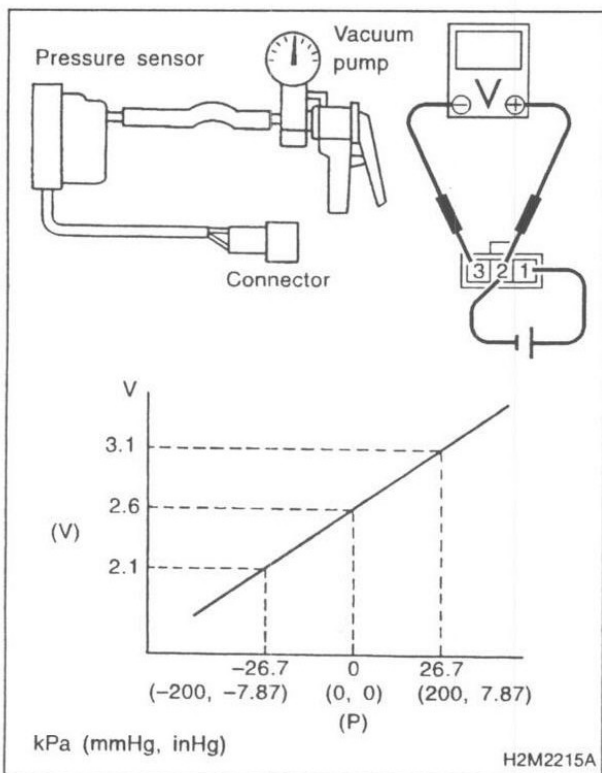
- 1) Turn ignition switch to ON.
- 2) Measure voltage between ECM connector terminal and body.

Connector & terminal / Specified voltage:

- (B136) No. 13 — Body / 5 V
 (B136) No. 14 — Body / 2.4 — 2.7 V
 (B136) No. 17 — Body / 0 V
 (B137) No. 6 — Body / 0 V or 10 — 13 V

2. CHECK RUBBER HOSE TO CONTACT INTAKE MANIFOLD PRESSURE.

- 1) Visually check the connection between pressure sensor and rubber hose, between pressure sources switching solenoid valve and rubber hose, and between intake manifold and rubber hose.
- 2) Check rubber hose for cracks and damage.

**3. CHECK PRESSURE SENSOR.**

- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from pressure sensor.
- 3) Apply 5 volt voltage across terminals No. 1 and No. 2, then connect terminal No. 1 to positive side and terminal No. 2 to negative side.
- 4) Install vacuum pump to hose fitting on pressure sensor.
- 5) Measure voltage across terminals when pressure is applied to pressure sensor.

Terminals / Specified voltage:

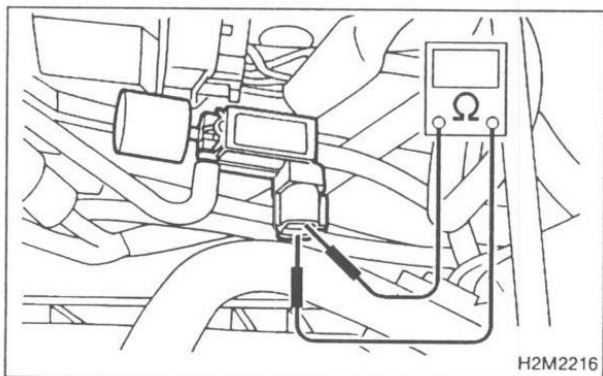
- No. 2 — No. 3 / 3.1 V at 26.7 kPa
 (200 mmHg, 7.87 inHg)
 2.6 V at 0 kPa
 (0 mmHg, 0 inHg)
 2.1 V at -26.7 kPa
 (-200 mmHg, -7.87 inHg)

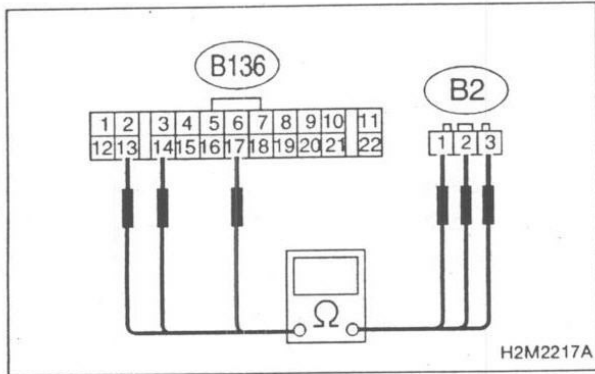
4. CHECK PRESSURE SOURCES SWITCHING SOLENOID VALVE.

- 1) Disconnect connector from pressure sources switching solenoid valve.
- 2) Measure resistance across terminals.

Terminals / Specified resistance:

- No. 1 — No. 2 / 37 — 48 Ω





5. CHECK HARNESS CONNECTOR BETWEEN ECM AND PRESSURE SENSOR.

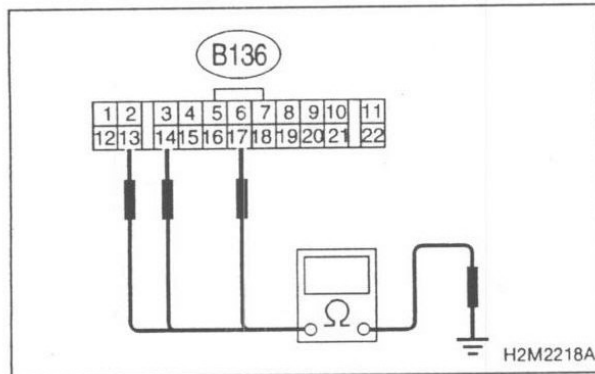
- 1) Disconnect connectors from ECM.
- 2) Measure resistance of harness connector between ECM and pressure sensor connector.

Connector & terminal / Specified resistance:

(B136) No. 13 — (B2) No. 1 / Less than 1 Ω

(B136) No. 14 — (B2) No. 3 / Less than 1 Ω

(B136) No. 17 — (B2) No. 2 / Less than 1 Ω



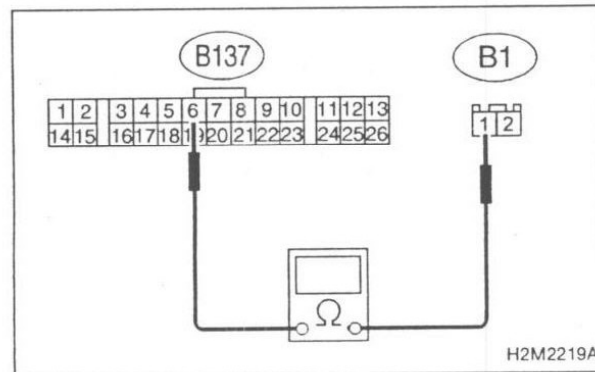
- 3) Measure resistance between ECM connector terminal and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

(B136) No. 13 — Body / More than 1 M Ω

(B136) No. 14 — Body / More than 1 M Ω

(B136) No. 17 — Body / More than 1 M Ω

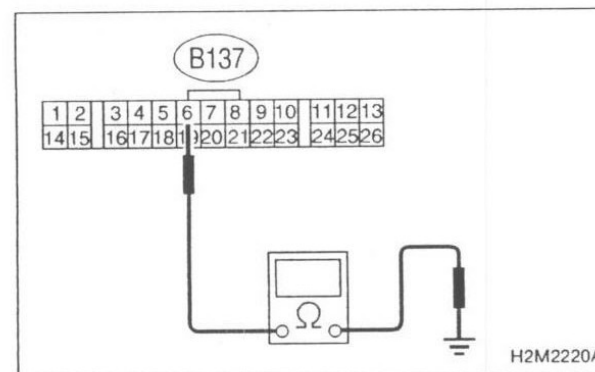


6. CHECK HARNESS CONNECTOR BETWEEN ECM AND PRESSURE SOURCES SWITCHING SOLENOID VALVE.

- 1) Measure resistance of harness connector between ECM and pressure sources switching solenoid valve connector.

Connector & terminal / Specified resistance:

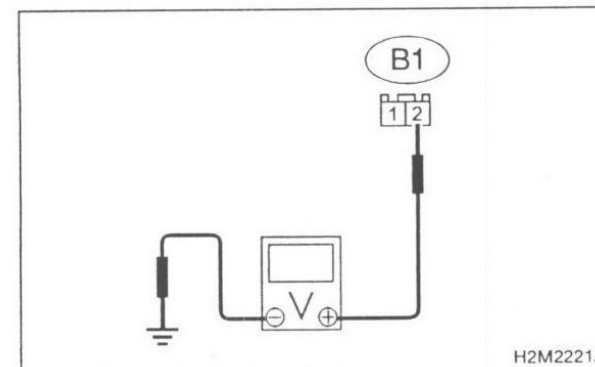
(B137) No. 6 — (B1) No. 1 / Less than 1 Ω



- 2) Measure resistance of harness connector between ECM terminal and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

(B137) No. 6 — Body / More than 1 M Ω



7. CHECK POWER SUPPLY TO PRESSURE SOURCES SWITCHING SOLENOID VALVE.

- 1) Turn ignition switch to ON.
- 2) Measure voltage between connector terminal of pressure sources switching solenoid valve and body.

Connector & terminal / Specified voltage:

(B1) No. 2 — body / More than 10 V

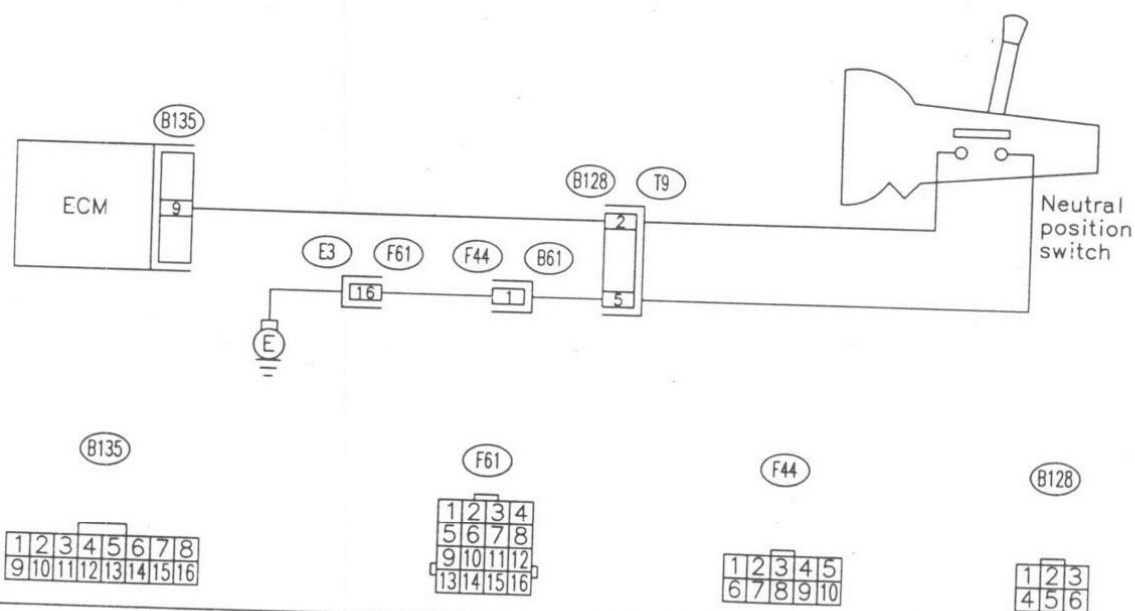
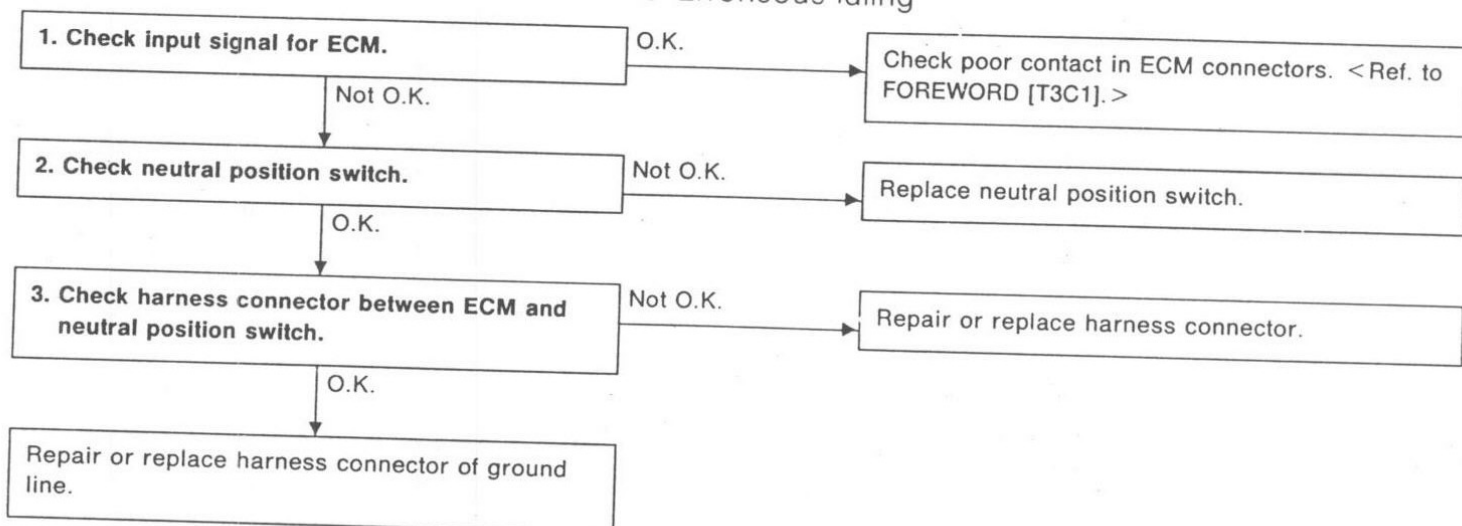
O: TROUBLE CODE (51) — NEUTRAL POSITION SWITCH (MT VEHICLE) —

DIAGNOSIS:

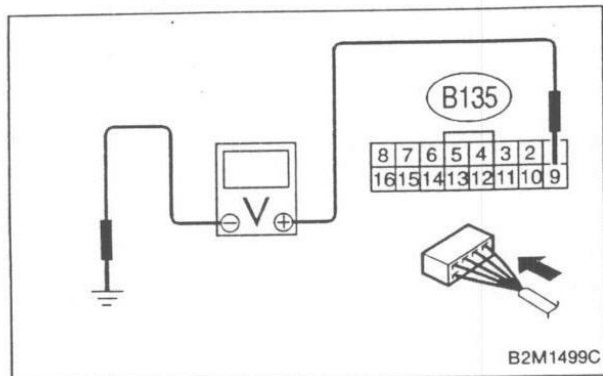
- The neutral position switch signal is abnormal.
- The harness connector between ECM and neutral position switch is in short or open.

TROUBLE SYMPTOM:

- Erroneous idling



H2M2222

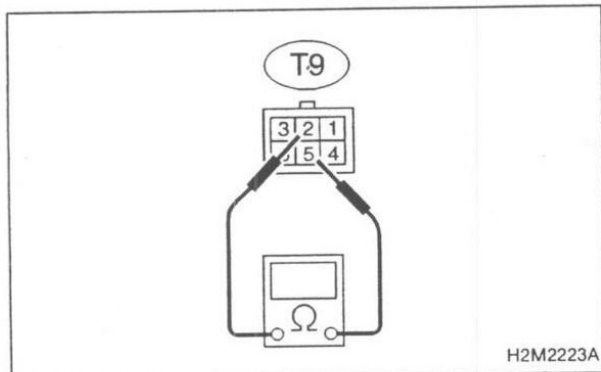


1. CHECK INPUT SIGNAL FOR ECM.

- 1) Turn ignition switch to ON.
- 2) Measure voltage between ECM and body.

Connector & terminal / Specified voltage:

(B135) No. 9 — Body / 5 V
(Neutral position)
/ 0 V
(Other positions)

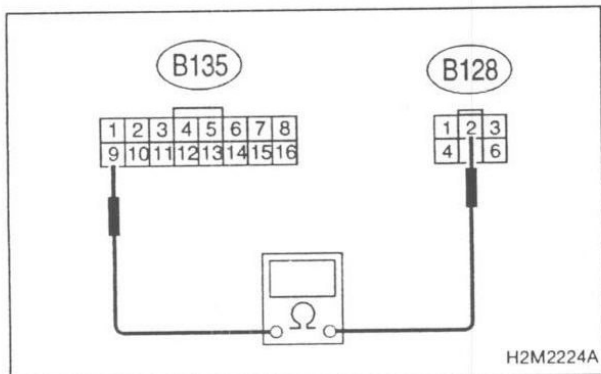


2. CHECK NEUTRAL POSITION SWITCH.

- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from transmission harness.
- 3) Measure resistance between connector terminals of transmission harness.

Connector & terminal / Specified resistance:

(T9) No. 2 — (T9) No. 5 / More than 1 MΩ
(Neutral position)
/ Less than 10 Ω
(Other positions)

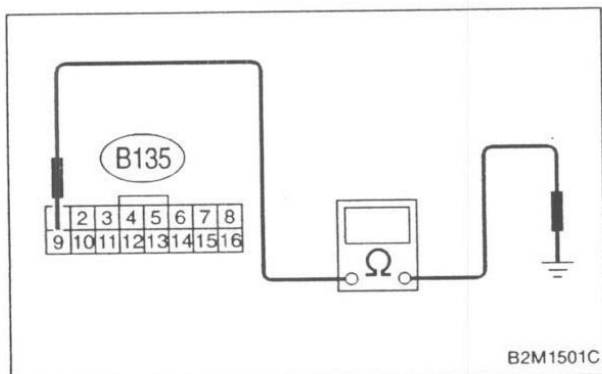


3. CHECK HARNESS CONNECTOR BETWEEN ECM AND NEUTRAL POSITION SWITCH.

- 1) Disconnect connectors from ECM.
- 2) Measure resistance of harness connector between ECM and neutral position switch.

Connector & terminal / Specified resistance:

(B135) No. 9 — (B128) No. 2 / Less than 1 Ω



- 3) Measure resistance of harness connector between ECM and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

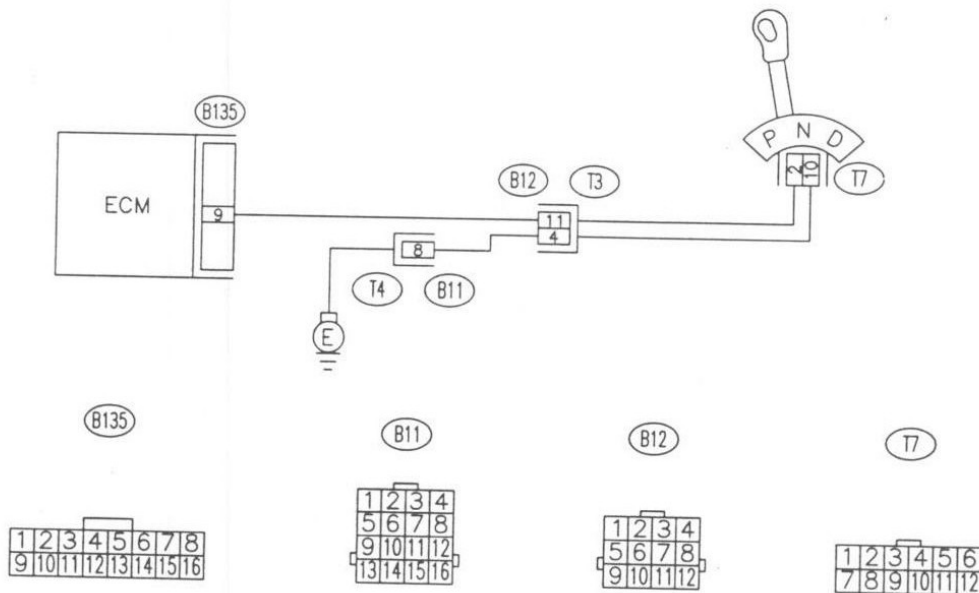
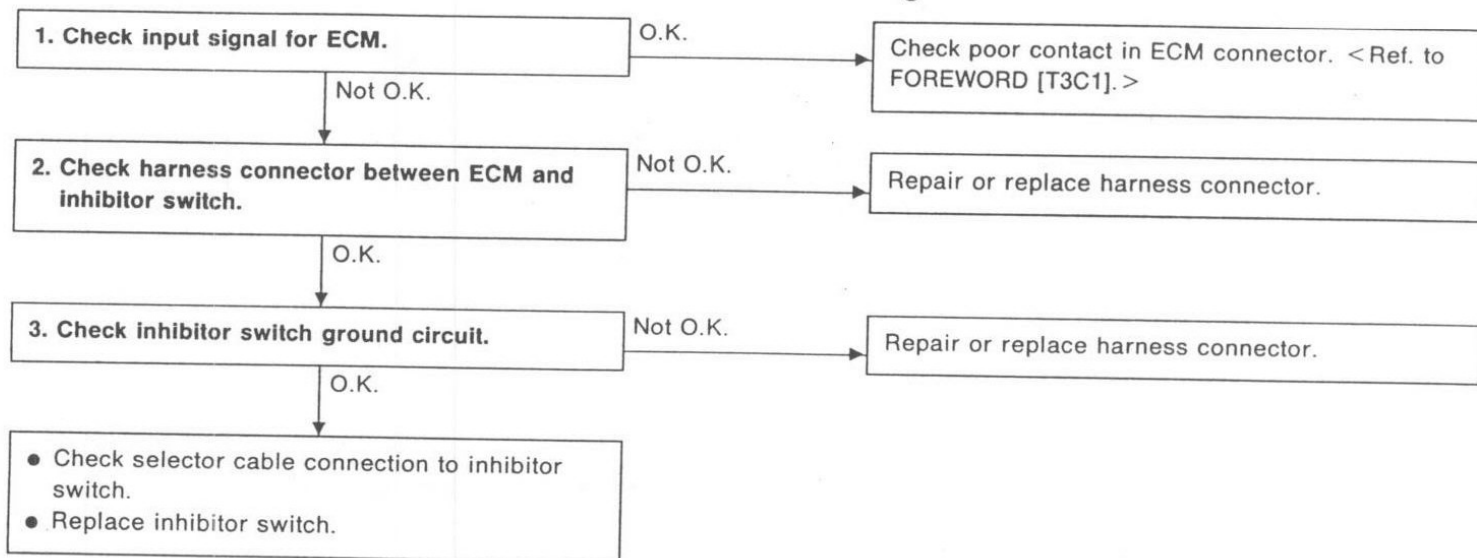
(B135) No. 9 — Body / More than 1 MΩ

P: TROUBLE CODE (51)**— PARK/NEUTRAL POSITION SWITCH (AT) —****DIAGNOSIS:**

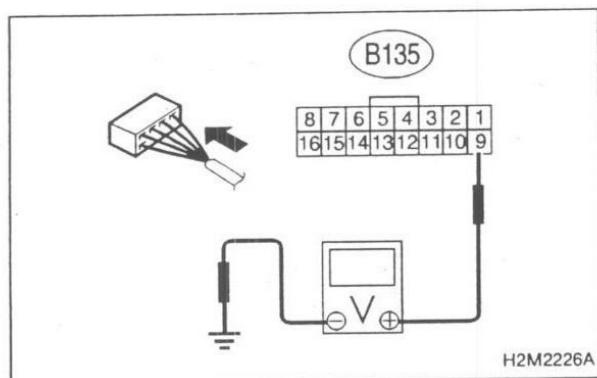
- The park/neutral position switch signal is abnormal.
- The shift cable is connected abnormally.
- The harness connector between ECM/TCM and inhibitor switch is in short or open.

TROUBLE SYMPTOM:

- Erroneous idling



H2M2225

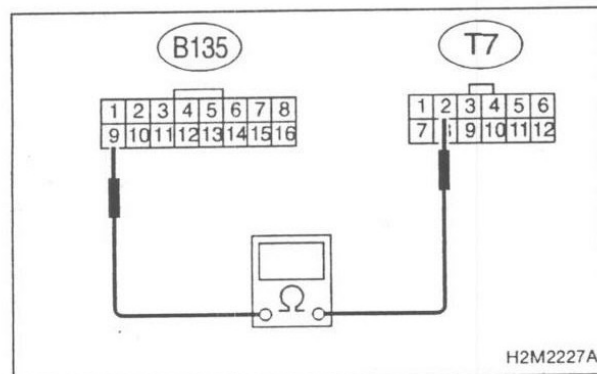


1. CHECK INPUT SIGNAL FOR ECM.

- 1) Turn ignition switch to ON.
- 2) Measure voltage between ECM and body.

Connector & terminal / Specified voltage:

(B135) No. 9 — Body / 0 V ("P" or "N" position)

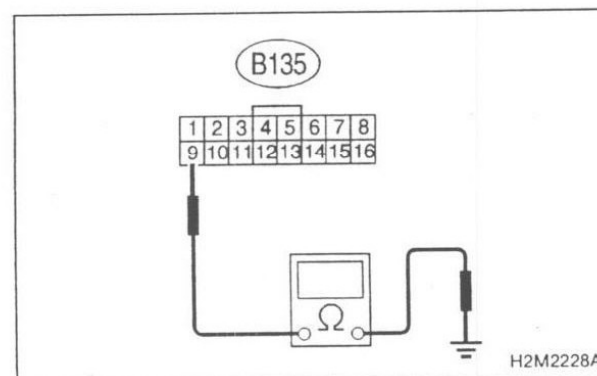


2. CHECK HARNESS CONNECTOR BETWEEN ECM AND INHIBITOR SWITCH.

- 1) Turn ignition switch to OFF.
- 2) Disconnect connector from ECM and transmission harness or inhibitor switch.
- 3) Measure resistance of harness connector between ECM and transmission harness or inhibitor switch.

Connector & terminal / Specified resistance:

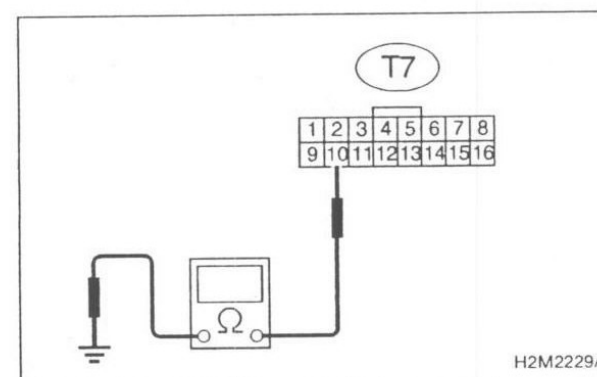
(B135) No. 9 — (T7) No. 2 / Less than 1 Ω



- 4) Measure resistance harness connector between ECM and body to make sure that circuit does not short.

Connector & terminal / Specified resistance:

(B135) No. 9 — Body / More than 1 M Ω



3. CHECK INHIBITOR SWITCH GROUND CIRCUIT.

Measure resistance of harness between transmission harness or inhibitor switch connector and body.

Connector & terminal / Specified resistance:

(T7) No. 10 — Body / Less than 5 Ω