INDEX

GENERAL INFORMATION

1. HOW TO READ ELECTRICAL WIRING DIAGRAM..... 3

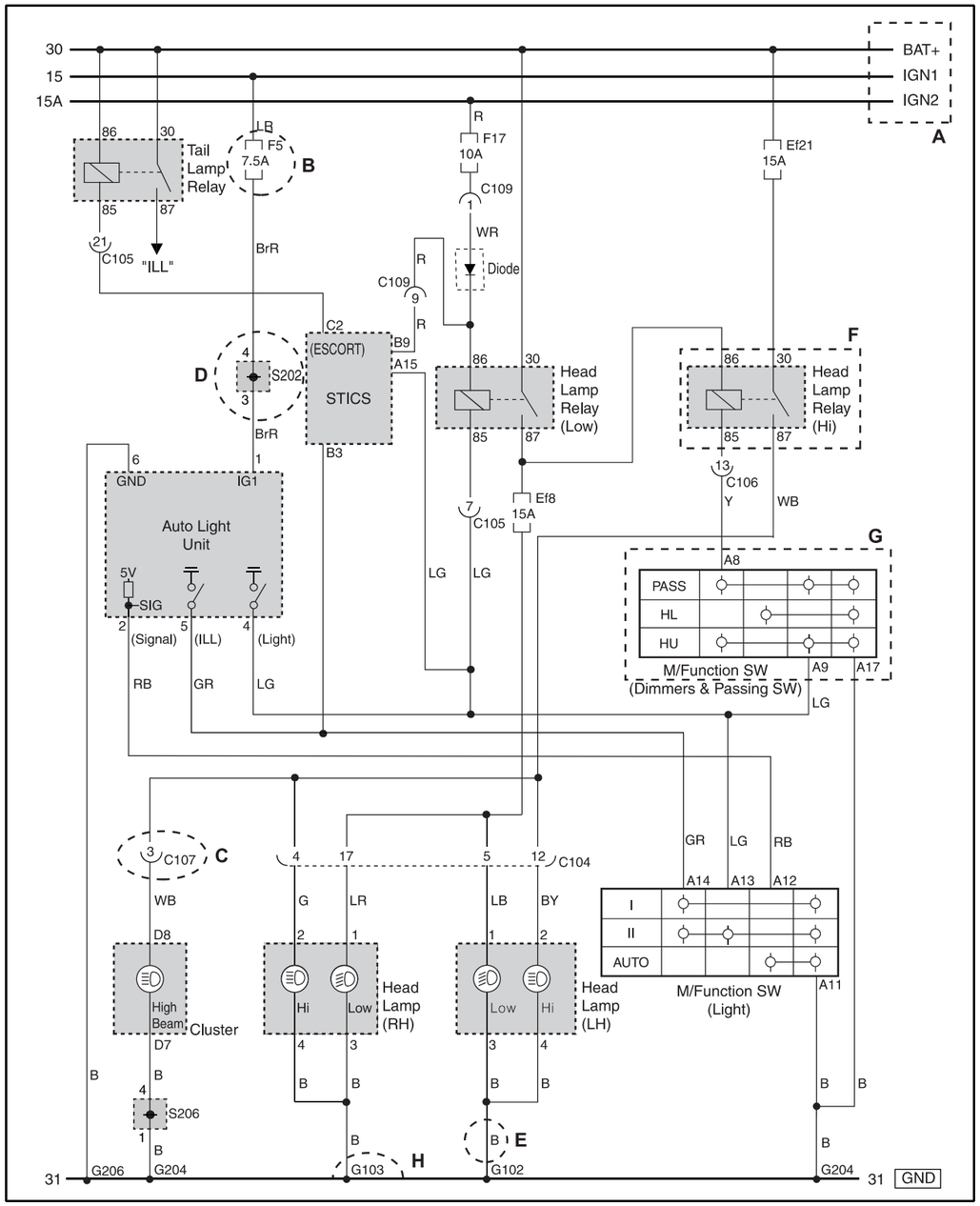
Memo

Memo

GENERAL INFORMATION

1. HOW TO READ ELECTRICAL WIRING DIAGRAM

1) HOW TO READ ELECTRICAL WIRING DIAGRAM



2) CONTENTS OF ELECTRICAL WIRING DIAGRAM (CIRCUIT)

Position	Explanation
A	- Upper horizontal lines : Power supply lines - Power supply lines : 30, 15, 15A, 15C, 58
B	- Ef20 or F2 : Fuse Number ·Ef20 : Fuse No #20 in engine room compartment ·F2 : Fuse No #2 in passenger room compartment
C	- Connector (C101 ~ C903) ·Connector No C203 terminal No1 ·Refer to Major Connector Position (Section 2)
D	- S201 : Splice pack (S201 ~ S207) ·Refer to Major Splice Pack Position (Section2)
E	- Wiring Harness Color ·Refer to Wiring Harness Color Abbreviation
F	- Internal circuit of component (Relay) (Component Name and Terminal Number)
G	- Internal circuit of component (Switch) (Component Name, Terminal Number and Connecting Wiring Circuit)
H	- Lower horizontal line : Ground line ·Ground position (G101 ~ G402) ·B : Body Ground ·Refer to Major Ground Position (Section2)

3) CIRCUIT IDENTIFICATION SYMBOL

Identification Symbol	Meaning
C	Connector
D	Diode
Ef	Fuse in engine room fuse & relay box
F	Fuse in passenger room fuse box
G	Ground
S	Splice pack (Junction connector)

4) FUNCTION OF POWER SUPPLY LINE (NUMBER)

Power supply No.	Power supply condition
15	Battery Voltage (B+) supply in Ignition Switch "ON" and "ST" (IGN 1)
15A	Battery Voltage (B+) supply in Ignition Switch "ON" (IGN 2)
15C	Battery Voltage (B+) supply in Ignition Switch "ON" and "ACC"
30	Battery Voltage (B+) supply directly regardless of Ignition Switch
31	Ground connected to battery (-)
58	Battery Voltage (B+) supply in Head Lamp Switch 1st and 2nd step (Illumination circuit)

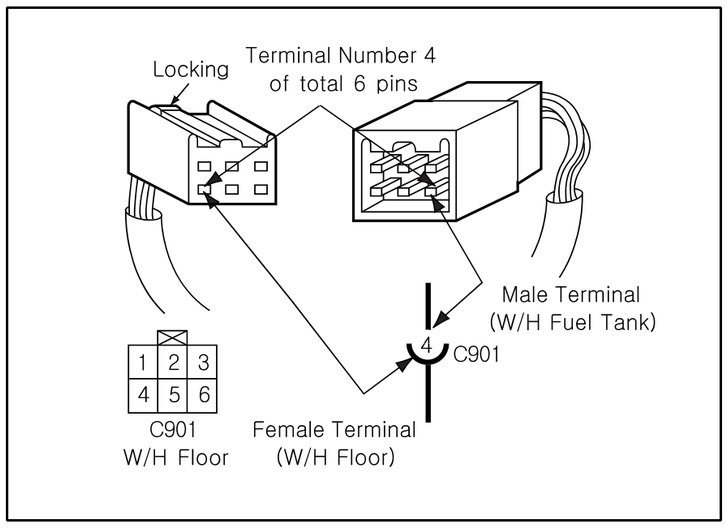
5) WIRING HARNESS COLOR IDENTIFICATION

Abbreviation	Color	Abbreviation	Color
Br	Brown	Sb	Sky Blue
G	Green	R	Red
V	Violet	L	Blue
P	Pink	Y	Yellow
W	White	Gr	Gray
Gr	Orange	B	Black
Lg	Light Green		

6) HOW TO CHECK TERMINAL NUMBER OF CONNECTOR

▶ **Terminal number is given based on Female Terminal Male Connector**

- ex) Terminal Number 4 of C901 connection



Modification basis	
Application basis	
Affected VIN	

7) PART LOCATION ACCORDING TO PART NUMBER

▶ **Ex.) C 1 0 2**

- C : Symbol character for connector

Symbol Character	Description
C	Connector (Connecting part that connects two wiring harness)
D	Diode
G	Ground
S	Splice pack (Joint connector that connects various wiring harness)

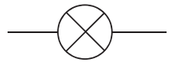
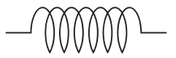
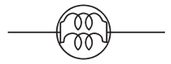
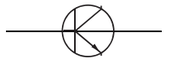
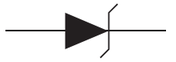
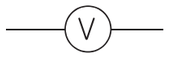
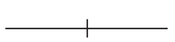
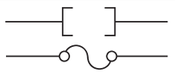
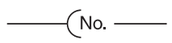
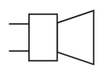
- 1 : Part location number

- Part number according to locating section

Part Numbe	Location
□ 1□□	Engine compartment
□ 2□□	Instrument panel
□ 3□□	Passenger compartment
□ 4□□	Tailgate
□ 5□□	Underbody

- In the locating section, the assignment for part number startsfrom left bottom and proceeds clockwise.
- In the fuse and relay box or the instrument panel, the partnumber is assigned from left top to light bottom.

8) ELECTRIC SYMBOLS

Items	Symbols	Items	Symbols
Resistance		Lamp	
Rheostat		Single Bulb	
Coil, Inductance		Double Bulb	
Condenser, Capacitor		Transistor : PNP type	
Ground, Earth		Transistor : NPN type	
Diode		~Meter, ~Gauge	
Zener Diode		Voltmeter	
Photo Diode		Amperemeter	
Light Emitting Diode		Switch	
Battery		Thermistor	
Disconnected Wire		Junction Point	
Fuse		Fusible Link	
Motor		Connector	
Speaker		Horn	

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CONNECTOR/GROUND

8201-00/8210-00/8210-02/8210-03/8210-09/8210-10/8210-06/8210-07/8210-08

WIRING

8201-00 WIRING HARNESS,
COMPONENTS LOCATION..... 3

CONNECTOR/GROUND

8210-00 W/H ENGINE ROOM..... 11
8210-02 W/H MAIN..... 12
8210-03 W/H FLOOR..... 13
8210-09 W/H ROOF..... 15
8210-10 W/H TAIL GATE..... 15
8210-06 W/H DRIVER DOOR..... 16
8210-07 W/H PASSENGER DOOR..... 16
8210-08 W/H RR DOOR..... 17

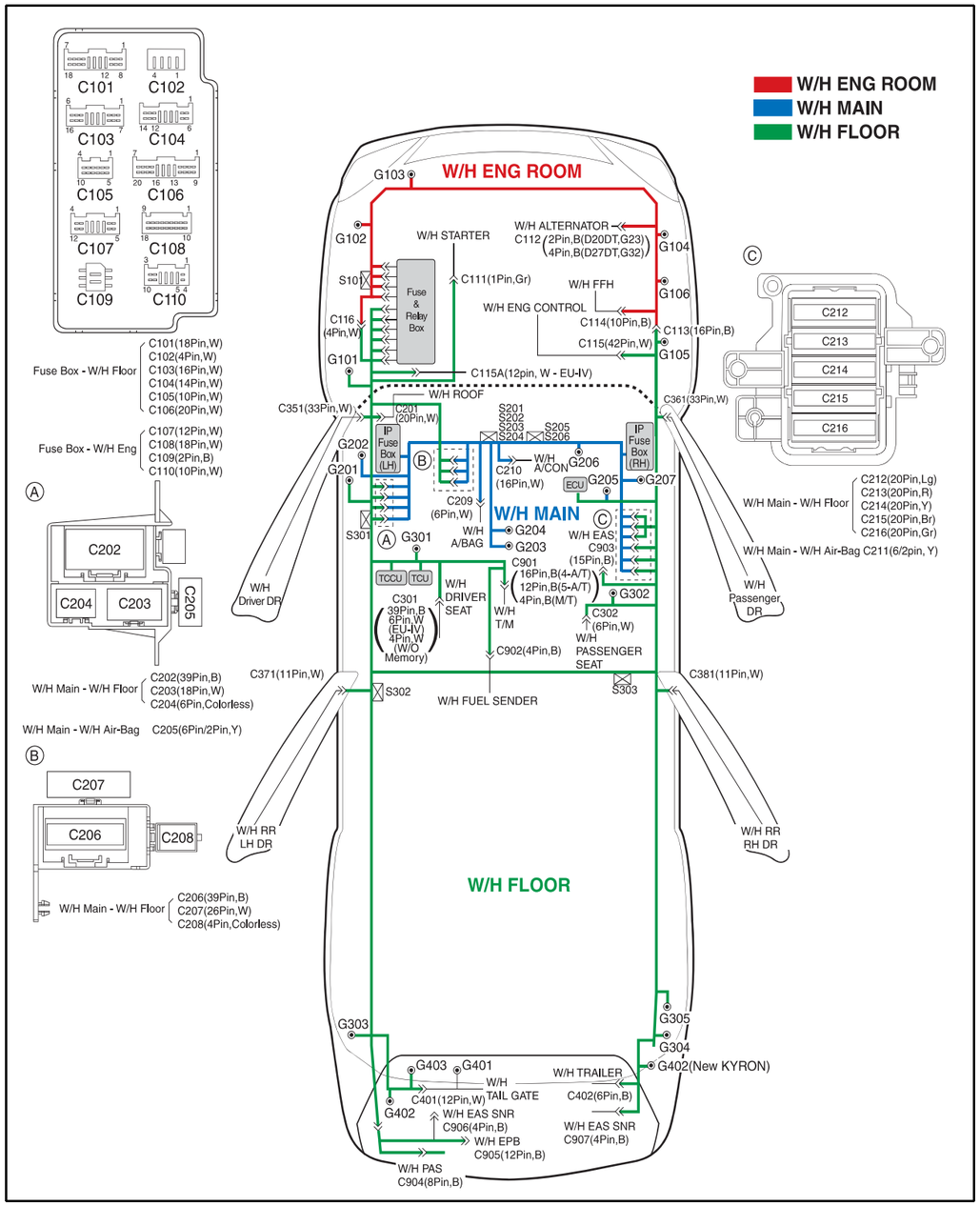
Memo

Memo

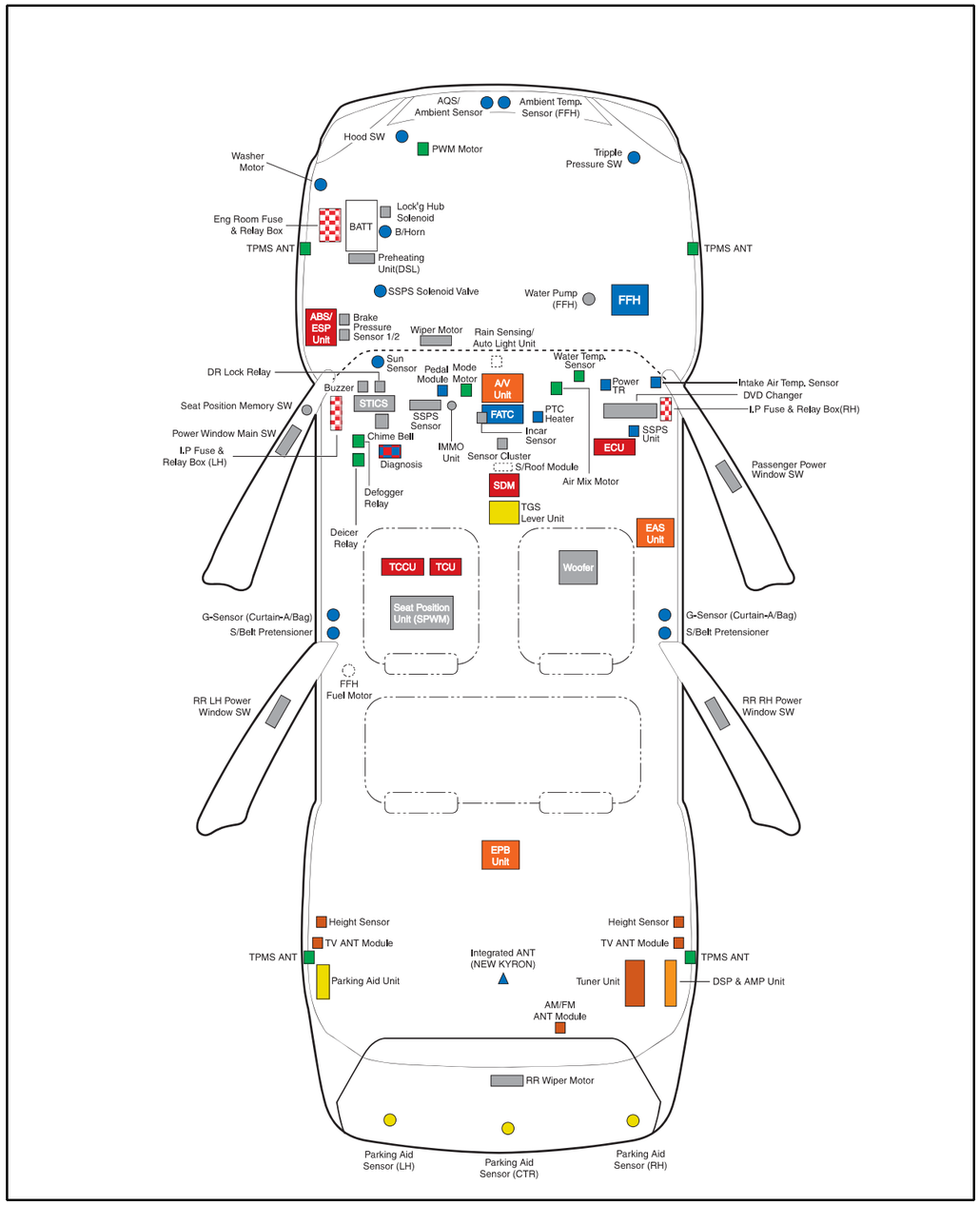
WIRING HARNESS

S.G.N. 8201-00 WIRING HARNESS, COMPONENTS LOCATION

1) WIRING HARNESS



2) COMPONENTS LOCATION



Modification basis	
Application basis	
Affected VIN	

3) CONNECTOR, GROUND & SPLICE PACK INFORMATION

▶ CONNECTOR

Connector Number (Pin Number, Color)	Connecting Wiring Harness	Connector Position	Remark
C101 (18Pin, White)	W/H Floor - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C102 (4Pin, White)	W/H Floor - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C103 (16Pin, White)	W/H Floor - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C104 (14Pin, White)	W/H Floor - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C105 (10Pin, White)	W/H Floor - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C106 (20Pin, White)	W/H Floor - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C107 (12Pin, White)	W/H Eng - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C108 (18Pin, White)	W/H Eng - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C109 (2Pin, Black)	W/H Eng - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C110 (10Pin, White)	W/H Eng - Eng Room Fuse & Relay Box	Eng Room Fuse & Relay Box	
C111 (1Pin, Gray)	W/H Floor - Starter Motor	Under the Preheating Time Relay	Solenoid
C112 (2Pin, Black)	W/H Eng - W/H Alternator	Behind RH Head Lamp	D20DT/GSL 3.2
(4Pin, Black)	W/H Eng - W/H Alternator	Behind RH Head Lamp	D27DT/GSL 3.2
C113 (16Pin, Black)	W/H Eng - W/H Floor	Inside RH Fender PNL	
C114 (10Pin, Black)	W/H Eng - W/H FFH	Right Eng Room Dash PNL	FFH
C115 (42Pin, Black)	W/H Floor - W/H Eng Control	Right Eng Room Dash PNL	
C115A (12Pin, White)	W/H Eng - W/H Floor	Beside ABS/ESP Unit	D20DT/D27DT(EU-IV)
C116 (4Pin, White)	W/H Eng - W/H Floor	Inside Fuse & Relay Box	ABS, ESP, TPMS
C201 (20Pin, White)	W/H Floor - W/H Roof	Inside Driver Cowl Side PNL	
C202 (39Pin, Black)	W/H Main - W/H Floor	Driver Cowl Side C/Holder	
C203 (18Pin, White)	W/H Main - W/H Floor	Driver Cowl Side C/Holder	
C204 (6Pin, Colorless)	W/H Main - W/H Floor	Driver Cowl Side C/Holder	
C205 (2Pin, Yellow)	W/H Main - W/H A/Bag	Driver Cowl Side C/Holder	Curtain A/Bag
(6Pin, Yellow)	W/H Main - W/H A/Bag	Driver Cowl Side C/Holder	C/Holder
C206 (39Pin, Black)	W/H Main - W/H Floor	Upper the Driver Legroom	C/Holder
C207 (26Pin, White)	W/H Main - W/H Floor	Upper the Driver Legroom	C/Holder
C208 (4Pin, Colorless)	W/H Main - W/H Floor	Upper the Driver Legroom	C/Holder
C209 (6Pin, White)	W/H Main - W/H A/Bag	Upper the Driver Legroom	
C210 (16Pin, White)	W/H Main - W/H A/Con	Inside the Middle I/P (Right PTC)	
C211 (2Pin, Yellow)	W/H Main - W/H A/Bag	Passenger Cowl Side C/Holder	Curtain A/Bag
(6Pin, Yellow)	W/H Main - W/H A/Bag	Passenger Cowl Side C/Holder	
C212 (20Pin, L/Green)	W/H Main - W/H Floor	Passenger Cowl Side C/Holder	
C213 (20Pin, Red)	W/H Main - W/H Floor	Passenger Cowl Side C/Holder	
C214 (20Pin, Yellow)	W/H Main - W/H Floor	Passenger Cowl Side C/Holder	
C215 (20Pin, Brown)	W/H Main - W/H Floor	Passenger Cowl Side C/Holder	
C216 (20Pin, Gray)	W/H Main - W/H Floor	Passenger Cowl Side C/Holder	

Connector Number (Pin Number, Color)	Connecting Wiring Harness	Connector Position	Remark
C301 (39Pin, Black)	W/H Floor - W/H Driver Seat	Under the Driver Seat	W/ Memory
(6Pin, White)	W/H Floor - W/H Driver Seat	Under the Driver Seat	W/O Mem(EU-IV)
(4Pin, White)	W/H Floor - W/H Driver Seat	Under the Driver Seat	W/O Memory
C302 (6Pin, White)	W/H Floor - W/H Passenger Seat	Under the Passenger Seat	
C351 (33Pin, White)	W/H Floor - W/H Driver DR	Under the LH "A" Pillar	
C361 (33Pin, White)	W/H Floor - W/H Passenger DR	Under the RH "A" Pillar	
C371 (11Pin, White)	W/H Floor - W/H RR LH DR	Under the LH "B" Pillar	
C381 (11Pin, White)	W/H Floor - W/H RR RH DR	Under the RH "B" Pillar	
C401 (12Pin, Black)	W/H Floor - W/H T/Gate	Inner the LH T/Gate	
C402 (6Pin, Black)	W/H Floor - W/H Trailer	Under RH Bumper	
C901 (16Pin, Black)	W/H Floor - W/H T/M	Upper the T/M	4-A/T
(12Pin, Black)	W/H Floor - W/H T/M	Upper the T/M	5-A/T
(4Pin, Black)	W/H Floor - W/H T/M	Upper the T/M	M/T
C902 (4Pin, Black)	W/H Floor - W/H Fuel Sender	Upper the T/M	
C903 (15Pin, Black)	W/H Floor - W/H EAS	Lower the Passenger	
C904 (8Pin, Black)	W/H Floor - W/H PAS	Under LH Bumper	
C905 (12Pin, Black)	W/H Floor - W/H EPB	Under LH Bumper	
C906 (4Pin, Black)	W/H Floor - W/H EAS Sensor	Under LH Bumper	
C907 (4Pin, Black)	W/H Floor - W/H EAS Sensor	Under RH Bumper	

Modification basis	
Application basis	
Affected VIN	

▶ GROUND

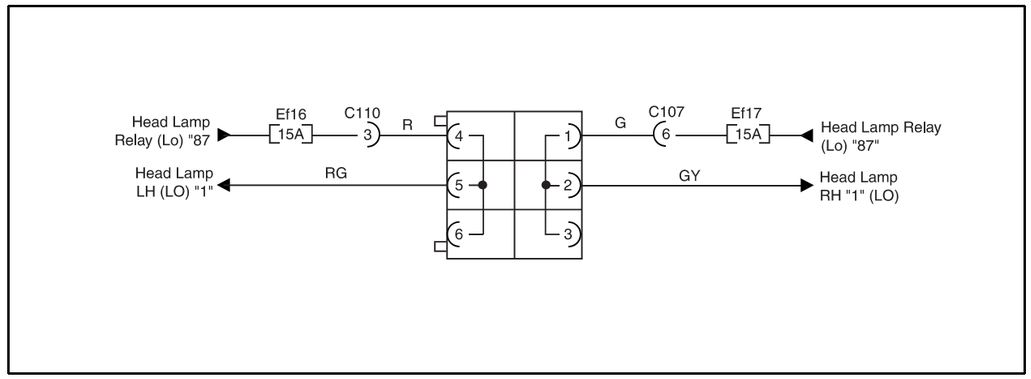
Connector Number	Connecting Wiring Harness	Connector Position	Remark
G101	W/H Floor	ABS/ESP Modulator	ABS/ESP
G102	W/H Eng Room	Behind LH Head Lamp	
G103	W/H Eng Room	LH FRT END PNL (LH Head Lamp Side)	P.W.M(GSL 2.3)
G104	W/H Eng Room	Behind RH Head Lamp	
G105	W/H Floor	RH Cowl Side PNL (Beside C114)	A/Bag
G106	W/H Eng Room	RH Fender PNL (Beside C113)	GSL
G201	W/H Floor	Under the Driver Cowl Side PNL	Under C/Holder
G202	W/H Main	Under the Driver “A” Pillar	
G203	W/H Main (W/H A/Bag)	Beside A/Bag Unit	A/Bag
G204	W/H Main	Backside TGS Lever Unit	
G205	W/H Main	RH Eng ECU	ECU
G206	W/H Main	LH Eng ECU	PTC
G207	W/H Main	Inner the Passenger Cowl Side PNL	
G301	W/H Floor	Under the Driver Seat	
G302	W/H Floor	Under the Passenger Seat	
G303	W/H Floor	Driver QTR PNL (Under the QTR Glass)	
G304	W/H Floor	Passenger QTR PNL (Under the QTR Glass)	
G305	W/H Floor	Passenger QTR PNL	Audio
G401	W/H T/Gate	Center the T/Gate	
G402	W/H Floor	Upper the LH T/Gate	
	W/H Floor	Upper the RH T/Gate	New KYRON
G403	W/H Floor	Upper the LH T/Gate	

▶ SPLICE PACK

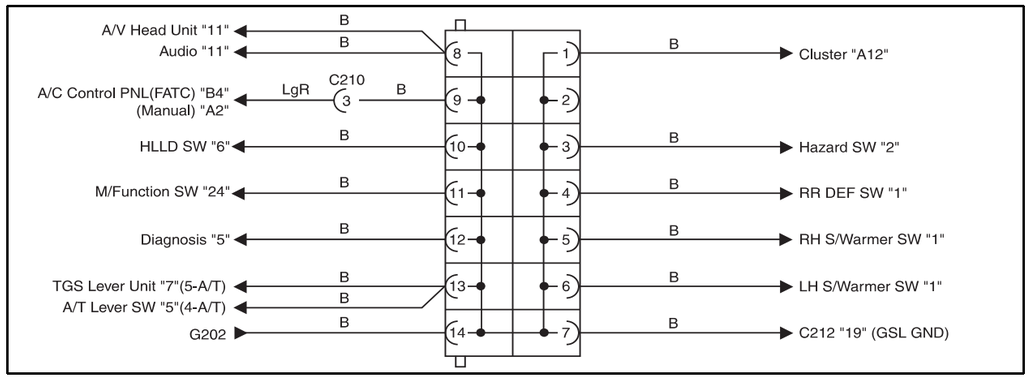
Connector Number (Pin Number, Color)	Connecting Wiring Harness	Connector Position	Remark
S101 (6Pin, Black)	W/H Eng	Inside the Eng Room Fuse & Relay Box	Head Lamp
S201 (14Pin, Black)	W/H Main	RH Protector of the Driver Legroom	
S202 (14Pin, Black)	W/H Main	RH Protector of the Driver Legroom	CAN
S203 (14Pin, Black)	W/H Main	RH Protector of the Driver Legroom	GND
S204 (14Pin, Black)	W/H Main	RH Protector of the Driver Legroom	ILL
S205 (14Pin, Black)	W/H Main	Upper the PTC Protector	GND
S206 (14Pin, Black)	W/H Main	Upper the PTC Protector	IGN1, T/Signal
S301 (14Pin, Black)	W/H Main	Beside Driver Seat W/H Protector	CAN
S302 (14Pin, Black)	W/H Main	Beside RR LH Seat W/H Protector	
S303 (8Pin, Black)	W/H Floor	Under the Passenger “B” PLR W/H Protector	DR Lock

4) SPLICE PACK CIRCUIT

▶ S101



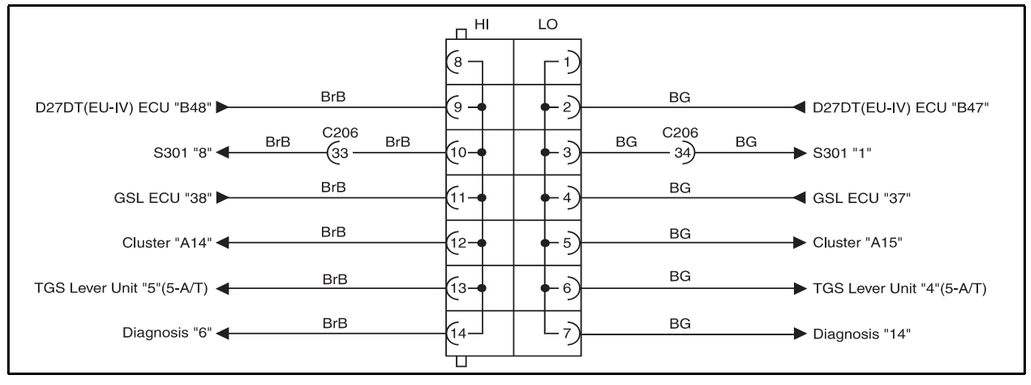
▶ S203 (GND)



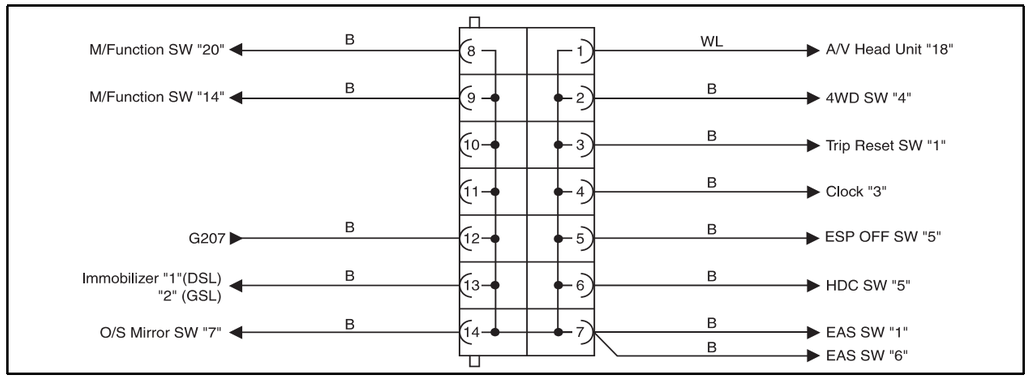
▶ S201

▶ S204 (ILL+)

▶ S202 (CAN)

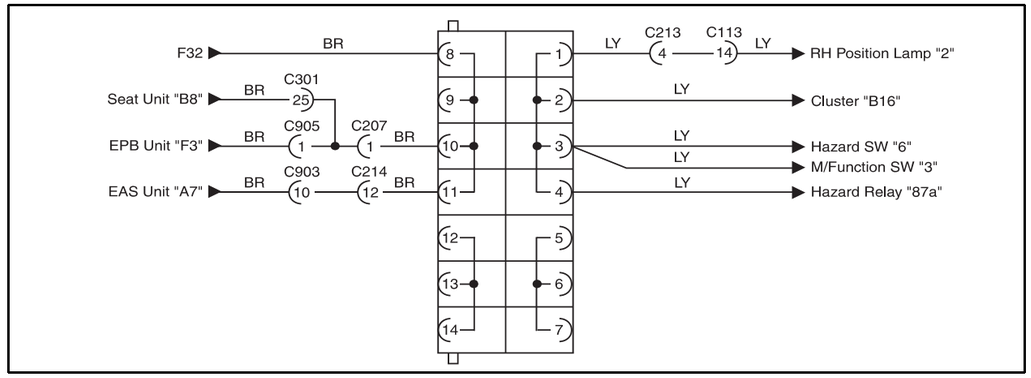


▶ S205 (GND)

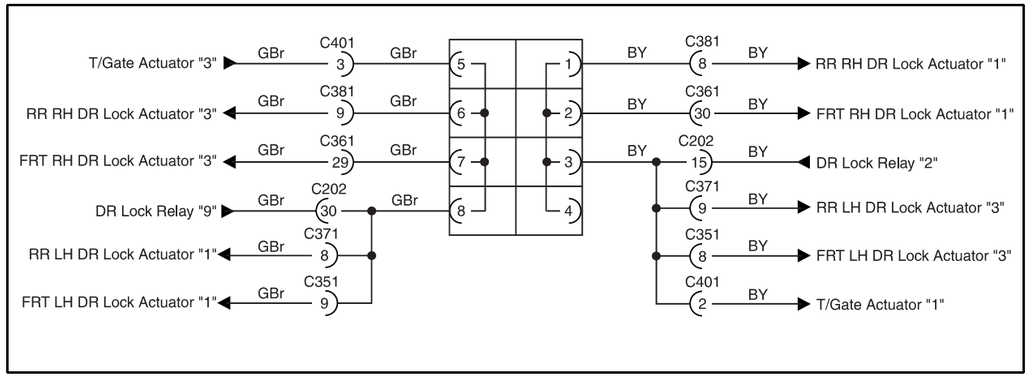


Modification basis	
Application basis	
Affected VIN	

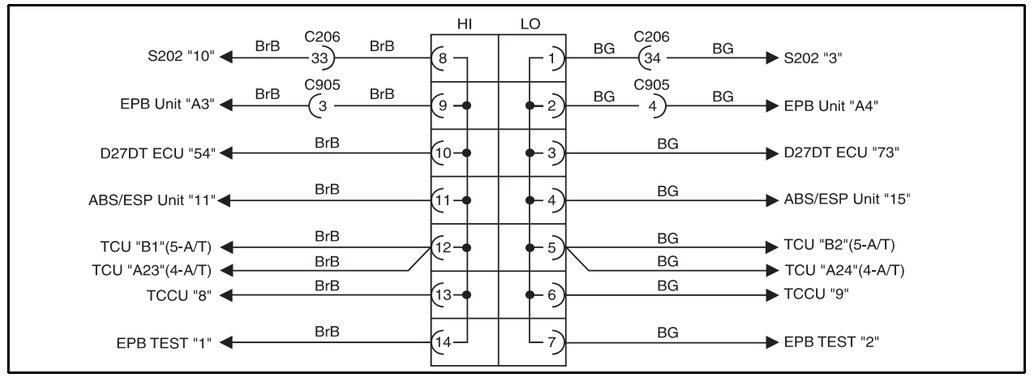
▶ S206



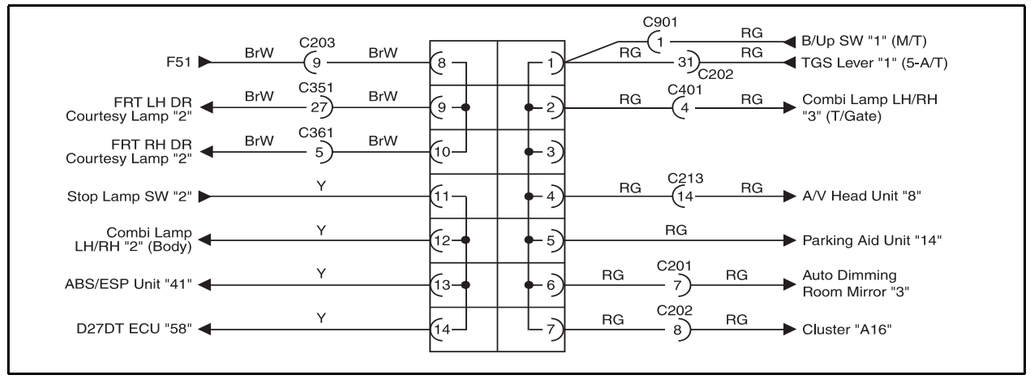
▶ S303



▶ S301 (CAN)



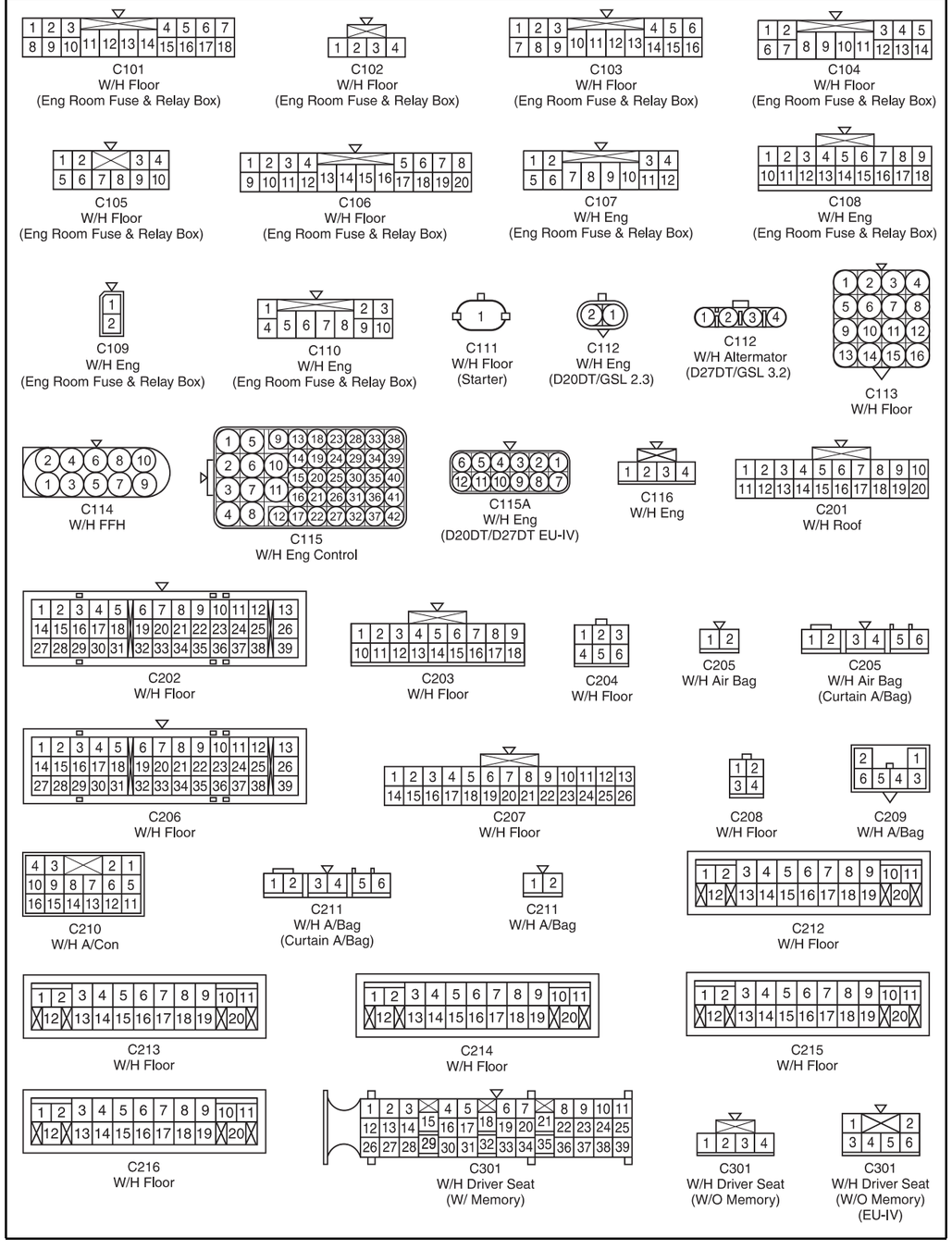
▶ S302



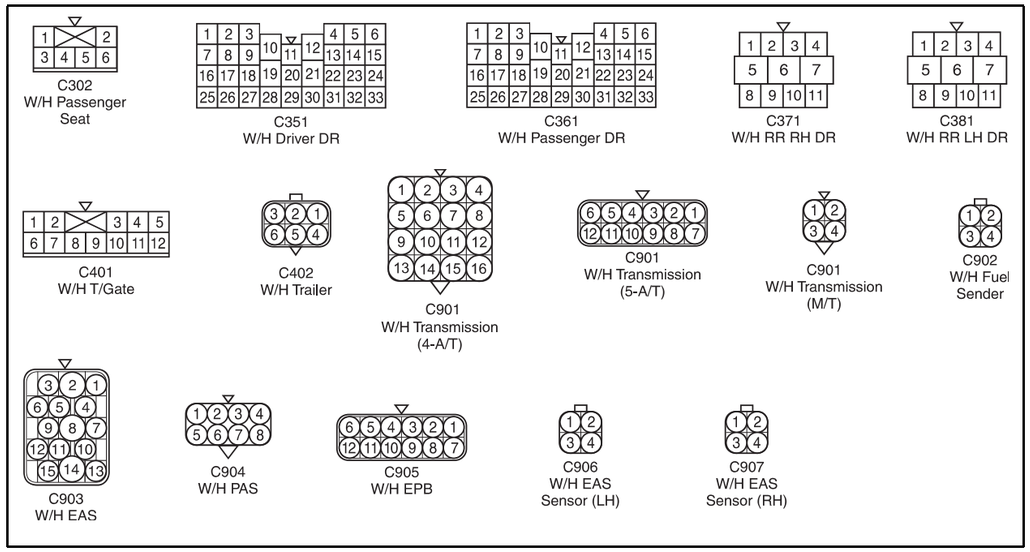
Modification basis	
Application basis	
Affected VIN	

5) CONNECTOR

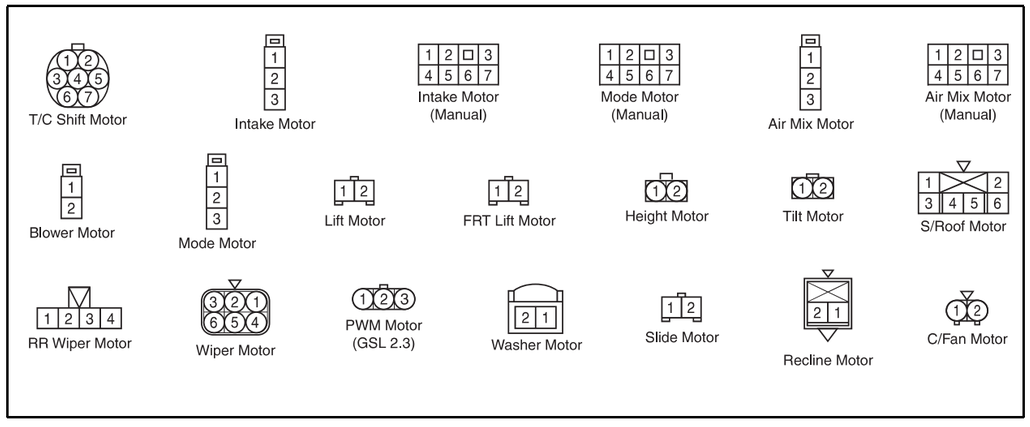
▶ WIRNING CONNECTOR



▶ WIRNING CONNECTOR

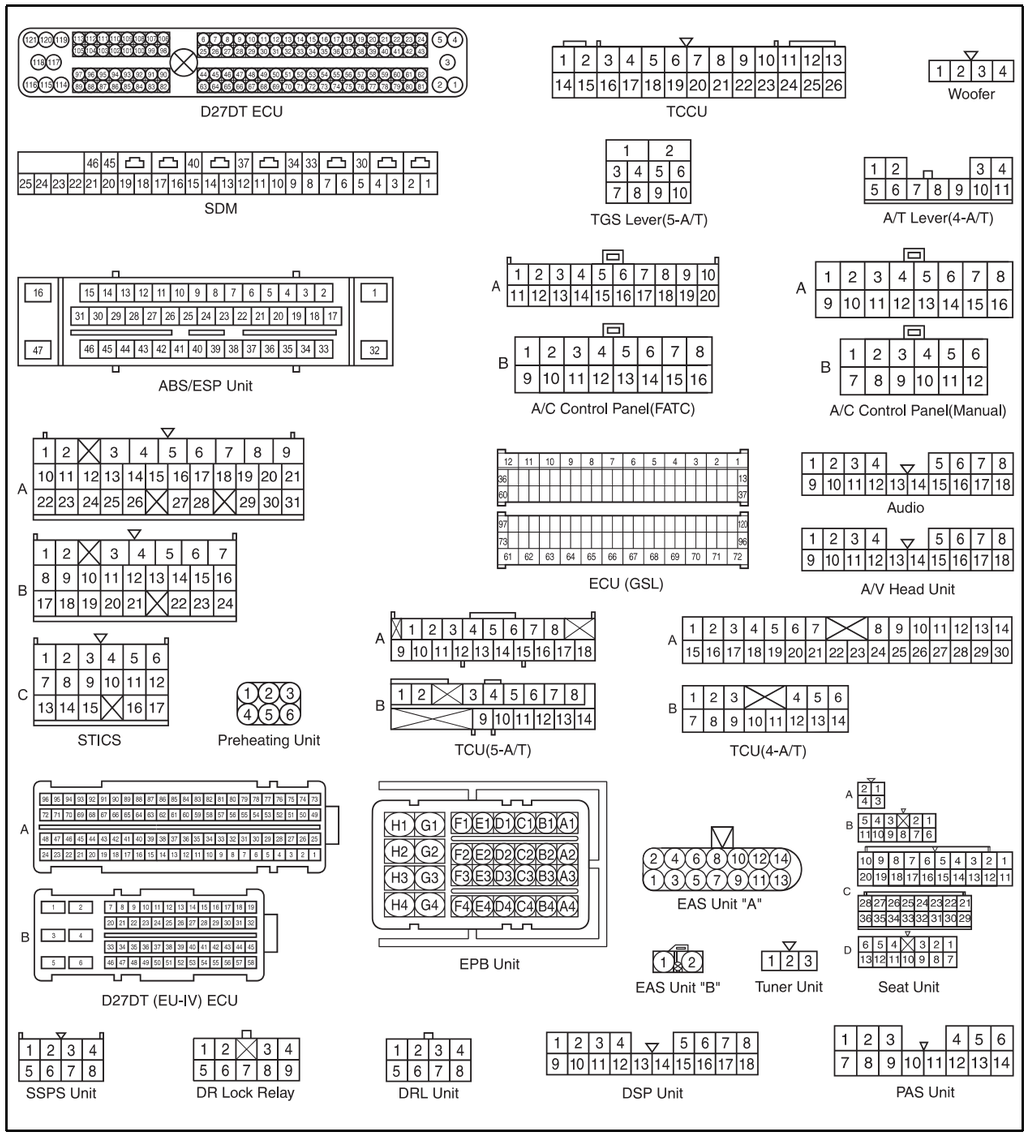


▶ MODE CONNECTOR

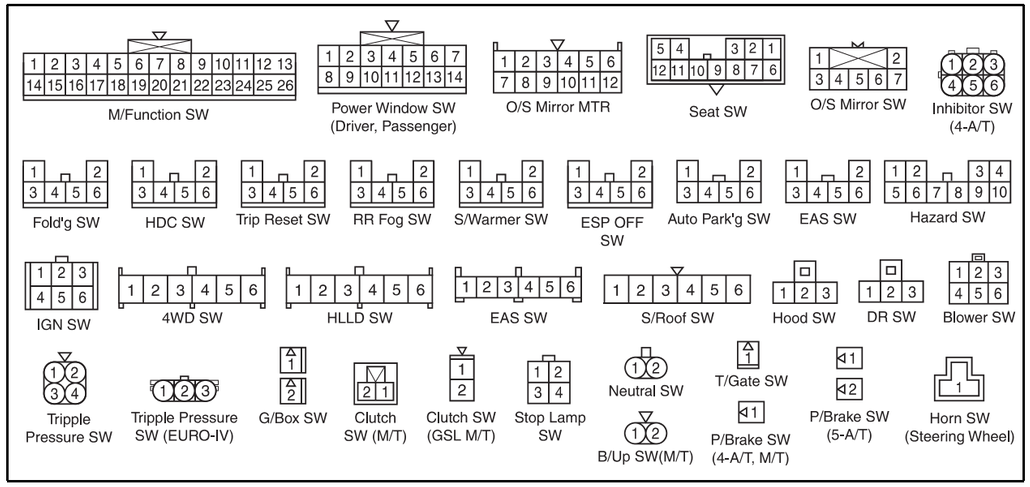


Modification basis	
Application basis	
Affected VIN	

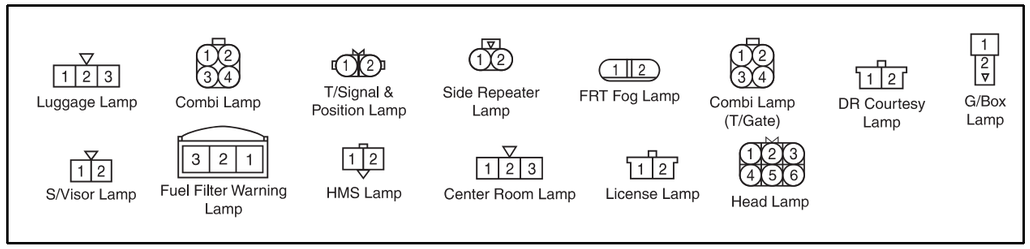
▶ UNIT CONNECTOR



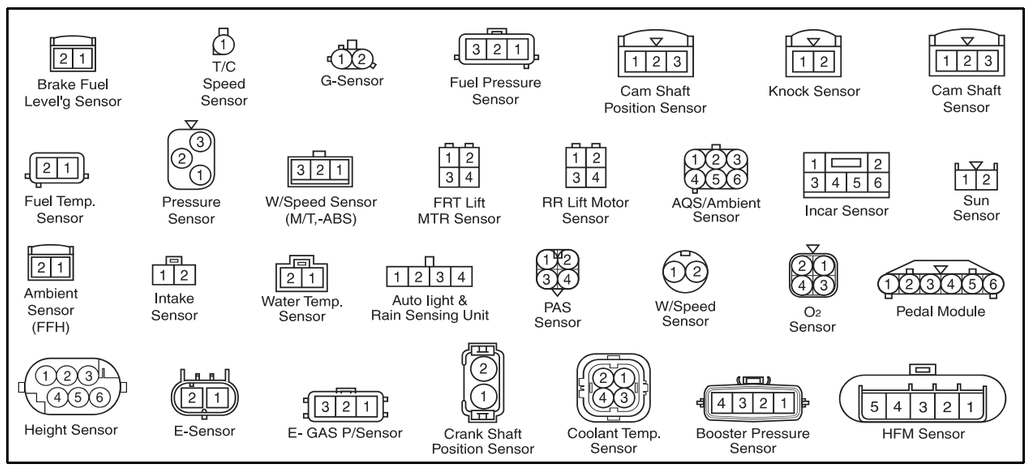
▶ SWITCH CONNECTOR



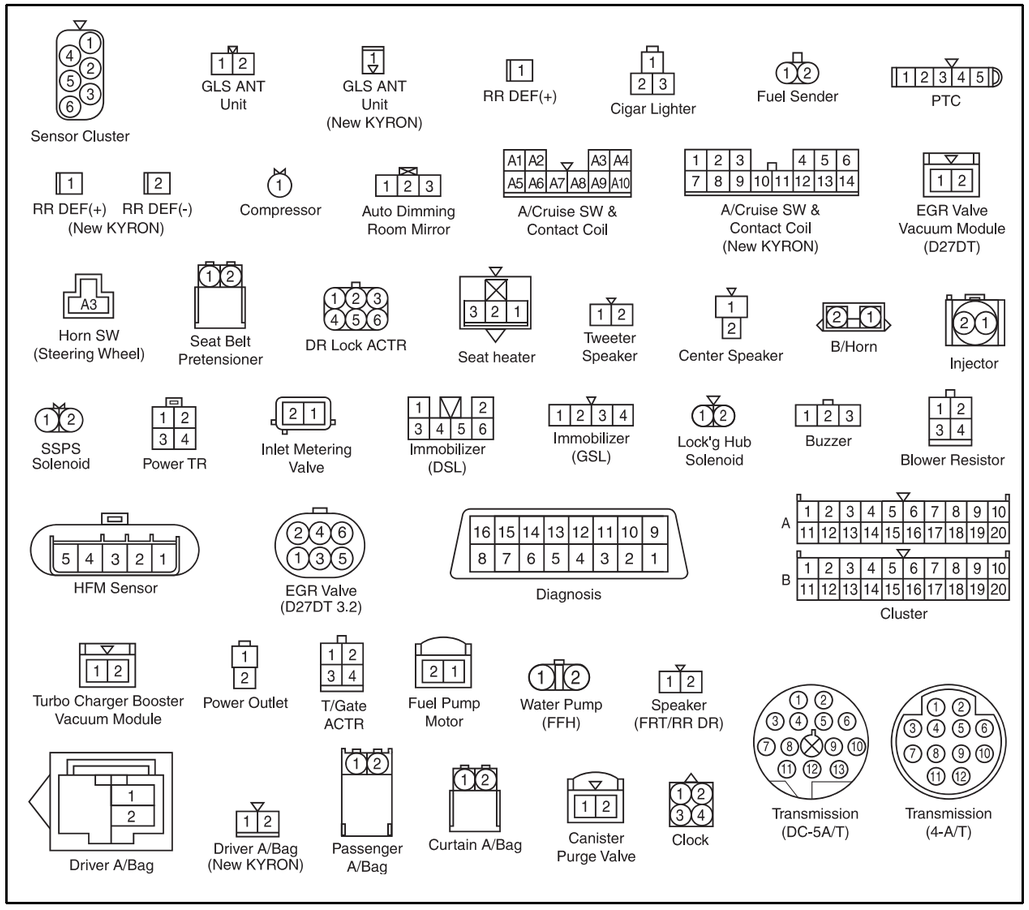
▶ LAMP CONNECTOR



▶ SENSOR CONNECTOR



▶ **ETC.**



Modification basis	
Application basis	
Affected VIN	

POWER DISTRIBUTION

8410-02/8410-04/8401-06

FUSE/RELAY

8410-02 ENGINE ROOM FUSE & RELAY BOX..... 3
8410-04 I/P - LH FUSE & RELAY BOX..... 5
8401-06 I/P - RH FUSE & RELAY BOX..... 6

ELECTRICITY DIVIDE

8210-02 ENGINE ROOM FUSE & RELAY BOX CIRCUIT..... 7
8410-04 I/P - LH FUSE & RELAY BOX CIRCUIT..... 12
8410-06 I/P - RH FUSE & RELAY BOX CIRCUIT..... 16

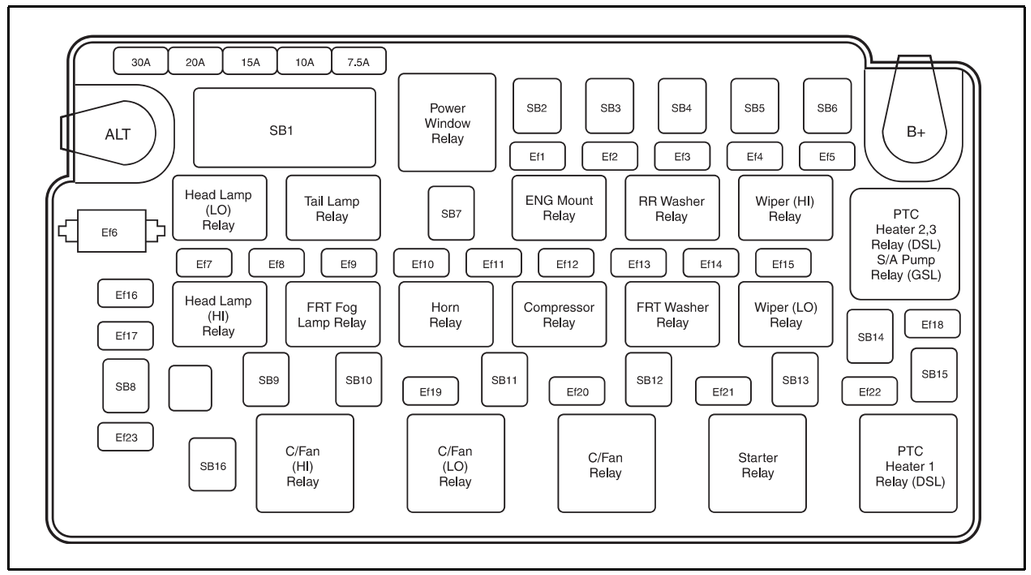
Memo

Memo

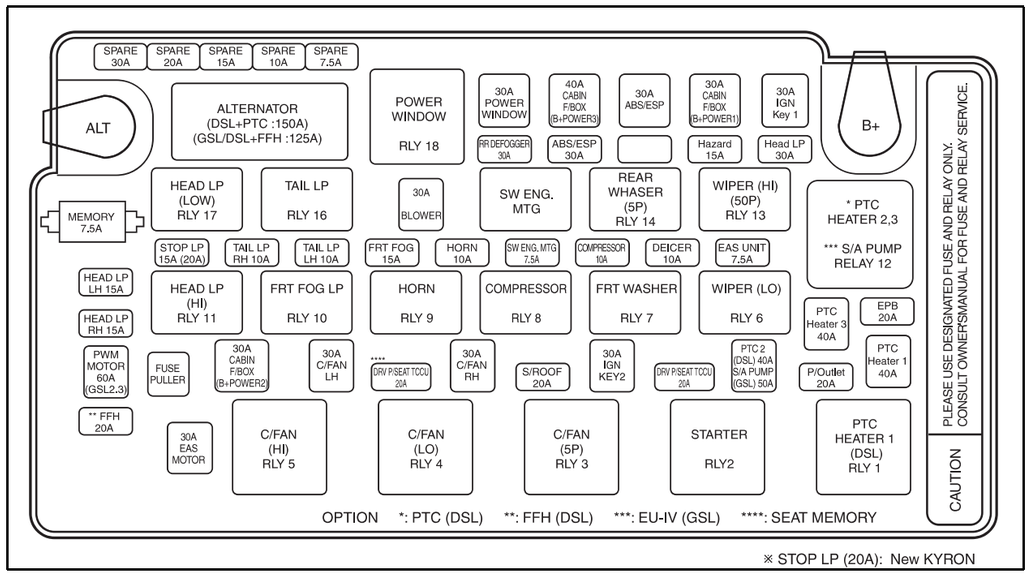
FUSE & RELAY

S.G.N. 8410-02 ENGINE ROOM FUSE & RELAY BOX

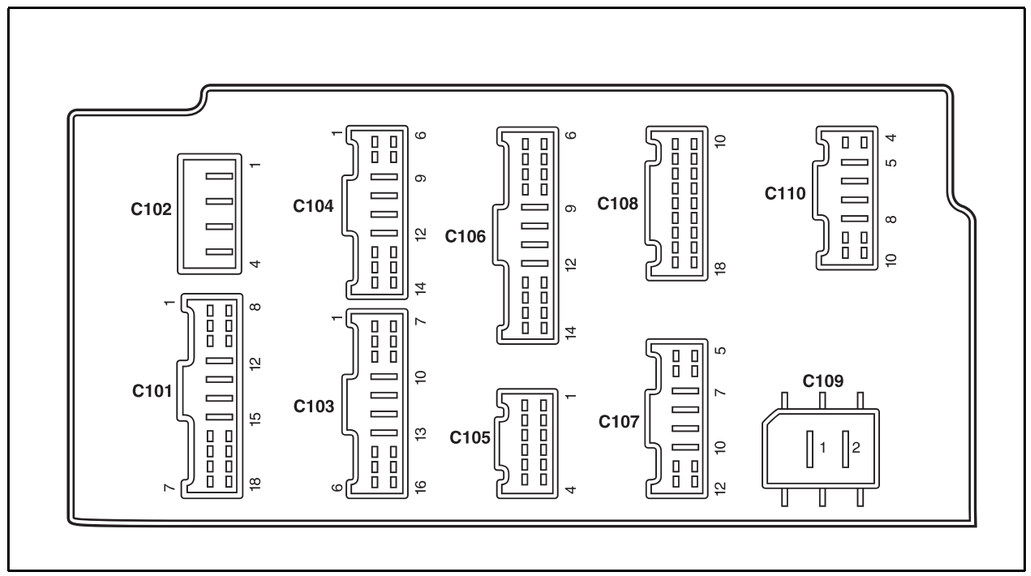
1) UPPER



3) ENGINE ROOM FUSE & RELAY BOX



2) LOW



Modification basis	
Application basis	
Affected VIN	

4) USAGE OF FUSE IN ENGINE ROOM FUSE BOX

Fuse No.	Capacity	Usage	Fuse No.	Capacity	Usage
SB1	150A/125A	Alternator (PTC/FFH)	Ef4	15A	Hazard
SB2	30A	Power Window	Ef5	30A	Head Lamp
SB3	40A	IP-RH Fuse Box (B+) F65~F71	Ef6	7.5A	Memory
SB4	30A	ABS/ESP	Ef7	15A (20A)	Stop Lamp (20A: New KYRON)
SB5	30A	IP-LH Fuse Box (B+) F44~F50	Ef8	10A	Tail Lamp (RH)
SB6	30A	IGN Key 1	Ef9	10A	Tail Lamp (LH)
SB7	30A	Blower Motor	Ef10	15A	FRT Fog
SB8	60A	P.W.M Motor (GSL 2.3)	Ef11	10A	Horn
SB9	30A	IP-LH Fuse Box (B+) F51~F55	Ef12	7.5A	Hub Solenoid
SB10	30A	C/Fan LH	Ef13	10A	Compressor
SB11	30A	C/Fan RH	Ef14	10A	Deicer
SB12	30A	IGN Key 2	Ef15	7.5A	EAS
SB13	40A	P.T.C Heater 2 (DSL)	Ef16	15A	Head Lamp (LH)
	50A	S/Air Pump (GSL)	Ef17	15A	Head Lamp (RH)
SB14	40A	P.T.C Heater 3 (DSL)	Ef18	20A	EPB
SB15	40A	P.T.C Heater 1 (DSL)	Ef19	20A	Driver P/Seat (Memory)
SB16	30A	EAS	Ef20	20A	S/Roof
Ef1	30A	RR Defogger	Ef21	20A	Driver P/Seat
Ef2	30A	ABS/ESP	Ef22	20A	P/Outlet
Ef3	7.5A	Fold'g Mirror (Only KYRON)	Ef23	20A	FFH

5) ENGINE ROOM FUSE BOX CONNECTOR NUMBER

Connector No.	Pin No.	Connector Color
C101	18	White
C102	4	White
C103	16	White
C104	14	White
C105	10	White
C106	20	White
C107	12	White
C108	18	White
C109	2	Black
C110	10	White

Modification basis	
Application basis	
Affected VIN	

S.G.N. 8410-04 I/P – LH FUSE & RELAY BOX

1) I/P - LH FUSE & RELAY BOX

	7.5A SPARE		10A SPARE	F24 10A	A/BAG	F41 7.5A	O/SIDE MRR DIGITAL CLOCK ECM MRR, S/ROOF
				F25 7.5A	CLUSTER STICS	F42 15A	C/LIGHTER
				F26 10A	ENG ROOM FUSE & RLY BOX	F43 10A	AUDIO TUNNER UNIT
				F27 7.5A	ALTERNATOR IMMOBILIZER S/LAMP	F44 20A	*GSL FUEL PUMP
				F28 10A	T/SIGNAL BACK UP LP	F45 10A	ENG ECU
				F29 10A	TCU, TGS TCCU	F46 20A	*GSL INJECTOR
				F30 10A	ENG ECU	F47 15A	*GSL SENSOR
				F31 -	SPARE	F48 -	SPARE
				F32 7.5A	SEAT UNIT EAS, EPB	F49 7.5A	DRL
				F33 10A	ABS/ESP	F50 -	SPARE
				F34 7.5A	HEAD LP R/SNR& AUTO LIGHT DRL	F51 10A	RR FOG LAMP INTERIOR LAMP
				F35 15A	S/WARMER	F52 7.5A	IMMOBILIZER BUZZER, CHIME
				F36 20A	FRT WIPER WASHER	F53 15A	DOOR LOCK/UNLOCK B/HORN
				F37 7.5A	PWR OUTLET A/CON	F54 7.5A	SEAT UNIT FOLDING DIAGNOSIS
				F38 10A	RR WIPER	F55 15A	RR SEAT WARMER
				F39 7.5A	STICS FRT & RR GLASS HEATER	F56 10A	STARTER GSL ECU
				F40 7.5A	ALT D (D20DT)	F57 7.5A	DEF IND O/S MRR DEF

	15A SPARE		20A SPARE
RR FOG LAMP			
FUSE PULLER			
SPARE			
D R L			
*GSL F/PUMP			

FLASHER UNIT

RR WIPER

BURGLAR HORN

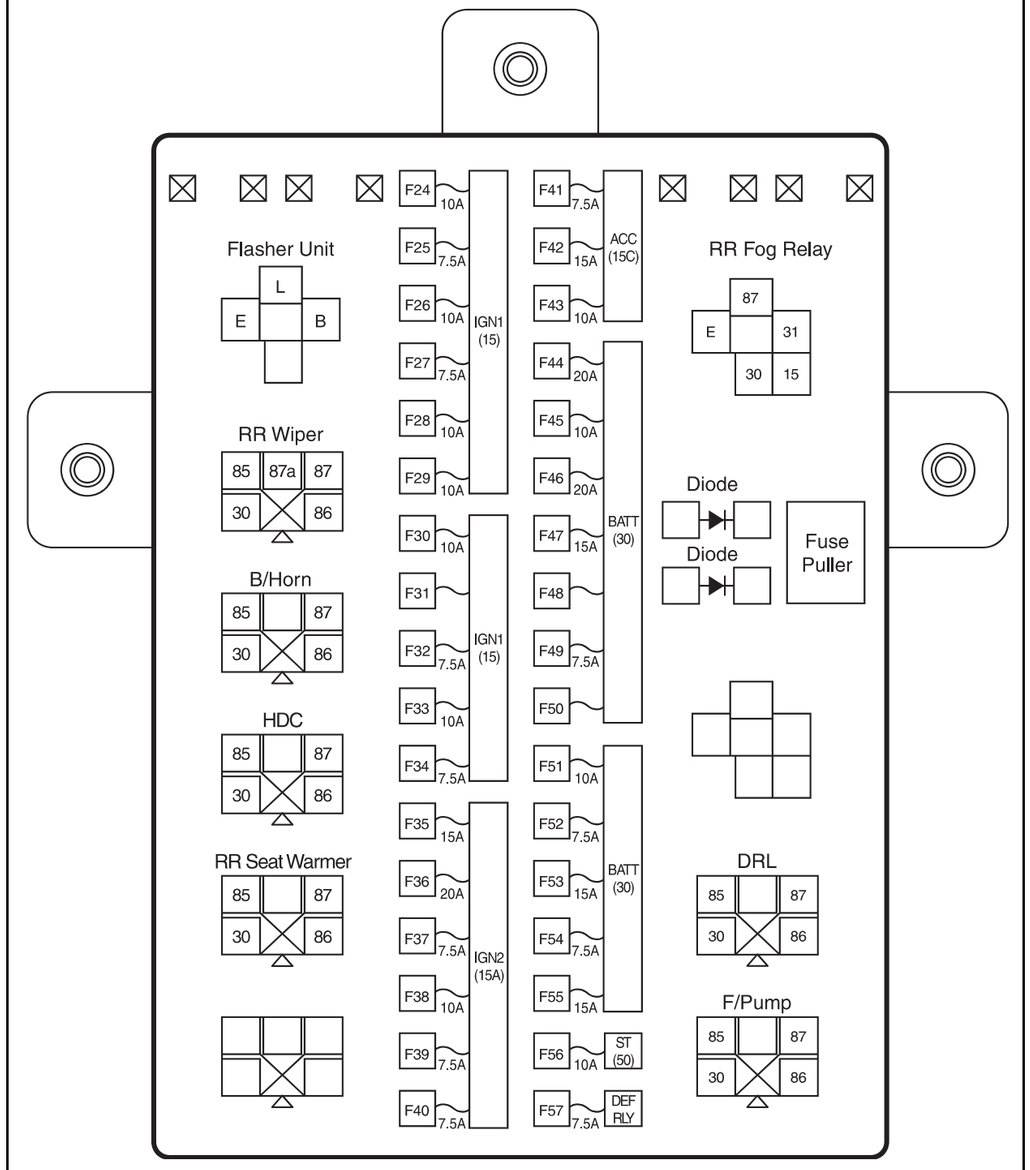
*HDC H D C

RR SEAT WARMER

SPARE

* PLEASE USE THE DESIGNATED FUSE AND RELAY

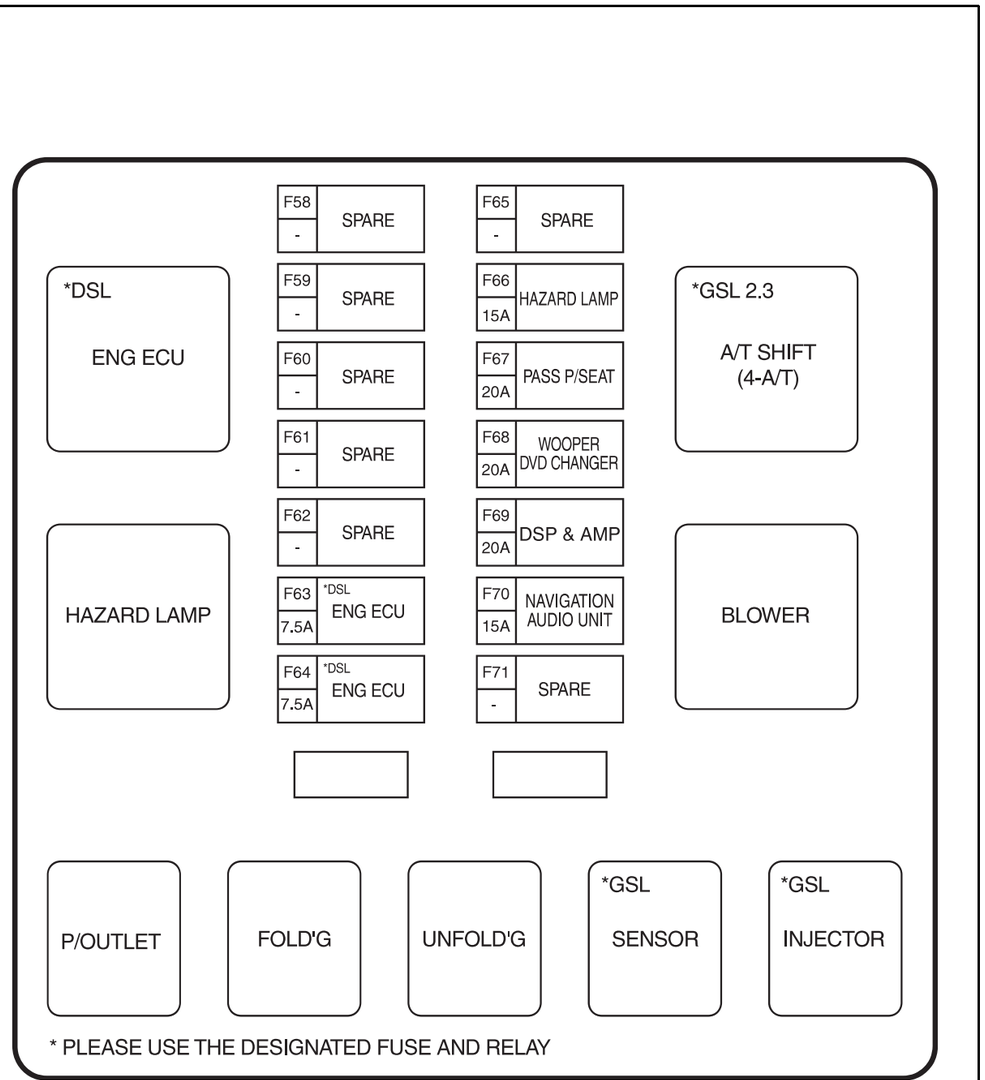
2) POWER SUPPLY

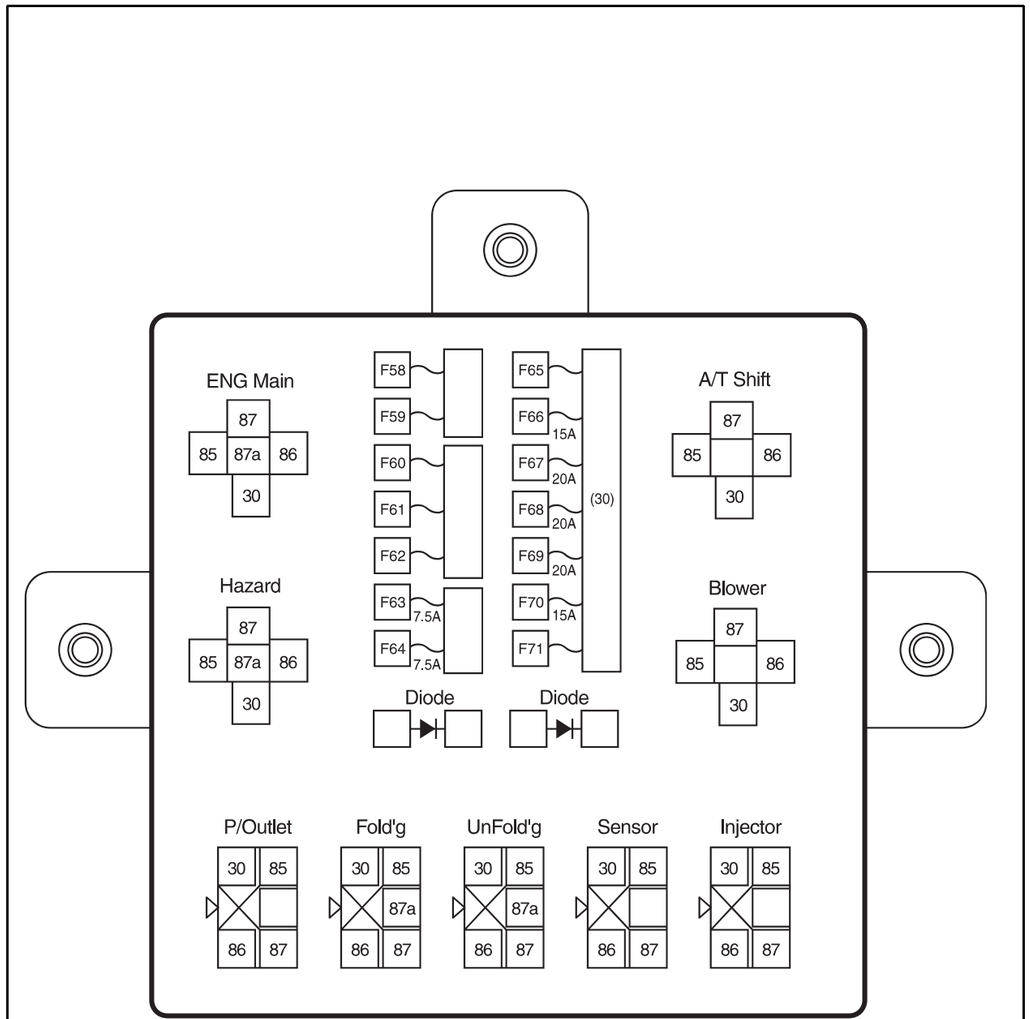


Modification basis	
Application basis	
Affected VIN	

S.G.N. 8410-06 I/P – RH FUSE & RELAY BOX

1) I/P - RH FUSE & RELAY BOX



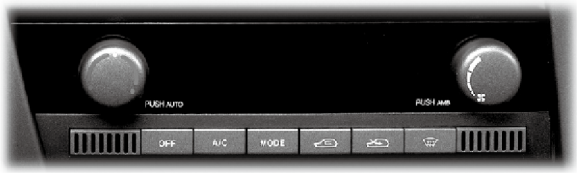


Modification basis	
Application basis	
Affected VIN	

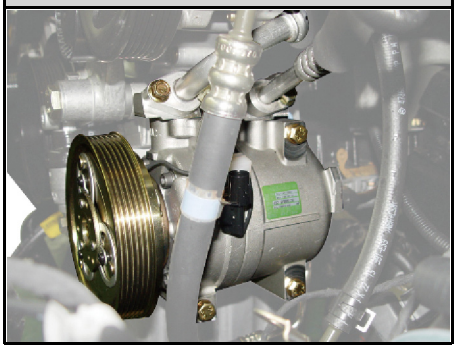
AIR CONDITIONER 6810-15

OVERVIEW AND OPERATION PROCESS

1. SYSTEM LAYOUT AND COMPONENTS

Type	Air Conditioner Controller
FATC	
Manual air conditioner	

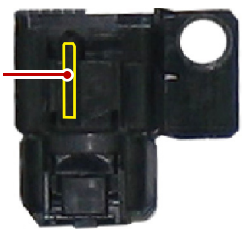
Compressor



Sun Sensor - Instrument Panel Upper Left

It changes sun load coming through front windshield into current to input to FATC controller.

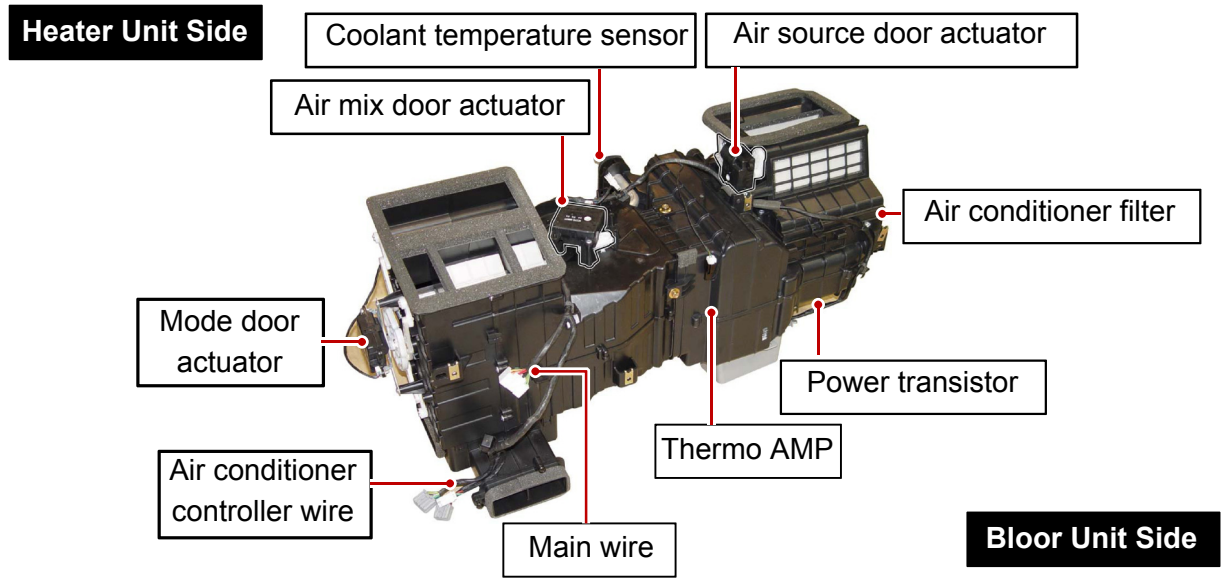
Ambient Temperature Sensor

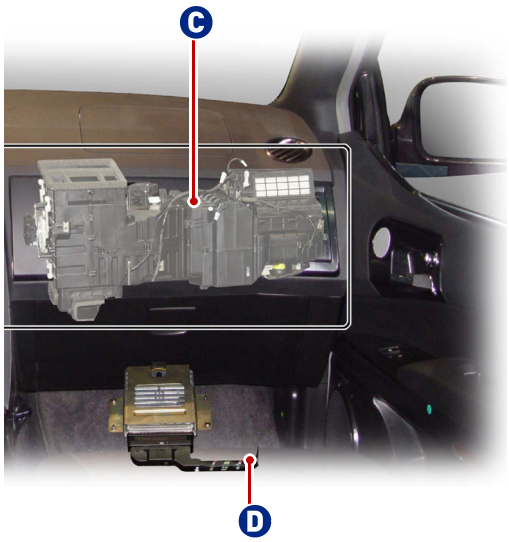


This sensor is installed at the front bottom of engine compartment.
This changes the air source mode by detecting the air pollution and the ambient temperature.

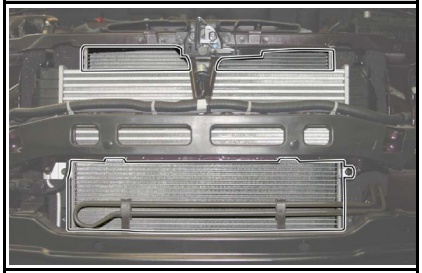
Modification basis	
Application basis	
Affected VIN	

C Front AirConditioner Module Assembly - Inside of Instrume

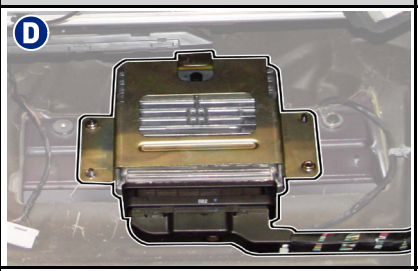
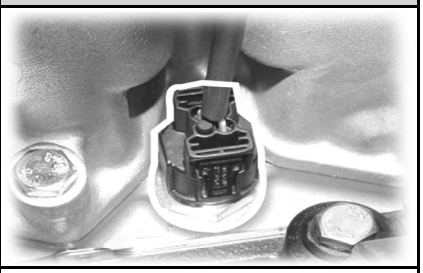




Condenser

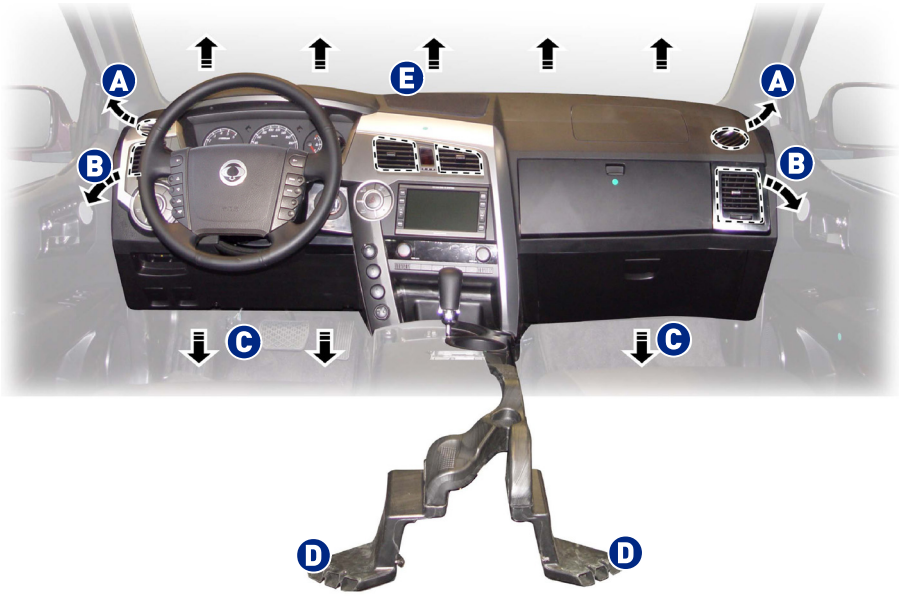


Installed in front of vehicle and condenses vapor refrigerant into low temperature and high pressure liquid refrigerant..

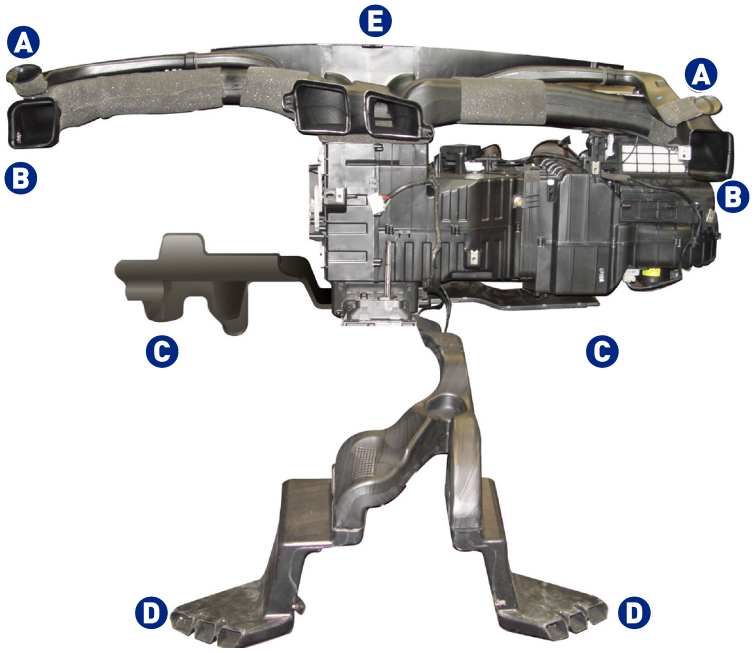
Receiver Drier (LH)	Engine ECU (Passenger Footstep)	Coolant Temperature Sensor (On Engine)
		
Absorbs moisture in the refrigerant and reserves refrigerant to supply smoothly.	Detects A/C switch position, coolant temperature, engine condition and driving condition to control the air conditioner.	A sensor that detects coolant temperature and transmits to engine ECU.

2. VENTILATION SYSTEM COMPONENTS

▶ Locations of Vents



▶ Air Duct

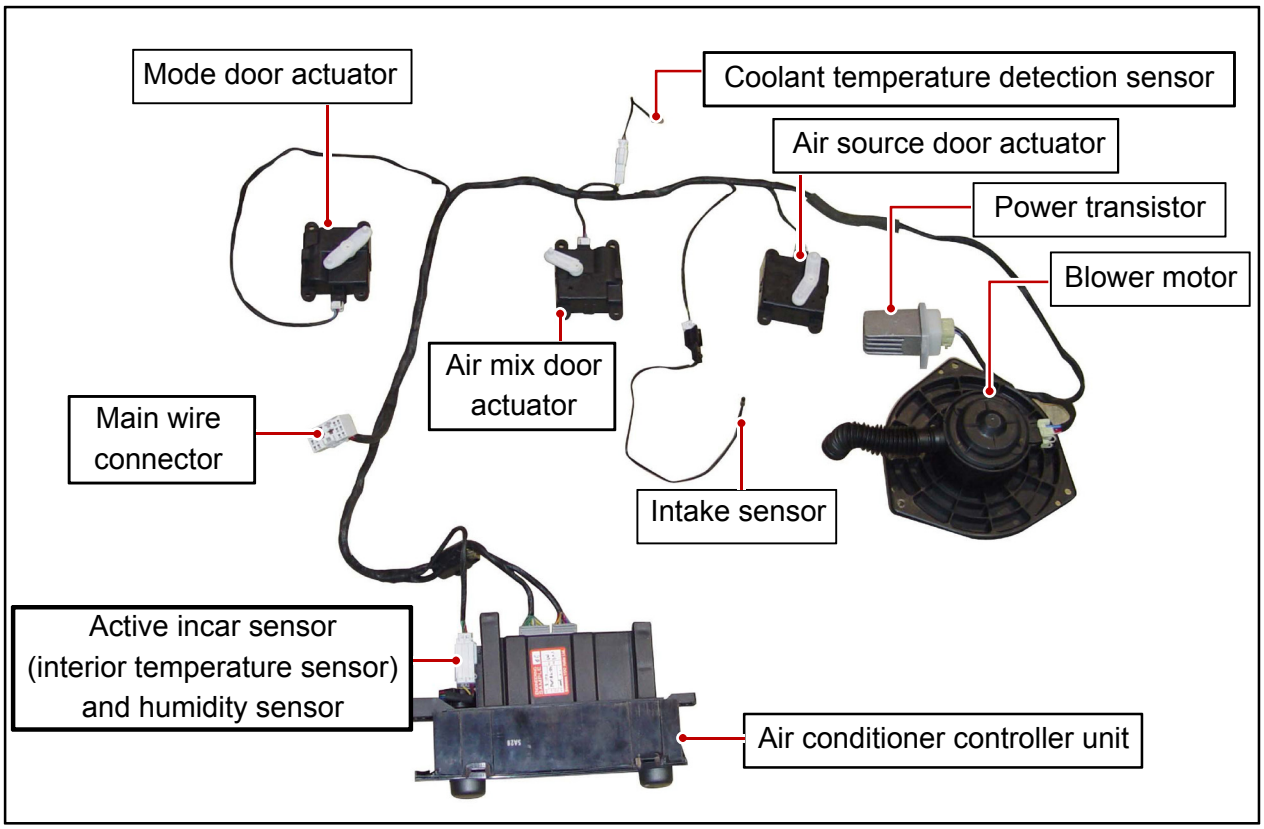


Modification basis	
Application basis	
Affected VIN	

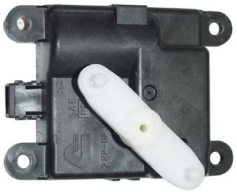
▶ **Air Duct Layout**

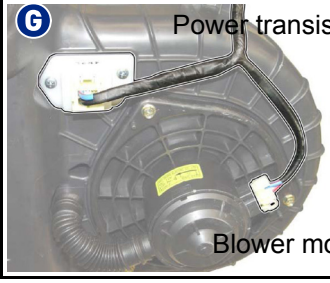
3. AIR CONDITIONER MODULE WIRING AND LAYOUT

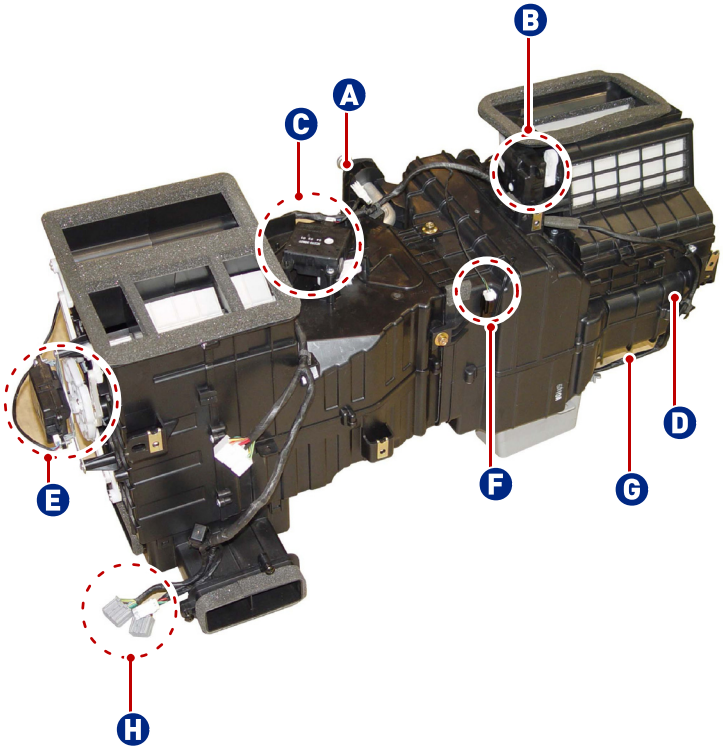
1) FRONT AIR CONDITIONER MODULE WIRING LAYOUT



2) LOCATIONS

Coolant Temperature Sensor
A
Air Source Door Actuator
B
C
Air Conditioner Filter
D
Mode Door Actuator
E 

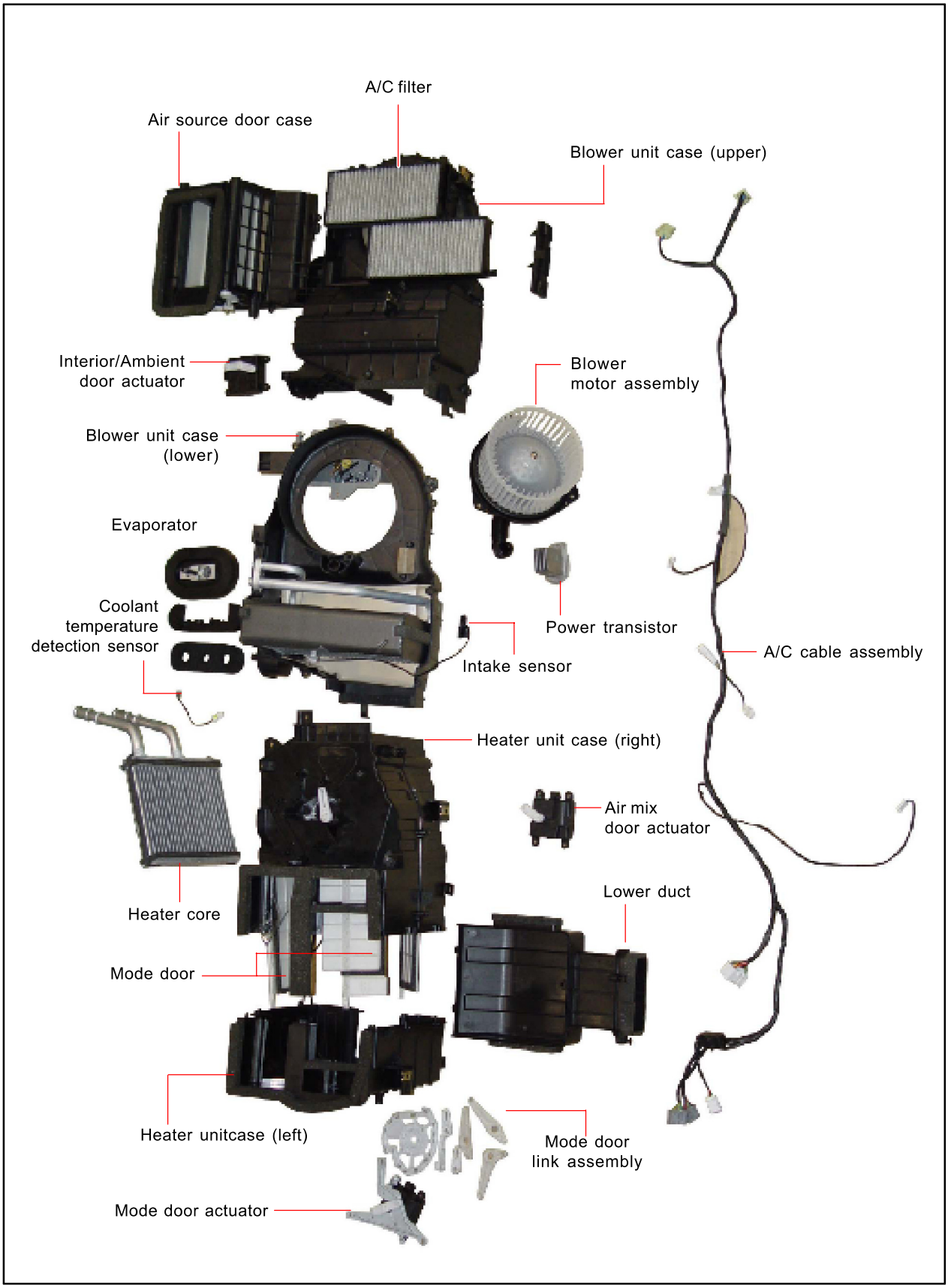
Intake Sensor	Power Transistor/Blower Motor
F	G 



A/C Controller Unit	Interior Temperature Sensor (Interior Humidity Sensor)
H Interior temperature and humidity sensor	H

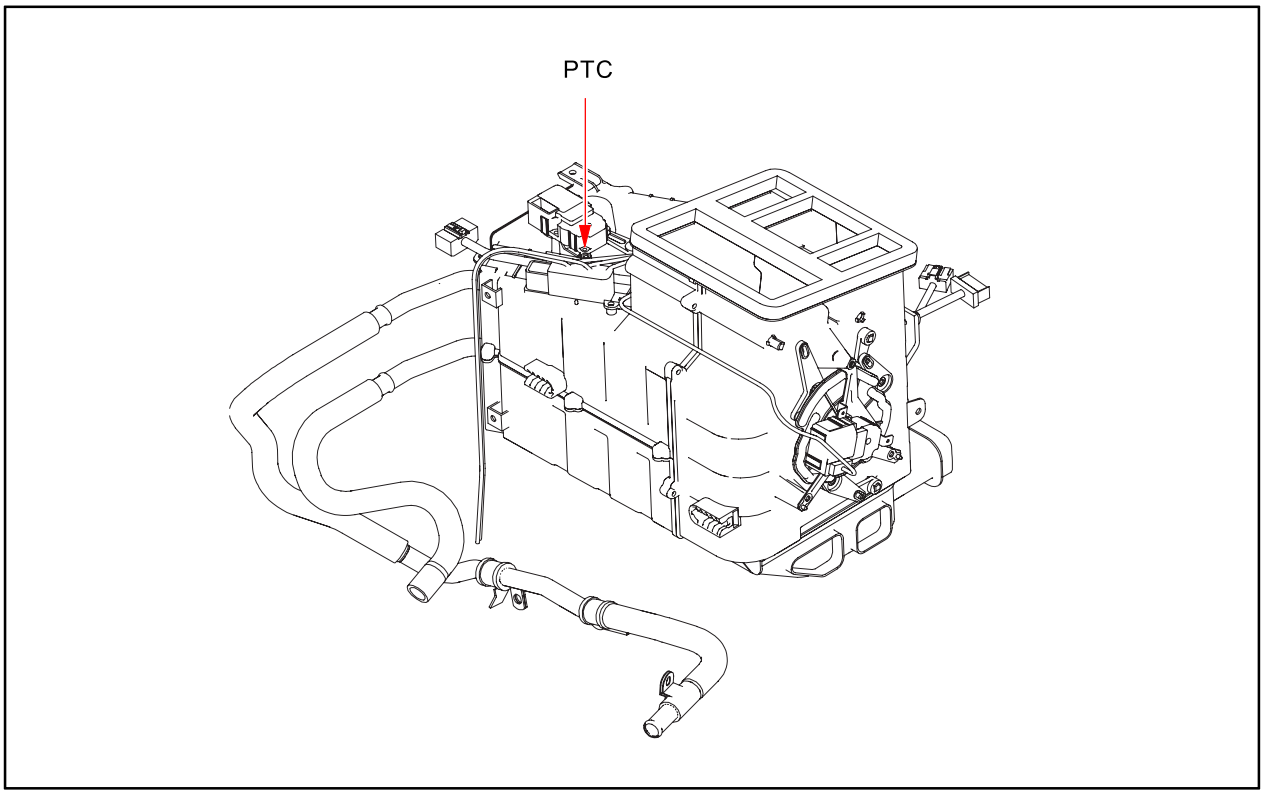
Modification basis	
Application basis	
Affected VIN	

3) Components

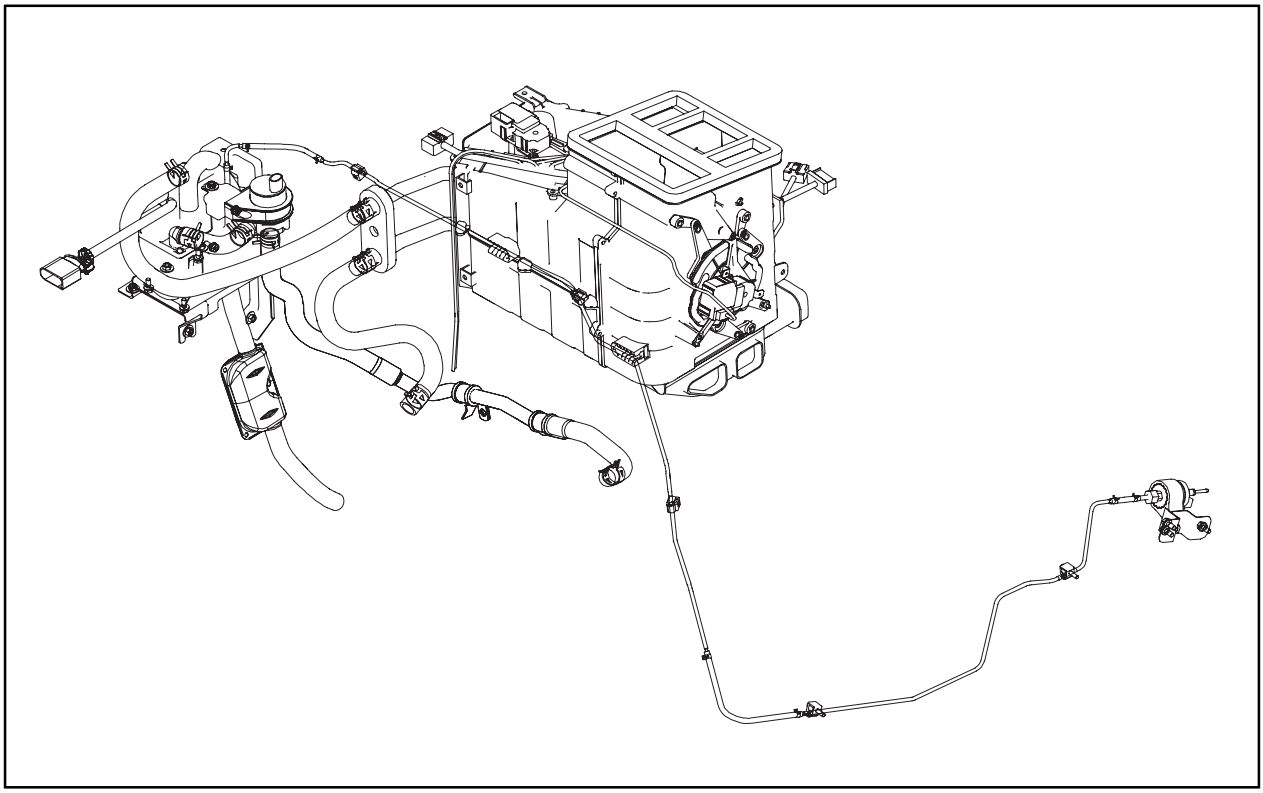


4. PTC HEATER AND FFH HEATER LAYOUT

1) PTC HEATER ASSEMBLY LAYOUT



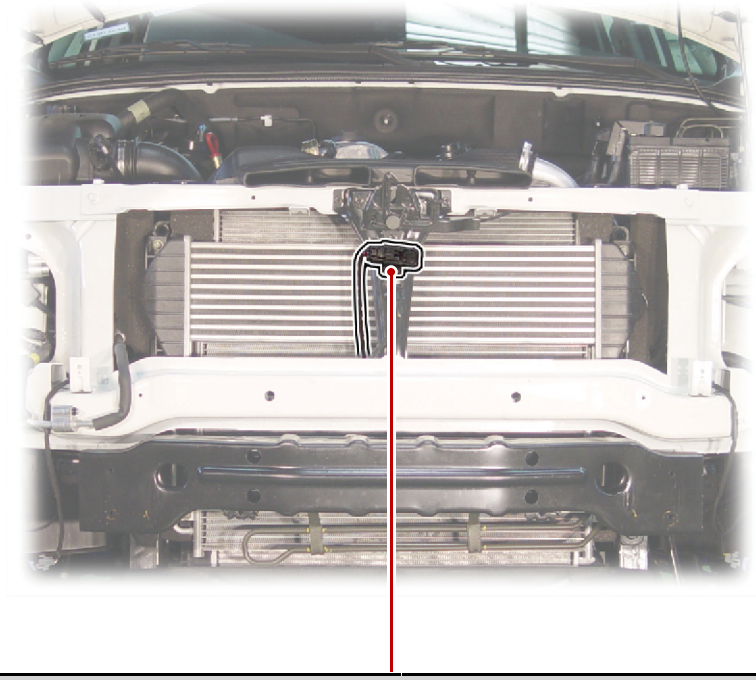
2) FFH HEATER ASSEMBLY LAYOUT



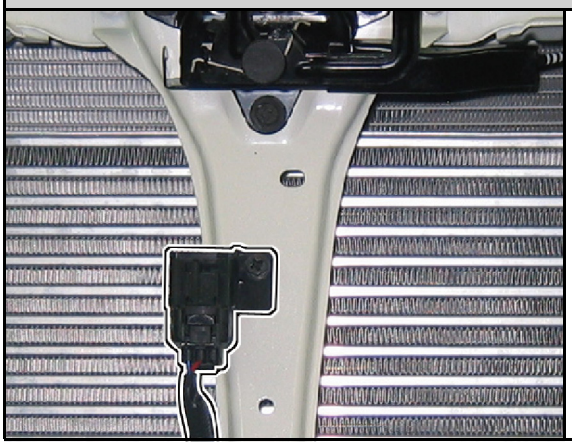
Modification basis	
Application basis	
Affected VIN	

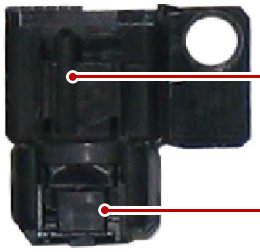
5. AMBIENT TEMPERATURE SENSOR

The ambient temperature sensor is installed in the front area of the engine compartment to detect the ambient temperature.



Ambient temperature sensor





6. SENSORS AND ACTUATORS

1) Sun Sensor

It is installed on the upper left end of instrument panel. It is using characteristics that the amount of current changes according to amount of light on the photosensitive surface. Photo diode, converts the changes in light intensity into electrical changes, detects the amount of light coming through windshield and changes it into current and then sends the signal to FATC controller.

▶ **Inspection**

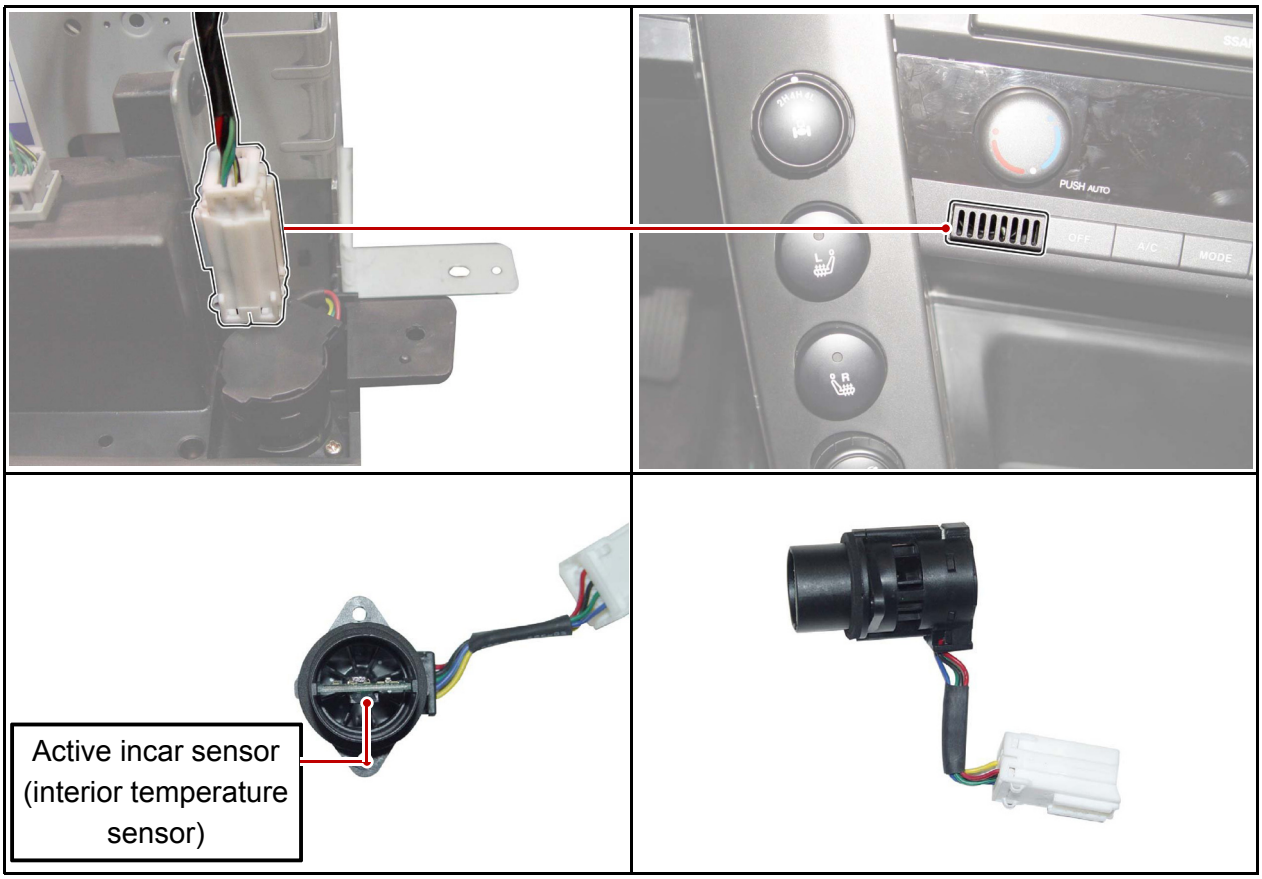
- Remove the sun sensor and measure the current between terminals under sunlight.
- Measure the current again under shade. It is in normal conditions if the measured value is less than the measured value under sunlight.
- Turn the ignition switch to "ON" position.
- Measure the voltage to the sun sensor from FATC connector. (approx. 2.5 V under sunlight and 4.8 V under shade.)
- If the voltage value cannot be measured, check the circuit for open. If the measured value is within the specified range, replace the FATC controller.

Modification basis	
Application basis	
Affected VIN	

2) Active Incar Sensor: AI Sensor

The AI sensor is installed at the driver side instrument panel undercover. It is a sensor that detects interior temperature.

(1) Location



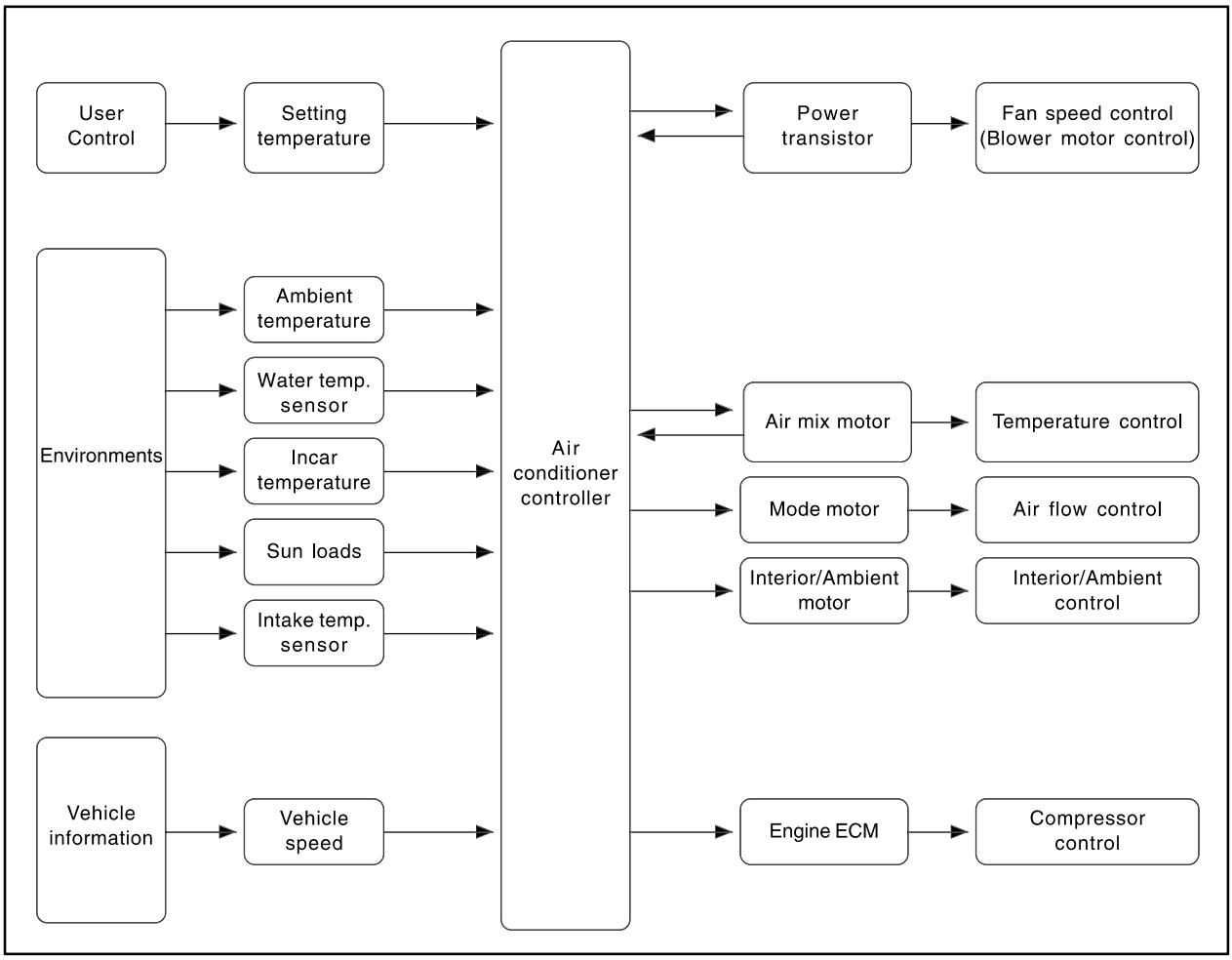
(2) Functions

▶ **Incar temperature sensor**

This sensor is a negative temperature coefficient (NTC) thermistor and detects the interior temperature with air coming from sensor hole and then sends the voltage value according to the changed resistance to FATC controller.

7. AIR CONDITIONER SYSTEM DIAGRAM

This figure shows the input and output system between FACT A/C components and A/C controller.



1) Air Conditioner Compressor Control by Engine ECU

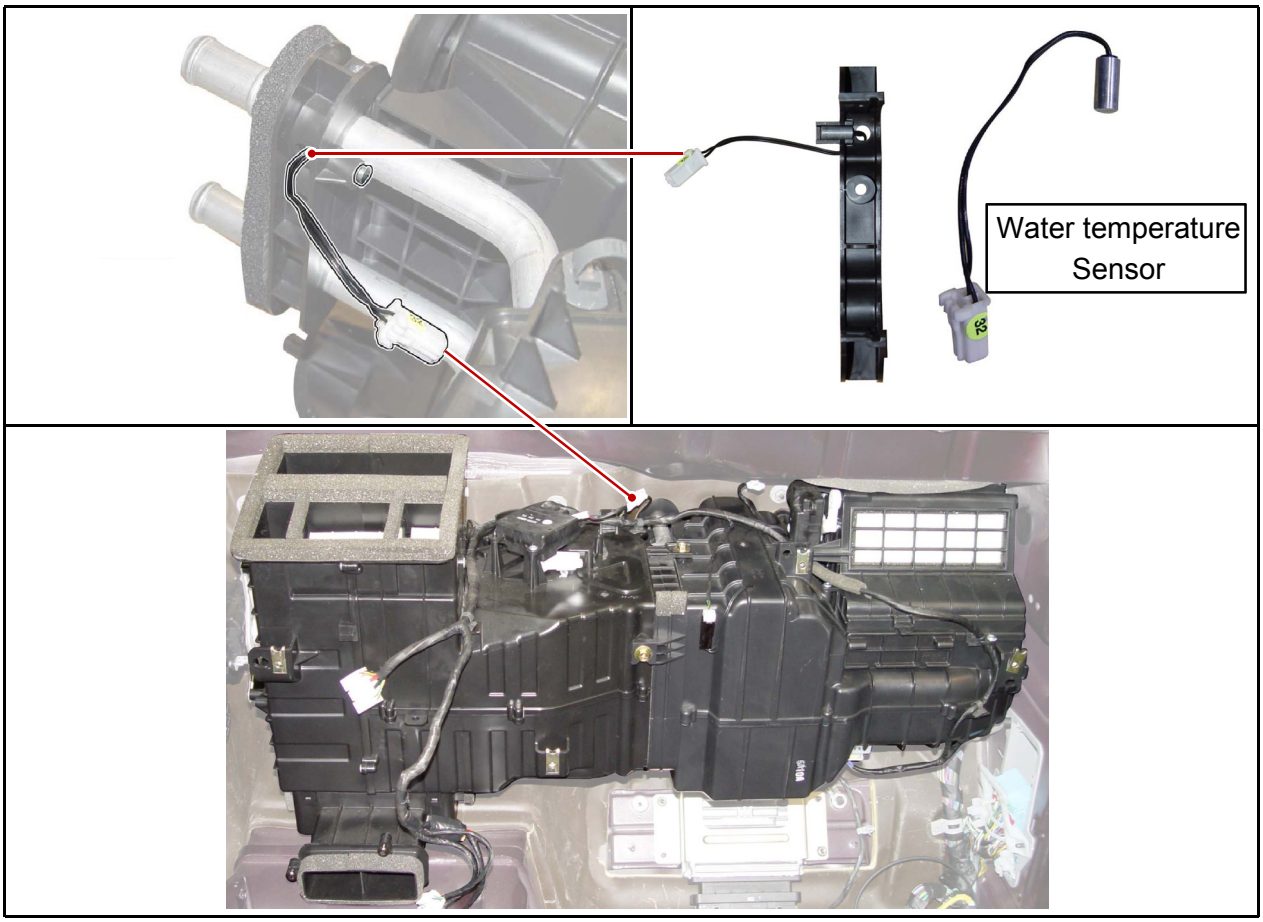
In case of conventional vehicle models, the system turns ON/OFF the compressor switch according to refrigerant pressure, ambient temperature and condenser temperature to protect air conditioner circuits. However, for the vehicle equipped with DI engine, the engine ECU turns off air conditioner compressor as below in addition to above conditions.

1. Coolant temperature: below −20°C
2. Coolant temperature: over 115°C
3. For approx. 4 seconds after starting the engine
4. When engine speed is below 650 rpm
5. When engine speed is over 4,500 rpm
6. During abrupt acceleration for the vehicle equipped with manual transmission

Modification basis	
Application basis	
Affected VIN	

8. AIR CONDITIONER MODULE SENSORS AND ACTUATORS

1) Water Temperature Sensor



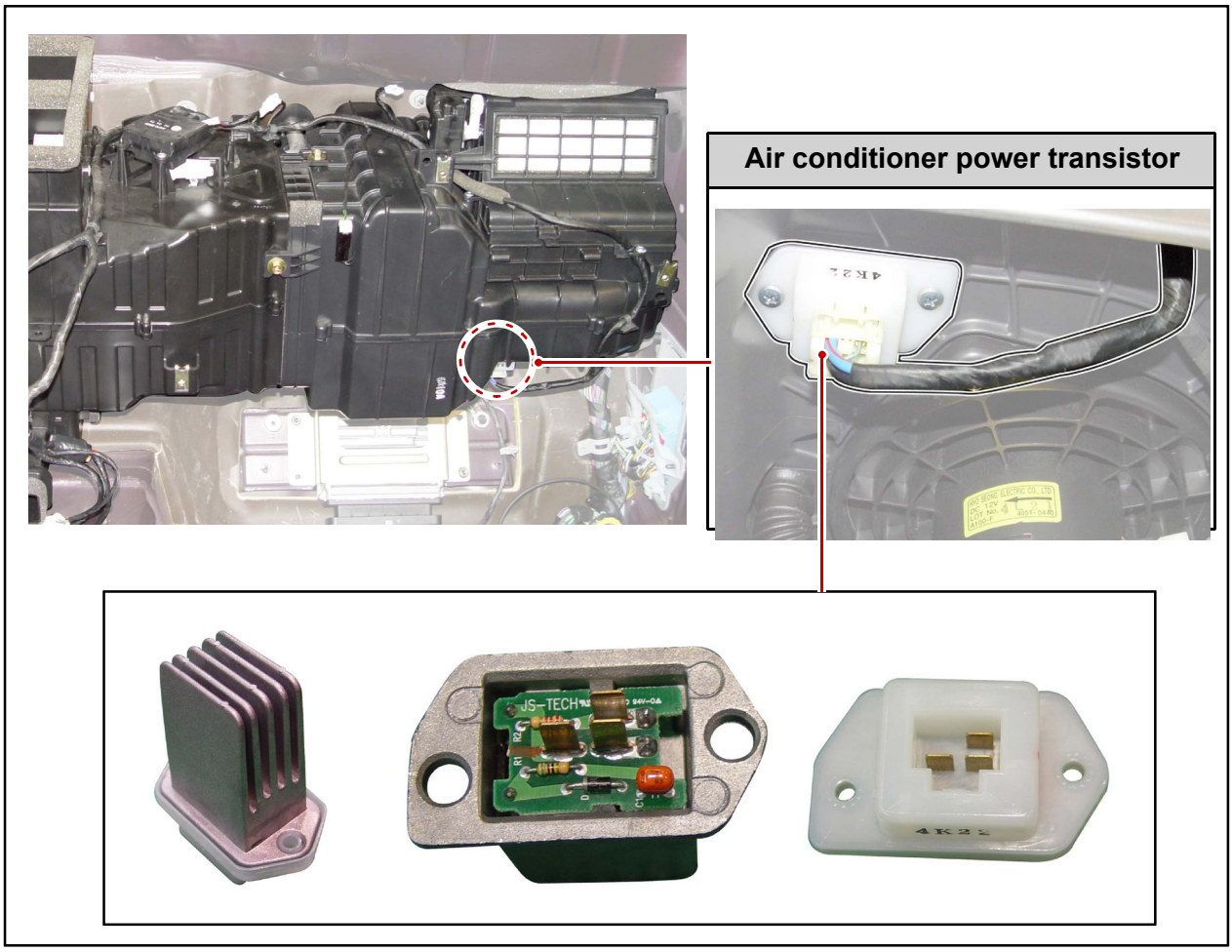
(1) Inspection

If the water temperature sensor defect code (DTC 3) is set, check as below.

- Remove the water temperature sensor and measure the resistance between terminals on the sensor connector.
  (standard: approx. 25°C, 2.2 kΩ)
  In addition, if the resistance is extremely high or low, replace the sensor.
- If the measured value is out of the specified range, replace the water temperature sensor. If the measured value is within the specified range, check as below.
- Turn the ignition switch to ON position and measure the voltage to water temperature sensor from the FATC controller connector. (standard: approx. 2 V at 25°C)
- If the voltage value cannot be measured, check the circuit for open. If the measured value is within the specified range, replace the FATC controller.

2) Power Transistor

The power transistor controls the fan speed. It controls the blower motor operating speed without stages by changing the current value to the base of power transistor when receiving the fan control signal from FATC.



(1) Inspection

If the power transistor defect code (DTC 6) appears, check as below.

- Turn the ignition switch to ON position.
- Measure the voltage between terminals while changing the fan speed from stage 1 to stage 6.
- The specified voltage value in each stage:

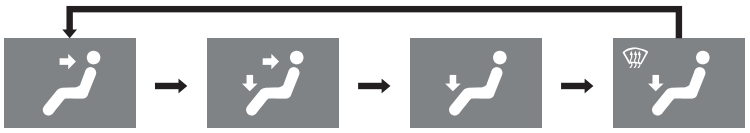
Stage	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Blower (V)	4.5	6.0	7.5	9.0	11	Max HI

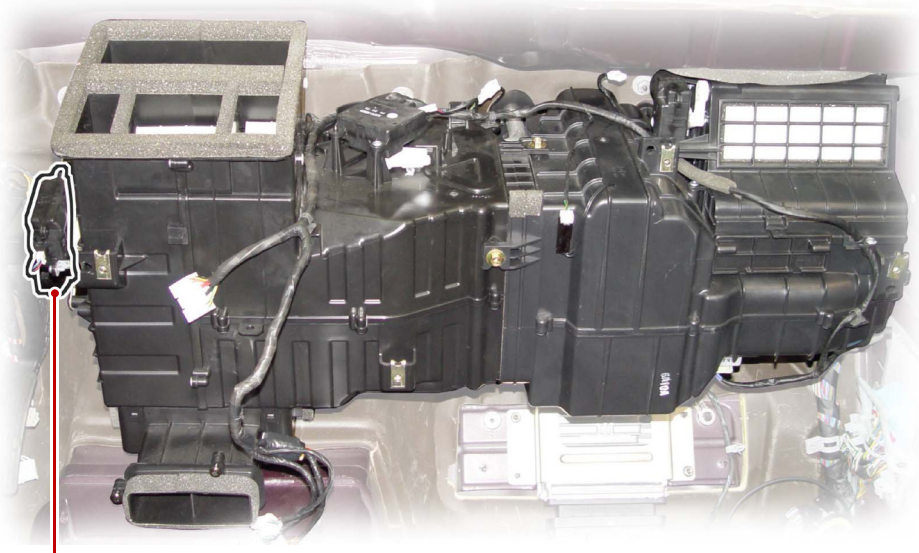
- If the voltage is out of specified value, check the circuit for open. If the circuit is in normal condition, replace the power transistor.

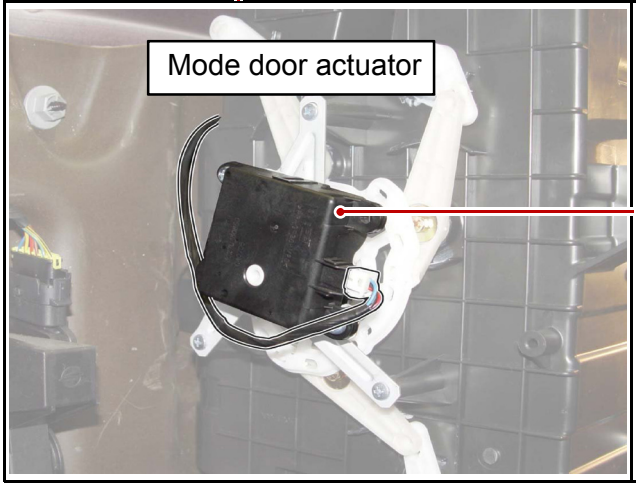
Modification basis	
Application basis	
Affected VIN	

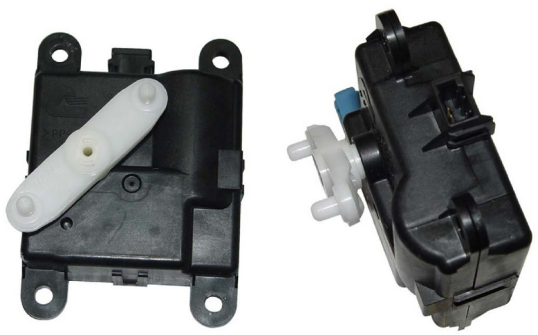
3) Mode Door Actuator

The mode door actuator is an actuator that closes, opens and adjusts the mode door for VENT, FOOT and DEF mode to change the air flow directions according to FATC controller. Under the FATC controller AUTO mode, it stays on DEF mode until the engine coolant temperature reaches at normal operating level and the mode is changed as below when the MODE switch is pressed.





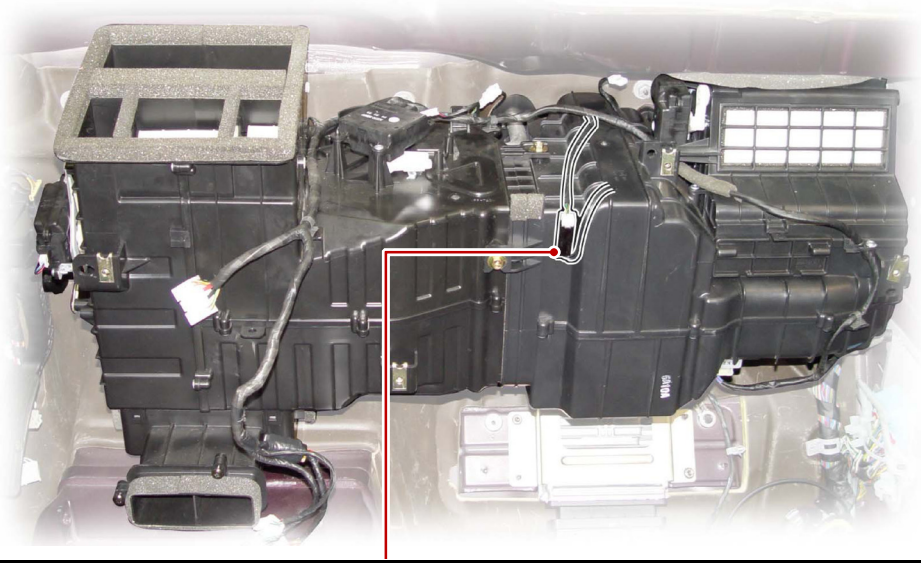


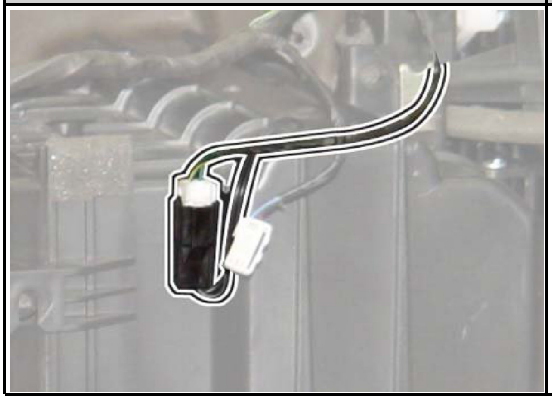


Modification basis	
Application basis	
Affected VIN	

4) Intake Temperature Sensor

The Intake Sensor outputs the compressor ON or OFF signal to ECU to prevent evaporator from freezing. The sensing part of the thermistor is the evaporator fin contact type.



Intake Sensor location	Intake Sensor
	

If the air conditioner does not turn on, check as below.

1. Remove the Intake Sensor and measure the voltage between terminal No. 1 and 2 on the connector.
2. Check whether the output voltages (ON: approx. 12 V, off: 0 V).
3. If the voltage value is out of the specified value, replace the Intake Sensor. If the circuit is in normal condition, check as below.
4. Turn the ignition switch to ON position and turn on the air conditioner by pressing the A/C button. And measure the voltage between terminal A12 and A11 on the FATC controller connector. (standard: approx. 12 V)
5. If the voltage value cannot be measured, check the circuit for open. If the measured value is within the specified range, replace the FATC controller.

Modification basis	
Application basis	
Affected VIN	

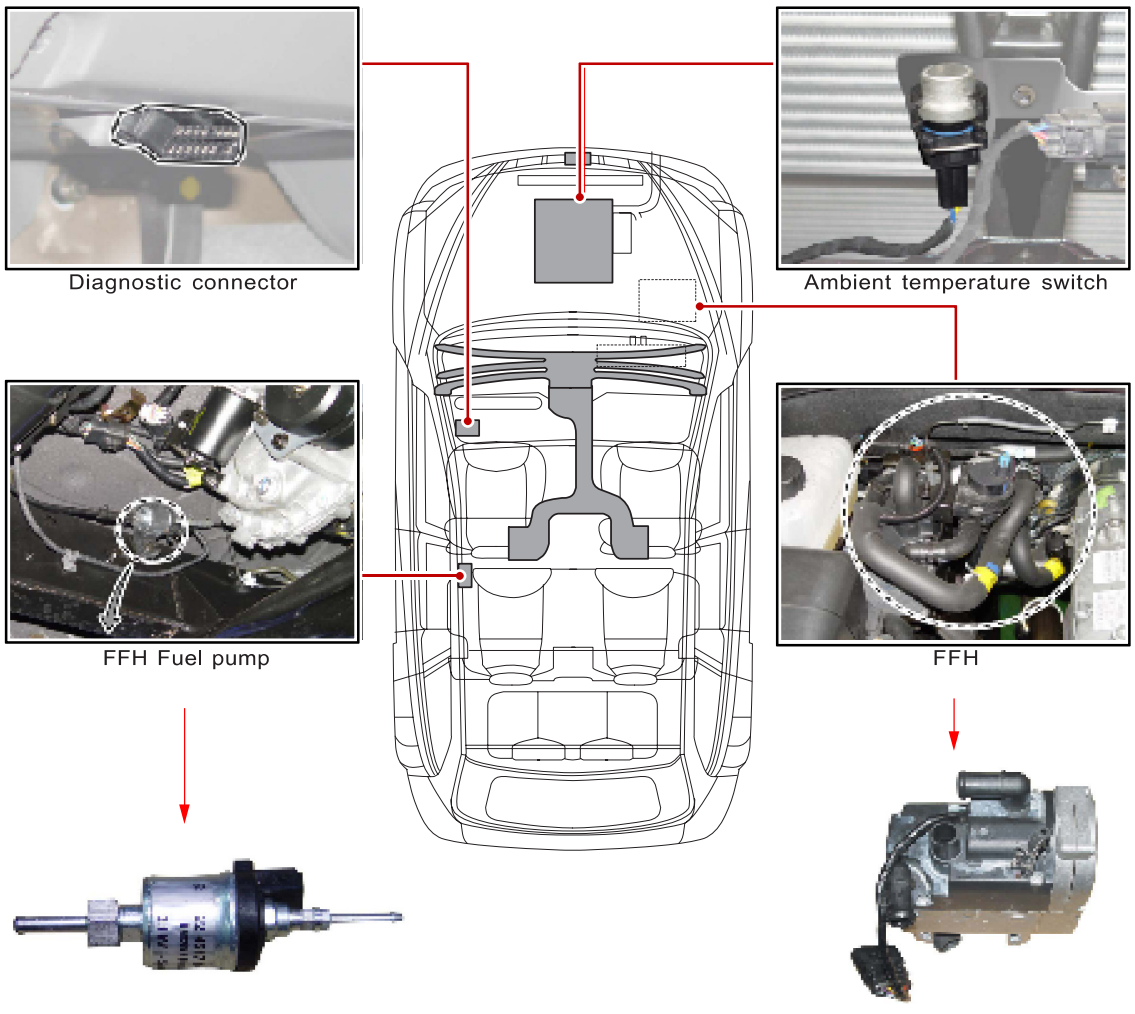
9. FFH (FUEL FIRED HEATER) SYSTEM COMPONENTS

1) OVERVIEW

The system is to increase the coolant temperature quickly by firing diesel fuel in the burner that is installed in engine cooling system when in winter time the ambient temperature and engine coolant temperature is low. (Option) The DI engine equipped vehicle has the Positive Temperature Coefficient (PTC) system as a basic equipment. FFH is operated by the coolant temperature and ambient temperature while PTC is operated by the coolant temperature intake air temperature.

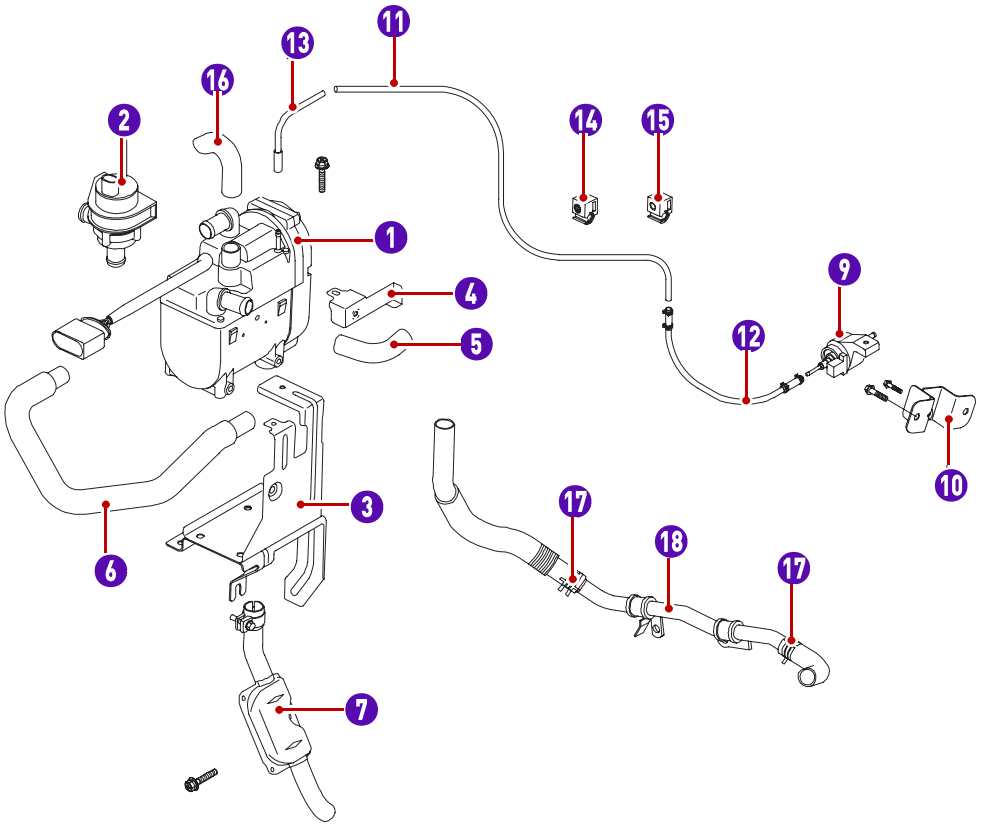
FFH system consists of independent fuel lines and fuel pump, coolant circuit and coolant circulation pump, electrical glow plug and exhaust system. It also provides the diagnostic function. FFH system cannot be operated or stopped by driver's intention. The FFH system is automatically operated by the coolant temperature and the ambient temperature. The FFH system operates up to more 2 minutes to burn the residual fuel inside the system when stopping the engine during its operation. Therefore, a certain period of FFH operation after stopping the engine is not a malfunction.

Components Locator



2) FFH LAYOUT

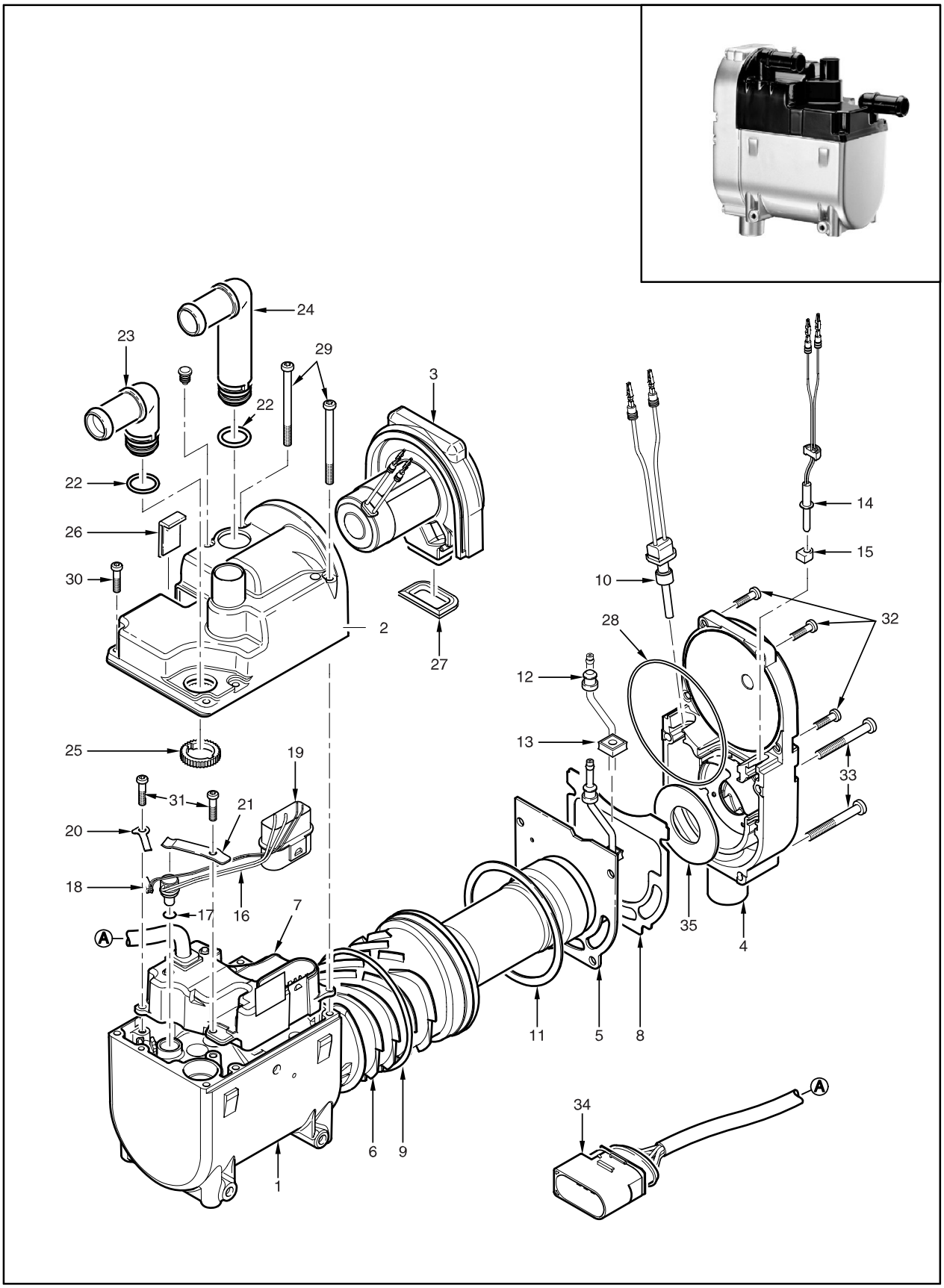
(1) Components



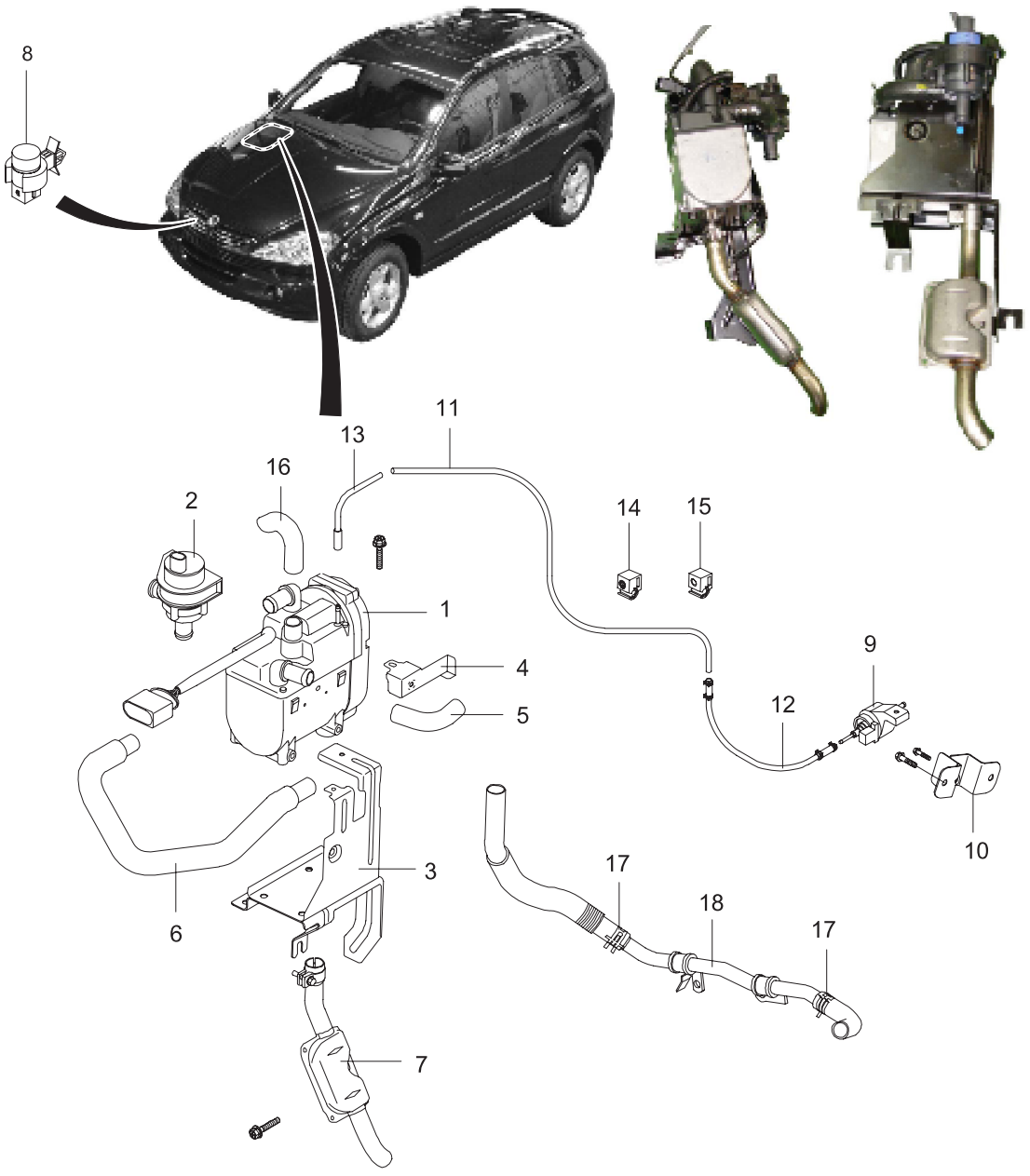
1. FFH assembly	7. FFH pipe assembly & silencer	13. Fuel pipe NO.3
2. Water pump and bracket assembly	8. Ambient temperature switch	14. Tube clip mounting
3. FFH bracket assembly	9. FFH fuel pump	15. Tube clip mounting
4. FFH water pump bracket	10. Fuel pump bracket	16. Intake hose
5. FFH NO.3 inlet hose	11. Fuel pipe NO.1	17. Clamp
6. FFH NO.2 inlet hose	12. Fuel pipe NO.2	18. FFH NO.1 inlet hose

Modification basis	
Application basis	
Affected VIN	

(2) Exploded View



Modification basis	
Application basis	
Affected VIN	



1. FFH assembly
2. Water pump and bracket assembly
3. FFH bracket assembly
4. FFH water pump bracket
5. FFH NO.3 inlet hose
6. FFH NO.2 inlet hose
7. FFH pipe assembly & silencer
8. Ambient temperature switch
9. FFH fuel pump
10. Fuel pump bracket
11. Fuel pipe NO.1
12. Fuel pipe NO.2
13. Fuel pipe NO.3
14. Tube clip mounting
15. Tube clip mounting
16. Intake hose
17. Clamp
18. FFH NO.1 inlet hose

Modification basis	
Application basis	
Affected VIN	

1. Jacket
2. Jacket cover
3. Combustion air fan
4. Combustion chamber
5. Combustion chamber with flame tube
6. Heat exchanger
7. Controller
8. Seal (between combustion chamber and combustion air fan)
9. O-ring
10. Glow plug with cable
11. Seal (between combustion chamber and heat exchanger)
12. Upper bush for fuel pipe
13. Lower bush for fuel pipe
14. Flame sensor
15. Bush for flame sensor (graphite)
16. Control and overheating sensor with cable
17. O-ring
18. Surface sensor with cable
19. Controller connector
    - 14-pin connector (waterproof)
20. Pressure spring for surface sensor
21. Pressure spring for control and overheating sensor
22. O-ring
23. Coolant hose (inlet)
24. Coolant hose (outlet)
25. Tooth ring (2x)
26. Cable harness cover
27. Rubber seal
28. O-ring
29. Screw (M4 x 55 TORX / 2x)
30. Screw (M4 x 16 TORX / 2x)
31. Screw (M4 x 12 TORX / 2x)
32. Screw (M4 x 16 TORX / 4x)
33. Screw (M4 x 44 TORX / 4x)
34. Controller cable harness
35. Insulation washer

(3) SPECIFICATIONS

Heater		D 5 S - H	
Heating medium		Coolant	
Control of the heat flow		Large (full load)	Small
Heat flow		5,000 W	2,300 W
Fuel consumption per hour		approx. 0.63 Liter	approx. 0.28 Liter
Mean electric power consumption	In operation	35 W	11 W
	At start	100 W	
	After-running	12 W	
Rated voltage		12 V	
* Lower voltage limit: An undervoltage protection device in the controller switches the heaters off at approx. 10 volt.		10 V	
* Upper voltage limit: An overvoltage protection device in the controller switches the heaters off at approx. 15 volt.		15 V	
Tolerable operating pressure		up to 2.5 bar overpressure	
Minimum water flow through the heater		300 L/H	
Fuel		In the main fuel tank (fuel)	
Tolerable ambient temperature	Operation	- 40°C ~ 80°C	
	Storage	-40°C ~ 125°C	
Weight (without coolant and water pump & bracket)		approx. 2.3 kg	

Modification basis	
Application basis	
Affected VIN	

10. FFH OPERATING PROCESS

1) Operating Condition

FFH is operated according to the ambient temperature and coolant tempreature.

(1) Initial Operating Conditions of FFH

▶ **Initial Operating Conditions of FFH**

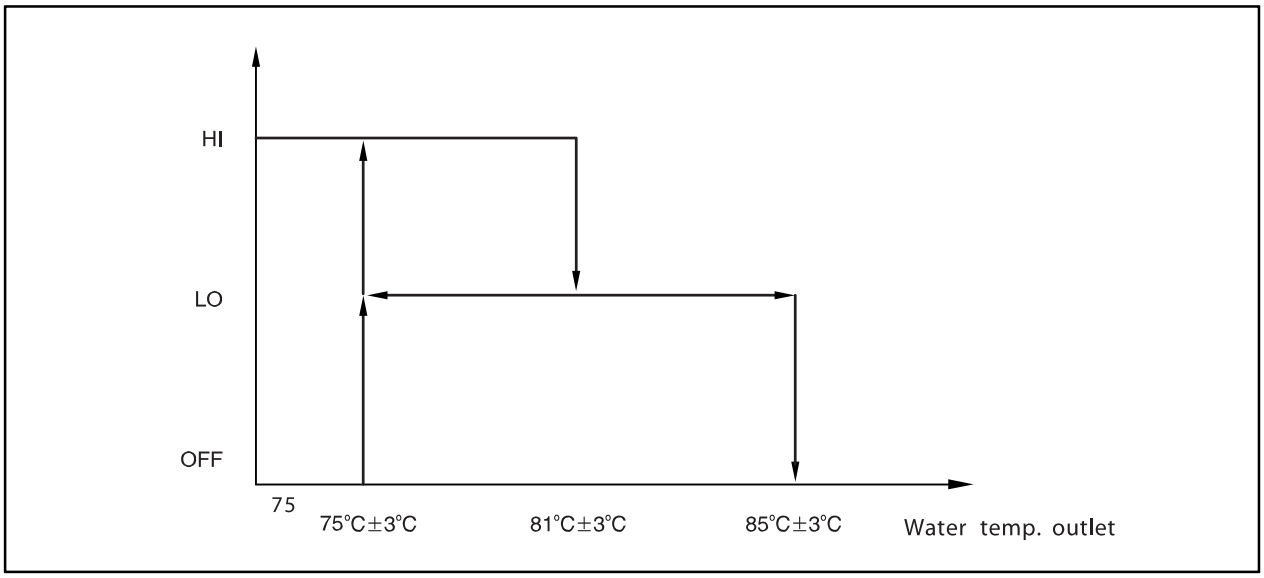
- Ambient temperature: below 5°C
- Coolant temperature: below 75°C

▶ **Repeated Operating Conditions of FFH**

- Coolant temperature: below 75°C
- When the difference between the ambient temperature at initial operation and current ambient temperature is over 3°C (to reduce the hysteresis with the temperature difference when operating FFH), FFH is operated again.

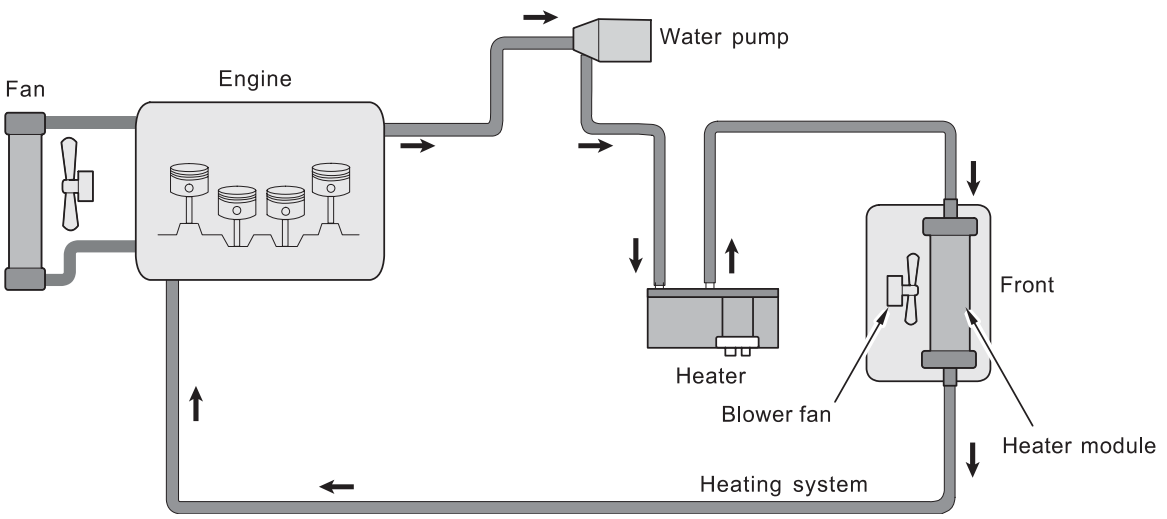
For example, if the initial operating temperature was 4°C, the ambient temperature at repeat operation should be below 1°C and the coolant temperature should be below 75°C.

(2) FFH Operations According To the Changes of Coolant Temperature



Above graph shows the FFH control process while the FFH is operating.
The control element is coolant temperature as shown in the graph.
The FFH is operated in HI mode (high output: approx. 5,000 W) until the coolant temperature reaches at 80°C and starts to be operated in LO mode (low output: approx. 2,300 W) from 81°C.
When the coolant temperature reaches at approx. 85°C, FFH stops its operation until the operating conditions will be met again.

2) Coolant Circulating Route



3) Connecting the Coolant Circuit

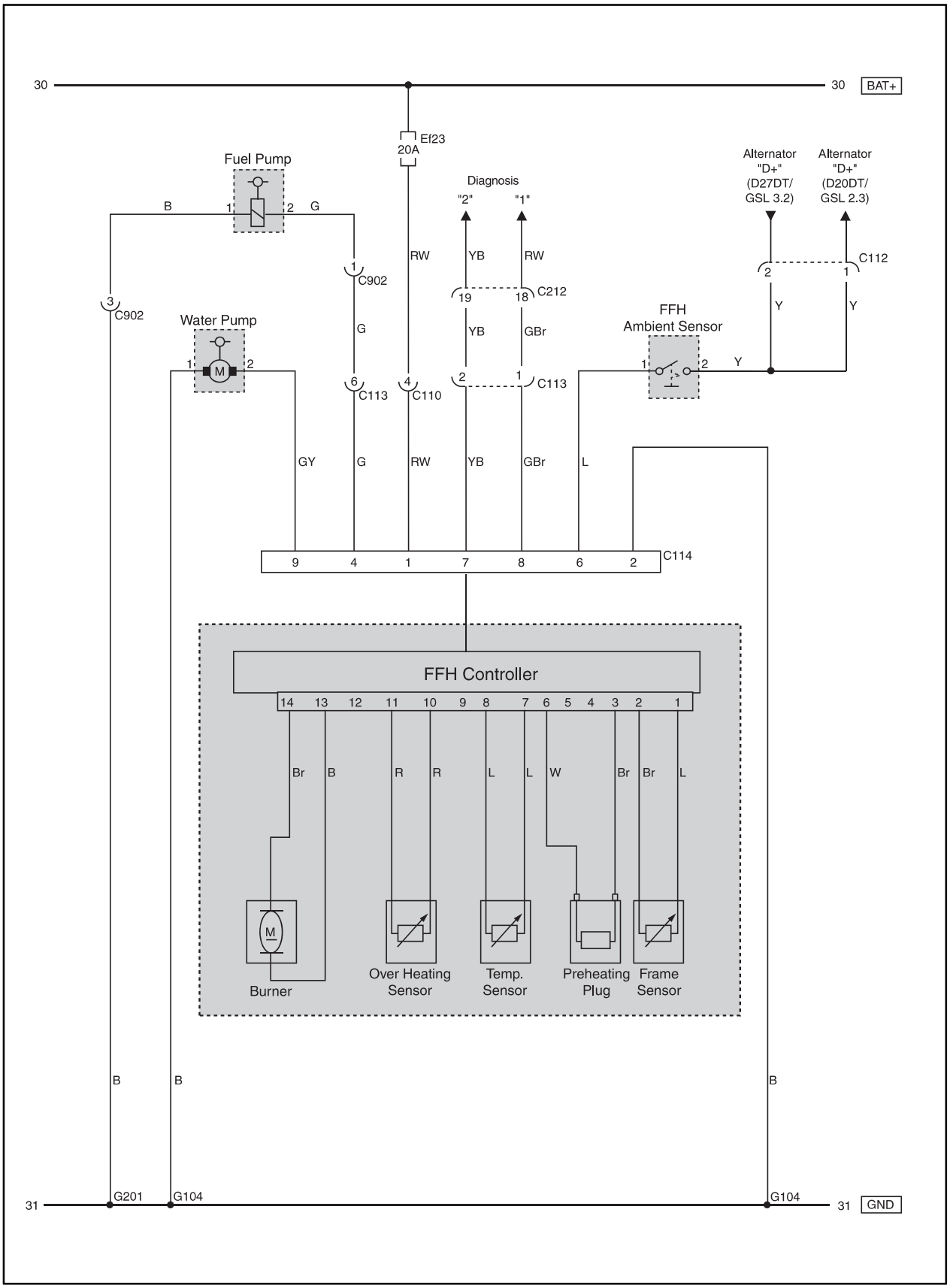
The heater is connected to the coolant circuit in the coolant feed pipe from the vehicle engine to the heat exchanger.

CAUTION

- Parts conveying coolant must be routed and fastened in such a way that they pose no temperature risk to
  person or material sensitive to temperature from radiation and direct contact.
- Before working on the coolant circuit, disconnect the negative battery cable and wait until all components have cooled down completely.
- When installing the heater and the water pump, note the direction of flow of the coolant circuit.
- Fill the heater and water hoses with coolant before connecting to the coolant circuit.
- When routing the coolant pipes, observe a sufficient clearance to hot vehicle parts.
- Protect all coolant hoses/coolant pipes from chafing and from extreme temperatures.
- Secure all hose connections with hose clamps.

Modification basis	
Application basis	
Affected VIN	

4) Circuit Diagram



Modification basis	
Application basis	
Affected VIN	

5) Control and Safety Mode

▶ Heater Operations and Safety Mode

- If the fuel pump fails to ignite within 90 seconds after fuel pumping starts, the start procedure is repeated as described. If after a further 90 seconds fuel pumping the fuel pump still fails to ignite, the heater is switched off in fault mode. The controller is locked after a certain number of failed starts.
- If the flame does out by itself during operation, firstly a new start is activated. If the fuel pump fails to ignite within 90 seconds after fuel pumping has started again, the heater is switched off.
- If the heater is overheated (lack of water, poorly vented cooling circuit), the overheating sensor triggers, the fuel supply is interrupted and the heater is switched off.
- The heater is switched off if the lower or upper voltage limit is reached.
- The fuel pump does not start when the glow plug is defect or electrical lead to the dosing pump is interrupted.
- The fan motor speed is monitored continuously. If the fan motor does not start up, is blocked or if the speed falls below 40% of the nominal speed, the heater is switched off in fault mode after 120 seconds.
- It is possible to diagnose the system by connecting the diagnostic device to controller. For details, refer to the "Diagnosis Procedures" section.

CAUTION

If an emergency shutdown -EMERGENCY OFF- is necessary during operation, proceed as follows;

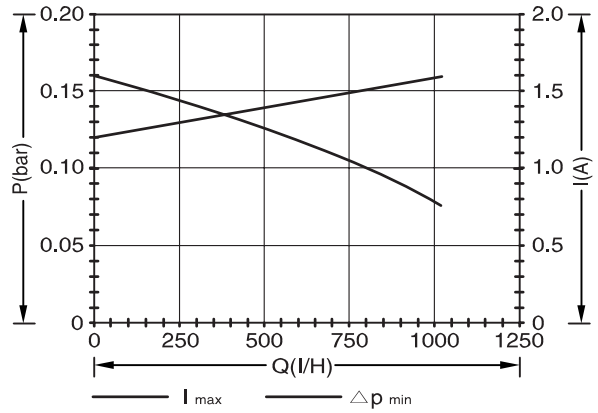
- Pull the fuse (Ef6: 20A) out.
- Disconnect the heater from the battery.

Modification basis	
Application basis	
Affected VIN	

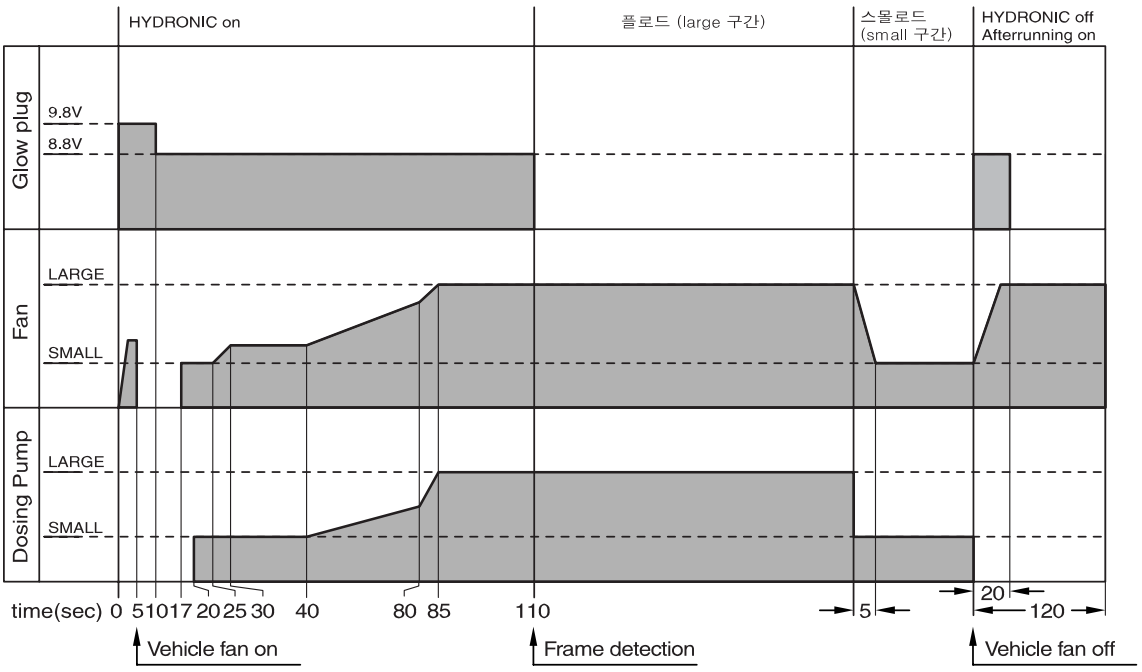
6) Specification - Water Pump

Rated voltage	12 V
Operating voltage	9 V ~ 15 V
Power consumption	16 W
Pumping capacity (0.1 bar)	800 l/h
Operating temperature	- 40°C ~ 135°C
Weight	0.28 kg

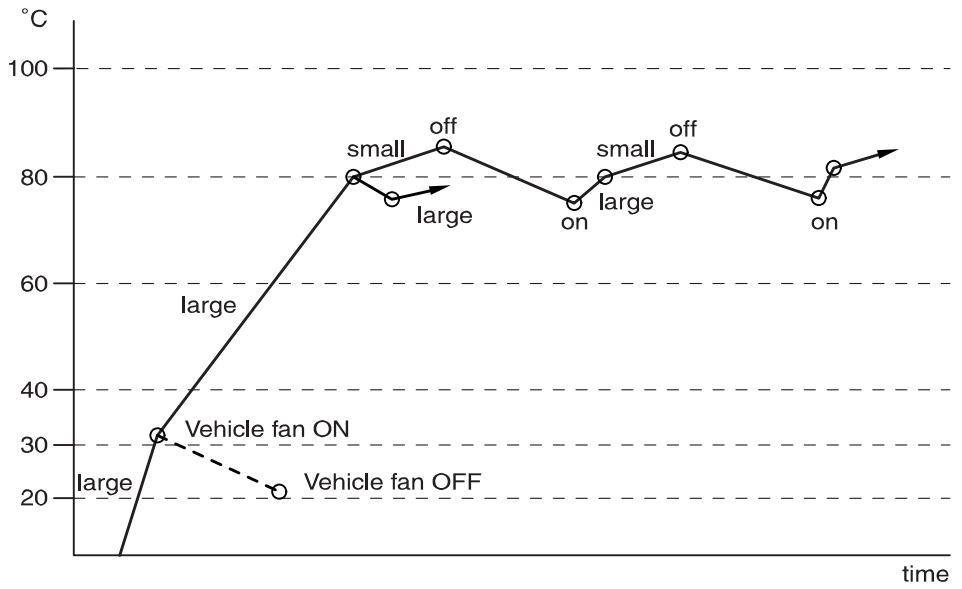
7) Characteristic Curve of Water Pump (12 V)



8) Function Diagram



9) Switching Diagram According to Temperature Changes



Modification basis	
Application basis	
Affected VIN	

AIR BAG SYSTEM 8810-03

GENERAL

1. REMINDER FOR AIR BAG RELATED COMPONENT REPLACEMENT

CAUTION

- When an air bag deploys (curtain air bags and seat belt pretensioners included), the air bag unit must be replaced. Please do not attempt to delete the failure code with scan-100 because some data about the deployment situation are stored in the unit.
- The air bag related components, especially the air bag unit, must be stored in a sealed case to prevent any damage.
- Please do not connect a tester to any air bag connector or single item to measure the supplied power or resistance.
  The detonator may explode due to a sudden extra power supplied by the tester.
- Before removing or installing any air bag related components, disconnect the negative battery cable.

Collision sensors, a kind of impact G (acceleration) sensor, detect the front and longitudinal collisions and determine whether or not the air bags are deployed. The roles of each collision sensor are as below :

▶ **Front G sensors (inside the air bag unit)**

- Send signals to the front air bags and the driver's and front passenger's seat belt pretensioners.
- By the signal from this sensor, front air bags (driver's and passenger's air bags) deploy and the seat belt pretensioners of the driver's and passenger's seat belts retract seat belts.

▶ **Curtain air bag G sensors**

- These are located inside the left and right B-pillar panel bottoms. When collision occurs, the air bag at the side of collision deploys accordingly. Please pay attention to that, in the case of the curtain air bag, only the air bag at the side of collision deploys, not both.

Once an air bag deploys, its repair parts vary according to the deployment situation and damage to the vehicle from collision. Needed repairs also slightly vary between the front air bags and the curtain air bags. The following are the differences :

▶ Replacement parts when the front air bags deploy

The air bag units and their connection wires (connectors included), the seat belt pretensioners and their connection wires (connectors included), the entire front air bags, and the instrument panel (IP).

▶ Replacement parts when a curtain air bag deploys

The new curtain air bag for the deployed side, the air bag unit and its connection wires (connectors included), the collision G sensor assembly for the curtain air bag, and the trims and roof headlining for the broken parts.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. AIR BAG SYSTEMS (INCLUDING CURTAIN AIR BAGS) OVERVIEW

The air bag systems for this vehicle are not much different from the previous air bag system installed in REXTON.
The curtain air bags are installed at the bottom of the roof trim and they enhance the passenger's safety.
The driver's and passenger's curtain air bags individually deploy.
When the front air bags deploy, the seat belt pretensioners retract the seat belts too.
Collision sensors, a kind of impact G (acceleration) sensor, detect the front and longitudinal collisions and determine whether or not the air bags are deployed. The roles of each collision sensor are
as below:

▶ **Front G sensors (inside the air bag unit)**

- Send signals to the front air bags and the driver's and front passenger's seat belt pretensioners.
- By the signal from this sensor, front air bags(driver's and passenger's air bags) deploy and the seat belt pretensioners of the driver's and passenger's seat belts retract seat belts.

▶ **Curtain air bag G sensors**

- These are located inside the left and right B-pillar panel bottoms. When a collision occurs, the air bag at the side of collision deploys accordingly. Please pay attention to that, in the case of the curtain air bag, only the air bag at the side of collision deploys, not both.

Once an air bag deploys, its repair parts vary according to the deployment situation and damage to the vehicle from collision. Needed repairs also slightly vary between the front air bags and the curtain air bags. The following are the differences:

▶ **Replacement parts when the front air bags deploy**

- The air bag units and their connection wires (connectors included), the seat belt pretensioners and their connection wires (connectors included), the entire front air bags, and the instrument panel (IP).

▶ **Replacement parts when a curtain air bag deploys**

- The new curtain air bag for the deployed side, the air bag unit and its connection wires (connectors included), the collision G sensor assembly for the curtain air bag, and the trims and roof headlining for the broken parts.

CAUTION

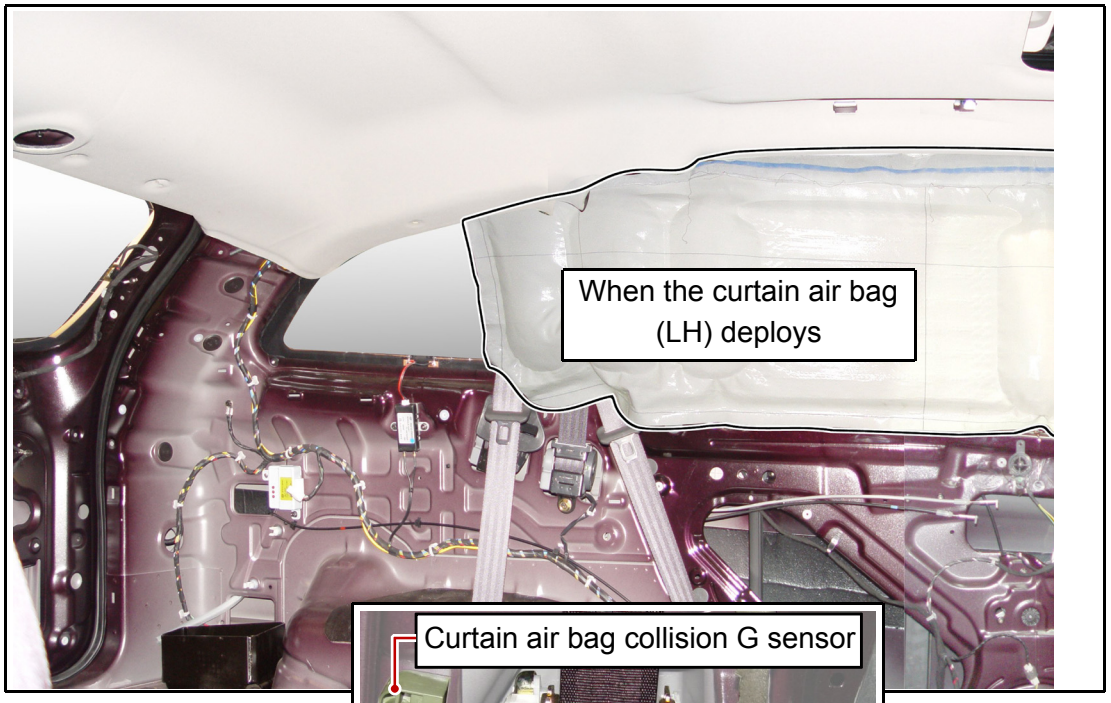
- When an air bag deploys (curtain air bags and seat belt pretensioners included), the air bag unit must be replaced. Please do not attempt to delete the failure code with SCAN-100 because some data about the deployment situation are stored in the unit.
- The air bag related components, especially the air bag unit, must be stored in a sealed case to prevent any damage.
- Please do not connect a tester to any air bag connector or single item to measure the supplied power or resistance. The detonator may explode due to a sudden extra power supplied by the tester.
- Before removing or installing any air bag related components, disconnect the negative battery cable.

Modification basis	
Application basis	
Affected VIN	

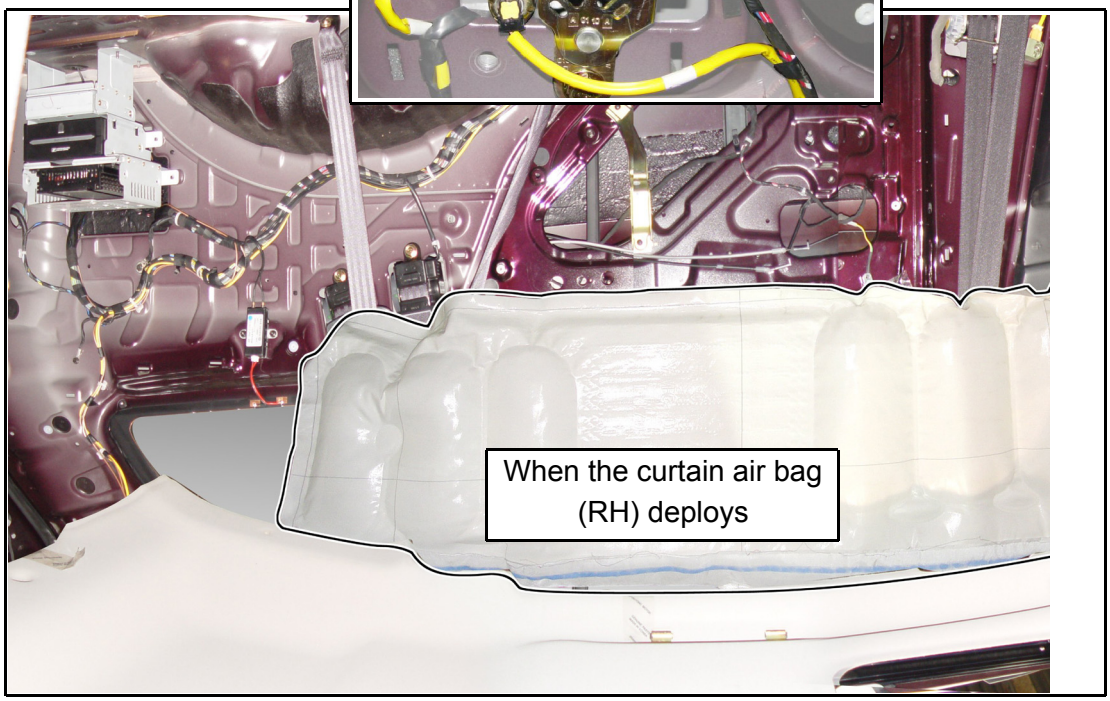
Memo

2. AIR BAG SYSTEM LOCATIONS AND RELATED COMPONENTS

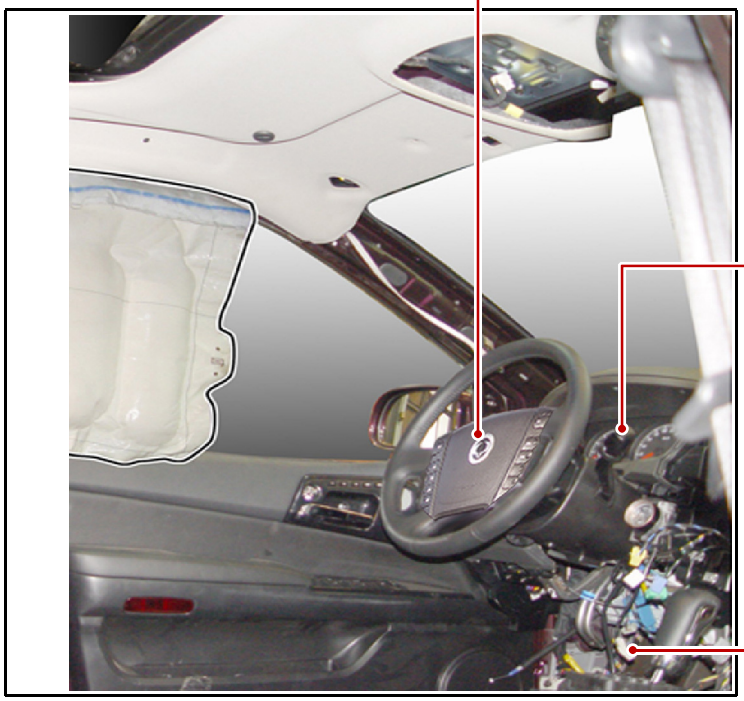
▶ LH

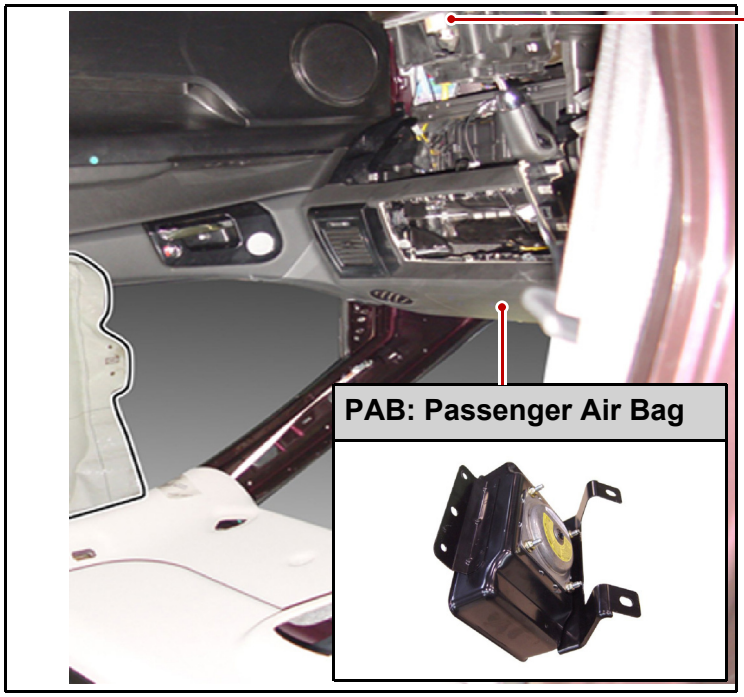


▶ RH



Modification basis	
Application basis	
Affected VIN	





DAB: Driver Air Bag

Air bag warning lamp

STICS

40 ms after receiving the air bag deployment signal at the vehicle speed 3 or higher km/h, it sends out the door
UNLOCK signal for 5 seconds.

Air Bag Unit (SDM)

The collision G sensor is installed nside this. And it sends out signals to deploy the front air bags (driver's and passenger's air bags) and (or) the driver's and passenger's seat belt pretensioners or the driver's and passenger's curtain air bag. When the front collision G sensor sends out only the air bag deployment signal, the signal deploys the two front air bags and activates their seat belt pretensioners.

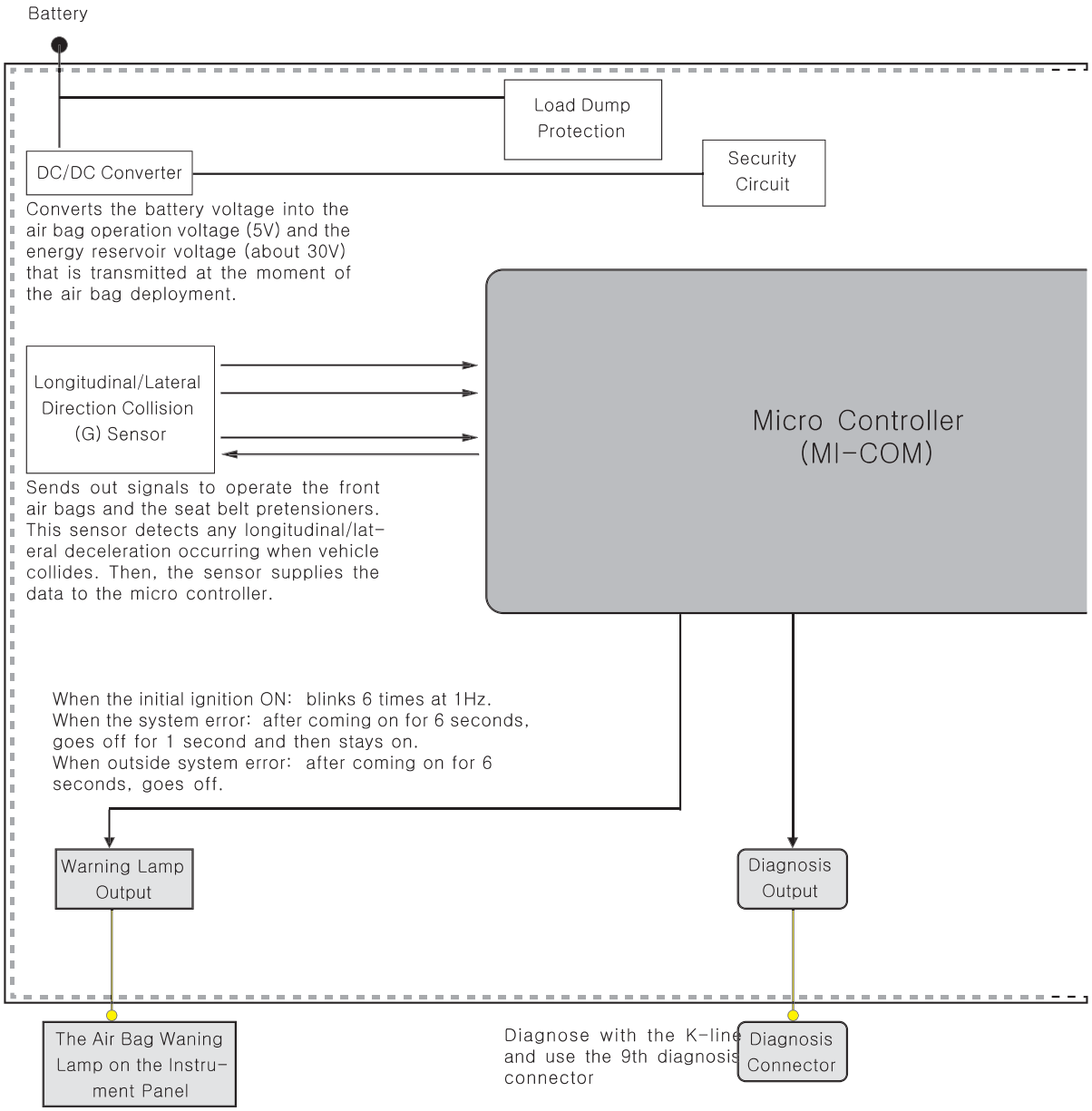
PAB: Passenger Air Bag

Modification basis	
Application basis	
Affected VIN	

3. AIR BAG SYSTEM OPERATION PROCESS

The overall air bag operation process and its functions and roles are broadly explained in this block diagram.
This diagram summarizes and highlights the functions adopted by Ssangyoung Motors.

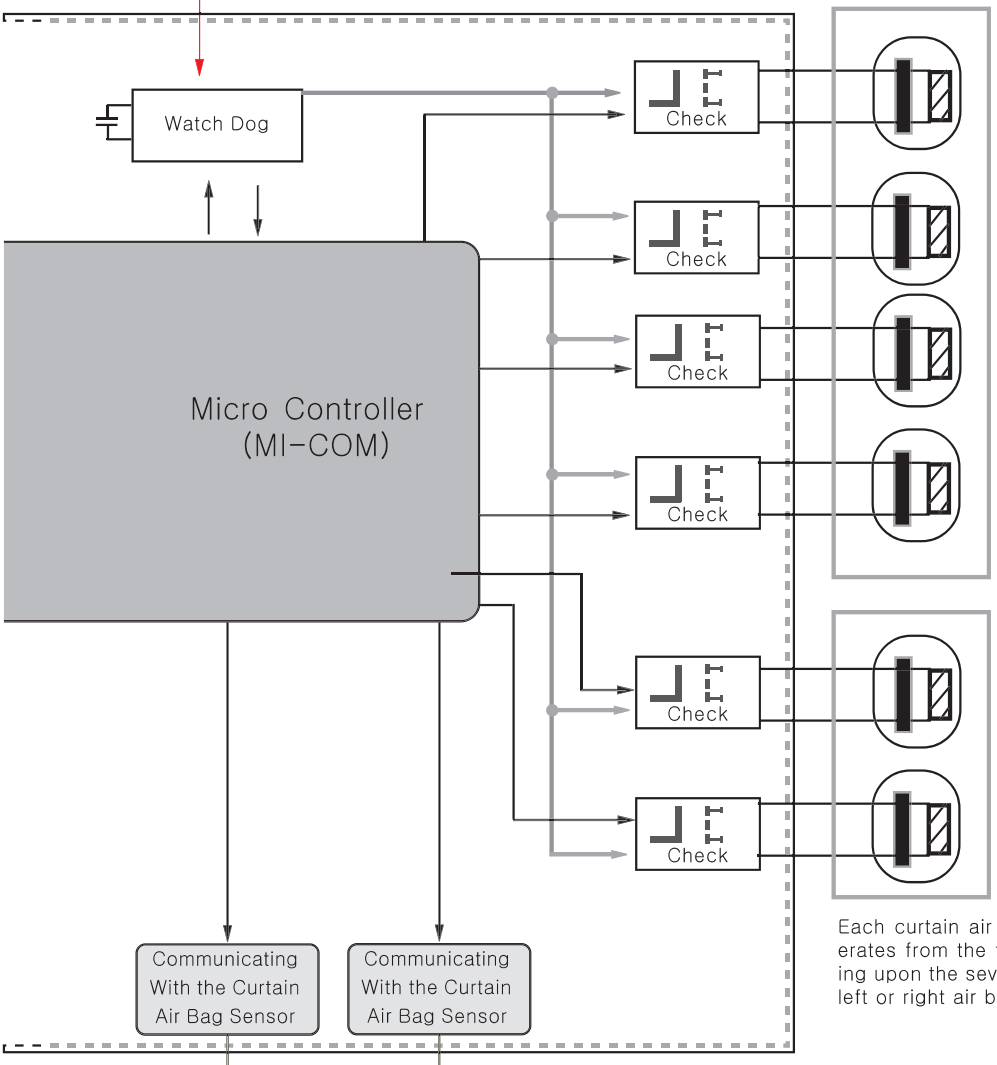
▶ **Air Bag System Block Diagram (Functions and Roles Included)**



Modification basis	
Application basis	
Affected VIN	

The watchdog monitors the micro controller, the air bags, and the seat belt pretensioners. When any error occurs, it turns on the air bag warning lamp.

When the front air bags deploy, the driver's air bag and the front passenger's air bag deploy simultaneously and their seat belt pretensioners also simultaneously retract their seat belts.
The air bag unit monitors conditions of the air bags and the seat belt pretensioners. When any error occurs, it stores the failure diagnostic code or turns on the air bag warning lamp on the instrument panel.



Each curtain air bag independently operates from the front air bags. Depending upon the severity of impact, only the left or right air bag may deploy.

The collision G sensors for the curtain air bags are installed at the bottom of left and right B-pillars. Each measures deceleration rate at time of collision and supplies information about the collision to the air bag unit. Each sensor measures the G value from its side and transmits the decesion to its air bag unit.

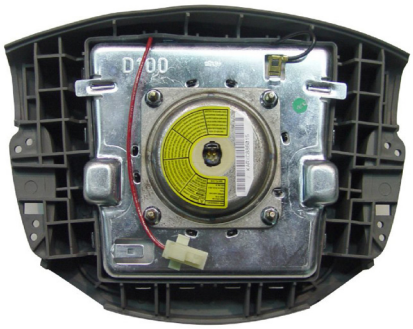
4. AIR BAG MODULE AND OTHER COMPONENTS

This section describes the air bag module installed in Kyron.
The module consists of the inflator, the cushion, and the mounting cover.

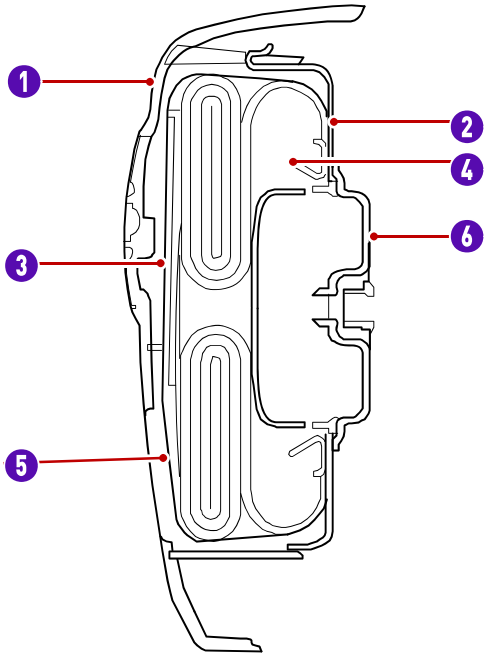
1) DAB: Driver Air Bag

The driver's air bag is installed inside the steering wheel.
If the acceleration sensor (inside the air bag unit) is activated by the deceleration from vehicle collision, the detonation is fired by the electrical signal of the air bag unit.
Then, the detonation sets off explosives and nitrogen gas is generated.

At this point, the air bag very quickly deploys and the gas is emitted from the relieving hole to absorb impact upon the driver.



(1) Components



1. Air bag cover
2. Air bag housing
3. Horn switch
4. Retainer ring
5. Air bag cushion (approx. 50 liters)
6. Inflator* (approx. 190 Kpa)

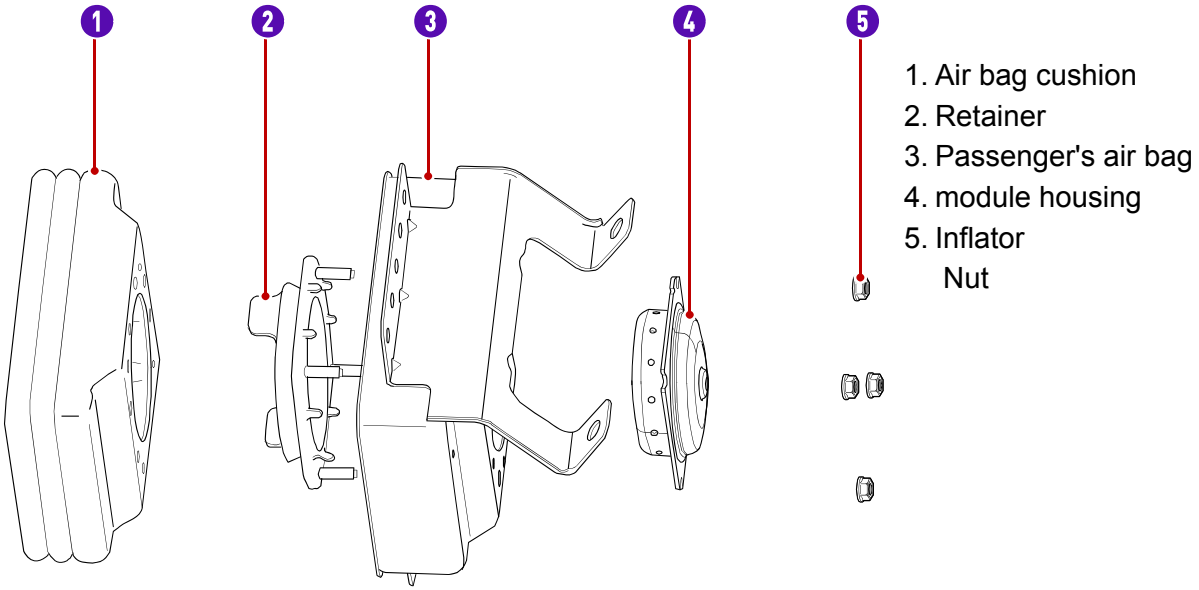
Modification basis	
Application basis	
Affected VIN	

2) PAB: Passenger Air Bag

The passenger's air bag is installed inside the instrument panel above the glove box.
Its operation process is the same as the driver's one.
The driver's air bag, the passenger's air bag, and the seat belt pretensioners on both seats are made to operate together.
When the collision G sensor inside the air bag unit sends a collision signal, the air bag unit instantaneously applies a high current to the driver's and passenger's air bags and the seat belt pretensioners on both seats, fires the detonator in the inflator, and inflates the air bag cushions (curtain air bags independently operate in case of the side collisions).

Front View	Rear View

(1) Components



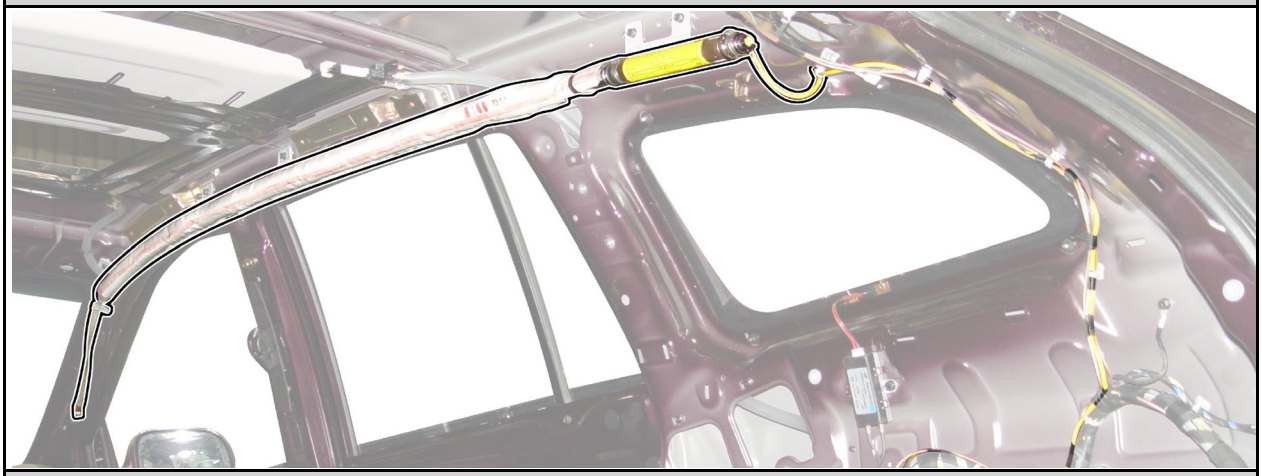
1. Air bag cushion
2. Retainer
3. Passenger's air bag
4. module housing
5. Inflator
   Nut

3) Curtain Air Bag (CAB)

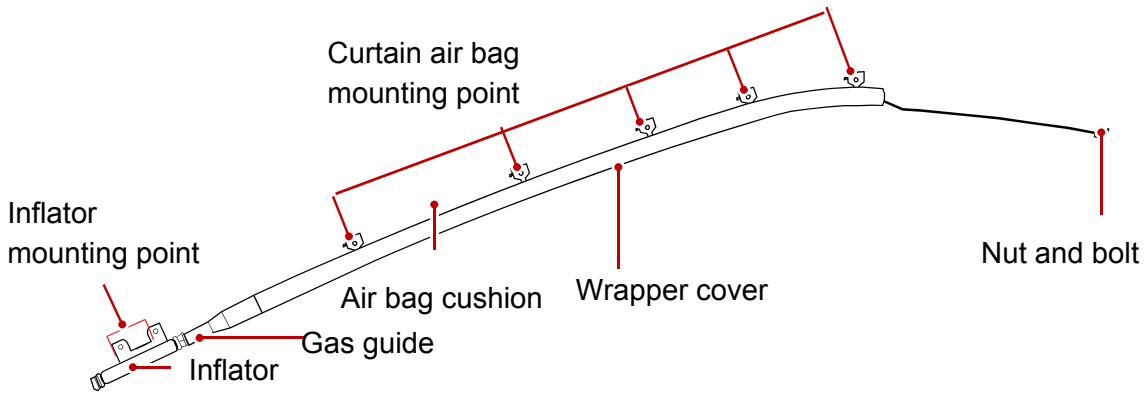
The curtain air bags are installed on both sides of the roof side rails and inside the headlinings. Each curtain air bag is also composed of the air bag cushion and the inflator that has the detonator, explosives, and the gas generator.

A collision situation is detected by the curtain air bag collision G sensor installed at the lower side of the B-pillar.
The signal is transmitted to the air bag unit. The air bag unit instantly inflates the necessary air bag necessary by sending a high current.

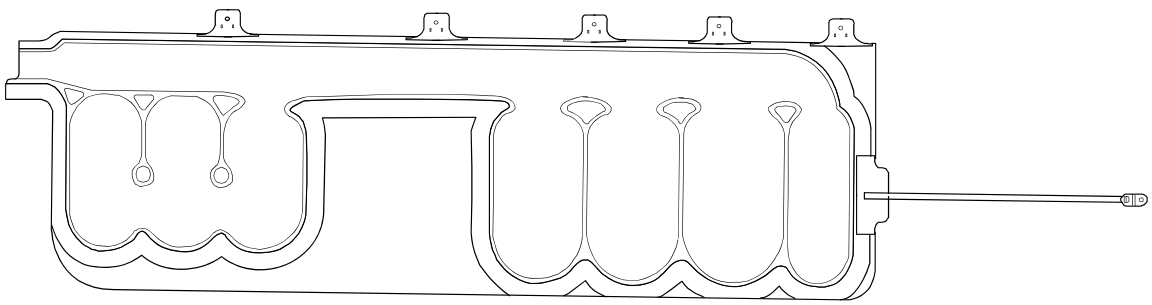
When the Curtain Air Bag is Installed



Terms of the Curtain Air Bag



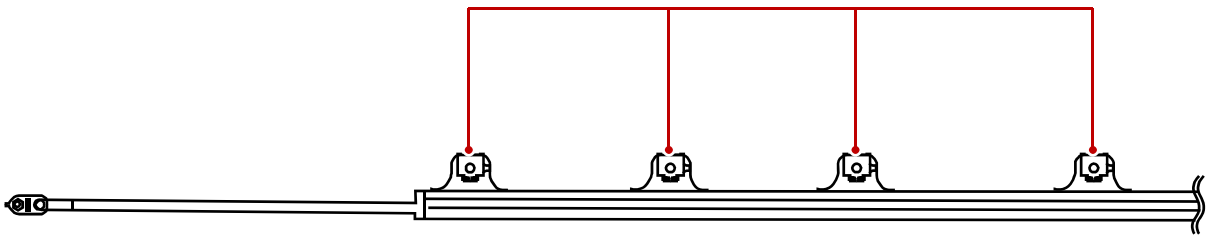
When the Curtain Air Bag Deploys



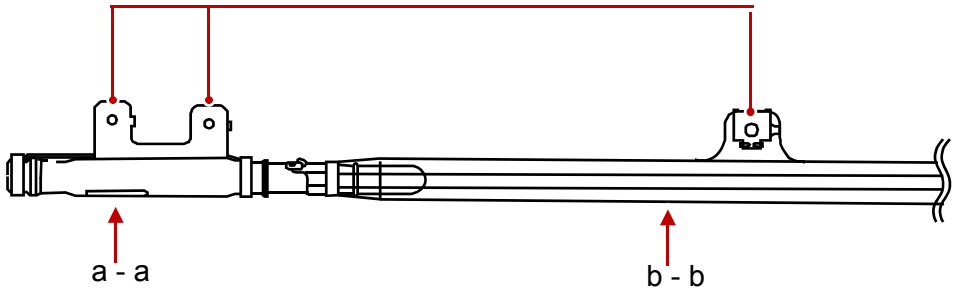
Modification basis	
Application basis	
Affected VIN	

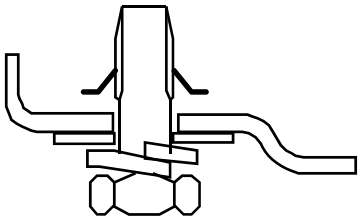
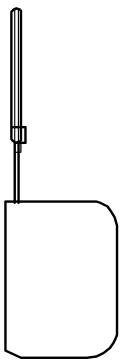
(1) Components

Tightening torque: 8 ~ 10 Nm



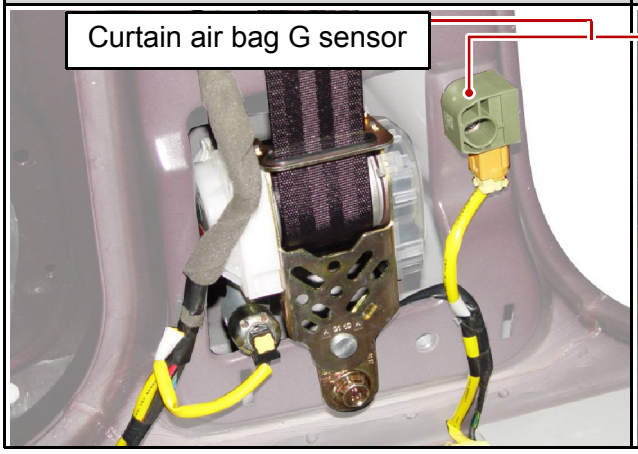
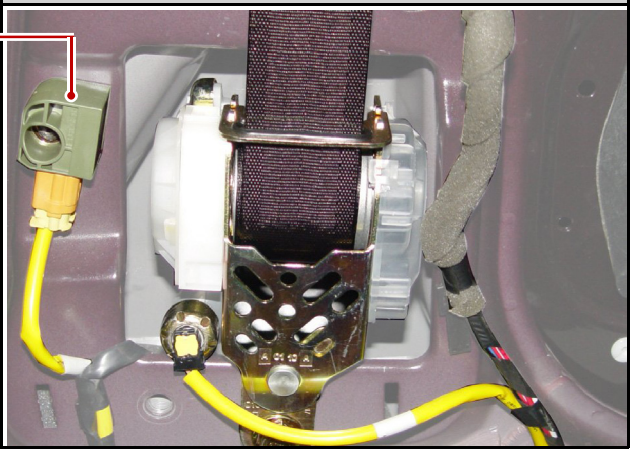
Tightening torque: 8 ~ 10 Nm



Sectimal view a-a	Sectimal view b-b
	

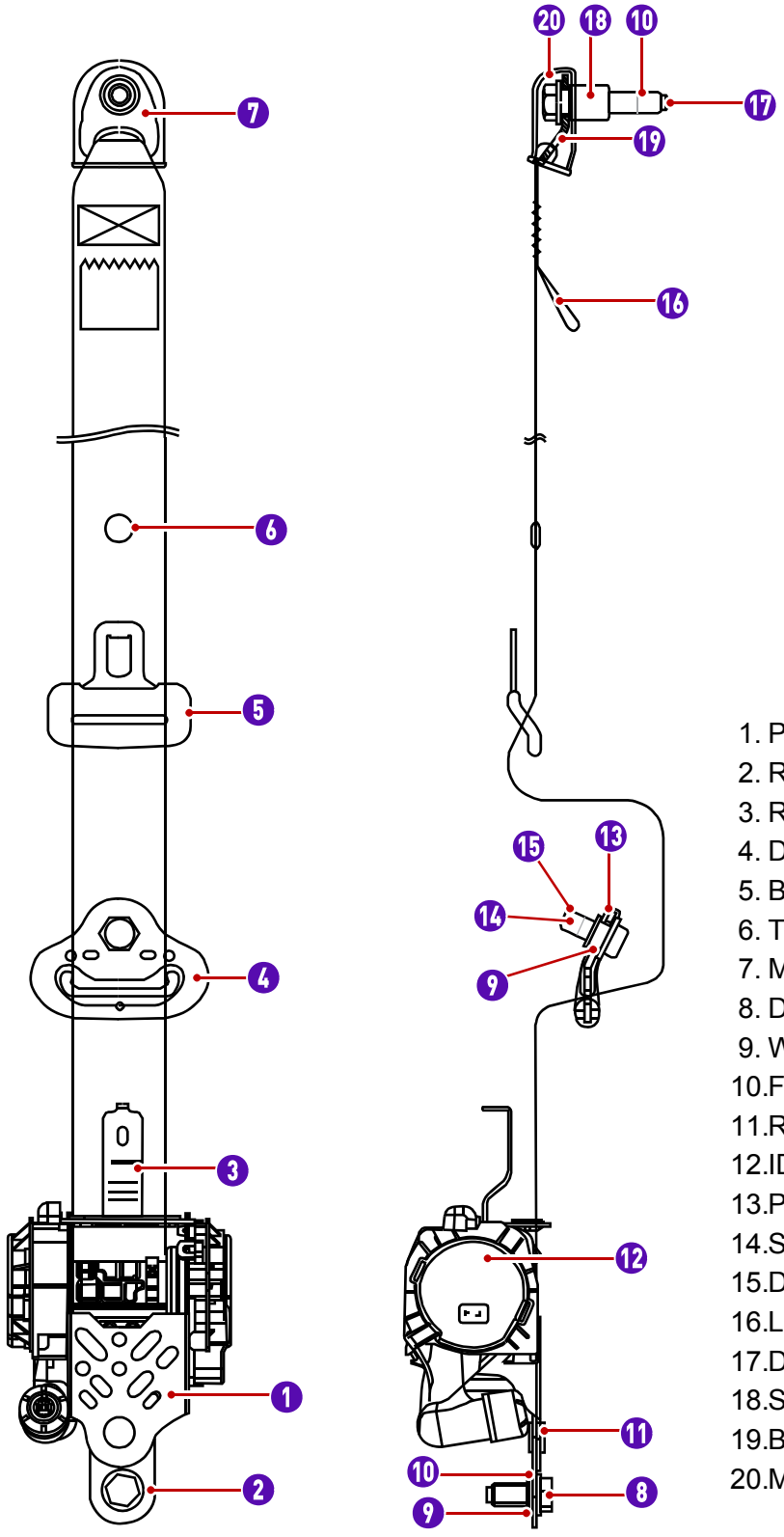
4) Driver and Passenger BPT (Belt Pre-Tensioner)

The belt pretensioner retracts the seat belt to tighten or take up slack in the wearer's belt.
When a collision occurs or when brakes are applied, a seat belt with a pretensioner detects the stopping action and tightens the belt before the wearer is propelled forward.
This holds the occupant more securely in the seat.

Belt Pretensioner (Driver Side)	Belt Pretensioner (Passenger Side)
Tightening torque 35 ~ 55 Nm	Tightening torque 35 ~ 55 Nm
Belt pretensioner (LH)	**Belt pretensioner (RH)**
	

Modification basis	
Application basis	
Affected VIN	

(1) Components

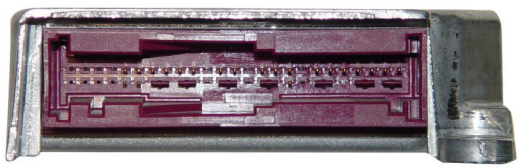


1. Pretensioner reel assembly
2. Reel bracket
3. Ring upper stay
4. D-ring
5. Bending tongue
6. Tongue stopper
7. Mini anchor
8. D-bolt
9. Washer
10. Fiber washer
11. Rivet
12. ID label
13. Plastic washer
14. Steel washer
15. D-bolt
16. Label
17. D-bolt
18. Spacer
19. Bush
20. Mini anchor cover

Modification basis	
Application basis	
Affected VIN	

5)Air Bag Unit

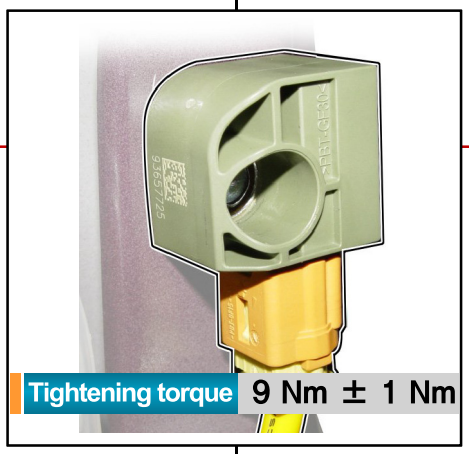
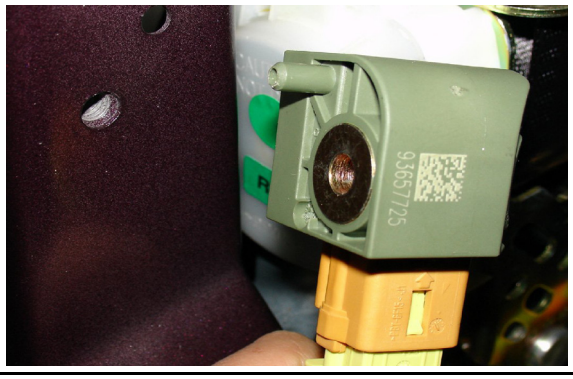
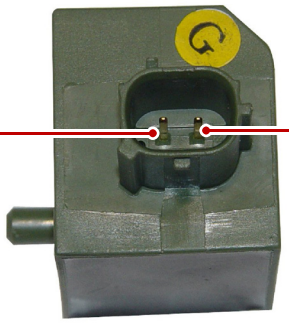
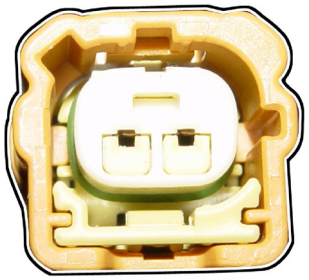
Air bag unit is installed under the AV head unit in center fascia panel.

Location of Air Bag


Modification basis	
Application basis	
Affected VIN	

6) Curtain Air Bag Sensor

The curtain air bag sensor is installed inside each B-pillar of the driver's and passenger's seats (that is, around the pretensioner reel).
The body panel has guiding holes to ensure its correct installation.
But incorrect tightening torque may break the sensor or make it insecure.
As a result, the sensor may have inaccurate judgment and have the air bag deployed inaccurately.

Driver's Side	Passenger's Side
	
	
	Connector 

5. AIR BAG SYSTEM DEPLOY (FIRING LOOP)

According to the collision deceleration rate that each collision G sensor reads, the air bag unit sends out about 2~4 or higher Amp current.
This current generates some heat, which fires the detonator in the inflator.
This table shows the basic inner resistance of the air bag related module and the basic instant current necessary for a firing.

Air bag module	Driver/passenger air bag (DAB / PAB)	Belt pretensioner (BPT)	Curtain air bag (CAB)
Resistance (at -30 ~ 85°C)	2 ± 0.3 W	2.15 ± 0.35 W	2 ± 0.3 W
Firing current for 2msec (at -35°C)	1.2 Amp	0.8 Amp	1.0 Amp

CAUTION

- Please do not connect a tester to any air bag connector or single item to measure the supplied power or resistance. The detonator may explode due to a sudden extra power supplied by the tester.
- Before removing or installing any air bag related components, disconnect the negative battery cable.

Modification basis	
Application basis	
Affected VIN	

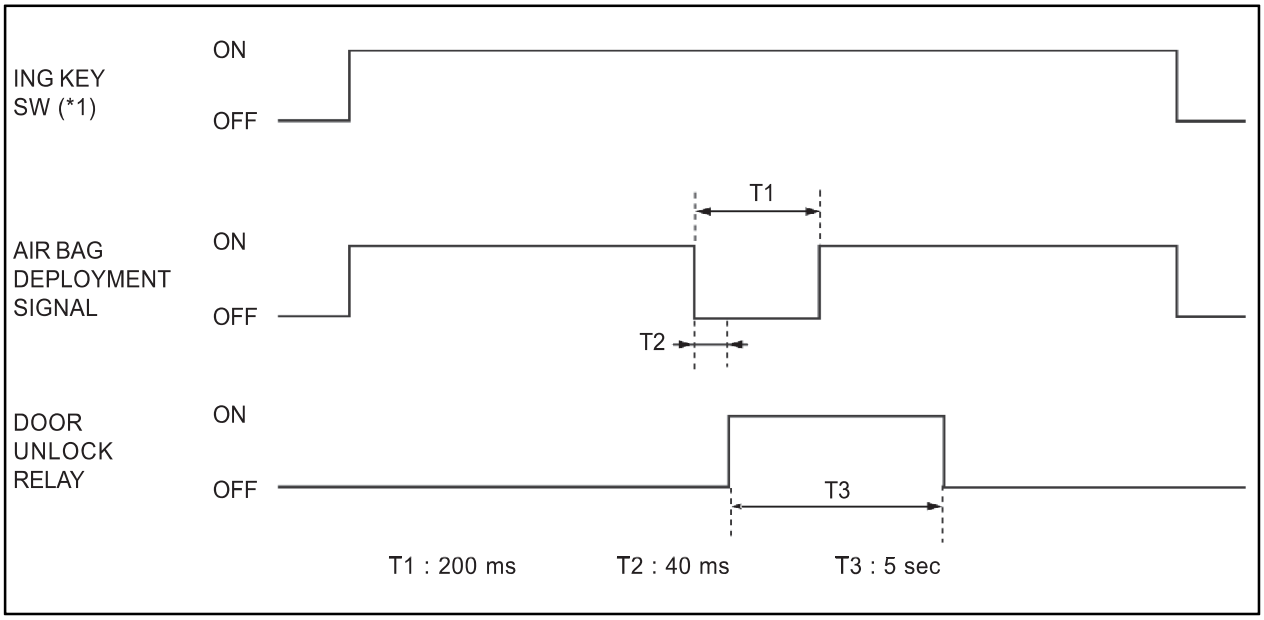
6. AIR BAG DEPLOYMENT SIGNAL OUTPUT (CRASH OUT)

When any air bag deploys, another signal is sent to the sticks to do two basic security operations.

One operation is the automatic door unlock function that cancels the automatic door lock mode.

1) Automatic Door Unlock (Crash unlock: unlock when colliding)

1. When the ignition key is the ON position, the air bag signal is not accepted for the first 7 seconds.
2. When the ignition key is the ON position and the vehicle speed is 3 km/h or higher, 40 ms after receiving the air bag deployment signal, the sticks sends out the door UNLOCK signal for 5 seconds.
3. Even though the ignition switch is turned off in the middle of the unlock signal being sent out, the unlock signal continues for the remaining time.
4. This function cancels when the ignition key is withdrawn.



CAUTION

Reminder for door lock/unlock control

- The unlock function by the air bag signal takes priority over any other lock/unlock
- operations. While or after the automatic unlock is made by the air bag system, any lock or unlock request by other functions is ignored unless the ignition key switch is turned off.
- When another lock or unlock output is requested while the door is being either locked or unlock, the new request will be ignored.
  But, if an unlock request is made by the air bag signal or the remote control key, the request will be accepted.
- When the lock and unlock functions are simultaneously requested, the lock will be performed and the unlock will be ignored.

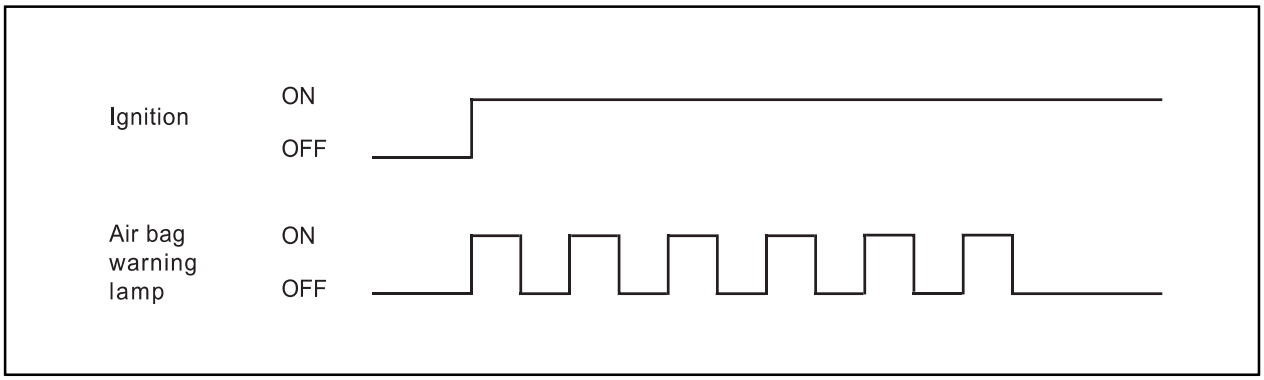
Modification basis	
Application basis	
Affected VIN	

7. AIR BAG WARNING LAMP OPERATIONAL CONDITIONS

The air bag warning lamp on the instrument panel has a few operational conditions.
The following are the conditions.

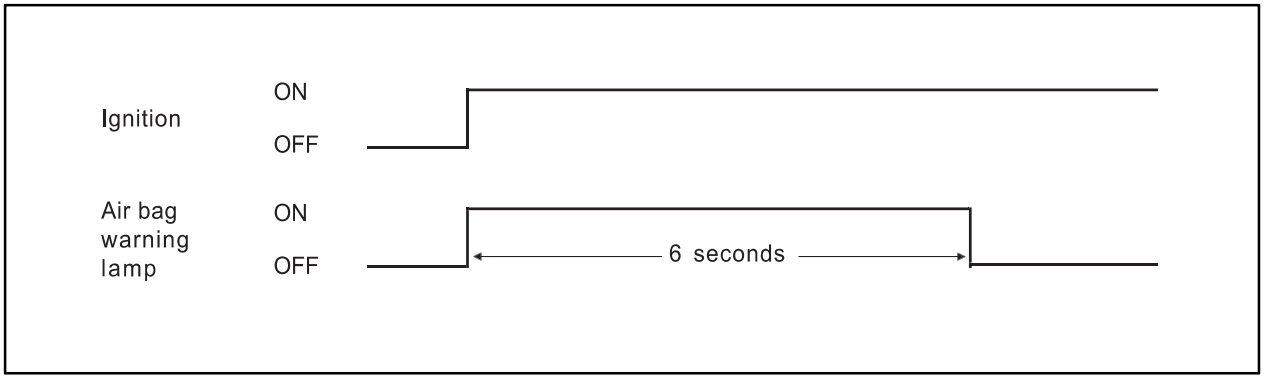
1) When Turning the Ignition Switch to ON Position

The air bag unit performs a turn-on test when the ignition is turned on. The air bag unit flashes the air bag warning lamp six times by supplying an intermittent ground to the warning lamp circuit. After flashing six times, the air bag warning lamp will turn off if no more malfunctions have been detected.



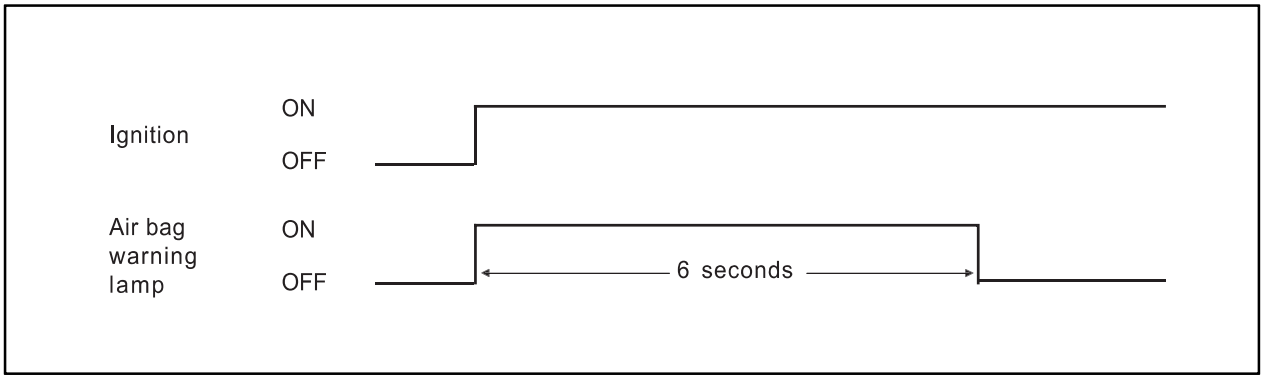
2) When Turning the Ignition Switch to the ON Position

When the air bag unit detects any malfunctions in its unit
When it is recorded as a system failure in the air bag unit, the air bag warning lamp on the instrument panel comes on for about 6 seconds and goes off for 1 second. Then the waning lamp stays on.



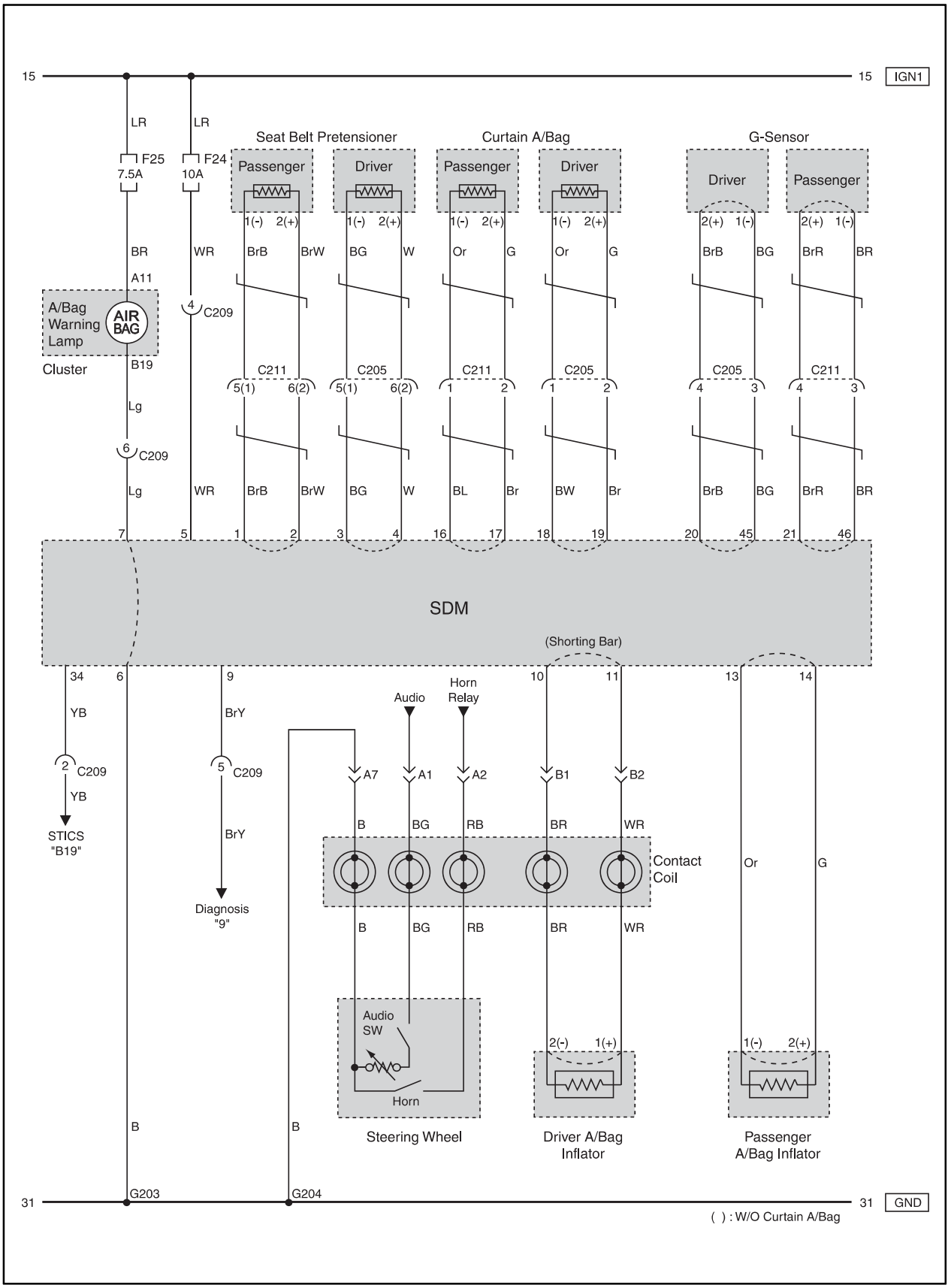
3) When the Air Bag Unit Receives Any Malfunction Signals from the Other Systems

When, due to an error from outside the system, the intermittent failure signal is received 5 times or less, the air bag warning lamp comes on for about 6 seconds and then, goes off.



Modification basis	
Application basis	
Affected VIN	

8. AIR BAG ELECTRICAL WIRING DIAGRAM



Modification basis	
Application basis	
Affected VIN	

SEAT AND SEAT BELT

7410 -01

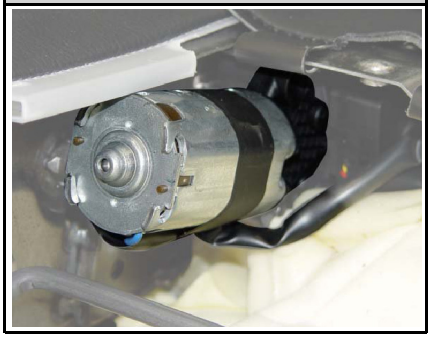
GENERAL

1. SEAT OVERVIEW

1)FRONT SEAT (DRIVER'S SEAT)

Lumbar support lever

Reclining Motor

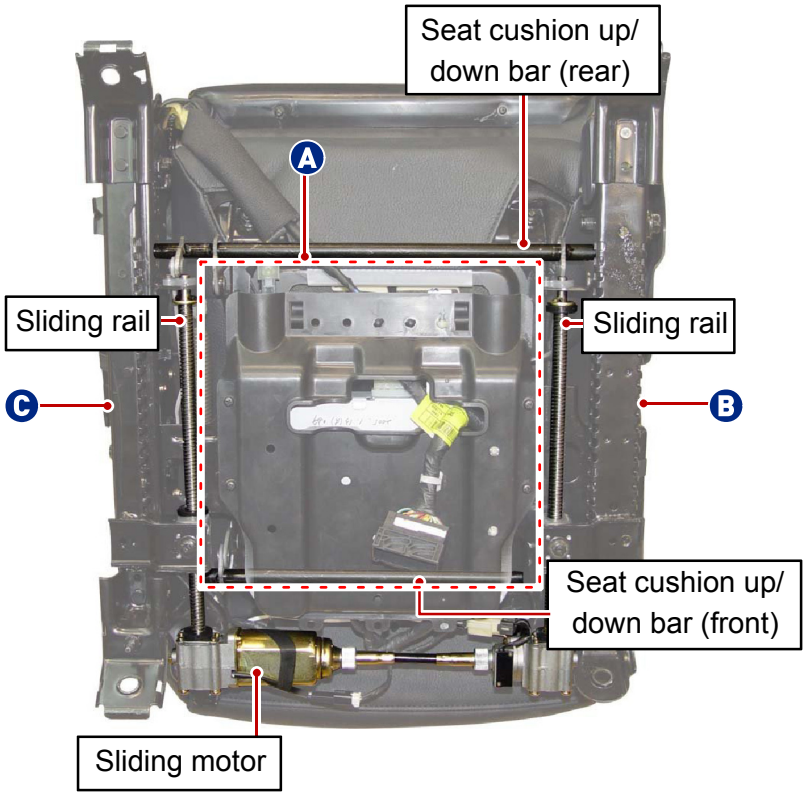


Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

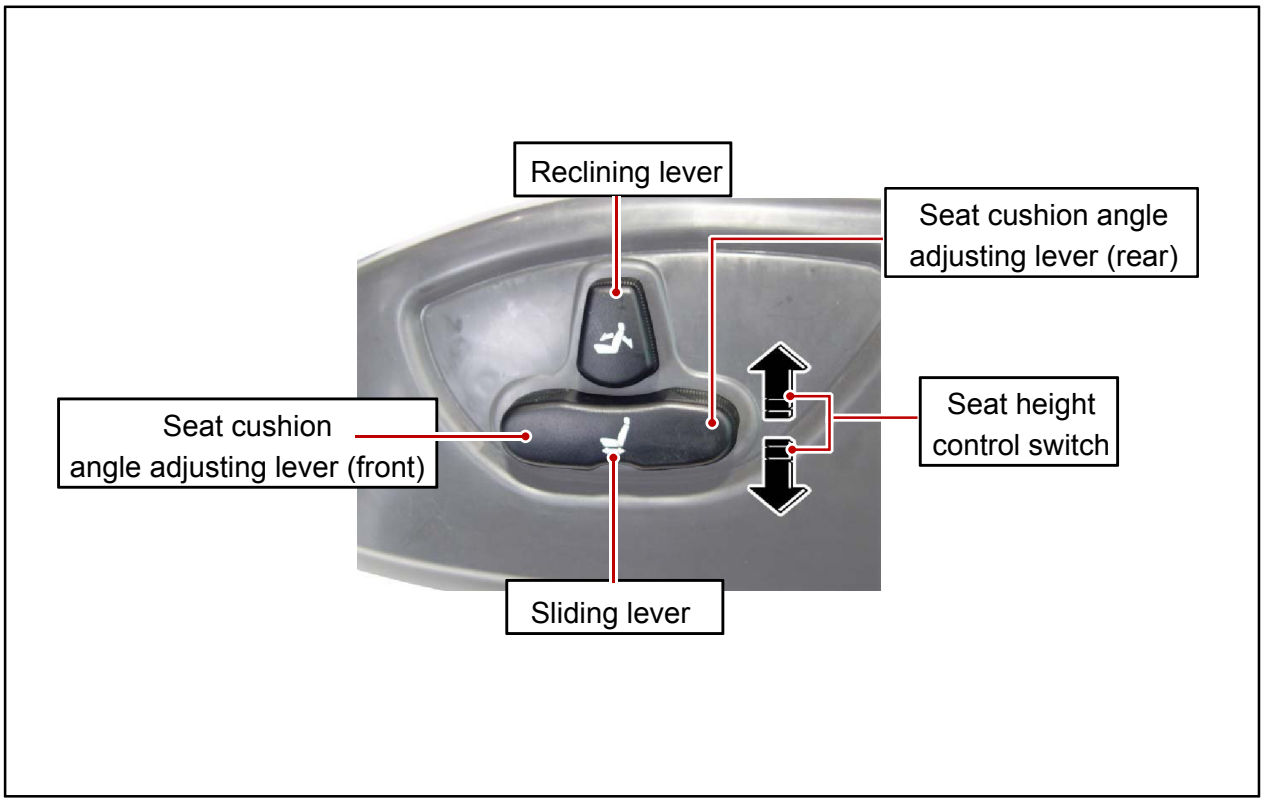
1. SEAT OVERVIEW

1) Front Seat (Driver's Seat)

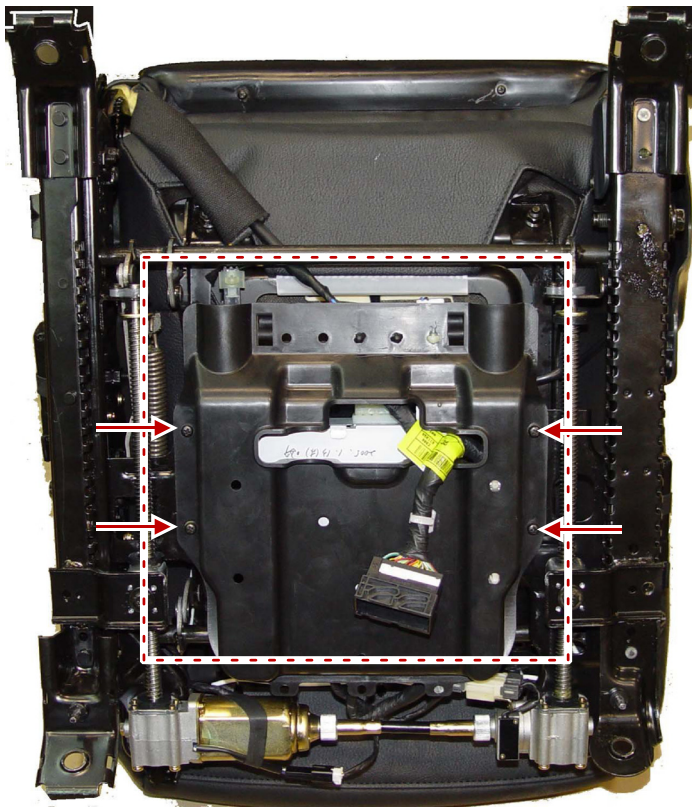


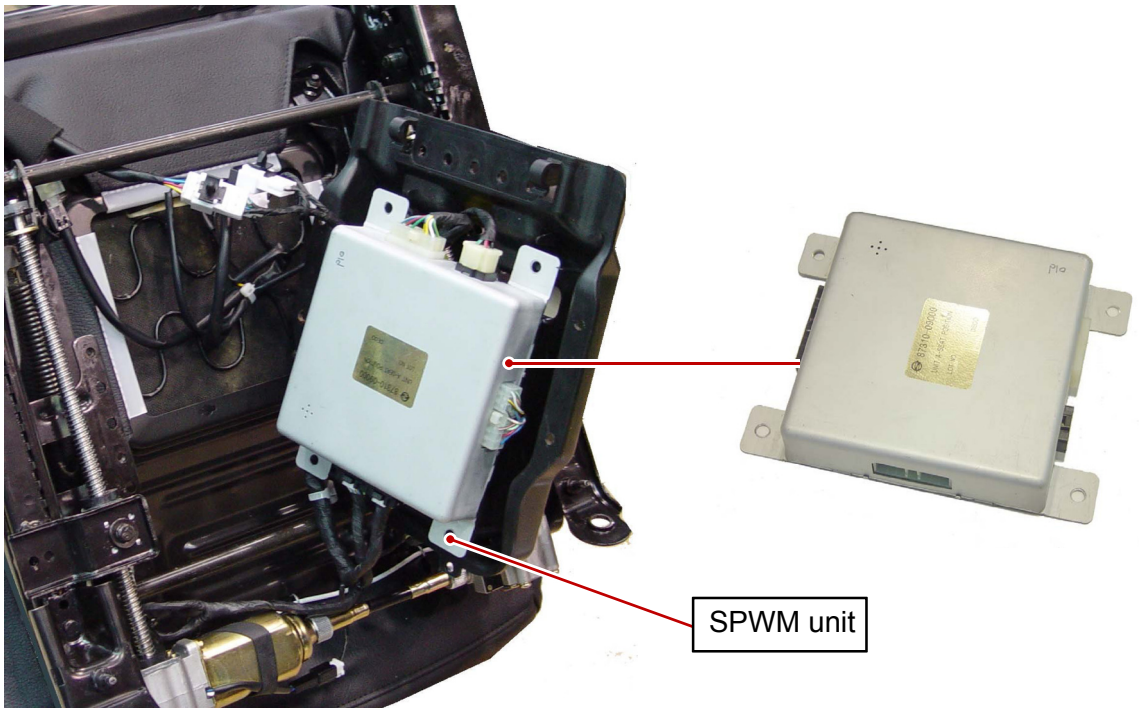
SPWM (Seat Position With Memory) Unit	Seat Cushion Motor (Front)	Seat Cushion Motor (Rear)
A	B	C

Modification basis	
Application basis	
Affected VIN	


Reclining lever
Seat cushion angle adjusting lever (rear)
Seat height control switch
Seat cushion angle adjusting lever (front)
Sliding lever

▶ Location of Seat Position With Memory Unit (Bottom of Driver Seat)

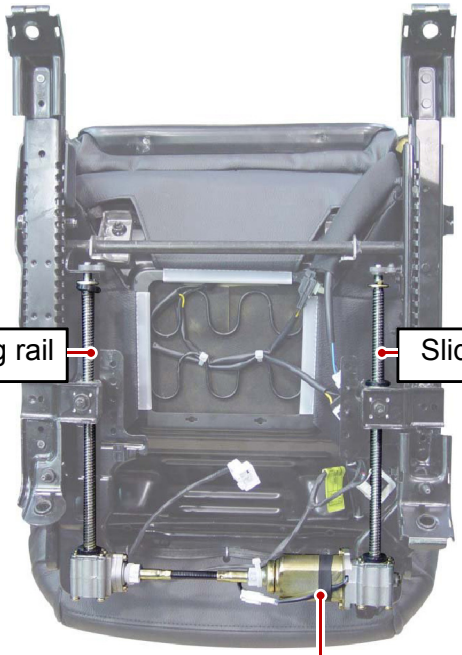




Modification basis	
Application basis	
Affected VIN	

2) Front Seat (Passenger Seat)

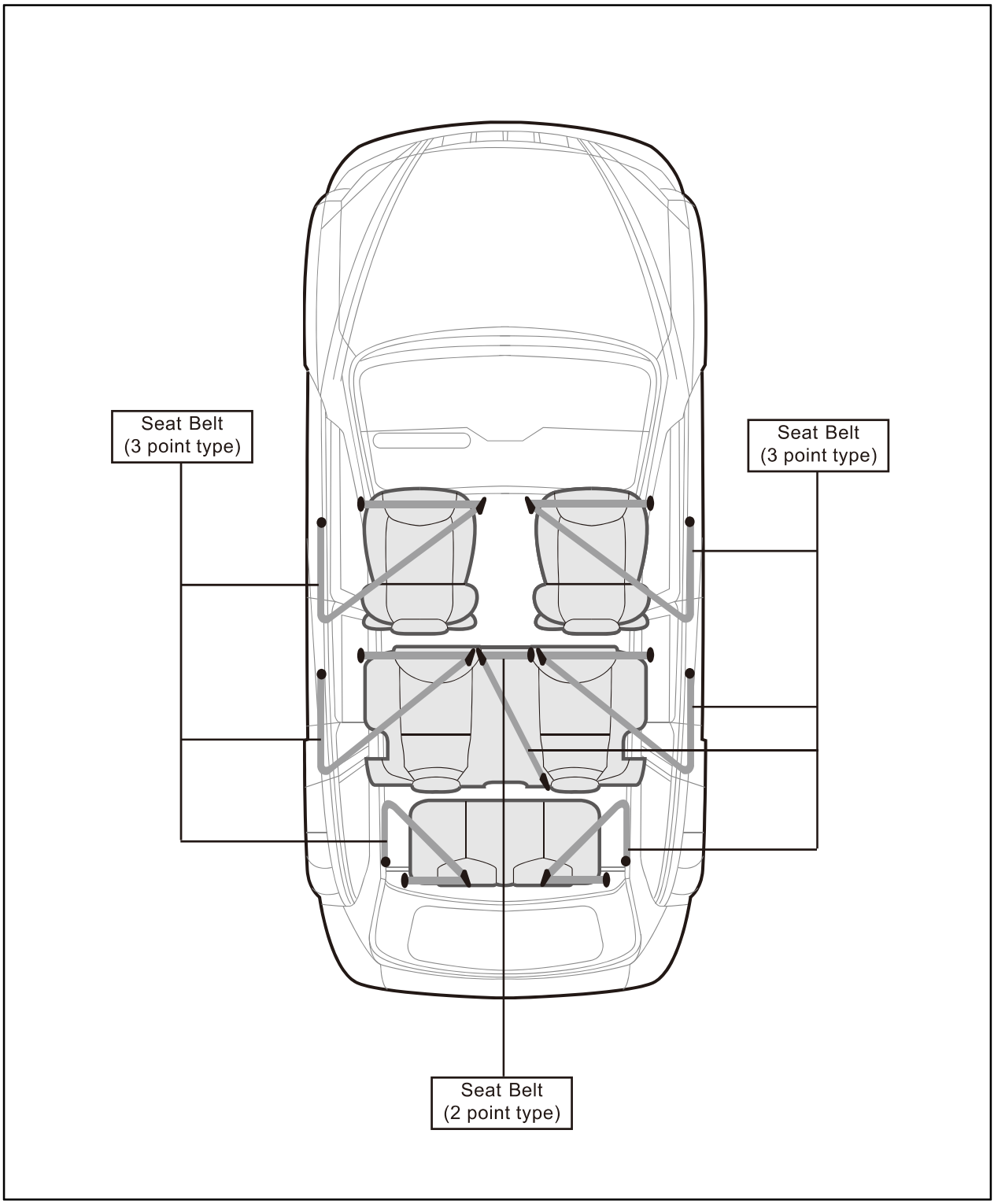
Reclining Motor



2. SEAT BELT OVERVIEW

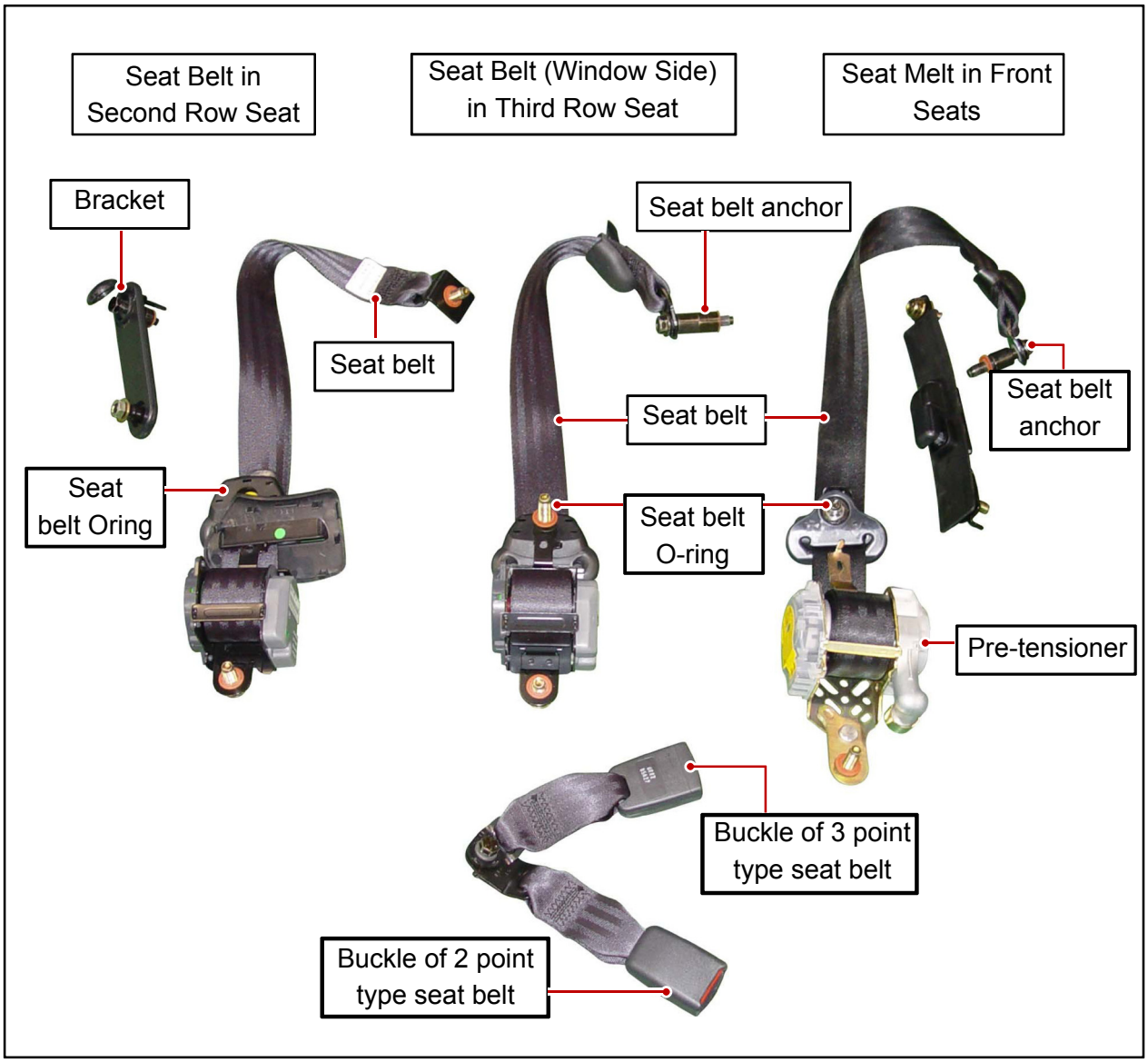
3 Point type seat belt: driver's seat, passenger's seat, window side seats of second row seat, third row seat 2 Point type seat belt: center seat of second row seat.

Pretensioner: Installed at front seats. The seat belt pretensioner rewinds the seat belt immediately to protect occupant's face and chest when a strong frontal collision occurs.



Modification basis	
Application basis	
Affected VIN	

1) Seat Belt (3 Point Type)



2) Seat Belt (2 Point Type)

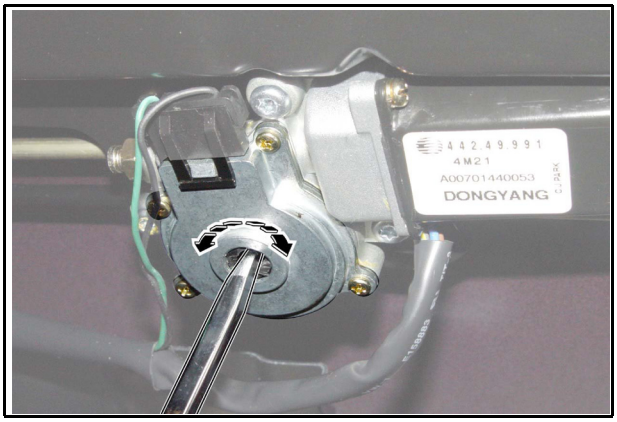
2. point type seat belt is installed only in the center seat of second row seat.

SUNROOF SYSTEM

7340-01

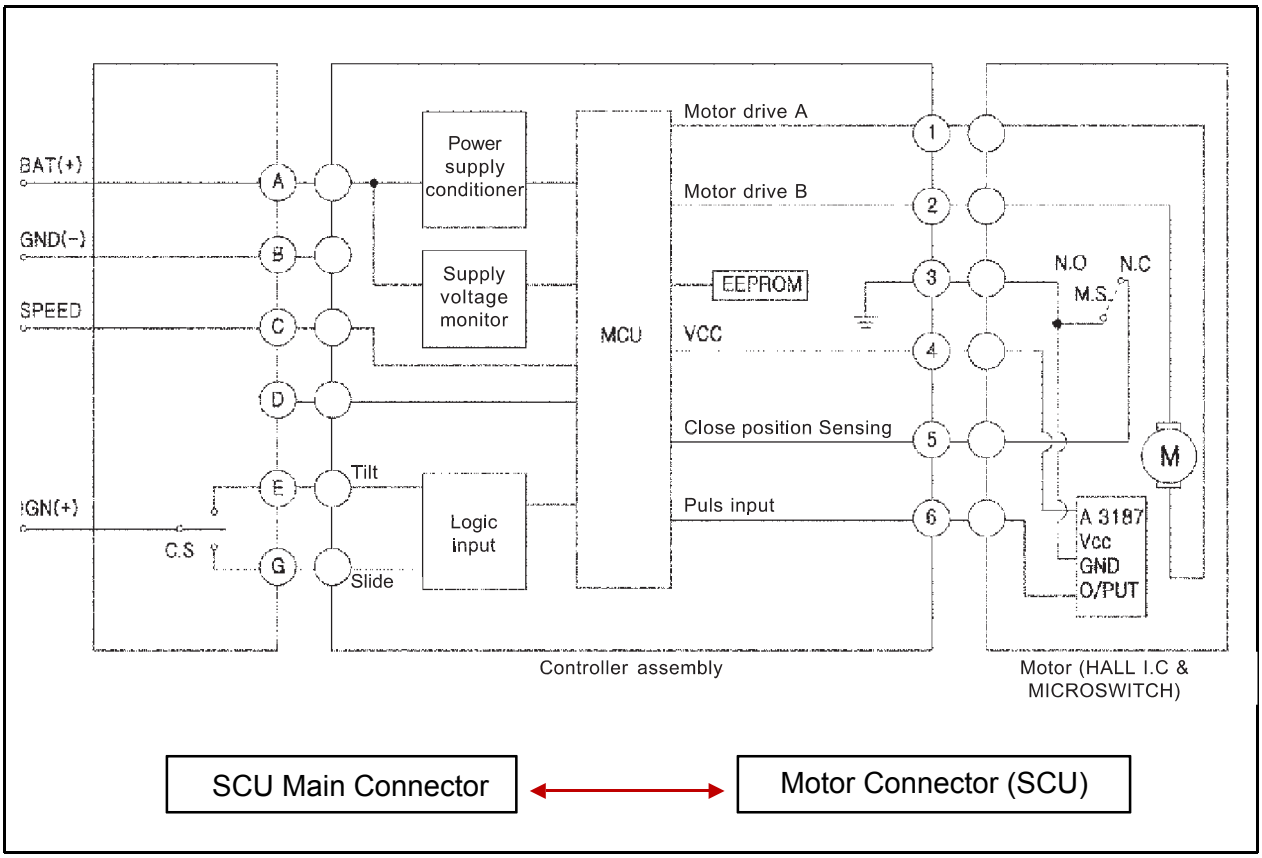
GENERAL

1. HAZARD (MANUAL) OPERATION



The sunroof can be operated by rotating the motor operating hole on the sunroof motor with a proper tool.

1) Circuit Diagram



2. RESETTING OF SUNROOF CONTROL UNIT

CAUTION

- If the sunroof does not operate properly, check and reset the sunroof control unit.

1. To prevent any parts damage and personal injury, the sunroof setting is canceled
   1) When the battery voltage is disconnected, the fuse is blown, or the abrupt voltage drop occurs due to old battery while operating the sunroof.
   2) When an undesired cancellation occurs due to mistake by a technician.
   3) When parts damage, shorted circuit, or electric leakage occurs.
   4) When keeping the sunroof switch at "OPEN" position.

2. Symptoms when the sunroof setting is canceled
   1) The one-touch operation cannot be activated.
   2) The sunroof is tilted even after completion of closing operation when closing it.
   3) The sunroof opening and tilting level is significantly low.
   4) The sunroof does not operate properly when operating the sunroof switch.

3. [0] point reset of sunroof
   1) Close the sunroof with the sunroof switch and keep the position for approx. 10 seconds. If the [0] point setting is successfully completed, the sunroof should be properly opened from this position.
   2) Check if the sunroof is fully closed. Tilt the sunroof with the sunroof switch and keep it at the position for 10 seconds ([0] point setting).
   3) Close the sunroof with the sunroof switch.

4. Checking after reset
   1) If the sunroof does not operate properly, check the power supply system.
   2) If the sunroof does not operate or operates only during the switch operation even the power supply system is in normal conditions, check if the ground circuit of switch is securely tightened and reset the sunroof system again.

CAUTION

- If the power supply system is in normal conditions, replace the sunroof motor or the sunroof control unit.
- Replace the sunroof control unit with new one and check if the sunroof operates properly before replacing the sunroof motor.

Modification basis	
Application basis	
Affected VIN	

3. TROUBLE DIAGNOSIS

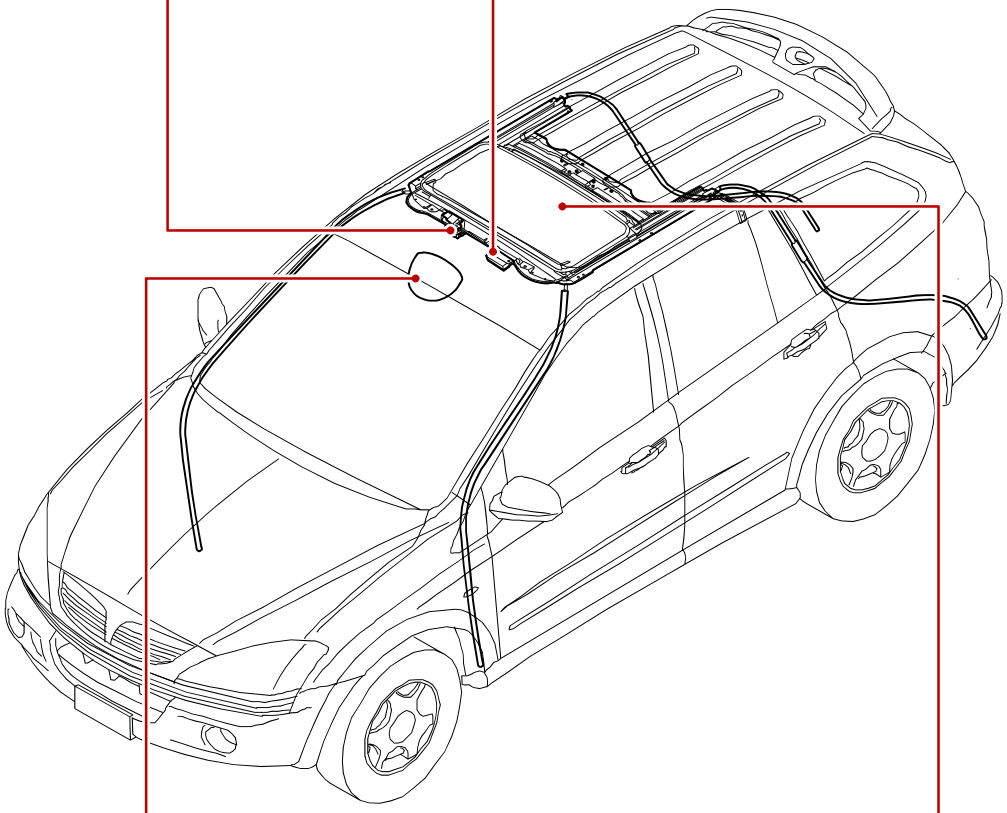
Symptom	Cause	Actio n
Leakage	Clogged or bent drain hose	Check and correct drain hose condition.
	Gap and clearance between panel and glass	Readjust glass location.
Wind noise	Gap and clearance between panel and glass	Readjust glass location.
Improper operations	Malfunction of wire, fuse and ground	Check and replace/repair.
	Malfunction of relay, motor and unit	Replace it.
	Damaged side cover by dislocation of sun shade	Reinstall sun shade and side cover. (Replace damaged parts.)
	Foreign material in rail	Remove foreign material.
Malfunction	Caught side cover by dislocation of sun shade	Reinstall sun shade and side cover. (Replace damaged parts.)
	Improper operation of anti-trap function	Check interference of body and wind deflector. (Relieve spring tension.)
	Improper operation of motor	Replace it.
Operation noise	Caught side cover by dislocation of sun shade	Reinstall sun shade and side cover. (Replace damaged parts.)
	Interference between drain hose and vehicle body	Install sponge to drain hose.
	Interference between vehicle body and roof panel	Apply sealant between vehicle body and roof panel.
	Gap and clearance between roof panel and glass	Readjust glass location.

OVERVIEW AND OPERATION PROCESS

1. SUNROOF COMPONENTS AND LOCATIONS

Sunroof Motor

Sunroof Control Unit (SCU)

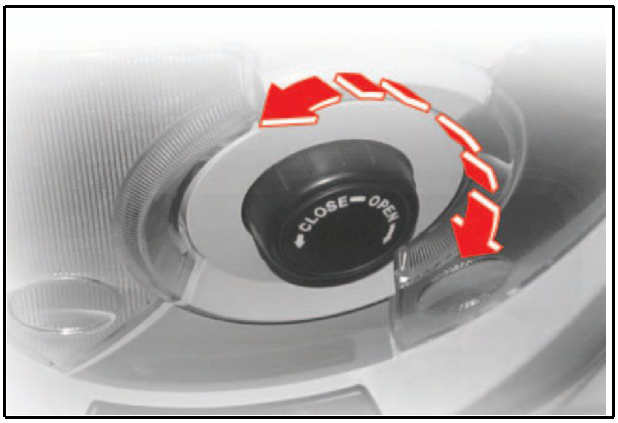


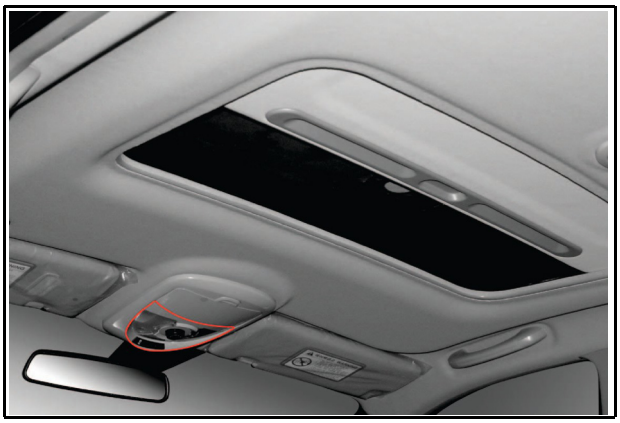
Sunroof Switch

Sunroof Assembly

Modification basis	
Application basis	
Affected VIN	

2. SUNROOF OPERATION AND FUNCTION





▶ Sunroof Sliding Operation

Open
To fully open the sunroof, briefly rotate the sunroof switch clockwise (OPEN direction) with the sunroof closed. To partially open the sunroof, rotate and hold the sunroof switch until it reaches at the desired position.

Close
To fully close the sunroof, briefly rotate the sunroof switch counterclockwise (CLOSE direction) with the sunroof open. To partially close the sunroof, rotate and hold the sunroof switch until it reaches at the desired position.

Anti-trap function is built in SCU

▶ Sunroof Tilting Operation

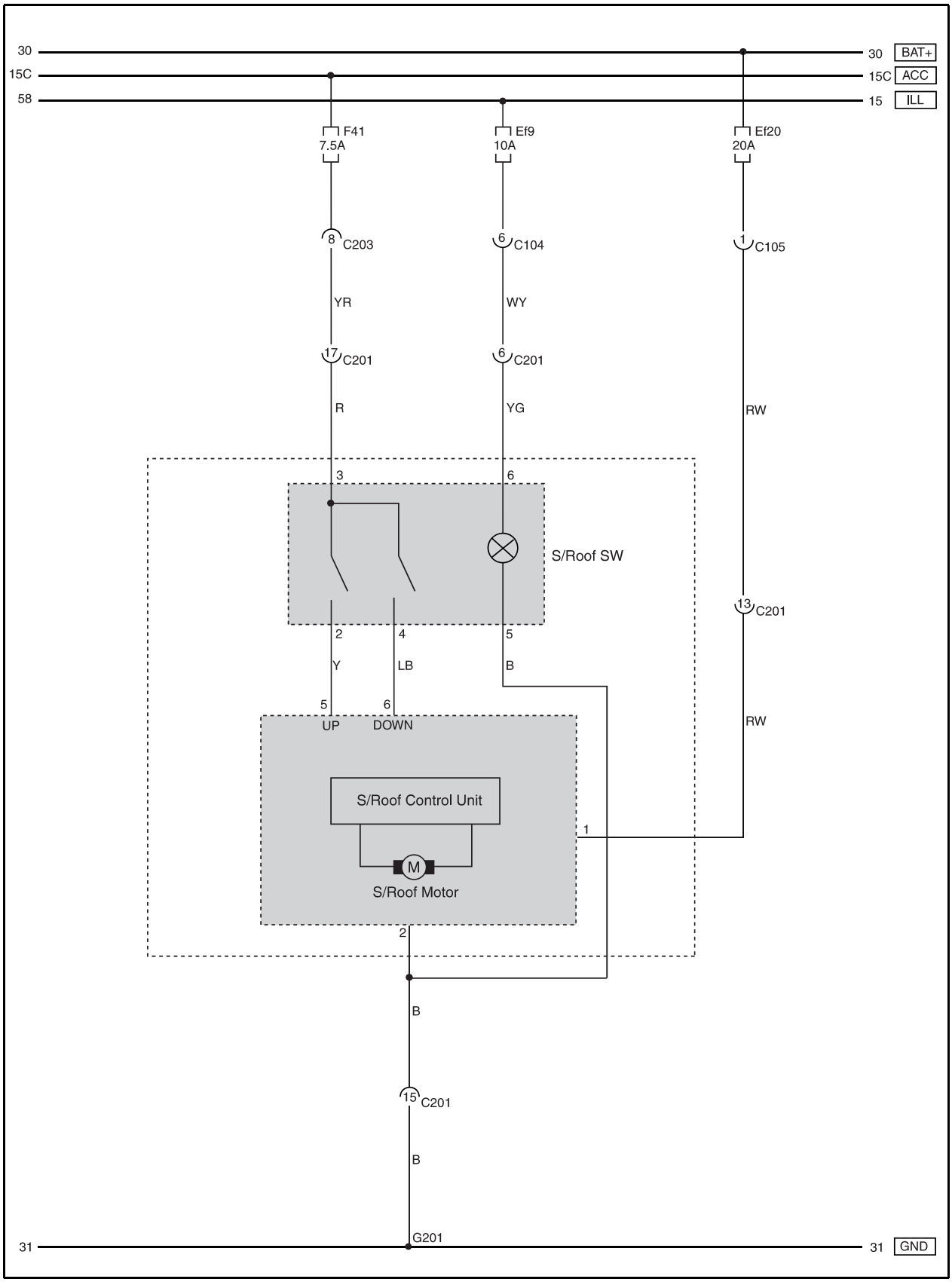
Tilt-up
To tilt-up the sunroof, rotate the sunroof switch counterclockwise (CLOSE direction) with the sunroof fully closed.

Tilt-down
To tilt-down the sunroof, rotate the sunroof switch clockwise (OPEN direction) with the sunroof tilted-up.

▶ Anti-trap Function

To prevent any body parts from being trapped by the sliding sunroof, an Anti-Trap function automatically opens the sunroof when an object is trapped. However, if the force against the sunroof is less than the specified value, the Anti-Trap function doesn't operate.

3.SUNROOF CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

NO DATA

NO DATA

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DIAGNOSIS

1. FFH..... 3

FFH

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DIAGNOSIS

1. FFH

Trouble Code	Trouble Description	Remedies
0	No faults	-
10	Shutdown for overvoltage	Measure battery voltage (must be < 15.9V). Check alternator and overvoltage.
11	Shutdown for undervoltage	Measure battery voltage (must be > 10.2V under load). Check alternator, wiring and undervoltage.
12	Overheating (abnormal reference value)	Temperature at overheating sensor > 125°C: check cooling system. Check temperature sensor and overheating sensor, replace if necessary.
14	Overheating (difference evaluation-1)	Difference in temperature values between surface sensor and control overheating sensor is too large. (Prerequisite for this trouble code display is that the heater is in operation and the water temperature at the overheating sensor has reached min. 80°C): check cooling system. Check temperature sensor and overheating sensor, replace if necessary
15	Overheating (abnormal heater operation)	Heater does not operate (The controller is locked.) Delete trouble code to release controller lock: check cooling system. Check temperature sensor and overheating sensor, replace if necessary
16	Overheating (difference evaluation-2)	If the surface sensor has a far higher temperature value than the control overheating sensor, then the system proceeds with a fault shutdown.
17	Overheating (defective hardware-2)	Temperature at control overheating sensor > 130°C: check cooling system. Check temperature sensor and overheating sensor, replace if necessary.
20	Open glow plug circuit	Check plug cable for damage, replace if necessary
21	Overload or short circuit of glow plug	Check plug cable for damage, replace if necessary
22	Short circuit of glow plug	Check plug cable for damage, replace if necessary
23	-	-
24	-	-
25	Short circuit of communication line	Check the communication line.
30	Abnormal speed of combustion fan motor	Defective fan wheel or combustion air fan motor (frozen, contaminated, stiff, damaged cable)
31	Defective combustion fan motor	Check cable harness for damage, replace if necessary.
32	Overload or short circuit of combustion fan motor	Defective fan wheel or combustion air fan motor (contaminated, stiff) Check cable harness for damage, replace if necessary.
34	Abnormal output of combustion fan motor	Check the ground and short of combustion air fan motor circuit, replace if necessary.
36	-	-
38	-	-
39	-	-
41	Abnormal water pump operation	Check connector.
42	Overload or short circuit of water pump	Check connector.

Modification basis	
Application basis	
Affected VIN	

Trouble Code	Trouble Description	Remedies
43	Abnormal output of water pump	-
47	Overload or short circuit of fuel pump	Check cable harness for damage, replace if necessary.
48	Abnormal fuel pump operation	Check cable harness for damage, replace if necessary. Check plug-in connection, replace if necessary.
49	Short circuit of fuel pump (B+)	Check cable harness for open to battery voltage, replace if necessary.
50	Improper operation	The controller is locked due to excessive starting problem.
51	Delayed heating time	During start (no flame formed yet), the flame sensor reports temperature value too high for too long, check exhaust gas, combustion air and flame sensor.
52	Time exceeded for cold blowing	Check exhaust gas and combustion air. Check fuel quantity and fuel supply. Clean or replace filter in fuel pump.
53	Flame aborted from “large” stage	Fault (no more starting attempt allowed). Check exhaust gas and combustion air system. Check fuel quantity and fuel supply. Check flame sensor - see trouble code 64 and 65.
54	Flame aborted from “small” stage	Fault (no more starting attempt allowed). Check exhaust gas and combustion air system. Check fuel quantity and fuel supply. Check flame sensor - see trouble code 64 and 65.
60	Abnormal overheating sensor operation	Check cable harness for damage, check plug-in connection, replace if necessary. Check sensor resistance value, replace if necessary.
61	Short circuit or ground of overheating sensor	Check cable harness, replace if necessary. Check sensor resistance value, replace if necessary.
64	Abnormal flame sensor operation	Check cable harness for damage, check plug-in connection, replace if necessary. Check sensor resistance value, replace if necessary.
65	Short circuit of flame sensor	Check cable harness, replace if necessary. Check sensor resistance value, replace if necessary.
71	Defective surface sensor	Check cable harness for damage, check plug-in connection, replace if necessary. Check sensor resistance value, replace if necessary.
72	Short circuit of surface sensor	Check cable harness, replace if necessary. Check sensor resistance value, replace if necessary.
74	Defective overheating prevention device	-
87	-	-
88	-	-
89	-	-
90	Watchdog reset	Replace controller.
91	Abnormal reset function	If too many resets occurs, replace controller
92	ROM error	Replace controller.
93	RAM error	Replace controller.
94	Defective transistor	Replace controller.

Modification basis	
Application basis	
Affected VIN	

Trouble Code	Trouble Description	Remedies
95	Software error	Check cable harness for open to battery voltage, replace if necessary. Replace controller.
96	Abnormal process operation	Replace controller.
97	Wrong processor cycle	Replace controller.
98	Defective main relay	Replace controller.
99	EEPROM error	Replace controller.

Causes		Remedies
Low coolant level	• Leakage in radiator • Leakage in coolant auxiliary tank • Leakage in heater core	• Change radiator. • Change coolant auxiliary tank • Change heater core.
	• Leakage in joint junction of coolant hose • Leakage in defective coolant hose	• Check hose or replace clamp. • Change hose.
	• Leakage in water pump gasket • Leakage in water pump sealing	• Change gasket. • Change water pump.
	• Leakage in water inlet cap • Leakage in thermostat housing	• Change water inlet cap gasket. • Change thermostat sealing.
	• Insufficient tightening torque of cylinder head bolt • Damaged cylinder head gasket	• Tighten bolt to specified torque. • Change cylinder head gasket.
Abnormally high coolant temperature	• The coolant leakage (Check the coolant level) • Excessive anti-freezer • Poor coolant hose condition	• Add coolant • Check density of coolant (Anti-freezer). • Check bent of hose, replace if necessary.
	• Defective thermostat • Defective water pump • Defective radiator • Defective coolant auxiliary tank or tank cap	• Change thermostat • Change water pump. • Change radiator. • Change coolant auxiliary tank or tank cap.
	• Crack in cylinder head or in cylinder block • Clogged water flow in cylinder head or block	• Change cylinder head or cylinder block. • Clean coolant flow line.
	• Clogged water flow in radiator core	• Clean radiator core.
	• Defective cooling fan	• Change or check cooling fan.
	• Defective temp. sensor, wiring, and lamp cluster	• Change sensor or check relevant wiring.
Abnormally low coolant temperature	• Defective thermostat	• Change thermostat.
	• Defective cooling fan	• Change or check cooling fan.
	• Defective temp. sensor, wiring, and lamp cluster	• Change sensor or check relevant wiring.

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DIAGNOSIS

1. P/TRUNK..... 3

P/TRUNK

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DIAGNOSIS

1. P/TRUNK

Function	System component	DTC	Description
Power Trunk Monitoring	Power striker	0	Faulty power striker
	Causes - The related wiring is damaged. - The connector is poorly connected or damaged. - The micro switch is malfunctioning. - The power striker'motor is malfunctioning. **Actions** - Check the related wiring and connector for proper connection. - Replace the power striker.		
	Power latch	1	Faulty power latch
	Causes - The related wiring is damaged. - The connector is poorly connected or damaged. - The micro switch is malfunctioning. - The power latch motor is malfunctioning. **Actions** - Check the related wiring and connector for proper connection. - Replace the power latch.		
	DC-Gear motor	2	Faulty DC-gear motor
	Causes - The related wiring is damaged. - The connector is poorly connected or damaged. - The hall sensor is malfunctioning. - The DC-gear motor is malfunctioning. **Actions** - Check the related wiring and connector for proper connection. - Replace the DC-gear motor.		
	Power trunk lid	3	Faulty power trunk lid
	Causes - The related wiring is damaged. - The connector is poorly connected or damaged. - The PTL ECU is malfunctioning. **Actions** - Check the related wiring for proper connection. - Replace the PTL ECU.		

<table>
<tr><th>Function</th><th>System component</th><th>DTC</th><th>Description</th></tr>
<tr><td rowspan="10">Power Trunk Monitoring</td><td>Battery</td><td>4</td><td>Low battery voltage</td></tr>
<tr><td colspan="3"><u>Causes</u>
- The related wiring is damaged.
- The connector is poorly connected or damaged.
- The battery is defective.
<u>Actions</u>
- Check the related wiring for proper connection.
- Check the battery and replace it if necessary.</td></tr>
<tr><td>CAN communication</td><td>5</td><td>Faulty CAN communication</td></tr>
<tr><td colspan="3"><u>Causes</u>
- The related wiring is damaged.
- The connector is poorly connected or damaged.
- The CAN communication is malfunctioning.
- The PTL ECU is malfunctioning.
<u>Actions</u>
- Check the related wiring for proper connection.
- Replace the PTL ECU.</td></tr>
<tr><td>Power trunk</td><td>6</td><td>Faulty usage</td></tr>
<tr><td colspan="3"><u>Cause</u>
- If the DC-gear motor is operated 7 times within 2 minutes, it is considered as misusage and overheated DC-gear motor.
<u>Action</u>
- The system resumes its operation in 90 seconds.</td></tr>
<tr><td>PTL ECU</td><td>7</td><td>Faulty temperature detection of unit</td></tr>
<tr><td colspan="3"><u>Causes</u>
- The related wiring is damaged.
- The connector is poorly connected or damaged.
- The internal temperature sensor in the PTL ECU is malfunctioning.
- The PTL ECU is malfunctioning.
<u>Actions</u>
- Check the related wiring for proper connection.
- Replace the PTL ECU.</td></tr>
<tr><td>PTL ECU</td><td>8</td><td>Faulty temperature detection of unit</td></tr>
<tr><td colspan="3"><u>Causes</u>
- The related wiring is damaged.
- The connector is poorly connected or damaged.
- The power trunk lamp is malfunctioning.
- The PTL ECU is malfunctioning.
<u>Actions</u>
- Check the related wiring for proper connection.
- Replace the power trunk lamp.
- Replace the PTL ECU.</td></tr>
</table>

Modification basis	
Application basis	
Affected VIN	

RAIN SENSOR

0000-00

DIAGNOSIS

1. TROUBLE SHOOTING..... 3

RAIN SENSOR

0000-00

DIAGNOSIS

1. TROUBLE SHOOTING

Symptom 1. The wiper does not operate one cycle when turning the multifunction wiper switch to the "AUTO" from the "OFF" position or starting the engine while the wiper switch is in the "AUTO" position.

1. When starting the engine with the multifunction wiper switch in the "AUTO" position, the wiper operates one cycle to remind a driver that the wiper switch is in the "AUTO" position.
2. When the wiper switch is turned to "AUTO" from "OFF", the wiper operates one cycle. It always operates one cycle for the initial operation, however, the wiper does not operate afterwards to prevent the wiper blade wear if not raining when turning the wiper switch to "AUTO" from "OFF". However, the wiper operates up to 5 minutes after rain stops. If this function does not occur, check No. 8 pin. If the pin is normal, check the wiper relay related terminals in the ICM box.

Symptom 2. It rains but the system does not work in the "AUTO" position.

1. Check whether the multifunction wiper switch is in the "AUTO" position.
2. Check the power to the sensor. Check the conditions of the pin 3 (Ground) and the pin 4 (IGN).
3. Check the wiper relay for defective.

Symptom 3. The wiper operates 3 or 4 times at high speed abruptly.

Check whether the variable resistance knob on the multifunction wiper switch is set in "FAST". The "FAST" is the highest stage of the sensitivity and very sensitive to small amount of rain drops. Therefore, change the knob to the low sensitivity.

Symptom 4. The wiper operates continuously even on the dry glass.

1. Check the wiper blade for wear. If the wiper blade cannot wipe the glass uniformly and clearly, this problem could be occurred. In this case, replace the wiper blade with a new one.
2. Check whether the variable resistance knob on the multifunction wiper switch is set in "FAST". The "FAST" is the highest stage of the ensitivity and very sensitive to small amount of rain drops. Therefore, change the knob to the low sensitivity.

Symptom 5. The wiper does not operate at high speed even in heavy rain.

Check if the wiper operates at high speed when grounding pin 1 and pin 2.

Symptom 6. The wiper responses are too fast or slow.

Check whether the variable resistance knob on the wiper switch is set in "FAST" or "SLOW". Notify that the customer can select the sensitivity by selecting the variable resistance value. And, select a proper stage.

Modification basis	
Application basis	
Affected VIN	

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DIAGNOSIS

1. STICS..... 3

STICS

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DIAGNOSIS

1. STICS

Fault Code	Malfunction	Descriptions
01	Dr Door Lock Knob	Driver's door lock knob is not operated when locking/unlocking doors.
02	Ps Door Lock Knob	Passenger's door lock knob is not operated when locking/unlocking doors.
03	Rr Door Lock Knob	Rear door lock knob is not operated when locking/unlocking doors.
04	T/Gate Lock Knob	Tailgate lock knob is not operated when locking/unlocking doors.
05	Door Lock Output	All door lock knob are not moved to lock position even when the door lock relay is activated.
06	Door Unlock Output	All door lock knob are not moved to unlock position even when the door unlock relay is activated.
07	C/DR Lock Output	Doors are locked by central door lock switch while the engine is running.
08	DR Lock Output	Doors are locked by driver's door lock switch while the engine is running.
09	PS Lock Output	Doors are locked by passenger's door lock switch while the engine is running.
10	Auto Door Lock Output	Door lock knob is not moved to lock position when the system outputs auto door lock signal while the ignition switch is in ON position and the vehicle speed is over 50 km/h.
11	Auto Door Unlock Output	Door lock knob is not moved to unlock position after receiving the output from collision sensor.
12	Wiper Output	The WIPER P-POS signal is not detected when the wiper relay is activated.
13	SPEED SIGNAL	The vehicle speed over 3 km/h is detected at the speed signal area while the ignition switch is in ON position and the alternator signal is "D" LOW.
14	INT WIPER Volume	The circuit is open (over 4.5 V) when changing the INT volume in the speed sensitive INT wiper (saved as history error).
15	SPEED SENSOR	The vehicle speed over 200 km/h is detected (saved as history error).
16	A/BAG COLLISION SENSOR INPUT	A signal is sent to the collision sensor input area while the ignition switch is in OFF position (saved as history error unconditionally).
17	A/BAG COLLISION SENSOR OUTPUT	The RKSTICS outputs UNLOCK signal after receiving collision sensor input while the ignition switch is in ON position (saved as history error).
18	A/BAG COLLISION MONITOR	The STICS outputs the Door Unlock signal due to the collision sensor and the feedback value is in proper range (saved as history error).
19	Door Ajar Warning IND	The door warning indicator blinks when the vehicle speed is over 10 km/h (saved as history error).
20	PARKING BRAKE IND	The parking brake indicator blinks when the vehicle speed is over 10 km/h (saved as history error).
21	Auto Washer Out	The auto washer output is not sent to the front washer (saved as history error).
22	WASHER RELAY	The front washer switch receives the input signal for more than 10 seconds (saved as history error).

Fault Code	Malfunction	Descriptions
23	REMOCON VOLTAGE CHECK	The voltage from remote control key is saved as history error.
24	SBR S/BELT SW (Only EU)	When the seat belt switch circuit is OPEN (HIGH) in KEY OUT & ARMED MODE, the system recognizes it as FAIL and saves it as History error (Normal Close (GND)).
25	SBR SENSOR (Only EU)	When the sensor value is recognized in KEY OUT & ARMED MODE, the system saves it as History error.
26	SBR CONNECTION (Only EU)	When the seat belt switch circuit maintains OPEN (HIGH) in KEY OUT & ARMED MODE while the vehicle speed is over 50 km/h, the system saves it as History error.

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DIAGNOSIS

1. TC..... 3

TC

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DIAGNOSIS

1. TC

Symptoms	Check	Action
Electric shift problems	• Faulty or damaged TCCU, speed sensor, motor, clutch or internal wirings	• Overhaul and check, replace if necessary
	• Damaged or worn shift cam, hub, fork and rail shift	• Overhaul and check for wear and damage.
	• Binding shift fork, hub collar or gear	• Check sliding parts, replace if necessary.
Cannot drive front wheel when shifting to 4H, 4L	• Broken drive chain	• Check internal parts and replace drive chain.
Noise in 4WD operation	• Improper or low oil	• Drain and replace with specified oil.
	• Loosened bolts or mounted parts	• Retighten as specified.
	• Noisy T/C bearing	• Disassemble bearings and parts and check for wear or damage. Replace if necessary.
	• Gear abnormal noise	• Check for wear and damage including speedometer gear. Replace if necessary.
Noise in 4H or 4L	• Worn or damaged sprockets or drive chain	• Disassemble and check for wear and damage. Replace if necessary.
	• Incorrect tire pressure	• Adjust tire pressure.
Transfer case oil leakage	• Cracked transfer case	• Replace the case.
	• Leakage from other parts	• Clean case and parts and check for leakage.
	• Breather clogging	• Remove breather hose and clean. Replace if necessary.
	• Improper or too much oil	• Use specified oil and adjust oil level.
	• Loosened sealing bolts	• Retighten.
	• Improperly applied sealant	• Use specified sealant and retighten.
	• Worn or damaged oil seal	• Replace oil seal.

Code	Description	Action
P1806	Detective CAN commuication	• Check communication line. • Replace TCCU if necessary.
P1805	Defective mode switch	• When the mode switch is defective • Check TCCU pin No.4 and 16. • Mode change - 2H (Pin No. 4: Ground) - 4H (No contact: Open) - 4L (Pin No.16: Ground)
P1821	Open or short to ground in magnetic clutch coil circuit	• Voltage at TCCU pin No.11: 11 ~ 15 V • EMC resistance: 2.5 Ω • Check the relevant connectors for contact. • Replace TCCU if necessary.
P1822	Open or short to ground in hub control circuit	• When the hub control circuit is open or short to ground over 0.2 second • Replace TCCU if necessary.
P1841	Open to ground in shift motor circuit	• When TCCU detects the motor failure for 1 second • Check the relevant harnesses for contact. • Replace TCCU if necessary.
P1842	Short to ground in shift motor output circuit	• When TCCU detects the motor failure for 1 second • Check the relevant harnesses for contact. • Replace TCCU if necessary.
P1843	Defective position sensor in motor	• 2H-4H: after 1.5 seconds • 4H-4L: after 3 seconds • Check the relevant harnesses for contact. • Replace TCCU if necessary.
P1844	Stuck in 4L mode	• When no shifting operation from 4L to 4H, even though the shift conditions are satisfied and no error. • Replace TCCU if necessary.

Modification basis	
Application basis	
Affected VIN	

Code	Description	Action
P1850	Defective position encoder	• When the position encoder is defective • Check the relevant harnesses. • Check the relevant connectors for contact. • Check the shift motor.
P1851	Short to ground for position encoder 1	• Short to ground for position encoder 1 in shift motor • Check the relevant harnesses for short. - TCCU pin No.18 • Check the relevant connectors for contact. • Check the shift motor.
P1852	Short to ground for position encoder 2	• Short to ground for position encoder 2 in shift motor • Check the relevant harnesses for short. - TCCU pin No.5 • Check the relevant connectors for contact. • Check the shift motor.
P1853	Short to ground for position encoder 3	• Short to ground for position encoder 2 in shift motor • Check the relevant harnesses for short. - TCCU pin No.19 • Check the relevant connectors for contact. • Check the shift motor.
P1854	Short to ground for position encoder 4	• Short to ground for position encoder 4 in shift motor • Check the relevant harnesses for short. - TCCU pin No.17 • Check the relevant connectors for contact. • Check the shift motor.
P1815	Abnormal CAN neutral signal	• No neutral signal from automatic transmission over 1 second through CAN. • Check CAN communication line. • Check TCU.

Symptoms		Cause	Action
Noise	Noise in all ranges	- Low oil level	- Check major components (bearing surface) for excessive wear
			- Replenish oil
		- Improper oil	- Drain oil and replenish the specified oil
		- Worn or broken chain	- Replace chain or sprocket
	Growling	- Broken bearing	- Replace transfer case housing
		- Low oil level	- Check major components (bearing surface) for excessive wear
			- Replenish oil
	Noise when cornering	- Worn pinion gear teeth	- Replace differential carrier assembly
	Low frequency noise and vibration	- Missing shaft support snap ring	- Visually check the relevant parts for wear and replace if necessary
	Howling	- Abnormal friction in drive system	- Disassemble drive system, check rotating parts for wear and replace the worn parts.
Clunking	Clunking (when starting and stopping)	- Excessive backlash in T/C (over 3°)	- Check backlash and replace if necessary
		- Improper mounting	- Excessive backlash in drive system
			- Check drive system
		- Excessive backlash in other parts	- Excessive backlash in drive system
			- Check drive system
Undrivable	Cannot deliver forward/reverse driving force	- Worn or broken chain	- Replace chain or sprocket
		- Broken sprocket	- Replace chain or sprocket
		- Broken differential carrier	- Replace differential carrier assembly
		- Broken shaft	- Replace shaft
Binding	Dragging in front wheels or rear wheels	- Differential carrier stuck	- Replace differential carrier
Leakage	Leakage at transmission connection	- Damaged oil seal in T/C	- Replace oil seal
		- Clogged breather	- Check breather for clogging
			- Replace connecting hose
	Leakage at front and rear shafts	- Foreign material in oil seal	- Remove any foreign material, check oil seal for damage and replace oil seal
		- Broken oil seal	- Replace oil seal
		- Clogged breather	- Check breather for clogging
			- Replace connecting hose
	Leakage at case or cover body	- Cracked case or cover	- Replace transfer case
		- Air bubbles inside	
	Leakage at drain plug	- Bubbles no mounting bolt	- Replace drain plug
		- Uneven or missing plug coating	
	Leakage at filler plug	- Bubbles no mounting bolt	- Replace filler plug
		- Uneven or missing plug coating	
	Leakage at body connection	- Improperly applied sealant	- Disassembe T/C, apply sealant and reassemble it
		- Loose bolt around the leaking area	- Tighten to the specified torque

Modification basis	
Application basis	
Affected VIN	

INDEX

DIAGNOSIS

1. TCU..... 3

TCU

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DIAGNOSIS

1. TCU

DTC Code	Defective	Cause and Action
P0742	Torque converter clutch engaged	Cause: - Torque conver clutch is engaged when solenoid valve (S7) is not operated. - The rpm of engine and output shaft is not consistent with the characteristic under the condition with torque converter not engaged. • Allowable slip rpm of torque converter < 50 rpm Symptom: - Torque converter clutch is locked. Action: - Check solenoid valve (S7) wiring for short to B+. - Replace solenoicd valve (S7) if necessary. - Check T/M connector TCU connector for their proper connection. - Replace TCU if necessary. - Returns to the normal operation if the failure does not occur within 30 seconds.
P0710	Defective T/M oil temperature sensor	Cause: - Oil temperature of T/M exceeds the specified value. • Oil temperature sensor voltage > 4.88 V • Oil temperature sensor voltage < 0.21 V Symptom: - Oil temperature is fixed to 120°C - Shifting impression is poor. Action: - Check T/M oil temperature sensor for short or open circuit. - Check T/M connector and TCU connector for proper connection. - Replace TCU if necessary. - Returns to the normal operation if the failure does not occur within 3 seconds.
P0790	Defective W/N/P mode switch	Cause: - The W/N/P mode switch's connection is intermittently disconnected (the input of the mode switch changes rapidly). Symptom: - The switch is fixed to normal mode. Action: - Check W/N/P mode switch input circuit for short or open circuit. - Check W/N/P mode switch wiring. - Replace W/N/P mode switch if necessary. - Returns to the normal operation if the failure does not occur within 3 seconds.

DTC Code	Defective	Cause and Action
P0742	Torque converter clutch engaged	Cause: - Torque conver clutch is engaged when solenoid valve (S7) is not operated. - The rpm of engine and output shaft is not consistent with the characteristic under the condition with torque converter not engaged. • Allowable slip rpm of torque converter < 50 rpm Symptom: - Torque converter clutch is locked. Action: - Check solenoid valve (S7) wiring for short to B+. - Replace solenoicd valve (S7) if necessary. - Check T/M connector TCU connector for their proper connection. - Replace TCU if necessary. - Returns to the normal operation if the failure does not occur within 30 seconds.
P0710	Defective T/M oil temperature sensor	Cause: - Oil temperature of T/M exceeds the specified value. • Oil temperature sensor voltage > 4.88 V • Oil temperature sensor voltage < 0.21 V Symptom: - Oil temperature is fixed to 120°C - Shifting impression is poor. Action: - Check T/M oil temperature sensor for short or open circuit. - Check T/M connector and TCU connector for proper connection. - Replace TCU if necessary. - Returns to the normal operation if the failure does not occur within 3 seconds.
P0790	Defective W/N/P mode switch	Cause: - The W/N/P mode switch's connection is intermittently disconnected (the input of the mode switch changes rapidly). Symptom: - The switch is fixed to normal mode. Action: - Check W/N/P mode switch input circuit for short or open circuit. - Check W/N/P mode switch wiring. - Replace W/N/P mode switch if necessary. - Returns to the normal operation if the failure does not occur within 3 seconds.

Modification basis	
Application basis	
Affected VIN	

DTC Code	Defective	Cause and Action
P1703	Abnormal engine rpm (CAN)	Cause: - The engine rpm signal (CAN) is out of specified value or there is no engine rpm signal. • Engine rpm < 0 rpm • Engine rpm > 7000 rpm Symptom: - The engine rpm corresponding to the max. engine torque is applyed to the shifting condition. Action: - Check ECU and TCU connectors for poor contact. - Replace TCU if necessary. - Returns to the normal operation if the failure does not occur within 3 seconds.
P1704	Abnormal output shaft rpm (CAN)	Cause: - The output shaft signal (CAN) is out of specified value or there is no output shaft signal. • Output shaft rpm < 0 rpm • Output shaft rpm > 9000 rpm - The actual vehicle speed is 0 while other signals indicate that vehicle is moving. Symptom: - Cannot shift down by limiting the engine rpm to prevent the engine from overrunning. Action: - Check ECU and TCU connectors for poor contact. - Replace TCU if necessary. - Returns to the normal operation if the failure does not occur within 3 seconds and the rpm is over 0.
P1708	Low TCU supply voltage	Cause: - The TCU supply voltage is low or there is no measured voltage value. Symptom: - Cannot shift to 1st gear position. - Cannot shift to other gear positions due to the low supply voltage. - No. 6 solenoid valve (S6) stops from its operation. Action: - Check TCU terminal for poor contact, bending or deformation. - Replace TCU if necessary. - Returns to the normal operation if the failure does not occur within 30 seconds.
P1709	High TCU supply voltage	Cause: - The TCU supply voltage is high. • TCU supply voltage > 16.5 V Symptom: - All solenoid valves stop from their operation when high battery voltage is detected. - Enters into the emergency mode. Action: - Check TCU terminal for short to B+ or short to ground. - Replace TCU if necessary. - Returns to the normal operation if the failure does not occur within 30 seconds.

DTC Code	Defective	Cause and Action
P1713	Defective accelerator pedal signal (CAN)	Cause: - The accelerator pedal signal (CAN) is out of the specified value. • Accelerator pedal signal < 0 % • Accelerator pedal signal > 100 % Symptom: - Cannot shift to 4th gear position. - Torque converter clucth stops from its operation. - The interior default value is applied for shift determination (if the accelerator pedal signal is defective, ECU selects the default value and sends it and error message to TCU via CAN line). - The accelerator pedal signal is not used for P, R, N B2. Action: - Check ECU and TCU connectors for poor contact and their terminals for bend or deformation. - Replace TCU if necessary. - Returns to the normal operation if the failure does not occur within 30 seconds.
P1714	Defective vehicle coding	Cause: - The vehicle coding stored in EEPROM is defective (self-test when IGN ON). Symptom: - Determines the vehicle coding value via CAN communication or selects 0 for the coding value. - Shifting impression is poor. Action: - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1715	Abnormal VPS offset	Cause: - VPS (Variable pressure solenoid valve) is used for controlling clutch and band pressure while shifting. - The VPS offset stored in EEPROM is incorrect (self-test when IGN ON). • VPS offset > 120 mA Symptom: - Shifting impression is poor. Action: - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1717	Defective RAM	Cause: - RAM operates abnormally. (self-test when IGN ON) Symptom: - No output signal. - Enters into the emergency mode. Action: - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1718	Defective ROM	Cause: - The program memory is defective (self-test when IGN ON). - The calculated checksum value is not consistent with the stored checksum value. Symptom: - No output signal. - Enters into the emergency mode. Action: - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.

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DTC Code	Defective	Cause and Action
P1719	Abnormal CAN communication	Cause: - Cannot use information necessary for TCU via CAN communication. Symptom: - The default value is used for all CAN signals. - Enters into the emergency mode. Action: - Check ECU and TCU connectors wiring for poor contact. - Check ECU and TCU connectors' terminals for bend or deformation. - Replace TCU if necessary. - Returns to the normal operation if the failure does not occur within 30 seconds.
P1720	Defective EEPROM	Cause: - EEPROM memory is defective. - The calculated checksum value is not consistent with the stored checksum value or the error occurs in EEPROM communication. (self-test when IGN ON) Symptom: - Determines the vehicle coding value via CAN communication or selects 0 for the coding value. - Shifting impression is poor. Action: - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1722	Incorrect vehicle model	Cause: - Cannot detect the vehicle coding through EEPROM or CAN communication. Symptom: - Selects 0 for the coding value. - Enters into the emergency mode. Action: - Check TCU connector and terminals for poor contact. - DTC disappears after turning ignition from OFF to ON.
P1733	No. 1 solenoid valve open	Cause: - The No. 1 solenoid valve operates with the No. 2 solenoid valve to control the oil flow for the 1-2 shift valve. - The No.1 solenoid valve internal circuit or solenoid valve wiring is open. - The solenoid valve connection is short to B+. Symptom: - The No. 1 solenoid valve is OFF. - Enters into the emergency mode. Action: - Check No. 1 solenoid valve wiring and connector (especially its ground condition). - Specified resistance value: 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No.1 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.

DTC Code	Defective	Cause and Action
P1734	No. 2 solenoid valve open	Cause: - The No. 2 solenoid valve operates with the No. 1 solenoid valve to control the oil flow for the 2-3 shift valve. - The No. 2 solenoid valve circuit is open. - The solenoid valve connection is short to B+. Symptom: - The No. 2 solenoid valve is OFF. - Enters into the emergency mode. Action: - Check No. 2 solenoid valve wiring and connector (especially, its ground condition). - Specified resistance value: 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No.2 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1735	No. 3 solenoid valve open	Cause: - The No. 3 solenoid valve operates with the No. 4 solenoid valve to shift smoothly and control the shifting order. - The No. 3 solenoid valve turns the clutch regulator valve ON and OFF. - The No. 3 solenoid valve circuit is open. - The solenoid valve connection is short to B+. Symptom: - The No. 3 solenoid valve is OFF. - Shifting impression is poor. Action: - Check No. 3 solenoid valve wiring and connector (especially, its ground condition). - Specified resistance value: 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No.3 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.

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DTC Code	Defective	Cause and Action
P1736	No. 4 solenoid valve open	Cause: - The No. 4 solenoid valve operates with the No. 3 solenoid valve to shift smoothly and control the shifting order. - The No. 4 solenoid valve turns the clutch regulator valve ON and OFF. - The No. 4 solenoid valve circuit is open. - The solenoid valve connection is short to B+. Symptom: - The No. 4 solenoid valve is OFF or ON. - Shifting impression is poor. Action: - Check No. 4 solenoid valve wiring and connector (especially, its ground condition). - Specified resistance value: 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No.4 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1737	No. 5 solenoid valve open	Cause: - The No. 5 solenoid valve is a variable solenoid valve to change the pressure for shifting. - The No. 5 solenoid valve circuit is open. - The solenoid valve connection is short to B+. Symptom: - The No. 4 solenoid valve is always OFF. - Shifting impression is poor. Action: - Check No. 5 solenoid valve wiring and connector (especially, its ground condition). - Specified resistance value: 3.6 ~ 5.5Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No.5 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1738	No. 6 solenoid valve open	Cause: - The No. 6 solenoid valve is used to set the hydraulic line pressure to HIGH/LOW level. - The No. 6 solenoid valve circuit is open. - The solenoid valve connection is short to B+. Symptom: - The hydraulic line pressure is high. (No. 6 solenoid valve stops its operation) - Cannot to shift to 1st gear position. Action: - Check No. 6 solenoid valve wiring and connector (especially, its ground condition). - Specified resistance value: 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No. 6 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.

DTC Code	Defective	Cause and Action
P1739	No. 7 solenoid valve open	Cause: - The No. 7 solenoid valve controls the operation of the torque converter clutch. - The No. 7 solenoid valve circuit is open. - The solenoid valve connection is short to B+. Symptom: - The No. 7 solenoid valve stops its operation (OFF). - The torque converter clutch cannot be locked. Action: - Check No. 7 solenoid valve wiring and connector (especially, its ground condition). - Specified resistance value: 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No. 7 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1741	No. 1 solenoid valve short	Cause: - The No. 1 solenoid valve operates with the No. 2 solenoid valve to control the oil flow for the 1-2 shift valve. - The No. 1 solenoid valve circuit is short to ground. Symptom: - The No. 1 solenoid valve is OFF. - Enters into the emergency mode. Action: - Check No. 1 solenoid valve wiring and connector (especially its ground condition). - Specified resistance value: 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No.1 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1742	No. 2 solenoid valve short	Cause: - The No. 2 solenoid valve operates with the No. 1 solenoid valve to control the oil flow for the 2-3 shift valve. - The No. 2 solenoid valve circuit is short to ground. Symptom: - The No. 2 solenoid valve is OFF. - Enters into the emergency mode. Action: - Check No. 2 solenoid valve wiring and connector (especially its ground condition). - Specified resistance value: 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No. 2 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.

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DTC Code	Defective	Cause and Action
P1743	No. 3 solenoid valve short	Cause: - The No. 3 solenoid valve operates with the No. 4 solenoid valve to shift smoothly and control the shifting order. - The No. 3 solenoid valve turns the clutch regulator valve ON and OFF. - The No. 3 solenoid valve circuit is short to ground. Symptom: - The No. 3 solenoid valve is OFF. - Shifting impression is poor. Action: - Check No. 3 solenoid valve wiring and connector (especially its ground condition). - Specified resistance value: 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No. 3 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1744	No. 4 solenoid valve short	Cause: - The No. 4 solenoid valve operates with the No. 3 solenoid valve to shift smoothly and control the shifting order. - The No. 4 solenoid valve turns the clutch regulator valve ON and OFF. - The No. 4 solenoid valve circuit is short to ground. Symptom: - The No. 4 solenoid valve is OFF. - Shifting impression is poor. Action: - Check No. 4 solenoid valve wiring and connector (especially its ground condition). - Specified resistance value: 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No. 4 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1745	No. 5 solenoid valve short	Cause: - The No. 5 solenoid valve is a variable solenoid valve to change the pressure for shifting. - The No. 5 solenoid valve circuit is short to ground. Symptom: - The No. 4 solenoid valve is always OFF. - Shifting impression is poor. Action: - Check No. 5 solenoid valve wiring and connector (especially, its ground condition). - Specified resistance value: 3.6 ~ 5.5Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No.5 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.

DTC Code	Defective	Cause and Action
P1746	No. 6 solenoid valve short	Cause: - The No. 6 solenoid valve is used to set the hydraulic line pressure to HIGH/LOW level. - The No. 6 solenoid valve circuit is short to ground. Symptom: - The hydraulic line pressure is high. (No. 6 solenoid valve stops its operation) - Cannot to shift to 1st gear position. Action: - Check No. 6 solenoid valve wiring and connector (especially, its ground condition). - Specified resistance value : 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No. 6 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.
P1747	No. 7 solenoid valve short	Cause: - The No. 7 solenoid valve controls the operation of the torque converter clutch. - The No. 7 solenoid valve circuit is short to ground. Symptom: - The No. 7 solenoid valve stops its operation (OFF). - The torque converter clutch cannot be locked. Action: - Check No. 7 solenoid valve wiring and connector (especially, its ground condition). - Specified resistance value: 22 ~ 30Ω - Check TCU connector for proper connection and its terminal for bend or deformation. - Replace No. 7 solenoid valve if necessary. - Replace TCU if necessary. - DTC disappears after turning ignition from OFF to ON.

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Trouble Code	Defectives	Action
P2000	Faulty TCU internal watchdog test	• Self-diagnosis with IGN ON. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P2001	Faulty TCU internal watchdog function	• Self-diagnosis. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P2002	Faulty TCU external watchdog test	• Self-diagnosis with IGN ON. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P2003	Faulty TCU external watchdog function	• Self-diagnosis. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P2004	Faulty TCU Clock	• Self-diagnosis. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P2005	Faulty TCU RAM	• Self-diagnosis with IGN ON. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P2006	Faulty TCU RAM CAN-Controller 1	• Self-diagnosis with IGN ON. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P2007	Faulty TCU RAM CAN-Controller 2	• Self-diagnosis with IGN ON. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P2008	Faulty TCU ROM	• Self-diagnosis with IGN ON. • When the TCU internal checksum is different from scanner checksum. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P200A	Faulty TCU EEPROM	• Self-diagnosis with IGN ON. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P200B	Faulty TCU CPU (internal)	• Self-diagnosis. • Check harness contact.
P200C	Faulty TCU program control	• Self-diagnosis. • Check harness contact.
P2010	No TCU variant coding	• Self-diagnosis with IGN ON. • When the TCU coding is not exist. • Check again after TCU coding.

Trouble Code	Defectives	Action
P2011	Faulty TCU variant coding	• Self-diagnosis with IGN ON. • When the TCU coding is faulty. • Check again after TCU coding.
P2012	Faulty TCU checksum	• Self-diagnosis with IGN ON. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P2013	Faulty TCU (internally)	• Self-diagnosis with IGN ON. • Cycle the IGN switch from OFF to ON. Check and replace TCU if the trouble still exists.
P2100	Defective 1-2, 4-5 shift solenoid valve	• When 1-2 or 4-5 shift solenoid valve is defective. • Measure the resistance of 1-2 or 4-5 shift solenoid valve (turn the IGN OFF, then and disconnect TCU connector). - TCU connector terminals: B12 (14), B3 (38) - Specified value: 3.8 ± 0.2 Ω • Triggered emergency mode when the defective is detected. - Fixed at 2nd gear in “D” range. • Check the related harness for open, short and contact.
P2101	1-2, 4-5 shift solenoid valve - short	• When 1-2 or 4-5 shift solenoid valve is defective. • Measure the resistance of 1-2 or 4-5 shift solenoid valve (turn the IGN OFF, then disconnect TCU connector). - TCU connector terminals: B12 (14), B3 (38) - Specified value: 3.8 ± 0.2 Ω • Triggered emergency mode when the defective is detected. - Fixed at 2nd gear in “D” range. • Check the related harness for open, short and contact.
P2102	Defective 2-3 shift solenoid valve	• When 2-3 shift solenoid valve is defective. • Measure the resistance of 2-3 shift solenoid valve (turn the IGN OFF, then disconnect TCU connector). - TCU connector terminals: B12 (14), B3 (38) - Specified value: 3.8 ± 0.2 Ω • Triggered emergency mode when the defective is detected. - Fixed at 2nd gear in “D” range. • Check the related harness for open, short and contact.
P2103	2-3 shift solenoid valve - short	• When 2-3 shift solenoid valve is defective. • Measure the resistance of 2-3 shift solenoid valve (turn the IGN OFF, then disconnect TCU connector). - TCU connector terminals: B12 (14), B3 (38) - Specified value: 3.8 ± 0.2 Ω • Triggered mechanical emergency mode when the defective is detected. - Fixed at 2nd gear in “D” range. • Check the related harness for open, short and contact.

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Trouble Code	Defectives	Action
P2104	Defective 3-4 shift solenoid valve	• When 3-4 shift solenoid valve is defective. • Measure the resistance of 3-4 shift solenoid valve (turn the IGN OFF, then disconnect TCU connector). - TCU connector terminals: B11 (15), B3 (38) - Specified value: 3.8 ± 0.2 Ω • Triggered mechanical emergency mode when the defective is detected. - Fixed at 2nd gear in “D” range. • Check the related harness for open, short and contact.
P2105	3-4 shift solenoid valve - short	• When 3-4 shift solenoid valve is defective. • Measure the resistance of 3-4 shift solenoid valve (turn the IGN OFF, then disconnect TCU connector). - TCU connector terminals: B11 (15), B3 (38) - Specified value: 3.8 ± 0.2 Ω • Triggered mechanical emergency mode when the defective is detected. - Fixed at 2nd gear in “D” range. • Check the related harness for open, short and contact.
P2106	Defective lockup clutch solenoid valve	• Measure the resistance of lockup clutch solenoid valve (turn the IGN OFF, then disconnect TCU connector). - TCU connector terminals: B9 (17), B3 (38) - Specified value: 2.5 ± 0.2 Ω • Triggered emergency mode when the defective is detected. - Fixed at 2nd gear in “D” range. • Check the related harness for open, short and contact.
P2107	Defective modulator pressure solenoid valve	• Measure the resistance of modulator pressure solenoid valve (turn the IGN OFF, then disconnect TCU connector). - TCU connector terminals: B5 (36), B3 (38) - Specified value: 5.0 ± 0.2 Ω • Triggered emergency mode when the defective is detected. - Fixed at 2nd gear in “D” range. • Check the related harness for open, short and contact.
P2108	Defective shift pressure solenoid valve	• Measure the resistance of shift pressure solenoid valve (turn the IGN OFF, then disconnect TCU connector). - TCU connector terminals: B4 (37), B3 (38) - Specified value: 5.0 ± 0.2 Ω • Triggered emergency mode when the defective is detected. - Electrical error: Fixed at 2nd gear in “D” range. • Check the related harness for open, short and contact.

Trouble Code	Defectives	Action
P2200	Faulty speed sensor N2 signal	• When the speed sensor N2 detects 0 rpm of front sun gear speed. • Check the related harness for open, short and contact. - TCU connector terminal B14: rectangular wave signal B8: signal ground B13: 6V
P2203	Faulty speed sensor N3 signal	• When the speed sensor N3 detects 0 rpm of planetary gear carrier speed. • Check the related harness for open, short and contact. - TCU connector terminal B6: rectangular wave signal B8: signal ground B13: 6V
P220A	Abnormal speed sensor output signal (N2, N3)	• When the rpm difference between speed sensor N2 and N3 is over 150 rpm. • Check the related harness for open, short and contact.
P2220	T/M Oil temperature sensor - short	• Turn the IGN OFF, then disconnect TCU connector. • Selector lever position: R or D • T/M Measure the resistance of oil temperature sensor. • TCU connector terminals B7, B8 • Check the related harness for open, short and contact.
P2221	Abnormal T/M oil temperature sensor signal	• Turn the IGN OFF, then disconnect TCU connector. • Selector lever position: R or D • Measure the resistance of T/M oil temperature sensor. • TCU connector terminals: B7, B8 • Check the related harness for open, short and contact.
P2222	Abnormal T/M oil temperature sensor signal	• Turn the IGN OFF, then disconnect TCU connector. • Selector lever position : R or D • Measure the resistance of T/M oil temperature sensor. • TCU connector terminals: B7, B8 • Check the related harness for open, short and contact.
P2300	Faulty CAN communication	• Turn the IGN OFF, then disconnect TCU connector. • Check the communication line for open, short and contact. • Measure the resistance of CAN line: B1, B2 • Specified value : approx. 120 W
P2301	Faulty CAN communication	• Turn the IGN OFF, then disconnect TCU connector. • Check the communication line for open, short and contact. • Measure the resistance of CAN line: B1, B2 • Specified value : approx. 120 W
P2310	CAN: Faulty brake system communication	• Check CAN communication line H and L. • Check ABS/ESP unit. • Check the related harness for open, short and contact.

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Trouble Code	Defectives	Action
P2311	CAN: Faulty ECU communication	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.
P2312	CAN: Faulty ECU communication	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.
P2313	CAN: Faulty selector lever control communication	• Check CAN communication line H and L. • Check selector lever. • Check the related harness for open, short and contact.
P2315	CAN: Faulty instrument panel communication	• Check CAN communication line H and L. • Check instrument cluster. • Check the related harness for open, short and contact.
P2317	CAN: Faulty communication between TCCU/TOD and CAN (For 4WD only)	• Check CAN communication line H and L. • Check TCCU/TOD unit. • Check the related harness for open, short and contact.
P2330	CAN: Faulty brake system signal	• Check CAN communication line H and L. • Check ABS/ESP unit. • Check the related harness for open, short and contact.
P2331	CAN: Faulty ECU message	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.
P2332	CAN: Faulty ECU message	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.
P2333	CAN: Faulty selector lever signal	• Check CAN communication line H and L. • Check selector lever. Check selector lever. • Check the related harness for open, short and contact.
P2335	CAN: Faulty instrument cluster signal	• Check CAN communication line H and L. • Check instrument cluster. • Check the related harness for open, short and contact.
P2337	CAN: Faulty TCCU/TOD (For 4WD only)	• Check CAN communication line H and L. • Check TCCU/TOD unit. • Check the related harness for open, short and contact.
P2400	CAN: Faulty rear RH wheel speed sensor signal	• Check CAN communication line H and L. • Check ABS/ESP unit. - Check wheel speed sensor connector. - Check the air gap between tooth wheel and wheel speed sensor. (Air gap: 0.309 ~ 0.958 mm) - Check the numbers of tooth wheel: 48 • Check the related harness for open, short and contact.

Trouble Code	Defectives	Action
P2401	CAN: Faulty rear LH wheel speed sensor signal	• Check CAN communication line H and L. • Check ABS/ESP unit. - Check wheel speed sensor connector. - Check the air gap between tooth wheel and wheel speed sensor. (Air gap: 0.309 ~ 0.958 mm) - Check the numbers of tooth wheel: 48 • Check the related harness for open, short and contact.
P2402	CAN: Faulty front RH wheel speed sensor signal	• Check CAN communication line H and L. • Check ABS/ESP unit. - Check wheel speed sensor connector. - Check the air gap between tooth wheel and wheel speed sensor. (Air gap: 0.335 ~ 0.945 mm) - Check the numbers of tooth wheel: 48
P2403	CAN: Faulty front LH wheel speed sensor signal	• Check CAN communication line H and L. • Check ABS/ESP unit. - Check wheel speed sensor connector. - Check the air gap between tooth wheel and wheel speed sensor. (Air gap: 0.335 ~ 0.945 mm) - Check the numbers of tooth wheel: 48
P2404	CAN: No brake signal	• Check CAN communication line H and L. • Check ABS/ESP unit. • Check the related harness for open, short and contact.
P2405	CAN: No accelerator pedal signal	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.
P2406	CAN: No engine torque signal	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.
P2407	CAN: No ESP signal	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.
P2408	CAN: No minimum engine torque signal	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.
P2409	CAN: No maximum engine torque signal	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.
P240A	CAN: No engine rpm signal	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.

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Trouble Code	Defectives	Action
P240B	CAN: No engine coolant temperature signal	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.
P240C	CAN: No selector lever position signal	• Check CAN communication line H and L. • Check selector lever. • Check the related harness for open, short and contact.
P240D	CAN: No transfer case position signal (For 4WD only)	• Check CAN communication line H and L. • Check TCCU/TOD unit. • Check the related harness for open, short and contact.
P2500	Invalid transmission gear ratio	• Cycle the IGN switch from OFF to ON. Check A/T system again after a certain period of driving. • If the trouble still exists, replace A/T assembly. • To protect transmission, any shift is not available.
P2501	Excessive engine rpm	• Check CAN communication line H and L. • Check engine ECU. • Check the related harness for open, short and contact.
P2503	Faulty recognition of currently selected gear	• Check selector lever. • Check the related harness for open, short and contact.
P220B	Excessive N2, N3 rpm	• Check speed sensor N2 and N3.
P2510	Torque converter lockup clutch stuck	• Check the hydraulic lines for leaks (valve No.22 in valve body). • Check the resistance of lockup clutch solenoid valve (Turn the IGN OFF, then disconnect TCU connector). - TCU connector terminals B9 (17), B3 (18) - Specified value : 2.5 ± 0.2 W • Triggered emergency mode when the defective is detected. - Fixed at 2nd gear in “D” range. • Check the related harness for open, short and contact.
P2511	Faulty torque converter lockup heat control	• Check the hydraulic lines for leaks.
P2520	Faulty recognition of torque reduction	• Check ECU.
P2502	Poor gear mesh, transmission slip	• Check the hydraulic lines for leaks. • Check oil filter.
P2600	Too low TCU supply voltage	• Check TCU supply voltage.
P2601	Too high TCU supply voltage	• Check TCU supply voltage.
P2602	Abnormal solenoid valve supply voltage	• Check solenoid supply voltage.
P2603	Abnormal speed sensor supply voltage	• Check speed sensor supply voltage. - TCU connector terminals B13 (13) : 6V

Memo

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DIAGNOSIS

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DTC	Malfunction	Help tips
P1000-1	Defective program memory	Cause: The calculated checksum value is not consistent with the stored checksum value. Symptom: - Solenoid valve is inoperative. - Backup lamp is OFF. - CAN bus is OFF. - All shift lever position indicators are OFF. Action: - Reset the unit by cyling the ignition switch (OFF → ON) several times.
P1000-2	Defective data memory	Cause: The malfunction is occurred during the RAM memory test with the ignition ON. Symptom: - Solenoid valve is inoperative. - Backup lamp: OFF - CAN bus: OFF - All shift lever position indicators: OFF Action: - If the malfunction stays after turning the ignition switch from OFF to ON, replace the TGS lever.
P1000-3	Faulty MCU reset	Cause: The malfunction is occurred during the microprocessor test with the ignition ON. Symptom: - Solenoid valve is inoperative. - Backup lamp is OFF. - CAN bus is OFF. - All shift lever position indicators are OFF. Action: - Reset the unit by cyling the ignition switch (OFF → ON) several times.
P1000-4	Faulty MCU data process	
P1000-5	Faulty MCU watchdog function	
P1000-6	Too long MCU data throughput time	
P1750-2	Low battery voltage	Cause: The battery voltage is low. (Specified value: less than 8.0 ± 0.3 V for 50 ms) Symptom: - All shift lever position indicators are OFF. Action: - The operation is automatically resumed if the battery voltage is over 8.7 ± 0.3 V for 50 ms. - Check the shift lever connector and power line for contact.
P1817-1	Faulty backup lamp operating current	Cause: The operating current is over 14 ~ 36 A for 50 ms when the backup lamp is in ON condition. Symptom: - Backup lamp is OFF. - Current shift lever indicator is flashing. - Indicator “R” is flashing in “R” position. Action: - Check the input and output wirings of backup lamp for open and short.
P1832-1	Faulty solenoid operating current	Cause: The solenoid valve operating current is over 3 ~ 5 A when the solenoid is operating. Symptom: - Solenoid valve is OFF. - Current shift lever indicator is flashing. Action: - The operation is automatically resumed since the interior temperature is normally within the solenoid operating temperature range. If the problem stays, check the power to the shift lever.

DTC	Malfunction	Help tips
P1833-2	Open solenoid valve circuit	Cause: The solenoid valve circuit is open or short to battery for 50 ms when the solenoid valve is OFF. Symptom: - Solenoid valve is OFF. - Current shift lever indicator is flashing. Action: - Check the power terminal to the shift lever.
P1856-1	Short shift lever position signal (to B+)	Cause: The shift lever position sensor or the power supply is malfunctioning. Symptom: - All shift lever position indicators are flashing.. - The incorrect lever position signal is transmitted through the CAN line. Action: - The operation is automatically resumed if the fault is not detected for 100 ms. - Check the power supply terminal to the shift lever.
P1856-2	Open or short shift lever position signal (to GND)	Cause: The shift lever position sensor is open or short to ground. Symptom: - All shift lever position indicators: flashing. - The incorrect lever position signal is transmitted through the CAN line. Action: - The operation is automatically resumed if the fault is not detected for 100 ms. - Check the power supply terminal to the shift lever.
P1856-3	Abnormal shift lever position signal	Cause: The shift lever position sensor signal is incorrect. Symptom: - All shift lever position indicators are flashing. - The incorrect lever position signal is transmitted through the CAN line. Action: - The operation is automatically resumed if the fault is not detected for 100 ms. - Check the power supply terminal to the shift lever.
P1856-4	Incorrect shift lever position sensor coding	Cause: The calibration value of shift lever position sensor is not stored or not consistent with the stored value. Symptom: - All shift lever position indicators are flashing. - The incorrect lever position signal is transmitted through the CAN line. Action: - Reset the unit by cyling the ignition switch (OFF → ON) several times. - Check the shift lever and replace it if necessary.
P1860-2	Faulty vehicle speed signal	Cause: The vehicle speed is detected as 300 km/h. Symptom: - The gear is shifted as for the vehicle speed is 0 km/h. - Current shift lever position indicator is flashing. Action: - The operation is automatically resumed if the fault is not detected. * For the shift lever, the vehicle speed data is needed to the solenoid valve operation for R/P lock and N lock function.
P1875-3	Faulty CAN bus OFF signal	Cause: The CAN bus OFF condition of the CAN controller is detected for 3 times in the unit. Symptom: - Cannot send the CAN message. - Current shift lever position indicator is flashing. Action: - Check the CAN communication line for open or short. - Check the shift lever and replace it if necessary. * CAN Bus OFF: The status that the CAN communication is totally interrupted if there is an error in the sent/received data through the CAN communication in the unit.

Modification basis	
Application basis	
Affected VIN	

DTC	Malfunction	Help tips
P1876-1	Abnormal CAN communication (vehicle speed)	Cause: There is no vehicle speed signal via CAN communication for 500 ms. Symptom: - The gear is shifted as for the vehicle speed is 0 km/h. - Current shift lever position indicator is flashing. Action: - Check the CAN communication line.
P1910-1	High battery voltage	Cause: The battery voltage is too high. (Specified value: Over 16.3 ± 0.3 V for 50 ms) Symptom: - All shift lever position indicators: OFF Action: - The operation is automatically resumed if the battery voltage is over 16.3 ± 0.3 V for 50 ms. - Check the shift lever power supply line.
P1912-1	Open/Short shift lever tip switch signal (to B+)	Cause: The shift lever tip switch signal is open or short to B+. Symptom: - Indicator “M” is flashing due to malfunction when the shift lever is in manual mode position. - If the shift lever is not in “M” position, the malfunction is overridden. Action: - The operation is automatically resumed if the fault is not detected for 50 ms. - Check the shift lever tip switch.
P1912-2	Short shift lever tip switch signal s(to GND)	Cause: The shift lever tip switch signal is open or short to ground. Symptom: - Indicator “M” is flashing due to malfunction when the shift lever is in the manual mode position. - If the shift lever is not in “M”, the malfunction is overridden. Action: - The operation is automatically resumed if the fault is not detected for 50 ms. - Check the shift lever tip switch.
P1912-3	Abnormal shift lever tip switch signal	Cause: The shift lever tip switch signal is faulty. Symptom: - Indicator “M” is flashing due to malfunction when the shift lever is in the manual mode position. - If the shift lever is not in “M” position, the malfunction is overridden. Action: - The operation is automatically resumed if the fault is not detected for 50 ms. - Check the shift lever tip switch.
P1912-4	Open/Short steering wheel tip switch signal (to B+)	Cause: The steering wheel tip switch signal is open or short to B+. Symptom: - Indicator “M” is flashing due to malfunction when the shift lever is in the manual mode position. - If the shift lever is not in “M” position, the malfunction is overridden. - The operation is automatically resumed if the fault is not detected for 50 ms. - Check the steering wheel's tip switch.
P1912-5	Open/Short steering wheel tip switch signal (to GND)	Cause: The steering wheel tip switch signal is open or short to ground. Symptom: - Indicator “M” is flashing due to malfunction when the shift lever is in the manual mode position. - If the shift lever is not in “M” position, the malfunction is overridden. Action: - The operation is automatically resumed if the fault is not detected for 50 ms. - Check the steering wheel tip switch.

DTC	Malfunction	Help tips
P1912-6	Abnormal steering wheel tip switch signal	Cause: The steering wheel tip switch signal is faulty. Symptom: - Indicator “M” is flashing due to malfunction when the shift lever is in the manual mode position. - If the shift lever is not in “M” position, the malfunction is overridden. Action: - The operation is automatically resumed if the fault is not detected for 50 ms. - Check the steering wheel tip switch.
P1912-7	Defective tip switch	Cause: The manual mode switch operates for 50 ms when the shift lever is P, R or N positions. Symptom: - Indicator “M” flashes if the shift lever is in D. - The mode is recognized as the manual mode even if the shift lever is in “D” position. Action: - The operation is automatically resumed if the fault is not detected for 50 ms and the shift lever is in P, R or N positions.
P1927-8	Faulty TCU shift	Check the TCU if there is errors related to the A/T shift.
P1928-4	Defective TCU CAN communication	Cause: The up/down shift command in not delivered to the TCU (faulty tip switch). - There is no CAN signal for 500 ms. Symptom: - Indicator “M” is flashing due to malfunction when the shift lever is in the manual mode position. - If the shift lever is not in “M” position, the malfunction is overridden. Action: - Check the CAN communication line.

Modification basis	
Application basis	
Affected VIN	

ENGINE FUEL SYSTEM

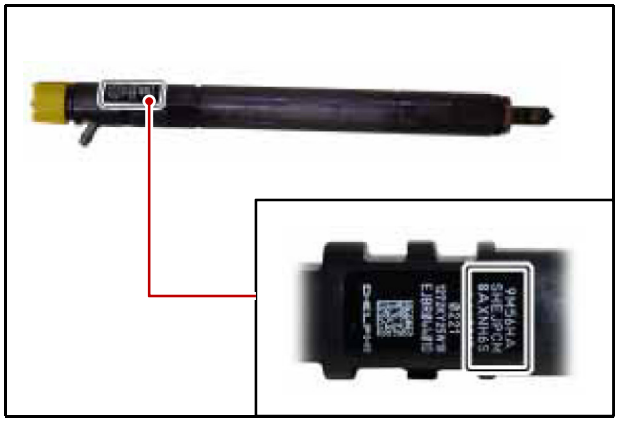
1881-09

GENERAL

1. MAJOR CHANGES IN FUEL SYSTEM OF ENGINE

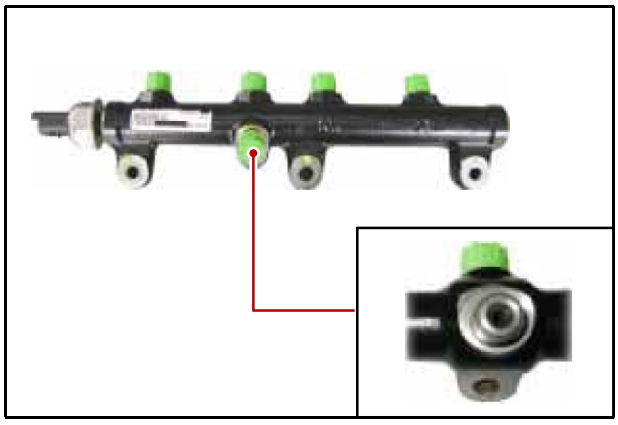
There are some changes in the parts related to the fuel system due to the newly adopted D20DT (EURO 4) engine.
The major changes are as follows. Refer to the next pages for further details.

1) Injector



- Two nozzle holes are added (currently 7) to the tip of the injector to increase the amount of fuel injection and to improve injection efficiency according to the increased engine power.
- The existing C2I coding (16 digits) is changed to C3I coding (20 digits) to monitor fuel injection and follow the target value.
- For the D20DT engine, the injector MDP (minimum current for the solenoid in the injector to lift the nozzle) is leaned only when the engine is running. However, for the D20DT (EURO 4) engine, it is learned when the vehicle is in motion and the engine is at idle speed.

2) Common Rail



- The orifice is added to the connection to the fuel pipe of the HP pump to prevent the fuel pulsation by the fuel supply and fuel cut according to the increase of injected fuel volume. (It is also installed on the connection of the high pressure fuel supply line of the HP pump.)

3) Fuel Rail - Chrome Color

Fuel pipe (Common rail → Injector)

Fuel high pressure pipe (HP pump → Common rail)

- The I.D and O.D of the fuel rail between HP pump and common rail are increased according to the increased amount of fuel injection.
  Also, the engine ECU, HFM sensor and EGR system are changed to control the fuel injection volume and engine more precisely.

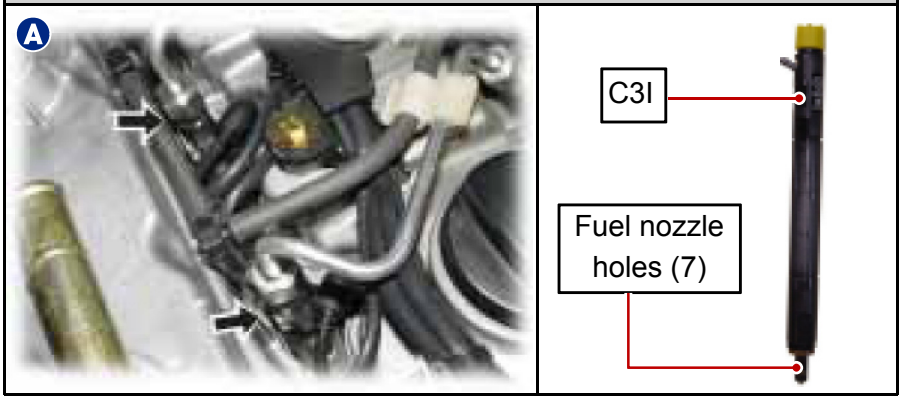
Modification basis	
Application basis	
Affected VIN	

Memo

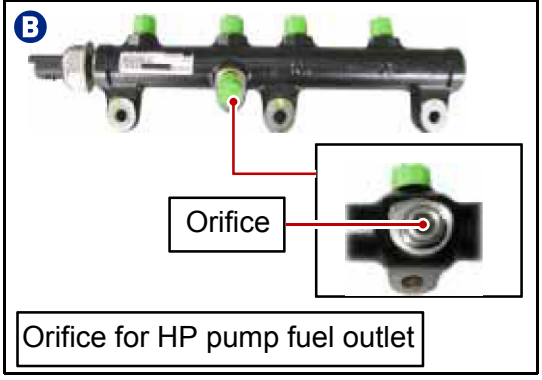
OVERVIEW AND OPERATION PROCESS

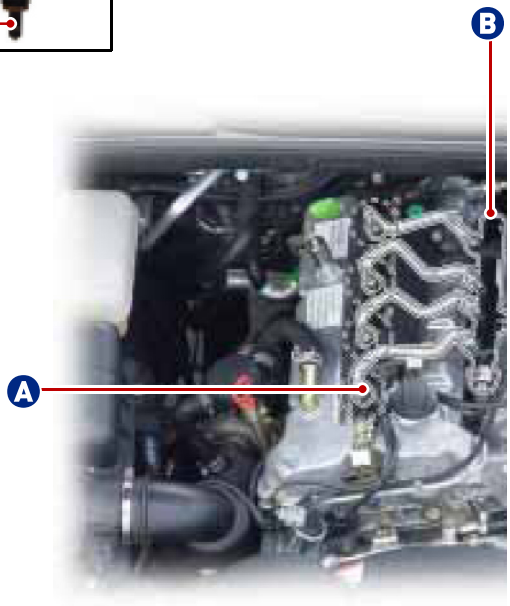
1. COMPONENTS OF FUEL SYSTEM

Injector (7-way Injection and C3I Coding)

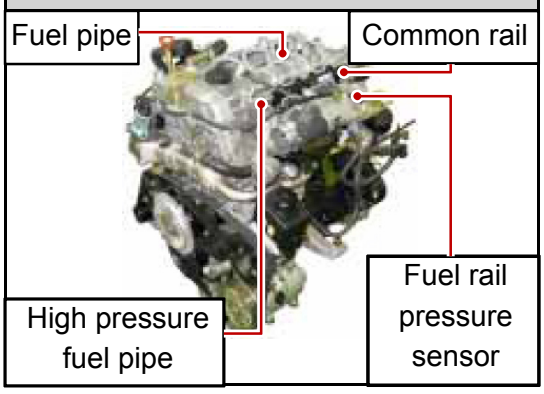


Common Rail (Orifice for Preventing Fuel Pulsation Added)

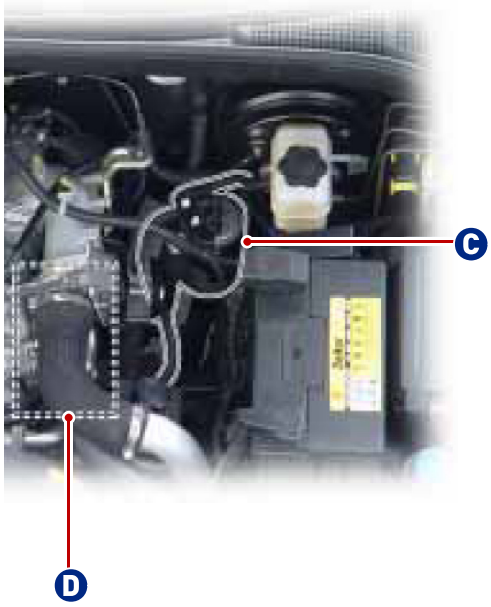




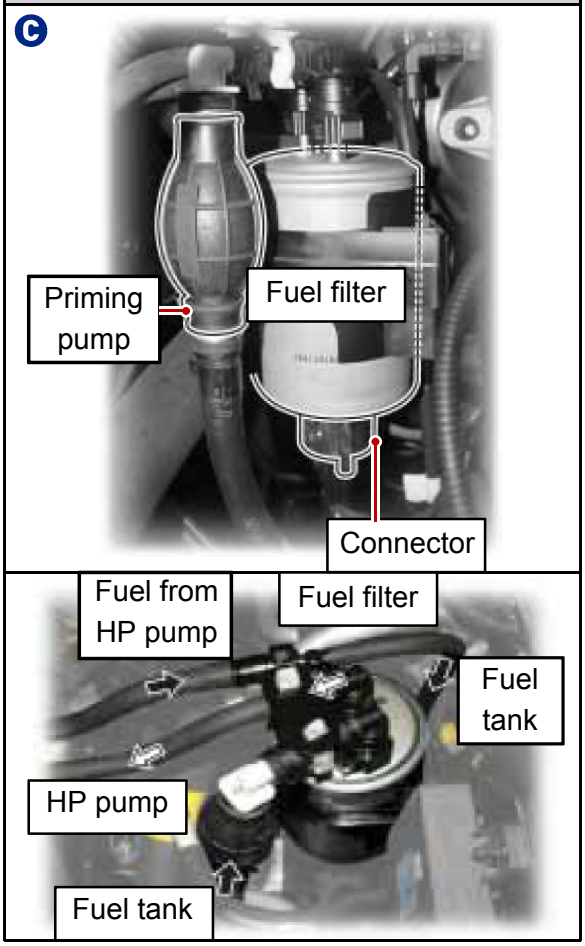
Fuel Supply Rail (Increase in I.D)



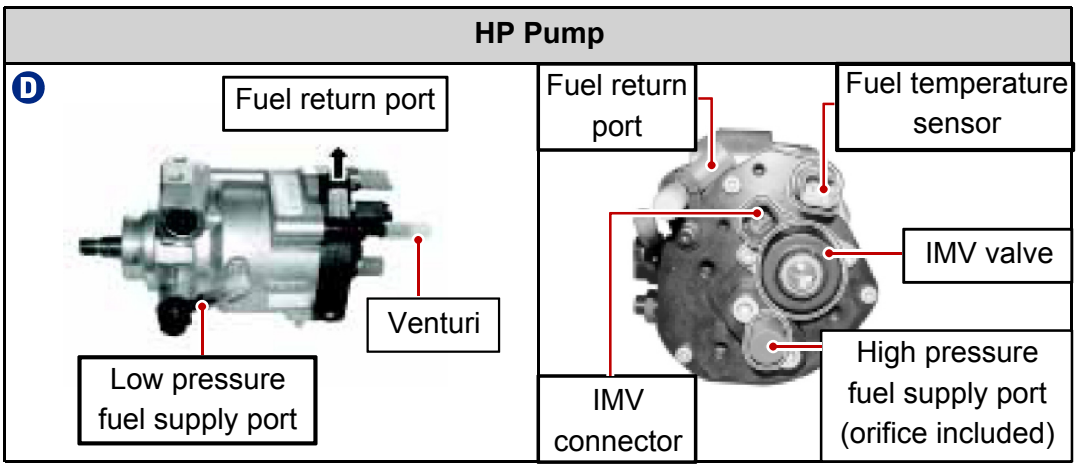
Modification basis	
Application basis	
Affected VIN	



Fuel filter Priming Pump

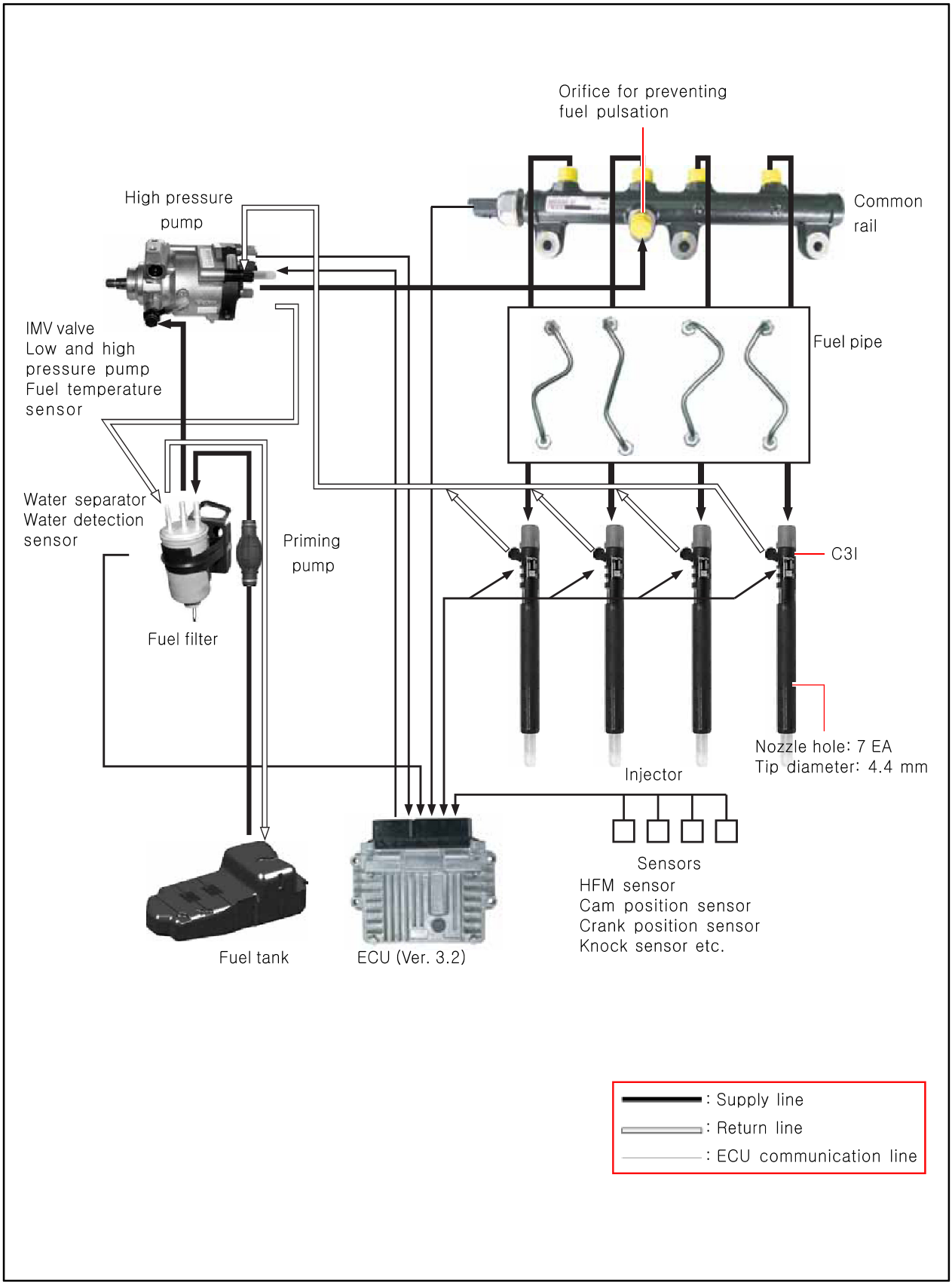


HP Pump



Modification basis	
Application basis	
Affected VIN	

2. FUEL FLOW OF D20DT (EU-IV) ENGINE



Modification basis	
Application basis	
Affected VIN	

ENGINE INTAKE SYSTEM 2321-01

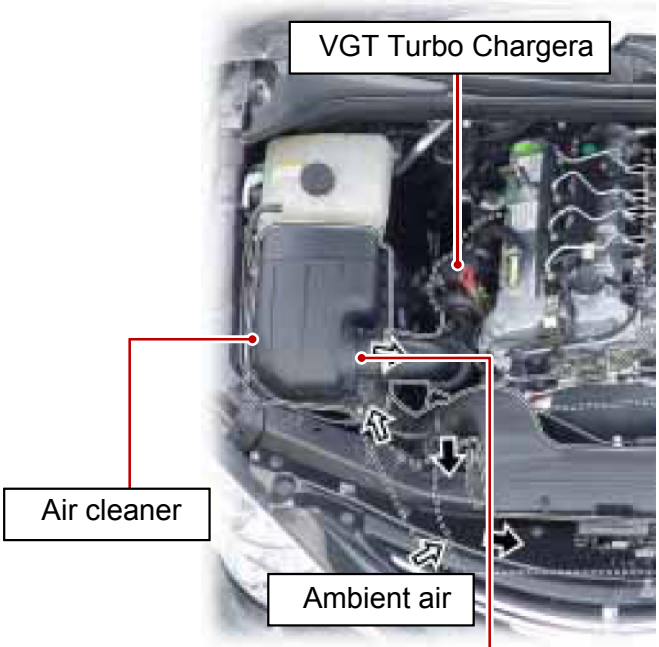
OVERVIEW AND OPERATION PROCESS

1. OVERVIEW

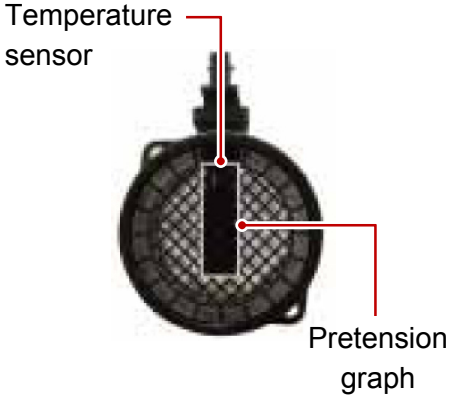
The intake system for the D20DT (EURO 4) engine is equipped with the throttle body that has a flap to block the air coming to the engine when the engine is switched off. Therefore, the structure of the intake manifold has been changed. Also, the improved HFM sensor (from HFM5.0 to HFM6.0) has been installed to control the intake air precisely so that the NOx in the exhaust gas can be decreased.

2. INTAKE SYSTEM LAYOUT

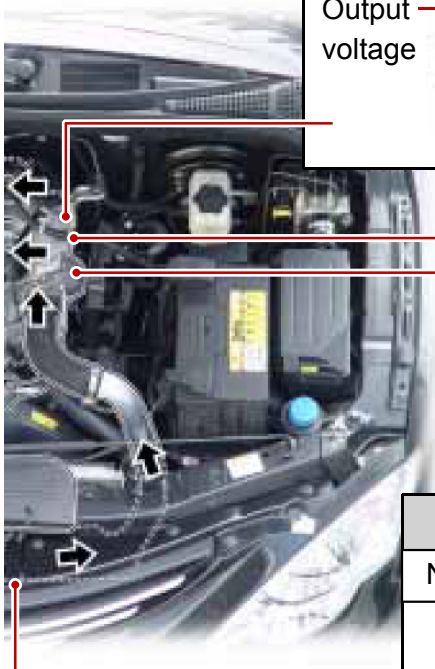
⇨ Uncompressed air
➡ Compressed air



HFM Sensor (ver. 6.0)



Modification basis	
Application basis	
Affected VIN	



Booster Pressure Sensor

Supply power

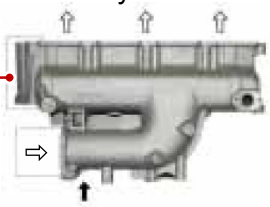
Ground

Output voltage

Intake Manifold

Coolant port

To corresponding cylinders



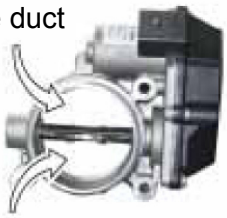
Compressed air

EGR gas

Throttle body

Normal: flap open

Intake duct



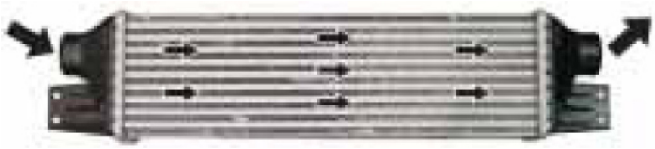
Intake duct

Engine stopped: flap closed

Intercooler

Turbo charger

Intake manifold (Throttle body)



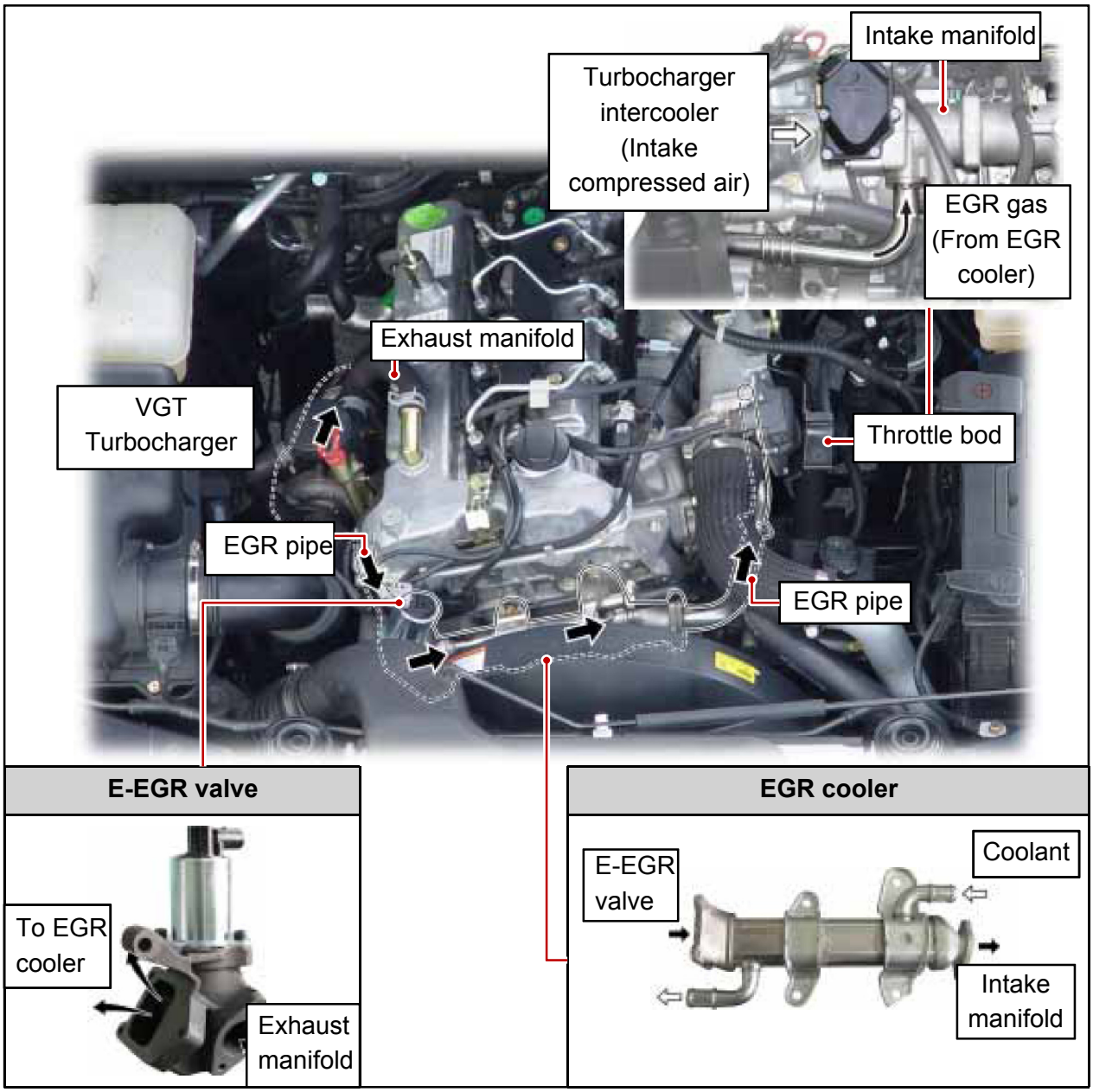
ENGINE EXHAUST SYSTEM 1792-01

OVERVIEW AND OPERATION PROCESS

1. COMPONENTS

The components of the exhaust system for the D20DT (EURO4) engine have been changed as follows:

- ▶ E-EGR valve - Controlling the EGR valve electrically and sends the valve location signal to ECU (vacuum modulator control has been deleted)
- ▶ EGR cooler - Decreasing EGR gas (NOx) efficiently by cooling the EGR gas and let it flow to the intake pipe



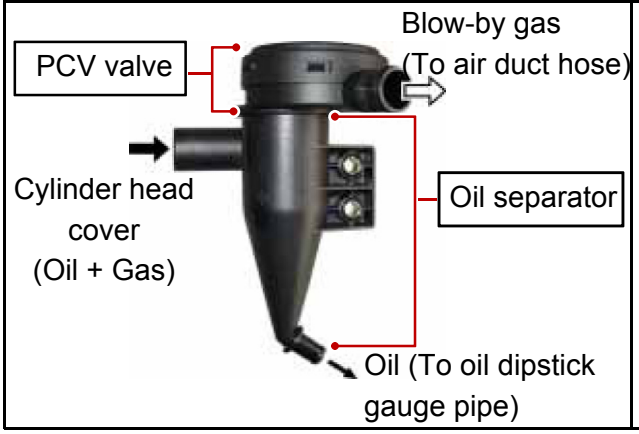
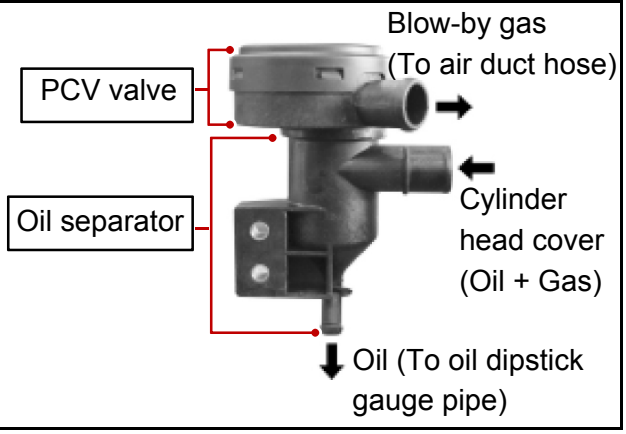
LUBRICATION SYSTEM

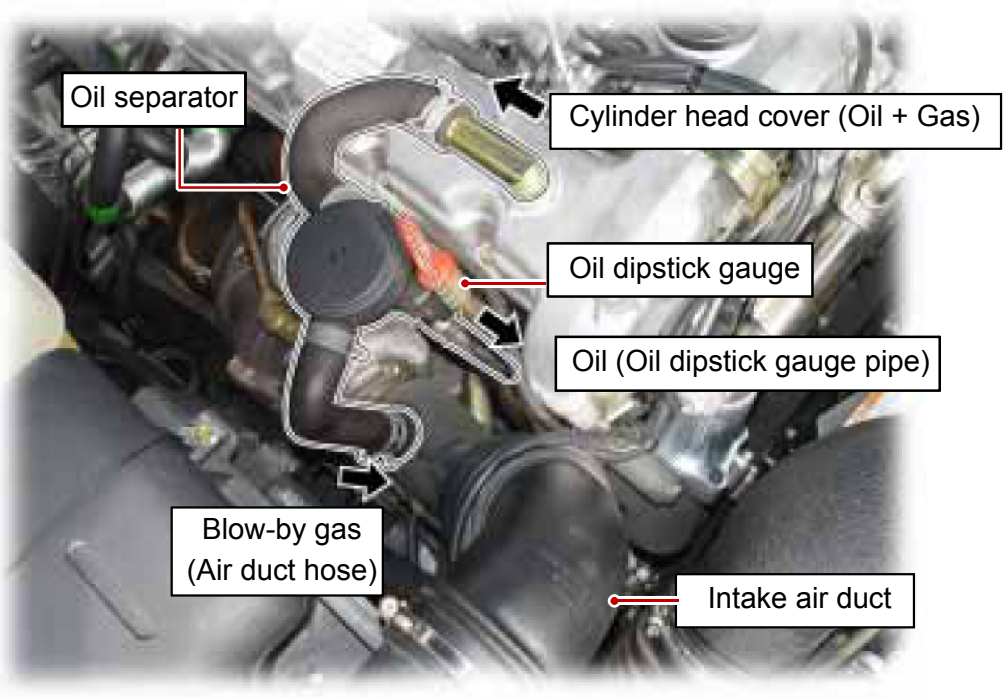
0000 -00

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW OIL SEPARATORS

For the D20DT (EURO4) engine, the PCV oil separator's capacity has been increased by 10% compared to the conventional PCV oil separator for D20DT engine to separate the oil and the gas more efficiently.

PCV Oil Separator (High Capacity Type)	PCV Oil Separator
	



The first separation will happen when blowby gas passes through baffle plates in cylinder head cover. Then oil and gas will be separated due to cyclone effect after entering the oil separator inlet port. Separated oil returns to oil pan via oil drain port and the gas will be burnt again after entering the combustion chamber through air duct hose via PCV valve that opens/closes due to pressure differences between the intake side and crankcase.

CAUTION

Performance of PCV Separator and Oil/Carbon Accumulation in Intake Manifold

It is not possible to separate the blowby gas (oil and unburned gas) completely from the crankcase.
This problem is related to the engine control and the PCV oil separator is designed to recirculate approx. 70% of blowby gas.

When servicing the intake system, you can find that oil and carbon is accumulated in the intake pipe.
It is normal for the vehicle that is normally used in city. Because of the engine control problem, the 100% of blowby gas cannot be recirculated and EGR and PCV oil separator's operating ranges are overlapped in normal driving mode. These are the cause of oil and carbon accumulated in the intake pipe.

When the EGR system is operated, the particulate material in the exhaust gas is drawn into the intake pipe and the oil not filtered in the PCV oil separator is also drawn into the intake pipe.

However, unless the particulate material or oil are accumulated excessively in the pipe, they do not affect the intake/exhaust valve or related components.

On the contrary, if they are removed using carbon cleaner or chemicals, the engine system may not function properly.

If too much oil or particulate material is accumulated, check the followings:

1. Engine oil level
2. EGR valve (exhaust gas leak and operating condition)
3. Turbocharger (oil/gas leak and operating condition)
4. PCV oil separator (installation condition and leak)
5. PCV oil separator (some functions)

Modification basis	
Application basis	
Affected VIN	

ENGINE COOLING SYSTEM

2112-00/1520-00

COOLING SYSTEM

1. COMPARISON IN COOLING SYSTEM FOR EACH ENGINE..... 3

WATER PUMP

1. OVERVIEW..... 4

Modification basis	
Application basis	
Affected VIN	

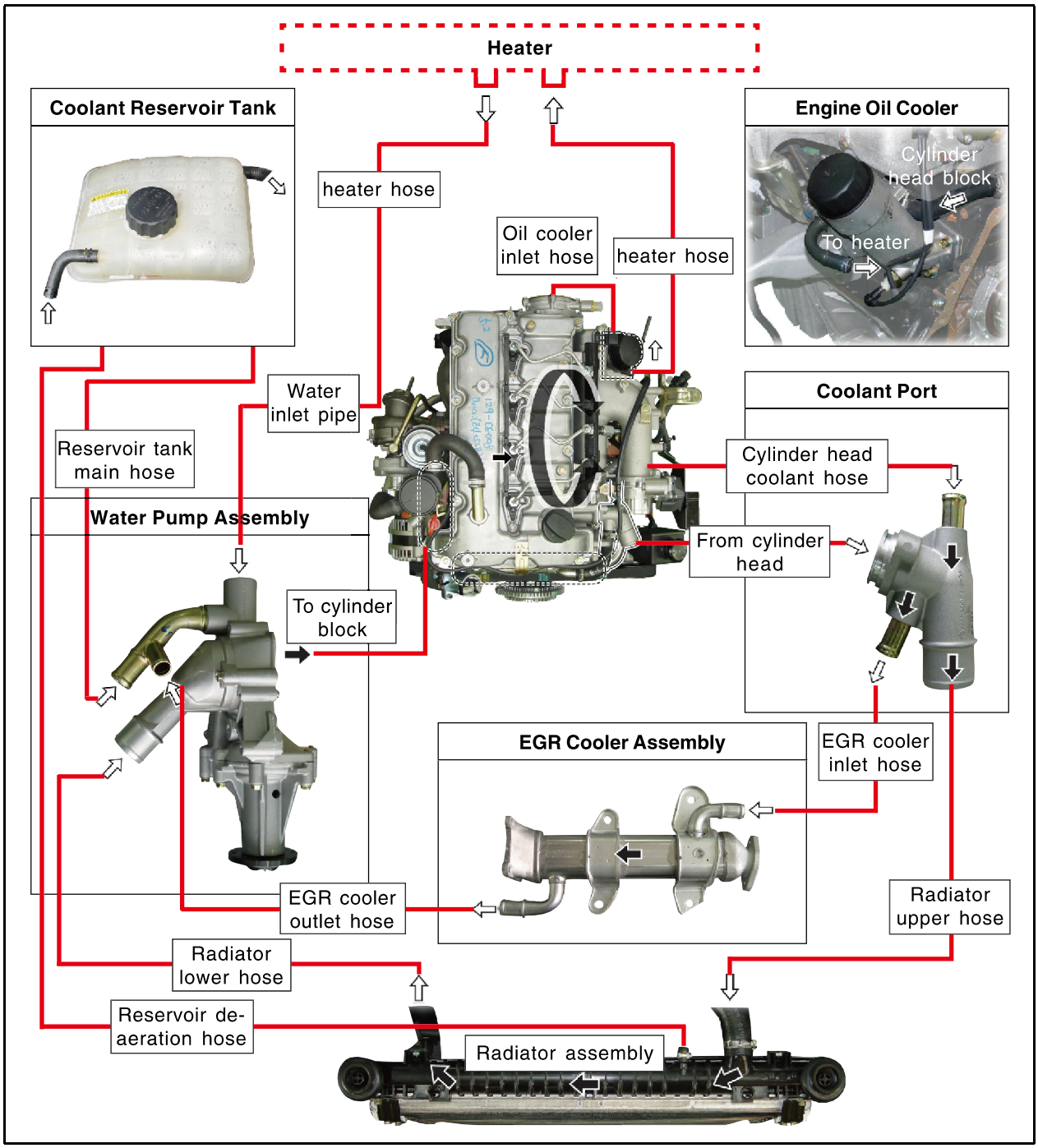
COOLING SYSTEM

2112-00

1. COMPARISON IN COOLING SYSTEM FOR EACH ENGINE

For the D20DT (EURO4) engine, the cooling system is equipped with E-EGR cooler and the water pump which its capacity is improved according to the additional coolant line in the cylinder block.

1) Cooling System for Engine



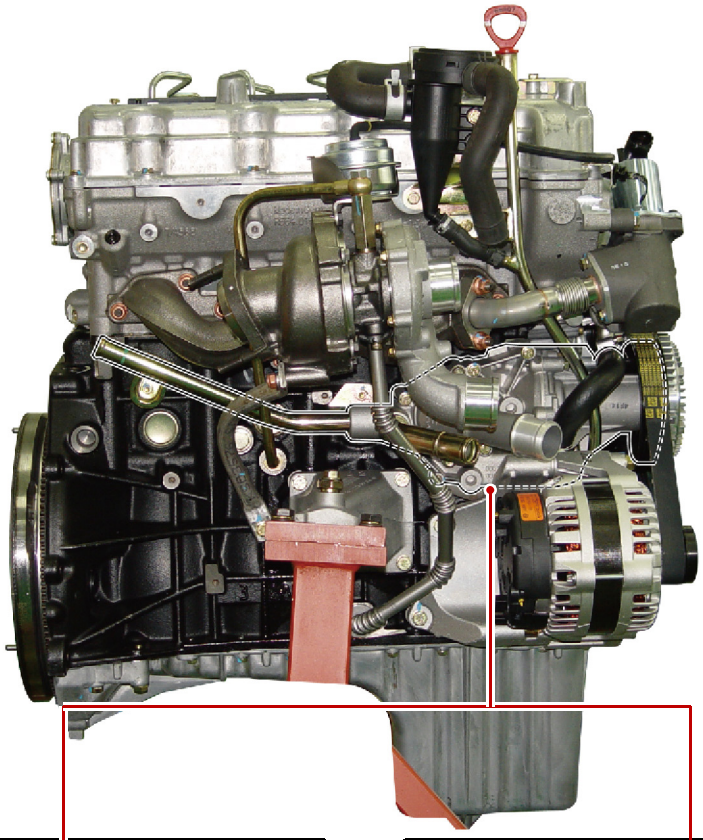
Modification basis	
Application basis	
Affected VIN	

WATER PUMP

1520-00

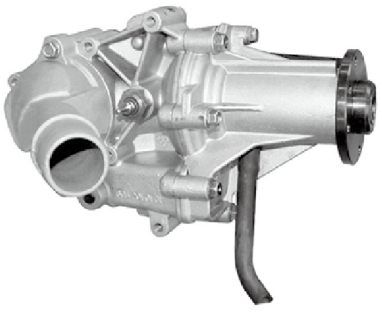
1. OVERVIEW

The belt-driven centrifugal water pump consists of an impeller, a drive shaft, and a belt pulley. The impeller is supported by a completely sealed bearing. The water pump is serviced as an assembly and, therefore, cannot be disassembled.
The capacity of water pump has been increased due to the EGR cooler, increased engine power and additional coolant port in the cylinder block.



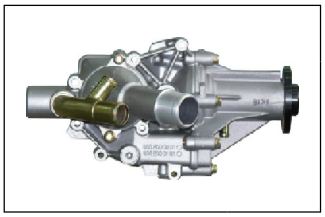
For D20DT (EURO4) engine

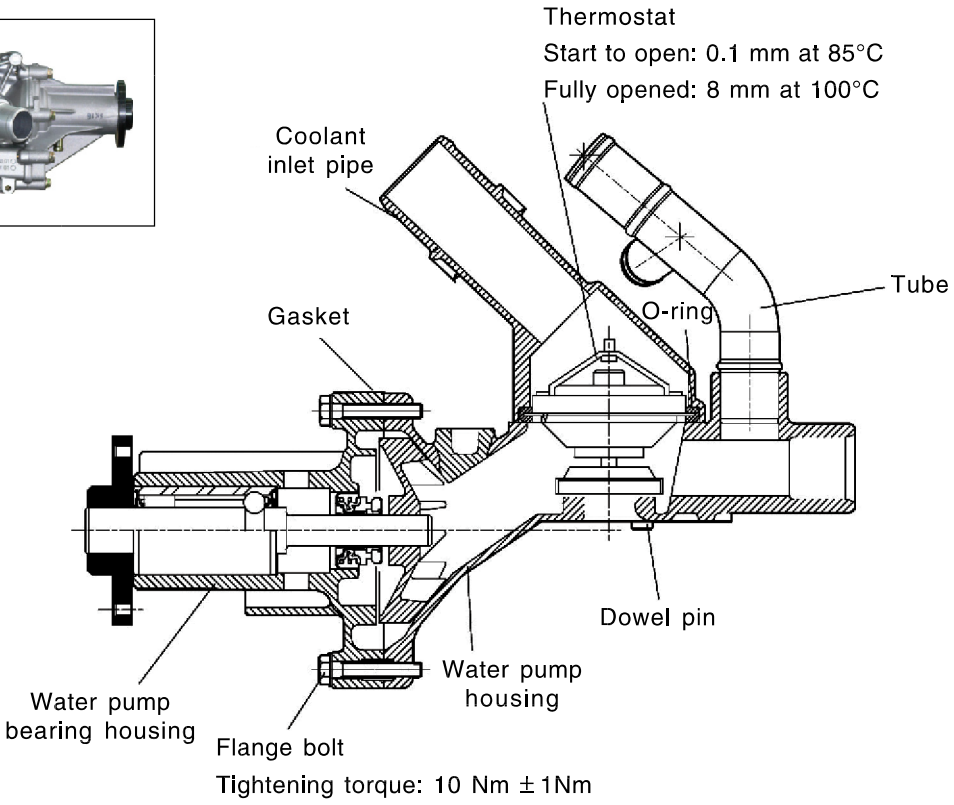
For D20DT engine

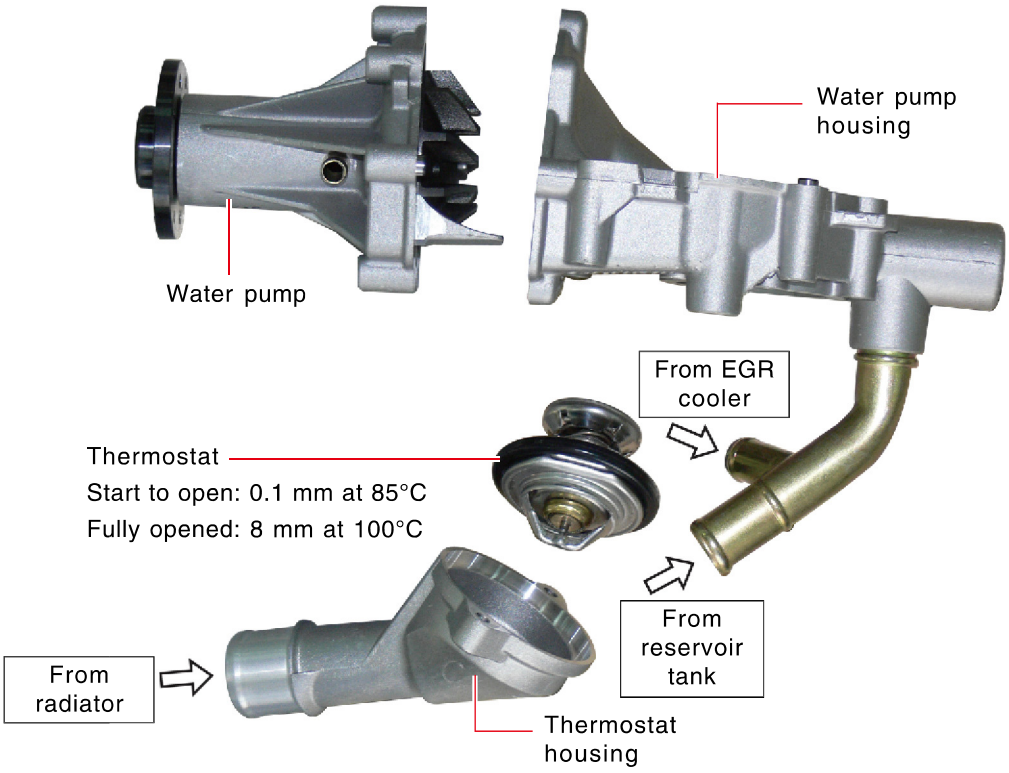


Modification basis	
Application basis	
Affected VIN	

1) Structure of Water Pump for D20DT Engine







Memo

ENGINE ELECTRIC DEVICES 1491-01

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW OF ENGINE ECU

The engine ECUs are various according to the engine model (D20DT engine, D20DT (EURO4) engine). For the D20DT (EURO4) engine, one connector is added to the engine ECU (2 connectors total) to control the additional sensor, actuator and exhaust gas control function.

D20DT (EURO4) Engine ECU - Ver. 3.2	D20DT Engine ECU - Ver. 3.1
Connector A Connector B	

For the D20DT (EURO4) engine, the connector pin is added and DTC is changed as the following components are added. the functions of engine ECU pin for D20DT (EURO4) engine and D20DT engine are not same. For more details, refer to the respective section.

▶ **E-EGR (Electric-Exhaust Gas Recirculation) Valve**

It is electrically controlled by the ECU for precise control. Old version was controlled by the vacuum modulator.

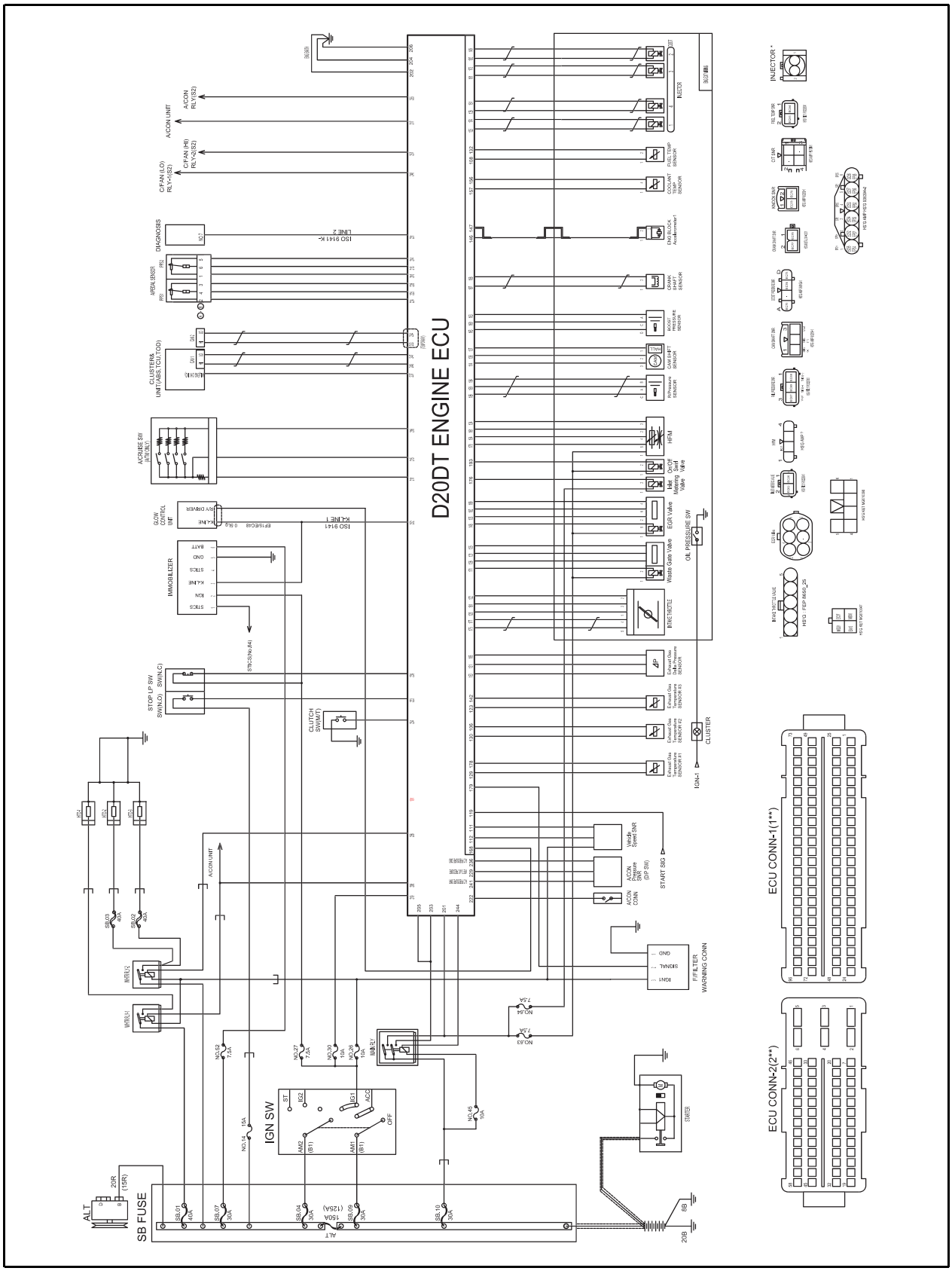
▶ **Throttle Body**

It is electrically controlled by ECU as E-EGR valve.

▶ **AQGS (Advanced Quick Glow System) Unit**

The glow control relay (K-line communication with engine ECU) is deleted. The unit communicates via CAN communication with engine ECU. Also, the number of pins is increased as glow plug's performance has been improved (1000˚C increase in approx. 2 seconds).

2. D20DT (EU-IV)) ENGINE'S ECU CIRCUIT



Modification basis	
Application basis	
Affected VIN	

CRUISE CONTROL SYSTEM 8510-23

OVERVIEW AND OPERATION PROCESS

1. CRUISE CONTROL SWITCH

The purpose of the cruise control system is to automatically maintain a vehicle speed set by the driver, without depressing the accelerator pedal. The cruise control switch is located under the right side of the steering wheel, and when this switch is operating "AUTO CRUISE" lamp comes on.

The minimum speed for setting the cruise control system is 36 km/h (22.37 mph). Pay constant attention to the distance between the vehicles and the traffic conditions when using the cruise control system.

CAUTION

The cruise control system is a supplementary system, which helps the driver to drive the vehicle at a desired speed without using the accelerator pedal under the traffic condition where the vehicle-to-vehicle distance meets the legal requirement.

1) When To Use

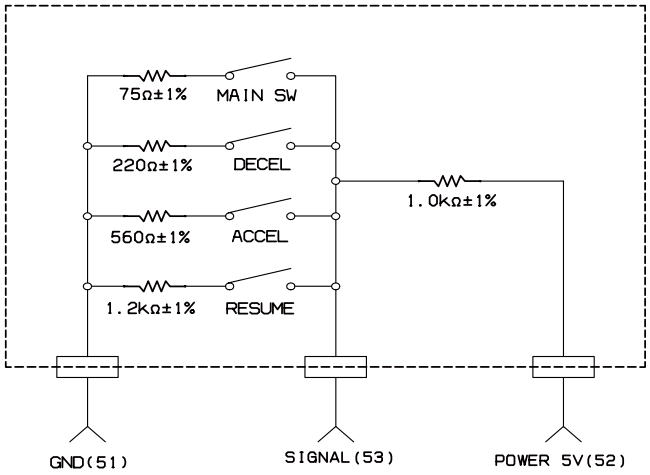
Use the cruise control system only when (a) the traffic is not jammed, (b) driving on motorways or highways where there is no sudden change in the driving condition due to traffic lights, pedestrian, etc.

WARNING

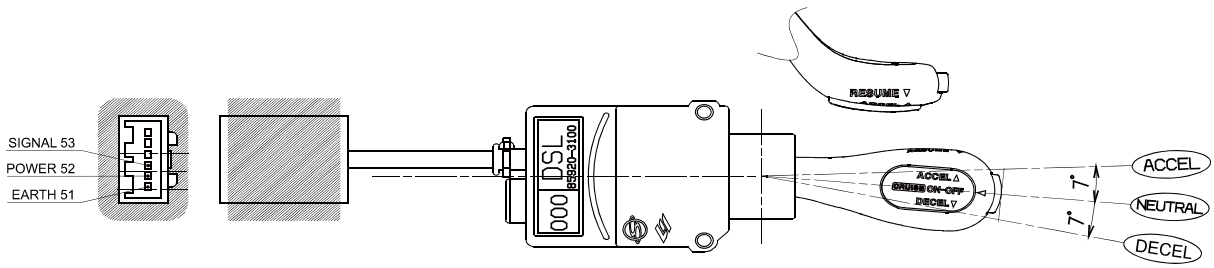
Use the cruise control system only when driving on motorways or highways. Do not use the cruise control system where the road conditions are as follows:
- When there is strong wind or cross wind.
- Heavy traffic.
- Slippery roads or steep decline.

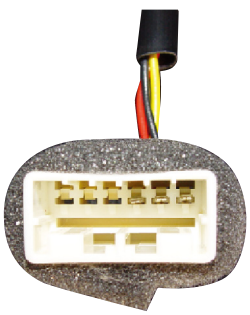
Modification basis	
Application basis	
Affected VIN	

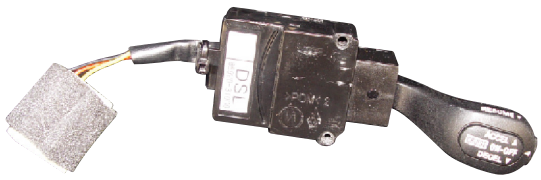
2. CIRCUIT DIAGRAM



1) Configuration







Modification basis	
Application basis	
Affected VIN	

3. HOW TO OPERATE CRUISE CONTROL SWITCH

1) How To Set Speed

1. To operate the cruise control system, accelerate the vehicle to the speed within the specified range below with depressing the accelerator pedal.
   - Cruise control operating range: between 36 km/h (22.37 mph) and 150 km/h (93.207 mph)
2. When the desired speed is reached, which should be within the above range, push up the cruise control switch lever to ACCEL side (upwards arrow), or push down the switch lever to DECEL side (downwards arrow).
   And then release the accelerator pedal slowly.
3. Now the vehicle is cruised by this system with the set speed. You don't need to use the accelerator pedal.
4. Refer to the following pages for details of operation.

CAUTION

Never use the cruise control system until you get used to it.
Improper use or not fully aware of this function could result in collision and/or personal injuries.

Modification basis	
Application basis	
Affected VIN	

2) Accelerating with the Cruise Control System

(1) While the cruise control system is running

1. To increase the set speed, push up the cruise control switch lever to ACCEL side and hold it until the desired speed is reached without depressing the accelerator pedal.
2. When the desired speed is set, release the switch lever.

(2) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

1. Accelerate the vehicle to more than 36 km/h (22.37 mph) using the accelerator pedal. Push up the cruise control switch lever to ACCEL side and hold it.
2. When the desired speed is reached, release the accelerator pedal and the switch lever.

(3) Tap-up while the cruise control system is running

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

1. Push up the cruise control switch lever to ACCEL side for less than 0.5 second per one switching while the cruise control system is running; the speed increases each time by 1.3 km/h (0.81 mph).
2. For example, if you want to increase the speed 13 km/h (81 mph) more than the previous set speed, tap up the switch lever to ACCEL side ten times without using the accelerator pedal.

3) Decelerating with the Cruise Control System

(1) While the cruise control system is running

1. To decrease the set speed, push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached without depressing the brake pedal.
   But the cruise control system cannot maintain the cruise function at less than 34 km/h (21.13 mph).
2. When the desired speed is set, release the switch lever.

(2) When the cruise control system is not running

To decrease the speed with the cruise control system while the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 36 km/h (22.37 mph).
2. When the desired speed is reached, release the switch lever.
3. But the cruise control system cannot maintain the cruise function at less than 34 km/h (21.13 mph).

(3) Tap-down while the cruise control system is running

To decrease the vehicle speed in stages while the cruise control system is running, follow the below procedures.

1. Push down the cruise control switch lever to DECEL side for less than 0.5 second per one switching while the cruise control system is running; the speed decreases each time by 1.0 km/h (0.62 mph).
2. For example, if you want to decrease the speed 10 km/h (62 mph) lower than the previous set speed, tap down the switch lever to DECEL side ten times without using the brake pedal.

Modification basis	
Application basis	
Affected VIN	

4) Recovery of Set Speed (RESUME)

Even if the cruise control is cancelled, the previous set cruise speed can be recovered by operating the cruise control switch lever like below:
- Pull the switch lever in the arrow direction shown in the illustration.

This RESUME function works only when the vehicle speed is more than 36 km/h (22.37 mph) without using the accelerator or brake pedal.

CAUTION

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

5) Normal Cancellation of the Cruise Control (OFF ↔ ON)

The cruise control system will be cancelled when the button on the side of the switch is pressed, or when one of the following conditions is met:

1. When the brake pedal is depressed or ESP is activated.
2. When the vehicle speed is less than 34 km/h (21.13 mph).
3. When the parking brake is applied while driving.
4. When the clutch pedal is depressed for shifting (M/T only).

CAUTION

Put the cruise control switch lever in the neutral position when not using the cruise control system.

(1) Abnormal Cancellation of the Cruise Control

1. When the rapid deceleration or acceleration occurs.
2. When the cruise control lever is faulty.
3. When the brake switch is malfunctioning or has an open circuit.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

- Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
- Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
- The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
- Ensure that the braking distance is maintained and use the brake pedal if needed.

Modification basis	
Application basis	
Affected VIN	

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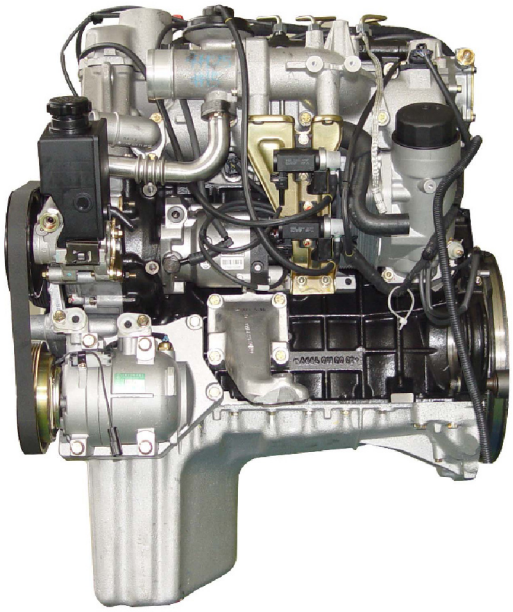
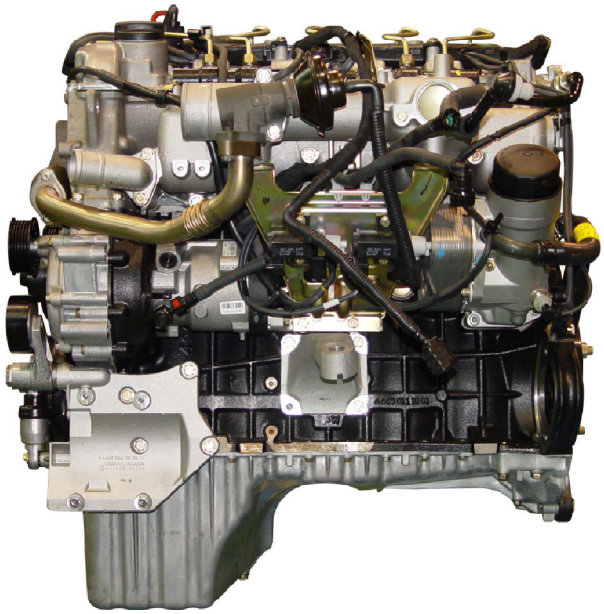
ENGINE GENERAL

0000-00

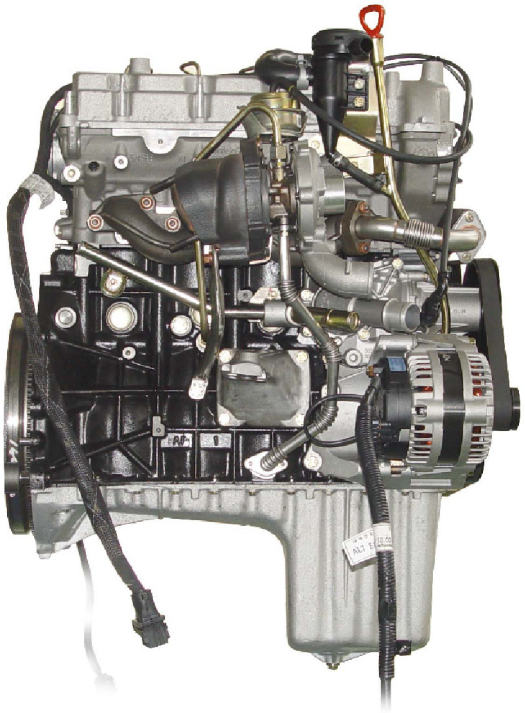
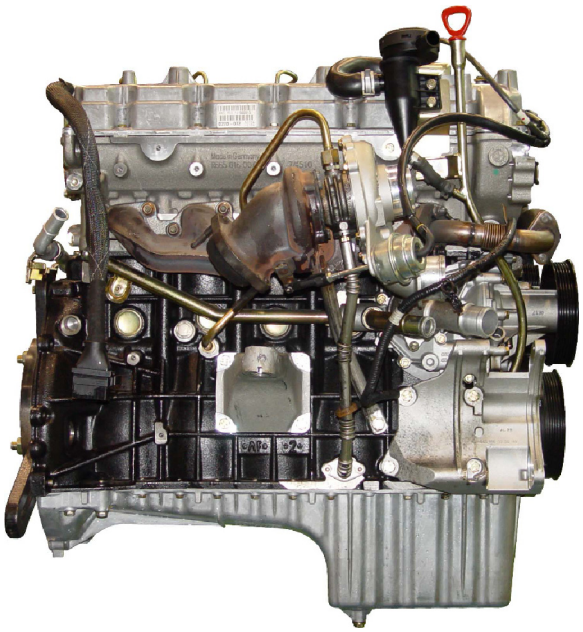
GENERAL

1. ENGINE ASSEMBLY LAYOUT

1) LH Side View

D20DT

D27DT


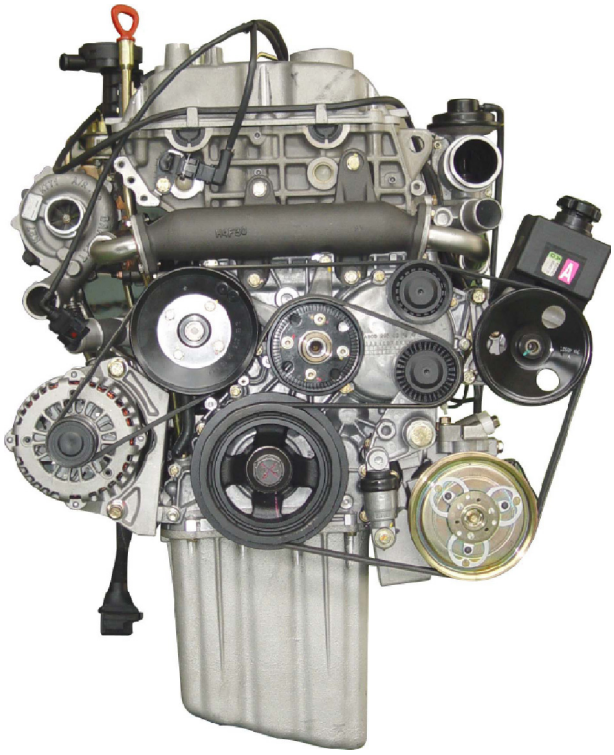
2) RH side view

D20DT

D27DT


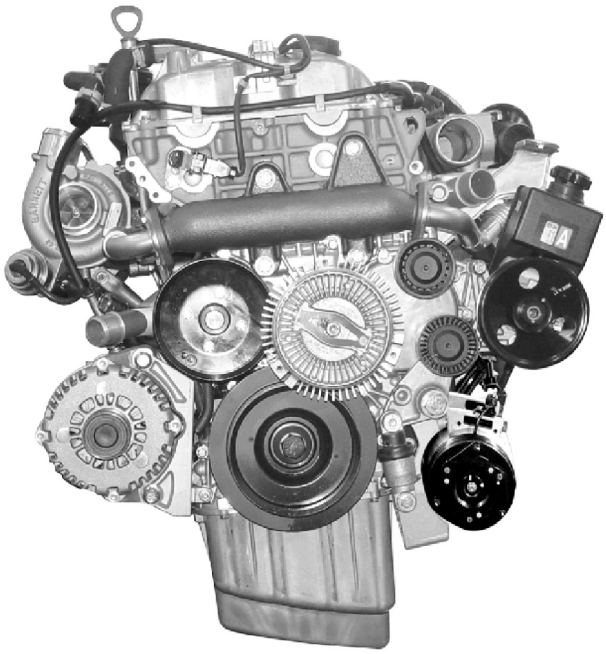
Modification basis	
Application basis	
Affected VIN	

3) Front view

D20DT

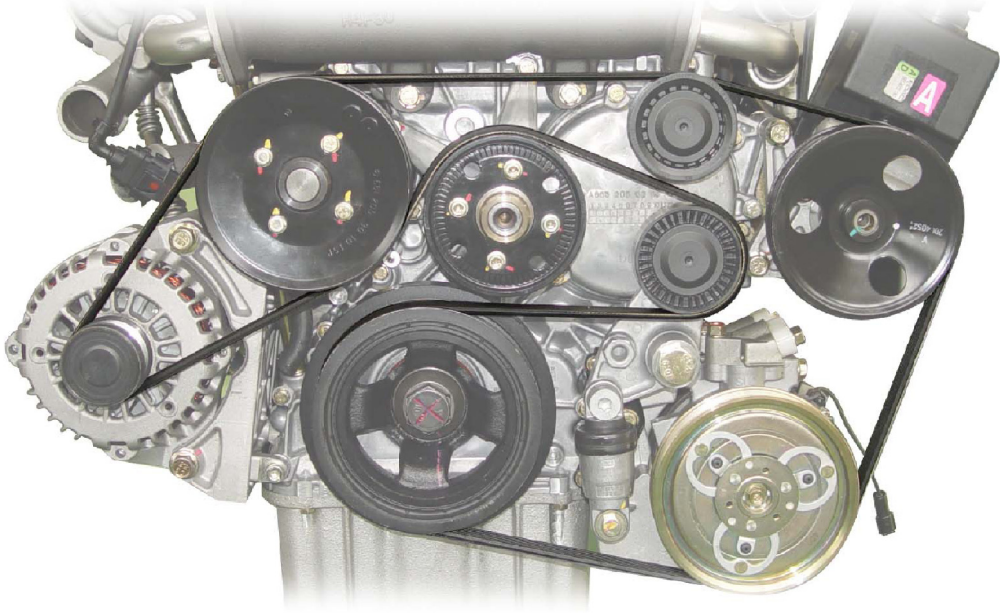
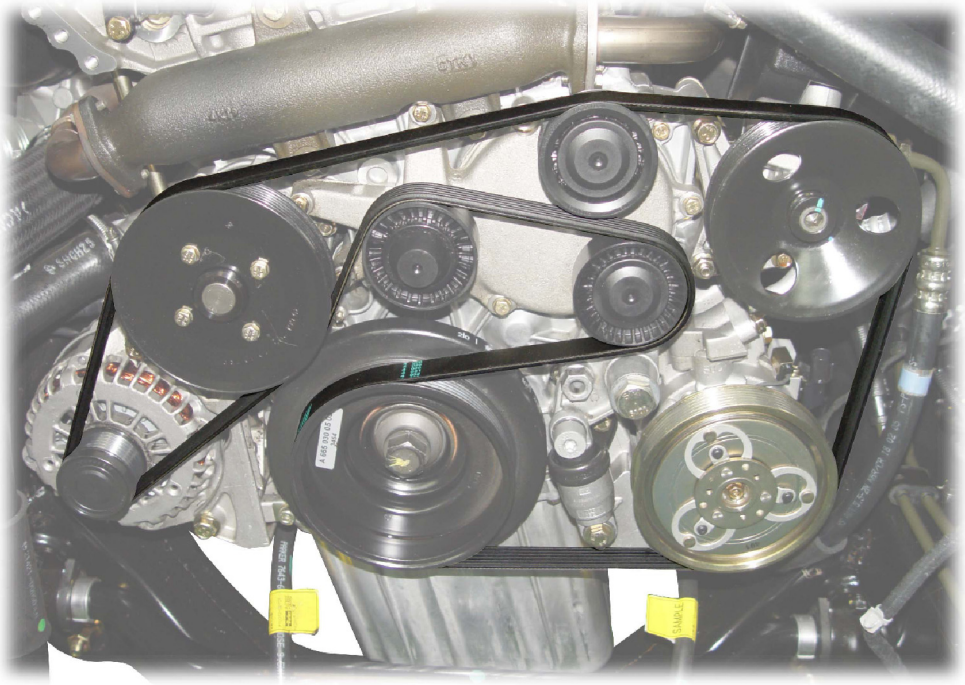


D27DT



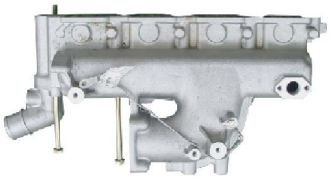
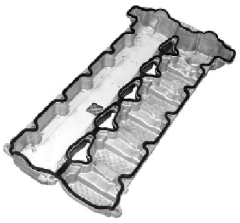
Modification basis	
Application basis	
Affected VIN	

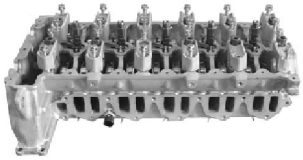
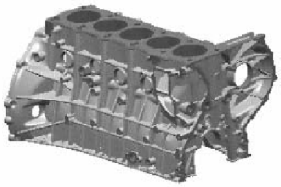
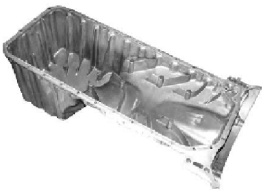
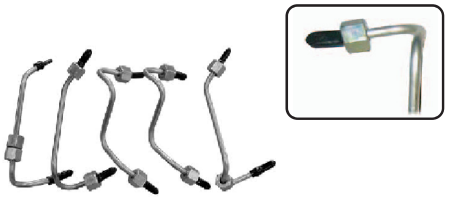
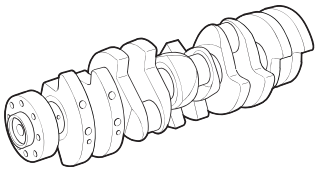
4) Fan belt

D20DT

D27DT


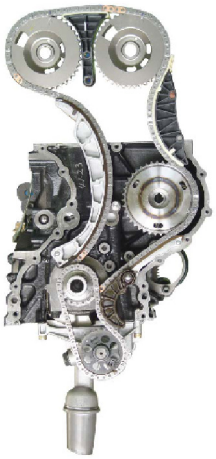
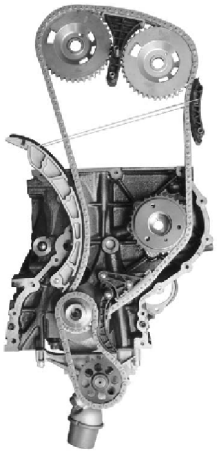
Modification basis	
Application basis	
Affected VIN	

2. COMPONENTS IN D20DT ENGINE AND D27DT ENGINE

Components	D20DT	D27DT
Turbocharger		
Common rail		
EGR valve		
Exhaust manifold		
Intake manifold		
Cylinder head cover		

Components	D20DT	D27DT
Cylinder head		
Cylinder block		
Oil pan		
High pressure pipe		
Intake camshaft and exhaust camshaft		
Crankshaft		

Modification basis	
Application basis	
Affected VIN	

Components	D20DT	D27DT
Sprocket - HP pump		
Timing chain devices		
Chain double bush	D20DT D27DT	
Tensioner rail		
Oil pump assy		

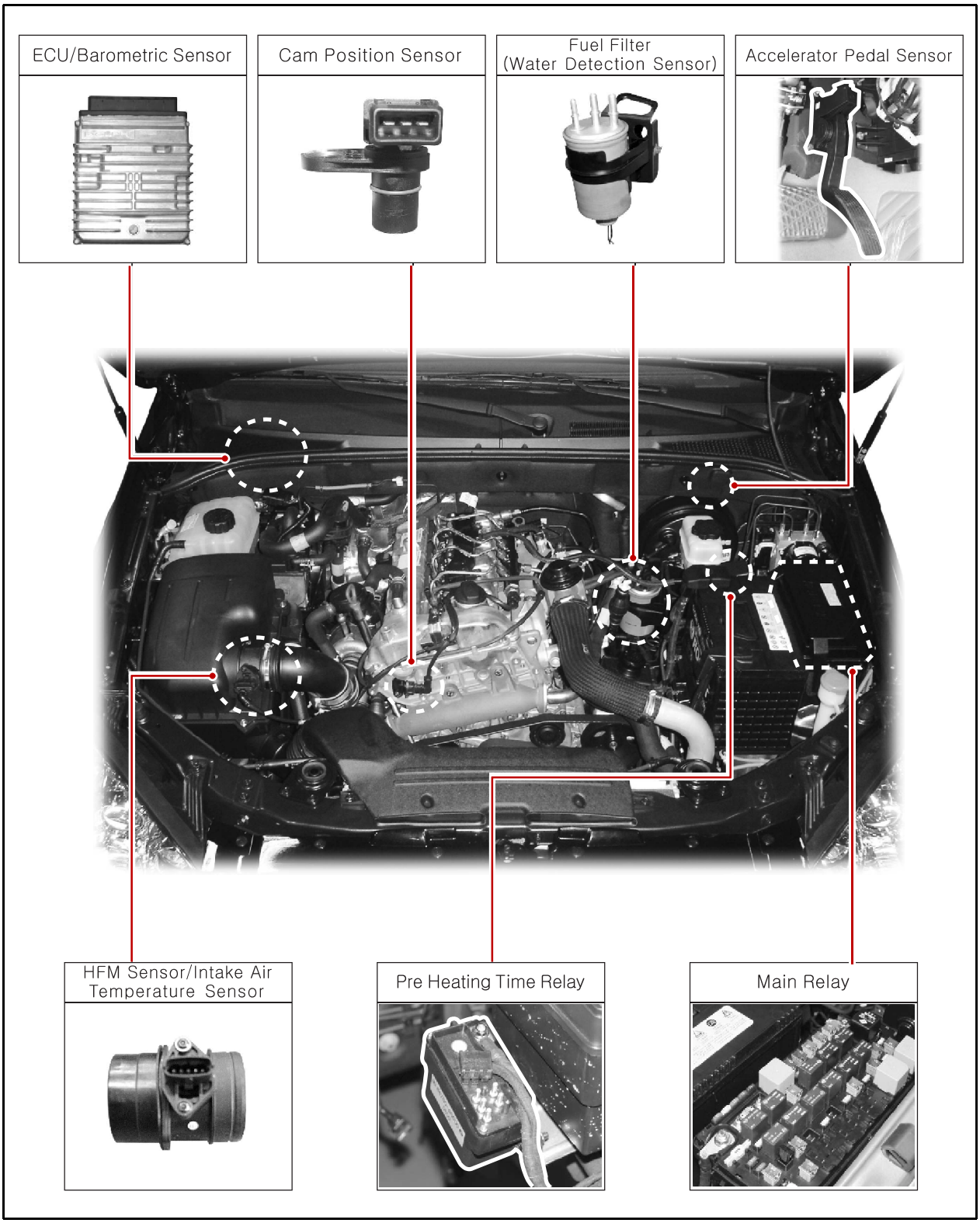
Components	D20DT	D27DT
Clamping rail comp		
Guid rail LWR		
EGR pipe - LH		
Fuel injector		

Modification basis	
Application basis	
Affected VIN	

3. ENGINE CONTROLS LAYOUT

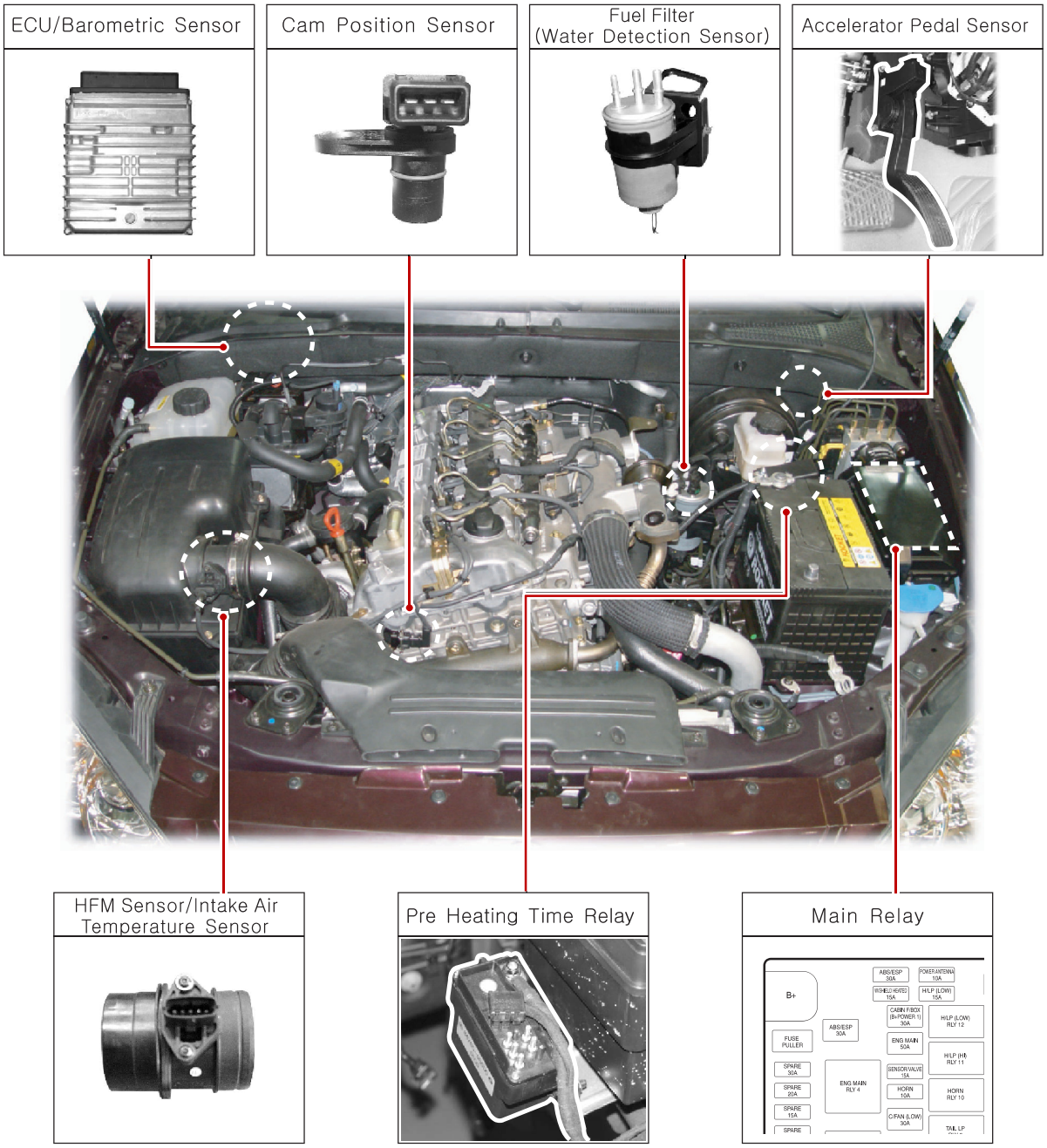
1) Ecu related componets

(1) D20DT Engine



Modification basis	
Application basis	
Affected VIN	

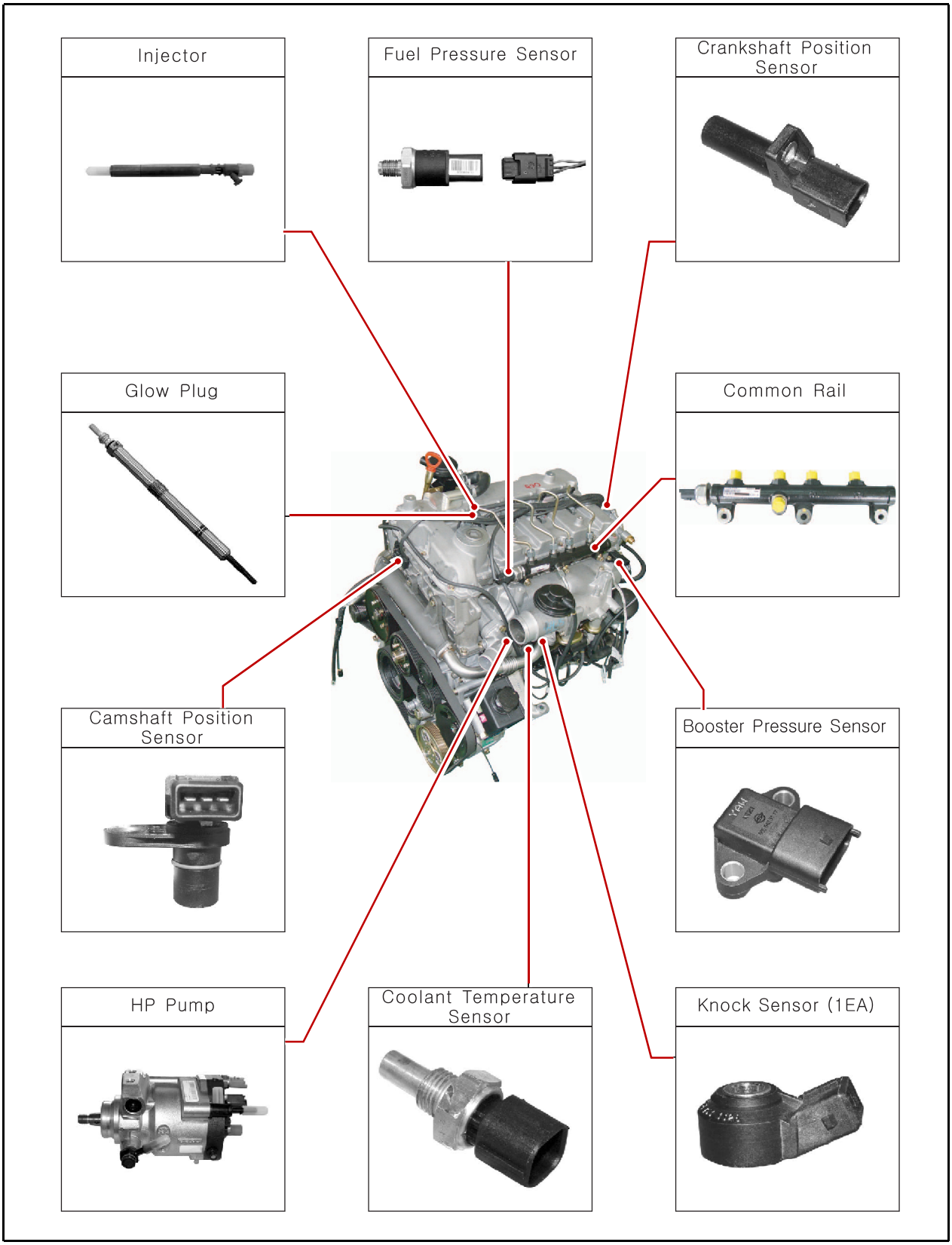
(2) D27DT Engine



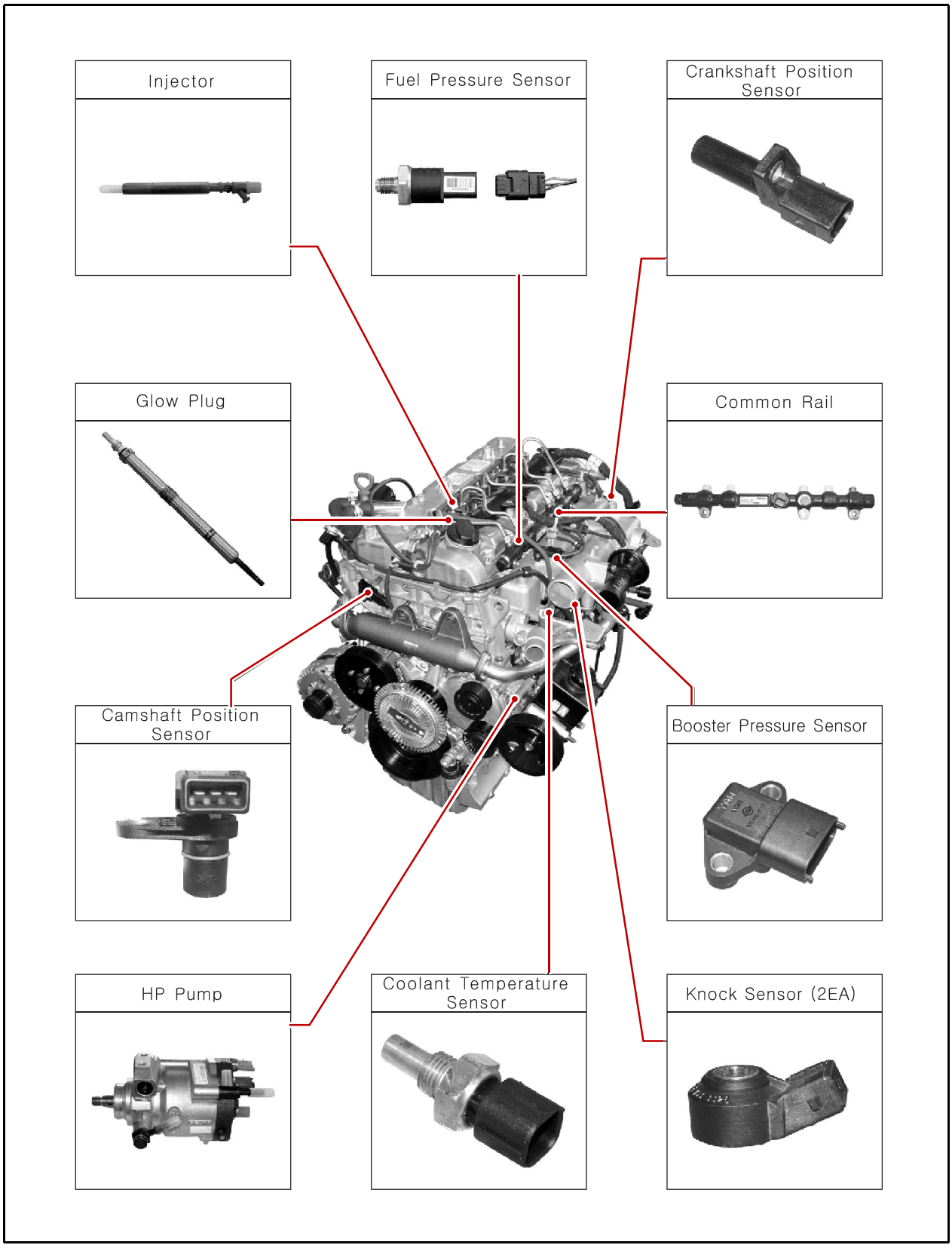
Modification basis	
Application basis	
Affected VIN	

2) ENGINE AND SENSORS

(1) D20DT Engine



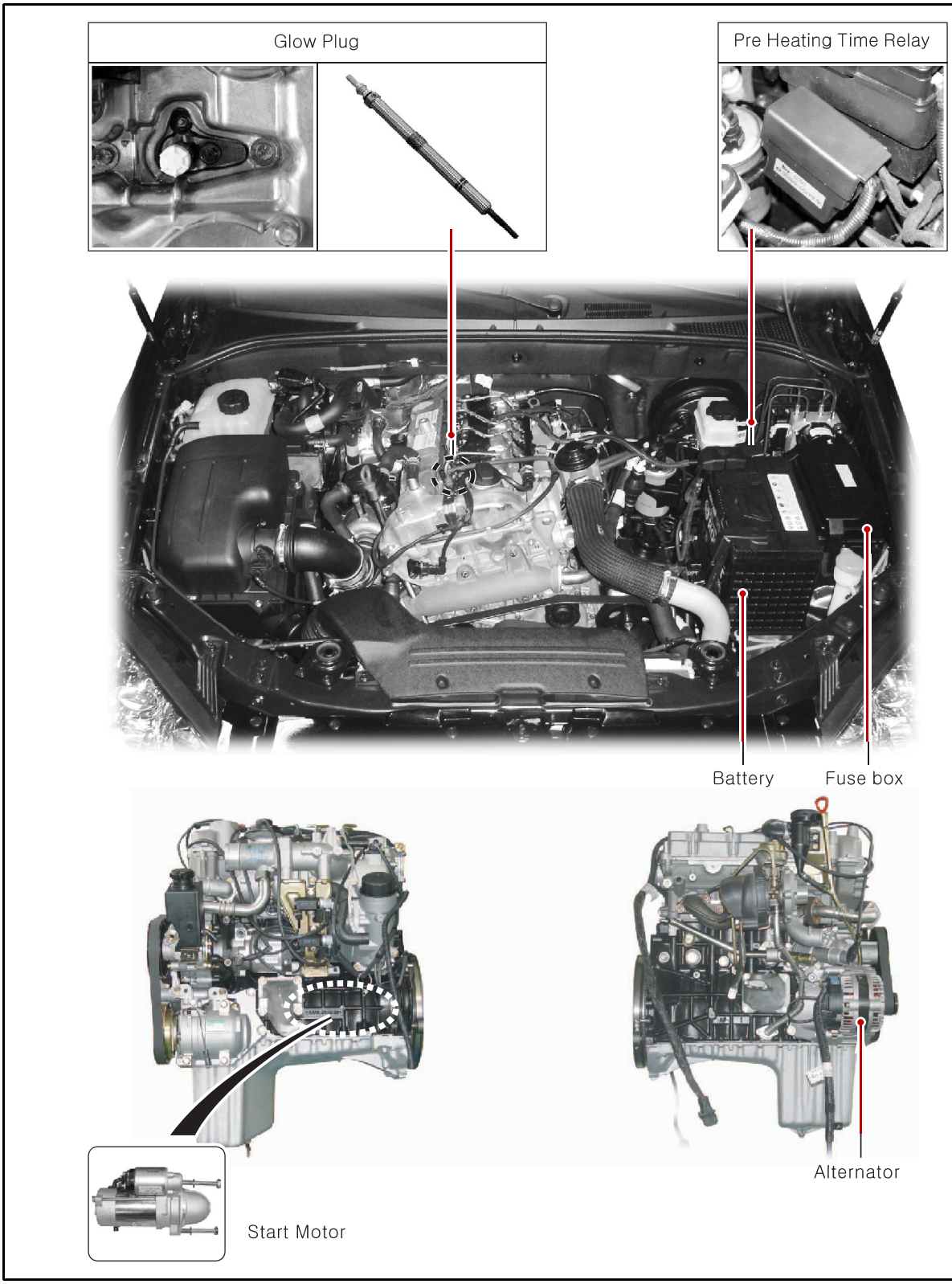
(2) D27DT Engine



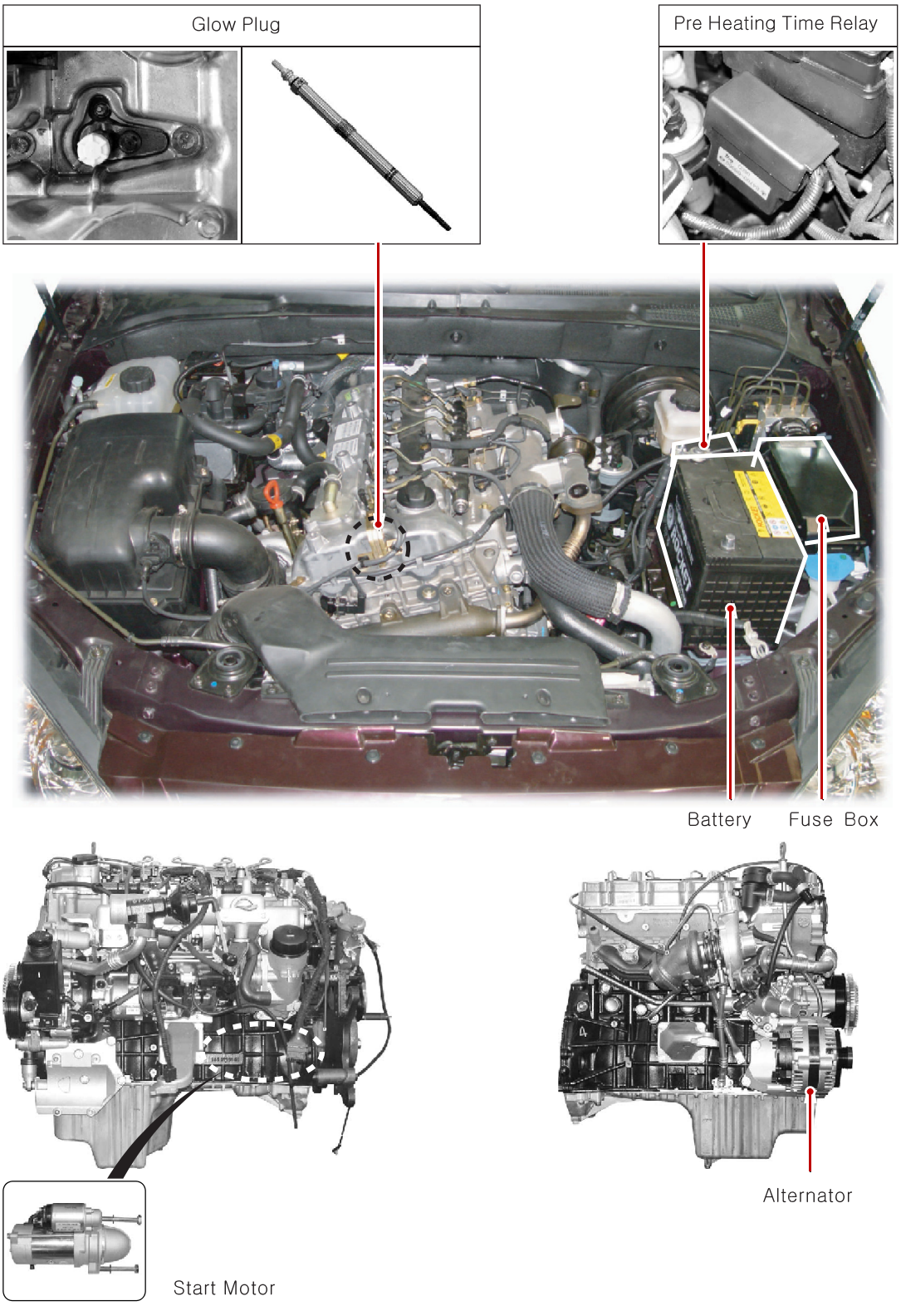
Modification basis	
Application basis	
Affected VIN	

4. ELECTRICAL COMPONENTS AND PREHEATING SYSTEM

1) D20DT Engine



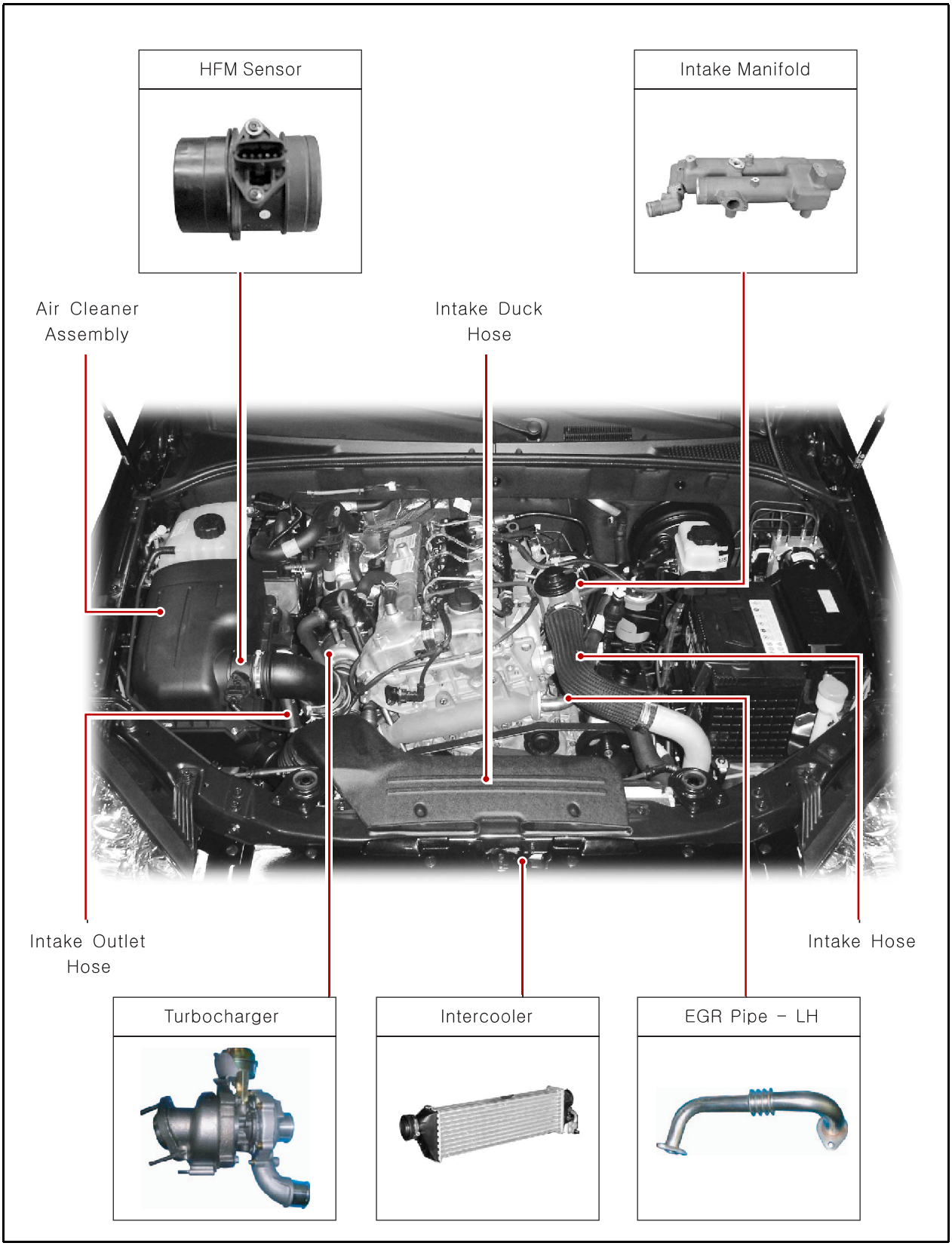
2) D27DT Engine



Modification basis	
Application basis	
Affected VIN	

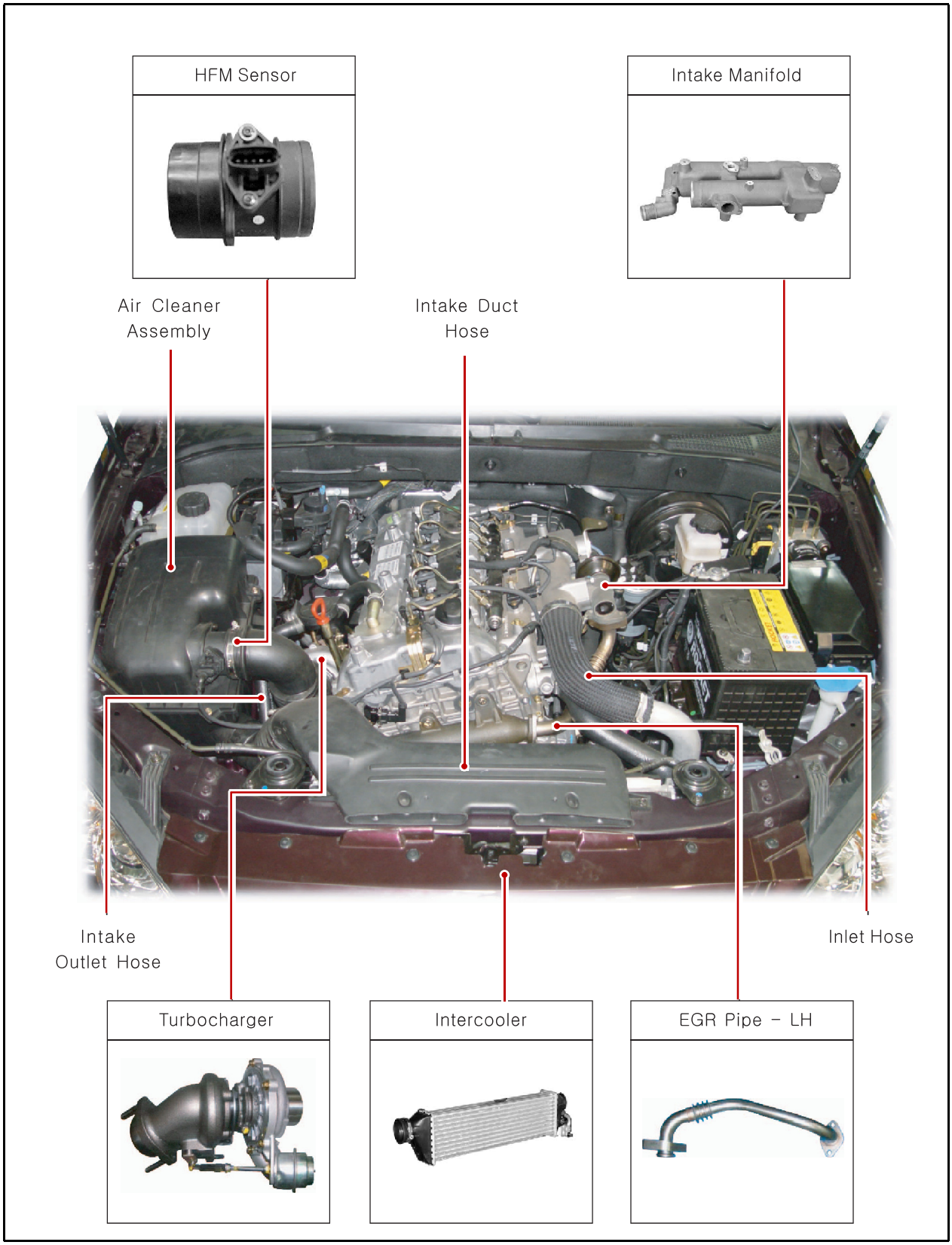
5. INTAKE SYSTEM LAYOUT

1) D20DT Engine



Modification basis	
Application basis	
Affected VIN	

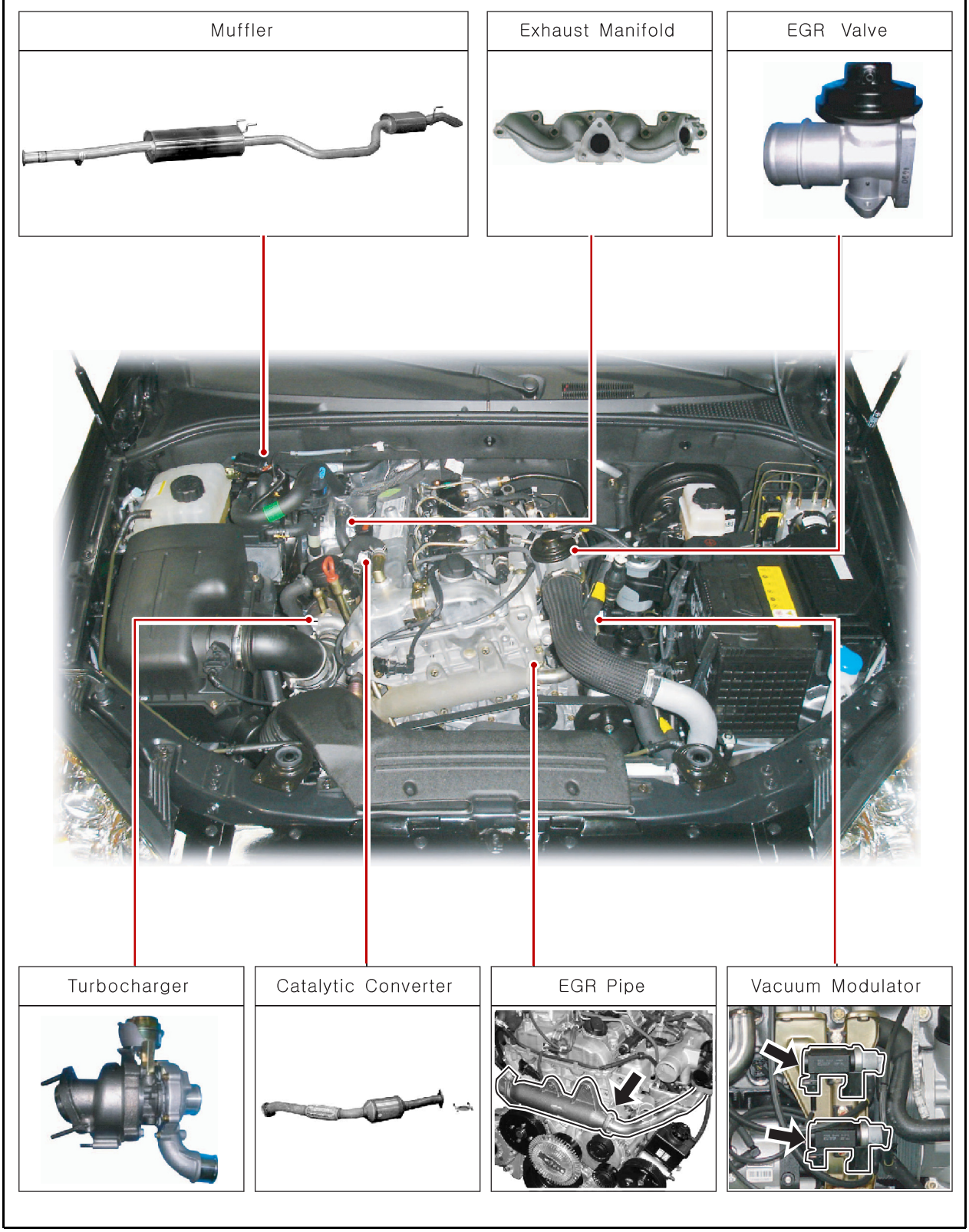
2) D27DT Engine



Modification basis	
Application basis	
Affected VIN	

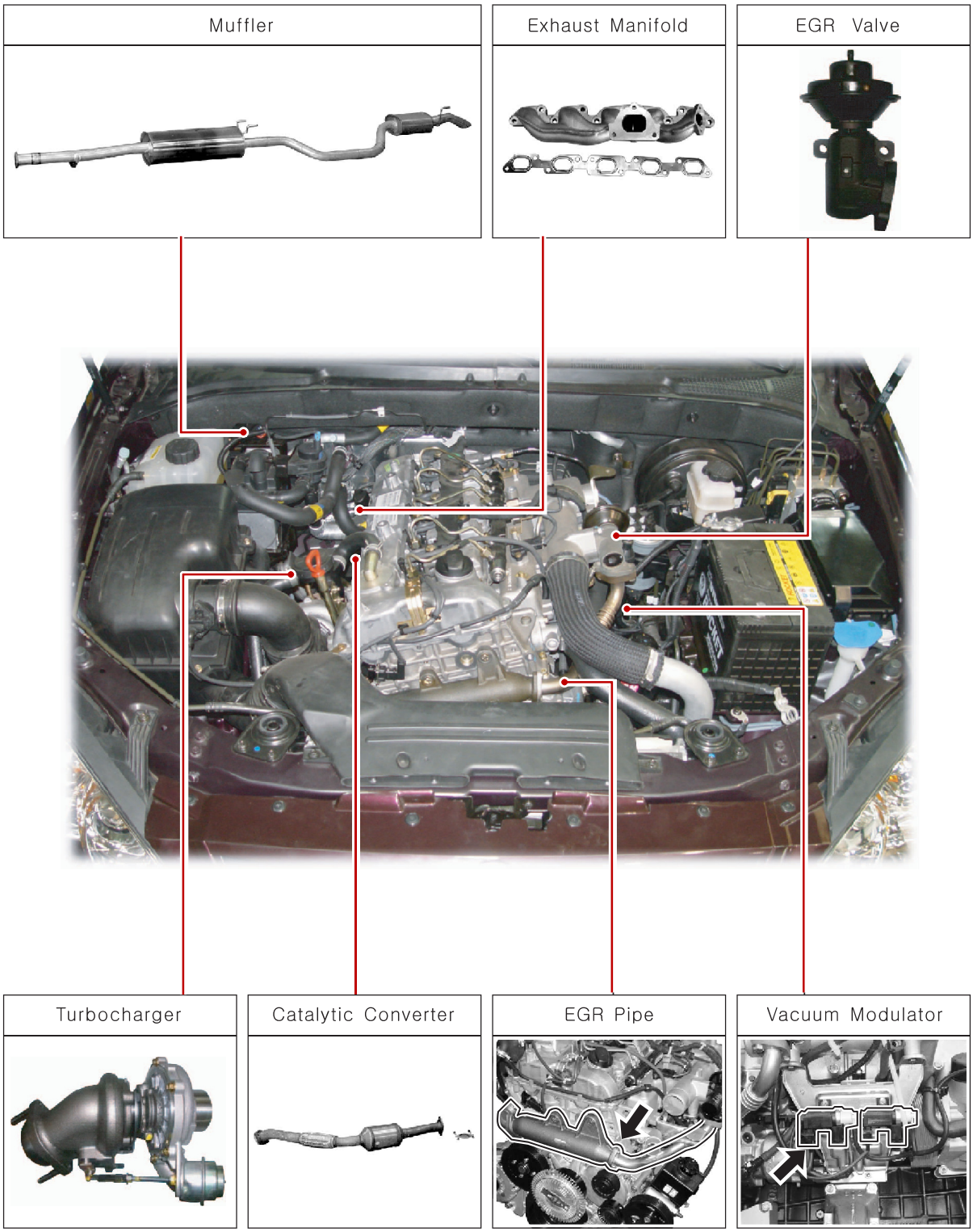
6. EXHAUST SYSTEM LAYOUT

1) D20DT Engine



Modification basis	
Application basis	
Affected VIN	

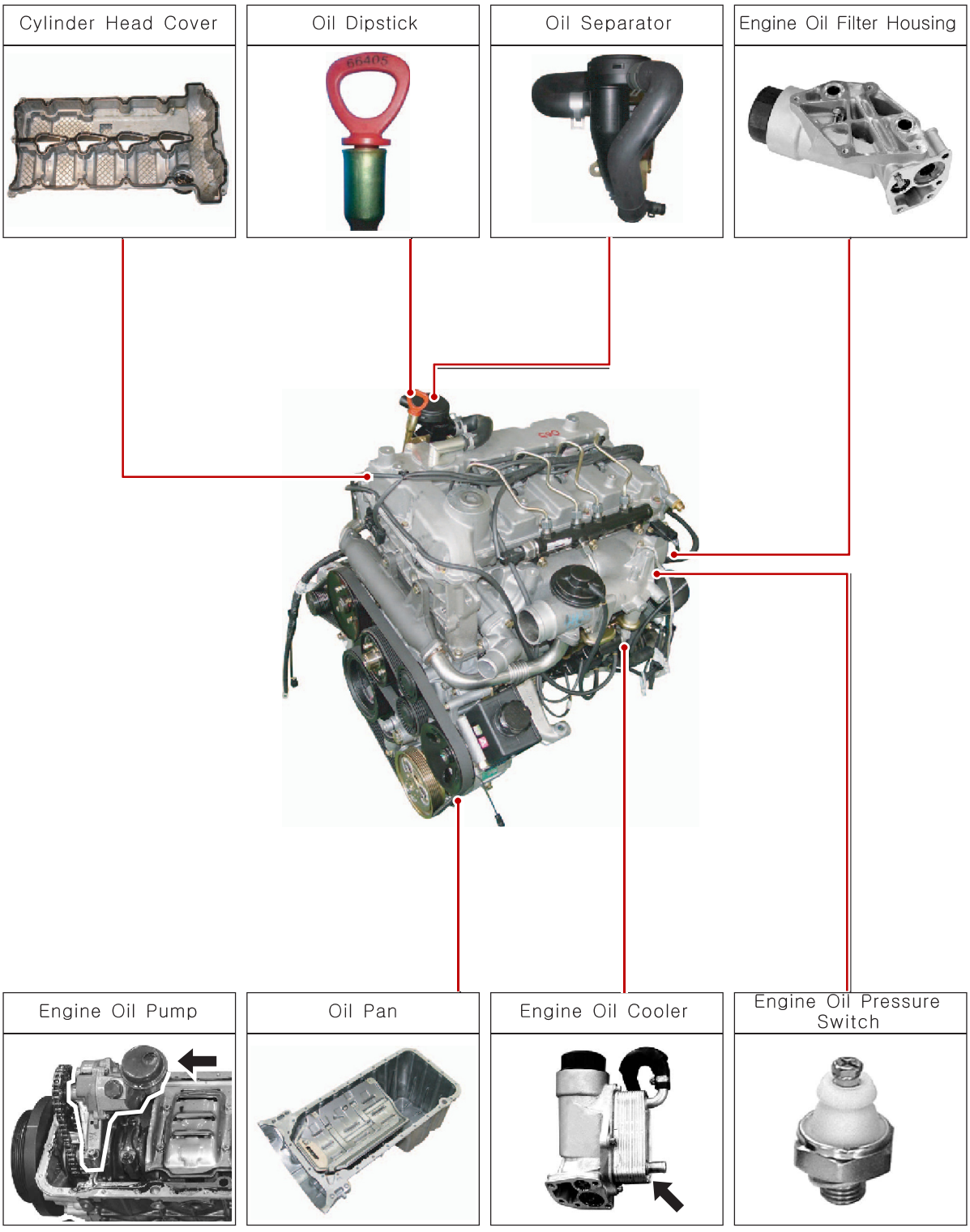
2) D27DT Engine



Modification basis	
Application basis	
Affected VIN	

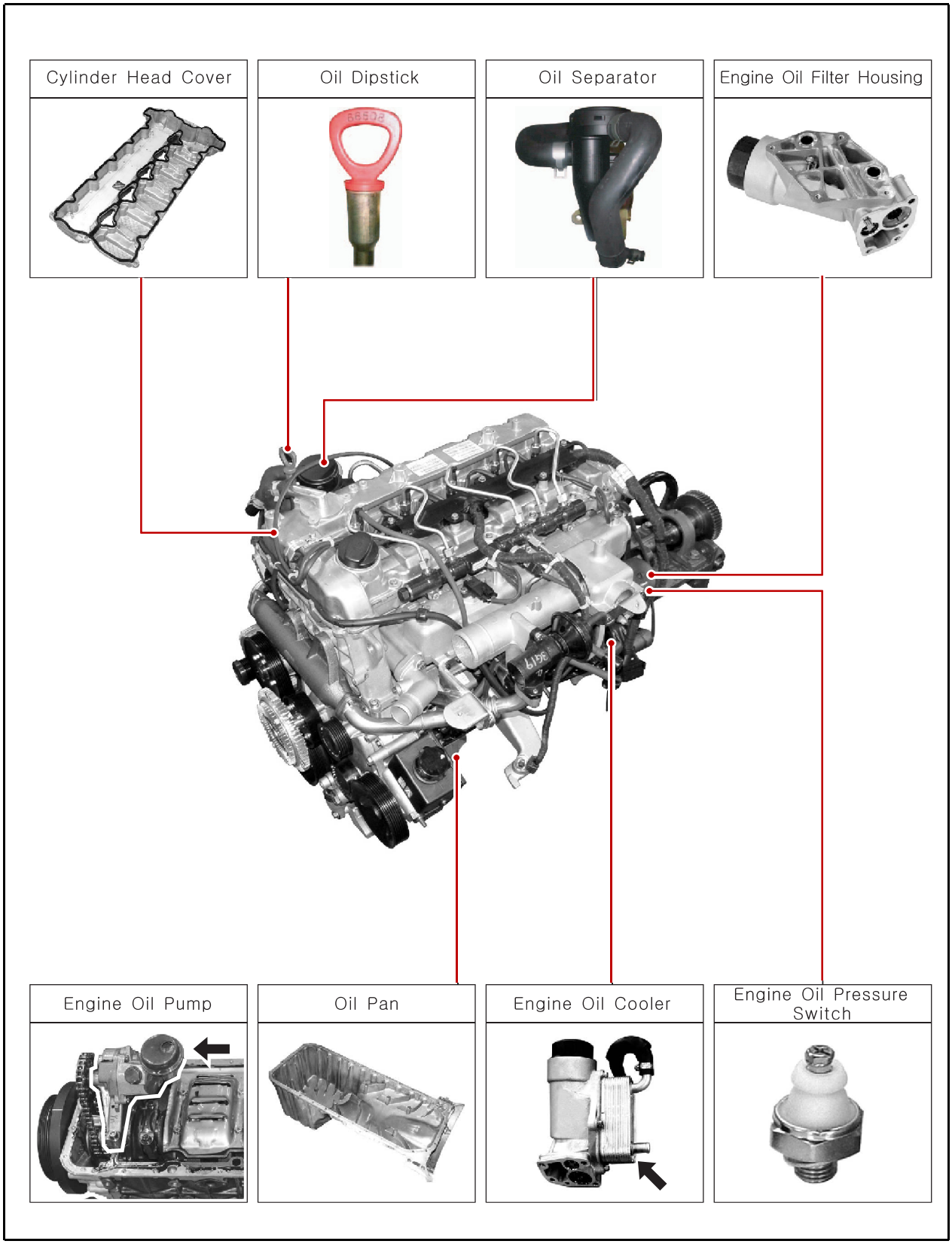
7. LUBRICATION SYSTEM LAYOUT

1) D20DT Engine



Modification basis	
Application basis	
Affected VIN	

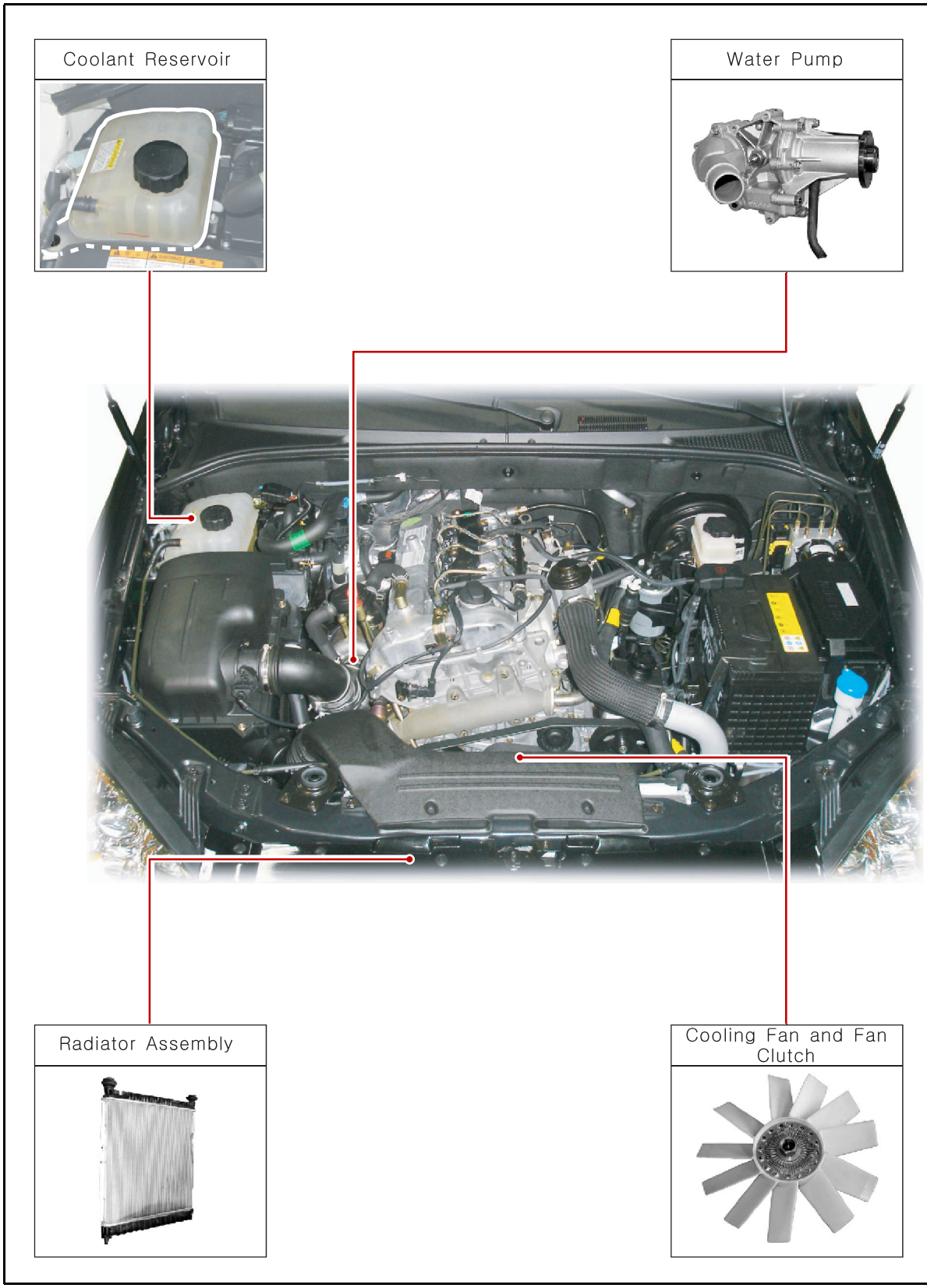
2) D27DT Engine



Modification basis	
Application basis	
Affected VIN	

8. COOLING SYSTEM LAYOUT

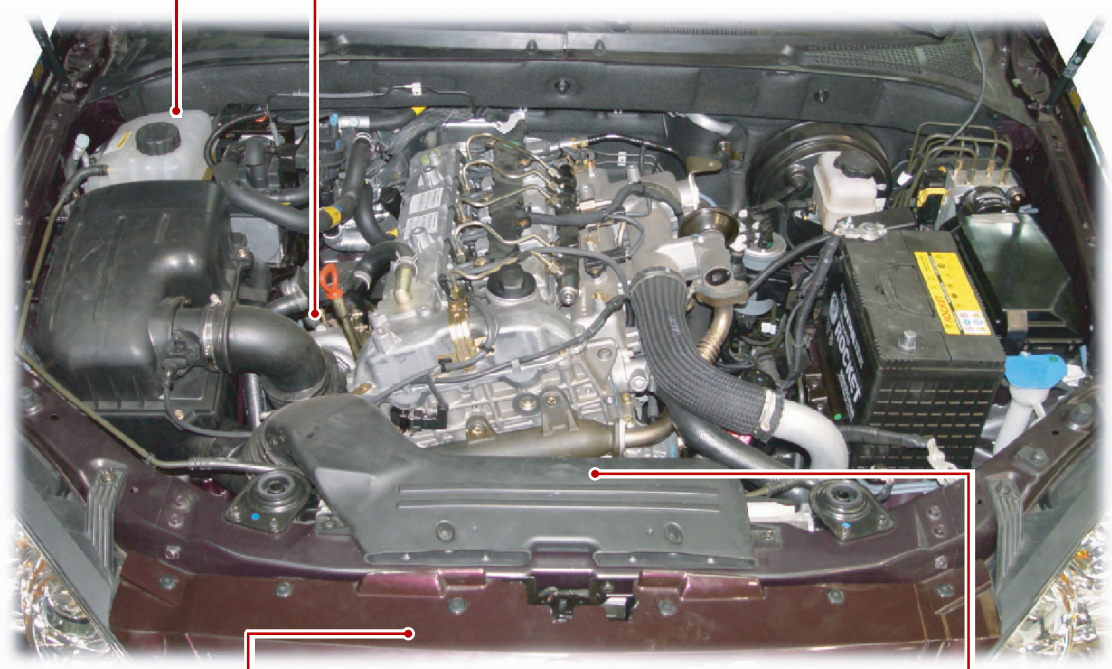
1) D20DT Engine



2) D27DT Engine

Coolant Reservoir

Water Pump



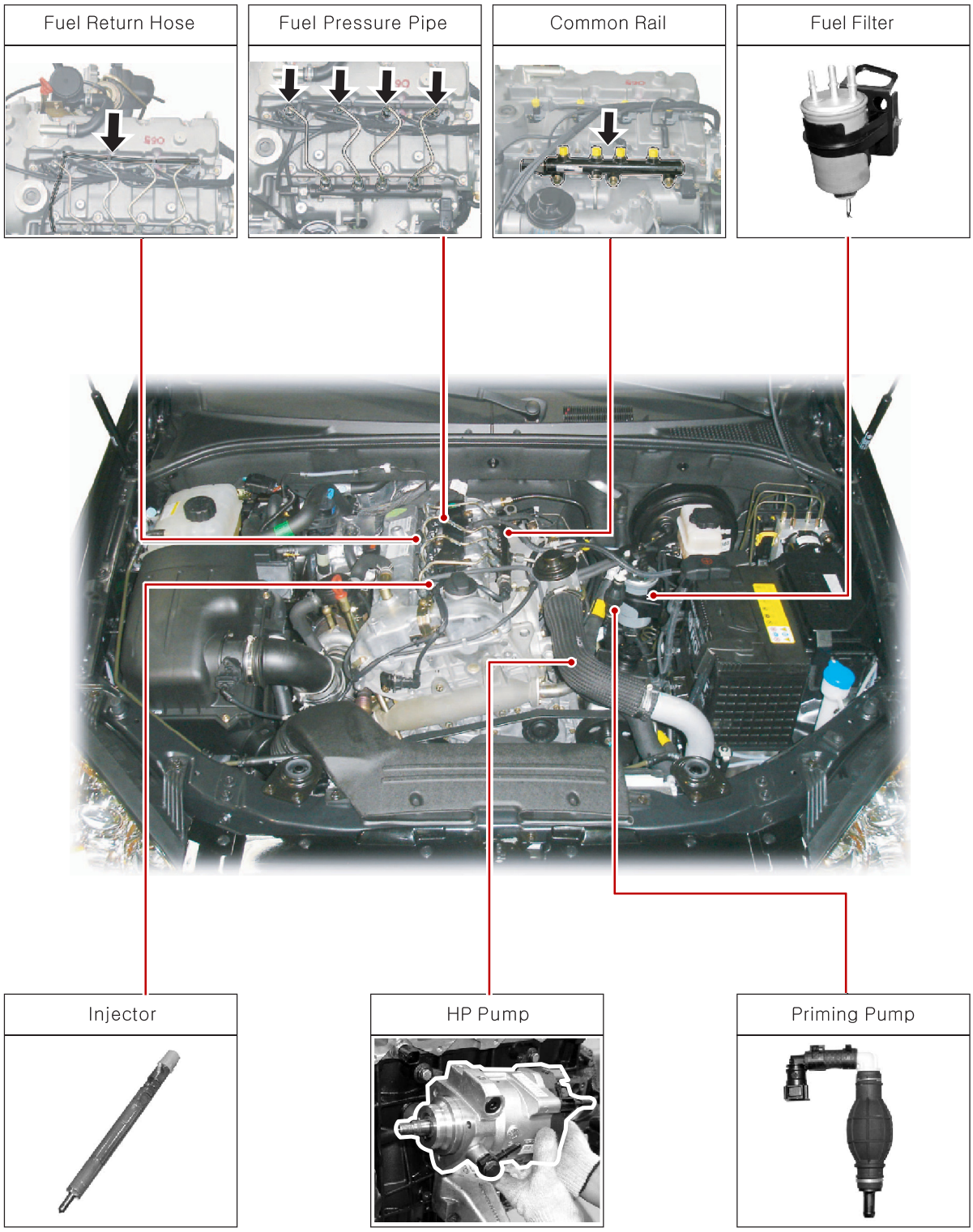
Radiator Assembly

Cooling Fan and Fan Clutch

Modification basis	
Application basis	
Affected VIN	

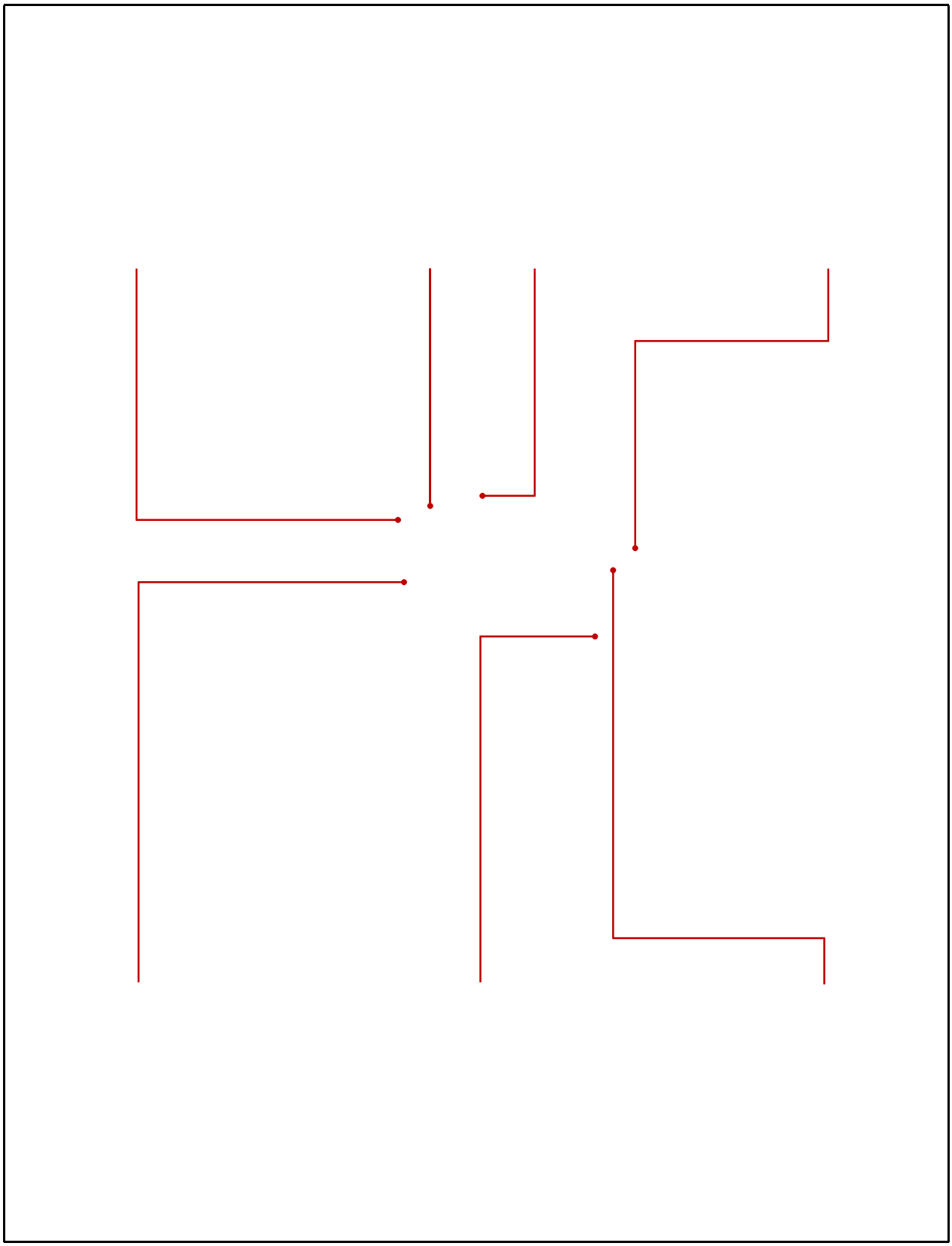
9. FUEL SYSTEM LAYOUT

1) D20DT Engine



Modification basis	
Application basis	
Affected VIN	

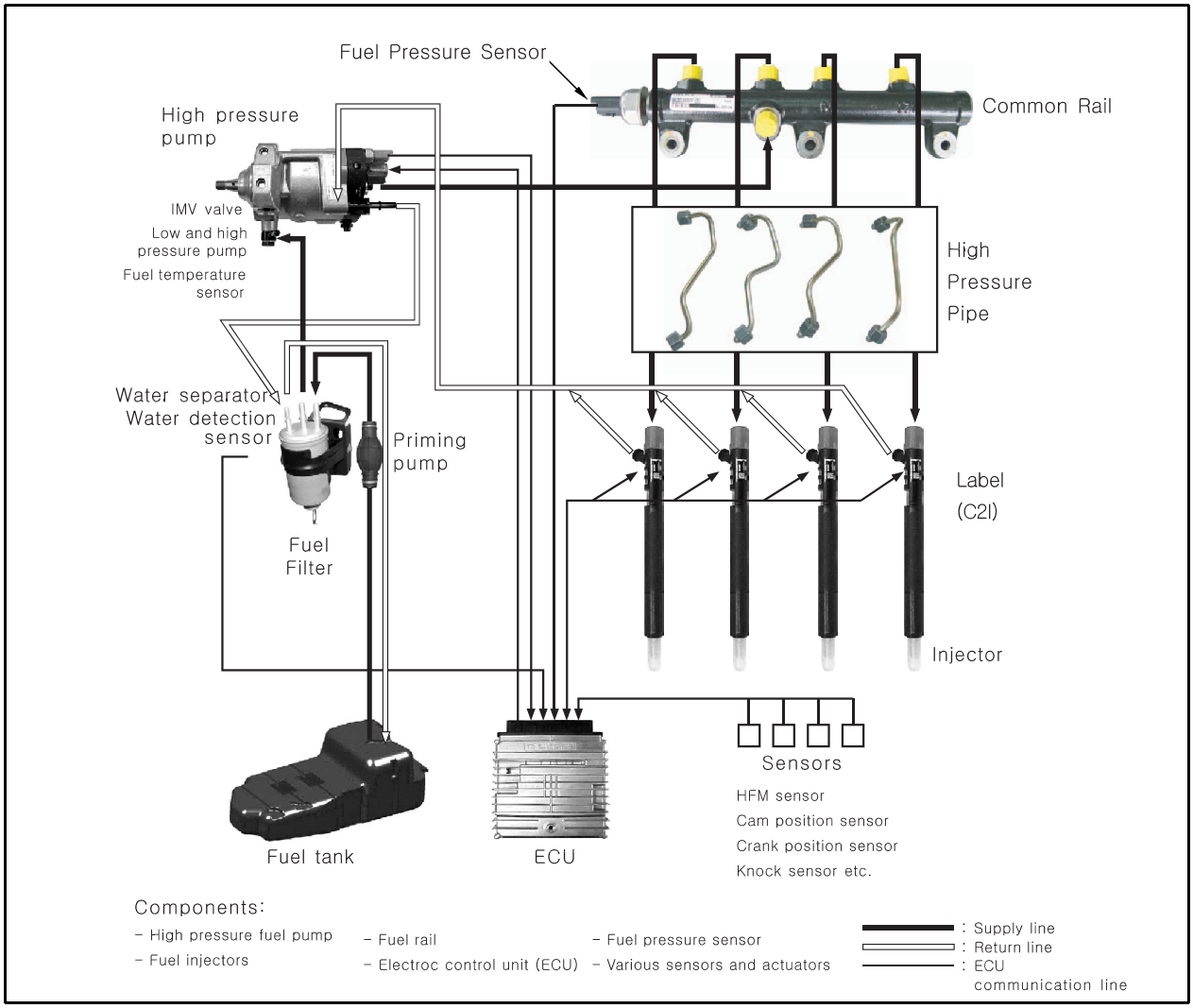
2) D27DT Engine



Modification basis	
Application basis	
Affected VIN	

10. FUEL SUPPLY SYSTEM

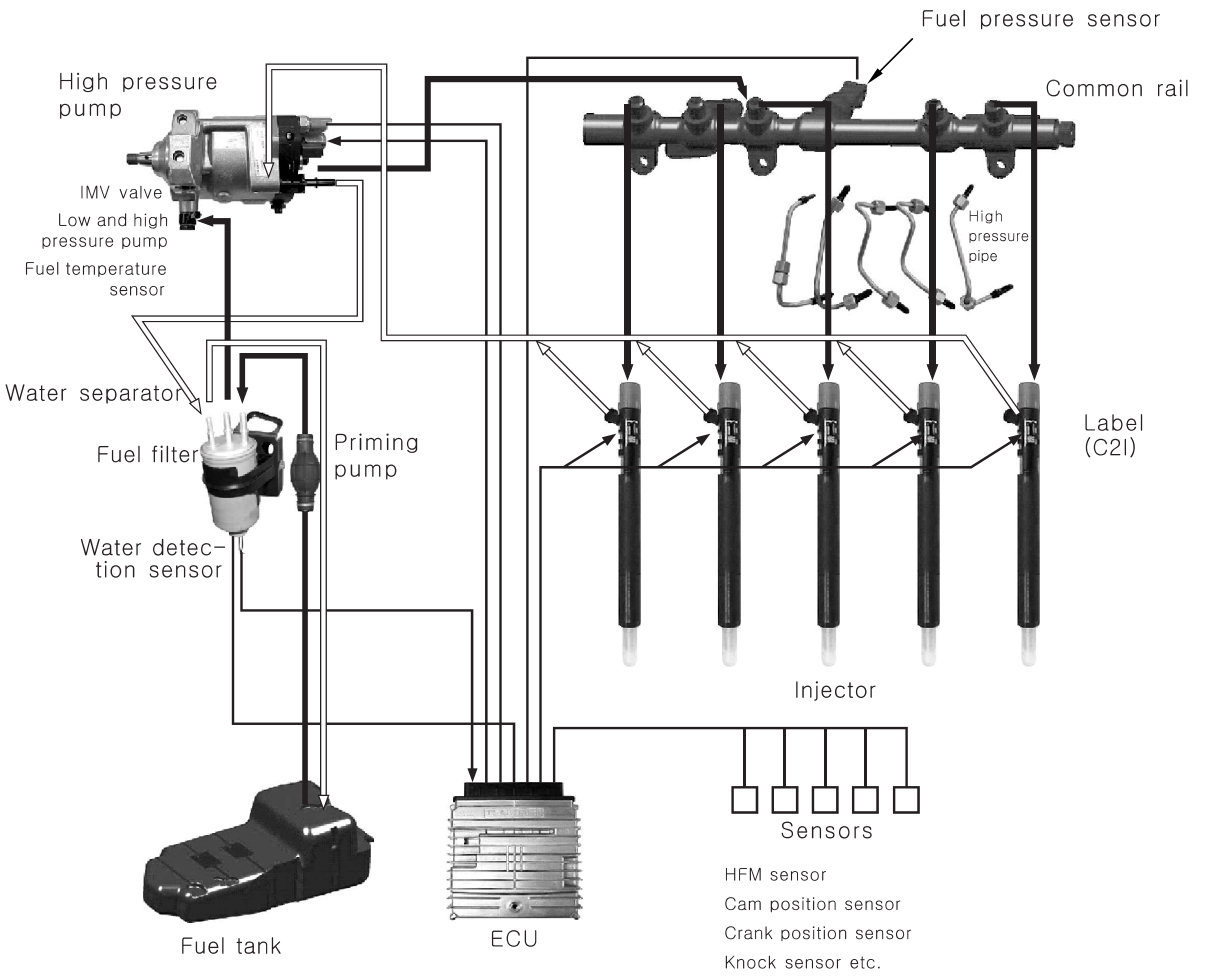
1) D20DT Engine



According to input signals from various sensors, engine ECU calculates driver's demand (position of the accelerator pedal) and then controls overall operating performance of engine and vehicle on that time.

ECU receives signals from sensors via data line and then performs effective engine air-fuel ratio controls based on those signals. Engine speed is measured by crankshaft speed (position) sensor and camshaft speed (position) sensor determines injection order and ECU detects driver's pedal position (driver's demand) through electrical signal that is generated by variable resistance changes in accelerator pedal sensor. Air flow (hot film) sensor detects intake air volume and sends the signals to ECU. Especially, the engine ECU controls the air-fuel ratio by recognizing instant air volume changes from air flow sensor to decrease the emissions (EGR valve control). Furthermore, ECU uses signals from coolant temperature sensor and air temperature sensor, booster pressure sensor and barometric sensor as compensation signal to respond to injection starting, pilot injection set values, various operations and variables.

2) D27DT Engine



Components:

- High pressure fuel pump
- Fuel injectors
- Fuel rail
- Electroc control unit (ECU)
- Fuel pressure sensor
- Various sensors and actuators

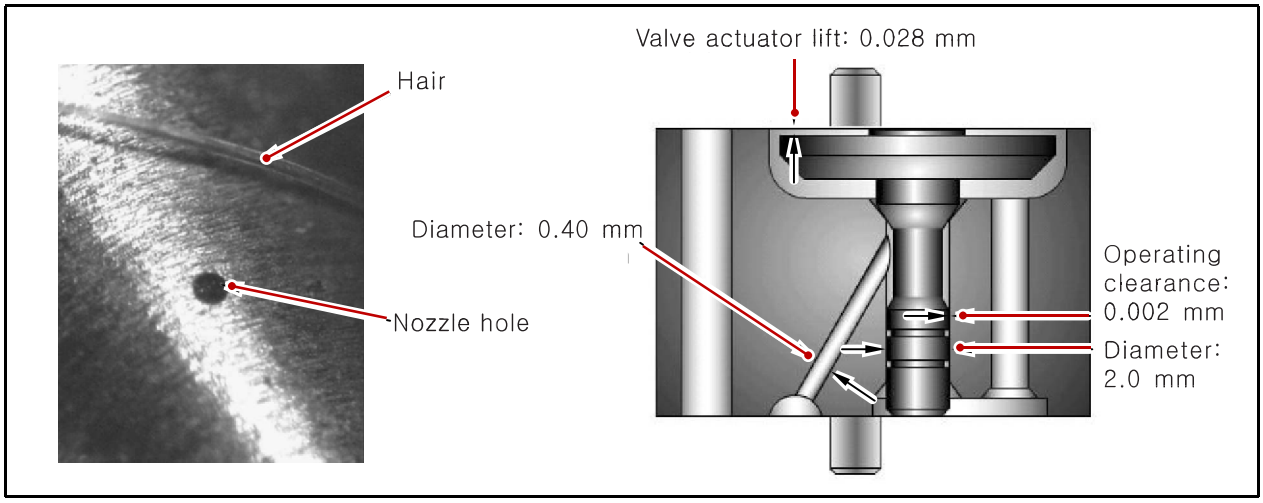
Supply line
Return line
ECU communication line

Modification basis	
Application basis	
Affected VIN	

11. CLEANNESS

1) Cleanness of di engine fuel system and service procedures

The fuel system for DI engine consists of transfer (low pressure) line and high pressure line. Its highest pressure reaches over 1600 bar.
Some components in injector and HP pump are machined at the micrometer 100 μm of preciseness.
The pressure regulation and injector operation are done by electric source from engine ECU. Accordingly, if the internal valve is stucked due to foreign materials, injector remains open. Even in this case, the HP pump still operates to supply high pressurized fuel. This increases the pressure to combustion chamber (over 250 bar) and may cause fatal damage to engine.
You can compare the thickness of injector nozzle hole and hair as shown in below figure (left side).
The right side figure shows the clearance between internal operating elements.



The core elements of fuel system has very high preciseness that is easily affected by dust or very small foreign material. Therefore, make sure to keep the preliminary works and job procedures in next pages. If not, lots of system problems and claims may arise.

2) Job procedures

1. Always keep the workshop and lift clean (especially, from dust).
2. Always keep the tools clean (from oil or foreign materials).
3. Wear a clean vinyl apron to prevent the fuzz, dust and foreign materials from getting into fuel system.
   Wash your hands and do not wear working gloves.
4. Follow the below procedures before starting service works for fuel system.

Carefully listen the symptoms and problems from customer.

↓

Visually check the leaks and vehicle appearance on the wiring harnesses and connectors in engine compartment.

↓

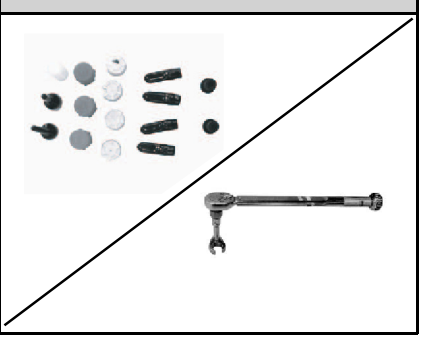
Perform the diagnosis proceee with SCAN-100
(refer to “DI10 DIAGNOSIS” section in this manual).

↓

Locate the fault. If the cause is from fuel system (from priming pump to injector, including return line), follow the step 1 through step 3 above.

5. If the problem is from HP pump, fuel supply line or injector, prepare the clean special tools and sealing caps to perform the diagnosis for DI engine fuel system in "DIAGNOSIS" section in this manual.
   At this point, thoroughly clean the related area in engine compartment.

CAUTION
- Clean the engine compartment before starting service works.

Tool kit for high pressure line	Took kit for low pressure line	Removal tool box and cap kits
		

Modification basis	
Application basis	
Affected VIN	

6. Follow the job procedures. If you find a defective component, replace it with new one.

Disconnect the negative battery cable.

↓

For safety reasons: check pressure is low before opening the HP systems (pipes)

↓

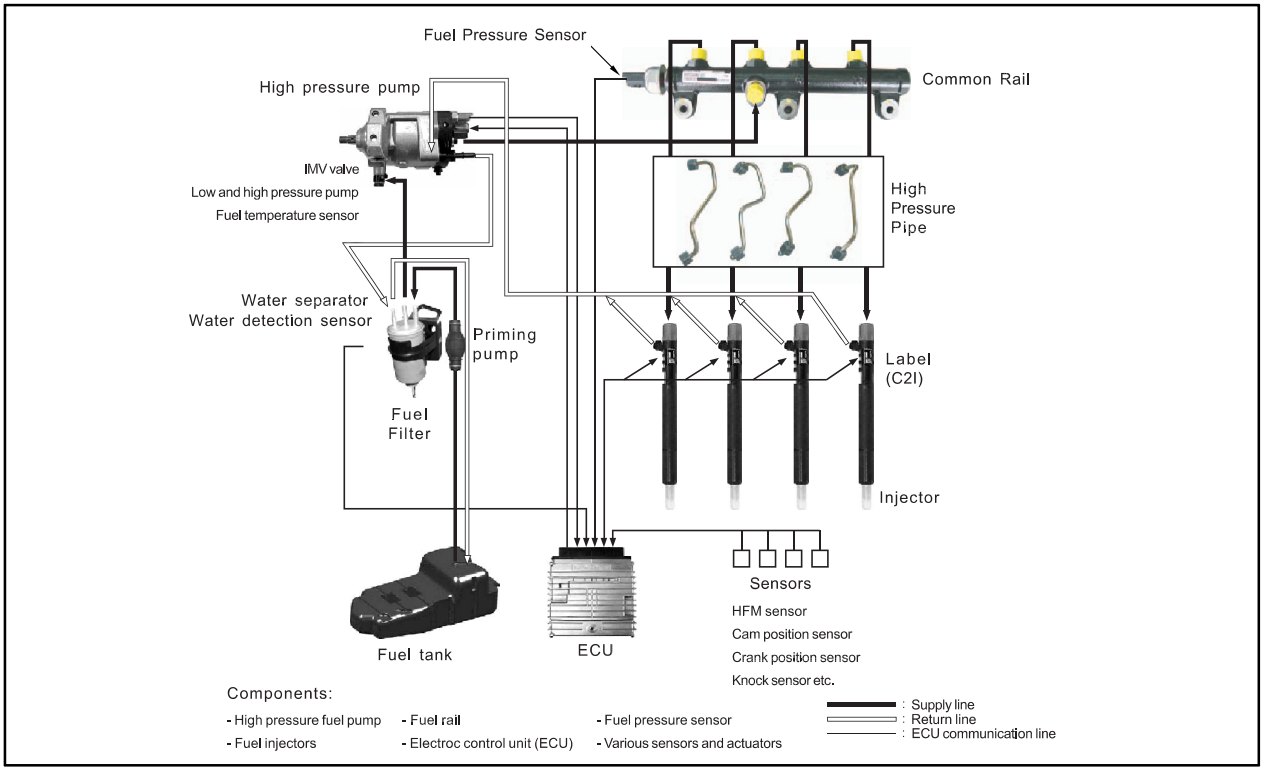
Use special tools and torque wrench to perform the correct works.

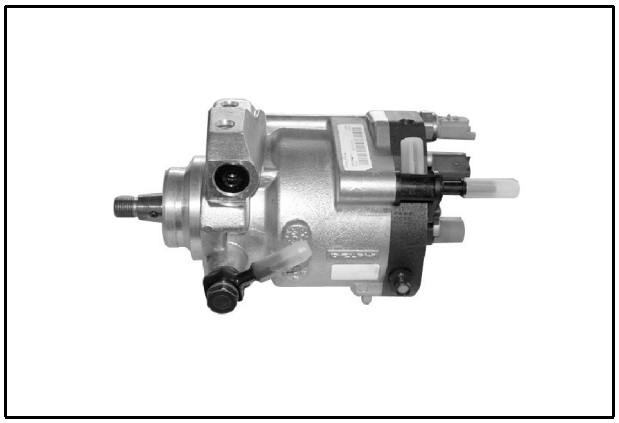
Once disconnected, the fuel pipes between HP pump and fuel rail and between fuel rail and each injector should be replaced with new ones. The pipes should be tightened to specified tightening torques during installation. Over or under torques out of specified range may cause damages and leaks at connections. Once installed, the pipes have been deformed according to the force during installtion, therefore they are not reusable.

The copper washer on injector should be replaced with new one. The injector holder bolt should be tightened to specified tightening torque as well. If not, the injection point may be deviated from correct position, and it may cause engine disorder.

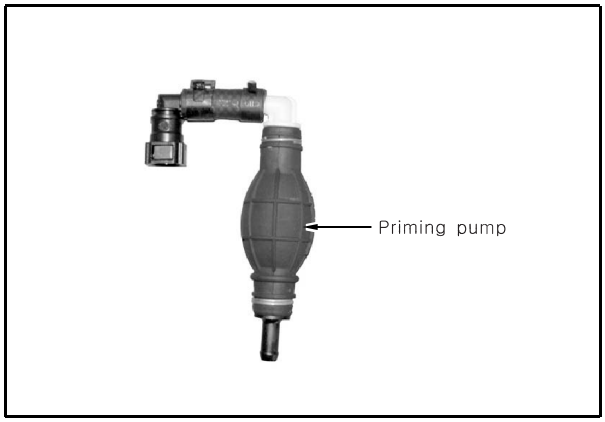
↓

Plug the disconnected parts with sealing caps, and remove the caps immediately before replacing the components.





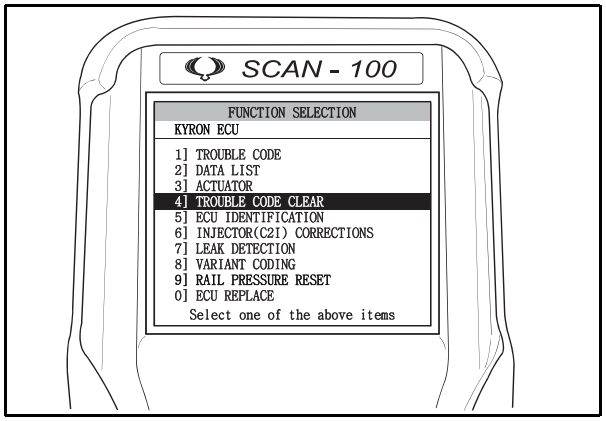
7. Plug the removed components with clean and undamaged sealing caps and store it into the box to keep the conditions when it was installed.
8. Clear the high pressure offset value by SCAN- 100 after replacing the high pressure pump.



9. To supply the fuel to transfer line of HP pump press the priming pump until it becomes hard.

CAUTION

- Do not crank engine before having filled pump.



10. Check the installed components again and connect the negative battery cable. Start the engine and check the operating status. With SCAN-100, check if there are current
11. faults and erase the history faults.

Modification basis	
Application basis	
Affected VIN	

3) Di engine and its expected problems and remedies can be caused by water in fuel

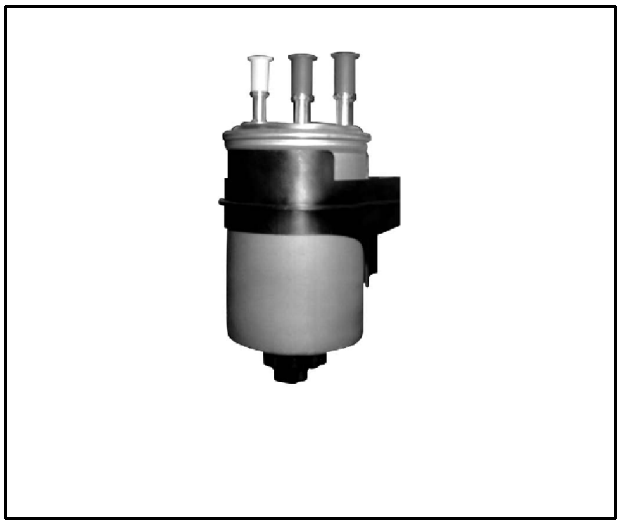
▶ SYSTEM SUPPLEMENT AGAINST PARAFFIN SEPARATION.

In case of Diesel fuel, paraffin, one of the elements, can be separated from fuel during winter and then can stick on the fuel filter blocking fuel flow and causing difficult starting finally. Oil companies supply summer fuel and winter fuel by differentiating mixing ratio of kerosene and other elements by region and season. However, above phenomenon can be happened if stations have poor facilities or sell improper fuel for the season.

In case of DI engine, purity of fuel is very important factor to keep internal preciseness of HP pump and injector.

Accordingly, more dense mesh than conventional fuel filter is used. To prevent fuel filter internal clogging due to paraffin separation, SYMC is using fuel line that high pressure and temperature fuel injected by injector returns through fuel filter to have an effect of built-in heater (see fuel system).

▶ SYSTEM SUPPLEMENT AND REMEDY AGAINST WATER IN FUEL



As mentioned above, some gas stations supply fuel with excessive than specified water. In the conventional IDI engine, excessive water in the fuel only causes dropping engine power or engine hunting. However, fuel system in the DI engine consists of precise components so water in the fuel can cause malfunctions of HP pump due to poor lubrication of pump caused by poor coating film during high speed pumping and bacterization (under long period parking). To prevent problems can be caused by excessive water in fuel, water separator is installed inside of fuel filter. When fuel is passing filter, water that has relatively bigger specific gravity is accumulated on the bottom of the filter.

If water in the separator on the fuel filter exceeds a certain level, it will be supplied to HP pump with fuel, so the engine ECU turns on warning light ( ) on the meter cluster and buzzer if water level is higher than a certain level.

Due to engine layout, a customer cannot easily drain water from fuel filter directly, so if a customer checks in to change engine oil, be sure to perform water drain from fuel filter. (See fuel system for details.)

Memo

12. MAINTENANCE AND REPAIR

1) Maintenance and lubrication

▶ Normal Vehicle Use

The maintenance instructions contained in the maintenance schedule are based on the assumption that the vehicle will be used for the following reasons:

1. To carry passengers and cargo within the limitation of the tire inflation prassure. Refer to "Wheels and Tire" in section 4H.
2. To be driven on reasonable road surfaces and within legal operating limits.

▶ Explanation of Scheduled Maintenance Services

The services listed in the maintenance schedule are further explained below.
When the following maintenance services are performed, make sure all the parts are replaced and all the necessary repairs are done before driving the vehicle. Always use the proper fluid and lubricants.

▷ **Engine Oil and Oil Filter Change**

Always use above the API SH grade or recommended engine oil.

▷ **Engine Oil Viscosity**

Engine oil viscosity (thickness) has an effect on fuel economy and cold weather operation. Lower viscosity engine oils can provide better fuel economy and cold weather performance; however, higher temperature weather conditions require higher viscosity engine oils for satisfactory lubrication. Using oils of any viscosity other than those viscosities recommended could result in engine damage.

▷ **Cooling System Service**

Drain, flush and refill the system with new coolant. Refer to "Recommended Fluids And Lubricants" in this section.

▷ **Spark Plug Wire Replacement**

Clean wires and inspect them for burns, cracks or other damage. Check the wire boot fit at the Distributor and at the spark plugs. Replace the wires as needed.

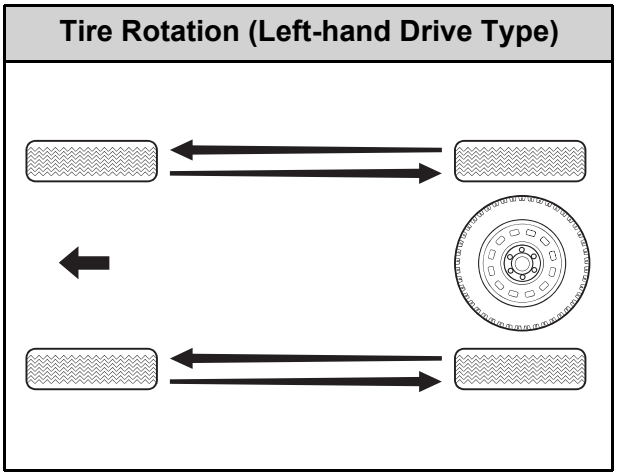
▷ **Brake System Service**

Check the disc brake pads or the drum brake linings.
Check the pad and the lining thickness carefully.

▷ **Tire and Wheel Inspection and Rotation**

Check the tires for abnormal wear or damage.
To equalize wear and obtain maximum tire life, rotate the tires. If irregular or premature wear exists, check the wheel alignment and check for damaged wheels. While the tires and wheels are removed, inspect the brakes.

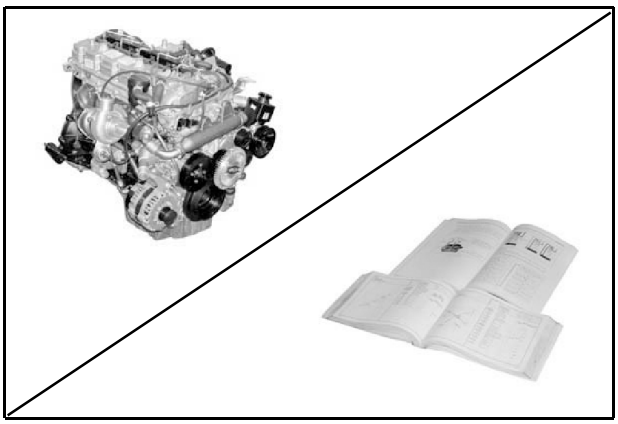
Tire Rotation (Left-hand Drive Type)



Modification basis	
Application basis	
Affected VIN	

13.GUIDELINES FOR SERVICE WORK SAFETY

1) General



To maintain and operate the vehicle under optimum state by performing safe service works, the service works should be done by following correct methods and procedures. Accordingly, the purpose of this manual is to prevent differences that can be caused by personal working method, skill, ways and service procedures and to allow prompt/correct service works.

▶ **Note, Notice**

While using this manual, there are a lot of Note or Notice having below meaning.

CAUTION

- Note means detailed description of supplementary information on work procedure or skill.

CAUTION

- Notice means precautions on tool/device or part damages or personal injuries that can occur during service works.

However, above references and cautions cannot be inclusive measures, so should have habits of taking concerns and cautions based on common senses.

2) Cautions on Inspection/Service

CAUTION

- During service works, be sure to observe below general items for your safety

· For service works, be sure to disconnect battery negative (-) terminal if not starting and inspection.
· While inspecting vehicle and replacing various consumable parts, be sure to take caution not to damage vehicle and injure people.
· Engine and transmission may be hot enough to burn you. So inspect related locations when they cooled down enough.
· If engine is running, keep your clothing, tools, hair and hands away from moving parts.
· Even when the ignition key is turned off and positioned to LOCK, electrical fan can be operated while working on near around electrical fan or radiator grille if air conditioner or coolant temperature rises.
· Every oil can cause skin trouble. Immediately wash out with soap if contacted.
· Painted surface of the body can be damaged if spilled over with oil or anti-freeze.
· Never go under vehicle if supported only with jack.
· Never near the battery and fuel related system to flames that can cause fire like cigarette.
· Never disconnect or connect battery terminal or other electrical equipment if ignition key is turned on.
· While connecting the battery terminals, be cautious of polarities (+, ?) not to be confused.
· There are high voltage and currency on the battery and vehicle wires. So there can be fire if short-circuited.
· Do not park while running the engine in an enclosed area like garage. There can be toxication with CO, so make sufficient ventilation.
· The electrical fan works electrically. So the fan can be operated unexpectedly during working causing injuries if the ignition key is not in LOCK position. Be sure to check whether ignition key is in LOCK position before work.
· Be careful not to touch hot components like catalytic converter, muffler and exhaust pipe when the engine is running or just stopped. They may burn you badly.

Modification basis	
Application basis	
Affected VIN	

3) Guidelines on engine service

To prevent personal injuries and vehicle damages that can be caused by mistakes during engine and unit inspection/ repair and to secure optimum engine performance and safety after service works, basic cautions and service work guidelines that can be easily forgotten during engine service works are described in.

▶ Cautions before service works

1. Before work on engine and each electrical equipment, be sure to disconnect battery negative (-) terminal.
2. Before service works, be sure to prepare the works by cleaning and aligning work areas.
3. Always position the ignition switch to OFF if not required. If not, there can be electrical equipment damages or personal injuries due to short-circuit or ground by mistake.
4. There should be no leak from fuel injection system (HP pump, fuel hose, high pressure pipe) of the D20DT & D27DT engine. So they should be protected from foreign materials.
5. While removing the engine, do not position the jack and others under the oil pan or engine. To secure the safety, use only safety hook on the engine.

▶ Engine and accessories

Engine has a lot of precise portions so tightening torque should be correct during disassembly / assembly and removal/installation and service work should be done in clean ways during disassembly / assembly.

Maintaining working area clean and cautious service administration is essential element of service works while working on the engine and each section of the vehicle.
So the mechanics should well aware of it.

1. While removing the engine, related parts (bolts, gaskets, etc.) should be aligned as a group.
2. While disassembling/assembling internal components of the engine, well aware of disassembly/assembly section in this manual and clean each component with engine oil and then coat with oil before installation.
3. While removing engine, drain engine oil, coolant and fuel in fuel system to prevent leakage.
4. During service work of removal/installation, be sure to check each connected portions to engine not to make interference.

▶ Fuel and lubrication system

Painted surface of the body can be damaged or rubber products (hoes) can be corroded if engine oil and fuel are spilled over. If spilled over engine, foreign materials in air can be accumulated on the engine damaging fuel system.

1. If work on the fluid system such as fuel and oil, working area should be well ventilated and mechanic should not smoke.
2. Gasket or seal on the fuel/lubrication system should be replaced with new and bolts and nuts should be tightened as specified.
3. After removal/installation works, be sure to check whether there is leak on the connecting section.

If fine dust or foreign material enters into DI engine's fuel system, there can be serious damages between HP pump and injectors. So, be sure to cover removed fuel system components with cap and protect removed parts not to be contaminated with dirt. (Refer to cleanness in this manual while working on DI engine fuel system)

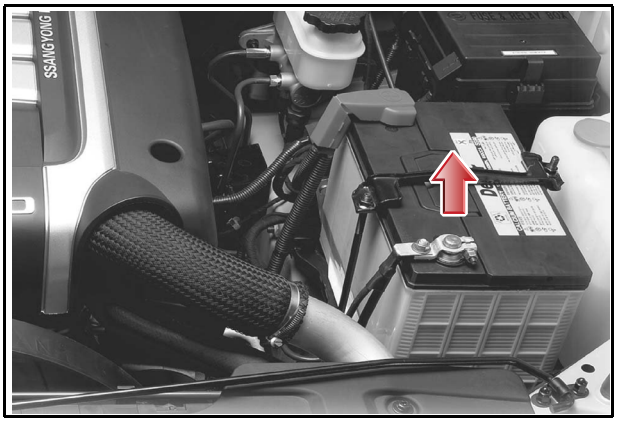
▶ Electrical equipment

Electrical equipment should be handled more carefully.
Currently, the engine is equipped with a lot of electrical equipments so there can be engine performance drops, incomplete combustion and other abnormals due to short and poor contact. Mechanics should well aware of vehicle's electrical equipment.

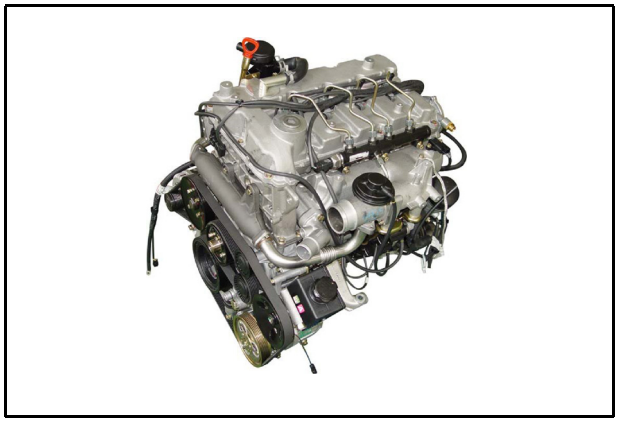
1. If have to work on the electrical equipment, be sure to disconnect battery negative (-) terminal and position the ignition switch to off if not required.
2. When replacing electrical equipment, use the same genuine part and be sure to check whether ground or connecting portions are correctly connected during installation. If ground or connecting portion is loosened, there can be vehicle fire or personal injury.

Modification basis	
Application basis	
Affected VIN	

14. DURING SERVICE WORK FOR INSPECTION



1. Before lifting up the vehicle with lift, correctly support the lifting points and lift up.
2. When using a jack, park the vehicle on the level ground and block front and rear wheels. Position the jack under the frame and lift up the vehicle and then support with chassis stand before service work.
3. Before service work, be sure to isconnect battery negative (-) terminal to prevent damages by bad wire and short.
4. If service from interior of the vehicle, use protection cover to prevent damage and contamination of seat and floor.
5. Brake fluid and anti-freeze can damage painted surface of body. So carefully handle them during service work.
6. Use recommended and specified tools to increase efficiency of service work.
7. Use only genuine spare parts.



8. Never reuse cotter pin, gasket, O-ring, oil seal, lock washer and self-locking nut. Replace them with new.
   If reused, normal functions cannot be maintained.
9. Align the disassembled parts in clean according to disassembling order and group for easy assembling.
10. According to installing positions, the bolts and nuts have different hardness and design. So be careful not to mix removed bolts and nuts each other and align them according installing positions.
11. To inspect and assemble, clean the parts.
12. Securely clean the parts that related with oil not to be affected by viscosity of oil.
13. Coat oil or grease on the driving and sliding surfaces before installing parts.
14. Use sealer or gasket to prevent leakage if necessary.
15. Damaged or not, never reuse removed gasket. Replace with new and cautious on installing directions.
16. Tighten every bolt and nut with specified torque.
17. When service work is completed, check finally whether the work is performed properly or the problem is solved.
18. If work on the fuel line between priming pump and injector (including return line), be sure to cover the removed parts with cap and be careful not to expose the connecting passage and removed parts to external foreign materials or dust. (Refer to cleanness.)
19. If remove high pressure fuel supply pipe between HP pump and fuel rail and high pressure fuel pipe between fuel rail and each injector, be sure to replace them with new.

Modification basis	
Application basis	
Affected VIN	

15. DURING SERVICE WORK FOR ELECTRIC DEVICES

CAUTION

- Be careful not to modify or alter electrical system and electrical device. Or there can be vehicle fire or serious damage.

1. Be sure to disconnect battery negative (-) terminal during every service work. Before disconnecting battery negative (-) terminal, turn off ignition key.
2. Replace with specified capacity of fuse if there is bad, blown or short circuited fuse. If use electrical wire or steel wire other than fuse, there can be damages on the various electrical systems. If replaced with over-capacity fuse, there can be damages on the related electrical device and fire.
3. Every wire on the vehicle should be fastened securely not to be loosened with fixing clip.
4. If wires go through edges, protect them with tape or other materials not to be damaged.
5. Carefully install the wires not to be damaged during installation/removal of parts due to interference.
6. Be careful not to throw or drop each sensor or relay.
7. Securely connect each connector until hear a "click" sound.

1) Lifting positions

▶ 4-post lift

As illustrated, position the vehicle on the 4-post lift securely and block the front and rear of each tire not to move during working.

CAUTION

During lifting, be sure to check whether vehicle is empty.

- Board-on lift connection device installed in front of vehicle should be positioned in front of sill locating under the front door.
- Install lift connecting device on the edge of front and rear of board-on lift.

WARNING

- Be sure to use attachment during lifting to prevent the lift from contacting with body floor.
- While lifting the vehicle, widen the lift floor as far as possible to stabilize between vehicle front and rear.
  When fixing the lift floor, be careful not to contact with brake tube and fuel lines.

▶ Safety jack and safety stand

If lift up the vehicle with safety jack and stand, should be more careful during works.

WARNING

- Never be under the vehicle if supported with only jack. If have to be under the vehicle, be sure to use safety block.
- Use wheel block in front and rear of every wheel.

16. OWNER INSPECTIONS AND SERVICES

1) While Operating The Vehicle

▶ Horn Operation

Blow the horn occasionally to make sure it works. Check all the button locations.

▶ Brake System Operation

Be alert for abnormal sounds, increased brake pedal travel or repeated puling to one side when braking. Also, if the brake warning light goes on, or flashes, something may be wrong with part of the brake system.

▶ Exhaust System Operation

Be alert to any changes in the sound of the system or the smell of the fumes.
These are signs that the system may be leaking or overheating. Have the system inspected and repaired immediately.

▶ Tires, Wheels and Alignment Operation

Be alert to any vibration of the steering wheel or the seats at normal highway speeds. This may mean a wheel needs to be balanced. Also, a pull right or left on a straight, level road may show the need for a tire pressure adjustment or a wheel alignment.

▶ Steering System Operation

Be alert to changes in the steering action. An inspection is needed when the steering wheel is hard to turn or has too much free play, or is unusual sounds are noticed when turning or parking.

▶ Headlamp Aim

Take note of the light pattern occasionally. Adjust the headlights if the beams seem improperly aimed.

Modification basis	
Application basis	
Affected VIN	

2) At each fuel fill

A fluid loss in any (except windshield washer) system may indicate a problem. Have the system inspected and repaired immediately.

▶ Engine Oil Level

Check the oil level and add oil if necessary. The best time to check the engine oil level is when the oil is warm.

1. After stopping the engine, wait a few minutes for the oil to drain back to the oil pan.
2. Pull out the oil level indicator (dip stick).
3. Wipe it clean, and push the oil level indicator back down all the way.
4. Pull out the oil level indicator and look at the oil level on it.
5. Add oil, if needed, to keep the oil level above the lower mark. Avoid overfilling the engine, since this may cause engine damage.
6. Push the indicator all the way back down into the engine after taking the reading.

If you check the oil level when the oil is cold, do not run the engine first. The cold oil will not drain back to the pan fast enough to give a true oil level reading.

▶ Engine Coolant Level and Condition

Check the coolant level in the coolant reservoir tank and add coolant if necessary. Inspect the coolant. Replace dirty or rusty coolant.

▶ Windshield Washer Fluid Level

Check the washer fluid level in the reservoir. Add fluid if necessary.

3) At least twice a month

Tire And Wheel Inspection and Pressure Check

Check the tire for abnormal wear or damage. Also check for damaged wheels. Check the tire pressure when the tires are cold (check the spare also, unless it is a stowaway).
Maintain the recommended pressures. Refer to "Wheels and Tire" is in section 4H.

4) At least monthly

▶ Lamp Operation

Check the operation of the license plate lamp, the headlamps (including the high beams), the parking lamps, the fog lamps, the taillamp, the brake lamps, the turn signals, the backup lamps and the hazard warning flasher.

▶ Fluid Leak Check

Periodically inspect the surface beneath the vehicle for water, oil, fuel or other fluids, after the vehicle has been parked for a while. Water dripping from the air conditioning system after use is normal. If you notice fuel leaks or fumes, find the cause and correct it at once.

5) At least twice a year

▶ Power Steering System Reservoir Level

Check the power steering fluid level. Keep the power steering fluid at the proper level. Refer to Section 4G, Power Steering System.

▶ Brake Master Cylinder Reservoir Level

Check the fluid and keep it at the proper level. A low fluid level can indicate worn disc brake pads which may need to be serviced. Check the breather hole in the reservoir cover to be free from dirt and check for an open passage.

▶ Weather-Strip Lubrication

Apply a thin film silicone grease using a clean cloth.

6) Each time the oil is changed

▶ Brake System Inspection

This inspection should be done when the wheels are removed for rotation. Inspect the lines and the hoses for proper hookup, binding, leaks, cracks, chafing, etc. Inspect the disc brake pads for wear. Inspect the rotors for surface condition. Inspect other brake parts, the parking brake, etc., at the same time. Inspect the brakes more often if habit or conditions result in frequent braking.

▶ Steering, Suspension and Front Drive Axle Boot And Seal Inspection

Inspect the front and rear suspension and the steering system for damaged, loose or missing parts, signs of wear or lack of lubrication. Inspect the power steering line and the hoses for proper hookup, binding, leaks, cracks, chafing, etc. Clean and inspect the drive axle boot and seals for damage, tears or leakage. Replace the seals if necessary.

▶ Exhaust System Inspection

Inspect the complete system (including the catalytic converter if equipped). Inspect the body near the exhaust system. Look for broken, damaged, missing, or out-ofposition parts as well as open seams, holes, loose connections, or other conditions which could cause heat buildup in the floor pan or could let exhaust fumes seep into the trunk or passenger compartment.

▶ Drain the Water from Fuel Filter

When the water level inside water separator in fuel filter exceeds a certain level, water separator warning light comes on and buzzer sounds. Also, the driving force of the vehicle decreases.

If these conditions occur, immediately drain the water from fuel filter & water separator.

▶ Hood Latch Operation

When opening the hood, note the operation of the secondary latch. It should keep the hood from opening all the way when the primary latch is released. The hood must close firmly.

Modification basis	
Application basis	
Affected VIN	

7) At least annually

▶ Lap and Shoulder Belts Condition and Operation

Inspect the belt system including: the webbing, the buckles, the latch plates, the retractor, the guide loops and the anchors.

▶ Movable Head Restraint Operation

On vehicles with movable head restraints, the restraints must stay in the desired position.

▶ Spare Tire and Jack Storage

Be alert to rattles in the rear of the vehicle. The spare tire, all the jacking equipment, and the tools must be securely stowed at all times. Oil the jack ratchet or the screw mechanism after each use.

▶ Key Lock Service

Lubricate the key lock cylinder.

▶ Body Lubrication Service

Lubricate all the body door hinges including the hood, the fuel door, the rear compartment hinges and the latches, the glove box and the console doors, and any folding seat hardware.

▶ Underbody Flushing

Flushing the underbody will remove any corrosive materials used for ice and snow removal and dust control. At least every spring clean the underbody. First, loosen the sediment packed in closed areas of the vehicle. Then flush the underbody with plain water.

▶ Engine Cooling System

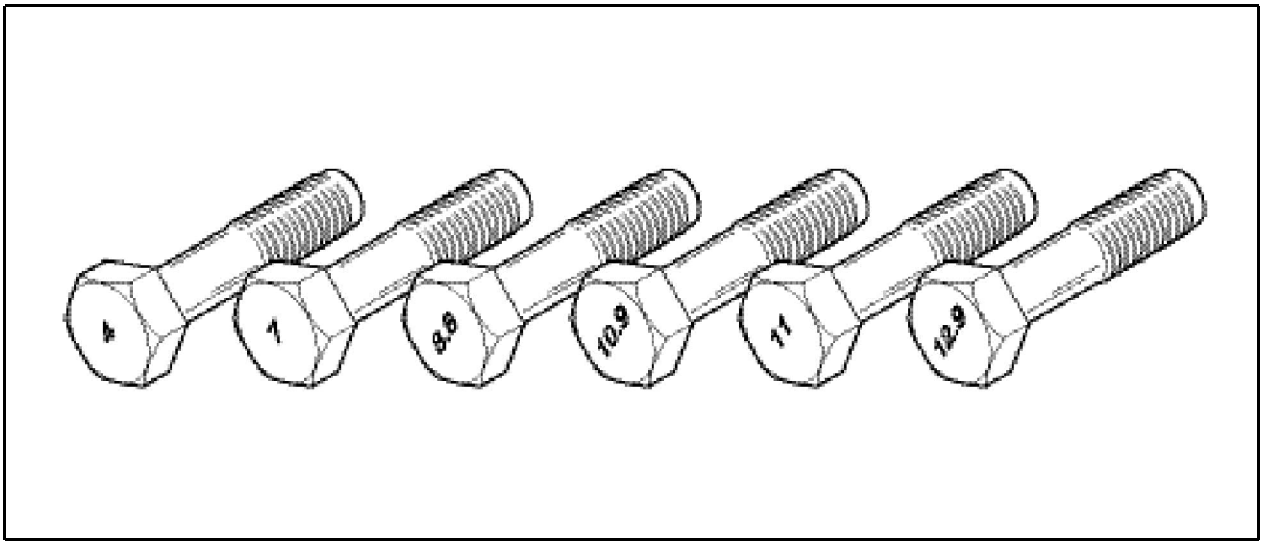
Inspect the coolant and freeze protection fluid. If the fluid is dirty or rusty, drain, flush and refill the engine cooling system with new coolant. Keep the coolant at the proper mixture in order to ensure proper freeze protection, corrosion protection and engine operating temperature. Inspect the hoses. Replace the cracked, swollen, or deteriorated hoses. Tighten the clamps. Clean the outside of the radiator and the air conditioning condenser. Wash the filler cap and the neck. Pressure test the cooling system and the cap in order to help ensure proper operation.

17. STANDARD BOLTS SPECIFICATIONS

Bolt*	Torque (Nm / lb-in)					
	Standard			Limit		
	4T	7T	9T	4T	7T	9T
M3 × 0.5	0.5 Nm (4.5 lb-in)	0.9 Nm (8 lb-in)	1.3 Nm (12 lb-in)	0.7 Nm (6.3 lb-in)	1.2 Nm (11 lb-in)	17 Nm (15 lb-in)
M4 × 0.7	1.2 Nm (11 lb-in)	2.0 Nm (18 lb-in)	3.0 Nm (27 lb-in)	1.6 Nm (14 lb-in)	2.6 Nm (23 lb-in)	4.0 Nm (36 lb-in)
M5 × 0.8	2.4 Nm (22 lb-in)	4.0 Nm (36 lb-in)	5.6 Nm (50 lb-in)	3.1 Nm (28 lb-in)	5.2 Nm (47 lb-in)	7.6 Nm (68 lb-in)
M6 × 1.0	4.0 Nm (36 lb-in)	6.7 Nm (60 lb-in)	9.7 Nm (87 lb-in)	5.4 Nm (49 lb-in)	9.0 Nm (81 lb-in)	12.7 Nm (114 lb-in)
M8 × 1.25	8.6 Nm (77 lb-in)	15.7 Nm (12 lb-in)	22.5 Nm (17 lb-in)	12.7 Nm (9 lb-in)	20.6 Nm (15.2 lb-in)	30.4 Nm (22 lb-in)
M10 × 1.25	18.6 Nm (14 lb-in)	32.3 Nm (24 lb-in)	46.0 Nm (34 lb-in)	25.5 Nm (19 lb-in)	42.1 Nm (31 lb-in)	60.8 Nm (31 lb-in)
M10 × 1.5	18.6 Nm (14 lb-in)	30.4 Nm (22 lb-in)	44.1 Nm (33 lb-in)	24.5 Nm (18 lb-in)	41.2 Nm (30 lb-in)	58.8 Nm (44 lb-in)
M12 × 1.25	34.3 Nm (25 lb-in)	56.8 Nm (42 lb-in)	82.3 Nm (61 lb-in)	45.0 Nm (33 lb-in)	75.5 Nm (56 lb-in)	107.8 Nm (80 lb-in)
M12 × 1.75	32.3 Nm (24 lb-in)	53.9 Nm (40 lb-in)	77.4 Nm (57 lb-in)	43.1 Nm (32 lb-in)	71.5 Nm (53 lb-in)	98.0 Nm (73 lb-in)
M14 × 1.5	54.0 Nm (40 lb-in)	89.2 Nm (66 lb-in)	127.4 Nm (94 lb-in)	71.6 Nm (53 lb-in)	117.6 Nm (87 lb-in)	166.6 Nm (123 lb-in)
M16 × 1.5	81.3 Nm (60 lb-in)	107.8 Nm (80 lb-in)	196.0 Nm (145 lb-in)	107.8 Nm (80 lb-in)	186.2 Nm (138 lb-in)	264.6 Nm (196 lb-in)
M18 × 1.5	117.6 Nm (87 lb-in)	196.0 Nm (145 lb-in)	284.2 Nm (210 lb-in)	156.8 Nm (116 lb-in)	264.6 Nm (196 lb-in)	372.4 Nm (276 lb-in)
M20 × 1.5	166.6Nm (123 lb-in)	274.4 Nm (203 lb-in)	392.0 Nm (290 lb-in)	215.6 Nm (160 lb-in)	362.6 Nm (268 lb-in)	519.4 Nm (384 lb-in)
M22 × 0.5	225.4Nm (167 lb-in)	372.4 Nm (276 lb-in)	529.2 Nm (392 lb-in)	294.0 Nm (218 lb-in)	490.0 Nm (362 lb-in)	705.6 Nm (522 lb-in)
M24 × 1.5	284.2 Nm (210 lb-in)	480.2 Nm (355 lb-in)	686.0 Nm (508 lb-in)	382.2 Nm (283 lb-in)	637.0 Nm (471 lb-in)	921.2 Nm (682 lb-in)
M24 × 2.0	274.4 Nm (203 lb-in)	460.6 Nm (341 lb-in)	666.4 Nm (493 lb-in)	372.4 Nm (276 lb-in)	617.4 Nm (457 lb-in)	891.8 Nm (660 lb-in)

*Diameter X pitch in millimeters

Modification basis	
Application basis	
Affected VIN	



1. Metric bolt strength is embossed on the head of each bolt. The strength of bolt can be classified as 4T, 7T, 8.8T, 10.9T, 11T and 12.9T in general.
2. Observe standard tightening torque during bolt tightening works and can adjust torque to be proper within 15 % if necessary. Try not to over max. allowable tightening torque if not required to do so.
3. Determine extra proper tightening torque if tightens with washer or packing.
4. If tightens bolts on the below materials, be sure to determine the proper torque.
   1) Aluminum alloy: Tighten to 80 % of above torque table.
   2) Plastics: Tighten to 20 % of above torque table.

Memo

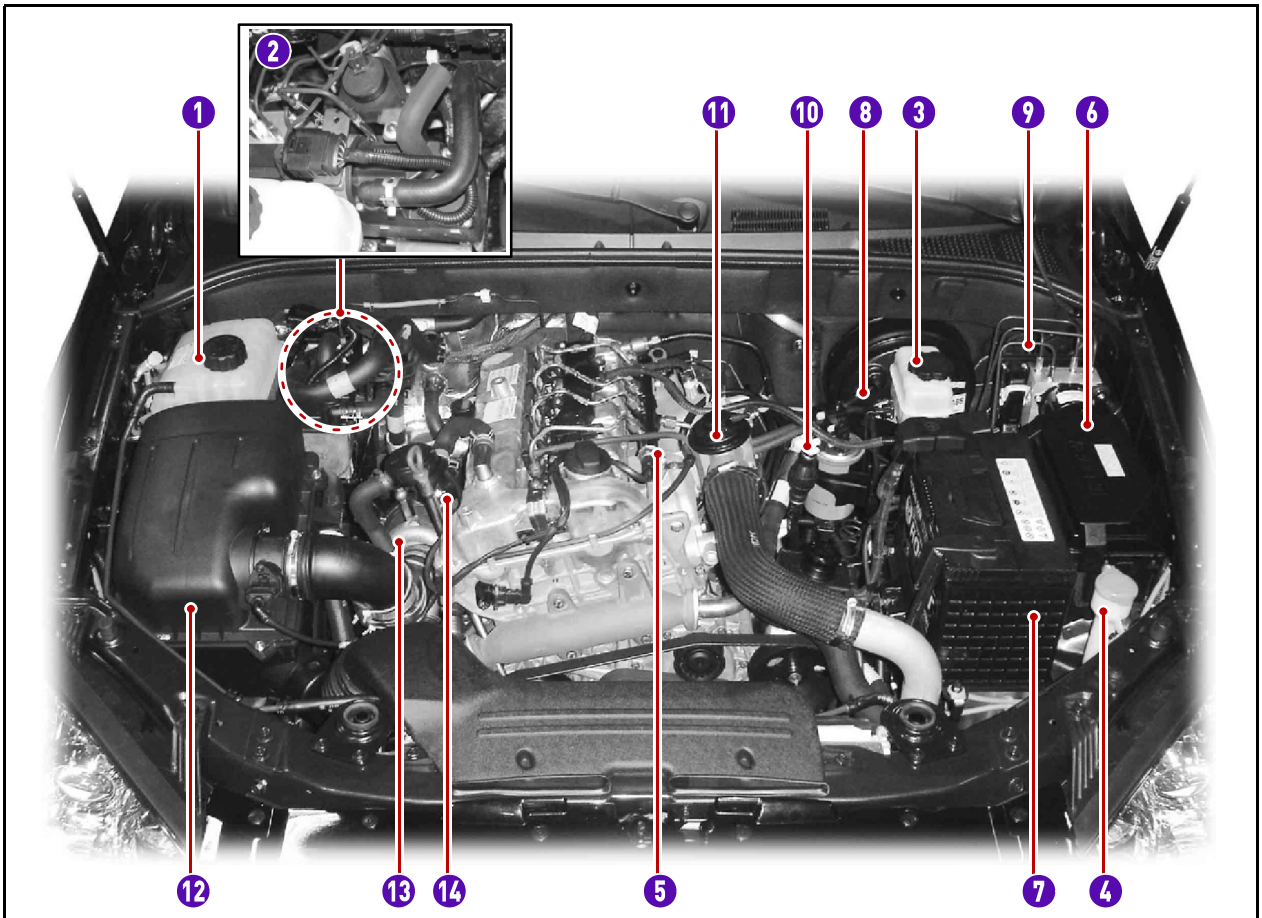
ENGINE ASSEMBLY 1114-01

GENERAL

1. MAJOR COMPONENTS IN ENGINE AND ENGINE COMPARTMENT

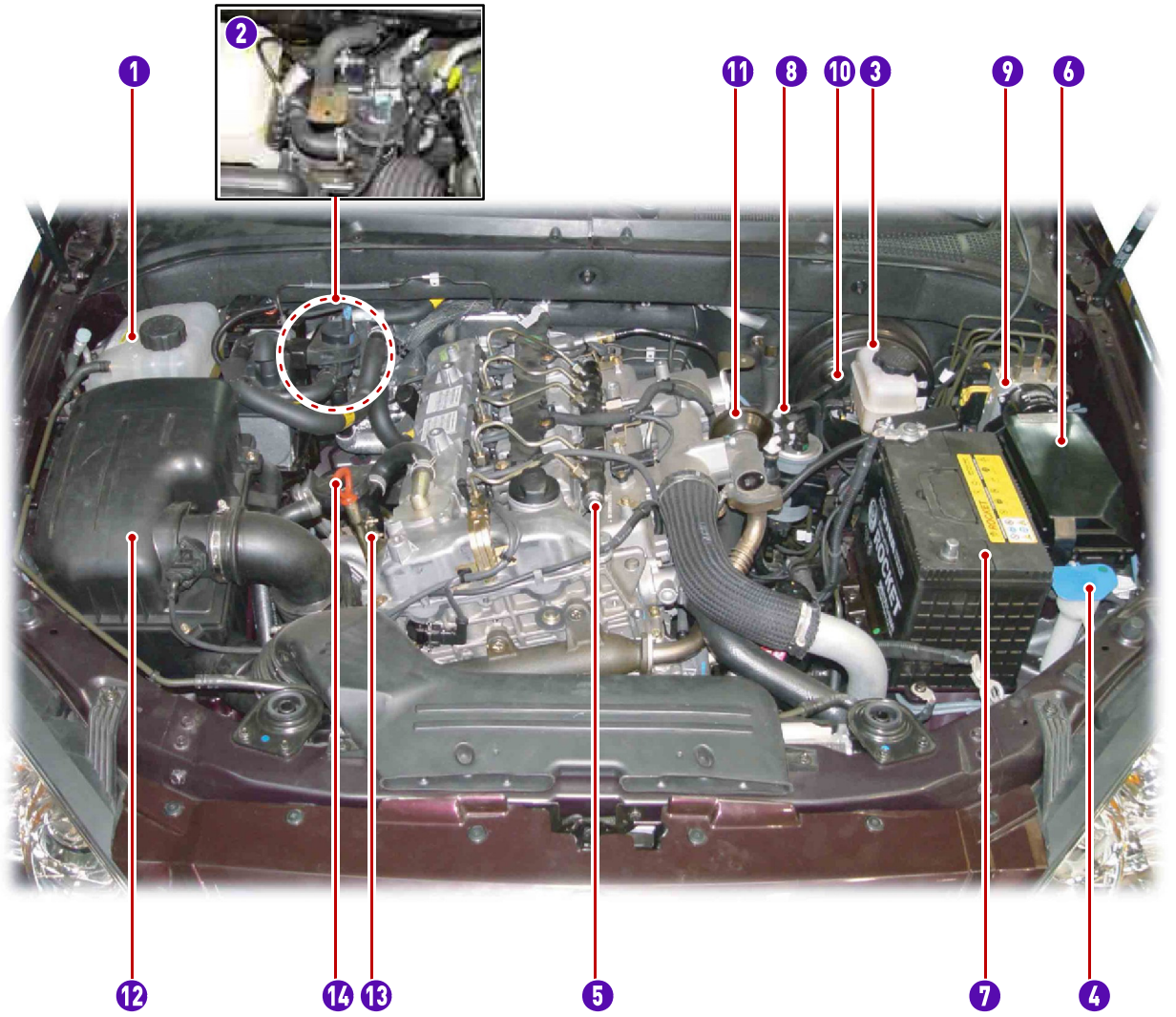
1) D20DT ENGINE

The advanced electronically controlled D20DT engine that has high pressure fuel system has been introduced to this vehicle. It satisfies the strict emission regulation and provides improved output and maximum torque.



1	Coolant reservoir	8	Fuel filter
2	FFH device	9	ABS/ESP unit
3	Brake fluid reservoir	10	Priming pump
4	Washer fluid reservoir	11	EGR valve
5	Common rail	12	Air cleaner assembly
6	Fuse box	13	Turbo charger
7	Battery	14	Oil dipstick

2) D27DT ENGINE



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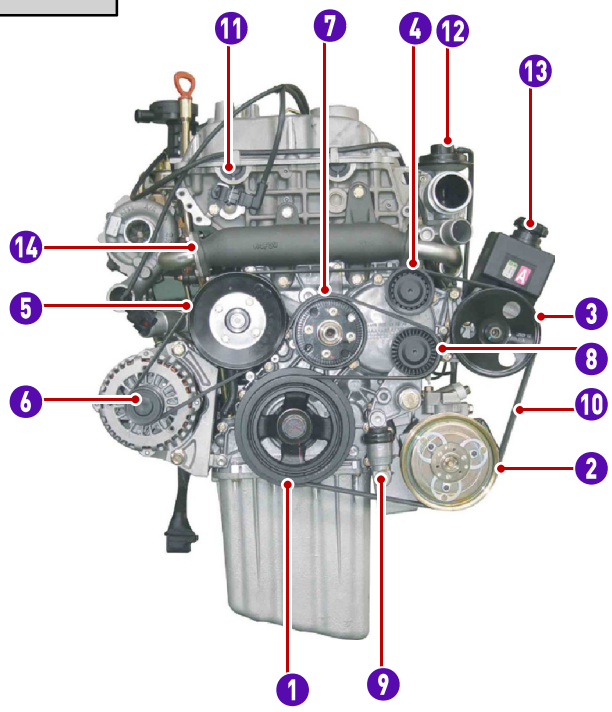
6	Fuse box	13	Turbo charger
7	Battery	14	Oil dipstick

Modification basis	
Application basis	
Affected VIN	

2. ENGINE STRUCTURE

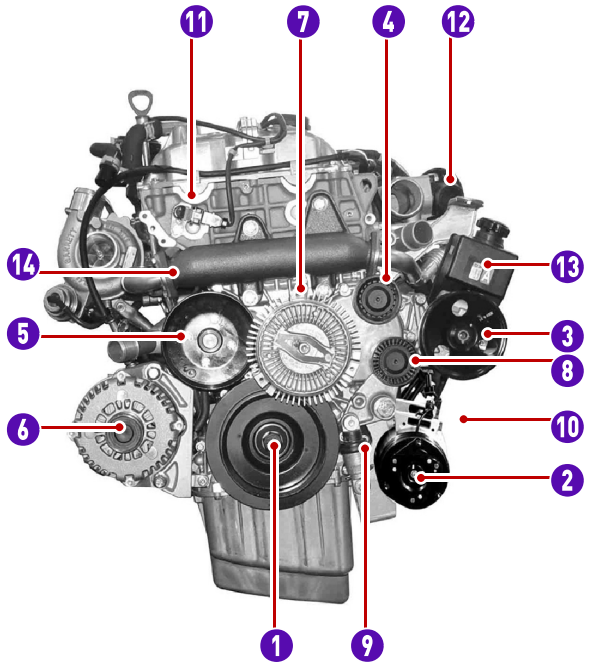
1) Front View

D20DT



1	TVD (Torsional Vibration Damper)
2	Air conditioner compressor
3	Power steering pump pulley
4	Idle pulley
5	Water pump pulley
6	Alternator
7	Viscos clutch pulley
8	Auto tensioner pulley
9	Auto tensioner
10	Poly-grooved belt
11	Cam position sensor
12	EGR valve
13	Power steering pump
14	EGR center pipe

D27DT



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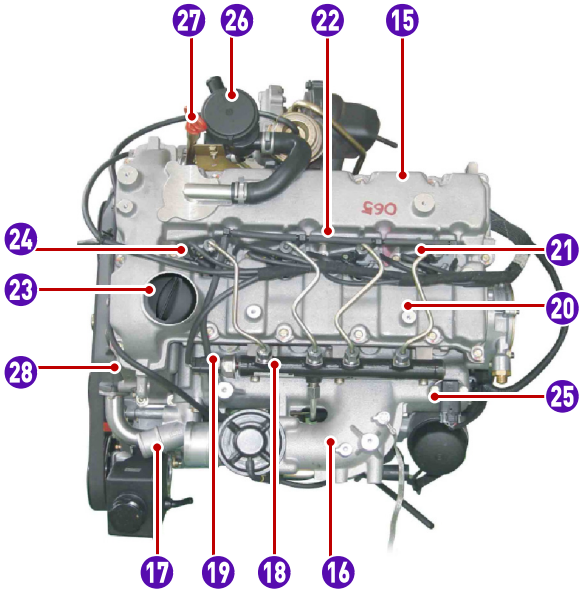
11	Cam position sensor
12	EGR valve
13	Power steering pump
14	EGR center pipe

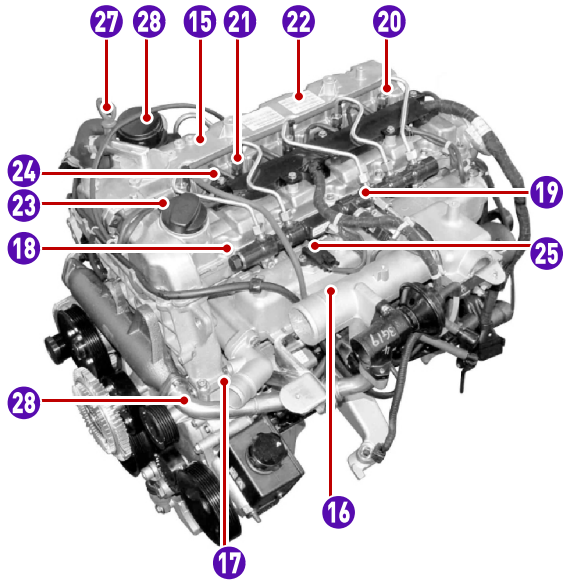
2) Top View

D20DT



15	Cylinder head cover
16	Intake manifold
17	Water outlet port
18	Common rail
19	Fuel pressure sensor
20	Fuel pipe
21	Injector
22	Fuel return line
23	Oil filler cap
24	Glow plug
25	Booster pressure sensor
26	PCV valve and oil separator
27	Oil dipstick
28	EGR-LH pipe

D27DT



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24	Glow plug
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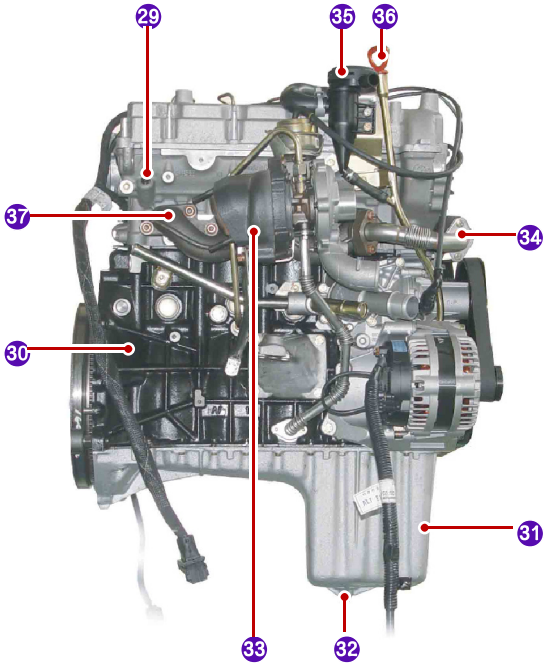
26	PCV valve and oil separator
27	Oil dipstick
28	EGR-LH pipe

Modification basis	
Application basis	
Affected VIN	

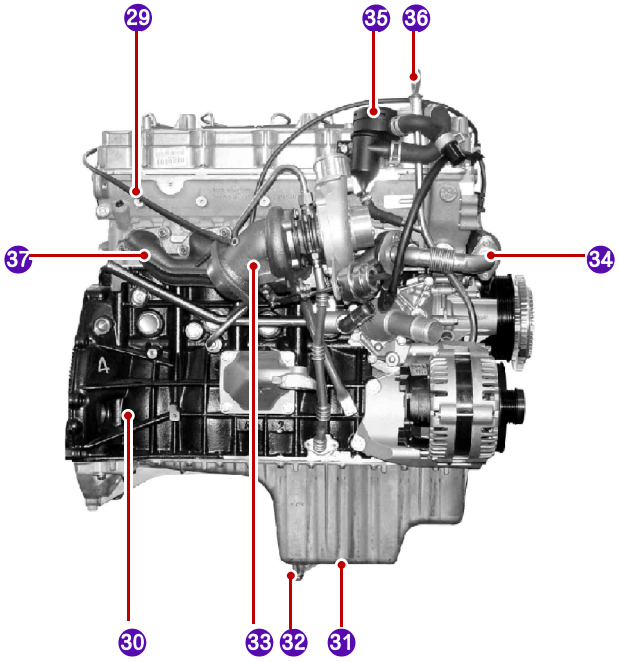
3) Right Side View

D20DT



29. Cylinder head
30. Cylinder block
31. Oil pan
32. Drain plug
33. Turbo charger
34. EGR-RH pipe
35. PCV valve and oil separator
36. Oil dipstick
37. Exhaust manifold

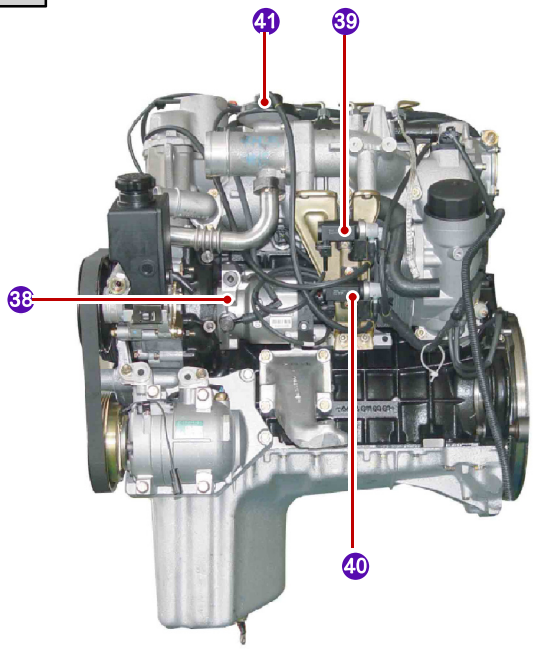
D27DT



29. Cylinder head
30. Cylinder block
31. Oil pan
32. Drain plug
33. Turbo charger
34. EGR-RH pipe
35. PCV valve and oil separator
36. Oil dipstick
37. Exhaust manifold

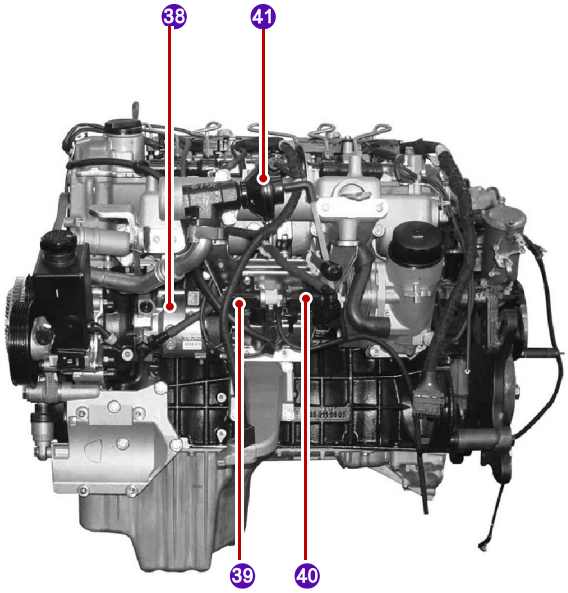
4) Left Side View

D20DT



38. High pressure pump
39. Turbo charger booster vacuum modulator (Gray)
40. EGR valve vacuum modulator
41. EGR valve (Black)

D27DT



38. High pressure pump
39. Turbo charger booster vacuum modulator (Gray)
40. EGR valve vacuum modulator
41. EGR valve (Black)

Modification basis	
Application basis	
Affected VIN	

3. SPECIFICATIONS AND PERFORMANCE CURVE

1) Specifications

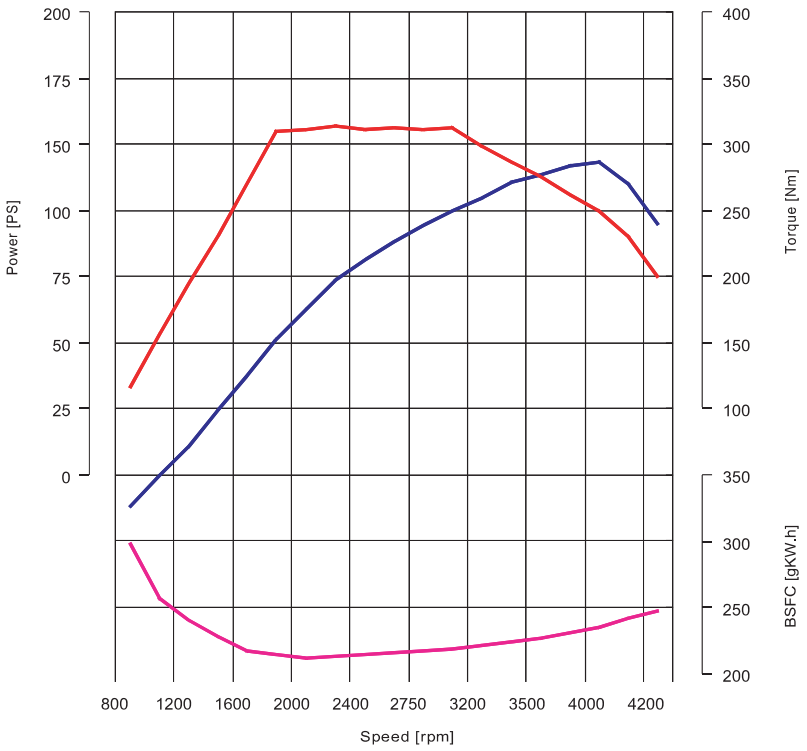
Description			D20DT	D27DT
Engine	Type/Number of cylinders		D20DT/4-cylinder	D27DT/5-cylinder
Cylinder	Inner diameter (mm)		86.2	86.2
	Stroke (mm)		85.6	92.4
Displacement (cc)			1998	2696
Compression ratio			17.5:1	18:1
Maximum output (ps/rpm)			141/4,000	165/4,000
Maximum torque (Nm/rpm)			310/1,800 ~ 2,750	340/1,800 ~ 3,250
Idle speed	For Manual Transmission		750 ± 50 rpm	750 ± 50 rpm
	For Automatic Transmission		750 ± 50 rpm	750 ± 50 rpm
Valve	Intake	Opens (BTDC)	9°	9°
		Closes (ABDC)	26°	26°
	Exhaust	Opens (BBDC)	38°	38°
		Closes (ATDC)	16°	16°
Camshaft	Type		DOHC	DOHC
Fuel system	Fuel type		Low sulfur diesel	Low sulfur diesel
	Fuel pump type		Vane pump in HP pump	Vane pump in HP pump
	Fuel supply pressure		HP pump inlet port: max. 400 mbar HP pump outlet port (with IMV fully open): over 1,050 bar	HP pump inlet port: max. 400 mbar HP pump outlet port (with IMV fully open): over 1,050 bar
	Water separation in fuel filter		at every 10,000 km	at every 10,000 km
	Fuel tank capacity (ℓ)		80	80
Lubrication system	Oil specification		SAE 10W40, 5W40 (MB Sheet 229.1, 229.3 approved oil)	SAE 10W40, 5W40 (MB Sheet 229.1, 229.3 approved oil)
	Lubrication type		Forced delivery	Forced delivery
	Oil filter type		Full flow, filter element type	Full flow, filter element type
	Oil capacity (ℓ)		5.0 ~ 7.5	6.0 ~ 8.5
Cooling system	Cooling type		Water cooling type	Water cooling type
	Cooling fan operation type		Belt operated type	Belt operated type
	Thermostat: Fully Open: 100°C)	Opening temperature (°C)	85	85
		Type	WAX pellet type	WAX pellet type
	Coolant capacity (ℓ)		11.5	11.5

2) Engine Performance Curve

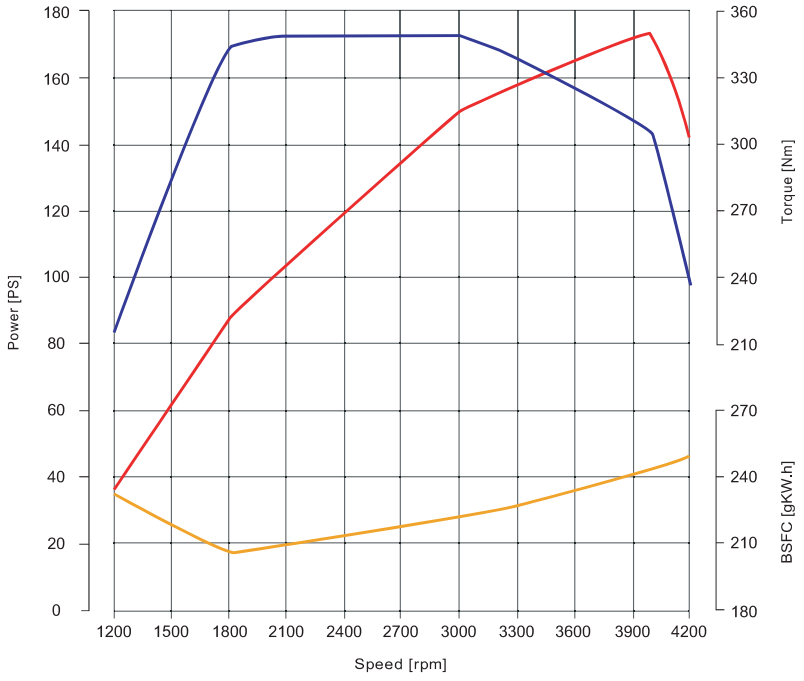
(1) Vehicle with A/T

▶ Output and Torque

D20DT engine



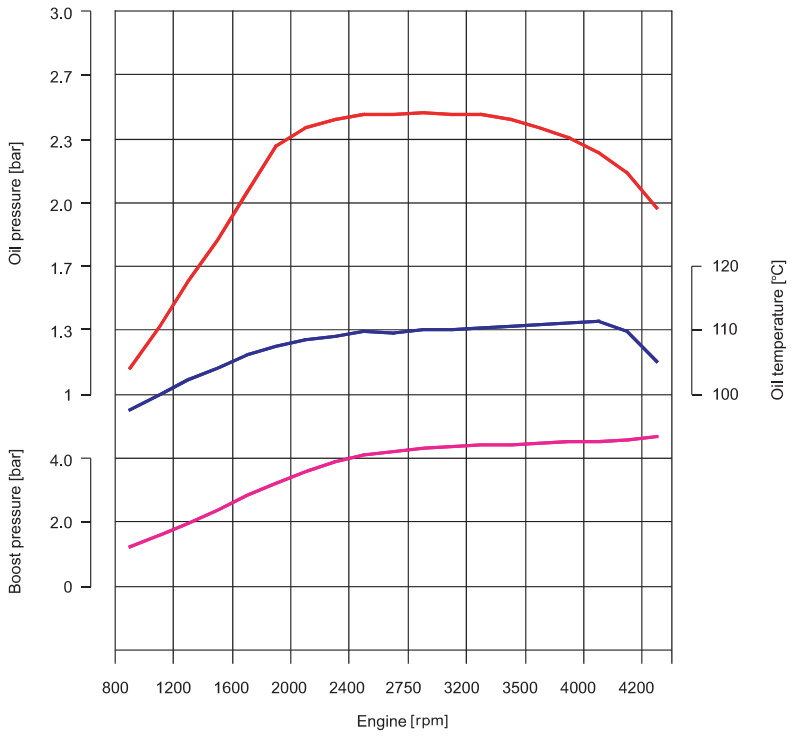
D27DT engine



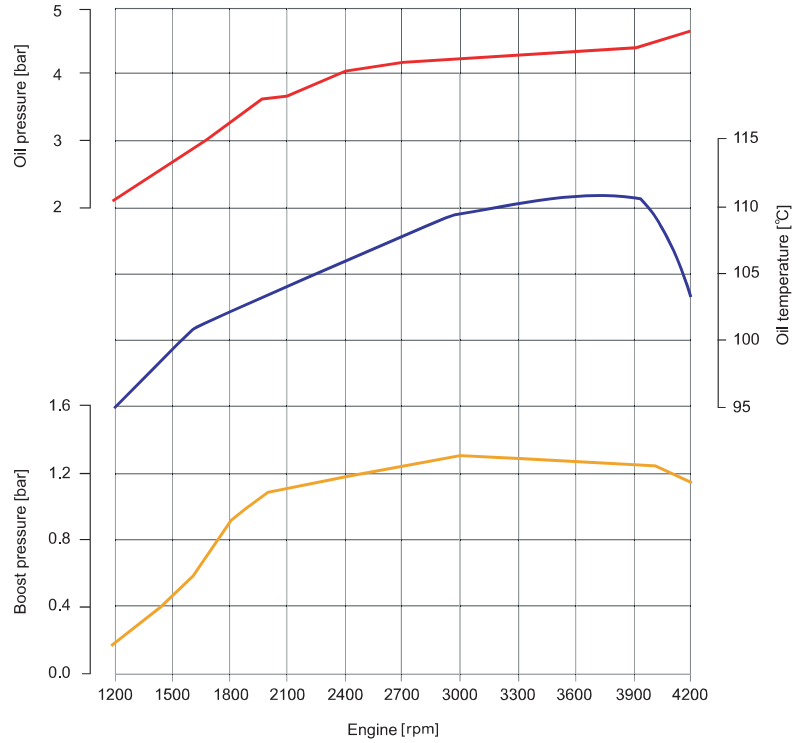
Modification basis	
Application basis	
Affected VIN	

▶ Oil Temperature/Pressure and Boost Pressure

D20DT engine



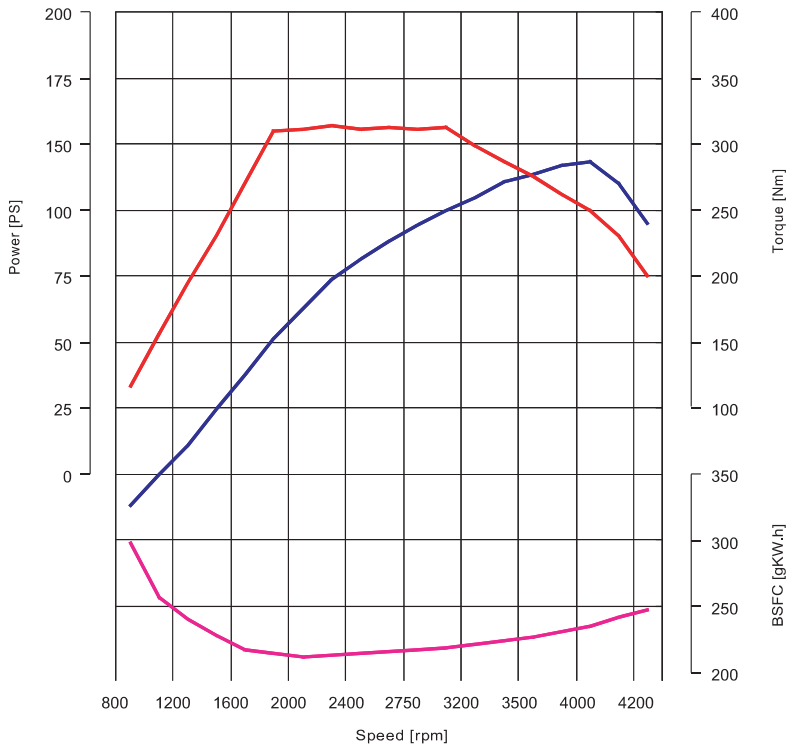
D27DT engine



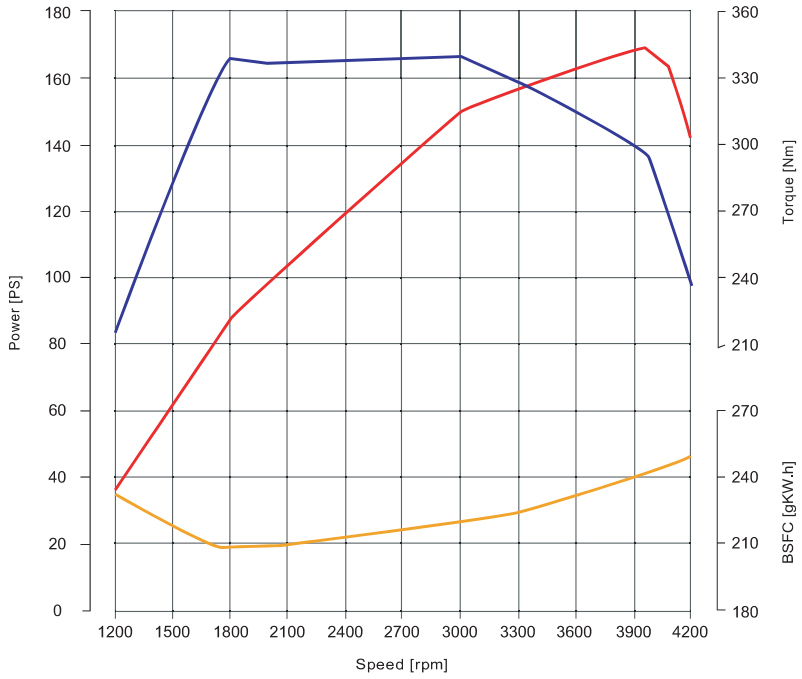
(2) Vehicle with M/T

▶ Output and Torque

D20DT engine



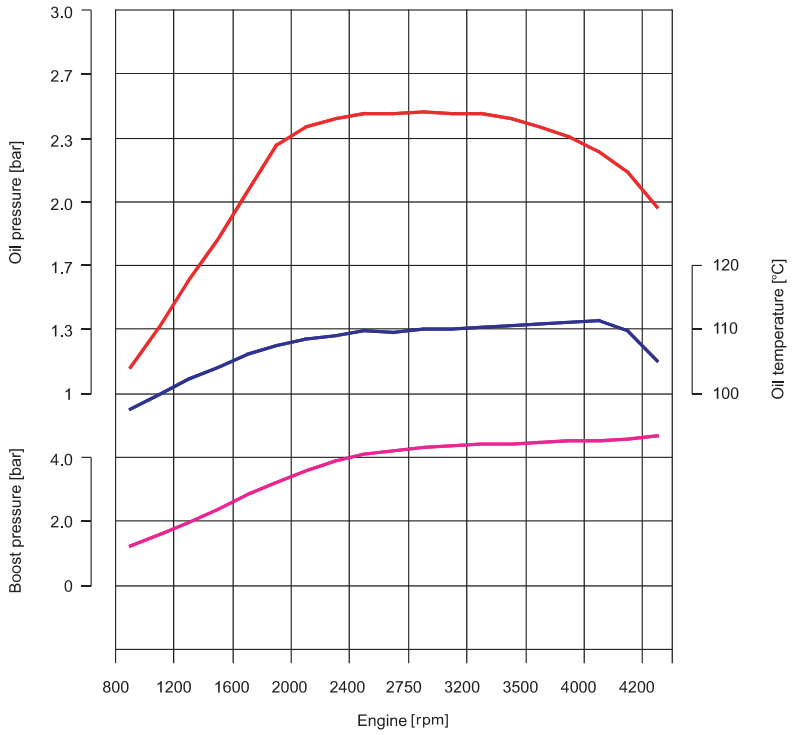
D27DT engine



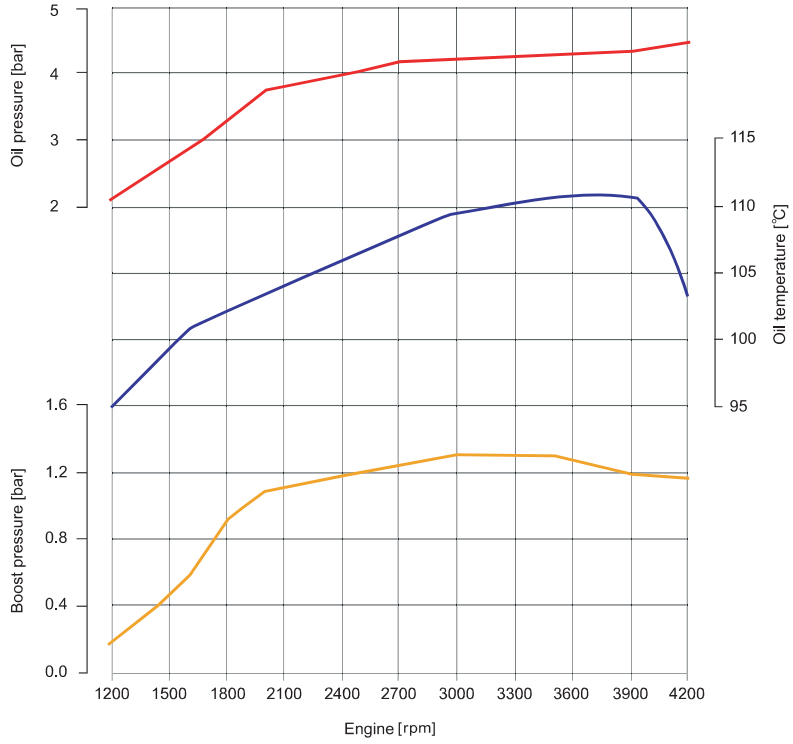
Modification basis	
Application basis	
Affected VIN	

▶ Oil Temperature/Pressure and Boost Pressure

D20DT engine



D27DT engine



Modification basis	
Application basis	
Affected VIN	

4. TIGHTENING TORQUE

NO.	Name	Size	Quantity	Tightening Torque (Nm)
1	Oil nozzle	M6 x 22	5	10 ± 1
2	Main bearing cap	M11 x 62	12	55 ± 5 90° ± 10°
3	Connecting rod cap	M9 x 52	5	40 ± 5 90° ± 10°
4	Rear cover	M6 x 20	6	10 ± 1
5	Oil pump	M8 x 35SOC	3	25 ± 2.5
6	Oil baffle plate assembly	M6 x 20	10	10 ± 1
7	T.G.C.C	M6 x 16	1	10 ± 1
		M6 x 40	6	10 ± 1
		M6 x 60	3	10 ± 1
		M6 x 70	2	10 ± 1
		M8 x 80SOC	1	25 ± 2.5
8	Flywheel	M10 x 28.5	8	45 ± 5 90° ± 10°
9	Crankshaft hub	M20 x 85 Head: M18	1	200 ± 20 180° ± 10°
10	Oil pan	M6 x 20	24	10 ± 1
		M6 x 35	3	10 ± 1
		M6 x 85	3	10 ± 1
		M8 x 40	4	25 ± 2.5
11	High pressure pump assembly	M8 x 40	4	25 ± 2.5
12	High pressure pump sprocket assembly	M14 x 1.5-8-1	1	65 ± 5
13	High pressure pump bracket	M7 x 16	3	20 ± 2 x 90° + 10°
14	Cylinder head assembly	M8 x 25	2	25 ± 2.5
		M8 x 50	2	
		M12 x 177	11	Step1: 20 ± 2 Step2: 85 ± 5
		M12 x 158	1	Step3: 3 x 90° + 10°
15	Camshaft cap	M8 x 60	24	25 ± 2.5
16	Stud bolt	M8	10	15 ± 1.5
17	Camshaft sprocket (Intake)	M11 x 52	1	25 ± 2.5
	Camshaft sprocket (Exhaust)		1	90° ± 10°
18	Chain tensioner	M22	1	65 ± 5
19	Coolant temperature sensor	M14	1	22 ± 2.2

Modification basis	
Application basis	
Affected VIN	

NO.	Name	Size	Quantity	Tightening Torque (Nm)
20	Auto tensioner	M8 x 45(LOWER)	1	32 ± 3
		M12 x 90	1	82 ± 6
21	Water pump assembly	M6 x 50	7	10 ± 1
22	Water pump pulley	M6 x 12	4	10 ± 1
23	Hot water inlet pipe assembly	M6 x 12	2	10 ± 1
24	Alternator bracket	M8 x 32	4	25 ± 2.5
25	Alternator	M10 x 90	2	46 ± 4.6
26	Air conditioner compressor assembly	M8 x 95	4	46 ± 4.6
27	Air conditioner compressor bracket assembly	M8 x 25	1	25 ± 2.5
		M8 x 60	3	25 ± 2.5
28	Air conditioner compressor sub bracket assembly	M6 x 14	1	10 ± 1.0
		M8 x 16	1	25 ± 2.5
29	Intake manifold	M8 x 45	6	25 ± 2.5
		M8 x 130	6	25 ± 2.5
30	Bracket	M6 x 16	1	10 ± 1.0
31	Knock sensor	M8 x 28	2	20 ± 2.6
32	Camshaft position sensor	M8 x 16	1	12 ± 1.7
33	Booster pressure sensor	M6 x 16	2	10 ± 1.0
34	Exhauster manifold	M8	10	40 ± 4
35	Turbo charger assembly	M8	4	25 ± 2.5
36	Turbo charger adaptor piece		1	32 ± 3.2
37	Nut	M8	1	25 ± 2.5
38	Combination bolt	M8 x 22	1	25 ± 2.5
39	T/C oil supply pipe	M6 x 16 (Cylinder block side)	1	25 ± 2.5
		M16 (T/C side)	1	20 ± 2.0
40	T/C oil return pipe	M6 x 16 (T/C side)	2	10 ± 1.0
		M6 x 16 (Cylinder block side)	2	10 ± 1.0
41	EGR valve assembly	M8 x 22	2	25 ± 2.5
42	EGR-LH pipe bolt	M6 x 16	2	10 ± 1.0
		M8 x 22	2	35 ± 2.0
43	EGR combination bolt	M6 x 16	4	10 ± 1.0
		M8 x 16	4	25 ± 2.5
	EGR-RH pipe nut	M8	2	35 ± 2.0
44	Glow plug cable nut	M5	5	15 ± 3
45	Vacuum pump	M6 x 20	3	10 ± 1.0
46	Cooling fan bracket assembly	M6 x 25	5	10 ± 1.0
		M6 x 65	1	10 ± 1.0
		M6 x 85	3	10 ± 1.0
47	Cylinder head cover	M6 x 35	21	23 ± 2.3

NO.	Name	Size	Quantity	Tightening Torque (Nm)
48	Vacuum modulator	M6 x 16SOC	4	10 ± 1.0
49	WDT combination bolt	M6 x 16	3	10 ± 1.0
50	Oil dipstick tube	M6 x 16	1	10 ± 1.0
51	Oil filter assembly	M8 x 35SOC	1	25 ± 2.5
		M8 x 50SOC	2	25 ± 2.5
		M8 x 55SOC	1	25 ± 2.5
52	Fuel rail assembly	M8 x 35SOC	3	25 ± 2.5
53	Injector clamp washer	M6 x 60	5	10 ± 1.0 180 + 20°
54	Fuel pipe clip (H-C)	M6 x 19	1	10 ± 1.0
55	Fuel pipe clip (C-I)	M6 x 16	5	10 ± 1.0
56	Crankshaft position sensor	M5 x 17	1	0.8 ± 0.4
57	Crankshaft position sensor	GAP	-	0.7 ~ 1.5 mm
58	Wiring	M6 x 16	5	10 ± 1.0
59	Intake manifold bracket	M8 x 16	2	25 ± 2.5
		M8 x 40	2	25 ± 2.5
60	Power steering pump	M8 x 100	2	25 ± 2.5
		NUT	2	25 ± 2.5
61	Piston protrusion	-	-	0.765 ~ 1.055 mm
62	Clearance between connecting rod and pin boss	-	-	0.05 ~ 0.31 mm
63	End play of crankshaft	NEW: 0.100 ~ 0.245 mm // USED: 0.300 mm		

Modification basis	
Application basis	
Affected VIN	

ENGINE FUEL SYSTEM 1881-01

GENERAL

1. CAUTIONS FOR DI ENGINE

This chapter describes the cautions for DI engine equipped vehicle. This includes the water separation from engine, warning lights, symptoms when engine malfunctioning, causes and actions.

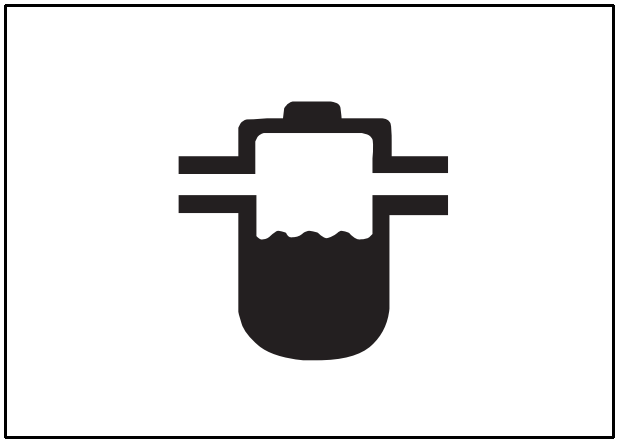
1) DI Engine

Comparatively conventional diesel engines, DI engine controls the fuel injection and timing electrically, delivers high power and reduces less emission.

2) System Safety Mode

When a severe failure has been occurred in a vehicle, the system safety mode is activated to protect the system. It reduces the driving force, restricts the engine speed (rpm) and stops engine operation. Refer to "Diagnosis" section in this manual.

3) Water Separator Warning Light



When the water level inside water separator in fuel filter exceeds a certain level (approx. 39 cc), this warning light comes on and buzzer sounds.
Also, the driving force of the vehicle decreases (torque reduction). If these conditions occur, immediately drain the water from fuel filter.
For the draining procedures, please refer to "How to drain the water from fuel filter" section.

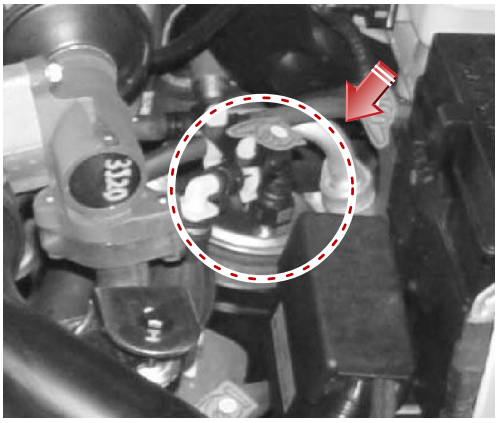
4) Priming Pump

The priming pump installed in fuel pump is the device to fill the fuel into the fuel filter. When the vehicle is under the conditions as below, press the priming pump until it becomes rigid before starting the engine.

5) Conditions for Using Priming Pump

- After run out of fuel
- After draining the water from fuel separator
- After replacing the fuel filter

6) Fuel Filter and Water Separator



1. Fuel filter
2. Water drain plug
   (water separating operation: every 10,000 km)
3. Priming pump

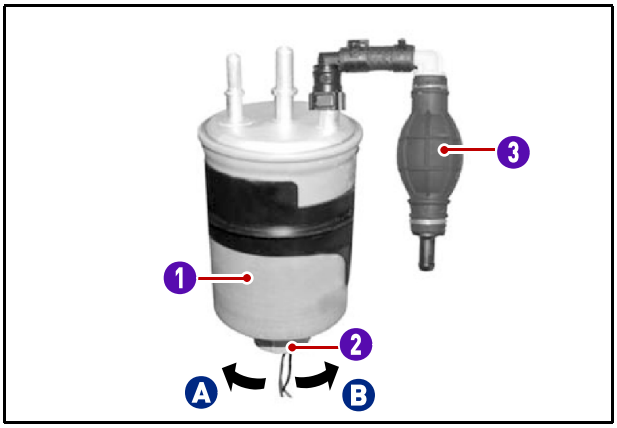
CAUTION

- When replaced the fuel filter or drained the water from fuel filter, press the priming pump until it becomes rigid before starting the engine.
- The water drain from fuel filter should be performed whenever changing the engine oil.

Modification basis	
Application basis	
Affected VIN	

▶ Draining the Water From Fuel Filter

1. Place the water container under the fuel filter.



2. Turn the drain plug (2) to "A" direction to drain the water.
3. Wait until a certain amount of fuel gets out from the port, then turn the drain plug to "B" direction to tighten it.

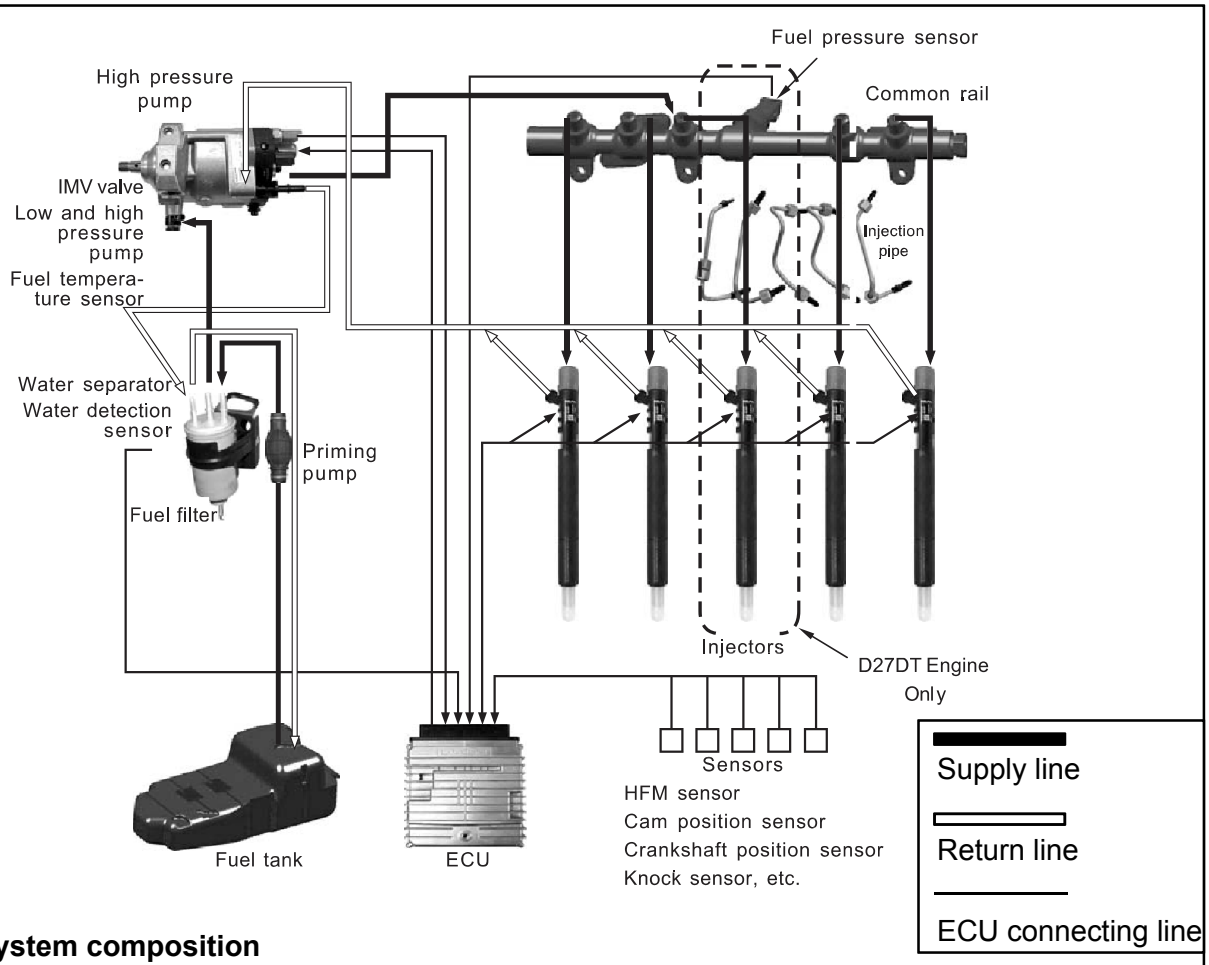
CAUTION
- Be careful not to be injured by surrounding equipment during the working procedures.

4. Press the priming pump until it becomes rigid.
5. Start the engine and check the conditions.

CAUTION
- If the priming pump is not properly operated, air may get into the fuel line. It may cause starting problem or fuel system problem. Make sure to perform the job in step 4.

OVERVIEW AND OPERATION PROCESS

1. ELECTRONIC CONTROL OF FUEL SYSTEM



System composition

- High pressure fuel pump
- Fuel rail
- Fuel pressure sensor
- Fuel injector
- Electronic control unit(ECU)
- Other sensors and actuators

According to input signals from various sensors, engine ECU calculates driver's demand (position of the accelerator pedal) and then controls overall operating performance of engine and vehicle on that time.

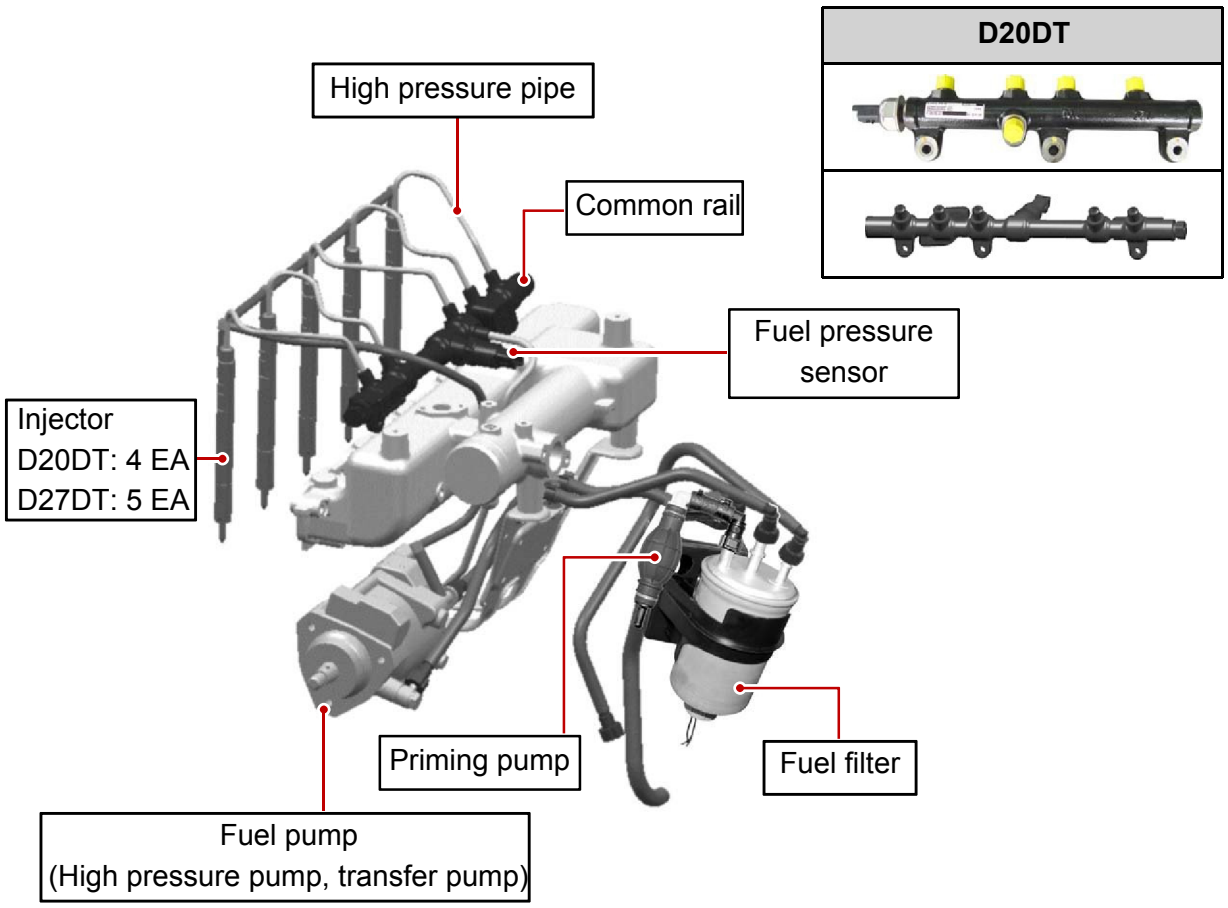
ECU receives signals from sensors via data line and then performs effective engine air-fuel ratio controls based on those signals. Engine speed is measured by crankshaft speed (position) sensor and camshaft speed (position) sensor determines injection order and ECU detects driver's pedal position (driver's demand) through electrical signal that is generated by variable resistance changes in accelerator pedal sensor. Air flow (hot film) sensor detects intake air volume and sends the signals to ECU. Especially, the engine ECU controls the air-fuel ratio by recognizing instant air volume changes from air flow sensor to decrease the emissions (EGR valve control). Furthermore, ECU uses signals from coolant temperature sensor and air temperature sensor, booster pressure sensor and atmospheric pressure sensor as compensation signal to respond to injection starting, pilot injection set values, various operations and variables.

Modification basis	
Application basis	
Affected VIN	

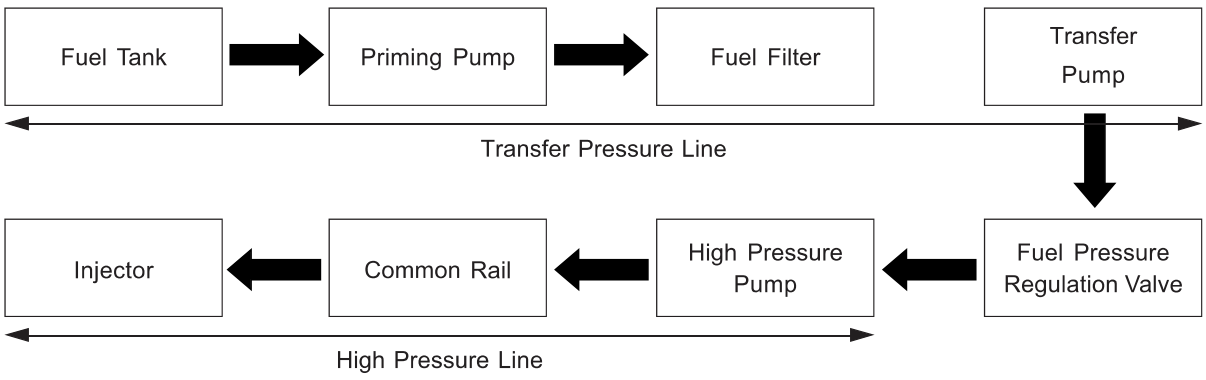
2. COMPOSITION OF FUEL SYSTEM

Components in fuel system are designed to generate and distribute high pressure, and they are controlled electronically by engine ECU. Accordingly, fuel system is completely different from injection pump type fuel supply system on the conventional Diesel engine. The fuel injection system in common rail engine is composed of transfer pressure section that transfers fuel in low pressure, high pressure section that transfers fuel in high pressure and ECU control section.

Fuel Line System

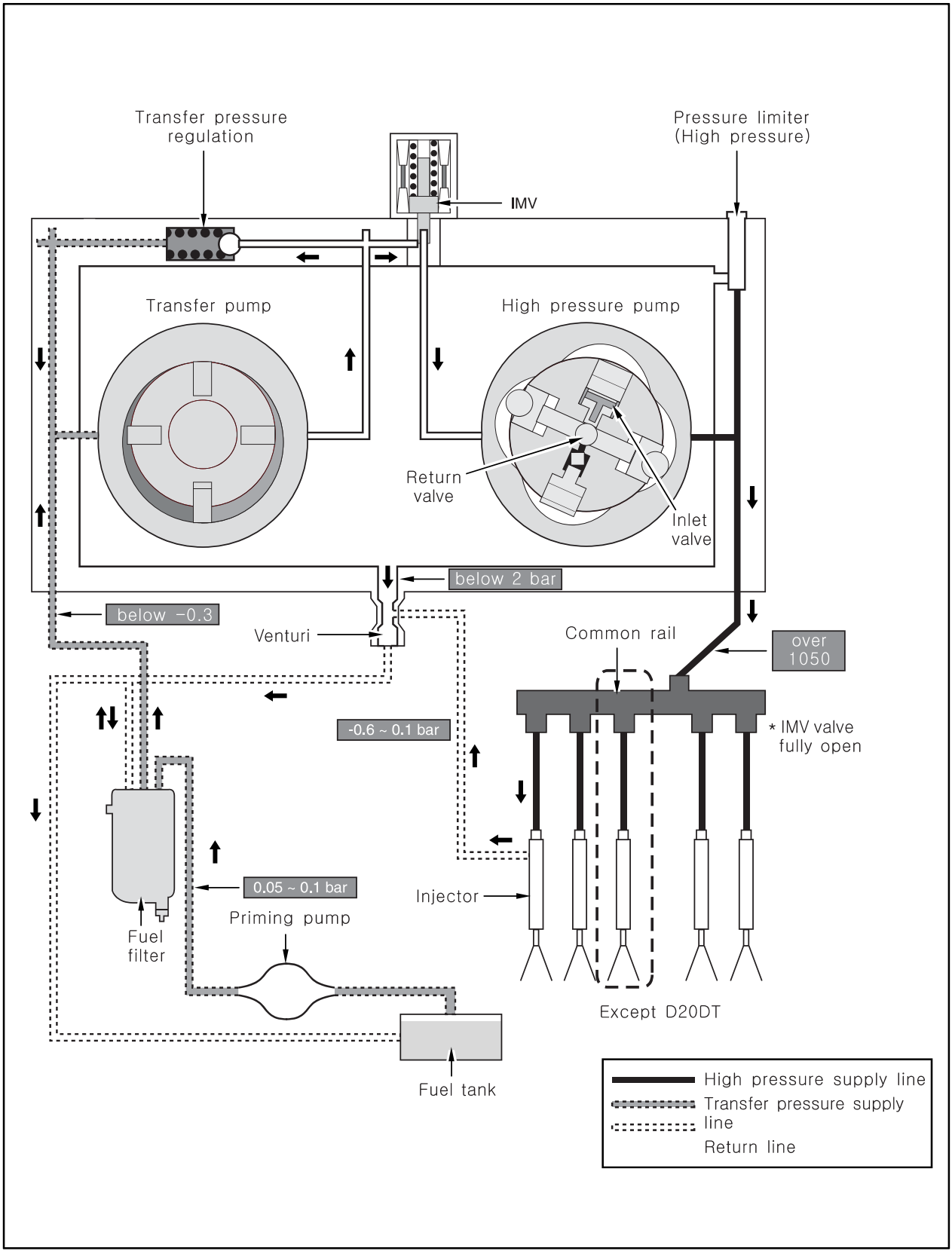


Fuel route



Modification basis	
Application basis	
Affected VIN	

3. HYDRAULIC CYCLE IN FUEL LINE (TRANSFER AND HIGH PRESSURE LINE)



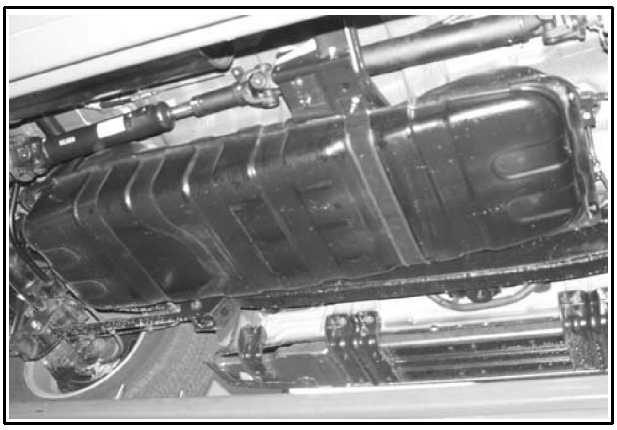
Modification basis	
Application basis	
Affected VIN	

4. COMPONENTS OF LOW PRESSURE TRANSFER LINE

Low pressure stage is to supply sufficient fuel to high pressure section and components are as below.

- Fuel tank (including strainer)
- Hand priming pump
- Fuel filter
- Transfer pump
- Other low pressure fuel hoses

1) Fuel tank



Fuel tank is made of anti-corrosion material and its allowable pressure is 2 times of operating pressure (more than min. 0.3 bar). It has protective cap and safety valve to prevent excessive pressure building. Also, to supply fuel smoothly, it has structure to prevent fuel from leaking in shocks, slopes and corners and.

2) Priming pump

If fuel runs out during driving or air gets into fuel line after fuel filter replacement, it may cause poor engine starting or damage to each component. Therefore, the hand priming pump is installed to bleed air from transfer line.

When the vehicle is under the conditions as below, press the priming pump until it becomes rigid before starting the engine.

- After run out of fuel
- After draining the water from fuel separator
- After replacing the fuel filter

Press the priming pump until it becomes rigid before starting the engine.

3) Fuel filter

It requires more purified fuel supply than conventional diesel engine. If there are foreign materials in the fuel, fuel system including pump components, delivery valve and injector nozzles may be damaged.
Fuel filter purifies fuel before it reaches to high pressure pump to help proper operations in high pressure pump.
And more, it separates water from fuel to prevent water from getting into FIE system (high pressure line).

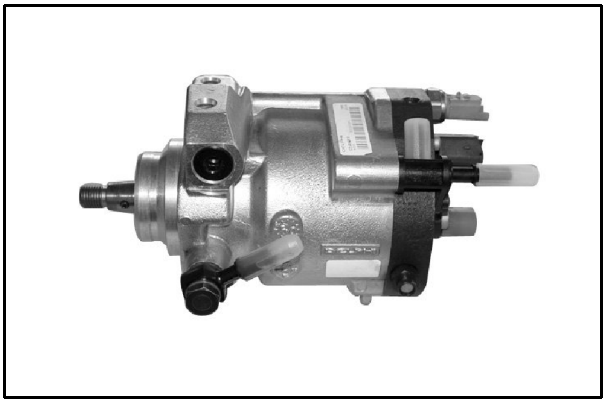
Modification basis	
Application basis	
Affected VIN	

5. COMPONENTS OF HIGH PRESSURE TRANSFER LINE

In the high pressure section, sufficient fuel pressure that injectors requires will be generated and stored. The components are as below:

- High pressure pump
- Rail pressure sensor
- Pressure limit valve
- Common rail
- High pressure pipe
- Injector
- Fuel pressure regulating valve (IMV)

1) High pressure pump



This is plunger pump that generates high pressure and driven by crankshaft with timing chain. The high pressure pump increases system pressure of fuel to approx. 1,600 bar and this compressed fuel is transferred to high pressure accumulator (common rail) in tube through high pressure line.

2) Common rail

D20DT

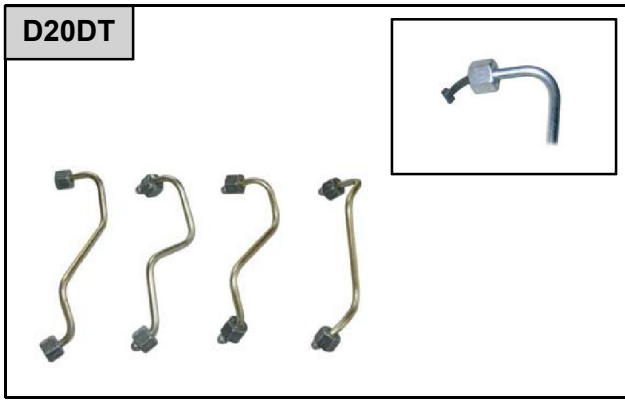
D27DT

It stores fuel transferred from high pressure pump and also stores actual high pressure of fuel. Even though the injectors inject fuel from the rail, the fuel pressure in the rail is maintained to a specific value. It is because the effect of accumulator is increased by unique elasticity of fuel. Fuel pressure is measured by rail pressure sensor.
And the fuel pressure regulating valve (IMV, Inlet Metering Valve) included in high pressure pump housing keeps pressure to a desired level.

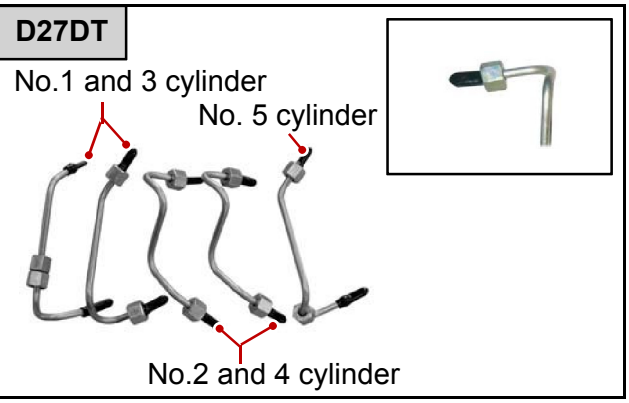
3) High pressure pipe (fuel pipe)

Fuel line transfers high pressure fuel. Accordingly, it is made of steel to endure intermittent high frequency pressure changes that occur under maximum system pressure and injection stops. Injection lines between rail and injectors are all in the same length; it means the lengths between the rail and each injector are the same and the differences in length are compensated by each bending.

D20DT



D27DT

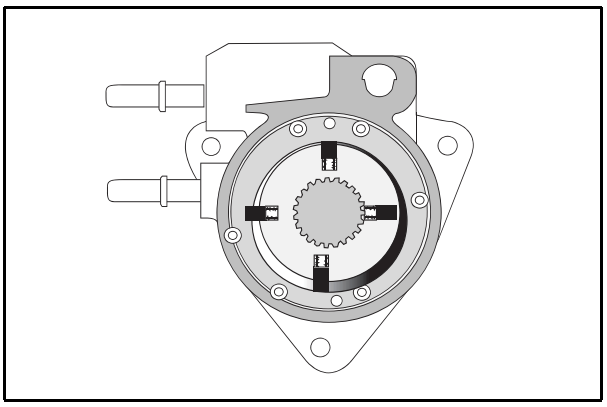


4) Injectors

The fuel injection device is composed of electrical solenoid valve, needle and nozzle and controlled by engine ECU. The injector nozzle opens when solenoid valve is activated to directly inject the fuel into combustion chamber in engine. When injector nozzle is open, remaining fuel after injection returns to fuel tank through return line.

Pressure limit valve, fuel returned by low pressure and fuel used for high pressure pump lubrication also return to fuel tank through return line.

5) Transfer pump



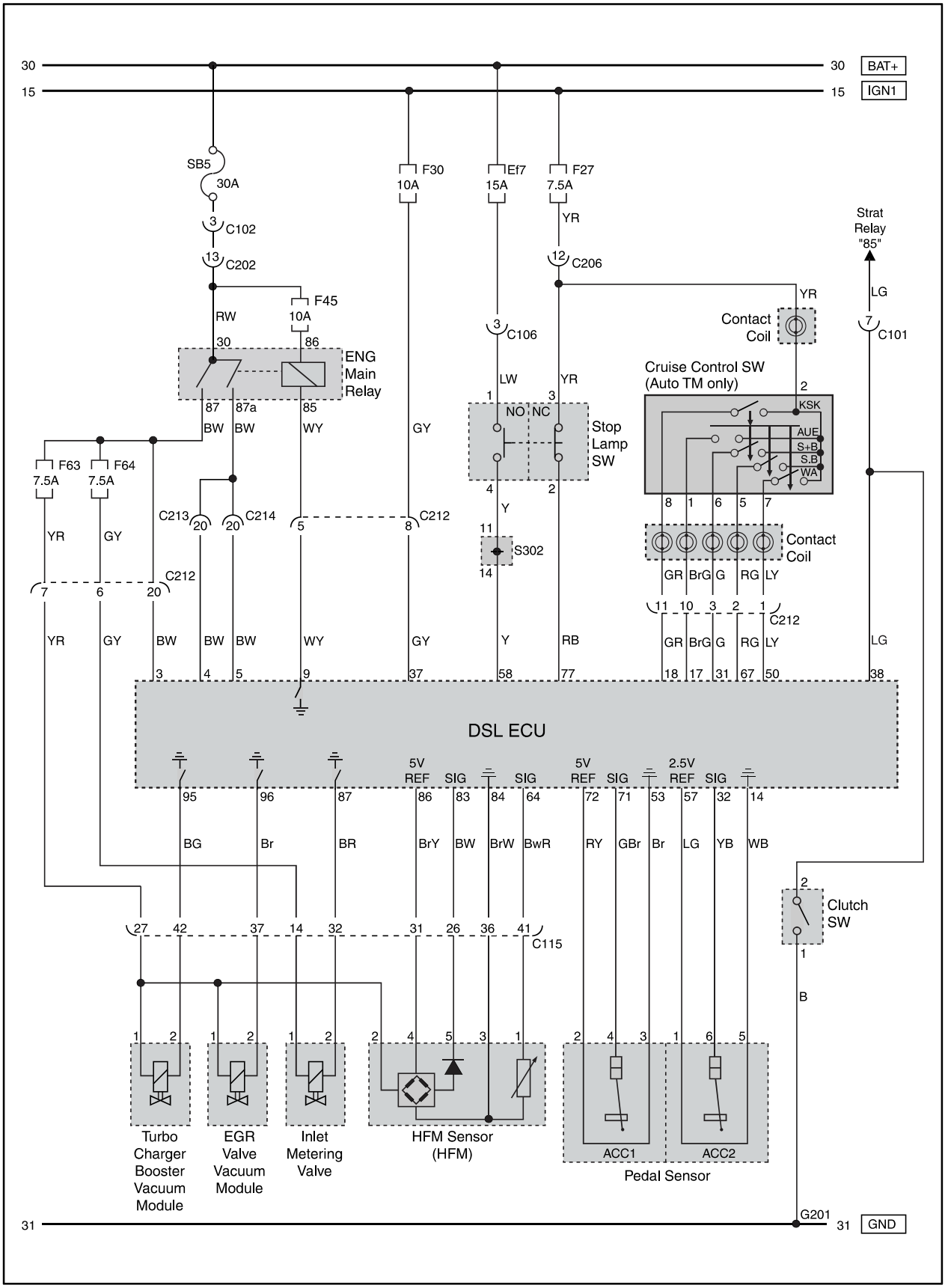
The transfer pump is included in the housing of the high pressure pump. The transfer pump is the volumetric blade type pump. To deliver the continuously required fuel volume, the pump transfers fuel from the fuel tank to high pressure pump.

Modification basis	
Application basis	
Affected VIN	

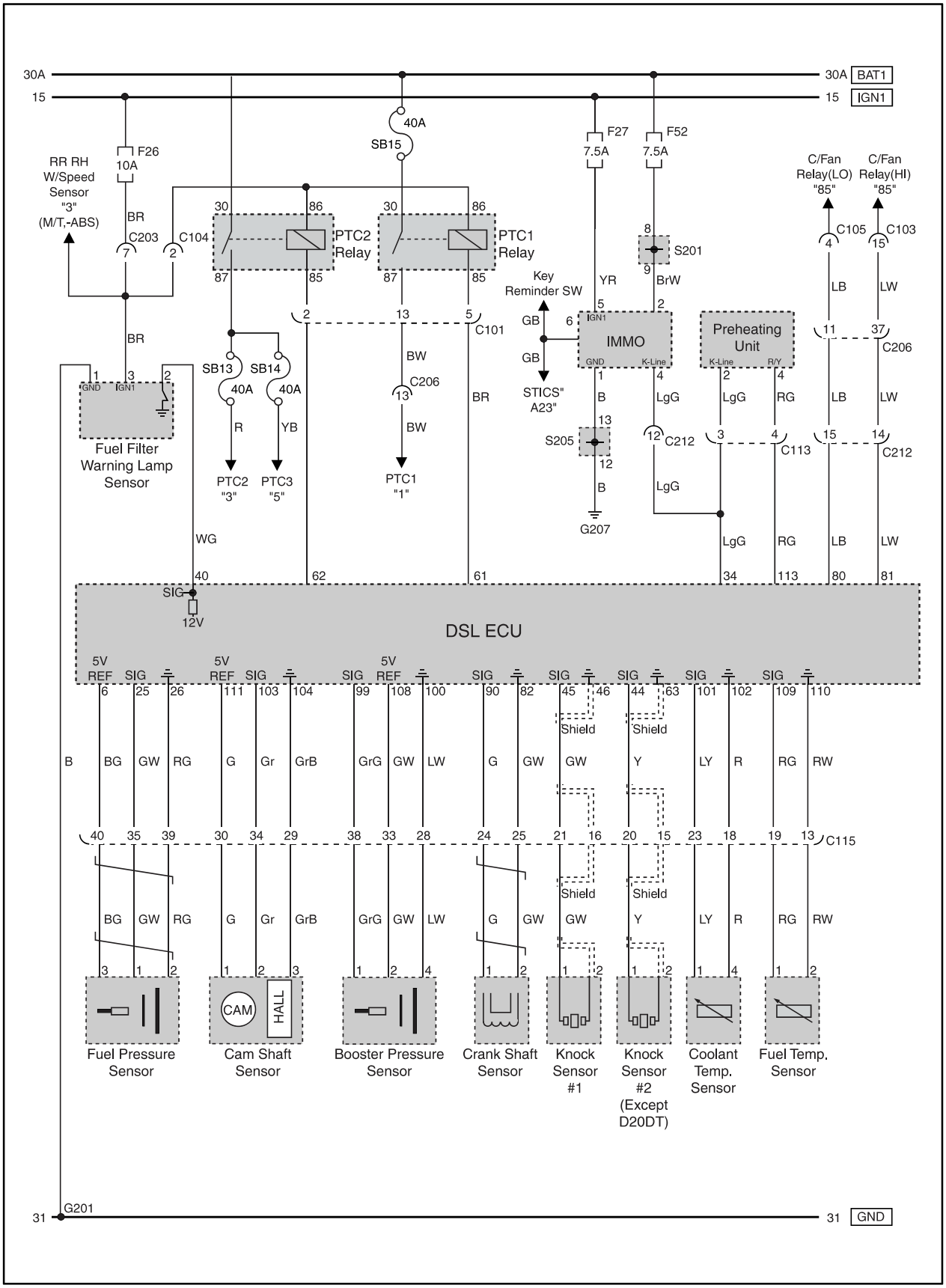
6) Fuel filter replacement

- Fuel filter change interval: every 30,000 km
- Water separation interval: every 10,000 km (same with engine oil change interval)
- Never reuse the removed fuel filter

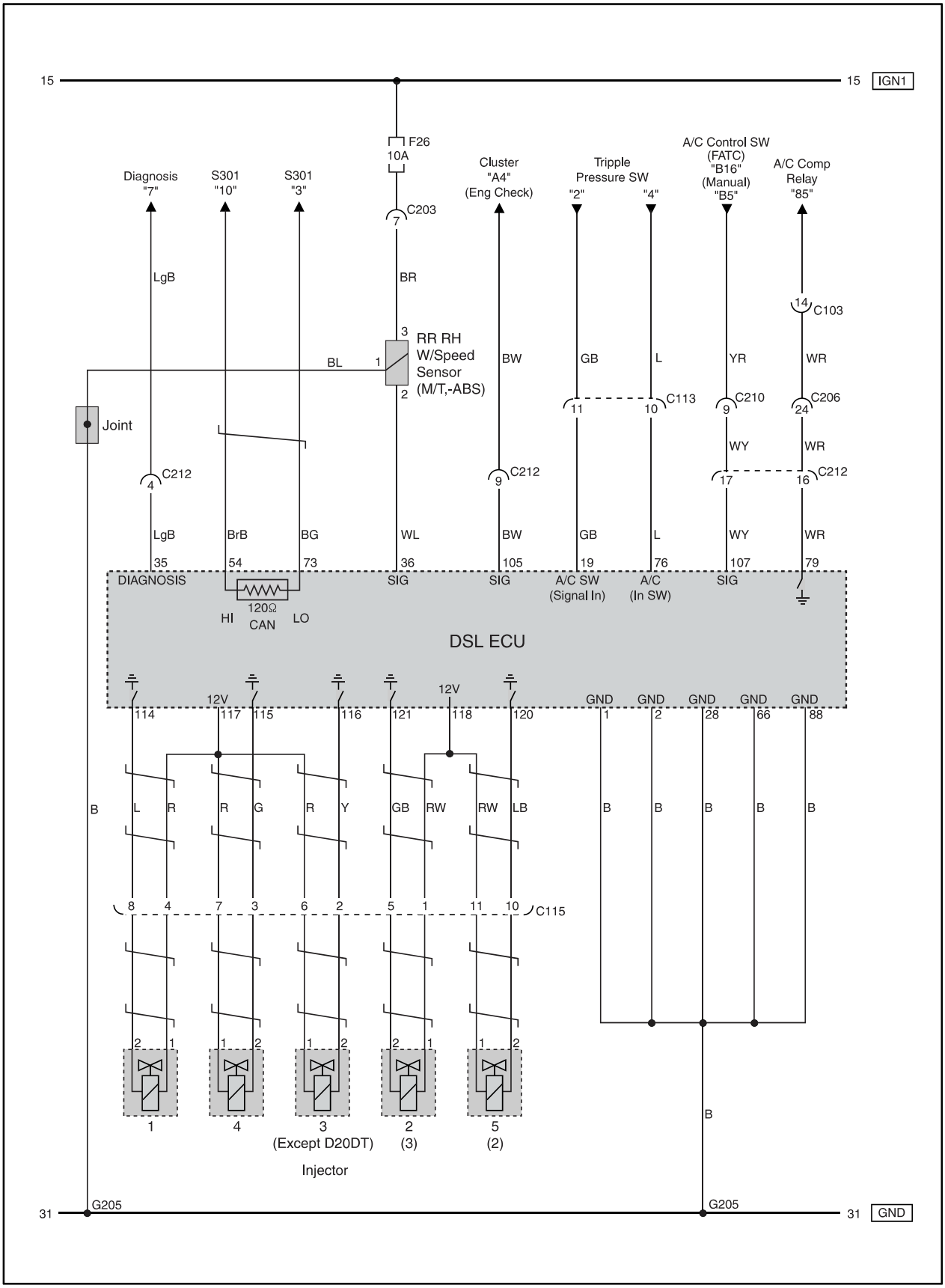
7) Circuit Diagram



Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	

INTAKE SYSTEM

2321-01

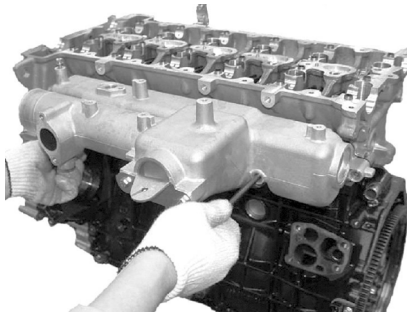
GENERAL

1. ENGINE INTAKE SPECIFICATIONS

1) Specifications

Element Type	Dry-Element Type
Service Interval	- Initial cleaning: 5,000 km, Clean or change every 10,000 km as required. However, change every 30,000 km. - If the vehicle is operated under severe condition (short distance driving, extensive ldling or driving in dusty condition): More frequent maintenance is required.

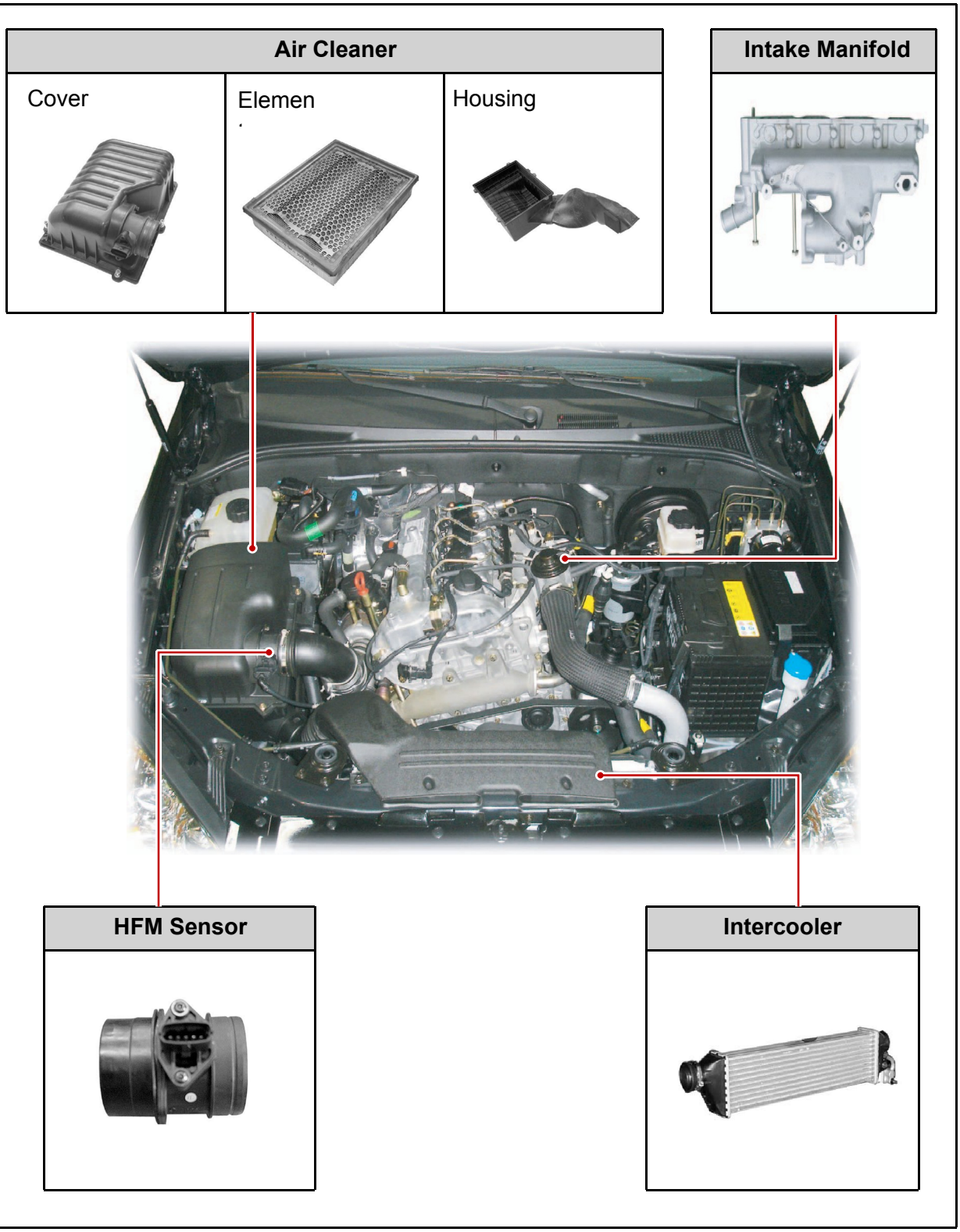
2) Special Tools and Equipment

Special Tools and Equipment	Application
Y99220112B Intake manifold guide pin 	Installation of intake manifold 

OVERVIEW AND OPERATION PROCESS

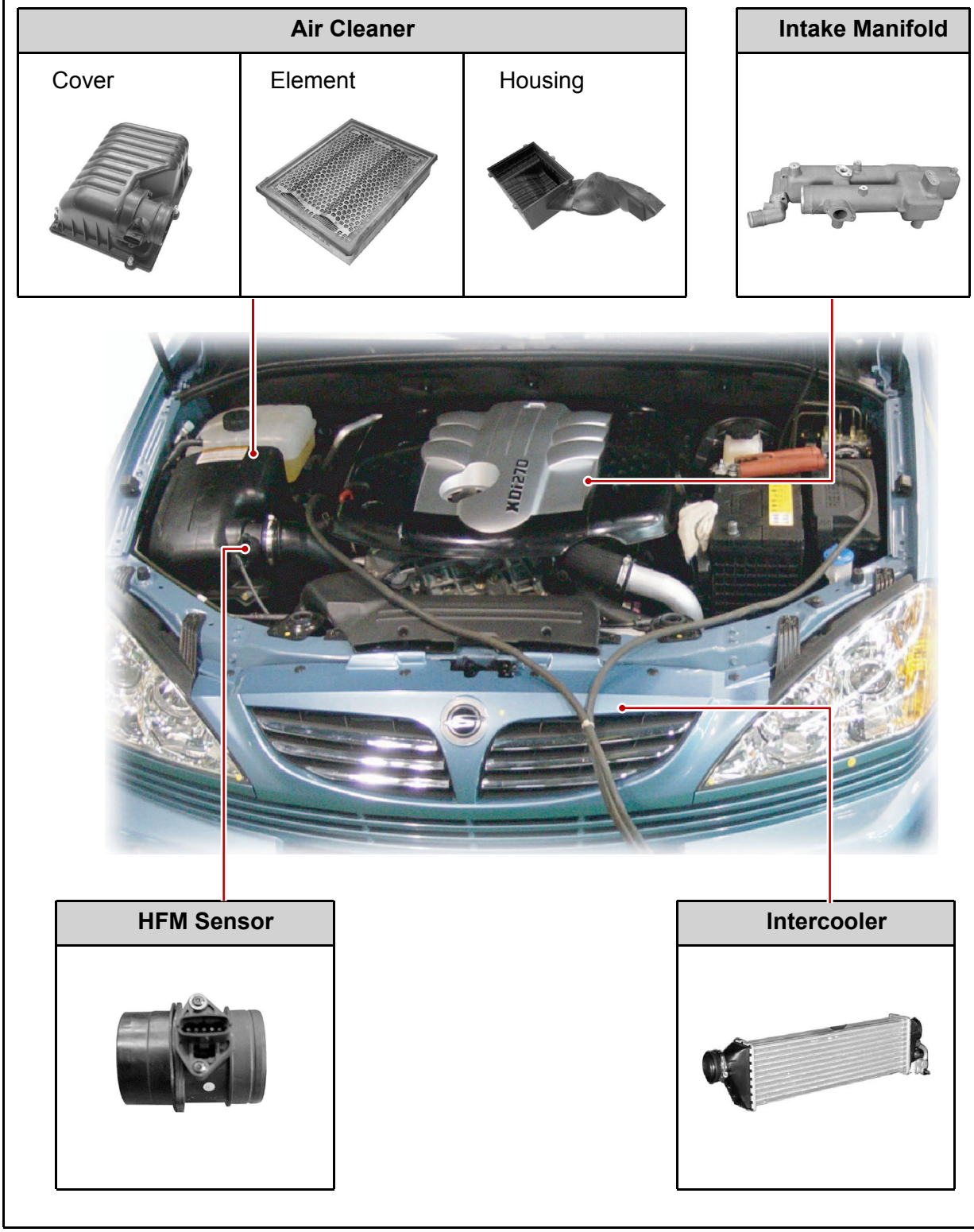
1. ENGINE INTAKE COMPONENTS LOCATOR

1) D20DT Engine



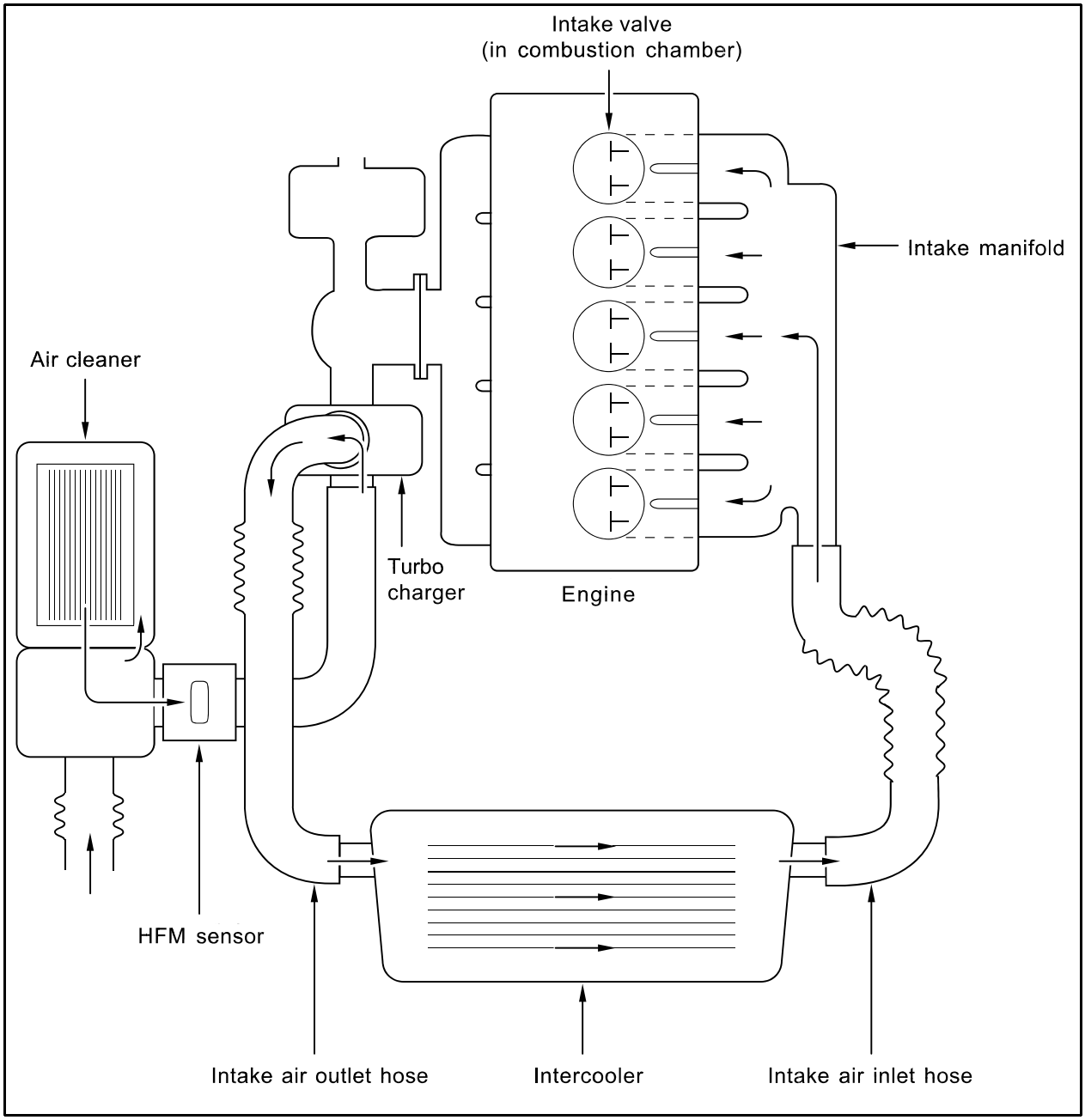
Modification basis	
Application basis	
Affected VIN	

2) D27DT Engine

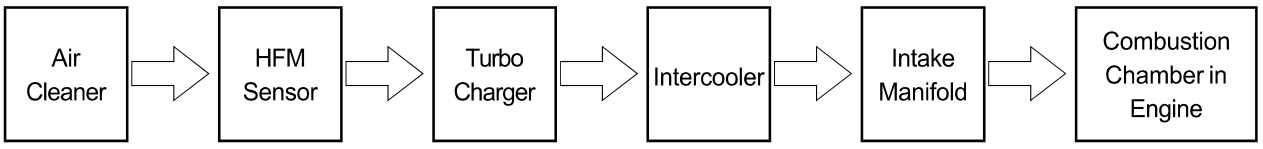


Modification basis	
Application basis	
Affected VIN	

2. AIR FLOWS



1) Work Flow of Intake System



Modification basis	
Application basis	
Affected VIN	

EXHAUST SYSTEM

1913-01

GENERAL

1. INSPECTION BEFORE DIAGNOSIS

The base of making diagnosis on the EGR related system is the inspection on the connections of the vacuum hoses in related system as the first priority.
When abnormal condition occurs with the EGR system, the basic approach is, as described in prior sentence, making detail inspections of vacuum circuits of each system before connecting the scan tool or vacuum tester.
It is necessary to manually check on the connections if there are any slacks or loose circuits even if the visual inspection shows vacuum hose as being connected.
If there are not any problems then the next inspection area is the connections of the system connectors.
Most problems with the occurrence of system malfunction are from conditions of vacuum line and connector connections and the causes from the malfunction of mechanical mechanism is actually very few.
For example, when there are no problems with basic components, let's assume that there is a vehicle having vacuum leak from connection slack in the vacuum line between EGR vacuum modulator and EGR valve.
This vehicle, due to the driving condition or, according to the circumstances, smog or other conditions, could create customer's complaint and by connecting the scanning device could display as the malfunction of the EGR valve's potentiometer.
As previously explained, this car has a separate controller to control the HUBER EGR and, in accordance with various input element, the controller controls EGR valve by regulating the force of vacuum being applied to the EGR valve through PWM control.
At this time, the controller has to receive feedback whether the EGR valve operates correctly according to the value sent to the EGR modulator and this role is performed by the EGR potentiometer located at top section of the EGR valve. In other word, the controller sent correct output value to the EGR vacuum modulator but, due to the leakage of vacuum, signal of required value can not be received from the EGR potentiometer causing to display as malfunction of related parts.
As a reference, the EGR valve of diesel vehicle (DI Engine) controlling from the engine ECU to EGR system has different shape than the HUBER EGR valve because the EGR valve's operation signal in the DI engine is performed by the HFM sensor instead of the EGR potentiometer.
This principle is that when the EGR valve opens up to flow exhaust gas into the intake unit the amount of fresh air, comparatively, will be reduced.
The DI engine ECU receives feedback signal of change in amount of air being passed through the HFM sensor according to the opening amount of the EGR valve.

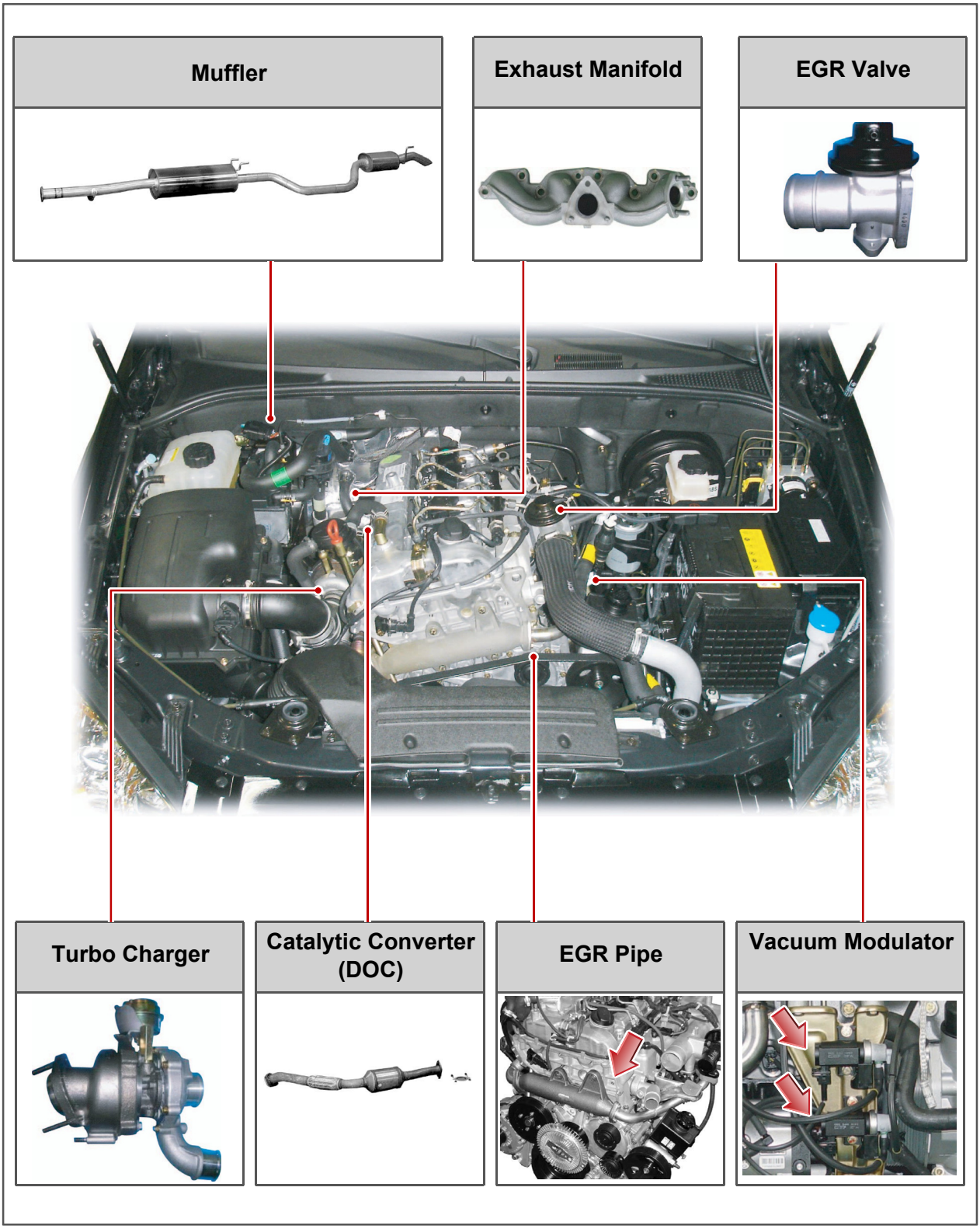
D20DT	D27DT
HUBER EGR System for IDI Engine (Including the EGR Valve Potentiometer)	EGR System for DI Engine

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. COMPONENTS LOCATOR OF EXHAUST SYSTEM

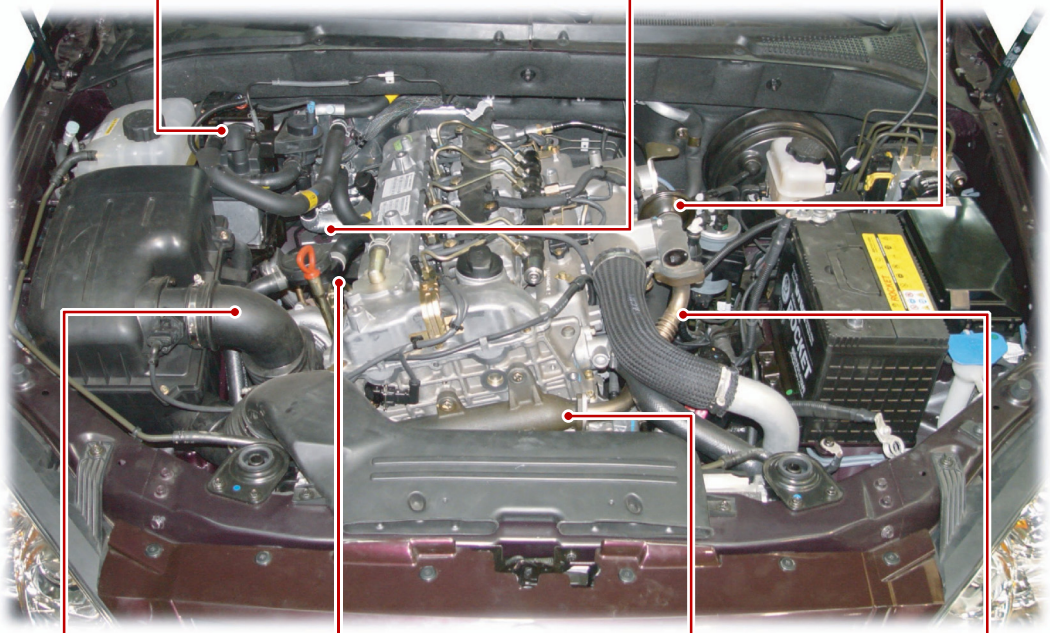
1) D20DT ENGINE



Muffler

Exhaust Manifold

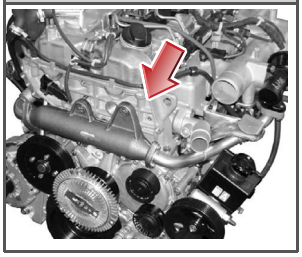
EGR Valve



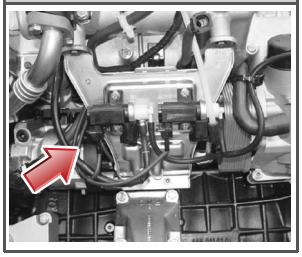
Turbo Charger

Catalytic Converter (DOC)

EGR Pipe

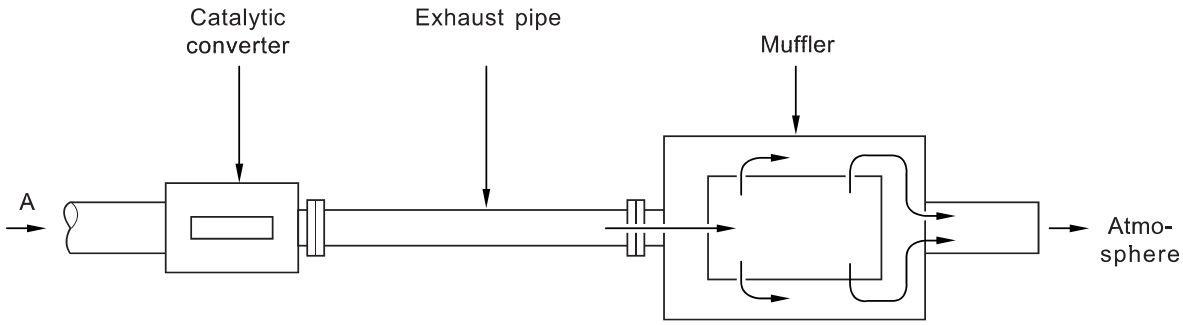


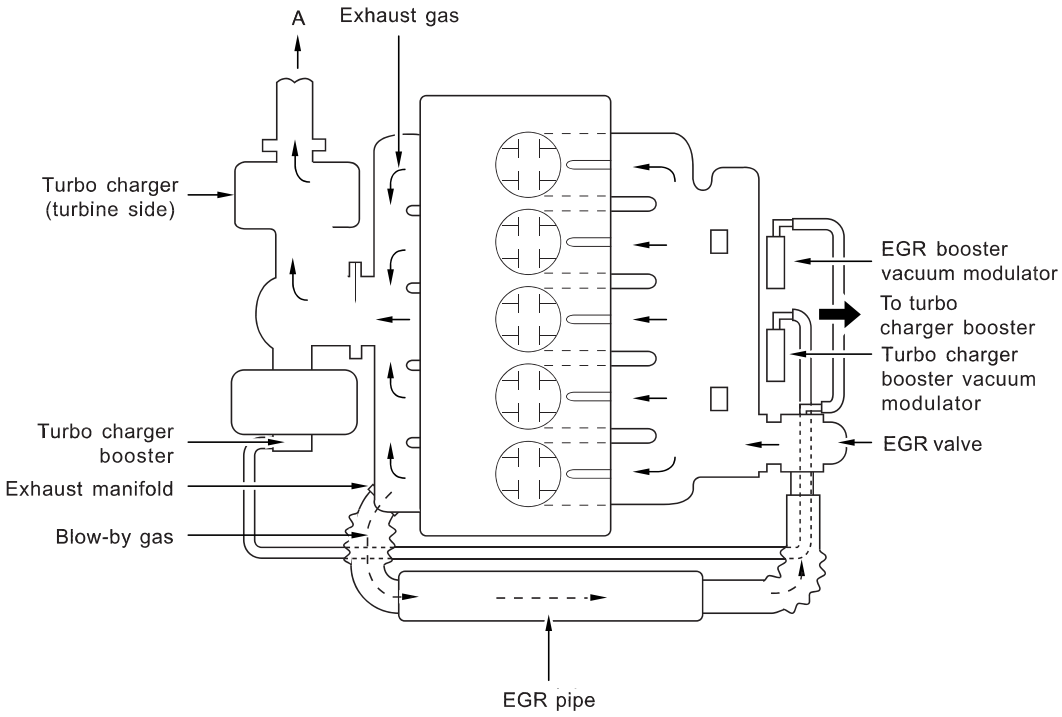
Vacuum Modulator

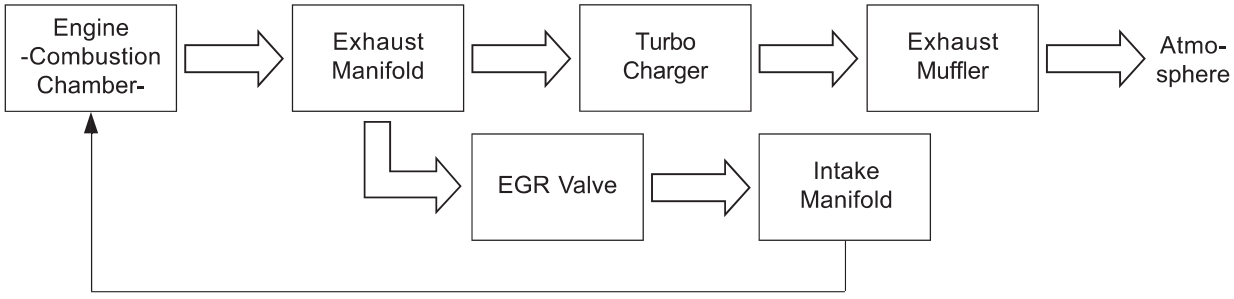


Modification basis	
Application basis	
Affected VIN	

2. EXHAUST GAS FLOWS







Modification basis	
Application basis	
Affected VIN	

ENGINE LUBRICATION SYSTEM 1533-01

GENERAL

1.SPECIFICATIONS OF ENGINE LUBRICATION

Engine oil	Specification	Approved by MB Sheet 229.1 or 229.3 Viscosity: See MB Sheet 224.1
	Capacity	6.8 ~ 8.3 liter
	Service interval	Initial change: 5,000 km, Change every 10,000 km or 12 months (Frequently check the oil level and add if needed. And, every 5,000 km or 6 months under severe conditions)
Engine oil filter		Same interval with engine oil
Oil relief valve opening pressure		5.8 ± 0.3 bar

Severe Condition:

1. When most trips include extended idling and/or frequent low-speed operation as in stop-and-go traffic.
2. When most trips are less than 6 km (Operating when outside temperatures remain below freezing and whenmost trips are less than 16 km)
3. When operating in dusty, sandy and salty areas
4. In hilly or moutainous terrain
5. When doing frequent trailer towing

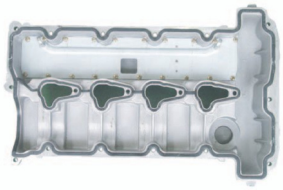
▶Oil Pressure Switch

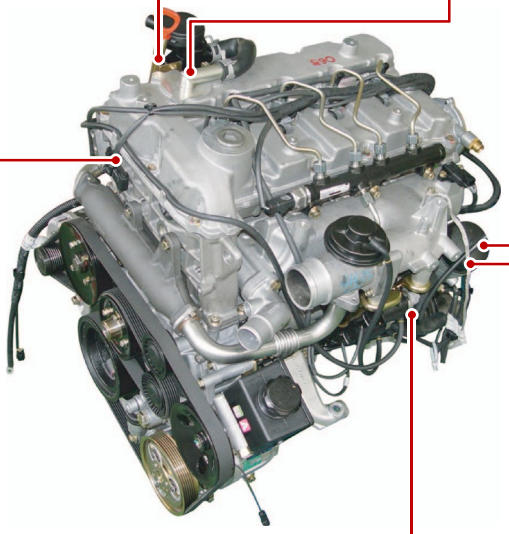
1. Operating temperature: −40 ~ 140°
2. Operating pressure: 0.3 ~ 0.55 bar
3. Permissible pressure: 10 bar

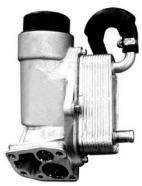
OVERVIEW AND OPERATION PROCESS

1. COMPONENTS OF LUBRICATION SYSTEM

1)D20DT ENGINE

Cylinder Head Cover	Oil Dipstick	Oil Separator	Oil Filter
			

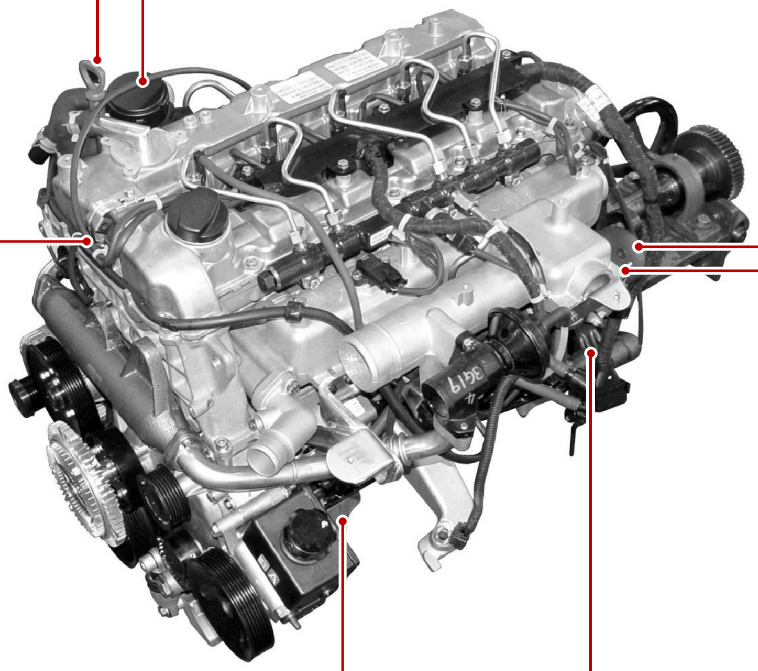


Oil Pump	Oil Pan	Oil Cooler	Oil Pressure Switch
			

Modification basis	
Application basis	
Affected VIN	

2)D27DT Engine

Cylinder Head Cover	Oil Dipstick	Oil Separator	Oil Filter



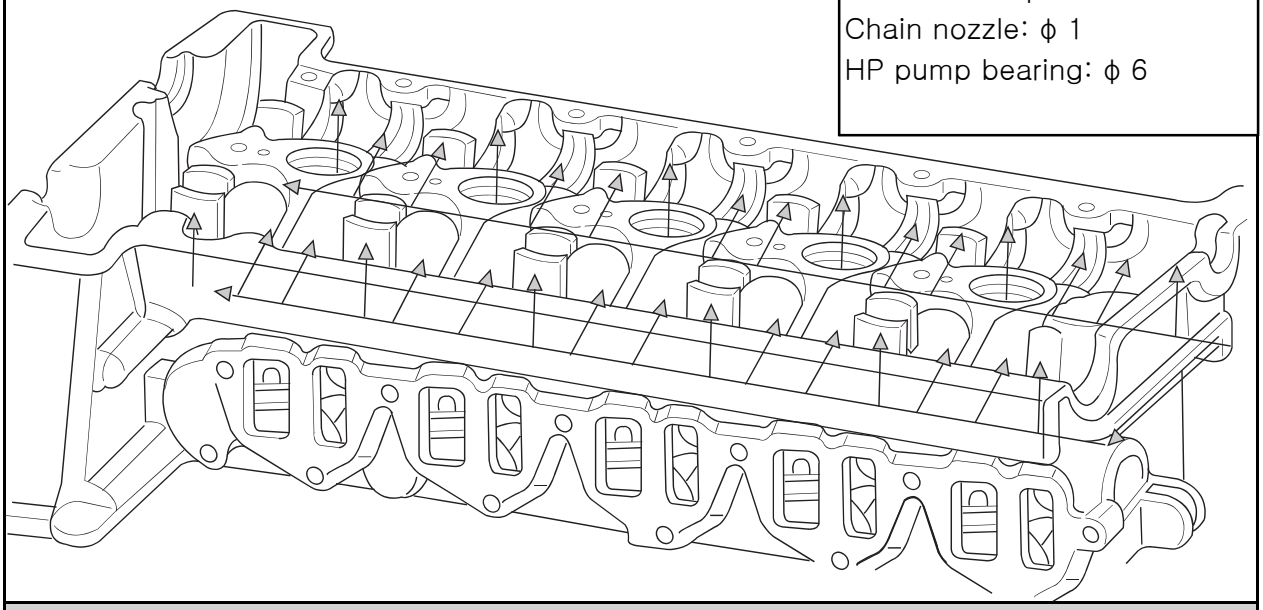
Oil Pump	Oil Pan	Oil Cooler	Oil Pressure Switch

Modification basis	
Application basis	
Affected VIN	

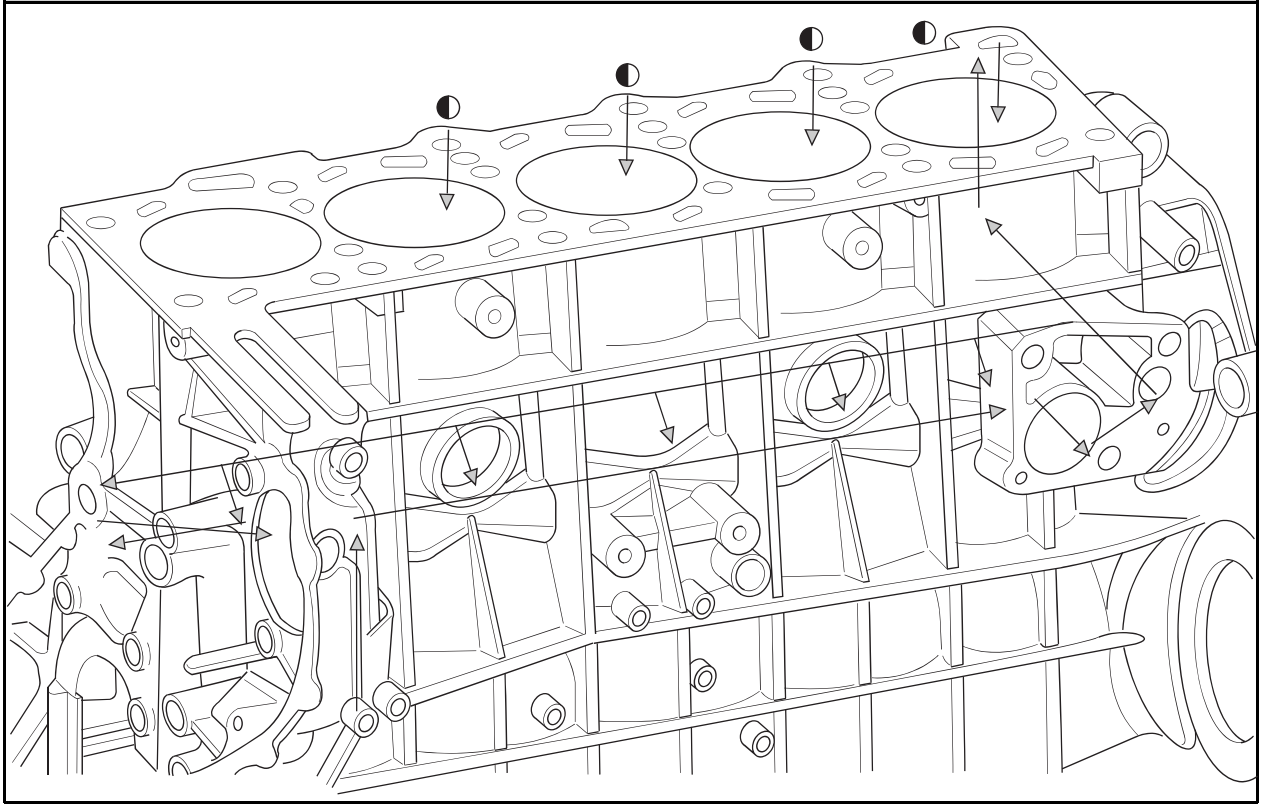
2.LUBRICATION SYSTEM LAYOUT

Cylinder Head

Main oil gallery: ϕ 16
Hole to cylinder head: ϕ 9
Main bearing hole: ϕ 7
Chain and injection pump: ϕ 7
Return hole: ϕ 14
Chain nozzle: ϕ 1
HP pump bearing: ϕ 6

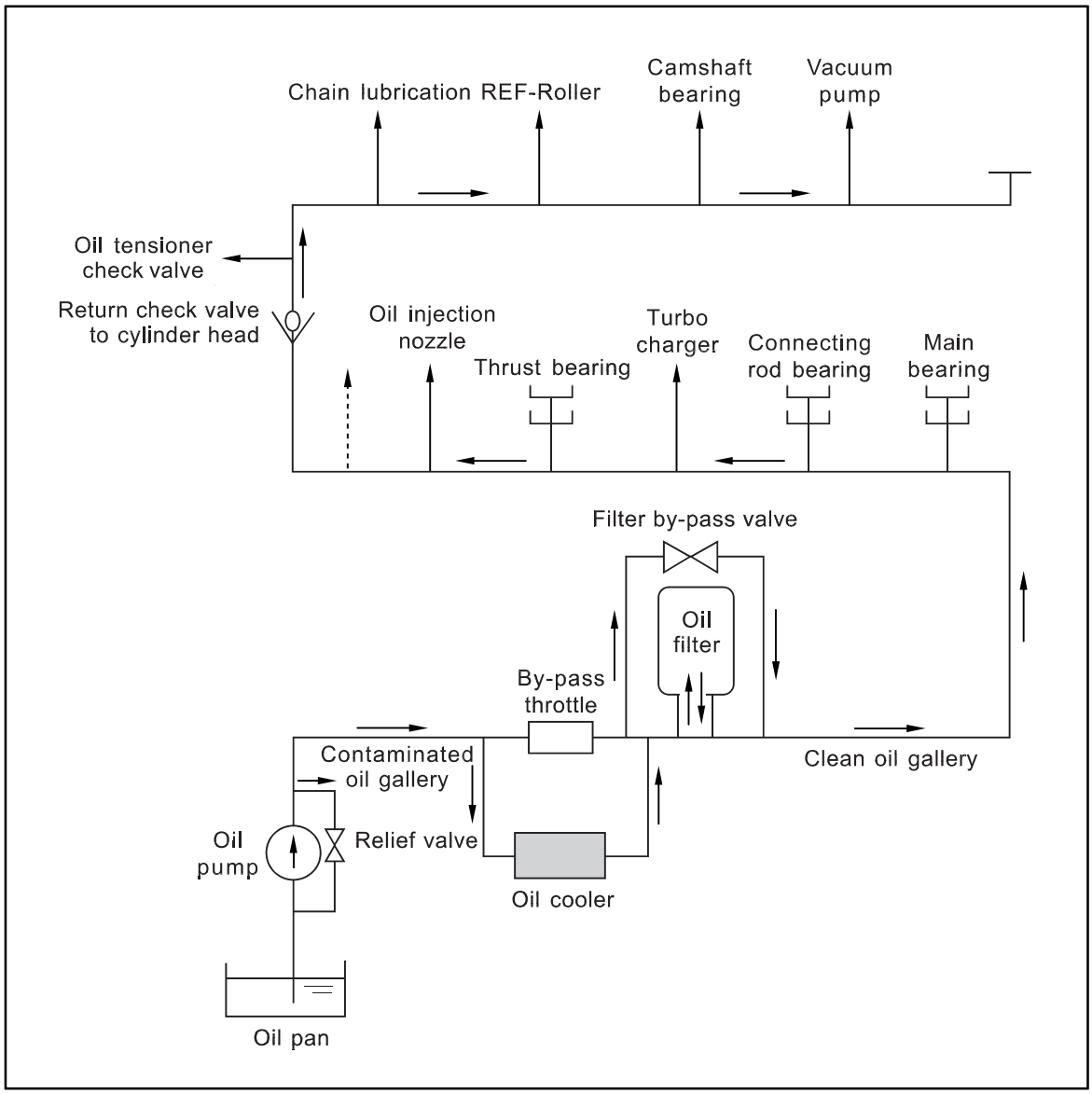


Cylinder Block



Modification basis	
Application basis	
Affected VIN	

3.LUBRICATION DIAGRAM



※ 1. Opening pressure of by-pass valve in oil filter: 3 ± 0.4 bar

2. To prevent instant oil shortage after stopping the engine, the return check valve is installed in oil supply line of cylinder head

ENGINE COOLING SYSTEM

9210-05

GENERAL

1. ENGINE COOLING SPECIFICATIONS

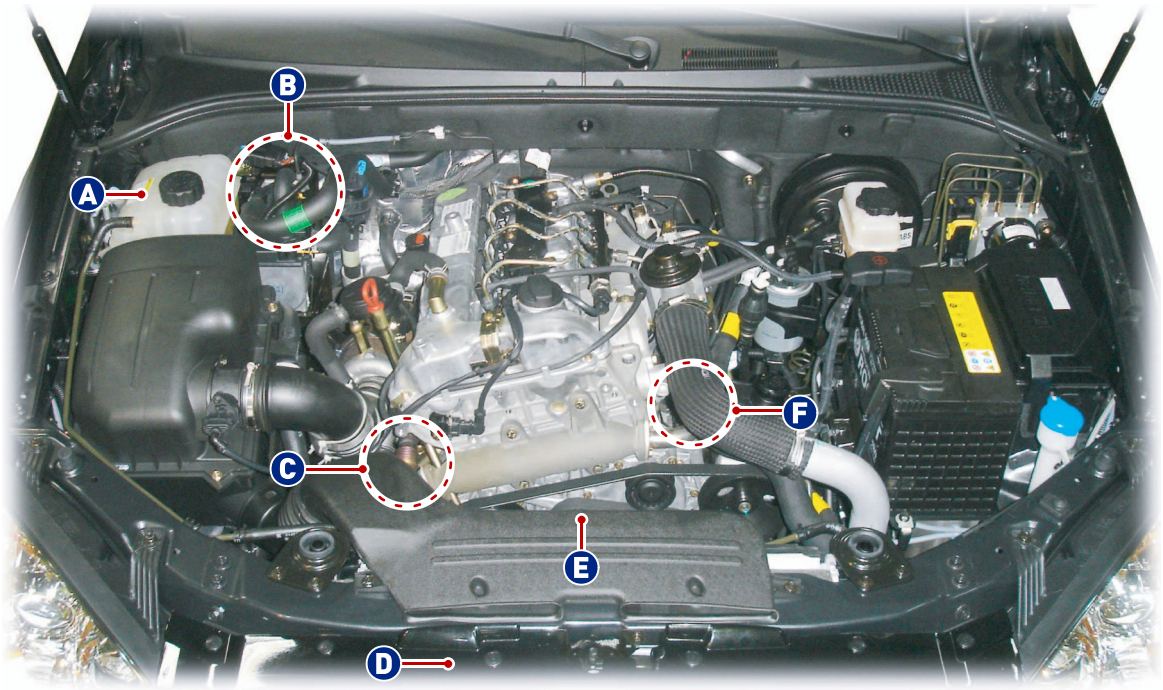
Descriptio n		Unit	Specificatio n
Cooling system	Type	-	Water cooling forced circulation
Coolant	Capacity	ℓ	11.3
Thermostat	Type	-	Wax pellet type
	Initial opening temperature	℃	85
	Fully opening temperature	℃	100
	Fully closing temperature	℃	83
	Stroke	mm	min. 8
Cooling fan	Blades		5
	Diameter	mm	320 (2)
	Low speed ON temp	℃	91
	Low speed OFF temp	℃	88
	High speed ON temp	℃	95
	High speed OFF temp	℃	92
	High speed ON temp. (By A/C pressure)	psi	270
Coolant reservoir	Pressure valve opening pressure	Kg/cm^2	1.2 ~ 1.5
	Vacuum valve opening pressure	Kg/cm^2	0.1
Water pump	Type	-	Centrifugal
	Impeller diameter	mm	72.3
	Impeller blades		10
Radiator	Type	-	Down-flow
	Core width	mm	701
	Core height	mm	372
	Core thickness	mm	18
	Minimum radiation capability	Kcal/h	45,000
Coolant temperature sensor	Resistance (at 20°C)	KΩ	3.33 ~ 3.78
	Resistance (at 80°C)	KΩ	0.32 ~ 0.35
Anti-freeze agent	Type	–	ALUTEC-P78
	Mixture ratio (water and anti-freeze)	–	50 : 50

OVERVIEW AND OPERATION PROCESS

1. COMPONENTS ENGINE COOLING

1) D20DT Engine

Coolant Reservoir	FFH	Water Pump
A	B	C

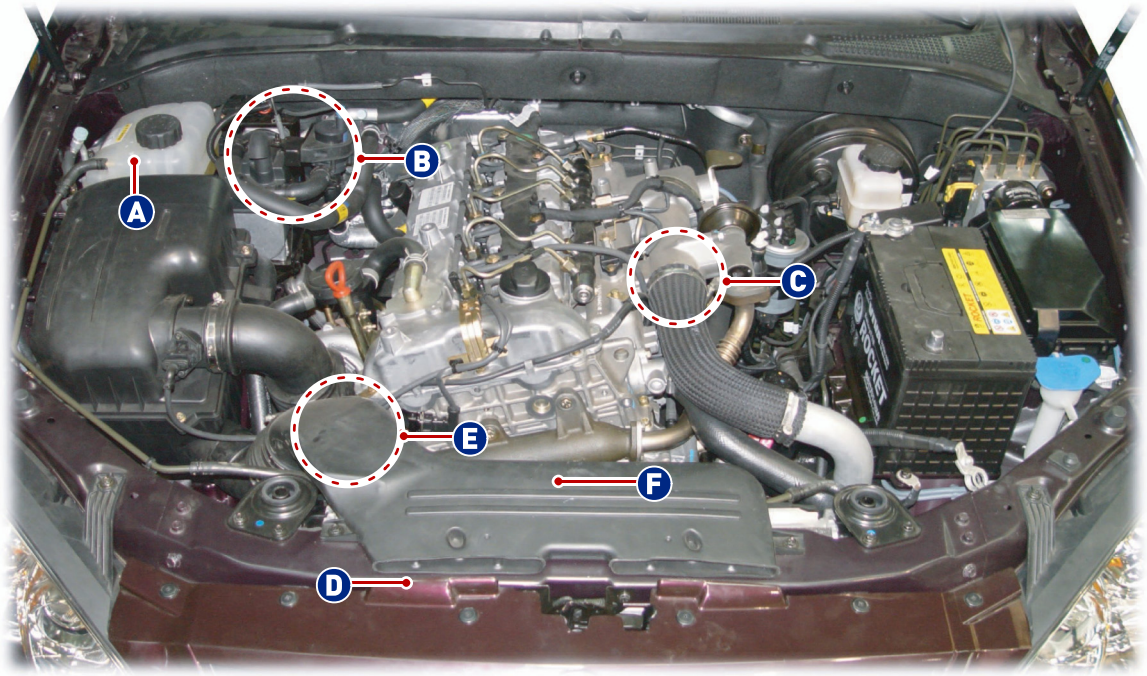


Radiator Assembly	Cooling Fan and Fan Clutch	Coolant Temperature Sensor
D	E	F

Modification basis	
Application basis	
Affected VIN	

2) D27DT Engine

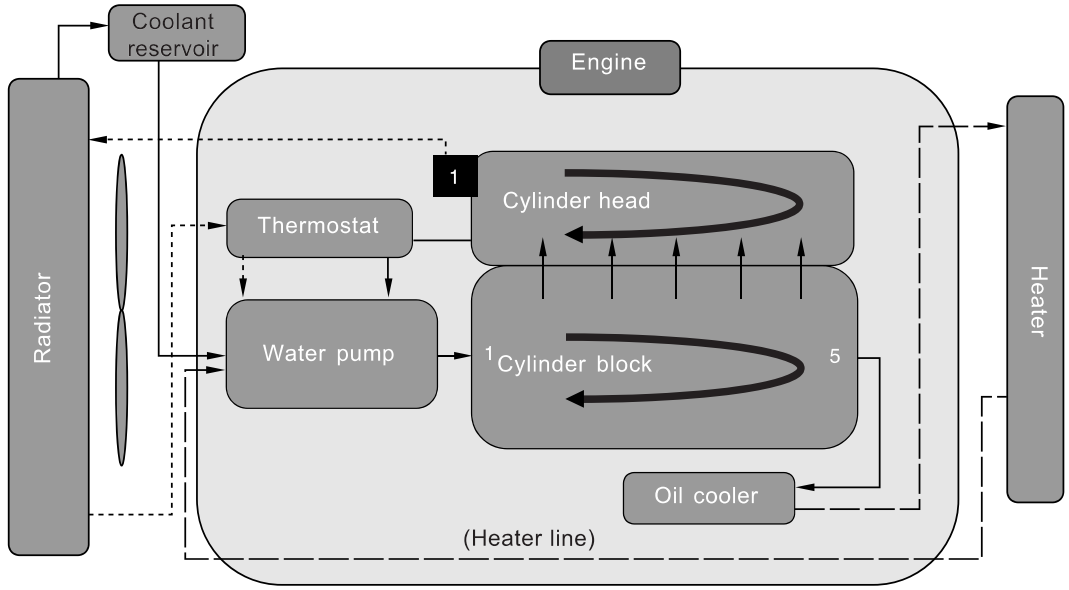
Coolant Reservoir	FFH	Coolant Temperature Sensor
A	B	C



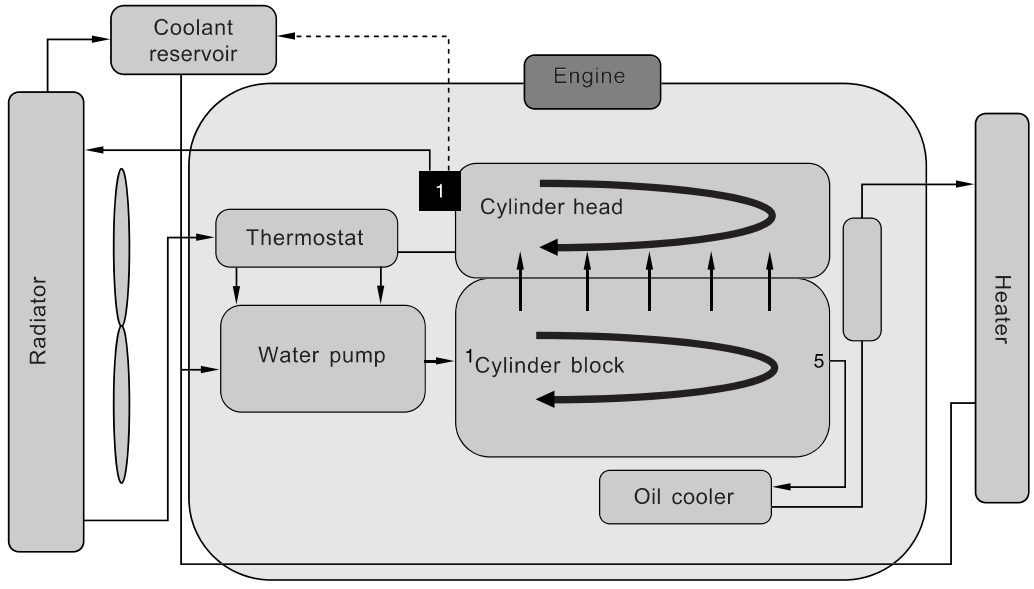
Radiator	Water Pump	Cooling Fan
D	E	F

2. COOLING SYSTEM FLOW

PTC Engine Coolant Flows



FFH Engine Coolant Flows

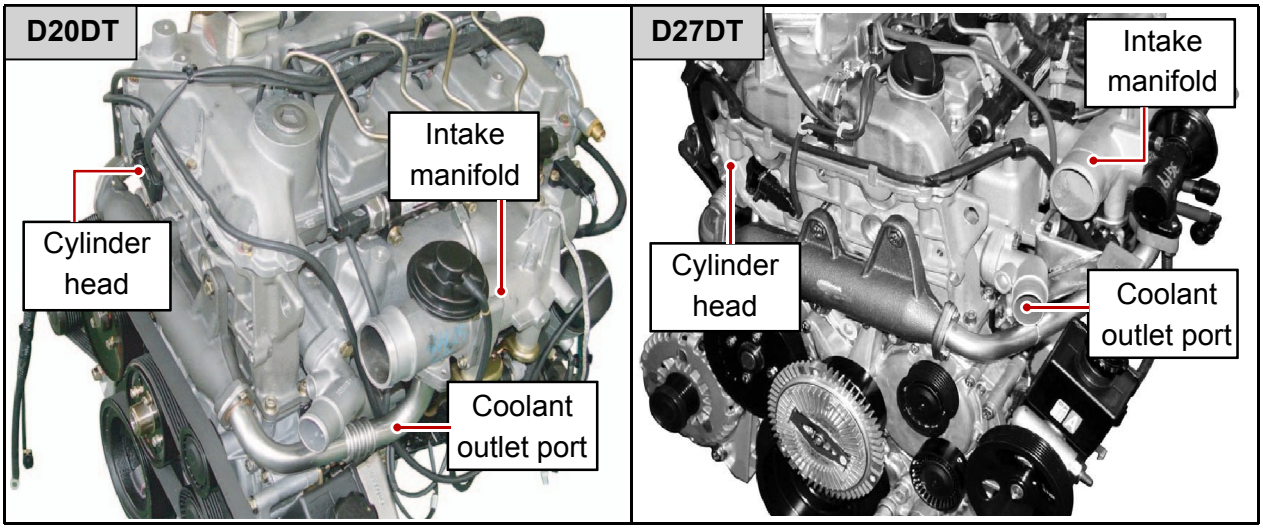


- Cylinder block side
  · Block #5 → Oil cooler → Heater → Heater water pump inlet pipe → Water pump
- Cylinder head side
  · Cylinder head → Coolant outlet port (intake #1) → Radiator → Water pump

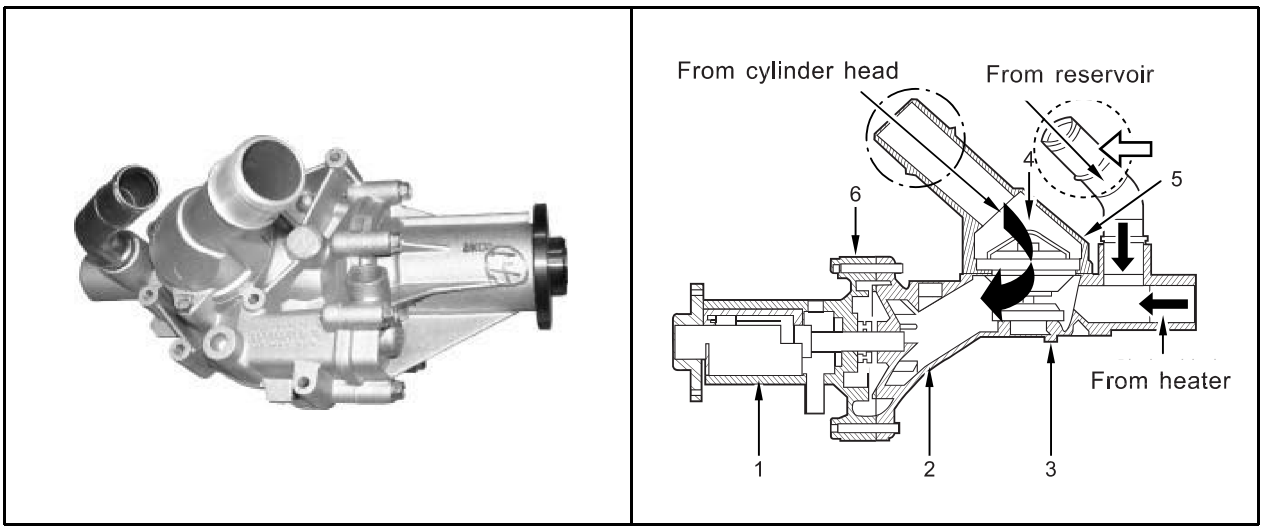
Modification basis	
Application basis	
Affected VIN	

3. FUNCTION DESCRIPTION OF COOLING SYSTEM

- Cylinder head coolant outlet port is integrated into intake manifold. (in front of cylinder #1)
  · Improved shape and gasket material to prevent coolant from leaking



- In OM 600 engine, coolant inflows through the heater line rear section (cylinder #4 and #5) of cylinder head.
  However, in D27DT engine, coolant inflows from cylinder block through oil cooler (refer to coolant flows layout in previous page).
  · It prevents cooling efficiency from decreasing due to coolant separation between cylinder #4 and #5.
- In OM 600 engine, the cooling fan is installed with water pump, however, in case of D27DT engine, it is connected to water pump with an additional pulley.



ENGINE ELECTRIC SYSTEM 1461-01

GENERAL

1.SPECIFICATIONS OF ENGINE ELECTRIC

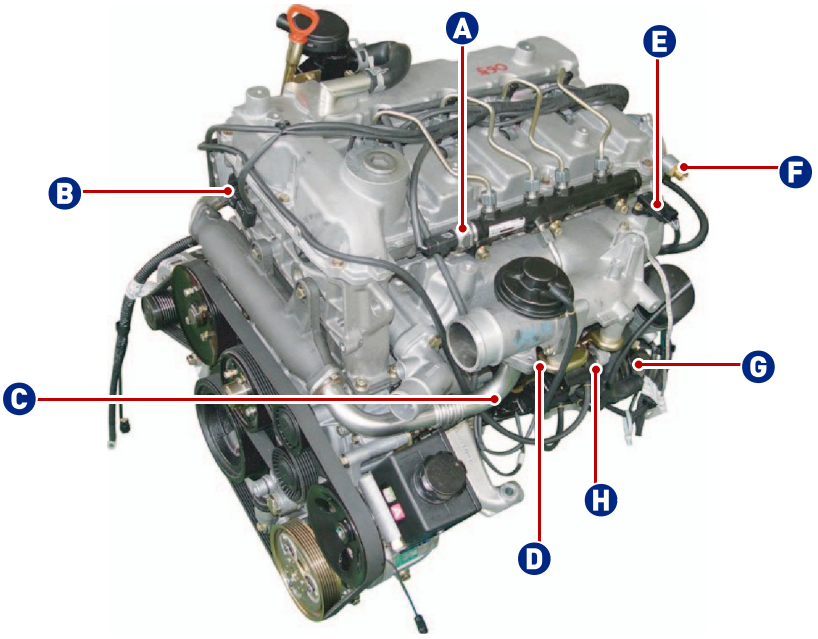
Descriptio			Unit	pecificatio n
Starter	Type		-	WP220
	Output power		Kw	2.2
	No load test □ 12 volts		A	160
	Drive pinion speed at no load		rpm	4500
	Drive pinion speed at load		rpm/A	1700/430
	Brush length		mm	18
	Armature diameter		mm	55
	Armature run-out		mm	0.1
	Segment groove depth		mm	21.7
Alternator	Type		-	CS128D
	Output voltage / current		V/A	PTC equipped vehicle: 12V-140A FFH equipped vehicle: 12V-115A
	Regulator type		-	←
	Regulating voltage		V	14.6
	Brush	Length	mm	12.5
		Quantity	-	2
		Wear limit	mm	7
Battery	Type		-	M F
	Capacity		AH	12V - 90AH
Glow plug	Reserved capatity		RC	160
	Type		-	Seized type
	Rated voltage		-	11.5
	Circuit connection		-	Parallel
	Preheating time		sec	Max. 60 (at -35°C)

OVERVIEW AND OPERATION PROCESS

1. COMPONENTS OF ELECTRIC IN ENGINE

1) D20DT ENGINE

Fuel Pressure Sensor	Camshaft Position Sensor	Coolant Temperature Sensor	Fuel Temperature Sensor
A	B	C	D

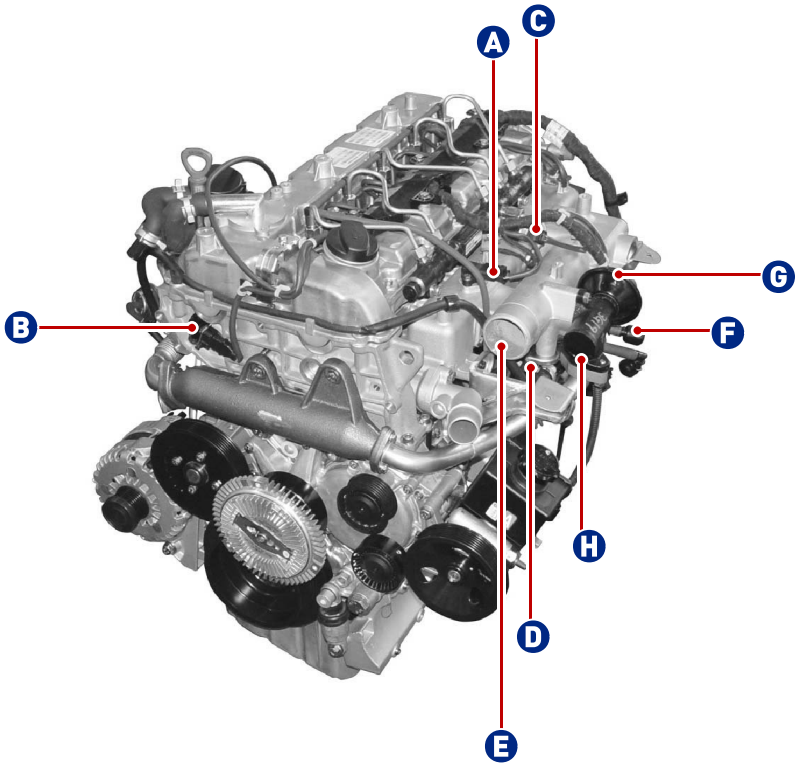


Booster Pressure Sensor	Oil Pressure Switch	Crankshaft Position Sensor	Knock Sensor (1 EA)
E	F	G	H

Modification basis	
Application basis	
Affected VIN	

2) D27DT ENGINE

Booster Pressure Sensor	Camshaft Position Sensor	Fuel Pressure Sensor	Fuel Temperature Sensor
A	B	C	D



Coolant Temperature Sensor	Oil Pressure Switch	Crankshaft Position Sensor	Knock Sensor (2 EA)
E	F	G	H

2. COMPONENTS OF ELECTRIC DEVICES IN ENGIN

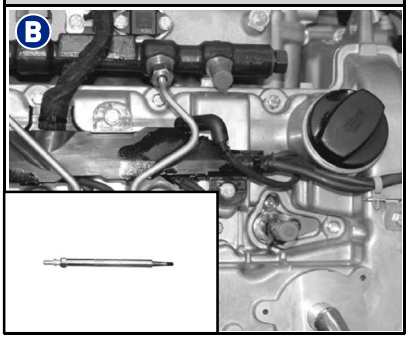
1) D20DT ENGINE

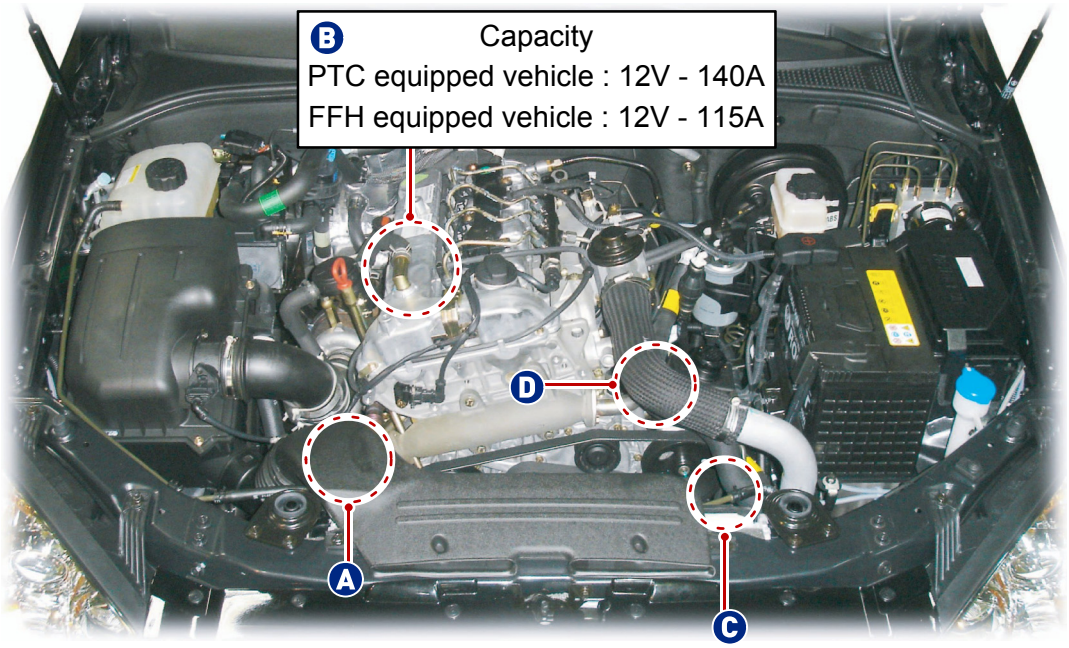
Alternator

Ⓐ

Glow Plug

Ⓑ





Air Conditioner Compressor

Ⓒ

Starter

Ⓓ

Modification basis	
Application basis	
Affected VIN	

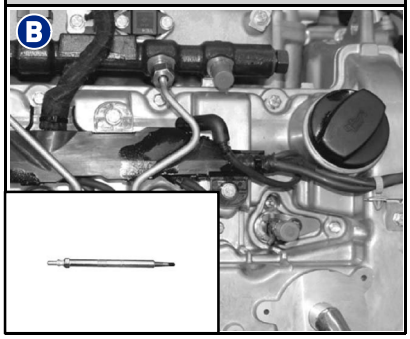
1) D27DT ENGINE

Alternator

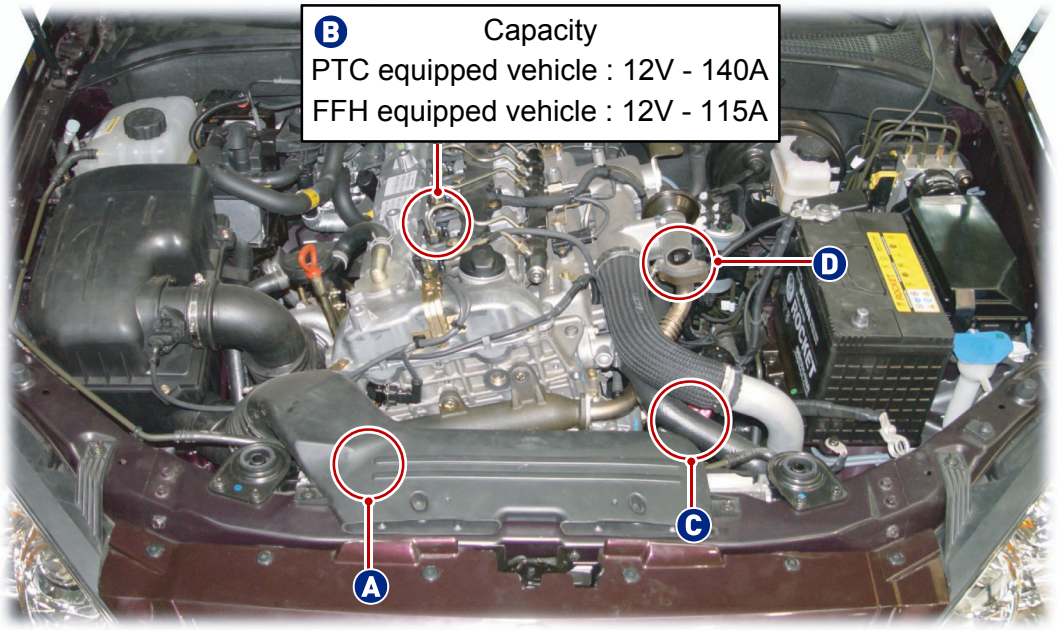
A

Glow Plug

B



B Capacity
PTC equipped vehicle : 12V - 140A
FFH equipped vehicle : 12V - 115A



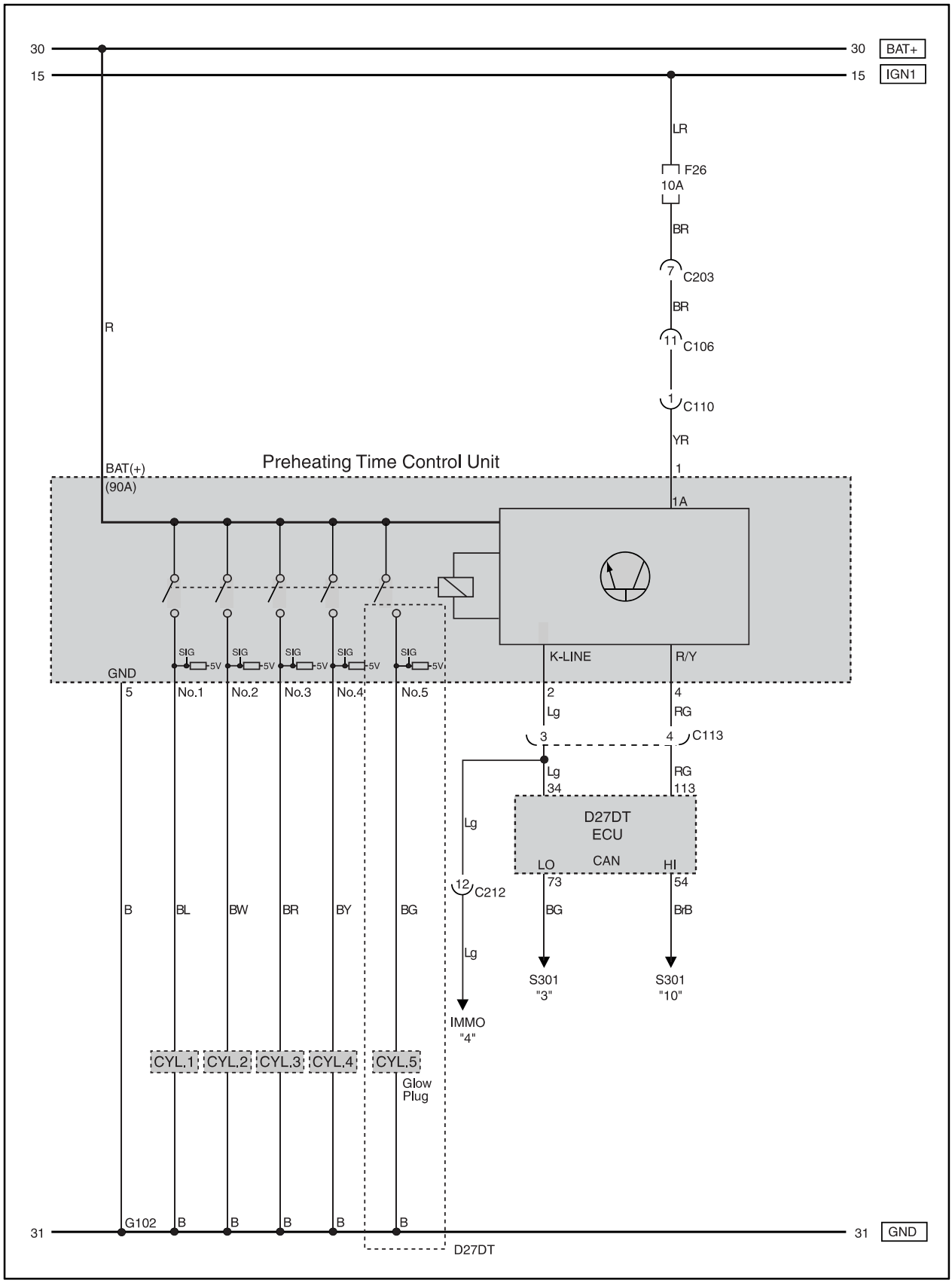
Air Conditioner Compressor

C

Starter

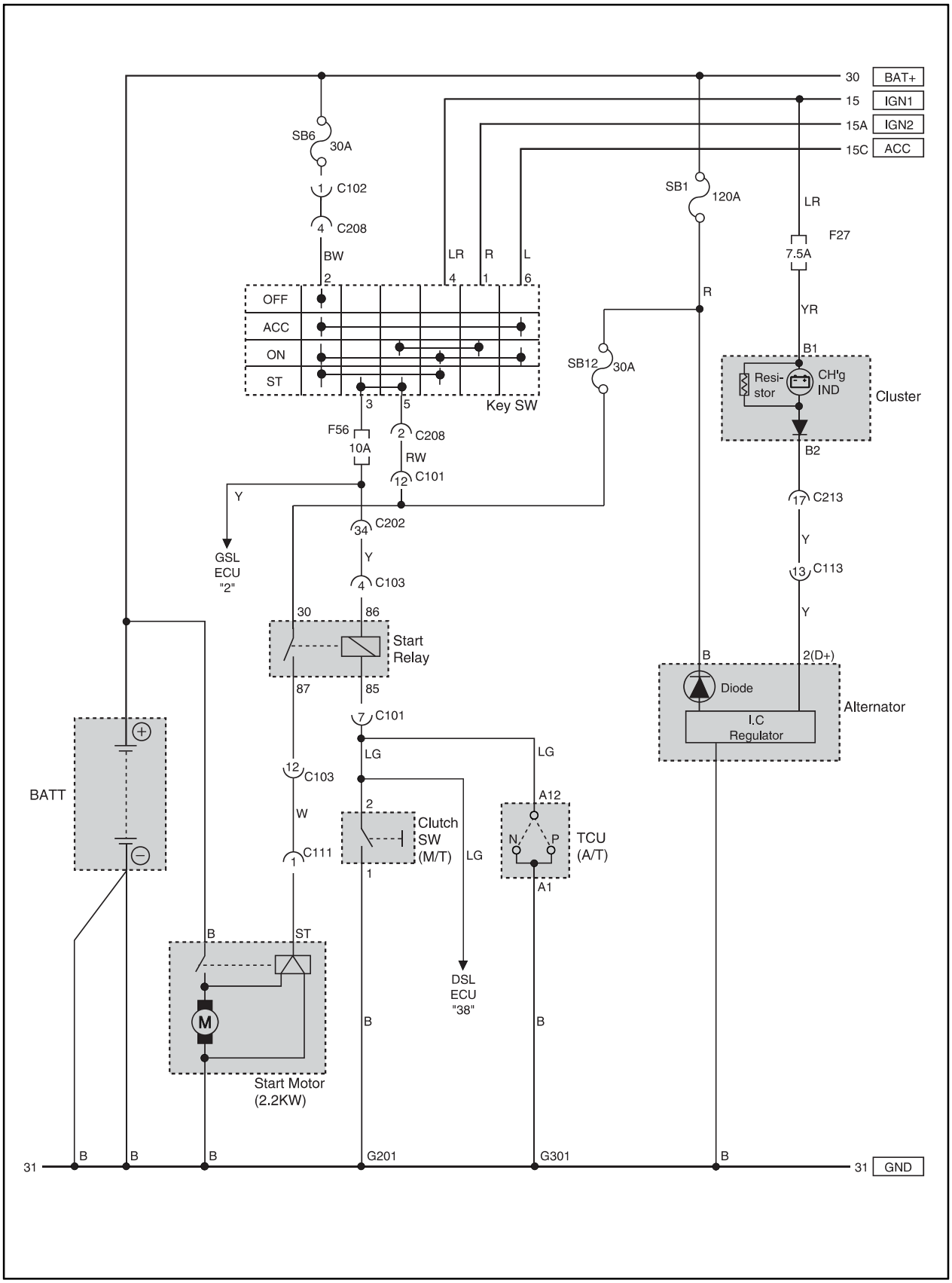
D

3. CIRCUIT DIAGRAM OF PREHEATING SYSTEM



Modification basis	
Application basis	
Affected VIN	

4. CIRCUIT DIAGRAM OF STARTING AND ALTERNATOR



Modification basis	
Application basis	
Affected VIN	

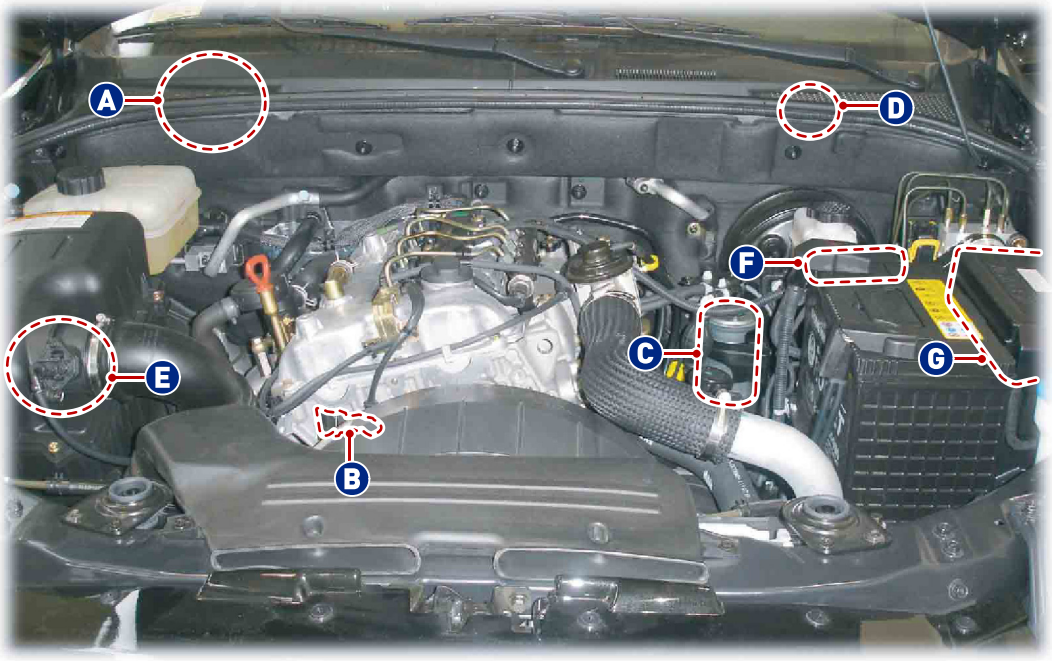
EGINE CONTROL SYSTEM

1491-01

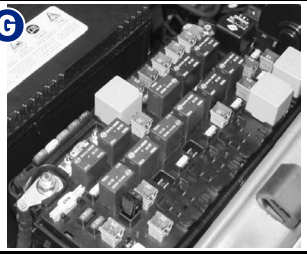
GENERAL

1. ENGINE ECU AND OTHER COMPONENTS

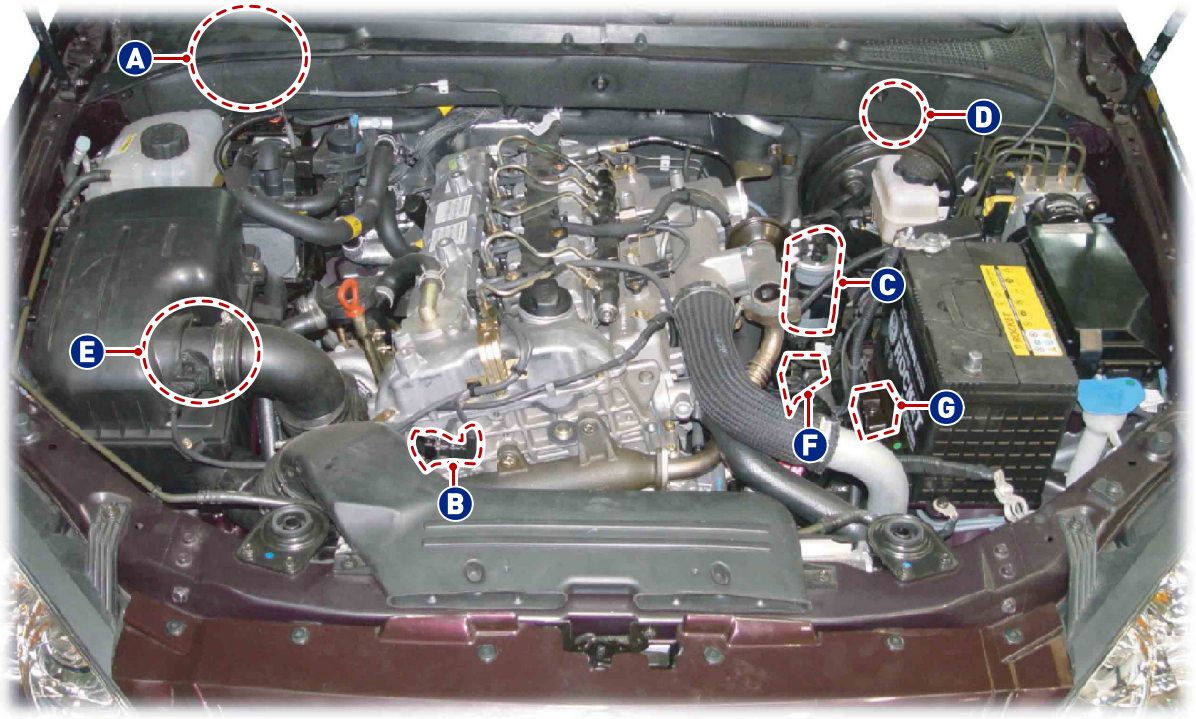
1) D20DT Engine

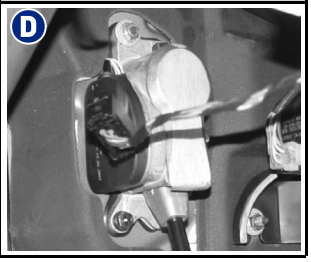


ECU/Barometric Sensor	Camshaft Position Sensor	Fuel Filter (Water Sensor)	Accelerator Pedal Sensor
A	B	C	D

HFM Sensor / Intake Air Temperature Sensor	Preheating Relay	Main Relay
E	F	G 

2) D20DT Engine



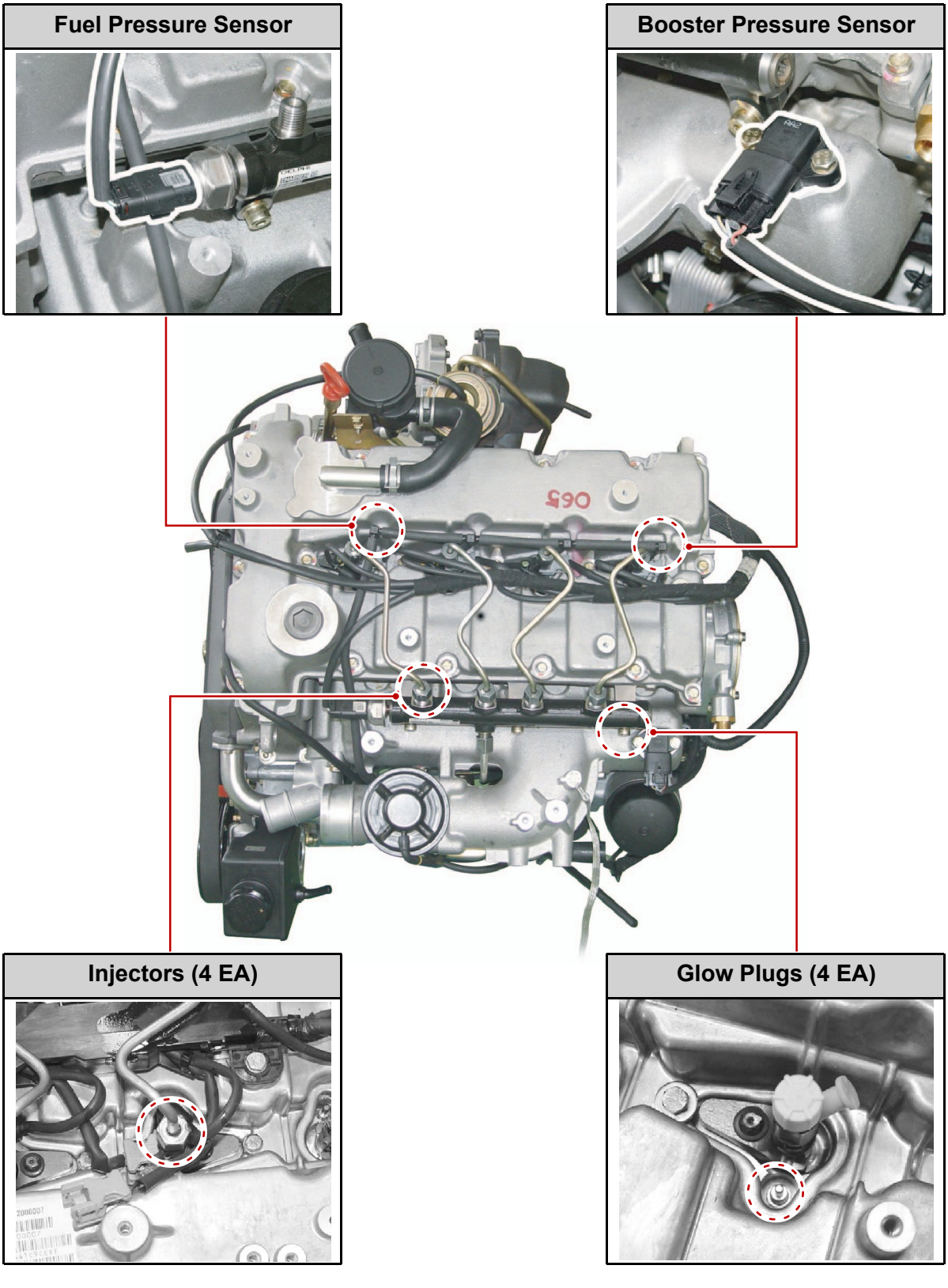
ECU/Barometric Sensor	Camshaft Position Sensor	Fuel Filter (Water Sensor)	Accelerator Pedal Sensor
A	B	C	D 

HFM Sensor / Intake Air Temperature Sensor	Preheating Relay	Main Relay
E	F	G

Modification basis	
Application basis	
Affected VIN	

3) TOP VIEW

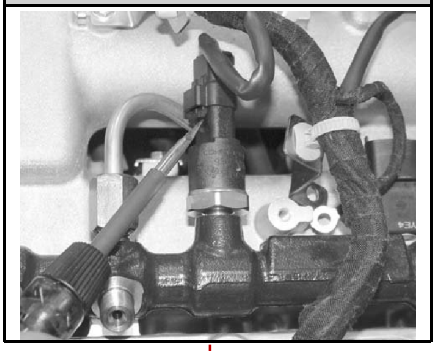
(1) D20DT Engine



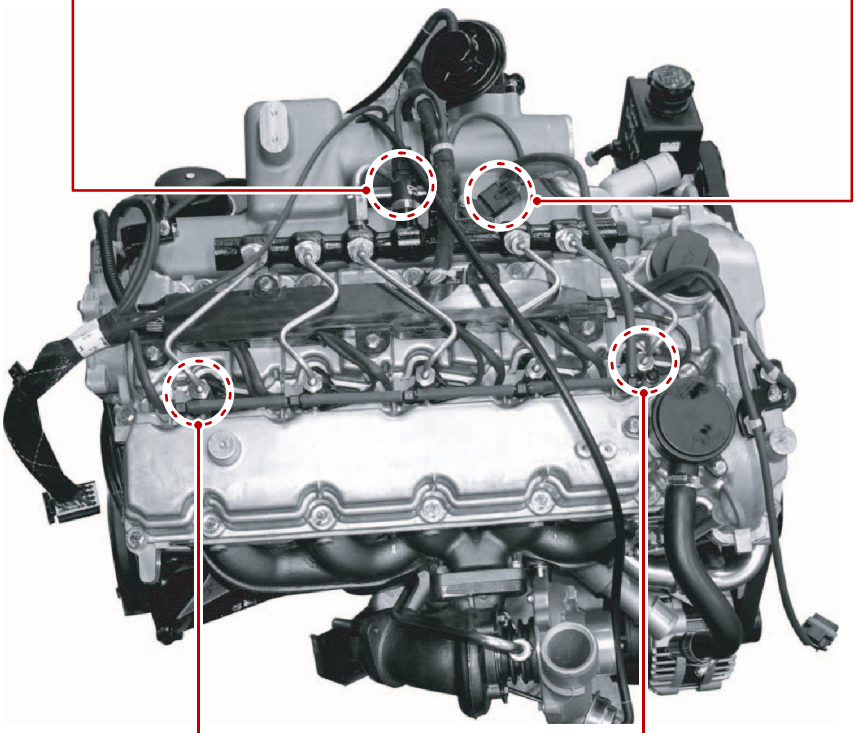
Modification basis	
Application basis	
Affected VIN	

(2) D27DT Engine

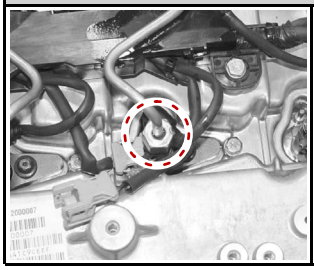
Fuel Pressure Sensor



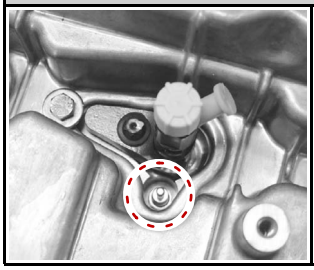
Booster Pressure Sensor



Injectors (5 EA)



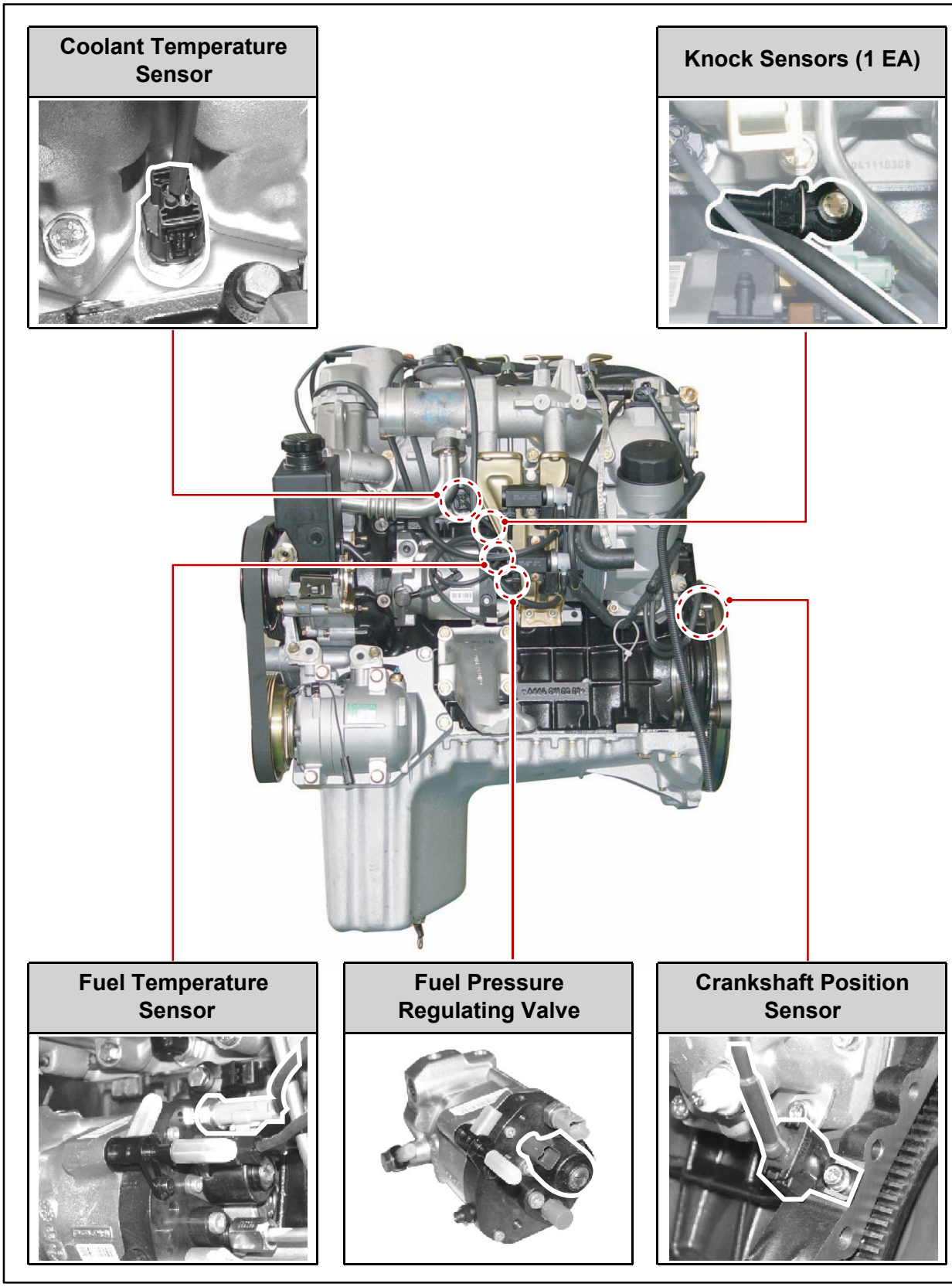
Glow Plugs (5)



Modification basis	
Application basis	
Affected VIN	

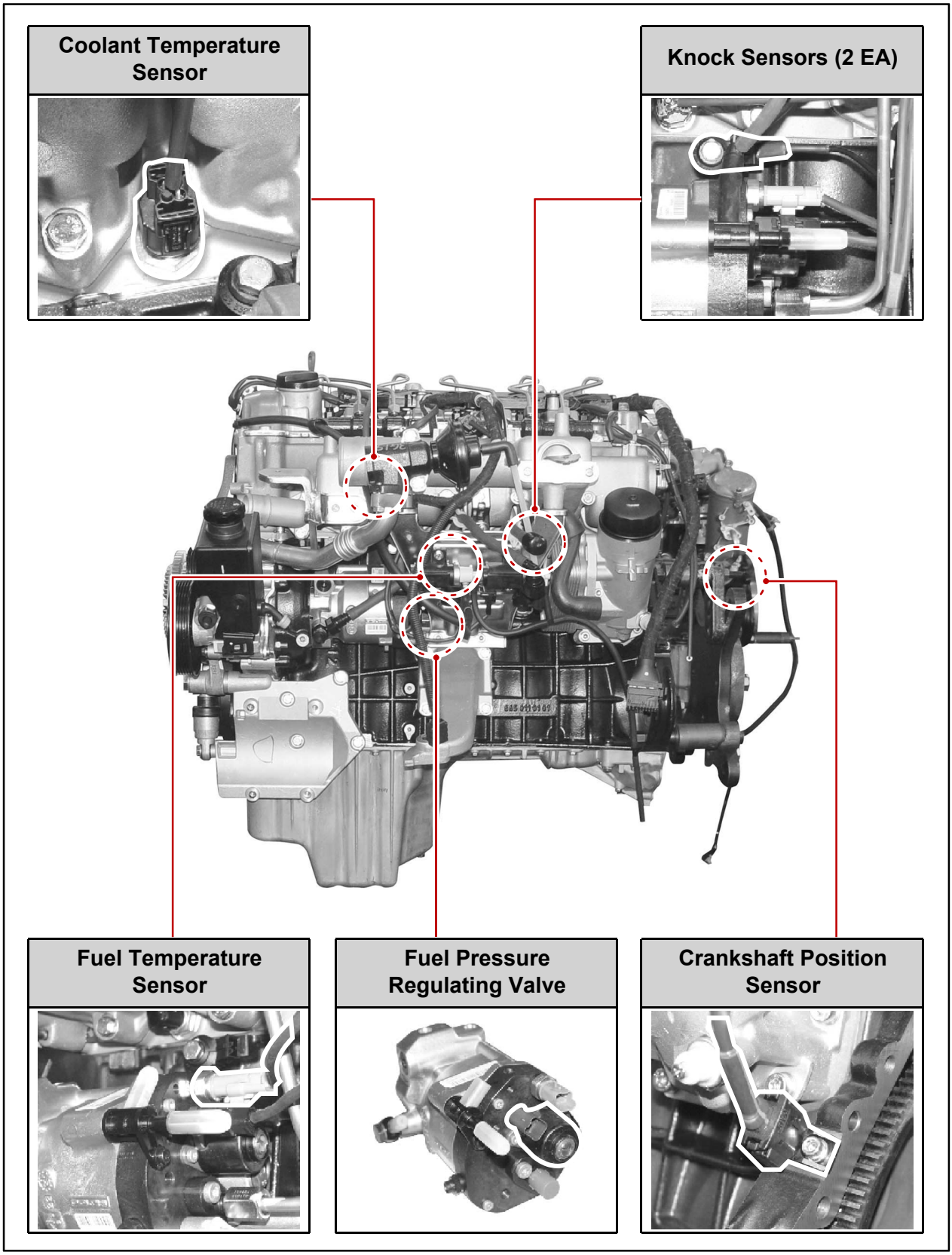
4) SIDE VIEW

(1) D20DT Engine



Modification basis	
Application basis	
Affected VIN	

(2) D27DT Engine



Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. ECU INPUTS/OUTPUTS

Inputs	Control	Output
Booster pressure sensor Atmospheric pressure sensor (Built-in ECU) Air flow sensor (HFM) Coolant temperature sensor Fuel temperature sensor Fuel pressure sensor Fuel filter water sensor Knock sensor crankshaft position sensor camshaft position sensor Accelerator sensor Vehicle speed sensor Switch input signal (IG, brake, clutch, A/C signal, A/C compressor)	E C U	Injector EGR system Fuel pressure regulating valve (IMV) Electrical fan control (Low/High-speed) A/C compressor relay Glow plug relay Immobilizer Warning lights (Water warning light, glow plug indicator light, engine warning light) Preheater (auxiliary heater) K - line CAN communication Self-diagnosis

2. STRUCTURE AND FUNCTION OF ECU

1) Function of ECU

ECU receives and analyzes signals from various sensors and then modifies those signals into permissible voltage levels and analyzes to control respective actuators.
ECU microprocessor calculates injection period and injection timing proper for engine piston speed and crankshaft angle based on input data and stored specific map to control the engine power and emission gas.
Output signal of the ECU microprocessor drives pressure control valve to control the rail pressure and activates injector solenoid valve to control the fuel injection period and injection timing; so controls various actuators in response to engine changes. Auxiliary function of ECU has adopted to reduce emission gas, improve fuel economy and enhance safety, comforts and conveniences. For example, there are EGR, booster pressure control, autocruise (export only) and immobilizer and adopted CAN communication to exchange data among electrical systems (automatic T/M and brake system) in the vehicle fluently. And Scanner can be used to diagnose vehicle status and defectives.
Operating temperature range of ECU is normally −40 ~ +85°C and protected from factors like oil, water and electromagnetism and there should be no mechanical shocks.
To control the fuel volume precisely under repeated injections, high current should be applied instantly so there is injector drive circuit in the ECU to generate necessary current during injector drive stages.
Current control circuit divides current applying time (injection time) into full-in-current-phase and hold-current-phase and then the injectors should work very correctly under every working condition.

3. CONTROL FUNCTION OF ECU

▶ **Controls by operating stages**

- To make optimum combustion under every operating stage, ECU should calculate proper injection volume in each stage by considering various factors.

▶ **Starting injection volume control**

- During initial starting, injecting fuel volume will be calculated by function of temperature and engine cranking speed.
  Starting injection continues from when the ignition switch is turned to ignition position to till the engine reaches to allowable minimum speed.

▶ **Driving mode control**

- If the vehicle runs normally, fuel injection volume will be calculated by accelerator pedal travel and engine rpm and the drive map will be used to match the drivers inputs with optimum engine power.

Modification basis	
Application basis	
Affected VIN	

4. FUEL PRESSURE CONTROL

1) Fuel Pressure Control Elements

Pressure control consists of 2 principle modules.

- Determines rail pressure according to engine operating conditions.
- Controls IMV to make the rail pressure to reach to the required value.

Pressure in the fuel rail is determined according to engine speed and load on the engine. The aim is to adapt the injection pressure to the engine's requirements.

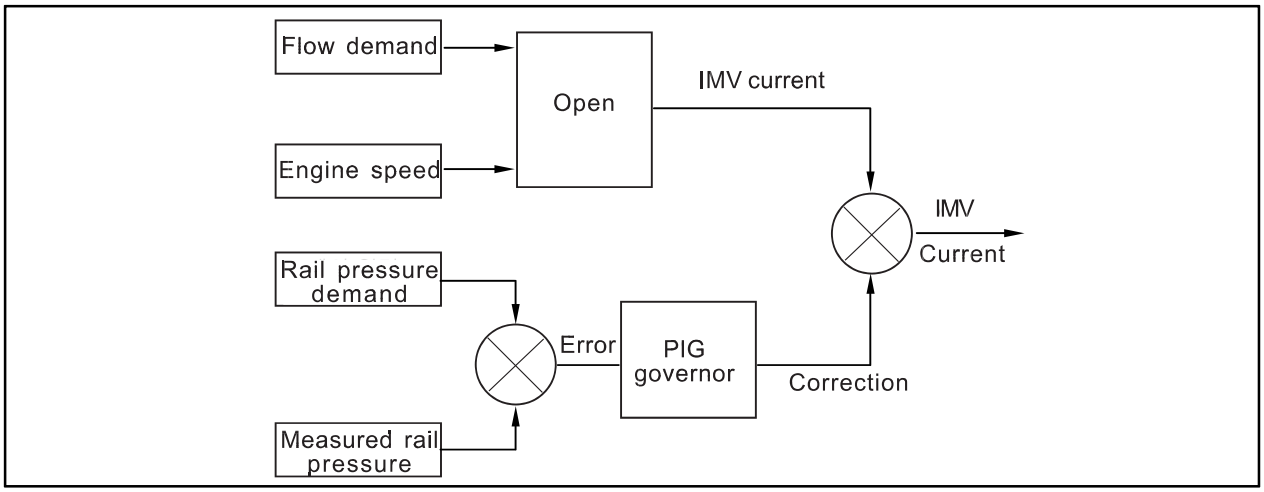
- When engine speed and load are high
  · The degree of turbulence is very great and the fuel can be injected at very high pressure in order to optimize combustion.
- When engine speed and load are low
  · The degree of turbulence is low. If injection pressure is too high, the nozzle's penetration will be excessive and part of the fuel will be sprayed directly onto the sides of the cylinder, causing incomplete combustion. So there occurs smoke and damages engine durability.

Fuel pressure is corrected according to air temperature, coolant temperature and atmospheric pressure and to take account of the added ignition time caused by cold running or by high altitude driving. A special pressure demand is necessary in order to obtain the additional flow required during starts. This demand is determined according to injected fuel and coolant temperature.

2) Fuel Pressure Control

Rail pressure is controlled by closed loop regulation of IMV. A mapping system - open loop - determines the current which needs to be sent to the actuator in order to obtain the flow demanded by the ECU. The closed loop will correct the current value depending on the difference between the pressure demand and the pressure measured.

- If the pressure is lower than the demand, current is reduced so that the fuel sent to the high pressure pump is increased.
- If the pressure is higher than the demand, current is increased so that the fuel sent to the high pressure pump is reduced.



5. FUEL INJECTION CONTROL

1) Fuel Injection Control

Injection control is used in order to determine the characteristics of the pulse which is sent to the injectors.

Injection control consists as below.

- Injection timing
- Injection volume
- Translating fuel injection timing and injection volume into values which can be interpreted by the injector driver.
  - a reference tooth (CTP)
  - the delay between this tooth and the start of the pulse (Toff)
  - the pulse time (Ton)

▶ Main injection timing control

The pulse necessary for the main injection is determined as a function of the engine speed and of the injected flow.

The elements are:

- A first correction is made according to the air and coolant temperatures.
  This correction makes it possible to adapt the timing to the operating temperature of the engine. When the engine is warm, the timing can be retarded to reduce the combustion temperature and polluting emissions (NOx). When the engine is cold, the timing advance must be sufficient to allow the combustion to begin correctly.
- A second correction is made according to the atmospheric pressure.
  This correction is used to adapt the timing advance as a function of the atmospheric pressure and therefore the altitude.
- A third correction is made according to the coolant temperature and the time which has passed since starting.
  This correction allows the injection timing advance to be increased while the engine is warming up (initial 30 seconds). The purpose of this correction is to reduce the misfiring and instabilities which are liable to occur after a cold start.
- A fourth correction is made according to the pressure error.
  This correction is used to reduce the injection timing advance when the pressure in the rail is higher than the pressure demand.
- A fifth correction is made according to the rate of EGR.
  This correction is used to correct the injection timing advance as a function of the rate of exhaust gas recirculation.
  When the EGR rate increases, the injection timing advance must in fact be increased in order to compensate for the fall in termperature in the cylinder.

During starting, the injection timing must be retarded in order to position the start of combustion close to the TDC.

To do this, special mapping is used to determine the injection timing advance as a function of the engine speed and of the water temperature. This requirement only concerns the starting phase, since once the engine has started the system must re-use the mapping and the corrections described previously.

Modification basis	
Application basis	
Affected VIN	

▶ Pilot injection timing control

The pilot injection timing is determined as a function of the engine speed and of the total flow.
The elements are:

- A first correction is made according to the air and coolant temperatures.
  This correction allows the pilot injection timing to be adapted to the operating temperature of the engine.
- A second correction is made according to the atmospheric pressure.
  This correction is used to adapt the pilot injection timing as a function of the atmospheric pressure and therefore the altitude.

During the starting phase, the pilot injection timing is determined as a function of the engine speed and of the coolant temperature.

6. FUEL FLOW CONTROL

1) Main Flow Control

The main flow represents the amount of fuel injected into the cylinder during the main injection. The pilot flow represents the amount of fuel injected during the pilot injection.

The total fuel injected during 1 cycle (main flow + pilot flow) is determined in the following manner.

: The driver's demand is compared with the value of the minimum flow determined by the idle speed controller.

- When the driver depress the pedal, it is his demand which is taken into account by the system in order to determine the fuel injected.
- When the driver release the pedal, the idle speed controller takes over to determine the minimum fuel which must be injected into the cylinder to prevent the enigne from stalling.

It is therefore the greater of these 2 values which is retained by the system. This value is then compared with the lower flow limit determined by the ASR trajectory control system. As soon as the injected fuel becomes lower than the flow limit determined by the ASR trajectory control system, the antagonistic torque (engine brake) transmitted to the drive wheels exceeds the adherence capacity of the vehicle and there is therefore a risk of the drive wheels locking. The system thus chooses the greater of these 2 values (main flow & pilot flow) in order to prevent any loss of control of the vehicle during a sharp deceleration.

This value is then compared with the flow limit determined by the cruise control. As soon as the injected fuel becomes lower than the flow limit determined by the cruise control, the vehicle's speed falls below the value required by the driver. The system therefore chooses the greater of these 2 values in order to maintain the speed at the required level.

This valve is then compared with the flow limit determined by the flow limitation strategy. This strategy allows the flow to be limited as a function of the operating conditions of the engine. The system therefore chooses the smaller of these 2 values in order to protect the engine. This value is then compared with the fuel limit determined by the ASR trajectory control system.

As soon as the injected fuel becomes higher than the fuel limit determined by the ASR trajectory control system, the engine torque transmitted to the wheels exceeds the adhesion capacity of the vehicle and there is a risk of the drive wheels skidding. The system therefore chooses the smaller of the two values in order to avoid any loss of control of the vehicle during accelerations.

The anti-oscillation strategy makes it possible to compensate for fluctuations in engine speed during transient conditions. This strategy leads to a fuel correction which is added to the total fuel of each cylinder. The correction is determined before each injection as a function of the instantaneous engine speed.

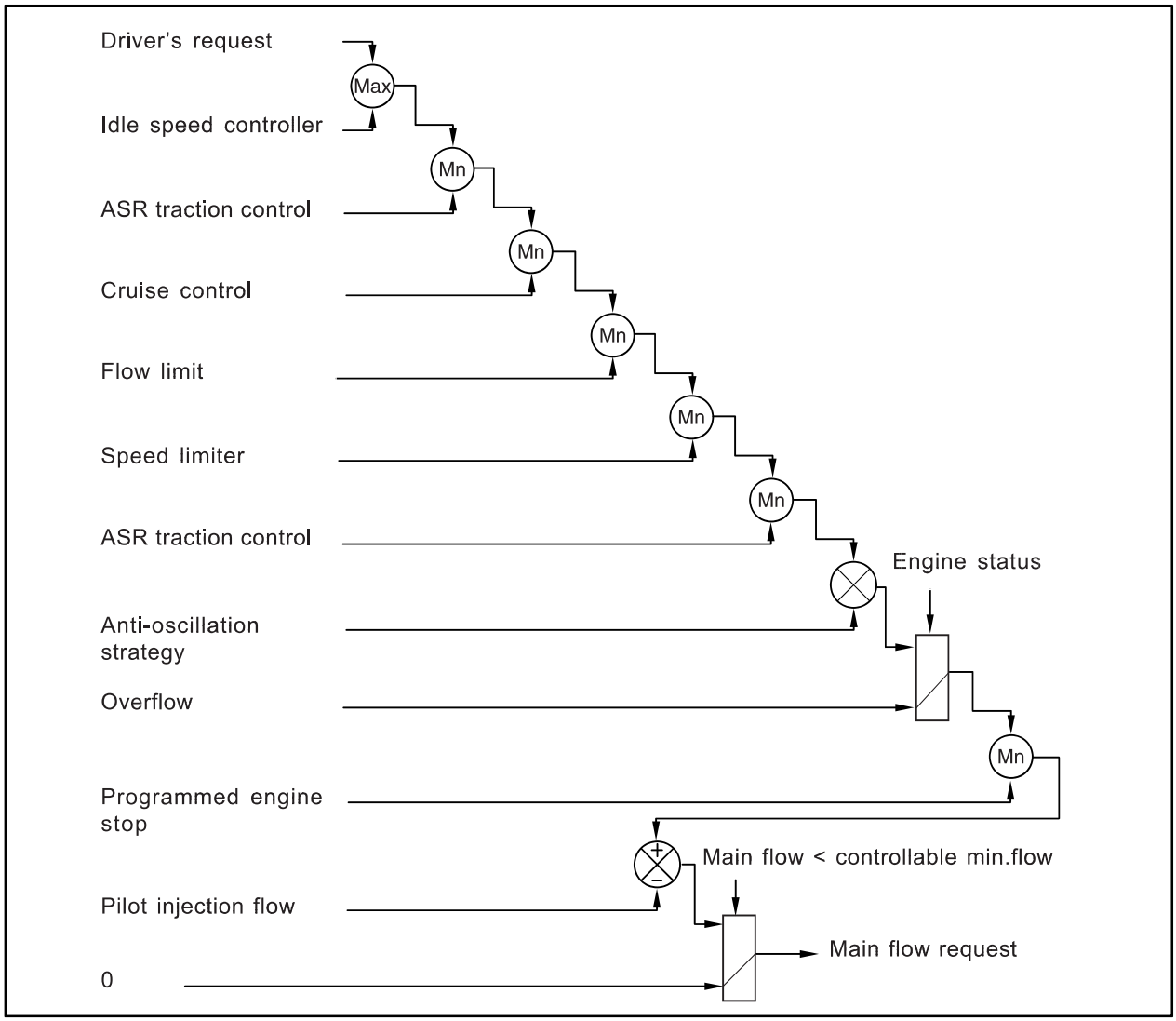
Modification basis	
Application basis	
Affected VIN	

A switch makes it possible to change over from the supercharge fuel to the total fuel according to the state of the engine.

- Until the stating phase has finished, the system uses the supercharged fuel.
- Once the engine changes to normal operation, the system uses the total fuel.

The main fuel is obtained by subtracting the pilot injection fuel from the total fuel.
A mapping determines the minimum fuel which can control an injector as a function of the rail pressure. As soon as the main fuel falls below this value, the fuel demand changes to 0 because in any case the injector is not capable of injecting the quantity demand.

2) Driver Demand



The driver demand is the translation of the pedal position into the fuel demand. It is calculated as a function of the pedal position and of the engine speed. The driver demand is filtered in order to limit the hesitations caused by rapid changes of the pedal position. A mapping determines the maximum fuel which can be injected as a function of the driver demand and the rail pressure. Since the flow is proportional to the injection time and to the square root of the injection pressure, it is necessary to limit the flow according to the pressure in order to avoid extending the injection for too long into the engine cycle. The system compares the driver demand with this limit and chooses the smaller of the 2 values. The driver demand is then corrected according to the coolant temperature. This correction is added to the driver demand.

Modification basis	
Application basis	
Affected VIN	

3) Idle Speed Controller

The idle speed controller consists of 2 principal modules:

- The first module determines the required idle speed according to:
  - · The operating conditions of the engine (coolant temperature, gear engaged)
  - · Any activation of the electrical consumers (power steering, air conditioning, others)
  - · The battery voltage
  - · The presence of any faults liable to interface with the rail pressure control or the injection control. In this case, the accelerated idle speed is activated to prevent the engine from stalling when operating in degraded mode.
  - · It is possible to increase or to reduce the required idle speed with the aid of the diagnostic tool.
- The second module is responsible for providing closed loop control of the engine's idle speed by adapting the minimum fuel according to the difference between the required idle speed and the engine speed.

4) Flow Limitation

The flow limitation strategy is based on the following strategies:

- The flow limitation depending on the filling of the engine with air is determined according to the engine speed and the air flow. This limitation allows smoke emissions to be reduced during stabilized running.
- The flow limitation depending on the atmospheric pressure is determined according to the engine speed and the atmospheric pressure. It allows smoke emissions to be reduced when driving at altitude.
- The full load flow curve is determined according to the gear engaged and the engine speed. It allows the maximum torque delivered by the engine to be limited.
- A performance limitation is introduced if faults liable to upset the rail pressure control or the injection control are detected by the system. In this case, and depending on the gravity of the fault, the system activates:
  - · Reduced fuel logic 1: Guarantees 75 % of the performance without limiting the engine speed.
  - · Reduced fuel logic 2: Guarantees 50 % of the performance with the engine speed limited to 3,000 rpm.
  - · Reduce fuel logic 3: Limits the engine speed to 2,000 rpm.

The system chooses the lowest of all these values.

A correction depending on the coolant temperature is added to the flow limitation. This correction makes it possible to reduce the mechanical stresses while the engine is warming up. The correction is determined according to the coolant temperature, the engine speed and the time which has passed since starting.

▶ **Superchager Flow Demand**

The supercharge flow is calculated according to the engine speed and the coolant temperature. A correction depending on the air temperature and the atmospheric pressure is made in order to increase the supercharge flow during cold starts. It is possible to alter the supercharge flow value by adding a flow offset with the aid of the diagnostic tool.

5) Pilot Flow Control

The pilot flow represents the amount of fuel injected into the cylinder during the pilot injection. This amount is determined according to the engine speed and the total flow.

- A first correction is made according to the air and water temperature.
  This correction allows the pilot flow to be adapted to the operating temperature of the engine. When the engine is warm, the ignition time decreases because the end-of-compression temperature is higher. The pilot flow can therefore be reduced because there is obviously less combustion noise when the engine is warm.
- A second correction is made according to the atmospheric pressure.

This correction is used to adapt the pilot flow according to the atmospheric pressure and therefore the altitude.

During starting, the pilot flow is determined on the basis of the engine speed and the coolant temperature.

6) Cylinder Balancing Strategy

▶ **Balancing of the point to point flows**

The pulse of each injector is corrected according to the difference in instantaneous speed measured between 2 successive injectors.

- The instantaneous speeds on two successive injections are first calculated.
- The difference between these two instantaneous speeds is then calculated.
- Finally, the time to be added to the main injection pulse for the different injectors is determined. For each injector, this time is calculated according to the initial offset of the injector and the instantaneous speed difference.

▶ **Detection of an injector which has stuck closed**

The cylinder balancing strategy also allows the detection of an injector which has stuck closed. The difference in instantaneous speed between 2 successive injections then exceeds a predefined threshold. In this case, a fault is signaled by the system.

Modification basis	
Application basis	
Affected VIN	

7) Accelerometer Strategy

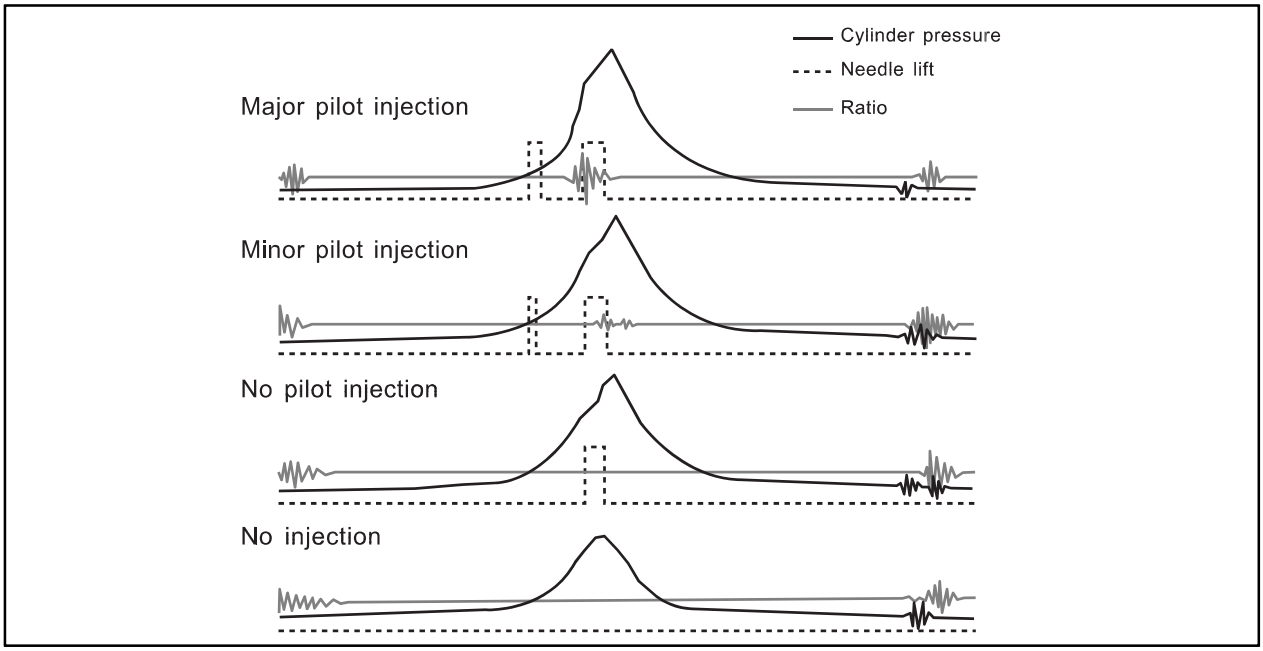
▶ Resetting the pilot injection

The accelerometer is used to reset the pilot injection flow in closed loop for each injector. This method allows the correction of any injector deviations over a period of time. The principle of use of the accelerometer is based on the detection of the combustion noises.

The sensor is positioned in such a way as to receive the maximum signal for all the cylinders. The raw signals from the accelerometer are processed to obtain a variable which quantifies the intensity of the combustion. This variable, known as the ratio, consists of the ratio between the intensity of the background noise and the combustion noise.

- A first window is used to establish the background noise level of the accelerometer signal for each cylinder. This window must therefore be positioned at a moment when there cannot be any combustion.
- The second window is used to measure the intensity of the pilot combustion. Its position is such that only the combustion noises produced by the pilot injection are measured . It is therefore placed just before the main injection.

The accelerometer does not allow any evaluation of the quantity injected. However, the pulse value will be measured when the injector starts injection and this pulse value is called the MDP (Minimum Drive Pulse). On the basis of this information, it is possible to efficiently correct the pilot flows. The pilot injection resetting principle therefore consists of determining the MDP, in other words the pulse corresponding to the start of the increase in value of the ratio (increase of vibration due to fuel combustion).



This is done periodically under certain operating conditions. When the resetting is finished, the new minimum pulse value replaces the value obtained during the previous resetting. The first MDP value is provided by the C2I. Each resetting then allows the closed loop of the MDP to be updated according to the deviation of the injector.

▶ **Detection of leaks in the cylinders**

The accelerometer is also used to detect any injector which may have stuck open. The detection principle is based on monitoring the ratio. If there is a leak in the cylinder, the accumulated fuel self-ignites as soon as the temperature and pressure conditions are favorable (high engine speed, high load and small leak).

This combustion is set off at about 20 degrees before TDC and before main injection.

The ratio therefore increases considerably in the detection window. It is this increase which allows the leaks to be detected. The threshold beyond which a fault is signaled is a percentage of the maximum possible value of the ratio.

Because of the severity of the recovery process (engine shut-down), the etection must be extremely robust.

An increase in the ratio can be the consequence of various causes:

- Pilot injection too strong
- Main combustion offset
- Fuel leak in the cylinder

If the ratio becomes too high, the strategy initially restricts the pilot injection flow and retards the main injection. If the ratio remains high despite these interventions, this shows that a real leak is present, a fault is signaled and the engine is shut down.

▶ **Detection of an accelerometer fault**

This strategy permits the detection of a fault in the sensor or in the wiring loom connecting the sensor to the ECU.

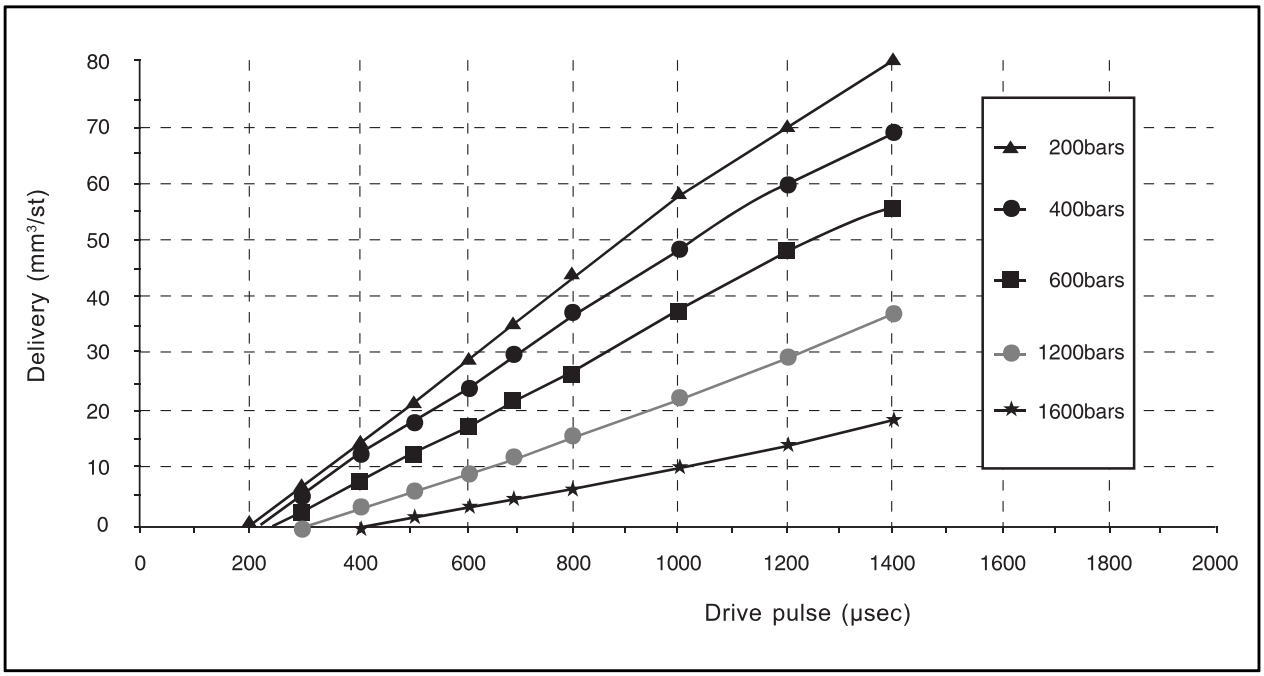
It is based on detection of the combustion. When the engine is idling, the detection window is set too low for the combustion caused by the main injection. If the ratio increases, this shows that the accelerometer is working properly, but otherwise a fault is signaled to indicate a sensor failure. The recovery modes associated with this fault consist of inhibition of the pilot injection and discharge through the injectors.

Modification basis	
Application basis	
Affected VIN	

7. INDIVIDUAL INJECTOR CALIBRATION (C2I)

Injected fuel is proportional to square root of injection time and rail pressure.

It is function between pulse and rail pressure and fuel injection curve is called injector characteristics curve having the following shape.



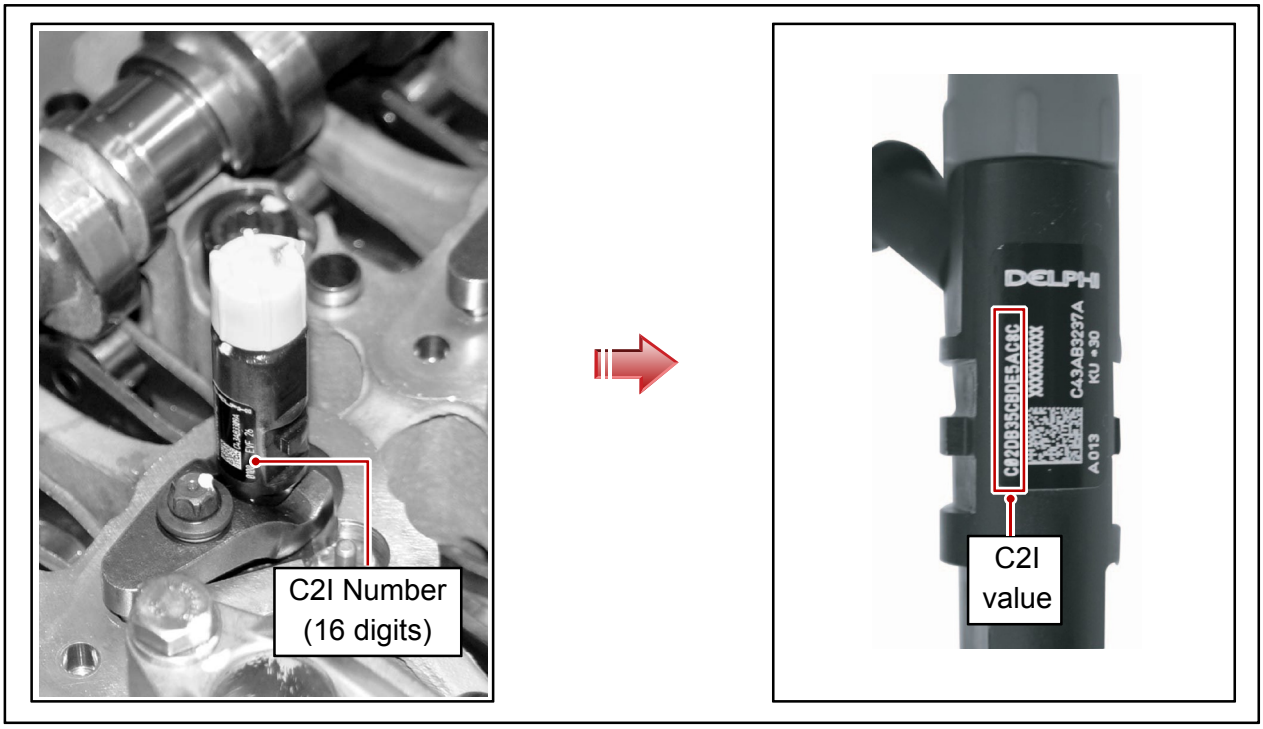
Common rail injectors are very accurate components. They are able to inject fuel delivery between 0.5 to 100 mg/str under pressure varying from 150 to 1600 bar.

This high level of accuracy requires very low machining tolerances (few ㎛).

Nevertheless, due to the machining dispersion, the loss of charge through the functional orifices, the friction between moving parts and electromagnetic field level are different from one injector to the other. So, the difference of fuel delivery for the same pressure and the same pulse can reach 5 mg/str from one injector to the other. It is impossible to control efficiently the engine with such a dispersion between the different injectors. It is necessary to add a correction that allows injecting the demanded fuel delivery whatever the initial hydraulic characteristics of the injector is. The method consists in correcting the pulse that is applied to the injector with an offset that depends on the initial hydraulic map of the injector. So, the pulse should be corrected according to characteristics of each injector.

C2I is composed of models on these characteristics of injectors.
C2I consists of 16-digit composed of numbers from 1 to 9 and alphabets from A to F. ECU remembers C2I, characteristics of each injector, to make the most optimal fuel injection.

- When replacing the injector, C2I code on the top of new injector should be input into ECU because the ECU is remembering the injector's C2I value. If C2I is not input, engine power drops and occurs irregular combustion.
- When ECU is replaced, C2I code of every injector should be input. If not, cannot accelerate the vehicle even when the accelerator pedal is depressed.



※ For coding of C2I, refer to "Diagnosis" section

Modification basis	
Application basis	
Affected VIN	

8. MINIMUM DRIVE PULSE (MDP) LEARNING

When the pulse value that the injector starts injection is measured, it is called mininum drive pulse (MDP). Through MDP controls, can correct pilot injections effectively. Pilot injection volume is very small, 1 ~ 2 mm/str, so precise control of the injector can be difficult if it gets old. So there needs MDP learning to control the very small volume precisely through learning according to getting older injectors.

1) Learning Conditions

Coolant temperature	> 75°C
Vehicle speed	> 50 Km/h (over 5 seconds)
Intake manifold pressure	> 0.7 bar
Engine speed	> 2,500 rpm
Battery voltage	10 V < MDP < 16 V
Fuel temperature	0 < fuel temperature < 80 °C
Initial MDP learning on each injector	5 seconds

2) Trouble Codes

Trouble code	Descriptio n	Diagnosis
P1171	Fault MDP learning on injector No. 1	• Check each injector
P1172	Fault MDP learning on injector No. 2	
P1173	Fault MDP learning on injector No. 3	
P1174	Fault MDP learning on injector No. 4	
P1175	Fault MDP learning on injector No. 5	

Memo

CRUISE CONTROL SYSTEM 8510-23

OVERVIEW AND OPERATION PROCESS

1. CRUISE CONTROL SWITCH

The purpose of the cruise control system is to automatically maintain a vehicle speed set by the driver, without depressing the accelerator pedal. The cruise control switch is located under the right side of the steering wheel, and when this switch is operating "AUTO CRUISE" lamp comes on.

The minimum speed for setting the cruise control system is 36 km/h (22.37 mph). Pay constant attention to the distance between the vehicles and the traffic conditions when using the cruise control system.

CAUTION

The cruise control system is a supplementary system, which helps the driver to drive the vehicle at a desired speed without using the accelerator pedal under the traffic condition where the vehicle-to-vehicle distance meets the legal requirement.

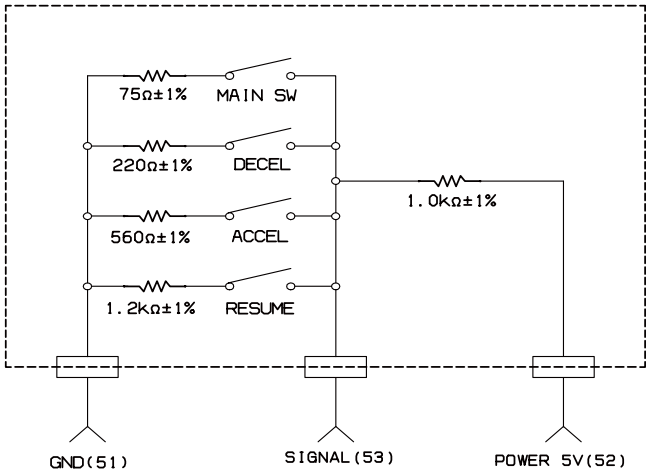
1) When To Use

Use the cruise control system only when (a) the traffic is not jammed, (b) driving on motorways or highways where there is no sudden change in the driving condition due to traffic lights, pedestrian, etc.

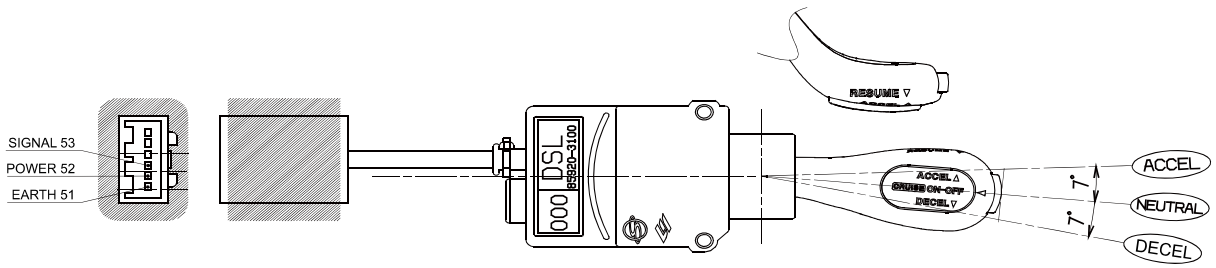
WARNING

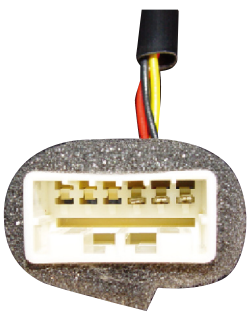
Use the cruise control system only when driving on motorways or highways. Do not use the cruise control system where the road conditions are as follows:
- When there is strong wind or cross wind.
- Heavy traffic.
- Slippery roads or steep decline.

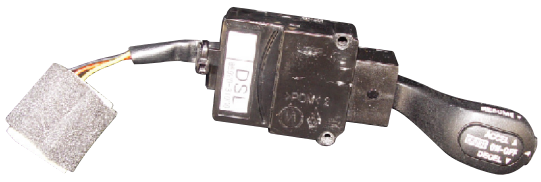
2. CIRCUIT DIAGRAM



1) Configuration







3. HOW TO OPERATE CRUISE CONTROL SWITCH

1) How To Set Speed

1. To operate the cruise control system, accelerate the vehicle to the speed within the specified range below with depressing the accelerator pedal.
   - Cruise control operating range: between 36 km/h (22.37 mph) and 150 km/h (93.207 mph)
2. When the desired speed is reached, which should be within the above range, push up the cruise control switch lever to ACCEL side (upwards arrow), or push down the switch lever to DECEL side (downwards arrow).
   And then release the accelerator pedal slowly.
3. Now the vehicle is cruised by this system with the set speed. You don't need to use the accelerator pedal.
4. Refer to the following pages for details of operation.

CAUTION

Never use the cruise control system until you get used to it.
Improper use or not fully aware of this function could result in collision and/or personal injuries.

Modification basis	
Application basis	
Affected VIN	

2) Accelerating with the Cruise Control System

(1) While the cruise control system is running

1. To increase the set speed, push up the cruise control switch lever to ACCEL side and hold it until the desired speed is reached without depressing the accelerator pedal.
2. When the desired speed is set, release the switch lever.

(2) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

1. Accelerate the vehicle to more than 36 km/h (22.37 mph) using the accelerator pedal. Push up the cruise control switch lever to ACCEL side and hold it.
2. When the desired speed is reached, release the accelerator pedal and the switch lever.

(3) Tap-up while the cruise control system is running

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

1. Push up the cruise control switch lever to ACCEL side for less than 0.5 second per one switching while the cruise control system is running; the speed increases each time by 1.3 km/h (0.81 mph).
2. For example, if you want to increase the speed 13 km/h (81 mph) more than the previous set speed, tap up the switch lever to ACCEL side ten times without using the accelerator pedal.

3) Decelerating with the Cruise Control System

(1) While the cruise control system is running

1. To decrease the set speed, push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached without depressing the brake pedal.
   But the cruise control system cannot maintain the cruise function at less than 34 km/h (21.13 mph).
2. When the desired speed is set, release the switch lever.

(2) When the cruise control system is not running

To decrease the speed with the cruise control system while the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 36 km/h (22.37 mph).
2. When the desired speed is reached, release the switch lever.
3. But the cruise control system cannot maintain the cruise function at less than 34 km/h (21.13 mph).

(3) Tap-down while the cruise control system is running

To decrease the vehicle speed in stages while the cruise control system is running, follow the below procedures.

1. Push down the cruise control switch lever to DECEL side for less than 0.5 second per one switching while the cruise control system is running; the speed decreases each time by 1.0 km/h (0.62 mph).
2. For example, if you want to decrease the speed 10 km/h (62 mph) lower than the previous set speed, tap down the switch lever to DECEL side ten times without using the brake pedal.

Modification basis	
Application basis	
Affected VIN	

4) Recovery of Set Speed (RESUME)

Even if the cruise control is cancelled, the previous set cruise speed can be recovered by operating the cruise control switch lever like below:
- Pull the switch lever in the arrow direction shown in the illustration.

This RESUME function works only when the vehicle speed is more than 36 km/h (22.37 mph) without using the accelerator or brake pedal.

CAUTION

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

5) Normal Cancellation of the Cruise Control (OFF ↔ ON)

The cruise control system will be cancelled when the button on the side of the switch is pressed, or when one of the following conditions is met:

1. When the brake pedal is depressed or ESP is activated.
2. When the vehicle speed is less than 34 km/h (21.13 mph).
3. When the parking brake is applied while driving.
4. When the clutch pedal is depressed for shifting (M/T only).

CAUTION

Put the cruise control switch lever in the neutral position when not using the cruise control system.

(1) Abnormal Cancellation of the Cruise Control

1. When the rapid deceleration or acceleration occurs.
2. When the cruise control lever is faulty.
3. When the brake switch is malfunctioning or has an open circuit.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

- Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
- Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
- The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
- Ensure that the braking distance is maintained and use the brake pedal if needed.

Modification basis	
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ENGINE GENERAL

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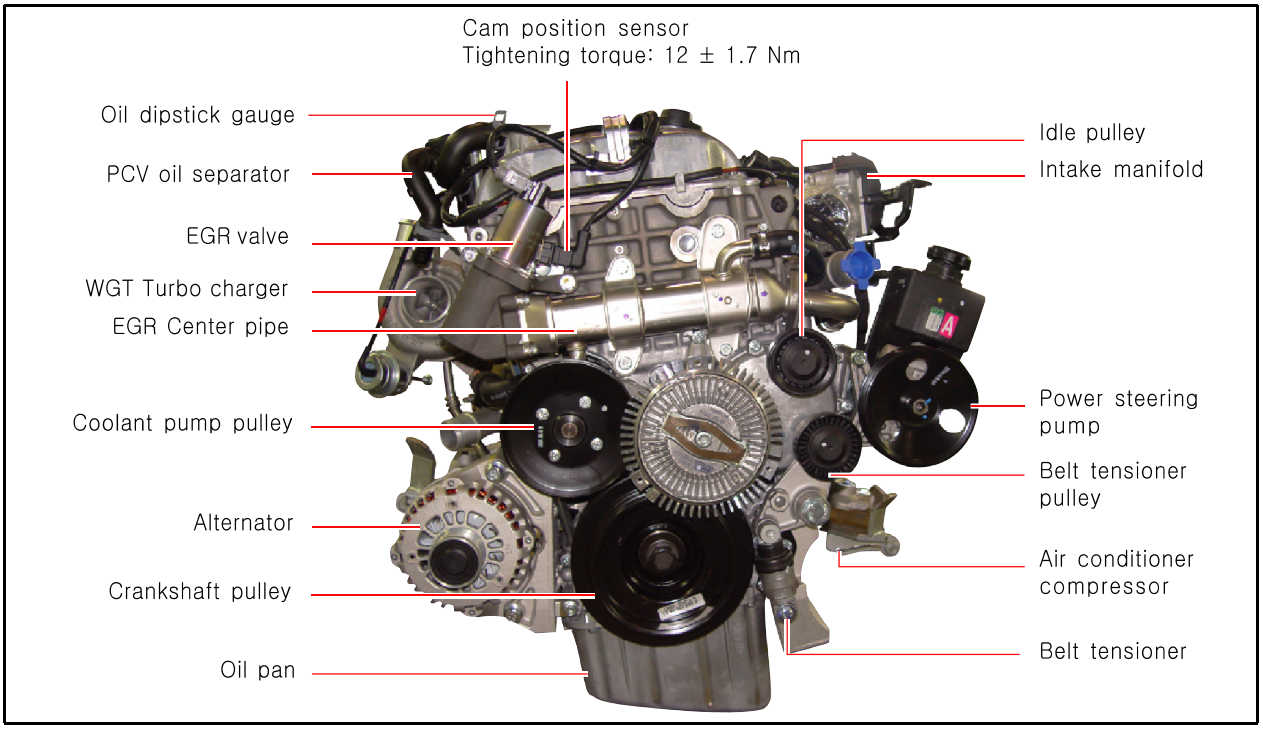
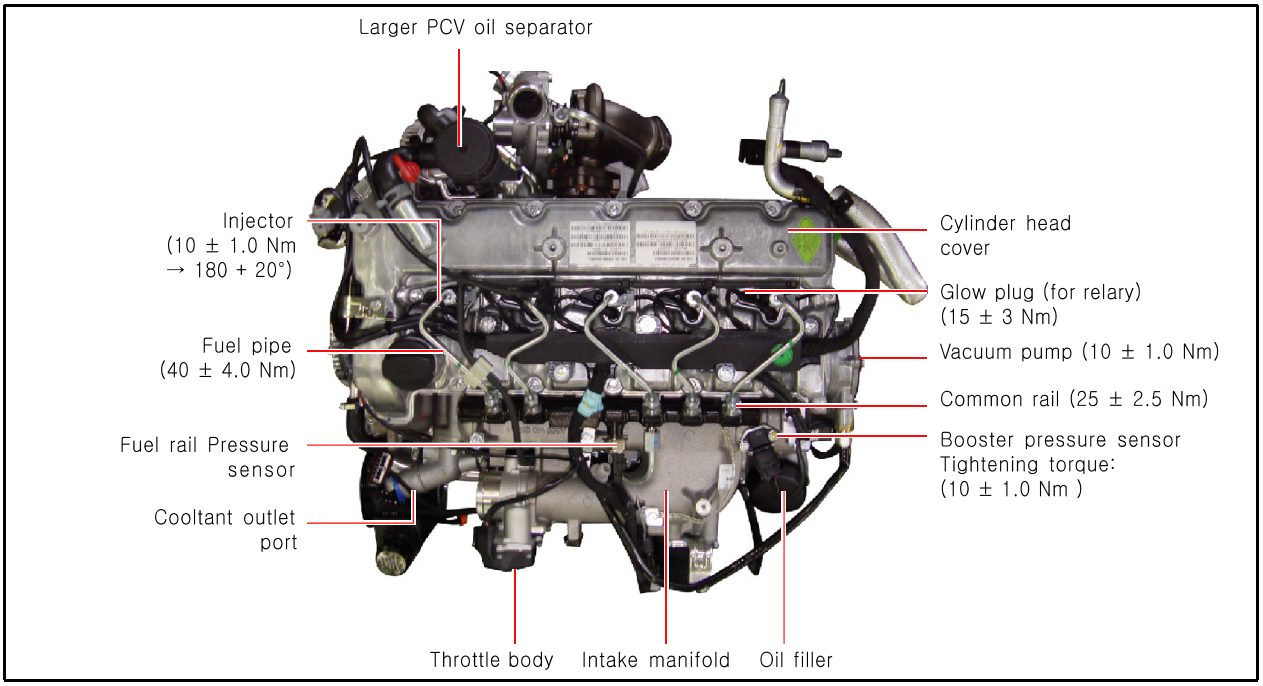
GENERAL

1. STRUCTURE AND COMPARISON

▶D27DT (EU IV) Engine - Front View

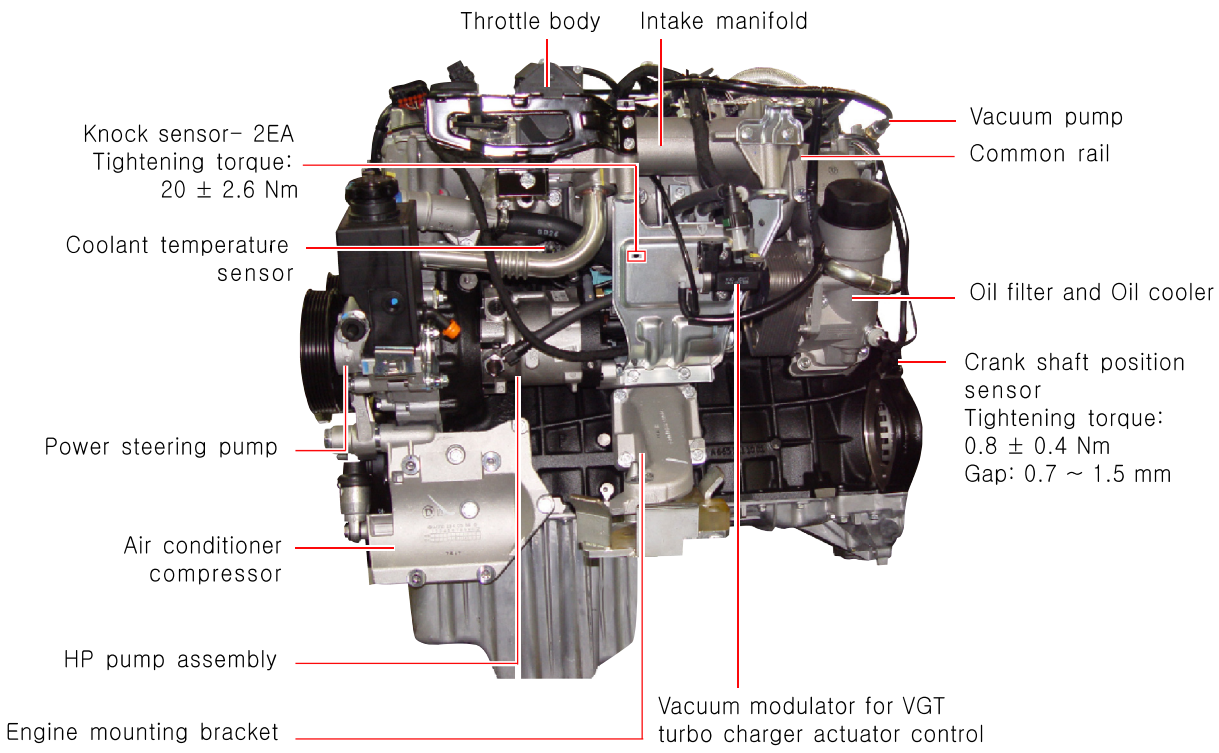


▶D27DT (EU IV) Engine - Top View

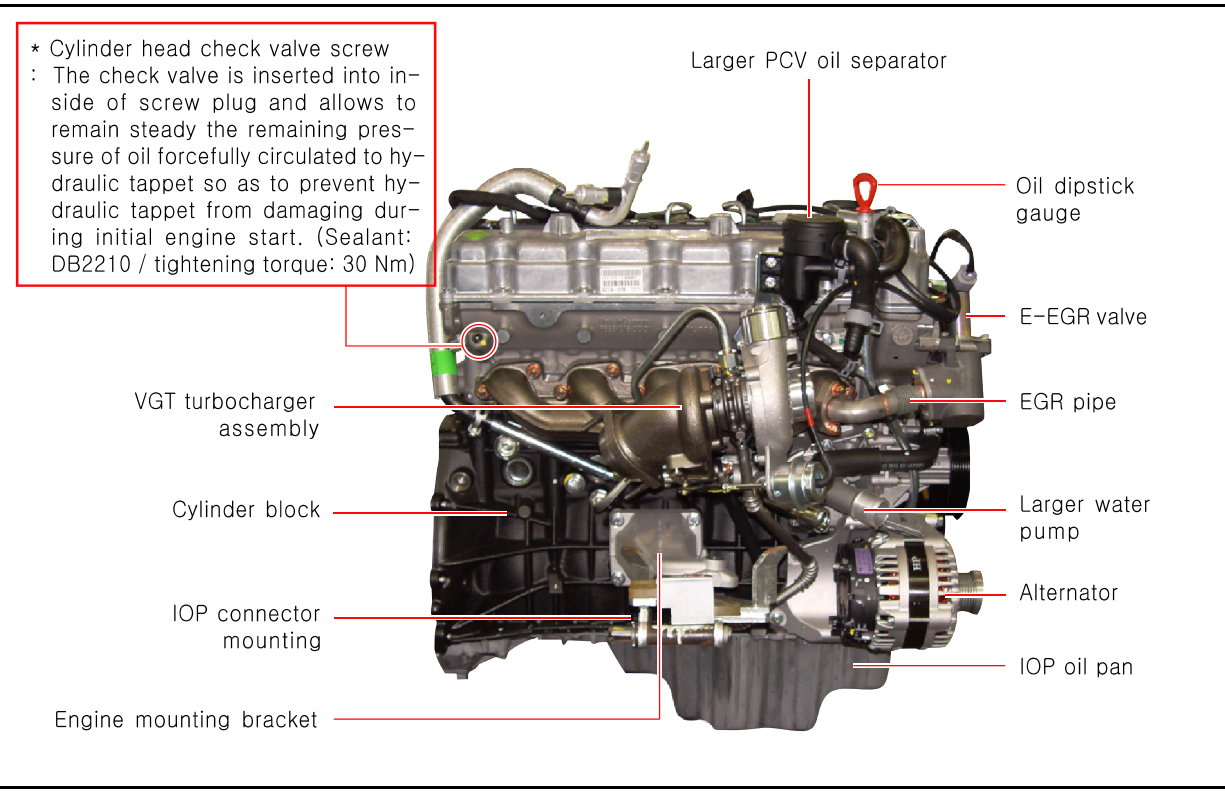


Modification basis	
Application basis	
Affected VIN	

▶D27DT (EU IV) Engine - Side View

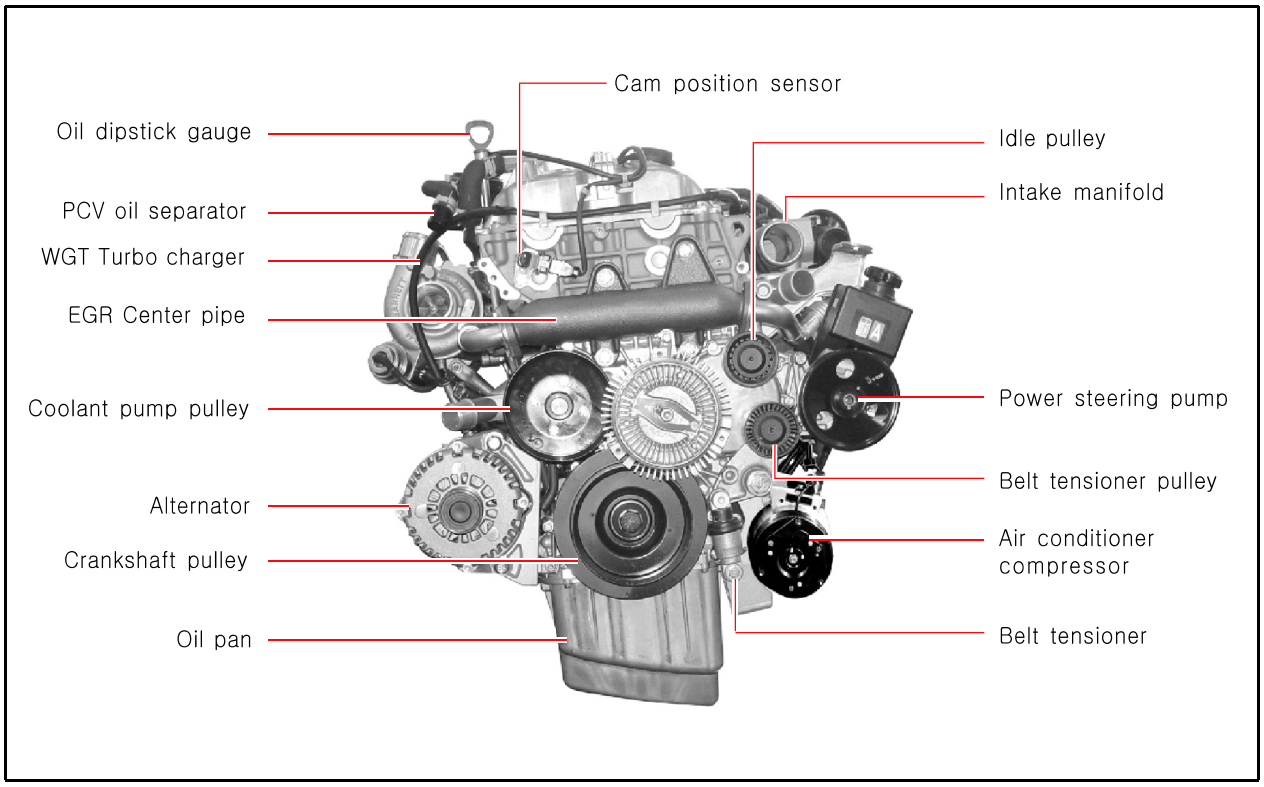


▶D27DT (EU IV) Engine - Left Side View

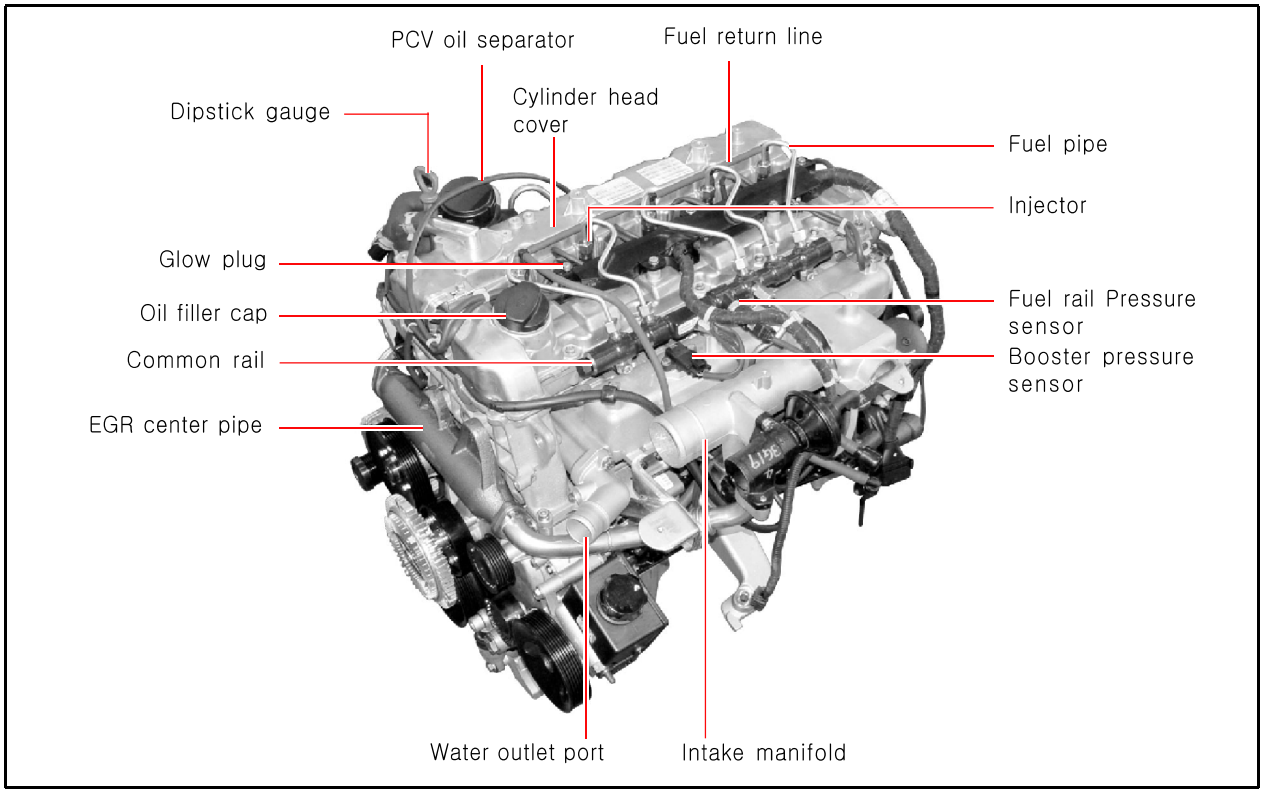


Modification basis	
Application basis	
Affected VIN	

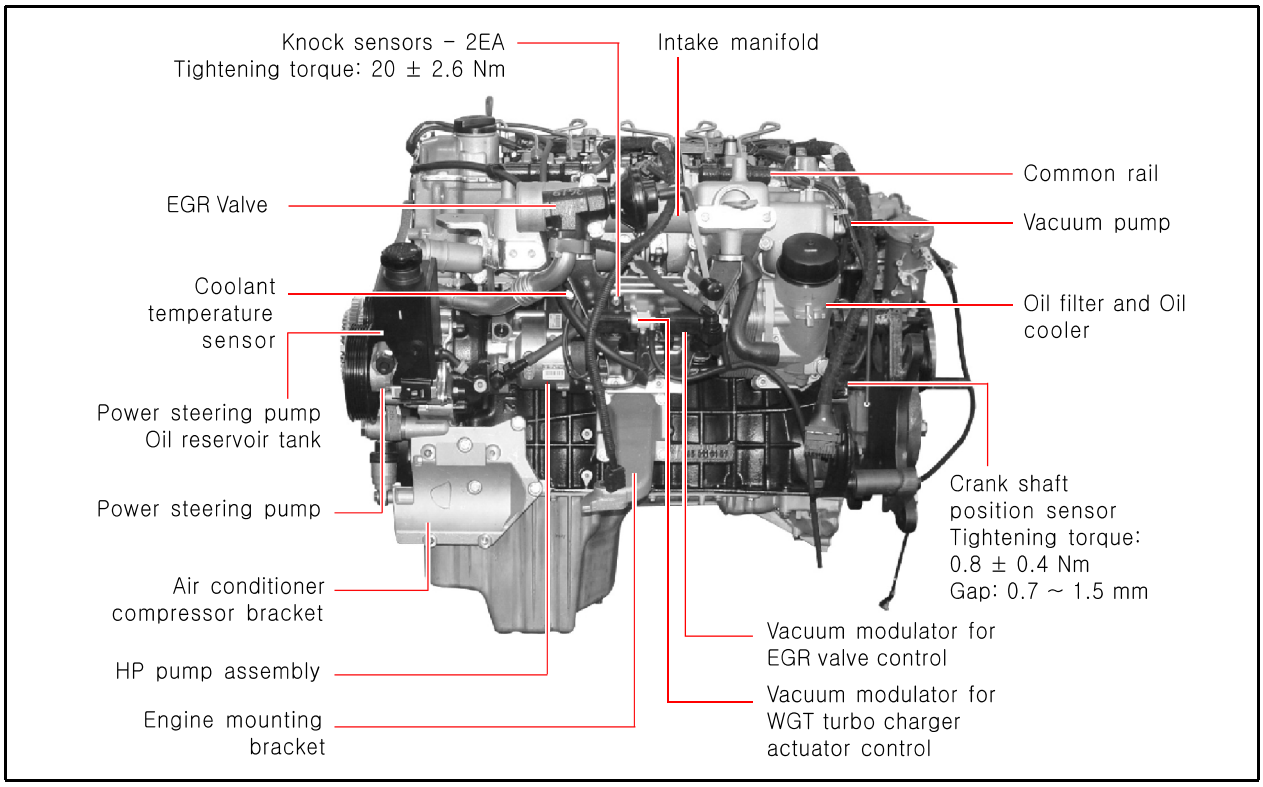
▶D27DT Engine (General) - Front View



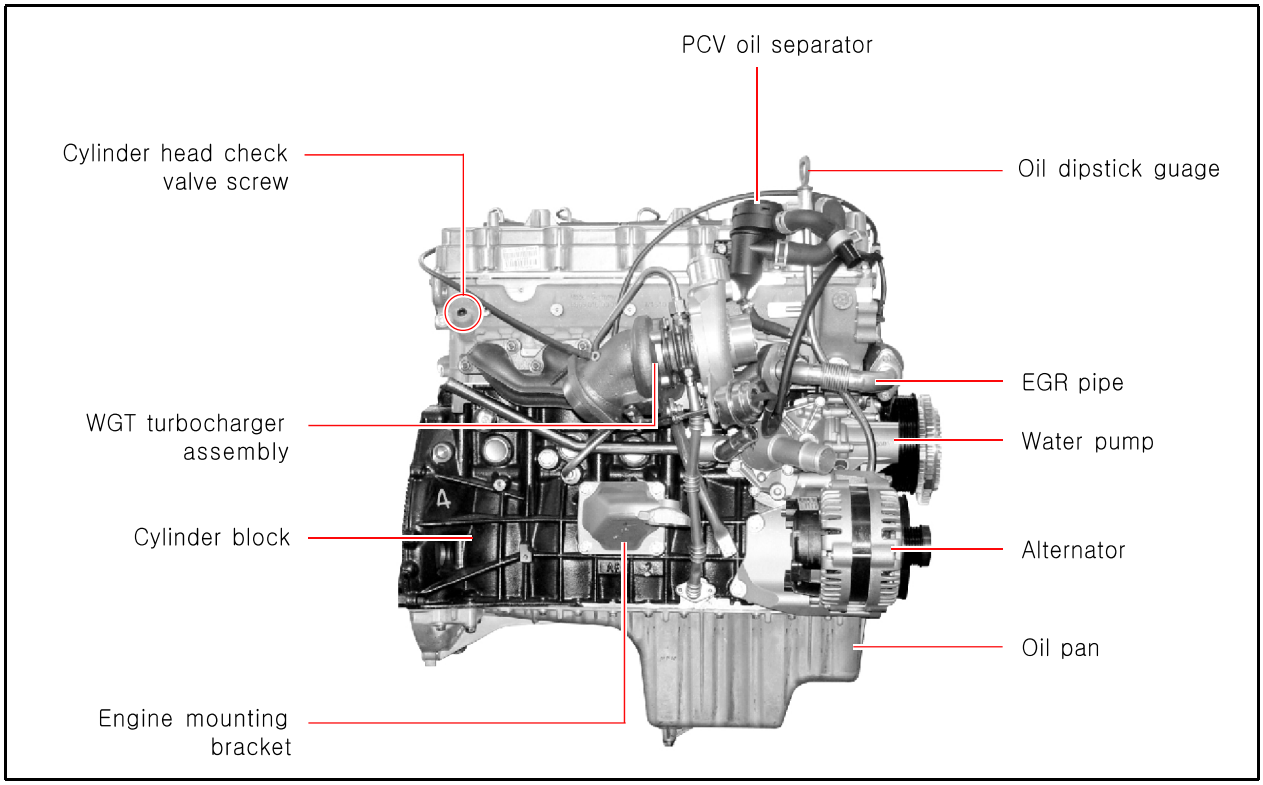
▶D27DT Engine (General) - Top View



▶D27DT Engine (General) - Side View



▶D27DT Engine (General) - Left Side View



Modification basis	
Application basis	
Affected VIN	

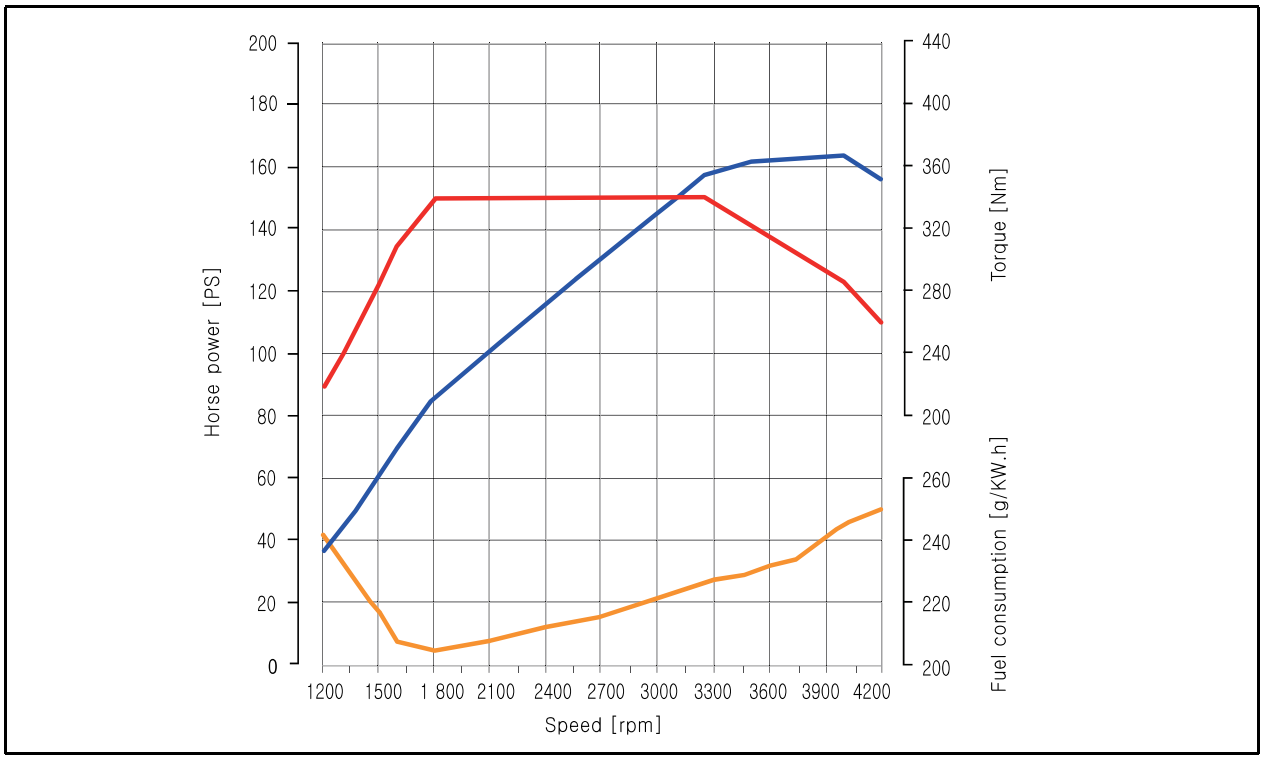
2. ENGINE SPECIFICATIONS AND PERFORMANCE CURVE

1) Specifications

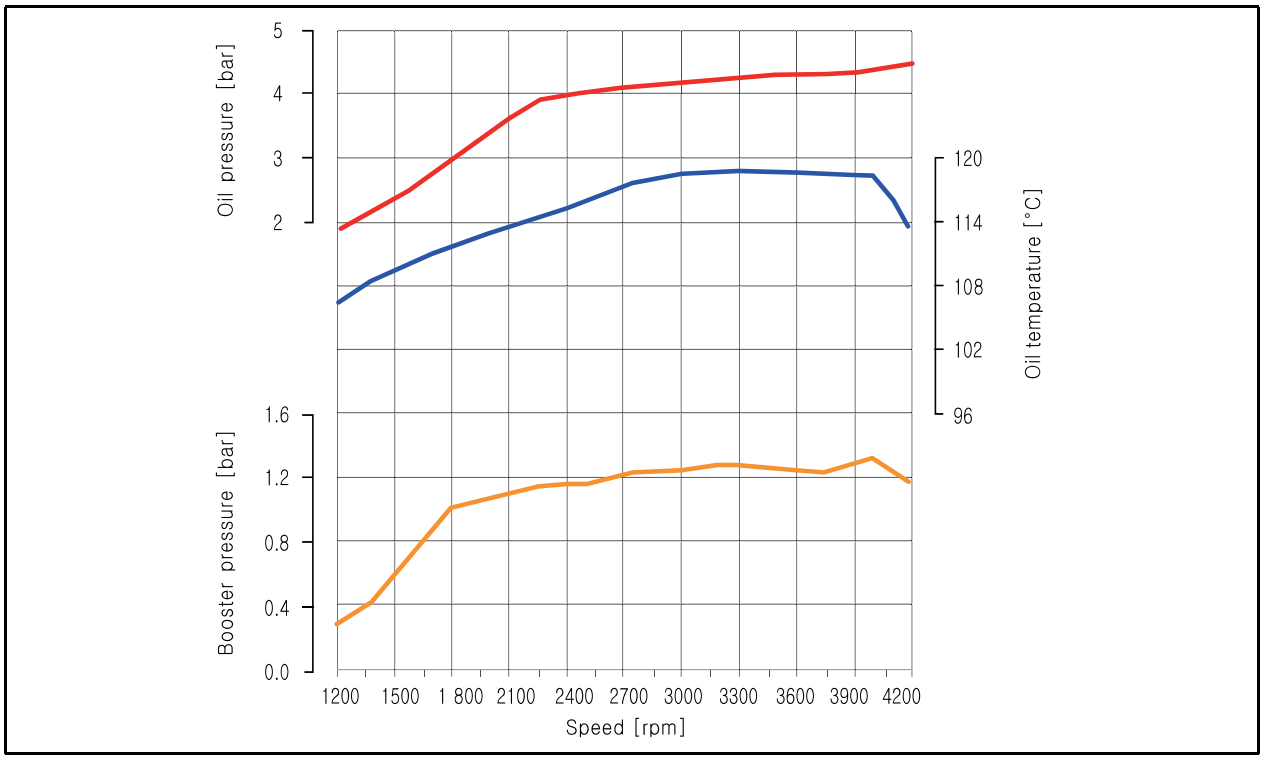
Descriptions			D27DTP (POWER UP) + CDPF Engine * ( ) : CDPF	D27DT (EU IV) Engine	D27DT Engine
Engine	Type/Number of cylinders		D27DT/5-cylinder	←	←
Cylinder	Inner diameter (mm)		86.2	←	←
	Stroke (mm)		92.4	←	←
Displacement (cc)			2696	←	←
Compression ratio			17.5:1	←	←
Maximum output (ps/rpm)		For Automatic	186 (180) / 4,000	165 / 4,000	←
		Transmission	-	165 / 4,000	←
Maximum torque (kg ·m/rpm)		For Manual	41 / 1,600 ~ 3,000	35.7 / 1,800 ~ 3,250	←
		Transmission	-	34.7 / 1,800 ~ 3,250	←
Idle speed	For Manual Transmission		-	750 ± 20 rpm	760 ± 50 rpm
	For Automatic Transmission		750 ± 20 rpm	←	←
Valve	Intake	Opens (btdc)	9°	←	←
		Closes (abdc)	26°	←	←
	Exhaust	Opens (bbdc)	38°	←	←
		Closes (atdc)	16°	←	←
Camshaft	Type		DOHC	←	←
Fuel system	Fuel type		Low sulfur diesel	←	←
	Fuel pump type		Vane pump in HP pump	←	←
	Fuel supply pressure	HP pump Inlet port	-0.4 ~ 0 mbar	Max. 400 mbar	←
		HP pump outlet port (with IMV fully open)	Below 1,600 bar	Above 1,050 bar	←
	Water separation in fuel filter		Every 10,000 km	←	←
	Fuel tank capacity (ℓ)		78	←	←
Lubrication system	Oil specification		SAE 10W40, 5W40 (MB Sheet 229.1, 229.3 approved oil)	←	←
	Lubrication type		Gear pump Forced circulation	←	←
	Oil filter type		Full flow type, filter element type	←	←
	Oil capacity (ℓ)		≒ 8.5	←	←
Cooling system	Cooling type		Water cooling type/ Forced circulation	←	←
	Cooling fan operation type		Belt operated type	←	←
	Thermostat (* Note: Fully opened at 100°C)	Opening temperature	85 °C	←	←
		Type	WAX Pellet Type	←	←
	Coolant capacity (ℓ)		≒ 11.0 ~ 11.5	←	←

2) D27DT Engine Performance Curve

(1) Output and Torque



(2) Oil Temperature/Pressure and Boost Pressure



Modification basis	
Application basis	
Affected VIN	

3. TIGHTENING TORQUE

This table shows the tightening torques for removal/mounting and disassembly/reassemly of the engine.

Name	Size	Quantity	Tightening Torque (Nm)		
			D20DT	D27DT	D27DTP
Main bearing cap	M11 x 67	10	55 ± 5 120° ± 10°	←	←
Connecting rod cap	M9 x 51	8	40 ± 5 90° ± 10°	←	←
Rear cover	M6 x 20	6	10 ± 1	←	←
Oil pump	M8 x 35SOC	3	25 ± 2.5	←	←
T.G.C.C	M6 x 40	6	10 ± 1	←	←
	M6 x 60	3	10 ± 1	←	←
	M6 x 70	2	10 ± 1	←	←
Flywheel	M10 x 22	8	45 ± 5 90° ± 10°	←	←
Crankshaft hub	M20 x 85	1	200 180° ± 10°	←	←
Oil pan	M6 x 20	24	10 ± 1	←	←
	M6 x 35	3	10 ± 1	←	←
	M6 x 85	3	10 ± 1	←	←
	M8 x 40	4	25 ± 2.5	←	←
High pressure pump mounting bolt	M8 x 55	3	25 ± 2.5	←	←
High pressure pump main nut (Intermediate shaft)	M14 x 1.5	1	65 ± 5	←	←
Cylinder head	M8 x 25	2	25 ± 2.5	←	←
	M8 x 50	2			
	M10 x 158	1	85 ± 5 270° ± 10°	←	←
	M10 x 177	9			
Camshaft sprocket (Intake)	M11 x 40	1	25 ± 2.5 90° ± 10°	←	←
Camshaft sprocket (Exhaust)					
Chain tensioner	M24	1	65 ± 5	←	←
Auto tensioner	M12 x 90(UP)	1	82 ± 6	←	←
	M8 x 45(LOW)	1	32 ± 3	←	←
Water pump	M6 x 50	7	10 ± 1	←	←
Water pump pulley	M6 x 10	4	10 ± 1	←	←
Hot water inner pipe	M6 x 12	2	10 ± 1	←	←
Alternator brackrt	M8 x 80	1	25 ± 2.5	←	←
	M8 x 34	2	25 ± 2.5	←	←
	M8 x 30	2	25 ± 2.5	←	←
Alternator	M10 x 90	1	46 ± 4.6	←	←
	M10 x 116	1	46 ± 4.6	←	←

Name	Size	Quantity	Tightening Torque (Nm)		
			D20DT	D27DT	D27DTP
Air conditioner compressor bracket	M8 x 25	1	25 ± 2.5	←	←
	M8 x 60	3	25 ± 2.5	←	←
Air conditioner compressor sub bracket	M6 x 16	1	10 ± 1.0	←	←
	M8 x 20	1	25 ± 2.5	←	←
Intake manifold	M8 x 50	5	25 ± 2.5	←	←
	M8 x 133	5	25 ± 2.5	←	←
Acoustic cover bracket	M6 x 16	2	25 ± 2.5	←	←
	M8 x 105	1	25 ± 2.5	←	←
Knock sensor	M8 x 28	1	20 ± 2.6	←	←
Camshaft position sensor	M8 x 14	1	12 ± 1.7	←	←
Booster pressure sensor	M6 x 20	2	10 ± 1.0	←	←
Exhauster manifold stud bolt	M8 x 46	10	15 ± 1.5	←	←
	M8 x 35	2	15 ± 1.5	←	←
Exhaust manifold nut	M8	10	40 ± 4.0	←	←
Turbo charger assembly	M8	3	25 ± 2.5	←	←
Turbo charger hollow bolt	M10 x 1.0	1	18 ± 1.8	←	15 ± 1.0
Turbo charger oil supply pipe	M16 (BLOCK side)	1	25 ± 2.5	←	←
Turbo charger support bar (nut)	M8	1	23 ± 2.3	←	←
Turbo charger support bar (bolt)	M8 x 20	1	25 ± 2.5	←	←
Turbo charger return pipe	M6 x 16 (T/C side)	2	10 ± 1.0	←	←
	M6 x 16 (BLOCK side)	2	10 ± 1.0	←	←
EGR Valve	M6 x 16	4	10 ± 1.0	←	-
EGR pipe (RH) nut	M8	2	35 ± 3.5	←	-
EGR pipe (RH) bolt	M6 x 16	2	10 ± 1.0	←	-
EGR cooler bolt	M8 x 16	4	25 ± 1.0	←	-
EGR valve & EGR cooler	M6 x 20	3	25 ± 2.5	←	-
	M6 x 20	2	25 ± 2.5	←	-
Glow plug	M5	5	15 ± 3.0	←	←
Vacuum pump	M6 x 20	3	10 ± 1.0	←	←
Cooling pan bracket	M6 x 25	5	10 ± 1.0	←	←
	M6 x 55	1	10 ± 1.0	←	←
	M6 x 85	3	10 ± 1.0	←	←
Cylinder head cover	M6 x 35	21	10 ± 1.0	←	←
Vacuum modulator	M6 x 16	4	10 ± 1.0	←	←
Oil dipstick gage	M6 x 16	1	10 ± 1.0	←	←
Oil filter	M8 x 35	1	25 ± 2.5	←	←
	M8 x 55	2	25 ± 2.5	←	←
	M8 x 125	1	25 ± 2.5	←	←

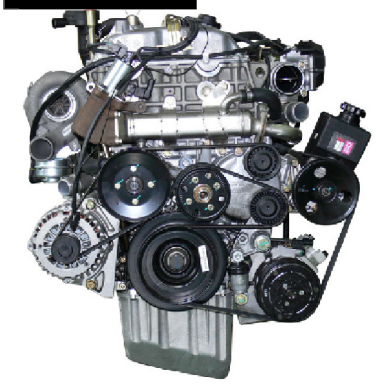
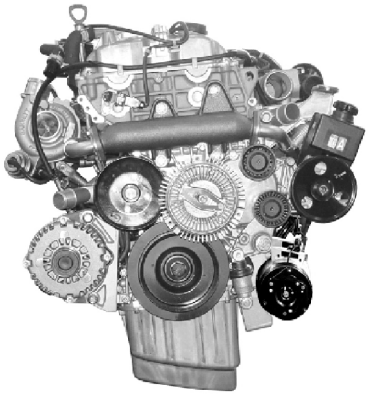
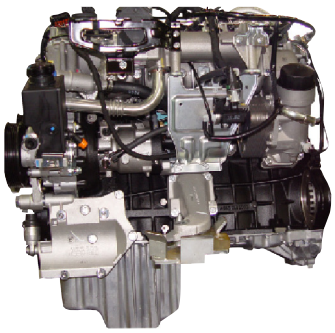
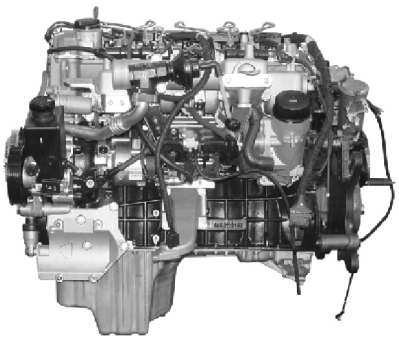
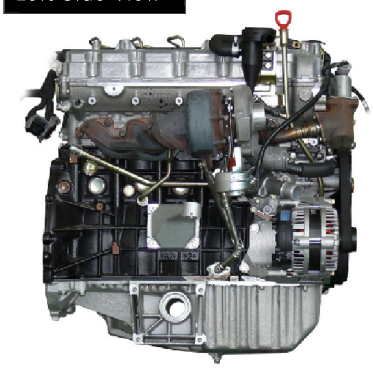
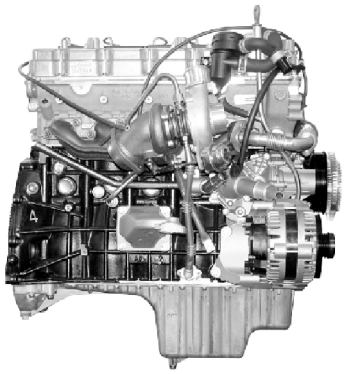
Modification basis	
Application basis	
Affected VIN	

Name	Size	Quantity	Tightening Torque (Nm)		
			D20DT	D27DT	D27DTP
Fuel rail	M8 x 35	2	25 ± 2.5	←	←
Injector	M6 x 60	4	10 ± 1.0 180° ± 20°	←	←
Fuel pipe nut (H -> C)	M14	2	40 ± 4.0	←	←
Fuel pipe nut (C -> I)	M14	8	40 ± 4.0	←	←
Crank position sensor	M6 x 14	1	0.8 ± 0.4	←	←
	Gap	-	0.7 ± 1.5 mm	←	←
Power steering pump	M8 x 100	2	25 ± 2.5	←	←
Head screw plug	-	1	25 ± 2.5	←	←
Camshaft cap bolt	M8 x 60	20	25 ± 2.5	←	←
Piston topping	-	-	0.765 mm ~ 1.055 mm		
Connecting rod end play	-	-	0.500 mm ~ 1.500 mm		
Camshaft end play	-	-	0.100 mm ~ 0.350 mm		
Crank shaft end play	-	-	0.100 mm ~ 0.254 mm		
E-EGR valve assembly	M8 x 60	1	-	25 ± 2.5 (EU IV)	←
	M8 x 35	1	-	25 ± 2.5 (EU IV)	←
	M6 x 20	3	-	10 ± 1.0 (EU IV)	←
E-EGR cooler	M8 x 16	4	-	25 ± 2.5 (EU IV)	←
EGR pipe combination bolt	M6 x 16	6	-	10 ± 1.0 (EU IV)	←
Throttle body	M6 x 45	3	-	10 ± 1.0 (EU IV)	←

4. MAJOR CHANGES IN D27DTP (POWER UP) ENGINE (COMPARED TO D27DT)

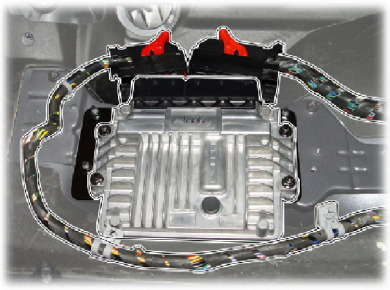
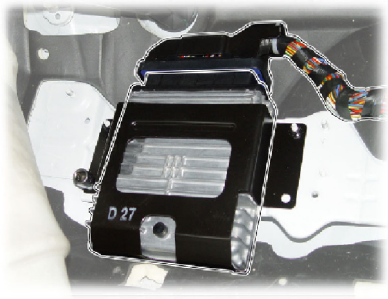
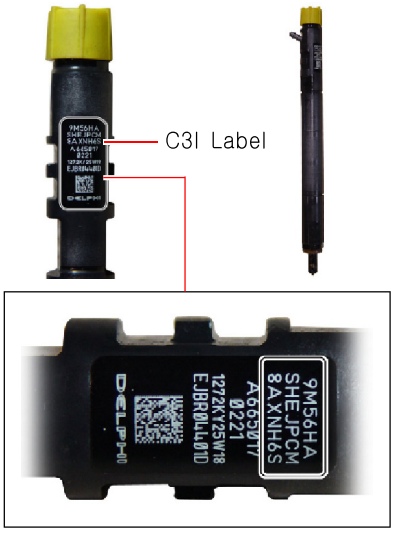
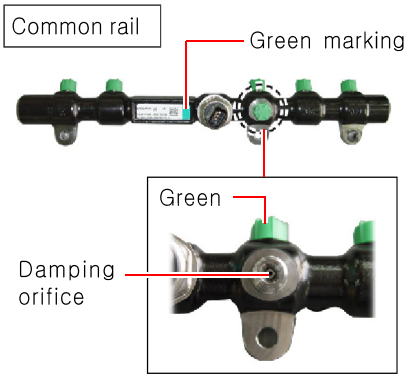
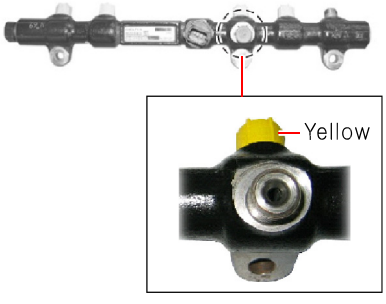
The shape and size of D27DTP (POWER UP) are slightly different from those of D27DT engine but the basic configuration of two systems is almost same.

1) Engine Assembly

D27DTP (POWER UP) + CDPF Engine	D27DT (EU IV) Engine	D27DT Engine (General)
Front Side View 		
Right Side View		
Left Side View 		

Modification basis	
Application basis	
Affected VIN	

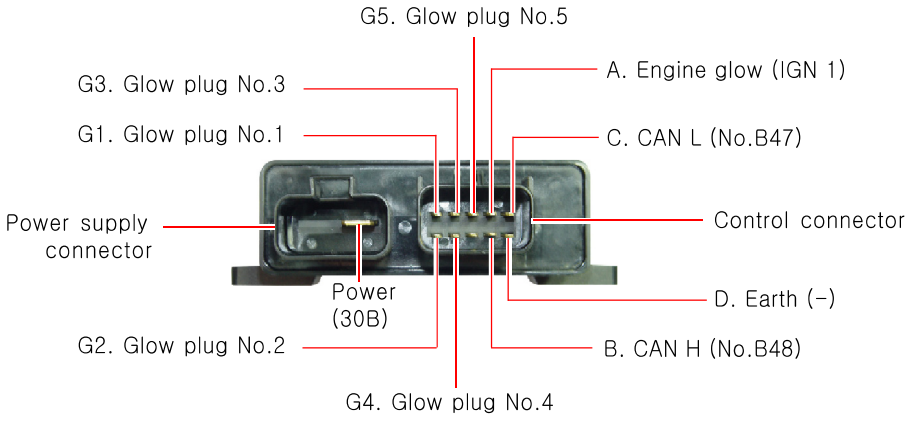
2) Major Changes and Summary

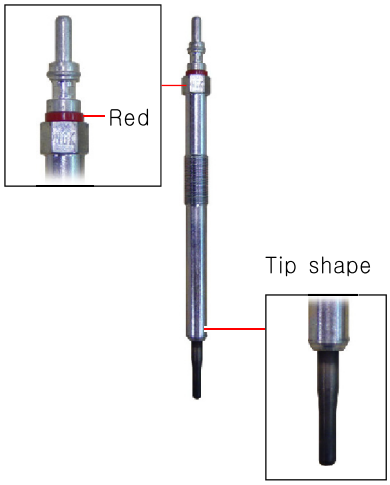
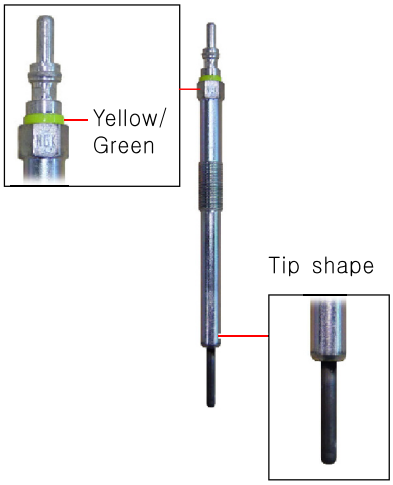
D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
ECU D27DTP Engine ECU - Ver. 3.2 	D27DT Engine ECU - Ver. 3.1 	ECU version of D27DTP (POWER UP) & D27DT (EU IV) engine: Changed to 3.2 from 3.1. Number of connectors of D27DTP (POWER UP) & D27DT (EU IV) engine: Changed to 2 from 1. 1.E-EGR valve and related system 2.Throttle body and related system 3.AQGS and related system
Injector 		* Injection nozzle (holes) - D27DT (General) (5) - D27DTP & D27DT (EU IV) (7) * Injector label - D27DT (General) (16 digits: C2I value) - D27DTP & D27DT (EU IV) (20 digits: C3I value)
Common rail 		* D27DTP: Added damping orifice. (Orifice is added to fuel inlet/ outlet ports in order to dampen the pulsation in fuel flow caused by multi-injections.)

Modification basis	
Application basis	
Affected VIN	

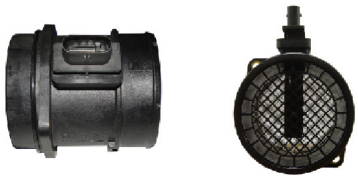
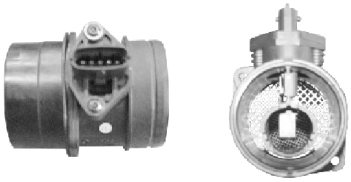
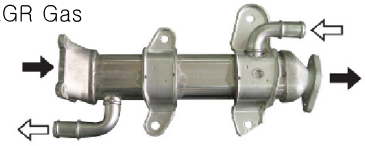
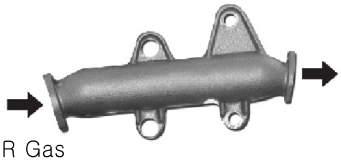
D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
Fuel pipe 		* Surface coating color – D27DT: Yellow – D27DTP & D27DT (EU IV): Chrome * Diameter increased – D27DT: ID (2.4 mm), OD (6.0 mm) – D27DTP & D27DT (EU IV): ID (3 mm), OD (6.35 mm)

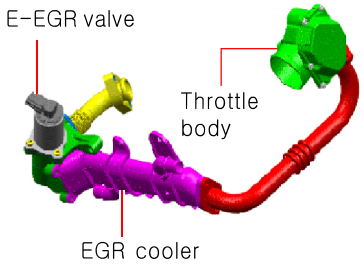
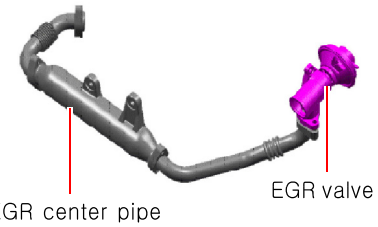
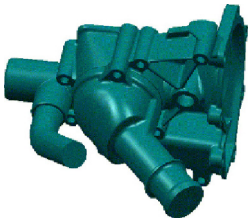
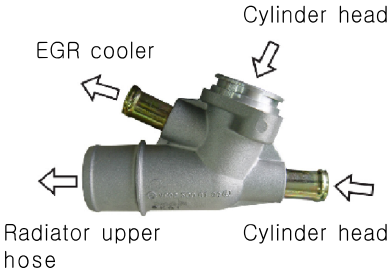
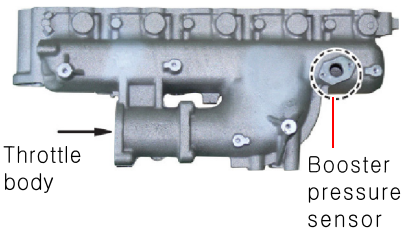
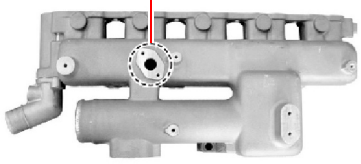
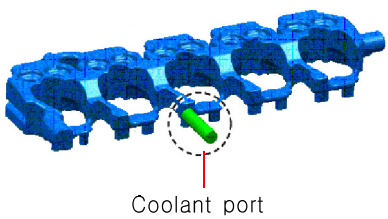
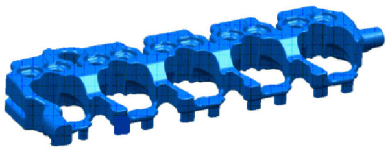
AQGS unit pin function



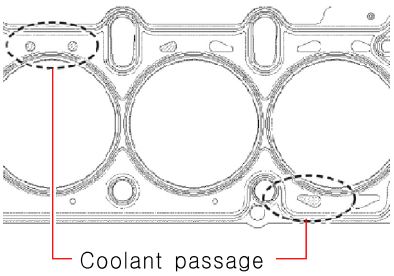
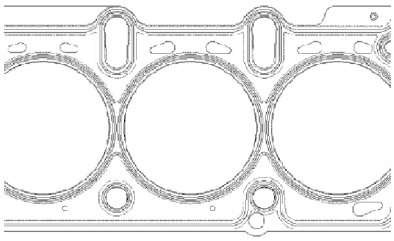
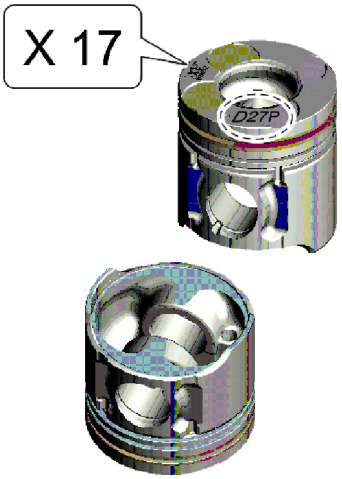
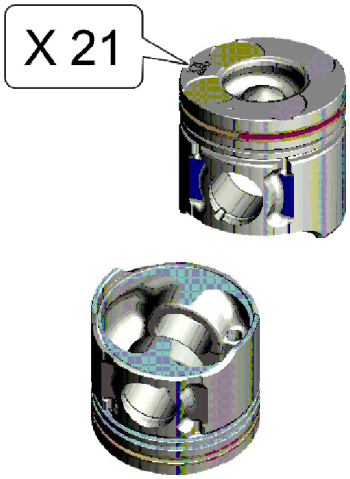
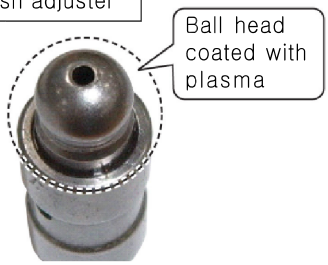
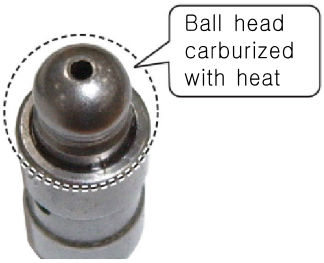
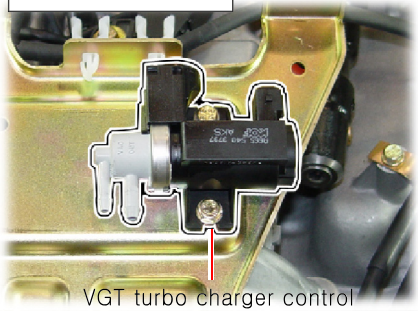
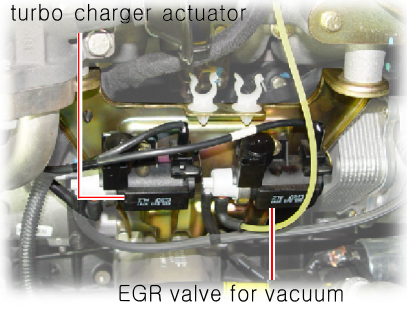
Glow plug 		* Insulator color – D27DT: Yellow (NGK) or green (BERU) – D27DTP & D27DT (EU IV): Red * Tip diameter and shape changed – D27DT: ϕ 3.5 / 4.0 mm – D27DTP & D27DT (EU IV): ϕ 4.4 mm

Modification basis	
Application basis	
Affected VIN	

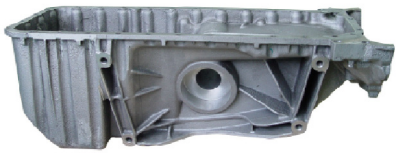
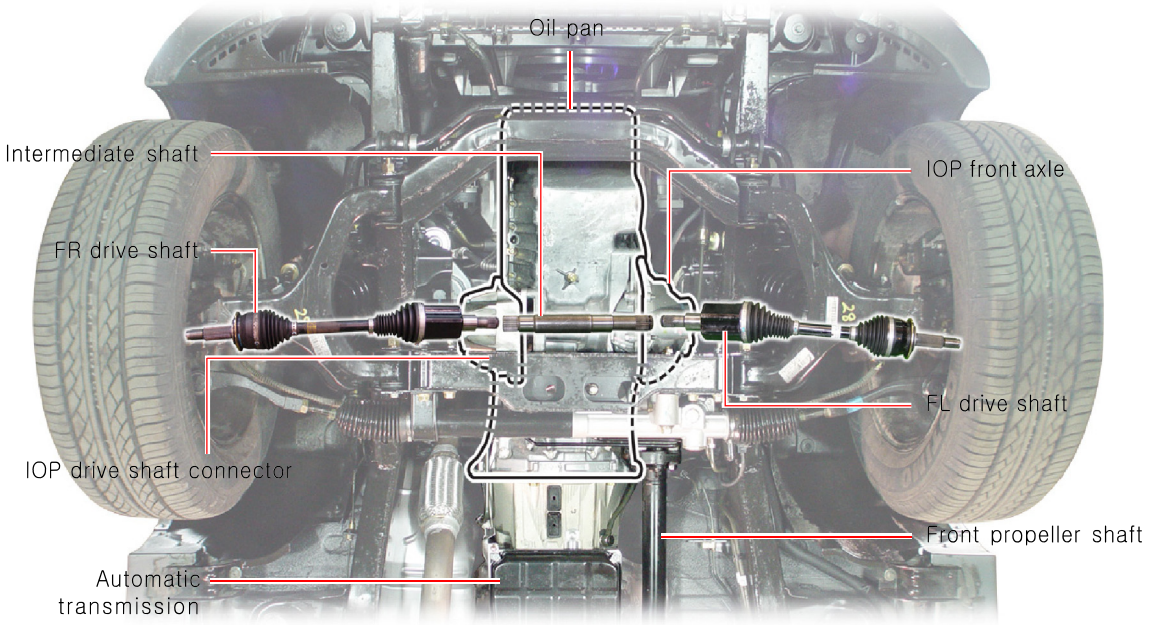
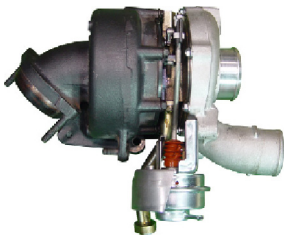
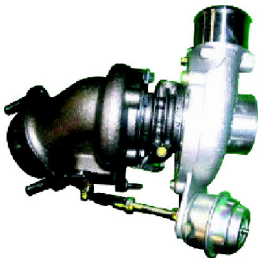
D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
HFM 6.0 	HFM 5.0 	* Version up - D27DT (General): HFM5-CI (Analog signal) - D27DTP & D27DT (EU IV): HFM6-ID (Digital signal added)
Electric controlled E-EGR valve 	Vacuum modulator controlled EGR valve 	* E-EGR valve: ECU controls the EGR valve directly without any media. It provide more precise EGR control by transmitting the electric signal of EGR valve operating position.
Throttle body 	N/A	* Throttle body is for future regulation requiring emission reductions. Currently, it is used to prevent the engine from turning off with fluttering noise at the moment the air to intake manifold is blocked by closed flap when the engine is switched off.
EGR cooler EGR Gas  Coolant	EGR center pipe  EGR Gas	* To enhance EGR function, coolant EGR cooler is adopted to reduce the temperature of exhaust gas into the intake manifold.

D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
E-EGR system layout  	EGR system layout  	* Reason of changes – To satisfy the emission regulation, E-EGR valve and EGR cooler are adopted. And the layout also has a great difference from D27DT.
Water pump 		* For D27DTP engine: Additional connecting port for EGR cooler hose
Coolant outlet port  		* For D27DTP (POWER UP) engine: Additional port for coolant of EGR cooler
Intake manifold  	Booster pressure sensor 	* The appearance of intake manifold is changed to the round type due to the throttle body. Also, the mounting location of booster pressure sensor is changed.
Cylinder head  		* The cooling port is added to improve cooling performance for D27DTP (POWER UP) & D27DT (EU IV) engine.

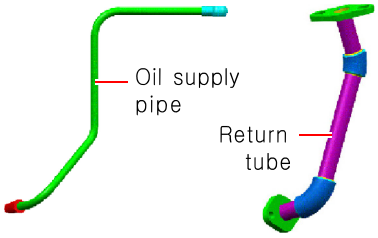
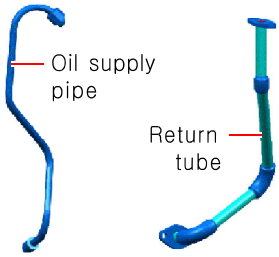
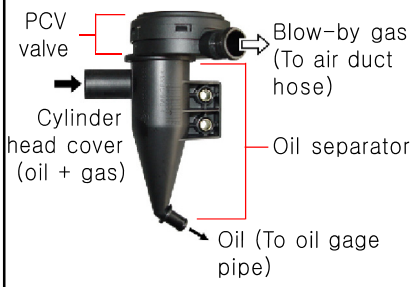
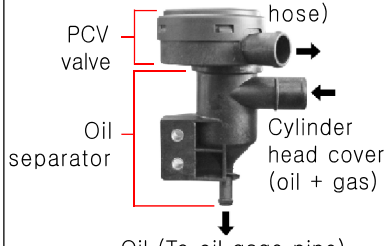
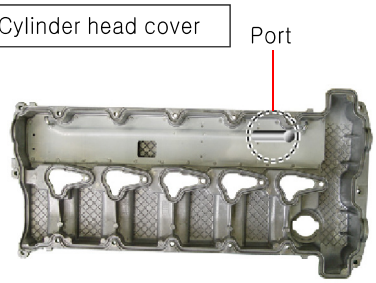
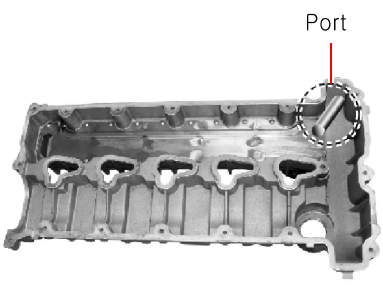
Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
Cylinder head gasket  		* The appearance of gasket is changed and the coolant passages are added to improve cooling performance for D27DTP (POWER UP) & D27DT (EU IV) engine.
Piston  	 	* Changed compression ratio - D27DT (General) (18:1) - D27DTP & D27DT (EU IV) (17.5:1) (The appearance of bowl is changed and the color mark is added due to the new compression ratio.) * The appearance fo bowl is changed and the color mark is added due to the new com-pression ratio (18 → 17.5). * The piston pin bending side and the appearance of piston pin hole taper is changed for reinforcement.
Lash adjuster  	 	* The ball head is coated with plasma to prevent the lash adjuster from wearing.
Vacuum modulator  	Vacuum modulator for controlling turbo charger actuator  	* D27DTP (POWER UP) & D27DT (EU IV) engine uses electric ally controlled E-EGR valve. Thus, the vacuum modulator for controlling EGR valve has been deleted.

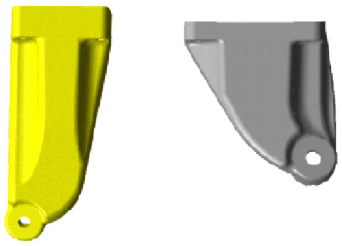
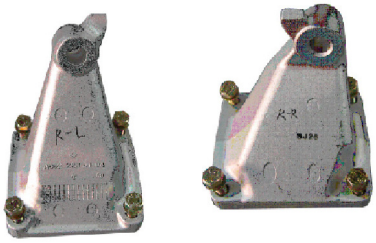
Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine	D27DT Engine (General) D27DT (EU IV) Engine	Remarks
IOP oil pan 	Oil pan	* The vehicle with D27DTP (POWER UP) engine is equipped with IOP axle. Refer to the figure below.
Glow system- AQGS unit	Glow system - Glow control relay	* D27DTP (POWER UP) engine adopts AQGS (Advanced Quick Glow System), which controls the quick preheating of glow plugs and CAN communication with engine ECU.
		
VGT turbocharger 	WGT turbocharger 	* D27DTP (POWER UP) engine is equipped with the enhanced VGT turbocharger.

Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine	D27DT Engine (General) D27DT (EU IV) Engine	Remarks
1.Support bar of Turbocharger		* Support bar is changed due to VGT turbocharger mounting.
2.Oil supply pipe and return tube of Turbocharger 		* The shape of oil supply pipe and return tube is changed due to VGT turbocharger mounting.
PCV oil separator 		* Increase of Oil separator capacity (approx. 10%) - D27DT & D27DT (EU IV): 120ℓ/min - D27DTP: 160ℓ/min
Cylinder head cover 		* The direction of blow-by outlet port is changed due to the introduction of larger oil separator.

Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine	D27DT Engine (General) D27DT (EU IV) Engine	Remarks
Switchable engine mounting 	Engine mounting 	* The switchable engine mounting system (SEM) controls the engine in soft mode or hard mode by dividing the speed to the low speed range and mid-high speed range according to the vehicle speed and the engine rpm. This is only available in D27DTP (POWER UP) engine.
Engine bracket LH RH 	LH RH 	* The bracket is changed due to the mounting location of D27DTP (POWER UP) engine and the switchable engine mounting.

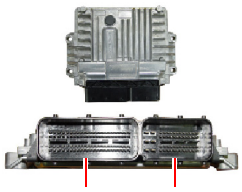
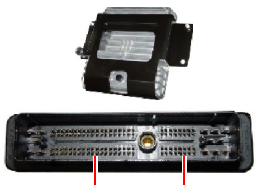
Modification basis	
Application basis	
Affected VIN	

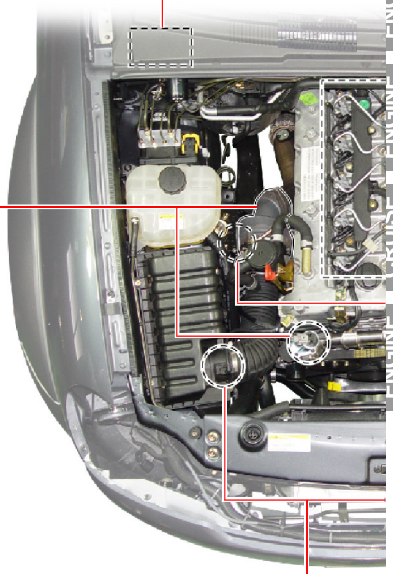
OVERVIEW AND OPERATION PROCESS

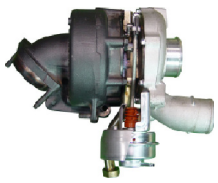
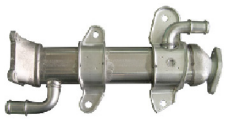
1. ENGINE COMPARTMENT

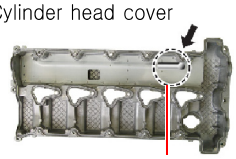
The major changes due to the newly adopted engine compared to D27DT engine are as follows:

Intake System	
D27DTP & D27DT (EU IV)	D27DT
HFM sensor (Ver. 6.0)	Throttle body

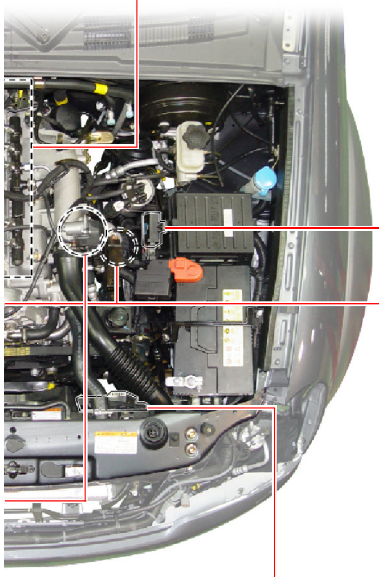
Engine Control (Engine ECU-3.2)	
D27DTP & D27DT (EU IV)	D27DT
 Connector A Connector B	 Connector A Connector B



Exhaust System		
VGT turbo charger	E-EGR valve	EGR cooler
		

Lubrication System		
D27DTP	Larger PCV oil separator	OP oil pan
Cylinder head cover  Modification in blow-by gas outlet port		* Axle integral type
D27DT (EU IV) & D27DT		

Modification basis	
Application basis	
Affected VIN	



Fuel System

D27DTP & D27DT (EU IV)

Injector

D27DTP & D27DT (EU IV)

Fuel pipe

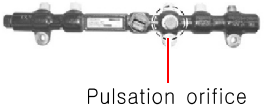
D27DTP & D27DT (EU IV)

Common rail

D27DT

D27DT

D27DT



Preheat System

AQGS unit

D27DTP & D27DT (EU IV)

Glow plug

D27DT

Switchable Engine M ounting (SEM)

D27DTP

LH

RH

D27DT (EU IV) & D27DT

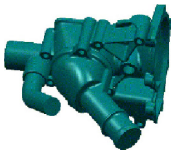
Cooling System

D27DTP & D27DT (EU IV)

Large water pump

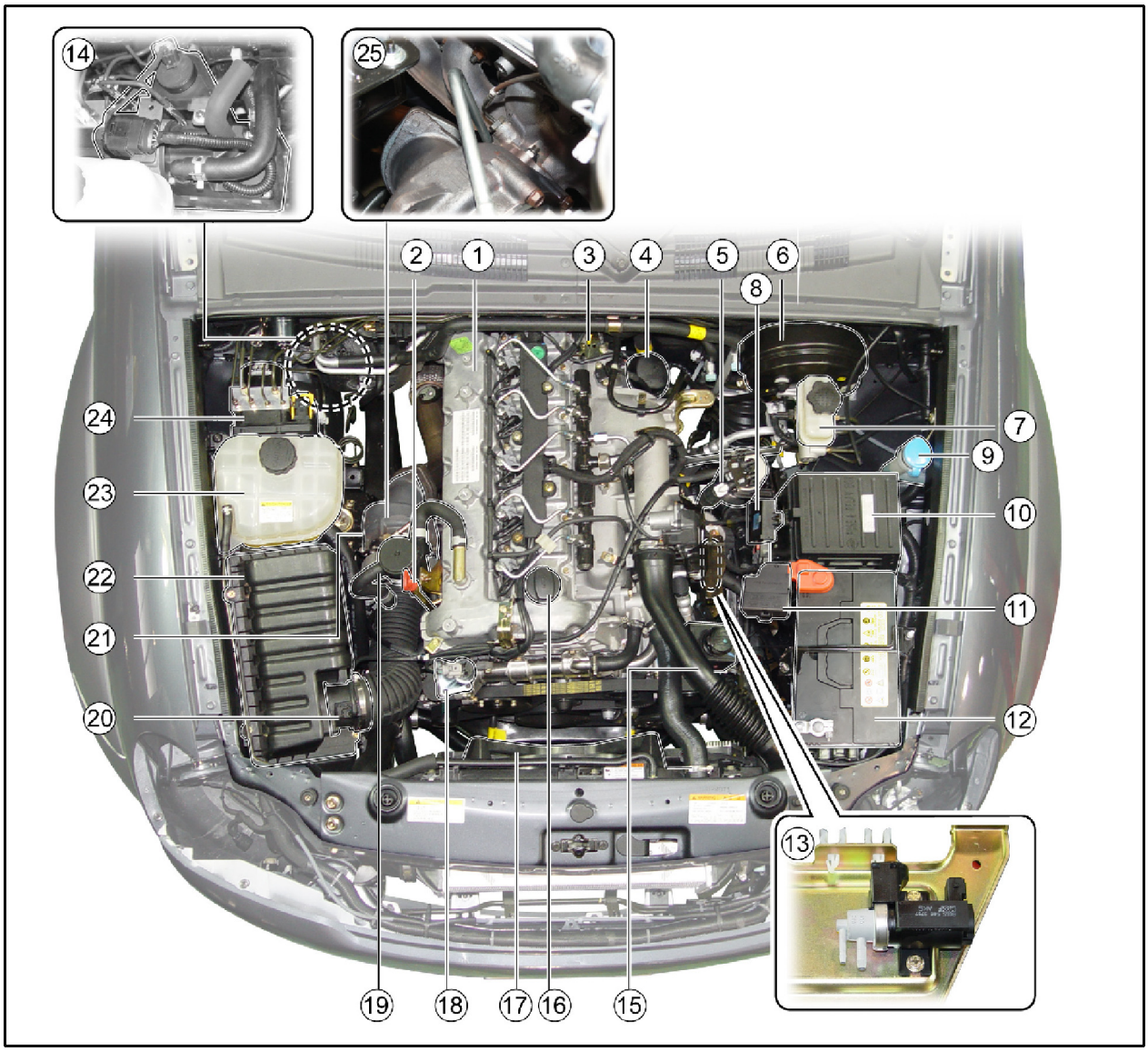
* EGR cooler port included

D27DT



Modification basis	
Application basis	
Affected VIN	

▶Engine Compartment Layout



1. Engine assembly
2. Engine oil dipstick
3. Vacuum pump
4. Oil filter and cooler
5. Fuel filter and priming pump
6. Brake booster
7. Brake oil tank
8. AQGS unit
9. Washer fluid filler cap
10. Engine compartment fuse box
11. PTC relay box
12. Battery
13. Vacuum modulator (for VGT turbo charger)
14. FFH Assembly (Only for vehicle with FFH)
15. Power steering oil tank
16. Engine oil filler cap
17. Fan shroud
18. E-EGR Valve
19. High-capacity PCV oil separator
20. HFM sensor (6.0)
21. VGT turbo charger
22. Air cleaner housing
23. 2Coolant surge tank
24. ABS/ESP HECU (Including TPMS function: optional)
25. Exhaust gas FRT Temp. sensor (T3)

Modification basis	
Application basis	
Affected VIN	

▶Major Sensors and Components

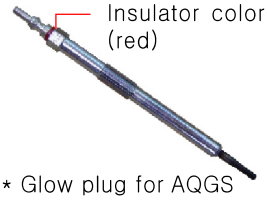
Injector

D27DTP & D27DT (EU IV)

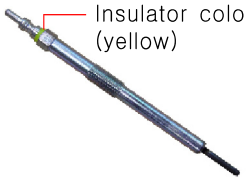
D27DT

Glow Plug

D27DTP & D27DT (EU IV)



D27DT

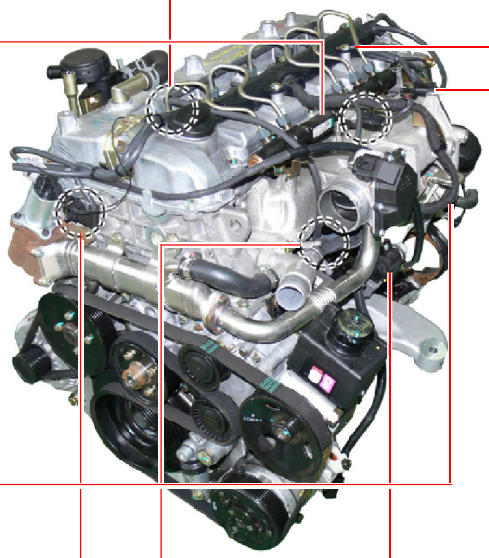


Common Rail

D27DTP & D27DT (EU IV)

* Orifice for preventing fuel pulsation

D27DT



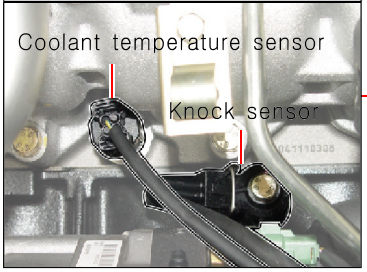
Fuel Pressure Sensor (Common Rail)

Booster Pressure Sensor

Crankshaft Position Sensor

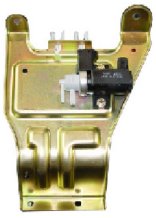
Camshaft Position Sensor

Knock Sensor (2EA) & Coolant Temperature Sensor



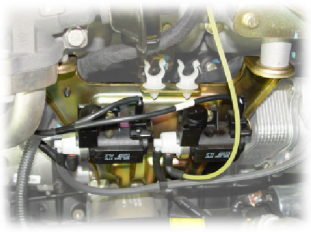
Vacuum Modulator for VGT Turbo Charger

D27DTP & D27DT (EU IV)



* Vacuum modulator for EGR valve deleted

D27DT

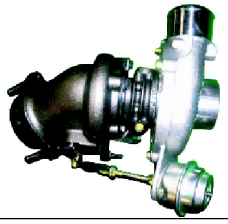


D27DTP

VGT Turbo Charger

D27DT (EU IV) & D27DT

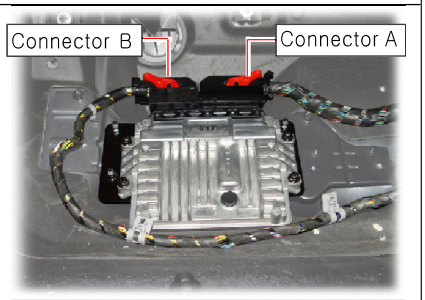
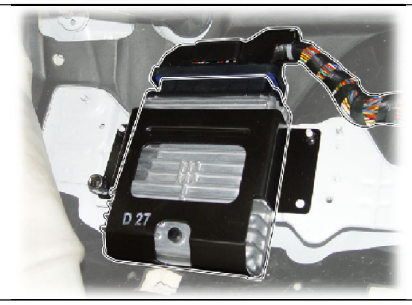
WGT Turbo Charger

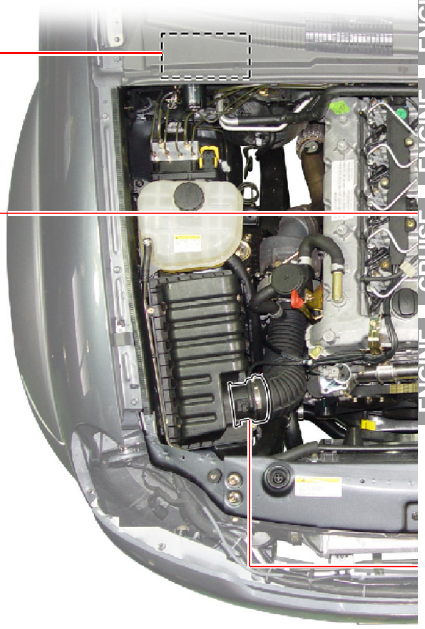


Modification basis	
Application basis	
Affected VIN	

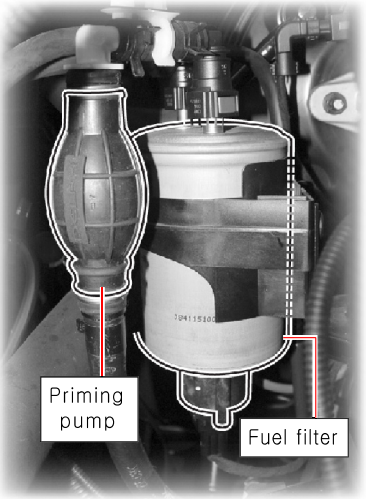
2. SYSTEMS IN ENGINE COMPARTMENT

1) Engine Accessories Related to ECU

Engine ECU – Ver. 3.2	Engine ECU Mounting Location
D27DTP & D27DT (EU IV)	
D27DT	

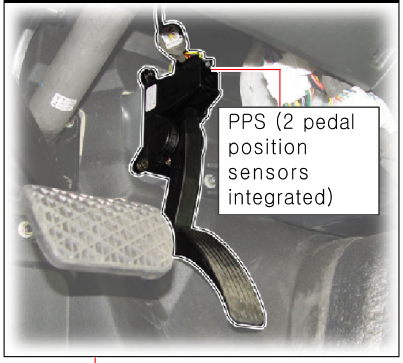


Fuel Filter (Water Detecting) Seneor

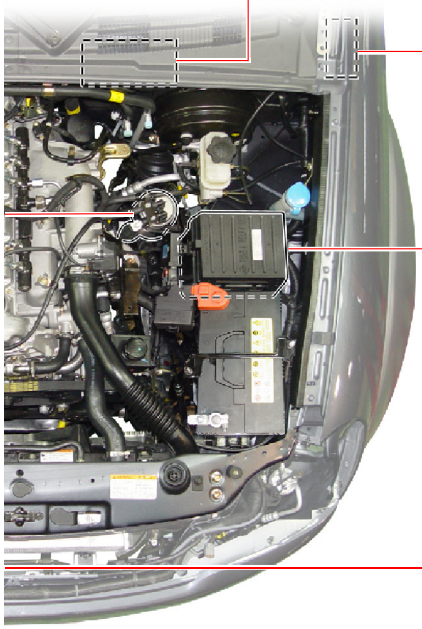


Draining water from fuel filter: every 10,000 km

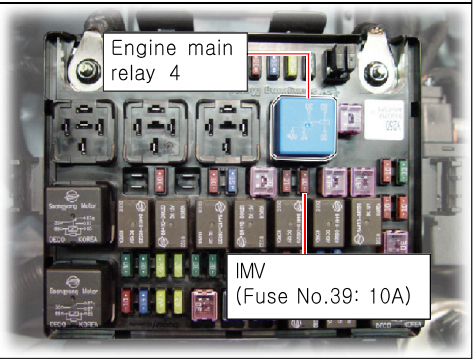
Accelerator Pedal Module



Interior Fuse Box (Driver's Side)



Engine Compartment Fuse Box



HFM Sensor (Ver. 6.0)

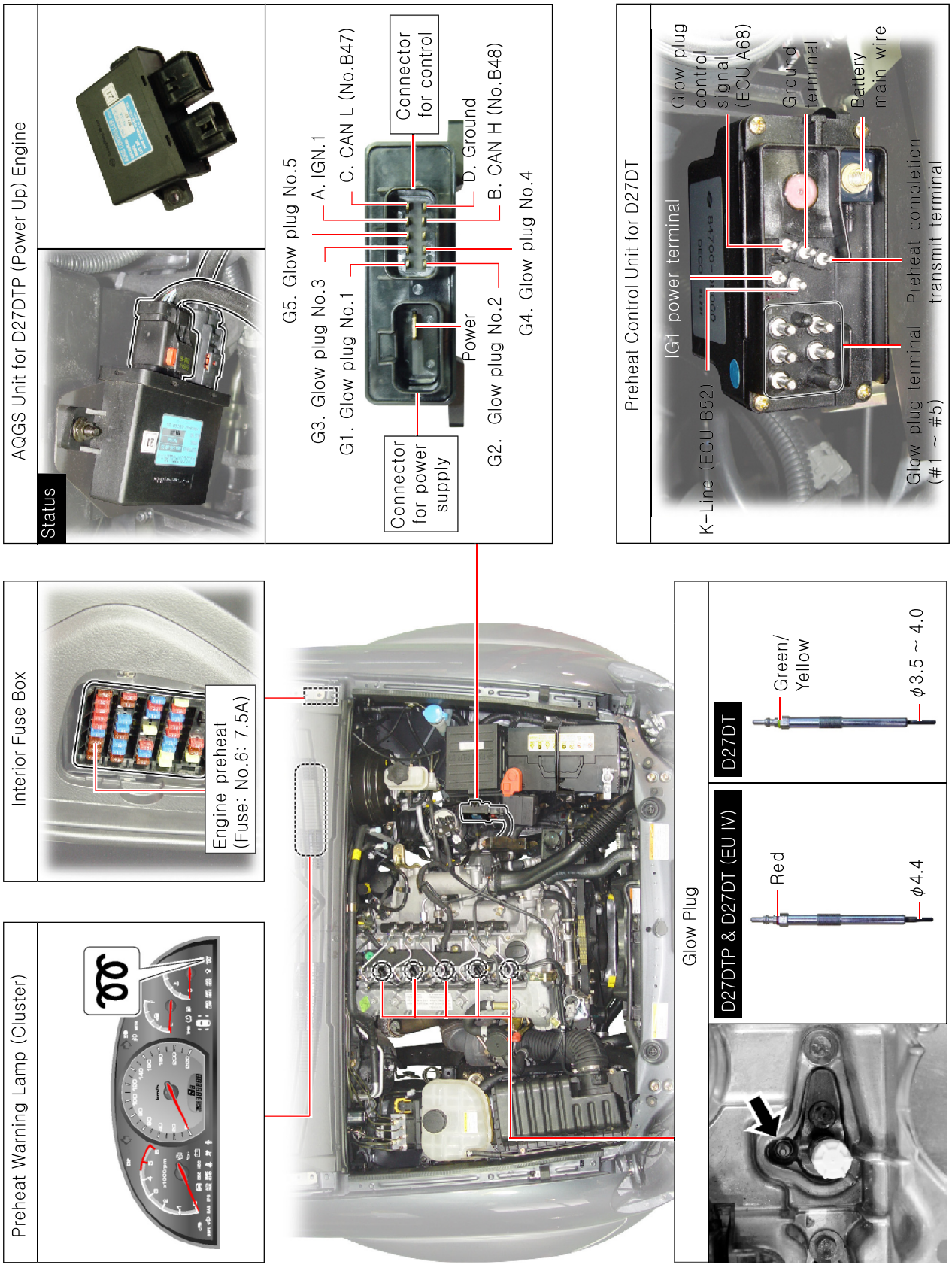
D27DTP & D27DT (EU IV)

Additional function: The digital signal about intake air volume is transfered to control the engine precisely.

D27DT

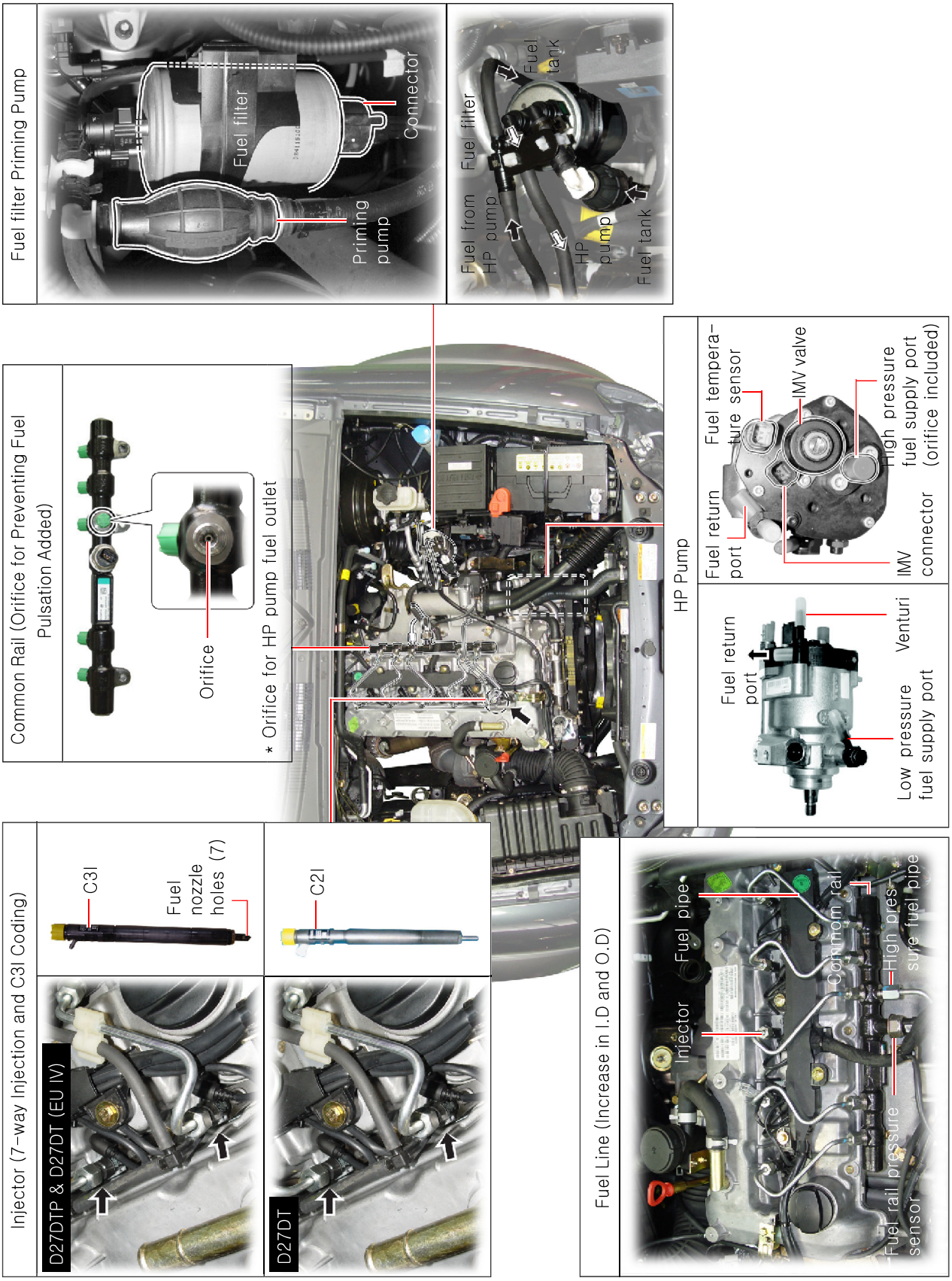
Modification basis	
Application basis	
Affected VIN	

2) Preheat System



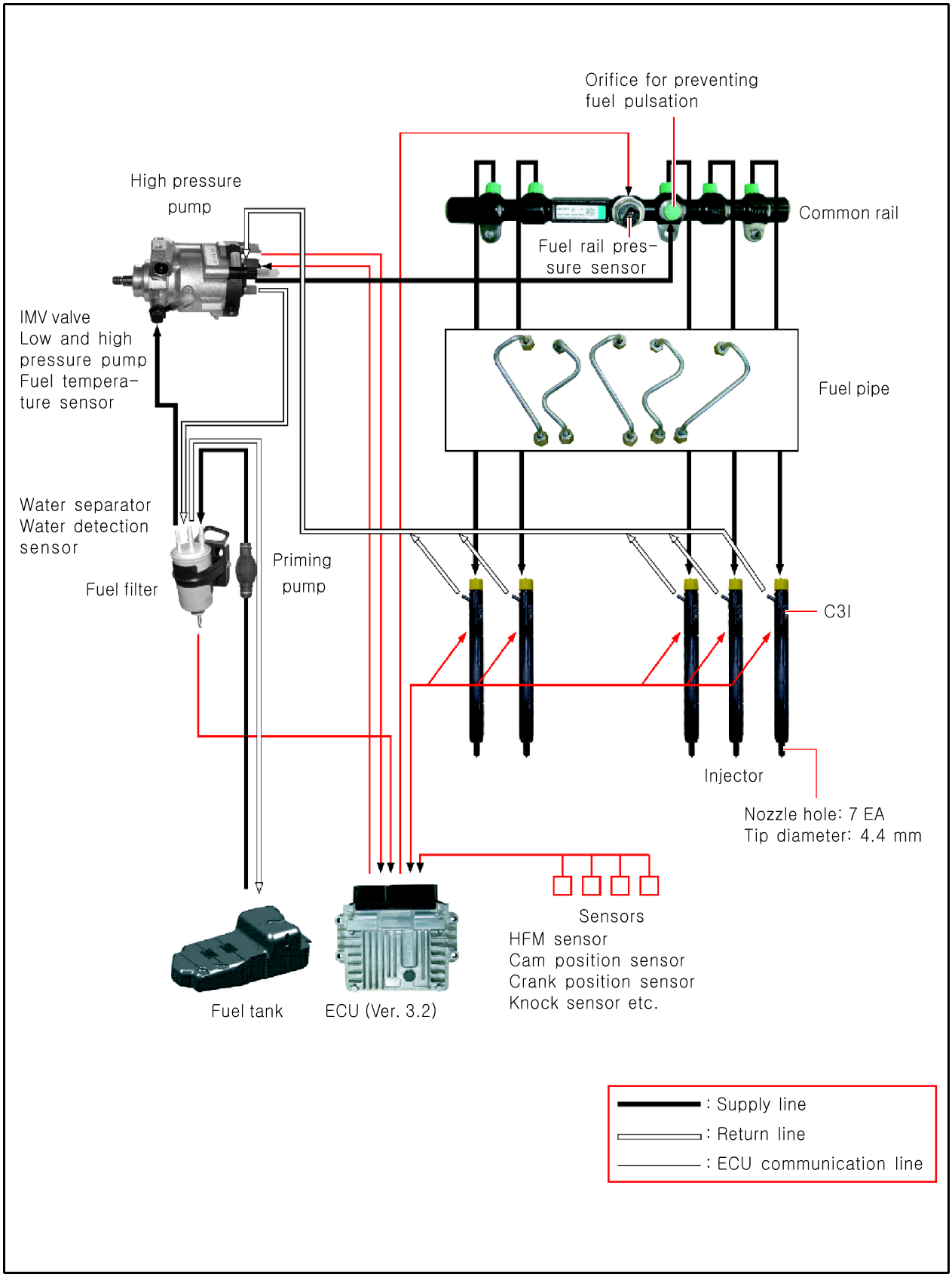
Modification basis	
Application basis	
Affected VIN	

3) Fuel System



Modification basis	
Application basis	
Affected VIN	

▶Fuel Supply System

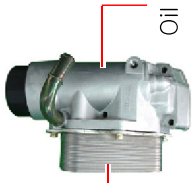


4) Lubrication System

Cylinder Head Cover

Blow-by gas port

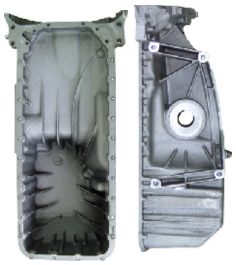
Oil Filter & Oil Cooler



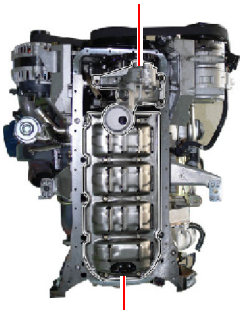
Oil Pan & Oil Strainer, Baffle Plate

D27DT & D27DT (EU IV)

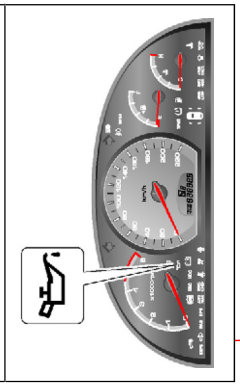
D27DTP



D27DTP



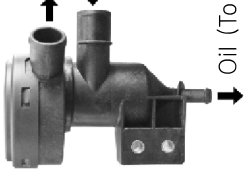
Oil Pressure Warning Light (Cluster)



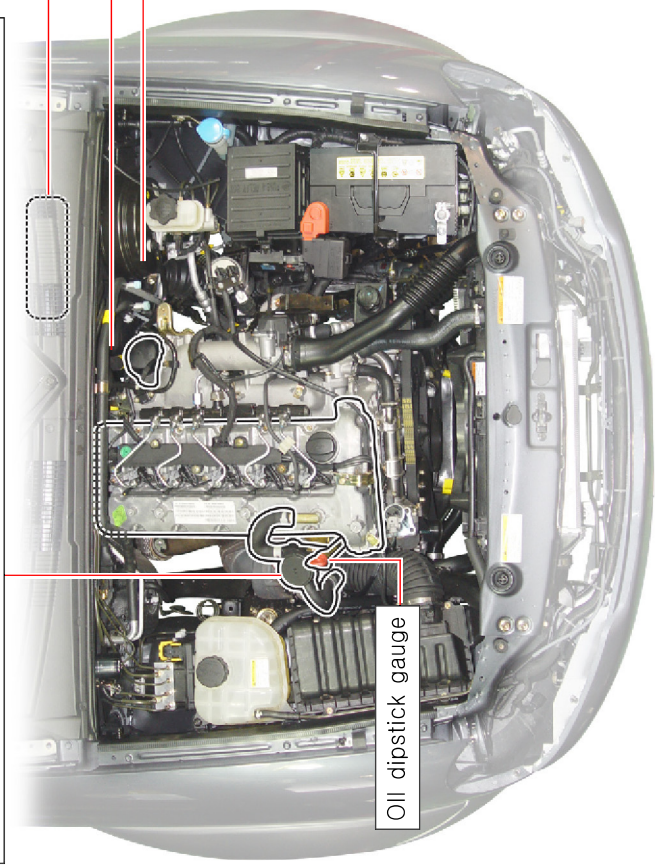
Large PCV Oil Separator

D27DTP

D27DT & D27DT (EU IV)

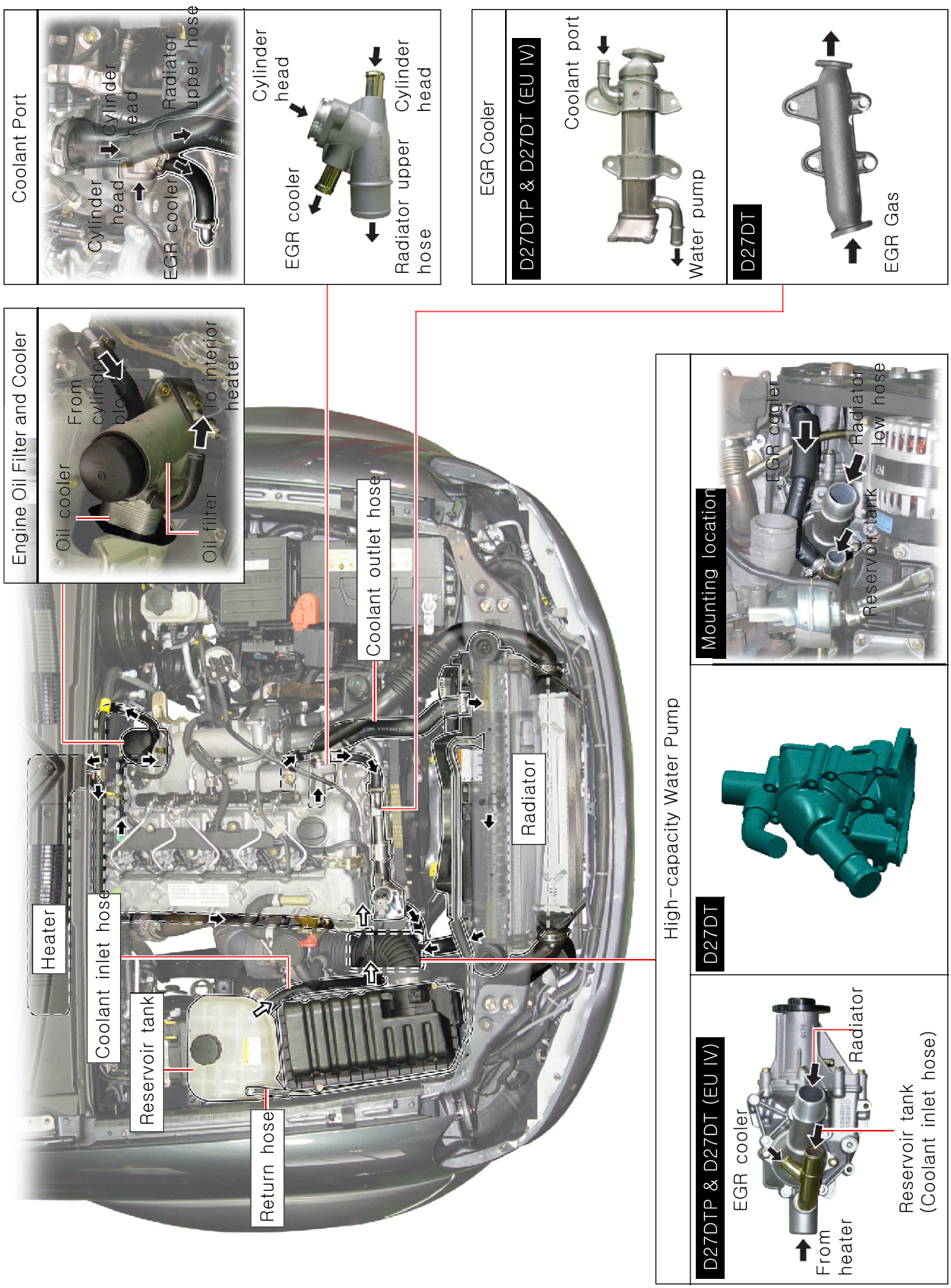


The first separation will happen when blow-by gas passes through baffle plates in cylinder head cover. Then oil and gas will be separated due to cyclone effect after entering the oil separator inlet port. Separated oil returns to oil pan via oil drain port and the gas will be burnt again after entering the combustion chamber through air duct hose via PCV valve that opens/closes due to pressure differences between the intake side and crankcase.



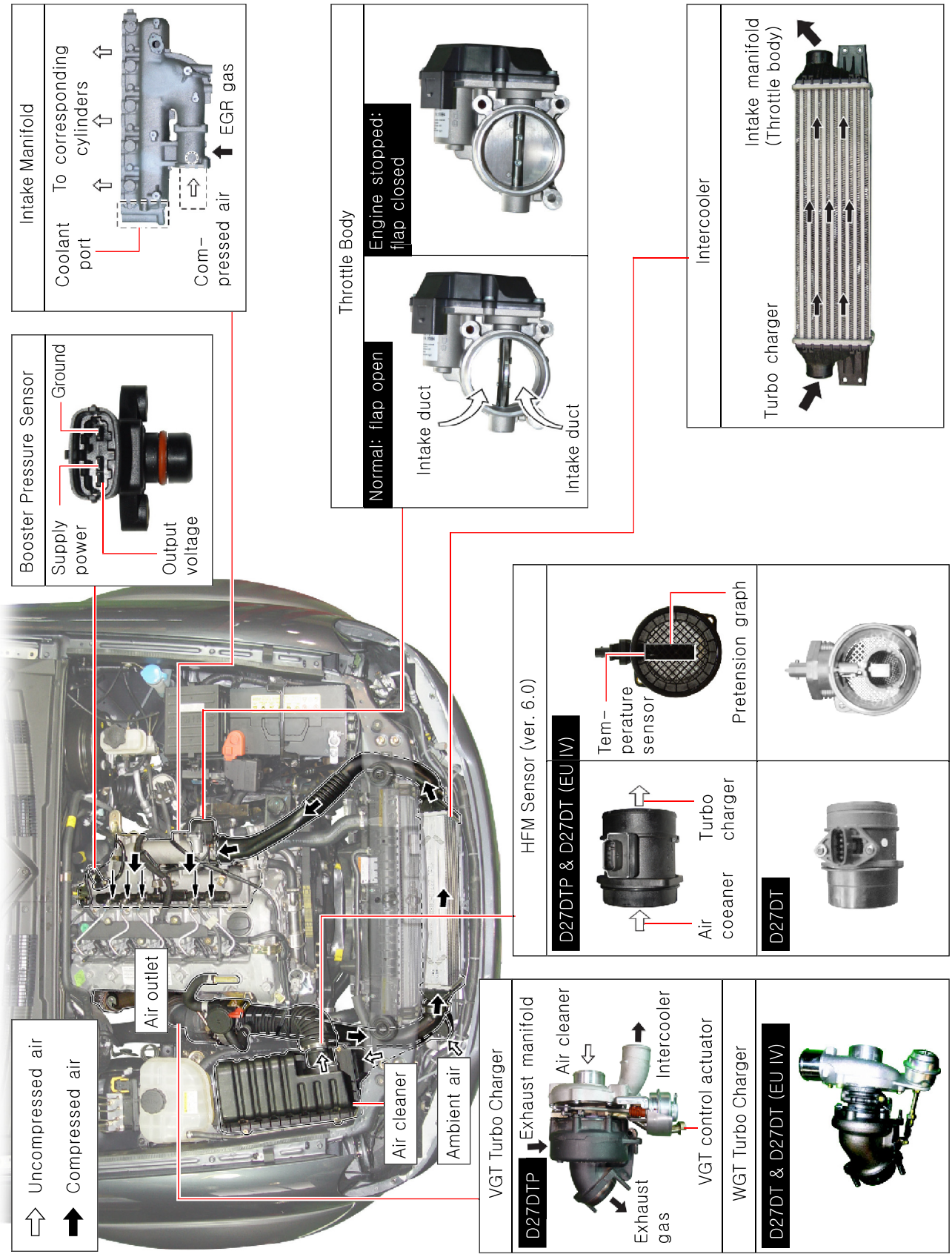
Modification basis	
Application basis	
Affected VIN	

5) Cooling System



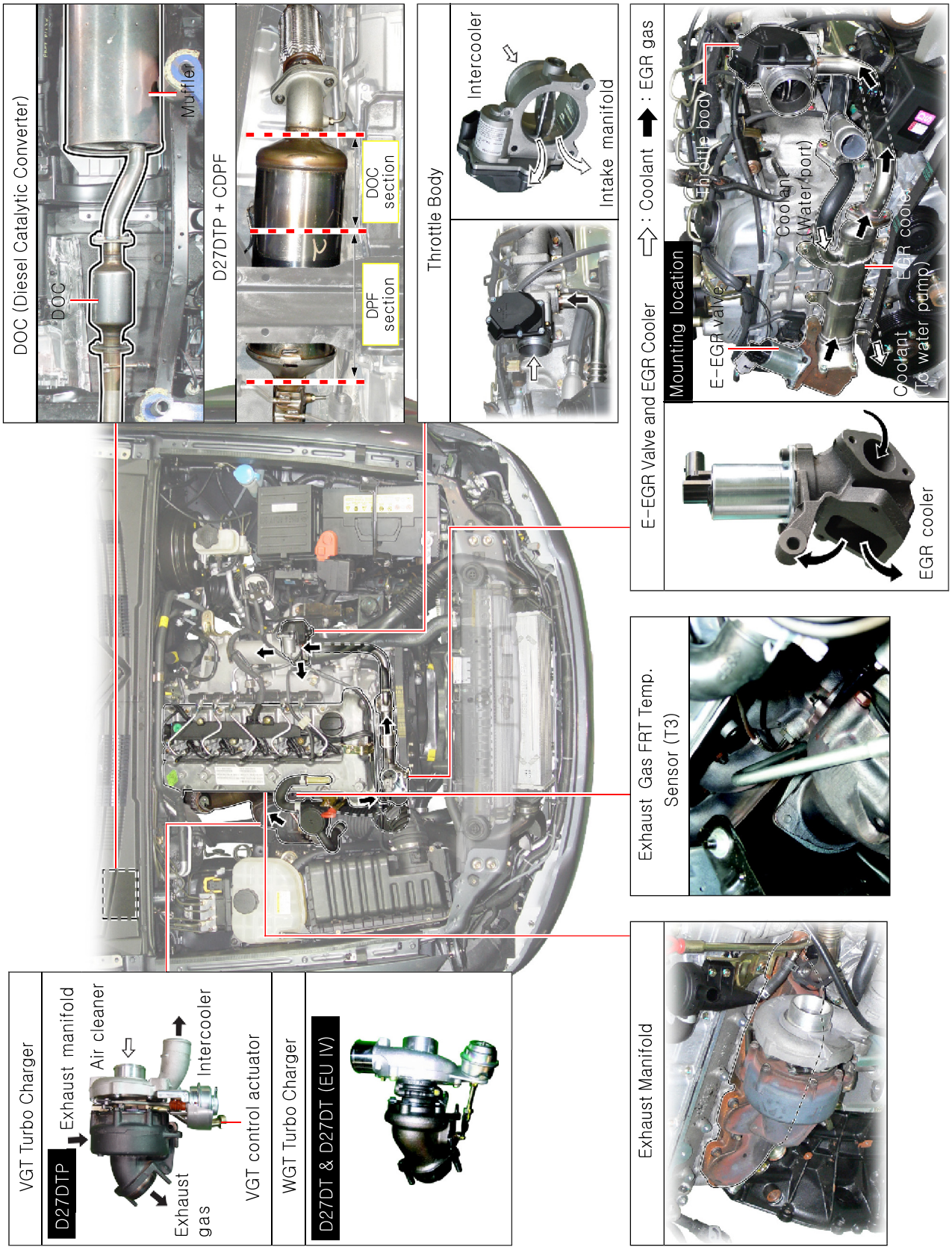
Modification basis	
Application basis	
Affected VIN	

6) Intake System



Modification basis	
Application basis	
Affected VIN	

7) Exhaust System



Modification basis	
Application basis	
Affected VIN	

ENGINE FUEL SYSTEM

1881-09

OVERVIEW AND OPERATION PROCESS

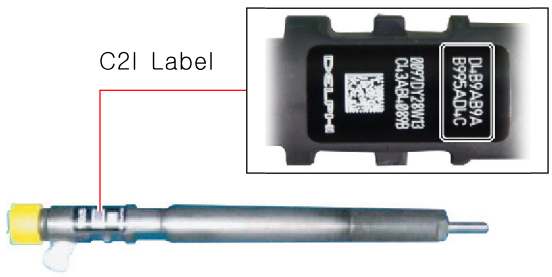
1. MAJOR CHANGES IN FUEL SYSTEM OF D27DTP (POWER UP) ENGINE

There are some changes in the parts related to the fuel system due to the newly adopted D27DTP (POWER UP) engine. The major changes are as follows. Refer to the next pages for further details.

1) Injector

D27DTP & D27DT (EU IV)

D27DT

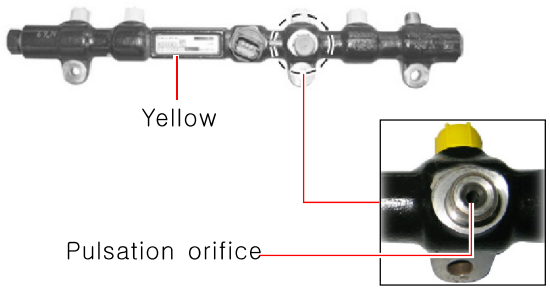


- Two nozzle holes are added (currently 7) to the tip of the injector to increase the amount of fuel injection and to improve injection efficiency according to the increased engine power.
- The existing C2I coding (16 digits) is changed to C3I coding (20 digits) to monitor fuel injection and follow the target value.
- For the D27DT engine, the injector MDP (minumum current for the solenoid in the injector to lift the nozzle) is leaned only when the engine is running. However, for the D27DTP engine, it is learned when the vehicle is in motion and the engine is at idle speed.

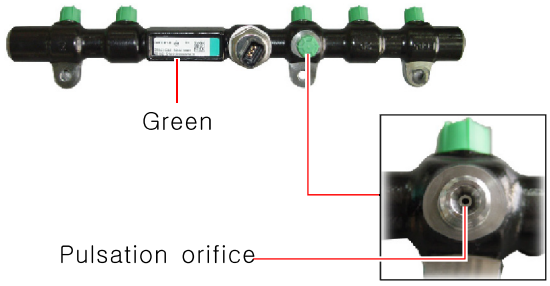
Modification basis	
Application basis	
Affected VIN	

2) Common Rail

D27DTP & D27DT (EU IV)



D27DT



· The orifice is added to the connection to the fuel pipe of the HP pump to prevent the fuel pulsation by the fuel supply and fuel cut according to the increase of injected fuel volume. (It is also installed on the connection of the high pressure fuel supply line of the HP pump.)

Modification basis	
Application basis	
Affected VIN	

3) Fuel Rail - Chrome Color

D27DTP & D27DT (EU IV)

* Fuel pipe (Common rail → Injector)

* Fuel high pressure pipe (HP pump → Common rail)

D27DT

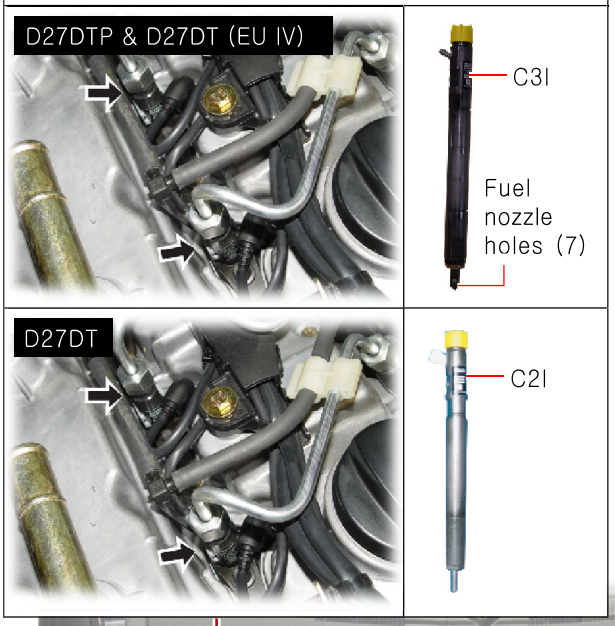
* Fuel pipe (Common rail → Injector)

* Fuel high pressure pipe (HP pump → Common rail)

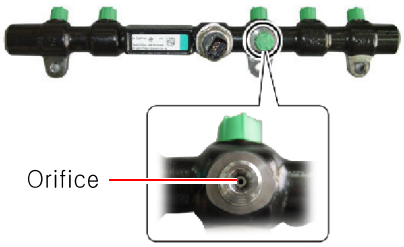
· The I.D and O.D of the fuel rail between HP pump and common rail are increased according to the increased amount of fuel injection.
Also, the engine ECU, HFM sensor and EGR system are changed to control the fuel injection volume and engine more precisely.

2. COMPONENTS OF FUEL SYSTEM

Injector (7-way Injection and C3I Coding)

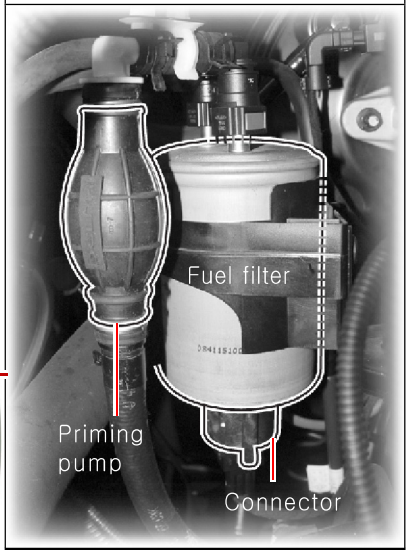


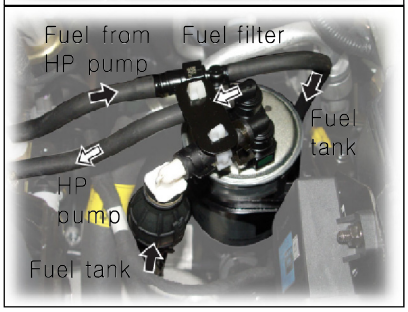
Common Rail (Orifice for Preventing Fuel Pulsation Added)

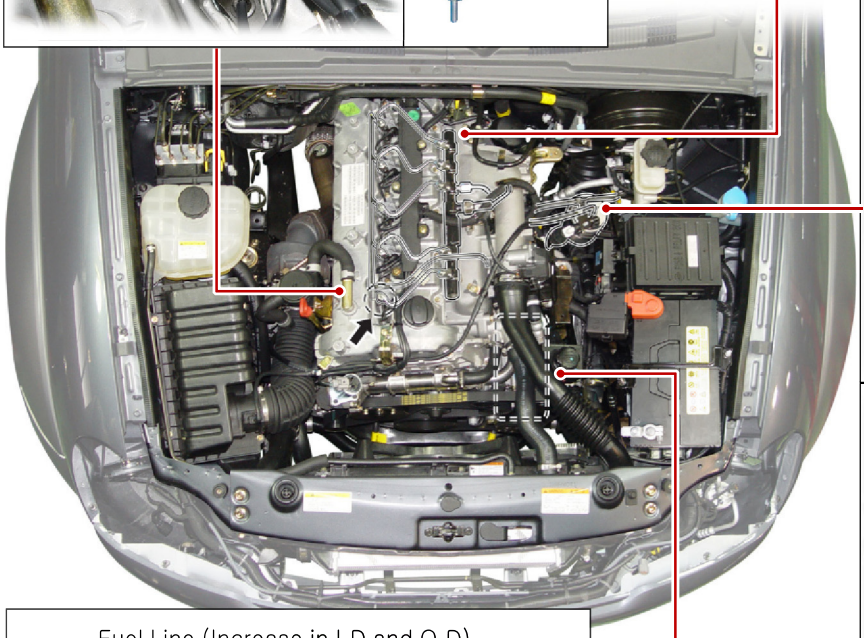


* Orifice for HP pump fuel outlet

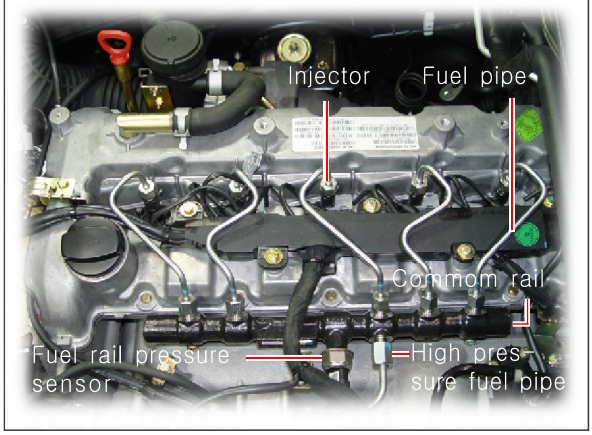
Fuel filter Priming Pump



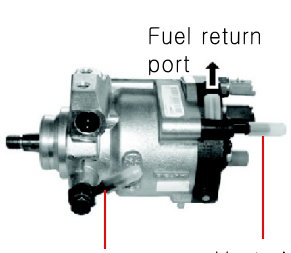


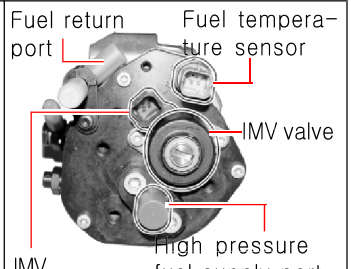


Fuel Line (Increase in I.D and O.D)



HP Pump

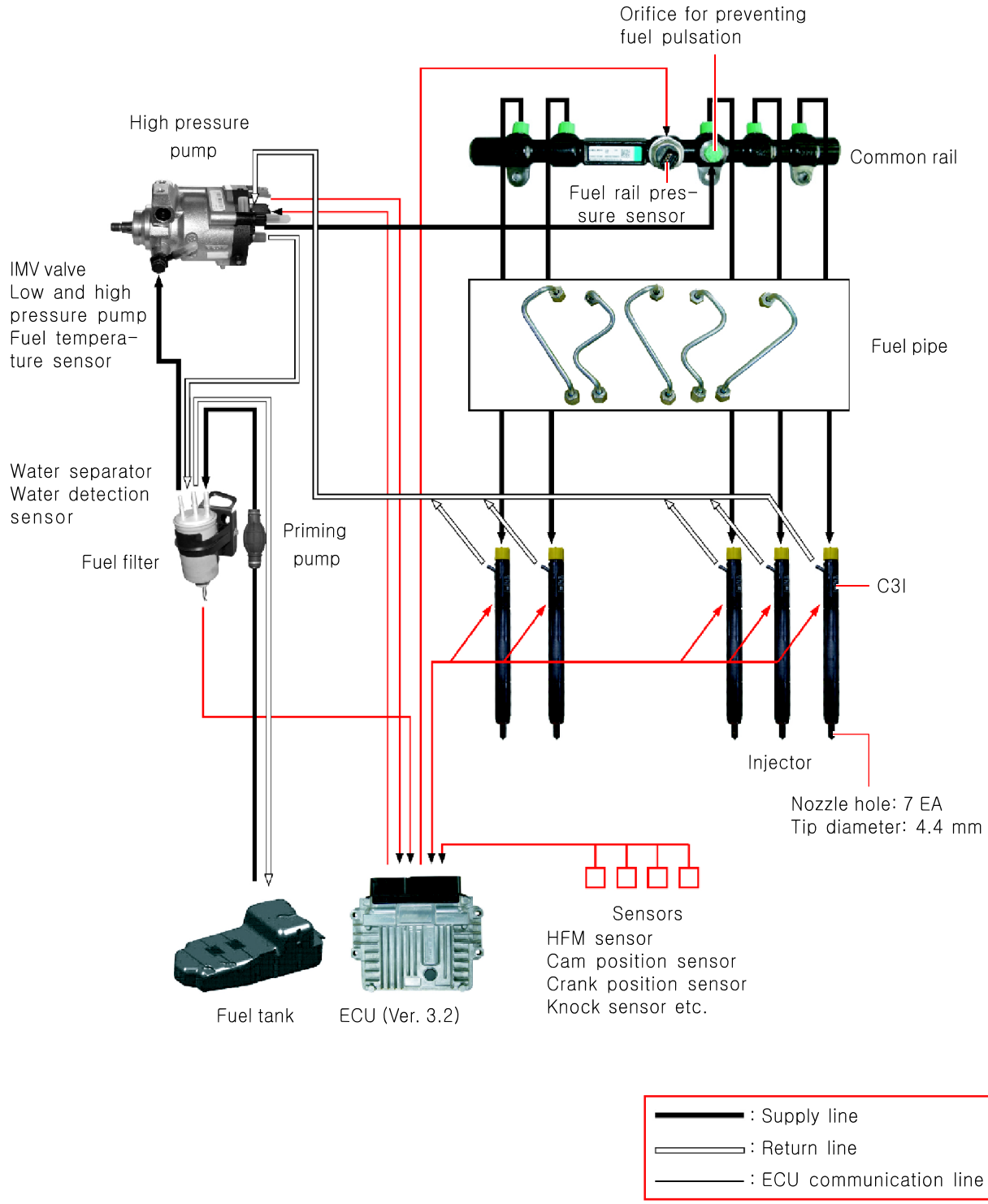




Modification basis	
Application basis	
Affected VIN	

▶Fuel Flow of D27DTP (Power Up) Engine

Fuel Supply System



Modification basis	
Application basis	
Affected VIN	

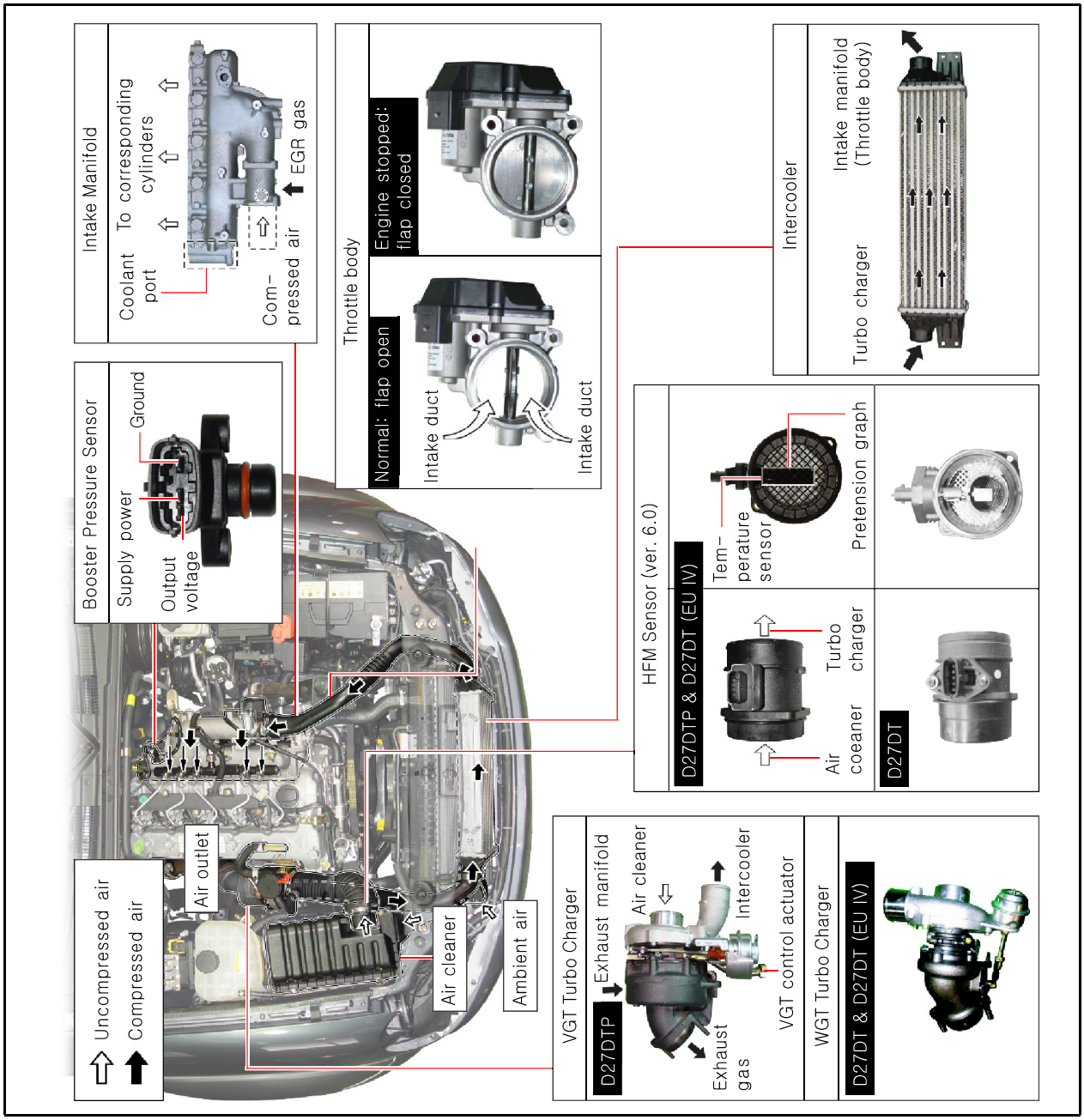
ENGINE INTAKE SYSTEM

2321-01

OVERVIEW AND OPERATION PROCESS

1. INTAKE SYSTEM LAYOUT

The intake system for the D27DTP (POWER UP) engine is equipped with the throttle body that has a flap to block the air coming to the engine when the engine is switched off. Therefore, the structure of the intake manifold has been changed.
Also, the improved HFM sensor (from HFM5.0 to HFM6.0) has been installed to control the intake air precisely so that the NOx in the exhaust gas can be decreased.



ENGINE EXHAUST SYSTEM

1792-01

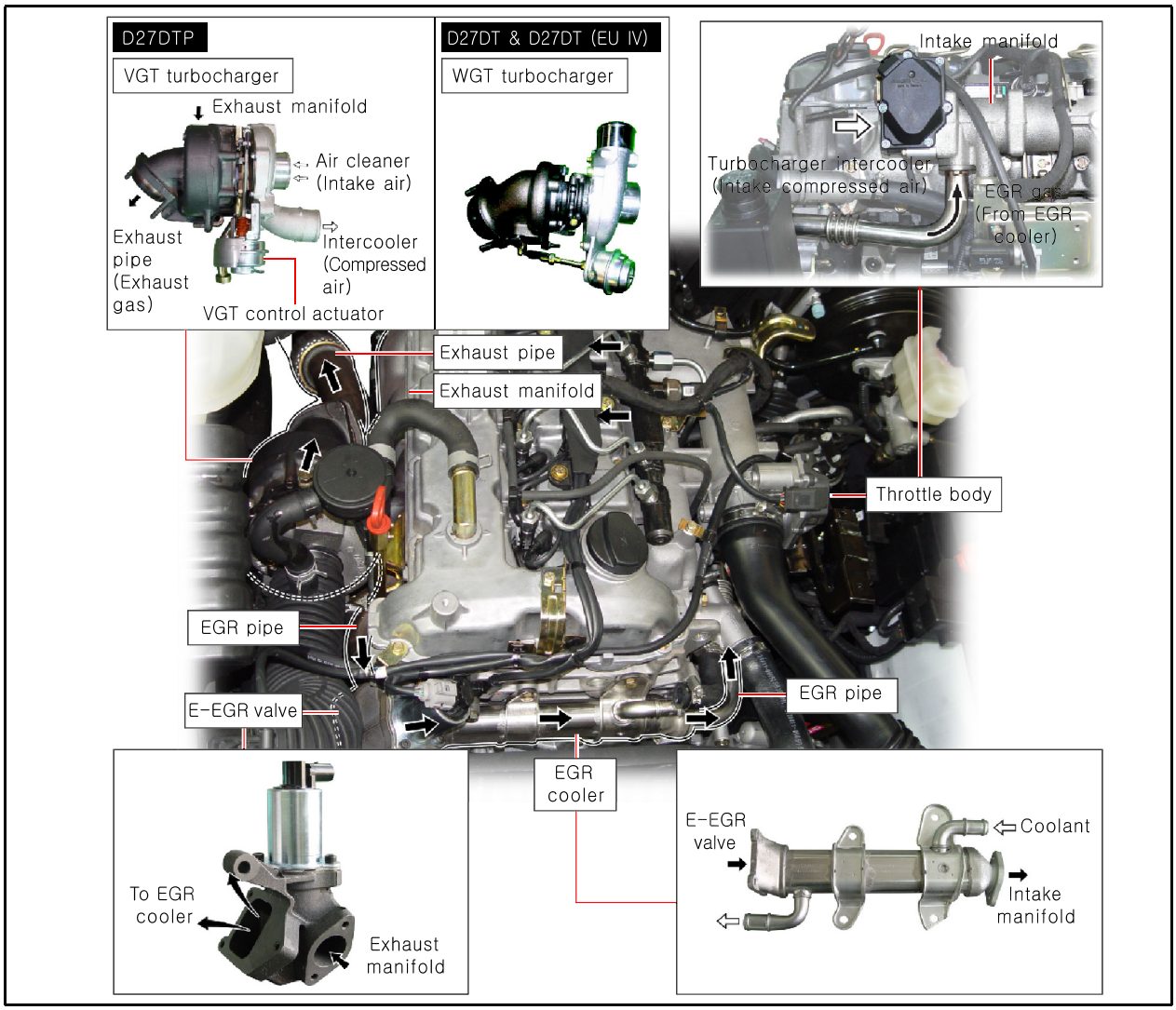
OVERVIE AND OPERATION PROCESS

1. COMPONENTS

The components of the exhaust system for the D27DTP (POWER UP) engine have been changed as follows:

1. E-EGR valve: Controlling the EGR valve electrically and sends the valve location signal to ECU (vacuum modulator control has been deleted)
2. EGR cooler: Decreasing EGR gas (NOx) efficiently by cooling the EGR gas and let it flow to the intake pipe
3. VGT turbocharger: Increase in capacity and performance compared to D27DTP & D20DT engine

The EGR system has been changed to control NOx more efficiently and the VGT turbo charger has been changed to increase the engine power. For more details, refer to the next description. The exhaust system for D27DTP (POWER UP) engine is as follows:



Modification basis	
Application basis	
Affected VIN	

NO DATA

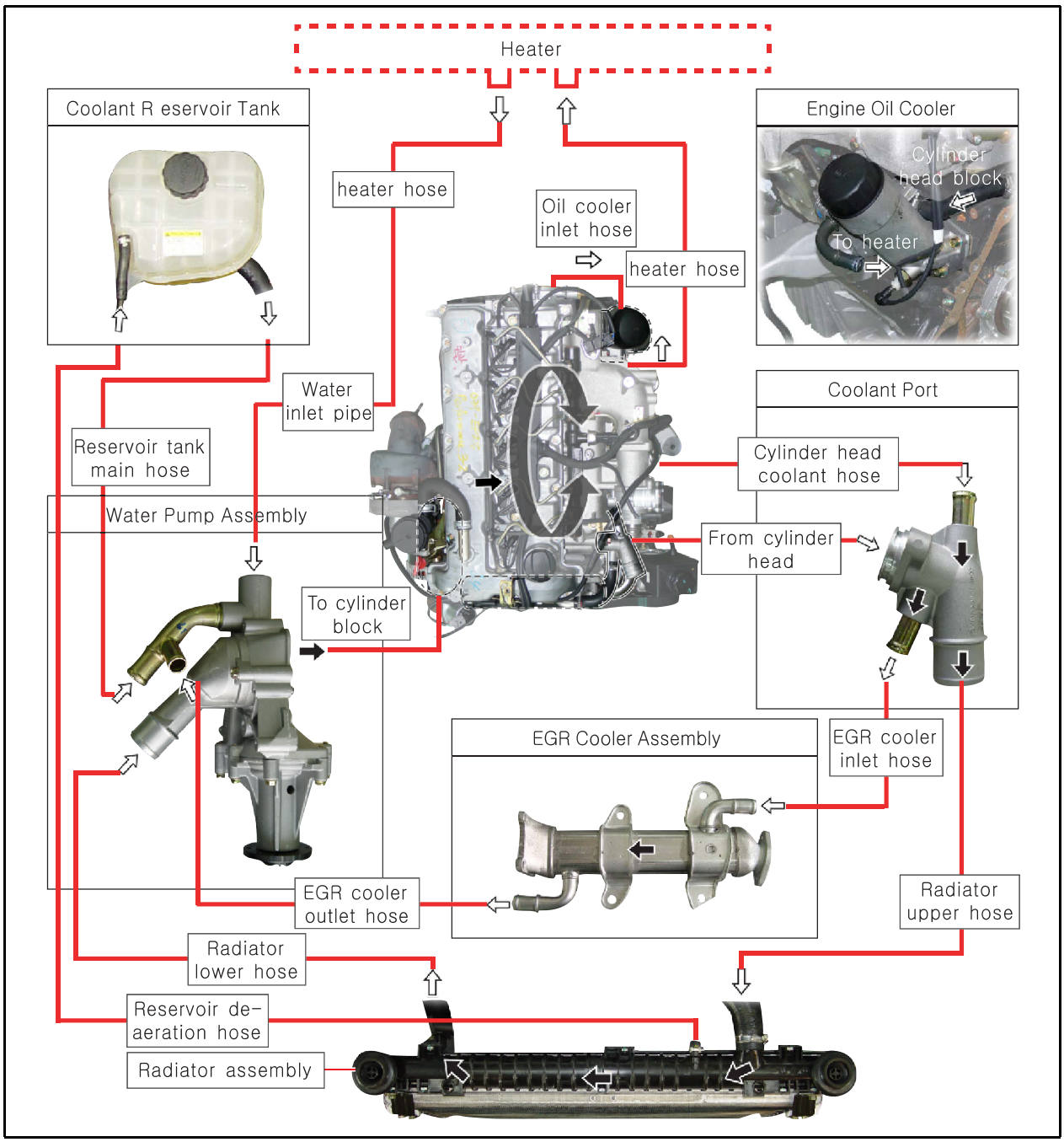
ENGINE COOLING SYSTEM 1520-01

OVERVIEW AND OPERATION PROCESS

1. COMPARISON IN COOLING SYSTEM FOR EACH ENGINE

For the D27DTP (POWER UP) engine, the cooling system is equipped with E-EGR cooler and the water pump which its capacity is improved according to the additional coolant line in the cylinder block. For the D27DT engine, the cooling system uses the fan clutch.

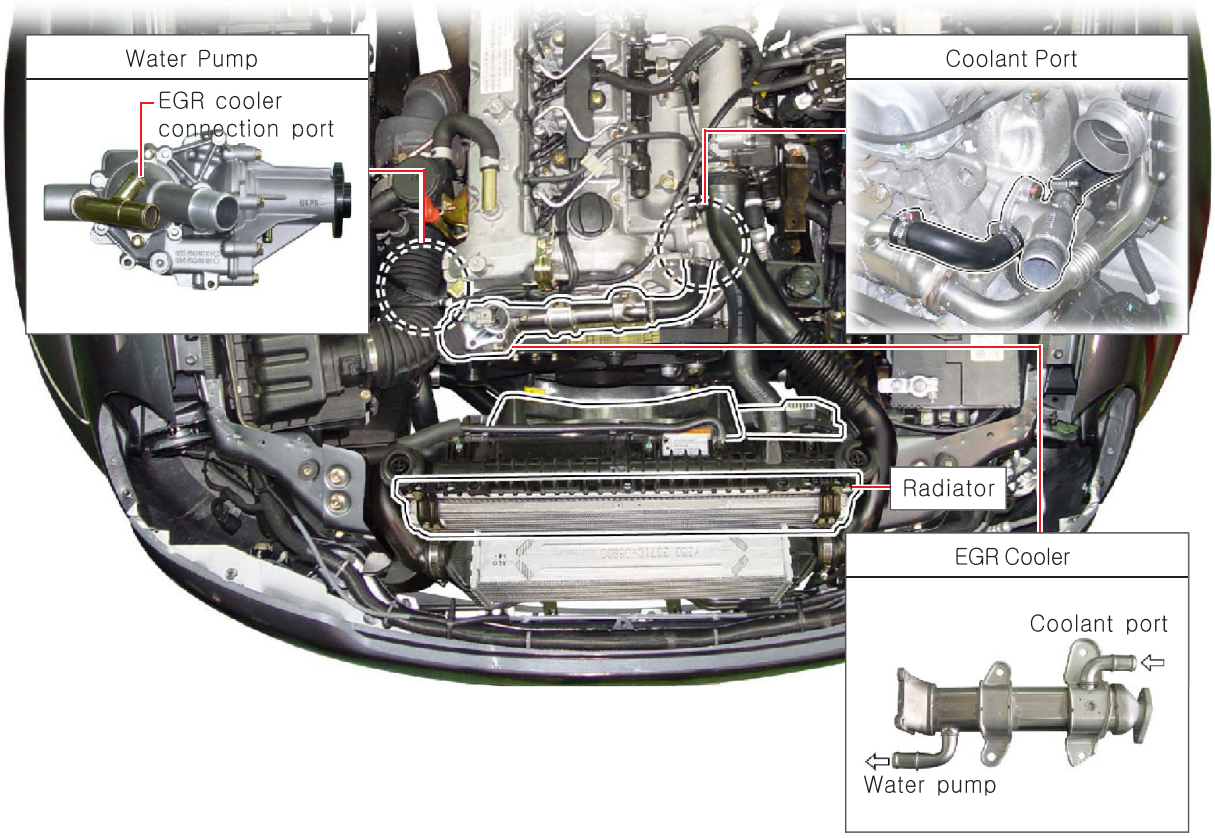
▶Cooling System for D27DTP (POWER UP) Engine



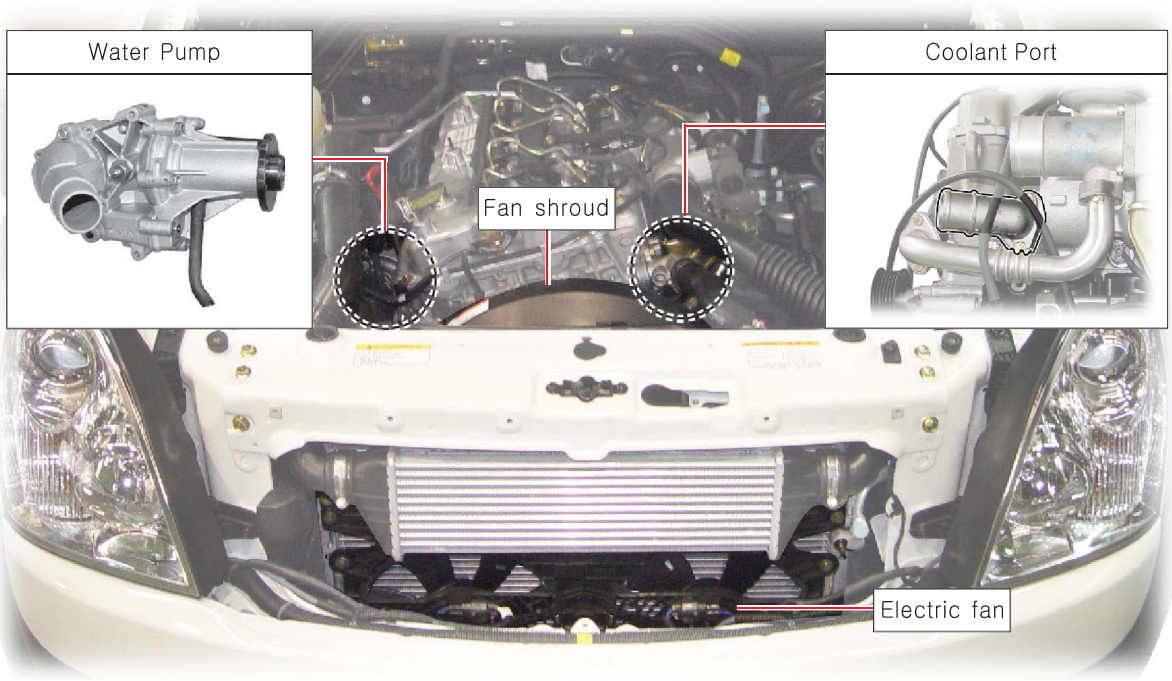
Modification basis	
Application basis	
Affected VIN	

▶Comparison

D27DTP (POWER UP) & D27DT (EU IV) Engine



D27DT Engine



Modification basis	
Application basis	
Affected VIN	

NO DATA

CRUISE CONTROL SYSTEM 8510-23

OVERVIEW AND OPERATION PROCESS

1. CRUISE CONTROL SWITCH

The purpose of the cruise control system is to automatically maintain a vehicle speed set by the driver, without depressing the accelerator pedal. The cruise control switch is located under the right side of the steering wheel, and when this switch is operating "AUTO CRUISE" lamp comes on.

The minimum speed for setting the cruise control system is 36 km/h (22.37 mph). Pay constant attention to the distance between the vehicles and the traffic conditions when using the cruise control system.

CAUTION

The cruise control system is a supplementary system, which helps the driver to drive the vehicle at a desired speed without using the accelerator pedal under the traffic condition where the vehicle-to-vehicle distance meets the legal requirement.

1) When To Use

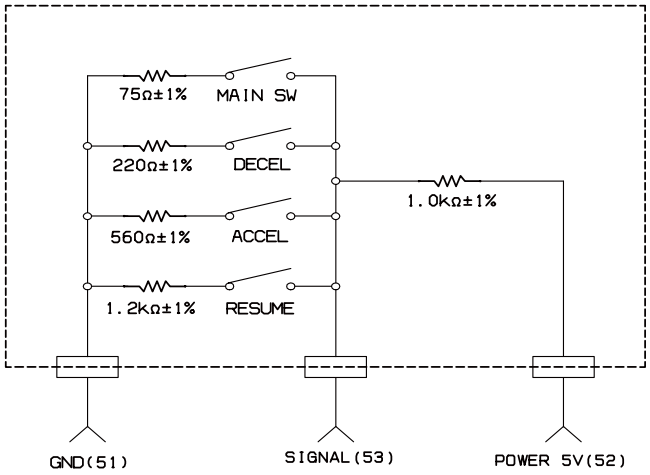
Use the cruise control system only when (a) the traffic is not jammed, (b) driving on motorways or highways where there is no sudden change in the driving condition due to traffic lights, pedestrian, etc.

WARNING

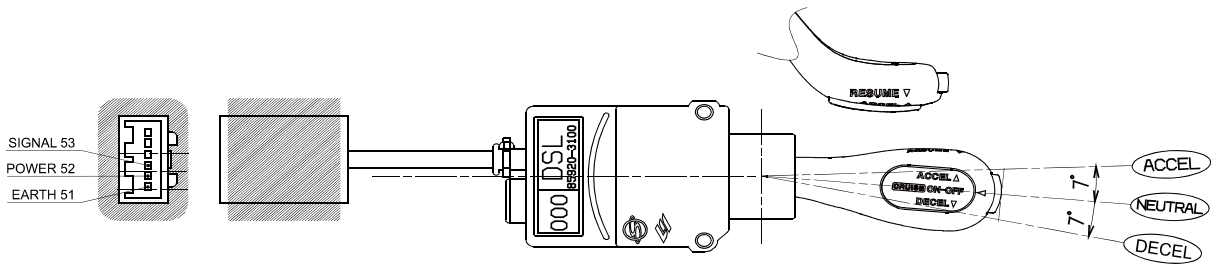
Use the cruise control system only when driving on motorways or highways. Do not use the cruise control system where the road conditions are as follows:
- When there is strong wind or cross wind.
- Heavy traffic.
- Slippery roads or steep decline.

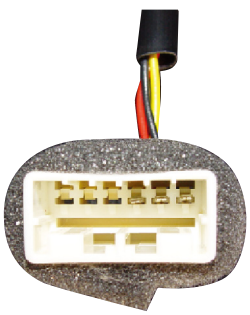
Modification basis	
Application basis	
Affected VIN	

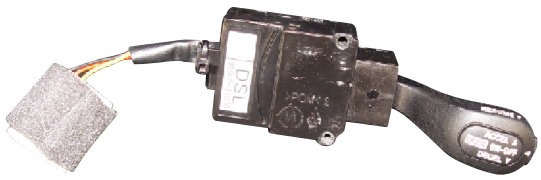
2. CIRCUIT DIAGRAM



1) Configuration







3. HOW TO OPERATE CRUISE CONTROL SWITCH

1) How To Set Speed

1. To operate the cruise control system, accelerate the vehicle to the speed within the specified range below with depressing the accelerator pedal.
   - Cruise control operating range: between 36 km/h (22.37 mph) and 150 km/h (93.207 mph)
2. When the desired speed is reached, which should be within the above range, push up the cruise control switch lever to ACCEL side (upwards arrow), or push down the switch lever to DECEL side (downwards arrow).
   And then release the accelerator pedal slowly.
3. Now the vehicle is cruised by this system with the set speed. You don't need to use the accelerator pedal.
4. Refer to the following pages for details of operation.

CAUTION

Never use the cruise control system until you get used to it.
Improper use or not fully aware of this function could result in collision and/or personal injuries.

Modification basis	
Application basis	
Affected VIN	

2) Accelerating with the Cruise Control System

(1) While the cruise control system is running

1. To increase the set speed, push up the cruise control switch lever to ACCEL side and hold it until the desired speed is reached without depressing the accelerator pedal.
2. When the desired speed is set, release the switch lever.

(2) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

1. Accelerate the vehicle to more than 36 km/h (22.37 mph) using the accelerator pedal. Push up the cruise control switch lever to ACCEL side and hold it.
2. When the desired speed is reached, release the accelerator pedal and the switch lever.

(3) Tap-up while the cruise control system is running

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

1. Push up the cruise control switch lever to ACCEL side for less than 0.5 second per one switching while the cruise control system is running; the speed increases each time by 1.3 km/h (0.81 mph).
2. For example, if you want to increase the speed 13 km/h (81 mph) more than the previous set speed, tap up the switch lever to ACCEL side ten times without using the accelerator pedal.

3) Decelerating with the Cruise Control System

(1) While the cruise control system is running

1. To decrease the set speed, push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached without depressing the brake pedal.
   But the cruise control system cannot maintain the cruise function at less than 34 km/h (21.13 mph).
2. When the desired speed is set, release the switch lever.

(2) When the cruise control system is not running

To decrease the speed with the cruise control system while the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 36 km/h (22.37 mph).
2. When the desired speed is reached, release the switch lever.
3. But the cruise control system cannot maintain the cruise function at less than 34 km/h (21.13 mph).

(3) Tap-down while the cruise control system is running

To decrease the vehicle speed in stages while the cruise control system is running, follow the below procedures.

1. Push down the cruise control switch lever to DECEL side for less than 0.5 second per one switching while the cruise control system is running; the speed decreases each time by 1.0 km/h (0.62 mph).
2. For example, if you want to decrease the speed 10 km/h (62 mph) lower than the previous set speed, tap down the switch lever to DECEL side ten times without using the brake pedal.

Modification basis	
Application basis	
Affected VIN	

4) Recovery of Set Speed (RESUME)

Even if the cruise control is cancelled, the previous set cruise speed can be recovered by operating the cruise control switch lever like below:
- Pull the switch lever in the arrow direction shown in the illustration.

This RESUME function works only when the vehicle speed is more than 36 km/h (22.37 mph) without using the accelerator or brake pedal.

CAUTION

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

5) Normal Cancellation of the Cruise Control (OFF ↔ ON)

The cruise control system will be cancelled when the button on the side of the switch is pressed, or when one of the following conditions is met:

1. When the brake pedal is depressed or ESP is activated.
2. When the vehicle speed is less than 34 km/h (21.13 mph).
3. When the parking brake is applied while driving.
4. When the clutch pedal is depressed for shifting (M/T only).

CAUTION

Put the cruise control switch lever in the neutral position when not using the cruise control system.

(1) Abnormal Cancellation of the Cruise Control

1. When the rapid deceleration or acceleration occurs.
2. When the cruise control lever is faulty.
3. When the brake switch is malfunctioning or has an open circuit.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

- Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
- Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
- The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
- Ensure that the braking distance is maintained and use the brake pedal if needed.

Modification basis	
Application basis	
Affected VIN	

NO DATA

ENGINE INFORMATION

0000-00

GENERAL)

1. COMPONENT LOCATOR..... 4
2. DESCRIPTION AND OPERATION..... 7

Memo

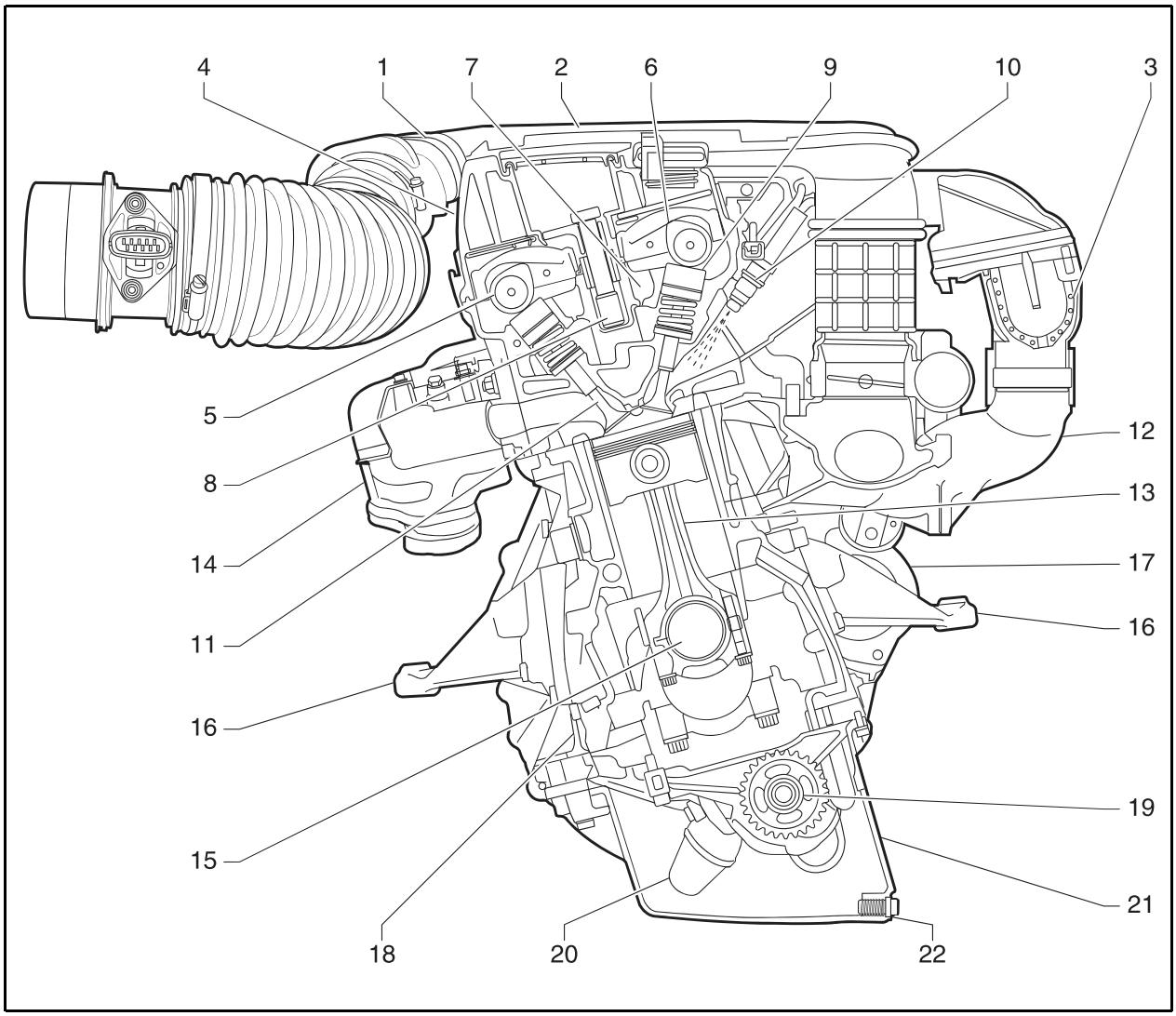
ENGINE GENERAL

0000-00

GENERAL

1. COMPONENT LOCATOR

1) Front View

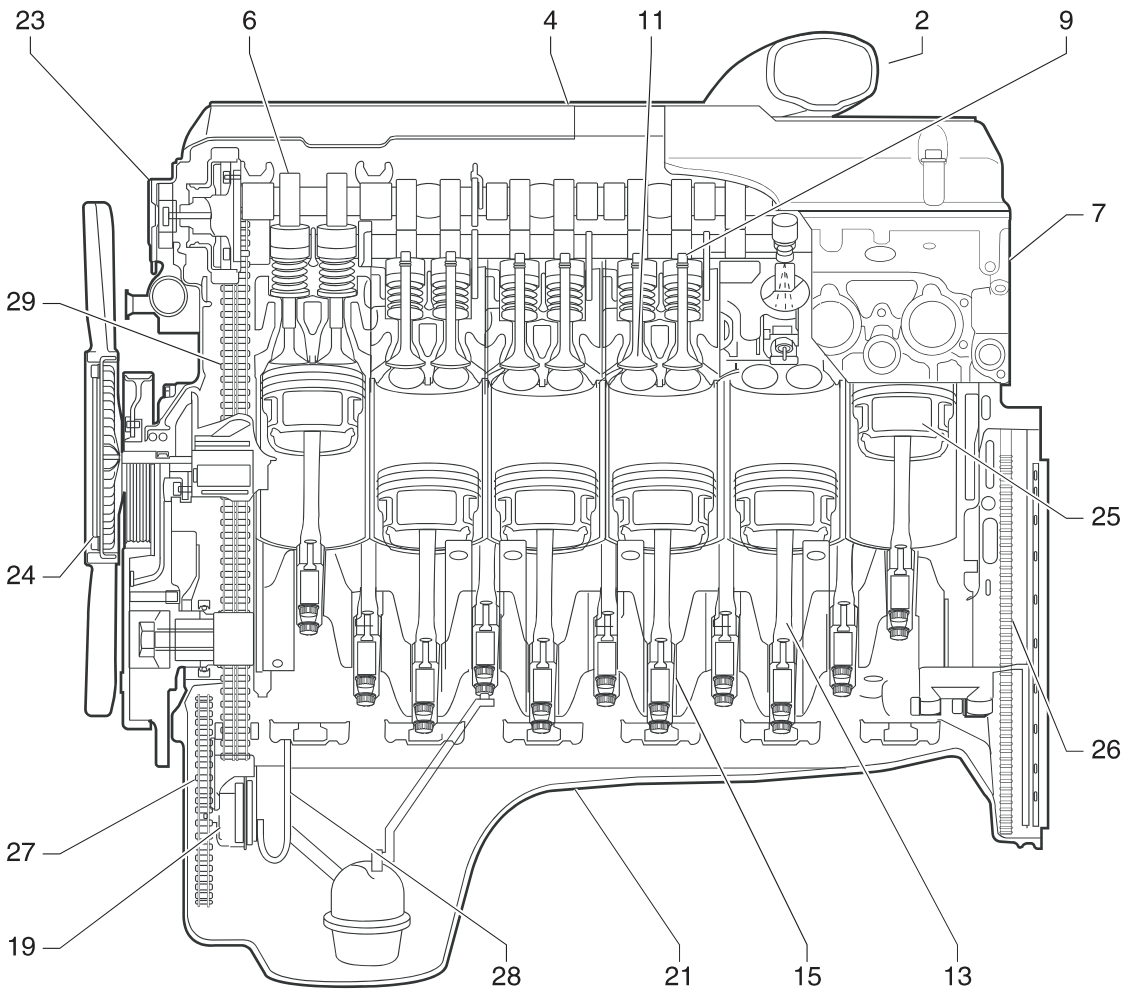


Modification basis	
Application basis	
Affected VIN	

▶ **Front View**

NO.	FUNCTION	NO.	FUNCTION
1	HFM sensor	12	Intake manifold
2	Intake air duct	13	Connecting rod
3	Resonance flap	14	Exhaust manifold
4	Cylinder head cover	15	Crankshaft
5	Exhaust camshaft	16	Engine mounting
6	Intake camshaft	17	Starter
7	Cylinder head	18	Crankcase
8	Spark plug connector	19	Oil pump sprocket
9	Valve tappet	20	Oil strainer
10	Injector	21	Oil pan
11	Exhaust valve	22	Drain plug

2) SIDE VIEW



NO.	FUNCTION	NO.	FUNCTION
23	Camshaft adjuster	27	Oil pump drive chain
24	Cooling fan and viscous clutch	28	Oil return pipe
25	Piston	29	Timing chain
26	Flywheel of drive plate		

Modification basis	
Application basis	
Affected VIN	

2. DESCRIPTION AND OPERATION

1) Cleanliness And Care

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten-thousanths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of enigne oil should be applied to friction areas during assembly, to protect and lubricate the surfaces on initial operation.

Proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Whenever valve train components are removed for service, they should be kept in order.

They should be installed in the same locations, and with the same mating surfaces, as when they were removed. Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.

2) On-Engine Service

CAUTION

- Disconnect the negative battery cable before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted. Notice Any time the air cleaner is removed, the intake opening

CAUTION

- Any time the air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material, which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.g

Memo

ENGINE ASSEMBLY 1113-01

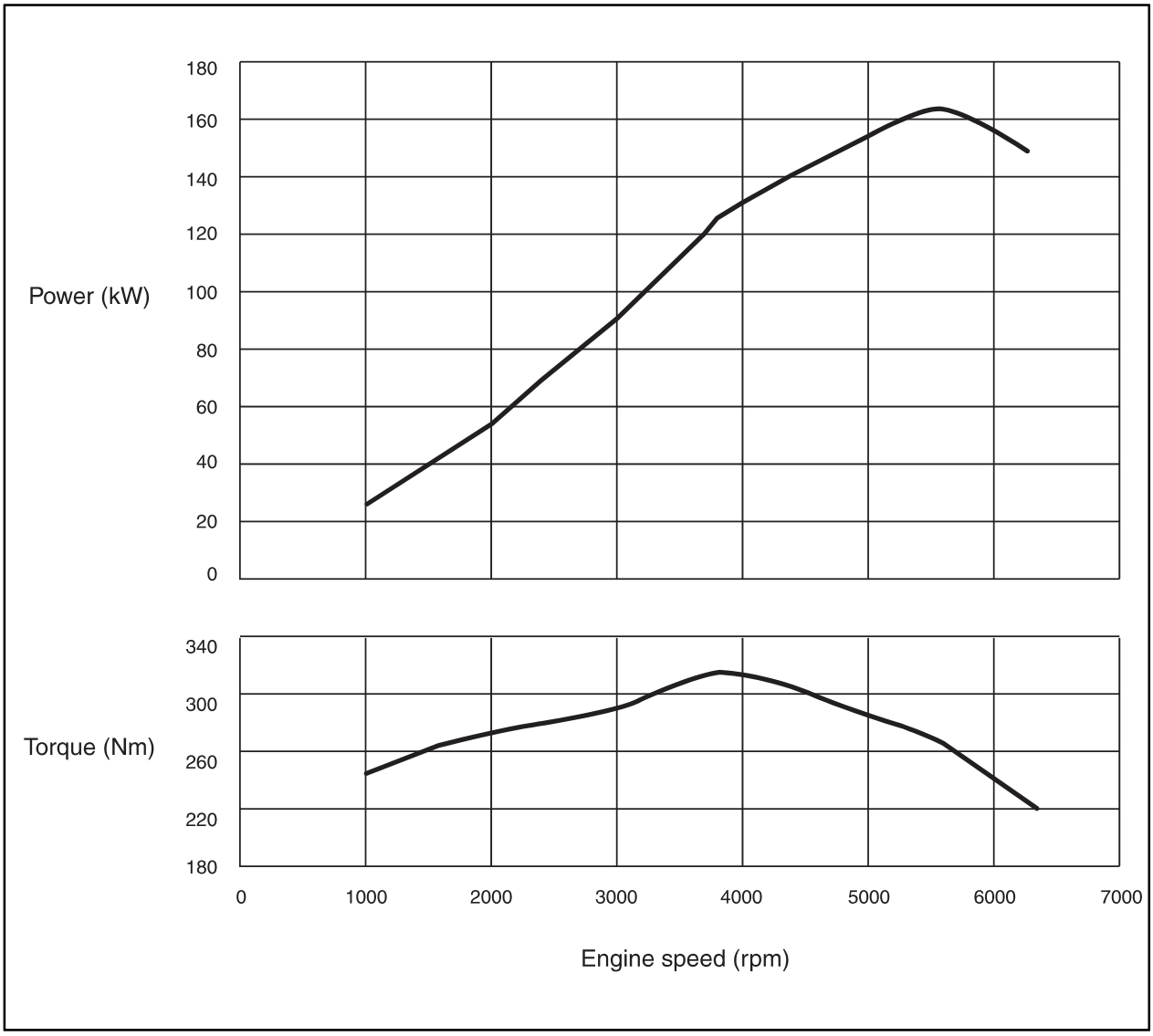
GENERAL

1. SPECIFICATIONS

1) ENGINE SPECIFICATIONS

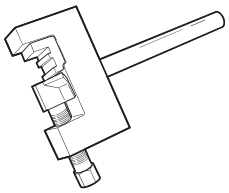
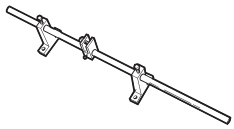
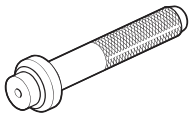
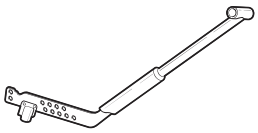
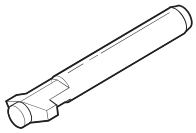
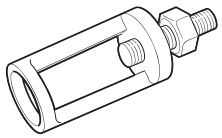
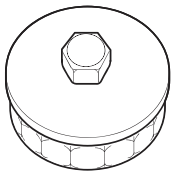
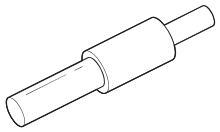
Application			M162 Engine
Engine model			M162.990
Displacement (CC)			3199
Cylinder (Bore x Stroke) (mm)			89.9 x 84.0
Fuel injection / Ignition system			MSE 3.63D
Compression ratio			10 : 1
Number of cylinders			6
Camshaft valve arrangement			DOHC
Camshaft drive type			Chain-Driven
Max. output (ps/rpm)			220 / 6000
Max. torque (kg•m/rpm)			31.6 / 3900
Firing order			1 - 5 - 3 - 6 - 2 - 4
Ignition type			Distributorless double ignition
Ignition timing			BTDC 8°
Va lve timing	Intake	Open/Close	AT DC 11° / ABDC 34°
Valve clearance adjustment			Automatic control
Idle speed (rpm)			700 ± 50
Fuel injection pressure (kg/cm^2)			3 ~ 4
Oil capacity (liter)			9
Lubrication type			Forced by gear pump
Oil filter type			Full flow with paper filter
Fuel			Unleaded gasoline

2) PERFORMANCE CURVE



Modification basis	
Application basis	
Affected VIN	

2. SPECIAL TOOLS AND EQUIPMENT

Name and Part Number	Name and Part Number
000 589 58 43 00 Chain Assembly 	A9917 0101B (111 589 01 59 00) Supporting Bar 
W991 1 0010B (102 589 00 15 00) Drift 	A9917 0111B (111 589 18 61 00) Lever Pusher 
A991 1 0050B (102 589 12 15 00) Drift 	A9917 0121B (111 589 25 63 00) Thrust Piece 
A9910 0050A (103 589 02 09 00) Oil Filter Remover 	A9913 0061B (116 589 01 34 00) Threaded Pin 

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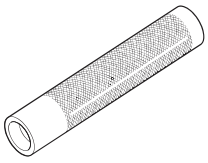
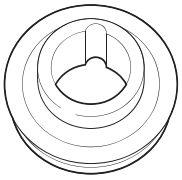
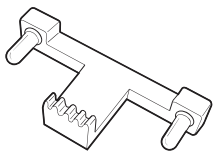
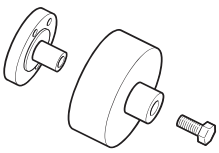
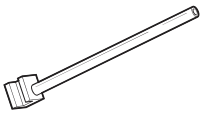
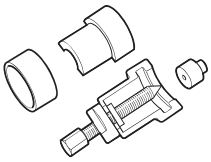
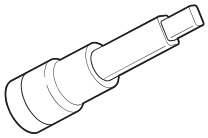
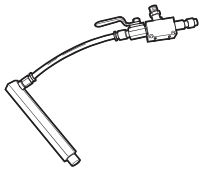
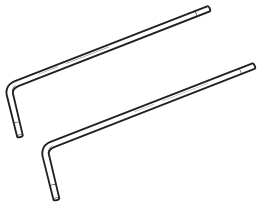
A9917 0171B (119 589 00 43 00) Drift 
A991 1 0060B (601 589 03 14 00) Crankshaft Front Seal Installer 
A9910 0150B (602 589 00 40 00) Engine Lock 
W991 1 0020B (601 589 03 43 00) Crankshaft Rear Seal Installer 

Name and Part Number
A9910 0150A (603 589 00 40 00) Fan Clutch Holder 
W9910 0150A (615 589 01 33 00) Crankshaft Sprocket Puller 
A9912 0080B (617 589 00 10 00) Allen Wrench Socket 
A991 1 0012B (DW1 10-090) Connecting Hose 

Modification basis	
Application basis	
Affected VIN	

Name and Part Number
A9917 0012B (DW110-120)Holding Pin 

3. FASTENER TIGHTENING SPECIFICATIONS

Application	Nm	Lb-Ft	Lb-In
A/C bracket bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Armature bolt in camshaft actuator	35	26	-
Belt tensioning pulley nut	40.5 ~ 49.5	29.9 ~ 36.5	-
Camshaft actuator bolt	9 ~ 11	-	80 ~ 97
Camshaft adjuster mounting nut	60 ~ 70	44 ~ 52	-
Camshaft bearing cap bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Chain tensioner assembly	72 ~ 88	53 ~ 65	-
Chain tensioner screw plug	40	30	-
Connecting rod bearing cap bolt	40 + 5 90° + 10°	30 + 3.7 90° + 10°	-
Cooling fan bracket bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Crankshaft bearing cap bolt	50 ~ 60 90° + 5°	37 ~ 44 90° + 5°	-
Crankshaft sealing rear cover mounting bolt	9 - 11	-	80 ~ 97
Cylinder block drain plug	30	22	-
Cylinder head bolt	55 +90° +90°	41 +90° +90°	-
Cylinder head cover bolt	9 ~ 11	-	80 ~ 97
Cylinder head front cover bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Engine mounting bracket nut	70	52	-
Exhaust camshaft sprocker bolt	18 ~ 22 90° ± 5°	13 ~ 16 90° ± 5°	-
Exhaust manifold and pipe	30	22	-
Flywheel mounting bolt	45 + 5 90° + 10°	33 + 3.7 90° + 10°	-
Fuel feed and return hose to fuel rail	21 ~ 25	15 ~ 18	-
Generator carrier bolt	25	18	-
Intake air duct nut	9 ~ 11	-	80 ~ 97
Intake flange shaft bolt	18 ~ 22 90° ± 5°	13 ~ 16 90° ± 5°	-
Lower engine mounting nut	38	28	-
Oil dipstick guide tube bolt	9 ~ 11	-	80 ~ 97
Oil drain plug	22.5 ~ 27.5	16.6 ~ 20.3	-

Modification basis	
Application basis	
Affected VIN	

4. FASTENER TIGHTENING SPECIFICATIONS (CONT'D)

Application		Nm	Lb-Ft	Lb-In
Oil filter bolt		22.5 ~ 27.5	16.6 ~ 20.3	-
Oil filter cover		25	18	-
Oil gallery screw plug in cylinder head		15	11	-
Oil pan bolt	M10	40	30	-
	M8	22.5 ~ 27.5	16.6 ~ 20.3	-
	M6	9 ~ 11	-	80 ~ 97
Oil pressure relief valve screw plug		50	37	-
Oil pump drive sprocket bolt		29 ~ 35	21 ~ 26	-
Oil pump mounting bolt		22.5 ~ 27.5	16.6 ~ 20.3	-
Oil pump sprocket bolt		29 ~ 35	21 ~ 26	-
Spark plug cover bolt		9 ~ 11	-	80 ~ 97
Steering pump bolt		22.5 ~ 27.5	16.6 ~ 20.3	-
Tensioning device bolt		26 ~ 32	19 ~ 24	-
Timing gear case cover bolt	M8	22.5 ~ 27.5	16.6 ~ 20.3	-
	M6	9 ~ 11	-	80 ~ 97
Torque converter mounting bolt		42	31	-
Transmission mounting nut		54 ~ 68	40 ~ 50	-
Under cover		28 ~ 47	21 ~ 35	-
Upper engine mounting nut		70	52	-
Vibration damper center bolt		180 ~ 220 90° + 10°	133 ~ 162 90° + 10°	-
Water pump pulley bolt		22.5 ~ 27.5	16.6 ~ 20.3	-

ENGINE FUEL SYSTEM 2211-22

OVERVEIW AND OPERATION PROCESS

1. FUEL SYSTEM SPECIFICATION

▶ Use Only Unleaded Fuel Rated at 89 Octane or Higher

Fuel quality and additives contained in fuel have a significant effect on power output, drivability, and life of theengine. Fuel with too low an octane number can cause engine knock.

CAUTION
- Use of fuel with an octane number lower than 89 may damage engine and exhaust system.

CAUTION
- To prevent accidental use of leaded fuel, the nozzles for leaded fuel are larger, and will not fit the fuel filler neck of your vehicle.

▶ Do Not Use Methanol

Fuels containing methanol (wood alcohol) should not be used in vehicle.
This type of fuel can reduce vehicle performance and damage components of the fuel system.

CAUTION
- Use of methanol may damage the fuel sys-tem.

▶ Vehicle Fueling from Drums or Storage Containers

For safety reasons (particularly when using noncommercial fueling systems) fuel containers, pumps and hoses must be properly earthed. Static electricity build up can occur under certain atmospheric and fuel flow conditions if unearthed hoses, particularly plastic, are fitted to the fuel-dispensing pump.

It is therefore recommended that earthed pumps with integrally earthed hoses be used, and that storage containers be properly earthed during all noncommercial fueling operations.

▶ temperature vs resistance

℃	℉	ECT Sensor	IAT Sensor
		ohms (Ω)	
Temperature vs Resistance Values (Approximate)			
130	266	88	102
120	248	111.6	127
110	230	143	159
100	212	202	202
90	194	261	261
80	176	340	340
70	158	452	452
60	140	609	609
50	122	835	835
40	113	1166	1166
30	86	1662	1662
20	68	2420	2420
10	50	3604	3604
0	32	5499	5499
-10	14	8609	8609
-20	-4	13850	13850
-30	-22	22960	22960
-40	-40	39260	39260

Modification basis	
Application basis	
Affected VIN	

NO DATA

ENGINE EXHAUST SYSTEM 2420-01

GENERAL

1. OVERVIEW OF EXHAUST SYSTEM

CAUTION

- When you are inspecting or replacing exhaust system components, make sure there is adequate clearance from all points on the underbody to avoid possible overheating of the floor panel and possible damage to the passenger compartment insulation and trim materials.
  Check the complete exhaust system and the nearby body areas and trunk lid for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections, or other deterioration which could permit exhaust fumes to seep into the trunk may be an indication of a problem in one of these areas. Any defects should be corrected immediately.

2. OVERVIEW OF MUFFLER

Aside from the exhaust manifold connection, the exhaust system uses a flange and seal joint design rather than a slip joint coupling design with clamp and U-bolts.
If hole, open seams, or any deterioration is discovered upon inspection of the front muffler and pipe assembly, the complete assembly should be replace, the complete assembly should be replaced.
The same procedure is applicable to the rear muffler assembly. Heat shields for the front and rear muffler assembly and catalytic converter protect the vehicle and the environment from the high temperatures that the exhaust system develops.

3. OVERVIEW OF CATALYTIC CONVERTER

CAUTION

- When jacking or lifting the vehicle from the body side rails, be certain that the lift pads do not contact the catalytic converter, as this could damage the catalytic converter.

CAUTION

- Use of anything other than unleaded fuel will damage the catalyst in the catalytic converter.
  · The catalytic converter are emission-control devices added to the exhaust system to reduce pollutants from the exhaust pipes.
  · The oxidation catalyst is coated with a catalytic material containing platinum and palladium, which reduces levels of hydrocarbon (HC) and carbon monoxide (CO) from the exhaust gas. The three-way catalyst has coatings which contain platinum and rhodium, which additionally lower the levels of oxides of nitrogen (NOx).

4. FASTENER TIGHTENING SPECIFICATIONS

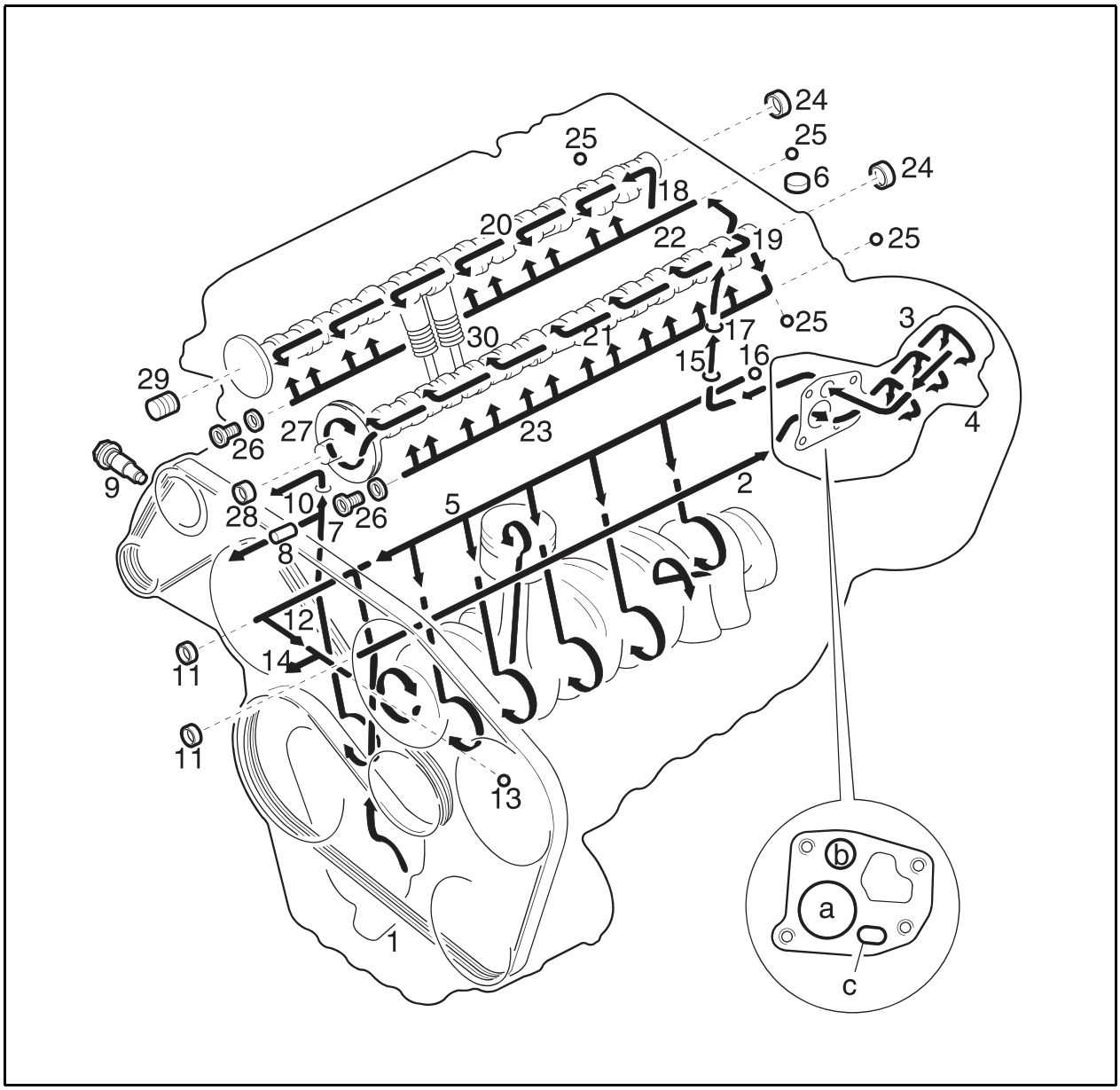
Application	Nm	Lb-Ft	Lb-In
Exhaust manifold to front exhaust pipe nut	15 ~ 28	11 ~ 21	-
Front exhaust pipe to muffler nut	28 ~ 47	21 ~ 35	-
Intake air duct mounting bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Intake manifold mounting bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Muffler to tail exhaust pipe nut	28 ~ 47	21 ~ 35	-
Resonance flap mounting bolt	9 ~ 11	-	80 ~ 97

Modification basis	
Application basis	
Affected VIN	

ENGINE LUBRICATION SYSTEM 9210-01

OVERVIEW AND OPERATION PROCESS

1. OIL CIRCULATION



▶ OIL CIRCULATION

NO.	FUNCTION	NO.	FUNCTION
1	Oil pump	18	Oil supply (to exhaust camshaft)
2	Oil gallery (to oil filter)	19	Oil supply (to intake camshaft)
3	Oil filter	20	Oil supply (to exhaust camshaft bearing)
4	Oil pressure switch	21	Oil supply (to intake camshaft bearing)
5	Main oil gallery	22	Oil gallery (oil supply to exhaust valve tappet)
6	Cylinder head closing cover	23	Oil gallery (oil supply to intake valve tappet)
7	Oil gallery (at chain tensioner)	24	Camshaft closing cover
8	Oil non-return valve	25	Ball (ϕ 8 mm)
9	Chain tensioner	26	Screw plug
10	Vent (chain tensioner)	27	Camshaft adjuster
11	Front closing cover (ϕ 17 mm)	28	Front closing cover (intake camshaft)
12	Oil gallery (perpendicular to the shaft)	29	Front treaded bushing (exhaust camshaft)
13	Ball (ϕ 6 mm)	30	Valve tappet
14	Oil spray nozzle (timing chain)	a	Oil gallery (from oil pump to oil filter)
15	Oil gallery (at cylinder head)	b	Main oil gallery
16	Ball (ϕ 15mm)	c	Oil return line (oil returns to the oil pan when replacing the filter element)
17	Oil restriction inner (ϕ 4mm)		

Modification basis	
Application basis	
Affected VIN	

ENGINE COOLING SYSTEM

2110-01

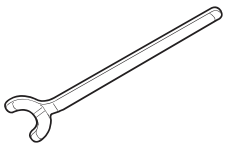
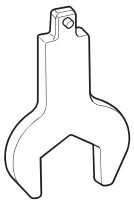
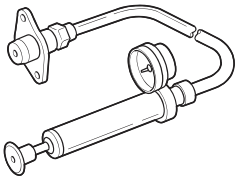
GENERAL

1. GENERAL SPECIFICATIONS

Application		Unit	Gasoline Engine
Cooling system	Type	-	Water cooling forced circulation
Coolant	Capacity	L	11.3
Thermostat	Type	-	Wax pellet type
	Initial opening temp.	°C (°F)	82 (180)
	Fully opening temp.	°C (°F)	95 (203)
	Fully closing temp.	°C (°F)	80 (176)
	Stroke	mm	7
Cooling fan	Type	-	Electric cooling
	Blades	-	5
	Diameter	mm	320
	Low speed ON temp.	°C (°F)	95 (203)
	Low speed OFF temp.	°C (°F)	90 (194)
	High speed ON temp.	°C (°F)	105 (221)
	High speed OFF temp.	°C (°F)	100 (212)
	High speed ON temp. (By A/C pressure)	kPa (psi)	269.8 (1860)
Coolant reservoir	Pressure valve opening pressure	kPa (psi)	118 ~ 147 (17.1 ~ 21.3)
	Vacuum valve opening pressure	kPa (psi)	9.8 (1.4)
Water pump	Type	-	Turbo centrifugal
	Impeller diameter	mm	65
	Impeller blades	-	8
Radiator	Type	-	Cross-flow
	Core width	mm	701
	Core height	mm	372
	Core thickness	mm	18
	Minimum radiation capability	Kcal/h	45,000
Coolant temperature gauge	Resistance (at 50°C (122°F))	Ω	185.2
	Resistance (at 80°C (176°F))	Ω	47.4
	Resistance (at 105°C (221°F))	Ω	28.2
Engine coolant temperature sensor	Resistance (at 20°C (68°F))	K Ω	3.33 ~ 37.8
	Resistance (at 80°C (176°F))	K Ω	0.32 ~ 0.35
Anti-freeze agent	Type	-	ALUTEC-P78
	Mixture of water and good quality ethylene glycol-base anti-freeze	-	50 : 50

Modification basis	
Application basis	
Affected VIN	

2. SPECIAL TOOLS AND EQUIPMENT

Name and Part Number	Name and Part Number
A9910 0060A (111 589 00 40 00) Holder 	A9910 0070A (111 589 02 01 00) Open End Wrench 
A9921 0012A (124 589 15 21 00) Leakage Te ster 	A9910 0150A (603 589 00 40 00) Fan Clutch Holder

Modification basis	
Application basis	
Affected VIN	

3. FASTENER TIGHTENING SPECIFICATIONS

Application	Nm	Lb-Ft	Lb-In
Automatic transmission oil cooler pipe	20	15	-
Automatic transmission oil cooler pipe mounting bolt	3 ~ 7	-	27 ~ 62
Coolant drain plug	30	22	-
Cooling fan bolt	9 ~ 11	-	80 ~ 97
Cooling fan shroud bolt	3 ~ 7	-	27 ~ 62
Engine hanger bracket and coolant outlet port bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Radiator mounting bracket bolt	3 ~ 7	-	27 ~ 62
Thermostat cover bracket bolt	9 ~ 11	-	80 ~ 97
Viscous clutch mounting bolt	40.5 ~ 49.5	29.8 ~ 36.5	-
Water pump mounting bolt	22.5 ~ 27.5	16.6 ~ 20.3	-

OVERVIEW AND OPERATION PROCESS

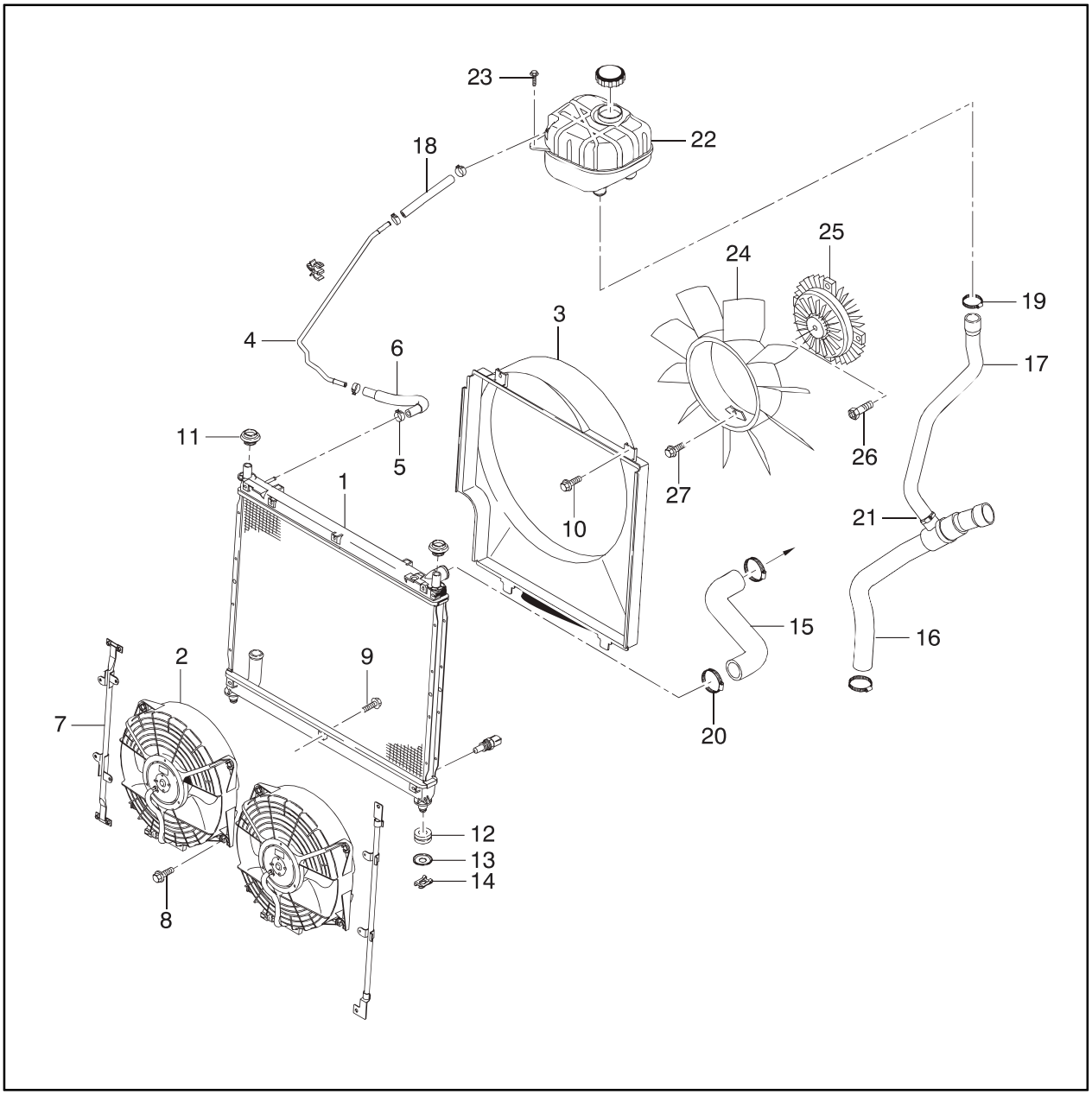
1. GENERAL DESCRIPTION

The cooling system maintains the engine temperature at an efficient level during all engine operating conditions. When the engine is cold, the cooling system cools the engine slowly or not at all. This slow cooling of the engine allows the engine to warm up quickly. The cooling system includes a radiator and recovery subsystem, cooling fans, a thermostat and housing, a water pump, and a water pump drive belt. The timing belt drives the water pump. All components must function properly for the cooling system to operation. The water pump draws the coolant from the radiator.

The coolant then circulates through water jackets in the engine block, the intake manifold, and the cylinder head. When the coolant reaches the operating temperature of the thermostat, the thermostat opens. The coolant then goes back to the radiator where it cools. This system directs some coolant through the hoses to the heat core. This provides for heating and defrosting. The coolant reservoir is connected to the radiator to recover the coolant displaced by expansion from the high temperatures. The coolant reservoir maintains the correct coolant level. The cooling system for this vehicle has no radiator cap or filler neck. The coolant is added to the cooling system through the coolant reservoir.

Modification basis	
Application basis	
Affected VIN	

2. COMPONENT LOCATOR



1. Radiator
2. Electric fan
3. Shroud
4. Deaeration tube
5. Clamp
6. Deaeration hose (radiator)
7. Electric fan mounting bracket
8. Bolt (M6, 8 pieces)
9. Bolt (M6, 4 pieces)
10. Bolt (M6, 4 pieces)
11. Upper radiator insulator
12. Lower radiator insulator
13. Plate
14. Clip
15. Inlet hose
16. Outlet hose
17. 3 way hose
18. Deaeration hose (reserver tank)
19. Clamp
20. Clamp
21. Make up hose holder
22. Reserver tank
23. Bolt (M6, 2 piece)
24. Cooling fan
25. Viscous clutch
26. Bolt (M6, 1 piece)
27. Bolt (M6, 3 piece)

Modification basis	
Application basis	
Affected VIN	

ENGINE ELECTRIC DEVICES 1452-01

GENERAL

1. GENERAL SPECIFICATIONS

Application			Unit	Gasoline Engine
Starter	Type		-	PG170S
	Output power		Kw	1.8
	No load test @ 12 volts		A	98
	Drive pinion speed at no load		rpm	2,600
	Drive pinion speed at load		rpm/A	1,087/380
	Brush length		mm	16.1
	Armature diameter		mm	54.1
	Armature run-out		mm	0.08
	Segment groove depth		mm	19.6
Alternator	Type		-	SG135
	Output voltage / current		V/A	14/115
	Regulator type		-	HYBRID
	Regulating voltage		V	14.7
	Brush	Length	mm	18.5
		Quantity	-	2
		Abrasion limit	mm	13.5
Battery	Type		-	MF
	Capacity		AH	75
	Reserve capacity		RC	130
Ignition coil	Type		-	DIS
	Primary coil resistance		W	0.3 ~ 0.9
	Secondary coil resistance		KW	6 ~ 8.5
Spark plug	Type		-	WR8DC
	Clearance		-	0.8 ~ 0.9
High tension cable	Resistance		KW/m	1.9

2. FASTENER TIGHTENING SPECIFICATIONS

Application	Nm	Lb-Ft	Lb-In
Batter cable nut	12 ~ 18	9 ~ 13	-
Battery cable nut on starter	12 ~ 15	9 ~ 11	-
Batter mounting bracket nut	12 ~ 18	9 ~ 13	-
Engine electric wire nut on starter	6 ~ 7	-	53 ~ 62
Alternator combination bolt	42 ~ 50	31 ~ 37	-
Alternator terminal b+ nut	14 ~ 18	10 ~ 13	-
Alternator terminal d+ nut	4 ~ 5	-	35 ~ 44
Ignition cable cover bolt	9 ~ 11	-	80 ~ 97
Ignition coil bolt	9 ~ 11	-	80 ~ 97
Spark plug	25 ~ 30	15 ~ 22	-
Starter mounting bolt	35 ~ 48	26 ~ 35	-

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. CHARGING SYSTEM OPERATION

Alternators use a new type of regulator that incorpo-rates a diode trio. A Delta stator, a rectifier bridge, and a rotor with slip rings and brushes are electrically similar to earlier alternators.
A conventional pulley and fan are used. There is no test hole.

1) CHARGING TIME REQUIRED

The time required to charge a battery will vary depending upon the following factors:

▶ Size of Battery
- A Completely discharged large heavy-duty battery required more than twice the recharging time as a completely discharged small passenger car battery.

▶ Temperature
- A longer time will be needed to charge any battery at −18°C (0°F) than at 27°C (80°F). When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first. The battery will accept a higher current rate as the battery warms.

▶ Charger Capacity
- A charger which can supply only 5 amperes will require a much longer charging period than a charger that can supply 30 amperes or more.

▶ State-of-Charge
- A completely discharged battery requires more than twice as much charge as a onehalf charged battery. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted by the battery is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.

2. STARTING SYSTEM OPERATION

The engine electrical system includes the battery, the ignition, the starter, the alternator, and all the related wiring. Diagnostic tables will aid in troubleshooting system faults. When a fault is traced to a particular component, refer to that component section of the service manual. The starting system circuit consists of the battery, the starter motor, the ignition switch, and all the related electrical wiring. All of these components are connected electrically.

3. IGNITION SYSTEM OPERATION

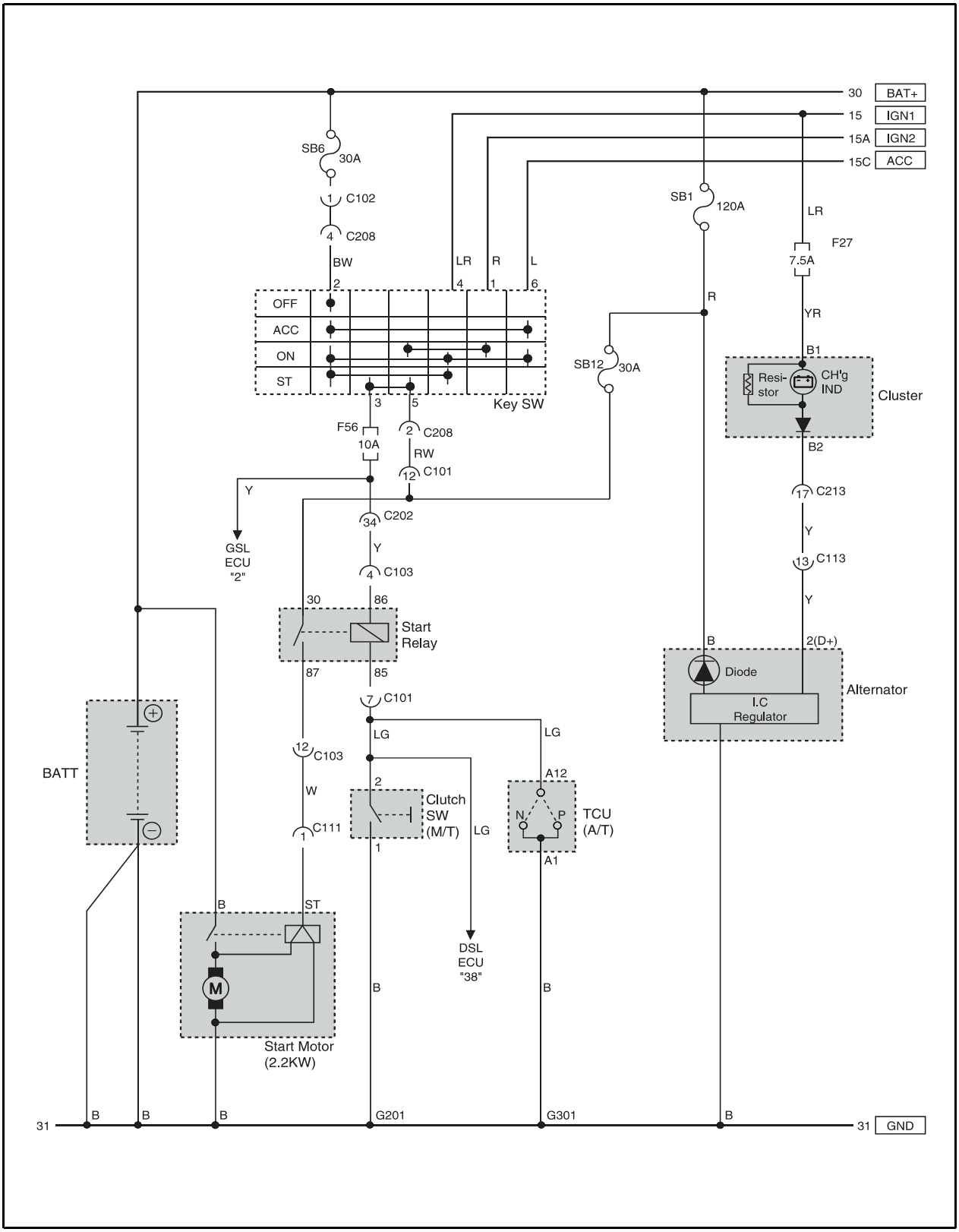
This ignition system does not use a conventional distributor and coil. It uses a crankshaft position sensor input to the Engine Control Module (ECM).
The ECM then determines Electronic Spark Timing (EST) and triggers the electronic ignition system ignition coil.
This type of distributorless ignition system uses a "waste spark" method of spark distribution. Each cylinder is paired with the cylinder that is opposite it (2.3L DOHC: 2 - 3 or 1 - 4, 3.2L DOHC: 1 - 6 or 2 - 5 or 3 - 4).
The spark occurs simultaneously in the cylinder coming up on the compression stroke and in the cylinder coming up on the exhaust stroke.
The cylinder on the exhaust stroke requires very little of the available energy to fire the spark plug.
The remaining energy is available to the spark plug in the cylinder on the compression stroke. These systems use the EST signal from the ECM to control the EST.
The ECM uses the following information: Engine load (mass air flow sensor, manifold air pressure sensor).
Engine coolant temperature.
Intake air temperature.
Crankshaft position.
Engine speed (rpm).

1) Electronic Ignition System Ignition Coil

The Electronic Ignition (EI) system ignition coil is located on the cylinder head cover.
The double ended coils re ceive the signal for the ECM which controls the spark advance.
Each EI system ignition coil provides the high voltage to two spark plugs simultaneously;
3.2L DOHC
T1/1: cylinder 2 and 5
T1/2: cylinder 3 and 4
T1/3: cylinder 1 and 6
The EI system ignition coil is not serviceable and must be replaced as an assembly.

Modification basis	
Application basis	
Affected VIN	

4. STARTING AND CHARGING SYSTEM (GASOLINE ENGINE) CIRCUIT



Modification basis	
Application basis	
Affected VIN	

ENGINE CONTROL SYSTEM

1522-16

GENERAL

1. ENGINE DATA DISPLAY TABLE

Parameter	Unit	Value
Engine coolant temp.	℃	greater than 95℃ after warm up
Intake air temp.	℃	-40 ~ 130℃ (varies with ambient temp. or engine mode)
Engine rpm	rpm	700 ± 50 (P/N), 600 ± 50 (D)
Regular rpm	rpm	700 ± 50 (P/N), 600 ± 50 (D)
Engine load	%	18 ~ 25 %
Mass air flow meter	Kg/h	16 ~ 25 Kg/h
Throttle position angle	℃TA	0℃TA (up to 100℃TA at the wide open throttle)
Spark advance	℃CA	℃CA (6 ~ 9℃CA)
Indicated engine torque	Nm	Varies with engine condition
Injection time	ms	3 ~ 5 ms
Battery voltage	V	13.5 ~ 14.1V (engine running)
Front axle speed	Km/h	0 ~ 265 Km/h
Rear axle speed	Km/h	0 ~ 265 Km/h
Accel. Pedal position 1	V	0.4 ~ 4.8 V
Accel. Pedal position 2	V	0.2 ~ 2.4 V
Throttle position 1	V	0.3 ~ 4.6 V
Throttle position 2	V	0.3 ~ 4.6 V
Fuel integrator		0.8 ~ 1.2
Oxygen sensor	mv	100 ~ 900 mv
A/c s/w condition	1=ON/0=OFF	-
Full load state	1=ON/0=OFF	-
Shift gear state (A/T)	1=ON/0=OFF	-
A/c control state	1=ON/0=OFF	-
Clutch switch (M/T)	1=ON/0=OFF	-
Cam actuator state	1=ON/0=OFF	-
Knocking control	1=ON/0=OFF	-
Protect mission	1=ON/0=OFF	-
Purge control valve	1=ON/0=OFF	-
Lambda function	1=ON/0=OFF	-
Catalyst heating	1=ON/0=OFF	-
Overrun fuel cut	1=ON/0=OFF	-
Full fuel cut	1=ON/0=OFF	-
Brake switch	1=ON/0=OFF	-
Cruise control status	1=ON/0=OFF	-

* Condition: Warmed up, idle, P/N or neutral

1) TEMPERATURE VS RESISTANCE

℃	°F	ECT Sensor	IAT Sensor
		ohms (Ω)	
Temperature vs Resistance Values (Approximate)			
130	266	88	102
120	248	111.6	127
110	230	143	159
100	212	202	202
90	194	261	261
80	176	340	340
70	158	452	452
60	140	609	609
50	122	835	835
40	113	1166	1166
30	86	1662	1662
20	68	2420	2420
10	50	3604	3604
0	32	5499	5499
-10	14	8609	8609
-20	-4	13850	13850
-30	-22	22960	22960
-40	-40	39260	39260

2. FASTENER TIGHTENING SPECIFICATIONS

Application	Nm	Lb-Ft	Lb-In
Camshaft position sensor retaining bolts	10	-	89
Canister mounting bolts	6	-	53
Coolant temperature sensor	30	22	-
Crankshaft position sensor retaining bolt	10	-	89
Engine Control Module (ECM) mounting bracket nuts	10	-	89
Fuel filter mounting bracket bolt	6	-	53
Fuel filter lines	28	21	-
Fuel pressure test connector	25	18	-
Fuel rail assembly bolts	25	18	-
Fuel return and supply lines	23	17	-
Fuel tank retaining nuts	38	28	-
Intake air duct mounting bolts	9	-	80
Knock sensor mounting bolt	25	18	-
Oxygen sensor	55	41	-
Pedal position censor mounting bolts and nut	6	-	53
Throttle body bolts	12	-	106

Modification basis	
Application basis	
Affected VIN	

CRUISE CONTROL SYSTEM 8510-23

OVERVIEW AND OPERATION PROCESS

1. CRUISE CONTROL SWITCH

The purpose of the cruise control system is to automatically maintain a vehicle speed set by the driver, without depressing the accelerator pedal. The cruise control switch is located under the right side of the steering wheel, and when this switch is operating "AUTO CRUISE" lamp comes on.

The minimum speed for setting the cruise control system is 36 km/h (22.37 mph). Pay constant attention to the distance between the vehicles and the traffic conditions when using the cruise control system.

CAUTION

The cruise control system is a supplementary system, which helps the driver to drive the vehicle at a desired speed without using the accelerator pedal under the traffic condition where the vehicle-to-vehicle distance meets the legal requirement.

1) When To Use

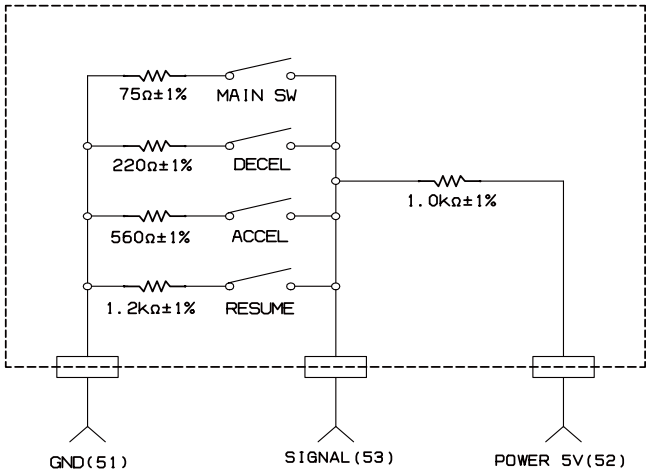
Use the cruise control system only when (a) the traffic is not jammed, (b) driving on motorways or highways where there is no sudden change in the driving condition due to traffic lights, pedestrian, etc.

WARNING

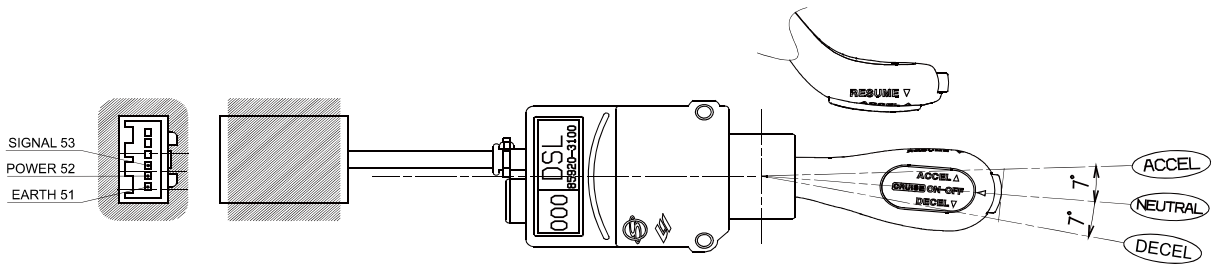
Use the cruise control system only when driving on motorways or highways. Do not use the cruise control system where the road conditions are as follows:
- When there is strong wind or cross wind.
- Heavy traffic.
- Slippery roads or steep decline.

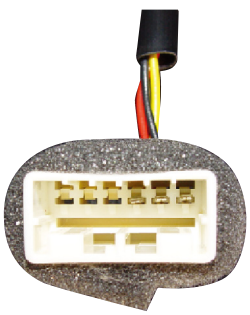
Modification basis	
Application basis	
Affected VIN	

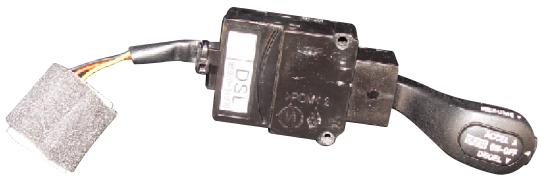
2. CIRCUIT DIAGRAM



1) Configuration







3. HOW TO OPERATE CRUISE CONTROL SWITCH

1) How To Set Speed

1. To operate the cruise control system, accelerate the vehicle to the speed within the specified range below with depressing the accelerator pedal.
   - Cruise control operating range: between 36 km/h (22.37 mph) and 150 km/h (93.207 mph)
2. When the desired speed is reached, which should be within the above range, push up the cruise control switch lever to ACCEL side (upwards arrow), or push down the switch lever to DECEL side (downwards arrow).
   And then release the accelerator pedal slowly.
3. Now the vehicle is cruised by this system with the set speed. You don't need to use the accelerator pedal.
4. Refer to the following pages for details of operation.

CAUTION

Never use the cruise control system until you get used to it.
Improper use or not fully aware of this function could result in collision and/or personal injuries.

Modification basis	
Application basis	
Affected VIN	

2) Accelerating with the Cruise Control System

(1) While the cruise control system is running

1. To increase the set speed, push up the cruise control switch lever to ACCEL side and hold it until the desired speed is reached without depressing the accelerator pedal.
2. When the desired speed is set, release the switch lever.

(2) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

1. Accelerate the vehicle to more than 36 km/h (22.37 mph) using the accelerator pedal. Push up the cruise control switch lever to ACCEL side and hold it.
2. When the desired speed is reached, release the accelerator pedal and the switch lever.

(3) Tap-up while the cruise control system is running

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

1. Push up the cruise control switch lever to ACCEL side for less than 0.5 second per one switching while the cruise control system is running; the speed increases each time by 1.3 km/h (0.81 mph).
2. For example, if you want to increase the speed 13 km/h (81 mph) more than the previous set speed, tap up the switch lever to ACCEL side ten times without using the accelerator pedal.

3) Decelerating with the Cruise Control System

(1) While the cruise control system is running

1. To decrease the set speed, push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached without depressing the brake pedal.
   But the cruise control system cannot maintain the cruise function at less than 34 km/h (21.13 mph).
2. When the desired speed is set, release the switch lever.

(2) When the cruise control system is not running

To decrease the speed with the cruise control system while the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 36 km/h (22.37 mph).
2. When the desired speed is reached, release the switch lever.
3. But the cruise control system cannot maintain the cruise function at less than 34 km/h (21.13 mph).

(3) Tap-down while the cruise control system is running

To decrease the vehicle speed in stages while the cruise control system is running, follow the below procedures.

1. Push down the cruise control switch lever to DECEL side for less than 0.5 second per one switching while the cruise control system is running; the speed decreases each time by 1.0 km/h (0.62 mph).
2. For example, if you want to decrease the speed 10 km/h (62 mph) lower than the previous set speed, tap down the switch lever to DECEL side ten times without using the brake pedal.

Modification basis	
Application basis	
Affected VIN	

4) Recovery of Set Speed (RESUME)

Even if the cruise control is cancelled, the previous set cruise speed can be recovered by operating the cruise control switch lever like below:
- Pull the switch lever in the arrow direction shown in the illustration.

This RESUME function works only when the vehicle speed is more than 36 km/h (22.37 mph) without using the accelerator or brake pedal.

CAUTION

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

5) Normal Cancellation of the Cruise Control (OFF ↔ ON)

The cruise control system will be cancelled when the button on the side of the switch is pressed, or when one of the following conditions is met:

1. When the brake pedal is depressed or ESP is activated.
2. When the vehicle speed is less than 34 km/h (21.13 mph).
3. When the parking brake is applied while driving.
4. When the clutch pedal is depressed for shifting (M/T only).

CAUTION

Put the cruise control switch lever in the neutral position when not using the cruise control system.

(1) Abnormal Cancellation of the Cruise Control

1. When the rapid deceleration or acceleration occurs.
2. When the cruise control lever is faulty.
3. When the brake switch is malfunctioning or has an open circuit.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

- Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
- Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
- The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
- Ensure that the braking distance is maintained and use the brake pedal if needed.

Modification basis	
Application basis	
Affected VIN	

ENGINE ASSEMBLY 1113-01

GENERAL

1. DESCRIPTION AND OPERATION

1) Cleanliness and Care

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten-thousanths of an inch.
When any internal engine parts are serviced, care and cleanliness are important.
A liberal coating of enigne oil should be applied to friction areas during assembly, to protect and lubricate the surfaces on initial operation. Proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure.
This is considered standard shop practice even if not specifically stated.
Whenever valve train components are removed for service, they should be kept in order. They should be installed in the same locations, and with the same mating surfaces, as when they were removed.
Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.

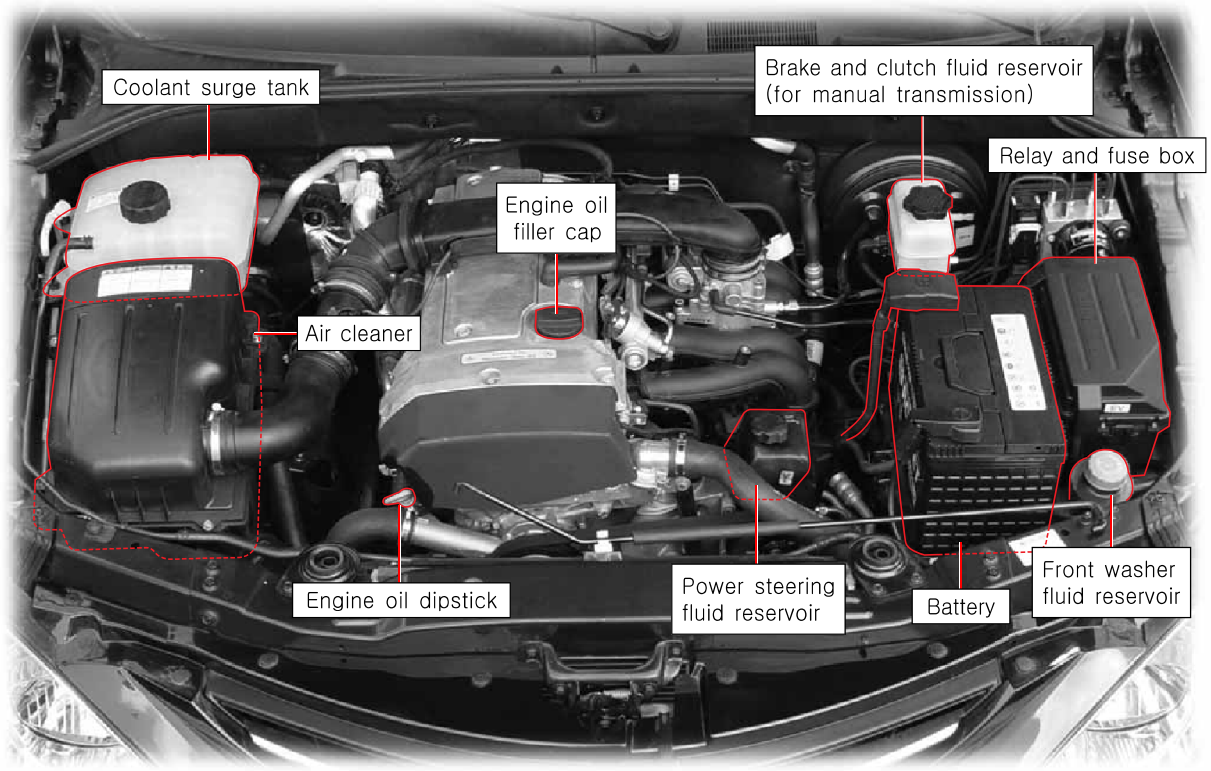
2) On-engine Service

CAUTION

- Disconnect the negative battery cable before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

CAUTION

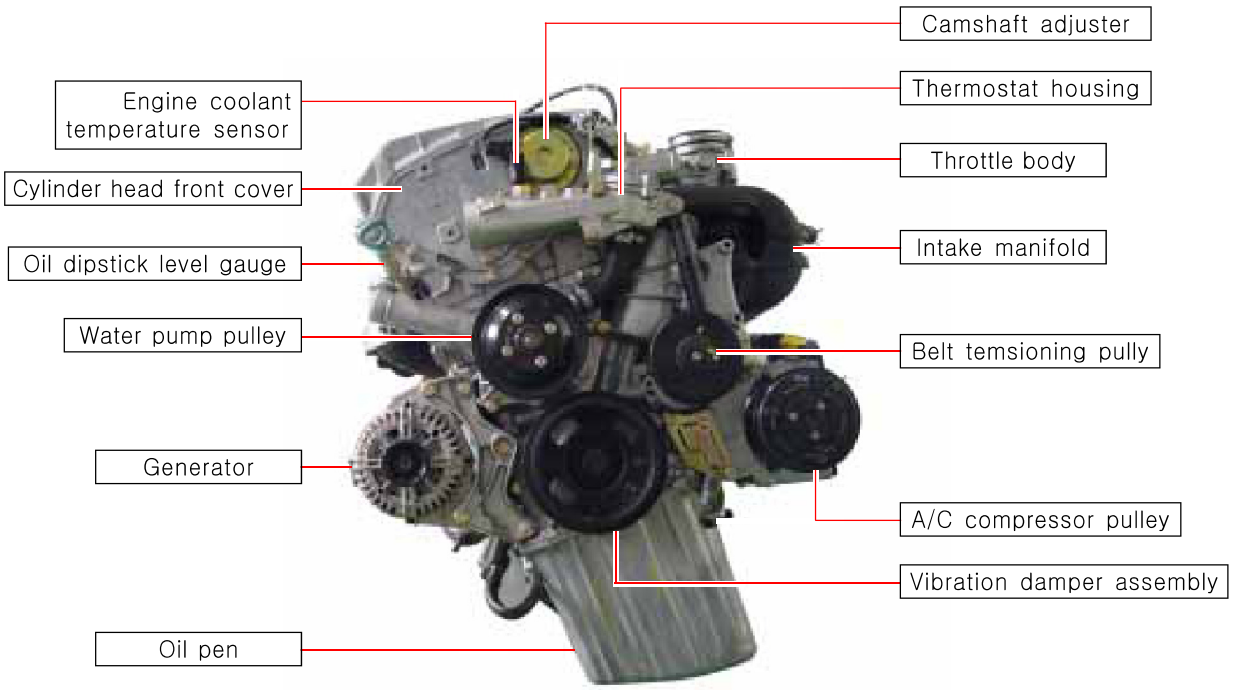
- Any time the air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material, which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.



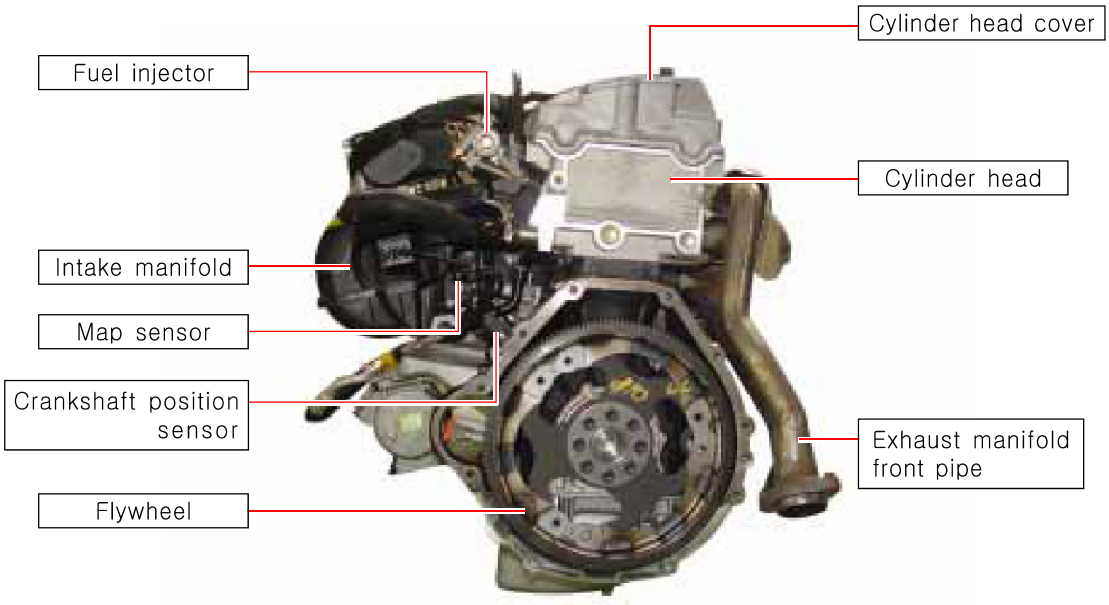
Modification basis	
Application basis	
Affected VIN	

2. G23D ENGINE ASSEMBLY

Front View

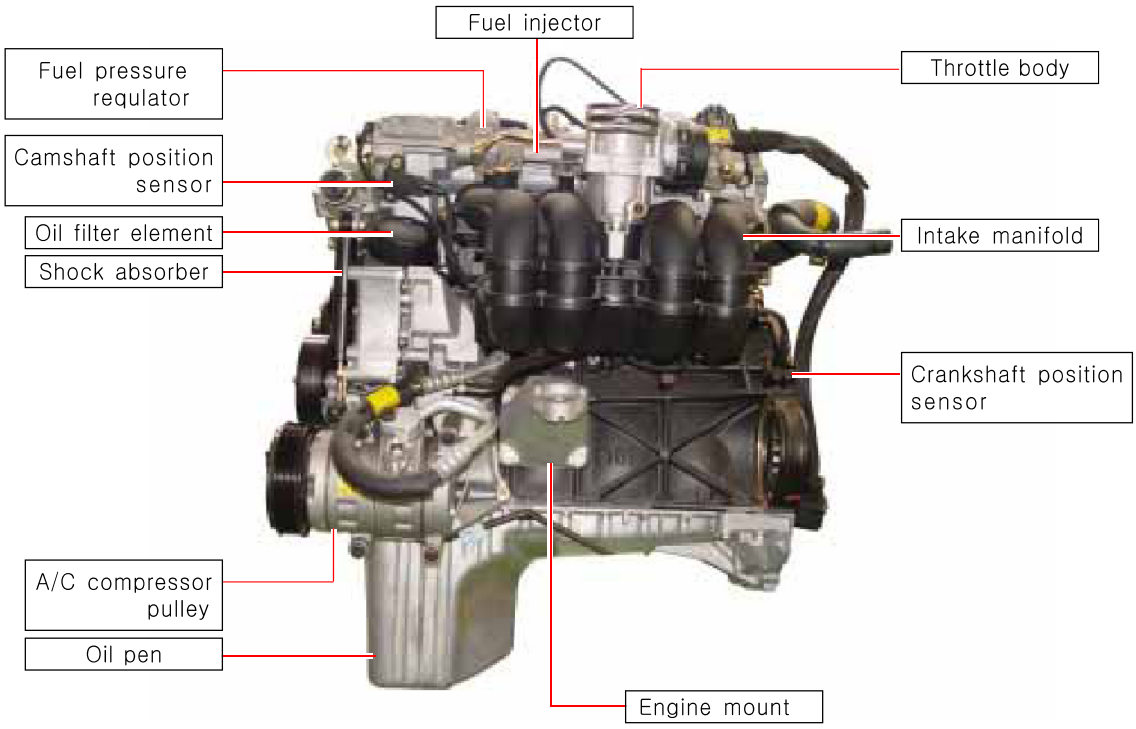


Rear View

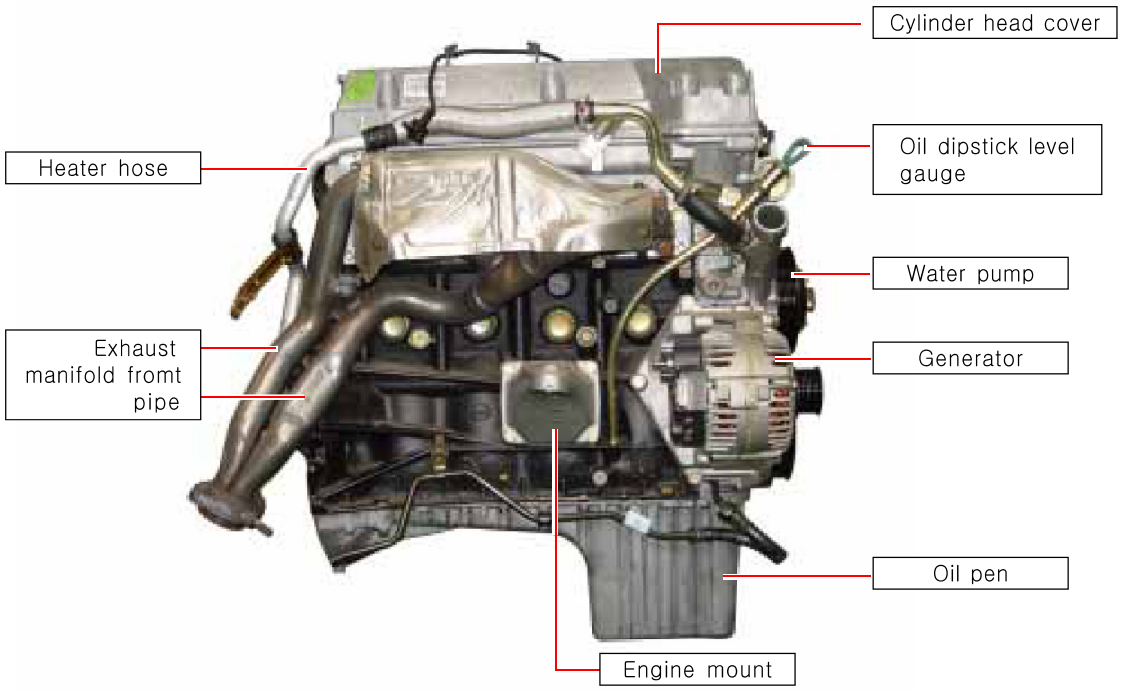


Modification basis	
Application basis	
Affected VIN	

LH Side View



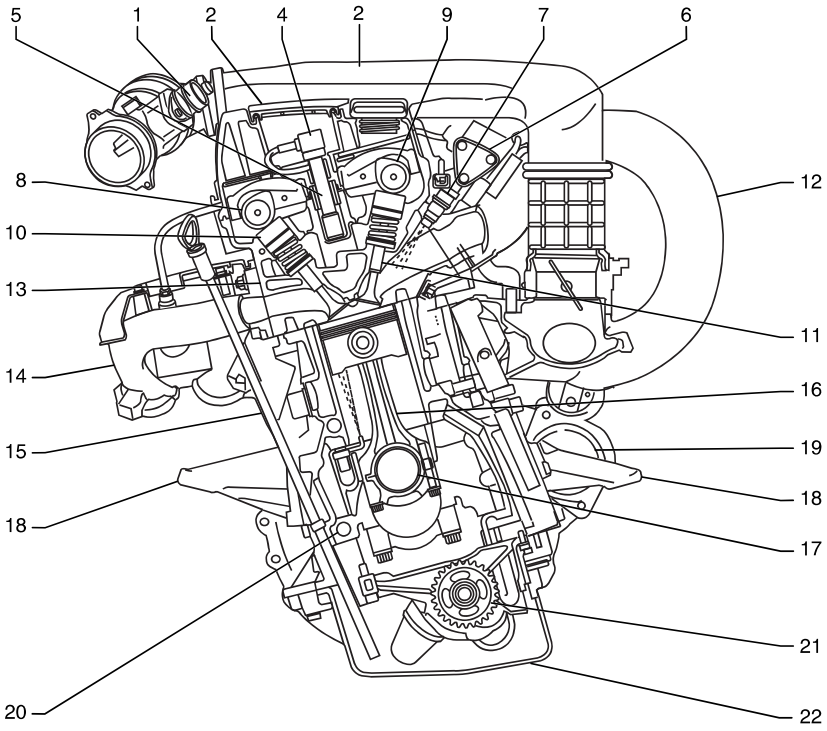
RH Side View



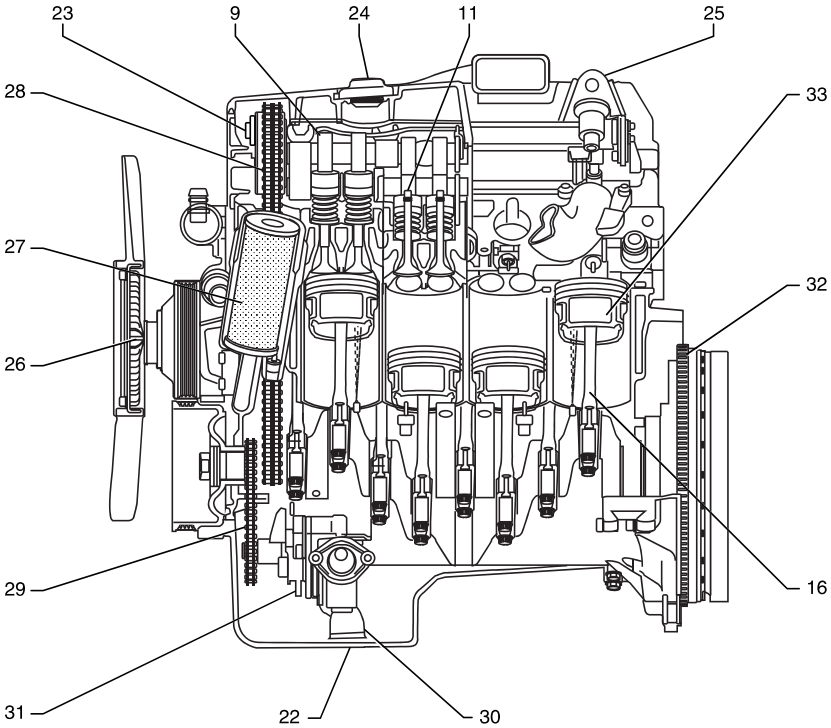
Modification basis	
Application basis	
Affected VIN	

3. G23D ENGINE STRUCTURE

Front View



Side View



▶ **Front View**

NO.	FUNCTION	NO.	FUNCTION
1	HFM Sensor	12	Intake Manifold
2	Intake Air Duct	13	Cylinder Head
3	Cylinder Head Cover	14	Exhaust Manifold
4	Ignition Coi	15	Dipstick Guide Tube and Gauge
5	Spark Plug Connector	16	Connecting Rod
6	Fuel Distributor	17	Crankshaft
7	Injector	18	Engine Mounting Bracket
8	Exhaust Camshaft	19	Starter
9	Intake Camshaft	20	Crankcase
10	Valve Tappet	21	Oil Pump Sprocket
11	Intake Valve	22	Oil Pan

▶ **Side View**

NO.	FUNCTION	NO.	FUNCTION
23	Camshaft Adjuster	29	Oil Pump Drive Chain
24	Oil Filler Cap	30	Oil Strainer
25	Engine Hanger Bracket	31	Oil Pump
26	Cooling Fan and Viscous Clutch	32	Ring Gear and Flywheel of Drive Plate
27	Oil Filter	33	Piston
28	Timing Chain		

Modification basis	
Application basis	
Affected VIN	

4. DIAGNOSTIC INFORMATION AND PROCEDURE

1) Oil Leak Diagnosis

Most fluid oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the necessary parts. On some occasions a fluid leak may be difficult to locate or repair. The following procedures may help you in locating and repairing most leaks.

▶ Finding the Leak

- Identify the fluid. Determine whether it is engine oil, automatic transmission fluid, power steering fluid, etc.
- Identify where the fluid is leaking from.
  · After running the vehicle at normal operating temperature, park the vehicle over a large sheet of paper.
  · Wait a few minutes.
  · You should be able to find the approximate location of the leak by the drippings on the paper.
- Visually check around the suspected component.
  Check around all the gasket mating surfaces for leaks. A mirror is useful for finding leaks in areas that are hard to reach.
- If the leak still cannot be found, it may be necessary to clean the suspected area with a degreaser, steam or spray solvent.
  · Clean the area well.
  · Dry the area.
  · Operate the vehicle for several miles at normal operating temperature and varying speeds.
  · After operating the vehicle, visually check the suspected component.
  · If you still cannot locate the leak, try using the powder or black light and dye method.

▶ Powder Method

- Clean the suspected area.
- Apply an aerosol-type powder (such as foot powder) to the suspected area.
- Operate the vehicle under normal operating conditoins.
- Visually inspect the suspected component. You should be able to trace the leak path over the white powder surface to the source.

▶ Black Light and Dye Method

A dye and light kit is available for finding leaks, Refer to the manufacturer's directions when using the kit.

- Pour the specified amount of dye into the engine oil fill tube.
- Operate the vehicle normal operating conditions as directed in the kit.
- Direct the light toward the suspected area. The dyed fluid will appear as a yellow path leading to the source.

▶ Repairing the Leak

Once the origin of the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly.

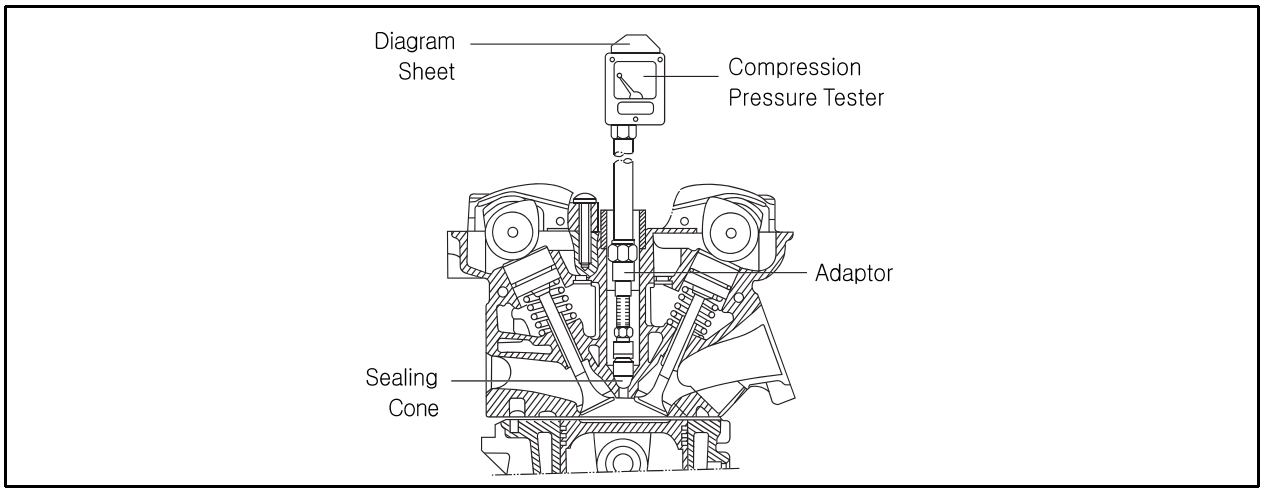
If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check for the following conditions and correct them as they may cause a leak.

▶ Gaskets

- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The seal bore is damaged (scratched, burred or nicked).
- The seal is damaged or worn.
- Improper installation is evident.
- There are cracks in the components.
- The shaft surface is scratched, nicked or damaged.
- A loose or worn bearing is causing excess seal wear.

Modification basis	
Application basis	
Affected VIN	

2) Compression Pressure Test



▶ Standard Service Data

Application	G23D Engine
Compression Ratio	10.4 : 1
Normal Engine Temperature	←
Normal Compression Pressure	Min. 11 bar, Max. 15 bar
Permissible Pressure Difference Between Individual C ylinders	←

CAUTION

- A9912 0012B (001 589 76 21 00) Compression Pressure Tester

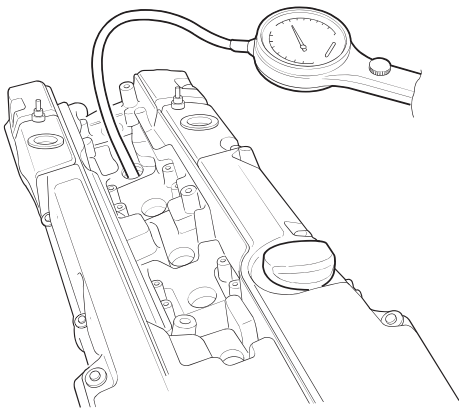
▶ Measuring Procedure

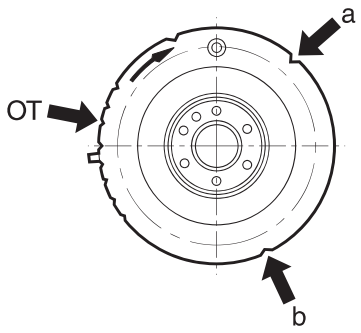
- Warm the engine up to normal operating temperature.
- Remove the spark plugs using the spark plug wrench.
- Place the diagram sheet to compression pressure tester A9912 0012B (001 589 76 21 00).
- Connect the adaptor to compression pressure tester A9912 0012B (001 589 76 21 00) and install it into the spark plug hole.
- Crank the engine approx. eight revolutions by using the start motor.
- Compare the measurements of compression pressure tester A9912 0012B (001 589 76 21 00) with the specifications.
- Measure the compression pressure of the other cylinders in the same way.
- If measured value is not within the specifications, perform the cylinder pressure leakage test.

CAUTION

- Discharge the combustion residues in the cylinders before testing the compression pressure.
- Apply the parking brake before cranking the engine.

3) Cylinder Pressure LeakageTest





▶ **Permissible Pressure Leakage**

At Whole Engine	Max. 25 %
At Valve and Cylinder Head Gasket	Max. 10 %
At Piston and Piston Ring	Max. 20 %

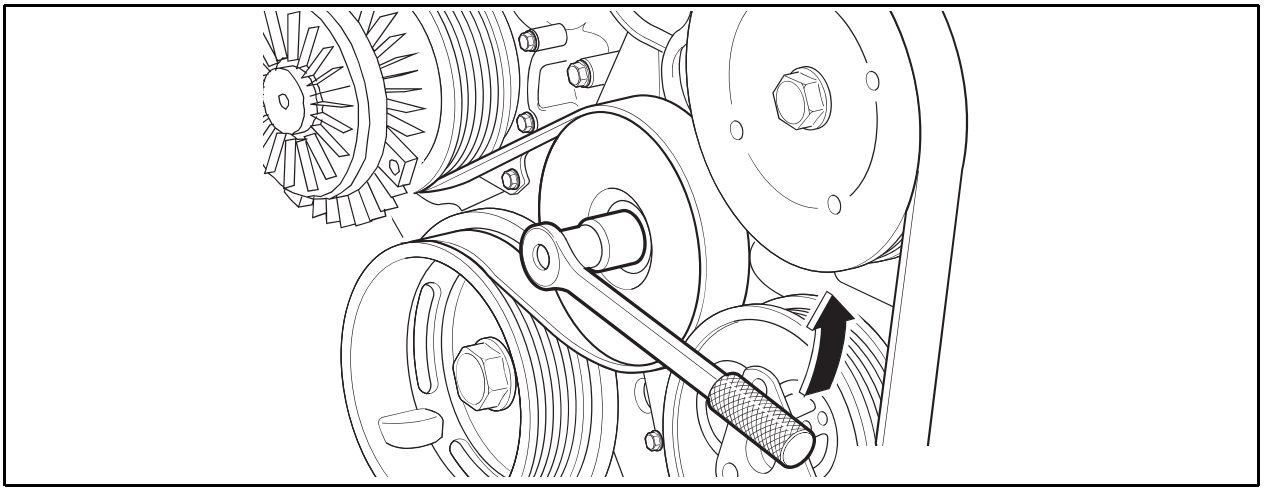
▶ **Cylinder Number**

OT (TDC)	1, 4
UT (BDC 180 °)	2, 3

▶ **Cylinder Number**

Cylinder Pressure Leakage Tester	Bosch, EFAW210A Sun, CLT 228

Modification basis	
Application basis	
Affected VIN	



▶ **Leakage Test**

- Warm the engine up to normal operating temperature.
- Disconnect the negative battery cable.
- Remove the spark plugs.
- Check the coolant level by opening the coolant reservoir cap and replenish if insufficient.
- Open the engine oil filler cap.
- Connect the tester to air pressure line and adjust the scale of tester.
- Install the connecting hose to spark plug hole.
- Position the piston of No.1 cylinder at TDC by rotating the crankshaft.
- Connect the connecting hose to tester and measure the leakage volume after blowing up 5 bar of compressed air.

CAUTION

- Measure the leakage volume in the completely opening condition of throttle valve by pulling the acceleration cable.

- Perform the pressure test according to the firing order.

CAUTION

- Firing Order: 1 - 3 - 4 - 2

- Compare the leakage pressure with the specifications.

5. GENERAL DIAGNOSIS

Condition		Probable Cause	Correction
Hard starting (With normal cranking)	Malfunction of immobilizer system	• Faulty immoblilzer system	• Check (Antenna, Immobilizer transponder) • Replace (Antenna, Immobilizer transponder)
	Malfunction of ignition system	• Faulty fuse	• Replace the fuse.
		• Faulty spark plug.	• Clean, adjust the plug gap or replace.
		• Electric leakage at the high tension cable.	• Replace the cable.
		• Poor connection of the high tension cable or lead wires.	• Replace the cable or wires.
		• Faulty ignition coil.	• Replace the ignition coil.
	Malfunction of fuel system	• Empty of fuel in the fuel tank.	• Feed the fuel.
		• Dirty or clogged fuel filter.	• Replace the filter.
		• Clogged fuel pipe.	• Clean the fuel pipe.
		• Malfunction of the fuel pump.	• Replace the fuel pump.
		• Malfunction of the fuel injector.	• Replace the injector.
		• The foreign material in the fuel tank.	• Clean the fuel tank.
	Decline of compression pressure	• Poor tightening spark plug.	• Tighten to the specified torque. Compression
		• Cracked cylinder head gasket.	• Replace the gasket.
		• Inadequate the valve clearance.	• Adjust the clearance.
		• Leakage of the valve clearance.	• Repair the valve.
		• Interference of the valve stem.	• Replace the valve or the valve guide.
		• Low elasticity or damage of the valve spring.	• Replace the valve spring.
		• Abnormal interference of pistons and cylinders.	• Replace the piston ring.
		• Excessive wear of pistons, rings, or cylinders.	• Replace the ring or the piston and boring or replace the cylinder.
	Others	• Broken timing belt.	• Replace the belt.
		• Loosening, damage or leakage of the vacuum hose.	• Connect the hose correctly or replace it.
		• Leakage of intake system.	• Replace intake system.
Lack of engine power	Decline of compression pressure	• Refer to above in this page.	• Refer to above in this page.
	Malfunction of ignition system	• Faulty spark plug.	• Adjust or replace the spark plug.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable correctly or replace it.

Modification basis	
Application basis	
Affected VIN	

▶ General Diagnosis (Cont'd)

Condition		Probable Cause	Correction
Lack of engine power	Malfunction of fuel system	• Clogged fuel pipe.	• Clean the pipe.
		• Clogged or contaminated fuel filter.	• Replace the filter.
	Others	• Clogged exhaust system.	• Check and repair the system.
		• Clogged or contaminated air cleaner element.	• Clean or replace the air cleaner element.
		• Leak of the intake manifold gasket.	• Replace the gasket.
		• Dragging brakes.	• Repair or replace the brakes.
Rough engine idling	Decline of compression pressure	• Refer to "Page 1A-7".	• Refer to "Page 1A-7".
	Malfunction of fuel system	• Clogged fuel pipe.	• Clean the pipe.
		• Clogged or contaminated fuel filter.	• Replace the filter.
		• Malfunction of the fuel pressure regulator.	• Replace the regulator.
	Malfunction of ignition system	• Malfunction of the spark plug.	• Adjust or replace the spark plug.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable correctly or replace it.
		• Malfunction of the ignition coil.	• Replace the ignition coil.
	Others	• Clogged or contaminated air cleaner element.	• Clean or replace the air cleaner element.
		• Leak of the intake manifold gasket.	• Replace the gasket.
		• Poor connection or damage or leakage of the vacuum hose.	• Connect the hose correctly or replace it.
Engine hesitate (Upon pressing accelerating pedal, the engine makes delayed response This situation is remarkable when cruising or starting.)	Decline of compression pressure	• Refer to "Page 1A-7".	• Refer to "Page 1A-7".
	Malfunction of ignition system	• Poor spark plug or Poor adjustment of the plug gap.	• Replace the plug or adjust the gap.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable correctly or replace it.
	Others	• Malfunction of the air cleaner system.	• Clean or replace the air cleaner system.
		• Leak of the intake manifold gasket.	• Replace the gasket.

▶ General Diagnosis (Cont'd)

Condition		Probable Cause	Correction
Engine surging (Engine power makes fluctuation in a fixed speed and speed changes without operating the accelerating pedal.)	Decline of compression pressure	• Refer to "Page 1A-7".	• Refer to "Page 1A-7".
	Malfunction of fuel system	• Clogged fuel pipe.	• Clean the pipe.
		• Clogged or contaminated fuel filter.	• Replace the filter.
		• Malfunction of the fuel pressure regulator.	• Replace the fuel pressure regulator.
	Malfunction of ignition system	• Malfunction of the spark plug.	• Adjust or replace the spark plug.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable correctly or replace it.
		• Poor ignition timing.	• Adjust the ignition timing.
	Others	• Leak of the intake manifold gasket.	• Clean or replace the gasket.
		• Leakage of the vacuum hose.	• Connect the hose correctly or replace it.
Excessive detonation (According to the opening range of Malfunction of metallic is made with abnormal explosion)	Overtheated engine	• Refer to "Overheat" in this page.	• Refer to "Overheat" in this page.
	Malfunction of fuel system	• Abnormal spark plug.	• Replace the spark plug.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable correctly or replace it.
	Malfunction of ignition system	• Clogged or contaminated fuel filter and fuel pipe.	• Clean or replace the fuel filter and the fuel pipe.
	Others	• Leak of the intake manifold gasket.	• Replace the gasket.
		• Excessive carbon deposit due to abnormal combustion.	• Remove the carbon.
Overheat	Malfunction of cooling system	• Lack of coolant.	• Refill coolant.
		• Malfunction of the thermostat.	• Replace the thermostat.
		• Malfunction of the cooling fan.	• Check or replace the cooling fan.
		• Poor water pump performance.	• Replace the pump.
		• Clogged or leaky radiator.	• Clean, repair or replace the radiator.
	Malfunction of lubrication system	• Poor engine oil.	• Replace engine oil with the specified one.
		• Blocking oil filter or strainer.	• Clean or repair the oil filter or the strainer.
		• Lack of engine oil.	• Refill oil.
		• Poor oil pump performance.	• Replace or repair the pump.
	Other	• Leakage of oil	• Repair.
		• Damaged cylinder head gasket.	• Replace the gasket.

Modification basis	
Application basis	
Affected VIN	

▶ General Diagnosis (Cont'd)

Condition		Probable Cause	Correction
Poor fuel consumption	Decline of compression pressure	• Refer to "Page 1A-7".	• Refer to "Page 1A-7".
	Malfunction of fuel system	• Leakage of the fuel tank or the fuel pipe.	• Repair or replace the fuel tank or the fuel pipe
	Malfunction of ignition system	• Abnormal spark plug (Excessive carbon deposit, inadequate gap, burnt electrode).	• Replace the plug.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable normally or replace it.
	Malfunction of cooling system	• Malfunction of the thermostat.	• Repair the thermostat.
	Others	• Improperly installed valve.	• Repair or replace the valve.
		• Low pressure of tires.	• Adjust the pressure of tires.
Excessive consumption of engine oil	Leakage of engine oil	• Loosened oil drain plug.	• Tighten the plug.
		• Loosened oil pan bolt.	• Tighten the bolt. Engine Oil
		• Loosened oil filter.	• Tighten the filter.
		• Loosened oil pressure switch.	• Tighten the switch.
		• Leakage of camshaft front oil seal.	• Replace the seal.
		• Leakage of crankshaft front oil seal.	• Replace the seal.
		• Leakage at the cylinder head cover gasket.	• Replace the gasket.
		• Damage of the cylinder head gasket.	• Replace the gasket.
	Oil mixing in combustion chamber	• Stuck piston ring.	• Remove carbon and replace the ring.
		• Worn piston or cylinder.	• Replace the piston or the cylinder.
		• Worn piston ring or ring groove.	• Replace the piston or ring.
		• Inadequate position of the piston ring cutting part.	• Adjust the position.
		• Abrasion or damage of the valve system.	• Replace the valve system.
Low oil pressure	Malfunction of lubrication system	• Inadequate oil viscosity.	• Replace with the specified one.
		• Loosening of the oil pressure switch.	• Tighten the switch.
		• Lack of engine oil.	• Refill oil.
		• Blocking oil strainer.	• Clean the strainer.
		• Lowered function of the oil pump.	• Replace the pump.
		• Abrasion or damage of the oil pump relief valve.	• Replace the valve.

▶ General Diagnosis (Cont'd)

Condition		Probable Cause	Correction
Engine noise	Valve noise	• Inadequate valve clearance	• Adjust the valve clearance.
		• Abrasion of valve stem or guide.	• Replace the valve stem or the guide.
		• Weak valve spring.	• Replace the spring.
	Piston, ring, cylinder noise	• Abrasion of the piston, the ring or the cylinder.	• Boring the cylinder or replace the piston, the ring or the cylinder.
	Connecting rod noise	• Abrasion of the connecting rod bearing.	• Replace the bearing.
		• Loosened the connecting rod nut.	• Tighten to the specified torque
	Crankshaft noise	• Abrasion of the crankshaft bearing.	• Replace the bearing.
		• Abrasion of the crankshaft journal.	• Grind or replace the crankshaft journal.
		• Loosened bearing cap bolt.	• Tighten to the specified torque.
		• Excessive clearance of the crankshaft thrust bearing.	• Adjust or replace.

Modification basis	
Application basis	
Affected VIN	

6. SPECIFICATIONS

1) Engine Specifications

Application			G23D Engine	Remarks
Engine Model			M161.970	
Displacement			2295 cc	
Cylinder (Bore x Stroke)			90.9 x 88.4 mm	
Fuel Injection / Ignition System			MSE 3.53D	
Compression Ratio			10.4 : 1	
Number of Cylinders			4	
Camshaft Valve Arrangement			DOHC	
Camshaft Drive Type			Chain-Driven	
Max. Output			149 ps / 5500 rpm	
Max. Torque			22.4 kg•m / 4000 rpm	
Firing Order			1 - 3 - 4 - 2	
Ignition Type			Distributor less double ignition	
Ignition Timing			BTDC 6° ± 2°	
Valve Timing	Intake	Open/Close	ATDC 13.15° / ABDC 13.57°	
	Exhaust	Open/Close	BBDC 16.58° / BTDC 17.05°	
Valve Clearance Adjustment			←	
Idle Speed			750 ± 50 rpm	
Fuel Injection Pressure			3.2 - 4.2 kg/cm²	
Oil Capacity			7.5 ℓ	
Lubrication Type			Forced by gear pump	
Oil Filter Type			Full flow with paper filter	
Fuel			Unleaded gasoline	

MSE : Engine Control Module

3.53D : 4 Cylinder Version

2) Fastener Tightening Specifications

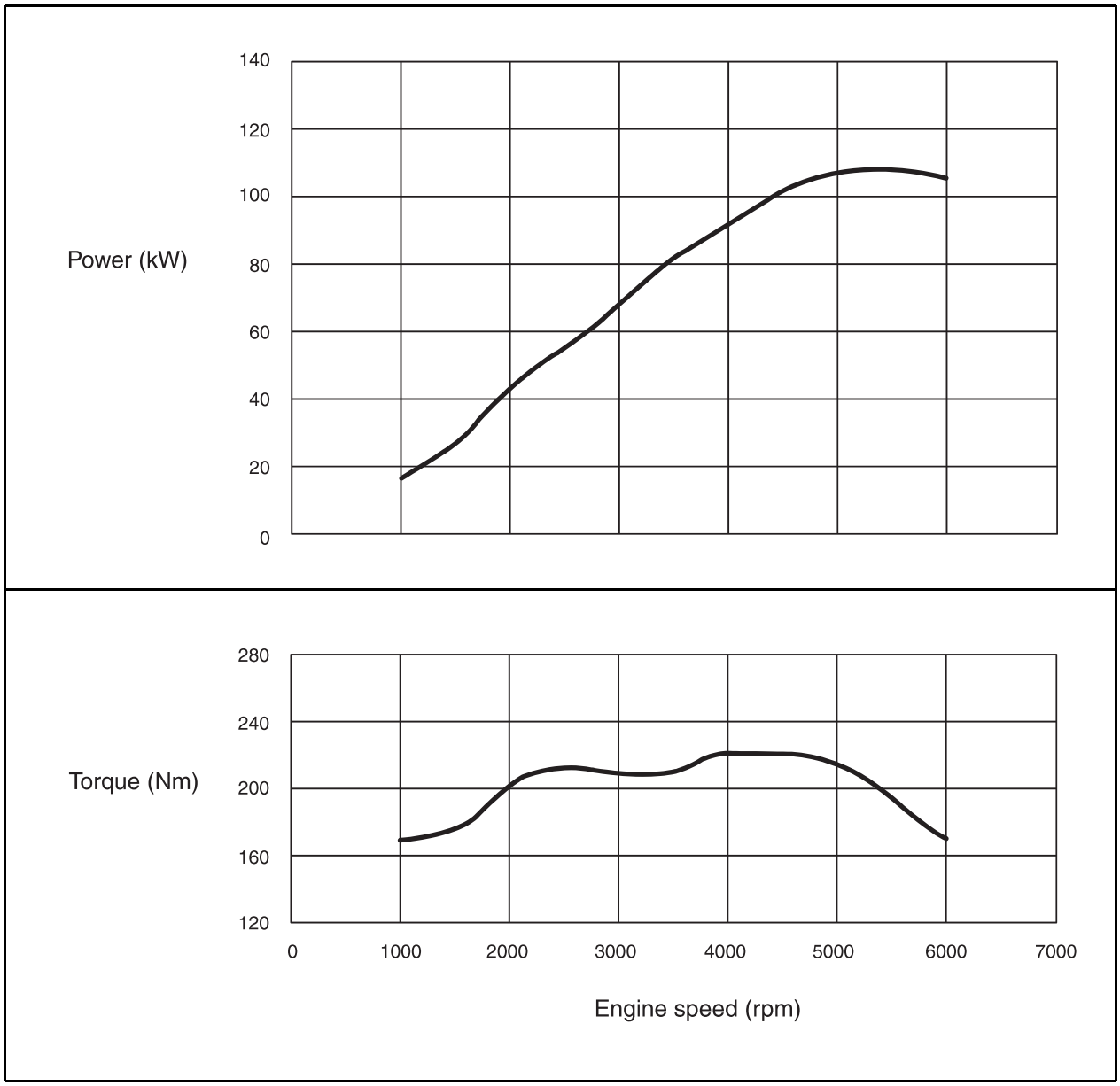
Application		N•m	Lb-Ft	Lb-In
Fuel Feed and Return Line		21 ~ 25	15 ~ 18	-
Exhaust Manifold and Pipe		30	22	-
Engine Mounting Nuts		70	52	-
Generator Carrier Bolts		25	18	-
Tensioning Pulley Bolt		40.5 ~ 49.5	29.9 ~ 36.5	-
Steering Pump Bolts		22.5 ~ 27.5	16.6 ~ 20.3	-
A/C Braket Bolts		22.5 ~ 27.5	16.6 ~ 20.3	-
Intake Air Duct Mounting Nuts		9 ~ 11	-	80 ~ 97
Spark Plug Cover Bolts		9 ~ 11	-	80 ~ 97
Cylinder Head Cover Bolts		9 ~ 11	-	80 ~ 97
Magnetic Assembly Bolt		9 ~ 11	-	80 ~ 97
Cylinder Head Front Cover Bolts	M8	22.5 ~ 27.5	16.6 ~ 20.3	-
	M6	9 ~ 11	-	80 ~ 97
Cylinder Head Bolts		55 +90° +90°	41 +90° +90°	- - 80 ~ 97
Timing Gear Case Cover Bolts		22.5 - 27.5	16.6 ~ 20.3	-
Crankshaft Sealing Rear Cover Mounting Bolts		9 ~ 11	-	-
Vibration Damper Center Bolts		200 + 20 +90° + 10°	148 + 15 +90° + 10°	- -
Flywheel Mounting Bolt		40 +90°	30 +90°	- -
Amarture Bolt in Flywheel		45 + 5	33 + 3.7	-
Camshaft Adjuster Flange Bolts		+90° + 10° 35	+90° + 10° 26	- -
Intake Flange Shaft Bolts		18 ~ 22 60° ± 5°	13 ~ 16 60° ± 5°	- -
Exhaust Camshaft Sprocket Bolts		18 ~ 22 60° ± 5°	13 ~ 16 60° ± 5°	- -
Intake Flange Shaft Bolts		18 ~ 22	13 ~ 16	-
Exhaust Camshaft Sprocket Bolts		60° ± 5°	60° ± 5°	-
Camshaft Bearing Cap Bolts		22.5 ~ 27.5	16.6 ~ 20.3	-
Chain Tensioner Screw Plug		40	30	-
Chain Tension Assembly		72 ~ 88	53 ~ 65	-
Oil Pump Sprocket Bolt		29 ~ 35	21 ~ 26	-
Tensioning Device Bolts		26 ~ 32	19 ~ 24	-
Water Pump Pulley		22.5 ~ 27.5	16.6 ~ 20.3	-
Upper Intake Manifold Bolt		22.5 ~ 27.5	16.6 ~ 20.3	-
Lower Intake Mainfold Bolt		22.5 ~ 27.5	16.6 ~ 20.3	-
Flange Bolt to Exhaust Mainfold		30	22	-

Modification basis	
Application basis	
Affected VIN	

▶ Fastener Tightening Specifications (Cont'd)

Application	N•m	Lb-Ft	Lb-In
Exhaust Mainfold Nut to Stud Bolt	26 ~ 34	19 ~ 25	-
Oil Drain Plug	25	18	-
Oil Filter Cover	25	18	-
Oil Filter Bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Oil Pump Drive Sprocket Bolt	29 ~ 35	21 ~ 26	-
Oil Pump Mounting Bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Oil Strainer Bracket Bolt	9 ~ 11	-	80 ~ 97
Oil Pressure Relief Valve Screw Plug	50	37	-
Oil Dipstick Guide Tube Bolt	9 ~ 11	-	80 ~ 97
Oil Gallery Screw Plug	15	11	-
Shock Absorber Bolts	22.5 ~ 27.5	16.6 ~ 20.3	-
Crankshaft Bearing Cap Bolts	55/+90°	41/+90°	-
Torque Converter Mounting Bracket Bolts	42	31	-

2) Performance Curve



Modification basis	
Application basis	
Affected VIN	

Memo

ENGINE INTAKE SYSTEM 1713-08

GENERAL

1. SPECIFICATIONS

(1) Fastener Tightening Specifications

Application	N•m	Lb-Ft	Lb-In
DOC to Muffler Nut	28 - 47	21 - 35	-
Exhaust Manifold to Front Exhaust Pipe Nut	15 - 28	11 - 21	-
Front Exhaust Pipe to DOC Nut	28 - 47	21 - 35	-
Front Exhaust Pipe to Muffler Nut	28 - 47	21 - 35	-
Intake Air Duct Mounting Bolt	22.5 - 27.5	16.6 - 20.3	-
Intake Manifold Mounting Bolt	22.5 - 27.5	16.6 - 20.3	-
Muffler to Tail Exhaust Pipe Nut	28 - 47	21 - 35	-
Resonance Flap Mounting Bolt	9 - 11	-	80 - 97

ENGINE EXHAUST SYSTEM

2420-01

GENERAL

1. SPECIFICATION

(1) Fastener Tightening Specifications

Application	N•m	Lb-Ft	Lb-In
DOC to Muffler Nut	28 - 47	21 - 35	-
Exhaust Manifold to Front Exhaust Pipe Nut	15 - 28	11 - 21	-
Front Exhaust Pipe to DOC Nut	28 - 47	21 - 35	-
Front Exhaust Pipe to Muffler Nut	28 - 47	21 - 35	-
Intake Air Duct Mounting Bolt	22.5 - 27.5	16.6 - 20.3	-
Intake Manifold Mounting Bolt	22.5 - 27.5	16.6 - 20.3	-
Muffler to Tail Exhaust Pipe Nut	28 - 47	21 - 35	-
Resonance Flap Mounting Bolt	9 - 11	-	80 - 97

OVERVIEW AND OPERATION PROCESS

1. DESCRIPTION AND OPERATION

1) Exhaust System

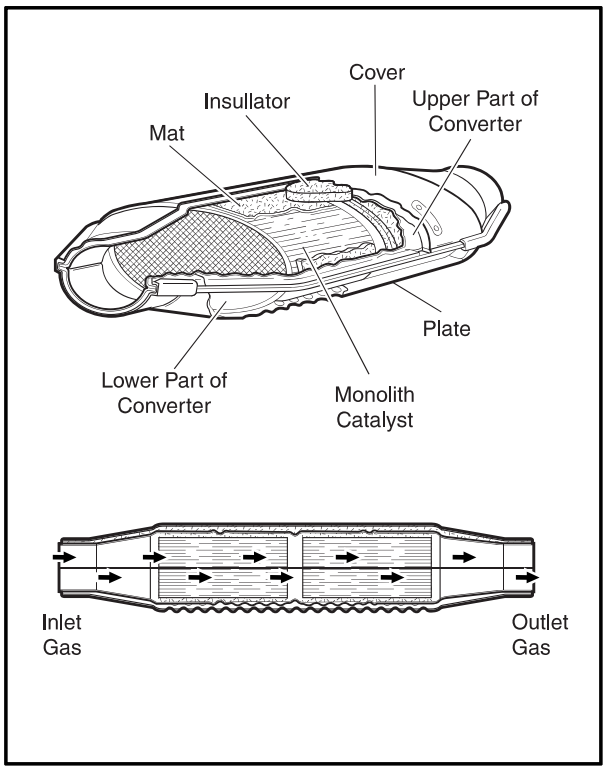
CAUTION

When you are inspecting or replacing exhaust system components, make sure there is adequate clearance from all points on the underbody to avoid possible
overheating of the floor panel and possible damage to the passenger compartment insulation and trim materials.
Check the complete exhaust system and the nearby body areas and trunk lid for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections, or other deterioration which could permit exhaust fumes to seep into the trunk may be an indication of a problem in one of these areas. Any defects should be corrected immediately.

2) Catalytic Converter (Gasoline Engine)

1. When jacking or lifting the vehicle from the body side rails, be certain that the lift pads do not contact the catalytic converter, as this could damage the catalytic converter.
2. Use of anything other than unleaded fuel will damage the catalyst in the catalytic converter.

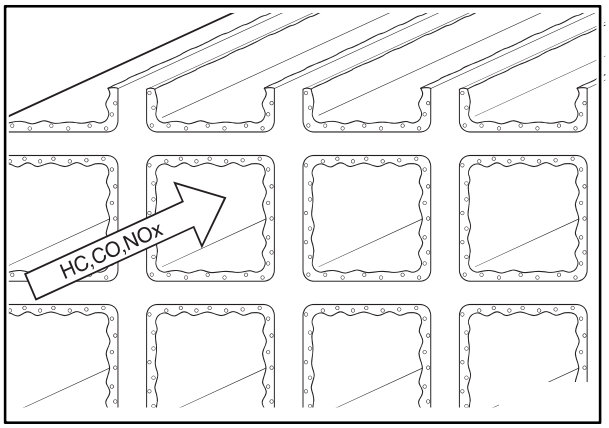
▶ **Catalytic Converter Structure**



The Catalytic converter of monolith type consists of 2 walled metal bodies which is made of Cordierite. The principal element of converter consists of the materials like Alumina or oxidized Serume in order to apply to Ceramic Monolith. Washer coat operates first, and catalytic metal elements (Pt, Pd, Rh) operates to washer coat next.
Monolith type is lighter than other types, easy to manufacture and quickly approaches to proper temperature. Washer coat is used to make a contact surface with exhaust gas bigger by adhering closely to small holes
of inner layer. If a lead compound or phosphorus adheres to the surface and the temperature rises, its surface is decreased. The total area of general monolith converter is about 45, 000~500,000ft3. (10 times of a football field) Generally Alumina (AL2 O3) is used as a raw materialand its 7 phases of gamma, delta, theta have big areas and high stability for the temperature, and nowadays gamma Alumina is used usually.

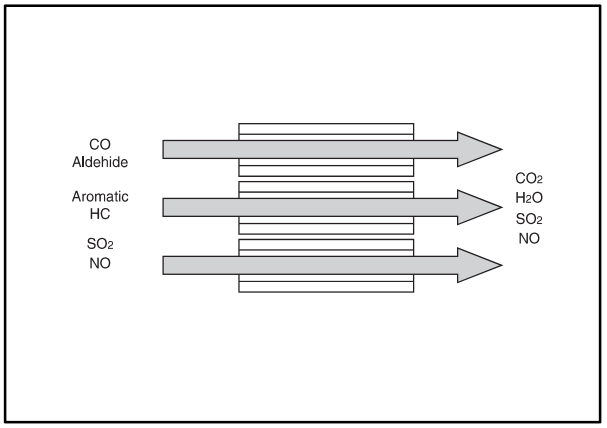
Modification basis	
Application basis	
Affected VIN	

▶ Catalytic Converter and Temperature

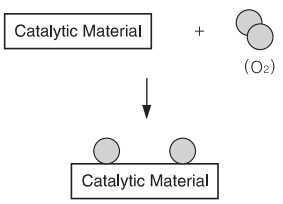
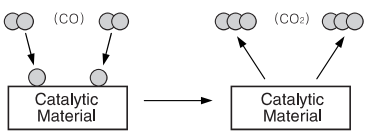
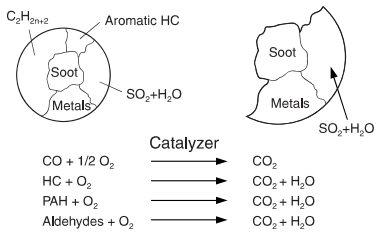


Catalytic converter has the normal function of purification at a range of the temperature. Because it has a weak point of decreasing of the purification rate in the condition of continuous high temperature, it should keep the temperature range of 400 to 500°C for normal condition. HC purification rate becomes better according to the increase of temperature in the normal range of temperature. CO purification rate becomes the best near the temperature of 450°C, and NOx does so near the temperature of 400 to 500°C.

▶ Purification of Catalytic Converter



- Adhesion of soluble organic fraction (SOF) below 180°C
- Purification of soluble organic fraction (SOF) over 180°C
  Chemical reaction formula
  SOF(HC)+O2 → CO2+H2O
  2CO+O2 → 2CO2
  2C2H6+7O2 → 4CO2+6H20
- By catalytic action of two primary catalytic converter, oxidation occurs in order to decrease HC and CO.

Oxygen adheres to catalytic material : below 180°C	Catalytic material supplies each CO and HC with O2 for their oxidation : above 180°C	Catalytic material conversion process by DOC
		

Modification basis	
Application basis	
Affected VIN	

▶ Method for Reduction of NOx

NOx is generated a great deal in case that combustion temperature and excess air factor are high. EGR valve can decrease NOx (30 to 35% decrease) by making temperature of combustion chamber fall by means of exhaust gas re-circulation.

- EGR valve is installed on the diesel engine of Musso, Korando, Istana and Rexton. And micro switch is installed together to control EGR valve.
- The setting method of micro switch is identical with the existing one.

Modification basis	
Application basis	
Affected VIN	

ENGINE COOLING SYSTEM 2110-01

GENERAL

1. GENERAL SPECIFICATIONS

Application		Unit	Gasoline Engine
Cooling System	Type	-	Water Cooling Forced Circulation
Coolant	Capacity	L	11.3
Thermostat	Type	-	Wax Pellet Type
	Initial Opening Temp.	°C (°F)	82 (180)
	Fully Opening Temp.	°C (°F)	95 (203)
	Fully Closing Temp.	°C (°F)	80 (176)
	Stroke	mm	7
Cooling Fan	Type	-	PWM
	Blades	-	5
	Diameter	mm	320
	Low Speed ON Temp.	°C (°F)	95 (203)
	Low Speed OFF Temp.	°C (°F)	90 (194)
	High Speed ON Temp.	°C (°F)	105 (221)
	High Speed OFF Temp.	°C (°F)	100 (212)
	High Speed ON Temp. (By A/C Pressure)	kPa (psi)	269.8 (1860)
Coolaant Reservoir	Pressure Valve Opening Pressure	kPa (psi)	118 - 147 (17.1 - 21.3)
	Vacuum Valve Opening Pressure	kPa (psi)	9.8 (1.4)
Water Pump	Type	-	Turbo Centrifugal
	Impeller Diameter	mm	65
	Impeller Blades	-	8
Radiator	Type	-	Cross-flow
	Core Width	mm	701
	Core Height	mm	372
	Core Thickness	mm	18
Coolant Temperature Gauge	Minimum Radiation Capability	Kcal/h	45,000
	Resistance (at 50 °C (122°F))	Ω	185.2
	Resistance (at 80 °C (176°F))	Ω	47.4
	Resistance (at 105 °C (221°F))	Ω	28.2
Engine Coolant Temperature Sensor	Resistance (at 20 °C (68°F))	K Ω	3.33 - 37.8
	Resistance (at 80 °C (176°F))	K Ω	0.32 - 0.35
Anti-Freeze Agent	Type	-	ALUTEC-P78
	Mixture of Water and Good Quality Ethylene Glycol-Base Anti-Freeze	-	50 : 50

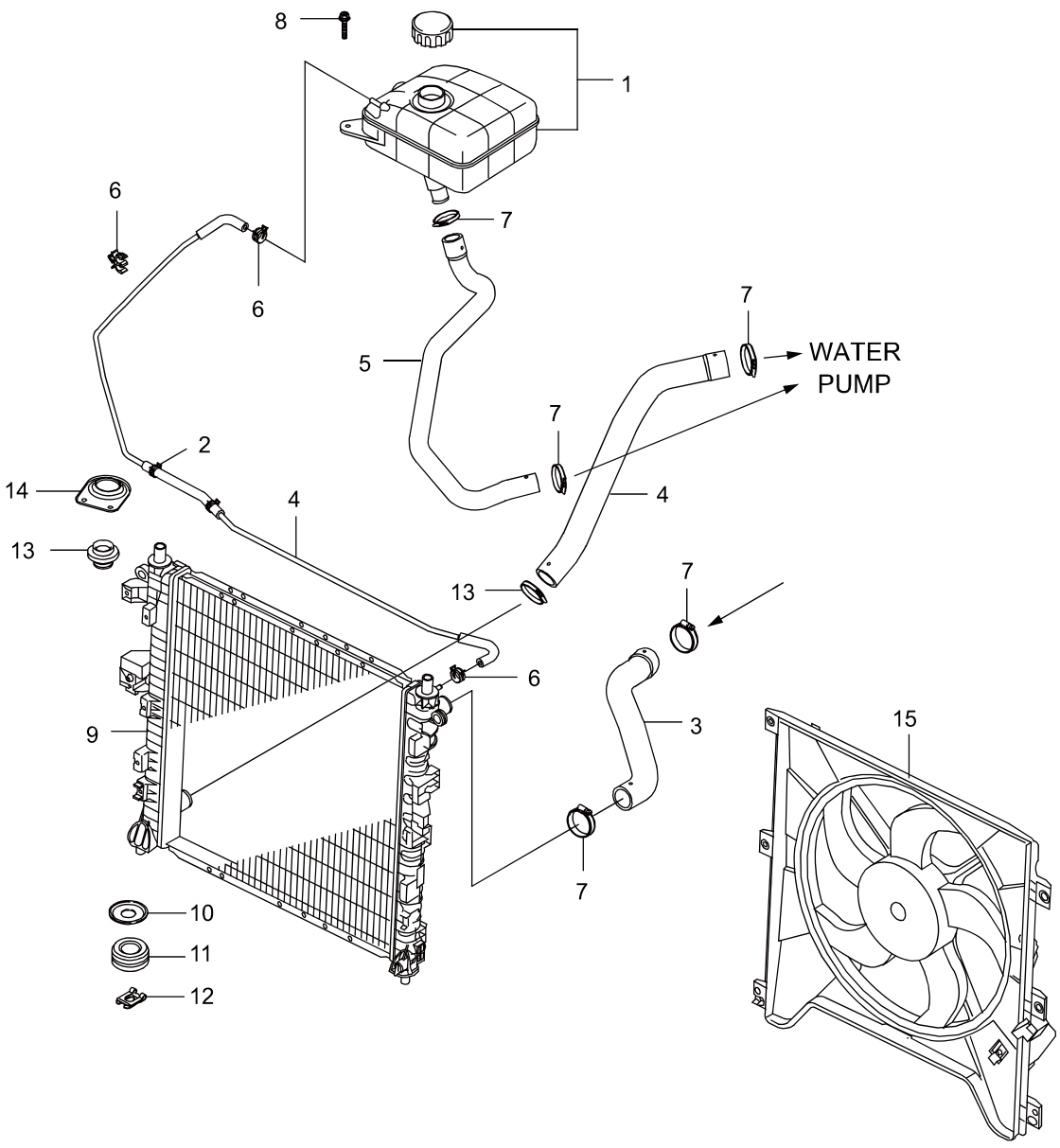
2. FASTENER TIGHTENING SPECIFICATIONS

Application		Nm	Lb-Ft	Lb-In
Automatic Transmission Oil Cooler Pipe		20	15	-
Automatic Transmission Oil Cooler Pipe Mounting Bolt		3 - 7	-	27 - 62
Coolant Drain Plug		30	22	-
Cooling Fan Bolt		9 - 11	-	80 - 97
Cooling Fan Shroud Bolt		3 - 7	-	27 - 62
Oil Cooler Pipe Line Bolt		9 - 11	-	80 - 97
Radiator Mounting Bracket Bolt		3 - 7	-	27 - 62
Tensioning Device Shock Absorber Bolt		22.5 - 27.5	16.6 - 20.3	-
Thermostat Cover Bolt		9 - 11	-	80 - 97
Thermostat Housing Bolt	M6	9 - 11	-	80 - 97
	M8	22.5 - 27.5	16.6 - 20.3	-
Viscous Clutch Mounting Bolt		40.5 - 49.5	29.8 - 36.5	-
Water Pump Housing Bolt	M6	9 - 11	-	80 - 97
	M8	22.5 - 27.5	16.6 - 20.3	-
Water Pump Pulley Bolt		9 - 11	-	80 - 97

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. COMPONENT LOCATOR



1. Reserver Tank
2. Deaeration Tube
3. Inlet Hose
4. Outlet Hose
5. 3 way Hose
6. Clamp
7. Clamp
8. Bolt (M6, 2 piece)
9. Radiator
10. Lower Radiator Insulator
11. Plate
12. Clip
13. Upper Radiator Insulator
14. Bracket
15. PWM Electric Fan

2. DESCRIPTION AND OPERATION

1) General Description

The cooling system maintains the engine temperature at an efficient level during all engine operating conditions.
When the engine is cold, the cooling system cools the engine slowly or not at all. This slow cooling of the engine allows the engine to warm up quickly.
The cooling system includes a radiator and recovery subsystem, cooling fans, a thermostat and housing, a water pump, and a water pump drive belt. The timing belt drives the water pump.
All components must function properly for the cooling system to operation. The water pump draws the coolant from the radiator. The coolant then circulates through water jackets in the engine block, the intake manifold, and the cylinder head. When the coolant reaches the operating
temperature of the thermostat, the thermostat opens. The coolant then goes back to the radiator where it cools.
This system directs some coolant through the hoses to the heat core. This provides for heating and defrosting.
The coolant reservoir is connected to the radiator to recover the coolant displaced by expansion from the high temperatures. The coolant reservoir maintains the correct coolant level.
The cooling system for this vehicle has no radiator cap or filler neck. The coolant is added to the cooling system through the coolant reservoir.

2) Radiator

This vehicle has a lightweight tube-and-fin aluminum radiator. Plastic tanks are mounted on the upper and the lower sides of the radiator core.
On vehicles equipped with automatic transaxles, the transaxle fluid cooler lines run through the radiator tank.
A radiator drain plug is on this radiator.
To drain the cooling system, open the drain plug.

3) Coolant Reservoir

The coolant reservoir is a transparent plastic reservoir, similar to the windshield washer reservoir.
The coolant reservoir is connected to the radiator by a hose and to the engine cooling system by another hose.
As the vehicle is driven, the engine coolant heats and expands. The portion of the engine coolant displaced by this expansion flows from the radiator and the engine into the coolant reservoir. The air trapped in the radiator and the engine is degassed into the coolant reservoir.
When the engine stops, the engine coolant cools and contracts. The displaced engine coolant is then drawn back into the radiator and the engine. This keeps the radiator filled with the coolant to the desired level at all times and increases the cooling efficiency.
Maintain the coolant level between the MIN and MAX marks on the coolant reservoir when the system is cold.

Modification basis	
Application basis	
Affected VIN	

4) Water Pump

The belt-driven centrifugal water pump consists of an impeller, a drive shaft, and a belt pulley.
The impeller is supported by a completely sealed bearing.
The water pump is serviced as an assembly and, therefore, cannot be disassembled.

5) Thermostat

A wax pellet-type thermostat controls the flow of the engine coolant through the engine cooling system. The thermostat is mounted in the thermostat housing to the front of the cylinder head.
The thermostat stops the flow of the engine coolant from the engine to the radiator to provide faster warm-up, and to regulate the coolant temperature. The thermostat remains closed while the engine coolant is cold, preventing circulation of the engine coolant through the radiator. At this point, the engine coolant is allowed to circulate only throughout the heater core to warm it quickly and evenly.
As the engine warms, the thermostat opens. This allows the engine coolant to flow through the radiator wherethe heat is dissipated. This opening and closing of the thermostat permits enough engine coolant to enter the radiator to keep the engine within proper engine temperature operating limits.
The wax pellet in the thermostat is hermetically sealed in a metal case. The wax element of the thermostat expands when it is heated and contracts when it is cooled.
As the vehicle is driven and the engine warms, the engine coolant temperature increases. When the engine coolant reaches a specified temperature, the wax pellet element in the thermostat expands and exerts pressure against the metal case, forcing the valve open. This allows the engine coolant to flow through the engine cooling system and cool the engine.
As the wax pellet cools, the contraction allows a spring to close the valve.
The thermostat begins to open at 82°C(180 °F) and is fully open at 95°C(203°F). The thermostat closes at 80°C (176°F).

6) Electric Cooling Fan

CAUTION

- Keep hands, tools, and clothing away from the engine cooling fans to help prevent personal injury.
  This fan is electric and can turn on even when the engine is not running.

CAUTION

- If a fan blade is bent or damaged in any way, no attempt should be made to repair or reuse the damaged part. A bent or damaged fan assembly should always be replaced with a new one to prevent possible injury.

The cooling fans are mounted behind the radiator in the engine compartment. The electric cooling fans increase the flow of air across the radiator fins and across the condenser on air conditioned (A/C)-equipped vehicles.
This helps to speed cooling when the vehicle is at idle or moving at low speeds.
All models have two fans. The main fan is 320 mm (12. 6 inches) in diameter with seven blades to aid the airflow through the radiator and the condenser. An electric motor attached to the radiator support drives the fan.
The auxiliary fan is 320 mm (12.6 inches) in diameter.

▶ **A/C Off or Non-AC Model**

- The cooling fans are actuated by the engine control module (ECM) using a low-speed cooling fan relay, a high-speed cooling fan relay and a cooling fan motor relay.
- The ECM will turn the cooling fans on at low speed when the coolant temperature reaches 95°C(203°F) and at high speed when the coolant temperature reaches 105°C(221°F).
- The ECM will change the cooling fans from high peed to low speed at 100°C(212°F) and will turn the cooling fans off at 90°C (194°F).

▶ **A/C On**

- The ECM will turn the cooling fans on at low speed when the A/C system is on. The ECM will change to high speed when the high side A/C pressure reaches 1860 kPa (269.8 psi).
- The cooling fans will return to low speed when the high side A/C pressure reaches 1378 kPa (199.8 psi).

7) Engine Coolant Temperature Sensor

The Engine Coolant Temperature (ECT) sensor uses a temperature to control the signal voltage to the Engine Control Module (ECM).

8) Coolant Temperature Gauge

The coolant temperature gauge controls the instrument panel temperature indicator. The coolant temperature gauge is located with ECT sensor.

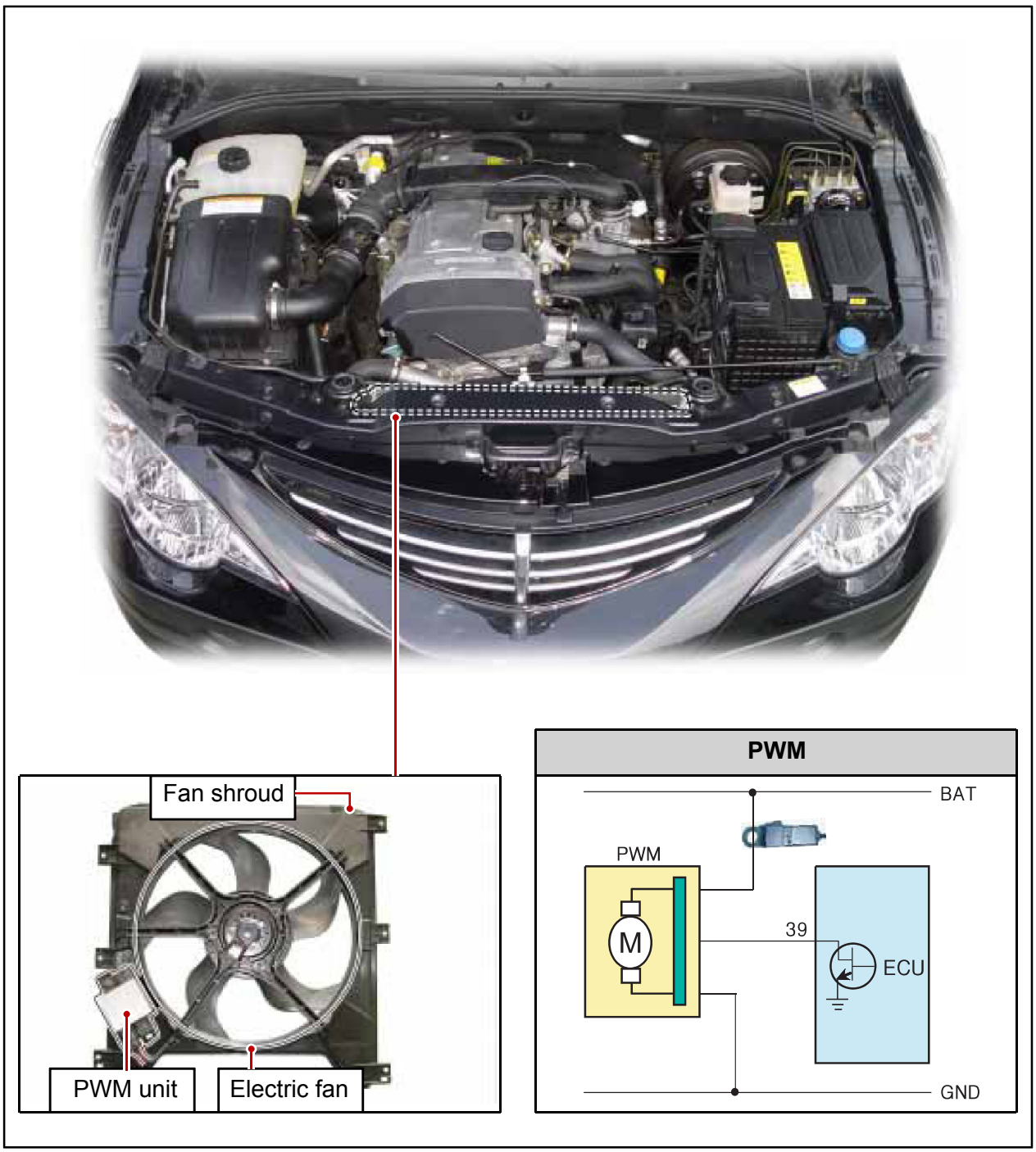
Modification basis	
Application basis	
Affected VIN	

3. PWM (PULSE WIDTH MODULATION) ELECTRIC FAN OPERATION

1) Function

The PWM (Pulse Width Modulation) high capacity electric fan is installed instead of electric condenser fan to enhance the durability and controllability and reduce noise.

2) Mounting Location



Modification basis	
Application basis	
Affected VIN	

3) PWM Electric Fan

(1) Advantages and Disadvantages of the PWM Electric Fan

▶ **Advantages**

- Enhanced A/C performance: at low speed, at idling, driving in city
- Reduction of vibration/noise: fan activated by PWM only when necessary
- Reduction of engine consuming power (V/Fan driving force) by 4 Hp - Cost saving

▶ **Disadvantage**

- Poor engine cooling perfomance at low and high rpm

4) PWM (Pulse Width Modulation) Unit

It controls the time of the output voltage to control the fan motor speed independently.

▶ **Internal functions**

- Motor power shutting-off function when overcurrent is applied
- Adverse voltage prevention function
- Detection function for the motor lock
- Temperature detecting function:
  The electric fan operates at FULL speed to cool down the PWM unit when the interior temperature of PWM unit is over 120~150°C.
  Communication function when failing:
- The fail signal is transmitted to the ECU when the PWM unit is malfunctioning.
- Soft start function: The motor speed is gradually increased when the motor is initially operated.

Modification basis	
Application basis	
Affected VIN	

5) Shutting-off Condition of the A/C Compressor

▶ **Coolant temperature**

- When coolant temperature is below 20°C or over 115°C, engine speed is below 650 rpm or over 4500 rpm for 4 seconds after engine starting, abrupt acceleration and A/C refrigerant pressure sensor detecting the followings
- A/C compressor is turned off when the refrigerant pressure is below 2.0 kg/cm2 and then is turned on when the refrigerant pressure is over 2.4 kg/cm2.
- A/C compressor is turned off when the refrigerant pressure is over 30 kg/cm2 and then is turned on when the refrigerant pressure is below 21.4 kg/cm2.

ENGINE ELECTRIC DEVICES 1452-01

GENERAL

1. DIAGNOSTIC INFORMATION AND PROCEDURE

1) Ignition System

Condition	Probable Cause	Correction
No Crank	• Low battery voltage.	• Charging the battery or Replace the battery.
	• Battery cable is loose, corroded, or damaged.	• Repair or Replace the battery cable.
	• Faulty starter motor or starter motor circuit is open.	• Repair or Replace the starter motor/starter motor circuit.
	• Faulty ignition switch.	• Replace the ignition switch.
	• Ground short.	• Repair the ground short.
Crank OK, But Too Slow	• Low battery voltage.	• Charging the battery or Replace the battery.
	• Battery. • Battery cables are loose, corroded, or damaged.	• Repair or Replace the battery cable.
	• Faulty starter motor.	• Repair or Replace the starter motor.
Starter Motor Does Not Stop	• Faulty starter motor.	• Repair or Replace the starter motor.
	• Faulty ignition switch.	• Replace the ignition switch.
Starter Motor Running, But Not Cranking	• Broken the clutch pinion gear or faulty starter motor.	• Replace the starter motor.
	• Broken the flywheel ring gear.	• Replace the flywheel.
	• Connected circuit is open.	• Repair the open circuit.
Battery Discharge	• Loosen the generator drive belt.	• Adjust the belt tension or Replace the belt.
	• The circuit is open or a short.	• Repair the open or a short circuit.
	• Battery run down.	• Replace the battery.
	• Open ground circuit.	• Repair the open ground circuit.
Charging Indicator Lamp Does Not Work When the Ignition Switch ON (Engine Does Not Work)	• Charging indicator lamp is blown or fuse is blown.	• Repair or Replace the charging indicator lamp/fuse.
	• Faulty ignition switch.	• Replace the ignition switch.
	• Generator ground circuit is open or a short.	• Repair the circuit.
Charging Indicator Lamp Does Not Put Out Lights After Starting the Engine	• Battery cable is corroded or damaged.	• Repair or Replace the battery cable.
	• Loosen the generator drive belt.	• Adjust the belt tension or Replace the belt.
	• Faulty wiring harness.	• Repair the wiring harness.
Battery Over Charging	• Generator Voltage Regulator Faulty	• Replace Generator
	• Voltage detecfing wiring faulty	• Repair Wiring

2) Ignition System (Cont'd)

Condition	Probable Cause	Correction
Hard Engine Starting	• Ignition coil faulty	• Replace ignition coil
	• Distributor (including optical sensor) faulty	• Replace distribator (or sensor)
	• Spark plug malfuntion	• Replace spark plug or adjust clearance
	• Ignition timing faulty (spark plug light is normal)	• Resetting valve timing
Unstable Engine Idling	• Spark plug malfunction	• Replace spark plug or adjust clearance
	• Ignition coil faulty	• Replace ignition coil
	• Ignition timing faulty	• Resetting valve timing
Enging Acceralation Malfunction	• Ignition timing faulty	• Resetting valve timing

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. DESCRIPTION AND OPERATION

1) Battey

The sealed battery is standard on all cars. There are no vent plugs in the cover.
The battery is completely sealed, except for two small vent holes in the sides.
These vent holes allow the small amount of gas produced in the battery to escape.
The battery has the following advantages over conventional batteries:

- No water addition for the life of the battery.
- Overcharge protection. If too much voltage is applied to the battery, it will not accept as much current as a conventional battery.
  In a conventional battery, the excess voltage will still try to charge the battery, leading to gassing, which causes liquid loss.
- Not as liable to self-discharge as a conventional battery. This is particularly important when a battery is left standing for long periods of time.
- More power available in a lighter, smaller case.

The battery has three major functions in the electrical system.
First, the battery provides a source of energy for cranking the engine.
Second, the battery acts as a voltage stabilizer for the electrical system. Finally, the battery can, for a limited time, provide energy when the electrical demand exceeds the output of the generator.

2) Ratings

▶ A battery has two ratings: (1) a reserve capacity rating designated at 27°C(80°F), which is the time a fully charged battery will provide 25 amperes of current flow at or above 10.5 volts (2) a cold cranking amp rating determined under testing at −18°C(0°F), which indicates the cranking load capacity.

(1)Reserve Capacity

The reserve capacity (RC) is the maximum length of time it is possible to travel at night with the minimum electrical load and no generator output. Expressed in minutes, the RC rating is the time required for a fully charged battery, at a temperature of 27°C(80°F) and being discharged at a current of 25 amperes, to reach a terminal voltage of 10.5 volts.

(2) Cold Cranking Amperage

The cold cranking amperage test is expressed at a battery temperature of −18°C(0°F).
The current rating is the minimum amperage, which must be maintained by the battery for 30 seconds at the specified temperature, while meeting a minimum voltage requirement of 7.2 volts.
This rating is a measure of cold cranking capacity.
The battery is not designed to last indefinitely. However, with proper care, the battery will provide many years of service. If the battery tests well, but fails to perform satisfactorily in service for no apparent reason, the following factors may point to the cause of the trouble:

- Vehicle accessories are left on overnight.
- Slow average driving speeds are used for short periods.
- The vehicle's electrical load is more than the generator output, particularly with the addition of aftermarket equipment.
- Defects in the charging system, such as electrical shorts, a slipping generator belt, a faulty generator, or a faulty voltage regulator.
- Battery abuse, including failure to keep the battery cable terminals clean and tight or a loose battery hold-down clamp.
- Mechanical problems in the electrical system, such as shorted or pinched wires.

3) Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

▶ Size of Battery - A Completely discharged large heavy-duty battery required more than twice the recharging time as a completely discharged small passenger car battery.

▶ Temperature − A longer time will be needed to charge any battery at −18°C(0°F) than at 27°C(80°F).
When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first.
The battery will accept a higher current rate as the battery warms.

▶ Charger Capacity - A charger which can supply only 5 amperes will require a much longer charging period than a charger that can supply 30 amperes or more.

▶ State-of-Charge - A completely discharged battery requires more than twice as much charge as a onehalf charged battery.
Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted by the battery is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.

Modification basis	
Application basis	
Affected VIN	

4) Charging a Completely Discharged Battery (Off the Vehicle)

Unless this procedure is properly followed, a perfectly good battery may be needlessly replaced.
The following procedure should be used to recharge a completely discharged battery:

1. Measure the voltage at the battery terminals with an accurate voltmeter.
   If the reading is below 10 volts, the charge current will be very low, and it could take some time before the battery accepts the current in excess of a few milliamperes.
   Refer to "Charging Time Required" in this section, which focuses on the factors affecting both the charging time required. Such low current may not be detectable on ammeters available in the field.
2. Set the battery charger on the high setting.

CAUTION

Some chargers feature polarity protection circuitry, which prevents charger unless the charger leads are correctly connected to the battery terminals.
A completely discharged battery may not have enough voltage to activate this circuitry, even though the leads are connected properly, making it appear that the battery will not accept charging current.
Therefore, follow the specific charger manufacturer's instruction for by passing or overriding the circuitry so that the charger will turn on and charge a low-voltage battery.

3. Continue to charge the battery until the charge current is measurable. Battery chargers vary in the amount of voltage and current provided. The time required for the battery to accept a measurable charger current at various voltages may be as follows:

Voltage	Hours
16.0 or more	Up to 4 hours
14.0 - 15.9	Up to 8 hours
13.9 or less	Up to 16 hours

- If the charge current is not measurable at the end of the above charging times, the battery should be replaced.
- If the charge current is measurable during the charging time, the battery is good, and charging should be completed in the normal manner.

CAUTION

It is important to remember that a completely discharged battery must be recharged for a sufficient number of ampere hours (AH) to restore the battery to a usable state.

- If the charge current is still not measurable after using the charging time calculated by the above method, the battery should be replaced.

5) Jump Starting Procedure

1. Position the vehicle with the charged battery so that the jumper cables will reach from the charged battery to the battery that requires charging.
2. Turn off the ignition, all the lights, and all the electrical loads in both vehicles.
3. Leave the hazard flasher on if jump starting where there may be other traffic and any other lights needed for the work area.
4. Apply the parking brake firmly in both vehicles.

CAUTION
In order to avoid damaging the vehicle make sure the cables are not on or near pulleys, fans, or other parts that will move when the engine starts.

5. Shift an automatic transmission to PARK.

CAUTION
In order to avoid injury, do not use cables that have loose or missing insulation.

6. Clamp one end of the first jumper cable to the positive terminal on the booster battery. Make sure it does not touch any other metal parts.
7. Clamp the other end of the same cable to the positive terminal on the discharged battery. Never connect the other end to the negative terminal of the discharged battery.

CAUTION
Do not attach the cable directly to the neg-ative terminal of the discharged battery. Doing so could cause sparks and possible battery explosion.

8. Clamp one end of the second cable to the negative terminal of the booster battery.
9. Make the final connection to a solid engine ground, such as the engine lift bracket at least 450 millimeters (18 inches) from the discharged battery.
10. Start the engine of the vehicle with the good battery.
    Run the engine at a moderate speed for several minutes.
11. Then start the engine of the vehicle with the discharged battery.
12. Remove the jumper cables by reversing the above sequence exactly, removing the negative cable from the vehicle with the discharged battery first.
    While removing each clamp, take care that it does not touch any other metal while the other end remains attached.

Modification basis	
Application basis	
Affected VIN	

6) Alternator

Alternators are equipped with internal regulators.
Unlike three-wire generators, the alternator may be used with only two connections: battery positive and an "D+" terminal to the charge indicator lamp.
As with other charging systems, the charge indicator lamp lights when the ignition switch is turned to RUN, and goes out when the engine is running.
If the charge idicator is on with the engine running, a charging system defect is indicated. This indicator light will glow at full brilliance for several kinds of defects as well as when the system voltage is too high or too low.
The regulator voltage setting varies with temperature and limits the system voltage by controlling rotor field current.
Achieve correct average field current for proper system voltage control by varying the on-off time. At high speeds, the on-time may be 10 percent and the off-time 90 percent.
At low speeds, with high electrical loads, the on-time may be 90 percent and the off-time 10 percent.

7) Charging System

Generators use a new type of regulator that incorporates a diode trio.
A Delta stator, a rectifier bridge, and a rotor with slip rings and brushes are electrically similar to earlier generators.
A conventional pulley and fan are used.
There is no test hole.

8) Starter

Wound field starter motors have pole pieces, arranged around the armature, which are energized by wound field coils.
Enclosed shift lever cranking motors have the shift lever mechanism and the solenoid plunger enclosed in the drive housing, protecting them from exposure to dirt, icy conditions, and splashes.
In the basic circuit, solenoid windings are energized when the switch is closed.
The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear.
The solenoid main contacts close. Cranking then takes place.
When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage.
To prevent excessive overrun, the switch should be released immediately after the engine starts.

9) Starting System

The engine electrical system includes the battery, the ignition, the starter, the generator, and all the related wiring.
Diagnostic tables will aid in troubleshooting system faults. When a fault is traced to a particular component, refer to that component section of the service manual.
The starting system circuit consists of the battery, the starter motor, the ignition switch, and all the related electrical wiring.
All of these components are connected electrically.

Modification basis	
Application basis	
Affected VIN	

CRUISE CONTROL SYSTEM 8510-23

OVERVIEW AND OPERATION PROCESS

1. CRUISE CONTROL SWITCH

The purpose of the cruise control system is to automatically maintain a vehicle speed set by the driver, without depressing the accelerator pedal. The cruise control switch is located under the right side of the steering wheel, and when this switch is operating "AUTO CRUISE" lamp comes on.

The minimum speed for setting the cruise control system is 36 km/h (22.37 mph). Pay constant attention to the distance between the vehicles and the traffic conditions when using the cruise control system.

CAUTION

The cruise control system is a supplementary system, which helps the driver to drive the vehicle at a desired speed without using the accelerator pedal under the traffic condition where the vehicle-to-vehicle distance meets the legal requirement.

1) When To Use

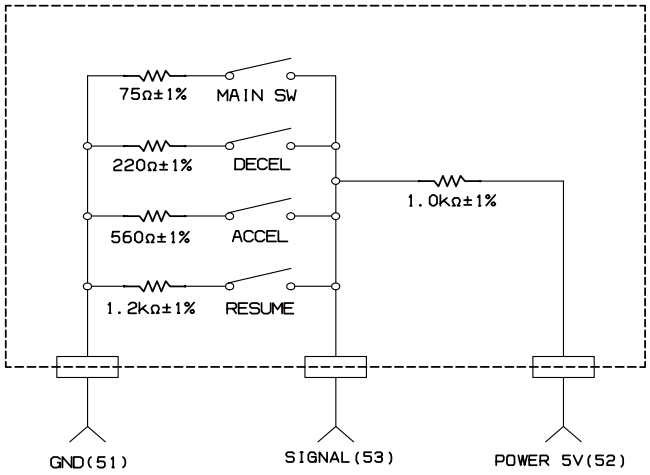
Use the cruise control system only when (a) the traffic is not jammed, (b) driving on motorways or highways where there is no sudden change in the driving condition due to traffic lights, pedestrian, etc.

WARNING

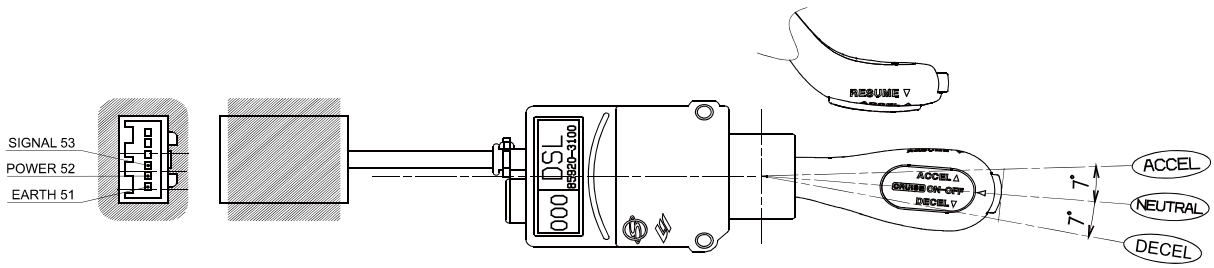
Use the cruise control system only when driving on motorways or highways. Do not use the cruise control system where the road conditions are as follows:
- When there is strong wind or cross wind.
- Heavy traffic.
- Slippery roads or steep decline.

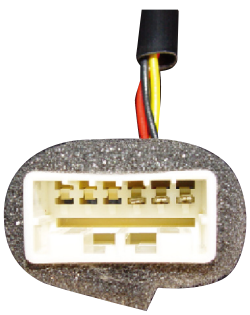
Modification basis	
Application basis	
Affected VIN	

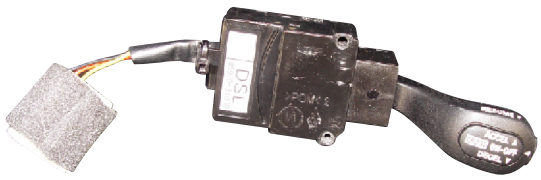
2. CIRCUIT DIAGRAM



1) Configuration







3. HOW TO OPERATE CRUISE CONTROL SWITCH

1) How To Set Speed

1. To operate the cruise control system, accelerate the vehicle to the speed within the specified range below with depressing the accelerator pedal.
   - Cruise control operating range: between 36 km/h (22.37 mph) and 150 km/h (93.207 mph)
2. When the desired speed is reached, which should be within the above range, push up the cruise control switch lever to ACCEL side (upwards arrow), or push down the switch lever to DECEL side (downwards arrow).
   And then release the accelerator pedal slowly.
3. Now the vehicle is cruised by this system with the set speed. You don't need to use the accelerator pedal.
4. Refer to the following pages for details of operation.

CAUTION

Never use the cruise control system until you get used to it.
Improper use or not fully aware of this function could result in collision and/or personal injuries.

Modification basis	
Application basis	
Affected VIN	

2) Accelerating with the Cruise Control System

(1) While the cruise control system is running

1. To increase the set speed, push up the cruise control switch lever to ACCEL side and hold it until the desired speed is reached without depressing the accelerator pedal.
2. When the desired speed is set, release the switch lever.

(2) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

1. Accelerate the vehicle to more than 36 km/h (22.37 mph) using the accelerator pedal. Push up the cruise control switch lever to ACCEL side and hold it.
2. When the desired speed is reached, release the accelerator pedal and the switch lever.

(3) Tap-up while the cruise control system is running

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

1. Push up the cruise control switch lever to ACCEL side for less than 0.5 second per one switching while the cruise control system is running; the speed increases each time by 1.3 km/h (0.81 mph).
2. For example, if you want to increase the speed 13 km/h (81 mph) more than the previous set speed, tap up the switch lever to ACCEL side ten times without using the accelerator pedal.

3) Decelerating with the Cruise Control System

(1) While the cruise control system is running

1. To decrease the set speed, push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached without depressing the brake pedal.
   But the cruise control system cannot maintain the cruise function at less than 34 km/h (21.13 mph).
2. When the desired speed is set, release the switch lever.

(2) When the cruise control system is not running

To decrease the speed with the cruise control system while the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 36 km/h (22.37 mph).
2. When the desired speed is reached, release the switch lever.
3. But the cruise control system cannot maintain the cruise function at less than 34 km/h (21.13 mph).

(3) Tap-down while the cruise control system is running

To decrease the vehicle speed in stages while the cruise control system is running, follow the below procedures.

1. Push down the cruise control switch lever to DECEL side for less than 0.5 second per one switching while the cruise control system is running; the speed decreases each time by 1.0 km/h (0.62 mph).
2. For example, if you want to decrease the speed 10 km/h (62 mph) lower than the previous set speed, tap down the switch lever to DECEL side ten times without using the brake pedal.

Modification basis	
Application basis	
Affected VIN	

4) Recovery of Set Speed (RESUME)

Even if the cruise control is cancelled, the previous set cruise speed can be recovered by operating the cruise control switch lever like below:
- Pull the switch lever in the arrow direction shown in the illustration.

This RESUME function works only when the vehicle speed is more than 36 km/h (22.37 mph) without using the accelerator or brake pedal.

CAUTION

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

5) Normal Cancellation of the Cruise Control (OFF ↔ ON)

The cruise control system will be cancelled when the button on the side of the switch is pressed, or when one of the following conditions is met:

1. When the brake pedal is depressed or ESP is activated.
2. When the vehicle speed is less than 34 km/h (21.13 mph).
3. When the parking brake is applied while driving.
4. When the clutch pedal is depressed for shifting (M/T only).

CAUTION

Put the cruise control switch lever in the neutral position when not using the cruise control system.

(1) Abnormal Cancellation of the Cruise Control

1. When the rapid deceleration or acceleration occurs.
2. When the cruise control lever is faulty.
3. When the brake switch is malfunctioning or has an open circuit.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

- Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
- Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
- The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
- Ensure that the braking distance is maintained and use the brake pedal if needed.

Modification basis	
Application basis	
Affected VIN	

INDEX

ELECTRIC GENERAL

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8. INTERIOR FUSE BOX 28

ELECTRIC SYSTEM

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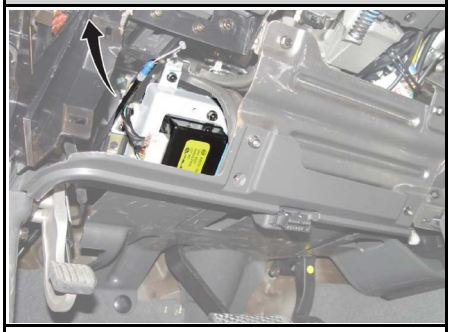
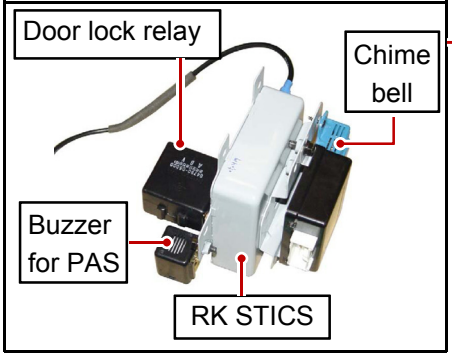
ELECTRIC GENERAL

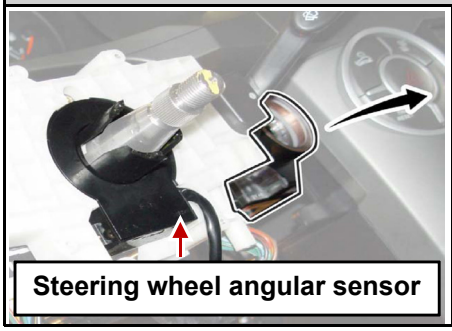
1. LOCATIONS OF INTERIOR UNITS AND SENSORS

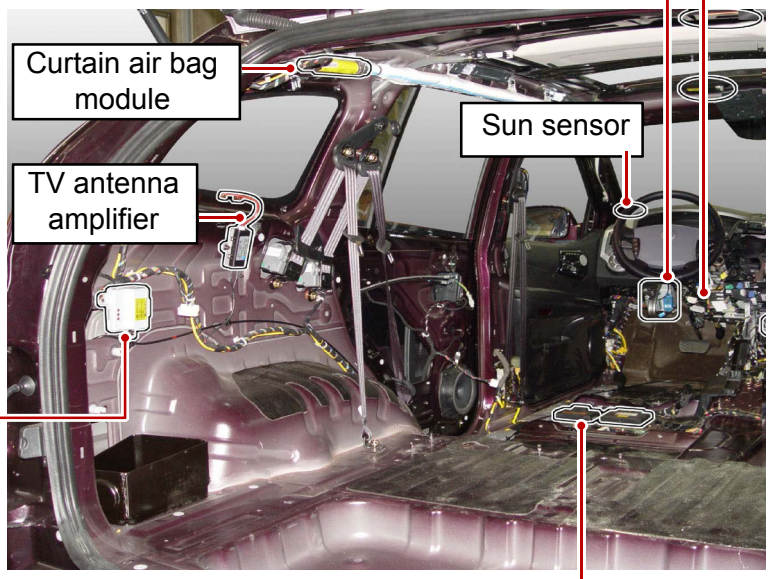
Under Instrument Panel



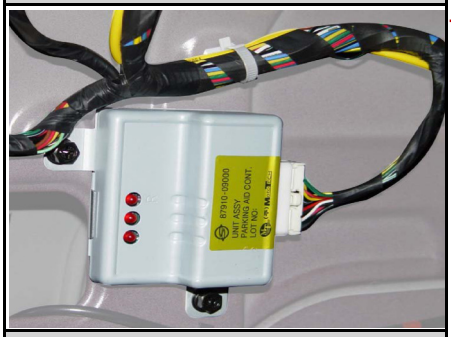


Steering Wheel Angular Sensor / Immobilizer



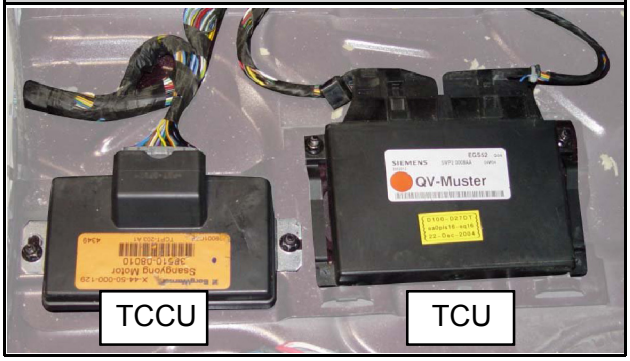


PAS Unit



Driver Seat Memory Switch

TCCU and TCU

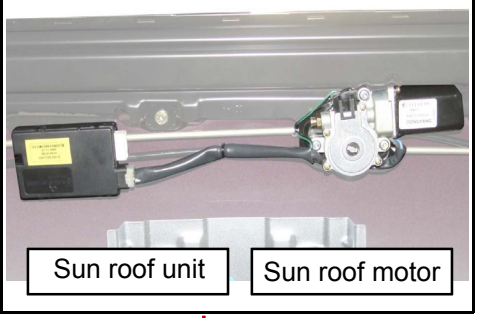


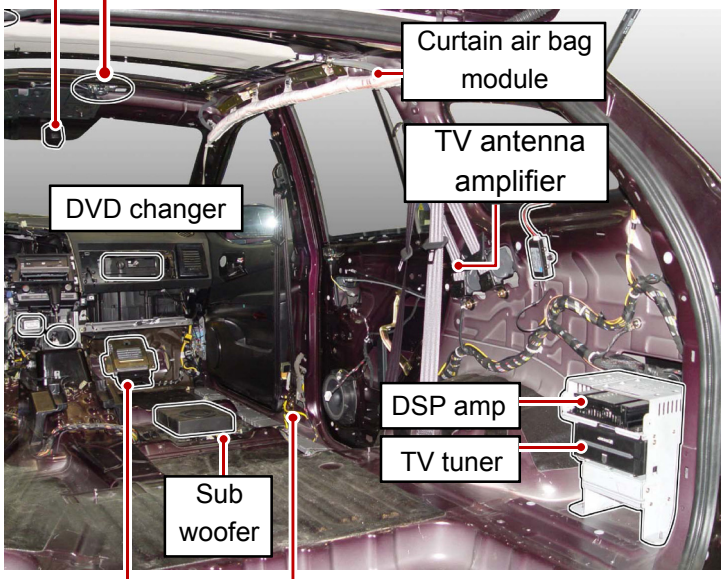
Modification basis	
Application basis	
Affected VIN	

Rain Sensing Unit (Including Auto Lignt) and ECM

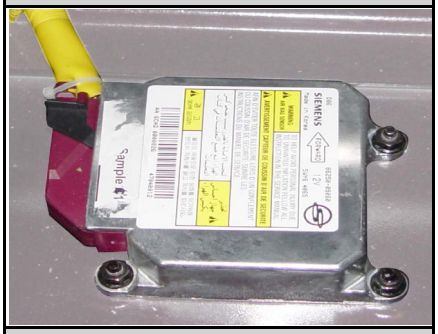
Sensor Cluster

Sun Roof Unit and Motor



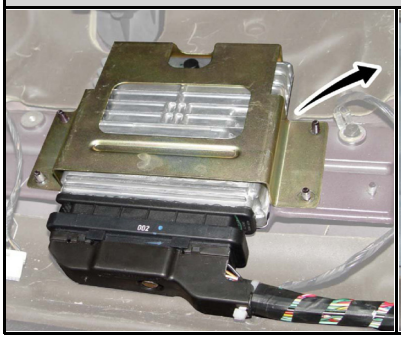


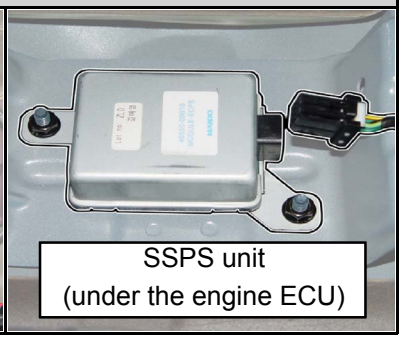
Air Bag ECU



Curtain Air Bag Sensor

Engine ECU and SSPS Unit





Interior Temperature and Humidity Sensor

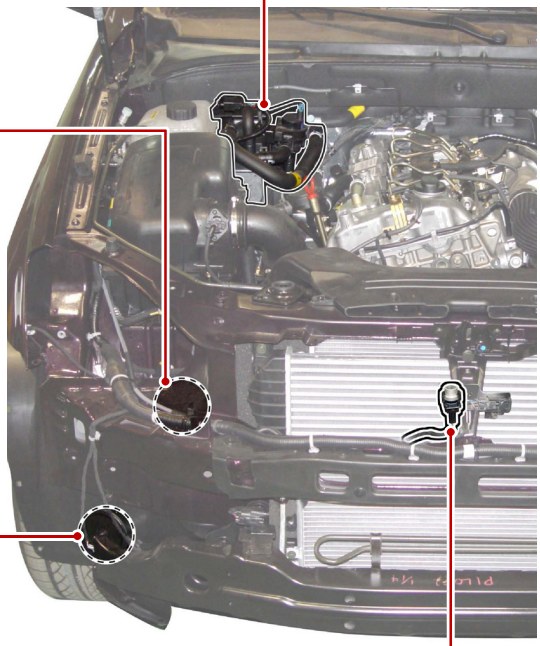
Modification basis	
Application basis	
Affected VIN	

2. SWITCHES, UNITS AND SENSORS IN ENGINE COMPARTMENT

FFH Assembly

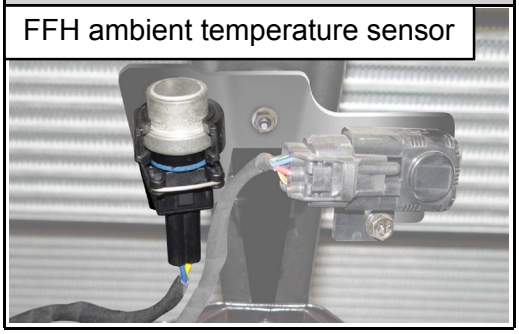
Receiver Drier and Triple Pressure Switch

Horn (RH)

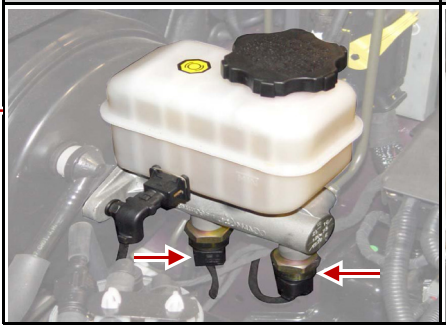


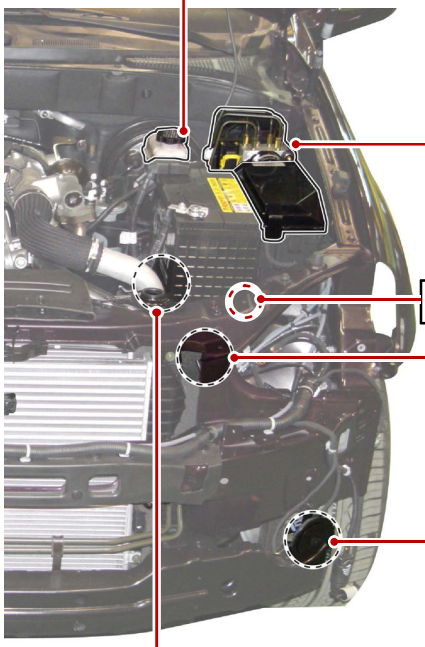
FFH Ambient Temperature Sensor

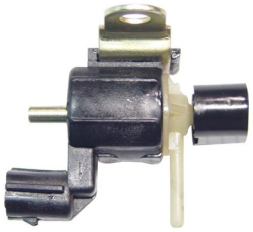
FFH ambient temperature sensor

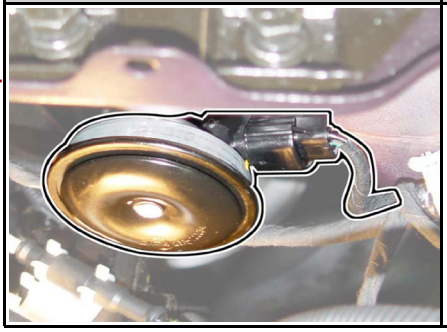
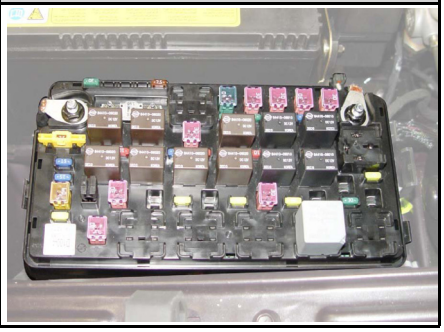


Modification basis	
Application basis	
Affected VIN	

ESP Pressure Sensor / Primary, Secondary	ABS (ESP) HECU
	



IWE Vacuum Solenoid Valve (4WD)


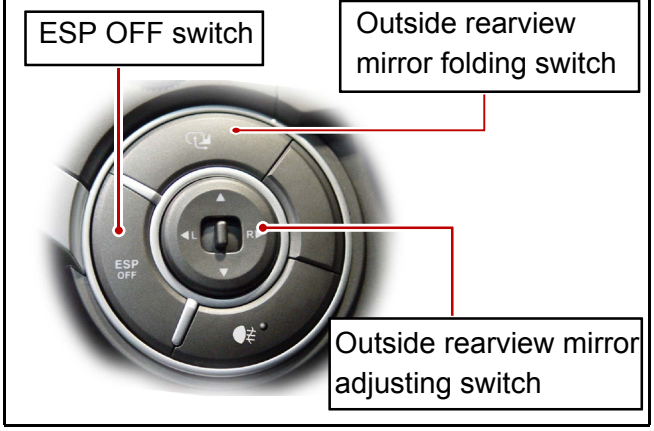
Theft Deterrent Horn (Under the Battery)	Fuse and Relay Box
	

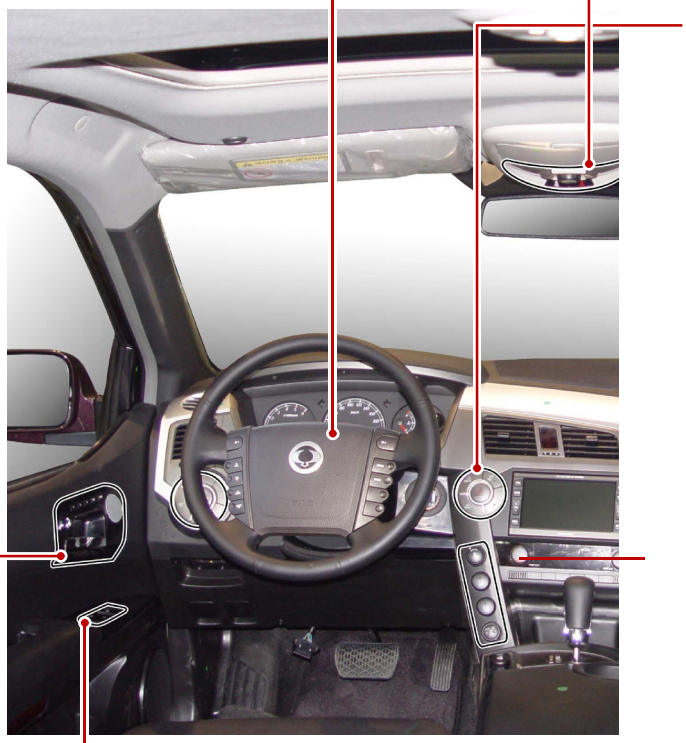
Modification basis	
Application basis	
Affected VIN	

3. INTERIOR SWITCHES

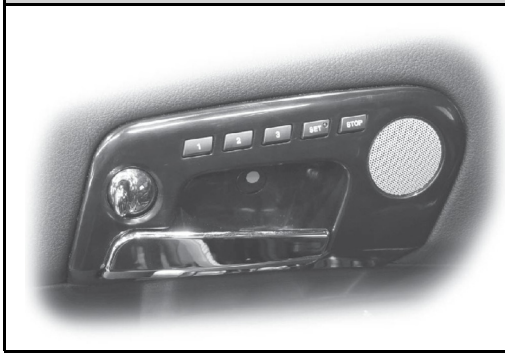
Remote Control Switch on the Steering Wheel

Bezel Assembly on Outside Rearview Mirror Adjusting Switch





Seat Position Memory Switch (Driver's Door)



Driver's Power Window Main Switch

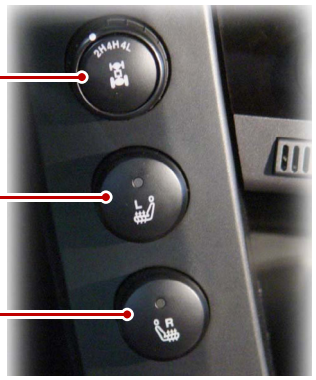
Modification basis	
Application basis	
Affected VIN	

Sun Roof Switch

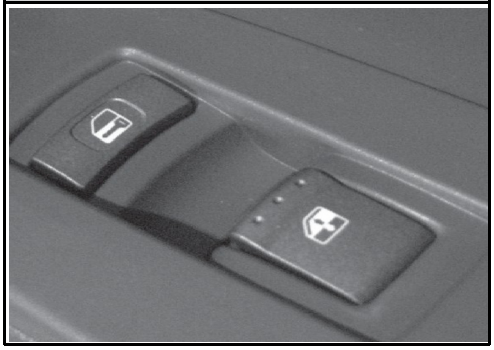
Bezel Assembly on Hazard Switch

1. HDC switch
2. Outside rearview mirror and rear glass heated switch
3. Hazard switch
4. TRIP switch
5. Front defogger switch

Center Fascia Switch



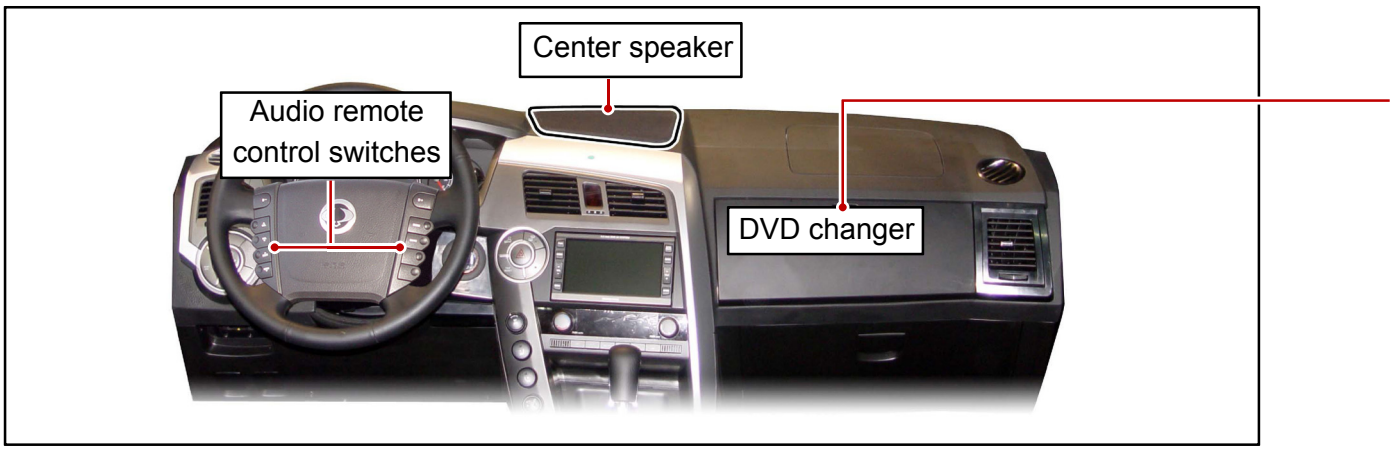
Passenger's Power Window Switch



Modification basis	
Application basis	
Affected VIN	

4. AUDIO / VIDEO SYSTEM

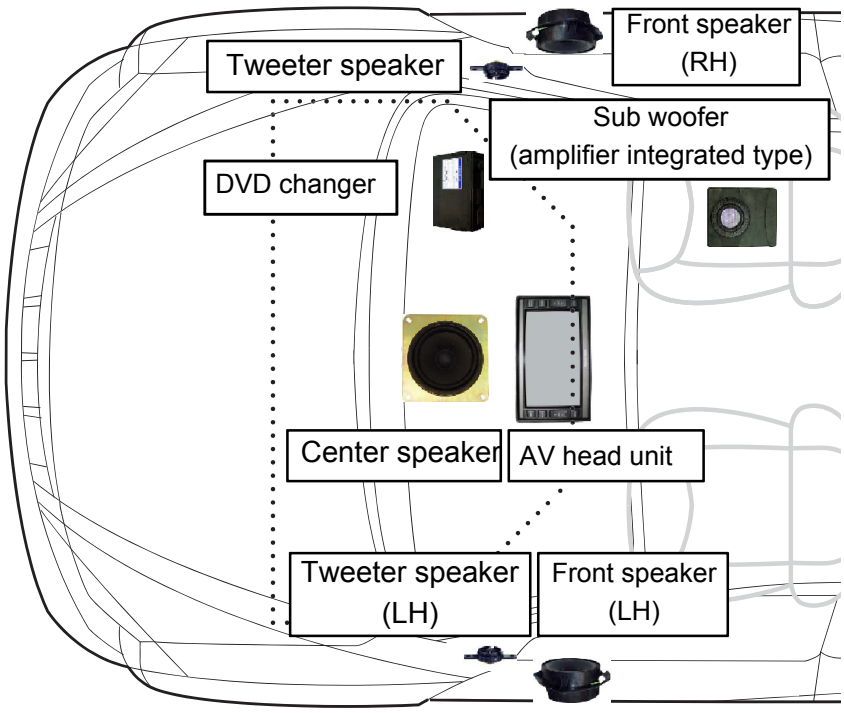
▶ AV System



AV Head Unit

DVD+tape

Sub Woofer

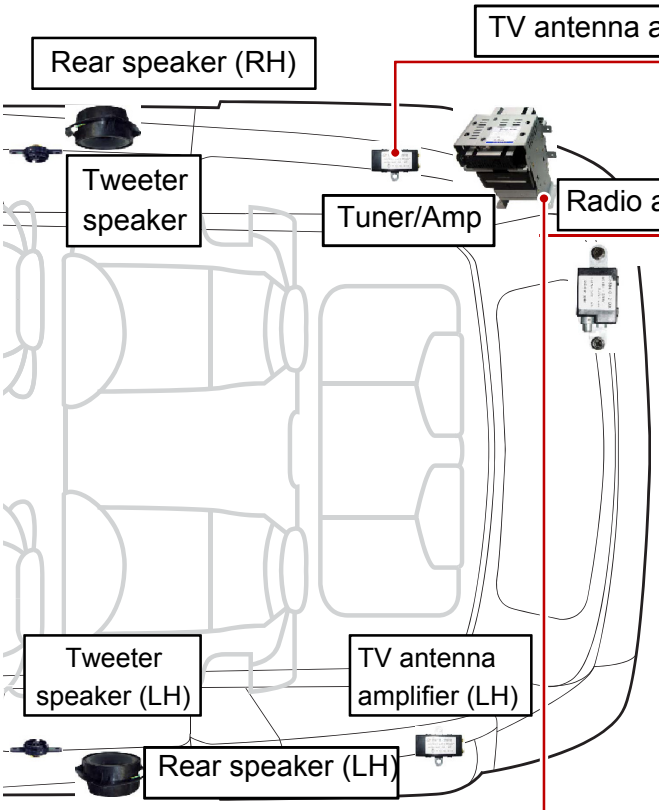


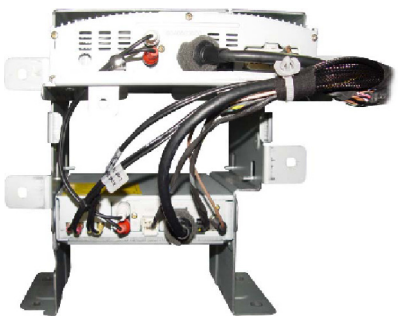
Other Audio Head Unit

6-INDASH CD+TAPE+RADIO	CD+RADIO

Modification basis	
Application basis	
Affected VIN	

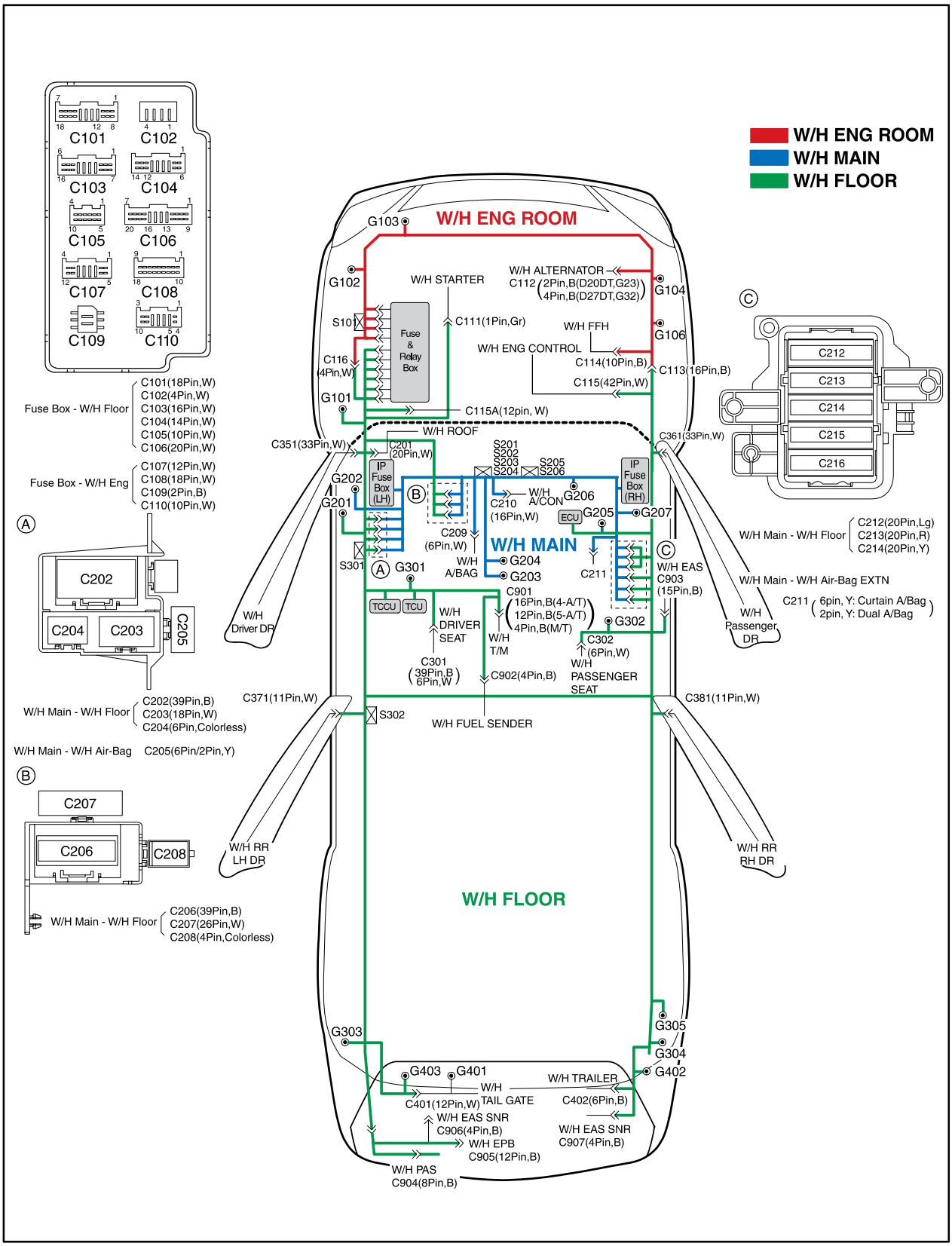
Location: Inside of panel above glove box	6 DVD changer



AV System


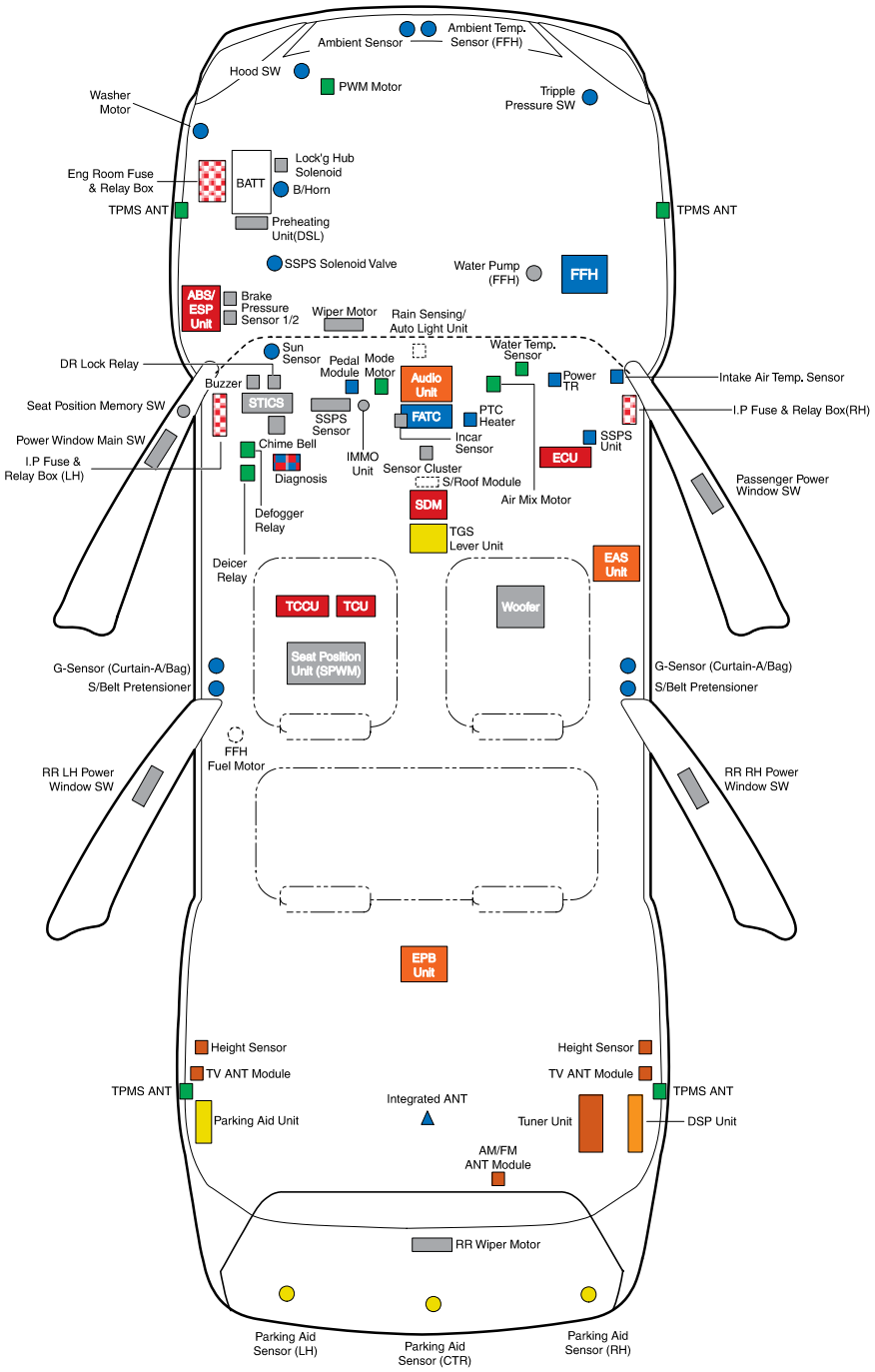
5. ELECTRIC COMPONENTS AND LAYOUT

▶ Wiring Harness Arrangement



Modification basis	
Application basis	
Affected VIN	

▶ Components Locator



Modification basis	
Application basis	
Affected VIN	

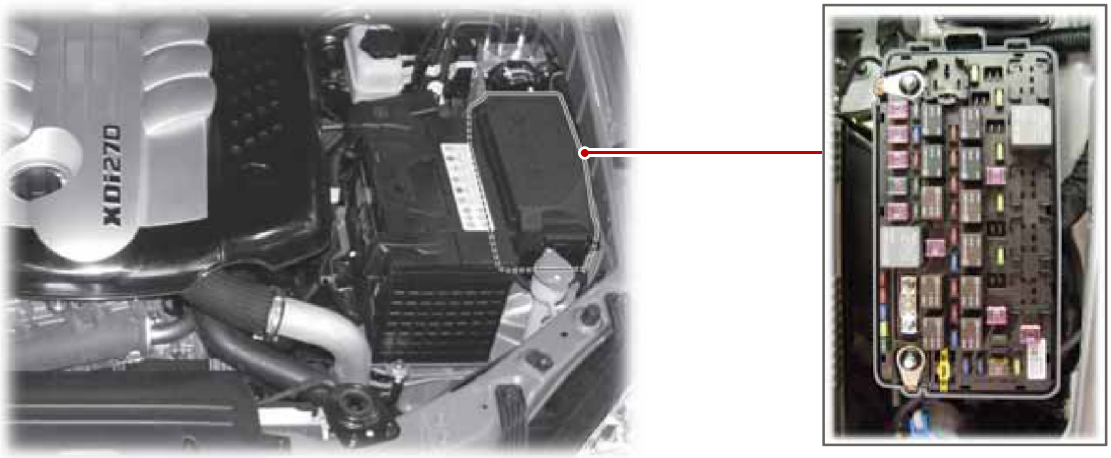
6. FUSE AND RELAY

1) FUSES AND RELAYS

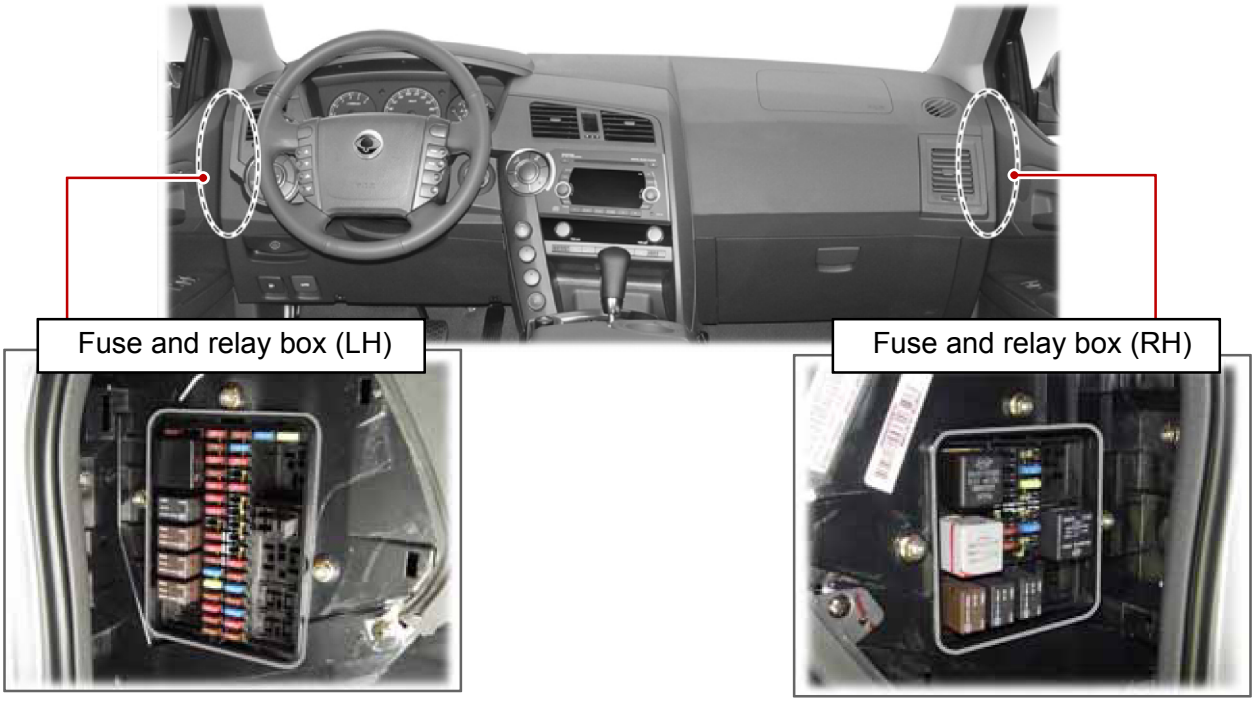
The fuse capacity for NEW KYRON has been changed due to the modification in rear combination lamp. There are three fuse and relay boxes in this vehicle (one at each side of the instrument panel and one in the engine compartment). The designation and capacity of relays and fuses are shown on the fuse and relay box cover.

▶ Location of Fuses and Relays

Engine compartment



Instrument panel

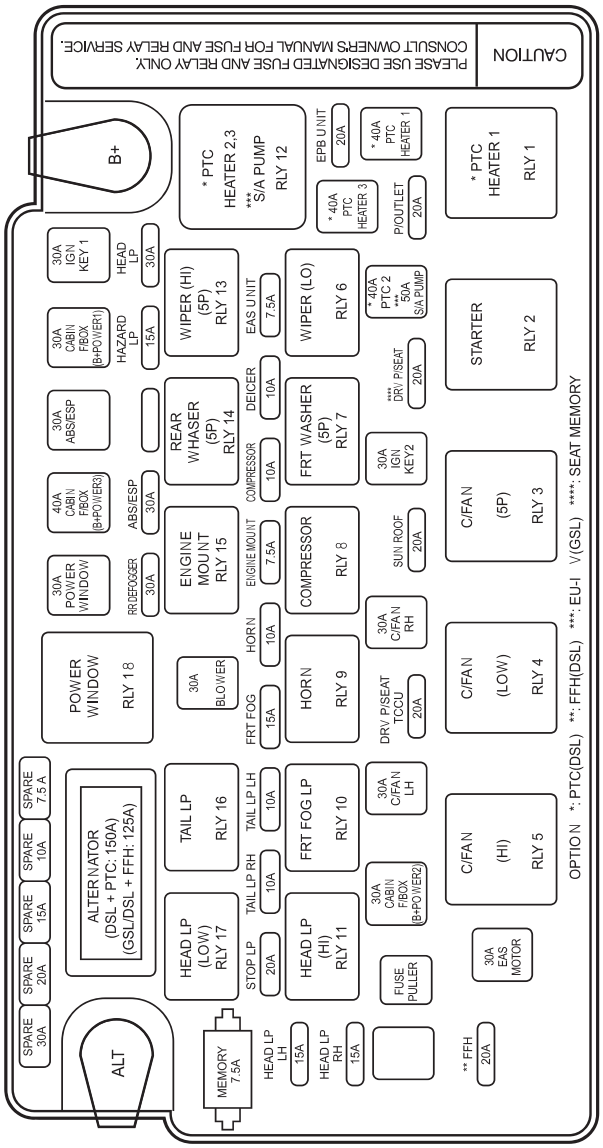


Modification basis	
Application basis	
Affected VIN	

▶ Designation and Capacity for Fuses and Relays in Engine Compartmentd Relays

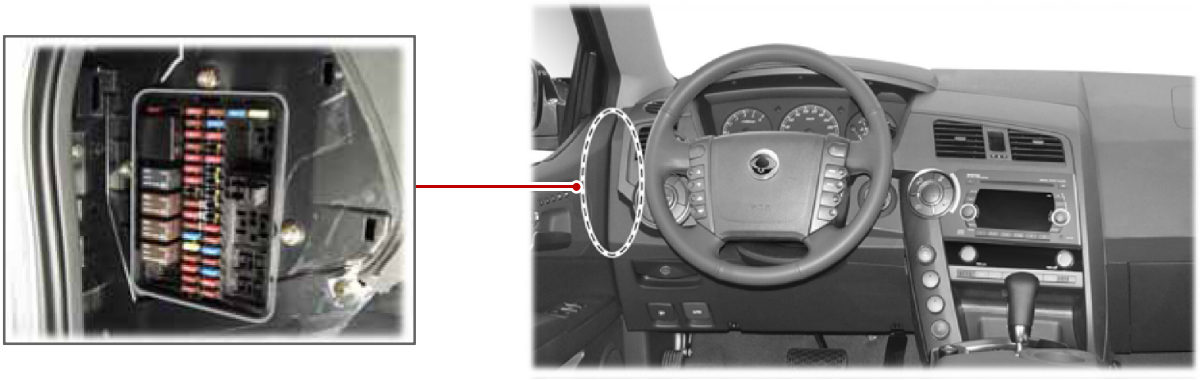
CAUTION

- The labels on the fuse box indicate only major circuits connected. Therefore, some system may not be shown on the labels. For details about the fuse and relay connection, refer to "Power distribution diagram" in this section.



▶ Designation and capacity for fuses and relays in instrument panel

Fuse and relay box (driver side)



	SPARE		SPARE	24 10A	A/BAG	41 7.5A	O/SIDE MRR D/CLOCK ECM MRR, S/ROOF
7.5A		10A					
	SPARE		SPARE	25 7.5A	CLUSTER STICS	42 15A	C/LIGHTER
	SPARE		SPARE	26 10A	ENG ROOM FUSE & RLY BOX	43 10A	AUDIO TUNNER UNIT
	SPARE		SPARE	27 7.5A	ALTERNATOR IMMOBILIZER S/LAMP	44 20A	*GSL FUEL PUMP
	SPARE		SPARE	28 10A	T/SIGNAL BACK UP LP	45 10A	ENG ECU
	SPARE		SPARE	29 10A	TCU, TGS TCCU	46 20A	*GSL INJECTOR
	SPARE		SPARE	30 10A	ENG ECU	47 15A	*GSL SENSOR
	SPARE		SPARE	31 -	SPARE	48 -	SPARE
	SPARE		SPARE	32 7.5A	SEAT UNIT EAS, EPB	49 7.5A	DRL RELAY
	SPARE		SPARE	33 10A	ABS/ESP	50 -	SPARE
	SPARE		SPARE	34 7.5A	HEAD LP R/SNR& AUTO LIGHT DRL	51 10A	RR FOG LAMP INTERIOR LAMP
	SPARE		SPARE	35 15A	FRT S/WARMER	52 7.5A	IMMOBILIZER BUZZER, CHIME
	SPARE		SPARE	36 20A	FRT WIPER WASHER	53 15A	DOOR LOCK B/HORN
	SPARE		SPARE	37 7.5A	PWR OUTLET RR/AWRMER ECPS & A/CON	54 7.5A	SEAT UNIT FOLDING DIAGNOSIS
	SPARE		SPARE	38 10A	RR WIPER	55 15A	RR S/WARMER
	SPARE		SPARE	39 7.5A	STICS FRT & RR GLASS HEATER	56 10A	STARTER GSL ECU
	SPARE		SPARE	40 7.5A	*D20DT ALTERNATOR	57 7.5A	DEF IND O/S MRR DEF

FLASHER UNIT

RR WIPER

BURGLAR HORN

*HDC HDC

RR S/WARMER

SPARE

RR FOG LAMP

FUSE PULLER

SPARE

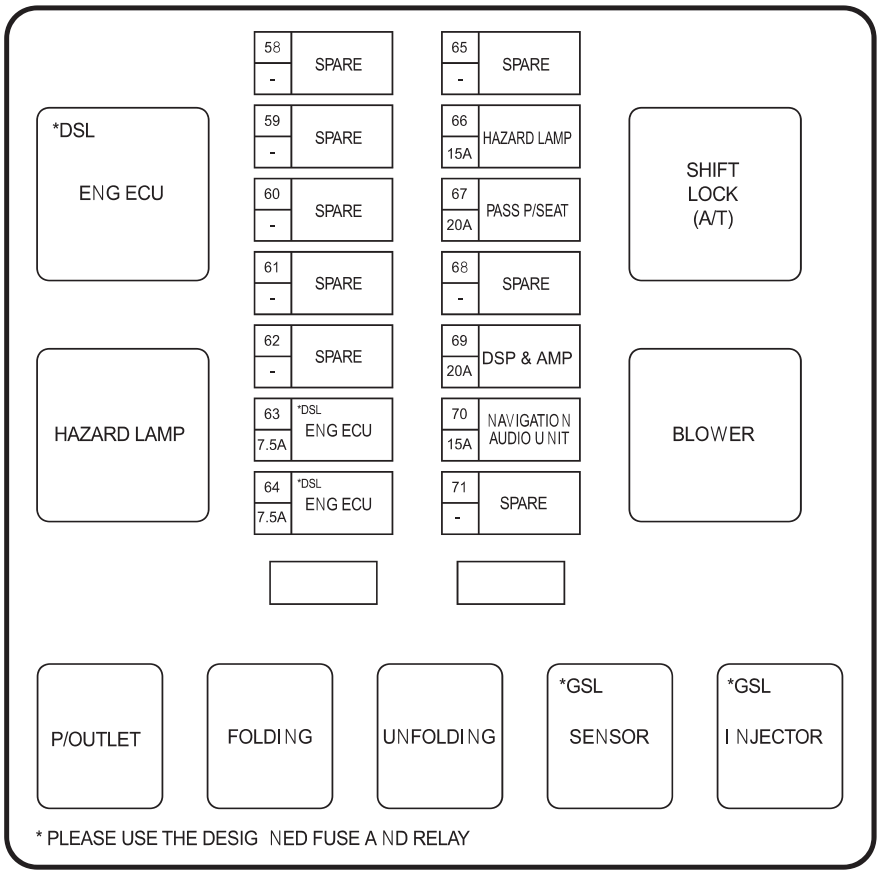
DRL

*GSL F/PUMP

* PLEASE USE THE DESIGNED FUSE AND RELAY

Modification basis	
Application basis	
Affected VIN	

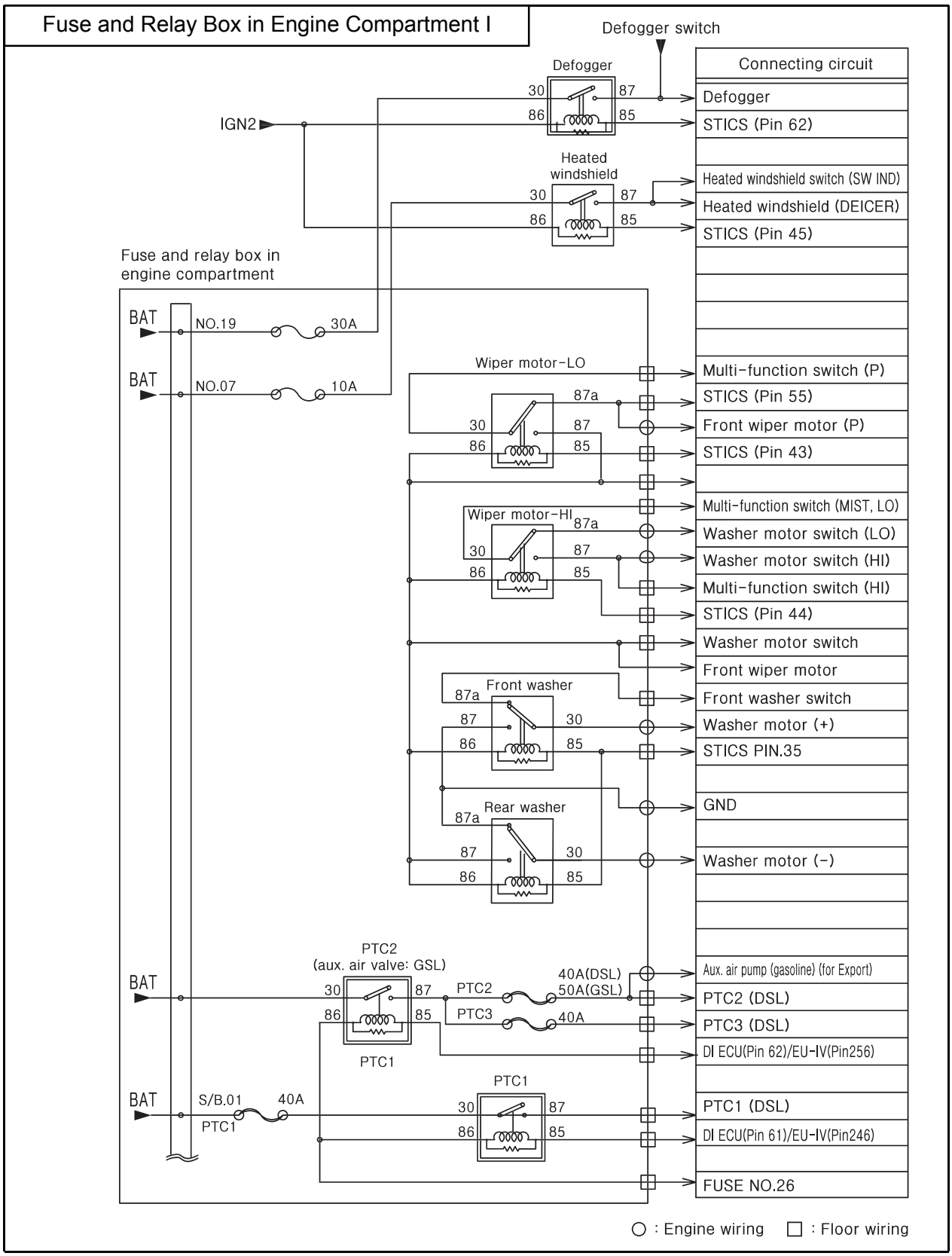
Fuse and relay box (passenger side)



Modification basis	
Application basis	
Affected VIN	

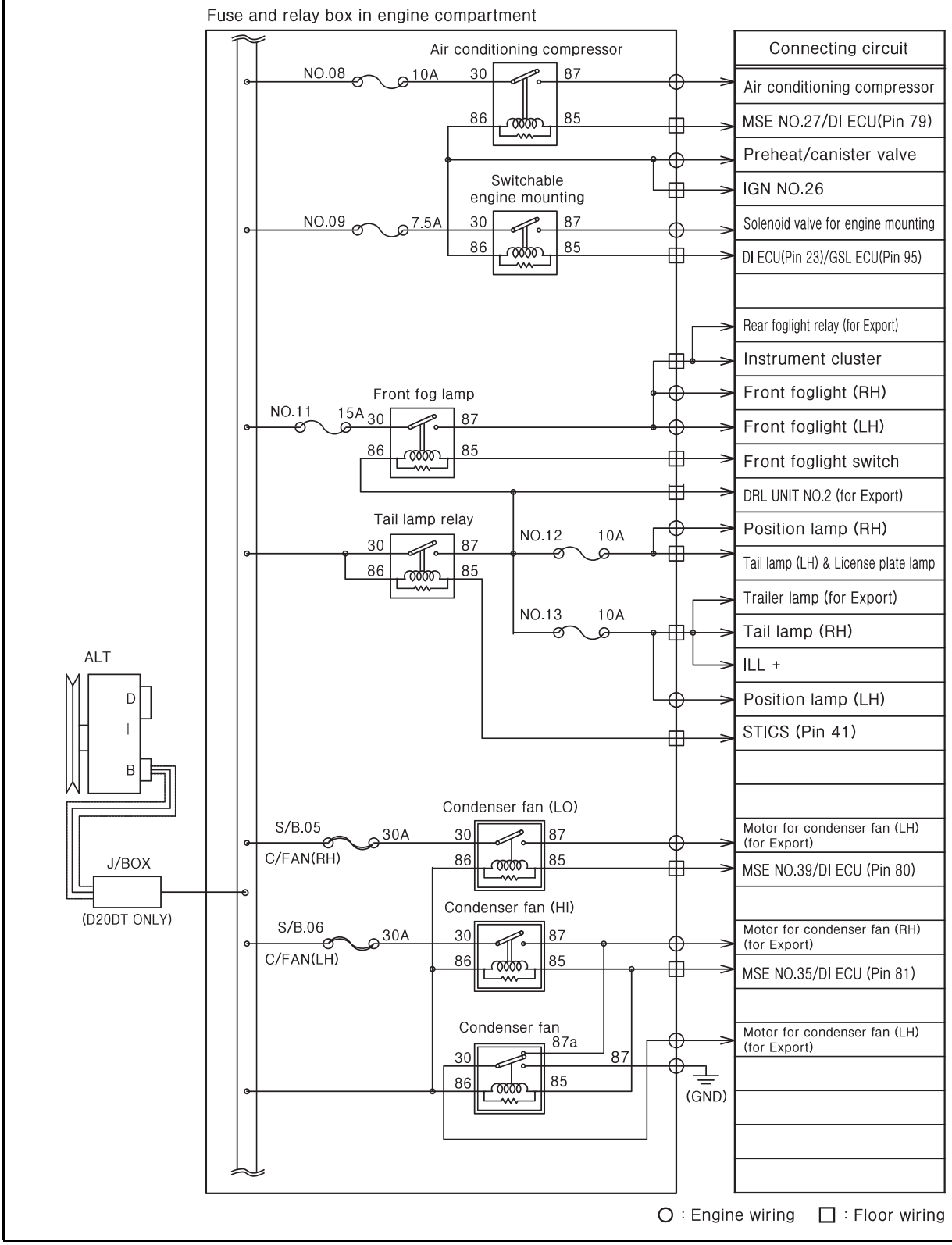
2) POWER DISTRIBUTION DIAGRAM

▶ Fuse and relay box in engine compartment



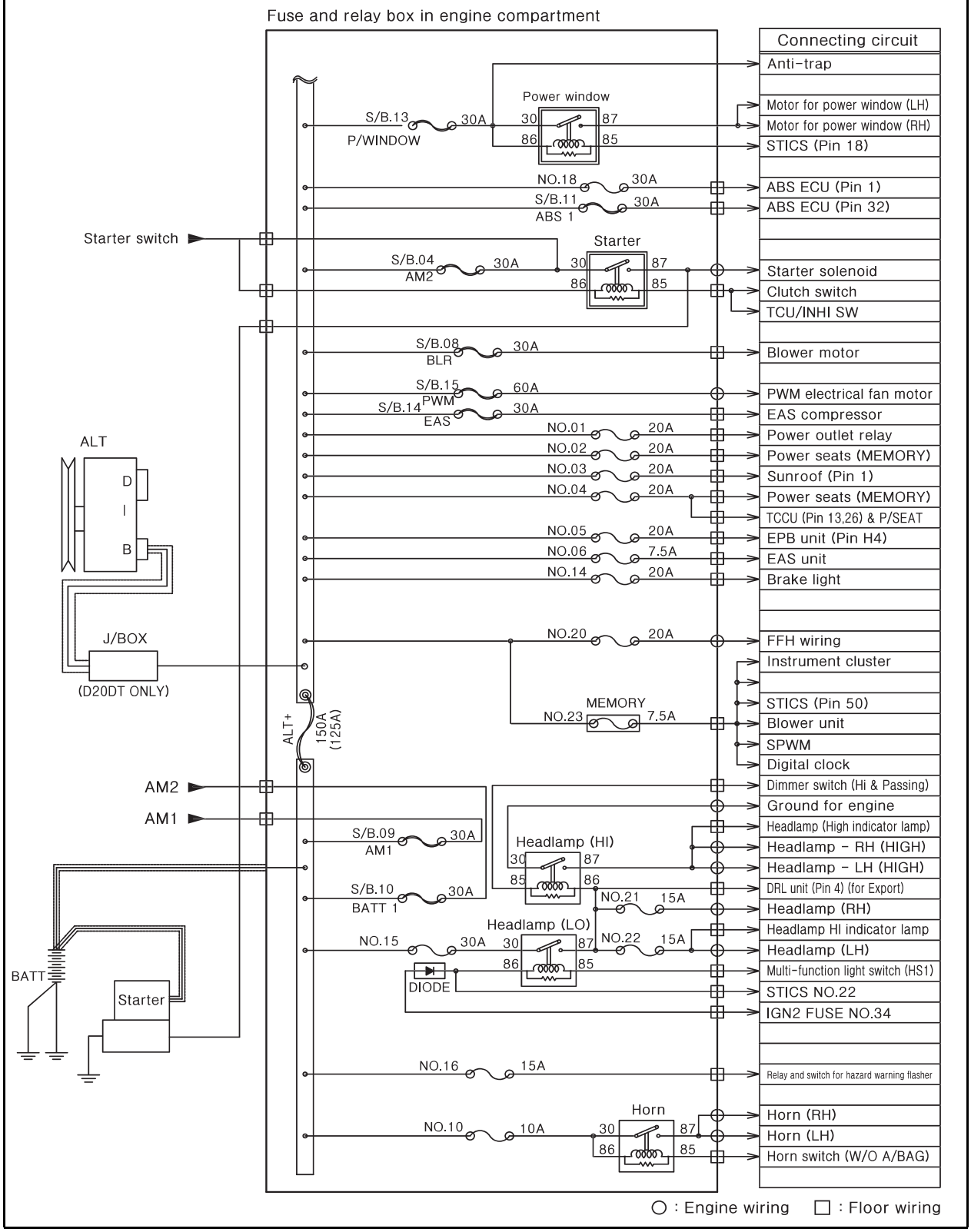
Modification basis	
Application basis	
Affected VIN	

Fuse and relay box in engine compartment II



Modification basis	
Application basis	
Affected VIN	

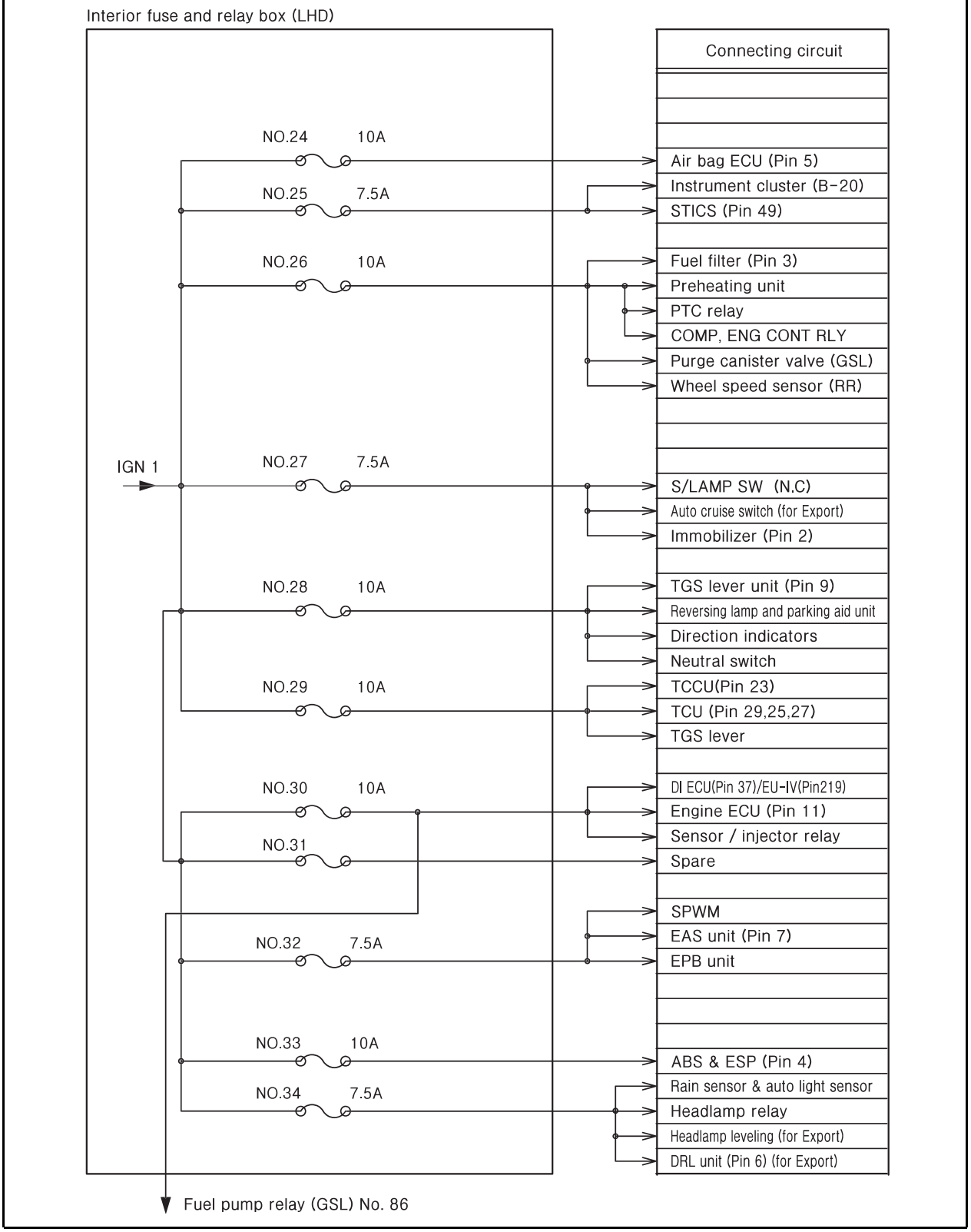
Fuse and relay box in engine compartment III



Modification basis	
Application basis	
Affected VIN	

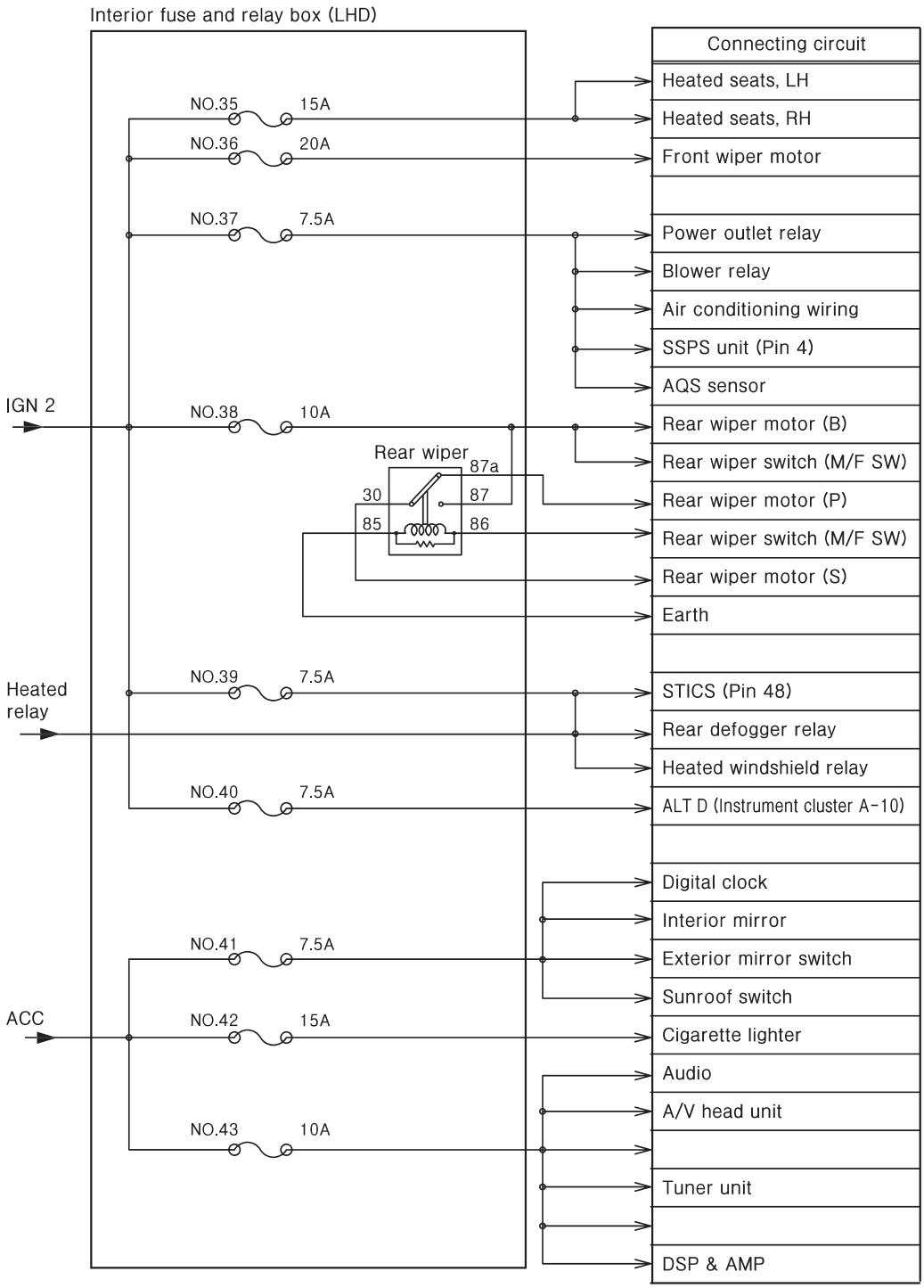
▶ Interior fuse and relay box (driver side)

Interior fuse and relay box (driver side) I



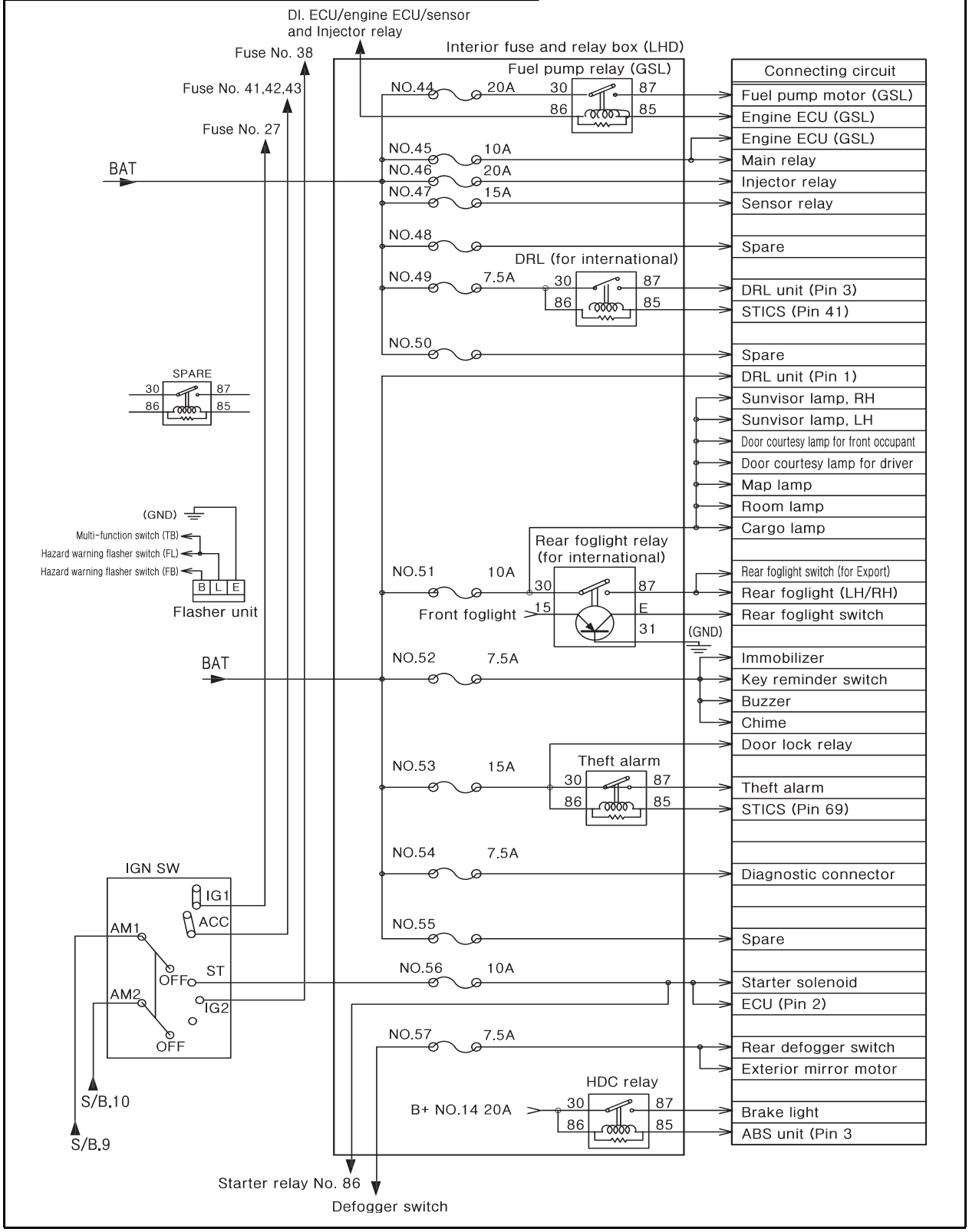
Modification basis	
Application basis	
Affected VIN	

Interior fuse and relay box (driver side) II



Modification basis	
Application basis	
Affected VIN	

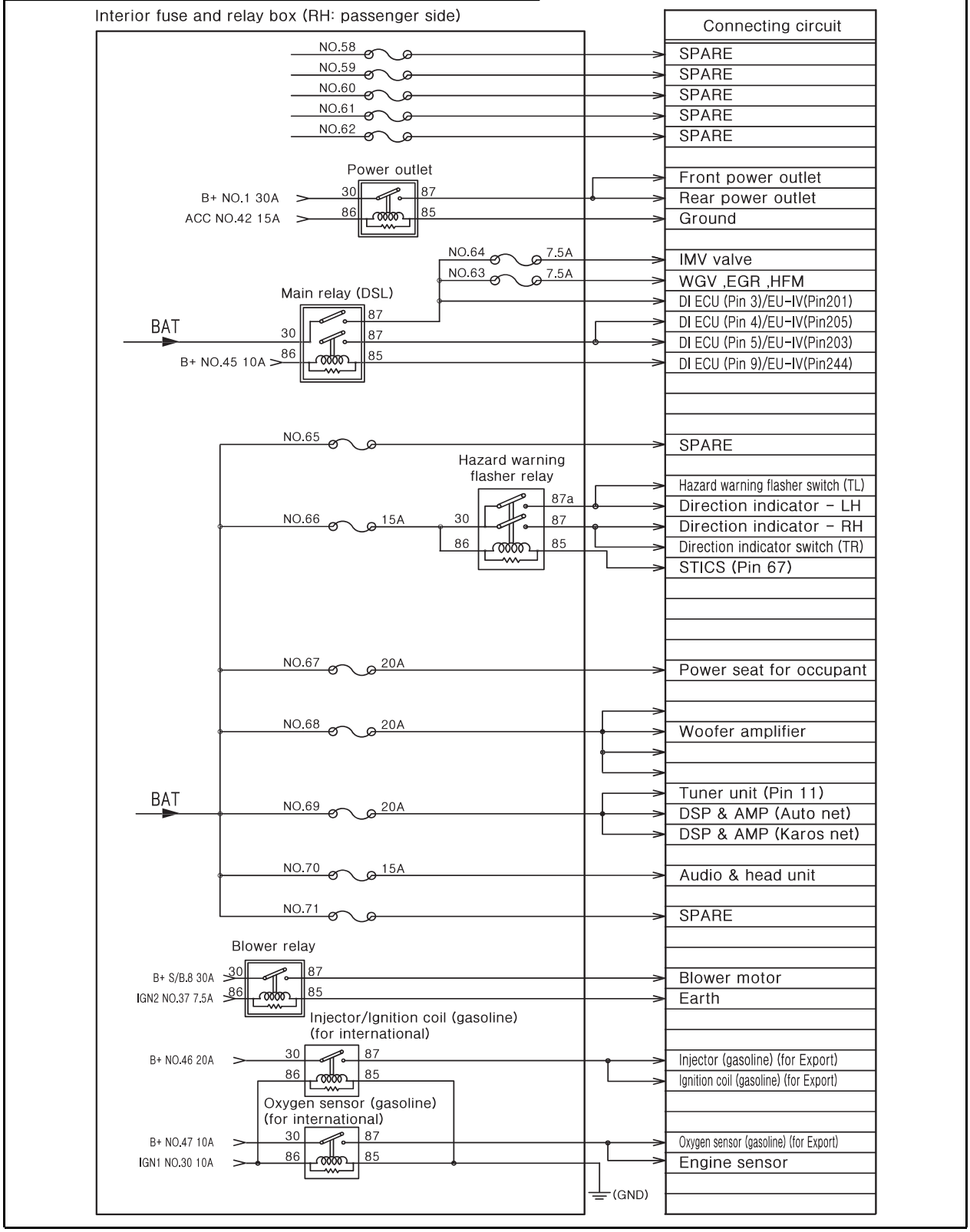
Interior fuse and relay box (driver side) III



Modification basis	
Application basis	
Affected VIN	

▶ Interior fuse and relay (passenger side)

Interior fuse and relay (passenger side)



Modification basis	
Application basis	
Affected VIN	

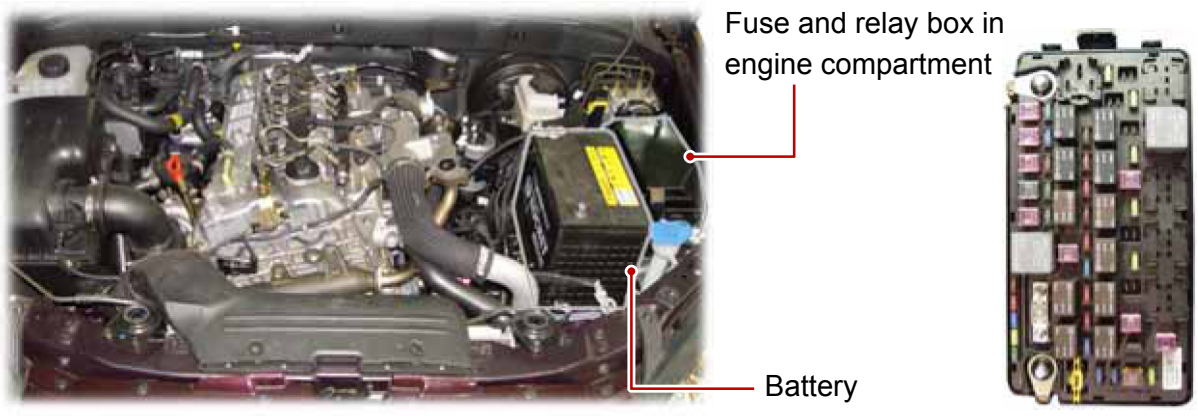
3) REMOVAL AND INSTALLATION OF FUSE AND RELAY BOX

S.G.N. 8410-02

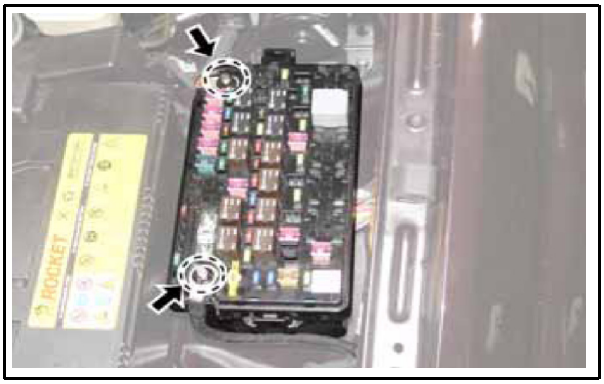
ENGINE ROOM FUSE AND RELAY BOX

Preceding work

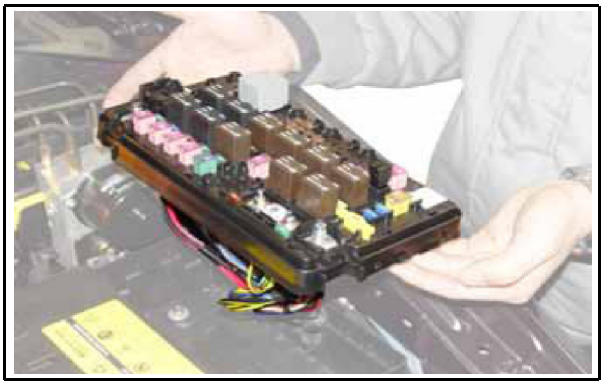
1. Disconnect the negative battery cable.

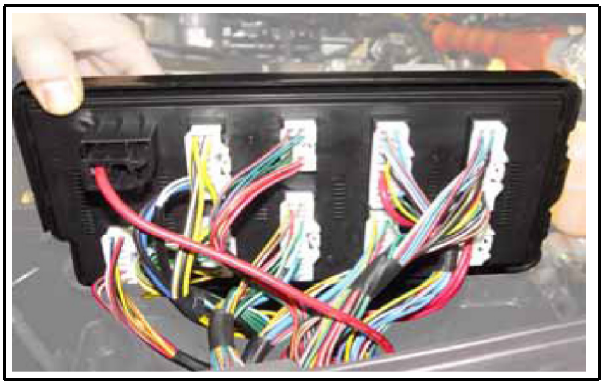


1. Open the box cover and unscrew box mounting nuts.



2. Lift up the ruse and relay box assembly and disconnect the connector from behind the box. Then, remove the fuse and relay box assembly.





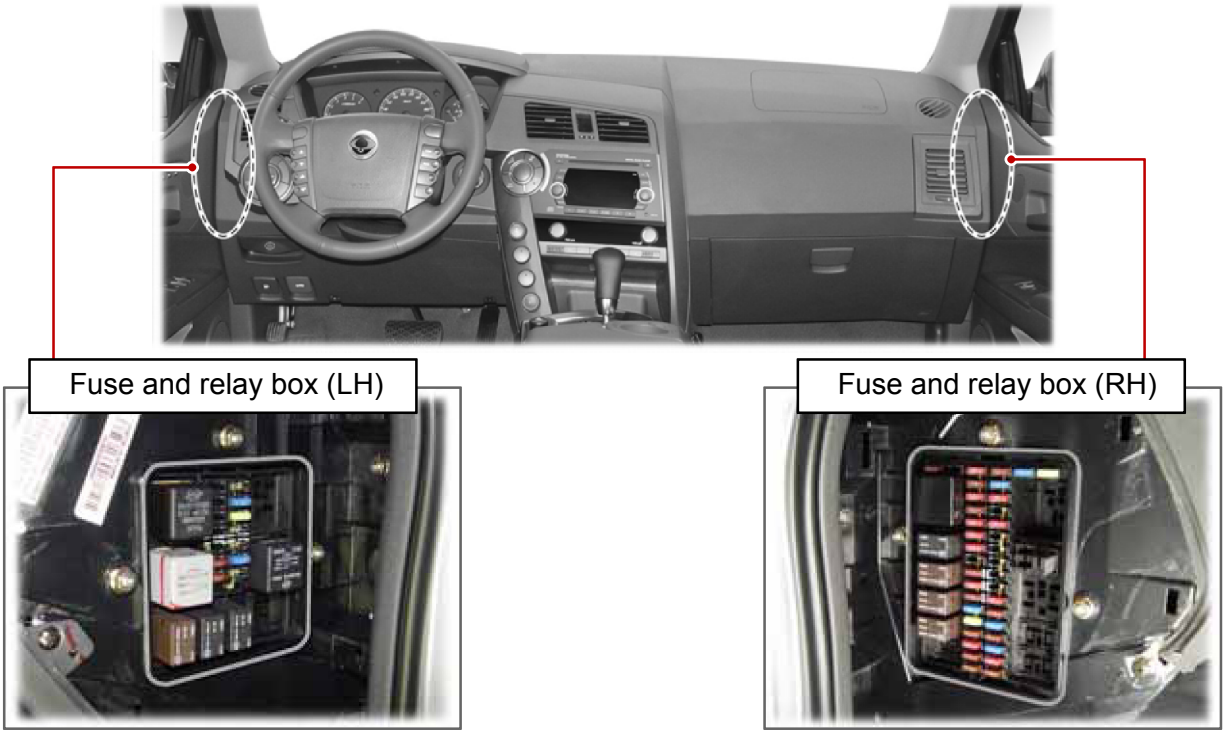
7. FUSE AND RELAY (G23D)

1) FUSES AND RELAYS

There are three fuse and relay boxes in this vehicle (one at each side of instrument panel and one in engine compartment). The designation and capacity of relays and fuses is shown on the fuse and relay box cover.

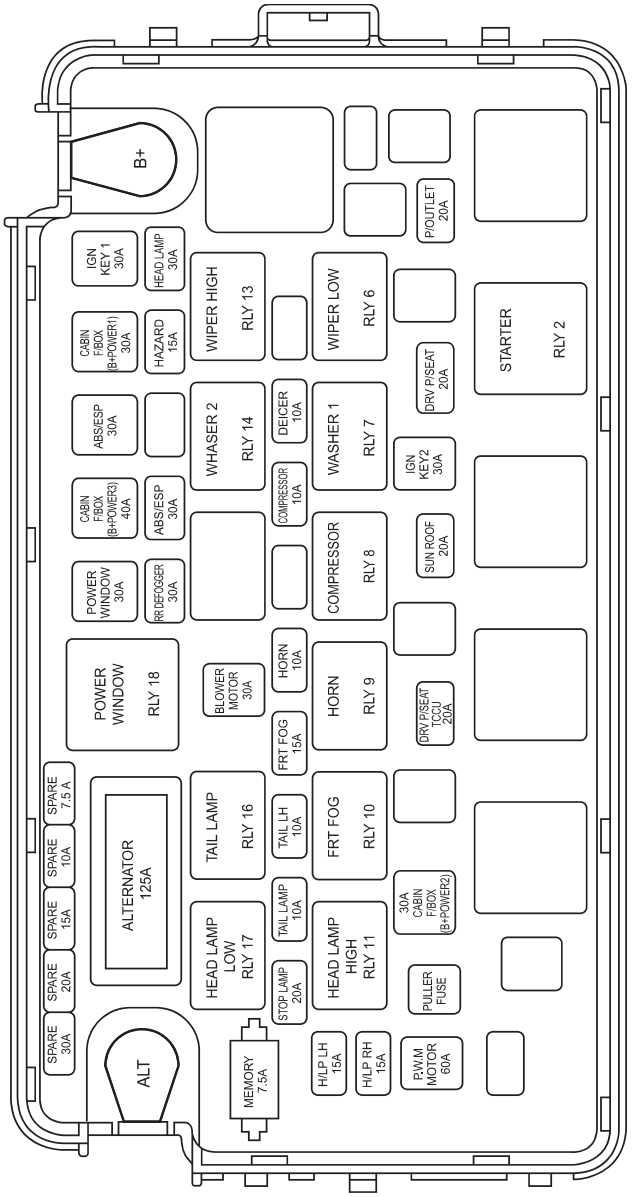
▶ **Engine Room (G23D)**

▶ **Interior (G23D)**



Modification basis	
Application basis	
Affected VIN	

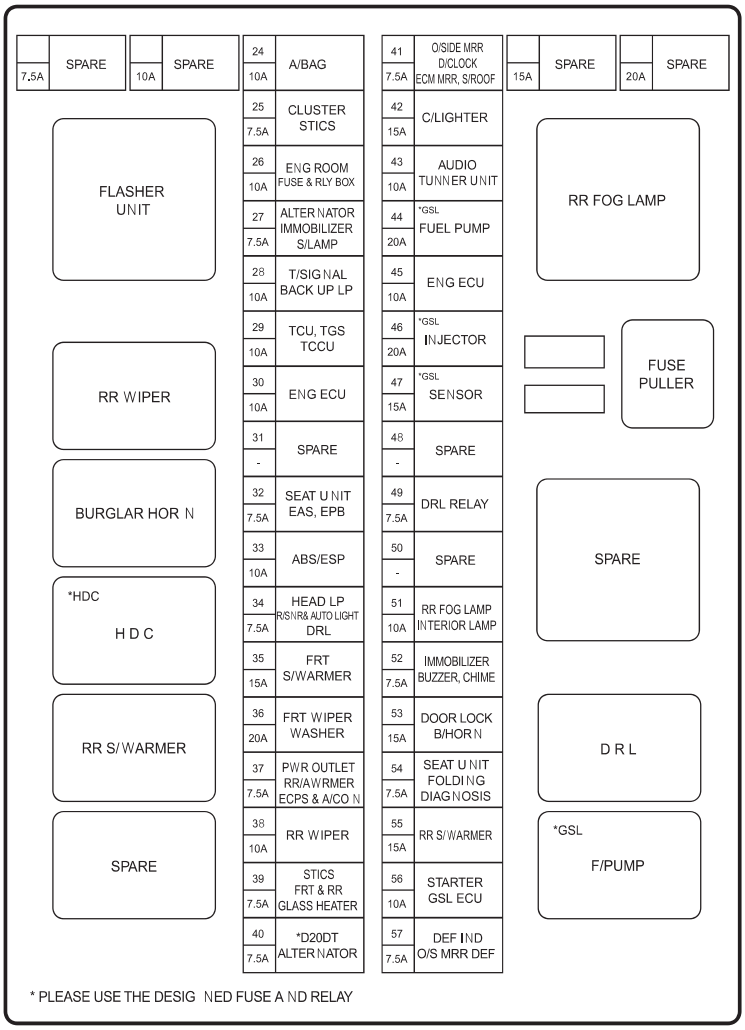
2) DESIGNATION AND CAPACITY OF FUSES AND RELAYS IN ENGINE COMPARTMENT



Modification basis	
Application basis	
Affected VIN	

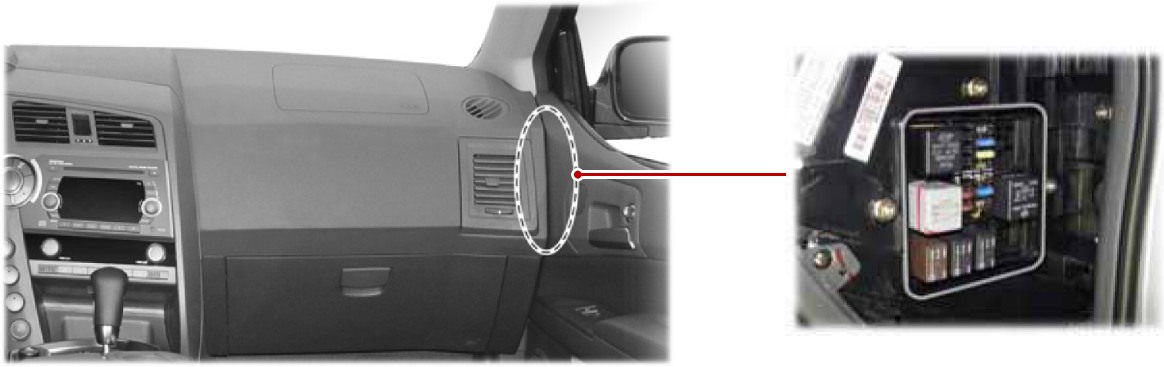
3) DESIGNATION AND CAPACITY OF INTERIOR FUSES AND RELAYS

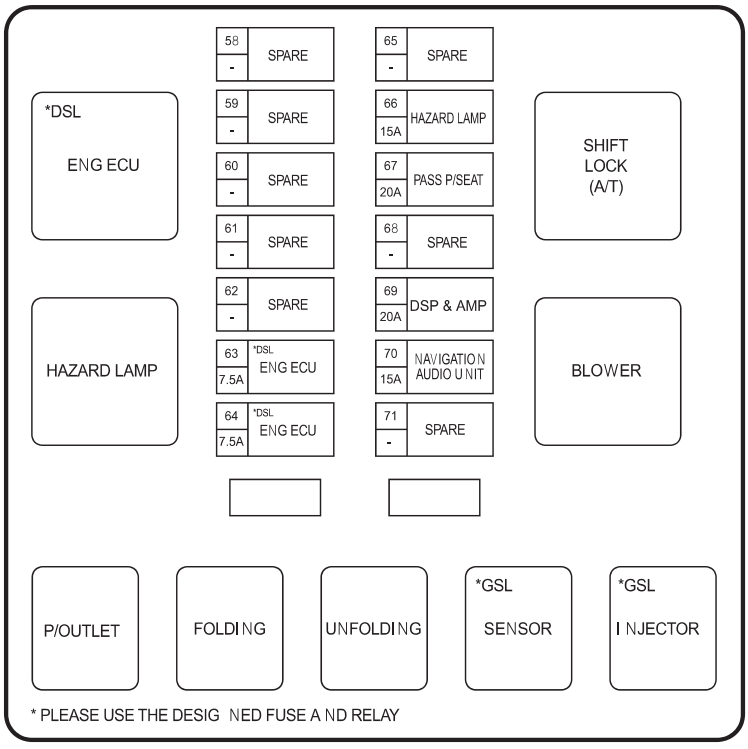
▶ Fuse and Relay (G23D)



Modification basis	
Application basis	
Affected VIN	

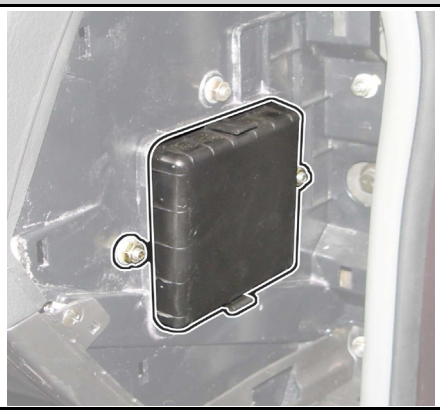
▶ Fuse and Relay (RH)(G23D)





Modification basis	
Application basis	
Affected VIN	

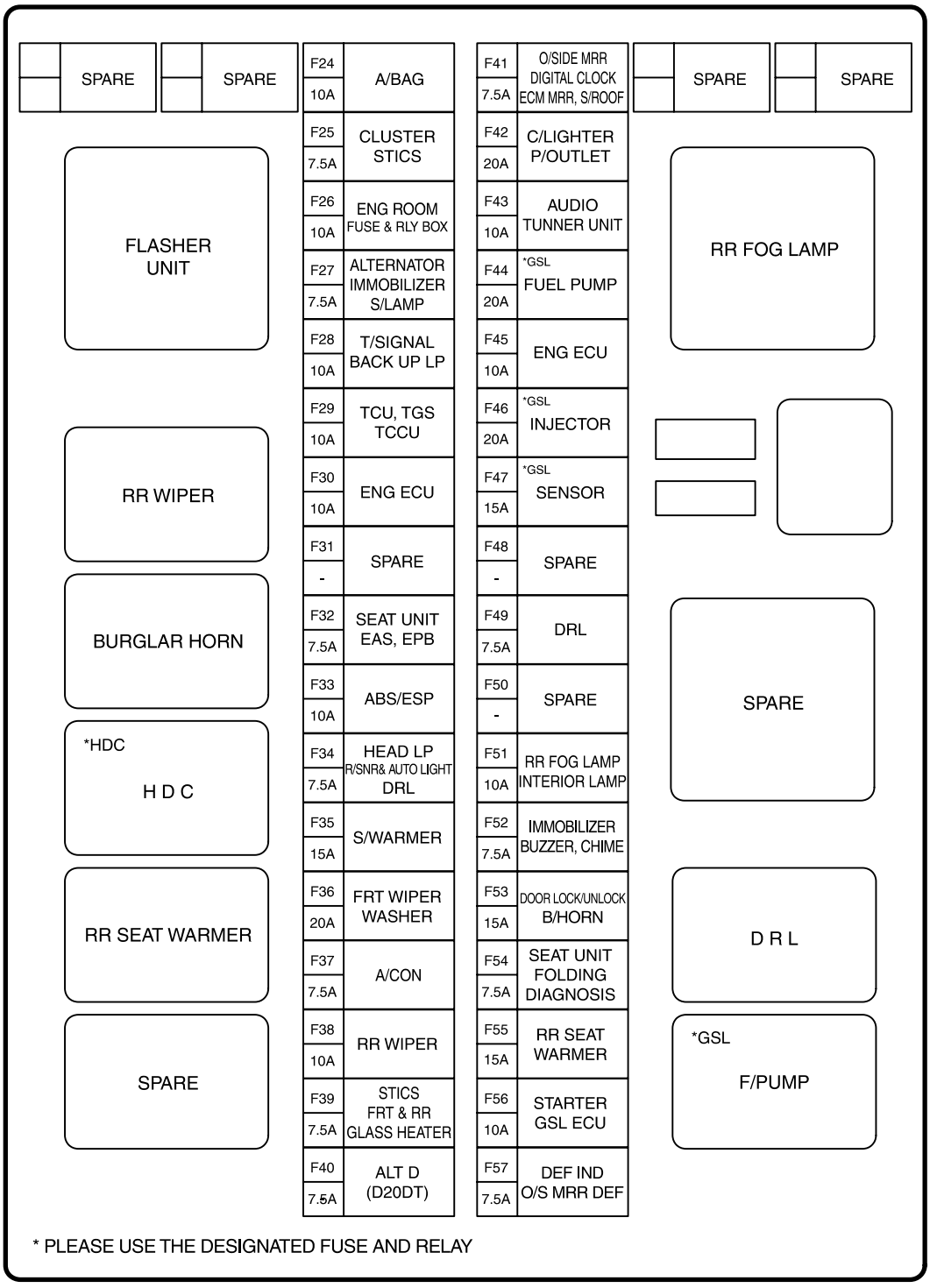
8. INTERIOR FUSE BOX

Fuse and Relay Box (LH)	Fuse and Relay Box (RH)
	

Modification basis	
Application basis	
Affected VIN	

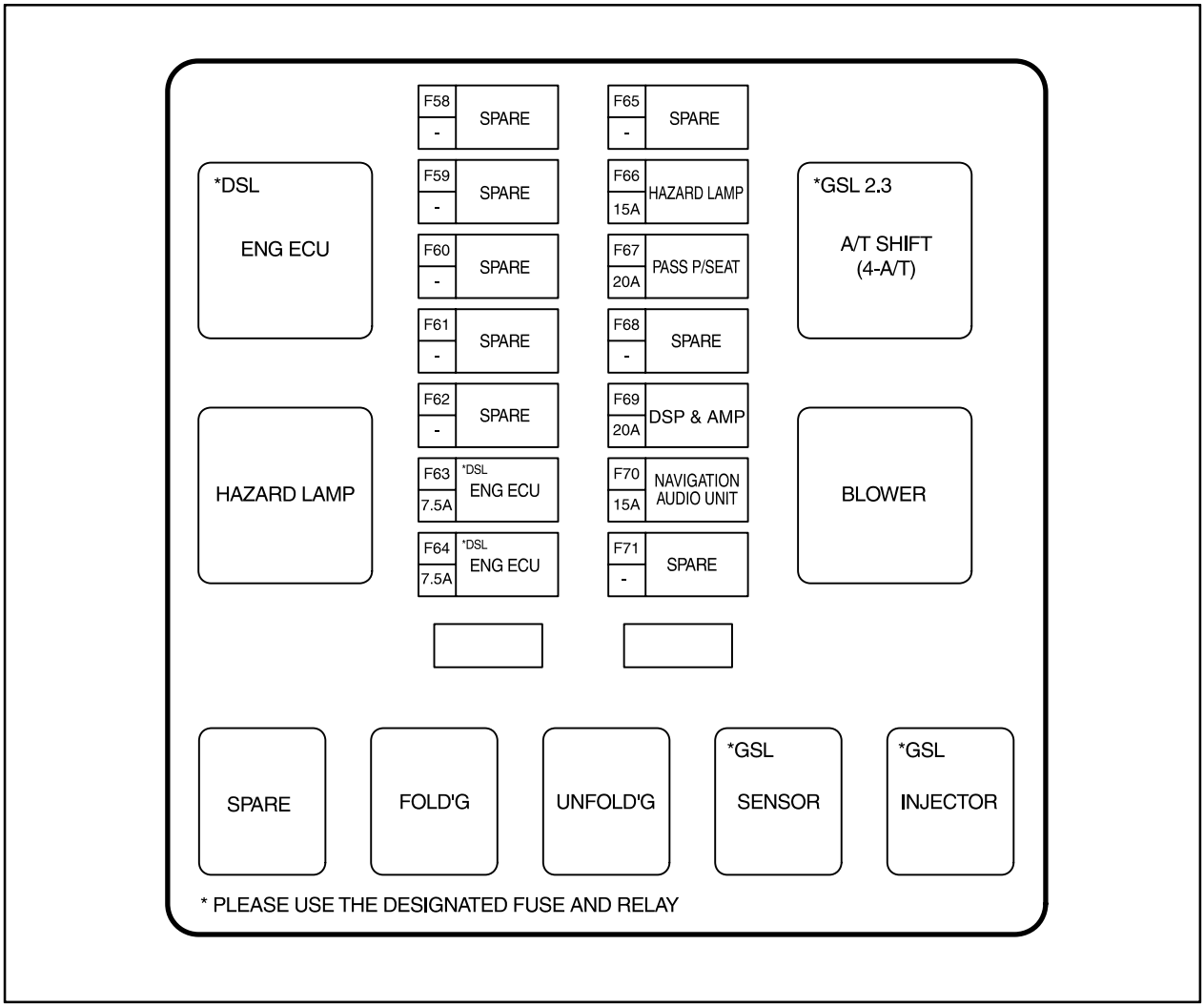
1) Designation and Capacity

▶ Driver Side



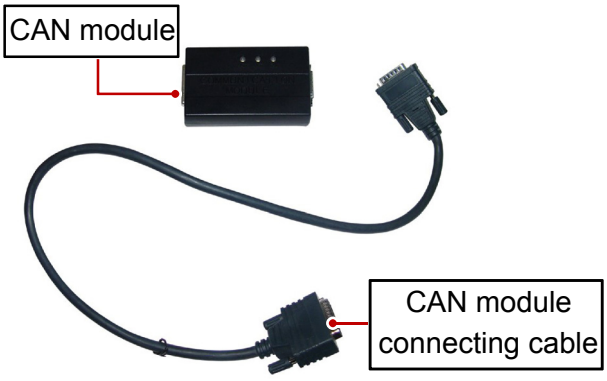
Modification basis	
Application basis	
Affected VIN	

▶ Passenger Side



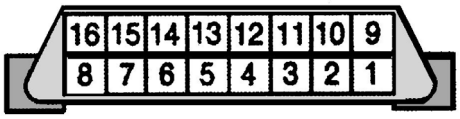
Modification basis	
Application basis	
Affected VIN	

1) Connection Between Scan-100 and Diagnostic Connector

Additional Devices of Scan-100 (Diagnosis: EAS, EPB Only)	Connection of Scan-100 (Including CAN Module and Additional Cable)
	

2) Pin Arrangement of Diagnostic Connector

It is installed under the instrument panel and consists of 16 pins.
The REKES key coding should be performed with Scan-100.

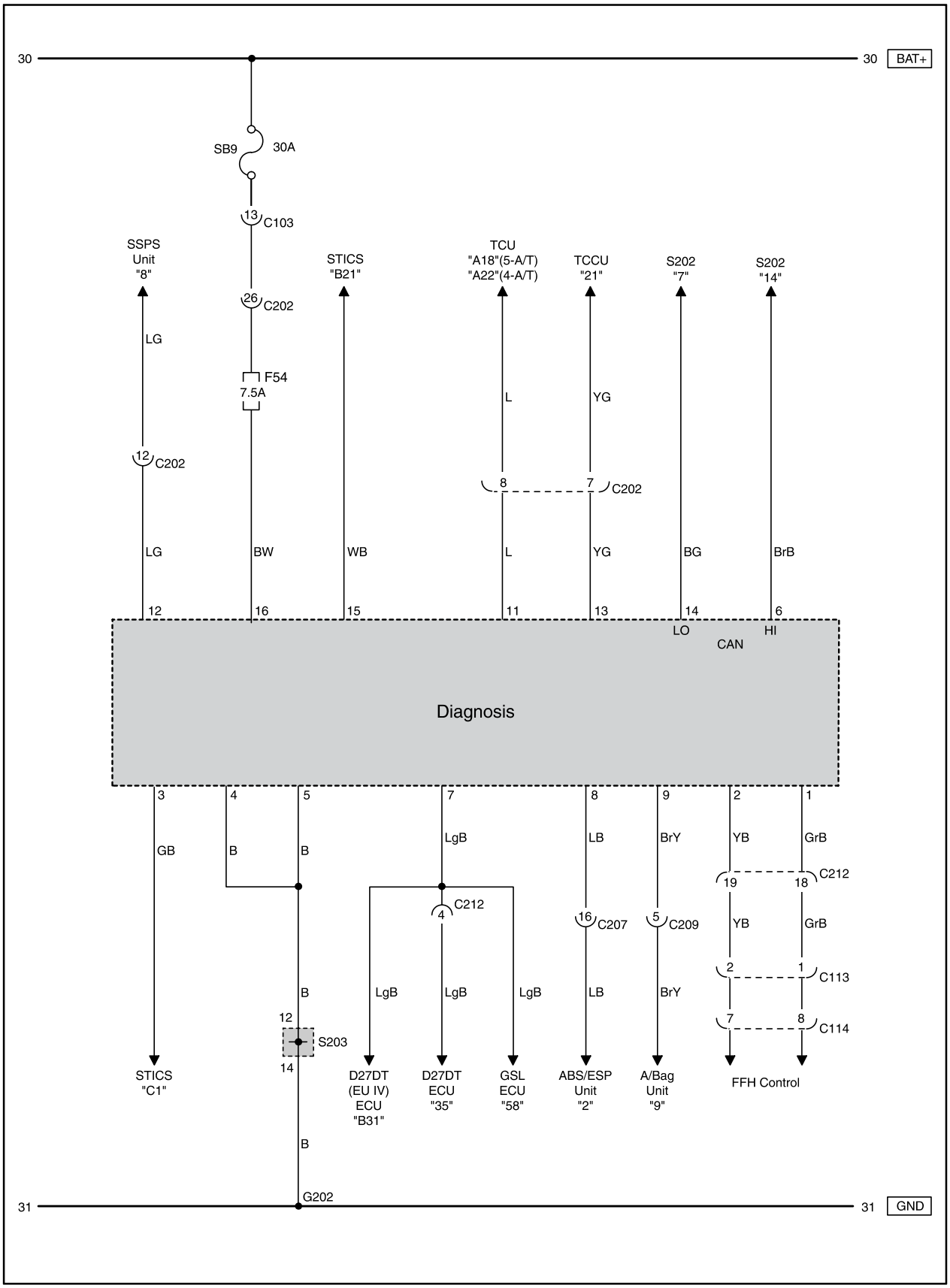


3) Functions of Terminal

Pin no. 1	FFH diagnosis
Pin no. 2	FFH forced driving
Pin no. 3	-
Pin no. 4	Ground
Pin no. 5	Signal ground
Pin no. 6	CAN - HIGH
Pin no. 7	Engine ECU
Pin no. 8	ABS / ESP
Pin no. 9	Air bag
Pin no. 10	TGS lever position unit
Pin no. 11	TCU
Pin no. 12	SSPS
Pin no. 13	TCCU
Pin no. 14	CAN - LOW
Pin no. 15	REKES coding
Pin no. 16	Battery +

Modification basis	
Application basis	
Affected VIN	

4) ELECTRICAL WIRING DIAGRAMS



Modification basis	
Application basis	
Affected VIN	

Memo

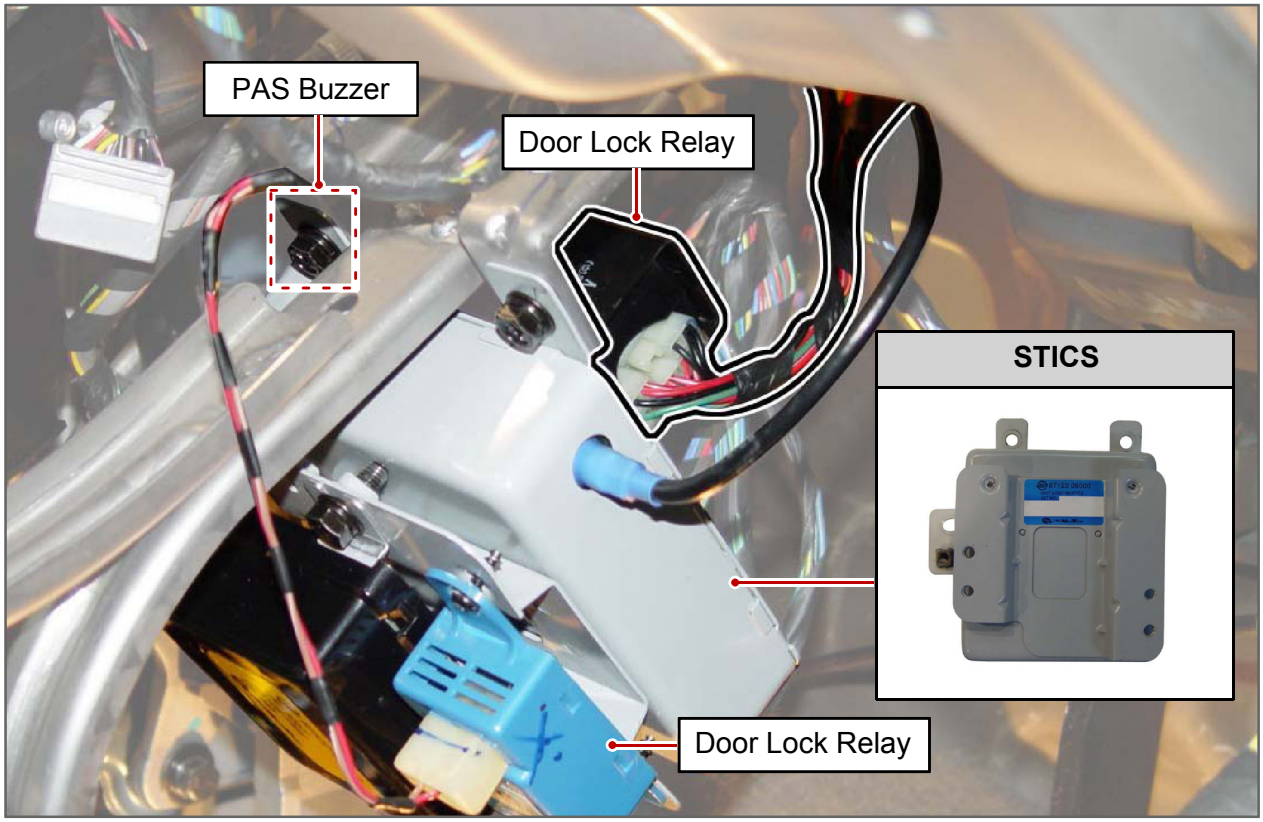
STICS

8710-01

GENERAL

1. STICS OVERVIEW

The RKSTICS (REKES + STICS (Super Time & Integrated Control System)) communicates with the transmitter (remote controller) and other electronic systems to transmit and receive the data. The STICS also includes a diagnosis function that can inspect the error for related devices.



2. SPECIFICATIONS

1) Electrical Performance

▶ Electrical Performance

Item	Requirement	Remark
Rated voltage	DC 12.0 V	
Operating voltage	DC 9.0 V ~ 16.0 V	Should operate normally within this range. (9.5 V ~ 16.0 V only for auto hazard lamp function)
Operating temperature	-30°C ~ +80°C	Should operate normally within this range.
Reserved temperature	-40°C ~ +85°C	
Max. operating humidity	95%	
Resistible voltage	24 V	
Insulating resistance	No heat and fire due to the current leaks.	Confined with PCB, waterproof and coating that requires the insulation.
Parasitic current	below 7.0 mA	When initiating the sleep mode after removing ignition key and locking the doors
Voltage drop	below 1.5 V below 1.8 V	Pin no. 72 and 2, 4, 7, 8, 9, 10, 11, 12, 19, 24, 27, 28, 29, 30, 31, 32, 33, 36, 56, 57, 58, 59, 60, 61, 70, 71 Pin no. 72 and 5, 6, 16, 17, 18, 20, 21, 23, 35, 37, 39, 41, 42, 43, 44, 45, 62, 64, 65, 66, 67, 68, 69

2) Characteristics of Radio Wave

1. Transmitting frequency: 447.800 ± 0.0125 MHz
2. Channel width: below 12.5 KHz
3. Frequency bandwidth: below 8.5 KHz
4. Modulation method: FSK (Frequency Shift Keying)
5. Receiving distance: Approx. 10 ~ 15 m (In case there are not obstacles around the system)

▶ Rated Load

NO.	Description	Rated Load
1	Chime bell / Buzzer	DC 12V 350 mA (Inducted load)
2	Front Room lamp	DC 12V 16W (Lamp load)
3	Rear Room lamp	DC 12V 8W (Lamp load)
4	Key hole illumination	DC 12V 1.2W (Lamp load)
5	Seatbelt warning lamp	DC 12V 1.2W (Lamp load)
6	Parking brake warning lamp	DC 12V 1.2W (Lamp load)
7	Door ajar warning lamp	DC 12V 1.2W (Lamp load)
8	Door lock relay	DC 12V 200 mA (Inducted load)
9	Door unlock relay	DC 12V 200 mA (Inducted load)
10	Horn relay	DC 12V 200 mA (Inducted load)
11	Tail lamp relay	DC 12V 200 mA (Inducted load)
12	Hazard warning relay	DC 12V 200 mA (Inducted load)
13	Power window relay	DC 12V 200 mA (Inducted load)
14	Rear defogger relay	DC 12V 200 mA (Inducted load)
15	Wiper LOW relay	DC 12V 250 mA (Inducted load)
16	Wiper HIGH relay	DC 12V 250 mA (Inducted load)
17	Front washer motor	DC 12V 1.5 A
18	Rear washer motor relay	DC 12V 500 mA (Inducted load)
19	Headlamp relay	DC 12V 750 mA (Inducted load)
20	Front defogger relay	DC 12V 200 mA (Inducted load)
21	Outside Rearview Mirror Folding Relay	DC 12V 200 mA (Inducted load)
22	Outside Rearview Mirror Unfolding Relay	DC 12V 200 mA (Inducted load)

▶ Input Signals

NO.	Input Signal Name	Logic Status
1	IGN1	ON = BAT (IGN "ON" or "START")
2	IGN2	ON = BAT (IGN "ON")
3	ALT_D	ON = BAT (engine running)
4	Key reminder (door ajar warning switch)	IN = BAT (Key in)
5	Driver's door switch	OPEN = GND, CLOSE = OPEN
6	Passenger's door switch	OPEN = GND, CLOSE = OPEN
7	Rear door switch	- OPEN (one of rear seat) = GND - CLOSE (all rear seats) = OPEN
8	Tailgate switch	OPEN = GND, CLOSE = OPEN
9	Hood switch	OPEN = GND, CLOSE = OPEN
10	Driver's door lock/unlock switch	LOCK = OPEN, UNLOCK = GND
11	Passenger's door lock/unlock switch	LOCK = OPEN, UNLOCK = GND
12	Rear door lock/unlock switch	- UNLOCK (one of rear seat) = GND - LOCK (all rear seats) = OPEN
13	Tailgate lock/unlock switch	LOCK = OPEN, UNLOCK = GND
14	Rear defogger switch	ON = GND, OFF = OPEN
15	Seatbelt switch	Unfastened = GND, Fastened = OPEN
16	Sunroof operation switch	ON = GND, OFF = OPEN
17	Parking brake switch	ON = GND, OFF = OPEN
18	Air bag collision sensor	ON = 200 ms output (LOW), OFF = OPEN
19	Wiper motor (parking) switch	STOP = BAT VOLTAGE, ROTATING = GND
20	Washer switch	ON = BAT, OFF = OPEN
21	Intermittent auto switch	ON = BAT, OFF = OPEN
22	Auto washer switch	ON = BAT, OFF = OPEN
23	Intermittent resistance	0 ~ 51kW (for intermittent wiper)
24	Speed sensor	ON = GND (PWM), OFF = OPEN
25	Outside rearview mirror folding/unfolding switch	ON = GND, OFF = OPEN
26	Front defogger switch	ON = GND, OFF = OPEN
27	Auto hazard switch	ON = GND, OFF = OPEN
28	Central door lock switch	ON = GND, OFF = OPEN
29	Rear washer switch	ON = BAT, OFF = OPEN
30	Multifunction auto light switch	ON = GND, OFF = OPEN
31	Indicator lamp switch	ON = BAT/GND, OFF = OPEN (Approx. 5.1V ~ 9.2V)
32	Seat adjustment and switch memory unit	ON = GND (PWM), OFF = OPEN
33	Rain sensor	ON = GND (DATA), OFF = BAT
34	Diagnosis (SCAN-100)	ON = GND (DATA), OFF = BAT (KWP2000)

Modification basis	
Application basis	
Affected VIN	

▶ Chattering of Input Signals

- Vehicle speed input:
  The vehicle speed is the average value of 4 pulses among 6 pulse inputs regardless of the input for 1.0 second after IGI 1 ON. The time indicated in each function does not include the vehicle speed calculating time.
- 20 ms target input:
  Wiper motor A/S (parking) terminal
- 100 ms target input switch
  All switches except wiper motor A/S (parking) terminal

▶ Time Tolerance

- If not indicated, time tolerance will be ± 10%.
  However, if less than 500 ms, time tolerance will be ± 100 ms.
- The time indicated in each function does not include chattering processing time from switch input changing point.

Memo

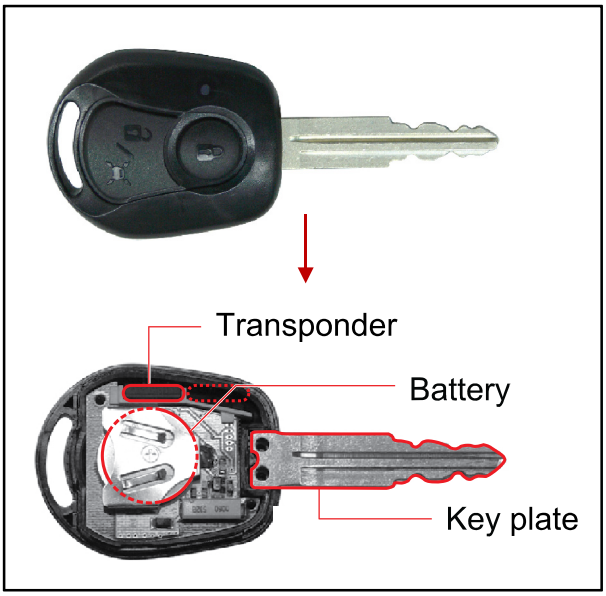
IMMOBILIZER SYSTEM 7010-06

GENERAL

1. IMMOBILIZER OVERVIEW

The immobilizer unit communicates with the enginecontrol unit to enable the engine starting.

1) What is the immobilizer system?



The immobilizer system prevents the vehicle theft byallowing only the authorized key to start the engine. Thetransponder inside the key communicates with the im-mobilizer installed in the key box, and the system per-mits the engine to start after confirming the encryptedcoding from the engine ECU. Refer to the informationthat follows for specific functions and their descriptions.

2. BASIC FUNCTIONS OF IMMOBILIZER KEY (REKES FUNCTION)

1) Remote Control Key

When pressing the switch on the remote control key, the vehicle control message coded by CPU is transmitted to RKSTICS. Then, STICS' CPU controls the vehicle. The key for 2007 Kyron differs from the previous model in appearance and function.

(1) Door Unlock and Panic Function

Briefly press (below 0.5 sec): Door unlock and theft deterrent mode is deactivated Press and hold (over 2 sec): Panic function

▶ **Door unlock (Briefly press)**

- If the unlock button on the remote control is pressed, the door will be opened and the theft deterrent mode will be activated. If the door coupled switch of front room lamp is pressed, the lamp will come on for 30 seconds.
  It will turn off immediately after the lock button of the remote control is pressed.

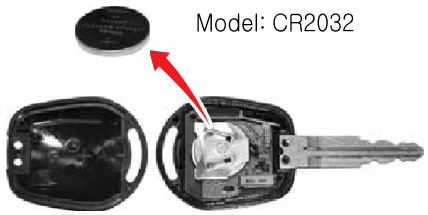
▶ **Panic function: activated in the theft deterrent mode**

- If you press and hold the door unlock and panic buttons, the buzzer will sound for 27 seconds.
- The function is inactivated if any button of remote control is pressed.

Without REKES key

With REKES key

Without REKES key



Model	CR 2032 (Rekes key type)
	V 625U (without Rekes)
Amount	One

Modification basis	
Application basis	
Affected VIN	

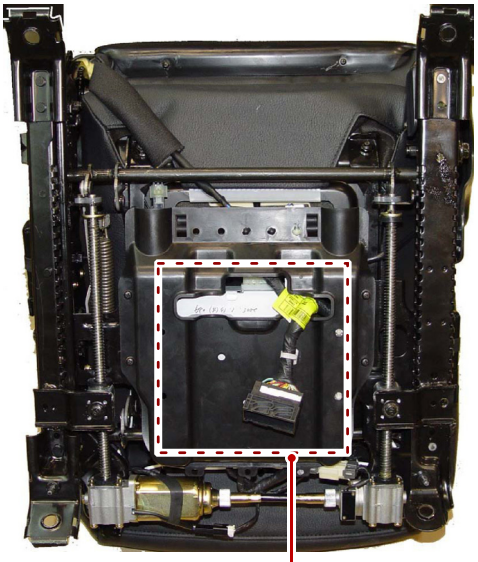
Memo

SPWM (Seat Position With Memory) UNIT

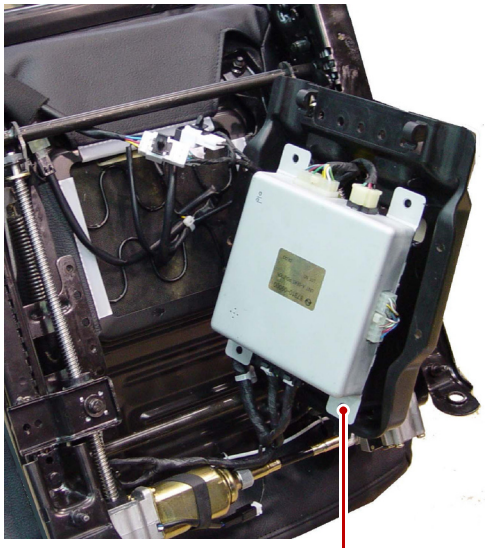
7410-13

GENERAL

1. SEAT POSITION WITH MEMORY OVERVIEW



Location
(Bottom of diver's seat)



SPWM

▶ **Functions of SPWM**

Seat Position With Memory

- **Power seat control**
- **Outside rearview mirror control**
- **Driver's seat and outside mirror position memory**

- Adjusting the power seat's position with the seat adjusting switch
- Adjusting the angle of the outside rearview mirrors (OSRVM)
- Seat memory positions: for 3 persons
- Folding/Unfolding the outside rearview mirrors

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. SEAT POSITION WITH MEMORY COMPONENTS

LH outside rearviewmirror

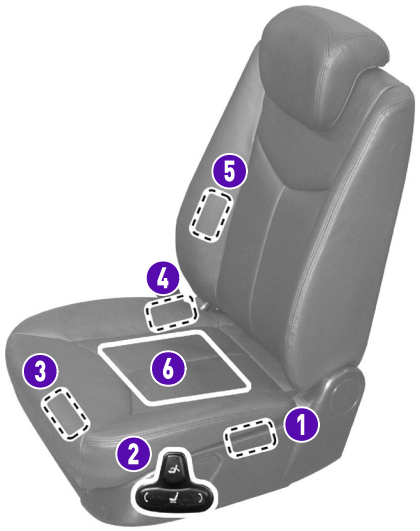
RH outside rearviewmirror

Seat memory switch

Outside rearview mirror folding switch

SPWM Unit

Seat Position With Memory COMPONENTS

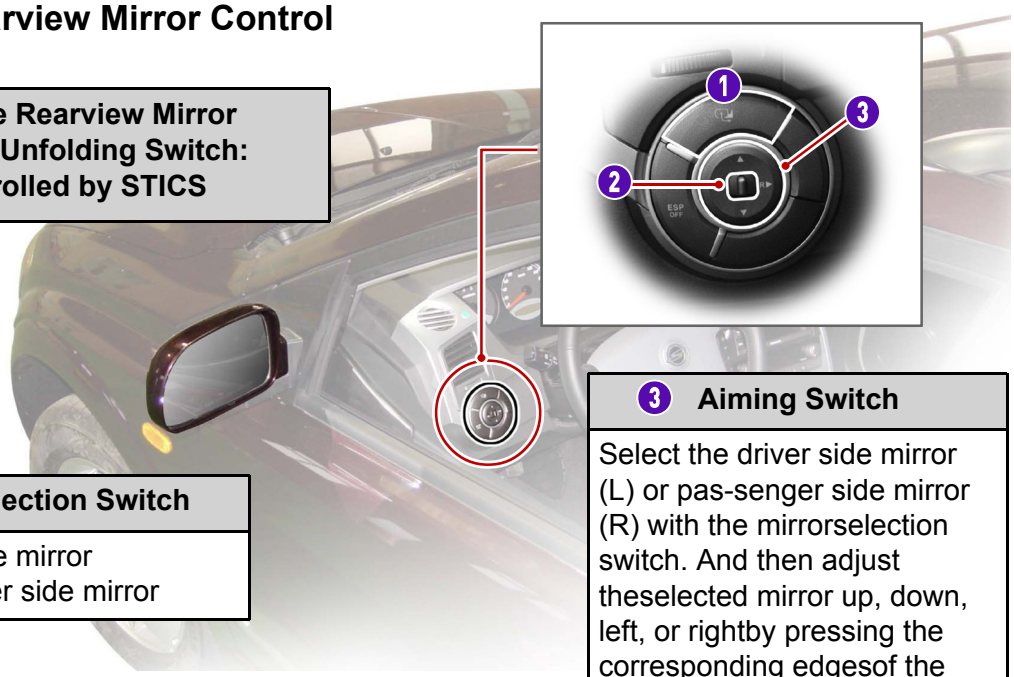


1. Front cushion motor/sensor
2. Seat adjusting switch
3. Sliding motor/sensor
4. Rear cushion motor/sensor
5. Reclining motor/sensor
6. SPWM Unit

Modification basis	
Application basis	
Affected VIN	

2. SEAT POSITION WITH MEMORY OPERATIONS

1) Outside Rearview Mirror Control



1 Outside Rearview Mirror Folding/Unfolding Switch: controlled by STICS

2 Mirror Selection Switch

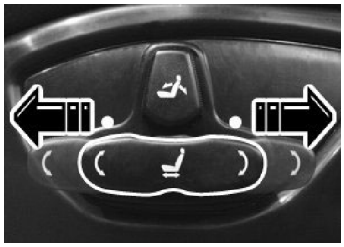
"L": Driver side mirror
"R": Passenger side mirror

3 Aiming Switch

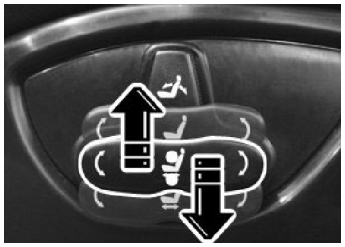
Select the driver side mirror (L) or pas-senger side mirror (R) with the mirrorselection switch. And then adjust theselected mirror up, down, left, or rightby pressing the corresponding edgesof the switch to get the direct rearview.

2) Seat Position Control

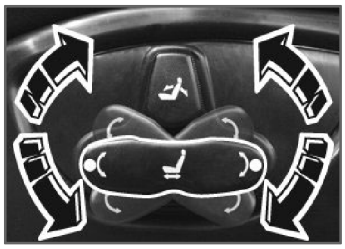
Seat Slide Adjustment



Seat Height Adjustment



Seat Tilt Adjustment



3) DRIVER'S SEAT POSITION MEMORY FUNCTION

The position memory is available for up to three drivers. Each driver can set his/her own driver's seat outside rearviewmirrors and interior rearview mirror positions and they will be separately stored in the integrated computer. If some-body has moved the seat, the memory positions can be recalled automatically by pressing the position button.

▶ **Storing Memory Settings**

1. Position the transmission shift lever to"P"with the ignition switch"ON"(for your safety, do not start the engine).Apply the parking brake if the vehicle is equipped with M/T.
2. Adjust the driver's seat and outside rearview mirrors to the desired positions.
3. Press the "SET"button. The indicator on the button will come on.
4. Within 5 seconds, press the buttons (1), (2) or (3) you want to set. The indicator on the set buttonblinks 3 times.

Modification basis	
Application basis	
Affected VIN	

4) OPERATING MEMORY SETTINGS

- Press and hold the desired buttons (1, 2 or 3) for more than 1.5 seconds.
- Driver's seat and outside rearview mirrors start to move. The position memory recall is canceled if moving thevehicle during its operation.
- Wait until they stop moving.
- When the position memory recall is completed, the buzzer sounds twice. (If failed, the buzzer sounds threetimes.)

CAUTION

· The position memory recall is canceled if operating the seat or the outside rearview mirrors during itsoperation.
· In the vehicle equipped with automatic transmission, the position memory recall is not available if the parkingbrake is released and the gear shift lever is not in "P" position.
· In the vehicle equipped with manual transmission, the position memory recall is not available if the parkingbrake is released.
· If the position memory recall is successfully completed the buzzer sounds twice. If it failed, the buzzer soundsthree times.

3. SEAT POSITION WITH MEMORY INPUT/OUTPUT OF SPWM UNIT

Seat memory power

Seat sliding, rear lift power

Seat reclining, front lift power

Instrument panel:
gear shift lever at "P" position

In the vehicle equipped with automatic transmission, the position memory recall is not available if the gear shift lever is not in "P" position.

Parking brake operation

In the vehicle equipped with manual transmission, the position memory recall is not available if the parking brake is released.

Vehicle speed signal

If vehicle speed is over 3 km/h, the position memory recall is not available.

Outside rearview mirror folding/unfolding switch

Outside rearview mirror adjusting switch

Power seat control switch

Seat memory switch

SPWM UNIT

Sliding motor

Cushion front motor

Cushion rear motor

RH outside rearview mirror folding/unfolding motor

LH outside rearview mirror folding/unfolding motor

RH outside mirror Up/ Down adjustment motor

RH outside mirror Left/ Right adjustment motor

LH outside mirror Up/ Down adjustment motor

LH outside mirror Left/ Right adjustment motor

The changes of each motor are always monitored by the sensor in the motor.

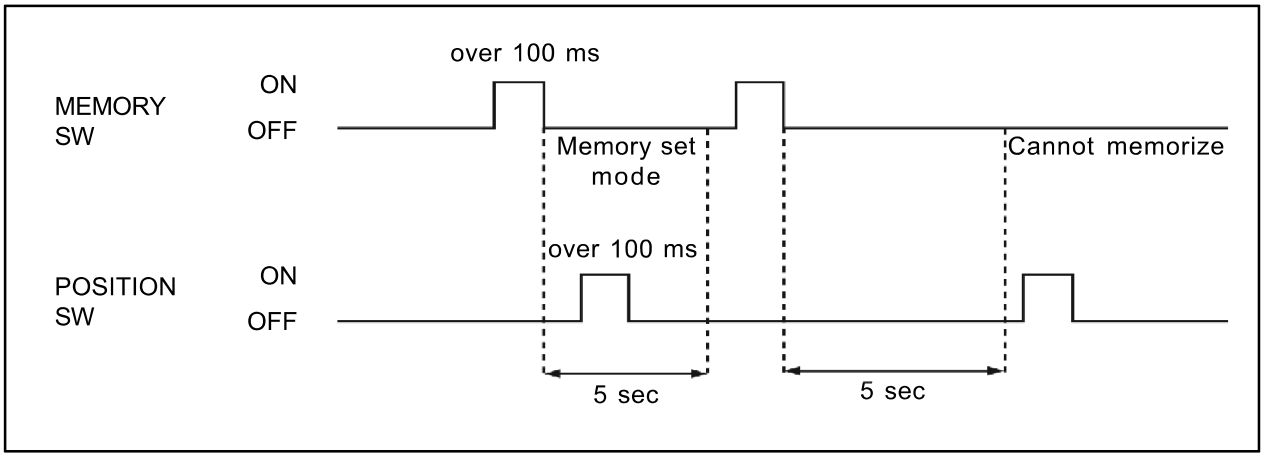
Modification basis	
Application basis	
Affected VIN	

4. CONTROL AND OPERATING CONDITIONS

1) Seat Position Memory

▶ Seat Position Memory Operation

- To store the seat position and the outside rearview mirror position, press the SET button and, within 5 seconds,press one of position switches. The memory setting is available for up to 3 different drivers.
- The memory set mode is only available within 5 seconds after pressing the SET button.

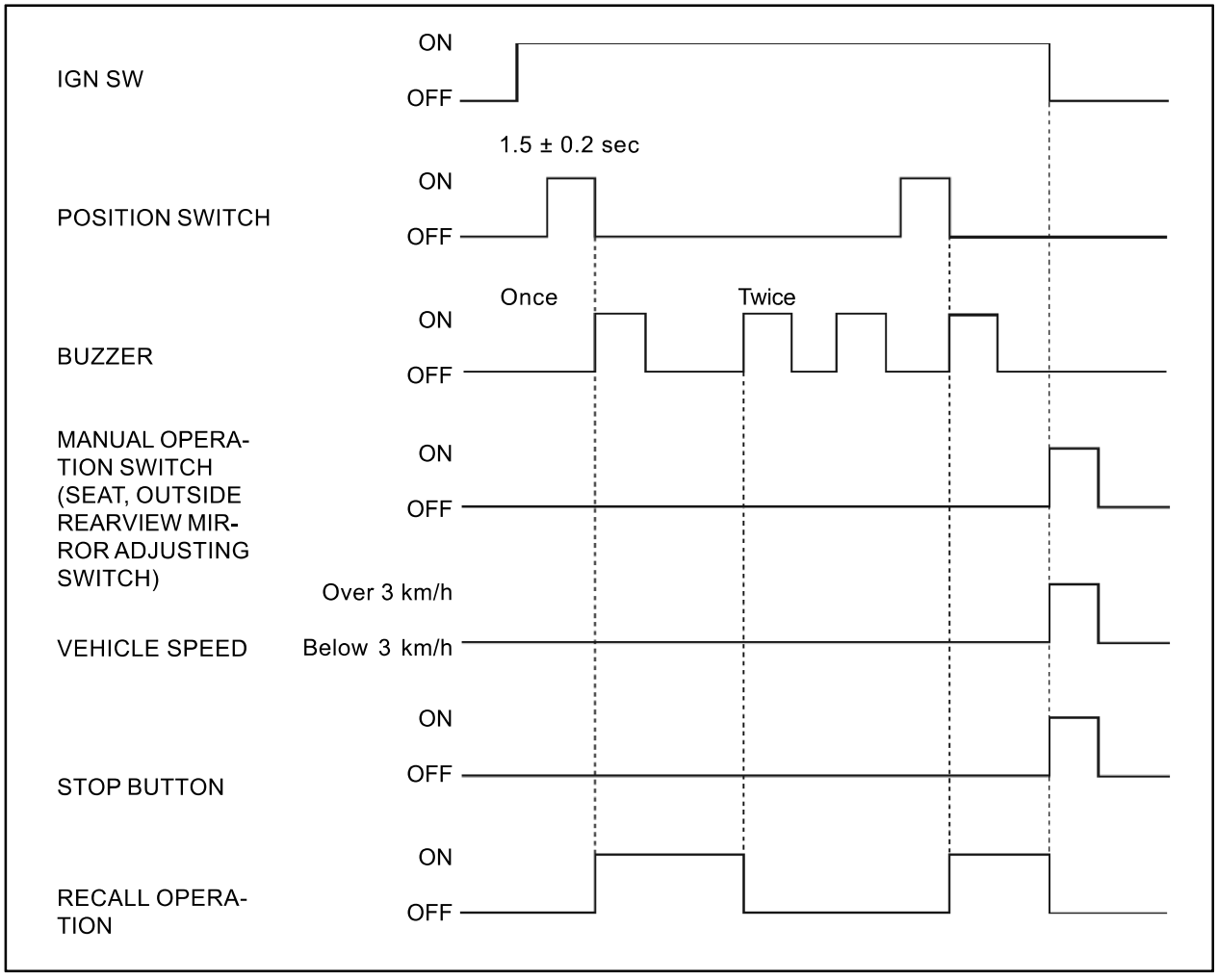


- If any of the following conditions is met, the memory set mode is canceled.
  - · No switch inputs within 5 seconds after pressing SET button.
  - · When adjusting the seat or outside rearview mirror positions during the memory recall operation.
  - · When turning off the ignition switch.
  - · When pressing the STOP button
  - · When the memory setting is completed.
- The memory recall is not available when the vehicle speed is over 3 km/h or the gear shift lever is not in "P"position with the parking brake released.
- The memory set can be unlimitedly renewed.
- The stored positions are erased when disconnecting the battery cables.
- The buzzer sounds once if the memory set mode is activated.
- The buzzer sounds twice if the memory setting/recalling is completed.
- The buzzer sounds three times if an error is found in the sensor during the memory recall operation.

▶ Seat Memory Recall Operation

- When pressing the position switch with the ignition switch ON, the seat and outside rearview mirrors move to thememorized positions.
- When pressing another position switch during previously activated memory recall
- operation, the newly pressedposition switch takes priority and recalls its stored position.
- The buzzer sounds once if a position switch is pressed.
- If any of the following conditions is met, the memory recall function is deactivated.
  - · When turning off the ignition switch.
  - · When the gear shift lever is not in "P"position with the parking brake released.
  - · When the parking brake is released (only for the vehicle equipped with manual transmission)
  - · When the vehicle speed is over 3 km/h.
  - · When pressing the STOP button during the memory recall operation.
  - · When adjusting the seat or outside rearview mirrors during the memory recall operation.
- The seat will not move unless a position switch has a memory setting.

▶ Timing Chart



Modification basis	
Application basis	
Affected VIN	

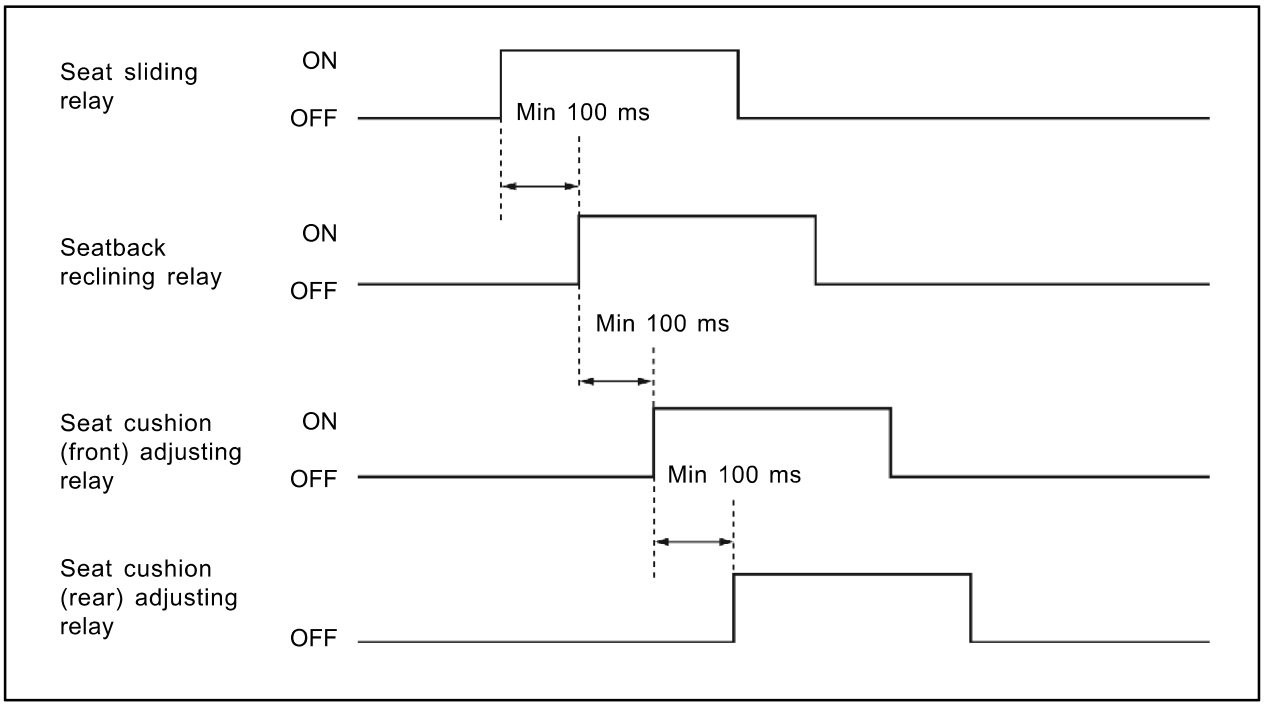
2) POWER SEAT

▶ Seat Position Control

- The position sensor senses the changes of motor in the seat.
- The seat position is stored by the memory order of position switch.
- The stored seat position is recalled by the recall order of position switch.
- The manual adjustment of seat positions takes priority over the memory and recall orders.

▶ Motor Drive Control

- In the case of the automatic control, each motor drive is delayed for 100 msec to prevent the irruptive current frombeing overlapped. The priorities are as follows.
  Seat sliding → Seatback reclining → Seat cushion height adjusting (front) → Seat cushion height adjusting (rear)



- Continuous motor driving timeSeat sliding: 16 seconds, Seatback reclining : 50 seconds, Cushion height adjusting : 6 seconds
- Reverse controlWhen reversing the control motor, the motor starts to rotate in the opposite direction 100 msec after the forwarddriving is completed.
- The motor doesn't operate if the difference between the stored position and the current position is out of thespecified range
  · Sliding : 12 edges (6 pulses)
  · Cushion height : 6 edges (3 pulses)
  · Reclining : 100 mV

▶ **Error Detection**

After the motor starts to drive, if the position sensor value doesn't change for about 3 seconds during the seat slidingor seatback reclining adjustment and for 1.6 seconds during the seat cushion height adjustment, it is determinedthat the harness circuit is open or the sensor failure occurred.

▶ **If an error is detected,**

The memory recall operation stops. However, the seat can be adjusted by manual switches.The memory recall operation can be activated after the failure is corrected. This is determined when the systemdetects the value changes from the position sensor. This is called the Release of automatic control stop

▶ **Relay Protection**

Once the relay is turned on, it will not be turned off within 60 ms.

▶ **Specifications**

- Rated voltage : DC 12 V
- Operating voltage : DC 9 ~ 16 V
- Current consumption : Max. 500 mA (not including the load)
- Operating temperature range : −30°C ~ 75°C
- Reserve temperature range : −40°C ~ 85°C
- Parasitic current : Max. 2 mA

Modification basis	
Application basis	
Affected VIN	

3) Outside Rearview Mirror (OSRVM)

▶ Mirror Position Control

- The position sensor senses the changes of motors in the mirrors.
- The mirror position is stored by the memory order of position switch.
- The mirror position is recalled by the recall order of position switch.
- The manual adjustment of mirror positions takes priority over the memory and recall orders.

▶ Motor Drive Control

- Driving sequenceHorizontal → Vertical
- Control during memory reca
  - · Horizontal direction : 1.5 ~ 3.7 V
  - · Vertical direction : 1.5 ~ 3.7 V

CAUTION

Field of vision :

· The control range of mirror that is notlimited mechanically.

· The control range of that doesn't affectthe sensor characteristics

- LOCK detection
  - · Timer monitors the motor driving time to detect LOCK condition.
- Monitoring the memory recall time
  - · If the memory recall operation cannot be finished within 40 seconds after activating it, the system stop themotor output and terminate the control.

▶ Error Detection

Even though the motor runs, if the drive input change (for 5 seconds) from the position sensor doesn't change, it isdetermined that the harness circuit is open or the motor/sensor failure occurred.When an error is detected, any memory set or recall operations are prohibited, but the manual operation is possible.When the sensor input changes by a manual operation, this error is cleared.

▶ Specification

- Rated voltage : DC 12 V
- Operating voltage : DC 9 ~ 16 V
- Current consumption : Max. 300 mA (not including the load)
- Operating temperature range : −30°C ~ 75°C
- Reserve temperature range : −40°C ~ 85°C

CLUSTER

8010-01

GENERAL

1. DESCRIPTIONS OF INDICATOR DISPLAY

The instrument cluster sends and receives the data through CAN communication.The HDC warning light and the engine hood open warning light are newly introduced.

D20DT, D27DT

1. Tachometer
2. Speedometer
3. Left turn signal indicator
4. Right turn signal indicator
5. Engine coolant temperature gauge
6. Fuel gauge
7. Engine overheat warning light
8. Fog light indicator
9. High beam indicator
10. Door ajar warning light
11. Seat belt reminder (passenger's seat)
12. Brake warning light
13. Low fuel level warning light
14. Winter mode indicator
15. ESP warning light
16. 4WD HIGH indicator
17. Battery charge warning light
18. Air bag warning light
19. HDC indicator
20. Immobilizer indicator
21. Water separator warning light
22. Seat belt reminder (driver's seat)
23. 4WD LOW indicator
24. 4WD CHECK warning light
25. Auto shift indicator (for automatic transmission)
26. ODOmeter/ Trip odometer
27. ABS warning light
28. EBD warning light
29. Engine hood open warning light
30. Glow indicator
31. Engine check warning light
32. Engine oil pressure warning light
33. Auto cruise indicator
34. SSPS warning light
35. Hazard warning light (Eastern Europe only)

Modification basis	
Application basis	
Affected VIN	

For Gasoline Engine

1. Tachometer
2. Speedometer
3. Left turn signal indicator
4. Right turn signal indicator
5. Engine coolant temperature gauge
6. Fuel gauge
7. Engine overheat warning light
8. Fog light indicator
9. High beam indicator
10. Door ajar warning light
11. Seat belt reminder (passenger's seat)
12. Brake warning light
13. Low fuel level warning light
14. Hazard warning light (Eastern Europe only)
15. ESP warning light
16. 4WD HIGH indicator
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27. EBD warning light
28. Engine hood open warning light
29. Engine check warning light
30. Engine oil pressure warning light
31. Auto cruise indicator
32. SSPS warning light
33. Power mode indicator
34. Winter mode indicator

Modification basis	
Application basis	
Affected VIN	

Memo

2.WARNING / INDICATOR PANEL

ESP Warning Light

This warning light comes on when pressing the “ESP OFF” switch or the ESP system is defective. If the ESP function operates while driving, this warning light flickers and the alarm sounds.

HDC Warning Light

Green light on: HDC is ready for use (by pressing the HDC switch).
Green light blinking: HDC is being applied.
Red light on: the HDC system is overheated or malfunctioning.
When HDC is applied, the green HDC indicator blinks.
When the red HDC indicator is on, the HDC system is overheated or malfunctioning.

When the red HDC indicator is on, the HDC function does not work.

Immobilizer Indicator

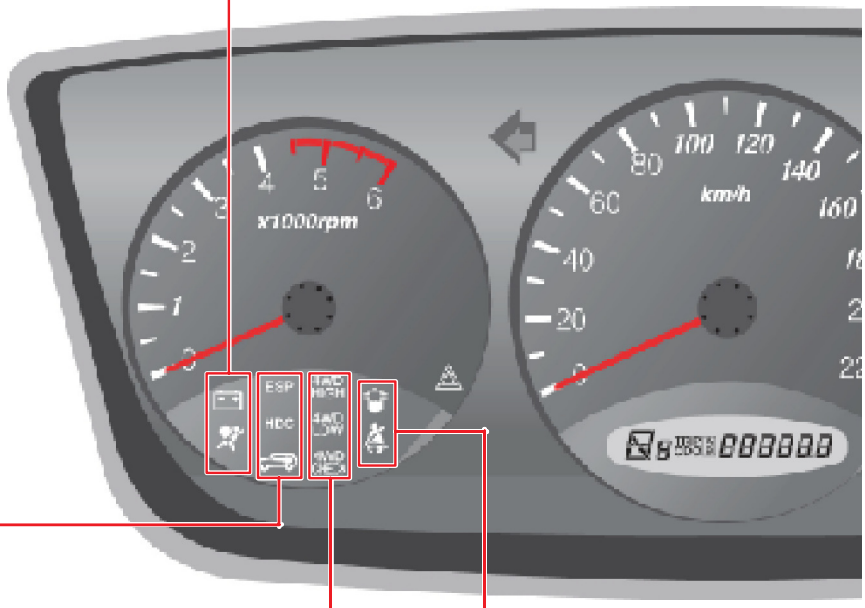
This indicator comes on when the ignition key is communicating with the engine control unit (during engine starting) for approx. 0.5 seconds.

Battery Charge Warning Light

This warning light comes on when the ignition switch is turned on and go off when the engine is started. If this light doesn’t go off after engine starting or comes on while driving, it means there is a malfunction in the system.

Air Bag Warning Light

When the ignition is switched on, this warning light illuminates and then should go out, to confirm that the air bag is operational. If it does not come on, or if it does not go out, or if it flashes or illuminates continuously while driving, it means that there is malfunction in the system.



4WD Indicator

4WD HIGH indicator
When shifting the driving mode from "4L" to "4H", this indicator blinks until the shifting operation is completed. After completion of the mode change to 4H, the indicator comes on.

4WD LOW Indicator
When shifting the driving mode between “4WD LOW” and “4WD HIGH”, this indicator blinks until the shifting operation is completed. After completion of mode change, the indicator goes out.

4WD CHECK Warning Light
If “4WD CHECK” warning light stays on continuously, it may indicate that there is something wrong in the transfer case system.

Water Separator Warning Light

When the water level inside water separator in fuel filter exceeds a certain level, this warning light comes on and buzzer sounds. Also, the driving force of the vehicle decreases. If these conditions occur, immediately drain the water from fuel filter and water separator.

Seat Belt Reminde r

The seat belt warning light comes on and the seat belt warning chime sound for 6 seconds when the ignition switch is turned to “ON” position unless the driver’s seat belt is securely fastened. This reminding operation stops when the driver fastens the seat belt even during its operation period.

Modification basis	
Application basis	
Affected VIN	

Over Temp. Warning Light

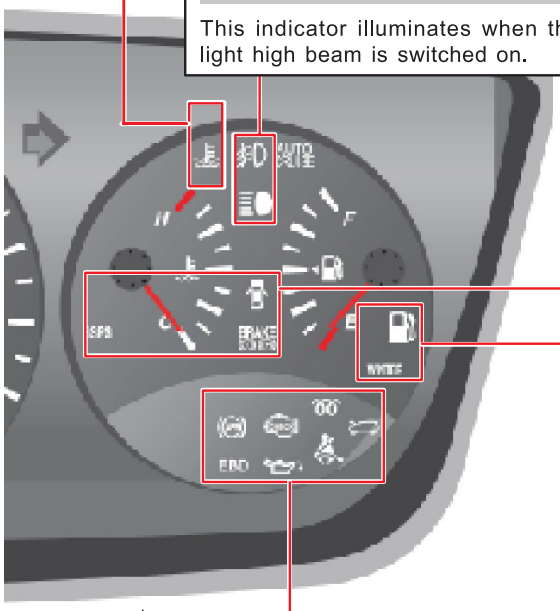
When the engine coolant temperate is abnormally hot (over 120ºC), the engine overheat warning light blinks and a warning buzzer sounds. (check the coolant system)

Fog Lamp Indicator

When the tail or head lights are on, the fog lights come on if the fog light switch is turned to the “ON” position. Then, the fog light indicator comes on the instrument panel.

High Beam Indicator

This indicator illuminates when the headlight high beam is switched on.



SSPS Warning Light

This warning light comes on when the SSPS system is defective. When this warning light comes one, the steerability becomes heavy.

Door Open Warning Light

This light comes on when a door or tailgate is either opened or not closed completely.

Brake Warning Light

This warning light comes on and warning buzzer sounds when the parking brake is applied and/or the brake fluid level is lower than specified level.

Low Fuel Level Warning Light

This warning light indicates that the fuel will soon be exhausted. The time it takes to turn on, however, varies according to the vehicle operating conditions or gradient of the road.

Winter Mode Indicator

The indicator comes on when the Winter mode (W) switch near the gear selector lever is pressed.
Use this mode to drive off smoothly under icy and slippery road.

Glow Indicator

This indicator comes on when the ignition switch is turned on and stays on for a short time or may go off right away. When the glow plugs are sufficiently heated for cold starting, the light will go out. In the vehicle equipped with direct injection type engine, this indicator may come on very shortly or may not come on.

Engine Hood Open Warning Light

When the engine hood is open, this light comes on to inform the driver.

EBD Warning Light

This warning light comes on when the ignition switch is turned to ON and should go out if the system is normal. If the EBD system is abnormal, EBD warning light comes on.

Engine Oil Pressure Warning Light

This warning light comes on when the ignition is switched on and should go out when the engine is started. If the light comes on while driving, it indicates that the oil pressure is dangerously low.

ABS Warning Light

This warning light comes on when the ignition switch is turned to ON and should go out if the system is normal. The vehicle equipped with ABS performs self-diagnosis on the system when the engine is started and drives off. During the diagnosis, brake pedal vibration and noise may be apparent when the driving motors discharges the hydraulic pressure from the internal hydraulic device. This means the ABS is properly functioning.

Engine Check Warning Light

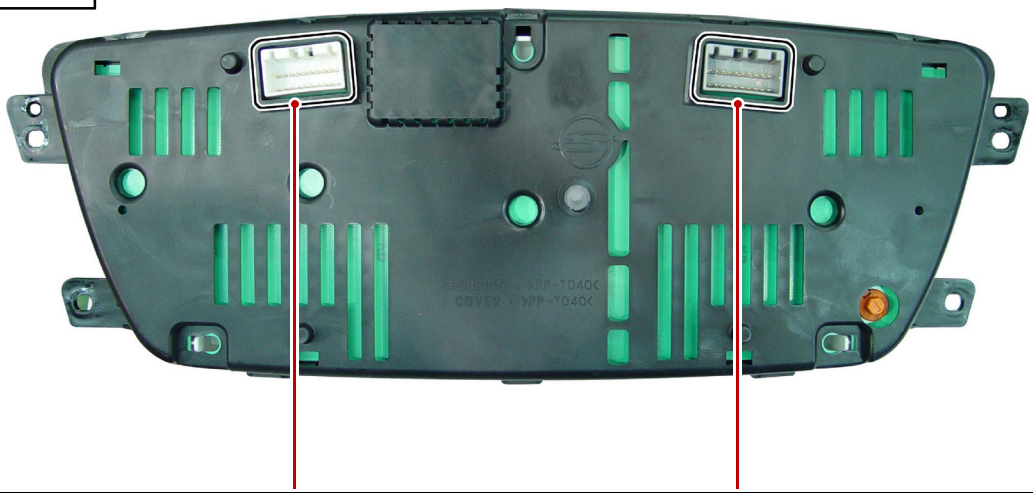
If the light stays on or comes on while driving, some of engine control components including sensors and devices are defective.
When this warning light comes on, the vehicle operates in safety mode to maintain minimum driving conditions and to prevent the system from being damaged. In this mode, the engine driving force may be decreased or the engine may stall.

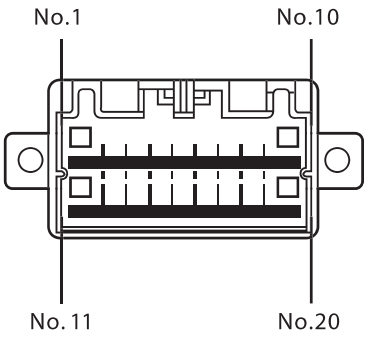
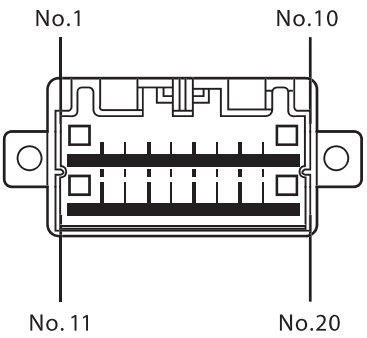
OVERVIEW AND OPERATION PROCESS

1. CLUSTER CONFIGURATION

Front View

Rear View

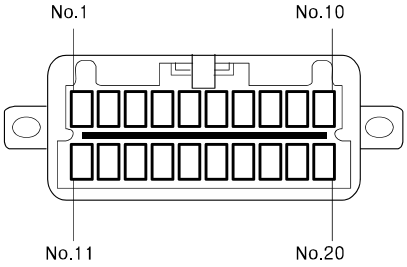


Main Connector	Sub Connector
	

Modification basis	
Application basis	
Affected VIN	

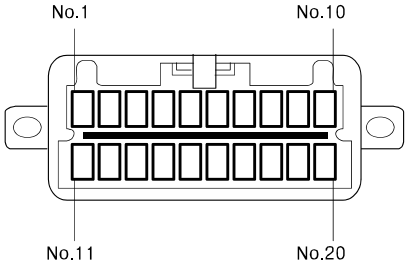
▶ Connector Pin Arrangement

Main Connector - 20 pins



PIN NO.	Function
1	A/T N (Neutral) output
2	Hood open
3	Seat belt (passenger)
4	SSPS
5	-
6	Front fog lamp
7	Hazard warning flasher
8	-
9	Charge
10	IGN (alternator)
11	A/T P (Parking) output
12	Air bag
13	Seat blet (driver)
14	High beam (-)
15	RH indicator lamp (+)
16	High beam (+)
17	LH indicator lamp (+)
18	Oil pressure
19	Parking brake signal input (STICS)
20	-

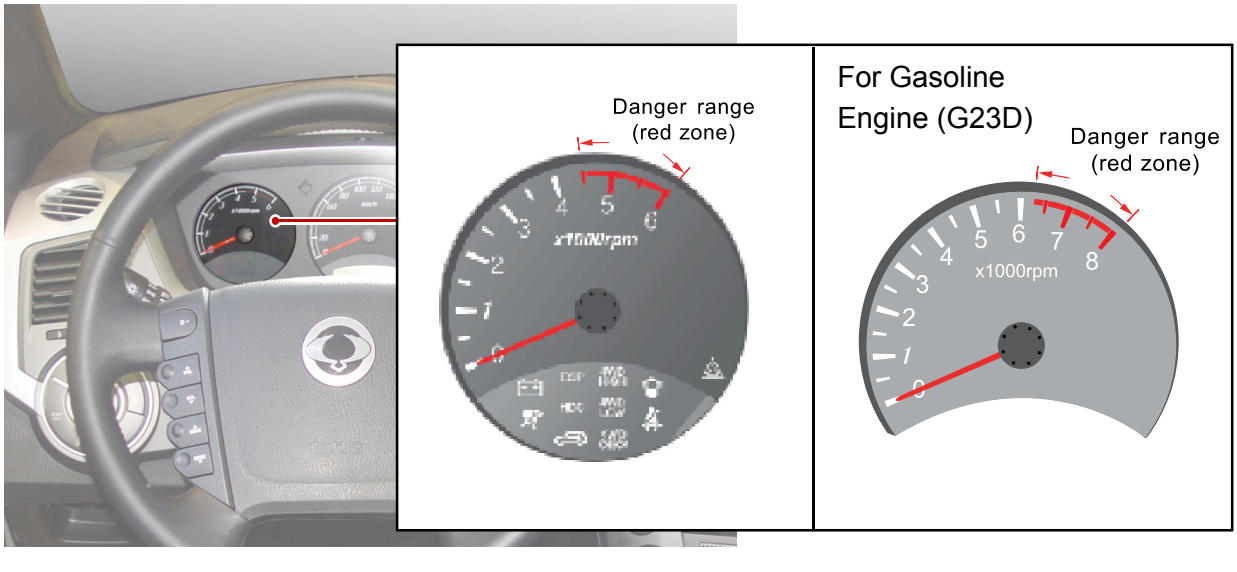
Sub Connector - 20 pins



PIN NO.	Function
1	-
2	-
3	4P output
4	Buzzer output
5	Light (+)
6	PGND (signal -)
7	Engine check
8	Door open
9	-
10	Battery
11	Troubleshooting
12	Fuel input signal
13	RESET / MODE switch
14	M/T N (Neutral) input
15	M/T P (Parking) input
16	CAN Low
17	CAN High
18	AGND (Fuel -)
19	MGND (Micom -)
20	IGN

2. CLUSTER WARNING LIGHTS AND INDICATORS

1) Engine Tachometer



The tachometer indicates engine speed in revolutions per minute. Multiply 1,000 to the current number, then it willbe the current number of engine revolutions.Under the normal engine operating temperature, the proper idling speed is 700 ~ 800 rpm. The red zone (danger rpmrange) starts from 4,500 rpm. (Gasoline Engine: 6,250rpm)

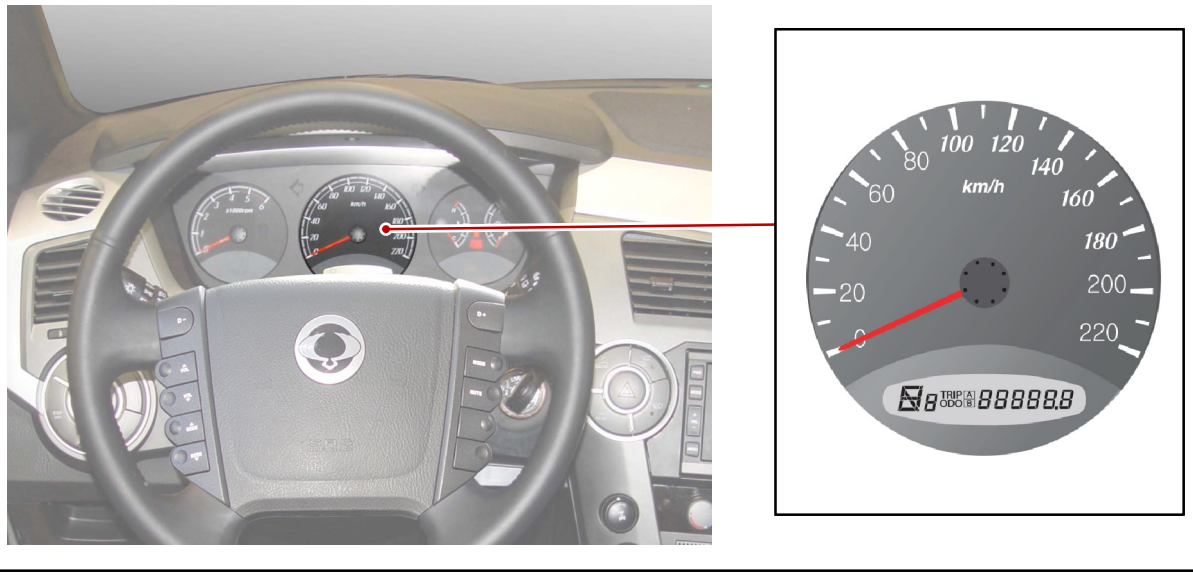
- Connect the tachometer for tune-up test and start the engine.
- Eliminate the hysteresis by tapping the tachometer.
- Compare the values on the tester and tachometer and replace the tachometer if the tolerance is excessive.

Description	Specification (VIN=13 ± 0.1V, Temperature: 25°C)						
Engine speed (rpm)	750	1000	2000	3000	4000	5000	6000
Tolerance (rpm)	-	+100	+100	+100	+100	+100	-
	-	-100	-100	-100	-100	-100	

If the tachometer pointer vibrates, stands at a certain range or sounds abnormal noise, there could be defectivesin tachometer. If there is a difference between actual engine speed (rpm) and reading from tachometer,connect a scanner and then compare the value on tachometer with the reading from scanner.

Modification basis	
Application basis	
Affected VIN	

2) Speedometer



The speedometer indicates the vehicle speed by calculating the signals from the rear (right 8 LEFT) wheel speedsensor through ABS or ESP unit. In this model, the wheel speed sensor is installed at the rear tire area even thoughthe ABS/ESP is not equipped. Its signal is used as a standard vehicle speed that is transmitted to instrument panel,TCU, TCCU, and engine ECU via CAN communication.

- ABS/ESP (equipped): ABS/ESP ECU (208h), RR RH wheel speed sensor
- ABS/ESP (not equipped): ENG ECU (320h), RR RH wheel speed sensor

If the speedometer pointer vibrates, stands at a certain range or sounds abnormal noise, **there could be defectives in speedometer. However, these symptoms also could be appeared when the tire has uneven wear, different tire inflation pressures or different tire specifications.**

Perform the speedometer test regarding the tolerance as described. However, it is not similar simple work in fielddue to lack of measuring conditions such as test equipment and preciseness.

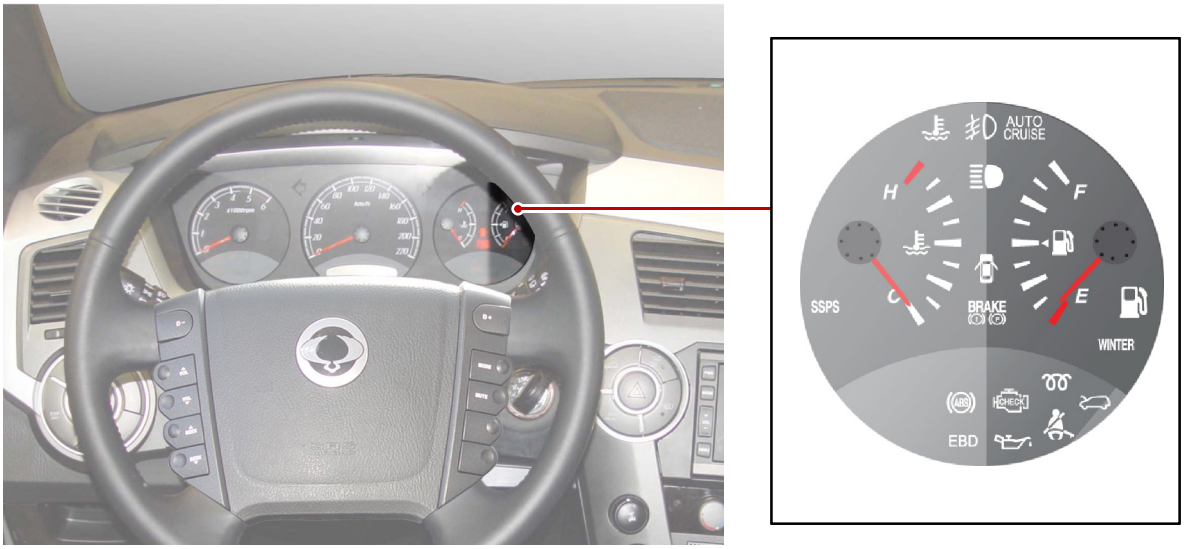
- Check the allowable tolerance of the speedometer and operations of the trip odometer by
- using a tester.
- Check if the speedometer pointer is shaking and the abnormal noise sounds.
  Eliminate the hysteresis by tapping the speedometer.

Description	(VIN = 13 ± 0.1V, Temperature: 25°C)								
Standard speed (Km/h)	20	40	(60)	80	100	120	140	(160)	(180)
Tolerance (Km/h)	+4	+4	+7	+9	+10.5	+12.5	+14.5	+16	+18
	0	0	+2.5	+3.5	+4	+6	+7.5	+8.5	+10

CAUTION

- The allowable tolerance increases when the tires are worn or the tire pressure is out of specified range.

3) Fuel Level Gauge



The fuel level gauge displays the resistance value of the float on the fuel sender in the fuel tank through a pointer.Note that this vehicle doesn't have a service hole for checking the fuel sender connector in the fuel tank.

The fuel sender and its connector can be checked and replaced only when the fuel tank is removed. The powersupply and resistance value should be measured at the connector in front of the fuel sender (refer to wiring diagram).When the power supply and output resistance are normal, the float operation by fuel level may be defective; if so,replace the fuel sender.

Tolerance and resistance value by indicating angle

	Tolerance and resistance value by indicating angle (VIN = 13.5 ± 0.1 V, temperature: 25°C)						
Scale	Full	Full (Gauge)	(3/4)	1/2	(1/4)	Empty (Gauge)	Empty
Indicating angle (°)	-	105	78.75	52.5	26.25	0	-
Tolerance (°)	-	+4, 0	-	±5	-	0, -4	-
Resistance (Ω)	38	43	67	99.5	150	276.3	283

CAUTION

- This table shows the tolerance and resistance value changes by fuel level in normal conditions. Therefore, thedifferences that can be occurred by the road conditions and fuel fluctuations are ignored.

Modification basis	
Application basis	
Affected VIN	

4) Coolant Temperature Gauge

The coolant temperature gauge displays the coolant temperature with a pointer. The angle of pointer thatchanges by coolant temperature is as shown below.

		Tolerance and resistance value by indicating angle		
Indicating angle (°)	0	52.5	102	105
Tolerance	+0°C -4°C	+0°C -4°C	-	+4°C +0°C
Coolant temperature	Less than 40°C	70 ~ 110°C	120°C	Over 125°C

Measurement of coolant temperature sensor resistance

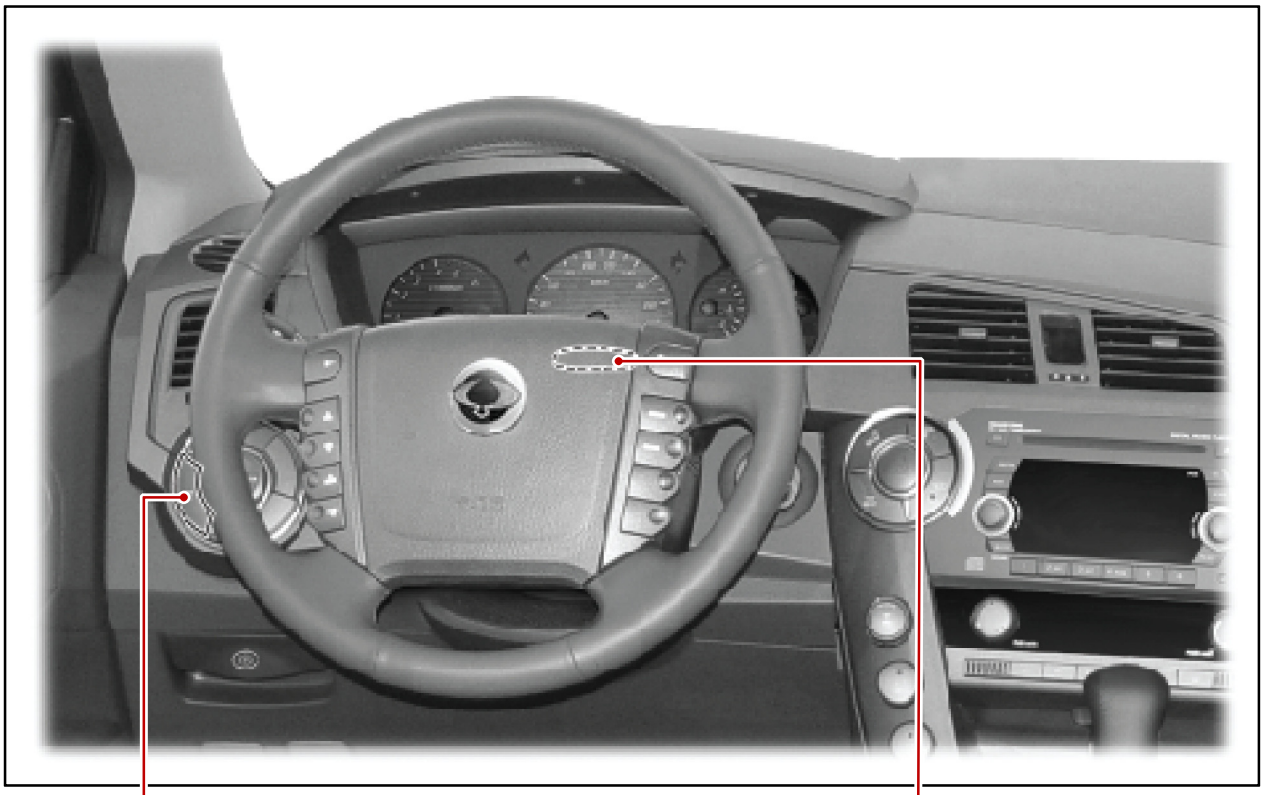
Measure the resistance between the terminal and the ground with an ohmmeter and replace if the resistance is outof specified range.

Resistance value by coolant temperature: 20°C – 2449W±5 %
50°C – 826W±5 %
80°C – 321W±5 %
100°C – 12W±5 %

CAUTION

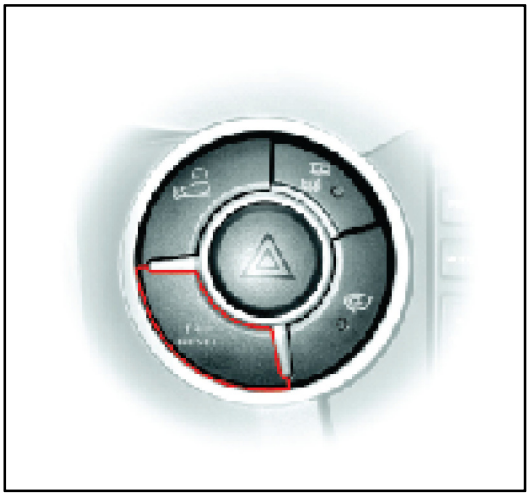
- When the resistance value by coolant temperature is within the specified range, check thermostat, waterpump, radiator related coolant circuit for normal operation. Also, check the wiring harnesses and connectorsfor proper connection.

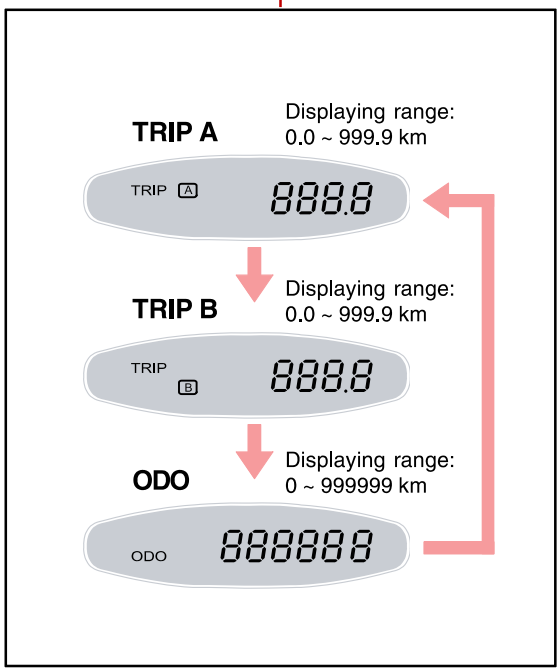
5) TRIP ODOmeter (TRIP A, TRIP B) and ODOmeter



Odometer/Trip Odometer

When pressing the TRIP/RESET switch on the cen-ter panel, the odometer/trip odometer is convertedand the meter resets to 0.0 km in Trip A and Trip B.





Modification basis	
Application basis	
Affected VIN	

3. OPERATION OF HDC INDICATOR CONTROLLER

This table describes the coming-on and blinking mode of HDC indicator according to the HDC switch operation (ON/OFF).

The HDC indicator on the instrument panel has two modes; green (function lamp) and red (warning lamp). The HDCswitch is a push & self return type switch ? when you press it once, it starts to operate and when you press it again,it stops the operation.

<table>
<tr><td colspan="3" rowspan="3">HDC Operation Mode</td><td>HDC indicator</td><td>HDC warning lamp</td></tr>
<tr><td>Green</td><td>Red</td></tr>
<tr><td>HDC</td><td>HDC</td></tr>
<tr><td colspan="3">Initial ignition ON (From hence, this signifies operation mode after the engine starts. Even when HDC switch is ON, if the ignition is OFF, HDC operation stops automatically.)</td><td>OFF</td><td>ON</td></tr>
<tr><td rowspan="2">Not available</td><td colspan="2">HDC switch OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td colspan="2">HDC system error</td><td>OFF</td><td>ON</td></tr>
<tr><td rowspan="2">Stand-by</td><td colspan="2">HDC switch ON</td><td>ON</td><td>OFF</td></tr>
<tr><td colspan="4">The HDC switch is turned ON, but HDC system is in stand-by mode because the operating requirements are not met.</td></tr>
<tr><td rowspan="2">In operation</td><td colspan="2">HDC system is operating.</td><td>Blinking (0.5 seconds of interval)</td><td>OFF</td></tr>
<tr><td colspan="4">The HDC switch is turned ON, and the operating requirements are met. HDC is operating with operating sound.</td></tr>
<tr><td rowspan="4">System overheat</td><td rowspan="2">High brake system temperature (over 350°C)</td><td>HDC stand-by mode</td><td>OFF</td><td>Blinking</td></tr>
<tr><td>HDC is operating</td><td colspan="2">Alternate blinking of green and red lamp (0.5 seconds of interval)</td></tr>
<tr><td colspan="2">Too high brake system temperature (over 450°C)</td><td>OFF</td><td>ON</td></tr>
<tr><td colspan="4">There is no specific temperature sensor in the system, but a programmed logic inside the HECU predicts the temperature based on the operating numbers and conditions of HDC (HDC cannot be operated).</td></tr>
</table>

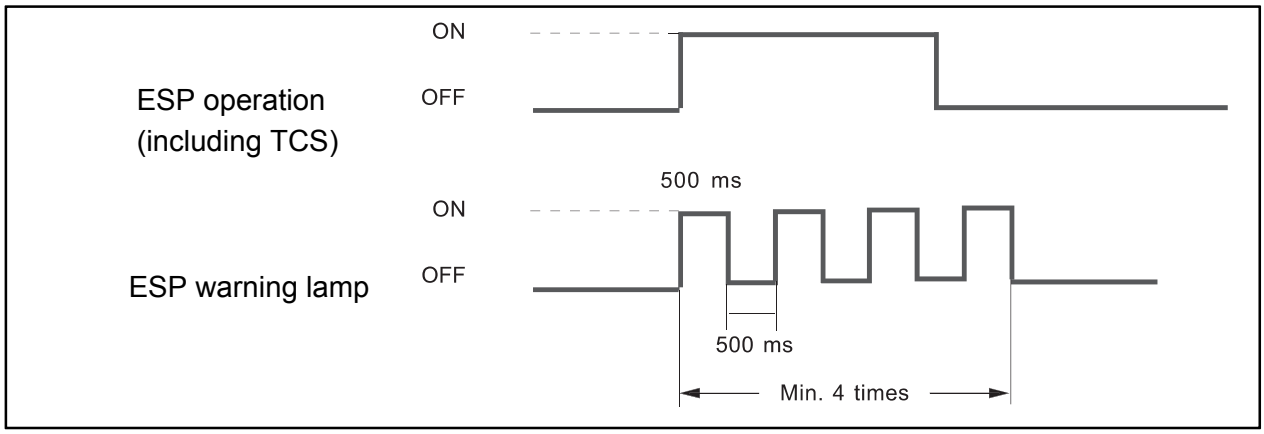
CAUTION

- Basically, the brake system's basic functions can work even when there are problems with the HDC system.As given in the table above, the HDC warning lamp comes on when:
  - · Initial ignition ON
  - · HDC system error occurs
  - · Brake system overheat

4. ESP WARNING LAMP

1) ESP Warning Lamp Blinking in Control

ESP warning lamp blinks when ESP control is activated. If the activation reaches a certain limitation, a beep soundsto warn the driver. The ESP warning lamp goes off when ESP function is deactivated. Even when the ESP isoperated for a very short period of time, the ESP warning lamp blinks minimum of 4 times every 500 milliseconds.



▶ **When receiving CAN data**

- LAMP: (200h, 1.5) ESP - INFO - BL: when receiving data, 500 ms on/off
- BUZZER: (200h, 1.4) ESP - INFO - BUZZ: when receiving data, 100 ms on/off

2) ESP System Cancellation Using the ESP OFF Switch

When the ESP switch is pressed (for over approximately 150 ms), the ESP system will be cancelled and thevehicle will be driven regardless of the output values from the corresponding sensors. Then, the ESPwarning lamp on the instrument panel comes on.

▶ **The detailed operation procedures are as follows:**

- The ESP warning lamp comes on when the ESP OFF switch is pressed for over 150 ms.
- The switch returns to normal position when the OFF switch is released.
- The ESP system will be cancelled after approximately 150 ms.

Based on the above procedures, we can see that the ESP system will be cancelled after a certain period (approx.150 ms) from releasing the switch to the original position. The ESP system does not get canceled immediatelywhen the ESP warning lamp is turned on by pressing the ESP OFF switch.When you turn the ESP system off by pressing the ESP switch for over 150 ms, the TCS system is turned off. And thebasic ABS system will operate.

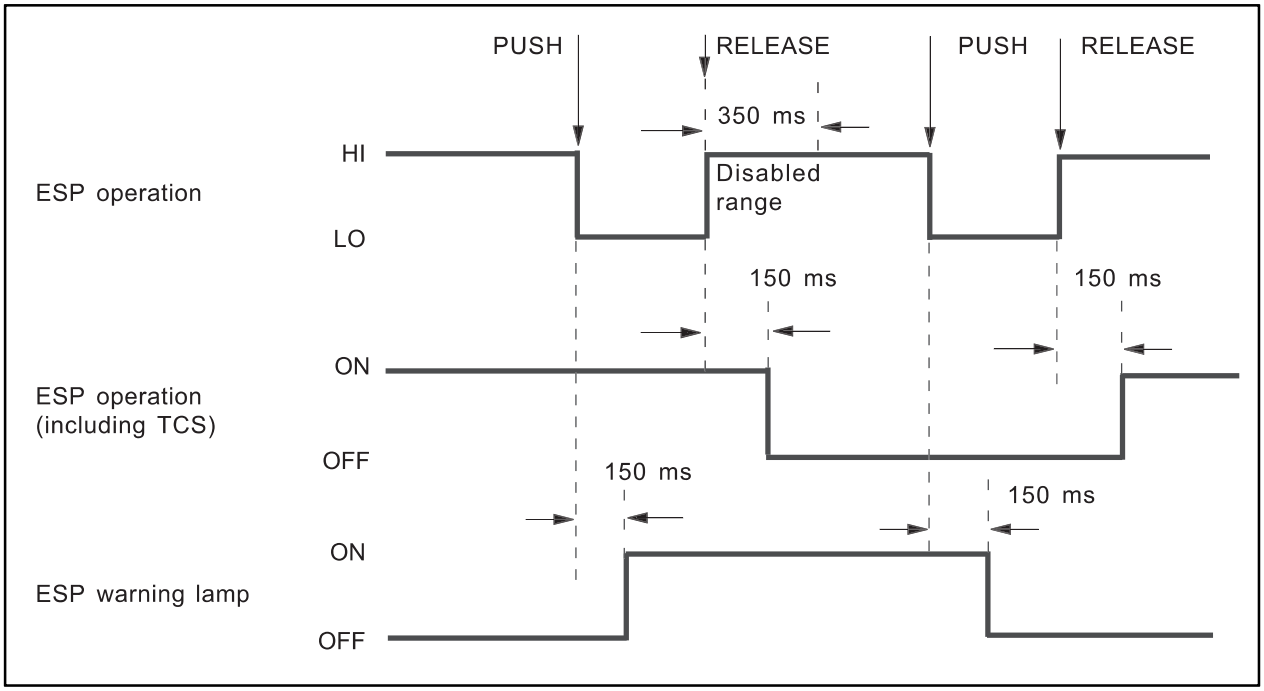
Modification basis	
Application basis	
Affected VIN	

3) Resuming the ESP System by Using the ESP OFF Switch

The ESP system will be resumed and the ESP warning lamp at the instrument panel goes off when the ESP switchat the center switch panel is pushed (for over approximately 150 ms) while the ESP system is not operating.

▶ **The detailed operation procedures are as follows.**

- The ESP warning lamp comes on when the ESP OFF switch is pushed for over 150 ms.
- The switch returns to normal position when the OFF switch is released.
- The ESP system will be resumed after approx. 150 ms.

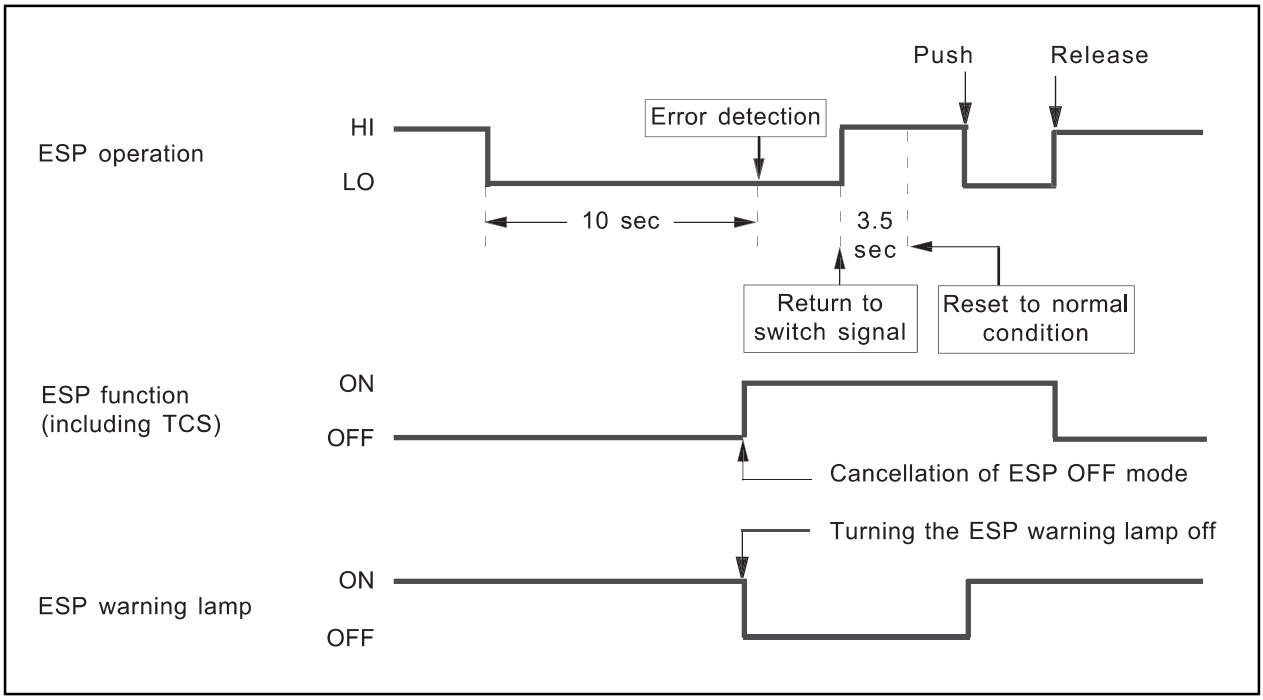


CAUTION

- When turning the ignition switch off while the ESP system is activated, the ESP system will be resumed whenignition switch is turned on again.
- When the vehicle is controlled by ESP system during driving, the ESP OFF switch does not operate.
- The ESP OFF switch operates when it is pushed for over 150 ms. When it is pushed for less than 150 ms, theESP OFF mode and the ESP warning lamp will not be changed.
- When the ESP OFF switch is pushed within 350 ms of being turned off, the ESP warning lamp and ESP systemwill not be turned on.

4) ESP OFF Switch Monitoring

When the ESP unit recognizes that the ESP OFF switch is pushed for over 10 seconds, the ESP unit determinesit as a ESP OFF switch malfunction. When the ESP OFF switch is pushed, the ESP system is resumed after 10seconds. However, the ESP warning lamp comes on when the ESP OFF switch is pushed (for over 150 ms) andthen goes out when the ESP system is resumed. When the ESP OFF switch returns to normal position, the ESPunit resets the ESP OFF switch for approx. 3.5 seconds.



Modification basis	
Application basis	
Affected VIN	

5) ESP Warning Lamp Operation Depending on System Conditions

The table shows ESP warning lamp operations when the ESP system is defective or ESP (including TCS function)is working.

	Warning Lamp		Controls			
	ABS W/L	ESP W/L	ABS	ASR	ABD	Vehicle yaw contro l
Initial start (for 1.8 sec)	ON	ON	NO	NO	NO	NO
Normal mode	OFF	BLINKS WHEN ESP OPERATION	OK	OK	OK	OK
ESP fault	OFF	ON	OK	NO	NO	NO
ABS fault	ON	ON	NO	NO	NO	NO
System fault	ON	ON	NO	NO	NO	NO
Low batt. voltage	ON	ON	NO	NO	NO	NO
High battery voltage	ON	ON	NO	NO	NO	NO
High brake pad temp.	OFF	ON	OK	NO	NO	NO
ESP-OFF mode	OFF	ON	OK	NO	NO	OK Note 1)
Entering diag. mode	ON	ON	NO	NO	NO	NO

CAUTION

· When the driver presses the brake pedal during the ESP OFF mode, the yaw control is performed to compen-sate the vehicle stability (posture) during ESP operation.

6) Reasons why N Switch Signal is Transmitted to Instrument Panel *(1)

▶ **HDC operation signal**

The HDC function operates when the HDC switch is turned on with gear shift lever is in forward/reverse drivingpositions. Vehicles with the automatic transmission receive the signal from the gear shift lever unit and vehicles withmanual transmission receive the neutral signal from the N (neutral) switch.

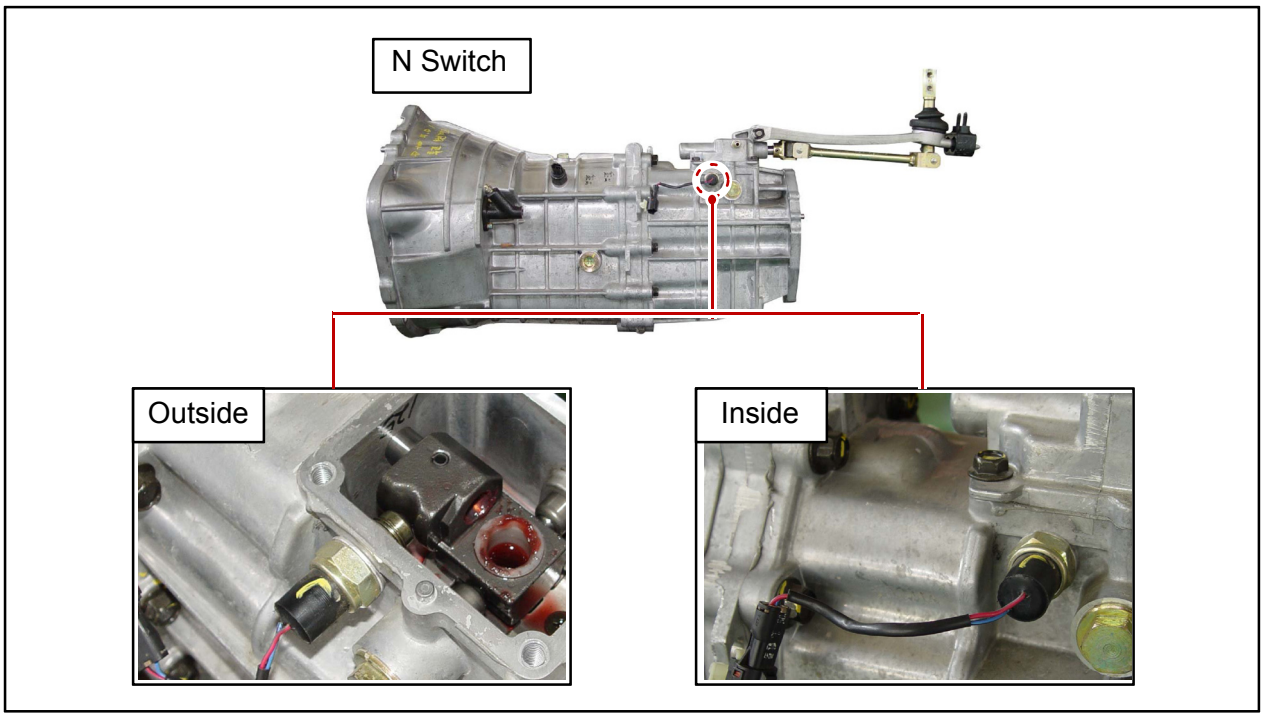
- Manual transmission: operates in the 1st gear or reverse gear position (does not operate in the neutral position).
- Automatic transmission: operates in all hear positions except P (parking) and N (neutral) position.

CAUTION

The vehicle with the manual transmission doesn't have a independent device or switch that detects the 1stgear position. It detects only the forward/reverse direction through the rear light switch and the neutral switch,and cannot solely detect the 1st gear position. The reason for noting the 1st gear above, although the HDC alsooperates at over the 2nd gear, is because the engine may be turned off during the HDC operation.The HDC operates on the very steep road. Thus, it should be used only when the transmission is in the 1st gearposition.

▶ **Raising the RPM in vehicles with the manual transmission.**

This switch detects whether the gear is in N position or in other positions. The instrument cluster sends the signalto the engine ECU. The engine ECU receives the N switch signal, the vehicle speed, the clutch operating conditions,and the engine coolant temperature and raises the engine speed by 100-200 rpm. This helps the vehicle startsmoothly during gear shifting.

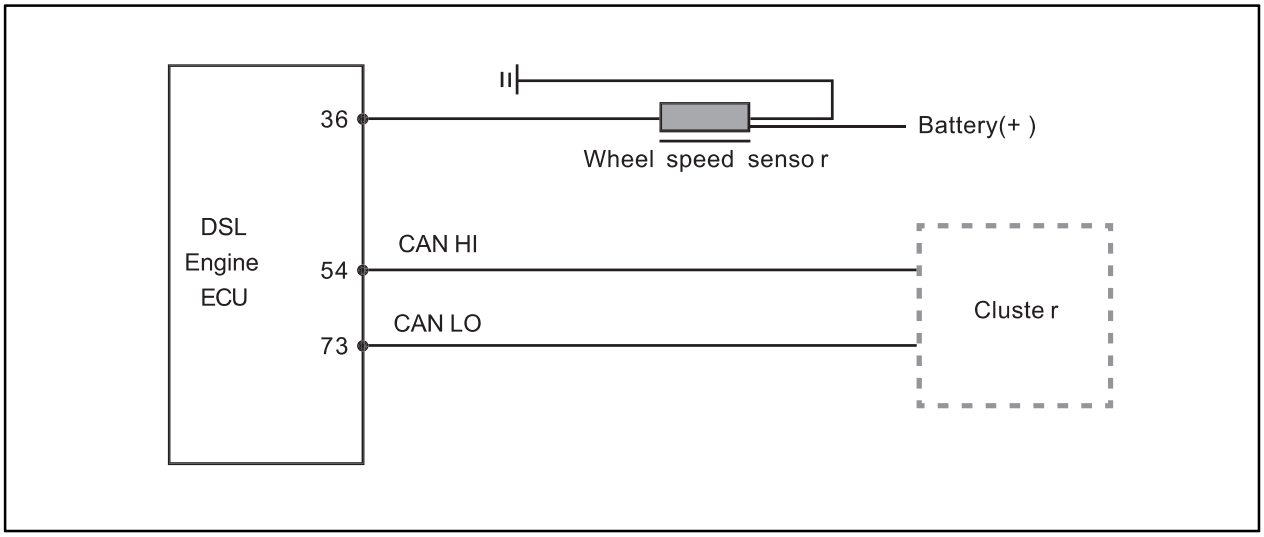


Modification basis	
Application basis	
Affected VIN	

7) Vehicle Speed Input to Non-ABS Equipped Vehicle

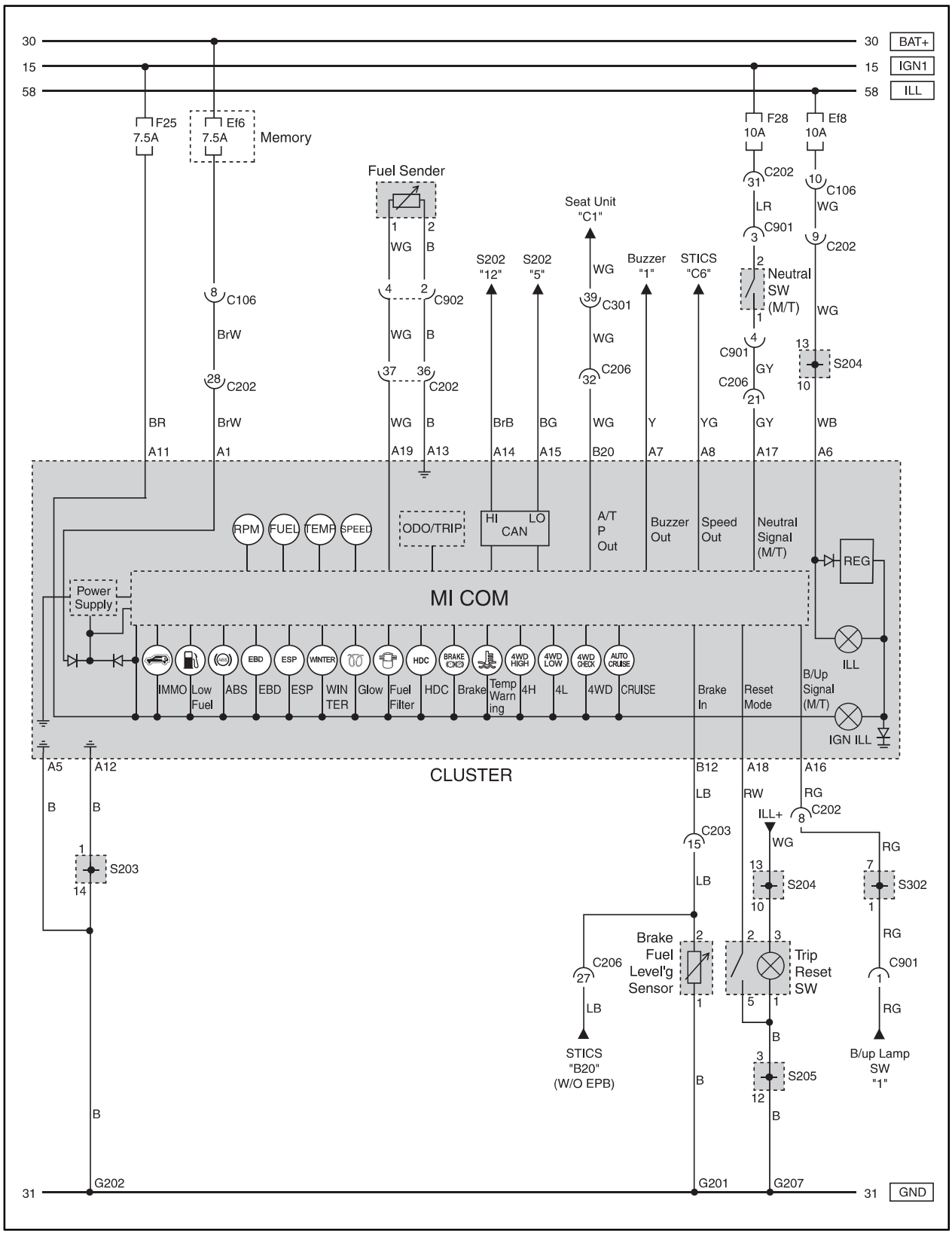
The wheel speed sensor is installed on the rear right wheel regardless of the ABS/ESP installation.

This sensor is to signal the vehicle speed to the engine ECU, TCCU, transmission, and instrument panel. There isno separate unit to process the wheel speed sensor signal. The wheel speed sensor is connected to the engine ECU(terminal 36), where its signal is processed, and is connected to other related systems through CAN communication.



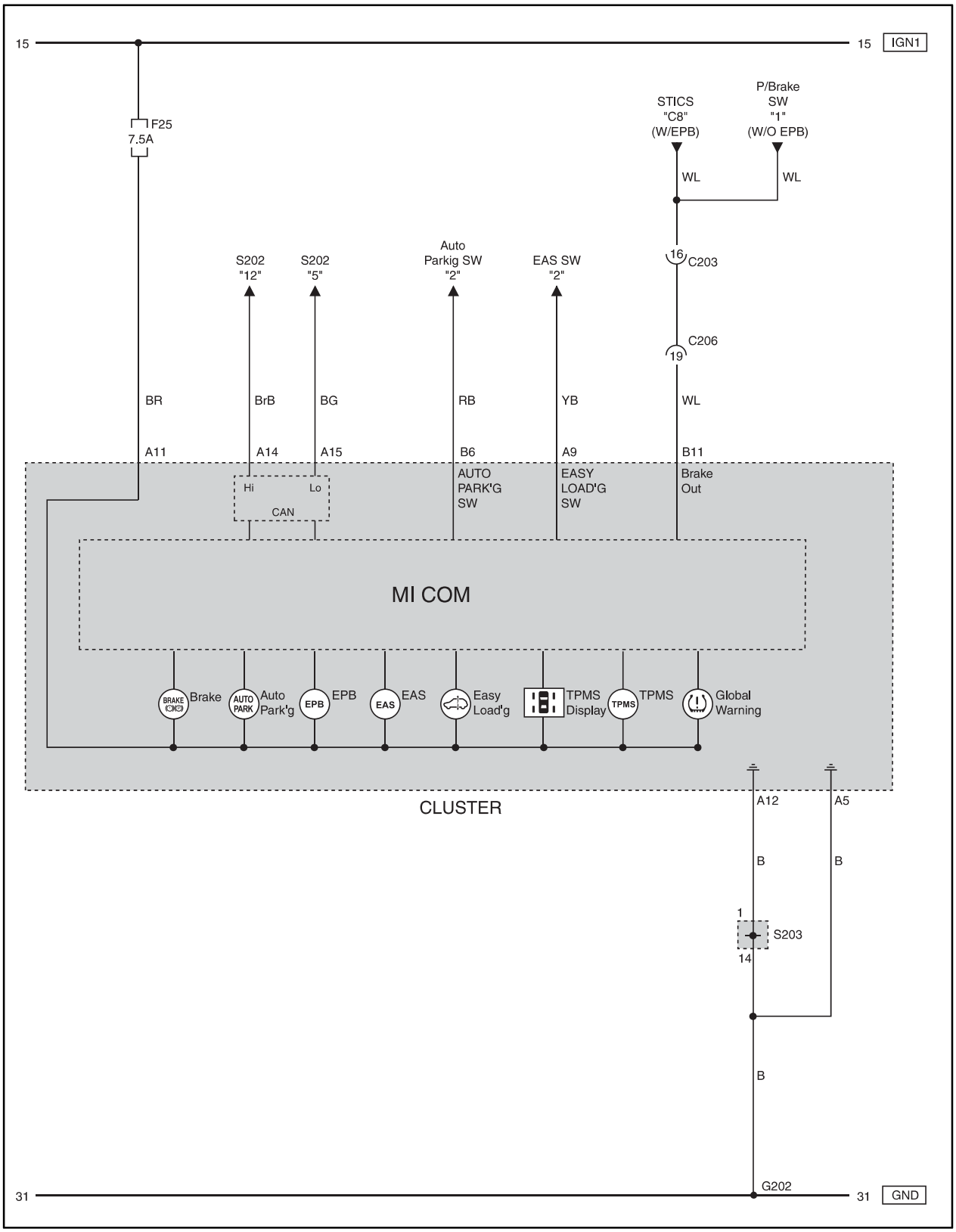
5. CLUSTER ELECTRICAL WIRING DIAGRAMS

▶ **Gauge (Speed, RPM, Fuel, Temp), Warning Lamp (Fuel, Fuel Filter, ABS/ESP, Brake, HDC, 4WD, EPB, EAS, TPMS)**



Modification basis	
Application basis	
Affected VIN	

▶ Warning Lamp (EAS, EPB, Auto Park's, TPMS, Grobal), Easy Load'g, TPMS Display



Modification basis	
Application basis	
Affected VIN	

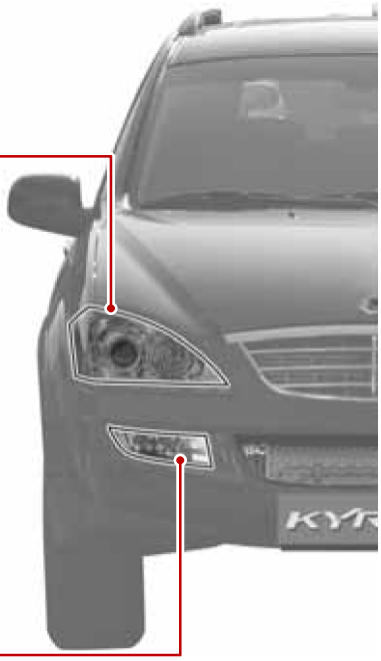
LAMP

8310-01

GENERAL

1. LOCATIONS OF LAMPS AND SPECIFICATIONS

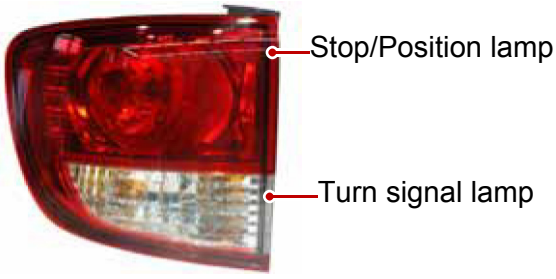
1) EXTERIOR LAMPS



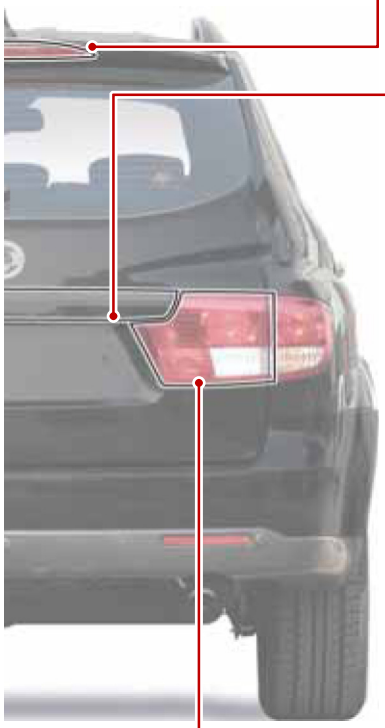
Headlamp Assembly

Fog Lamp Assembly

Quarter Combination Lamp Assembly



Modification basis	
Application basis	
Affected VIN	



Side Repeater Assembly

High Mounted Stop Lamp Assembly

License Plate Assembly

Reflector Assembly

Tailgate Combination Lamp Assembly

Tail lamp

Backup lamp

Rear fog lamp or stop lamp (Rear fog lamp: Regulation required only)

Modification basis	
Application basis	
Affected VIN	

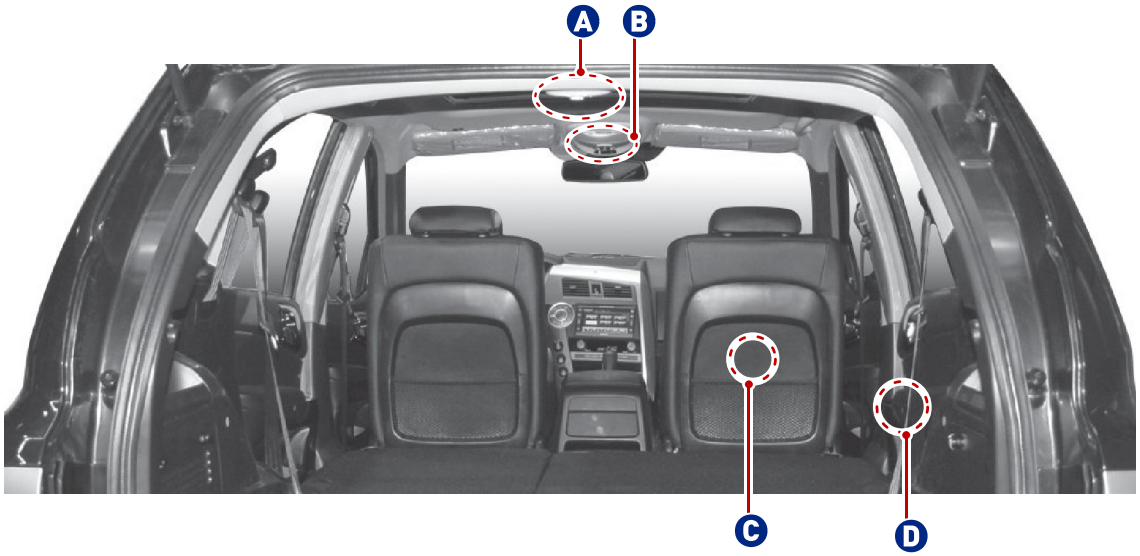
▶ BULB SPECIFICATIONS

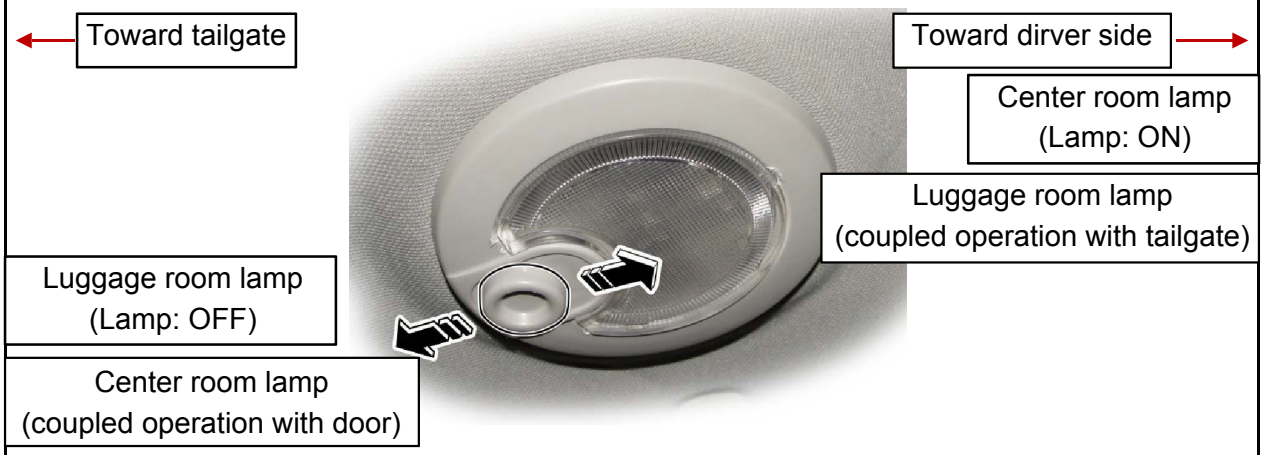
Description			Amount	Specification (EU)	Specification (General)
Exterior lamp	Headlamp	High beam	2	55W	←
		Low beam	2	55W	←
		Turn signal lamp	2	PY21W	28W AMBER
		Position lamp	2	W5W	8W
	Front fog light		2	H27W/2	←
	Side repeater		2	W5W	5W
	Rear combination lamp	Stop (tail) lamp	4	P21W(5W)	27W(8W)
		Turn signal lamp	2	PY21W	27W AMBER
	Back-up lamp	EU	1	16W	-
		General	2	-	16W
	Rear fog light		1	P21W	-
	License plate lamp		2	W5W	5W
	High mounted stop lamp	LED type	-	-	-
		Bulb type	5	W5W	5W
Interior lamp	Front room lamp		2	10W	←
	Glove box lamp		1	10W	←
	Center room lamp		1	10W	←
	Luggage lamp		1	10W	←
	Door courtesy lamp		2	5W	←

Modification basis	
Application basis	
Affected VIN	

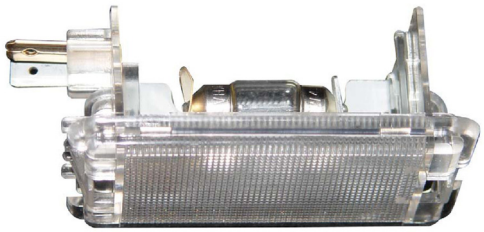
Memo

2) INTERIOR LAMPS



A Center and Luggage Room Lamp	
	
Center Room Lamp	**Luggage Room Lamp**
When this switch is pushed towards the rear of the vehicle, the lamp comes on. If the switch is pushed to the opposite direction, the lamp will go off. But, when any door is open, the lamp comes on and stays for 30 seconds. When the door is closed, the lamp will go off.	When this switch is pushed towards the tailgate, the lamp comes on when the tailgate is open. If the switch is pushed to the opposite direction, the lamp will go off and will not come on even if the tailgate is open.

Modification basis	
Application basis	
Affected VIN	

C Glove Box	D Door Courtesy Lamp
	
12V/5W - One at glove box	12V/5W - one at each door

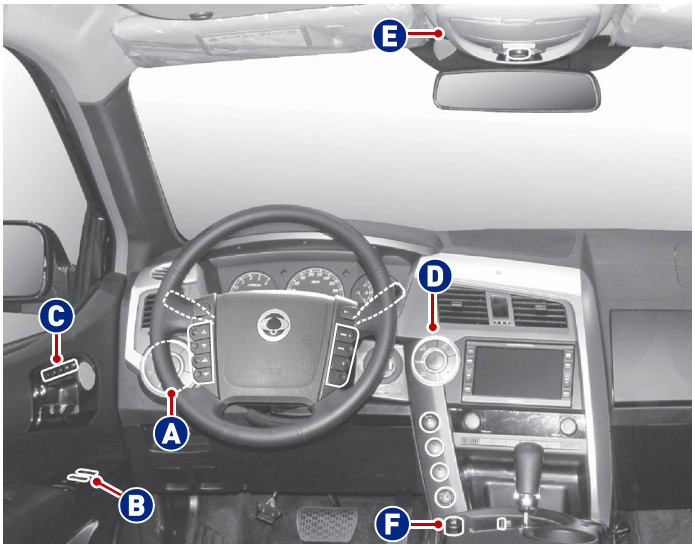
B Front Room Lamp

The driver's room lamp and the passenger's room lamp are separately turned on when pressing the switch (1, 2). However, the front lamps are turned on when opening a door and turned off when closing it. The front room lamps and center are turned on when pressing the room lamp main switch (3).

SWITCHES / ELECTRIC DEVICES 8510-13

GENERAL

1. SWITCH ARRANGEMENT



▶ Outside Rearview Mirror Folding Switch A

To fold the outside rearview mirrors, press the switch. To unfold the mirrors, press it again.

▶ ESP OFF Switch A

If you press the ESP OFF switch, the ESP function stops and the indicator lamp in instrument panel comes on. Press this switch again to resume the ESP function. At this time, the indicator lamp goes out.

▶ Driver's Power Window Switch B

Driver can controls all door windows (Open/Close/Lock/Unlock) and doors (Lock/Unlock) with this switch unit

▶ Seat Position Memory Switch C

The position memory is available for up to three drivers. Each driver can set his/ her own driver's seat and outside rearview mirrors' positions and it will be separately stored in the integrated computer. If somebody has moved the seat, the memory positions can be recalled automatically by pressing the position button.

D

▶ HDC Switch 1

When this button is pressed once, HDC is ready for use. The green HDC indicator comes on the instrument panel. When the button is pressed again, HDC is deactivated and the indicator goes off. (Refer to ABS/ESP section.)

▶ Tailgate Glass and Out side Rearview Mirror Heated Glass Switch 2

Press this switch to turn on the tailgate and outside rearview mirror defogger. It will operate for about 12 minutes.

▶ Windshield Heated Glass Switch 3

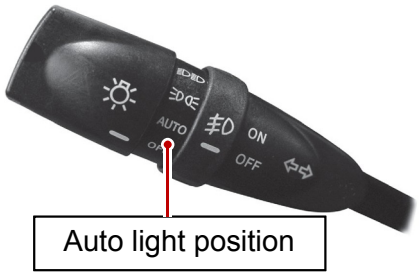
Press this switch to turn on the windshield heated glass. It will operate for about 12 minutes.

▶ TRIP Switch 4

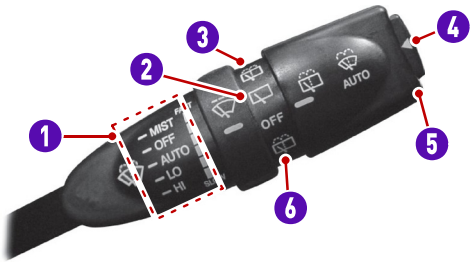
To choose a desired driving distance display mode, press the switch: Changing sequence:
ODO - TRIP A - TRIP B - ODO

Modification basis	
Application basis	
Affected VIN	

Additional Functions of Multifunction Switch



Auto light position



Front wiper operation range ❶
(move the wiper lever up/down)

Rear wiper operation ❷

Washer fluid will be sprayed ❸
onto the rear window glass once during rear wiper operation.

Auto Washer Switch ❹

When the front wiper switch is off and this switch is pressed, washer fluid will be sprayed and the wiper will automatically operate 4 times. Then, the fluid will be sprayed again and the wiper will automatically operate 3 times.

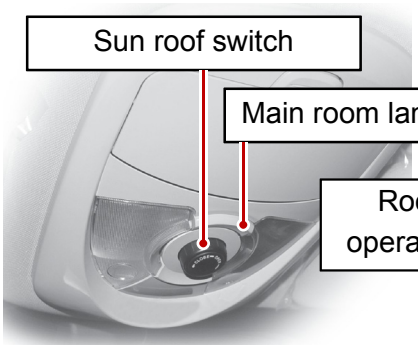
Front Wiper and Washer Coupled Operation ❺

Pull the lever briefly (below 0.6 seconds): One wiping cycle Pull and hold the lever for more than 0.6 seconds: Three wiping cycles with washer spray

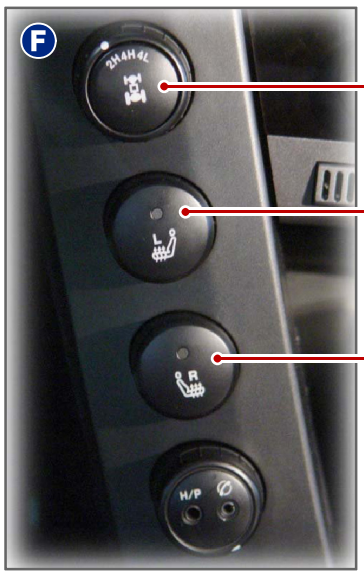
Washer fluid will be sprayed onto ❻

the rear window glass and the wiper will also operate once.

Ⓔ



Ⓕ



Audio Remote Control Switch

▲ VOL	MODE
VOL ▼	MUTE
POWE	
▲ SEEK	
SEEK ▼	

WIPER AND WASHER SYSTEM 7810-01

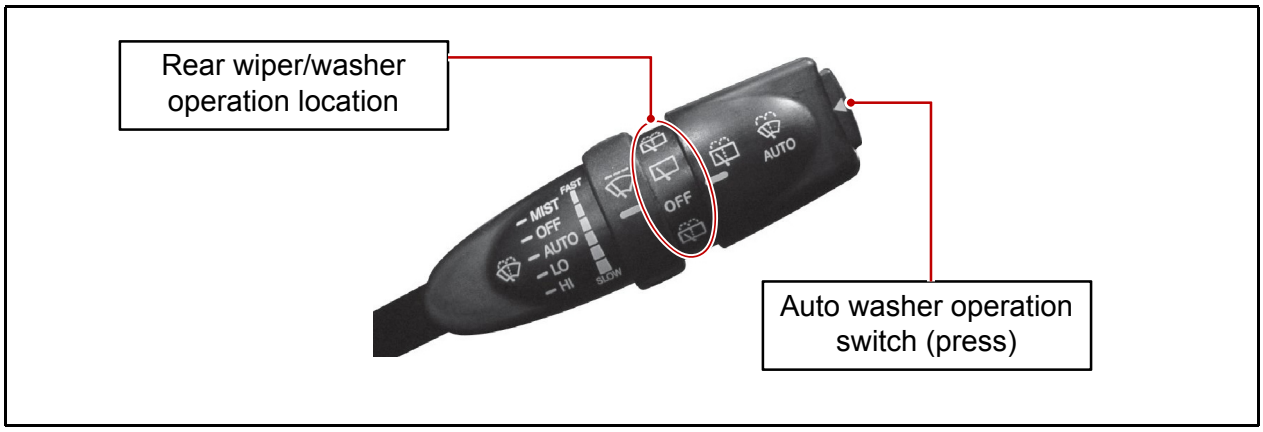
GENERAL

1. WIPER AND WASHER SYSTEM OVERVIEW

The wiper and washer system are controlled by STICS according to driver's wiper switch operation. And the detection of rain drops by rain sensor is transmitted to STICS as the signal for wiper system control.

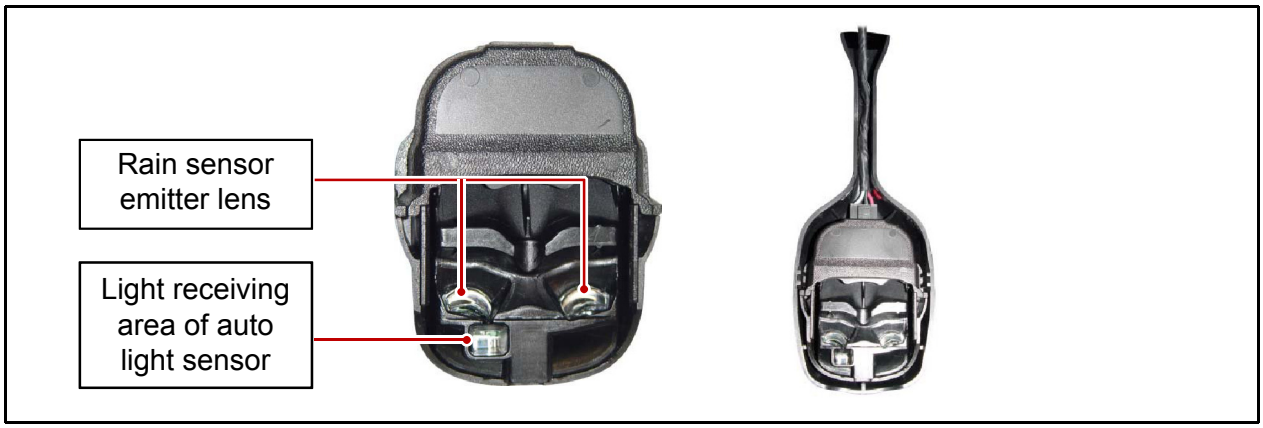
The characteristics of the wiper and washer system including basic functions of manual wiper are as follows.

1) Wiper function coupled auto washer



When the front wiper switch is off and this switch is pressed, washer fluid will be sprayed and the wiper will automatically operate 4 times. Then, the fluid wil be sprayed again and the wiper will automatically operate 3 times.

2) Integrated auto light sensor in rain sensor unit

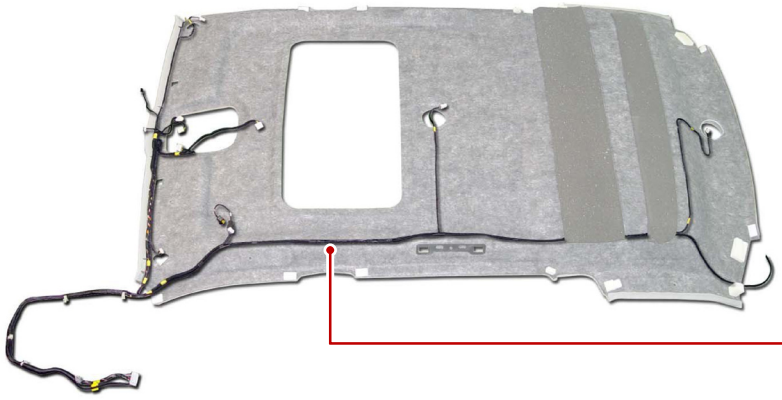


The rain sensor unit is installed on a proper location to detect the rain drops and the illumination intensity.

To control the system, the sensed values of rain sensor and auto light sensor are sent to pin no. 63 in STICS unit.

3) Rear washer fluid supply system

There is no separate washer fluid reservoir for the rear washer system in this vehicle. The rear washer system uses the front washer fluid reservoir.
Because of this, the washer hose is supposed to be long between front reservoir tank and rear washer nozzle.
To avoid being damaged or interfered while in assembling the vehicle, the rear washer hose is fixed on headlining with silicone

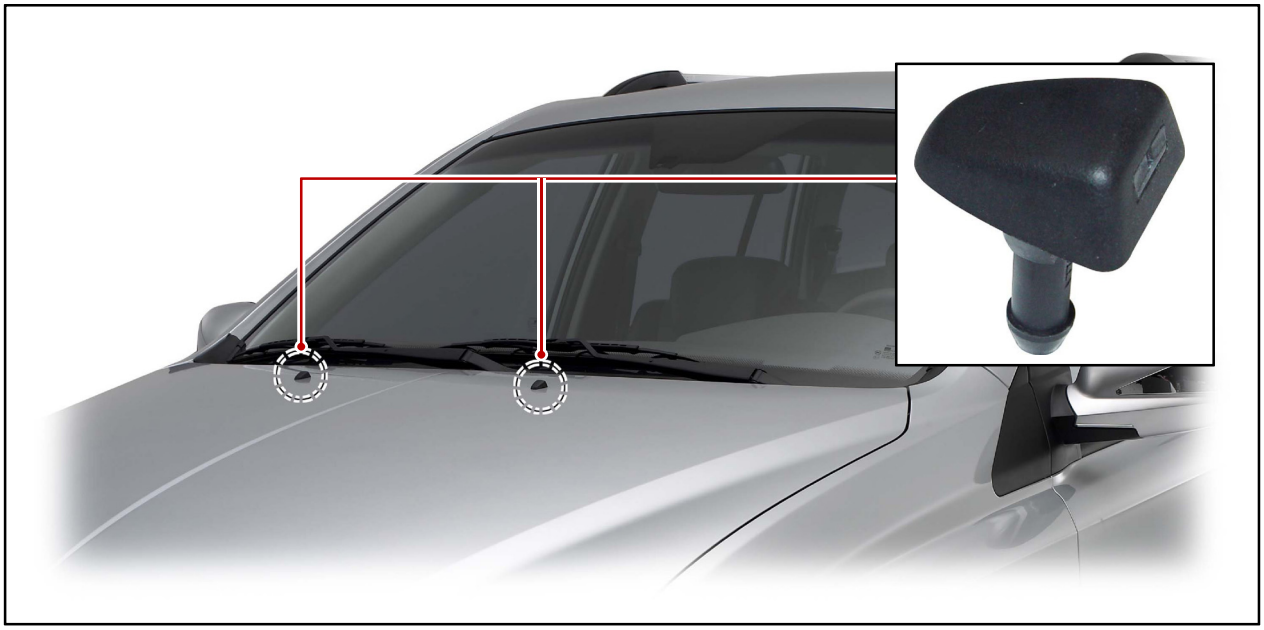


Rear washer hose and roof wiring harness are fixed at the headlining section with silicone.

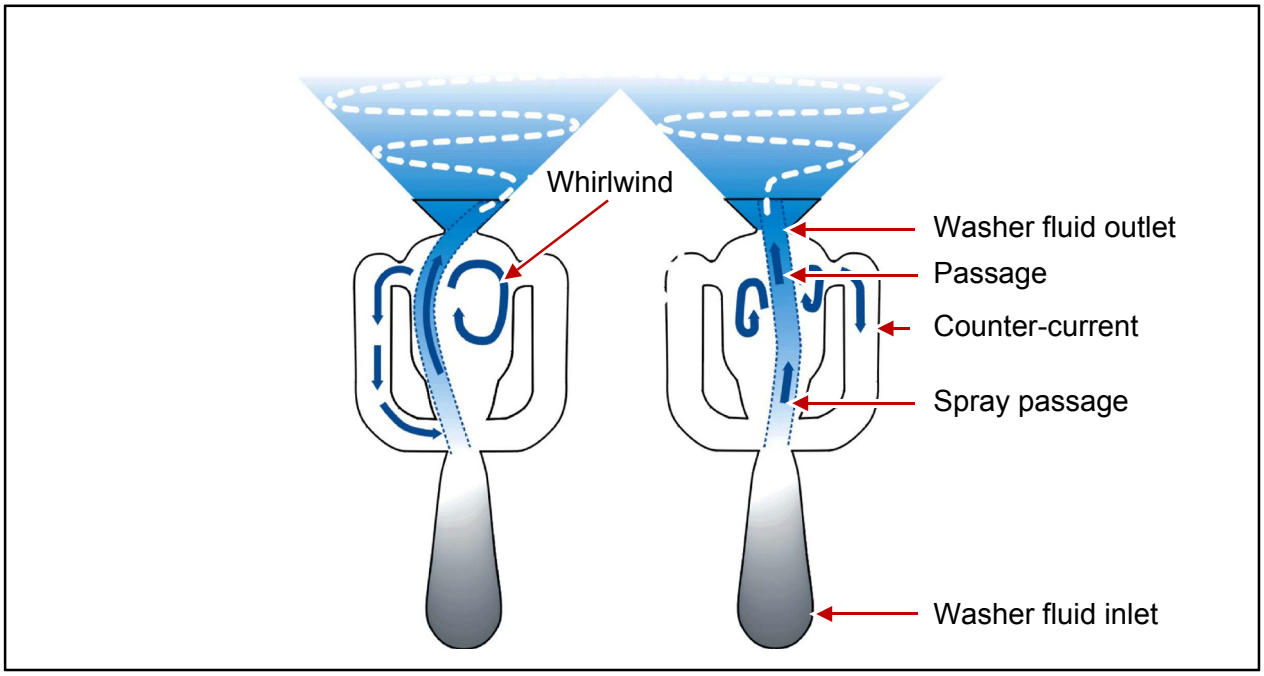
Modification basis	
Application basis	
Affected VIN	

4) Fluidic washer nozzle

Fluidic Washer Nozzle is applied to the front washer spray system in this vehicle.
The inside of nozzle is designed to utilize the fluidic movement.



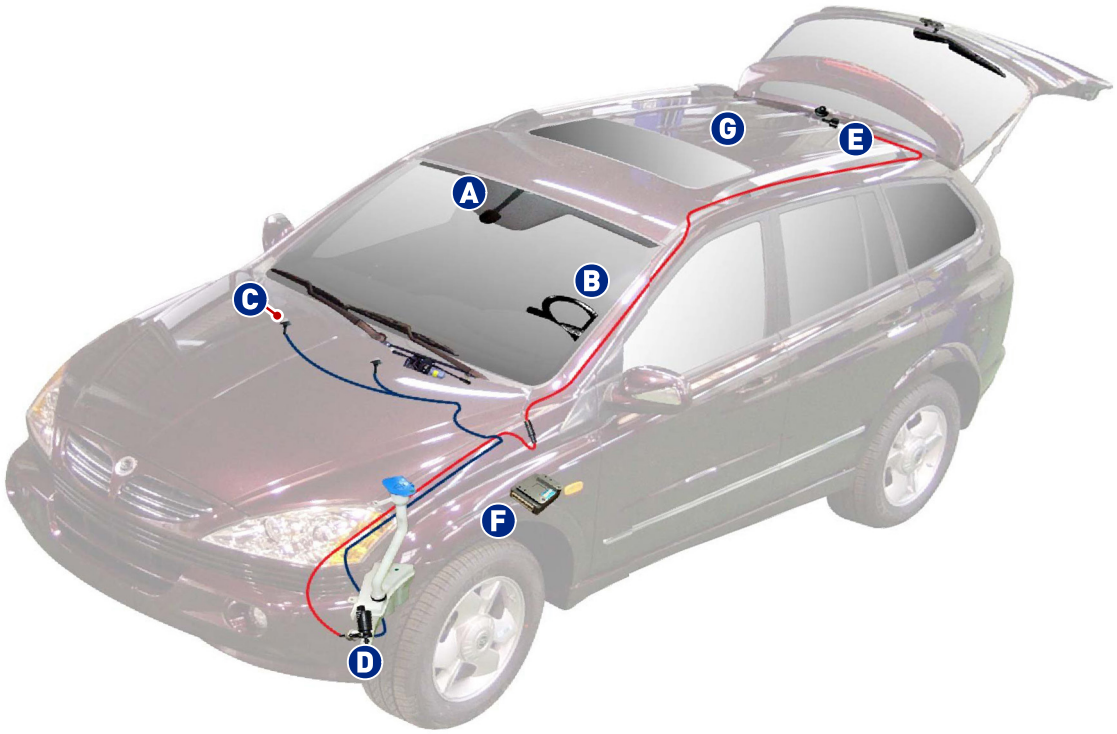
This is a shape of the inside of nozzle.
It is designed to change the spraying direction continuously according to the spraying time. (fan-shape)
The figure below shows the changes of spraying direction according to the spraying time.

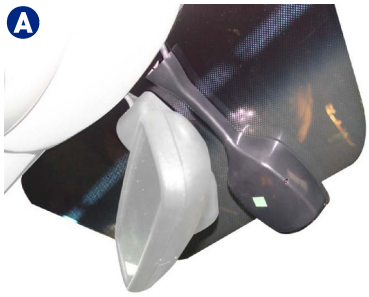


It is designed to be changed spraying direction using the whirlwind and backflow generated in nozzle.

OVERVIEW AND OPERATION PROCE

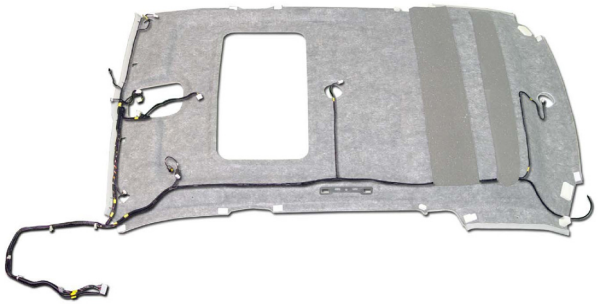
1. SYSTEM LAYOUT OF WIPER AND WASHER (WITH RAIN SENSOR)



Rain Sensor Unit	Multifunction Wiper and Washer Switch	Front Nozzle Assembly
A 	B	C

Washer Reservoir Tank Assemblyt	Rear Washer Nozzle and Check Valve
D	E 1. Rear nozzle assembly 2. Rear nozzle 3. Check valve

Modification basis	
Application basis	
Affected VIN	

STICS	Rear Washer Hose Mounting
F	G 

▶ **Rain Sensor Unit** A
- The rain sensor unit is integrated into the auto light sensor. It sends the amount of rain drops to STICS.

▶ **Multifunction Wiper and Washer Switch** B
- When the front wiper switch is off and this switch is pressed, washer fluid will be sprayed and the wiper will automatically operate 4 times. Then, the fluid wil be sprayed again and the wiper will automatically operate 3 times.

▶ **Front Nozzle Assembly** C
- The washer nozzles are installed at both sides of engine hood. The spraying pattern is specially designed to improve the spraying performance.

▶ **Washer Reservoir Tank Assemblyt** D
- There is no separate washer reservoir tank for the rear washer fluid.
  The rear washer system uses the front washer fluid reservoir.

▶ **Rear Washer Nozzle and Check Valve** E

▶ **STICS** F
- STICS receives the rain sensing datafrom the rain sensor and controls the wiper and washer systems.

▶ **Rear Washer Hose Mounting** G
- There is no separate washer fluid reservoir for the rear washer system in this vehicle. The rear washer system uses the front washer fluid reservoir. Because of this, the washer hose is supposed to be long between front reservoir tank and rear washer nozzle. To avoid being damaged or interfered while in assembling the vehicle, the rear washer hose is fixed on headlining with silicone

2. WIPER / WASHER RELATED FUNCTION AND SPECIFICATION

1) Wiper and Washer Fluid Switch Operation

MIST

When turning up the switch, the wiper operates once. When releasing the switch, the pointers return back to “OFF” position.

OFF

Wiping stops

AUTO

Wiper speed controls automatically according to the vehicle speed or amount of rain (rain sensing wiper).

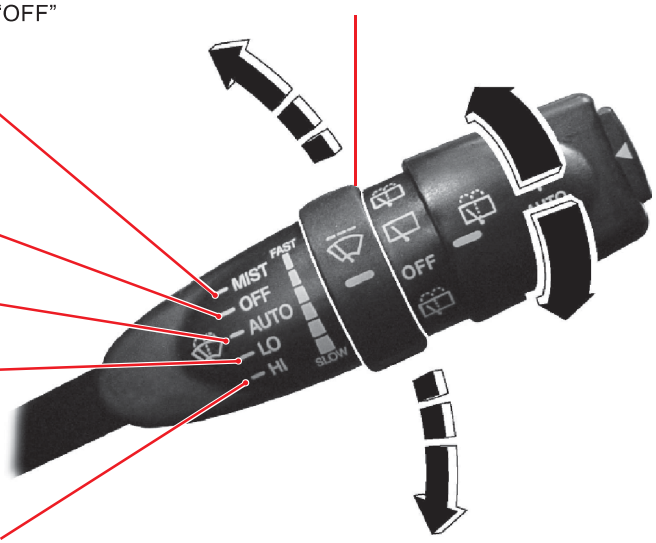
LO

Wiping speed gets slower when placing the pointer at the “LO” positon.

Wiping speed gets faster when placing the pointer at the “HI” positon.

HI

Wiper speed control switch
When turning to FAST, wiping speed gets faster and when turing to SLOW, wiping speed gets slower.

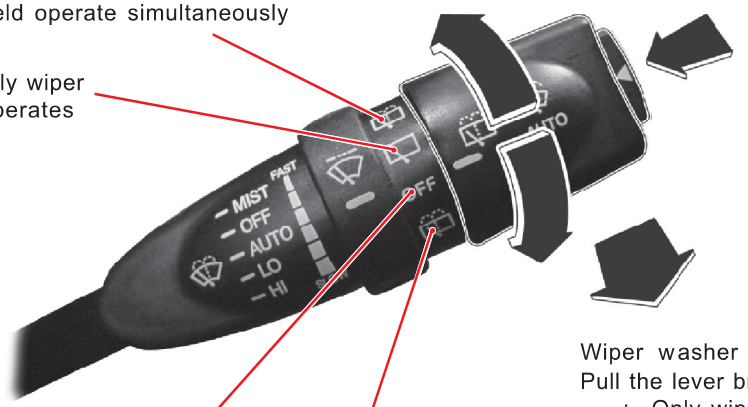


Wiper and washer fluid for rear wind-shield operate simultaneously

Only wiper operates

Wiping stops

Washer fluid for rear windshield operates once.



Auto washer switch
If pressing the switch when the wiper switch turns to the “OFF” position, washer fluid is sprayed once and wiper operates 4 times.
After a while, washer fluid is sprayed one more and the wiper operates 3 times.

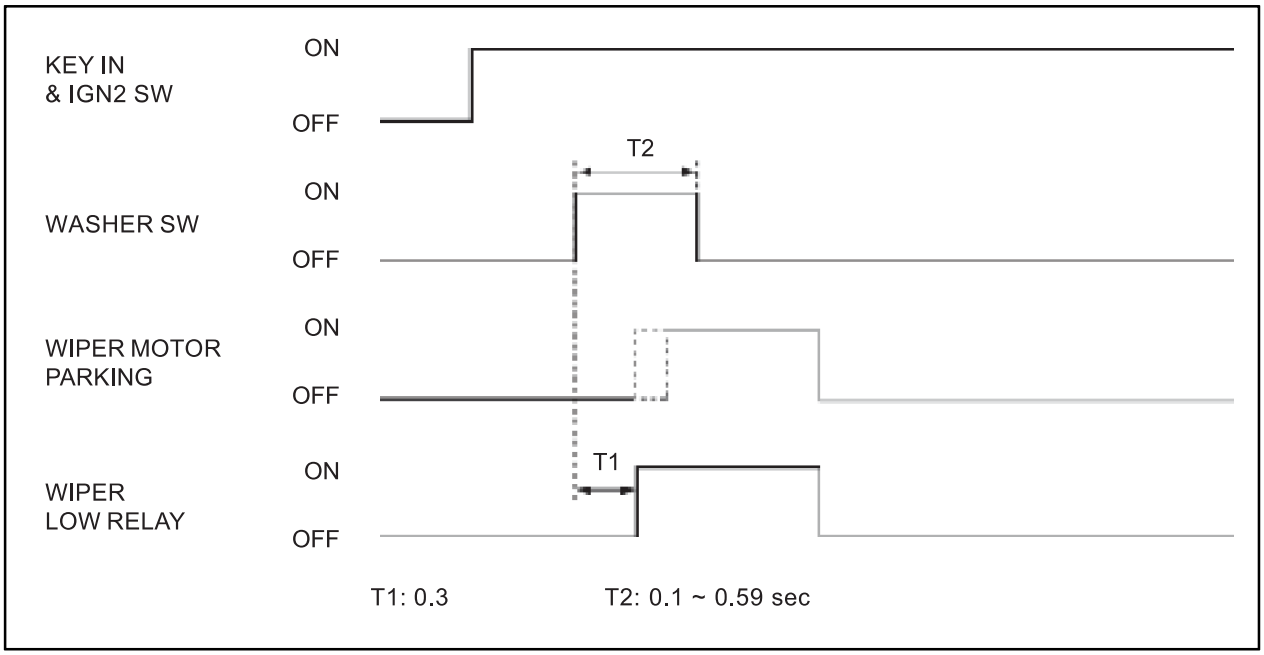
Wiper washer fluid coupled function
Pull the lever briefly (below 0.6 seconds)
: Only wiper operates
Pull and hold the lever for more than 0.6 seconds
: Wiper operates 3 times
Washer fluid coupled operation

Modification basis	
Application basis	
Affected VIN	

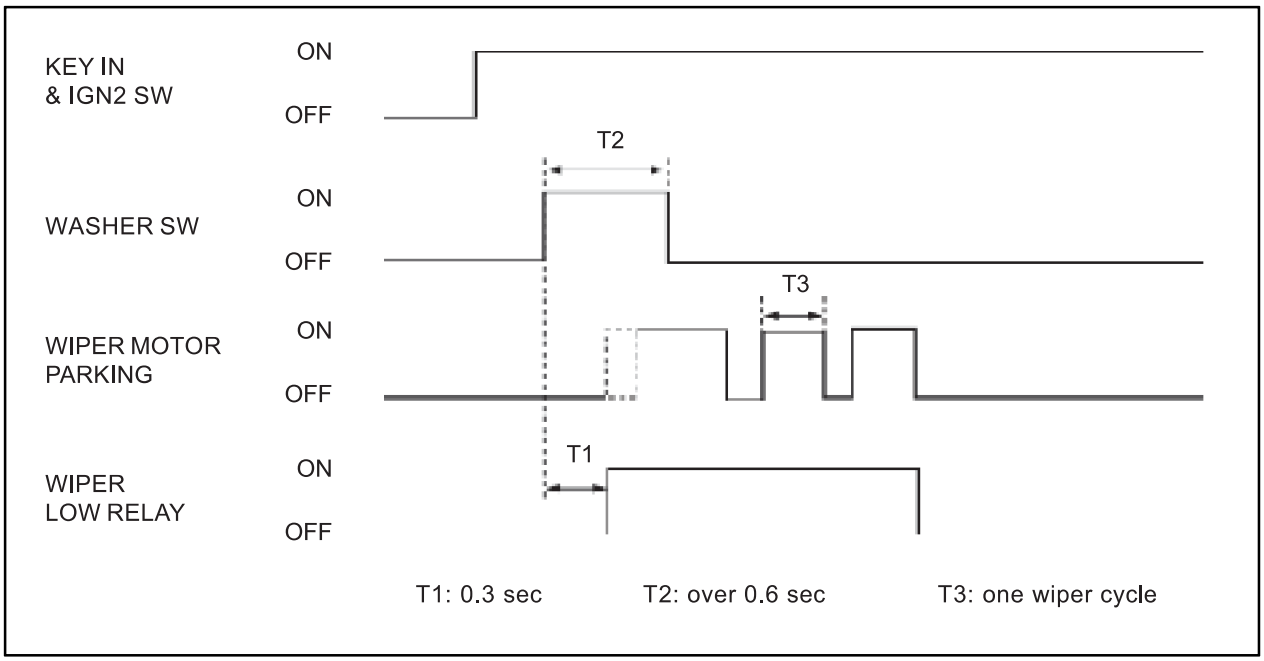
2) STICS Control Logic Related to Wiper and Washer

(1) Wiper MIST and Front Washer Coupled Wiper

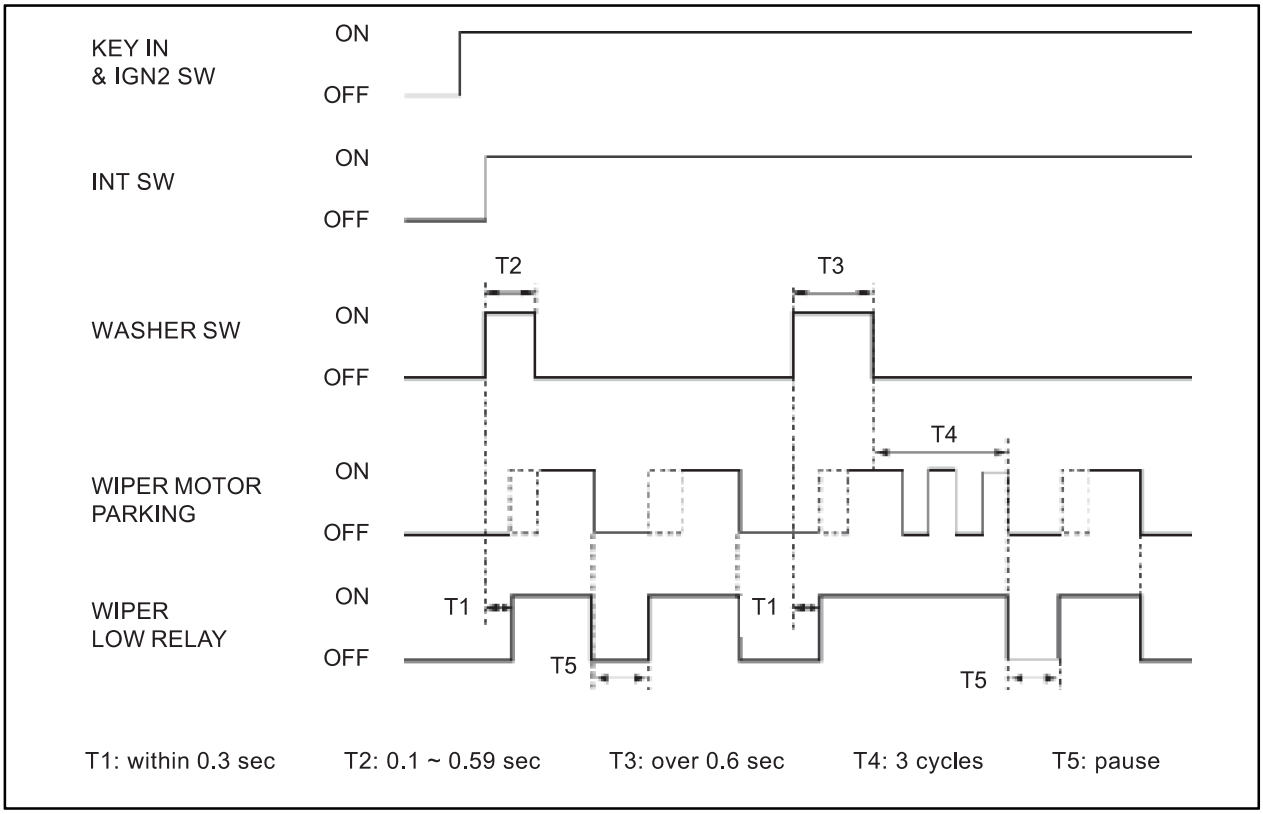
- The wiper relay is turned on 0.3 seconds after turning "ON" the washer switch for 0.1 ~ 0.59 seconds with the ignition key "ON", and it is turned off when the parking terminal is turned off.



- The wiper relay is turned on 0.3 seconds after turning "ON" the washer switch over 0.6 seconds with the ignition key "ON", and it is turned on three times immediately after turning off the washer switch.

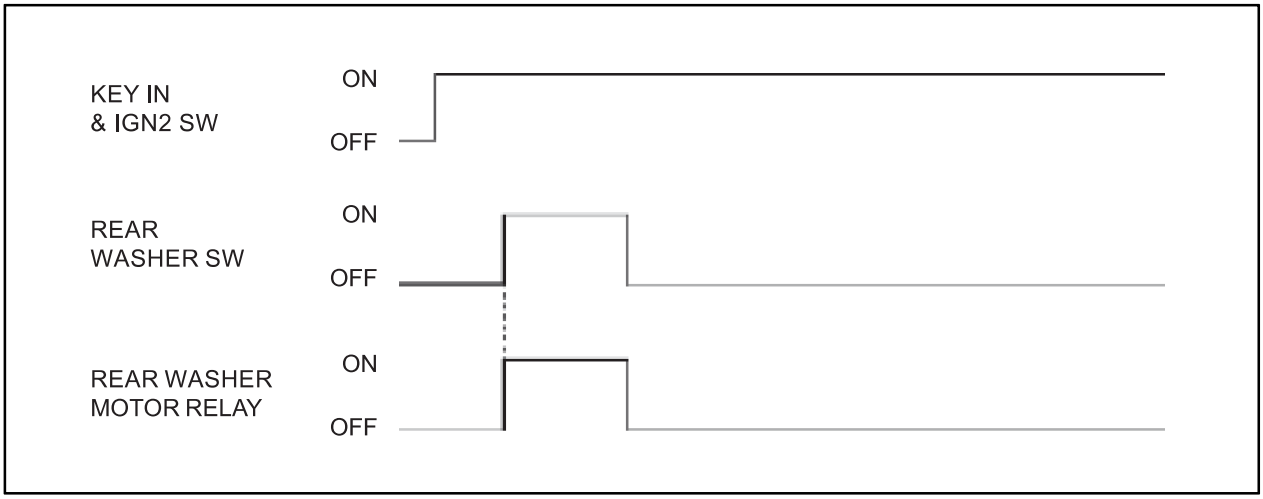


- When the washer switch is ON for more than 0.6 seconds during the wiper operation by the INT switch, the operation in step (2) is performed. When it is ON for a certain period of time (0.1 to 0.59 seconds), the operation in step (1) is performed.



(2) Rear Washer Motor Control

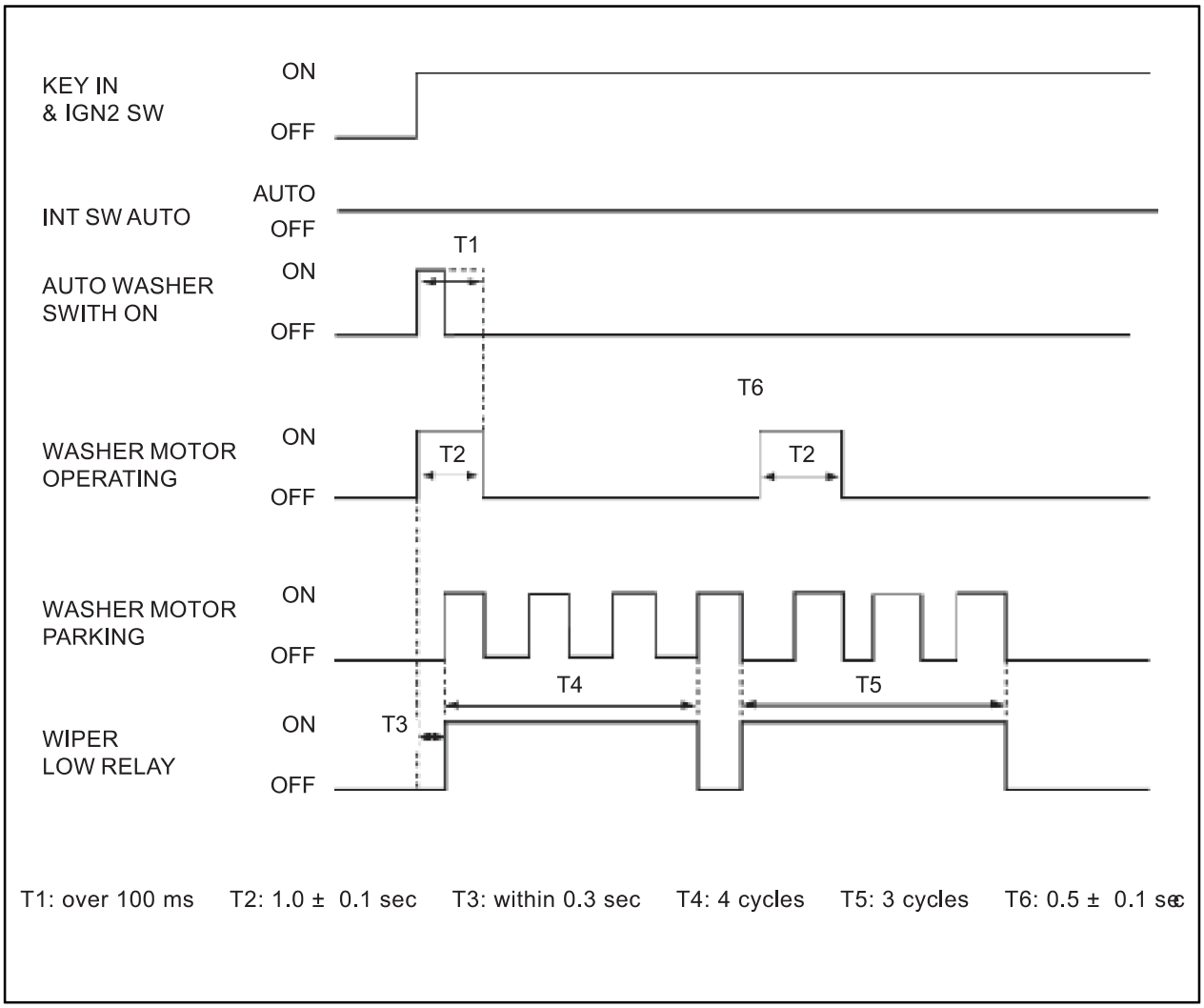
- When the rear washer switch is turn on with the ignition switch "ON", the rear washer motor relay output is activated from the time when the rear washer switch is turned on, and it is deactivated when the rear washer switch is turned off.
- It cannot be activated while the front washer switch or the auto washer and wiper (AFW: Advanced Fast Washer) is in operation.



Modification basis	
Application basis	
Affected VIN	

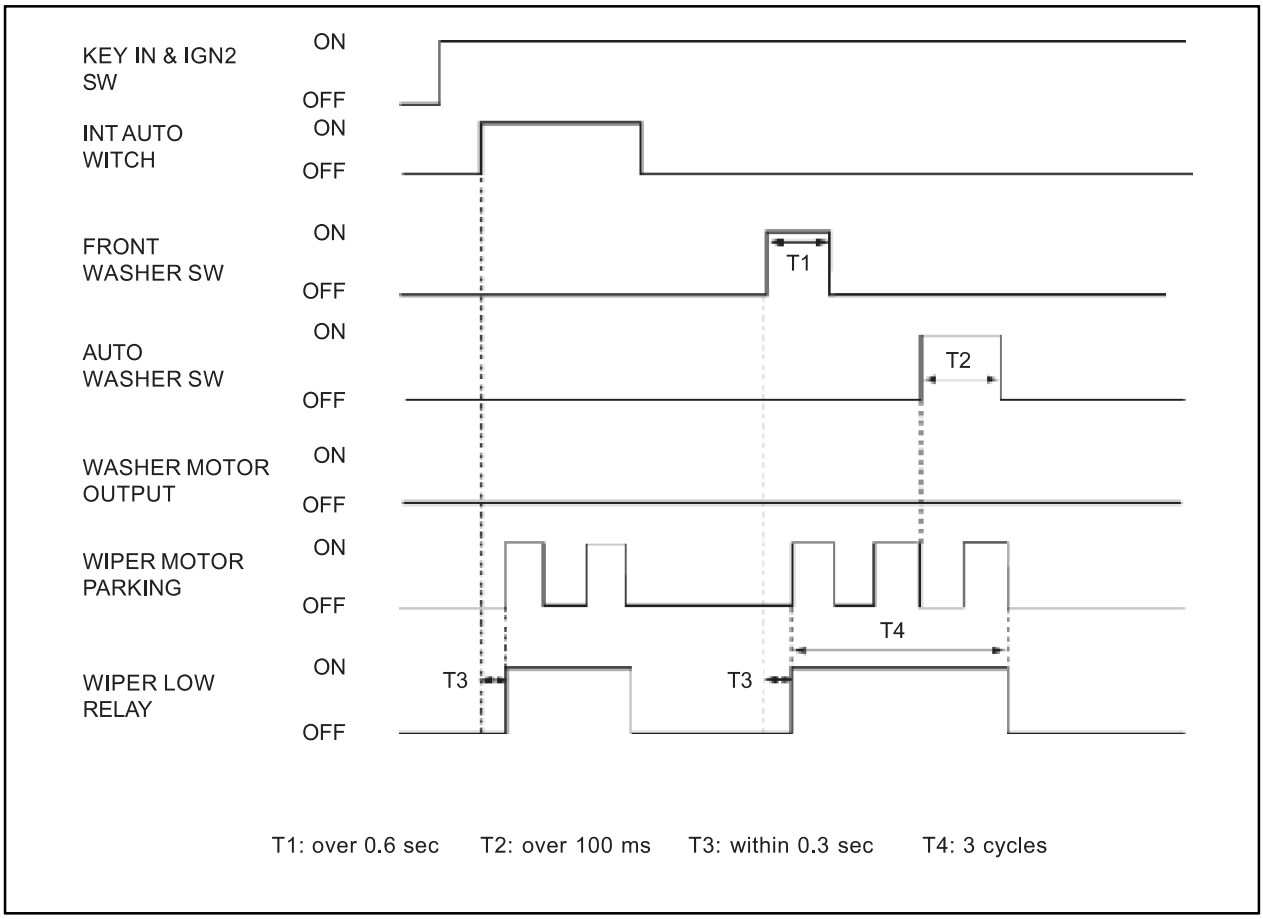
(3) Auto Washer and Wiper Switch (AFW)

- When the auto washer switch is turned on with the ignition switch "ON" and the INT switch "OFF", the washer motor output is activated for 1 second. If the system recognizes this output, the wiper relay output is activated during 4 cycles and the washer motor output is activated for 1 second. Then, the wiper relay output is deactivated after 3 cycles.



(4) FRONT Washer & AUTO Washer and Wiper Switch operation

- The auto washer switch output is overridden during the washer coupled wiper operation.
- The auto washer switch input is overridden during the auto washer coupled wiper operation.
- The auto washer switch input is overridden during the rain sensor coupled wiper or vehicle speed sensitive INT wiper operation.
- When the auto INT switch input is received during the auto washer operation, the auto washer operation stops and the auto INT operation is activated.

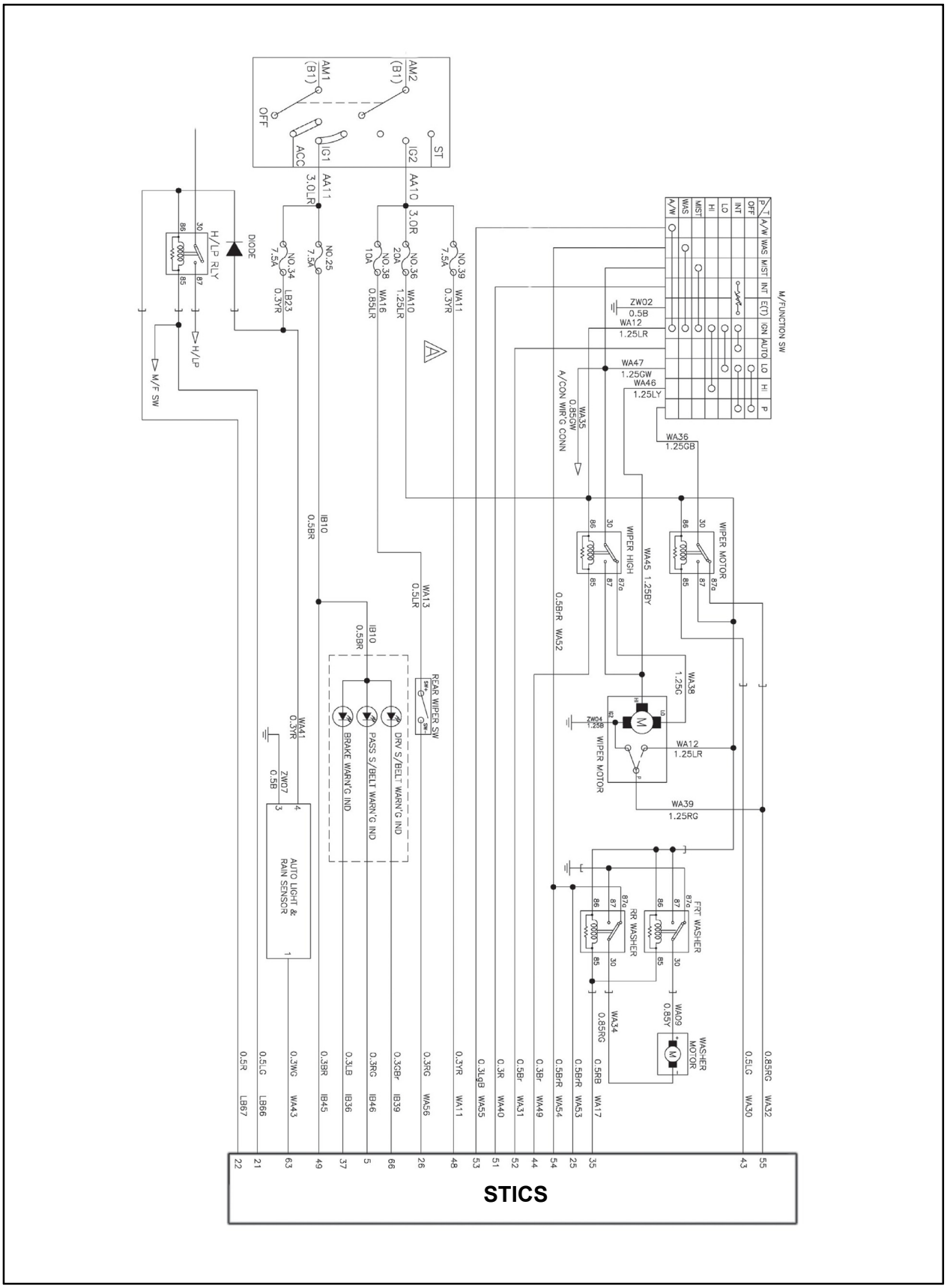


(5) Priorities in Washer Operations

1. The rear washer switch input is overridden during the front washer operation.
2. The rear washer switch input is overridden during the auto washer and wiper (AFW) operation.
3. The front washer switch input is overridden during the rear washer operation.
4. The auto washer switch input is overridden during the rear washer operation.
5. The front washer switch input is overridden during the auto washer and wiper (AFW) operation.
6. The auto washer switch input is overridden during the front washer operation.

Modification basis	
Application basis	
Affected VIN	

3. WIPER AND WASHER SYSTEM RELATED CIRCUIT



Modification basis	
Application basis	
Affected VIN	

RAIN SENSING SYSTEM (WITH AUTO LIGHT SENSOR) 8610-09

GENERAL

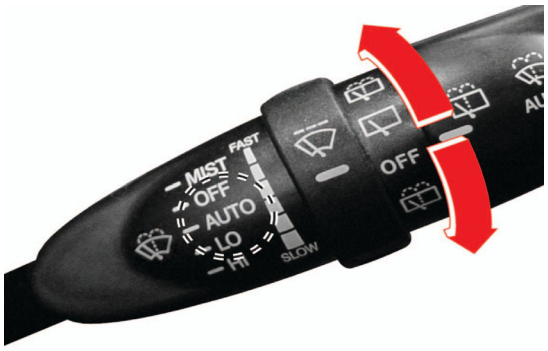
1. RAIN SENSING SYSTEM (WITH AUTO LIGHT SENSOR) OVERVIEW

The rain sensing wiper unit in this vehicle doesn't control the wiper directly.
The rain sensing unit detects the amount of rain drops and sends the operating signal to STICS, and STICS drives the wiper directly.

Rain sensing unit (Auto light sensor integrated type)

A sensor that emits infrared rays through LED and then detects the amount of rain drops by receiving reflected rays against sensing section (rain sensor mounting section on the windshield) with photodiode. The auto light sensor is Integrated into the rain sensor. (refer to the below picture)

Multifunction wiper switch: AUTO and sensitivity control



AUTO: Wiper operates automatically by rain sensor
FAST <——> SLOW: Auto delay/Auto speed control.
A position that can control sensitivity against rains on the windshield and transmits wiping demand signal accordingly.

▶ **Emitter lens**
The LED emits the infrared rays is located at bottom and the lens guides the infrared rays to target point.

Enlarged auto light sensor section

Horizon autolight sensor

Auto light sensor

Vertical autolight sensor

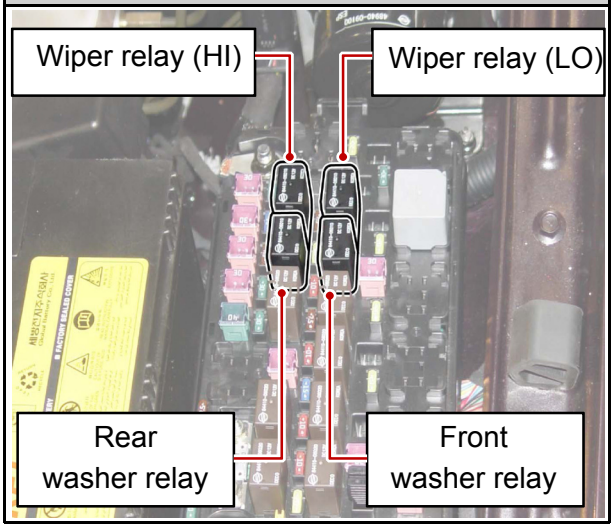
Modification basis	
Application basis	
Affected VIN	

1) STICS

The rain sensing unit detects the amount of rain drops and sends the operating signal to STICS, and STICS drives the wiper directly.
At this moment, STICS determines the wiper operation mode (washer, MIST, AUTO), then sends the information to the rain sensor.

STICS

Engine compartment fuse box



(1) Auto Light Sensor And Rain Sensor Coupled Control

▶ **Rain detected headlamp**

- If it rains heavy which requires the highest INT speed, the headlamps are turned on automatically.

▶ **Night detected wiping**

- When the auto light control turns on the headlamps and the rain sensor detects the rain, the wiper sensitivity is automatically increased by one level.
  (For example, the AUTO wiper switch is at the 3rd level, but the wiper operates at the 4th level.)

Modification basis	
Application basis	
Affected VIN	

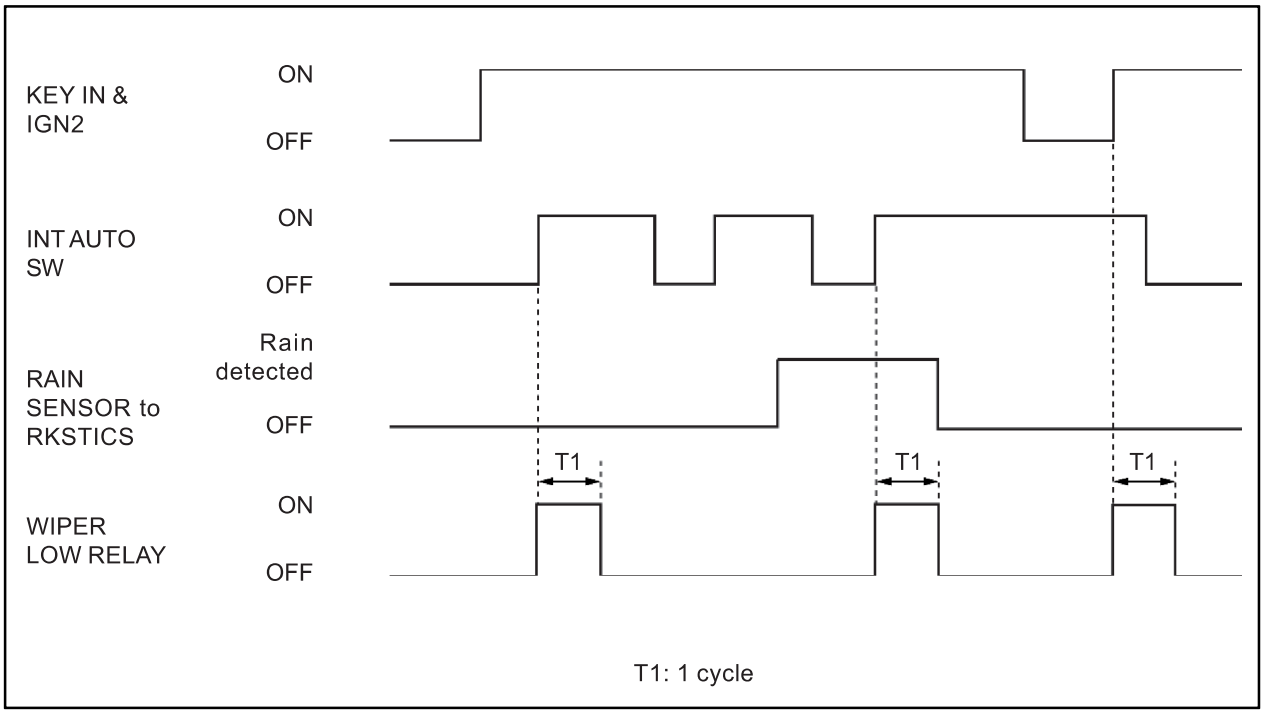
OVERVIEW AND OPERATION PROCESS

1. FUNCTIONS AND SPECIFICATIONS OF RAIN SENSING WIPER

1) Power-up Reminder Wiper

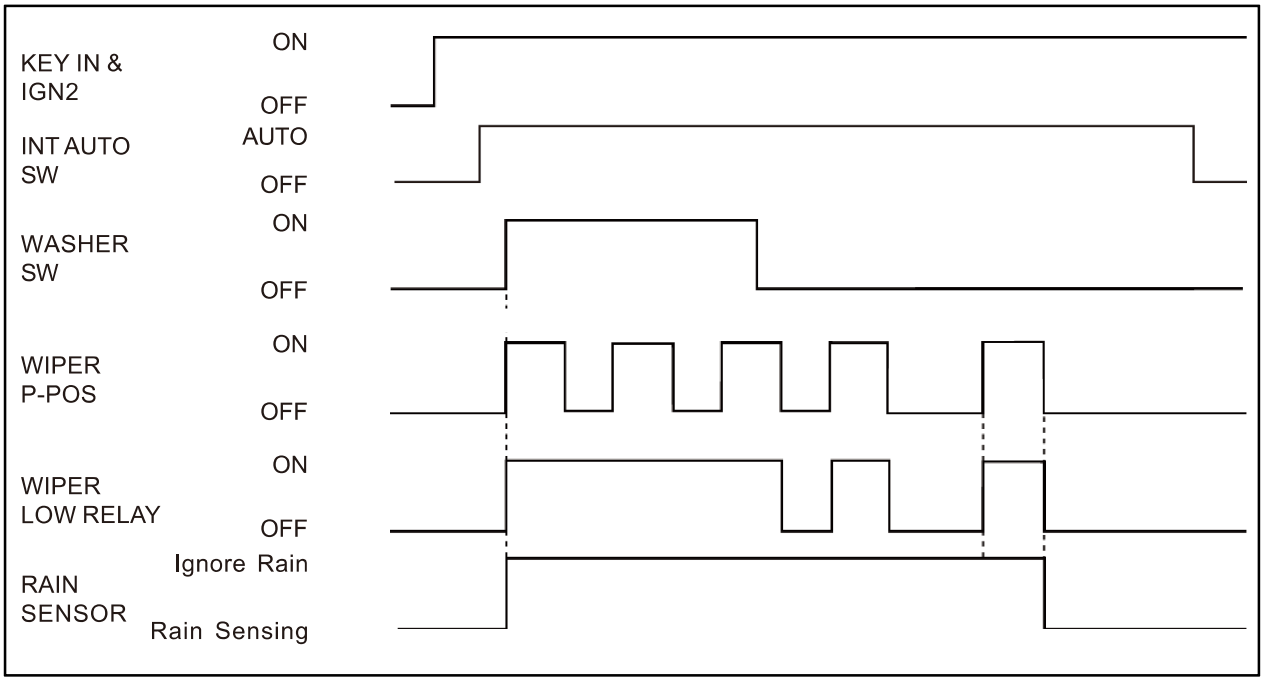
- When turning off and on the auto INT switch, the system drives the wiper motor through LOW relay regardless of communication with rain sensor.
- The wiper relay (LOW) is turned on and the wiper motor runs one cycle when changing the wiper switch to "AUTO" position from any other positions (while the ignition key is in "ON" position).

When the wiper switch is turned to "ON" position again from other positions, the system Drives the wiper motor through LOW relay one cycle only when the rain sensor detects the "Rain Detected" signal.



2) Washer Coupled Wiper in the Rain Sensing Mode

- The washer coupled wiper is operated when receiving the washer switch input with the ignition switch "ON" and the auto INT switch "ON" in rain sensing mode. At this moment, the communication with the rain sensor is overridden. However, the washer switch input is overridden during continuous operation.
- The operation data is sent to the rain sensor even during the washer coupled wiper operation.

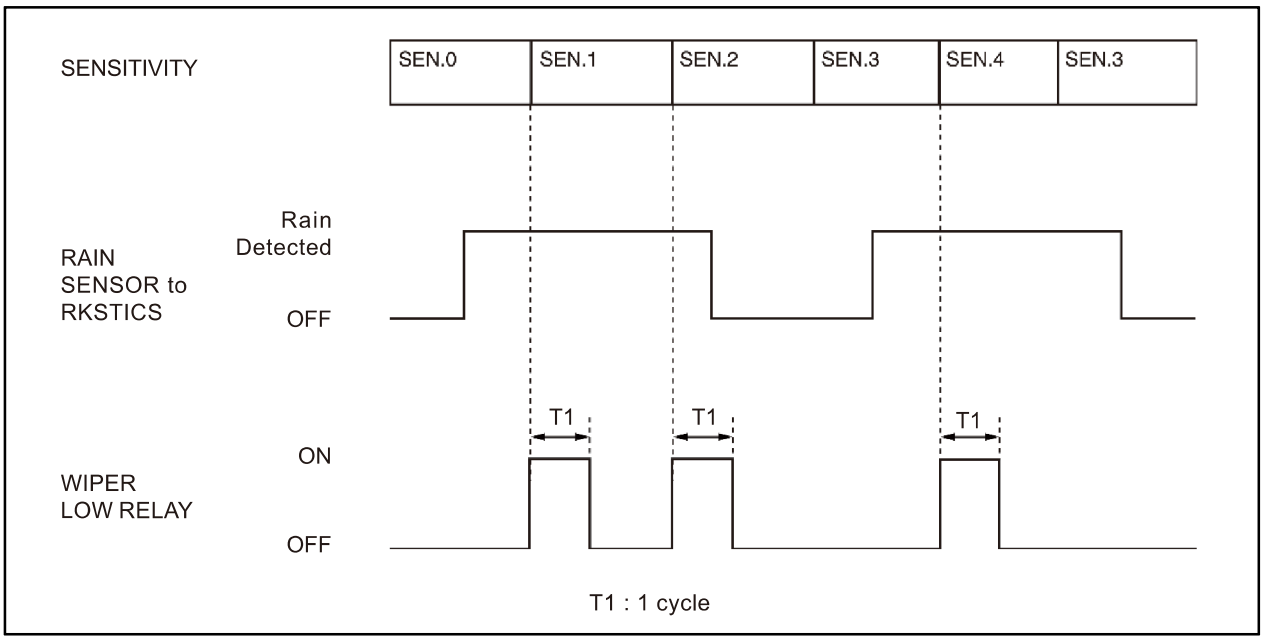


Modification basis	
Application basis	
Affected VIN	

3) Rain Sensing Sensitivity Control

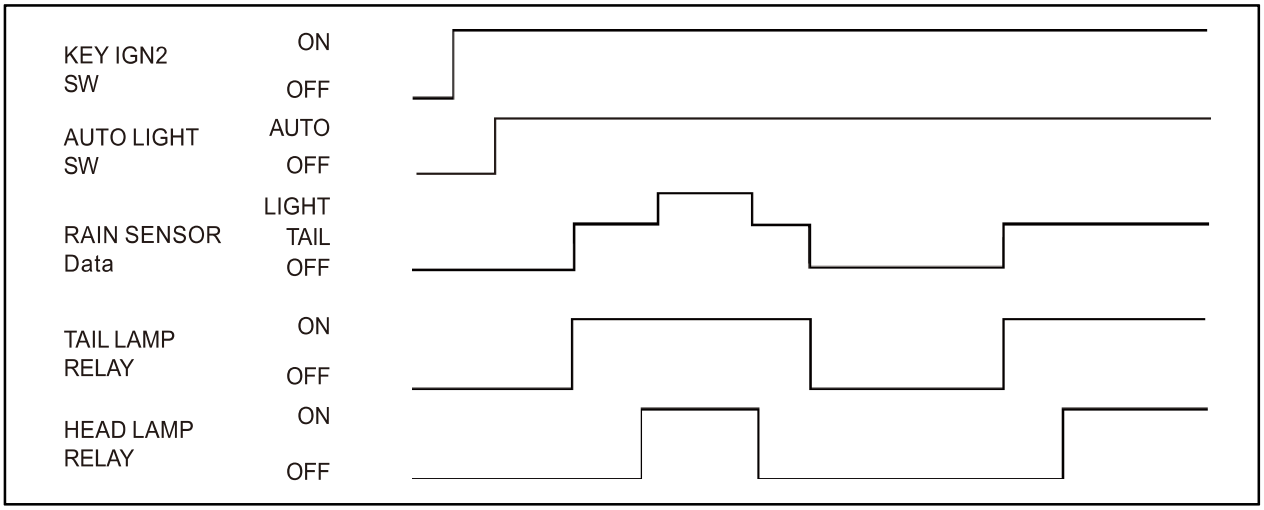
- The wiper relay (LO) is turned on and the wiper motor runs one cycle when the volume sensitivity is increased (ex: from 0 to 1) (while the ignition key is in "ON" position, the wiper switch is in "AUTO" position, and the wiper motor is in "Parked" position). However, the wiper motor can be operated only when the rain sensor detects the "Rain Detected" signal.

- If the volume sensitivity is changed more than 2 stages within 2 seconds, the wiper motor runs only one cycle.



4) Auto Light Control

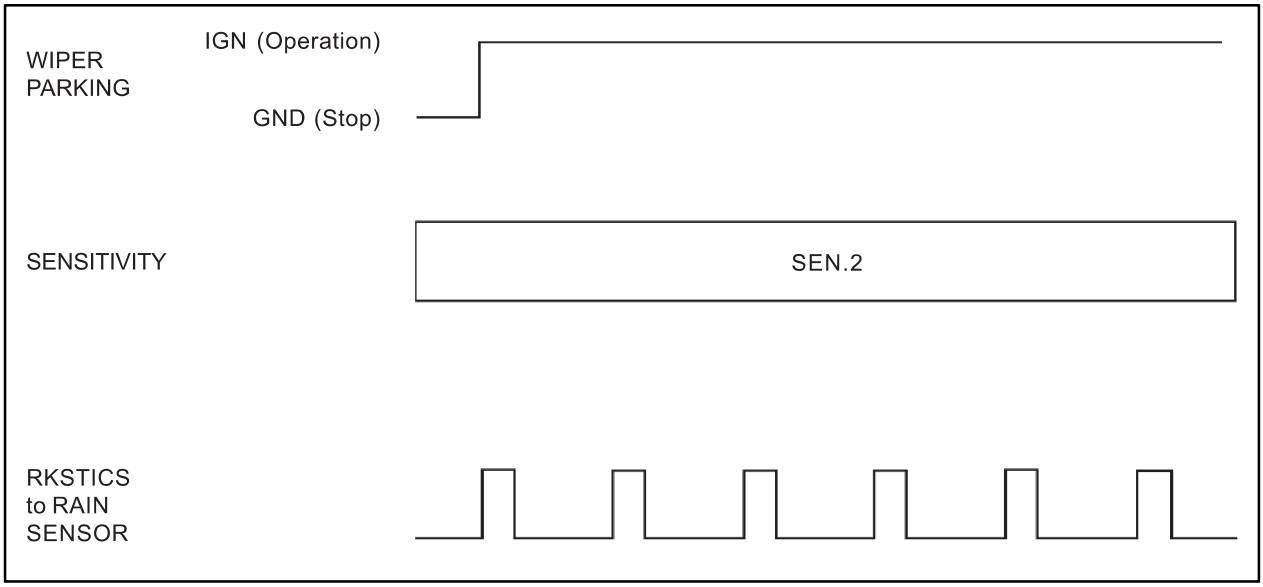
- Only when the auto light switch is in "AUTO" position, control the tail lamp and headlamp by communicating with the rain sensor (while the ignition key is in "ON" position).



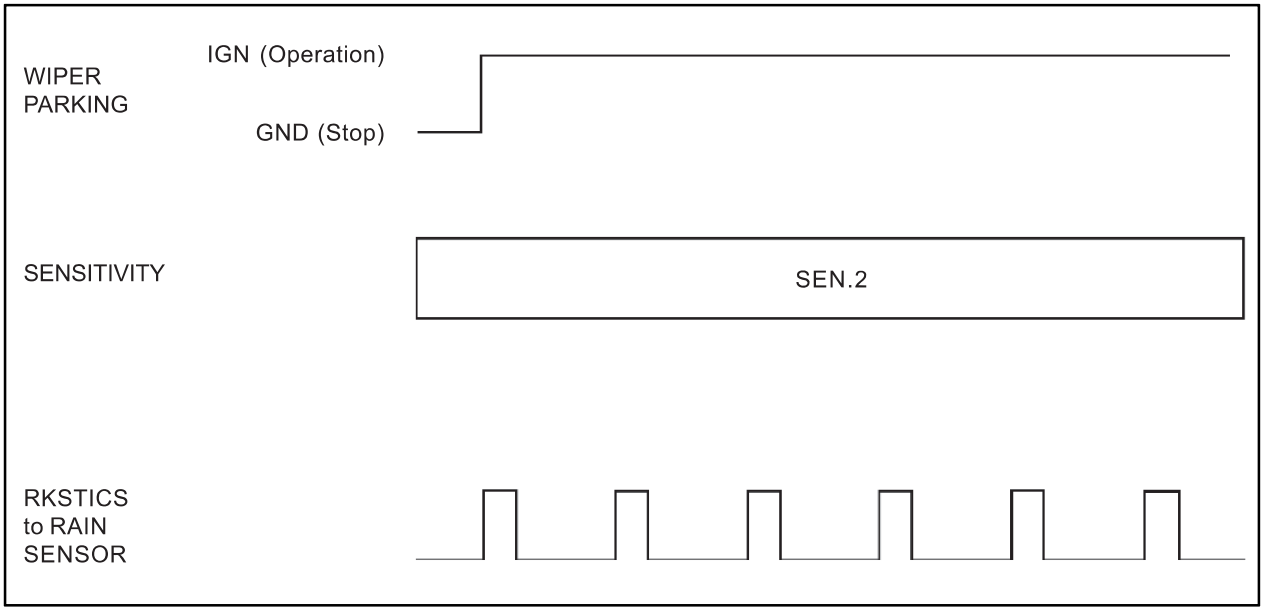
Modification basis	
Application basis	
Affected VIN	

5) Wiper Operation When the Wiper Parking Terminal Is Grounded

- The wiper system continuously outputs the parking signal of current sensitivity when the parking terminal is grounded (while the ignition key is in "ON" position and the INT switch is in "ON" position).
- **The wiper motor runs only when the rain sensor requires.**



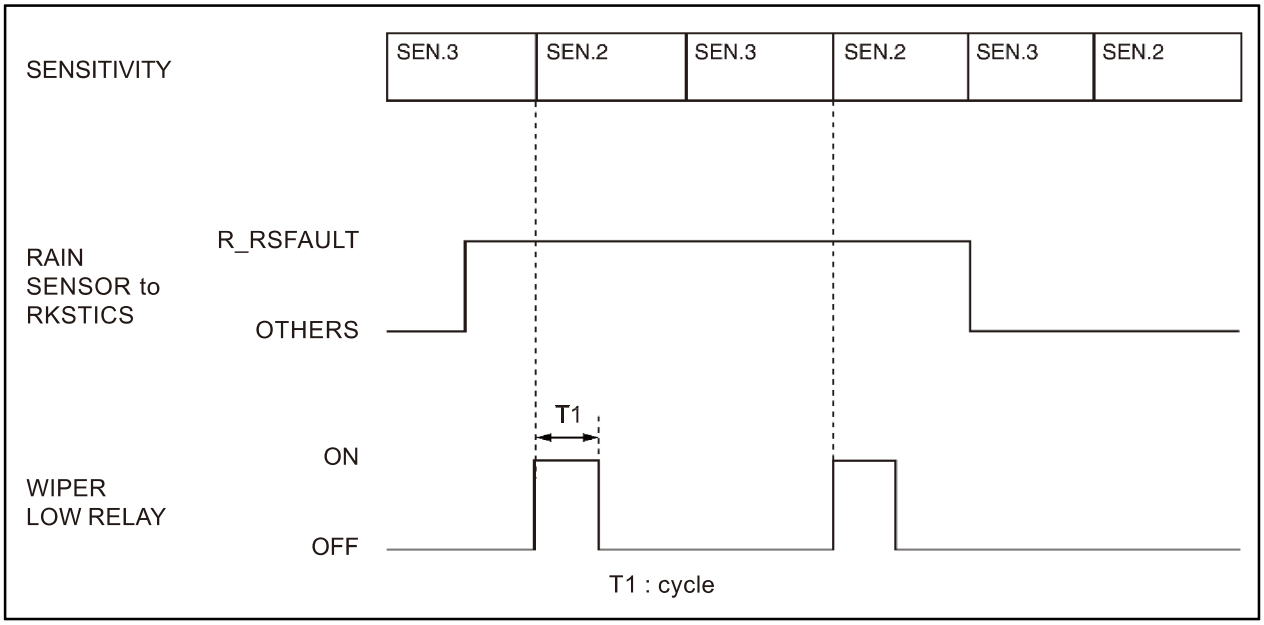
- When the parking terminal is fixed to IGN (HIGH), the wiper system outputs the operating signal of current sensitivity for 2 seconds, then continuously outputs the parking signal of current sensitivity (while the ignition key is in "ON" position and the INT switch is in "ON" position).
- **The wiper motor runs only when the rain sensor requires.**



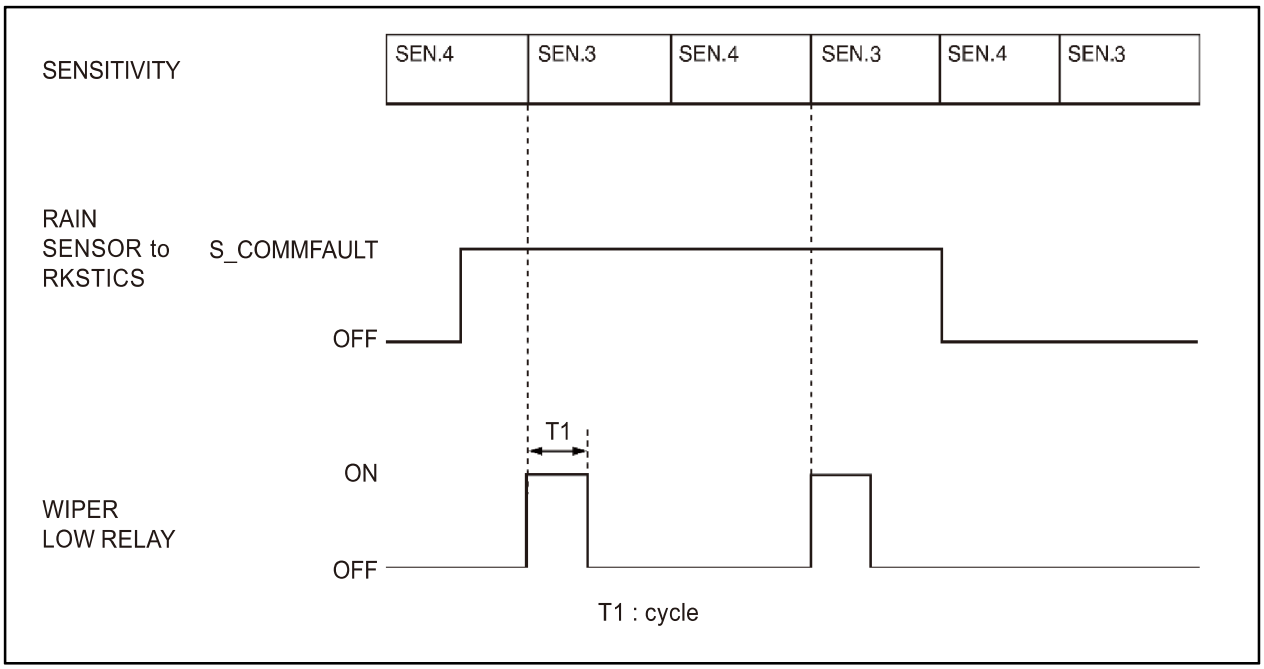
Modification basis	
Application basis	
Affected VIN	

6) Defective Rain Sensor

- The wiper relay (LO) is turned on and the wiper motor runs one cycle when the wiper sensitivity is changed to 2 from 3 during receiving the malfunction signal (1) from the rain sensor (while the ignition key is in "ON" position and the INT switch is in "ON" position).



- The wiper relay (LO) is turned on and the wiper motor runs one cycle when the wiper sensitivity is changed to 3 from 4 during receiving the malfunction signal (2) from the rain sensor (while the ignition key is in "ON" position and the INT switch is in "ON" position).



2. OPERATION MODE OF RAIN SENSING WIPER SYSTEM

Driver Switch Positions		Operation Mode
MIST (Transmits the manual operation mode signal to sensor)		As long as the switch is in MIST position, the wiper motor operates in low speed. The wiper blade returns to parking position if the switch returns to the original position. The rain sensor ignores inputs during parking signal periods.
OFF (Transmits the manual operation mode signal to sensor)		The wiper motor rotates in low speed until it returns to parking position. When the system is in manual mode, the sensitivity of sensor will be set to 2 (AUTO 2) internally. By doing so, immediate wiping with proper intervals is possible when a driver sets the system from OFF to AUTO.
AUTO 1 (low sensitivity)	SLOW ▲	Auto delay/auto speed control. Low sensitivity against rains on windshield. When the switch is in AUTO position, the sensor transmits the wiping request signal to STICS.
AUTO 2 (low/med sensitivity)		Auto delay/auto speed control. Low/medium sensitivity against rains on windshield.
AUTO 3 (medium sensitivity)		Auto delay/auto speed control. Medium sensitivity against rains on windshield.
AUTO 4 (med/hi sensitivity)		Auto delay/auto speed control. Medium/high sensitivity against rains on windshield.
AUTO 5 (high sensitivity)	▼ FAST	Auto delay/auto speed control. High sensitivity against rains on windshield.
LOW SPEED (transmits the manual operation mode signal to sensor)		The wiper motor rotates continuously in low speed of approx. 45 rev./minute at B+=13.5V (in the normal battery voltage). The rain sensor operations are same as in MIST.
HI SPEED (transmits the manual operation mode signal to sensor)		The wiper motor rotates continuously in high speed of approx. 70 rev./minute at B+=13.5V (in the normal battery voltage). The rain sensor operations are same as in MIST.

▶ **Rain detected headlamp**

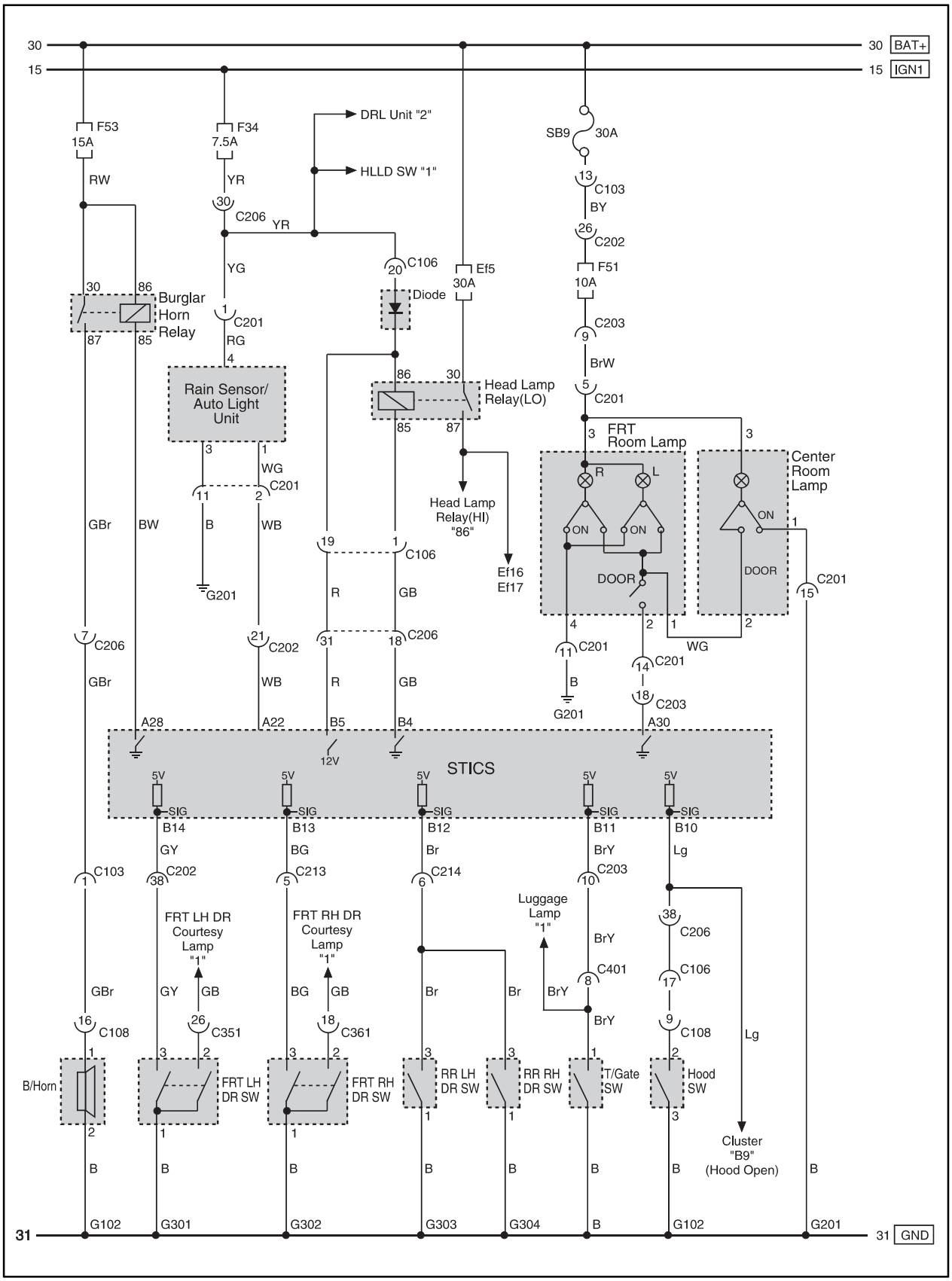
- If it rains heavy which requires the highest INT speed, the headlamps are turned on automatically.

▶ **Night detected wiping**

- When the auto light control turns on the headlamps and the rain sensor detects the rain, the wiper sensitivity is automatically increased by one level. (i.e. the AUTO wiper switch is at the 3rd level, but the wiper operates at the 4th level.)

Modification basis	
Application basis	
Affected VIN	

3. ELECTRICAL WIRING DIAGRAM



Modification basis	
Application basis	
Affected VIN	

PAS(PARKING AID SYSTEM)

8790-03/8790-01/8790-00

GENERAL

1. COMPONENT SPECIFICATIONS..... 3

OVERVIEW AND OPERATION PROCESS

1. SYSTEM CONFIGURATION..... 4
2. ALARM INTERVAL AND TROUBLE SHOOTING..... 5
3. CAUTIONS ON PARKING AID SYSTEM 7
4. CIRCUIT DIAGRAM..... 8

REMOVAL AND INSTALLATION

8790-03 PARKING AID SENSOR..... 9
8790-01 PARKING AID UNIT..... 12
8790-00 PAS PIEZOMETRIC BUZZER..... 13

PARKING AID SYSTEM

8790-00

GENERAL

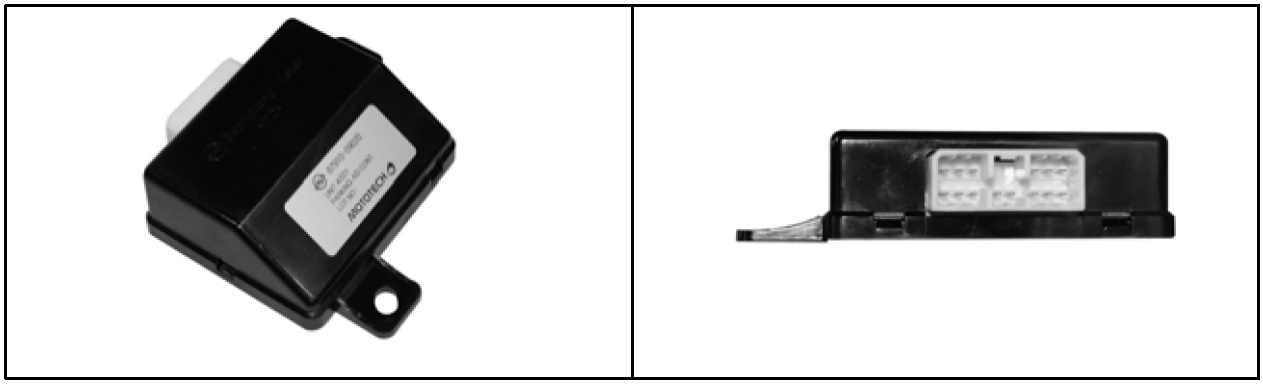
1. COMPONENT SPECIFICATIONS

The parking aid system emits the supersonic wave signals from the sensors on the rear bumper with a specific interval and detects the reflected signals from obstacles while the gear selector lever is in "R" position. The alarm interval becomes faster as the obstacle approaches. This supplementary system is to secure the safety distance for parking.

Items		Value	Items		Value
Rated voltage		DC 12 V	Operating temperature		-30°C ~ +80°C
Operating voltage		UNIT 12 V , SENSOR 8 V	Storage temperature		-40°C ~ +85°C
Allowable max. current	Unit	100 mA (DC 12 V)	Relative humidity		95% (max.)
	Sensor	20 mA (DC 8 V)	Weight	Unit	160g ± 10g (max.)
Sensor insulating resistance		More than 5M Ω		Sensor	50g ± 10g (max.)

1) Parking Aid Unit

Detecting type: Supersonic wave Detecting distance: 25 cm ~ 100 cm (direct distance between sensor and obstacle)



2) Parking Aid Sensor

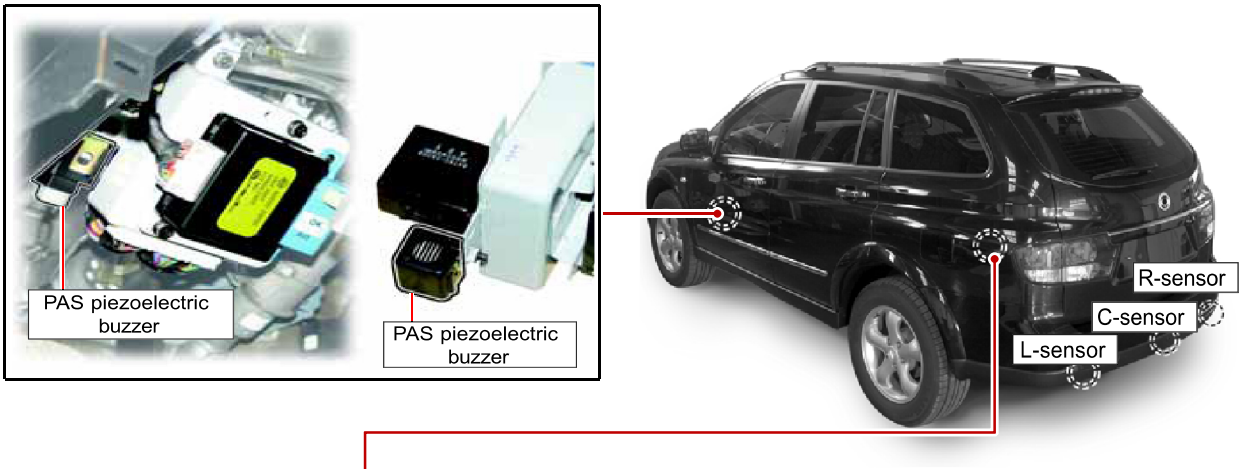
Detecting type: Supersonic wave
(Piezometric ceramic element)
measuring time taken that the emitted
supersonic wave is reflected and returned to the sensor.

OVERVIEW AND OPERATION PROCESS

1. SYSTEM CONFIGURATION

The parking aid device is integrated in the rear bumper and it uses three piezoelectric elements to measure vertical and horizontal distance to obstacles.

If the sensor receives the reverse signal, it calculates the distance between itself and obstacles and sends the calculated value to the PAS unit, which will warn a driver by controlling the activation of the Piezo buzzer in relation to the distance. The PAS unit of KYRON from Mach '07 has been changed for its installed positions and shape due to the shape change of the rear bumper and also its internal elements have been changed due to the setting values of the PAS unit.



Parking Aid Unit

PAS Sensor Components

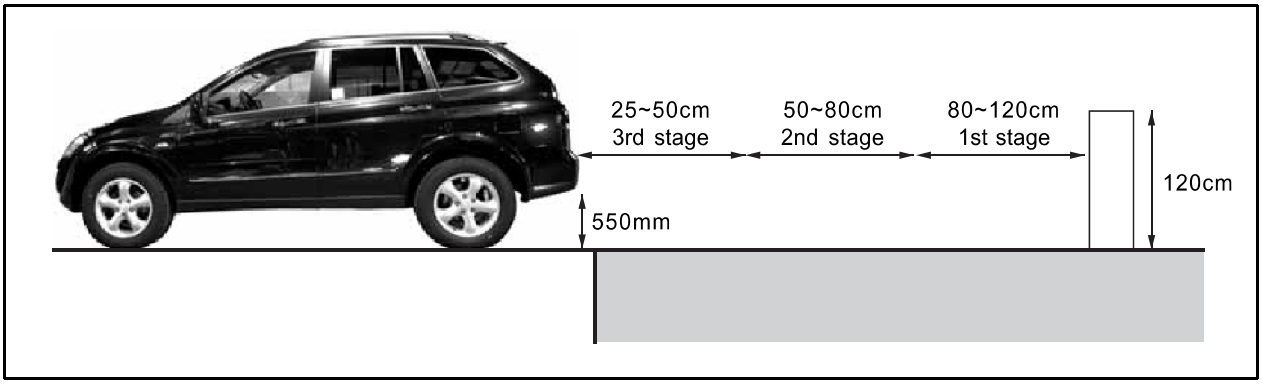
CAUTION

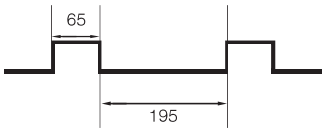
- KYRON from '07 March and earlier KYRON are not compatible with the PAS unit and its sensor parts each other.

Modification basis	
Application basis	
Affected VIN	

2. ALARM INTERVAL AND TROUBLE SHOOTING

1) Detected Distance and Range



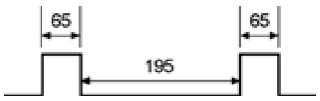
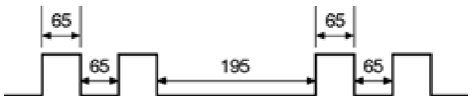
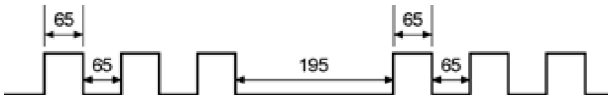
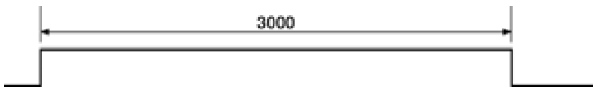
Stage	LH & RH sensors	Center sensor	Alarm interval (msec)	Remarks
1	80 ~ 100 cm	80 ~ 120 cm		"Beep----, Beep----"
2	50 ~ 80 cm			"Beep-, Beep-, Beep-"
3	25 ~ 50 cm			"Beep----"
Tolerance	± 10 cm		± 10%	

2) Troubleshooting

When the power is applied (gear selector lever is in "R" position), the sensor will be diagnosed once. If normal, the warning buzzer sounds only for 65 ms. If found any failure due to open circuit to sensor or communication error, the data in failed sensor is transmitted to notice its failure by buzzer sound.

If more than one sensor is defective, warning buzzer sounds for 3 seconds.

▶ When failed

Items	Alarm interval (msec)	Diagnosis conditions
LH sensor failed ("Beep----Beep")		1. Ignition key ON 2. Failing condition - Open circuit in line that transmits data from sensor to unit - Open circuit in line that supply power (+, -)
Center sensor failed ("Beep Beep---- Beep Beep")		
RH sensor failed ("Beep Beep Beep---- Beep Beep Beep")		
Sensor failed (over 2EA) ("Beep----")		

Modification basis	
Application basis	
Affected VIN	

3. CAUTIONS ON PARKING AID SYSTEM

CAUTION

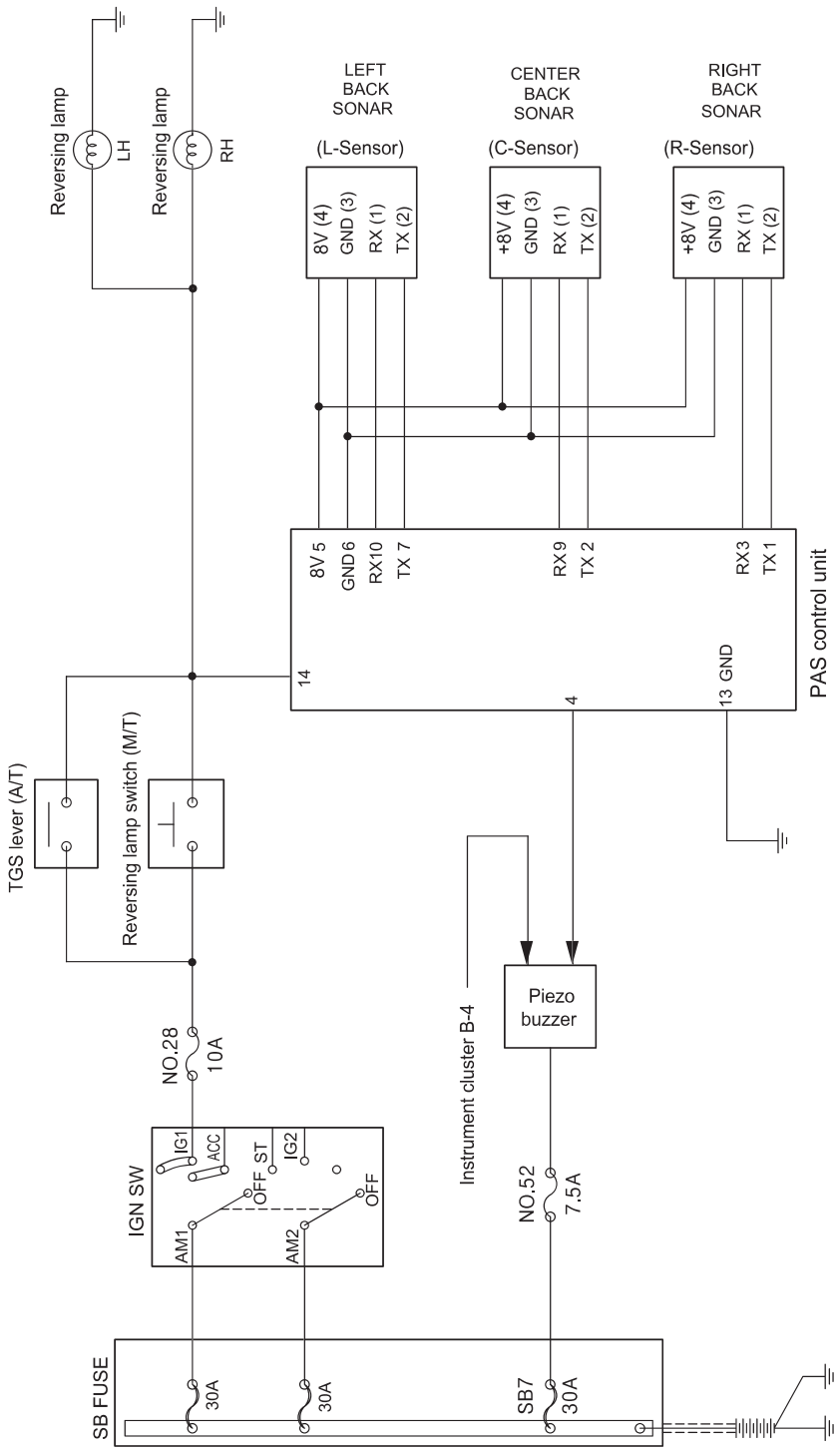
- Note that the display does not show everything in the rear area. Always check nobody, especially animals and children, is behind the vehicle.
- If you can not properly check back, get out of the vehicle and then check it.

1. The parking aid system is just a supplemental device to help your parking operation.
2. Always keep the safety precautions.
3. Do not press or shock the sensors by hitting or high-pressure water gun while washing, or the sensors will be damaged.
4. If the system is in normal operating conditions, a short beep sounds when the gear selector lever is moved into "R" position with the ignition key "ON".

▶ **The parking aid system will not work or improperly work under following cases:**

1. Certain obstacles that sensors can not detect
   - Wires, ropes, chains.
   - Cotton, sponge, clothes, snow that absorb ultrasonic waves.
   - Obstacles lower than the bumper.
2. Not defective but improperly working
   - When the sensing portion is frozen. (operates normally after thawed)
   - When the sensing portion is covered by rain, water drops, snow or mud (operates normally after cleaned).
   - When receiving other ultrasonic signals (metal sound or air braking noises from heavy commercial vehicles).
   - When a high-power radio is turned on.
3. Narrowed sensing area
   - When the sensing portion is partially covered by snow or mud. (operates normally after cleaned)
   - Surrounding temperature of sensor is too high (approx. over 80 °C) or too low (approx. below -30 °C).
4. Not defective but may occur improper working
   - When driving on the rough roads, gravel road, hill and grass.
   - When the bumper height is changed due to the heavy load.
   - When the sensing portion is frozen.
   - When the sensing portion is covered by rain, water drops, snow or mud.
   - When receiving other ultrasonic signals (metal sound or air braking noises from heavy commercial vehicles).
   - When a high-power radio is turned on.
   - When some accessories are attached in detecting ranges.
   - When the vehicle height is lowered due to operation of EAS.

4. CIRCUIT DIAGRAM



CAUTION

- The instrument panel sends operating signals to the buzzer not only for parking aid system, but also for other warning functions, such as ESP warning, overspeed warning and insufficient fuel warning functions. Warning functions which use the buzzer may vary depending on regions where vehicles are sold.

Modification basis	
Application basis	
Affected VIN	

AV

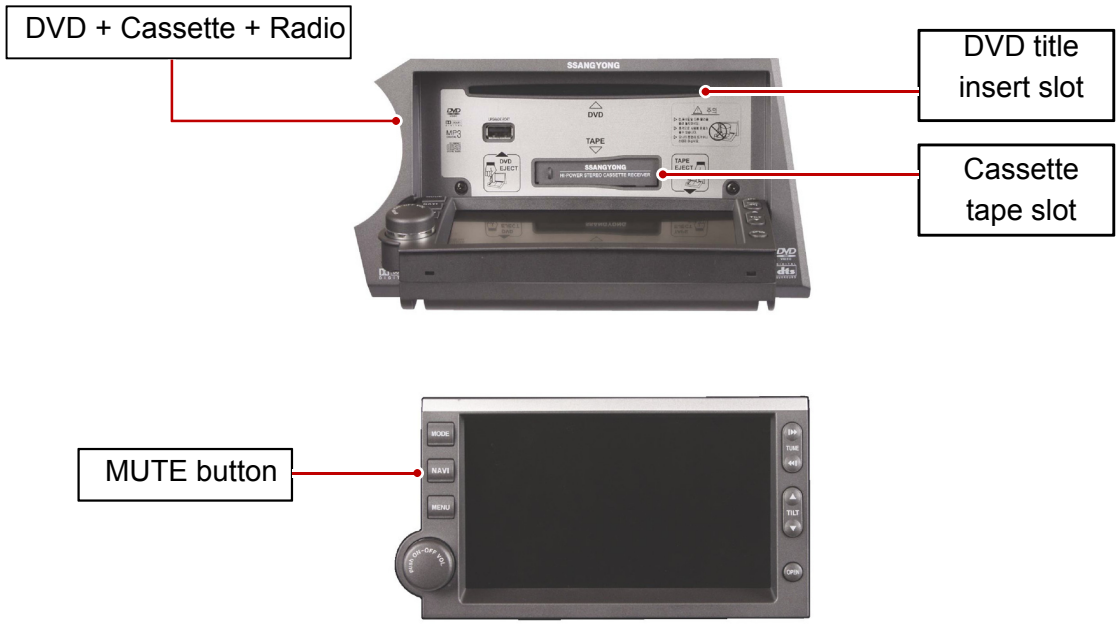
8930-14

GENERAL

1. AV HEAD UNIT OVERVIEW

DVD + Cassette player : 10 speakers (center speaker, woofer speakers, tweeter speakers)

AV head unit



Tuner

DVD 6 DISC changer

DSP amplifier

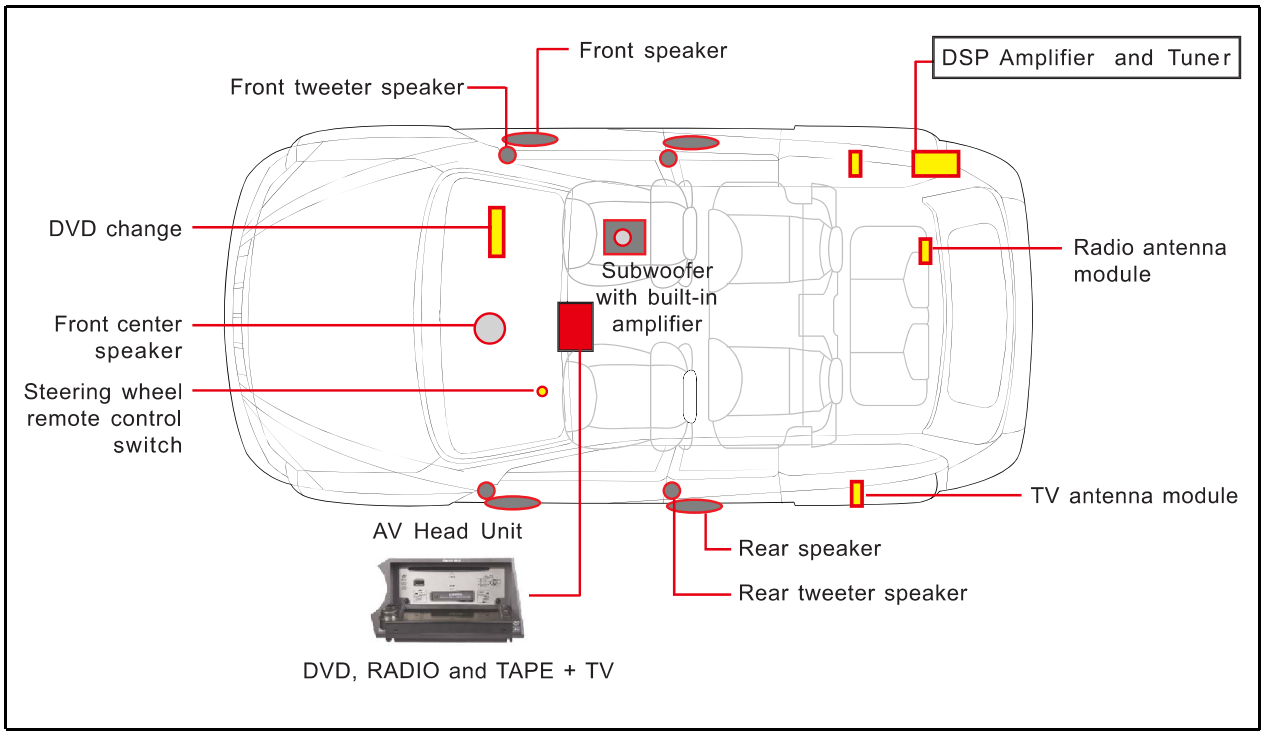
Subwoofer

Modification basis	
Application basis	
Affected VIN	

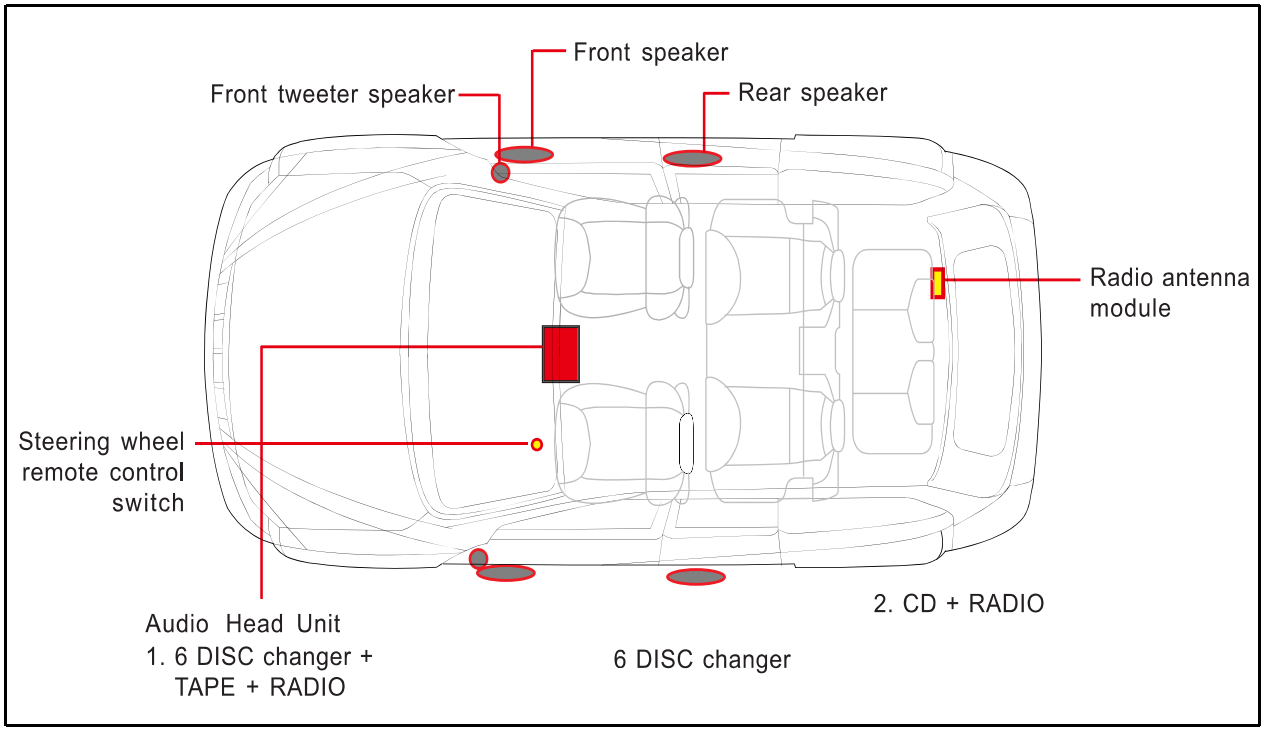
OVERVIEW AND OPERATION PROCESS

1. AV SYSTEM CONFIGURATION

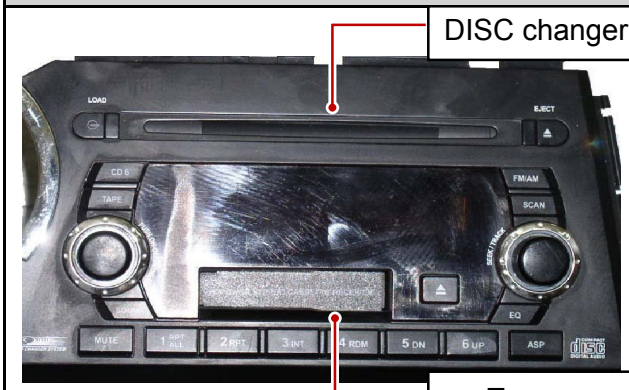
▶ AV System (DVD Head Unit + DVD Changer)



▶ Audio System - 6 Speakers



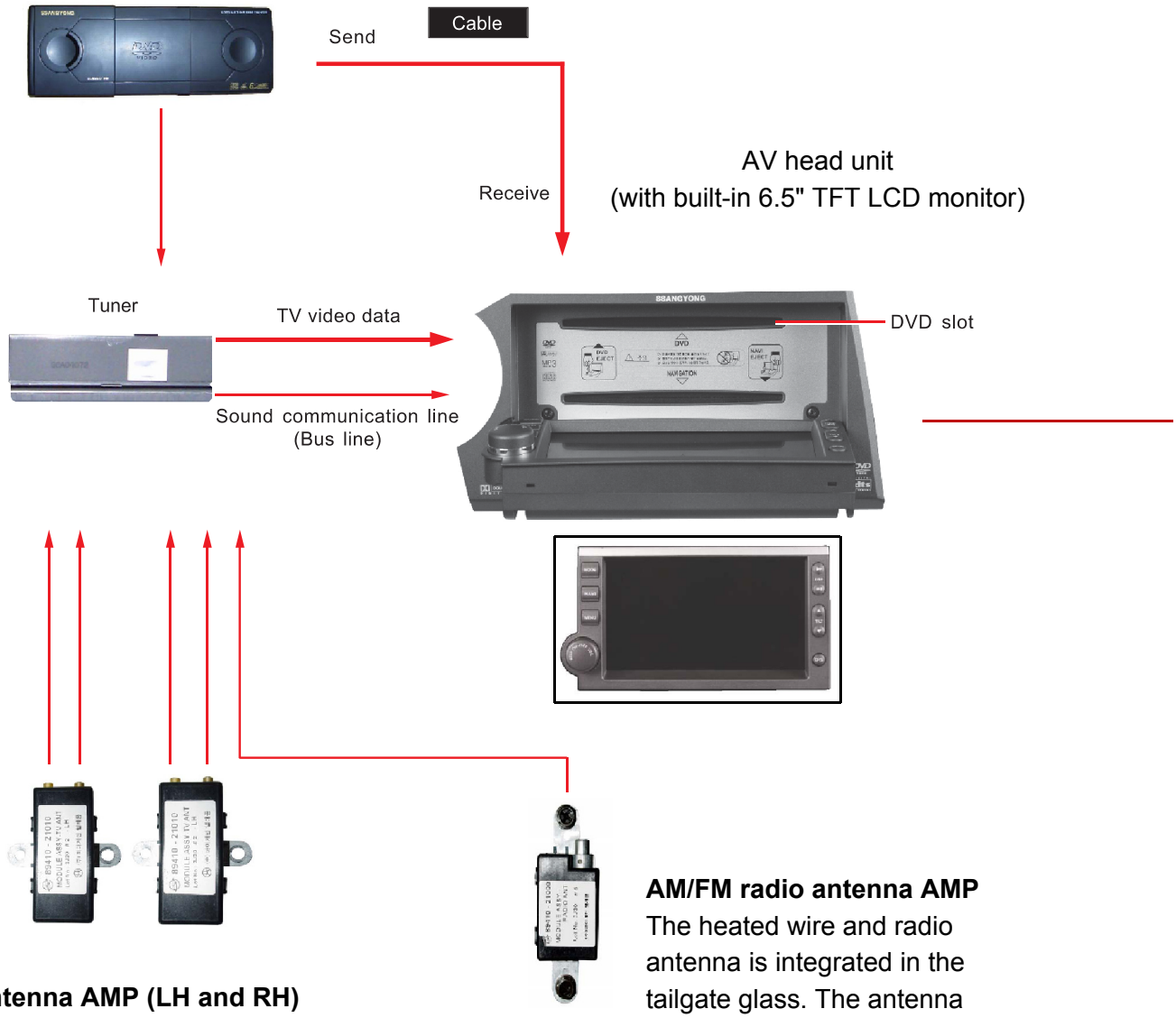
Modification basis	
Application basis	
Affected VIN	

6 DISC changer + TAPE + RADIO	CD + RADIO
	

2. AV HEAD SYSTEM CIRCULATION

DVD changer

It is installed in the center console. Audio signal of DVD changer outputs to corresponding speakers through the cable. Video signal is transmitted to the monitor of AV head unit.



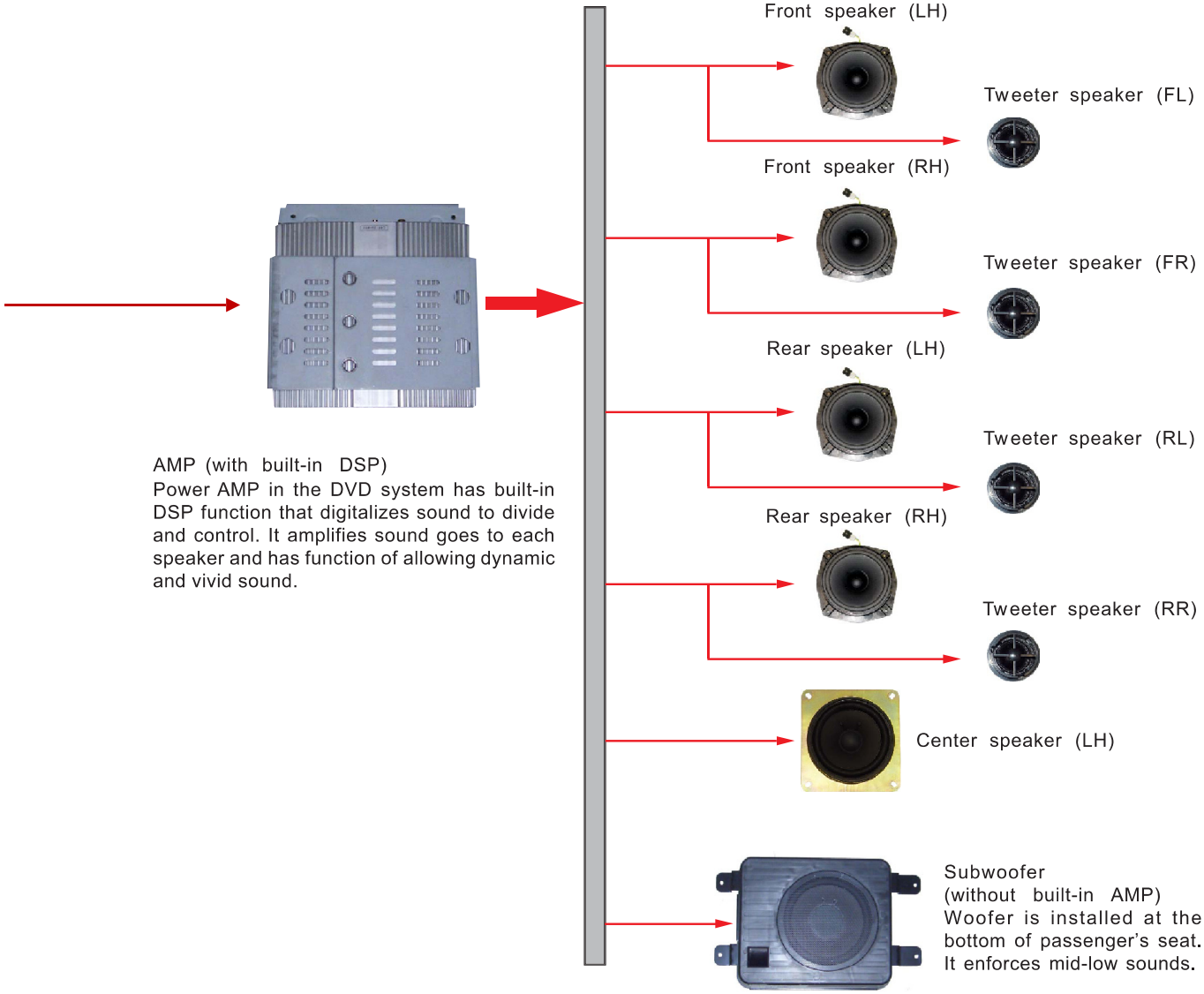
TV antenna AMP (LH and RH)

The glass antennas at both rear quarter glasses are to receive TV and AM radio (quarter RH glass) signals and transmits each 2-channel video and audio signals to tuner. Each AMP amplifies receives TV signals and then transmits to tuner.

AM/FM radio antenna AMP

The heated wire and radio antenna is integrated in the tailgate glass. The antenna transmits AM/ FM audio signals to tuner.

Modification basis	
Application basis	
Affected VIN	



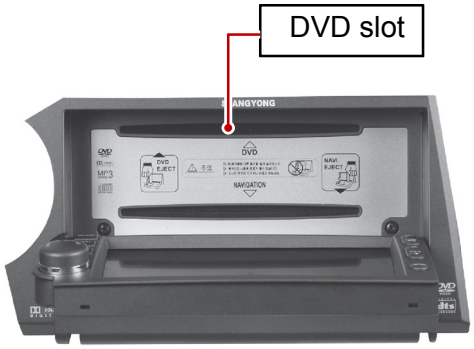
AMP (with built-in DSP)
Power AMP in the DVD system has built-in DSP function that digitalizes sound to divide and control. It amplifies sound goes to each speaker and has function of allowing dynamic and vivid sound.

Subwoofer
(without built-in AMP)
Woofer is installed at the bottom of passenger's seat. It enforces mid-low sounds.

Modification basis	
Application basis	
Affected VIN	

3. AV SYSTEM FUNCTIONS

AV system head unit operates Radio, TV, Audio CD, DVD and Video CD.
The touch screen type 6.5" TFT LCD monitor is installed on the system.



①	Power ON/OFF, Volume control
②	AV replay, AV reset screen
③	Replay mode selection (briefly press), Current replay mode (press and hold)
④	Next channel (radio or TV) or next track (audio or video)
⑤	
⑥	The monitor moves to parking position when turning the ignition switch to OFF position. It moves to the preset position when turning the ignition switch to ON position again.

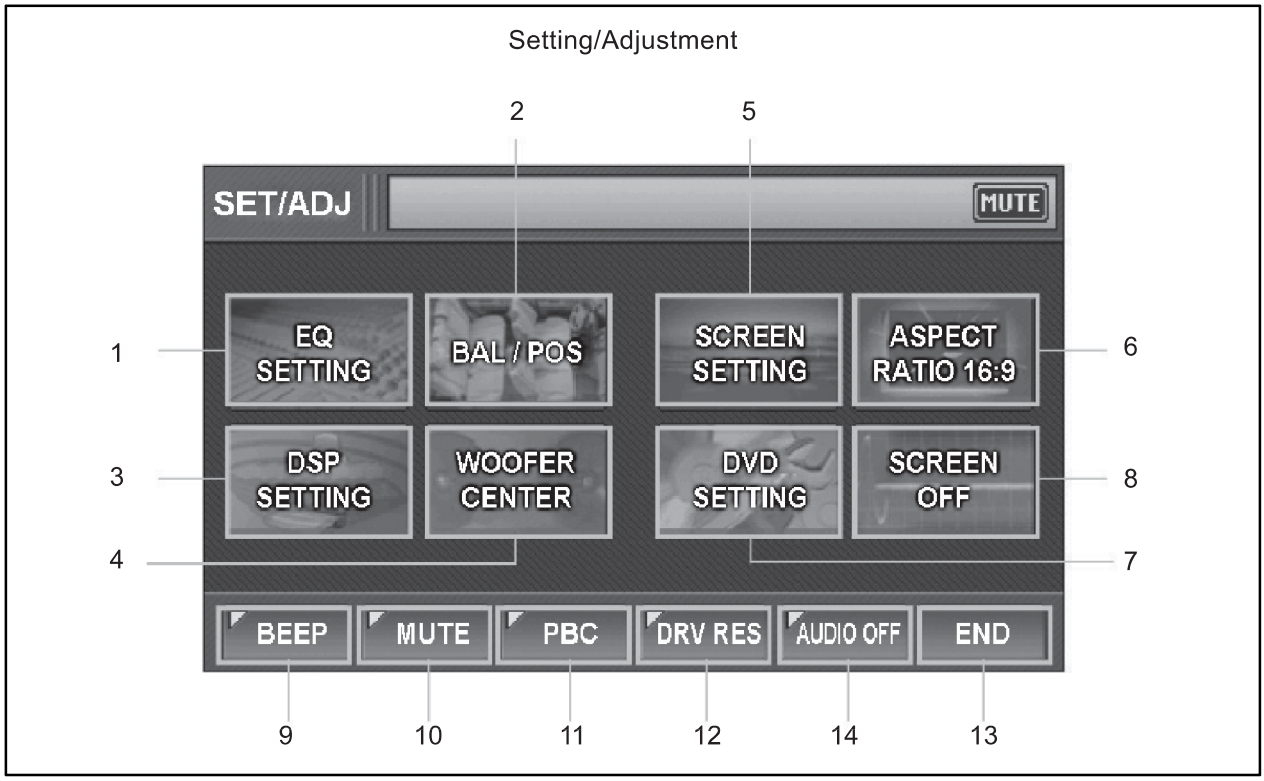
Display when turning on the monitor

Modification basis	
Application basis	
Affected VIN	

4. AV SYSTEM SPECIFICATIONS AND CONTROL

Display	6.5 Wide TFT LCD Aspect ratio: Full/16x9/4:3 Touch screen key: Full touch
TV	Diversity Antenna with high reception performance Automatic station selection
Radio	Automatic station selection Station memory: 8 channels in each band (AM1, AM2, FM1, FM2)
DVD	Automatic replay: Audio CD, DVD title Playback control supported Sub woofer speakers
DVD Changer (option)	Install 6-discs in the magazine Automatic replay: Audio CD, DVD title
Others	DSP function, Equalizer function

▶ Function Settings on Touch Panel (Example)



1	Equalizer setting: Preset value, Treble/Medium/Bass
2	Balance setting
3	DSP (Digital Signal Process) setting
4	Volume control of sub woofer and center speakers
5	Screen setting: brightness, colors, gamma, contrast
6	Aspect ratio setting: 16:9/4:3/ZOOM1/ZOOM2
7	Initial screen setting of DVD title: sound, caption etc.
8	Turning OFF the screen (however, audio system still operates)
9	Turning OFF/ON the button operating sound (“Beep” sound)
10	Turning OFF/ON the speakers
11	Turning OFF/ON the PBC function
12	Turning OFF/ON the driving restriction
13	Moves to replay mode out from SET/ADJUSTMENT mode
14	Audio OFF

Modification basis	
Application basis	
Affected VIN	

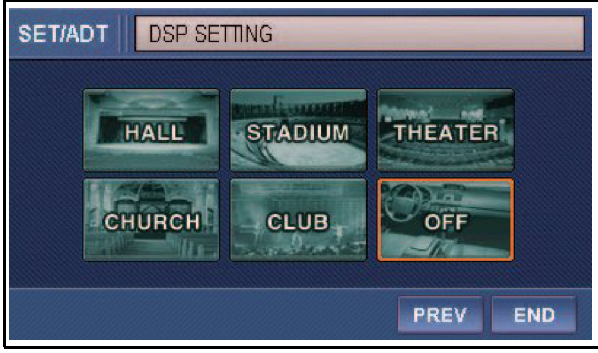
Basic display

Turn the AV system ON.

Press "MODE" button to select a mode.

When pressing "RADIO" section on the screen, the "RADIO" mode screen is displayed.

DSP control

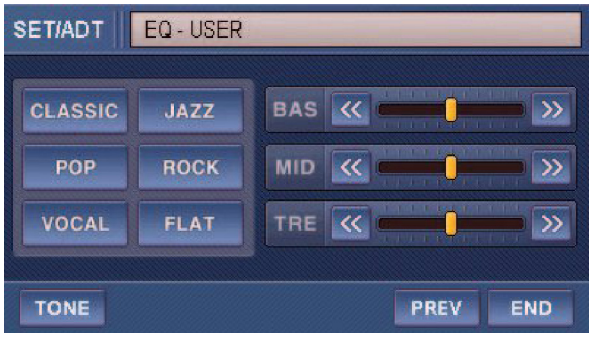


Selecting an acoustic perspective

Press "DSP SETTING" button in "SET/ADJ" screen and select one acoustic perspective (HALL, STADIUM, THEATER, CHURCH, CLUB).

Press "OFF" button to cancel the DSP function.

EQ control

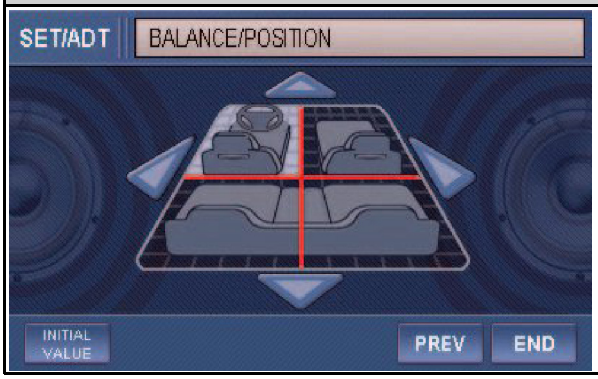


Adjusting the sound according to the music genre Press "EQ SETTING" button in "SET/ADJ" screen and adjust the sound.

To adjust the tone, press "TONE" button.

The tone can be adjusted by BAS/MID/TRE bars on the screen.

BALANCE/POSITION control



Adjusting the sound according to the seated position.

Press "BAL/POS" button in "SET/ADJ" screen and select a seat position (driver's, passenger's, rear seats, all seats) on the screen (Position setting).

To, adjust the balance, use the arrows on the screen.

* BALANCE function and POSITION function cannot be used simultaneously.

ION 4-SPEED

3410-01

GENERAL

1. SPECIFICATIONS

Description		Specifications	Remark
Gear ratios	1st	2.742	
	2nd	1.508	
	3rd	1.000	
	4th	0.708	
	Reverse	2.428	
	Final gear ratio	4.55	
Torque converter	Diamerter	260 (mm)	
	Number of element	3 EA	
	Number of Step	1 EA	
	Number of Phase	2 EA	
Transmission component	Planetary gear set	1 EA	
	One-way clutch	3 EA	
	Multi disc clutch	4 EA	
	Band brake	2 EA	
Weight	Including oil	76 kg	
Oil	Fluid specification	CASTROL TQ 95	
	Fluid capacity	Approx. 9.5 ℓ	
Resistance of oil temperature sensor	-20°C	13,638 ~ 17,287 Ω	
	0°C	5,177 ~ 6,616 Ω	
	20°C	2,278 ~ 2,723 Ω	
	100°C	177 ~ 196 Ω	
	135°C	75 ~ 85 Ω	
Resistance of gear position sensor	1 gear position	1.0 ~ 1.4 kΩ(1.0 V)	
	2 gear position	1.8 ~ 2.2 kΩ(1.5 V)	
	3 gear position	3.0 ~ 3.4 kΩ(2.0 V)	
	D gear position	4.5 ~ 4.9 kΩ(2.5 V)	
	N gear position	6.8 ~ 7.2 kΩ(3.0 V)	
	R gear position	10.8 ~ 11.2 kΩ(3.5 V)	
	P gear position	18.6 ~ 19.0 kΩ(4.0 V)	

2. FASTENER TIGHTENING SPECIFICATIONS

Application	Nm	Lb-Ft	Lb-Ft
Adaptor Housing to Case Bolts	30 ~ 35	22 ~ 26	-
Cam Plate to Case (Parking Pawl) Screws	16 ~ 22	12 ~ 16	-
Centre Support to Case Bolts	20 ~ 27	15 ~ 20	-
Detent Spring Screw	20 ~ 22	15 ~ 16	-
Extension Housing to Case Bolts	54 ~ 68	40 ~ 50	-
Front Propeller Shaft Bolts	70 ~ 80	52 ~ 59	-
Inhibitor Switch to Case Bolts	4 ~ 6	-	35 ~ 53
Oil Cooler Pipes	40 ~ 45	29 ~ 33	-
Oil Pan to Case Bolts	4 ~ 6	-	35 ~ 53
On/Off Solenoid valve Retainer Screws	8 ~ 12	-	71 ~ 106
Output Flange Nuts	35	26	-
Pump Cover Plate to Crescent Screw	13 ~ 16	10 ~ 12	-
Pump Cover Plate to Pump Cover Screws	13 ~ 16	10 ~ 12	-
Pump Cover to Case Bolts	24 ~ 34	18 ~ 25	-
Pump to Pump Cover Bolts	24 ~ 27	18 ~ 20	-
Rear Propeller Shaft Bolts	70 ~ 80	52 ~ 59	-
Rear Servo Cover to Case Bolts	30 ~ 35	22 ~ 26	-
TCM Mounting Bolt	10	-	89
Torque Converter Housing to Case Bolts	54 ~ 68	40 ~ 50	-
Torque Converter Mounting Bolts	42	31	-
Transfer Case to Transmission Housing Bolts	35 ~ 60	26 ~ 44	-
Transmission Filler Plug	30 ~ 35	22 ~ 26	-
Upper Valve Body to Lower Valve Body Screws	11 ~ 16	8 ~ 12	-
Valve Body To Case Bolts	8 ~ 13	-	71 ~ 115
Variable Pressure Solenoid valve (S5) Retainer Screw	8 ~ 12	-	71 ~ 106

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. DESCRIPTION AND OPERATION OF AUTOMATIC TRANSMISSION

The ION (BTR) Four Speed Automatic Transmission is an electronically controlled overdrive four speed unit with a lock-up torque converter. The lock-up torque converter results in lower engine speeds at cruise and eliminates unnecessary slippage. These features benefit the customer through improved fuel economy and noise reduction.

Of primary significance is the Transmission Control Module (TCU) which is a microprocessor based control system.

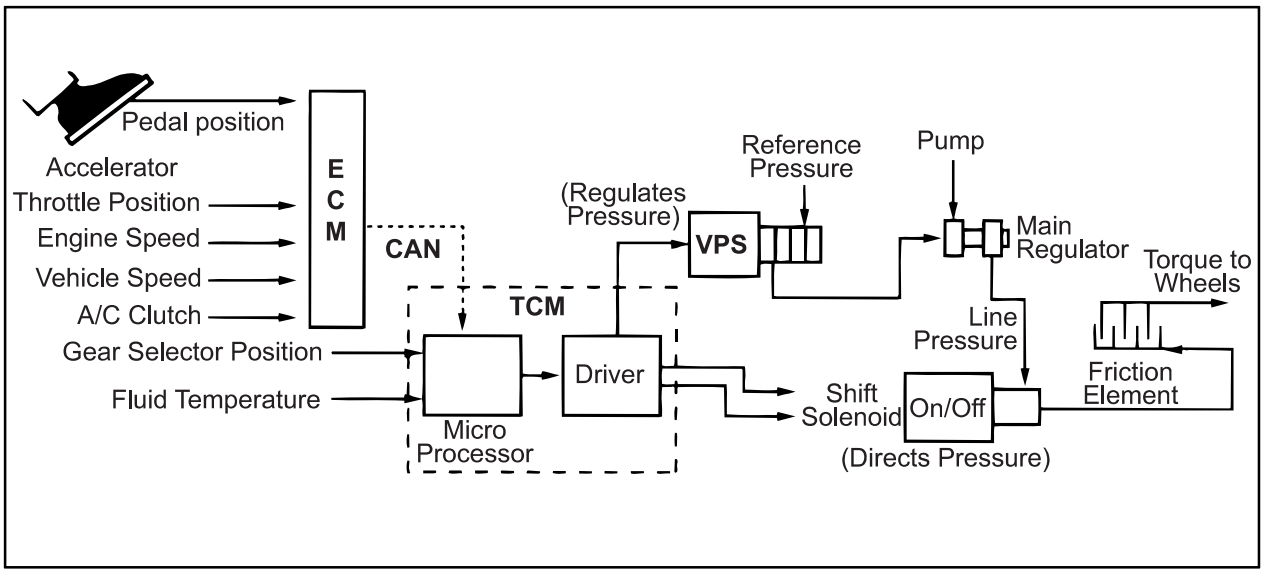
	Max. Power (kW)	Configuration
320	160	260 mm Torque Converter-Wide Ratio Gear Set Splined Output for Transfer Case

The TCU utilizes throttle position, rate of throttle opening, engine speed, vehicle speed, transmission fluid temperature, gear selector position and mode selector inputs, and in some applications a Kickdown Switch to control all shift feel and shift schedule aspects.

The TCU drives a single proportional solenoid multiplexed to three regulator valves to control all shift feel aspects. The output pressure of this solenoid is controlled as a function of transmission fluid temperature to maintain consistent shift feel throughout the operating range.

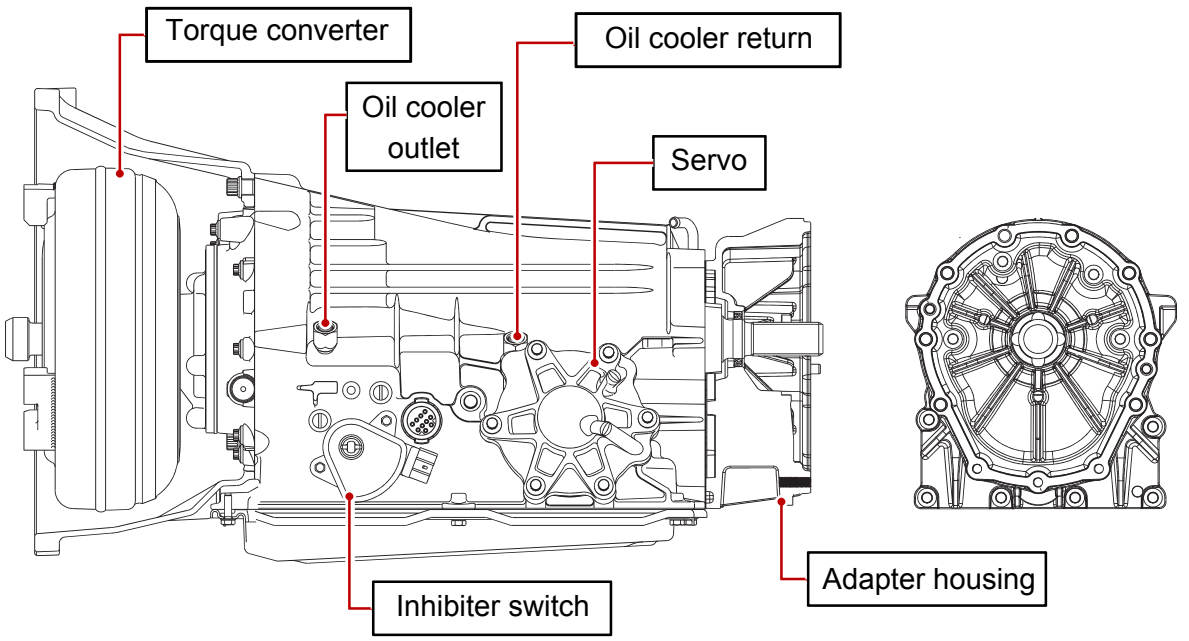
Shift scheduling is highly flexible, and several independent schedules are programmed depending on the vehicle.

Typically the NORMAL schedule is used to maximize fuel economy and driveability, and a POWER schedule is used to maximize performance. WINTER schedule is used to facilitate starting in second gear.

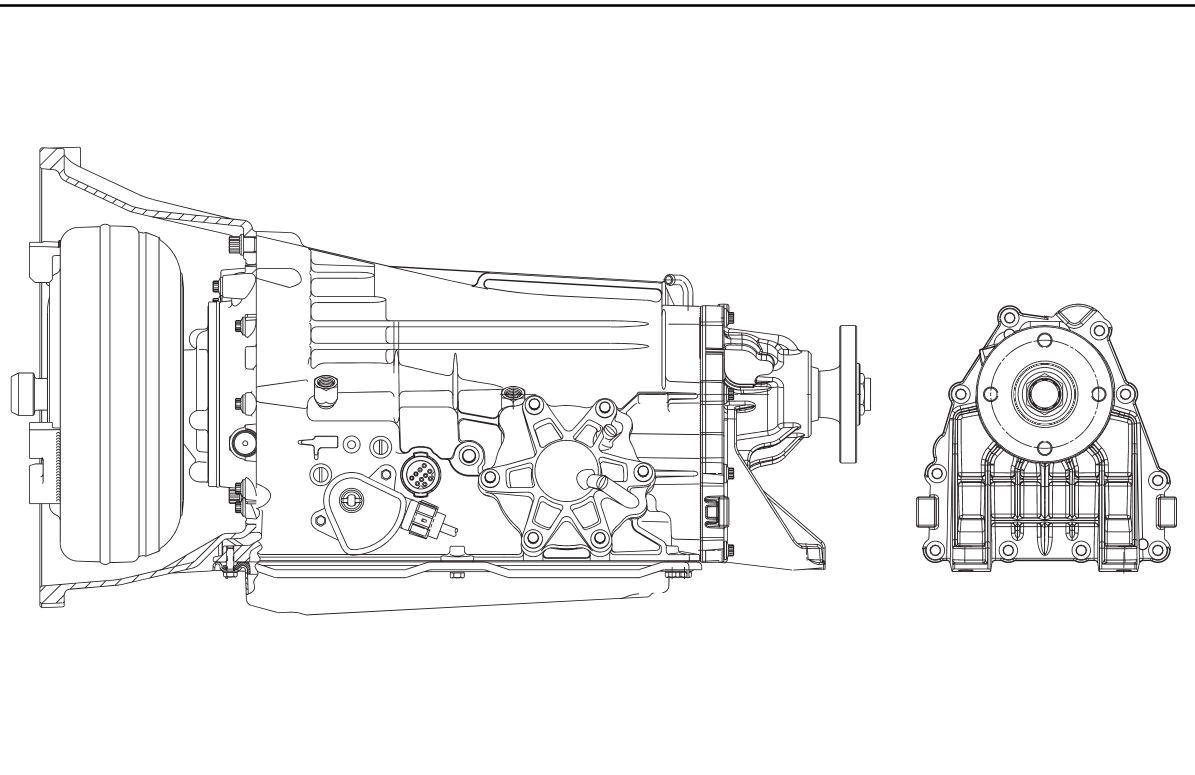


2. APPEARANCE

1) 4WD Automatic Transmission



2) 2WD Automatic Transmission



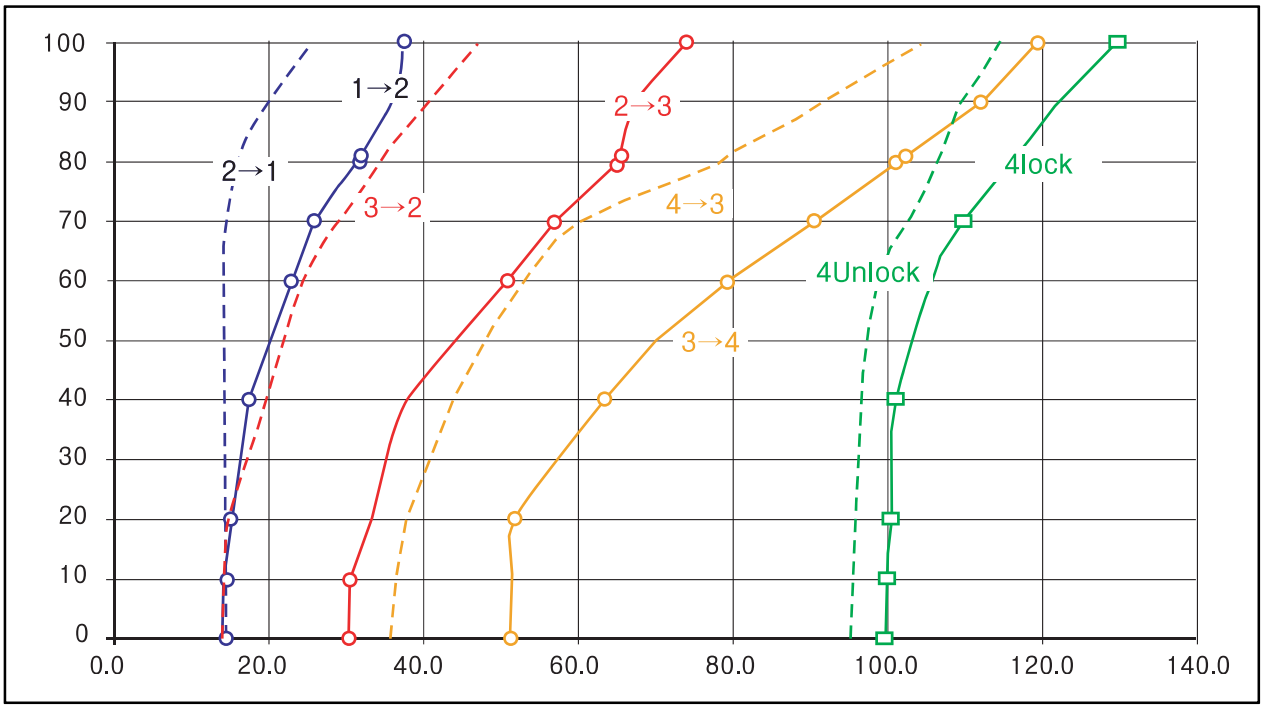
Modification basis	
Application basis	
Affected VIN	

3. SHIFT PATTERN DIAGRAM

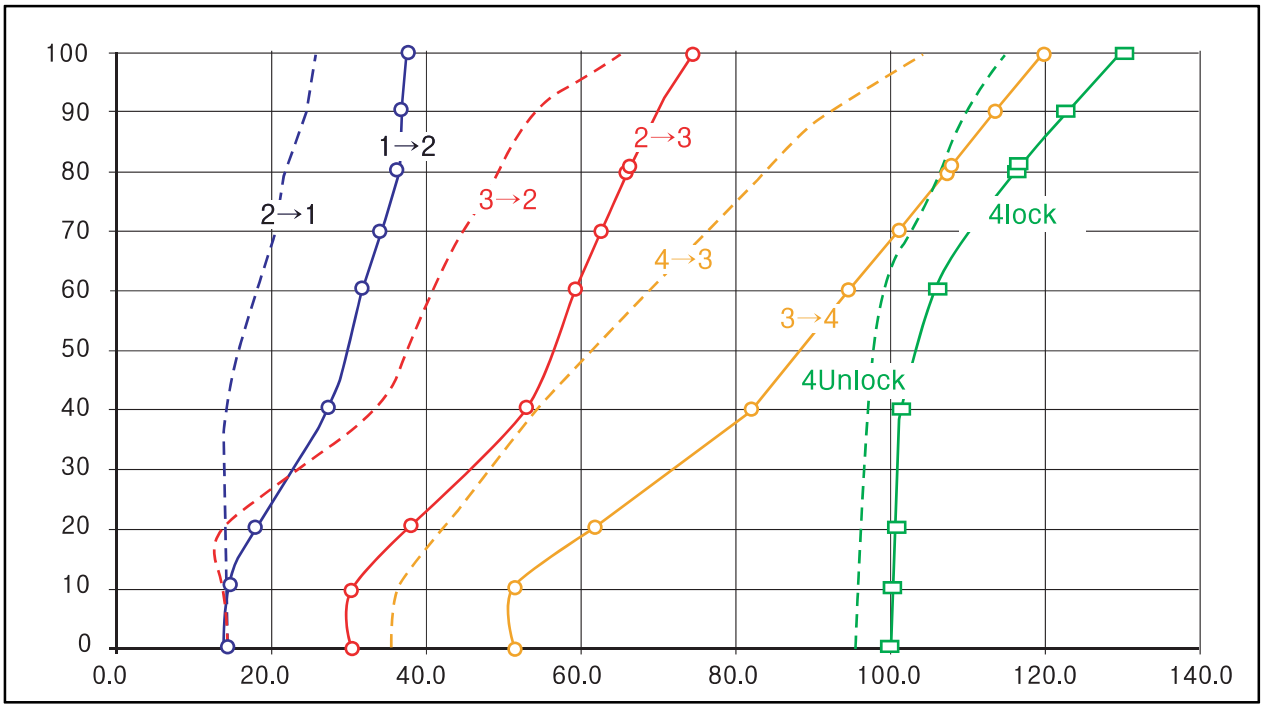
1) Normal Mode

CAUTION

- WINTER mode has same shift pattern with NORMAL mode except 2nd gear drive-off.



2) Power Mode



Modification basis	
Application basis	
Affected VIN	

4. OPERATORS INTERFACES

There are three operator interfaces as the following

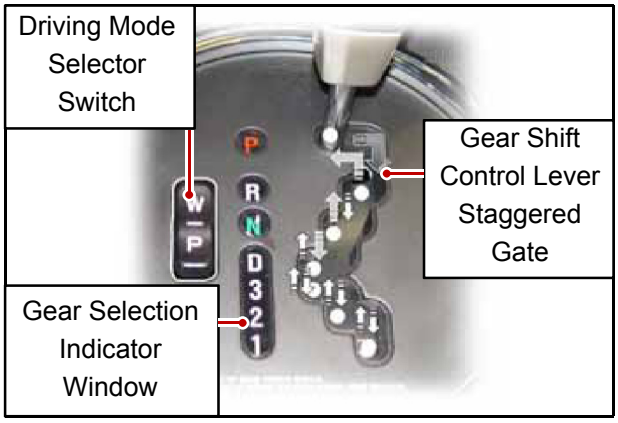
- Gear Shift Control Lever
- Driving Mode Selector
- Indicator Light

1) Gear Shift Control Lever

The transmission uses a conventional shift control lever.
The gear shift control lever can be moved from one position to another within the staggered configuration of the shift control lever gate to positively indicate the gear selection.

- P - Park position prevents the vehicle from rolling either forward or backward by locking the transmission output shaft. The inhibitor switch allows the engine to be started. For safety reasons, the parking should be used in addition to the park position. Do not select the Park position until the vehicle comes to a complete stop because it mechanically locks the output shaft.
- R - Reverse allows the vehicle to be operated in a rearward direction. The inhibitor switch enables reverse lamp operation.
- N - Neutral allows the engine to be started and operated while driving the vehicle. The inhibitor switch allows the engine to be started. There is no power transferred through the transmission in Neutral. But the final drive is not locked by the parking pawl, so thewheels are free to rotate.
- D - Overdrive range is used for all normal driving conditions. 4th gear (overdrive gear) reduces the fuel consumption and the engine noise. Engine braking is applied with reduced throttle.
  First to second (1 → 2), first to third (1 → 3), second to third (2 → 3), second to fourth (2 → 4), third to fourth (3 → 4), fourth to third (4 → 3), fourth to second (4 → 2), third to second (3 → 2), third to first (3 → 1) and second to first (2 → 1) shifts are all available as a function of vehicle speed, throttle position and the time change rate of the throttle position.
  Downshifts are available for safe passing by depressing the accelerator. Lockup clutch may be enabled in 3rd and 4th gears depending on vehicle type.
- 3 - Manual 3 provides three gear ratios (first through third) and prevents the transmission from operating in 4th gear. 3rd gear is used when driving on long hill roads or in heavy city traffic. Downshifts are available by depressing the accelerator.
- 2 - Manual 2 provides two gear ratios (first and second). It is used to provide more power when climbing hills or engine braking when driving down a steep hill or starting off on slippery roads.
- 1 - Manual 1 is used to provide the maximum engine braking when driving down the severe gradients.

Modification basis	
Application basis	
Affected VIN	



2) Driving Mode Selector

The driving mode selector consists of a driving mode selector switch and indicator light. The driving mode selector is located on the center console and allows the driver to select the driving mode.

The driving modes available to be selected vary with vehicle types. Typically the driver should have the option to select among NORMAL, POWER and WINTER modes.

When NORMAL mode is selected upshifts will occur to maximize fuel economy. When POWER mode is selected, upshifts will occur to give maximum performance and the POWER mode indicator light is switched ON.

When WINTER mode is selected, starting in second gear is facilitated, the WINTER mode indicator light is switched ON and the POWER mode indicator light is switched OFF.

3) Indicator Light

The indicator light is located on the instrument panel.

- Auto shift indicator light comes ON when the ignition switch ON and shows the gear shift control lever posi-tion.
- POWER mode indicator light comes ON when the POWER mode is selected and when the kickdown switch is depressed.
- WINTER mode indicator light comes ON when the WINTER mode is selected.

5. CONTROL SYSTEMS

BTRA M74 4WD automatic transmission consists of two control systems. One is the electronic control system that monitors vehicle parameters and adjusts the transmission performance. Another is the hydraulic control system that implements the commands of the electronic control system commands.

6. ELECTRONIC CONTROL SYSTEM

The electronic control system comprises of sensors, a TCU and seven solenoids. The TCU reads the inputs and activates the outputs according to values stored in Read Only Memory (ROM).

The TCU controls the hydraulic control system. This control is via the hydraulic valve body, which contains seven electromagnetic solenoids. Six of the seven solenoids are used to control the line pressure, operate the shift valves and the torque converter lock-up clutch, and to turn ON and OFF the two regulator valves that control the shift feel.

The seventh solenoid is the proportional or Variable Pressure Solenoid (VPS) which works with the two regulator valves to control shift feel.

1) Transmission Control Module (TCU)

The TCU is an in-vehicle micro-processor based transmission management system. It is mounted under the driver's side front seat in the vehicle cabin.

The TCU contains :

- Processing logic circuits which include a central microprocessor controller and a back-up memory system.
- Input circuits.
- Output circuits which control external devices such as the Variable Pressure Solenoid (VPS) driver, On/ Off solenoid drivers, a diagnostics output and the driving mode indicator light.

Modification basis	
Application basis	
Affected VIN	

2) Processing Logic

Shift schedule and calibration information is stored in an Erasable Programmable Read Only Memory (EPROM).

Throttle input calibration constants and the diagnostics information are stored in Electrically Erasable Programmable Read Only Memory (EEPROM) that retains the memory even when power to the TCU is disconnected.

TCU continuously monitors the input values and uses these, via the shift schedule, to determine the required gear state. At the same time it monitors, via the solenoid outputs, the current gear state, whenever the input conditions change such that the required gear state is different to the current gear state, the TCU initiates a gear shift to bring the two states back into line.

Once the TCU has determined the type of gearshift required the TCU accesses the shift logic, estimates the engine torque output, adjusts the variable pressure solenoid ramp pressure then executes the shift.

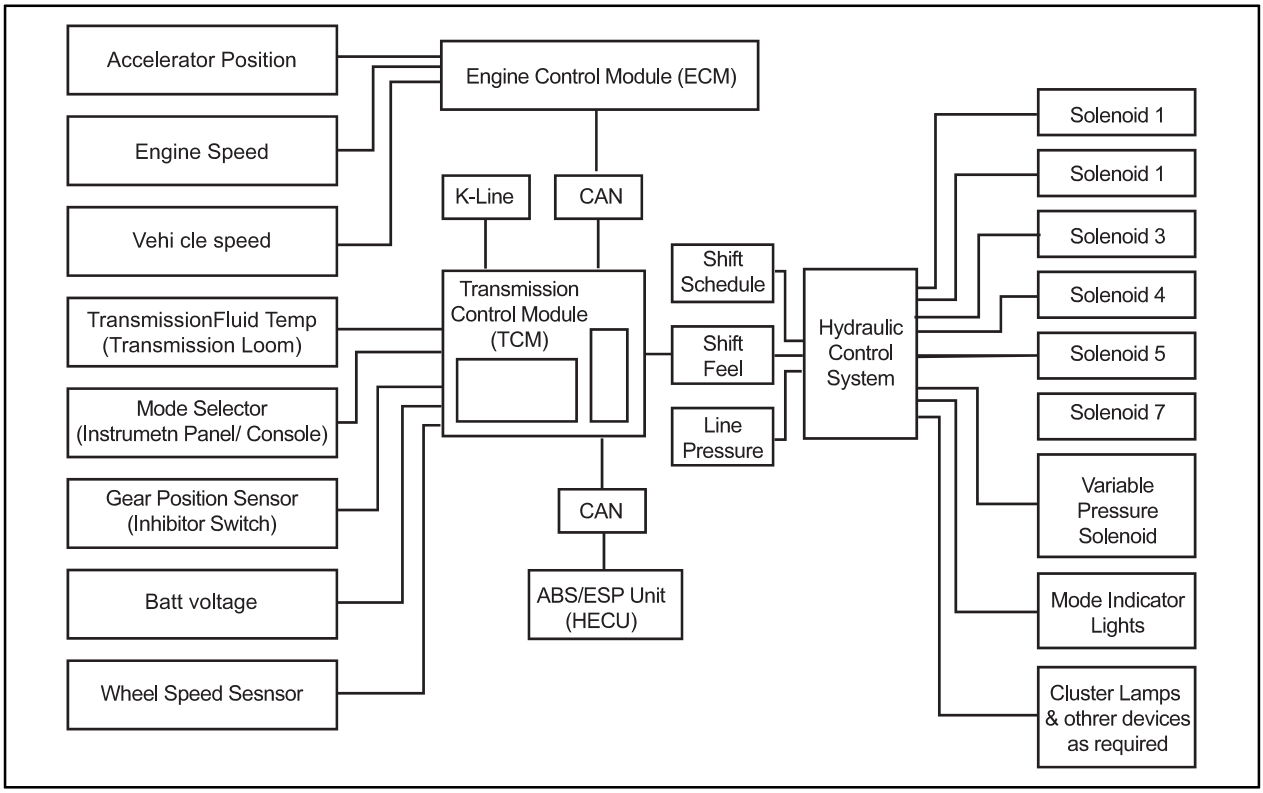
The TCU continuously monitors every input and output circuit for short or open circuits and operating range.

When a failure or abnormal operation is detected the TCU records the condition code in the diagnostics memory and implements a Limp Home Mode (LHM).

The actual limp home mode used depends upon the failure detected with the object to maintain maximum driveability without damaging the transmission. In general input failures are handled by providing a default value.

Output failures, which are capable of damaging the transmission, result in full limp mode giving only third or fourth gear and reverse. For further details of limp modes and memory retention refer to the Diagnostic Trouble Code Diagnosis Section.

The TCU is designed to operate at ambient temperatures between - 40 and 85°C (- 40 and 185°F). It is also protected against electrical noise and voltage spikes, however all the usual precautions should be observed, for example when arc welding or jump starting.



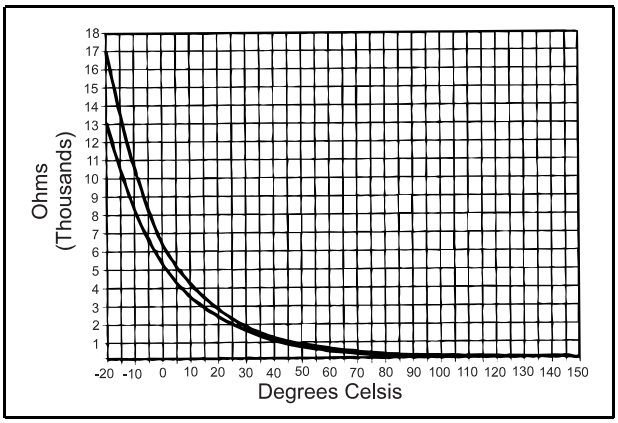
3) TCU Inputs

To function correctly, the TCU requires engine speed, vehicle speed, transmission fluid temperature, throttle position, gear position and Kickdown Switch inputs to determine the variable pressure solenoid current ramp and on/off solenoid states. This ensures the correct gear selection and shift feel for all driving conditions.

The inputs required by the TCU are as follows :

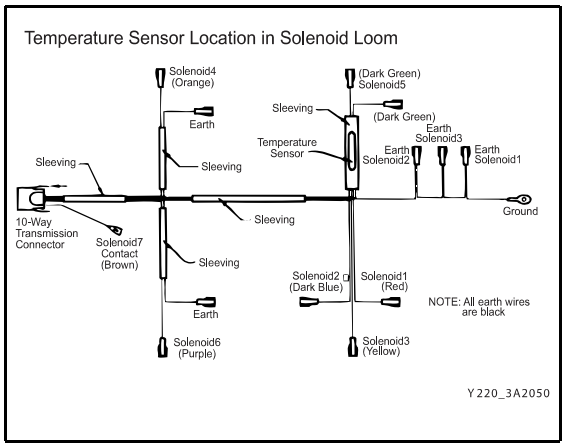
- Engine Speed The engine speed signal is derived from the Controller Area Network (CAN) via Engine Control Module (ECM).
- Vehicle Speed The vehicle speed sensor, which is located in the transfer case, sends the output shaft speed signal to the Engine Control Module (ECM). The information is then transferred to the TCU via the CAN.
- Transmission Fluid Temperature The transmission fluid temperature sensor is a thermistor located in the solenoid wiring loom within the valve body of the transmission. This sensor is a typical Negative Temperature Coefficient (NTC) resistor with low temperatures producing a high resistance and high temperatures producing a low resistance.
  If the transmission fluid temperature exceeds 135°C (275°F), the TCU will impose converter lock-up at lower vehicle speeds and in some vehicles flashes the mode indicator light. This results in maximum oil flow through the external oil cooler and eliminates slippage in the
  torque converter. Both these actions combine to reduce the oil temperature in the transmission.

Modification basis	
Application basis	
Affected VIN	



Temperature (°C)	Resistance (Ohms)	
	Minimum	Maximum
-20	13,638	17,287
0	5,177	6,616
20	2,278	2, 723
100	117	196
135 (Overheat Mode Threshold)	75	85

▶ **Pin No. Codes and colors in Solenoid Loom**

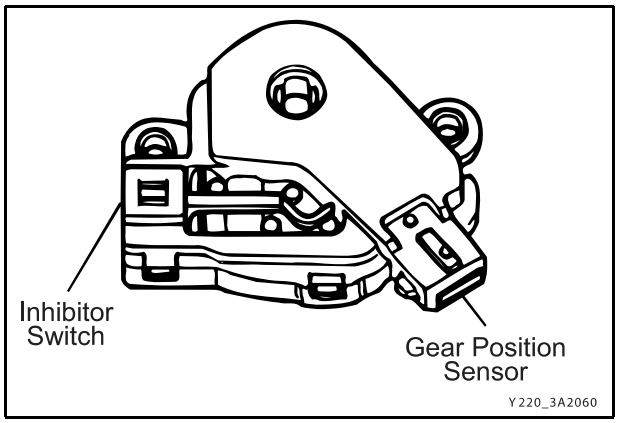


Pin No.	Wire Color	Connects to
1	Red	Solenoid 1
2	Blue	Solenoid 2
3	Yellow	Solenoid 3
4	Orange	Solenoid 4
5	Green	Solenoid 5
6	Violet	Solenoid 6
7	Brown	Solenoid 7
8	Green	Solenoid 5
9	White	Temperature Sensor
10	White	Temperature Sensor

4) Gear Position Sensor

The gear position sensor is incorporated in the inhibitor switch mounted on the side of the transmission case.

The gear position sensor is a multi-function switch providing three functions:



- Inhibit starting of the vehicle when the shift lever is in a position other than Park or Neutral
- Illuminate the reverse lamps when Reverse is selected
- Indicate to the TCU which lever position has been selected by way of a varying resistance.

Modification basis	
Application basis	
Affected VIN	

Readings for Resistance / Shift Lever Positions

Shift Lever Position	Resistance (kΩ)
Manual 1	1 ~ 1.4
Manual 2	21.8 ~ 2.2
Manual 3	3 3 ~ 3.4
Drive	4.5 ~ 4.9
Neutral	6.8 ~ 7.2
Reverse	10.8 ~ 11.2
Park	18.6 ~ 19

5) Diagnostic Inputs

The diagnostic control input or K-line is used to initiatethe outputting of diagnostic data from the TCU to a diagnostic test instrument. This input may also be used to clear the stored fault history data from the TCU's retentive memory. Connection to the diagnostic input of the TCU is via a connector included in the vehicle's wiring harness or computer interface.

6) Battery Voltage Monitoring Input

The battery voltage monitoring input is connected to the positive side of the battery. This signal is taken from the main supply to the TCU.

If the battery voltage at the TCU falls below 11.3 V, the transmission will adopt a low voltage mode of operating in which shifts into first gear are inhibited. All other shifts are allowed but may not occur because of the reduced voltage. This condition normally occurs only when the battery is in poor condition.

If the battery voltage is greater than 16.5 V, the transmission will adopt limp home mode and all solenoids are turned OFF.

When system voltage recovers, the TCU will resume normal operation after a 30 seconds delay period.

7) TCU Outputs

The outputs from the TCU are supplied to the components described below :

- Solenoids
- Mode Indicator Light

8) Solenoids

The TCU controls seven solenoids. Solenoids 1 to 6 (S1 to S6) are mounted in the valve body, while Solenoid 7 (S7) is mounted in the pump cover.

- Solenoid 1 and 2: S1 and S2 are normally open ON/ OFF solenoids that set the selected gear. These solenoids determine static gear position by operating the shift valves. Note that S1 and S2 solenoids also send signal pressure to allow or prohibit rear band engagement.
- Solenoid 3 and 4: S3 and S4 are normally open ON/ OFF solenoids that combine to control shift quality and sequencing. S3 switches the clutch regulator valve OFF or ON. S4 switches the front band regulator valve OFF or ON. S5 also provides the signal pressure for the converter clutch regulator valve.
- Solenoid 5: S5 is a variable pressure solenoid that ramps the pressure during gear changes. This solenoid provides the signal pressure to the clutch and band regulator, thereby controlling the shift pressures.
  S5 also provides the signal pressure for the converter clutch regulator valve.
- Solenoid 6: S6 is a normally open ON/OFF solenoid that sets the high/low level of line pressure. Solenoid OFF gives high pressure.
- Solenoid 7: S7 is a normally open ON/OFF solenoid that controls the application of the converter clutch.
  Solenoid ON activates the clutch.

Solenoid Logic for Static Gear States

Gear	S1	S2
1st	ON	ON
2nd	OFF	ON
3rd	OFF	OFF
4th	ON	OFF
Reverse	OFF	OFF
Neutral	OFF	OFF
Park	OFF	OFF

Modification basis	
Application basis	
Affected VIN	

▶ Solenoid Operation during Gearshifts

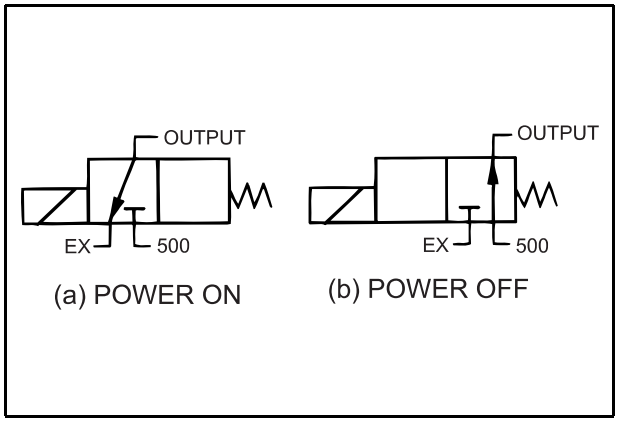
Shift	To Initiate Shift	Typical S5 Current Ramp	To Complete Shift
1-2	S1 OFF S4 ON	750 mA to 600 mA	S4 OFF
1-3	S1 OFF S2 OFF S3 ON S4 ON	850 mA to 750 mA	S3 OFF S4 OFF
1-4	S2 OFF S3 ON S4 ON	850 mA to 750 mA	S3 OFF S4 OFF
2-3	S2 OFF S3 ON S4 ON	700 mA to 500 mA	S3 OFF S4 OFF
3-4	S1 ON S4 ON	750 mA to 600 mA	S4 OFF
4-3	S4 ON	750 mA to 900 mA	S1 OFF S4 OFF
4-2	S3 ON	750 mA to 950 mA	S1 OFF S2 ON S3 OFF
4-1	S3 ON S4 ON	600 mA to 1000 mA	S2 ON S3 OFF S4 OFF
3-2	S2 ON S4 ON	600 mA to 450 mA @ 20 kph. 550 mA to 400 mA @ 60 kph. 800 mA to 650 mA @ 100 kph.	S4 OFF
3-1	S3 ON S4 ON		S1 ON S2 ON S3 OFF
2-1	S4 ON	700 mA to 950 mA 800 mA to 950 mA	S4 OFF S1 ON S4 OFF
Conv. Clutch			
ON	S7 ON	700 mA to 400 mA	S7 OFF
OFF		600 mA to 100 mA	

▶ Solenoid valve symbols (ON/OFF solenoids)

The solenoid symbol shown adjacent to each solenoid on the hydraulic system schematics indicates the state of the oil flow through the solenoid valve with the power ON or OFF.

▶ Normally open (NO) solenoid

POWER ON: Line 500 port is closed. The output port is open to exhaust at the solenoid valve.
POWER OFF: The exhaust port is closed. The output port is open to line 500.



▶ Variable pressure solenoid multiplexing system

Friction element shifting pressures are controlled by the Variable Pressure Solenoid (VPS).
Line pressure is completely independent of shift pressure and is a function of throttle position, gear state and engine speed.
S5 is a proportional or variable pressure solenoid that provides the signal pressure to the clutch and band regulator valves thereby controlling shift pressures.
VPS pressure is multiplexed to the clutch regulator valve, the band regulator valve and the converter clutch regulator valve during automatic gearshifts.
A variable pressure solenoid produces a hydraulic pressure inversely proportional to the current applied. During a gearshift the TCU applies a progressively increasing or decreasing (ramped) current to the solenoid. Current applied will vary between a minimum oaf 200 mA and a maximum of 1000 mA. Increasing current decreases output (S5) pressure. Decreasing current increases output (S5) pressure.
Line 500 pressure, (approximately 440 to 560 kPa), is the reference pressure for the VPS, and the VPS output pressure is always below line 500 pressure.

Modification basis	
Application basis	
Affected VIN	

When the VPS is at standby, that is no gearshift is taking place, the VPS current is set to 200 mA giving maximum output pressure.
Under steady state conditions the band and clutch regulator valve solenoids are switched OFF. This applies full Line 500 pressure to the plunger and because Line 500 pressure is always greater than S5 pressure it squeezes the S5 oil out between the regulator valve and the plunger. The friction elements are then fed oil pressure equal to Line 500 multiplied by the amplification ratio.
When a shift is initiated the required ON/OFF solenoid is switched ON cutting the supply of Line 500 to the plunger.
At the same time the VPS pressure is reduced to the ramp start value and assumes control of the regulator valve by pushing the plunger away from the valve. The VPS then carries out the required pressure ramp and the timed shift is completed by switching OFF the ON/ OFF solenoid and returning the VPS to the standby pressure.
This system enables either the band or clutch or both to be electrically controlled for each gearshift.

▶ **Mode indicator light**

Depending on the application, the mode indicator light may be used to indicate the mode that has been selected or if an overheat condition exists. The mode indicator light is usually located on the instrument cluster.

9) Communication Systems

(1) CAN

The Controller Area Network (CAN) connects various control modules by using a twisted pair of wires, to share common information. This results in a reduction of sensors and wiring. TCU obtains the actual engine speed and throttle position, vehicle speed and accelerator position etc. from ECM via CAN without any additional sensors.

(2) K-Line

The K-line is typically used for obtaining diagnostic information from the TCU. A scan tool with a special interface is connected to the TCU via Data Link Connector (DLC) and all current faults, stored faults, runtime parameters are then available. The stored trouble codes can also be cleared by scan tool.
The K-line can be used for vehicle coding at the manufacturer's plant or in the workshop. This allows for one TCU design to be used over different vehicle mod-els.
The particular code is sent to the microprocessor via the K-line and this results in the software selecting the correct shift and VPS ramp parameters.

7. HYDRAULIC CONTROL SYSTEM

The hydraulic controls are located in the valve body, pump body and main case.

The valve body contains the following :

- Manual valve
- Three shift valves
- Sequence valve
- Solenoid supply pressure regulator valve
- Line pressure control valve
- Clutch apply feed regulator valve
- Band apply feed regulator valve
- Solenoid S1 to S6
- Reverse lockout valve

The pump cover contains the following :

- Primary regulator valve for line pressure
- Converter clutch regulator valve
- Converter clutch control valve
- Solenoid S7

The main case contains the following :

- B1R exhaust valve

All upshifts are accomplished by simultaneously switching on a shift valve(s), switching VPS pressure to the band and/or clutch regulator valve, and then sending the VPS a ramped current. The shift is completed by switching the regulators OFF and at the same time causing the VPS to reach maximum pressure.

All downshifts are accomplished by switching VPS pressure to the band and/or clutch regulator valve and sending a ramped current to the VPS. The shift is completed by simultaneously switching the regulators OFF, switching the shift valves and at the same time causing the VPS to return to stand-by pressure.

The primary regulator valve is located in the pump cover and supplies four line pressures; high and low for forward gears, and high and low for reverse. This pressure has no effect on shift quality and merely provides static clutch capacity during steady state operation. Low pressure can be obtained by activating an ON/OFF solenoid with high line pressure being the default mode.

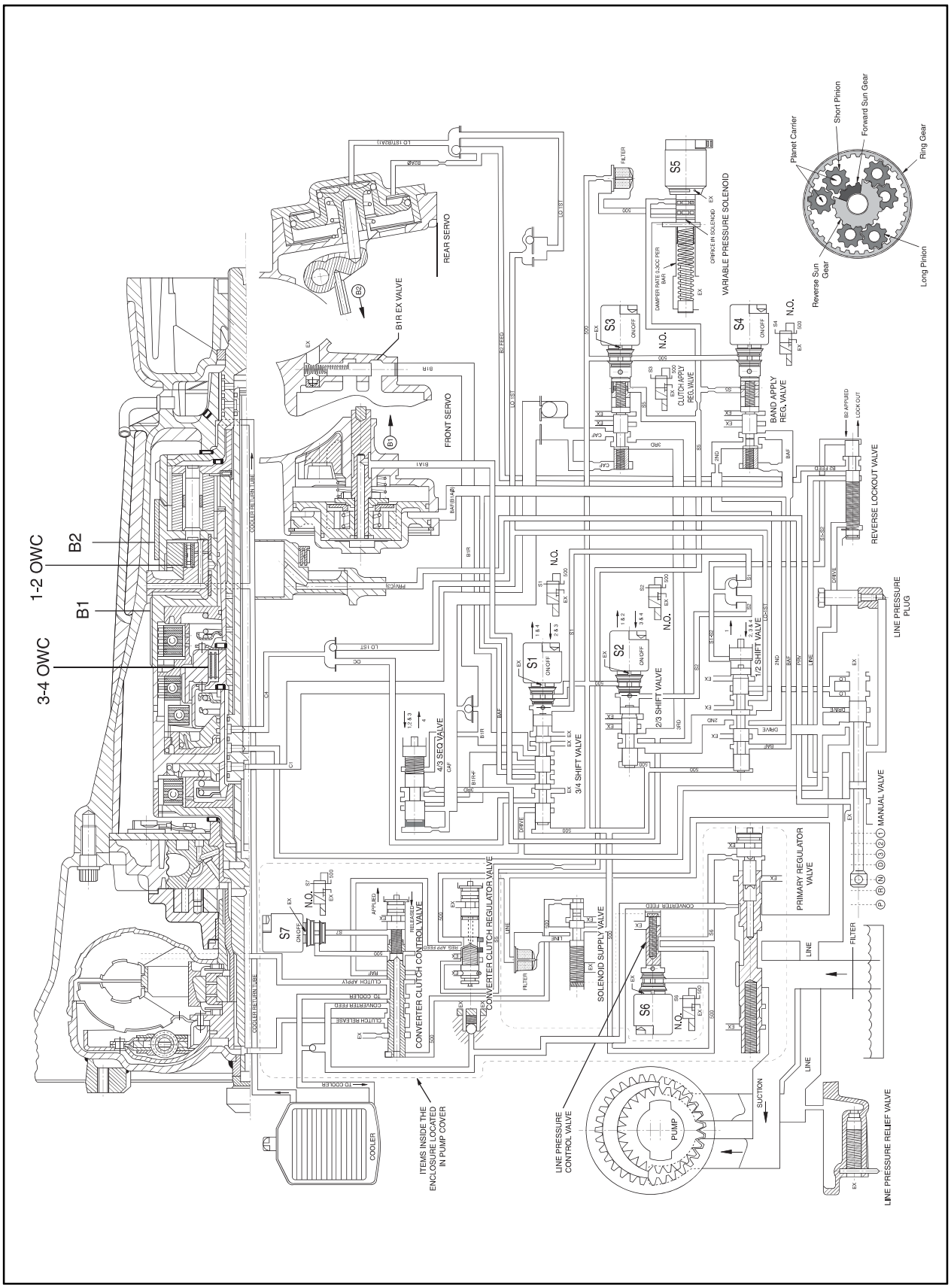
Torque converter lock-up is initiated by toggling the converter clutch control valve with an ON/OFF solenoid.

The actual apply and release of the clutch is regulated by the VPS via the converter clutch regulator valve.

The solenoid supply pressure regulator valve provides reference pressure for all the solenoids.

Modification basis	
Application basis	
Affected VIN	

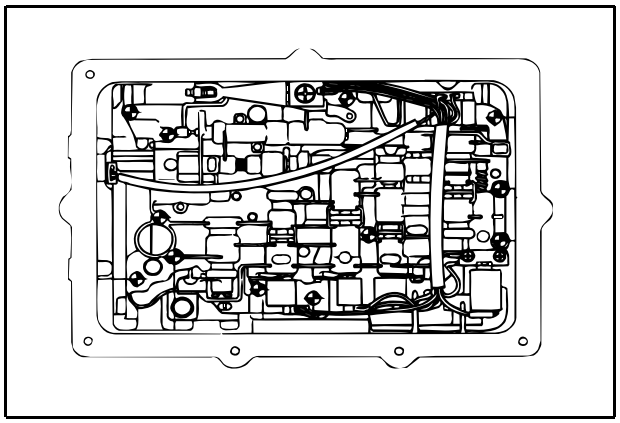
1) Hydraulic Control Circuit

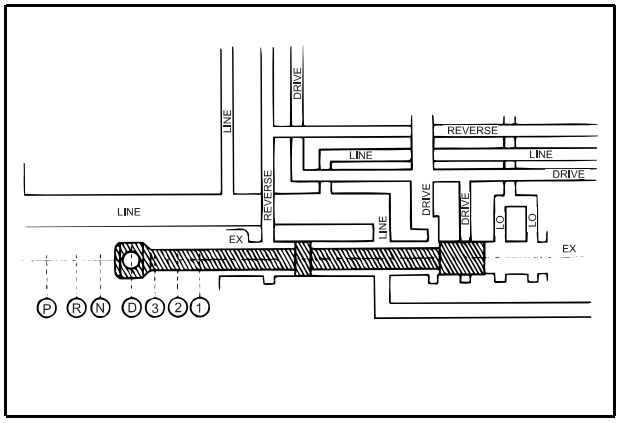


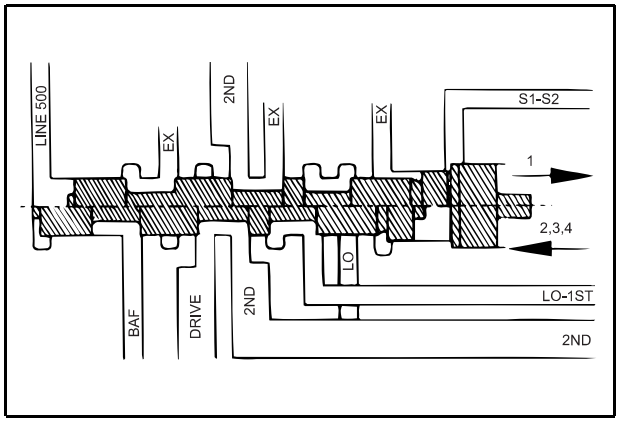
Modification basis	
Application basis	
Affected VIN	

2) Hydraulic Components

(1) Valve Body







▶ Manual valve

The manual valve is connected to the vehicle selector mechanism and controls the flow of oil to the forward and reverse circuits. The manual valve function is identical in all forward gear positions except that in the Manual 1 position an additional supply of oil is directed to the 1- 2 shift valve for application of the rear band and the C4 overrun clutch. The manual valve directs the line pressure into the PRND fluid circuits.

▶ 1-2 shift valve

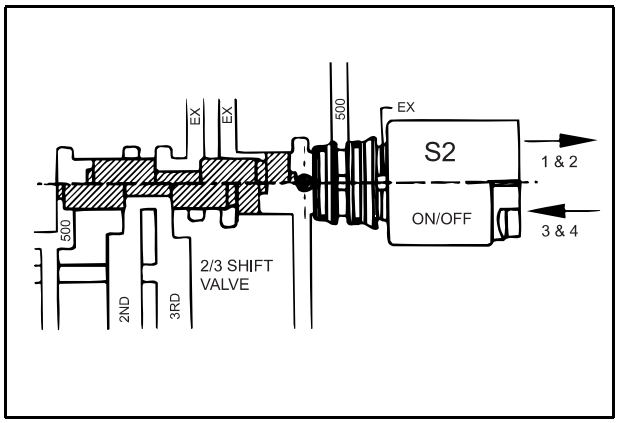
The 1-2 shift valve is a two position valve that must be switched to the 2, 3 and 4 position in order to get any forward gear other than first gear. It is used for all 1-2 and 2-1 gearshifts.

The switching of this valve is achieved by using S1 and/ or S2.

During a 1-2 gearshift drive oil from the manual valve passes through to the second gear circuit. During a 2-1 gearshift the band apply feed oil is allowed to exhaust via the 1-2 shift valve.

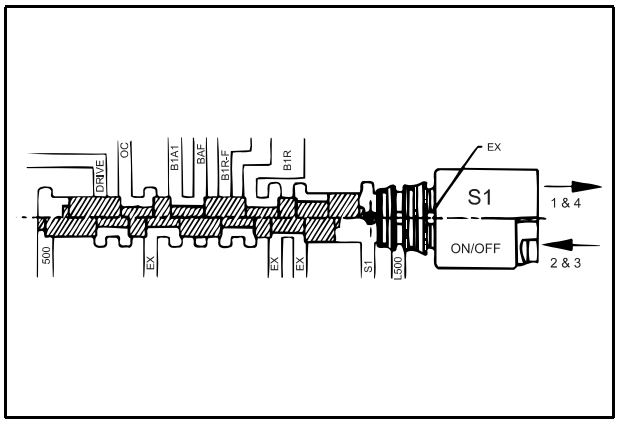
The 1-2 shift valve works in conjunction with the 3-4 shift valve to disengage the C4 clutch in first gear, and engage C4 in second gear. When Manual 1 is selected the C4 clutch and rear band (B2) are engaged.

Modification basis	
Application basis	
Affected VIN	



▶ 2-3 shift valve

The 2-3 shift valve is a two position valve. It is used on all 2-3 and 3-2 gearshifts.
The switching of this valve is achieved by S2 which is located at the end of the valve spool.
In the 1, 2 position, second gear oil from the 1-2 shift valve is prevented from entering the third gear circuit.
When the valve is moved to the 3, 4 position, oil from the second gear circuit is routed to the third gear circuit and the transmission is changed to third gear.



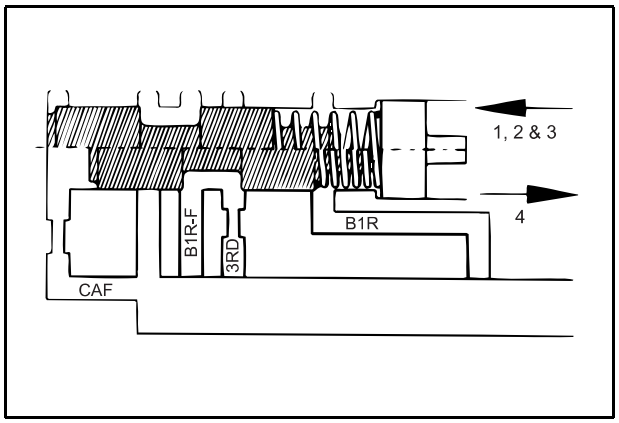
▶ 3-4 shift valve

The 3-4 shift valve is a two position valve. It is used for all 3-4 and 4-3 gearshifts.
The switching of this valve is achieved by S1 which is located at the end of the valve spool.

During a 3-4 gearshift the 3-4 shift valve:

- Exhausts the front band release (B1R) circuit thereby allowing the application of the front band (B1).
- Connects the inner apply area of the front servo (B1AI) to the Band Apply Feed (BAF) circuit thus allowing greater apply forces to the front band.
- Exhausts the Overrun Clutch (OC) circuit which allows the C4 clutch to disengage.

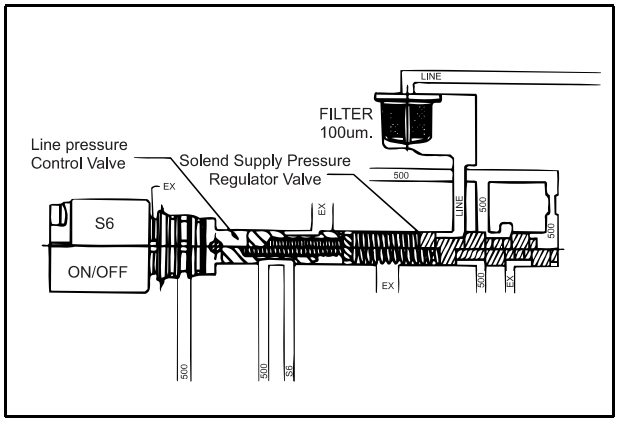
During a 4-3 gearshift, the C4 clutch is engaged and the front band (B1) is released. These actions are sequenced by the 4-3 sequence valve.
The 3-4 shift valve also switches during 1-2 and 2-1 gearshifts where its function is to apply the overrun clutch (C4) in second gear but to release it in first gear.
Note that the C4 clutch is applied in Manual 1 by virtue of the manual valve and the 1-2 hift valve. Refer to "1-2 Shift Valve" in this section.



▶ 4-3 sequence valve

The 4-3 sequence valve is a two position spring loaded valve. It switches during 3-4 and 4-3 gearshifts although it performs no function during the 3-4 shift.

During the 4-3 shift the 4-3 sequence valve delays the connection of the Clutch Apply Feed (CAF) circuit to the B1R circuit until the B1R circuit has been fully pressurized by using the third gear circuit. This prevents objectionable engine flare on completion of the 4-3 gearshift.



▶ Solenoid supply pressure regulator valve

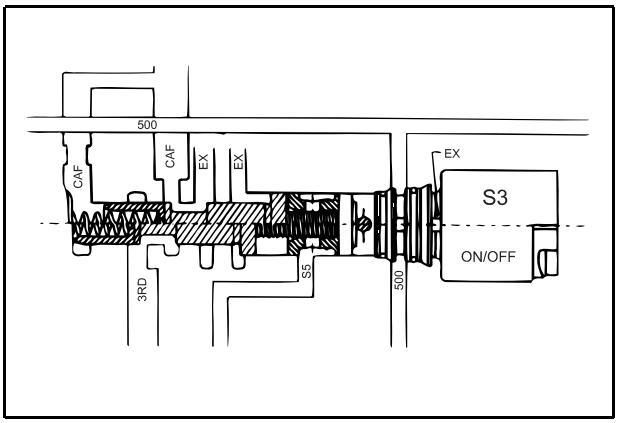
The solenoid supply pressure regulator valve supplies a constant pressure to all solenoids (S1 to S7). Line pressure is used as the feeding oil to this regulator and the output is termed line 500.

▶ Line pressure control valve

Line pressure is controlled by S6, which acts as the line pressure control valve. When S6 pressure is applied to the end of the Primary Regulator Valve (PRV), it is opposed by spring force and causes LOW line pressure for light throttle application and cruising.

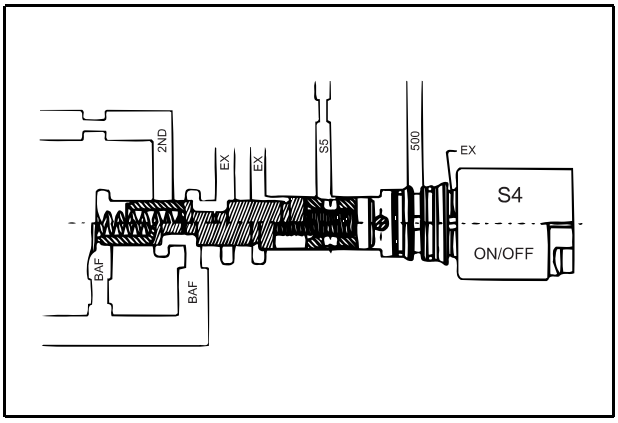
Heavy throttle application causes the normally open S6 to open (switch Off) thus closing line 500 and opening S6 to exhaust. Removal of S6 pressure from the PRV results in HIGH line pressure.

Modification basis	
Application basis	
Affected VIN	



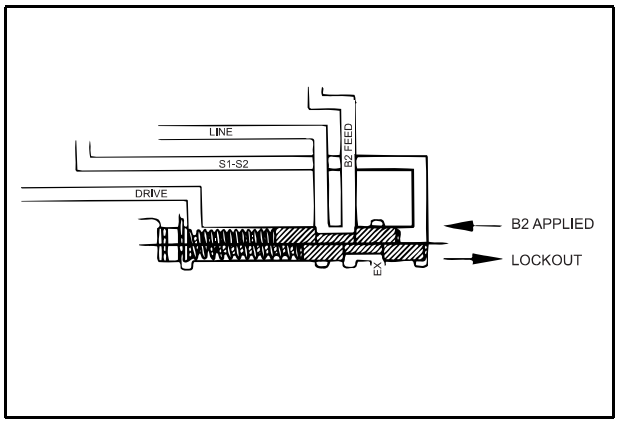
▶ Clutch apply feed regulator valve

The clutch apply feed regulator valve is a fixed ratio (2.25:1) valve. This valve provides a regulated pressure to the C1 clutch and controls the change rate of the clutch state to give the desired shift quality.
Third gear oil supplied to the valve is regulated to provide an output pressure, Clutch Apply Feed (CAF) pressure, of 2.25 times the S5 signal pressure when S3 is ON. When S3 is OFF, the output pressure is 2.25 times the line 500 pressure.



▶ Band apply feed regulator valve

The band apply feed regulator valve is a fixed ratio (1.4:1) valve. It provides a regulated pressure to the front servo, and controls the change rate of the front band (B1) state to give the desired shift quality.
Second gear oil supplied to the valve is regulated to provide an output pressure, Band Apply Feed (BAF) pressure, of 1.4 times the S5 signal pressure when S4 is ON. When S4 is OFF the output pressure is 1.4 times the line 500 pressure.



▶ Reverse lockout valve

The reverse lockout valve is a two position valve contained in the upper valve body. This valve uses S1-S2 pressure as a signal pressure and controls the application of the rear band (B2).

While the manual valve is in D, 3, 2 or 1 positions, drive oil is applied to the spring end of the valve, overriding any signal pressures and holding the valve in the lockout position. This prevents the application of B2 in any of the forward driving gears except M1.

When the manual valve is in P, R or N positions, drive oil is exhausted and the reverse lockout valve may be toggled by S1-S2 pressure.

B2 is applied in P, R, and N if the following conditions are satisfied :

- In P or N, vehicle speed = 3 km/h.
- In R, vehicle speed = 10 km/h.
- Engine speed = 1600 rpm.
- Throttle position = 12 %.

Under these conditions, the TCU switches solenoids S1 and S2 to OFF. The reverse lockout valve toggles under the influence of the S1-S2 pressure, to connect the line pressure to the B2 feed. Oil is fed to both the inner and outer apply areas of the rear servo piston, applying B2.

If any of the above conditions are not satisfied, the TCU switches solenoids S1 and S2 to ON.

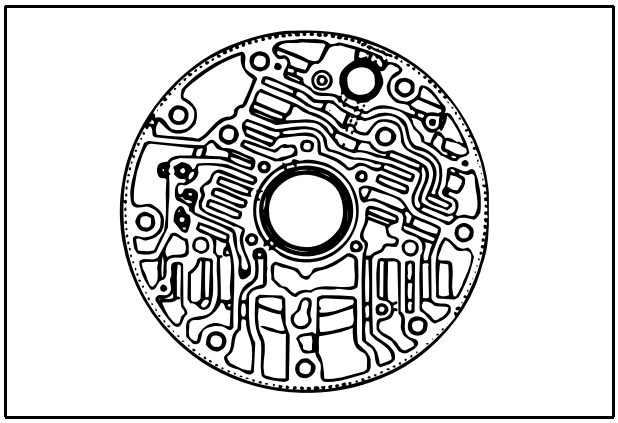
S1- S2 pressure is exhausted and the valve is held in the lockout position by the spring. In this position, engagement of B2 is prohibited.

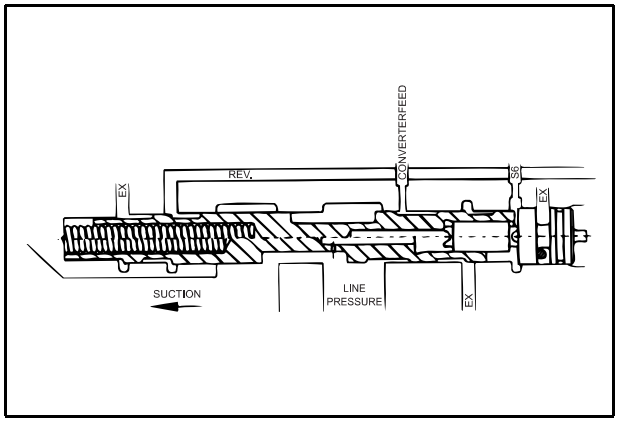
This feature protects the transmission from abuse by preventing the undesirable application of B2 at high speed, and by providing a reverse lockout function.

Note that if the transmission is in failure mode, the rear band will be applied at all times in P, R and N.

Modification basis	
Application basis	
Affected VIN	

(2) Pump cover





▶ Primary regulator valve

The Primary Regulator Valve (PRV) regulates the transmission line pressure (or pump output pressure). This valve gives either high or low line pressure depending on whether S6 is switched OFF or ON. When S6 is switched ON, S6 pressure is applied to the PRV moving it against spring pressure and opening the line pressure circuit to the pump suction port resulting in reduced line pressure.

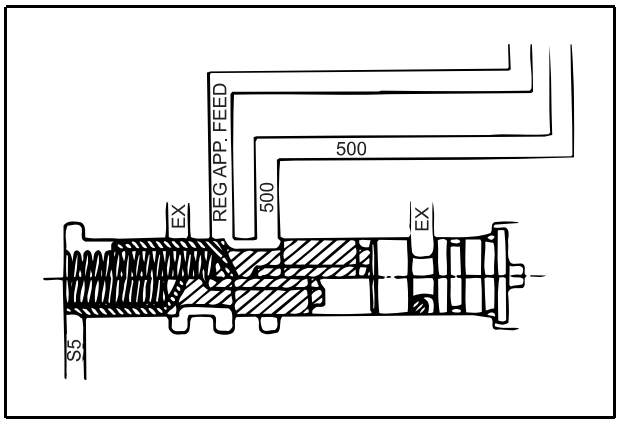
Low line pressure is used during light throttle applications and cruising. Heavy throttle will cause S6 to switch OFF and thereby cause high line pressure.

This stepped line pressure control has no detrimental effect on shift feel because all shifting pressures are controlled by separate band and clutch regulator valves, and the output of S5.

When reverse gear is selected, both the low and high line pressure values are boosted to guard against slippage.

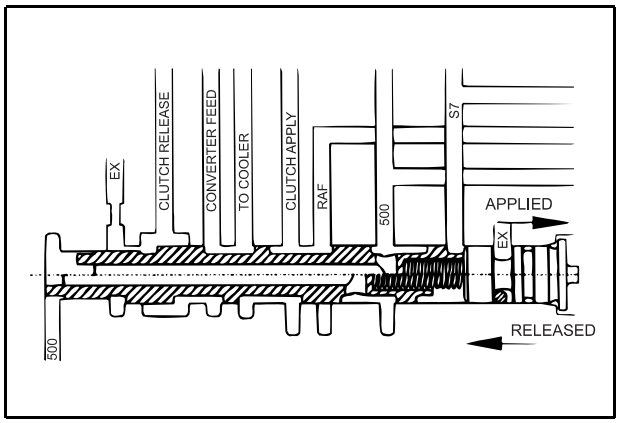
This is achieved by applying reverse oil line pressure to the PRV to assist the spring load. The other end of the valve contains ports for line pressure feedback and S6 pressure.

The PRV also regulates the supply of oil to the converter via the converter feed port. The cascade effect of the PRV ensures the first priority of the valve is to maintain line pressure at very low engine speeds. When the engine speed increases and the pump supplies an excess of oil the PRV moves to uncover the converter feed port thereby pressurizing the converter. If there is an excess of oil for the transmission's needs then the PRV moves further to allow oil to return to the suction port.



▶ Converter clutch regulator valve

The converter clutch regulator valve regulates the pressure of the oil which applies the converter clutch. Input oil from the line 500 circuit is regulated within the valve, with the output pressure being variable according to the signal pressure from the S5 circuit. Converter clutch apply and release application is smoothed by electronically varying the S5 circuit pressure.



▶ Converter clutch control valve

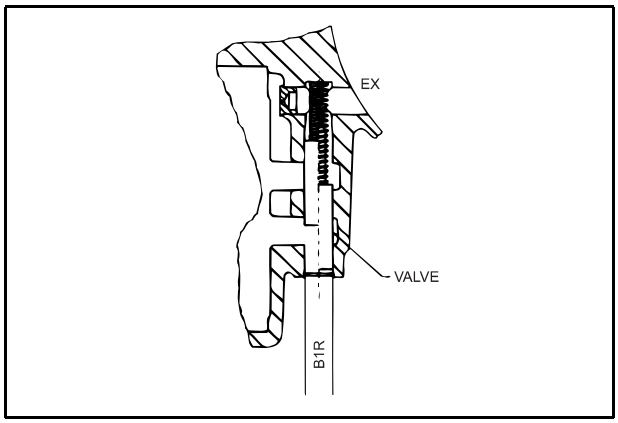
The converter clutch control valve is a two position valve which applies or releases the converter clutch.

The switching of this valve is governed by the signal pressure from S7.

When the valve is in the OFF or released position, converter feed oil from the PRV is directed to the release side of the converter clutch. After flowing through the converter, oil returns to the converter clutch control valve and is then directed to the oil cooler.

When the valve is in the ON or applied position, regulated oil from the converter clutch regulator valve is directed to the apply side of the converter clutch. This oil remains within the converter because the converter clutch piston is sealed against the flat friction surface of the converter cover. To provide oil flow to the cooler the converter clutch control valve directs converter feed oil from the PRV directly to the cooler circuit.

Modification basis	
Application basis	
Affected VIN	



▶ B1R exhaust valve

The B1R exhaust valve is a two position spring loaded valve located in the transmission case directly adjacent to the front servo. It permits the servo release oil to be rapidly exhausted into the transmission case during application of the front band (B1). This prevents the needto force the oil back from the front servo through the valve body and through the 3-4 shift valve. The spring positions the valve to prevent oil entering the release area of the servo until the B1R circuit oil pressure reaches approximately 100 kPa.

(3) Power train system

The Power Train System consists of :

- A torque converter with single face lock-up clutch
- Four multi-plate clutch assemblies
- Two brake bands
- Two one-way clutches
- Planetary gear set
- Parking mechanism

A conventional six pinion Ravigneaux compound planetary gear set is used with overdrive (fourth gear) being obtained by driving the carrier.
The cross-sectional arrangement is very modular in nature.
Four main sub-assemblies are installed within the case to complete the build.

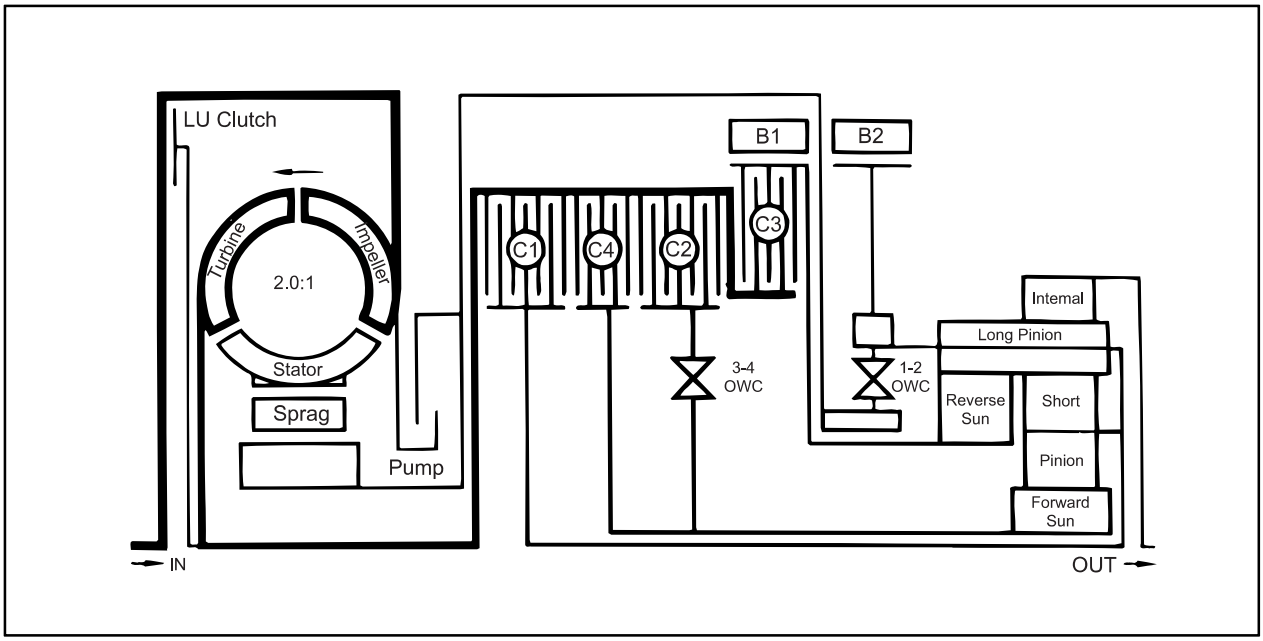
These subassemblies are :

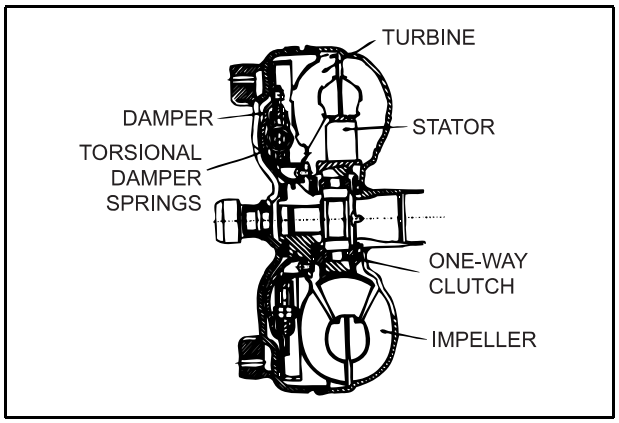
- Gear set-sprag-centre support
- C1 -C2 -C3 -C4 clutch sub-assembly
- Pump assembly
- Valve body assembly

One, or a combination of selective washers are used between the input shaft flange and the number 4 bearing to control the transmission end float. This arrangement allows for extensive subassembly testing and simplistic final assembly during production.
A general description of the operation of the Power Train System is detailed below.
First gear is engaged by applying the C2 clutch and locking the 1-2 One Way Clutch (1-2 OWC). The 1-2 shift is accomplished by applying the B1 band and overrunning the 1-2 OWC. The 2-3 shift is accomplished by applying the C1 clutch and releasing the B1 band. The 3-4 shift is accomplished by re-applying the B1 band and overrunning the 3-4 OWC. Reverse gear is engaged by applying the C3 clutch and the B2 band.
The C4 clutch is applied in the Manual 1, 2 and 3 ranges to provide engine braking. In addition, the C4 clutch is also applied in the Drive range for second and third gears to eliminate objectionable freewheel coasting.
The B2 band is also applied in the Manual 1 range to accomplish the low-overrun shift.
Both the front and rear servos are dual area designs to allow accurate friction element matching without the need for secondary regulator valves. All the friction elements have been designed to provide low shift energies and high static capacities when used with the new low static co-efficient transmission fluids. Non-asbestos friction materials are used throughout.

Modification basis	
Application basis	
Affected VIN	

ELEMENTS ENGAGED										
Gear	Gear Ratio	C1	C2	C3	C4	B1	B2	1-2 OWC	3-4 OWC	LU CLUTCH
First	2.741		X					X	X	
Second	1.508		X			X			X	
Third	1.000	X	X		X				X	
Fourth	0.708	X	X		X	X				X
Reverse	2.428			X			X			
Manual 1	2.741		X		X		X		X	





▶ Torque converter

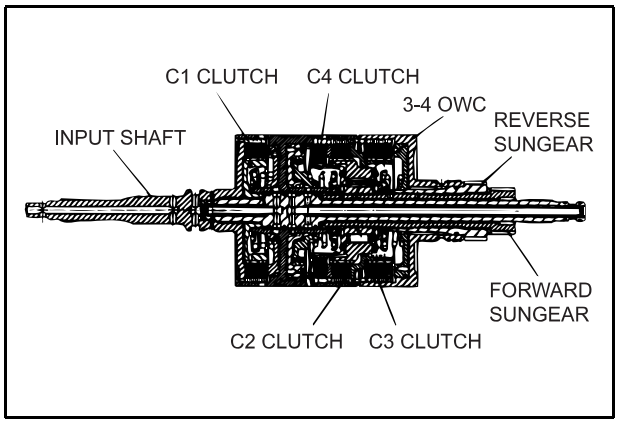
The torque converter consists of a turbine, stator pump, impeller and a lock-up damper and piston assembly. As in conventional torque converters, the impeller is attached to the converter cover, the turbine is splined to the input shaft and the stator is mounted on the pump housing via a one way clutch (sprag).

The addition of the damper and piston assembly en-ables the torque converter to lock-up under favorable conditions.

Lock-up is only permitted to occur in third and fourth gears under specified throttle and vehicle speed conditions.

Lock-up is achieved by applying hydraulic pressure to the damper and piston assembly which couples the turbine to the converter cover, locking-up the converter and eliminating unwanted slippage. Whenever lock-up occurs, improved fuel consumption is achieved. Torsional damper springs are provided in the damper and piston assembly to absorb any engine torque fluctuations during lock-up.

Modification basis	
Application basis	
Affected VIN	



▶ Clutch packs

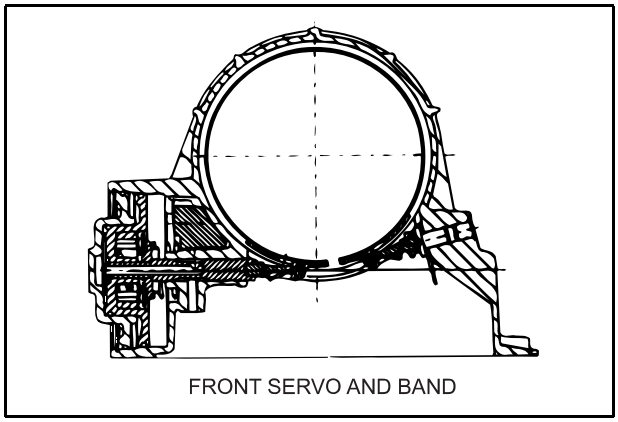
There are four clutch packs. All clutch packs are composed of multiple steel and friction plates.

C1 CLUTCH: When applied, this clutch pack allows the input shaft to drive the planet carrier. This occurs in third and fourth gears.

C2 CLUTCH: When applied this clutch pack allows the input shaft to drive the forward sun gear via the 3-4 OWC.
This occurs in all forward gears.

C3 CLUTCH: When applied this clutch pack allows the input shaft to drive the reverse sun gear. This only occurs in reverse gear.

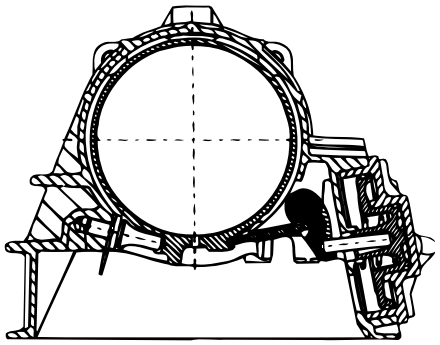
C4 CLUTCH: When applied this clutch provides engine braking on overrun. This occurs in Manual 1, 2 and 3 and also Drive 2 and Drive 3 to prevent objectionable free wheel coasting.


FRONT SERVO AND BAND

▶ Bands

The transmission utilizes two bands, the B1 band (sometimes known as the 2-4 band), and the B2 band (sometimes known as the low-reverse band).

The B1 band is a flexible band which is engaged by the front servo piston. B1 is activated in second and fourth gear. When activated B1 prevents the reverse sun gear from rotating by holding the C3 clutch assembly stationary. In second gear only the outer area of the apply piston is utilized. In fourth gear both areas are utilized for greater clamping force.



REAR SERVO AND BAND

▶ One way clutches

The transmission uses two OWCs, the 1-2 OWC and the 3-4 OWC. (Note that a third OWC is located in the torque converter, also known as a sprag.)

The 1-2 OWC is located between the planetary carrier assembly and the center support. This allows the carrier to rotate around the center support in one direction only. The one way clutch is engaged only in Drive 1.

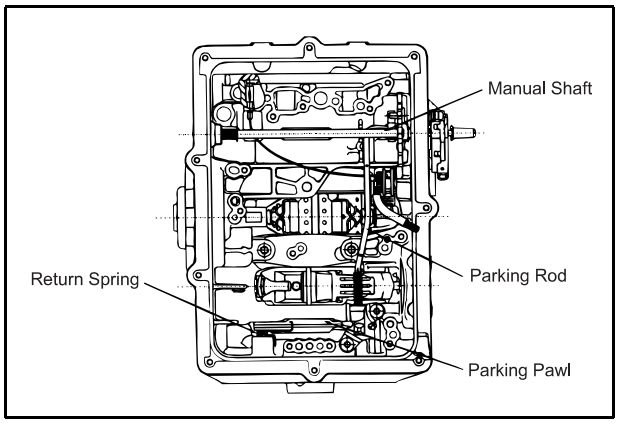
This 3-4 OWC is located between the C4 and the C2 clutch assemblies. This allows the C2 clutch to drive the forward sun gear in first, second and third gears but unlocks in fourth gear and during overrun.

The B2 band is a solid band which is engaged by the rear servo piston. B2 is activated in Park, Reverse, Neutral and Manual 1. When activated B2 prevents the planet carrier assembly from rotating. In Manual 1 only the inner area of the apply piston is utilized. In Park, Reverse and Neutral, both areas are utilized for greater clamping force.

▶ Planetary gear set

The planetary gear set used in the transmission is a conventional six pinion Ravigneaux compound gear set.

Modification basis	
Application basis	
Affected VIN	



▶ Parking mechanism

When Park is selected the manual lever extends the park rod rearwards to engage the parking pawl. The pawl will engage the external teeth on the ring gear thus locking the output shaft to the transmission case. When Park is not selected a return spring holds the parking pawl clear of the output shaft, preventing accidental engagement of Park.

8. POWER FLOWS

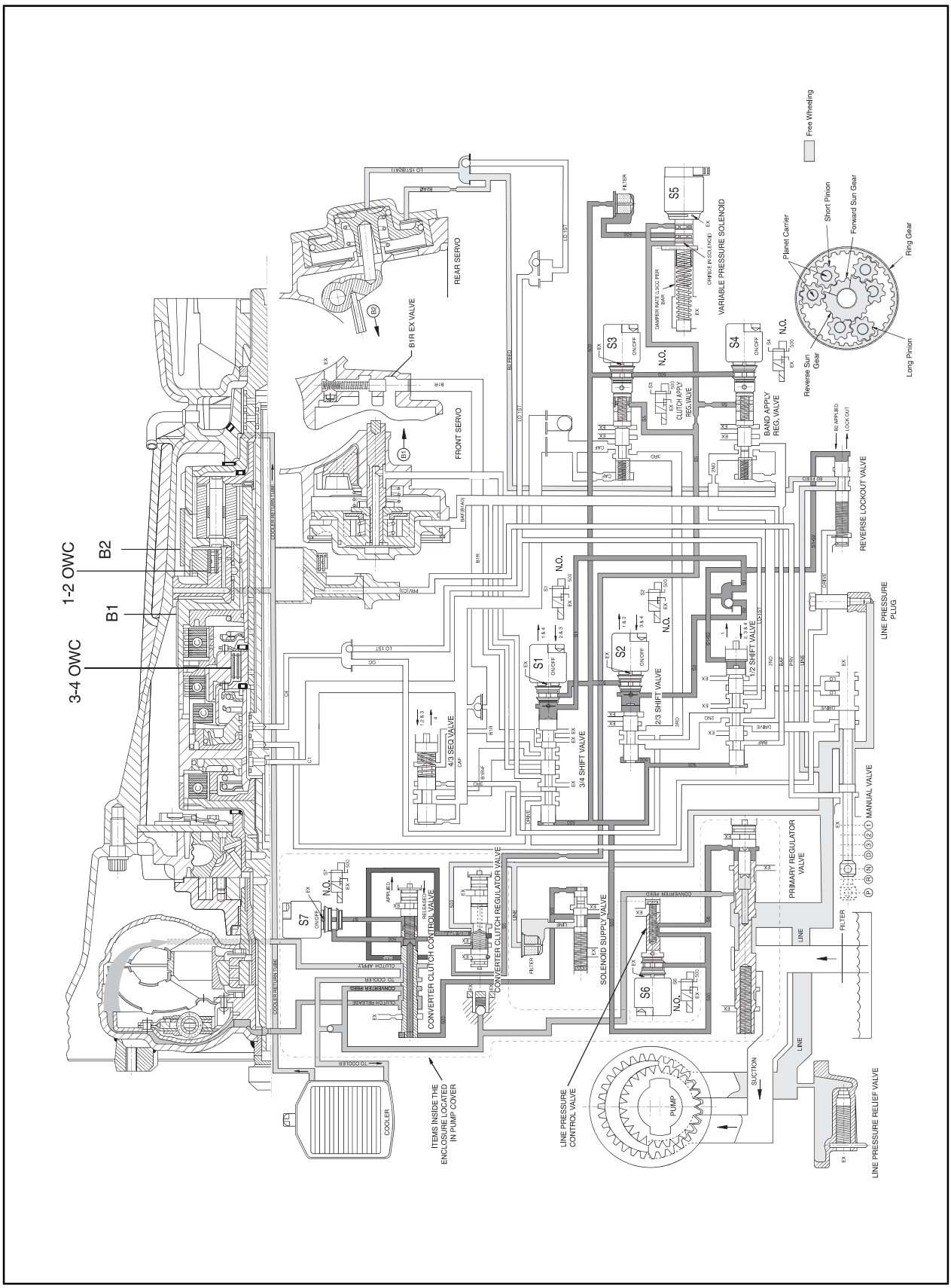
The power flows for the various transmission selections are listed below :

- Power Flow - Neutral and Park
- Power Flow - Reverse
- Power Flow - Manual 1
- Power Flow - Drive 1
- Power Flow - Drive 2
- Power Flow - Drive 3
- Power Flow - Drive 3 Lock Up
- Power Flow - Drive 4 (Overdrive)
- Power Flow - Drive 4 Lock Up

The following table details the engaged elements versus the gear selected for all transmission selections.

ELEMENTS ENGAGED									
Gear State	C1	C2	C3	C4	B1	B2	1-2 OWC	3-4 OWC	LU CLUTCH
Park and Neutral	-	-	-	-	-	X	-	-	-
Reverse	-	-	X	-	-	X	-	-	-
Manual 1	-	X	-	X	-	X	-	X	-
Drive 1	-	X	-	-	-	-	X	X	-
Drive 2 and Manual 2	-	X	-	X	X	-	-	X	-
Drive 3 and Manual 3	X	X	-	X	-	-	-	X	-
Drive 3 Lock Up and Manual 3 Lock Up	X	X	-	-	-	-	-	X	-
Drive 4 Overdrive	X	X	-	-	X	-	-	-	-
Drive 4 Lock Up	X	X	-	-	X	-	-	-	X

1) Park and Neutral



Modification basis	
Application basis	
Affected VIN	

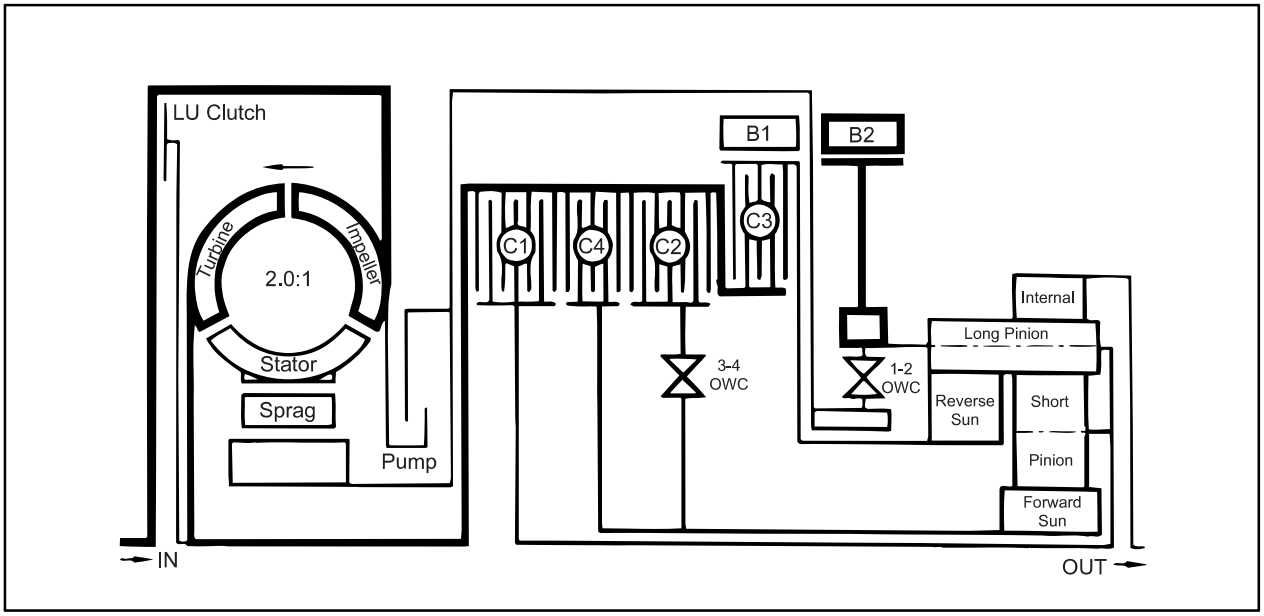
(1) Power flow - Park and neutral

In Park and Neutral, there is no drive to the planetary gear set. The rear band is applied to eliminate 'clunk' on engagement of the reverse gear, and to improve the low range engagement for 4WD applications. No other clutches or bands are applied.
In Park the transmission is mechanically locked by engaging a case mounted pawl with teeth on the output shaft ring gear.

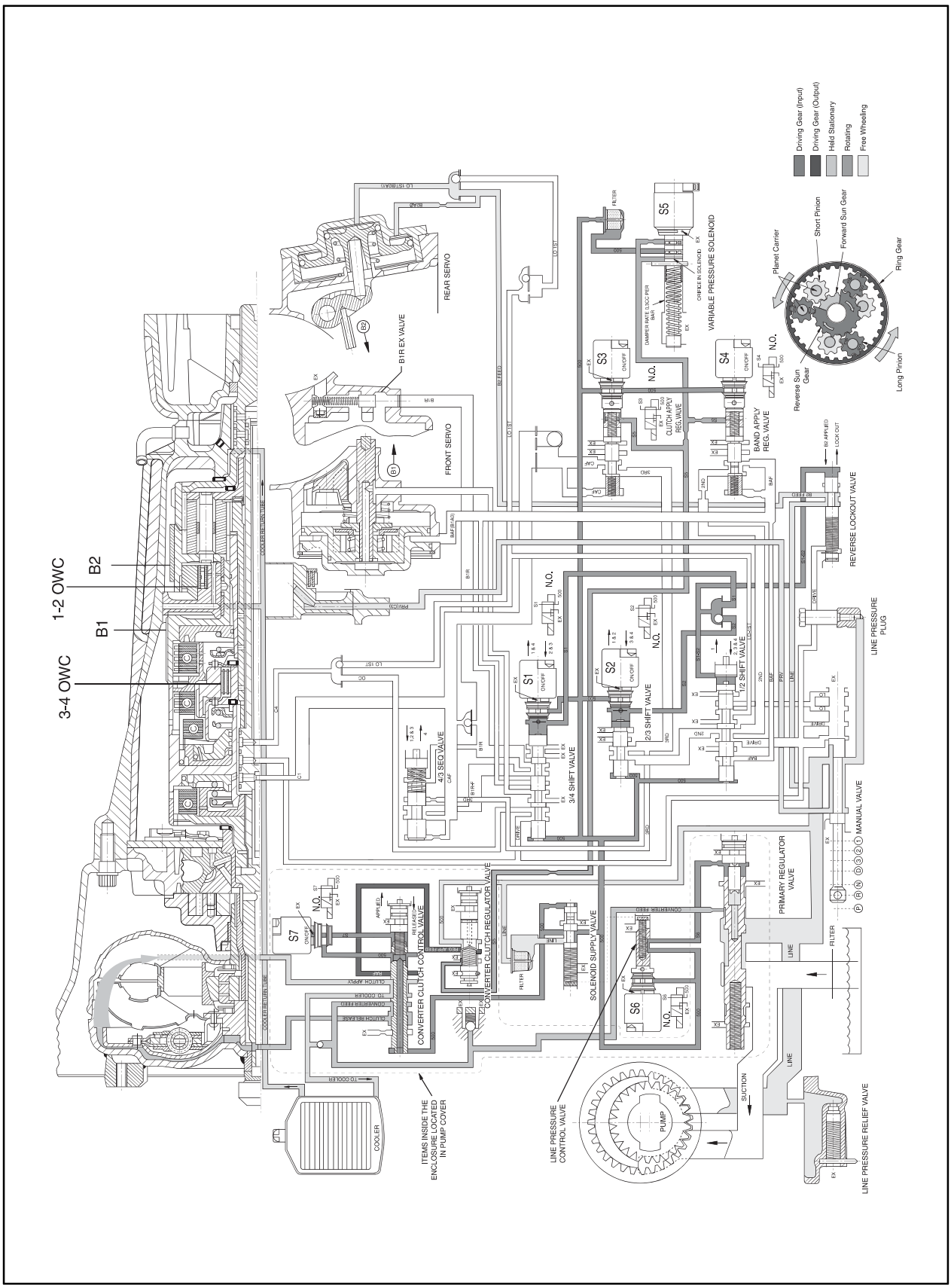
(2) Control

To maintain this arrangement in the steady state solenoids and valves are activated as follows:

- Solenoids S1 and S2 are switched OFF.
- Line (pump) pressure is applied to the Primary Regulator Valve (PRV) and to the solenoid supply pressure regulator valve.
- The converter, oil cooler, and lubrication circuits are charged from the primary regulator valve.
- The line 500 circuit is charged by the solenoid supply pressure regulator valve.
- The S5 circuit is charged by the variable pressure solenoid (S5).
- Line pressure is prevented from entering the drive circuit by the manual valve.
- The B1 circuit and all clutch circuits are open to exhaust.



2) Reverse



Modification basis	
Application basis	
Affected VIN	

(1) Power flow - Reverse

In Reverse, transmission drive is via the input shaft and the forward clutch cylinder to the hub of the C3 clutch.

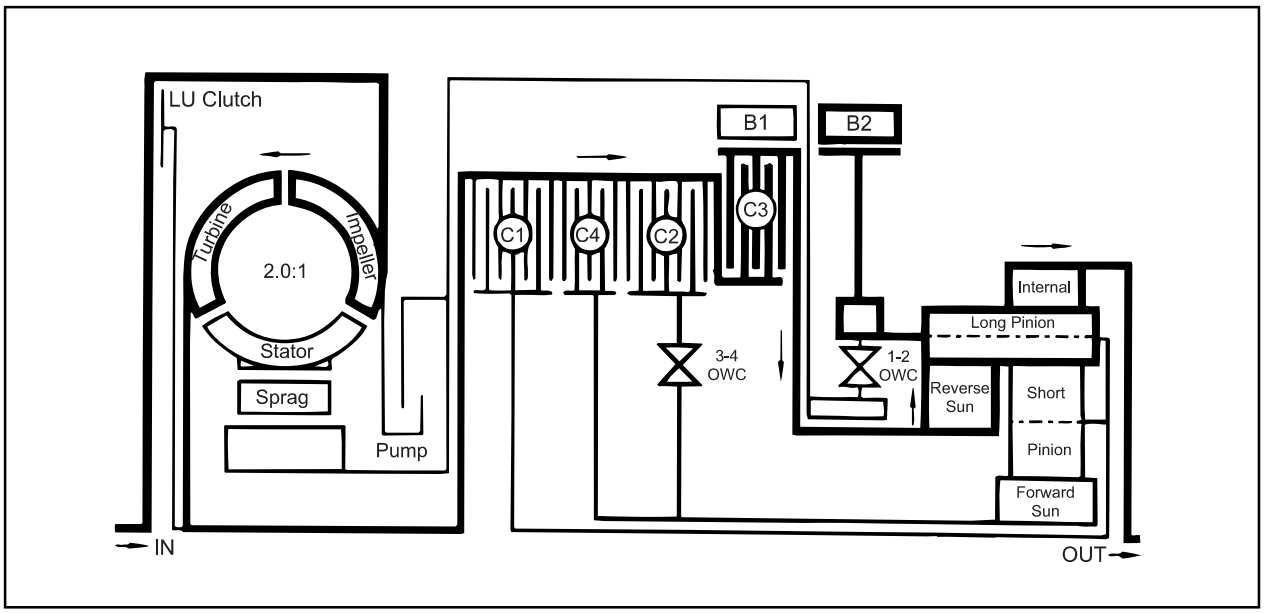
The elements of the transmission function as follows :

- The C3 clutch is engaged and drives the reverse sun gear in a clock-wise direction.
- The B2 band is engaged and holds the planetary gear carrier stationary causing the long pinion to rotate anti-clockwise about its axis on the pinion shaft.
- The long pinion drives the internal ring gear in the same direction.
- The internal ring being splined to the output shaft drives it in an anti-clockwise or reverse direction.

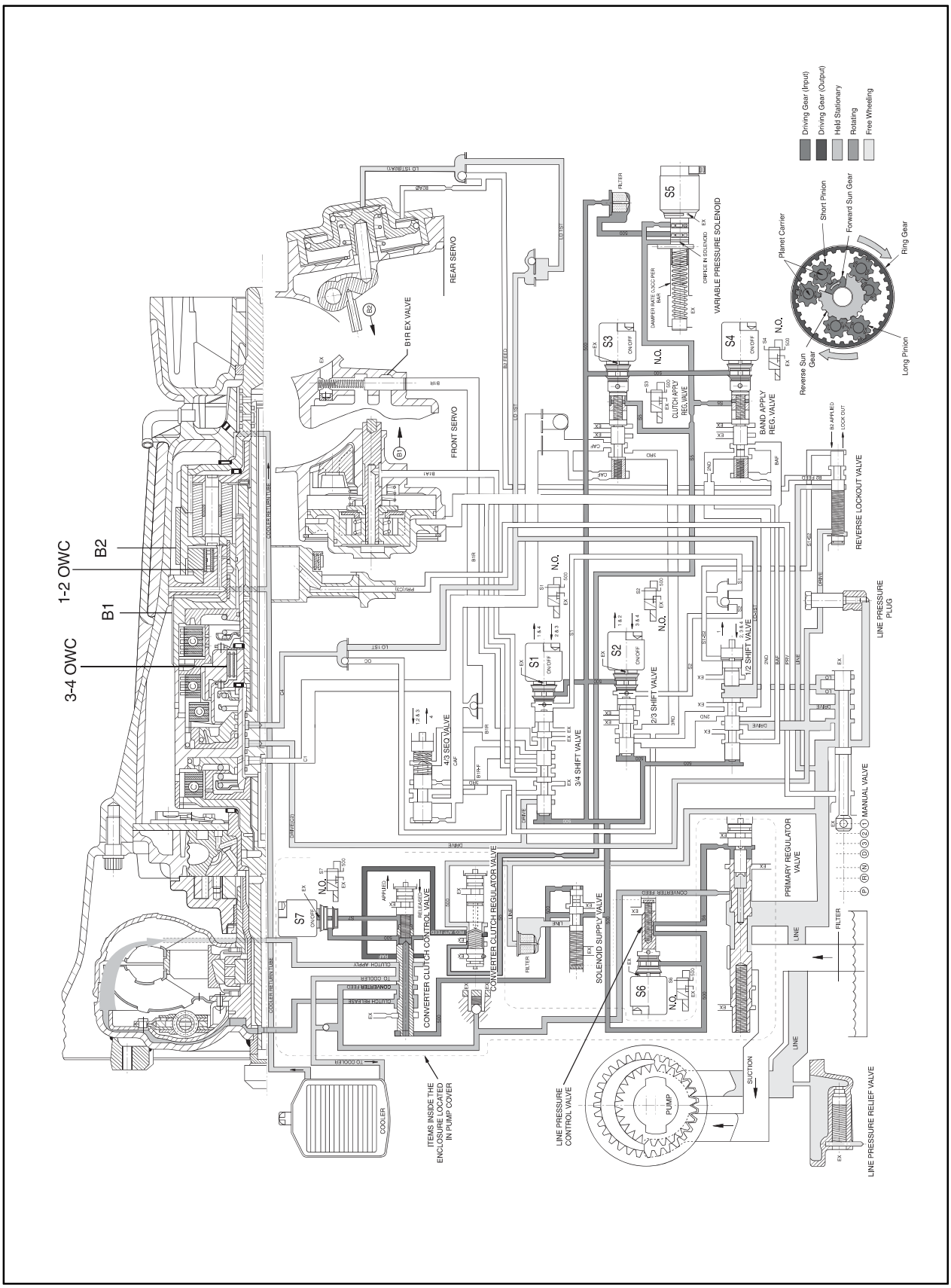
(2) Control

To maintain this arrangement in the steady state solenoids and valves are activated as follows :

- Solenoids S1 and S2 are switched OFF.
- Line pressure is directed through the reverse lockout valve to both the inner and outer apply areas of the rear servo piston for B2 band application.
- Line pressure feeds the reverse oil circuit via the manual valve.
- Reverse oil is routed from the manual valve to the C3 clutch.
- Reverse oil is also applied to the spring end of the primary regulator valve to assist the spring and to boost the line pressure value.
- All other clutch and band apply circuits are open to exhaust.



3) Manual 1



Modification basis	
Application basis	
Affected VIN	

(1) Power flow - Manual 1

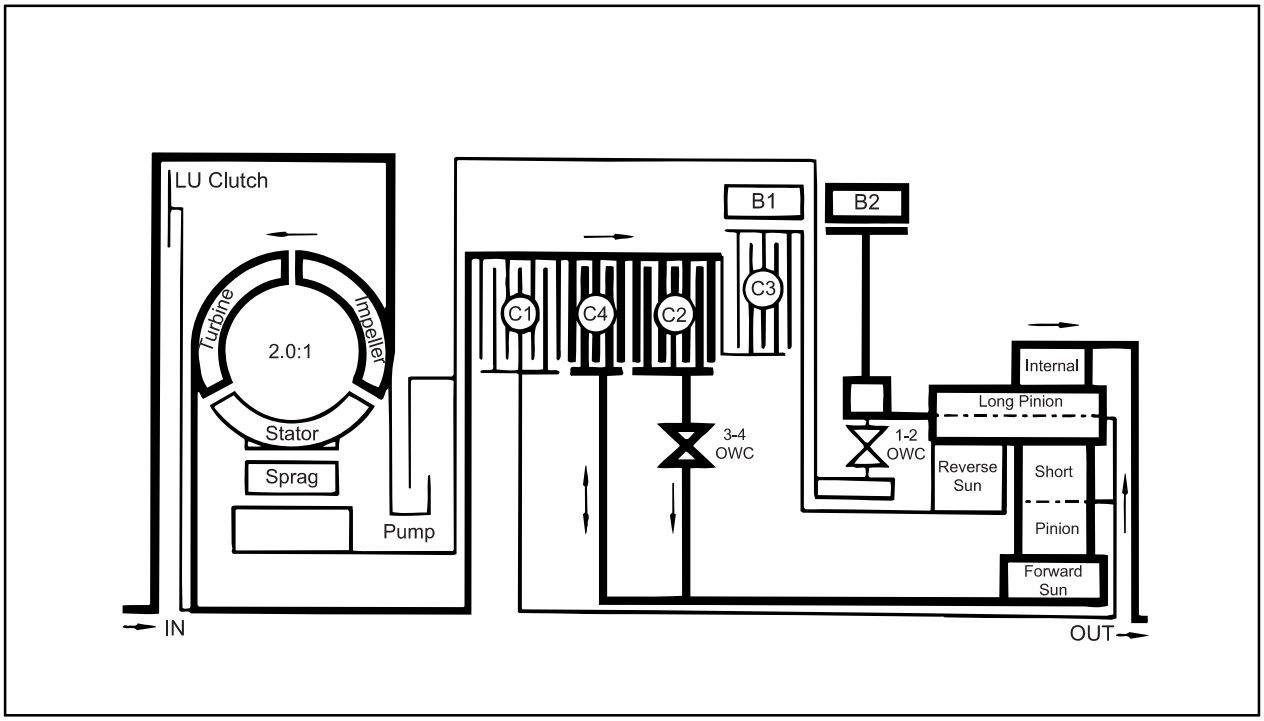
In Manual 1, transmission drive is via the input shaft to the forward clutch cylinder. The elements of the transmission function as follows;

- The C2 clutch is engaged to drive the forward sun gear, via the 3-4 OWC.
- The B2 band is engaged to hold the planetary gear carrier stationary.
- The forward sun gear drives the short pinion anticlockwise.
- The short pinion drives the long pinion clockwise.
- The long pinion rotating about its axis drives the internal ring gear and the output shaft in a clockwise or forward direction.
- The C4 clutch provides engine braking through the 3-4 OWC on overrun.

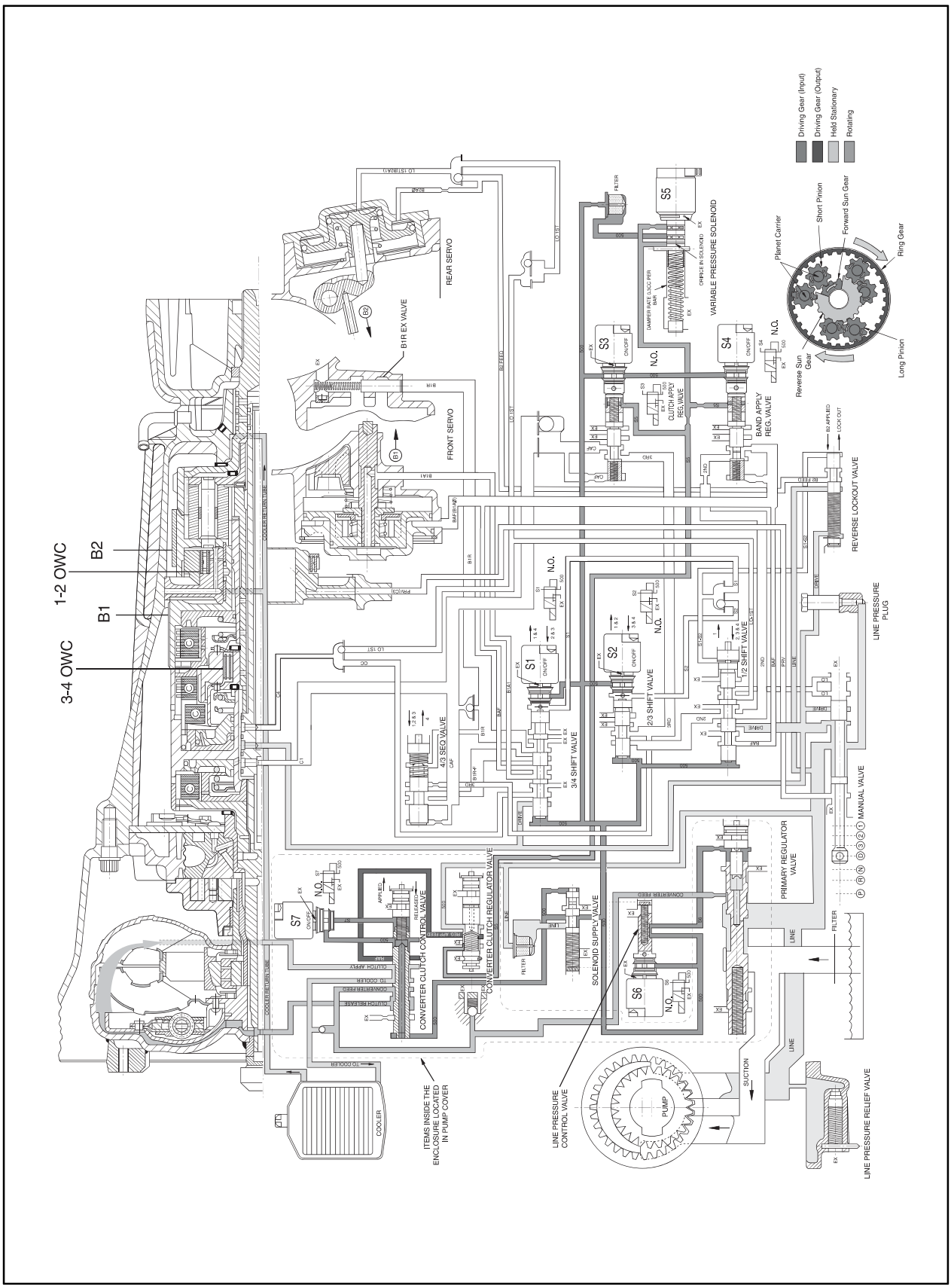
(2) Control

To maintain this arrangement in the steady state solenoids and valves are activated as follows :

- Solenoids S1 and S2 are switched ON.
- The 1-2, 2-3, and 3-4 shift valves are held in their first gear positions by line 500 pressure.
- Drive (line pressure) oil from the manual valve engages the C2 clutch.
- Lo-1st (line pressure) oil is routed through the 1-2 shift valve to the C4 clutch, and to the inner apply area of the rear servo piston for B2 band application.



4) Drive 1



Modification basis	
Application basis	
Affected VIN	

(1) Power flow - Drive 1

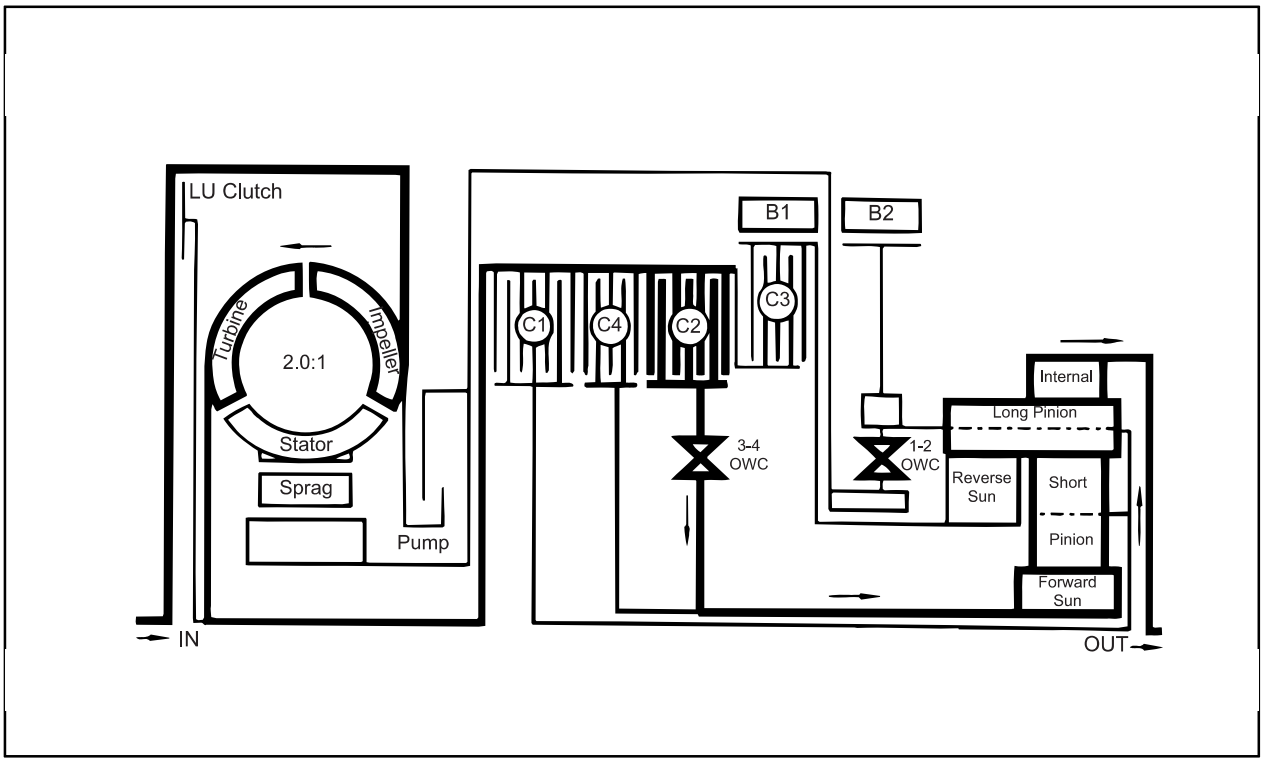
In Drive 1, transmission drive is via the input shaft to the forward clutch cylinder. The elements of the transmission function as follows :

- The C2 clutch is engaged to drive the forward sun gear via the 3-4 OWC.
- The forward sun gear drives the short pinion anticlockwise.
- The short pinion drives the long pinion clockwise.
- The 1-2 OWC prevents the planetary gear carrier from rotating under reaction force and the long pinion rotates on its axis driving the internal ring gear and output shaft in a clockwise or forward direction.
- There is no engine braking on overrun.

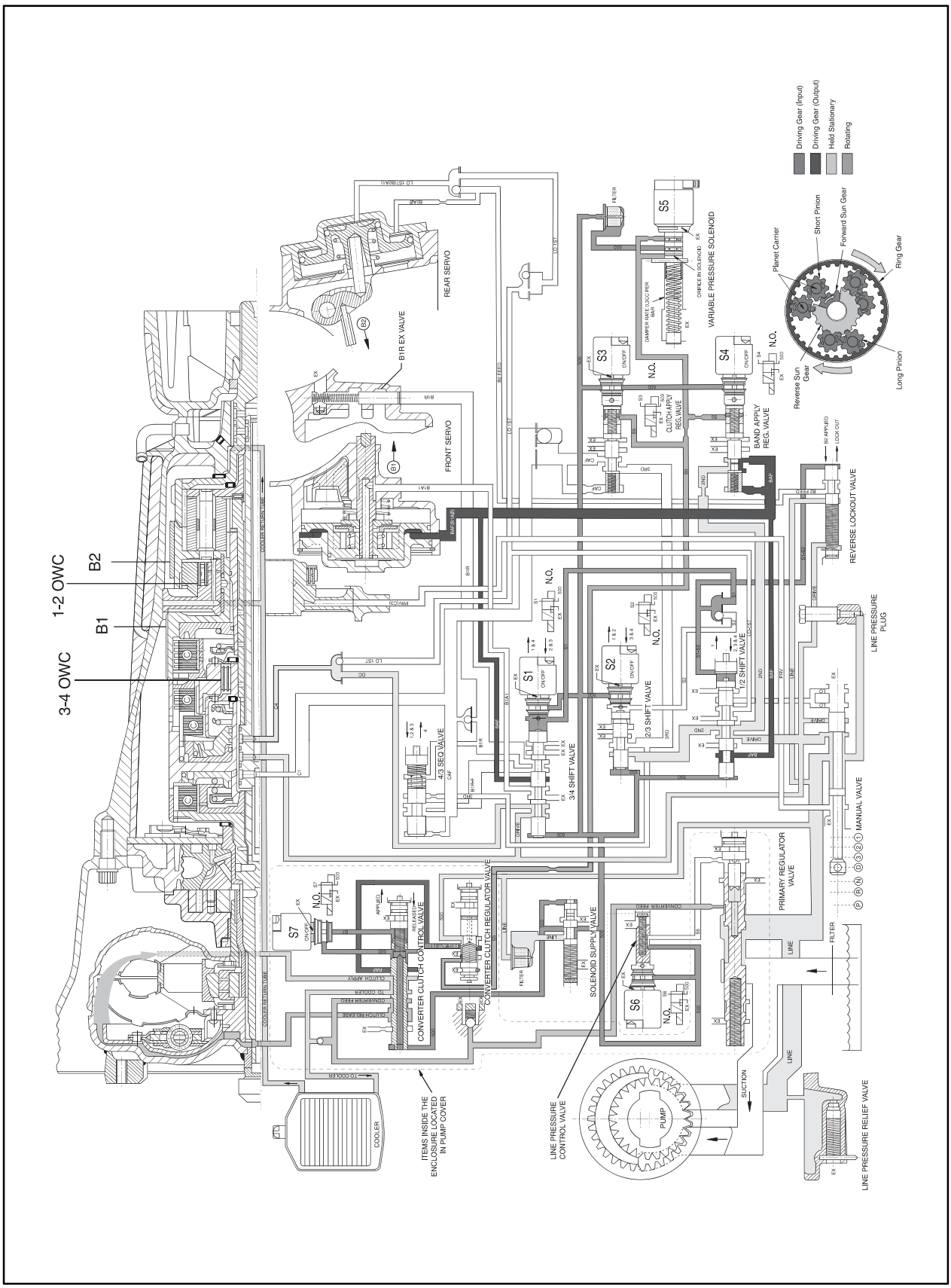
(2) Control

To maintain this arrangement in the steady state solenoids and valves are activated as follows :

- Solenoids S1 and S2 are switched ON.
- The 1-2, 2-3, and 3-4 shift valves are held in their first gear positions by line 500 pressure.
- Drive (line pressure) oil from the manual valve engages the C2 clutch.



5) Drive 2 and Manual 2



Modification basis	
Application basis	
Affected VIN	

(1) Power flow - Drive 2 and manual 2

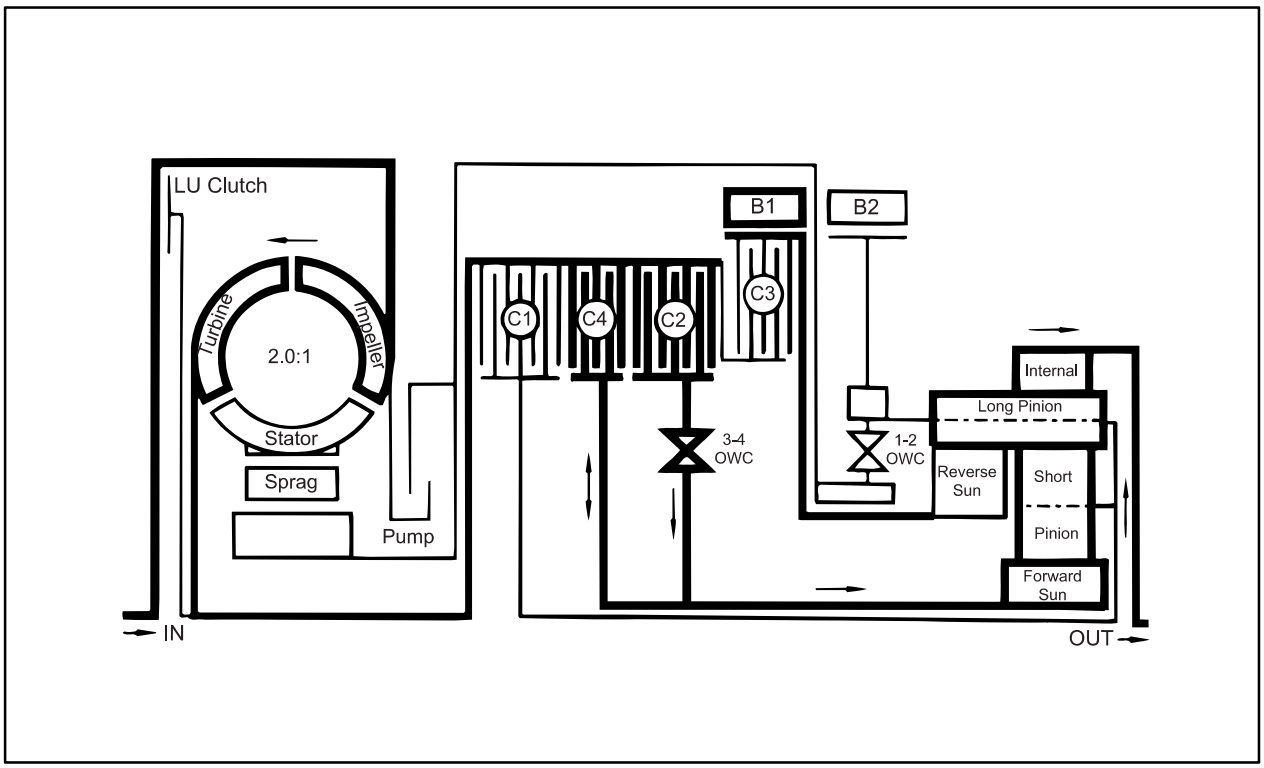
In Drive 2 and Manual 2, transmission drive is via the input shaft and forward clutch cylinder. The elements of the transmission function as follows :

- The C2 clutch is engaged to drive the forward sun gear via the 3-4 OWC.
- The forward sun gear drives the short pinion anticlockwise.
- The short pinion drives the long pinion clockwise.
- The 1-2 OWC prevents the planetary gear carrier from rotating under reaction force and the long pinion rotates on its axis driving the internal ring gear and output shaft in a clockwise or forward direction.
- There is no engine braking on overrun.

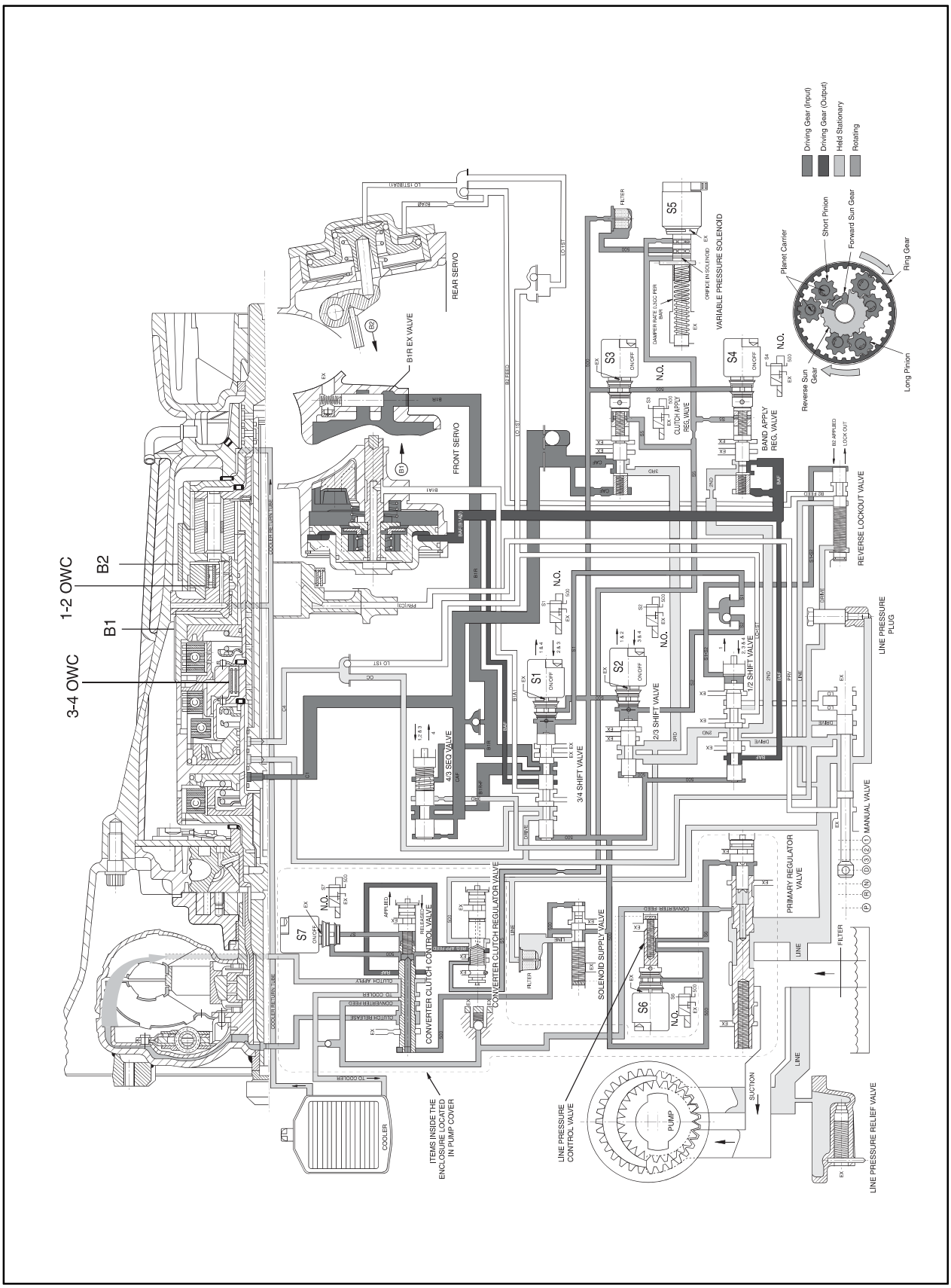
(2) Control

To maintain this arrangement in the steady state solenoids and valves are activated as follows :

- Solenoids S1 and S2 are switched ON.
- The 1-2, 2-3, and 3-4 shift valves are held in their first gear positions by line 500 pressure.
- Drive (line pressure) oil from the manual valve engages the C2 clutch.



6) Drive 3 and Manual 3



Modification basis	
Application basis	
Affected VIN	

(1) Power flow - Drive 3 and manual 3

In Drive 2 and Manual 2, transmission drive is via the input shaft and forward clutch cylinder. The elements of the transmission function as follows :

- The C2 clutch is engaged to drive the forward sun gear.
- The C1 clutch is engaged to drive the planet carrier.
- The short pinion drives the long pinion clockwise.
- The forward sun gear and the planet carrier are driven clockwise at the same speed therefore there is no relative motion between the sun gear and the pinions.
- The ring gear and output shaft are driven in a clockwise or forward direction at input shaft speed.
- The C4 clutch is applied to bypass the 3-4 OWC and provide engine braking on overrun.

(2) Control

To maintain this arrangement in the steady state solenoids and valves are activated as follows:

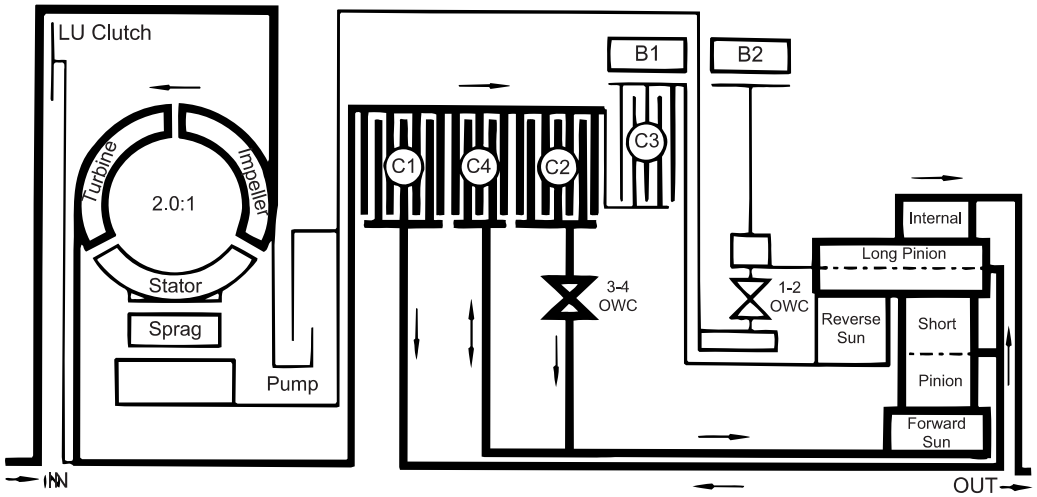
- Solenoid S1 is switched OFF. S2 is switched OFF.
- With S1 and S2 switched OFF, the 2-3 and 3-4 shift valves are held in the third gear position by line 500 pressure.
- The 1-2 shift valve is held in the third gear position by S1-S2 oil pressure.
- 2nd oil (line pressure) from the 1-2 shift valve is directed to the band apply feed regulator valve and to the 2-3 shift valve.
- The band apply feed regulator valve supplies 2nd oil (regulated to line pressure multiplied by the valvera-tio) to the Band Apply Feed (BAF) circuit.
- Band apply feed oil is directed to
  - The outer apply area of the front servo
  - The 1-2 shift valve to provide an exhaust port when the transmission is shifted to first gear
  - The 3-4 shift valve for use when the transmission is shifted into fourth gear
- 2nd oil at the 2-3 shift valve is directed to the 3rd oil circuit.
- 3rd oil from the 2-3 shift valve is directed to the clutch apply regulator valve, and to the 4-3 sequence valve.
- The clutch apply regulator valve supplies oil (regulated to line 500 pressure multiplied by the valve ratio) to the Clutch Apply Feed (CAF) circuit.

The CAF oil is directed to :

- The C1clutch
- The 4-3 sequence valve

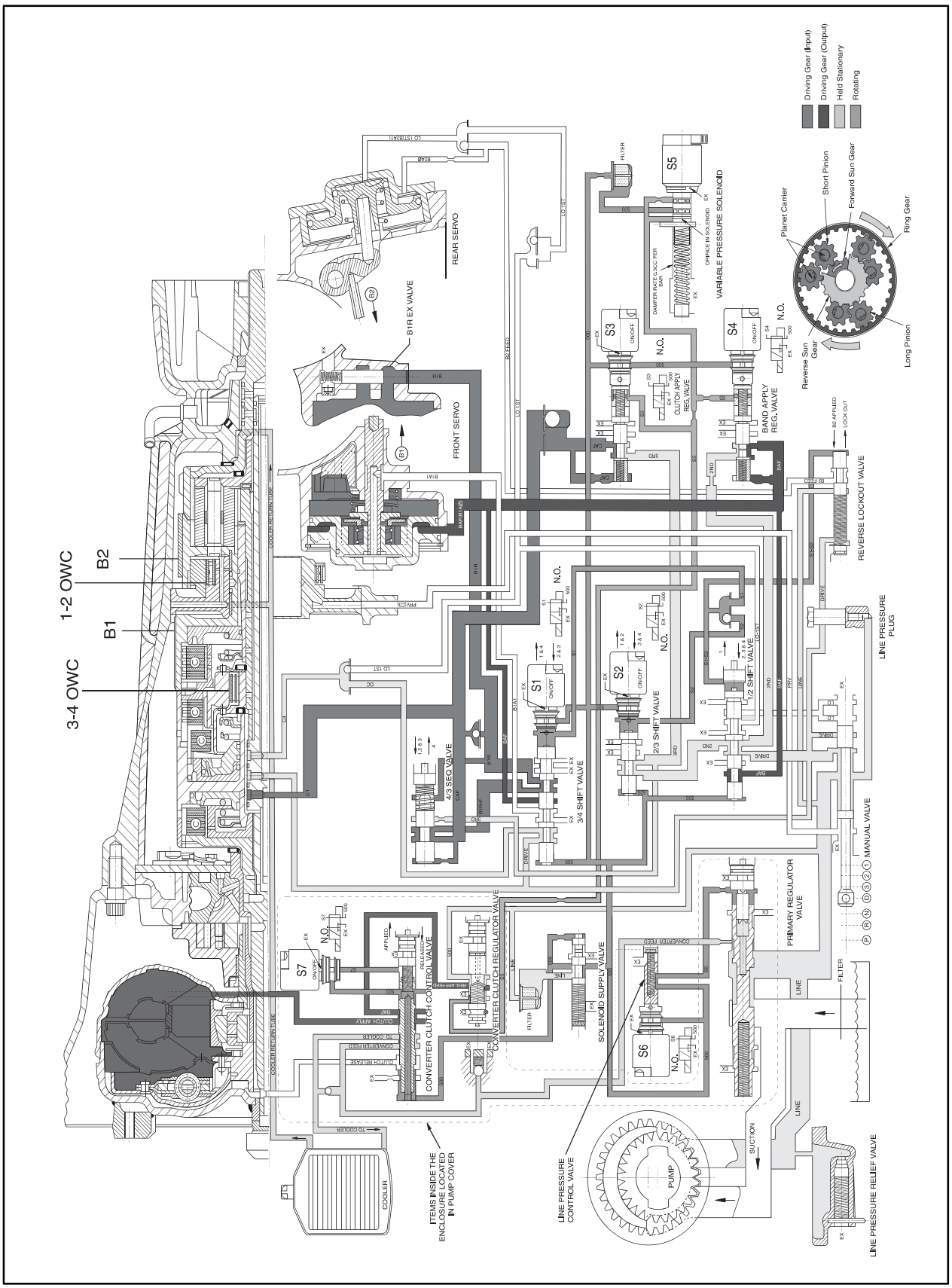
- At the 4-3 sequence valve the CAF oil becomes Band 1 Release Feed (B1R-F) oil, and is directed through the 3-4 shift valve to the spring end of the 4-3 sequence valve, and to the release side of the front servo piston to hold band 1 OFF.
- Drive (line pressure) is routed through the 3-4 shift valve to apply the C4 clutch.

	ELEMENTS ENGAGED								
Gear State	C1	C1	C1	C1	B1	B1	1-2 OWC	3-4 OWC	LU CLUTCH
Drive 3 and Manual 3	x	x	-	x	-	-	-	x	-



Modification basis	
Application basis	
Affected VIN	

7) Drive 3 Lock Up and Manual 3 Lock Up



Modification basis	
Application basis	
Affected VIN	

(1) Power flow - Drive 3 lock up and manual 3 lock up

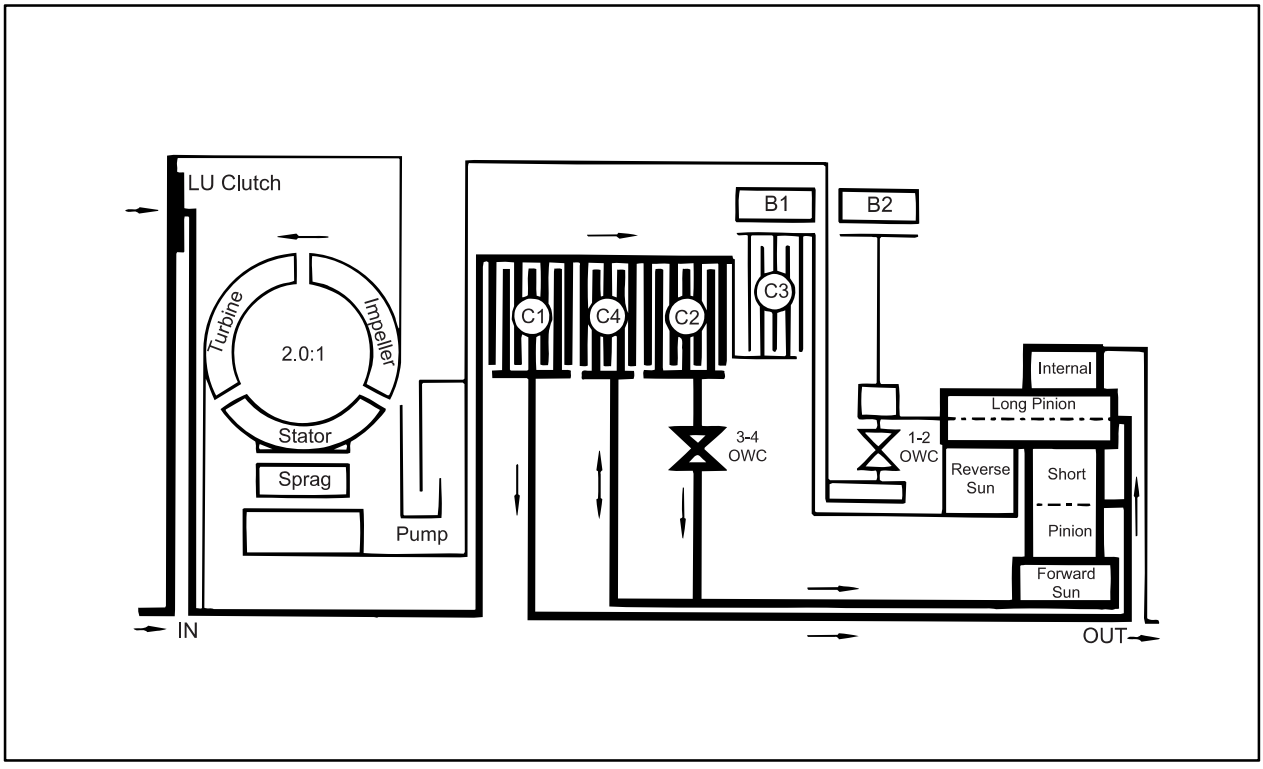
In Drive 3 Lock Up and Manual 3 Lock Up, transmission drive is the same as for Drive 3 but with the application of the converter lock up clutch to provide positive no-slip converter drive.

(2) Control

Control for Drive 3 Lock Up and Manual 3 Lock Up is the same as for Drive 3 with the addition of the converter clutch circuit activated by solenoid S7.

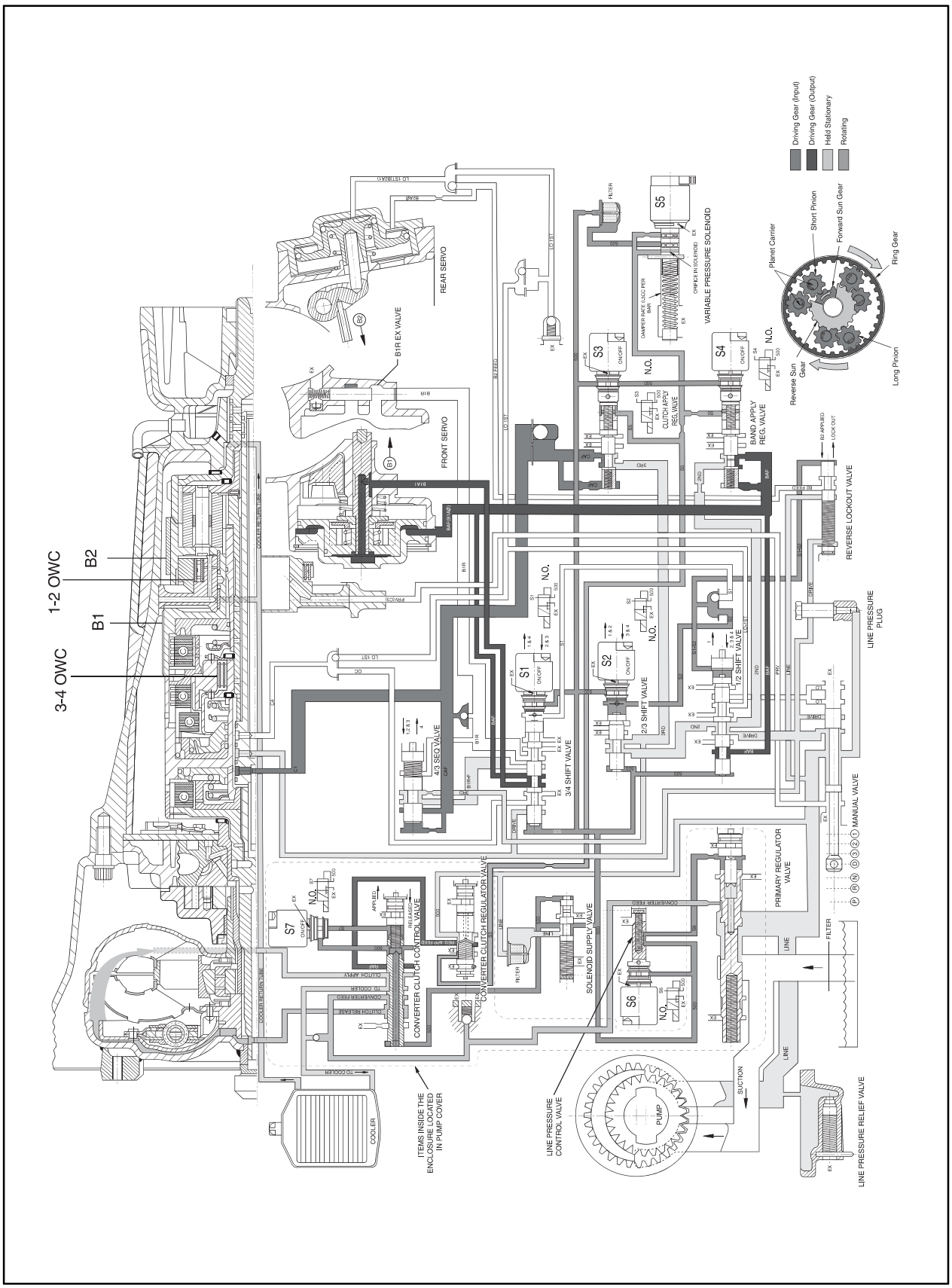
- When S7 is switched ON, S7 feed oil to the converter clutch control valve is switched OFF and allowed to exhaust through the S7 solenoid. This allows the valve to move to the clutch engage position.
- Regulated apply feed oil, drive oil at the converter clutch regulator valve, is directed by the converter clutch control valve to the engage side of the converter clutch.
- Converter clutch release oil is exhausted at the converter clutch control valve.
- Converter feed oil is re-routed by the converter clutch control valve directly to the oil cooler and lubrication circuit.

	ELEMENTS ENGAGED								
Gear State	C1	C1	C1	C1	B1	B1	1-2 OWC	3-4 OWC	LU CLUTCH
Drive 3 Lock Up and Manual 3 Lock Up	x	x	-	x	-	-	-	x	x



Modification basis	
Application basis	
Affected VIN	

8) Drive 4 (Overdrive)



Modification basis	
Application basis	
Affected VIN	

(1) Power flow - Drive 4 (Overdrive)

In Drive 4 (Overdrive), transmission drive is via the input shaft to the forward clutch cylinder.

The elements of the transmission function as follows :

- The C1 clutch is applied to drive the planet carrier clockwise.
- The B1 band is applied to hold the reverse sun gear stationary.
- As the planet carrier tuns, the long pinion walks around the stationary reverse sun gear and rotates around its axis driving the internal ring gear and output shaft in a clockwise or forward direction at a speed faster than the input shaft i.e. in overdrive ratio.
- The forward sun gear is also driven faster than the input shaft and overruns the 3-4 OWC.
- The C2 clutch is engaged to reduce the speed differential across the 3-4 OWC.

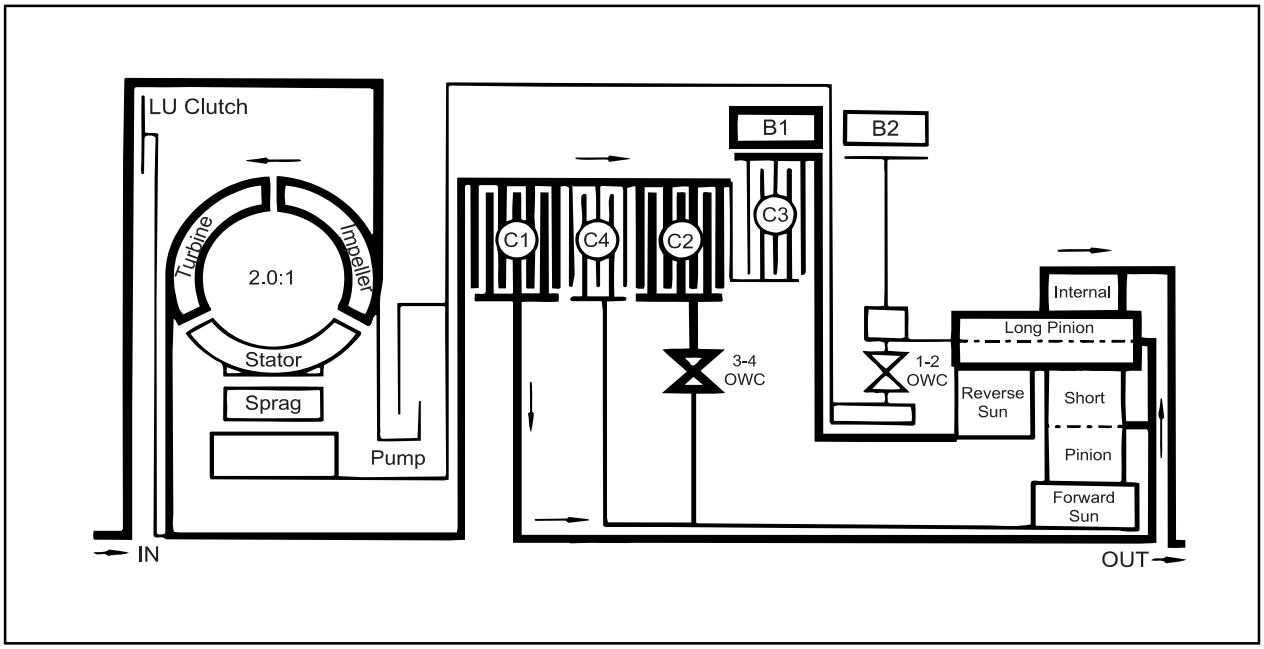
(2) Control

To maintain this arrangement in the steady state solenoids and valves are activated as follows :

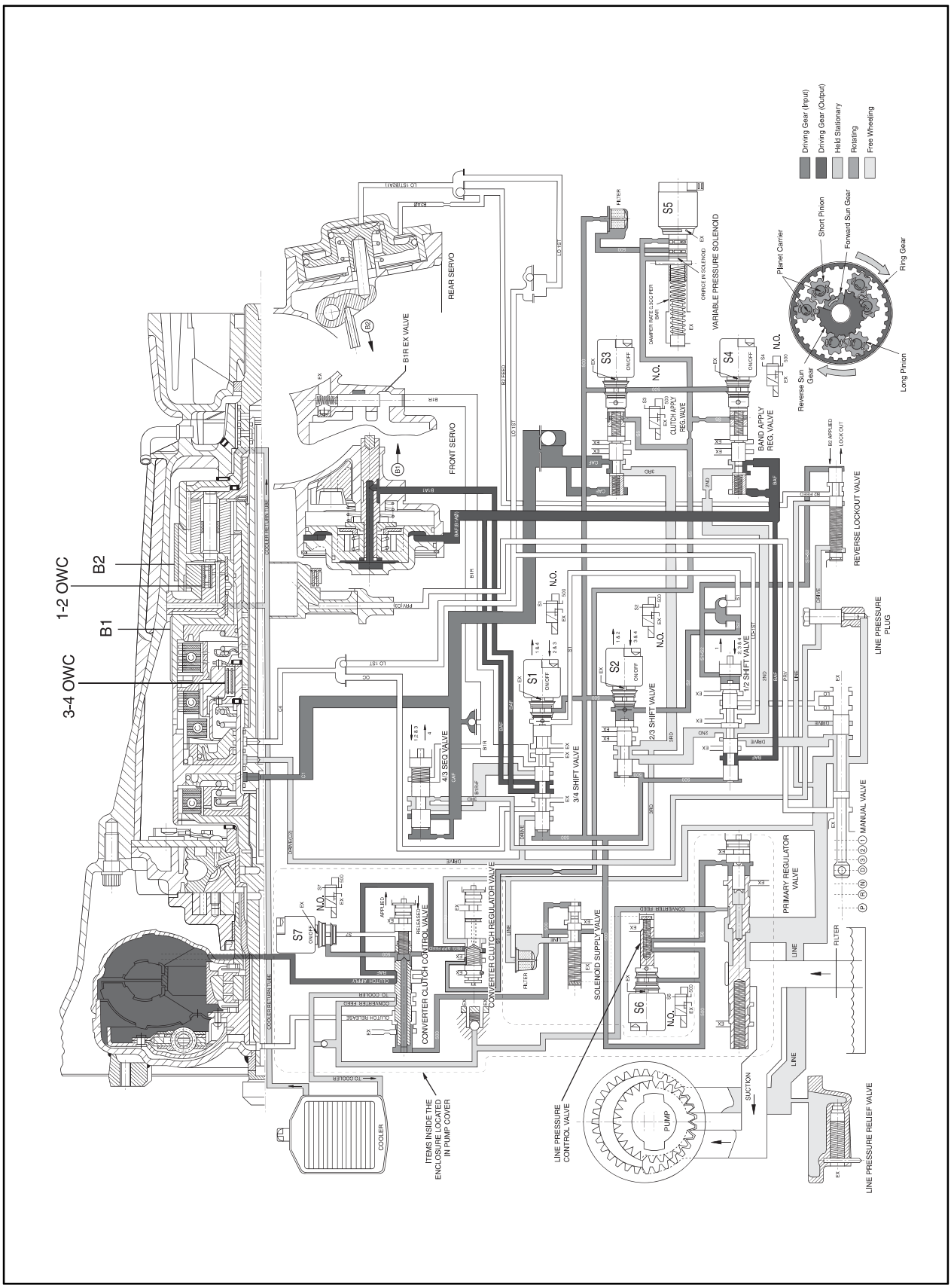
- Solenoid S1 is switched ON. S2 is switched OFF.
- With S1 switched ON, the 3-4 shift valve is held in the fourth gear position by line 500 pressure on the small end of the valve.
- With S2 switched OFF, the 2-3 shift valve is held in the fourth gear position by line 500 pressure on the large end of the valve.
- The 1-2 shift valve is held in the fourth gear position by S2 oil pressure.
- 2nd oil (line pressure) from the 1-2 shift valve is directed to the band apply feed regulator valve, and to the 2-3 shift valve.
- The band apply feed regulator valve supplies 2nd oil (regulated to line pressure multiplied by the valve ra-tio) to the Band Apply Feed (BAF) circuit.
- Band apply feed oil is directed to
  · the outer apply area of the front servo
  · the inner apply area of the front servo piston via the 3-4 shift valve
  · the 1-2 shift valve to provide an exhaust port when the transmission is shifted to first gear
- 2nd oil at the 2-3 shift valve is directed to the 3rd oil circuit.
- 3rd oil from the 2-3 shift valve is directed to the clutch apply regulator valve, and to the 4-3 sequence valve.
- The clutch apply regulator valve supplies oil (regulated to line 500 pressure multiplied by the valve ratio) to the Clutch Apply Feed (CAF) circuit.
- The CAF oil is directed to
  · The C1clutch
  · The 4-3 sequence valve
- Drive oil (line pressure) from the manual valve engages the C2 clutch.

Modification basis	
Application basis	
Affected VIN	

	ELEMENTS ENGAGED								
Gear State	C1	C1	C1	C1	B1	B1	1-2 OWC	3-4 OWC	LU CLUTCH
Drive 4 Overdrive	x	x	-	-	x	-	-	-	-



9) Drive 4 Lock Up



Modification basis	
Application basis	
Affected VIN	

(1) Power flow - Drive 4 lock up

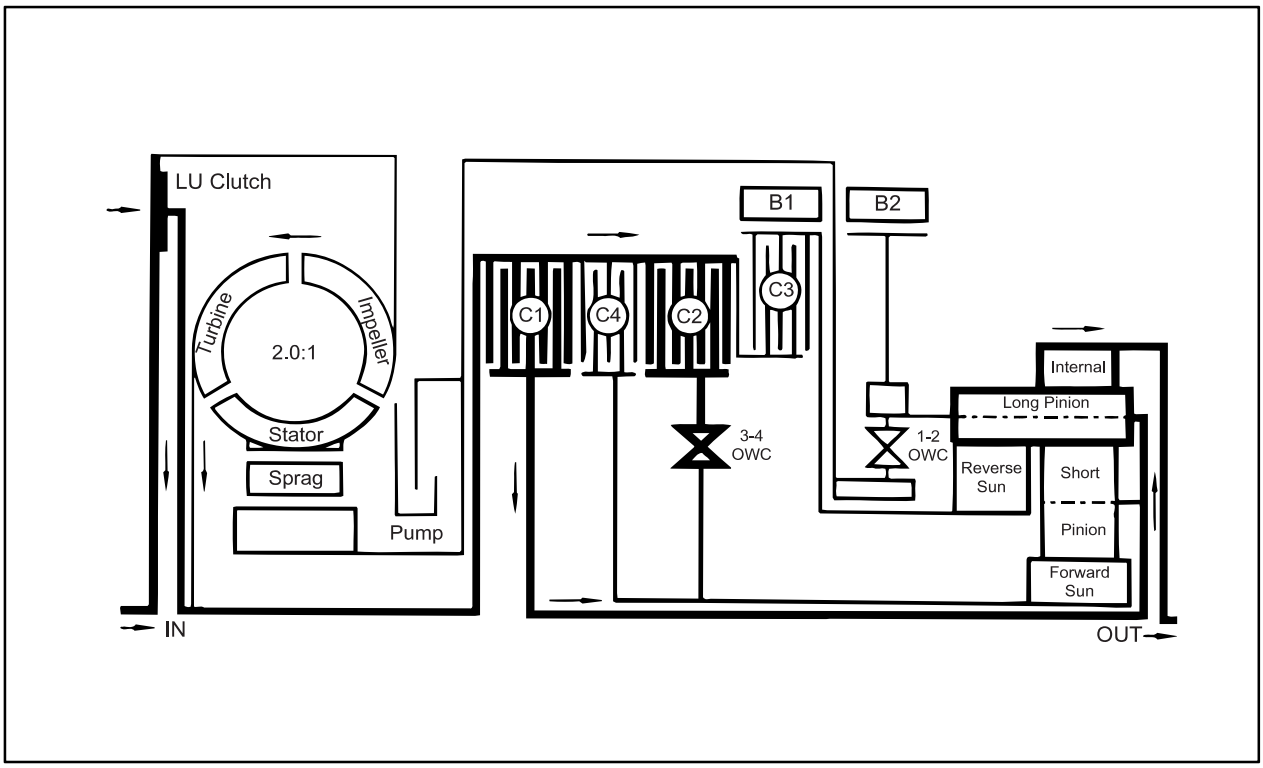
In Drive 4 Lock Up, transmission drive is the same as for Drive 4 but with the application of the converter lock up clutch to provide positive no-slip converter drive.

(2) Control

To maintain this arrangement in the steady state solenoids and valves are activated as follows :

- When S7 is switched ON, S7 feed oil to the converter clutch control valve is switched OFF and allowed to exhaust through the S7 solenoid. This allows the valve to move to the clutch engage position.
- Regulated apply feed oil, drived from drive oil at the converter clutch regulator valve, is directed by the converter clutch control valve to the engage side of the converter clutch.
- Converter clutch release oil is exhausted at the converter clutch control valve.
- Converter feed oil is re-routed by the converter clutch control valve directly to the oil cooler and lubrication circuit.

	ELEMENTS ENGAGED								
Gear State	C1	C1	C1	C1	B1	B1	1-2 OWC	3-4 OWC	LU CLUTCH
Drive 4 Overdrive	x	x	-	-	x	-	-	-	x



AUTOMATIC TRANSMISSION (DC 5-SPEED) 3650-01

GENERAL

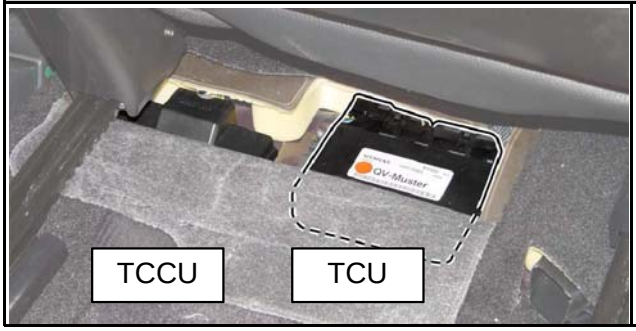
1. AUTOMATIC TRANSMISSION OVERVIEW

DC 5-speed Automatic Transmission Assembly	
	T-Tronic DC 5-speed automatic transmission is an electronically controlled 5-speed transmission with a lockup clutch in the torque converter. The ratios for the gears are realized by three planetary gear sets. The 5th gear is designed with a step-up ratio of 0.83 as an overdrive. The selector lever is controlled by electronically and mechanically. The gears are shifted by the corresponding combination of three hydraulically actuated multiple-disc brakes, three hydraulically actuated multiple-disc clutches and two mechanical one-way clutches. This electronically controlled automatic transmission adjusts the operating pressure to provide proper shifting in relation to engine power. This function improves shifting quality significantly. And, the driver can select "S" (Standard) mode or "W" (Winter) mode according to the driving conditions.

Modification basis	
Application basis	
Affected VIN	

A Instrument Panel

B TCU Assembly



Releasing Lock-up Solenoid Valve

When the gear selector lever cannot be moved from "P" position to other positions, manually release the lock-up function as shown in figure.

C Standard Mode / Winter Mode

"S" mode is used in normal driving.
When "W" mode is selected, the vehicle starts from 2nd gear (forward and reverse) to achieve smooth starting on the slippery road.

D Selector Lever

Downshift (Manual Mode)

1← 2 ← 3 ← 4 ← D

The shiftable gear is down by one step as the lever is moved to left (-) direction.

Upshift (Manual Mode)

1→ 2 → 3 → 4 → D

The shiftable gear is up by one step as the lever is moved to right (+) direction.

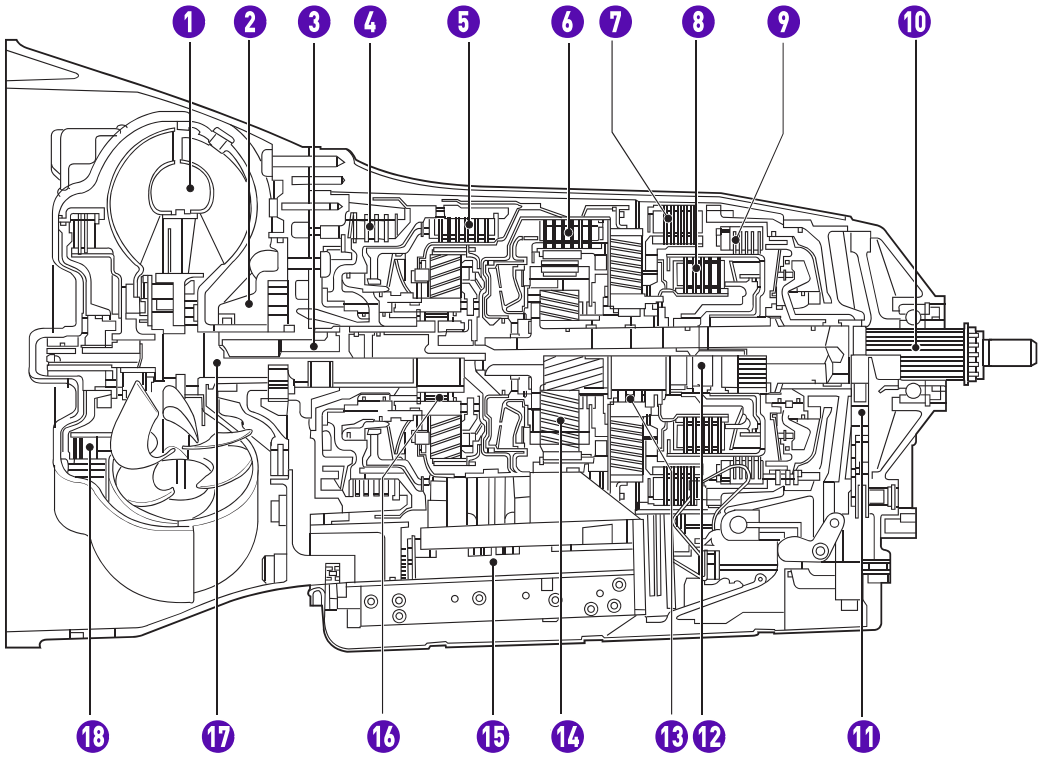
2. AUTOMATIC TRANSMISSION (DC 5-SPEED) APPEARANCE

Left Side

With Torque Converter	Without Torque Converter	Rear View

Modification basis	
Application basis	
Affected VIN	

3. AUTOMATIC TRANSMISSION STRUCTURE



※ This sectional drawing is based on DC 5-speed A/T 2WD model. 4WD model has also same structure.

1. Torque converter
2. Oil pump
3. Input shaft
4. Disc brake B1
5. Disc clutch C1
6. Disc clutch C2
7. Disc brake B3
8. Disc clutch C3
9. Disc brake B2
10. Output shaft
11. Parking lock gear
12. Intermediate shaft
13. Freewheel F2
14. Center planetary gear set
15. Electric control unit (valve body)
16. Freewheel F1 (Front planetary gear set)
17. Stator shaft
18. Converter lockup clutch

Modification basis	
Application basis	
Affected VIN	

▶ Specifications

Item		5-Speed Automatic Transmission	
		D20DT	D27DT
Input torque		2WD (580 Nm), 4WD (400 Nm)	
Weight (including ATF)		76 kg (2WD), 78 kg (4WD)	
Diameter (torque converter)		270 mm	
Lockup function		Yes	
Gear ratios	1st	3.951	3.595
	2nd	2.423	2.186
	3rd	1.486	1.405
	4th	1.000	1.000
	5th	0.833	0.831
	Rev. 1st: S / Rev. 2nd: W	3.147/1.93	3.167/1.926
Driving type		2WD/4WD	
Fluid specification		Fuchs ATF 3353 or Shell ATF 3353	
Fluid capacity		Approx. 8 ℓ	
Selector lever position	P.R.N.D	Mechanical	
	D+/D-	Electrical	
Parking lock system		Brake switch (signal) → TGS lever	
Selected lever indication	P.R.N.D	Lever position	
	4, 3, 2, 1	CAN	
Oil temperature sensor	Resistance: R, D	0.5 ~ 2.5 kW	
TCU		EGS 52	
Shift solenoid valve (25°C)	Resistance	3.8 ± 0.2 W	
	Operating distance	0.2 mm	
	Operating current	1.5 ~ 2 A	
M/P, S/P solenoid valve (23°C)	Resistance	5.0 ± 0.2 W	
	Operating distance	0.6 mm	
	Operating current	0 ~ 1.2 A	
Lockup solenoid valve (25°C)	Resistance	2.5 ± 0.2 W	
	Operating distance	0.2 mm	
	Operating current	1.5 ~ 2.0 A	
	Operating range	3rd to 5th gears	
Speed sensor	Type	HALL type	
	Operating voltage	6 V	
Start lockout switch	Switch contact	ON (D, R position)	
	Switch contact	OFF (P, N position)	

Modification basis	
Application basis	
Affected VIN	

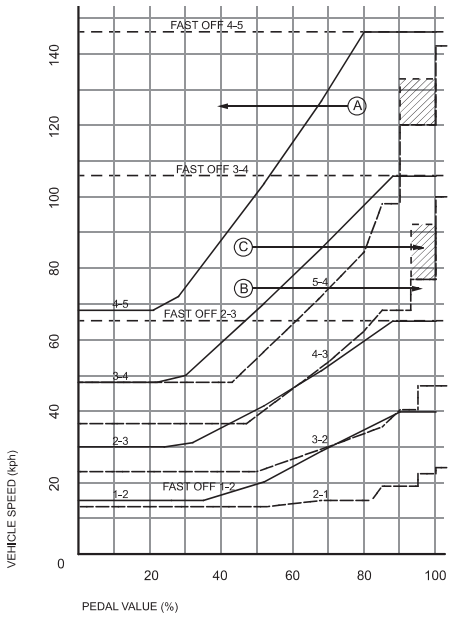
Item		5-Speed Automatic Transmission
Mode switch		W (Winter)
		S (Standard)
One-way clutch		F1, F2
Planetary gear set	Number of planetary gear set pinion (Front, Center, Rear)	4, 4, 4
Disc clutch	C1	Single side friction plate
	C2	Double side friction plate
	C3	Single side friction plate
Disc brake	B1	Single side friction plate
	B2	Double side friction plate
	B3	Double side friction plate

▶ Characteristics of Automatic Transmission

- Performance Curve

D20DT

Standard Mode



Upshift: ——————

Downshift: ——·——·——

Lockup (slipping): – – ———— – –

Unlock (open): ————

FAST OFF: – – – – – – – – – –

Dynamic shift zone: ▱▱▱▱▱▱▱▱▱▱▱▱

FAST OFF: When abruptly releasing the accelerator pedal, the transmission remains at 4th gear other than 4 → 5 shift (when slowly releasing the accelerator pedal, the transmission is shifted to 5th gear).

Dynamic shift zone:

When operating the accelerator pedal (B), the 4 → 3 shift is completed by kick-down signal after completion of 4 → 3 shift (100% of pedal position). When promptly operating the accelerator pedal (C), the 4 → 3 shift is done in shaded area (93% of pedal position).

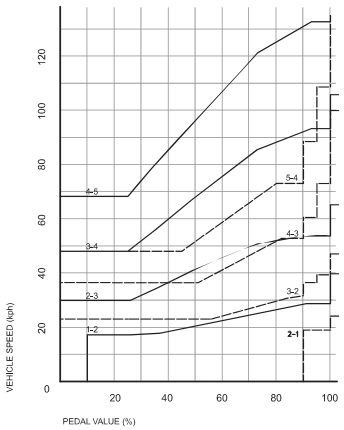
4th gear: 1.000

5th gear: 0.833

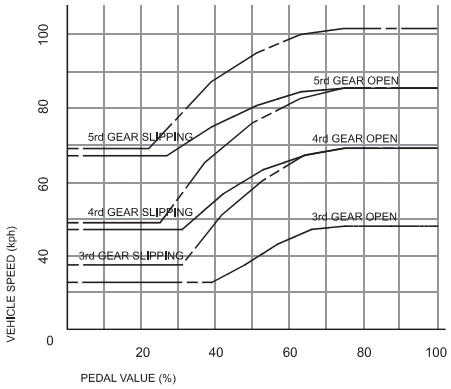
Rev. 1st gear: 3.147

Rev. 2nd gear: 1.93

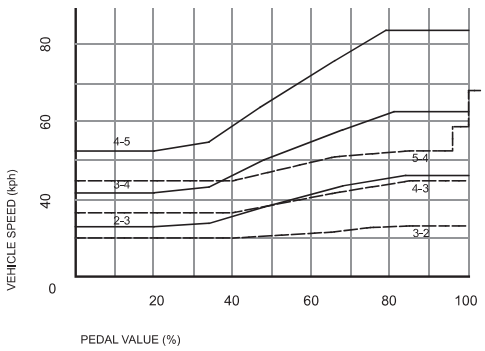
WINTER Mode (2WD)



Lockup Mode (Open/Slipping)



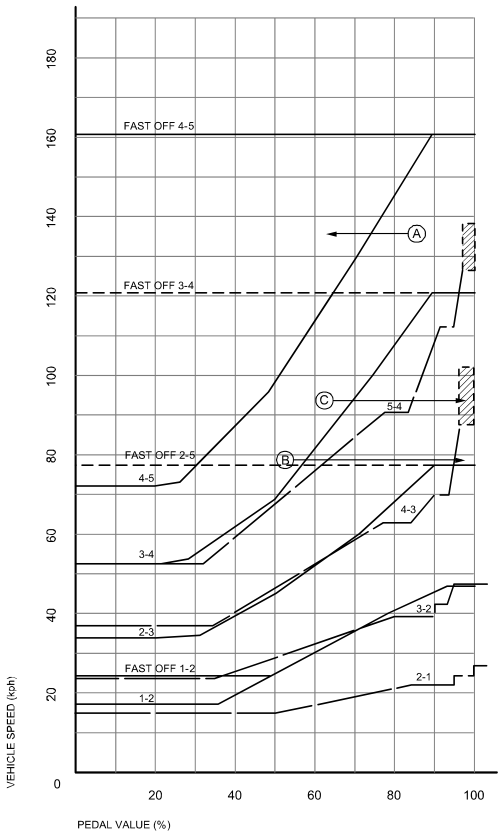
Low Mode (4WD)



Modification basis	
Application basis	
Affected VIN	

D27DT

Standard Mode



Upshift:
Downshift:
Lockup (slipping):
Unlock (open):
FAST OFF:
Dynamic shift zone:

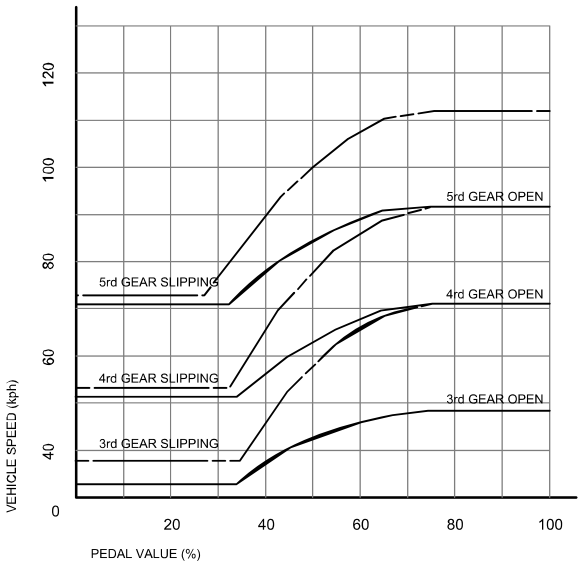
FAST OFF: When abruptly releasing the accelerator pedal, the transmission remains at 4th gear other than 4 → 5 shift (when slowly releasing the accelerator pedal, the transmission is shifted to 5th gear).

Dynamic shift zone:

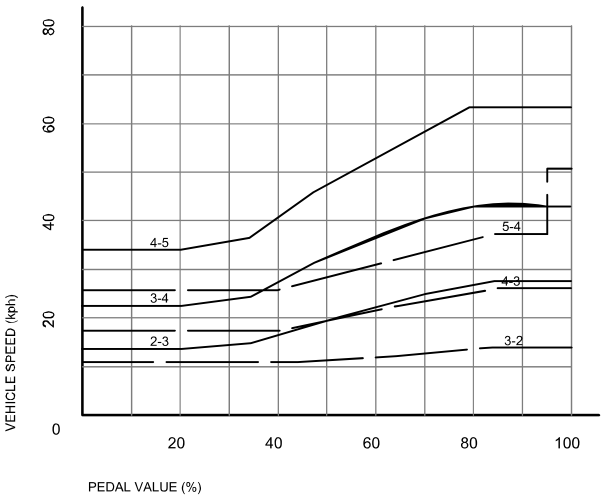
When operating the accelerator pedal (B), the 4 → 3 shift is completed by kick-down signal after completion of 4 → 3 shift (100% of pedal position). When promptly operating the accelerator pedal (C), the 4 → 3 shift is done in shaded area (93% of pedal position).

4th gear: 1.000
5th gear: 0.833
Rev. 1st gear: 3.147
Rev. 2nd gear: 1.93

Lockup Mode (Open/Slipping)



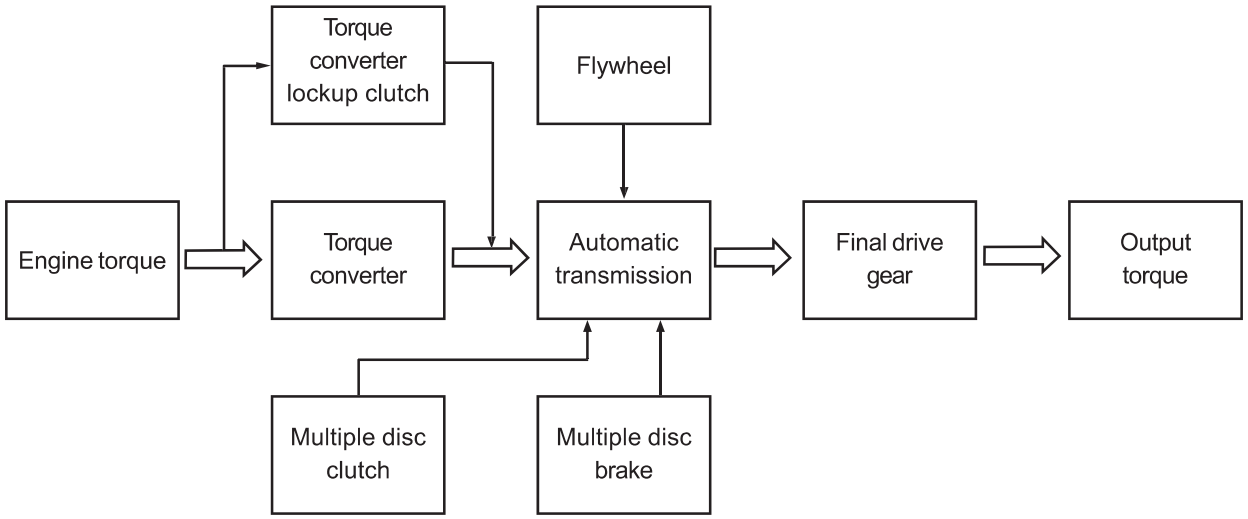
WINTER Mode



Modification basis	
Application basis	
Affected VIN	

▶ General Characteristics

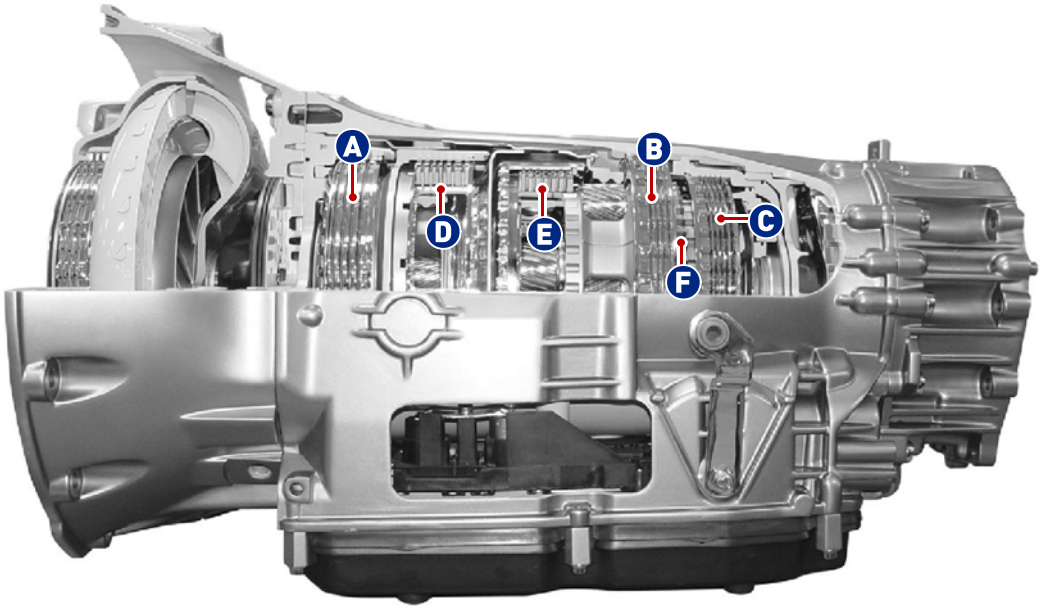
Characteristic	Function and Effect
Slope recognition (down hill, up hill)	Slope is recognized based on engine RPM and accelerator pedal position. → Delays up shift
Engine torque reduction	Ignition timing is delayed to reduce torque at all shifting moments. → Improves shift quality
Engine rpm limitation	Engine rpm is limited until the gears are fully engaged when shifting from “N” to “D”. → Prevents shift shock
ESP Operation	When the ESP is controlling the engine torque, shifting is not available and vehicle starts off with 2nd gear. → Cannot use kick-down function and shift at maximum rpm
ABS Operation	Brake control is not affected.
Fast-off function	It is not shifted up when accelerator pedal is abruptly released. → To get engine brake effect during cornering
Altitude recognition	As altitude increases (atmospheric pressure reduces), engine torque decreases. To compensate this torque reduction, shift up occurs when depressing the accelerator pedal more than usual operation (adjusting shift diagram). → Improves driving performance and increases torque
Oil temperature	If transmission fluid temperature is too low, the shifting point gets delayed in full throttle and kick down. → Improves driving performanc e
Hydraulic pressure is produced in emergency driving mode	When starting the engine with cycling the ignition switch (“OFF” and “ON”) due to transmission trouble, the selector lever should be placed in “P” position. If starting the engine with selector lever “N” position, the lever should be moved into “P” position. The selector valve changes the path of hydraulic pressure in selector lever “P” position. → The hydraulic pressure flows to direct operation mode via “R” and “D” valve to operate “reverse 2nd” and “forward 2nd” gear.
Adaptation	Function to optimize the shifting quality. → Compensates the shifting quality according to play and wear



Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. POWER FLOW



Brake B1(disk) assembly	Brake B3 (disk) assembly	Brake B2 (disk) assembly
A	B	C
C1 (Disk clutch) assembly	**C2 (Disk clutch) assembly**	**C3 (Disk clutch) assembly**
D	E	F

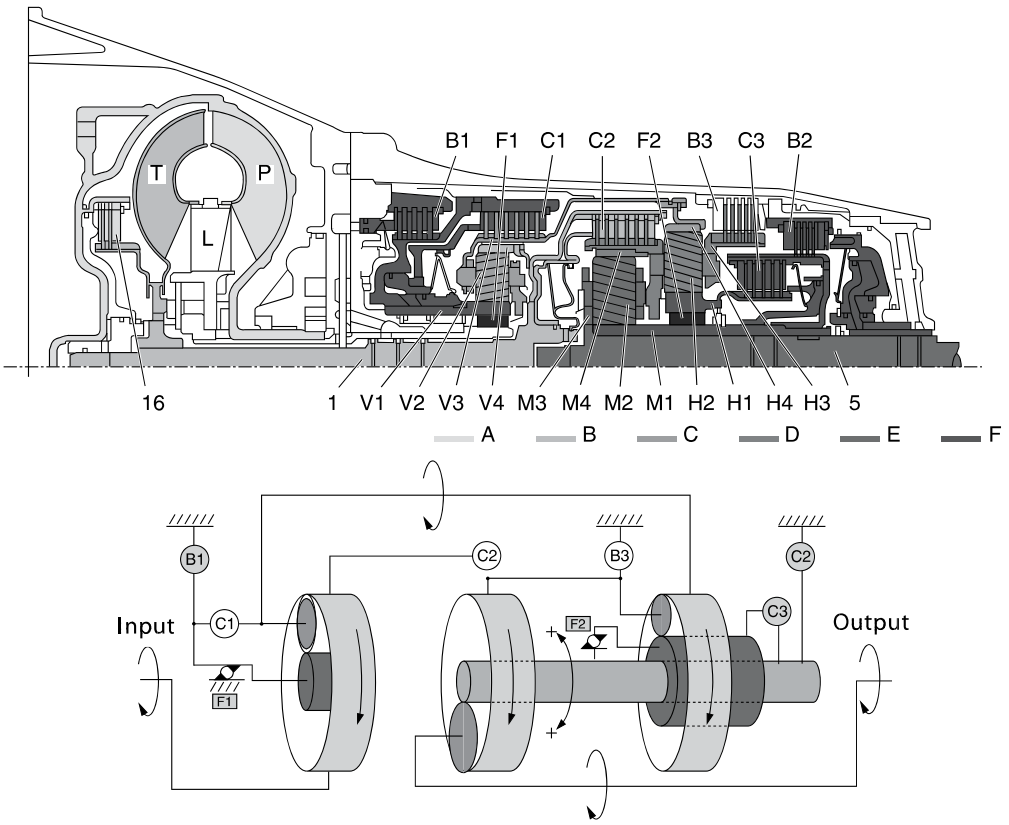
▶ Shifting Elements

Gear	C1	C2	C3	B1	B2	B3	F1	F2
1			● 3)	● 3)	●		●	●
2	●		● 3)		●			●
3	●	●			●			
4	●	●	●					
5		●	●	● 3)			●	
P/N 1)			●	●				
P/N 2)	●		●					
R 1)			●	● 3)		●	●	
R 2)	●		●			●		

※ 1) Selector program switch: S mode 2) Selector program switch: W mode 3) Overrun

Modification basis	
Application basis	
Affected VIN	

1) 1st Gear (D20DT: 3.951, D27DT: 3.595)



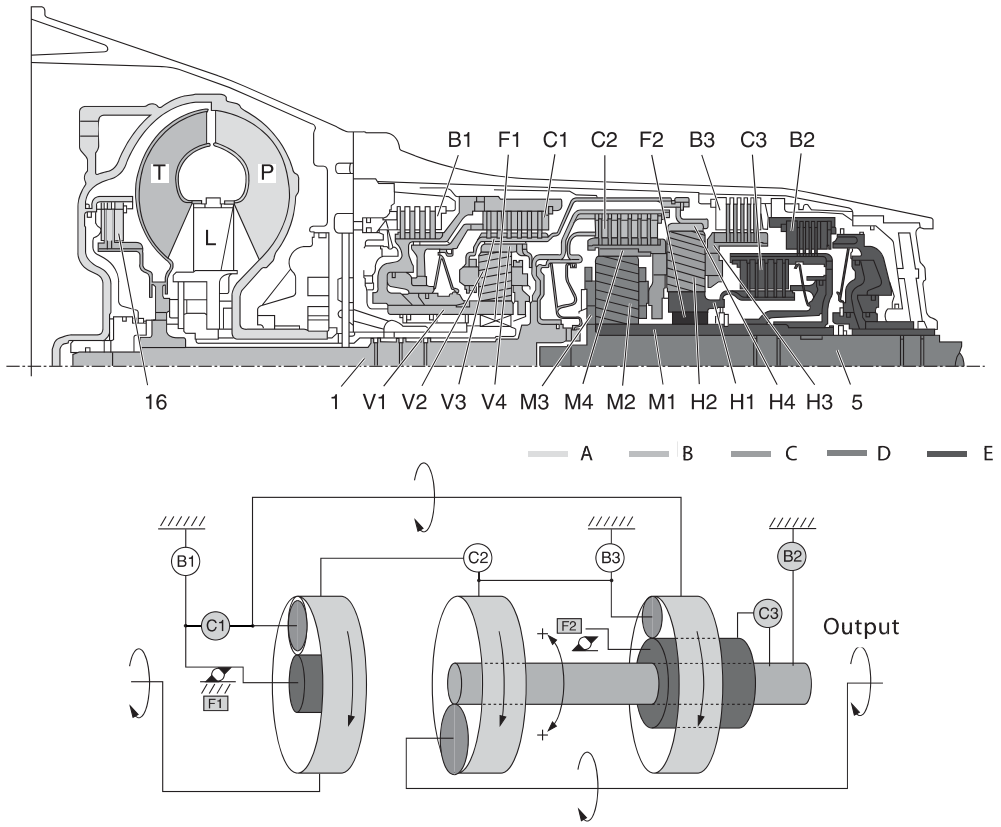
16. Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. 2nd gear ratio
E. 3rd gear ratio
F. Locking elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

1. Input shaft: Clockwise rotation
2. Front sun gear: Locked by F1 and B1, Planetary gear carrier: Rotation with reduced speed
3. Rear ring gear: clockwise rotation
4. Rear sun gear: Locked by F2 and B2, Planetary gear carrier: Clockwise rotation with reduced speed
5. Center ring gear: Clockwise rotation
6. Center sun gear: Locked by B2, Rotation with reduced speed
7. Output shaft: Clockwise rotation

Gear	C1	C2	C3	B1	B2	B3	F1	F2	Lockup clutch
1			● 3)	● 3)	●		●	●	

※ 3) Overrun

2) 2nd Gear (D20DT: 2.423, D27DT: 2.186)



16. Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. 2nd gear ratio
E. Locking elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

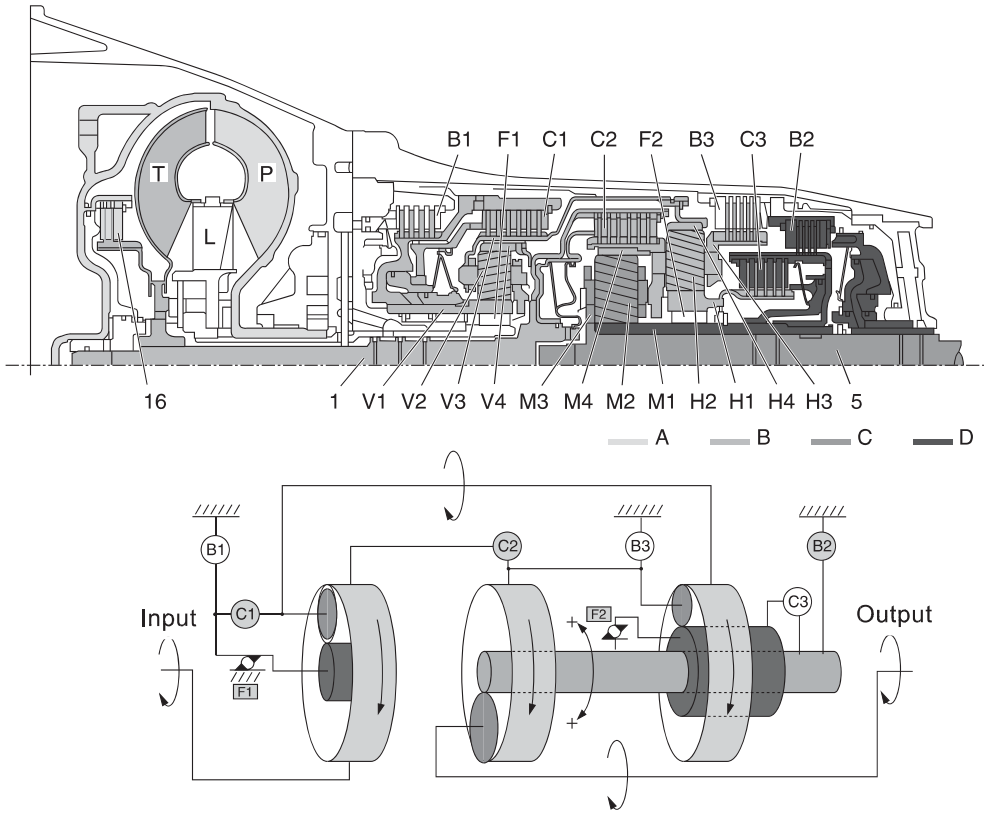
1. Input shaft: Clockwise rotation
2. Sun gear and planetary gear carrier: Clockwise rotation by C1 activation
3. Rear ring gear: Clockwise rotation
4. Rear sun gear: Locked by F2 and B2, Planetary gear carrier: Rotation with reduced speed
5. Center ring gear: Clockwise rotation
6. Sun gear: Locked by B2, Planetary gear carrier: Rotation with reduced speed
7. Output shaft: Clockwise rotation

Gear	C1	C2	C3	B1	B2	B3	F1	F2
2	●		● 3)		●			●

※ 3) Overrun

Modification basis	
Application basis	
Affected VIN	

3) 3rd Gear (D20DT: 1.486, D27DT: 1.405)

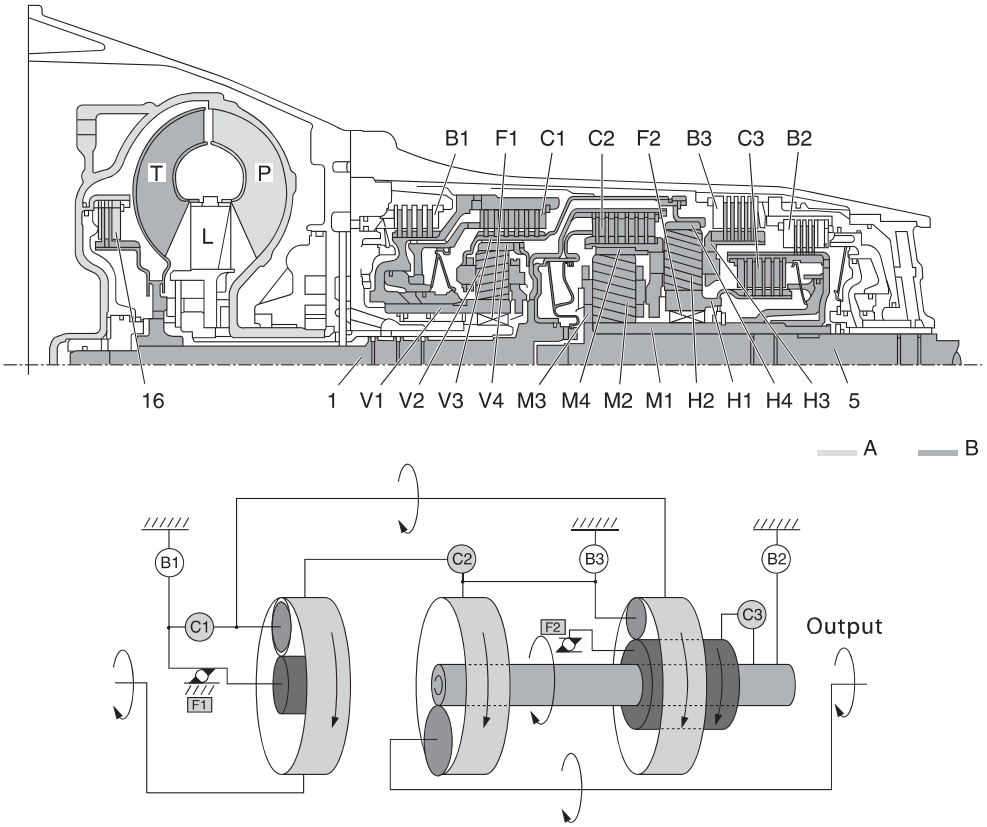


16. Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. Locking elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

1. Input shaft: Clockwise rotation
2. Front ring gear: Clockwise rotation
3. Center ring gear: Clockwise rotation by clutch 2 activation (direct connection)
4. Center sun gear: Locked by B2, Planetary gear carrier: Clockwise rotation with reduced speed
5. Output shaft: Clockwise rotation

Gear	C1	C2	C3	B1	B2	B3	F1	F2
3	●	●			●			

4) 4th Gear (1.000)



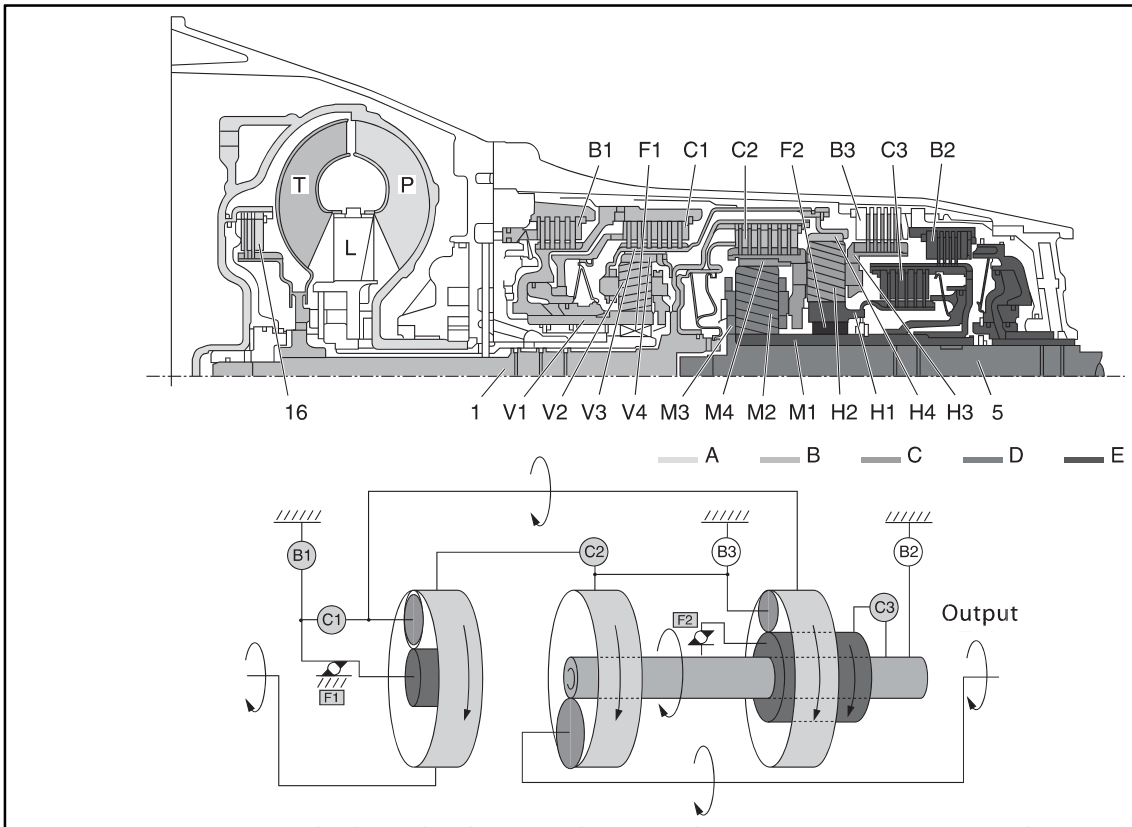
16. Torque converter lockup clutch
L. Stator
T. Turbine wheel
A. Engine speed
M. Center planetary gear set
V. Front planetary gear set
B. Planetary gear set
P. Impeller

1. Input shaft: Clockwise rotation
2. Front ring gear: Clockwise rotation
3. Center ring gear and rear planetary gear carrier: Clockwise rotation
4. Front sun gear and planetary gear carrier: Clockwise rotation (direct connection)
5. Rear ring gear: Clockwise rotation
6. Rear sun gear: Rotation by ring gear and planetary gear carrier (direct connection)
7. Center sun gear: Clockwise rotation by C3 activation
8. Planetary gear carrier: Clockwise rotation by center sun gear and ring gear (direct connection)
9. Output shaft: Clockwise rotation

Gear	C1	C2	C3	B1	B2	B3	F1	F2
4	●	●	●					

Modification basis	
Application basis	
Affected VIN	

5) 5th Gear (D20DT: 0.833, D27DT: 0.831)



16. Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. 2nd gear ratio
E. 3rd gear ratio
F. Locking elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

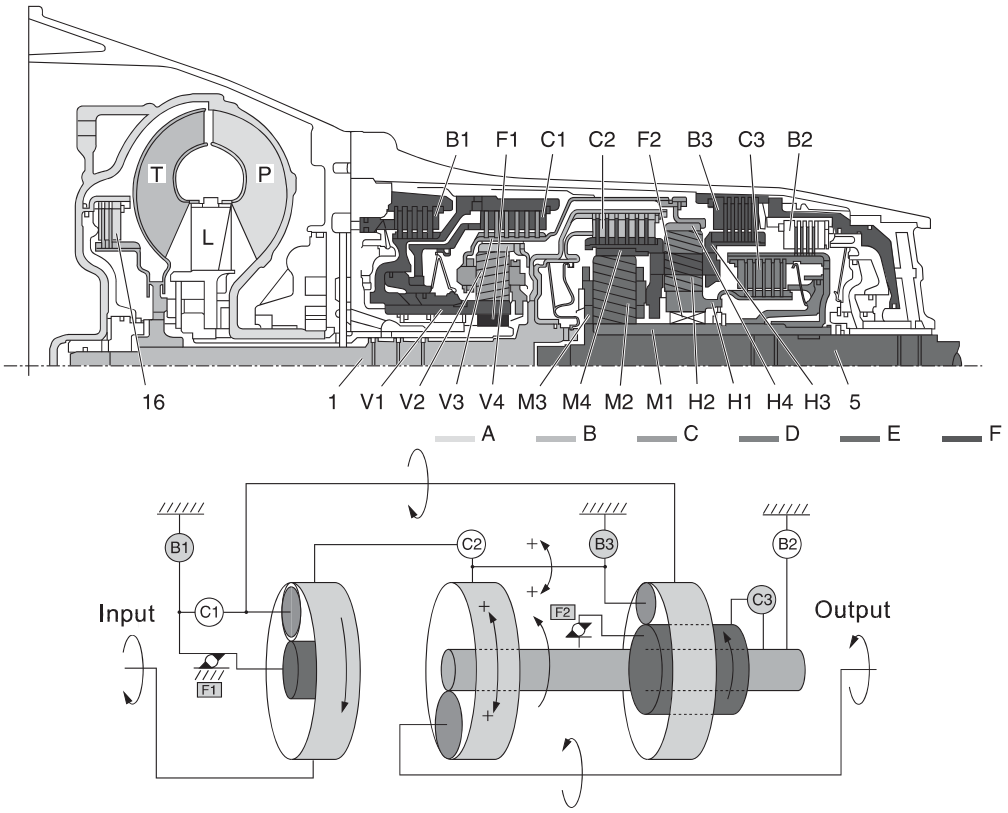
1. Input shaft: Clockwise rotation
2. Front sun gear: Locked by B1, Planetary gear carrier: Rotation with reduced speed
3. Rear planetary gear ring gear: Clockwise rotation with reduced speed
4. Center ring gear and rear planetary gear carrier: Clockwise rotation by clutch C2 activation
5. Rear sun gear: Clockwise rotation because rear planetary gear carrier rotates faster than rear ring gear(increased speed)
6. Center sun gear: Clockwise rotation with increased speed by clutch C3 activation
7. Center planetary gear carrier: Clockwise rotation (increased speed)
8. Output shaft: Clockwise rotation (increased speed)

Gear	C1	C2	C3	B1	B2	B3	F1	F2
5		●	●	● 3)			●	

※ 3) Overrun

6) Reverse 1st Gear (D20DT: 3.147, D27DT: 3.167)

- Standard (S) Mode



16. Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. 2nd gear ratio
E. Locking elements
F. Locking elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

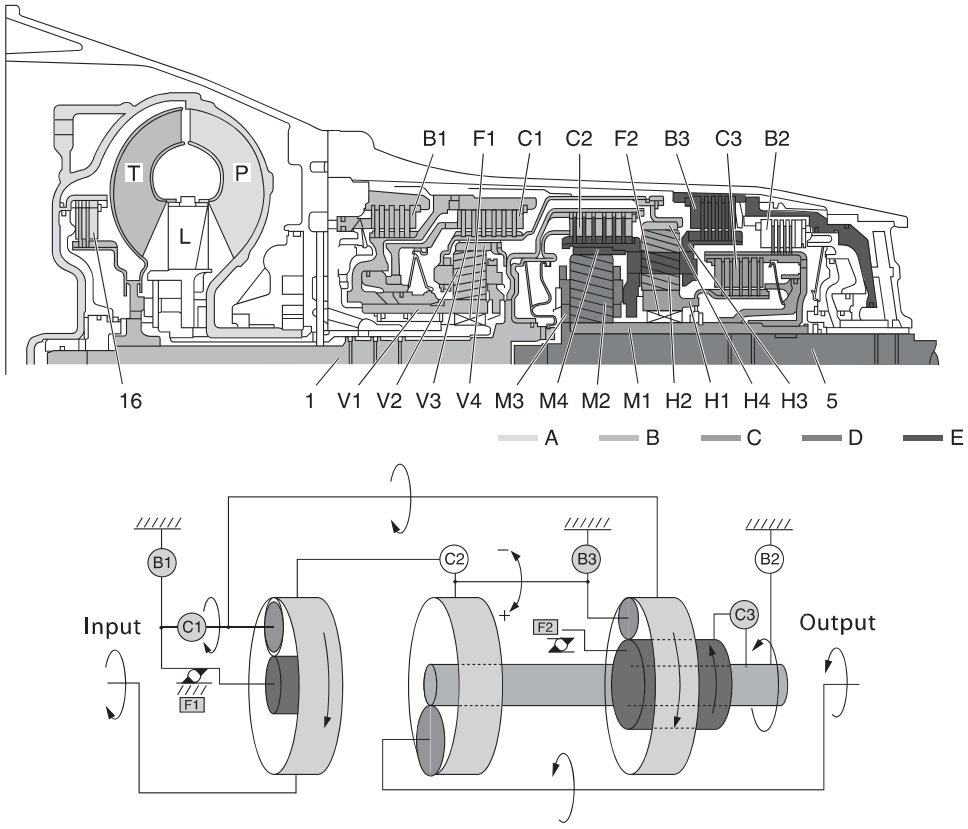
1. Input shaft: Clockwise rotation
2. Front ring gear: Clockwise rotation
3. Front sun gear: Locked by one-way clutch F1
4. Front planetary gear carrier: Clockwise rotation (reduced speed)
5. Rear planetary gear ring gear: Clockwise rotation
6. Rear planetary gear carrier: Locked by B3
7. Rear sun gear and center sun gear: Counterclockwise rotation (increased speed)
8. Center ring gear: Locked by B3
9. Center planetary gear carrier: Counterclockwise rotation (reduced speed)
10. Output shaft: Counterclockwise rotation

Gear	C1	C2	C3	B1	B2	B3	F1	F2
R (S)			●	● 3)		●	●	

※ 3) Overrun

Modification basis	
Application basis	
Affected VIN	

7) Reverse 2nd Gear (D20DT: 1.93, D27DT: 1.926) - Winter (W) Mode Mode



16. Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. 2nd gear ratio
E. Locking elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

1. Input shaft: Clockwise rotation
2. Front ring gear: Clockwise rotation
3. Front planetary gear carrier: Clockwise rotation by clutch C1 activation (direct connection)
4. Rear ring gear: Clockwise rotation
5. Rear planetary gear carrier and center ring gear: Locked by brake B3
6. Rear sun gear and center sun gear: Counterclockwise rotation (increased speed)
7. Center planetary gear carrier: Counterclockwise rotation (reduced speed)
8. Output shaft: Counterclockwise rotation

Gear	C1	C2	C3	B1	B2	B3	F1	F2
R (W)	●		●			●		

TGS LEVER

3721-01

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW

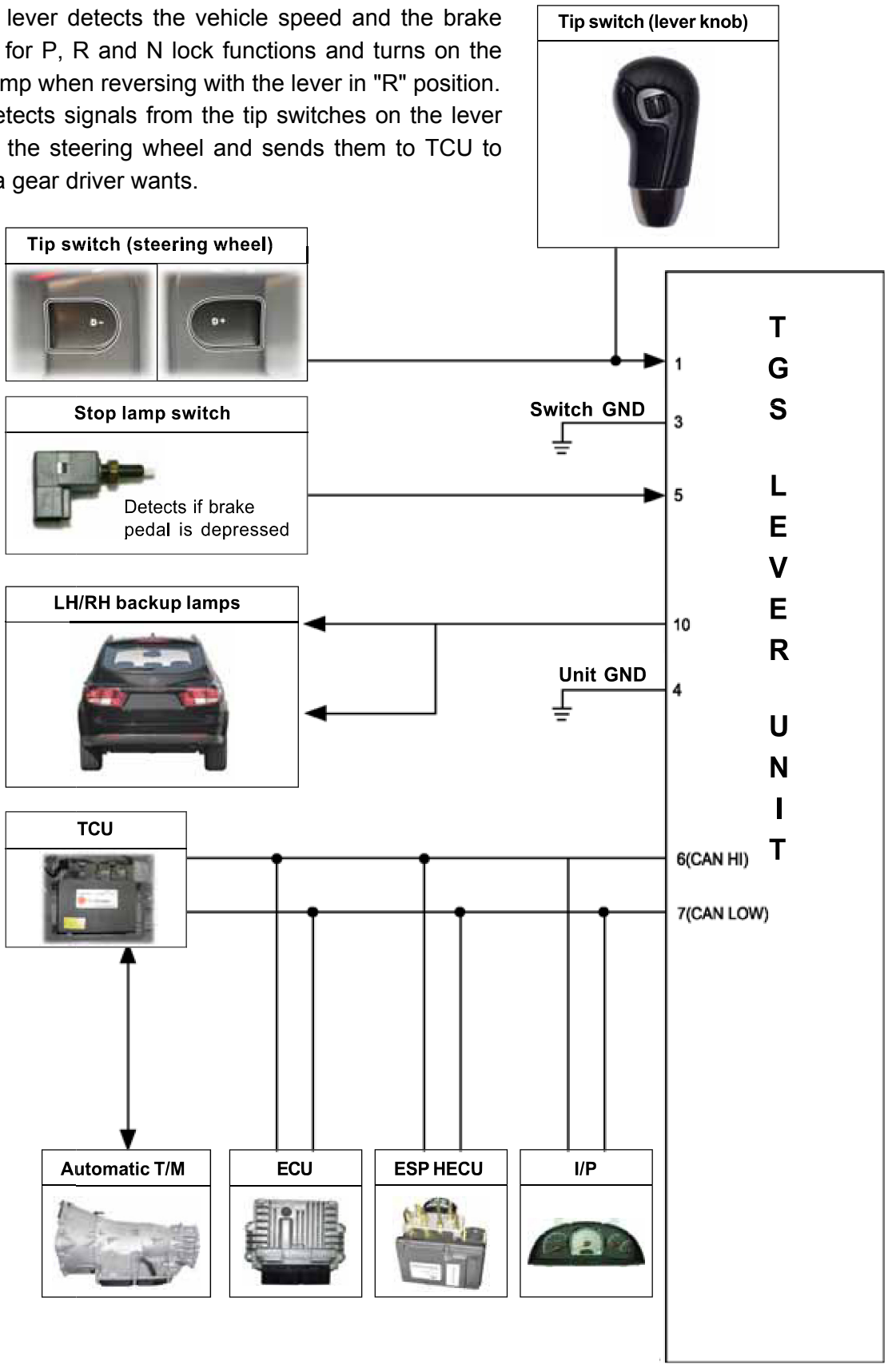
The TGS lever communicates with TCU (Transmission Control Unit), ECU (Engine Control Unit), ESP HECU and instrument panel to let the driver shift to desired gear as well as to keep desired driving conditions. The tip switches installed on the lever knob and the steering wheel is for selecting gears manually with the selector lever in the "M" position. The tip switches on the steering wheel is for driver's convenience especially when driving on bumpy road (during engine braking). Gear shifting with the tip switches is only possible when the selector lever is in the "M" position. For safety reason, it is possible to move the selector lever from the "N", "P" or "R" position to any other positions only when the ignition key is in the "ON" position and the brake pedal is depressed (N, P and R lock functions). The TGS lever of KYRON from March '07 is the same as the one of REXTON II in the aspect of the system, but the knob, the top cover, the lever, the bracket and the rod is newly designed due to differences of the shape of the lever mounting body.

2. LOCATIONS AND COMPONENTS

Modification basis	
Application basis	
Affected VIN	

3. INPUT/OUTPUT OF TGS LEVER

The TGS lever detects the vehicle speed and the brake operation for P, R and N lock functions and turns on the backup lamp when reversing with the lever in "R" position. Also, it detects signals from the tip switches on the lever knob and the steering wheel and sends them to TCU to shift into a gear driver wants.



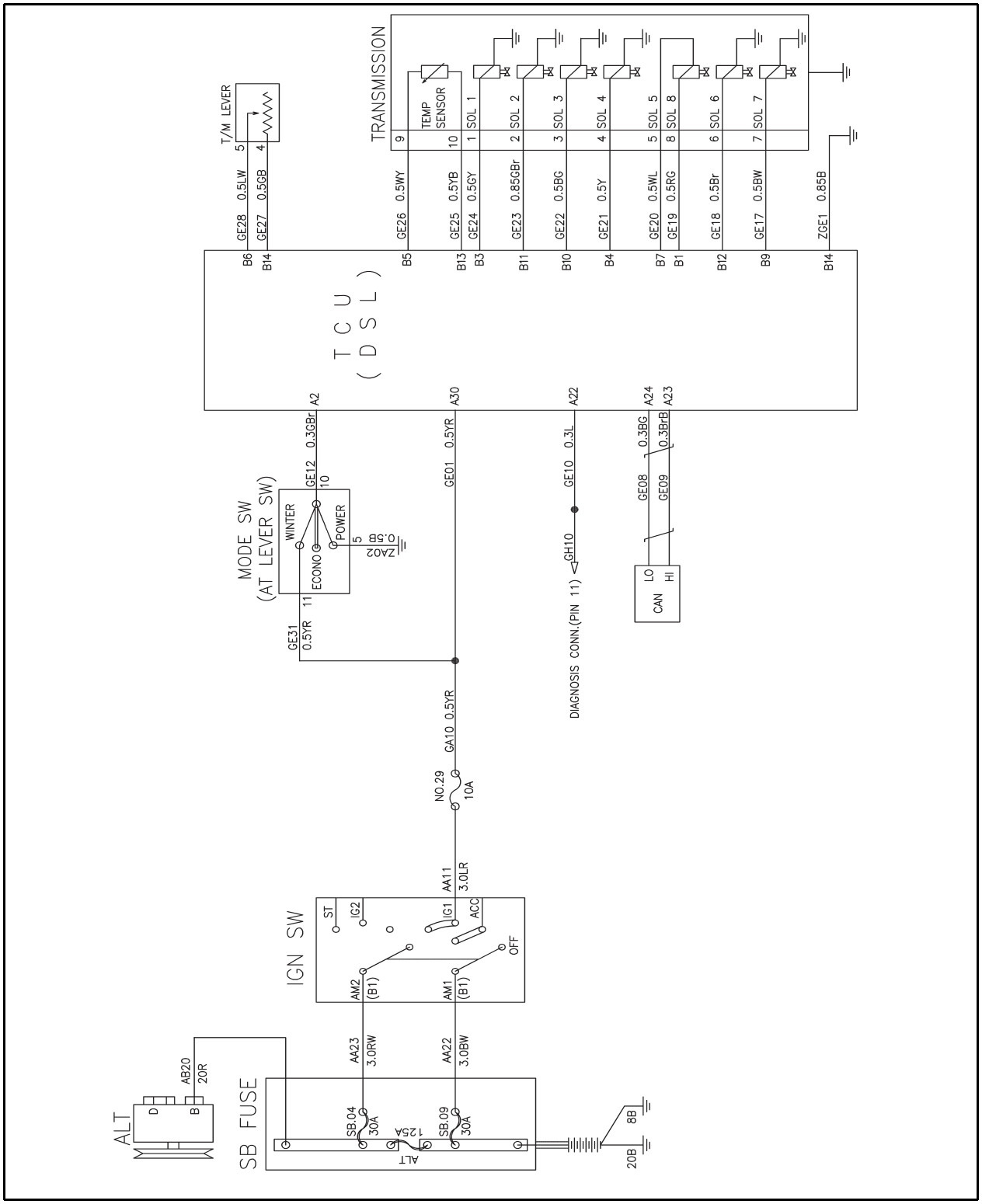
Modification basis	
Application basis	
Affected VIN	

T/M LEVER

3170-01

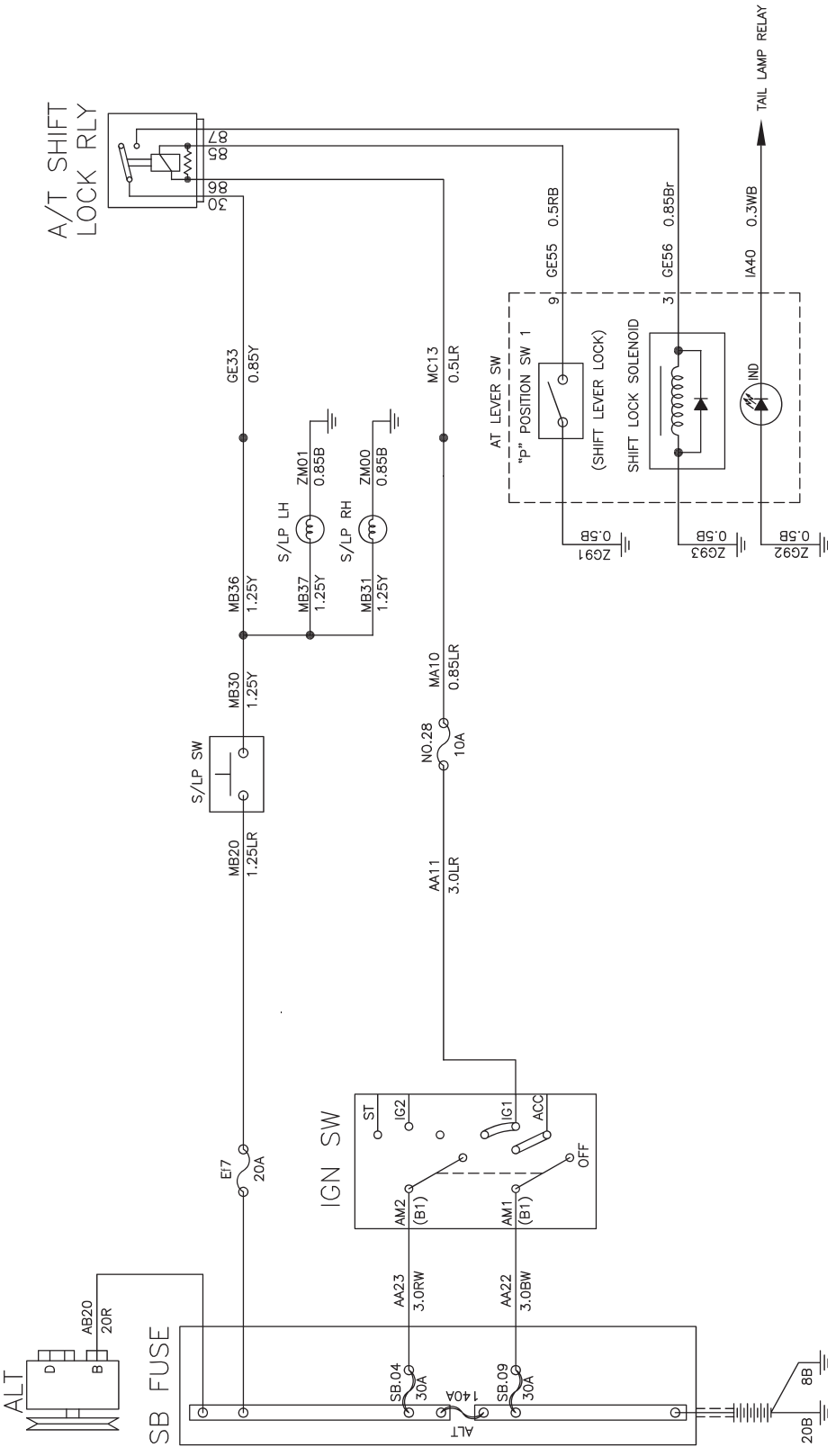
OVERVIEW AND OPERATION PROCESS

1. CIRCUIT OF ION 4-SPEED AUTOMATIC T/M



Modification basis	
Application basis	
Affected VIN	

2. CIRCUIT OF SHIFT INTER LOCK

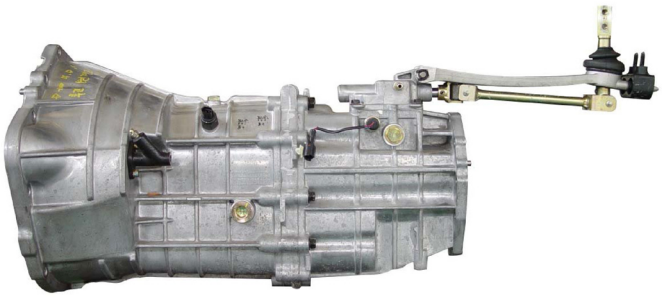


Modification basis	
Application basis	
Affected VIN	

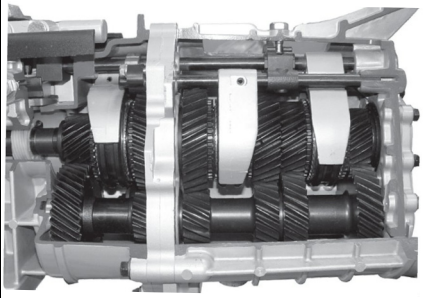
GENERAL

1. OVERVIEW AND CHARACTERISTICS OF MANUAL TRANSMISSION

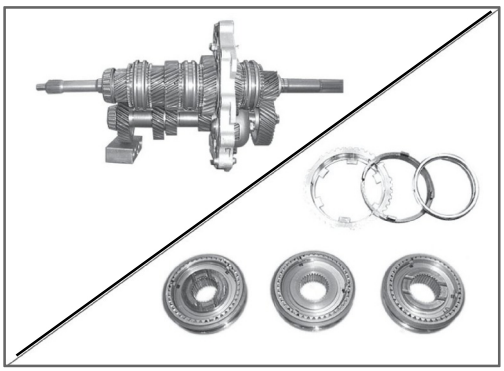
1) SYSTEM COMPONENTS



Inside



Front View



(1) Features

1. All gears use the helical type and high strength materials.

CAUTION

- The helical type gear prevents the axial gear missing and provides less noise.

2. The semi-remote control type gear shift mechanism is used to prevent incorrect shifting.
3. To improve the shifting performance, 3-piece double cone is used for 1/2 shift.
4. The synchronizing devices are installed in 1/2, 3/4, 5/R gears. To prevent the double engagement, the independent interlock devices are installed.

CAUTION

- TSM54/52 transmission uses the inertia lock type key to make smooth gear engagement and to provide silent gear engagement.

5. The clutch release system is available to use CSC (Concentric Slave Cylinder) or Fork type according to the vehicle model.

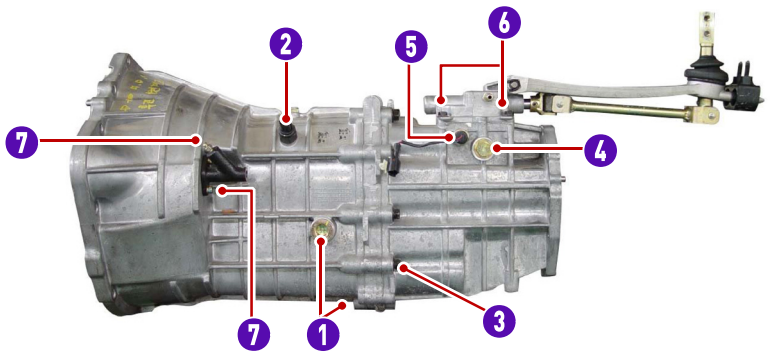
2. SPECIFICATIONS AND TIGHTENING TORQUE OF MANUAL TRANSMISSION

1) Specifications

Descriptio n		Specifications (D20DT, D27DT)
Length (mm)		628.3 mm
Distance between shafts (mm)		81 mm
Input torque (kg-m)		34.7 kg-m (340 Nm)
Transmission control type		Semi-remote
Weight (kg) - not including transmission fluid		44 kgm
Gear ratio/Gear teeth (input gear: main gear)	1st gear	4.315
	2nd gear	2.475
	3rd gear	1.536
	4th gear	1.000
	5th gear	0.807
	Reverse gear	3.919
Transmission fluid	Specification	ATF DEXRON II
	Capacity (ℓ)	3.6 ℓ / 3.4 ℓ (4WD / 2WD)
	Change interval	Inspect at every 10,000 km, replace at every 60,000 km (add or replace if necessary)

2) Tightening Torque

Descriptio n	Tightening Torque
1. Oil drain plug & filler plug	40 ~ 50 Nm
2. Backup lamp switch (24 mm)	30 ~ 40 Nm
3. Extension housing bolt (14 mm)	42 ~ 57 Nm
4. Extension housing spring plug (27 mm)	70 ~ 100 Nm
5. Neutral switch	30 ~ 40 Nm
6. Shift top cover bolt (12 mm)	17 ~ 26 Nm
7. Concentric slave cylinder adapter bolt	10 ~ 16 Nm

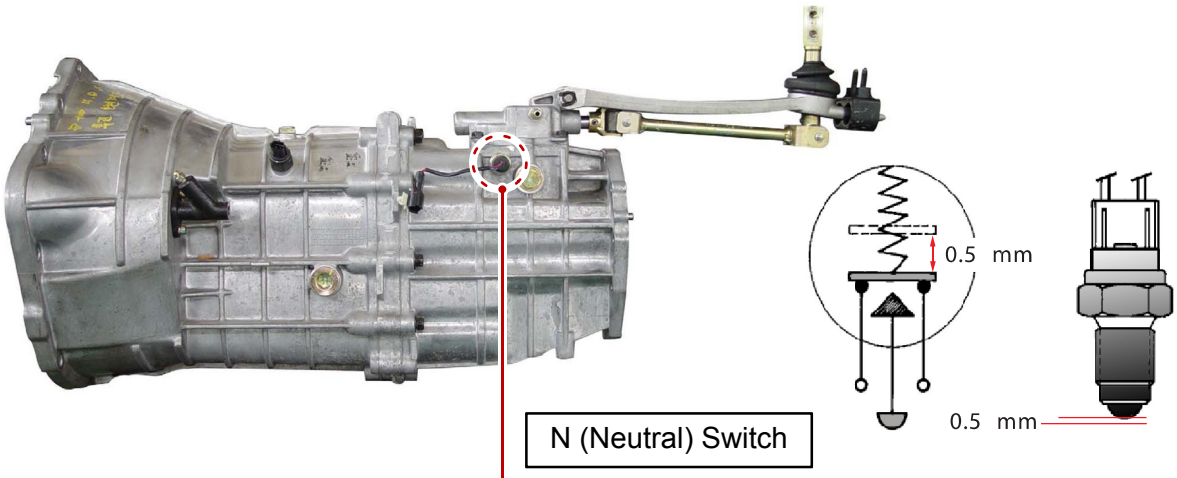


Modification basis	
Application basis	
Affected VIN	

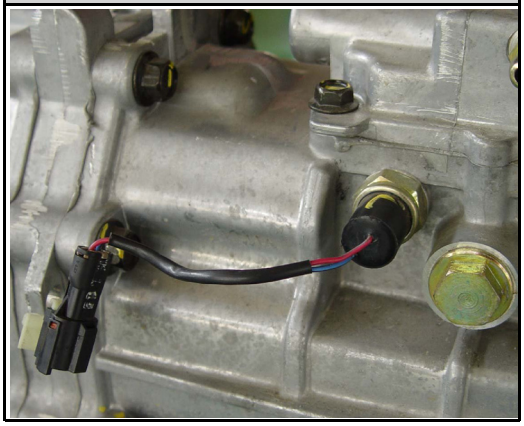
OVERVIEW AND OPERATION PROCESS

1. MANUAL TRANSMISSION SYSTEM

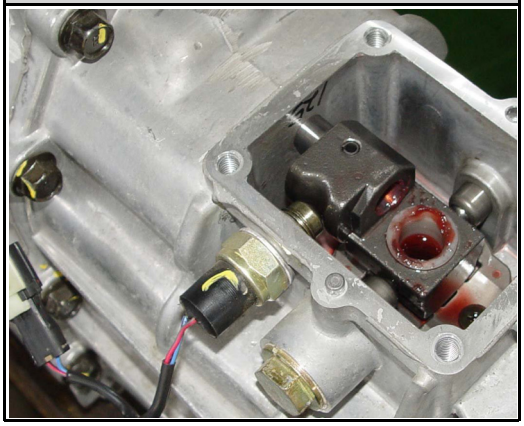
1) Neutral Switch



Outside N Switch



Inside N Switch



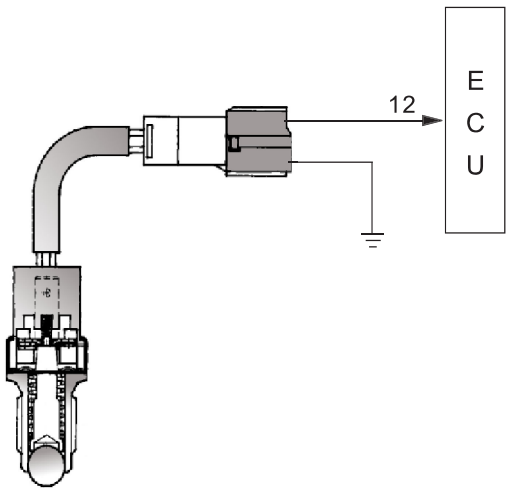
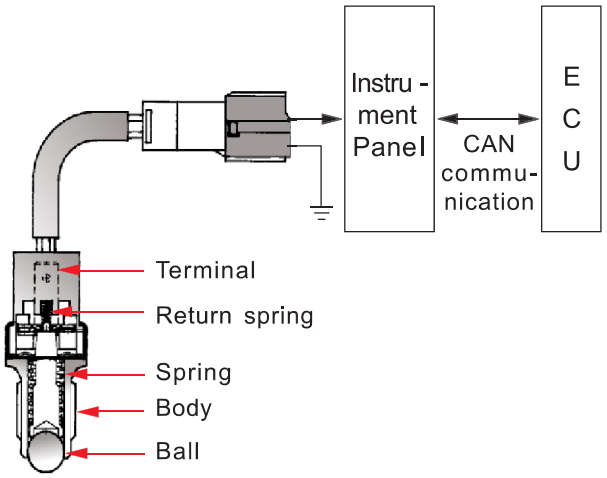
2) Function of N Switch

▶ **Aids a smooth start of the vehicle by raising the RPM during the gear shifting when the engine is cold.**

When the vehicle is trying to start from the stopped state (vehicle speed below 3 km/h), the N switch determines the shifting timing by using the clutch switch and the N switch. It raises the engine RPM (100 ~ 200 rpm). Operation conditions are as follows.

- The vehicle speed is at the stopped state (Vehicle speed below 3km/h detection).
- While depressing the clutch (Clutch switch detection).
- The gear lever is at a position other than neutral (N switch detection).
- Start the vehicle while depressing the clutch pedal (Clutch switch detection).
- The RPM increases in accordance with the temperature of the engine coolant (Engine coolant temperature sensor detection).
  : appx. 100 rpm increase
  : appx. 100 ~ 170 rpm increase
  : appx. 80°C (normal temperature of the engine coolant): around 200 rpm increase
- When the gear has been smoothly shifted and the vehicle speed exceeds 3km/h, it returns to the previous operation interval of the engine RPM.

In case of Kyron, the N switch signal is transmitted to the instrument panel, and then the instrument panel transmits it to the engine ECU through the CAN communication.

Vehicle Made After 04.09.15	Kyron
	

Modification basis	
Application basis	
Affected VIN	

▶ **Detects the position of the shifting lever for the HDC operation among ABS/ESP functions.**

It is used for the second item of the 6 operation conditions of the ABS/ESP's HDC function.
Please refer to the ABS/ESP section for the specific information related to the HDC.

- HDC Operation switch ON **and**
- Forward/Reverse Shifting lever location **and**
  - · Manual transmission: operates in the 1st gear or reverse gear position (does not operate in the neutral position).
  - · Automatic transmission: possibly operates except in the P (parking) or N (neutral) position.

CAUTION

- The vehicle with the manual transmission does not have a separate device or switch that detects the 1st gear. It only detects the forward/reverse direction of the vehicle through the back-up light switch and the neutral switch, and cannot solely detect the 1st gear position. The reason for noting the 1st gear above, though the HDC also operates in the 2nd gear position, is because the engine may turn off during the HDC operation process. You may face a very dangerous situation if the engine turns off at a steep hill.
- The HDC aids the slowdown of the vehicle when driving down a steep hill and cannot sufficiently decelerate only with the engine brake. Thus, a driver must operate the HDC only in the 1st gear when driving a vehicle with the manual transmission.

- When not depressing the accelerator pedal or brake pedal. **and**
- The vehicle speed is above 7 km/h (based on the automatic transmission/4H drive mode). **and**
- The ESP's vehicle position control function and HBA function are not in operation. **and**
  - · The HDC is added to aid drivers when driving down the hill, but when any basic function of the ESP is in operation prior to the HDC system operation, the ESP takes priority over the HDC.
- The inclination of the driving road exceeds 10%.
  - · When the inclination of the driving road exceeds 10%, the HDC operates until the vehicle reaches the speed condition given in step 4).

When the Inclination is 10% ~ 20% During the HDC Operation
When depressing the accelerator pedal or brake pedal, it converts to the stand-by mode, and when depressing the accelerator pedal again, the HDC operates again. Therefore, driver may maintain a desired speed by repeating this depressing and releasing process of the accelerator pedal.
When the Inclination Exceeds 20% During the HDC Operation
When depressing the accelerator pedal, it converts to the HDC operation stand-by mode. When depressing the brake pedal, the HDC operation state is maintained and the braking power is enhanced. In this case, the HECU emits an abnormal noise and the brake pedal may feel very rigid, but this is a normal occurrence resulted from the HDC operation.

Overview of HDC Operation

HDC (Hill Descent Control) System

The HDC system is an automatic descent control device that allows the vehicle to automatically decelerate to about 7 km/h with increment of 0.1G, on steep roads (inclination exceeding 10%) through a separately installed switch operation. When the vehicle speed reaches below 7 km/h (refer to the information below), the HDC automatically terminates the operation.

The HDC does not have a separate sensor for the input signal and detects the inclination of hills by using the G sensor (acceleration sensor) in the sensor cluster.

A HDC Switch

When you see a steep downhill ahead, press the HDC switch and the green HDC indicator comes on. When the G sensor within the sensor cluster detects a inclination exceeding 10%, the ESP's HDC function operates. When this occurs, the green HDC indicator goes off along with a loud operation noise.

B Sensor Cluster

The G Sensor within the sensor cluster detects the inclination of driving roads. When the HDC switch is in operation, if the G sensor detects a downhill inclination exceeding 10%, it transmits the HDC operation signal to the ESP HECU.

Modification basis	
Application basis	
Affected VIN	

Ⓒ HDC Indicator (Instrument panel)	
	When pressing the HDC switch, the green HDC indicator on the instrument panel comes on, and when the HDC operates, the green HDC indictor blinks with 0.5 seconds of interval. HDC (Red Letters) HDC (Green Letters)

CAUTION

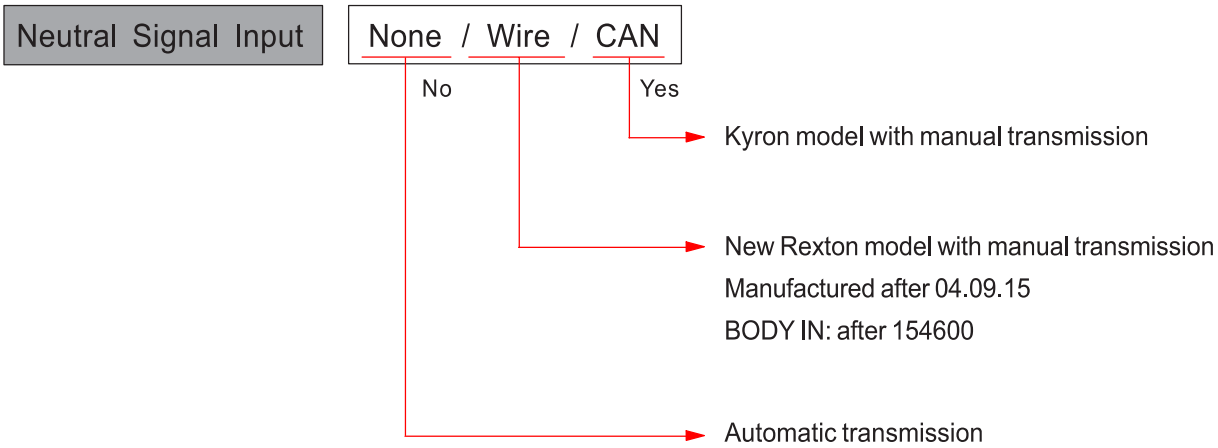
- The G sensor within the sensor cluster measures the actual road inclination. However, it may recognize a sharp turn or rough road as a downhill with a inclination exceeding 10%, and the HDC may operate.

※ For the specific information, please refer to the ABS/ESP section.

3) Variant Coding Related to N Switch

Kyron's N Switch transmits information to the ECU through the CAN communication while New Rexton is connected to the ECU through wires. Thus, if you set the variant coding in the engine ECU, you must do it differently, and you must set the variant coding differently according to the vehicle category and specification as below.

Variant Coding Options



Modification basis	
Application basis	
Affected VIN	

Memo

GENERAL

1. CLUTCH SPECIFICATIONS

Description		Specification
Operating type		Hydraulic
Clutch pedal	Type	Suspended
	Maximum pedal stroke	140 mm
	Pedal free play	5 ~ 15 mm
Clutch disc	Type	Single dry diaphragm
	Dimension of facing	240 × 160 × 3.5 mm / 240 × 155 × 4.0 mm
	Facing size/quantity	251 cm^2 / 2 / 263 cm^2 / 2
	Thickness of disc	Free: 8.4 ~ 9.0 mm / 9.55 ~ 10.5 mm When loaded: 7.7 ~ 8.3 mm / 8.9 ~ 9.5 mm
Clutch cover assembly setting force		Min. 680 kg / 490 ~ 570 kg
Clutch master cylinder	Stroke	30 mm
	Inner diameter	ϕ 17.46 mm
Concentric slave cylinder	Stroke	7.0 mm
	Sectional area	706 mm^2
Clutch fluid		DOT4

2. TIGHTTENING TORQUE

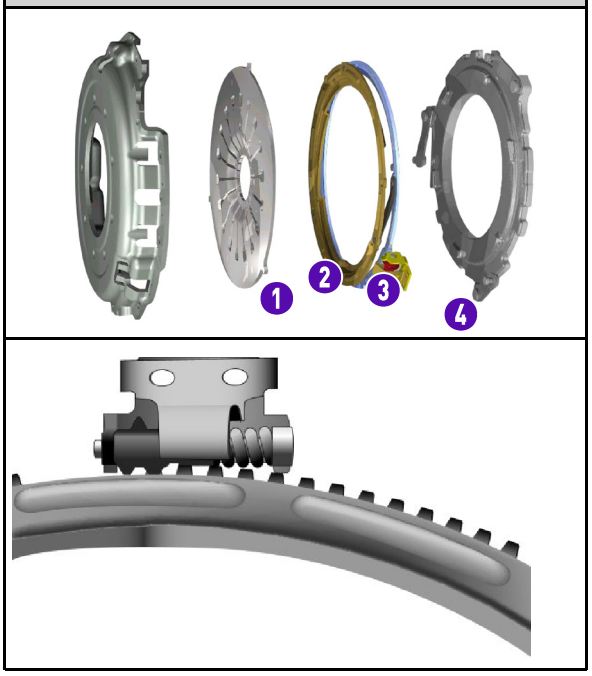
Description	Tightening Torque
Clutch housing bolt (8 locations)	49 ~ 59 Nm
Clutch cover (pressure plate) bolt	21 ~ 27 Nm
Concentric slave cylinder bolt (3 locations)	10 ~ 16 Nm
Concentric slave cylinder flare nut	20 ~ 25 Nm
Adapter flare nut	20 ~ 25 Nm
Clutch oil pipe flange nut	15 ~ 18 Nm
Master cylinder bolt	8 ~ 18 Nm
Fulcrum (clutch pedal bushing) bolt/nut	16 ~ 22 Nm
Clutch pedal bracket mounting bolt	8 ~ 18 Nm
Stopper bolt	16 ~ 22 Nm

OVERVIEW AND OPERATION PROCESS

1. FUNCTION AND OVERVIEW

1) SAT (Self Adjusting Technology) Clutch System

Internal Components of Clutch Cover



(1) Function

SAT is new clutch system which adjusts the clutch freeplay according to the wear of clutch disc.

(2) Operation description

- Diaphragm spring rotates the adjusting equipment as clutch disc is wearing and so, pressure plate is pushed to clutch disc side at the amount of wear.
- Disc wear (Free play) → Diaphragm spring (1) → Adjusting equipment (2 , 3) → Pressure plate (4)

2) Overview

▶ **Driving Elements**

The driving elements consist of two flat surfaces machined to a smooth finish.
One of these is the rear face of the engine flywheel and the other is the clutch pressure plate. The clutch pressure plate is fitted into a clutch steel cover, which is bolted to the flywheel.

▶ **Driven Elements**

The driven element is the clutch disc with a splined hub which is free to slide lengthwise along the splines of the input shaft.
The driving and driven elements are held in contact by spring pressure. This pressure is exerted by a diaphragm spring in the clutch cover pressure plate assembly.

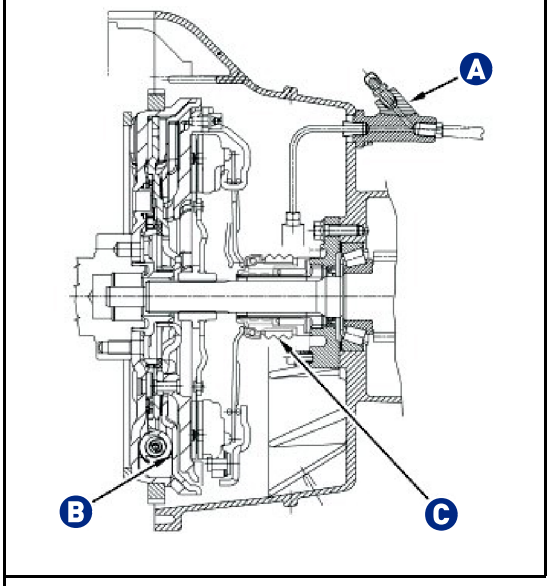
▶ **Operating Elements**

The clutch "release" system consists of the clutch pedal and clutch release cylinder.
This system directly releases the clutch by using hydraulic pressure while the conventional clutch system releases the clutch by using release lever and release fork. This system provides higher efficiency than conventional clutch system, and its durability is superior.
1) Clutch master cylinder (mounted on clutch pedal)
2) Concentric slave cylinder pipe (mounted inside of transmission)

Modification basis	
Application basis	
Affected VIN	

3) Functions

Components of Clutch Assembly

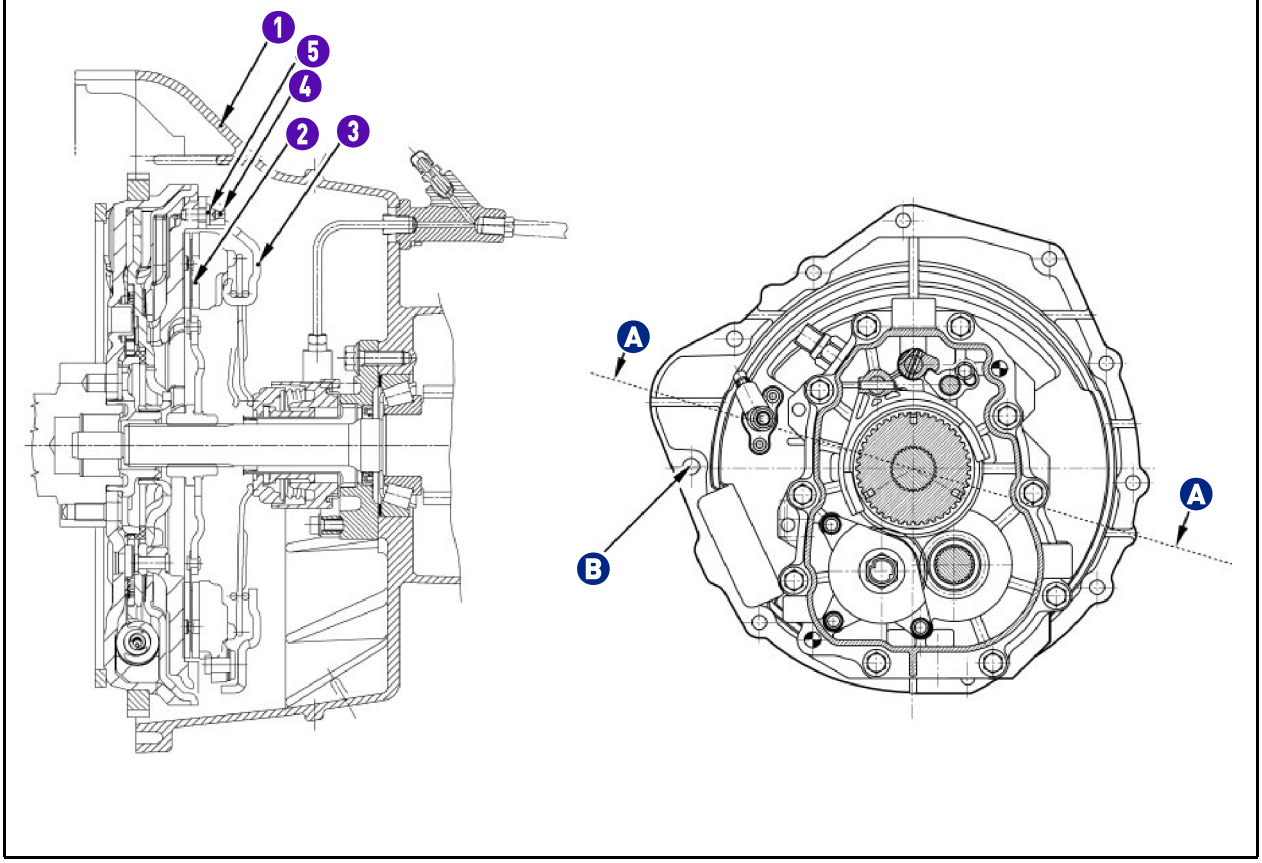


A Adapter/Pipe Assembly

B Clutch Assembly

C Concentric Slave Cylinder

Cross Sectional View of Clutch Assembly



1 Transmission housing
2 Clutch disc assembly
3 Clutch disc cover assembly
4 Bolt
5 Washer
6 Bolt

Modification basis	
Application basis	
Affected VIN	

GENERAL

1. AXLE SPECIFICATIONS

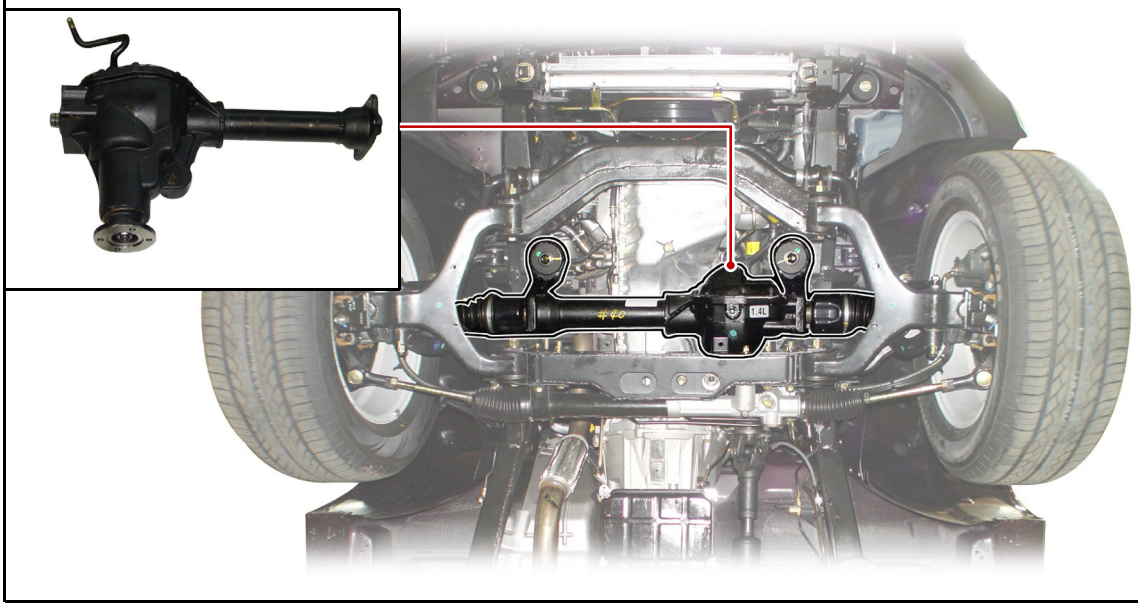
Location		Front axle				Rear axle	
Specification		M/T		A/T		Independent suspension	5-link
Torque		-		-		5,164 Nm	-
Gear ratio		D20DT	D27DT	D20DT	D27DT	←	←
		4.27	3.91	3.54	3.31		
Gear	Type	→		→		Hypoid	←
	Size	f 198.1 mm		←		218 mm (diameter)	f 243.8 mm
	Offset	30 mm		←		Less than 30 mm	-
Housing		Steel casting (steel, aluminum cover)		←		Aluminum die casting	Steel casting (steel, aluminum cover)
Oil	Specification	SAE 80W/90		←		SAE 75W/90 (Synthetic)	SAE 80W/90
	Capacity	1.4 L		1.4 L		1.5 L	1.9 L
Length		448.0 mm		←		412 mm	469.0 mm
Width		681.9 mm		←		292 mm	1717.7 mm
Weight		45 kg		←		30 kg	100 kg

OVERVIEW AND OPERATION PROCESS

1. AXLE OVERVIEW

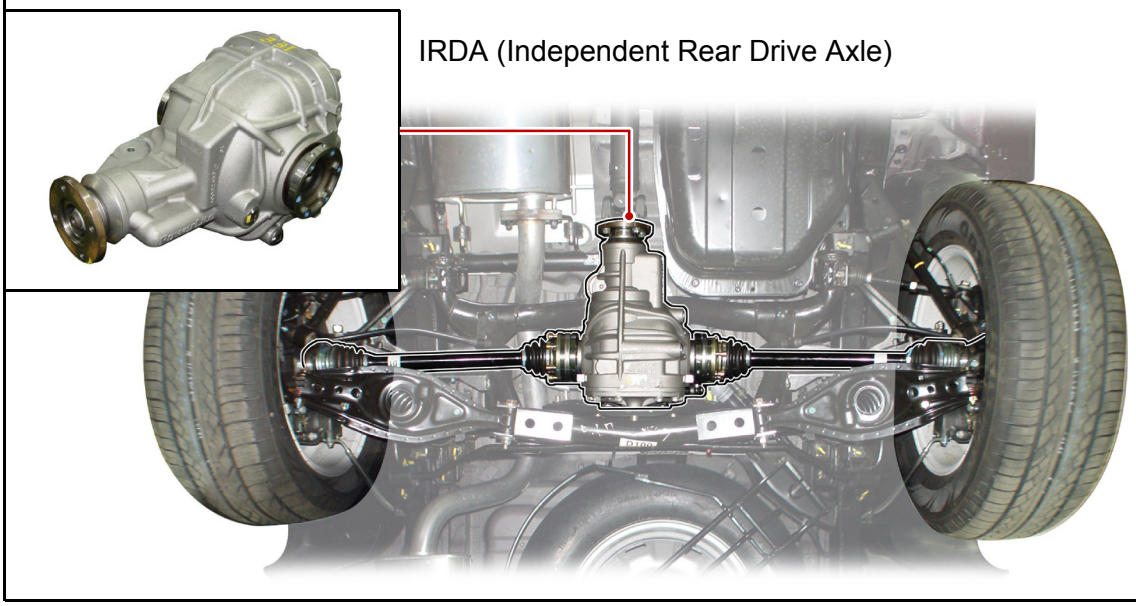
Compared to previous models, in addition to existing 5-link suspension, the IRDA (Independent Rear Drive Axle) is adopted for the independent type suspension in this vehicle.
The below figures for rear axle show the rear axle with the independent type suspension (4WD, A/T).

Front Axle



Rear Axle

IRDA (Independent Rear Drive Axle)



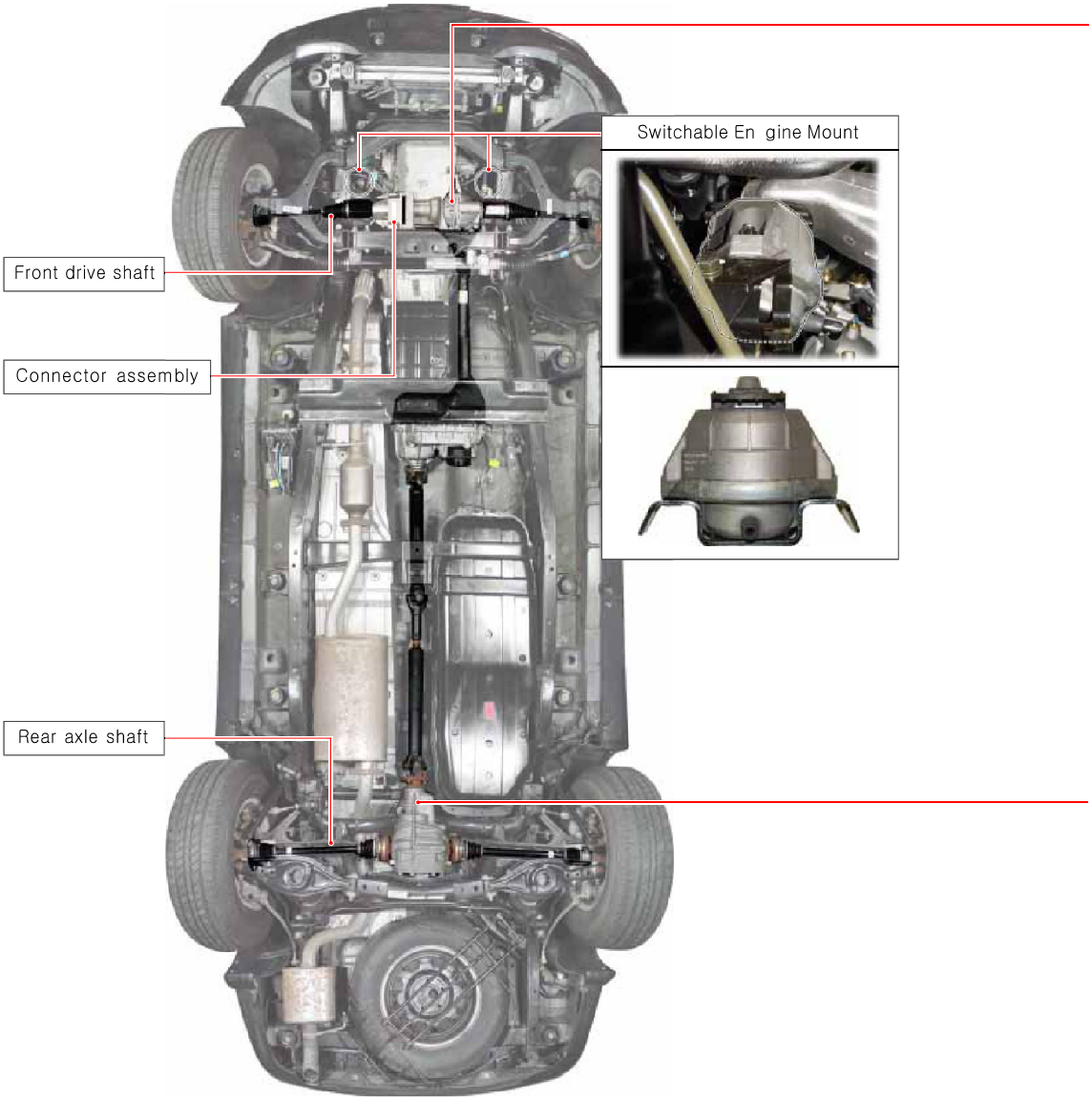
Modification basis	
Application basis	
Affected VIN	

AXLE (IOP) 4210-01

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW

The 2007 Kyron is equipped with different types of front and rear axles.
As the IOP axle is installed, AWD (All Wheel Driver) transfer case and the switchable engine mount are installed.



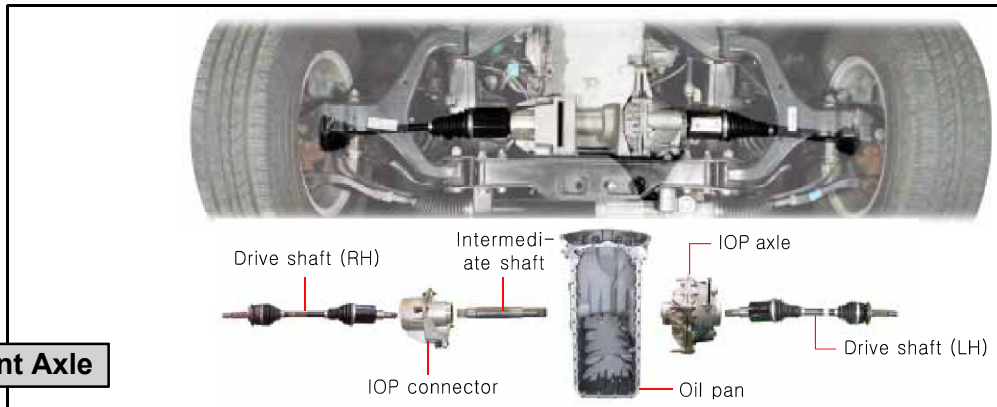
This vehicle is equipped with front IOP axle system and IRDA with new technology.

Modification basis	
Application basis	
Affected VIN	

Front Axle

IOP axle

The IOP front axle is integrated with the engine oil pan so that the engine mounting height is lowered and the engine vibration is reduced.



Conventional axle (Non IOP axle)

Rear Axle

5-link type rear axle (semi floating type: integrated type)

Independent suspension type rear axle (IRDA)

There is not much different in the rear axle system. However, as EAS and EPB with new technology are adopted, suspension specification and rear axle module have been changed.

2. WHEEL ALIGNMENT

Items		Before alignment	After alignment				Remarks
			Kyron		Actyon	Actyon Sports	
Front	Camber	-0.19° ± 0.3°	LH	-0.19° ± 0.25°	←	-0.19° ± 0.3°	The adjustment values for LH and RH side are different for Kyron and Actyon.
			RH	-0.29° ± 0.25°	←		
	Caster	4.4° ± 0.5°	LH	4.4° ± 0.4°	←	4.4° ± 0.5°	
			RH	4.5° ± 0.4°	←		
	Toe-in	22 mm (0 ~ 4 mm)	22mm (0 ~ 4mm)		←	←	-
Rear	Camber	-0.79° ± 0.18°	←		-	-	Applied only to Kyron's IRS type
	Total toe	0.19° ± 0.18° (22 mm)	←		-	-	No specific adjustment value

▶ Actions

1. Before performing the wheel alignment, unload all the items from the vehicle.
2. When setting the wheel alignment tools, the above adjustment values should be followed.
3. The difference of the front camber and the caster at both ends should be below 30' (0.5°).

Modification basis	
Application basis	
Affected VIN	

PART TIME TRANSFER CASE & LOCKING HUB SYSTEM 3240-01

GENERAL

1. PART TIME TRANSFER CASE OVERVIEW

By using the planetary gear sets, two-gears shift type part time transfer case achieves direct connection when selecting 4WD "HIGH" and 2.48 of reduction gear ratio when selecting 4WD "LOW". The silent chain in transfer case transfers the output power to front wheels.
The simple operation of switches on instrument panel allows to shift between "2H" and "4H" easily while driving (for 4L: stop vehicle first). The warning lamp warns the driver when the system is defective.

The 4WD system integrated in KYRON does not have big difference in comparison to the conventional part time transfer case, but the changes in comparison to the conventional transfer case are as follows:

- No additional coding is required when replacing TCCU.
- Delete the devices (tone wheel speed sensor, wiring etc.) related to the speed sensor in the transfer case.
  This system receives the speed signals from ABS/ESP HECU or instrument panel (for non-ABS vehicle(Note 1) through the CAN communication.
- The new TCCU is available to install on the vehicle with the conventional DI engine part time TCCU.

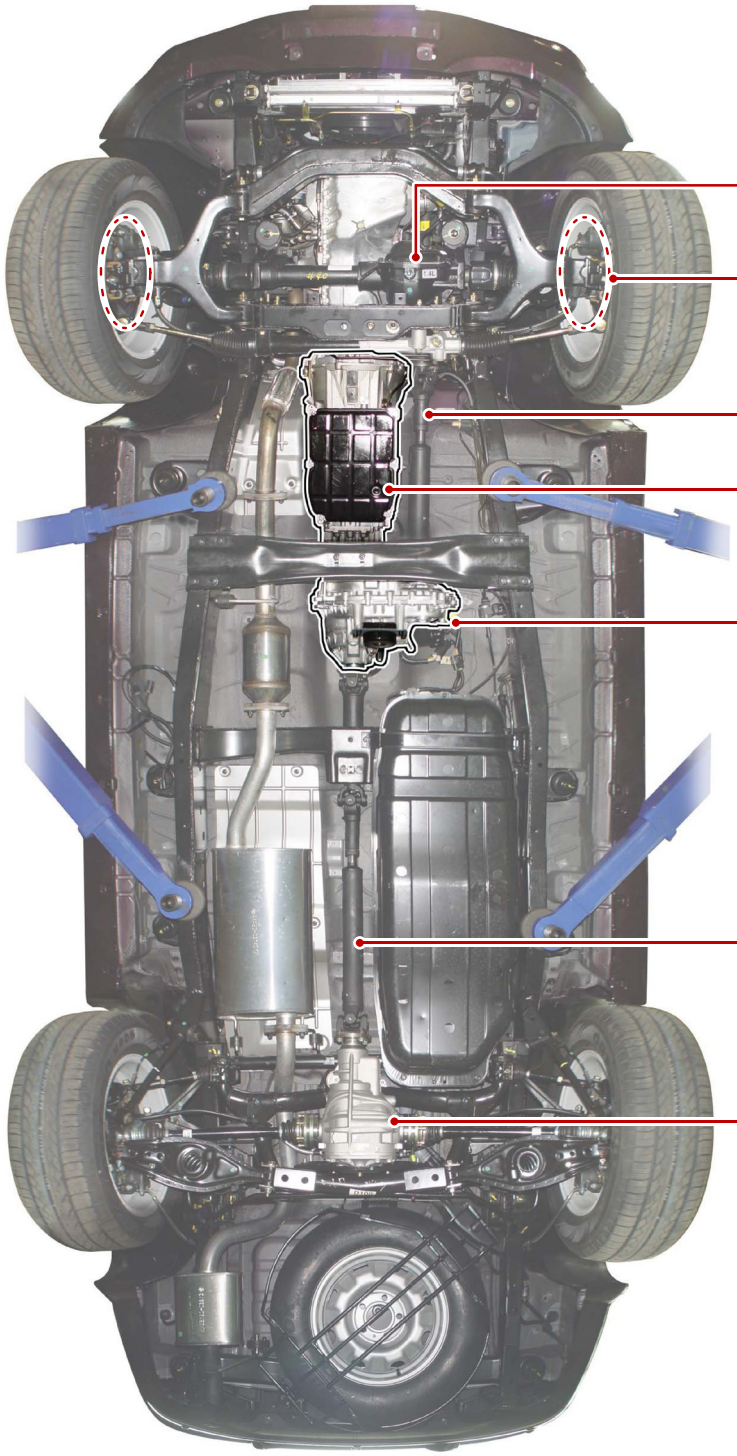
CAUTION
- In non-ABS vehicle, the vehicle speed sensor is installed on the rear drive axle. The engine ECU sends the speed signal to the instrument panel, and then the instrument panel provides the information to TCCU and other devices.

2. PART TIME TRANSFER CASE SPECIFICATIONS

Descriptio n		Part Time T/C
Total length		343 mm
Mating surface of front flange		40 mm
Weight		33.9 Kg (without oil)
Oil capacity		1.4 L
Location		Transfer case
Major elements	Housing	Part time
	Tightening bolt	11EA, M8 x 1.25
	Input shaft	A/T: External spline M/T: Internal spline
	Ring gear	Inserted into housing groove
	Sun gear	Separated input shaft and sun gear

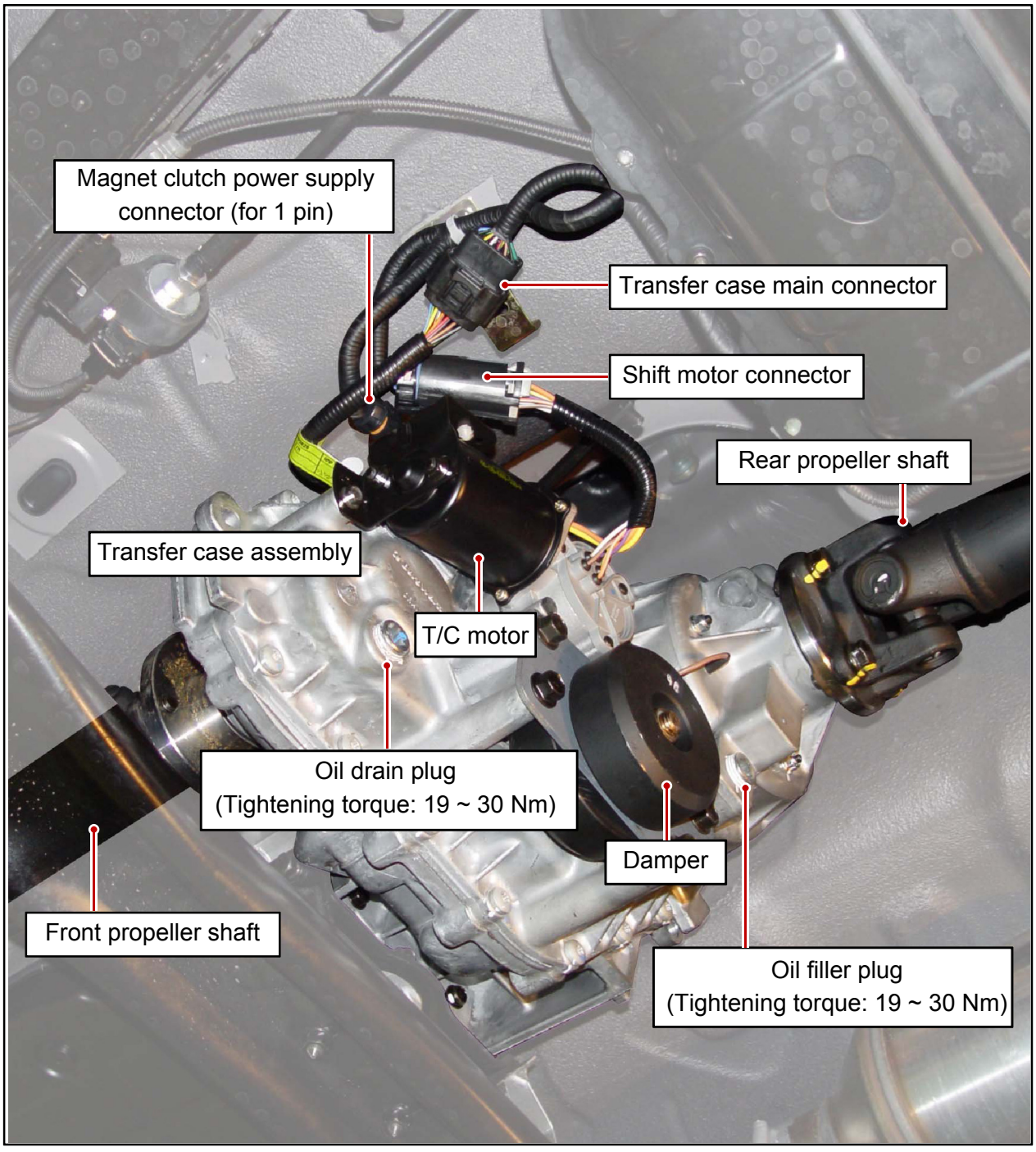
OVERVIEW AND OPERATION PROCESS

1. STRUCTURE



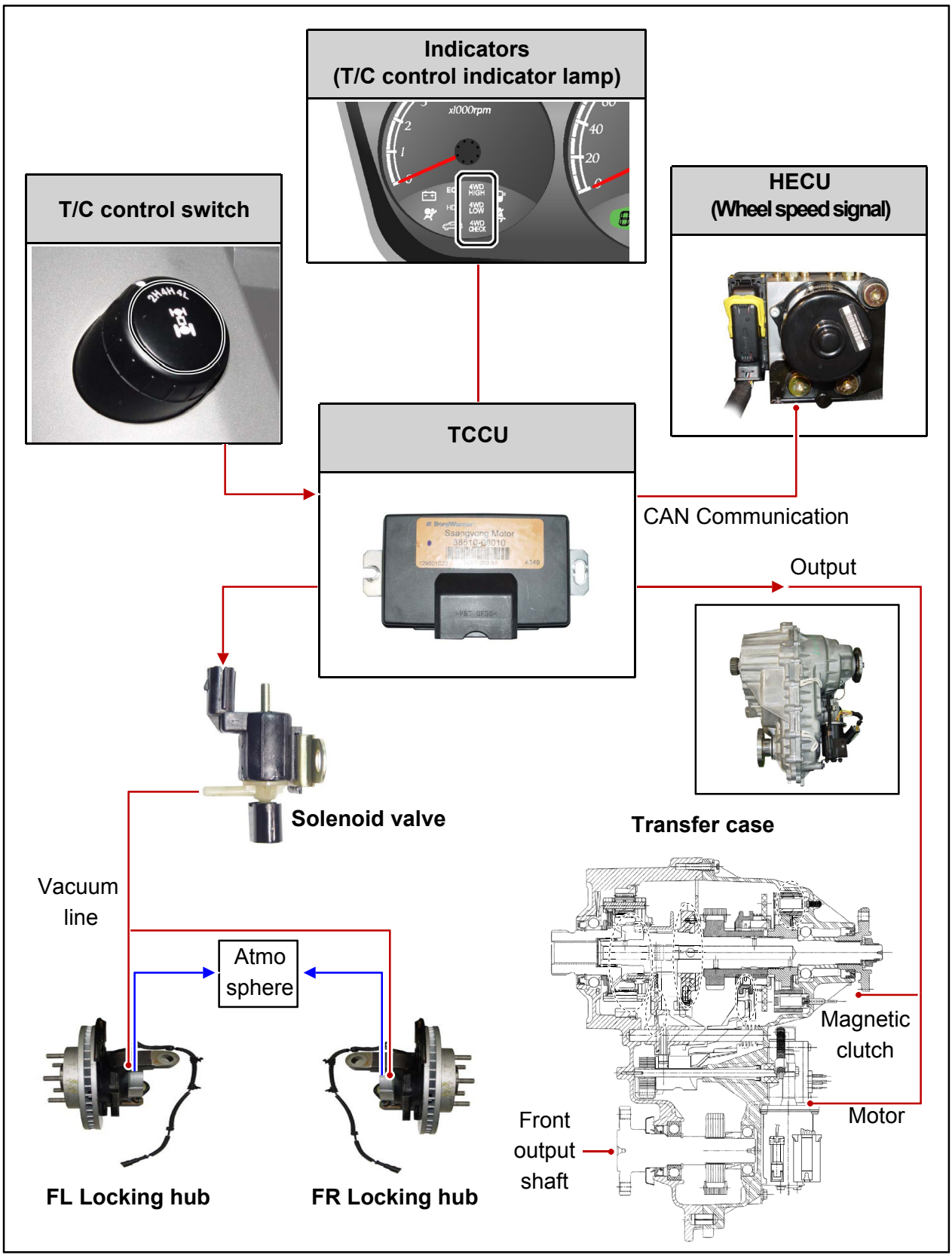
Modification basis	
Application basis	
Affected VIN	

1) Components Location



2. SYSTEM LAYOUT AND FUNCTIONS

1) System Layout



Modification basis	
Application basis	
Affected VIN	

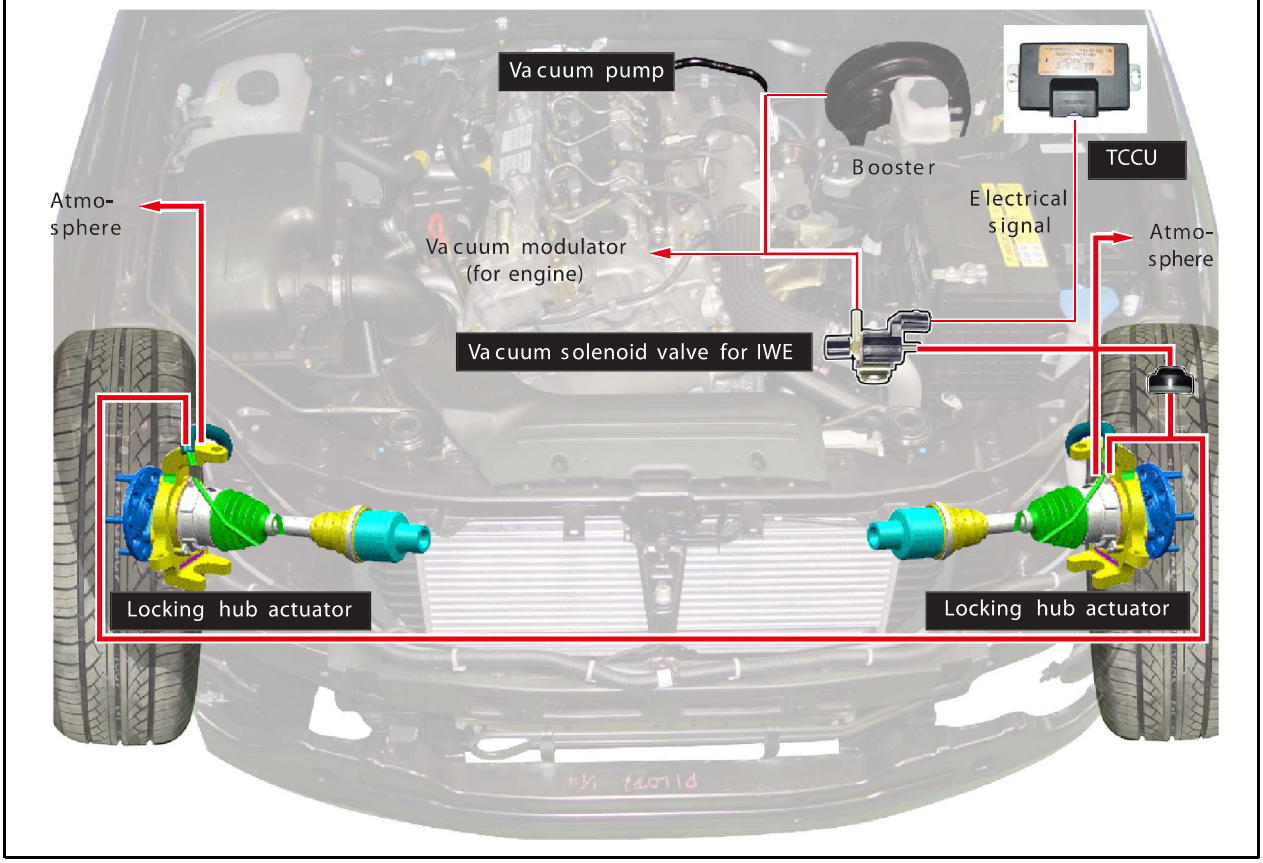
3. LOCKING HUB SYSTEM

The transfer case and the TCCU differ from previous models only in the speed sensor related parts. However, the vacuum locking hub operation system works oppositely from previous models and its components also have changed.

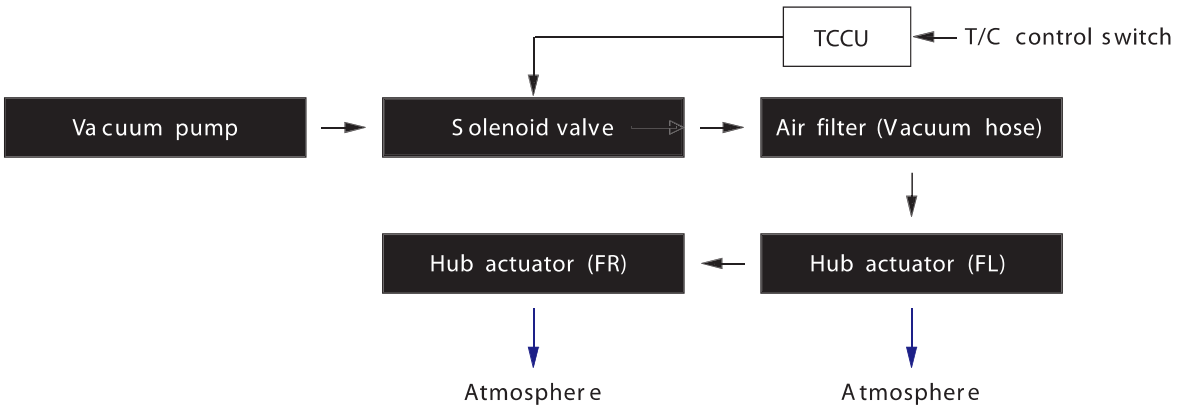
The vacuum locking hub that is applied to Kyron uses the IWE (Integrated Wheel End) system, and in this system, the vacuum is generated only within the hub actuator.

It is structured to transmit power to the front section after the actuator hub is engaged following the release of vacuum from the drive shaft end gear and the hub end gear.

Operating Process



Vacuum generation process in front hub actuator:



Modification basis	
Application basis	
Affected VIN	

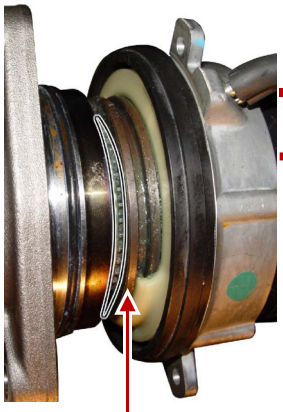
1) Vacuum System

Vacuum operation during 2WD mode

During 2WD mode, the vacuum pressure from vacuum pump is continuously transmitted to the locking hub system. This vacuum pressure pulls in the locking hub actuator so that it will not be engaged with the front end hub gear.

In 4WD mode, the TCCU blocks the transferring of vacuum pressure from vacuum pump to locking hub by supplying the power to solenoid valve.

Air filter



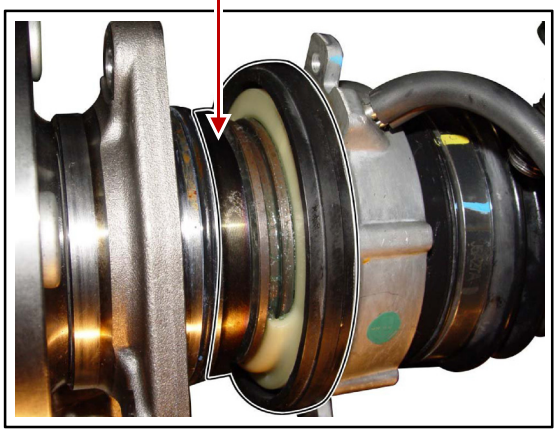
Atmosphere
(in 4WD mode)

2WD (applying vacuum pressure to hub actuator)

The vacuum pressure pulls in the locking hub actuator so that it will not be engaged with the front end hub gear.

4WD (releasing vacuum pressure from hub actuator)

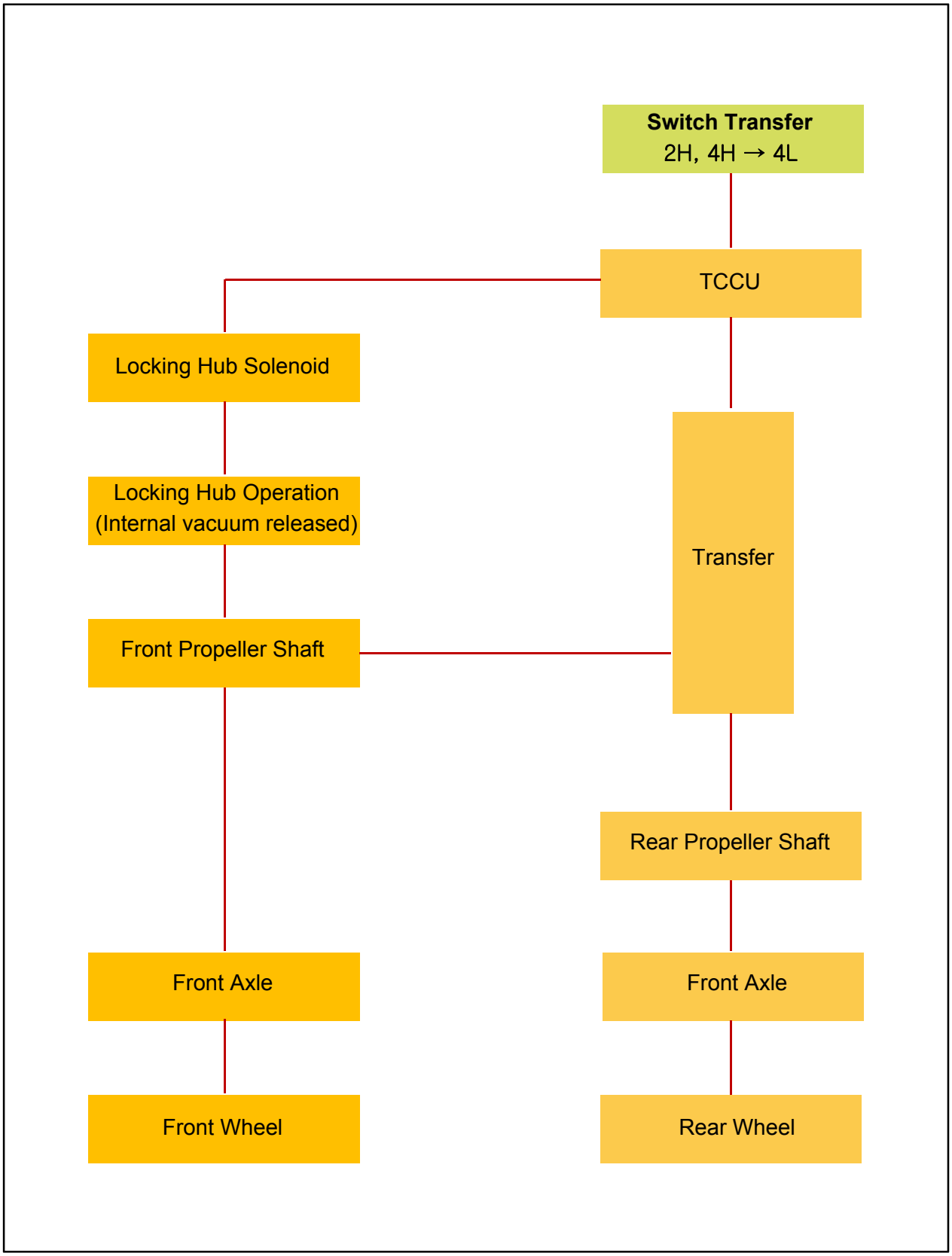
The vacuum pressure is released from the hub actuator. At this time, the front hub end gear is engaged.



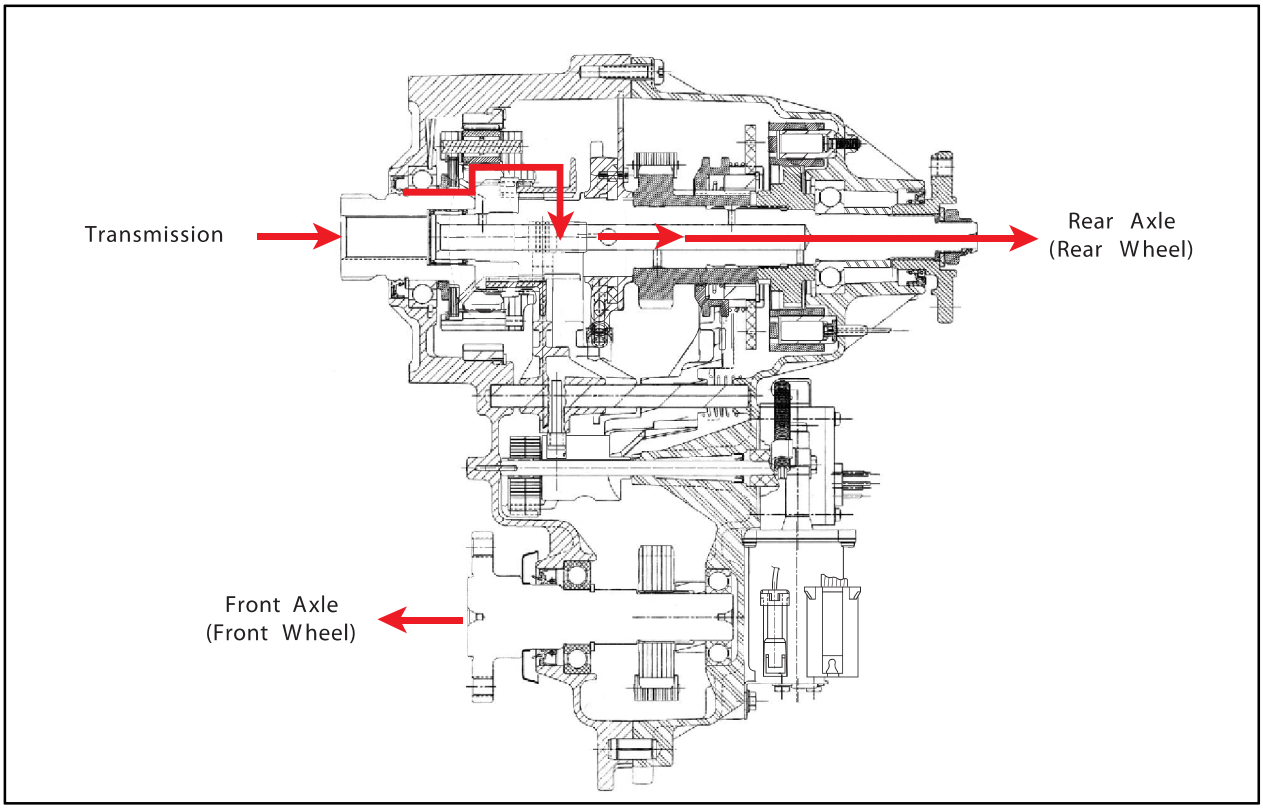
Modification basis	
Application basis	
Affected VIN	

4. POWER FLOW

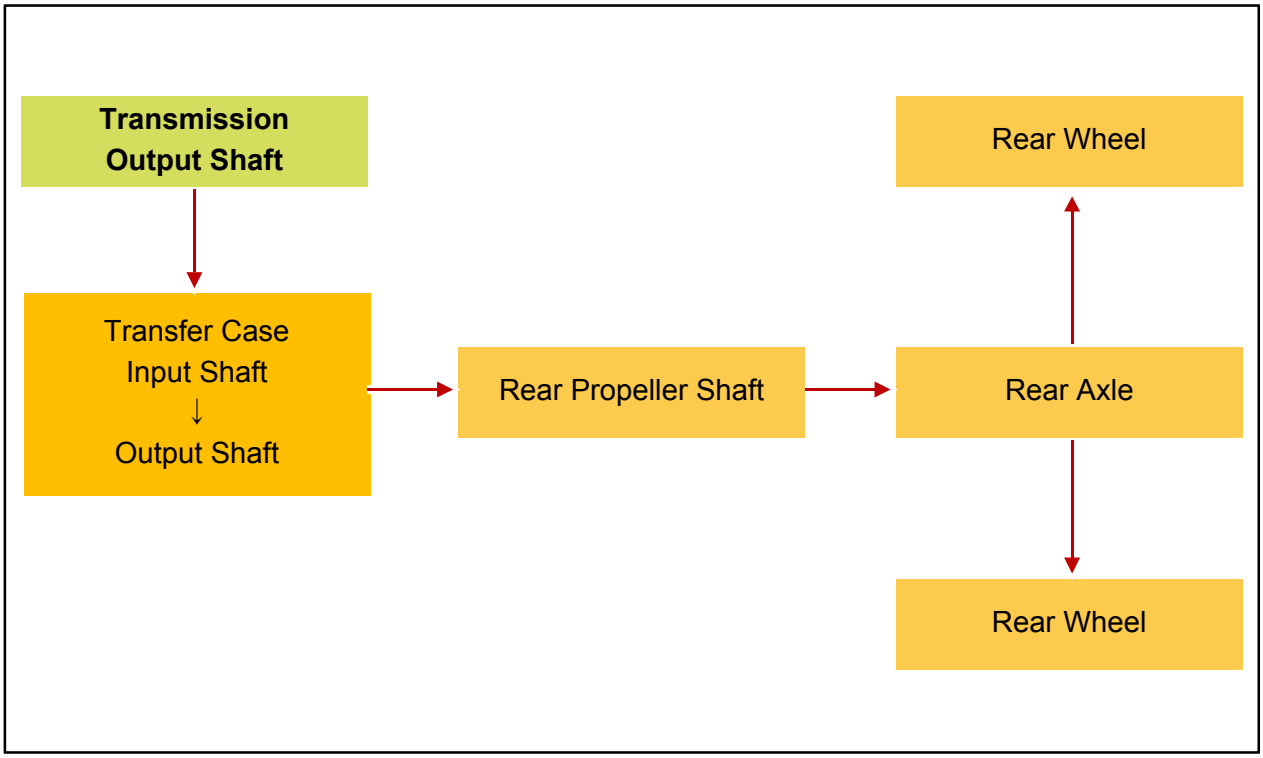
1) POWER FLOW



2) 2H MODE (2WD)

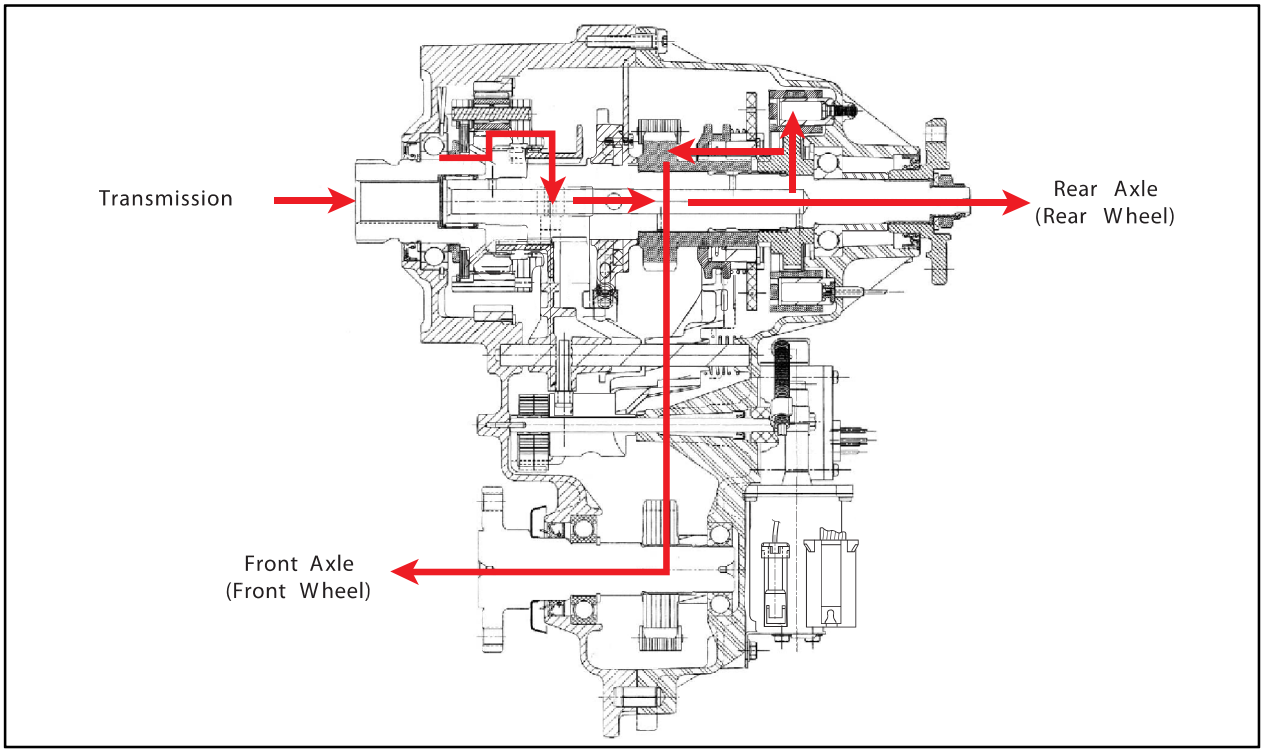


▶ **Power Flow**

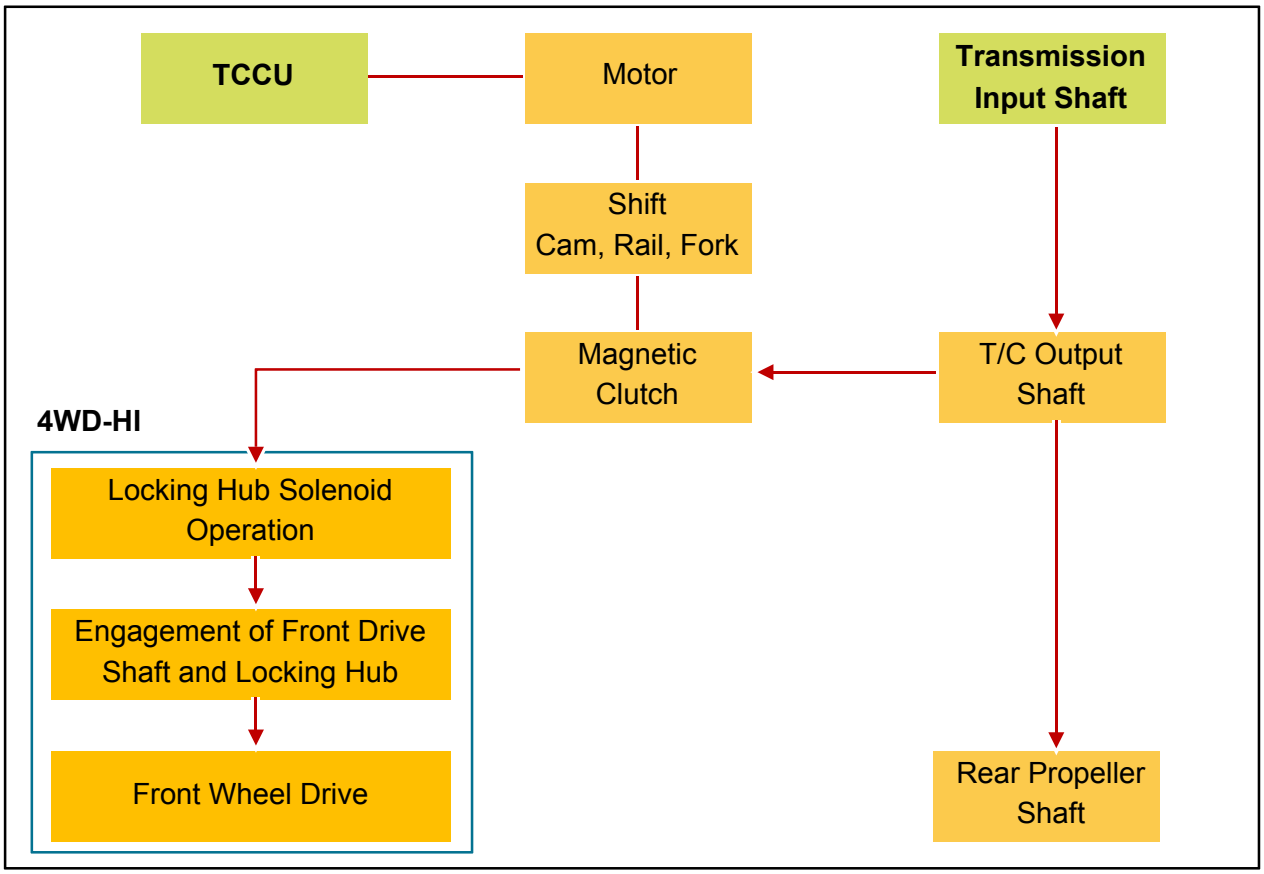


Modification basis	
Application basis	
Affected VIN	

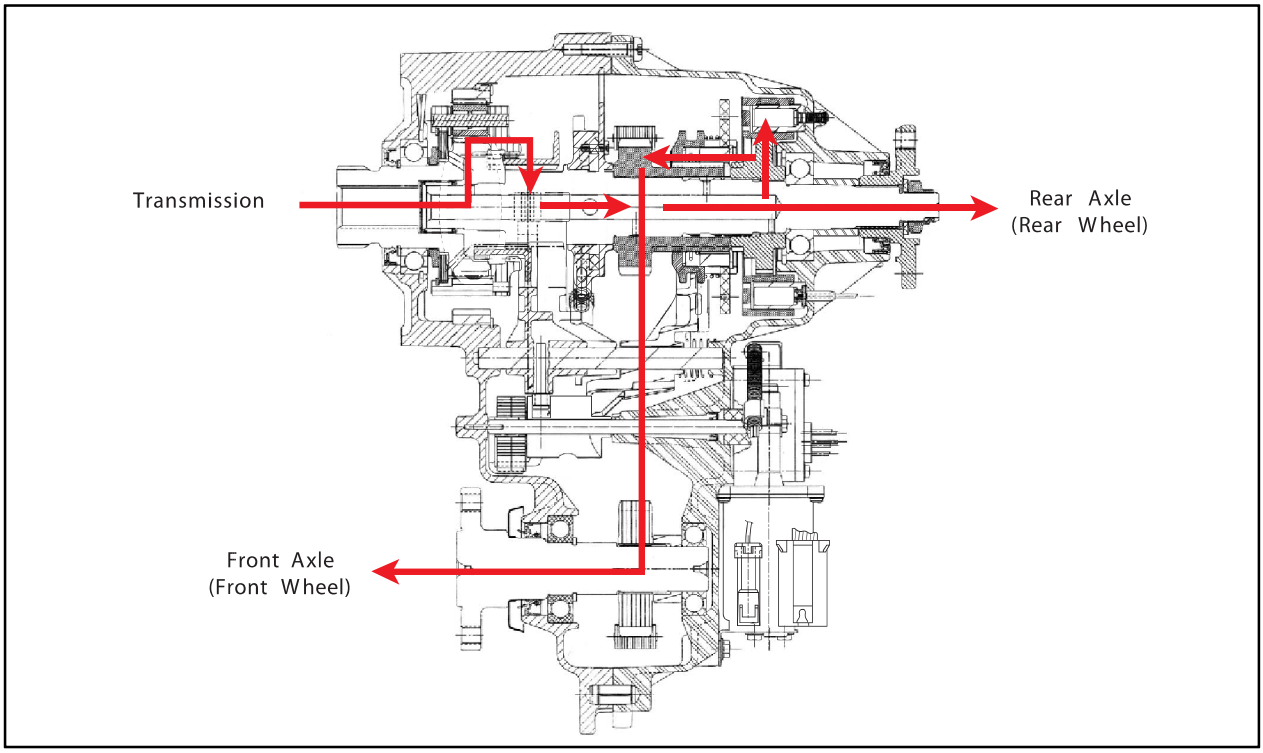
3) 4H MODE (4WD - HIGH SPEED)



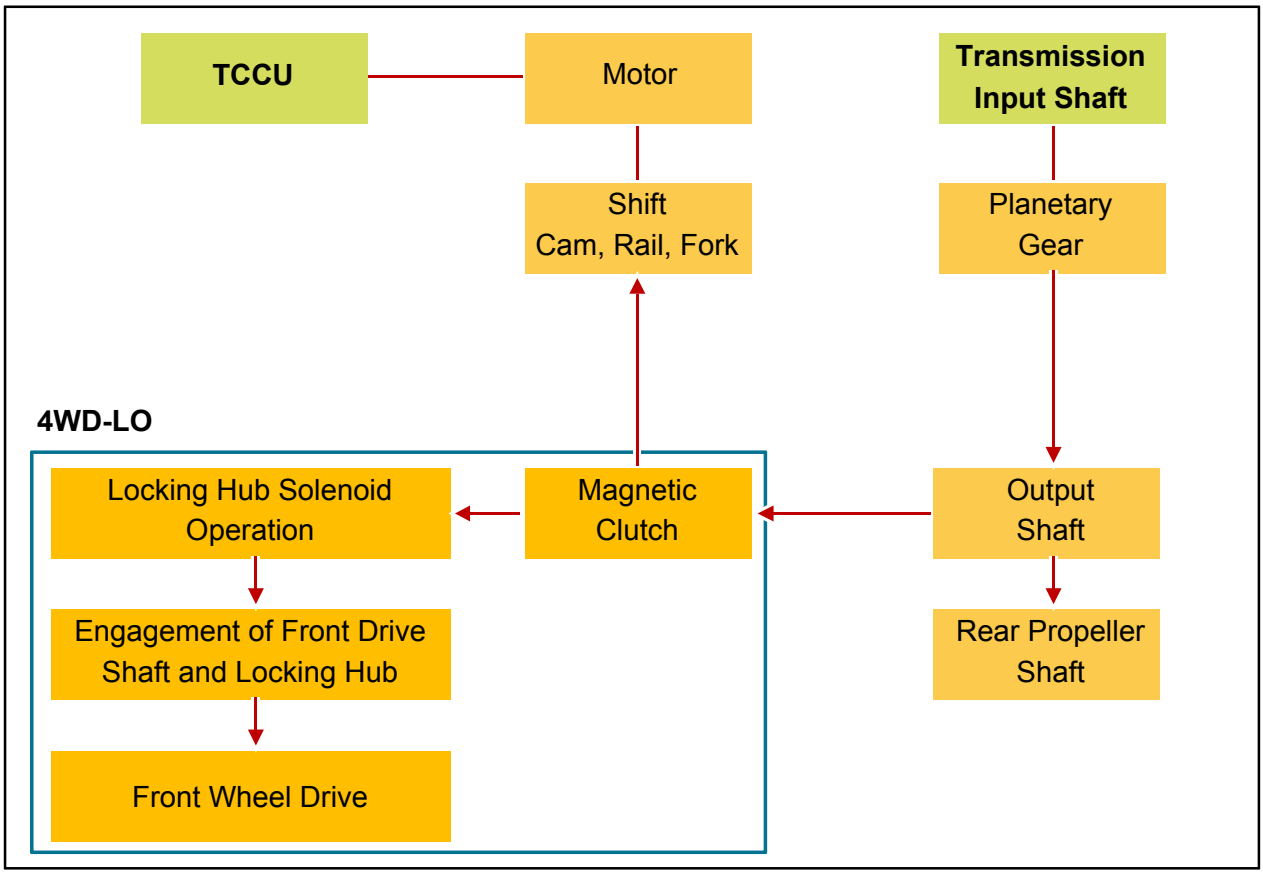
▶ **Power Flow**



4) 4L MODE (4WD - LOW SPEED)



▶ **Power Flow**



Modification basis	
Application basis	
Affected VIN	

PROPELLER SHAFT

3310-01/3310-00/3310-06

GENERAL

1. SPECIFICATION..... 3

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW..... 4
2. COMPONENT LOCATOR..... 5
3310-01 FRONT PROPELLER SHAFT..... 7
3310-06 REAR PROPELLER SHAFT..... 9
3310-00 DISASSEMBLY AND REASSEMBLY PROPELLER SHAFT..... 11

PROPELLER SHAFT

3310-00

GENERAL

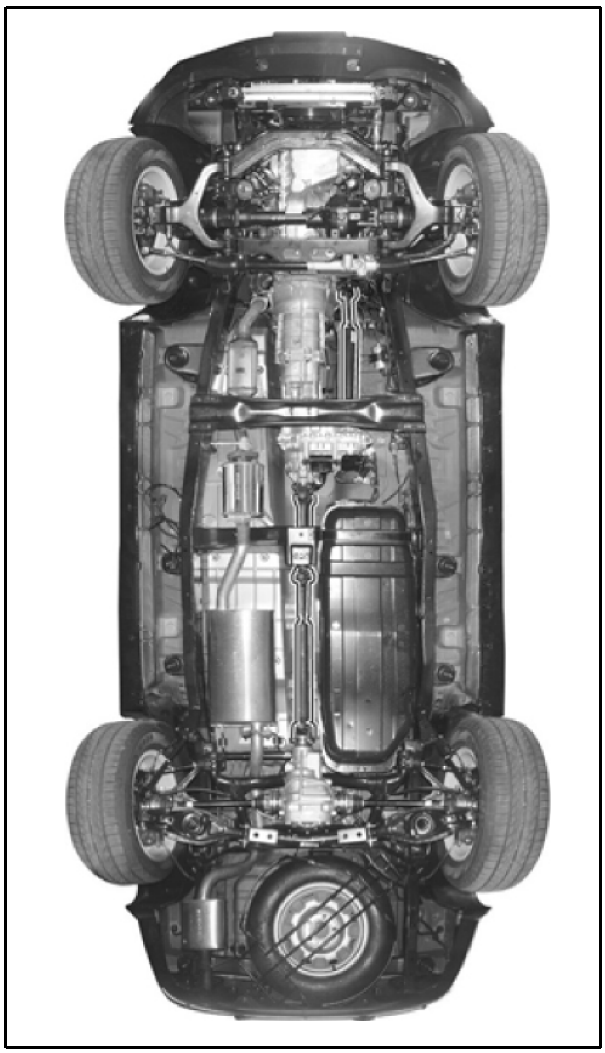
1. SPECIFICATION

Description	Specification		
Structure			Yoke and spider type universal joint
Joint type			Spider (Needle roller bearing)
Number of spiders	Front	Full time T/C	1
		Part time T/C	2
	Rear		3
Outer diameter of spider (mm)			ϕ17.91
Tube run-out (after installation)			below 0.4 mm
Front shaft dimension Length x Inner diameter x Outer diameter (mm)	Diesel + M/T(A/T) + 4408 TC (Part time)		607.1 x ϕ59.5 x ϕ63.5 (compressed)
	Gasoline + M/T(A/T) + 4421 TC (TOD)		577.9 x ϕ44.7 x ϕ50.8 (center position)
Front shaft dimension Length x Inner diameter x Outer diameter (mm)	Diesel + M/T(A/T) + 4408 TC		(585.2 + 567.5) x ϕ59.5 x ϕ63.5 (compressed)
	Gasoline + M/T(A/T) + 4421 TC		(566.1 + 567.5) x ϕ59.5 x ϕ63.5 (compressed)
Unbalance	below 30 g·cm @ 4500 rpm (Front shaft + Part time TC, Rear shaft)		
	below 14.5 g·cm @ 5300 rpm (Front shaft + Full time TC)		
Front shaft dimension Length x Inner diameter x Outer diameter (mm)	DI engine + M/T(A/T) + Part time TC		575.7 x ϕ59.5 x ϕ63.5 (compressed)
	DI engine + M/T(A/T) + Full time TC		560.8 x ϕ44.7 x ϕ50.8 (center position)
Front shaft dimension Length x Inner diameter x Outer diameter (mm)	DI engine + M/T(A/T) + Part time TC		(565.9 + 547.6) x ϕ59.6 x ϕ63.5 (compressed)
	DI engine + M/T(A/T) + Full time TC		

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW



The propeller shaft transfers the power through the transmission and transfer case to the front/rear axle differential carrier (final reduction gear). It is manufactured by a thin rounded steel pipe to have the strong resisting force against the torsion and bending.

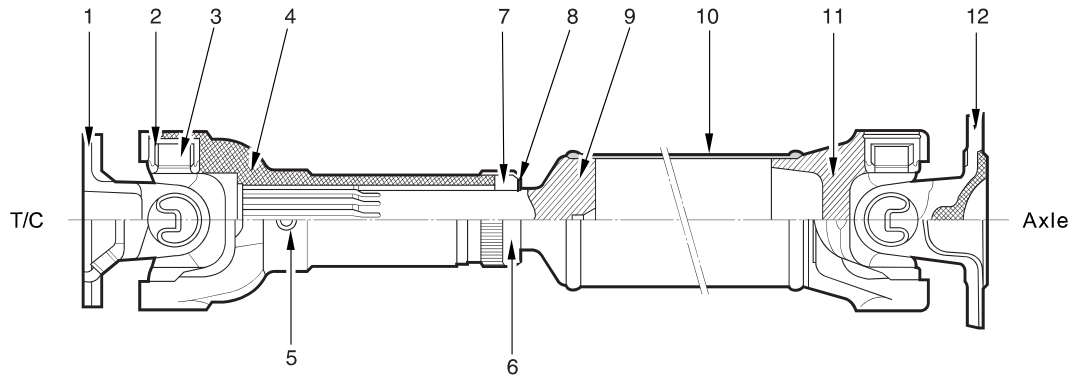
Both ends of propeller shaft are connected to the spider and the center of propeller shaft is connected to the spline to accommodate the changes of the height and length. The rubber bushing that covers the intermediate bearing keeps the balance of rear propeller shaft and absorbs its vibration.

Modification basis	
Application basis	
Affected VIN	

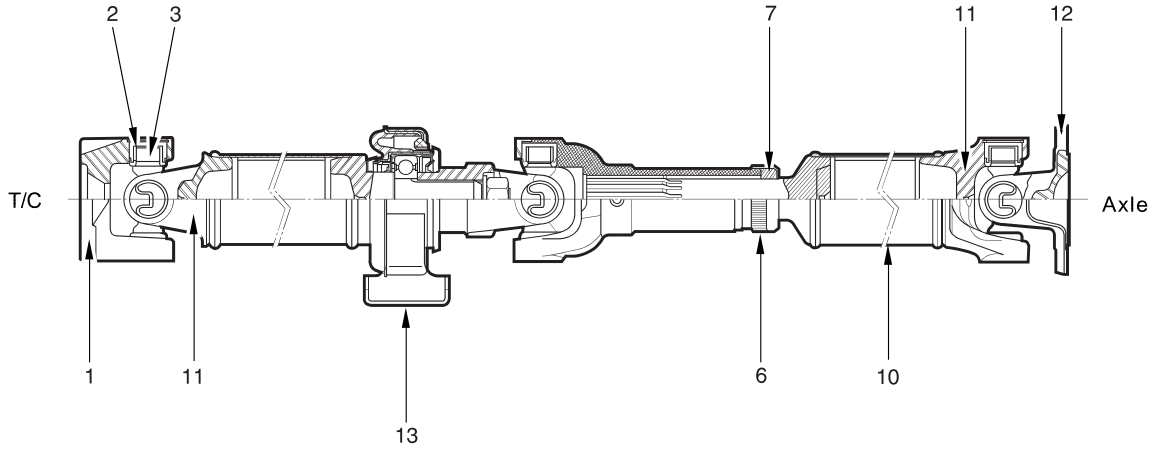
2. COMPONENT LOCATOR

1) Cross Sectional View

Front propeller shaft

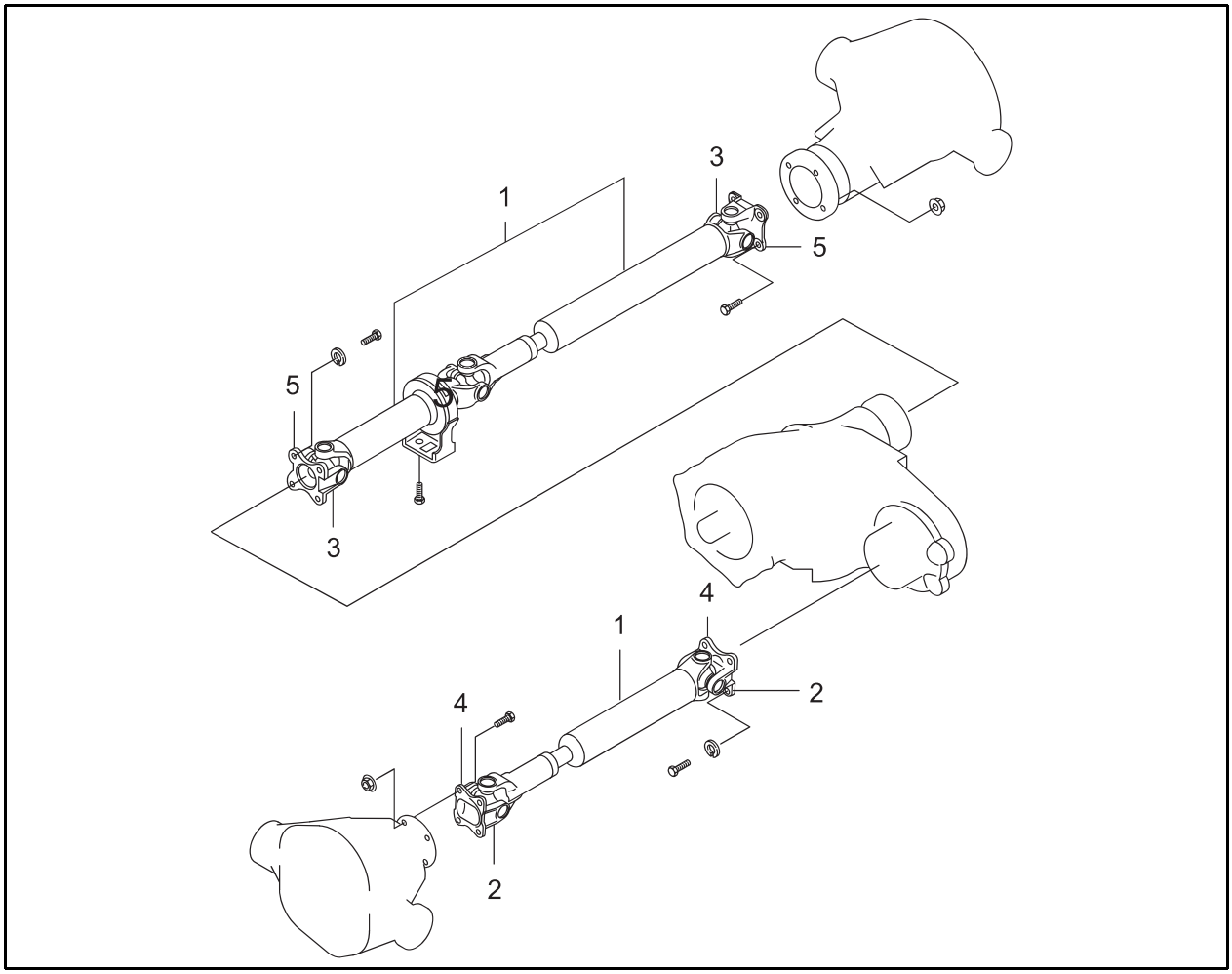


Rear Propeller Shaft



1. Flange yoke
2. Journal bearing cap
3. Spider journal
4. Slip yoke assembly
5. Grease nipple
6. Dust cap
7. Oil seal
8. Split washer
9. Slip tube shaft
10. Tube
11. Tube yoke
12. Flange yoke
13. Center bearing

2) Propeller Shaft Assemble



1. Propeller shaft
2. Joint (propeller front)
3. Joint (propeller rear)
4. Yoke (front)
5. Yoke (rear)

Modification basis	
Application basis	
Affected VIN	

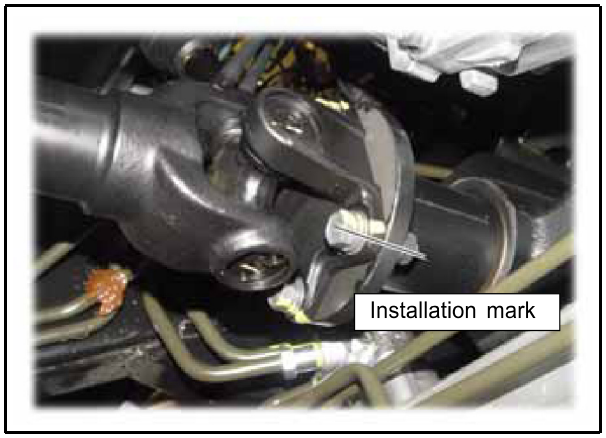
S.G.N.
3310-01 FRONT PROPELLER SHAFT

Manual Transmission	Automatic Transmission (For Gasoline Engine)

1. Remove the flange yoke mounting bolt on the transfer case side of the front propeller shaft.

CAUTION
- Put installation marks on the yoke to the propeller and the flange to the transfer case.

Modification basis	
Application basis	
Affected VIN	



2. Remove the flange yoke mounting bolt and nut on the front axle side of the front propeller shaft.

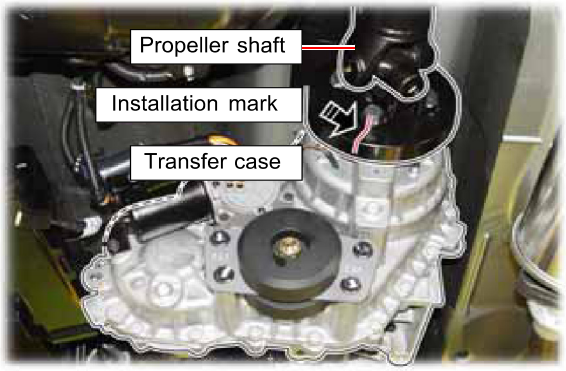
CAUTION
- Put installation marks on the yoke to the propeller and the flange to the transfer case.

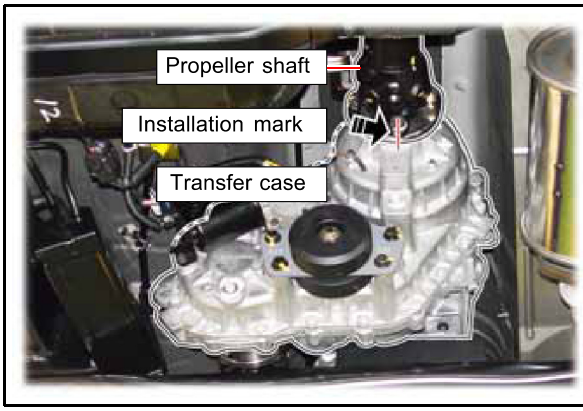
3. Remove the front propeller shaft.

Modification basis	
Application basis	
Affected VIN	

S.G.N.
3310-06 REAR PROPELLER SHAFT

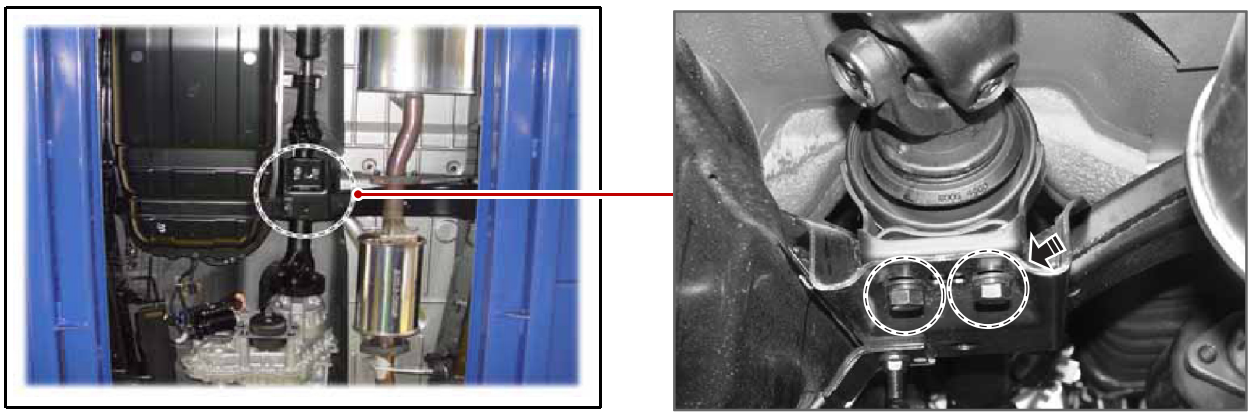
1. Remove the yoke mounting bolt and nut on the transfer case side of the rear propeller shaft.



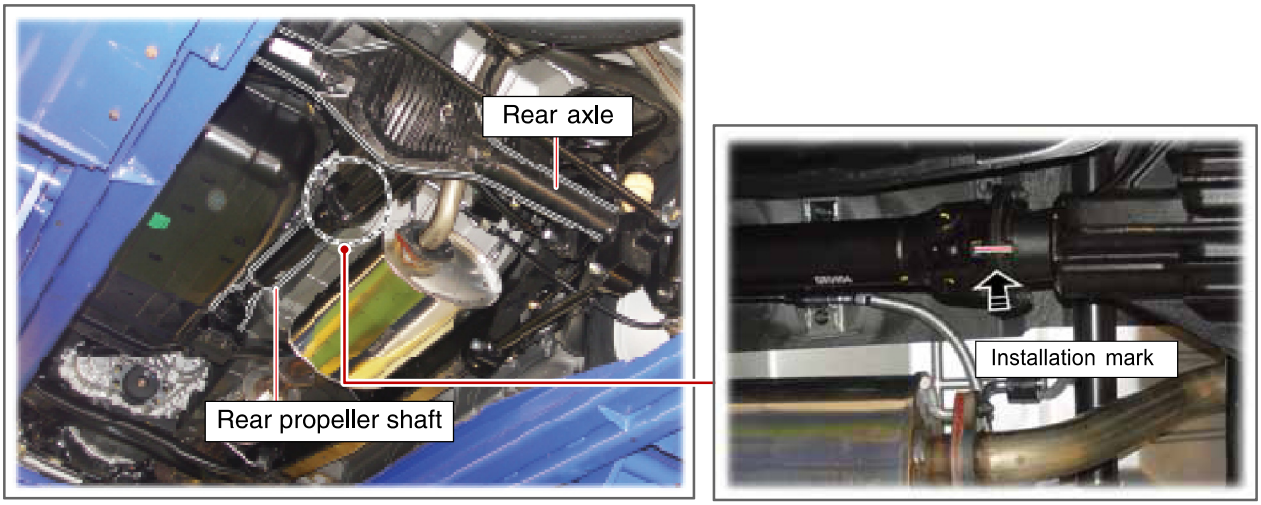


CAUTION
- Put installation marks on the yoke of the rear propeller shaft and the flange of the transfer case.

2. Remove the intermediate bearing(center) bolts.

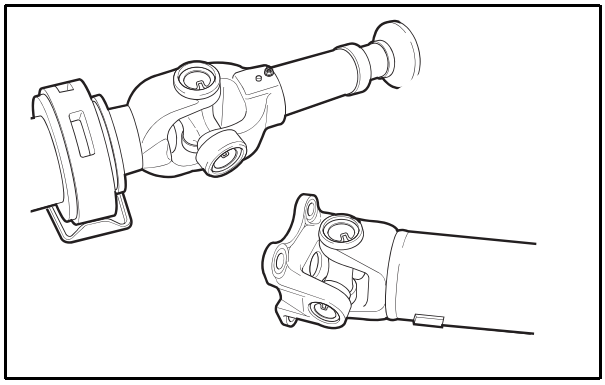


3. Remove the yoke and flage mounting bolts and nuts on the rear axle side of the rear propeller shaft. Then, remove the rear propeller shaft.



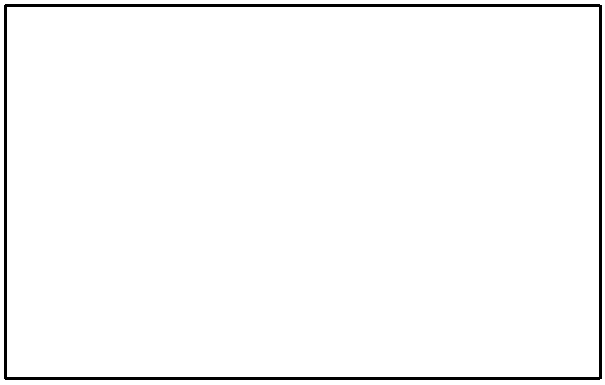
Modification basis	
Application basis	
Affected VIN	

S.G.N.
3310-00 DISASSEMBLY AND REASSEMBLY PROPELLER SHAFT

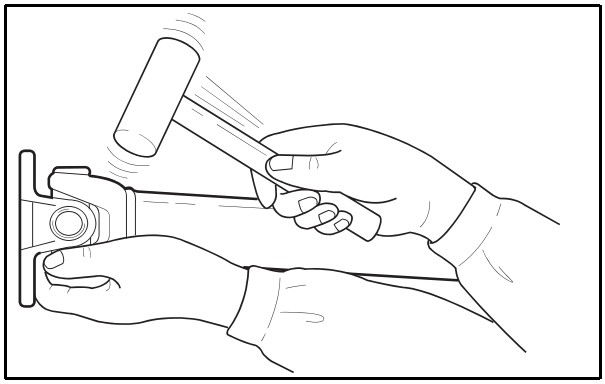


1) Disassembly

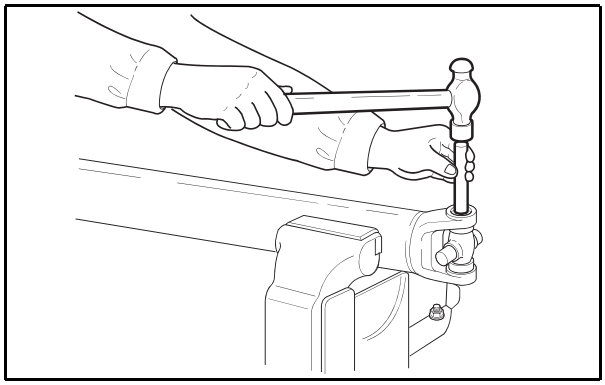
1. Place an alignment mark and remove the propeller shaft.
2. Place an alignment on the spiders before removing.



3. Remove the snap ring with snap ring pliers.

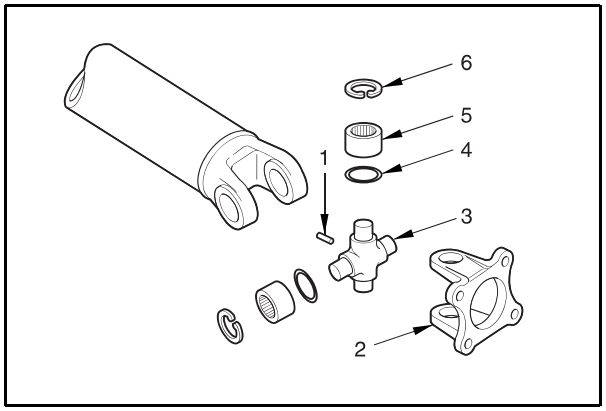


4. Tap the yoke shoulder on shaft with copper hammer to remove the roller bearing. Remove the other bearings with same manner.

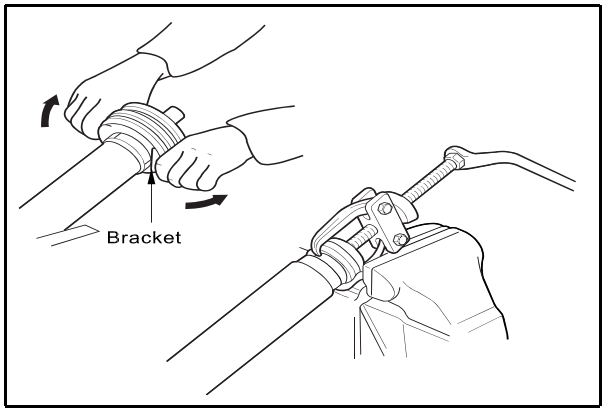


5. If it cannot be removed, hold the welding area with vise and remove the needle bearing by using a suitable drift and hammer.

Modification basis	
Application basis	
Affected VIN	

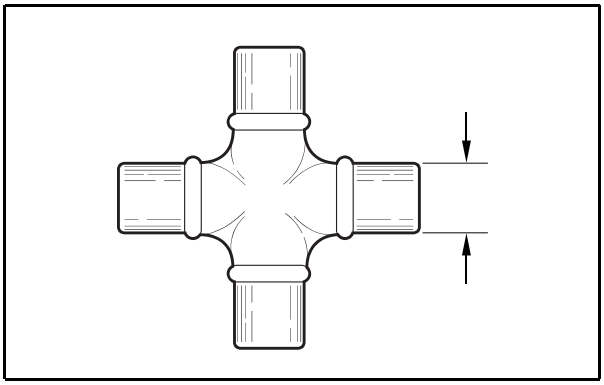


6. Disassemble the universal joint.
   The universal joint compensates the angle changes due to vertical movement of the axle shaft.



7. Remove the intermediate bearing bracket and remove the bearing with special tool.

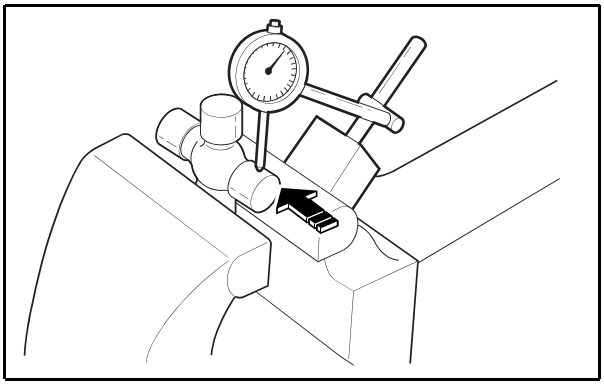
Modification basis	
Application basis	
Affected VIN	



2) Check

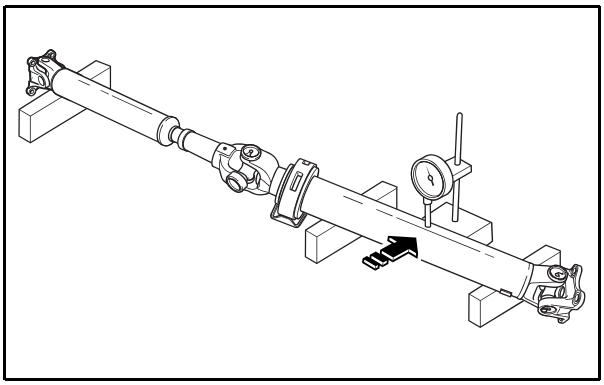
1. Visual Check Check the components for wear and crack and replace if needed.
2. Outer diameter of spider journal.

Specified value	17.893 mm
Limit	17.910 mm



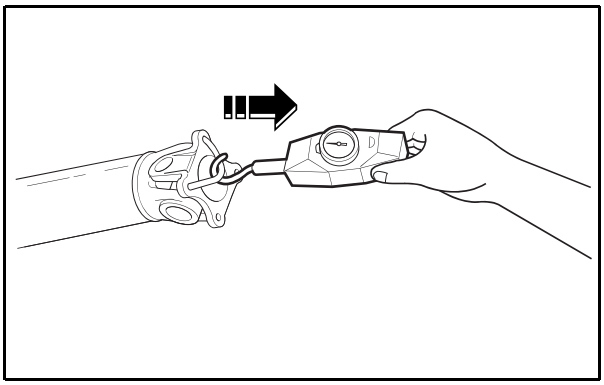
3. Clearance between spider journal and bearing.

Specified value	0.03 ~ 0.098 mm
Limit	0.25 mm



4. Run-out of propeller shaft Set up the dial gauge on the center point of propeller shaft and measure the run-out. If the run-out is out of the specified range, correct it with press or replace it with new one.

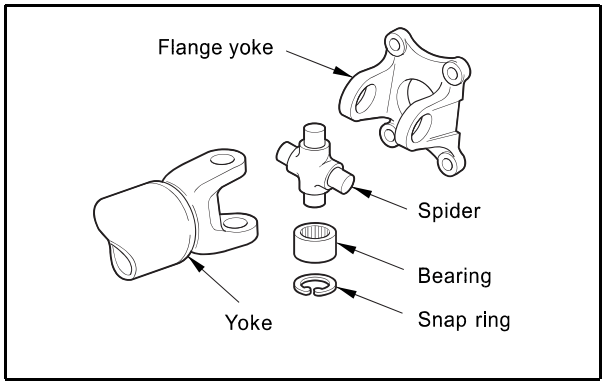
Limit	0.4 mm



5. Starting torque of universal joint.

Specified value	3 ~ 8 kg.cm

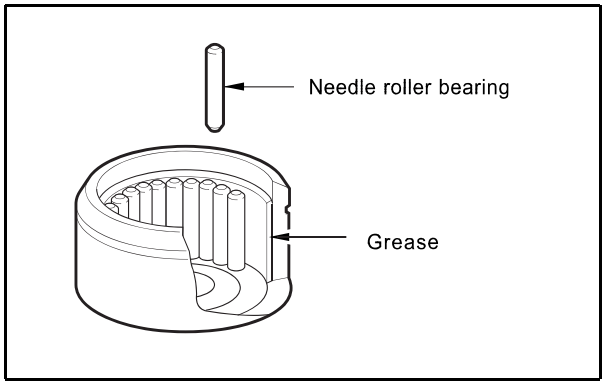
6. Major causes of vibration
   - Balance weights missing
   - Excessive run-out of propeller shaf
   - When using the general bolts
   - Excessive wear of universal joint
   - Stuck in sleeve joint
   - Vibration is mainly caused by the angle changes in front and rear universal joint. It normally occurs when the vehicle speed is 60 ~ 100 km/h.



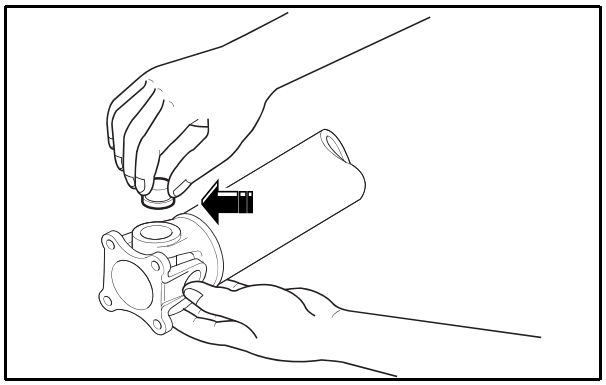
3) Assembly

Clean the components and replace if damaged.

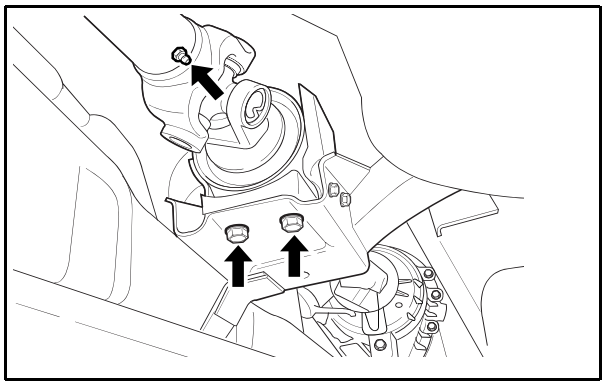
1. Align the alignment marks on the yoke and assemble the spider, bearing and snap ring.



2. Apply the grease to the inner lip of needle roller bearing and assemble the needle roller.



3. Install the yoke bearing shaft on the shaft and insert the spider. Place the cap on the opposite side and tap it with plastic hammer to seat it. Adjust the clearance of spider below 0.1 mm and install the snap ring.



4. Install the intermediate bearing to the rear propeller shaft.
5. Apply the grease on the propeller shaft and install it.

Modification basis	
Application basis	
Affected VIN	

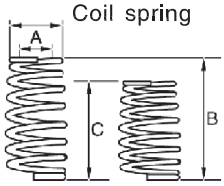
SUSPENSION 4411-01

GENERAL

1. FRONT SUSPENSION SPECIFICATIONS

Description		Specification
Suspension type		Double wishbone
Spring type		Coil spring
Shock absorber type		Cylindrical double tube (gas type)
Stabilizer type		Torsion bar
Wheel alignment	Toe-in	2 ± 2 mm
	Camber	-0.19° ± 0.3° (the difference between both ends is should be below 30')
	Caster	4.4° ± 0.5° (the difference between both ends is should be below 30')
Height “H”		96.5 ± 5 mm

2. REAR SUSPENSION SPECIFICATIONS

Description		Specification
Suspension type		IRS type
Spring type		Coil spring
Stabilizer bar type		Torsion bar
Shock absorber	Type	Cylindrical double tube
	Max. length	463 mm
	Min. length	310 mm
Coil spring 	Coil thickness	14.9 mm
	Inner diameter of coil (A)	ø 70.1 mm
	Free length (B)	344.9 mm
	Length at load (C)	252.1 mm
	Spring rate	8.68 ± 5 %

GENERAL

1. BRAKE SYSTEM GENERAL INFORMATION

Front Disc
Front Ventilated Disc and Caliper (2 internal Cylinders)

1) FRONT BRAKE

For **the front brake system**, the ventilated disc type is applied regardless of the ABS/ESP system installation.
Two 43 mm diameter calipers (non-ABS/ESP equipped vehicles) and two 45 mm diameter calipers (ABS/ESP equipped vehicles) are installed.

Rear Disc
ABS/ESP + 5Link Suspension: solid type disc ABS/ESP + Independent suspension: ventilated disc
Rear Disc and Caliper (1 Internal Cylinder)

2) REAR BRAKE

For the rear brake system, specifications differ between ABS/ESP system equipped vehicles and non-ABS/ESP system equipped vehicles. The drum type brake is installed on non-ABS equipped vehicles.
When ABS/ESP is installed on the 5-link type suspension, the solid disc (disc thickness: approx. 10.4 mm) is installed. When ABS/ESP is installed on the independent suspension, the ventilated disc (disc thickness: approx. 20 mm) is installed.

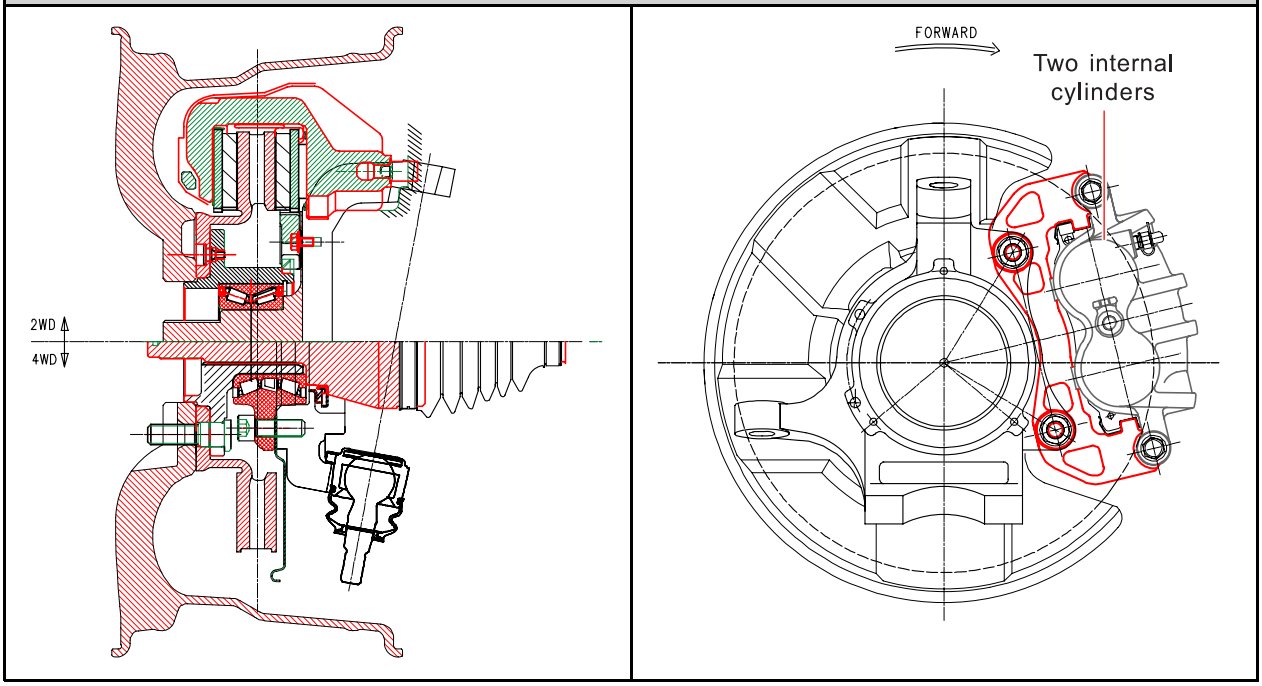
Parking brake system: The hand operated type parking brake is installed on vehicles with the manual transmission and the foot operated type parking brake is installed on vehicles with the automatic transmission.

Hand Operated Type (Vehicle with Manual Transmission)	Foot Operated Type (Vehicle with Automatic Transmission)

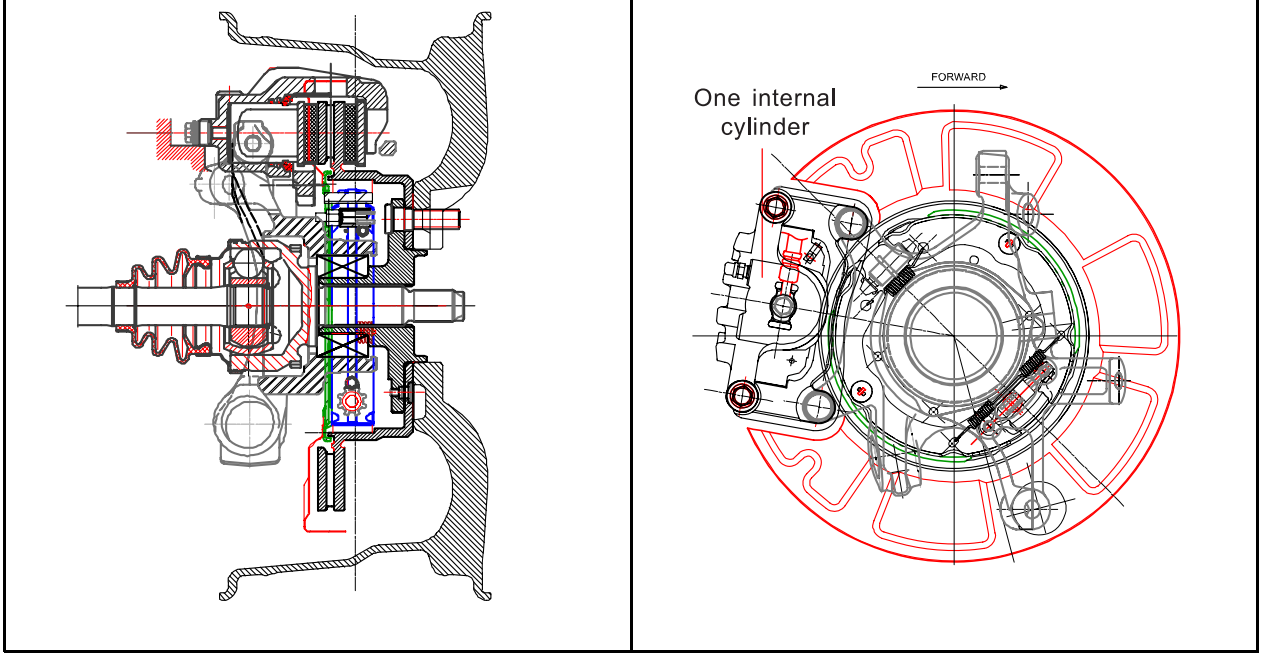
Modification basis	
Application basis	
Affected VIN	

3) SECTIONAL DRAWING

Front Disc Brake

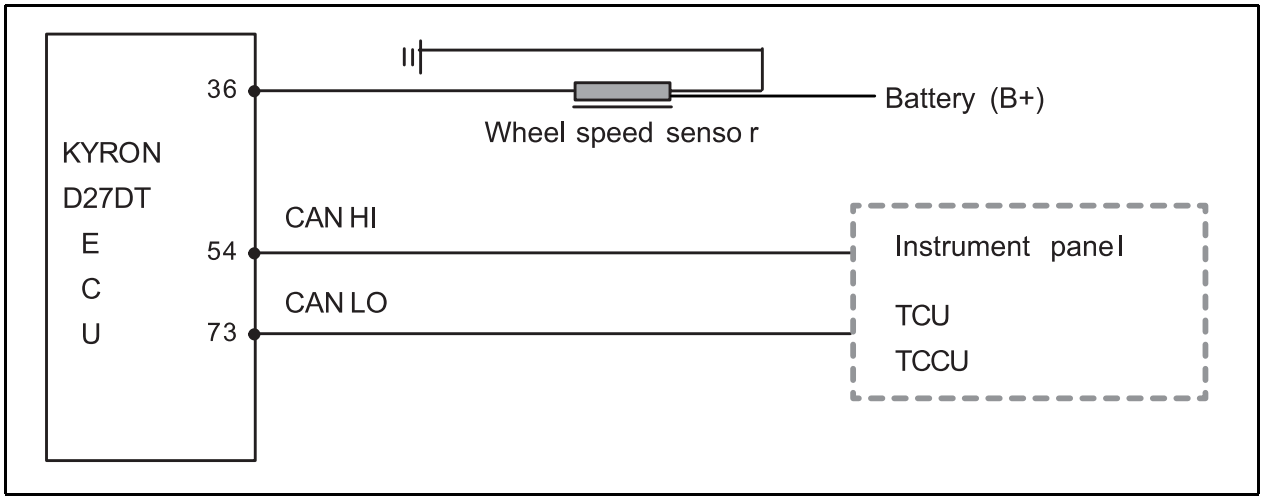


Rear Disc Brake



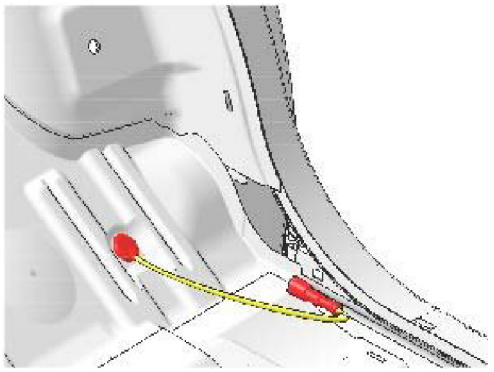
4) NON-ABS EQUIPPED VEHICLE ? WITH ONE WHEEL SPEED SENSOR

The wheel speed sensor is installed on the rear right wheel regardless of the ABS/ESP installation.
This sensor is to signal the vehicle speed to the engine ECU, TCCU, transmission, and instrument panel.
There is no separate unit to process the wheel speed sensor signal.
The wheel speed sensor is connected to the engine ECU (terminal 36), where its signal is processed, and is connected to other related systems through CAN communication.

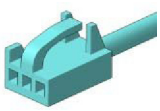
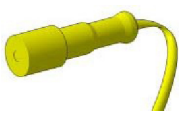


Location of the wheel speed sensor (rear right wheel)

Location of the Sensor Connector



Connector Appearance

In vehicle without ABS	In vehicle with ABS/ESP
	

Modification basis	
Application basis	
Affected VIN	

2. BRAKE SYSTEM SPECIFICATIONS

Description		NON-ABS (5-link suspension)	ABS/ESP	
			5-link suspension	Independent suspension (IRS)
Brake pedal	Pedal ratio	4.0 : 1		
	Max. operating stroke	150 mm		
	Free play	1 ~ 4 mm		
Brake master cylinder	Type	Tandem type (with level sensor)		
	I.D. of cylinder	φ25.4 mm		
Brake booster	Type	Vacuum assisted type		
	Booster pressure ratio	9 : 1		
Front brake	Type	Ventilated disc type		
	I.D. of caliper cylinder	2 x φ43 mm	2 x φ45 mm	
	Pad thickness	10.5 mm	10.5 mm	
	Brake pad wear limit	2 mm	2 mm	
	Disc plate thickness	26 mm	28 mm	
	Disc plate wear limit	24 mm	25.4 mm	
	I.D./O.D. of disc plate	φ294 /φ184 mm	φ294 /φ184 mm	
Rear brake	Type	Drum type	Solid disc type	Ventilated disc type
	I.D. of drum	φ254 mm	-	-
	W x L x T	55 x 243 x 5	-	-
	I.D. of wheel cylinder	φ23.81 mm	-	-
	I.D. of caliper cylinder	-	φ42.9 mm	φ42.9 mm
	Brake pad thickness	-	10 mm	10 mm
	Wear limit of brake pad	-	2 mm	2 mm
	Disc plate thickness	-	10.4 mm	20 mm
	Wear limit of disc plate	-	8.5 mm	18.4 mm
	I.D./O.D. of disc plate	-	φ299/φ220 mm	φ307/φ214 mm
Parking brake	Type	Mechanical type, rear wheels operated		Mechanical type, rear wheels operated
	Operation type	Manual type - Hand (MT)/Foot (AT)		Manual type - Foot
	I.D. of drum	φ254 mm	φ190 mm	φ190 mm
Brake fluid	Capacity	0.7 ~ 0.8 ℓ		
	Specification	DOT4		

3. BRAKE OPERATION AND NOISE

This section describes the noise phenomena possibly occurring in the brake system operation. Distinguish between the information given below and the actual problems and then, inspect the vehicle and take appropriate measures.

▶ Noise Phenomena and Causes

Phenomenon 1. If depressing the brake when the engine is cold, "screeching" sound always occurs and, after driving for a while, it disappears.

This usually occurs in the morning. When the temperature goes down, the dew condensation phenomenon sets moisture on the brake disc as the window frost forms. Due to this moisture, the iron within the brake disc and pad oxidizes, forming undetectable micro-rusts on the disc surface.
When starting the engine under this condition, noise may sound due to the friction of micro-rusts. When operating the brake several times, the disc temperature goes up and the micro-rusts come off and the noise goes away.
Depending on the driving conditions, noise gets louder when slightly depressing the brake pedal and oppositely, noise is smaller when deeply depressing the brake pedal. This is simply a physical phenomenon, called "morning effect" in professional terms, and does not imply any problems with the brake system.

Phenomenon 2. Slip or screech after the brake pad replacement.

This usually occurs when the bed-in is not made between the disk and the pad's friction material. The bed-in is a state that the brake system normally works and gives no noise out, when, after about 300 km city driving, the contact area of the pad friction material is enlarged and the disk is in complete contact with the pad's friction material. Therefore, for some time after the brake disk/pad replacement, the brake system poorly operates or noise (abnormal sound) occurs due to the partial contact.

Phenomenon 3. "Groaning" sound occurs in the automatic transmission vehicle when slightly taking the foot off the brake pedal to slowly start after waiting for the signal, or slightly depressing the brake pedal

This is the noise "Creep groan" that occurs when, in both the automatic and manual transmission, slightly releasing the brake pedal in the neutral gear at downhill roads. It frequently occurs at the low braking power and low speed, through the following process. When operating the brake system at low speed and low pressure, adhesion and slip repeatedly take place between the brake disk and the friction material, and this makes the braking power inconstant, instantly increasing or decreasing, and gives out the brake noise. It is also a physical phenomenon and has no relation with the brake performance.

Modification basis	
Application basis	
Affected VIN	

4. ESP SYSTEM RELATED PRECAUTIONS

1. The HDC system is intended for use only on off-roads with a slope level exceeding 10%. Thus, do not use it on public road.
2. Too frequent use of HDC system may weaken the durability of the ESP HECU and related systems.
3. Driver must turn the HDC switch to OFF position when driving on public and level roads. As mentioned previously, when a driver make sharp turns or drive on rough roads, the HDC may suddenly operate for these sudden shocks influence the G sensor values. When such occurs, the driver may panic because the vehicle speed drops sharply and the driver will experience difficulty in controlling the vehicle.
4. During the HDC operation, a loud noise and the vehicle vibration may occur from the HECU and the brake system, but this is a normal condition during the HDC operation.
5. The warning lamp flashes and warning beep sounds when the ESP is operating
   When the ESP operates during vehicle movement, the ESP warning lamp on the instrument panel flashes and beep comes on every 0.1 seconds.

1) CAUTIONS WHEN USING HDC SYSTEM

Customers must first acquaint themselves with the HDC operation related information, e.g. operation conditions and non-operation conditions, because they may feel unfamiliar with its function and operation process. The noise during the HDC operation is very different from that during the ABS/ESP operation. This noise may be irritating and accompany some vibration, because, on steep hills, it attempts to control the physical properties of the vehicle weight with the braking power.

Below is the summary of precautions to remember in HDC operation.

CAUTION

- The HDC system is intended for use only on off-roads with a slope level exceeding 10%. Thus, do not use it on public road.
- Too frequent use of HDC system may weaken the durability of the ESP HECU and related systems.
- Driver must turn the HDC switch to OFF position when driving on public and level roads. As mentioned previously, when a driver make sharp turns or drive on rough roads, the HDC may suddenly operate for these sudden shocks influence the G sensor values. When such occurs, the driver may panic because the vehicle speed drops sharply and the driver will experience difficulty in controlling the vehicle.
- During the HDC operation, a loud noise and the vehicle vibration may occur from the HECU and the brake system, but this is a normal condition during the HDC operation.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCE

1. ESP SYSTEM OF GENERAL INFORMATION

The ESP system consists of basic ABS functions, the vehicle position control depending on the driving conditions and the road conditions, the HBA (Hydraulic Brake Assist System) that improves the braking power in an emergency, the ARP (Active Rollover Protection) that obstructs the physical tendency to rollover during sharp turns and prevents the vehicle rollover by quickly and firmly controlling the engine output and the brake.

The HDC (Hill Descent Control) is newly introduced function that helps drivers maintain their speed automatically by switch operation when driving slowly on steep hills (over 10%: about 5.71° (degree)).

ESP HECU	HDC Switch / Indicator

Functions applied on ESP system are as follows.

1. ABS (Anti-Lock Brake System)
2. EBD (Electronic Brake-Force Distribution)
3. ABD (Automatic Braking Differential)
4. ASR (Acceleration Slip Regulation)
5. AYC (Active Yaw Control, Understeer Oversteer control)
6. HBA (Hydraulic Brake Assist System)
7. ARP (Active Rollover Protection)
8. HDC (Hill Descent Control)

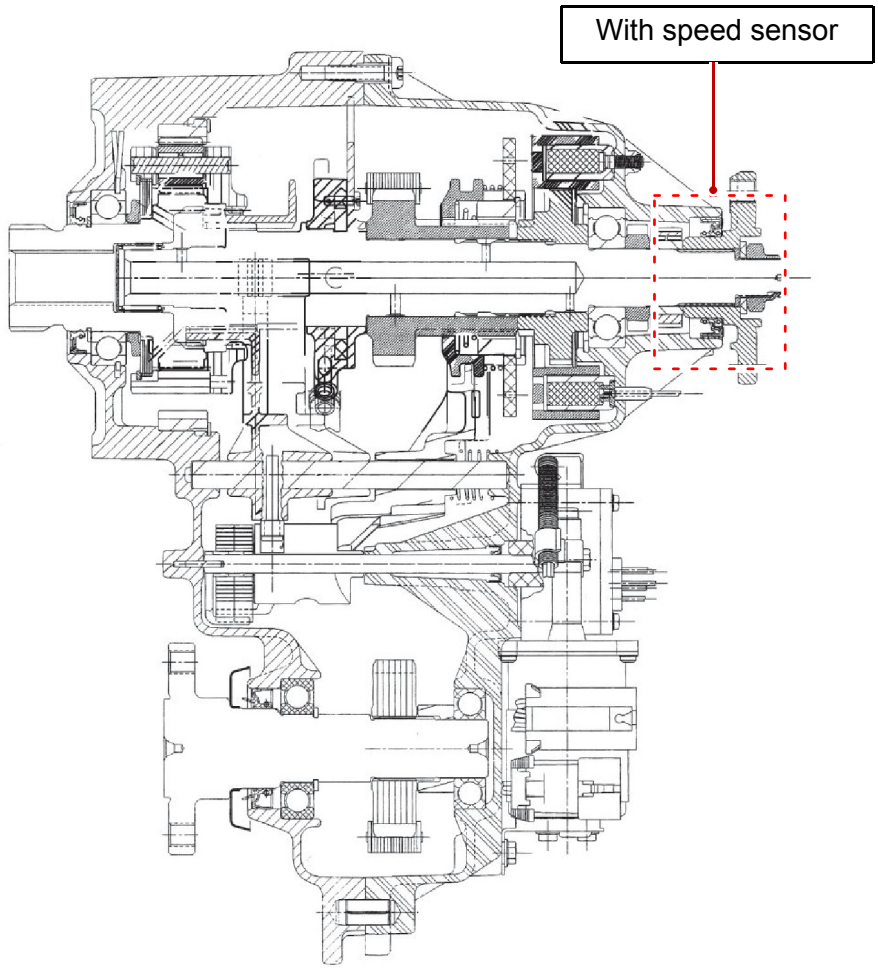
1) GENERAL INFORMATION OF ESP SYSTEM

Differences compared to other models: Appearance of wheel speed sensor, Location, Layout of relevant components

ESP HECU	Active Wheel Speed Sensor	HDC Switch

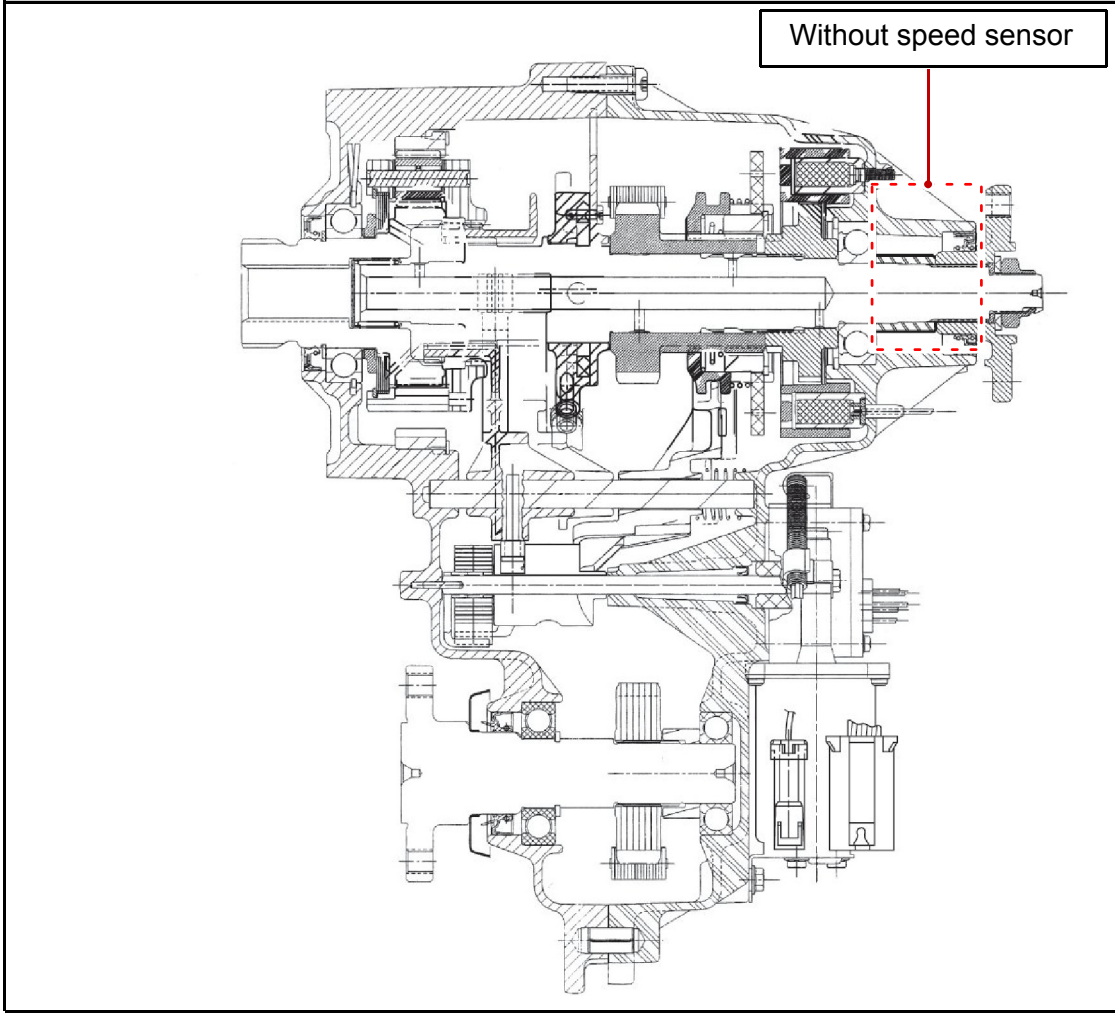
The transfer case (T/C) installed on this vehicle doesn't have the internal speed sensing device and receives the speed signal for T/C control from ESP HECU via CAN bus.

[Conventional T/C]



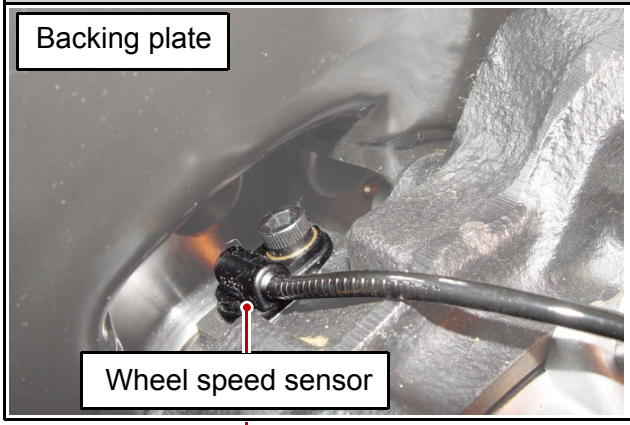
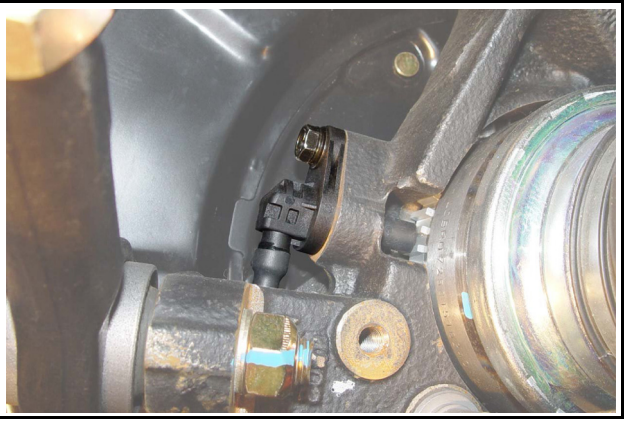
Modification basis	
Application basis	
Affected VIN	

[New T/C]

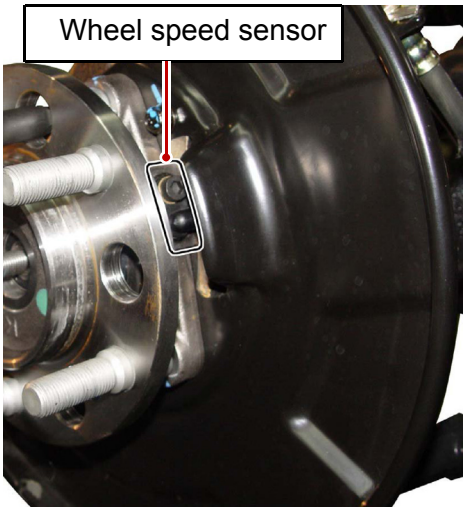


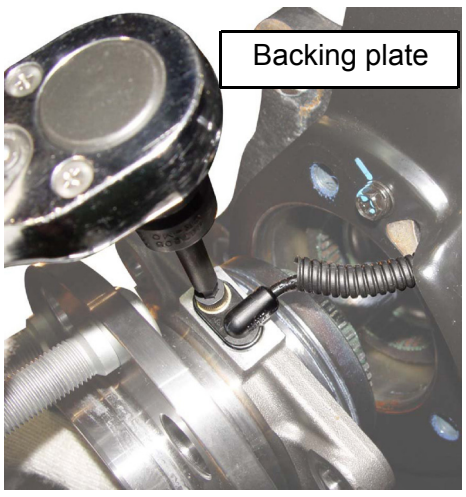
Modification basis	
Application basis	
Affected VIN	

Cautions When Removing the Front Wheel Speed Sensor
The locking hub system of the KYRON part time 4WD utilizes a different hub actuator from the conventional approach. It utilizes IWE (Integrated Wheel End) system that locks the 4WD depending on the vacuum condition within the actuator. Thus, the wheel speed sensor is installed on the front wheel end area. It is installed inside the backing plate to be protected from heat and foreign materials. Therefore, the **front wheel end system (including disc) should be removed before removing the front wheel speed sensor.**

Front Wheel Speed Sensor (4WD)	Rear Wheel Speed Sensor (IRS Type)
	

Wheel Speed Sensor

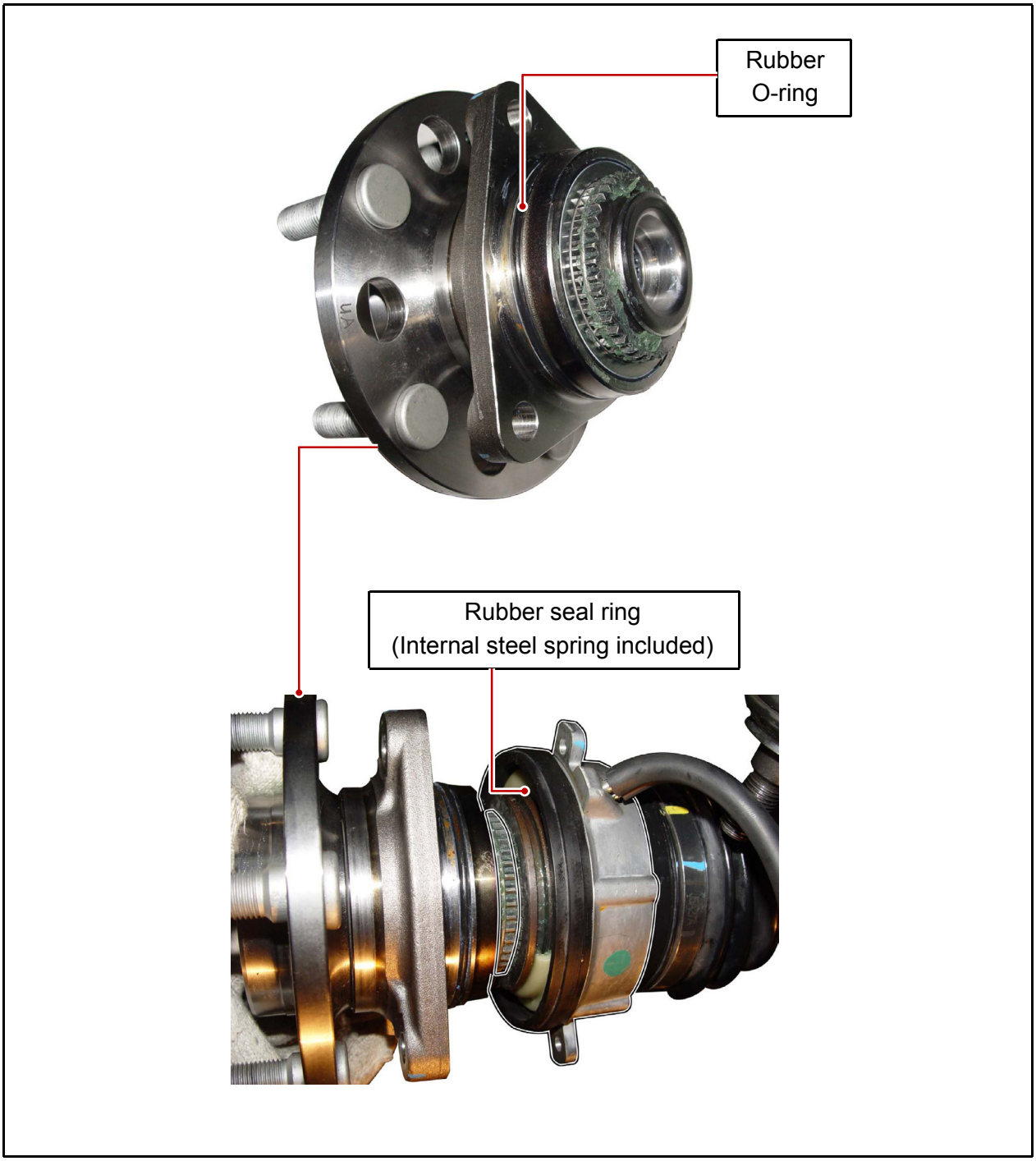




Modification basis	
Application basis	
Affected VIN	

The rubber O-ring in IWE (Integrated Wheel End) should be replaced with new one when the front wheel end has been removed.
The rubber O-ring prevents moisture and foreign materials from entering the IWE system.

In addition, when installing the hub actuator of the IWE system, you must install it from the same angle as the drive shaft to prevent the rubber seal ring inside the actuator from being squeezed.



Please refer to the part time transfer case section for more specific information.

Modification basis	
Application basis	
Affected VIN	

When the ESP system is added to the ABS system, some devices will be added to the HECU (Hydraulic & Electronic Control Unit) and wheel speed sensor used in the ABS system.
The devices are as follows:

1. 2 pressure sensors installed on the master cylinder
2. Sensor cluster (integrated yaw rate sensor and lateral sensor) and longitudinal sensor installed in IP.
3. SWAS (Steering Wheel Angle Sensor) installed in the steering column.

▶ Comparison with ABS System

Name	Specifications		Locatio n
	ABS	ESP	
HECU (Hydraulic & Electronic Control Unit)	CPU: PEC 1 (32 bit) Clock Frequency: 28 MHz Memory: 512 KB EEP ROM: 1 KB	CPU: PEC 1 (32 bit) Clock Frequency: 33 MHz Memory: 512 KB EEP ROM: 1 KB New software version: KM 20	beside of brake booster
Wheel Speed Sensor	Active Type	Active Type	Mounted in each wheel (×4EA) Front airgap: 0.335 ~ 0.945 mm Rear airgap: 0.309 ~ 0.958 mm
Steering Wheel Angle Sensor	N/A	Maximum angular velocity: 1500°/sec Working voltage: 9 ~ 16 V	In steering wheel
Sensor Cluster	N/A	Integrated yaw rate sensor and lateral sensor. Also, used for sensing G value for HDC (Hill Descent Control).	Behind the center audio in instrument panel
Pressure Sensor	N/A	Analog Output	Under master cylinder

Modification basis	
Application basis	
Affected VIN	

Memo

2. PRINCIPLE OF ESP

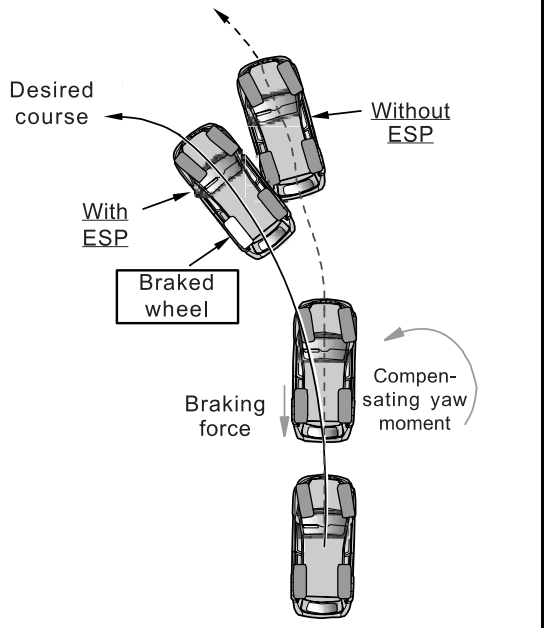
1) Understeer & Oversteer Control

ESP (Electronic Stability Program) recognizes critical driving conditions, such as panic reactions in dangerous situations, and stabilizes the vehicle by wheel-individual braking and engine control intervention with no need for actuating the brake.
This system is developed to help the driver avoid the danger of losing the control of the vehicle stability due to under-steering or over-steering during cornering.

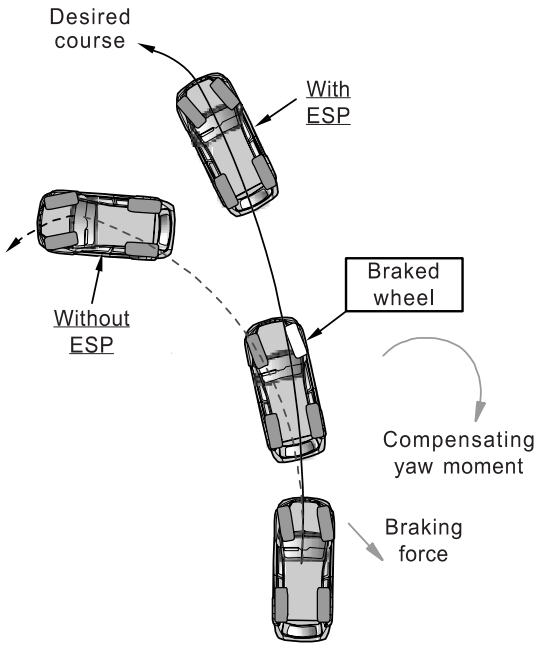
The yaw rate sensor, lateral sensor and longitudinal sensor in the sensor cluster and the steering wheel angle sensor under the steering column detect the spin present at any wheels during over-steering, under-steering or cornering. The ESP ECU controls against over-steering or under-steering during cornering by controlling the vehicle stability using the input values from the sensors and applying the brakes independently to the corresponding wheels.

The system also controls during cornering by detecting the moment right before the spin and automatically limiting the engine output (coupled with the ASR system).

Under Steering



Over Steering



Modification basis	
Application basis	
Affected VIN	

▶ Understeering

Understeering is when the steering wheel is steered to a certain angle during driving and the front tires slip toward the reverse direction of the desired direction.
Generally, vehicles are designed to have under steering.
The vehicle can return back to inside of cornering line when the steering wheel is steered toward the inside even when the vehicle front is slipped outward. As the centrifugal force increases, the tires can easily lose the traction and the vehicle tends to slip outward when the curve angle gets bigger and the speed increases.

▶ Oversteering

Oversteering is when the steering wheel is steered to a certain angle during driving and the rear tires slip outward losing traction.
When compared with under steering vehicles, the controlling of the vehicle is difficult during cornering and the vehicle can spin due to rear wheel moment when the rear tires lose traction and the vehicle speed increases.

▶ ESP controls during under steering

The ESP system recognizes the directional angle with the steering wheel angle sensor and senses the slipping route that occurs reversely against the vehicle cornering direction during understeering with the yaw rate sensor and the lateral sensor.
Then the ESP system **applies the brake at the rear inner wheel** to compensate the yaw moment value. In this way, the vehicle does not lose its driving direction and the driver can steer the vehicle as driver intends.

▶ ESP controls during oversteering

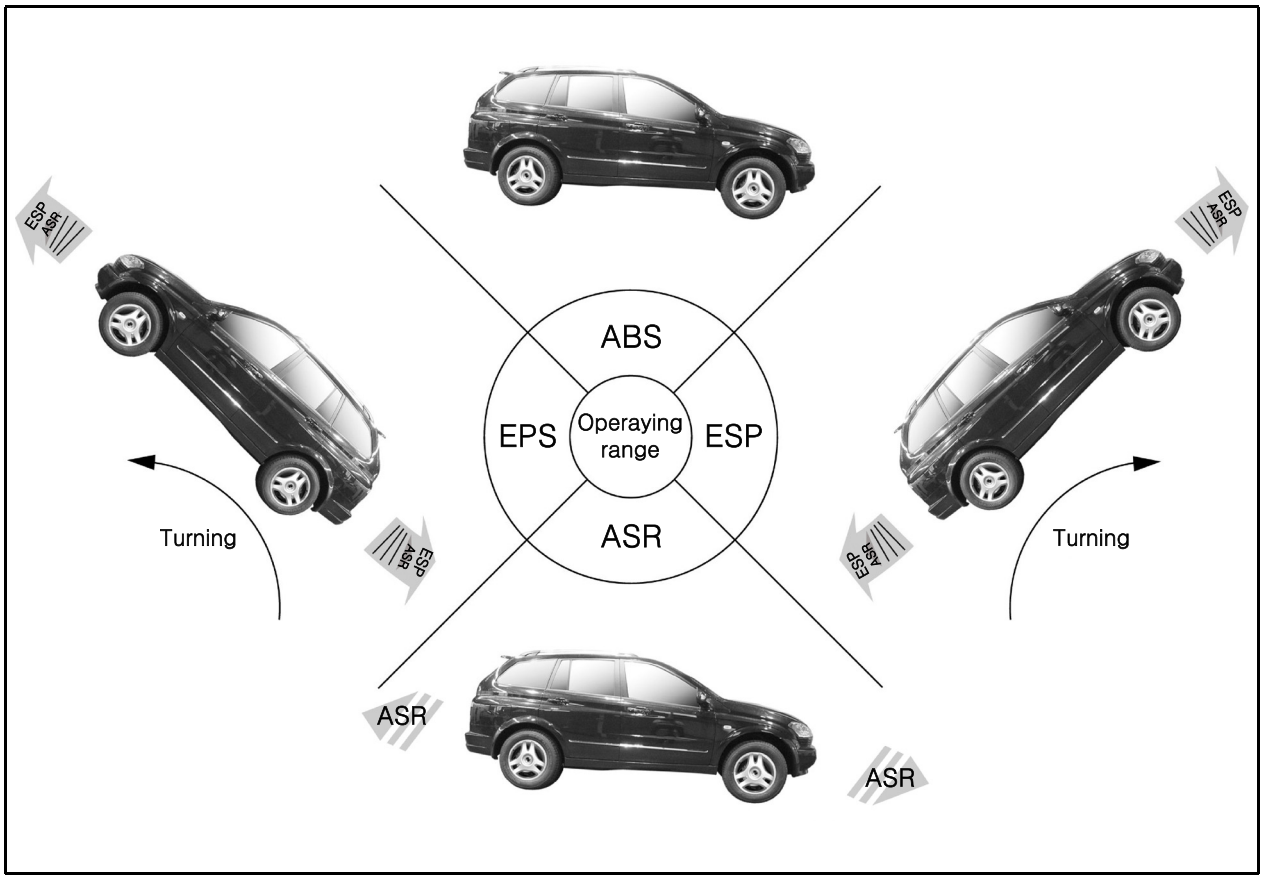
The ESP system recognizes the directional angle with the steering wheel angle sensor and senses the slipping route that occurs towards the vehicle cornering direction during oversteering with the yaw rate sensor and the lateral sensor.
Then the ESP system **applies the brake at the front outer wheel** to compensate the yaw moment value. In this way, the vehicle does not lose its driving direction and the driver can steer the vehicle as he or she intends.

2) ESP Control

As the single-track vehicle model used for the calculations is only valid for a vehicle moving forward, ESP intervention never takes place during backup.

The ESP system includes the ABS/EBD and ASR systems allowing the system to be able to operate depending to the vehicle driving conditions. For example, when the brakes are applied during cornering at the speed of 100 km/h, the ABS system will operate at the same time the ASR or ABD systems operate to reduce the power from the slipping wheel. And when yaw rate sensor detects the rate exceeding 4 degree/seconds, the ESP system is activated to apply the brake force to the corresponding wheel to compensate the yaw moment with the vehicle stability control function.

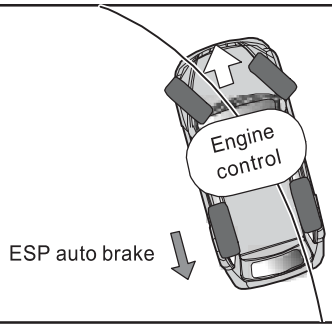
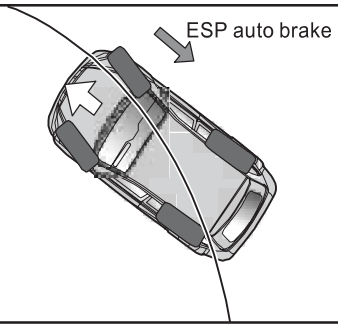
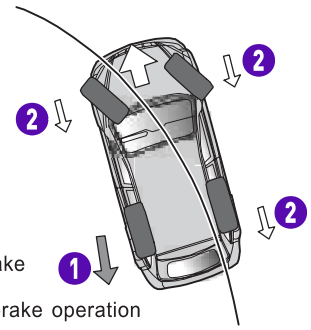
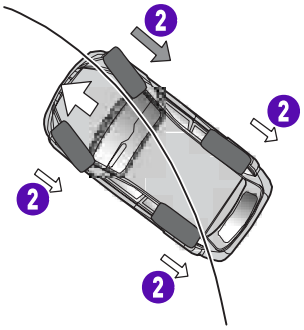
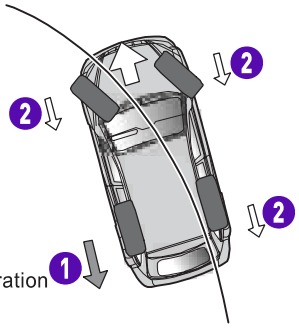
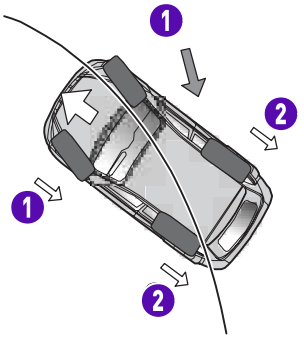
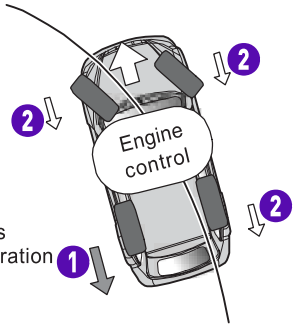
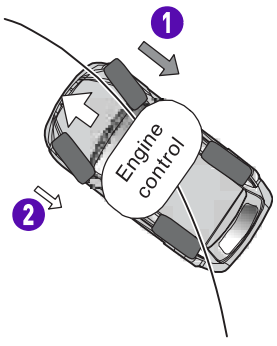
When various systems operate simultaneously under a certain situation, there may be vehicle control problems due to internal malfunction of a system or simultaneous operations. In order to compensate to this problem, the ESP system sets the priority among systems.
The system operates in the order of TCS (ASR or ABD), ESP and ABS.
The order may be changed depending on the vehicle driving situations and driving conditions.



Modification basis	
Application basis	
Affected VIN	

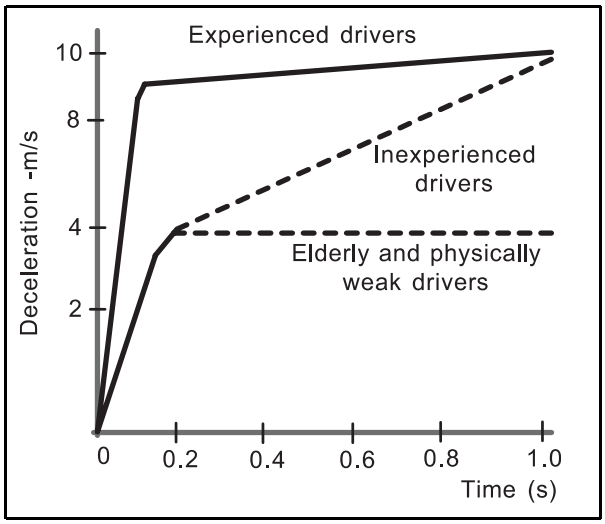
3) Vehicle Control During Cornering

The figure below shows the vehicle controls by ESP system under various situations such as when the brake pedal is pressed (or not pressed) during cornering and when the ABS is operating or when just the conventional brake is operating during braking.
It also includes the vehicle conditions when the TCS that is included in the ESP system is operating.

Operations	Understeering Control	Oversteering Control
Only ESP operating No braking by driver		
ESP + Conventional brake (ABS not operating)		
ESP + ABS brake		
ESP + TCS (Engine Control)		

3. HBA (HYDRAULIC BRAKE ASSIST SYSTEM)

HBA (Hydraulic Brake Assist) system helps in an emergency braking situation when the driver applies the brake fast, but not with sufficient pressure, which leads to dangerously long braking distance. ECU recognizes the attempt at full braking and transmits the signal calling for full brake pressure from the hydraulic booster.



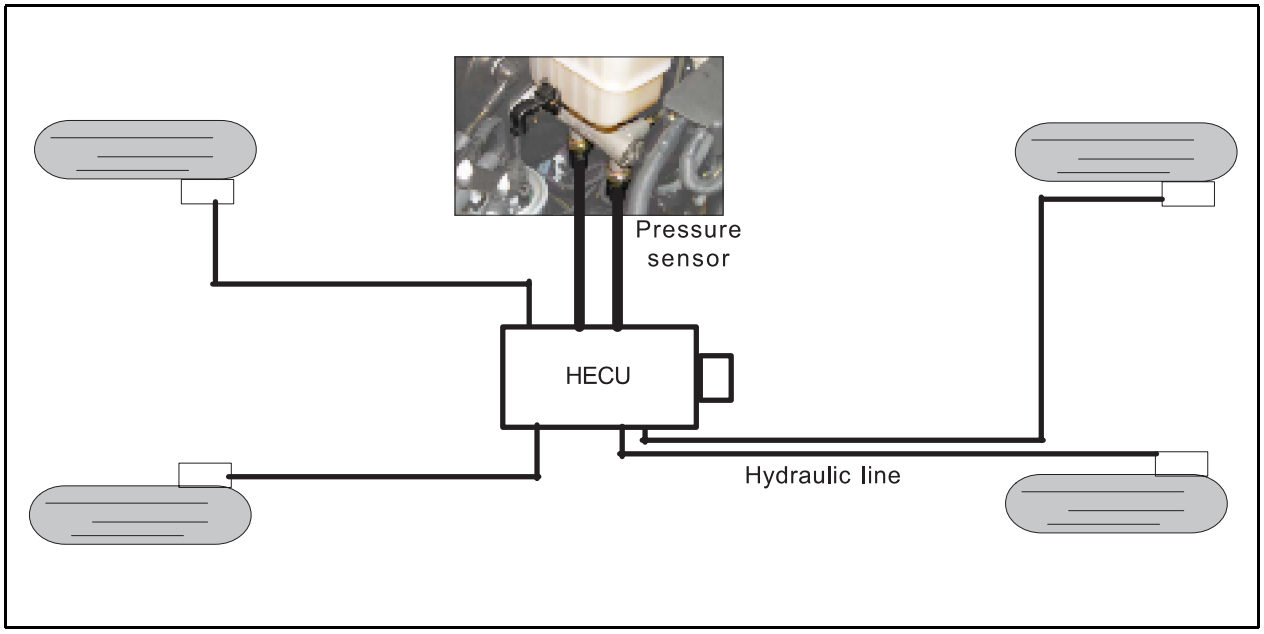
An inexperienced, elderly or physically weak driver may suffer from the accident by not fully pressing the brake pedal when hard braking is required under emergency. The HBA System increases the braking force under urgent situations to enhance the inputted braking force from the driver.

Based on the fact that some drivers depress the brake pedal too soft even under when hard braking is necessary, the HECU system is a safety supplementary system that builds high braking force during initial braking according to **pressure value of the brake pressure sensor** and **the pressure changes of the pressure sensor intervals.**

When the system is designed to apply high braking force when brake pedal is depressed softly by an elderly or physically weak driver, the vehicle will make abrupt stopping under normal braking situation due to high braking pressure at each wheels.

Modification basis	
Application basis	
Affected VIN	

The brake pressure value and the changed value of the pressure sensor are the conditions in which the HBA System operates.
There are 2 pressure sensors under the master cylinder. When the ESP ECU system determines that emergency braking is present, the pump operates, the brake fluid in the master cylinder is sent to the pump and the braking pressure is delivered to the wheels via the inlet valves.
If the drive depresses the brake pedal slowly, the pressure change is not high. In this case, only the conventional brake system with booster is activated.



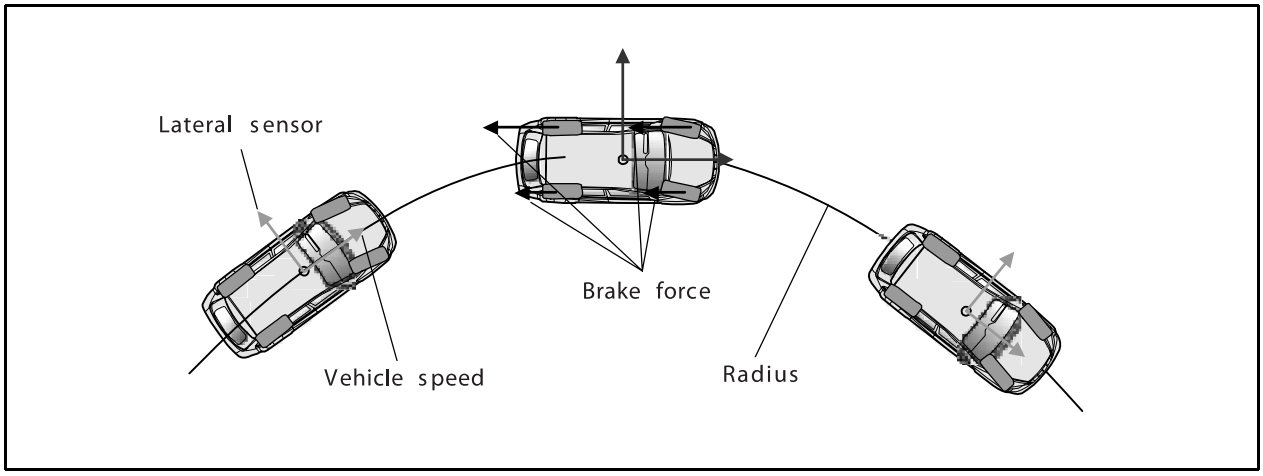
Operating conditions:
1. Pressure: over 20 bar
2. Pressure changes: over 1500 bar/sec
3. Vehicle speed: over 7 Km/h

4. ARP (ACTIVE ROLL-OVER PROTECTION)

The ARP (Active Roll-over Protection) system is a safety assistant device that minimizes, by controlling brakes and the engine, the physical tendency of the vehicle rollover during sharp lane changes or U-turns. For the system, software is added to the existing ESP system and no additional device or switch is needed.

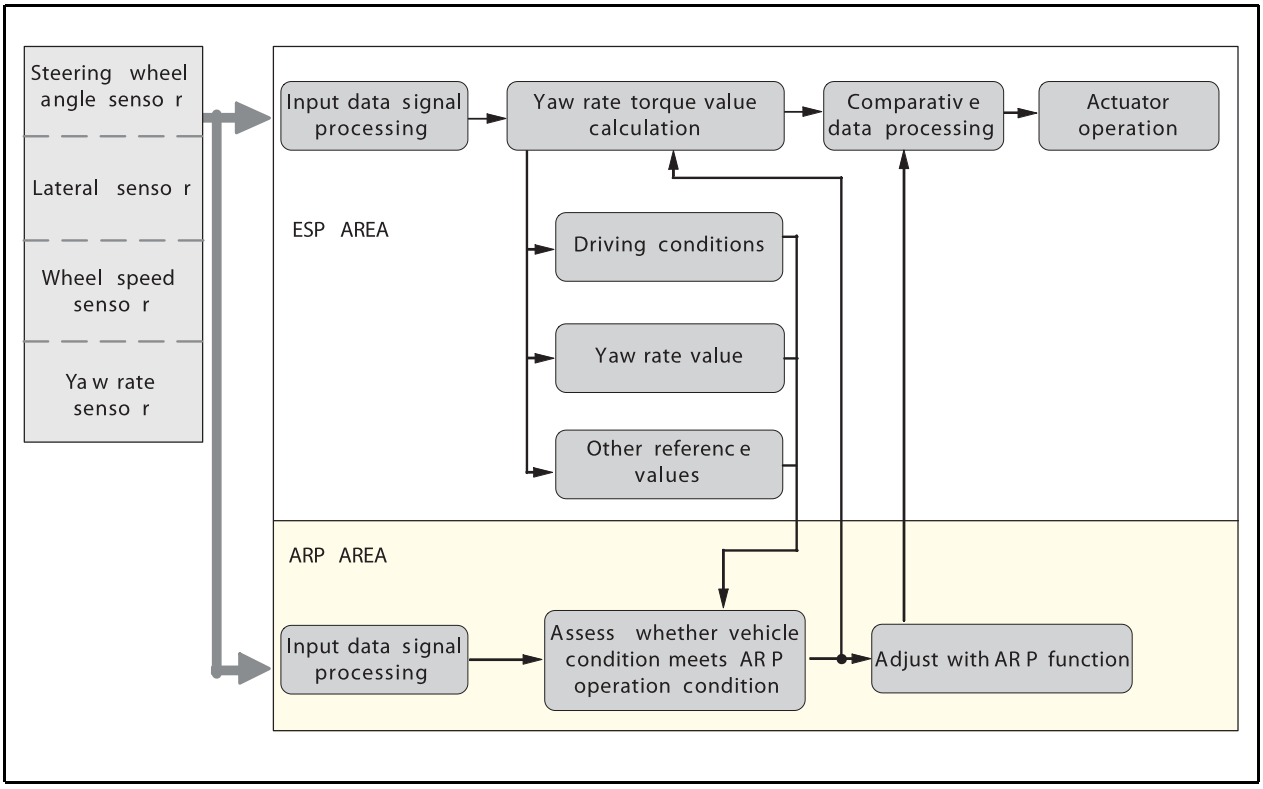
One must note that the ARP system, just as general assistant devices including the ABS, is only a safety assistant device using the ESP system and its function is useless when the situation overcomes the physical power.

Following picture shows how the ARP compensates the vehicle position by varying each wheel's braking power to overcome the physical tendency of the vehicle rollover during sharp turns.



Modification basis	
Application basis	
Affected VIN	

The vehicle driving condition is controlled by the internally programmed logic according to the input signals from wheel speed sensor, steering angle sensor and lateral sensor.



CAUTION

· During the ARP operation, vehicle safety (rollover prevention) takes the first priority and thus, stronger engine control is in effect. Consequently, the vehicle speed decreases rapidly, so the driver must take caution for the vehicle may drift away from the lane.

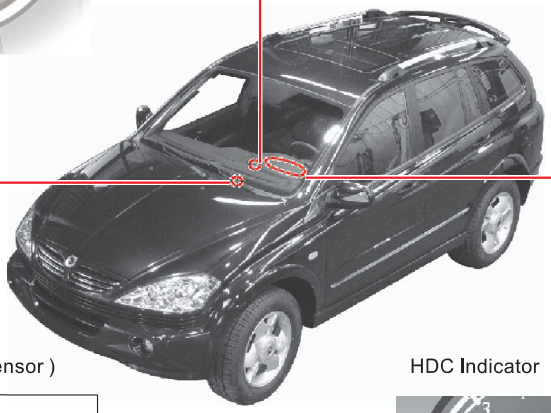
5. HDC (HILL DESCENT CONTROL)

1) System Overview

The HDC system is an automatic descent control device that allows the vehicle to automatically decelerate to about 7 km/h by 0.1G, on steep roads (slope level exceeding 10%) through a separately installed switch operation.
When the vehicle speed reaches below 7 km/h (refer to the information below), the HDC automatically terminates the operation.

HDC Switch

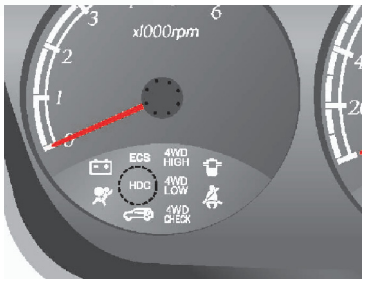
When you see a steep downhill ahead, press the HDC switch and the green HDC indicator comes on. When the G sensor within the sensor cluster detects a slope level exceeding 10%, the ESP's HDC function operates. When this occurs, the green HDC indicator flashes along with a loud operation sound.



Sensor Cluster (G Sensor)

The G Sensor within the sensor cluster detects the steepness of driving roads. When the HDC switch is in operation, if the G sensor detects a downhill steepness exceeding 10%, it transmits the HDC operation signal to the ESP HECU.

HDC Indicator (Instrument Panel)



When you press the HDC switch, the green HDC indicator comes on, and when the HDC operates, the green HDC indictor flashes at 0.5 second of interval.

HDC
Red letters

HDC
Green letters

CAUTION

· The G sensor in sensor cluster measures the actual road steepness. However, it may recognize a sharp turn or rough road as a downhill road with a slope level exceeding 10%, and the HDC may operate.

Modification basis	
Application basis	
Affected VIN	

Memo

2) HDC (Hill Descent Control) System Operating Conditions

1. When HDC switch is turned ON and

2. Gearshift lever position (Forward/Reverse) and

Manual transmission: operates in the 1st gear or reverse gear position (does not operate in neutral position).
Automatic transmission: operates in any position except for P (parking) or N (neutral) positions.

CAUTION

- The **vehicles with manual transmission** do not have a separate device or switch that detects the 1st gear. It only detects the forward/reverse driving direction of the vehicle through backup lamp switch and neutral switch, and cannot solely detect the 1st gear position. The reason for noting the 1st gear above, though the HDC also operates in 2nd gear position, is because the engine may turn off during the HDC operation process. You may face a very dangerous situation if the engine turns off at a steep hill.
- The HDC is the device to improve the engine brake effect during downhill driving on a steep hill. For manual transmission equipped vehicle, HDC system should operated only in 1st gear.

3. When not depressing the accelerator pedal or brake pedal. and

4. The vehicle speed is above 7 km/h (in Automatic transmission/4H mode). and

CAUTION

- The vehicle speed given in step (3) varies according to the vehicle driving mode, and the speed ranges by the vehicle driving mode and condition are as follows.

Modification basis	
Application basis	
Affected VIN	

1) Speed available in HDC mode (slope)

Forward driving	2H/4H mode: vehicle speed below 50 km/h (operation slope level: 10%, termination slope level: when it reaches 8%) 4L mode: vehicle speed below 25 km/h (operation slope level: 10%, termination slope level: when it reaches 5%)
Reverse driving	2H/4H mode: vehicle speed below 50 km/h (operation slope level: 8%, termination slope level: when it reaches 5%) 4L mode: vehicle speed below 25 km/h (operation slope level: 8%, termination slope level: when it reaches 4%)

2) HDC target speed in 2H/4H mode

(The HDC target speed is the speed that the HDC is not terminated even after the vehicle speed reaches 7 km/h, but is converted to the stand-by mode. When the vehicle speed increases again as a result of the increase of the road steepness, etc., the HDC goes into operation.)

Forward driving: 7 km/h
Reverse driving: 7 km/h (automatic transmission), 8.5 km/h (manual transmission)

3) HDC target speed in 4L mode

Forward and reverse driving: 3 km/h

5. Vehicle position control function in ESP and HBA function are not in operation:

and

The HDC is the device to improve the engine brake effect during downhill driving on a steep hill. If the ESP function is in operation, HDC operation is overridden.

6. Slope level exceeds 10%.

When the slope level exceeds 10%, the HDC operates until the vehicle reaches the speed value given in step (4).

▶ When the slope level is between 10% and 20% during the HDC operation

When depressing the accelerator pedal or brake pedal, HDC system is changed to stand-by mode. When depressing the accelerator pedal again, HDC starts its operation again. Therefore, drivers can control the vehicle speed to a desired level by operating the accelerator pedal.

▶ When the slope level exceeds 20% during the HDC operation

When depressing the accelerator pedal, HDC system is changed to stand-by mode.
When depressing the brake pedal, HDC continues its operation and the braking power is increased.
In this case, HECU sounds an abnormal noise and brake pedal may be very rigid, but this is a normal condition due to HDC operation.

3) HDC (Hill Descent Control) System Non-Operation Conditions

1. When HDC switch is turned OFF or

2. Gearshift lever has passed neutral (N) position. or

CAUTION
· Vehicle with manual transmission: Sensing at the neutral switch
· Vehicle with automatic transmission: Sensing at the selector lever unit

3. When the vehicle speed is out of the specified values. or

4. When the ESP related functions, e.g. vehicle position control, HBA, ARP is activated during HDC operation. or

The HDC is the device to improve the engine brake effect during downhill driving on a steep hill. If the ESP function is in operation, HDC operation is overridden.

5. When the internal temperature of HDC system goes over 450°C **due to long downhill driving on a steep hill with HDC operated.** or

There is no specific temperature sensor in the system, but a programmed logic inside the HECU predicts the temperature based on the operating numbers and conditions of HDC.

CAUTION
· The red HDC warning lamp blinks when the internal temperature goes over 350°C. When it reaches 450°C, the HDC warning lamp comes on. The HDC can be operated in the range even where the HDC warning lamp blinks.

6. When the slope level is below 10%

When the slope level exceeds 10%, the HDC operates until the vehicle reaches the speed condition given in step (4).

▶ When the slope level is between 10% and 20% during the HDC operation

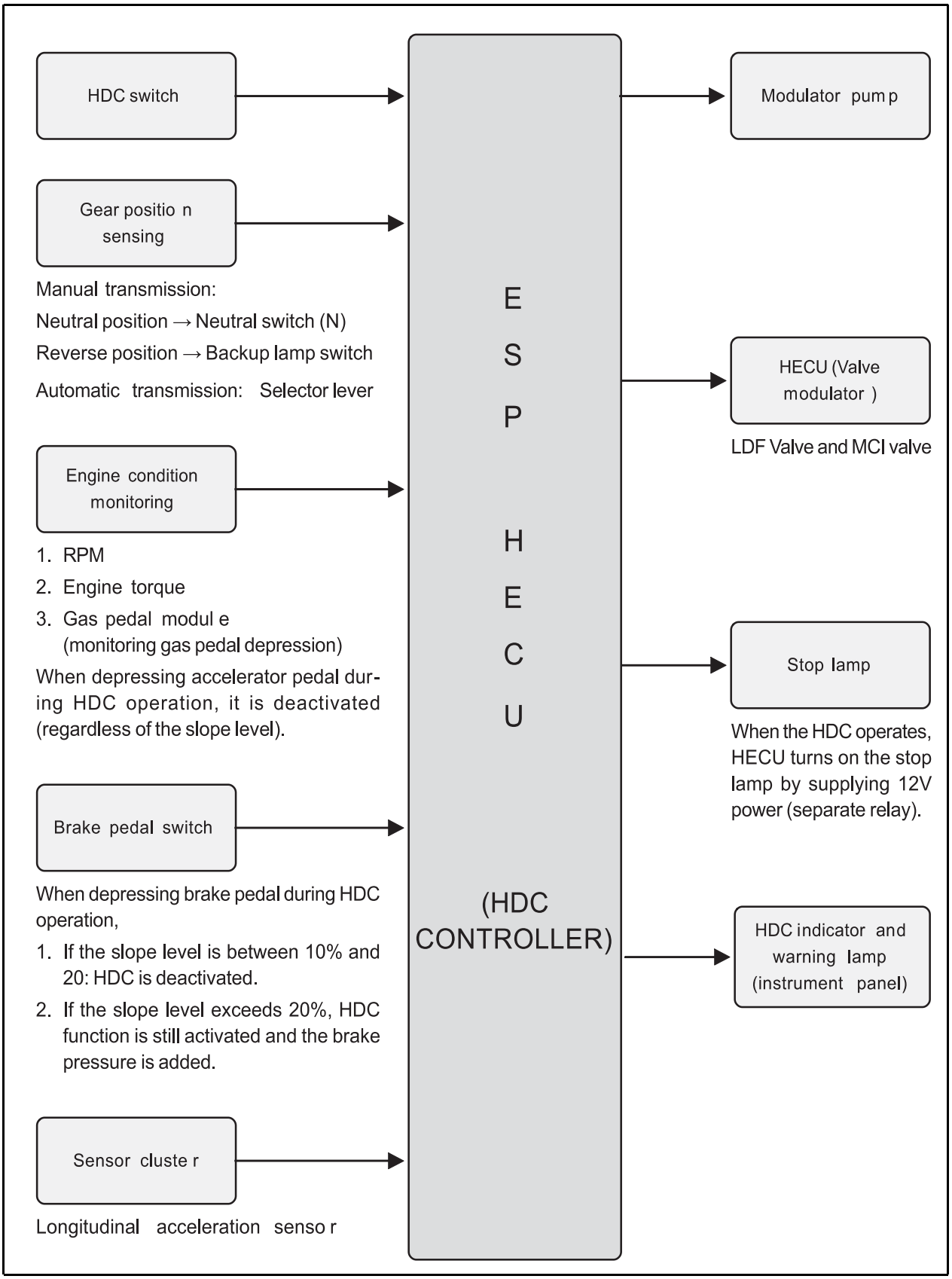
When depressing the accelerator pedal or brake pedal, HDC system is changed to stand-by mode. When depressing the accelerator pedal again, HDC starts its operation again. Therefore, drivers can control the vehicle speed to a desired level by operating the accelerator pedal.

▶ When the slope level exceeds 20% during the HDC operation

When depressing the accelerator pedal, HDC system is changed to stand-by mode. When depressing the brake pedal, HDC continues its operation and the braking power is increased. In this case, HECU sounds an abnormal noise and brake pedal may be very rigid, but this is a normal condition due to HDC operation.

Modification basis	
Application basis	
Affected VIN	

4) Input/Output Signals for HDC Operation



Modification basis	
Application basis	
Affected VIN	

5) Operation of HDC Indicator Controller

This table describes the coming-on and blinking mode of HDC indicator according to the HDC switch operation (ON/OFF).

The HDC indicator on the instrument panel has two modes; green (function lamp) and red (warning lamp). The HDC switch is a push & self return type switch ? when you press it once, it starts to operate and when you press it again, it stops the operation.

<table>
<tr><td colspan="4" rowspan="3">HDC Operation Mode</td><td>HDC Indicator</td><td>HDC Warning Lamp</td></tr>
<tr><td>Green</td><td>Red</td></tr>
<tr><td> </td><td> </td></tr>
<tr><td colspan="4">Initial ignition ON (From hence, this signifies operation mode after the engine starts. Even when HDC switch is ON, if the ignition is OFF, HDC operation stops automatically.)</td><td>OFF</td><td>ON
(goes off after 1.8 seconds)</td></tr>
<tr><td rowspan="2">Not available</td><td colspan="3">HDC switch OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td colspan="3">HDC system error</td><td>OFF</td><td>ON</td></tr>
<tr><td rowspan="2">Stand-by</td><td colspan="3">HDC switch ON</td><td>ON</td><td>OFF</td></tr>
<tr><td colspan="5">The HDC switch is turned ON, but HDC system is in stand-by mode because the operating requirements are not met.</td></tr>
<tr><td rowspan="2">In operation</td><td colspan="3">HDC system is operating.</td><td>Blinking (0.5 seconds of interval)</td><td>OFF</td></tr>
<tr><td colspan="5">The HDC switch is turned ON, and the operating requirements are met. HDC is operating with operating sound.</td></tr>
<tr><td rowspan="3">System overheat</td><td rowspan="2">High brake system temperature (over 350°C)</td><td>HDC stand-by mode</td><td colspan="2">OFF</td><td>Blinking</td></tr>
<tr><td>HDC is operating</td><td colspan="3">Alternate blinking of green and red lamp (0.5 seconds of interval)</td></tr>
<tr><td colspan="2">Too high brake system temperature (over 450°C)</td><td colspan="2">OFF</td><td>ON</td></tr>
<tr><td colspan="5">There is no specific temperature sensor in the system, but a programmed logic inside the HECU predicts the temperature based on the operating numbers and conditions of HDC (HDC cannot be operated).</td></tr>
</table>

CAUTION

Basically, the brake system's basic functions can work even when there are problems with the HDC system.

As given in the table above, the HDC warning lamp comes on when:

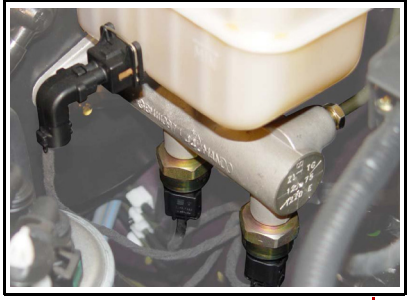
- Initial ignition ON
- HDC system error occurs
- Brake system overheat

Modification basis	
Application basis	
Affected VIN	

Memo

6. ESP COMPONENTS AND LOCATIONS

Master cylinder pressure sensor

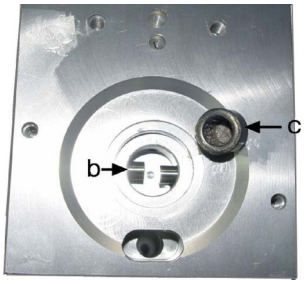


Sensor cluster: (Yaw rate + lateral sensor +longitudinal sensor)

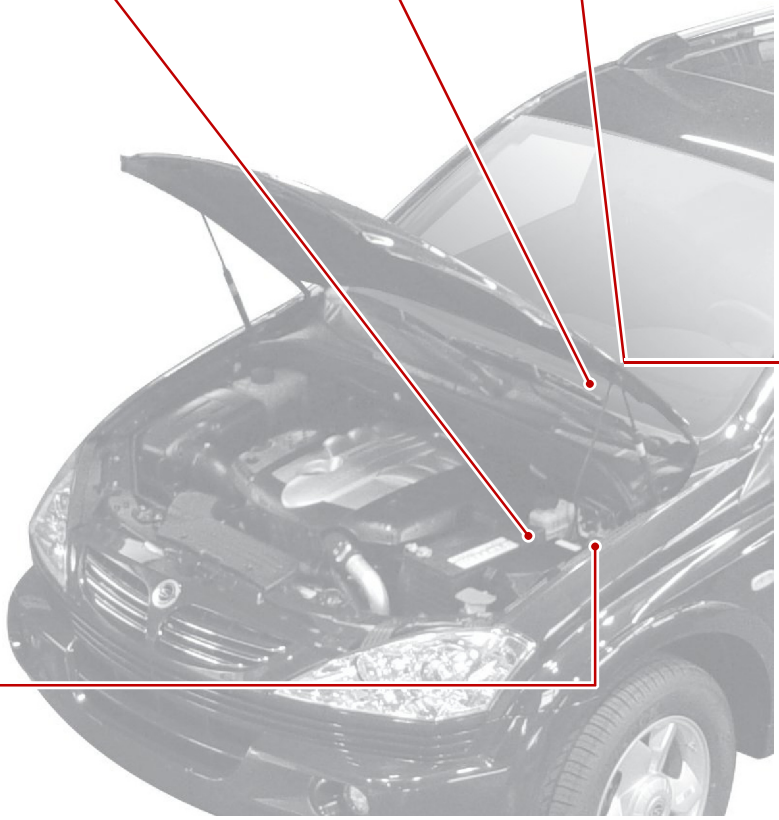
Steering wheel angle sensor

HECU (Valve body and ECU integrated type)

Valve body



Motor pump



Modification basis	
Application basis	
Affected VIN	

▶ Comparison with ABS System

No	Name	ESP Component		Remark
1	HECU	0	0	ESP system contains ESP OFF switch and HDC switch.
2	Pressure sensor	0	N/A	
3	Wheel speed sensor	0	0	
4	Sensor cluster	0	N/A	
5	Steering wheel angle sensor	0	N/A	

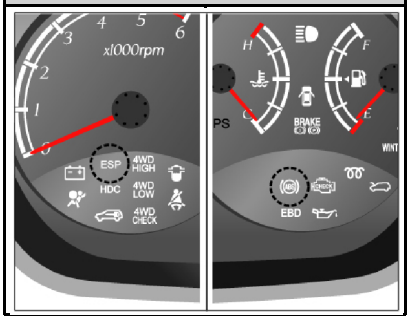
Active Wheel Speed Sensor

HDC Switch

HDC Indicator

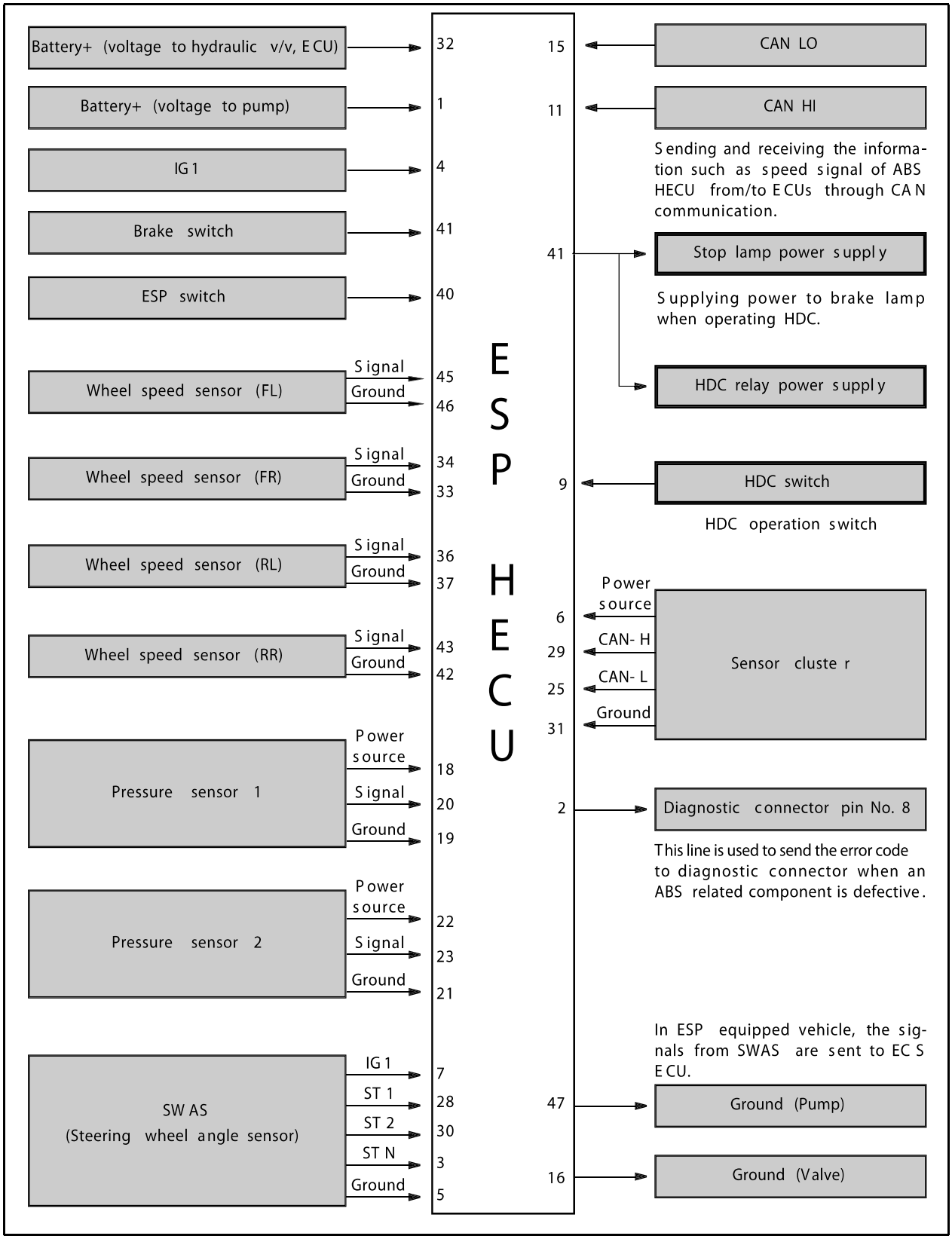
ESP OFF Switch

ABS / ESP Indicator



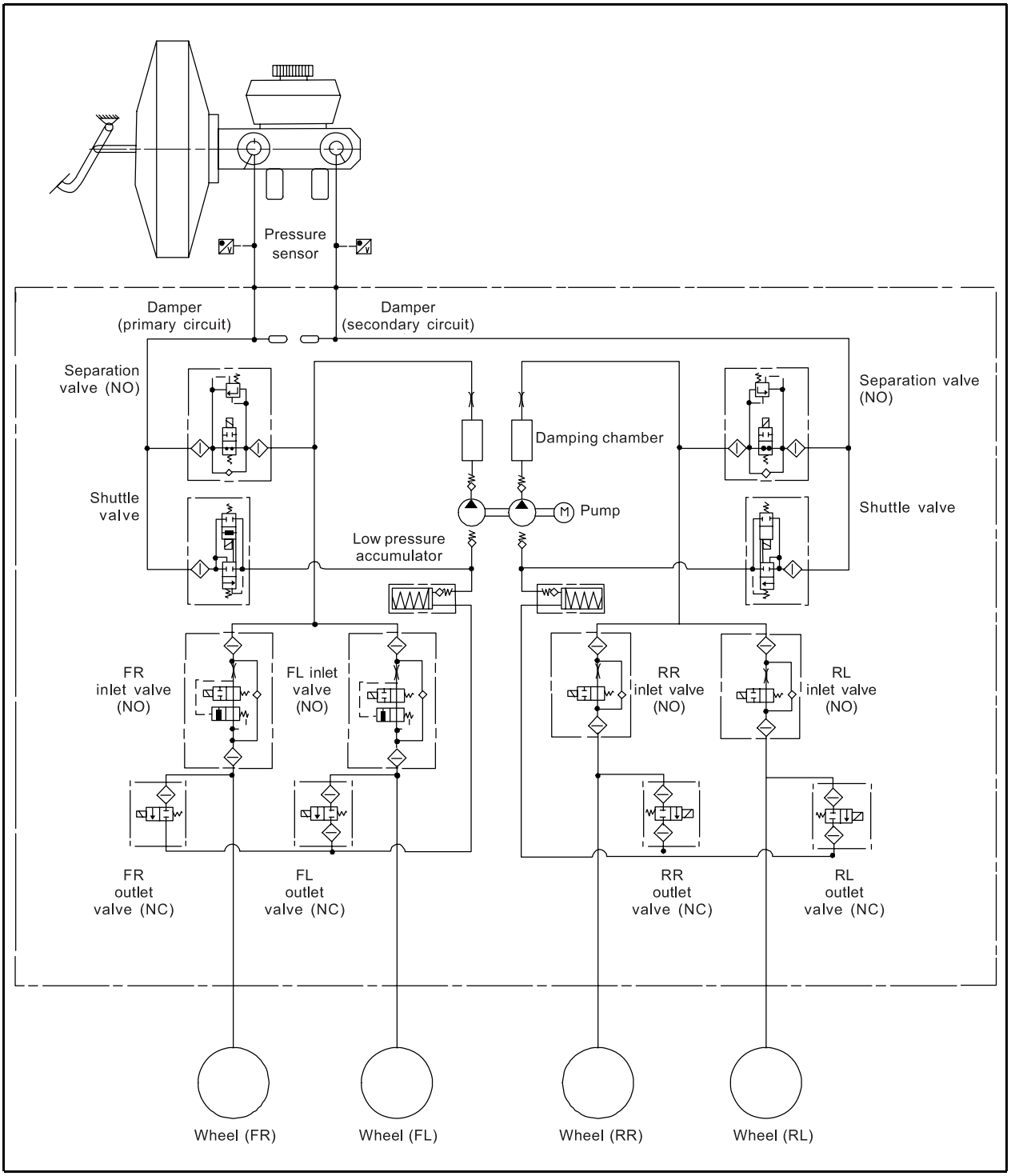
7. INPUT/OUTPUT SIGNALS FOR HDC OPERATION

▶ Input/Output of ESP System



Modification basis	
Application basis	
Affected VIN	

8. ESP HYDRAULIC CIRCUIT DIAGRAM



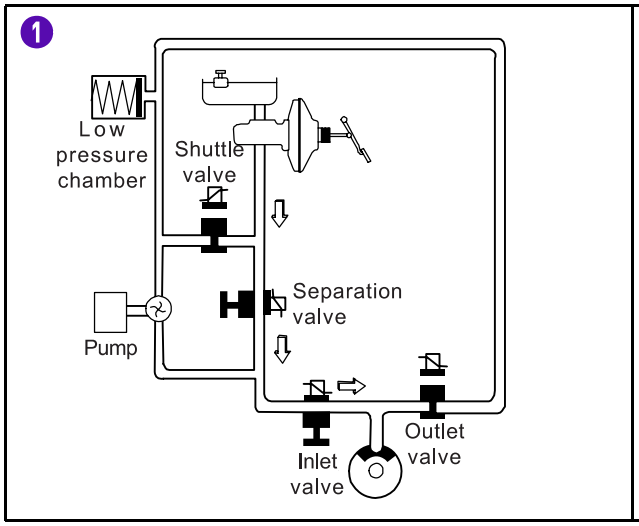
Modification basis	
Application basis	
Affected VIN	

9. HYDRAULIC PRESSURE FOR EACH ESP OPERATING RANGE

1) ESP Operating Explanation

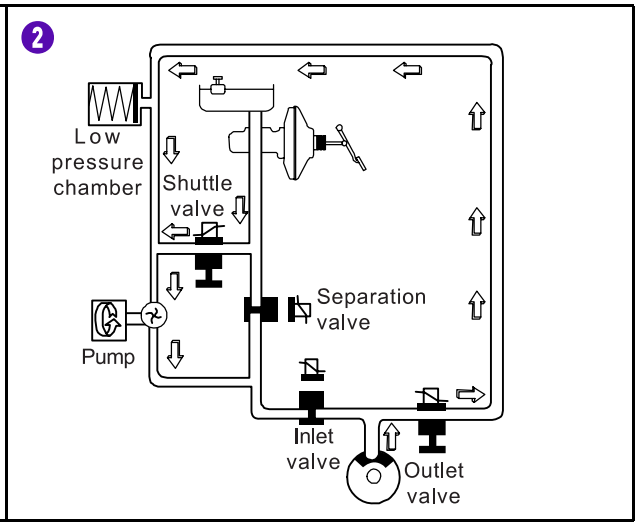
When equipped with ABS, the braking force at each wheel will be controlled with 3-channel 4-sensor method. And when equipped with ESP, 4 wheels will be controlled independently with 4-channel method. (When controlling ABS system only, it will be operated with 3-channel method.)
When compared to the vehicle equipped with ABS/EBD only, the internal hydraulic circuit has a normally-open separation valve and a shuttle valve in primary circuit and in secondary circuit.
When the vehicle brakes are not applied during engine running or when applying the non-ABS operating brakes, the normally-open separation valve and the inlet valve are open, whereas the normally-closed shuttle valve and the outlet valve are closed. When the ESP system is operating, the normally-open separation valve will be closed by the solenoid valve operation and the hydraulic circuit will be established by the shuttle valve. Then, the inlet and outlet valves will be closed or open depending on the braking pressure increase, decrease or unchanged conditions.

For details, refer to **"Hydraulic Pressure for each ESP Operating Range".**



▶ **ESP Hydraulic unit in idling and normal braking position**

In this position, the separation valve and the inlet valve are open (normal open), the electrically operated shuttle valve and the outlet valve are closed.
When the brake is applied under these conditions, the brake fluid will be sent to each wheel via the separation valve and inlet valve.

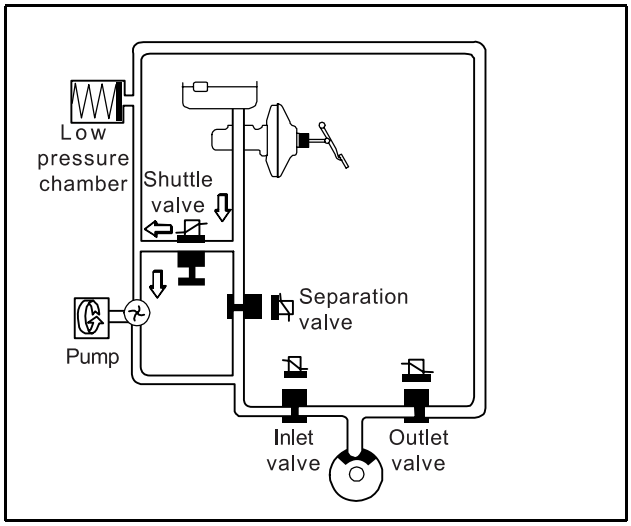


▶ **ESP Hydraulic unit (decreased pressure)**

The pressure decreases just before the wheel speed drops and the wheels. The inlet valve closes and the outlet valve opens as in the ABS HECU and the oil is gathered at the low pressure chamber while no additional oil is being supplied. Then the pump operates to allow fast oil drainage.

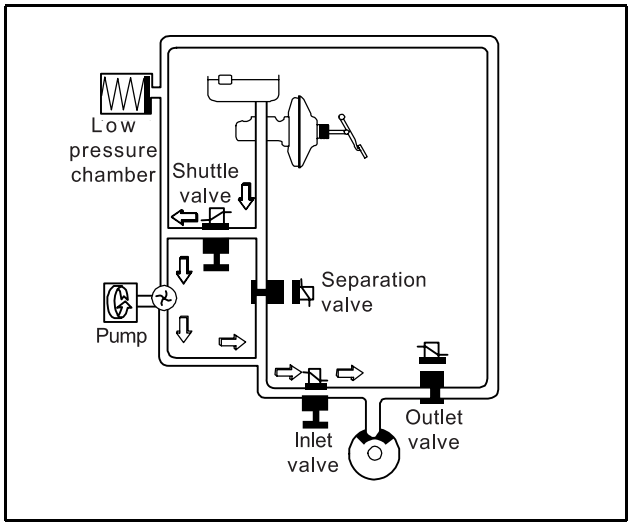
Modification basis	
Application basis	
Affected VIN	

▶ ESP unit circuit (when the pressure is maintained)



The Inlet valve and outlet valve will be closed to maintain the pressure in the hydraulic circuit applied at the wheels. By closing the valves, the hydraulic pressure at the wheels will not be lost or supplied any more. During ESP operation, the separation valve closes and only the shuttle valve at the pump opens.

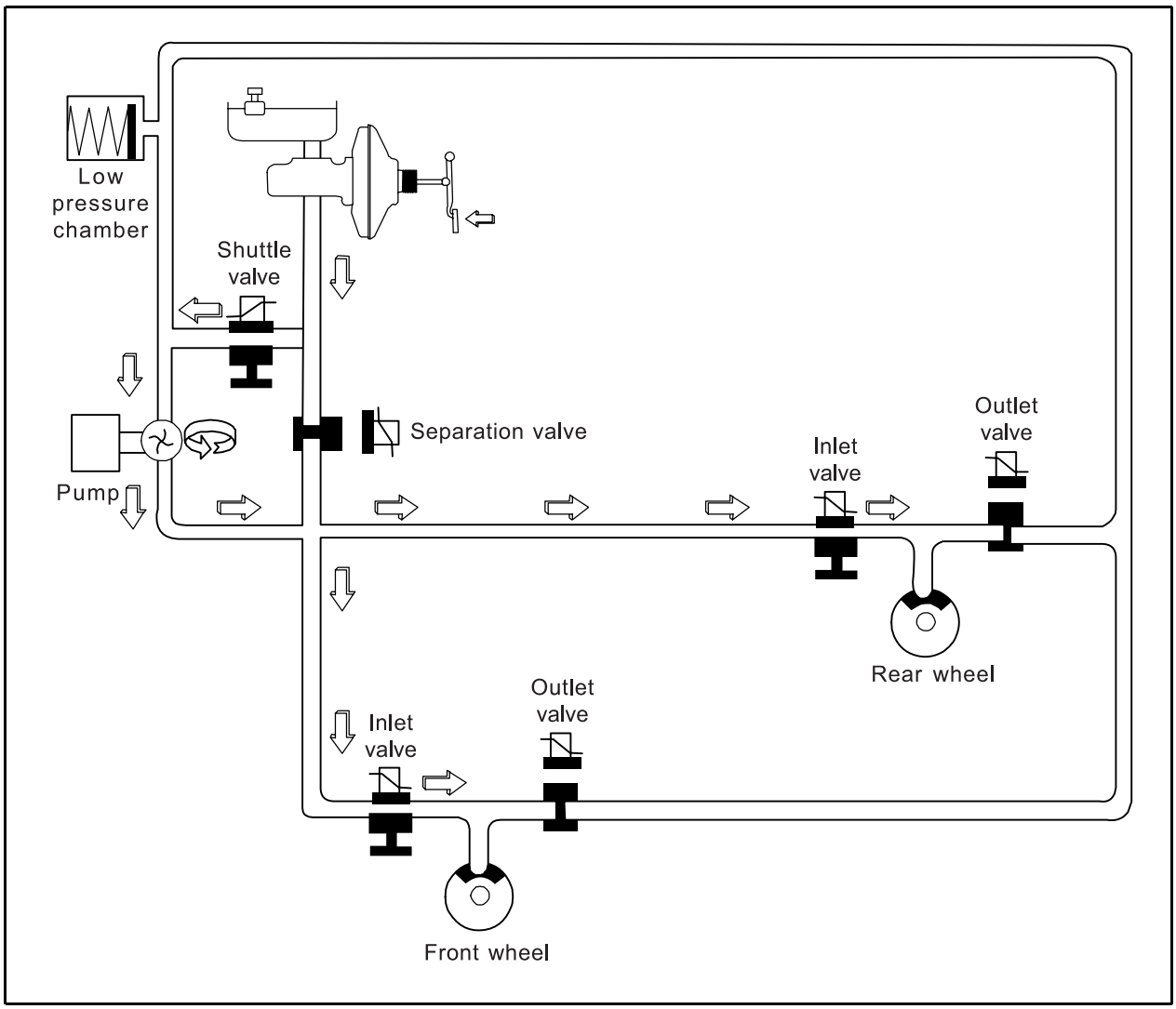
▶ ESP unit circuit (when the pressure is increased)



The shuttle valve and inlet valve will be open and the separation valve and outlet valve will be closed. Then, the pump is operated.

When ESP operates while the ABS is operating, the pressure will be increased continuously until just before the corresponding wheel gets locked.

10. HYDRAULIC CIRCUIT OF HBA (HYDRAULIC BRAKE ASSIST)



The above figure shows one front and one rear wheel and the same hydraulic circuit forms as in the ESP operation.

When HECU recognizes that it is an emergency and it is required for hard braking, depending on the pressure value of the brake pressure sensor and pressure changes caused by the pressure sensor timing, it operates the pump immediately to apply the brake pressure at the wheels. Then, the pressure in the pump increases until just before the corresponding wheel gets locked. The motor still keeps rotating and the outlet valve and the separation valve are will stay closed.

When the wheel starts to lock, the HBA function cancels and switches to ABS operation.

Modification basis	
Application basis	
Affected VIN	

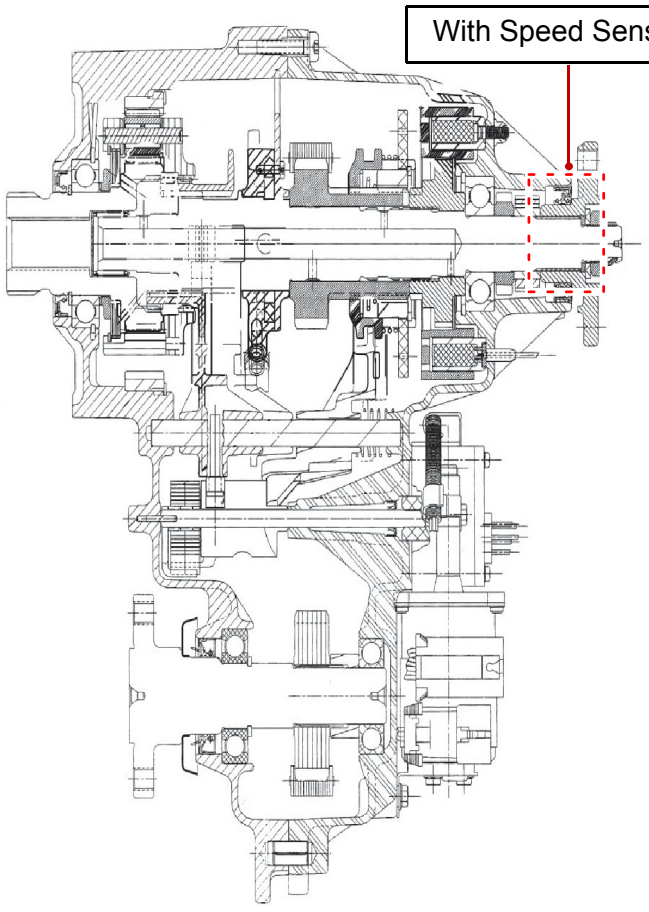
11. GENERAL INFORMATION OF ABS SYSTEM

Differences compared to other models: Appearance of wheel speed sensor, Location, Layout of relevant components

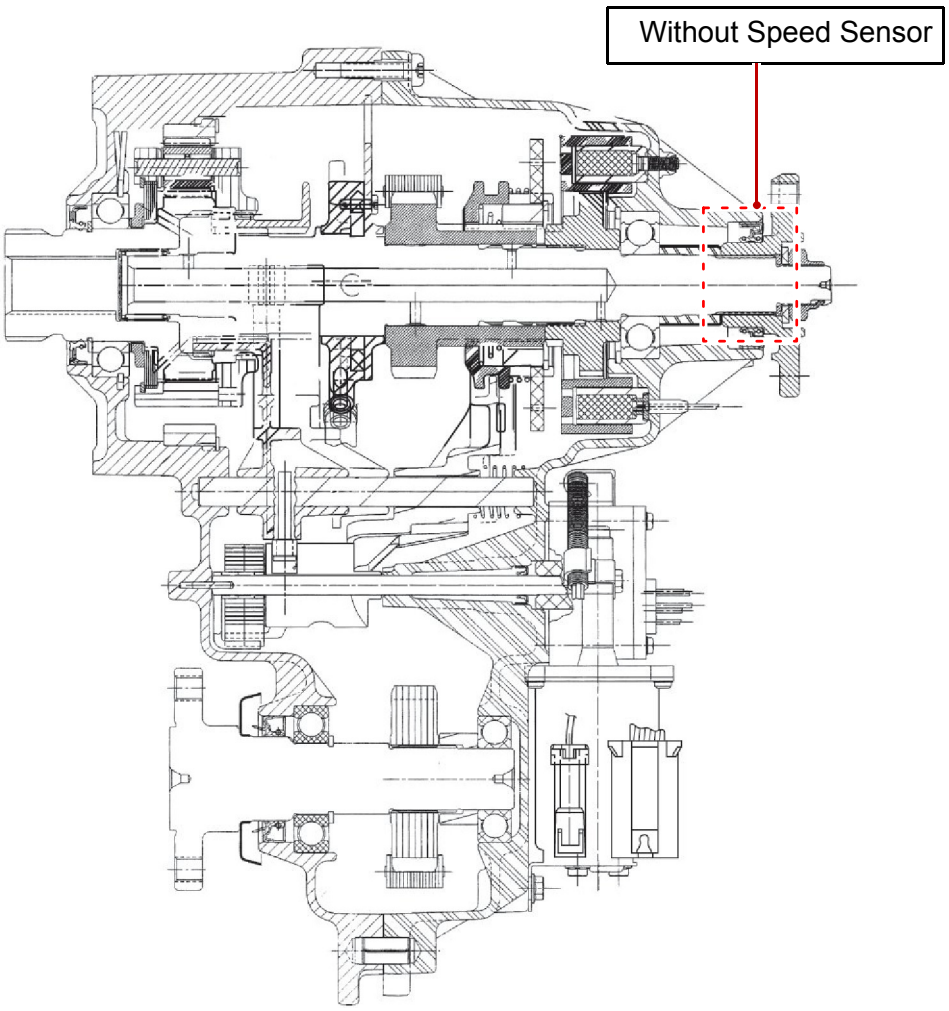
ABS HECU	Active Wheel Speed Sensor (for 4WD)

The transfer case (T/C) installed on this vehicle doesn't have the internal speed sensing device and receives the speed signal for T/C control from ABS HECU.

Conventional Transfer Case

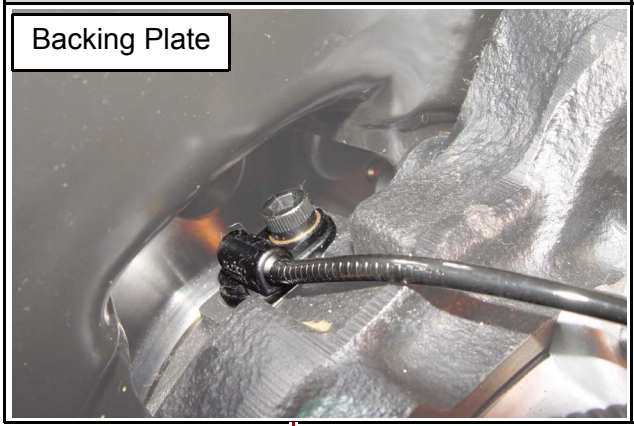
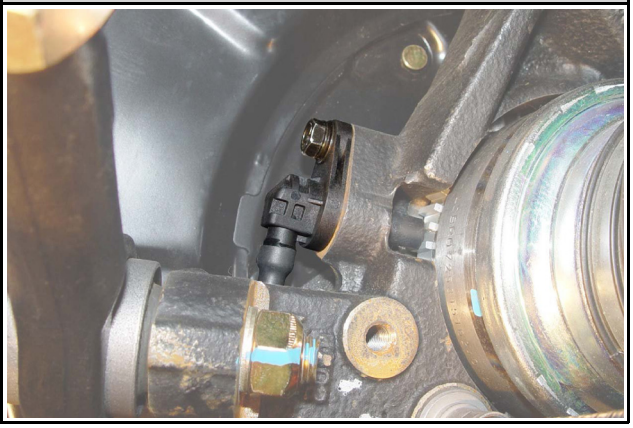


New Transfer Case

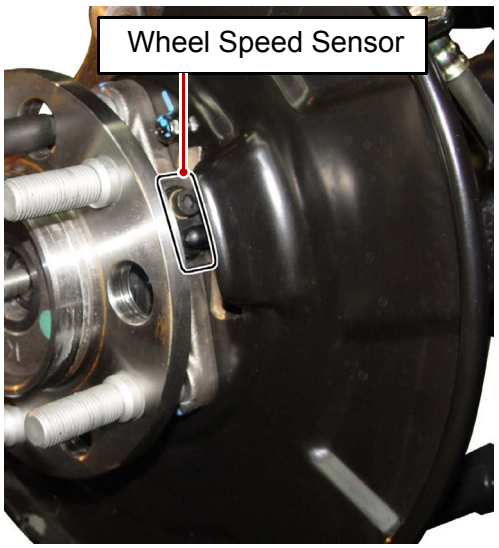


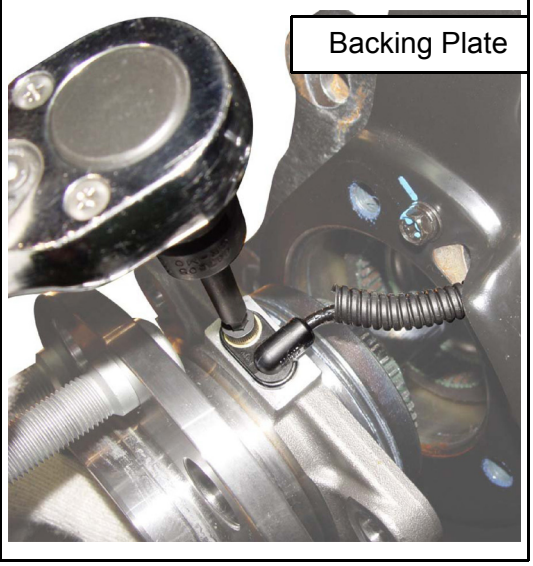
Modification basis	
Application basis	
Affected VIN	

Cautions When Removing the Front Wheel Speed Sensor
The locking hub system of the KYRON part time 4WD utilizes a different hub actuator from the conventional approach. It utilizes IWE (Integrated Wheel End) system that locks the 4WD depending on the vacuum condition within the actuator. Thus, the wheel speed sensor is installed on the front wheel end area. It is installed inside the backing plate to be protected from heat and foreign materials. Therefore, **the front wheel end system (including disc) should be removed before removing the front wheel speed sensor.**

Front Wheel Speed Sensor	Rear Wheel Speed Sensor
	

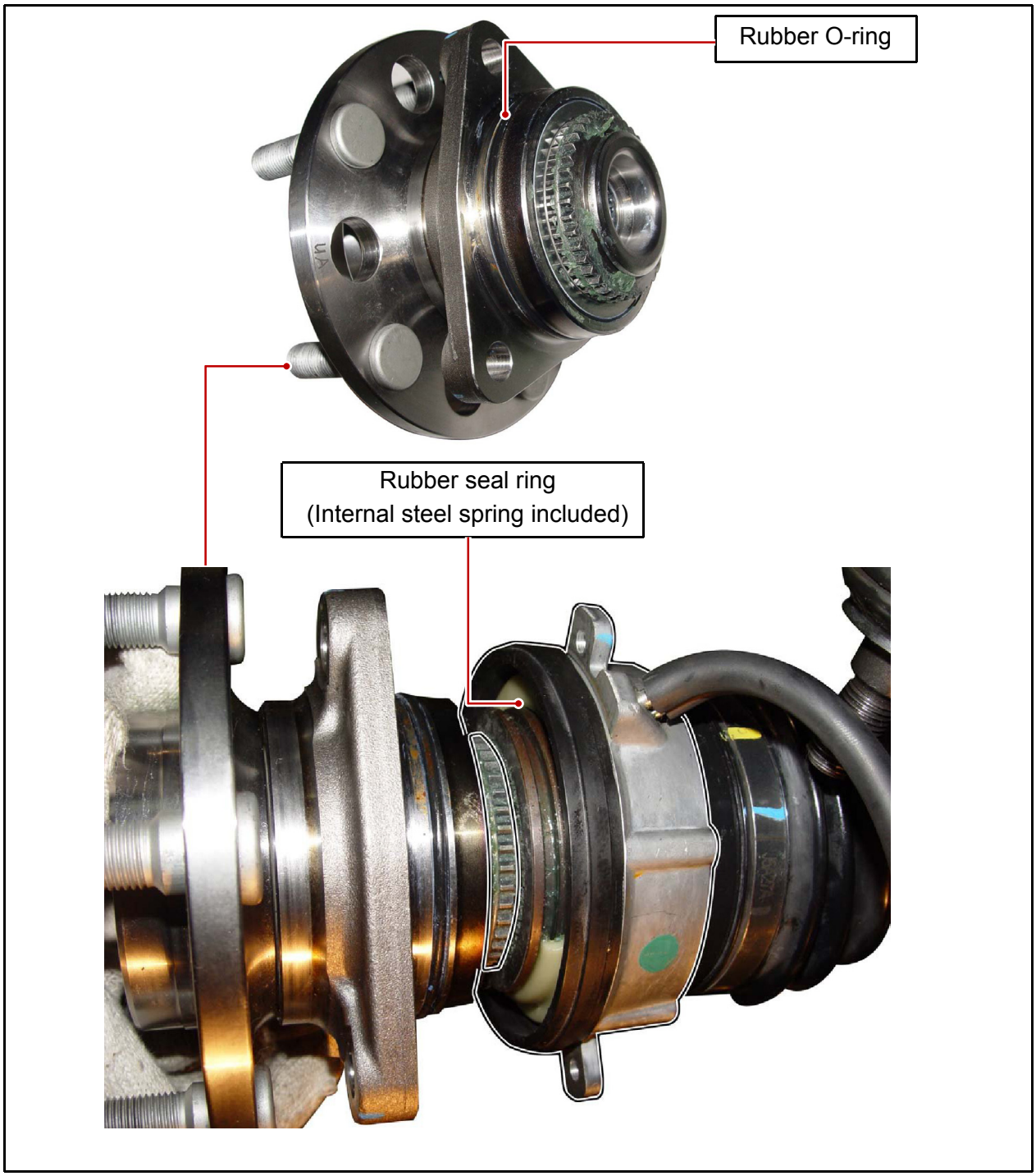
Wheel Speed Sensor





The rubber O-ring in IWE (Integrated Wheel End) should be replaced with new one when the front wheel end has been removed.
The rubber O-ring prevents moisture and foreign materials from entering the IWE system.

In addition, when installing the hub actuator of the IWE system, you must install it from the same angle as the drive shaft to prevent the rubber seal ring inside the actuator from being squeezed.

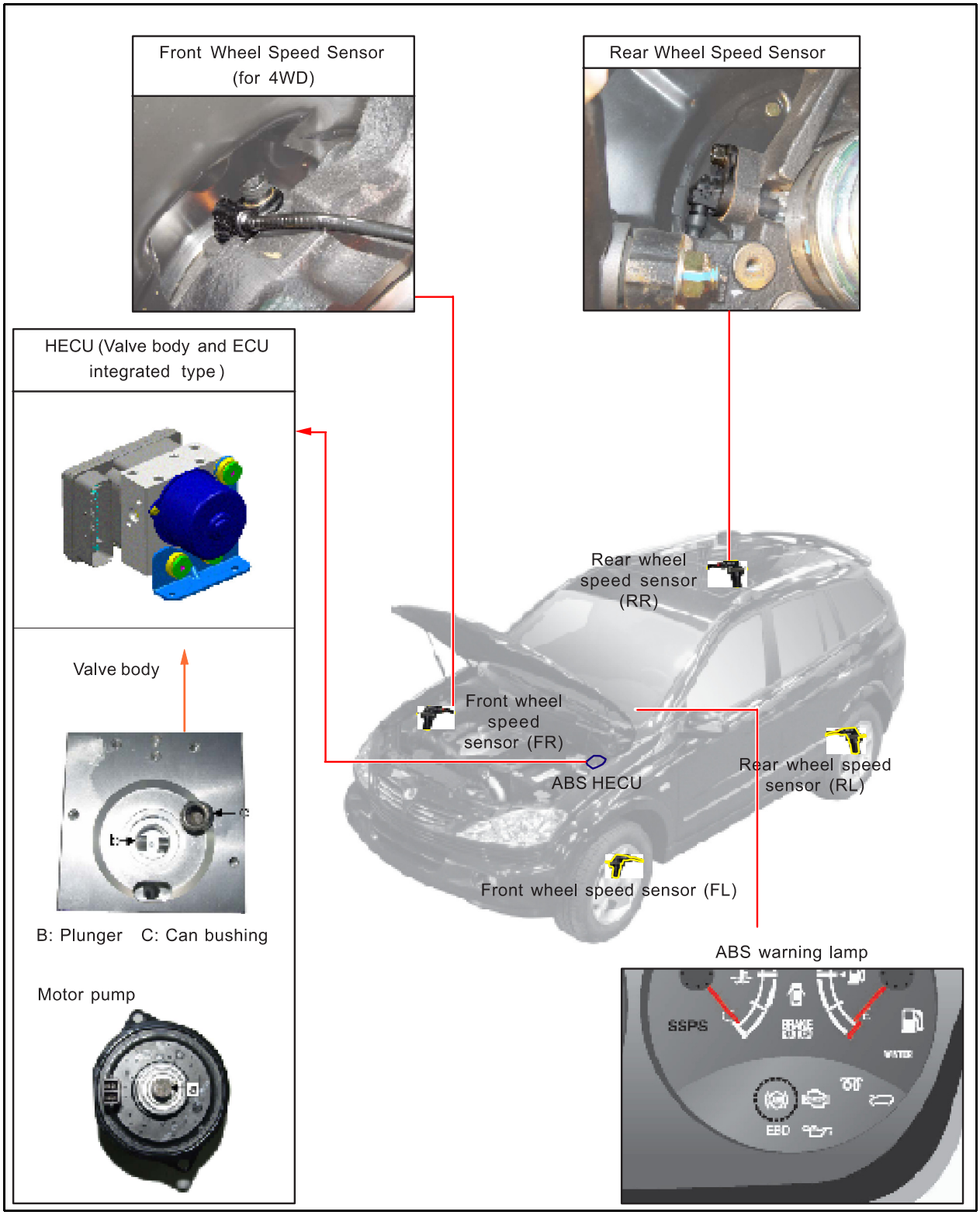


Please refer to the part time transfer case section for more specific information.

Modification basis	
Application basis	
Affected VIN	

12. CONFIGURATION OF ABS SYSTEM

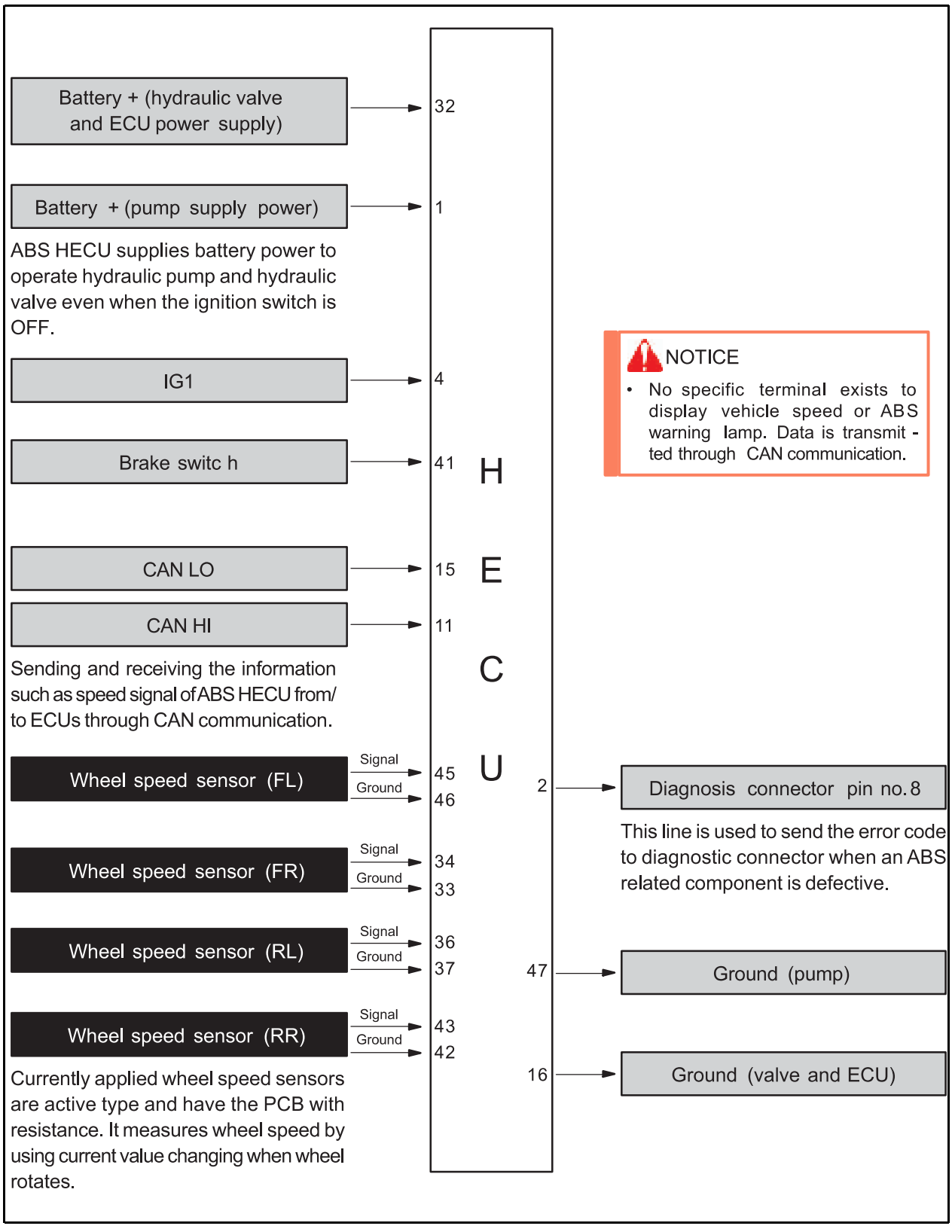
The following figure shows the basic system components of the ABS. This system consists of HECU (valve body and ECU integrated type), front wheel speed sensor, and rear wheel speed sensor.



Modification basis	
Application basis	
Affected VIN	

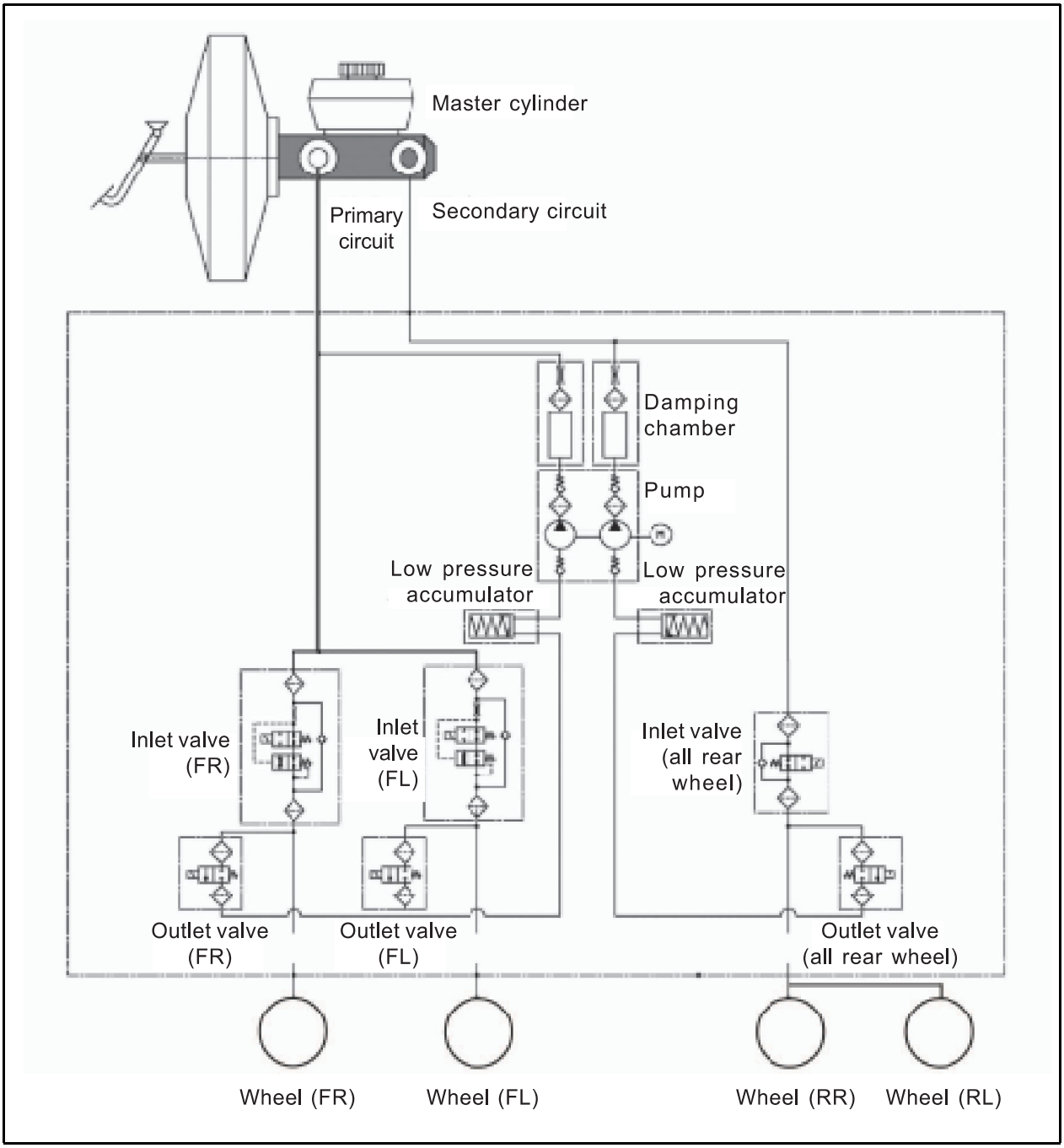
13. INPUT AND OUTPUT DIAGRAM OF ABS

▶ Input/Output of ABS (without TPMS)



Modification basis	
Application basis	
Affected VIN	

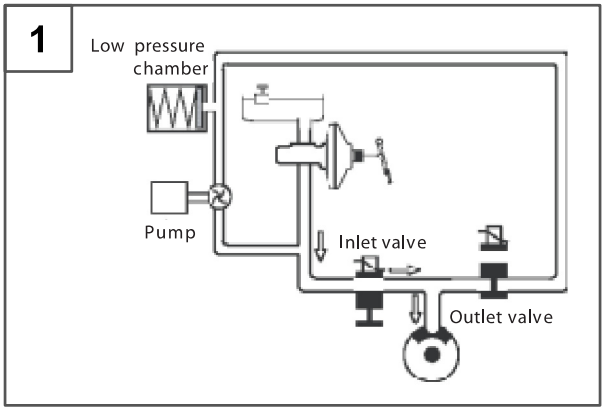
14. HYDRAULIC CIRCUIT OF ABS



The vehicle equipped only with the ABS controls the wheel's braking force using or channel 4-sensor method.

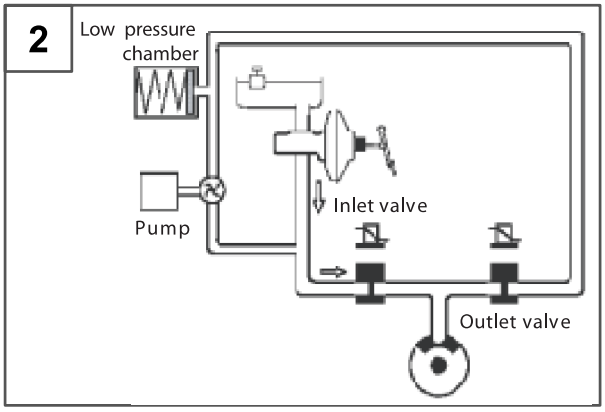
The front wheels that are the primary circuit of the brake system is composed of two wheel speed sensors and two channel valves system with two inlet valves and two outlet valves. The rear wheels that are the secondary circuit of the brake system is composed of two wheel speed sensors, one inlet valve and one outlet valve. This system is similar to the one from the previous model.

15. ABS CIRCUIT IN EACH OPERATION RANGE



▶ **Hydraulic Pressure Circuit when ABS is Not Operating**

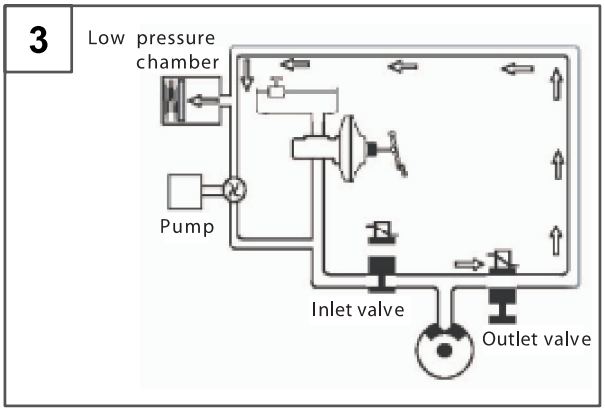
- The hydraulic pressure in the master cylinder increases through the vacuum booster and it is delivered to the wheel via the normal open inlet valve. At this moment, the normally- closed outlet valve is closed. The speed of the wheel that hydraulic pressure is delivered reduces gradually.



▶ **No Hydraulic Pressure Circuit when ABS is Operating**

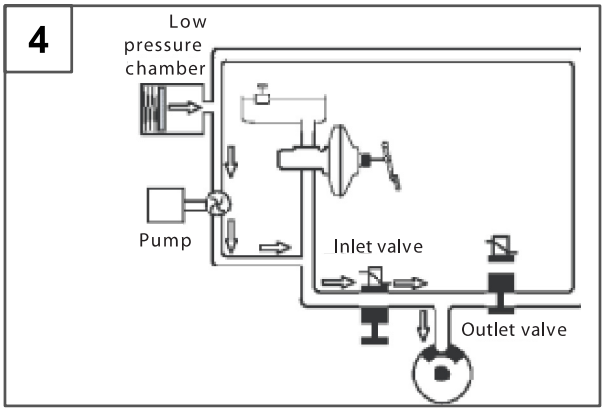
- As hydraulic pressure on each wheel increases, the wheel tends to lock. In order to prevent the wheel from locking, the hydraulic valve modulator operates the inlet valve control solenoid to close the inlet valve and stop the hydraulic pressure increases. At this moment, the outlet valve is closed. This procedure helps the wheel to maintain a stable hydraulic pressure.

Modification basis	
Application basis	
Affected VIN	



▶ Pressure Decreases in the Circuit when ABS is Operating

- Even when the hydraulic pressure on each circuit is stable, the wheel can be locked as the wheel speed decreases.
This is when the ABS ECU detects the wheel speed and the vehicle speed and gives the optimized braking without locking the wheels. In order to prevent from hydraulic pressure increases, the inlet valve is closed and the outlet valve is opened. Also, the oil is sent to the low pressure chamber and the wheel speed increases again. The ABS ECU operates the pump to circulate the oil in the low pressure chamber to the master cylinder. This may make the driver to feel the brake pedal vibration and some noises.



▶ Pressure Increases in the Circuit when ABS is Operating

- As the wheel speed increases, the inlet valve opens and the wheel's pressure increases due to the master cylinder pressure. The oil in the low pressure chamber circulates to the wheel by the pump and the wheel speed decreases as the hydraulic pressure at wheel increases.
This operation continues repetitively until there are no signs that the ABS ECU is locking the wheels. When the ABS hydraulic pressure control takes place, there may be some vibration and noises at the brake pedal.

POWER STEERING SYSTEM 4610-00

GENERAL

1. POWER STEERING SYSTEM OVERVIEW

The power steering has been designed to make the wheel move more easily than in a manual steering system. The hydraulic power assists the process utilizing hydraulic fluid. The fluid increases pressure in the power steering pump and aids the movement of the steering mechanism.

The power steering system consists of pump, oil reservoir, rack and gear box.

The power steering pump is a vane type and delivers hydraulic pressure to operate the power steering system.

The pressure relief valve in the pump controls the discharging pressure.

The rotary valve in the rack and the pinion gear directs the oil from the power steering pump to one side of the rack piston. The integrated rack piston converts the hydraulic pressure to linear movement. The operating force of the rack moves the wheels through the tie rod, the tie rod end and the steering knuckle. Even though the hydraulic pressure cannot be generated, a driver can steer the vehicle without power assist but it needs very high steering force.

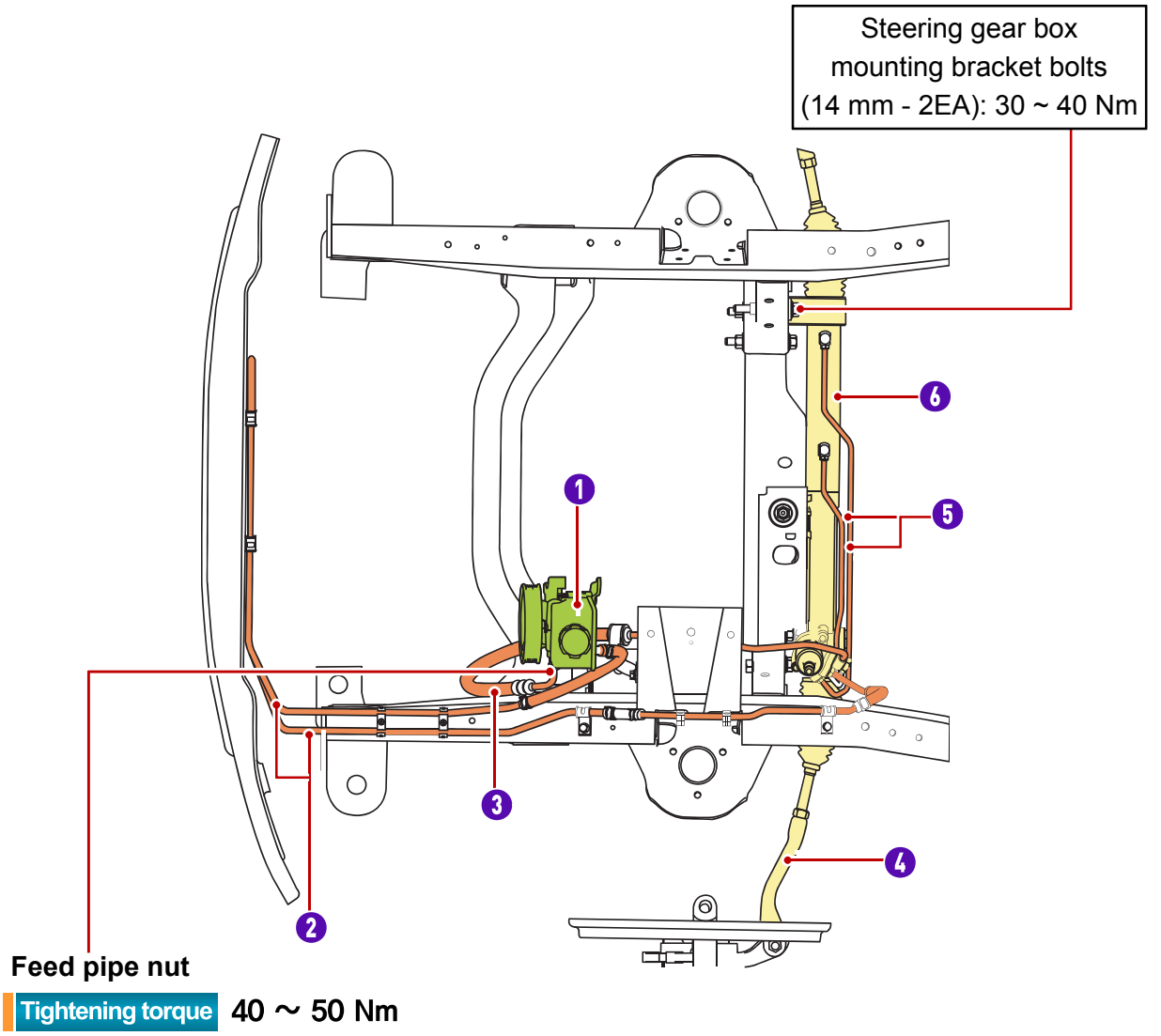
In this case, the operating force of the steering wheel is conveyed to the pinion, and the movement of the pinion moves the rack through the pinion gear combined to the rack gear.

2. POWER STEERING SPECIPICATIONS

Description			Spec ification
Steering wheel	Type		4-spoke type
	Outer diameter (mm)		390
Steering gear box	Type		Rack and pinion
	Gear ratio		?
	Steering angle	Inner	36° 20'
		Outer	32° 40'
Oil pump	Type		Vane type
	Maximum pressure (kgf/cm²)		85 ~ 92
	Displacement (ℓ /min)		10.5
	Pulley size (mm)		124
Tilt column adjusting angle	Up		4°
	Down		8°
Minimum turning radius (m)			5.7
Oil	Specification		ATF Dexron III
	Capacity (ℓ)		1.0

OVERVIEW AND OPERATION PROCESS

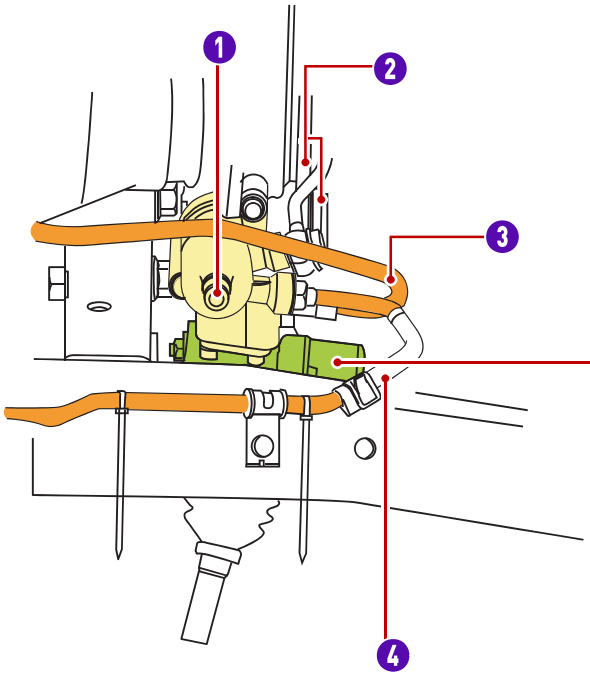
1. POWER STEERING SYSTEM LAYOUT



1. Power steering pump assembly	4. Tie rod end
2. Power steering return pipe	5. Power steering gear box pipe
3. Power steering high pressure hose and pipe	6. Power steering gear box assembly

Modification basis	
Application basis	
Affected VIN	

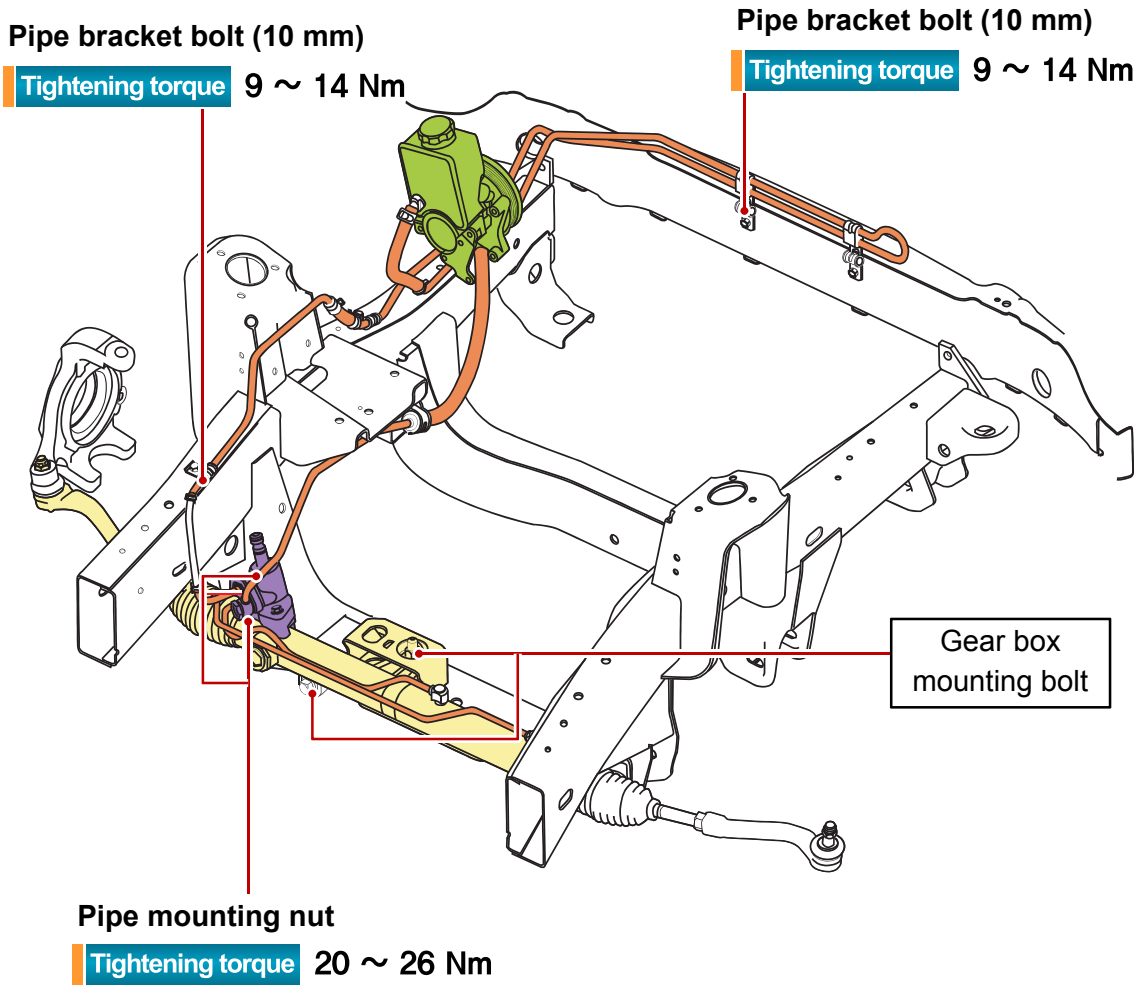
With SSPS



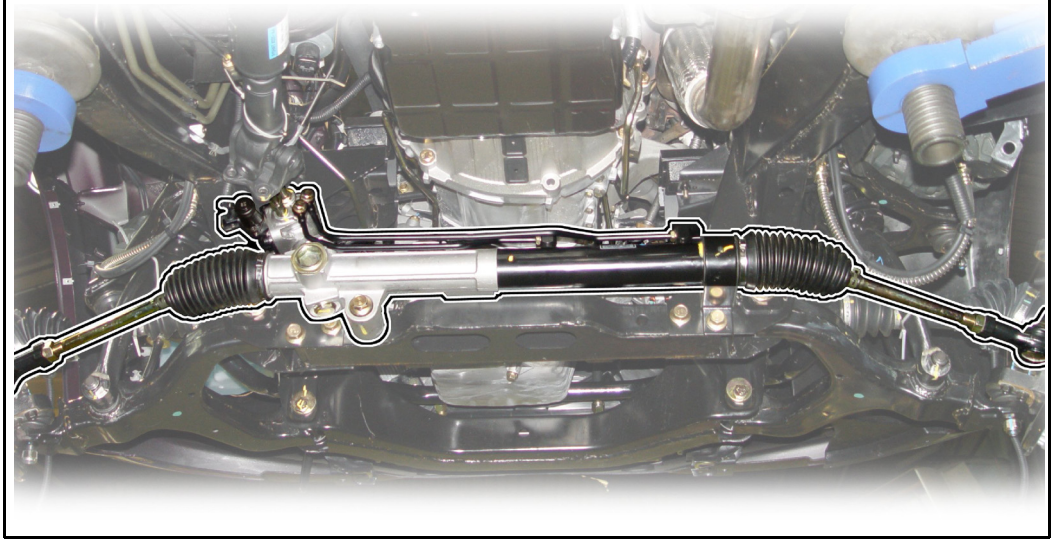
SSPS Solenoid Valve

cannot be replaced

1. Power steering gear box	3. Power steering high pressure hose and pipe
2. Gear box pipe	4. Return hose and pipe

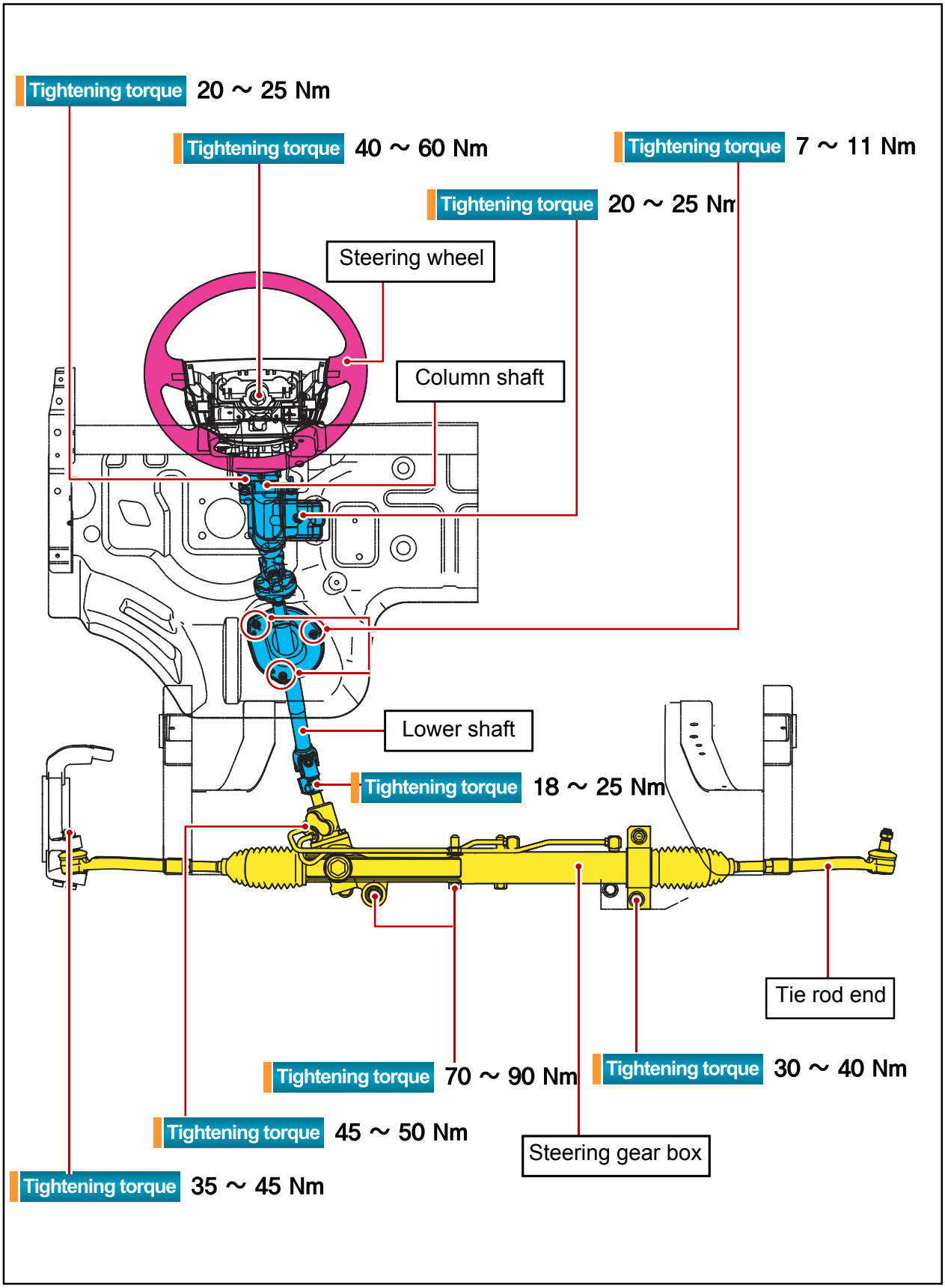


Installation Drawing of SSPS

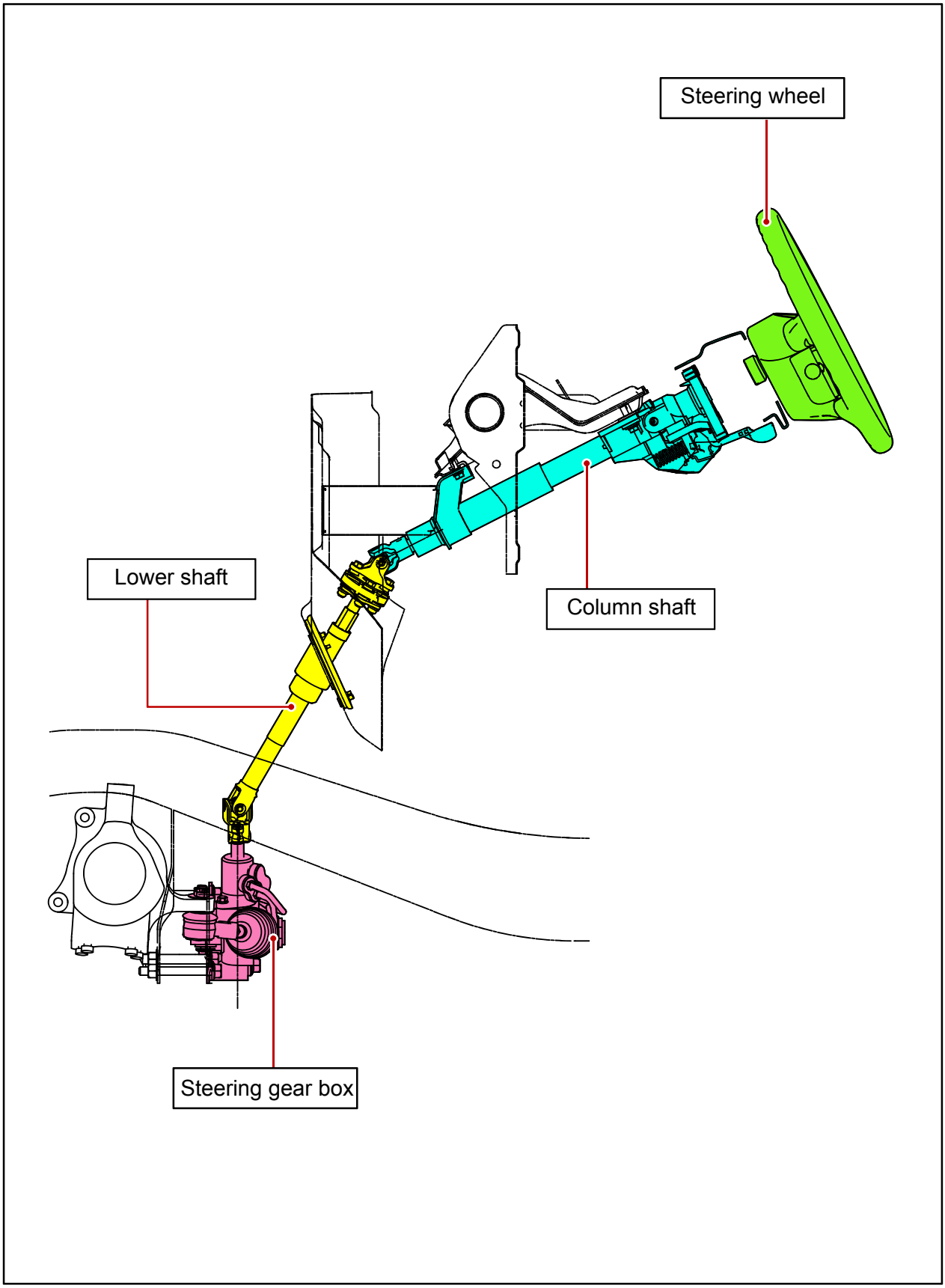


Modification basis	
Application basis	
Affected VIN	

▶ Components



Modification basis	
Application basis	
Affected VIN	



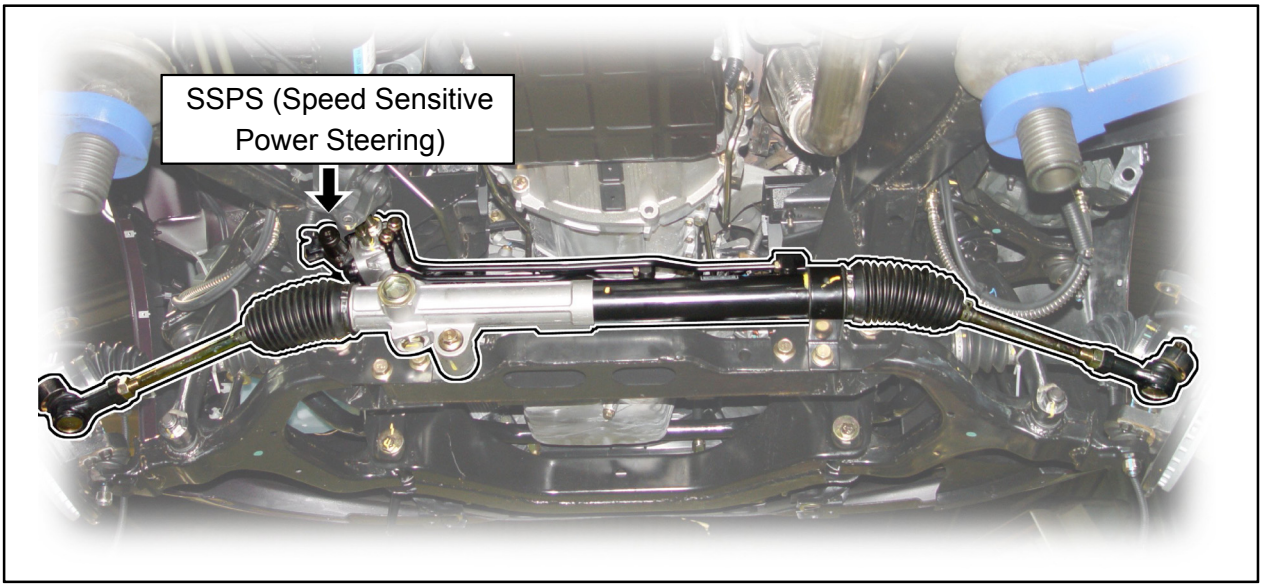
Modification basis	
Application basis	
Affected VIN	

2. SSPS (SPEED SENSING POWER STEERING) OVERVIEW AND FUNCTIONS

1) OVERVIEW

In the conventional constant power assist steering system, the steerability gets lighter as vehicle speed rises, and this may cause a dangerous situation. Where as having heavy steerability in high speed driving makes it difficult to manipulate the steering wheel when vehicle is in stop. This steering system solves this problem as the steerability is changed according to the vehicle speed, which is called Speed Sensitive Power Steering (SSPS).

SSPS, by providing appropriate steerability to a driver according to the changes of vehicle speed, gives steering stability. The power steering control unit adjusts the hydraulic pressure to reaction plunger by controlling the pressure solenoid valve located in the gear box to optimize the steerability. In other words, the steering wheel gets lighter by adjusting steerability in stop or low speed and provides steering stability by adjusting steering wheel to become heavier in high speed.

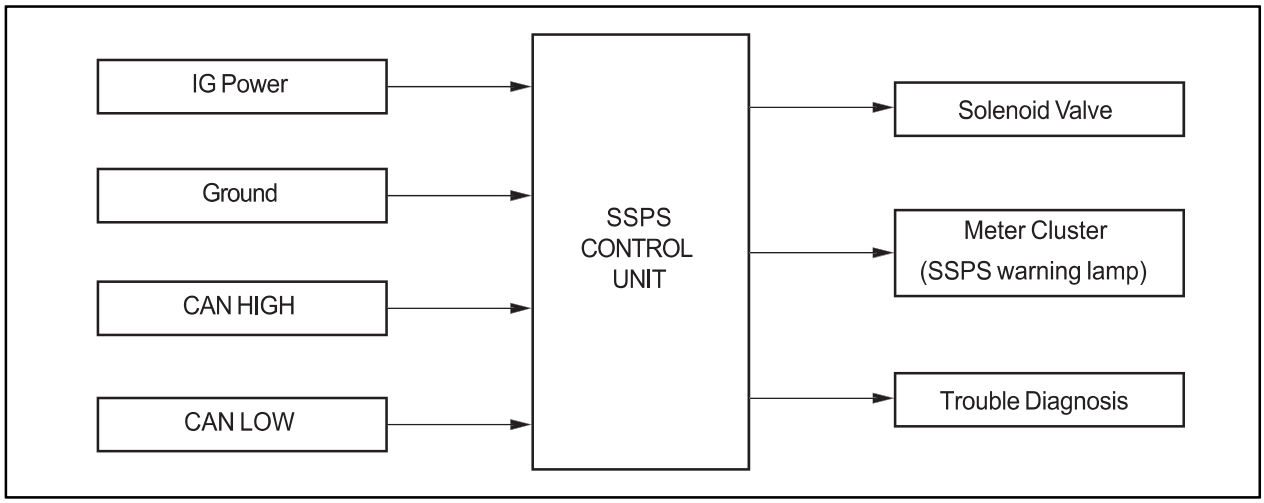


CAUTION

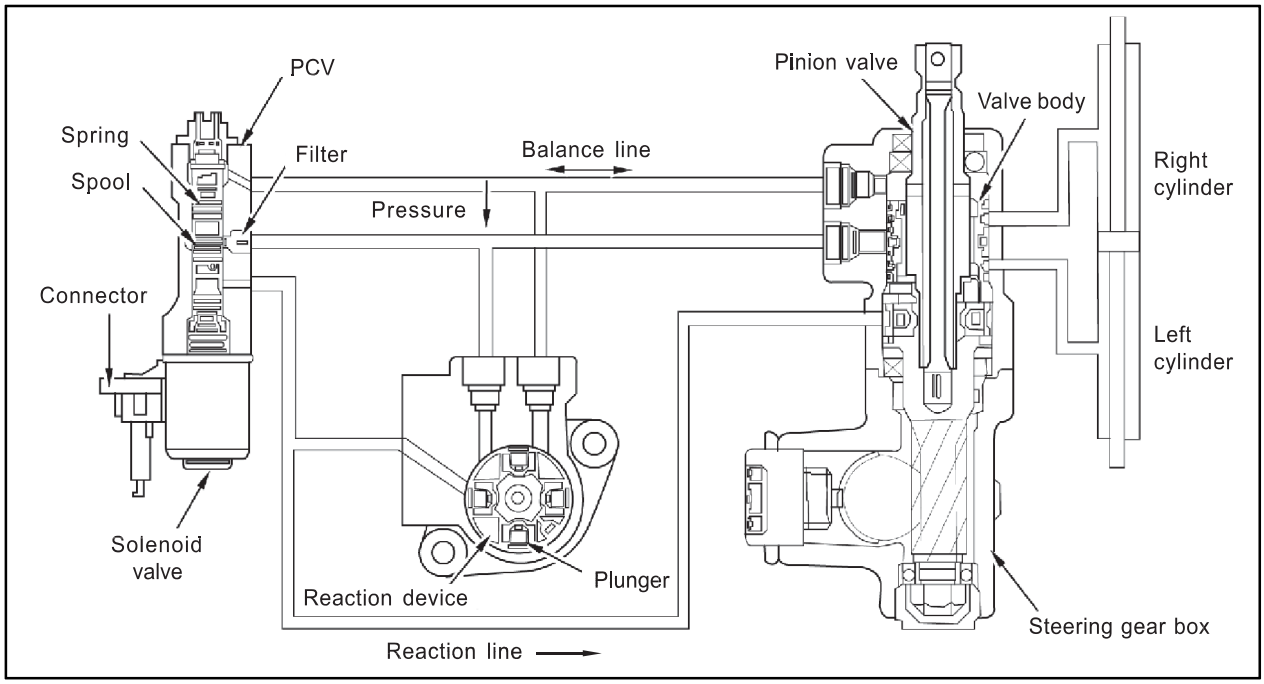
- If the SSPS solenoid valve is defective, the power steering assembly should be replaced.

2) FUNCTION

▶ **Input/Output of SSPS Control Unit**



▶ **SSPS Configuration**



PCV (Pressure Control Valve)

This valve controls the hydraulic pressure supplied to reaction device by moving the spool valve according to the changes of solenoid valve.

Reaction device

This device increases the steerability effect by binding the input shaft with supplied hydraulic pressure from PCV.

Solenoid valve

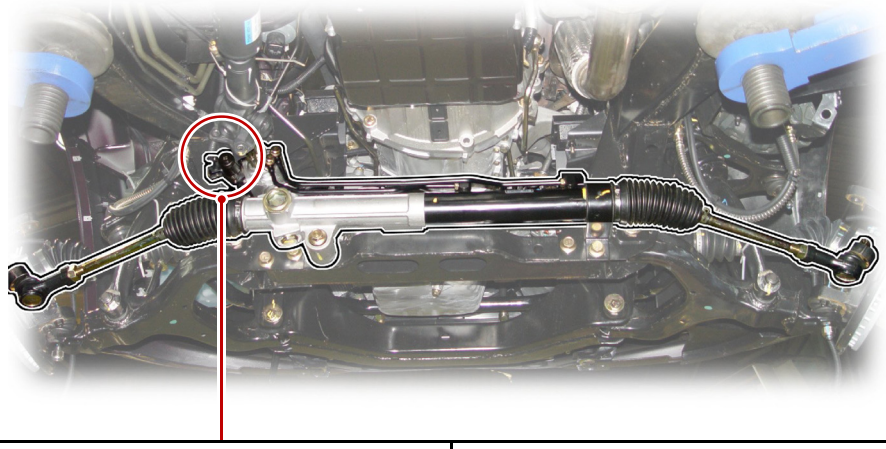
This valve determines the valve spool position in PCV with the electric current supplied from SSPS control unit.

Modification basis	
Application basis	
Affected VIN	

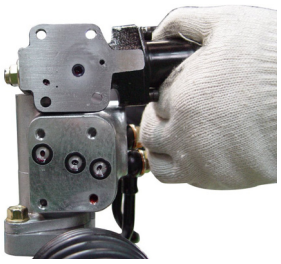
3. S.S.P.S OPERATIONS

1) SOLENOID VALVE

(1) LOCATION



Cannot be replaced



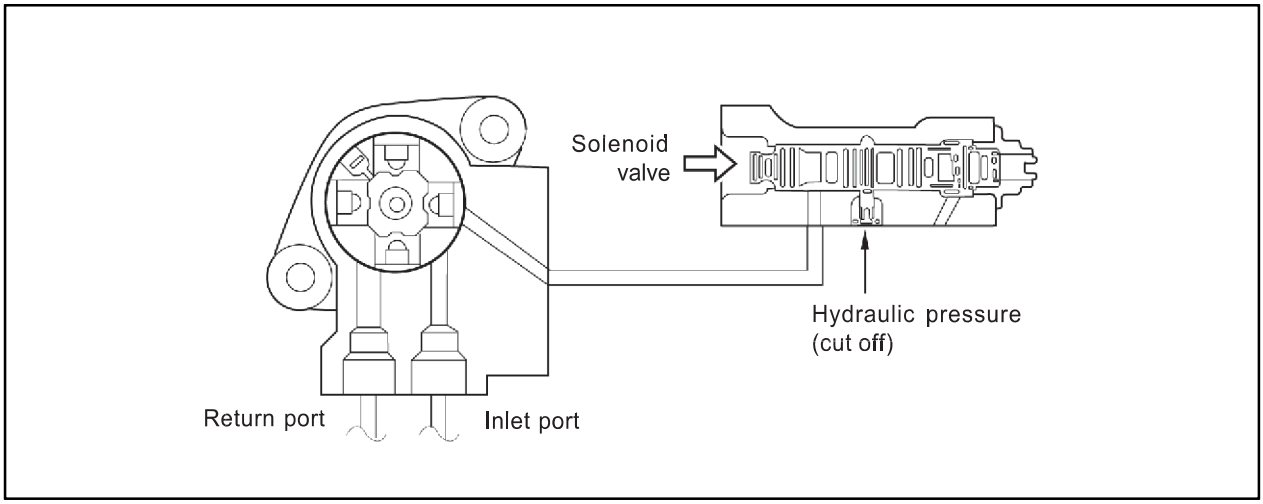
The SSPS control unit controls the amount of electric current to the solenoid valve according to the vehicle speed. In other words, the solenoid valve controls the hydraulic pressure applied to reaction plunger by changing the valve spool position that is linked with solenoid valve according to the amount of electric current. The changes of hydraulic pressure applied to input shaft according to the pressure changes applied to the reaction plunger provide proper steerability based on the amount of electric current.

(2) Specifications

Description	Specification
Voltage Rating	DC 12 V
Current Rating	1.0 A
Resistance	6.7 ± 1 W

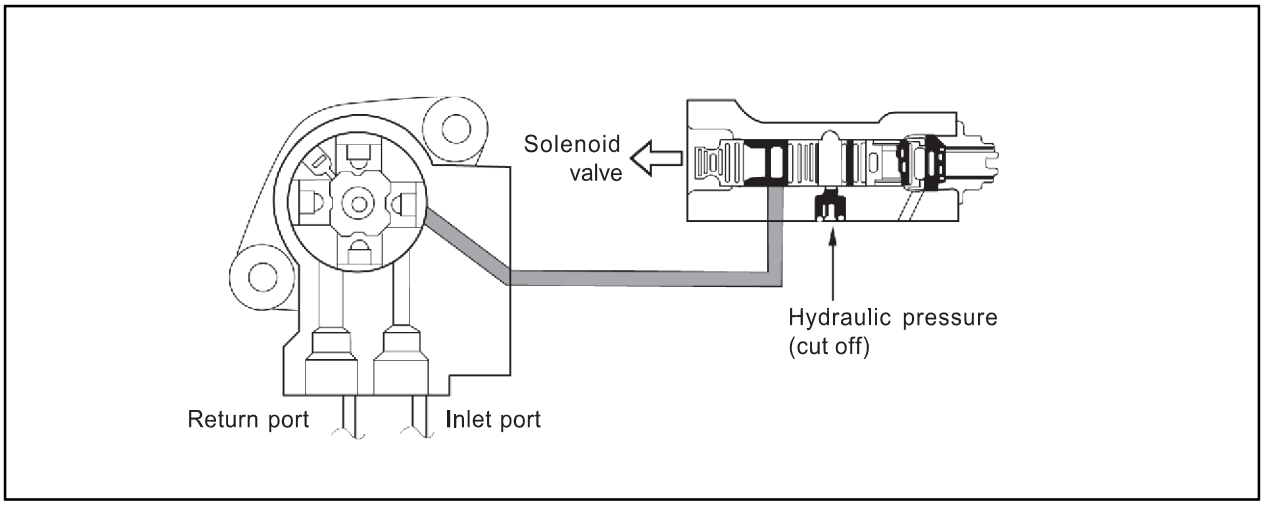
(3) OPERATION

▶ **During parking and low speed driving**



1) The SSPS control unit outputs nearly maximum electrical current.
2) The solenoid rod pushes the PCV spool to the right side.
3) The hydraulic pressure coming from pump is not supplied to the reaction device as the spool orifice is cut off.
4) The hydraulic pressure is cut off and the manipulation of steering wheel becomes lighter.

▶ **In medium and high speed driving**

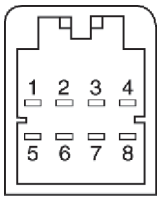


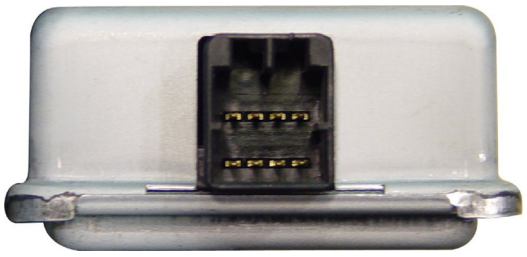
1) The shaft operating force of solenoid rod is reduced due to the reduction of output current from the SSPS control unit.
2) The coil spring pulls the PCV spool toward solenoid valve to open it.
3) The hydraulic pressure from pump flows to pinion reaction area through orifice and applies reaction force to reaction plunger.
4) At this time, the reaction plunger transmits the reaction force to V-groove in input shaft to provide heavy steerability.

Modification basis	
Application basis	
Affected VIN	

2) SSPS CONTROL UNIT

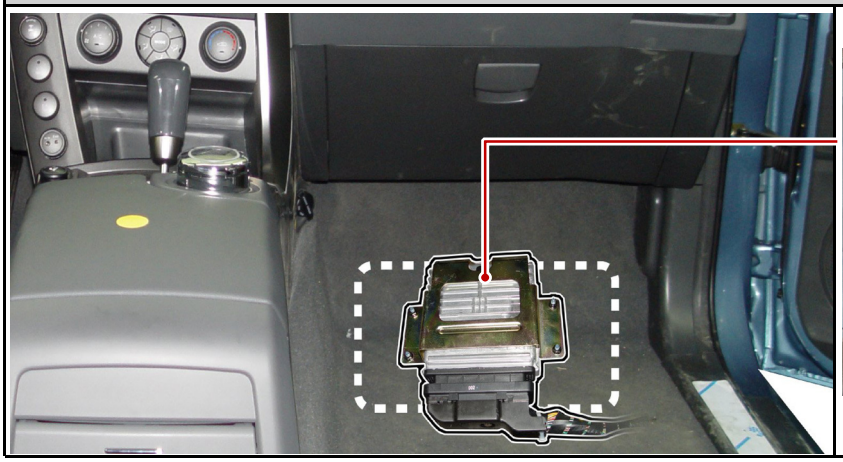
1. To provide proper steerability to a driver, the SSPS control unit controls the solenoid valve by receiving the vehicle speed and the throttle position data via CAN communication.
2. The SSPS control unit controls the working current for the solenoid valve with PWM type duty ratio of 333 Hz frequency and sets the target current to 1A during 1 second after the ignition is "ON".
3. When a trouble occurs in the system, the SSPS control unit generates a trouble code using fail safe function.

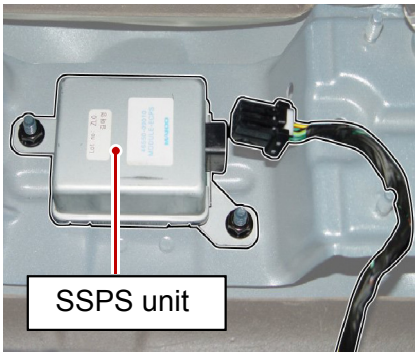




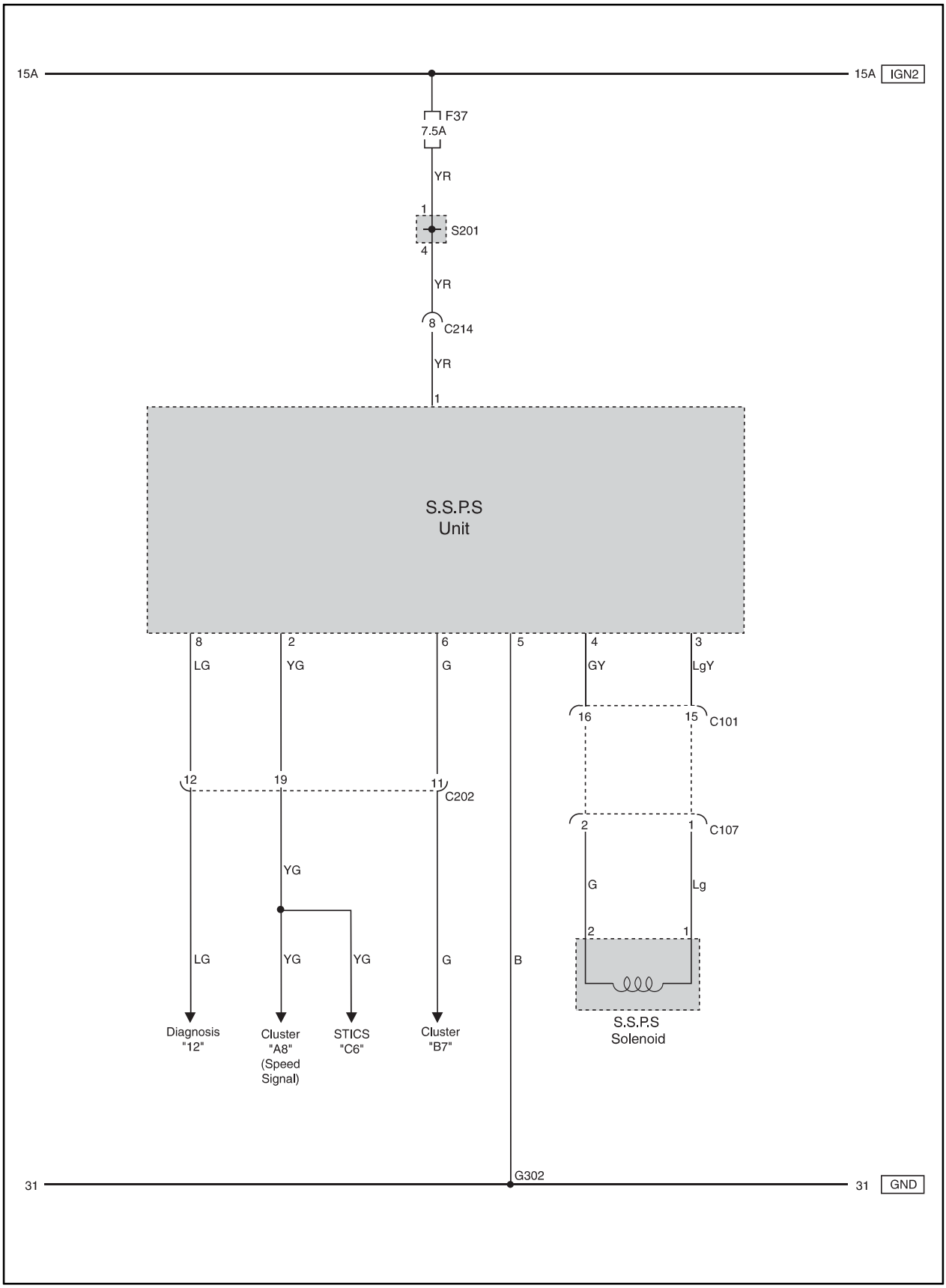
Pin No.	Function
1	Ignition Power Supply
2	CAN HIGH
3	Solenoid
4	Solenoid
5	Ground
6	Warning Lamp (SSPS)
7	CAN LOW
8	Self Diagnosis

Location



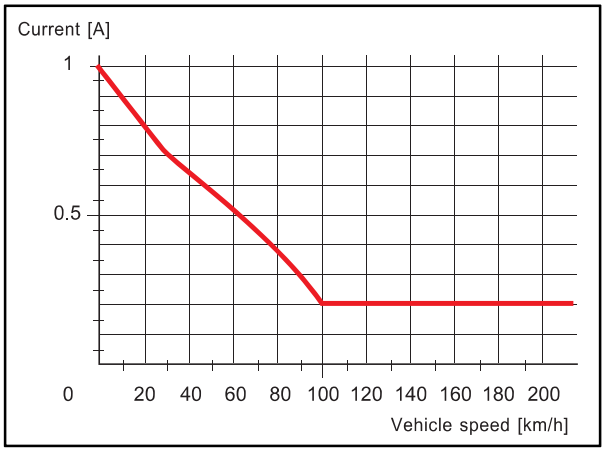


3) CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

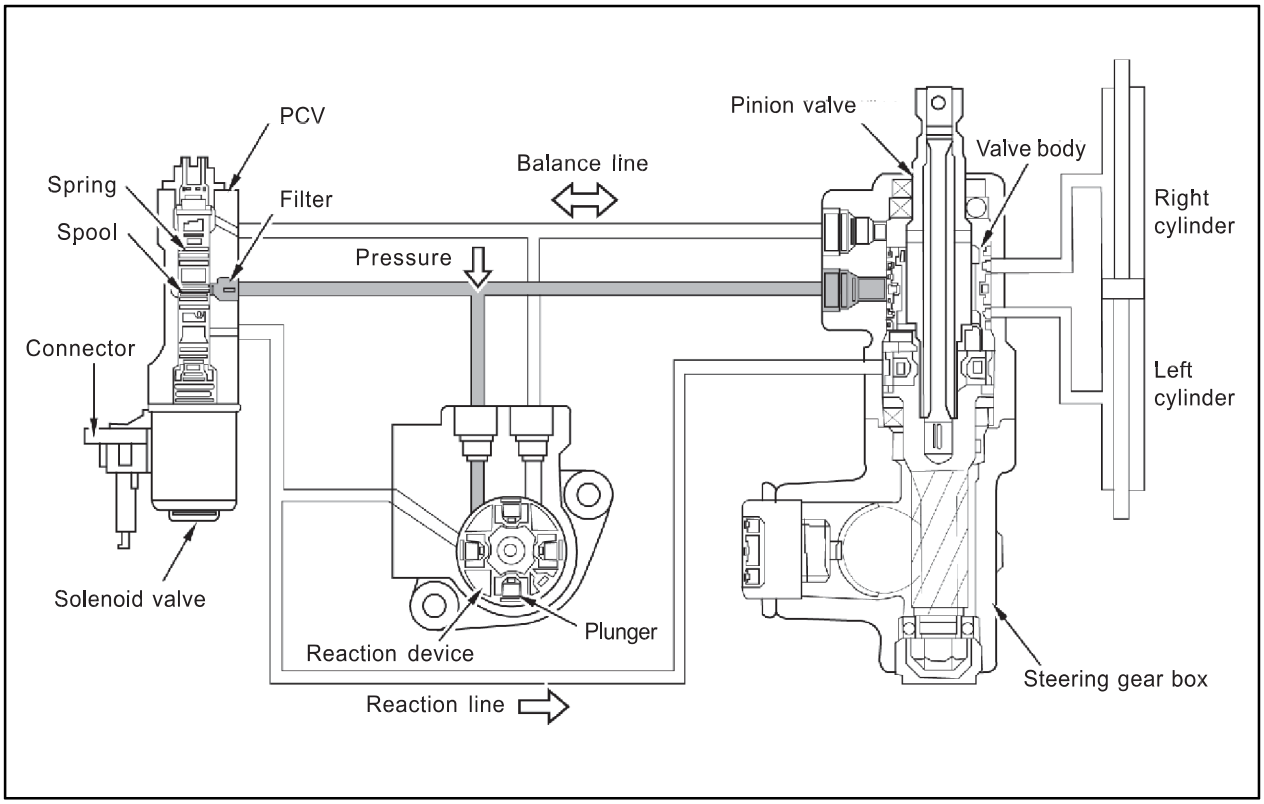
4) S.S.P.S SYSTEM CONTROL



The SSPS system, according to the vehicle speed, enables to achieve proper steering characteristics by controlling hydraulic pressure to reaction plunger located in input shaft of power steering gear box. In other words, the SSPS control unit enhances the parking conveniences by controlling duty type current control. It provides heavy steerability with low current as the vehicle speed increases. Also, it provides light steerability with high current as the vehicle speed decreases.

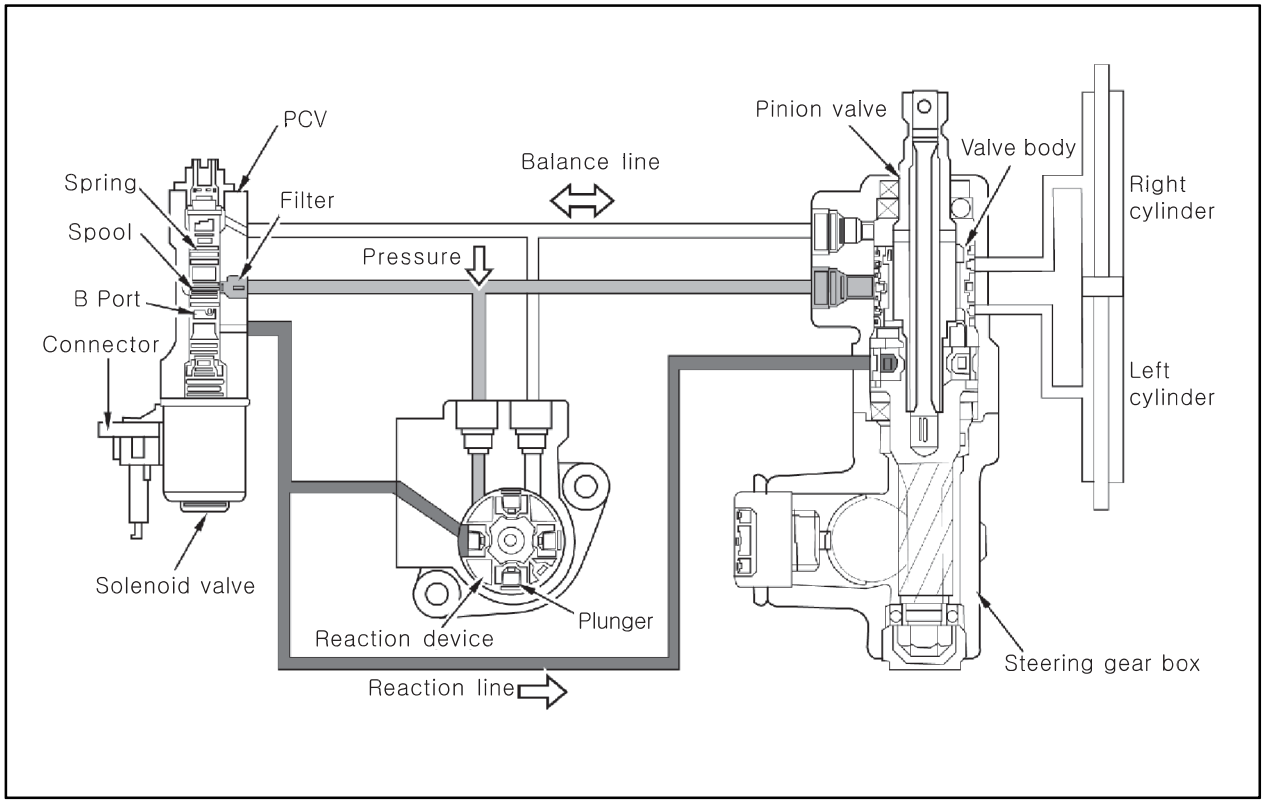
▶ During parking and low speed driving

During parking and driving in low speed, the control unit supplies approx. 1 A of electric current to solenoid valve. Then, the spool located in PCV compresses the upper spring and elevates upward, and the working pressure from oil pump (A port) is not able to flow to the reaction plunger (C port). As a result, the pressing force from the reaction plunger disappears and the steerability enhances.



▶ During high speed driving

During high speed driving, the control unit supplies weak electric current to solenoid valve. Then, the spool located PCV moves from top to bottom, and the working pressure (A port) from oil pump is applied to reaction plunger (C port) through B port. As a result, the pressing force from reaction plunger against input shaft is increased and the steerability becomes heavier.



Modification basis	
Application basis	
Affected VIN	