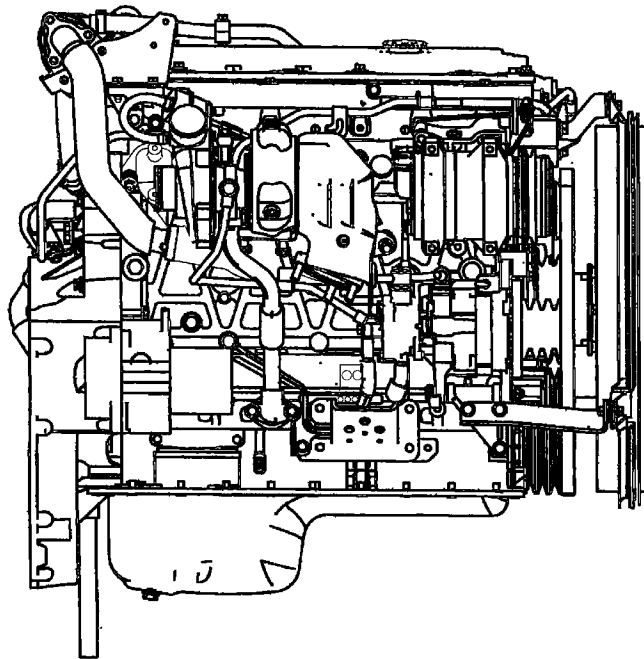


FOR SERVICE TRAINING

4HK1-TC ENGINE

-Engine Mechanical Features-
-Engine Control System & Diagnosis-

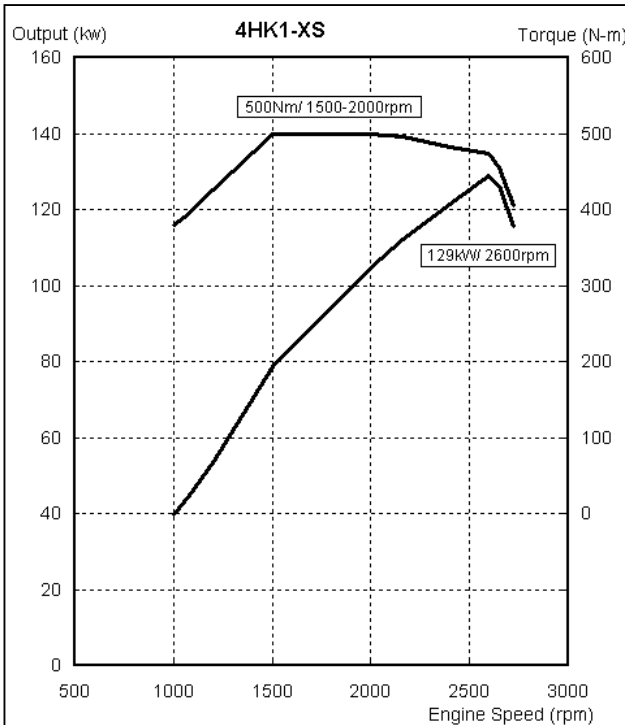


Applicable Model

<i>Model Year</i>	<i>Vehicle Model</i>	<i>Main Market</i>
2005	NPR & NQR	General Export (Euro 3 Regulation) Europe, Australia, Thailand, South Africa & etc.

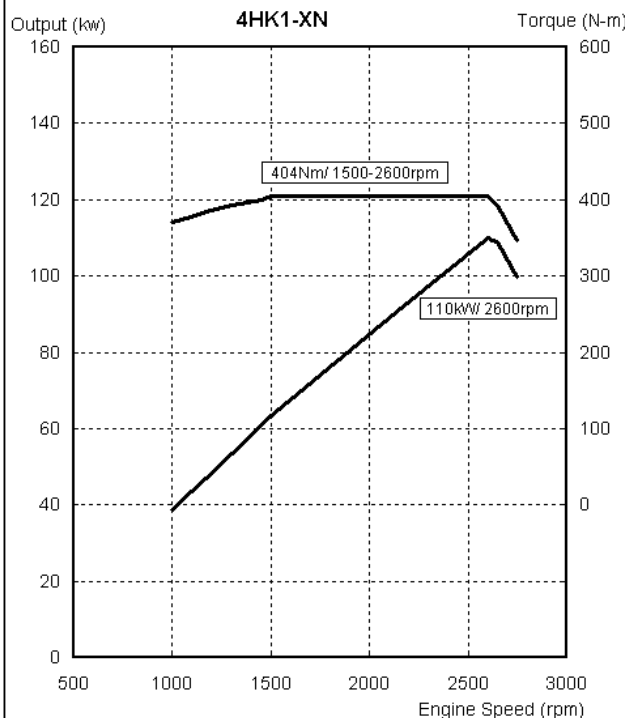
ISUZU
ISUZU MOTORS LIMITED

INTRODUCTION & ENGINE MECHANICAL FEATURES



The 2005 model year NPR/NQR truck, the 4HK1-TC inline 4 cylinder engine replaces the 4HE1-TC engine for advanced exhaust emission countries. The 4HK1-TC engine has been newly developed on the basis of previous 4HE1-TC engine, with additional features including the employment of four valve mechanism per a cylinder that are operated via a single camshaft, common rail fuel injection system, water-cooled exhaust gas re-circulation (EGR) system, and the change of combustion chamber form. The larger engine displacement and the common rail fuel injection system have resulted in an increase both in maximum output and torque, and met Euro 3 emission regulation standard. Most conspicuous items are listed below.

- Multi fuel injection type high-pressure common rail system and is made with Denso.
- Single overhead camshaft (OHC) with 4 valves per a cylinder.
- Electrical control EGR valve, water-cooled EGR cooler.
- Turbocharger with intercooler.



Engine Type	Maximum Output	Maximum Torque
4HK1-TCS	129kw (175ps)/2600RPM	500Nm (51kgm)/1500-2000RPM
4HK1-TCN	110kw (150ps)/2600RPM	404Nm (41kgm)/1500-2600RPM

The base transmission is MYY for 4HK1-TCN low output engine, MZZ for 4HK1-TCS high output engine. The Smoother system is available for only MYY transmission.



Major mechanical changed items are listed below.

Part	Status	Description or Reason in Comparison with 4HE1-TC Engine
Cylinder Block	Change	Bore size is upped (110mm to 115mm / 4.33in to 4.53in)
Crankshaft	Carry-over	-
Cylinder Head	Change	Four valve type with camshaft position sensor hole
Cylinder Head Gasket	Change	Cylinder head is changed
Camshaft	Change	Four valve type is employed
Camshaft Gear	Change	Scissors gear type is employed
Inlet Valve	Change	Four valve type is employed
Exhaust Valve	Change	Four valve type is employed
Valve Spring	Change	Four valve type is employed
Rocker Arm	Change	Four valve type is employed
Cylinder Head Cover	Change	Four valve type is employed
Timing Gear Train	Change	Fuel system is changed
Flywheel	Change	Crankshaft position sensor is ring added
Flex Plate	Carry-over	-
Flywheel Housing	Change	Common rail system is employed & crankshaft position sensor hole
Engine Hanger	Change	Cylinder head and EGR layout is changed
Piston	Change	Bore size is upped
Piston Ring	Change	Bore size is upped
Connecting Rod	Carry-over	-
Oil Pan	Change	Oil level switch is added
Oil Pump	Carry-over	-
Oil Cooler	Change	Engine size is changed
Front Cover	Carry-over	-
Water Pump	Carry-over	-
Cooling Fan	Change (4HK1-TCS) Carry-over (4HK1-TCN)	4HK1-TCS: Size is changed to improve performance
EGR Cooler	New	Newly adopted
EGR Pipe	Change	EGR layout is changed
EGR Valve	Change	Electrical control type
PCV System	Carry-over	-
Fuel Pump	Change	Common rail system is employed (supply pump)
Injection Nozzle	Change	Common rail system is employed
Injection Pipe	Change	Common rail system is employed
Fuel Pipe	Change	Common rail system is employed
Intake Duct	Change	Layout is changed & boost pressure sensor are added
Intake Manifold	Change	Layout is changed
Intercooler	Change	Size is upped
Exhaust Manifold	Carry-over	-
Turbocharger	Change	Wastegate valve actuator setting is changed
ACG	Change	
Starter	Carry-over	-
Engine Harness	Change	Common rail system is employed

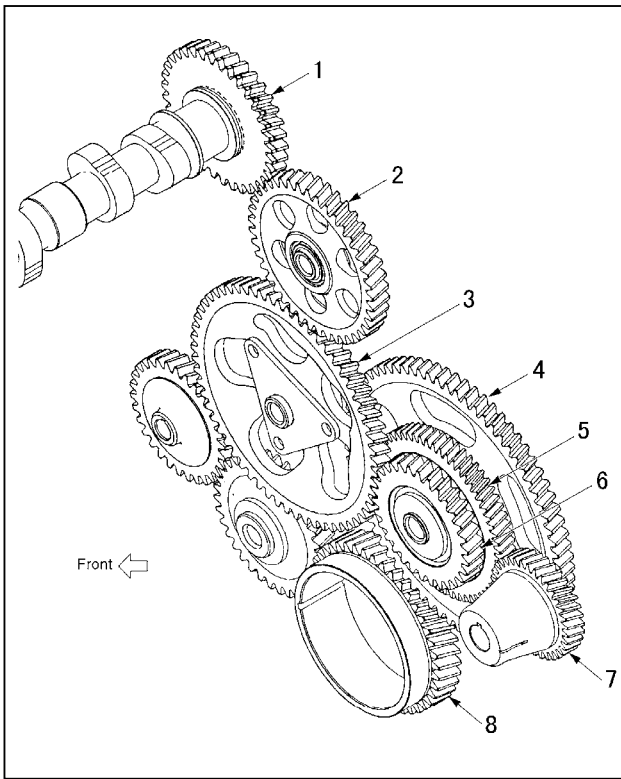
**ENGINE MAIN DATA & SPECIFICATIONS**

Engine Model	4HE1-TC	4HK1-TC
Engine Type	Diesel, Four Cycle	
Cylinder Layout - Number of Cylinders	Inline-Four Cylinders	
Fuel Injection Order	1-3-4-2	
Bore x Stroke (mm/in)	110.0 x 125.0 / 4.33 x 4.92	115.0 x 125.0 / 4.53 x 4.92
Total Displacement (cc)	4751	5193
Compression Ratio	18.0	18.5
Compression Pressure at 200 rpm (MPa / psi)	3.0 / 441	3.3 / 478
Combustion Chamber Type	Direct Injection	
Cylinder Liner	Dry Type	
Idle Speed (rpm)	800±25	650±25
Fuel System	Mechanical Type Governor	Common Rail System
Injection Pump Type	BOSCH In-line Type (MITICS)	DENSO (HP3) Supply Pump
Injection Nozzle Type	Hole Nozzle (Mechanical Type)	Electrical Controlled Injector (G2)
Number of Injection Hole	6	7
Diameter of Injection Hole (mm)	0.21	0.16
Injection Nozzle Operating Pressure (MPa)	17.65	Electrically Controlled
Fuel Filter Type	Cartridge Paper Element & Water Separator	
Valve System		
Valve Layout	Overhead Valve	
Drive Type	Gear Drive	
Intake Valve Open At BTDC (deg)	14.0	19.0
Intake Valve Close At ABDC (deg)	51.0	53.0
Exhaust Valve Open At BBDC (deg)	49.0	48.0
Exhaust Valve Close At ATDC (deg)	16.0	14.0
Intake Valve Clearance At Cold (mm)	0.4	
Exhaust Valve Clearance At Cold (mm)	0.4	
Cooling System		
Cooling Method	Water Cooled	
Water Capacity (litter/gal)	14 (3.7)	
Water Pump Type	Centrifugal Impeller Type	
Thermostat Type	Wax Pellet	
Thermostat Opening Temperature (deg. C / deg. F)	82 & 85 / 180 & 185	
Lubricating System		
Lubricating Method	Full Flow Pressure Circulation	



Oil Pump Type	Gear	
Oil Capacity (litter/gal)	13 (3.4)	
Oil Filter Type	Cartridge Paper Element	
Air Cleaner Type	Dry Paper Element	
EGR System	W/O Cooler & Vacuum Control EGR Valve	W/Cooler & Electrical Control EGR Valve
PCV System	Open Type	
Preheating System	Glow Plug	
Starting System		
Starter Motor Output (V-kW)	24 - 3.0	
Charge System		
Alternator Output (V-A)	24 – 50, 60 or 80	
Regulator Type	IC	
Battery Size	115E41R x 2	

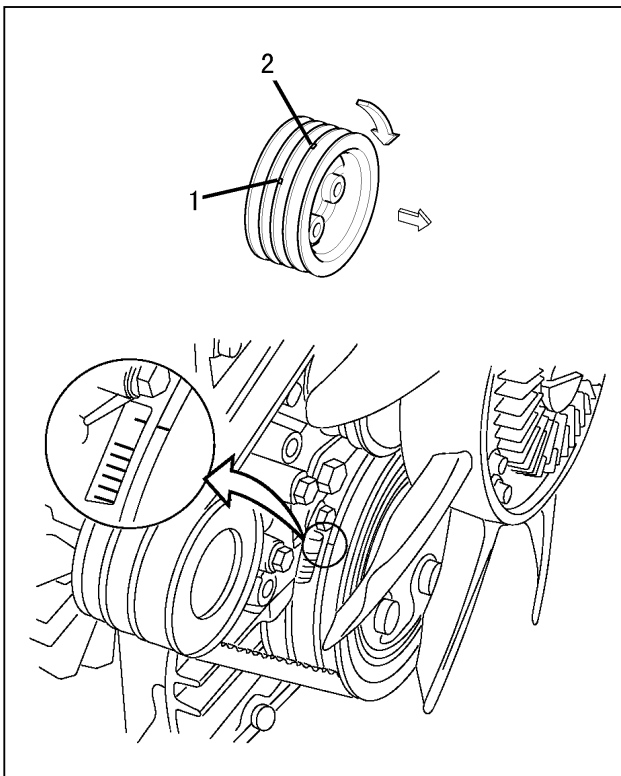
GEAR TRAIN



To rotate the fuel supply pump with engine speed, idle gear has changed with three steps. The crankshaft gear (42 teeth) corresponds with the large diameter of idle gear A (72 teeth). The fuel supply pump gear (35 teeth) corresponds with the middle diameter of idle gear A (60 teeth). The idle gear B (61 teeth) corresponds with the small diameter of idle gear A (30 teeth).

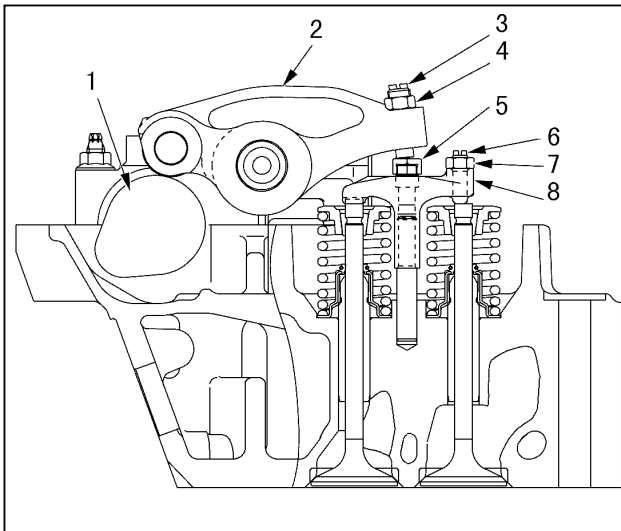
1. Camshaft Gear (Z=35)
2. Idle Gear C (Z=41)
3. Idle Gear B (Z=61)
4. Idle Gear A (Large) (Z=72)
5. Idle Gear A (Middle) (Z=60)
6. Idle Gear A (Small) (Z=30)
7. Fuel Supply Pump Gear (Z=35)
8. Crankshaft Gear (Z=42)

Valve Train



To improve exhaust emission and engine output performance, four valve mechanism is newly adopted for 4HK1-TC engine. Note that the adjustment method of valve clearance has been changed from 4HK1-TC engine as following steps.

1. Rotate the crankshaft to make the No.1 cylinder meet the compression top dead center (TDC). There are 2 marks stamped on the crank pulley. The mark (1) is used to bring the engine No.1 or No. 4 cylinder to TDC. The mark (2) is irrelevant. Do not use the mark (2).



2. Loosen fully each adjusting screw (8) & (2) of the bridge and the rocker arm.
3. Insert a 0.4mm (0.016in) thickness gauge between the tip of the rocker arm and bridge cap (5), and adjust the clearance with the adjusting screw (3) on the rocker arm, and then fix it with a lock nut (4).
4. With a thickness gauge kept inserted, check that the adjusting screw (6) contacts the valve shaft end and the movement of the thickness gauge has become tight when the adjusting screw (6) on the bridge is tightened lightly.
5. Check the valve shaft end on the opposite side floats or it contacts obliquely. In case of a floating or oblique contact, loosen a little the adjusting screw (6) on the bridge side and adjust so that the valve shaft ends on both sides get in contact properly. Bridge (8) & valve shaft end clearance less than 0.1 mm (0.004in).
6. After the adjustment so that the end of the valves on both sides touch properly, tighten up the lock nut (7) on the bridge (8).

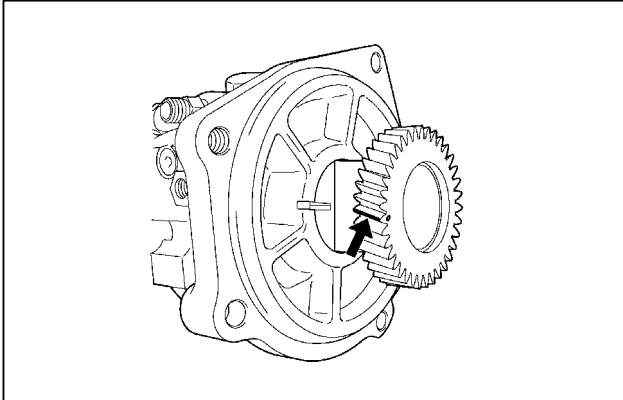
Note that unless the bridge is kept horizontal, the bridge is pressed obliquely, thus causing the bridge and bridge guide to be seized or damaged. Therefore, exact adjustment is required.

- Valve clearance: 0.4mm (0.016in) intake & exhaust side at cold
- Adjusting screw lock nut tightening torque: 22Nm (16lb ft)

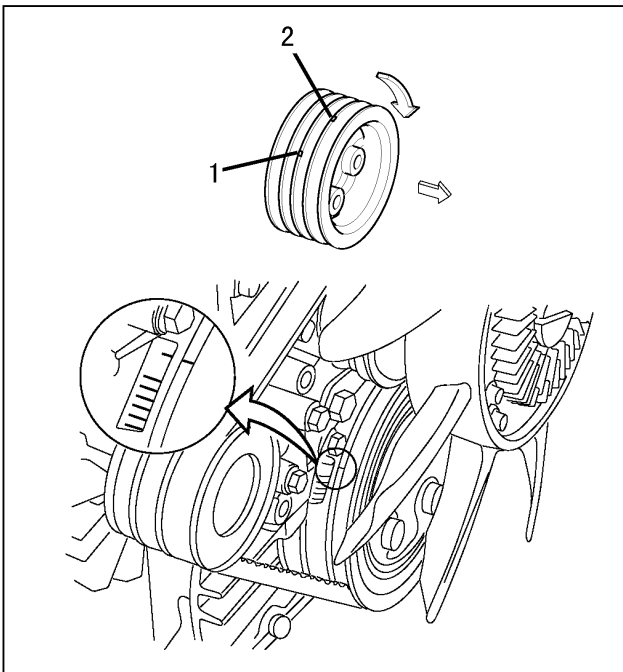
Cylinder No.	1		2		3		4	
Valve	IN	EX	IN	EX	IN	EX	IN	EX
No.1 Cylinder Compression TDC	O	O	O			O		
No.4 Cylinder Compression TDC				X	X		X	X

At the No.1 cylinder compression top dead center, the valves with "O" mark in the following table, or at the No.4 cylinder compression top dead center, the valve with "X" mark can be adjusted.

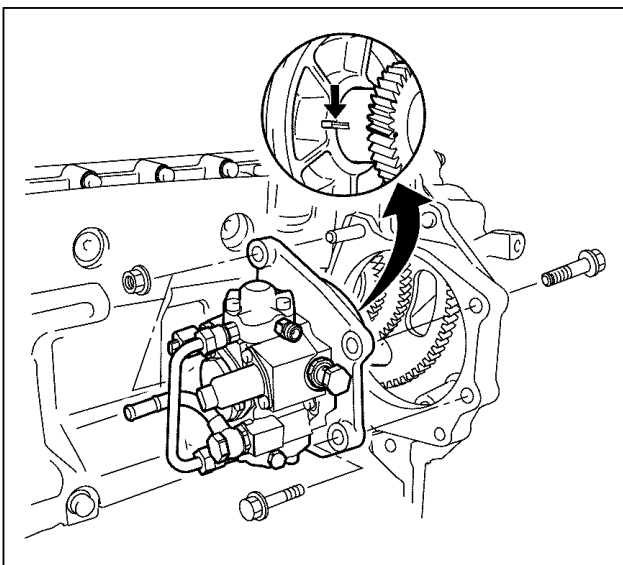
Fuel Supply Pump Installation



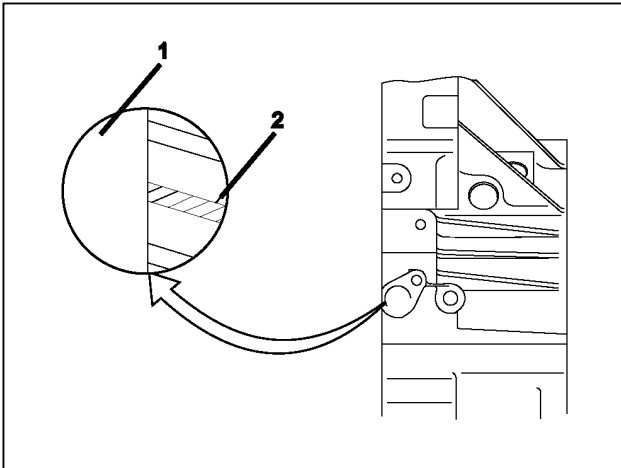
1. Apply white paint to the top of the fuel supply pump gear tooth directly above the stamped "O" mark.



2. Rotate the crankshaft to the compression top dead center (TDC). There are 2 marks stamped on the crank pulley. The mark (1) is used to bring the engine No.1 or No. 4 cylinder to TDC. The mark (2) is irrelevant. Do not use the mark (2).



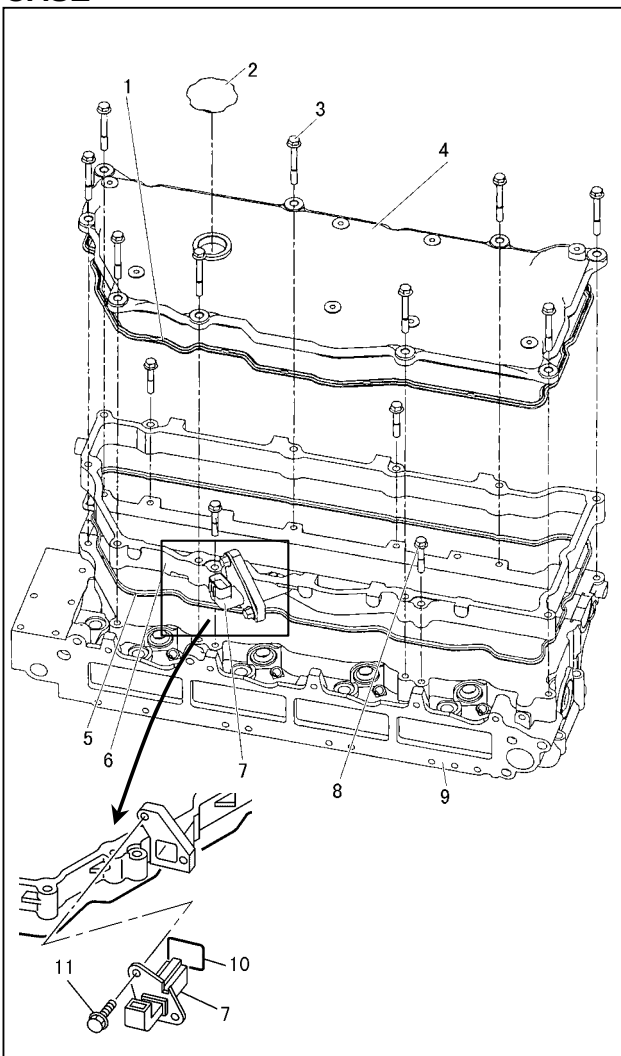
3. Install the O-ring to the fuel supply pump.
4. Align a slit of the fuel supply pump bracket with a white paint on the gear and install the fuel supply pump in the gear case using the stud bolts as a guide.



5. Check through the hole (1) that a white paint (2) on the gear is in the position shown on the left.

- Fixing nut tightening torque: 50Nm (37lb ft)
- Fixing bolt tightening torque: 76Nm (56lb ft)

CYLINDER HEAD COVER & HEAD COVER CASE



Along with the employment of a common rail type fuel injection system, the head cover is split and housed in a newly introduced head cover case attached with an intermediate connector for the injector. The head cover case is so designed that it is secured individually to the cylinder head with four bolts, and further it is tightened together with the head cover with nine bolts. Accordingly, the head cover is removable individually regardless of the injector harness, thus enabling easy inspection and service including the valve clearance adjustment.

1. Gasket
2. Oil Filler Cap
3. Head Cover Bolt
4. Head Cover
5. Gasket
6. Head Cover Case
7. Intermediate Harness Connector
8. Cylinder Head Cover Case Bolt
9. Cylinder Head
10. Gasket
11. Connector Fixing Bolt

ENGINE CONTROL MODULE (ECM)



The engine control module (ECM) is located at inside of engine-side cover on the left via mounting bracket and is beside the engine. The ECM is made by Transtron. The ECM mainly controls the following.

- Fuel injection control
- Fuel timing control
- Exhaust gas recirculation (EGR) system control
- Preheating system control
- Exhaust brake control
- Power take off (PTO) control
- On-board diagnostics for engine control

The ECM constantly observes the information from various sensors. The ECM controls the systems that affect vehicle performance. The ECM performs the diagnostic function of the system. The ECM can recognize operational problems, alert the driver through the malfunction indicator lamp (MIL), and store diagnostic trouble code (DTC). DTC identify the system faults to aid the technician in making repair.

This diagnostic applies to internal microprocessor integrity conditions within the ECM. The electronically erasable programmable read only memory (EEPROM) memorize learning data and injector ID code data for engine control and communication with other control module.

Symbol "!" warns you of an electric shock hazard. To avoid shock and possible serious injury, DO NOT touch the terminals. When disconnecting the harness connector, always turn OFF the ignition switch or disconnect the battery cable.

Parts number of each ECM mainly differs with following contents.

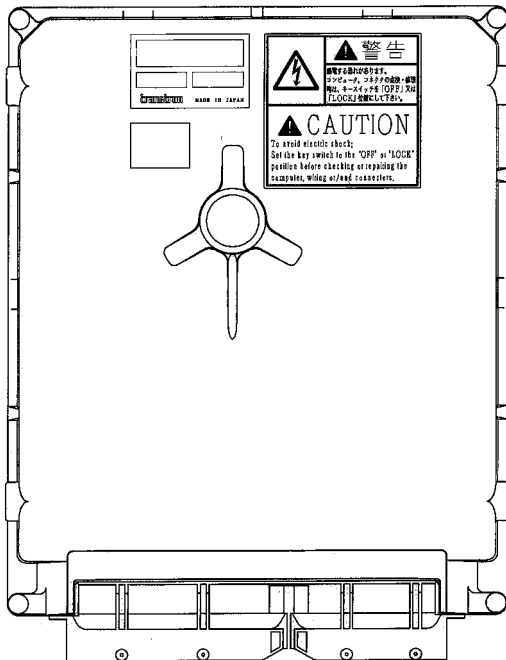
- Engine specification (output or torque)
- Transmission specification (MY, MZ or Smoother)
- Speed limiter application

Notice!

If the ECM is to be replaced the fuel injector ID Code Data (24, 0-9 or A-F characters for each fuel injector) MUST be programmed into the new ECM.

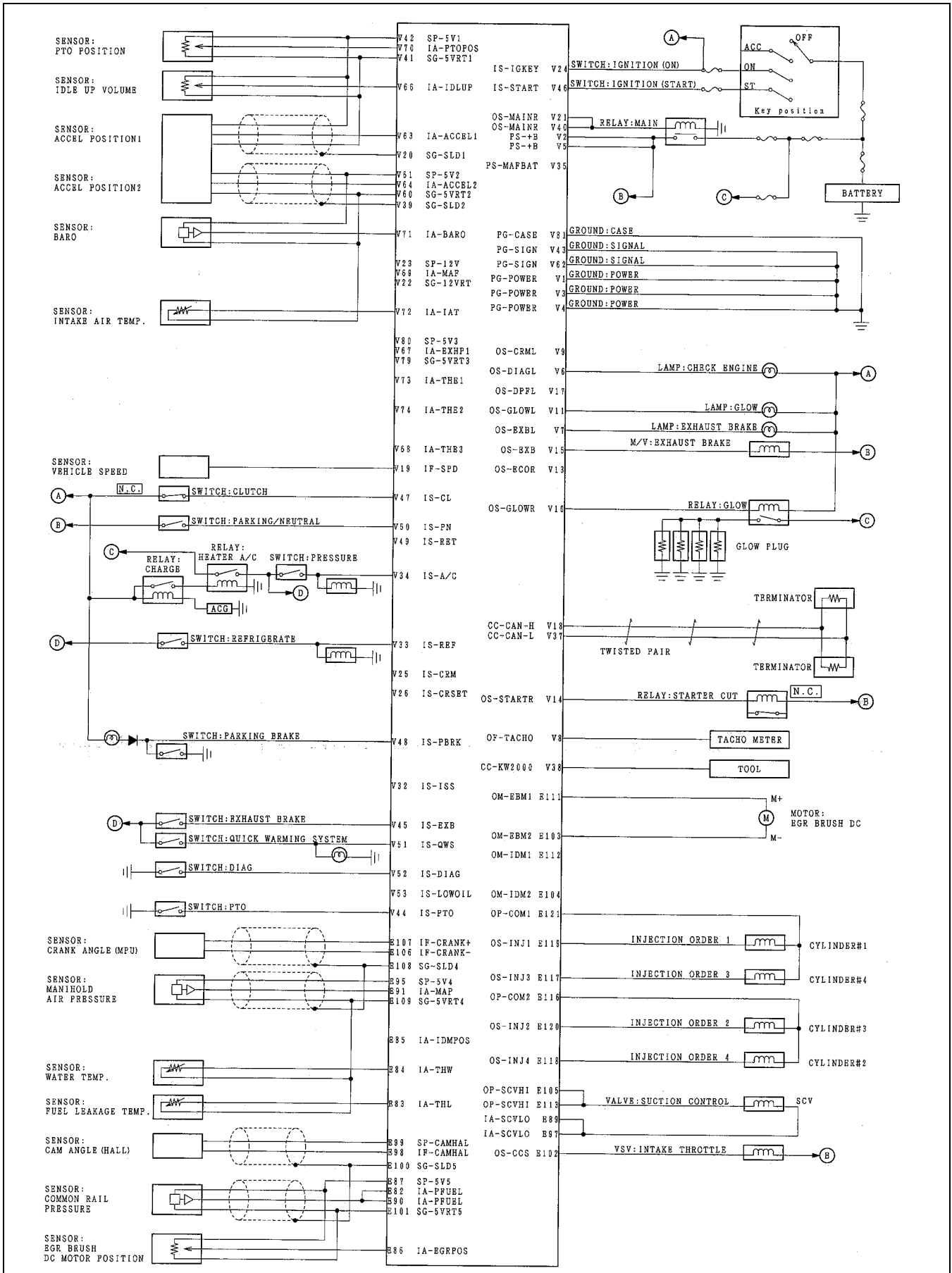
Notice!

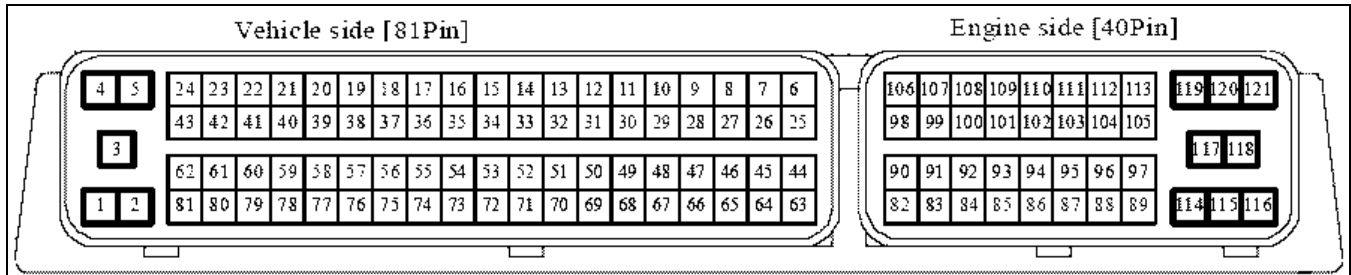
This ECM does not have ability of re-flash function by Service Programming System (SPS) via Tech 2 scan tool.



ISUZU

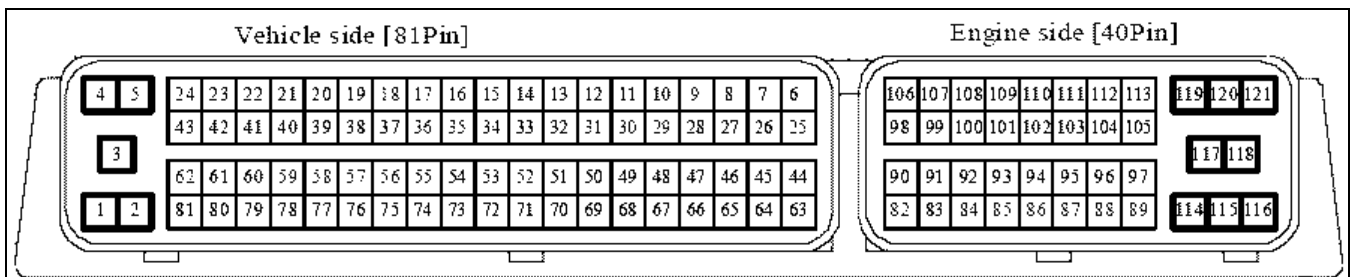
N*R 4HK1-TC Engine-10



ECM Connector Pin Assignment


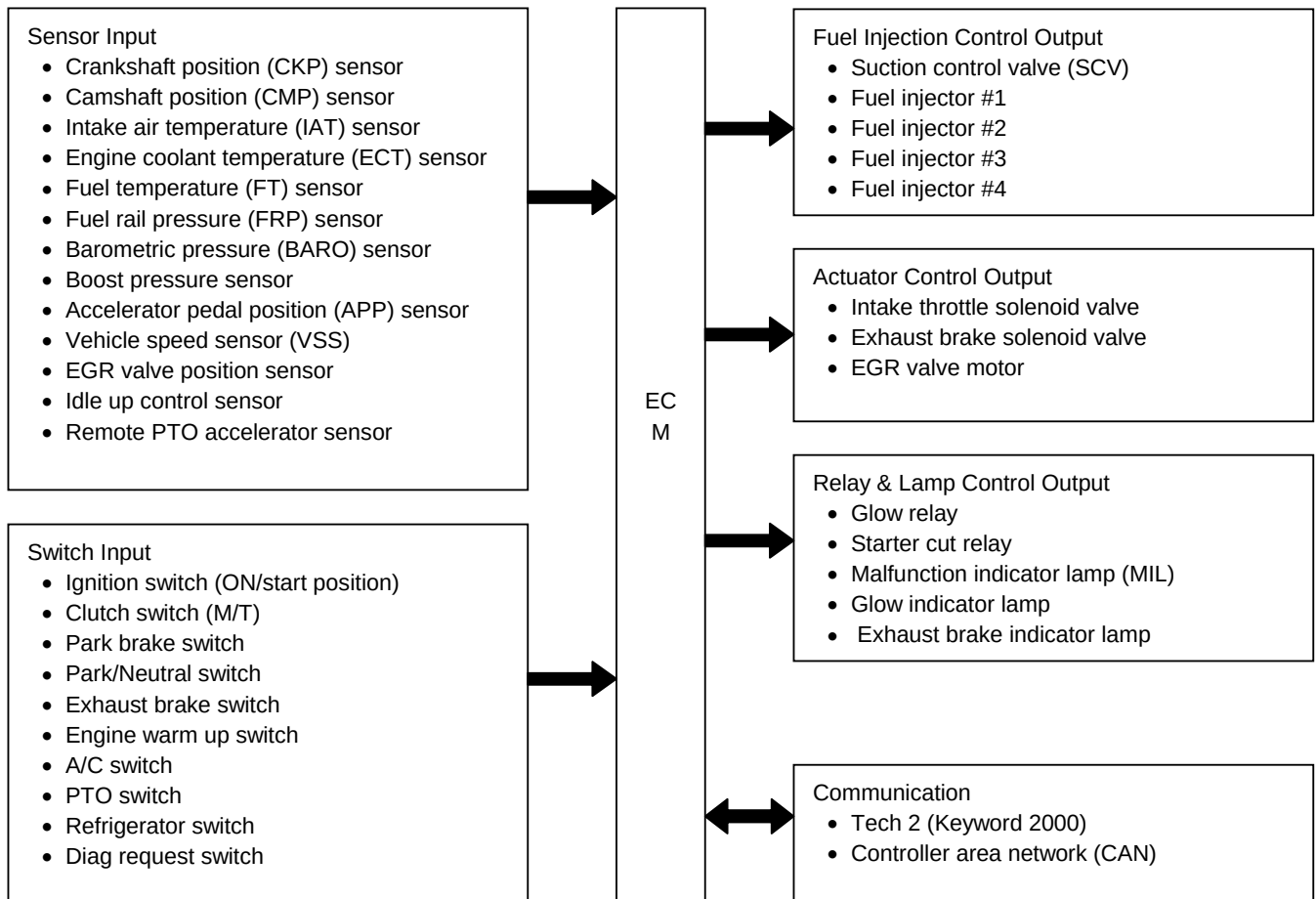
Pin No.	Pin Function	Pin No.	Pin Function	Pin No.	Pin Function
1	ECM Power Ground	28	Not Used	55	Not Used
2	Main Relay Voltage	29	Not Used	56	Not Used
3	ECM Power Ground	30	Not Used	57	Not Used
4	ECM Power Ground	31	Not Used	58	Not Used
5	Main Relay Voltage	32	Not Used	59	Not Used
6	Malfunction Indicator Lamp (MIL) Control	33	Refrigerator Switch Input Signal	60	APP Sensor 2, BARO Sensor, IAT Sensor Low Reference
7	Exhaust Brake Lamp Control	34	A/C Switch Input Signal	61	APP Sensor 2, BARO Sensor, IAT Sensor 5V Reference
8	Engine Speed Signal Output to IPC	35	Not Used	62	ECM Signal Ground
9	Not Used	36	Not Used	63	APP Sensor 1 Input Signal
10	Glow Plug Relay Control	37	CAN Low Signal	64	APP Sensor 2 Input Signal
11	Glow Indicator Lamp Control	38	Keyword 2000 Serial Data	65	Not Used
12	Not Used	39	APP Sensor 2 Shield	66	Idle Up Sensor Input Signal
13	Not Used	40	Main Relay Power Supply	67	Not Used
14	Starter Cut Relay Control	41	APP Sensor 1, Idle Up Sensor, Remote PTO Accelerator Sensor Low Reference	68	Not Used
15	Exhaust Brake Solenoid Control	42	APP Sensor 1, Idle Up Sensor, Remote PTO Accelerator Sensor 5V Reference	69	Not Used
16	Not Used	43	ECM Signal Ground	70	Remote PTO Accelerator Sensor Input Signal
17	Not Used	44	PTO Operation Switch Input Signal	71	BARO Sensor Input Signal
18	CAN High Signal	45	Exhaust Brake Switch Input Signal	72	IAT Sensor Input Signal
19	VSS Input Signal	46	Start Position Input Signal	73	Not Used
20	APP Sensor 1 Shield	47	Clutch Switch Input Signal (M/T Only)	74	Not Used
21	Main Relay Power Supply	48	Park Brake Switch Input Signal	75	Not Used
22	Not Used	49	Not Used	76	Not Used
23	Not Used	50	Neutral Switch Input Signal	77	Not Used
24	Ignition ON Switch Input Signal	51	Engine Warm Up Switch Input Signal	78	Not Used
25	Not Used	52	Diag Switch	79	Not Used
26	Not Used	53	Not Used	80	Not Used

27	Not Used	54	Not Used	81	ECM Case Ground
----	----------	----	----------	----	-----------------

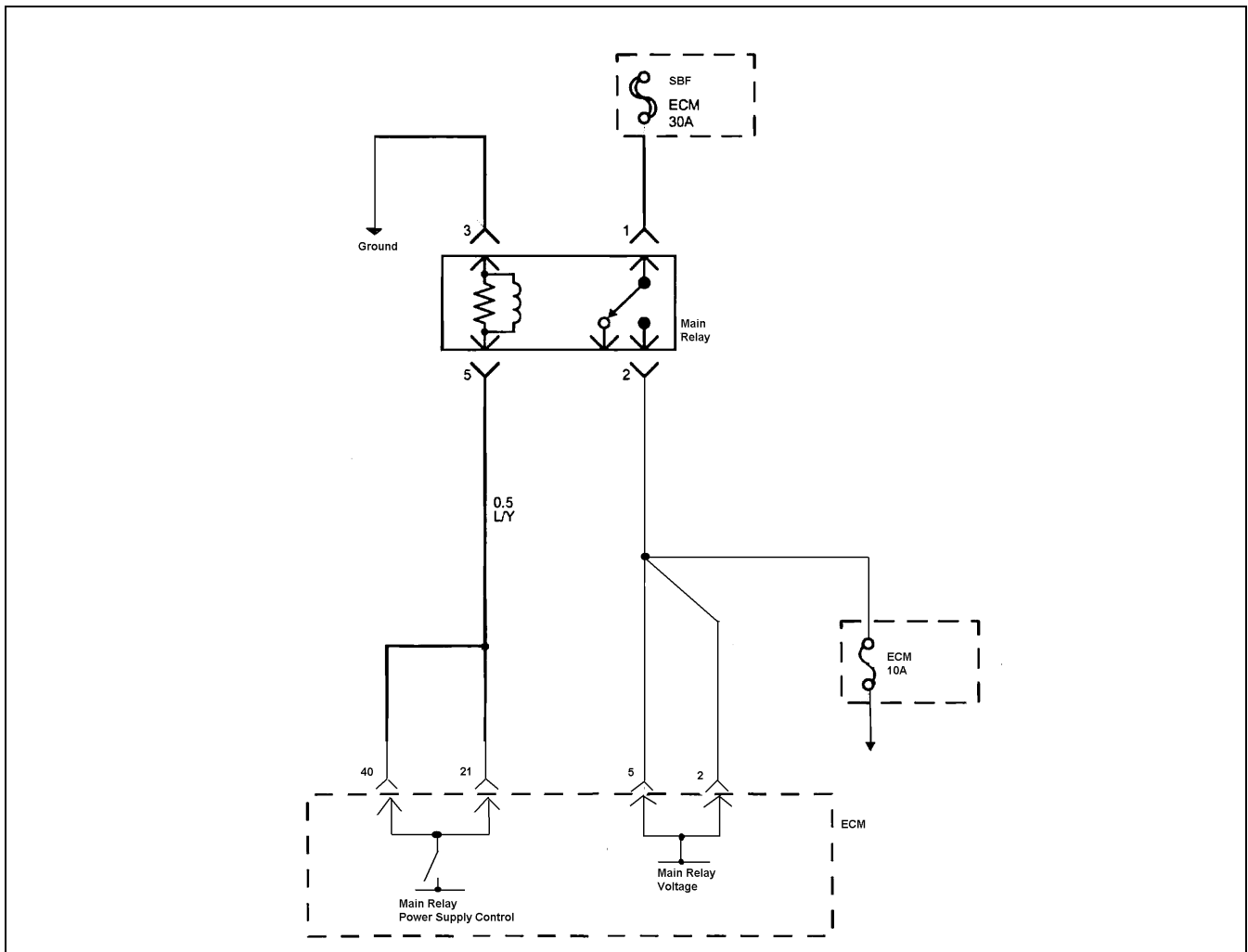


Pin No.	Pin Function	Pin No.	Pin Function	Pin No.	Pin Function
82	FRP Sensor Input Signal	96	Not Used	110	Not Used
83	FT Sensor Input Signal	97	SCV Low Control	111	EGR Valve DC Motor Control
84	ECT Sensor Input Signal	98	CMP Sensor 12V Reference	112	Not Used
85	Not Used	99	CMP Sensor Input Signal	113	SCV High Control
86	EGR Valve Position Sensor Input Signal	100	FRP Sensor, CMP Sensor Shield	114	Not Used
87	FRP Sensor, EGR Valve Position Sensor Input Signal	101	FRP Sensor, EGR Valve Position Sensor Low Reference	115	Not Used
88	Not Used	102	Intake Throttle Solenoid Valve Control	116	Cylinder #2, #3 Injector Power Supply
89	SCV Low Control	103	EGR Valve DC Motor Power Supply	117	Cylinder #4 Injector Control
90	FRP Sensor Input Signal	104	Not Used	118	Cylinder #2 Injector Control
91	Boost Pressure Sensor Input Signal	105	SCV High Control	119	Cylinder #1 Injector Control
92	Not Used	106	CKP Sensor Low Signal Input	120	Cylinder #3 Injector Control
93	Not Used	107	CKP Sensor High Signal Input	121	Cylinder #1, #4 Injector Power Supply
94	Not Used	108	Boost Pressure Sensor, CKP Sensor Shield		
95	Boost Pressure Sensor 5V Reference	109	Boost Pressure Sensor, ECT Sensor, FT Sensor Low Reference		

ECM Inputs & Outputs



The ECM monitors the battery voltage through the ECM main relay load supply voltage terminals "2" and "5", and the ignition voltage on the ignition voltage feed terminal "24" to make sure that the voltage stays within the proper range. When the charging system detects a malfunction, the charge indicator will light.



Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1625	ECM Main Relay Circuit	- DTC P1603 is not set. - The ignition switch is ON. - The ignition switch ON time is longer than 3 seconds.	The ECM detects that a low voltage condition on the ECM main relay voltage feed circuit for longer than 3 seconds when the ECM main relay is commanded ON.	- ECM main relay coil side power supply circuit is open circuit or high resistance. - ECM main relay voltage feed circuit is open circuit or high resistance. - Faulty ECM main relay.
P1625	ECM Main Relay Circuit	The ignition switch is OFF.	The ECM detects that a high voltage condition on the ECM main relay voltage feed circuit for longer than 5 seconds when the ECM main relay is commanded OFF.	- ECM main relay coil side power supply circuit is short to battery voltage circuit. - ECM main relay voltage feed circuit is short to battery voltage circuit. - Faulty ECM main relay.

The engine control module (ECM) provides 5volts reference voltage through the reference circuit 1, 2, 3, 4 and 5 to the following sensors.

5volts reference circuit 1

- Accelerator pedal position (APP) sensor 1
- Idle up volume sensor
- Remote PTO accelerator sensor

5volts reference circuit 2

- APP sensor 2
- Barometric pressure (BARO) sensor

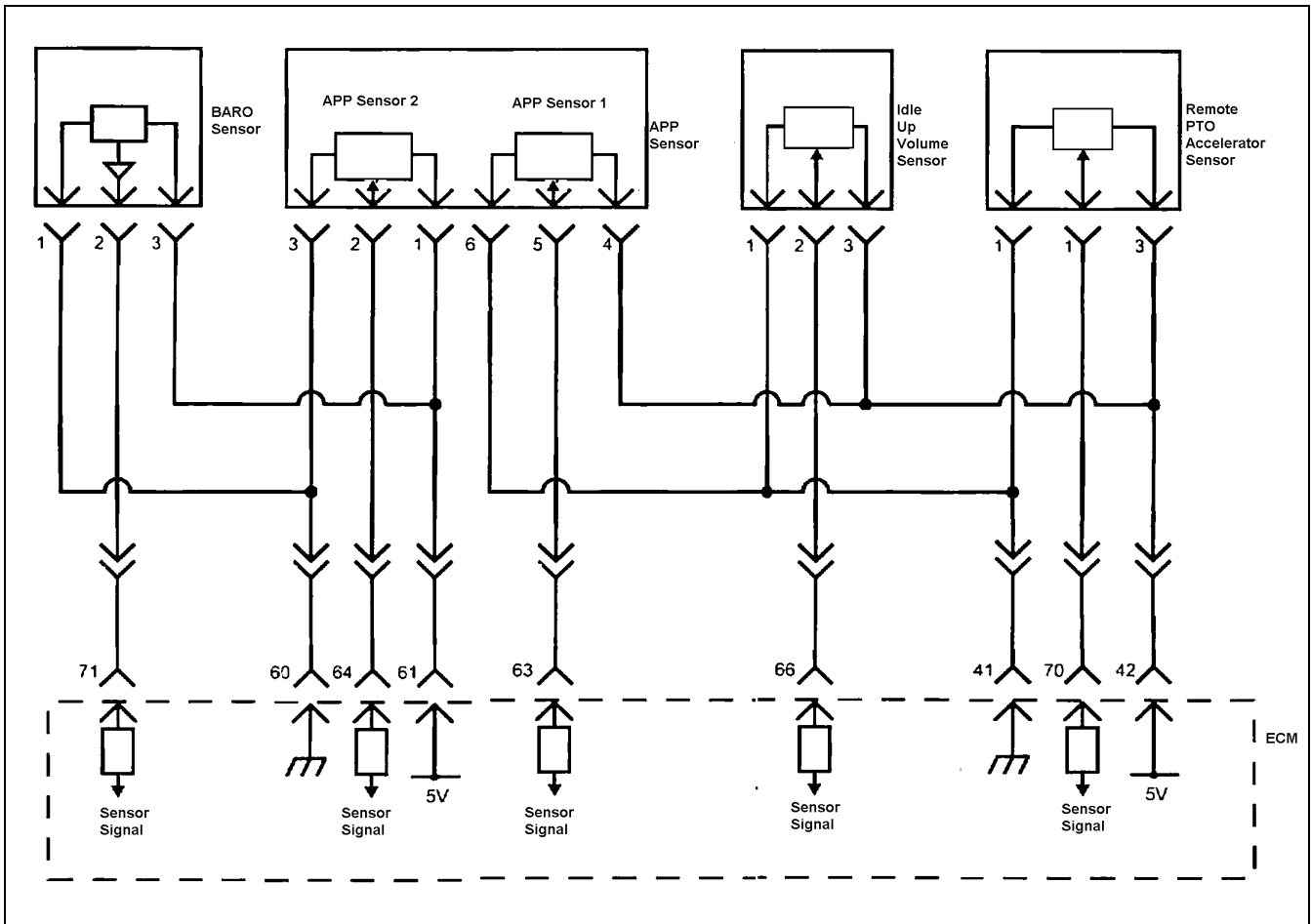
5volts reference circuit 3 (Not Used)

5volts reference circuit 4

- Boost pressure sensor

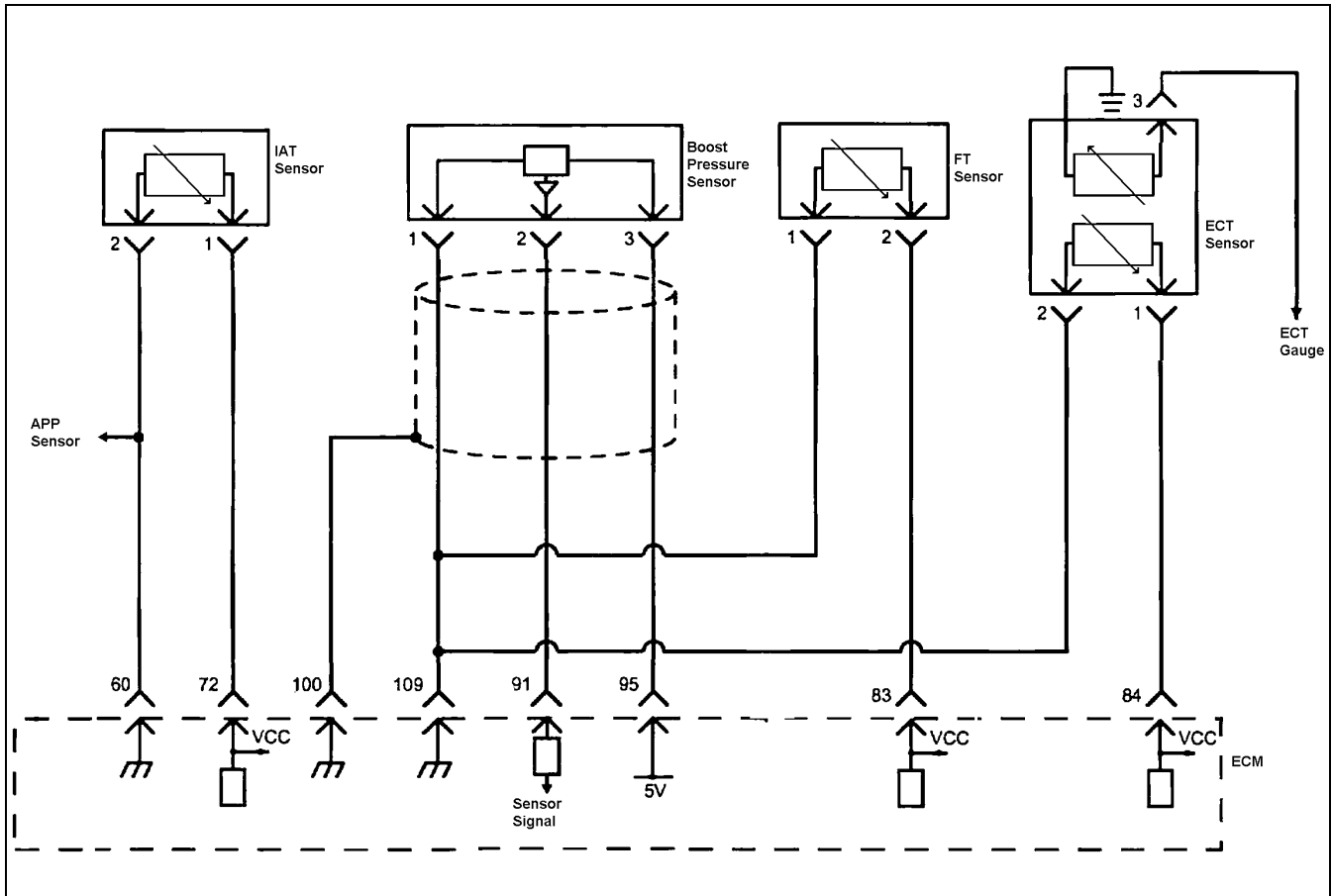
5volts reference circuit 5

- Fuel rail pressure (FRP) sensor
- EGR valve position sensor



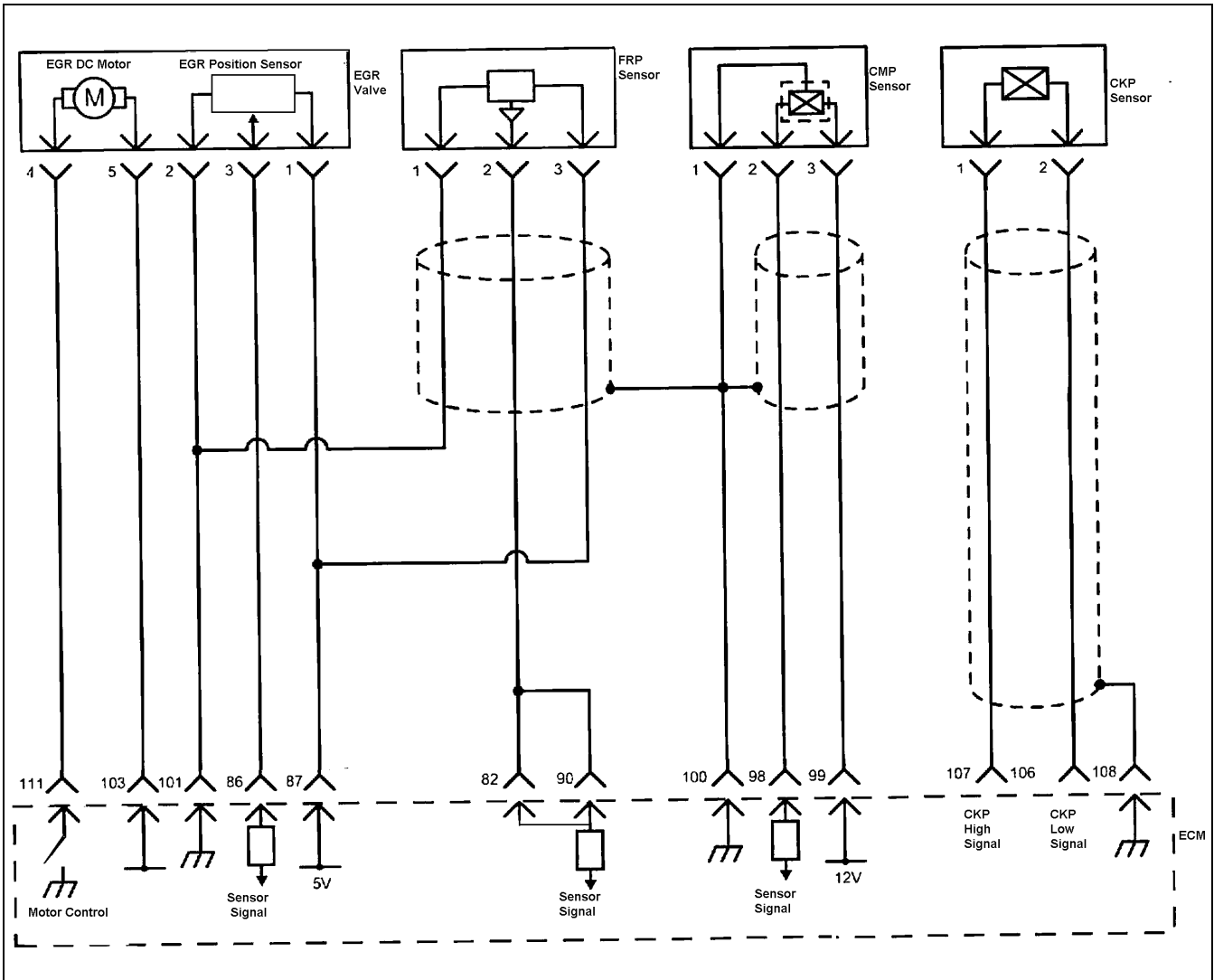
Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1631	5 Volt Reference Circuit 1	- DTC P1630 is not set. - The battery voltage is between 16 – 32 volts. - The ignition switch is ON.	- The ECM detects that the 5 volts reference circuit 1 voltage is less than 4.5 volts. OR - The ECM detects that the 5 volts reference circuit 1 voltage is more than 5.5 volts.	- APP sensor 1 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - Idle up sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - PTO accelerator sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - Faulty APP sensor 1. - Faulty Idle up sensor. - Faulty PTO accelerator sensor. - Faulty ECM. Notice: APP sensor 1 is internal to APP sensor assembly.
P1632	5 Volt Reference Circuit 2	- DTC P1630 is not set. - The battery voltage is between 16 – 32 volts. - The ignition switch is ON.	- The ECM detects that the 5 volts reference circuit 2 voltage is less than 4.5 volts. OR - The ECM detects that the 5 volts reference circuit 2 voltage is more than 5.5 volts.	- APP sensor 2 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - BARO sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - Faulty APP sensor 2. - Faulty BARO sensor. - Faulty ECM. Notice: APP sensor 2 is internal to APP sensor assembly.



Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1633	5 Volt Reference Circuit 3	- DTC P1630 is not set. - The battery voltage is between 16 – 32 volts. - The ignition switch is ON.	- The ECM detects that the 5 volts reference circuit 3 voltage is less than 4.5 volts. OR - The ECM detects that the 5 volts reference circuit 3 voltage is more than 5.5 volts.	-
P1634	5 Volt Reference Circuit 4	- DTC P1630 is not set. - The battery voltage is between 16 – 32 volts. - The ignition switch is ON.	- The ECM detects that the 5 volts reference circuit 4 voltage is less than 4.5 volts. OR - The ECM detects that the 5 volts reference circuit 4 voltage is more than 5.5 volts.	- Boost pressure sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - Faulty boost pressure sensor. - Faulty ECM.



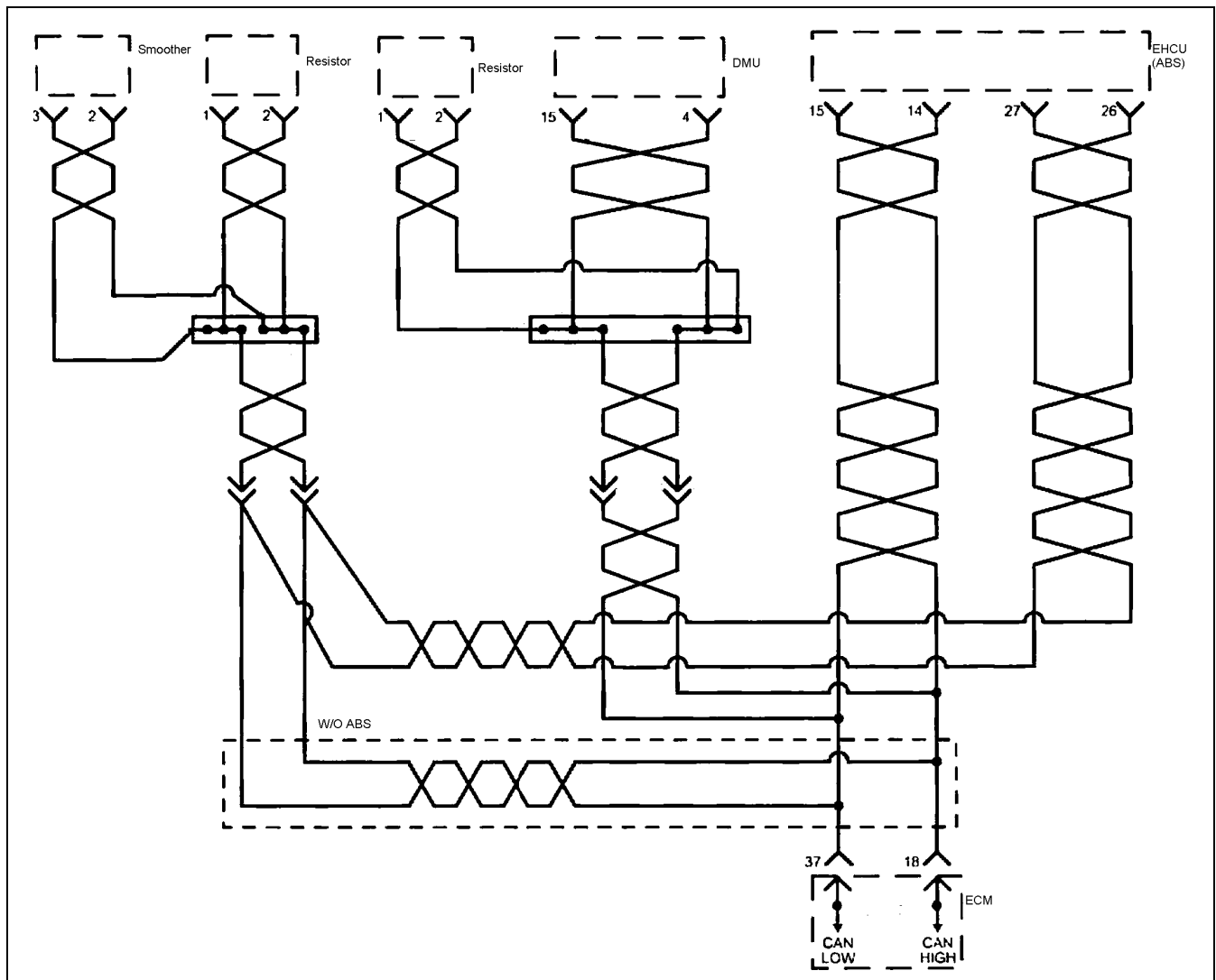
Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1635	5 Volt Reference Circuit 5	- DTC P1630 is not set. - The battery voltage is between 16 – 32 volts. - The ignition switch is ON.	- The ECM detects that the 5 volts reference circuit 5 voltage is less than 4.5 volts. OR - The ECM detects that the 5 volts reference circuit 5 voltage is more than 5.5 volts.	- FRP sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - EGR valve position sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - Faulty FRP sensor. - Faulty EGR valve position sensor. - Faulty ECM. Notice: EGR valve position sensor is internal to EGR valve assembly.

The engine control module (ECM), the smoother control module, ABS control module (EHCUC) and the DMU, interchange of data among each controller performed via a controller area network (CAN) communication bus. Following signals are communicated via a CAN bus.

- Accelerator pedal position signal
- Engine output torque
- PTO control signal
- Exhaust brake cut signal
- Engine speed signal
- Injection volume reduction signal

The ECM monitors CAN operational status by expecting a constant flow of messages from each module. If the ECM fails to receive an expected message from each module, DTC U2104, U2106 or U2108 will set depending on what communication is lost.

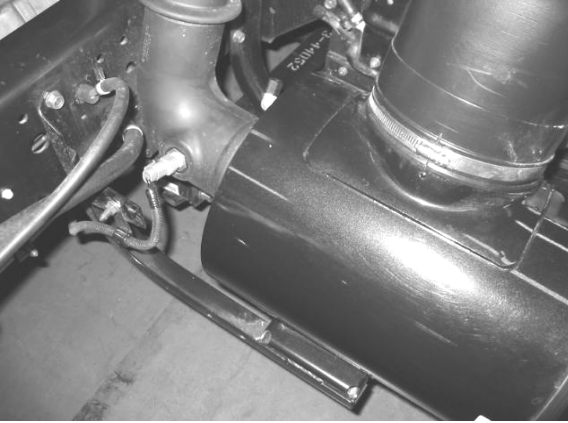


Related DTC

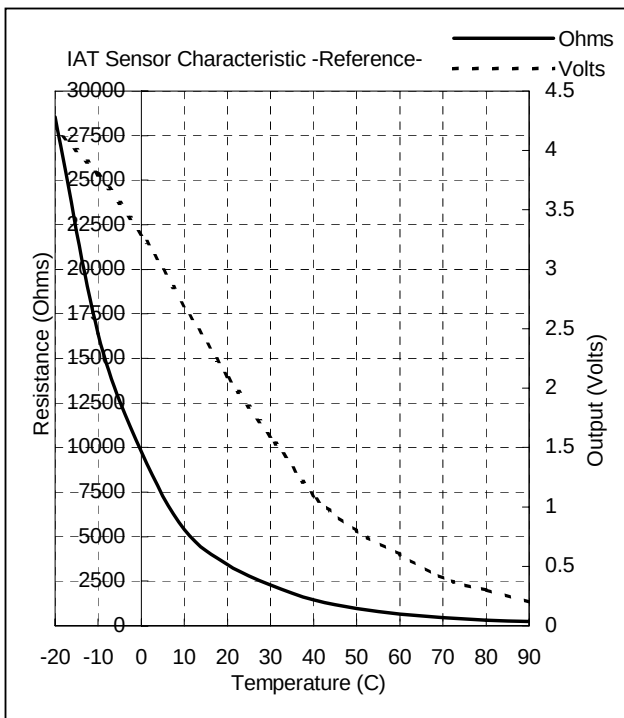
DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
U2104	CAN Bus Reset Counter Overrun	■ The ignition switch is ON.	■ The ECM detects that the CAN Bus OFF is detected.	■ CAN high circuit is short to ground, short to battery or ignition voltage. ■ CAN low circuit is short to ground, short to battery or ignition voltage. ■ Electrical interference. ■ Faulty ECM. ■ Faulty TCM. ■ Faulty EHC.
U2106	Lost CAN Communications With Transmission Control System	■ The ignition switch is ON.	■ The ECM detects that the CAN Bus messages from the TCM are not being received.	■ CAN high circuit is short to ground, short to battery or ignition voltage. ■ CAN low circuit is short to ground, short to battery or ignition voltage. ■ Electrical interference. ■ Faulty ECM. ■ Faulty TCM.
U2108	Lost Communications With ABS/TCS Control System	■ The ignition switch is ON.	■ The ECM detects that the CAN Bus messages from the EHC (ABS control unit) are not being received.	■ CAN high circuit is short to ground, short to battery or ignition voltage. ■ CAN low circuit is short to ground, short to battery or ignition voltage. ■ Electrical interference. ■ Faulty ECM. ■ Faulty EHC.

ELECTRICAL COMPONENTS

INTAKE AIR TEMPERATURE (IAT) SENSOR



The intake air temperature (IAT) sensor is fitted between the air cleaner and turbocharger. The IAT sensor is a variable resistor. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 volts to the IAT sensor signal circuit and a ground for the IAT sensor low reference circuit. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the IAT sensor signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT sensor signal circuit. The ECM uses this value to calculate a fuel injection quantity, injection timing and EGR control.

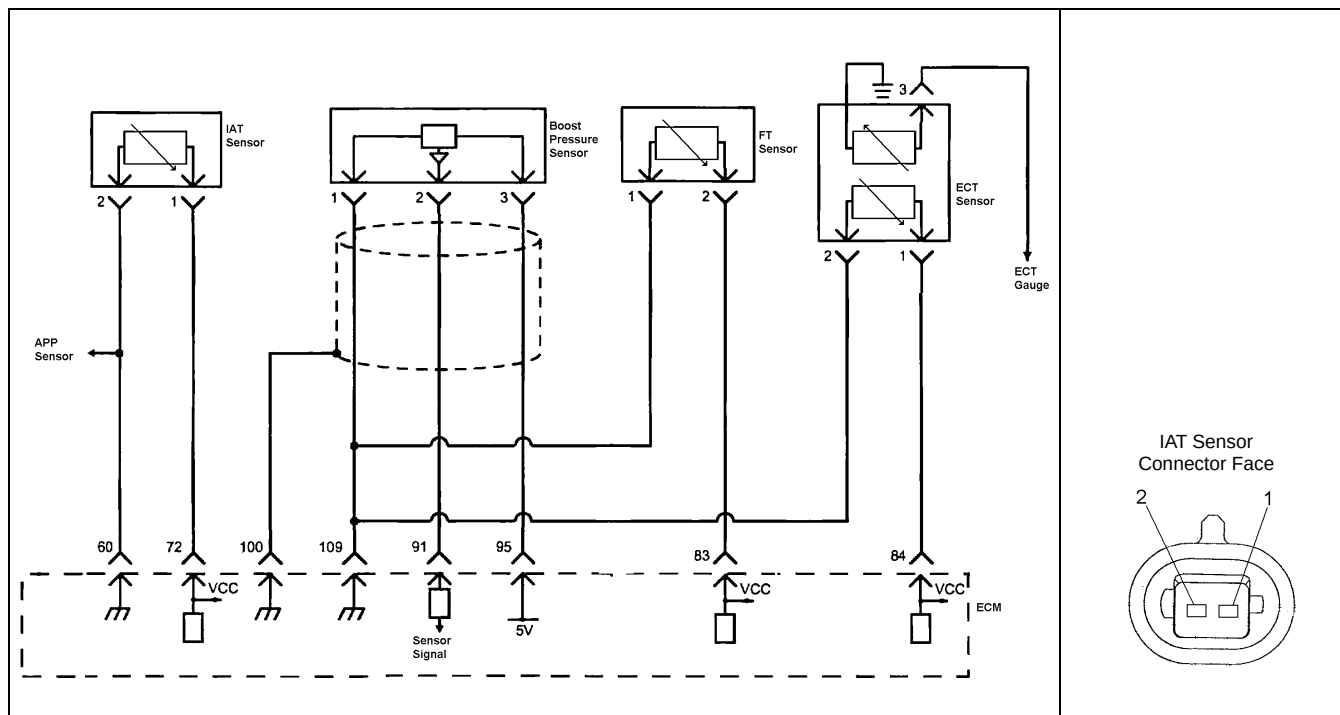


The characteristic of the IAT sensor is displayed in the graph and table. Calculated intake air temperature can be found on the Tech 2 by unit "°C" or "°F". The output voltage also can be found on the Tech 2.

Notice!

In data display "°C" or "°F" will be fixed to a default value when DTC is set relating to the IAT sensor open or short circuit. To diagnose this DTC, observe the "Volts" in the data display.

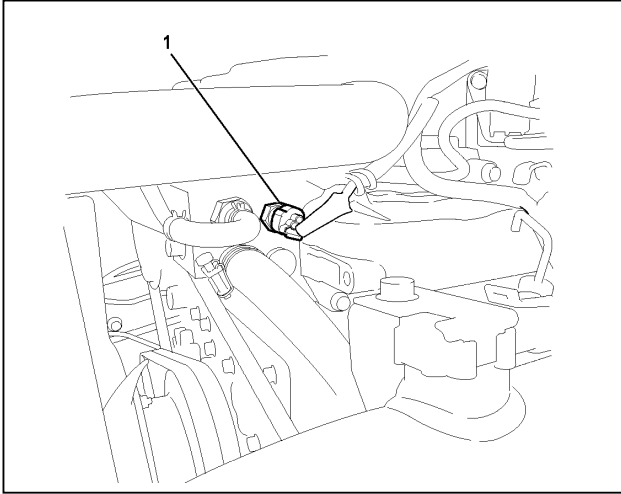
°C	°F	Ohms	Volts
90	194	240	0.2
80	176	320	0.3
70	158	450	0.4
60	140	660	0.6
50	122	960	0.8
40	104	1440	1.1
30	86	2300	1.6
20	68	3430	2.1
10	50	5410	2.7
0	32	9770	3.3
-10	14	16410	3.8
-20	-4	28560	4.2



Related DTC

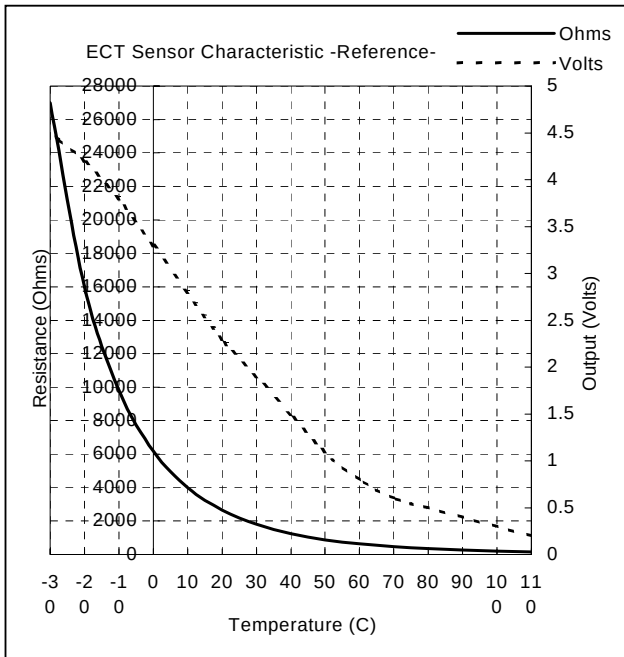
DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0112	Intake Air Temperature (IAT) Sensor Circuit Low Voltage	- DTCs P1630 and P1632 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the IAT sensor signal voltage is less than 0.1 volts for 5 seconds.	- Sensor signal circuit is short to ground or short to the low reference circuit. - Faulty IAT sensor. - Faulty ECM.
P0113	Intake Air Temperature (IAT) Sensor Circuit High Voltage	- DTCs P1630 and P1632 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine run time is longer than 3 minutes.	The ECM detects that the IAT sensor signal voltage is more than 4.8 volts for 5 seconds.	- Sensor signal circuit is open circuit, high resistance, short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty IAT Sensor. - Faulty ECM.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR



The engine coolant temperature (ECT) sensor is installed to the coolant stream on the thermostat housing. It is a variable resistor. The ECT sensor measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT sensor signal circuit and a ground for the ECT sensor low reference circuit. When the ECT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the ECT sensor signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the ECT sensor signal circuit. The ECM uses to this value to calculate a fuel injection quantity, injection timing and EGR control and preheating control.

1.Engine Coolant Temperature (ECT) Sensor

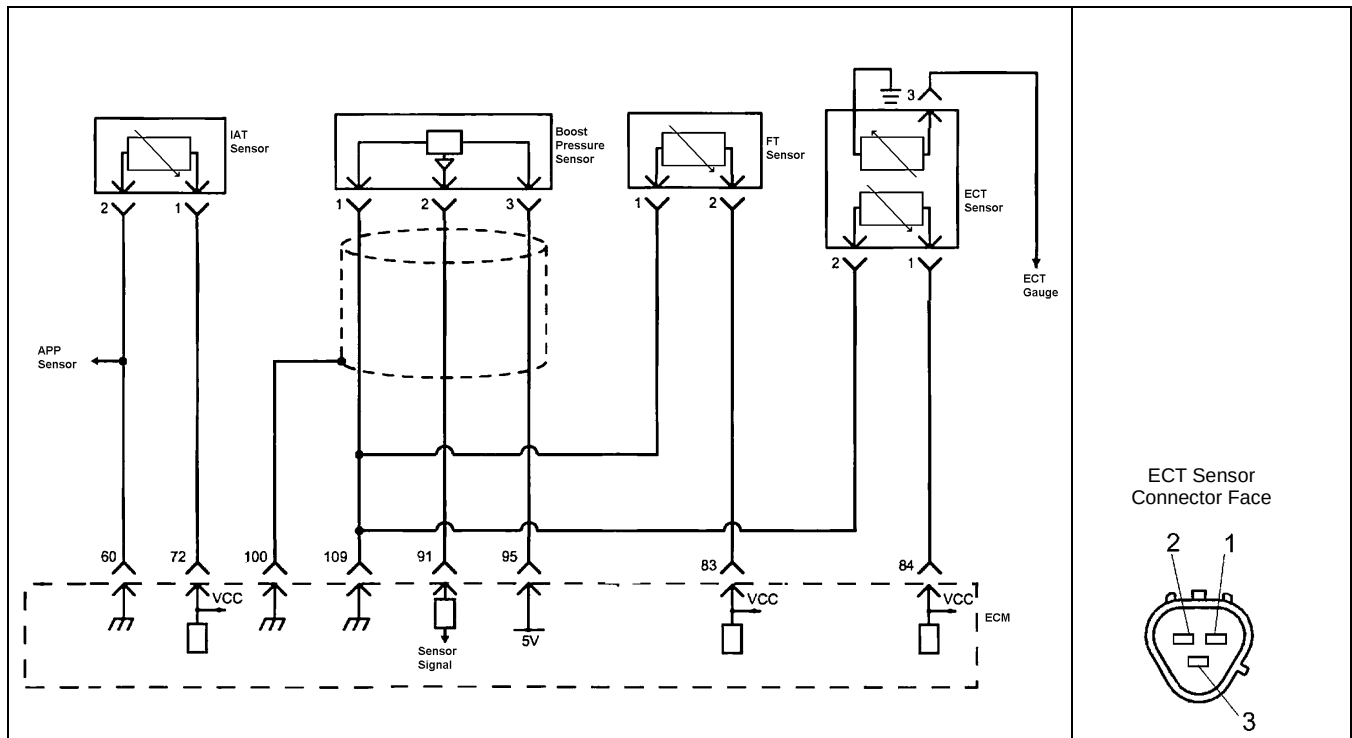


The characteristic of the ECT sensor is displayed in the graph and table. Calculated coolant temperature can be found on the Tech 2 by unit "°C" or "°F". The output voltage also can be found on the Tech 2.

Notice!

In data display "°C" or "°F" will be fixed to a default value when DTC is set relating to the ECT sensor. To diagnose this DTC, observe the "Volts" in the data display.

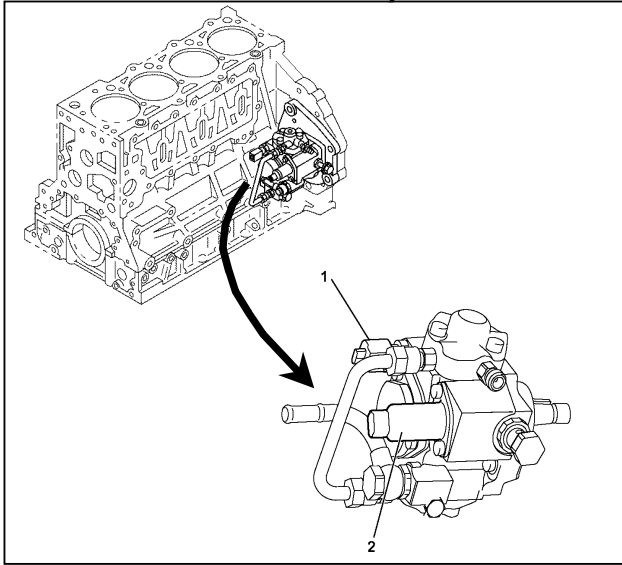
°C	°F	Ohms	Volts
110	230	160	0.2
100	212	200	0.3
90	194	260	0.4
80	176	350	0.5
70	158	470	0.6
60	140	640	0.8
50	122	880	1.1
40	104	1250	1.5
30	86	1800	1.9
20	68	2650	2.3
10	50	4000	2.8
0	32	6180	3.3
-10	14	9810	3.8
-20	-4	16000	4.2
-30	-22	27000	4.5



Related DTC

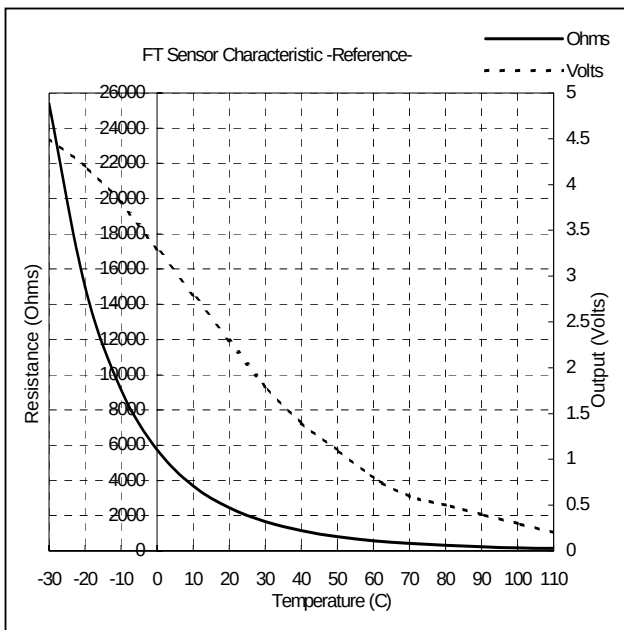
DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0117	Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage	- DTCs P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the ECT sensor signal voltage is less than 0.1 volts for 5 seconds.	- Sensor signal circuit is short to ground or short to the low reference circuit. - Faulty ECT sensor. - Faulty ECM.
P0118	Engine Coolant Temperature (ECT) Sensor Circuit High Voltage	- DTCs P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine run time is longer than 3 minutes.	The ECM detects that the ECT sensor signal voltage is more than 4.8 volts for 5 seconds.	- Sensor signal circuit is open circuit, high resistance, short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty ECT Sensor. - Faulty ECM.
P1173	Engine Overheat	- DTCs P0117, P0118, P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running.	The ECM detects that the ECT is more than 110°C (230°F) for 5 seconds.	- Engine overheat. - Faulty engine cooling system - Faulty ECT sensor.

FUEL TEMPERATURE (FT) SENSOR



The fuel temperature (FT) sensor is installed to the supply pump. It is a variable resistor. The FT sensor measures the temperature of the fuel. The engine control module (ECM) supplies 5volts to the FT sensor signal circuit and a ground for the FT sensor low reference circuit. When the FT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the FT sensor signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the FT sensor signal circuit. The ECM uses to this value to calculate a fuel injection volume, injection timing and EGR control.

1. Fuel Temperature (FT) Sensor
2. Suction Control Valve (SCV)

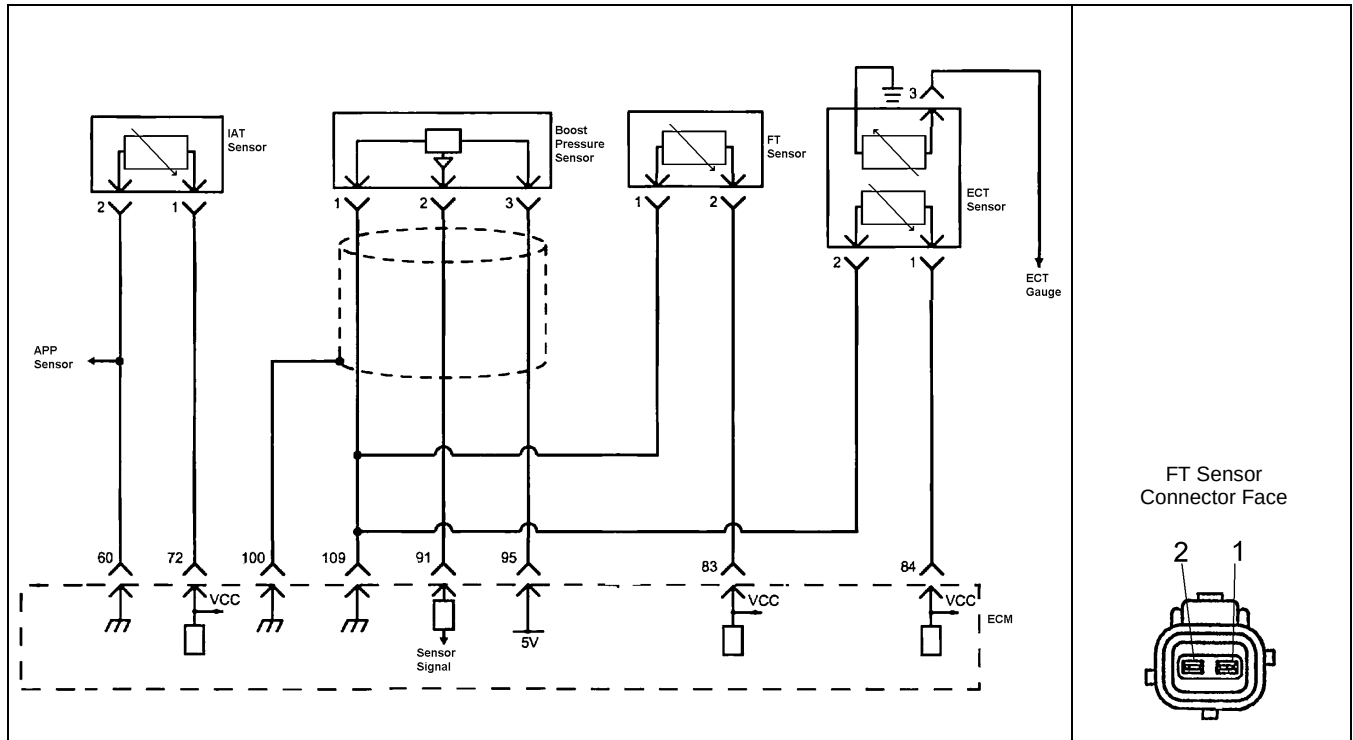


The characteristic of the FT sensor is displayed in the graph and table. Calculated coolant temperature can be found on the Tech 2 by unit "°C" or "°F ". The output voltage also can be found on the Tech 2.

Notice!

In data display "°C" or "°F" will be fixed to a default value when DTC is set relating to the FT sensor. To diagnose this DTC, observe the "Volts" in the data display.

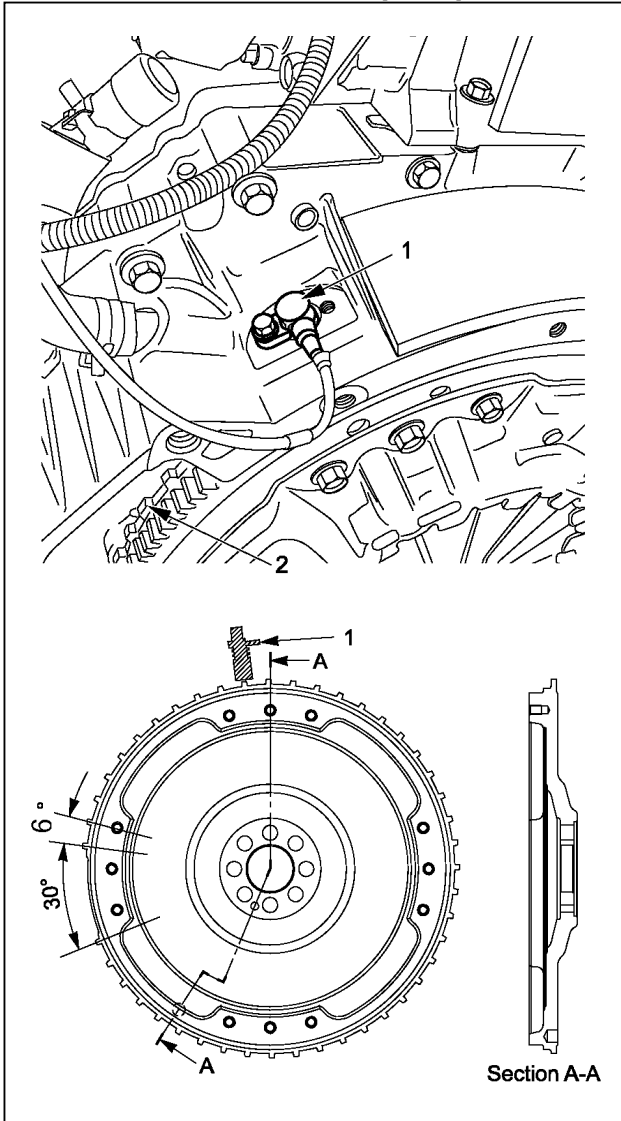
°C	°F	Ohms	Volts
110	230	140	0.2
100	212	180	0.3
90	194	240	0.4
80	176	310	0.5
70	158	420	0.6
60	140	580	0.9
50	122	810	1.1
40	104	1150	1.5
30	86	1660	1.8
20	68	2450	2.3
10	50	3700	2.8
0	32	5740	3.3
-10	14	9160	3.8
-20	-4	15000	4.2
-30	-22	25400	4.5



Related DTC

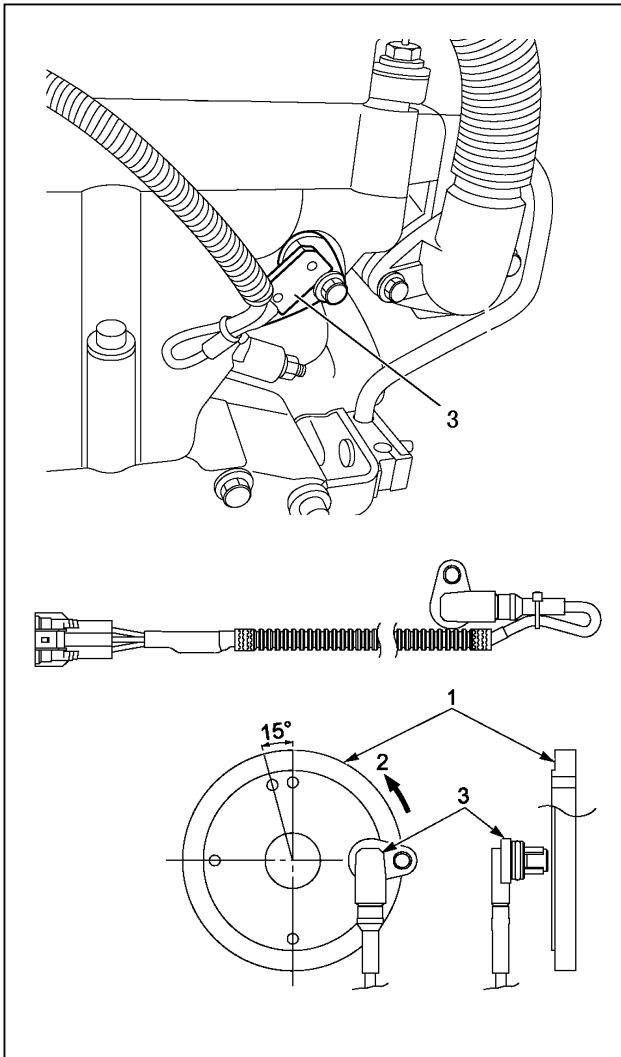
DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0182	Fuel Temperature Sensor Circuit Low Voltage	- DTCs P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the FT sensor signal voltage is less than 0.1 volts for 5 seconds.	- Sensor signal circuit is short to ground or short to the low reference circuit. - Faulty FT sensor. - Faulty ECM.
P0183	Fuel Temperature Sensor Circuit High Voltage	- DTCs P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine run time is longer than 3 minutes.	The ECM detects that the FT sensor signal voltage is more than 4.8 volts for 5 seconds.	- Sensor signal circuit is open circuit, high resistance, short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty FT Sensor. - Faulty ECM.

CRANKSHAFT POSITION (CKP) SENSOR & CAMSHAFT POSITION (CMP) SENSOR



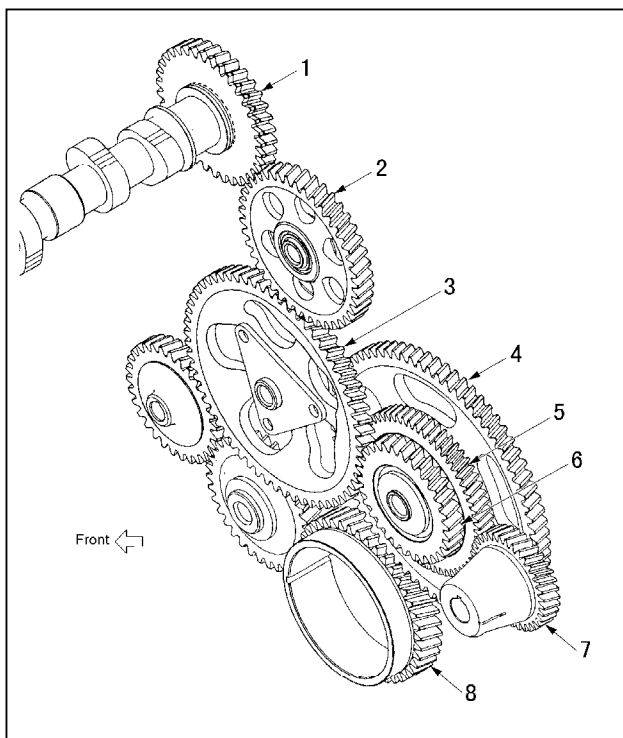
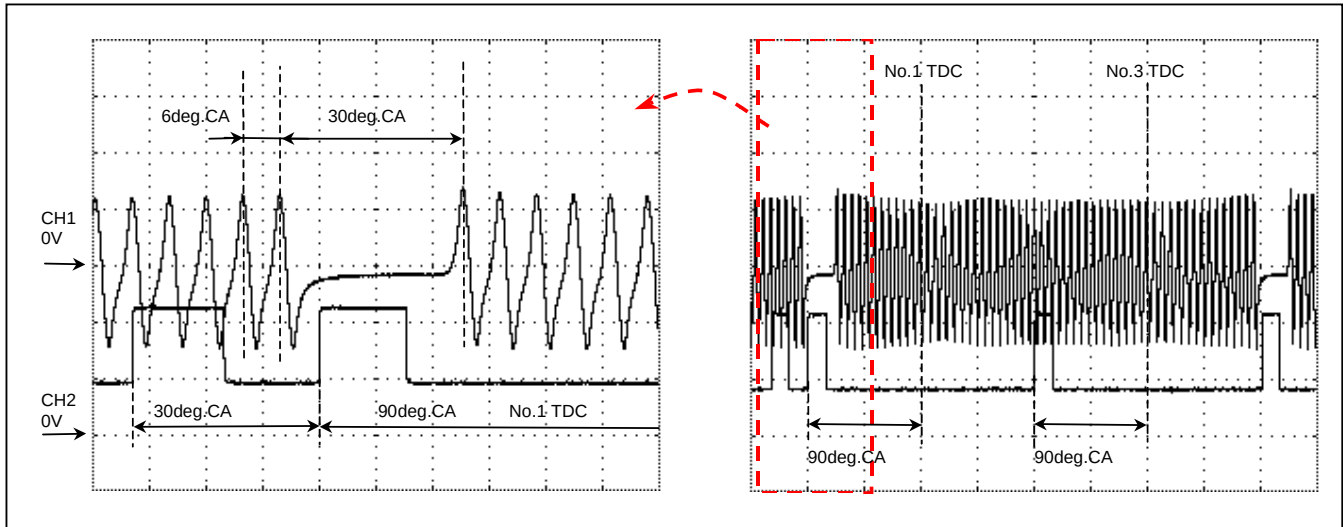
The crankshaft position (CKP) sensor is located on top of the flywheel housing. There are 56 notches spaced 6deg. apart and a 30deg. section that is uncut. This uncut portion allows for the detection of top dead center (TDC). The CKP sensor is a magnet coil type sensor, which generates an AC signal voltage based on the crankshaft rotational speed. If the CKP sensor fails, the camshaft position (CMP) sensor signals will substitute for the CKP sensor signal backup.

1. Crankshaft Position (CKP) Sensor
2. Sensor Wheel

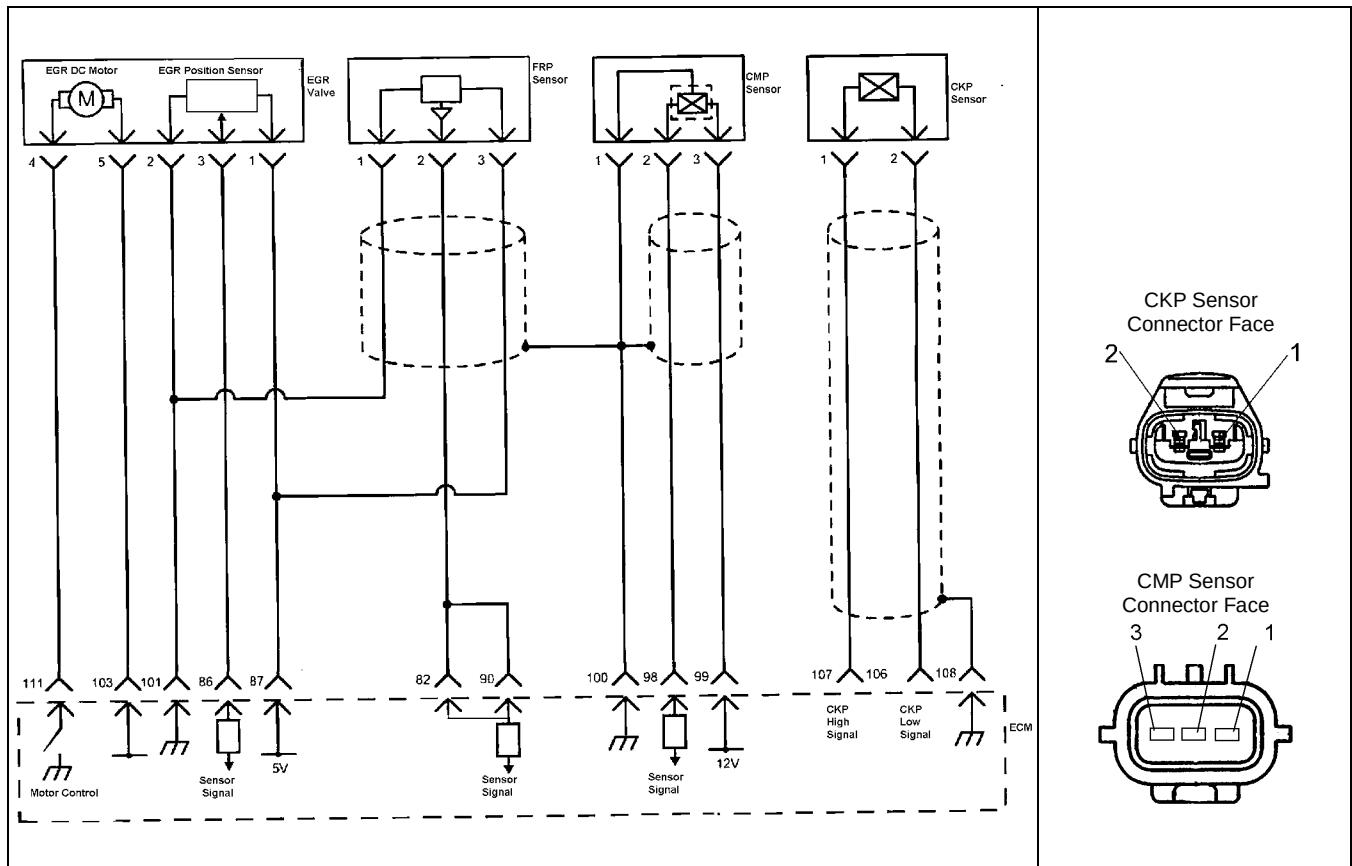


The camshaft position (CMP) sensor is installed on the cylinder head at the rear of the camshaft. The CMP sensor detects a total five through holes, four reference holes arranged equally every 90deg. space and one reference hole on the camshaft gear flange surface, and sends signals to the engine control module (ECM). Receiving these signals, the ECM determines cylinder #1 compression top dead center (TDC). If the CMP sensor fails, the crankshaft position (CKP) sensor signals will NOT substitute for the CMP sensor signal backup. Engine cranks but does not start.

1. Camshaft Gear
2. Gear Rotating Direction
3. Camshaft Position (CMP) Sensor



The relationship of CKP sensor and CMP sensor is displayed on the above picture. The ECM detects 112 CKP sensor pulses (56 x 2) and 5 CMP sensor pulses per 2 crankshaft rotations (720 deg.CA). Both sensor wheels are mechanically bit with each other. Therefore, the relationship of each pulse is always constant. The injection timing suitable for the vehicle conditions is controlled based on the inputs from respective sensors.



Related DTC

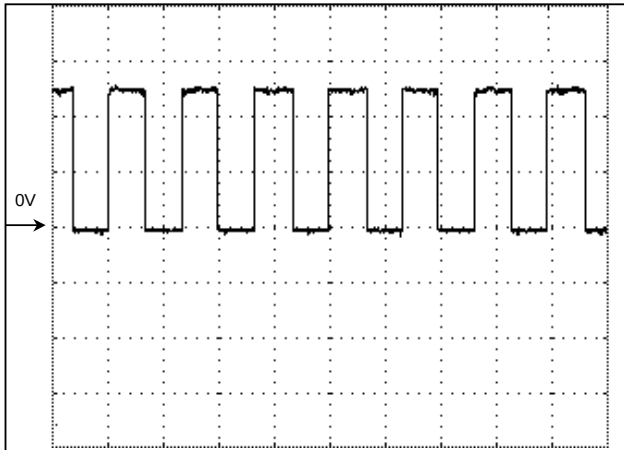
DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0219	Engine Overspeed	-	Engine speed is higher than 4300 RPM for 1 second.	- Engine over-running. - Faulty CKP sensor. - Faulty ECM. - Electrical interference. - Magnetic interference.
P0335	Crankshaft Position (CKP) Sensor No Pulse	- DTCs P0336, P0340, P0341 and P1345 are not set. - The ignition switch is ON. - The CMP sensor signal pulse is detected.	The ECM detects that the CKP sensor pulses are not generated.	- Sensor high circuit is open circuit, short to ground or short to battery, short to ignition voltage or short to any 5V reference. - Sensor low circuit is open circuit, or short to battery, short to ignition voltage or short to any 5V reference. - Sensor shield wire open circuit, short to battery, short to ignition voltage or short to any 5V reference. - Sensor harness connector is poor connection. - Faulty CKP sensor. - Electrical interference. - Magnetic interference. - Faulty ECM. - Sensor installation is poor condition. - Faulty sensor wheel.
P0336	Crankshaft Position (CKP) Sensor Extra or Missing	- DTCs P0335, P0340, P0341 and P1345 are not set. - The ignition switch is ON. - The CMP sensor signal pulse is detected.	The ECM detects extra or missing CKP sensor pulses	- Sensor high circuit is intermittently open circuit or poor connection. - Sensor low circuit is intermittently open circuit or poor connection. - Faulty CKP sensor. - Electrical interference. - Magnetic interference. - Sensor installation is poor condition. - Faulty sensor wheel.

P0340	Camshaft Position (CMP) Sensor No Pulse	■ DTCs P0335, P0336, P0341 and P1345 are not set. ■ The ignition switch is ON. ■ The CKP sensor signal pulse is detected.	■ The ECM detects that the CMP sensor pulses are not generated.	■ Sensor 12V reference circuit is open circuit, short to ground circuit. ■ Sensor signal circuit is open circuit, short to battery, short to ignition voltage or short to any 5V reference. ■ Sensor shield wire open circuit or short to battery or ignition voltage ■ Sensor harness connector is poor connection. ■ Faulty CMP sensor. ■ Electrical interference. ■ Magnetic interference. ■ Faulty ECM. ■ Sensor installation is poor condition. ■ Faulty sensor wheel.
P0341	Camshaft Position (CMP) Sensor Pulse Faulty or Invalid	■ DTCs P0335, P0336, P0340 and P1345 are not set. ■ The ignition switch is ON. ■ The CKP sensor signal pulse is detected.	■ The ECM detects extra or missing CMP sensor pulses	■ Sensor 12V feed circuit is intermittently open circuit or poor connection. ■ Sensor signal circuit is intermittently open circuit or poor connection. ■ Sensor shield wire is intermittently open circuit or poor connection. ■ Faulty CMP sensor. ■ Electrical interference. ■ Magnetic interference. ■ Sensor installation is poor condition. ■ Faulty sensor wheel.
P1345	Crankshaft Position & Camshaft Position Signal Off Phase	■ DTCs P0335, P0336, P0340 and P0341 are not set. ■ The ignition switch is ON. ■ The CKP sensor signal pulse is detected. ■ The CMP sensor signal pulse is detected.	■ The ECM detects that the CKP sensor signals and CMP sensor signals are out of synchronization	■ Incorrect engine mechanical timing.

VEHICLE SPEED SENSOR (VSS)



The vehicle speed sensor (VSS) is a magnet rotated by the transmission output shaft. The VS sensor uses a hall effect element. It interacts with the magnetic field created by the rotating magnet and outputs square wave pulse signal. The 24 volts operating supply form the "Meter" (15A) fuse. The engine control module (ECM) calculates the vehicle speed by the VS sensor.



Calculated signal can be found on the Tech 2 as vehicle speed unit "km/h" or "MPH". The reference waveform of the VS sensor is displayed on the left.

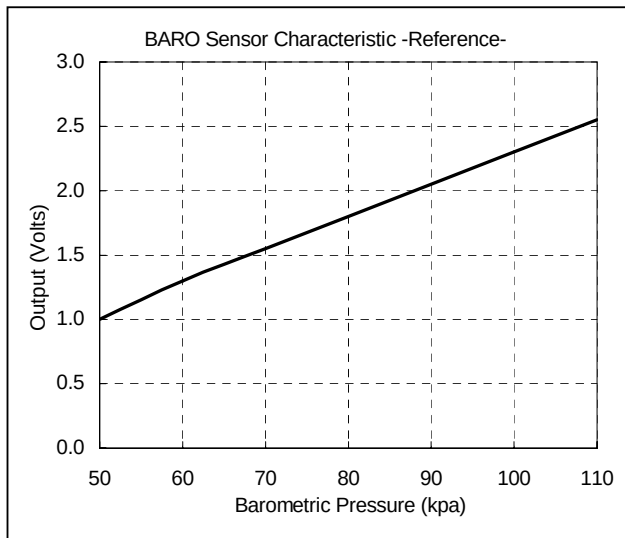


DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0500	Vehicle Speed Sensor (VSS) Circuit No Pulse	■ The ignition switch is ON. ■ The ignition voltage is more than 18 volts. ■ The engine speed is more than 2000 RPM. ■ The commanded fuel supply is OFF.	■ The ECM detects that the VSS signals are not generated for 5 seconds.	■ Sensor +12V circuit is open circuit. ■ Sensor signal circuit is open circuit, short to ground or short to battery or ignition voltage. ■ Sensor low reference circuit is open circuit. ■ Sensor harness connector is poor connection. ■ Sensor internal circuit is open circuit or short circuit. ■ Electrical interference. ■ ECM malfunction.
P0501	Vehicle Speed Sensor (VSS) Performance	■ The ignition switch is ON. ■ The ignition voltage is more than 18 volts.	■ The ECM detects that the VSS signals are changed larger than a predetermined speed.	■ Sensor +12V circuit is open circuit. ■ Sensor signal circuit is open circuit, short to ground or short to battery or ignition voltage. ■ Sensor low reference circuit is open circuit. ■ Sensor harness connector is poor connection. ■ Sensor internal circuit is open circuit or short circuit. ■ Electrical interference. ■ ECM malfunction.

BAROMETRIC PRESSURE (BARO) SENSOR



The barometric pressure (BARO) sensor is located under the instrument panel cluster near the clutch pedal bracket. But, it is not installed into the manifold. Just placed on via a bracket. The BARO sensor is a transducer that varies voltage according to changes surrounding barometric pressure. The BARO sensor provides a signal to the engine control module (ECM) on the BARO sensor signal circuit, which is relative to the pressure changes. The sensor should detect a low signal voltage at low barometric pressure, such as high altitude area. The ECM should detect high signal voltage at high barometric pressure, such as sea level area. The ECM uses this voltage signal to calibrate the fuel injection volume and injection timing for altitude compensation.

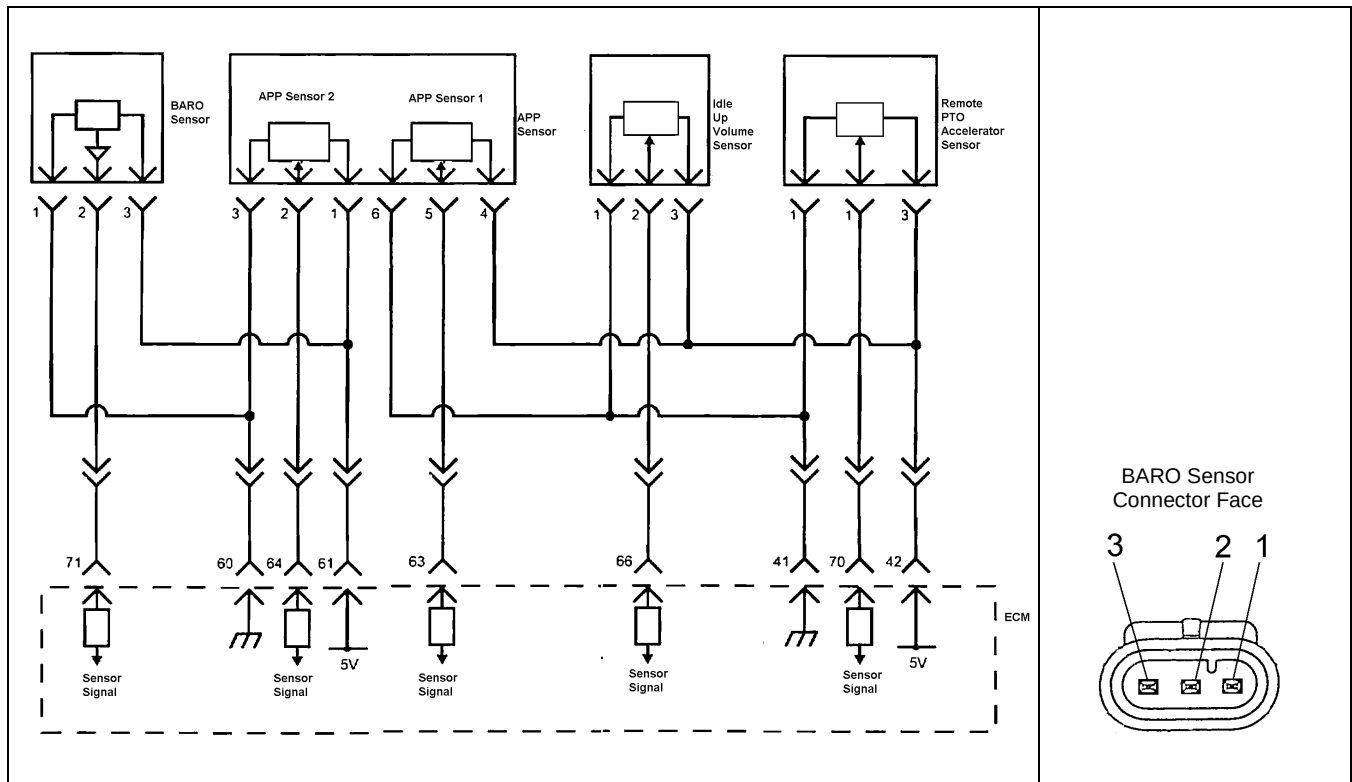


The characteristic of the BARO sensor is displayed in the graph and table. Calculated barometric pressure can be found on the Tech 2 by unit "kpa". The output voltage also can be found on the Tech 2.

Notice!

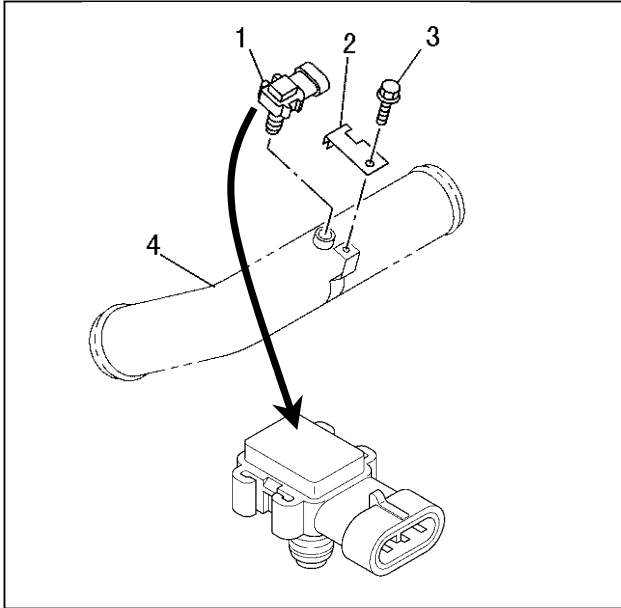
In data display "kpa" will be fixed to the default value when DTC is set relating to the BARO sensor. To diagnose this DTC, observe the "Volts" in the data display.

kpa	psi	Volts
50	7.3	1.0
60	8.7	1.3
70	10.2	1.6
80	11.6	1.8
90	13.1	2.1
100	14.5	2.3
110	16.0	2.6



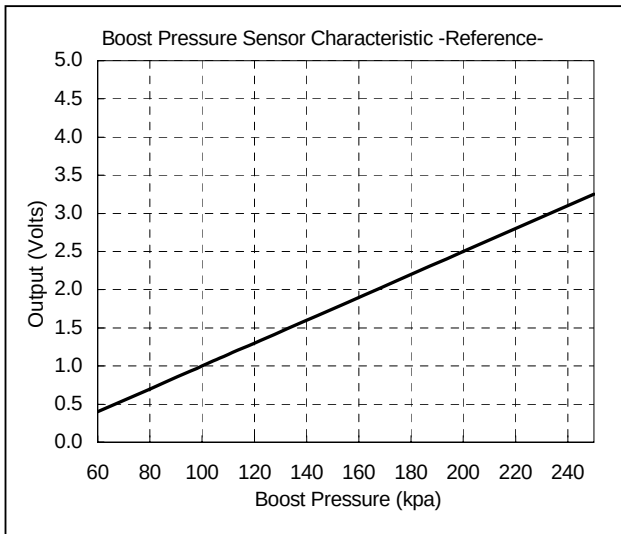
Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0107	Barometric Pressure (BARO) Sensor Circuit Low Voltage	- DTCs P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the BARO sensor signal voltage is less than 0.5 volts for 5 seconds.	- Sensor 5V reference circuit is open circuit, high resistance. - Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1632 may also set.) - Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. - Poor harness connector connection. - Faulty BARO sensor. - Faulty ECM.
P0108	Barometric Pressure (BARO) Sensor Circuit High Voltage	- DTCs P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the BARO sensor signal voltage is more than 4.9 volts for 5 seconds.	- Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1632 may also set.) - Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty BARO sensor. - Faulty ECM.

BOOST PRESSURE SENSOR

The boost pressure sensor is located in the air induction tubing. The boost pressure sensor is a transducer that varies voltage according to changes in the air pressure inside the air tubing. The boost pressure sensor provides a signal to the engine control module (ECM) on the boost pressure sensor signal circuit, which is relative to the pressure changes in the manifold. The sensor should detect a low signal voltage at low boost pressure, such as low engine load. The ECM should detect high signal voltage at a high boost pressure, such as high engine load. The ECM uses to this value to calculate a fuel injection volume.

1. Boost Pressure Sensor
2. Retaining Plate
3. Fixing Bolt
4. Intake Pipe

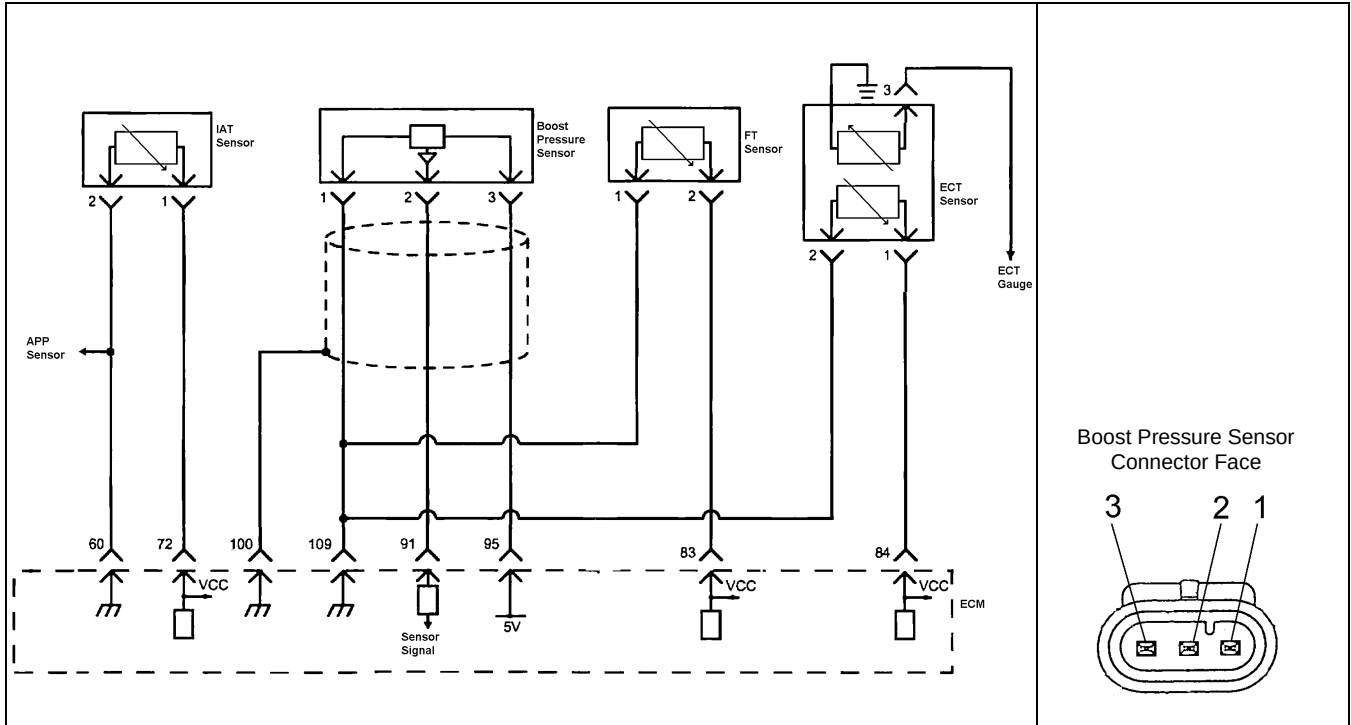


The characteristic of the boost pressure sensor is displayed in the graph and table. Calculated boost pressure can be found on the Tech 2 by unit "kpa". The output voltage also can be found on the Tech 2.

Notice!

In data display "kpa" will be fixed to a default value when DTC is set relating to the boost pressure sensor. To diagnose this DTC, observe the "Volts" in the data display.

kpa	psi	Volts
60	8.7	0.4
80	11.6	0.7
100	14.5	1.0
110	16.0	1.2
150	21.8	1.8
200	29.0	2.5
250	36.3	3.3



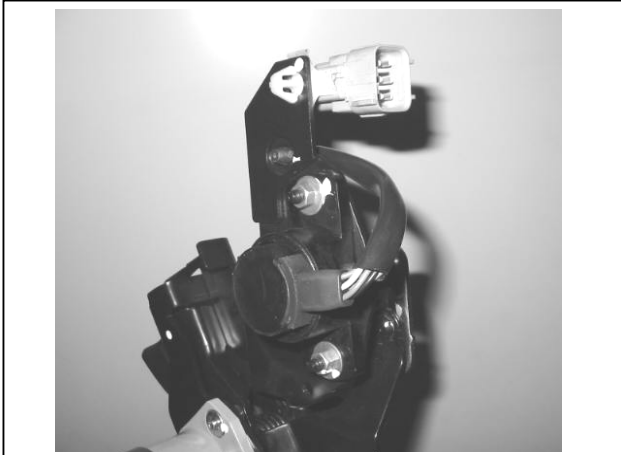
Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0234	Turbocharger Engine Overboost	- DTCs P0237, P0238, P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running. - The fuel injection quantity is more than a calculated value.	The ECM detects that the boost pressure is more than 228 kPa (33 psi) for 3 seconds.	- Boost pressure sensor low reference circuit is intermittently open circuit or high resistance. - Faulty boost pressure sensor. - Faulty turbocharger waste gate valve. - Restricted intake or collapsed hose between the intake throttle and sensor. - Intake throttle plate sticking in the closed position. - Faulty BARO sensor. - Faulty ECM.
P0236	Turbocharger Engine Underboost	- DTCs P0107, P0108, P0237, P0238, P1630, P1634 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running. - The fuel injection quantity is more than a calculated value.	- The ECM detects that the boost pressure is less than 78 kPa (11 psi) for 20 seconds when the engine speed is less than 900 RPM. - OR - The ECM detects that the boost pressure is less than 82 to 151 kPa (12 to 22 psi) for 20 seconds when the engine speed is between 1200 and 3000 RPM. - When the barometric pressure (BARO) is lower than 100 kPa, the BARO is subtracted from 100 kPa (100 kPa – BARO) is added to the thresholds.	- Boost pressure sensor 5V reference circuit is intermittently open circuit or high resistance. - Boost pressure sensor signal circuit is intermittently open circuit or high resistance. - Faulty boost pressure sensor. - Air leakage. - Intake duct is disconnected. - Intake system is obstructed. - Faulty turbocharger waste gate valve. - Faulty turbocharger. (Shaft stick) - Faulty BARO sensor. - Faulty ECM.

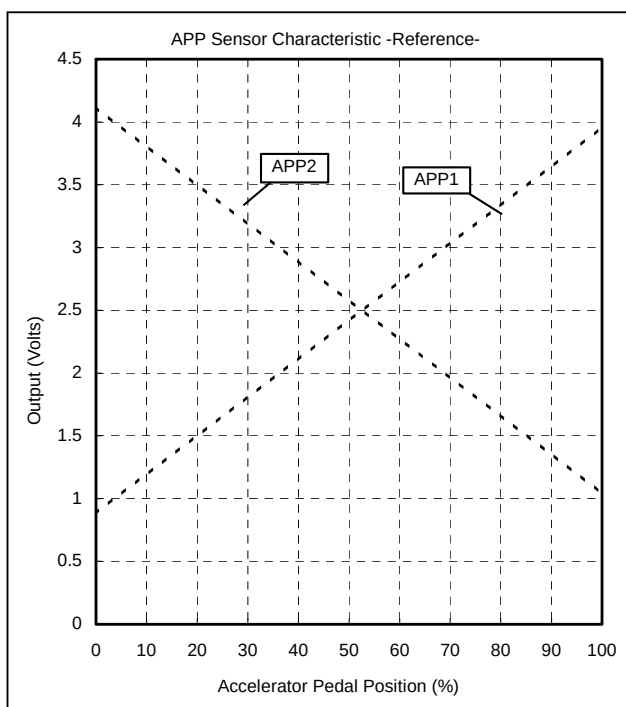
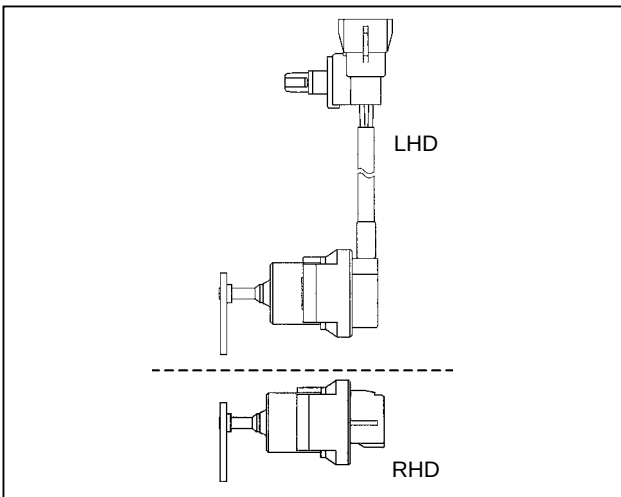


P0237	Turbocharger Boost Sensor Circuit Low Voltage	■ DTCs P1630 and P1634 are not set. ■ The ignition switch is ON. ■ The ignition voltage is more than 18 volts.	■ The ECM detects that the boost pressure sensor signal voltage is less than 0.1 volts for 3 seconds.	■ Sensor 5V reference circuit is open circuit, high resistance. ■ Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1634 may also set.) ■ Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. ■ Poor harness connector connection. ■ Faulty boost pressure sensor. ■ Faulty ECM.
P0238	Turbocharger Boost Sensor Circuit High Voltage	■ DTCs P1630 and P1634 are not set. ■ The ignition switch is ON. ■ The ignition voltage is more than 18 volts.	■ The ECM detects that the boost pressure sensor signal voltage is more than 4.9 volts for 3 seconds.	■ Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1634 may also set.) ■ Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. ■ Sensor low reference circuit is open circuit or high resistance. ■ Poor harness connector connection. ■ Faulty boost pressure sensor. ■ Faulty ECM.

ACCELERATOR PEDAL POSITION (APP) SENSOR



The accelerator pedal position (APP) sensor is mounted on the accelerator pedal assembly. The sensor is made up of two individual sensors within one housing. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injection control.

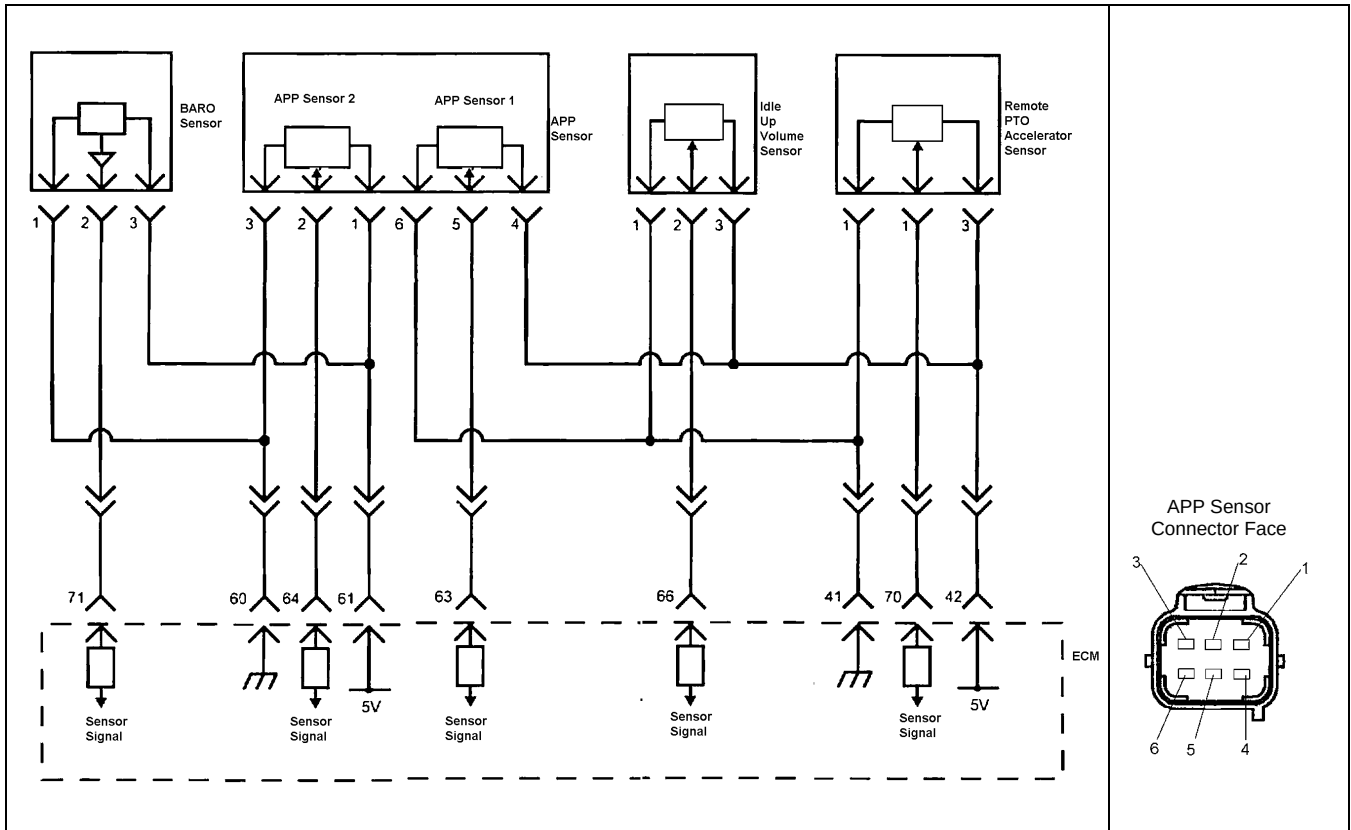


The characteristic of the APP sensor 1 and 2 is displayed in the graph and table. Calculated accelerator pedal angle can be found on the Tech 2 by unit “%”. Also, output voltage can be found on the Tech 2.

The ECM monitors both sensor signals. If out of correlation between two sensors such as skewed sensor, P1271 will set.

Notice!

If one of the APP sensor is failed (DTC set), the ECM will use the remaining another APP sensors to calculate pedal angle. Indicated APP angle will being 0 –100%.



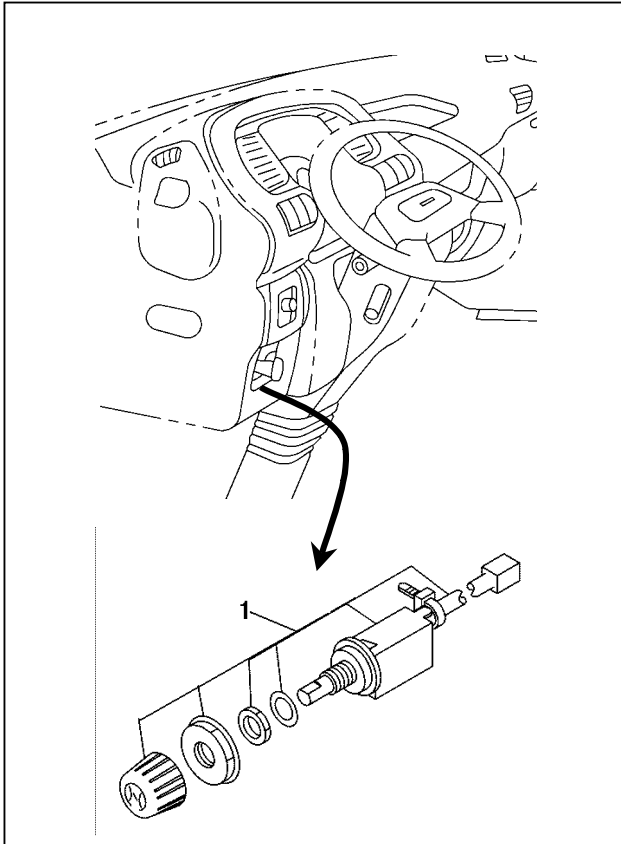
Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1271	Accelerator Pedal Position (APP) Sensor 1-2 Correlation	- DTCs P1630, P1631 and P1632 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the APP sensor 1 and 2 are more than 45% out of range of each other.	- APP sensor 1 5V reference circuit is high resistance. - APP sensor 1 signal circuit is high resistance. - APP sensor 1 low reference circuit is high resistance. - APP sensor 2 5V reference circuit is high resistance. - APP sensor 2 signal circuit is high resistance. - APP sensor 2 low reference circuit is high resistance. - Poor harness connector connection. - Electrical interference. - Faulty APP sensor 1 or 2. - Faulty ECM. Notice: APP sensor 1 or 2 is internal to APP sensor assembly.
P1277	Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage	- DTCs P1630 and P1631 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the APP sensor 1 signal voltage is less than 0.2 volts.	Sensor 5V reference circuit is open circuit, high resistance. Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1631 may also set.) Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. - Poor harness connector connection. - Faulty APP sensor 1. - Faulty ECM. Notice: APP sensor 1 is internal to APP sensor assembly.



P1278	Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage	■ DTCs P1630 and P1631 are not set. ■ The ignition switch is ON. ■ The ignition voltage is more than 18 volts.	■ The ECM detects that the APP sensor 1 signal voltage is more than 4.9 volts.	■ Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1631 may also set.) ■ Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. ■ Sensor low reference circuit is open circuit or high resistance. ■ Poor harness connector connection. ■ Faulty APP sensor 1. ■ Faulty ECM. Notice: APP sensor 1 is internal to APP sensor assembly.
P1282	Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage	■ DTCs P1630 and P1632 are not set. ■ The ignition switch is ON. ■ The ignition voltage is more than 18 volts.	■ The ECM detects that the APP sensor 2 signal voltage is less than 0.2 volts.	■ Sensor 5V reference circuit is open circuit or high resistance. ■ Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1632 may also set.) ■ Sensor signal circuit is short to ground or short to the low reference circuit. ■ Poor harness connector connection. ■ Faulty APP sensor 2. ■ Faulty ECM. Notice: APP sensor 2 is internal to APP sensor assembly.
P1283	Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage	■ DTCs P1630 and P1632 are not set. ■ The ignition switch is ON. ■ The ignition voltage is more than 18 volts.	■ The ECM detects that the APP sensor 2 signal voltage is more than 4.9 volts.	■ Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1635 may also set.) ■ Sensor signal circuit is open circuit, high resistance, short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. ■ Sensor low reference circuit is open circuit or high resistance. ■ Poor harness connector connection. ■ Faulty APP sensor 2. ■ Faulty ECM. Notice: APP sensor 2 is internal to APP sensor assembly.

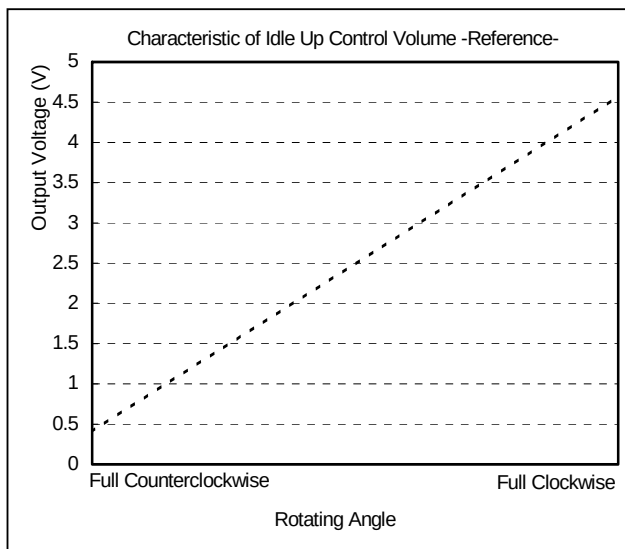
ENGINE IDLE UP CONTROL VOLUME

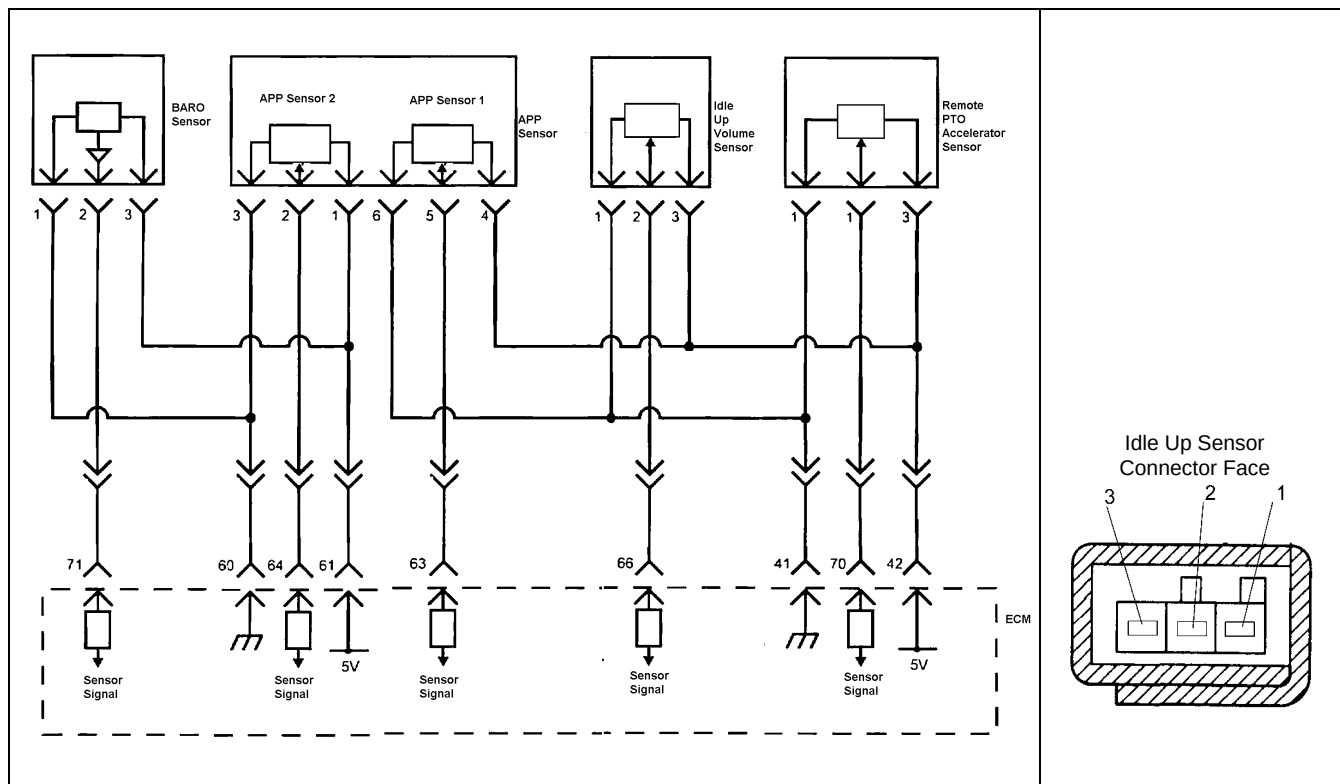


The idle up volume controls the idle speed during warm-up and it is installed in the driver's side instrument panel. This volume is active only when the gear position is neutral position. When the shift lever is moved to another position, the volume is canceled. The engine control module (ECM) receives the idle up volume signal from the idle up volume and controls the fuel injection volume.

1. Idle Up Volume

The characteristic of the idle up volume is displayed in the graph.



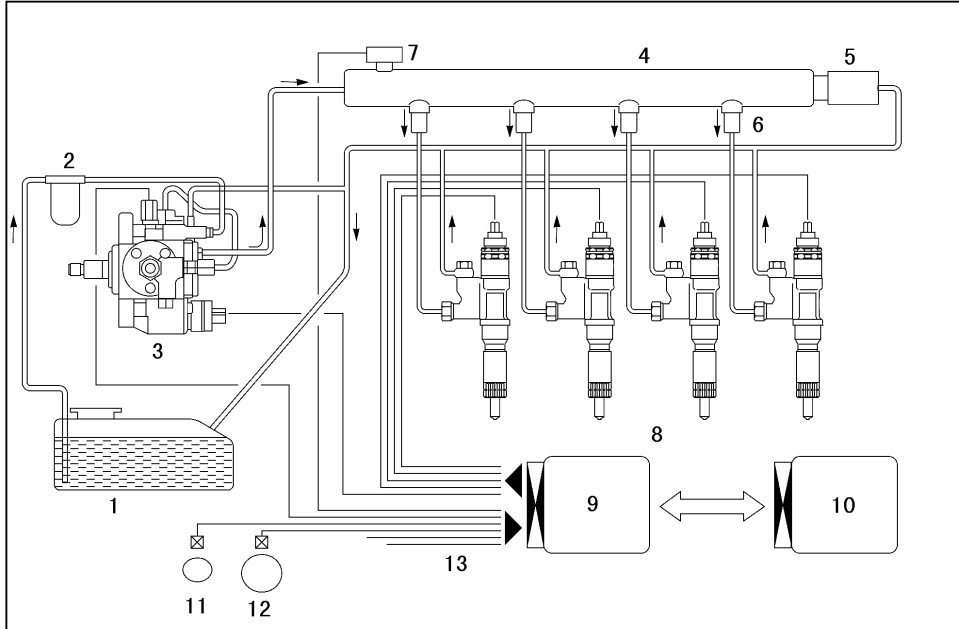


Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1225	Engine Idle Speed Selector Sensor Circuit	- DTCs P1630 and P1631 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	- The ECM detects that the idle up control sensor signal voltage is less than 0.1 volts for 3 seconds. OR - The ECM detects that the idle up control sensor signal voltage is more than 4.9 volts for 3 seconds.	- Sensor 5V reference circuit is open circuit, high resistance. - Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1635 may also set.) - Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1631 may also set.) - Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. - Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Poor harness connector connection. - Faulty idle up control sensor. - Faulty ECM.

FUEL SYSTEM

FEATURE OF THE COMMON RAIL SYSTEM

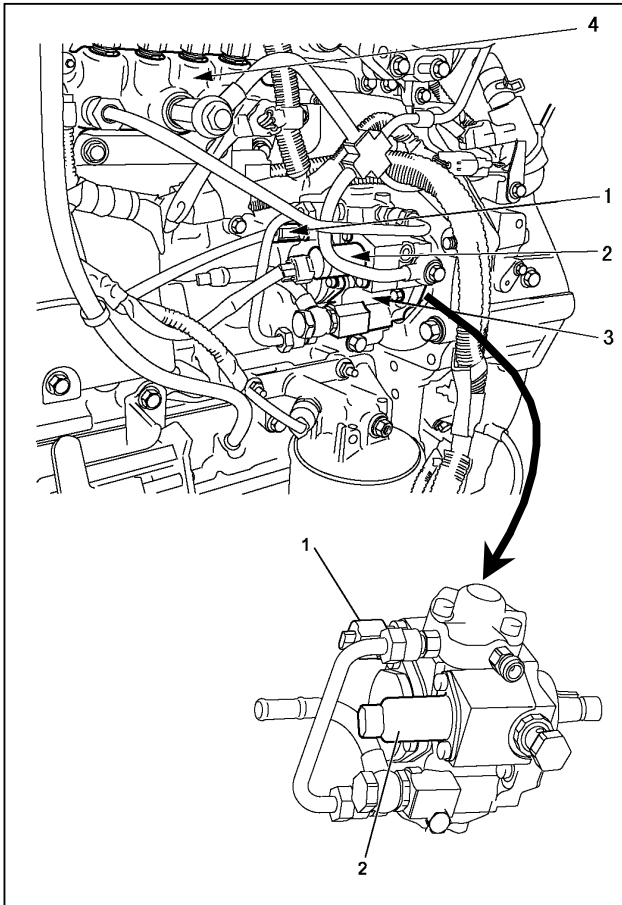


1. Fuel Tank
2. Fuel Filter
3. Fuel Supply Pump
4. Fuel Rail
5. Pressure Limiter
6. Flow Damper
7. Fuel Rail Pressure Sensor
8. Injector
9. Engine Control Module (ECM)
10. Other Control Module
11. Camshaft Position (CKP) Sensor
12. Crankshaft Position (CKP) Sensor
13. Various Sensor Inputs

The common rail system uses a type of accumulator chamber called the fuel rail to store pressurized fuel, and injectors that contain electronically controlled solenoid valves to spray the pressurized fuel in the combustion chambers. The injection system (injection pressure, injection rate, and injection timing) is controlled by the engine control module (ECM), and therefore the common rail system can be controlled independently, free from the influence of engine speed and load. This ensures a stable injection pressure at all time, particularly in the low engine speed range, so that black smoke specific to diesel engines generated during vehicle starting or acceleration can be reduced dramatically. As a result, exhaust gas emissions are clear and reduced, and higher output is achieved.

1. High Pressure Control
 - Enables high pressure injection from low engine speed range.
 - Optimizes control to minimize particulate matter and NOx emissions.
2. Injection Timing Control
 - Enables finely tuned optimized control in accordance with running conditions.
3. Injection Rate Control
 - Pilot injection control that performs a small amount of injection before main injection.

FUEL SUPPLY PUMP

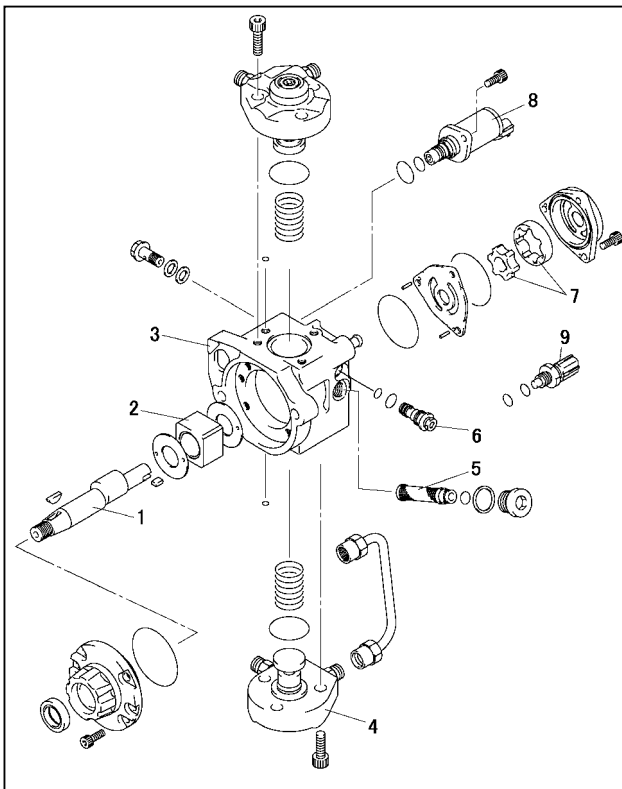


Along with the employment of the common rail type electronic control fuel injection system, the injection pump was disused and a plunger type supply pump is provided to supply high pressure fuel to the fuel rail. The supply pump is installed at the position where conventionally the injection pump was installed, and it is driven 1:1 to the engine. The feed pump (trochoid type) is built in the supply pump to feed fuel from the fuel tank to the plunger chamber. Also, the supply pump is attached with a suction control valve (SCV) to control high pressure fuel supply to the fuel rail and a fuel temperature (FT) sensor to detect fuel temperature.

1. Fuel Temperature (FT) Sensor
2. Suction Control Valve (SCV)
3. Fuel Supply Pump
4. Fuel Rail

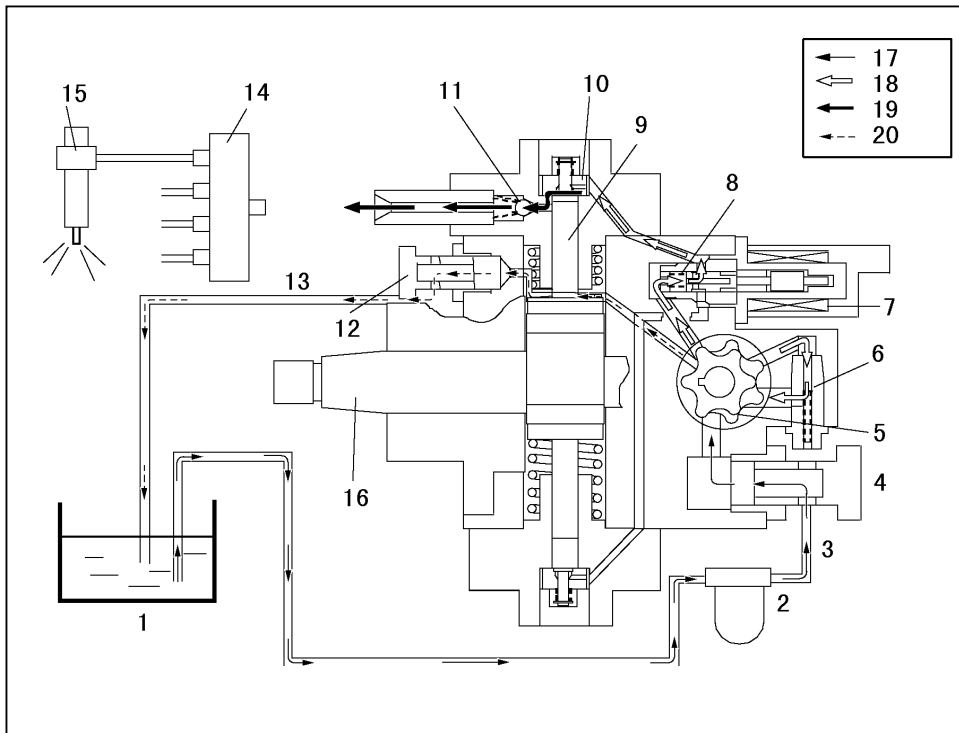
Notice!

In order to make the fuel supply pump characteristic relearn into the ECM, let the engine idle until warm-up after ECM or supply pump replacement.



Type	HP3
Gear Ratio to Crankshaft	1:1
Rotational Direction	Counterclockwise as viewed from drive side
Feed Pump	Trochoid type
Plunger Diameter x Number	8.5mm x 2
Plunger Lift	5.6mm
SCV Type	Normally Open

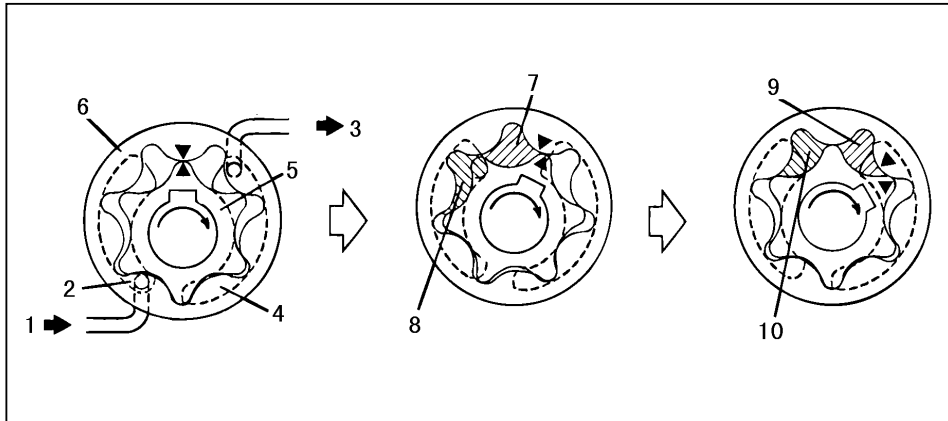
1. Driveshaft
2. Ring Cam
3. Pump Body
4. Plunger
5. Filter
6. Regulating Valve
7. Feed Pump
8. Suction Control Valve (SCV)
9. Fuel Temperature (FT) Sensor



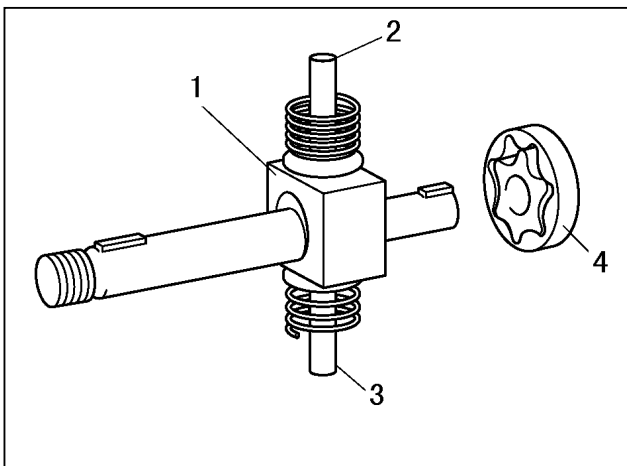
- 1. Fuel Tank
- 2. Fuel Filter
- 3. Suction
- 4. Fuel Inlet
- 5. Feed Pump
- 6. Regulating Valve
- 7. Suction Control Valve (SCV)
- 8. Return Spring
- 9. Plunger
- 10. Suction Valve
- 11. Delivery Valve
- 12. Fuel Overflow
- 13. Return
- 14. Fuel Rail
- 15. Injector
- 16. Driveshaft
- 17. Suction Pressure
- 18. Feed Pressure
- 19. High Pressure
- 20. Return Pressure

The fuel is fed under pressure to the plunger chamber by the feed pump built in the supply pump, and further it is fed under high pressure to the fuel rail by two plungers driven by the camshaft therein. Operating the SCV based on the signals from the engine control module (ECM) controls the quantity and timing of fuel supply to the fuel rail. Since this type of pump adjusts the fuel amount at low pressure side, and it can deliver required high pressure and is efficient.

Operation of the Fuel Feed Pump



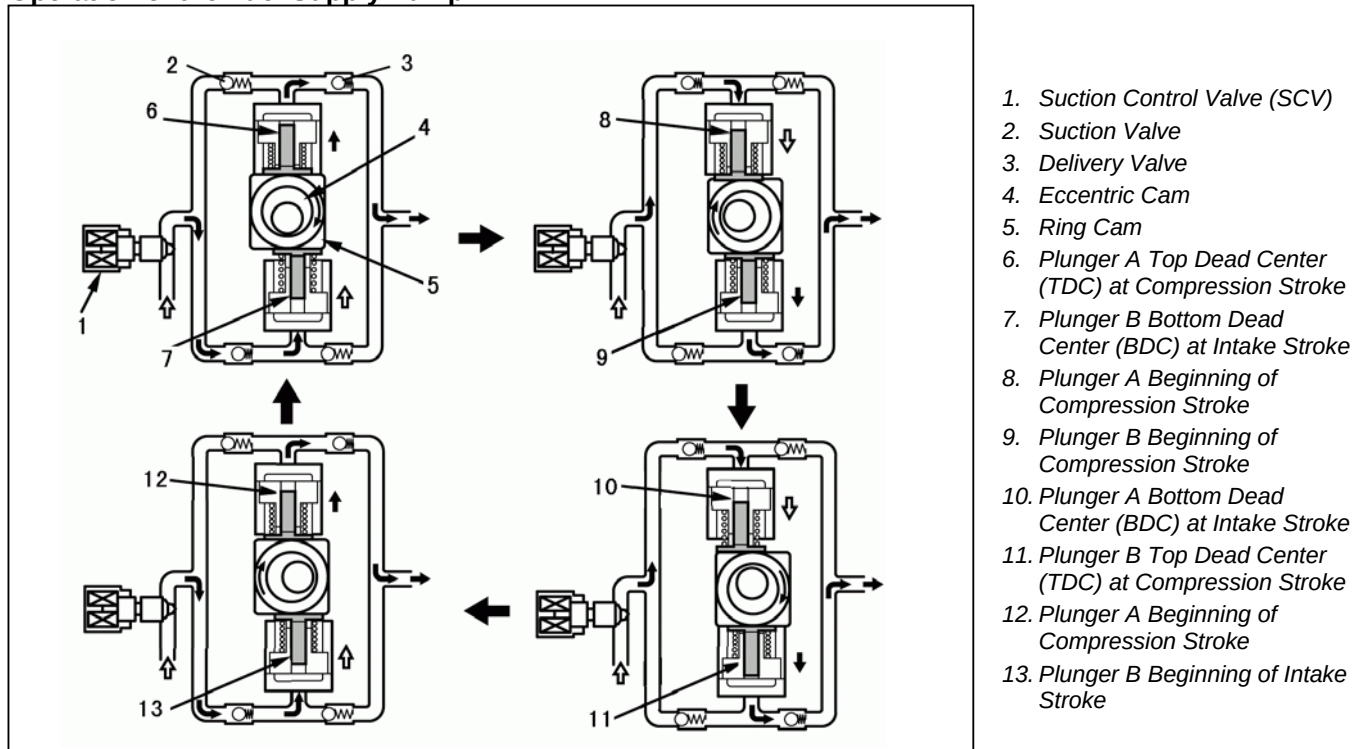
1. From Fuel Tank
2. Intake Port
3. To Pump Chamber
4. Discharge Port
5. Inner Rotor
6. Outer Rotor
7. Fuel Quantity Decrease
8. Fuel Quantity Increase
9. Fuel Quantity Decrease (Fuel Discharge)
10. Fuel Quantity Increase (Fuel Intake)



The trochoid type feed pump, which is integrated in the fuel supply pump, draws fuel from the fuel tank and feeds it to the two plungers via the filter and SCV. The feed pump is driven by the drive shaft. With the rotation of the inner rotor, the feed pump draws fuel from its suction port and pumps it out through the discharge port. This is done in accordance with the space that increases and decreases with the movement of the outer and inner rotors.

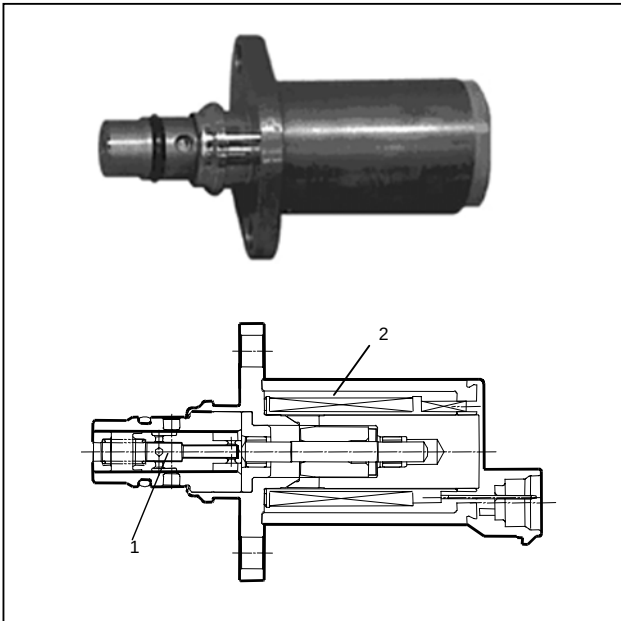
1. Ring Cam
2. Plunger A
3. Plunger B
4. Feed Pump

Operation of the Fuel Supply Pump



The ring cam pushes the plunger "A" in upward direction as the eccentric cam rotates as shown above picture. The plunger "B" is pulled in the opposite direction of plunger "A" by a spring force. As a result, the plunger "B" sucks fuel while the plunger "A" feeds fuel under pressure to the fuel rail.

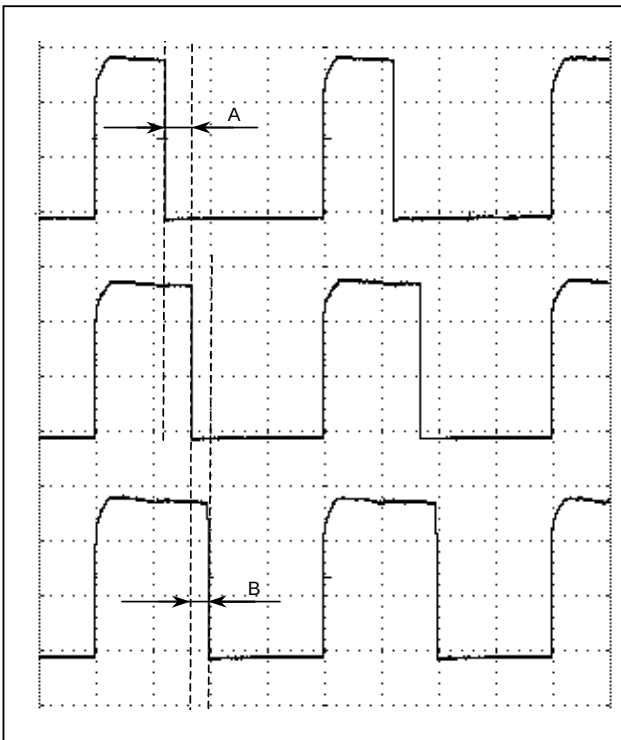
Operation of Suction Control Valve (SCV)



A linear solenoid type valve has been adopted. The ECM controls the 250Hz duty ratio (the length of time that the current is applied to the SCV), in order to control the quantity of fuel that is supplied to the high-pressure plunger. Because only the quantity of fuel that is required for achieving the target rail pressure is drawn in, the drive load of the supply pumps decreases.

When current flows to the SCV, variable electromotive force is created in accordance with the duty ratio, moving the armature to the left side. The armature moves the cylinder to the left side, changing the opening of the fuel passage and thus regulating the fuel quantity. With the SCV OFF, the return spring contracts, completely opening the fuel passage and supplying fuel to the plungers. (Full quantity intake and full quantity discharge) When the SCV is ON, the force of the return spring moves the cylinder to the right, closing the fuel passage (normally opened).

SCV control feedback current can be found on the Tech 2 data display by unit "mA". SCV On duty ratio also can be found on the Tech 2 data display by "%".



1. Valve

2. Coil

A. Small Duty Ratio (Large Suction Quantity)

B. Large Duty Ratio (Small Suction Quantity)

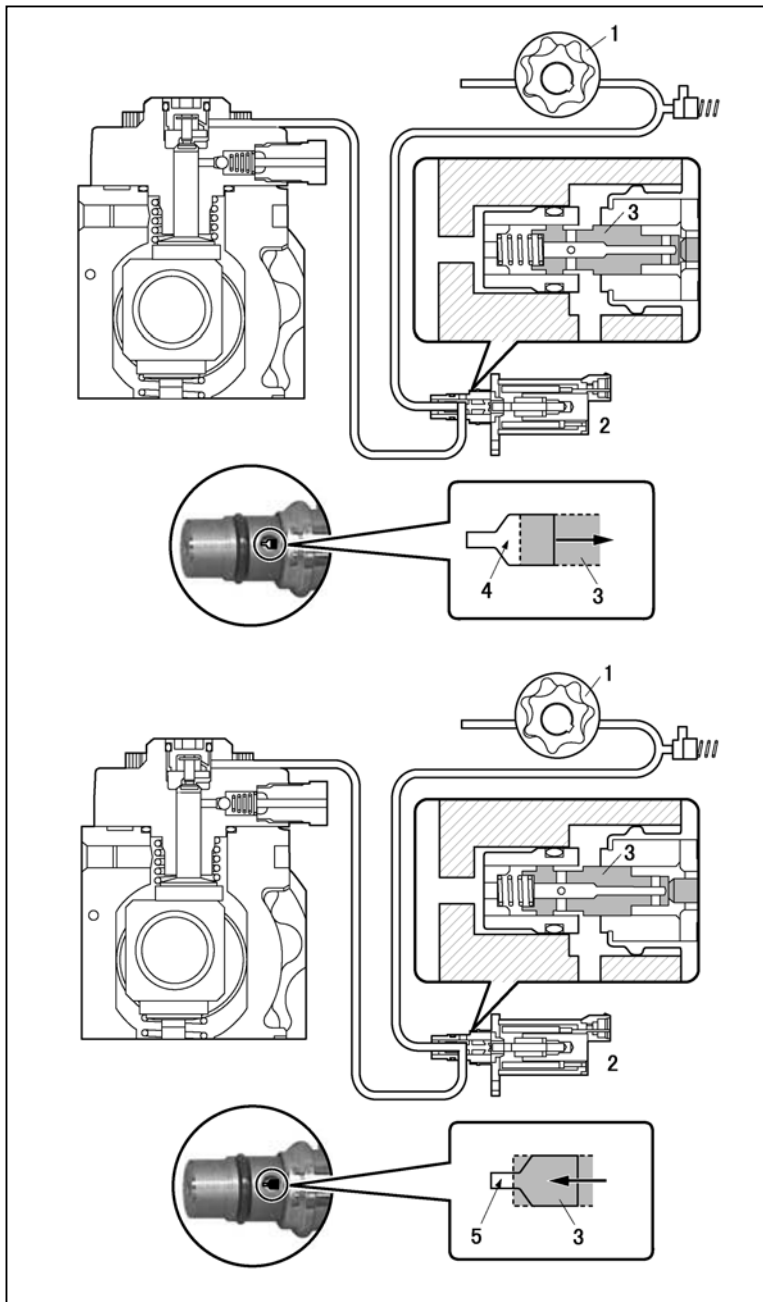
Notice!

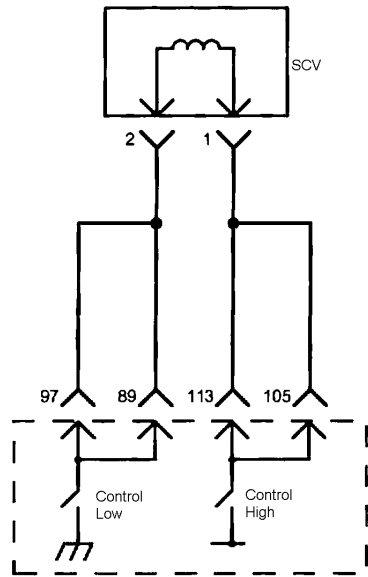
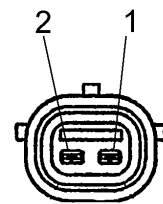
DO NOT attempt engine cranking or starting with the SCV harness connector or ECM harness connector disconnect. The pressure limiter valve will be opened since the SCV is normal open and full amount of fuel is supplied to the fuel rail.

Therefore, unless a diagnostic procedure instructs you, DO NOT disconnect.

Notice!

If the SCV control low circuit between the ECM and SCV are short to ground, DTC may not stored. This condition will cause engine stall, hard start or engine cranks but may not start. But SCV feedback current will be dropped approximately 300 - 500mA.

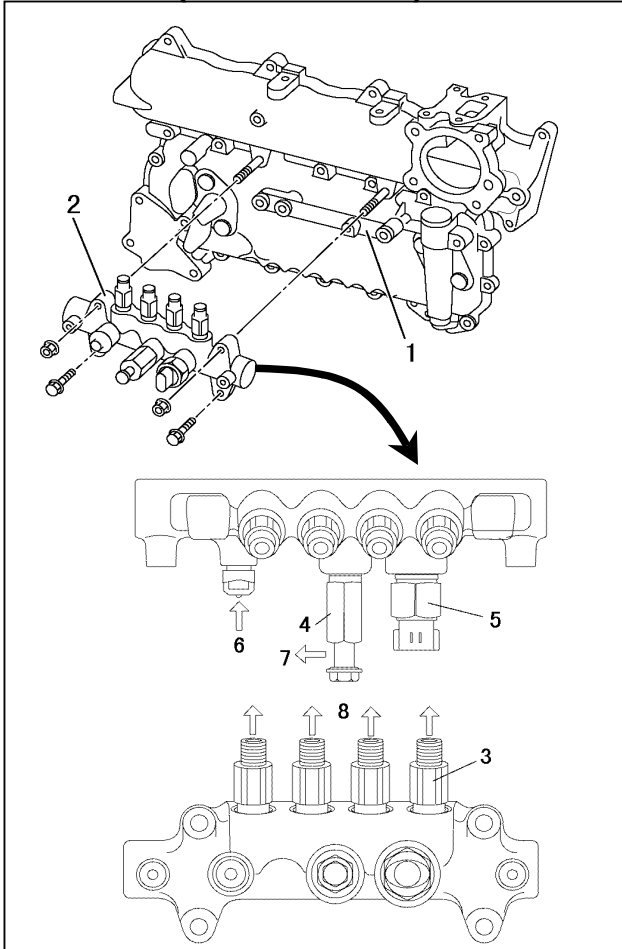


Suction Control Valve (SCV)
Connector Face

Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0090	Fuel Pressure Regulator Solenoid Control Circuit Invalid (Suction Control Valve Solenoid Circuit Invalid)	▪ DTCs P1630 is not set. ▪ The ignition switch is ON. ▪ The ignition voltage is more than 18 volts. ▪ The SCV commanded duty cycle is between 10 – 90 %.	▪ The ECM detects that the SCV feedback current is less than 50 mA. OR ▪ The ECM detects that the SCV feedback current is more than 2400 mA OR ▪ The ECM detects that the difference of SCV desired current and feedback current is more than 1000 mA .	▪ SCV control high circuit is open circuit or high resistance. ▪ SCV control high circuit is high resistance, short to ground, short to battery or ignition voltage. ▪ SCV control low circuit is open circuit, high resistance or short to ground. ▪ SCV control low circuit is short to battery or ignition voltage. ▪ Faulty SCV. ▪ Faulty ECM. Notice: SCV is internal to fuel supply pump assembly.

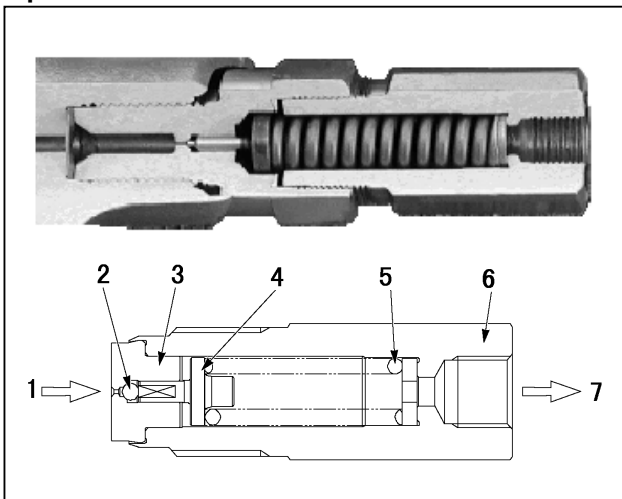
FUEL RAIL (COMMON RAIL)



Along with the employment of a common rail type electronic control fuel injection system, the fuel rail is provided to store high pressure fuel between supply pump and injectors. A pressure sensor and a pressure limiter are installed on the fuel rail. The pressure sensor detects the fuel pressure inside the fuel rail and sends its signal to the ECM. Based on this signal, the ECM controls the fuel pressure inside the fuel rail via the suction control valve of the supply pump. The pressure limiter opens the valve mechanically to relieve the pressure when the fuel pressure inside the fuel rail increases extremely.

1. Fuel Rail Bracket
2. Fuel Rail
3. Flow Damper
4. Pressure Limiter
5. Fuel Rail Pressure Sensor
6. High Pressure Fuel Inlet
7. To Fuel Tank
8. To Injectors

Operation of the Pressure Limiter Valve



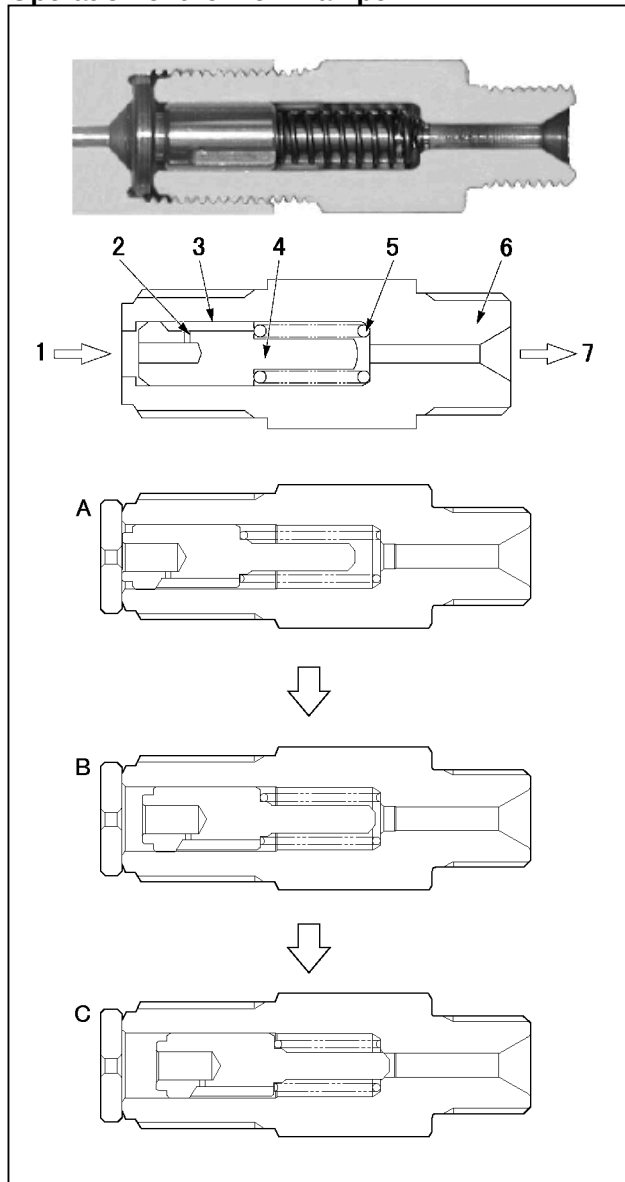
The pressure limiter valve relieves pressure by opening the valve (2) if abnormally high pressure is generated. The valve (2) opens when pressure in rail reaches approximately 200MPa (29000psi), and close when pressure falls to approximately 50MPa (7250psi). Fuel leaked by the pressure limiter valve re-turns to the fuel tank through the return line.

1. From Fuel Rail
2. Valve
3. Valve Body
4. Valve Guide
5. Spring
6. Housing
7. To Fuel Return Pipe

Notice!

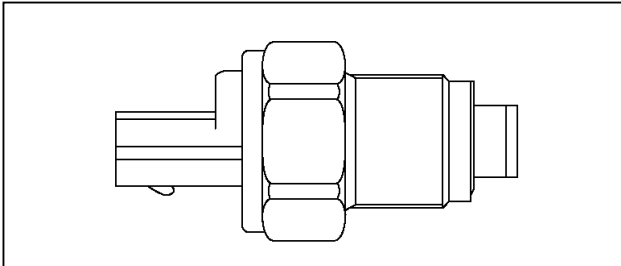
If the pressure limiter valve is operated many times, opening pressure has fallen and it may cause fuel system DTCs set.

Operation of the Flow Damper



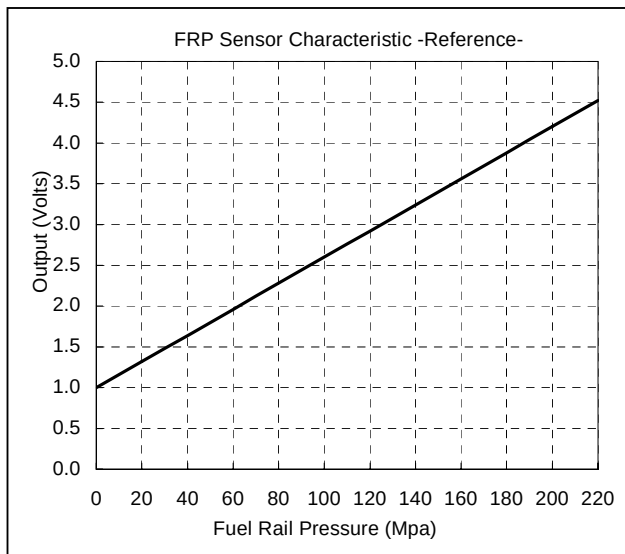
The flow dampers are installed at the outlet of fuel rail to damp a pulsation of fuel pressure inside the fuel rail or to cut off the fuel supply when the fuel leaks in the downstream of flow damper. The fuel is supplied to the injectors through an orifice of the piston. The pressure pulsation occurring in the fuel rail is damped by a resistive force of the return spring (5) and a passing resistance of the orifice (2), wherein the piston (4) acts as a damper. Also, the leading end of piston (4) closes an fuel supply port to cut off the fuel supply, if the fuel leak occurs in the injection pipe or injectors, and the fuel pressure on the downstream side of flow damper supplied through an orifice (2) + resistive force of return spring (5) do not balance with the fuel pressure applied on the piston (4) surface prior to the orifice (2). The piston (4) will return when the fuel pressure inside the common rail less than 1.0MPa (145psi).

1. From Fuel Rail
2. Orifice
3. Slit
4. Piston
5. Return Spring
6. Housing
7. To Injector

FUEL RAIL PRESSURE (FRP) SENSOR

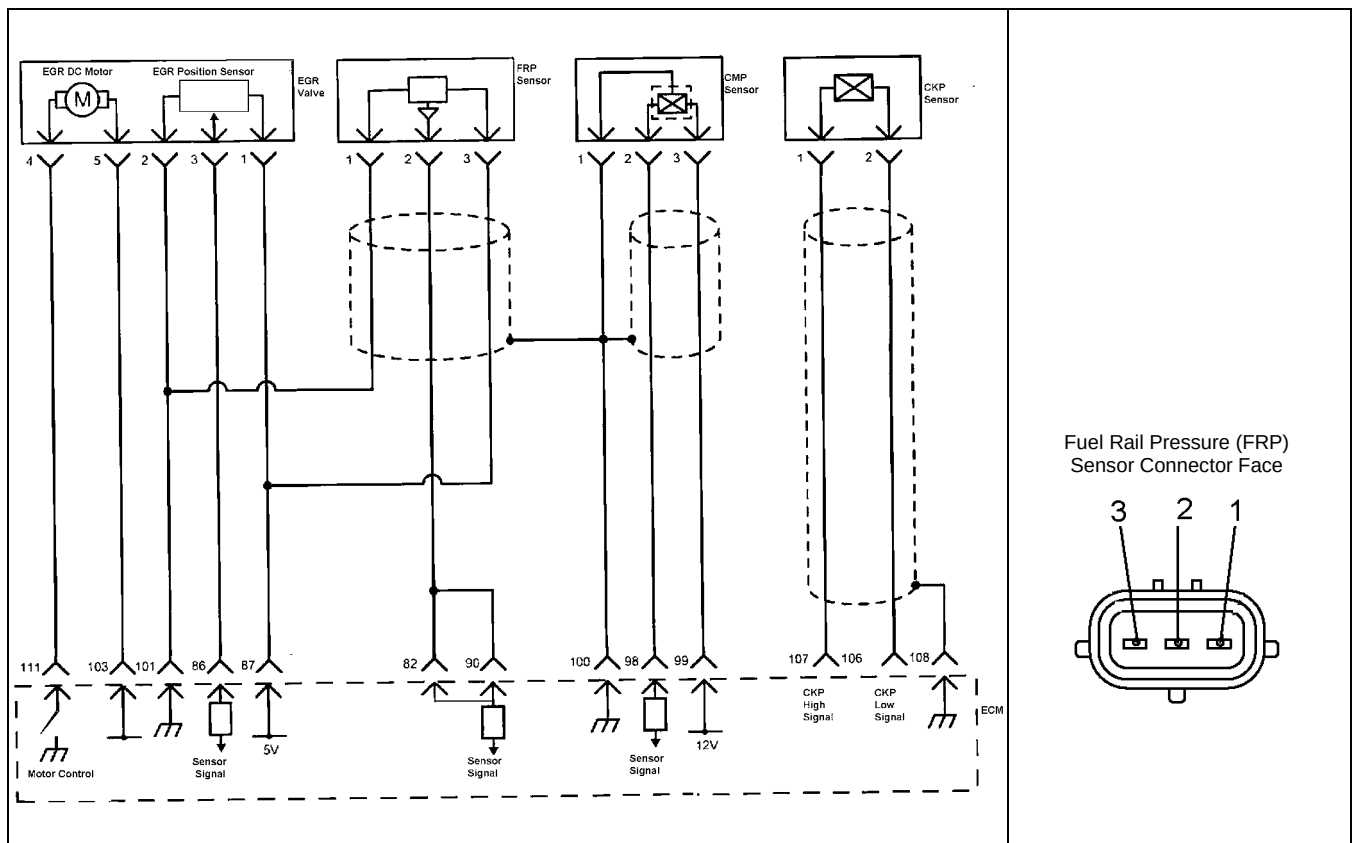
The fuel rail pressure (FRP) sensor is installed to the fuel rail and it detects the fuel pressure in the fuel rail, converts the pressure into a voltage signal, and sends the signal to the engine control module (ECM). The ECM supplies 5-volts to the FRP sensor on the 5-volts reference circuit. The ECM also provides a ground on the low circuit. Higher fuel pressure provides higher FRP sensor voltage while lower pressure provides lower FRP sensor voltage. The ECM calculates actual fuel rail pressure (fuel pressure) from the voltage signal and uses the result in fuel injection control tasks.

The characteristic of the FRP sensor is displayed in the graph and table. The output voltage can be found on the Tech 2.

**Notice!**

The fuel rail pressure display in the Tech 2 is difference pressure (actual value – desired value). This data display will be fixed to 0 MPa (0psi) when DTC is set relating to the FRP sensor open or short circuit. To diagnose this DTC, observe the "Volts" in the data display.

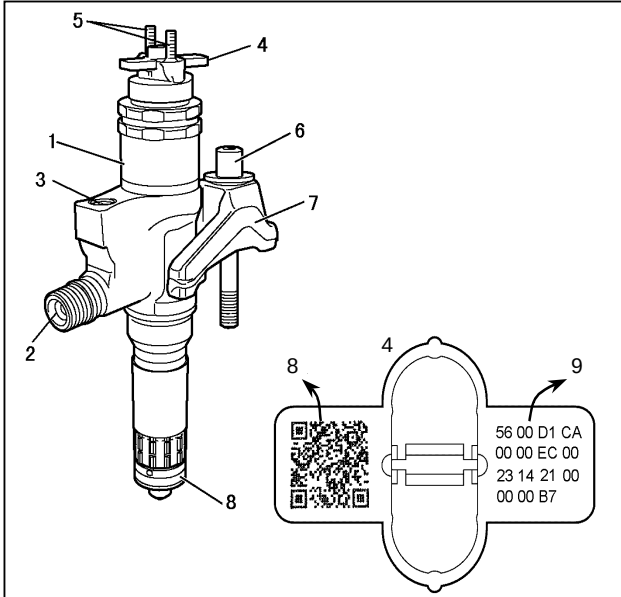
Mpa	psi	Volts
0	0	1.0
20	2900	1.3
40	5800	1.6
60	8700	2.0
80	11600	2.3
100	14500	2.6
120	17400	2.9
140	20310	3.2
160	23210	3.6
180	26110	3.9
200	29010	4.2
220	31910	4.5



Related DTC

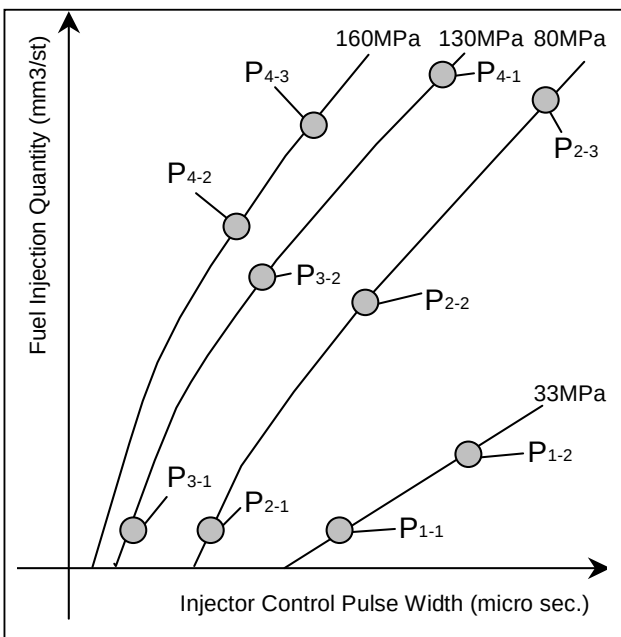
DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0192	Fuel Rail Pressure (FRP) Sensor Circuit Low Voltage	- DTCs P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the FRP sensor signal voltage is less than 0.7 volts.	- Sensor 5V reference circuit is open circuit or high resistance. - Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1635 may also set.) - Sensor signal circuit is short to ground or short to the low reference circuit. - Poor harness connector connection. - Faulty FRP sensor. - Faulty ECM.
P0193	Fuel Rail Pressure (FRP) Sensor Circuit High Voltage	- DTCs P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the FRP sensor signal voltage is more than 4.5 volts.	- Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1635 may also set.) - Sensor signal circuit is open circuit, high resistance, short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty FRP sensor. - Faulty ECM.

FUEL INJECTOR



Electronic control type injectors controlled by the engine control module (ECM) are used. Compared with conventional injection nozzles, a command piston, solenoid valve, etc. are added.

Two dimensional barcode displaying various injector characteristics are laser marked on the fuel injector body, and ID codes showing these in numeric form (24 alphanumeric figures) are laser marked on the connector housing. This system uses QR code information to optimize injection quantity control. When an injector is newly installed in a vehicle, it is necessary to input the ID codes in the engine control module (ECM). In order to minimize performance tolerance of injectors, ID codes have been adopted to enhance the injection quantity correction precision of the injectors. Using ID codes has resulted in a substantial increase in the number of the fuel injection quantity correction points, and thus the injection quantity control precision has improved. The characteristics of the engine cylinders have been further unified, contributing to improvements in combustion efficiency, reductions in exhaust gas emissions and so on.



1. Injector Assembly
2. Fuel Intake Port
3. Fuel Return Port
4. QR Plate
5. Terminal Stud
6. Bolt
7. Injector Clamp
8. QR Code (Two Dimensional Barcode for Assembly Production Use)
9. ID Code (30 Alphanumeric Figures)

Notice!

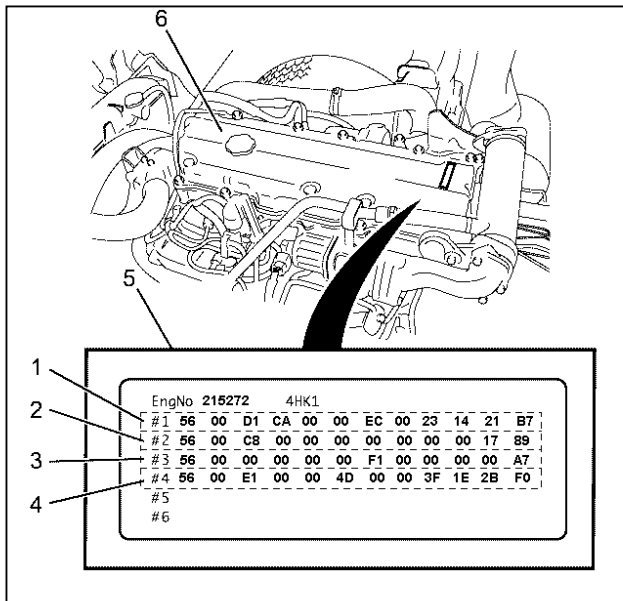
Replacement injector **MUST** be programmed. Also, if ECM is replaced, ID codes **MUST** be programmed.

First 2 figures mean an engine code. The following 20 figures mean ten fuel injection quantity correction points. The last two figures mean checksum code of 22 figures.

Notice!

This Engine Code "56" is identification of engine model, which used only injectors. **DO NOT** confuse with the Engine Code "75" assigned in VIN (17 figures chassis number).

Engine Code	P1-1	P1-2	P2-1
P2-2	P2-3	P3-1	P3-2
P4-1	P4-2	P4-3	00
00	00	Checksum Code	

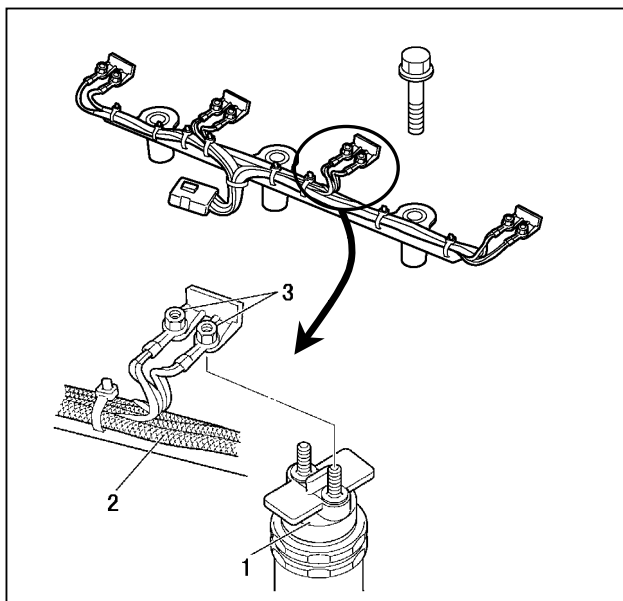


The each fuel injector's ID code can also be found on the factory affixed label located on the cylinder head cover.

Notice!

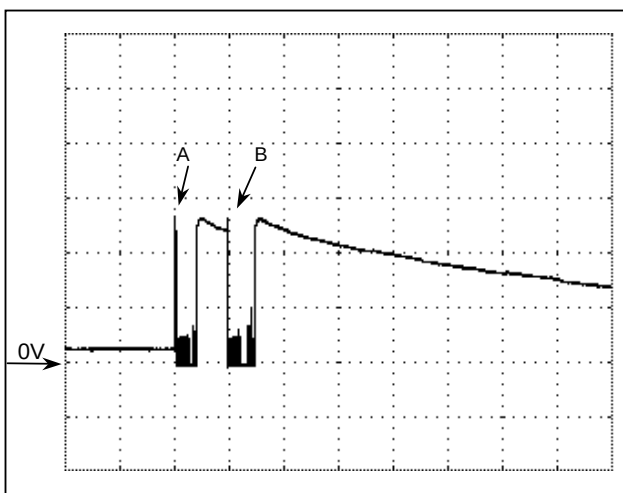
When programming ID code, recording from this label only perform if the fuel injector(s) is (are) NOT being replaced in the past.

1. Cylinder Number 1 Fuel Injector ID Code
2. Cylinder Number 2 Fuel Injector ID Code
3. Cylinder Number 3 Fuel Injector ID Code
4. Cylinder Number 4 Fuel Injector ID Code
5. Injector ID Code Label
6. Cylinder Head Code



The charge up circuit in the ECM steps up the voltage (approximately 130volts) for fuel injectors and is divided into two banks, common 1 and 2. The common 1 covers fuel injector in cylinders 1 and 4. The common 2 covers fuel injector in cylinders 2 and 3.

1. Injector
2. Injector Harness
3. Injector Terminal Nut

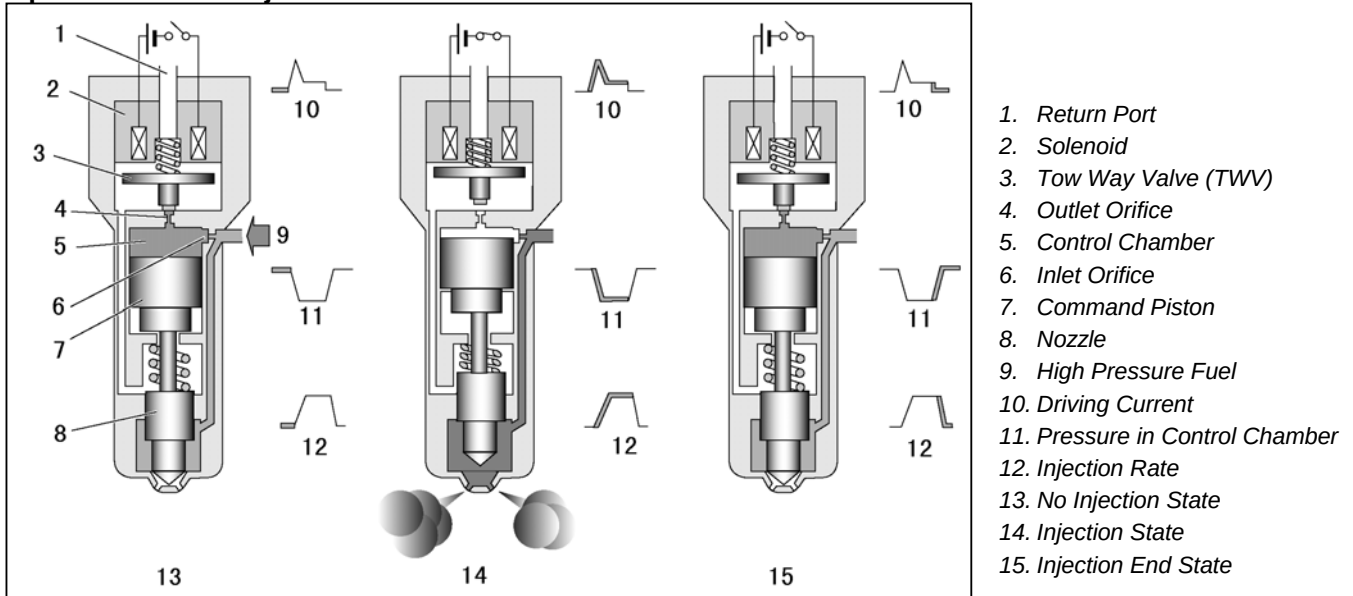


To realize the engine noise reduction and low emission exhaust gas, pre injection (pilot injection) is applied to this system.

The left waveform shows the ECM control signal to the injector. The first pulse (A) is pre injection. After approximately 2ms, next pulse (B) is sent for main injection.

Measurement Scale: 50V/div 2ms/div

Measurement Condition: Idle Speed (650RPM)

Operation of Fuel Injector**1) Non-injection state**

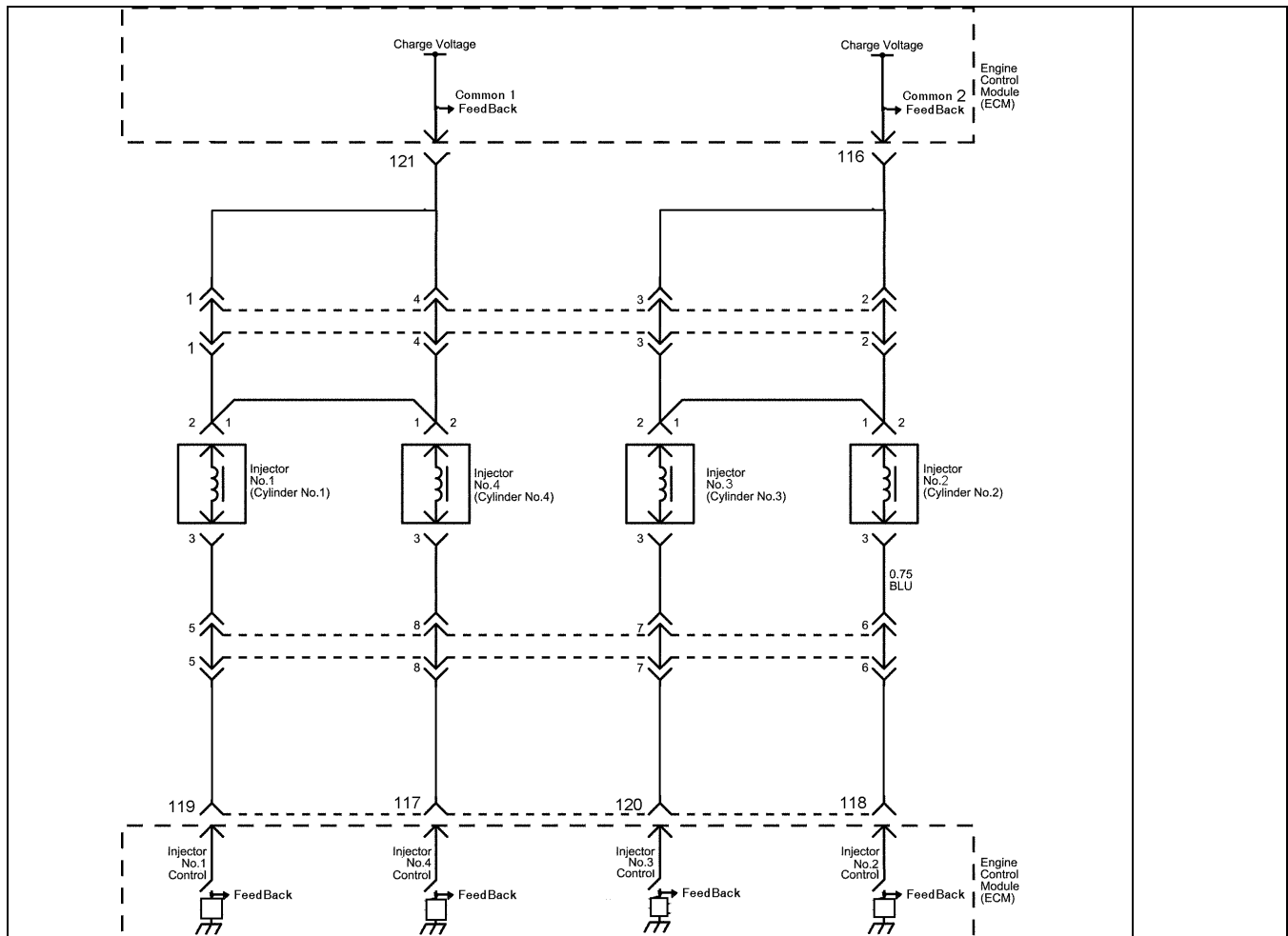
The two way valve (TWV) (3) closes the outlet orifice (4) by means of a spring force, when no current is supplied from the ECM to the solenoid (2). At this time, the fuel pressure applied to the nozzle (8) leading end is equal to the fuel pressure applied to the control chamber (5) through the inlet orifice (6). As for the force competition in this state, the pressure on the command piston (7) upper surface + nozzle spring force defeat the pressure on the nozzle leading end, and consequently the nozzle (8) is pushed downward to close the injection holes.

2) Injection start

The TWV (3) is pulled up to open the outlet orifice (4), and thus the fuel leaks toward the return port (4), when the current is supplied from the ECM to the solenoid (2). As a result, the nozzle (8) is pushed up together with the command piston (7) by the fuel pressure applied to the nozzle leading end, and then the nozzle injection holes open to inject the fuel.

3) Injection end

The TWV (3) lowers to close the outlet orifice (4), when the ECM shuts off a current supply to the solenoid (2). As a result, the fuel cannot leak from the control chamber (5), and thus the fuel pressure in the control chamber (5) rises abruptly and then the nozzle (8) is pushed down by the command piston (7) to close the nozzle injection holes, resulting in the end of fuel injection.



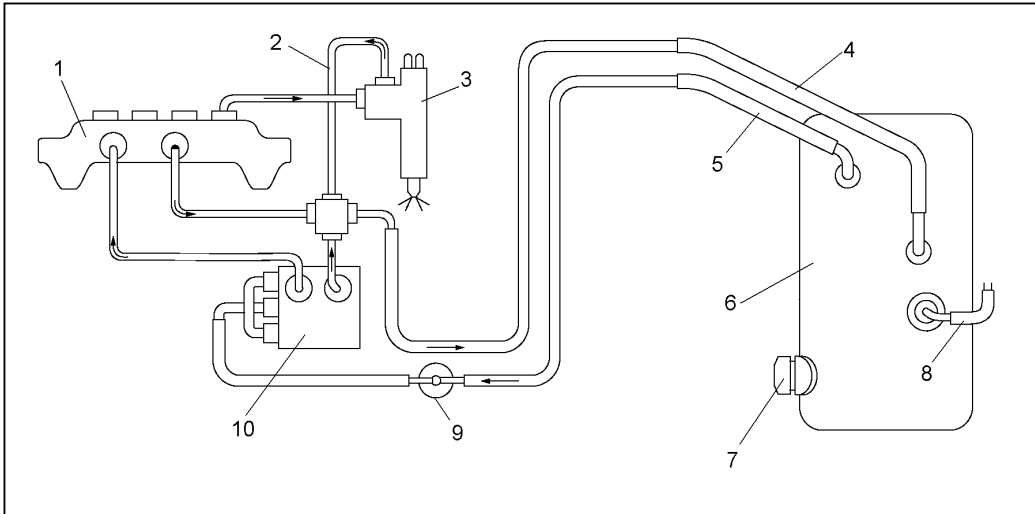
Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0201	Injector 1 Control Circuit (Cylinder 1 Injector Control Circuit)	- The ignition switch is ON. - The battery voltage is more than 18 volts. - The engine is running.	The ECM detects that the cylinder #1 fuel injector solenoid coil control circuit is open.	- Cylinder #1 fuel injector solenoid coil control circuit is open circuit. - Faulty cylinder #1 fuel injector. - Faulty ECM.
P0202	Injector 2 Control Circuit (Cylinder 2 Injector Control Circuit)	- The ignition switch is ON. - The battery voltage is more than 18 volts. - The engine is running.	The ECM detects that the cylinder #2 fuel injector solenoid coil control circuit is open.	- Cylinder #2 fuel injector solenoid coil control circuit is open circuit. - Faulty cylinder #2 fuel injector. - Faulty ECM.
P0203	Injector 3 Control Circuit (Cylinder 3 Injector Control Circuit)	- The ignition switch is ON. - The battery voltage is more than 18 volts. - The engine is running.	The ECM detects that the cylinder #3 fuel injector solenoid coil control circuit is open.	- Cylinder #3 fuel injector solenoid coil control circuit is open circuit. - Faulty cylinder #3 fuel injector. - Faulty ECM.
P0204	Injector 4 Control Circuit (Cylinder 4 Injector Control Circuit)	- The ignition switch is ON. - The battery voltage is more than 18 volts. - The engine is running.	The ECM detects that the cylinder #4 fuel injector solenoid coil control circuit is open.	- Cylinder #4 fuel injector solenoid coil control circuit is open circuit. - Faulty cylinder #4 fuel injector. - Faulty ECM.
P0611	Fuel Injector Control Module Group 1	The battery voltage is more than 18 volts.	The ECM detects an internal common 1 fuel injector charge up circuit malfunction.	Faulty ECM. Notice: Injector charge up circuit is internal to ECM.
P0612	Fuel Injector Control Module Group 2	The battery voltage is more than 18 volts.	The ECM detects an internal common 2 fuel injector charge up circuit malfunction.	Faulty ECM. Notice: Injector charge up circuit is internal to ECM.



P1261	Injector Positive Voltage Circuit Group 1 Load Short	▪ The ignition switch is ON. ▪ The battery voltage is more than 18 volts. ▪ Engine is running.	▪ The ECM detects that the cylinder #1 or #4 fuel injector solenoid coil control circuit is short to ground or voltage circuit. ▪ The ECM detects that the common 1 fuel injector drive circuit is open, short to ground or short to voltage circuit.	
P1262	Injector Positive Voltage Circuit Group 2 Load Short	▪ Battery voltage is more than 9V. ▪ Engine is running.	▪ The ECM detects that the cylinder #2 or #3 fuel injector solenoid coil control circuit is short to ground or voltage circuit. ▪ The ECM detects that the common 2 fuel injector drive circuit is open, short to ground or short to voltage circuit.	

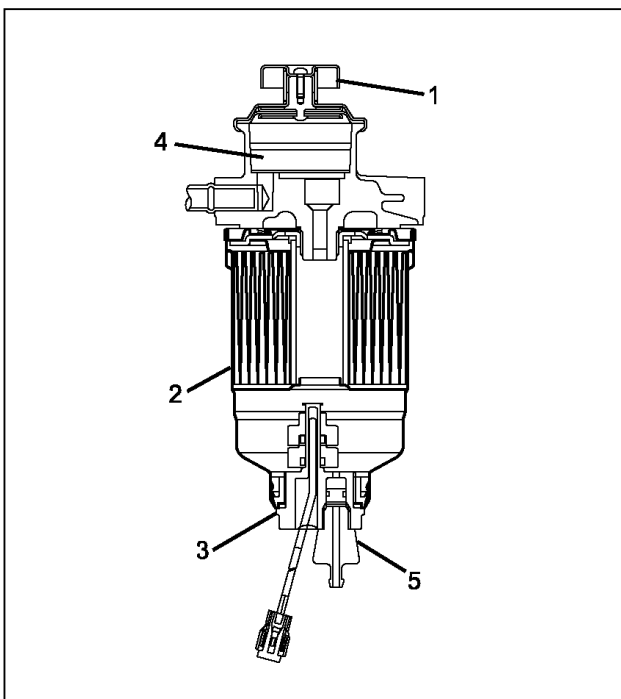
FEATURE OF THE FUEL LINE & FUEL FILTER



Low-pressure side fuel line consists following components.

- Fuel Tank
- Fuel Feed Pipe/Hose
- Fuel Return Pipe/Hose
- Fuel Filter & Water Separator

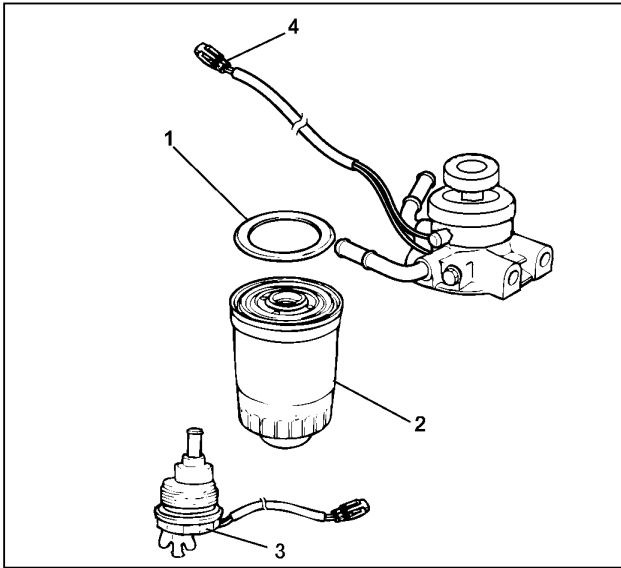
FUEL FILTER & WATER SEPARATOR



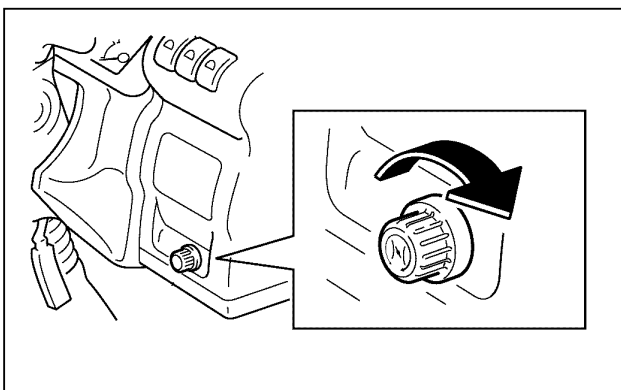
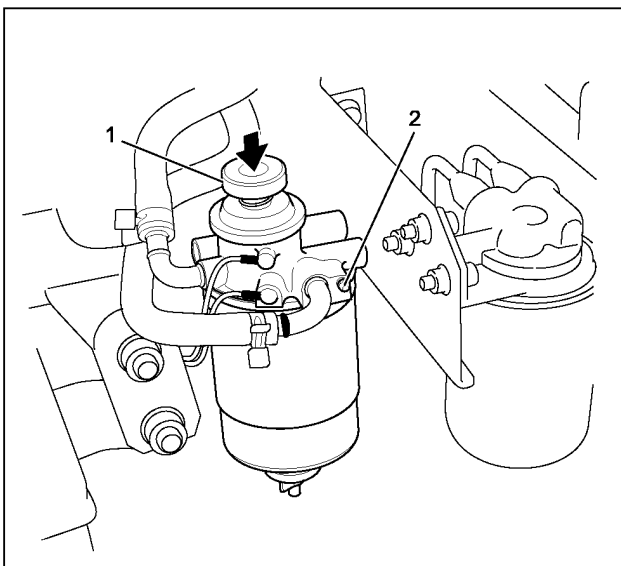
As the inside of the fuel supply pump is lubricated by the fuel which it is pumping and common rail system is needed perfectly clean. A special type of filter construction is adopted for this system to eliminate "air collects" into the filter that will cause the engine problem such as driveability concern or DTC store. Therefore, replacement to the genuine filter is strongly recommended.

The fuel filter and the water separator removes water particles and other foreign material from the fuel before it reaches the fuel supply pump. The water separator has an internal float. When the float reaches the specified level (approximately over 80cc), a warning light comes on to inform the driver to drain the water from the water separator. A diaphragm type priming pump is installed at the top of the fuel filter. It is used during the air bleeding procedure.

1. Priming Pump
2. Cartridge
3. Water Level Sensor
4. Heater
5. Drain Plug



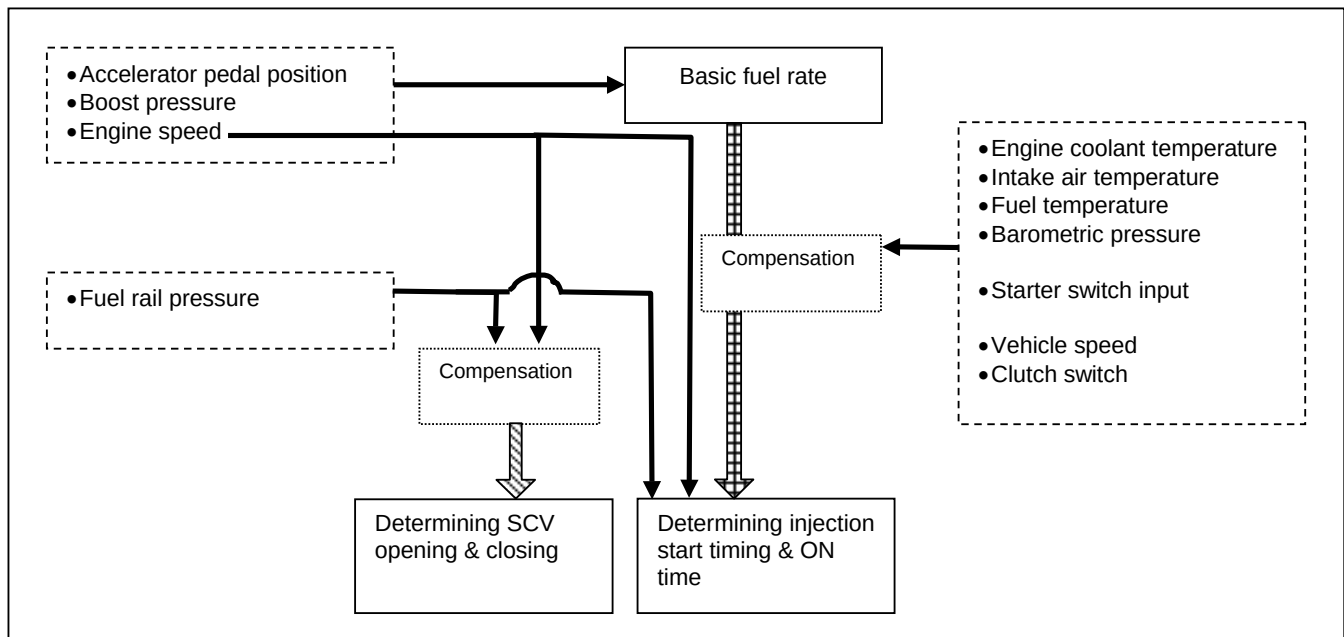
1. Gasket
2. Cartridge
3. Water Level Sensor
4. Heater Harness



Air Bleeding Procedure:

Insufficient air bleeding may cause the DTC store or driveability concern.

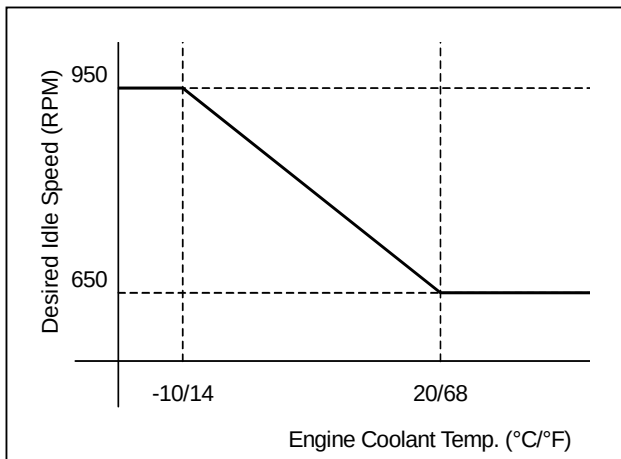
1. Before starting the engine
 - a. Fit a tray below the fuel filter (below the air bleed plug).
 - b. Loosen the plug adequately and operate the priming pump more than 20 times until the fuel near the plug overflows.
 - c. Tighten the plug, and operate the priming pump more than 10 times until it is filled with fuel. After waiting for approximately a minute, loosen the plug and bleed out the air in the fuel filter. (This work must be repeated a minimum of three times until no more air comes out from the plug.)
 - d. Tighten the plug firmly and wipe the fuel in the surrounding area. Operate the priming pump (10 to 15 times) till it is filled with fuel and then send fuel to the engine.
2. After starting the engine
 - a. Start the engine by rotating the starter without depressing the accelerator pedal.
 - b. After starting, maintain the idling rotation for 5 seconds.
 - c. Slowly rotate the idling control knob clockwise and maintain it for 3 minutes.
 - d. Fully depress the accelerator pedal and increase the rotations to maximum. (Repeat this operation several times)
 - e. Rotate the idling knob counterclockwise and return to idling mode.

FUEL INJECTION QUANTITY CONTROL

This control determines the fuel injection quantity by adding coolant temperature, fuel temperature, intake air temperature, barometric pressure, vehicle speed and some switch information corrections to the basic injection quantity is calculated by the engine control module (ECM), based on the engine operating conditions and driving conditions.

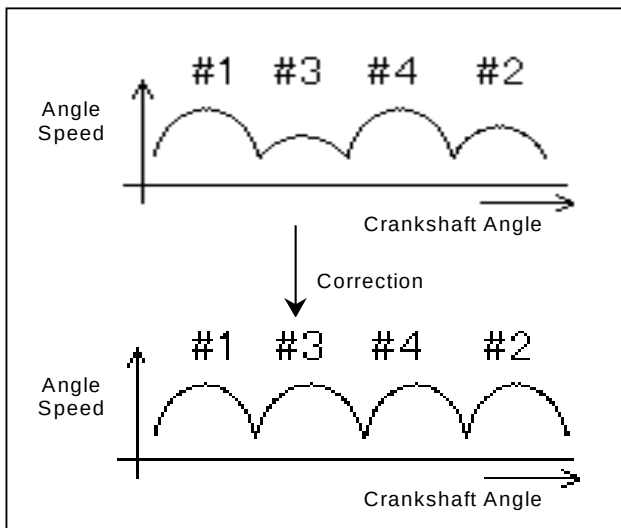
During normal running, optimum fuel injection quantity is controlled according to the engine speed and accelerator pedal pressing amount. More fuel rate indicates if the engine load is increased as the accelerator pedal is stepped on at constant engine speed.

At the engine starting (after the ignition switch is turned to the start position to start the engine, up to return of key switch to the ON position), optimum fuel injection quantity is controlled based on the information on the engine speed and engine coolant temperature. At low temperature, the fuel injection quantity increases. When the engine started completely, this increased quantity mode at the starting is cancelled and normal running mode is restored.



Idle Speed Control

A control is made so as to achieve stable idling speed at all time regardless of engine secular changes or engine condition variations. The ECM sets target idling speed and controls the fuel injection quantity according to the engine conditions (actual engine speed, coolant temperature, engine load ON/OFF signals of air conditioner) to follow actual engine speed to the desired idling speed so as to ensure stable idling speed.



Idle Vibration Control

A control is made so as to reduce the engine vibration caused by torque variations between cylinders due to variations in fuel injection quantity of each cylinder or injector performance. The ECM corrects the injection quantity between cylinders based on the revolution signals from the crankshaft position (CKP) sensor. Normal range of correction quantity between cylinders is within $\pm 5 \text{ mm}^3/\text{st}$.

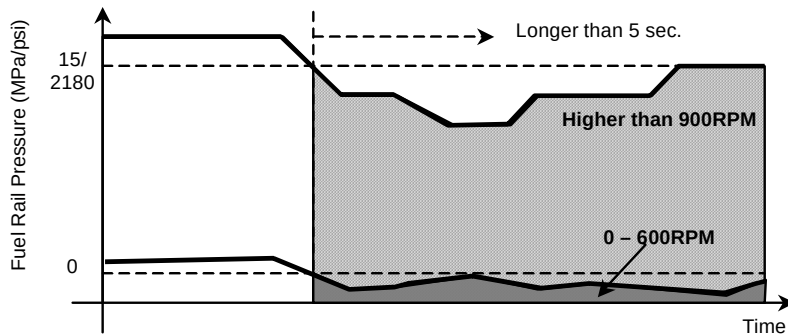
Compensation value on each cylinder can be found on the Tech 2. When the compensation volume is negative, the fuel volume is reducing. When the compensation volume is positive, the fuel volume is increasing.

Notice!

If there is a cylinder that is an excessively high or low value, it may indicate faulty fuel injector, faulty injector ID code programming, weak or slightly seized cylinder.

Fuel System DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0087	Fuel Rail Pressure (FRP) Too Low	- DTCs P1095, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	- The ECM detects that the fuel rail pressure is 0 MPa (0 psi) (1.0 volt) for 5 seconds when the engine speed is between 0 - 600 RPM. OR - The ECM detects that the fuel rail pressure is less than 15MPa (2180psi) (1.2 volts) for 5 seconds when the engine speed is higher than 900RPM.	- Fuel leaking at high pressure side. - Loss fuel or less fuel in the fuel tank. - Pressure limiter valve opening pressure drop. - SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.

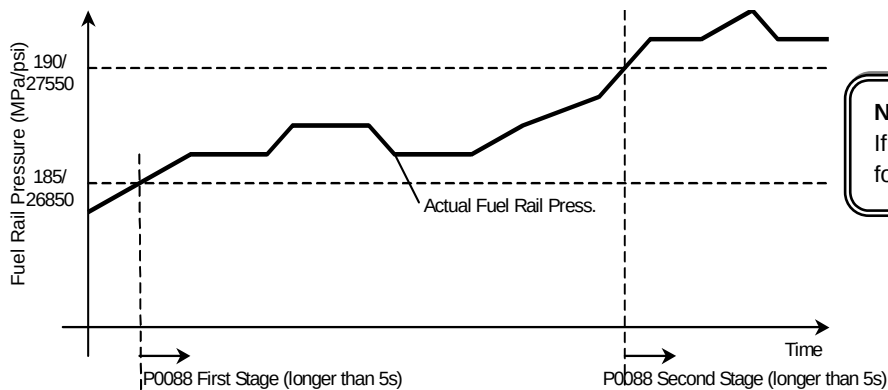


Notice:

If the fuel rail pressure is certain pressure low as compared with engine speed, this DTC will set.

This DTC most likely indicates loss of fuel pressure by fuel leak from the high-pressure side. Inspect the high-pressure side fuel leakage between the fuel supply pump and fuel injectors FIRST.

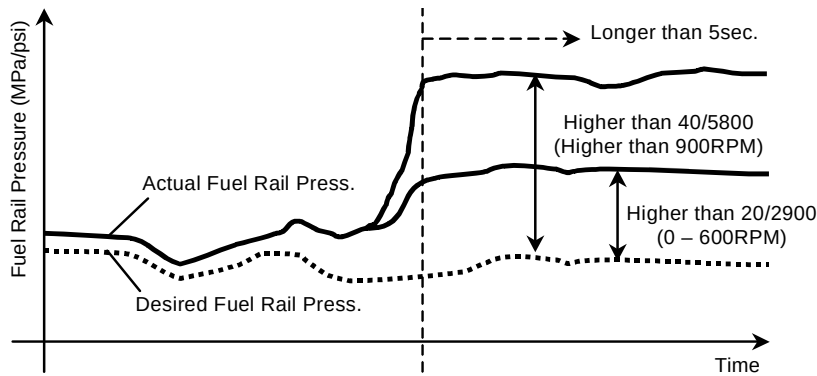
DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0088	Fuel Rail Pressure (FRP) Too High	- DTCs P1092, P1093, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running.	The ECM detects that the fuel rail pressure is more than 185 MPa (26850 psi) (3.9 volts) for longer than 5 second.	- SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.
P0088	Fuel Rail Pressure (FRP) Too High	- DTCs P1092, P1093, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running.	The ECM detects that the fuel rail pressure is more than 190 MPa (27550 psi) (4.0 volts) for longer than 5 second during the ignition cycle after first stage has occurred.	- SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.



Notice:

If the fuel rail pressure is excessively high for certain length of time, this DTC will

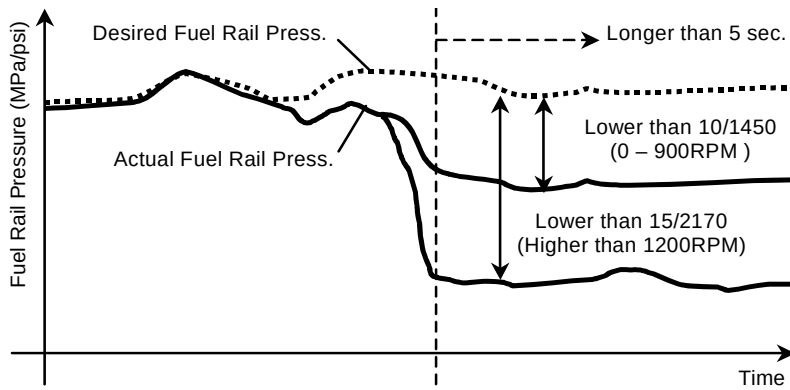
DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0089	Fuel Pressure Regulator Performance (Fuel Rail Pressure Deviation)	- DTCs P0090, P0192, P0193, P1092, P0201, P0202, P0203, P0204, P0611, P0612, P1093, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running. - The SCV control duty cycle is more than 40% or commanded fuel supply is less than 90mm³/sec.	- The ECM detects that the actual fuel rail pressure is higher than desired pressure by 20MPa (2900psi) (0.3 volts) for longer than 5 seconds when the engine speed is between 0 - 600 RPM. OR - The ECM detects that the actual fuel rail pressure is higher than desired pressure by 40 MPa (5800 psi) (0.6 volts) for longer than 5 seconds when the engine speed is higher than 900 RPM.	- SCV is sticking. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.



Notice:

If the fuel rail pressure is certain pressure higher than desired fuel rail pressure for a certain length of time, this DTC will set.

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1093	Fuel Rail Pressure (FRP) Too Low	- DTCs P1095, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The SCV control duty cycle is less than 33% or commanded fuel supply is more than 28000 mm³/sec.	- The ECM detects that the actual fuel rail pressure is lower than desired pressure by 10 MPa (1450 psi) (0.2 volts) for longer than 5 seconds when the engine speed is between 0 – 900 RPM. OR - The ECM detects that the actual fuel rail pressure is lower than desired pressure by 15 MPa (2170 psi) (0.2 volts) for longer than 5 seconds when the engine speed is higher than 1200RPM.	- Fuel leaking at high pressure side. - Loss fuel or less fuel in the fuel tank. - Pressure limiter valve opening pressure drop. - SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.



Notice:

If the fuel rail pressure is a certain pressure lower than desired fuel rail pressure for a certain length of time, this DTC will set.

This DTC most likely indicates loss of fuel pressure by fuel leak from the high-pressure side. Inspect the high-pressure side fuel leakage between the fuel supply pump and fuel injectors FIRST.

If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set.



DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1094	Fuel Rail Pressure (FRP) Too Low	▪ DTCs P0117, P0118, P0500, P0501, P1095, P1630 and P1635 are not set. ▪ The ignition switch is ON. ▪ The ignition voltage is more than 18 volts. ▪ The engine is running. ▪ The accelerator pedal position is 0%. ▪ The engine coolant temperature is more than 50°C (122 °F). ▪ The vehicle speed is less than 5 km/h (4 MPH). ▪ The difference of desired engine idle speed and actual idle speed lower than 50 RPM.	▪ The engine speed is between 600 – 1500 RPM. ▪ The fuel injection quantity is less than 100mm³/st. ▪ The SCV commanded fuel is between 16,000 – 25,500mm³/sec. ▪ Above conditions are met for 5 seconds.	▪ Loss fuel or less fuel in the fuel tank. ▪ Pressure limiter valve opening pressure drop. ▪ SCV is sticking. ▪ Faulty fuel injector. ▪ Fuel suction side looseness, kinks or blocked. ▪ Faulty or clogged fuel filter. ▪ Excessive air in the fuel suction side. ▪ Faulty FRP sensor. ▪ FRP sensor circuit is intermittently open circuit, poor connection or corrosion. (P0192 or P0193 may also set.) ▪ FRP sensor circuit high resistance. ▪ SCV circuit is intermittently open circuit, poor connection or corrosion. ▪ SCV circuit high resistance. ▪ Faulty fuel supply pump. Notice: SCV regulator is part of the fuel supply pump assembly.

Notice:

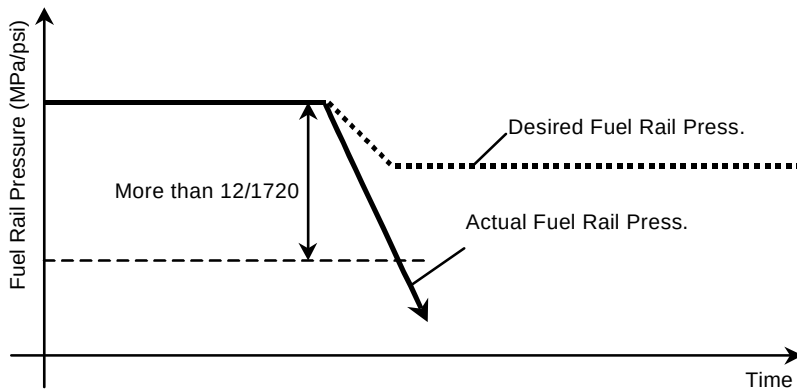
If the SCV commanded fuel is certain amount high for a certain length of time at low engine speed even the fuel rail pressure is following, this DTC will set.

The pressure limiter valve by which opening pressure has fallen may set this DTC most likely caused by having opened many times.

If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set.



DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1094	Fuel Rail Pressure (FRP) Too Low	- DTCs P1095, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running. - The accelerator pedal position is 0%. - The engine coolant temperature is more than 50°C (122 °F). - The vehicle speed is more than 50 km/h (31 MPH). - The fuel injection quantity is 0mm³/st.	The ECM detects that the actual fuel rail pressure is shapely dropped more than 12MPa (1740psi) (0.2 volts) when the engine cuts fuel.	- Loss fuel or less fuel in the fuel tank. - Pressure limiter valve opening pressure drop. - SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. (P0192 or P0193 may also set.) - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV regulator is part of the fuel supply pump assembly.



Notice:

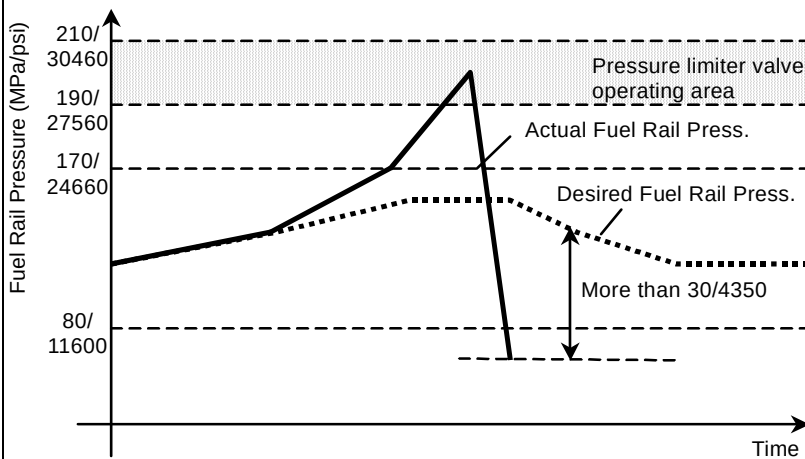
If the fuel rail pressure is certain amount low for a certain length of time while fuel cut, this DTC will set.

The pressure limiter valve by which opening pressure has fallen may set this DTC most likely cased by having opened many times.

If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set.



DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1095	Fuel Rail Pressure (FRP) Too Low (Fuel Rail Pressure Limiter Activation)	- DTCs P0192, P0193, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the fuel rail pressure drops quickly from more than 170 MPa (24,660 psi) (3.7 volts) to less than 80 MPa (11,600psi) (2.3 volts), and then the actual fuel rail pressure is lower than desired pressure by 30 MPa (4350 psi) (0.5 volts).	- Loss fuel or less fuel in the fuel tank. - SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. (P0192 or P0193 may also set.) - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.

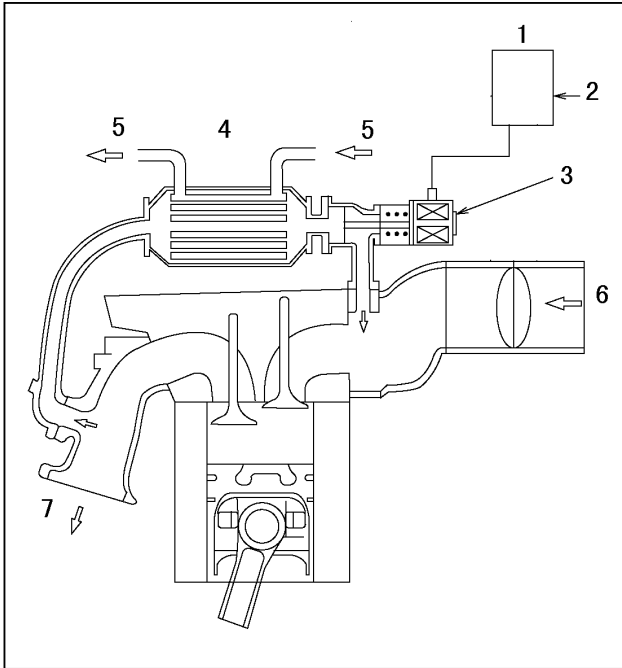


Notice:

If the fuel rail pressure went excessively high, then sharply decreased, this DTC will set indicating high fuel pressure, which activated the pressure limiter valve.

If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set.

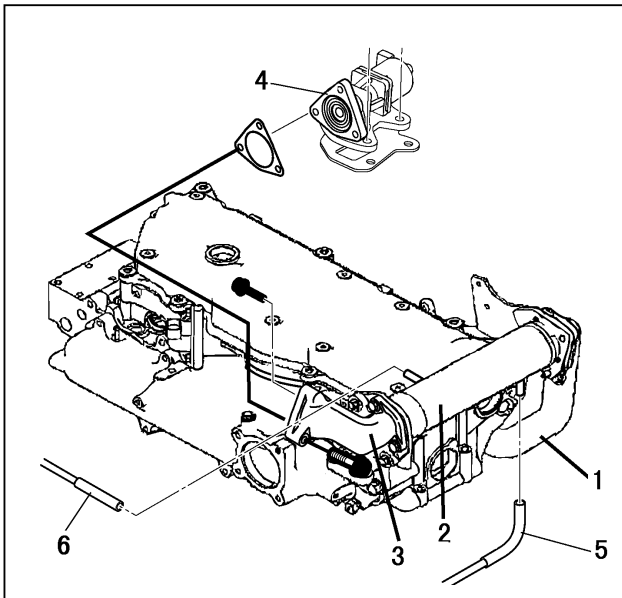
EGR (EXHAUST GAS RE-CIRCULATION) SYSTEM



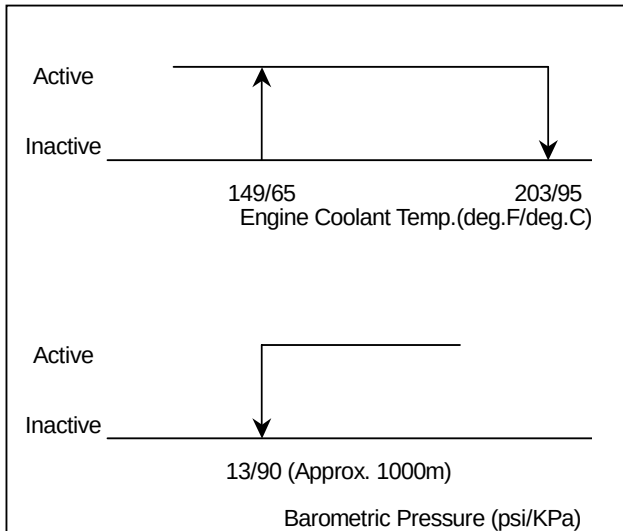
The exhaust gas re-circulation (EGR) system combination with EGR cooler reduces the temperature of the combustion temperature. This results in reducing nitrogen oxide (NOx) emissions. The EGR control system uses an electronic control system to ensure both driveability and emission. The control current from the engine control module (ECM) operates the DC motor to control the lift amount of the EGR valve. Also, a valve position sensor is provided at the rear of the motor to feedback actual valve lift amount to the ECM for more precision control of the EGR amount.

The EGR control starts when the conditions including the engine speed, engine coolant temperature, intake air temperature are satisfied, and the valve opening is calculated according to the engine speed and desired fuel injection quantity. Based on this valve opening, the drive duty of the motor is determined and the motor is driven accordingly.

1. Engine Control Module (ECM)
2. Various Sensor Inputs
3. Exhaust Gas Re-circulation (EGR) Valve
4. EGR Cooler
5. Engine Coolant
6. Intake Air



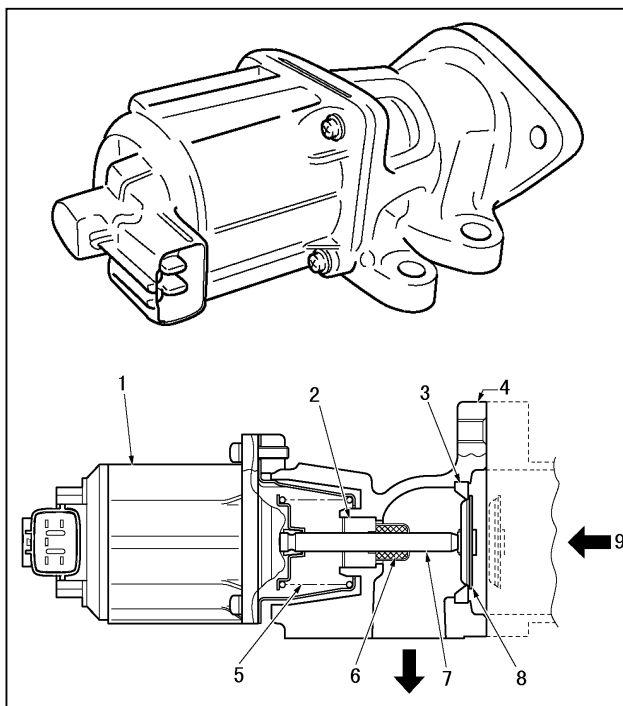
1. EGR Pipe
2. EGR Cooler
3. EGR Adapter
4. EGR Valve
5. Engine Coolant Feed
6. Engine Coolant Return



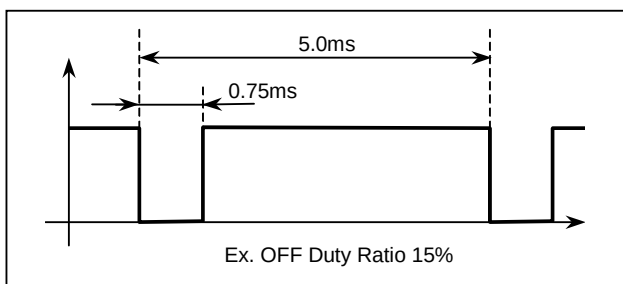
The system is started from engine idle speed and enabled based on following inputs are met.

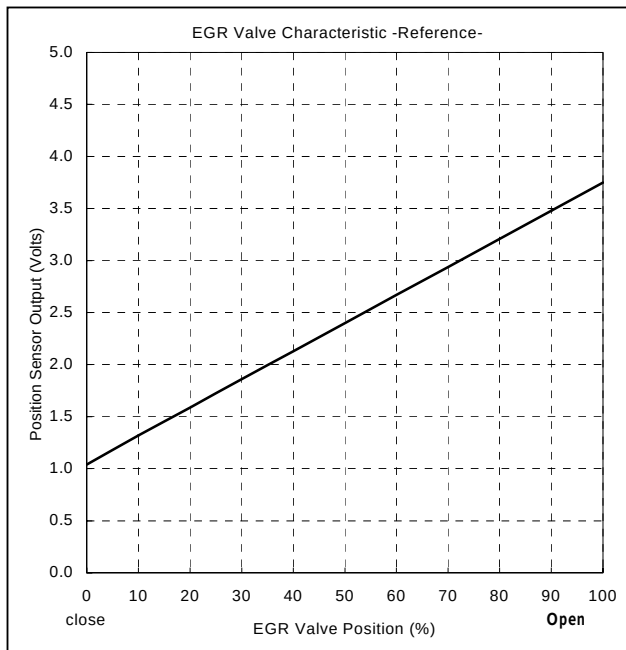
- Coolant temperature
- Barometric pressure
- Fuel injection quantity

EGR VALVE



The EGR valve is mounted on the intake manifold. It controls EGR gas flow amount. A position sensor is installed on the EGR valve body together with EGR valve control motor. The EGR valve position sensor changes output voltage according to EGR valve position. The control motor is controlled based on duty signal sent from the ECM. The 200Hz duty ratio is the time that the EGR valve is opened to one operating cycle. A duty ratio change of 0% to appropriate percentage is EGR valve lift control. To open the valve, duty ratio is increased. To close the valve, duty ratio becomes small.





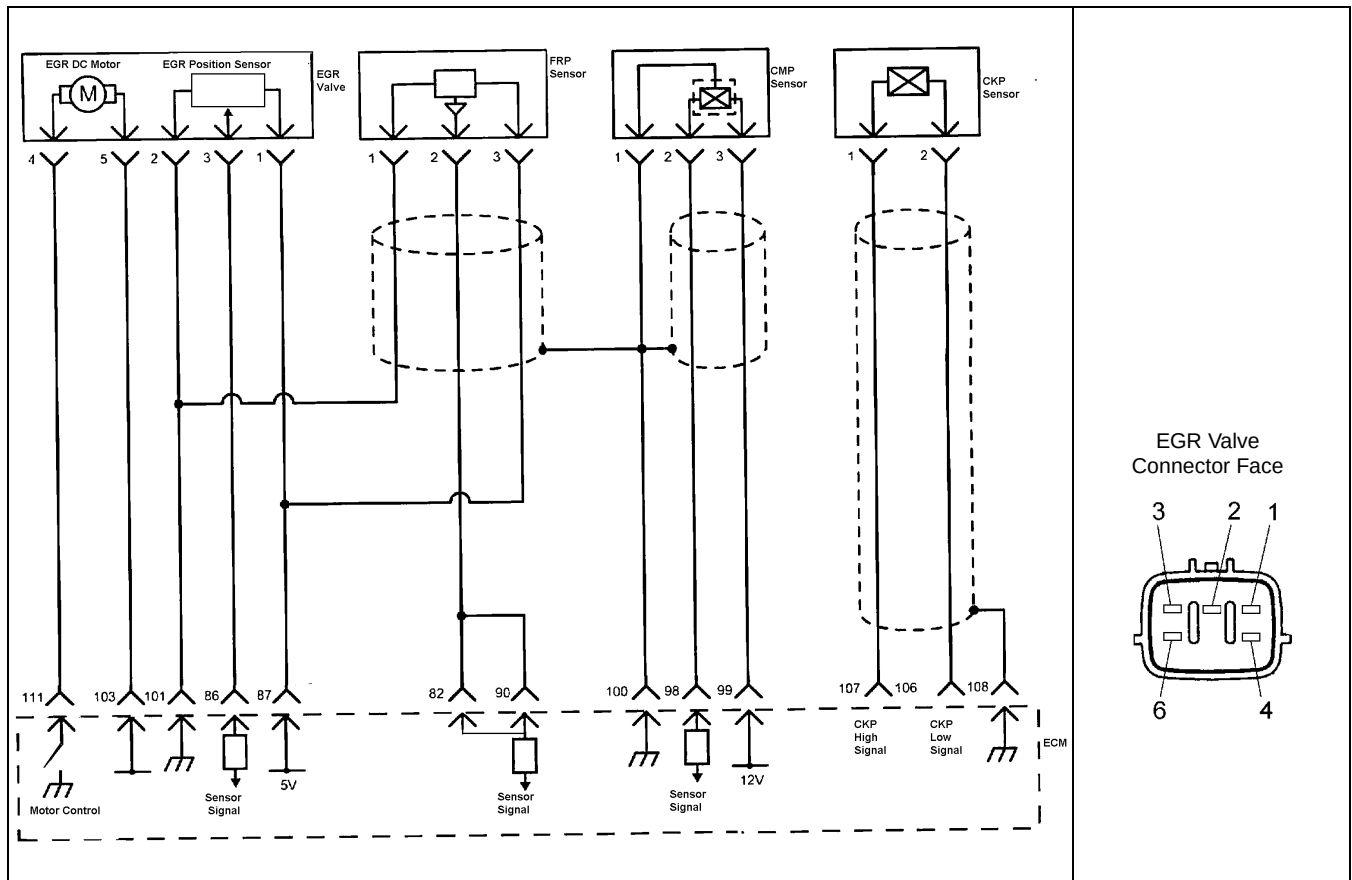
Position (%)	Volts
0	1.0
10	1.3
20	1.6
30	1.9
40	2.1
50	2.4
60	2.7
70	2.9
80	3.2
90	3.5
100	3.7

The characteristic of the EGR valve position sensor is displayed in the graph and table. The output voltage can be found on the Tech 2. Desired position and actual position are compared and ECM adjusts EGR valve motor driven by duty cycle signal.

Notice!

The EGR Position (DC Motor) in the Tech 2 is difference position (actual value – desired value). This data display will be fixed to 0% when DTC is set relating to the EGR position sensor open or short circuit. To diagnose this DTC, observe the “Volts” in the data display.

To check EGR valve sticking, Actuator Test on the Tech 2 is suitable. The purpose of this test is for checking whether the actual position of the EGR valve is moved within 0 - 100% as commanded. Restricted valve movement by foreign materials, excessive deposits or faulty valve could be considered if the EGR Position Difference is large.



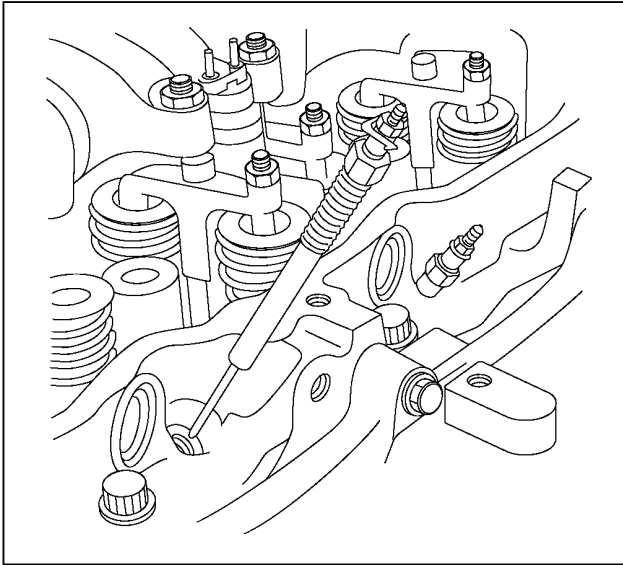
Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0485	Exhaust Gas Recirculation (EGR) Position Sensor Circuit Low Voltage	- DTCs P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the EGR valve position sensor signal voltage is less than 0.1 volts for 3 seconds.	- Glow indicator lamp battery feed circuit is open circuit or high resistance. - Glow indicator lamp control circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage circuit. - Poor harness connector connection. - Faulty instrument panel cluster (meter assembly). - Faulty glow indicator bulb. - Faulty ECM.
P0496	Exhaust Gas Recirculation (EGR) Position Sensor Circuit High Voltage	- DTCs P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the EGR valve position sensor signal voltage is less than 0.1 volts for 3 seconds.	- Sensor 5V reference circuit is open circuit, high resistance. - Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1635 may also set.) - Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. - Poor harness connector connection. - Faulty EGR valve position sensor. - Faulty ECM. Notice: EGR valve position sensor is internal to EGR valve assembly.

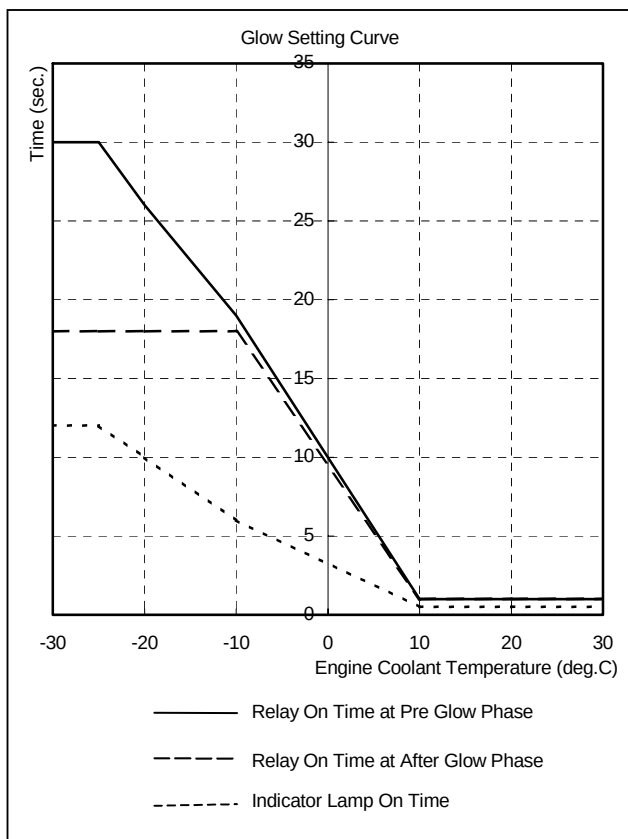


P0488	Exhaust Gas Recirculation (EGR) Position Sensor Performance	■ DTCs P1630 and P1634 are not set. ■ The ignition switch is ON. ■ The ignition voltage is more than 18 volts.	■ The ECM detects that the EGR valve position sensor signal voltage is more than 4.9 volts for 3 seconds.	■ Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1635 may also set.) ■ Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. ■ Sensor low reference circuit is open circuit or high resistance. ■ Poor harness connector connection. ■ Faulty EGR valve position sensor. ■ Faulty ECM. Notice: EGR valve position sensor is internal to EGR valve assembly.
-------	---	--	---	---

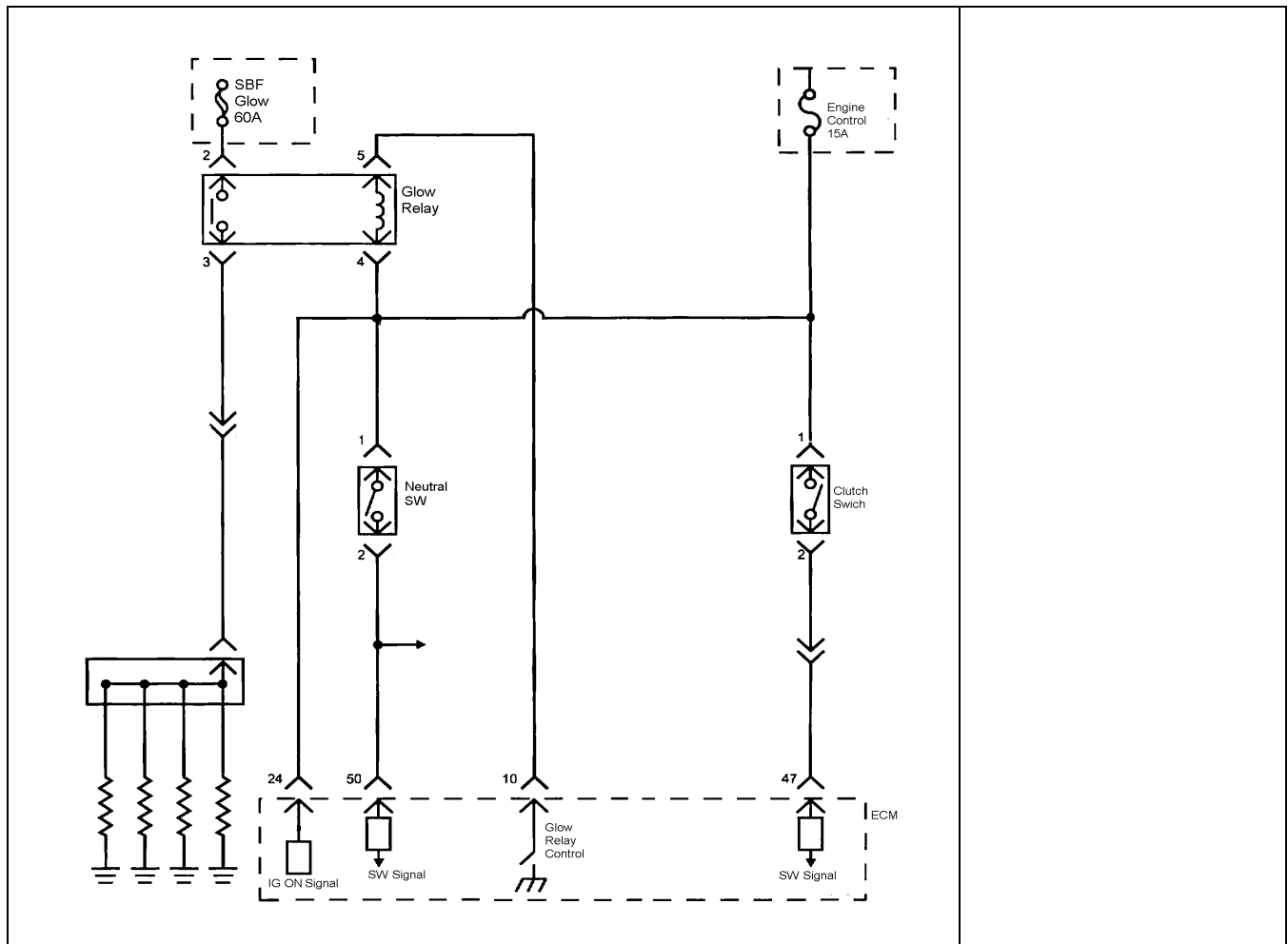
PREHEATING SYSTEM



The preheating system consists the engine control module (ECM), glow relay and glow plugs. The ECM switches glow relay depends on engine coolant temperature to energize the glow plugs. In the after glow phase, the glow indicator lamp is not illuminated but glow plugs remain active for a certain period.



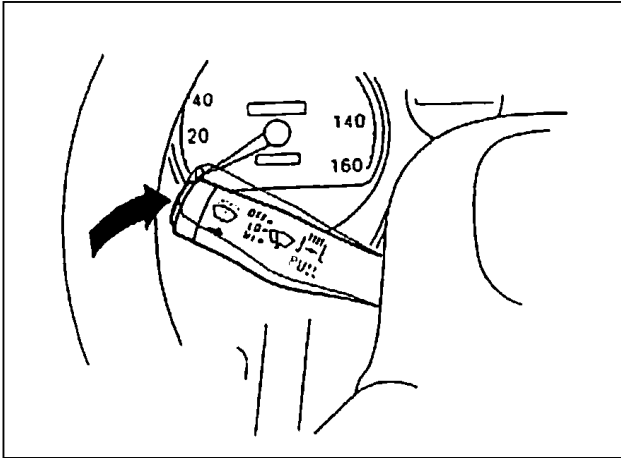
Commanded state of the glow relay can be found on the Tech 2. Over 10deg. C (50 deg. F), glow relay is activated only 1 second. Also, indicator lamp is remaining ON 0.5 seconds when the ignition switch is turned ON.



Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0380	Glow Plug Relay Control Circuit	The battery voltage is between 16 - 32 volts.	- The ECM detects a high voltage condition on the glow relay control circuit for longer than 3 seconds when the glow relay is commanded ON. - OR - The ECM detects a low voltage condition on the glow relay control circuit for longer than 3 seconds when the glow relay is commanded OFF.	- Glow relay battery feed circuit is open circuit or high resistance. - Glow relay control circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage circuit. - Poor harness connector connection. - Glow relay is poor installation. - Faulty glow relay. - Faulty ECM.
P0381	Glow Indicator Lamp Control Circuit	The ignition voltage is more than 18 volts.	- The ECM detects a high voltage condition on the glow indicator lamp control circuit for longer than 3 seconds when the lamp is commanded ON. - OR - The ECM detects a low voltage condition on the glow indicator lamp control circuit for longer than 3 seconds when the lamp is commanded OFF.	- Glow indicator lamp battery feed circuit is open circuit or high resistance. - Glow indicator lamp control circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage circuit. - Poor harness connector connection. - Faulty instrument panel cluster (meter assembly). - Faulty glow indicator bulb. - Faulty ECM.

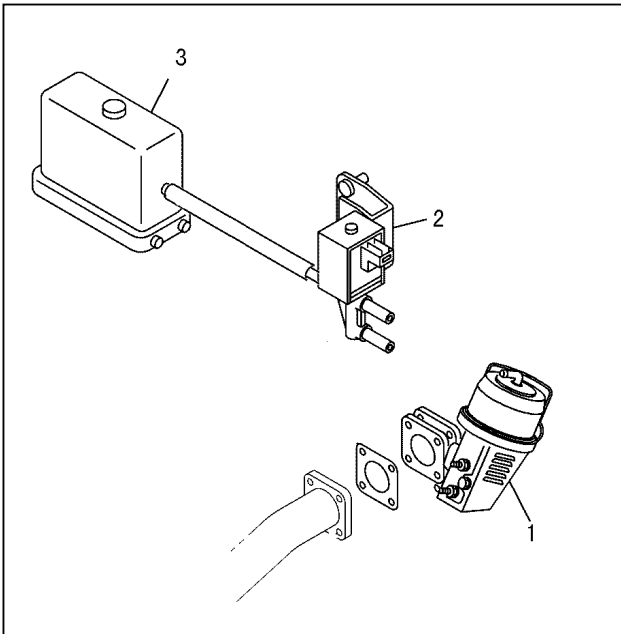
EXHAUST BRAKE SYSTEM & ENGINE WARM UP SYSTEM



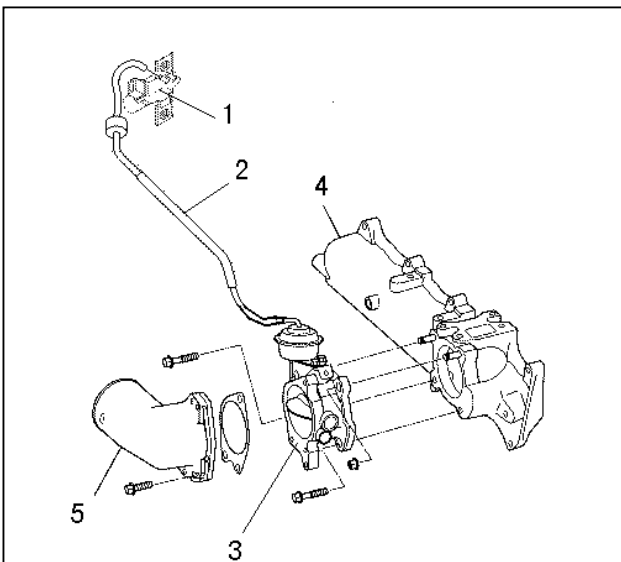
The exhaust brake system consists the exhaust brake valve, exhaust brake magnetic valve, exhaust brake switch and engine control module (ECM). In addition to this, intake throttle valve is used to reduce engine noise during exhaust brake operation. The system is enabled following conditions are met.

- Exhaust brake switch is ON
- Accelerator pedal is not depressed
- Clutch pedal is not depressed (M/T)
- Vehicle speed is higher than specified range

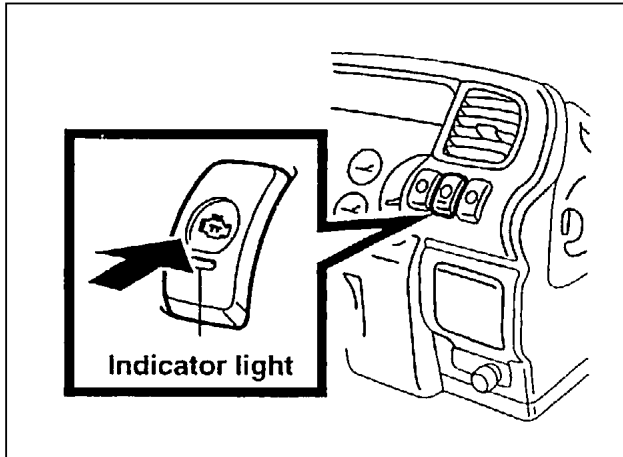
The exhaust brake magnetic valve and intake throttle control solenoid valve is energized if the above conditions are met. Then, the vacuum is supplied to the exhaust brake valve and intake throttle to close each valve.



1. Exhaust Brake Valve
2. Magnetic Valve
3. Air Filter



1. Intake Throttle Control Solenoid Valve
2. Vacuum Hose
3. Intake Throttle
4. Intake Manifold
5. Intake Pipe

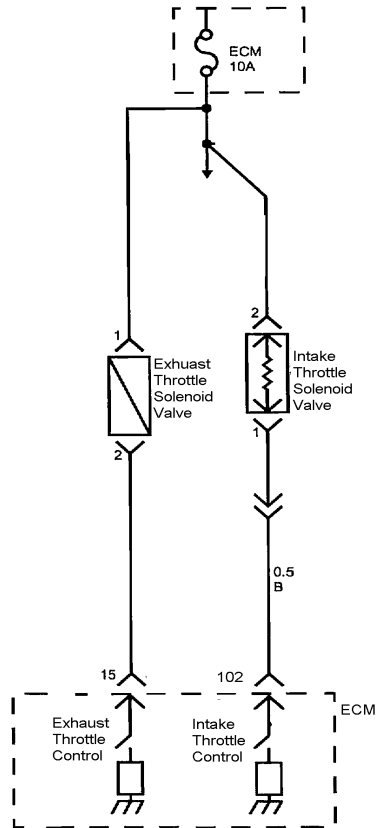


In order to warm up the engine more quickly and reduce white smoke at low temperature, engine warm up system is adopted. The engine load is increased by the exhaust pressure and energy in the engine is transmitted to cooling water through the cylinder block, and warm up has been improved. Increasing the injection volume at the same time raises the exhaust temperature, and warm up is promoted, too.

The engine warm up system consists similar with exhaust brake system such as exhaust brake valve, exhaust brake magnetic valve, intake throttle valve, intake throttle solenoid and engine control module (ECM). The switch of engine warm up system is located on dash and the system is enabled following conditions are met.

- Engine warm up switch is ON
- Accelerator pedal is not depressed
- Engine coolant temperature is lower than 65 deg. C (149 deg. F)

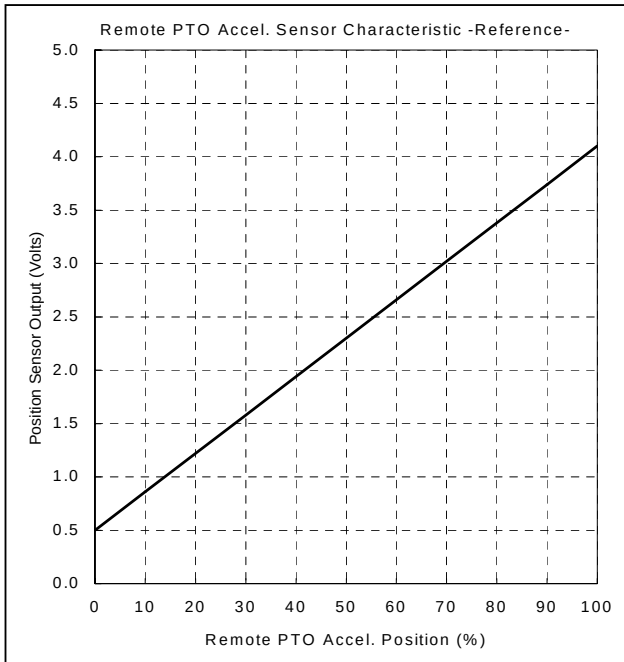
The exhaust brake magnetic valve and intake throttle control solenoid valve is energized if the above conditions are met. Then, the vacuum is supplied to the exhaust brake valve and intake throttle to close each valve. Also the desired engine idle speed will increase up to 740 RPM. If the desired idle speed is higher than this value such as low temperature condition, higher desired speed is selected for desired idle speed.



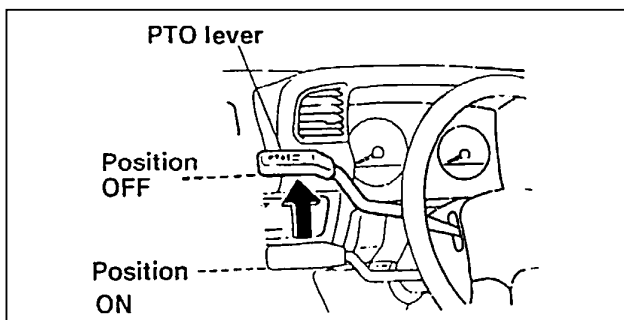
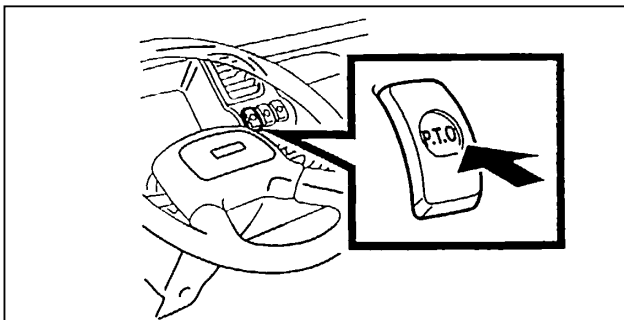
Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1681	Exhaust Brake Control Solenoid Valve Control Circuit Low Voltage	- The battery voltage is between 16 – 32 volts. - The ignition switch is ON. - The engine is running.	The ECM detects a low voltage condition on the exhaust throttle control solenoid valve control circuit for longer than 3 second when the exhaust brake is commanded OFF.	- Exhaust throttle solenoid valve voltage feed circuit is open circuit or high resistance. - Exhaust throttle solenoid valve control circuit is open circuit, high resistance or short to ground. - Poor harness connector connection. - Faulty exhaust throttle solenoid valve. - Faulty ECM.
P1682	Exhaust Brake Control Solenoid Valve Control Circuit High Voltage	- The battery voltage is between 16 – 32 volts. - The ignition switch is ON. - The engine is running.	The ECM detects a high voltage condition on the exhaust throttle control solenoid valve control circuit for longer than 3 second when the exhaust brake is commanded ON.	- Exhaust throttle solenoid valve control circuit is short to battery or ignition voltage circuit. - Faulty exhaust throttle solenoid valve. - Faulty ECM.

POWER TAKE OFF (PTO) SYSTEM



Position (%)	Volts
0	0.5
10	0.9
20	1.2
30	1.6
40	1.9
50	2.3
60	2.7
70	3.0
80	3.4
90	3.7
100	4.1



The engine control module (ECM) has the functionality to accommodate on PTO control. This PTO control is performed while the vehicle is stopped using an arbitrarily set engine speeds as the PTO desired engine speed.

It is possible to use both inputs; additional remote PTO accelerator sensor at cabin outside and the accelerator pedal at cabin inside. Either of high request engine speed is chosen for PTO desired engine speed.

The remote PTO accelerator sensor can be enabled when vehicle is stationary. The body builder-installed remote PTO accelerator sensor can variable increases or decreases the PTO engine speed while this sensor is operating. The sensor needs to be a potential meter. The ECM supplies 5 volts reference circuit to the remote PTO accelerator sensor from the ECM 42 terminal connector. The ECM also provides a ground on the low reference circuit from the ECM 41 terminal. The ECM monitors the remote PTO accelerator sensor signal on the ECM 70 terminal.

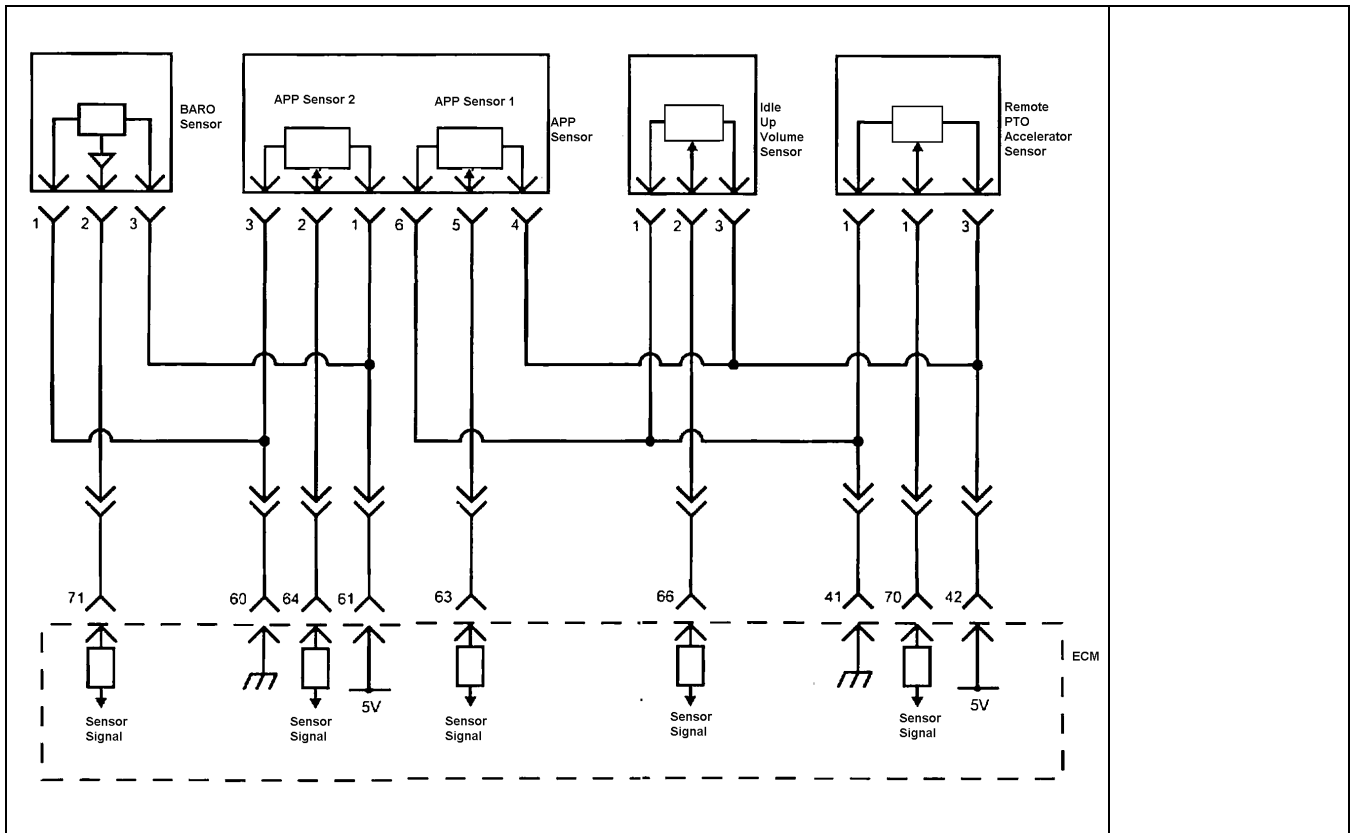
The body builders can access remote PTO accelerator sensor harness connector. It is located near the fuse & relay box on the chassis frame side. But, it has DTC in case output voltage is higher than 4.8 volts.

It is possible even if not entering the PTO mode by using the PTO switch to get the PTO desired engine speed only by inputting from either of accelerator sensor, such as low load equipments.

However, the entering fuel injection characteristic is switched to the PTO mode when the change in the load characteristic is necessary for the engine side according to the specification and the work characteristic of body builder.

The factory-option dash mounted PTO main switch is used to enable or cancel PTO mode. PTO lever is moved to ON position, the engine speed will be set to the PTO standby engine speed. This PTO standby engine speed can change within 650 – 900 RPM if Smoother is fitted.

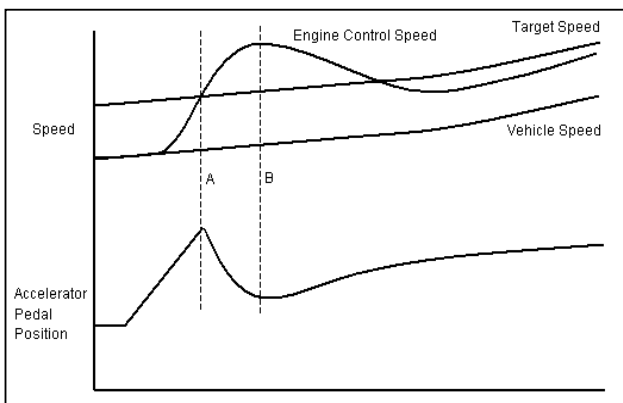
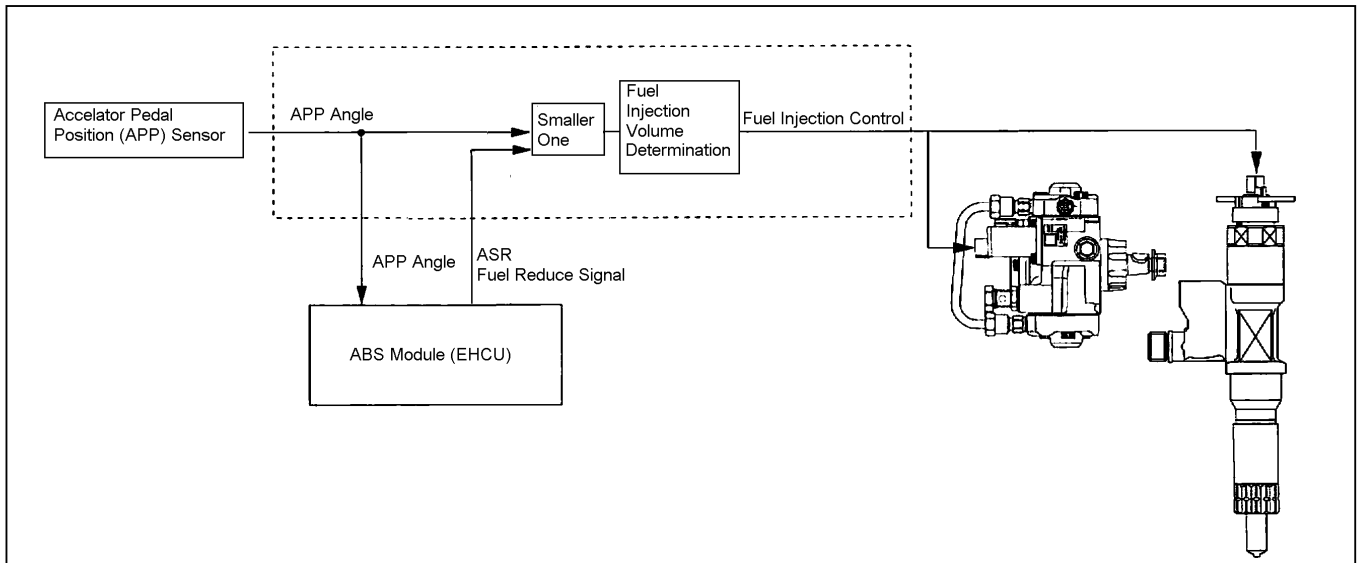
This PTO control is performed while the vehicle is stopped. It is possible to increase the PTO desired engine speed by inputting from either of accelerator sensor, same procedure as without PTO switch.



Related DTC

DTC	DTC Name On Scan Tool	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1120	PTO Engine Speed Selector Sensor Circuit High Voltage	- DTCs P1630 and P1631 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the PTO accelerator sensor signal voltage is more than 4.8 volts.	- Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1631 may also set.) - Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty PTO accelerator sensor. - Faulty ECM.

ANTI SLIP REGULATOR (ASR) SYSTEM

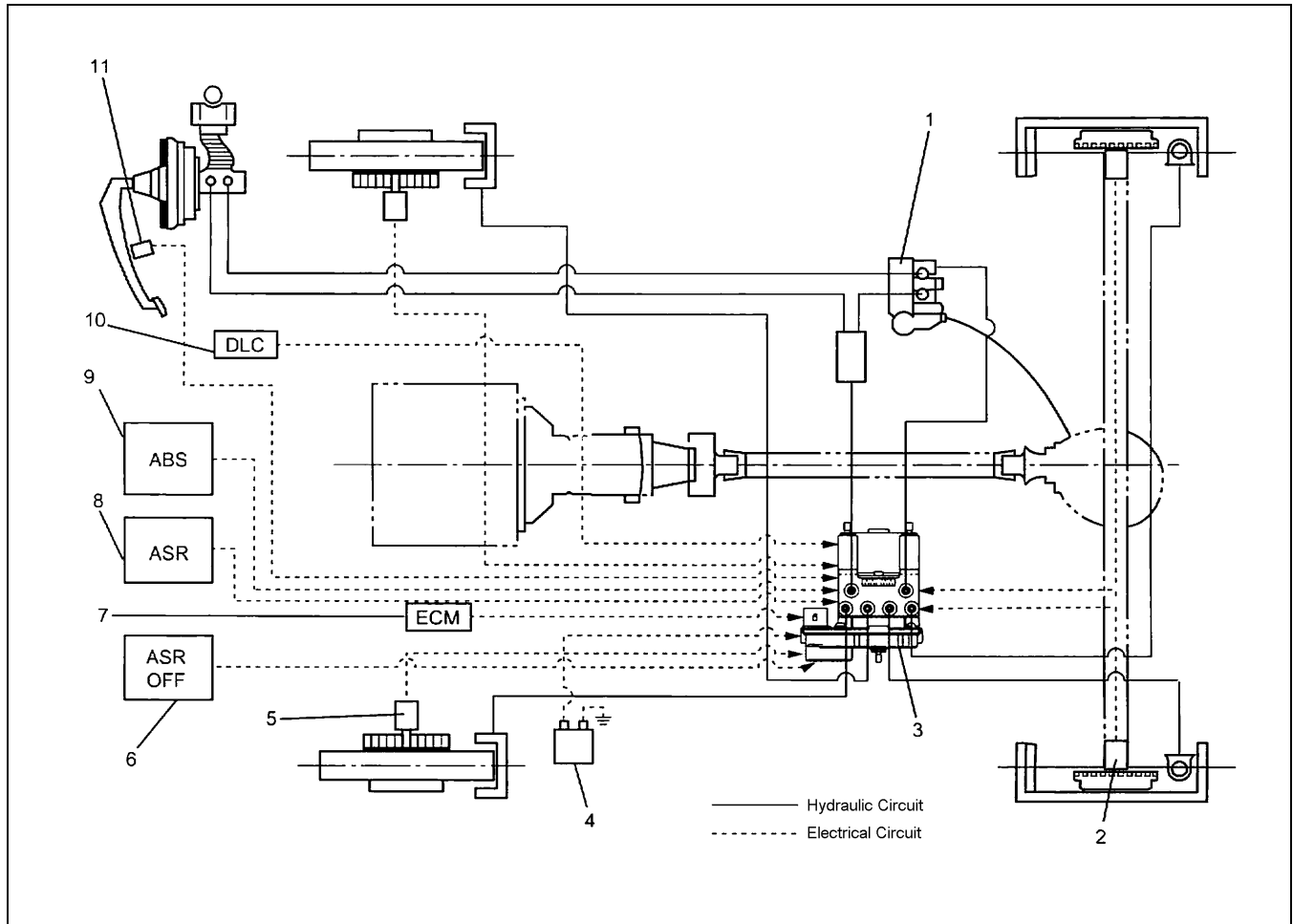


Anti Slip Regulator (ASR) system controls the engine torque to prevent the drive wheels slip when the vehicle with heavy accelerated or slippery road.

The ABS/ASR control unit (EHC) calculates the engine control speed (average speed of the right and left drive wheels) and the vehicle speed (wheels on turned side = front right and left wheels) based on the signal from the wheel speed sensor of each wheel.

The engine control module (ECM) and EHC communicates via controller area network (CAN) bus system. The ECM constantly sends an accelerator pedal position to the EHC that is request signal by driver.

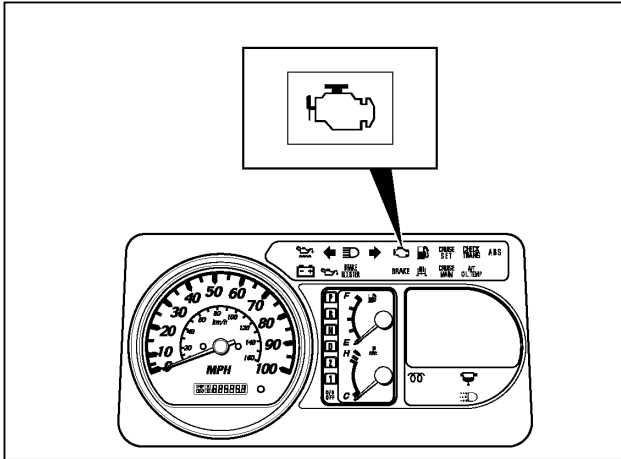
When slipping on the drive wheels are occurred, and the difference between the engine control speed and the vehicle speed reaches a predetermined target value (point A), the EHC sends a reduction accelerator pedal position signal to the ECM to reduce a fuel injection volume, so that the slipping amount may become proper (from point B).



1. Load Sensing Proportioning Valve (LSPV)
2. Wheel Speed Sensor (Rear)
3. Electronic Hydraulic Control Unit (EHCU) (ABS Module)
4. Battery
5. Wheel Speed Sensor (Front)
6. ASR OFF Switch
7. Engine Control Module (ECM)
8. ASR Indicator Lamp
9. ABS Indicator Lamp
10. Data Link Connector
11. Brake Switch

DIAGNOSTIC

MALFUNCTION INDICATOR LAMP (MIL)

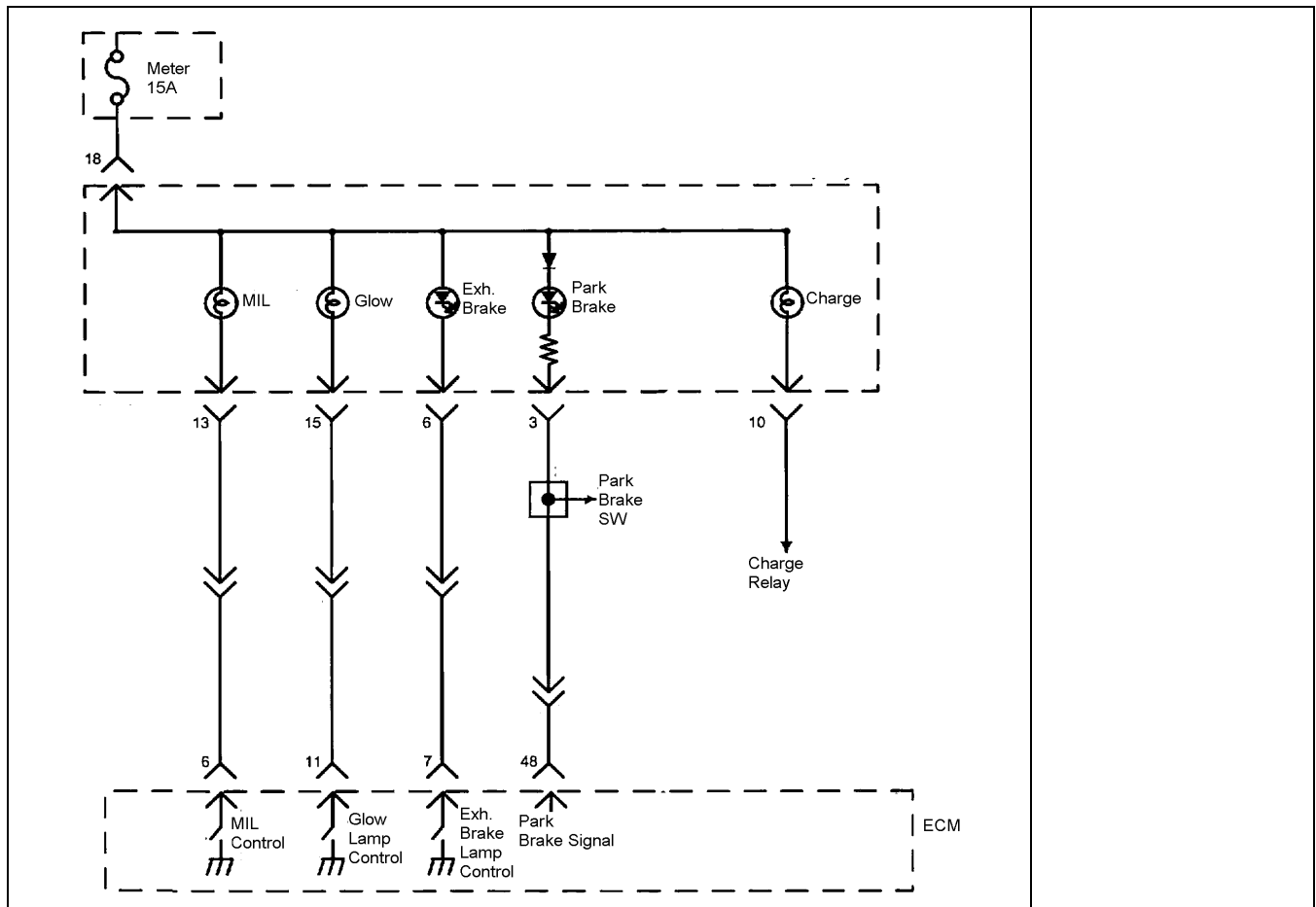


The malfunction indicator lamp (MIL) is located in the instrument panel cluster. The MIL will display the engine symbol when commanded ON:

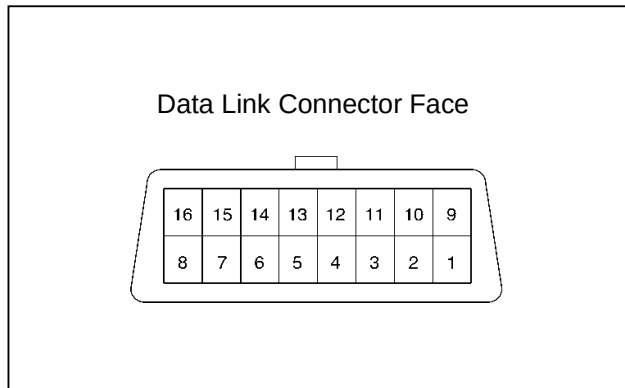
The MIL indicates that an emission related fault has occurred and vehicle service is required.

The following is a list of the modes of operation for the MIL:

- The MIL illuminates when the ignition switch is turned ON, with the engine OFF. This is a bulb test to ensure the MIL is able to illuminate.
- The MIL turns OFF after the engine is started if a diagnostic fault is not present.
- The MIL remains illuminated after the engine is started if the ECM detects a fault. A diagnostic trouble code (DTC) is stored any time the ECM illuminates the MIL due to an emission related fault.



DATA LINK CONNECTOR (DLC)



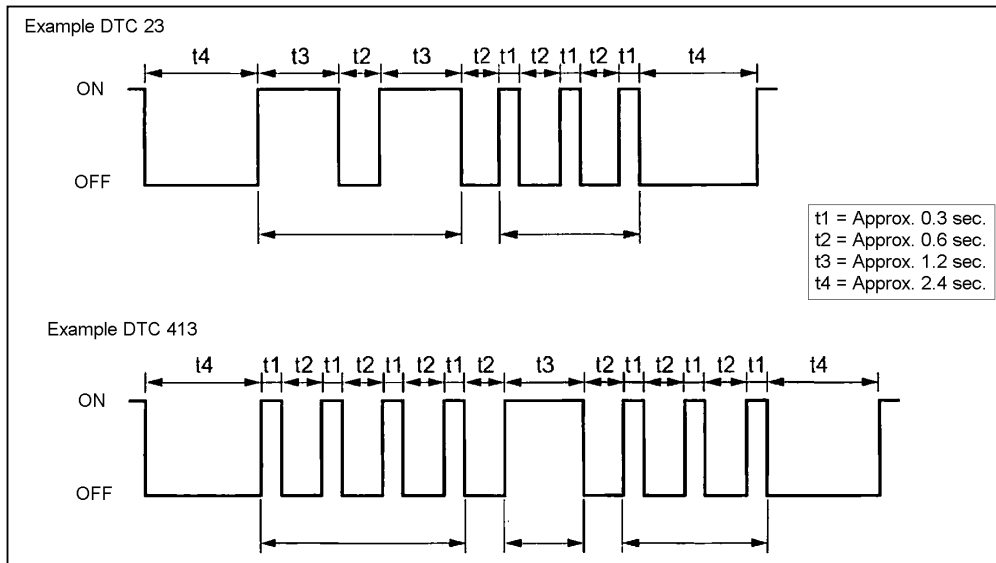
Data link connector (DLC) is fixed to the driver's side dash panel on the. The communication between the Tech 2 and ECM is established using Keyword 2000 serial data communication.

1. *Diag Request SW (ECM)*
2. *Class 2 Communication Line (ABS Module)*
3. *Not Used*
4. *Connected to Ground*
5. *Connected to Ground*
6. *Not Used*
7. *Keyword 2000 Commination Line (ECM, SRS, Soomther or HSA)*
8. *Not Used*
9. *Not Used*
10. *Not Used*
11. *Diag Request SW (Soomther or HSA)*
12. *Diag Request SW (ABS Module)*
13. *Diag Request SW (SRS Module)*
14. *Not Used*
15. *Not Used*
16. *Not Used*

FLASH DIAGNOSTIC TROUBLE CODE

The diagnostic trouble code(s) (DTCs) stored in the ECM's memory can be read either through a hand-held diagnostic scanner such as Tech 2 plugged into the DLC or by counting the number of flashes of the Malfunction Indicator Lamp (MIL) when the diagnostic test terminal of the DLC is grounded. The DLC terminal "1" (diagnostic request switch) is pulled "Low" (grounded) by jumped to DLC terminal "4", which is a ground wire.

Once terminals "1" and "4" have been connected, the ignition switch must be moved to the "ON" position, with the engine not running. The MIL will indicate a DTC three times is a DTC is present and history. If more than one DTC has been stored in the ECM's memory, the DTCs will be output numerical order with each DTC being displayed three times. The DTC display will continue as long as the DLC is shorted. When the engine is started, only present DTCs will be output.



Clearing Diagnostic Trouble Codes (DTCs) with The Tech 2 or without Tech2

Do not clear DTCs unless directed to do so by the service information provided for each diagnostic procedure. To clear DTCs, use the Tech 2 "Clear DTC Information". If there is no Tech 2, history DTCs cannot be cleared by driving cycles. Following procedure must be done in case without Tech 2.

Preparation:

1. Turn the ignition ON.
2. Short the terminal 1 and 4 at DLC.

Operating Procedure:

1. Depress accelerator pedal within 1 – 3 seconds.
2. Release accelerator pedal within 1 – 3 seconds.
3. Depress accelerator pedal within 1 – 3 seconds.
4. Release accelerator pedal within 1 – 3 seconds.
5. Depress accelerator pedal within 1 – 3 seconds.

TECH 2 SCAN TOOL

F0: Diagnostic Trouble Codes
 F0: Read DTC Info As Stored By ECU
 F1: Clear DTC Information
F1: Data Display
F2: Snapshot
F3: Actuator Test
 F0: Common Rail System
 F0: Rail Pressure Control
 F1: Injector Balancing
 F2: Injection Timing
 F3: Pre Injection Stop
 F4: Injector Forced Drive
 F1: Device Controls
 F0: Glow Plug Relay
 F1: Exhaust Brake Control
 F2: EGR Control
F4: Programming
 F0: Injector ID Code
 F0: Injector ID Code
 F1: ID Code Registration
 F2: Upload ID Code
 F3: Download ID Code

Operating Procedure

1. Press Enter at start screen.
2. Select "F0: Diagnostic" then press Enter.
3. Select the appropriate vehicle identification.
4. Select "F0: Powertrain" then press Enter.
5. Select "4HK1"

The table in left-hand side shows, which functions are used the available equipment versions.

F0: Diagnostic Trouble Code

The purpose of the "Diagnostic Trouble Code" mode is to display stored trouble code in the ECM. When "Clear DTC Information" is selected, "Clear DTC Information", warning screen appears. This screen informs you that by cleaning DTC's "all stored DTC information in the ECM will be erased".

- **Injector Balancing**

The purpose of this test is for checking whether the fuel injector is operated when it commanded ON/OFF. Faulty injector(s) could be considered that does not change the engine speed when commanded OFF.

- **Injection Timing**

The purpose of this test is for checking whether the main injection timing is changed within -5 - 10°C as commanded.

- **Pre Injection Stop**

The purpose of this test is for checking whether the fuel injector is operated when it commanded Stop. Faulty injector(s) could be considered that does not change engine noise when commanded Stop.

- **Injector Forced Drive**

The purpose of this test is for checking whether the fuel injector is operated when it commanded ON/OFF. Faulty injector(s) could be considered that does not create clicking noise (solenoid operating noise), interrupted noise or abnormal noise when commanded ON.

- **Glow Plug Relay**

The purpose of this test is for checking whether the glow relay is operated when it commanded ON. Faulty circuit(s) or relay could be considered when not energizing with commanded ON.

- **Exhaust Brake Control**

The purpose of this test is for checking whether the exhaust brake solenoid valve or throttle diaphragm valve is operated when it commanded ON. Restricted diaphragm valve movement by shaft sticking, kinked or disconnected vacuum hose or faulty solenoid valve could be considered when not operating with commanded ON.

- **EGR Control**

The purpose of this test is for checking whether the actual position of the EGR valve is moved within 0 - 100% as commanded. Restricted valve movement by foreign materials, excessive deposits or faulty valve could be considered if the EGR Position Difference is large.

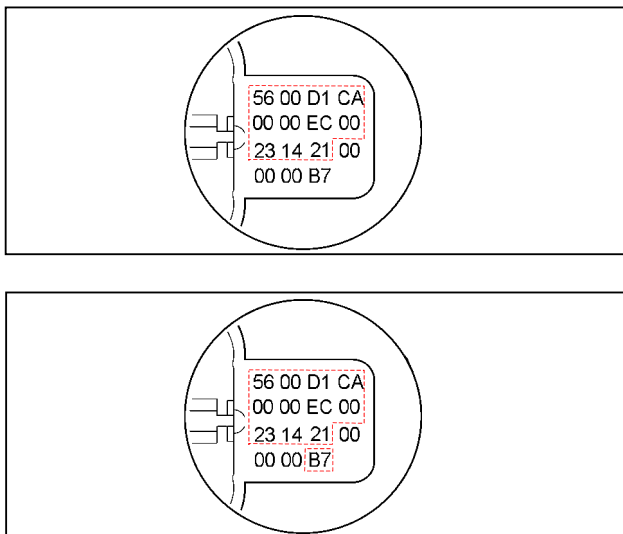
F4: Programming

The purpose of "Programming" is to program the fuel injector ID code into the ECM if the fuel injector or ECM is to be replaced.

Fuel Injector ID Code Data Programming Procedure

1. Install the Tech 2.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > Powertrain > appropriate engine model > Programming > ID Code Registration.
4. Select replaced cylinder and press Change. Input 22 figures. Then, input in order from the upper sequence to the lower sequence from the left end to the right end. The correct order for the left illustration is as follows:
56 00 D1 CA 00 00 EC 00 23 14 21 00
5. After complete the registration, turn OFF the ignition for 30 second.
6. Turn ON the ignition.
7. Select Injector ID Code. At this point, all registered fuel injector ID code data can be verified. Compare the ID code values registered into the ECM with the replaced each fuel injector including the last 2 figures. The correct order for the left illustration is as follows:

56 00 D1 CA 00 00 EC 00 23 14 21 B7



ECM Replacement Overview

Uploading the Fuel Injector ID Code Data from the ECM

Important: Only perform this procedure if the ECM is being replaced. The current fuel injector ID code data can be determined with the Tech 2. If the ECM does not communicate with the Tech 2, go to the next procedure.

1. Install the Tech 2.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > Powertrain > appropriate engine model > Programming > Upload ID Code.
4. After complete the upload, turn OFF the Tech 2.
5. Turn OFF the ignition.

Retrieving the Fuel Injector ID Code Data with a Non-communicating ECM

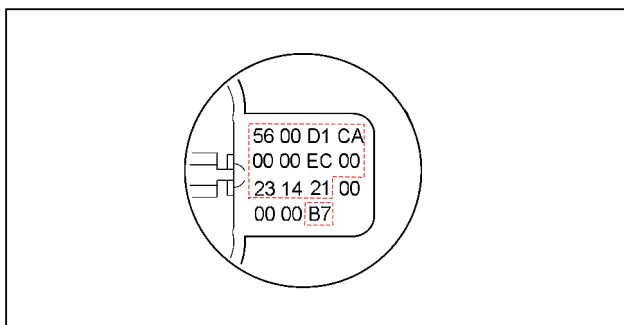
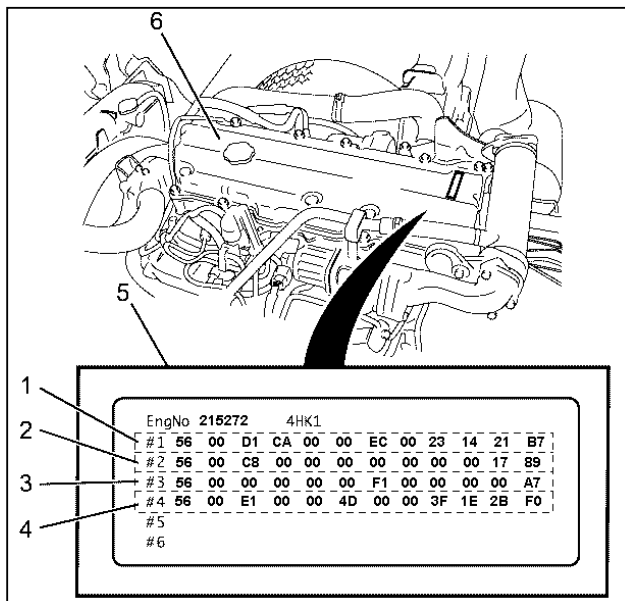
Important: Only perform following procedure if the ECM is being replaced and the Tech 2 does not communicate. The current fuel injector ID code data can not be determined with the Tech 2, the fuel injector numbers must be recorded from the factory affixed label on the cylinder head cover or each fuel injector ID plate.

Recording from the label on cylinder head cover;

Important: Only perform this procedure if the fuel injectors are not being replaced in the past.

1. Record all numbers of each cylinder on the label.

1. Cylinder Number 1 Fuel Injector ID Code
2. Cylinder Number 2 Fuel Injector ID Code
3. Cylinder Number 3 Fuel Injector ID Code
4. Cylinder Number 4 Fuel Injector ID Code
5. Injector ID Code Label
6. Cylinder Head Cover



Recording from the each injector ID Plate;

1. Remove the cylinder head cover.
2. Record 24 figures of each fuel injector ID plate. The correct order for the left illustration is as follows:

56 00 D1 CA 00 00 EC 00 23 14 21 00 00 00 B7

ECM Removal & ECM Installation

Fuel Injector ID Code Data Programming Procedure

Important: Only perform this procedure if the fuel injector ID code data can be uploaded with the Tech 2. If the ECM can not be uploaded with the Tech 2, go to the next procedure.

1. Install the Tech 2.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > Powertrain > appropriate engine model > Programming > Download ID.
4. After complete the download, turn OFF the ignition for 30 second.

5. Turn ON the ignition.
6. Select Injector ID Code then press Enter. At this point, all downloaded fuel injector ID code data can be verified. Compare the ID code values downloaded into the ECM and each fuel injector.
7. Start the engine and let idle.

Important: In order to make the fuel supply pump characteristic learn into the replaced ECM, let the engine idle until warm-up. If the fuel system DTC's stored in the meantime, once clear DTC and warm-up the engine again.

Important: If the current injector ID code data can not be uploaded with the Tech 2, the recorded all numbers must be entered into the Tech 2.

1. Install the Tech 2.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > Powertrain > appropriate engine model > Programming > ID Code Registration.
4. Select the cylinder 1 to 4 and press Change. Input 22 figures. Then, input in order from the upper sequence to the lower sequence from the left end to the right end. The correct order for the left illustration is as follows:

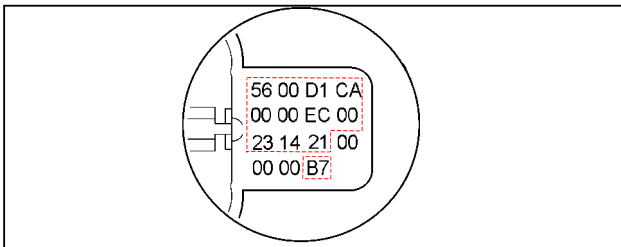
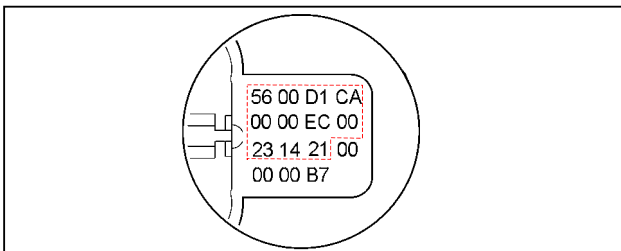
56 00 D1 CA 00 00 EC 00 23 14 21

5. After complete the registration, turn OFF the ignition for 30 second.

6. Turn ON the ignition.

7. Select Injector ID Code. At this point, all registered fuel injector ID code data can be verified. Compare the ID code values registered into the ECM with the replaced each fuel injector including the last 2 figures. The correct order for the left illustration is as follows:

56 00 D1 CA 00 00 EC 00 23 14 21 B7



TECH 2 DATA & DEFINITIONS

Tech 2 Parameter	Units Displayed	Definitions
Ignition Voltage	Volts	This parameter displays the ignition voltage measured by the ECM at the ignition feed circuit. Voltage is applied to the ECM when the ignition switch is ON position.
Battery Voltage	Volts	This parameter displays the system voltage measured by the ECM at the ECM main relay voltage feed circuit .
Desired Idle Speed	RPM	The idle speed that is requested by the ECM. The ECM will change desired idle speed based on engine coolant temperature (ECT) and Idle up sensor status
Engine Speed	RPM	This parameter displays the speed of the crankshaft signal input to the ECM from the crankshaft position (CKP) sensor. If the CKP sensor is failed, the camshaft position (CMP) is substituted with CKP sensor. The Tech 2 will display the engine speed in revolution per minute (RPM).
APP Sensor 1 (Accelerator Pedal Position)	Volts	This parameter displays the voltage signal input to the ECM from the accelerator pedal position (APP) sensor 1 of the APP sensor assembly. APP sensor 1 is a range of values indicating a low voltage when the accelerator pedal is not depressed to a high voltage when the accelerator pedal is fully depressed.
APP Sensor 2 (Accelerator Pedal Position)	Volts	This parameter displays the voltage signal input to the ECM from the accelerator pedal position (APP) sensor 2 of the APP sensor assembly. APP sensor 2 is a range of values indicating a high voltage when the accelerator pedal is not depressed to a low voltage when the accelerator pedal is fully depressed.
Accelerator Pedal Position	%	This parameter displays the angle of the accelerator pedal as calculated by the ECM using the signal input from the accelerator pedal position sensors. The APP indicated angle is a range of values indicating a low percentage when the accelerator pedal is not depressed to a high percentage when the accelerator pedal is fully depressed.
Fuel Rail Pressure	MPa / psi	This parameter displays the difference of actual and desired fuel rail pressure (actual – desired) as calculated by the ECM using the signal from the fuel rail pressure (FRP) sensor. The negative value is indicating a lower actual pressure. The positive value is indicating a higher actual pressure. This value is listed in psi or MPa.
Fuel Rail Pressure Sensor	Volts	This parameter displays the voltage signal input to the ECM terminals from fuel rail pressure (FRP) sensor. FRP sensor is a range of values indicating a low voltage when the fuel rail pressure is low to a high voltage when the fuel rail pressure is high.
Rail Pressure Feedback	Restart Mode / Shutoff Mode / Wait Mode / Feedback Mode	This parameter displays the state of the fuel rail pressure feedback to the ECM. "Wait Mode" indicates the ignition switch is turned ON position. "Feedback Mode" indicates the engine is during crank or run. "Shutoff Mode" indicates the ignition switch is turned OFF position. "Restart Mode" indicates the ignition switch continues being OFF position from "Shutoff Mode".

Tech 2 Parameter	Units Displayed	Definitions
SCV Duty Cycle	%	This parameter displays the suction control valve (SCV) control duty signal from the ECM terminals. When the small duty signal, the SCV is controlled to open (fuel supply to the fuel rail is increased). When the large duty signal, the SCV is controlled to close (fuel supply to the fuel rail is reduced).
SCV Current	mA	This parameter displays the suction control valve (SCV) control feedback current input to the ECM terminals from the SCV. When the low current is supplied, the SCV is controlled to open (fuel supply to the fuel rail is increased). When the high current is supplied, the SCV is controlled to close (fuel supply to the fuel rail is reduced).
Coolant Temperature Sensor	Volts	This parameter displays the temperature of the engine coolant based on signal input from the engine coolant temperature (ECT) sensor to the ECM. The Tech 2 will display a low signal voltage when the temperature is high and a high signal voltage when the temperature is low.
Coolant Temperature	°C / °F	This parameter displays the temperature of the engine coolant as calculated by the ECM using the signal input from the engine coolant temperature (ECT) sensor. The Tech 2 will display a low temperature when signal voltage is high and a high temperature when the signal voltage is low.
Intake Air Temperature Sensor	Volts	This parameter displays the temperature of the intake air based on signal input from the intake air temperature (IAT) sensor to the ECM. The Tech 2 will display a low signal voltage when the temperature is high and a high signal voltage when the temperature is low.
Intake Air Temperature	°C / °F	This parameter displays the temperature of the intake air as calculated by the ECM using the signal input from the intake air temperature (IAT) sensor. The Tech 2 will display a low temperature when signal voltage is high and a high temperature when the signal voltage is low.
Fuel Temperature Sensor	Volts	This parameter displays the temperature of the fuel based on signal input from the fuel temperature (FT) sensor to the ECM. The Tech 2 will display a low signal voltage when the temperature is high and a high signal voltage when the temperature is low.
Fuel Temperature	°C / °F	This parameter displays the temperature of the fuel as calculated by the ECM using the signal input from the fuel temperature (FT) sensor. The Tech 2 will display a low temperature when signal voltage is high and a high temperature when the signal voltage is low.
Barometric Pressure Sensor	Volts	This parameter displays the voltage signal input to the ECM from barometric pressure (BARO) sensor. BARO sensor is a range of values indicating a low voltage where in high altitude area.
Barometric Pressure	KPa	This parameter displays the barometric pressure as calculated by the ECM using the signal input from the barometric pressure (BARO) sensor.
EGR Position Sensor	Volts	This parameter displays the voltage signal input to the ECM from the EGR position sensor of the EGR valve. EGR position sensor is a range of values indicating a low voltage when the EGR valve is closed to a high voltage when the EGR valve is opened.

Tech 2 Parameter	Units Displayed	Definitions
EGR Position (DC Motor)	%	This parameter displays the difference of actual and desired EGR valve position (actual – desired) as calculated by the ECM using the signal from the EGR position sensor. The negative value is indicating a lower actual valve position. The positive value is indicating a higher actual valve position.
EGR Motor Duty Cycle	%	This parameter displays the EGR valve control duty signal from the ECM. When the small duty signal, the EGR valve is controlled to close. When the large duty signal, the EGR valve is controlled to open.
Boost Pressure Sensor	Volts	This parameter displays the voltage signal input to the ECM from boost pressure sensor.
Boost Pressure	kPa	This parameter displays the boost pressure in the intake manifold as calculated by the ECM using the signal input from the boost pressure sensor. True boost pressure is determined by subtracting BARO from the actual reading.
ASR Control Accelerator	%	This parameter indicates the range of the operation with the accelerator pedal when anti slip regulator (ASR) system operates is displayed. 100% indicates that the ASR does not operate. Fuel injection decreases in the effect of ASR system while becoming a low percentage.
Vehicle Speed	km/h / MPH	This parameter indicates the vehicle speed calculated by the ECM based on input from the vehicle speed sensor (VSS) to the ECM. The Tech 2 will display a high value at higher vehicle speeds, and a low value at lower vehicle speeds.
Cylinder 1 Compensation	mm ³ /st	This parameter displays the adjustment of fuel volume for cylinder 1 at low engine speed area (from idle to around 1000RPM) as calculated by the ECM. When the compensation volume is negative, the fuel volume is reducing. When the compensation volume is positive, the fuel volume is increasing. If there is a cylinder that is excessively high or low, it may indicate faulty fuel injector, weak or slightly seized cylinder. Or fuel injector ID code may incorrectly programmed.
Cylinder 2 Compensation	mm ³ /st	This parameter displays the adjustment of fuel volume for cylinder 2 at low engine speed area (from idle to around 1000RPM) as calculated by the ECM. When the compensation volume is negative, the fuel volume is reducing. When the compensation volume is positive, the fuel volume is increasing. If there is a cylinder that is excessively high or low, it may indicate faulty fuel injector, weak or slightly seized cylinder. Or fuel injector ID code may incorrectly programmed.
Cylinder 3 Compensation	mm ³ /st	This parameter displays the adjustment of fuel volume for cylinder 3 at low engine speed area (from idle to around 1000RPM) as calculated by the ECM. When the compensation volume is negative, the fuel volume is reducing. When the compensation volume is positive, the fuel volume is increasing. If there is a cylinder that is excessively high or low, it may indicate faulty fuel injector, weak or slightly seized cylinder. Or fuel injector ID code may incorrectly programmed.

Tech 2 Parameter	Units Displayed	Definitions
Cylinder 4 Compensation	mm ³ /st	This parameter displays the adjustment of fuel volume for cylinder 4 at low engine speed area (from idle to around 1000RPM) as calculated by the ECM. When the compensation volume is negative, the fuel volume is reducing. When the compensation volume is positive, the fuel volume is increasing. If there is a cylinder that is excessively high or low, it may indicate faulty fuel injector, weak or slightly seized cylinder. Or fuel injector ID code may incorrectly programmed.
Engine Mode	Halt Mode / Wait Mode / Crank Mode / Fuel Mode	This parameter displays the state of engine. "Wait Mode" indicates the ignition switch is turned ON position. "Crank Mode" indicates the engine is during crank. "Fuel Mode" indicates the engine is run. "Halt Mode" indicates the ignition switch is turned OFF position.
QWS Switch	On / Off	This parameter displays the input status of the engine warm up switch to the ECM. The Tech 2 will display On or Off. On indicates the engine warm up switch is closing the engine quick warm up system request circuit to the ECM. Off indicates the engine warm up switch is open.
Ignition Switch	On / Off	This parameter displays the input status of the ignition switch to the ECM. The Tech 2 will display On or Off. On indicates the ignition switch is turned ON position.
Starter Switch	On / Off	This parameter displays the input status of the starter switch to the ECM. The Tech 2 will display On or Off. On indicates the ignition switch is turned at START position.
Clutch Switch	On / Off	This parameter displays the state of the clutch pedal as determined by the ECM based on an input from the clutch pedal switch. The Tech 2 will display On or Off. On indicates the clutch pedal is not being push down. Off indicates the clutch switch is being depressed.
Park/ Neutral Switch	On / Off	This parameter displays the input status of the neutral switch (M/T) to the ECM. The Tech 2 will display On or Off. On indicates the neutral switch is ON position (actual position).
Parking Switch	On / Off	This parameter displays the input status of the park brake switch to the ECM. The Tech 2 will display On or Off. On indicates the park brake is ON position (lever is pulled position).
Exhaust Brake Switch	On / Off	This parameter displays the input status of the exhaust brake switch to the ECM. The Tech 2 will display On or Off. On indicates the exhaust brake switch is closing the exhaust brake request circuit to the ECM and allowing to energize the exhaust brake throttle valve and intake throttle solenoid valve depending on driving condition. Off indicates the exhaust brake switch is open and exhaust brake relay will not engage.
Exhaust Valve R/L Control Status	On / Off	This parameter displays the commanded state of the exhaust brake solenoid valve control circuit. The Tech 2 will display On or Off. On indicates the exhaust brake solenoid valve is being energized by the ECM. Off indicates the exhaust brake solenoid valve is not being commanded On by the ECM.
PTO Switch	On / Off	This parameter displays input status of the PTO switch to the ECM. The Tech 2 will display On or Off.
PTO Accelerator Opening	%	This parameter displays the angle of the remote PTO accelerator sensor as calculated by the ECM using the signal input from the

Tech 2 Parameter	Units Displayed	Definitions
		remote accelerator pedal position sensors.
PTO Accelerator Sensor	Volts	This parameter displays the voltage signal sent to the ECM from the PTO throttle sensor. The PTO throttle sensor is a range of values indicating a low voltage when the throttle sensor is not operated to a high voltage when the throttle sensor is fully operated.
Idle Up Volume Sensor	Volts	This parameter displays the voltage signal sent to the ECM from the idle up sensor. The idle up sensor has a range of values indicating a low voltage when the idle up sensor rotates in a counterclockwise direction to a high voltage when the idle up sensor rotates in a clockwise direction.
A/C Clutch Switch	On / Off	This parameter displays the state of the air conditioning (A/C) compressor engage. On indicates the ECM receiving an A/C compressor On signal. Off indicates the ECM is not receiving an A/C compressor On signal.
ABS Exh. Brake Cut Request	On / Off	This parameter displays the input status of the exhaust brake cut request from the EHCU (ABS unit) to the ECM. The Tech 2 will display On or Off. On indicates the EHCU is commanding to the ECM to release the exhaust brake. Off indicates the EHCU is not being commanded.
TCM Exh. Brake Cut Request	On / Off	To be removed
Idle Stop System	On / Off	To be removed
Refrigerator Switch	On / Off	This parameter displays the state of the refrigerator compressor engage. On indicates the ECM receiving a refrigerator compressor On signal. Off indicates the ECM is not receiving a refrigerator compressor On signal.
Glow Relay Control	On / Off	This parameter displays the commanded state of the glow relay control circuit. The Tech 2 will display On or Off. On indicates the glow relay control circuit is being grounded by the ECM, allowing voltage to the glow plugs. Off indicates the glow relay is not being commanded ON by the ECM.
Diagnostic Switch		To be removed
Engine Start Counts		To be removed
Engine Start Counts (Starter Exchange)		To be removed



ENGINE CONTROL SYSTEM CHECK SHEET		Inspectors Name	
Customer's Name		Model & Model Year	
Driver's Name		Chassis No.	
Date Vehicle Brought In		Engine No.	
License No.		Odometer Reading	Km/miles
Problem Symptoms ☐ Engine Does Not Run ☐ Engine does not crank ☐ No initial combustion ☐ No complete combustion			
☐ Hard Start ☐ Engine cranks slowly ☐ Other ()			
☐ Incorrect Idle ☐ Abnormal idling speed ☐ High idling speed (RPM) ☐ Low idling speed (RPM) ☐ Rough idling ☐ Other ()			
☐ Poor Driveability ☐ Hesitation, sag, stumble ☐ Surge, chuggles ☐ Cut out, misses ☐ Lack of power, sluggishness, sponginess ☐ Other ()			
☐ Engine Stall ☐ Soon after starting ☐ After accelerator pedal depressed ☐ During A/C operation ☐ After accelerator pedal released ☐ Shifting from N to D ☐ Other ()			
☐ Others ☐ Black smoke ☐ White smoke ☐ Poor fuel economy ☐ Fuel knock, combustion noise ☐ Other ()			
Dates problem occurred			
Problem frequency ☐ Constant ☐ Intermittently (times per day/month) ☐ Once only ☐ Other ()			
Condition When Problem Occurs Weather ☐ Fine ☐ Cloudy ☐ Rainy ☐ Snow ☐ Various/Other ()			
Outside Temperature ☐ Hot (approx.) ☐ Warm ☐ Cool ☐ Cold (approx.) ☐ Any temperature			
Place ☐ Highway ☐ Suburbs ☐ City area ☐ Uphill ☐ Downhill ☐ Rough road ☐ Other ()			
Load Condition ☐ Over (approx. tons) ☐ No load ☐ Other (approx. tons)			
Engine Temperature ☐ Cold ☐ Warming up ☐ After warming up ☐ Any temperature ☐ Other ()			
Engine Operation ☐ Starting ☐ Just after starting (Min.) ☐ Idling ☐ Racing ☐ Driving ☐ Constant speed ☐ Acceleration ☐ Deceleration ☐ A/C switch On/Off ☐ Other ()			
Fuel Amount ☐ Full ☐ Above 1/2 ☐ Below 1/2 ☐ Near empty			
Fuel Bland			
Condition of MIL		☐ Remains On ☐ Intermittently turns On ☐ Does not turn On	
Diagnostic Trouble Code (DTC) or Flash Code	Present Code	☐ Nothing ☐ Code No. ()	
	History Code	☐ Nothing ☐ Code No. ()	
Other Additional Condition			

Engine Cranks but Does Not Run

Description

The Engine Cranks but Does Not Run diagnostic table is an organized approach to identifying a condition that causes an engine to not start. The diagnostic table directs the service technician to the appropriate system diagnosis. The diagnostic table assumes the following conditions are met:

- The batteries are completely charged and terminals are cleaned and tight.
- The engine cranking speed is normal.
- There is adequate fuel in the fuel tank.
- There is no air in the fuel line.
- Filters (Air, Fuel) are clean.
- Fuses and slow blow fuses are normal.

Notice:

The engine will start even if the exhaust brake is fully engaged.

Test Description

The numbers below refers to the step number on the diagnostic table.

5. If the suction control valve (SCV) low control circuits between the ECM and the SCV are shorted to ground, "SCV Feedback" will be 500mA or more low during the crank.

Engine Cranks but Does Not Run

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM)

Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check –Engine Controls?	—	Go to Step 2	Go to <i>Diagnostic System Check Engine Controls</i>
2	1. Install the Tech 2. 2. Crank the engine for the specified amount of time. 3. Monitor the Diagnostic Trouble Code (DTC) Information with a Tech 2. Does the Tech 2 display any DTCs that failed this ignition?	15 seconds	Go to Diagnostic Trouble Code (DTC) List	Go to Step 3
3	1. Turn OFF the ignition. 2. Wait 2 minutes for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. 4. Observe the Fuel Rail Pressure (FRP) parameter with a Tech 2. Is the FRP parameter the specified value?	1.0 Volts	Go to Step 4	Go to Step 6
4	Notice: If the vehicle has run out of fuel, air may be trapped in the fuel system. 1. Make sure the fuel tank(s) have adequate fuel and the fuel quality is good (take a sample). 2. Observe the Fuel Rail Pressure Sensor parameter on the Tech 2 while cranking over the engine for 5 seconds. Does the FRP Sensor reach the minimum specified value during crank?	1.4 Volts	Go to Step 9	Go to Step 5

Step	Action	Value(s)	Yes	No
5	Observe the SCV (suction control valve) Feedback parameter on the Tech 2 while cranking over the engine for 5 seconds. Does the SCV Feedback parameter more than the specified value during crank?	800 mA	Go to Fuel System Check - Fuel System Section	Go to Step 8
6	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins1, 2 and 3). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP sensor circuit at the harness connector of the ECM (pins 82, 87, 90 and 101). 6. Test for high resistance on each FRP sensor circuit. 7. Repair the circuit(s) as necessary. Did you find and correct the condition?	-	Go to Step 12	Go to Step 7
7	Replace the fuel rail pressure (FRP) sensor. Refer to Fuel Rail Replacement in this section. Did you complete the replacement?	-	Go to Step 12	-
8	1. Test the SCV low control circuits between the engine control module (ECM) (pins 89 & 97) and the SCV (pin 2) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	-	Go to Step 12	Go to Step 11
9	1. Check for normal readings at key up for the following sensor inputs: Use the Tech 2 Data List or a known good vehicle to determine nominal values. • Engine Coolant Temperature (ECT) Sensor • Barometric Pressure (BARO) • Boost Pressure Sensor • EGR Valve Position Sensor 2. Repair the circuit(s) or replace the sensor as necessary. Did you find and correct the condition?	-	Go to Step 12	Go to Step 10



Step	Action	Value(s)	Yes	No
10	1. Other possible causes for the no-start condition: • Engine mechanical timing • Flywheel installed incorrectly causing the crankshaft position (CKP) sensor to be incorrectly timed to the engine. Disconnect sensor and attempt to start engine to verify. • Heavily restricted intake or exhaust plugged solid. • Poor engine compression. • Water or gasoline contamination in fuel. 2. Repair as necessary. Did you find and correct the condition?	-	Go to Step 12	-
11	Important: Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement/Fuel Injector ID Code Programming in this section. Did you complete the replacement?	-	Go to Step 12	-
12	1. Reconnect all previously disconnected harness connector(s). 2. Turn OFF the ignition for 30 seconds. 3. Attempt to start the engine. Does the engine start and continue to run?	-	Go to Step 13	Go to Step 2
13	Observe the DTC information with the Tech 2. Are there any DTCs that you have not diagnosed?		Go to Diagnostic Trouble Code (DTC) List	System OK

Fuel System Check

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the engine control module (ECM) using the suction control valve (SCV) dependant upon values from the FRP sensor attached to the fuel rail. In case of fuel rail overpressure, a pressure limiter valve threaded into the fuel rail will open to release overpressure and return fuel back to the fuel tank.

The Fuel System Check diagnostic table directs the service technician to the appropriate fuel system diagnosis. The diagnostic table assumes the following conditions are met:

- The batteries are completely charged.
- The engine cranking speed is normal.
- There is adequate fuel in the fuel tank.
- There is no air in the fuel line.

Diagnostic Aids

- The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight or if there is a crack in one of the fuel hoses. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load.
- If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted. Perform bleeding of fuel system after refilling.

Notice:

The Fuel Rail Pressure display in the Tech 2 is difference pressure (actual value – desired value).

Step	Action	Value(s)	Yes	No
1	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Diagnostic Trouble Code (DTC) Information of the engine control module with a Tech 2. Are any DTC(s) set?	-	Refer to Applicable Diagnosis Trouble Code (DTC) in Engine Control Section	Go to Step 2

Step	Action	Value(s)	Yes	No
2	1. Inspect the high pressure side between the fuel supply pump and the fuel injectors for fuel leakage. The following components may contain an external leak: ▪ Fuel supply pump ▪ Fuel rail ▪ Pressure limiter valve ▪ Flow damper valve ▪ Fuel rail pressure (FRP) sensor ▪ Fuel pipe between the fuel supply pump and fuel rail ▪ Fuel pipe between the fuel rail and fuel injectors ▪ Each fuel pipe sleeve nuts Notice: Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel in the engine oil. 2. Repair any fuel system leaks as necessary. Did you find and correct the condition?	-	Go to Step 18	Go to Step 3
3	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. Notice: The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load. 3. Pump the priming pump on the fuel filter until it becomes firm. If there is a leak on the suction side of the fuel system between the priming pump and the fuel supply pump, the priming pump will not build up sufficient firmness and fuel leakage may occur. 4. Repair any fuel system leaks as necessary. Did you find and correct the condition?	-	Go to Step 18	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Make sure the fuel tank(s) have adequate fuel and the fuel quality is good (take a sample). 2. Bleed the air from the fuel system as necessary. Refer to Fuel System Air Bleeding in this section. 3. Start the engine and let idle. If the engine does not start, continue to crank. 4. Observe the Fuel Rail Pressure with the Tech 2. Is the FRP display less than the specified value?	-725psi (-5 MPa)	System OK	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector from the cylinder head cover case. 3. Remove the rubber fuel hose from the fuel filter housing (fuel supply pump side). Use a pan to catch the fuel leakage from the removed fuel line. Important: The fuel vacuum pump/pressure gauge connector and the adapter hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the tools line may damage the fuel supply pump. 4. Connect the suction side fuel pressure adapter EN-47667 with fuel vacuum/pressure gauge assembly J-44638 in series with the filter housing and the disconnected fuel hose. Ensure the service tool and fuel line connections are tight. 5. Bleed the fuel system by priming the priming pump until it becomes firm, then crank over the engine for a maximum of 5 seconds. Perform procedure three times. 6. Fully clamp off a fuel hose as close to the fuel tank as possible (this will draw vacuum on the fuel system). You can also disconnect a fuel line and plug it. 7. Crank over the engine (for no longer than 15 seconds) while monitoring the fuel pressure/vacuum gauge. Notice: Release the clamp or open the plug when the gauge is likely to be more than 8 inHg during the test. Can a vacuum of at least the specified amount be pulled on the fuel system?	8 inHg	Go to Step 8	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Inspect the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. 2. Draw fuel from the fuel tank at the fuel line going to the fuel pickup tube to verify a clean stream of fuel comes out (use the hand-held vacuum pump J-23738-A with a clear hose or equivalent) This will ensure the fuel pickup tube is not cracked drawing air into the fuel line. 3. Repair as necessary. Did you find and correct the condition?	-	Go to Step 18	Go to Step 7
7	1. Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in this section. 2. Retest the fuel system vacuum test described in Step 5. Can a vacuum of at least the specified amount be pulled on the fuel system?	8 inHg	Go to Step 18	Go to Step 17
8	1. Unclamp or unplug the fuel line from Step 5 and reconnect the fuel line. 2. Prime the priming pump until firmness is felt. 3. Crank over the engine for 5 seconds. 4. Repeat steps 2 and 3 three times to bleed the fuel system. 5. Crank over the engine (for no longer than 15 seconds at a time) while monitoring the fuel pressure/vacuum gauge. Does the vacuum/pressure gauge ever indicate a larger than the specified value?	5 inHg	Go to Step 9	Go to Step 10
9	1. Inspect the fuel lines between the fuel supply pump and fuel tank for being crushed or kinked. 2. Inspect the fuel tank vent hose for a plugged or kinked condition. 3. Inspect the fuel cap for a plugged condition. 4. Inspect inside the fuel tank (if possible) for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. 5. Repair the condition as necessary. Did you find and correct the condition.	-	Go to Step 18	Go to Step 14

Step	Action	Value(s)	Yes	No
10	1. Turn OFF the ignition. 2. Make sure the in-line harness connector (H-125) is disconnected from the cylinder head cover case. 3. Remove the eyebolt from the cylinder head that connects to the leak-off pipe. 4. Connect the fuel adapter J-45873-103 with hose assembly to the cylinder head. Install the hose into a graduated cylinder from the J-45873-100 kit. 5. Remove the eyebolt from the pressure limiter valve that connects to the leak-off pipe. 6. Connect the fuel adapter J-45873-105 with hose assembly to the pressure limiter valve. 7. Crank over the engine for 10 seconds. Make sure the batteries are fully charged and the engine is cranking at normal speed for each test. Notice: Perform this test three times and take the average of the fuel return amount coming from the cylinder head. Is fuel leaking from the pressure limiter valve?	-	Go to Step 15	Go to Step 11
11	Is the average fuel return coming from the cylinder head less than the specified value?	15 ml	Go to Step 12	Go to Step 13
12	1. Remove each glow plug from the cylinder head. 2. Inspect the tip of the plugs for wet fuel. Did you find wet fuel on any glow plug?	-	Go to Step 16	Go to Step 17
13	1. Remove the cylinder head cover and injector harness in order to connect the fuel adapter J-45873-101 with hose assembly to each injector leak-off port. Refer to Fuel Injector Replacement in this section. 2. Crank over the engine for 10 seconds. Important: Replacement injector must be programmed. 3. Replace the injector(s) that return more fuel than the specified value. Refer to Fuel Injector Replacement/Fuel Injector Flow Rate Programming in this section. 4. Retest after replacement of the fuel injector(s). Did you complete the replacement?	3 ml	Go to Step 18	-
14	Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in this section. Did you complete the replacement?	-	Go to Step 18	-

Step	Action	Value(s)	Yes	No
15	Replace the pressure limiter valve. Refer to Fuel Rail Replacement in this section. Did you complete the replacement?	-	Go to Step 18	-
16	Important: Replacement injector must be programmed. Replace the appropriate injector(s) that was leaking fuel found at Step. Refer to Fuel Injector Replacement/Fuel Injector Flow Rate Programming in this section. Did you complete the replacement?	-	Go to Step 18	-
17	Important: The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. Replace the fuel supply pump. Refer to Fuel Supply Pump Replacement/Fuel Supply Pump Relearn Procedure in this section. Did you complete the replacement?	-	Go to Step 18	-
18	1. Reconnect all previously disconnected harness connector(s) or components. 2. Turn OFF the ignition for 30 seconds. 3. Bleed the air from the fuel system. Refer to Fuel System Air Bleeding in this section. 4. Start the engine and let idle. 5. Observe the Fuel Rail Pressure parameter with the Tech 2. Is the Fuel Rail Pressure less than the specified value?	- 725psi (- 5 MPa)	System OK	Go to Step 1

Diagnostic Trouble Code (DTC) List

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0087	227	ON (Keep ON during same ignition cycle)	Fuel Rail Pressure (FRP) Too Low	- DTCs P1095, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	- The ECM detects that the fuel rail pressure is 0 MPa (0 psi) (1.0 volt) for 5 seconds when the engine speed is between 0 - 600 RPM. OR - The ECM detects that the fuel rail pressure is less than 15MPa (2180psi) (1.2 volts) for 5 seconds when the engine speed is higher than 900RPM.	- Fuel leaking at high pressure side. - Loss fuel or less fuel in the fuel tank. - Pressure limiter valve opening pressure drop. - SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. (P0192 or P0193 may also set.) - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.
P0088	118	ON (Keep ON during same ignition cycle)	Fuel Rail Pressure (FRP) Too High	- DTCs P1092, P1093, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running.	The ECM detects that the fuel rail pressure is more than 185 MPa (26850 psi) (3.9 volts) for longer than 5 second.	- SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. (P0192 or P0193 may also set.) - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.
P0088	118	ON (Keep ON during same ignition cycle)	Fuel Rail Pressure (FRP) Too High	- DTCs P1092, P1093, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running.	The ECM detects that the fuel rail pressure is more than 190 MPa (27550 psi) (4.0 volts) for longer than 5 second during the ignition cycle after first stage has occurred.	- SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. (P0192 or P0193 may also set.) - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.
P0089	151	ON (Keep ON during same ignition cycle)	Fuel Pressure Regulator Performance (Fuel Rail Pressure Deviation)	- DTCs P0090, P0192, P0193 P1092, P0201, P0202, P0203, P0204, P0611, P0612, P1093, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running. - The SCV control duty cycle is more than 40% or commanded fuel supply is less than 90mm3/sec.	- The ECM detects that the actual fuel rail pressure is higher than desired pressure by 20MPa (2900psi) (0.3 volts) for longer than 5 seconds when the engine speed is between 0 - 600 RPM. OR - The ECM detects that the actual fuel rail pressure is higher than desired pressure by 40 MPa (5800 psi) (0.6 volts) for longer than 5 seconds when the engine speed is higher than 900 RPM.	- SCV is sticking. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. (P0192 or P0193 may also set.) - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.
P0090	247	ON (Keep ON during same ignition cycle)	Fuel Pressure Regulator Solenoid Control Circuit Invalid (Suction Control Valve Solenoid Circuit Invalid)	- DTCs P1630 is not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The SCV commanded duty cycle is between 10 – 90 %.	- The ECM detects that the SCV feedback current is less than 50 mA. OR - The ECM detects that the SCV feedback current is more than 2400 mA OR - The ECM detects that the difference of SCV desired current and feedback current is more than 1000 mA .	- SCV control high circuit is open circuit or high resistance. - SCV control high circuit is high resistance, short to ground, short to battery or ignition voltage. - SCV control low circuit is open circuit, high resistance or short to ground. - SCV control low circuit is short to battery or ignition voltage. - Faulty SCV. - Faulty ECM. Notice: SCV is internal to fuel supply pump assembly.
P0107	71	ON	Barometric Pressure (BARO) Sensor Circuit Low Voltage	- DTCs P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the BARO sensor signal voltage is less than 0.5 volts for 5 seconds.	- Sensor 5V reference circuit is open circuit, high resistance. - Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1632 may also set.) - Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. - Poor harness connector connection. - Faulty BARO sensor. - Faulty ECM.
P0108	71	ON	Barometric Pressure (BARO) Sensor Circuit High Voltage	- DTCs P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the BARO sensor signal voltage is more than 4.9 volts for 5 seconds.	- Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1632 may also set.) - Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty BARO sensor. - Faulty ECM.
P0112	22	ON	Intake Air Temperature (IAT) Sensor Circuit Low Voltage	- DTCs P1630 and P1632 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the IAT sensor signal voltage is less than 0.1 volts for 5 seconds.	- Sensor signal circuit is short to ground or short to the low reference circuit. - Faulty IAT sensor. - Faulty ECM.
P0113	22	ON	Intake Air Temperature (IAT) Sensor Circuit High Voltage	- DTCs P1630 and P1632 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine run time is longer than 3 minutes.	The ECM detects that the IAT sensor signal voltage is more than 4.8 volts for 5 seconds.	- Sensor signal circuit is open circuit, high resistance, short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty IAT Sensor. - Faulty ECM.
P0117	23	ON	Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage	- DTCs P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the ECT sensor signal voltage is less than 0.1 volts for 5 seconds.	- Sensor signal circuit is short to ground or short to the low reference circuit. - Faulty ECT sensor. - Faulty ECM.
P0118	23	ON	Engine Coolant Temperature (ECT) Sensor Circuit High Voltage	- DTCs P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine run time is longer than 3 minutes.	The ECM detects that the ECT sensor signal voltage is more than 4.8 volts for 5 seconds.	- Sensor signal circuit is open circuit, high resistance, short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty ECT Sensor. - Faulty ECM.
P0182	211	ON	Fuel Temperature Sensor Circuit Low Voltage	- DTCs P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the FT sensor signal voltage is less than 0.1 volts for 5 seconds.	- Sensor signal circuit is short to ground or short to the low reference circuit. - Faulty FT sensor. - Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0183	211	ON	Fuel Temperature Sensor Circuit High Voltage	- DTCs P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine run time is longer than 3 minutes.	The ECM detects that the FT sensor signal voltage is more than 4.8 volts for 5 seconds.	- Sensor signal circuit is open circuit, high resistance, short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty FT Sensor. - Faulty ECM.
P0192	245	ON	Fuel Rail Pressure (FRP) Sensor Circuit Low Voltage	- DTCs P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the FRP sensor signal voltage is less than 0.7 volts.	- Sensor 5V reference circuit is open circuit or high resistance. - Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1635 may also set.) - Sensor signal circuit is short to ground or short to the low reference circuit. - Poor harness connector connection. - Faulty FRP sensor. - Faulty ECM.
P0193	245	ON	Fuel Rail Pressure (FRP) Sensor Circuit High Voltage	- DTCs P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the FRP sensor signal voltage is more than 4.5 volts.	- Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1635 may also set.) - Sensor signal circuit is open circuit, high resistance, short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty FRP sensor. - Faulty ECM.
P0201	271	ON (Keep ON during same ignition cycle)	Injector 1 Control Circuit (Cylinder 1 Injector Control Circuit)	- The ignition switch is ON. - The battery voltage is more than 18 volts. - The engine is running.	The ECM detects that the cylinder #1 fuel injector solenoid coil control circuit is open.	- Cylinder #1 fuel injector solenoid coil control circuit is open circuit. - Faulty cylinder #1 fuel injector. - Faulty ECM.
P0202	272	ON (Keep ON during same ignition cycle)	Injector 2 Control Circuit (Cylinder 2 Injector Control Circuit)	- The ignition switch is ON. - The battery voltage is more than 18 volts. - The engine is running.	The ECM detects that the cylinder #2 fuel injector solenoid coil control circuit is open.	- Cylinder #2 fuel injector solenoid coil control circuit is open circuit. - Faulty cylinder #2 fuel injector. - Faulty ECM.
P0203	273	ON (Keep ON during same ignition cycle)	Injector 3 Control Circuit (Cylinder 3 Injector Control Circuit)	- The ignition switch is ON. - The battery voltage is more than 18 volts. - The engine is running.	The ECM detects that the cylinder #3 fuel injector solenoid coil control circuit is open.	- Cylinder #3 fuel injector solenoid coil control circuit is open circuit. - Faulty cylinder #3 fuel injector. - Faulty ECM.
P0204	274	ON (Keep ON during same ignition cycle)	Injector 4 Control Circuit (Cylinder 4 Injector Control Circuit)	- The ignition switch is ON. - The battery voltage is more than 18 volts. - The engine is running.	The ECM detects that the cylinder #4 fuel injector solenoid coil control circuit is open.	- Cylinder #4 fuel injector solenoid coil control circuit is open circuit. - Faulty cylinder #4 fuel injector. - Faulty ECM.
P0219	543	OFF	Engine Overspeed	-	Engine speed is higher than 4300 RPM for 1 second.	- Engine over-running. - Faulty CKP sensor. - Faulty ECM. - Electrical interference. - Magnetic interference.
P0234	42	ON	Turbocharger Engine Overboost	- DTCs P0237, P0238, P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running. - The fuel injection quantity is more than a calculated value.	The ECM detects that the boost pressure is more than 228 kPa (33 psi) for 3 seconds.	- Boost pressure sensor low reference circuit is intermittently open circuit or high resistance. - Faulty boost pressure sensor. - Faulty turbocharger waste gate valve. - Restricted intake or collapsed hose between the intake throttle and sensor. - Intake throttle plate sticking in the closed position. - Faulty BARO sensor. - Faulty ECM.
P0236	65	ON	Turbocharger Engine Underboost	- DTCs P0107, P0108, P0237, P0238, P1630, P1634 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running. - The fuel injection quantity is more than a calculated value.	- The ECM detects that the boost pressure is less than 78 kPa (11 psi) for 20 seconds when the engine speed is less than 900 RPM. - OR - The ECM detects that the boost pressure is less than 82 to 151 kPa (12 to 22 psi) for 20 seconds when the engine speed is between 1200 and 3000 RPM. - When the barometric pressure (BARO) is lower than 100 kPa, the BARO is subtracted from 100 kPa (100 kPa – BARO) is added to the thresholds.	- Boost pressure sensor 5V reference circuit is intermittently open circuit or high resistance. - Boost pressure sensor signal circuit is intermittently open circuit or high resistance. - Faulty boost pressure sensor. - Air leakage. - Intake duct is disconnected. - Intake system is obstructed. - Faulty turbocharger waste gate valve. - Faulty turbocharger. (Shaft stick) - Faulty BARO sensor. - Faulty ECM.
P0237	32	ON	Turbocharger Boost Sensor Circuit Low Voltage	- DTCs P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the boost pressure sensor signal voltage is less than 0.1 volts for 3 seconds.	- Sensor 5V reference circuit is open circuit, high resistance. - Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1634 may also set.) - Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. - Poor harness connector connection. - Faulty boost pressure sensor. - Faulty ECM.
P0238	32	ON	Turbocharger Boost Sensor Circuit High Voltage	- DTCs P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the boost pressure sensor signal voltage is more than 4.9 volts for 3 seconds.	- Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1634 may also set.) - Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty boost pressure sensor. - Faulty ECM.
P0335	15	ON (Keep ON during same ignition cycle)	Crankshaft Position (CKP) Sensor No Pulse	- DTCs P0336, P0340, P0341 and P1345 are not set. - The ignition switch is ON. - The CMP sensor signal pulse is detected.	The ECM detects that the CKP sensor pulses are not generated.	- Sensor high circuit is open circuit, short to ground or short to battery, short to ignition voltage or short to any 5V reference. - Sensor low circuit is open circuit, or short to battery, short to ignition voltage or short to any 5V reference. - Sensor shield wire open circuit, short to battery, short to ignition voltage or short to any 5V reference. - Sensor harness connector is poor connection. - Faulty CKP sensor. - Electrical interference. - Magnetic interference. - Faulty ECM. - Sensor installation is poor condition. - Faulty sensor wheel.
P0336	15	ON (Keep ON during same ignition cycle)	Crankshaft Position (CKP) Sensor Extra or Missing	- DTCs P0335, P0340, P0341 and P1345 are not set. - The ignition switch is ON. - The CMP sensor signal pulse is detected.	The ECM detects extra or missing CKP sensor pulses	- Sensor high circuit is intermittently open circuit or poor connection. - Sensor low circuit is intermittently open circuit or poor connection. - Faulty CKP sensor. - Electrical interference. - Magnetic interference. - Sensor installation is poor condition. - Faulty sensor wheel.

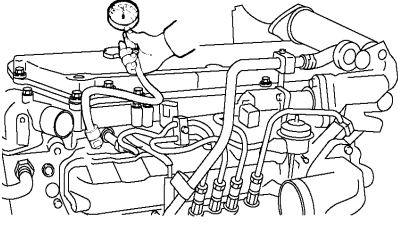
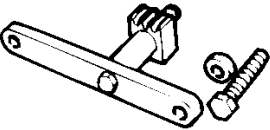
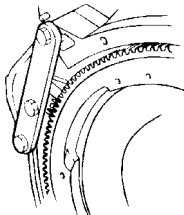
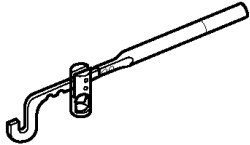
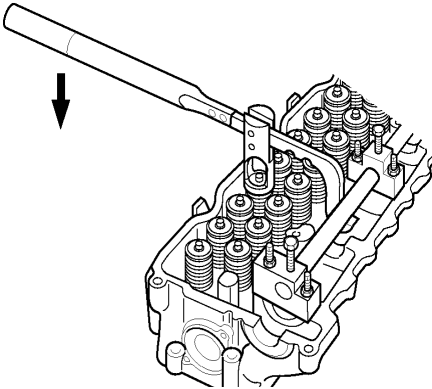
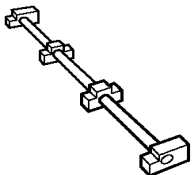
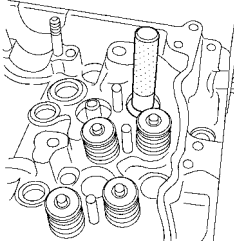
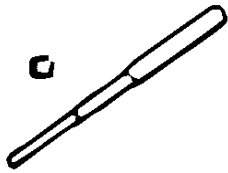
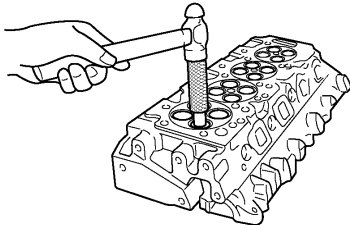
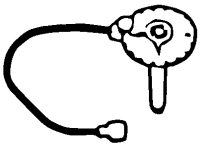
DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0340	14	ON (Keep ON during same ignition cycle)	Camshaft Position (CMP) Sensor No Pulse	- DTCs P0335, P0336, P0341 and P1345 are not set. - The ignition switch is ON. - The CKP sensor signal pulse is detected.	The ECM detects that the CMP sensor pulses are not generated.	- Sensor 12V reference circuit is open circuit, short to ground circuit. - Sensor signal circuit is open circuit, short to battery, short to ignition voltage or short to any 5V reference. - Sensor shield wire open circuit or short to battery or ignition voltage - Sensor harness connector is poor connection. - Faulty CMP sensor. - Electrical interference. - Magnetic interference. - Faulty ECM. - Sensor installation is poor condition. - Faulty sensor wheel.
P0341	14	ON at Next Ignition Cycle (Keep ON during same ignition cycle)	Camshaft Position (CMP) Sensor Pulse Faulty or Invalid	- DTCs P0335, P0336, P0340 and P1345 are not set. - The ignition switch is ON. - The CKP sensor signal pulse is detected.	The ECM detects extra or missing CMP sensor pulses	- Sensor 12V feed circuit is intermittently open circuit or poor connection. - Sensor signal circuit is intermittently open circuit or poor connection. - Sensor shield wire is intermittently open circuit or poor connection. - Faulty CMP sensor. - Electrical interference. - Magnetic interference. - Sensor installation is poor condition. - Faulty sensor wheel.
P0380	66	ON (Keep ON during same ignition cycle)	Glow Plug Relay Control Circuit	The battery voltage is between 16 - 32 volts.	- The ECM detects a high voltage condition on the glow relay control circuit for longer than 3 seconds when the glow relay is commanded ON. OR - The ECM detects a low voltage condition on the glow relay control circuit for longer than 3 seconds when the glow relay is commanded OFF.	- Glow relay battery feed circuit is open circuit or high resistance. - Glow relay control circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage circuit. - Poor harness connector connection. - Glow relay is poor installation. - Faulty glow relay. - Faulty ECM.
P0381	67	OFF	Glow Indicator Lamp Control Circuit	The ignition voltage is more than 18 volts.	- The ECM detects a high voltage condition on the glow indicator lamp control circuit for longer than 3 seconds when the lamp is commanded ON. OR - The ECM detects a low voltage condition on the glow indicator lamp control circuit for longer than 3 seconds when the lamp is commanded OFF.	- Glow indicator lamp battery feed circuit is open circuit or high resistance. - Glow indicator lamp control circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage circuit. - Poor harness connector connection. - Faulty instrument panel cluster (meter assembly). - Faulty glow indicator bulb. - Faulty ECM.
P0485	44	ON	Exhaust Gas Recirculation (EGR) Position Sensor Circuit Low Voltage	- DTCs P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the EGR valve position sensor signal voltage is less than 0.1 volts for 3 seconds.	- Sensor 5V reference circuit is open circuit, high resistance. - Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1635 may also set.) - Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. - Poor harness connector connection. - Faulty EGR valve position sensor. - Faulty ECM. Notice: EGR valve position sensor is internal to EGR valve assembly.
P0486	44	ON	Exhaust Gas Recirculation (EGR) Position Sensor Circuit High Voltage	- DTCs P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the EGR valve position sensor signal voltage is more than 4.9 volts for 3 seconds.	- Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1635 may also set.) - Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty EGR valve position sensor. - Faulty ECM. Notice: EGR valve position sensor is internal to EGR valve assembly.
P0488	45	ON (Keep ON during same ignition cycle)	Exhaust Gas Recirculation (EGR) Position Sensor Performance	- DTCs P0485, P0486, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The battery voltage is between 20 - 32 volts. - The desired EGR valve position is stable condition. - The EGR valve control duty cycle is more than 90%.	The ECM detects difference of desired EGR valve position and actual EGR valve position is more than 20% for 10 seconds.	- EGR valve position sensor 5V reference circuit is high resistance. - EGR valve position sensor signal circuit is high resistance - EGR valve position sensor low reference circuit is high resistance. - EGR valve position sensor harness connector is poor connection or corrosion. - Faulty EGR valve position sensor. - Faulty EGR valve. (Stick) - Faulty ECM. Notice: EGR valve position sensor is internal to EGR valve assembly.
P0500	25	ON	Vehicle Speed Sensor (VSS) Circuit No Pulse	- The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine speed is more than 2000 RPM. - The commanded fuel supply is OFF.	The ECM detects that the VSS signals are not generated for 5 seconds.	- Sensor +12V circuit is open circuit. - Sensor signal circuit is open circuit, short to ground or short to battery or ignition voltage. - Sensor low reference circuit is open circuit. - Sensor harness connector is poor connection. - Sensor internal circuit is open circuit or short circuit. - Electrical interference. - ECM malfunction.
P0501	25	ON	Vehicle Speed Sensor (VSS) Performance	- The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the VSS signals are changed larger than a predetermined speed.	- Sensor +12V circuit is open circuit. - Sensor signal circuit is open circuit, short to ground or short to battery or ignition voltage. - Sensor low reference circuit is open circuit. - Sensor harness connector is poor connection. - Sensor internal circuit is open circuit or short circuit. - Electrical interference. - ECM malfunction.
P0601	53	ON	ECM Program Code Checksum	-	The ECM detects a total sum of ROM data is not equal to registered value.	Faulty ECM.
P0603	54	ON	ECM Memory Failure	-	- The ECM detects a reading or writing form EEPROM data is failed. OR - The ECM detects a total sum of EEPROM data is not equal to registered value.	Faulty ECM.
P0606	51	ON	Control Module Internal Performance	The battery voltage is more than 16 volts.	The ECM detects an internal main CPU malfunction during initialization.	Faulty ECM.
P0606	52	ON	Control Module Internal Performance	The battery voltage is more than 16 volts.	The ECM detects an internal sub CPU malfunction.	Faulty ECM.
P0611	34	ON	Fuel Injector Control Module Group 1	The battery voltage is more than 18 volts.	The ECM detects an internal common 1 fuel injector charge up circuit malfunction.	Faulty ECM. Notice: Injector charge up circuit is internal to ECM.
P0612	34	ON	Fuel Injector Control Module Group 2	The battery voltage is more than 18 volts.	The ECM detects an internal common 2 fuel injector charge up circuit malfunction.	Faulty ECM. Notice: Injector charge up circuit is internal to ECM.
P0615	19	ON	Starter Relay Control Circuit	The battery voltage is between 16 - 32 volts.	- The ECM detects a high voltage condition on the starter cut relay control circuit for longer than 3 seconds when the relay is commanded ON. OR - The ECM detects a low voltage condition on the starter cut relay control circuit for longer than 3 seconds when the relay is commanded OFF.	- Starter cut relay battery feed circuit is open circuit or high resistance. - Starter cut relay control circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage circuit. - Poor harness connector connection. - Starter cut relay is poor installation. - Faulty starter cut relay. - Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P0650	77	OFF	Malfunction Indicator Lamp (MIL) Control Circuit	The ignition voltage is more than 18 volts.	- The ECM detects a high voltage condition on the MIL control circuit for longer than 2 seconds when the MIL is commanded ON. OR - The ECM detects a low voltage condition on the MIL control circuit for longer than 2 seconds when the MIL is commanded OFF.	- MIL battery feed circuit is open circuit or high resistance. - MIL control circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage circuit. - Poor harness connector connection. - Faulty instrument panel cluster (meter assembly). - Faulty MIL bulb. - Faulty ECM.
P1093	227	ON (Keep ON during same ignition cycle)	Fuel Rail Pressure (FRP) Too Low	- DTCs P1095, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The SCV control duty cycle is less than 33% or commanded fuel supply is more than 28000 mm3/sec.	- The ECM detects that the actual fuel rail pressure is lower than desired pressure by 10 MPa (1450 psi) (0.2 volts) for longer than 5 seconds when the engine speed is between 0 – 900 RPM. OR - The ECM detects that the actual fuel rail pressure is lower than desired pressure by 15 MPa (2170 psi) (0.2 volts) for longer than 5 seconds when the engine speed is higher than 1200RPM.	- Fuel leaking at high pressure side. - Loss fuel or less fuel in the fuel tank. - Pressure limiter valve opening pressure drop. - SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. (P0192 or P0193 may also set.) - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.
P1094	226	ON (Keep ON during same ignition cycle)	Fuel Rail Pressure (FRP) Too Low	- DTCs P0117, P0118, P0500, P0501, P1095, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running. - The accelerator pedal position is 0%. - The engine coolant temperature is more than 50°C (122 °F). - The vehicle speed is less than 5 km/h (4 MPH). - The difference of desired engine idle speed and actual idle speed lower than 50 RPM.	- The engine speed is between 600 – 1500 RPM. - The fuel injection quantity is less than 100mm3/st. - The SCV commanded fuel is between 16,000 – 25,500mm3/sec. - Above conditions are met for 5 seconds.	- Loss fuel or less fuel in the fuel tank. - Pressure limiter valve opening pressure drop. - SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. (P0192 or P0193 may also set.) - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV regulator is part of the fuel supply pump assembly.
P1094	226	ON (Keep ON during same ignition cycle)	Fuel Rail Pressure (FRP) Too Low	- DTCs P1095, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running. - The accelerator pedal position is 0%. - The engine coolant temperature is more than 50°C (122 °F). - The vehicle speed is more than 50 km/h (31 MPH). - The fuel injection quantity is 0mm3/st.	The ECM detects that the actual fuel rail pressure is shapely dropped more than 12MPa (1740psi) (0.2 volts) when the engine cuts fuel.	- Loss fuel or less fuel in the fuel tank. - Pressure limiter valve opening pressure drop. - SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. (P0192 or P0193 may also set.) - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV regulator is part of the fuel supply pump assembly.
P1095	225	ON (Keep ON during same ignition cycle)	Fuel Rail Pressure (FRP) Too Low (Fuel Rail Pressure Limiter Activation)	- DTCs P0192, P0193, P1630 and P1635 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the fuel rail pressure drops quickly form more than 170 MPa (24,660 psi) (3.7 volts) to less than 80 MPa (11,600psi) (2.3 volts), and then the actual fuel rail pressure is lower than desired pressure by 30 MPa (4350 psi) (0.5 volts).	- Loss fuel or less fuel in the fuel tank. - SCV is sticking. - Faulty fuel injector. - Fuel suction side looseness, kinks or blocked. - Faulty or clogged fuel filter. - Excessive air in the fuel suction side. - Faulty FRP sensor. - FRP sensor circuit is intermittently open circuit, poor connection or corrosion. (P0192 or P0193 may also set.) - FRP sensor circuit high resistance. - SCV circuit is intermittently open circuit, poor connection or corrosion. - SCV circuit high resistance. - Faulty fuel supply pump. Notice: SCV is part of the fuel supply pump assembly.
P1173	542	ON	Engine Overheat	- DTCs P0117, P0118, P1630 and P1634 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts. - The engine is running.	The ECM detects that the ECT is more than 110°C (230°F) for 5 seconds.	- Engine overheat. - Faulty engine cooling system - Faulty ECT sensor.
P1220	28	ON	PTO Engine Speed Selector Sensor Circuit High Voltage	- DTCs P1630 and P1631 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the PTO accelerator sensor signal voltage is more than 4.8 volts.	- Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1631 may also set.) - Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty PTO accelerator sensor. - Faulty ECM.
P1225	31	ON	Engine Idle Speed Selector Sensor Circuit	- DTCs P1630 and P1631 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	- The ECM detects that the idle up control sensor signal voltage is less than 0.1 volts for 3 seconds. OR - The ECM detects that the idle up control sensor signal voltage is more than 4.9 volts for 3 seconds.	- Sensor 5V reference circuit is open circuit, high resistance. - Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1635 may also set.) - Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1631 may also set.) - Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. - Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Poor harness connector connection. - Faulty idle up control sensor. - Faulty ECM.
P1261	158	ON (Keep ON during same ignition cycle)	Injector Positive Voltage Circuit Group 1 Load Short	- The ignition switch is ON. - The battery voltage is more than 18 volts. - Engine is running.	- The ECM detects that the cylinder #1 or #4 fuel injector solenoid coil control circuit is short to ground or voltage circuit. - The ECM detects that the common 1 fuel injector drive circuit is open, short to ground or short to voltage circuit.	
P1262	159	ON (Keep ON during same ignition cycle)	Injector Positive Voltage Circuit Group 2 Load Short	- Battery voltage is more than 9V. - Engine is running.	- The ECM detects that the cylinder #2 or #3 fuel injector solenoid coil control circuit is short to ground or voltage circuit. - The ECM detects that the common 2 fuel injector drive circuit is open, short to ground or short to voltage circuit.	
P1271	24	ON (Keep ON during same ignition cycle)	Accelerator Pedal Position (APP) Sensor 1-2 Correlation	- DTCs P1630, P1631 and P1632 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the APP sensor 1 and 2 are more than 45% out of range of each other.	- APP sensor 1 5V reference circuit is high resistance. - APP sensor 1 signal circuit is high resistance. - APP sensor 1 low reference circuit is high resistance. - APP sensor 2 5V reference circuit is high resistance. - APP sensor 2 signal circuit is high resistance. - APP sensor 2 low reference circuit is high resistance. - Poor harness connector connection. - Electrical interference. - Faulty APP sensor 1 or 2. - Faulty ECM. Notice: APP sensor 1 or 2 is internal to APP sensor assembly.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
P1277	24	ON	Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage	- DTCs P1630 and P1631 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the APP sensor 1 signal voltage is less than 0.2 volts.	- Sensor 5V reference circuit is open circuit, high resistance. - Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1631 may also set.) - Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. - Poor harness connector connection. - Faulty APP sensor 1. - Faulty ECM. Notice: APP sensor 1 is internal to APP sensor assembly.
P1278	24	ON	Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage	- DTCs P1630 and P1631 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the APP sensor 1 signal voltage is more than 4.9 volts.	- Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1631 may also set.) - Sensor signal circuit is short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty APP sensor 1. - Faulty ECM. Notice: APP sensor 1 is internal to APP sensor assembly.
P1282	24	ON	Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage	- DTCs P1630 and P1632 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the APP sensor 2 signal voltage is less than 0.2 volts.	- Sensor 5V reference circuit is open circuit or high resistance. - Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1632 may also set.) - Sensor signal circuit is short to ground or short to the low reference circuit. - Poor harness connector connection. - Faulty APP sensor 2. - Faulty ECM. Notice: APP sensor 2 is internal to APP sensor assembly.
P1283	24	ON	Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage	- DTCs P1630 and P1632 are not set. - The ignition switch is ON. - The ignition voltage is more than 18 volts.	The ECM detects that the APP sensor 2 signal voltage is more than 4.9 volts.	- Sensor 5V reference circuit is short to battery, ignition voltage circuit or short to any 12V reference circuit. (P1635 may also set.) - Sensor signal circuit is open circuit, high resistance, short to any 5V or 12V reference circuit, short to battery or ignition voltage circuit. - Sensor low reference circuit is open circuit or high resistance. - Poor harness connector connection. - Faulty APP sensor 2. - Faulty ECM. Notice: APP sensor 2 is internal to APP sensor assembly.
P1345	16	ON (Keep ON during same ignition cycle)	Crankshaft Position & Camshaft Position Signal Off Phase	- DTCs P0335, P0336, P0340 and P0341 are not set. - The ignition switch is ON. - The CKP sensor signal pulse is detected. - The CMP sensor signal pulse is detected.	The ECM detects that the CKP sensor signals and CMP sensor signals are out of synchronization	Incorrect engine mechanical timing.
P1625	416	ON	ECM Main Relay Circuit	- DTC P1603 is not set. - The ignition switch is ON. - The ignition switch ON time is longer than 3 seconds.	The ECM detects that a low voltage condition on the ECM main relay voltage feed circuit for longer than 5 seconds when the ECM main relay is commanded ON.	- ECM main relay coil side power supply circuit is open circuit or high resistance. - ECM main relay voltage feed circuit is open circuit or high resistance. - Faulty ECM main relay.
P1625	416	ON	ECM Main Relay Circuit	The ignition switch is OFF.	The ECM detects that a high voltage condition on the ECM main relay voltage feed circuit for longer than 5 seconds when the ECM main relay is commanded OFF.	- ECM main relay coil side power supply circuit is short to battery voltage circuit. - ECM main relay voltage feed circuit is short to battery voltage circuit. - Faulty ECM main relay.
P1630	36	ON	Control Module Internal Performance	-	The ECM detects an internal A/D converter malfunction.	Faulty ECM.
P1631	55	ON (Keep ON during same ignition cycle)	5 Volt Reference Circuit 1	- DTC P1630 is not set. - The battery voltage is between 16 – 32 volts. - The ignition switch is ON.	- The ECM detects that the 5 volts reference circuit 1 voltage is less than 4.5 volts. OR - The ECM detects that the 5 volts reference circuit 1 voltage is more than 5.5 volts.	- APP sensor 1 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - Idle up sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - PTO accelerator sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - Faulty APP sensor 1. - Faulty Idle up sensor. - Faulty PTO accelerator sensor. - Faulty ECM. Notice: APP sensor 1 is internal to APP sensor assembly.
P1632	55	ON (Keep ON during same ignition cycle)	5 Volt Reference Circuit 2	- DTC P1630 is not set. - The battery voltage is between 16 – 32 volts. - The ignition switch is ON.	- The ECM detects that the 5 volts reference circuit 2 voltage is less than 4.5 volts. OR - The ECM detects that the 5 volts reference circuit 2 voltage is more than 5.5 volts.	- APP sensor 2 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - BARO sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - Faulty APP sensor 2. - Faulty BARO sensor. - Faulty ECM. Notice: APP sensor 2 is internal to APP sensor assembly.
P1633	55	ON (Keep ON during same ignition cycle)	5 Volt Reference Circuit 3	- DTC P1630 is not set. - The battery voltage is between 16 – 32 volts. - The ignition switch is ON.	- The ECM detects that the 5 volts reference circuit 3 voltage is less than 4.5 volts. OR - The ECM detects that the 5 volts reference circuit 3 voltage is more than 5.5 volts.	
P1634	55	ON (Keep ON during same ignition cycle)	5 Volt Reference Circuit 4	- DTC P1630 is not set. - The battery voltage is between 16 – 32 volts. - The ignition switch is ON.	- The ECM detects that the 5 volts reference circuit 4 voltage is less than 4.5 volts. OR - The ECM detects that the 5 volts reference circuit 4 voltage is more than 5.5 volts.	- Boost pressure sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - Faulty boost pressure sensor. - Faulty ECM.
P1635	55	ON (Keep ON during same ignition cycle)	5 Volt Reference Circuit 5	- DTC P1630 is not set. - The battery voltage is between 16 – 32 volts. - The ignition switch is ON.	- The ECM detects that the 5 volts reference circuit 5 voltage is less than 4.5 volts. OR - The ECM detects that the 5 volts reference circuit 5 voltage is more than 5.5 volts.	- FRP sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - EGR valve position sensor 5V reference circuit is short to ground, short to any 12V reference circuit, short to battery or ignition voltage circuit. - Faulty FRP sensor. - Faulty EGR valve position sensor. - Faulty ECM. Notice: EGR valve position sensor is internal to EGR valve assembly.
P1681	46	ON	Exhaust Brake Control Solenoid Valve Control Circuit Low Voltage	- The battery voltage is between 16 – 32 volts. - The ignition switch is ON. - The engine is running.	The ECM detects a low voltage condition on the exhaust throttle control solenoid valve control circuit for longer than 3 second when the exhaust brake is commanded OFF.	- Exhaust throttle solenoid valve voltage feed circuit is open circuit or high resistance. - Exhaust throttle solenoid valve control circuit is open circuit, high resistance or short to ground. - Poor harness connector connection. - Faulty exhaust throttle solenoid valve. - Faulty ECM.
P1682	46	ON	Exhaust Brake Control Solenoid Valve Control Circuit High Voltage	- The battery voltage is between 16 – 32 volts. - The ignition switch is ON. - The engine is running.	The ECM detects a high voltage condition on the exhaust throttle control solenoid valve control circuit for longer than 3 second when the exhaust brake is commanded ON.	- Exhaust throttle solenoid valve control circuit is short to battery or ignition voltage circuit. - Faulty exhaust throttle solenoid valve. - Faulty ECM.

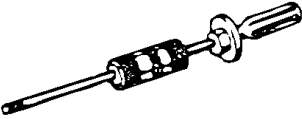
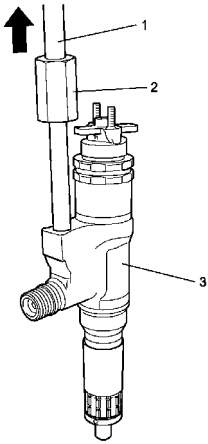
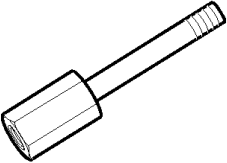
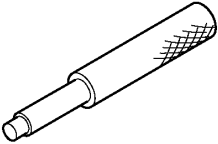
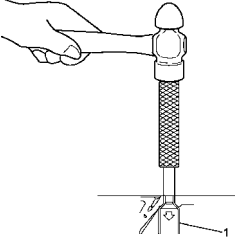
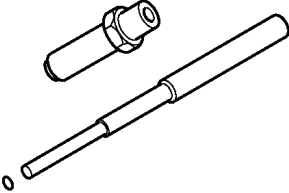
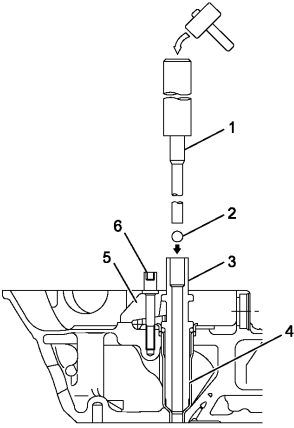
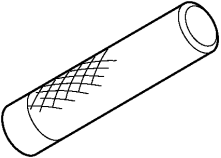
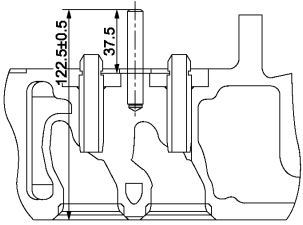
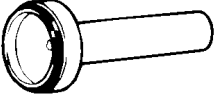
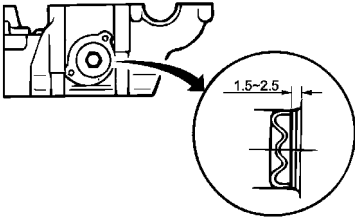
DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Suspected Cause
U2104	84	ON	CAN Bus Reset Counter Overrun	The ignition switch is ON.	The ECM detects that the CAN Bus OFF is detected.	- CAN high circuit is short to ground, short to battery or ignition voltage. - CAN low circuit is short to ground, short to battery or ignition voltage. - Electrical interference. - Faulty ECM. - Faulty TCM. - Faulty EHCU.
U2106	85	ON	Lost CAN Communications With Transmission Control System	The ignition switch is ON.	The ECM detects that the CAN Bus messages from the TCM are not being received.	- CAN high circuit is short to ground, short to battery or ignition voltage. - CAN low circuit is short to ground, short to battery or ignition voltage. - Electrical interference. - Faulty ECM. - Faulty TCM.
U2108	89	OFF	Lost Communications With ABS/TCS Control System	The ignition switch is ON.	The ECM detects that the CAN Bus messages from the EHCU (ABS control unit) are not being received.	- CAN high circuit is short to ground, short to battery or ignition voltage. - CAN low circuit is short to ground, short to battery or ignition voltage. - Electrical interference. - Faulty ECM. - Faulty EHCU.

SERVICE SPECIAL TOOL (SST)

SST Illustration	SST Usage	SST Name	SST Parts Number
		Compression Gage Gage Adapter	J-26999-12 / 5-8840-2675-0 EN-46722 / 5-8840-2815-0
		Crankshaft Stopper	EN-47680 / 5-8840-2230-0
		Valve Spring Replacer	J-43263 / 5-8840-2621-0
		Pivot Assembly	EN-46721 / 5-8840-2808-0
		Valve Stem Seal Installer	EN-47685 / 9-8522-1289-0
		Valve Guide Replacer	J-43272 / 5-8840-2628-0
 5884002660		Angle Gauge	5-8840-0266-0

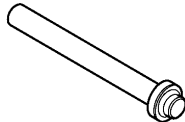
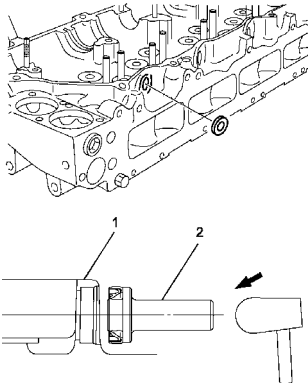
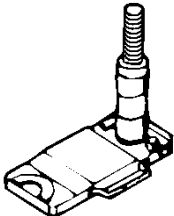
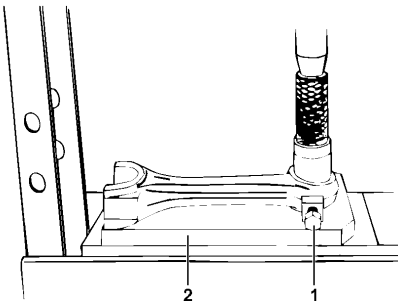
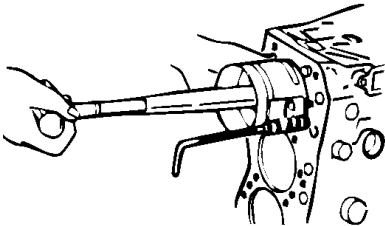
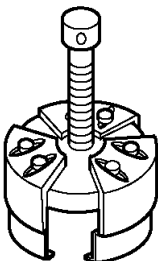
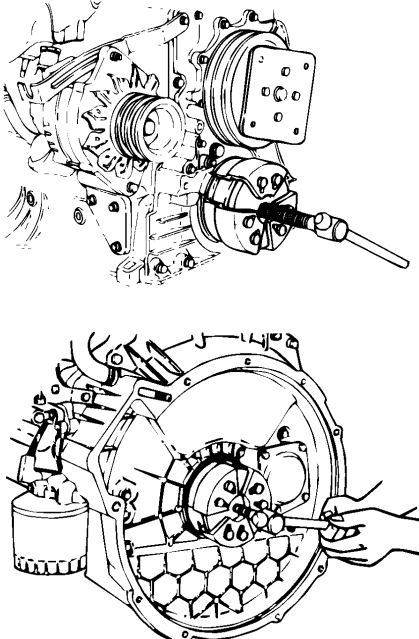
ISUZU

N*R 4HK1-TC Engine-116

SST Illustration	SST Usage	SST Name	SST Parts Number
		Sliding Hammer	J-23907 / 5-8840-0019-0
		Fuel Injector Remover	EN-46720 / 5-8840-2826-0
		Nozzle Sleeve Remover	J-43265 / 5-8840-2623-0
		Nozzle Sleeve Installer	J-43266 / 5-8840-2624-0
		Bridge Installer	J-43268 / 5-8840-2626-0
		Sealing Cap Installer	EN-47690 / 5-8840-2222-0

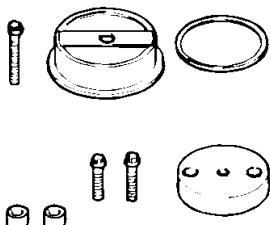
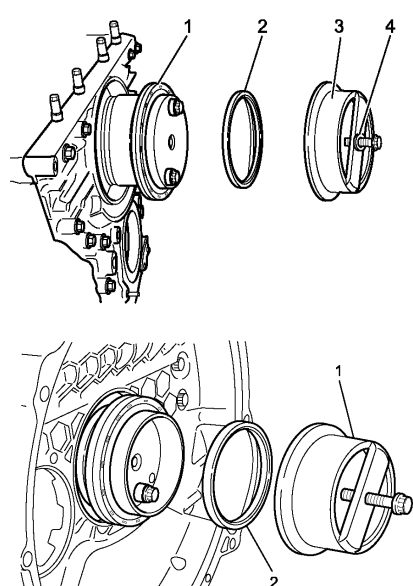
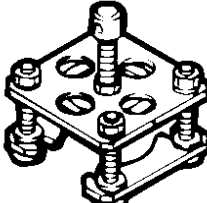
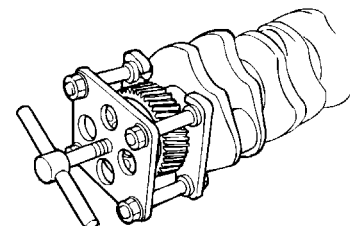
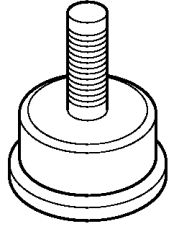
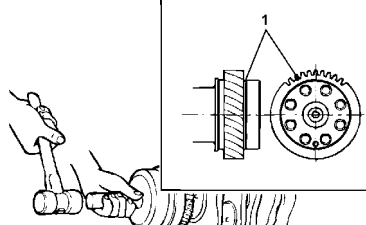
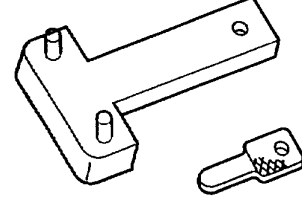
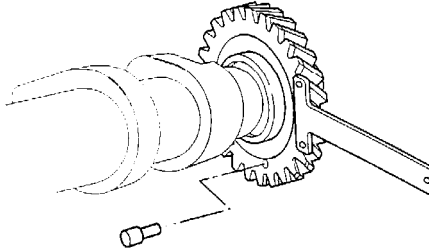
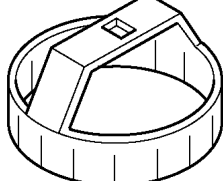
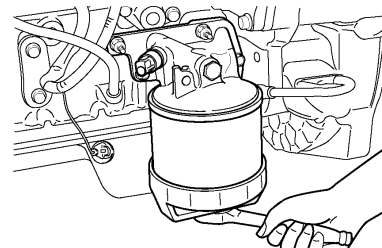
ISUZU

N*R 4HK1-TC Engine-117

SST Illustration	SST Usage	SST Name	SST Parts Number
		Oil Seal Installer	J-43269 / 5-8840-2627-0
		Connecting Rod Bush Replacer	EN-47682 / 5-8840-2340-0
		Piston Ring Compressor	J-8037 / 5-8840-9018-0
		Slinger Puller	J-43285 / 5-8840-26300-0

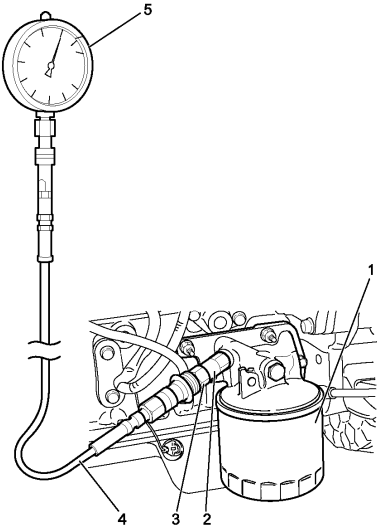
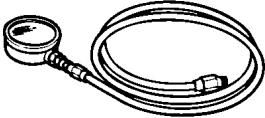
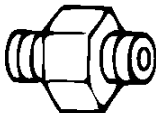
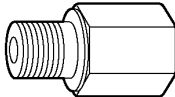
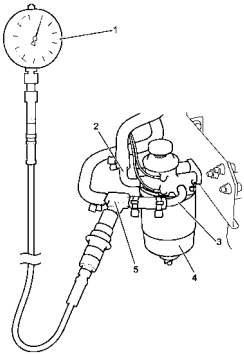
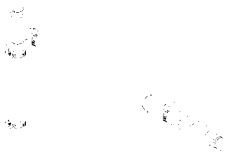
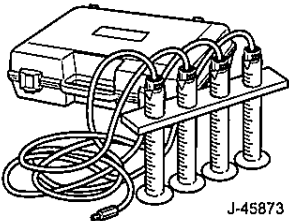
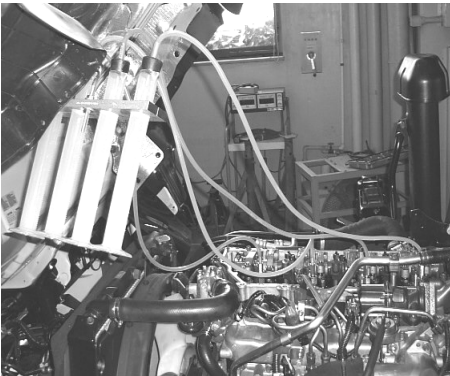
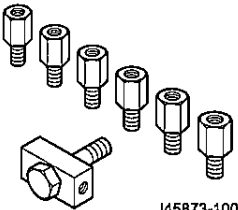
ISUZU

N*R 4HK1-TC Engine-118

SST Illustration	SST Usage	SST Name	SST Parts Number
		Oil Seal Installer Kit	J-43282 / 5-8840-2703-0
		Crankshaft Gear Puller	EN-47684 / 8-9439-618-0
		Crankshaft Gear Installer	J-41222 / 8-9439-6189-0
		Scissors Gear Spring Wrench	5-8840-2674-0
		Oil Filter Wrench	EN-47683 / 1-8522-1097-0

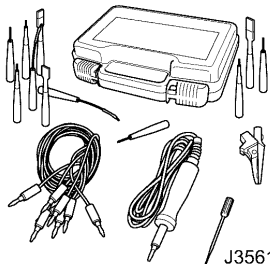
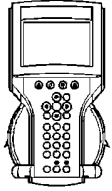
ISUZU

N*R 4HK1-TC Engine-119

SST Illustration	SST Usage	SST Name	SST Parts Number
		Fuel Filter Wrench	J-22700 / 5-8840-0253-0
		Oil Pressure Gauge	J-43620-20 /
		Hose	J-43630 /
		Connector	J-43630-14 /
		Oil Pressure Testing Adapter	J-46333 /
		Fuel Pressure Gauge	EN-47667 /
		Adapter	J-44638 /
 J-45873		Fuel Test Set	J-45873 /
 J45873-100		Adapter Kit	J45873-100 /

ISUZU

N*R 4HK1-TC Engine-120

SST Illustration	SST Usage	SST Name	SST Parts Number
 J35616-C		Connector Test Adapter Kit with Test Lamp	J-35616-C / 5-8840-2835-0
		Digital Multimeter	J-39200 / 5-8840-0285-0
		Tech 2 Kit	