SECTION 1F2

M161 ENGINE CONTROLS

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

TABLE OF CONTENTS

ENGINE AND ECM PROBLEM CHECK REPORT

VEHICLE AND CUSTOMER INFORMATION

Date Problem Occurred			
Customer Name		Vehicle Model	
Driver Name		VIN	
Purchase date		Engine Model	
License No.		Mileage	Km miles

MIL INFORMATION

Condition of MIL	☐ Remains on ☐ Sometimes illuminates ☐ Does not illuminate
DTC inspection (if available)	☐ Normal ☐ Malfunction code(s) (code) ☐ Freeze frame data ( )

PROBLEM DESCRIPTION

☐ Engine Does Not Start	☐ No cranking ☐ No initial combustion ☐ No complete combustion
☐ Hard to Start	☐ Slow cranking ☐ Others
☐ Poor Idling	☐ Incorrect first Idle ☐ Abnormal idle rpm ☐ High (rpm) ☐ Low (rpm) ☐ Idling Unstable ☐ Others
☐ Poor Driveability	☐ Hesitation ☐ Back fire ☐ Muffler explosion (after-burning) ☐ Surging ☐ Knocking ☐ Poor performance ☐ Other
☐ Engine Stall	☐ Soon after starting ☐ After accelerator pedal depressed ☐ After accelerator pedal released ☐ During A/C operation ☐ Shifting from N to D or D to N ☐ At full steering ☐ Others
☐ Others	

CONDITION WHEN PROBLEM OCCURS

Problem Frequency	☐ Constant ☐ Intermittent (times per day/month) ☐ Once only ☐ Others
Weather	☐ Fine ☐ Cloudy ☐ Rainy ☐ Snowy ☐ Various/Others
Ambient Temperature	☐ Hot ☐ Warm ☐ Cool ☐ Cold (approx.____°F/____°C)
Place	☐ Highway ☐ Suburbs ☐ Inner City ☐ Uphill ☐ Downhill ☐ Rough Road ☐ Others
Engine Temperature	☐ Cold ☐ Warming Up ☐ Before warming up ☐ After warm-up ☐ Any temp. ☐ Others
Engine Operation	☐ Starting ☐ Just after starting (min.) ☐ Idling ☐ Racing ☐ Driving ☐ Constant speed ☐ Acceleration ☐ Deceleration ☐ A/C switch ON/OFF ☐ Other

DIAGNOSTIC INFORMATION AND PROCEDURE
FAILURE CODE DIAGNOSIS

CLEARING FAILURE CODES

Notice: To prevent Engine Control Module (ECM) damage, the key must be OFF when disconnecting or reconnecting the power to the ECM (for example battery cable, ECM pigtail connector, ECM fuse, jumper cables, etc.)

Parameters listed in the table may not be exactly the same as your reading due to the type of instrument or other factors. If a failure code is displayed during the “TROUBLE CODE” in scan tool check mode, check the circuit for the code listed in the table below. For details of each code, turn to the page referred to under the “See Page” for the respective “Failure Code” in the below table.

Failure codes should be cleared after repairs have been completed.

FAILURE CODES TABLE

Failure code	See Page	Description
00	1F2-56	Engine coolant temperature sensor low voltage
01	1F2-56	Engine coolant temperature sensor high voltage
02	1F2-56	Engine coolant temperature sensor plausibility
03	1F2-52	Intake air temperature sensor low voltage
04	1F2-52	Intake air temperature sensor high voltage
05	1F2-52	Intake air temperature sensor plausibility
06	1F2-56	Engine coolant temperature insufficient for closed loop fuel control
08	1F2-28	System voltage too low
09	1F2-52	Mass air flow sensor plausibility
10	1F2-52	Mass air flow sensor low voltage
11	1F2-52	Mass air flow sensor high voltage
17	1F2-13	Crankshaft position sensor signal failure (no engine revolution signal)
18	1F2-13	Crankshaft position sensor signal failure (rpm > max. value)
19	1F2-17	Camshaft position sensor signal : No.1 cylinder recognition failure
20	1F2-13	Crankshaft position sensor signal failure (gap recognition failure)
21	1F2-80	Transmission coding failure
23	1F2-78	CAN communication failure : ASR/MSR
24	1F2-78	CAN communication failure : ABS
25	1F2-84	Communication with transponder missing
26	1F2-78	CAN communication failure : TCU (A/T only)
29	1F2-79	CAN communication failure : ID 200h not plausible
30	1F2-79	CAN communication failure : ID 208h not plausible
31	1F2-79	CAN communication failure : communication initialization failure
32	1F2-67	Engine rpm output circuit short circuit to battery
33	1F2-67	Engine rpm output circuit short circuit to ground or open
34	1F2-33	Fuel pump relay short circuit to battery
35	1F2-33	Fuel pump relay short circuit to ground or open
40	1F2-41	Purge control valve short circuit to battery
41	1F2-41	Purge control valve short circuit to ground or open

FAILURE CODES TABLE (Cont'd)

Failure code	See Page	Description
44	1F1-62	Cooling fan (HI) relay short circuit to power
45	1F1-62	Cooling fan (HI) relay short circuit to ground or open
54	1F1-41	Purge control circuit malfunction
56	1F1-23	No.1 knock sensor signal failure
58	1F1-17	Camshaft position sensor signal : No.1 cylinder synchronization failure
59	1F1-79	CAN communication failure : MSR data transmission not plausible
60	1F1-79	CAN communication failure : ASR data transmission not plausible
64	1F1-11	No ignition voltage output (No.1 ignition coil)
65	1F1-11	No ignition voltage output (No.2 ignition coil)
67	1F1-13	Crankshaft position sensor adaptation failure
68	1F1-25	Random/Multiple Misfire
71	1F1-29	Starter signal recognition failure
72	1F1-37	No.1 injector short circuit to battery
73	1F1-37	No.1 injector short circuit to ground or open
74	1F1-37	No.2 injector short circuit to battery
75	1F1-37	No.2 injector short circuit to ground or open
76	1F1-37	No.3 injector short circuit to battery
77	1F1-38	No.3 injector short circuit to ground or open
78	1F1-38	No.4 injector short circuit to battery
79	1F1-38	No.4 injector short circuit to ground or open
80	1F1-72	Oxygen sensor high voltage
81	1F1-73	Bank 1 system short term fuel trim adaptation below lean threshold
82	1F1-72	Oxygen sensor no activity detected
83	1F1-72	Oxygen sensor not lean after overrun fuel shut -off
84	1F1-72	Oxygen sensor slow response
85	1F1-72	Oxygen sensor heater failure
86	1F1-72	Oxygen sensor heater short circuit to battery
87	1F1-72	Oxygen sensor heater short circuit to ground or open
89	1F1-72	Oxygen sensor low voltage
93	1F1-73	Bank 1 system short term fuel trim adaptation above rich threshold
96	1F1-73	Bank 1 system short term fuel trim at rich stop
97	1F1-73	Bank 1 system short term fuel trim at lean stop
98	1F1-73	Bank 1 system idle adaptation failure (above rich threshold)
99	1F1-73	Bank 1 system idle adaptation failure (below lean threshold)
100	1F1-73	Bank 1 system learning control failure (rich, low load)
101	1F1-73	Bank 1 system learning control failure (lean, low load)
102	1F1-73	Bank 1 system learning control failure (rich, high load)
103	1F1-73	Bank 1 system learning control failure (lean, high load)
104	1F1-47	Throttle position sensor 1 low voltage
105	1F1-47	Throttle position sensor 1 high voltage

FAILURE CODES TABLE (Cont'd)

Failure code	See Page	Description
108	1F1-47	Throttle position sensor 2 low voltage
109	1F1-47	Throttle position sensor 2 high voltage
110	1F1-82	Throttle actuator learning data fault
116	1F1-47	Throttle actuator learning control failure
117	1F1-82	Exceed fuel-cut safety time
119	1F1-47	Throttle valve return spring failure
120	1F1-82	Cruise control interruption memory failure
121	1F1-47	Throttle actuator failure
122	1F1-59	Accelerator pedal position sensor signal failure
123	1F1-47	Different Mass air flow sensor signal with throttle position sensor
125	1F1-47	Both throttle position sensors failure
126	1F1-48	Throttle position sensor 1 not plausible with throttle position sensor 2
127	1F1-48	High permanent throttle signal
129	1F1-64	Cruise control "OFF" due to message counter failure
130	1F1-64	Vehicle speed signal failure
131	1F1-64	Vehicle speed signal failure
132	1F1-64	Cruise control lever failure
133	1F1-64	Cruise control acceleration failure
134	1F1-64	Cruise control deceleration failure
135	1F1-66	Stop lamp switch failure
136	1F1-80	ECU failure (RAM)
137	1F1-80	ECU failure (EPROM)
138	1F1-82	Call monitoring
139	1F1-82	Servo motor control output interruption memory failure
140	1F1-82	Servo motor open/short
141	1F1-84	Unprogramed ECU with immobilizer
142	1F1-80	Uncoded/unprogramed ECU
143	1F1-80	ECU failure (EEPROM/Flash-EPROM checksum failure)
144	1F1-80	ECU failure (coding ID checksum failure)
145	1F1-80	ECU failure (coding checksum failure)
146	1F1-80	ECU failure (programing checksum failure)
150	1F1-65	TCS input signal short circuit to battery
151	1F1-65	TCS input signal short circuit to ground or open
160	1F1-59	Accelerator pedal position sensor 1 low voltage
161	1F1-59	Accelerator pedal position sensor 1 high voltage
162	1F1-59	Accelerator pedal position sensor 2 low voltage
163	1F1-59	Accelerator pedal position sensor 2 high voltage
164	1F1-59	Accelerator pedal position sensor 1 not plausible with pedal position sensor 2
167	1F1-59	Both setpoint accelerator pedal position sensor defective
185	1F1-48	Mass air flow sensor and throttle position sensor failure
186	1F1-82	ECU failure (incompatible CPU)

FAILURE CODES TABLE (Cont'd)

Failure code	See Page	Description
187	1F1-82	ECU failure (CPUs communication failure)
188	1F1-82	ECU failure (CPU 2 configuration failure)
189	1F1-82	ECU failure (CPU 2 fault)
190	1F1-82	ECU failure (CPU run time failure between CPUs)
226	1F1-21	Camshaft actuator short circuit to battery
227	1F1-21	Camshaft actuator short circuit to ground or open
228	1F1-63	A/C compressor relay short circuit to battery
229	1F1-63	A/C compressor relay short circuit to ground or open
231	1F1-82	ECU failure (CPU 2 cruise control message counter failure)
232	1F1-82	Over decceleration limit (CPU 2)
233	1F1-82	Over acceleration limit (CPU 2)
234	1F1-82	Cruise control lever dual operation (CPU 2)
235	1F1-82	Cruise control lever safety terminal failure (CPU 2)
236	1F1-82	Unusual pedal position variation (CPU 2)
237	1F1-82	Unusual throttle position variation (CPU 2)
238	1F1-82	Unusual throttle controller monitor data comparison fault (CPU 2)
239	1F1-83	Unusual accelerator pedal position sensor comparison fault (CPU 2)
240	1F1-83	Throttle potentiometer comparision fault (CPU 2)
241	1F1-83	Unusual CPU communication (CPU 2)
242	1F1-83	Unusual CPU configuration (CPU 2)
243	1F1-83	A/D converter failure (CPU 2)
244	1F1-83	Accelerator pedal position sensor setpoint fault between CPU 1 and CPU 2
245	1F1-83	Position controller setpoint fault between CPU 1 and CPU 2
246	1F1-83	MSR setpoint fault between CPU 1 and CPU 2
247	1F1-83	Idle control setpoint fault between CPU 1 and CPU 2
248	1F1-83	A/D converteroverflow (CPU 2)
249	1F1-83	ROM f aul t (CPU 2)
250	1F1-83	RAM f aul t (CPU 2)
251	1F1-83	Cycle monitor fault (CPU 2)

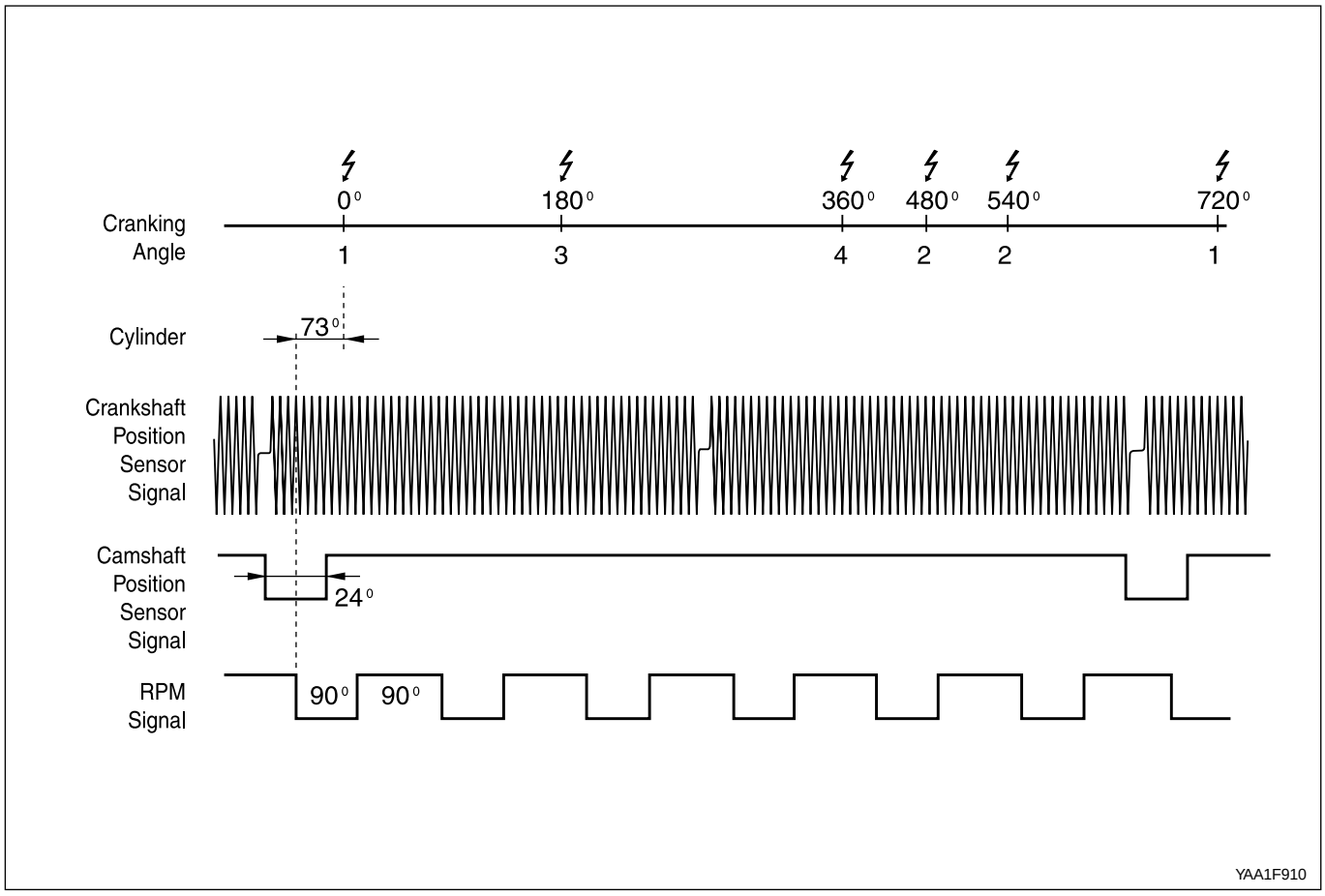
IGNITION SYSTEM

This ignition system does not use a conventional distributor and coil. It uses a crankshaft position sensor input to the Engine Control Module (ECM). The ECM then determines Electronic Spark Timing (EST) and triggers the electronic ignition system ignition coil.

This type of distributorless ignition system uses a ‘‘waste spark” method of spark distribution. Each cylinder is paired with the cylinder that is opposite it (2-3 or 1-4). The spark occurs simultaneously in the cylinder coming up on the compression stroke and in the cylinder coming up on the exhaust stroke. The cylinder on the exhaust stroke requires very little of the available energy to fire the spark plug. The remaining energy is available to the spark plug in the cylinder on the compression stroke.

These systems use the EST signal from the ECM to control the EST. The ECM uses the following information:

- Engine load (mass air flow sensor).
- Engine temperature.
- Intake air temperature.
- Crankshaft position.
- Engine speed (rpm).



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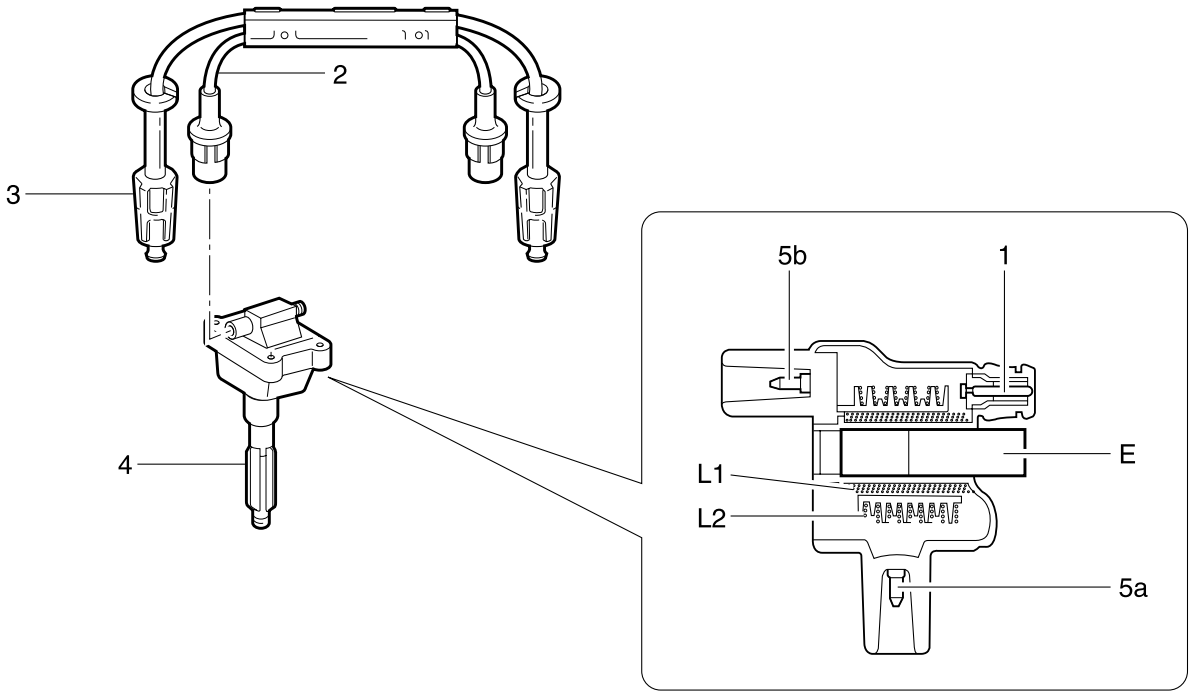
IGNITION COIL



1 Control Cable Connection
2 Ignition Cable
3 Spark Plug Connector
4 Coupling Plug
5a, 5b Secondary Voltage Connection
E Iron Core
L1 Secondary Ignition Coil
L2 Primary Ignition Coil

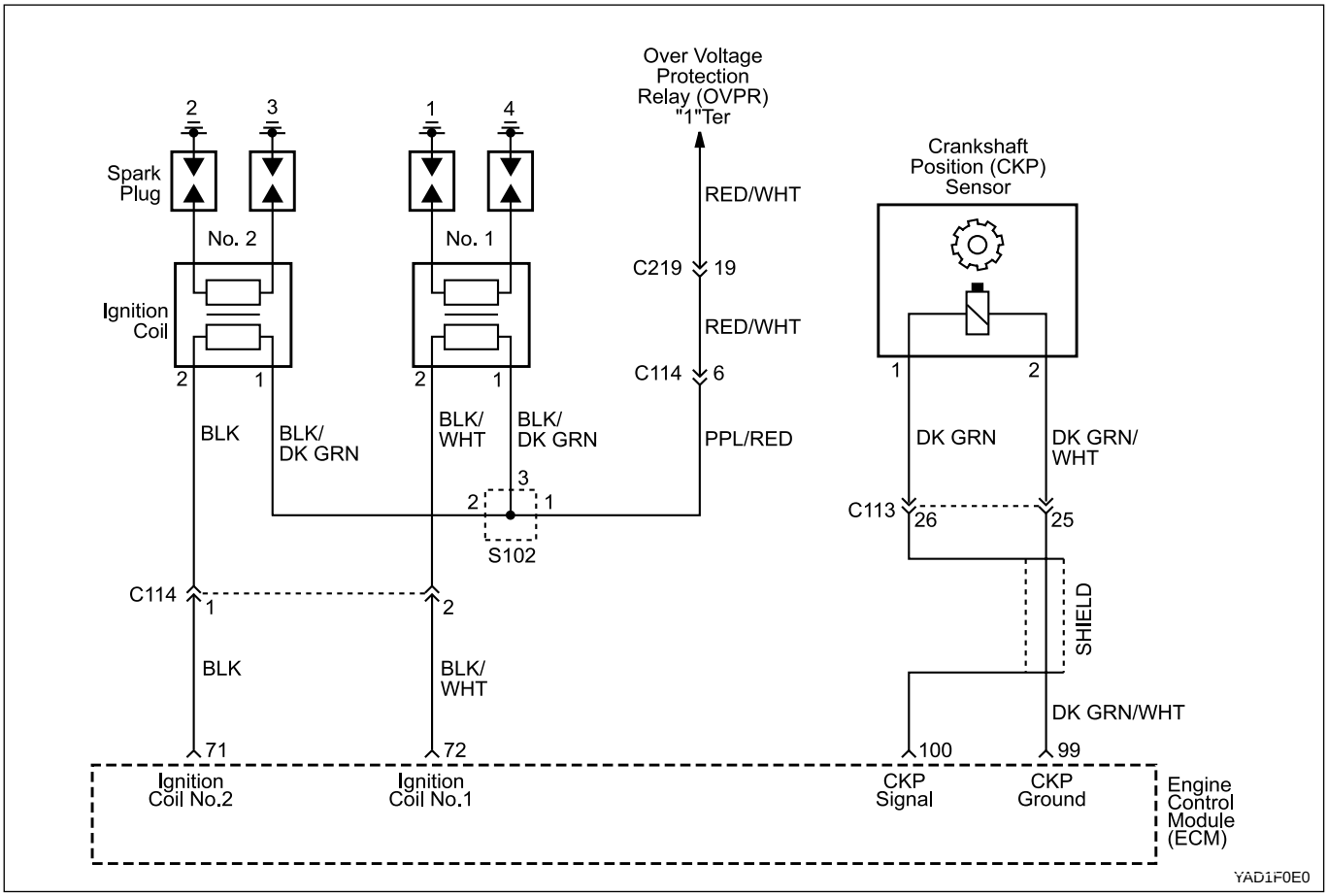
The Electronic Ignition (EI) system ignition coil is located on the cylinder head cover. The double ended coils receive the signal for the Engine Control Module (ECM) which controls the spark advance.

Each EI system ignition coil provides the high voltage to two spark plugs simultaneously;

T1/1: cylinder 1 and 4

T1/2: cylinder 2 and 3

The EI system ignition coil is not serviceable and must be replaced as an assembly.



Failure Code	Description	Trouble Area	Maintenance Hint
64	No ignition voltage output (No. 1 ignition coil)	Malfunction of ignition circuit Primary current values or secondary short circuit	• Inspection the ECM pin 71 and 72 about short circuit or open with bad contact • Inspection the power source to ignition coil • Inspection the ignition coil, high tension cords etc. • Inspection the spark plug (wet, cracks, wear, improper gap, burned electrodes, heavy deposit) • Inspection the ECM
65	No ignition voltage output (No. 2 ignition coil)		

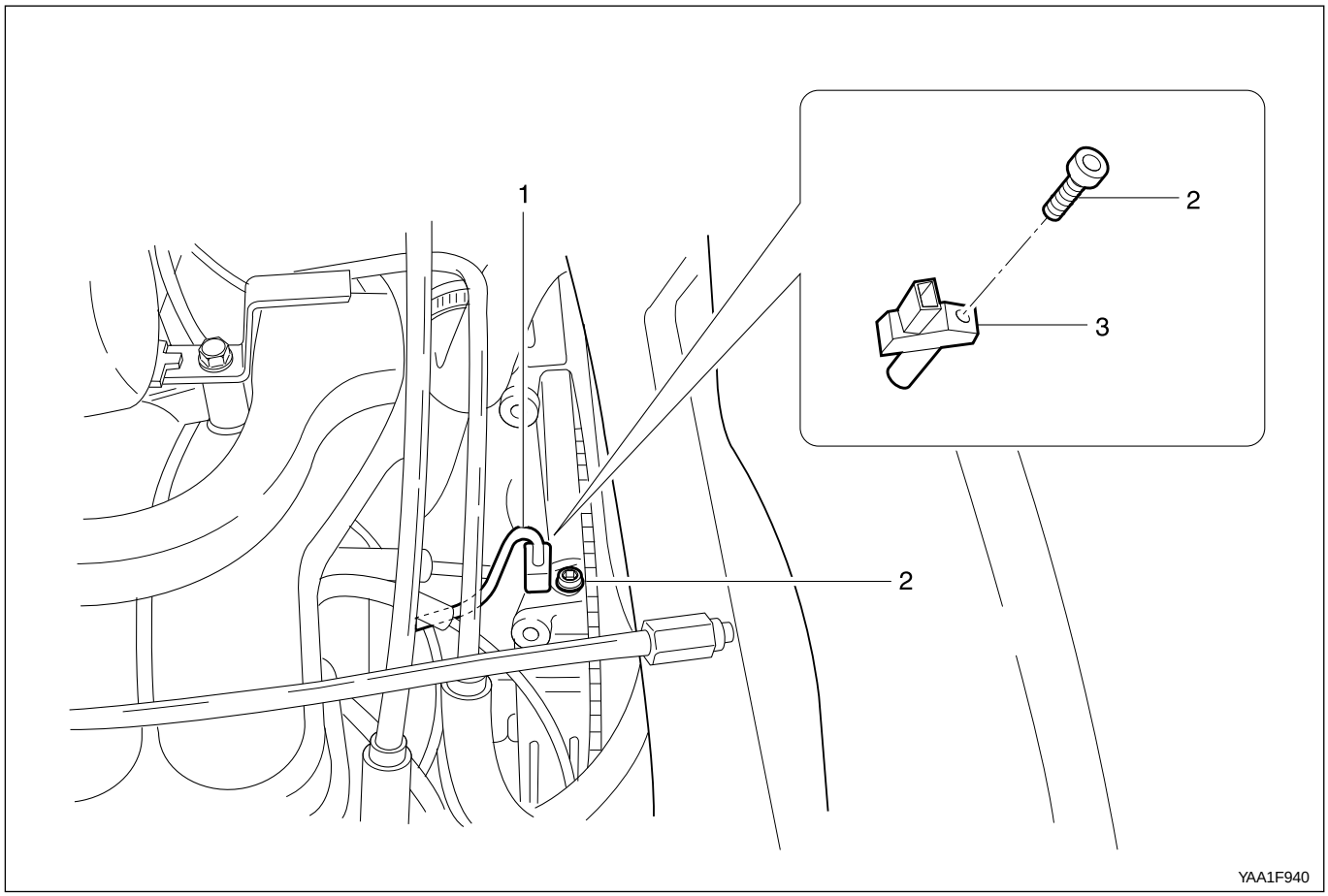
Circuit Description

The Electronic Ignition (EI) system uses a waste spark method of spark distribution. The Crankshaft Position (CKP) sensor sends reference pulses to the ECM. The ECM then triggers the EI system ignition coils. Once the ECM triggers the EI system ignition coils both of the connected spark plugs fire at the same time. One cylinder is on its compression stroke at the same time that the other is on the exhaust stroke, resulting in lower energy needed to fire the spark plug in the cylinder on its exhaust stroke.

This leaves the remainder of the high voltage to be used to fire the spark plug in the cylinder on its compression stroke.

Since the CKP sensor is in a fixed position, timing adjustments are not possible or needed.

CRANKSHAFT POSITION (CKP) SENSOR

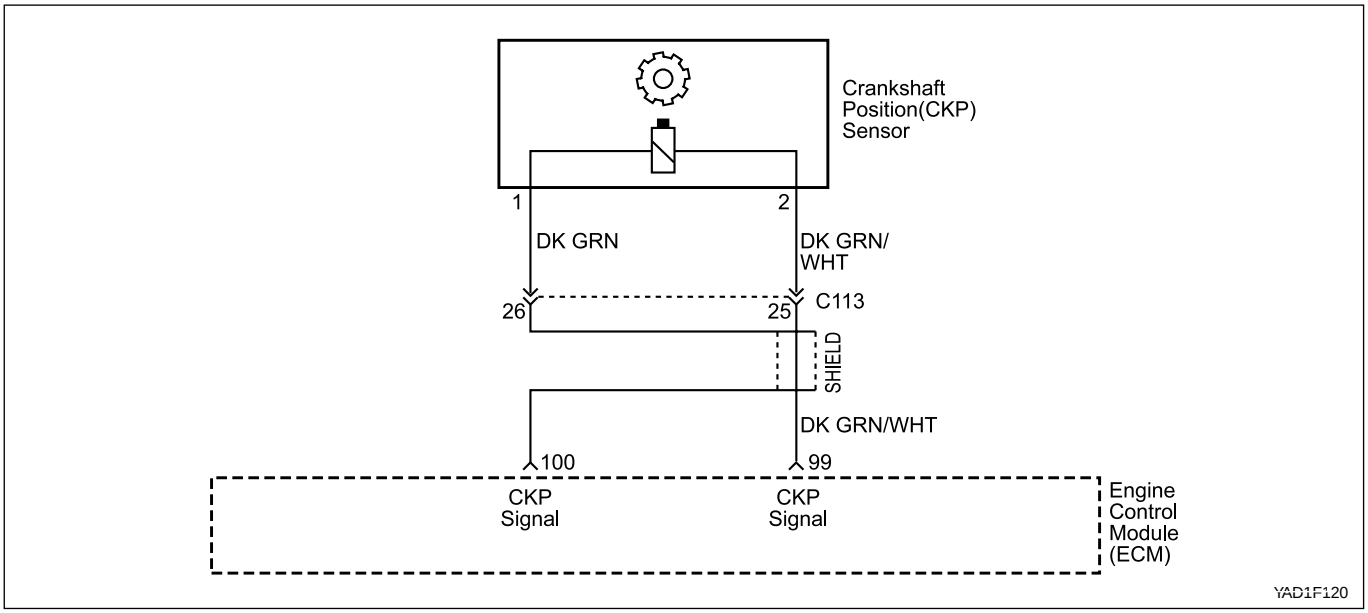


1 Crankshaft Position Sensor Connector
2 Bolt
3 Crankshaft Position Sensor

This Electronic Ignition (EI) system uses inductive or pick up type magnetic Crankshaft Position (CKP) sensor. The CKP sensor is located in the opposite side of the crankshaft pulley and triggers the pick-up wheel teeth which is equipped 60-2 teeth with agap of 2 teeth at 360 degree spacing. This sensor protrudes through its mount to within 1.1 ± 0.14 mm.

The output of the sensor is a sinusoidal signal. Each tooth of the pick-up 60-2 wheel generates a positive half wave.

The Engine Control Module (ECM) uses this sensor signal to generate timed ignition and injection pulses that it sends to the ignition coils and to the fuel injectors.



Failure Code	Description	Trouble Area	Maintenance Hint
17	Crankshaft position sensor signal failure (no engine revolution signal)	Even through cam position recognition is normal, no crankshaft position signal recognition	• Monitoring the actual rpm through or scan tool • Inspection the ECM pin 100, 99 about short circuit with bad contact • Inspection the CKP sensor • Inspection the air gap between sensor and drive plate • Inspection the drive plate (teeth condition) • Inspection the ECM
18	Crankshaft position sensor signal failure (rpm > max. value)	When more than applicable revolution values or implausible to 60-2 teeth.	
20	Crankshaft position sensor signal failure (gap recognition failure)	When implausible recognition of cam and crank angle signal or intermittent sensing the signal or error count of undetected gap.	
67	Crankshaft position sensor adaptation failure	When faulty crank angle sensor adaption	

Circuit Description

The 58X reference signal is produced by the CKP sensor. During one crankshaft revolution, 58 crankshaft pulses will be produced. The ECM uses the 58X reference signal to calculate engine rpm and CKP. The ECM constantly monitors the number of pulses on the 58X reference circuit and compares them to the number of Camshaft Position (CMP) signal pulses being received. If the ECM receives and incorrect number of pulses on the 58X reference circuit, this failure code will set.

Crankshaft Position Sensor Resistance Inspection

1. Disconnect the coupling “E” of ECM while the ignition switch is in “OFF” position.
2. Measure the resistance between the coupling terminal pin No. 99 and No. 100 using a multimeter.

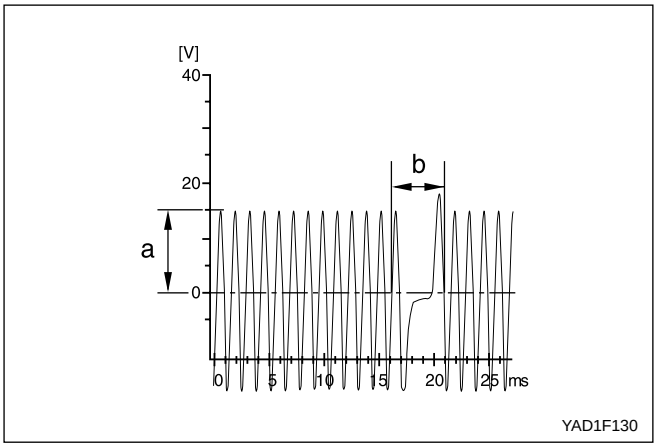
Specified Value	1,050 ~ 1,400 Ω

Notice: Measure the insulator resistance of the CKP sensor if out of the specified value.

Crankshaft Position Sensor Output Wave Inspection

1. Measure the output wave between the ECM terminals No. 99 and No. 100 using the scan tool or the oscilloscope while engine cranking (start motor activated).

   Notice: Check the segment or crankshaft position sensor and air gap if cannot get the output wave as shown in the figure.



a Voltage
b Identifying the No. 1-2 Missing Teeth

Crankshaft Position Sensor Insulator Resistance Inspection

1. Disconnect the coupling from ECM while the ignition switch is in “OFF” position.
2. Measure the resistance between the coupling terminal pin No. 100 and No. 69 using a multimeter.

Specified Value	>20 kΩ

   Notice: Measure the check and ground terminal of the CKP sensor if out of the specified value.

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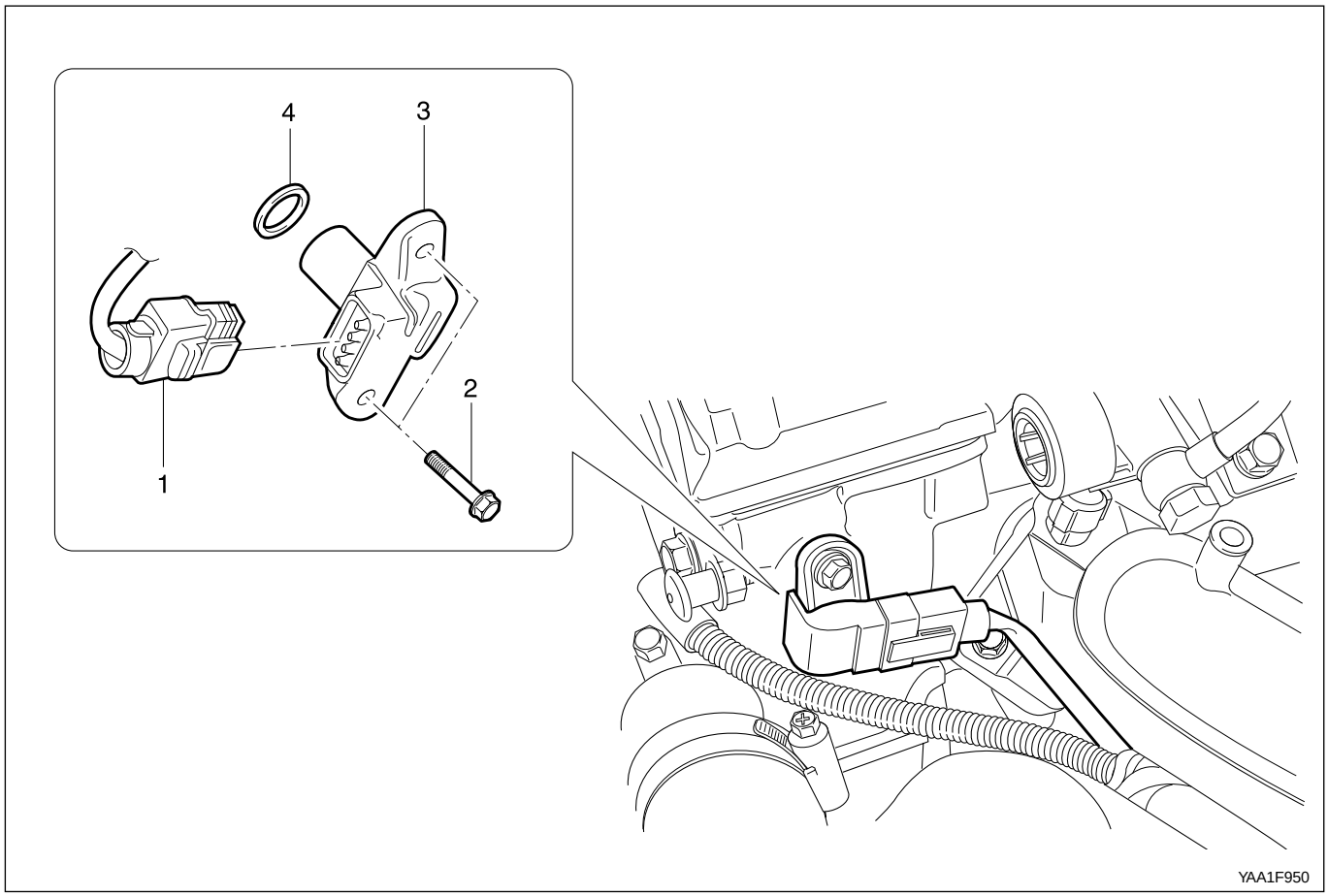
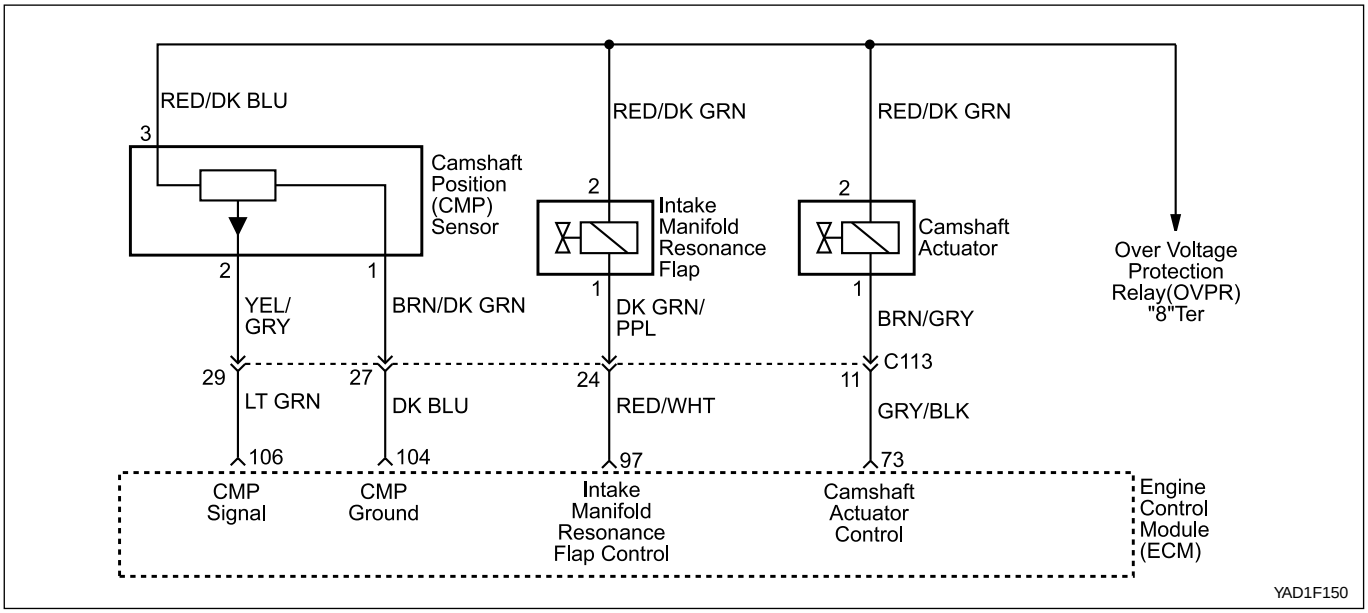
CAMSHAFT POSITION (CMP) SENSOR



1 Camshaft Position Sensor Connector
2 Bolt
3 Camshaft Position Sensor
4 O-Ring

The Camshaft Position (CMP) sensor sends a CMP signal to the Engine Control Module (ECM). The ECM uses this signal as a “synchronized pulse” to trigger the injectors in the proper sequence. The ECM uses the CMP signal to indicate the position of the #1 piston during its power stroke. This allows the ECM to calculate true sequential fuel injection mode of operation.



Failure Code	Description	Trouble Area	Maintenance Hint
19	Camshaft position sensor signal : No. 1 cylinder recognition failure	When no cam recognition signal during TN 24 counts more. (maintain the constant low or high level)	• Inspection the source voltage of CMP sensor • Inspection the ECM pin 106, 104 about short circuit or open with bad contact • Inspection the CMP sensor • Inspection the damage of sensor or sprocket • Inspection the ECM
58	Camshaft position sensor signal : No. 1 cylinder synchronization failure	When synchronization fault of cylinder 1 (TDC recognition)	

Circuit Description

The CMP sensor sends a cam position signal to the ECM. If the cam position signal is lost while the engine is running, the fuel injection system shifts to a calculated sequential fuel injection mode based on the last fuel injection pulse, and the engine continuous to run.

Camshaft Position Sensor Signal Voltage Inspection

1. Measure the voltage between the ECM terminal No. 11 and No. 106 while the engine speed is at idle.

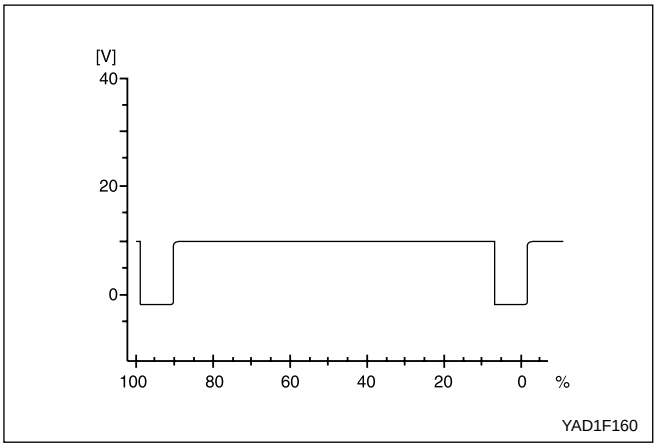
Specified Value	1.2 ~ 1.7 v

Notice: The signal voltage will be changed in the range of 1.2 ~ 1.7 v.

Camshaft Position Sensor Output Wave Inspection

1. Measure the output wave between the ECM terminals No. 104 and No. 106 using the scan tool or the oscilloscope while engine speed is at idle.

   Notice: Replace the CAM sensor if cannot get the output wave as shown in the figure.



Camshaft Position Sensor Power Supply Inspection

1. Disconnect the CMP sensor Connector.
2. Measure the resistance between the No. 1 and No. 3 pin of the CMP sensor connector while the ignition switch is in “ON” position.

Specified Value	11 ~ 14 v

   Notice: If the measured value is not within the specified value, check the cable.

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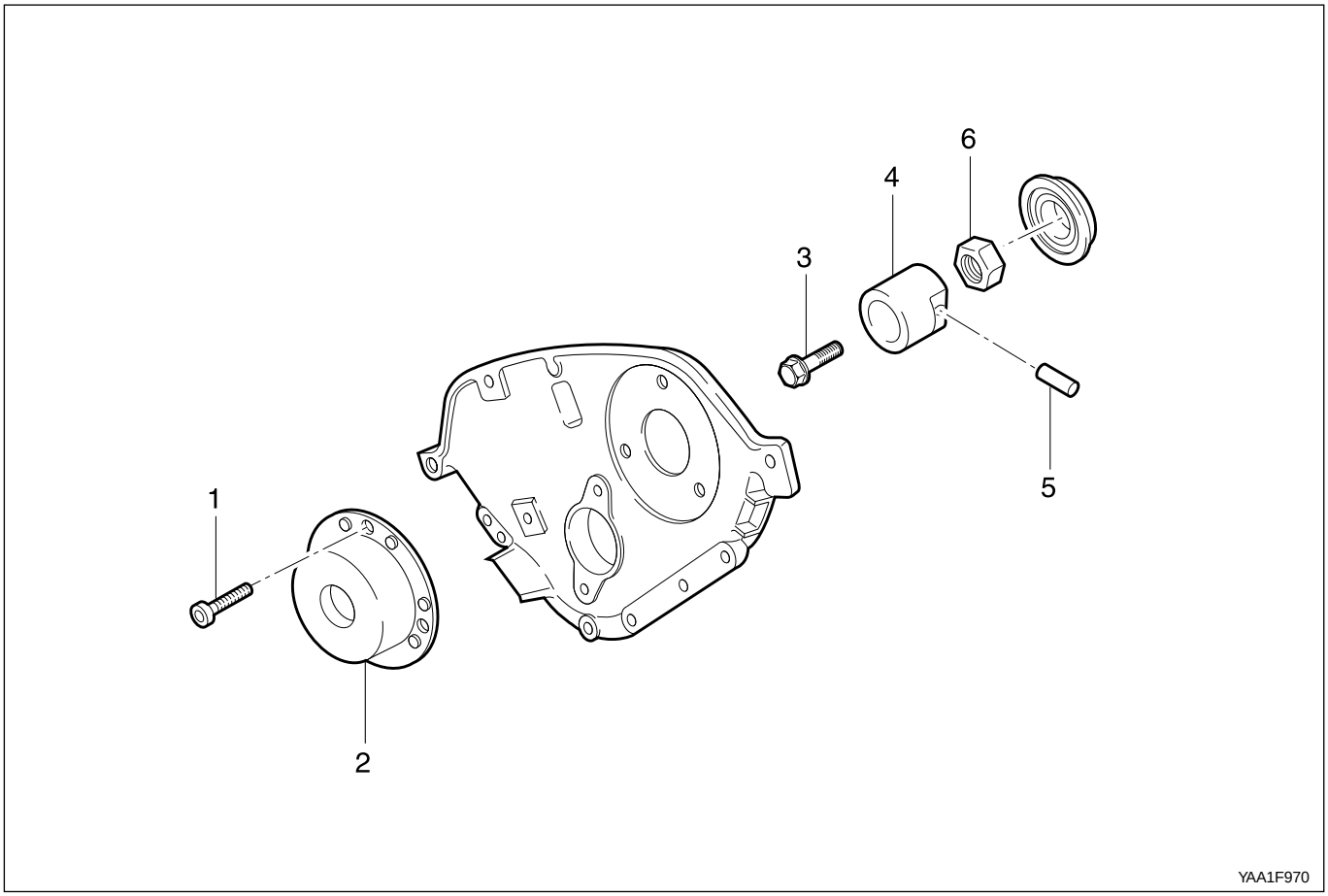
CAMSHAFT ACTUATOR



1 Bolt
2 Camshaft Actuator
3 Bolt
4 Armature
5 Roll Pin
6 Nut

When the engine is running, the camshaft actuator rotates the intake camshaft hydraulically and mechanically relative to the camshaft sprocket by 20 ° crank angle to the “advanced” position and back to the “retard” position.

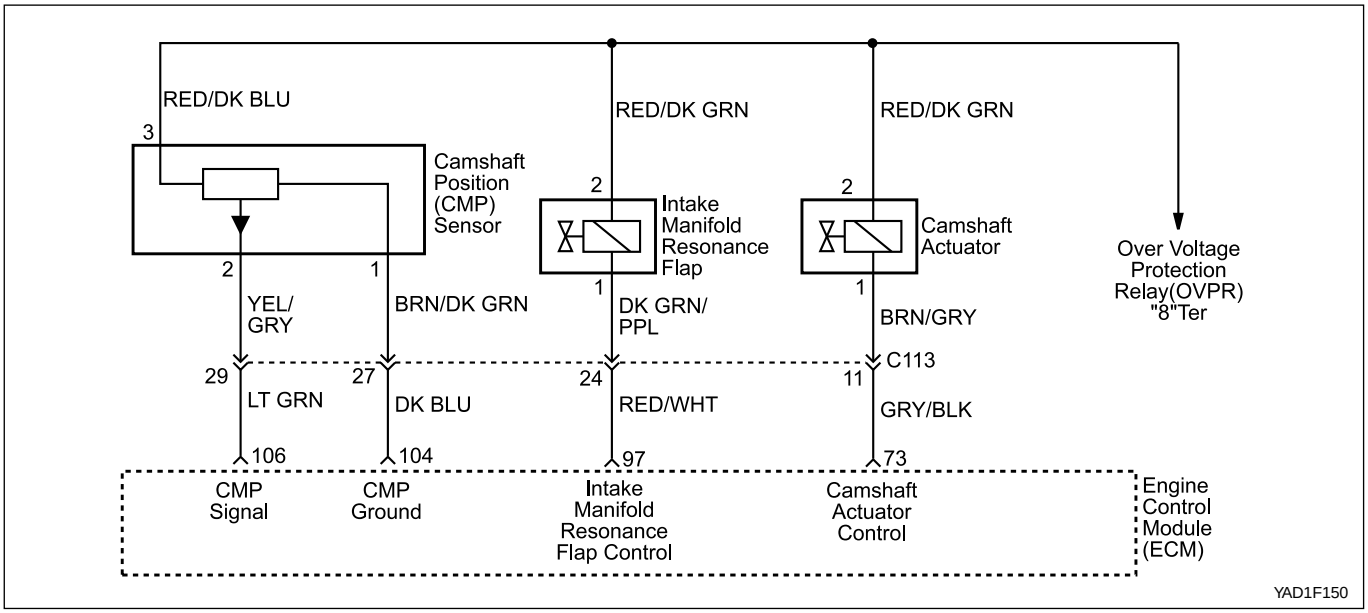
The camshaft actuator is actuated electro-mechanically by the Engine Control Module (ECM).

The positioning time of apporx. 1 second is dependent on the engine oil pressure at the camshaft actuator and on the oil viscosity and oil temperature, respectively.

The camshaft indicator on the camshaft sprocket provides the camshaft rotational speed to the position sensor as an input parameter for the engine ignition control unit.

Operation Condition of Camshaft Actuator

Engine RPM	Camshaft Position	Effect
Engine stop	Retard	-
0 ~ 1,740 rpm	Retard	Idle speed is improved Blow-by gas is decreased Valve overlap is decreased
1,740 ~ 3,540 rpm	Advanced	Torque is increased Fuel loss is decreased NOx is decreased
Above 3,540 rpm	Retard	Engine overrun is prohibited



Failure Code	Description	Trouble Area	Maintenance Hint
226	Camshaft actuator short circuit to battery	When malfunction of cam phasing control	• Monitoring the actual operational status through scan tool • Inspection the ECM pin 73 about short circuit or open • Inspection the power source short circuit or open to cam actuator • Inspection the magnet and hardware • Inspection the ECM
227	Camshaft actuator short circuit to ground or open		

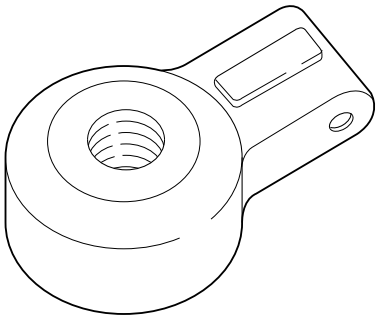
Camshaft Actuator Current Consumption Inspection

1. Run the engine to reach the coolant temperature above 70 °C.
2. Increase the engine rpm up to 2000 rpm
3. Measure the current between the No. 1 and No. 2 pin of the camshaft actuator connector.

Specified Value	1 ~1.5 A

Notice: If the measured value is not within the specified value, check the cable.

KNOCK SENSOR (KS)



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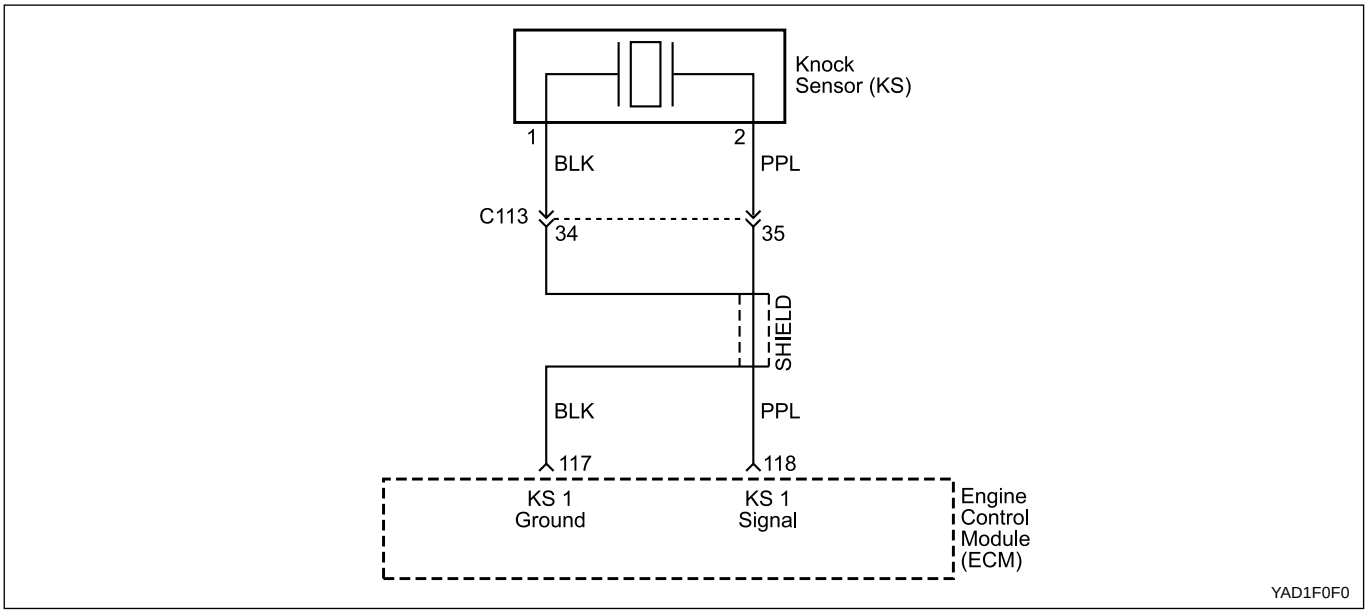
The Knock Sensor (KS) detects abnormal knocking in the engine. The two KS are mounted in the engine block near the cylinders. The sensors produce an output voltage which increases with the severity of the knock. This signal is sent to the Engine Control Module (ECM) via a shielded cable. The ECM then adjusts the ignition timing to reduce the spark knock.



Failure Code	Description	Trouble Area	Maintenance Hint
56	No. 1 knock sensor signal failure	When recognition in more than control gain threshold at normal operational condition of other system during over 75 and 3,000 rpm running area (cylinder 1, 2, 3, 4)	• Inspection the ECM pin 118, 117 about short circuit or open with bad contact • Inspection the KS 1 malfunction • Inspection the ECM

Circuit Description

The KS system is used to detect engine detonation, allowing the ECM to retard the ignition control spark timing based on the KS signal being received. The KS signal's amplitude and frequency depend upon the amount of knock being experienced. The ECM monitors the KS signal and can diagnose the KS sensor and circuitry.

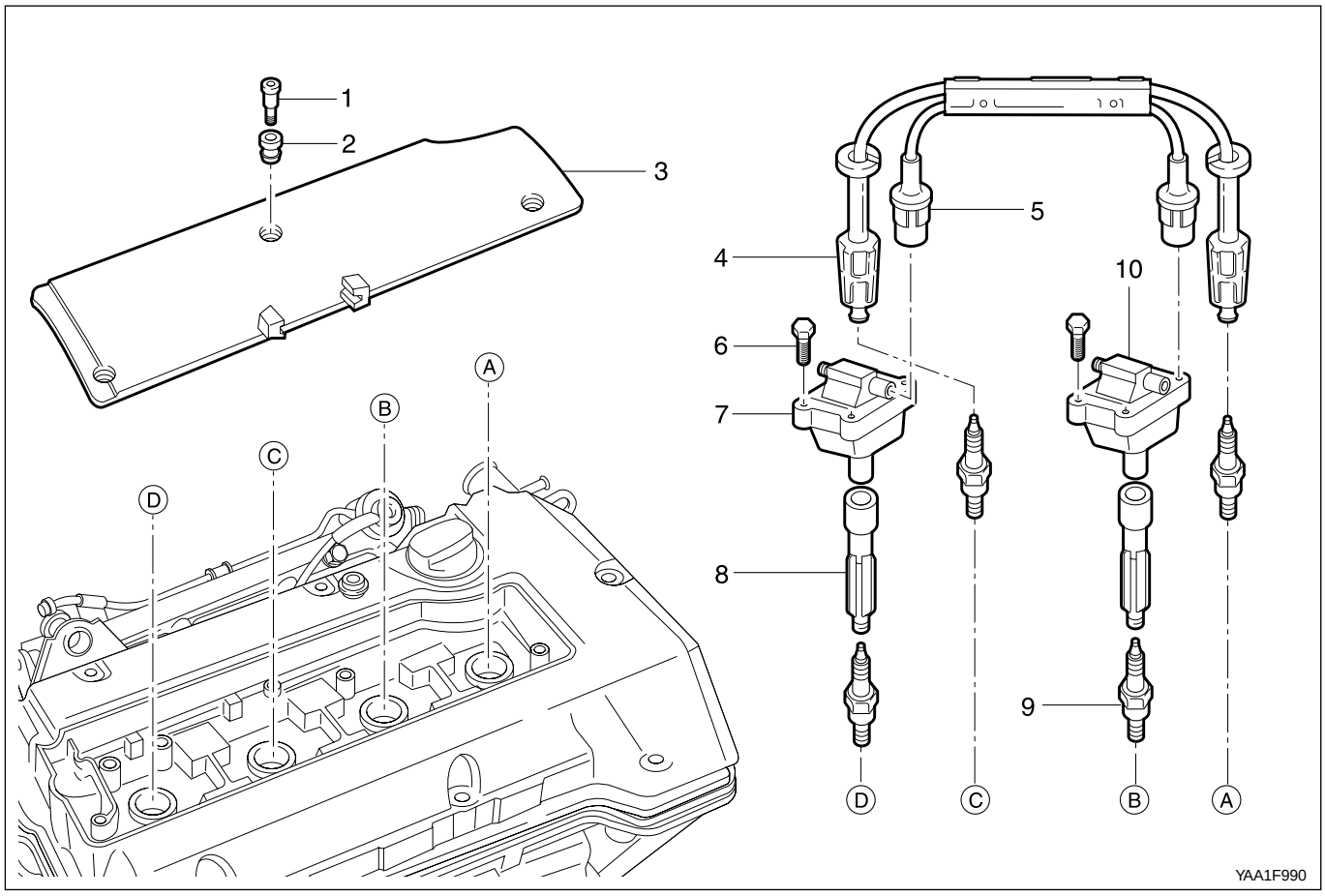
Knock Sensor Resistance Inspection

1. Disconnect the coupling from ECM while the ignition switch is in "OFF" position.
2. Measure the resistance between the coupling terminal pin No. 118 and No. 117 using a multimeter.

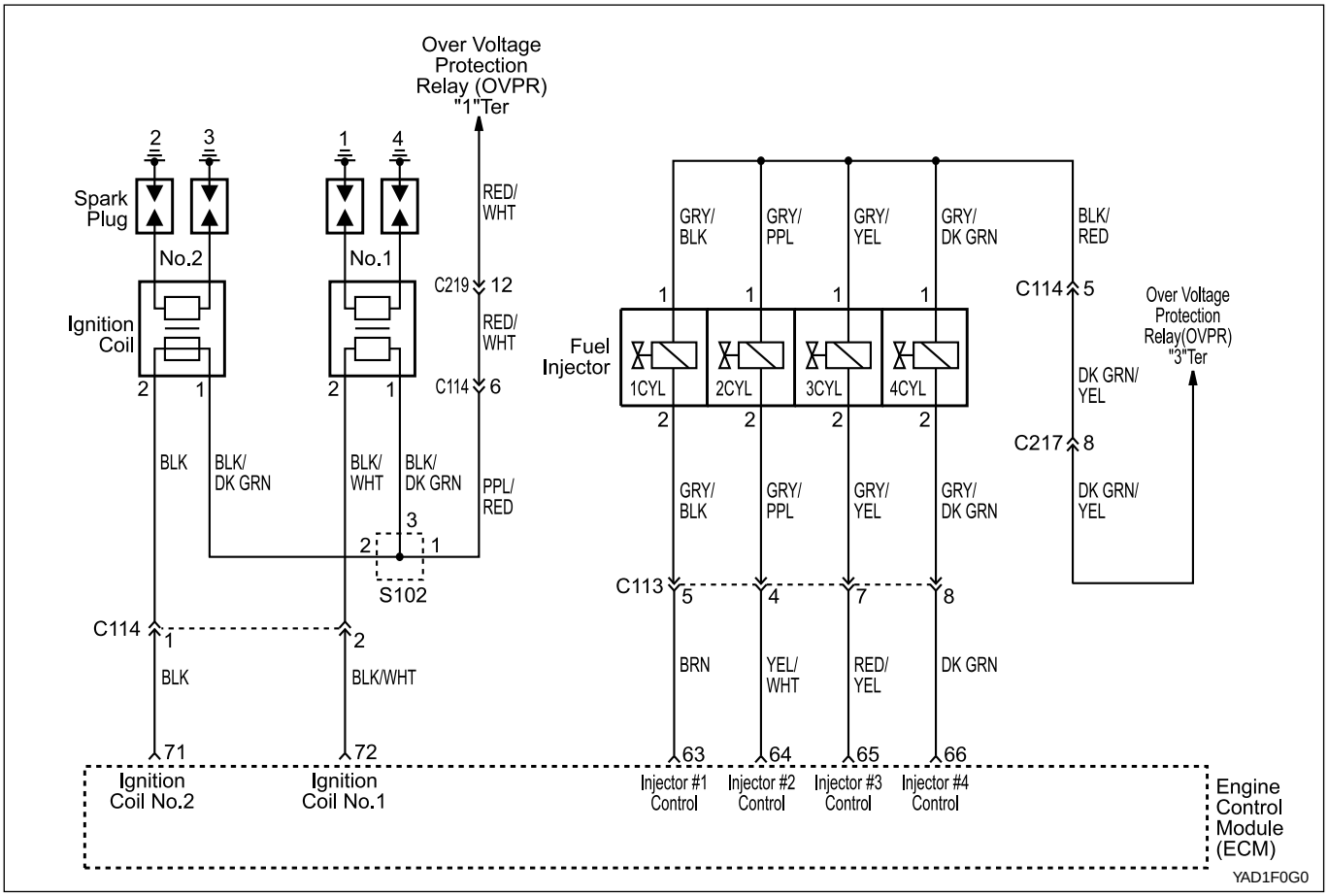
Specified Value	>10 MΩ

Notice: Replace the KS if the measured values is out of the specified values. Check the connector and wire connection between ECM and the KS if the measured values are normal.

SPARK PLUG



1 Screw
2 Adaptor
3 Ignition Coil Cable Cover
4 Spark Plug Connector
5 Ignition Coil Connector
6 Bolts
7 Ignition Coil (T 1/1)
8 Coupling Plug
9 Spark Plug
10 Ignition Coil (T 1/2)



Failure Code	Description	Trouble Area	Maintenance Hint
68	Random / Multiple Misfire	When detection misfire of multiple cylinder for source of over the emission threshold or catalyst damage	• Inspection the ignition system • Inspection the injection system • Inspection the fuel pressure • Inspection the compression pressure • Inspection the valve timing or clearance • Inspection the air flow sensor • Inspection the crankshaft position sensor and air gap • Inspection the engine wiring system • Inspection the Engine Control Module (ECM)

Circuit Description

The ECM monitors the crankshaft and camshaft positions to detect if the engine is misfiring. The ECM looks for a quick drop in crankshaft speed. Misfire multiple cylinder is monitored by engine roughness measuring. The actual roughness value is compared with the actual (emission and catalyst damage) threshold.

Spark Plug Cable Resistance Inspection

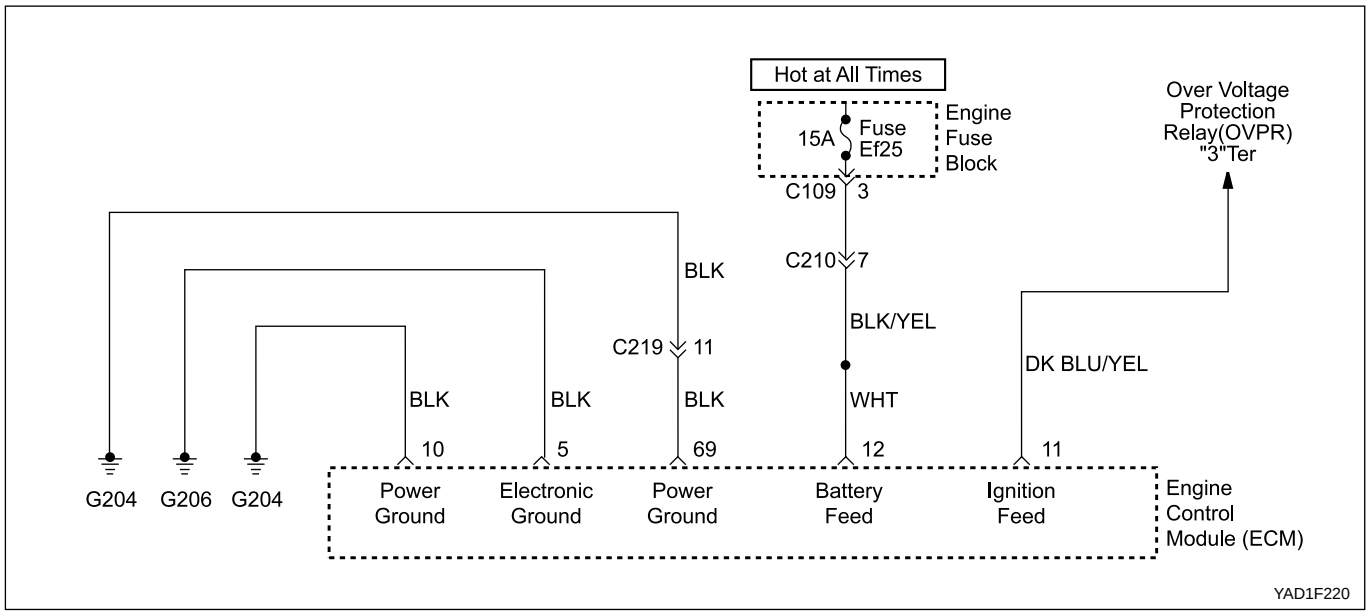
1. Turn the ignition switch “OFF” position.
2. Disconnect the spark plug cables Refer to *Section 1E1, Engine electrical.*
3. Measure the spark plug resistance using a multimeter.

Specified Value	1.8 ~ 2.2 kΩ

Notice: Replace the spark plug cable if the measured values is out of the specified values.

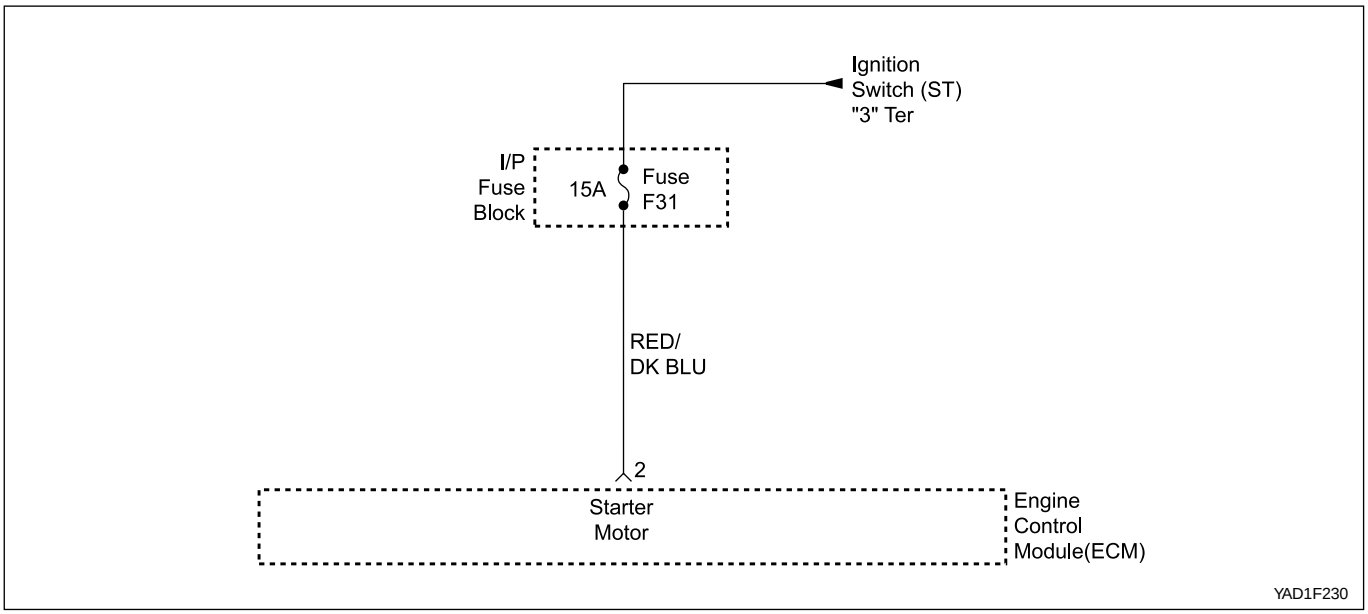
BLANK

SYSTEM VOLTAGE



Failure Code	Description	Trouble Area	Maintenance Hint
08	System voltage too low	Malfunction in recognition of system source voltage. Less than minimum 8 volts in 2,000 rpm below, or less than 10 volts in 2,000 rpm above.	• Monitoring the actual battery voltages through the scan tool • Inspection the Engine Control Module (ECM) pin 12, 11, 10, 5 about short circuit or open with bad contact • Inspection the over voltage protection relay • Inspection the battery • Inspection ECM

IGNITION SWITCH



Failure Code	Description	Trouble Area	Maintenance Hint
71	Starter signal recognition failure	When not detection of starter signal	• Inspection the Engine Control Module (ECM) pin 2 circuit short or open with bad contact • Inspection ECM

FUEL SYSTEM

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions.

The fuel is delivered to the engine by the individual fuel injectors mounted into the intake manifold near each cylinder.

The main fuel control sensors are the Mass Air Flow (MAF) sensor and the oxygen (O2) sensors.

The MAF sensor monitors the mass flow of the air being drawn into the engine. An electrically heated element is mounted in the intake air stream, where it is cooled by the flow of incoming air. Engine Control Module (ECM) modulates the flow of heating current to maintain the temperature differential between the heated film and the intake air at a constant level. The amount of heating current required to maintain the temperature thus provides an index for the mass air flow. This concept automatically compensates for variations in air density, as this is one of the factors that determines the amount of warmth that the surrounding air absorbs from the heated element. MAF sensor is located between the air filter and the throttle valve.

Under high fuel demands, the MAF sensor reads a high mass flow condition, such as wide open throttle. The ECM uses this information to enrich the mixture, thus increasing the fuel injector on-time, to provide the correct amount of fuel. When decelerating, the mass flow decreases. This mass flow change is sensed by the MAF sensor and read by the ECM, which then decreases the fuel injector on-time due to the low fuel demand conditions.

The O2 sensors are located in the exhaust pipe before catalytic converter. The O2 sensors indicate to the ECM the amount of oxygen in the exhaust gas, and the ECM changes the air/fuel ratio to the engine by controlling the fuel injectors. The best air/fuel ratio to minimize exhaust emissions is 14.7 to 1, which allows the catalytic converter to operate most efficiently. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a “closed loop” system.

The ECM uses voltage inputs from several sensors to determine how much fuel to provide to the engine. The fuel is delivered under one of several conditions, called “modes”.

Starting Mode

When the ignition is turned ON, the ECM turns the fuel pump relay on for 1 second. The fuel pump then builds fuel pressure. The ECM also checks the Engine Coolant Temperature (ECT) sensor and the Throttle Position (TP) sensor and determines the proper air/fuel ratio for starting the engine. This ranges from1.5 to 1 at -36 °C (-33 °F) coolant temperature to 14.7 to 1 at 94 °C (201 °F) coolant temperature. The ECM controls the amount of fuel delivered in the starting mode by changing how long the fuel injector is turned on and off. This is done by ‘‘pulsing” the fuel injectors for very short times.

Run Mode

The run mode has two conditions called ‘‘open loop” and ‘‘closed loop”.

Open Loop

When the engine is first started and it is above 690 rpm, the system goes into “open loop” operation. In “open loop”, the ECM ignores the signal from the HO2S and calculates the air/fuel ratio based on inputs from the ECT sensor and the MAF sensor. The ECM stays in “open loop” until the following conditions are met:

- The O2 has a varying voltage output, showing that it is hot enough to operate properly.
- The ECT sensor is above a specified temperature (22.5 °C).
- A specific amount of time has elapsed after starting the engine.

Closed Loop

The specific values for the above conditions vary with different engines and are stored in the Electronically Erasable Programmable Read-Only Memory (EEPROM). When these conditions are met, the system goes into “closed loop” operation. In “closed loop”, the ECM calculates the air/fuel ratio (fuel injector on- time) based on the signals from the O2 sensors. This allows the air/fuel ratio to stay very close to 14.7 to 1.

Acceleration Mode

The ECM responds to rapid changes in throttle position and airflow and provides extra fuel.

Deceleration Mode

The ECM responds to changes in throttle position and airflow and reduces the amount of fuel. When deceleration is very fast, the ECM can cut off fuel completely for short periods of time.

Battery Voltage Correction Mode

When battery voltage is low, the ECM can compensate for a weak spark delivered by the ignition module by using the following methods:

- Increasing the fuel injector pulse width.
- Increasing the idle speed rpm.
- Increasing the ignition dwell time.

Fuel Cut-Off Mode

No fuel is delivered by the fuel injectors when the ignition is off. This prevents dieseling or engine run-on. Also, the fuel is not delivered if there are no reference pulses received from the CKP sensor. This prevents flooding.

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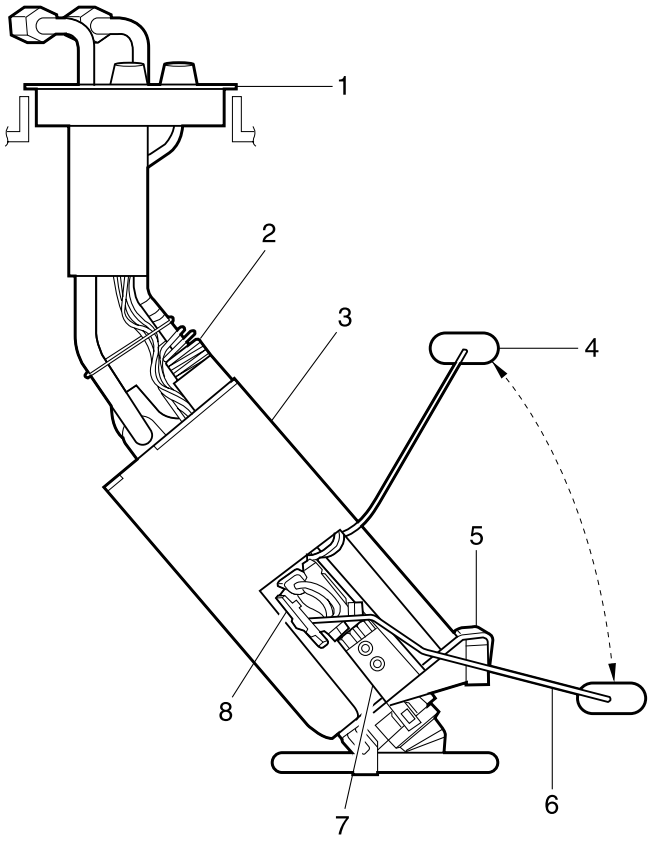
FUEL PUMP

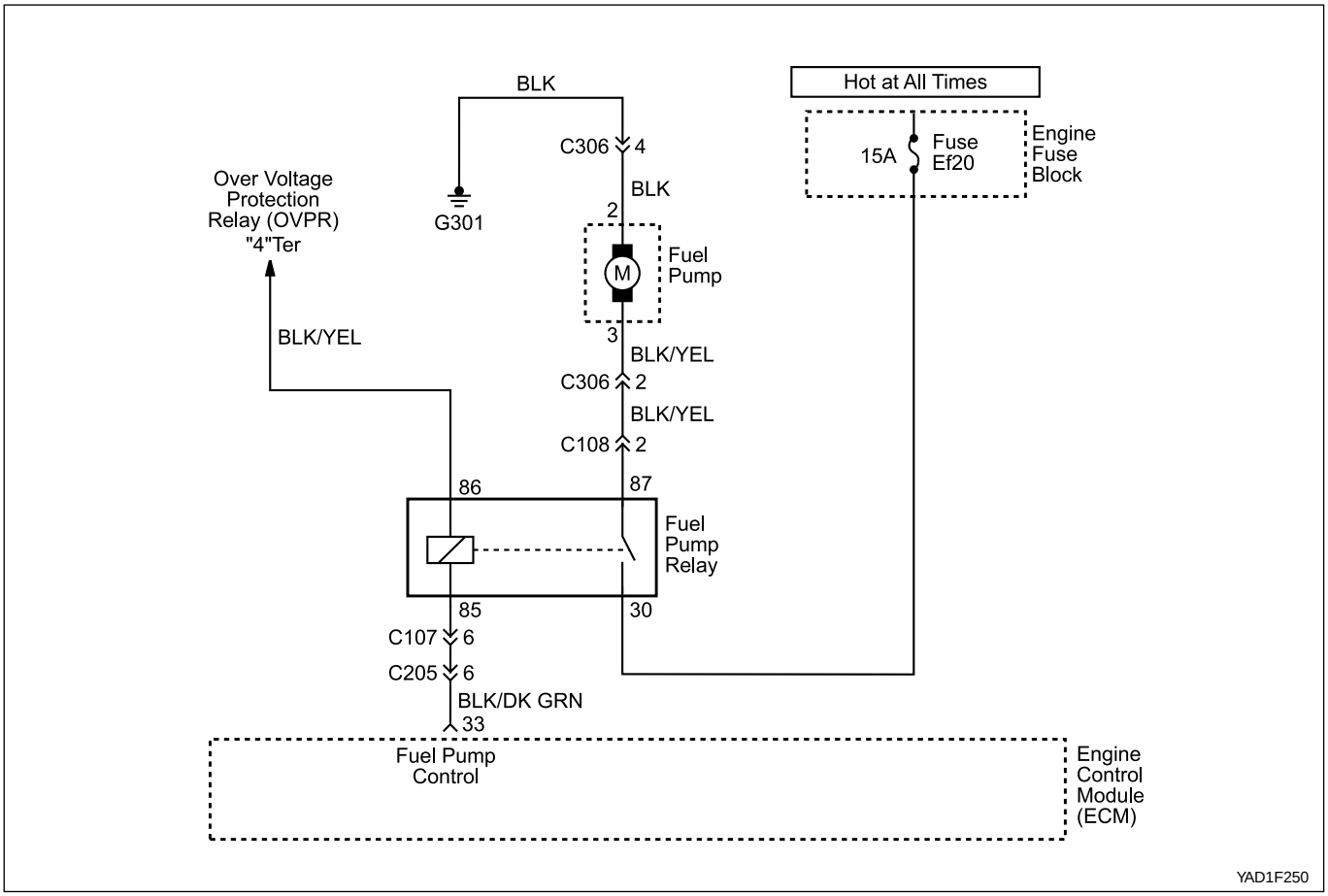


YAD1F240

1 Flange and Harness Assembly
2 Spring
3 Fuel Pump
4 Float
5 Thermistor
6 Float Arm
7 Thermistor Housing
8 Resistor Card and Wiper

Requirements for Fuel Pump

Item	Specified Value	Item	Specified Value
System Pressure	3.8 bar	Minimum Delivery at 8V	30 Litre/ Hr
Maximum Pressure	8.5 bar (12 V)	Operating Voltage	8 V
Minimum Pressure	5.0 bar (12 V)	Maximum Allowable Current	7.5 A
Nominal Voltage	12 V	Ambient Temperature	-30 ~ +70° C
Minimum Amount of Fuel Supply	114 Liter/ Hr (12 V, 3.8 bar, -30 ~ +70° C)	Maximum Amount of Fuel Supply	165 Liter/ Hr (12 V, 3.8 bar, -30 ~ +70° C)



Failure Code	Description	Trouble Area	Maintenance Hint
34	Fuel pump relay short circuit to battery	When short circuit to power source	• Inspection the Engine Control Module (ECM) pin 33 about short circuit or open with bad contact • Inspection the fuel pump relay • Inspection the ECM
35	Fuel pump relay short circuit to ground or open	When short circuit to ground or open	

Circuit Description

When the ignition switch is turned ON, the ECM will activate the pump relay and run the in-tank fuel pump. The fuel pump will operate as long as the engine is cranking or running and the ECM is receiving ignition reference pulses.

If there are no reference pulses, the ECM will shut off the fuel pump within 2 seconds after the ignitions witch is turned ON, engine stopped or engine stalled.

Fuel Pump Relay Inspection

Measure the voltage between the ECM terminal No. 33 and ground.

Ignition Switch : ON	0 V (for 1 ~ 2 sec.)
Cranking	0 V

Measure the Fuel Delivery from the Fuel Pump

1. Disconnect the return pipe from fuel distributor and insert the appropriate hose into it.
2. Place the hose end into the beaker with the minimum capacity of 1 Liter
3. Turn the ignition switch to “ON” position.
4. Connect the terminal No. 33 and No. 5 of ECM with a service wire.
5. Measure the fuel delivery from the fuel pump.

Specified Value	1 Liter/max. 35 sec.

Notice: Check the fuel filter and fuel line when the fuel delivery is not within specified value.

Measure the Current Consumption of Fuel Pump

1. Remove the fuel pump relay from fuse and relay box in trunk, and turn the ignition switch to “ON” position.
2. Using a multimeter, measure the current consumption by connecting the terminal No. 30 and No. 87 of the fuel pump relay connector.

Specified Value	5 ~ 9 A

Notice: Replace the fuel pump relay if the measured value is over 9 A.

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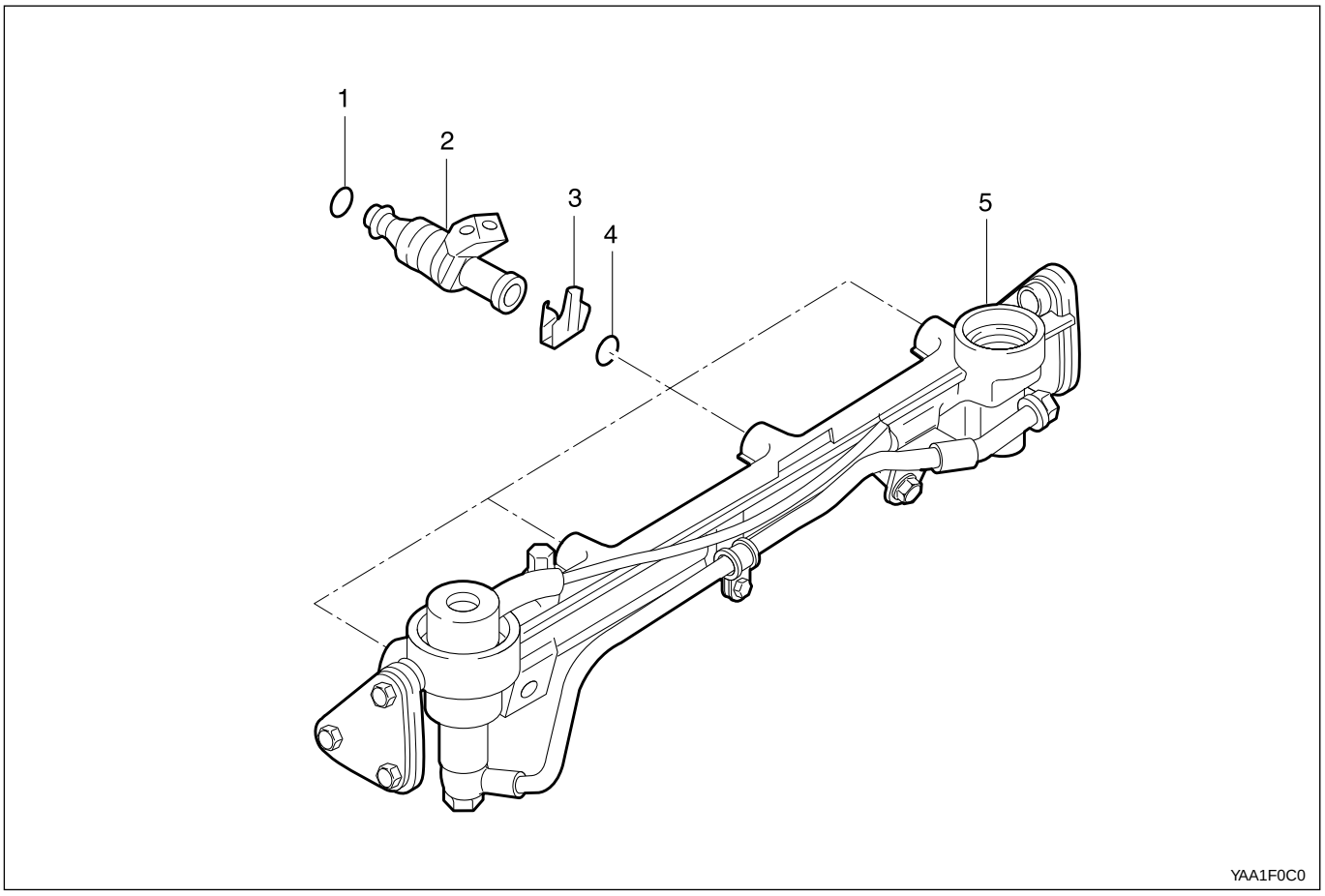
FUEL INJECTOR

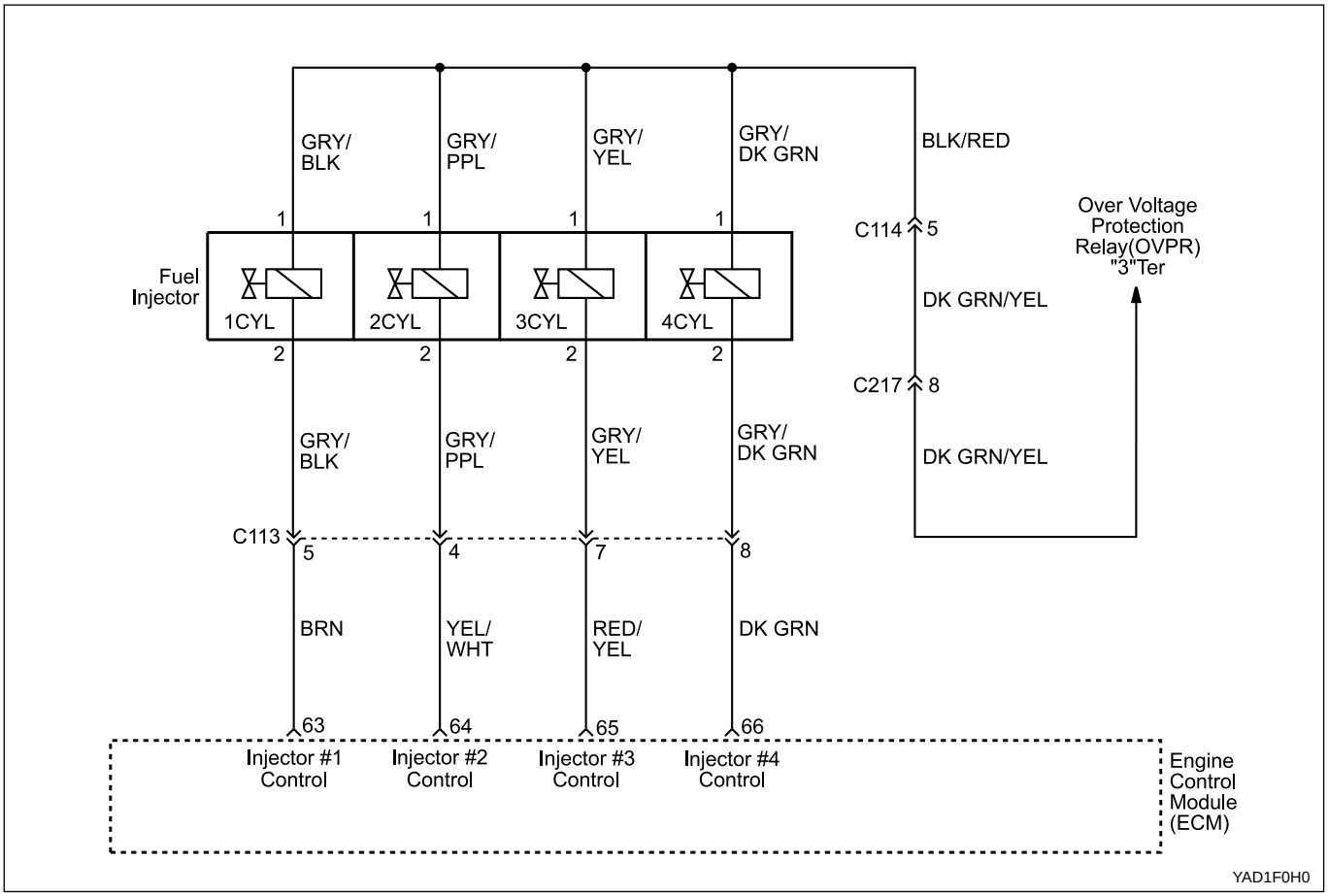


1 O-Ring
2 Injector
3 Injector Bracket
4 O-Ring
5 Fuel Rail

The Multipoint Fuel Injection (MFI) assembly is a solenoid-operated device controlled by the Engine Control Module (ECM) that meters pressurized fuel to an each individual cylinder. The injector sprays the fuel, in precise quantities at a point in time determined by the ECM, directly towad the cylinder intake valve. ECM energizes the fuel injector solenoid to lift the needle valve and to flow the fuel through the orifice. This injector's discharge orificeis calibrated to meet the effective fuel atomization necessary for both ensuring the maximum homogeneity in the air-fuel mixture and holding the condensation along the walls of the intake tract to a minimum.

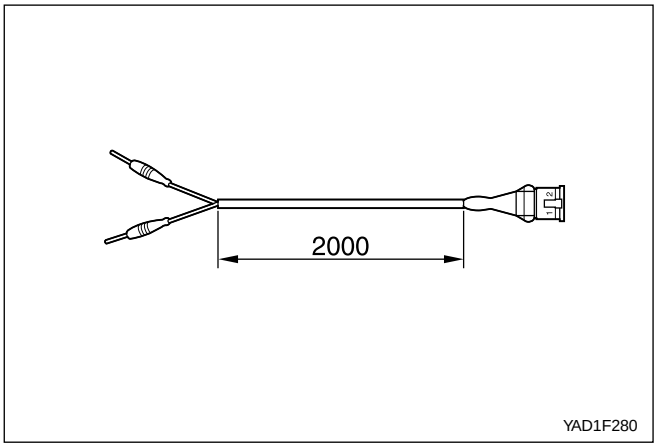
Fuel enters the top feed injector from above and flows through its vertical axis. The lower end extends into the intake valve. Fuel from the tip is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber.

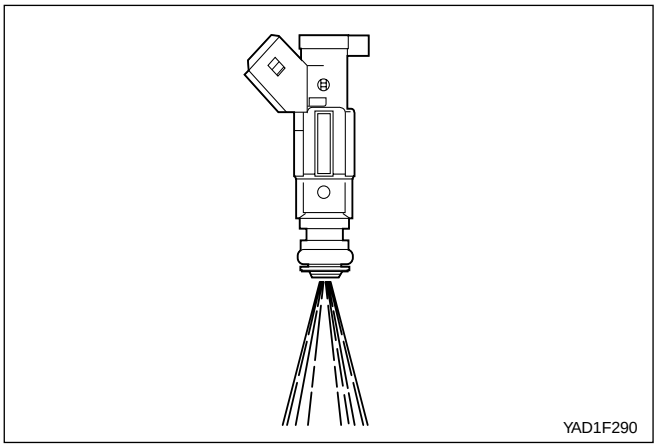
A fuel injector which is stuck partially open would cause a loss of fuel pressure after the engine is shut down. Also, an extended crank time would be noticed on some engines. Dieseling could also occur because some fuel could be delivered to the engine after the ignition is turned off.



Failure Code	Description	Trouble Area	Maintenance Hint
72	No. 1 injector short circuit to battery	When malfunction of injector circuit Injector #1 short circuit to power	• Inspection the power to injector #1 or bad contact • Inspection the injector • Inspection the ECM
73	No. 1 injector short circuit to ground or open	When malfunction of injector circuit Injector #1 short circuit to ground or open	• Inspection the ECM pin 63 about short circuit or open with bad contact • Inspection the injector • Inspection the ECM
74	No. 2 injector short circuit to battery	When malfunction of injector circuit Injector #2 short circuit to power	• Inspection the power to injector #2 or bad contact • Inspection the injector • Inspection the ECM
75	No. 2 injector short circuit to ground or open	When malfunction of injector circuit Injector #2 short circuit to ground or open	• Inspection the ECM pin 64 about short circuit or open with bad contact • Inspection the injector • Inspection the ECM
76	No. 3 injector short circuit to battery	When malfunction of injector circuit Injector #3 short circuit to power	• Inspection the power to injector #3 or bad contact • Inspection the injector • Inspection the ECM

Failure Code	Description	Trouble Area	Maintenance Hint
77	No. 3 injector short circuit to ground or open	When malfunction of injector circuit Injector #3 short circuit to ground or open	• Inspection the ECM pin 65 about short circuit or open with bad contact • Inspection the injector • Inspection the ECM
78	No. 4 injector short circuit to battery	When malfunction of injector circuit Injector #4 short circuit to power	• Inspection the power to injector #4 or bad contact • Inspection the injector • Inspection the ECM
79	No. 4 injector short circuit to ground or open	When malfunction of injector circuit Injector #4 short circuit to ground or open	• Inspection the ECM pin 66 about short circuit or open with bad contact • Inspection the injector • Inspection the ECM





Injector Spray Pattern Check

1. Turn the ignition switch OFF.
2. Remove the fuel injector connectors.
3. Remove the fuel distributor and injector with a unit. At this time, do not remove the supply and return line.

   Notice: Prepare the beaker for taking the fuel.

4. Connect the shop made cable to the inject or with a firing order.
5. Connect the other end of shop made cable to the positive battery cable and negative battery cable.
6. Turn the ignition switch ON.
7. Check the inject or for normal spray pattern as shown in the figure. Check inject or for leaks or later drop

Injector Resistance Inspection

1. Turn the ignition switch OFF.
2. Remove the fuel injector connectors .
3. Meas ure the fuel injector coil resistance using a multimeter.

Specified Value	14 ~ 17 Ω

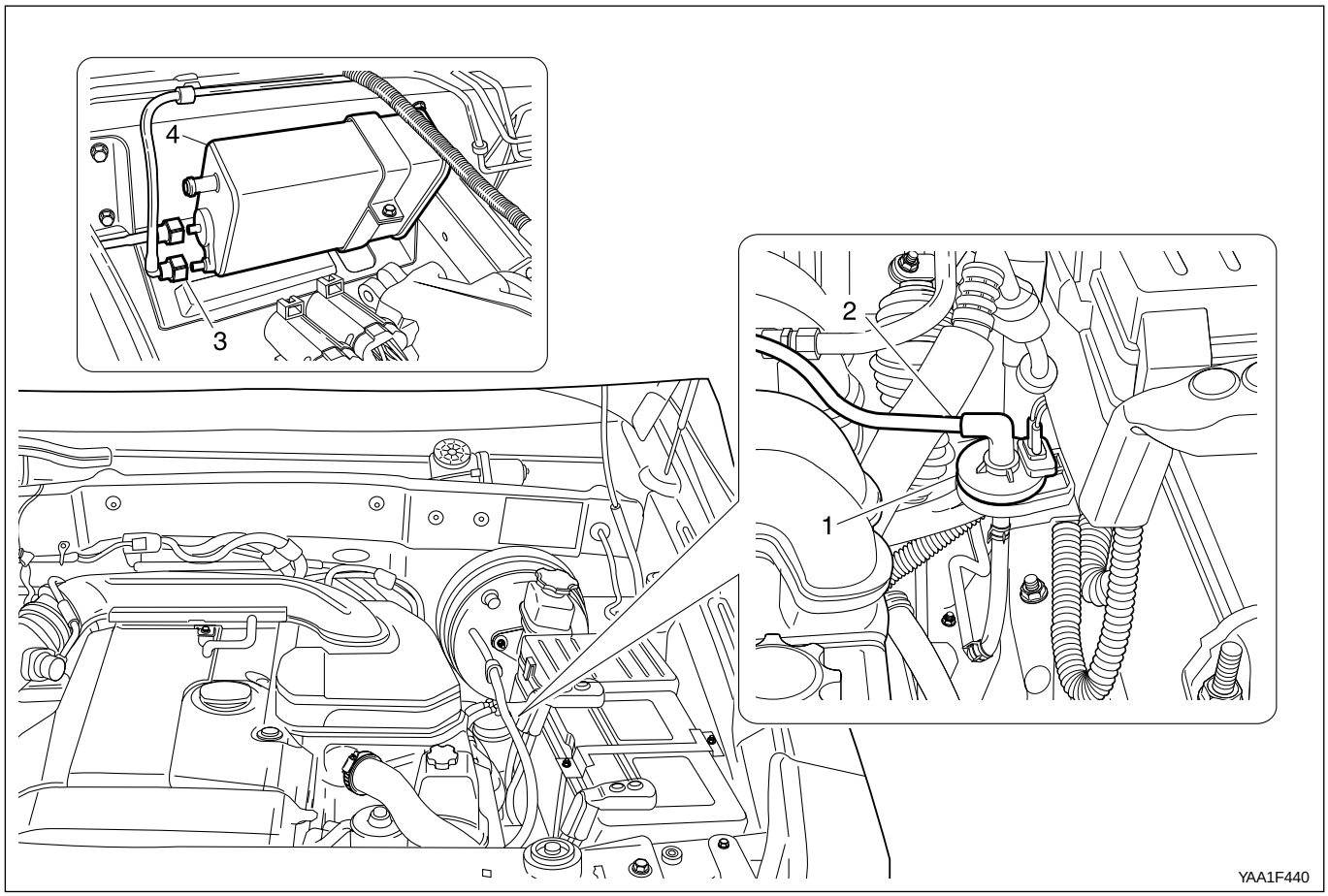
Notice: Replace the fuel injector if the measured value is out of the specified values . Check the connector and wire connection between the ECM and the injector if the measured values are normal.

Injector Pulse Width Inspection

1. Turn the ignition switch OFF.
2. Install the scan tool.
3. Turn the ignition switch ON.
4. Monitor the “INJECTION TIME” with a scan tool.

Cranking	8.0 ms
Engine Idle	3 ~ 5 ms
Wide Open Throttle (WOT)	14 ms

PURGE CONTROL VALVE



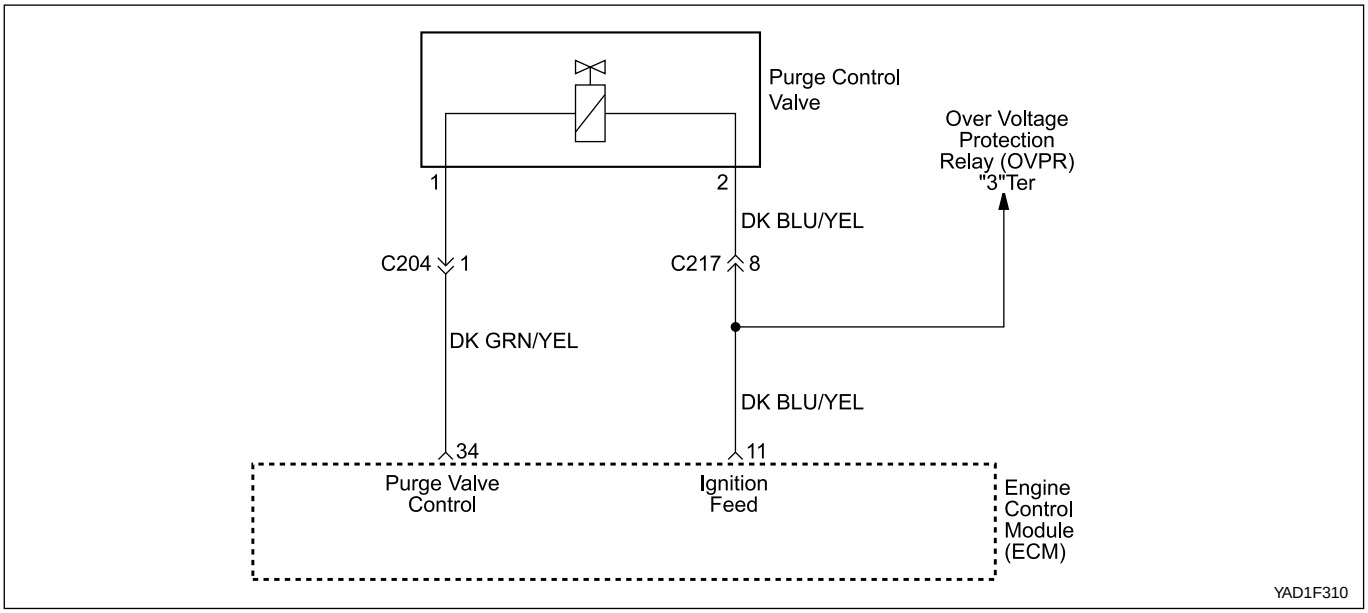
1 Purge Control Valve
2 Line to Engine
3 Line to Canister
4 Canister

The fuel vaporization control system is installed to inhibit the fuel vaporized gas from discharging into the atmosphere. The fuel vaporized gas that is accumulated in the canister abstracts through the purge control valve purification during the engine combustion (except the decreasing mode) and coolant temperature of over 80 °C. For this reason, the Engine Control Module (ECM) transacts the engine speed, air inflow quantity, coolant temperature, and intake temperature.

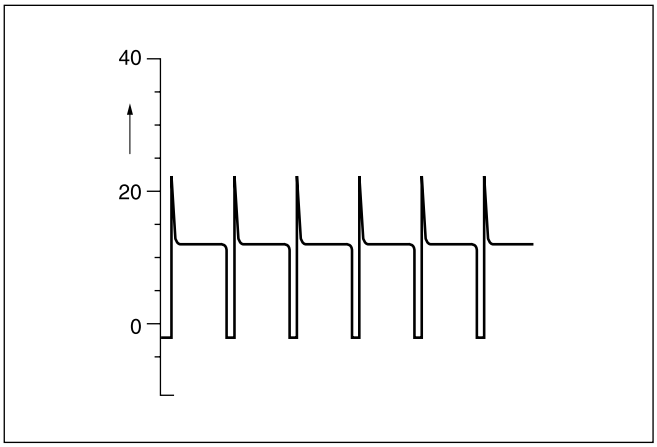
The purge control valve is activated by the ECM frequency according with the engine rotating speed to adjust the purification rate. The purification rate is determined by the continuous valve opening interval.

The purge control valve is activated by the ECM for the following conditions:

- Coolant temperature of over 80 °C
- Engine speed of over 1,000 rpm
- 2 minutes after starting
- When the fuel cut-off mode is not activated



Failure Code	Description	Trouble Area	Maintenance Hint
40	Purge control valve short circuit to battery	When short circuit to power source	• Inspection the ECM pin 34 about short circuit or open with bad contact • Inspection the source power of valve • Inspection the purge control solenoid vale • Inspection the ECM
41	Purge control valve short circuit to ground or open	When short circuit to ground or open	
54	Purge control circuit malfunction	When malfunction of purge control : not work	



Test

1. Maintain the normal temperature and idling state by operating the engine.
2. Connect the ECM terminal No. 11 and No. 34 and check for normal operation through the output waves using oscilloscope.

   Notice: Test during purge control valve operation after the minimum of 1 minute after the engine turned on.

3. Connect the ECM terminal No. 34 and No.10 and check for current consumption during the ignition switch ON.

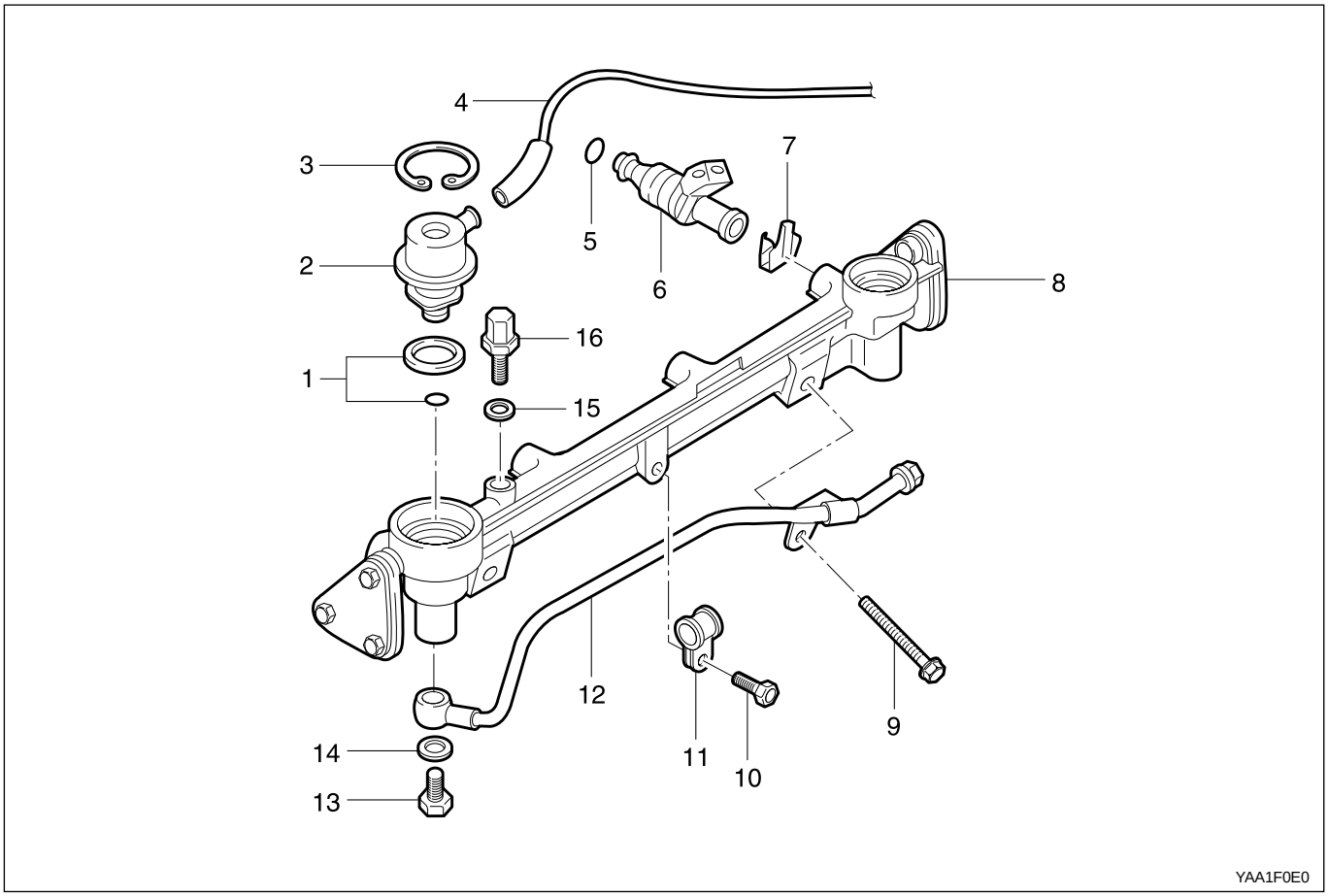
Specified Value	0.3 ~ 0.5 A

4. Remove the line to canister and measure the pressure with the vacuum pressure gauge.

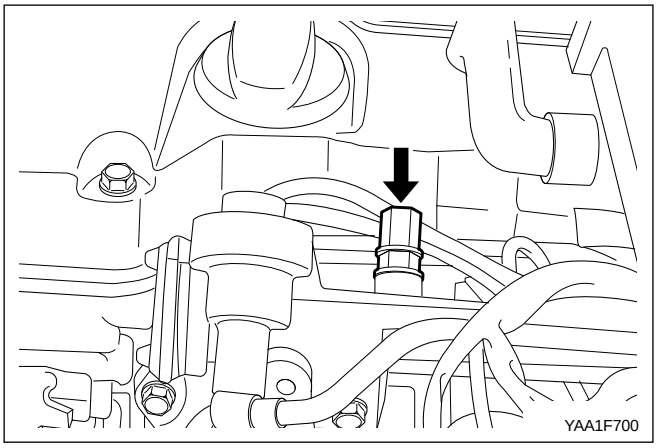
Specified Value	> 500 mbar (after approx. 1 min.) purge control valve operates at this time

Notice: Test while at normal temperature and at idling state by operating the engine.

FUEL RAIL



1 O-Ring
2 Fuel Pressure Regulator
3 Circlip
4 Vacuum Hose
5 O-Ring
6 Injector
7 Injector Bracket
8 Fuel Rail
9 Combination Bolt
10 Bolt
11 Clamp
12 Fuel Return Line
13 Hollow Bolt
14 Seal Ring
15 Seal Ring
16 Fuel Pressure Test Connector



Fuel Pressure Test

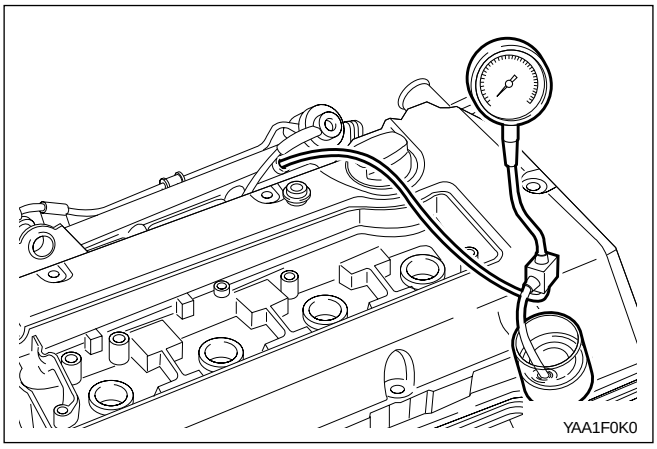
Tools Required

103 589 00 21 00 Fuel Pressure Gauge

1. Turn the ignition switch to “OFF” position.
2. Remove the fuel pressure test connector.
3. Connect the fuel pressure gauge to the fuel pressure test connector.
4. Test the fuel pressure at idling by operating the engine using the fuel pressure gauge 103 589 00 21 00.

Vacuum Hose Connected (bar)	3.2 ~ 3.6
Vacuum Hose Disconnected (bar)	3.7 ~ 4.2

5. Replace the pressure regulator diaphragm if out of the specification.



Internal Leakage Test

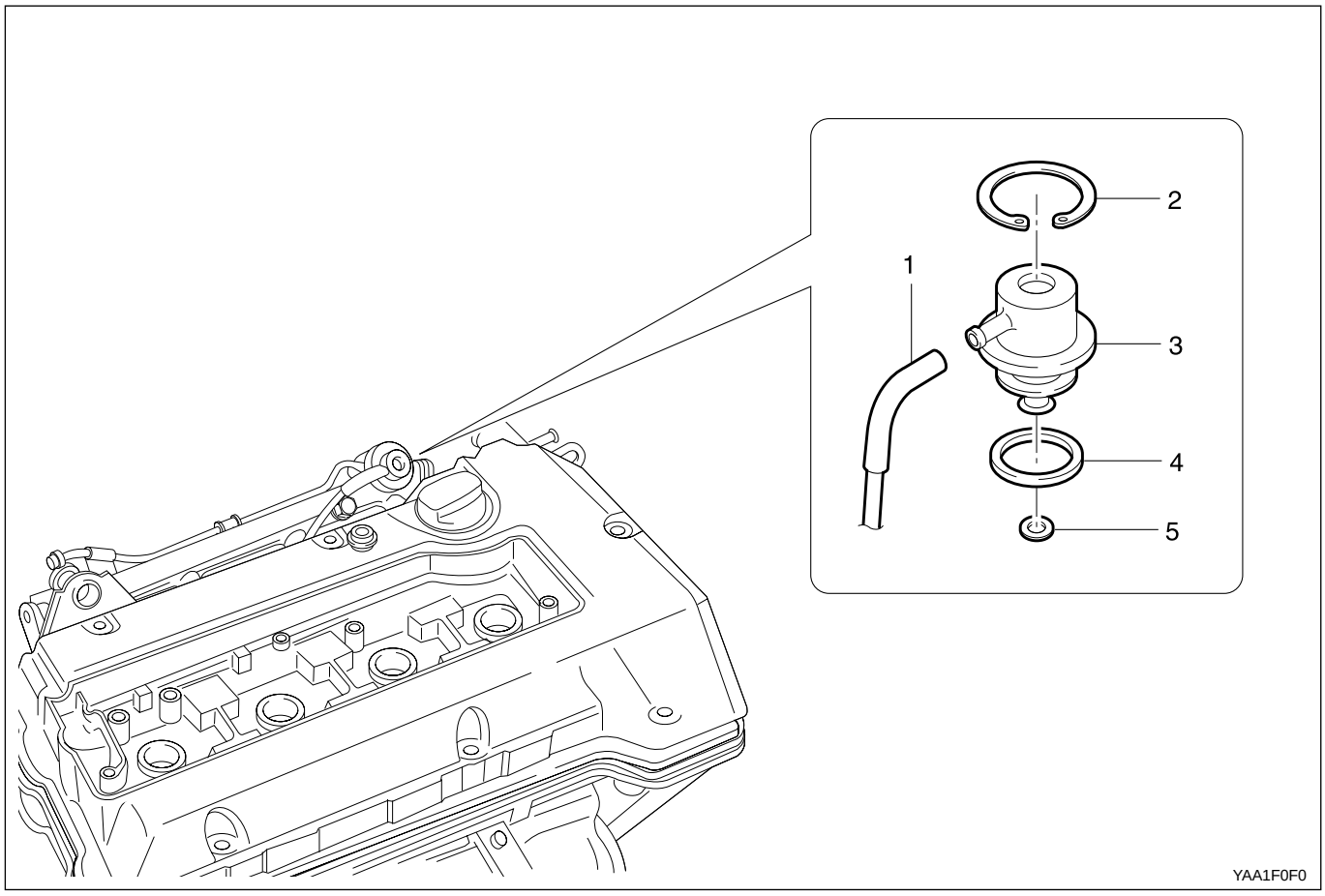
1. Connect the fuel pressure gauge103 589 002100 to the fuel pressure test connector.
2. Stop the engine for approximately 30 minutes and then check the fuel pressure changes.

Pressure change	
Fuel pressure drops slowly	• Fuel leakage at the injector • Faulty fuel pressure regulator’s diaphragm and O-ring
Fuel pressure drops rapidly	• Faulty check valve in the fuel pump

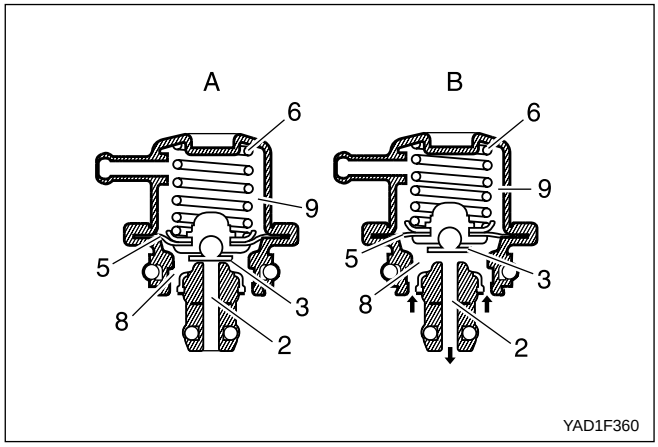
3. If there is no change in fuel pressure and maintain the following pressure over 30minutes, it is normal.

Fuel pressure (bar)	≥ 2.5

FUEL PRESSURE REGULATOR



1 Vacuum Hose
2 Circlip
3 Fuel Pressure Regulator
4 O-Ring
5 O-Ring



2. Fuel return line
3. Valve
5. Diaphragm
6. Compression Spring
8. Fuel Chamber
9. Spring Chamber

A. Valves Closed
B. Valves Opened

Function of the Fuel Pressure Regulator

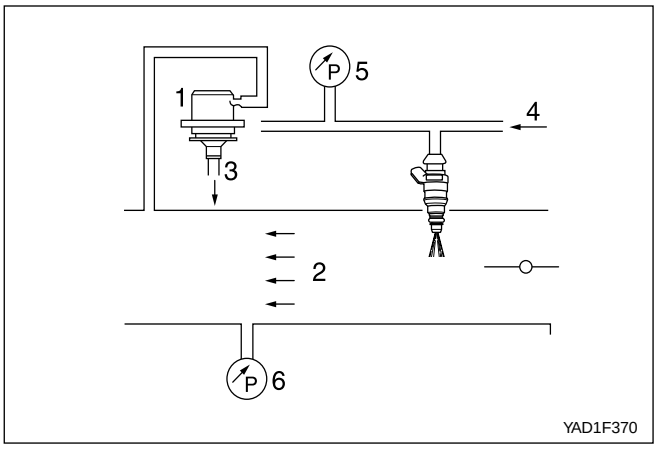
The fuel pressure regulator maintains the fuel pressure in the fuel line with the pressure of 3.2 bars to 3.8 bars according to the intake manifold pressure. This operating pressure cannot be changed, and the fuel injection volume will be only determined by the injection time. Over supplied fuel returns to the fuel tank through the return line.

<Operating at full load>

There is no negative pressure applied to the spring chamber (9) during the full load, and it is separated from the fuel chamber (8) by the diaphragm (5).

When the fuel pressure goes up, the diaphragm forces the compression spring (6) in the direction of compression. At this moment, the valve (3) sticks to the diaphragm by the fuel pressure, and the fuel return line (2) opens. The fuel over supplied returns to the fuel tank through the return line.

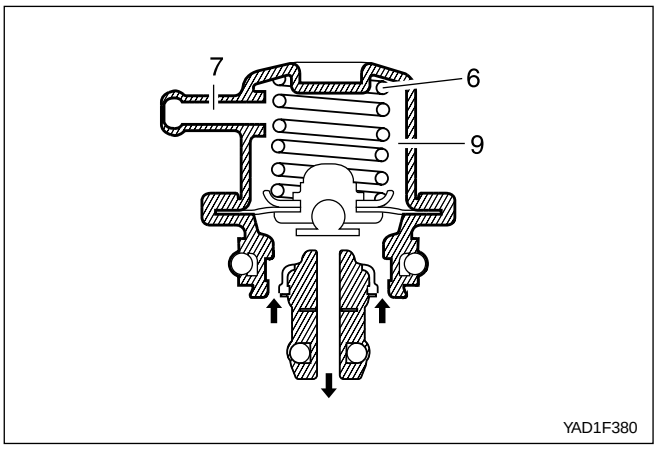
The pressure difference between the fuel pressure and the intake manifold is about 3.8 bars during the full load.



1. Fuel Pressure Regulator
2. Intake Manifold
3. Fuel Return (to fuel tank)
4. Fuel Supply (from fuel pump)
5. Fuel Pressure (approx. 3.8 bars)
6. Intake Manifold Negative Pressure (0 bar)

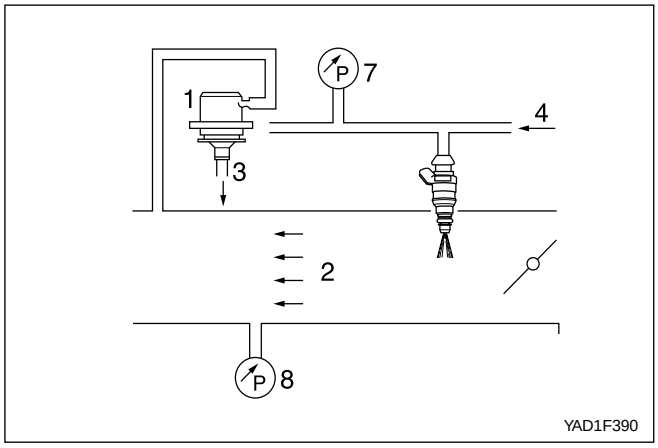
<Operating at Idle and partial load>

The spring chamber (9) is connected to the intake manifold with the vacuum hose at the intake pipe connection (7). The negative pressure generated in the intake manifold activates the diaphragm, and thus the fuel pressure gets reduced to the rate of the operating extent of the diaphragm by the intake manifold's negative pressure.



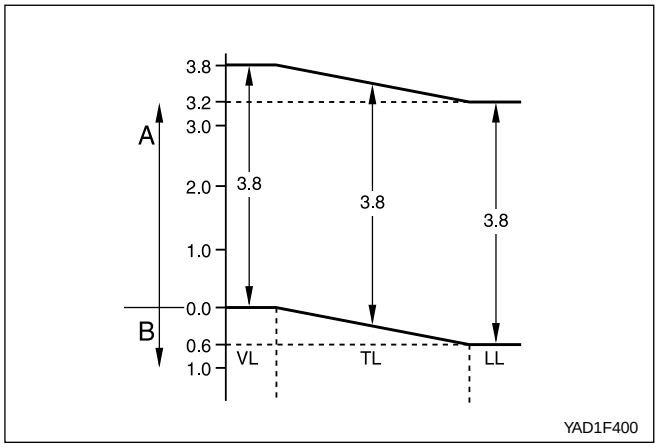
Consequently, the fuel pressure in the fuel distributor changes by the intake manifold's negative pressure, and the injector's fuel pressure gets reduced independently to the throttle valve's position. Thus, the fuel injection volume can only be determined according to the injector's injecting duration.

The pressure difference between the fuel pressure and the intake manifold is approx. 3.2 bars during idling.



1. Fuel Pressure Regulator
2. Intake Manifold
3. Fuel Return (to fuel tank)
4. Fuel Supply (from fuel pump)
7. Fuel Pressure (approx. 3.2 bars)
8. Intake Manifold Negative Pressure (0.6 bars)

<Fuel Pressure Diagram>



A. Fuel pressure
B. Intake Manifold Negative Pressure
LL. Idling
TL. Partial load
VL. Full load