SECTION 1F1

M162 ENGINE CONTROLS

CAUTION: Disconnect the negative battery cabl e beforer emoving or i nstalling 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 other-wise 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 re-spective “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	1F1-56	Engine coolant temperature sensor low voltage
01	1F1-56	Engine coolant temperature sensor high voltage
02	1F1-56	Engine coolant temperature sensor plausibility
03	1F1-52	Intake air temperature sensor low voltage
04	1F1-52	Intake air temperature sensor high voltage
05	1F1-52	Intake air temperature sensor plausibility
06	1F1-56	Engine coolant temperature insufficient for closed loop fuel control
08	1F1-28	System voltage too low
09	1F1-52	Mass air flow sensor plausibility
10	1F1-52	Mass air flow sensor low voltage
11	1F1-52	Mass air flow sensor high voltage
17	1F1-13	Crankshaft position sensor signal failure (no engine revolution signal)
18	1F1-13	Crankshaft position sensor signal failure (rpm > max. value)
19	1F1-17	Camshaft position senosr signal : No.1 cylinder recognition failure
20	1F1-13	Crankshaft position sensor signal failure (gap recognition failure)
21	1F1-79	Transmission coding failure
23	1F1-77	CAN communication failure : ASR/MSR
24	1F1-77	CAN communication failure : ABS
25	1F1-82	Communication with transponder missing
26	1F1-77	CAN communication failure : TCU (A/T only)
27	1F1-78	CAN communication failure : TOD (E32 only)
29	1F1-78	CAN communication failure : ID 200h not plausible
30	1F1-78	CAN communication failure : ID 208h not plausible
31	1F1-78	CAN communication failure : communication initialization failure
32	1F1-68	Engine rpm output circuit short circuit to battery
33	1F1-68	Engine rpm output circuit short circuit to ground or open
34	1F1-33	Fuel pump relay short circuit to battery
35	1F1-33	Fuel pump relay short circuit to ground or open
40	1F1-41	Purge control valve short circuit to battery
41	1F1-41	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
57	1F1-23	No.2 knock sensor signal failure
58	1F1-17	Camshaft position sensor signal : No.1 cylinder synchronization failure
59	1F1-78	CAN communication failure : MSR data transmission not plausible
60	1F1-78	CAN communication failure : ASR data transmission not plausible
62	1F1-61	Clutch switch defective
64	1F1-11	No ignition voltage output (No.1 ignition coil)
65	1F1-11	No ignition voltage output (No.2 ignition coil)
66	1F1-11	No ignition voltage output (No.3 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)

FAILURE CODES TABLE (Cont'd)

Failure code	See Page	Description
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
108	1F1-47	Throttle position sensor 2 low voltage
109	1F1-47	Throttle position sensor 2 high voltage
110	1F1-80	Throttle actuator learning data fault
116	1F1-47	Throttle actuator learning control failure
117	1F1-80	Exceed fuel -cut safety time
119	1F1-47	Throttle valve return spring failure
120	1F1-80	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	1F1-67	Stop lamp switch failure
136	1F1-79	ECU failure (RAM)
137	1F1-79	ECU failure (EPROM)
138	1F1-80	Call monitoring
139	1F1-80	Servo motor control output interruption memory failure
140	1F1-80	Servo motor open/short
141	1F1-82	Unprogramed ECU with immobilizer
142	1F1-79	Uncoded/unprogramed ECU
143	1F1-79	ECU failure (EEPROM/Flash-EPROM checksum failure)
144	1F1-79	ECU failure (coding ID checksum failure)
145	1F1-79	ECU failure (coding checksum failure)
146	1F1-79	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

FAILURE CODES TABLE (Cont'd)

Failure code	See Page	Description
167	1F1-59	Both setpoint accelerator pedal position sensor defective
185	1F1-48	Mass air flow sensor and throttle position sensor failure
186	1F1-80	ECU failure (incompatible CPU)
187	1F1-80	ECU failure (CPUs communication failure)
188	1F1-80	ECU failure (CPU 2 configuration failure)
189	1F1-80	ECU failure (CPU 2 fault)
190	1F1-80	ECU failure (CPU run time failure between CPUs)
192	1F1-38	No.5 injector short circuit to battery
193	1F1-38	No.5 injector short circuit to ground or open
194	1F1-38	No.6 injector short circuit to battery
195	1F1-38	No.6 injector short circuit to ground or open
198	1F1-66	Resonance flap short circuit to battery
199	1F1-66	Resonance flap short circuit to ground or open
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	1F1-80	ECU failure (CPU 2 cruise control message counter failure)
232	1F1-80	Over decceleration limit (CPU 2)
233	1F1-80	Over acceleration limit (CPU 2)
234	1F1-80	Cruise control lever dual operation (CPU 2)
235	1F1-80	Cruise control lever safety terminal failure (CPU 2)
236	1F1-80	Unusual pedal position variation (CPU 2)
237	1F1-80	Unusual throttle position variation (CPU 2)
238	1F1-80	Unusual throttle controller monitor data comparison fault (CPU 2)
239	1F1-81	Unusual accelerator pedal position sensor comparison fault (CPU 2)
240	1F1-81	Throttle potentiometer comparision fault (CPU 2)
241	1F1-81	Unusual CPU communication (CPU 2)
242	1F1-81	Unusual CPU configuration (CPU 2)
243	1F1-81	A/D converter failure (CPU 2)
244	1F1-81	Accelerator pedal position sensor setpoint fault between CPU 1 and CPU 2
245	1F1-81	Position controller setpoint fault between CPU 1 and CPU 2
246	1F1-81	MSR setpoint fault between CPU 1 and CPU 2
247	1F1-81	Idle control setpoint fault between CPU 1 and CPU 2
248	1F1-81	A/D converteroverflow (CPU 2)
249	1F1-81	ROM f aul t (CPU 2)
250	1F1-81	RAM f aul t (CPU 2)
251	1F1-85	Cycle monitor fault (CPU 2)

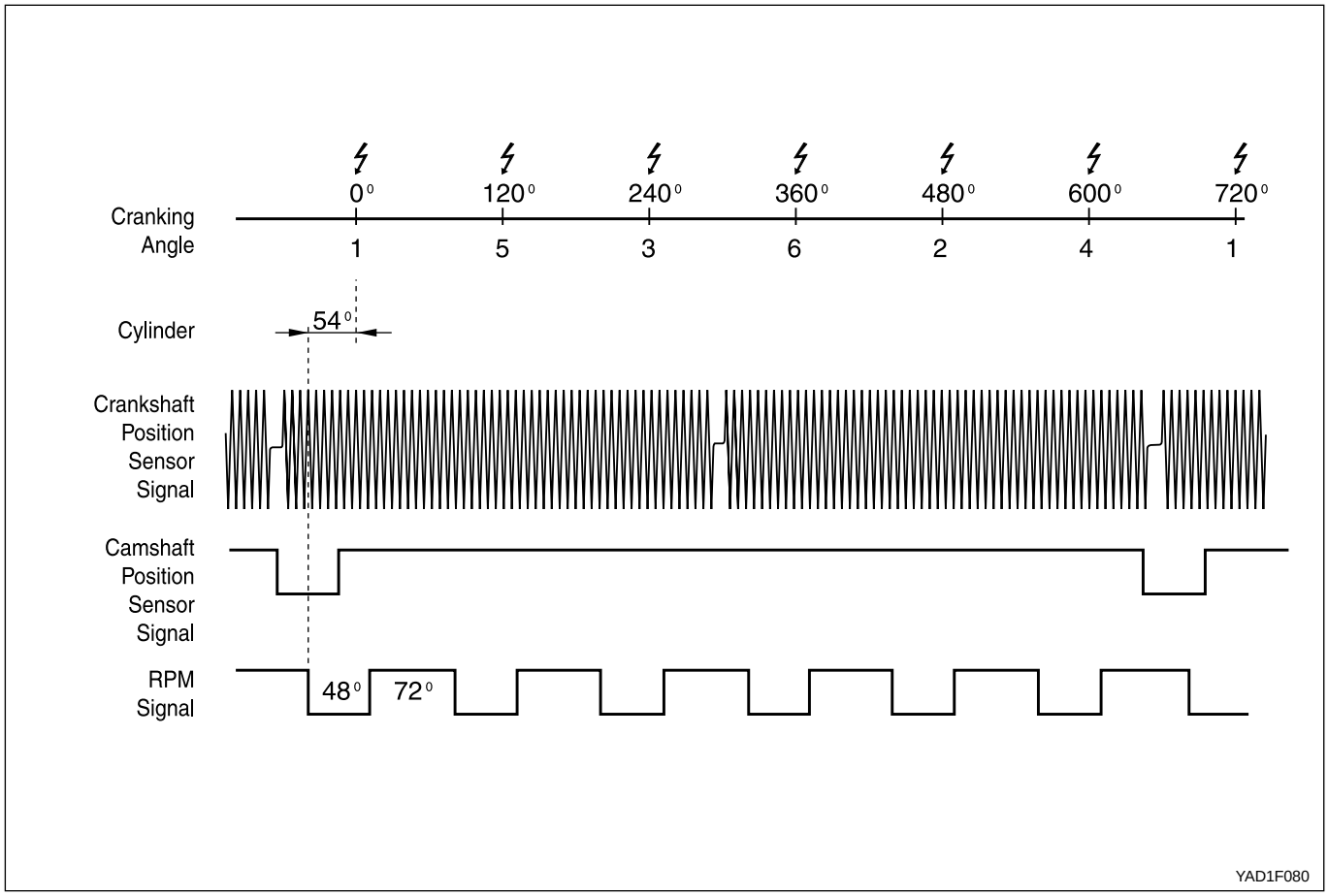
IGNITION SYSTEM

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 (1-6 or 2-5 or 3-4). The spark occurs simultaneously in the cylinder coming upon 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 tofire 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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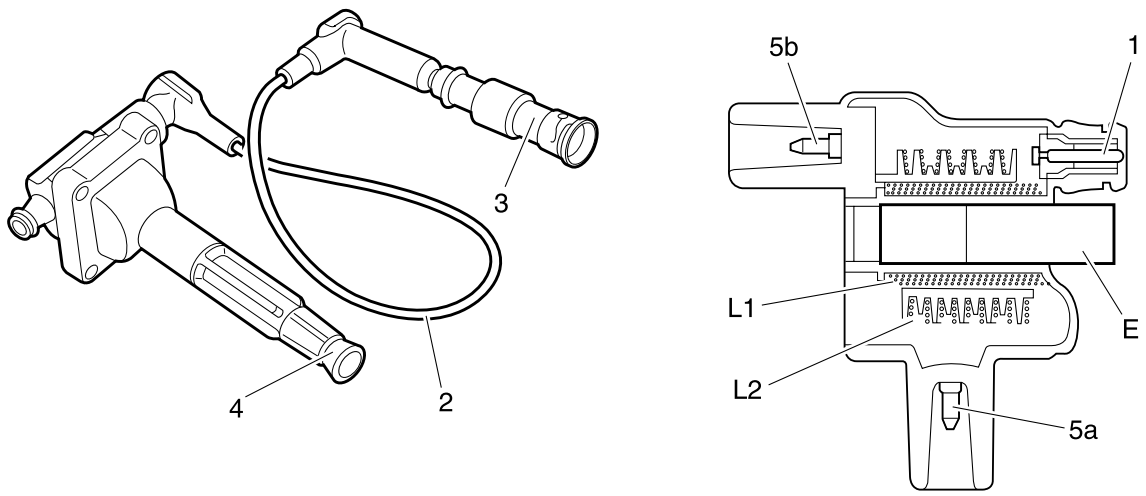
IGNITION COIL



YAD1F090

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.

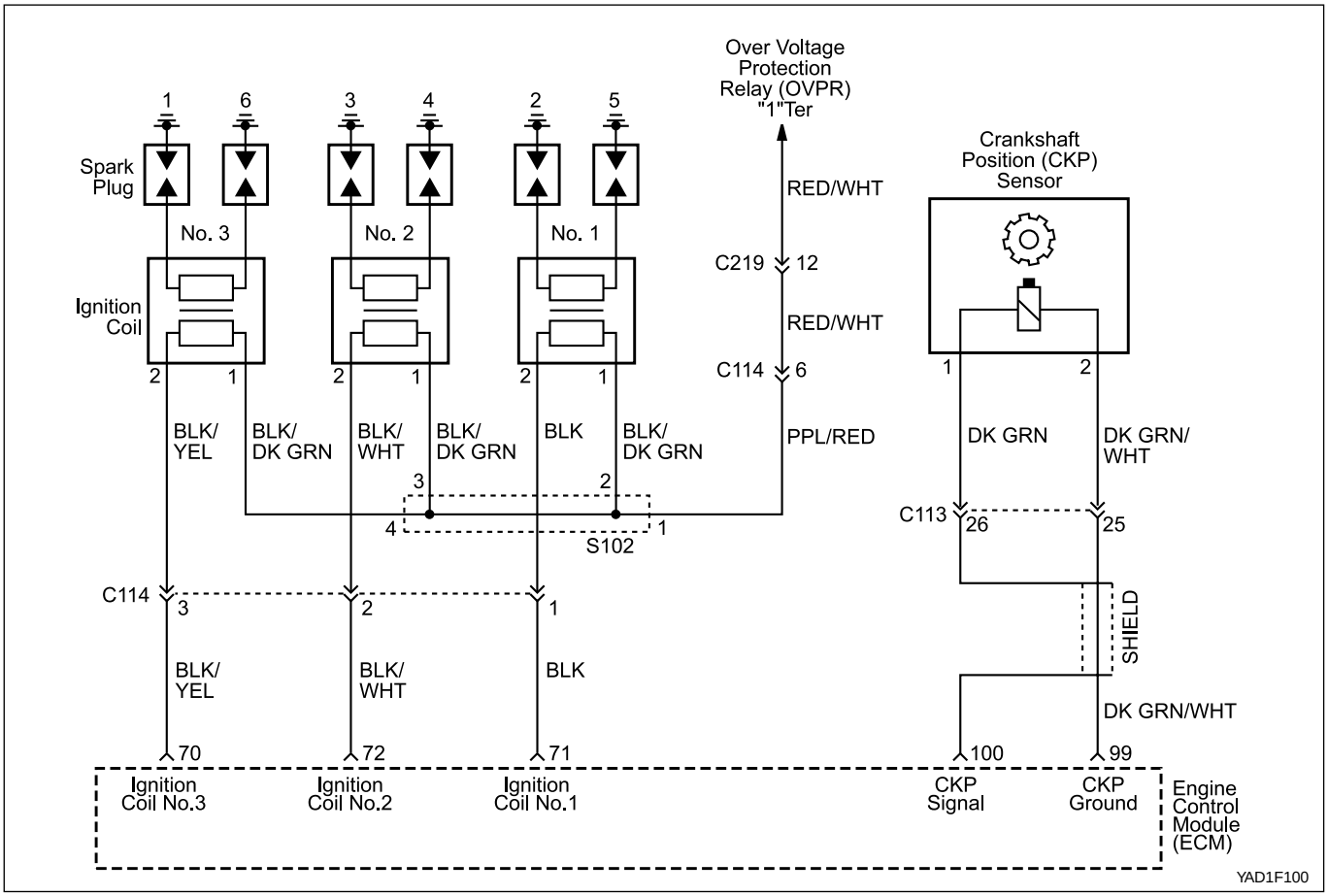
Each EI system ignition coil provides the high voltage to two spark plugs simultaneously;

T1/1: cylinder 2 and 5

T1/2: cylinder 3 and 4

T1/3: cylinder 1 and 6

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



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 70 (71 and72) about short circuit or open with bad contact • Inspection the power source to ignition • 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)		
66	No ignition voltage output (No. 3 ignition coil)		

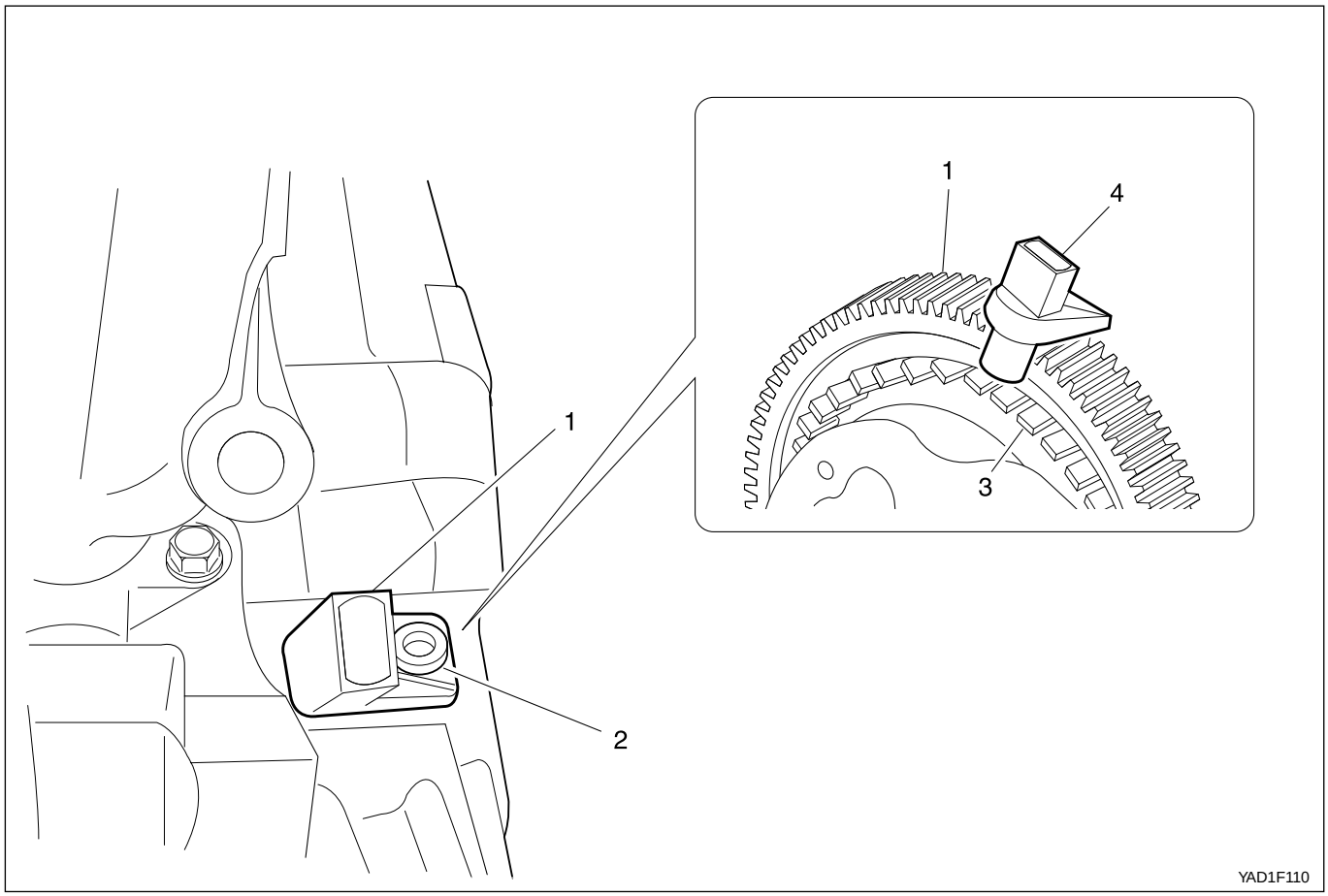
Circuit Description

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 plugin the cylinder on its exhaust stroke.

This leaves there 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

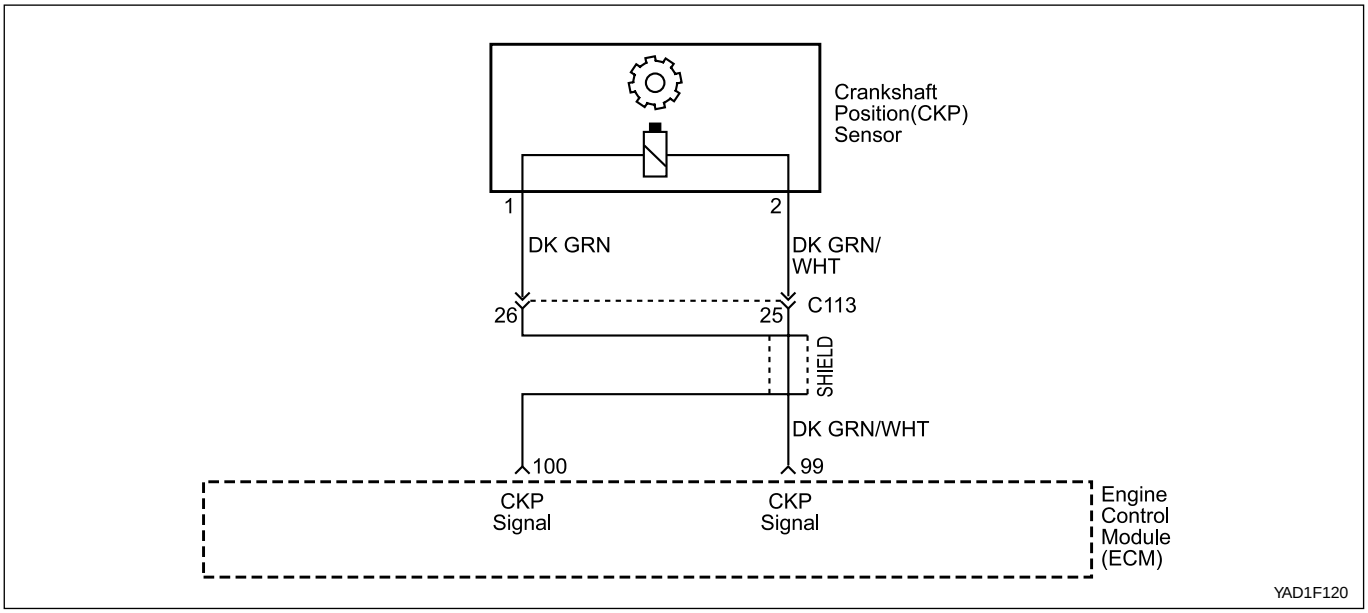


1 Crankshaft Position Sensor
2 Bolt
3 Segment
4 Flywheel

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 a gap of 2 teeth at 360 degree spacing. This sensor protrudes throughits 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 scan tool	
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.

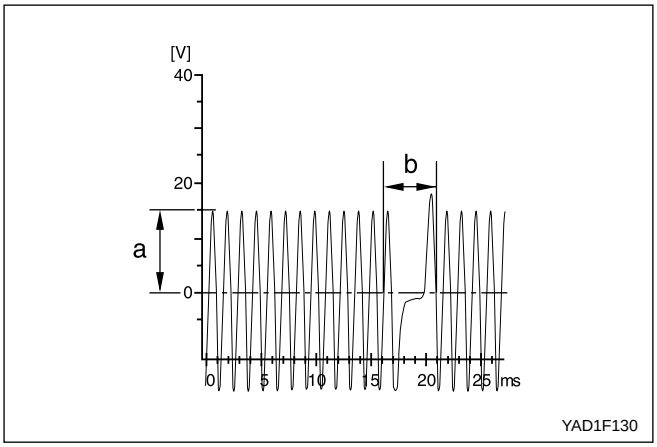
Specified Value	1,050 ~ 1,400 Ω

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.



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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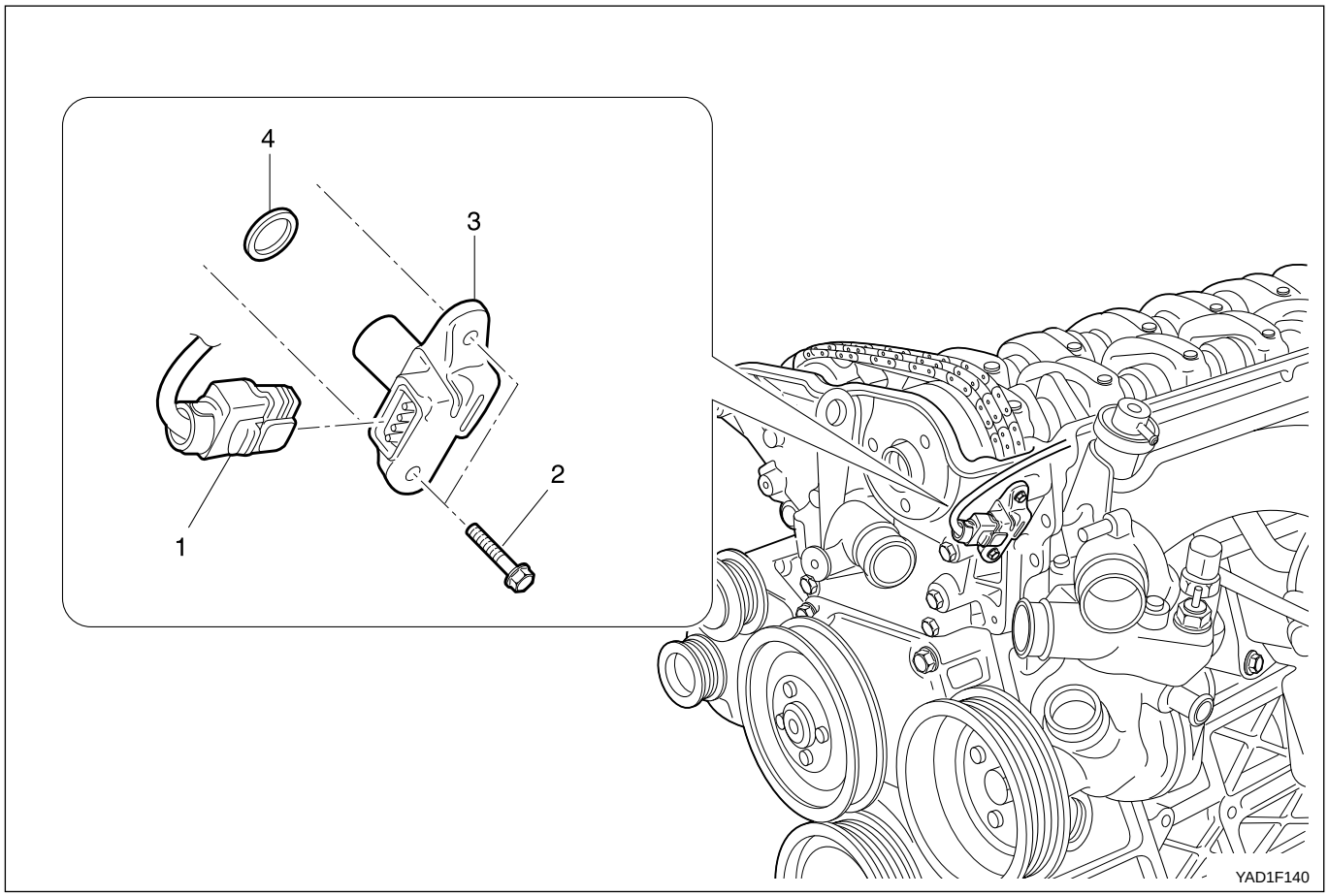
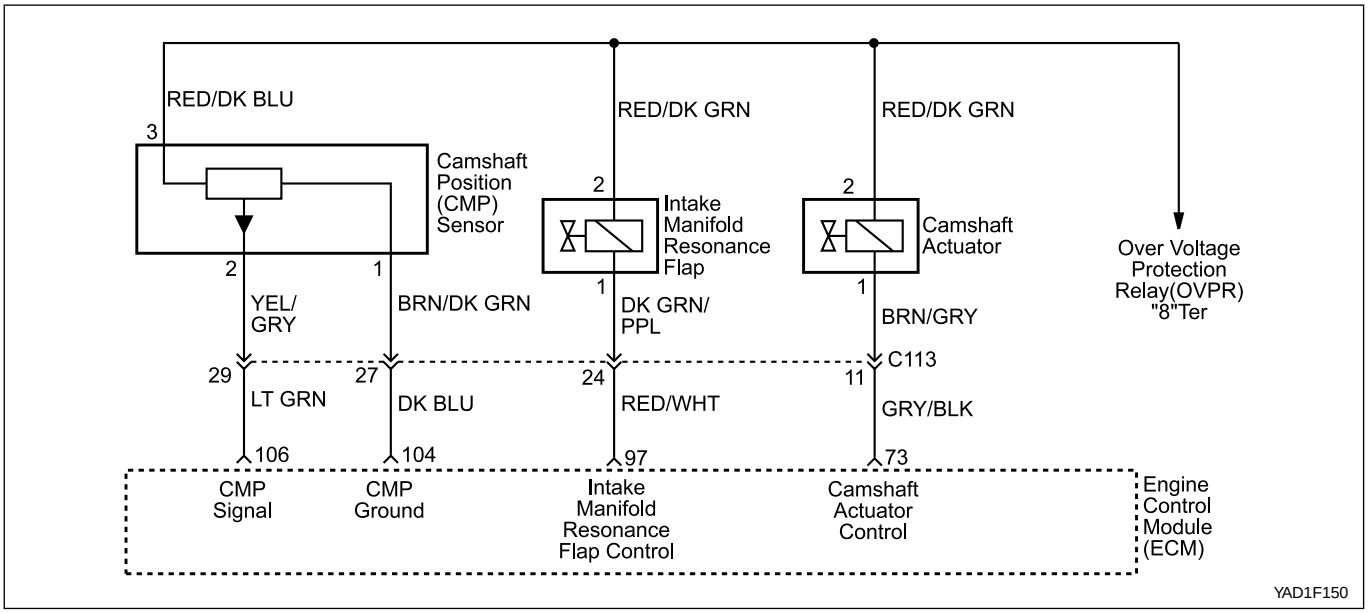
CAMSHAFT POSITION (CMP) SENSOR



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.

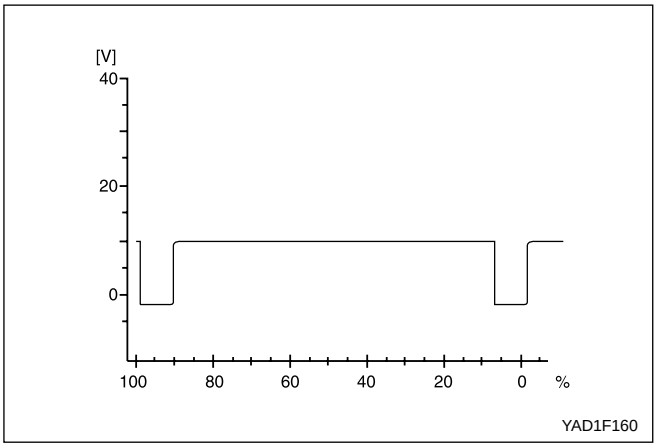
Specified Value	1.2 ~ 1.7 v

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 out-put wave as shown in the figure.



Camshaft Position Sensor Power Supply Inspection

1. Disconnect the CMP sensor Connector.
2. Measure the voltage between the No. 1and 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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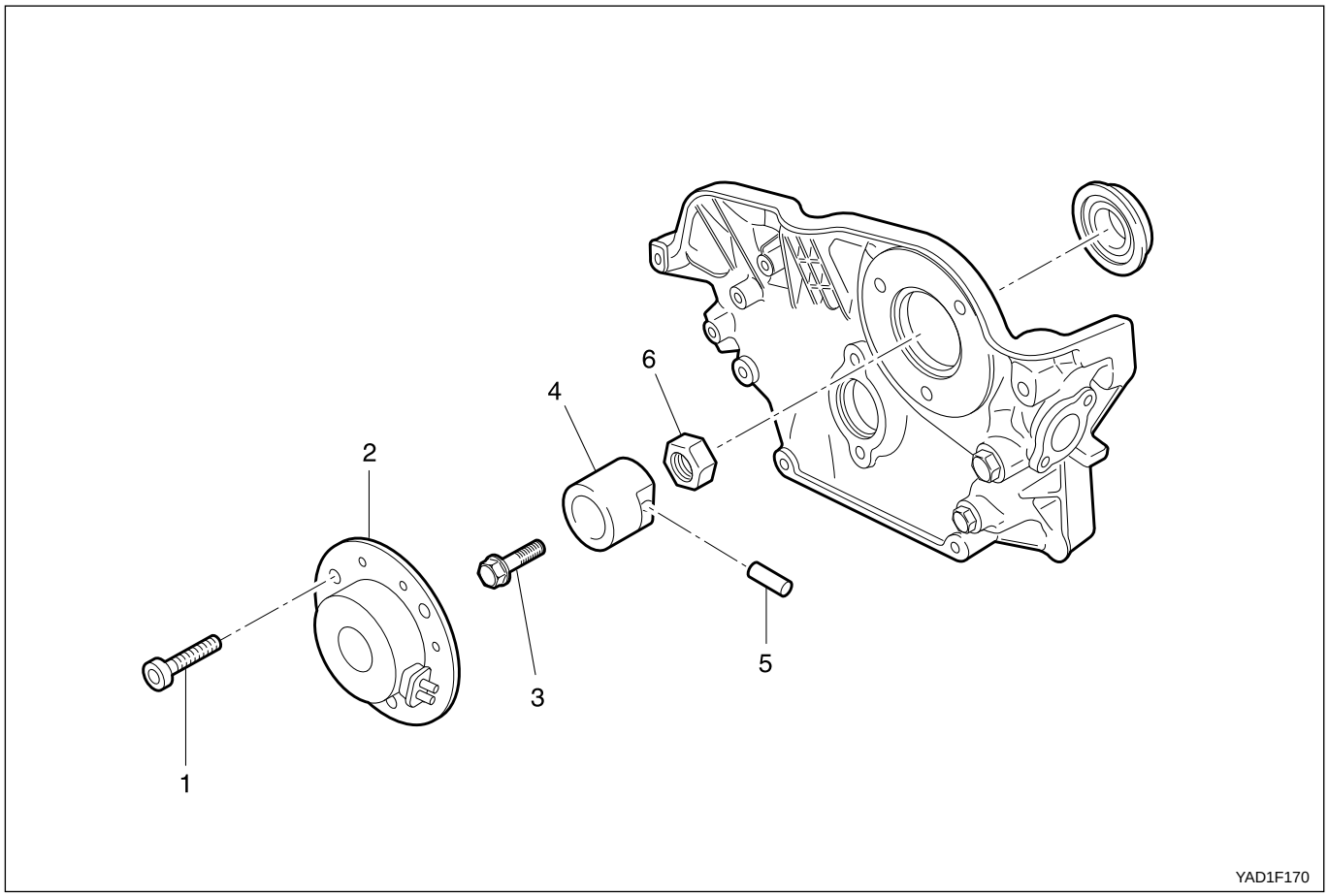
CAMSHAFT ACTUATOR

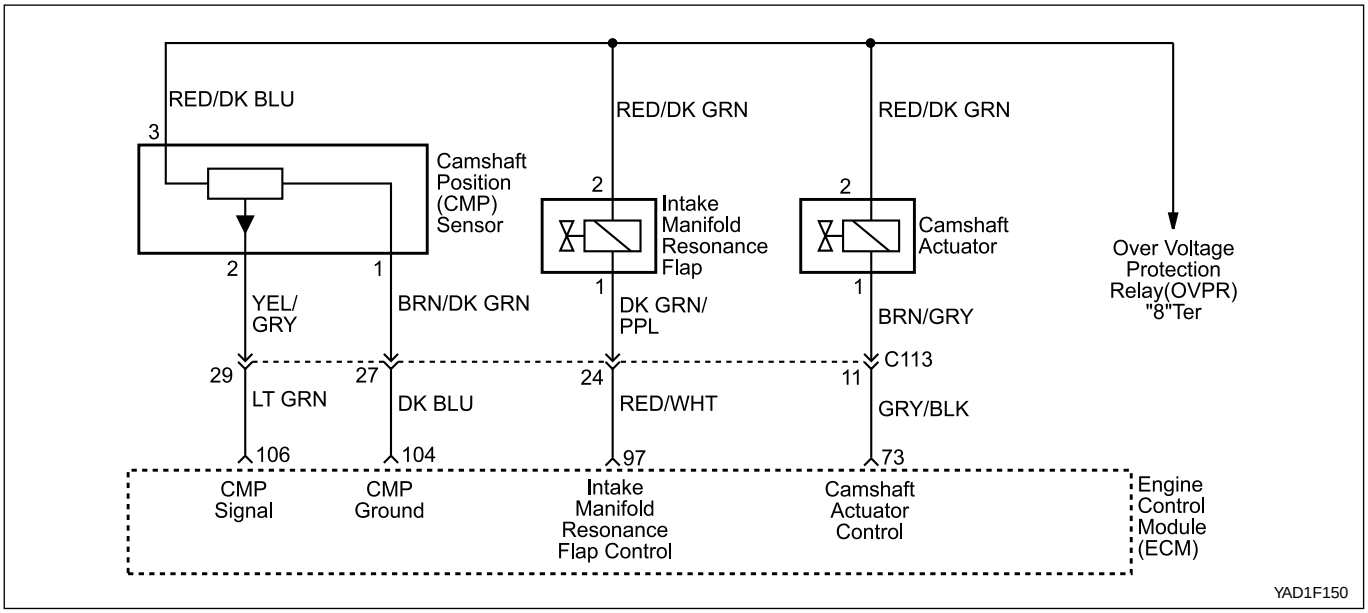


1 Bolt
2 Camshaft Actuator
3 Bolt
4 Armature
5 Roll Pin
6 Nut

When the engine is running, the camshaft actuator rotates the intake camshaft hydraulically and mechanically relative to the camshaft sprocket by 32° 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 ~ 1,500 rpm	Retard	Idle speed is improved Blow-by gas is decreased Valve overlap is decreased
1,500 ~ 4,300 rpm	Advanced	Torque is increased Fuel loss is decreased NOx is decreased
Above 4,300 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		

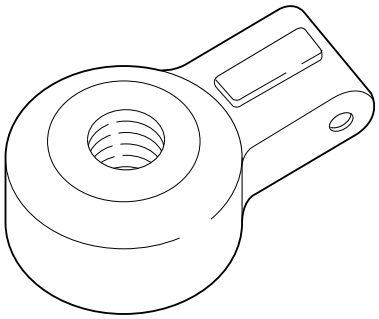
Camshaft Actuator Current Consumption Inspection

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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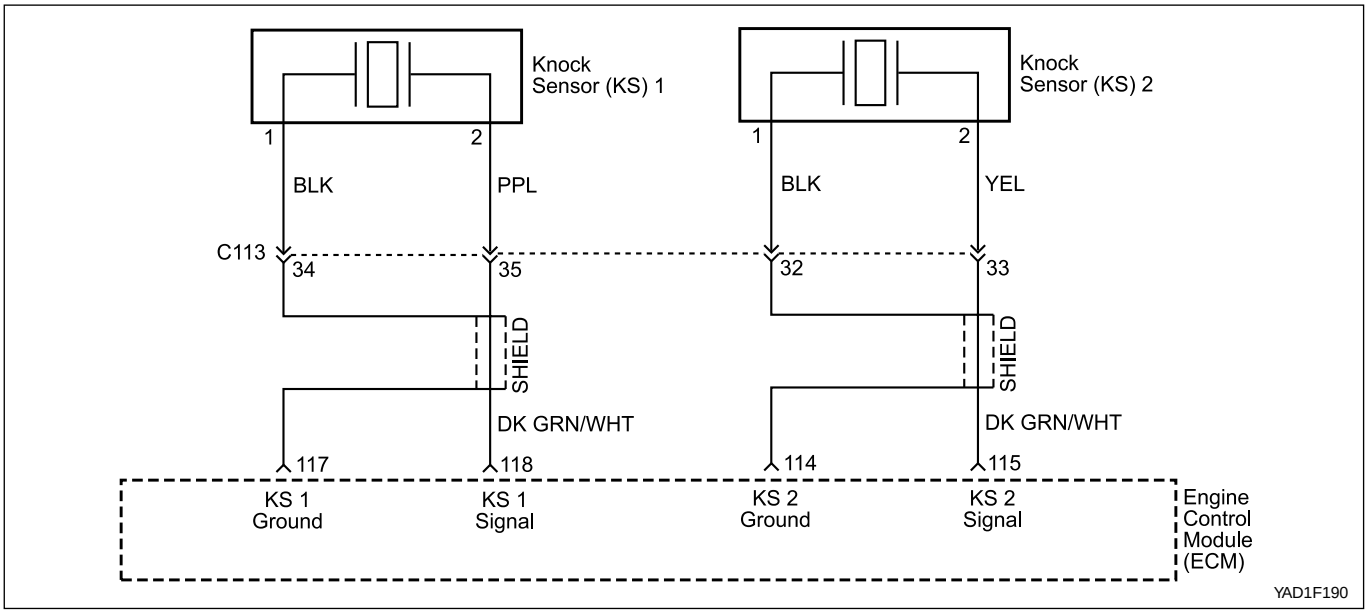
The Knock Sensor (KS) detects abnormal knocking in the engine. The two KS are mounted in the engine block near the cylinders. The sensors produce an output voltage which increases with the severity of the knock. This signal is sent to the Engine Control Module (ECM) via a shielded cable. The ECM then 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)	• Inspection the ECM pin 118, 117about short circuit or open with bad contact • Inspection the KS 1 malfunction • Inspection the ECM • Inspection the ECM pin 115, 114 about short circuit or open with bad contact • Inspection the KS 2 malfunction • Inspection the ECM
57	No. 2 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 4, 5, 6)	

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.

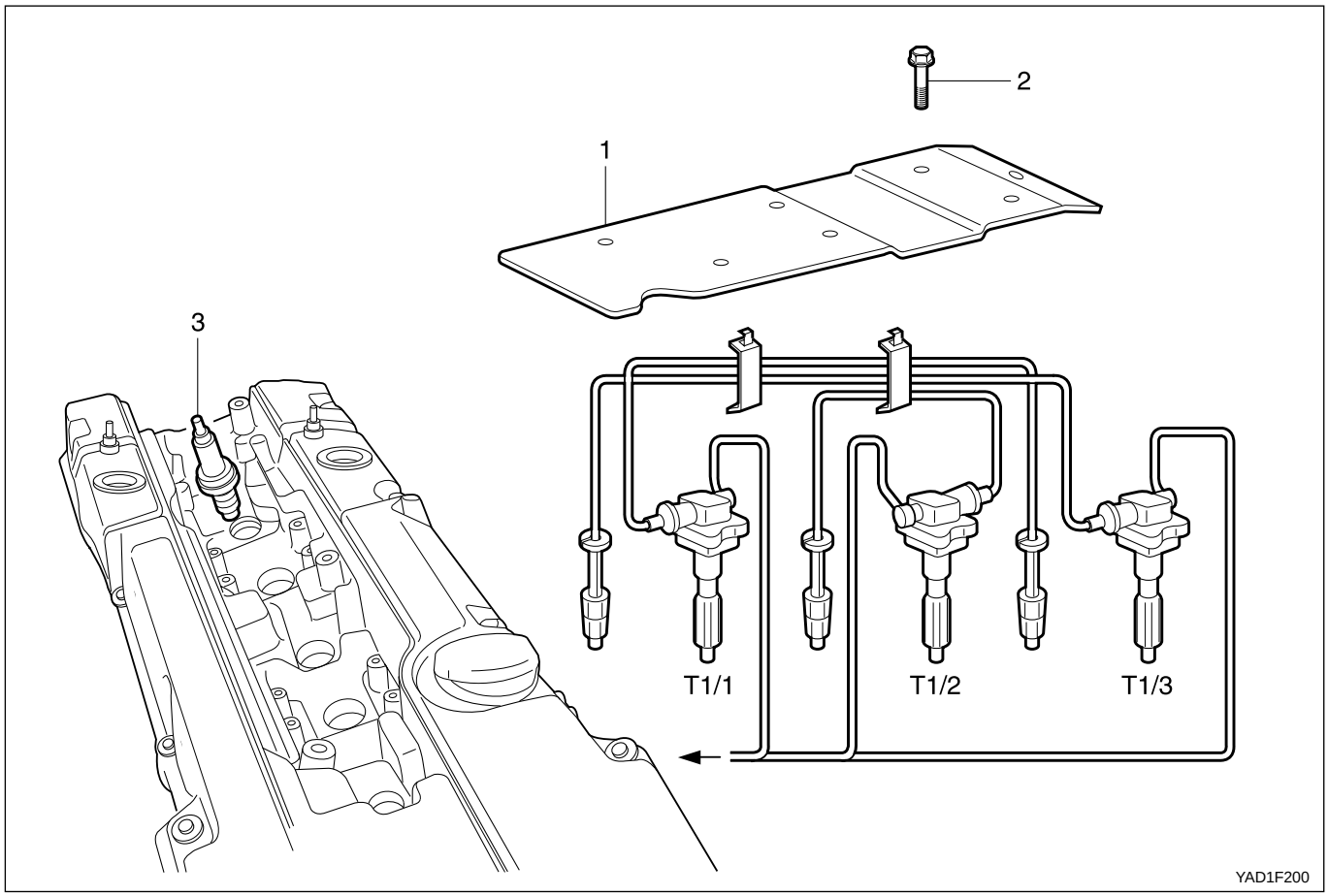
Knock Sensor Resistance Inspection

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 and terminal pin No. 115 and No. 114 using a multimeter.

Specified Value	>10 MΩ

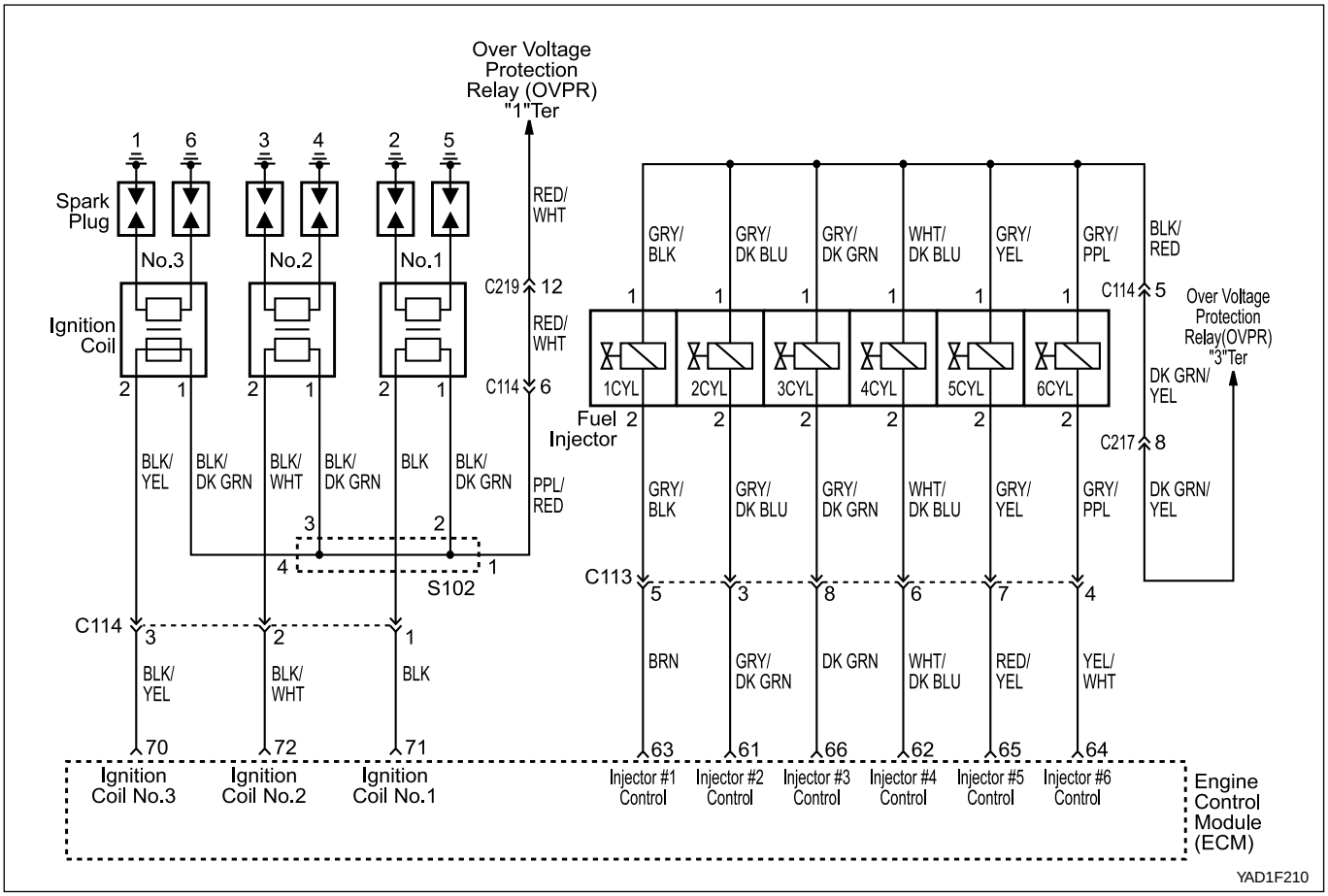
Notice: Replace the KS if the measured values is out of the specified values. Check the connector and wire connection between ECM and the KS if the measured values are normal.

SPARK PLUG



1 Ignition Coil Cable Cover
2 Bolt
3 Spark Plug

T 1/1 Ignition Coil Cylinder 2 and 5
T 1/2 Ignition Coil Cylinder 3 and 4
T 1/3 Ignition Coil Cylinder 1 and 6



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

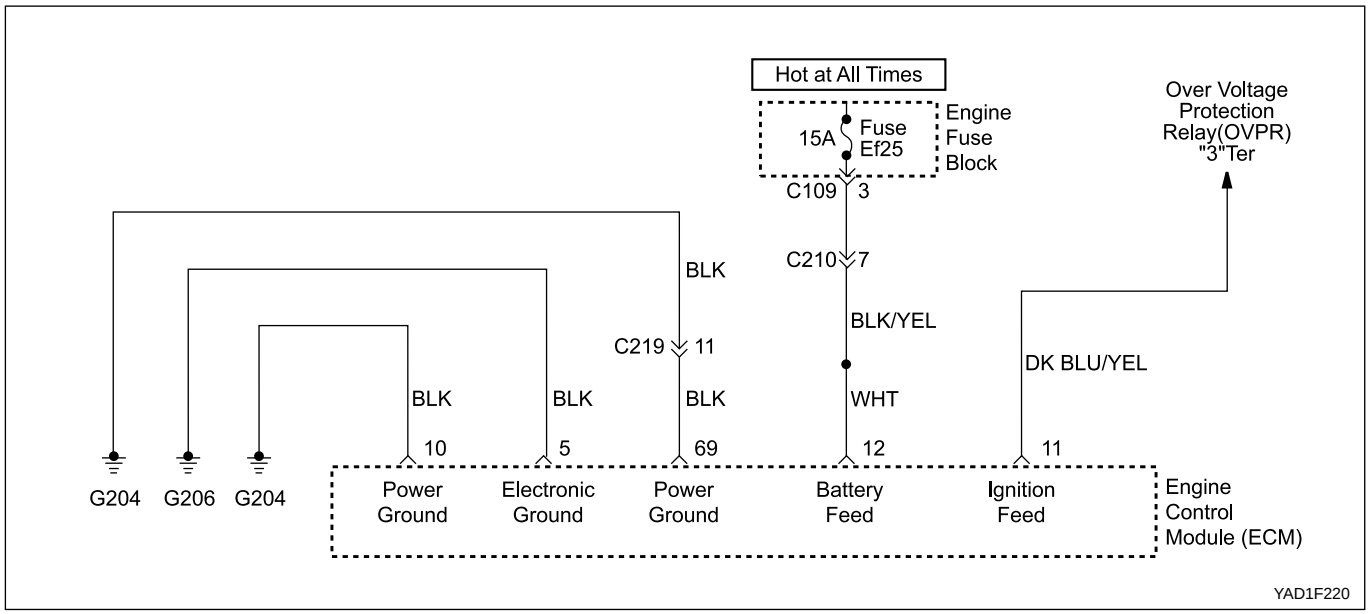
1. Turn the ignition switch “OFF” position.
2. Disconnect the spark plug cables Refer to *Section 1E1, Engine electrical.*
3. Measure the spark plug resistance using a multimeter.

Specified Value	1.8 ~ 2.2 kΩ

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

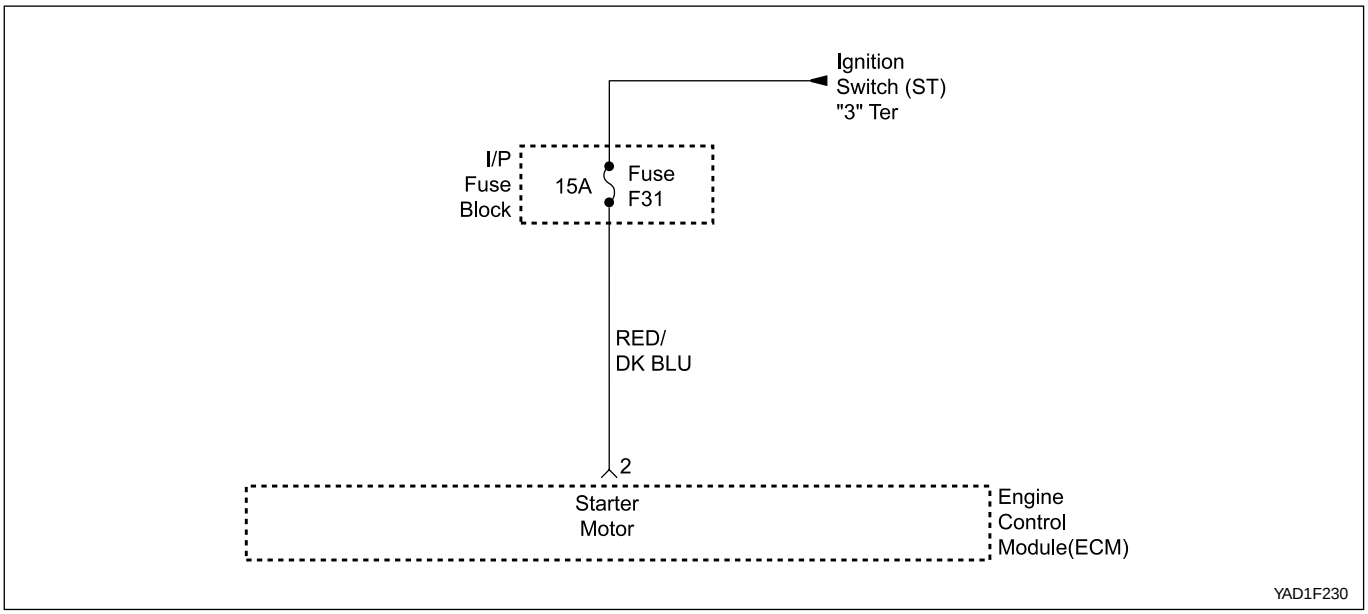
BLANK

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 O2S 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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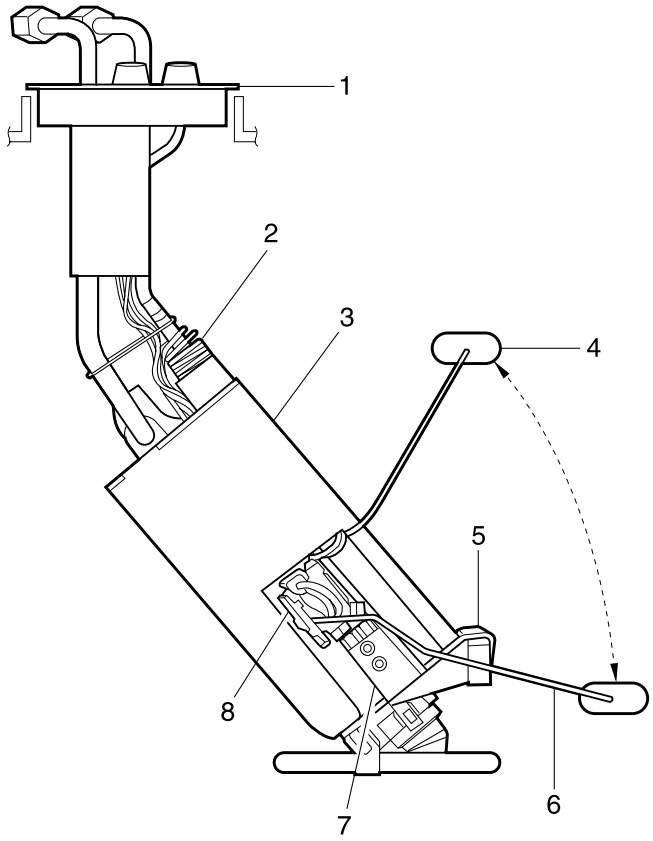
FUEL PUMP

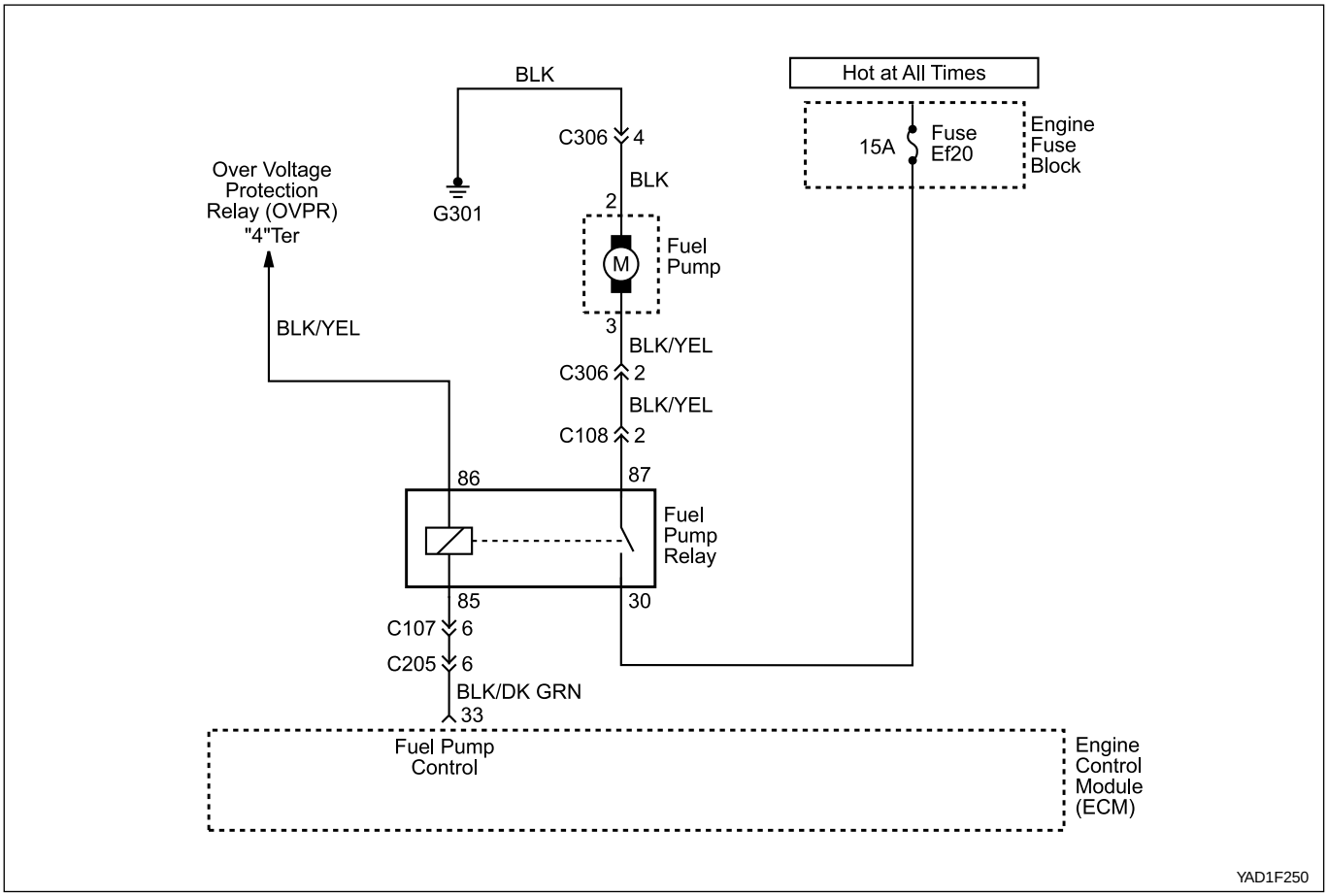


YAD1F240

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 (12V, 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 open with bad contact	

Circuit Description

When the ignition switch is turned ON, the ECMwill 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 ECMis receiving ignition reference pulses.

If there are no reference pulses, the ECM will shut off the fuel pump within 2 seconds after the ignition switch 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 (for1 ~ 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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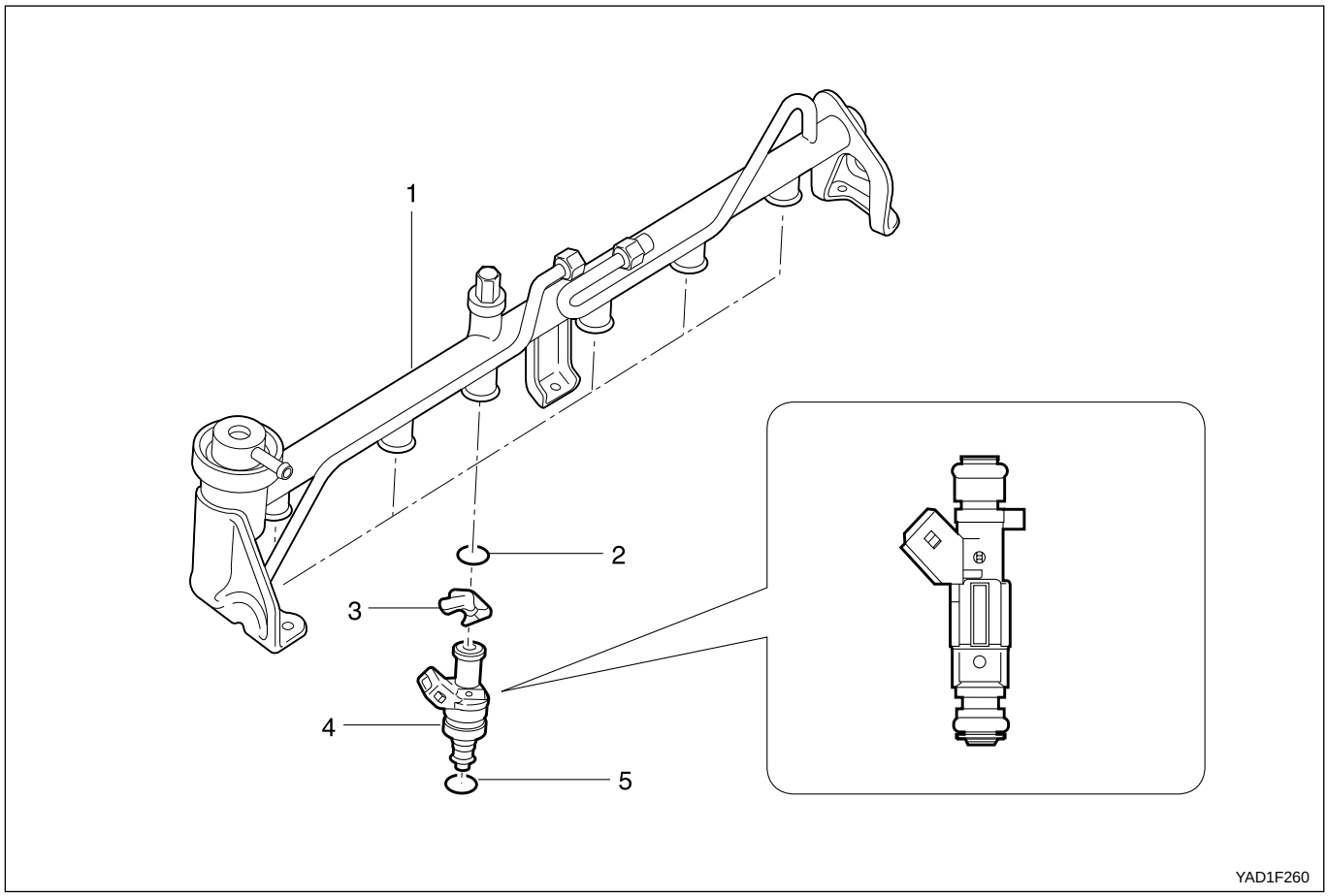
FUEL INJECTOR

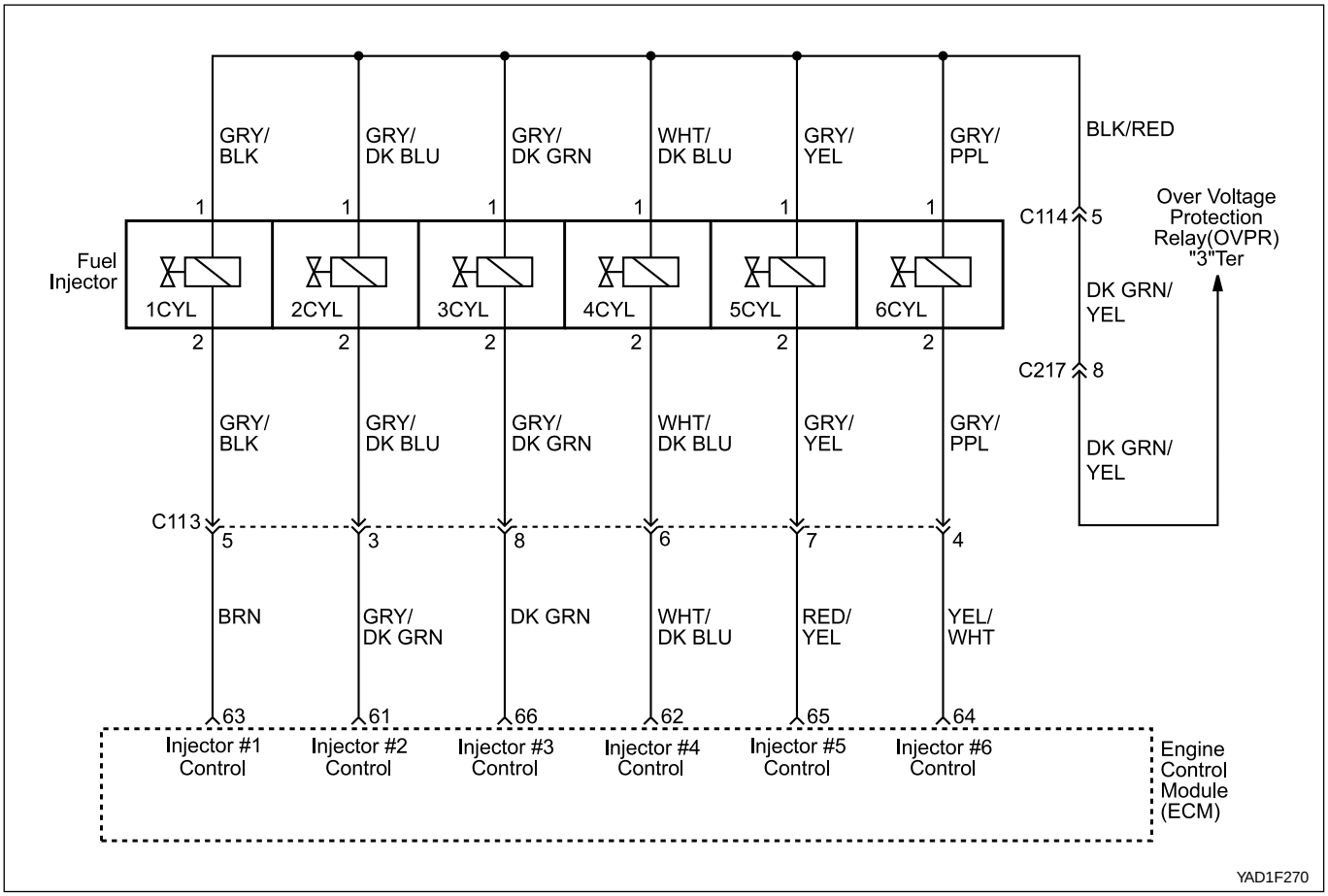


1 Fuel Rail
2 O-Ring
3 Injector Bracket
4 Injector
5 O-Ring

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 to ward 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 orifice is 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.

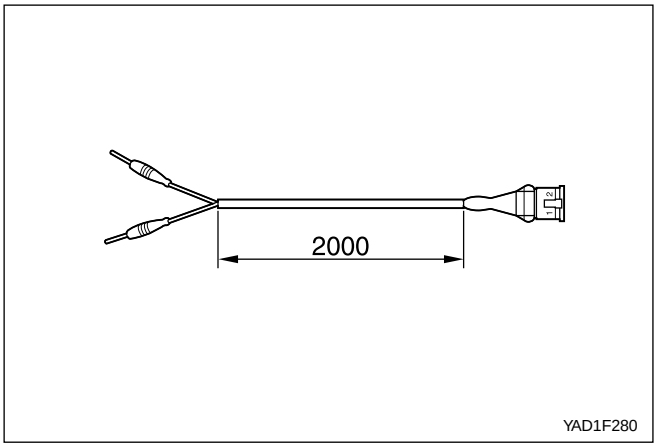
Fuel enters the top feed injector from above and flows through its vertical axis. The lower end extends into the intake valve. Fuel from the tip is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber.

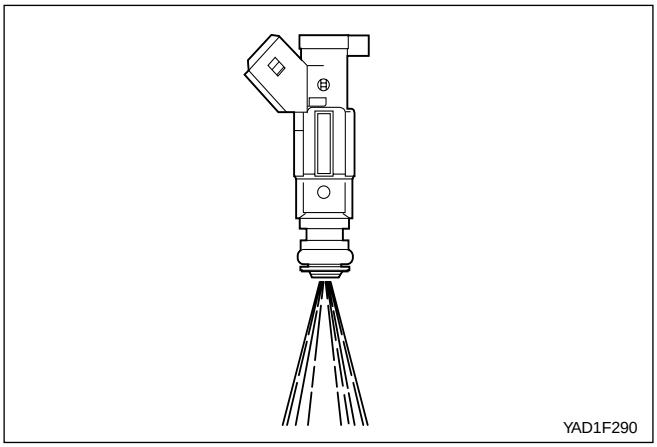
A fuel injector which is stuck partially open would cause a loss of fuel pressure after the engineis shut down. Also, an extended crank time would be noticed on some engines. Dieseling could also occur because some fuel could be delivered to the engine after the ignition is turned off.



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 61 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 66 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 62 about short circuit or open with bad contact • Inspection the injector • Inspection the ECM
192	No. 5 injector short circuit to battery	When malfunction of injector circuit Injector #5 short circuit to power	• Inspection the power to injector #5 or bad contact • Inspection the injector • Inspection the ECM
193	No. 5 injector short circuit to ground or open	When malfunction of injector circuit Injector #5 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
194	No. 6 injector short circuit to battery	When malfunction of injector circuit Injector #6 short circuit to power	• Inspection the power to injector #6 or bad contact • Inspection the injector • Inspection the ECM
195	No. 6 injector short circuit to ground or open	When malfunction of injector circuit Injector #6 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





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 injector 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 injector for normal spray pattern as shown in the figure. Check injector for leaks or later drop

Injector Resistance Inspection

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

Specified Value	14 ~ 17 Ω

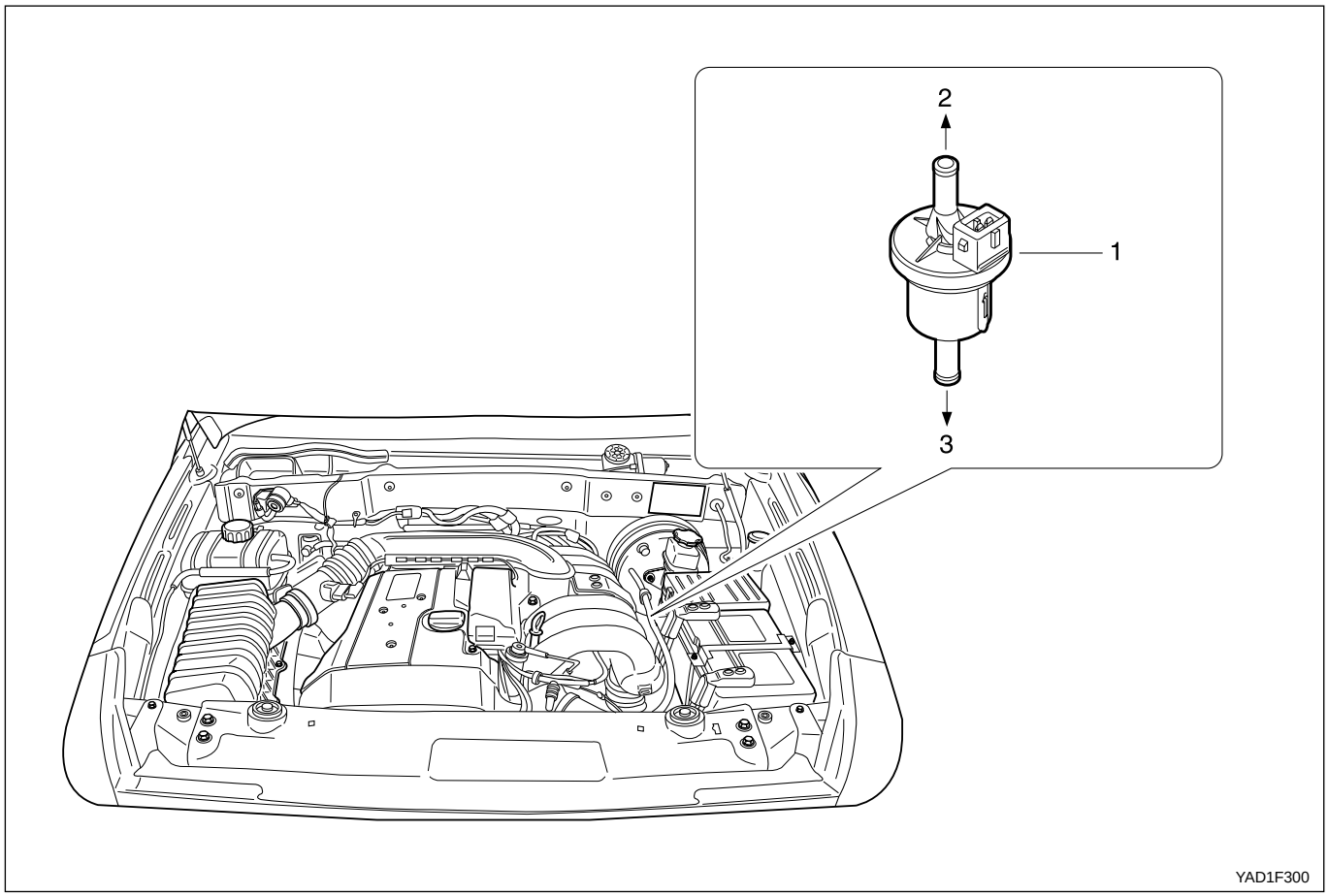
Notice: Replace the fuel injector if the measured value is out of the specified values. Check the connector and wire connection between the ECM and the injector if the measured values are normal.

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 Conister

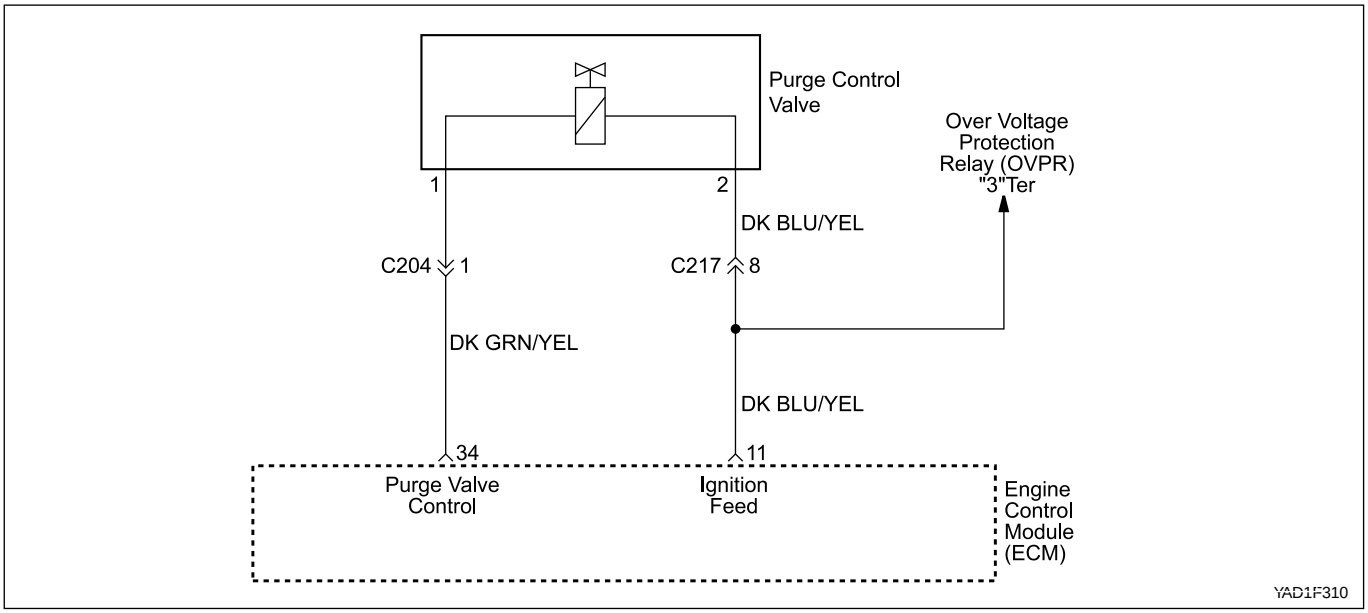
The fuel vaporization control system is in stalled to inhibit the fuel vaporized gas from discharging into the atmosphere.

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.

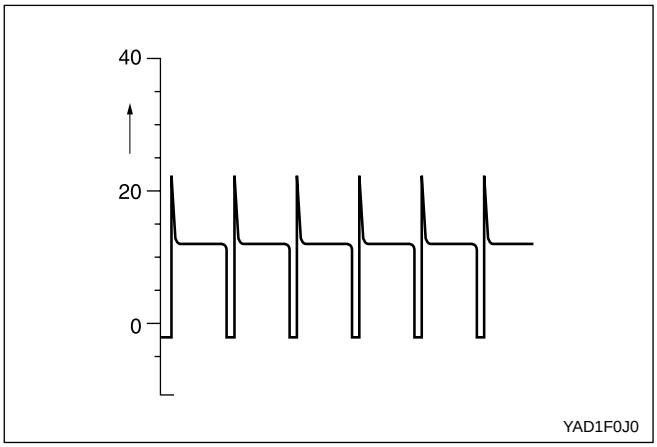
The purge control valve is activated by the ECM frequency according with the engine rotating speed to adjust the purification rate. The purification rate is determined by the continuous valve opening interval.

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 circuit or open with bad contact	
54	Purge control circuit malfunction	When malfunction of purge control : not work vale	



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.

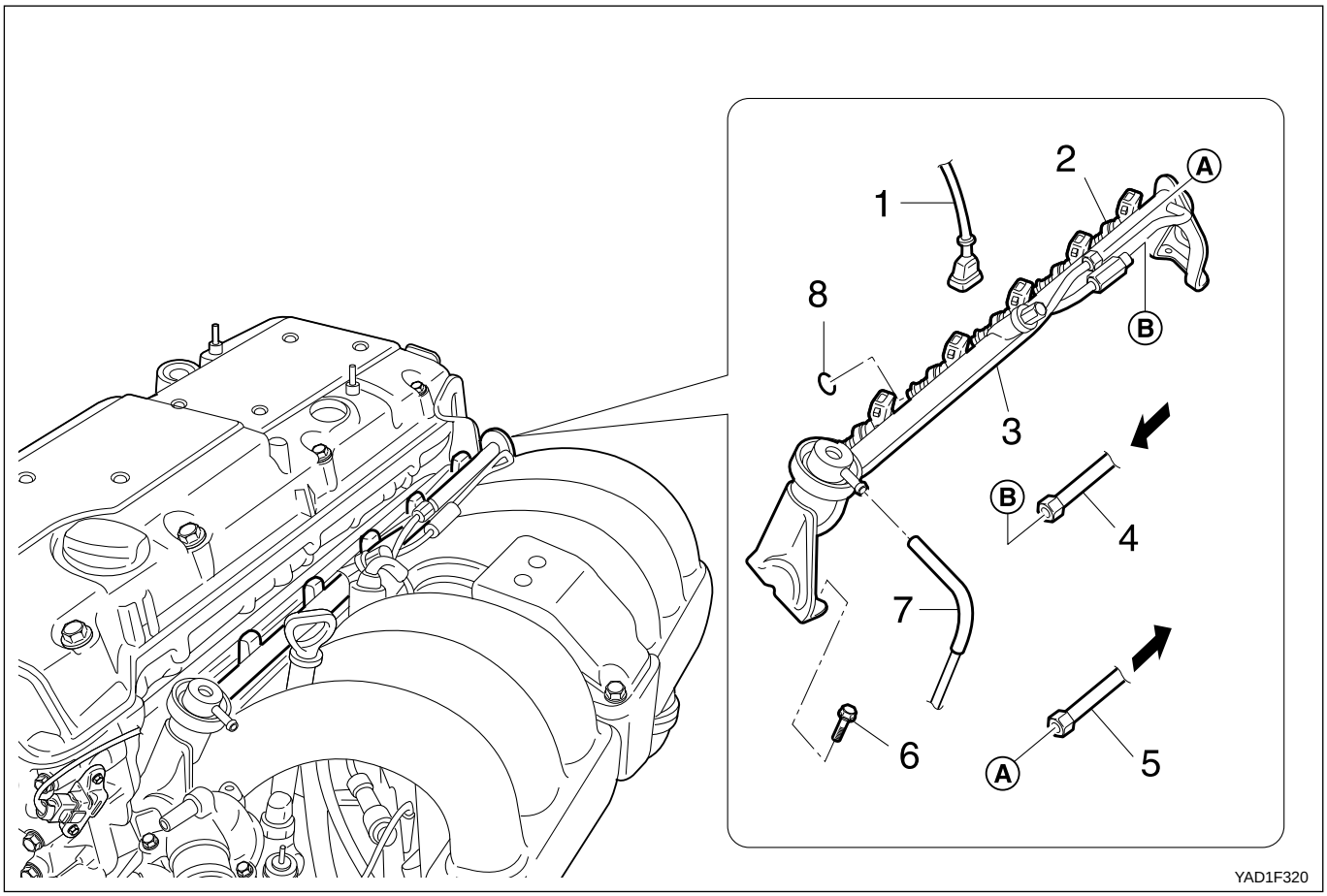
Specified Value	0.3 ~ 0.5 A

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

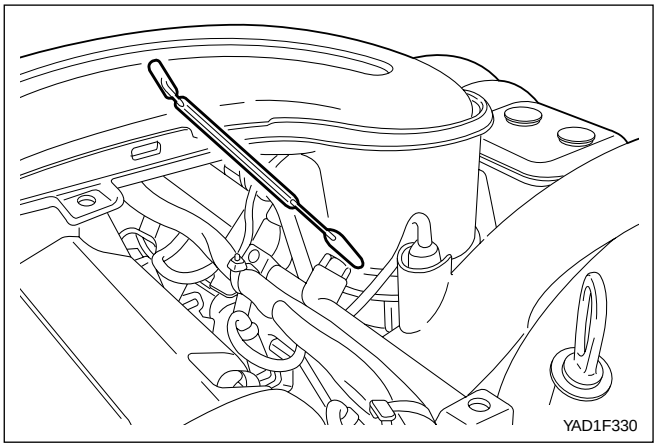
Specified Value	> 500 mbar (after approx. 1 min.) purge control valve operates at this time

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

FUEL RAIL



1 Injector Connector
2 Injector
3 Fuel Rail
4 Fuel Supply Line
5 Fuel Return Line
6 Bolt
7 Vacuum Hose
8 O-Ring



Fuel Pressure Test

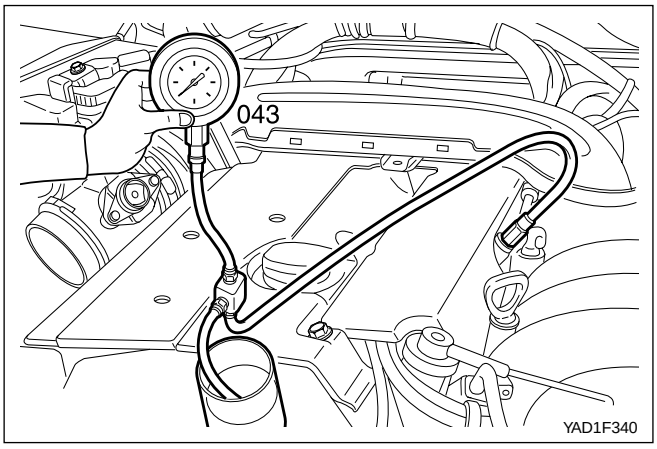
Tools Required

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

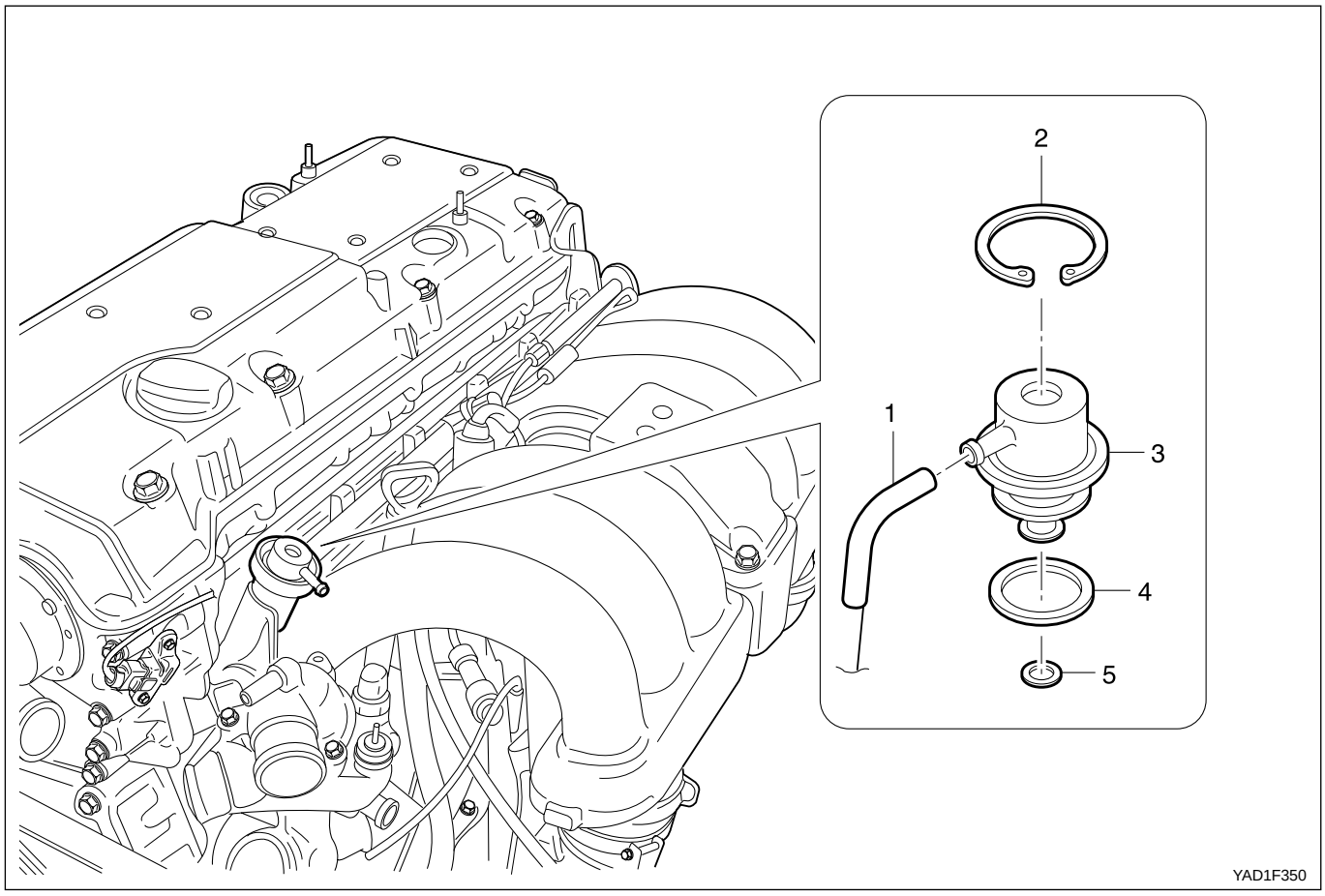
1. Connect thefuel pressure gauge 103 589 00 21 00 to the fuel pressure test connector.
2. Stop the engine for approximately 30 minutes and then check the fuel pressure changes.

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

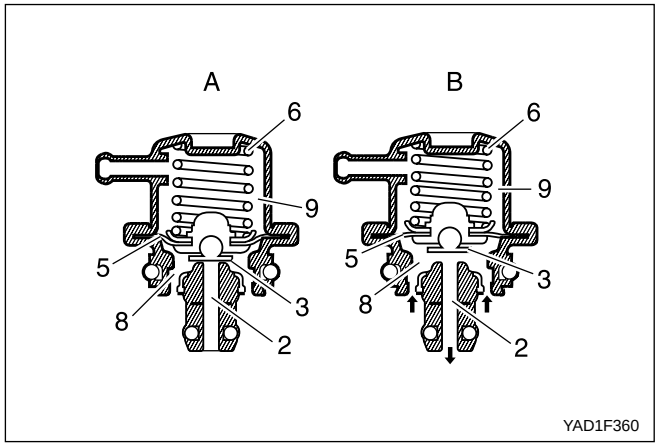
3. If there is no change in fuel pressure and maintain the following pressure over 30 minutes, it is normal.

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.

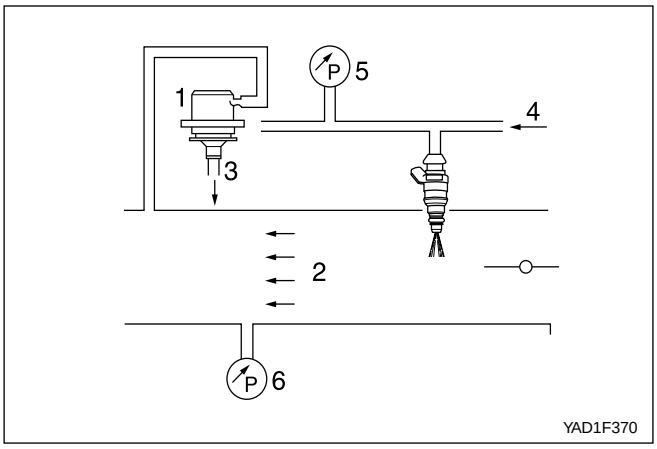
Over supplied fuel returns to the fuel tank through the return line.

<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.

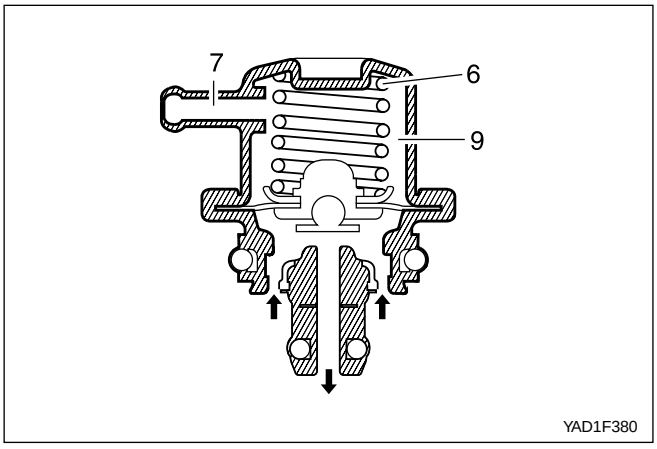
The pressure difference between the fuel pressure and the intake manifold is about 3.8 bars during the full load.



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)

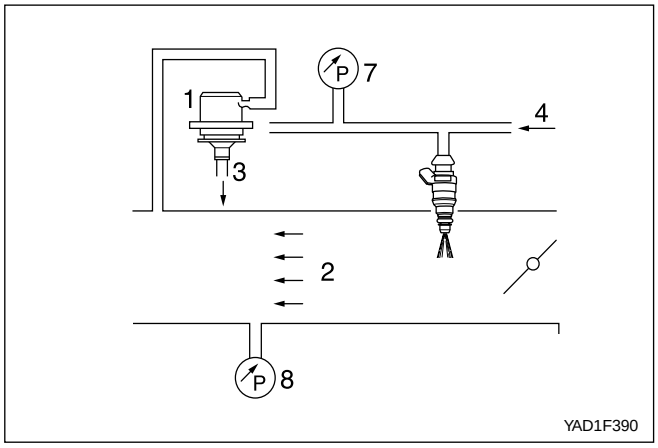
<Operating at Idle and partial load>

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.



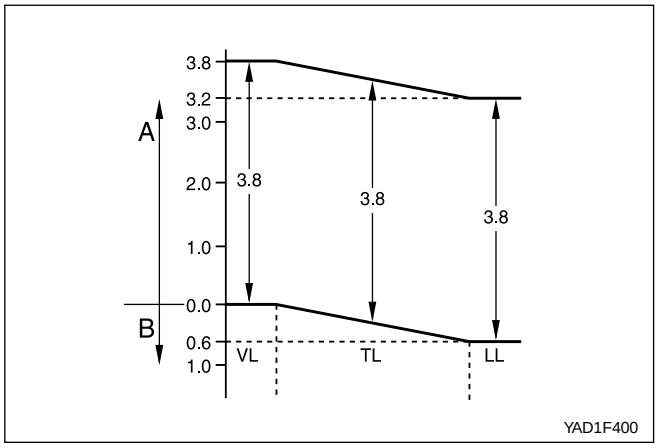
Consequently, the fuel pressure in the fuel distributor changes by the intake manifold's negative pressure, and the injector's fuel pressure gets reduced independently to the throttle valve's position. Thus, the fuel injection volume can only be determined according to the injector's injecting duration.

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)

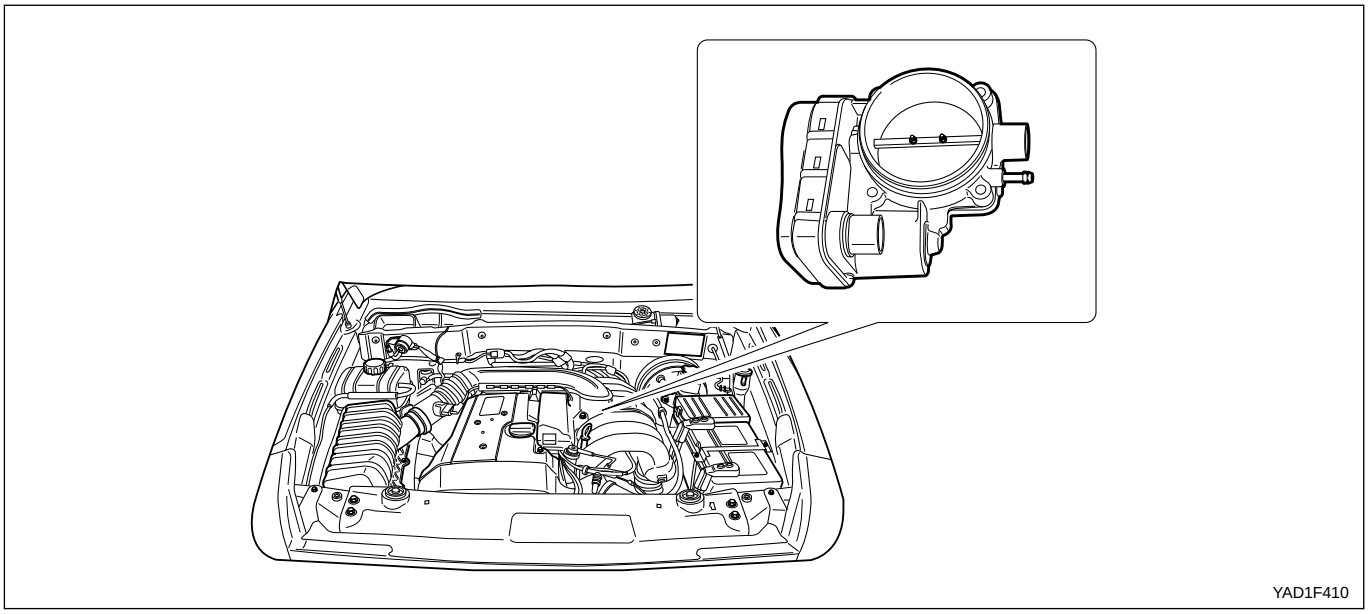
<Fuel Pressure Diagram>



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

INDUCTION SYSTEM

THROTTLE VALVE ACTUATOR



The throttle actuator is actuated by the Engine Control Module(ECM) according to the position of the accelerator pedal position.

It has two potentiometers which signal the position of the throttle valve to the ECM to enable it to recognize the various engine load states.

Ignition “Off”

In the de-energized states the throttle valve position is determined to be spring capsule.

Ignition “On”

When the ignition S/W on the servo motor in the throttle actuator is operated by the ECM. The throttle valve adopts a position in line with the coolant temperature.

Closed position

In the closed throttle position, the servo motor controls engine speed by operating the throttle valve further (greater mixture) or closing it further (reduced mixture), depending on coolant temperature and engine load. When this is done, the throttle valve can be closed further by the servo motor overcoming the force of the spring capsule (mechanical end stop). If the actuator is deenergized, the throttle valve is resting against the spring capsule.

Consequently, the throttle valve opening is a constant 10-12 °approximately.

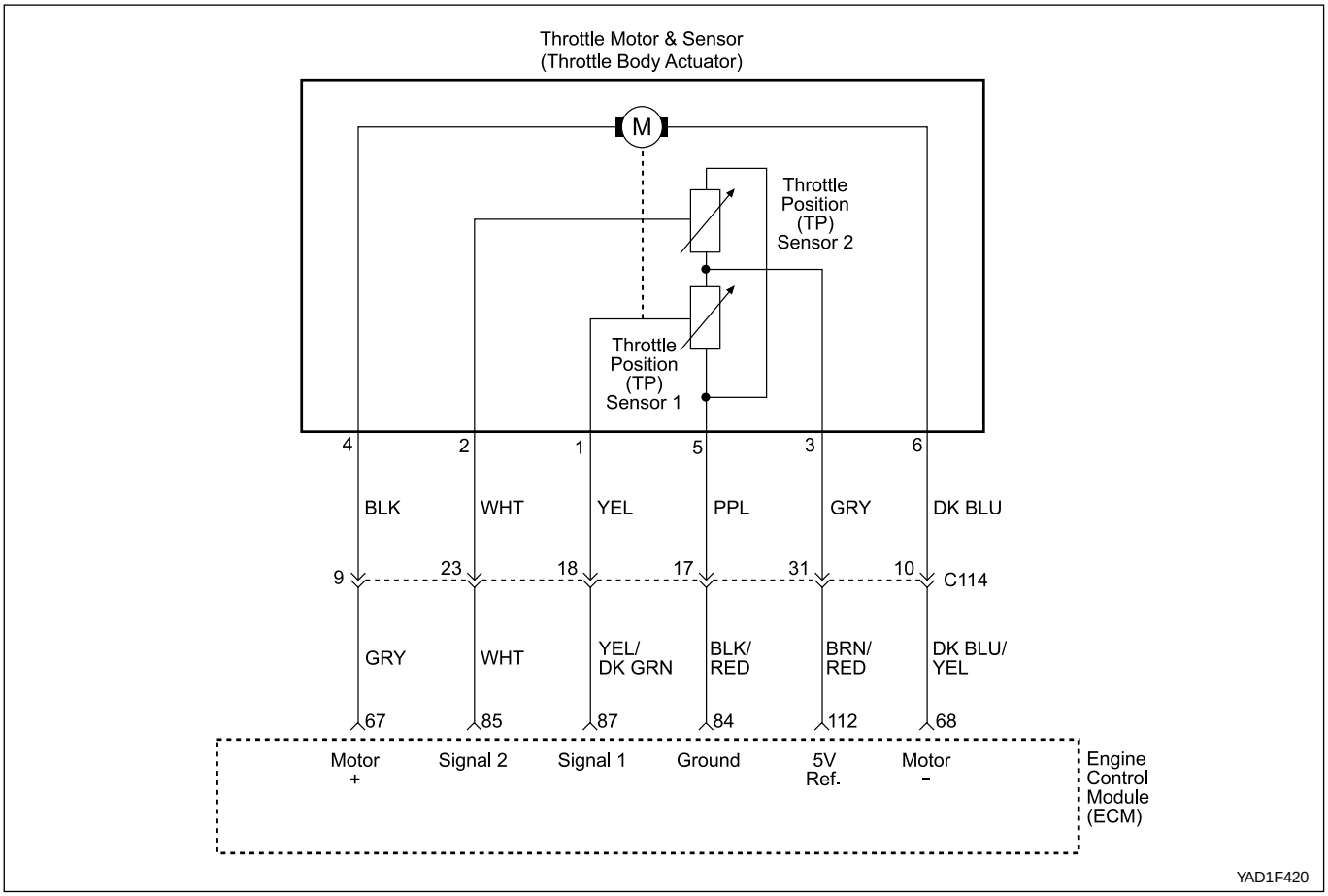
At no load, this produces an engine speed of about 1,800 rpm

Driving

When driving (part/full throttle), the servo motor controls the throttle valve in line with the various load states and according to the input signals from the pedal value sensor according to the input signals from the pedal value sensor according to the position of the accelerator pedal.

The function of the EA (electronic accelerator) in the ECM determines the opening angle of the throttle valve through the throttle actuator. Further functions are;

- Idle speed control
- Cruise control
- Reducing engine torque for ASR/ABS operation
- Electronic accelerator emergency running
- Storing faults
- Data transfer through CAN



Failure Code	Description	Trouble Area	Maintenance Hint
104	Throttle position sensor 1 low voltage	TPS 1 short circuit to ground or open	• Monitoring the actual values through • Inspection the ECM pin 84, 85, 87, 112, 67, 68 about short circuit or open with bad contact • Inspection the throttle valve actuator • Inspection the ECM
105	Throttle position sensor 1 high voltage	TPS 1 short circuit to power	
108	Throttle position sensor 2 low voltage	TPS 2 short circuit to ground or open	
109	Throttle position sensor 2 high voltage	TPS 2 short circuit to power	
116	Throttle actuator learning control failure	When actuator adaption fluctuation or not meet the condition scan tool	
119	Throttle valve return spring failure	When return spring defective of actuator with bad contact	
121	Throttle actuator failure	When supply voltage of the actuator short circuit to power Inspection the ECM	
123	Different mass air flow sensor signal with throttle position sensor	When shut down of output driver	
125	Both throttle position sensor failure	When defective of both potentiometers	

Failure Code	Description	Trouble Area	Maintenance Hint
126	Throttle position sensor 1 not plausible with Throttle position sensor 2	When difference between TPS 1 and TPS 2	• Monitoring the actual values through scan tool • Inspection the ECM pin 84, 85, 87, 112, 67, 68 about short circuit or open with bad contact • Inspection the throttle valve actuator • Inspection the ECM
127	High permanent throttle signal	When failure of wiring harness or actuator	
185	Mass air flow sensor and throttle position sensor failure	When difference between MAF and TPS signal	

Circuit Description

The ECM supplies a 5 volt reference signal and a ground to the TP sensor. The TP sensor sends a voltage signal back to the ECM relative to the throttle plate opening. The voltage signal will vary from approximately 0.3 ~ 0.9 volts at closed throttle, to over 4.0 ~ 4.6 volts at Wide Open Throttle (WOT).

The TP sensors serve for engine load control according to the drive pedal command. Load adjustments independent of the drive pedal command can be implemented; such functions are, for instance, idle control, speed control, drive slip control, load shock damping, and similar functions.

When the actuator current fails, the throttle valve is returned to emergency operating position by a spring. The throttle valve position, thereby the actuator drive position check back is provided by two potentiometers. The motor positions the throttle valve against the return spring force. Motor and return spring are two separate energy sources. Each of Them is able to position the throttle valve in emergency position alone. Throttle valve position check back and monitoring is provided by two actual value potentiometers connected to the engine control electronics.

Throttle Actuator Inspection

1. Turn the ignition switch to “ON” position.
2. Measure the TPS 1 signal voltage at the ECM pin No. 87 and TPS 2 signal voltage at the ECM pin No. 85.

	Pedal Position	Specified Value
TPS 1	Closed	0.3 ~ 0.9 v
	Opened	1 4.0 ~ 4.6 v
TPS 2	Closed	4.0 ~ 4.6 v
	Opened	0.3 ~ 0.9 v

Throttle Actuator DC Motor Inspection

1. Turn the ignition switch to “ON” position.
2. Measure the signal voltage between the ECM pin No. 67 and No. 68.

Application		Specified Value
Engine Status	Ignition “ON”	0.8 ~ 2.3 v
	Idling	1.0 ~ 2.5 v (Coolant temperature is over 70 °C)

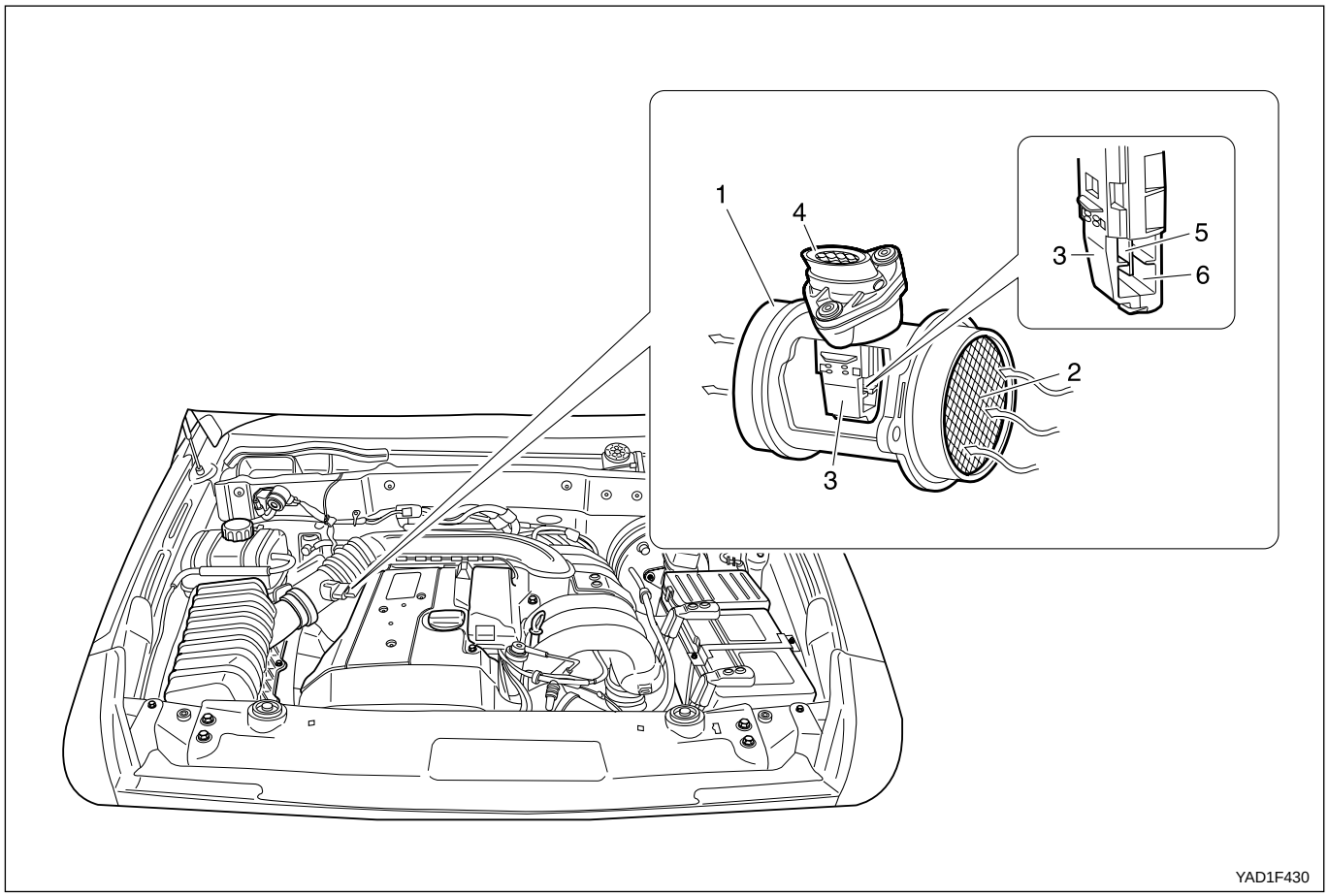
Throttle Actuator DC Motor Resistance

1. Turn the ignition switch to “OFF” position.
2. Measure the resistance between the ECM pin No. 67 and No. 68.

Specified Value	<10 Ω

BLANK

HOT FILM AIR MASS (HFM) SENSOR



1 Housing
2 Protector Net
3 Electronic Housing
4 Connector
5 Hot Film Air Mass Sensor
6 Measuring Port

The Hot Film Air Mass (HFM) sensor with recognition of flow direction related to pulsating flow is designed for recording load on Engine Control Module (ECM) by measuring the output voltage proportional to the reference voltage of the ECM.

Mass Air Flow Sensor

Mass Air Flow (MAF) is a thermal flow meter whose sensor element with its temperature sensors and heating area is exposed to the MAF to be measured. A heating area located in the center of a thin membrane is controlled to an over-temperature by a heating resistor and a temperature sensor of this membrane. And the value of over-temperature depends on the temperature of the in-flowing air.

Two temperature sensors on upstream and downstream of the heating area show the same temperature without incoming flow. With incoming flow, upstream part is cooled down but downstream temperature retains its temperature more or less due to the air heated up in the heating area. This temperature difference in quantity and direction depends on the direction of the incoming flow.

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 MAF. 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 (WOT). 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.

To facilitate the installation of the HFM in the intake passage, lubricating agents may be used. However, when lubricants are used care must be taken to ensure that they do not enter the flow passage and cannot be sucked in with the air flow.

The following tables show the relationship between MAF and output voltage.

Mass Air Flow (kg/h)	Voltage (V)	Mass Air Flow (kg/h)	Voltage (V)
0	0.95 ~ 1.05	250	3.51
10	1.28	370	3.93
15	1.41	480	4.23
30	1.71	640	4.56
60	2.16	800	4.82
120	2.76		

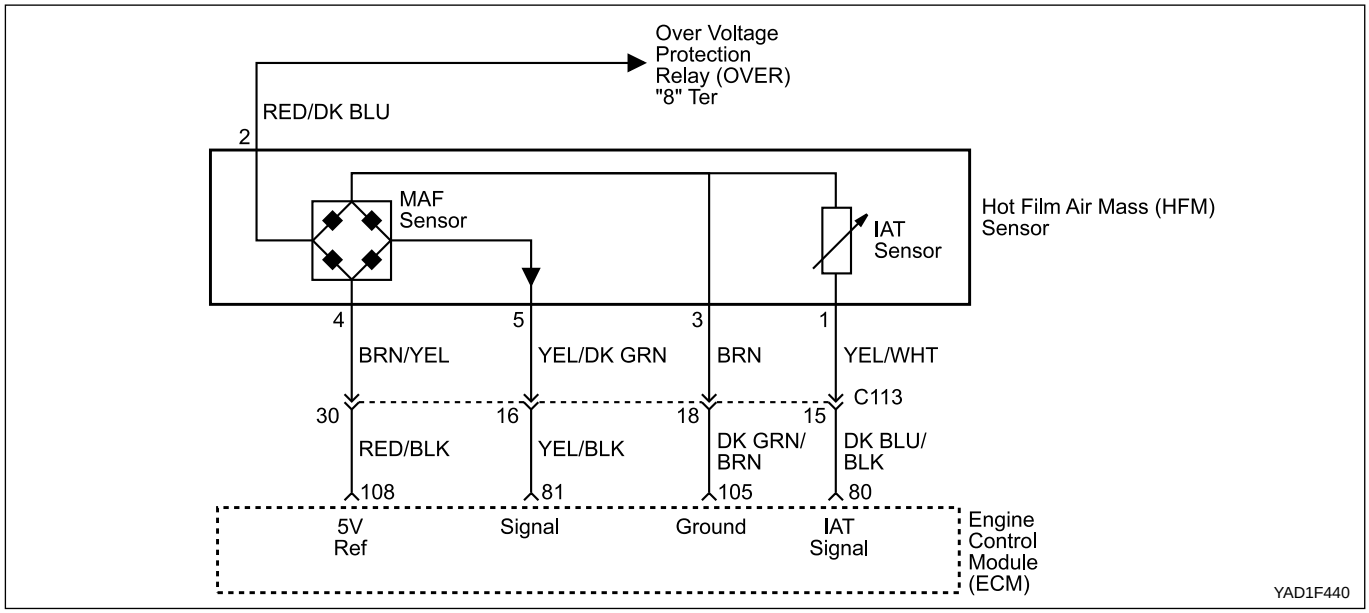
Intake Air Temperature

The Intake Air Temperature (IAT) sensor is a part of Hot Film Air Mass (HFM) sensor and is a thermistor, a resistor which changes value based on the temperature of the air entering the engine. Low temperature produces a high resistance, while high temperature causes a low resistance as the following table.

The ECM provides 5 volts to the IAT sensor through a resistor in the ECM and measures the change in voltage to determine the IAT. The voltage will be high when the manifold air is cold and low when the air is hot. The ECM knows the intake IAT by measuring the voltage.

The IAT sensor is also used to control spark timing when the manifold air is cold.

Temp. (°C)	R min.(Ω)	R nom. (Ω)	R max. (Ω)
-40	35140	39260	43760
-20	12660	13850	15120
0	5119	5499	5829
20	2290	2420	2551
40	1096	1166	1238
60	565	609	654
80	312	340	370
100	184	202	222
120	114	127	141
130	91	102	114



Failure Code	Description	Trouble Area	Maintenance Hint
03	Intake air temperature sensor low voltage	IAT sensor short circuit to ground or open	• Monitoring the actual air temperature through scan tool • Inspection the ECM pin 80, 79 about short circuit or open with bad contact • Inspection the IAT sensor (integrated in HFM sensor) • Inspection the ECM
04	Intake air temperature sensor high voltage	IAT sensor short circuit to power	
05	Intake air temperature sensor plausibility	Malfunction in recognition of IAT When functional problem	
09	Mass air flow sensor plausibility	Malfunction in recognition of MAF When air mass not plausible	• Monitoring the actual air mass flow through scan tool • Inspection the ECM pin 81, 105 about short circuit or open with bad contact • Inspection the MAF sensor (integrated 11 in HFM sensor) • Inspection the ECM
10	Mass air flow sensor low voltage	MAF sensor short circuit to ground or open	
11	Mass air flow sensor high voltage	MAF sensor short circuit to power	

Circuit Description

The heated element on the MAF is a platinum film resistor (heater). It is located on a ceramic plate together with the other elements in the bridge circuit. The temperature sensitive resistor (flow sensor) also included in the bridge. The separation of heater and flow sensor facilitates design of the control circuitry. Saw cuts are employed to ensure thermal decoupling between the heating element and the intake air temperature (IAT) sensor. The complete control circuitry is located on a single layer. The voltage at the heater provides the index for the mass air flow. The MAF's electronic circuitry then converts the voltage to a level suitable for processing in the ECM. This device does not need a burn off process to maintain its measuring precision over an extended period. In recognition of the fact that most deposits collect on the sensor element's leading edge, the essential thermal transfer elements are located downstream on the ceramic layer. The sensor element is also design to ensure that deposits will not influence the flow pattern around the sensor.

The IAT sensor uses a thermistor to control the signal voltage to the ECM. The ECM supplies 5 volt reference and a ground to the sensor. When the air is cold, the resistance is high; therefore the IAT signal voltage will be high. If the intake air is warm, resistance is low; therefore the IAT signal voltage will be low.

Mass Air Flow Sensor Input Voltage Inspection

1. Turn the ignition switch to “ON” position.
2. Measure the signal voltage between the ECM pin

Application		Specified Value
Engine Status	Ignition “ON”	0.9 ~ 1.1 V
	Idling	1.3 ~ 1.7 V (Coolant temperature is over 70 °C)

Notice: If the measured value is not within the specified value, the possible cause may be in cable or MAF sensor in itself. Perform the 5 volt power supply inspection procedures.

Mass Air Flow Sensor 5 volt Power Supply Inspection

1. Turn the ignition switch to “OFF” position.
2. Disconnect the HFM sensor connector.
3. Turn the ignition switch to “ON” position.
4. Measure the voltage between the ECM pin No. 108 and MAF sensor connecter terminal No. 3.

Specified Value	4.7 ~ 5.2 V

Notice: If the measured value is not within the specified value, the possible cause may be in cableor ECM coupling.

5. Measure the voltage between the ECM pin No. 105 and MAF sensor connecter terminal No. 4.

Specified Value	4.7 ~ 5.2 V

Notice: If the measured value is not within the specified value, the possible cause may be in cableor ECM coupling.

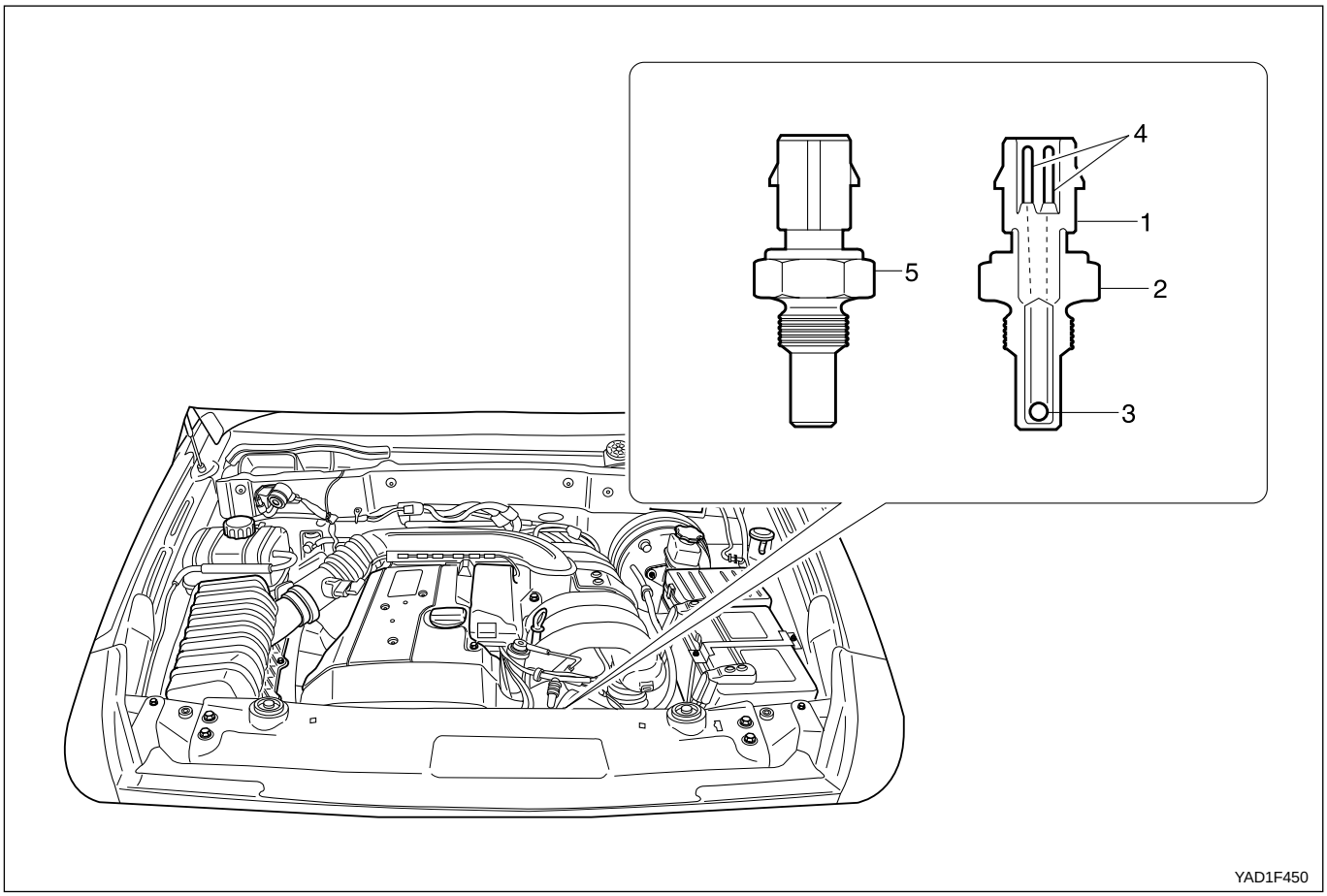
Mass Air Flow Sensor 12 volt Power Supply Inspection

1. Turn the ignition switch to “OFF” position.
2. Disconnect the HFM sensor connector.
3. Turn the ignition switch to “ON” position.
4. Measure the voltage between the ECM pin No. 105 and MAF sensor connecter terminal No. 2.

Specified Value	11 ~ 14 V

Notice: If the measured value is not within the specified value, the possible cause may be in cable or Over Voltage Protection Relay (OVPR).

ENGINE COOLANT TEMPERATURE (ECT) SENSOR



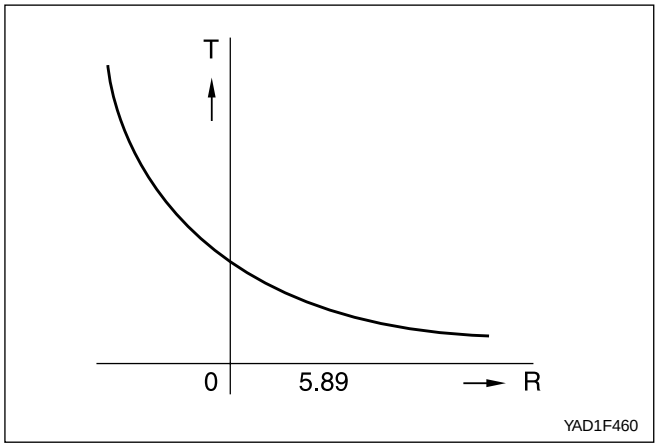
1 Artificial Resin Housing
2 Metal Housing
3 NTC (Negative Temperature Coefficient) Resistor
4 Connector
5 Engine Coolant Temperature Sensor

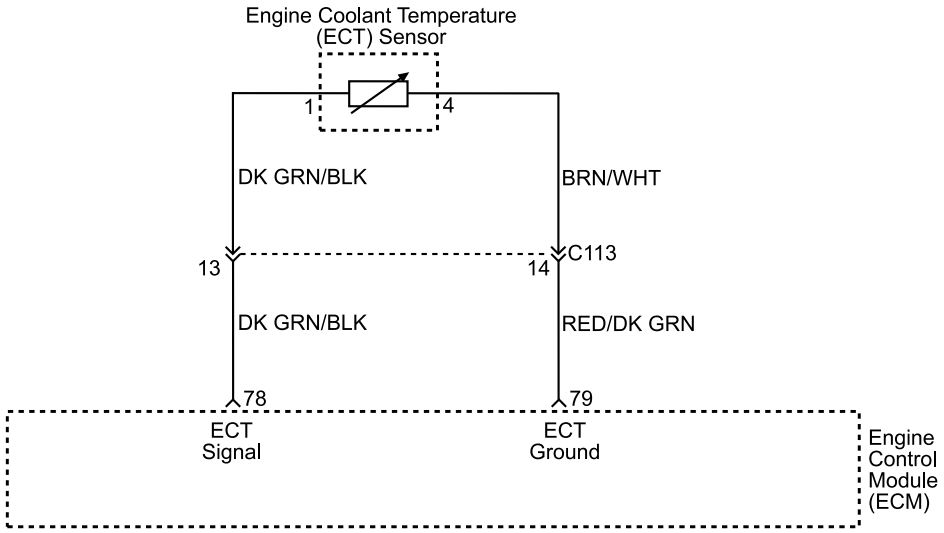
Engine Coolant Temperature (ECT) sensor detects coolant temperature and supplies information to the ECM. It is composed of metal housing with two NTC resistor, 4 pin connector. The ECM provides a 5 volt signal to the ECT sensor through a dropping resistor. When the engine is cold, the ECT sensor provides high resistance, which the ECM detects as a high signal voltage. As the engine warms up, the sensor resistance becomes lower, and the signal voltage drops. At normal engine operating temperature, the ECT signal will measure about 1.5 to 2.0 volts.

The ECM uses information about coolant temperature to make the necessary calculations for:

- Fuel delivery
- Ignition control
- Knock sensor system
- Idle speed
- Torque converter clutch application
- Canister purge
- Cooling fan operation
- Others

Temperature (°C)	Resistance (Ω)	Voltage (V)
-40	48,550	4.90
-30	27,000	4.82
-20	15,570	4.70
-10	9,450	4.52
0	5,890	4.43
10	3,790	3.96
20	2,500	3.57
30	1,692	3.14
40	1,170	2.70
50	826	2.26
60	594	1.86
70	434	1.51
80	322	1.22
90	243	0.98
100	185	0.78
110	143	0.63
120	111.6	0.50
130	88	0.40
140	71.2	0.33





YAD1F470

Failure Code	Description	Trouble Area	Maintenance Hint
00	Engine coolant temperature sensor low voltage	ECT sensor short circuit to ground or open	• Monitoring the actual coolant temperature through scan tool • Inspection the ECM pin 78, 79 about short circuit or open with bad contact • Inspection the ECT sensor • Inspection the ECM
01	Engine coolant temperature sensor high voltage	ECT sensor short circuit to power	
02	Engine coolant temperature sensor plausibility	Malfunction in recognition of ECT When drop to about 50 °C below after warm up	
06	Engine coolant temperature insufficient for closed loop fuel control	Malfunction in recognition of ECT When minimum temperature for lambda control after warm up	

Circuit Description

The ECT sensor uses a thermistor to control the signal voltage to the ECM. The ECM supplies a voltage on the signal circuit to the sensor. When the engine coolant is cold, the resistance is high; therefore the ECT signal voltage will be high

Engine Coolant Temperature Sensor Inspection

1. Turn the ignition switch to “ON” position.
2. Measure the voltage between the ECM pin No. 78 and No. 79.

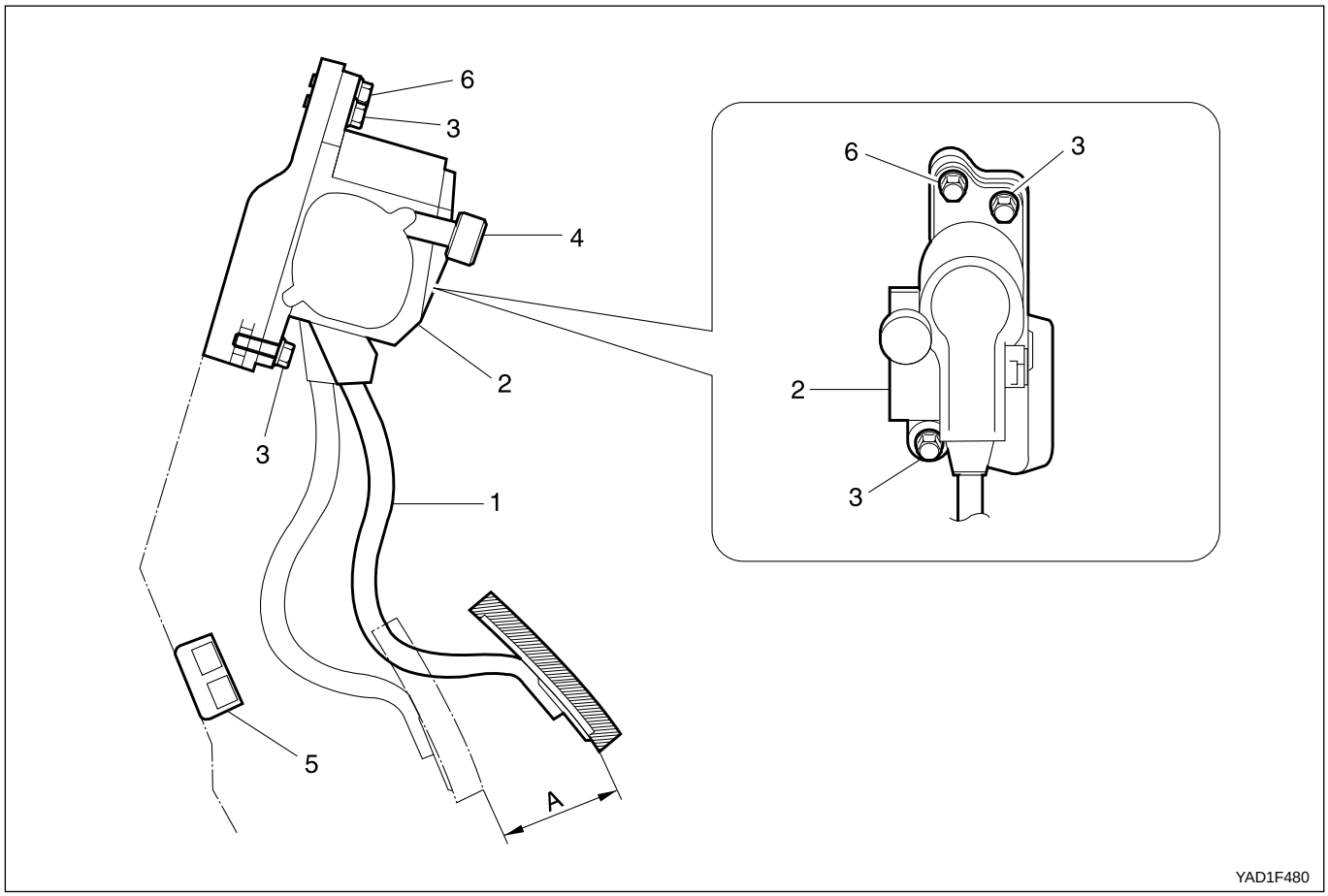
Temperature (°C)	Specified Value (V)
20	3.57
80	1.22
100	0.78

3. Turn the ignition switch to “OFF” position.
4. Disconnect the ECT sensor connector.
5. Turn the ignition switch to “ON” position.
6. Measure the resistance between the ECT sensor terminal pin No. 1 and No. 4.

Temperature (°C)	Specified Value (Ω)
20	2,500
80	322
100	185

Notice: Replace wiring and coolant temperature sensor if out of specified value.

ACCELERATOR PEDAL MODULE



1 Accelerator Pedal
2 Accelerator Pedal Sensor
3 Bolts
4 6-Pin Connector
5 Kick-down Switch
6 Nut

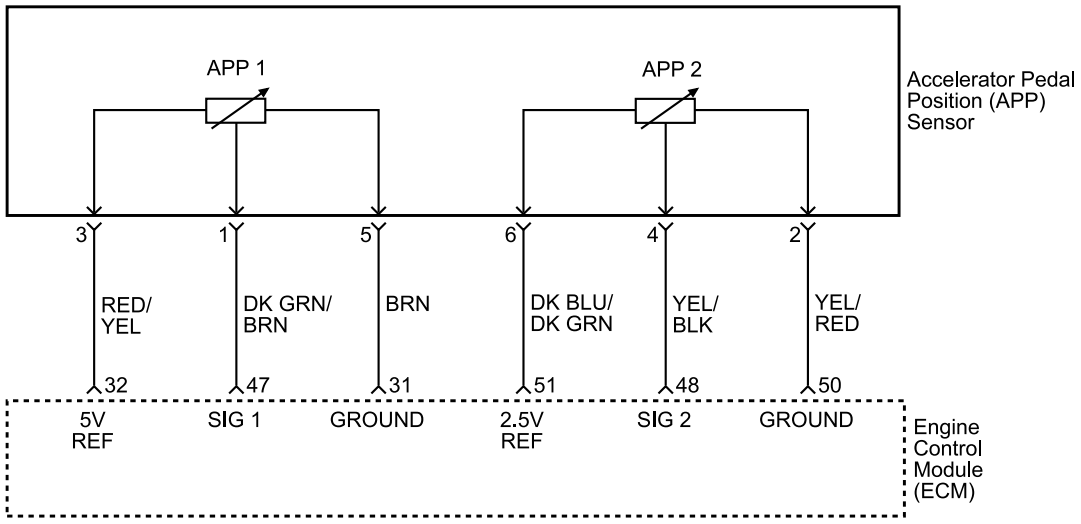
The Acceleration Pedal Position (APP) sensor is mounted on the accelerator pedal assembly. The sensor is actually two individual APP sensors and one housing. This sensor works with the Throttle Position (TP) sensor to provide input to the Engine Control Module (ECM) regarding driver requested accelerator pedal and throttle angle at the throttle body.

When the APP sensor is defected:

When the APP1 or APP 2 sensor is defected condition, the engine is still running at idle condition but, the accelerator pedal reaction is not response correctly and also, the engine rpm will be reacted to 4,000 rpm slowly. If the APP 1 sensor is out of order, the APP 2 sensor will be conducted with signal as a default signal but, the throttle valve opening is limited 60% and delayed opening speed.

When the TP sensor or servo motor is defected:

When the TP 1, 2 sensor or servo motor is defected condition, the throttle valve will be closed to the spring capsule by spring force, at this condition, the throttle valve will open 10° ~ 20°and engine rpm will be controlled by ECM with opening (On/Off) time of injector. The engine rpm will be maintaining 900 rpm (at idle) to 1,800 according to the engine load.



YAD1F490

Failure Code	Description	Trouble Area	Maintenance Hint
122	Acceleration pedal position sensor signal failure	When malfunction of APP sensor	• Monitoring the actual values through scan tool • Inspection the ECM pin 31, 47, 32, 48, 59, 51 about short circuit or open with • Inspection the APP sensor • Inspection the ECM
160	Acceleration pedal position 1 sensor low voltage	APP 1 sensor short circuit to ground or open	
161	Acceleration pedal position sensor 1 high voltage	APP 1 sensor short circuit to power	
162	Acceleration pedal position sensor 2 low voltage	APP 2 sensor short circuit to ground or open	
163	Acceleration pedal position sensor 2 high voltage	APP 2 sensor short circuit to power bad contact	
164	Accelerator pedal position sensor 1 not plausible with accelerator pedal position sensor 2	When difference between APP 1 sensor and APP 2 sensor	
167	Both setpoint accelerator pedal position sensor defective	When defective of both APP sensor	

Circuit Description

The ECM supplies a 5 or 2.5 volt reference signal and a ground to the APP sensor 1or 2. The ECM calculates on these signal lines. The APP sensor output changes as the accelerator pedal is moved. The output of the APP 1and APP2 sensor are low, about 0.4 ~ 0.7 volts and 0.2 ~ 0.35 volts respectively at the closed throttle position. As pushing the accelerator pedal, the output increases so that the output voltages will be about 4.3 ~ 4.8 volts and 2.1 ~ 2.4 volts individually when accelerating fully with the kick down, at Wide Open Throttle (WOT).

Acceleration Pedal Position Sensor 1 Inspection

1. Turn the ignition switch to “ON” position.
2. Measure the signal voltage between the ECM pin No. 47andNo. 31while operating the accelerator pedal as following conditions.
   - Not depress the pedal (closed throttle position)
   - Fully depress the pedal (full throttle with kick down)

Condition of Throttle Valve	Specified Value (V)
Closed Throttle Valve	0.3 ~ 0.7
Fully Depressed Throttle Valve	4.3 ~ 4.8

Notice: If measured value is not within the specified value, check the pedal valve sensor and the supply voltage to APP 1 sensor.

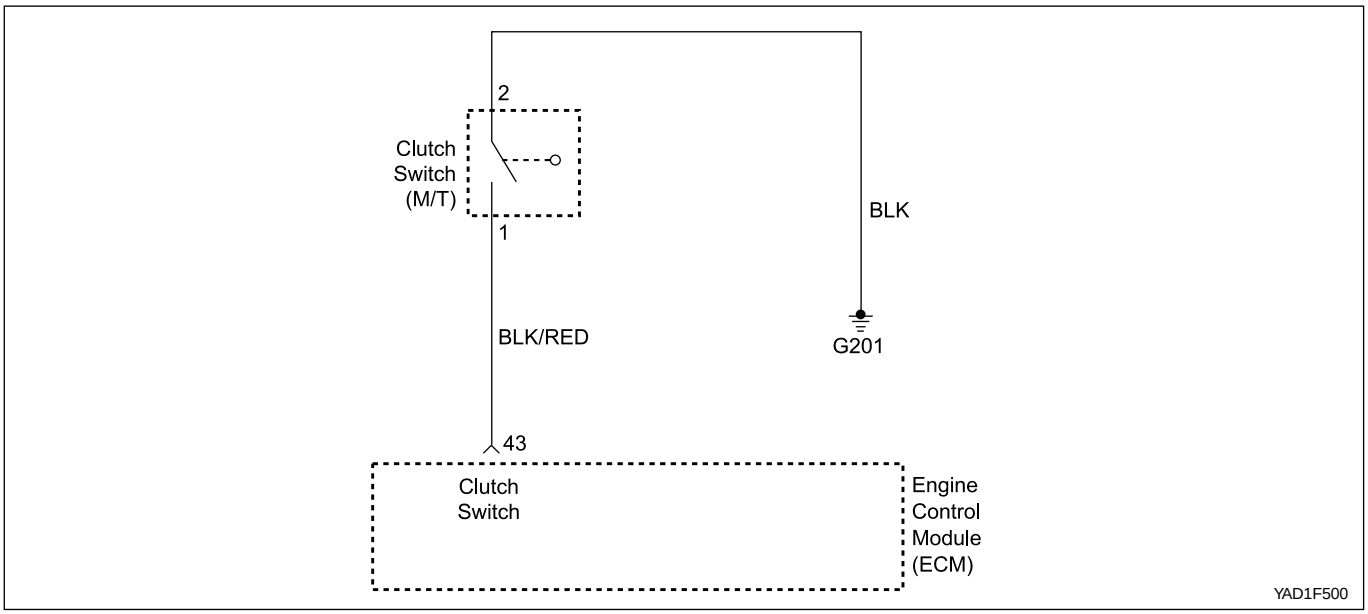
Acceleration Pedal Position Sensor 2 Inspection

1. Turn the ignition switch to “ON” position.
2. Measure the signal voltage between the ECM pin No. 48 and No. 50 while operating the accelerator pedal as following conditions.
   - Not depress the pedal (closed throttle position)
   - Fully depress the pedal (full throttle with kick down)

Condition of Throttle Valve	Specified Value (V)
Closed Throttle Valve	0.1 ~ 0.4
Fully Depressed Throttle Valve	2.1 ~ 2.5

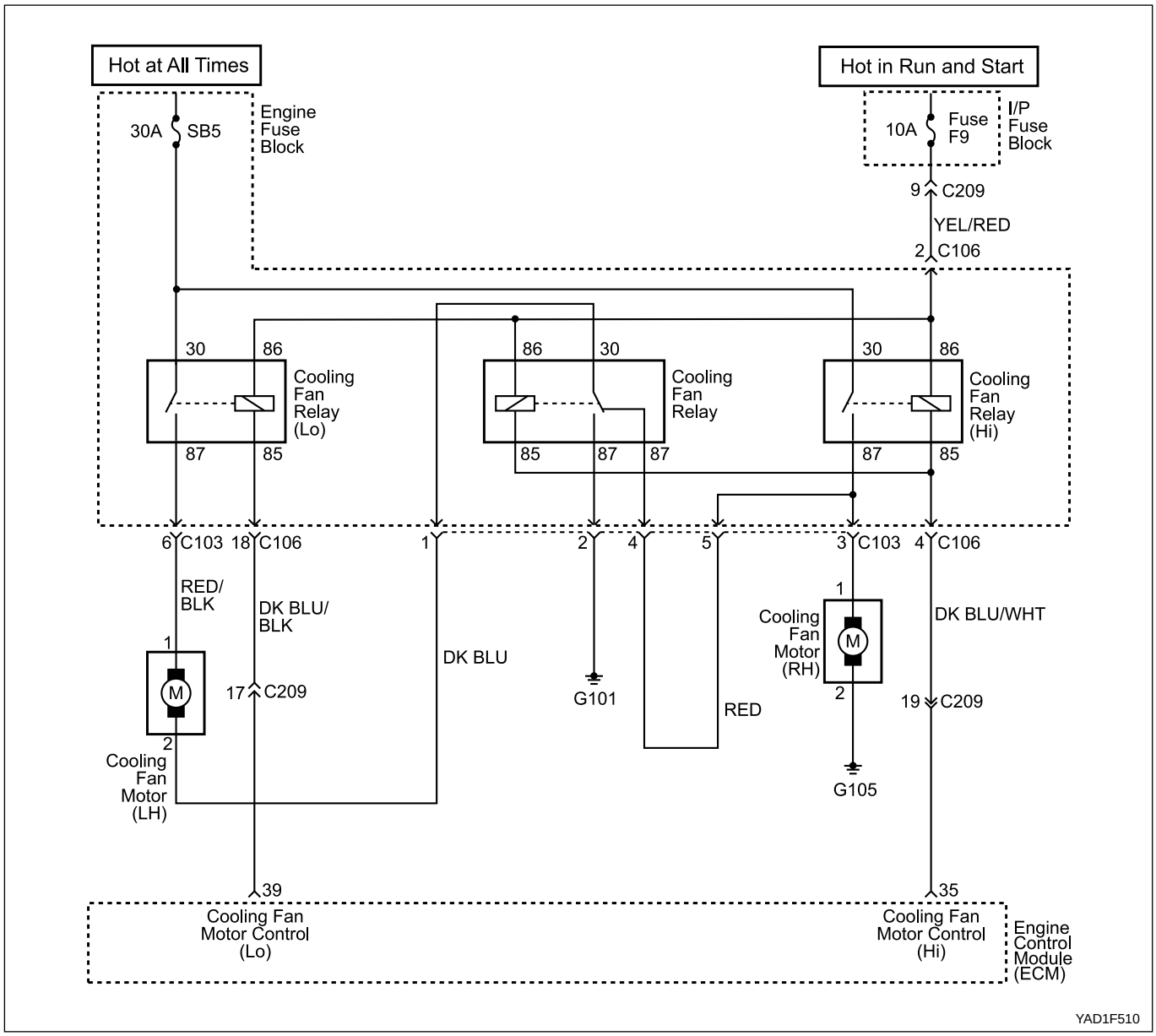
Notice: If measured value is not within the specified value, check the pedal valve sensor and the supply voltage to APP sensor 2.

CLUTCH SWITCH



Failure Code	Description	Trouble Area	Maintenance Hint
62	Clutch switch defective	When malfunction of clutch switch	• Inspection the Engine Control Module (ECM) pin 43 about shout circuit or open • Inspection the clutch switch • Inspection the ECM

COOLING FAN



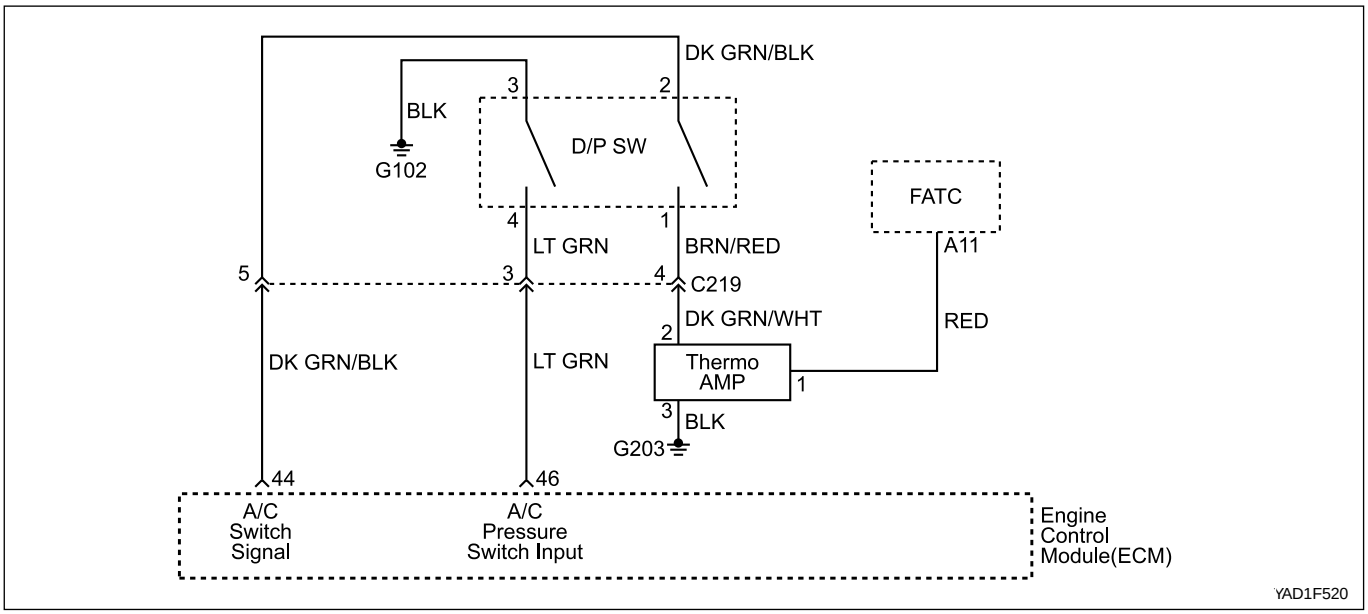
Failure Code	Description	Trouble Area	Maintenance Hint
44	Cooling fan (HI) relay short circuit to power	Cooling fan short circuit to power	• Inspection the Engine Control Module (ECM) pin 35 about short circuit or open with bad contact • Inspection the power source • Inspection the cooling fan • Inspection the ECM
45	Cooling fan (HI) relay short circuit to ground or open	Cooling fan short circuit to ground or open with bad contact	

Circuit Description

Ignition voltage is supplied directly to the cooling fan relay coil. The ECM controls the relay by grounding the control circuit. When the ECM is commanding a command ON, the voltage of the control circuit should be low (near 0 volt).

When the ECM is commanding the control circuit should be high (near battery voltage). If the fault detection circuit senses a voltage other than what is expected, the fault line status will change causing the fault code to set.

A/C COMPRESSOR RELAY

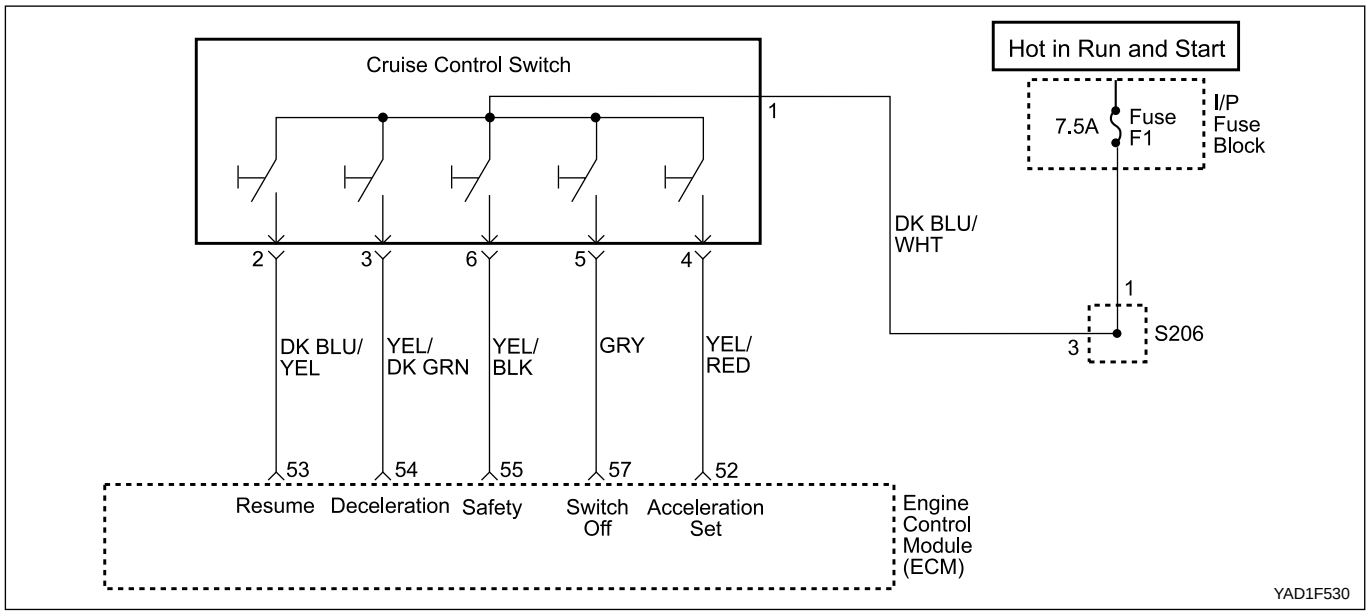


Failure Code	Description	Trouble Area	Maintenance Hint
228	A/C compressor relay short circuit to battery	When malfunction of A/C compressor control	• Monitoring the actual operation through scan tool • Inspection the Engine Control Module (ECM) pin 44 about short circuit or open with bad contact • Inspection the relay short circuit or open • Inspection the ECM
229	A/c compressor relay short circuit to ground or open		

Circuit Description

When the ECM detects that A/C has been requested, the ECM will activated the A/C clutch relay. When the relay has been activated, voltage should be present at both the A/C clutch relay and A/C switch circuit at ECM.

CRUISE CONTROL SWITCH

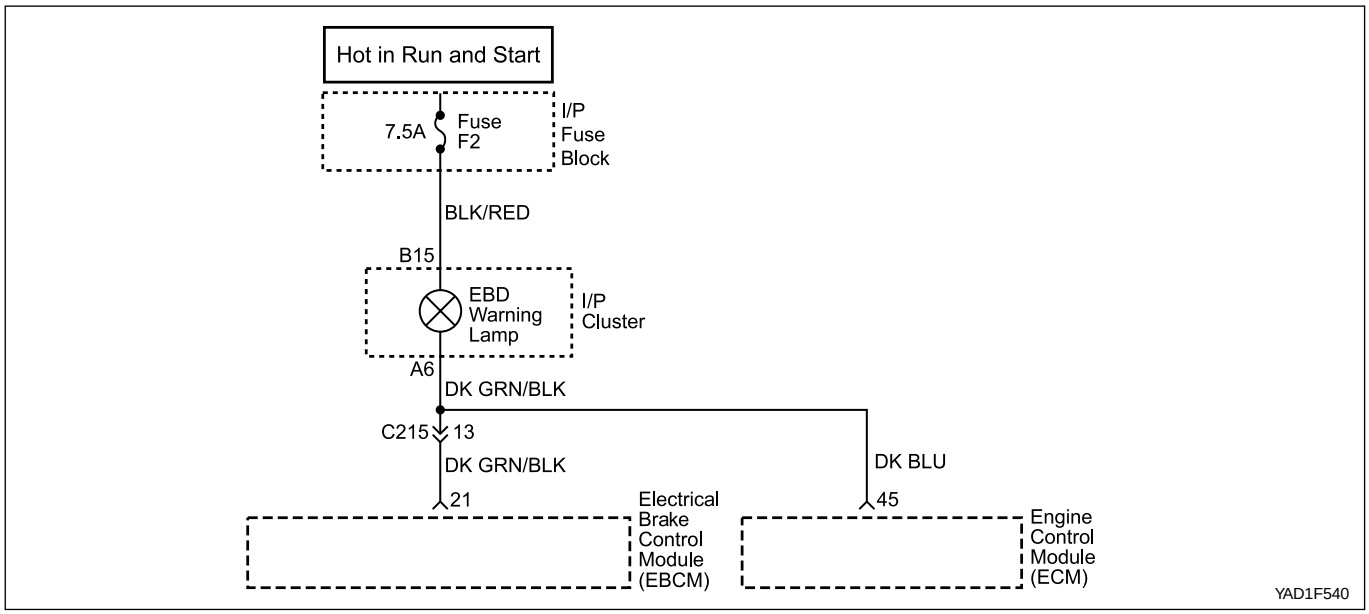


Failure Code	Description	Trouble Area	Maintenance Hint
129	Cruise control “OFF” due to message counter failure	Cruise control system message counter fault	• Monitoring the actual recognition status and vehicle speed signal through scan tool • Inspection the Engine Control Module (ECM) pin 52 53 54 55 57 about short circuit or open with bad contact • Inspection the CAN and ABS • Inspection the cruise control lever switch • Inspection the ECM
130	Vehicle speed signal failure	When malfunction of auto-cruise system Implausible condition of vehicle speed signal.	
131	Vehicle speed signal failure		
132	Cruise control lever failure	Cruise control lever defective	
133	Cruise control acceleration failure	Cruise control system Implausible condition of acceleration signal	
134	Cruise control deceleration failure	Cruise control system Implausible condition of deceleration signal	

Circuit Description

Cruise control is an automatic speed control system that maintain a desired driving speed without using the accelerator pedal. The vehicle speed must be greater than 40 km/h to engage cruise control.

TRACTION CONTROL SYSTEM (TCS)

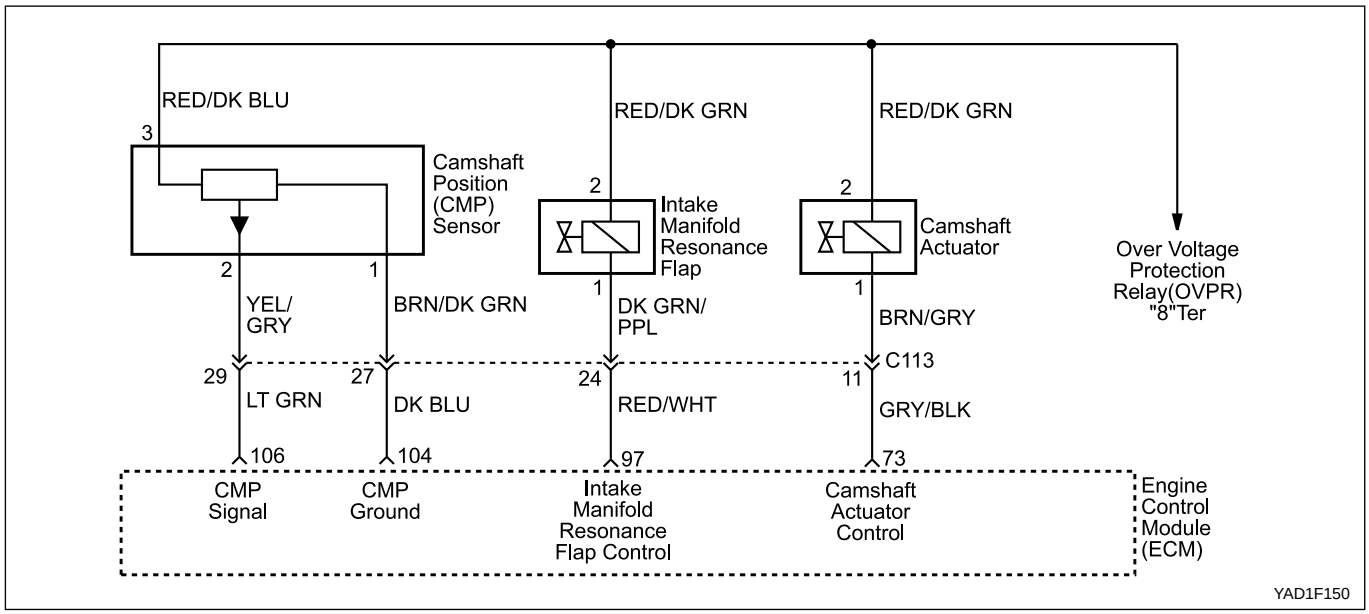


Failure Code	Description	Trouble Area	Maintenance Hint
150	TCS input signal short circuit to battery	TCS short circuit to power	• Inspection the Engine Control Module (ECM) pin 45 about short circuit or open with bad contact • Inspection the TCS lamp of I/P cluster. • Inspection the ECM
151	TCS input signal short circuit to ground or open	TCS short circuit to ground or open	

Circuit Description

Battery voltage is supplied to the TCS warning lamp with the ignition in ON and START. The warning lamp can be activated only by the Electrical Brake Control Module (EBCM) internally supplying ground to terminal 21. If the TCS input circuit is open or short, this failure code will be set.

RESONANCE FLAP



Failure Code	Description	Trouble Area	Maintenance Hint
198	Resonance flap short circuit to battery	Resonance flap short circuit to power	• Monitoring the actual operational status and vehicle speed signal through scan tool • Inspection the Engine Control Module (ECM) pin 97 about short circuit or open with bad contact • Inspection the power source short circuit or open to resonance flap • Inspection the resonance flap solenoid and hardware • Inspection the ECM
199	Resonance flap short circuit to ground or open	Resonance flap short circuit to ground or open	

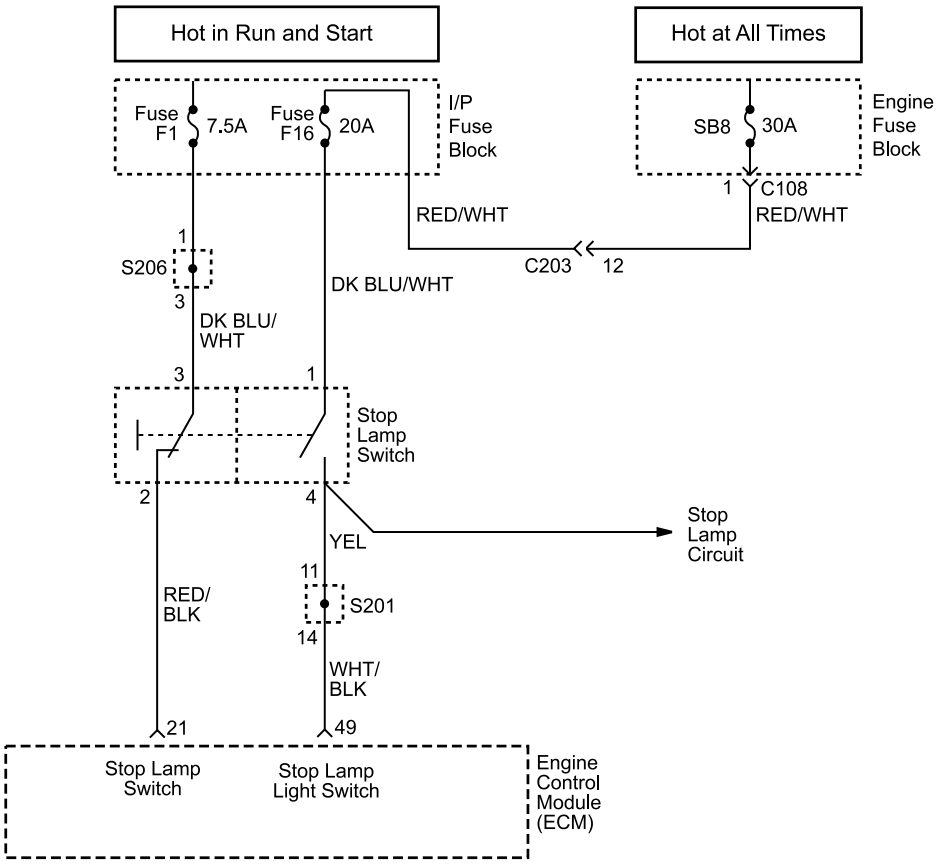
Circuit Description

A pneumatically actuated resonance flap is located on the intake manifold, and will be opened and closed by load, which operates resonance flap according to engine and controlled by ECM and rpm.

Resonance flap is closed at idle/partial load (less than 3,800/rpm). The switch valve will be adjusted by ECM and resonance flap will be closed. By increasing air flow passage through dividing intake air flow toward both air collection housing. This leads to a significant increase in the torque in the lower speed range.

Resonance flap is open at full load (over 3,800/rpm). The switch valve will not be adjusted by ECM and resonance flap will be open. The collected air in the air collection housing will not be divided and intake air passage will be shorten.

STOP LAMP SWITCH

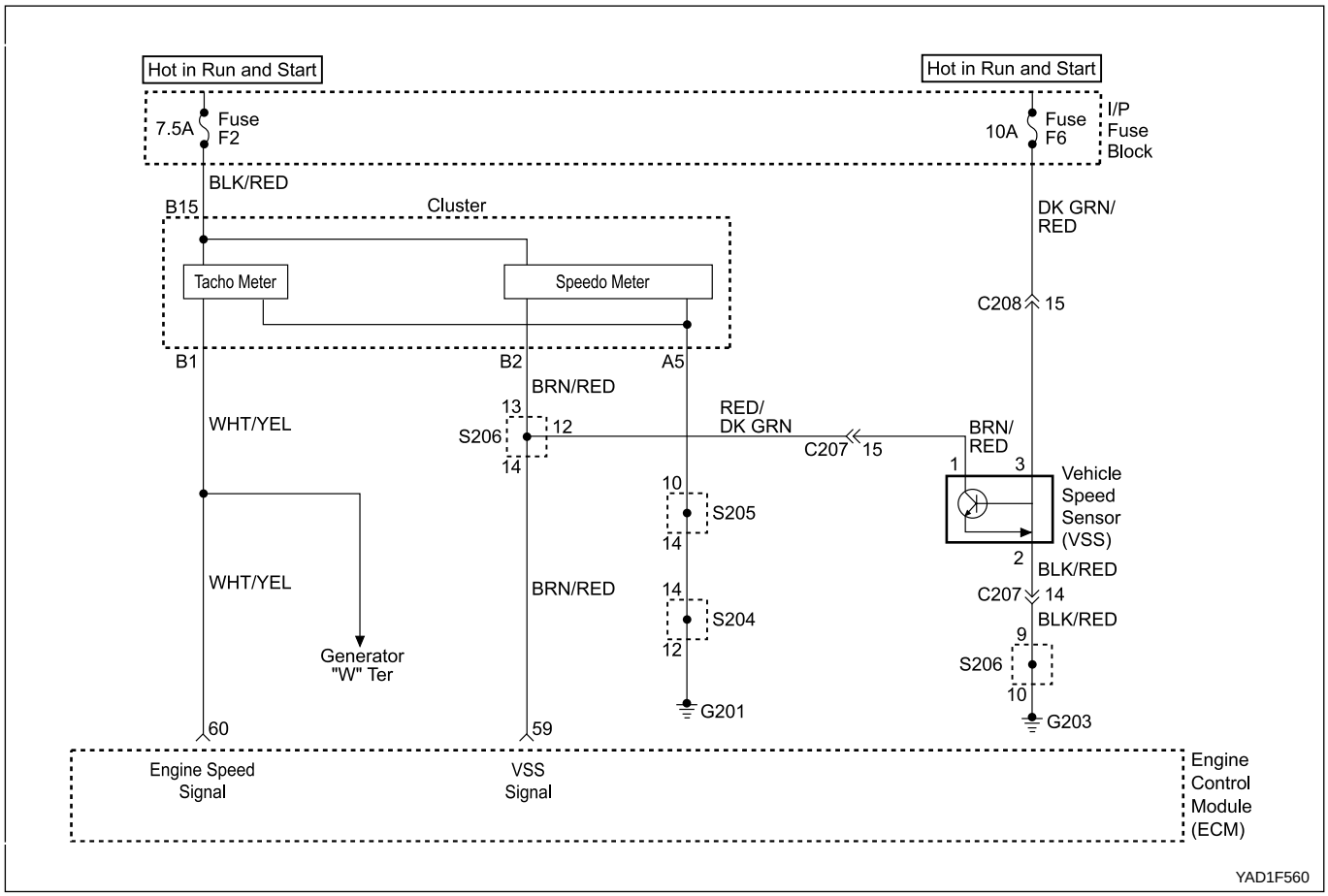


Failure Code	Description	Trouble Area	Maintenance Hint
135	Stop lamp switch failure	When malfunction of stop lamp switch - implausible condition of stop lamp signal input	• Monitoring the actual operational status and vehicle speed signal through scan tool • Inspection the Engine Control Module (ECM) pin 49 about short circuit or open with bad contact • Inspection the contact condition of stop lamp switch • Inspection the ECM

Circuit Description

The stop lamp switch is normally opened. When the ignition switch ON and brake ON, the battery voltage is supplied to the ECM. A scan tool should display ON when brake pedal is depressed and should read OFF with brake pedal released.

ENGINE RPM



Failure Code	Description	Trouble Area	Maintenance Hint
32	Engine rpm output circuit short circuit to battery	When short circuit to battery	• Inspection the cluster panel board circuit • Inspection the ECM • Monitoring the actual rpm in cluster • Inspection the Engine Control Module (ECM) pin 60 about short circuit or open
33	Engine rpm output circuit short circuit to ground or open	When short circuit to ground or open	

EXHAUST SYSTEM

CATALYTIC CONVERTER

The purpose of the catalytic converter is to convert the three pollutants of carbon monoxide(CO), hydrocarbons (HC) and oxides of nitrogen (NOx) contained in the exhaust of gasoline engines, into the harmless compounds of water (H2O), carbon dioxide (CO2) and nitrogen (N2).

The catalytic converter contains a catalyst, a word coming from the Greek and which designates the element essential for catalyst which triggers chemical reactions without itself being consumed.

These catalysts in the 3-way catalytic converter are the rare metals platinum (Pt) and rhodium (Rh).

The catalytic converter consists essentially of three main elements. The exhaust gases flow through the catalytic converter and, in so doing, coming into contact with rare metals (Pt and Rh).

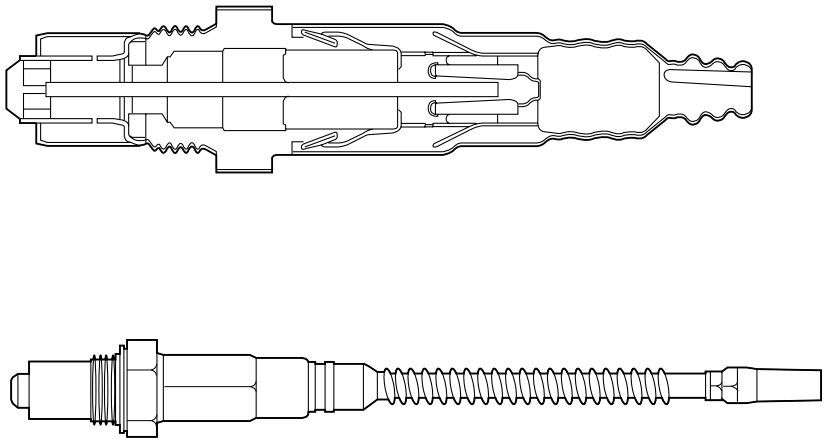
The following chemical reaction are produced.

$CO + O_2 \rightarrow CO_2$

$HC + O_2 \rightarrow CO_2 + H_2O$

$NO_x \rightarrow N_2 + O_2$

OXYGEN SENSOR



YAD1F570

The oxygen sensor is unique among the engine control sensors because is acts like a battery and is able to generate its own low voltage signal. It is located the exhaust system and monitors the amount of oxygen in the exhaust stream and provides feedback to the Engine Control Module (ECM).

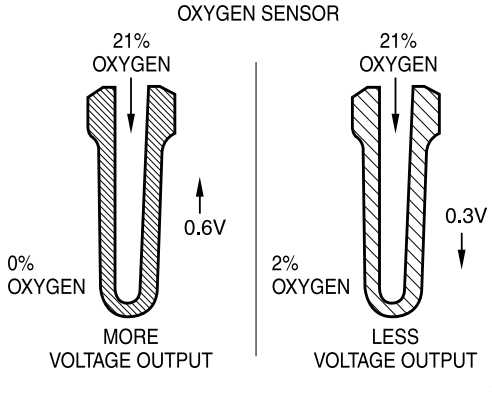
The electrically heated oxygen sensor warms up quickly and remains hot, even at idle when the exhaust manifold may cool down.

The ECM applies a reference voltage of 450 mv to the oxygen sensor, the ECM compares this reference voltage with the voltage generated by oxygen sensor. The amount of voltage the oxygen sensor generates is proportionate to the difference between the amount of oxygen in the outside air and the exhaust gases. The atmosphere contains about 21% oxygen. The exhaust from a rich air/fuel ratio contains almost no oxygen. With a large difference between the amounts of oxygen containing the two surface, the sensor generates less voltage.

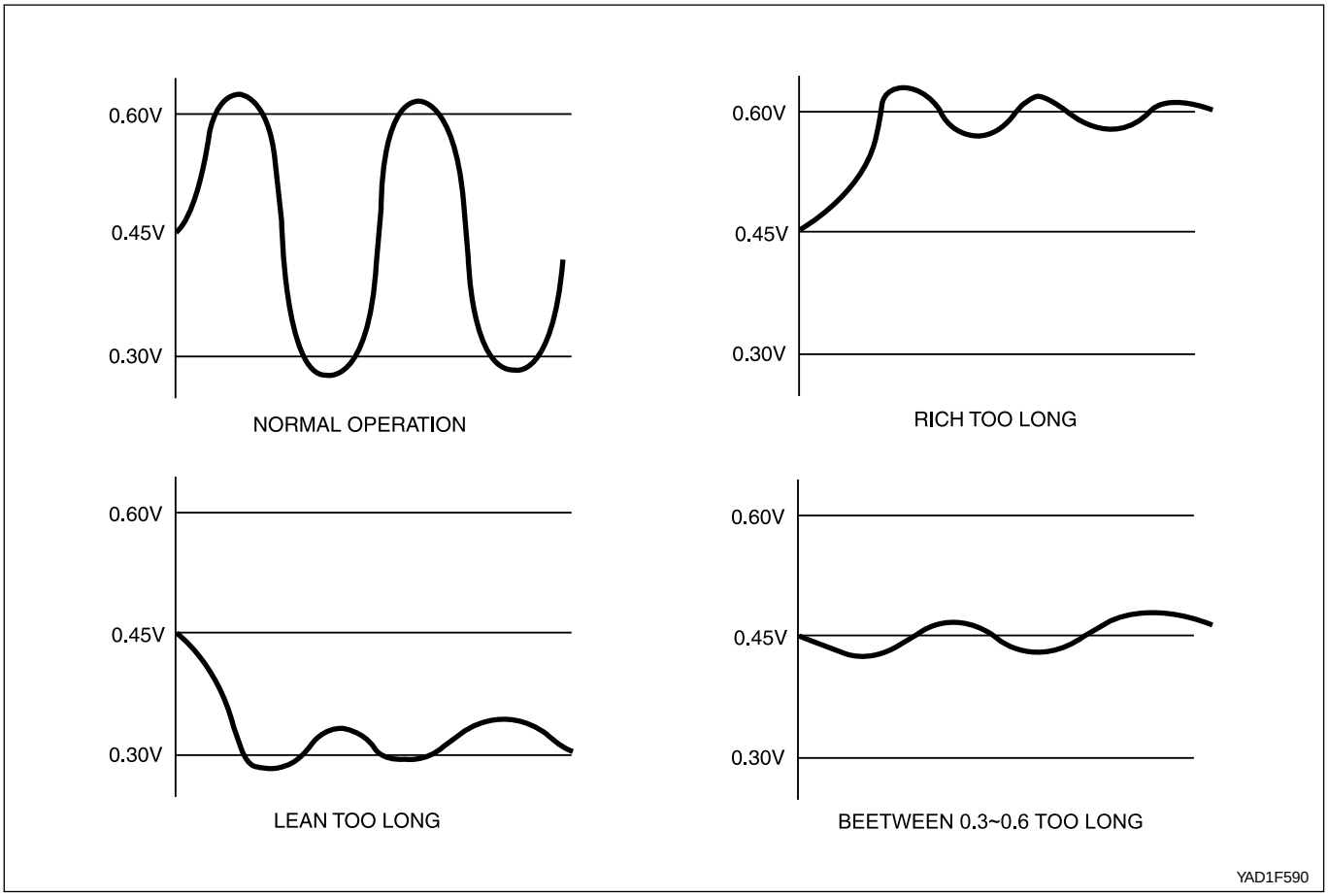
When the exhaust gas is rich (below 14.7:1), the voltage output is high, above450mv. When the exhaust gas is lean (above 14.7:1 air/fuel ratio), the sensor's voltage output is low, below 450 mv.

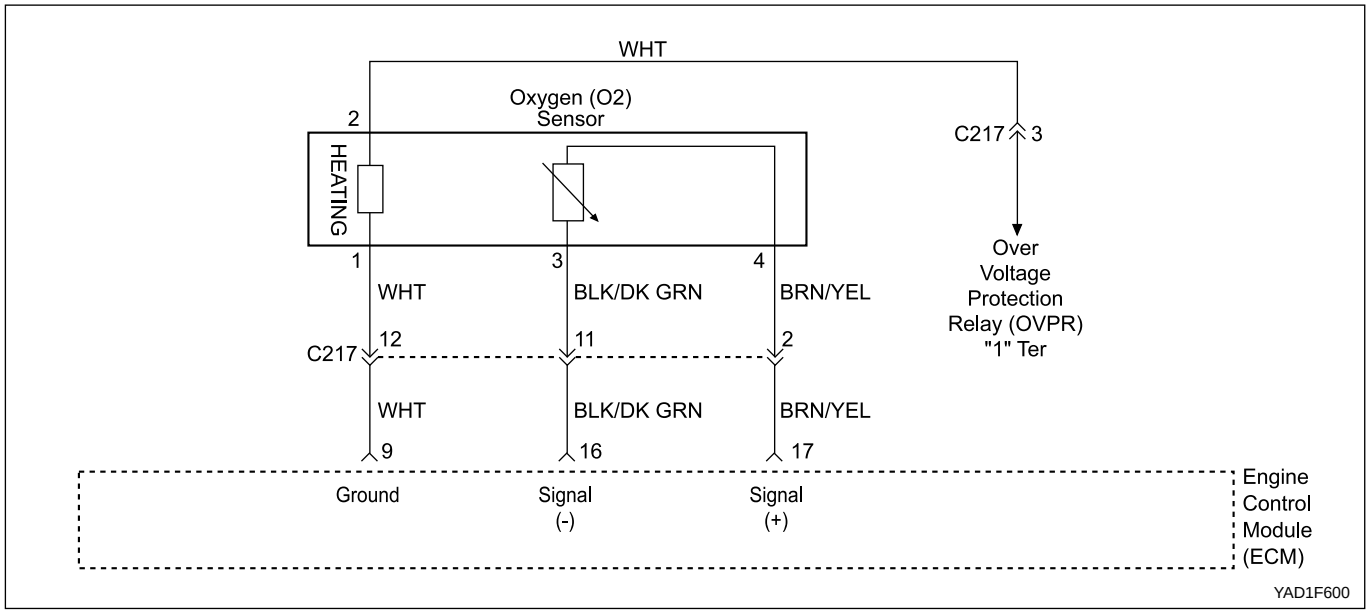
The ECM uses oxygen sensor information for:

- Open loop / closed loop criteria
- Ideal air / fuel ratio



YAD1F580


0.60V
0.45V
0.30V
NORMAL OPERATION
0.60V
0.45V
0.30V
RICH TOO LONG
0.60V
0.45V
0.30V
LEAN TOO LONG
0.60V
0.45V
0.30V
BEETWEEN 0.3~0.6 TOO LONG
YAD1F590



Failure Code	Description	Trouble Area	Maintenance Hint
80	Oxygen sensor high voltage	When recognition the output that more than nominal threshold, malfunction of sensing voltage.	• Monitoring the actual output signal through scan tool • Inspection the ECM pin 16, 17 about short circuit or open with bad contact • Inspection the oxygen sensor • Inspection the ECM
89	Oxygen sensor low voltage	When recognition the output that more than nominal threshold, malfunction of sensing voltage.	
82	Oxygen sensor no activity detected	When recognition the output that not active the sensor etc.	
83	Oxygen sensor not lean after overrun fuel shut-off	When recognition the output that no lean signal after overrun fuel shut-off	
84	Oxygen sensor slow response	When slow response of sensor signal	
85	Oxygen sensor heater failure	When recognition the heating circuit	• Monitoring the heating status through scan tool • Inspection the ECM pin 9 about short circuit or open with bad contact • Inspection the heating power source • Inspection the heating circuit of oxygen sensor • Inspection the ECM
86	Oxygen sensor heater short circuit to battery	When recognition the heating currents that more or less than set values (less than 0.2 A or more than 2 A)	
87	Oxygen sensor heater short circuit to ground or open	When recognition the heating voltages than less than set values (less than 2v)	

Failure Code	Description	Trouble Area	Maintenance Hint
81	Bank 1 system short term fuel trim adaptation below lean threshold	When recognition the value less than nominal control threshold, it means that when big deviation in control range of adaptation values through fuel and air mixture formation	• Inspection the intake air leakage • Inspection the injection quantities with injector block or leakage • Inspection the exhaust leakage • Inspection the ECM
93	Bank 1 system short term fuel trim adaptation above rich threshold	When recognition the value more than nominal control threshold, it means that when big deviation in control range of adaptation values through fuel and air mixture formation	
96	Bank 1 system short term fuel trim at rich stop	When recognition the short term fuel trim that more than nominal threshold	
97	Bank 1 system short term fuel trim at lean stop	When recognition the short term fuel trim that less than nominal threshold	
98	Bank 1 system idle adaptation failure (above rich threshold)	When recognition the long term fuel trim exceeds rich threshold	
99	Bank 1 system idle adaptation failure (below rich threshold)	When recognition the long term fuel trim exceeds lean threshold	
100	Bank 1 system learning control failure (rich, low load)	When recognition the long term fuel trim exceeds rich threshold	
101	Bank 1 system learning control failure (lean, low load)	When recognition the long term fuel trim exceeds lean threshold	
102	Bank 1 system learning control failure (rich, high load)	When recognition the long term fuel trim exceeds rich threshold	
103	Bank 1 system learning control failure (rich, low load)	When recognition the long term fuel trim exceeds lean threshold	

Circuit Description

In order to control emissions, a catalytic converter is used to covert harmful emissions into harmless water vapor and carbon dioxide. The ECM has the ability to monitor this process by using a oxygen sensor. The oxygen sensor produces and output signal which indicates the storage capacity of the catalyst. This in turn indicates the catalyst's ability to convert exhaust emission effectively. If the oxygen sensor pig tail wiring, connector, or terminal is damaged. Do not attempt to repair the wiring, connector, or terminals. In order for the sensor to function properly, it must have a clean air reference provided to it. This clean air reference is obtained by way of the oxygen sensor wire(s). Any attempt to repair the wires, connector, or terminal and degrade the oxygen sensor performance.

Oxygen Sensor Signal Voltage Inspection

1. Maintain the engine speed is at idle while the coolant temperature is over 80 °C.
2. Measure the oxygen sensor signal voltage between the ECM terminal No. 16 and No. 17.

Specified Value	2 ~ 1.0 V

Notice: If the measured value is not within the specified value, the possible cause may be in cable, oxygen sensor or ECM

Oxygen Sensor Heating Voltage Inspection

1. Maintain the engine speed is at idle while the coolant temperature is over 80 °C.
2. Measure the oxygen sensor signal voltage between the ECM terminal No. 11 and No. 9.

Specified Value	11 ~ 14 V

Notice: If the measured value is not within the specified value, the possible cause may be in cable, oxygen sensor or ECM

Oxygen Sensor Heating Current Consumption Inspection

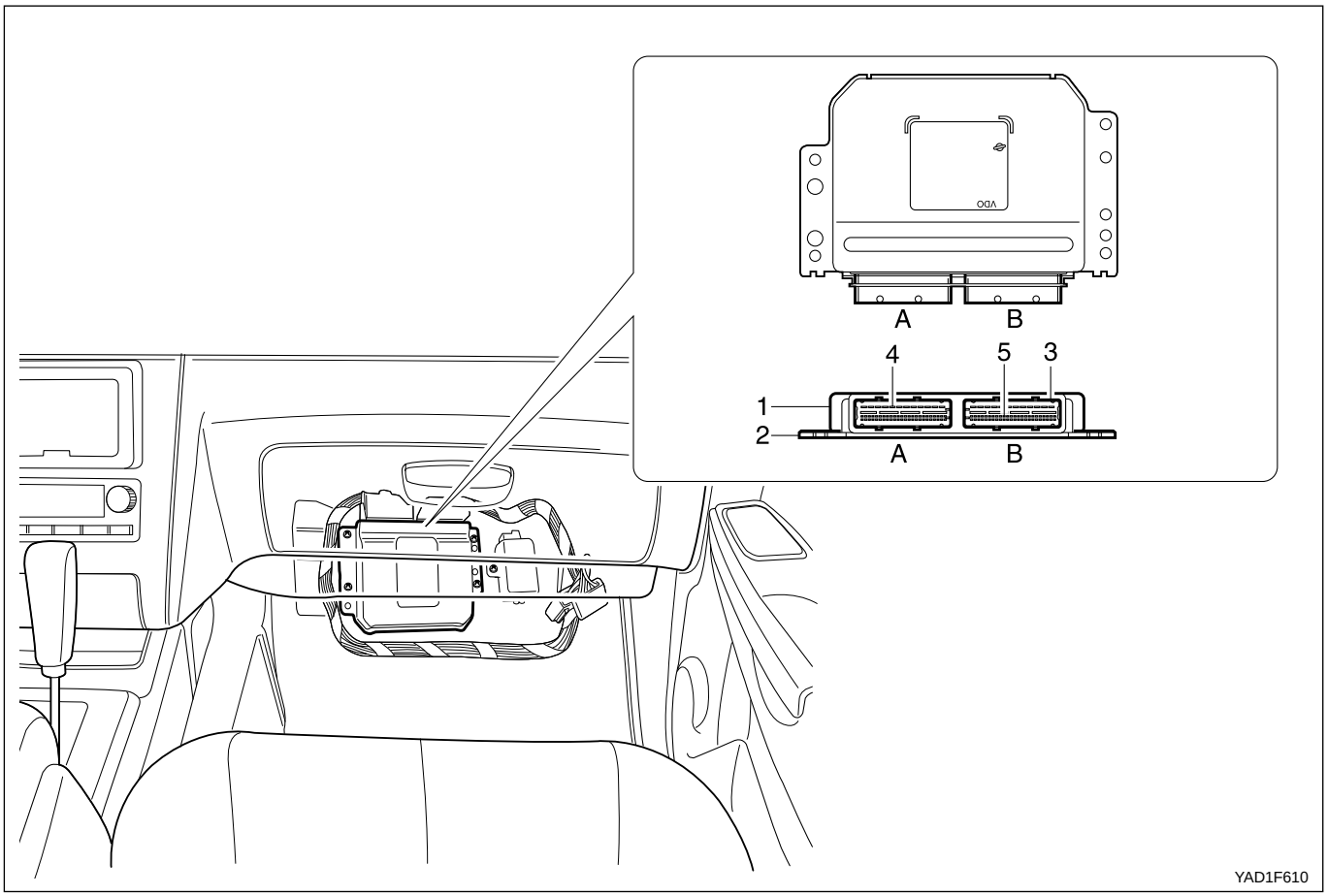
1. Turn the ignition switch to “ON” position.
2. Measure the oxygen sensor heating current consumption between the ECM terminal No. 9 and No. 5.

Specified Value	0.2 ~ 2.0 A

Notice: If the measured value is not within the specified value, the possible cause may be in cable, oxygen sensor or ECM

BLANK

ENGINE CONTROL MODULE



1 Cover
2 Plate
3 Connector
4 Flat Pin
Vehicle Side : No. 1-12
Engine Side : No. 61-72
5 Pin
Vehicle Side : No. 13-60
Engine Side : No. 73-120
A Vehicle Side Connector : Black
B Engine Side Connector : Gray

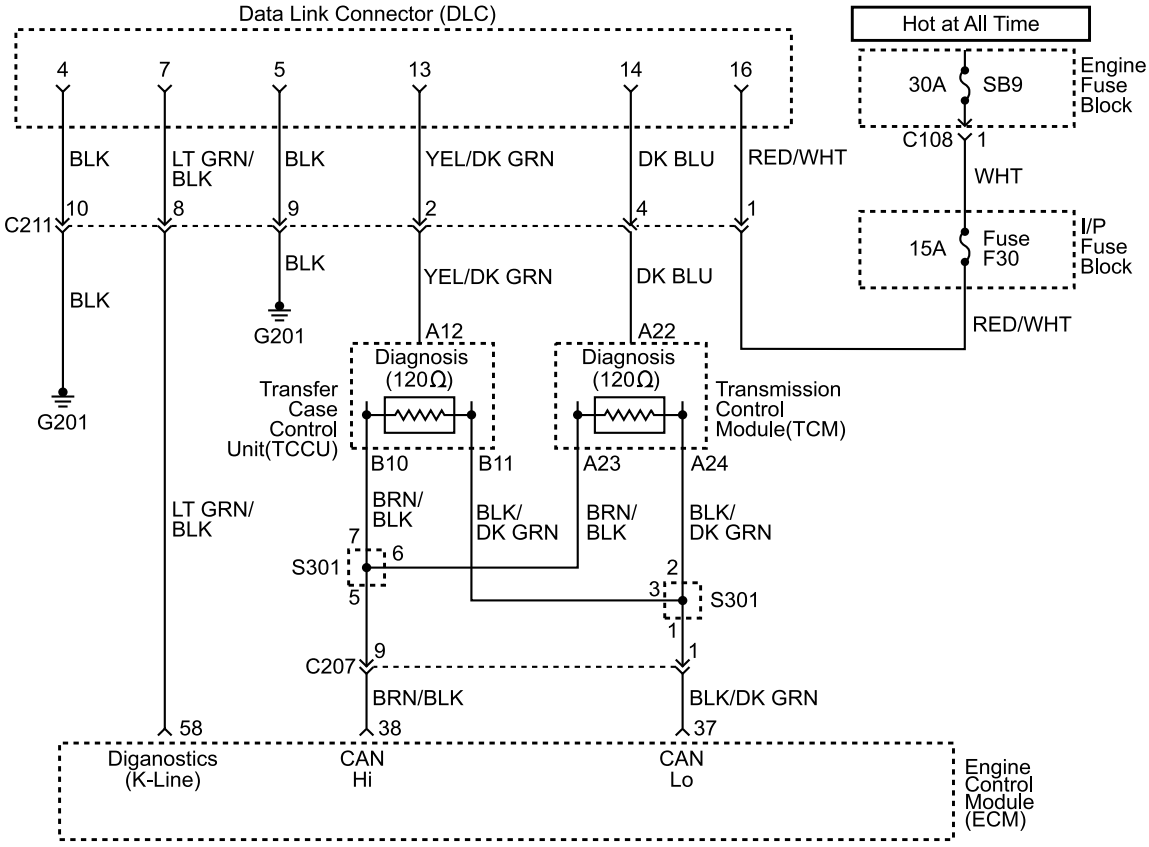
The Engine Control Module (ECM), located inside the right side kick panel, is the control center of the fuel injection system. It constantly looks at the information from various sensors and controls the systems that affect the vehicle's performance. Engine rpm and air mass are used to measure the air intake quantity resulting in fuel injection metering.

The ECM also performs the diagnostic functions of the system. It can recognize operational problems, store failure code(s) which identify the problem areas to aid the technician in making repairs.

There are no serviceable parts in the ECM. The calibrations are stored in the ECM in the Programmable Read Only Memory (PROM).

The ECM supplies either 5 or 12 volts to power the sensors or switches. This is done through resistance in the ECM which are so high in value that a test light will not come ON when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give and accurate reading because its resistance is too low. You must use a digital voltmeter with a 10 Mohm input impedance to get accurate voltage readings. The ECM controls output circuits such as the ignition coils, the fuel injectors, the fuel pump relay, the intake manifold resonance flap, the camshaft actuator, the canister purge valve, etc., by controlling the ground circuit.

SERIAL DATA COMMUNICATION



Failure Code	Description	Trouble Area	Maintenance Hint
23	CAN communication failure: ASR/MSR	When CAN signal message missing or implausibility for ASR/MSR unit or not initialized condition	• Inspection the ASR unit with CAN connection • Inspection the Engine Control Module (ECM) pin 38, 37 about short circuit or open with bad contact • Inspection the ECM
24	CAN communication failure: ABS	When CAN signal message missing or implausibility for ABS unit or not initialized condition	• Inspection the ABS unit with CAN connection • Inspection the ECM pin 38, 37 about short circuit or open with bad contact • Inspection the ECM
26	CAN communication failure: TCU (A/T only)	When CAN signal message missing or implausibility for TCU unit or not initialized condition	• Inspection the TCM unit with CAN connection • Inspection the ECM pin 38, 37 about short circuit or open with bad contact • Inspection the ECM

Failure Code	Description	Trouble Area	Maintenance Hint
27	CAN communication failure: TOD (E32 only)	When CAN signal message missing or implausibility for TOD unit or not initialized condition	• Inspection the TOD unit with CAN connection • Inspection the ECM pin 38, 37 about short circuit or open with bad contact • Inspection the ECM
29	CAN communication failure: ID 200h not plausible	When CAN signal message missing or implausibility for ABS/ABD unit or not initialized condition	• Inspection the ABS/ABD unit with CAN connection • Inspection the ECM pin 38, 37 about short circuit or open with bad contact • Inspection the ECM
30	CAN communication failure: ID 208h not plausible	When CAN signal message missing or implausibility for ABS/ABD unit or not initialized condition	• Inspection the ABS/ABD unit with CAN connection • Inspection the ECM pin 38, 37 about short circuit or open with bad contact • Inspection the ECM
31	CAN communication failure: communication initialization failure	When CAN signal message missing or implausibility for each unit (ABS, ASR, TCM, TOD etc.) or not initialized condition	• Inspection the each control unit with CAN connection • Inspection the ECM pin 38, 37 about short circuit or open with bad contact • Inspection the ECM
59	CAN communication failure: MSR data transmission not plausible	When CAN signal message missing or implausibility for MSR unit or not initialized condition	• Inspection the MSR unit with CAN connection • Inspection the Engine Control Module (ECM) pin 38, 37 about short circuit or open with bad contact • Inspection the ECM
60	CAN communication failure: ASR data transmission not plausible	When CAN signal message missing or implausibility for ASR unit or not initialized condition	• Inspection the ASR unit with CAN connection • Inspection the Engine Control Module (ECM) pin 38, 37 about short circuit or open with bad contact • Inspection the ECM

Circuit Description

The provision for communicating with the ECM is the Data Link Connector (DLC). It is located in the instrument panel fuse block. The DLC is used to connect the scan tool. Battery power and ground is supplied for the scan tool through the DLC. CAN line is used to communicate with the other module such as the Transmission Control Module (TCM) and Transfer Case Control Unit (TCCU).

Keyword 2000 Serial Data Communications

Each bit of information can have one of two lengths: long or short. This allows vehicle wiring to be reduced by transmitting and receiving multiple signals over a singles wire. The message carried on KWP 2000 data streams are also prioritized. If two messages attempt to establish communications on the data line at the same time, only the message with higher priority will must wait.

INTERNAL FAILURE

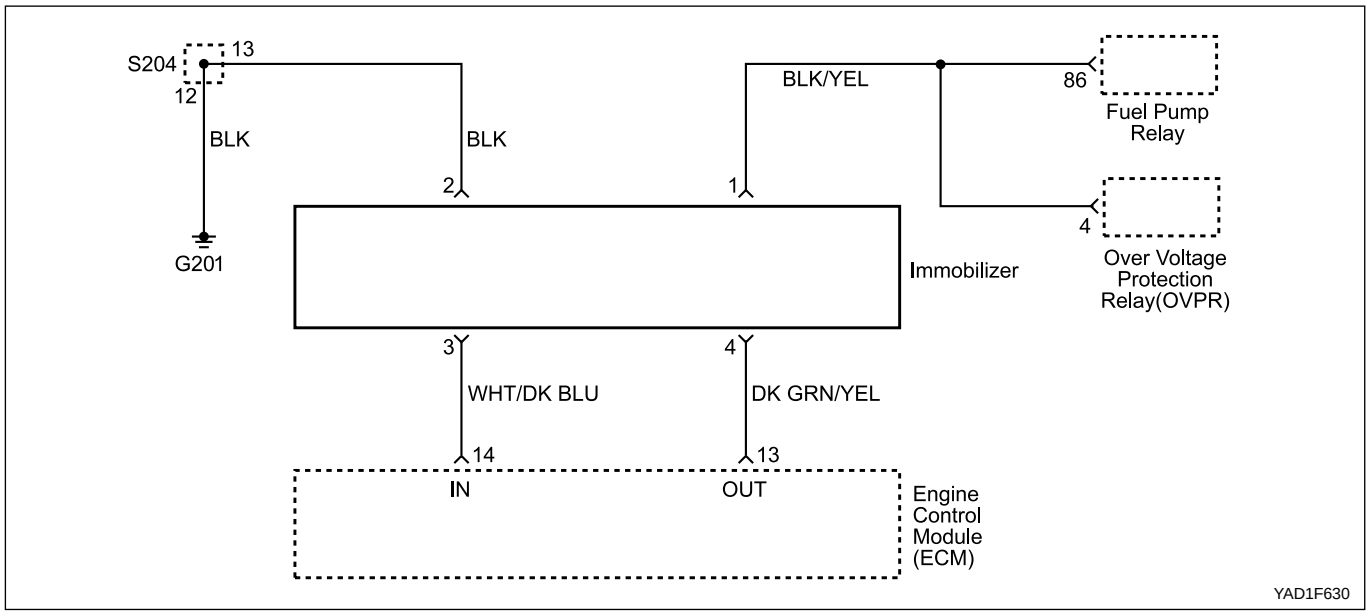
Failure Code	Description	Trouble Area	Maintenance Hint
21	Transmission coding failure	When faulty of variant coding of transmission	• Inspection the coding condition through scan tool • Inspection the Engine Control Module (ECM) • Inspection the CAN line • Inspection the TCM
136	ECM failure (RAM)	When malfunction of random access memory - ECM internal error	• Inspection the ECM
142	Uncoded/ unprogramed ECM	When malfunction of ECM coding-required ECM encoding	• Fulfill the ECM variant coding
137	ECM failure (EPROM)	When malfunction of ECM internal	• Inspection the ECM
143	ECM failure (EEPROM/ Flash - EPPOM checksum failure)		
144	ECM failure (coding ID checksum failure)		
145	ECM failure (coding checksum failure)		
146	ECM failure (programming checksum failure)		

ELECTRONIC THROTTLE CONTROLLER SAFETY MALFUNCTION

Failure Code	Description	Trouble Area	Maintenance Hint
110	Throttle actuator learning data fault	System internal failure	• Inspection the Engine Control Module (ECM)
117	Exceed fuel-cut safety time		
120	Cruise control interruption memory failure		
138	Call Monitoring		
139	Servo motor control output interruption memory failure		
140	Servo motor open/short		
186	ECM failure (incompatible CPU)		
187	ECM failure (CPUs communication failure)		
188	ECM failure (CPU 2 configuration failure)		
189	ECM failure (CPU 2 fault)		
190	ECM failure (CPU run time failure between CPUs)		
231	ECM failure (CPU 2 cruise control message counter failure)		
232	Over deceleration limit (CPU 2)		
233	Over acceleration limit (CPU 2)		
234	Cruise control lever dual operation (CPU 2)		
235	Cruise control lever safety terminal failure (CPU 2)		
236	Unusual pedal position variation (CPU 2)		
237	Unusual throttle position variation (CPU 2)		
238	Unusual throttle controller monitoring data comparison fault (CPU 2)		

Failure Code	Description	Trouble Area	Maintenance Hint
239	Unusual accelerator pedal position sensor comparison fault (CPU 2)	System internal failure	• Inspection the Engine Control Module
240	Throttle potentiometer comparison fault (CPU 2)		
241	Unusual CPU communication (CPU 2)		
242	Unusual CPU configuration (CPU 2)		
243	A/D converter failure (CPU 2)		
244	Accelerator pedal position sensor set-point fault between CPU 1 and CPU 2 (ECM)		
245	Position controller set-point fault between CPU 1 and CPU 2		
246	MSR setpoint fault between CPU 1 and CPU 2		
247	Idle control setpoint fault between CPU 1 and CPU 2		
248	A/D converter overflow (CPU 2)		
249	ROM fault (CPU 2)		
250	RAM fault (CPU 2)		
251	Cycle monitor fault (CPU 2)		

IMMOBILIZER



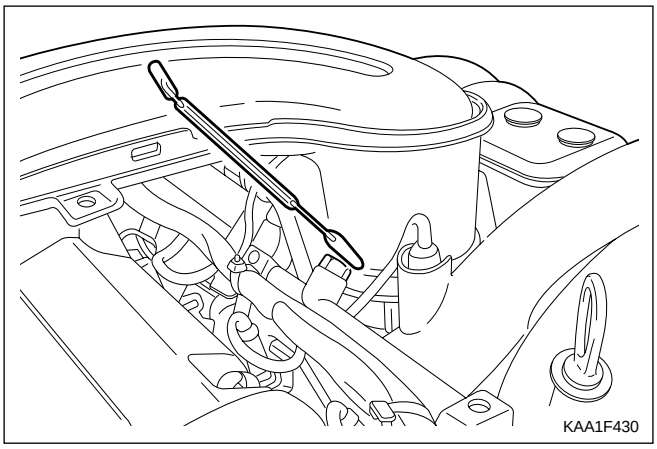
Failure Code	Description	Trouble Area	Maintenance Hint
25	Communication with transponder missing	When missing the transponder signal	• D Inspection the Engine Control Module (ECM) pin 13, 14 about short circuit or open with bad contact • Inspection the power source or ground short circuit or open of immobilizer unit • Inspection the transponder condition (broken etc.) • Inspection the ECM
141	Unprogramed ECM with immobilizer	When malfunction of immobilizer Required immobilizer encoding, no paired condition of immobilizer even through start trial	• Fulfill the immobilizer pairing

Circuit Description

Immobilizer is a device disabling vehicle ignition unless a specific key is used and designed to help prevent vehicle theft.

Immobilizer is comprised of two devices, a key with encoded transponder and ECM with the same encoding of the transponder. When a key is inserted into the hole to start vehicle and turned to ON, the ECM reads and decodes the transponder code and, if the same, starts the engine, it is called immobilizer. It means immobilizer system disables starting by stopping fuel supply if the code in the transponder does not match the code stored in ECM each other.

MAINTENANCE AND REPAIR


KAA1F430

ON-VEHICLE SERVICE

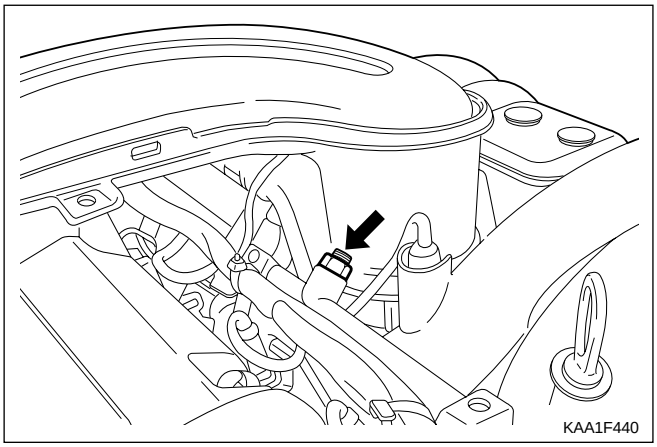
DISCHARGING THE PRESSURE IN FUEL SYSTEM

Removal and Installation Procedure

1. Remove the fuel pressure test connector.

   Installation Notice

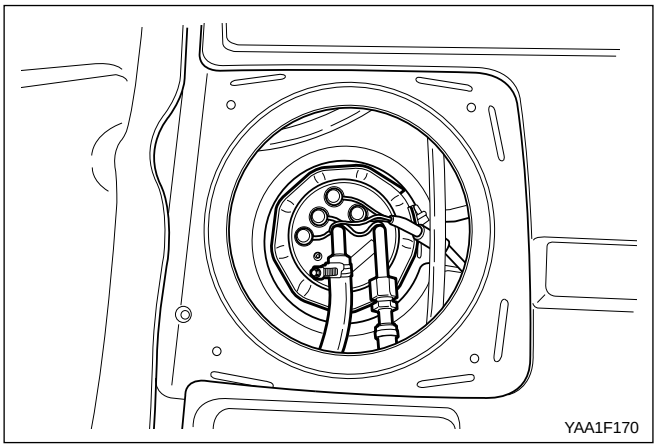
Tightening Torque	25 N•m (18 lb-ft)


KAA1F440

2. Remove the fuel pressure in fuel system by pressing the service valve with a clean, pointy tool.

   Notice: Place a cloth so that the fuel doesn't stain around.

3. Installation should follow the removal procedure in the reverse order.


YAA1F170

FUEL PUMP

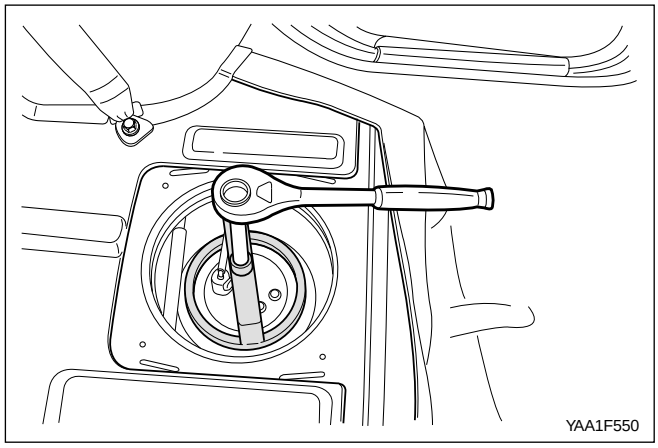
Tools Required

661 589 00 46 00 Fuel Tank Cap Wrench

Removal and Installation Procedure

Caution: The fuel system is under pressure. To avoid fuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

1. Relieve the fuel system pressure. Refer to "Discharging the Pressure in Fuel System" in this section.
2. Disconnect the negative battery cable.
3. Put aside the floor carpet to remove the fuel pump access cover.
4. Remove the fuel pump access cover.
5. Remove the fuel pump wiring connectors.
6. Disconnect the fuel supply and return pipes.
7. Remove the fuel pump locking cap band.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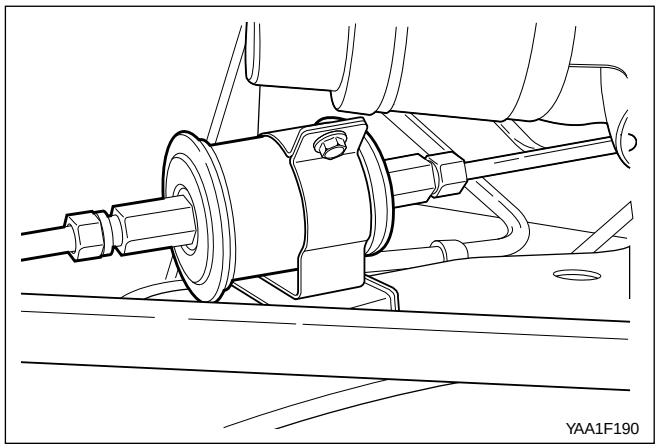

YAA1F190

8. Using the fuel tank cap wrench 661 589 00 46 00, remove the locking cap.
9. Remove the pump from the fuel tank.

   Notice: Check the condition of the seal and replace if necessary. Drain the fuel before removing the pump.

10. Perform an operational check of the fuel pump.
11. Installation should follow the removal procedure in the reverse order.

FUEL FILTER

Removal and Installation Procedure

1. Disconnect the negative battery cable.

Caution: The fuel system is under pressure. To avoid fuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

2. Relieve the fuel system pressure. Refer to “Discharging the Pressure in Fuel System” in this section.
3. Disconnect the fuel lines from the fuel filter.

   Installation Notice

Tightening Torque	28 N•m (21 lb-ft)

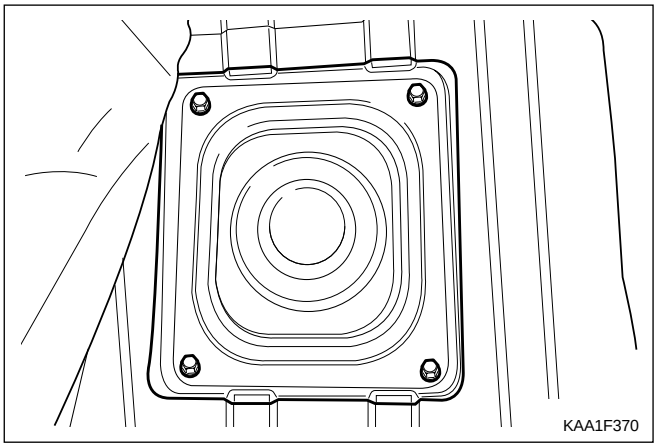
4. Remove the fuel filter mounting bracket bolt.

   Installation Notice

Tightening Torque	28 N•m (21 lb-ft)

   Notice: Place the fuel pump pad. There may be a corrosion due to the contact between the fuel filter and the bracket.

5. Remove the fuel filter.
6. Install the fuel filter.
7. Perform a leak test of the fuel filter.
8. Installation should follow the removal procedure in the reverse order.

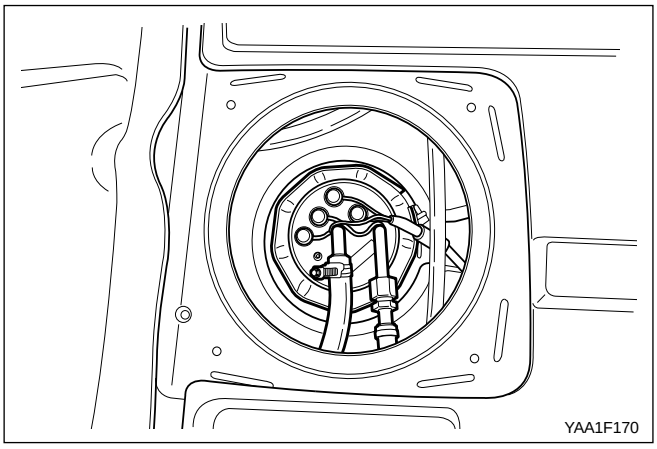

KAA1F370

FUEL TANK

Removal and Installation Procedure

Caution: The fuel system is under pressure. To avoid fuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

1. Relieve the fuel pressure. Refer to “Discharging the Pressure in Fuel System” in this section.
2. Disconnect the negative battery cable.
3. Drain the fuel tank.
4. Put aside the floor carpet to remove the fuel pump access cover.
5. Remove the fuel pump access cover.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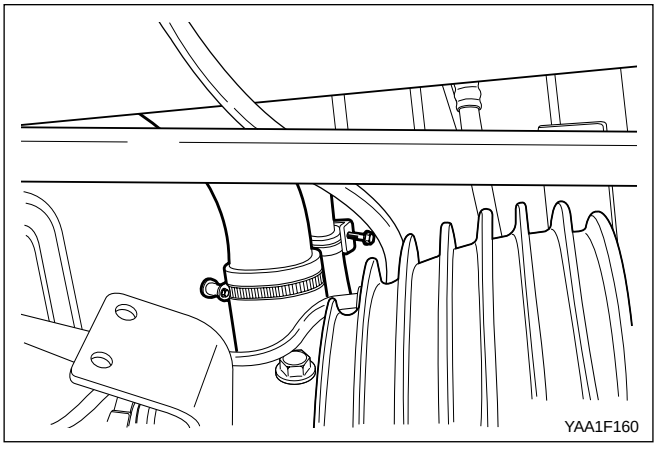
6. Disconnect the return line.
7. Disconnect the supply line.
8. Disconnect the fuel tank-to-canister hose from the fuel tank.
9. Disconnect the fuel pump wiring connector.

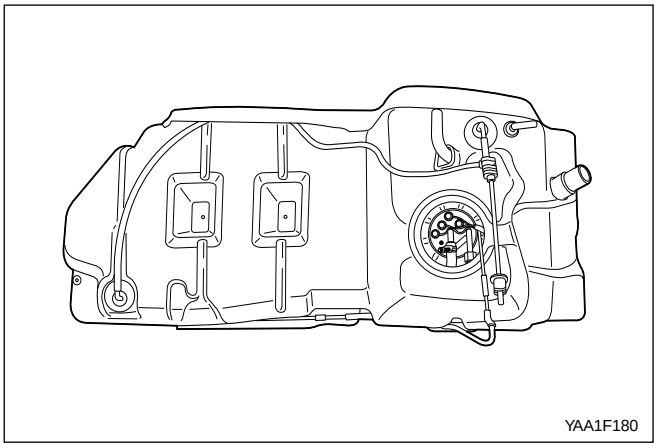

YAA1F160

10. Disconnect the fuel filler hose and air vent hose from the fuel tank.
11. Support the fuel tank.
12. Remove the fuel tank retaining nuts.

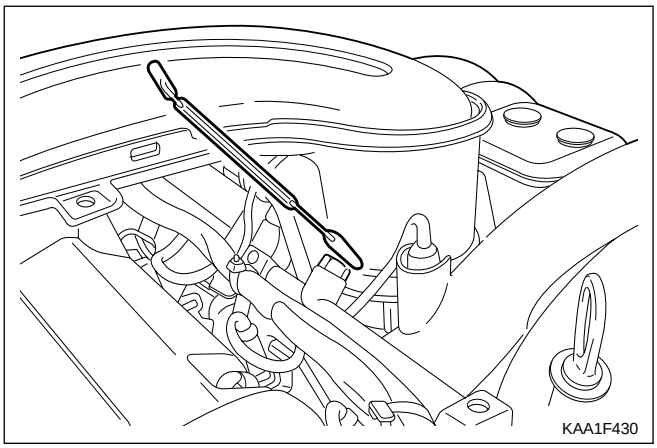
    Installation Notice

Tightening Torque	38 N•m (28 lb-ft)

13. Carefully lower the fuel tank.


YAA1F180

14. Turn the roll over valves counterclockwise at an angle of 90 degrees.
15. Turn the lock ring counterclockwise.
16. Remove and discard the gasket.
17. Installation should follow the removal procedure in the reverse order.


KAA1F430

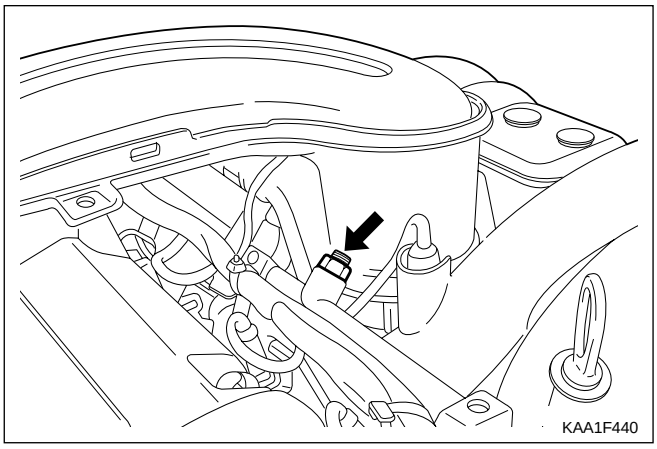
FUEL PRESSURE REGULATOR

Removal and Installation Procedure

1. Disconnect the negative battery cable.
2. Remove the fuel pressure test connector.

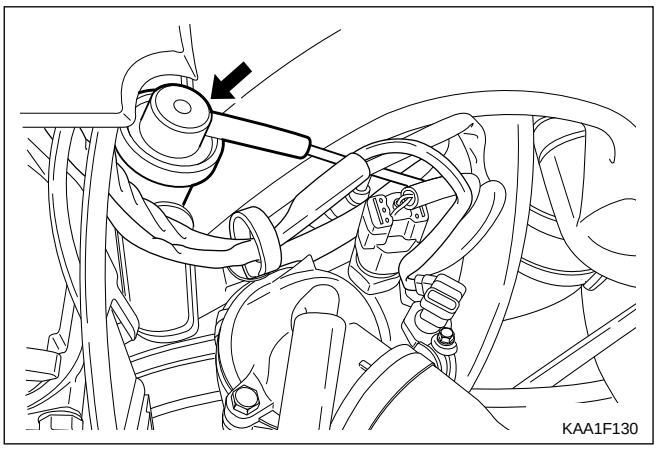
Installation Notice

Tightening Torque	25 N•m (18 lb-ft)

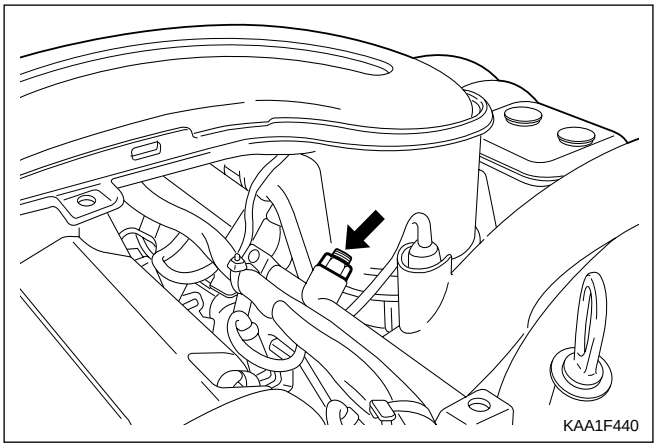

KAA1F440

Caution: The fuel system is under pressure. To avoid fuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

3. Relieve the fuel pressure in fuel supply system by pressing the service valve.


KAA1F130

4. Disconnect the vacuum hose.
5. Disconnect the circlip and remove the fuel pressure regulator.
6. Apply the oil to O-ring lightly and then replace it.
7. Perform a leak test of the fuel pressure regulator with the engine off and the ignition on.
8. Installation should follow the removal procedure in the reverse order.

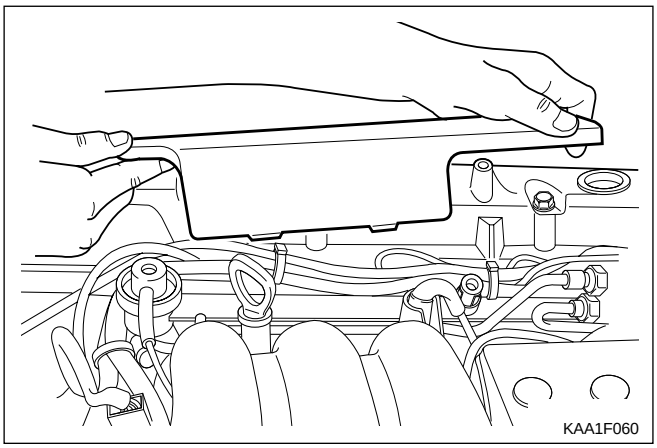


FUEL RAIL AND INJECTORS

Removal and Installation Procedure

Caution: The fuel system is under pressure. To avoidfuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

1. Discharge the fuel pressure from the fuel pressure test connector.
2. Disconnect the negative battery cable.
3. Disconnect the vacuum hose from the fuel pressure regulator.

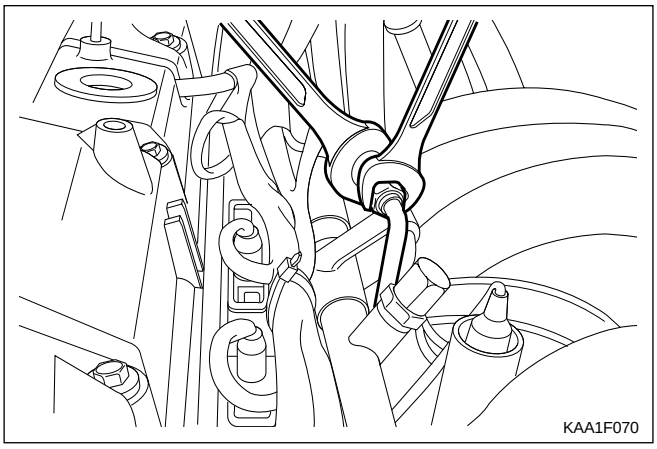


4. Remove the cable guide.
5. Disconnect the Hot Film Air Mass (HFM) sensor connector.
6. Remove the intake air duct mounting bolts.

Installation Notice

Tightening Torque	9 N•m (80 lb-ft)

7. Remove the intake air duct clamps.
8. Remove the intake air duct.



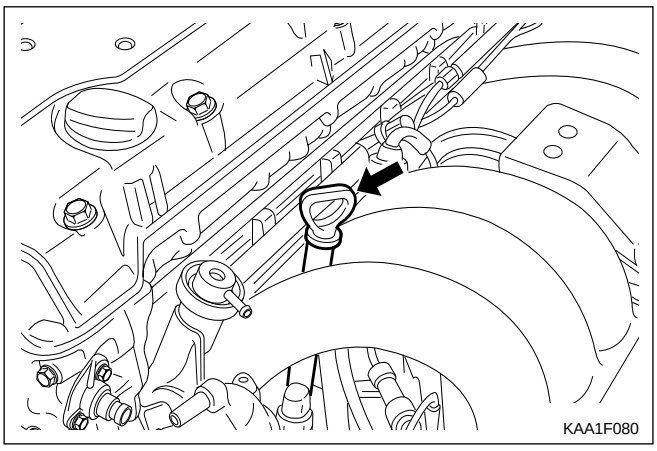
9. Remove the fuel return and supply line.

   Notice: For removal, cover around parts with cloths not to be stained by fuel. In case of checking the injector only, do not remove the fuel return and supply line.

Installation Notice

Tightening Torque	23 N•m (17 lb-ft)

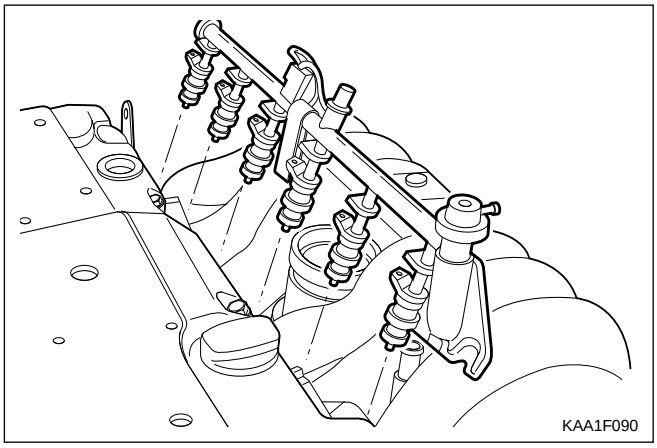
10. Remove the six injector connectors.



11. Remove the two left and two right bolts and one center bolt of the fuel rail assembly from the intake manifold.

Installation Notice

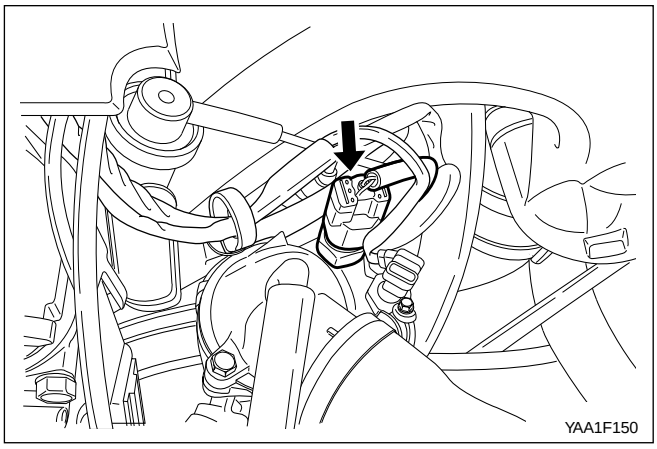
Tightening Torque	25 N•m (18 lb-ft)


KAA1F090

Notice: Before removal, the fuel rail assembly may be cleaned with as pray type cleaner, following package instructions. Do not immerse the fuel rails in liquid cleaning solvent. Use care in removing the fuel rail assembly to prevent damage to the electrical connectors and injector spray tips. Prevent dirt and other contaminants from entering open lines and passages. Fittings should be capped and holes plugged during service.

Important: If an injector becomes separated from the rail and remains in the cylinder head, replace the injector O-ring seals and the retaining clip.

12. Remove the injectors and the fuel rail carefully.
13. Remove the fuel injector retainer clips.
14. Remove the fuel injectors by pulling them down and out.
15. Discard the fuel injector O-rings.
16. Lubricate the new fuel injector O-rings with engine oil. Install the new O-rings on the fuel injectors.
17. Perform a leak check of the fuel rail and fuel injectors.
18. Installation should follow the removal procedure in the reverse order.


YAA1F150

ENGINE COOLANT TEMPERATURE SENSOR

Removal and Installation Procedure

1. Relieve the coolant system pressure.
2. Disconnect the negative battery cable.
3. Disconnect the engine coolant temperature sensor connector.

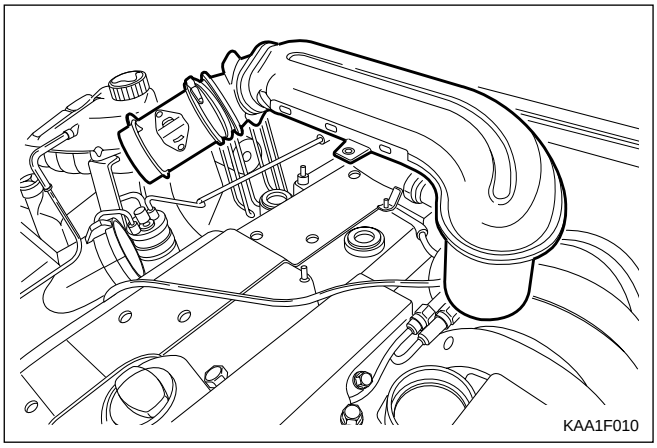
   Notice: Take care when handling the engine coolant temperature sensor. Damage to the sensor will affect the proper operation of the fuel injection system.

4. Remove the engine coolant temperature sensor from the pump hosing.

   Installation Notice

Tightening Torque	30 N•m (22 lb-ft)

5. Installation should follow the removal procedure in the reverse order.


KAA1F010

THROTTLE BODY (INTEGRATED WITH THE ACTUATOR)

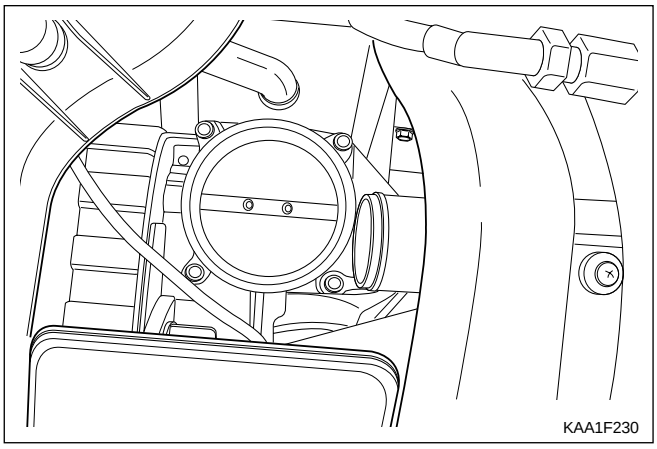
Removal and Installation Procedure

1. Disconnect the negative battery cable.
2. Disconnect the mass air flow sensor connector.
3. Disconnect the mass air flow sensor from the air filter housing.
4. Remove the intake air duct mounting bolts.

Installation Notice

Tightening Torque	9 N•m (80 lb-ft)

5. Remove the air inlet housing clamps.
6. Remove the inlet air housing.

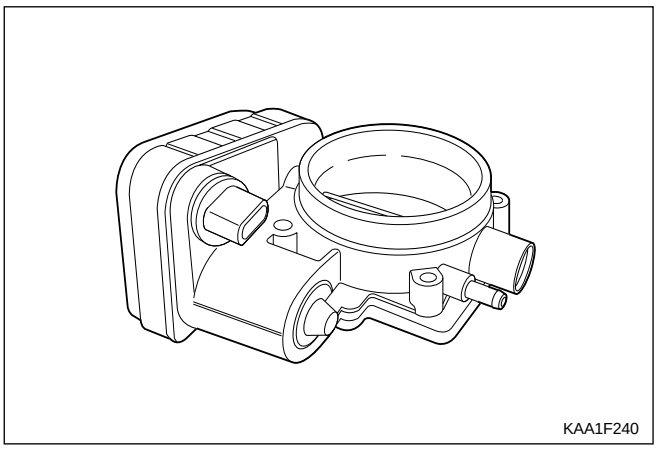

KAA1F230

7. Disconnect the throttle body electrical connector.
8. Remove the throttle body bolts.

Installation Notice

Tightening Torque	12 N•m (106 lb-ft)

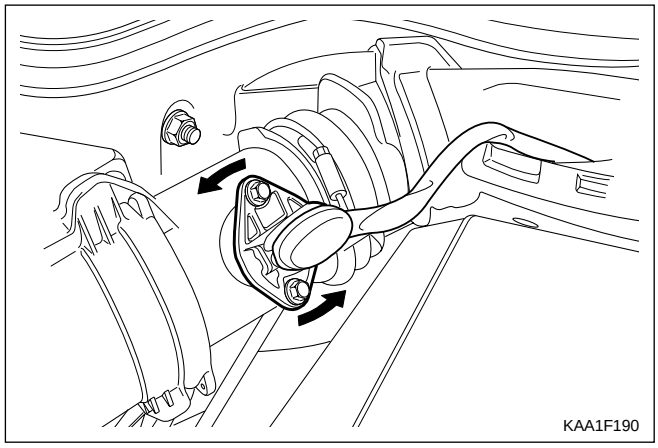
9. Remove the vacuum hose.


KAA1F240

10. Remove the throttle body and discard the gasket.

    Important: Use care in cleaning old gasket material. Sharp tools may damage sealing surfaces.

11. Installation should follow the removal procedure in the reverse order.


KAA1F190

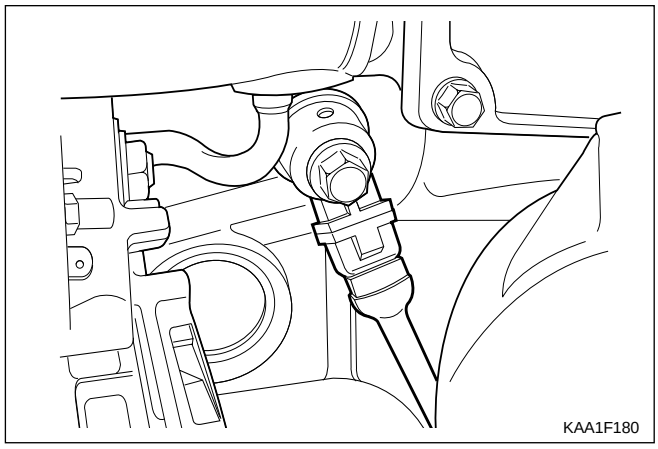
HOT FILM AIR MASS (HFM) SENSOR

Removal and Installation Procedure

1. Disconnect the negative battery cable.
2. Disconnect the Hot Film Air Mass (HFM) sensor electrical connector.
3. Remove the HFM sensor retaining screws.
4. Turn the HFM sensor coupling in the direction shown in the figure in the left so that it gets separated from the contact surface.

   Notice: Make sure the HFM sensor coupling connects completely with the contact surface installation.

5. Remove the HFM sensor.
6. Installation should follow the removal procedure in the reverse order.


KAA1F180

KNOCK SENSOR

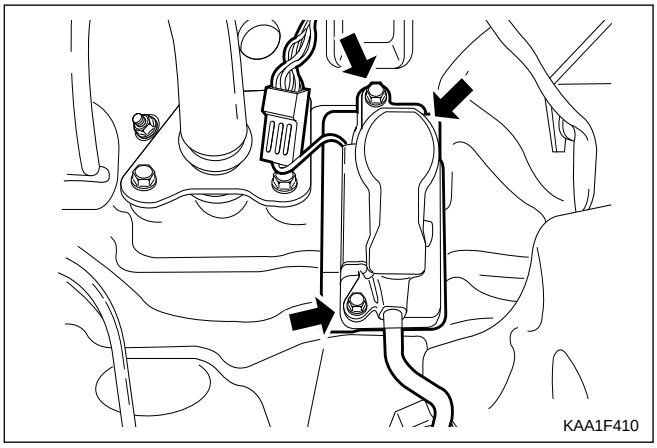
Removal and installation Procedure

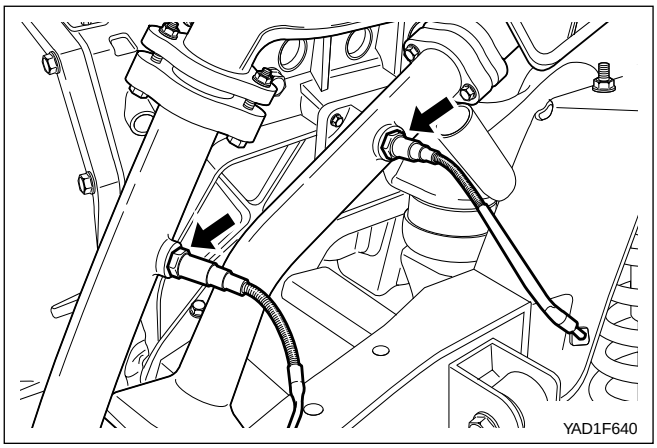
1. Disconnect the negative battery cable.
2. Disconnect the knock sensor electrical connector from the intake manifold bracket.
3. Remove the knock sensor mounting bolt from the knock sensor installed on the cylinder block.

   Installation Notice

Tightening Torque	25 N•m (18 lb-ft)

4. Remove the knock sensor.
5. Installation should follow the removal procedure in the reverse order.





PEDAL POSITION SENSOR

Removal and installation Procedure

1. Disconnect the negative battery cable.
2. Disconnect the pedal position sensor connector.
3. Unscrew the bolts and nut.

Installation Notice

Tightening Torque	6 N•m (53 lb-ft)

4. Remove the pedal and sensor assembly.
5. Installation should follow the removal procedure in the reverse order.

OXYGEN SENSOR

Removal and Installation Procedure

1. Disconnect the negative battery cable.

   Notice: The oxygen sensor uses a permanently attached pigtail and connector. This pigtail should not be removed from the oxygen sensor. Damage or removal of the pigtail or the connector could affect proper operation of the oxygen sensor. Do not drop the oxygen sensor.

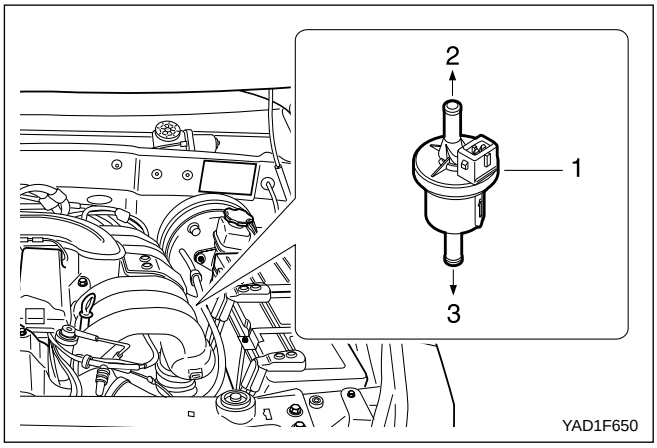
2. Disconnect the electrical connector.
3. Carefully remove the oxygen sensor from the exhaust pipe.

Installation Notice

Tightening Torque	55 N•m (41 lb-ft)

Important: A special anti-seize compound is used on the oxygen sensor threads. This compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or serviced sensors will al-ready have the compound applied to the threads. If a sensor is removed from any engine and is to be rein-stalled, the threads must have an anti-seize compound applied before reinstallation.

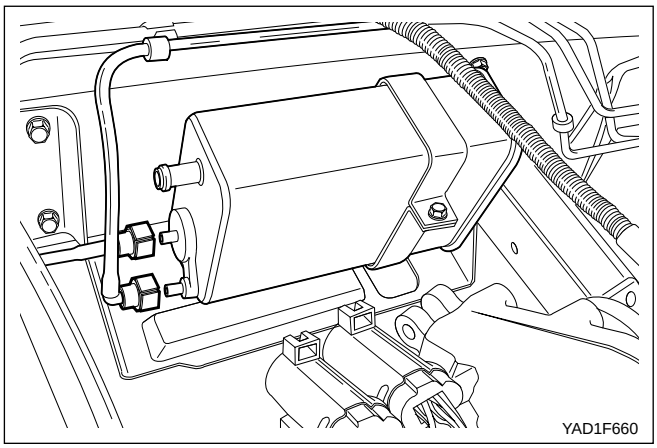
4. Coat the threads of the oxygen sensor with an anti-seize compound, if needed.
5. Installation should follow the removal procedure in the reverse order.



PURGE CONTROL VALVE

Removal and Installation Procedure

1. Disconnect the negative battery cable.
2. Disconnect the purge control valve connector.
3. Disconnect the throttle body-to-purge control valve hose from the purge control valve.
4. Disconnect the canister-to-purge control valve hose from the purge control valve.
5. Remove the purge control valve.
6. Installation should follow the removal procedure in the reverse order.

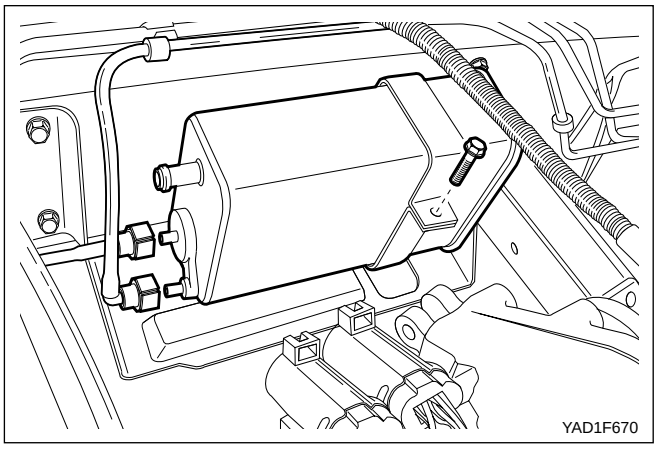


CANISTER

Removal and Installation Procedure

Caution: Canister and vacuum hoses contain fuel vapors. Do not smoke in the area or permit an open flame.

1. Disconnect the fuel tank-to-canister hose form the canister.
2. Disconnect the canister-to-purge control valve hose form the canister.

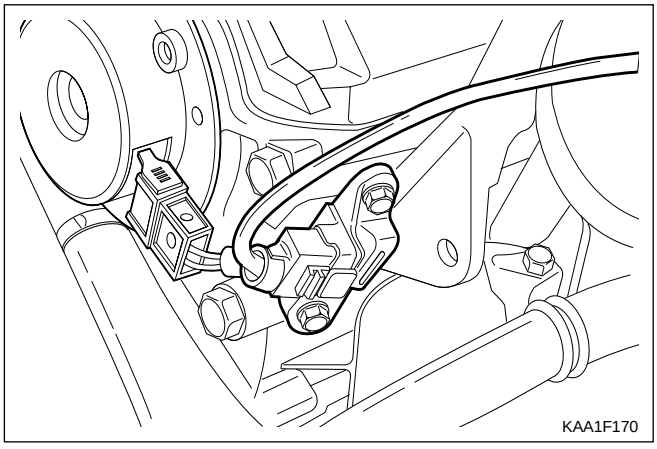


3. Remove the canister mounting bolts.

   Installation Notice

Tightening Torque	6 N•m (53 lb-ft)

4. Remove the canister.
5. Installation should follow the removal procedure in the reverse order.



CAMSHAFT POSITION SENSOR

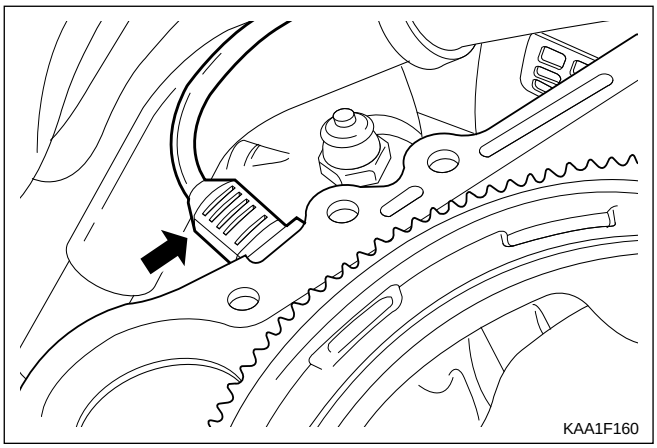
Removal and Installation Procedure

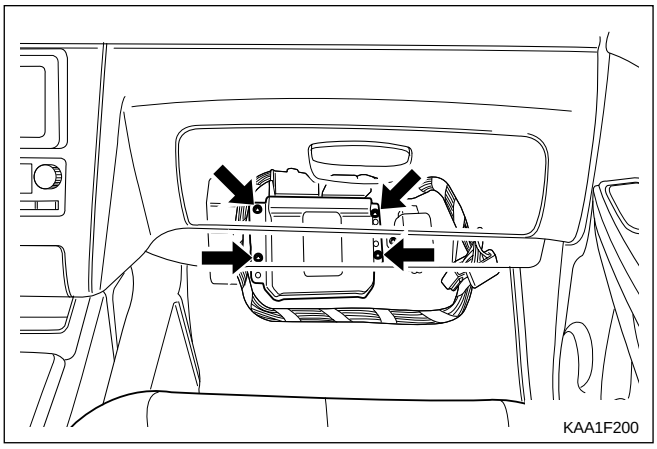
1. Disconnect the negative battery cable.
2. Disconnect the electrical connector from the camshaft position sensor.
3. Remove the camshaft position sensor retaining bolt.

   Installation Notice

Tightening Torque	10 N•m (89 lb-ft)

4. Check the O-ring for damage and replace it if neces sary.
5. Installation should follow the removal procedure in the reverse order.


KAA1F160


KAA1F200

CRANKSHAFT POSITION SENSOR

Removal and installation Procedure

1. Disconnect the negative battery cable.
2. Disconnect the electrical connector at the crankshaft position sensor.
3. Remove the crankshaft position sensor retaining bolt.

Installation Notice

Tightening Torque	25 N•m (18 lb-ft)

4. Installation should follow the removal procedure in the reverse order.

ENGINE CONTROL MODULE

Removal and installation Procedure

1. Disconnect the negative battery cable.
2. Remove the cowl side trim form passenger side. Refer to *Section 9G, Interior trim.*
3. Remove the four securing nuts for the Engine Control Module (ECM) from the mounting bracket.

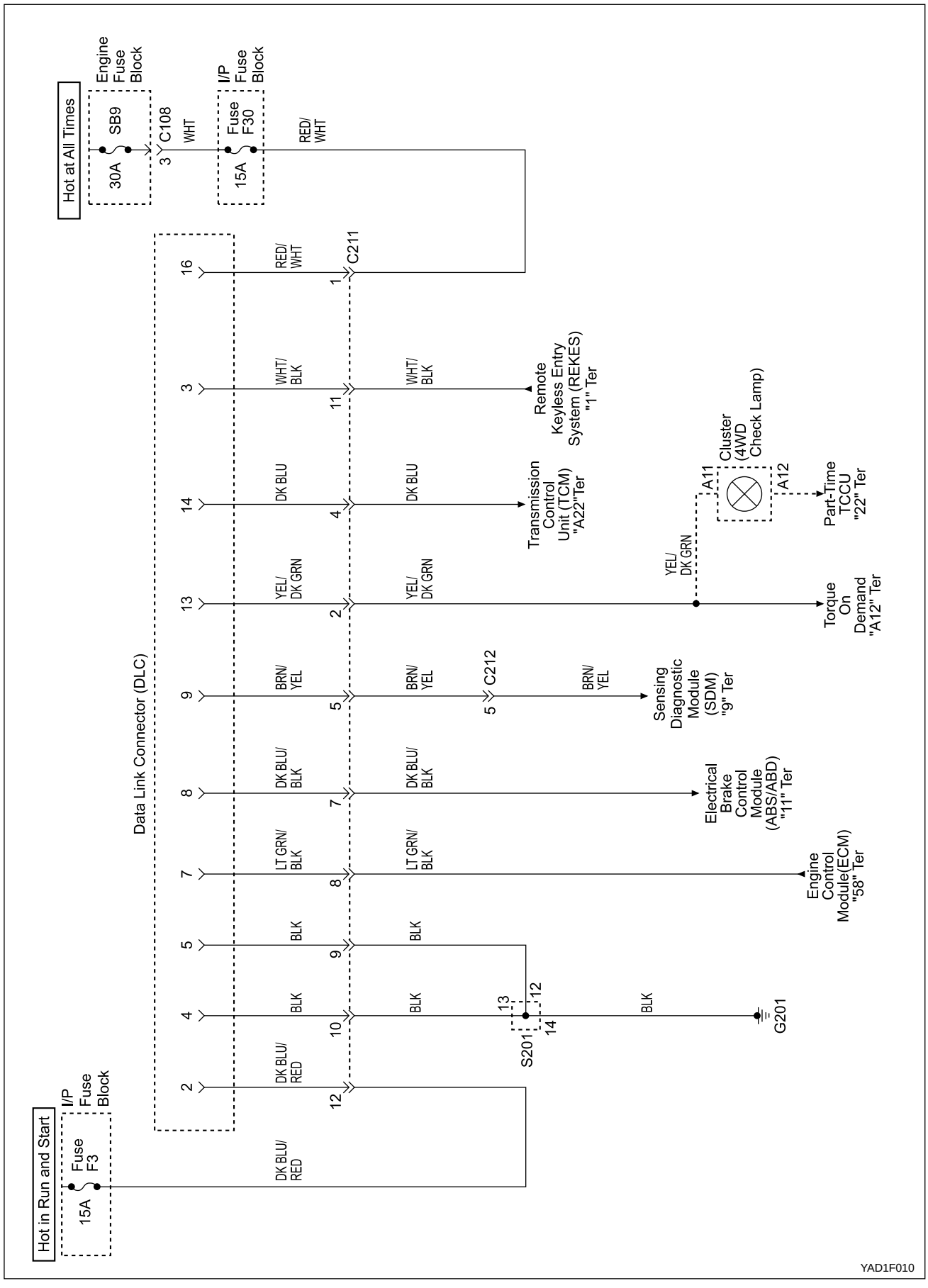
Installation Notice

Tightening Torque	25 N•m (18 lb-ft)

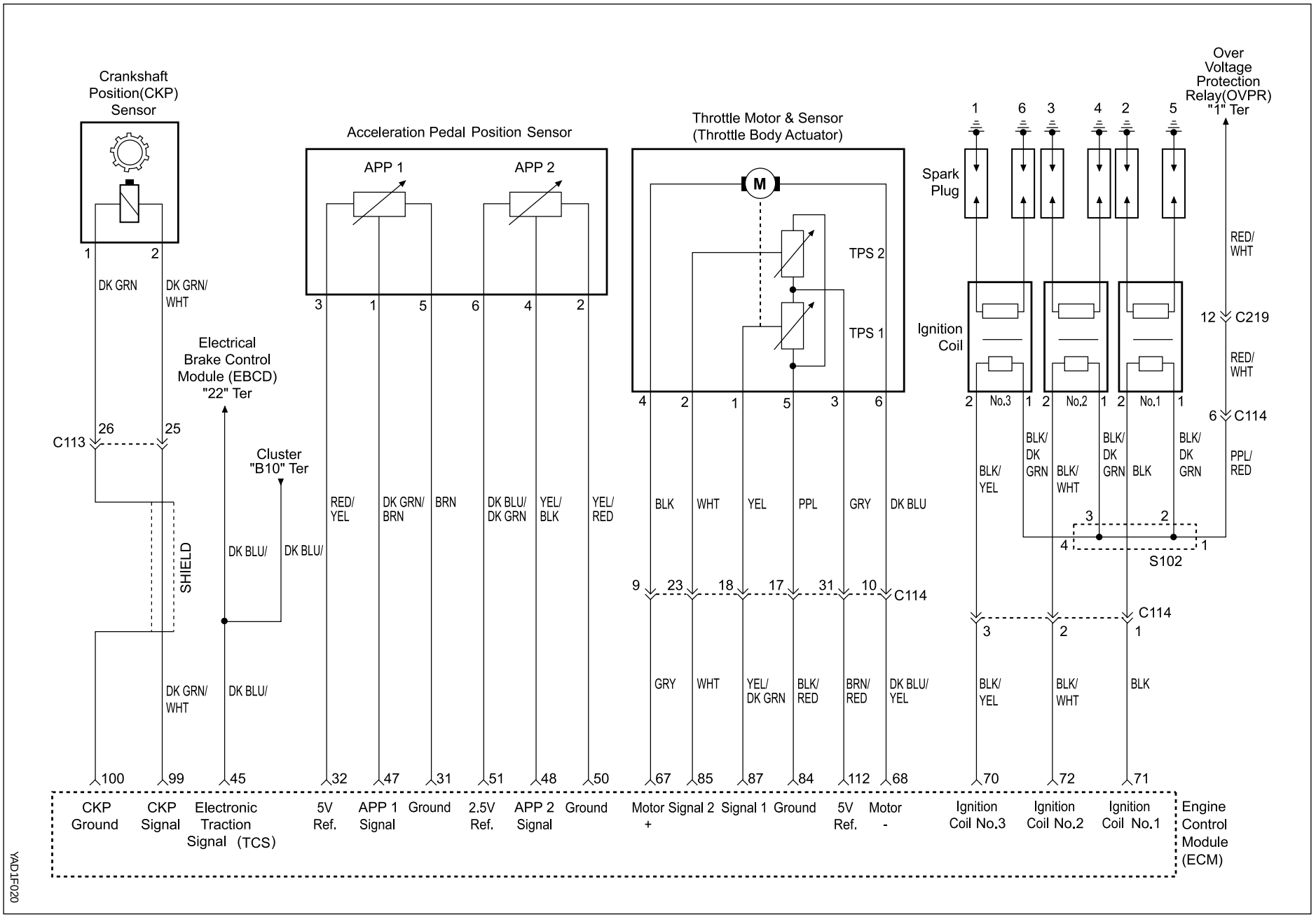
4. Pull out the ECM from the bracket.
5. Disconnect the vehicle side coupling.
6. Installation should follow the removal procedure in the reverse order.

SCHEMATIC AND ROUTING DIAGRAMS

ECM WIRING DIAGRAM (3.2L DOHC - 1 OF 7) (MSE 3.63D)

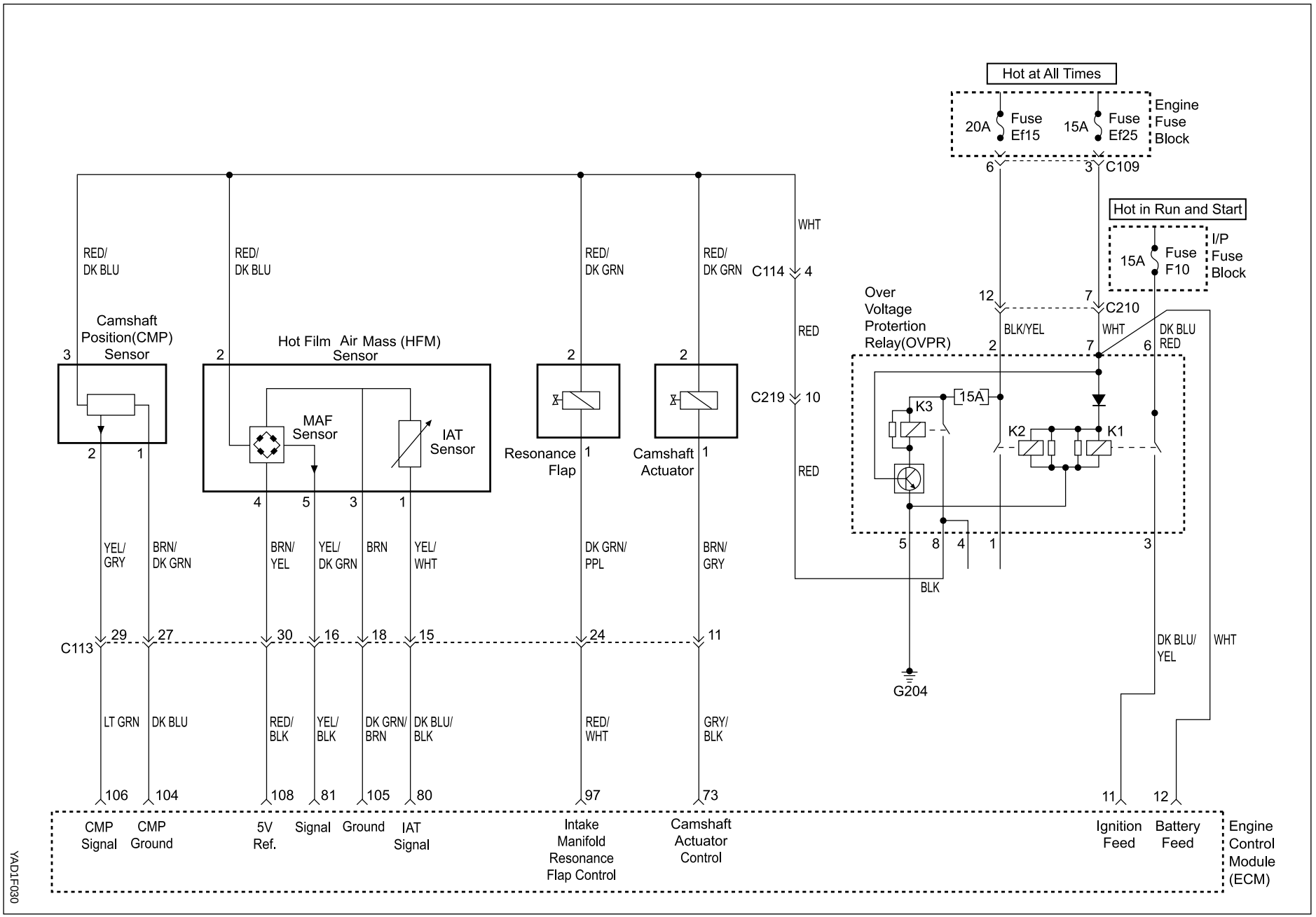


ECM WIRING DIAGRAM (3.2L DOHC - 2 OF 7) (MSE 3.63D)



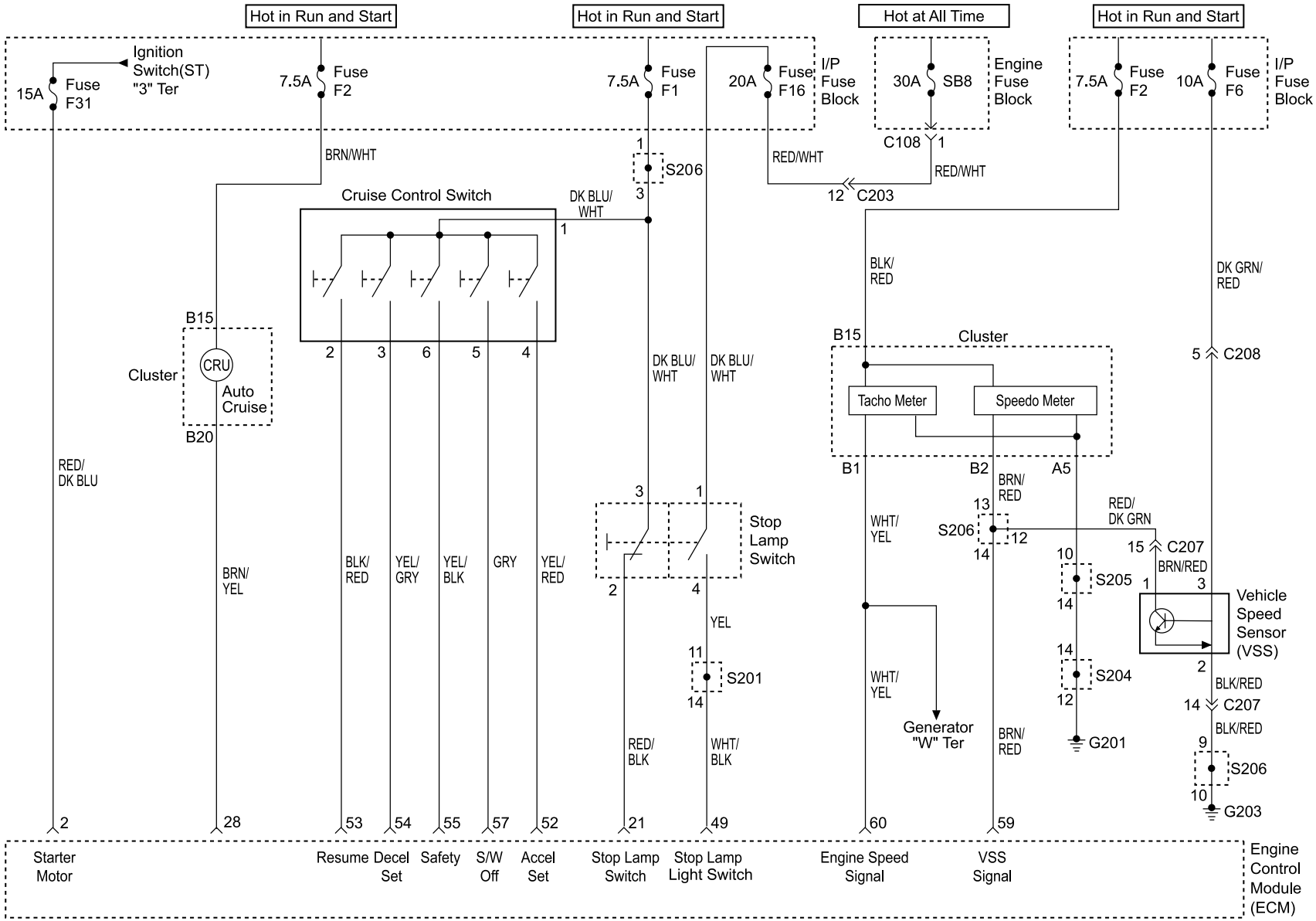
YAD1F020

ECM WIRING DIAGRAM (3.2L DOHC - 3 OF 7) (MSE 3.63D)

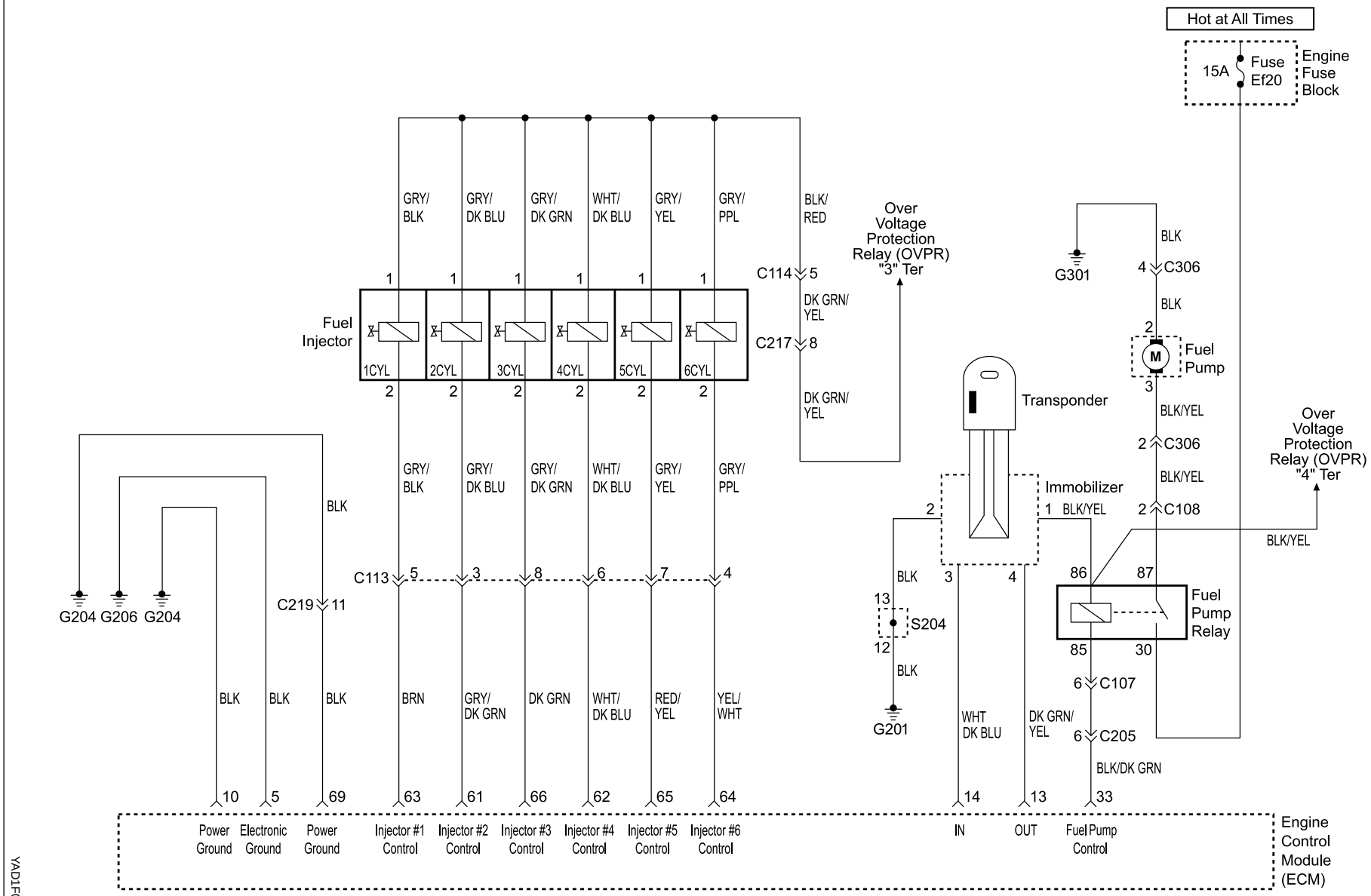


YAD1F030

ECM WIRING DIAGRAM (3.2L DOHC - 4 OF 7) (MSE 3.63D)

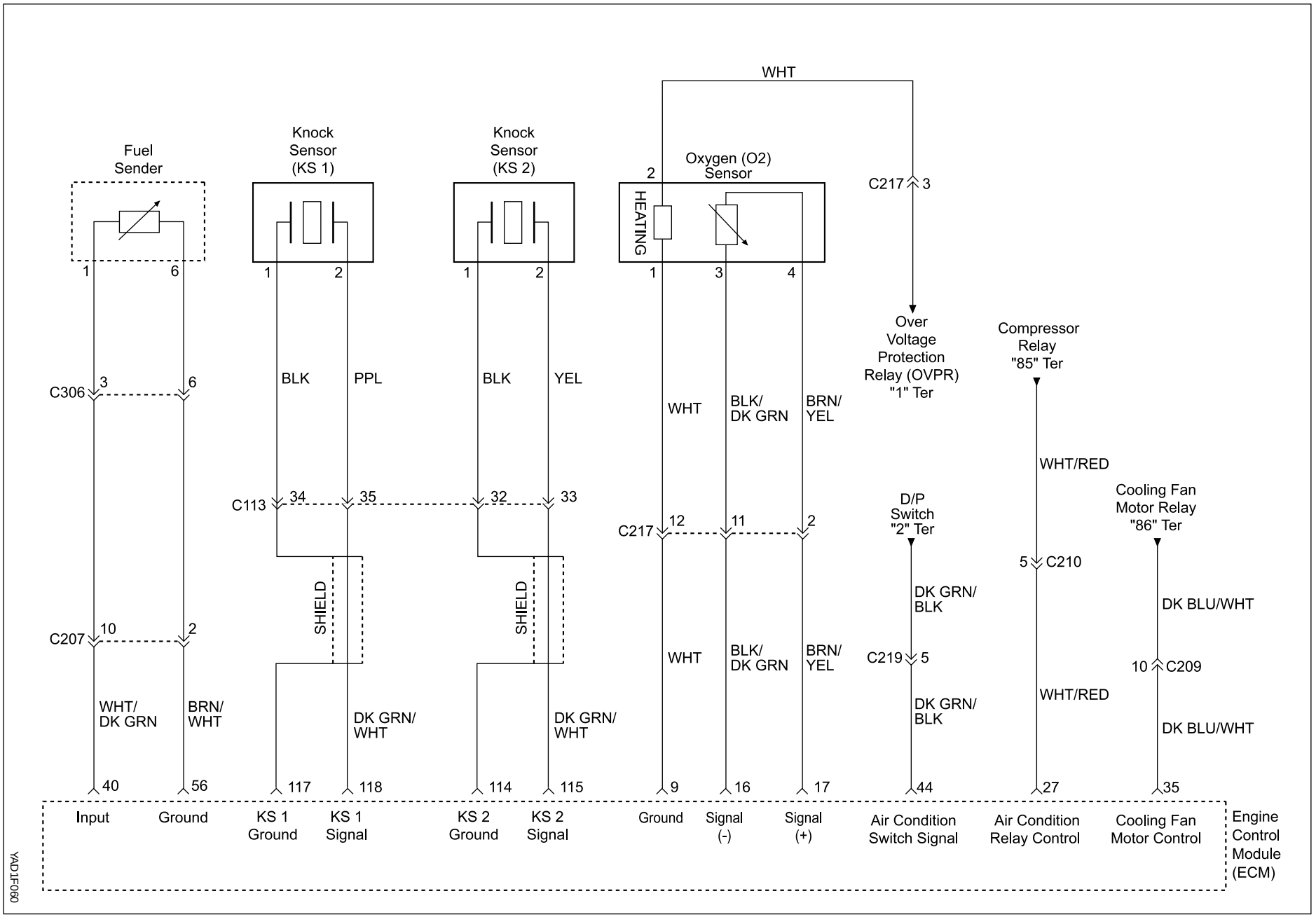


ECM WIRING DIAGRAM (3.2L DOHC - 5 OF 7) (MSE 3.63D)



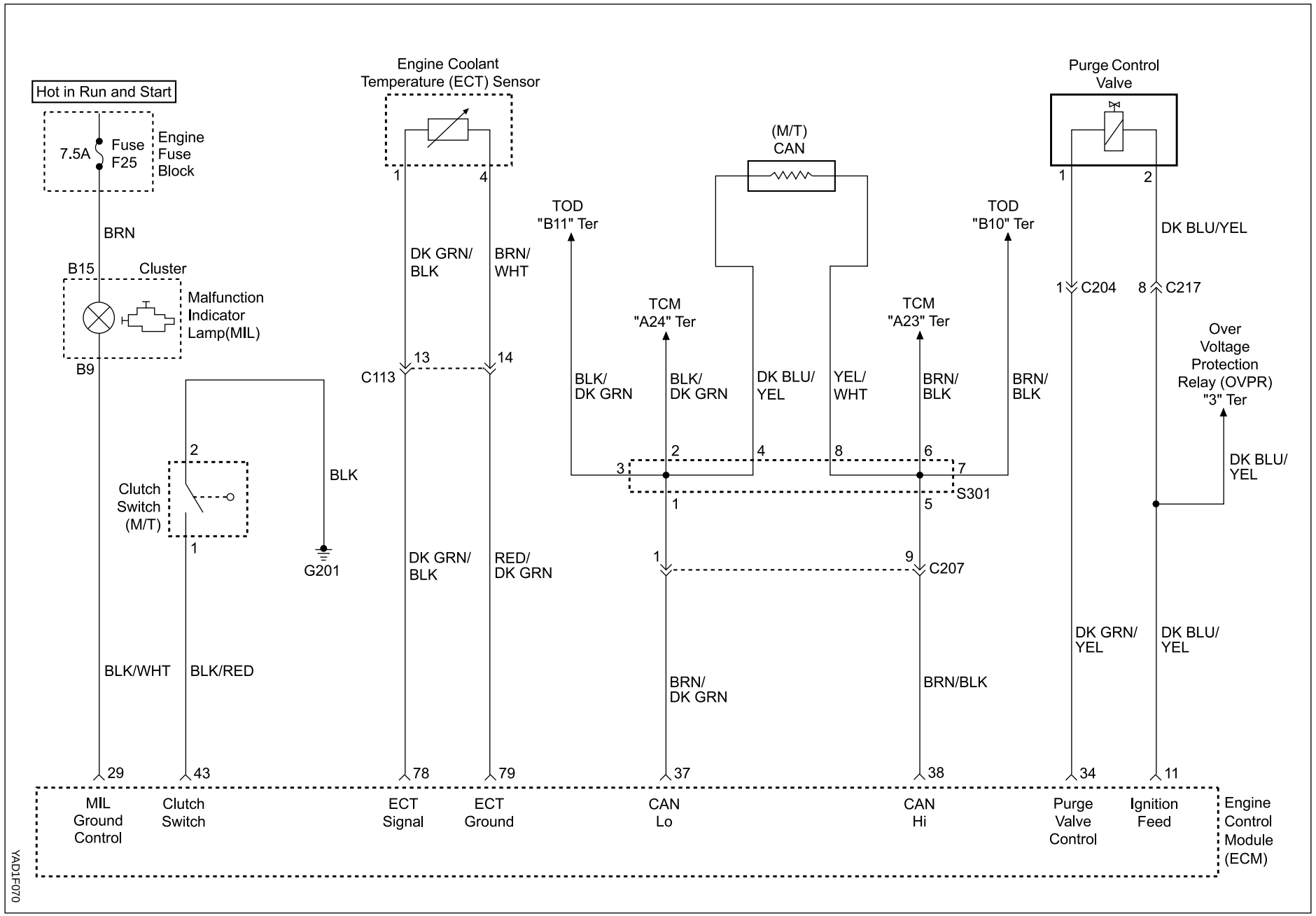
YAD1F050

ECM WIRING DIAGRAM (3.2L DOHC - 6 OF 7) (MSE 3.63D)



YAD1F060

ECM WIRING DIAGRAM (3.2L DOHC - 7 OF 7) (MSE 3.63D)



SPECIFICATIONS

ENGINE DATA DISPLAY TABLE

Parameter	Unit	Value
Engine Coolant Temp.	°C	greater than 95 °C after warm up
Intake Air Temp.	°C	-40 ~ 130 °C (varies with ambient temp. or engine mode)
Engine RPM	rpm	700 ± 50 (P/N), 600 ± 50 (D)
Regular RPM	rpm	700 ± 50 (P/N), 600 ± 50 (D)
Engine Load	%	18 ~ 25 %
Mass Air Flow Meter	Kg/h	16 ~ 25 Kg/h
Throttle Position Angle	°TA	0 °TA (up to 100 °TA at t he wi de open throttle)
Spark Advance	°CA	°CA (6 ~ 9 °CA)
Indicated Engine Torque	Nm	Varies with engine condition
Injection Time	ms	3 ~5 ms
Battery Voltage	V	13.5 ~ 14.1 v (engine running)
Front Axle Speed	Km/h	0 ~ 265 Km/h
Rear Axle Speed	Km/h	0 ~ 265 Km/h
Accel. Pedal Position 1	V	0.4 ~ 4.8 V
Accel. Pedal Position 2	V	0.2 ~ 2.4 V
Throttle Position 1	V	0.3 ~ 4.6 V
Throttle Position 2	V	0.3 ~ 4.6 V
Fuel Integrator		0.8 ~ 1.2
Oxygen Sensor	mv	100 ~ 900 mv
A/C S/W Condition	1=ON/0=OFF	-
Full Load State	1=ON/0=OFF	-
Shift Gear State (A/T)	1=ON/0=OFF	-
A/C Control State	1=ON/0=OFF	-
Clutch Switch (M/T)	1=ON/0=OFF	-
Cam Actuator State	1=ON/0=OFF	-
Knocking Control	1=ON/0=OFF	-
Protect Mission	1=ON/0=OFF	-
Purge Control Valve	1=ON/0=OFF	-
Lambda Function	1=ON/0=OFF	-
Catalyst Heating	1=ON/0=OFF	-
Overrun Fuel Cut	1=ON/0=OFF	-
Ful l Fuel Cut	1=ON/0=OFF	-
Brake Switch	1=ON/0=OFF	-
Cruise Control Status	1=ON/0=OFF	-

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

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Camshaft Position Sensor Retaining Bolts	10	-	89
Canister Mounting Bolts	6	-	53
Coolant Temperature Sensor	30	22	-
Crankshaft Position Sensor Retaining Bolt	10	-	89
Engine Control Module (ECM) Mounting Bracket Nuts	10	-	89
Fuel Filter Mounting Bracket Bolt	6	-	53
Fuel Filter Lines	28	21	-
Fuel Pressure Test Connector	25	18	-
Fuel Rail Assembly Bolts	25	18	-
Fuel Return And Supply Lines	23	17	-
Fuel Tank Retaining Nuts	38	28	-
Intake Air Duct Mounting Bolts	9	-	80
Knock Sensor Mounting Bolt	25	18	-
Oxygen Sensor	55	41	-
Pedal Position Censor Mounting Bolts And Nut	6	-	53
Throttle Body Bolts	12	-	106

FUEL SYSTEM SPECIFICATION

Use Only Unleaded Fuel Rated at 89 Octane or Higher

Fuel quality and additives contained in fuel have a significant effect on power output, drivability, and life of theengine.

Fuel with too low an octane number can cause engine knock.

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

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

Do Not Use Methanol

Fuels containing methanol (wood alcohol) should not be used in vehicle.

This type of fuel can reduce vehicle performance and damage components of the fuel system.

Caution: Use of methanol may damage the fuel system.

Vehicle Fueling from Drums or Storage Containers

For safety reasons (particularly when using noncommercial fueling systems) fuel containers, pumps and hoses must be properly earthed.

Static electricity build up can occur under certain atmospheric and fuel flow conditions if unearthed hoses, par-ticularly plastic, are fitted to the fuel-dispensing pump.

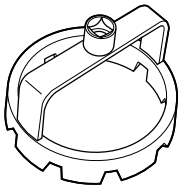
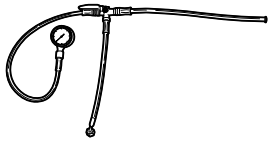
It is therefore recommended that earthed pumps with integrally earthed hoses be used, and that storage containers be properly earthed during all noncommercial fueling operations.

TEMPERATURE VS RESISTANCE

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

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS TABLE

 YAA1F890	**661 589 00 46 00** **Fuel Tank Cap Wrench**
 KAA1F490	**103 589 00 21 00** **Fuel Pressure Gauge**