ENGINE CONTROL SYSTEM

1311-25/1430-01/1490-01/1491-01/1521-26/1712-06/ 2010-01/8510-23/

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ENGINE CONTROL SYSTEM 1521-01

GENERAL

1. ENGINE DATA DISPLAY TABLE

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

1) TEMPERATURE VS RESISTANCE

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

2. FASTENER TIGHTENING SPECIFICATIONS

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

CONFIGURATION AND FUNCTIONS

S.G.N. 1490-01 ENGINE CONTROL MODULE

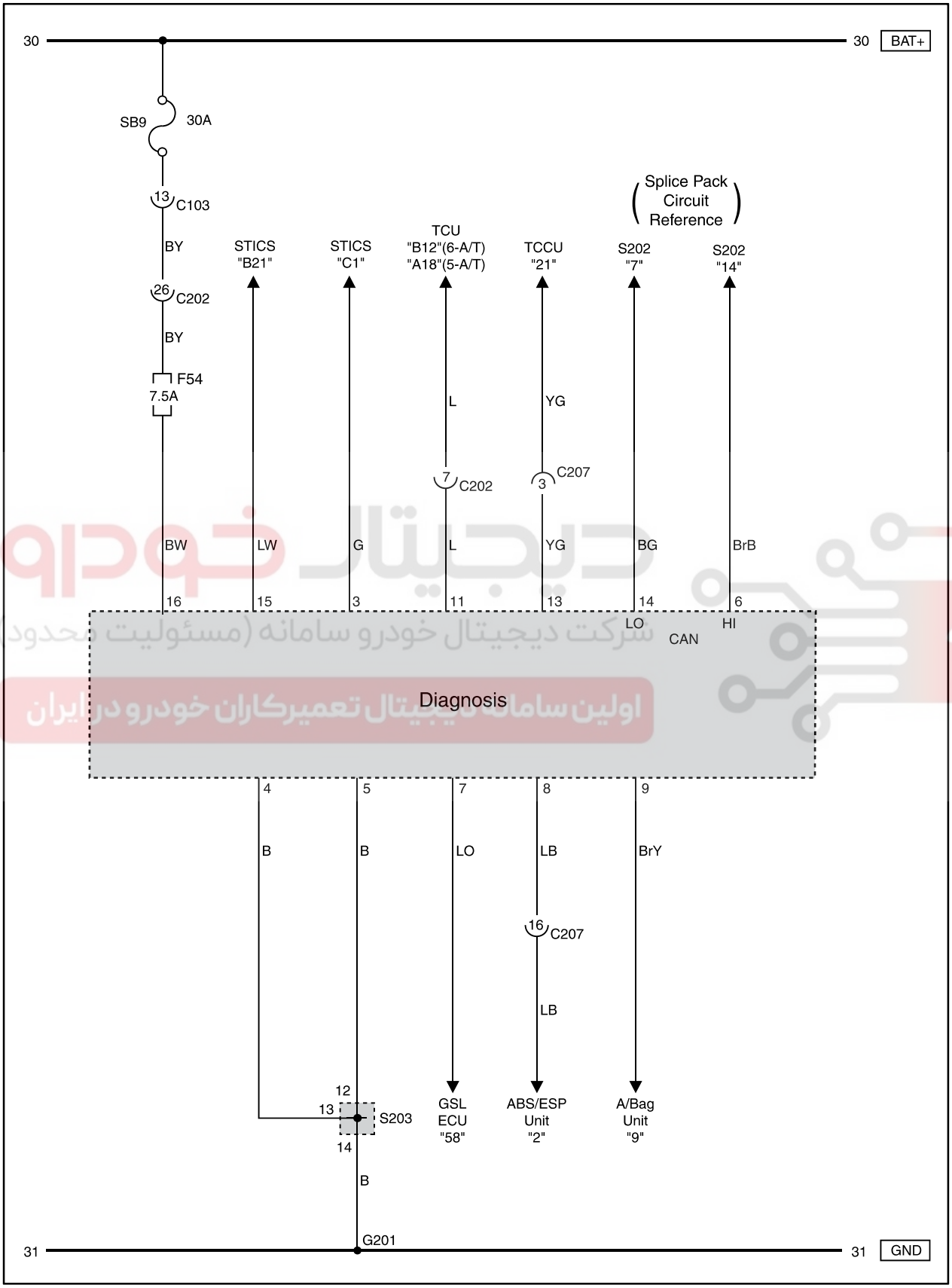
1. FUNCTION

1) Engine Control Module

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, alert the driver through the Malfunction Indicator Lamp (MIL), and store diagnostic trouble 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 resistances 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 an accurate reading because its resistance is too low. You must use a digital voltmeter with a 10 M ohm 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 (3.2L DOHC), the camshaft actuator, fuel tank shut off solenoid, Malfunction Indicator lamp (MIL), or the A/C clutch relay, etc., by controlling the ground circuit through transistors or a device called a "quad-driver".

Modification basis	
Application basis	
Affected VIN	

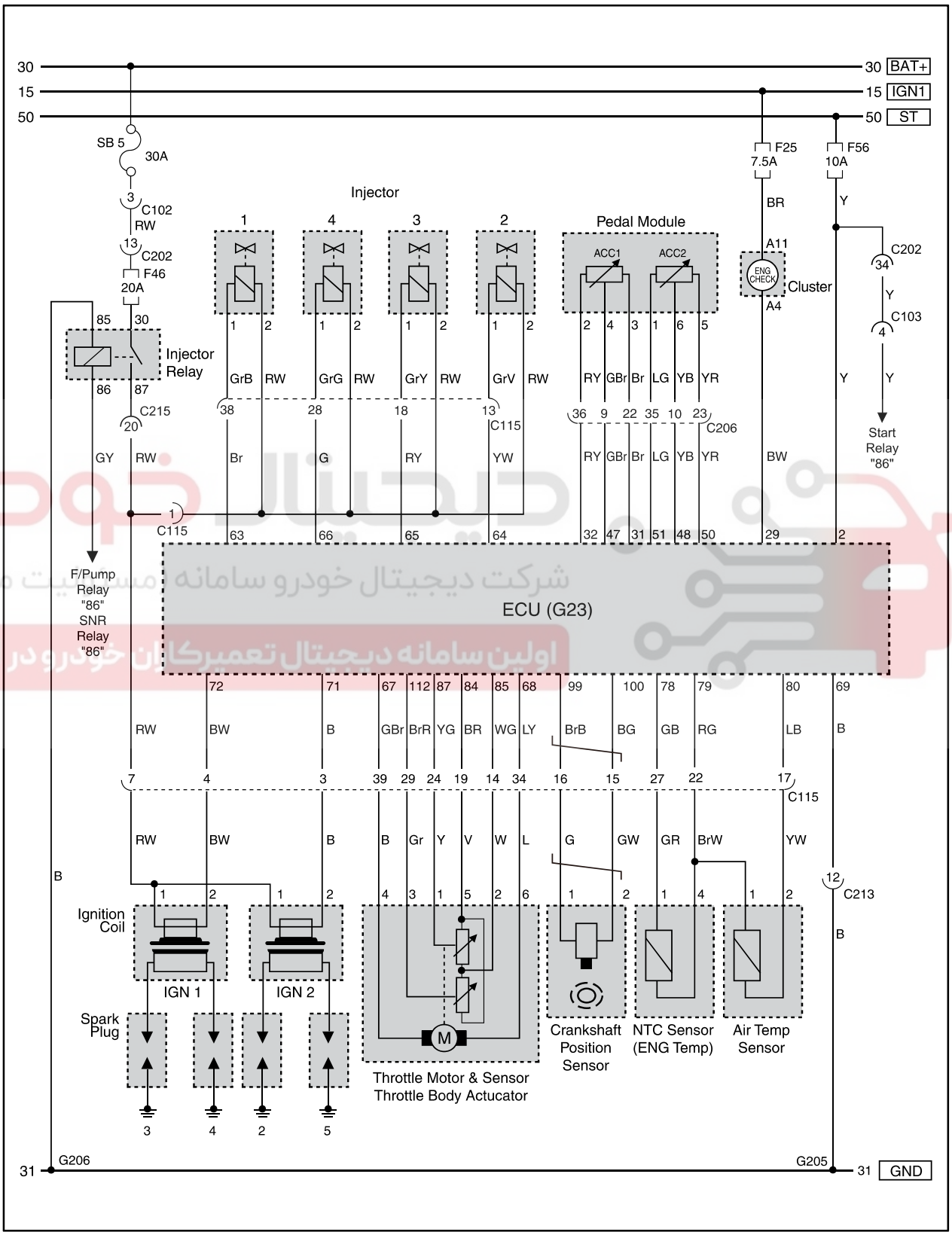
2) Circuit of diagnosis



Modification basis	
Application basis	
Affected VIN	

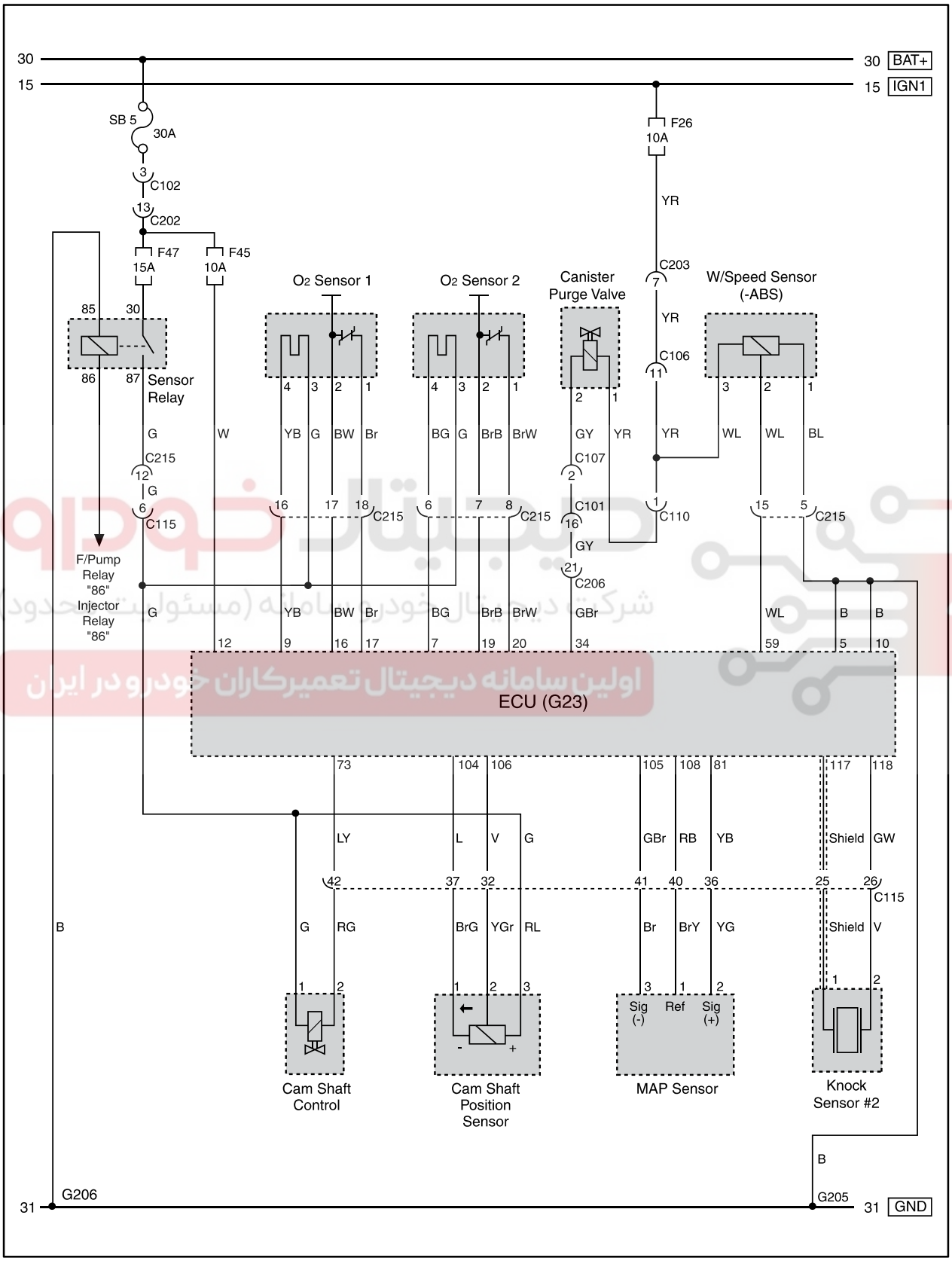
3) Circuit of ECU(GSL/G23D)

(1) IGN COIL, CPS, AIR FLOW SENSOR, THROTTLE SENSOR, TPS



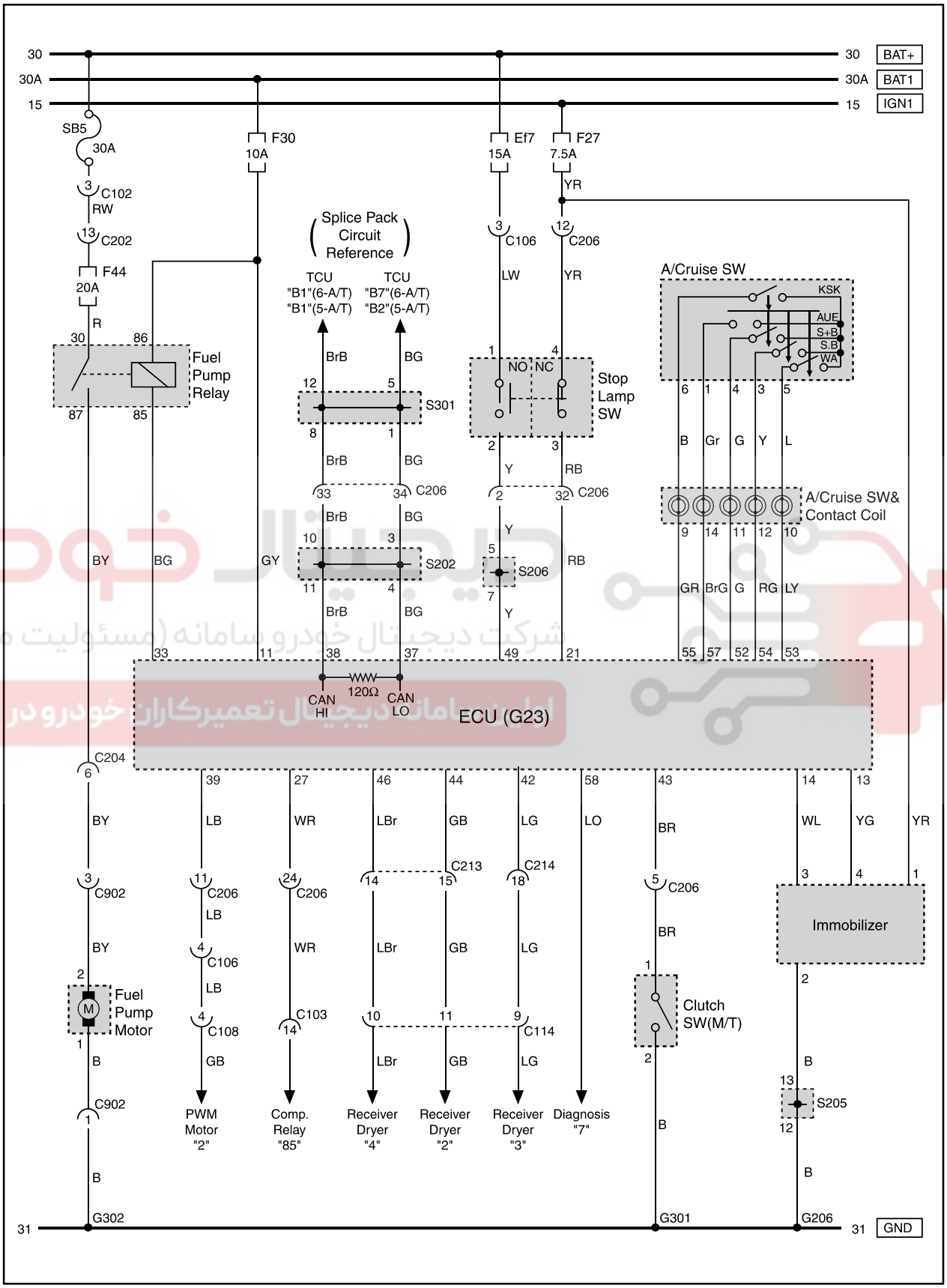
Modification basis	
Application basis	
Affected VIN	

(2) O2 SENSOR, CPS, KNOCK SENSOR, MAP SENSOR, CANISTER PURGE VALVE



Modification basis	
Application basis	
Affected VIN	

(3) STOP LAMP, CRUISE CONTROL SW, FUEL PUMP, IMMOBILIZER

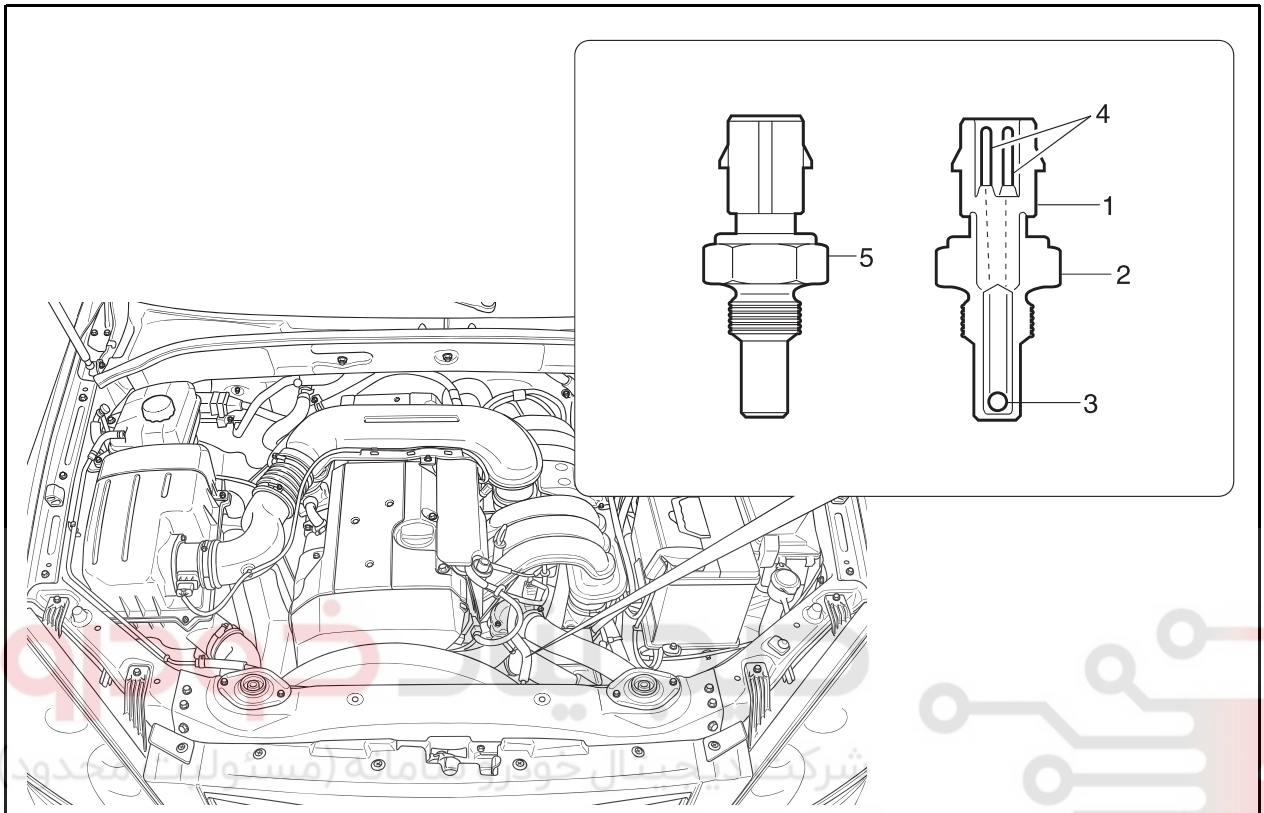


Modification basis	
Application basis	
Affected VIN	

S.G.N. 1521-26

ENGINE COOLANT TEMPERATURE SENSOR

1) Components of engine coolant temperature sensor



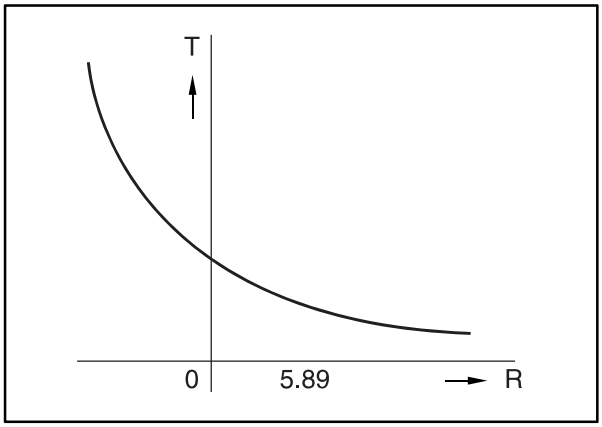
1. Artificial resin housing
2. Metal housing
3. NTC (Negative Tcemperature Coefficient) resistor
4. Connector
5. Engine coolant temperature sensor

Modification basis	
Application basis	
Affected VIN	

2) Description of 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



Te mperature (°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

Modification basis	
Application basis	
Affected VIN	

3) 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 (V)
20	2,500
80	322
100	185

CAUTION
- Replace wiring and coolant temperature sensor if out of specified value

4) Diagnosis of engine coolant temperature sensor

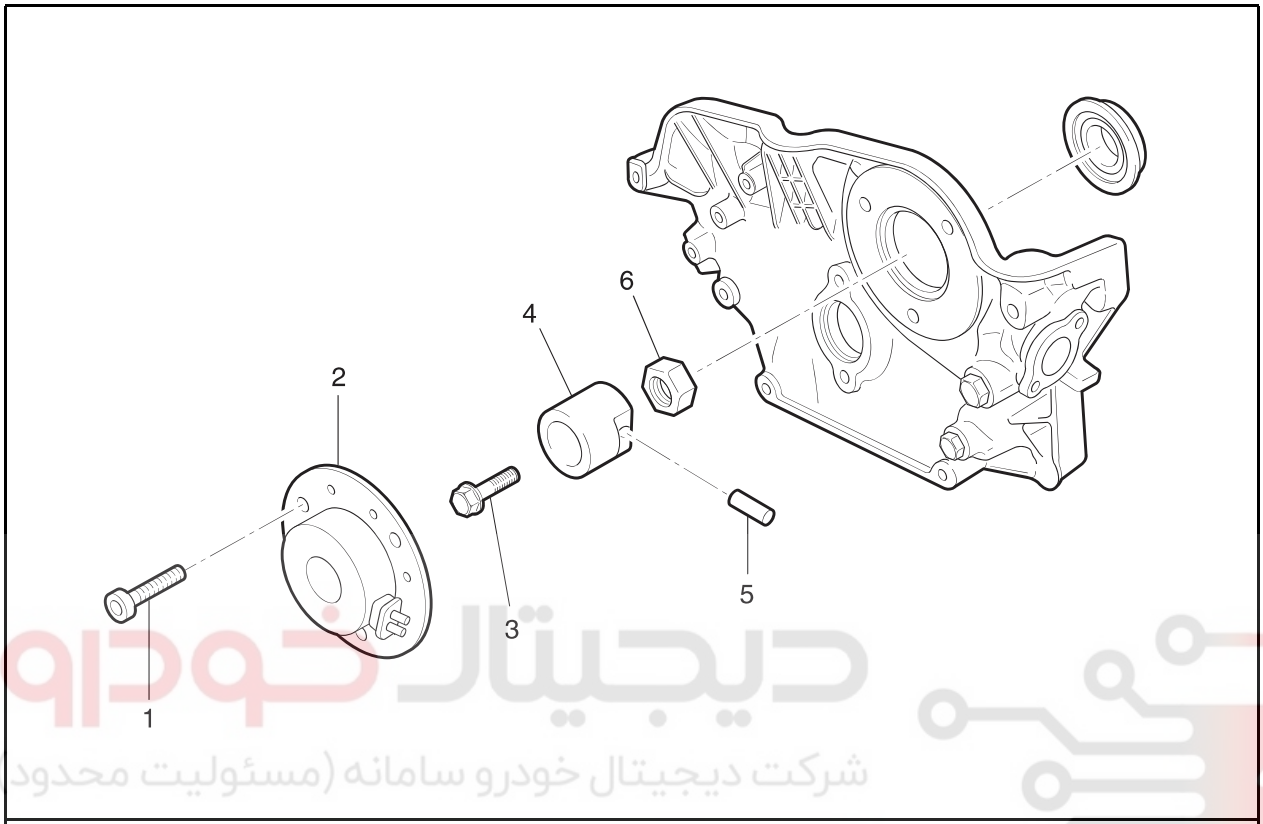
DTC No.	Symptom No.	Description	Trouble Area	Maintenance Hint
P0116	02	Engine coolant temperature sensor plausibility	Malfunction in recognition of ECT When drop to about 50°C below after warm up	• Monitoring the actual coolant temperature through scan tool • Inspection the ECM pin 78, 79 about short circuit or open with bad contact • Inspection the ECT sensor • Inspection the ECM
P0117	00	Engine coolant temperature sensor low voltage	ECT sensor short circuit to ground or open	
P0118	01	Engine coolant temperature sensor high voltage	ECT sensor short circuit to power	
P0125	06	Engine coolant temperature insufficient for closed loop fuel control	Malfunction in recognition of ECT When minimum temperature for lambda control after warm up	

5) 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.

S.G.N.
1311-25 CAMSHAFT ACTUATOR

1) Components of camshaft actuator



1. Bolt
2. Camshaft actuator
3. Bolt
4. Armature
5. Roll pin
6. Nut

Modification basis	
Application basis	
Affected VIN	

2) Description of camshaft actuator

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.

3) 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

4) Diagnosis of camshaft actuator

DTC No.	Symptom No.	Description	Trouble Area	Maintenance Hint
P0010	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		

5) 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

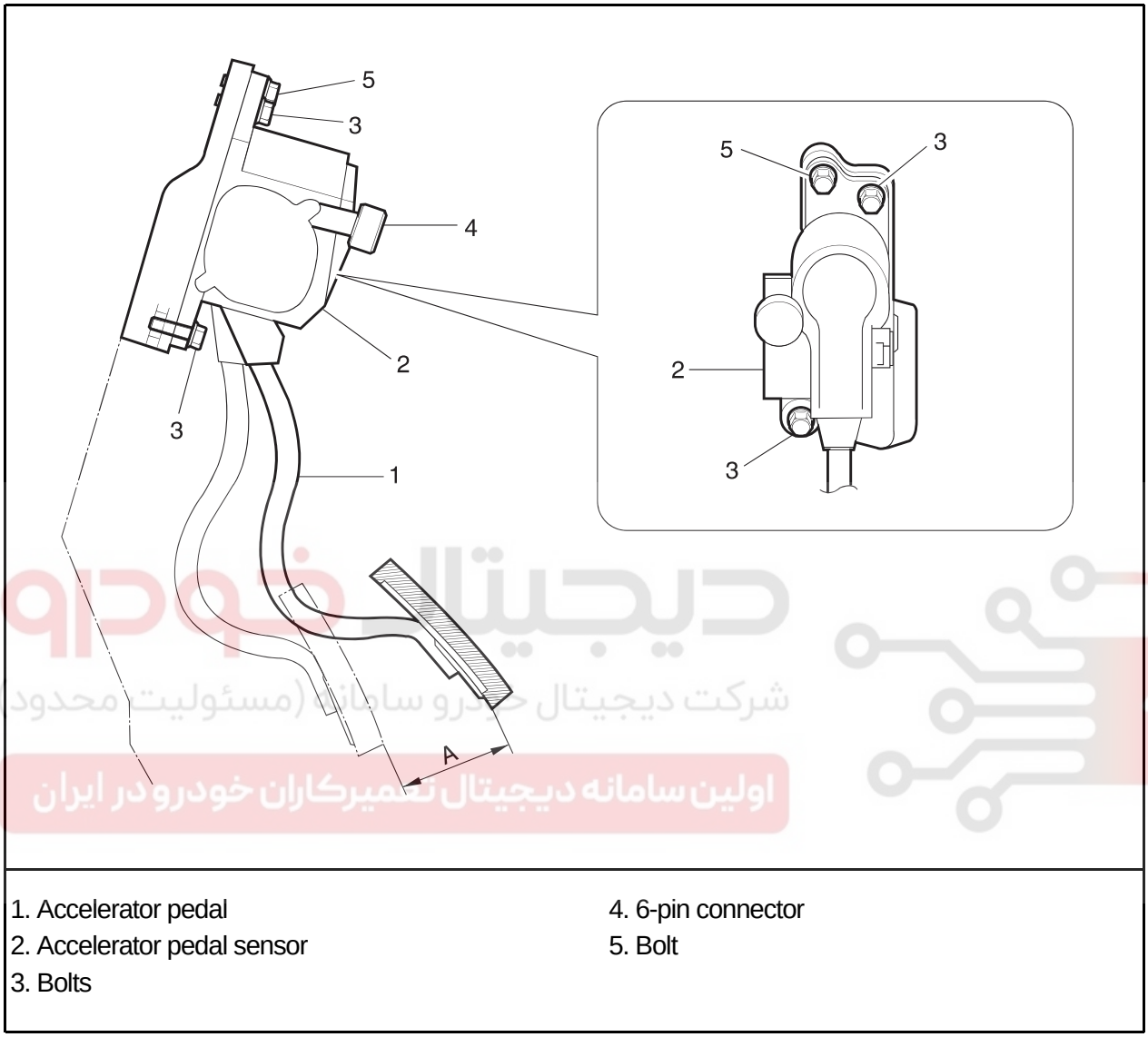
CAUTION

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

S.G.N. 2010-01

ACCELERATOR PEDAL MODULE

1) Components of accelerator pedal module



1. Accelerator pedal
2. Accelerator pedal sensor
3. Bolts
4. 6-pin connector
5. Bolt

Modification basis	
Application basis	
Affected VIN	

2) Description of APP sensor

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.

(1) 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.

(2) 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.

3) Diagnosis of APP module

DTC No.	Symptom No.	Description	Trouble Area	Maintenance Hint
P0220	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	

4) 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).

5) 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

CAUTION

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

6) 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

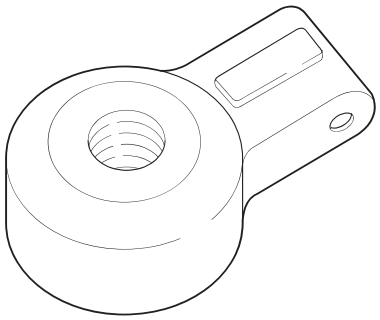
CAUTION

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

S.G.N. 1712-06

KNOCK SENSOR

1) Description of knock sensor



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.

Modification basis	
Application basis	
Affected VIN	

2) Diagnosis of knock sensor

DTC No.	Symptom No.	Description	Trouble Area	Maintenance Hint
P0325	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

3) 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.

4) 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.

Specified value	>10 MΩ

CAUTION

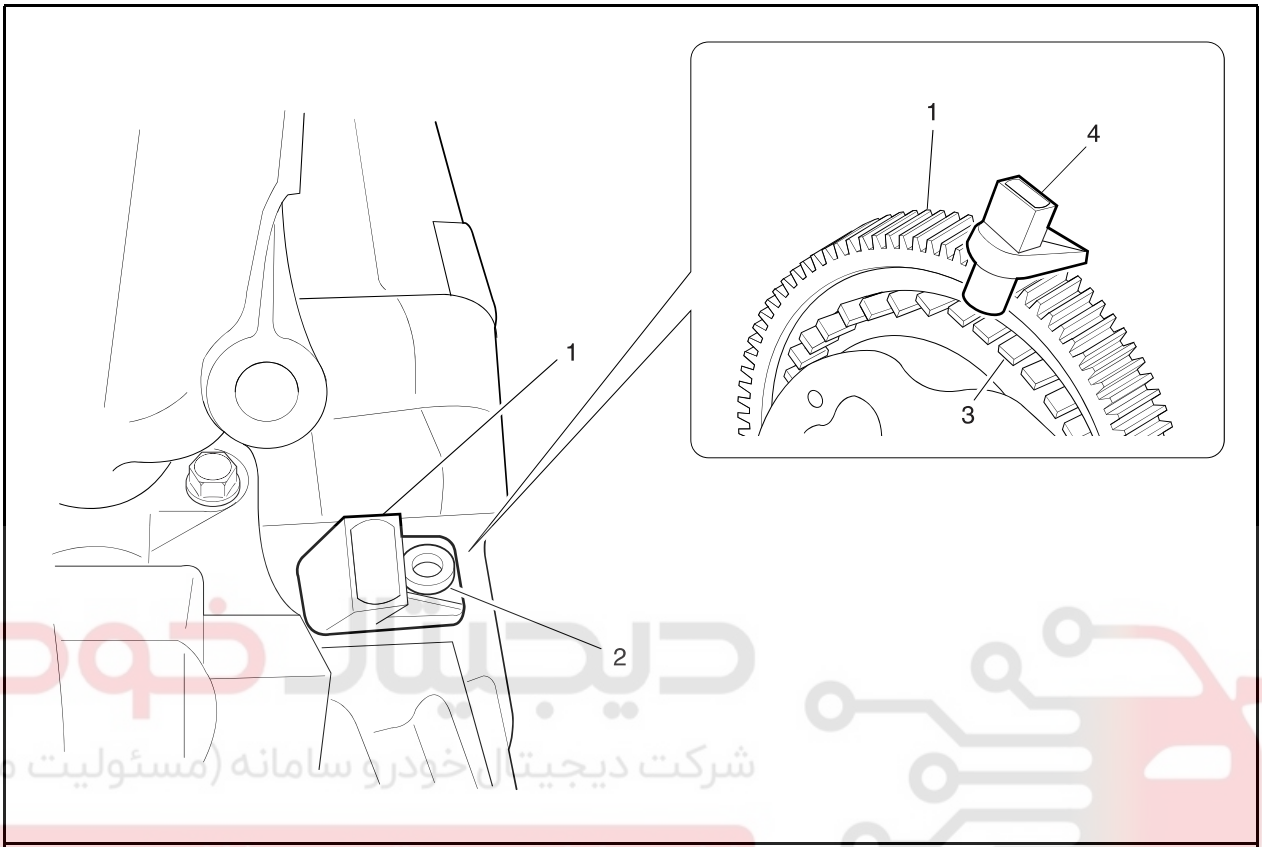
- Replace the KS if the measured values is out of the specified values. Check the connector and wire connection between ECM and the KS if the measured values are normal.

Modification basis	
Application basis	
Affected VIN	

S.G.N. 1430-01

CRANKSHAFT POSITION SENSOR

1) Components of crankshaft position sensor



1. Crankshaft position sensor
2. Bolt
3. Segment
4. Flywheel

2) Description of crankshaft position sensor

This Electronic Ignition (EI) system uses inductive or pick up type magnetic Crankshaft Position (CKP) sensor. The CKP sensor is located in the opposite side of the crankshaft pulley and triggers the pick-up wheel teeth which is equipped 60 - 2 teeth with 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.

3) Diagnosis of crankshaft position sensor

DTC No.	Symptom No.	Description	Trouble Area	Maintenance Hint
P0335	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
	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	
P0336	18	Crankshaft position sensor signal failure (rpm > max. value)	When more than applicable revolution values or implausible to 60-2 teeth scan tool	

4) 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.

5) 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.

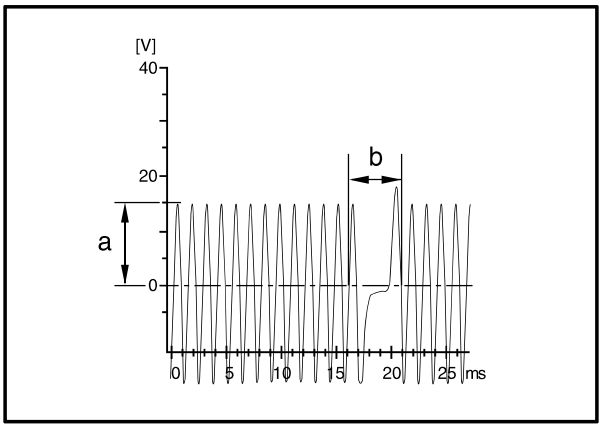
Specified value	1,050 ~ 1,400 Ω

CAUTION

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

Modification basis	
Application basis	
Affected VIN	

6) 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).

CAUTION

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

7) 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

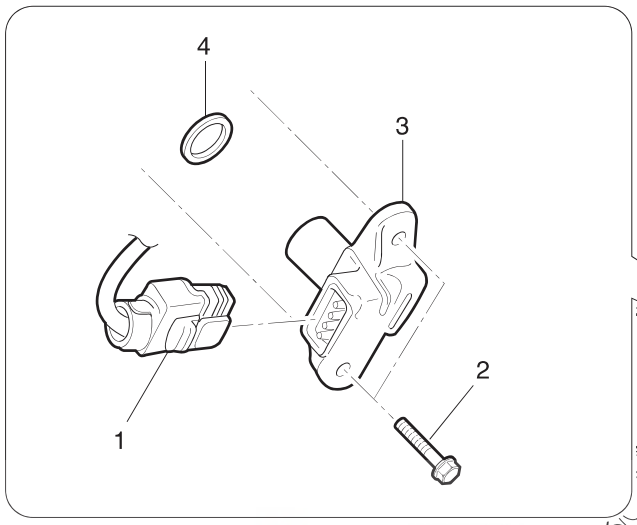
CAUTION

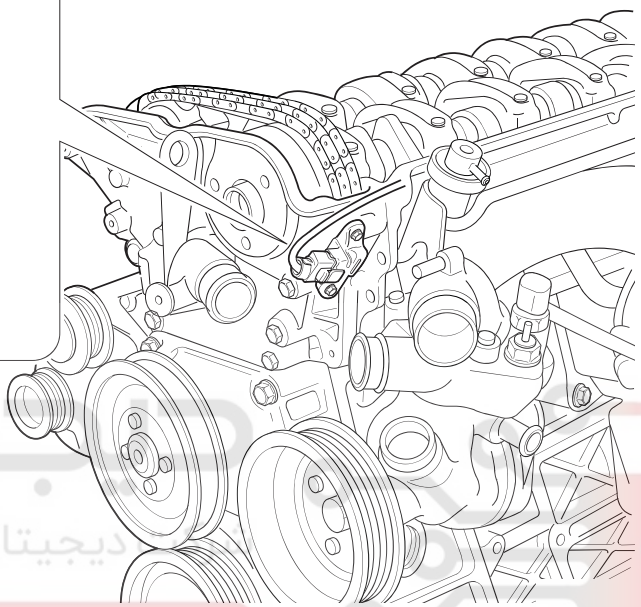
- Measure the check and ground terminal of the CKP sensor if out of the specified value.

S.G.N. 1311-25

CAMSHAFT POSITION SENSOR

1) Components of camshaft position sensor





1. Camshaft position sensor connector
2. Bolt
3. Camshaft position sensor
4. O-ring

Modification basis	
Application basis	
Affected VIN	

2) Description of camshaft position sensor

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.

3) 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.

4) 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.

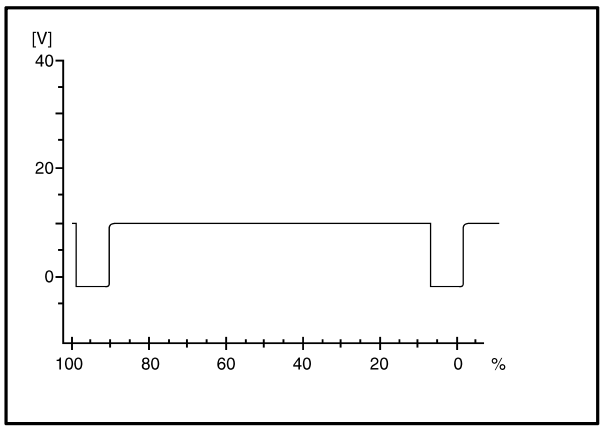
CAUTION

- The signal voltage will be changed in the range of 1.2 ~ 1.7V.

5) Diagnosis of camshaft position sensor

DTC No.	Symptom No.	Description	Tr ouble Area	Maintenance Hint
P0340	58	Camshaft position sensor signal : No. 1 cylinder synchro-nization failure	When synchronization fault of cylinder 1 (TDC recognition)	• 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
P0341	19	Camshaft position sensor signal : No. 1 cylinder recogni-tion failure	When no cam recognition signal during TN 24 counts more. (maintain the constant low or high level)	

6) 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.

CAUTION

- Replace the CAM sensor if cannot get the out-put wave as shown in the figure.

7) 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.

CAUTION

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

Modification basis	
Application basis	
Affected VIN	

S.G.N. 8510-23

CRUISE CONTROL SWITCH

1) Diagnosis of cruise control switch

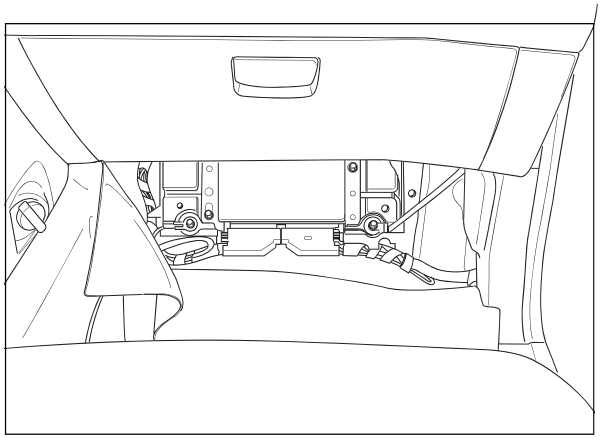
DTC No.		Description	Trouble Area	Maintenance Hint
P0481	32	MOL low short circuit to battery	When short circuit to Ubatt	• Step1. Monitoring the actual rpm through Diagnostic program or Scan Tool • Step2. Inspection the ECU Pin 60 about short circit or open • Step3. Inspection the circuit board of Cluster • Step4. Inspection the ECU
	33	MOL low short to GND	When short circuit to ground or open	
P0500	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
	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	
P0501	130	Vehicle speed signal failure	When malfunction of auto-cruise system Implausible condition of vehicle speed signal.	
	131	Vehicle speed signal failure		
P0564	132	Cruise control lever failure	Cruise control lever defective	

2) 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 50 km/h to engage cruise control.

REMOVAL AND INSTALLATION

S.G.N.
1490-01 ENGINE CONTROL MODULE



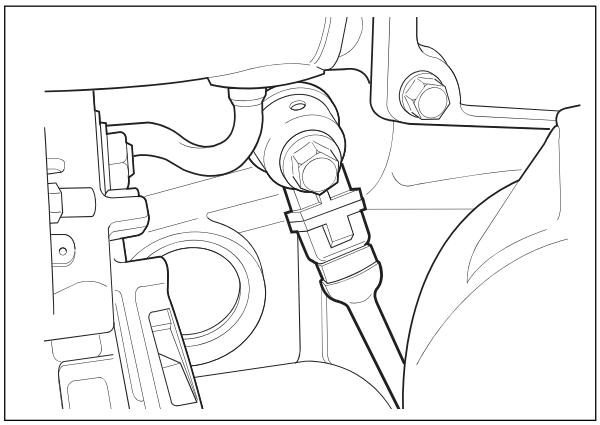
1. Disconnect the negative battery cable.
2. Remove the cowl side trim form passenger side.
   Remove the four securing nuts for the Engine
3. Control Module (ECM) from the mounting bracket.

   Tightening torque **25 Nm (18 lb–ft)**

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

Modification basis	
Application basis	
Affected VIN	

S.G.N.
1712-06 KNOCK SENSOR



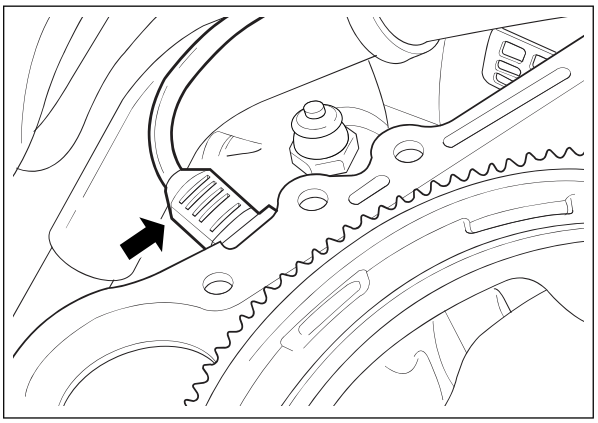
1. Disconnect the negative battery cable.
2. Disconnect the knock sensor electrical connector from the intake manifold bracket.
3. Remove the knock sensor mounting bolt from the knock sensor installed on the cylinder block.

Tightening torque 25 Nm (18 lb–ft)

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

Modification basis	
Application basis	
Affected VIN	

S.G.N.
1430-01 CRANKSHAFT POSITION SENSOR



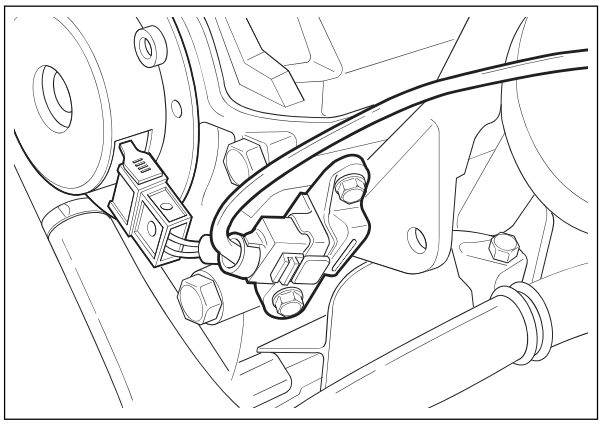
1. Disconnect the negative battery cable.
2. Disconnect the electrical connector at the crankshaft position sensor.
3. Remove the crankshaft position sensor retaining bolt.

   Tightening torque **25 Nm (18 lb–ft)**

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

Modification basis	
Application basis	
Affected VIN	

S.G.N.
1311-25 CAMSHAFT POSITION SENSOR



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

   Tightening torque **10 Nm (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.

S.G.N. 1490-01

STRATEGY-BASED DIAGNOSTICS

1) Description of Diagnostics

(1) Strategy-Based Diagnostics

The strategy-based diagnostic is a uniform approach to repair all Electrical/Electronic (E/E) systems. The diagnostic flow can always be used to resolve an E/E system problem and is a starting point when repairs are necessary. The following steps will instruct the technician on how to proceed with a diagnosis:

- Verify the customer complaint. To verify the customer complaint, the technician should know the normal operation of the system.
- Perform preliminary checks as follows:
  - Conduct a thorough visual inspection.
  - Review the service history.
  - Detect unusual sounds or odors.
  - Gather Diagnostic Trouble Code (DTC) information to achieve an effective repair.
- Check bulletins and other service information. This includes videos, newsletters, etc.
- Refer to service information (manual) system check(s).
- Refer to service diagnostics.

(2) No Trouble Found

This condition exists when the vehicle is found to operate normally. The condition described by the customer may be normal. Verify the customer complaint against another vehicle that is operating normally. The condition may be intermittent. Verify the complaint under the conditions described by the customer before releasing the vehicle.

(3) Re-examine the complaint.

When the complaint cannot be successfully found or isolated, a re-evaluation is necessary. The complaint should be reverified and could be intermittent as defined in "Intermittents", or could be normal. After isolating the cause, the repairs should be made. Validate for proper operation and verify that the symptom has been corrected. This may involve road testing or other methods to verify that the complaint has been resolved under the following conditions:

- Conditions noted by the customer.
- If a DTC was diagnosed, verify a repair by duplicating conditions present when the DTC was set as noted in the Failure Records or Freeze Frame data.

Modification basis	
Application basis	
Affected VIN	

(4) Verifying Vehicle Repair

Verification of the vehicle repair will be more comprehensive for vehicles with Euro On-Board Diagnostic (EOBD) system diagnostics. Following a repair, the technician should perform the following steps: Important: Follow the steps below when you verify repairs on EOBD systems. Failure to follow these steps could result in unnecessary repairs. Review and record the Failure Records and the Freeze Frame data for the DTC which has been diagnosed (Freeze Fame data will only be stored for an A or B type diagnostic and only if the Malfunction Indicator Lamp has been requested).

- Clear the DTC(s).
- Operate the vehicle within conditions noted in the Failure Records and Freeze Frame data.
- Monitor the DTC status information for the specific DTC which has been diagnosed until the diagnostic test associated with that DTC runs.

(5) EOBD SERVICEABILITY ISSUES

Based on the knowledge gained from Euro On-Board Diagnostic (EOBD) experience in the 2001 model years, this list of nonvehicle faults that could affect the performance of the EOBD system has been compiled. These nonvehicle faults vary from environmental conditions to the quality of fuel used. With the introduction of EOBD across the entire passenger car and light-duty truck market in 2000, illumination of the Malfunction Indicator Lamp\ (MIL) due to a nonvehicle fault could lead to misdiagnosis of the vehicle, increased warranty expense and customer dissatisfaction. The following list of nonvehicle faults does not include every possible fault and may not apply equally to all product lines.

(6) Fuel Quality

Fuel quality is not a new issue for the automotive industry, but its potential for turning ON the MIL with EOBD systems is new. Fuel additives such as "dry gas" and "octane enhancers" may affect the performance of the fuel. If this results in an incomplete combustion or a partial burn, it will set Diagnostic Trouble Code (DTC) P0300. The Reid Vapor Pressure of the fuel can also create problems in the fuel system, especially during the spring and fall months when severe ambient temperature swings occur. A high Reid Vapor Pressure could show up as a Fuel Trim DTC due to excessive canister loading. High vapor pressures generated in the fuel tank can also affect the Evaporative Emission diagnostic. Using fuel with the wrong octane rating for your vehicle may cause driveability problems. Many of the major fuel companies advertise that using "premium" gasoline will improve the performance of your vehicle. Most premium fuels use alcohol to increase the octane rating of the fuel. Although alcohol-enhanced fuels may raise the octane rating, the fuel's ability to turn into vapor in cold temperatures deteriorates. This may affect the starting ability and cold driveability of the engine. Low fuel levels can lead to fuel starvation, lean engine operation, and eventually engine misfire.

(7) Non-OEM Parts

The EOBD system has been calibrated to run with Original Equipment Manufacturer (OEM) parts. Aftermarket electronics, such as cellular phones, stereos, and antitheft devices, may radiate Electromagnetic Interference (EMI) into the control system if they are improperly installed. This may cause a false sensor reading and turn ON the MIL.

(8) Environment

Temporary environmental conditions, such as localized flooding, will have an effect on the vehicle ignition system. If the ignition system is rainsoaked, it can temporarily cause engine misfire and turn ON the MIL.

(9) Vehicle Marshaling

The transportation of new vehicles from the assembly plant to the dealership can involve as many as 60 key cycles within 2 to 3 miles of driving. This type of operation contributes to the fuel fouling of the spark plugs and will turn ON the MIL with a set DTC P0300.

(10) Poor Vehicle Maintenance

The sensitivity of the EOBD will cause the MIL to turn ON if the vehicle is not maintained properly. Restricted air filters, fuel filters, and crankcase deposits due to lack of oil changes or improper oil viscosity can trigger actual vehicle faults that were not previously monitored prior to EOBD. Poor vehicle maintenance can not be classified as a "nonvehicle fault," but with the sensitivity of the EOBD, vehicle maintenance schedules must be more closely followed.

(11) Severe Vibration

The Misfire diagnostic measures small changes in the rotational speed of the crankshaft. Severe driveline vibrations in the vehicle, such as caused by an excessive amount of mud on the wheels, can have the same effect on crankshaft speed as misfire and, therefore, may set DTC P0300.

(12) Related System Faults

Many of the EOBD system diagnostics will not run if the Engine Control Module (ECM) detects a fault on a related system or component. One example would be that if the ECM detected a misfire fault, the diagnostics on the catalytic converter would be suspended until the misfire fault was repaired. If the misfire fault is severe enough, the catalytic converter can be damaged due to overheating and will never set a Catalyst DTC until the misfire fault is repaired and the Catalyst diagnostic is allowed to run to completion. If this happens, the customer may have to make two trips to the dealership in order to repair the vehicle.

Modification basis	
Application basis	
Affected VIN	

2) Euro On-Board Diagnostic

(1) On-Board Diagnostic Tests

A diagnostic test is a series of steps, the result of which is a pass or fail reported to the diagnostic executive. When a diagnostic test reports a pass result, the diagnostic executive records the following data:

- The diagnostic test has been completed since the last ignition cycle.
- The diagnostic test has passed during the current ignition cycle.
- The fault identified by the diagnostic test is not currently active.

When a diagnostic test reports a fail result, the diagnostic executive records the following data:

- The diagnostic test has been completed since the last ignition cycle.
- The fault identified by the diagnostic test is currently active.
- The fault has been active during this ignition cycle
- The operating conditions at the time of the failure.

Remember, a fuel trim Diagnostic Trouble Code (DTC) may be triggered by a list of vehicle faults. Make use of all information available (other DTCs stored, rich or lean condition, etc.) when diagnosing a fuel trim fault.

Modification basis	
Application basis	
Affected VIN	

3) Comprehensive Component Monitor Diagnostic Operation

Comprehensive component monitoring diagnostics are required to monitor emissionsrelated input and output powertrain components.

(1) Input Components

Input components are monitored for circuit continuity and out-of-range values. This includes rationality checking. Rationality checking refers to indicating a fault when the signal from a sensor does not seem reasonable, i.e. Throttle Position (TP) sensor that indicates high throttle position at low engine loads or Mass Air Flow (MAF) voltage. Input components may include, but are not limited to, the following sensors:

- Vehicle Speed Sensor (VSS).
- Crankshaft Position (CKP) sensor.
- Throttle Position (TP) sensor.
- Engine Coolant Temperature (ECT) sensor.
- Camshaft Position (CMP) sensor.
- Mass Air Flow (MAF) sensor or Manifold Absolute Pressure (MAP) sensor.

In addition to the circuit continuity and rationality check, the ECT sensor is monitored for its ability to achieve a steady state temperature to enable closed loop fuel control.

(2) Output Components

Output components are diagnosed for proper response to control module commands. Components where functional monitoring is not feasible will be monitored for circuit continuity and out-of-range values if applicable. Output components to be monitored include, but are not limited to the following circuit:

- Control module controlled Evaporative Emission (EVAP) Canister Purge Valve.
- A/C relays.
- Cooling fan relay.
- Malfunction Indicator Lamp (MIL) con

Refer to "Engine Control Module" and the sections on Sensors in General Descriptions.

(3) Passive and Active Diagnostic Tests

A passive test is a diagnostic test which simply monitors a vehicle system or component. Conversely, an active test, actually takes some sort of action when performing diagnostic functions, often in response to a failed passive test.

Modification basis	
Application basis	
Affected VIN	

(4) Intrusive Diagnostic Tests

This is any on-board test run by the Diagnostic Management System which may have an effect on vehicle performance or emission levels.

(5) Warm-Up Cycle

A warm-up cycle means that engine at temperature must reach a minimum of 70 °C (160 °F) and rise at least 22 °C (40 °F) over the course of a trip.

(6) Freeze Frame

Freeze Frame is an element of the Diagnostic Management System which stores various vehicle information at the moment an emissions-related fault is stored in memory and when the MIL is commanded ON. These data can help to identify the cause of a falut

(7) Failure Records

Failure Records data is an enhancement of the EOBD Freeze Frame feature. Failure Records store the same vehicle information as does Freeze Frame, but it will store that information for any fault which is stored in on-board memory, while Freeze Frame stores information only for emission-related faults that command the MIL ON.

4) Common EOBD Terms

(1) Diagnostic

When used as a noun, the word diagnostic refers to any on-board test run by the vehicle's Diagnostic Management System. A diagnostic is simply a test run on a system or component to determine if the system or component is operating according to specification. There are many diagnostics, shown in the following list:

- Misfire.
- Oxygen sensors (O2S)
- Fuel Trim
- Evaporative Emission
- Catalyst monitoring

(2) Enable Criteria

The term "enable criteria" is engineering language for the conditions necessary for a given diagnostic test to run. Each diagnostic has a specific list of conditions which must be met before the diagnostic will run. "Enable criteria" is another way of saying "conditions required." The enable criteria for each diagnostic is listed on the first page of the Diagnostic Trouble Code (DTC) description under the heading "Conditions for Setting the DTC." Enable criteria varies with each diagnostic and typically includes, but is not limited to the following items:

- Engine speed.
- Vehicle speed
- Engine Coolant Temperature (ECT)
- Mass Air Flow (MAF) or Manifold Absolute Pressure (MAP)
- Intake Air Temperature (IAT)
- Throttle Position (TP)
- Canister Purge Valve Status
- Fuel trim
- A/C ON

Modification basis	
Application basis	
Affected VIN	

(3) Trip

Technically, a trip is a key-on run key-off cycle in which all the enable criteria for a given diagnostic are met, allowing the diagnostic to run. Unfortunately, this concept is not quite that simple. A trip is official when all the enable criteria for a given diagnostic are met. But because the enable criteria vary from one diagnostic to another, the definition of trip varies as well. Some diagnostics are run when the vehicle is at operating temperature, some wmple. A trip is official when all the enable criteria for a given diagnostic are met. But because the enable criteria vary from one diagnostic to another, the definition of trip varies as well. Some diagnostics are run when the vehicle is at operating temperature, some when the vehicle first starts up; some require that the vehicle cruise at a steady highway speed, some run only when the vehicle is at idle. Some run only immediately following a cold engine startup. A trip then, is defined as a key-on run-key off cycle in which the vehicle is operated in such a way as to satisfy the enable criteria for a given diagnostic, and this diagnostic will consider this cycle to be one trip. However, another diagnostic with a different set of enable criteria (which were not met) during this driving event, would not consider it a trip. No trip will occur for that particular diagnostic until the vehicle is driven in such a way as to meet all the enable criteria.

The diagnostic charts and functional checks are designed to locate a faulty circuit or component through a process of logical decisions. The charts are prepared with the requirement that the vehicle functioned correctly at the time of assembly and that there are not multiple faults present. There is a continuous selfdiagnosis on certain control functions. This diagnostic capability is complimented by the diagnostic procedures contained in this manual. The language of communicating the source of the malfunction is a system of diagnostic trouble codes. When a malfunction is detected by the control module, a DTC is set, and the Malfunction Indicator Lamp (MIL) is illuminated.

(5) Malfunction Indicator Lamp (MIL)

Basically, the MIL is turned ON when the Engine Control Module (ECM) detects a DTC that will impact the vehicle emissions. The MIL is under the control of the Diagnostic Executive. The MIL will be turned ON if an emissions-related diagnostic test indicates a malfunction has occurred. It will stay ON until the system or component passes the same test for three consecutive trips with no emissions related faults.

(6) Extinguishing the MIL

When the MIL is ON, the Diagnostic Executive will turn OFF the MIL after three consecutive trips that a "test passed" has been reported for the diagnostic test that originally caused the MIL to illuminate. Although the MIL has been turned OFF, the DTC will remain in the ECM memory (both Freeze Frame and Failure Records) until forty (40) warm-up cycles after no faults have been completed. If the MIL was set by either a fuel trim or misfire-related DTC, additional requirements must be met. In addition to the requirements stated in the previous paragraph, these requirements are as follows:

- The diagnostic tests that are passed must occur with 375 rpm of the rpm data stored at the time the last test failed.
- Plus or minus ten percent of the engine load that was stored at the time the last test failed. Similar engine temperature conditions (warmed up or warming up) as those stored at the time the last test failed.

Meeting these requirements ensures that the fault which turned ON the MIL has been corrected. The MIL is on the instrument panel and has the following functions:

- It informs the driver that a fault affecting the vehicle's emission levels has occurred and that the vehicle should be taken for service as soon as possible.
- As a system check, the MIL will come ON with the key ON and the engine not running. When the engine is started, the MIL will turn OFF.
- When the MIL remains ON while the engine is running, or when a malfunction is suspected due to a driveability or emissions problem, an EOBD System Check must be performed. The procedures for these checks are given in EOBD System Check. These checks will expose faults which may not be detected if other diagnostics are performed first.

Modification basis	
Application basis	
Affected VIN	

(7) Data Link Connector (DLC)

The provision for communicating with the control module is the Data Link Connector (DLC). The DLC is used to connect to a scan tool. Some common uses of the scan tool are listed below:

- Identifying stored DTCs.
- Clearing DTCs.
- Performing output control tests.
- Reading serial data.

(8) DTC

Each Diagnostic Trouble Code (DTC) is directly related to a diagnostic test. The Diagnostic Management System sets DTCs based on the failure of the tests during a trip or trips. Certain tests must fail two consecutive trips before the DTC is set. The following are the two types of DTCs and the characteristics of those codes:

▶ Type A

- Emissions related.
- Requests illumination of the Malfunction Indicator. Lamp (MIL) of the first trip with a fail.
- Stores a History DTC on the first trip with a fail.
- Stores a Freeze Frame (if empty).
- Stores a Fail Record.
- Updates the Fail Record each time the diagnostic test fails.

▶ Type B

- Emissions related.
- "Armed" after one trip with a fail.
- "Disarmed" after one trip with a pass.
- Requests illumination of the MIL on the second consecutive trip with a fail.
- Stores a History DTC on the second consecutive trip. with a fail (The DTC will be armed after the first fail).
- Stores a Freeze Frame on the second consecutive trip with a fail (if empty).

CAUTION

- Only four Fail Records can be stored. Each Fail Record is for a different DTC. It is possible that there will not be Fail Records for every DTC if multiple DTCs are set.

(9) Reading Diagnostic Trouble Codes

The procedure for reading Diagnostic Trouble Code(s) (DTC) is to use a diagnostic scan tool. When reading DTC(s) , follow instructions supplied by tool manufacturer.

(10) Clearing Diagnostic Trouble Codes

CAUTION

- Do not clear DTCs unless directed to do so by the service information provided for each diagnostic procedure. When DTCs are cleared, the Freeze Frame and Failure Record data which may help diagnose an intermittent fault will also be erased from memory. If the fault that caused the DTC to be stored into memory has been corrected, the Diagnostic Executive will begin to count the "warm-up" cycles with no further faults detected, the DTC will automatically be cleared from the Engine Control Module (ECM) memory. To clear DTCs, use the diagnostic scan tool. When a scan tool is not available.

CAUTION

- To prevent system damage, the ignition key must be OFF when disconnecting or reconnecting battery power.

- The power source to the control module. Examples: fuse, pigtail at battery ECM connectors, etc.
  The negative battery cable. (Disconnecting the negative battery cable will result in the loss of other
- on-board memory data, such as preset radio tuning.)

Modification basis	
Application basis	
Affected VIN	

4) Primary System-Based Diagnostics

There are primary system-based diagnostics which evaluate the system operation and its effect on vehicle emissions. The primary system-based diagnostics are listed below with a brief description of the diagnostic function:

(1) Oxygen Sensor Diagnosis

The fuel control oxygen sensor (O2S) is diagnosed for the following conditions:

- Slow response.
- Response time (time to switch Rich/Lean or Lean/ Rich).
- Inactive signal (output steady at bias voltage approximately 450 mv).
- Signal fixed high.
- Signal fixed low.
- Heater performance (time to activity on cold start).
- Signal fixed low during steady state conditions or power enrichment (hard acceleration when a rich mixture should be indicated).
- Signal fixed high during steady state conditions or deceleration mode (deceleration when a lean mixture should be indicated).

If the O2S pigtail wiring, connector or terminal are damaged, the entire O2S assembly must be replaced. Do not attempt to repair the wiring, connector or terminals. In order for the sensor to function properly, it must have clean reference air provided to it. This clean air reference is obtained by way of the O2S wire(s). Any attempt to repair the wires, connector or terminals could result in the obstruction of the reference air and degrade the O2S performance

(2) Misfire Monitor Diagnostic Operation

The misfire monitor diagnostic is based on crankshaft rotational velocity (reference period) variations. The Engine Control Module (ECM) determines crankshaft rotational velocity using the Crankshaft Position (CKP) sensor and the Camshaft Position (CMP) sensor. When a cylinder misfires, the crankshaft slows down momentarily. By monitoring the CKP and CMP sensor signals, the ECM can calculate when a misfire occurs. For a noncatalyst damaging misfire, the diagnostic will be required to monitor a misfire present for between 1000 engine revolutions. For catalyst-damaging misfire, the diagnostic will respond to misfire within 200 engine revolutions. Rough roads may cause false misfire detection. A rough road will cause torque to be applied to the drive wheels and drive train. This torque can intermittently decrease the crankshaft rotational velocity. This may be falsely detected as a misfire. ECM compensates about rough road without any additional sensor. It means that ECM could distinguish the actual misfire or rough road variation.

(3) Misfire Counters

Whenever a cylinder misfires, the misfire diagnostic counts the misfire and notes the crankshaft position at the time the misfire occurred. These "misfire counters" are basically a file on each engine cylinder. A current and a history misfire counter are maintained for each cylinder. The misfire current counters (Misfire Cur #1-6) indicate the number of firing events out of the last 200 cylinder firing events which were misfires. The misfire current counter will display real time data without a misfire DTC stored. The misfire history counters (Misfire Hist #1-6) indicate the total number of cylinder firing events which were misfires. The misfire history counters will display 0 until the misfire diagnostic has failed and a DTC P0300 is set. Once the misfire DTC P0300 is set, the misfire history counters will be updated every 200 cylinder firing events. A misfire counter is maintained for each cylinder. If the misfire diagnostic reports a failure, the diagnostic executive reviews all of the misfire counters before reporting a DTC. This way, the diagnostic executive reports the most current information.

When crankshaft rotation is erratic, a misfire condition will be detected. Because of this erratic condition, the data that is collected by the diagnostic can sometimes incorrectly identify which cylinder is misfiring. Use diagnostic equipment to monitor misfire counter data on EOBD compliant vehicles. Knowing which specific cylinder(s) misfired can lead to the root cause, even when dealing with a multiple cylinder misfire. Using the information in the misfire counters, identify which cylinders are misfiring. If the counters indicate cylinder number 1 misfired, look for a circuit or component related to cylinders number 1. The misfire diagnostic may indicate a fault due to a temporary fault not necessarily caused by a vehicle emission system malfunction. Examples include the following tems:

- **Contaminated fuel.**
- **Low fuel.**
- **Fuel-fouled spark plugs.**
- **Basic engine fault.**

Modification basis	
Application basis	
Affected VIN	

(4) Fuel Trim System Monitor Diagnostic Operation

This system monitors the averages of short-term and longterm fuel trim values. If these fuel trim values stay at their limits for a calibrated period of time, a malfunction is indicated. The fuel trim diagnostic compares the averages of short-term fuel trim values and longterm fuel trim values to rich and lean thresholds. If either value is within the thresholds, a pass is recorded. If both values are outside their thresholds, a rich or lean DTC will be recorded. The fuel trim system diagnostic also conducts an intrusive test. This test determines if a rich condition is being caused by excessive fuel vapor from the Evaporative Emission (EVAP) canister. In order to meet EOBD requirements, the control module uses weighted fuel trim cells to determine the need to set a fuel trim DTC. A fuel trim DTC can only be set if fuel trim counts in the weighted fuel trim cells exceed specifications. This means that the vehicle could have a fuel trim problem which is causing a problem under certain conditions (i.e., engine idle high due to a small vacuum leak or rough idle due to a large vacuum leak) while it operates fine at other times. No fuel trim DTC would set (although an engine idle speed DTC or O2S DTC may set). Use a scan tool to observe fuel trim counts while the problem is occurring. A fuel trim DTC may be triggered by a number of vehicle faults. Make use of all information available (other DTCs stored, rich or lean condition, etc.) when diagnosing a fuel trim fault.

(5) Fuel Trim Cell Diagnostic We

No fuel trim DTC will set regardless of the fuel trim counts in cell 0 unless the fuel trim counts in the weighted cells are also outside specifications. This means that the vehicle could have a fuel trim problem which is causing a problem under certain conditions (i.e. engine idle high due to a small vacuum leak or rough due to a large vacuum leak) while it operates fine at other times. No fuel trim DTC would set (although an engine idle speed DTC or O2S DTC may set). Use a scan tool to observe fuel trim counts while the problem is occurring.

S.G.N. 1491-01 SYSTEM DIAGNOSIS

1. DIAGNOSTIC AIDS

If an intermittent problem is evident, follow the guidelines below.

1) Preliminary Check

Before using this section you should have already performed the "Euro On-Board Diagnostic System Check." Perform a thorough visual inspection. This inspection can often lead to correcting a problem without further checks and can save valuable time. Inspect for the following conditions:

- Engine Control Module (ECM) grounds for being clean, tight, and in their proper location.
- Vacuum hoses for splits, kinks, collapsing and proper connections as shown on the Vehicle Emission Control Information label. Inspect thoroughly for any type of leak or restriction.
- Air leaks at the throttle body mounting area and the intake manifold sealing surfaces.
- Ignition wires for cracks, hardness, proper routing, and carbon tracking.
- Wiring for proper connections.
- Wiring for pinches or cuts.

2) Diagnostic Trouble Code Tables

Do not use the Diagnostic Trouble Code (DTC) tables to try and correct an intermittent fault. The fault must be present to locate the problem. Incorrect use of the DTC tables may result in the unnecessary replacement of parts

3) Faulty Electrical Connections or Wiring

Most intermittent problems are caused by faulty electrical connections or wiring. Perform a careful inspection of suspect circuits for the following:

- Poor mating of the connector halves.
- Terminals not fully seated in the connector body.
- Improperly formed or damaged terminals. All connector terminals in a problem circuit should be carefully inspected, reformed, or replaced to insure contact tension.
- Poor terminal-to-wire connection. This requires removing the terminal from the connector body.

Modification basis	
Application basis	
Affected VIN	

4) Road Test

If a visual inspection does not find the cause of the problem, the vehicle can be driven with a voltmeter or a scan tool connected to a suspected circuit. An abnormal voltage or scan tool reading will indicate that the problem is in that circuit. If there are no wiring or connector problems found and a DTC was stored, refer to the applicable DTC tables.

5) Intermittent Malfunction Indicator Lamp (MIL)

An intermittent Malfunction Indicator Lamp (MIL) with no DTC present may be caused by the following:

- Improper installation of electrical options such as lights, two way radios, sound, or security systems. MIL driver wire intermittently shorted to ground.
-

6) Fuel System

Some intermittent driveability problems can be attributed to poor fuel quality. If a vehicle is occasionally running rough, stalling, or otherwise performing badly, ask the customer about the following fuel buying habits:

- Do they always buy from the same source? If so, fuel quality problems can usually be discounted. Do they buy their fuel from whichever fuel station that is advertising the lowest price? If so, check
- the fuel tank for signs of debris, water, or other contamination.

7) Process of Flywheel Backlash Compensation for Misfire Detection

When an ECM is reflashed, initialized or replaced, and driveplate of flywheel has been replaced, follow these procedures to relearn the Crankshaft Position (CKP) system variation:

CAUTION

- To avoid personal injury when performing the flywheel adaptation procedure, always set the vehicle parking brake and block the drive wheels. Release the throttle immediately when the engine starts to decelerate. Once the learning procedure is completed, engine control will be learned to the operator, and the engine will respond to the throttle position.

2. DTC LIST

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Variable Valve Timing System	P0010	Cam Actuator - Short circuit to B+	• **Condition** - Variable valve timing system circuit: short circuit to battery • **Actions** 1. Check the actual operating condition using SCAN-100. 2. Inspect the circuit and terminal of ECU pin No. 73. 3. Check the cam actuator's power circuit for short and open. 4. Check the magnet and hardware. 5. Check the ECU.	o
		Cam Actuator - Short or Open circuit to Ground	• **Condition** - Variable valve timing system circuit: short or open circuit to ground • **Actions** 1. Check the actual operating condition using SCAN-100. 2. Inspect the circuit and terminal of ECU pin No. 73. 3. Check the cam actuator's power circuit for short and open. 4. Check the magnet and hardware. 5. Check the ECU.	o
	P0011	Cam Actuator - Fixed to Advance Position	• **Condition** - The noise occurred by valve timing (advance/retard) in each range is over than the specified value. • **Actions** 1. Check the actual operating condition using SCAN-100. 2. Inspect the circuit and terminal of ECU pin No. 73. 3. Check the cam actuator's power circuit for short and open. 4. Check the magnet and hardware. 5. Check the ECU.	o
	P0012	Cam Actuator - Fixed to Retard Position	• **Actions** 1. Check the actual operating condition using SCAN-100. 2. Inspect the circuit and terminal of ECU pin No. 73. 3. Check the cam actuator's power circuit for short and open. 4. Check the magnet and hardware. 5. Check the ECU.	o
HFM Sensor	P0101	Faulty HFM Sensor Signal	• **Condition** - Improper air volume is detected. • **Specification** - 20 kg/h - 0.47 V 0 kg/h - 0.99 V 10 kg/h - 1.2226 ~ 1.2398 V 15 kg/h - 1.3552 ~ 1.3778 V 30 kg/h - 1.6783 ~ 1.7146 V 60 kg/h - 2.1619 ~ 2.2057 V 120 kg/h - 2.7215 ~ 2.7762 V 250 kg/h - 3.4388 ~ 3.5037 V 370 kg/h - 3.8796 ~ 3.9511 V 480 kg/h - 4.1945 ~ 4.2683 V 640 kg/h - 4.5667 ~ 4.6469 V • **Actions** 1. Measure the actual air volume using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 92 and 116. 3. Inspect HFM sensor. 4. Check the ECU.	o

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
HFM Sensor	P0102	Low HFM Sensor Signal	• **Condition** - The signal is below the minimum engine load (0.02). - Related circuit: open circuit • **Specification** - 20 kg/h - 0.47 V 0 kg/h - 0.99 V 10 kg/h - 1.2226 ~ 1.2398 V 15 kg/h - 1.3552 ~ 1.3778 V 30 kg/h - 1.6783 ~ 1.7146 V 60 kg/h - 2.1619 ~ 2.2057 V 120 kg/h - 2.7215 ~ 2.7762 V 250 kg/h - 3.4388 ~ 3.5037 V 370 kg/h - 3.8796 ~ 3.9511 V 480 kg/h - 4.1945 ~ 4.2683 V 640 kg/h - 4.5667 ~ 4.6469 V • **Actions** 1. Measure the actual air volume using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 92 and 116. 3. Inspect HFM sensor. 4. Check the ECU.	o
	P0103	High HFM Sensor Signal	• **Condition** - The signal is over the maximum engine load (0.02). - Related circuit: short circuit • **Specification** - 20 kg/h - 0.47 V 0 kg/h - 0.99 V 10 kg/h - 1.2226 ~ 1.2398 V 15 kg/h - 1.3552 ~ 1.3778 V 30 kg/h - 1.6783 ~ 1.7146 V 60 kg/h - 2.1619 ~ 2.2057 V 120 kg/h - 2.7215 ~ 2.7762 V 250 kg/h - 3.4388 ~ 3.5037 V 370 kg/h - 3.8796 ~ 3.9511 V 480 kg/h - 4.1945 ~ 4.2683 V 640 kg/h - 4.5667 ~ 4.6469 V • **Actions** 1. Measure the actual air volume using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 92 and 116. 3. Inspect HFM sensor.	o
MAP Sensor (G23 only)	P0105	Defective Intake Manifold Pressure Sensor Signal		

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Intake Air Temperature Sensor	P0111	Faulty Intake Air Temperature Sensor Signal	• **Condition** - The temperature change of over 20 °C is occurred more than 5 times. • **Specification** 20°C - 2420 Ω - 2.65 V 30°C - 1662 Ω - 2.18 V 50°C - 853 Ω - 1.40 V • **Actions** 1. Measure the actual temperature using SCAN-100. 2. Inspect the circuits of ECU pin No. 80 and 116. 3. Inspect intake air temperature sensor (ATS-HFM6.0 integrated). 4. Check the ECU.	o
	P0112	Intake Air Temperature Sensor Malfunction - Open circuit	• **Condition** - The sensor value is less than minimum specified value (0.1 V). - Related circuit: open circuit • **Specification** 20°C - 2420 Ω - 2.65 V 30°C - 1662 Ω - 2.18 V 50°C - 853 Ω - 1.40 V • **Actions** 1. Measure the actual temperature using SCAN-100. 2. Inspect the circuits of ECU pin No. 80 and 116. 3. Inspect intake air temperature sensor (ATS-HFM6.0 integrated). 4. Check the ECU.	o
	P0113	Intake Air Temperature Sensor Malfunction - Short circuit	• **Condition** - The sensor value is over the maximum specified value (4.9 V). - Related circuit: short circuit • **Specification** 20°C - 2420 Ω - 2.65 V 30°C - 1662 Ω - 2.18 V 50°C - 853 Ω - 1.40 V • **Actions** 1. Measure the actual temperature using SCAN-100. 2. Inspect the circuits of ECU pin No. 80 and 116. 3. Inspect intake air temperature sensor (ATS-HFM6.0 integrated). 4. Check the ECU.	o
Coolant Temperature Sensor	P0116	Faulty Coolant Temperature Sensor Signal	• **Condition** - The coolant temperature is below 50 °C after engine warmed up. • **Specification** 20°C - 2.50 kΩ - 3.57 V 80°C - 0.32 kΩ - 1.22 V 100°C - 0.18 kΩ - 0.78 V • **Actions** 1. Measure the actual temperature using SCAN-100. 2. Inspect the circuits of ECU pin No. 78 and 79. 3. Check the coolant temperature sensor. 4. Check the ECU.	o

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Coolant Temperature Sensor	P0117	Coolant Temperature Sensor Malfunction - Open circuit	• **Condition** - The sensor value is less than minimum specified value (0.11 V). - Related circuit: open circuit • **Specification** 20°C - 2.50 kΩ - 3.57 V 80°C - 0.32 kΩ - 1.22 V 100°C - 0.18 kΩ - 0.78 V • **Actions** 1. Measure the actual temperature using SCAN-100. 2. Inspect the circuits of ECU pin No. 78 and 79. 3. Check the coolant temperature sensor. 4. Check the ECU.	o
	P0118	Coolant Temperature Sensor Malfunction - Short circuit	• **Condition** - The sensor value is over the maximum specified value (4.96 V). - Related circuit: short circuit • **Specification** 20°C - 2.50 kΩ - 3.57 V 80°C - 0.32 kΩ - 1.22 V 100°C - 0.18 kΩ - 0.78 V • **Actions** 1. Measure the actual temperature using SCAN-100. 2. Inspect the circuits of ECU pin No. 78 and 79. 3. Check the coolant temperature sensor. 4. Check the ECU.	o
Throttle Body Control	P0120	No.1 Throttle Position Sensor - Low Voltage	• **Condition** - No.1 throttle position sensor circuit: short or open circuit to ground. • **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	o

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Throttle Body Control	P0120	No.1 Throttle Position Sensor - High Voltage	• **Condition** - No.1 throttle position sensor's main power is grounded. • **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	O
		No.2 Throttle Position Sensor - Low Voltage	• **Condition** - No.2 throttle position sensor circuit: short or open circuit to ground. • **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	O
		No.2 Throttle Position Sensor - High Voltage	• **Condition** - No.2 throttle position sensor's main power is grounded. • **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	O

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Throttle Body Control	P0120	Throttle Actuator - Insuffcient Supply Power	• **Condition** - Actuator circuit: short circuit • **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	o
		TPS Valve Inconsistent with HFM Sensor Value	• **Condition** - The potentiometer is defective. • **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	o
		Both Throttle Position Sensors Malfunction	• **Condition** - The potentiometer is defective. • **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Throttle Body Control	P0120	Inconsistent Signals of No.1 and No.2 Throttle Position Sensors	• **Condition** - The difference in amount of 1/2 is occurred in potentiometer. • **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	o
		Throttle Actuator Control Malfunction	• **Condition** - The wiring or actuator is defective. • **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	o
		Intake Air Flow Sensor and Throttle Sensor Malfunction	• **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	o

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Accelerator Pedal Sensor	P0120	Accelerator Pedal Sensor Malfunction - Supply Voltage Fault	• **Specification** - SPS 1/2 pull-down resistance: 464 kΩ - Potentiometer 1/2 voltage: 5 / 2.5 V • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 31, 32, 47, 48, 50 and 51. 3. Check the electric throttle controller.	o
		Accelerator Pedal Sensor #1 Malfunction - Low Voltage	• **Specification** - SPS 1/2 pull-down resistance: 464 kΩ - Potentiometer 1/2 voltage: 5 / 2.5 V • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 31, 32, 47, 48, 50 and 51. 3. Check the electric throttle controller.	o
		Accelerator Pedal Sensor #1 Malfunction - High Voltage	• **Specification** - SPS 1/2 pull-down resistance: 464 kΩ - Potentiometer 1/2 voltage: 5 / 2.5 V • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 31, 32, 47, 48, 50 and 51. 3. Check the electric throttle controller.	o
		Accelerator Pedal Sensor #2 Malfunction - Low Voltage	• **Specification** - SPS 1/2 pull-down resistance: 464 kΩ - Potentiometer 1/2 voltage: 5 / 2.5 V • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 31, 32, 47, 48, 50 and 51. 3. Check the electric throttle controller.	o
		Accelerator Pedal Sensor #2 Malfunction - High Voltage	• **Specification** - SPS 1/2 pull-down resistance: 464 kΩ - Potentiometer 1/2 voltage: 5 / 2.5 V • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 31, 32, 47, 48, 50 and 51. 3. Check the electric throttle controller.	o
		Accelerator Pedal Sensor #1 & #2 - Defective Signal	• **Specification** - SPS 1/2 pull-down resistance: 464 kΩ - Potentiometer 1/2 voltage: 5 / 2.5 V • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 31, 32, 47, 48, 50 and 51. 3. Check the electric throttle controller.	o
		Accelerator Pedal Sensor #1 & #2 Malfunction	• **Specification** - SPS 1/2 pull-down resistance: 464 kΩ - Potentiometer 1/2 voltage: 5 / 2.5 V • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 31, 32, 47, 48, 50 and 51. 3. Check the electric throttle controller.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Throttle Body Control	P0121	Throttle Position Sensor Actuator's Learning Control Malfunction	• **Condition** - The actuator is not properly adjusted and the conditions are not satisfied. • **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	o
		Faulty Throttle Body Return Spring	• **Condition** - The return spring of actuator is defective. • **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	o
Coolant Temperature Sensor	P0125	Low coolant temperature while controlling air/fuel ratio	• **Condition** - The coolant temperature is below the specified temperature for controlling air/fuel ratio after engine warmed up. • **Specification** 20°C - 2.50 kΩ - 3.57 V 80°C - 0.32 kΩ - 1.22 V 100°C - 0.18 kΩ - 0.78 V • **Actions** 1. Measure the actual temperature using SCAN-100. 2. Inspect the circuits for ECU pin No. 78 and 79. 3. Check the coolant temperature sensor. 4. Check the ECU.	o
Thermostat	P0128	Thermostat Fully Open	• **Condition** 1. The actual coolant temperature is lower than the coolant temperature calculated by ECU due to the slow preheat. • **Actions** 1. Check the thermostat.	o

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
No.1 Oxygen Sensor (Installed Before Catalytic Converter)	P0131	No.1 Oxygen Sensor - Below the Minimum Permissible Voltage	• **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds (refer to P0133) • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 9. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o
	P0132	No.1 Oxygen Sensor - Overvoltage	• **Condition** - No.1 oxygen sensor is defective. Output voltage > 1.05 V The sensing voltage is not in the specified range. • **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) - Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 16 and 17. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
	P0133	No.1 Oxygen Sensor - Poor Performance	• **Condition** - No.1 oxygen sensor is defective. The response to the sensor signal is delayed. Closed loop interval of air/fuel ratio control > 1500 ms • **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) - Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 16 and 17. 3. Inspect the oxygen sensor. 4. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
No.1 Oxygen Sensor (Installed Before Catalytic Converter)	P0134	No.1 Oxygen Sensor - Malfunction	• **Condition** - No.1 oxygen sensor is defective. The sensor does not operate. • **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) - Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 16 and 17. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
		No.1 Oxygen Sensor - Lean Indication (When Decelerating)	• **Condition** - No.1 oxygen sensor is defective. There is no "LEAN" signal after shutting off the fuel. • **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) - Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 16 and 17. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
	P0135	No.1 Oxygen Sensor - Faulty Heating Current, Heater Circuit is Open or Short circuit or Short circuit to Ground	• **Condition** - No.1 oxygen sensor is improperly heated. The heating current is below or over the specified range (below 0.2 A or over 2 A). • **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 9. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
No.1 Oxygen Sensor (Installed Before Catalytic Converter)	P0135	No.1 Oxygen Sensor Heater - Short circuit to B+	• **Condition** - No.1 oxygen sensor is improperly heated. The heating current is below or over the specified range (below 0.2 A or over 2 A). • **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 9. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o
		No.1 Oxygen Sensor Heater - Open or Short circuit to Ground	• **Condition** - No.1 oxygen sensor is improperly heated. The heating current is below or over the specified range (below 0.2 A or over 2 A). • **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 9. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o
No.2 Oxygen Sensor (Installed After Catalytic Converter)	P0137	No.2 Oxygen Sensor - Below the Minimum Permissible Voltage	• **Condition** - No.2 oxygen sensor is defective. The sensor does not operate. • **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 19 and 20. 3. Inspect the oxygen sensor. 4. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
No.2 Oxygen Sensor (Installed After Catalytic Converter)	P0138	No.2 Oxygen Sensor - Overvoltage	• **Condition** - No.2 oxygen sensor is defective. The output value is not within the specified range. The sensing voltage is not in the specified range. • **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 19 and 20. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
	P0140	No.2 Oxygen Sensor - Lean Indication (When Decelerating)	• **Condition** - No.2 oxygen sensor is defective. There is no "LEAN" signal after shutting off the fuel. • **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 19 and 20. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
	P0141	No.2 Oxygen Sensor Heater - Short circuit to B+	• **Condition** - No.2 oxygen sensor is improperly heated. The heating current is below or over the specified range (below 0.2 A or over 2 A). • **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 7. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
No.2 Oxygen Sensor (Installed After Catalytic Converter)	P0141	No.2 Oxygen Sensor Heater - Open or Short circuit to Ground	• **Condition** - No.2 oxygen sensor is improperly heated. The heating current is below or over the specified range (below 0.2 A or over 2 A). • **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 7. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o
		No.2 Oxygen Sensor - Poor Heating	• **Condition** - No.2 oxygen sensor is defective. The response to the sensor signal is delayed. • **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 7. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o
No.3 Oxygen Sensor (Installed Before Catalytic Converter)	P0151	No.3 Oxygen Sensor - Below the Minimum Permissible Voltage	• **Specification** - Specified voltage: Below 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 22 and 23. 3. Inspect the oxygen sensor. 4. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
No.3 Oxygen Sensor (Installed Before Catalytic Converter)	P0152	No.3 Oxygen Sensor - Overvoltage	• **Condition** - No.3 oxygen sensor is defective. The output value is not within the specified range. The sensing voltage is not in the specified range. • **Specification** - Specified voltage: Below 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 22 and 23. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
	P0153	No.3 Oxygen Sensor - Poor Performance	• **Condition** - No.3 oxygen sensor is defective. The response to the sensor signal is delayed. • **Specification** - Specified voltage: Below 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 22 and 23. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
	P0154	No.3 Oxygen Sensor - Malfunction	• **Condition** - No.3 oxygen sensor is defective. The sensor does not operate. • **Specification** - Specified voltage: Below 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 22 and 23. 3. Inspect the oxygen sensor. 4. Check the ECU.	o

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
No.3 Oxygen Sensor (Installed Before Catalytic Converter)	P0154	No.3 Oxygen Sensor - Lean Indication (When Decelerating)	• **Condition** - No.3 oxygen sensor is defective. There is no "LEAN" signal after shutting off the fuel. • **Specification** - Specified voltage: Below 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 22 and 23. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
	P0155	No.3 Oxygen Sensor - Faulty Heating Current	• **Condition** - No.3 oxygen sensor is improperly heated. The heating current is below or over the specified range (below 0.2 A or over 2 A). • **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 6. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o
		No.3 Oxygen Sensor Heater - Short circuit to B+	• **Condition** - No.3 oxygen sensor is improperly heated. The heating current is below or over the specified range (below 0.2 A or over 2 A). • **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 6. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o
		No.3 Oxygen Sensor Heater - Open or Short circuit to Ground	• **Condition** - No.3 oxygen sensor is improperly heated. The heating current is below or over the specified range (below 0.2 A or over 2 A). • **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 6. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
No.4 Oxygen Sensor (Installed After Catalytic Converter)	P0157	No.4 Oxygen Sensor - Below the Minimum Permissible Voltage	• **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 MΩ (850°C) Between sensor circuit and housing - Operating temperature: 850 °C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 25 and 26. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
	P0158	No.4 Oxygen Sensor - Overvoltage	• **Condition** - No.4 oxygen sensor is defective. The output value is not within the specified range. The sensing voltage is not in the specified range. • **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 MΩ (850°C) Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip -Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 25 and 26. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
	P0160	No.4 Oxygen Sensor - Lean Indication (When Decelerating)	• **Condition** - No.4 oxygen sensor is defective. There is no "LEAN" signal after shutting off the fuel. • **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 MΩ (850°C) Between sensor circuit and housing - Operating temperature: 850 °C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 25 and 26. 3. Inspect the oxygen sensor. 4. Check the ECU.	o

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
No.4 Oxygen Sensor (Installed After Catalytic Converter)	P0161	No.4 Oxygen Sensor - Poor Heating	• **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 3. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o
		No.4 Oxygen Sensor Heater - Short circuit to B+	• **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 3. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o
		No.4 Oxygen Sensor Heater - Open or Short circuit to Ground	• **Specification** - Operating current: below 1.6 A - Initial current: below 6.0 A for 2 seconds • **Actions** 1. Check the heating condition using SCAN-100. 2. Inspect the circuit and terminal of the ECU pin No. 3. 3. Inspect the heating power supply. 4. Inspect the heating circuit of oxygen sensor. 5. Check the ECU.	o
No.1 Oxygen Sensor (Installed Before Catalytic Converter)	P0171	Short-term Learning Control of Air/Fuel Ratio: Fuel Rich	• **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) - Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 16 and 17. 3. Inspect the oxygen sensor. 4. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Fuel Correction	P0171	Air/Fuel Ratio Control Malfunction - Fuel Rich	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	•
		Learning Control Malfunction - Rich at Idling	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	•
		Learning Control Malfunction - Rich under Low Load	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	•
		Learning Control Malfunction - Rich under High Load	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	•
	P0172	Air/Fuel Ratio Control Malfunction - Fuel Lean	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	•
		Learning Control Malfunction - Lean at Idling	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	•
		Learning Control Malfunction - Lean under Low Load	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	•
		Learning Control Malfunction - Lean under High Load	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	•

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
No.2 Oxygen Sensor (Installed After Catalytic Converter)	P0172	Short-term Learning Control of Air/Fuel Ratio: Fuel Lean	• **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 19 and 20. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
Fuel Correction	P0174	Air/Fuel Ratio Control Malfunction - Fuel Rich	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	o
		Fuel Rich at Idling	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	o
		Fuel Rich under Low Load	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	o
		Fuel Rich under High Load	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	o
No.3 Oxygen Sensor (Installed Before Catalytic Converter)	P0174	Short-term Learning Control of Air/Fuel Ratio: Fuel Rich	• **Specification** - Specified voltage: Below 100 ~ 900 mV - Insulating resistance: ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 kΩ (850°C) Between sensor circuit and housing - Operating temperature: 850 °C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 22 and 23. 3. Inspect the oxygen sensor. 4. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Fuel Correction	P0175	Air/Fuel Ratio Control Malfunction - Fuel Lean	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	o
		Fuel Lean at Idling	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	o
		Fuel Lean under Low Load	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	o
		Fuel Lean under High Load	• **Actions** 1. Check the oxygen sensor signal and heating line. 2. Check the purge valve unit and circuit. 3. Check the coolant temperature sensor. 4. Check the ignition coil and spark plug. 5. Check the HFM sensor's intake air temperature.	o
No.4 Oxygen Sensor (Installed After Catalytic Converter)	P0175	Short-term Learning Control of Air/Fuel Ratio: Fuel Lean	• **Specification** - Specified voltage: 100 ~ 900 mV - Insulating resistance : ≥ 10 MΩ (350°C) ≥ 300 kΩ (850°C) Resistance between heater and sensor: ≥ 10 MΩ (850°C) Between sensor circuit and housing - Operating temperature: 850°C Gas temperature at ceramic tip - Internal resistance: ≥ 1 kΩ • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of the ECU pin No. 25 and 26. 3. Inspect the oxygen sensor. 4. Check the ECU.	o
Throttle Body Safety Function	P0221	Deceleration Over Limit (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		Acceleration Over Limit (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Throttle Body Safety Function	P0221	Control Lever Double Action (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		Control Lever Safety Terminal Malfunction (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		Pedal Position Change Fault (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		Throttle Position Change Fault (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		Defective Constant Speed Driving Control Data (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		Faulty Pedal Position Detected (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		Faulty Throttle Position Detected (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		Faulty CAN Communi-cation Detected (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		Faulty Configuration Detected (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		Faulty A/D Converter Detected (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		CPU #1 and #2 - Pedal Position Signal Fault	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Throttle Body Safety Function	P0221	CPU #1 and #2 - TP Valve Position Signal Fault	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		CPU #1 and #2 - MSR Signal Fault	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		CPU #1 and #2 - Idle Control	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		AD Converter Overflow Detected (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		ROM Malfunction (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		RAM Malfunction (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
		CPU Recognition Malfunction (CPU2)	• **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the electric throttle controller. 3. Check the ECU.	o
Fuel Pump Relay	P0231	Fuel Pump Relay - Open circuit to Ground	• **Condition** - Fuel pump circuit: short or open circuit to ground • **Specification** - The voltage drop of pin No. 33 and ground: Below 1 V (current = 150 mA) • **Actions** 1. Inspect the circuit and terminal of ECU pin No. 33. 2. Inspect the fuel pump relay. 3. Check the ECU.	o
	P0232	Fuel Pump Relay - Short circuit to B+	• **Condition** - Fuel pump: short circuit to battery • **Specification** - The voltage drop of pin No. 33 and ground: Below 1 V (current = 150 mA) • **Actions** 1. Inspect the circuit and terminal of ECU pin No. 33. 2. Inspect the fuel pump relay. 3. Check the ECU.	o

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Fuel Injection System	P0261	No.1 Injector - Short or Open circuit to Ground	• **Condition** - No.1 injector is defective. No.1 injector circuit: short circuit to ground • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 63. 2. Inspect the injector. 3. Check the ECU.	o
	P0262	No.1 Injector - Short circuit to B+	• **Condition** - No.1 injector is defective. No.1 injector circuit: short circuit to battery • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Check the No.1 injector's power supply and terminal. 2. Inspect the injector. 3. Check the ECU.	o
	P0264	No.2 Injector - Short or Open circuit to Ground	• **Condition** - No.2 injector is defective. No.2 injector circuit: short circuit to ground • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 61. 2. Inspect the injector. 3. Check the ECU.	o
	P0265	No.2 Injector - Short circuit to B+	• **Condition** - No.2 injector is defective. No.2 injector circuit: short circuit to battery • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Check the No.2 injector's power supply and terminal. 2. Inspect the injector. 3. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Fuel Injection System	P0267	No.3 Injector - Short or Open circuit to Ground	• **Condition** - No.3 injector is defective. No.3 injector circuit: short circuit to ground • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 66. 2. Inspect the injector. 3. Check the ECU.	O
	P0268	No.3 Injector - Short circuit to B+	• **Condition** - No.3 injector is defective. No.3 injector circuit: short circuit to battery • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Check the No.3 injector's power supply and terminal. 2. Inspect the injector. 3. Check the ECU.	O
	P0270	No.4 Injector - Short or Open circuit to Ground	• **Condition** - No.4 injector is defective. No.4 injector circuit: short circuit to ground • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 62. 2. Inspect the injector. 3. Check the ECU.	O
	P0271	No.4 Injector - Short circuit to B+	• **Condition** - No.4 injector is defective. No.4 injector circuit: short circuit to battery • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Check the No.4 injector's power supply and terminal. 2. Inspect the injector. 3. Check the ECU.	O

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Fuel Injection System	P0273	No.5 Injector - Short or Open circuit to Ground	• **Condition** - No.5 injector is defective. No.5 injector circuit: short circuit to ground • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 65. 2. Inspect the injector. 3. Check the ECU.	O
	P0274	No.5 Injector - Short circuit to B+	• **Condition** - No.5 injector is defective. No.5 injector circuit: short circuit to battery • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Check the No.5 injector's power supply and terminal. 2. Inspect the injector. 3. Check the ECU.	O
	P0276	No.6 Injector - Short or Open circuit to Ground	• **Condition** - No.6 injector is defective. No.6 injector has a short circuit to ground. • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 64. 2. Inspect the injector. 3. Check the ECU.	O
	P0277	No.6 Injector - Short circuit to B+	• **Condition** - No.6 injector is defective. No.6 injector circuit: short circuit to battery • **Specification** - Electric resistance: 14.5 Ω ± 0.7 Ω at 20°C - Operating pressure: 380 Kpa - Supply voltage: 6 ~ 16 V • **Actions** 1. Check the No.6 injector's power supply and terminal. 2. Inspect the injector. 3. Check the ECU.	O

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Poor Ignition (Misfire)	P0300	Cylinder - Poor Ignition	• **Condition** - Misfire is occurred in more than one cylinder causing excessive exhaust gas and catalyst deterioration. • **Actions** 1. Check the ignition system. 2. Check the fuel injection system. 3. Check the fuel pressure. 4. Check the compression pressure. 5. Check the valve timing and clearance. 6. Check the intake air flow sensor. 7. Check the crank angle sensor and air cap. 8. Check the engine wiring harness. 9.Check the ECU.	•
	P0301	No.1 Cylinder - Poor Ignition	• **Condition** - Misfire is occurred in No.1 cylinder causing excessive exhaust gas and catalyst deterioration. • **Actions** 1. Check the ignition system. 2. Check the fuel injection system. 3. Check the fuel pressure. 4. Check the compression pressure. 5. Check the valve timing and clearance. 6. Check the intake air flow sensor. 7. Check the crank angle sensor and air cap. 8. Check the engine wiring harness. 9. Check the ECU.	•
	P0302	No.2 Cylinder - Poor Ignition	• **Condition** - Misfire is occurred in No.2 cylinder causing excessive exhaust gas and catalyst deterioration. • **Actions** 1. Check the ignition system. 2. Check the fuel injection system. 3. Check the fuel pressure. 4. Check the compression pressure. 5. Check the valve timing and clearance. 6. Check the intake air flow sensor. 7. Check the crank angle sensor and air cap. 8. Check the engine wiring harness. 9. Check the ECU.	•

Modification basis	
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Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Poor Ignition (Misfire)	P0303	No.3 Cylinder - Poor Ignition	• **Condition** - Misfire is occurred in No.3 cylinder causing excessive exhaust gas and catalyst deterioration. • **Actions** 1. Check the ignition system. 2. Check the fuel injection system. 3. Check the fuel pressure. 4. Check the compression pressure. 5. Check the valve timing and clearance. 6. Check the intake air flow sensor. 7. Check the crank angle sensor and air cap. 8. Check the engine wiring harness. 9. Check the ECU.	•
	P0304	No.4 Cylinder - Poor Ignition	• **Condition** - Misfire is occurred in No.4 cylinder causing excessive exhaust gas and catalyst deterioration. • **Actions** 1. Check the ignition system. 2. Check the fuel injection system. 3. Check the fuel pressure. 4. Check the compression pressure. 5. Check the valve timing and clearance. 6. Check the intake air flow sensor. 7. Check the crank angle sensor and air cap. 8. Check the engine wiring harness. 9. Check the ECU.	•
	P0305	No.5 Cylinder - Poor Ignition	• **Condition** - Misfire is occurred in No.5 cylinder causing excessive exhaust gas and catalyst deterioration. • **Actions** 1. Check the ignition system. 2. Check the fuel injection system. 3. Check the fuel pressure. 4. Check the compression pressure. 5. Check the valve timing and clearance. 6. Check the intake air flow sensor. 7. Check the crank angle sensor and air cap. 8. Check the engine wiring harness. 9. Check the ECU.	•

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Poor Ignition (Misfire)	P0306	No.6 Cylinder - Poor Ignition	• **Condition** - Misfire is occurred in No.6 cylinder causing excessive exhaust gas and catalyst deterioration. • **Actions** 1. Check the ignition system. 2. Check the fuel injection system. 3. Check the fuel pressure. 4. Check the compression pressure. 5. Check the valve timing and clearance. 6. Check the intake air flow sensor. 7. Check the crank angle sensor and air cap. 8. Check the engine wiring harness. 9. Check the ECU.	•
Knock Sensor	P0325	#1 Knock Sensor Malfunction (1, 2, 3 CYL)	• **Condition** - No.1 knock sensor is defective. The value is not within the specified range when the engine temperature is over 75°C, the engine speed is over 3000 rpm and other units are properly operated (for cylinder No. 1, 2 and 3). • **Specification** - Sensitivity: approx. 26 ± 8 mV/g Resistance > 10 MΩ • **Actions** 1. Inspect the circuits and terminals of the ECU pin No. 117 and 118. 2. Inspect the No.1 knock sensor. 3. Check the ECU.	o
	P0330	#2 Knock Sensor Malfunction (4, 5, 6 CYL)	• **Condition** - No.2 knock sensor is defective. The value is not within the specified range when the engine temperature is over 75°C, the engine speed is over 3000 rpm and other units are properly operated (for cylinder No. 4, 5 and 6). • **Specification** - Sensitivity: approx. 26 ± 8 mV/g Resistance > 10 MΩ • **Actions** 1. Inspect the circuits and terminals of the ECU pin No. 114 and 115. 2. Inspect the No.2 knock sensor. 3. Check the ECU.	o

Modification basis	
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Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Crank Position Sensor	P0335	Faulty Crank Position Sensor Signal - No Engine RPM	• **Condition** - The crank angle signals cannot be detected even the cam position is properly detected. • **Specification** - Sensor's internal resistance : 700 ~ 1050 Ω • **Actions** 1. Measure the crankshaft rpm using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 100 and 99. 3. Inspect the crank angle sensor. 4. Inspect air gap between sensor and drive plate. 5. Check the drive plate's teeth. 6. Check the ECU.	o
		Faulty Crank Position Sensor Signal - Faulty Recognition of Gap	• **Condition** - The cam and crank angle signal is improperly recognized or not recognized. • **Specification** - Sensor internal resistance: 700 ~ 1050 Ω • **Actions** 1. Measure the crankshaft rpm using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 100 and 99. 3. Inspect the crank angle sensor. 4. Inspect air gap between sensor and drive plate. 5. Check the drive plate's teeth. 6. Check the ECU.	o
		Crank Position Sensor Adaptation Malfunction - Poor Initialization	• **Condition** - The crank angle sensor is faulty initialized. • **Specification** - Sensor internal resistance: 700 ~ 1050 Ω • **Actions** 1. Measure the crankshaft rpm using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 100 and 99. 3. Inspect the crank angle sensor. 4. Inspect air gap between sensor and drive plate. 5. Check the drive plate's teeth. 6. Check the ECU.	o
	P0336	Crank Position Sensor - Excessive Engine RPM	• **Condition** - The engine rpm is over the proper amount or improper. • **Specification** - Sensor internal resistance: 700 ~ 1050 Ω • **Actions** 1. Measure the crankshaft rpm using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 100 and 99. 3. Inspect the crank angle sensor. 4. Inspect air gap between sensor and drive plate. 5. Check the drive plate's teeth. 6. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Cam Position Sensor	P0340	#1 Cylinder Synchronization Malfunction	• **Condition** - The cam position sensor is defective. The No.1 cylinder is poorly synchronized. • **Specification** - Sensor supply voltage: 4.5 V - 24 V • **Actions** 1. Measure the set voltage of cam position sensor. 2. Inspect the circuits and terminals of ECU pin No. 106 and 104. 3. Inspect the cam position sensor. 4. Check the cam sensor and sprocket for damage. 5. Check the ECU.	o
	P0341	#1 Cylinder Recognition Malfunction	• **Condition** - There is no cam recognition signal. • **Specification** - Sensor supply voltage: 4.5 V - 24 V • **Actions** 1. Measure the set voltage of cam position sensor. 2. Inspect the circuits and terminals of ECU pin No. 106 and 104. 3. Inspect the cam position sensor. 4. Check the cam sensor and sprocket for damage. 5. Check the ECU.	o
Ignition Coil	P0351	#1 Ignition Coil - Faulty Output Voltage	• **Condition** - The ignition unit is defective (for No. 2 and 5 cylinders). Ignition circuit: short circuit to primary and secondary current • **Specification** - Primary resistance: 0.36 Ω Secondary resistance: 5.9 kΩ - Secondary voltage: 38 KV - Ignition output Primary current: 7.0 A Primary voltage: 380 V • **Actions** 1. Inspect the circuits and terminals of the ECU pin No. 70, 71 and 72. 2. Inspect the power supply of ignition coil. 3. Inspect the ignition coil and high-voltage cable. 4. Inspect the spark plug for moisture, crack, wear, improper cap and excessive burnt electrode residue. 5. Check the ECU.	o

Modification basis	
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Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Ignition Coil	P0352	#2 Ignition Coil - Faulty Output Voltage	• **Condition** - The ignition unit is defective (for No. 3 and 4 cylinders). Ignition circuit: short circuit to primary and secondary current • **Specification** - Primary resistance: 0.36 Ω Secondary resistance: 5.9 kΩ - Secondary voltage: 38 KV - Ignition output Primary current: 7.0 A Primary voltage: 380 V • **Actions** 1. Inspect the circuits and terminals of the ECU pin No. 70, 71 and 72. 2. Inspect the power supply of ignition coil. 3. Inspect the ignition coil and high-voltage cable. 4. Inspect the spark plug for moisture, crack, wear, improper cap and excessive burnt electrode residue. 5. Check the ECU.	o
	P0353	#3 Ignition Coil - Faulty Output Voltage	• **Condition** - The ignition unit is defective (for No. 1 and 6 cylinders). Ignition circuit: short circuit to primary and secondary current • **Specification** - Primary resistance: 0.36 Ω Secondary resistance: 5.9 kΩ - Secondary voltage: 38 KV - Ignition output Primary current: 7.0 A Primary voltage: 380 V • **Actions** 1. Inspect the circuits and terminals of the ECU pin No. 70, 71 and 72. 2. Inspect the power supply of ignition coil. 3. Inspect the ignition coil and high-voltage cable. 4. Inspect the spark plug for moisture, crack, wear, improper cap and excessive burnt electrode residue. 5. Check the ECU.	o
Secondary Air Supply System	P0411	Defective Secondary Air Pump - Insufficient Air Volume	• **Condition** - The secondary air injection pump relay and air pump valve/ hose are defective. • **Specification** - The voltage drop of pin No. 76 and ground: Below 1 V (current = 1000 mA) • **Actions** 1. Inspect the circuit and terminal of ECU pin No. 76. 2. Inspect the secondary air pump relay. 3. Inspect the arrange ment of secondary air pump's valve and hose. 4. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Secondary Air Supply System	P0413	Secondary Air Pump - Open circuit to Ground	• **Condition** - Secondary air injection pump relay circuit: short or open circuit to ground • **Specification** - The voltage drop of pin No. 76 and ground: Below 1 V (current = 1000 mA) • **Actions** 1. Inspect the circuit and terminal of ECU pin No. 76. 2. Inspect the secondary air pump relay. 3. Check the ECU.	o
	P0414	Secondary Air Pump - Short circuit to B+	• **Condition** - Secondary air injection pump relay circuit: short circuit to battery • **Specification** - The voltage drop of pin No. 76 and ground: Below 1 V (current = 1000 mA) • **Actions** 1. Inspect the circuit and terminal of ECU pin No. 76. 2. Inspect the secondary air pump relay. 3. Check the ECU.	o
Catalytic Monitoring Device	P0420	Faulty Catalyst 1 Purification Rate (1, 2, 3 Cylinder lines)	• **Condition** - The calculated purification rate for bank 1 is below the specified range. (Bank 1 - Cylinder 1/2/3) • **Actions** 1. Inspect the exhaust gas for leaks. 2. Inspect the oxygen sensor and its signal. 3. Inspect the actual effciency of exhaust gas through the exhaust gas test. 4. Inspect the catalyst. 5. Check the ECU.	o
	P0430	Faulty Catalyst 2 Purification Rate (4, 5, 6 Cylinder lines)	• **Condition** - The calculated purification rate for bank 2 is below the specified range. (Bank 2 - Cylinder 4/5/6) • **Actions** 1. Inspect the exhaust gas for leaks. 2. Inspect the oxygen sensor and its signal. 3. Inspect the actual effciency of exhaust gas through the exhaust gas test. 4. Inspect the catalyst. 5. Check the ECU.	o
Evaporated Gas Control System	P0442	Fuel Tank: Oil Leakage	• **Condition** - Minute leak of evaporated gas is occurred (below 1 mm). • **Actions** 1. Inspect the fuel tank and connecting route for the followings: - Fuel tank cap for crack or damage - Vacuum hose for crack, puncture and clogging - Fuel tank for crack, puncture and damage - Canister for crack, puncture and damage - Fuel tank pressure sensor - Canister shut-off valve 2. Check the ECU.	o

Modification basis	
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Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Purge Control Solenoid Valve	P0443	Purge Control Solenoid Valve Malfunction - Faulty closing	• **Condition** - The purge control circuit is defective. The purge control is not available. • **Specification** - Duty ratio: 0 ~ 100 % Below 20 % - 7.5 Hz 20 ~ 30 % - 15 Hz 30 ~ 75 % - 30 Hz - Internal resistance ≥ 26 Ω • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 34. 2. Inspect the power of the solenoid valve. 3. Inspect the purge control solenoid valve. 4. Check the ECU.	o
	P0444	Purge Control Solenoid Valve Malfunction - Short or Open circuit to Ground	• **Condition** - Power supply circuit: short or open circuit to ground • **Specification** - Duty ratio: 0 ~ 100 % below 20 % - 7.5 Hz 20 ~ 30 % - 15 Hz 30 ~ 75 % - 30 Hz - Internal resistance ≥ 26 Ω • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 34. 2. Inspect the power of the solenoid valve. 3. Inspect the purge control solenoid valve. 4. Check the ECU.	o
	P0445	Purge Control Solenoid Valve Malfunction - Short circuit to B+	• **Condition** - Power supply circuit: short circuit to battery • **Specification** - Duty ratio: 0 ~ 100 % below 20 % - 7.5 Hz 20 ~ 30 % - 15 Hz 30 ~ 75 % - 30 Hz - Internal resistance ≥ 26 Ω • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 34. 2. Inspect the power of the solenoid valve. 3. Inspect the purge control solenoid valve. 4. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Canister Shut-off Valve	P0447	Canister Shut-off Valve Malfunction - Short or Open circuit to Ground	• **Condition** - Fuel system shut-off valve circuit: short or open circuit to ground • **Specification** - Duty ratio: 0 ~ 100 % below 20 % → 7.5 Hz 20 ~ 30 % → 15 Hz 30 ~ 75 % → 30 Hz - Internal resistance ≥ 26 Ω • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 36. 2. Inspect the power of the solenoid valve. 3. Inspect the purge control solenoid valve. 4. Check the ECU.	O
	P0448	Canister Shut-off Valve: Short circuit to B+	• **Condition** - Fuel system shut-off valve circuit: short circuit to battery • **Specification** - Duty ratio: 0 ~ 100 % below 20 % → 7.5 Hz 20 ~ 30 % → 15 Hz 30 ~ 75 % → 30 Hz - Internal resistance ≥ 26 Ω • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 36. 2. Inspect the power of the solenoid valve. 3. Inspect the purge control solenoid valve. 4. Check the ECU.	O
Fuel tank pressure sensor	P0450	Fuel Tank Pressure Sensor Malfunction	• **Condition** - Improper fuel tank pressure is detected. • **Specification** 37.5 mbar → 4.51 V 30.0 mbar → 3.90 V 20.0 mbar → 3.10 V 10.0 mbar → 2.30 V 0 mbar → 1.50 V 10.0 mbar → 0.60 V 12.5 mbar → 0.49 V • **Actions** 1. Measure the actual fuel tank pressure using SCAN-100. 2. Inspect the circuits of ECU pin No. 18 and 41 and check pin No. 42. 3. Check the fuel tank pressure sensor. 4. Check the ECU.	O

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Fuel tank pressure sensor	P0452	Low Fuel Tank Pressure Sensor Signal	• **Condition** - The fuel tank pressure signal is below the minimum fuel tank pressure (0.1V). - Related circuit: open circuit • **Specification** 37.5 mbar → 4.51 V 30.0 mbar → 3.90 V 20.0 mbar → 3.10 V 10.0 mbar → 2.30 V 0 mbar → 1.50 V 10.0 mbar → 0.60 V 12.5 mbar → 0.49 V • **Actions** 1. Measure the actual fuel tank pressure using SCAN-100. 2. Inspect the circuits of ECU pin No. 18 and 41 and check pin No. 42. 3. Check the fuel tank pressure sensor. 4. Check the ECU.	o
	P0453	High Fuel Tank Pressure Sensor Signal	• **Condition** - The fuel tank pressure signal is over the maximum fuel tank pressure (4.9 V). - Related circuit: open circuit • **Specification** 37.5 mbar → 4.51 V 30.0 mbar → 3.90 V 20.0 mbar → 3.10 V 10.0 mbar → 2.30 V 0 mbar → 1.50 V 10.0 mbar → 0.60 V 12.5 mbar → 0.49 V • **Actions** 1. Measure the actual fuel tank pressuring using SCAN-100. 2. Inspect the circuits of ECU pin No. 18 and 41 and check pin No. 42. 3. Check the fuel tank pressure sensor. 4. Check the ECU.	o
Evaporated Gas Control System	P0455	Fuel Tank: Large Oil Leakage	• **Condition** - The evaporated gas in the fuel tank is leaked. Diagnosis for large leaks • **Actions** 1. Inspect the fuel tank and connecting route for the followings: - Fuel tank cap for crack or damage - Vacuum hose for crack, puncture and clogging - Fuel tank for crack, puncture and damage - Canister for crack, puncture and damage - Fuel tank pressure sensor - Canister shut-off valve 2. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Fuel Level Detection Sensor	P0460	Faulty Fuel Pump Fuel Level Sensor Indication	• **Condition** - The fuel level or the changed amount of fuel after driving for certain distance is improper. • **Specification** 67.29 liters - 38.0 Ω 62.48 liters - 48.2 Ω 58.28 liters - 56.8 Ω 52.23 liters - 67.0 Ω 45.34 liters - 83.3 Ω 37.41 liters - 99.5 Ω 30.10 liters - 122.5 Ω 21.36 liters - 150.0 Ω 6.45 liters - 268.2 Ω • **Actions** 1. Measure the actual fuel level using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 102 and 75. 3. Check the external resistance (200 Ω). 4. Inspect the fuel sender unit. 5. Check the ECU.	o
	P0462	Faulty Fuel Pump Fuel Level Transmission	• **Condition** - The FF (hexadecimal) is inputted to ECU from cluster. • **Specification** 67.29 liters - 38.0 Ω 62.48 liters - 48.2 Ω 58.28 liters - 56.8 Ω 52.23 liters - 67.0 Ω 45.34 liters - 83.3 Ω 37.41 liters - 99.5 Ω 30.10 liters - 122.5 Ω 21.36 liters - 150.0 Ω 6.45 liters - 268.2 Ω • **Actions** 1. Measure the actual fuel level using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 102 and 75. 3. Check the external resistance (200 Ω). 4. Inspect the fuel sender unit. 5. Check the ECU.	o
Cooling fan system (PWM electric fan)	P0480	PWM electric fan - Short circuit to power supply	• **Condition** - The cooling fan's output wiring has a short circuit to power supply. • **Actions** 1. Inspect the circuit and the terminal of No. 39 ECU pin. 2. Inspect the power supply. 3. Inspect the cooling fan. 4. Check the ECU.	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Cooling fan system (PWM electric fan)	P0480	PWM electric fan - Open/Short circuit to ground	• **Condition** - The cooling fan's output wiring has a short circuit to power supply. • **Actions** 1. Inspect the circuit and the terminal of No. 39 ECU pin. 2. Inspect the power supply. 3. Inspect the cooling fan. 4. Check the ECU.	
Condenser Fan Unit	P0481	Condenser Fan (Low) Relay - Short circuit to B+	• **Condition** - Power supply wiring: short circuit • **Actions** 1. Inspect the circuit and terminal of ECU pin No. 35. 2. Inspect the power supply. 3. Inspect the cooling fan. 4. Check the ECU.	
		Condenser Fan (Low) Relay - Open circuit to Ground	• **Condition** - Short or open circuit to ground • **Actions** 1. Inspect the circuit and terminal of ECU pin No. 35. 2. Inspect the power supply. 3. Inspect the cooling fan. 4. Check the ECU.	
Cooling fan system (PWM electric fan)	P0483	PWM electric fan - Motor overloaded	• **Condition** - The cooling fan's output wiring has a short circuit to power supply. • **Actions** 1. Inspect the circuit and the terminal of No. 39 ECU pin. 2. Inspect the power supply. 3. Inspect the cooling fan. 4. Check the ECU.	
	P0484	PWM electric fan - Motor stalled	• **Condition** - The cooling fan's output wiring has a short circuit to power supply. • **Actions** 1. Inspect the circuit and the terminal of No. 39 ECU pin. 2. Inspect the power supply. 3. Inspect the cooling fan. 4. Check the ECU.	
	P0485	PWM electric fan - Short circuit	• **Condition** - The cooling fan's output wiring has a short circuit to power supply. • **Actions** 1. Inspect the circuit and the terminal of No. 39 ECU pin. 2. Inspect the power supply. 3. Inspect the cooling fan. 4. Check the ECU.	

Modification basis	
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Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Auto Cruise Control	P0500	CAN signal Fault: Auto Cruise Malfunction	• **Condition** - The auto cruise is defective.	o
		Auto Cruise Acceleration Function Fault	• **Condition** - The acceleration signal is faulty.	o
		Auto Cruise Deceleration Function Fault	• **Condition** - The deceleration signal is faulty.	o
	P0501	Defective Vehicle Speed Sensor Signal	• **Condition** - The vehicle speed signal is faulty.	o
		Defective Vehicle Speed Sensor Signal	• **Condition** - The vehicle speed signal is faulty.	o
Battery Voltage	P0562	Low Battery Voltage	• **Condition** - The voltage of ECU is faulty. * Less than minimum 8 Volts in 2000 rpm below * Less than 10 Volts in 2000 rpm above • **Specification** Over 8 V • **Actions** 1. Measure the actual battery voltage using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 12, 11, 10 and 5. 3. Check the power supply relay. 4. Check the battery and the ECU.	o
Auto Cruise Control	P0564	Defective Auto Cruise Control Lever	• **Condition** - The auto cruise lever is defective.	o
CAN Communication	P0600	CAN Communication Malfunction: ASR	• **Condition** - The CAN communication with ASR is defective. • **Specification** - Transfer rate: 500 K Baud • **Actions** 1. Check the CAN communication line of relevant unit. 2. Inspect the circuits and terminals of ECU pin No. 37 and 38. 3. Check the ECU.	o
		CAN Communication Malfunction: ABS	• **Condition** - The CAN communication with ABS is defective. • **Specification** - Transfer rate: 500 K Baud • **Actions** 1. Check the CAN communication line of relevant unit. 2. Inspect the circuits and terminals of ECU pin No. 37 and 38. 3. Check the ECU.	o
		Defective Immobilizer System	• **Specification** - Transfer rate: 500 K Baud • **Actions** 1. Check the CAN communication line of relevant unit. 2. Inspect the circuits and terminals of ECU pin No. 37 and 38. 3. Check the ECU.	o

Modification basis	
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Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
CAN Communica-tion	P0600	CAN Communication Malfunction: TCU	• **Condition** - The CAN communication with TCU is defective. • **Specification** - Transfer rate: 500 K Baud • **Actions** 1. Check the CAN communication line of relevant unit. 2. Inspect the circuits and terminals of ECU pin No. 37 and 38. 3. Check the ECU.	o
		CAN Communication Malfunction: TOD (Not used)	• **Condition** - The CAN communication with TOD is defective. • **Specification** - Transfer rate: 500 K Baud • **Actions** 1. Check the CAN communication line of relevant unit. 2. Inspect the circuits and terminals of ECU pin No. 37 and 38. 3. Check the ECU.	o
		CAN Communication Malfunction: Shift Lever	• **Condition** - The CAN communication with TGS lever is defective. • **Specification** - Transfer rate: 500 K Baud • **Actions** 1. Check the CAN communication line of relevant unit. 2. Inspect the circuits and terminals of ECU pin No. 37 and 38. 3. Check the ECU.	o
		CAN Communication Malfunction: ABS Speed Sensor (FR)	• **Condition** - The ABS front speed sensor's signal is defective. • **Specification** - Transfer rate: 500 K Baud • **Actions** 1. Check the CAN communication line of relevant unit. 2. Inspect the circuits and terminals of ECU pin No. 37 and 38. 3. Check the ECU.	o
		CAN Communication Malfunction: ABS Speed Sensor (RR)	• **Condition** - The ABS rear speed sensor's signal is defective. • **Specification** - Transfer rate: 500 K Baud • **Actions** 1. Check the CAN communication line of relevant unit. 2. Inspect the circuits and terminals of ECU pin No. 37 and 38. 3. Check the ECU.	o

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Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
CAN Communication	P0600	CAN Communication Malfunction: Faulty Initialization	• **Condition** - The communication network data is not initialized. • **Specification** - Transfer rate: 500 K Baud • **Actions** 1. Check the CAN communication line of relevant unit. 2. Inspect the circuits and terminals of ECU pin No. 37 and 38. 3. Check the ECU.	o
		CAN Communication Malfunction: MSR Transmission Signal	• **Specification** - Transfer rate: 500 K Baud • **Actions** 1. Check the CAN communication line of relevant unit. 2. Inspect the circuits and terminals of ECU pin No. 37 and 38. 3. Check the ECU.	o
		CAN Communication Malfunction: ASR Transmission Signal	• **Specification** - Transfer rate: 500 K Baud • **Actions** 1. Check the CAN communication line of relevant unit. 2. Inspect the circuits and terminals of ECU pin No. 37 and 38. 3. Check the ECU.	o
Throttle Body Control	P0601	Throttle Position Sensor - Faulty Learning Signal	– **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	o
ECU	P0601	Auto Cruise Shutdown Memory Malfunction	• **Condition** - The ECU's internal circuit is defective. • **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		ECU Malfunction (Call Monitor)	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o

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Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
ECU	P0601	Servo Motor's Voltage Output Stopped	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		Servo Motor - Short or Open circuit	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		ECU Malfunction (CPU not compatible)	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		ECU Malfunction (Faulty CPU Communication)	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		ECU Malfunction (Faulty CPU (2) Environment)	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		ECU Malfunction (CPU (2) Malfunction)	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		ECU Malfunction (Faulty CPU run-time)	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		Communication Malfunction (CPU2)	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
	P0602	ECU Not Coded	• **Condition** - The ECU coding is incorrect. • **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
Incorrect Coding	P0602	Incorrect Transmission Coding	• **Condition** - TCU (Variant) coding is faulty. • **Actions** 1. Check the current coding using SCAN-100. 2. Check ECU and TCU. 3. Check the CAN line.	o
Incorrect Coding	P0603	Incorrect VIN ECU Coding	• **Actions** 1. Check the current coding using SCAN-100. 2. Check ECU and TCU. 3. Check the CAN line.	o
ECU	P0604	ECU Fault (RAM)	• **Condition** - The memory function of ECU RAM is defective. • **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
ECU	P0605	ECU Fault (EPROM)	• **Condition** - The memory function of ECU is defective. • **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		ECU Fault (Faulty NVRAM Checksum)	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		ECU Fault (Faulty Coding ID Checksum)	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		ECU Fault (Faulty Coding Checksum)	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
		ECU Fault (Faulty Programming Checksum)	• **Actions** 1. Check the ECU connector for contact. 2. Check the ECU.	o
Engine CHECK Warning Lamp	P0650	Engine CHECK Warning Lamp - Short circuit to B+	• **Condition** - Lamp circuit: short circuit to battery • **Actions** 1. Check the actual operating condition using SCAN-100. 2. Inspect the circuit and terminal of ECU pin No. 29.	o
		Engine CHECK Warning Lamp - Open or Short circuit to Ground	• **Condition** - Lamp circuit: short or open circuit to ground • **Actions** 1. Check the actual operating condition using SCAN-100. 2. Inspect the circuit and terminal of ECU pin No. 29.	o
Variable Air Intake System	P0661	Variable Air Intake Valve - Open or Short circuit to Ground	• **Condition** - Variable air intake valve circuit: short or open circuit to ground • **Specification** - ON/OFF flip range: approx. 3500 rpm - Operating current: 0.4 - 0.6 A - Solenoid internal resistance: 25 ± 5 Ω (20°C) • **Actions** 1. Check the actual operation condition using SCAN-100. 2. Inspect the circuit and terminal of ECU pin No. 97. 3. Check the resonance flap's power supply. 4. Check the resonance flap solenoid and unit for damage. 5. Check the ECU.	o

Modification basis	
Application basis	
Affected VIN	

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Variable Air Intake System	P0662	Variable Air Intake Valve - Short circuit to B+	• **Condition** - Variable air intake valve circuit: short circuit to battery • **Specification** - ON/OFF flip range: approx. 3500 rpm - Operating current: 0.4 - 0.6 A - Solenoid internal resistance: 25 ± 5 Ω (20°C) • **Actions** 1. Check the actual operating condition using SCAN-100. 2. Inspect the circuit and terminal of ECU pin No. 97. 3. Check the resonance flap's power supply. 4. Check the resonance flap solenoid and unit for damage. 5. Check the ECU.	o
TCU	P0702	TCU Fault	• **Actions** - Check DTC codes for TCU.	o
		Transmission Malfunction: Solenoid Valve Voltage	• **Actions** - Check DTC codes for TCU.	o
Auto Cruise Control	P0703	CAN Communication Fault: Stop Lamp Switch	• **Condition** - The brake switch is defective.	o
TCU	P0705	Transmission Malfunction: Shift Lever	• **Actions** - Check DTC codes for TCU.	o
	P0715	Transmission Malfunction: Vehicle Speed Sensor	• **Actions** - Check DTC codes for TCU.	o
	P0720	Transmission Malfunction: Faulty Speed to Output	• **Actions** - Check DTC codes for TCU.	o
	P0730	Transmission Malfunction: Hydraulic System	• **Actions** - Check DTC codes for TCU.	o
		Transmission Malfunction: Faulty Gear Recognition	• **Actions** - Check DTC codes for TCU.	o
	P0734	A/T Control Malfunction	• **Actions** - Check DTC codes for TCU.	o
	P0740	Transmission Malfunction: TCC Head Control	• **Actions** - Check DTC codes for TCU.	o
	P0743	Transmission Malfunction: Lockup Converter Clutch	• **Actions** - Check DTC codes for TCU.	o
	P0748	Transmission Malfunction: Modulator Pressure	• **Actions** - Check DTC codes for TCU.	o
	P0753	Transmission Malfunction: Solenoid Valve 1-2/4-5	• **Actions** - Check DTC codes for TCU.	o
	P0758	Transmission Malfunction: Solenoid Valve 2-3	• **Actions** - Check DTC codes for TCU.	o
	P0763	Transmission Malfunction: Solenoid Valve 3-4	• **Actions** - Check DTC codes for TCU.	o
	P0778	Transmission Malfunction: Transmission Pressure	• **Actions** - Check DTC codes for TCU.	o
	P0836	Transmission Malfunction: Transfer Case	• **Actions** - Check DTC codes for TCU.	o

Related Item	DTC	Trouble	Help	Engine CHECK warning lamp
Incorrect Coding	P1570	Immobilizer Not Coded	• **Actions** 1. Check the current coding using SCAN-100. 2. Check ECU and TCU. 3. Check the CAN line.	o
Throttle Body Control	P1590	Safety Fuel Shut-off Time Expired	• **Specification** - Connection between No.1 throttle position sensor and No.2 throttle position sensor No.1 TPS's pull-down resistance: 464 kΩ No.2 TPS's pull-up resistance: 464 kΩ - Potentiometer voltage: 5 V - Potentiometer resistance: 1 kΩ ± 20 % - Permissible current for wiper arms: below 15 μA - Protective resistance for wiper arms: 320 Ω ± 20 % - Motor voltage/max. current : 12 V / below 1.7 A • **Actions** 1. Measure the actual output value using SCAN-100. 2. Inspect the circuits and terminals of ECU pin No. 67, 68, 84, 85, 87 and 112. 3. Inspect the electric throttle controller. 4. Check the ECU.	o
Starter Signal	P1609	Starter Signal Recognition Malfunction	• **Condition** - The starter signal is improperly recognized. • **Specification** - Over 9.6 V (for 1 seconds) • **Actions** 1. Inspect the circuit and terminal of the ECU pin No. 2. 2. Check the ECU.	o

Modification basis	
Application basis	
Affected VIN	