Engine Electrical Devices

Precautions

Precaution for Engine Electrical Device

CENDK1111300001

Refer to “General Precautions” in Section 00 (Page 00-1) and “Precautions on Engine Control Diagnosis” in Section 1A (Page 1A-1).

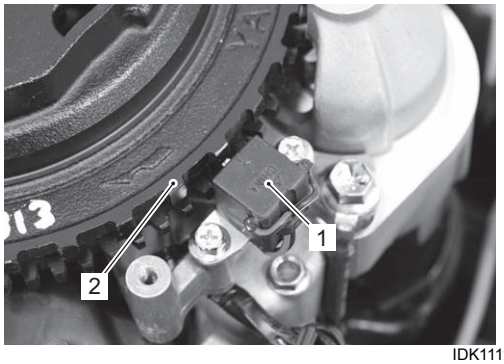
General Description

Sensor and Switch Description

CENDK1111301001

CKP Sensor

- There is one CKP sensor installed on the stator base. When the reluctor bars on the flywheel pass the sensor, a signal (voltage pulse) is generated and sent to the ECM. This is the fundamental signal used to judge engine speed and crankshaft angle.
- There are 34 reluctor bars. They are located 10 degrees apart, except at one position where it is 30 degrees apart.
  During one crankshaft rotation, 34 signals are input to the ECM.
- **Failure Symptom:**
  Without the CKP sensor signal input, the ECM does not output the ignition and fuel injection signals.

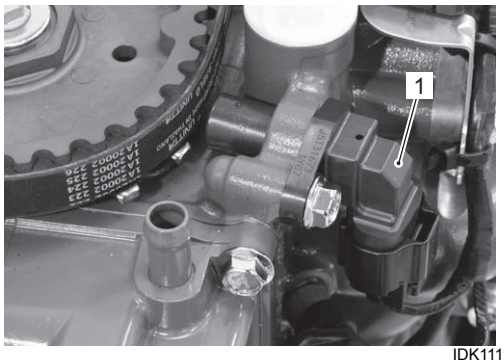


IDK111130020-02

1. CKP sensor	2. Reluctor bar

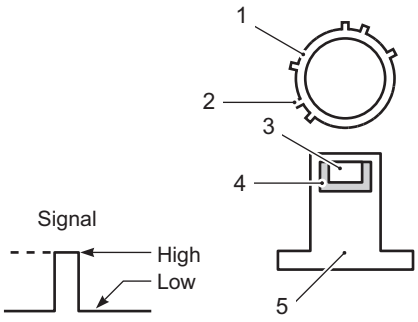
CMP Sensor

- The CMP sensor is mounted on the cylinder head. When the trigger vanes on the cam pulley passes the sensor, a voltage signal is generated and sent to the ECM as pulse signal.
  This sensor is used to detect piston position.
- Signals received from this sensor are also used by the ECM to determine sequential fuel injection.
  The six cam pulley trigger vanes provide six high voltage signals from the CMP sensor to the ECM during one camshaft rotation (two rotations of crankshaft).
- **Failure symptom:**
  Without the CMP sensor signal input, the ECM does not output the ignition and fuel injection signals.



IDK111130021-02

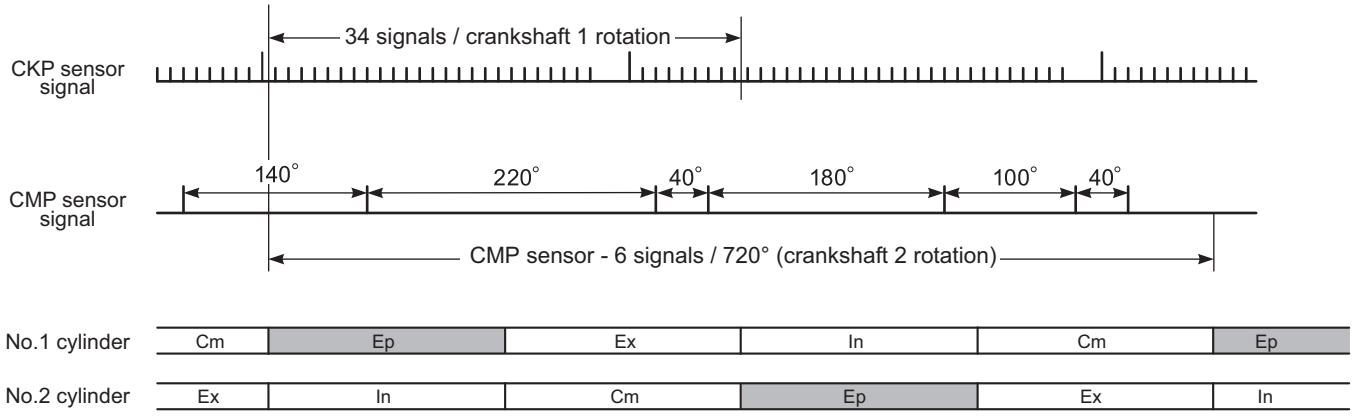
1. CMP sensor



IDK111130008-01

1. Camshaft (Cam pulley)	4. Magnet
2. Trigger vane	5. CMP sensor
3. Magnet resistive semiconductor	

- **ECM cylinder identification:**
  The cylinders are identified by a calculation of two signals; one from the CKP sensor and one from the CMP sensor.



Cm.: Compression, Ep.: Explosion, Ex.: Exhaust, In.: Intake,

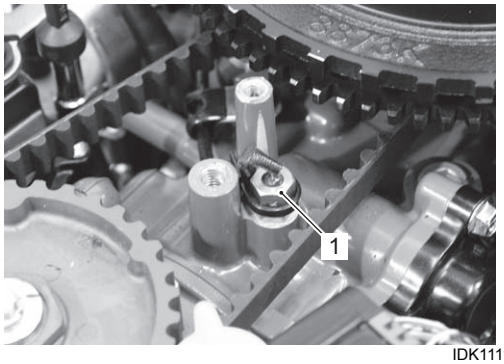
IDK111130001-01

Cylinder Temperature Sensor

The cylinder temperature sensor is installed on the cylinder (top side) and is used to detect the cylinder temperature.

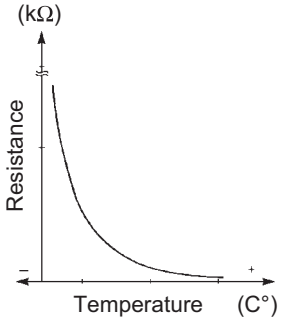
This is a thermistor type sensor (resistance of which changes depending on temperature) and inputs a signal to the ECM as a voltage value. This signal is used to compensate the fuel injection duration, ignition timing, etc.

This sensor is also used to detect engine over-heat as the ECM detects both the temperature and temperature change rate (gradient temp.-temperature rise vs. time).



IDK111130022-02

1. Cylinder temp. sensor



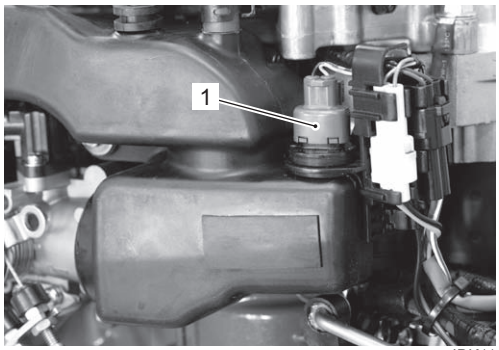
I9J011130003-02

IAT Sensor

The IAT sensor is installed on the air intake silencer case and is used to detect the intake air temperature.

This sensor is the same type as the cylinder temperature sensor, and inputs a signal to the ECM as a voltage value.

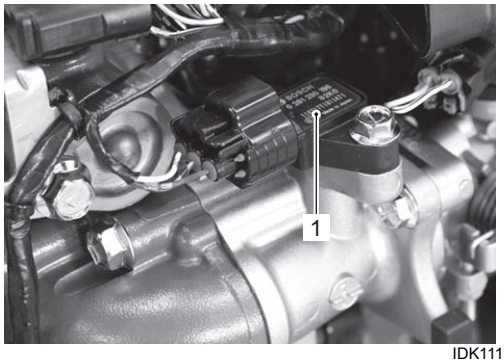
This signal is used to compensate the fuel injection duration.



IDK111130023-02

1. IAT sensor

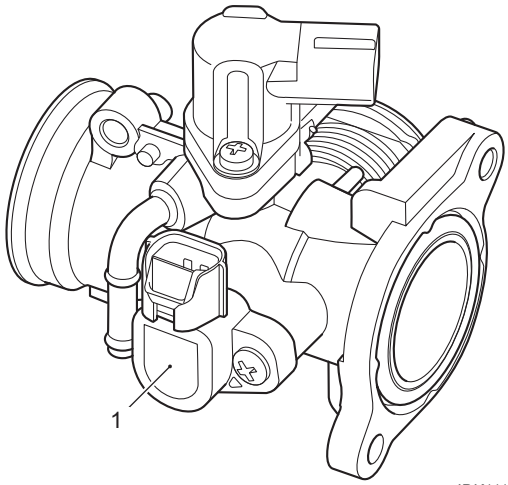
MAP Sensor
The MAP sensor is installed on the intake manifold and used to detect the intake manifold pressure.
This sensor inputs the intake manifold pressure to the ECM as a voltage value.
This input signal is used as the fundamental signal to determine fuel injection duration, ignition timing, etc.



IDK111130024-03

1. MAP sensor

Throttle Position Sensor (TPS)
The TPS is installed on the throttle body and detects the degree of throttle opening. The throttle shaft is interlocked with the TPS shaft.
This sensor is a variable resistor, changing resistance (Ohms) in accordance with the throttle opening.
The varying resistance value is converted to voltage and input to the ECM.
Based on the TPS voltage, the ECM calculates the idle and throttle opening position to determine the control modes of the various controls systems (Idle air control, fuel injection control system, etc.).

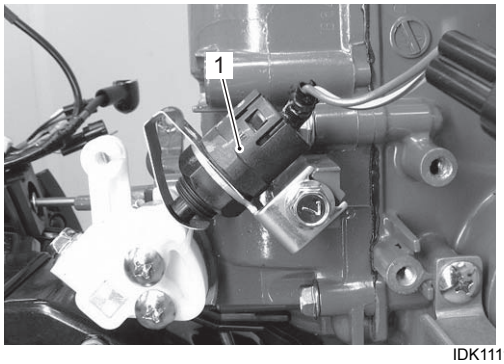


IDK111130009-01

1. TPS

Neutral Switch
The neutral switch is installed on the cylinder block (PORT side) and is used to detect the shift position. This switch is “ON” in neutral and “OFF” in forward or reverse.
The ECM performs the following controls based on the neutral switch signal:

- Fuel injection and ignition are not performed when the shift is in forward or reverse at the time of engine start. (Start-in-gear protection. Refer to “Start-In-Gear Protection System Description” in Section 1I (Page 1I-1).)
- When the shift lever is in neutral, fuel injection is controlled so that the engine speed does not exceed 3000 r/min.
- After shifting into forward or reverse from neutral, the IAC valve is controlled to increase intake air to prevent unstable engine idle or stalling.

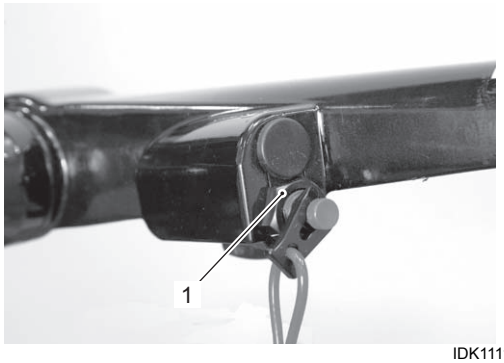


IDK111130025-02

1. Neutral switch

Emergency Stop Switch
When the cord from the plate of the switch is secured to the operator, the plate will be pulled off if the operator is suddenly thrown overboard.
The circuit of emergency stop switch will be closed when the plate is removed.
Then the ECM does not provide fuel injector operating signal, ignition signal and fuel pump operating signal.

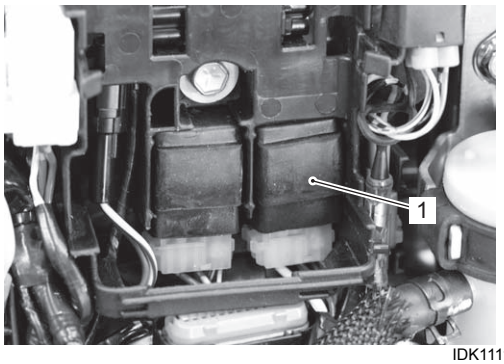
Failure Symptoms
A switch short circuit will not allow the motor to start.



IDK111130026-02

1. Emergency stop switch

Battery Relay
(for electric start models)
The battery relay is installed in the electric parts holder. The relay is turned on when ECM detects 6 volts or more as a battery voltage after engine starting, and a charging circuit is formed which supplies charging current to the battery.
If the battery voltage decreases to less than 6 volts while operating the engine, the battery relay is turned off.



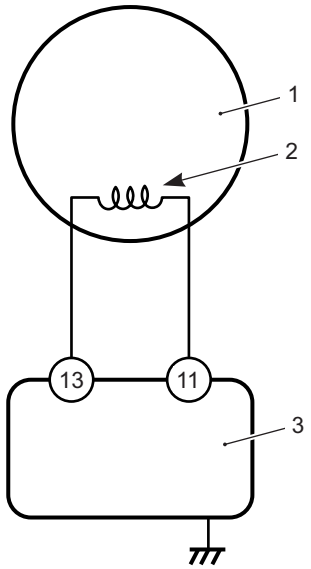
IDK111130027-02

1. Battery relay	

ECM Power Source

CENDK1111301002

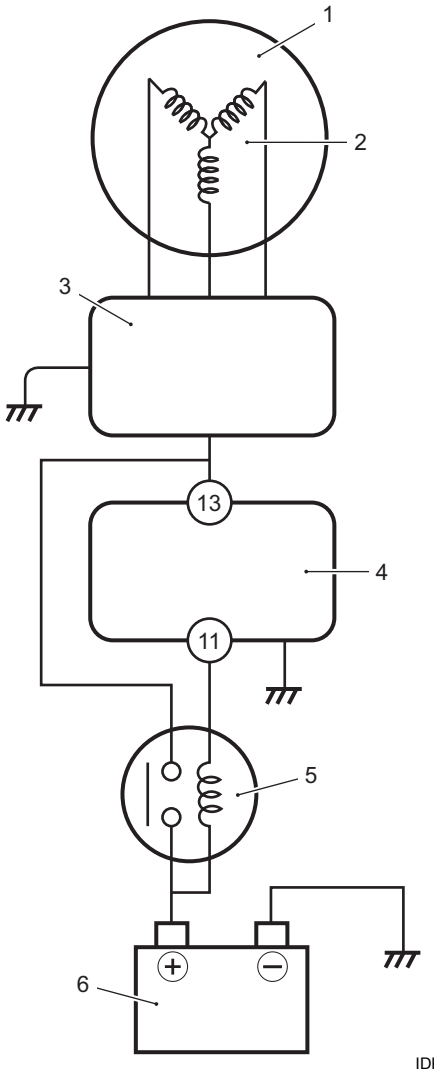
Manual Starter Model
The AC output to which electricity is generated by the ECM power source coil is input through No.13 and No.14 terminal to the ECM.
The AC output is rectified to the DC power in ECM, and it is supplied to the engine control system.



IDK111130003-01

1. Flywheel	3. ECM
2. ECM power source coil	

Electric Starter Model
The AC output from the battery charge coil is rectified to DC power by the rectifier / regulator. The DC power inputs to ECM through ECM No.13 terminal, and it is supplied to the engine control system.



IDK111130004-01

1. Flywheel	4. ECM
2. Battery charge coil	5. Battery relay
3. Rectifier / Regulator	6. Battery

Component Location

Location of Sensor and Switch

CENDK1111303001

Refer to “Wiring Harness Routing Diagram” in Section 4A (Page 4A-3).

Service Instructions

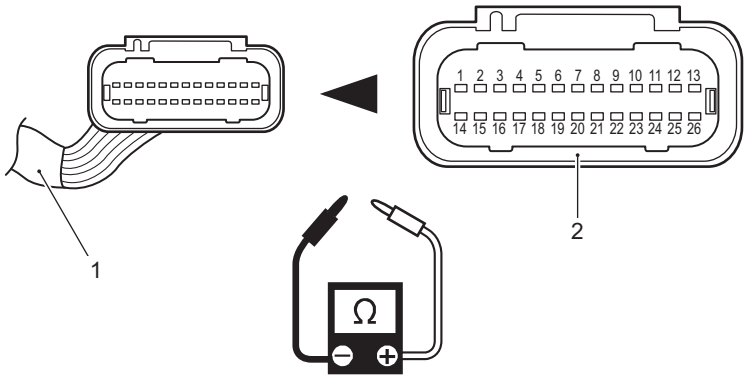
Resistance Check

CENDK1111306001

Special tool
TOOL : 09930–99320 (Digital tester)

Tester knob indication
Resistance (Ω)

1) Stop the engine.
2) Disconnect battery cables from battery.
3) Disconnect wire harness connector from ECM.
4) Connect the tester probes to terminal (wire harness side) and measure resistance according to the “Resistance Table” (Page 1C-5).



IDK111130005-01

1. Engine main wire harness	2. Black connector

Resistance Table

Circuit	Terminal for tester probe connection	Standard resistance (at 20 °C)
ECM Power source coil (Manual starter model)	13 (Br/R) to 11 (Br/W)	2.1 – 3.2 Ω
CKP sensor	26 (R/B) to 7 (B)	148 – 222 Ω
Fuel injector No.1	2 (O/B) to 9 (Gr/R)	10 – 14 Ω
Fuel injector No.2	15 (B/Br) to 9 (Gr/R)	
IAC Valve	17 (W/B) to 9 (Gr/R)	31 – 42 Ω
IAT sensor	22 (Lg/B) to 7 (B)	0 ° C (32 °F): 5.3 – 6.6 kΩ 25 ° C (77 °F): 1.8 – 2.3 kΩ 50 ° C (122 °F): 0.73 – 0.96 kΩ 75 ° C (135 °F): 0.33 – 0.45 kΩ (Thermistor characteristic)
Cylinder temperature sensor	24 (Lg/W) to 7 (B)	

ECM Power Source Coil Peak Voltage Inspection

CENDK1111306002

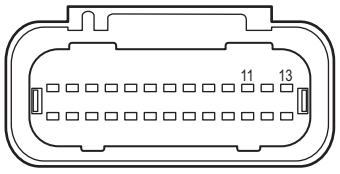
Applicable model: Manual starter model

Special tool
CD-77 : Stevens peak reading voltmeter CD-77

Tester knob indication
POS 50

1) Disconnect the wire harness connector from ECM.
2) Connect the tester probe ("–", Black) to No.11 terminal as shown in figure.
3) Connect the tester probe ("+", Red) to No.13 terminal.

Tester probe connection	
Red (+)	**Black (–)**
No.13 (Br/R)	No.11 (Br/W)



IDK111130006-01

4) Remove the all spark plugs.
5) Crank with the recoil starter, then measure voltage.

ECM power source coil peak voltage
16 V or over

6) If measurement is out of specification, check wire harness for open and short.
If wire harness is in good condition, replace the ECM power source coil.

ECM Power Source Coil Removal and Installation

CENDK1111306003

Applicable model: Manual starter model
Refer to "ECM Power Source Coil / Battery Charge Coil / CKP Sensor / Stator Base Removal and Installation" in Section 1K (Page 1K-10).

CKP Sensor Peak Voltage Inspection

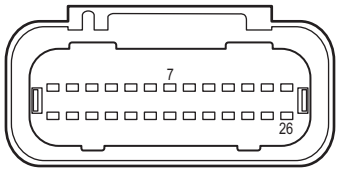
CENDK1111306004

Special tool
CD-77 : Stevens peak reading voltmeter CD-77

Tester knob indication
SEN 5

1) Disconnect the wire harness connector from ECM.
2) Connect the tester probe ("–", Black) to No.7 terminal (or to body ground) as shown in figure.
3) Connect the tester probe ("+", Red) to No.26 terminal.

Tester probe connection	
Red (+)	**Black (–)**
No.26 (R/B)	No.7 (B)



IDK111130007-01

4) Remove all spark plugs.
5) Crank with the recoil starter, then measure voltage.

CKP sensor peak voltage
1 V or over

6) If measurement is out of specification,
   - 1st, check CKP sensor air gap
   - 2nd, check wire harness for open and short.

If wire harness and air gap are in good condition, replace CKP sensor and recheck.

CKP Sensor Removal and Installation

CENDK1111306005

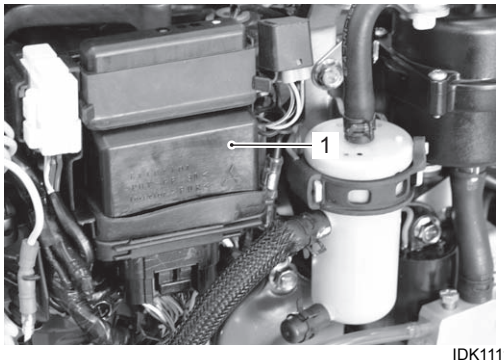
Refer to "Battery Charge Coil / CKP Sensor / Stator Base Removal and Installation" in Section 1K (Page 1K-5).

Cylinder Temp. Sensor Removal and Installation

CENDK1111306006

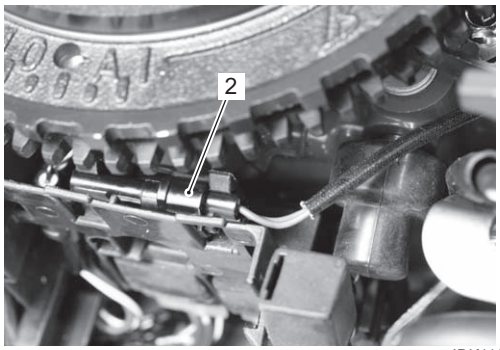
Removal

1) Remove the recoil starter.
   Refer to “Recoil Starter Removal and Installation” in Section 1J (Page 1J-3).
2) Disconnect lead wire connector from ECM (1), then remove ECM.



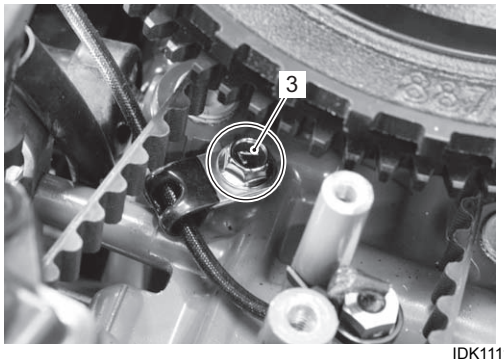
IDK111130028-02

3) Disconnect the cylinder temp. sensor lead wire connector (2).



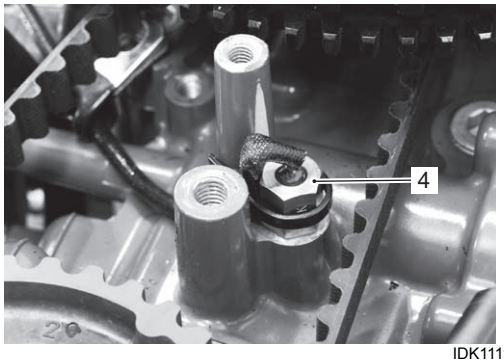
IDK111130029-02

4) Remove the bolt (3) securing lead wire clamp.



IDK111130030-02

5) Cut the cable tie securing sensor lead wire.
   Loosen and remove the cylinder temp. sensor (4).



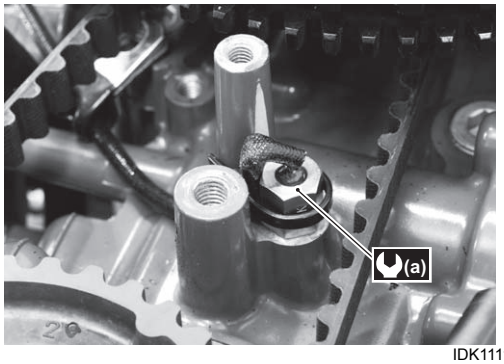
IDK111130031-02

Installation

Installation is reverse order of removal.

- Clean mating surface of sensor and cylinder.
- Tighten sensor to specified torque.

Tightening torque
Cylinder temp. sensor (a): 9 N·m (0.9 kgf-m, 6.5 lbf-ft)



IDK111130032-02

- Connect connector to sensor securely.
- Secure the sensor lead wire with the cable tie.
- Check to ensure that all removed parts are back in original position.
- Check wire routing.
  Refer to “Wiring Harness Routing Diagram” in Section 4A (Page 4A-3).

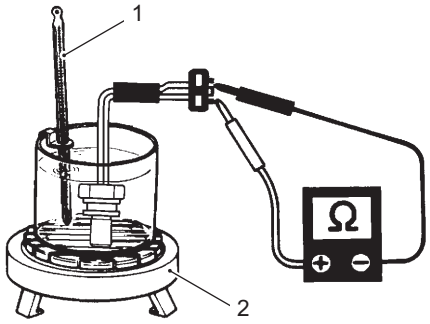
Cylinder Temp. Sensor Inspection

CENDK1111306007

1) Remove the cylinder temperature sensor.
   Refer to “Cylinder Temp. Sensor Removal and Installation” (Page 1C-7).
2) Immerse temperature sensing part of cylinder temp. sensor in water.
3) Measure resistance between sensor terminals while heating water gradually.
4) If measured resistance does not change in the proportion indicated, replace sensor.

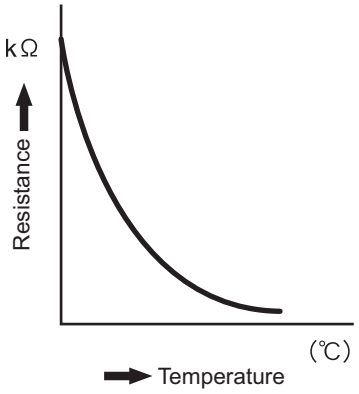
Cylinder temp. sensor specification

Water temperature: °C (°F)	0 (32)	25 (77)	50 (122)	75 (135)
Resistance (kΩ)	5.3 – 6.6	1.8 – 2.3	0.73 – 0.96	0.33 – 0.45



I9J011130051-01

1. Thermometer	2. Heater



I9J011130008-02

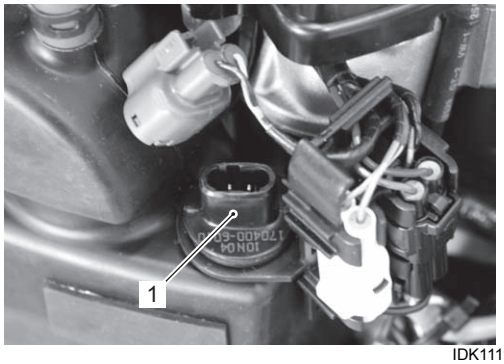
5) Reinstall the cylinder temp. sensor.
   Refer to “Cylinder Temp. Sensor Removal and Installation” (Page 1C-7).

IAT Sensor Removal and Installation

CENDK1111306009

Removal

1) Disconnect the IAT sensor lead wire connector.
2) Remove IAT sensor (1).



IDK111130033-02

Installation

Installation is reverse order of removal with special attention to the following steps.

- Check to ensure that all removed parts are back in original position.
- Check wire routing.
  Refer to “Wiring Harness Routing Diagram” in Section 4A (Page 4A-3).

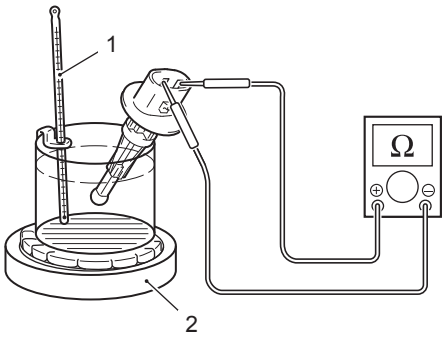
IAT Sensor Inspection

CENDK1111306010

1) Remove the IAT sensor.
   Refer to “IAT Sensor Removal and Installation” (Page 1C-8).
2) Immerse temperature sensing part of IAT sensor in water.
3) Measure resistance between sensor terminals while heating water gradually.
4) If measured resistance does not change in the proportion indicated, replace sensor.

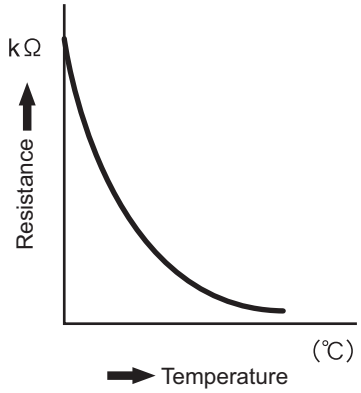
IAT sensor specification

Water temperature: °C (°F)	0 (32)	25 (77)	50 (122)	75 (135)
Resistance (kΩ)	5.3 – 6.6	1.8 – 2.3	0.73 – 0.96	0.33 – 0.45



I9J011130007-03

1. Thermometer	2. Heater



I9J011130008-02

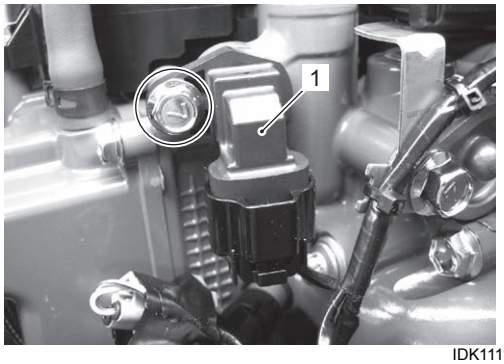
5) Reinstall the IAT sensor.
Refer to “IAT Sensor Removal and Installation” (Page 1C-8).

CMP Sensor Removal and Installation

CENDK1111306012

Removal

1) Disconnect the CMP sensor lead wire connector at sensor.
2) Remove the bolt and CMP sensor (1).



IDK111130034-01

Installation

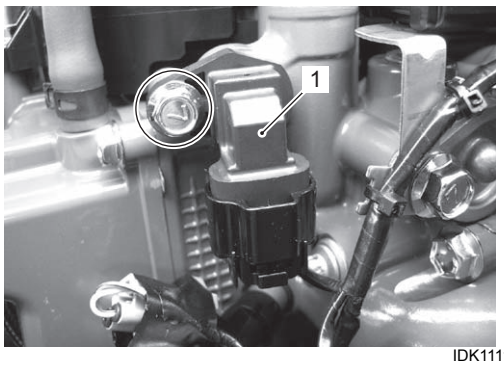
Installation is reverse order of removal.

- Install CMP sensor, then tighten mounting bolt securely.
- Connect sensor lead wire connector to CMP sensor.

CMP Sensor Inspection

CENDK1111306011

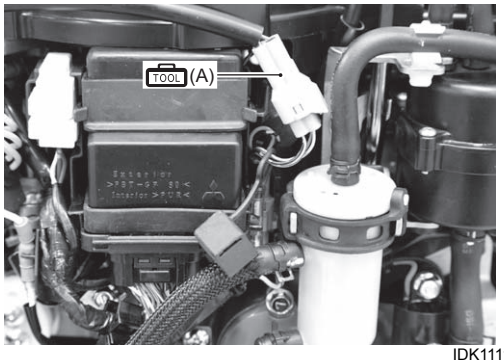
1) Stop the engine.
2) Remove the bolt and CMP sensor (1).



IDK111130034-01

3) Connect the ECM power source cable to SDS communication connector.

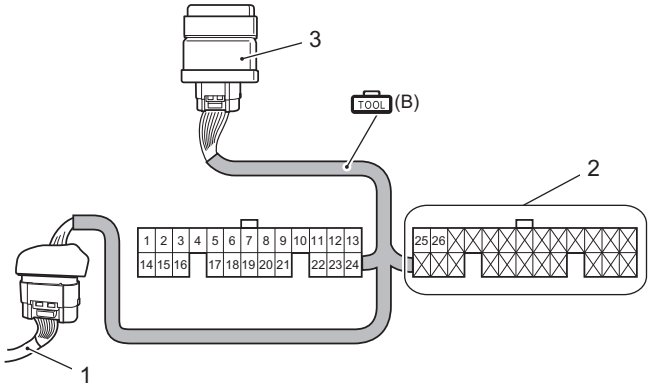
Special tool
TOOL (A): 09933–08910 (ECM power source cable)



IDK111130035-02

4) Connect the 26-pin test cord between ECM and wire harness as shown in figure.

Special tool
(B): 09930–88940 (26-pin test cord)



IDK111130010-01

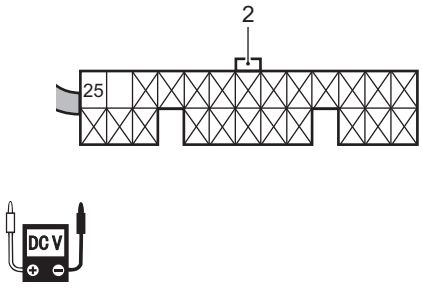
1. Wire harness	2. Black connector	3. ECM

5) Connect the ECM power source cable to battery.
6) Connect the tester probe (“+”, Red) to No.25 terminal.
7) Connect the tester probe (“–”, Black) to No.7 terminal (or to body ground).

Special tool
: 09930–99320 (Digital tester)

Tester knob indication
DC Voltage

26-pin test cord (Black connector)

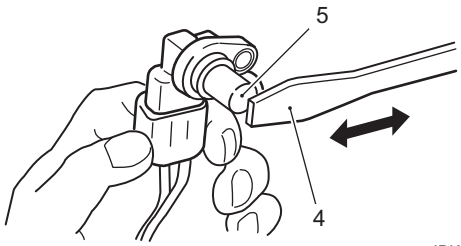


IDK111130011-02

8) Measure the voltage when the tip of a steel screwdriver is brought near and then pulled away from the sensor tip.

When screwdriver is brought near
Approx. 5 V

When screwdriver is pulled away
Approx. 0.3 V



IDK111130018-02

4. Screw driver	5. CMP sensor

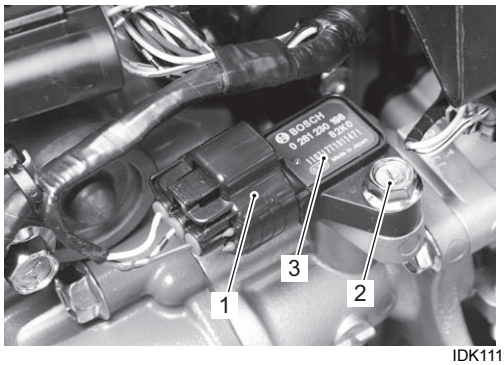
9) If the voltage does not change in the above test, check wire harnesses for open and short.
If wire harnesses are in good condition, replace CMP sensor and recheck.
10) Reinstall CMP sensor.

MAP Sensor Removal and Installation

CENDK1111306013

Removal

1) Disconnect lead wire connector (1) at MAP sensor.
2) Remove the bolt (2) and MAP sensor (3).



IDK111130036-02

Installation

Installation is reverse order of removal.

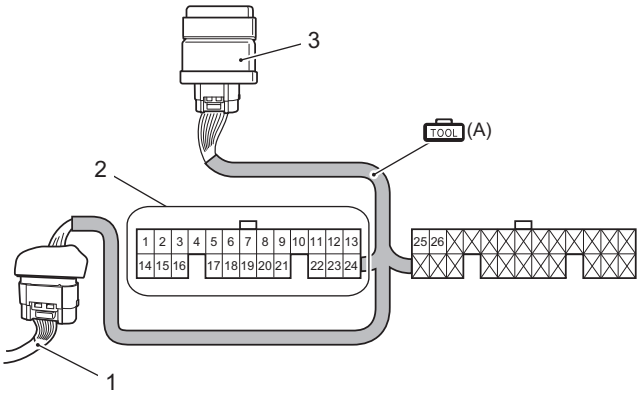
- Install MAP sensor, then tighten mounting bolt securely.
- Connect sensor lead wire connector to MAP sensor.

MAP Sensor Output Voltage Inspection

CENDK1111306014

1) Connect the 26-pin test cord between ECM and wire harness as shown in figure.

Special tool
TOOL (A): 09930–88940 (26-pin test cord)

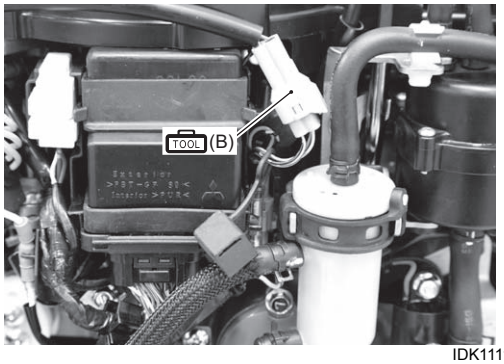


IDK111130012-01

1. Wire harness	2. White connector	3. ECM

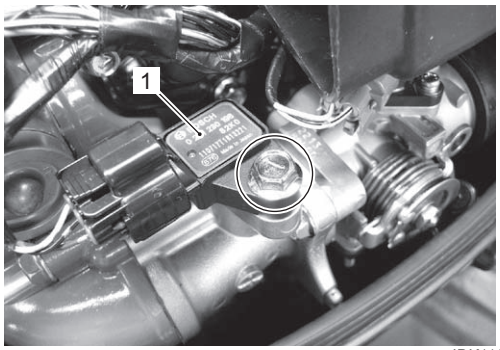
2) Connect the ECM power source cable to SDS communication connector and battery.

Special tool
TOOL (B): 09933–08910 (ECM power source cable)



IDK111130037-02

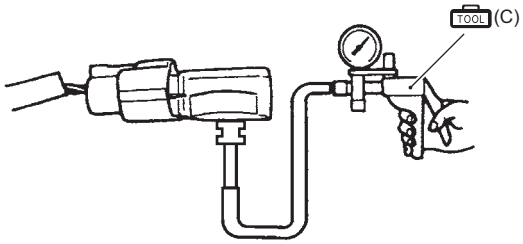
3) Remove the bolt and MAP sensor (1) from intake manifold.



IDK111130038-01

4) Connect vacuum pump gauge (with hose) to MAP sensor as shown in figure.

Special tool
TOOL (C): 09917–47011 (Vacuum pump gauge)



IDK111130002-03

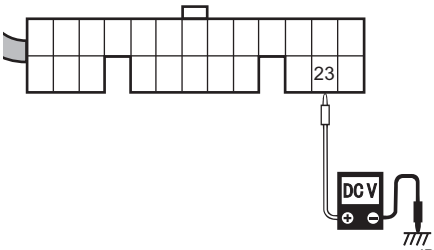
5) While applying negative pressure (vacuum) to MAP sensor, measure “23” terminal voltage.

MAP sensor output voltage change

Negative pressure: kPa (kg/cm², mmHg)	0 (0, 0)	40 (0.4, 300)	80 (0.8, 600)
“23” terminal voltage (V)	4.00	2.42	0.84

(at 759.8 mmHg, 101.3 kPa, 29.91 inHg barometric pressure.)

26-pin test cord (White connector)



IDK111130013-01

Special tool
TOOL : 09930–99320 (Digital tester)

Tester knob indication
DC Voltage (⎓)

6) If out of specification, Check wire harnesses for open and short. If wire harnesses are in good condition, replace MAP sensor and recheck.

7) Reinstall MAP sensor.
Refer to “MAP Sensor Removal and Installation” (Page 1C-10).

IAC Valve Removal and Installation

CENDK1111306015

Refer to “Throttle Body Removal and Installation” in Section 1D (Page 1D-7).

NOTICE

The throttle body will lose its original performance if it has been disassembled and reassembled.

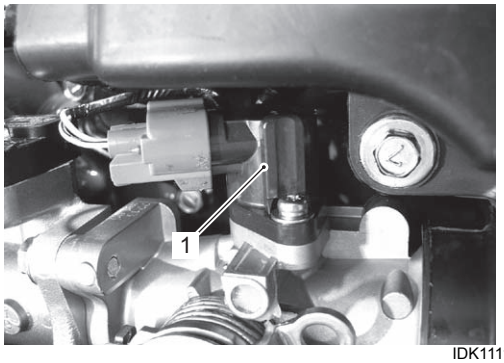
Do not try to adjust or remove any of the throttle body component parts (Throttle position sensor, throttle valve, throttle stop screw, etc.).
These components have been factory adjusted to precise specifications.

IAC Valve Inspection

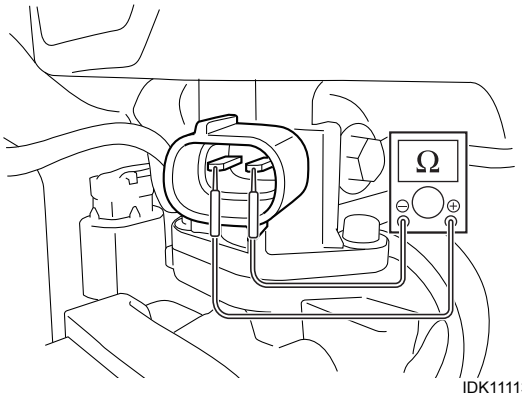
CENDK1111306016

1) Disconnect connector from IAC valve (1).
2) Check the coil of IAC valve for resistance.
   If out of specification, replace IAC valve.

IAC valve resistance
Standard: 31 – 42 Ω



IDK111130039-01



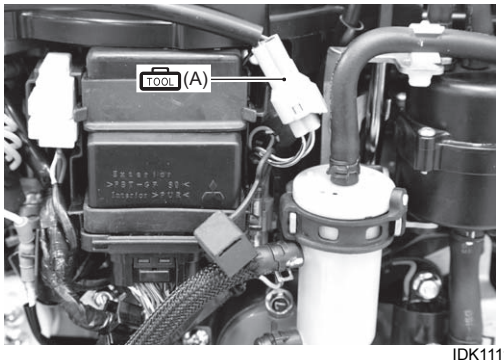
IDK111130019-01

TPS Inspection

CENDK1111306017

1) Stop the engine.
2) Connect the ECM power source cable to SDS communication connector.

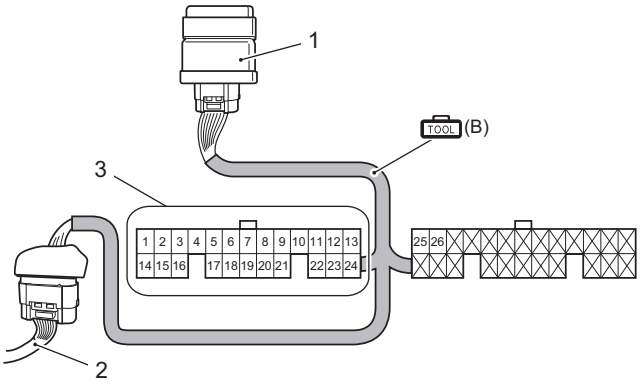
Special tool
TOOL (A): 09933–08910 (ECM power source cable)



IDK111130040-02

3) Connect the 26-pin test cord between ECM and wire harness as shown in figure.

Special tool
TOOL (B): 09930–88940 (26-pin test cord)

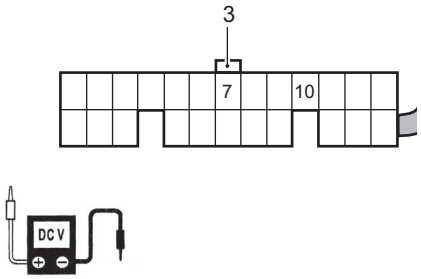


IDK111130014-01

1. ECM	2. Wire harness	3. White connector

4) Connect the ECM power source cable to battery.
5) Connect tester probe (“+”, Red) to No.10 terminal.

6) Connect tester probe ("–", Black) to No.7 terminal (or to body ground)
26-pin test cord (White connector)



IDK111130015-01

7) Check for sensor output voltage.
Slowly move the throttle control grip to open, and check if voltage changes linearly within specification, according to throttle valve opening angle.

Sensor output voltage
FCT position: Approx. 0.7 V
WOT position: Approx. 3.8 V

Special tool
TOOL : 09930–99320 (Digital tester)

Tester knob indication
DC Voltage (⎓)

NOTICE

The throttle body will lose its original performance if it has been disassembled and reassembled.

Do not try to adjust or remove any of the throttle body component parts (Throttle position sensor, throttle valve, throttle stop screw, etc.).
These components have been factory adjusted to precise specifications.

8) If out of specification, check wire harness for open and short. If wire harnesses are in good condition, replace the throttle body and recheck.

Emergency and Engine Stop Switch Inspection

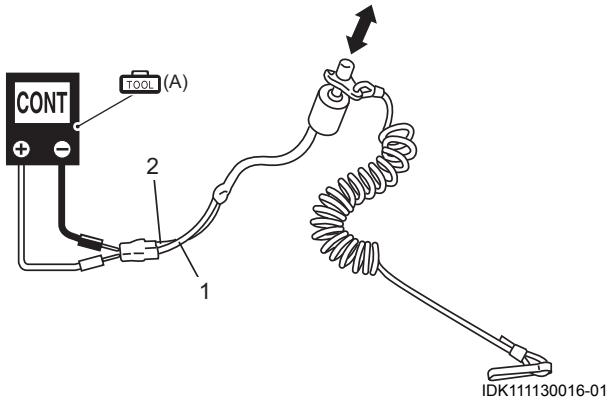
CENDK1111306008

1) Disconnect the emergency stop switch lead wire.
2) Check the continuity / infinity between the wiring leads under the condition shown below.

Special tool
TOOL (A): 09930–99320 (Digital tester)

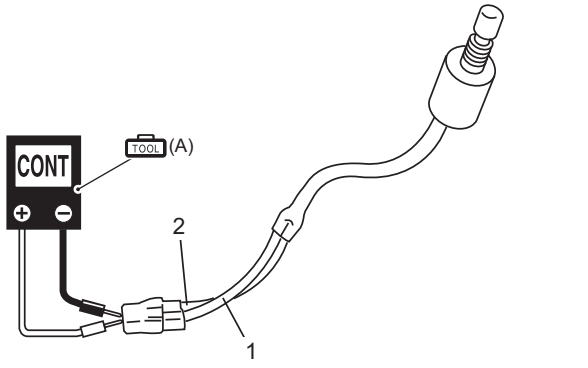
Tester knob indication
Continuity (•))))

	Tester probe connection		Tester indicates
	Red (+)	Black (–)	
Lock plate installed	Blue / Red	Black	Infinity
Lock plate removed			Continuity
Lock plate installed and stop button depressed			Continuity



IDK111130016-01

1. Bl/R	2. B



IDK111130017-02

1. Bl/R	2. B

3) If out of specification, replace the switch.