PART NO. KM-6WG1-E-00 (1/2)

HITACHI

Engine Manual (1/2)

6WG1

6WG1 ENGINE MANUAL (1/2)

Hitachi Construction Machinery Co., Ltd.

URL:http://www.hitachi-c-m.com

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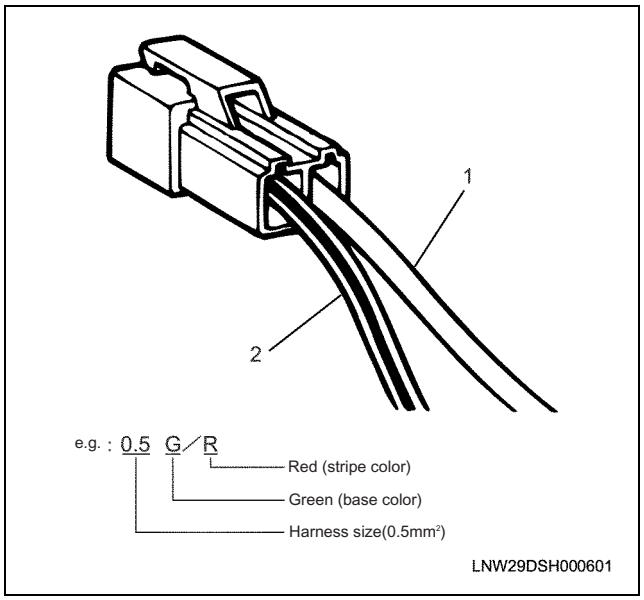
This manual consists of the following sections.
Control System

About colors of wirings

All harnesses are identified by using different colors of claddings. The harness for the main circuit in a certain electrical system is identified by using a single color, while the harness for the sub circuit uses a color in stripes. Sizes and colors coding in a wiring diagram are as follows.



Name
1. Single color
2. Color stripe

Symbol	Color	Symbol	Color
B	Black	BR	Brown
W	White	LG	Light green
R	Red	GR	Grey
G	Green	P	Pink
Y	Yellow	SB	Sky blue
L	Blue	V	Violet
O	Orange		

Data link connector (DLC)

The data link connector is communication device with control unit. The DLC is also used to connect a scan tool. General use of scan tool is described below.

Note:
The location of DLC and existence of DLC vary depending on each machine. Refer to the machine's manual.

- Identification of stored DTC
- Reading of serial data

About ECM OFF

The power of ECM is cut off 10 seconds after the key switch is turned to OFF, and then it will be ECM OFF condition.

Operation of comprehensive diagnosis for monitors of components

It is necessary to comprehensively diagnose components for the proper operation of the engine.

Input components:

Input components are confirmed to check if there are open circuit and the values exceed the range.
Though the following does not include all input components, these sensors are included.

- Crankshaft position (CKP) sensor
- G sensor
- Engine coolant temperature (ECT) sensor
- Vehicle speed sensor
- Boost pressure sensor
- Common rail pressure sensor
- Accelerator position (AP) sensor

Output components:

Output components are diagnosed if their responses to commands from control units are relevant. Check whether there are open circuit and the values exceed the range.
Though the following does not include all the output components to be confirmed, these circuits are included.

- Pressure control valve (PCV)
- Lamp, relay control
- Magnetic valve
- Diagnosis lamp

How to read DTC

How to read DTC by diagnosis lamp

The diagnosis lamp blinks to indicate the current and history trouble codes (DTCs) stored in ECM by connecting the diagnosis switch.

Note:
Refer to the machine's manual for the locations of diagnosis lamp.

- Turn the key switch to ON and make sure the diagnosis lamp illuminates. (Bulb check)
- Turn the key switch to ON, and the engine OFF.
- Connect the diagnosis switch (connector).
- Read the blinking pattern of the diagnosis lamp.
- Judge the contents of DTC by DTC table.

If a scan tool has been connected, it can be read using the tool.

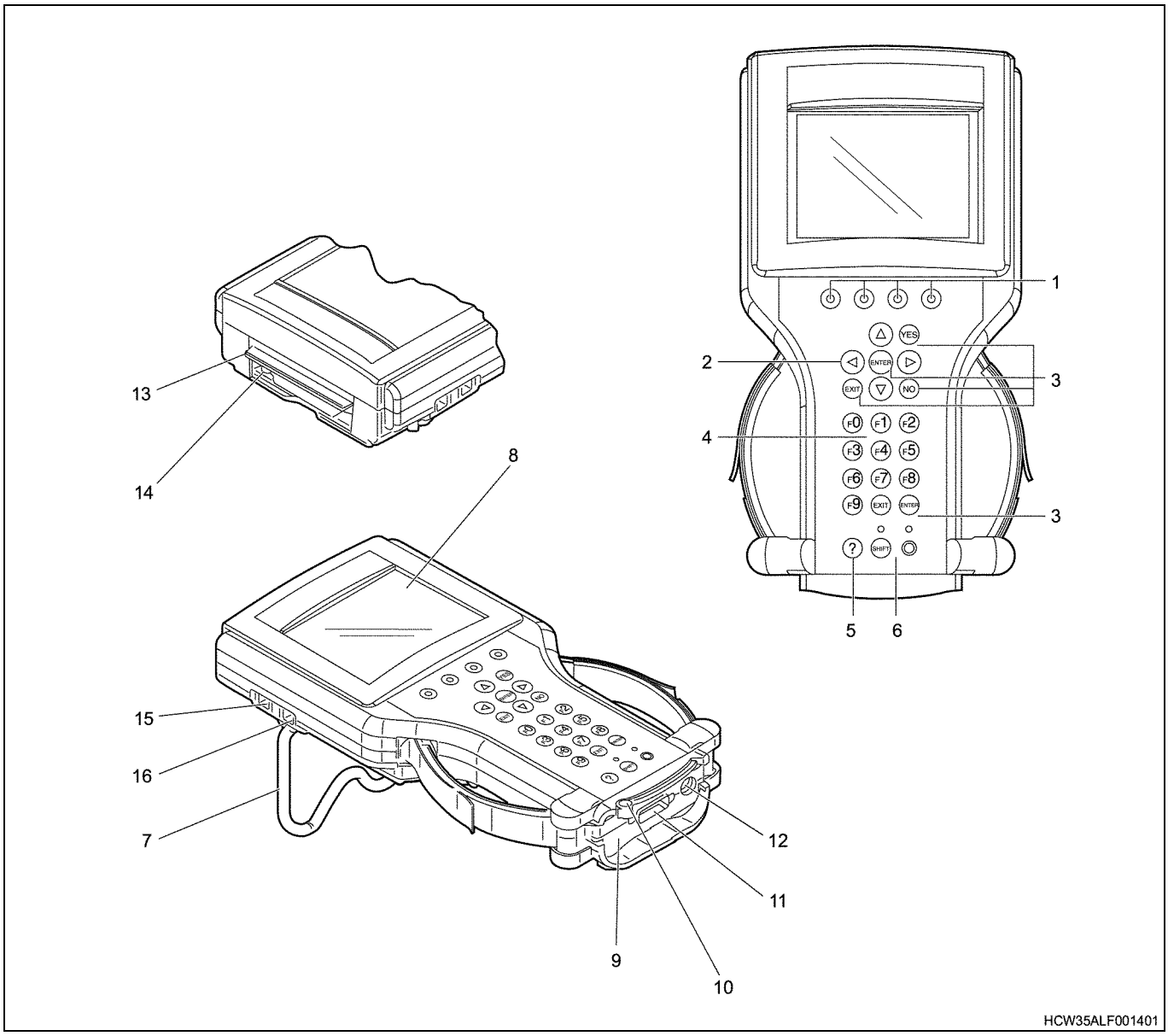
Indication with no DTC stored

The code "1", which indicates starting of code display, is repeatedly displayed.

Indication with DTC stored

Stored trouble code is displayed three times. If more than one trouble code are stored, they are displayed in the ascending order for three times each. After taking a round, codes are repeatedly displayed in the ascending order. This will last as long as the diagnosis connector is connected.

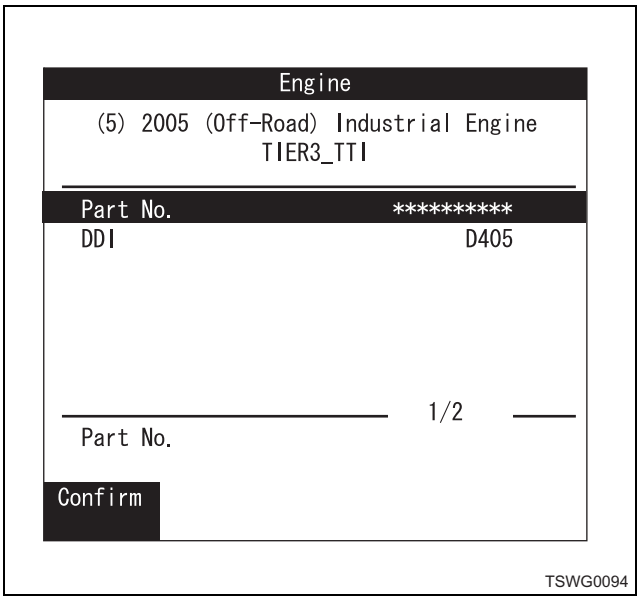
Each part of Tech2



Name

1. Softkeys
2. Selection keys (Arrow keys)
3. Action keys (YES, NO, ENTER, EXIT)
4. Function keys (F0 — F9)
5. Help key (?)
6. Control keys (PWR / SHIFT)
7. Wide stand
8. Display area (LCD)
9. Machine communication interface (VCI) module
10. Fastening bar of VCI module
11. Connector of DLC cable connection
12. Connector for AC adapter connection
13. PCMCIA card insertion slot with cover
14. PCMCIA card release button
15. Connector for external communication (RS-232 port)
16. Connector for external communication (RS-485 port)

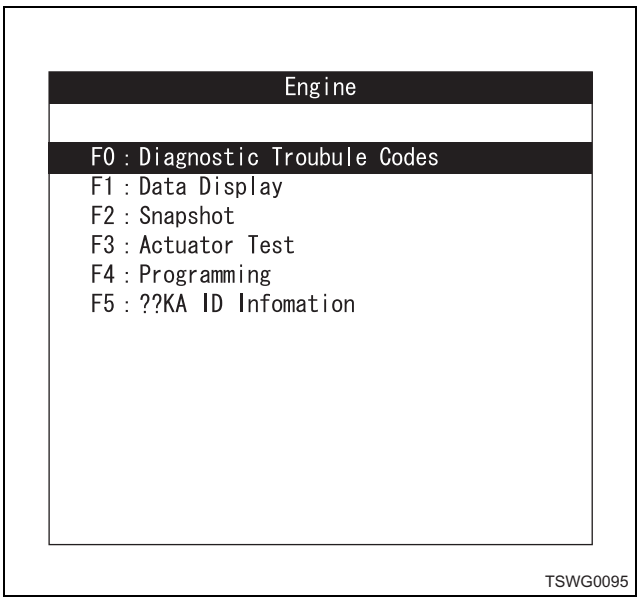
1. Softkeys
   While operating the Tech2, selection boxes appear on the upper part of the screen. The softkeys correspond the selection boxes. They cannot be used unless the selection boxes are displayed.
2. Selection keys (Arrow keys)
   They are used to select the menu or switch the display on the screen of Tech2. Selected part is highlighted in the screen.
3. Action keys (YES, NO, ENTER, EXIT)
   They are used to execute the operation of Tech2, respond to instruction/question, and switch/move to each menu screen.
4. Function keys (F0 — F9)
   They are used to execute a menu function in the screen. These keys also correspond to F numbers, such as “F0”, when they are displayed on the menu screen.



Pressing [EXIT] key in the steps 3 to 9 will return you to the “Main Menu” screen.

DTC check

1. Select “F0: Diagnostic Trouble Codes” on the “Engine” screen.



   F0: Diagnostic Trouble Codes
   This function allows the user to analyze the information on the Trouble Code related to the system currently under test.
2. Choosing “F0: Diagnostic Trouble Codes”, the following menu is displayed.
   F0: DTC Display
   F1: DTC Clear

F0: DTC Display
Loads and displays the DTC information stored in the machine controller in a priority order.

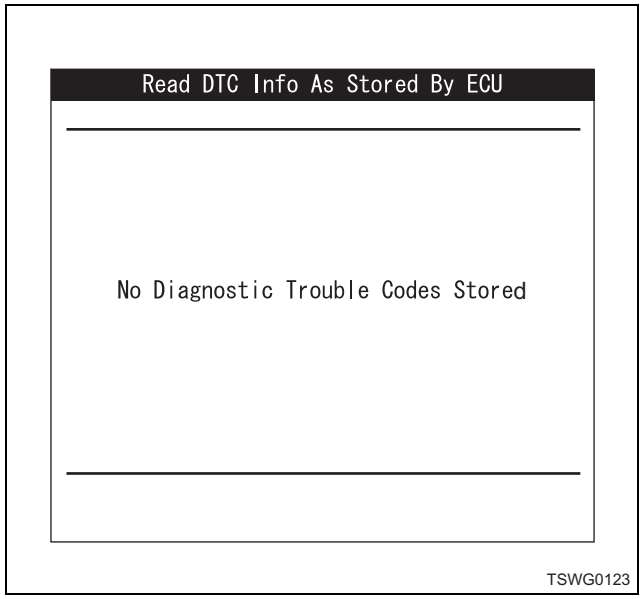
F1: DTC Clear

Depending on a machine, DTC is not clearing by Tech2. (The memory clear harness on the machine side needs to be connected to ground.)

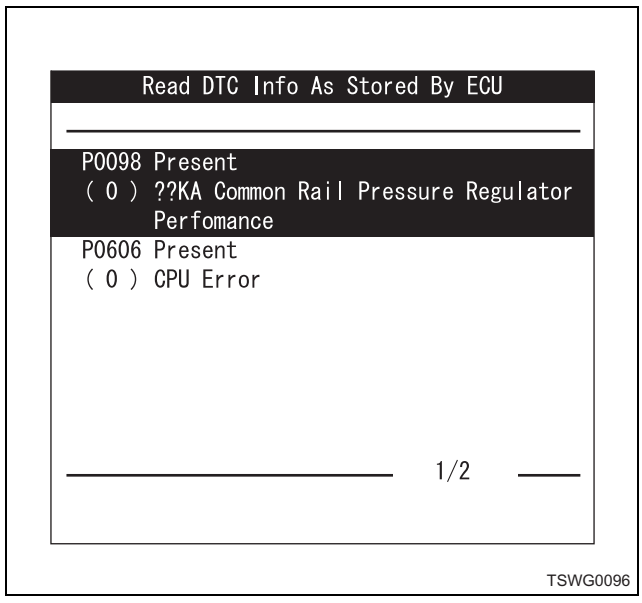
DTC application menu display screen

[Example] Industrial Engine
F0: DTC Display

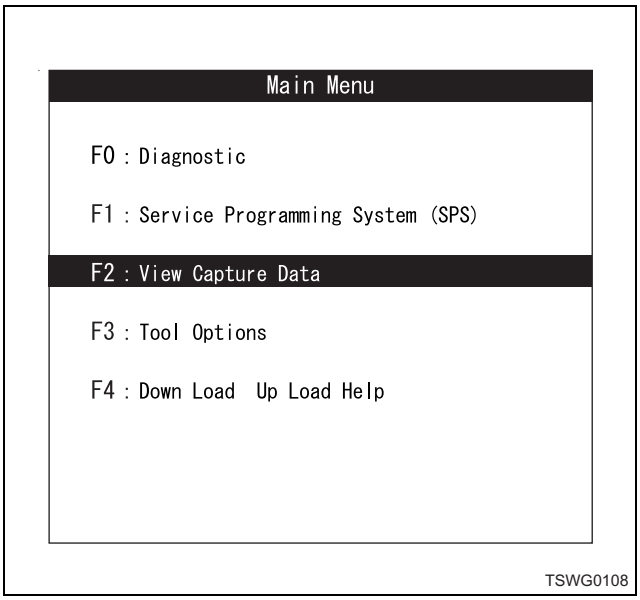
If no DTC stored



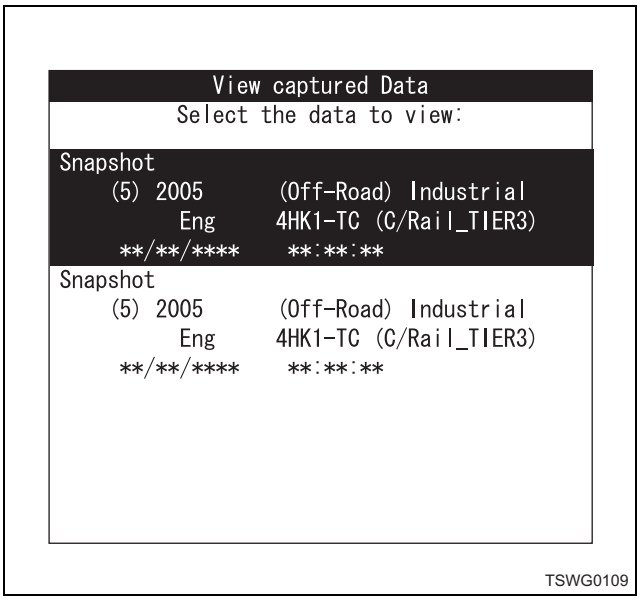
If DTC stored



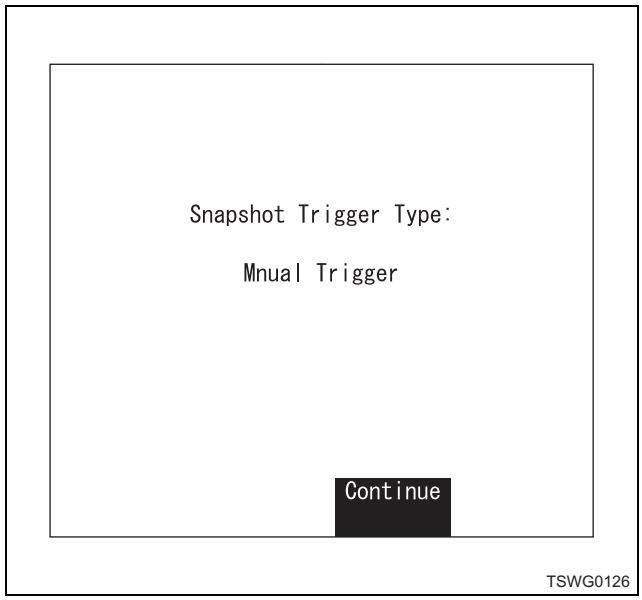
2. Press [ENTER].



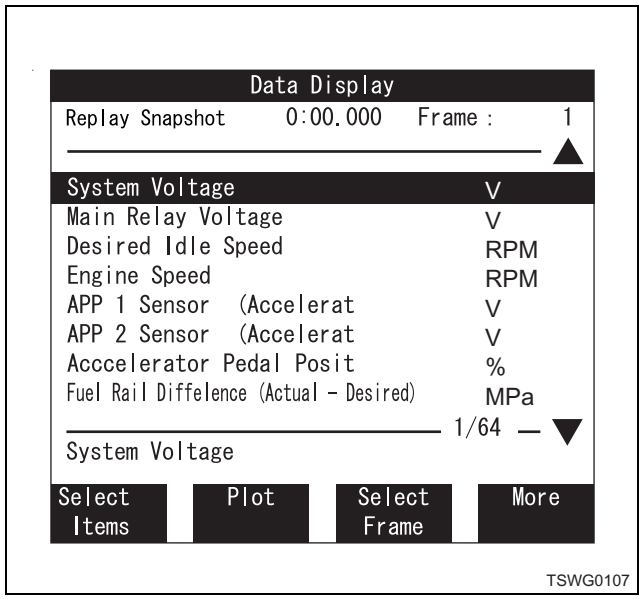
3. Choose “F2: View Capture Data” and press the [ENTER] key. “View Captured Data” appears.
4. Choose “Snapshot Data” with selection keys (▲▼) and press the [ENTER] key.



5. Press the softkey “Continue” on the display screen.



6. Snapshot Replay Screen appears.

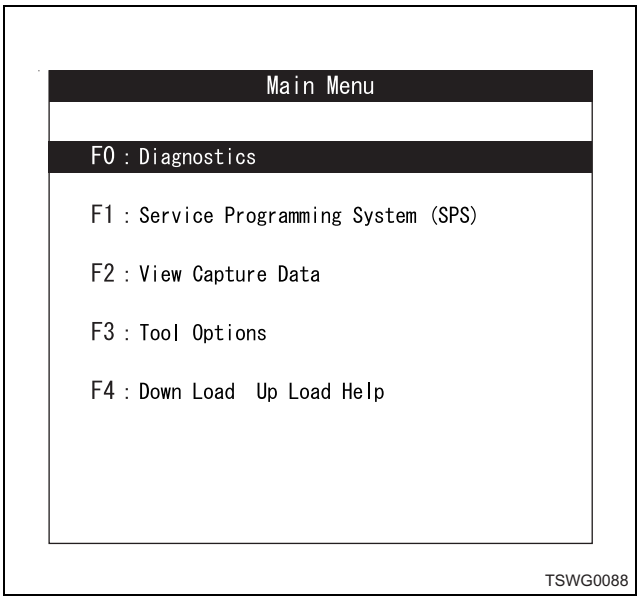


Softkey functions

1. Choose the softkey “More” on the Snapshot Replay screen
   - Select Items: Chosen to fix and display a parameter (up to 5 parameters).
   - Plot: Draws a graph (Up to 3 parameter items).
   - Select Frame: Allows to specify a frame No. and to move a parameter to the specified frame.
   - More: Switches the displayed softkeys.
2. Choose “More” out of the 4 softkeys on the display screen.
   - Auto Reverse: Allows to view changes of data of each frame.
   - Stop: Stops a frame in motion.
   - Auto Forward: Allows to view changes of data of each frame.
   - More: Switches the displayed softkeys.

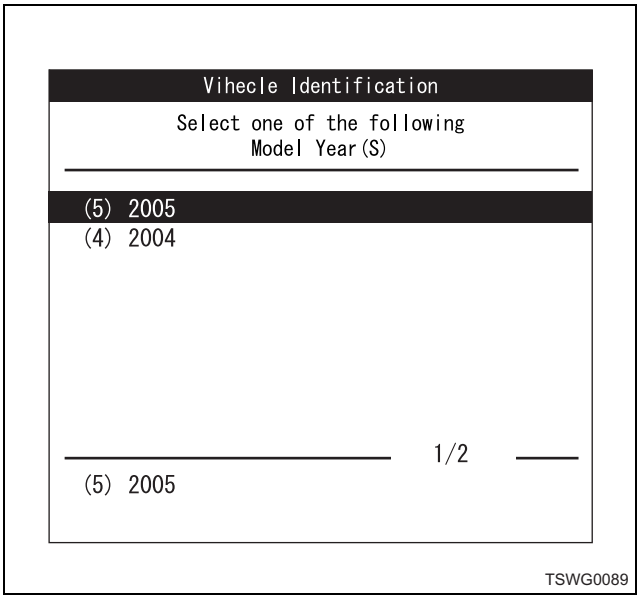
Step 2

- Choose the menu F0: Diagnostics with ▲, ▼ (up/down) keys or F0 (function) key, and press [ENTER].



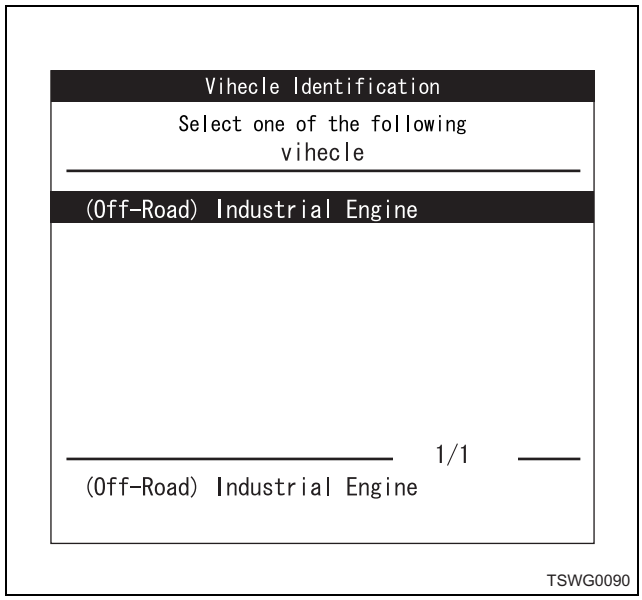
Step 3

- Choose the menu (5) 2005 with ▲, ▼ (up/down) keys, and press the [ENTER] key.



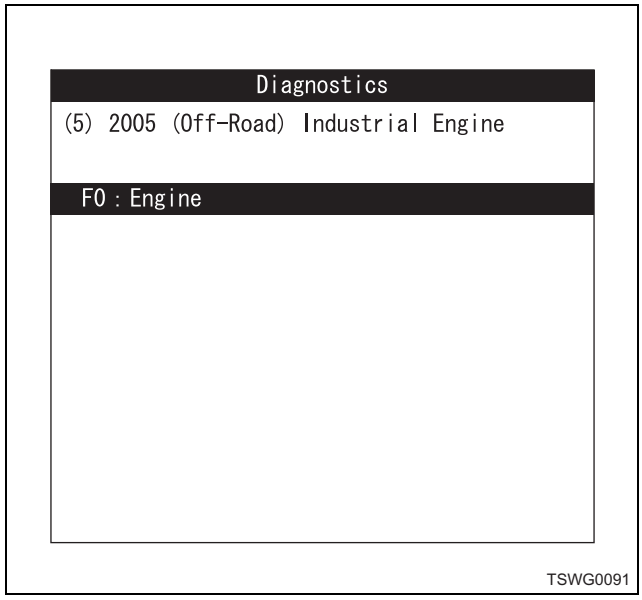
Step 4

- Choose the menu (Off-Road) Industrial Engine with ▲, ▼ (up/down) keys, and press the [ENTER] key.



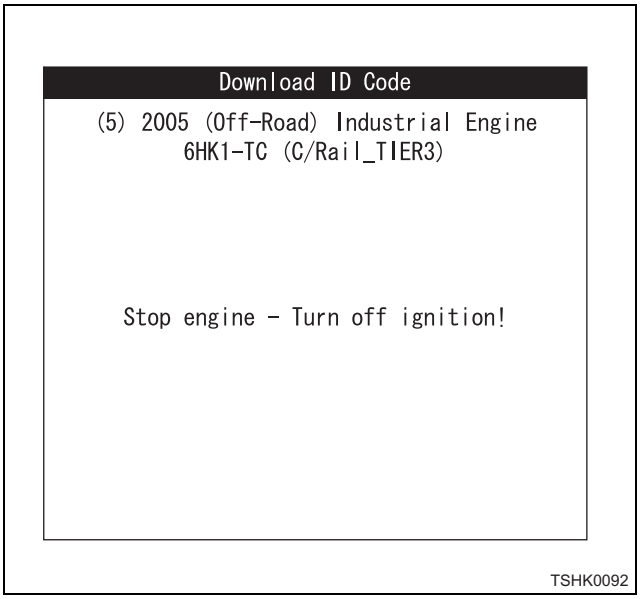
Step 5

- Choose F0: Engine in Menu with ▲, ▼ (up/down) keys or F0 (function), and press [ENTER].



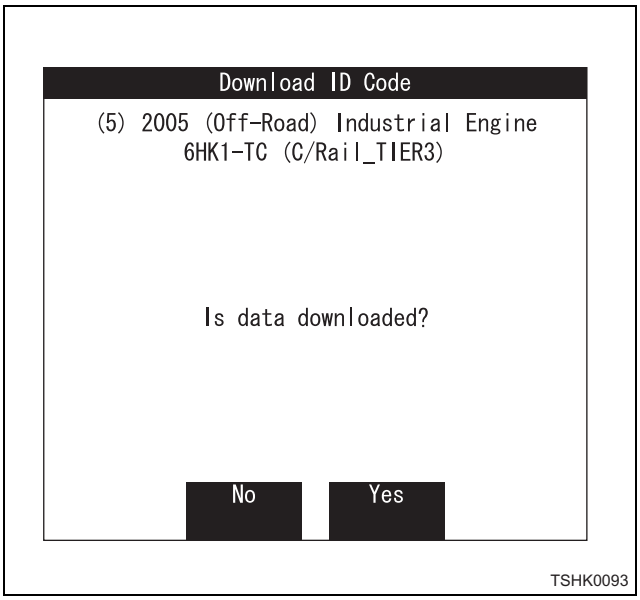
Step 12-2

- The following display appears when the engine speed is not 0 rpm.
  In this case, stop the engine as instructed in the message, and try again from Step 1.



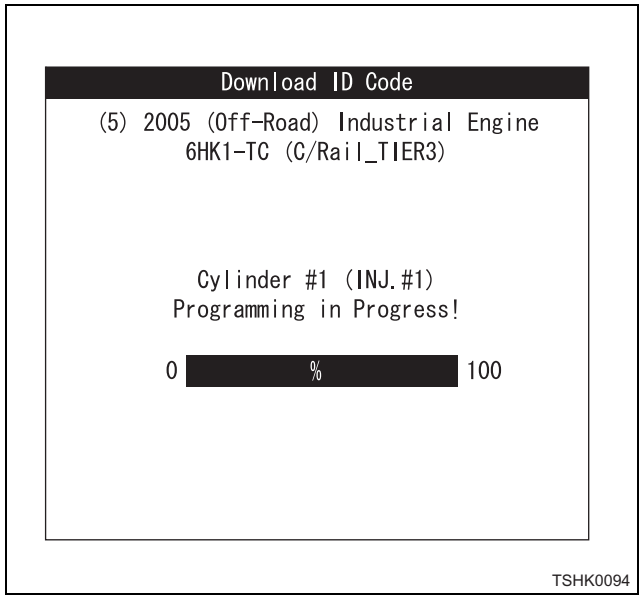
Step 13

- Pressing the softkey [Yes] downloads (registers) the uploaded ID codes (Cyl.1-Cyl.6) to the ECM. Pressing the softkey [No] returns you to Step 11.
- Download is the function to register (write) the stored (uploaded) ID codes (No. 1 cylinder – No. 6 cylinder) in the Tech2 to the ECM. ID is registered from No. 1 cylinder to No. 6 cylinder in the order.



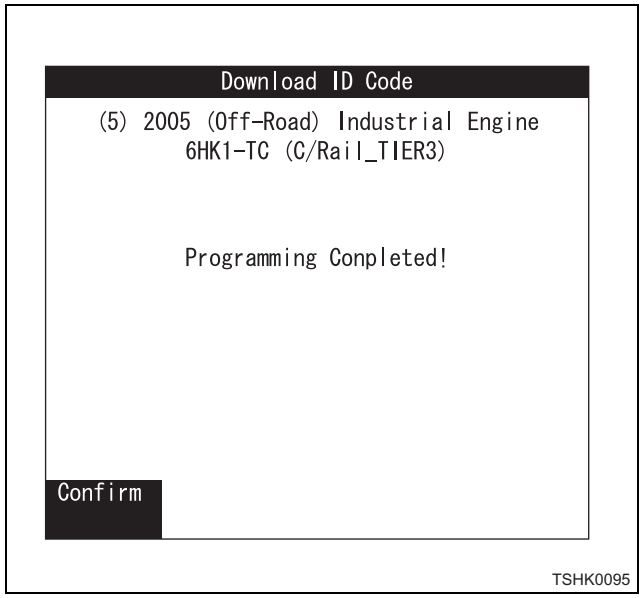
Step 13-1

- Registration is started from No. 1 cylinder (INJ.#1) to No. 2 cylinder (INJ.#5) and the ECM in the order. The status for registration (writing) of data to ECM will appear.
  The message in the screen changes in the order of No. 1 cylinder (INJ.#1) and No. 2 cylinder (INJ.#5). When it is abnormal, the registration repeats 3 times.



Step 13-2

- When the downloaded ID code corresponds to that registered (written) in the ECM, the following message will appear. Download (registration) is completed.
  Pressing the softkey [Confirm] returns you to Step 11.



Standard update (This mode is not used this time. Select the “Custom”.)
Description: Standard mode can be used only when the old version of software is installed and registered in the database. Only “Custom” mode can be used in any other cases. In “Standard” mode, the latest version will be installed for the language and the model (manufacturer) which are set in Tech2 at that time.

The procedure of Tech2 “Standard” update, using “Software Download” function, is as follows.

1. Connect the Tech2 to the PC with RS-232C cable.
2. Connect the standard accessory power cable to Tech2.
3. Startup TIS 2000 on the PC.
4. Choose “Software Download” icon on the initial screen of TIS 2000.
5. Check the selected location on the “Select Diagnostic Tool for Download” screen, and go to next.

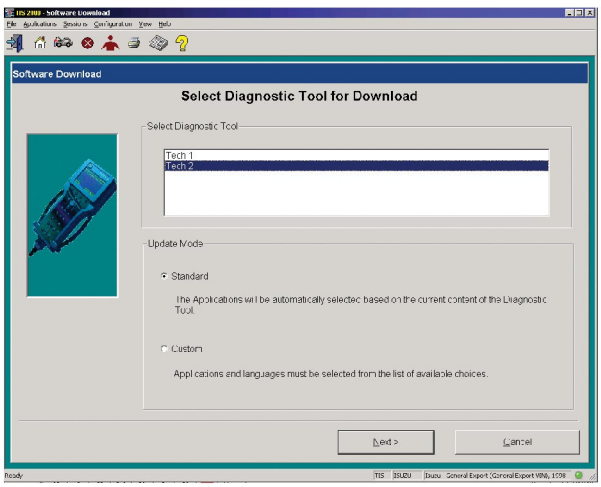


Fig. 2: Selection of diagnostic tool to be updated and update mode

- Check the selected location and click “Next”. An explanation appears as “Reading information of diagnostic tool”.

6. The “Software Update Confirmation” screen appears on the PC.
   Also, the stored contents of the current Tech2 and stored data after transmitting diagnostic software appear on the screen. Click the [Continue] to go on.
7. “Transmitting Software” appears on the screen to tell the transmission status.
8. When the transmission is completed, “Transmission is completed” will appear on the screen. Click the “Close” button to quit the application. The latest software has been transmitted to the diagnostic tool.

Custom update

Use custom update when installing the old version software, software other than Isuzu software or software with different language, or when the database cannot identify the software version being installed. After selecting “Custom” on the selection screen (See Fig. 2), perform the following procedure.

1. The “Application Selection” appears on the screen. The list of the software release No. appears on the left hand of the screen. Clicking [+] mark allows to view the list of available language of each release.

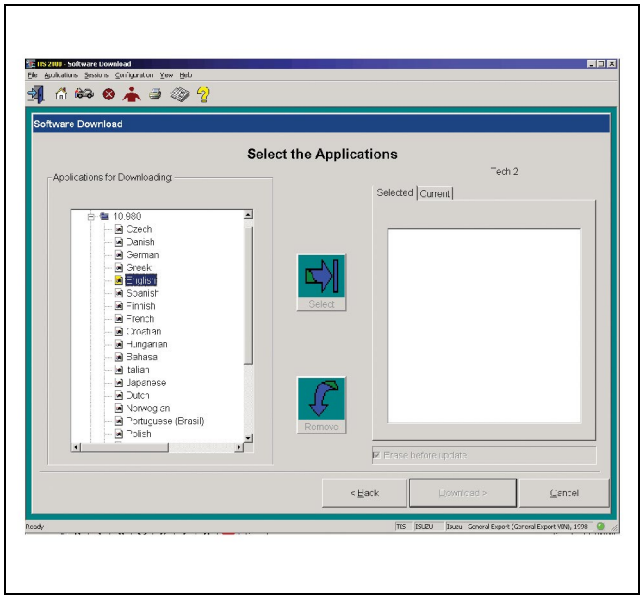
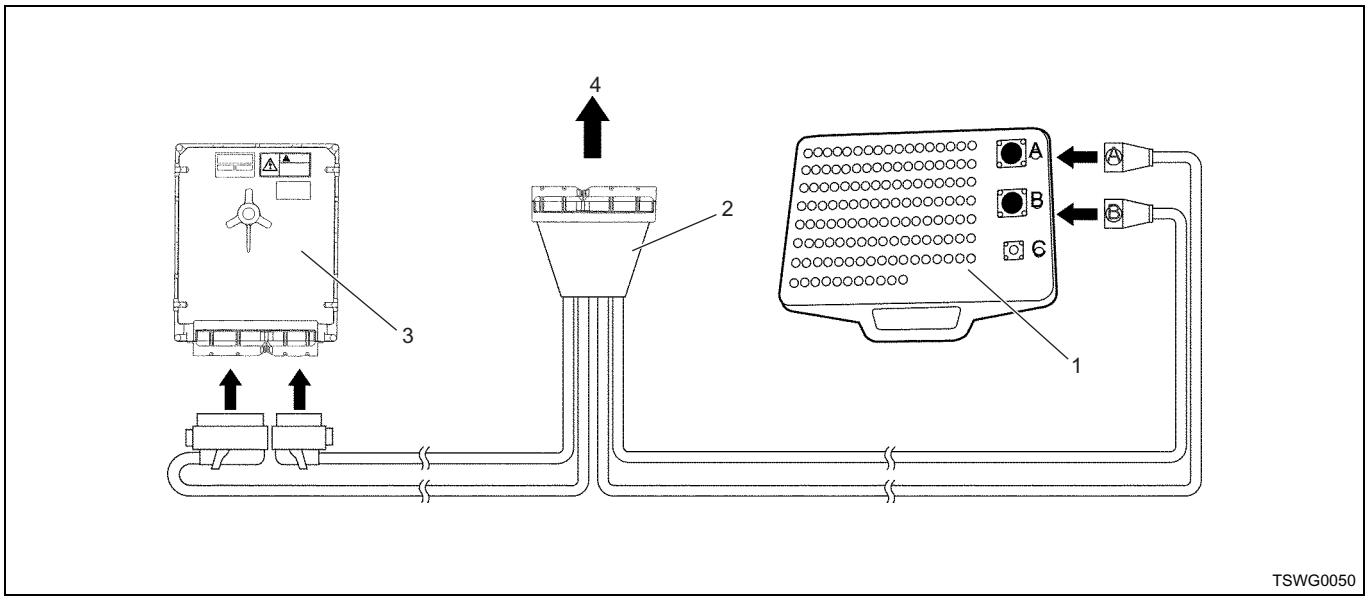


Fig. 3: Selection of application for “Custom” mode

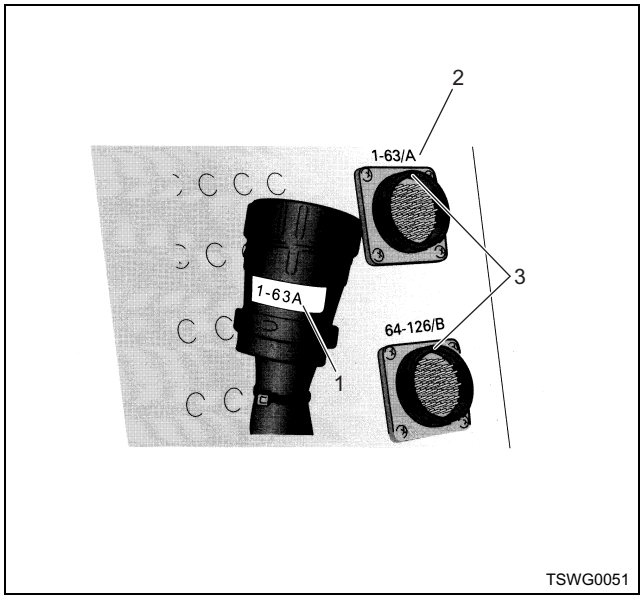
2. Either double-click the relevant software version and language, or click the “Select” button to select. The software you have chosen appears on the right hand of the screen. To compare current software with selected software of the diagnostic tool, click the mark on the right hand of the screen.
3. Clicking the [Download] button starts updating.
4. “Transmitting Software” appears on the screen to tell the transmission status.
5. When the transmission completes, “Transmission is completed” will appear on the screen. Click the “Close” button to quit the application. The selected software has been transmitted to the diagnostic tool.



Name
1. Breaker box
2. Adapter harness
3. ECM
4. To machine-side harness

Caution:
Take care with the following items when connecting the adapter harness to breaker box. Failure to connect may damage the ECM.

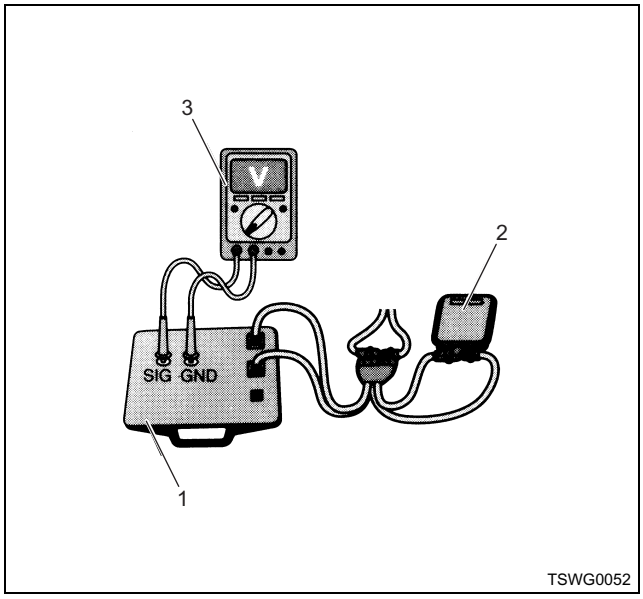
- **Connect the connector on adapter harness side to the connector of breaker box with the same No. each other.**
- **When the connecting the connector, align the cutouts of connector and breaker box each other.**



Name
1. Connector No. (Adapter harness)
2. Connector No. (Breaker box)
3. Cutout

Example of use for breaker box

1. Inspection and measurement of voltage
   - Accelerator position sensor
   - Engine coolant temperature sensor
   - Intake air temperature sensor etc.



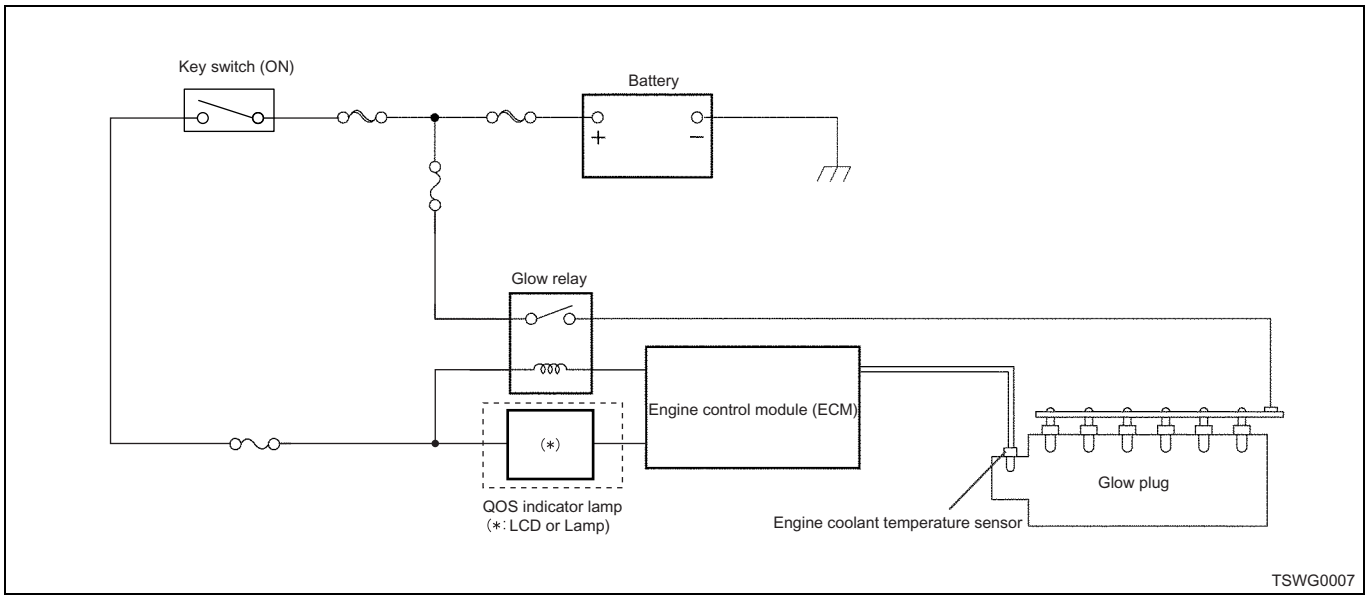
Name
1. Breaker box
2. ECM
3. Digital multi-meter

2. Inspection and measurement of resistance
   - Crank position sensor
   - G sensor
   - PCV etc.

Preheating control

QOS (Quick On Start) system

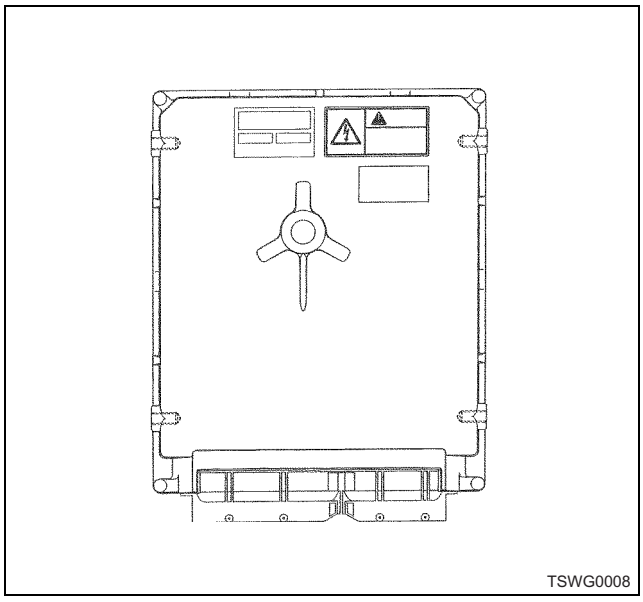
The ECM determines the period required for glow (pre-glow, glow, after-glow), and operates the glow relay and QOS indicator lamp. QOS system allows to make the starting at cold weather easier and reduce white smoke and noise at starting. When turning the key switch to ON, the ECM detects the engine coolant temperature by signal from engine coolant temperature (ECT) sensor and changes the period for glow so that the proper starting conditions can be achieved all the time. Also, after-glow function allows to stabilize idling immediately after starting.



Engine Control Module (ECM)

About functions of ECM

Note:
Refer to the machine's manual for the locations of ECM.



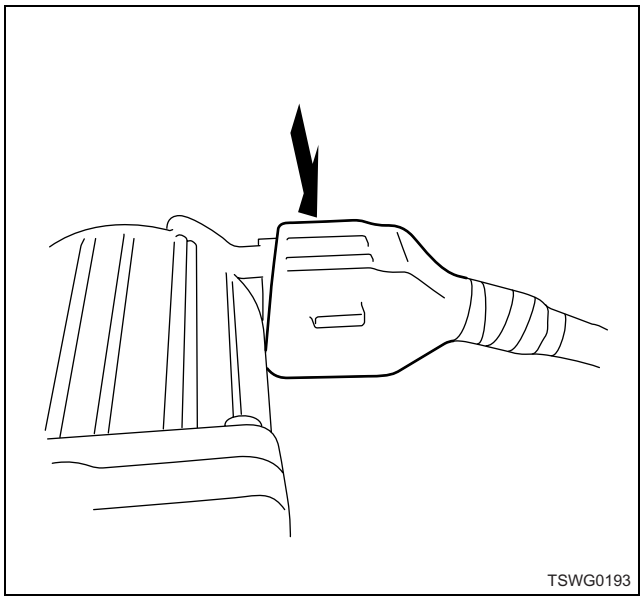
The ECM monitors the information sent from various sensors all the time and controls each system of the powertrain. The ECM performs the diagnostic function of the system, detects operational problems of the system, gives a warning through diagnosis lamp to a driver and stores DTC (diagnostic trouble code). The area where the trouble occurred can be identified by the DTC to assist a mechanic to perform repair work.
The ECM sends the voltage of 5 V to supply the power to various sensors or switches. The ECM controls the output circuits by controlling the ground or power supply circuit through a certain device.

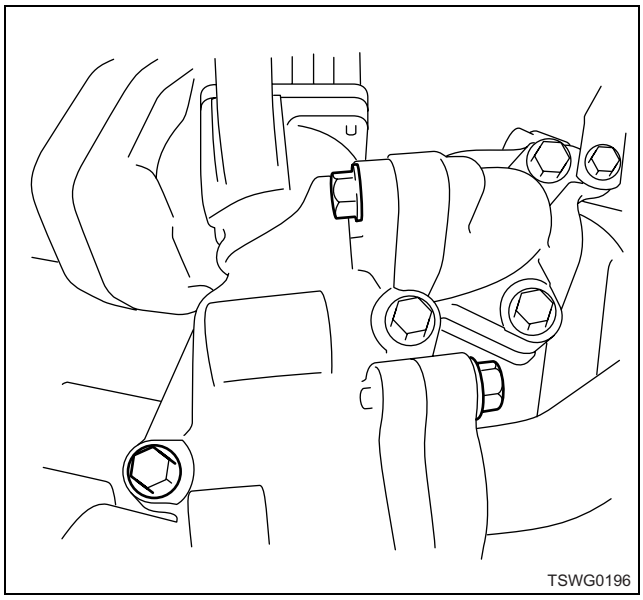
ECM and components

The ECM is designed to maintain the level of emission as the emission control regulations and get a good performance and fuel efficiency at the same time. The ECM monitors various functions of the engine through the sensors such as crankshaft position (CKP) sensor etc.

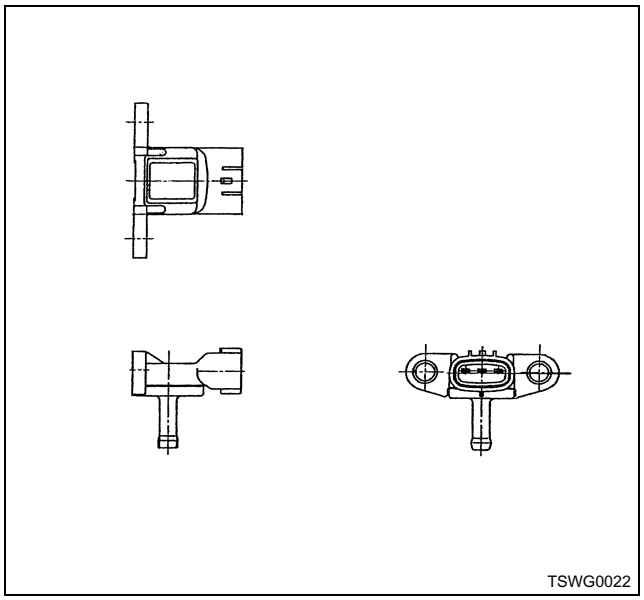
Removal

- Disconnect the connector, and remove the six 12mm-mounting bolts and EGR valve.


TSWG0193


TSWG0196

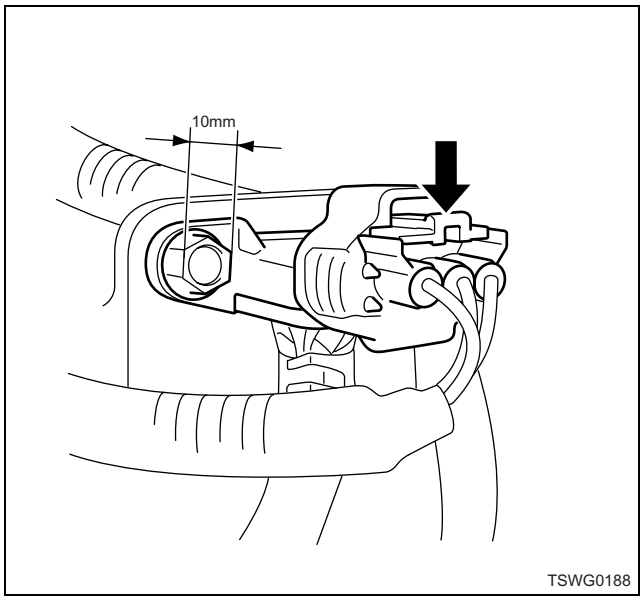
Boost pressure sensor


TSWG0022

The boost pressure sensor uses the pressure hose between the boost pressure sensor and intake pipe, detects boost (intake air pressure), converts the pressure into the voltage signal and sends it to engine control module (ECM). Voltage becomes higher as pressure becomes higher, and lower as one does lower. ECM calculates the boost (intake air pressure) based on the voltage signal sent from sensors and uses it for fuel injection control etc.

Removal

- Disconnect the connector, and remove the two 10mm-mounting bolts, hoses and sensor.

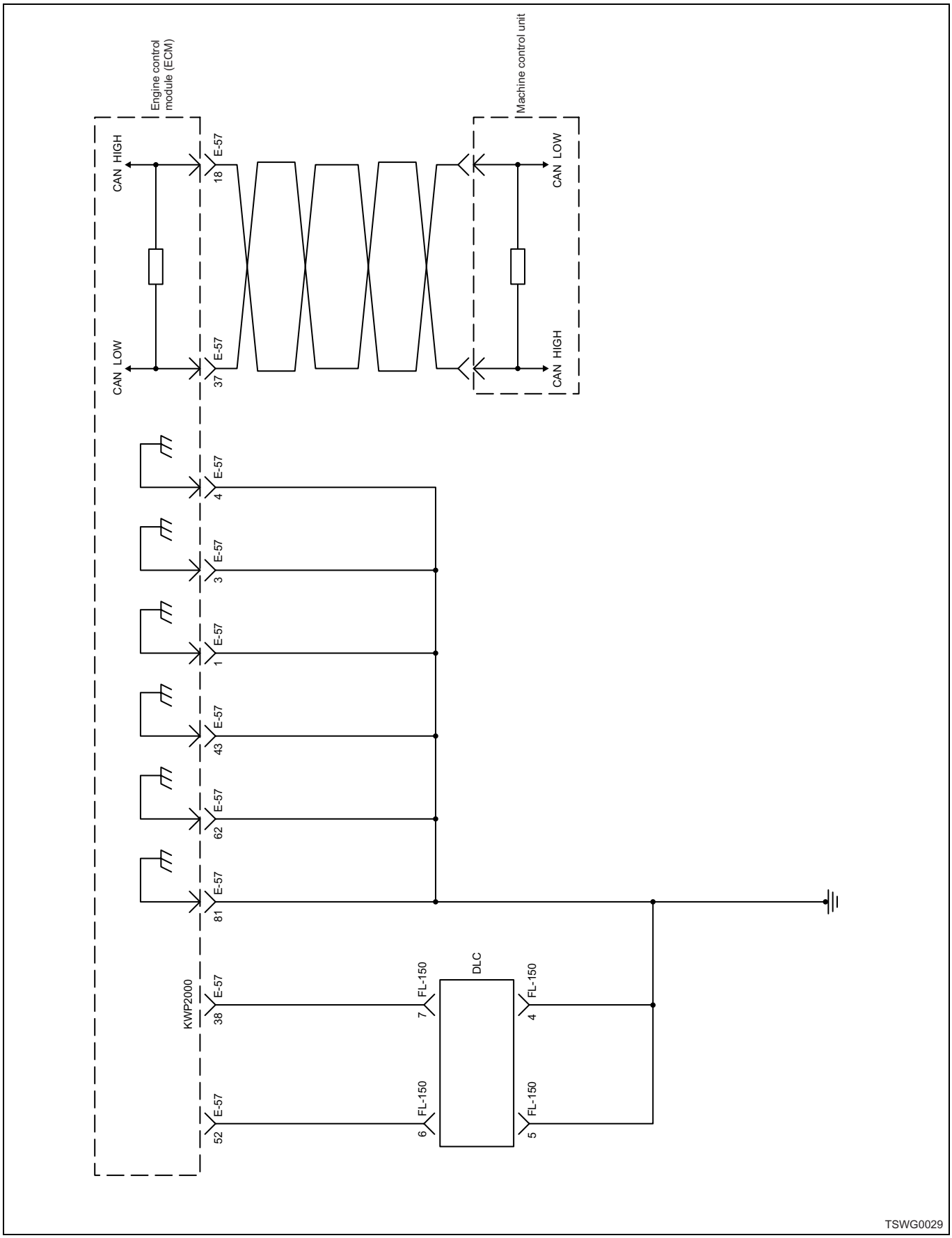


TSWG0188

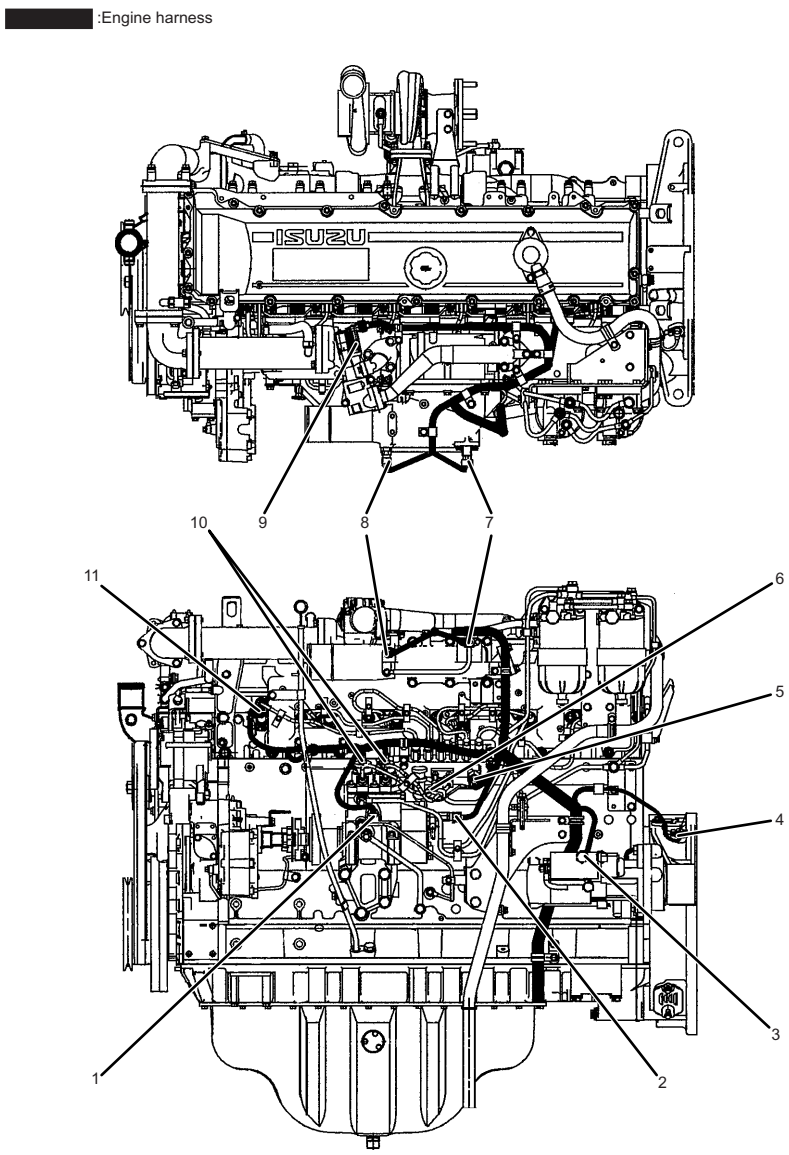
Installation

Tightening torque: 4 — 6 N·m {0.4 — 0.6 kg·m/35 — 53 lb·ft}

CAN, GND, DLC circuits



Engine harness location



Name

1. G sensor
2. Fuel temperature sensor
3. Engine oil pressure sensor
4. CKP sensor
5. Common rail pressure sensor
6. Engine coolant temperature sensor
7. Boost pressure sensor
8. Boost temperature sensor
9. EGR position sensor
10. PCV
11. Glow plug

OBD system check

About OBD system check

OBD system check is systematic method to check the problems which caused by engine control system malfunction. It is the first procedure of all complaint diagnosis for operationality. Use of this diagnostic step properly enables to shorten the diagnosis period and to prevent unnecessary replacement of proper parts.

Test description

5. Communication disability with scan tool is caused by fault in the communication circuit between each ECU and scan tool.
8. If DTC is detected, proceed to the relevant DTC diagnosis by referring to the list of DTC. If more than one DTC is detected, start with the one with smallest DTC number unless otherwise instructed in the diagnostic step.

Note for OBD system check

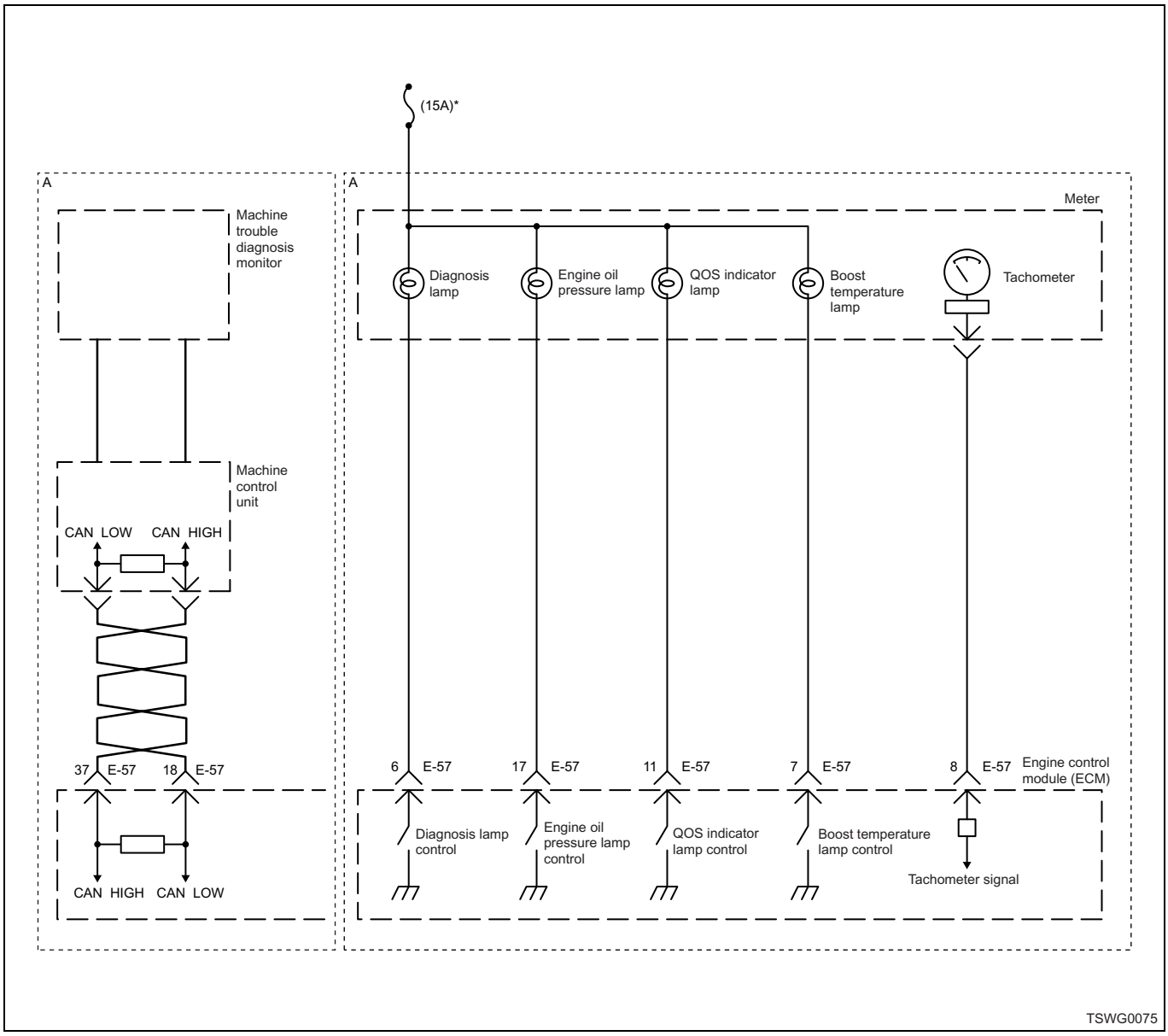
Important:

- **If there is no complaint for operationality, never perform this diagnostic step unless otherwise instructed in other items.**
- **Before the diagnosis, check the service information.**
- **Never erase DTCs unless otherwise instructed in the diagnostic step.**
- **If fault is found in the engine starting system, refer to "Electrical system" in the service manual "Engine section".**
- **Ensure the battery is fully charged.**
- **Make sure the battery cable is normal and securely connected.**
- **Make sure the ground cable of ECM is connected to the proper position securely.**

Step	Action	Value	YES	NO
1	1. Turn the key switch to "ON". 2. Check the diagnosis lamp (trouble display monitor on the machine). Does the diagnosis lamp (trouble display monitor on the machine) come on?	—	Go to Step 2.	Go to Step 2 in "Diagnosis lamp illumination circuit system check".
2	1. Connect the diagnosis connector. • If the machine is not equipped with diagnosis lamp, go to Step 3. 2. Check the diagnosis lamp. Does the diagnosis lamp blink?	—	Go to Step 3.	Go to Step 2 in "Diagnosis lamp blinking circuit system check".
3	Is the scan tool (KW communication) available?	—	Go to Step 4.	Go to Step 6.
4	1. Connect the scan tool. 2. Turn the key switch to "ON". 3. Turn the power switch of the scan tool to "ON". Does the scan tool powered "ON"?	—	Go to Step 5.	Go to "Scan tool power supply circuit system check".
5	Communicate with ECM using scan tool. Does it communicate with ECM properly?	—	Go to Step 6.	Go to Step 2 in "Scan tool communication circuit system check".
6	Turn the key switch to "START". Does the starter operate?	—	Go to Step 7.	Go to "Starting circuit system check".
7	Turn the key switch to "START". Does the engine start?	—	Go to Step 8.	Go to "Starting system check".
8	Check if DTC is detected. Is DTC detected?	—	Go to the relevant DTC diagnosis.	Go to Step 9.

Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Check for installation condition of the ECM connector and coupling connector. 1. Check for play or looseness in the connection. 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 3.
3	1. Check the DLC for following conditions. • Poor connection of terminal from connector • Poor contact between terminal and wire 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 4.
4	1. Check for followings in the circuit between ECM and DLC using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Open circuit • High resistance • Short circuit to ground 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 5.
5	1. Connect the scan tool. 2. Turn the key switch to “ON”. 3. Communicate with ECM using scan tool. Does it communicate with ECM properly?	—	Go to “Diagnostic aid”.	Go to Step 6.
6	Is EMPS available?	—	Go to Step 7.	Go to Step 8.
7	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 9.	Go to Step 8.

Step	Action	Value	YES	NO
8	1. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 2. Turn the key switch to “OFF” for more than 10 seconds. 3. Start the engine. Is the trouble detected?	—	Go to Step 9.	Go to Step 2.
9	Check the DTC. Is DTC detected?	—	Go to the relevant diagnosis of DTC detected.	Check the repair, and Go to “OBD system check”.
10	1. Check the PCV-LOW circuit between the ECM and the PCV. 2. If the trouble is detected, repair the circuit as required. Is the procedure completed?	—	Go to Step 11.	—
11	1. Check for following faults. • Engine mechanical timing is off. • Improper installation position of flywheel • Excessive clogging in intake system • Excessive clogging in exhaust system 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 8.	—



Note:
The QOS circuit is the same for both the starter ECM control specifications and the safety relay specifications.

Circuit description

The QOS (Quick On Start) system consists of the ECM, glow relay, glow plug, and QOS indicator lamp. When the key switch is turned ON with low engine coolant temperatures, the ECM determines the glow time and operates the glow relay and QOS indicator lamp. After a certain time has elapsed, the ECM will turn the glow relay and QOS indicator lamp to “OFF”.

Test description

Numbers below indicate step numbers in the chart.
7. The QOS indicator lamp turns on when the key switch is “ON” using lamp check function, even if the QOS is not operating.
12. The QOS indicator lamp goes off within maximum 10 seconds.

Step	Action	Value	YES	NO
1	Perform the OBD check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.

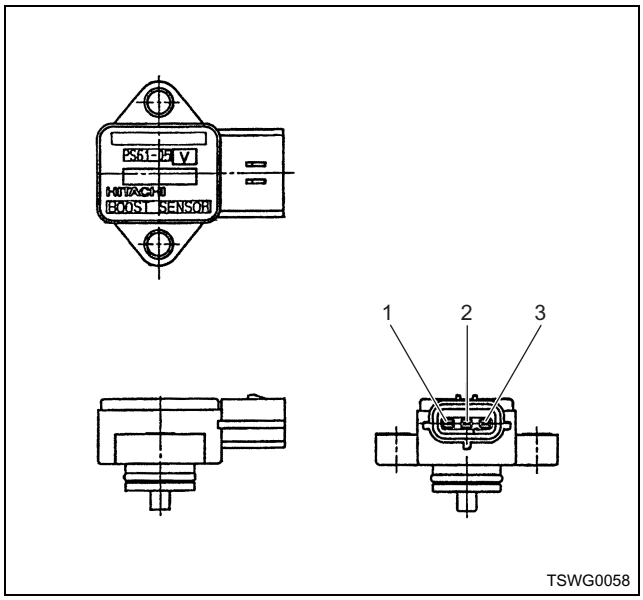
DTC	Flash code	DTC description	Item to be detected	Preconditions when DTC is set	DTC set condition	Judgment Time	Behavior when trouble occurs	Diagnos is lamp	Recovery from failure
P0522	294	Engine oil pressure sensor fault (low voltage fault)	Open/short circuit/ breakage of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1633 is not detected.	Engine oil pressure sensor voltage is less than 0.1 V.	Approx. 4 sec.	Operationality is not affected. Back-up: No back-up	ON	*2
P0523		Engine oil pressure sensor fault (high voltage fault)	Short circuit in sensor or harness	• Key switch input voltage is 16V or more. • DTC P1633 is not detected.	Engine oil pressure sensor voltage is more than 4.85 V.	Approx. 4 sec.	Operationality is not affected. Back-up: No back-up	ON	*2
P0601	53	ROM fault	ROM fault	—	ROM is faulty. Reflash failure	—	Engine stopped Back-up: Engine stopped	ON	
P0603	54	EEPROM fault	EEPROM fault	—	EEPROM is faulty.	—	Operationality is not affected. Back-up: No back-up	ON	*2
P0606	51	CPU fault	CPU fault	—	Sub-CPU detects main CPU fault in 100 msec after key switch ON. (SUB-CPU resets CPU.)	Nearly simultaneous to fault occurrence	Output lowering Back-up: Specified back-up value SUB-CPU stops control	ON	*2
	52	CPU monitoring IC fault	Sub-CPU fault	• 480 msec or more has elapsed after key switch ON. • Key switch input power supply voltage is higher than 16 V.	RUN-SUB pulse does not change for 20 msec or more.	Nearly simultaneous to fault occurrence	Output lowering Back-up: Limited injection amount 1	ON	*2
P0611	34	Charge circuit fault (bank 1)	ECM charge circuit 1 fault (internal burnout, open circuit, etc.)	• Main relay power supply voltage is 16V or more.	When charge circuit bank 1 voltage inside ECM is low.	Approx. 1.5 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault, engine stall are possible. Back-up: Specified back-up value	ON	*2
P0612		Charge circuit fault (bank 2)	ECM charge circuit 2 fault (internal burnout, open circuit, etc.)		When charge circuit bank 2 voltage inside ECM is low.	Approx. 1.5 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault, engine stall are possible. Back-up: Specified back-up value	ON	*2
P0615	19	Starter cut relay fault	Relay fault	• Key switch input power supply voltage is between 16 — 32 V.	No starter cut relay monitor signal exists against starter cut relay drive signal.	When trouble occurs 40 out of 50 samples.	Operationality is not affected. Back-up: No back-up	ON	*1
P0650	77	Check engine lamp fault	Lamp fault	• Key switch input voltage is 16V or more. • DTC P0650 is not detected.	No check engine lamp monitor signal exists.	When trouble occurs 11 out of 12 samples.	Operationality is not affected. Back-up: No back-up	ON	*1

Step	Action	Value	YES	NO
3	Is the scan tool (KW communication) available?	—	Go to Step 4.	Go to Step 5.
4	1. Turn the key switch to “OFF” for more than 30 seconds. 2. Start the engine. 3. Check for “Differential fuel rail pressure” on the data display using scan tool. Is “Differential fuel rail pressure” within the specified value?	Differential pressure ±5 MPa (±725 psi) (at idle)	Go to Step 5.	Go to “Diagnostic aid”.
5	1. Check the fuel return pipe between the supply pump and the fuel tank for breakage, twist, etc. 2. Check for clogging or twisting in the vent hose of the fuel tank. 3. Check for foreign matter in the fuel tank. 4. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 8.	Go to Step 6.
6	1. Replace the common rail (common rail pressure sensor) since it seems that abnormal value of the pressure sensor is detected. **Note:** **For work procedure, refer to “Engine section” in the service manual.** 2. Check the DTC. Is the trouble detected?	—	Go to Step 7.	Go to Step 8.
7	Replace the supply pump. **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 8.	—
8	Check the DTC again. 1. Connect all the harnesses. 2. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 3. Turn the key switch to “OFF” for more than 10 seconds. 4. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P0088 detected?	—	Go to Step 2.	Go to Step 9.
9	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

Step	Action	Value	YES	NO
10	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 12.	Go to Step 11.
11	Replace the ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 12.	—
12	Check the DTC again. 1. Connect all the harnesses. 2. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 3. Turn the key switch to “OFF” for more than 10 seconds. 4. Start the engine, and test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is the DTC P0091/1291detected?	—	Go to Step 2.	Go to Step 13.
13	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the barometric pressure sensor connector. 3. Short between the barometric pressure sensor connector power supply terminal and the signal terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check the value for “Barometric pressure sensor” using scan tool. Is the “Barometric pressure sensor” more than the specified value?	4.8V	Go to Step 8.	Go to Step 6.
6	1. Check for followings in the power supply circuit between ECM and barometric pressure sensor using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Open circuit • High resistance 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 7.
7	1. Check for followings in the signal circuit between ECM and barometric pressure sensor using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Short circuit to barometric pressure sensor ground circuit • Short circuit to ground • Open circuit • High resistance 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 9.
8	Replace the barometric pressure sensor. Is the procedure completed?	—	Go to Step 12.	—
9	Is EMPS available?	—	Go to Step 10.	Go to Step 11.

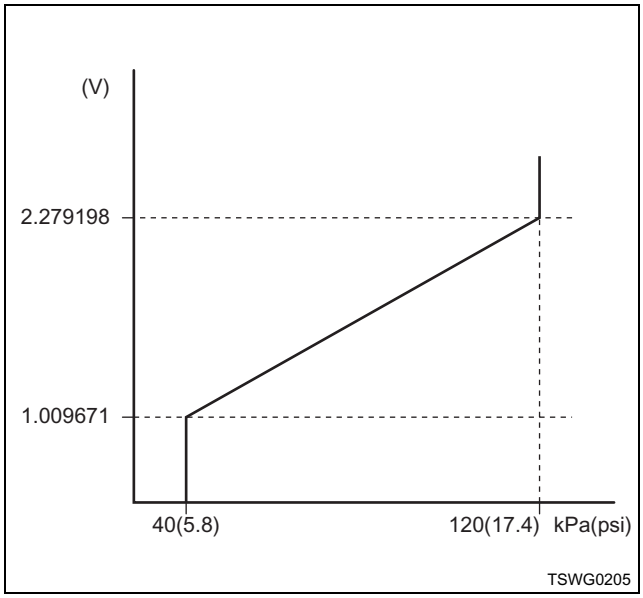
About barometric pressure sensor



Name
1. Power supply
2. GND
3. Signal

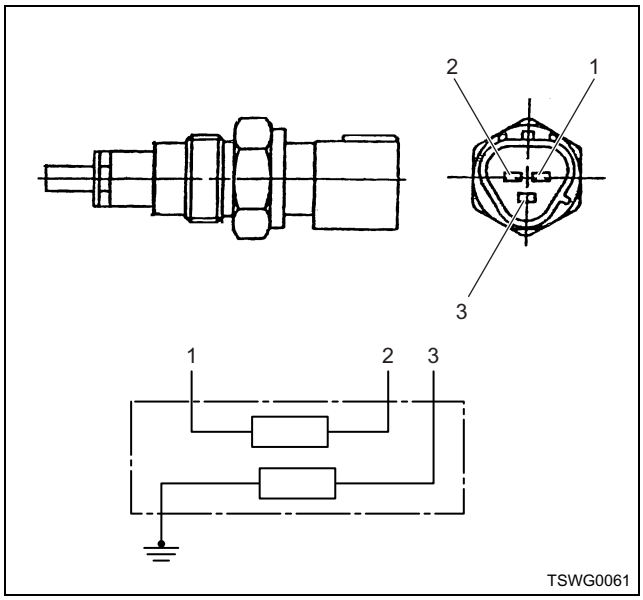
Characteristics of barometric pressure sensor

The output voltage of barometric pressure sensor changes according to the barometric pressure. The scan tool with CAN communication displays a fixed value when the value exceeds the threshold voltage. Therefore, judge as it is more than the threshold value if the value of 40 kPa (5.8 psi) or 120 kPa (17.4 psi) is not changed.
When error occurs, error value (127 kPa {18.4 psi}) is displayed.
The following illustration shows the correlation between physical value and voltage displayed in the scan tools with CAN communication.
Tech2 and scan tools with KW communication can display both physical value and voltage.



Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the IAT sensor connector. 3. Short the IAT sensor connector signal terminal to the ground terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check the value for “Intake air temperature sensor” using scan tool. Is the “Intake air temperature sensor” less than the specified value?	0V	Go to Step 9.	Go to Step 6.
6	1. Check the signal circuit between ECM and IAT sensor for short circuit to the power supply circuit or ignition power supply circuit using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** **Important:** If the IAT sensor circuit is shorted to the power supply circuit, the sensor may be broken. 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 7.
7	1. Check for followings in the signal circuit between ECM and IAT sensor using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Open circuit • High resistance 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 8.

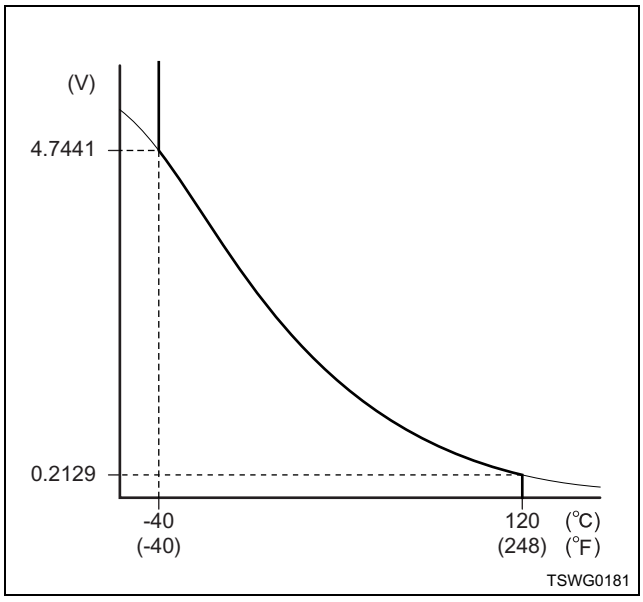
About ECT sensor

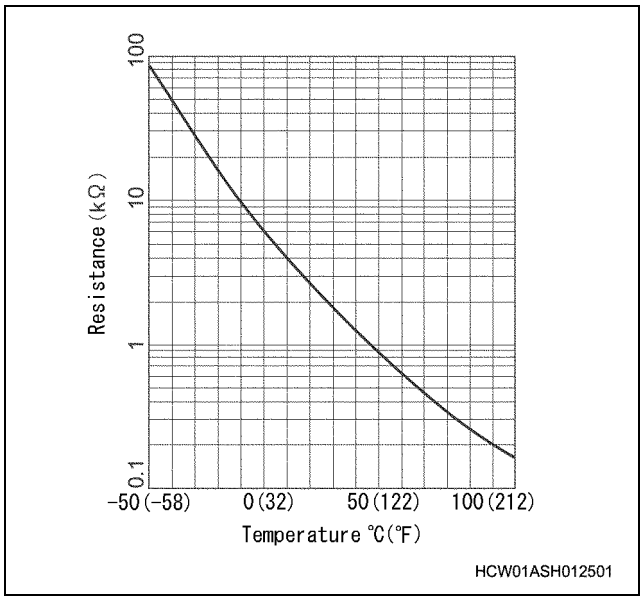


Name
1. Sensor ground (for engine control)
2. Sensor signal (for engine control)
3. Sensor signal (for meter)

Characteristics of ECT sensor

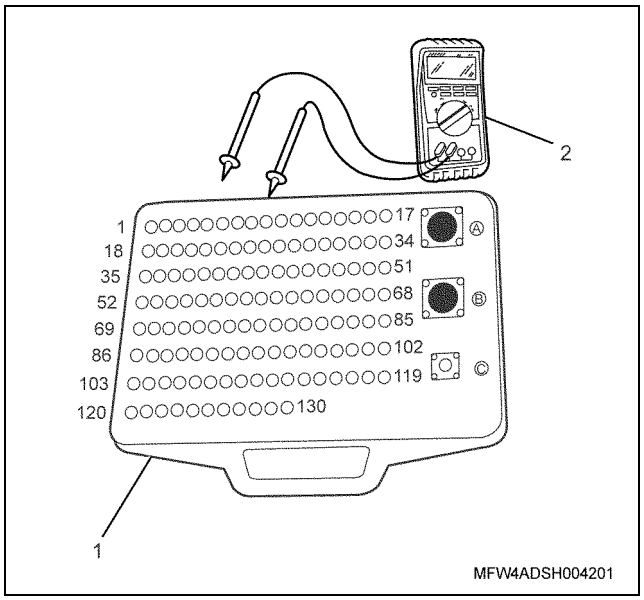
The output voltage of ECT sensor changes according to the engine coolant temperature. The scan tool with CAN communication displays a fixed value when the value exceeds the threshold voltage. Therefore, judge as it is more than the threshold value if the value of −40°C (−40°F) or 120°C (248°F) is not changed.
When error occurs, error value (214°C {419°F}) is displayed.
The following illustration shows the correlation between physical value and voltage displayed in the scan tools with CAN communication.
Tech2 and scan tools with KW communication can display both physical value and voltage.





Breaker box inspection procedure

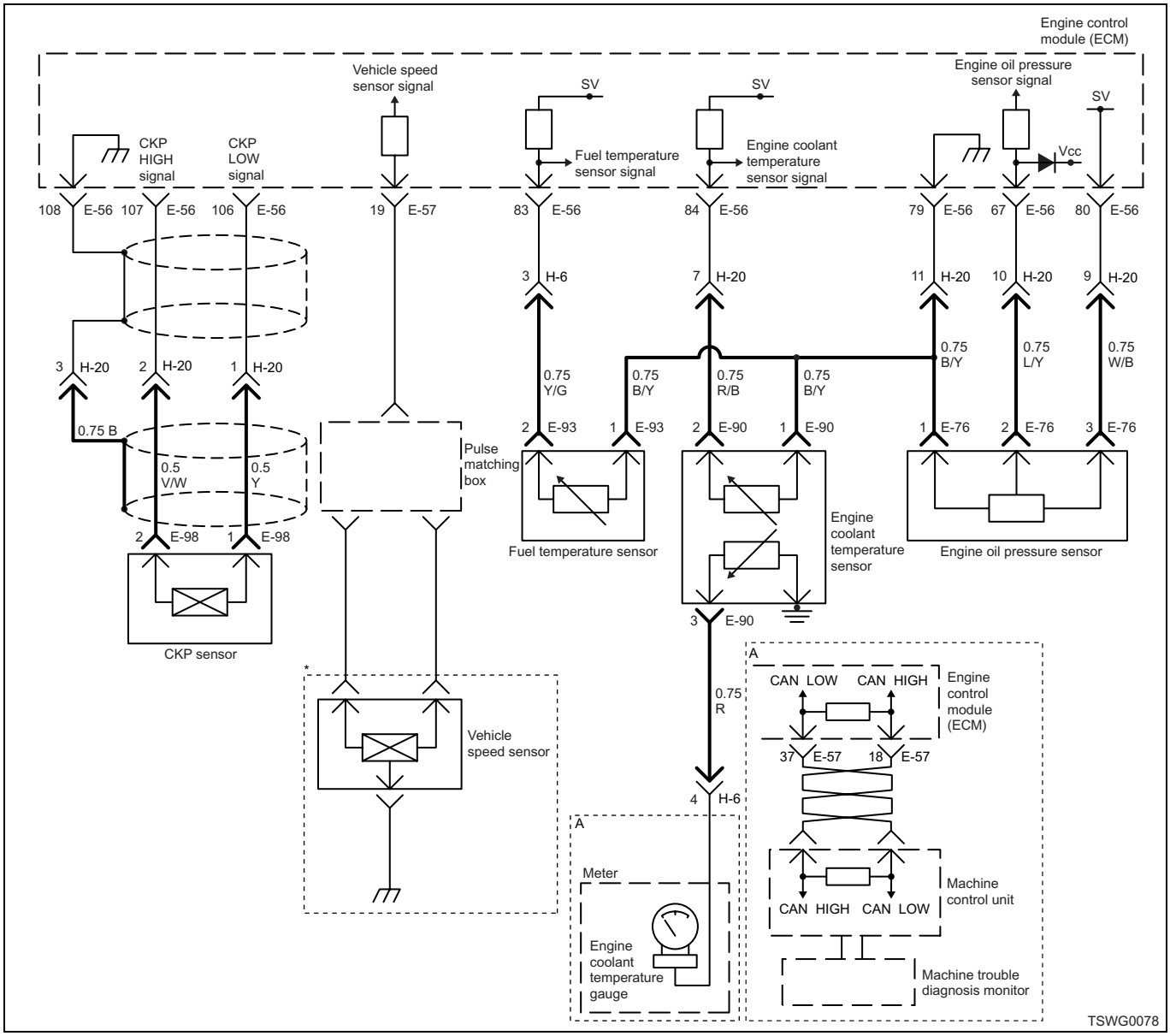
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

DTC: P0182 (Flash code 211) Fuel temperature sensor fault (low voltage fault, GND short)

(*: Specifications vary depending on each machine. Refer to the machine's manual.)



Description of circuit

The fuel temperature (FT) sensor is the thermistor type and the value of resistance changes according to the temperature. The fuel temperature (FT) sensor is installed near the fuel inlet duct in the supply pump. The resistance is low when the fuel temperature is high, and is high when the temperature is low. The ECM energizes 5 V to the FT sensor through the pull up resistance, and calculates the fuel temperature from the change in voltage, to utilize for supply control etc. If the resistance is low (temperature is high), the voltage becomes low; if the resistance is high (temperature is low), the voltage becomes high.

Main trouble symptom

Operationality is affected.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630 or P1633 is not detected.

DTC set condition

- FT sensor voltage is 0.1 V or less.

Action taken when DTC is set

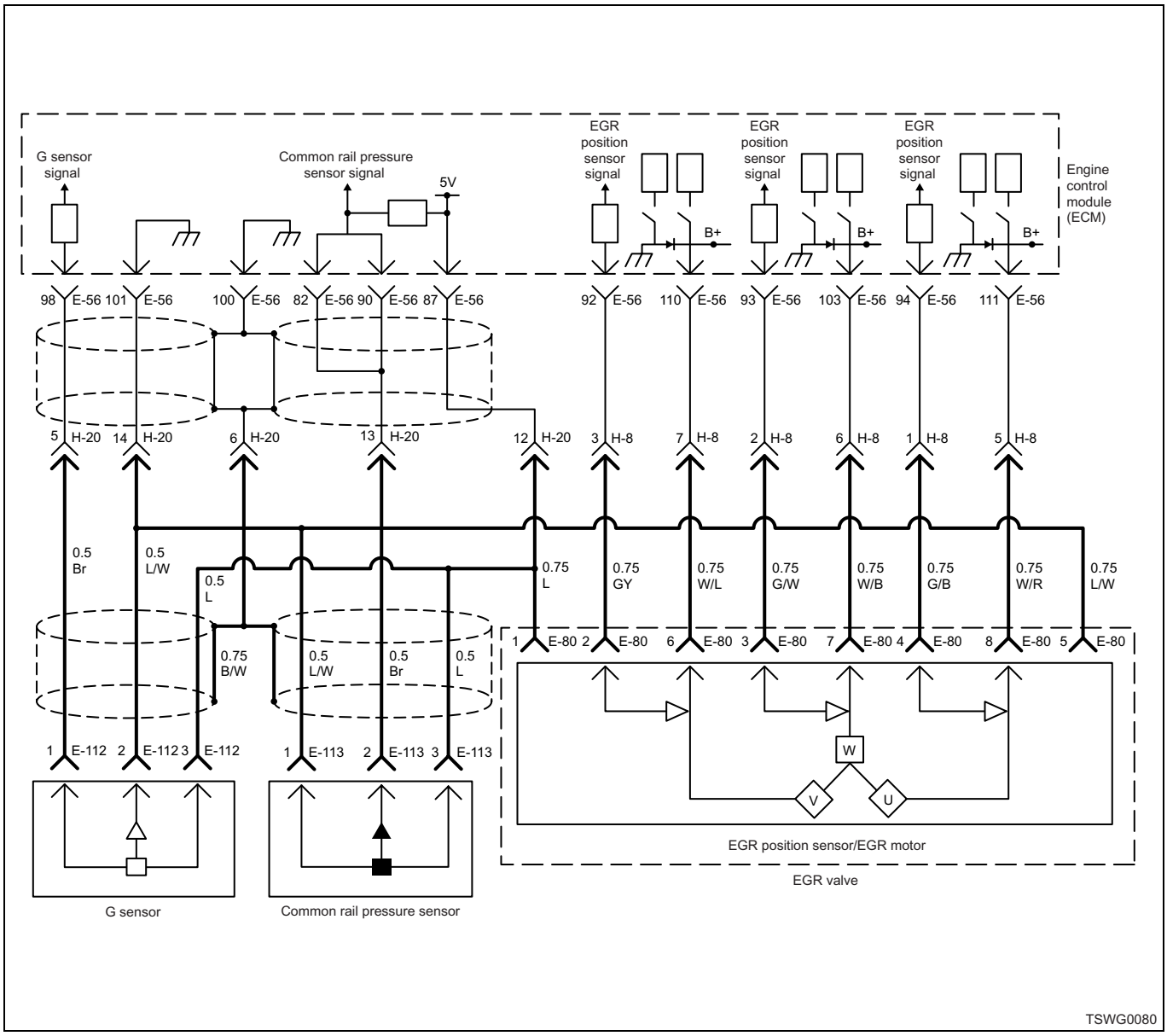
- Trouble is displayed on the monitor of the machine or diagnosis lamp comes on.

Back-up mode

- Fuel temperature default setting
  (at starting: −20°C {−4°F}, at running: 70°C {158°F})

Step	Action	Value	YES	NO
14	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
15	1. Start the engine. 2. Check the display of “Fuel temperature”. Display of fuel temperature is 214°C (419°F) due to back-up mode after fault judgment. Does the display of “Fuel temperature” show error value?	214°C (419°F) (Displayed error value)	Go to Step 16.	Go to “Diagnostic aid”.
16	Check for installation condition of the FT sensor, ECM and coupling connector. 1. Check for play or looseness in the connection. 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 17.
17	1. Check the signal circuit between ECM and FT sensor for short circuit to the power supply circuit or ignition power supply circuit using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** **Important:** If the FT sensor circuit is shorted to the power supply circuit, the sensor may be broken. 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 18.
18	1. Check for followings in the signal circuit between ECM and FT sensor using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Open circuit • High resistance 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 19.

DTC: P0193 (Flash code 245) Common rail pressure sensor fault (high voltage fault, open circuit)



Description of circuit

The common rail pressure sensor detects the common rail internal pressure. The common rail pressure sensor is installed to the common rail. As the common rail internal pressure changes depending on engine condition, output voltage of the common rail pressure sensor will change (if the common rail internal fuel pressure is low, output voltage becomes low, if the pressure is high, the output voltage becomes high as well). The engine control module (ECM) reads this output voltage change, converting it into common rail internal pressure, to utilize for control. Dedicated communication circuits are used for the sensor power supply (5V), SIG, and ground in the common rail pressure sensor, which are connected to the ECM. Also, the sensor circuit is shielded to avoid electrical noise etc.

Main trouble symptom

- Output lowering
- Black smoke emitted
- Engine stall possible
- Engine hunting

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630 or P1635 is not detected.

DTC set condition

- Common rail pressure sensor voltage is 4.5 V or more.

Step	Action	Value	YES	NO
7	1. Check for following in the circuit between injector terminal and coupling connector. • Open circuit • High resistance 2. If the trouble is detected, repair or replace as required. Is there any trouble in the circuit?	—	Go to Step 13.	Go to Step 9.
8	Check for installation condition of the ECM connector. 1. Turn the key switch to “OFF”. 2. Remove the ECM. 3. Check for play or looseness in the connection. 4. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 10.
9	1. Replace the No. 1 cylinder injector. **Note:** • **For work procedure, refer to “Engine section” in the service manual.** • **There are two kinds of injectors. Be sure to use the same kind of one which was used before replacement.** Is the procedure completed?	—	Go to Step 13.	—
10	Is EMPS available?	—	Go to Step 11.	Go to Step 12.
11	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 13.	Go to Step 12.
12	Replace the ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 13.	—

Step	Action	Value	YES	NO
7	1. Check for following in the circuit between injector terminal and coupling connector. • Open circuit • High resistance 2. If the trouble is detected, repair or replace as required. Is there any trouble in the circuit?	—	Go to Step 13.	Go to Step 9.
8	Check for installation condition of the ECM connector. 1. Turn the key switch to “OFF”. 2. Remove the ECM. 3. Check for play or looseness in the connection. 4. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 10.
9	1. Replace the No. 3 cylinder injector. **Note:** • **For work procedure, refer to “Engine section” in the service manual.** • **There are two kinds of injectors. Be sure to use the same kind of one which was used before replacement.** Is the procedure completed?	—	Go to Step 13.	—
10	Is EMPS available?	—	Go to Step 11.	Go to Step 12.
11	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 13.	Go to Step 12.
12	Replace the ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 13.	—

Step	Action	Value	YES	NO
7	1. Check for following in the circuit between injector terminal and coupling connector. • Open circuit • High resistance 2. If the trouble is detected, repair or replace as required. Is there any trouble in the circuit?	—	Go to Step 13.	Go to Step 9.
8	Check for installation condition of the ECM connector. 1. Turn the key switch to “OFF”. 2. Remove the ECM. 3. Check for play or looseness in the connection. 4. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 10.
9	1. Replace the No. 5 cylinder injector. **Note:** • **For work procedure, refer to “Engine section” in the service manual.** • **There are two kinds of injectors. Be sure to use the same kind of one which was used before replacement.** Is the procedure completed?	—	Go to Step 13.	—
10	Is EMPS available?	—	Go to Step 11.	Go to Step 12.
11	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 13.	Go to Step 12.
12	Replace the ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 13.	—

Main trouble symptom

Operationality is affected.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630 or P1634 is not detected.

DTC set condition

- Boost pressure sensor voltage is 0.1 V or less.

Action taken when DTC is set

- Trouble is displayed on the monitor of the machine or diagnosis lamp comes on.

Back-up mode

- Boost pressure default setting (200 MPa {29008 psi})
- Boost pressure correction/EGR stopped

Recovery from failure

Refer to “List of diagnostic trouble code” and “About recovery from failure” in this section for recovery from failure.

The conditions to clear the MIL/DTC

- The present trouble turns to history trouble when the condition is out of the range from DTC set condition (recovery from failure).
- The diagnosis lamp will go off after the code turns to history trouble and the key switch is turned “OFF” then “ON” again.
- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

Diagnostic aid

If the intermittent trouble is suspected, followings may be the cause.

- Improper connection of harness connector
- Defective harness routing
- Worn harness cladding
- Wire disconnection inside harness cladding

Following inspections are necessary to detect these causes.

- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items on the scan tool data display while moving the connector and the harness which are related to the sensor. The variation of the display indicates the faulty part.

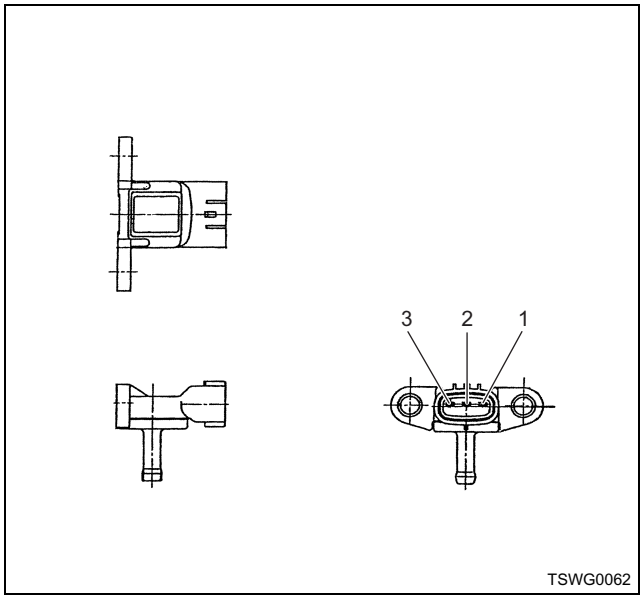
Test description

Numbers below indicate step numbers in the chart.
3. In the case of present trouble, the “MAP (manifold absolute pressure) sensor” displays less than the threshold value. If more than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If “MAP (manifold absolute pressure) sensor” displays more than the threshold value when terminals between the boost pressure sensor connector are shorted, the circuit beyond the sensor is normal including ECM.

Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 14.
3	1. Turn the key switch to “ON”. 2. Check for “MAP (manifold absolute pressure) sensor” on the data display using scan tool. Is the “MAP (manifold absolute pressure) sensor” less than the threshold value?	0.1V	Go to Step 4.	Go to “Diagnostic aid”.

Step	Action	Value	YES	NO
16	1. Check the signal circuit between ECM and boost pressure sensor for short circuit to the power supply circuit or ignition power supply circuit using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** **Important:** If the boost pressure sensor circuit is shorted to the power supply circuit, the sensor may be broken. 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 17.
17	1. Check for followings in the ground circuit between ECM and boost pressure sensor using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 8.

About boost pressure sensor



Name
1. Sensor ground
2. Sensor signal
3. Sensor power supply

Recovery from failure

Refer to “List of diagnostic trouble code” and “About recovery from failure” in this section for recovery from failure.

The conditions to clear the MIL/DTC

- The present trouble turns to history trouble when the condition is out of the range from DTC set condition (recovery from failure).
- The diagnosis lamp will go off after the code turns to history trouble and the key switch is turned “OFF” then “ON” again.
- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

Diagnostic aid

If the intermittent trouble is suspected, followings may be the cause.

- Improper connection of harness connector
- Defective harness routing
- Worn harness cladding
- Wire disconnection inside harness cladding

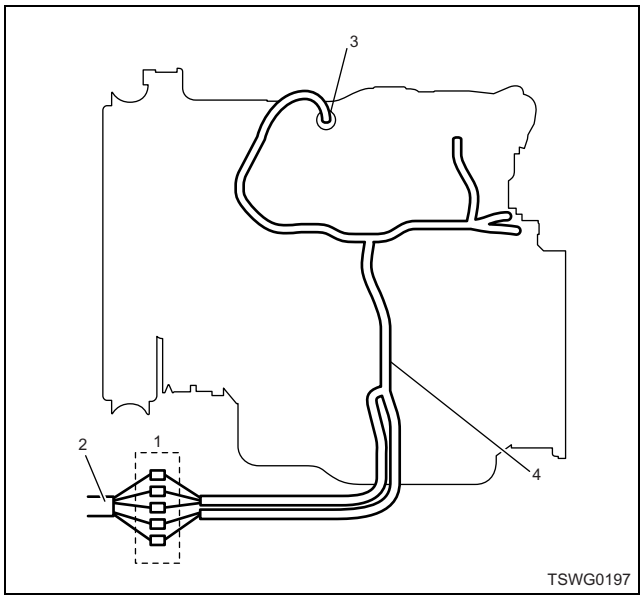
Following inspections are necessary to detect these causes.

- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items on the scan tool data display while moving the connector and the harness which are related to the sensor. The variation of the display indicates the faulty part.
- For crank sensor fault, DTC won’t be detected unless the engine cranks for 14 revolutions. Especially when running with low speed such as idling, engine stalls before cranking for 14 revolutions if no crank signal exist. In this case, the back-up mode will not be active because DTC is not detected. Therefore, the engine can be restarted even after it stalls, making it difficult to identify the fault. If the engine experienced stall, raise the engine speed up to No Load Max, and check if crank sensor fault is detected while cranking for 14 revolutions. If crank sensor fault is detected at No Load Max, DTC will be detected. If intermittent trouble is found, raise the engine speed up to No Load Max, and check if DTC P0355 is detected.

Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Check for installation condition of the crankshaft position (CKP) sensor. 1. Turn the key switch to “OFF”. 2. Visually check the sensor for installation condition such as play or looseness. 3. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 3.	—
3	Check for installation condition of the CKP sensor, ECM and coupling connector. 1. Check for play or looseness in the connection. 2. If the trouble is detected, repair or replace as required. Is the procedure completed?	—	Go to Step 4.	—

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	99 - Sensor connector power supply terminal	100 Ω or less	10 MΩ or more
	Short circuit to ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	99 - Ground	10 MΩ or more	100 Ω or less
7	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	98 - Sensor connector signal terminal	100 Ω or less	10 MΩ or more
	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	98 - Ground	0V	18V or more
8	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	100 - Sensor connector shield terminal	100 Ω or less	10 MΩ or more
	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	100 - Ground	0V	18V or more

On-board check procedure for sensors



Name
1. Coupling connector between engine — the machine
2. Machine harness
3. Sensor connector
4. Engine harness

1. Disconnect the coupling connector, and check the sensor from engine harness connector.
2. Disconnect the connector from sensor, and short the wiring of sensor connector.
3. Check the harness from coupling connector for open circuit.
   - If both steps 1 and 2 are faulty, repair the harness. Check from step 1 again.
   - If only step 1 is faulty, replace the sensor.

Step	Action	Value	YES	NO
13	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 15.	Go to Step 14.
14	Replace the ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 15.	—
15	Check the DTC again. 1. Connect all the harnesses. 2. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 3. Turn the key switch to “OFF” for more than 10 seconds. 4. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P0380 detected?	—	Go to Step 2.	Go to Step 16.
16	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
17	Check for installation condition of the glow relay, ECM connector and coupling connector. 1. Check for play or looseness in the connection. 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 7.

Step	Action	Value	YES	NO
6	Check the DTC again. 1. Connect all the harnesses. 2. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 3. Turn the key switch to “OFF” for more than 10 seconds, and then start the engine. 4. Warm-up the engine until the engine coolant temperature exceeds 80°C (176°F). 5. Check the DTC. Is DTC P0487 detected?	—	Go to Step 7.	Go to Step 11.
7	Is EMPS available?	—	Go to Step 8.	Go to Step 9.
8	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 10.	Go to Step 9.
9	Replace the ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 10.	—
10	Check the DTC again. 1. Connect all the harnesses. 2. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 3. Turn the key switch to “OFF” for more than 10 seconds. 4. Warm-up the engine until the engine coolant temperature exceeds 80°C (176°F). 5. Check the DTC. Is DTC P0487 detected?	—	Go to Step 2.	Go to Step 11.

Back-up mode

- Back-up: No back-up action

Recovery from failure

Refer to “List of diagnostic trouble code” and “About recovery from failure” in this section for recovery from failure.

The conditions to clear the MIL/DTC

- The present trouble turns to history trouble when the condition is out of the range from DTC set condition (recovery from failure).
- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

Diagnostic aid

If the intermittent trouble is suspected, followings may be the cause.

- Improper connection of harness connector
- Defective harness routing
- Worn harness cladding
- Wire disconnection inside harness cladding

Following inspections are necessary to detect these causes.

- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items on the scan tool data display while moving the connector and the harness which are related to the sensor. The variation of the display indicates the faulty part.

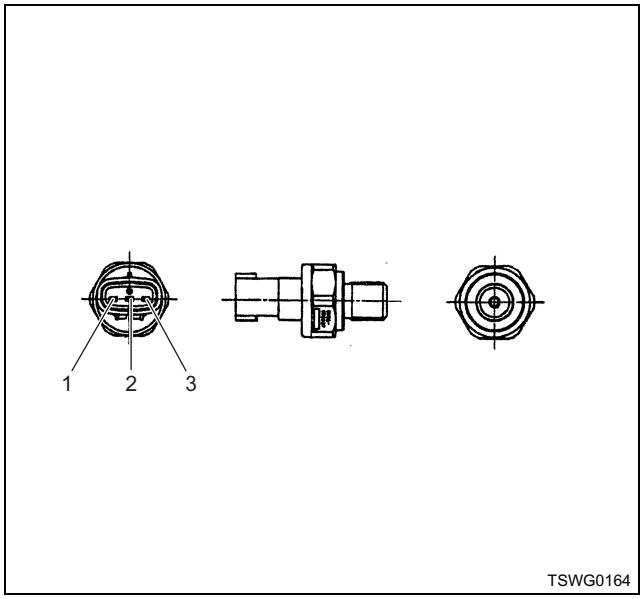
Test description

Numbers below indicate step numbers in the chart.
3. In the case of present trouble, the “Engine oil pressure sensor” displays more than the specified value. In this case, identify the cause by referring to “Diagnostic aid”.
5. If the “Engine oil pressure sensor” displays more than the specified value when the ECT sensor connector is removed, the circuit beyond the sensor is normal including ECM.

Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Perform “OBD system check”, and Go to Step 2.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 6.
3	Check the value for engine oil pressure sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. 3. Check the value for “Engine oil pressure sensor” using scan tool. Is the “Engine oil pressure sensor” less than the specified value?	0.1V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the engine oil pressure sensor, ECM and coupling connector. 1. Check for play or looseness in the connection. 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 5.

Step	Action	Value	YES	NO
18	1. Check for followings in the ground circuit between ECM and engine oil pressure sensor, using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Open circuit • High resistance 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 9.

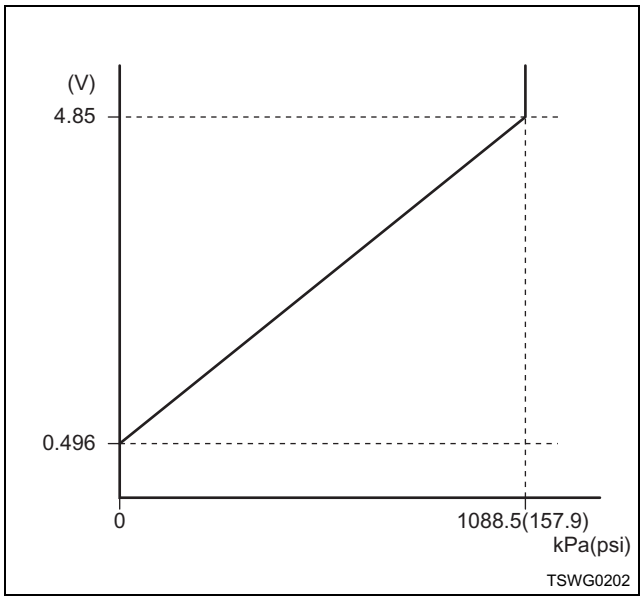
About engine oil pressure sensor



Name
1. Sensor ground
2. Sensor signal
3. Sensor power supply

Characteristics of engine oil pressure sensor

The output voltage of engine oil pressure sensor changes according to the engine oil pressure. The scan tool with CAN communication displays a fixed value when the value exceeds the threshold voltage. Therefore, judge as it is more than the threshold value if the value of 0 kPa (0 psi) or 1088.5 kPa (157.9 psi) is not changed.
When error occurs, error value (1016 kPa {147.4 psi}) is displayed.
The following illustration shows the correlation between physical value and voltage displayed in the scan tools with CAN communication.
Tech2 and scan tools with KW communication can display both physical value and voltage.



Recovery from failure

Refer to “List of diagnostic trouble code” and “About recovery from failure” in this section for recovery from failure.

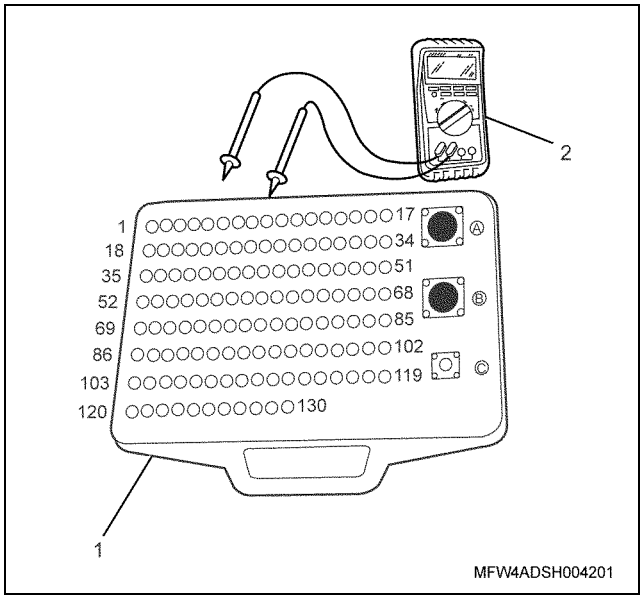
The conditions to clear the MIL/DTC

- The present trouble turns to history trouble when the condition is out of the range from DTC set condition (recovery from failure).
- The diagnosis lamp will go off after the code turns to history trouble and the key switch is turned “OFF” then “ON” again.
- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Is the scan tool available?	—	Go to Step 3.	Go to Step 12.
3	1. Make sure all the communication between ECU and scan tool is normal. 2. Make sure the system which require programming operates normally. 3. Check the DTC. Is DTC P0611 detected?	—	Go to Step 4.	Go to Step 10.
4	1. Check for followings in the ground circuit between ECM terminals (1, 3, 4, 43, 62, 81) and ECM ground terminal (E2) using breaker box or DMM. • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 10.	Go to Step 5.
5	1. Turn the key switch to “OFF”. 2. Remove the ECM ground terminal (E2). 3. Check the ECM ground terminal (E2) for intermittent trouble or poor contact. 4. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 10.	Go to Step 6.
6	1. Turn the key switch to “OFF”. 2. Remove the ECM. 3. Check the ECM terminals (1, 3, 4, 43, 62, 81) for intermittent trouble or poor contact. 4. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 10.	Go to Step 7.
7	Is EMPS available?	—	Go to Step 8.	Go to Step 9.

Breaker box inspection procedure

Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

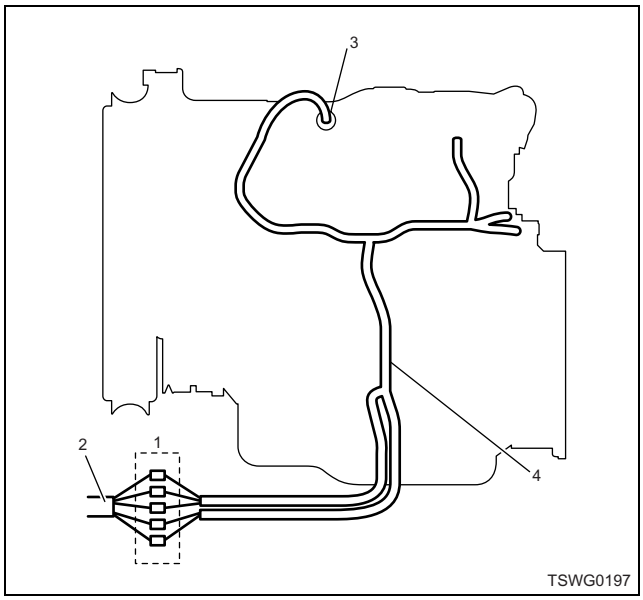
Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
7	Short circuit to ground	Resistance measurement	• Disconnect the relay. • Key switch “OFF”	14 - Ground	10 MΩ or more	100Ω or less
	Open circuit/ high resistance	Resistance measurement	• Disconnect the relay. • Key switch “OFF”	14 - Relay installing terminal	100Ω or less	10 MΩ or more
10	Short circuit to ground	Resistance measurement	• Disconnect the key switch connector. • Key switch “OFF”	46 - Ground	10 MΩ or more	100 Ω or less
	Open circuit/ high resistance	Resistance measurement	• Disconnect the key switch connector. • Key switch “OFF”	46 - Key switch “START” terminal	100 Ω or less	10 MΩ or more
12	Short circuit to power supply circuit	Voltage measurement	• Disconnect the relay. • Key switch “ON”	14 - Ground	0V	18V or more

Step	Action	Value	YES	NO
6	Check for rise of fuel level in the oil level gauge or light oil odor. Is the trouble detected?	—	Go to Step 7.	Go to Step 8.
7	Check the connection of the fuel pipe in each injector, and replace the injector if oil leakage is confirmed. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the procedure completed?	—	Go to Step 19.	—
8	Is the scan tool (KW communication) available?	—	Go to Step 9.	Go to Step 22.
9	Check the injector. 1. Clear the DTC. Refer to "How to clear diagnosis trouble code (DTC)" of "Procedure of trouble diagnosis" in this section for how to clear DTCs. 2. Start the engine. 3. Select the "Actuator test" from the menu. 4. Select the "Injection stop at each injector" in the "Common rail system". 5. Press the "OFF" soft key to stop the fuel injection in the cylinder one by one, and check the change in engine sound. Is there any cylinder of which engine vibration and engine sound did not change when it is stopped?	—	Go to Step 10.	Go to Step 11.
10	1. Replace the injector in the cylinder of which engine sound did not change when it is stopped in step 9. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the procedure completed?	—	Go to Step 20.	—
11	Check the common rail pressure. 1. Turn the key switch to "ON". 2. Check for "Common rail pressure" on the data display using scan tool. 3. Start the engine and run it at idle. 4. Check for "Common rail pressure" on the data display using scan tool. 5. Race it quickly for about 5 times. 6. Check for "Common rail pressure" on the data display using scan tool. Is each value of "Common rail pressure" (at engine stopped, idling and racing) around specified value?	At engine stopping: −30 MPa (−4351 psi); At idling, racing: ±5 MPa (±725 psi)	Go to Step 18.	Go to Step 12.

Step	Action	Value	YES	NO
11	Replace the injector in the cylinder of which engine sound did not change when it is stopped in step 9. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the procedure completed?	—	Go to Step 17.	—
12	Replace the supply pump. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the procedure completed?	—	Go to Step 13.	—
13	Check the DTC again. 1. Bleed air from the fuel system. 2. Clear the DTC. Refer to "How to clear diagnosis trouble code (DTC)" of "Procedure of trouble diagnosis" in this section for how to clear DTCs. 3. Turn the key switch to "OFF" for more than 10 seconds. 4. Test run with the "Preconditions when DTC is set". 5. Check the DTC. Is DTC P1094 detected?	—	Go to Step 14.	Go to Step 18.
14	Is EMPS available?	—	Go to Step 15.	Go to Step 16.
15	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to "How to use flash tool" in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to "Engine Control System, Engine control module (ECM), Installation of ECM" in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 17.	Go to Step 16.
16	Replace the ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to "Engine Control System, Engine control module (ECM), Installation of ECM" in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 17.	—

Step	Action	Value	YES	NO
14	Check the DTC again. 1. Restore the machine. 2. Bleed air from the fuel. 3. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 4. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P1095 detected?	—	Go to Step 15.	Go to Step 19.
15	1. Replace the common rail. **Note:** **For work procedure, refer to “Engine section” in the service manual.** 2. Bleed air from the fuel. 3. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 4. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P1095 detected?	—	Go to Step 16.	Go to Step 18.
16	1. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 2. Start the engine. If Tech2 is available, go to step 3. If Tech2 is not available, go to step 17. 3. Select the “Actuator test” from the menu. 4. Select the “Rail pressure control” in the “Common rail system”. 5. Press the “Up” soft key to check the value of “Differential fuel pressure”. Is “Differential fuel rail pressure” within the specified value?	±5 MPa (±725 psi)	Go to Step 18.	Go to Step 17.
17	Replace the supply pump. **Note:** • **Bleed air completely after the parts are replaced. If air bleeding is not sufficient, P1095 may be detected due to overshoot of fuel pressure.** • **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 18.	—

On-board check procedure for sensors



Name

1. Coupling connector between engine — the machine
2. Machine harness
3. Sensor connector
4. Engine harness

---

1. Disconnect the coupling connector, and check the sensor from engine harness connector.
2. Disconnect the connector from sensor, and short the wiring of sensor connector.
3. Check the harness from coupling connector for open circuit.
   - If both steps 1 and 2 are faulty, repair the harness. Check from step 1 again.
   - If only step 1 is faulty, replace the sensor.

Step	Action	Value	YES	NO
5	1. Check the signal circuit between ECT sensor and ECM for short circuit to signal circuits of other sensors using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 10.
6	1. Check the engine coolant amount. 2. If insufficient, add engine coolant. 3. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 4. Turn the key switch to “OFF” for more than 10 seconds. 5. Start the engine, and check the DTC. Is DTC P1173 detected?	—	Go to Step 7.	Go to Step 13.
7	1. Check for following mechanical defects. (Refer to “Cooling system” of “Engine section” in the service manual.) • Clogging of radiator • Defective radiator cap • Loose fan belt • Defective thermostat • Defective water pump • Defective cylinder head gasket 2. If the trouble is detected, adjust or replace as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 8.
8	Replace the ECT sensor. Is the procedure completed?	—	Go to Step 13.	—
9	Check the DTC again. 1. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 2. Turn the key switch to “OFF” for more than 10 seconds. 3. Test run with the “Preconditions when DTC is set”. 4. Check the DTC. Is DTC P1173 detected?	—	Go to Step 10.	Go to “Diagnostic aid”.
10	Is EMPS available?	—	Go to Step 11.	Go to Step 12.

Step	Action	Value	YES	NO
5	1. Check for followings in the injector power supply 1 circuit using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Open circuit • High resistance • Short circuit to ground 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
6	1. Turn the key switch to “OFF”. 2. Remove the ECM-side harness connector from the coupling connector (H-94). 3. Measure the resistance between the No. 1 cylinder injector drive circuit (H94 male-side No. 2) and the ground. Is the resistance more than the specified value?	10MΩ	Go to Step 7.	Go to Step 9.
7	1. Turn the key switch to “OFF”. 2. Remove the ECM-side harness connector from the coupling connector (H-94). 3. Measure the resistance between the No. 2 cylinder injector drive circuit (H94 male-side No. 7) and the ground. Is the resistance more than the specified value?	10MΩ	Go to Step 8.	Go to Step 10.
8	1. Turn the key switch to “OFF”. 2. Remove the ECM-side harness connector from the coupling connector (H-94). 3. Measure the resistance between the No. 3 cylinder injector drive circuit (H94 male-side No. 6) and the ground. Is the resistance more than the specified value?	10MΩ	Go to Step 12.	Go to Step 11.

Step	Action	Value	YES	NO
5	1. Check for followings in the injector power supply 2 circuit using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Open circuit • High resistance • Short circuit to ground 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
6	1. Turn the key switch to “OFF”. 2. Remove the ECM-side harness connector from the coupling connector (H-95). 3. Measure the resistance between the No. 4 cylinder injector drive circuit (H95 male-side No. 2) and the ground. Is the resistance more than the specified value?	10MΩ	Go to Step 7.	Go to Step 9.
7	1. Turn the key switch to “OFF”. 2. Remove the ECM-side harness connector from the coupling connector (H-95). 3. Measure the resistance between the No. 5 cylinder injector drive circuit (H95 male-side No. 7) and the ground. Is the resistance more than the specified value?	10MΩ	Go to Step 8.	Go to Step 10.
8	1. Turn the key switch to “OFF”. 2. Remove the ECM-side harness connector from the coupling connector (H-95). 3. Measure the resistance between the No. 6 cylinder injector drive circuit (H95 male-side No.6) and the ground. Is the resistance more than the specified value?	10MΩ	Go to Step 12.	Go to Step 11.

Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the AP sensor connector. 3. Short between the sensor power supply terminal of the AP sensor connector and the signal terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check for “Accelerator sensor 1” on the data display using scan tool. Is the “Accelerator sensor 1” more than the specified value?	4.7V	Go to Step 8.	Go to Step 7.
6	1. Check for high resistance in the power supply circuit between ECM and AP sensor using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 16.	Go to Step 11.
7	1. Check for high resistance in the signal circuit between ECM and AP sensor using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 16.	Go to Step 11.
8	1. Check for high resistance in the ground circuit between ECM and AP sensor using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 16.	Go to Step 11.

Back-up mode

- 1 system fault...No back-up
- 2 system fault...Accelerator opening angle is controlled to 0%.

Recovery from failure

Refer to “List of diagnostic trouble code” and “About recovery from failure” in this section for recovery from failure.

The conditions to clear the MIL/DTC

- The present trouble turns to history trouble when the condition is out of the range from DTC set condition (recovery from failure).
- The diagnosis lamp will go off after the code turns to history trouble and the key switch is turned “OFF” then “ON” again.
- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

Diagnostic aid

When the DTC P1283 is detected at the same time, the accelerator pedal position sensor and accelerator pedal position sensor signal circuit (before the bifurcation point) may be faulty.
If the intermittent trouble is suspected, followings may be the cause.

- Improper connection of harness connector
- Defective harness routing
- Worn harness cladding
- Wire disconnection inside harness cladding

Following inspections are necessary to detect these causes.

- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items on the scan tool data display while moving the connector and the harness which are related to the sensor. The variation of the display indicates the faulty part.

Test description

Numbers below indicate step numbers in the chart.
3. In the case of present trouble, the “Accelerator sensor 1” displays more than the specified value. If less than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If the “Accelerator sensor 1” displays less than the specified value when the AP sensor connector is removed, the circuit beyond the sensor is normal including ECM.

Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Is the scan tool available?	—	Go to Step 3.	Go to Step 14.
3	1. Turn the key switch to “ON”. 2. Check for “Accelerator sensor 1” on the data display using scan tool. Is the “Accelerator sensor 1” more than the specified value?	4.9V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the AP sensor connector, ECM connector and coupling connector. 1. Check for play or looseness in the connection. 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 5.
5	1. Turn the key switch to “OFF”. 2. Disconnect the AP sensor connector. 3. Turn the key switch to “ON”. 4. Check for “Accelerator sensor 1” on the data display using scan tool. Is the “Accelerator sensor 1” less than the specified value?	0.1V	Go to Step 8.	Go to Step 6.

Back-up mode

- 1 system fault...No back-up
- 2 system fault...Accelerator opening angle is controlled to 0%.

Recovery from failure

Refer to “List of diagnostic trouble code” and “About recovery from failure” in this section for recovery from failure.

The conditions to clear the MIL/DTC

- The present trouble turns to history trouble when the condition is out of the range from DTC set condition (recovery from failure).
- The diagnosis lamp will go off after the code turns to history trouble and the key switch is turned “OFF” then “ON” again.
- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

Diagnostic aid

When the DTC P1278 is detected at the same time, the accelerator pedal position sensor and accelerator pedal position sensor signal circuit (before the bifurcation point) may be faulty.
If the intermittent trouble is suspected, followings may be the cause.

- Improper connection of harness connector
- Defective harness routing
- Worn harness cladding
- Wire disconnection inside harness cladding

Following inspections are necessary to detect these causes.

- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items on the scan tool data display while moving the connector and the harness which are related to the sensor. The variation of the display indicates the faulty part.

Test description

Numbers below indicate step numbers in the chart.
3. In the case of present trouble, the “Accelerator sensor 2” displays more than the specified value. If less than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If the “Accelerator sensor 2” displays less than the specified value when the AP sensor connector is removed, the circuit beyond the sensor is normal including ECM.

Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Is the scan tool available?	—	Go to Step 3.	Go to Step 14.
3	1. Turn the key switch to “ON”. 2. Check for “Accelerator sensor 2” on the data display using scan tool. Is the “Accelerator sensor 2” more than the specified value?	4.9V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the AP sensor connector, ECM connector and coupling connector. 1. Check for play or looseness in the connection. 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 5.
5	1. Turn the key switch to “OFF”. 2. Disconnect the AP sensor connector. 3. Turn the key switch to “ON”. 4. Check for “Accelerator sensor 2” on the data display using scan tool. Is the “Accelerator sensor 2” less than the specified value?	0.1V	Go to Step 8.	Go to Step 6.

Recovery from failure

Refer to “List of diagnostic trouble code” and “About recovery from failure” in this section for recovery from failure.

The conditions to clear the MIL/DTC

- The present trouble turns to history trouble when the condition is out of the range from DTC set condition (recovery from failure).
- The diagnosis lamp will go off after the code turns to history trouble and the key switch is turned “OFF” then “ON” again.
- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

Diagnostic aid

If the intermittent trouble is suspected, followings may be the cause.

- Fault in switch body
- Improper adjustment of switch
- Improper connection of harness connector
- Defective harness routing
- Worn harness cladding
- Wire disconnection inside harness cladding

Following inspections are necessary to detect these causes.

- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items on the scan tool data display while moving the connector and the harness which are related to the sensor. The variation of the display indicates the faulty part.

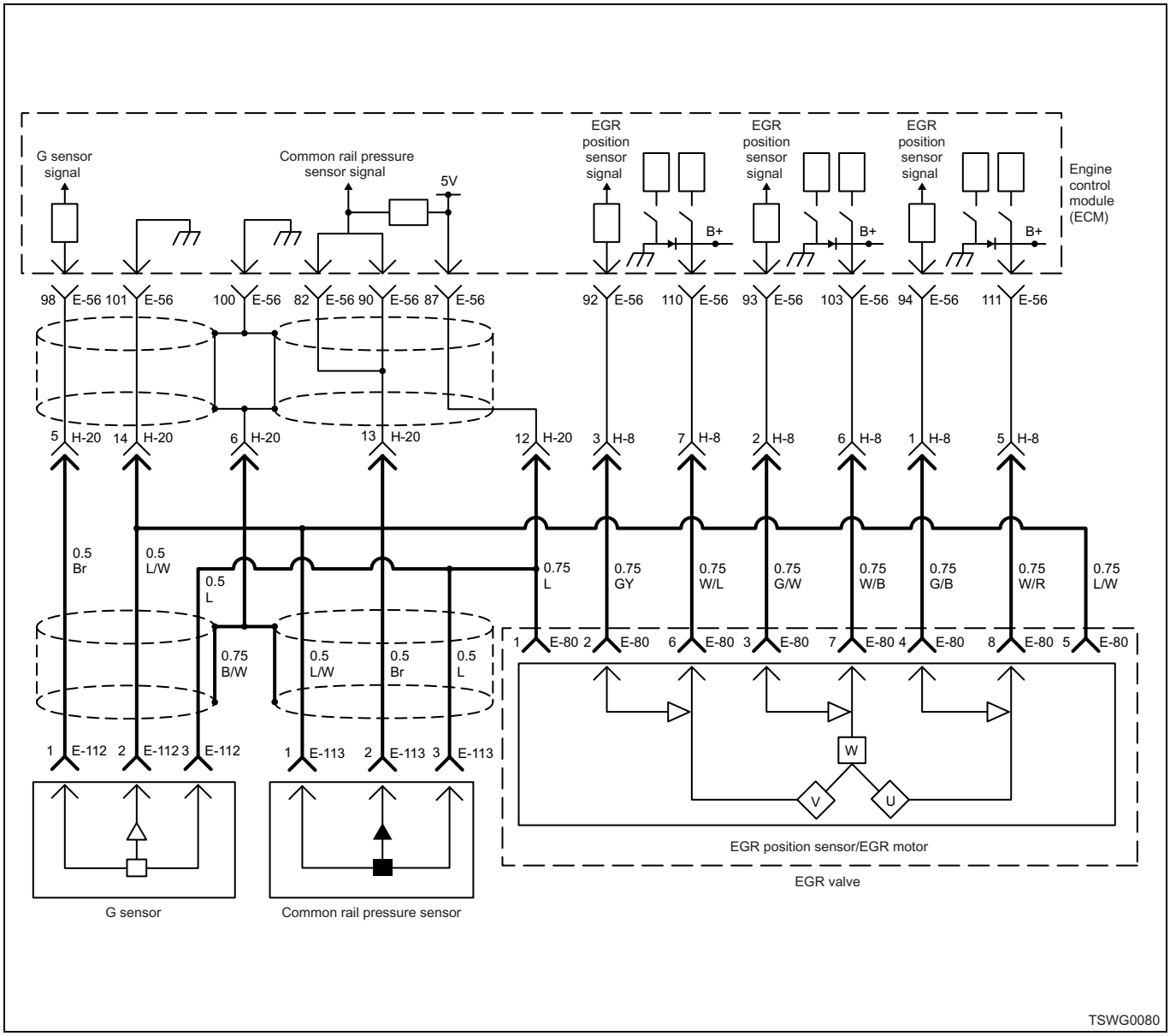
Test description

Numbers below indicate step numbers in the chart.
4. If the main relay is stuck closed, it is possible to communicate with ECM using scan tool even with the key switch “OFF”.
5. If it is still possible to communicate with ECM using scan tool and the DTC is detected when the main relay is removed, the circuit beyond the relay or ECM is faulty.
8. If the “Main relay voltage” displays more than the specified value when terminals between the main relay installing portion are shorted, the circuit beyond the relay is normal including ECM.

Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 17.
3	1. Turn the key switch to “ON”. 2. Check for “Main relay voltage” on the data display using scan tool. Is the “Main relay voltage” more than the specified value?	1V	Go to Step 4.	Go to Step 7.
4	1. Turn the key switch to “OFF”. 2. Check the DTC. Is DTC P1625 detected?	—	Go to Step 5.	Go to “Diagnostic aid”.
5	1. Remove the main relay. 2. Check the DTC. **Note:** **Refer to the machine’s manual for installing position and installation/removal procedures of the main relay.** Is DTC P1625 detected?	—	Go to Step 6.	Go to Step 11.

Step	Action	Value	YES	NO
6	Is EMPS available?	—	Go to Step 7.	Go to Step 8.
7	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 9.	Go to Step 8.
8	Replace the ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 9.	—
9	Check the DTC again. 1. Connect all the harnesses. 2. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 3. Turn the key switch to “OFF” for more than 10 seconds. 4. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P1631 detected?	—	Go to Step 2.	Go to Step 10.
10	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

DTC: P1635 (Flash code 55) Voltage fault in 5-V power supply 5



Description of circuit

The 5-V power supply circuit is provided to the ECM for 5 systems. The 5-V power supply circuit 5 supplies power to the common rail pressure sensor and the EGR position sensor.
The ECM sets the DTC when the voltage in the 5-V power supply circuit 5 and 2 is higher or lower than the normal range.

Main trouble symptom

- Engine blow up
- Output lowering
- Black smoke emitted
- Engine stall possible

Preconditions when DTC is set

- DTC P1630 is not detected.
- Key switch input power supply voltage is higher than 16 V but lower than 32 V.

DTC set condition

- Key switch power supply voltage is 5.5 V or more, or 4.5 V or less.

Action taken when DTC is set

- Trouble is displayed on the monitor of the machine or diagnosis lamp comes on.

Back-up mode

- Same to rail pressure sensor fault and EGR position sensor fault

Step	Action	Value	YES	NO
4	1. Check for followings in the CAN-Low circuit and CAN-High circuit between ECM and machine control unit (ECU) using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Short circuit to ground circuit • Short circuit to power supply circuit or ignition power supply circuit 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 5.
5	Check the DTC again. 1. Connect all the harnesses. 2. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 3. Turn the key switch to “OFF” for more than 10 seconds. 4. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC U2106 detected?	—	Go to Step 6.	Go to “Diagnostic aid”.
6	1. If the DTC U2104 is detected, and the history and present troubles of DTC U2106 are alternately detected, check the circuit between ECM terminals (32) and (18) for the following conditions. • Short circuit 2. If the trouble is detected, repair or replace as required. 3. Check if DTC is not detected again. Is the procedure completed?	—	—	Go to Step 7.
7	Replace the machine control unit. Is the procedure completed?	—	Go to Step 11.	—
8	Is EMPS available?	—	Go to Step 9.	Go to Step 10.

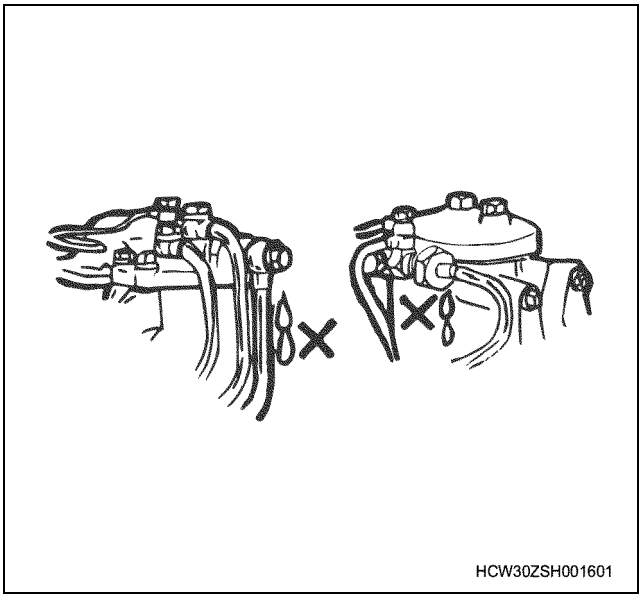
Step	Action	Value	YES	NO
8	Check the fuel system in the following procedure. 1. Check the high pressure pipe and low pressure pipe for looseness in the connection (fuel leakage), crush or clogging. Check the clogging in the following procedure. • Fuel filter (main fuel filter, pre-fuel filter, gauze filter) • Fuel tank (pump strainer) • Fuel system pipe 2. Check the fuel pipe, fuel filter, and inside of the fuel tank for freeze or waxing. (at cold temperature) 3. Check the feed pipe inside the fuel tank for clogging of foreign matter. 4. Repair or replace the faulty part. Is the procedure completed?	—	Go to Step 9.	—
9	Check the intake system. Is the procedure completed?	—	Go to Step 10.	Go to “Intake system check”.
10	Check the exhaust system. Is the procedure completed?	—	Go to Step 11.	Go to “Exhaust system check”.
11	Check the mechanical part of the engine, and repair if faulty. • Compression pressure • Valve system • Injector • Timing gear • Related part of piston/crank Is the procedure completed?	—	Go to Step 12.	—
12	Is EMPS available?	—	Go to Step 13.	Go to Step 14.
13	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to “Engine Control System, Engine control module (ECM), Installation of ECM” in this section for learning of EGR.** Is the procedure completed?	—	Verify repair.	Go to Step 14.

Step	Action	Value	YES	NO
22	Repair the machine, and check the repair. Is the procedure completed?	—	Verify repair.	—

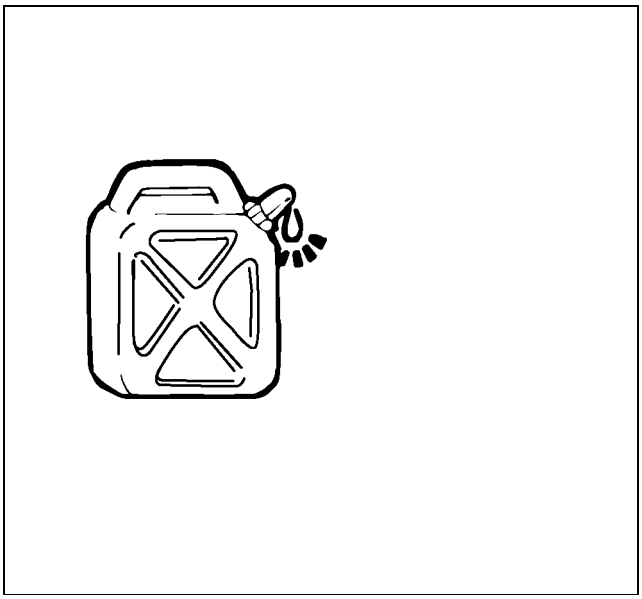
Step	Action	Value	YES	NO
3	Check if periodic maintenance has been performed for engine oil replacement, air cleaner filter, fuel filter, etc. Is the procedure completed?	—	Perform maintenance for the machine.	Go to Step 4.
4	Check the intake system and intercooler for water accumulation. Is the procedure completed?	—	Go to Step 5.	Go to “Intake system check”.
5	Check the exhaust system for crush, bent or clogging. Is the procedure completed?	—	Go to Step 6.	Go to “Exhaust system check”.
6	Check for output shortage. Is the procedure completed?	—	Go to Step 7.	Go to “Output shortage, lag down”.
7	1. Check the coupling of the supply pump for damage. 2. Check the coupling of the supply pump for worn out of alignment mark. Repair or replace the faulty part. Is the procedure completed?	—	Go to Step 8.	—
8	Check if the engine oil of viscosity mentioned in the operation manual is used. Is the appropriate oil used?	—	Go to Step 9.	Replace with the appropriate oil, and Go to Step 1.
9	Check the cooling fan for fault. Repair or replace the faulty part. Is the procedure completed?	—	Go to Step 10.	—
10	Is the scan tool (KW communication) available?	—	Go to Step 11.	Go to Step 16.
11	Perform “Injection Stop for Each Injector”. 1. Select the “Actuator test” from the scan tool menu. 2. Select the “Injection stop at each injector” in the “Common rail system”. 3. Press the “OFF” soft key to stop the fuel injection in the cylinder one by one, and check the change in engine sound. Is there any cylinder of which engine vibration and engine sound did not change when it is stopped?	—	Go to Step 12.	Go to Step 13.
12	Replace the injector in the cylinder of which engine sound did not change when it is stopped. **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 13.	—
13	Check the engine compression pressure. Repair or replace the faulty part. Is the procedure completed?	—	Go to Step 14.	—

DTC	Flash code	DTC description	Item to be detected	Preconditions when DTC is set	DTC set condition	Judgment Time	Behavior when trouble occurs	Diagnos is lamp	Recovery from failure
P0202	272	Open circuit in injection nozzle #2 drive system	Open/short circuit in electrical wiring No. 2 cylinder injector	• Main relay power supply voltage is 16V or more. • 70 rpm or more • DTC P0611, P1261 or P0202 is not detected.	No injector 2 monitor input signal exists.	Approx. 3 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Injection for cylinder #3 stopped	ON	*1
P0203	273	Open circuit in injection nozzle #3 drive system	Open/short circuit in electrical wiring No. 3 cylinder injector	• Main relay power supply voltage is 16V or more. • 70 rpm or more • DTC P0611, P1261 or P0203 is not detected.	No injector 3 monitor input signal exists.	Approx. 3 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Injection for cylinder #6 stopped	ON	*1
P0204	274	Open circuit in injection nozzle #4 drive system	Open/short circuit in electrical wiring No. 4 cylinder injector	• Main relay power supply voltage is 16V or more. • 70 rpm or more • DTC P0612, P1262 or P0204 is not detected.	No injector 4 monitor input signal exists.	Approx. 3 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Injection for cylinder #2 stopped	ON	*1
P0205	275	Open circuit in injection nozzle #5 drive system	Open/short circuit in electrical wiring No. 5 cylinder injector	• Main relay power supply voltage is 16V or more. • 70 rpm or more • DTC P0612, P1262 or P0205 is not detected.	No injector 5 monitor input signal exists.	Approx. 3 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Injection for cylinder #4 stopped	ON	*1
P0206	276	Open circuit in injection nozzle #6 drive system	Open/short circuit in electrical wiring No. 6 cylinder injector	• Main relay power supply voltage is 16V or more. • 70 rpm or more • DTC P0612, P1262 or P0206 is not detected.	No injector 6 monitor input signal exists.	Approx. 3 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Common 1 stop (#1, #2, #3 cylinders stopped)	ON	*1
P0219	543	Overrun	Engine speed abnormally high	• Key switch input voltage is 16V or more.	When engine speed is more than 1970 rpm.	Nearly simultaneous to fault occurrence	Output lowering Back-up: Limited injection amount 1 Limitation is lifted if the speed decreases	ON	*2
P0606	51	CPU fault	CPU fault	—	Sub-CPU detects main CPU fault in 100 msec after key switch ON. (SUB-CPU resets CPU.)	Nearly simultaneous to fault occurrence	Output lowering Back-up: Limited injection amount 2 (multi-injection stopped) SUB-CPU stops control	ON	*2
	52	CPU monitoring IC fault	Sub-CPU fault	• 480 msec or more has elapsed after key switch ON. • Key switch input power supply voltage is higher than 16 V.	RUN-SUB pulse does not change for 20 msec or more.	Nearly simultaneous to fault occurrence	Output lowering Back-up: Limited injection amount 1	ON	*2

8. Always check that there are no fuel leaks when performing maintenance work on the fuel system. (It may cause a fire.)



9. Pay close attention to the risk of ignition if you are handling parts that carry a high voltage.
   Furthermore, any oil or fat spilt onto rubber parts must be wiped off immediately, as it will cause deterioration of the rubber.



Liquid gasket

Replacement parts and part numbers.

1. Always replace packing, oil seals, o-rings, caulking lock nuts, folding lock plates, split pins and other such parts with brand new parts.
2. The parts numbers contained in this manual may not represent the supply condition of the parts, and the part numbers may be changed due to revisions. Therefore, parts should always be checked against a parts catalogue before use.

Liquid gasket

1. Each time you disassemble parts that use liquid gasket, completely remove the old gasket residue from each of the parts and matching sections using a scraper, then clean each of the parts to completely remove oil, water, and dirt etc. from the various surfaces. Using the specified type of liquid gasket, apply new liquid gasket to each of the surfaces before reassembling the parts.
2. In order to make it easier to clean liquid gasket surfaces, apply gasket remover liquid (Pando-391D made by Three Bond Co., Ltd.) and leave the part to stand for approximately 10 minutes, after which the old liquid gasket residue will be easier to remove.
   However, this should not be used on resin components or painted components.
3. Please take care not to apply too much or too little liquid gasket.
   Also, you should always re-apply the liquid gasket upon itself when you start and finish application.
4. Make sure that there are no gaps when re-installing the liquid gasket parts to each other. If there are gaps between the two parts, re-apply the liquid gasket. Some parts, especially the oil pan, use the same size studs as a guide to eliminate the need for knock pin positioning etc.
5. Re-install these parts within 7 minutes of applying the liquid gasket.
   If more than 7 minutes passes, remove the previous liquid gasket and re-apply it.
6. Please wait for at least 30 minutes since the last part is installed before starting the engine.

Seal section	Product name	Manufacturer's name
Between head cover – Gear case – Cylinder head (Head upper side)	1207B	Three Bond
Between gear case – Cylinder head	FMD–127	Loctite
Between head cover – Gear case – Cylinder head (Head gasket upper side)	1207B	Three Bond
Between head cover and – Gear case – Cylinder block (Head gasket underside)	1207B	Three Bond

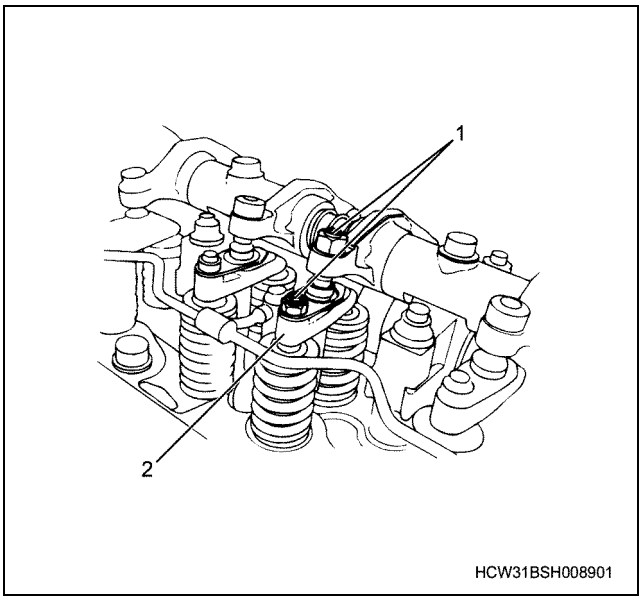
Disassemble and Assemble Engine

Engine mechanical
(6WG1 (Common rail))

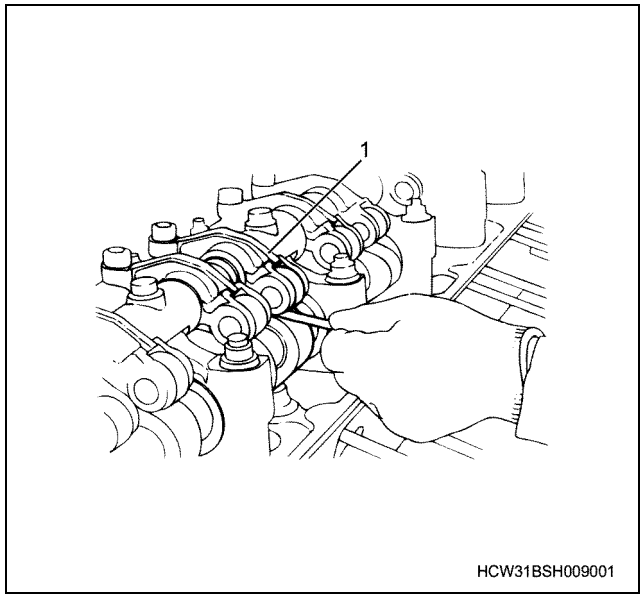
Contents

Valve clearance adjustment

1. Adjust the valves shown in the valve clearance adjustment table.
2. Completely tighten each of the adjustment screws (1) on the rocker arm and bridge (2).



3. Insert a thickness gauge between the rocker arm (1) and cam, adjust with the locker arm adjustment screw and fix with the lock nut.



4. With the thickness gauge inserted in place, tighten the bridge adjustment screw until the thickness gauge doesn't move.
5. Gradually loosen the bridge adjustment screw and adjust until a suitable hardness for inserting and removing the thickness gauge is reached, then fix the bridge lock nut.

Valve clearance (when cool)

Including intake and exhaust 0.40 mm

Tightening torque:
Rocker arm adjustment screw and lock nut 78 N·m {8.0 kgf·m}
Bridge adjust screw and lock nut 54 N·m {5.5 kgf·m}

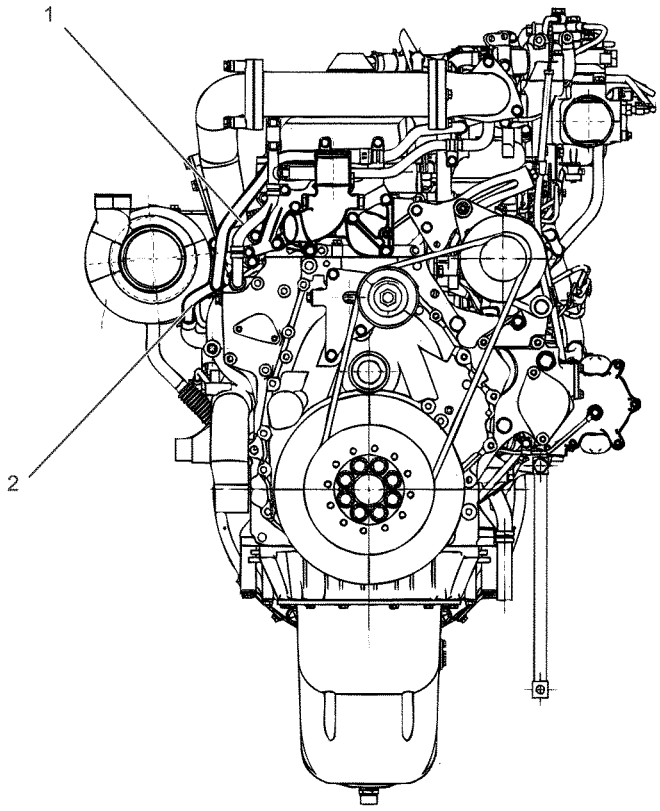
Notes:

- **Stop the engine, and wait for a reasonable amount of time before starting work.**
- **When removing the head cover, a small amount of oil may escape, so be prepared to clean up the oil with a rag etc.**

Valve clearance adjustment table

	Cylinder No.	1		2		3		4		5		6	
Conditions	Valve array	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake
Adjust Valve	When setting to the Number 1 cylinder compression top dead center	○	○		○	○			○	○			
	When setting to the Number 6 cylinder compression top dead center			○			○	○			○	○	○

Injection order (1-5-3-6-2-4)



PAW5Z0LF001201

Legend

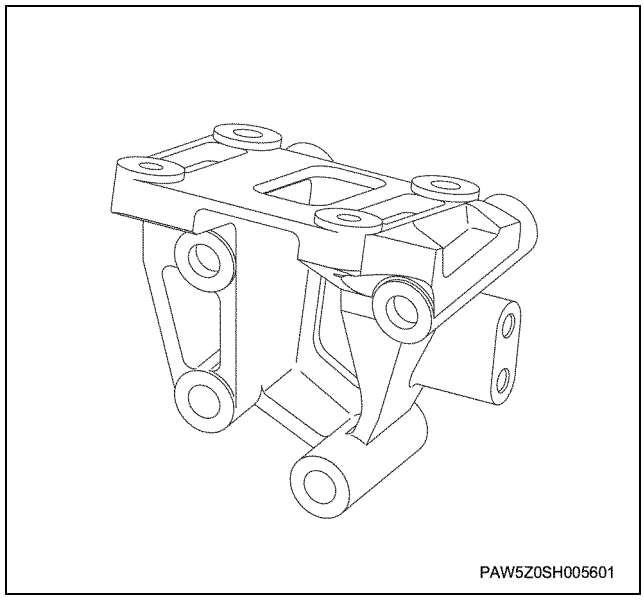
1. Water pipe, hose (feed side) (EGR cooler)
2. Water pipe, hose (return side) (EGR cooler)

Removal

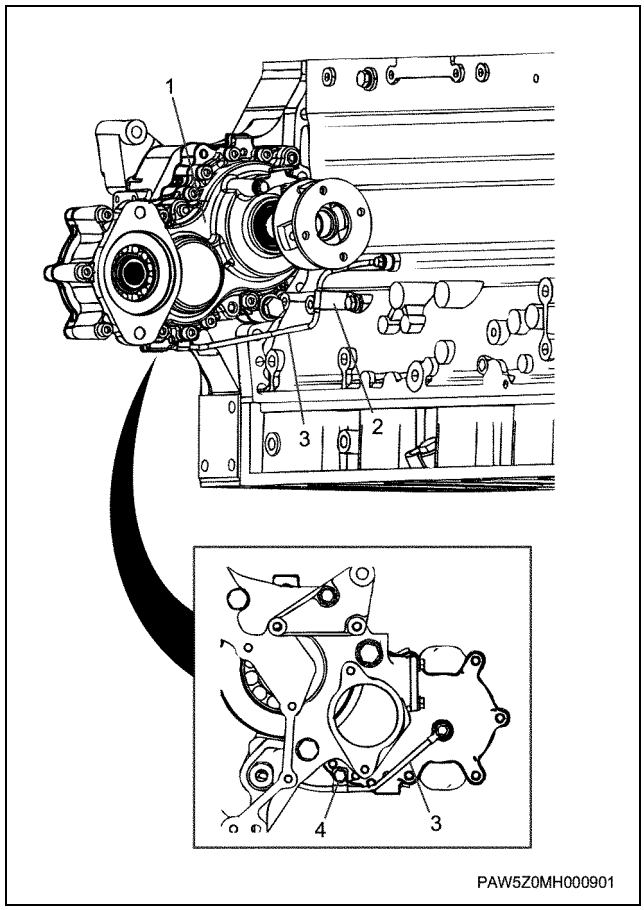
1. Remove the engine harness (1).

Notes:
It is a lot easier to re-install the harness clip if you mark the installed position of the harness clip with a paint marker before removing.

37. Loosen the bolt and remove the supply pump bracket.



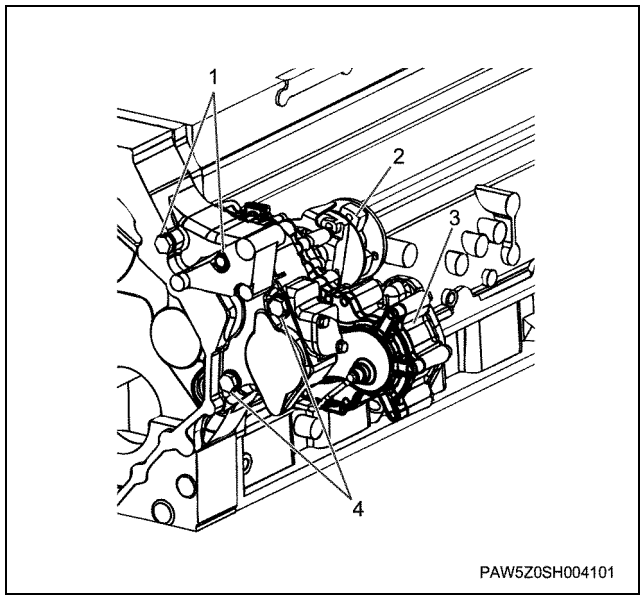
38. Release the clips and remove the oil pipe for the PTO.



Legend

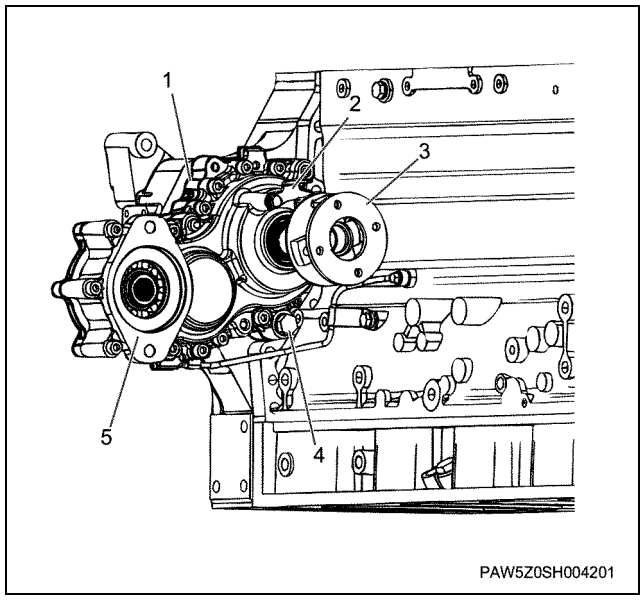
1. PTO gear ASM
2. Clip
3. Oil pipe
4. Clip

39. Loosen the bolt and remove the PTO gear ASM.



Legend

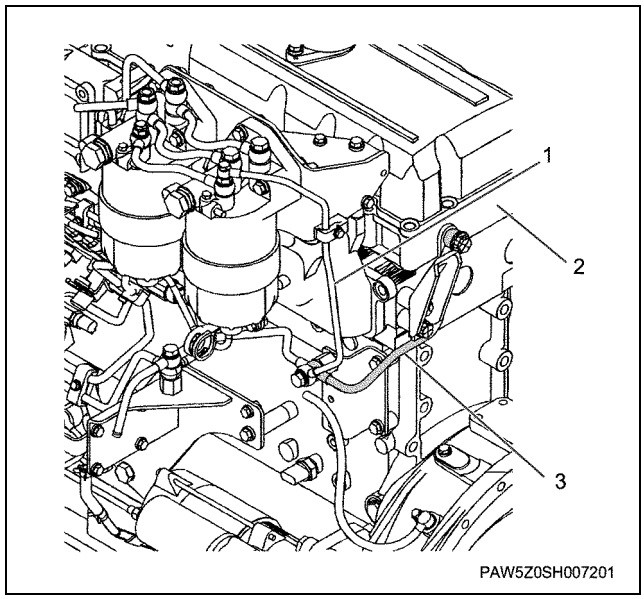
1. Bolt
2. Coupling
3. PTO gear ASM
4. Bolt



Legend

1. Gasket
2. Pointer
3. Coupling
4. Bolt
5. PTO gear ASM

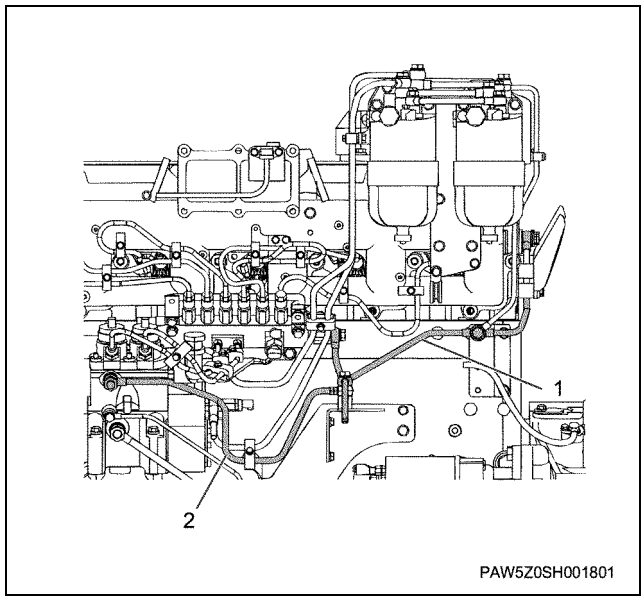
25. Install the nozzle leak off pipe.



Legend

1. Fuel return pipe (filter)
2. Head lower cover
3. Nozzle leak off pipe

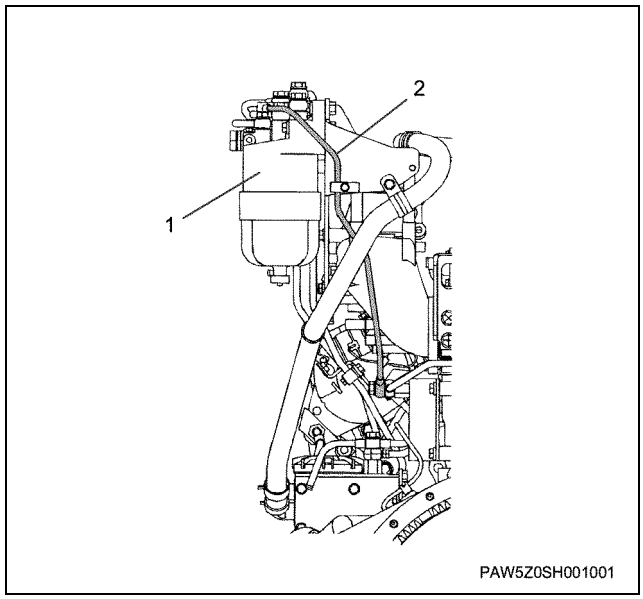
26. Install the fuel return pipe.



Legend

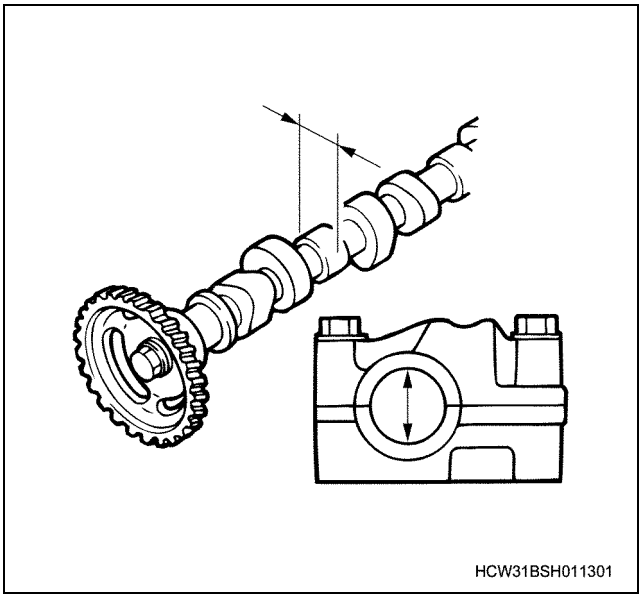
1. Nozzle leak off pipe
2. Fuel return pipe (supply pump)

27. Install the fuel return pipe (for the filter).

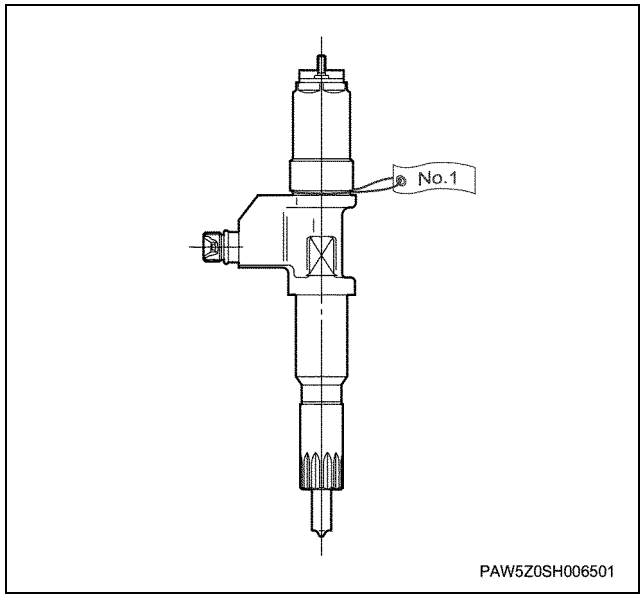


Legend

1. Fuel filter
2. Fuel return pipe



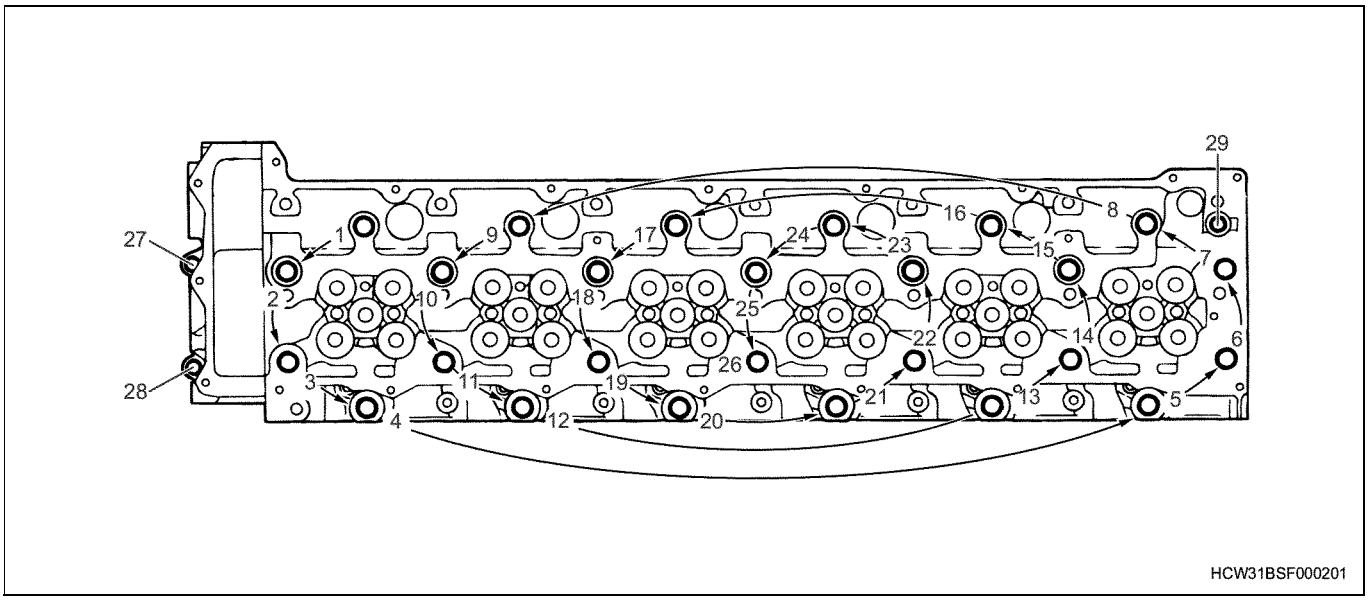
11. Remove the injector & clamp.
    - Loosen the clamp, and use a replacer to remove the injector.
    - Install a number to each injection before removing.



12. Remove the cylinder head ASM.
    - Remove the fixing bolts (27) and (28), then loosen and remove the tightening bolts from the outside in a balanced way in the numbered order shown in the diagram.

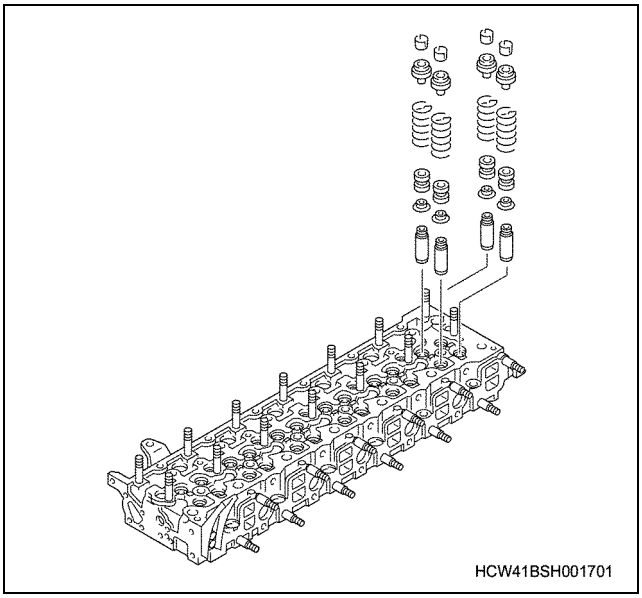
Important:

- **Do not forget to remove the fixing bolts (27) and (28) first.**
- **Use a rag etc. to cover the timing gear hole.**



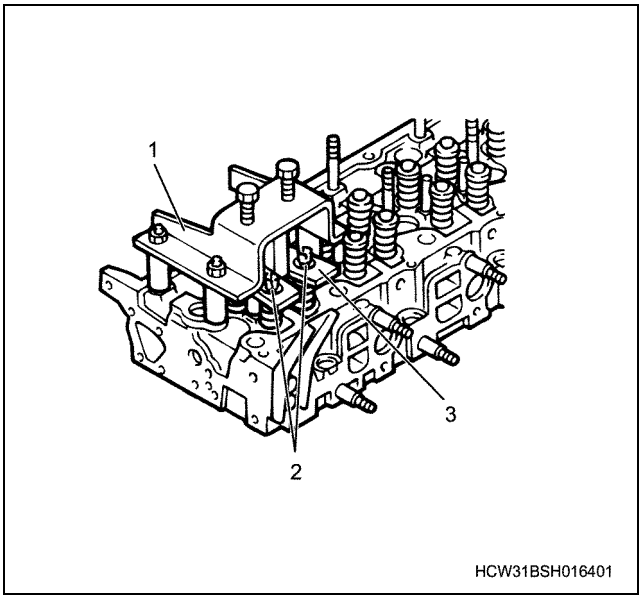
13. Remove the cylinder head gasket.

- Rest the cylinder head on a wooden board, and assemble the lower spring seat, valve spring and upper spring seat in order. Install the intake valve spring so that the narrower pitch is towards the underside of the head. There is no difference between the top and bottom of the exhaust valve spring.



11. Install a split collar.
    - Press the valve spring in with a valve spring compressor and install the split collar.
      After installing, gently strike the valve stem head with a rubber hammer to set the split collar down.

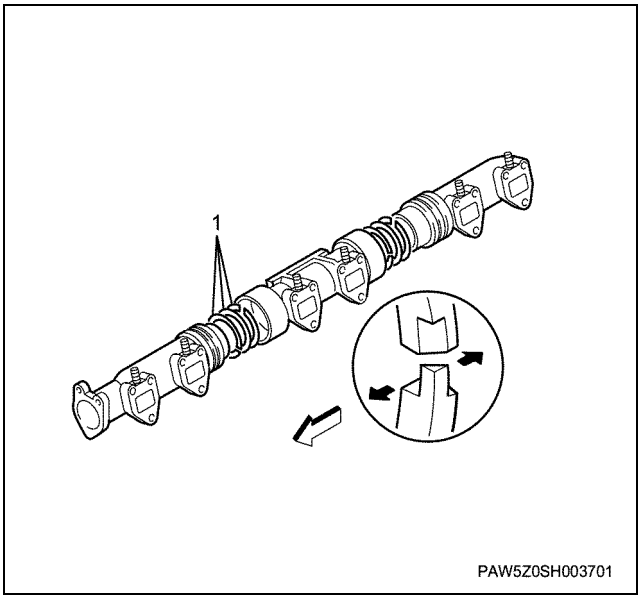
Compressor; Valve spring: 1-8523-5013-0



Legend
1. Bracket
2. Split collar
3. Bridge

12. Install the seal ring to the exhaust manifold.
    - Install the seal ring (1) with a 120° gap, then reassemble the manifold.

Notes:
The seal ring (1) has a correct installation direction, so please be careful when reassembling.



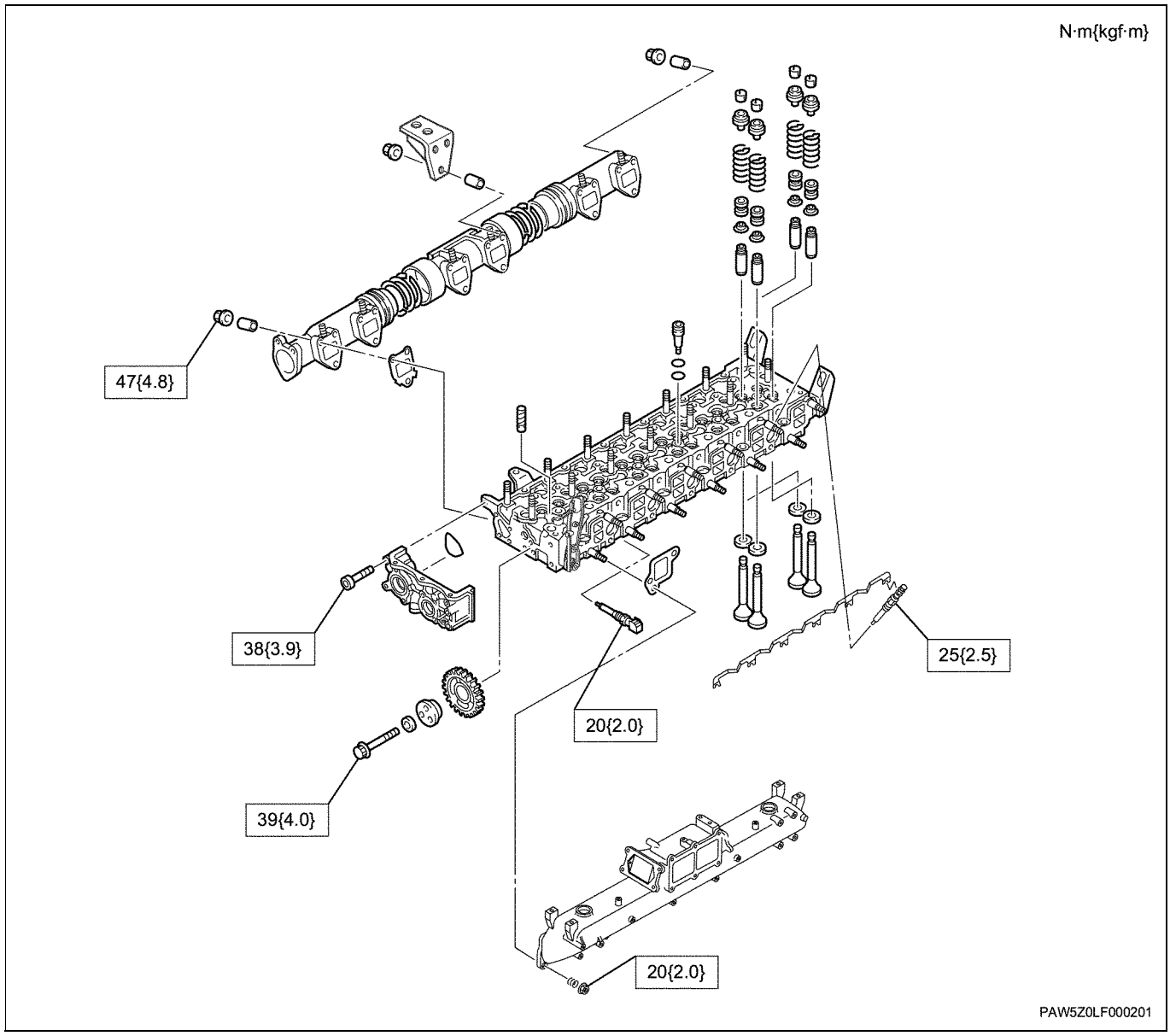
13. Install the exhaust manifold.
    - Clip the gasket, install the manifold to the cylinder head, and tighten in the numbered order shown in the diagram.
      (When tightening the flanges, start with the under side flanges and proceed to tighten in a clockwise direction.)

Tightening torque: 48 N·m {4.9 kgf·m}

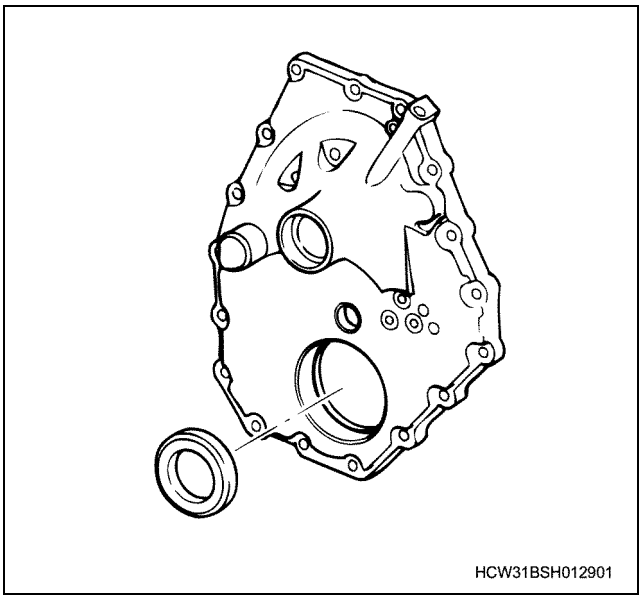
Important:
The locking nut cannot be reused.

Notes:
- **Install the distance tube so that it faces the nut side.**
- **Reassemble so that the gasket marking is at the bottom right.**

Torque specifications



- The oil seal cannot be re-used.

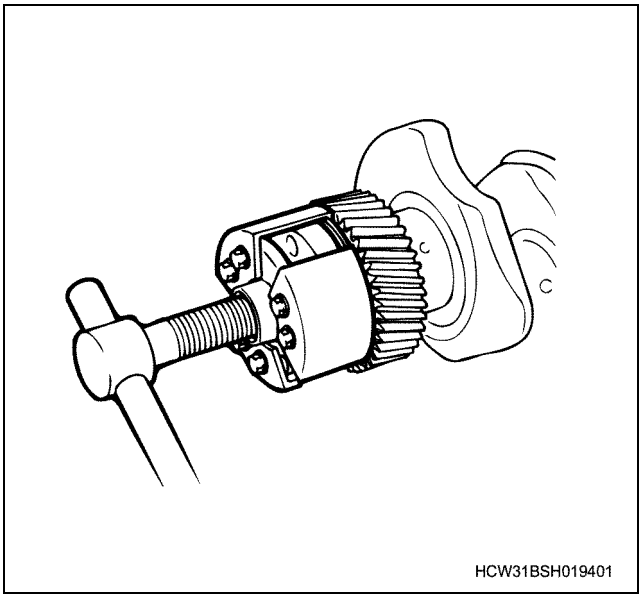


- Use a remover to remove the slinger.
- The slinger cannot be re-used.

Caution:

- **When replacing the oil seal, always replace the slinger together as a set.**
- **If the remover separates easily from the slinger, tightening the jig's perimeter with a clip band to makes it easier to remove the slinger.**

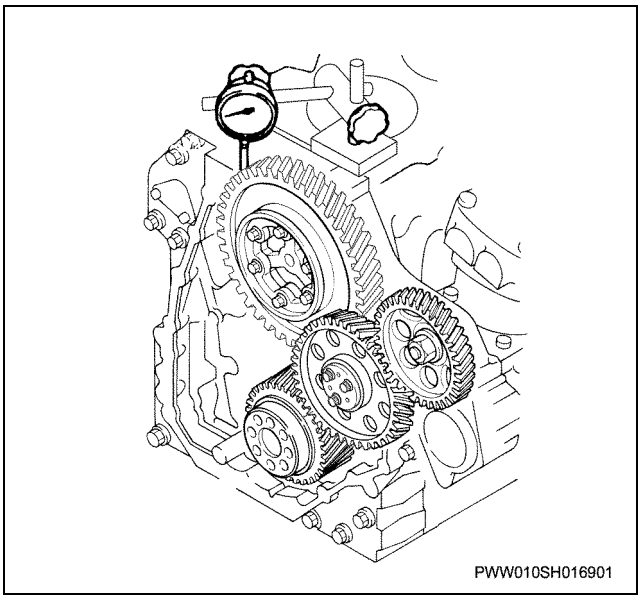
Remover; Slinger: 1-8521-0027-0



6. Remove the oil pump.
7. Remove the O-ring for the oil pump.
8. Remove the distance bolt.
9. Remove idle gear A and idle gear B.
   - Before removing the idle gear, measure each idle gear backlash.

Backlash (mm)

Standard	Limit
0.060 ~ 0.095	0.23



- Measure the idle gear A shaft orientation clearance.

Shaft orientation clearances (mm)

Standard	Limit
0.165 ~ 0.230	0.35

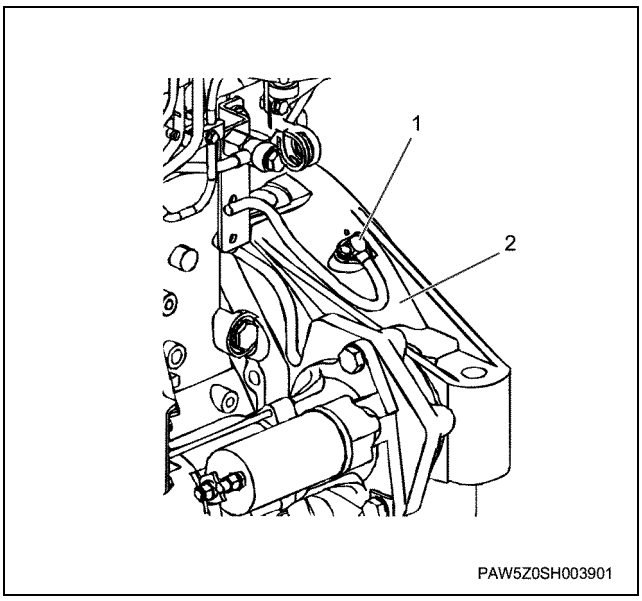
- Measure the idle gear B shaft orientation clearance.

Shaft orientation clearances (mm)

Standard	Limit
0.050 ~ 0.140	0.25

Removal

1. Remove the NE sensor.

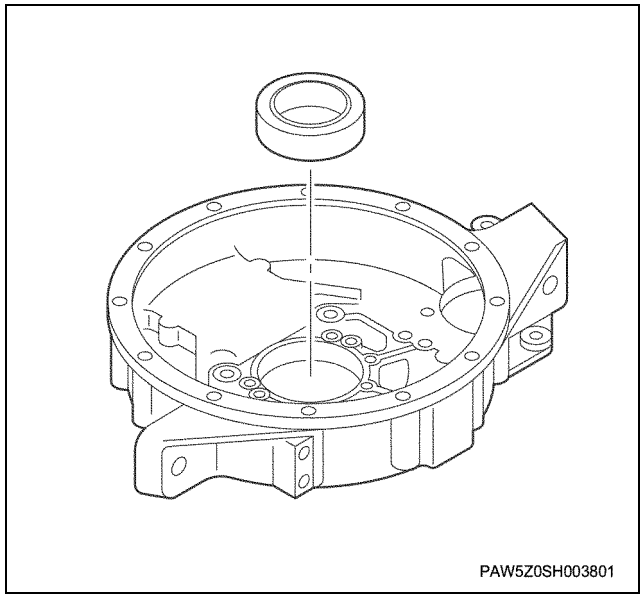


Legend
1. NE sensor
2. Flywheel housing

2. Remove the washer.
3. Remove the flywheel.
4. Remove the flywheel housing stay.
5. Remove the flywheel housing.
6. Remove the oil seal.
   - Be careful not to damage or scratch the force-fit surface of the fly wheel housing's oil seal when removing the oil seal.

Important:
When replacing the oil seal, always replace the slinger together as a set.

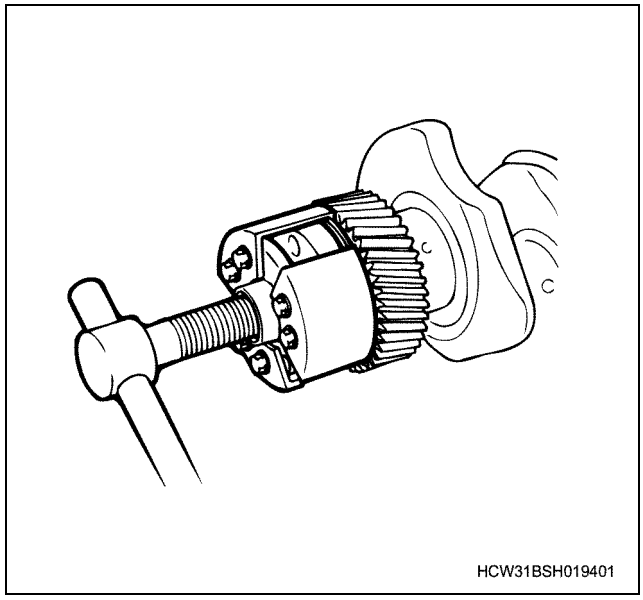
Notes:
If the remover separates easily from the slinger, tightening the jig's perimeter with a clip band to makes it easier to remove the slinger.



7. Use a slinger remover to remove the slinger.

Important:
When replacing the oil seal, always replace the slinger together as a set.

Remover; Slinger: 1-8521-0027-0

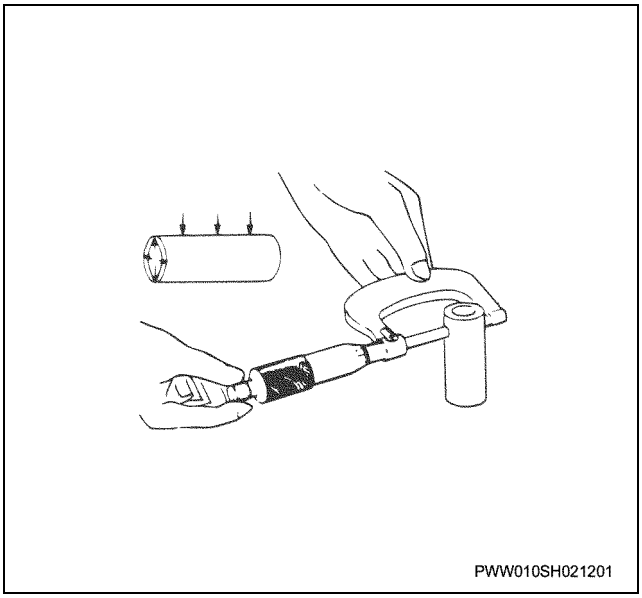


Disassembly

Flywheel

1. Remove the flywheel starter gear.
   - Inspect the flywheel starter gear for damage. If there are no problems with it, do not remove it.
   - Removing the flywheel starter gear
     Rest the flywheel on a wooden block, put a hit-stick on the flywheel starter gear and strike it to remove it.

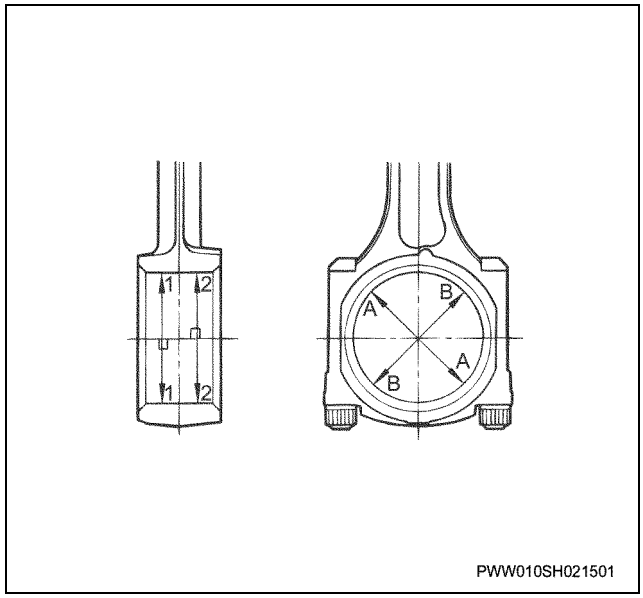
	Nominal dimension mm	Standard mm	Limit mm
Piston pin outer diameter	ϕ56	—	ϕ55.97
Clearance between piston pin and piston pin hole	—	0.008 ~ 0.021	0.05
Clearance between piston pin and connecting rod bush	—	0.020 ~ 0.037	0.10



Connecting rod

- Measurement of clearance between connecting rod bearing and crank pin
  Clean the bearing and bearing installation surface, and install the bearing. Next, apply molybdenum disulphide to the installation nut screw section and bearing surface and alternately tighten them, then measure the 4 points of the connecting rod bearing shown on the diagram with a cylinder gauge.

Tightening torque: 98 N·m {10.0 kgf·m} → Angle method 30° → 30°

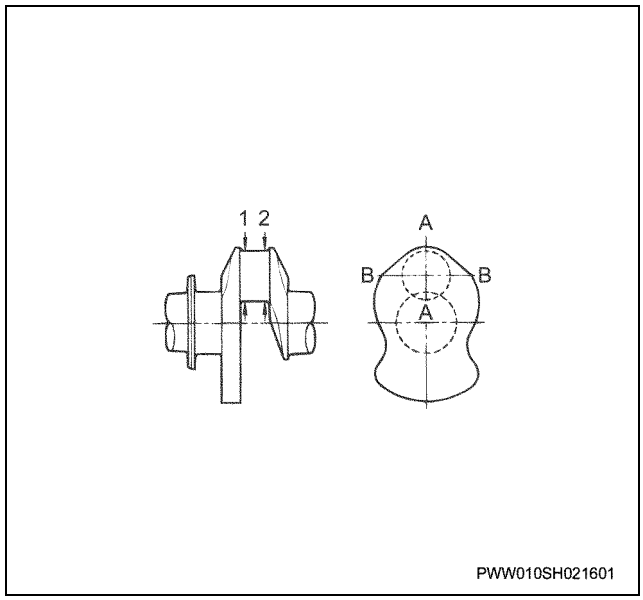


Measure the 4 points of the crank pin diameter shown in the diagram with a micrometer.

Clearance between bearing and crank pin (mm)

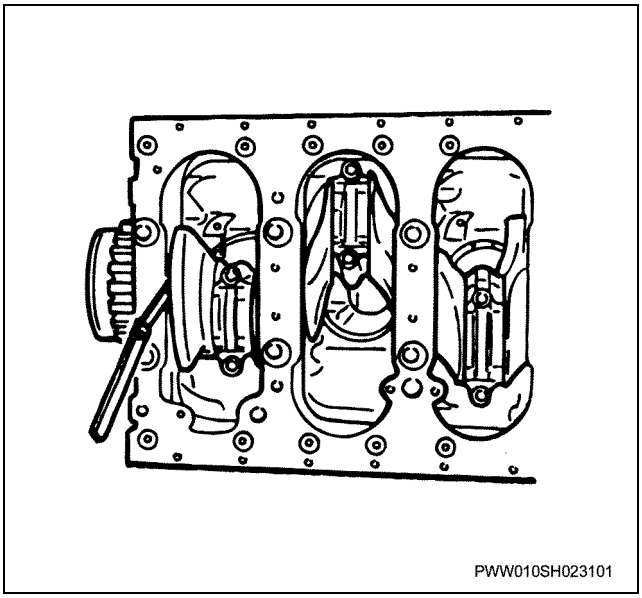
Standard	Limit
0.033 ~ 0.103	0.16

Important:
Do not modify the crankshaft as it has been treated with soft-nitrating treatment.
*** Refer to the general remarks section when using a plastiguage to measure the clearance.**

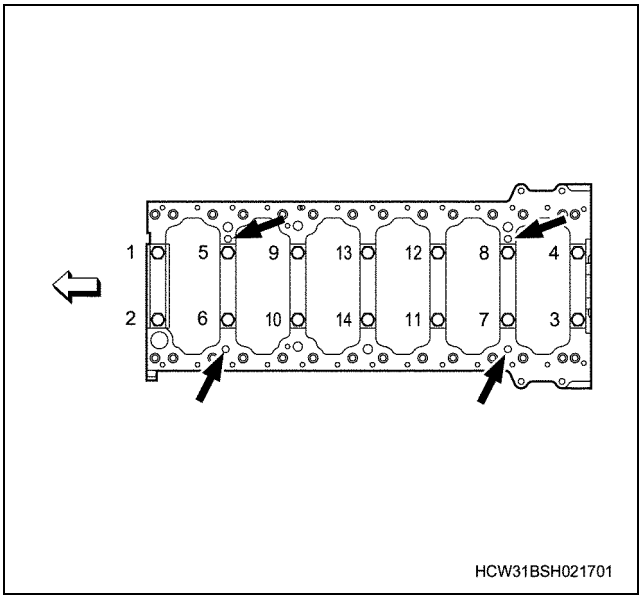


- Connecting rod deformation measurement
  Use a connecting rod aligner to measure the torsion of the large and small pore edges and the parallelism.

Notes:
The measurements use the bearing as a standard, so check that the bearing is not becoming worn.


PWW010SH023101

- Loosen and remove the bearing installation bolt from the outside. Next, extract the crank case installation bolt, screw in a M10 × 1.5 bolt with a neck lower length longer than 105mm into the crankcase replacer hole (arrow in the diagram), raise the crankcase, lift it horizontally and remove it.

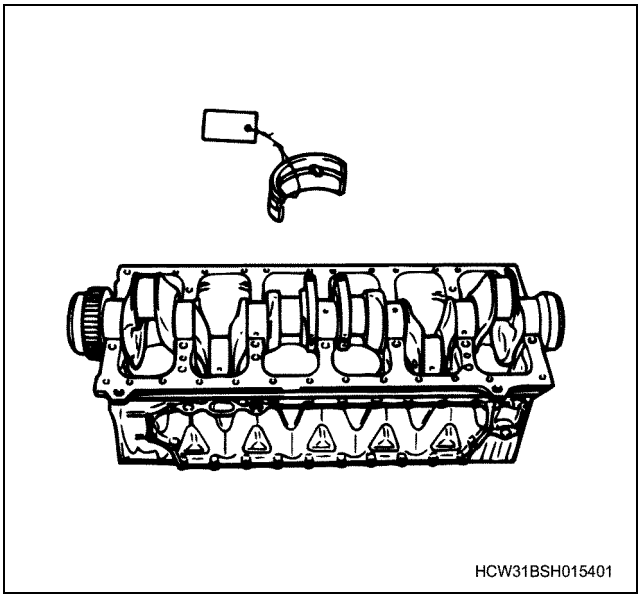


HCW31BSH021701

2. Remove the crankshaft.
3. Remove the crankshaft bearing.
   - Use a label or other such marker to mark the bearing's installation position.

Important:

- **Do not damage or scratch the crankshaft bearing sliding surface.**


HCW31BSH015401

4. Remove the thrust bearing.
   - Use a label or other such marker to mark the thrust bearing's installation position.

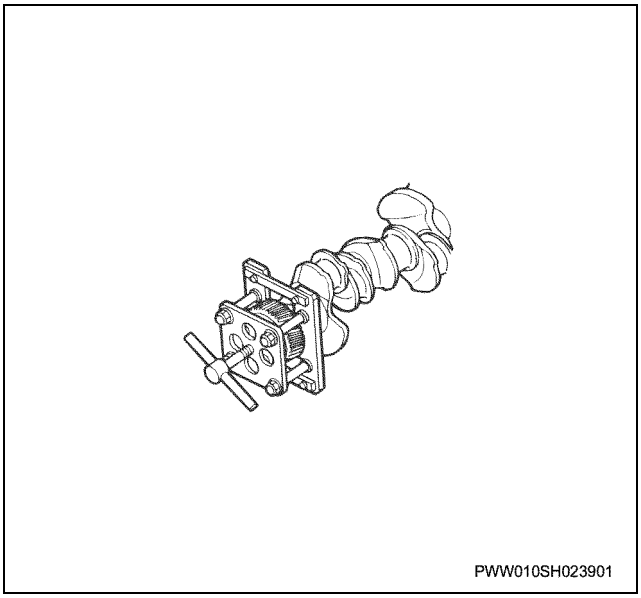
Disassembly

1. Use a gear remover to remove the crankshaft gear.

Remover; Crankshaft gear:	1-8521-0064-0
Remover; Slinger:	1-8521-0027-0

Notes:

- **Inspect the gears for damage. If there are no problems with it, do not remove it.**
- **If a slinger is installed, remove the slinger first.**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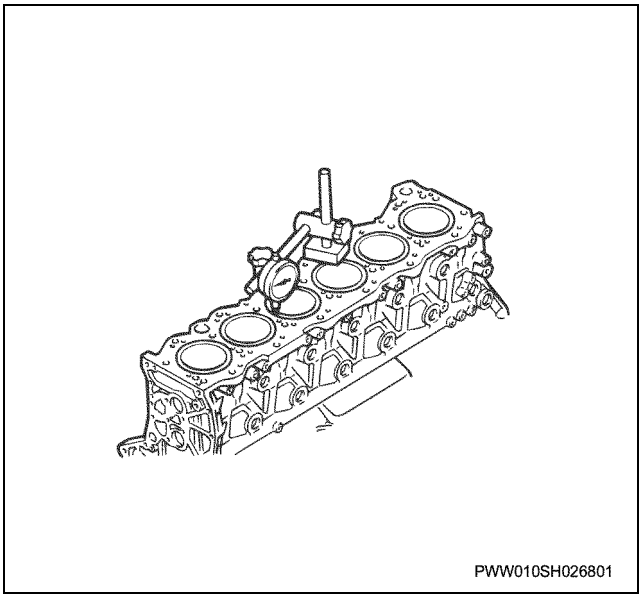
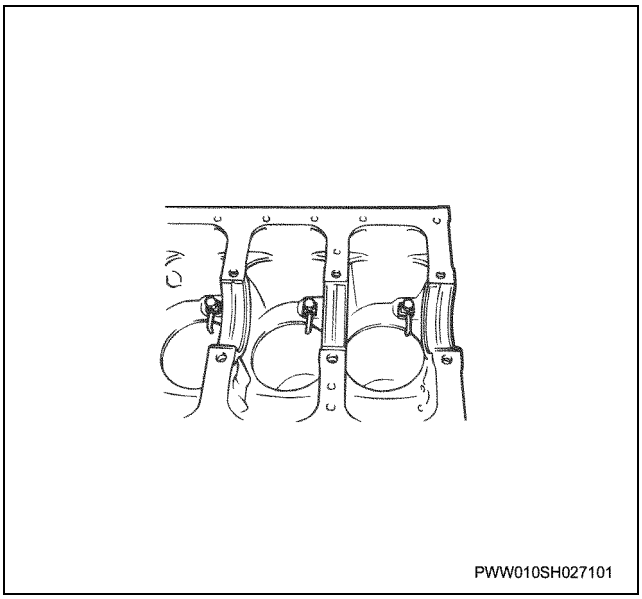

PWW010SH026801

3. Install the oil jet.
   - Check that the tip of the oil jet is facing the entrance to the piston cooling cavity and install it.

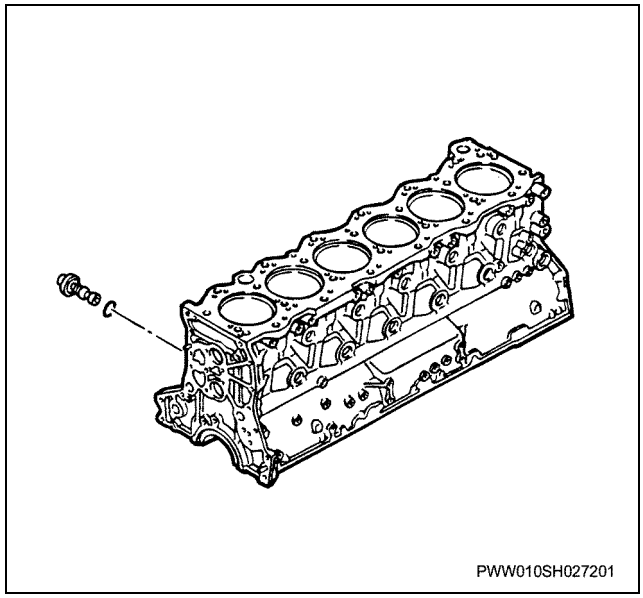
Tightening torque: 69 N·m {7.0 kgf·m}


PWW010SH027101

Important:
Do not bend the oil jet tip out of shape.

4. Install the crankcase.
   For an outline on assembly, see the crankshaft section.
5. Install the oil relief valve.
   - Apply engine oil to the O-ring and install the relief valve.
   - Apply engine oil to the relief valve screw section and install the cylinder block.

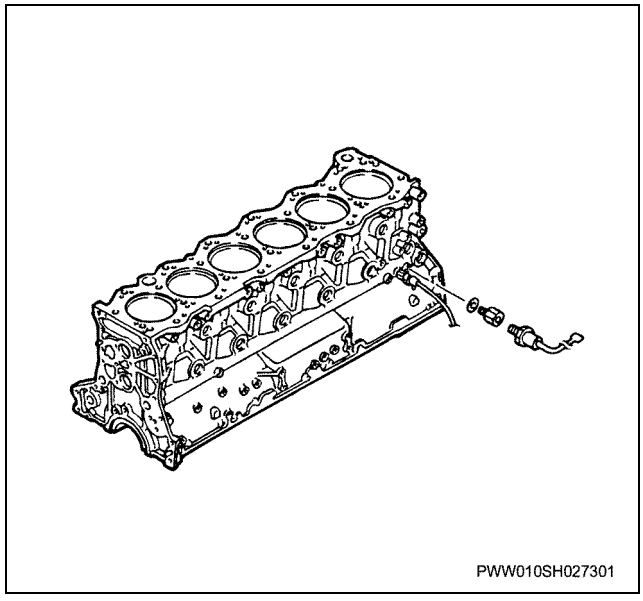
Tightening torque: 20 N·m {2.0 kgf·m}


PWW010SH027201

6. Install the oil pressure unit.
   - Install the adapter and oil pressure unit through the gasket.

Tightening torque

Adapter:	59 N·m {6.0 kgf·m}
Oil pressure unit:	18 N·m {1.8 kgf·m}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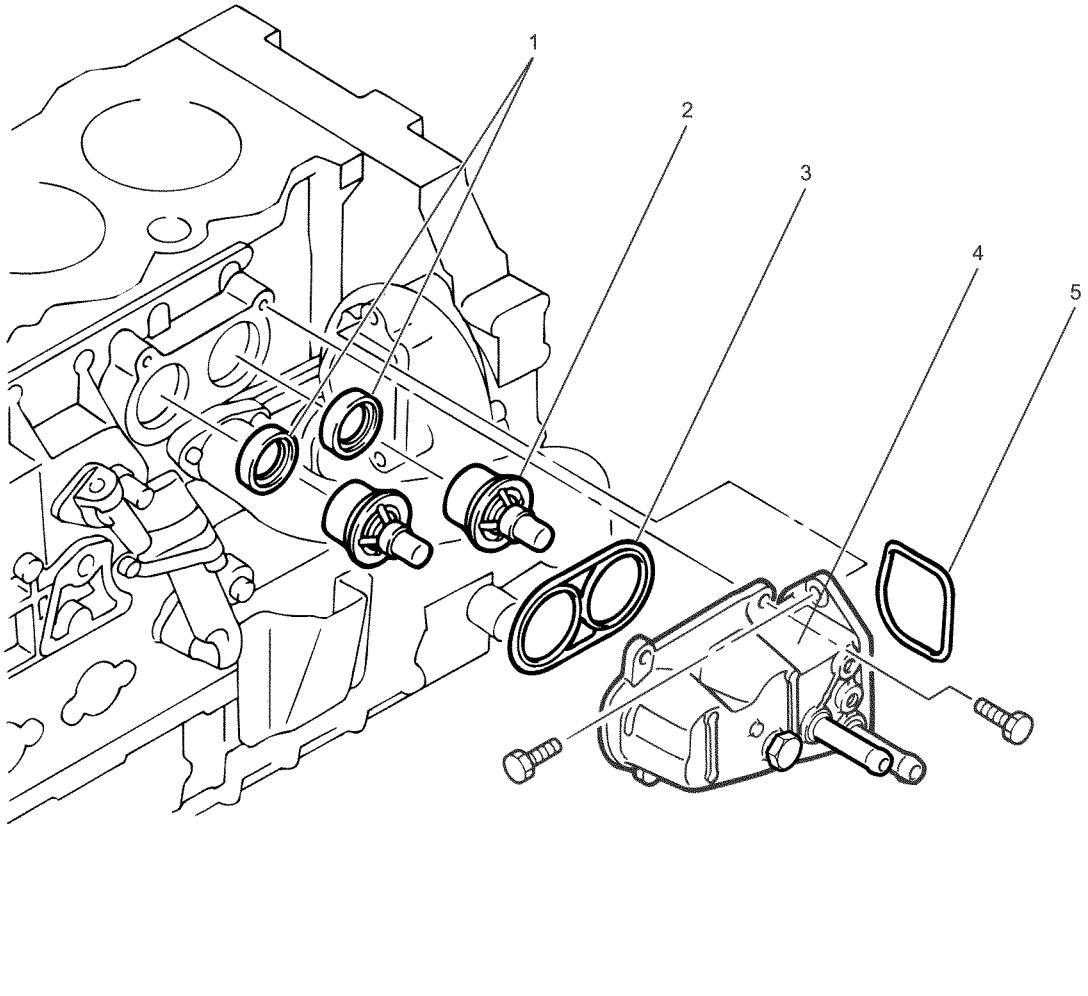
Thermostat

Component parts



Legend

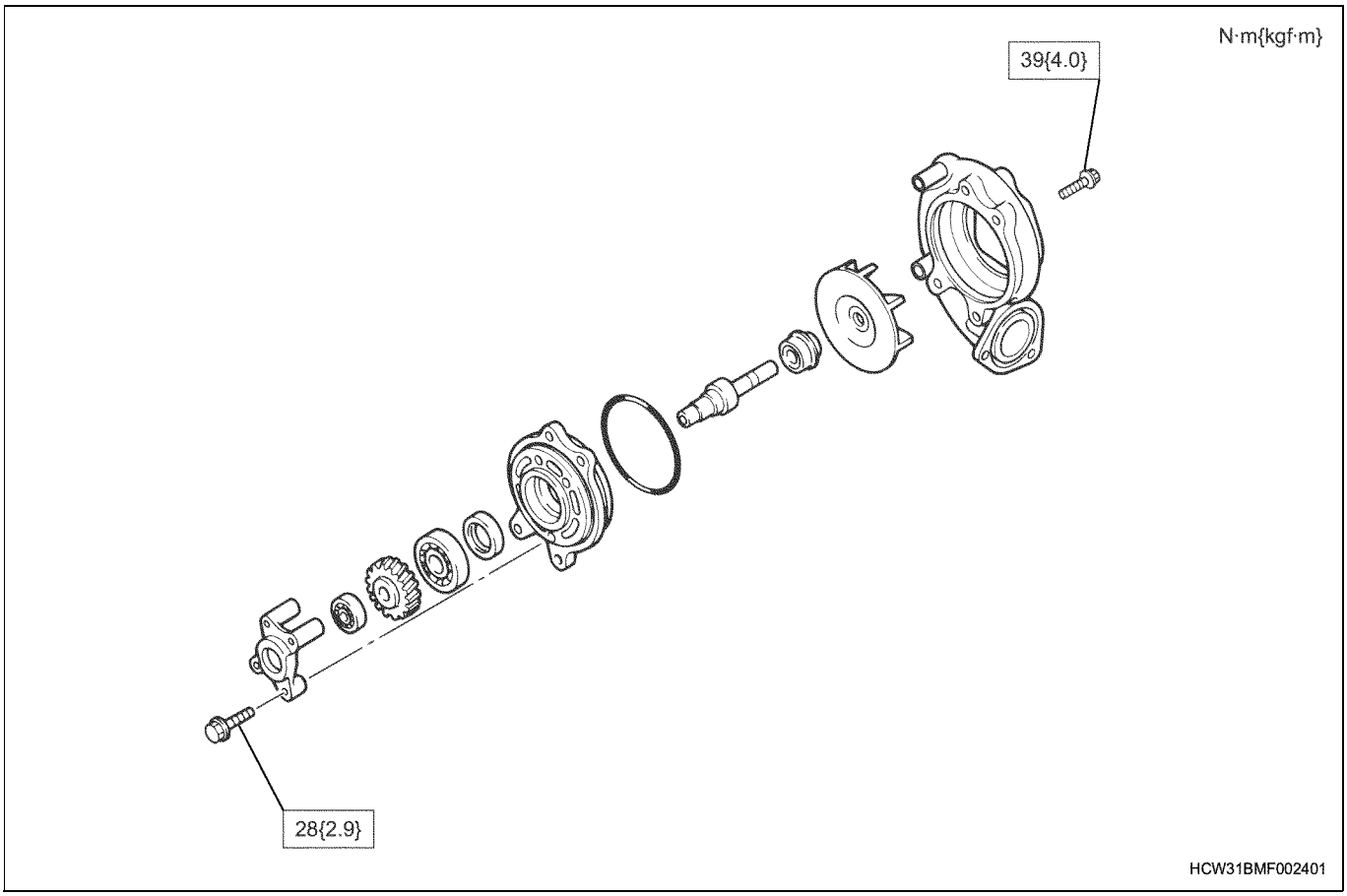
1. Seal ring
2. Thermostat
3. Gasket
4. Thermostat housing
5. O-ring

Removal

1. Remove the thermostat housing.
2. Remove the gasket.
3. Remove the O-ring.
4. Remove the thermostat.
5. Remove the seal ring.
   - Use a thermostat seal ring puller to remove the seal ring.

Puller; Thermostat seal ring: 1-8521-0067-0

Torque specifications



Main data and specifications

Fuel pump specifications

	Engine Model	6WG1-TC
Heading		
Fuel injection pump type		Electronic control fuel-injection system (common rail type)
Supply pump type		SP160-6HD
Pump maximum discharge amount		490mm^3/ST
Direction of rotation		Rotates to the right when looking from the drive side
Pressurized discharge sequence		1-2-1-2-1-2 (Pump cylinder number)
Plunger diameter		ϕ8.5
Overflow valve opening pressure	kPa {kgf/cm^2}	255 {2.6}
Feed pump		Trochoid type 10.5cm^3/rev

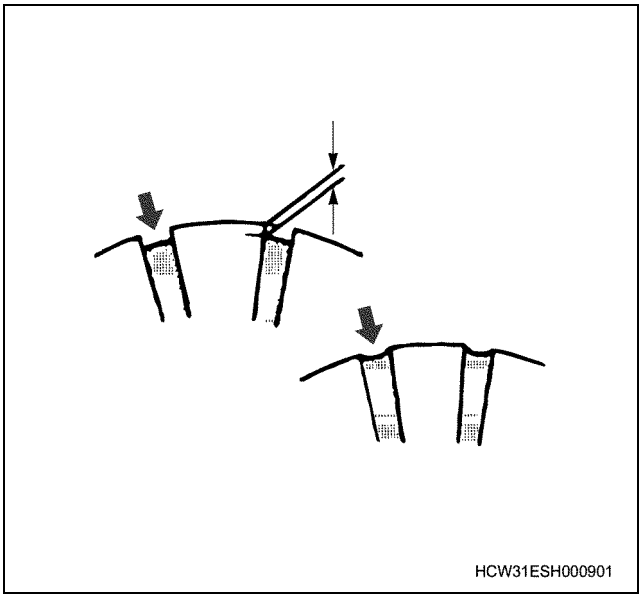
Injector specifications

Heading	Item
Injector type	DLL-P
Nozzle discharge hole $\times$ number mm	ϕ0.19 $\times$ 8

Trouble shooting

- Even if the starter switch is switched on, the starter does not function
- The pinion advances but does not engage the ring gear
- The pinion engagement motor turns but the engine does not turn
- The pinion engages but the engine does not turn
- After starting the engine, the starter doesn't stop when the starter switch is turned off

- Inspect the depth of the commutator insulation mold (undercut).
  Remove dirt and powder etc. caused by wear from the brushes, and repair if there are any faults.



Gear inspection

- Inspect the gear section for wear or damage.
  If a fault is detected, replace the armature.

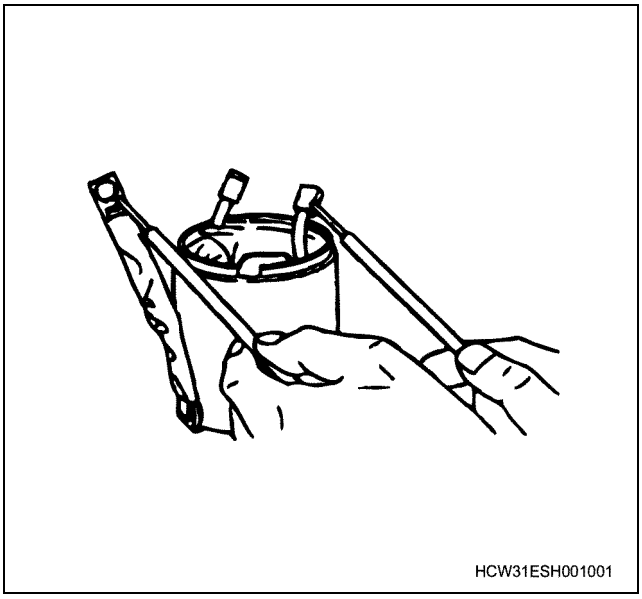
Bearing inspection

- Inspect the bearings for abnormal noise, looseness, and leaking grease.
  If a fault is detected, replace the bearing.

2. Field coil

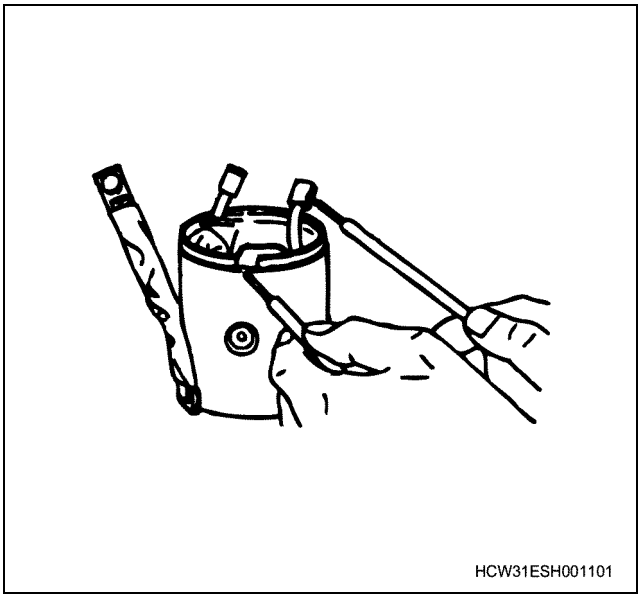
Conduction inspection

- Use a circuit tester to inspect the coil for broken wires.
  If the broken wire is detected the yoke ASM must be replaced.



Earth inspection

- Use a circuit tester to inspect the coil earth (bad insulation).
  If the coil is earthed, either repair it or replace the yoke ASM.



3. Brush

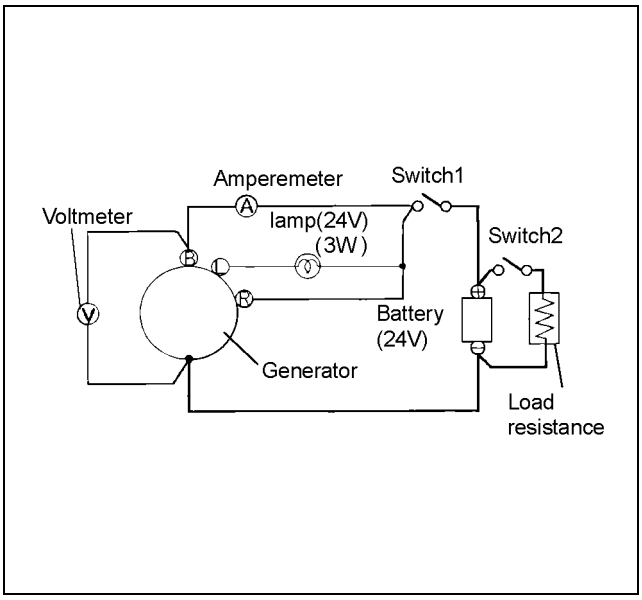
- Inspect the brush length for wear.
  If the brushes are close to the wearing limit, replace the entire brush holder ASM to replace the brush holder side brushes. To replace the yoke ASM side brushes, you can replace just the brushes only.
- Check that the brushes move smoothly in the brush holder.
  Also inspect the pressure of the brush spring.
- Use a circuit tester to inspect the brush holder earth (bad insulation).
  The brush holder should be cleaned before inspection.
  Place one of the circuit tester probes on the brush holder plate (metal part) and the other probe on the insulated holder. The presence of conduction indicates bad insulation, so the brush holder ASM must be replaced.

Does not charge at all

Condition	Probable cause	Correction
Does not charge at all	Battery fault	Replace
	Broken wire in electrical wiring or ampere meter, short, disconnected connection section	Repair
	Broken wire in each generator coil, earth, short, and damaged diode	Replace
	Regulator fault	Replace
	Bad connection in the regulator terminal	Repair

Functional check:

Generator bench test



Adjustment voltage inspection

- Wire as shown in the diagram.
  Use a 100 A rated ampere meter, and a 30V rated voltmeter.
  Use a 50A or over rated ampere meter for testing parts that have adjustable load resistance.
- Close switch 1. Leave switch 2 open.
  At this time the lamp will light.
  If the lamp does not light, inspect the L terminal's voltage.
  If the voltage is close to the battery's voltage, inspect the generator.
  If the voltage is low, there is a broken wire in the lamp or lamp circuit.
- Gradually increase the generator's rotation speed.
  Check that the lamp remains out until the rotation speed is approx. 1300 rpm.
  Observe the voltage. If the voltage exceeds 30 V without being controlled, a fault in the IC regulator must be considered.
  If the voltage does not increase over the battery voltage, the generator is not generating electricity.
  Re-inspect the generator.
  If the lamp does not go out, re-inspect the generator.
- Increase the generator's rotation speed to approx. 5000rpm and read the ampere meter reading.
  If the reading is below 5 A, read the voltmeter reading. This is the adjustment voltage.
  If the ampere meter reading is above 5 A, continue to recharge until the reading drops below 5 A, or replace the battery with a fully recharged battery.
  If the adjustment voltage falls outside the reference value, replace the regulator.

Output voltage test

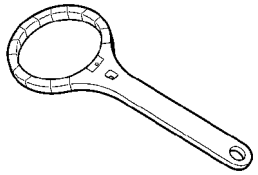
The output voltage test inspects whether the generator can give out the rated output or not.

- After the adjustment voltage inspection, reduce the generator's rotation speed and stop the generator.
- Close switch 1. The lamp lights.
- Increase the load resistance value to the maximum value (minimum voltage) and close switch 2.
- Increase the generator's rotation speed, and while keeping the speed at 5000 rpm, adjust the load resistance so that the output voltage is at a maximum.
  Keep the generator rotating in this condition for 15 minutes to raise the temperature of the generator.
  After 15 minutes, alter the generator's rotating speed to the rotating speed shown in the adjustment standard (2500 and 5000 rpm). In this condition, adjust the load resistance so that the output voltage is at a maximum.
  At this time, if the voltmeter's display shows a value that is within the maintenance standard values, the generator is operating correctly.
  If the value is below the maintenance standard values, refer to the section on generator [Inspection] and re-inspect the generator.

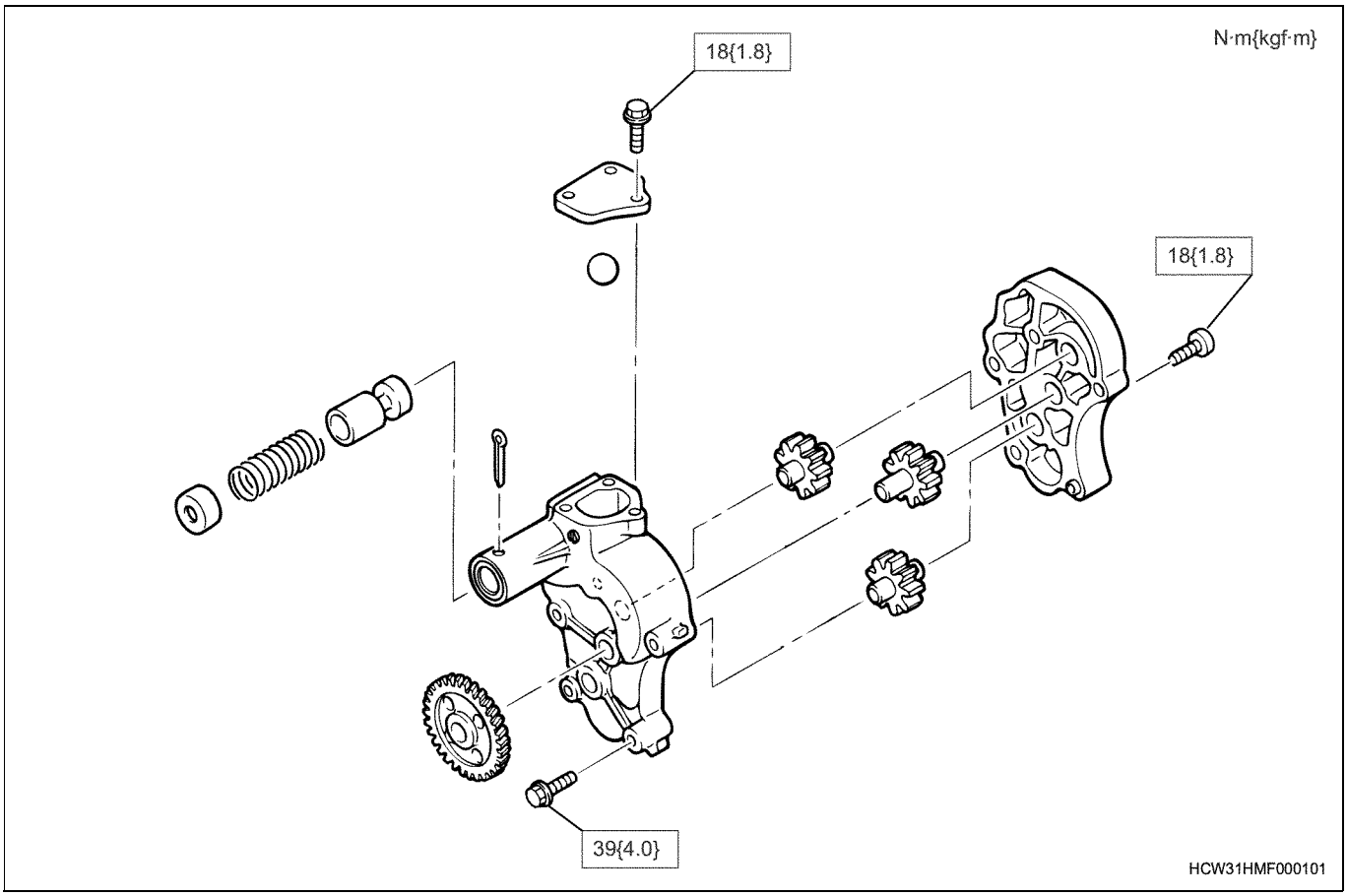
Maintenance standard

	Rotating speed	2500 rpm	5000 rpm
Output characteristics (when hot)	Voltage	27 V	27 V
	Current	More than 42 A	More than 50A
Field coil resistance (at 20°C)		4.4 ~ 5.2 Ω	
Regulator adjustment voltage		28 ~ 29 V	
Rotation direction (viewed from the pulley side)		Clockwise direction	

Special tools

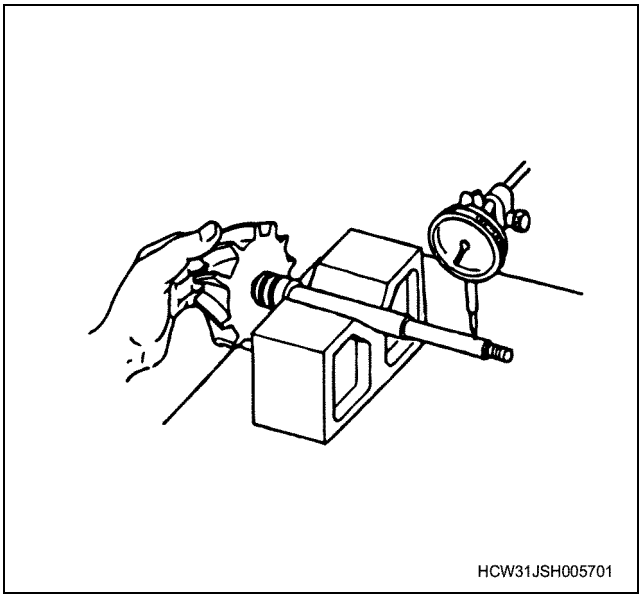
Illustration	Tool number Tool name
 8980131700	8-9801-3170-0 Wrench; Main filter

Torque specifications



Trouble shooting

- If faults or vibrations occur
- When the turbocharger is thought to be mainly fine but output power is low
- Oil is leaking in the exhaust pipe or intake pipe
  Exhaust gas is white

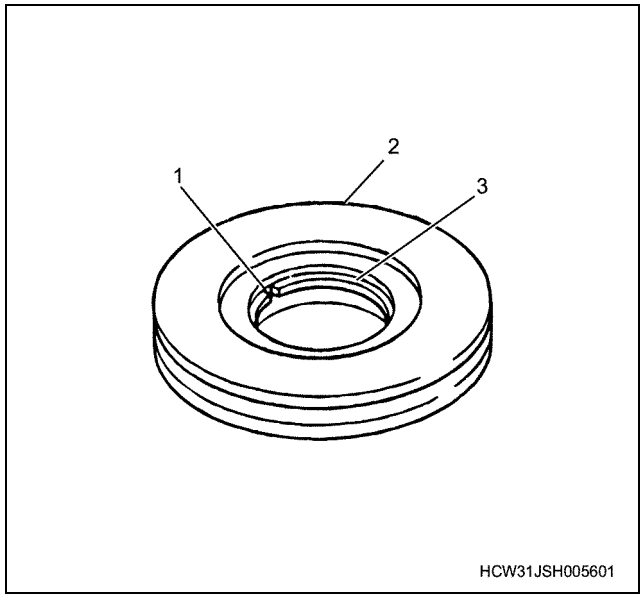


Insert

- Fit a brand new piston ring firmly into the insert, and measure the piston ring joining section clearance.
  If the measured clearance falls outside of the standard value, replace the insert.

Piston ring joining section clearance

Limit:	0.05 ~ 0.25 mm



Legend

1. Joining section
2. Insert
3. Piston ring

Parts for replacement when disassembling

- Piston ring (C)
- Piston ring (T)
- O-ring
- O-ring

Maintenance standard table

Maintenance items		Name value	Standard Standard Clearance	Limit Clearance	Notes
Bearing insertion section inner diameter for the bearing housing		ϕ20.5		ϕ20.506	
Bearing	External diameter			ϕ20.382	
	Internal diameter			ϕ12.042	
	Length			11.94	
Shaft & turbine wheel's Journal diameter		ϕ12.0		ϕ11.996	
Shaft & turbine wheel concentricity				0.015	
Piston ring mitre clearance			0.05 ~ 0.25		With the piston ring fixed in the insert
Shaft & turbine wheel and turbine housing clearance			0.39 ~ 1.0		
Shaft & turbine wheel shaft orientation clearance			0.075 ~ 0.155		
Shaft & turbine wheel and turbine back plate clearance			0.48 ~ 0.92		