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

HITACHI

Engine Manual (1/2)

6WG1

6WG1 ENGINE MANUAL (1/2)

Hitachi Construction Machinery Co., Ltd.

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This manual consists of the following sections.
Control System

Introduction

This Manual describes the structure and the troubleshooting of electronic control fuel injection system (common rail type) in 6WG1 industrial engines. Use this manual sufficiently to perform service work properly and quickly.

Hitachi Construction Machinery Co., Ltd

General Contents

Control System

Engine Control

(Electronic control fuel injection system (Common rail type))

Engine Manual (2/2)

Disassemble and Assemble Engine

General Information

Engine Mechanical (6WG1(Common rail))

Cooling System (6WG1(Common rail))

Fuel System (6WG1(Common rail))

Electrical System (6WG1(Common rail))

Lubricating System (6WG1(Common rail))

Intake System (6WG1(Common rail))

Preheating System (6WG1(Common rail))

Control System

Engine Control

(Electronic control fuel injection system (Common rail type))

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How to use this manual

This manual describes about engine-related trouble diagnosis, and is closely related to the machine trouble diagnosis. Always refer to both manuals for the trouble diagnosis.

This manual consists of the following contents. This section “How to use this manual” describes about abbreviations and instructions to use this manual. Therefore, if you are familiar with manuals, start with Precautions on service work and Basic procedure of trouble diagnosis.

How to use this manual
- Table of abbreviation
- List of parts according to engine control specifications
- Wiring color code
- How to use wiring diagram

Precautions on service work

Procedure of trouble diagnosis

How to use trouble diagnosis-related tool
- How to use scan tool
- How to use TIS 2000
- How to use injector checker
- How to use flash tool
- How to use breaker box

Engine control system

List of function checks

List of diagnostic trouble codes

List of trouble symptom

Table of abbreviation

Abbreviation	Name	Meaning and remarks
A/D	Analog/Digital	Analog/Digital
AP	Accelerator Position	Accelerator opening angle
CAN	Controller Area Network	Communication system used to communicate between ECM and the machine control unit
CKP	Crankshaft Position	Crankshaft (the sensor is installed onto flywheel housing) position
C/U	Control/Unit	Abbreviation of control unit
CMP	Camshaft Position	Camshaft (the sensor is installed onto the rear of cylinder head) position
DLC	Data Link Connector	Connector for scan tool (also known as: Checker connector)
EMPS	Engine Module Programming System	Rewriting of control program in ECM
DMM	Digital Multi-Meter	Diagnostic tester for electrical equipment system (5-8840-2691-0)
DTC	Diagnostic Trouble Code	Self-diagnosis code numbers which indicate trouble condition
ECT	Engine Coolant Temperature	Engine coolant temperature
ECM	Engine Control Module	Core of engine control in engine control computer
ECU	Electronic Control Unit	Computer for various control
EGR	Exhaust Gas Recirculation	Recirculation system which mixes exhaust gas from engine with intake air again to lower the combustion temperature resulting in reduction of NOx.
EMI	Electro Magnetic Interference	Electro Magnetic Interference
Exh	Exhaust	Exhaust
F/B	Feed/Back	Abbreviation of feedback
FT	Fuel Temperature	Fuel temperature (the sensor is installed onto supply pump.)
GND	Ground	Ground/Earth
IAT	Intake Air Temperature	Intake air temperature
J/C	Joint/Connection	Connector which connects each harness
MIL	Malfunction Indicator Lamp	Warning lamp MIL (diagnosis lamp)
PC	Pressure Control	Pressure control/Common rail pressure
PCV	Pressure Control Valve	Valve which controls fuel flow to common rail and is installed onto supply pump
PWM	Pulse Width Modulation	Pulse width modulated wave
QOS	Quick On Start	Warming-up device
RP	Rail Pressure	Pressure in common rail
SBF	Slow Blow Fuse	Slow-blow type fuse which protects circuits of battery, motor, etc.
SIG	Signal	Signal

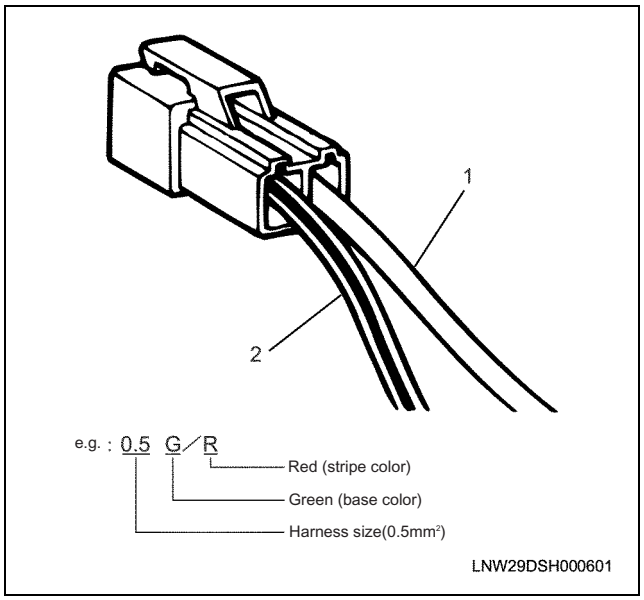
Abbreviation	Name	Meaning and remarks
VSS	Vehicle Speed Sensor	Sensor used to detect vehicle speed to control meters or engine
W/S	Weld/Splice	Joint of each harness without connector

List of parts according to engine control specifications

	Engine					Function
	6W	6U	6H	4H	4J	
PCV	❍	❍				Controls the fuel pressure feed of supply pump.
SCV			❍	❍	❍	Controls the fuel pressure feed of supply pump.
CMP sensor			❍	❍	❍	Detects camshaft position of engine (used for identifying cylinder.)
G sensor	❍	❍				Detects cam position of supply pump (used for identifying cylinder.)
CKP sensor	❍	❍	❍	❍	❍	Detects crankshaft position (used for engine control in general.)

About colors of wirings

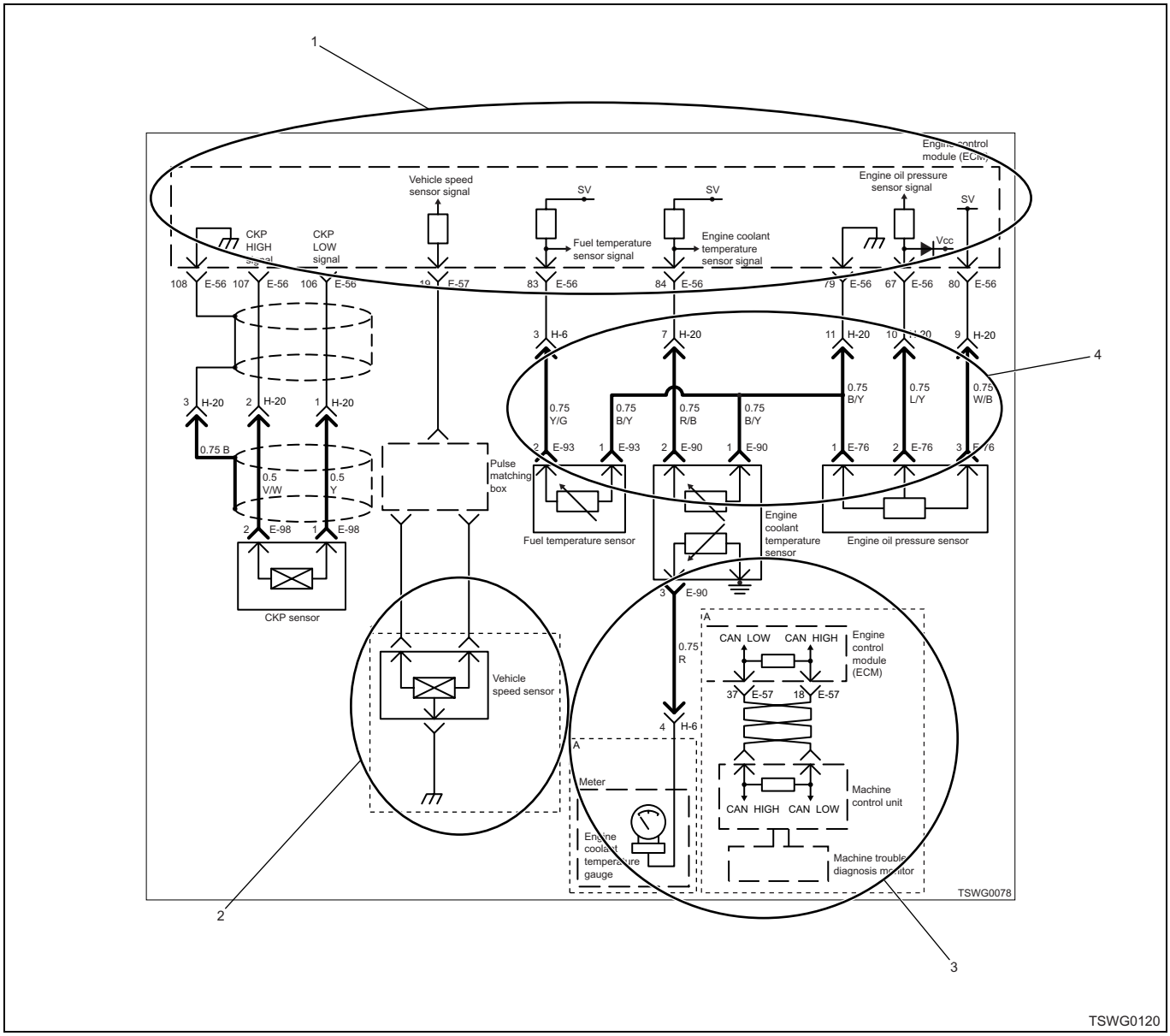
All harnesses are identified by using different colors of claddings. The harness for the main circuit in a certain electrical system is identified by using a single color, while the harness for the sub circuit uses a color in stripes. Sizes and colors coding in a wiring diagram are as follows.



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		

About wiring diagrams



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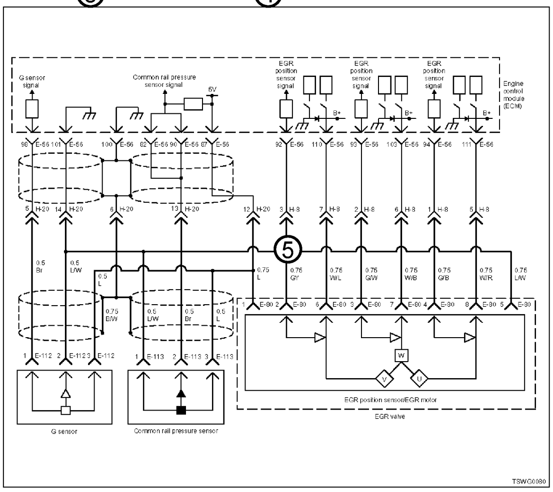
1. Sections surrounded by long broken lines are used to indicate the units, such as ECM.
2. Sections surrounded by dotted lines are used to classify or differentiate the specifications of machines. Confirmation of specifications is needed.
3. Sections surrounded by dotted lines and marked with a symbol (“A” in example) on the upper left are used to classify different wiring in the specifications of machines. Confirmation of specifications is needed.
4. Sections surrounded by heavy lines are used to differentiate engine harnesses from other harnesses. Heavy lines indicate engine harnesses, other lines indicate machine harnesses.

How to read trouble diagnosis section

The following illustration is an example for trouble diagnosis section. See this illustration and description.

DTC: (1) 92 (Flush co(2)5)
Common rai(3)ssure sensor fault (low v(4)ge fault)



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 (6) common rail internal fuel pressure is low, outpu(6)tage 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

- Engine blow u(7)

Preconditions when DTC is set

- Key switch inp(8)oltage is 18 V or more.
- DTC P1630 o(8)35 is not detected.

DTC set condition

- Common rail (9)sure sensor voltage is 0.7 V or less.

Action taken when DTC is set

- Turns the diag(10)s lamp ON.

Back-up mode

- Specified back(11)alue (depending on the machine manufacturer).

Return to normal condition

(12)

The conditions to clear the MIL/DTC

- The current trouble turns to past trouble (history) when the condition is out of the range from DTC set condition (recovery from trouble).
- The diagnosis lamp will go off after the code turns to history code 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 (13)g
- Worn harness clad(13)
- 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.

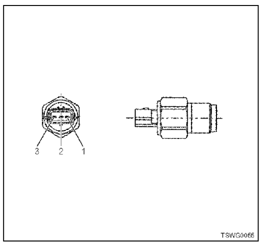
Test description

Numbers below indicate step numbers in the chart.
3. In case of current trouble, the "Common rail pressure sensor" displays more than the specified value. In this case, identify the cause by referring to "Diagnostic aid".
5. If the "Common rail pressure sensor" displays more than the specified value when the common rail pressure 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 available?	—	Go to Step 3.	Go to Step 14.
3	Check the value for common rail pressure sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. ... for "Common rail	0.7V (at idle)	...to Step 4.	Go to "Diagnostic aid".

6	Refer to "Breake... procedure". • 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 7.
7	1. Check for followings in the signal circuit between ECM and common rail pressure sensor using breaker box or DMM. Refer to "Breaker box inspection procedure". • Short circuit to common rail pressure sensor ground circuit • Short circuit to ground 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 common rail (common rail pressure sensor). **Note:** **For work procedure, refer to "Engine ... service manual.**	—	Go to Step 12.	—
			Go to Step 10.	Go to Step 11.

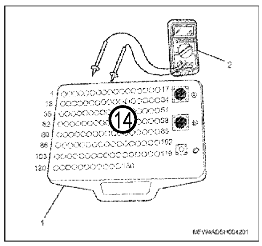
About common rail pressure sensor



Name
1. GND
2. Signal
3. Power supply

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
6	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch "OFF"	87 - Sensor connector power supply terminal	100Ω or less	10MΩ or more
7	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the sensor connector. • Key switch "OFF"	82 - 101 90 - 101 82 - Ground 90 - Ground	10MΩ or more	100Ω or less
	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch "OFF"	82 - Sensor connector signal terminal 90 - Sensor connector signal terminal	100Ω or less	10MΩ or more

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Description of DTC diagnosis section

The following numbers correspond to those shown in the illustration. They describe each item.

1. DTC:
   This indicates trouble code.
2. Flash code
   Trouble code indicated by lamp flashing
3. Description of trouble symptom
4. Conditions on system that establish the codes
5. Circuit diagram
   Circuit diagram related to trouble code
6. Description of circuit
   System circuit principle related to trouble
7. Main trouble symptom
   Expected state of engine caused by system trouble
8. Preconditions when DTC is set
   Judgment is not performed unless this condition is established.
9. DTC set condition
   Condition for fault judgment when preconditions are met
10. Action taken when DTC is set
    Behavior of diagnosis lamp, monitor display on the machine and engine control when trouble code is set.
11. Back-up mode
    A system operation mode that uses back-up data stored in the ECM memory in disregard of abnormal signal from sensor, when making fault judgment.
12. Recovery from failure
    Description of recovery from failure to normal state
13. Diagnostic aid
    Expected trouble causes are listed. They are important information to perform diagnosis.
    Be sure to read before trouble diagnosis.
14. Breaker box inspection procedure
    There is an appropriate table in diagnostic chart. It describes detailed diagnostic procedure.

Precautions on Service Work

Use of tools for circuit test

If there are no special instructions according to the diagnostic procedure, test lights must not be used in the diagnosis of electric system of powertrain. Use a connector test adaptor kit 5-8840-0385-0 when a probe connector is required during the diagnostic procedure.

Commercial electrical equipment

Commercial electrical equipment means that commercial electrical components installed to a machine after shipment from factory. Be careful that no special consideration for this equipment is taken in the design process of the machine.

Caution:
Connect commercial electrical equipment to the circuit whose power supply and ground wires are not related to the electronic control system.

Commercial electrical equipment may cause malfunction of the electronic control system even if they are installed properly. They include devices which are not connected to the electrical systems on the machine, such as mobile phones or radios. Therefore, in trouble diagnosis of powertrain, first check if this commercial electrical equipment is installed, and if so, remove it from the machine. If the trouble has not been solved after the removal, diagnose it in usual procedures.

Welding work on the machine

If performing welding on the machine, remove the battery in advance. Otherwise, the current during welding may cause system trouble or damage.

Damage caused by electrostatic discharge

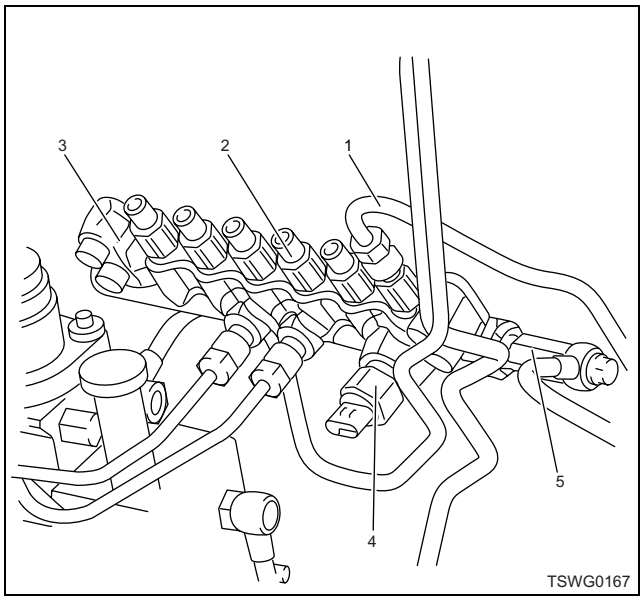
The electronic components used in the electronic control systems are easy to get damaged, caused by electrostatic discharge because they are designed to operate in a very low voltage. Some kinds of electronic components may get damaged by electrostatic in even less than 100 V which human cannot feel. For reference sake, the voltage of 4,000 V is needed for human to feel the flow of electrostatic discharge.
There are several ways for human body to have electrostatic charged. The common way to be charged is caused by friction or induction.

- For example, a charging by friction is caused when a person slides on the seat of the machine.
- A charging by induction occurs when a person who wears well-insulated shoes stands near the high-electrified object and then he grounds instantly. The same electric charge flows out and that person is charged in the high opposite electric charge. It is important to be careful in handling or testing the electronic components because electrostatic causes damage.

Caution:
The following guidelines should be followed to prevent the damage caused by electrostatic discharge:

- **Do not touch the ECM connector pins or the electronic components soldered on to the circuit board of the ECM.**
- **Package of that part should not be opened until the preparation of the installation of the replacement part is completed.**
- **Connect that package to the normal grounding on the machine before taking out the parts from the package.**
- **If handling the parts with moving seats in sliding, or sitting down from the standing position, or walking for a certain distance, it is required to touch the normal grounding before the installation of the parts.**

Fuel pipe

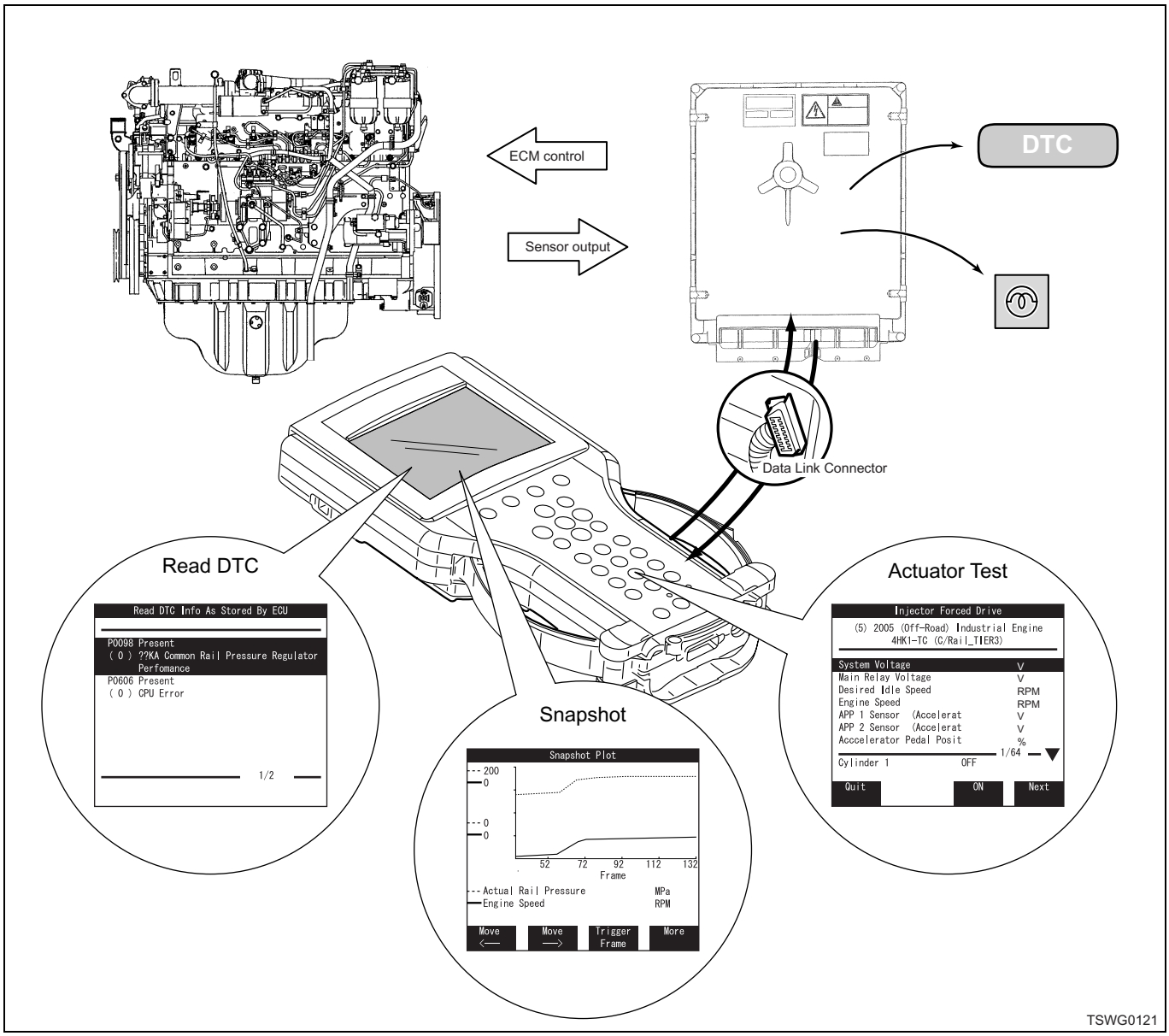


Name
1. Injector pipe
2. Flow damper
3. Common rail
4. Common rail pressure sensor
5. Pressure limiter

- Do not reuse the high-pressure pipe and injector pipe of the fuel system. Replace with new one if it is removed.
- Never replace the pressure limiter or flow damper alone. If faulty, replace the common rail assembly and all the fuel pipes.

Procedure of trouble diagnosis

The following diagnostic procedure is extremely important to solve the problems of all electric/electronic (E/E) systems. Failure to perform this procedure may require unnecessary repair. Read carefully this procedure to understand, and then perform trouble diagnosis.
In addition, use the effective function or a scan tool to perform trouble diagnosis and system check.



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Step 1 Confirm the user's complaint

- **Organize the trouble conditions using a check list.**

Step 2 Perform pre-inspection

- **Perform an overall visual check.**
- **Confirm the service history in the past.**
- **Detect faulty such as noise, abnormal smell, etc.**
- **Collect the diagnostic trouble code (DTC) information for effective repair.**
- **Check for faults by comparing with the specified value.**

Step 3 Check service information

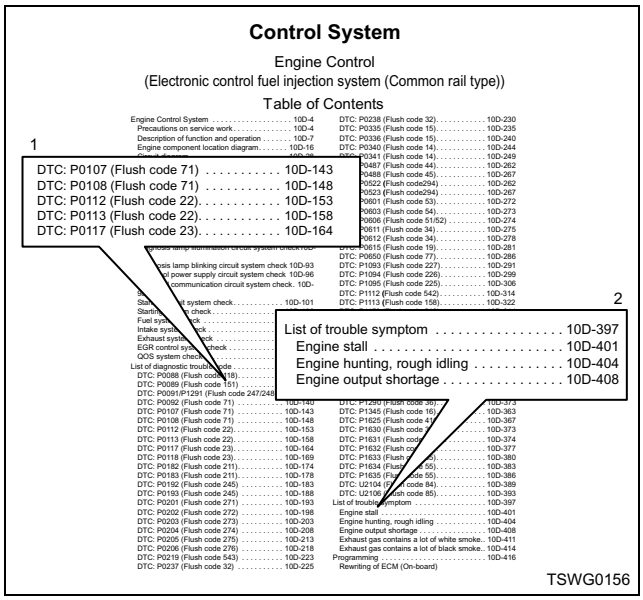
- **Check service bulletins for the market.**

Step 4 Check according to each DTC

- **Check the items indicated by the diagnostic trouble code (DTC)**

Step 5 Perform fault inspection for each symptom

- **Check the items not indicated by the diagnostic trouble code (DTC)**



Name

1. Diagnosis for each DTC
2. List of trouble symptom

Information:

About types of system trouble diagnosis

System diagnostic method is a standardized method to repair all the electric/electronic (E/E) systems. The faults in E/E system often occur in the following stages, different from general machine fault.

1. Early stage of fault;
   - As the fault occurs for a short period and singly, a customer often does not notice and miss it. In this stage, customer's complaint is indefinite and it is impossible to reproduce the trouble. However, the engine control module (ECM) may store the fault.
     = Past fault (history trouble)
2. Middle stage of fault;
   - The fault occurs for a short period and singly, but repeats intermittently and definitely occurs under a specific condition. A customer's complaint (contents of the fault) is clear but description of condition of the fault is not clear. Therefore, it is possible to reproduce the trouble if a mechanic could figure out the conditions.
     = Intermittent trouble (intermittent)
3. Stage that fault is real;
   - The fault occurs on a steady basis and a customer's complaint is realistic and clear. Therefore, it is possible for a mechanic to reproduce the fault. However, sometimes there are multiple causes.
     = Current fault (present trouble)

Interview

Interview

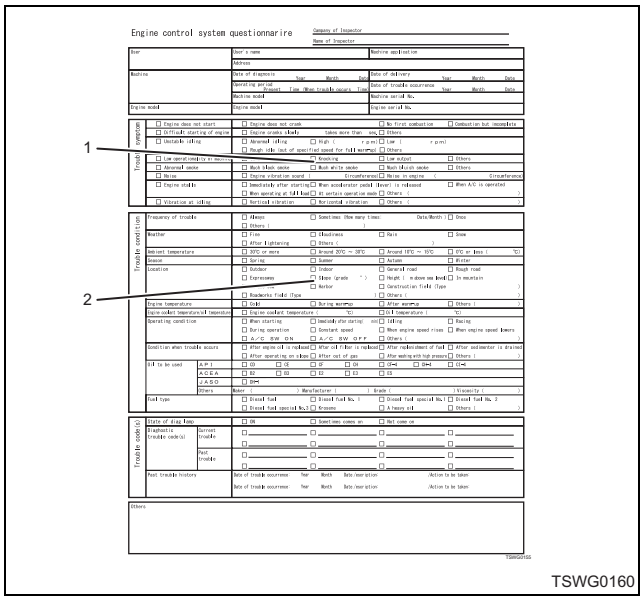
1. Comprehend the contents of a customer's complaint using "Check list (engine control system)".
   <Reference>
   Do not interview blindly. Interview about the trouble presumed by symptoms (cases).
2. Evaluate the trouble information correctly.
   Figure out specifically based on 5W1H.
   Example: The temperature is low, at the time of starting, constantly, in the vicinity of the engine portion, metallic noise, etc.

Points for interview

• What	Trouble symptom
• When	Date, time, frequency of occurrence
• Where	Road condition
• In what condition	Running condition, operating condition, weather
• How	Feeling about symptom

Check list for engine control system

It is necessary to confirm "Trouble symptom" and "Data of occurrence of a trouble" based on check list (engine control system) on receiving the machine from a customer at a service shop.



Name

1. Trouble symptom
2. Frequency of trouble occurrence / trouble conditions

Because:

1. It may be impossible to reproduce the trouble symptom at a service shop.
2. All of complaints from customers do not always mean troubles.
3. Extra repair steps are caused if the trouble condition is not correctly reported to a mechanic in charge.

• The check list helps to diagnose, repair, and recheck after repair work in the maintenance shop.

Engine control system questionnarire

Campany of inspector

Name of inspector

User	User's name		Machine application
	Address		
Machine	Date of diagnosis Year Month Date		Date of delivery Year Month Date
	Operating period Present Time (When trouble occurs Time)		Date of trouble occurrence Year Month Date
	Machine model		Machine serial No.
Engine model	Engine model		Engine serial No.

Trouble symptom	☐ Engine does not start	☐ Engine does not crank		☐ No first combustion	☐ Combustion but imcomplete
	☐ Difficult starting of engine	☐ Engine cranks slowly takes more than sec.		☐ Others	
	☐ Unstable idling	☐ Abnormal idling	☐ High (rpm)	☐ Low (rpm)	
		☐ Rough idle (out of specified speed for full warm-up)		☐ Others	
	☐ Low operationality of machine	☐ Surging	☐ Knocking	☐ Low output	☐ Others
	☐ Abnormal smoke	☐ Much black smoke	☐ Much white smoke	☐ Much bluish smoke	☐ Others
	☐ Noise	☐ Engine vibration sound (Circumference)		☐ Noise in engine (Circumference)	
	☐ Engine stalls	☐ Immediately after starting	☐ When accelerator pedal (lever) is released		☐ When A/C is operated
		☐ When operating at full load	☐ At certain operation mode	☐ Others ( )	
	☐ Vibration at idling	☐ Vertical vibration	☐ Horizontal vibration	☐ Others ( )	

Trouble condition	Frequency of trouble	☐ Always	☐ Sometimes (How many times: Date/Month)		☐ Once
		☐ Others ( )			
	Weather	☐ Fine	☐ Cloudiness	☐ Rain	☐ Snow
		☐ After lightening	☐ Others ( )		
	Ambient temperature	☐ 30℃ or more	☐ Around 20℃ ～ 30℃	☐ Around 10℃ ～ 15℃	☐ 0℃ or less (℃)
	Season	☐ Spring	☐ Summer	☐ Autumn	☐ Winter
	Location	☐ Outdoor	☐ Indoor	☐ General road	☐ Rough road
		☐ Expressway	☐ Slope (grade °)	☐ Height (m above sea level)	☐ In mountain
		☐ On the sea	☐ Harbor	☐ Construction field (Type)	
		☐ Roadworks field (Type)		☐ Others ( )	
	Engine temperature	☐ Cold	☐ During warm-up	☐ After warm-up	☐ Others ( )
	Engine coolant temperature/oil temperature	☐ Engine coolant temperature (℃)		☐ Oil temperature (℃)	
	Operating condition	☐ When starting	☐ Immediately after starting(min)	☐ Idling	☐ Racing
		☐ During operation	☐ Constant speed	☐ When engine speed rises	☐ When engine speed lowers
		☐ A／C SW ON	☐ A／C SW OFF	☐ Others ( )	
	Condition when trouble occurs	☐ After engine oil is replaced	☐ After oil filter is replaced	☐ After replenishment of fuel	☐ After sedimenter is drained
		☐ After operating on slope	☐ After out of gas	☐ After washing with high pressure	☐ Others ( )
	Oil to be used — API	☐ CD ☐ CE	☐ CF ☐ CH	☐ CF-4 ☐ CH-4	☐ CI-4
	— ACEA	☐ B2 ☐ B3	☐ E2 ☐ E3	☐ E5	
	— JASO	☐ DH-1			
	— Others	Maker ( ) Manufacturer ( ) Grade ( ) Viscosity ( )			
	Fuel type	☐ Diesel fuel	☐ Diesel fuel No. 1	☐ Diesel fuel special No.1	☐ Diesel fuel No. 2
		☐ Diesel fuel special No.3	☐ Krosene	☐ A heavy oil	☐ Others ( )

Trouble code(s)	State of diag lamp	☐ ON	☐ Sometimes comes on	☐ Not come on	
	Diaghostic trouble code(s) — Current trouble	☐ _____	☐ _____	☐ _____	☐ _____
		☐ _____	☐ _____	☐ _____	☐ _____
	— Past trouble	☐ _____	☐ _____	☐ _____	☐ _____
		☐ _____	☐ _____	☐ _____	☐ _____
	Past trouble history	Date of trouble occurrence: Year Month	Date /escription:	/Action to be taken:	
		Date of trouble occurrence: Year Month	Date /escription:	/Action to be taken:	

Others

TSWG0155

Pre-inspection

Visual inspection of engine compartment

Visual inspection of engine compartment should be carefully when performing the diagnostic procedure. This inspection can often solve the trouble with no extra steps. If performing visual inspection, follow the guideline below.

- Check all the air hoses etc. for punch hole, cut, disconnection or improper routing.
- Inspect the hoses hidden behind other components.
- Check if all the harnesses of the engine compartment are properly connected, if there are any burnout parts or worn parts, if harnesses are pinched, if there are any contacts with sharp edges, or an exhaust manifold or pipes in high temperature, etc.

Machine maintenance result check

If the maintenance of the machine is not properly performed, the diagnosis lamp comes on. Clogging in oil filter or fuel filter caused by insufficient oil change or improper oil viscosity and deposit in crankcase may cause troubles on the machine, which were not found before on-board diagnosis (OBD) system check.
Though improper maintenance of the machine is not classified as “The trouble caused by other than a machine”, a maintenance schedule should be more strictly followed because of high sensitivity of the on-board diagnosis (OBD) system check.

Non-OEM parts

All the on-board diagnosis system checks are adjusted to be operated by genuine parts. Therefore, if a commercial general sensor or switch is installed, the diagnosis lamp comes on due to faulty diagnosis.
If commercial electronic devices, such as mobile phone, stereo, antitheft device, etc. are installed and their installation is not proper, EMI (electromagnetic interference) may be discharged to the control system. That leads to the generation of fault sensor information and the diagnosis lamp comes on. When performing trouble diagnosis, turn the power of all commercial parts to “OFF” or remove those parts, and check for faults again.

Information:

Fault in related system

Many on-board diagnosis (OBD) system checks enter the back-up operating mode by instruction from engine control module (ECM) when the ECM detects the fault in related systems or components. In the back-up operating mode, they lower output to protect the machine.

Trouble Diagnosis

About diagnostic trouble code (DTC)

Every time turning the key switch to ON, the ECM performs self-test of most wiring and components and stores the detected faults in memory. For some DTCs, it also performs the back-up control. If the fault which affects operation occurs, the diagnosis lamp comes on to notify an operator.

Basic knowledge for required tools

Important:
If performing the diagnostic procedure, no basic knowledge on this powertrain may lead to faulty diagnosis or damage to powertrain components. If you do not have basic knowledge, do not perform the diagnosis of the trouble relating to powertrain. Basic understanding on hand tools, such as scan tools, is required to utilize service manual effectively.

About on-board diagnosis test

Types of trouble diagnosis results are the following.

1. History trouble
   Trouble codes which occurred under the following conditions are called “History trouble”.
   - Diagnostic test was completed at previous ignition cycle.
   - Diagnosis test has accepted at current ignition cycle.
   - Faults found by the diagnostic test do not currently exist.
2. Present trouble
   Trouble codes which occurred under the following conditions are called “Present trouble”.
   - Diagnostic test was completed at previous ignition cycle.
   - The faults detected by the diagnostic test currently exist.
   - The faults exist at current ignition cycle.

Description of terms

Ignition cycle

Ignition cycle is defined as Key ON, Run and Key OFF so that the machine can be operated under the specified diagnostic standard.

Diagnosis lamp

Basically, the diagnosis lamp comes on when the fault occurs in electronic control, such as engine control module (ECM), and a DTC (diagnostic trouble code) is detected.

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.

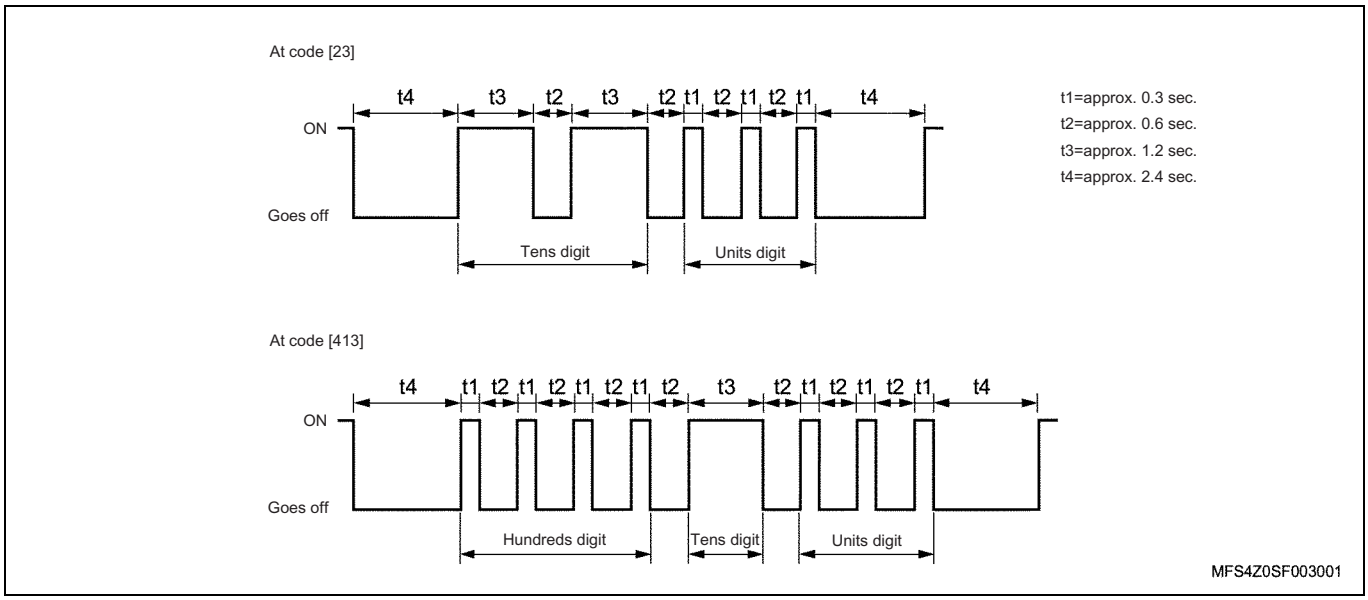
If a scan tool has been connected, it can be read using the tool.

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.



About DTC indicated by blinking of diagnosis lamp

While the engine stops, both the current and past DTCs are displayed.
While the engine is operated, the lamp illuminates only if the current DTC occurs.

How to read DTC by trouble display monitor

When a DTC occurs, it is displayed on trouble display monitor on the machine.

How to read DTC by a scan tool

DTC can be read using a scan tool.

Note:
Refer to "Trouble diagnosis with scan tool, Operation procedure" for work procedure.

If the DTC (diagnostic trouble code) is stored

Perform service correctly according to the specified DTC chart.

If there is no DTC

Select symptom from the diagnostic chart according to symptom. Complete the service following diagnostic procedure. You may also perform inspection by referring function diagnosis.

If there is no applicable symptom

1. Confirm the complaint in detail.
2. Create diagnostic plan.
3. Use wiring diagram and principle of operation.

Ask for technical support when repair history is available for similar case. Connect technician's knowledge with the effective usage of available service information.

If there is intermittent (intermittent trouble)

The trouble situation not occurring constantly is called intermittent (intermittent trouble). Perform the following steps to solve the intermittent trouble.

1. Check the DTC information and data display.
2. Evaluate symptom and situation explained by the customer.
3. Check the circuits or the electric system components using check sheet or other methods.

If the trouble is not detected

In this case, the machine is judged as it operates properly. The condition explained by the customer may be the normal condition. Confirm the customer's complaint comparing with the condition of the machine to that of another machine. That condition may mean an intermittent trouble. Confirm the complaint in the situation the customer explains before returning the machine to the customer.

1. Confirm the complaint again.
   If the complaint can not be fully detected or identified, the machine must be diagnosed again. Confirm the complaint one more time. The complaint may be an intermittent trouble as defined in "If there is intermittent", but it may also be possible that the machine is normal.
2. Repair and confirm.
   If the problem is confirmed, repair it. Confirm that the machine operates properly and the symptoms are corrected. This includes test on the machine or other procedures to confirm that the trouble is solved under following conditions:
   - Confirm by testing in the situation that the customer described.
   - If DTC is diagnosed, reproduce the situation found while the DTC is set, and confirm the repair by checking a scan tool data.

Confirmation after repair

Confirmation of machine repair

If an electronic control system is repaired, it is necessary to confirm that repair is properly performed after the repair work. If this confirmation is not properly performed, it may happen that the diagnosis lamp comes on again or a trouble in operability occurs in the course of delivering the machine to the customer. Especially as for intermittent (trouble), it is needed to reproduce and confirm the situation according to the customer's complaint.

About confirmation of machine repair

It is effective for confirmation of machine repair to use on-board diagnosis (OBD) system check. Mechanic should perform the following steps to diagnose the machine after repair.

1. Review and record the DTC (diagnostic trouble code) or scan tool data used in diagnosis.
2. Clear the DTC.
3. Operate the machine based on scan tool data.
4. Confirm the DTC status information of specified DTC used in diagnosis until the diagnostic test relating that DTC is performed by control unit.

In the case of confirmation of repair by on-board diagnosis (OBD) system check, performing these steps is extremely important. Failure to perform these steps may require unnecessary repair.

List of final check items

No.	Item	Purpose	Method
1	Check of DTC	Confirm the DTC display after repair.	Clear previous DTC. To gain a test environment, warm-up sufficiently with idling and raise the engine speed to "No Load Max." to race.
2	Confirmation of idle speed after the engine is warmed-up.	To check whether the idling control is normal or not.	Check whether the idle speed after warm-up is stable under no load condition. If the trouble is detected, refer to "Unstable idling" in symptom diagnosis.
3	Check the scan tool data list.	Check the engine control and communication status for faults at standard condition.	Monitor the scan tool data list and use a typical data sheet to perform the check. Confirm the typical data of scan tool data list.
4	Confirmation of ability of restarting	To check whether the starting control is normal.	Confirm that after the engine is warmed up. Confirm that the engine starts after less than 5 second of cranking time and becomes stable.
5	Confirmation of powerful electric wave transmitter.	If an electric wave transmitting equipment such as transceiver is additionally installed, confirm whether interfering electric wave is consequently transmitted or not.	Check if idling engine speed changes due to "ON" and "OFF" of an electric wave transmitter such as transceiver. If a fault is found, inform a customer of necessity to change the location and output of an electric wave transmitter.

Confirmation of powerful electric wave transmitter; if faults are found in these items, inform a customer of the following check items as required.

- An antenna should be installed as far away from control unit/sensors or electrical systems on the machine as possible.
- Antenna codes should be installed at least 20 cm (7.8 in) away from control units/sensors or electrical systems on the machine.
- Do not put the antenna codes and other wire together. Keep the antenna codes as far away from other wire as possible.
- When installing an additional equipment, follow its installation manual to install it securely.
- Do not install mobile communication equipment with high output.

Caution:
If confirming repair using on-board diagnosis system check, perform the following steps. If not following these steps, unnecessary repair may be needed.

- **Review and record the scan tool data related to DTC which is diagnosed.**
- **Clear the DTC.**
- **Operate the machine while checking the relevant scan tool data.**

How to clear DTC

Clear of DTC

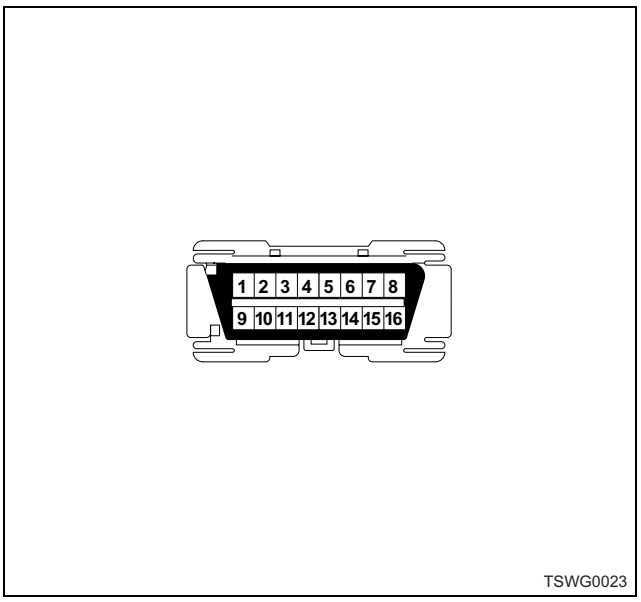
The DTC, which have been stored in the engine control module (ECM) upon trouble occurrence, will not be erased even if the faulty parts are repaired, unless it is compulsory cleared in the following procedure.

Clear with a scan tool

If a scan tool (Tech2 or scan tool with KW communication) has been connected, it can be cleared by clear operation of the scan tool (Tech2 or scan tool with KW communication).
If a scan tool with CAN communication has been connected, clear with the memory clear switch.

Clear with memory clear switch

1. Turn the key switch to ON.
2. Turn the diagnosis switch to ON.
3. Turn the memory clear switch to ON.
4. Leave as it is ON for 3 seconds.
5. Turn the memory clear switch to OFF.
6. Turn the diagnosis switch to OFF.
7. Turn the key switch to OFF.
8. Leave as it is for 10 seconds.
9. Turn the key switch to ON.
10. Turn the diagnosis switch to ON.
11. Make sure that memory is cleared.



Note:

- **Refer to the machine's manual for the locations of memory clear switch and diagnosis switch.**
- **Perform the same procedure to clear memory regardless of forms of switches (switches, connectors). (ON = Connection, OFF = Disconnection)**

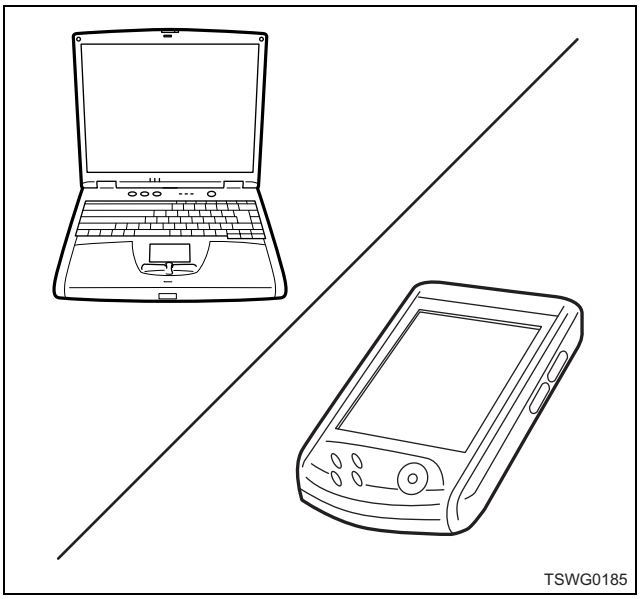
Clear with ECM (intermittent trouble)

The DTC stored in ECM will be cleared if the same one is not valid within 20 ignition cycles.

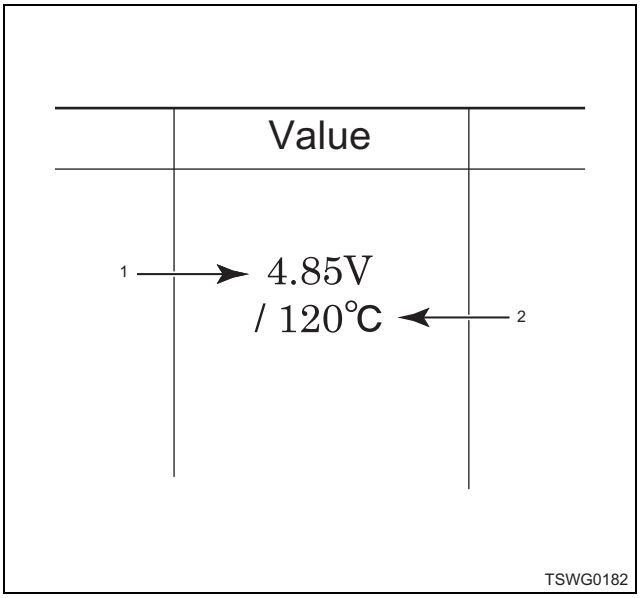
Trouble diagnosis with scan tool

About scan tool

There are the scan tool for Hitachi Construction Machinery and the scan tool (Tech2) for Isuzu, etc. They have different display method respectively.
The scan tool for Hitachi Construction Machinery and the scan tools with CAN communication display only the physical value in data parameters.



Isuzu scan tool (Tech2) and the scan tools with KW communication can display both the physical value and voltage value.
In some diagnostic charts, both the voltage value and physical value may be shown. Refer to the voltage value for Tech2 and the scan tools with KW communication or the physical value for the scan tools with CAN communication.



Name
1. Tech2 and scan tool with KW communication
2. Hitachi Construction Machinery scan tool and scan with CAN communication

About scan tool display

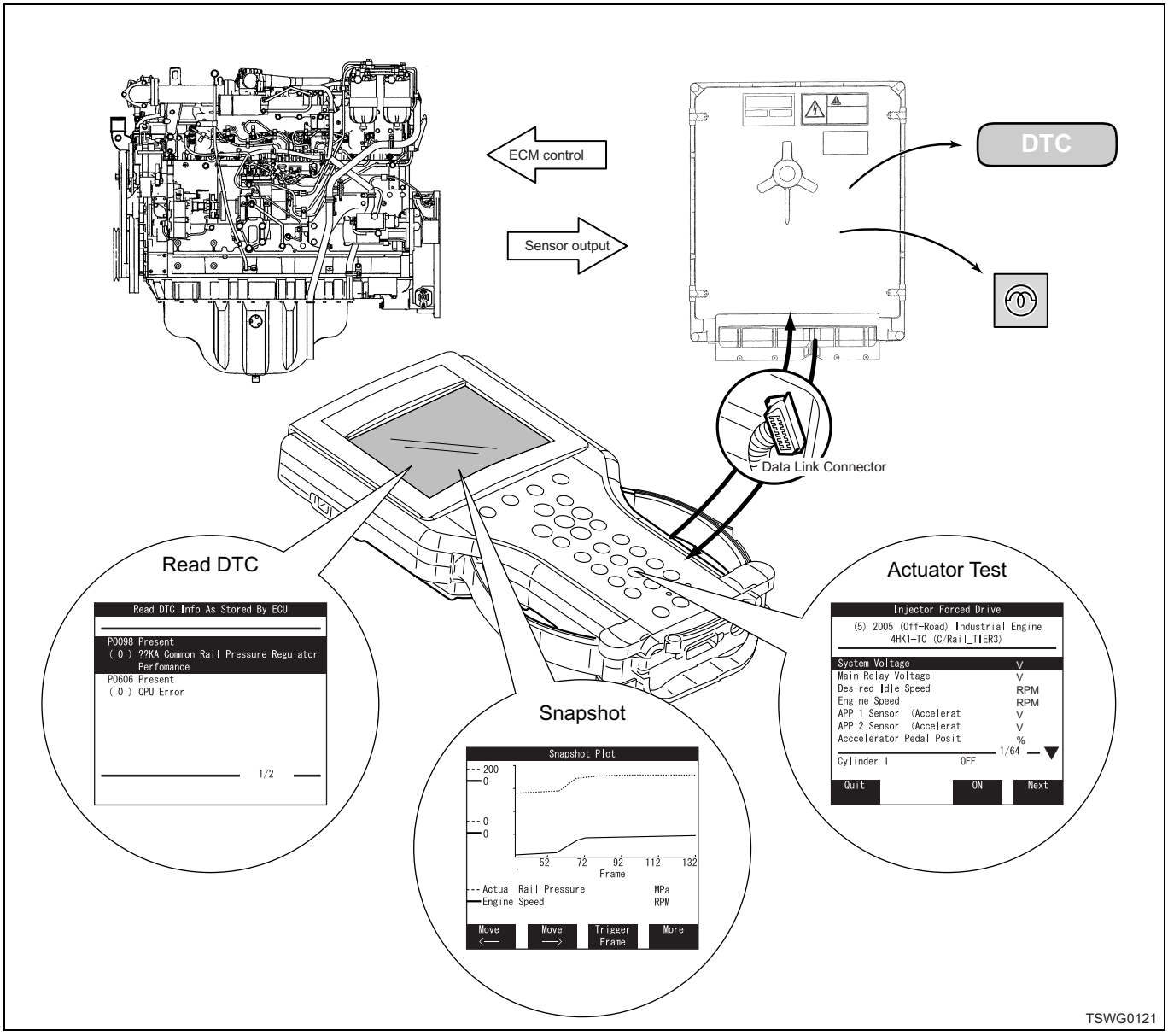
ECM has different displays; KW and CAN. For data display, refer to appropriate section for Hitachi Construction Machinery.

Tech2, KW display	CAN display
Engine Model (EEPROM)	Engine Model
Engine Serial Number (EEPROM)	Engine Serial Number
ECM Parts Number (EEPROM)	ECM Parts Number
Software ID (EEPROM)	Software Identification
Q Resistance (EEPROM)	Q adjustment data
QR Code (EEPROM)	QR code
Starter Switch (On)	—
Starter Switch (ST)	—
EGR BLDC Position 1	—
EGR BLDC Position 2	—
EGR BLDC Position 3	—
Glow Relay Switch	—
—	Glow Signal
Accelerator Sensor 1	Act Accel position
System Voltage	—
Main Relay Voltage	—
—	Battery Voltage
Intake Air Temperature Sensor	—
Fuel Temperature Sensor	—
Engine Coolant Temperature Sensor	—
Idle Up Volume Sensor	—
Barometric Pressure Sensor	—
Differential Fuel Rail Pressure	—
Differential EGR Valve Position Sensor	—
Engine Speed	Act. Engine Speed
Desired Engine Speed	Request Engine Speed
Intake Air Temperature	Intake Air Temperature
—	Boost pressure
—	Boost Temperature
Engine Coolant Temperature	Coolant Temperature
Fuel Temperature	Fuel Temperature
Barometric Pressure	Barometric Pressure
Engine Oil Pressure	Engine Oil Pressure
—	Fuel Flow
—	Engine Torque
—	Trip used fuel
—	Total used fuel

Tech2, KW display	CAN display
Differential EGR Position (BLDC Motor)	—
PCV Duty	—
EGR BLDC Motor Duty	—
EGR DC Motor Duty	—
PCV F/B	—
Desired Idle Speed	—
Common Rail Pressure F/B Mode	—
Engine Mode	—
Target Fuel Flow	—
Main Fuel Injection Timing	—
Pre-fuel Injection Amount	—
Main Fuel Injection Amount	—

About scan tool (Tech2)

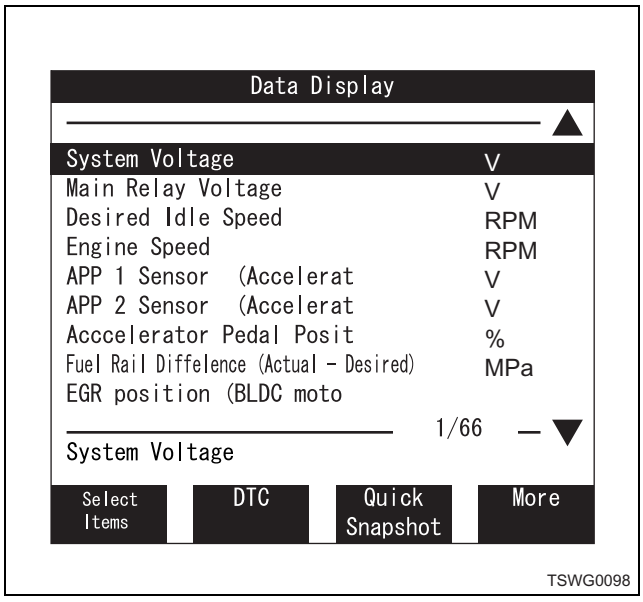
This is an useful tool to diagnose the electric faults and the system check of the engine control system. The Tech2 is small and light tester. It can communicate with each control unit to perform various types of diagnosis and test by connecting it to DLC equipped to the machine using Tech2 adapter.



Function of Tech2

Data display

This displays conditions recognized and controlled by ECM at each items.
The values of display items is described in typical data of Tech2 data list.
The contents of display items describe about data.



This menu can be used to display the current data.
The display synchronizes with the status of the machine or equipment.

- If the data display menu cannot be selected:
  Trouble occurs on the cable between ECM and DLC.
  The position of select switch on Tech2 adapter is wrong.
- If the abnormal fixed value is displayed:
  [Example] The data display value of engine speed, each sensor, etc. is fixed and different from actual one. Move the connector or harness by hand. If the display changes from fix to release, connection of the connector is faulty, pin tip length is uneven, or open or short circuit exists in the harness where you have moved. Therefore, repair is necessary.

- When asterisk mark (*) is displayed in place of numeric display;
  The Tech2 software has problem.
  If asterisk mark (*) is found on any of the data, PCMCIA card must be version-upgraded.

Snapshot

To find the cause of trouble, perform this snapshot to review the data.

- The snapshot can record the data list menu and plot a graph.
- Utilizing this mode, reproduce and record the conditions claimed by the customer to identify the data fault.
- The trigger type allows to record the data of the time when DTC is displayed.
- The stored data can be replayed with a domestic power supply.

Programming

Confirm the data history before replacement of ECM. (Data confirmation) Then, upload the data to the Tech2. After replacement of ECM, download data from Tech2 to new ECM.

Actuator test

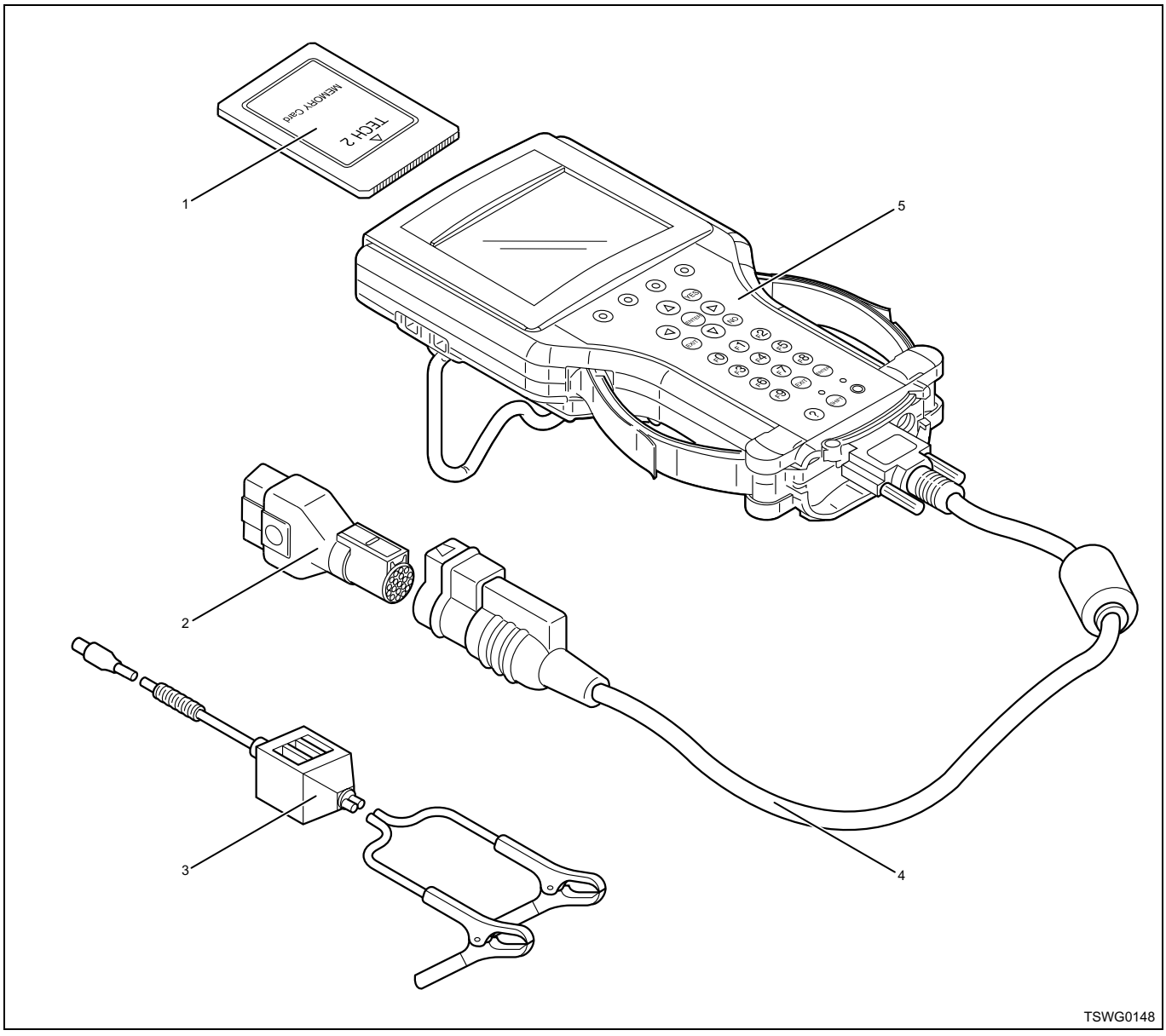
Perform each test to check the operation or function of appropriate parts for faults.
When giving instruction to ECM from test screen, set the select switch of the Tech2 adapter to “2” position.

Caution:
Each test may not performed if the machine, engine operation status, coolant temperature, vehicle speed, switch status, gear position, etc. does not meet conditions or if DTC is detected.

How to use trouble diagnosis-related tool

How to use Tech2

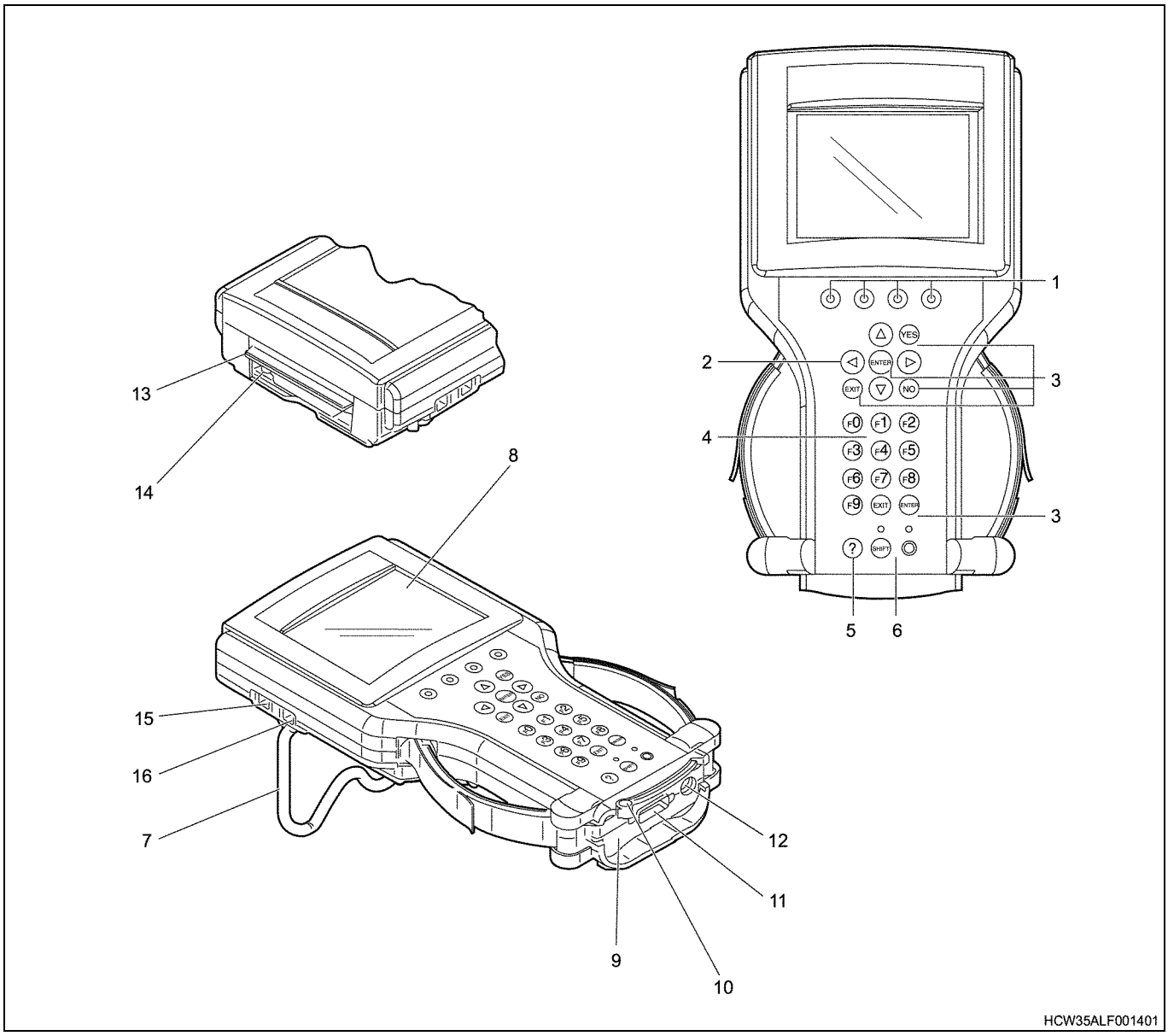
Components of Tech2



Name

1. PCMCIA card
2. SAE 16/19 adapter
3. Power cable
4. DLC cable
5. Tech2

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.

5. Help key (?)
   Explanation of Tech2 function, which is being used at the time when the key is pressed, is displayed
6. Control keys (PWR / SHIFT)
   The PWR key turns on/off the power to the Tech2. The SHIFT key is used to adjust the screen contract. When the SHIFT key is active, the orange LED illuminates. In this case, all the keys except selection keys and functions are locked. When the power is on, the green LED illuminates.
7. Wide stand
   Use this as a stand. The stand opens angle of 0 — 180°.
8. Display area (LCD)
   This is liquid crystal display (LCD) with contrast adjusting function. It displays ECM information and various instructions.
9. Machine communication interface (VCI) module
   This is a module to communicate between the machine and Tech2.
10. Fastening bar of VCI module
    The bar is used to install/fasten/remove the VCI.
11. Connector of DLC cable connection
    This is used to connect the Tech2 to the machine. Connect the DLC cable.
12. Connector for AC adapter connection
    This is used to connect the attached AC adapter when using Tech2 with other than the machine.
13. PCMCIA card insertion slot with cover
    Open the cover when inserting the PCMCIA card into Tech2. Insert the PCMCIA card with the cover opened. Never insert/remove the PCMCIA card when the Tech2 is powered on.
14. PCMCIA card release button
    This is used to remove the PCMCIA card from Tech2. Press the button to remove the PCMCIA card. Never remove the PCMCIA card when the Tech2 is powered on.
15. Connector for external communication (RS-232 port)
    This is used to connect the Tech2 to a computer.
16. Connector for external communication (RS-485 port)
    This is a connector for phone line connection, however it is not currently used. Do not connect the phone line etc. to this connector.

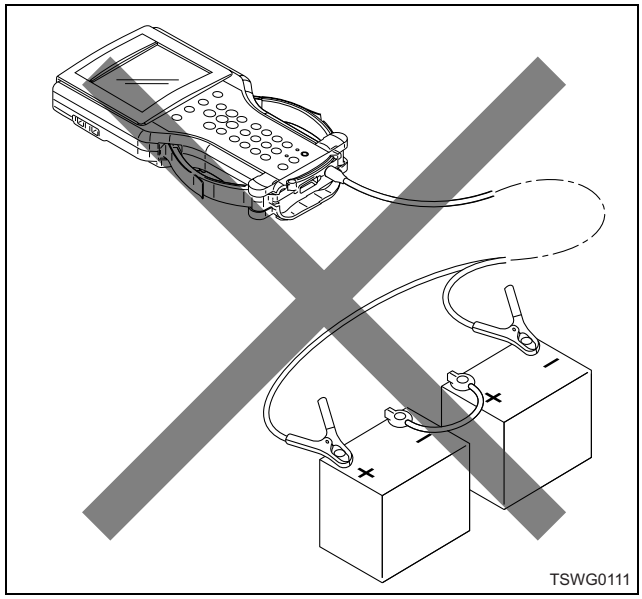
Precautions on handling Tech2

Ventilation

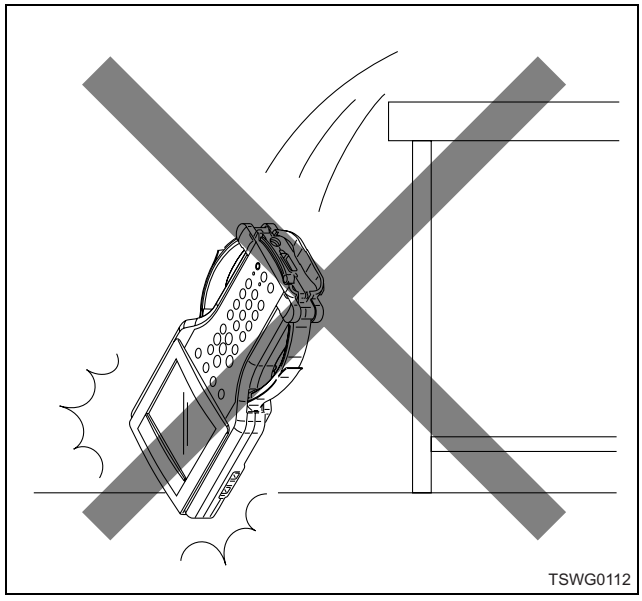
If performing inspection and test with engine running in badly ventilated area, such as garage, ventilate sufficiently. In badly ventilated area, poisoning may occur due to inhaling colorless, odorless carbon monoxide included exhaust gas.

Handling

- The Tech2 is “precision electronic device”. Handle with extreme care.
- Operating voltage of Tech2 is DC 12 V. Do not energize 24 V to it.

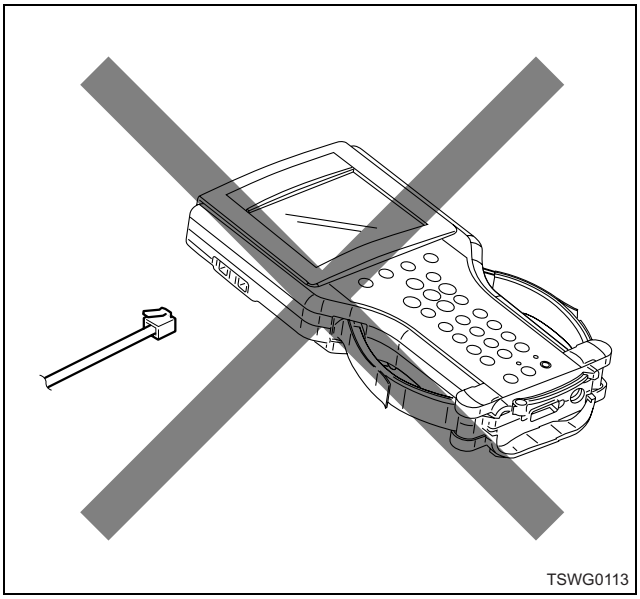


- Do not have an impact on it by dropping. It causes internal faults even no damage on appearance.

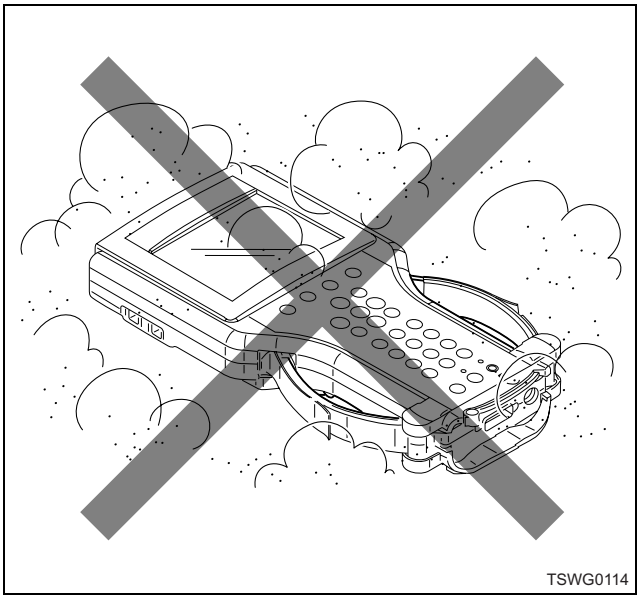


- Be sure to turn off the power of Tech2 when installing/removing the PCMCIA card. Avoid repetition of installing/removing the card as possible. Otherwise, the card may be deteriorated.
- Before turning on the Tech2, make sure that the cables and adapters are connected securely.
- Do not disconnect the cables and adapters connected to Tech2 while the key switch is ON or the engine is starting.

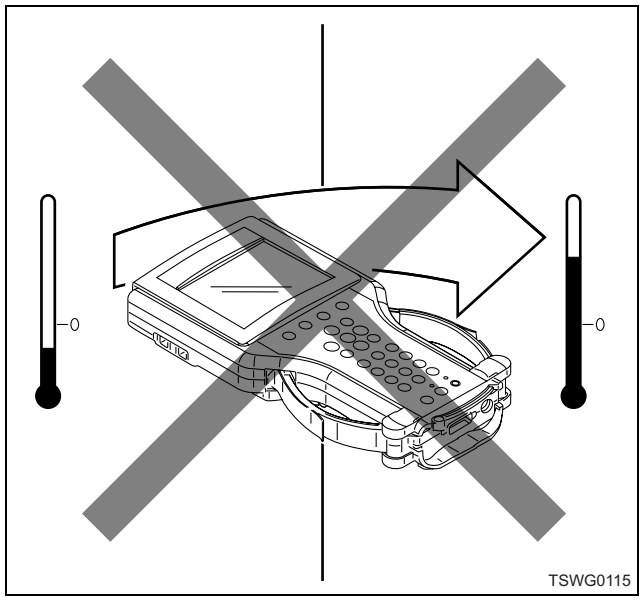
- Do not connect the phone jack to communication port on the side of Tech2.


TSWG0113

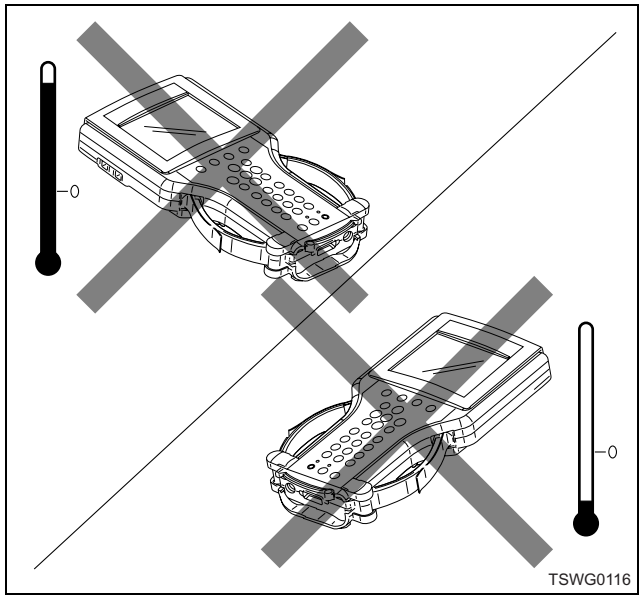
- Avoid using and storing it in dusty area. When not using it, always put it in its case to prevent the adapter from getting dust.


TSWG0114

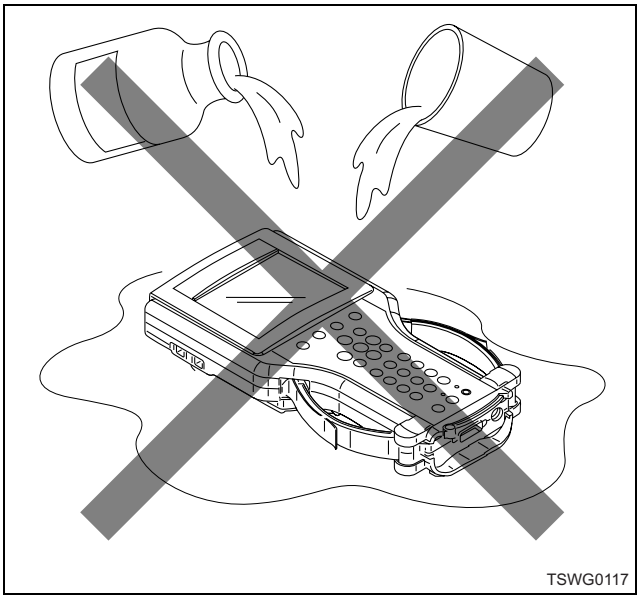
- Avoid using and storing it in a place with rapid changes of temperature. If bringing it from cold outside into warm indoor suddenly, dew condensation may occur resulting in malfunction or trouble.


TSWG0115

- Avoid using and storing it in a place with extreme high or low temperature. Especially in summer, do not leave it in the machine exposed to direct sunlight.


TSWG0116

- Avoid using and storing it in a place that it may contact water or chemicals. When cleaning, use cloth with mild detergent, not highly-volatile solvent such as thinner, and wipe out using dry cloth. Its display is easy to get dirty, clean periodically using antistatic cloth.



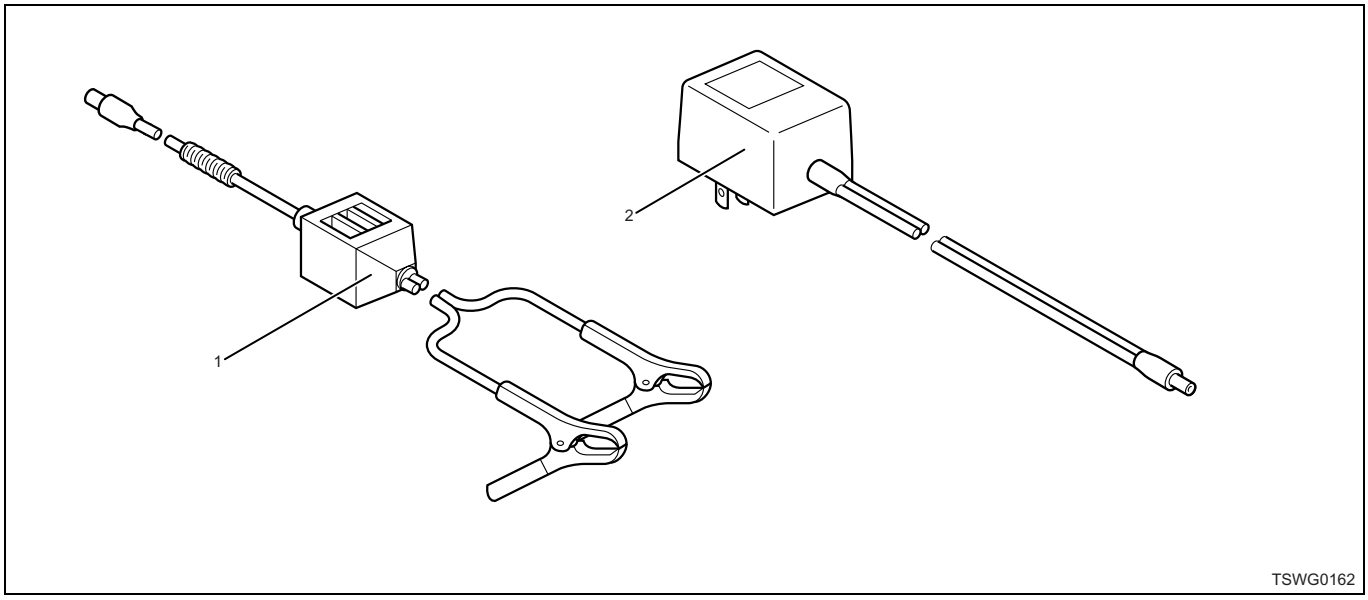
Power supply

About power supply

The power supply method for the Tech2 varies depending on the voltage of the machine, shape of DLC and the situation in which the unit is used. Therefore the user will have to gain good understanding of the relevant connecting procedure.
Notice that machine data and DTC will not be able to be checked if the connection is not established in accordance with the power supply of the machine.

Note:
Use of the external power (AC power) does not allow to utilize the applications.

Connection of power

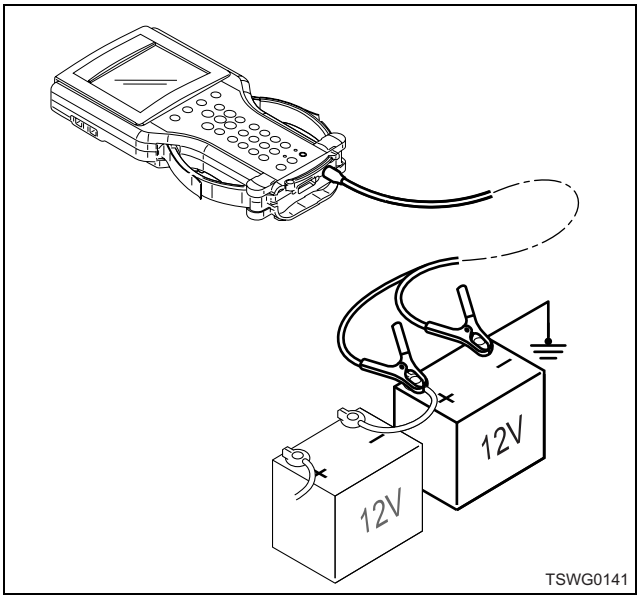


Name
1. Battery cable
2. Power socket cable (AC/DC adapter)

Battery cable

This cable should be used, in the case where no power is supplied even when the Tech2 is connected to the machine through the machine DLC cable, or where the machine works with a higher voltage than the operating voltage of the unit. When connecting the cable, pay heed to the polarities of the clamps. (The black clip of the cable is to be connected to the negative terminal of the battery and the red clip to the positive terminal.)

Caution:
In the case of a 24-V machine, connect to battery on the body ground side to take out 12 V.



Power socket cable (AC/DC adapter)

This is used to check the captured data by operating Tech2 away from the machine.

Caution:
Be sure to use the power socket cable adapted to local standards. Otherwise, it may result in failure of Tech2 or power socket cable due to different voltage and current depending on regions.

Check items before use

VCI

Check to see whether the VCI module is securely inserted and whether the fastening latch bar of the VCI module is located on the left-hand end.
Attach the DLC cable and fasten it by tightening the two lock screws.

PCMCIA Card

Check to see whether the slot (upper side) has this card inserted with its “Tech2” label side up.

Caution:
If the card is not inserted properly and the unit is switched on, “NO PCMCIA CARD INSERTED” will appear. If that is the case, turn off the power and redo the insertion of the PCMCIA Card.

Connection

Check to see whether the DLC cable is fitted with an adapter compatible with the machine.

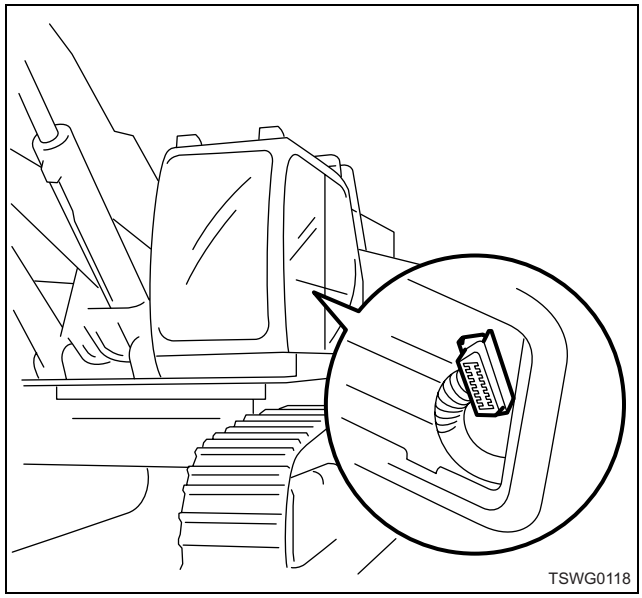
Note:
Before connecting the cable to the machine, verify that the key switch is in the “OFF” position.

Caution:
In the case of a 24-V machine, connect to battery on the body ground side to take out 12 V.

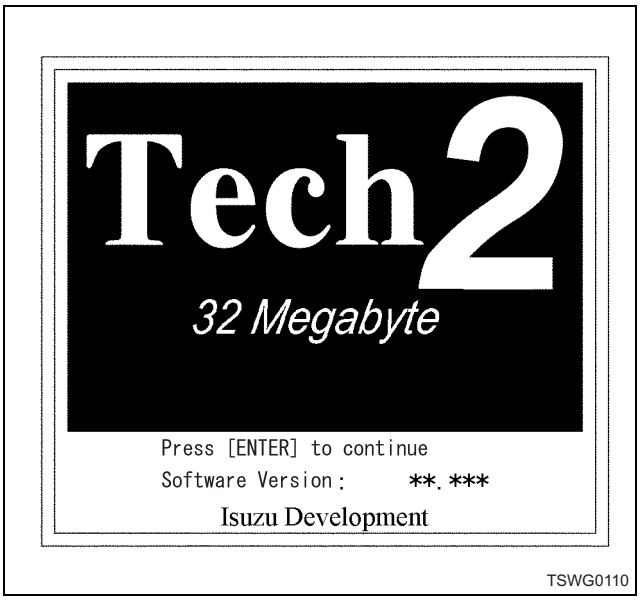
How to connect Tech2

1. Insert the PCMCIA Card with the latest version of ISUZU system into the Tech2.
2. Connect the SAE 16/19 adapter to the DLC cable.
3. Connect the DLC cable to the Tech2.
4. Make sure that the key switch is OFF.
5. Connect the SAE 16/19 adapter of Tech2 to the machine DLC.

Caution:
Connecting method varies depending on each machine. Refer to the machine’s manual. The following description is for the machine with DLC.



6. Turn the ignition switch to ON and press the “PWR” key of the Tech2.
7. Check the display of the Tech2.

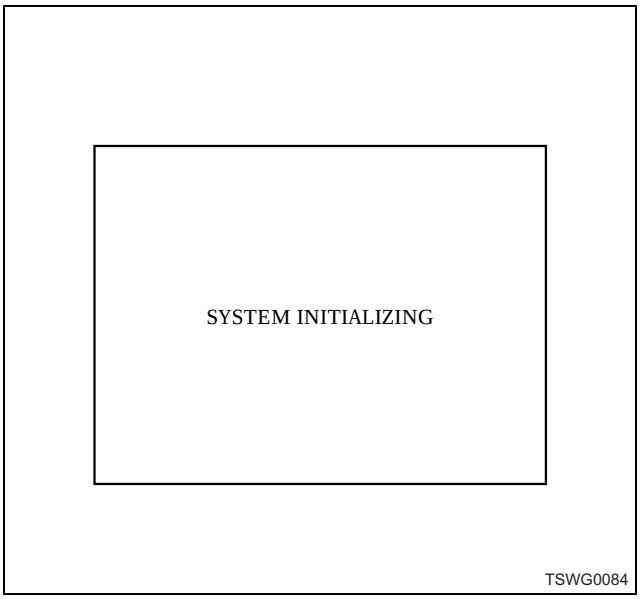


Caution:
Be sure to turn off the power of Tech2 when installing/removing the PCMCIA card.

Operation procedure

Start-up

The Tech2 is designed to automatically conduct a self-function test every time it is started. Immediately after the unit has been switched on, the “SYSTEM INITIALIZING” message will appear. During this period, POST (Power-On Self Test) is carried out, and if the test ends normally, a sound will be issued at the completion of the test. Simultaneously, the LED of the SHIFT key will momentarily come on. This is also meant to check the normality of the LED.

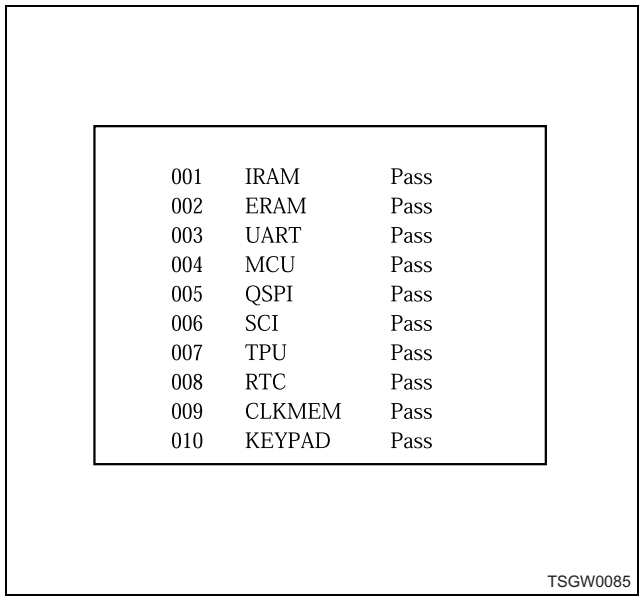


Display of POST results:

If the test ends normally, “Pass” will appear and one short sound will be heard.
If the test ends abnormally, “Fail” will appear and three short sounds will be heard.

Note:

- **If the LED fails to come on, it means a malfunction of the LED, not a malfunction of the SHIFT key.**
- **Absence of sound means a malfunction of the Sound Transducer[*1], but the unit can be used as is, without any problem.**
  ***1. Sound Transducer: The sound is intended to indicate the completion of a data setup or an error in a setup.**



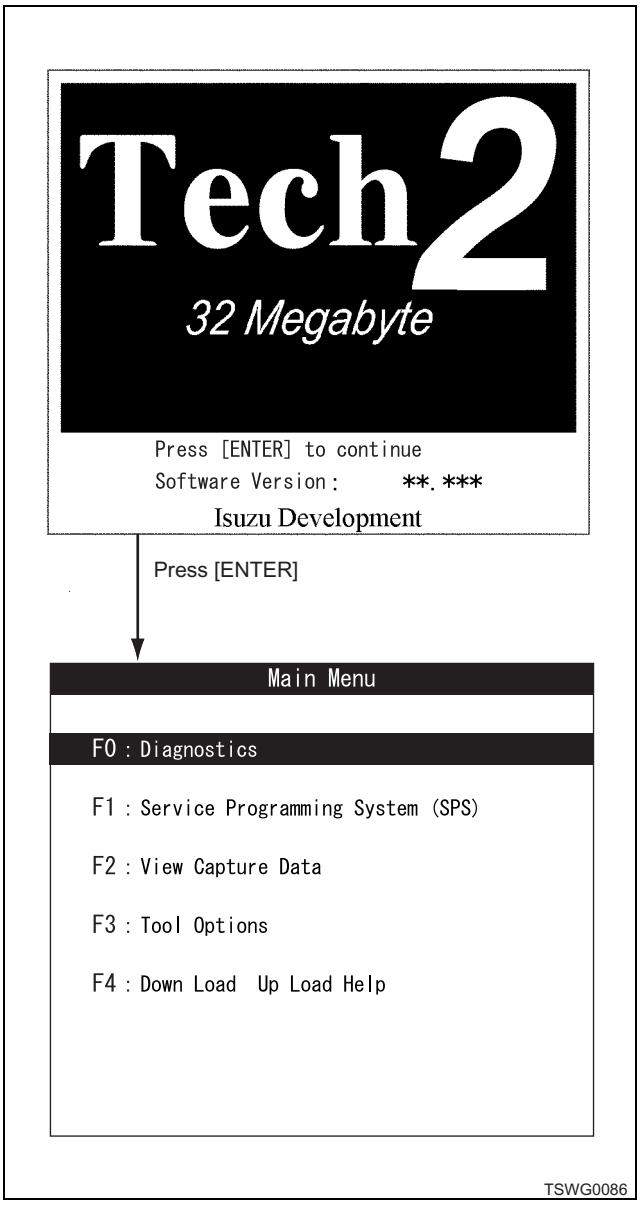
Pass: Normal
Fail: Abnormal

Note:
Only for UART, SCI, RTC, and CLKMEM in particular, the test result may appear as “Fail” without this meaning any trouble. For “Fail” above, refer to “Tech2 Self Test in Tool Options”.

IRAM: Internal RAM
ERAM: External RAM
UART: Universal Asynchronous Receiver and Transmitter
MCU: MC68332 Microcontroller
QSPI: Queued Serial Peripheral Interface
SCI: Serial Communication Interface
TPU: Time Processor Unit
RTC: Real-Time Clock
CLKMEM: Clock Memory
KEYPAD: Keypad

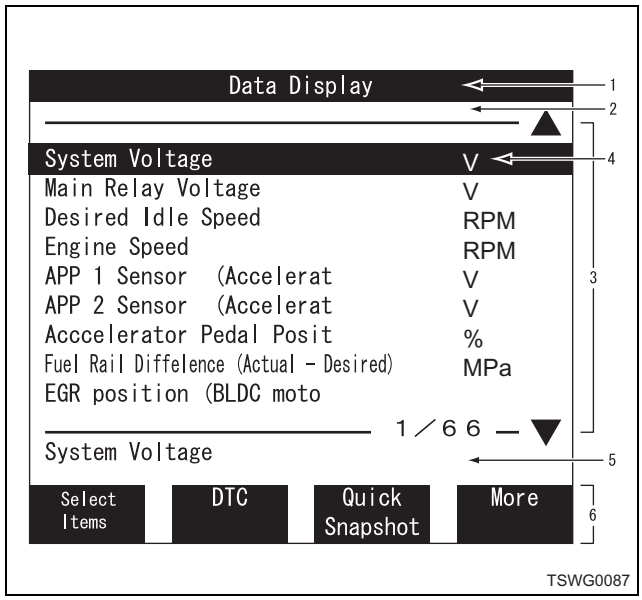
Main Menu

If all the functions are normal after the Tech2 has been switched on, the Start Up screen will open, displaying the Version No. and the applicable model year, stored on the PCMCIA card, to allow the user to verify the information. After the Start Up screen has opened, pressing the [ENTER] key will cause the “Main Menu” to appear. The Main Menu offers 4 different applications to select from. The desired menu can be executed moving the highlight bar to it with the relevant function key or selection keys and pressing the [ENTER] key.



Screen composition:

The screen for data display is composed in the following manner.



Name

1. TITLE AREA
2. MESSAGE AREA
3. DISPLAY AREA
4. Highlight bar
5. FULL TEXT AREA
6. SOFT KEY AREA

- TITLE AREA: Shows the item currently selected.
- MESSAGE AREA: Shows a supplementary explanation or instruction.
- DISPLAY AREA: Displays data parameters and values (9 lines x 23 characters).
- FULL TEXT AREA: Shows details of the parameter under the highlight bar.
- SOFT KEY AREA: The softkeys below the function item display boxes are valid.

Main Menu

F0: Diagnostics

Allows the user to check data, including Tech2-compatible DTC (Diagnostics Trouble Codes), Data Display, Snapshot, Miscellaneous Tests, etc., by selecting a machine ID and System.

- DTC: Shows the contents and situation of DTC stored in the controller of the system.
- Data Display: Shows the input/output data to/from the machine controller under test. Since the displayed data varies from a system to another, and besides, most of the items do not have their guidance standard values installed, it is necessary to first check what the displayed data means.

- Snapshot: Allows to record and display the data of malfunctions occurred. The displayed data not only includes the one corresponding to the moment when a malfunction occurred, but also those that existed before and after the occurrence of the malfunction. It also provides the function (Plot) to draw graphs.

F1: Service Programming System (SPS)

Note:
Except industrial engine.

F2: View Capture Data
Allows to review data recorded under Snapshot of “F0: Diagnostics”.

F3: Tool Options
Offers the function to make settings for the Tech2 main unit, to display POST (Power On Self Test) results, and to perform detailed tests (PCB, VCI).

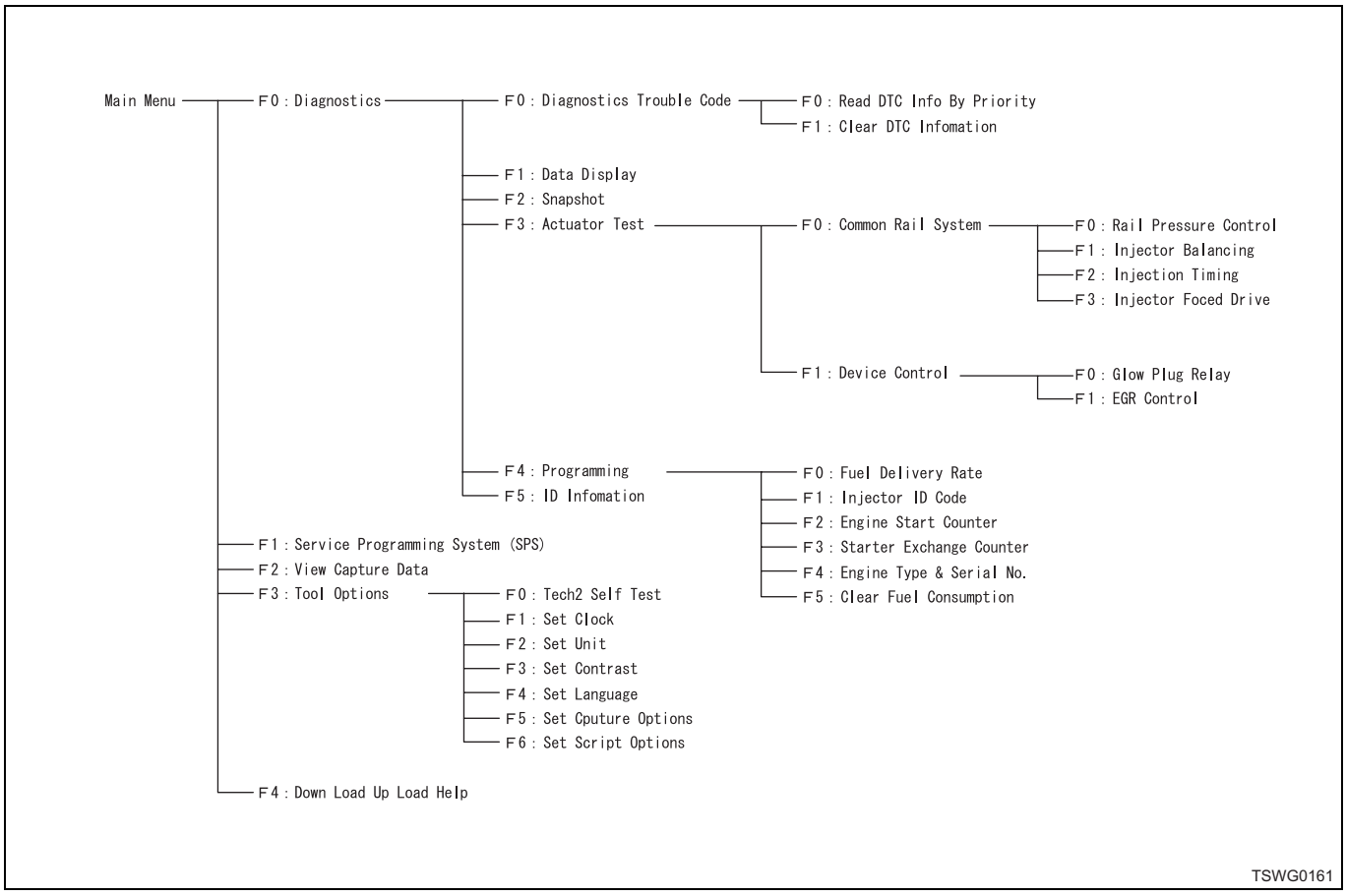
- Tech2 Self Test: Performs troubleshooting on the functions of the main unit.

Caution:
While this function is under execution, do not connect the unit to the machine!

- Set Clock: Sets the internal clock of the Tech2.
- Set Unit: Switches between the Metric system and the English system.
- Set Contrast: Adjusts the brightness of the display.

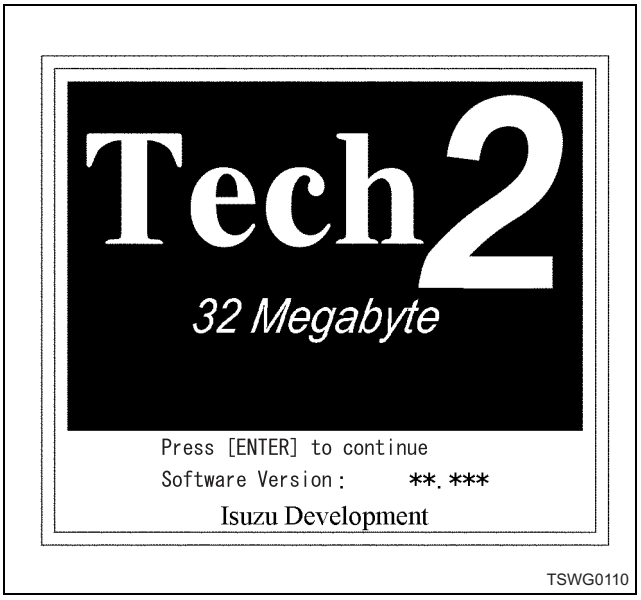
F4: Down Load Up Load Help
The function to upload/download data (DTC, Snapshot, etc.) acquired through the Tech2 to/from a PC, and the Help function to render assistance in case the operation encounters a hitch.

List of functions of Tech2

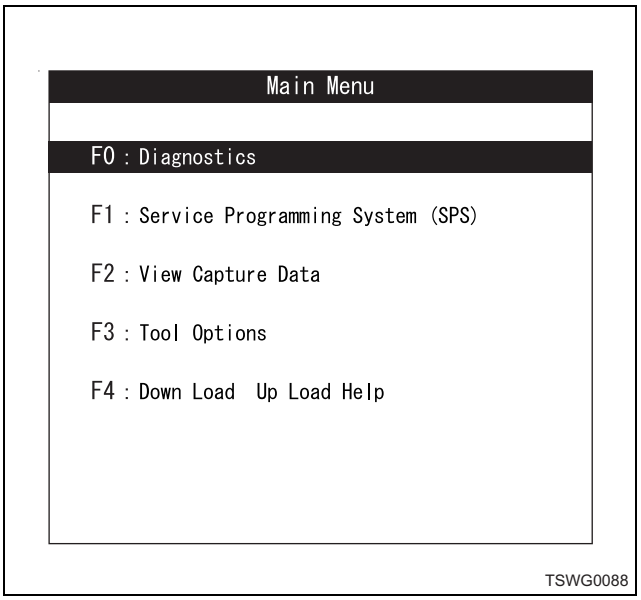


Diagnostic procedure

1. When the Tech2 is switched on, the software version and the model year applicable to the software will also be shown. Confirm the display and press [ENTER].

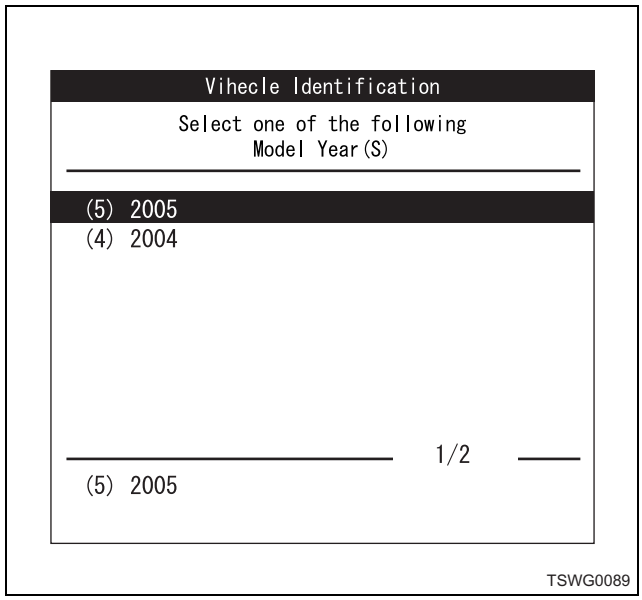


2. Press the function key [F0] or bring the cursor to [F0: Diagnostics] on the “Main Menu” screen by operating the selection keys (▲▼). And then, press the [ENTER] key.

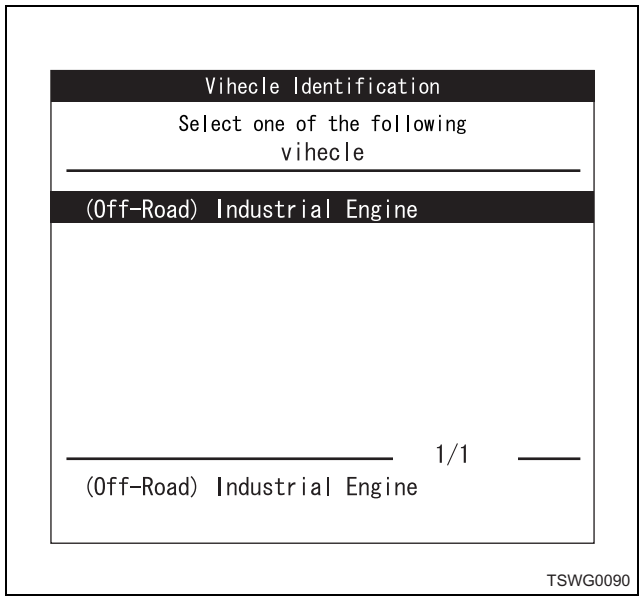


3. Select the Model Year corresponding to the desired diagnostic action on the “Vehicle Identification” screen and press the [ENTER] key.

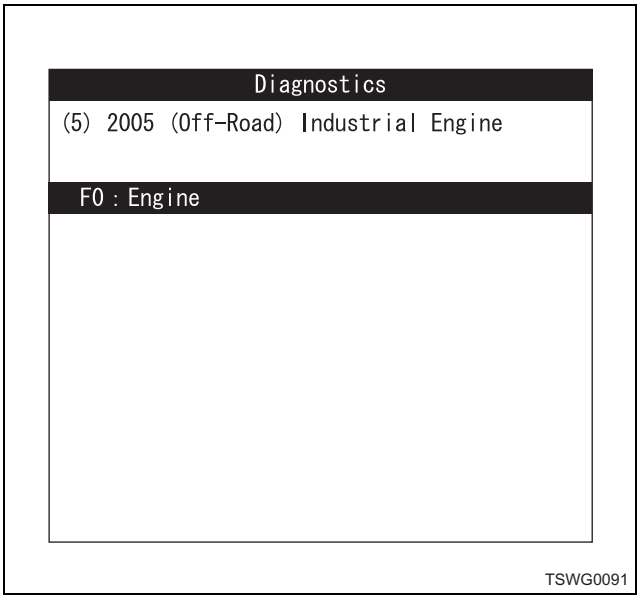
Note:
Select the model year of the relevant machine by checking VIN of each machine.



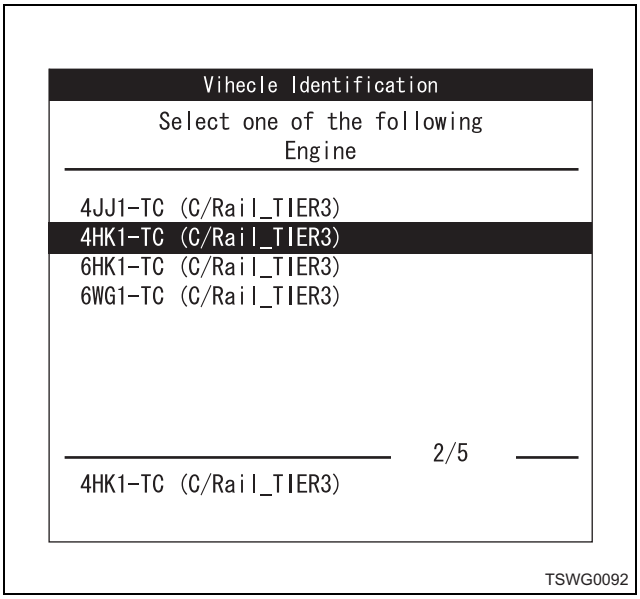
4. Select the Vehicle Type on the “Vehicle Identification” screen and press the [ENTER] key.



5. Press the function key [F0] or bring the cursor to [F0: Engine] by operating the selection keys (▲▼). And then, press the [ENTER] key.

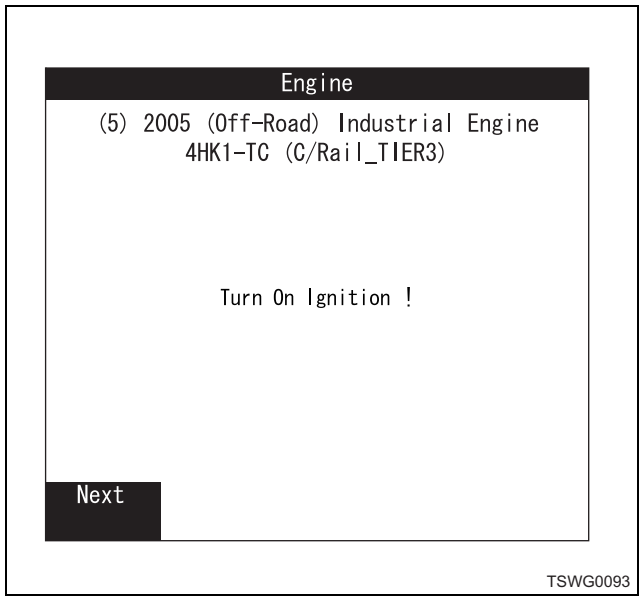


6. Select Powertrain (Eng. name) on the “Vehicle Identification” screen and press the [ENTER] key.

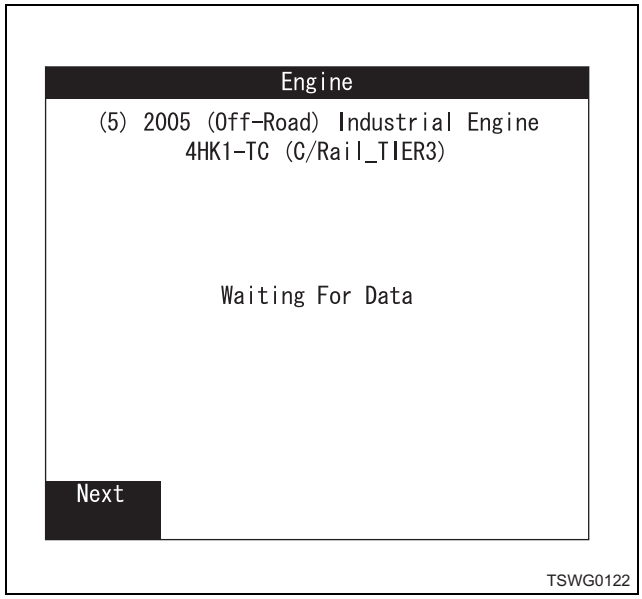


7. The items chosen in steps 3 to 6 are shown in the Message Area display section. If the identification of the machine is OK, turn the ignition key “ON” to “START” and press “Next” by following instructions given on the screen.

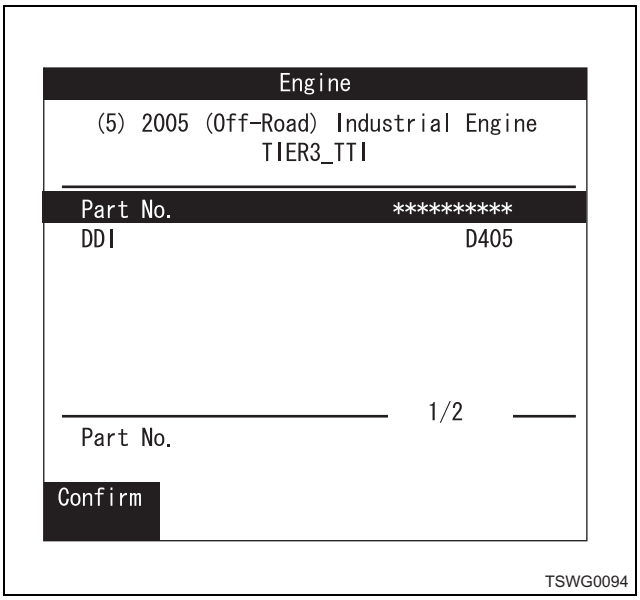
Note:
If you make any mistake, pressing the [EXIT] key will return you to the “Main Menu”.



8. The following illustration shows the state in which the Tech2 is waiting for communication with the machine controller. If the softkey “Next” is pressed with the ignition key in “OFF”, this display will stay forever. (State of communication disabled) However, turning the ignition key “ON” to “START” in this condition will place the unit in the waiting state for communication.



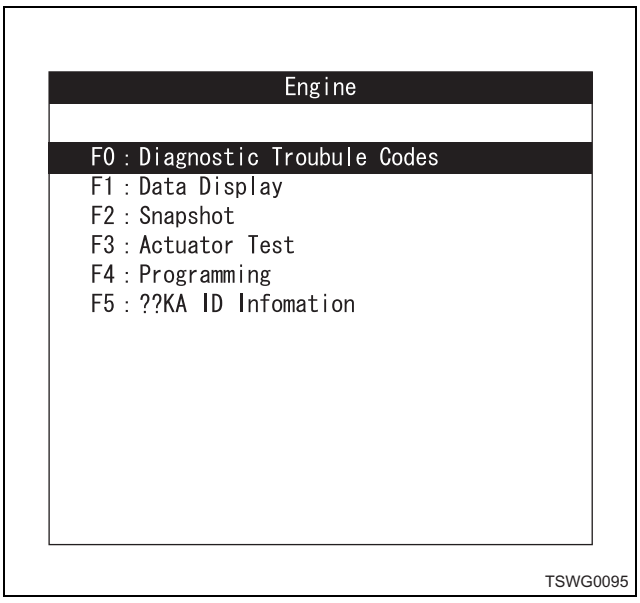
9. Once the communication is established, the unit will show the part No. and DDI (Diagnostic Data Identification) (which varies from a system to another). Press the softkey “Confirm” and go on to the application. If any mistake was made in the selection of the vehicle type, despite that the communication is enabled, a message to that effect will appear flashing. If that is the case, check the vehicle type again and redo the operation from step 1.



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.

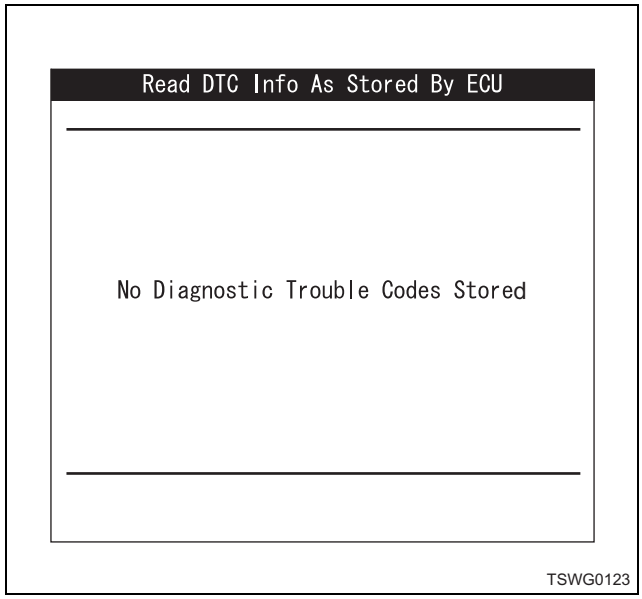
F1: DTC Clear

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

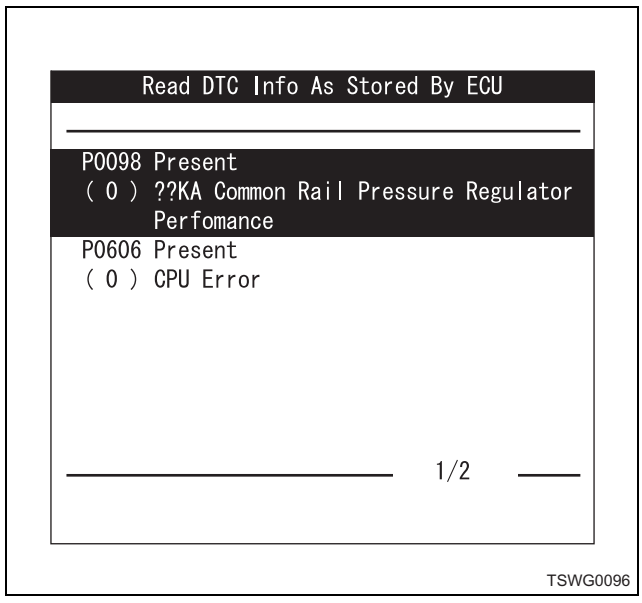
DTC application menu display screen

[Example] Industrial Engine
F0: DTC Display

If no DTC stored

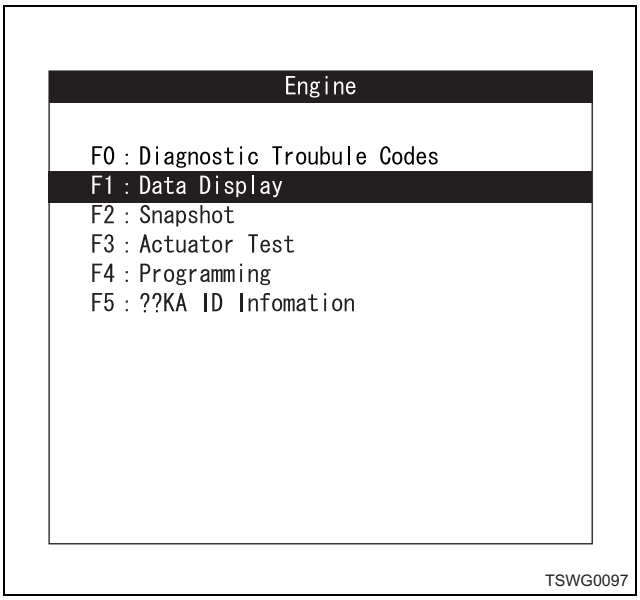


If DTC stored

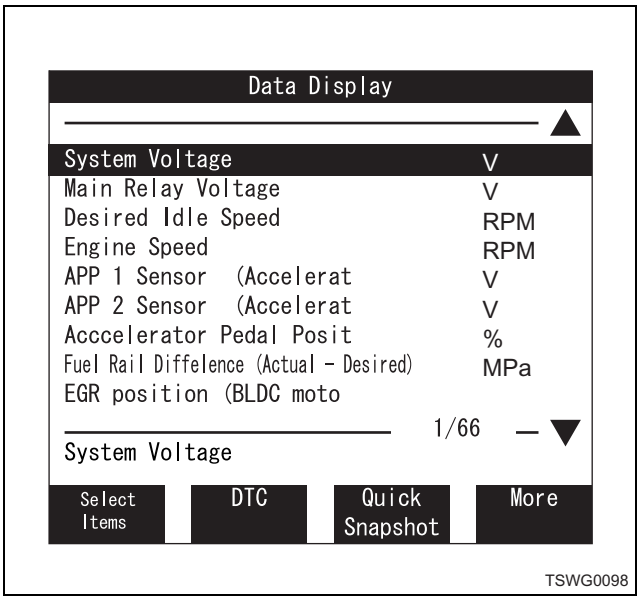


Data Display

1. Select “F1: Data Display” on the “Engine” screen.
   F1: Data Display
   Displays the information concerning various parts of the engine and transmission as data on the screen of the Tech2.



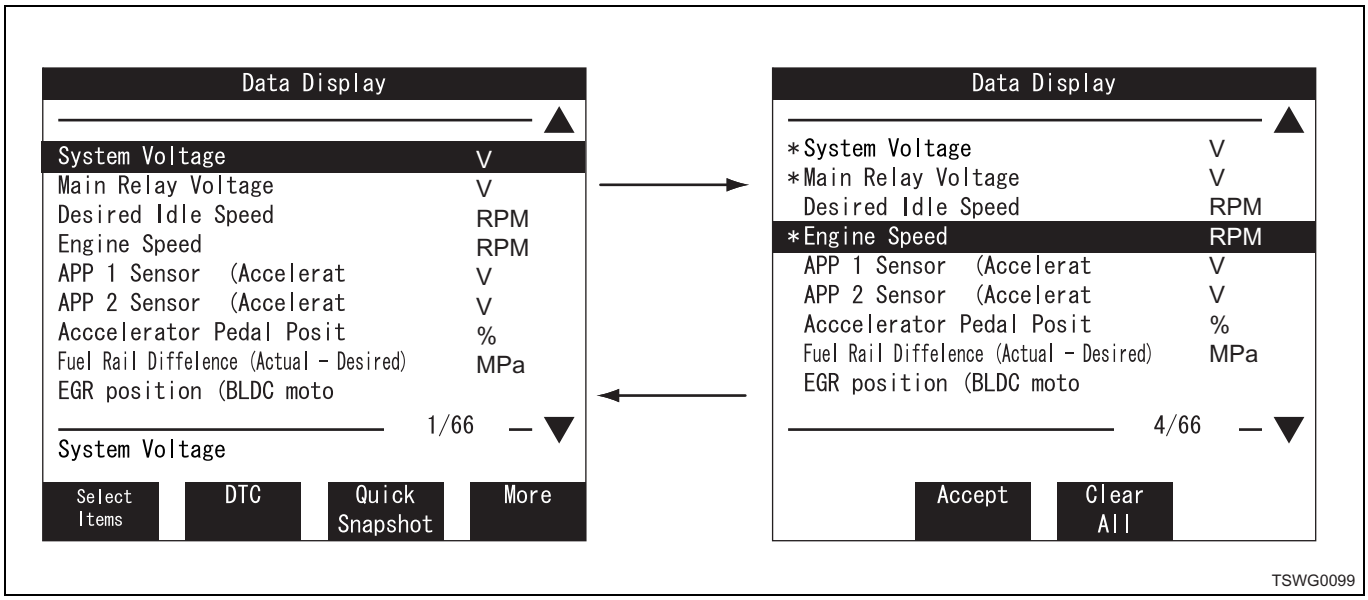
2. F1: Choosing “Data Display”, the engine data is displayed.



Softkey functions

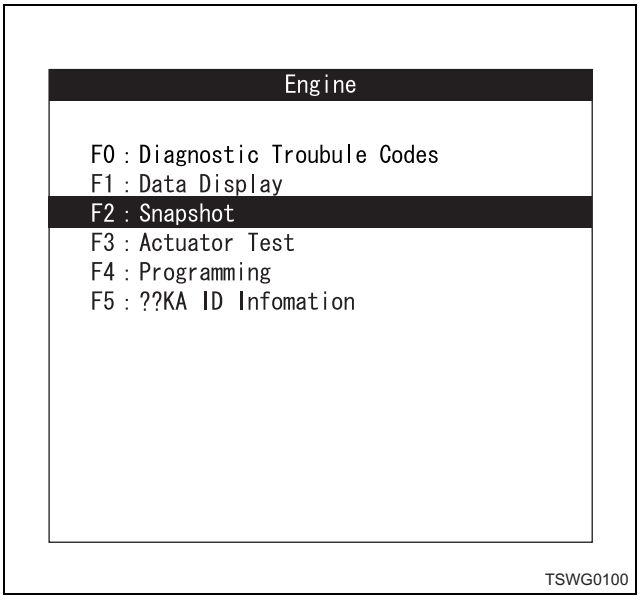
A maximum of 5 data parameters can be fixed on the “Data Display” screen. The 5 fixed parameters will be retained at the upper part of the screen, even when the display is scrolled up or down. To fix parameters, bring the highlight bar to the desired parameter on the screen, which appears as you select the softkey “Select Items”, and press the [ENTER]. The selected item can be identified by the asterisk (*) which will be placed atop the parameter. Move the highlight bar with the selection keys (▲▼), and once you have chosen all the parameters you want fixed, press the softkey “Accept”. “Data Display” screen is displayed again. To modify the fixed parameter list, choose “Select Items”, move the highlight bar to the parameter you want changed, and press the [ENTER] key. The parameter will be cleared. Choosing “Clear All” will clear all the fixed parameters.

If you select the softkey “DTC” while the “Data Display” function remains active, DTC will be displayed on the “Data Display” screen.
Snapshot can be used while the “Data Display” function remains active. For this, choose “Quick Snapshot.”
Choosing the softkey “More” allows to use additional functions.
For “Quick Snapshot,” refer to “Snapshot.”



Snapshot

1. Select “F2: Snapshot” on the “Engine” screen.



2. Choosing “F2: Snapshot”, the following menu is displayed.
   F0: Manual Trigger
   F1: Any Code
   F2: Single Code
   F4: Beginning
   F5: Center
   F6: End

Snapshot

Snapshot is intended to save information received by the machine controller during its execution. It provides an effective means to analyze data generated when the machine encounters a trouble. Use of this function enables the user to focus on the situation in which the trouble took place, without having to view all the data for suspected malfunctions. The Tech2 is capable of holding two different Snapshot data. This ability of storing two different Snapshot data allows to compare Good and Bad machine states with each other. Since these data are saved on a first-in, first-out basis, the first Snapshot data (of older date/time) stored on the PCMCIA card will be lost as it is overwritten when a third data comes in. Therefore, be sure to set the internal clock of the Tech2 precisely before starting the Tech2. If a given data must not be erased, highlight that data and choose the softkey “Write Protect”. This prevents the data from being overwritten. Pressing the softkey “Clear” cancels the protect.

Snapshot is available in the following 2 types:

- Snapshot: To be chosen in the Snapshot Menu.
- Quick Snapshot: To be chosen through the softkey on the “Data Display” screen.

The Snapshot Data will not be lost even when the Tech2 is switched off, because the data is saved on the PCMCIA card.

About trigger type:

Choosing the Trigger Type Menu allows to check the cause that triggered [Snapshot]. [Snapshot] is executed when there is one of the three causes of occurrence.

F0: Manual Trigger:
Pressing the softkey “Trigger” saves data.

F1: Any Code:
Data is saved in case any trouble code is issued.

F2: Single Code:
Data is saved in case the specified trouble code is issued.

About trigger point:

Trigger Point corresponds to the point in time where triggering is originated by a code issued or by Manual Trigger activated. This information is useful to know the time point of Snap Point and to investigate changes in the data parameter. Trigger Point can be set up at “Beginning”, “Center”, or “End.”

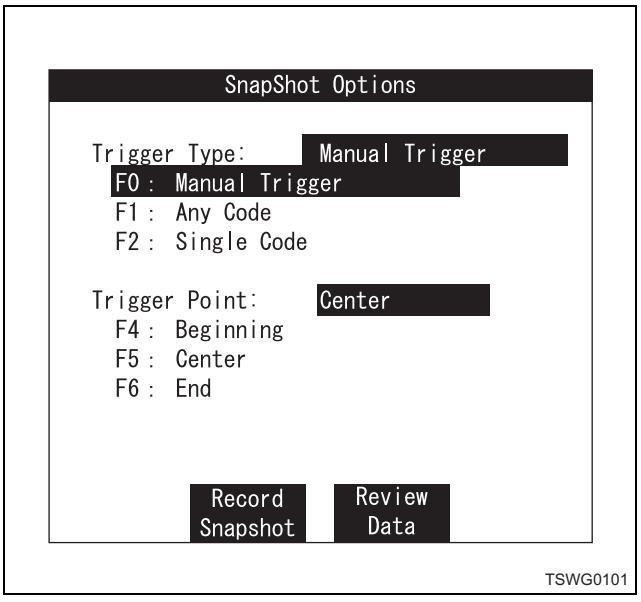
F4: Beginning
Starts saving data from Trigger Point, and keeps on saving it, until the Snapshot recording area is filled up. This selection is effective when the trouble that constitutes the cause is foreseeable.

F5: Center
This function is commonly utilized, since it saves not only the data after Trigger Point, but also those prior to that. This selection allows to compare data that existed before the occurrence of a trouble, those present at the time of occurrence of the trouble, and those after the trouble, among themselves.

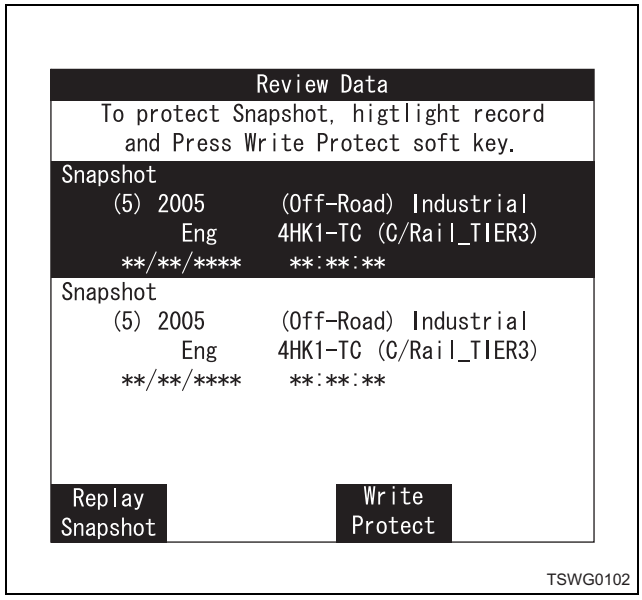
F6: End
Saves only the data prior to Trigger Point. This selection is useful when it is desired to terminate Snapshot after the occurrence of a trouble.

Snapshot data replay

1. Press the softkey “Review Data” on the “Snapshot Options” screen.



2. Move the highlight bar to the data you want replayed, and press the [ENTER] key. The data will be replayed.



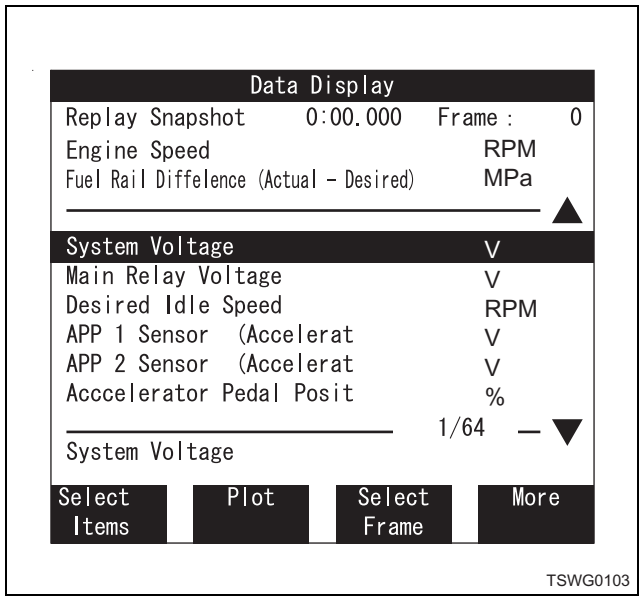
Note:
Flashing “Trigger” means that data is being recorded. Pressing the [EXIT] key in this condition will abort the recording. The recording will also be cancelled when the memory capacity is filled up. In either case, the data is saved in memory.

Plot

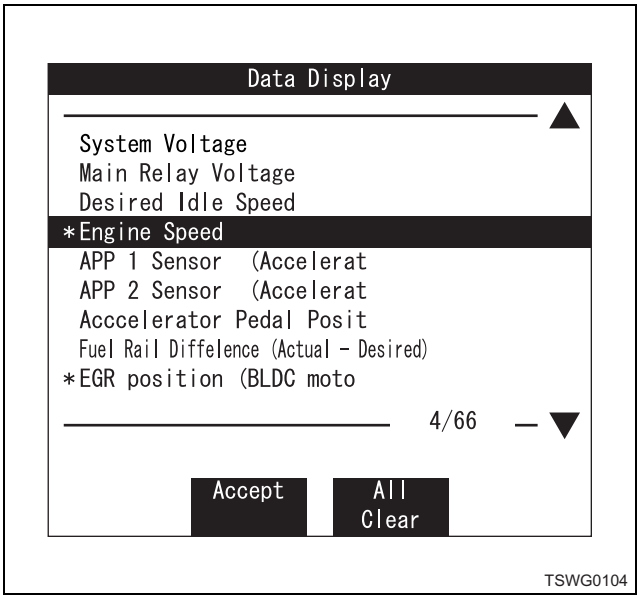
Snapshot can also be replayed in “View Captured Data.”

Plot setup procedure

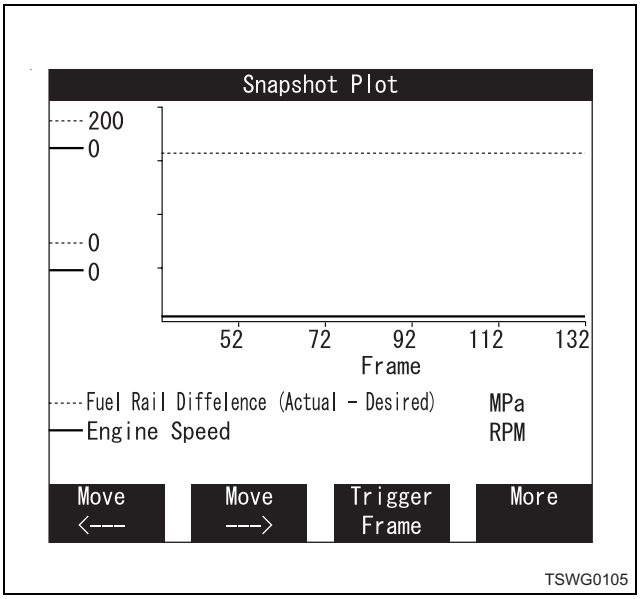
1. Pressing the softkey “Plot” switches the “Data Display” screen.



2. Bring the highlight bar to the parameter you want plotted in a graph, as with “Select Items”, and press the [ENTER] key.
3. The selected parameter can be identified by the asterisk that appears at its top. No more than 3 parameters can be displayed.



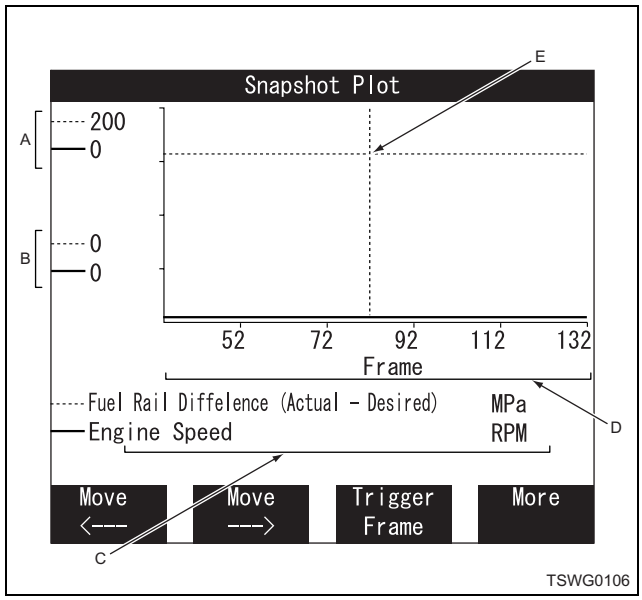
4. Choosing the softkey “Accept” changes the display screen and shows a graph after a while.



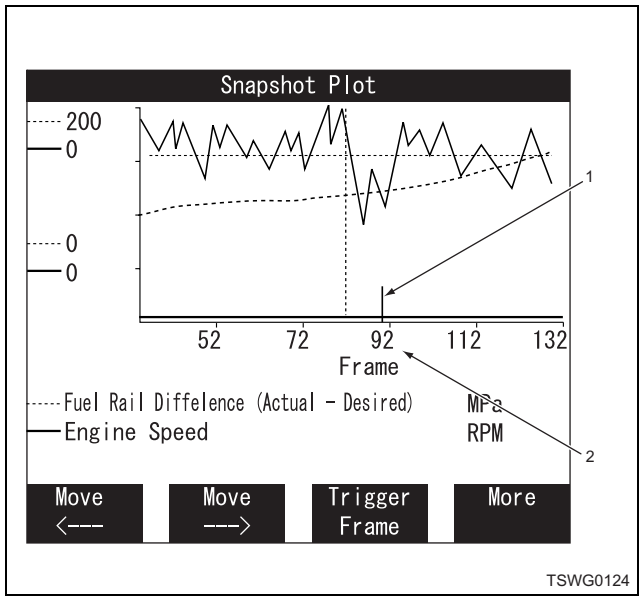
Plot cancel

To close the graph display screen, press the [ENTER] key and you will be returned to the “Data Display” screen.

Explanation of Plot data displayed



A: Maximum values of selected parameters
B: Minimum values of selected parameters
C: Values of selected parameters and Center Point (E) in frame
D: Number of frames/time
E: Center point of graph indication



1. Denotes recognition of DTC.
   A vertical line appears in abscissa, if there is a Trouble Code issued in the Snapshot Data loaded. When plotting a graph, it is advisable to check for DTC through “Over View”.
2. DTC-recognized frame 236 (Actually issued in Frame 235.)

Softkey functions

Choose the “More” on the snapshot graph display screen.

- Move ← : Allows to view changes of data preceding the display screen.

- Move → : Allows to view changes of data following the display screen.
- Trigger Frame: Displays a trigger point.
- More: Switches the displayed softkeys.

Choose the “More” on the plot display screen.

- Zoom In: Shows the abscissa by enlarging it (each press doubles the display).
- Zoom Out: Shows the abscissa by reducing it (each press halves the display).
- Over View: Shows the entire frame.
- More: Switches the displayed softkeys.

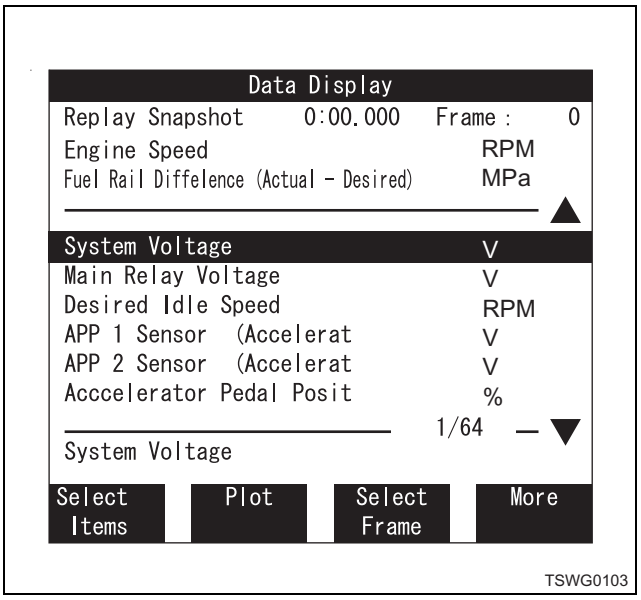
Choose the “More” on the plot display screen.

- Time / Frame conversion: Switches the value in abscissa.
- More: Switches the displayed softkeys.

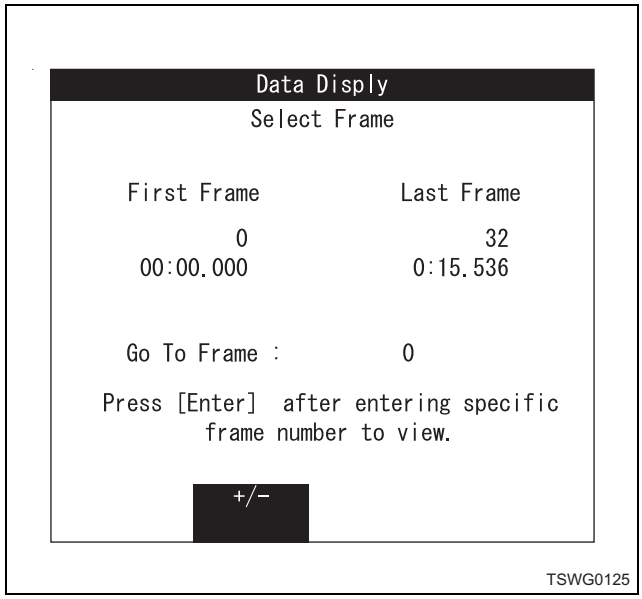
Select frame

Select frame setup procedure

1. Press softkey “Select Frame.”

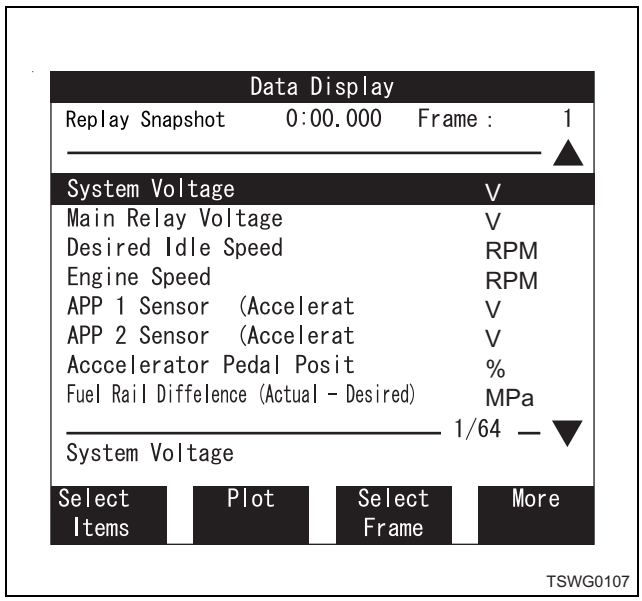


2. Pressing the softkey “Select Frame” causes the following screen.



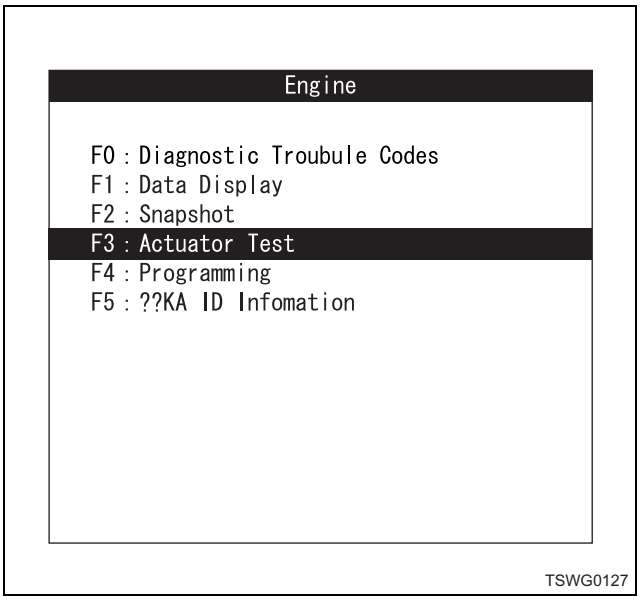
- First Frame: First frame No. and data acquisition time from Trigger Point (calculated backward).
- Last Frame: Last frame No. and data acquisition time from Trigger Point (integrated).
- Go To Frame: Entering a frame No. allows to view its data.
- +/-: Only the “-” sign is displayed.

3. “1” entered via keys in the “Go To Frame” area.



Frame No. 1 and recording time displayed, and data values in Display Area represent those of Frame 1.

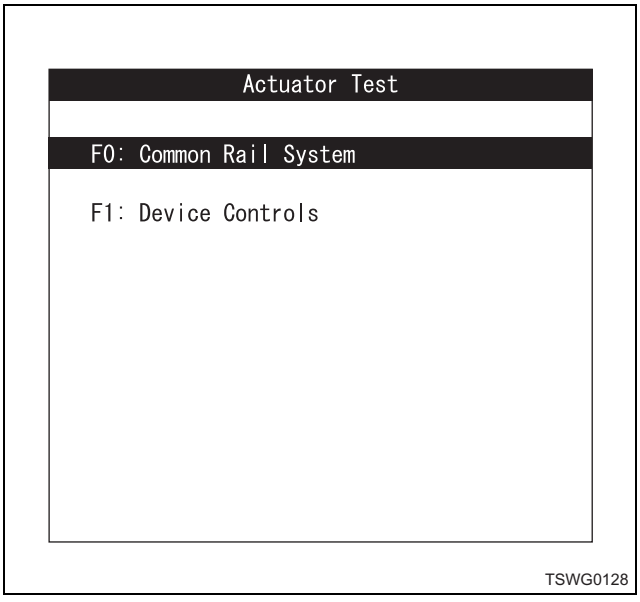
Actuator test



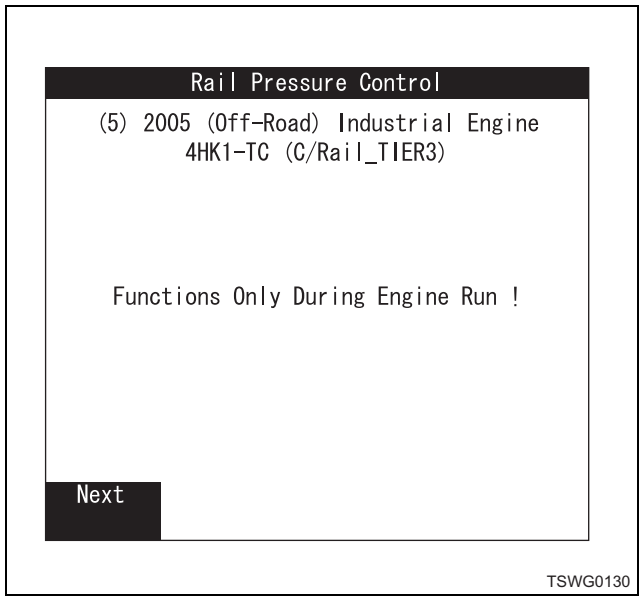
Common rail pressure control test

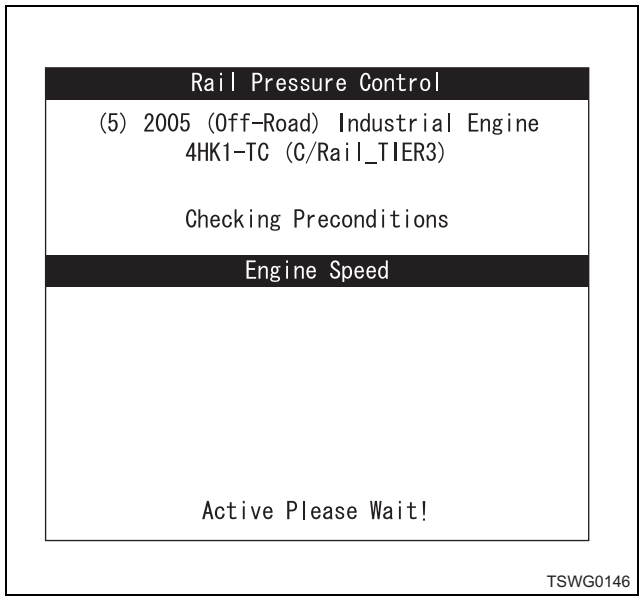
This test is performed to check the operation of RPCV.
The Tech2 must be used in this test.
Test procedure

1. Connect the Tech2 to the machine DLC.
2. Start the engine and run it at idle.
3. Select the Common Rail System.

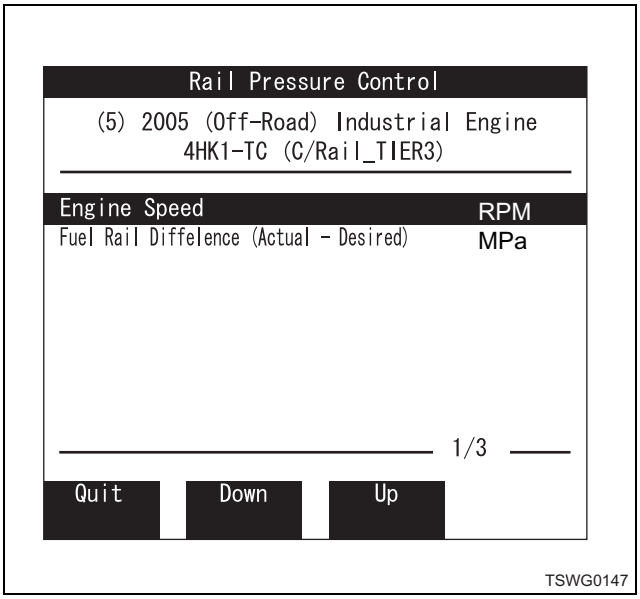


4. Select the Rail Pressure Test.





5. Send the instruction to RPCV and check the data list.



6. If variation of data list is proper value, RPCV is judged as normal.

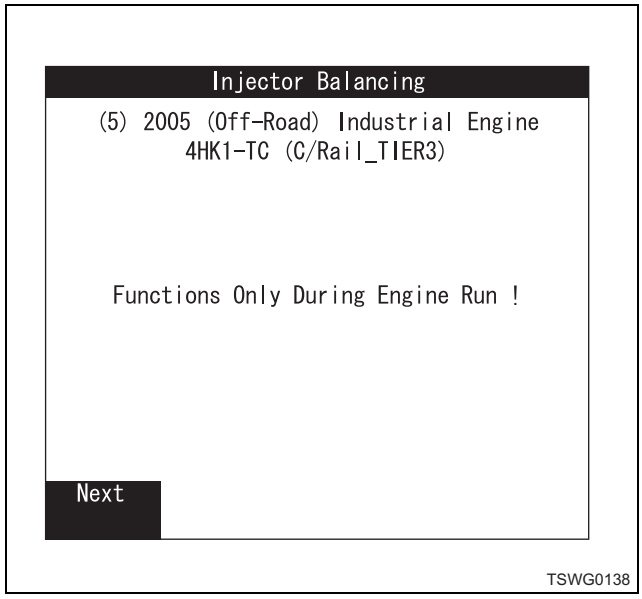
Injector balance test

This test is performed to confirm that proper electric signal is sent to injector while the engine is running.

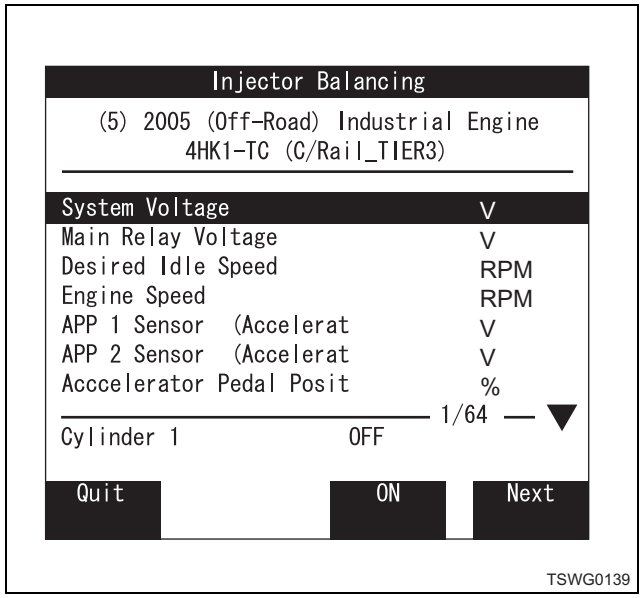
Note:
At test, the engine is controlled to low idle speed, in order to clarify the variation of engine speed.

Test procedure

1. Connect the Tech2 to the machine DLC.
2. Start the engine and run it at idle.
3. Select the Common Rail System.
4. Select Injection Stop for Each Injector.



5. Send instruction to each injector (set to OFF by softkey on Tech2 screen) to stop the injector, and check the variation of engine speed.

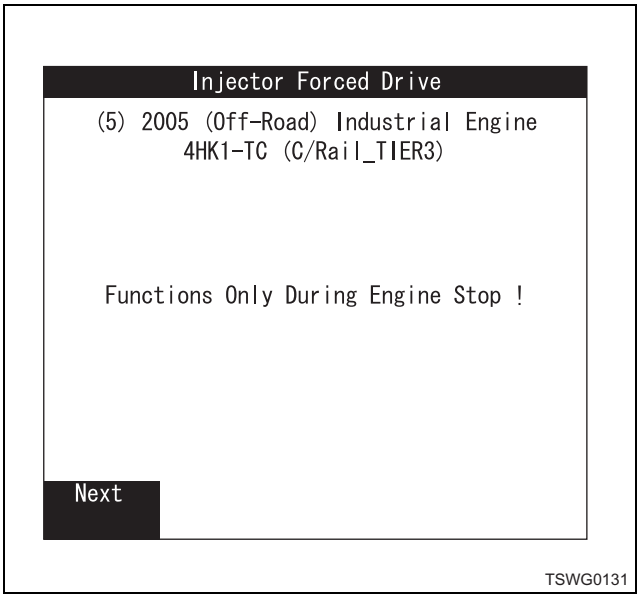


6. If the engine speed varies when the injector stops, electrical circuit of that injector is judged as normal.
   If the engine speed does not vary when the injector stops, electrical circuit of that injector or injector body is judged as faulty.

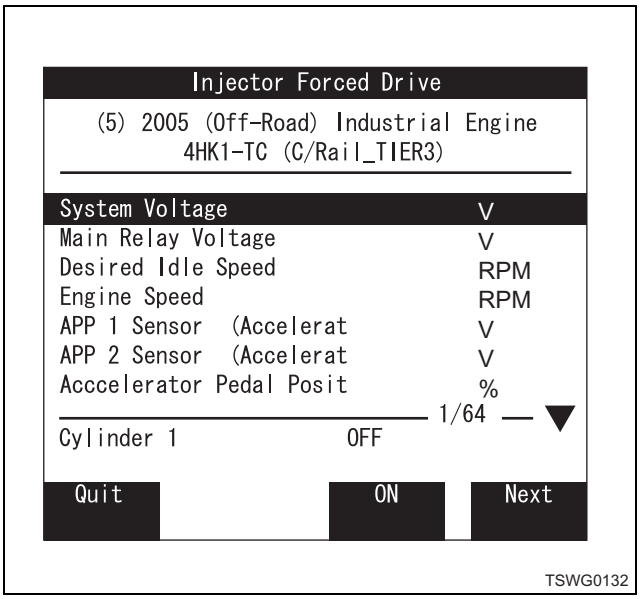
Injector control test

This test is performed to confirm that proper electric signal is sent to each injector. The Tech2 must be used in this test.
Test procedure

1. Connect the Tech2 to the machine DLC.
2. Turn the key switch to ON (engine is standstill).
3. Select the Common Rail System.
4. Select Compulsory Drive of Injector.



5. Send instruction to each injector (set to ON by softkey on Tech2 screen), and check the operation sound of injector.



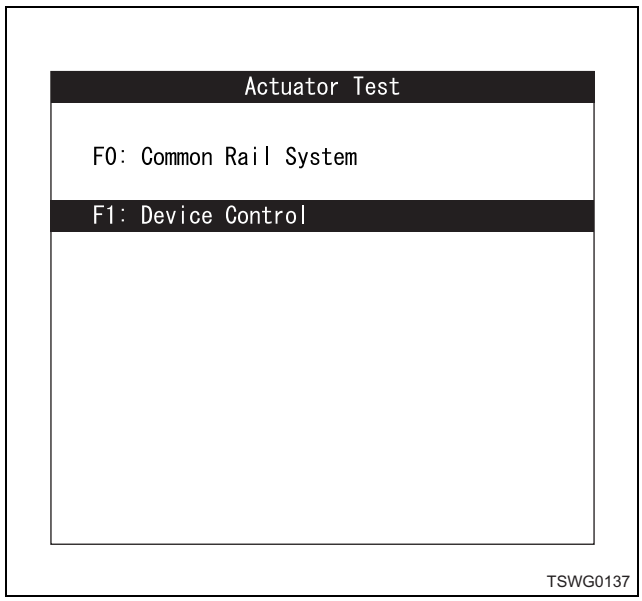
6. If the operation sound is heard, electrical circuit of that injector is judged as normal.
   If the operation sound is not heard, electrical circuit of that injector or injector body is judged as faulty.

Note:
After injector control test, the key switch must be turned to OFF once to restart.

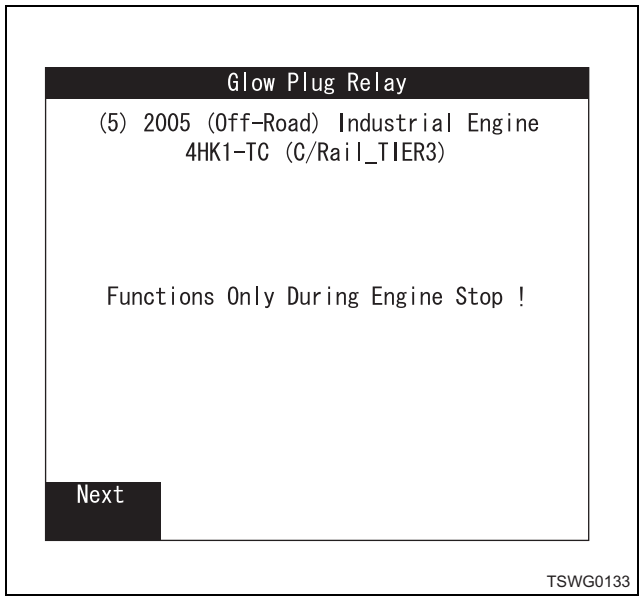
Glow time relay test

This test is performed to check the operation of QOS lamp.
The Tech2 must be used in this test.
Test procedure

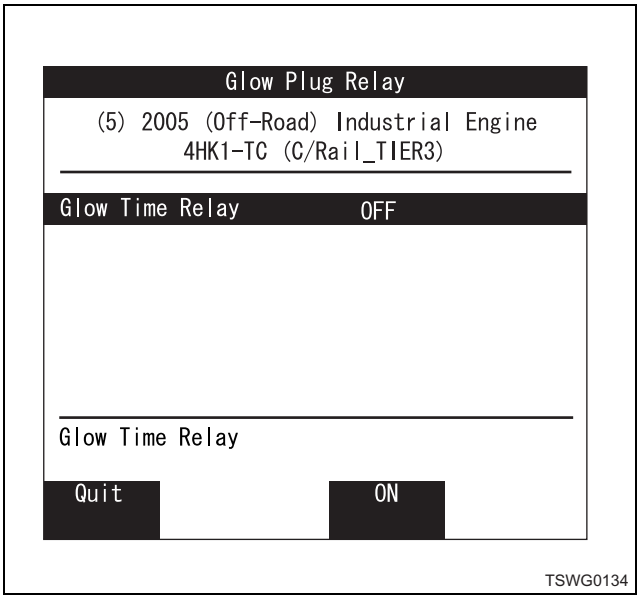
1. Connect the Tech2 to the machine DLC.
2. Turn the key switch to ON.
3. Select the Device Control.



4. Select the Glow Plug Relay.



5. Send the instruction to glow plug relay and check whether the lamp on the machine operates.

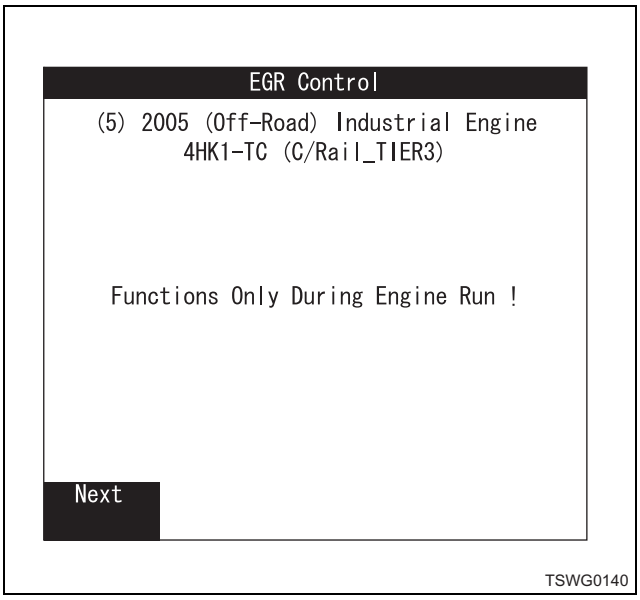


6. If the lamp operates properly, it is judged as normal.

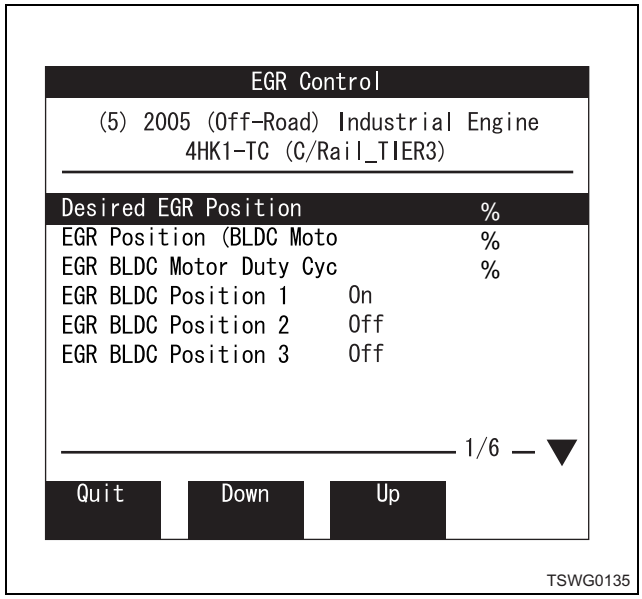
EGR regulating valve test

This test is performed to check the operation of EGR valve.
The Tech2 must be used in this test.
Test procedure

1. Connect the Tech2 to the machine DLC.
2. Start the engine and run it at idle.
3. Select the Device Control.
4. Select the EGR Control.



5. Send the instruction to EGR valve and check the data list.



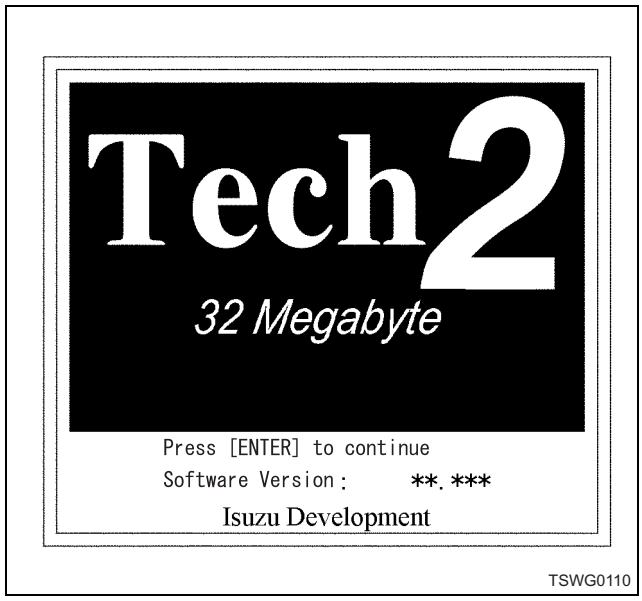
6. If variation of data list is proper value, EGR valve is judged as normal.

View captured data.

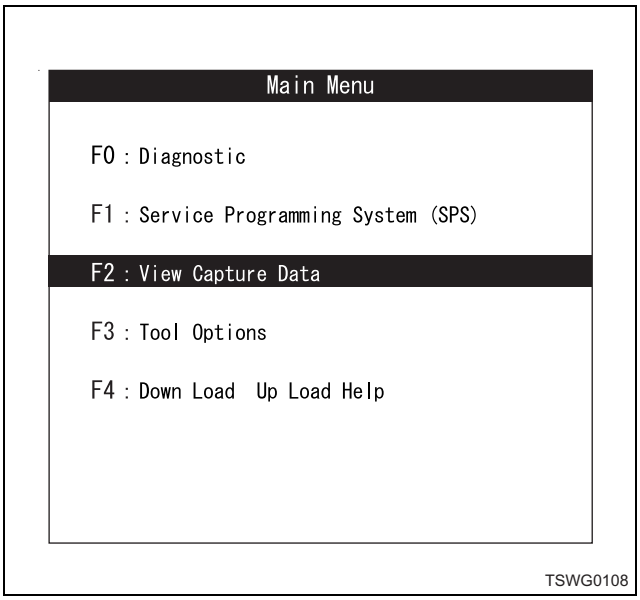
The Snapshot data acquired through the application menu “F2: Snapshot” under the “Main Menu, F0: Diagnostics” can be replayed.
Since the data is saved on the PCMCIA card, it can be viewed after disconnecting the Tech2 (DLC) from the machine. Two data items can be saved there. The internal clock of the Tech2 needs to be set precisely, since the data are identified with dates and times.

Sample use of snapshot data replay

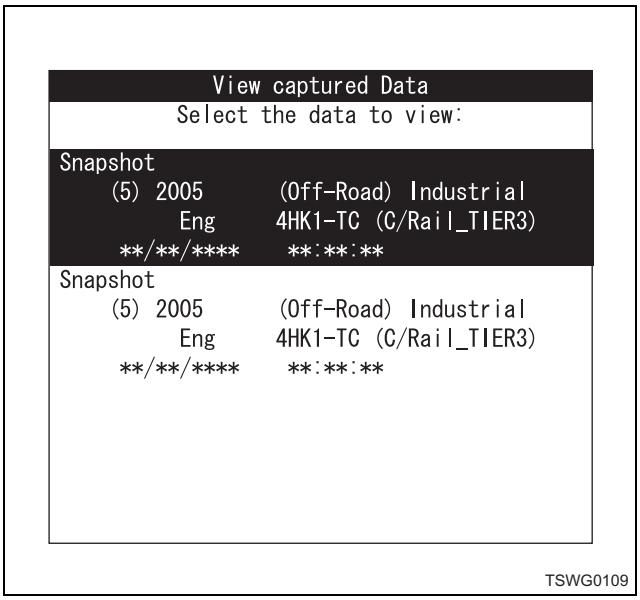
1. Turn on the power.



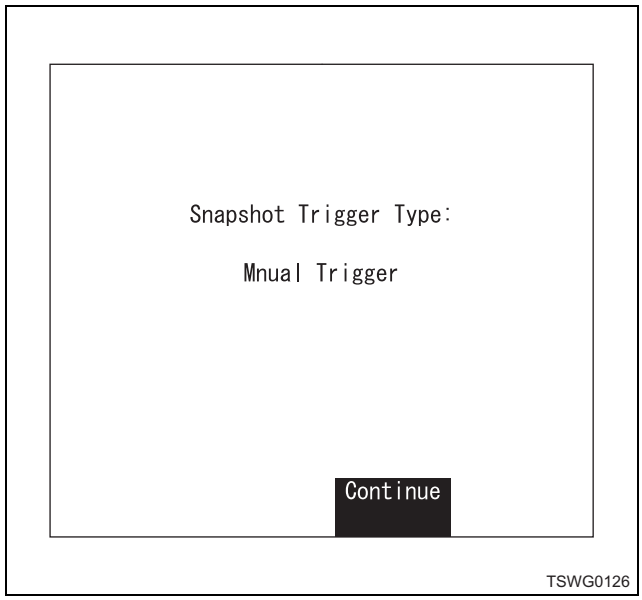
2. Press [ENTER].



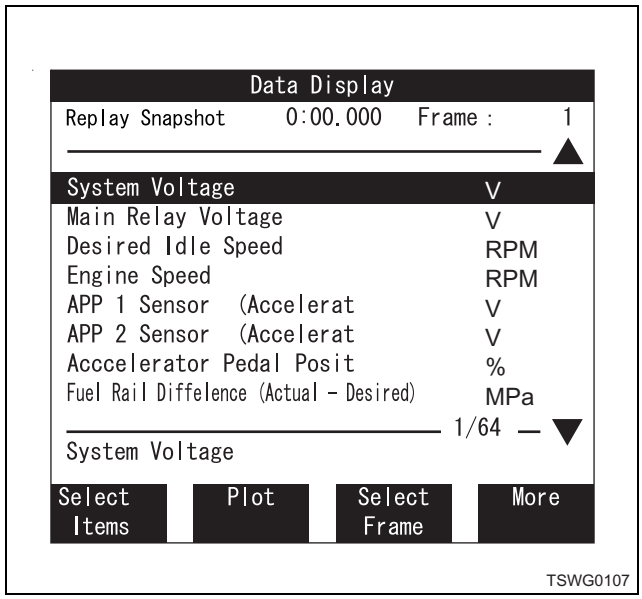
3. Choose “F2: View Capture Data” and press the [ENTER] key. “View Captured Data” appears.
4. Choose “Snapshot Data” with selection keys (▲▼) and press the [ENTER] key.



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.

3. Choose “More” out of the 4 softkeys on the display screen.
   - First Frame: Allows to view the top data frame.
   - Trigger Frame: Allows to view a triggered frame.
   - Last Frame: Allows to view the last data frame.
   - More: Switches the displayed softkeys.
4. Choose “More” out of the 4 softkeys on the display screen.
   - Units: Changes the unit (speed/temperature).
   - Previous Frame: Allows to view changes of data by reversing it, frame No. by frame No.
   - Next Frame: Allows to view changes of data by feeding it forward, frame No. by frame No.
   - More: Switches the displayed softkeys.
5. Choose “More” out of the 4 softkeys on the display screen.
   - DTC: Shows the frames in which a Trouble Code was issued, in the range from the top frame to the displayed frame.
   - Previous DTC-Chg: Shows the frames in which a Trouble Code was issued, in the range before the displayed frame.
   - Next DTC-Chg: Shows the frames in which a Trouble Code was issued, in the range after the displayed frame.
   - More: Switches the displayed softkeys.
6. Choose “More” out of the 4 softkeys on the display screen.
   The Snapshot Replay screen is restored.

Difference in operation of Snapshot Data Replay:

The operations of Snapshot Data Replay under “F2: View Captured Data” are somewhat different from those of Replay (softkey function “Review Data”) under “F2: Snapshot”. Be careful not to confuse them.

Tool options

Tool Options is the function to conduct a detailed test, in case communication cannot be established with the machine at the time of setup of the Tech2 or at the time of Power On Self Test (POST).

Tool option menu

F0: Tech2 Self Test
Allows to conduct a test that assists with the diagnostics of the Tech2 itself. Normally the Self Test function need not be executed, since the Tech2 conducts the Power On Self Test (POST) every time it is switched on. If the POST demonstrates any trouble, the results of the POST can be checked choosing the Self Test menu.

F1: Set Clock
Resets the date and time of the Tech2. Before exiting this menu, press the softkey “Set Clock” to save the settings.

F2: Set Unit
Switches the unit between the English and the Metric system.

F3: Set Contrast
Changes the screen contrast (lighter or darker). The change will be saved even after the Tech2 is switched off.

Tech2 self test menu

F0: Automated Main PCB and VCI
Automatically executes function tests on the Main PCB and VCI modules.

F1: Automated Main PCB
Automatically executes function tests on the Main PCB module.

F2: Automated VCI
Automatically executes function tests on the VCI module.

F3: Selectable Main PCB
Allows to check detailed information on the PCB module test items.

F4: Selectable VCI
Allows to check detailed information on the VCI module test items.

F5: Power On Self Test Results
Displays POST test results again.

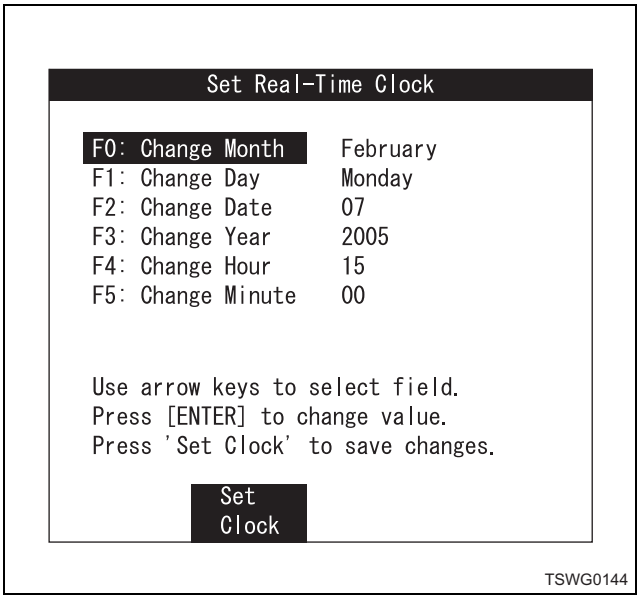
Set clock

Operation procedure:

1. Choose the “F2: Tool Options” and press [ENTER].
2. Choose the “F1: Set Clock” and press [ENTER].
3. Display the “Set Real-Time Clock” screen. Move the cursor to the item you want changed by operating the selection keys (▲▼), and press the [ENTER] key.

Note:
Each press on the [ENTER] key will increment the numeric value one by one, but it will not exceed the preset maximum value.

4. After all the values have been entered, press the softkey “Set Clock” and the changes will be saved.

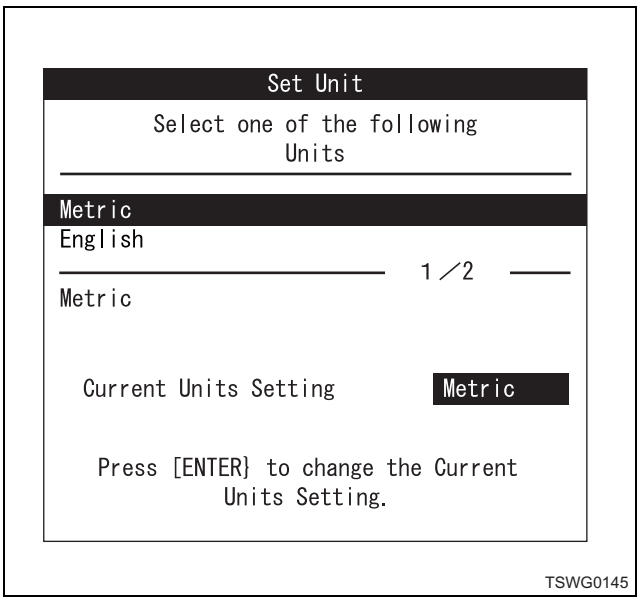


Set units

Operation procedure:

1. Choose the “F2: Tool Options” and press [ENTER].
2. Choose the “F2: Set Unit” and press [ENTER].
3. Display the “Set Unit” screen. Then move the cursor to the item you want changed by operating the selection keys (▲▼), and press [ENTER] key.
4. When the setup is complete, press the [EXIT] key to save the current setting.

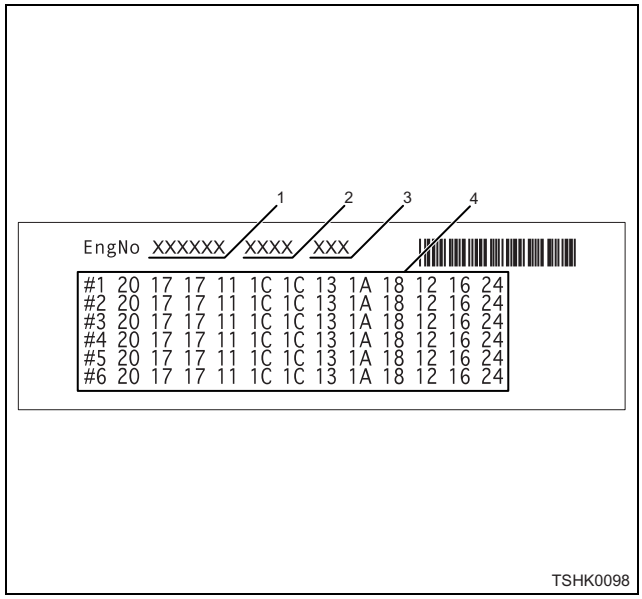
Note:
It will take effect next time the Tech2 is switched on.



* Metric
Temperature: °C Speed: km/h
* English
Temperature: °F Speed: MPH

Rewrite setting of Q adjust correction data by Tech2

“Q adjust, Injector code label” is attached to the cylinder head cover. It is used for rewriting and registering the ID.



Name

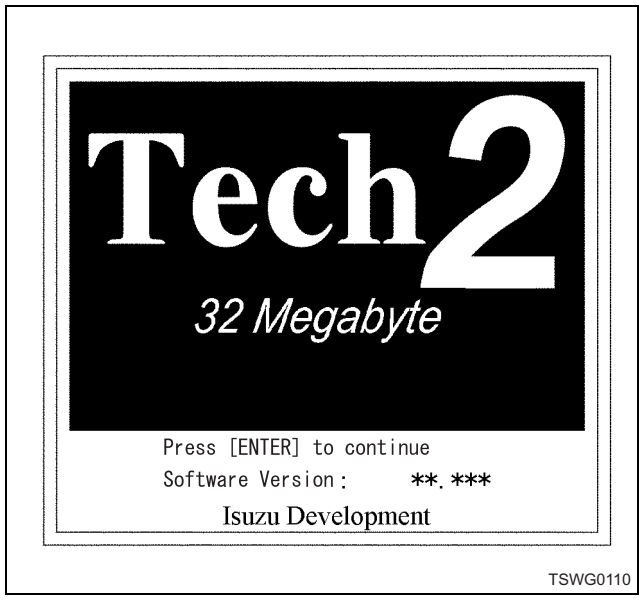
1. Engine number
2. Typical engine model
3. Q adjust information
4. Injector information

There is the injector code on the top of injector as well. When replacing the injector, register its code.

1. Refer to the following instruction for how to setup the Q adjust data.

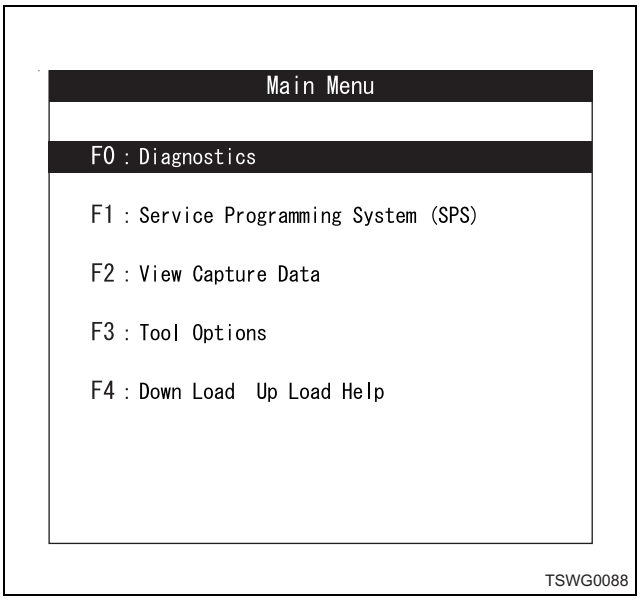
Step 1

- Press [ENTER].



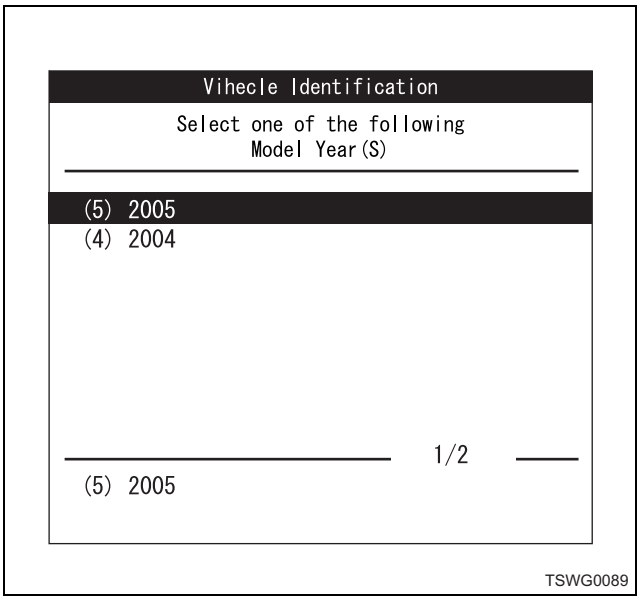
Step 2

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



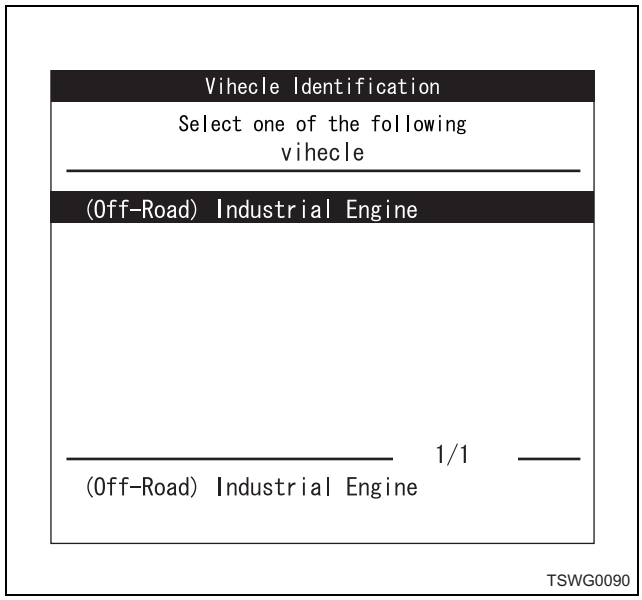
Step 3

- Choose the menu (5) 2005 with ▲, ▼ (up/down) keys, and press the [ENTER] key.
  * Applicable for 2000MY or later.



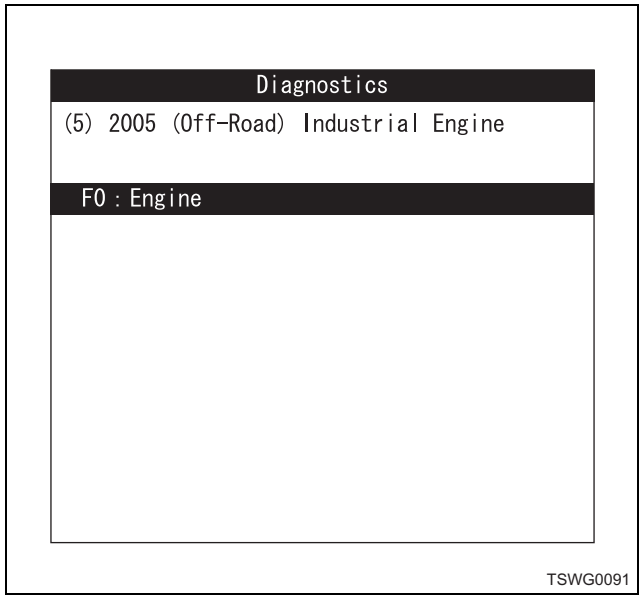
Step 4

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



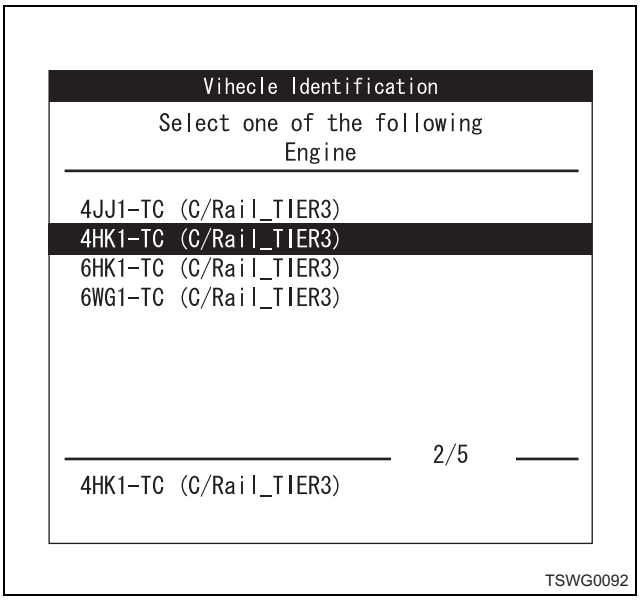
Step 5

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



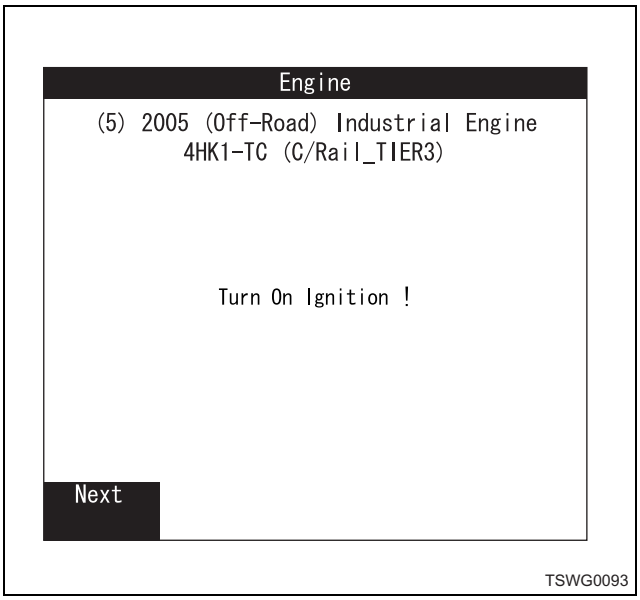
Step 6

- Choose “6HK1-TC (C/Rail_TIER3)” with ▲, ▼ (up/down) keys, and press [ENTER].

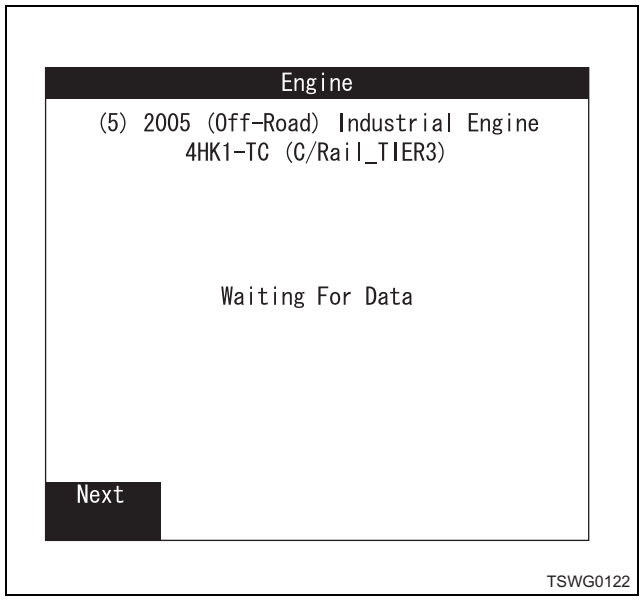


Step 7

- Press the softkey “Confirm”.
- The ignition is ON at this time.

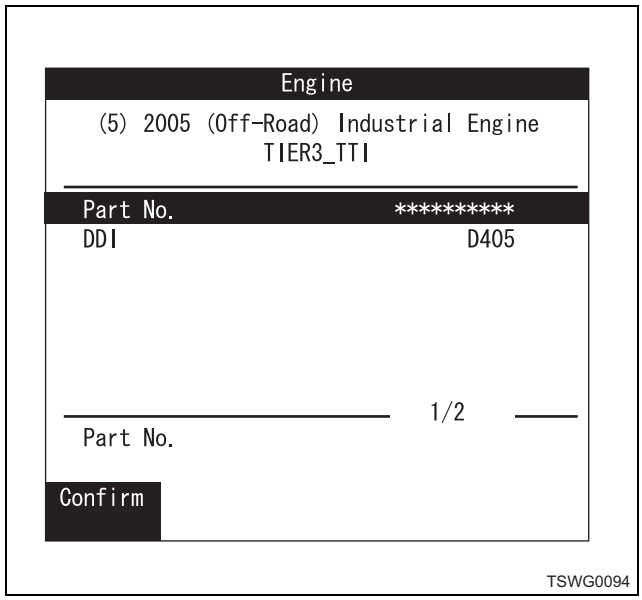


Step 7-1



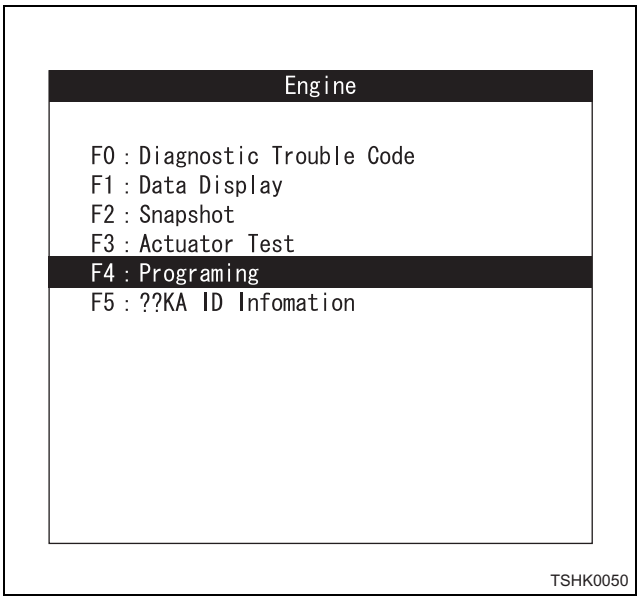
Step 8

- Press the softkey “Confirm”.
- This displays the ECU ID information.



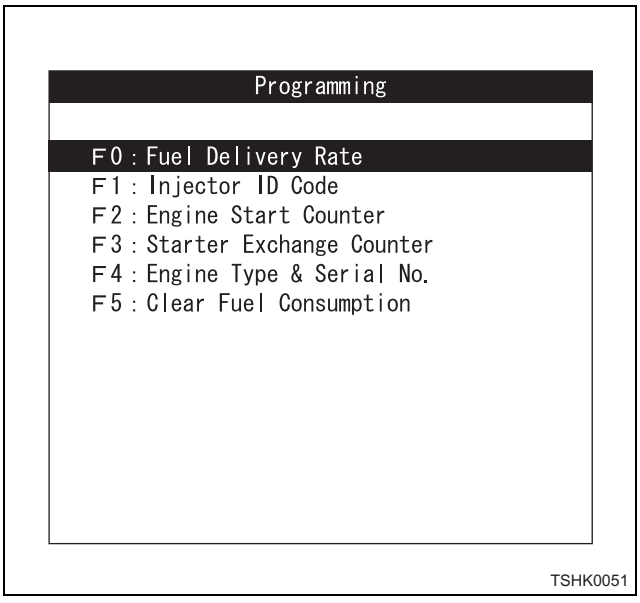
Step 9

- Choose the menu F4: Programming with ▲, ▼ (up/down) keys or F4 (function) key, and press [ENTER].



Step 10

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



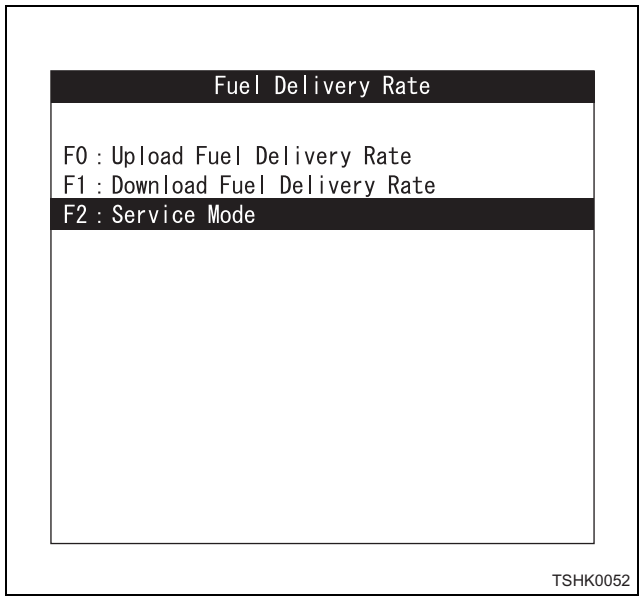
Step 11

- Choose the menu F2: Service mode with ▲, ▼ (up/down) keys or F2 (function) key, and press [ENTER].

F0: Uploads the three-point Q adjust data stored in the ECM to the Tech2.
* Registers the data when replacing ECM.

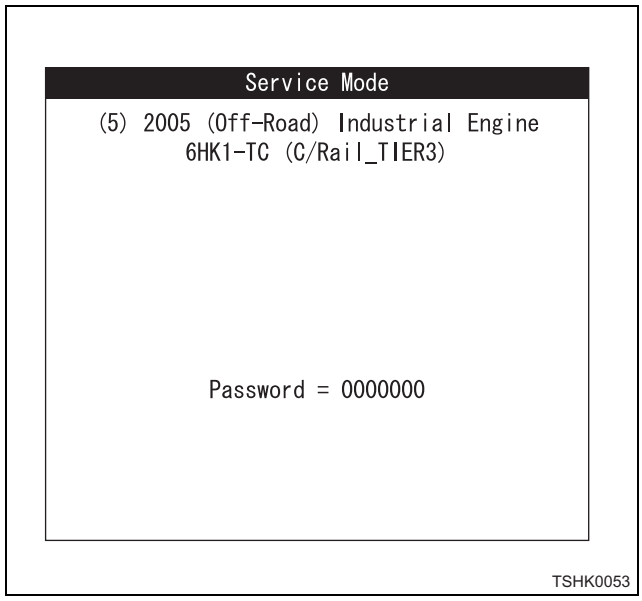
F1: Writes the three-point Q adjust data temporarily stored in the Tech2 to the ECM.
* Registers to the ECM after replacing ECM.

F2: Any data can be written. However, password and ID are required.



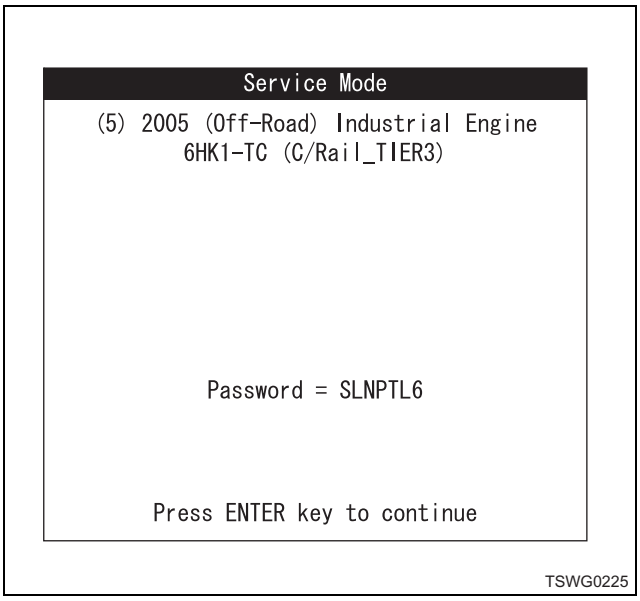
Step 12

- Password input screen
- This procedure will end automatically if the registration is not completed within 120 seconds. The message “Time Over” appears.



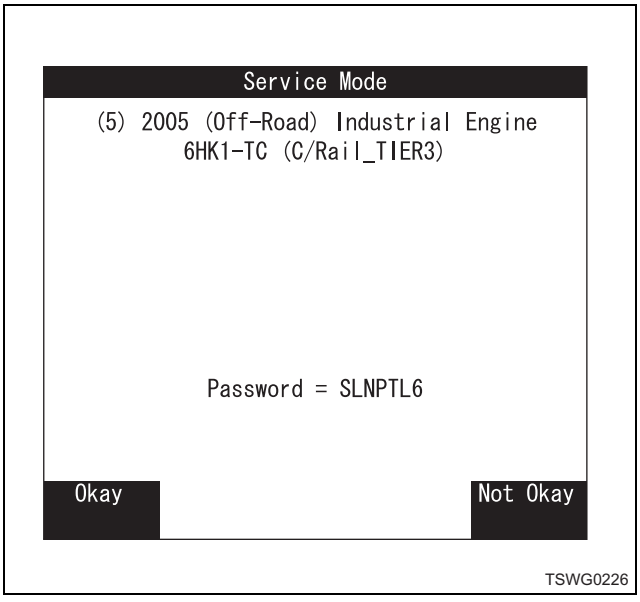
Step 12-1

- After entering the password, press [ENTER] key.
- The password for 6WG1 is “SLNPTL6”.
- The password for 4/6HK1 is “SLNPTL4”.
- Entering wrong password will return to the previous menu.



Step 12-2

- If the password you have entered is correct, press the softkey [Okay].
- Enter the password within 120 seconds. Failure to enter the password within 120 seconds will return to Step 11.



Step 13

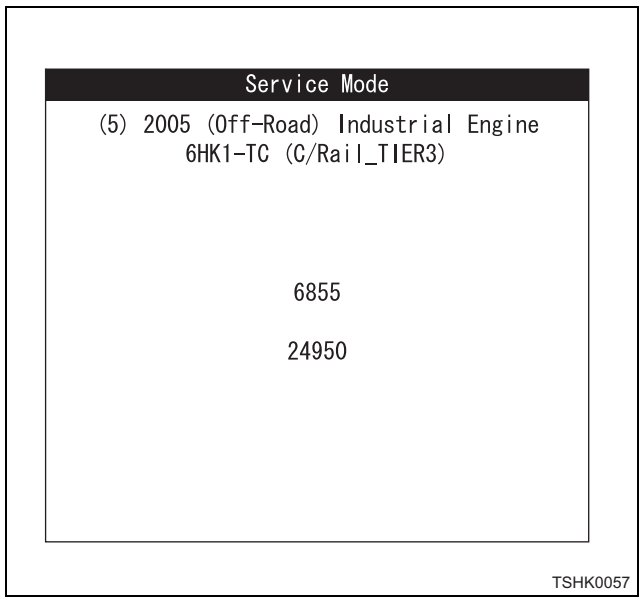
- After completing the password registration, proceed to ID registration.

Step 13-1

The numbers will appear on the screen. Obtain the ID code from Hitachi Construction Machinery service center by using this number (6855 in this case). Enter the obtained ID code (2495 in this case).

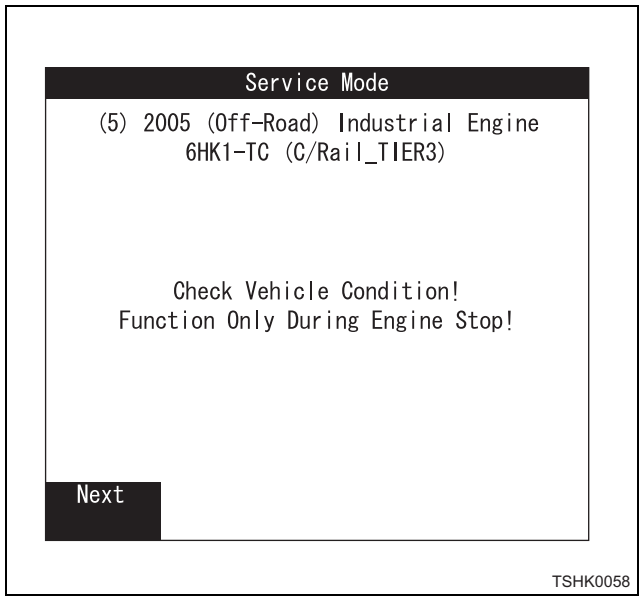
Note:
The ID code you have entered will appear on the screen, suffixed with “0”.
The clock of Tech2 must be correctly set.

- After entering, press [ENTER] key.



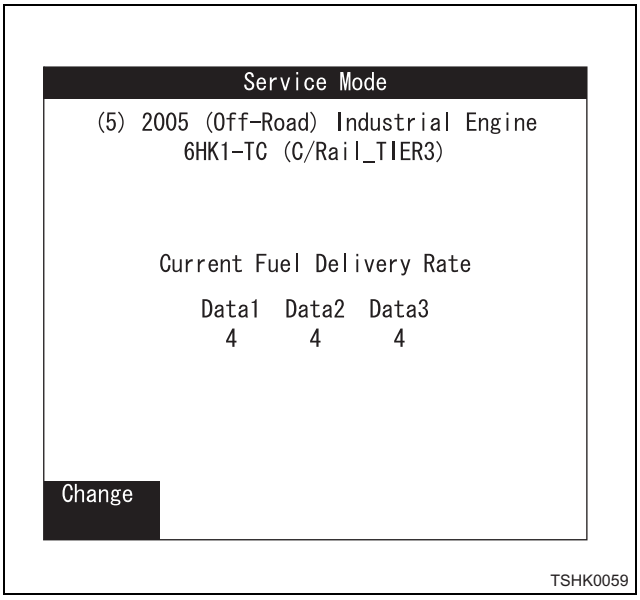
Step 14

- When the ID code matches, the following screen will appear.
  Press the softkey “Next”.
- This step can be performed only when the engine speed is 0 rpm.



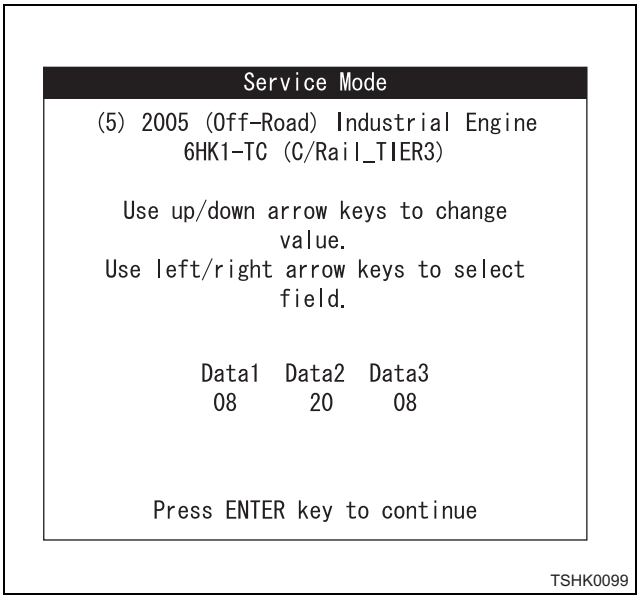
Step 15

- Displays the three-point Q adjust data in the ECM.
  1. To modify the Q adjust data, press the softkey “Change”.



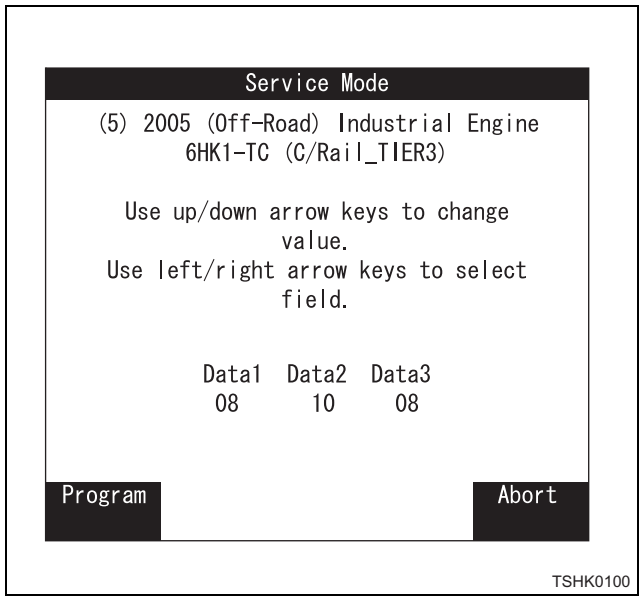
Step 15-1

- If the Q adjust data you have entered is correct, press [ENTER] key.
  1. The entry conditions are as follows.
     Conditions:
     C/Rail system entry setting is “1 – 15”.
     TIS system entry setting is “1 – 8”.



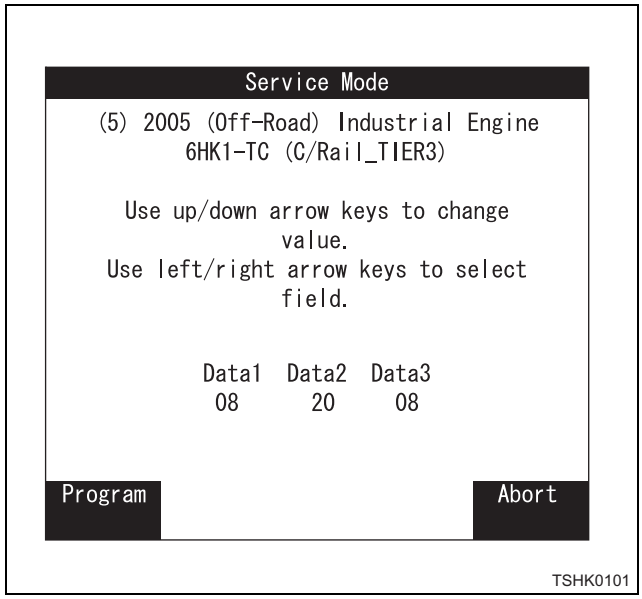
Step 15-2

- If the Q adjust data you have entered is correct, press the softkey “Program”.



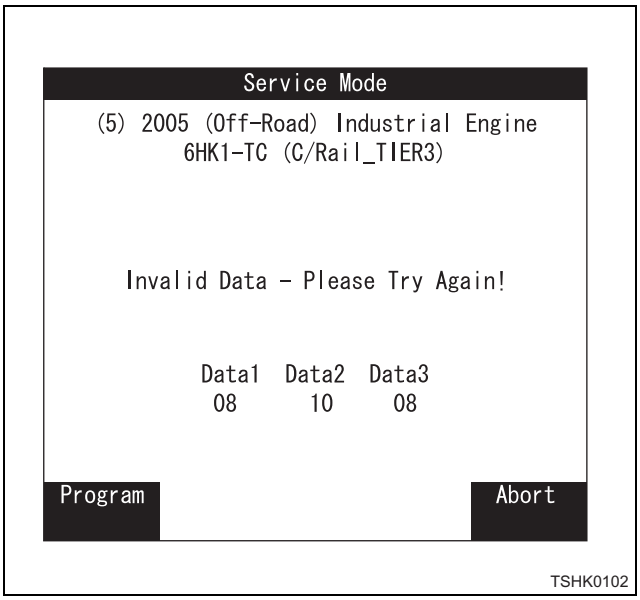
Step 15-3

- If the Q adjust data you have entered is off the set value, the message shown as Step 15-4 appears.



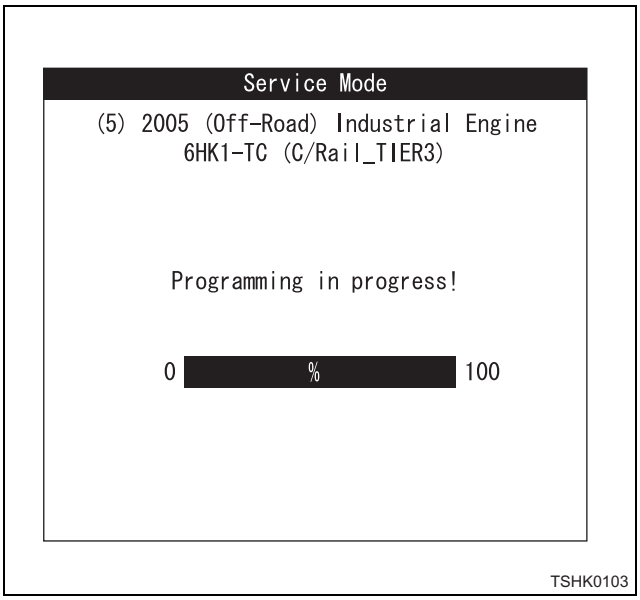
Step 15-4

- To go to Step15-5, modify the Q adjust data within the set value and press the softkey “Program”.



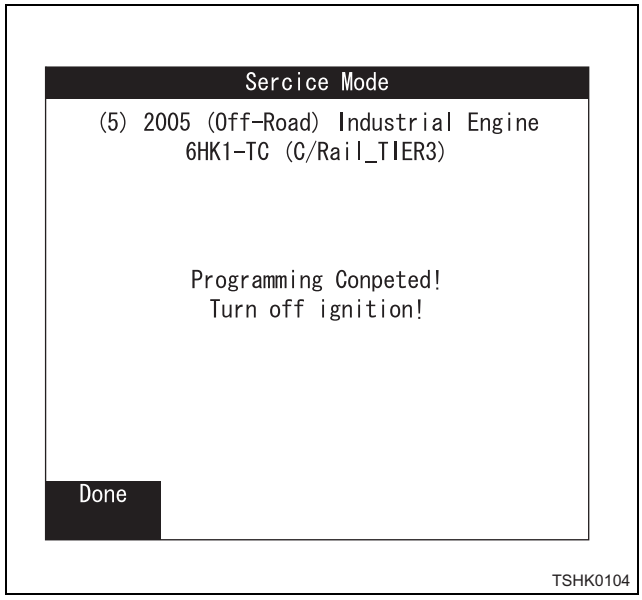
Step 15-5

- If the entered values meet the conditions in Step 15-1 and 15-3, the status display of data registration (writing) from the Tech2 to ECM as shown below will appear.



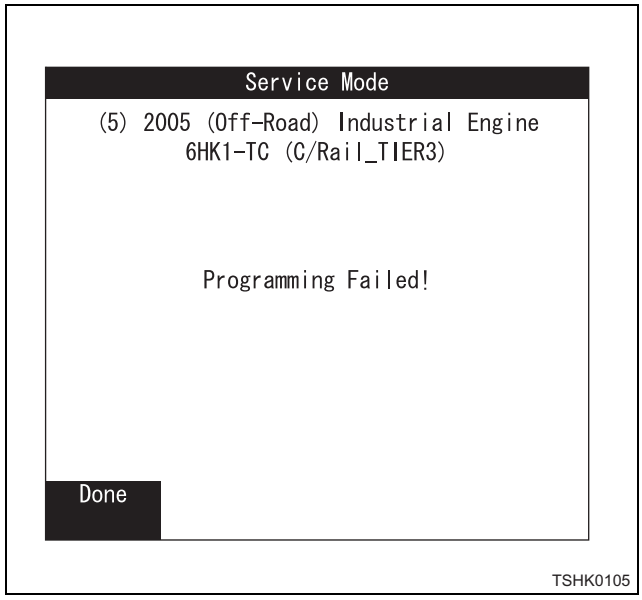
Step 16

- When the writing of data completes, the following screen will appear.
  This indicates that the result of comparison of entered data with that written in the EEPROM of the ECM is in good condition.



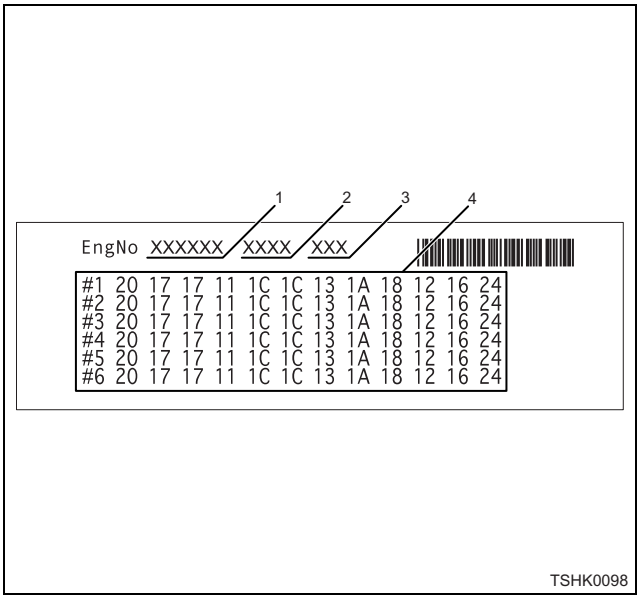
Step 16-1

- If the entered Q adjust data in Step 15-1 does not correspond to that written in the EEPROM of the ECM, the following message will appear.
  Pressing the softkey [End] returns you to Step 11.



Injector ID code (No. 1 cylinder – No. 6 cylinder) registration setting using Tech2

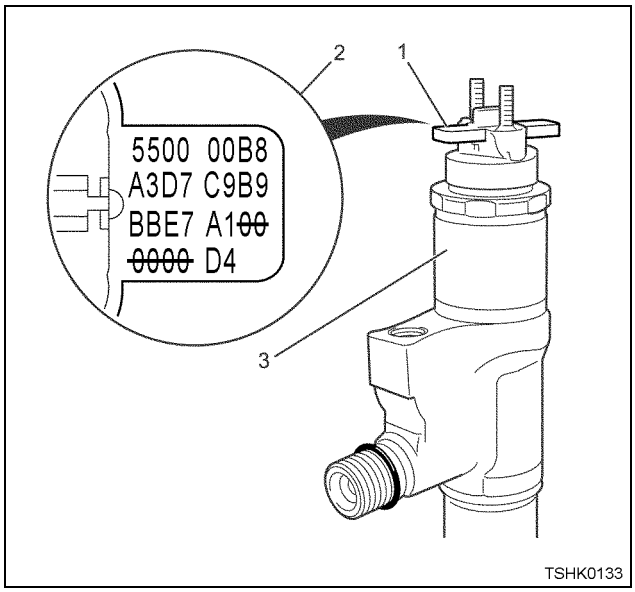
"Q adjust, Injector code label" is attached to the cylinder head cover. It is used for rewriting and registering the ID.



Name
1. Engine number
2. Typical engine model
3. Q adjust information
4. Injector information

There is the injector code on the top of injector as well. When replacing the injector, register its code.

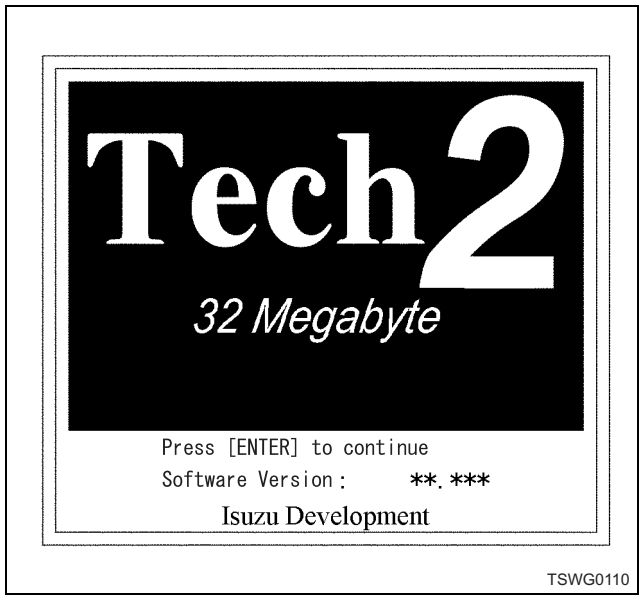
Note:
Do not enter the six figures "0", indicated with strikethrough in the illustration, of ID code on the injector ID plate.



Name
1. Injector ID plate
2. Injector ID code
3. Injector

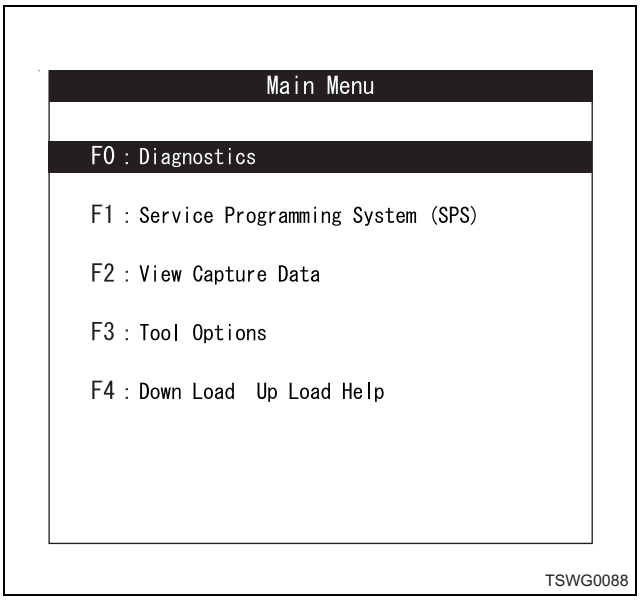
1. Refer to the following instruction for how to register Injector ID code.

Step 1
- Press [ENTER].



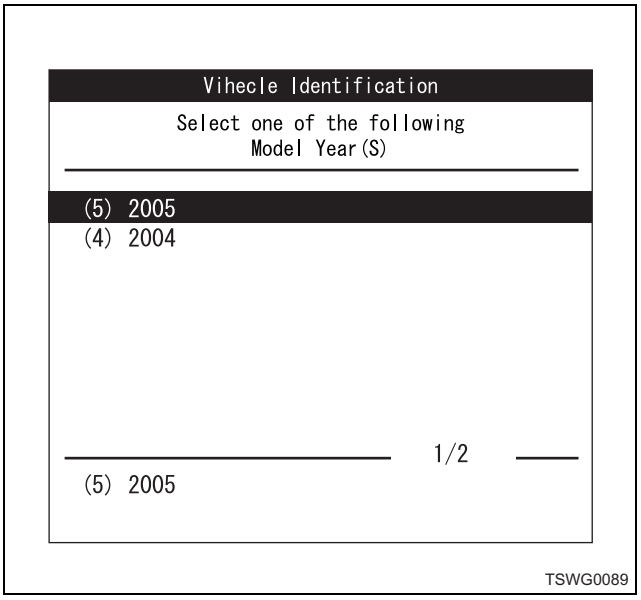
Step 2

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



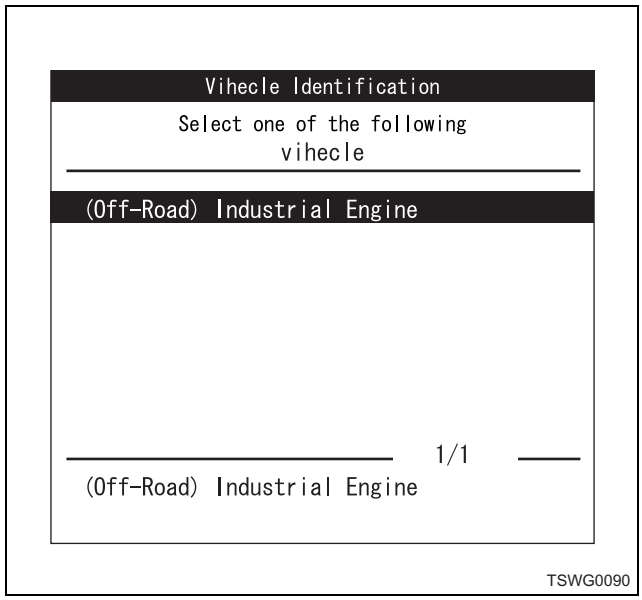
Step 3

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



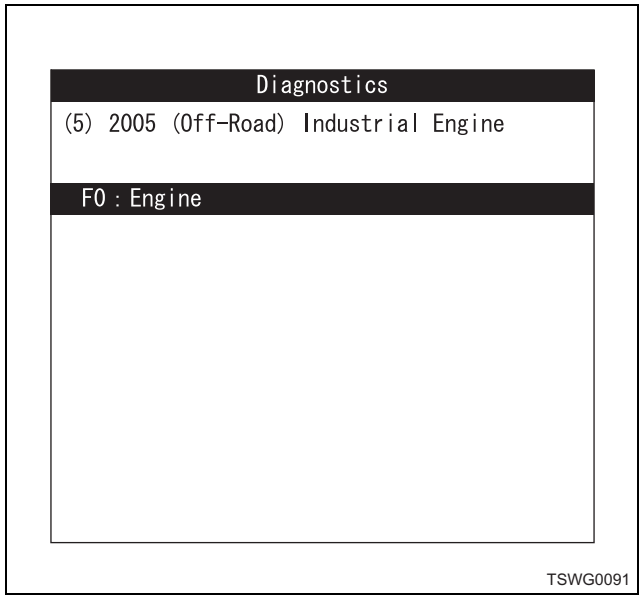
Step 4

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



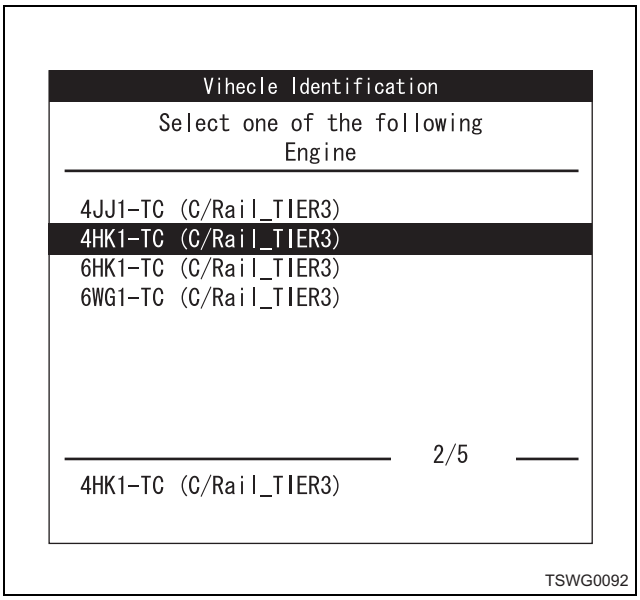
Step 5

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



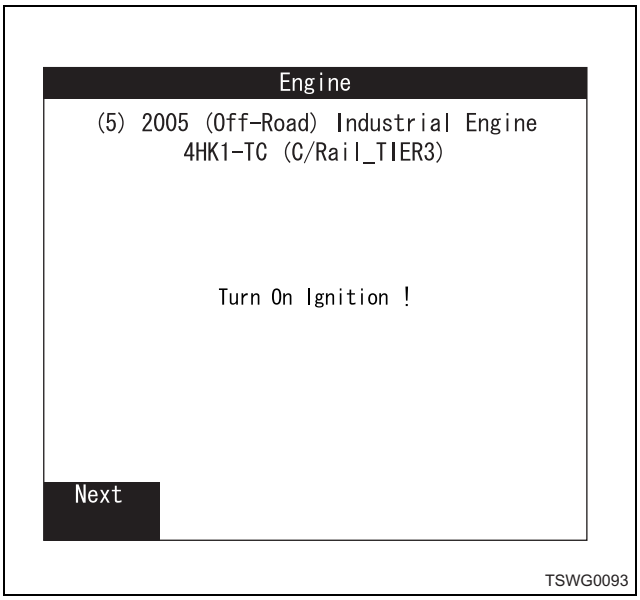
Step 6

- Choose 6HK1-TC (C/Rail_TIER3) with ▲, ▼ (up/down) keys, and press [ENTER].

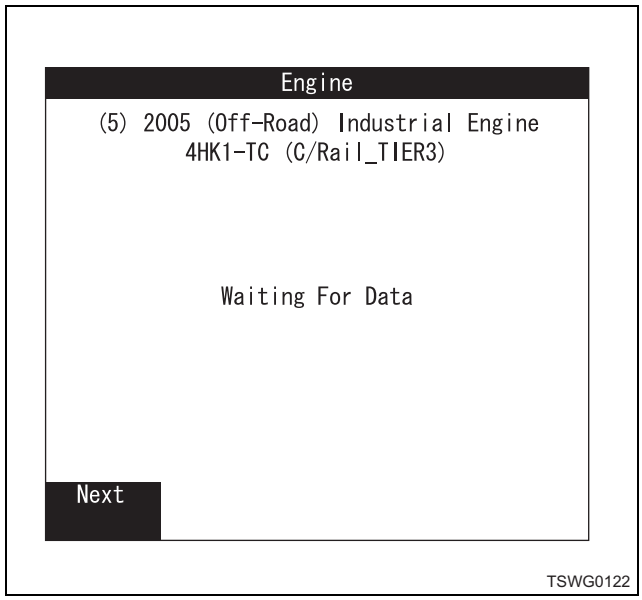


Step 7

- Press the softkey “Confirm”.
- The ignition is ON at this time.

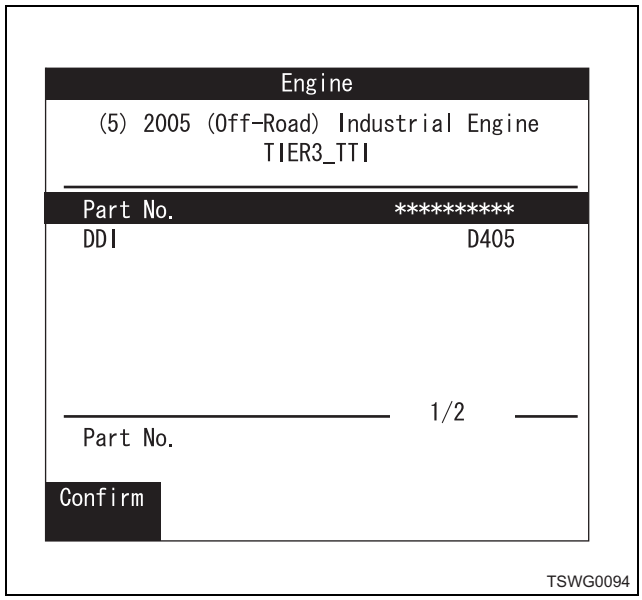


Step 7-1



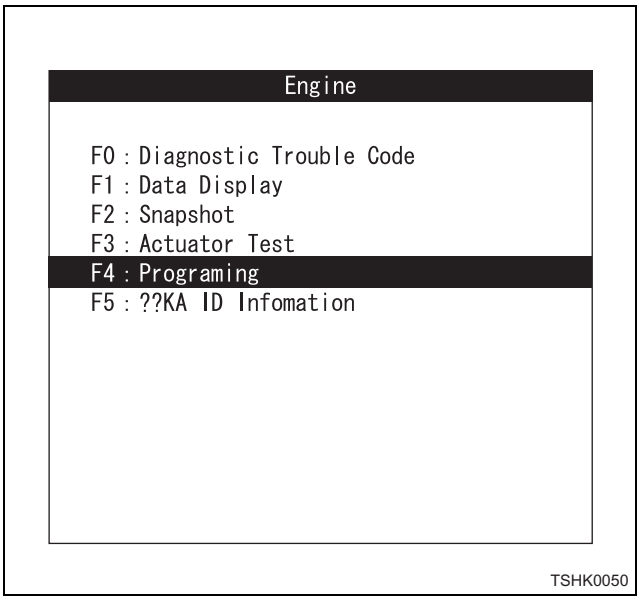
Step 8

- Press the softkey [Confirm].
- This displays the ECU ID information.



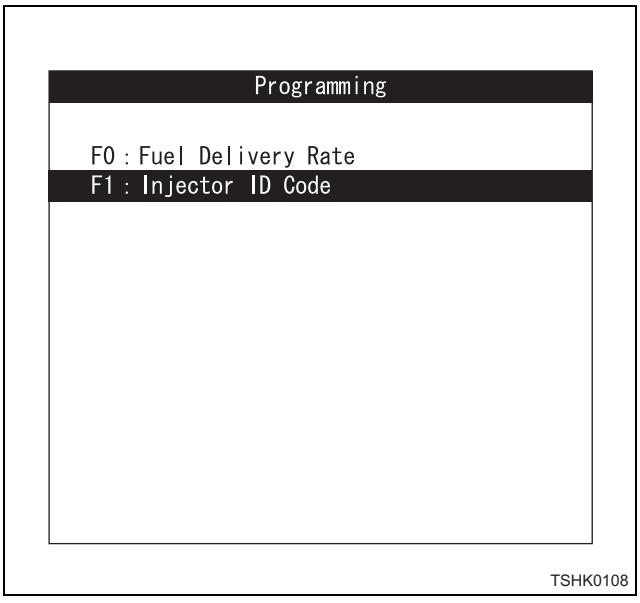
Step 9

- Choose the menu F4: Programming with ▲, ▼ (up/down) keys or F4 (function) key, and press [ENTER].



Step 10

- Choose the menu F1: Injector ID code with ▲, ▼ (up/down) keys or F1 (function) key, and press [ENTER].



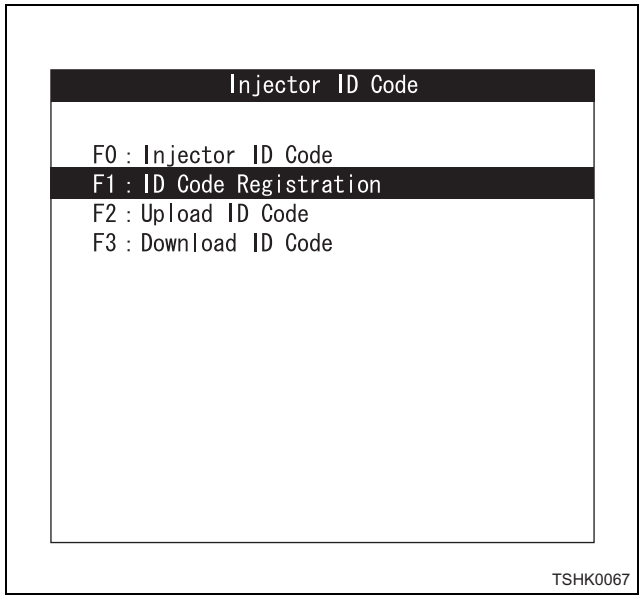
Step 11

- Choose the menu F1: ID code registration with ▲, ▼ (up/down) keys or F1 (function) key, and press [ENTER].

F0: Displays the Injector ID codes (hereinafter called ID code) of Cyl.1-Cyl.6.
Allows you to confirm the ID code after registration.

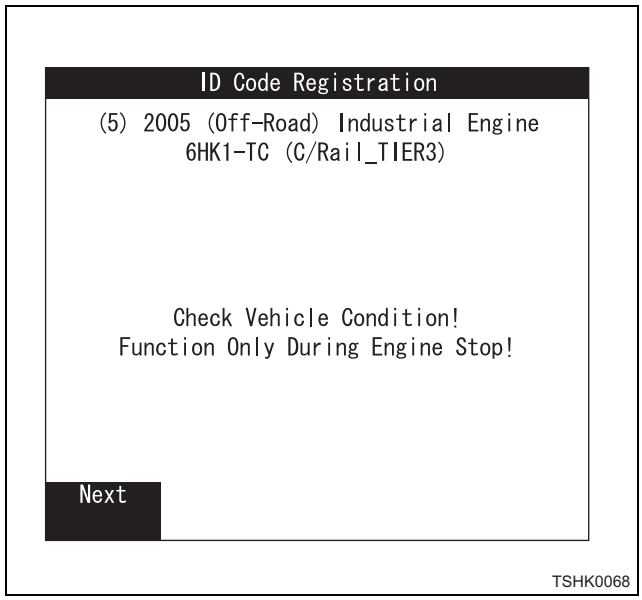
F2: Uploads (transfers) the ID code (No. 1 cylinder – No. 6 cylinder) registered in the ECM to Tech2 to store in its memory.

F3: Allows you to download (batch registration) the uploaded ID codes from Tech2 to the ECM.



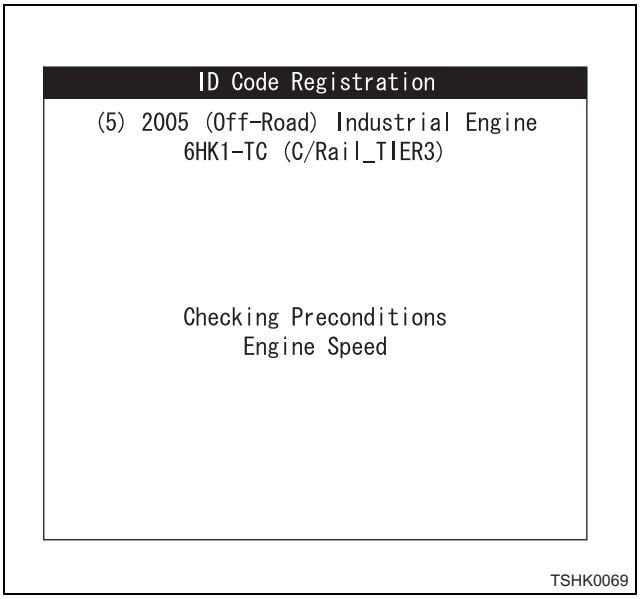
Step 12

- Press the softkey [Next].
- As an example, the vehicle will be checked whether it is in the condition (engine stopped) that the ECM requests during ID registration.

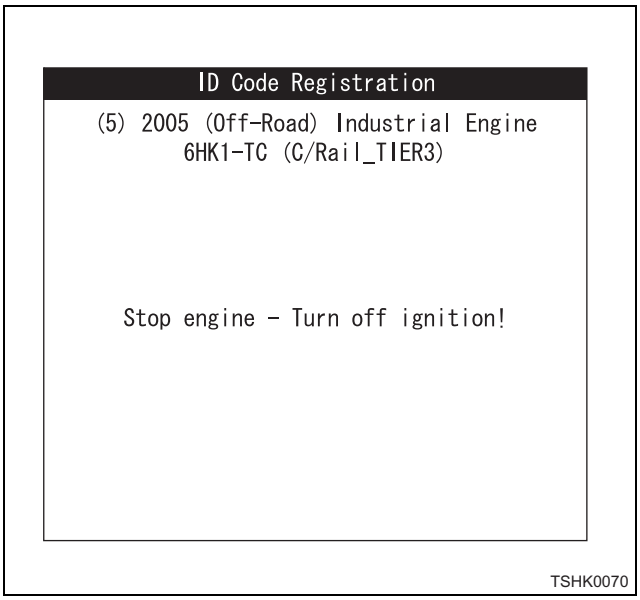


Step 12-1

- The following display appears while checking if the engine speed is 0 rpm.
  When the engine speed is 0 rpm, it will take you to Step 13.

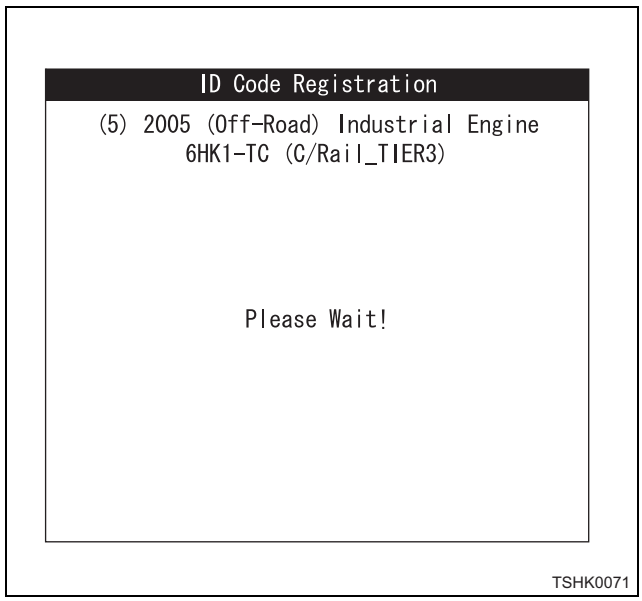


Step 12-2



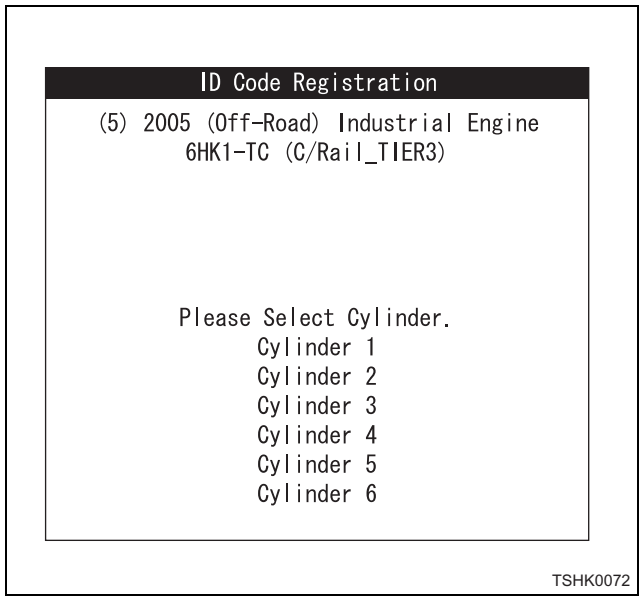
Step 12-3

- You need to enter the ID on the following display. ID code is number of year. The following conditions must be met.
  Conditions:
  1. The time setting of Tech2 matches with the calendar.
  2. Press the function keys (F0 — F9) to enter.



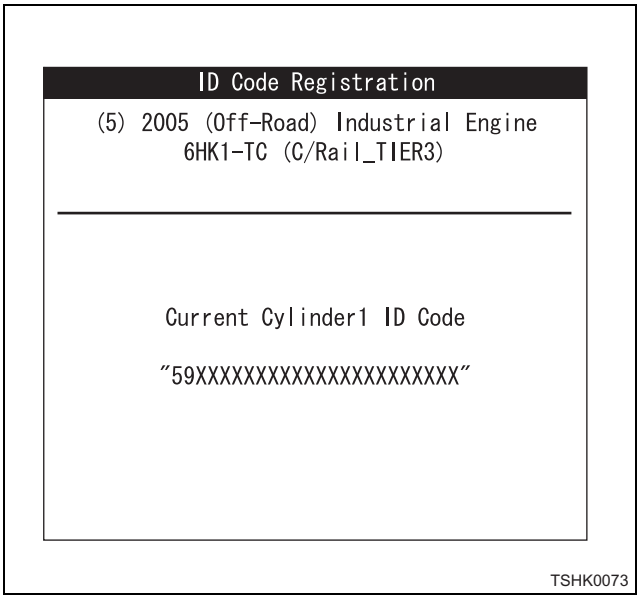
Step 13

- Choose the cylinder (No. 1 cylinder – No. 6 cylinder) you want to register the ID code with ▲, ▼ (up/down) keys, and press the [ENTER] key.
- As an example, this describes about No. 1 cylinder.



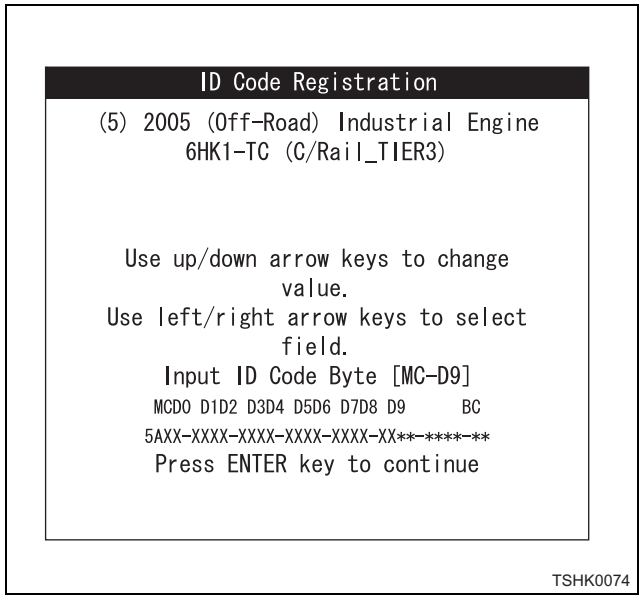
Step 14

- To register the ID code, press the softkey [Change].
- The ID code for Cylinder1 (No. 1 cylinder) selected at Step 13 is shown here.



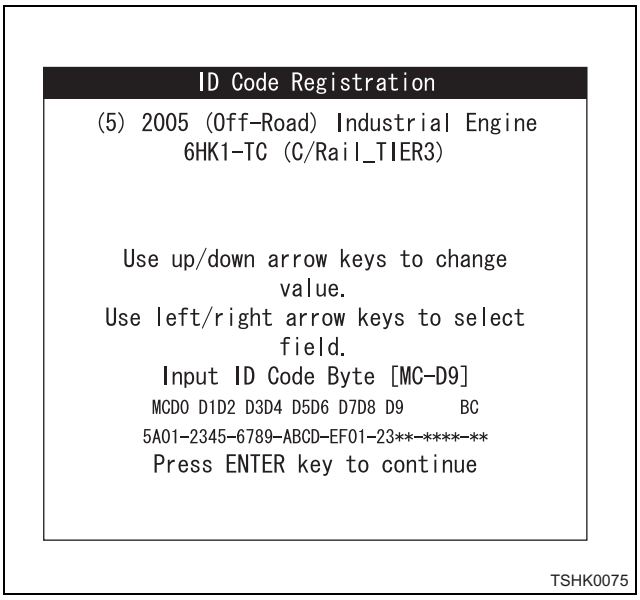
Step 15

- ID code registration (data entry)
  1. The cursor is positioned at M (model code) in the default setting.
     MCD0 D1D2
  2. At this point, enter the model code (MC) and ID code (D0) in this order.
     - Entering with the function keys (F0 – F9) will automatically move the cursor to the right. However, if you enter with ▲, ▼ (up/down) keys, you need to move the cursor with the arrow (left/right) keys.
  3. Entered data must be within $00 – $FF.
     - You can enter 0 — 9 with the function keys (F0 – F9), or 0 — Z with ▲, ▼ (up/down) keys.
  4. For VC17 (China), BCC code needs to be entered. NK3 request
- Tech2 calculates the entered data and displays the following message.
  • When entered ID code (QR) is out of the set value:
  Writing unable
  • When entered BCC code is out of the set value:
  Writing unable
  • When the ID code (QR) does not correspond to BCC code:
  Writing unable



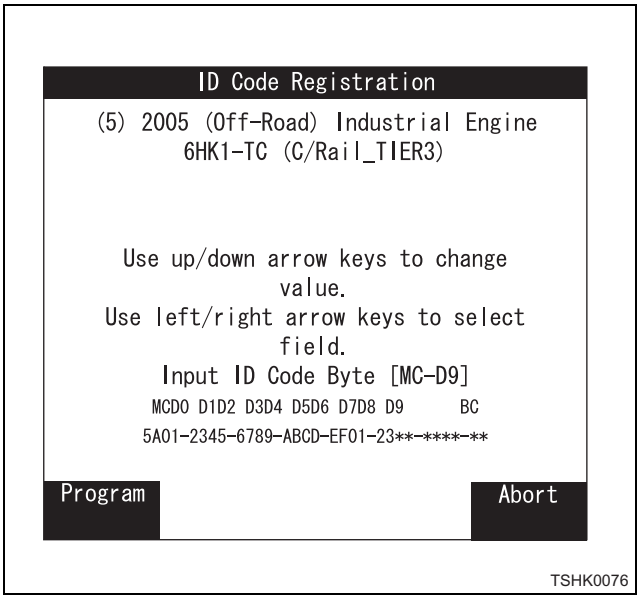
Step 15-1

1. The model code (MC) for VC25 is $5A, the Tech2 specifies to register (write) $5A automatically. However you may also enter.
   Tech2 calculates the BCC code (BC) and registers automatically.
   Therefore, you do not need to enter.
2. After entering the ID code input data byte (MC-D9), press [ENTER] key.



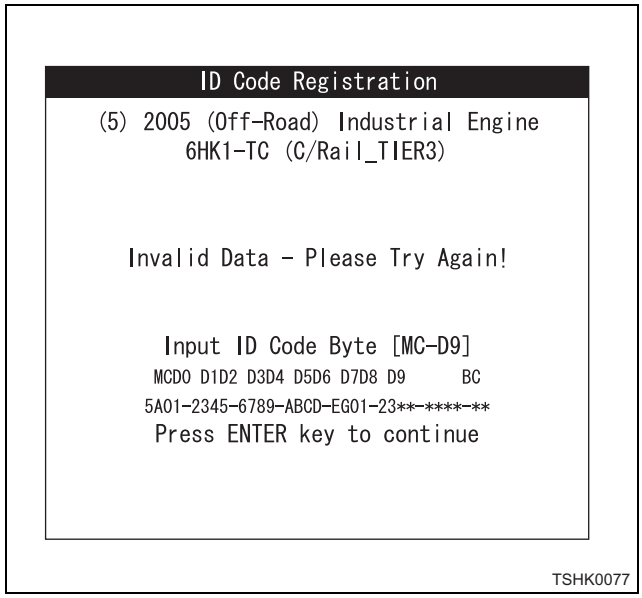
Step 15-2

- If the ID code you have entered is correct, press the softkey [Program].
  If you want to quit the program (registration), press the softkey [Abort] or press [EXIT] key.
- Quitting the registration or pressing [EXIT] key returns you to Step 11.



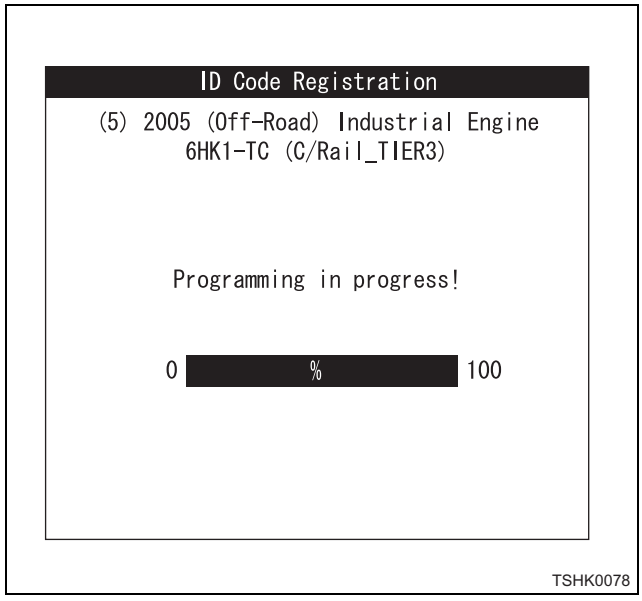
Step 15-3

- If you have entered incorrectly (D7:$EG), do the following.
  1. After pressing [ENTER] key as with Step 15-1, press the softkey [Program]. This cause the error message “Invalid data – Try again!” to appear.
  2. Set the data entry limit judgment.
     Judgment condition: Data (1 byte) meets the following condition.
     MSB:$F ≥ Data ≤ LSB:$F
- The following error message will be displayed until the value that meets the condition is entered.



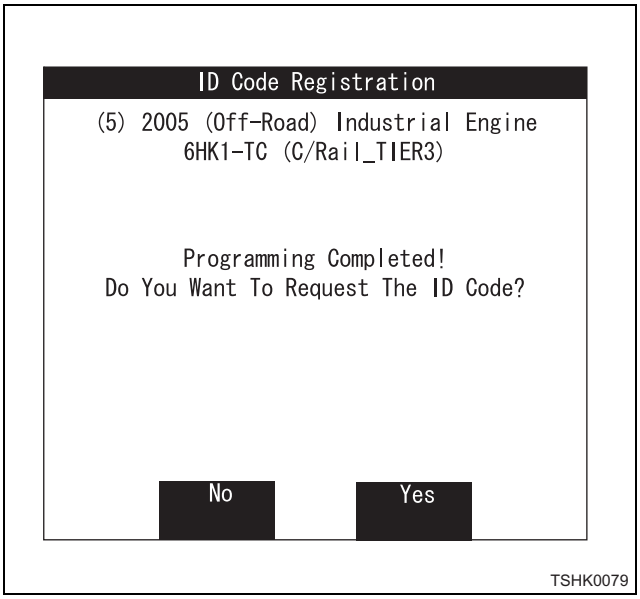
Step 16

- If the entered values meet the conditions in Step 15-1 and 15-3, the status display of data registration (writing) from the Tech2 to ECM as shown below will appear.



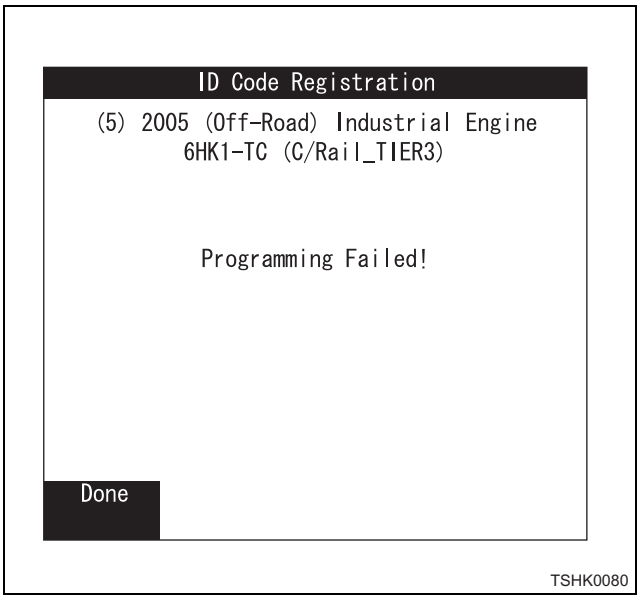
Step 17

- When the ID code entered in Steps 15-1 and 15-3 corresponds to that registered in the ECM, the following message will appear. Also, if you want to register ID again, press the softkey [Yes]. This returns you to Step 13, and allows you make registration as before. Pressing the softkey [No] will take you to Step 18.
  This completes the ID code registration.



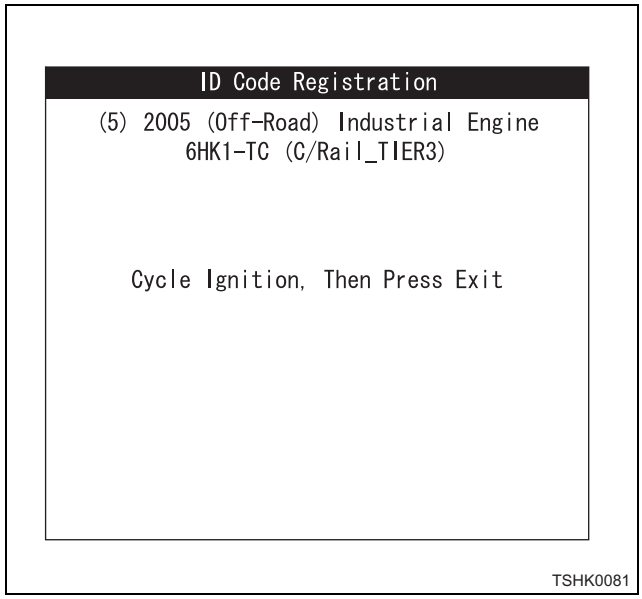
Step 17-1

- When the ID code entered in Steps 15-1 and 15-3 does not correspond to that registered in the ECM, the following message will appear.
  Pressing the softkey [End] returns you to Step 11.



Step 18

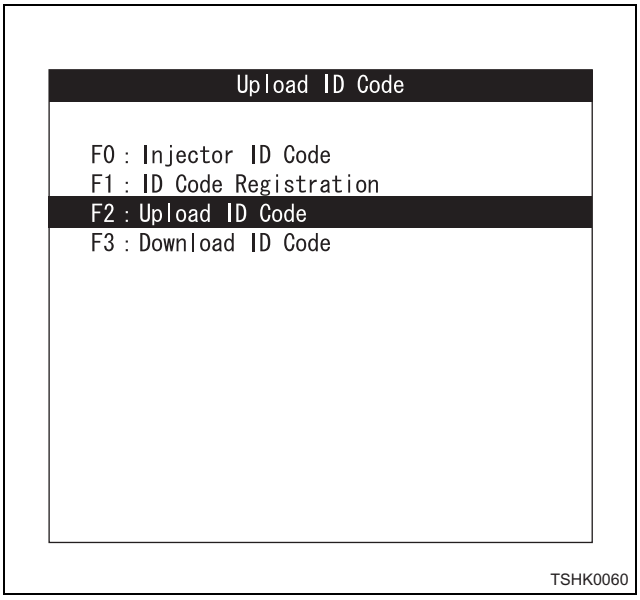
- Pressing [EXIT] key returns you to Step 11.



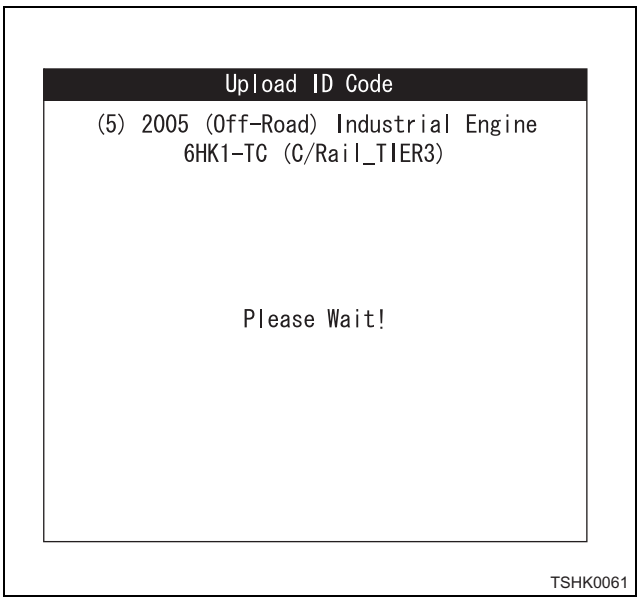
ID code upload (Tech2)

Step 11

- This step 11 describes ID code registration continued from the step right before.
  1. Choose the menu F2: ID code upload (Tech2) with ▲, ▼ (up/down) keys or F2 (function) key, and press [ENTER].

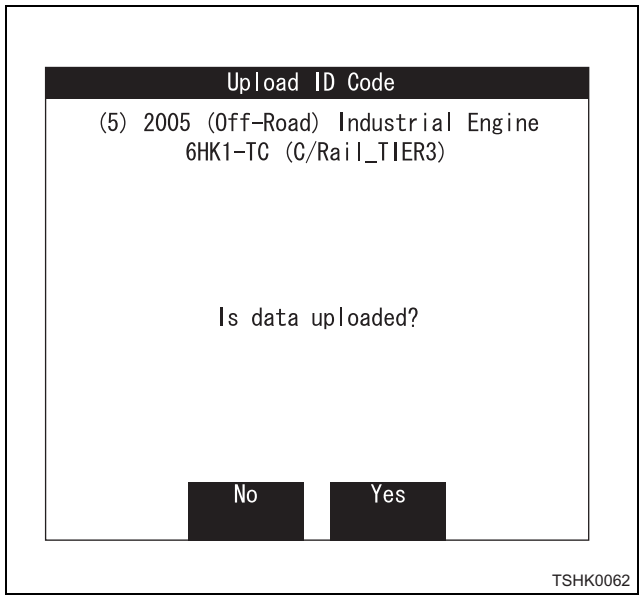


Step 11-1

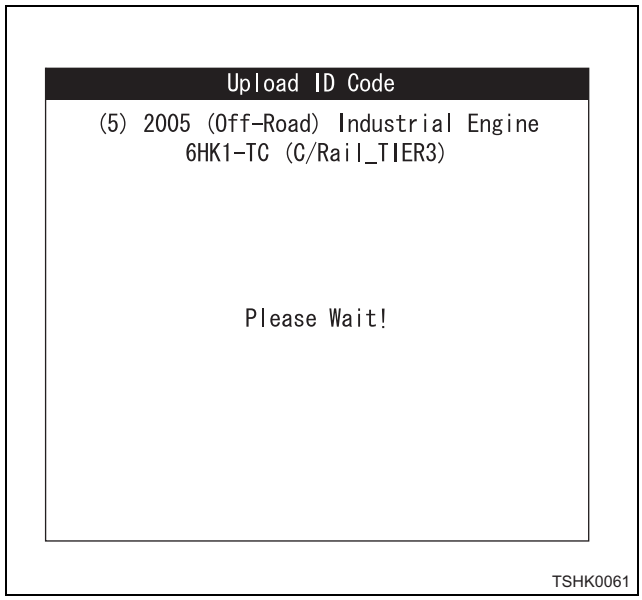


Step 12

- Pressing the softkey [Yes] updates the ID codes of No. 1 cylinder – No. 6 cylinder stored in the ECM, to the Tech2.
  Pressing the softkey [No] returns you to Step 11 without uploading the data.
- Upload is the function to transfer the registered ID code from ECM to Tech2 to store the data in it.

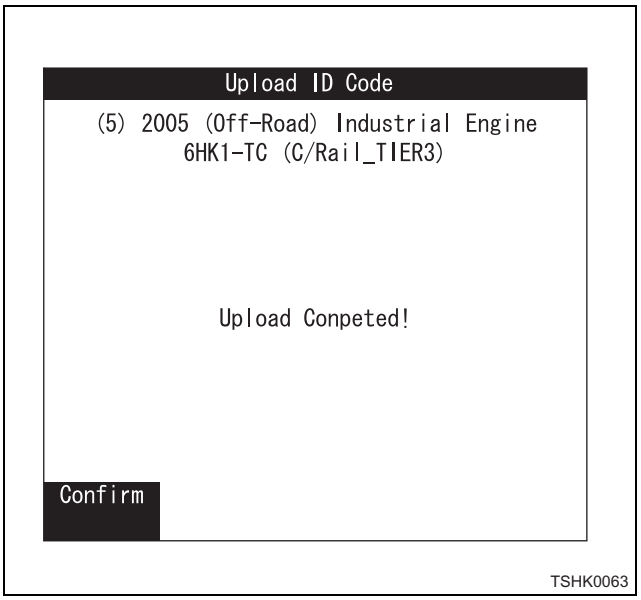


Step 12-1



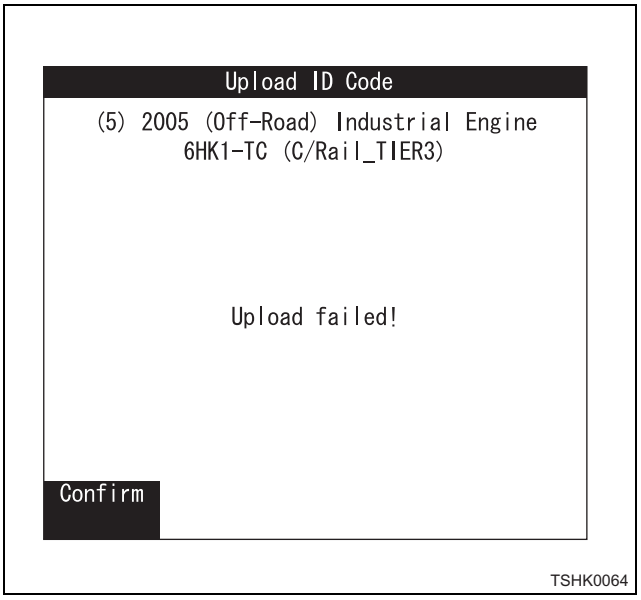
Step 12-2

- When the ID code registered in the ECM corresponds to that uploaded to the Tech2, the following message will appear.
  Upload is completed.
  Pressing the softkey [Confirm] returns you to Step 11.



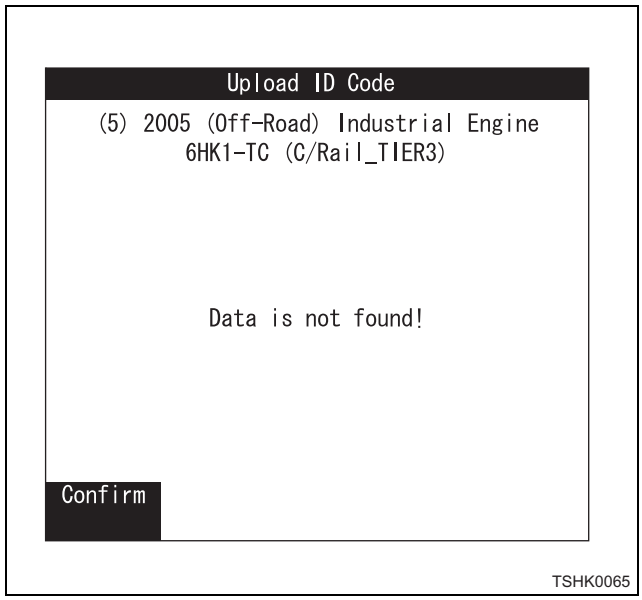
Step 12-3

- When the ID code registered in the ECM does not correspond to that uploaded to the Tech2, the following message will appear.
  Pressing the softkey [Confirm] returns you to Step 11.
- In this case, the uploaded ID code will be erased. Therefore, perform upload again. The message shown in Step 12-4 will appear.



Step 12-4

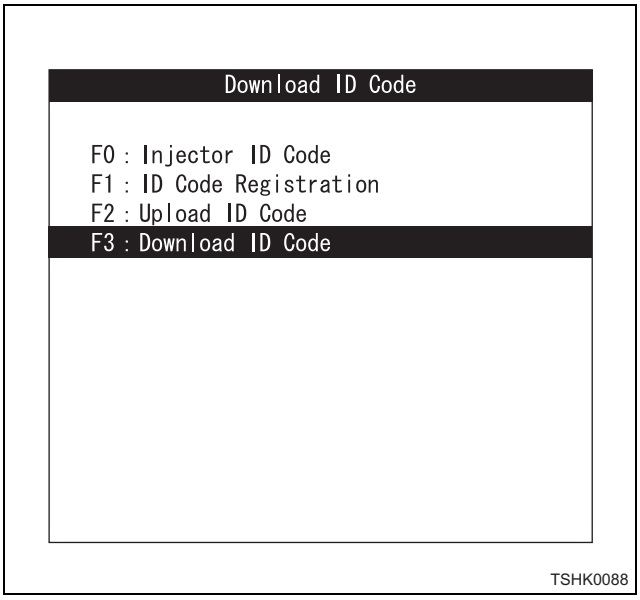
- Pressing the softkey [Confirm] returns you to Step 11.



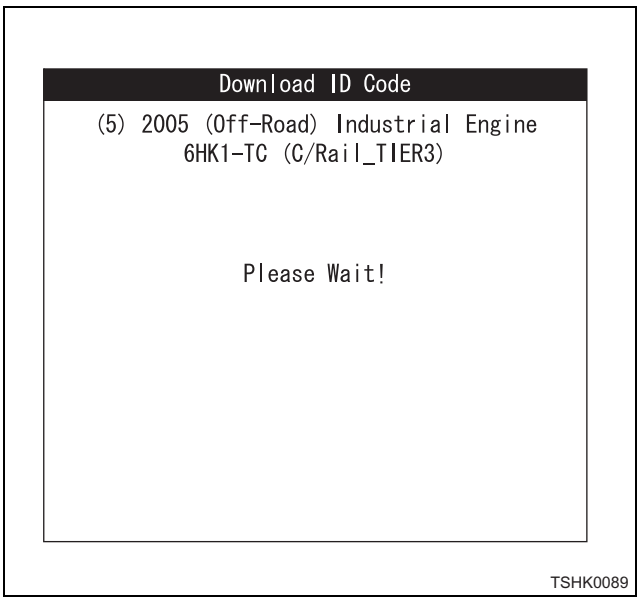
ID code download (Tech2)

Step 11

- This step 11 describes ID code registration continued from the step right before.
  1. Choose the menu F3: ID code download (ECM) with ▲, ▼ (up/down) keys or F2 (function) key, and press [ENTER].

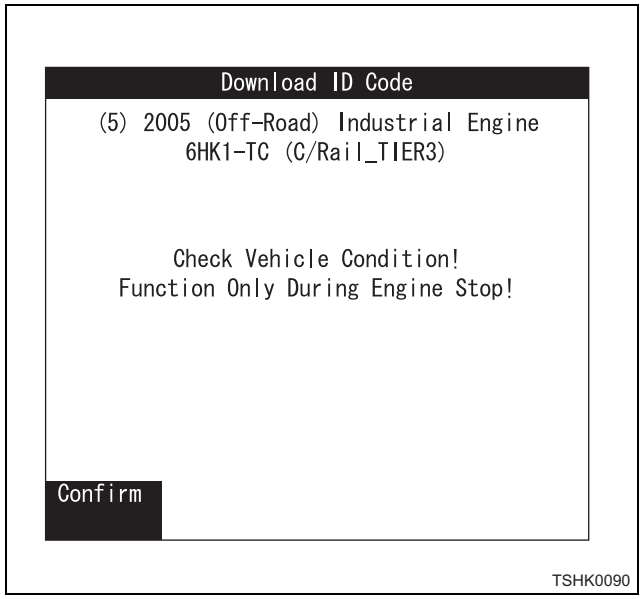


Step 11-1



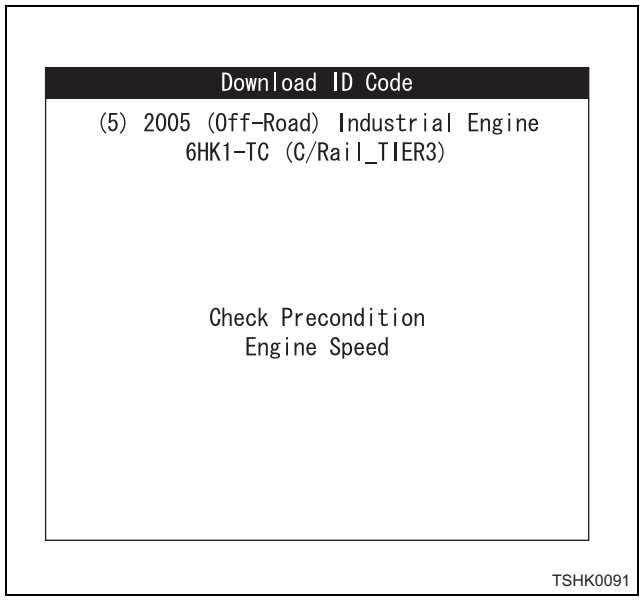
Step 12

- Press the softkey “Confirm”.
- As an example, the vehicle will be checked whether it is in the condition (engine stopped) that the ECM requests during ID registration.



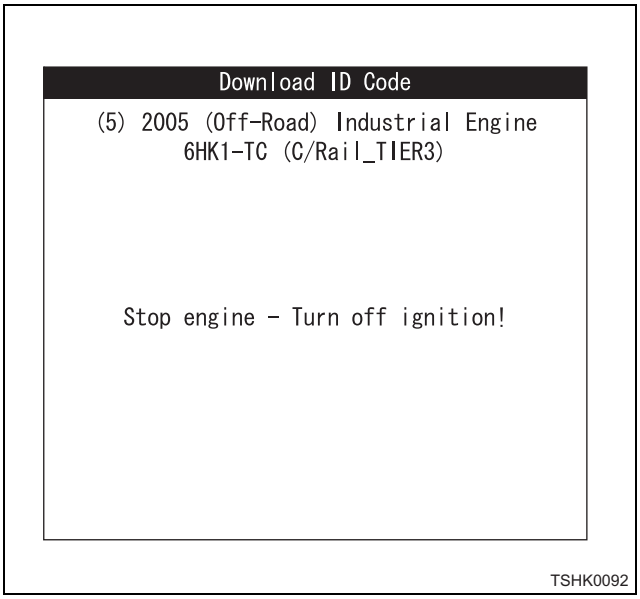
Step 12-1

- The following display appears while checking if the engine speed is 0 rpm.
  When the engine speed is 0 rpm, it will take you to Step 13.



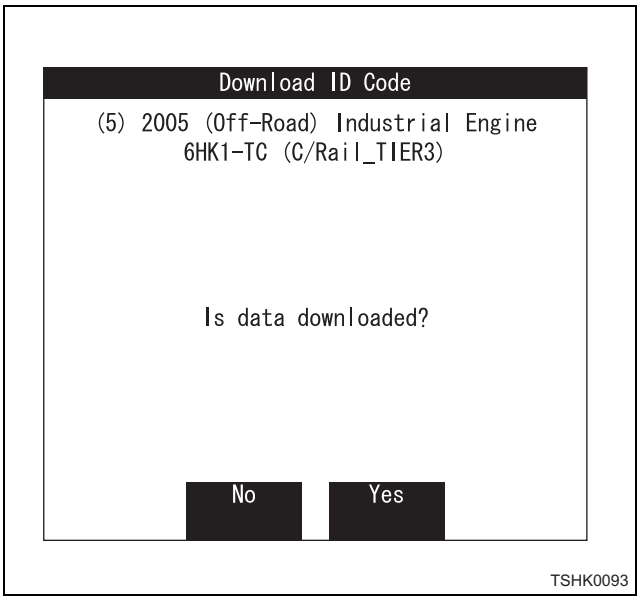
Step 12-2

- 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.



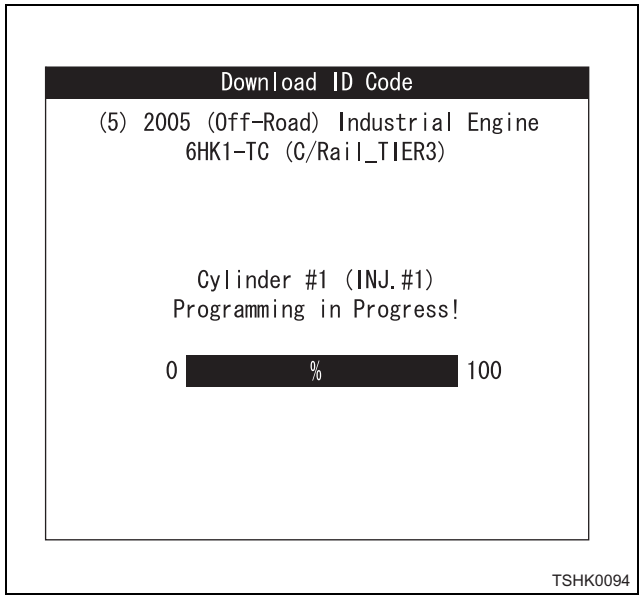
Step 13

- 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.



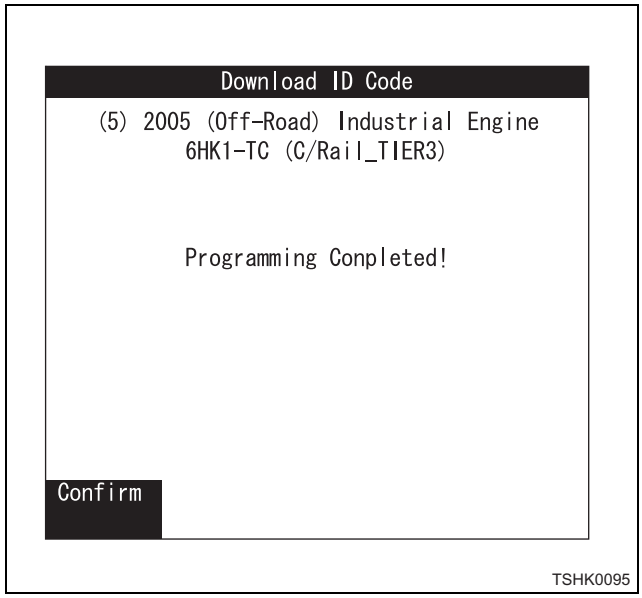
Step 13-1

- 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.



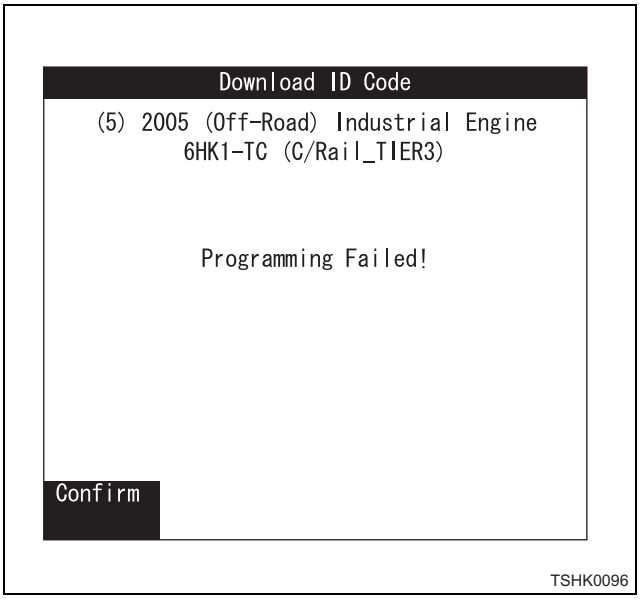
Step 13-2

- 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.



Step 13-3

- When the downloaded ID code does not correspond to that registered (written) in the ECM, the following message will appear.
  Pressing the softkey [Confirm] returns you to Step 11.



How to use TIS 2000

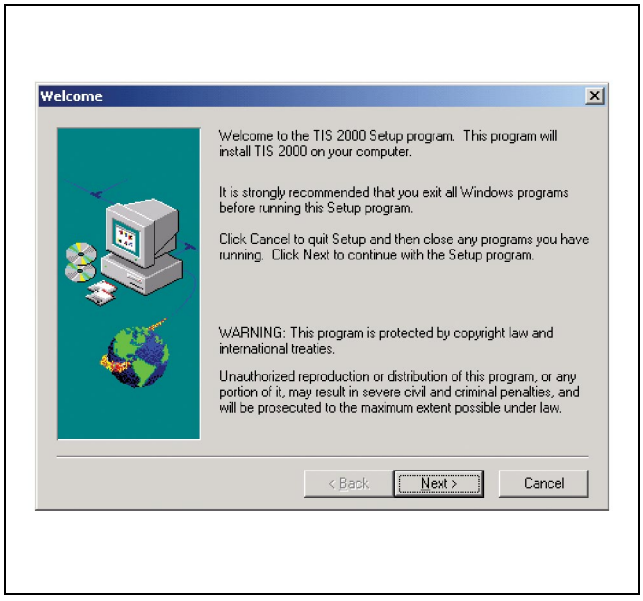
TIS 2000 installation procedure

(Time needed: 30 minutes)

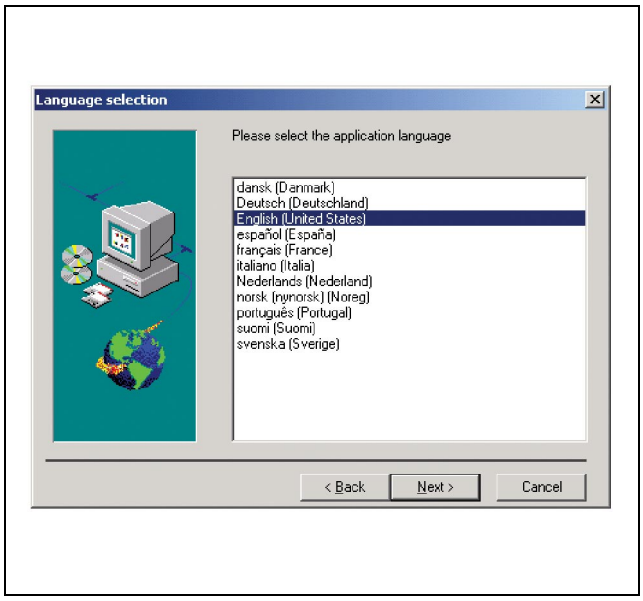
System Requirements	1. PC OS: Windows 95 or higher CD-ROM drive 2. Distribution CD-ROM	Free hard disk space: 150MB or more RS-232C connector

* Internet Explorer version 4.01 or later is required to use TIS 2000.
* If Internet Explorer prior to version 4.01 is installed, or it is not installed on your PC, Internet Explorer version 4.01 (English version) will be installed automatically.

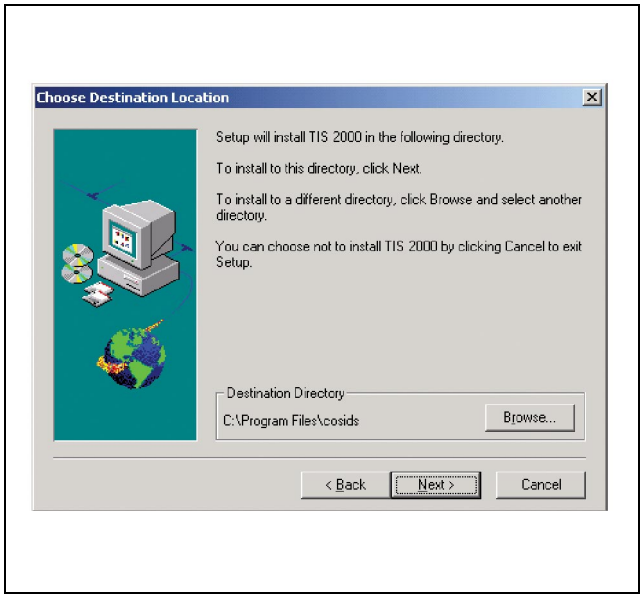
1. Turn on the power to start-up Windows.
2. Insert the distribution CD-ROM into the CD-ROM drive of PC.
3. The following screen will appear in approx. 10 seconds.
   * If the screen does not appear, open the file of “Autorun.Exe” in the CD-ROM.
4. When the “Welcome” screen appears, click the “Next”.



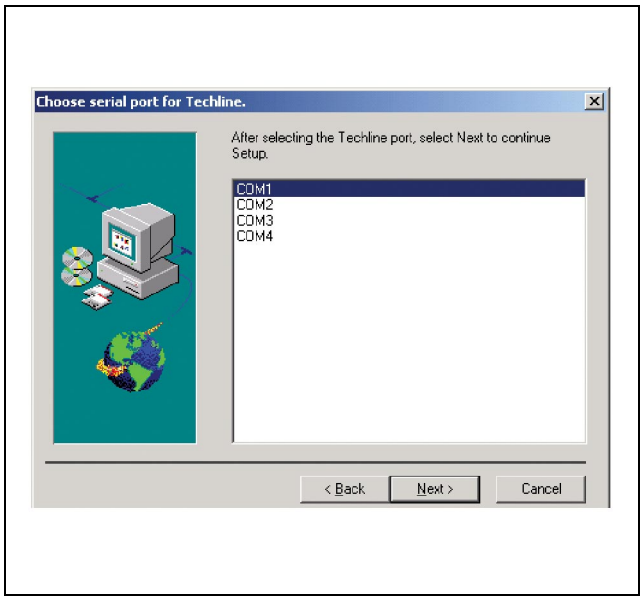
5. Select the language to be used, and click the “Next”.



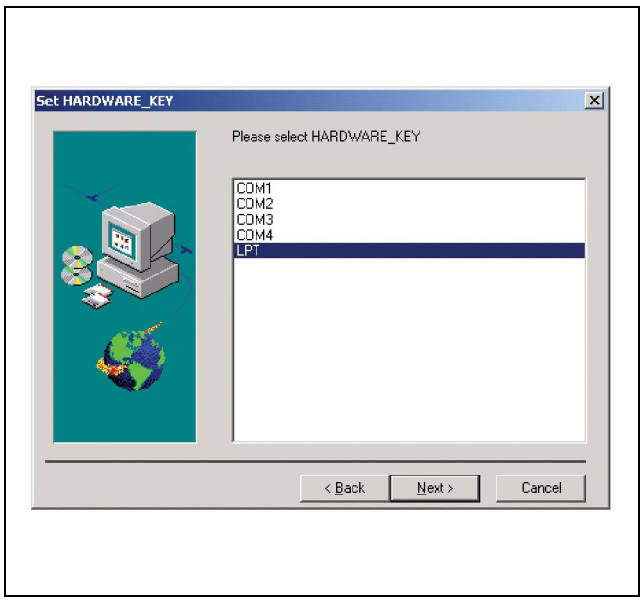
6. Usually, leave the “Destination Directory” as it is, and click the “Next”.



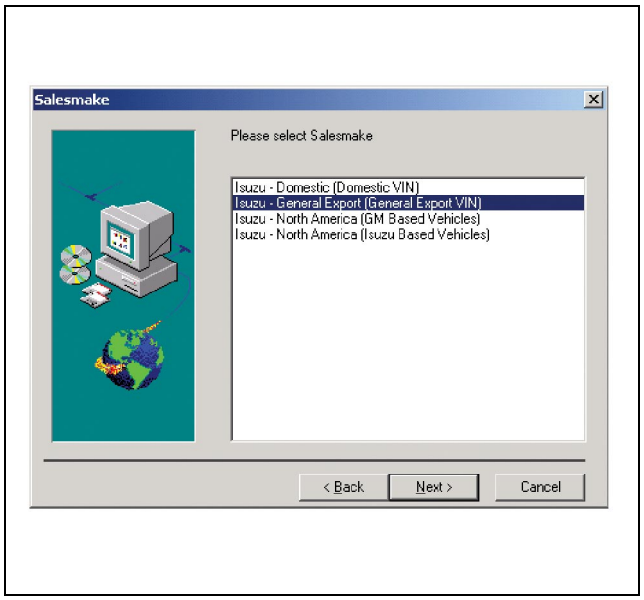
7. On the “Choose serial port for Techline.” screen, select the serial port of the serial cable to connect Tech2 to the PC.
   Normally, select the “COM1” and click the “Next”.



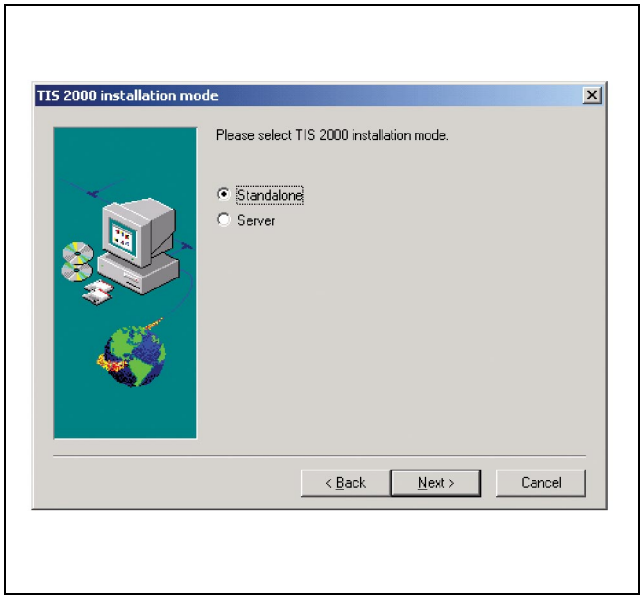
8. On the “Set HARDWARE_KEY” screen, select the “LPT” and click the “Next”.



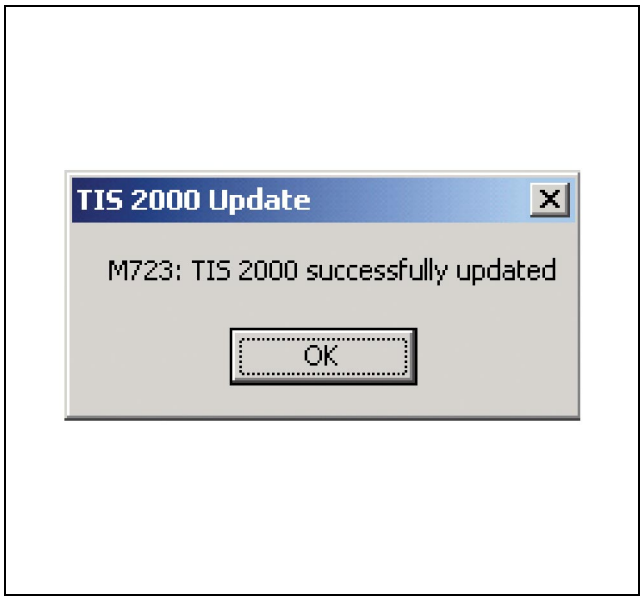
9. On the “Salesmake” screen, select either the “Isuzu - General Export (General Export VIN)” or “Isuzu US (US VIN)” and click the “Next”.
   [Example (UBS 6VE1 engine)]
   General VIN: JACUBS26GY7100001
   US VIN: JACDJ58X3Y7100001



10. On the “TIS 2000 installation mode”, select the “Standalone” and click the “Next”.



11. On the “TIS 2000 Update” screen, click the “OK”.



12. If the installation is completed, the “TIS 2000” icon is displayed on the desktop.
    * An error message may appear when restarting the PC at Step 12.
      In this case, install the following file in the CD-ROM.
      ~cosids¥Diag¥Mdac_type.ex_
      Copy this file on your hard disk, change the file name into “mdac.exe”, and double-click “mdac.exe”.
      After this work, install TIS 2000 again.

How to display snapshot

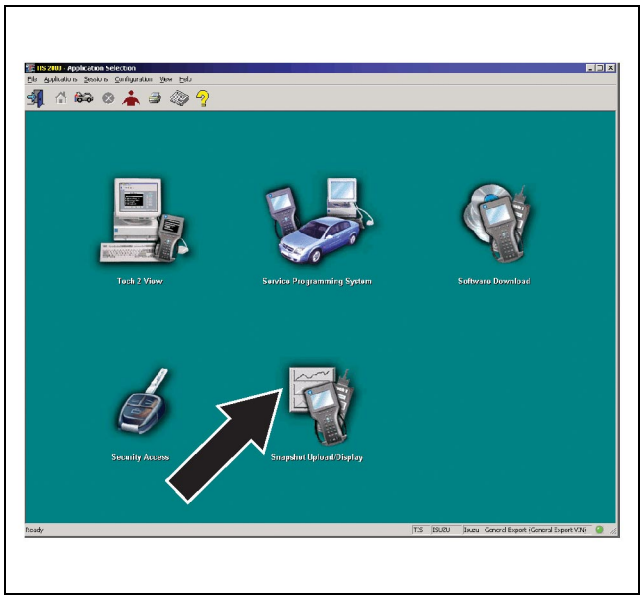


Fig. 1: “Application Selection” screen

This describes about how to transmit and display Tech2 snapshot data using the “Snapshot Upload” function of TIS 2000. Snapshot data can be displayed with the “Snapshot Upload” function of TIS 2000. The trouble symptom can be checked by analyzing snapshot data with various methods. To display the snapshot data, perform the following 3 steps;

A. Record the snapshot data in Tech2.

B. Transmit the snapshot data to PC.

After recording the snapshot data to Tech2, transmit the data from Tech2 to PC in the following procedure.

1. Startup TIS 2000.
2. Choose the “Snapshot Upload/Display” on the initial screen of TIS 2000.
3. Either select the “Upload from diagnostic tool” or click the appropriate icon on the tool bar.
4. Select the “Tech2” and transmit the saved snapshot data.
5. Select the “Transmitted Snapshot”.
6. When the snapshot data transmission is completed, the data parameter list will appear on the screen.

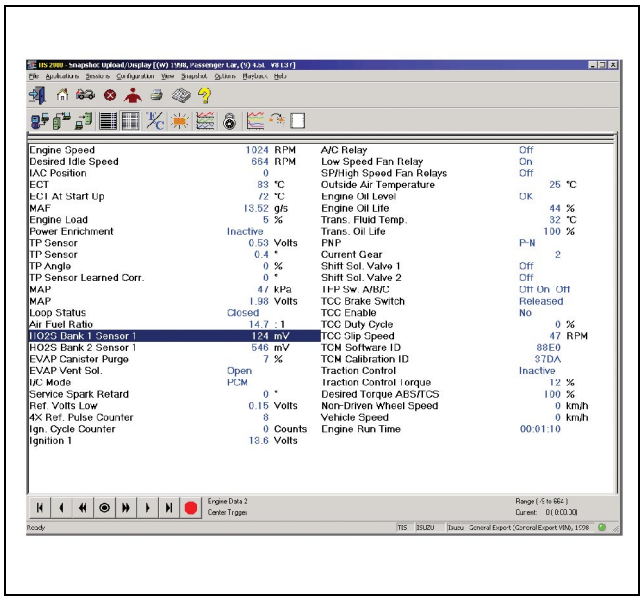


Fig. 2: Data display (sample)

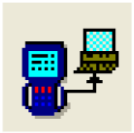
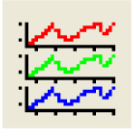
C. Display snapshot data with the "Snapshot Upload" function of TIS 2000.

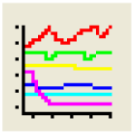
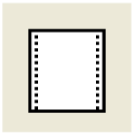
Snapshot data are stored in the PC hard disk or floppy disk, and they can be displayed any time. Stored snapshot can be displayed in the following procedure.

1. Startup TIS 2000.
2. Choose the "Snapshot Upload/Display" on the initial screen of TIS 2000.
3. Either select the "Open file" or click the relevant icon on the tool bar.
4. Select the "Transmitted Snapshot".
5. When the snapshot data opens, the data parameter list will appear on the screen.

Icons to be displayed

The following icons are used for data display.

	Transmits the snapshot from Tech to PC.
	Uploads the snapshot data from the floppy disk or hard disk.
	Saves the snapshot data on the floppy disk or hard disk.
	Displays the data parameters in one frame.
	Displays the data parameters in two frames.
	Changes the unit.
	Displays the data parameters in graph and list (up to 3 parameter items for graph display).
	Selects/cancels the parameter.

	Displays the data parameters in graph only (up to 6 parameter items).
	Prints (data parameter print out).

Snapshot data replay

Snapshot data can be replayed using icons in the bottom of the screen.

	1st record: Displays the first record of the snapshot.
	Previous record: Displays the previous record of that currently displayed.
	Regeneration in reverse direction: Replays in the reverse direction.
	Trigger of record: Moves to the trigger position and displays the snapshot.
	Regeneration in forward direction: Replays all the snapshot in the forward direction.
	Next record: Displays the next record of that currently displayed.
	Last record: Displays the last record of the snapshot.
	End of regeneration: Clicking the snapshot ends the replay of record.

Graph display

Numeric value and graph (up to 3 for graph display):

1. Clicking the icon for graph display opens “Graph Parameters” window.
2. Click the 1st graph icon in the top of the window, and select one parameter from the list in the bottom of the window. Selected parameter is shown next to the graph icon. Graph category can be selected with the field located in the right hand of the parameter.
3. Perform the same procedure for the 2nd and 3rd graph icons.
4. After selecting all the parameters (up to 3 parameters) you wish to view, click the [OK] button.

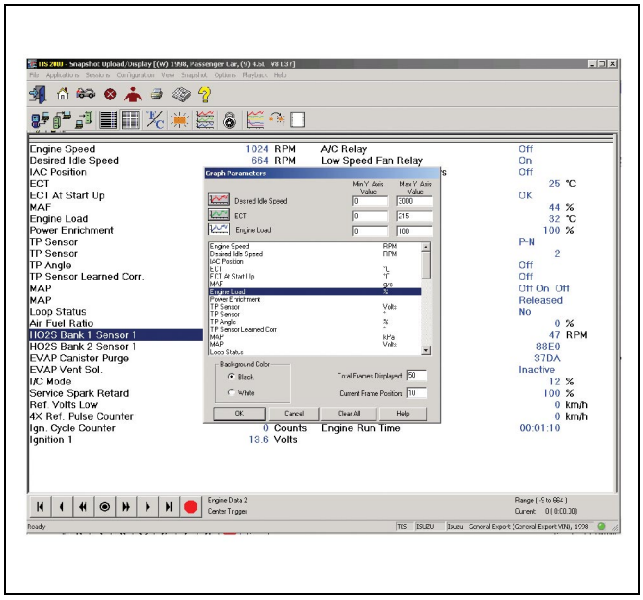


Fig. 4: “Graph Parameters” window (sample)

5. Selected parameter is shown in graph form, in the right hand of the data parameter on the screen.

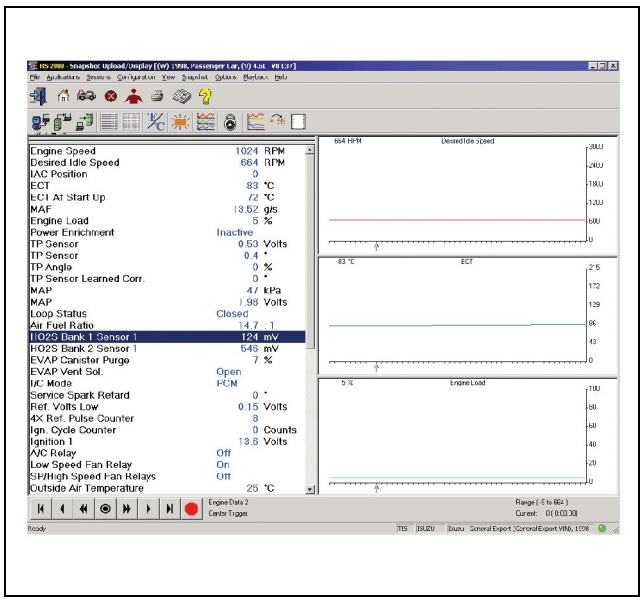


Fig. 5: Graph display screen (sample)

6. Graph display can be moved with the navigation icons.
7. If you wish to view the graph with different parameter, drag the parameter in the list onto the display screen. (Click the parameter and move the cursor with the mouse button pressed, and then release the mouse button in the display screen.) New parameter appears to replace the old one. To view the graph in full screen, move the cursor to the top of the screen, and click the screen where the cursor changes to magnifying glass icon. This will display the graph in full screen.

Graph display in one frame (up to 6 for graph display)

1. Click the “Six graph” icon. This opens “Graph Parameters” window.

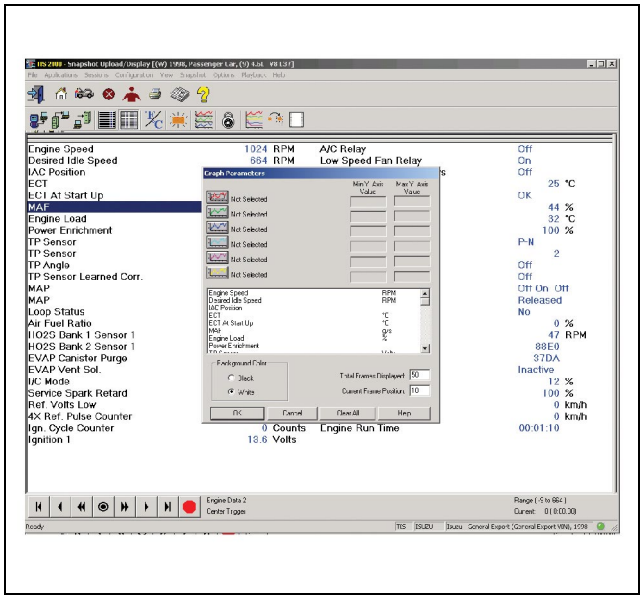


Fig. 6: “Graph Parameters” window

2. Click the graph icon, and select the parameter you wish to view from the list. Change the graph category as required.
3. Perform the same procedure for the 2nd to 6th parameters with graph icons.
4. Clicking the [OK] button displays the graph.

5. In this case, parameters are available only in graph form. All the parameters are shown in one frame.

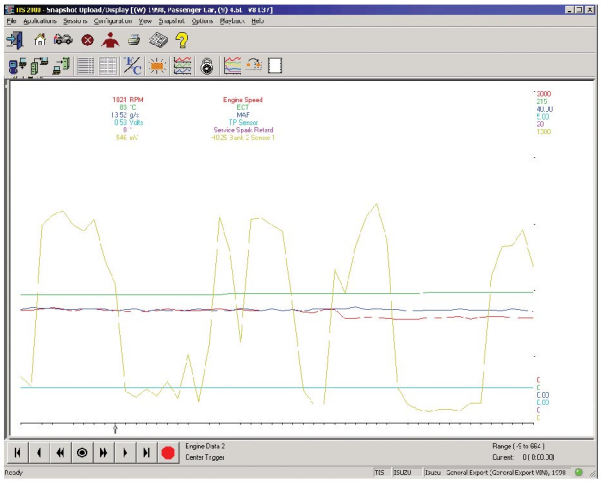


Fig. 7: Graph display screen (sample)

6. Graph display screen can be moved with the navigation icons.

Selects/cancels the parameter.

Use of parameter select/cancel function allows to select particular parameter from the list and to display it instantly. First click the parameter you want to view to mark it, then click “Select/Cancel Parameters”. Selected parameter is shown in the upper area of [Lock line] on the top of the data list. Other parameters can be added in the same procedure. Use of parameter [LOCK] allows the parameters to be displayed continuously for data comparison. To eliminate a parameter from the list, click the parameter you want to eliminate to put mark on it, then click “Select/Cancel Parameters”. When quitting the [Snapshot Display] application, “Do you want to save this file?” dialog box appears automatically. The file can be saved on the PC hard disk or floppy disk.

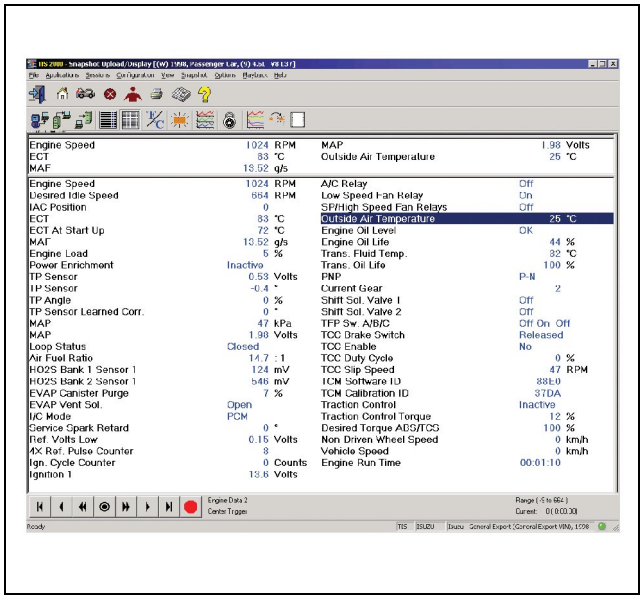


Fig. 8: Parameter selection

Directory to save data

Normally data is saved in “C:¥Program Files¥cosids¥DATA¥SNAPSHOT¥” folder. This directory is different if you changed installation directory when installing the application. Two sample files (“10000000SUR”, “10000001.SUR”) are already stored when installing the application.

TIS 2000 navigation

TIS 2000 application can be operated using the following icons.

	[TIS2000 end]: Quits all TIS 2000 applications to return to the Windows desktop screen.
	[Select page]: Returns to the initial page of TIS 2000 without quitting applications currently used. The applications currently used run in the background.
	[Vehicle data]: Starts [Vehicle data display] function. This displays all the vehicle information.
	[Executed applications end]: Quits the application currently used to return to the initial page of TIS 2000.
	[Session]: Allows to register and display user information.
	[Print]: Prints the screen.
	[Help]: Launches the integrated help function of TIS 2000.

Software download

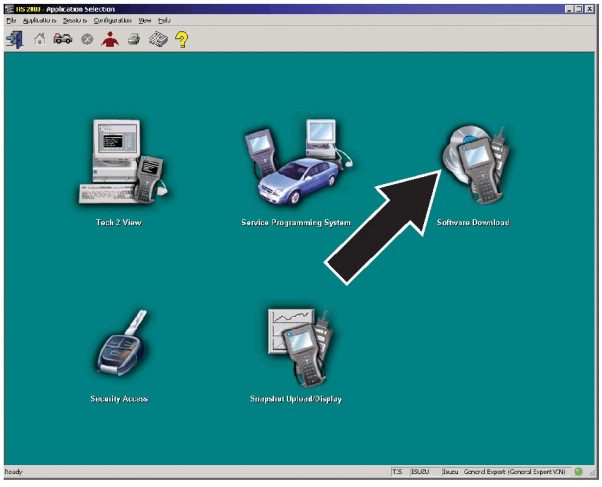


Fig. 1: “Application Selection” screen

Herein, it is described about how to update Tech2 software using “Software Download” function of TIS 2000.

Updating Tech2 (Software download)

Update the Tech2 software to the latest version using “Software Download” function of TIS 2000.
Tech2 software is updated on a regular basis to correspond to the change in vehicle specifications and diagnostic methods. Updated information includes new vehicle system, amendment of diagnostic method, update from previous version, addition of new diagnostic method, etc.

There are two kinds of download mode; “Standard” and “Custom”.

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.

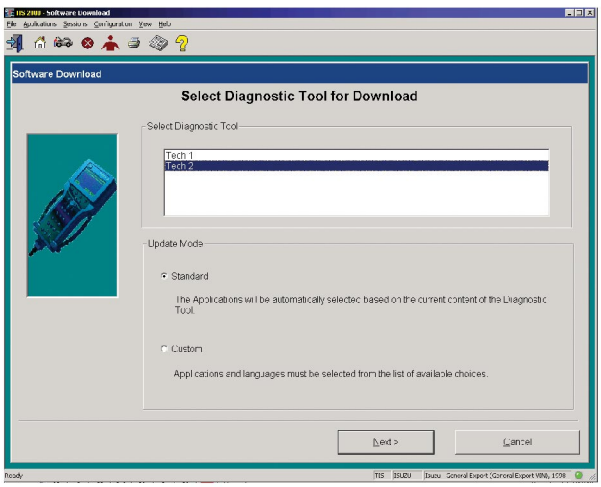


Fig. 2: Selection of diagnostic tool to be updated and update mode

- 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.

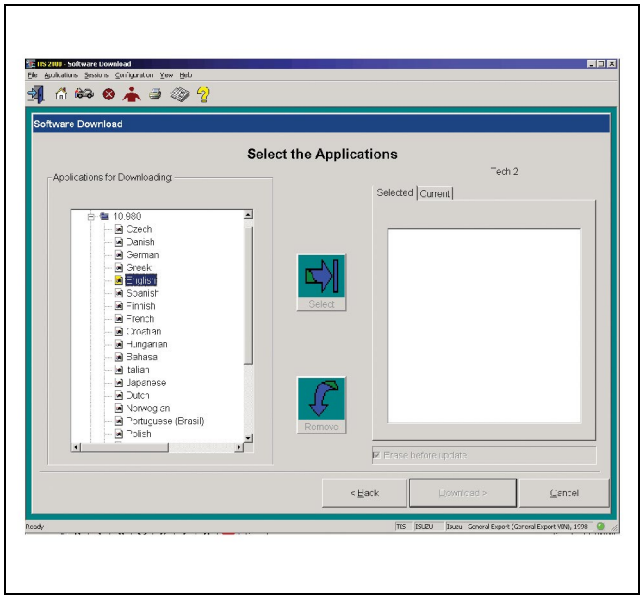


Fig. 3: Selection of application for “Custom” mode

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.

TIS 2000 navigation

TIS 2000 application can be operated using the following icons.

	[TIS2000 end]: Quits all TIS 2000 applications to return to the Windows desktop screen.
	[Select page]: Returns to the initial page of TIS 2000 without quitting applications currently used. The applications currently used run in the background.
	[Vehicle data]: Starts [Vehicle data display] function. This displays all the vehicle information.
	[Executed applications end]: Quits the application currently used to return to the initial page of TIS 2000.
	[Session]: Allows to register and display user information.
	[Print]: Prints the screen.
	[Help]: Launches the integrated help function of TIS 2000.

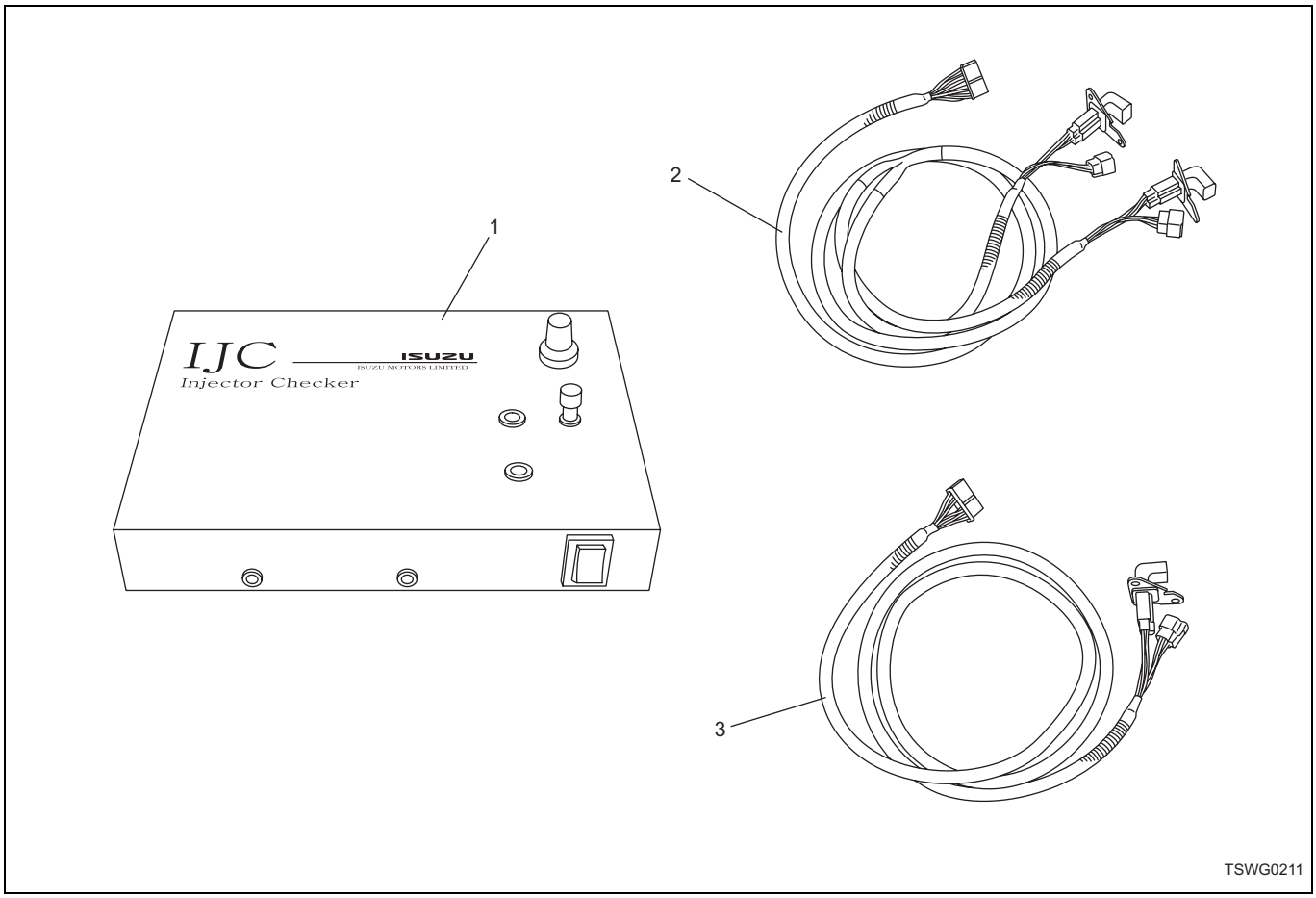
Snapshot transmission method using e-mail

- Upload the snapshot data from Tech2 to hard disk on PC.
- Open the file in the following procedure to download data.
- Double-click “C: ¥Program Files”.
- Double-click the “cosids” folder.
- Double-click the “DATA” folder.
- Double-click the “SNAPSHOT” folder to download.
- Make sure that the file extension is “.sur”, and attach the file to e-mail.

How to Inspect Injector

How to use injector checker

Components of injector checker

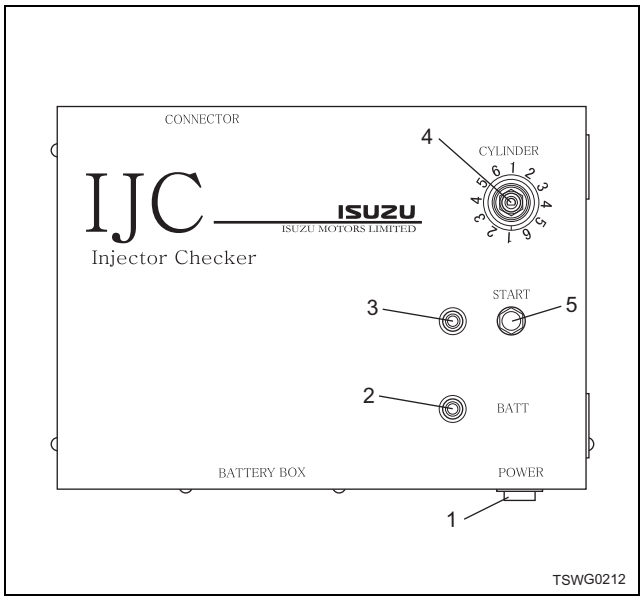


Name

1. Injector checker body
2. Test harness for 6-cylinders
3. Test harness for 4-cylinders

* To prevent wrong connection, the end of corrugate tube of connection harness for 6-cylinders is wrapped by identification tape (red) for 4-5-6 cylinder side harness.

Each part of injector checker



Name

1. Main switch
2. Battery lamp
3. Operation lamp
4. Cylinder selection switch
5. Start button

Main switch

This is used to switch ON and OFF of injector checker function.

Note:
Be sure to turn it to OFF before removing/installing harness.

Battery lamp

This comes on when the battery (9V) in the body gets low (7.2V or less).
If the battery lamp comes on, replace the battery as soon as possible. (Refer to Battery Replacement)

Note:
When using the main switch, it comes on momentarily due to voltage change. If the battery lamp does not come on when using the main switch, check the battery. Replace it if it gets low (7.2V or less).

Cylinder selection switch

This is used to switch a cylinder to be checked. Turn it left fully before check, and then start to check clockwise ($1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6$).

Note:

- **One rotation of cylinder selection switch allow to check twice for each cylinder. At the third time or later, turn the selection switch left back to the original position and start to check.**
- **Do not turn the selection switch excessively after it is turned to stopper.**

Start switch

This is used to stop the cylinder selected by the cylinder selection switch. Injection of selected cylinder stops approx. 2.4 seconds.

Operation lamp

This comes on while injector is checked (approx. 2.4 seconds) after starting button is pressed.

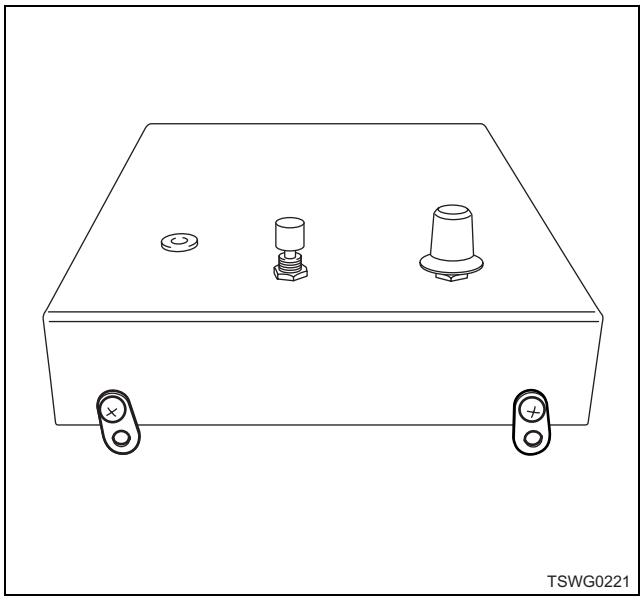
Note:
Do not use any switches and operate the machine while the lamp comes on. Otherwise, diagnosis result is not correct.

Holder

Holders are used to hang or fix the body. They are tightened on the body. To use the holders, loosen the screws to move.

Note:

- **When using or storing holders, be sure to tighten them to fix.**
- **Be careful not to tighten screws excessively. This may damage the body.**



Precautions on handling the body

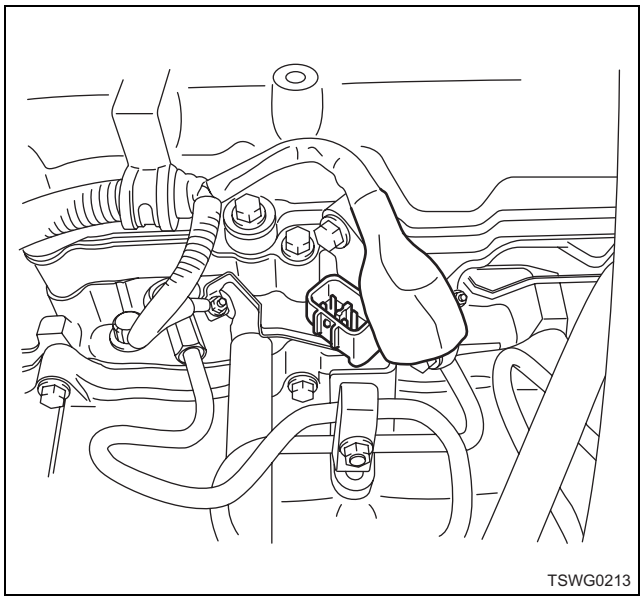
- **The body is a precision equipment. Do not drop it or make a high impact on it.**
- **The body is drip-proof type. However, avoid using it in rainy day or operating with wet hands to prevent water from entering through connector connection.**
- **Power for the body must be supplied from internal battery, not from external one.**
- **Prevent foreign matter from entering into the body while replacing battery.**

- **Do not use screws to tighten battery holder except original ones. This may cause body damage or battery damage and electric leakage.**
- **Do not disassemble the body in any circumstances. Contact Hitachi Construction Machinery. if it is faulty.**

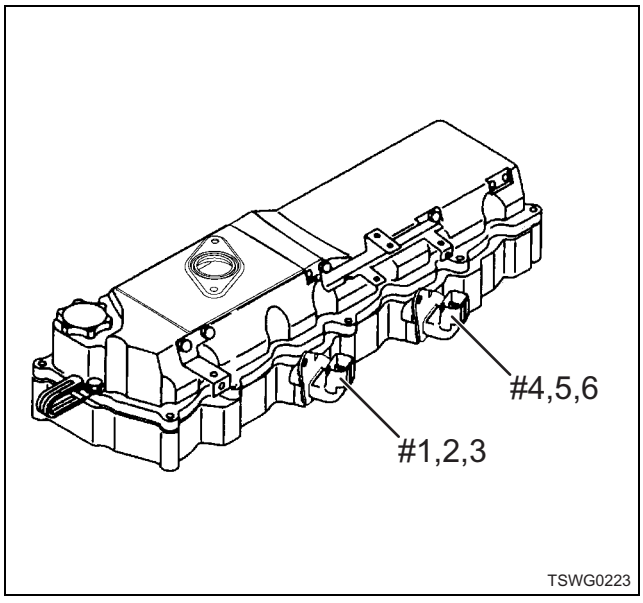
Injector test

1. Check the DTC.
- If DTC unrelated to injector is detected, repair or check to eliminate the faults before test.
2. Turn the key switch to OFF.
3. Disconnect the injector connector from engine on the machine. (4-cylinder: one, 6-cylinder: two)

4HK1



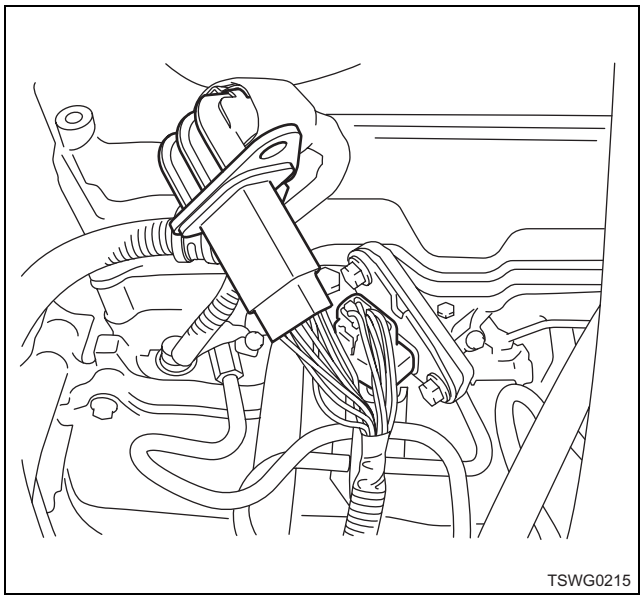
6HK1



4. Connect the test harness to the engine side.

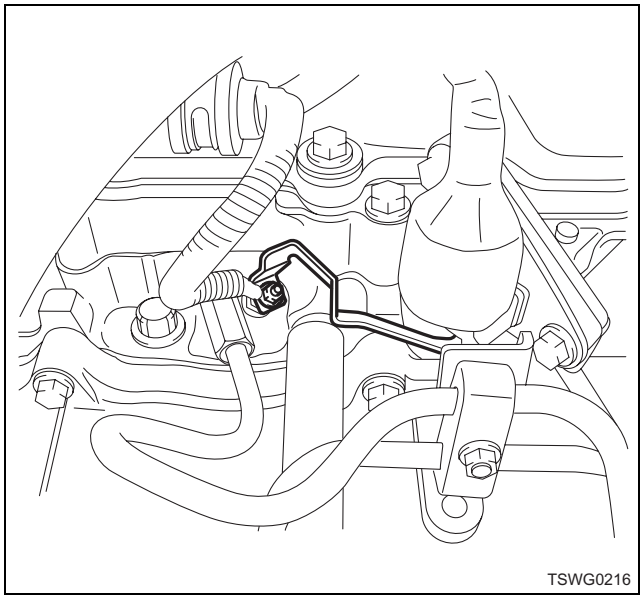
Note:

- **Be careful not to let the metal parts of test harness and connector contact glow plug connector. Protect it with cloth to prevent short during operation of key switch.**
- **Do not connect wrong connector. (Confirm the identification tape (red) before connecting.)**
- **DTC will be detected if disconnecting or connecting the harness with the key switch to ON. Turn it to OFF during work.**

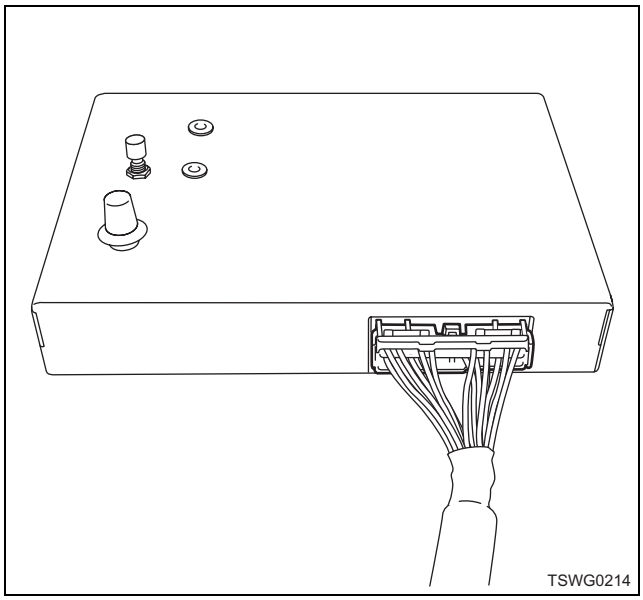


* 4HK1 is shown in the illustration.

Note:
Be careful not to let the metal parts of connector contact glow plug connector while connecting the harness.



5. Connect the test harness to the body.
   - Do not directly place the body on the engine.
   - Avoid high vibration and impact.



6. Start the engine.
7. If the machine has function to lower idle speed, lower the speed to clarify the engine reaction.
8. Set the selection switch to “1”, and check the No. 1 cylinder.
9. Press the start button and check the engine vibration level and change in exhaust noise.
   - If it is difficult to recognize the change, touch the engine directly to check change in the vibration.

Note:
Do not operate the body and the machine while the operation lamp comes on.

10. Confirm that the lamp goes off and repeat check of the remaining cylinders as steps 8 and 9.
11. Replace the injector in the cylinder of which engine vibration level and exhaust noise did not change.

Note:
For work procedure, refer to “Engine section” in the service manual.

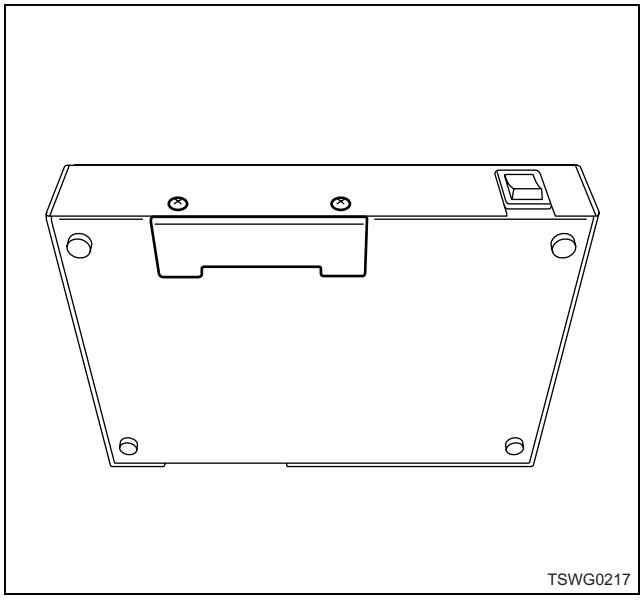
12. Turn the key switch to OFF, remove the test harness, and restore the injector harness.

Note:
DTC will be detected if disconnecting or connecting the harness with the key switch to ON. Turn it to OFF during work.

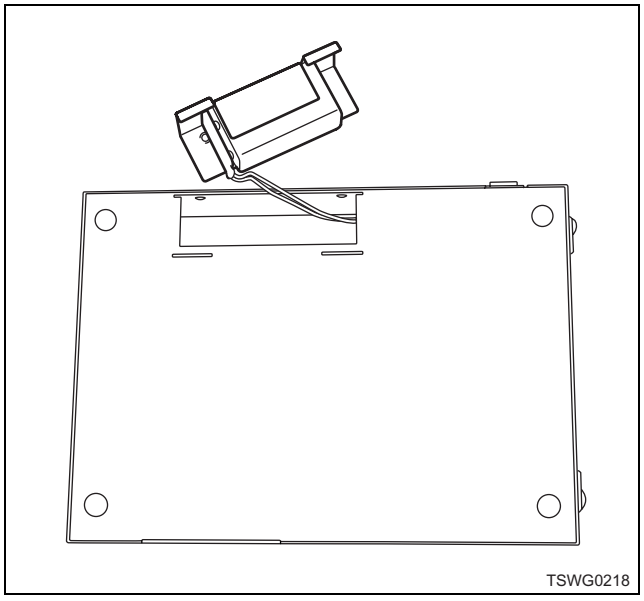
13. Start the engine and return the idle speed at specified one.
14. Clear the DTC.
    Refer to the machine’s manual for how to clear DTCs.
15. Perform a test drive, and check that there are no faults.

Battery Replacement

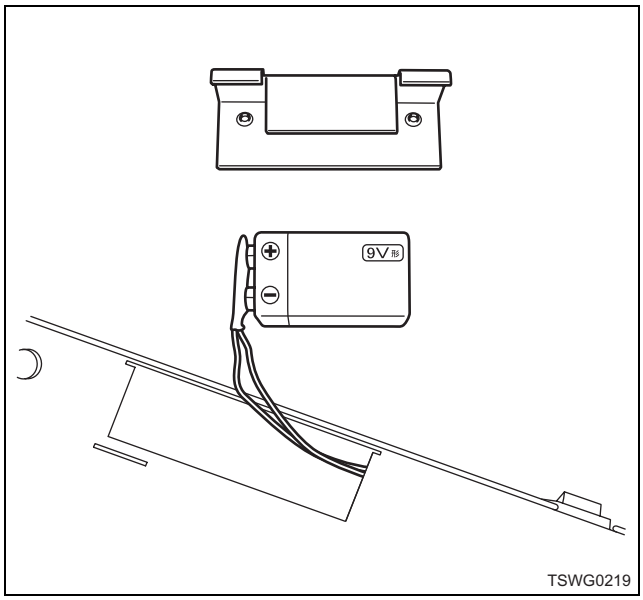
1. Remove the two screws on the side of the body.



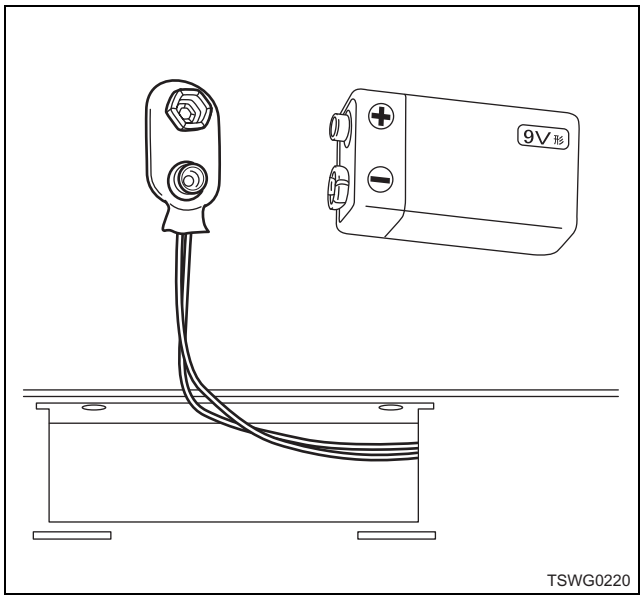
2. Pull out the battery holder.



3. Remove the battery from the holder.



4. Disconnect the connector from battery, and replace the battery.



5. Restore in the reverse order.

Note:

- **Prevent foreign matter from entering in while removing the battery.**
- **Do not tighten the battery holder screws excessively.**
- **Do not replace the battery holder screws with other than original ones.**
- **Be sure to use specified battery.**

Method to identify using non-contact infrared thermometer

There are three methods to identify injectors as follows. Since the method varies depending on the necessary tools you have, and/or the judgment difficulty of each machine, refer to the section of Hitachi Construction Machinery.

Method to identify

1. Method of judgment by an injector balance test using a diagnostic tool with KW or CAN communication such as Tech2.
   - For the procedure of a balance test, refer to the “Injector balance test” in “How to use scan tool”.
2. Method of judgment by such an injector balance test that the injector power line is broken for a short time using an injector checker without communication with the ECM.
   - Refer to “How to use injector checker”.
3. Method of judgment by measuring and comparing the rising trend of the exhaust temperature using a non-contact infrared thermometer.

Depending on machine types, proficiency may be required to judge only using an injector checker when a diagnostic tool is not available. If it is difficult to judge, we recommend the method of measuring and comparing the rising trend of exhaust pipe temperature using a non-contact infrared thermometer.

Method to measure

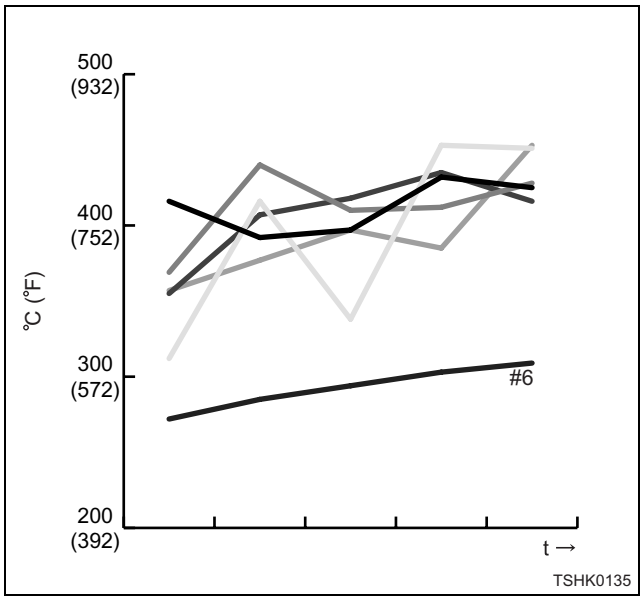
Use a non-contact infrared thermometer capable of measuring 500°C (932°F), and continuously measure at a rated point (for excavators, the points on two pump relief) on the engine which you can stably measure.
Measuring period should be 3 to 5 minutes after the engine stabilized. Measure and compare the exhaust pipe temperature of each cylinder, and judge as faulty cylinder if the temperature of certain cylinder is significantly lower than others.

Comparing exhaust pipe temperature of engine unit alone

Note:
Reference for test on engine unit. Test results will show similar tendency when trouble occurs although variation may differ depending on machine type and measuring conditions.

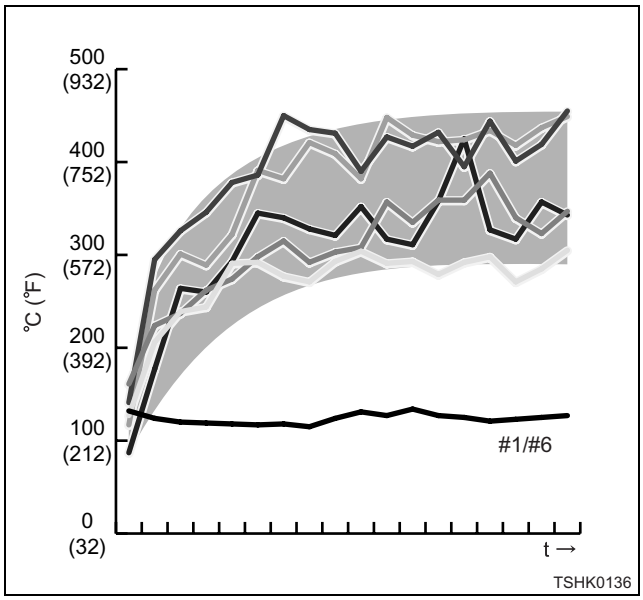
Note:
Be careful not to continue the test condition for a long time. Otherwise the test result may be incorrect due to heat conduction of the exhaust pipe.

Changes in the temperature in the normal condition



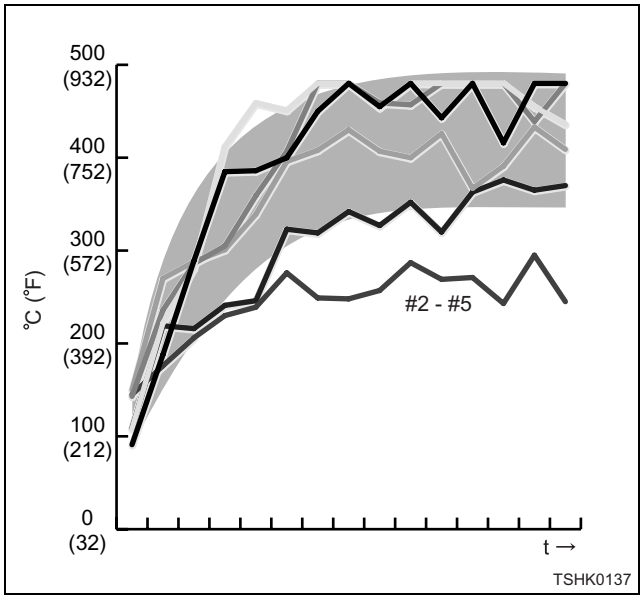
In the normal condition, the temperature of the No. 6 cylinder keeps lower than others.

Changes in the temperature when injection in 1st or No. 6 cylinder stops



When injection in No. 1 or No. 6 cylinder stops, there are significant difference in the temperature between No. 1 or No. 6 cylinder and other cylinders that perform normal injection.

Changes in the temperature when injection in one of No. 2 to No. 5 cylinders stops



When injection in one of No. 2 to No. 5 cylinders stops, the temperature of the stopped cylinder keeps lower than normal cylinders.

Refer to the relevant section for the reference value of Hitachi Construction Machinery.

How to use flash tool

Refer to related document.

How to use breaker box

Breaker box inspection procedure

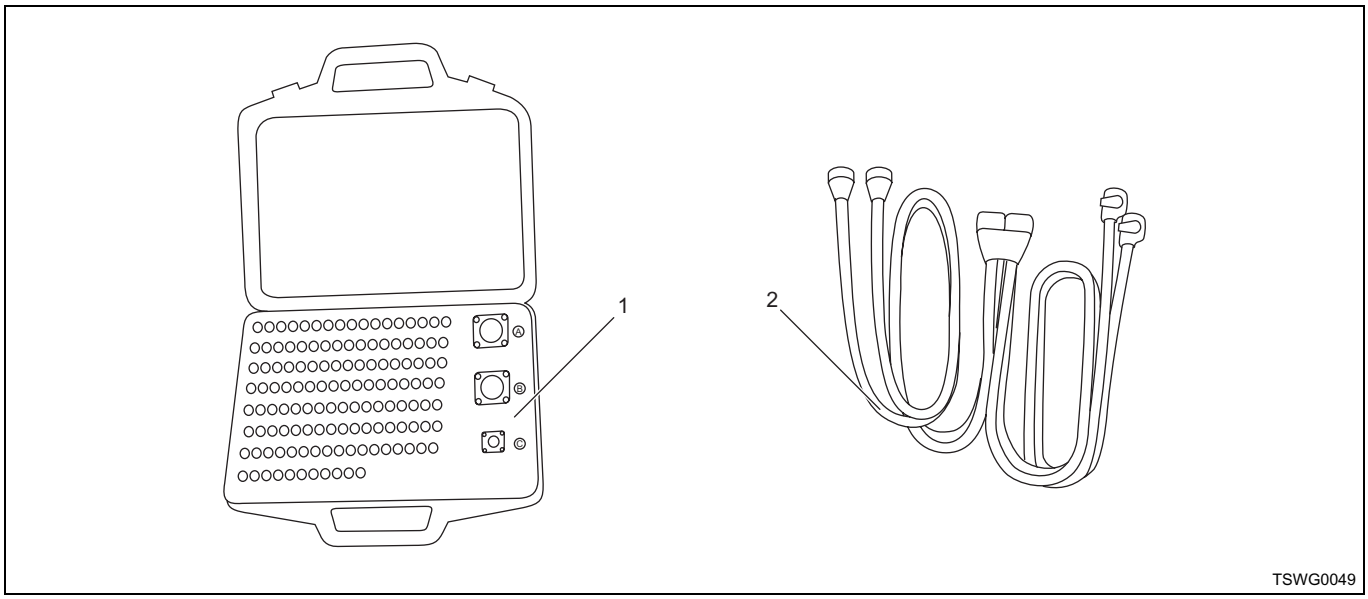
The breaker box is a tool to easily check open or short circuit in connector pin and harness between ECM and each sensor or actuator, which used to be difficult to check. Voltage and continuity on pins of ECM can be measured through breaker box using digital multi-meter (5-8840-2691-0). If a scan tool is also used, more precise inspection and service can be performed.

Important:

When inspecting or measuring the voltage and continuity of ECM, be sure to use a adapter harness which is appropriate to the breaker box and the inspected machine

- **Before inspection and measurement of ECM are performed, confirm the pin position. Otherwise the ECM may get damaged.**

Note:
The pin No. of ECM in diagnostic procedure matches with the pin No. of breaker box.

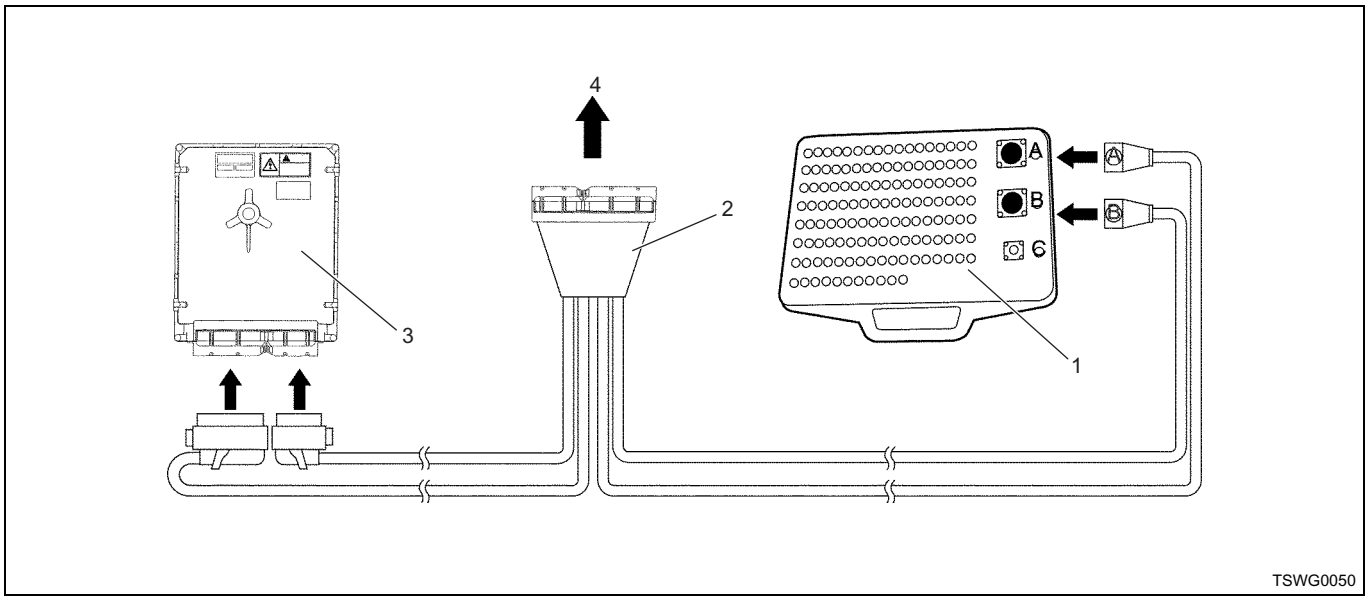


Name
1. Breaker box
2. Adapter harness

How to connect breaker box

Caution:
Be sure to turn off the key switch before the connectors are disconnected.

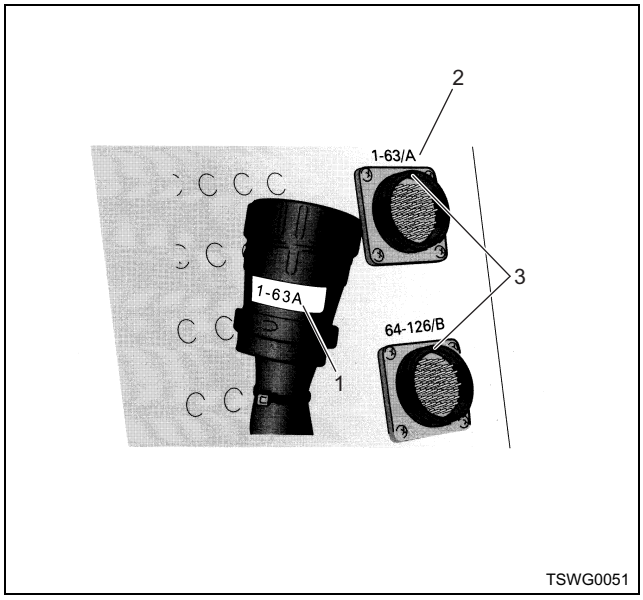
1. Disconnect the ECM connector from ECM.
2. Connect the connector of adapter harness to ECM.
3. Connect the ECM connector to adapter harness.
4. Connect the adapter harness to breaker box.



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.

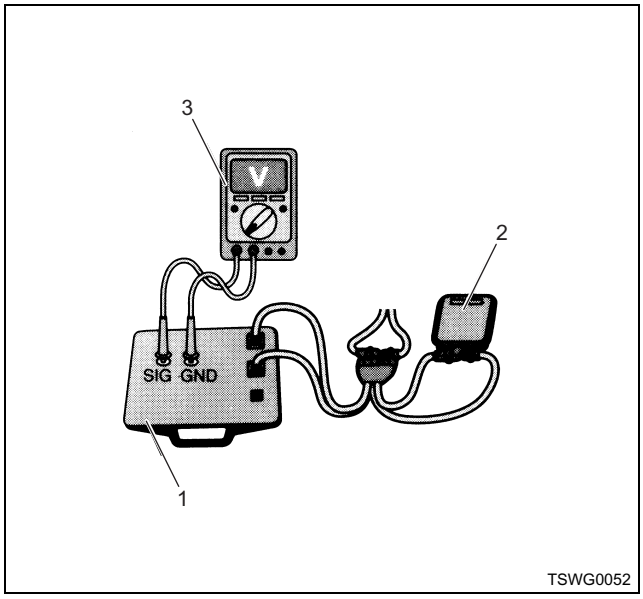
- **Connect the connector on adapter harness side to the connector of breaker box with the same No. each other.**
- **When the connecting the connector, align the cutouts of connector and breaker box each other.**



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

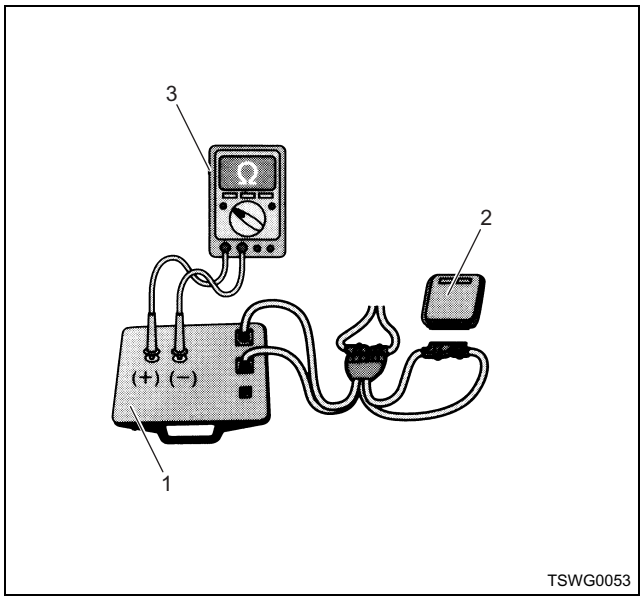
Example of use for breaker box

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

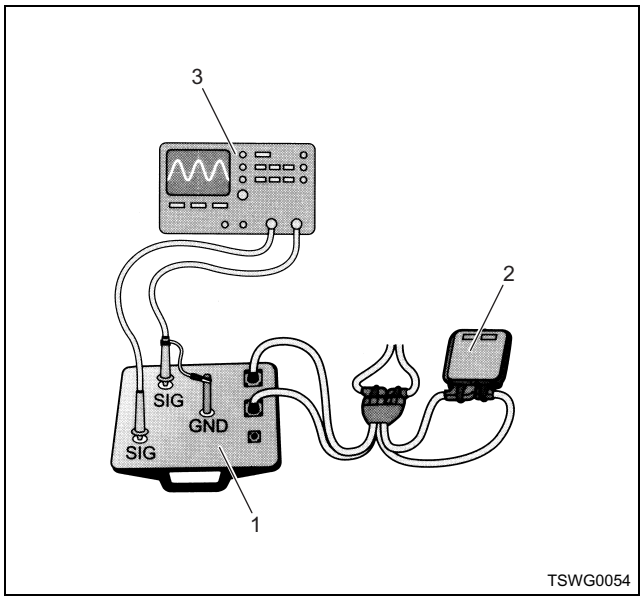
2. Inspection and measurement of resistance
   - Crank position sensor
   - G sensor
   - PCV etc.



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

---

3. Inspection and measurement with oscilloscope
   - Vehicle speed sensor signal
   - Crank position sensor signal
   - G sensor signal etc.



Name
1. Breaker box
2. ECM
3. Oscilloscope

Caution:
During inspection and measurement, interference of measurement lead on breaker box or mistaking terminal to be measured may cause damage to ECM or sensors. Work with extreme care.

Engine Control System

Description of function and operation

About engine control (common rail) system

General and detailed description in engine control system

The engine control system is electronic control system which maintains optimum combustion status of engine all the time according to operating conditions. It consists of the following components.

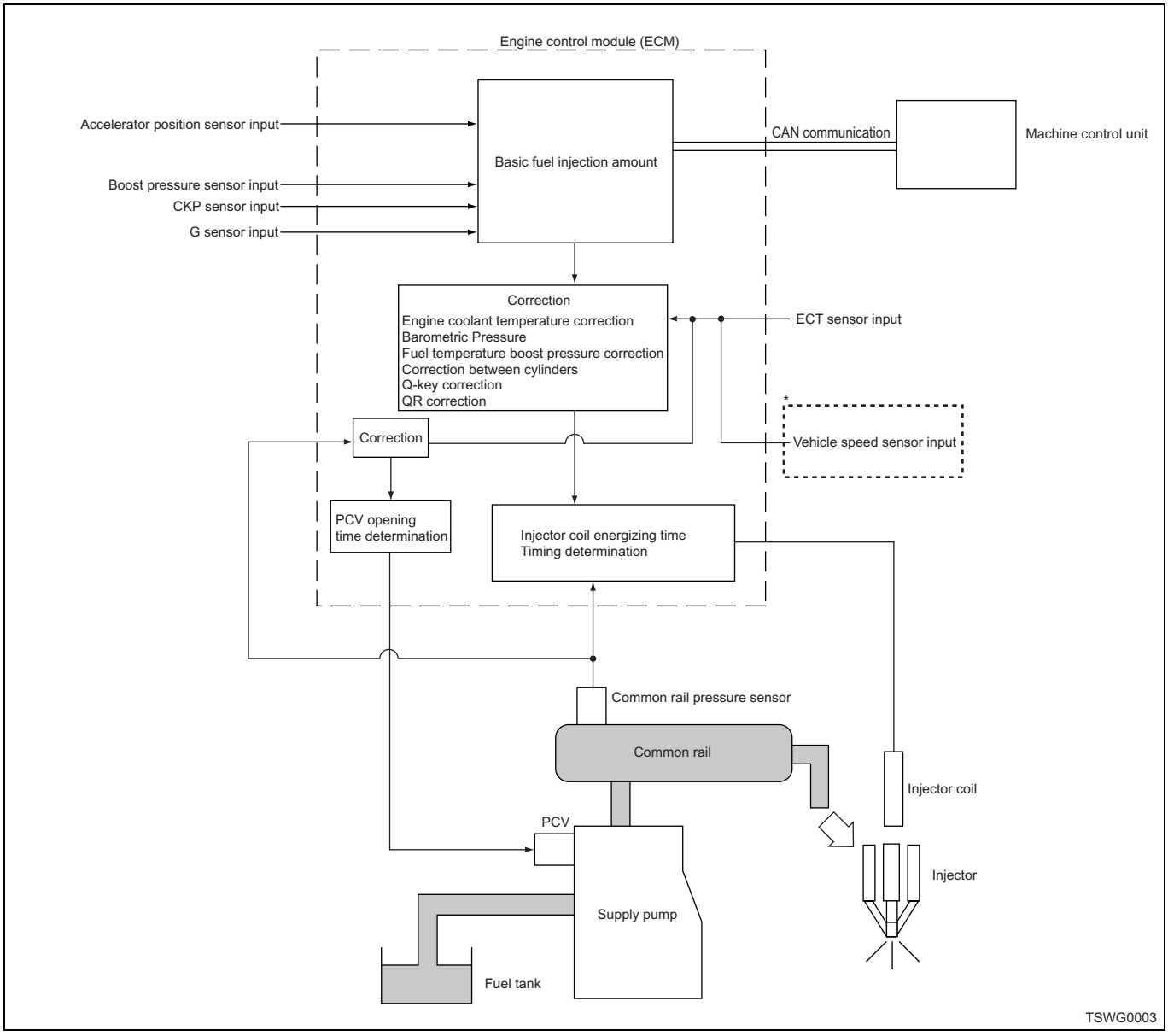
- Electronic control fuel injection system (Common rail type)
- EGR (Exhaust gas recirculation)
- Idle speed control

The engine control system also has the following system control functions other than engine control.

- QOS (Quick On Start) system
- Engine speed signal output
- Self-diagnosis function
- CAN (Controller Area Network) communication (SAE J1939/21, SAE J1939/11)

System control schematic diagram

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

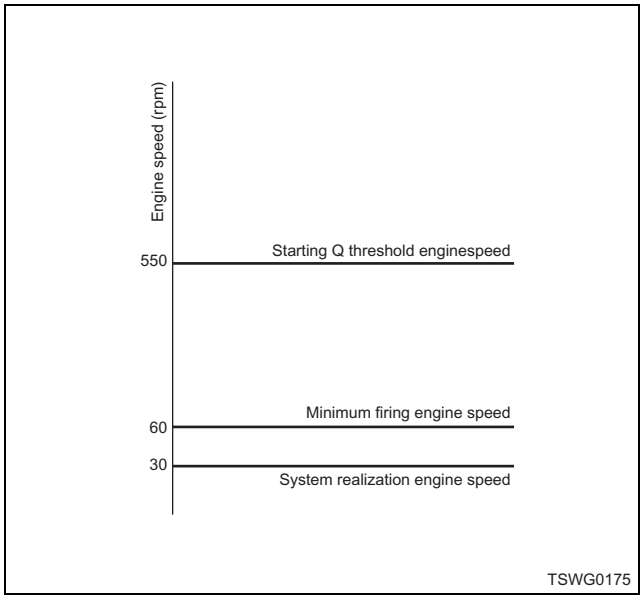


About fuel injection correction

ECM calculates the basic injection amount based on the signals from accelerator position sensor, boost pressure sensor, CKP sensor, G sensor, etc. It regulates the opening/closing period of PCV or electric conduction of injector according to the common rail pressure, engine coolant temperature, etc. at this time, to correct the optimum injection timing and injection amount.

About starting Q adjust

ECM performs starting Q adjust when the engine speed is less than the starting Q threshold value at engine starting.
Also, ECM cannot perform starting Q adjust or start the engine when the engine speed is less than the lowest speed that system can recognize, since it does not recognize engine rotation.



About high-altitude correction

ECM calculates the current altitude based on the barometric pressure sensor signal.
It corrects the optimum fuel flow according to the altitude etc. at this time.

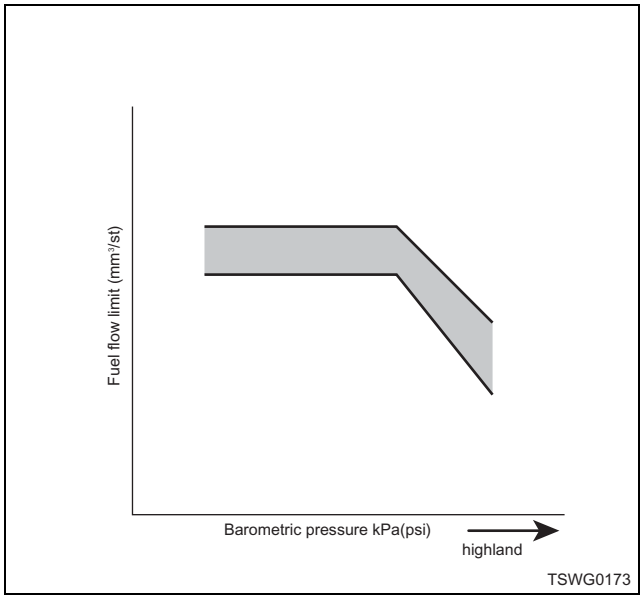
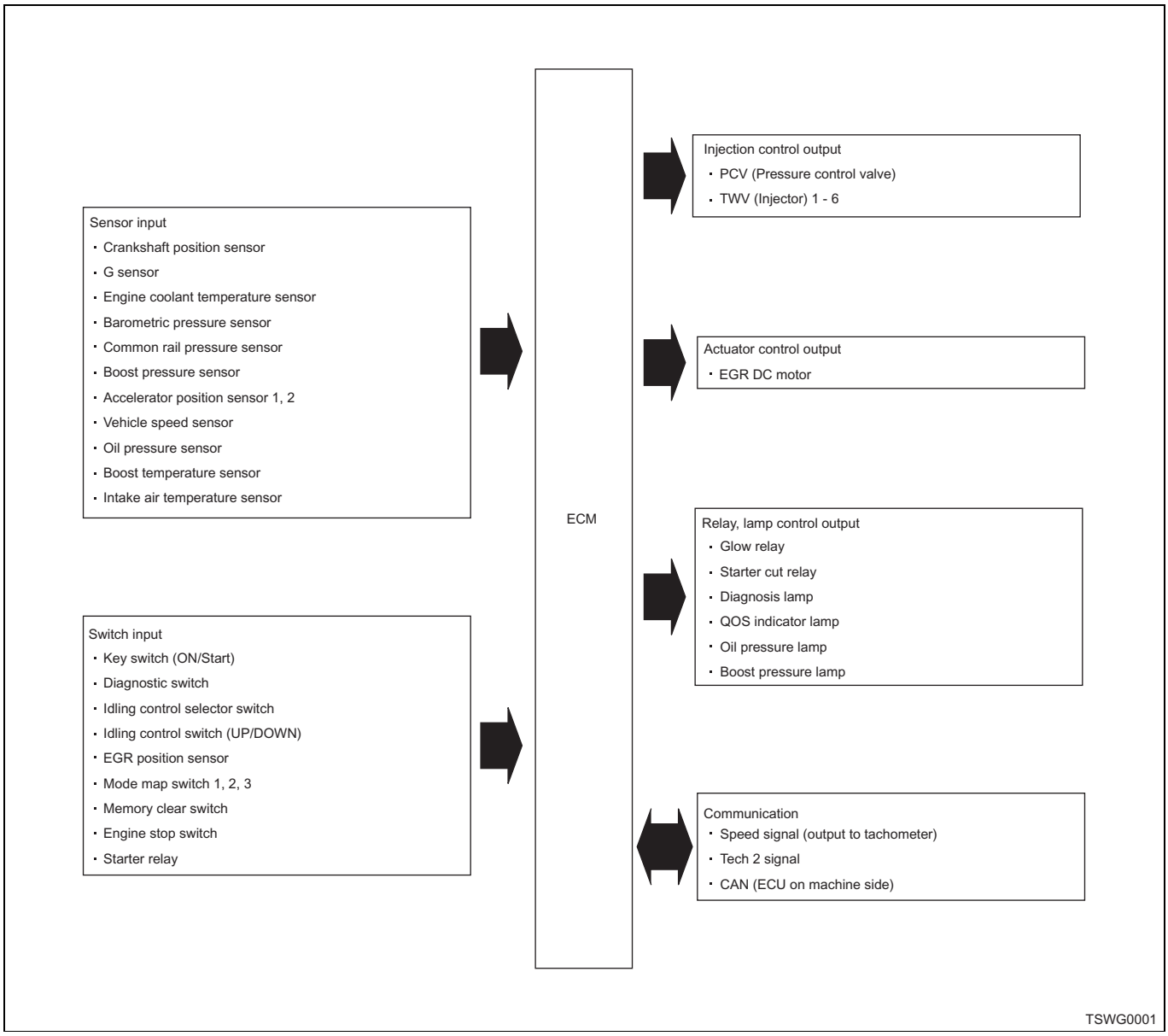


Table of Input/Output



Electronic control fuel injection system (Common rail type)

The engine control module (ECM) gets information, such as engine speed, engine load, etc. (signals from various sensors), and sends electrical signals, based on the information, to the supply pump, injector, etc. in order to properly control the fuel injection amount, injection timing, etc. in each cylinder.

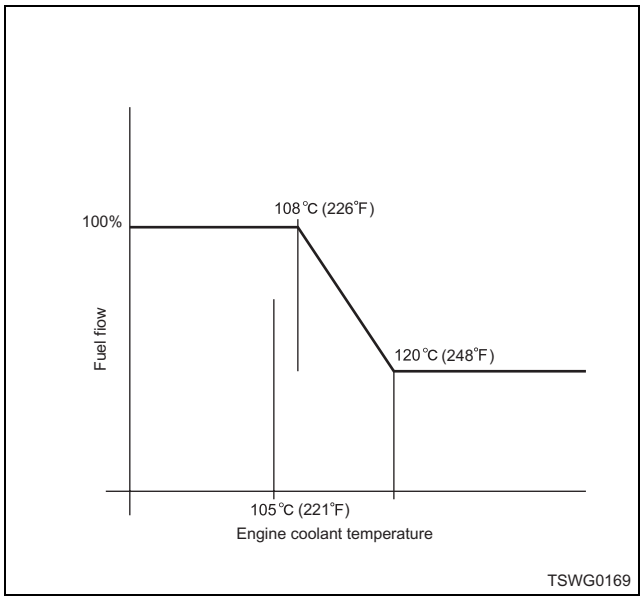
Injection amount control
The system controls the injector, mainly based on the signals from engine speed and accelerator opening angle or the designated speed of machine control unit, to maintain the optimum injection amount.

Injection pressure control
The system controls the injection pressure by controlling fuel pressure in common rail. It calculates the appropriate pressure in common rail on the basis of engine speed, fuel injection amount, etc., and discharges the proper amount of fuel by operating supply pump resulting in pressure feed to common rail.

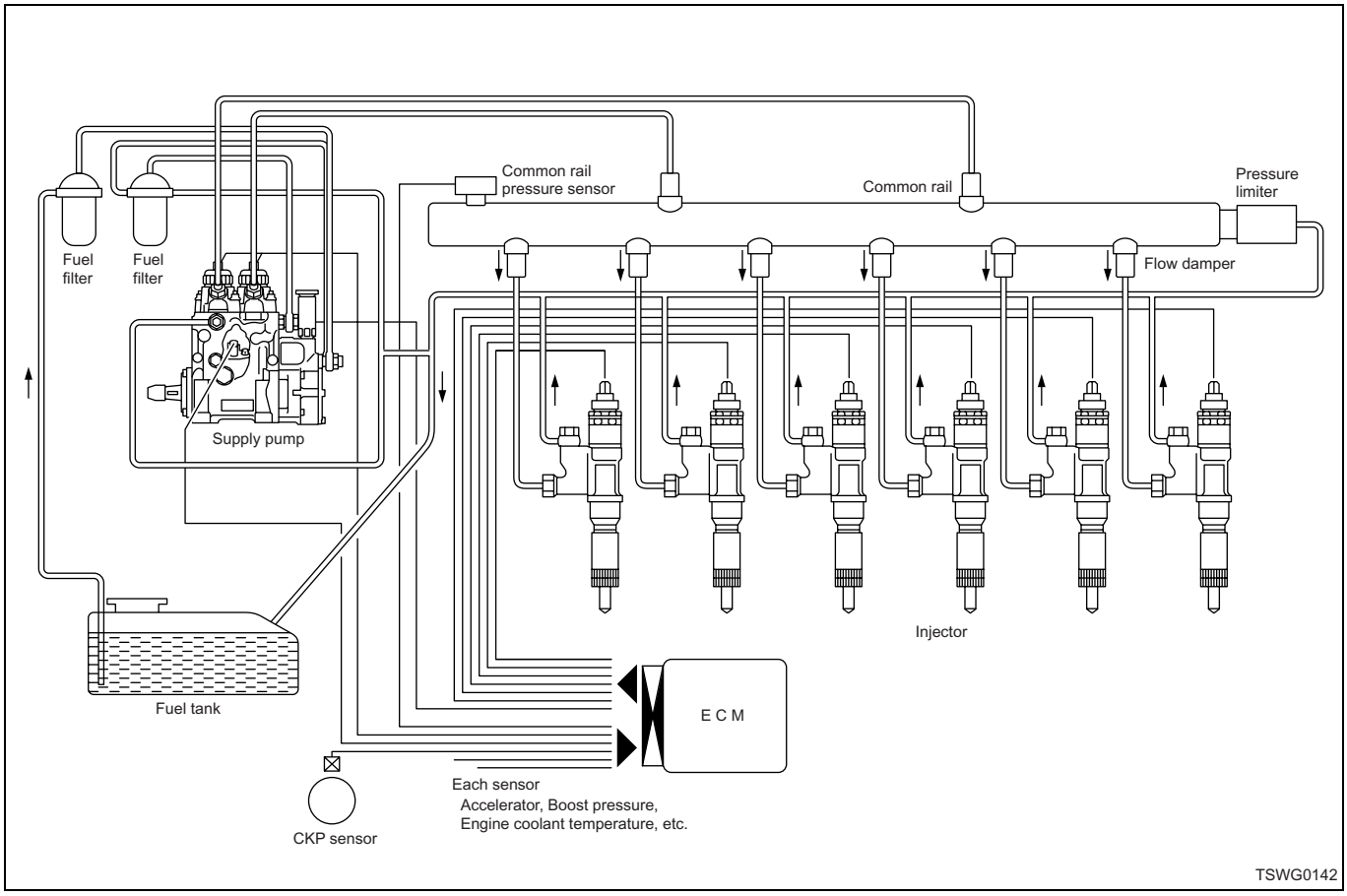
Injection timing control
This is substitute for a timer function. The system calculates the fuel injection timing on the basis of mainly engine speed, injection amount, etc. and controls the injector.

Injection rate control
To improve combustion in cylinders, the system injects a little fuel (pre-injection) and ignites it at the beginning, then perform the second injection (main injection) after the first ignition. It controls these injection timing and injection amount by operating the injector.

Control during overheat
In overheating, ECM begins to limit fuel flow when the engine coolant temperature exceeds 108°C (226°F), for engine protection. It limits fuel flow further as the engine coolant temperature goes up. Fuel flow is limited to a certain level at around 120°C (248°F).
The system raises an alarm from 105°C (221°F) for some machines. In addition to alarm, by reducing the load to the machine, it enables to avoid such conditions that the fuel flow is limited.

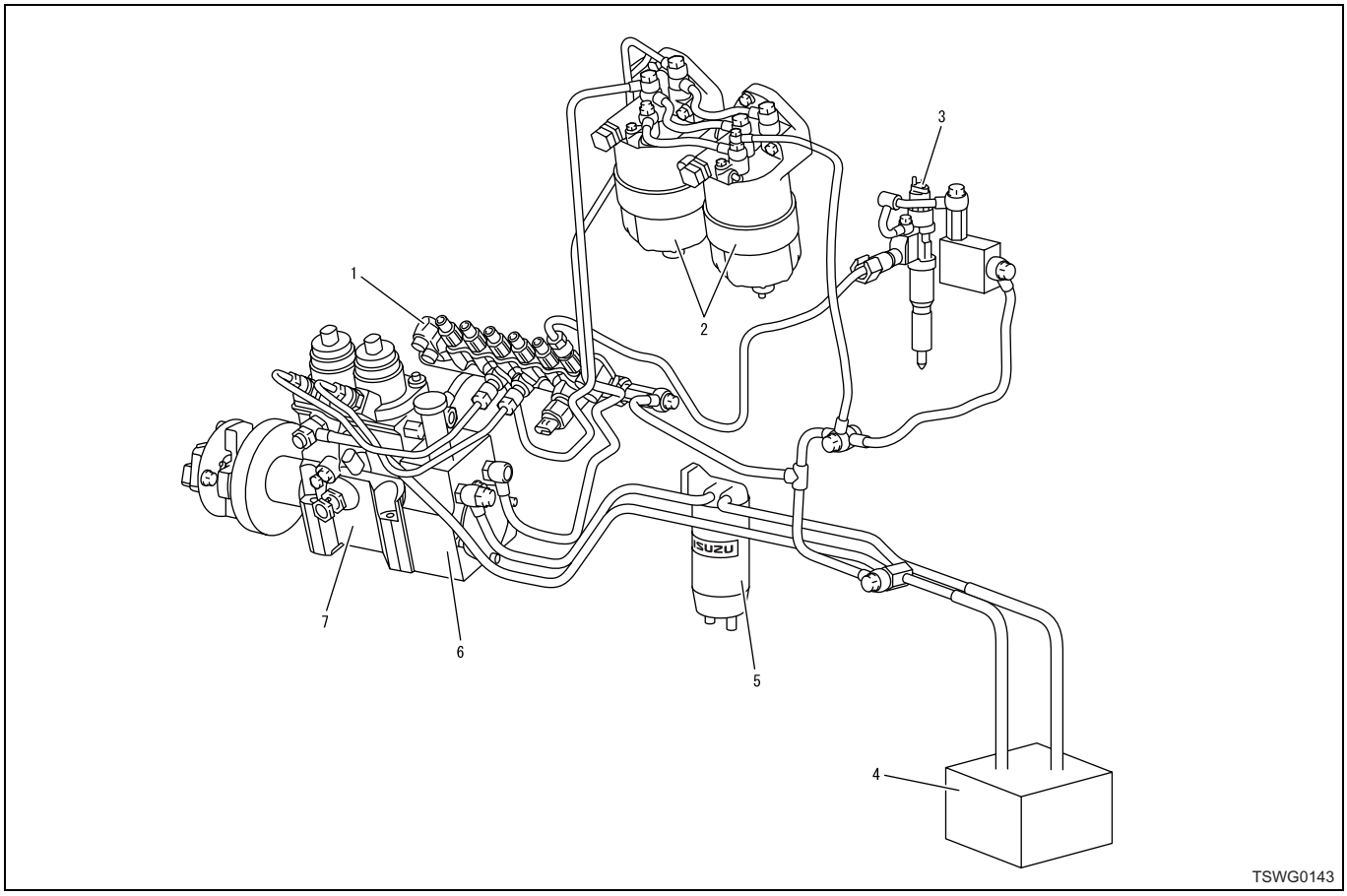


System schematic diagram



Fuel system

Fuel is supplied from fuel tank to supply pump, then supplied to common rail after pressurized by the pump. At this time, the system operates the pressure control valve (PCV) by the signal from ECM to control fuel amount supplied to common rail.



Name
1. Common rail
2. Fuel filter
3. Injector
4. Fuel tank
5. Pre-filter
6. Feed pump
7. Supply pump

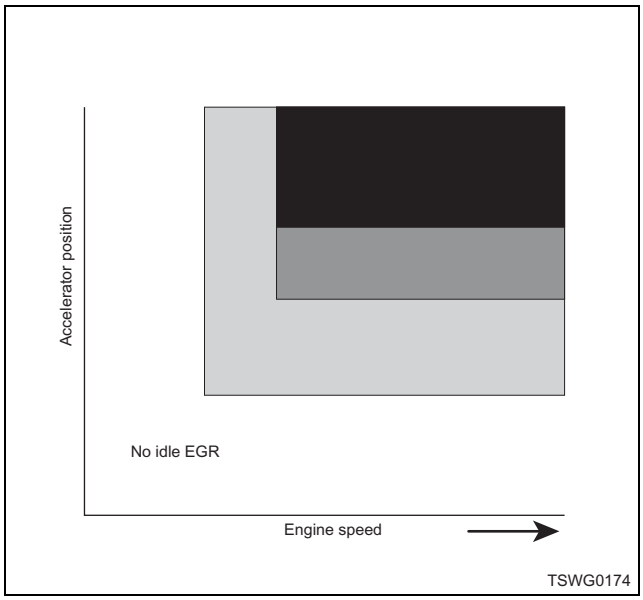
EGR (Exhaust gas recirculation)

Exhaust Gas Recirculation system is abbreviated to EGR system. It recirculates part of exhaust gas into intake manifold to mix an inert gas with intake air. This leads to lower the combustion temperature to limit emissions of nitrogen oxide (NOx).
It controls amount of EGR by opening/closing the EGR valve installed between exhaust manifold and intake manifold. It determines amount of EGR, based on the engine speed and load rate on engine (fuel injection amount), and operates the EGR valve to control the amount of EGR.
The cooling system (EGR cooler) equipped on the EGR gas passage allows to cool down high temperature EGR gas and mix it with new air to lower the combustion temperature further, resulting in limiting NOx effectively (Cooled EGR).

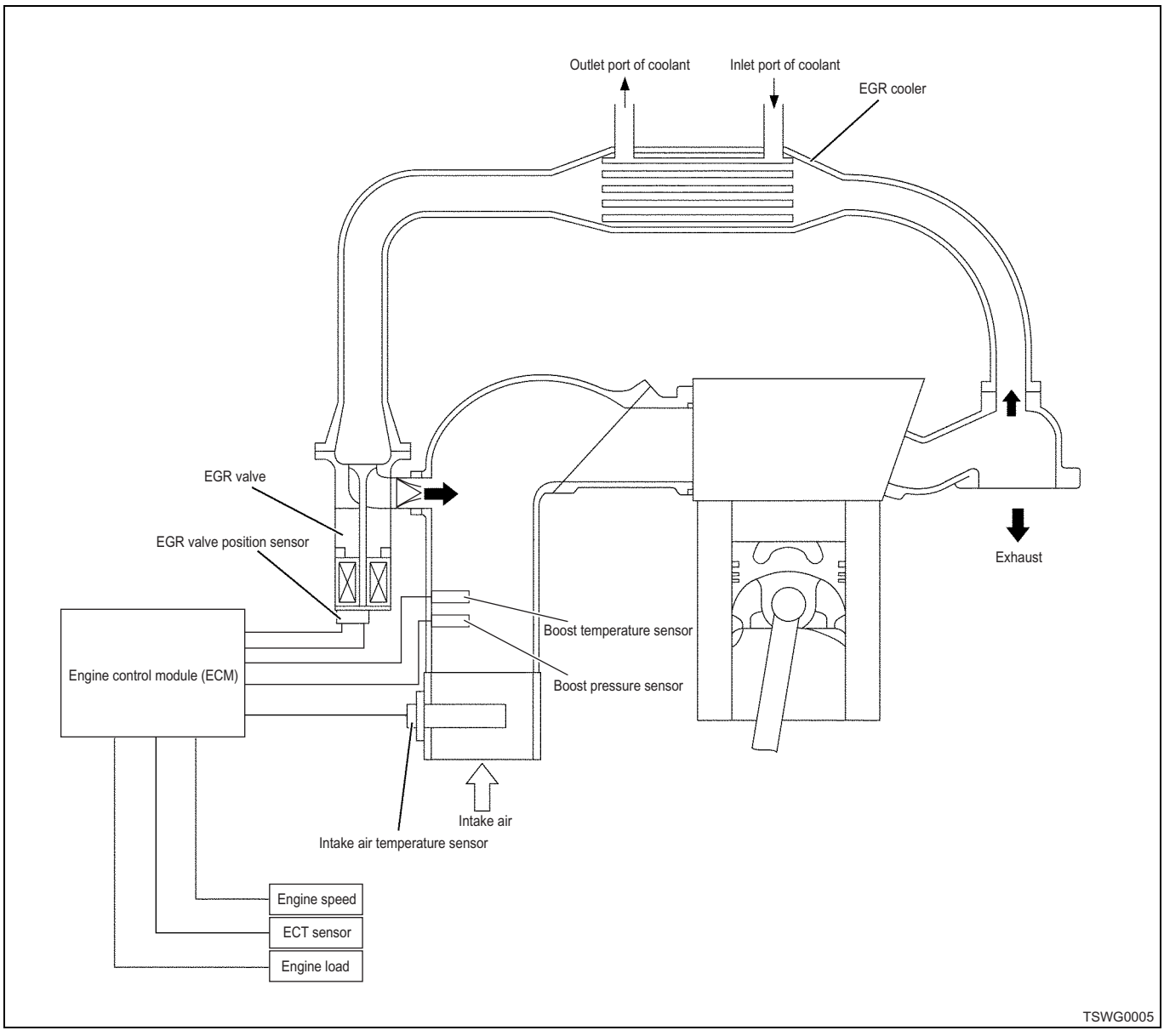
On 6WG1-TC machine, the EGR system has the check valve to stop backward flow of EGR gas and flows it in one way direction, leading to increase the amount of EGR.

EGR control

ECM operates the motor according to engine speed, engine load, etc. to control amount of EGR valve lift. Amount of valve lift is detected by EGR position sensor. The dark color area in the figure shows that the valve lift amount is large, and the darkest color area shows that the valve lift amount is almost 100%.



EGR system schematic diagram



Idling control

At warm-up operation, using the “Idling control selector switch” allows to control the lowest idling speed. Also, using the “Idling control selector switch” allows to automatically set the lowest idling speed to the optimum value according to engine coolant temperature.

Note:
Since specifications vary depending on each machine. Available functions also vary.

Idling control selector switch

Using the “Idling control selector switch” allows to switch the idling control function.

Idling control switch

Using the “Idling control switch” allows to control the idling speed.

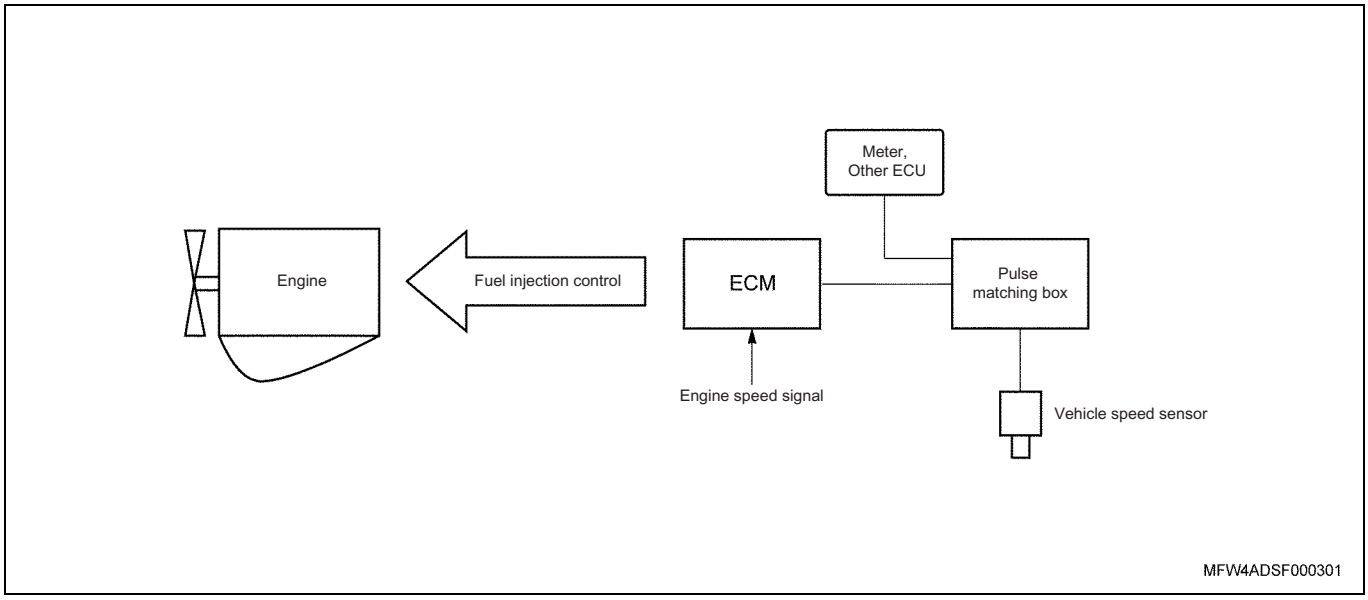
Note:
Refer to the machine’s manual for the locations of idling control selector switch and idling control switch.
The highest speed varies depending on engine model, machine specifications and warm-up condition of engine.

UP
While pressing the “UP” side of switch, the engine speed increases, resulting in increasing the idling speed.

DOWN
While pressing the “DOWN” side of switch, the engine speed decreases, resulting in decreasing the idling speed. However, the idling speed does not decrease below the lowest speed.
The engine speed controlled by idling control switch is stored in ECM when the key switch is turned to OFF. The same speed can be achieved at the next operation.

Speed limit control

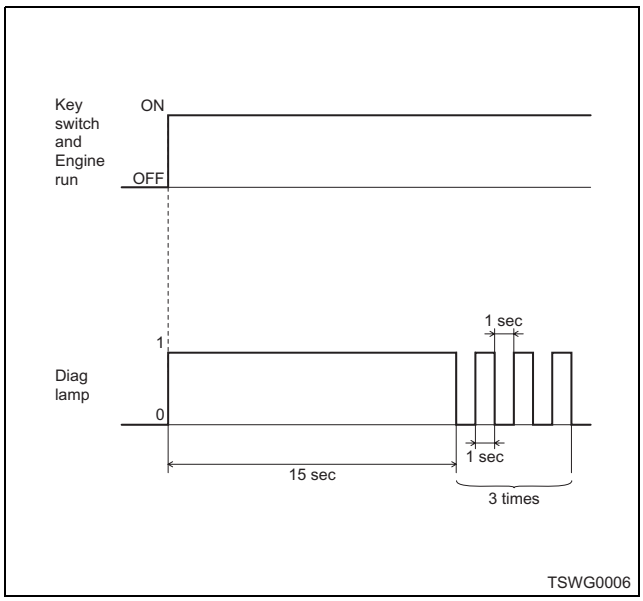
Speed limit control means that the engine control module (ECM) controls fuel injection amount, based on vehicle speed signal and engine speed, so that the machine speed does not exceed the setting value.
The vehicle speed signal is sent from vehicle speed sensor to pulse matching box. The pulse matching box corrects the signal to match with the machine, and sends it to ECM, meter, etc. The ECM recognizes the engine speed by the signal from crankshaft position (CKP) sensor.



Check for speed limit control

To check whether the speed limit control on the machine is active, check blinking of diagnosis lamp.

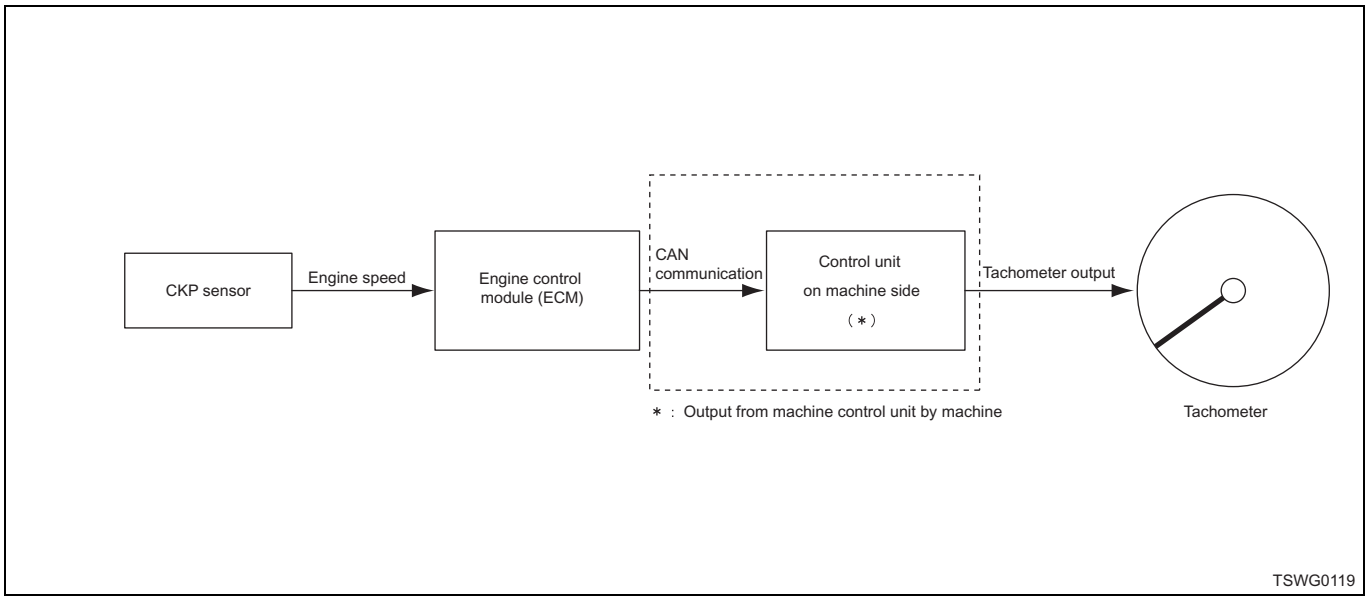
1. Turn the key switch to OFF.
2. Turn the key switch to ON.
3. Diagnosis lamp illuminates for 15 seconds and then blinks three times.



Note:
If it does not blink, the speed limit control is not active.

Engine speed output to tachometer

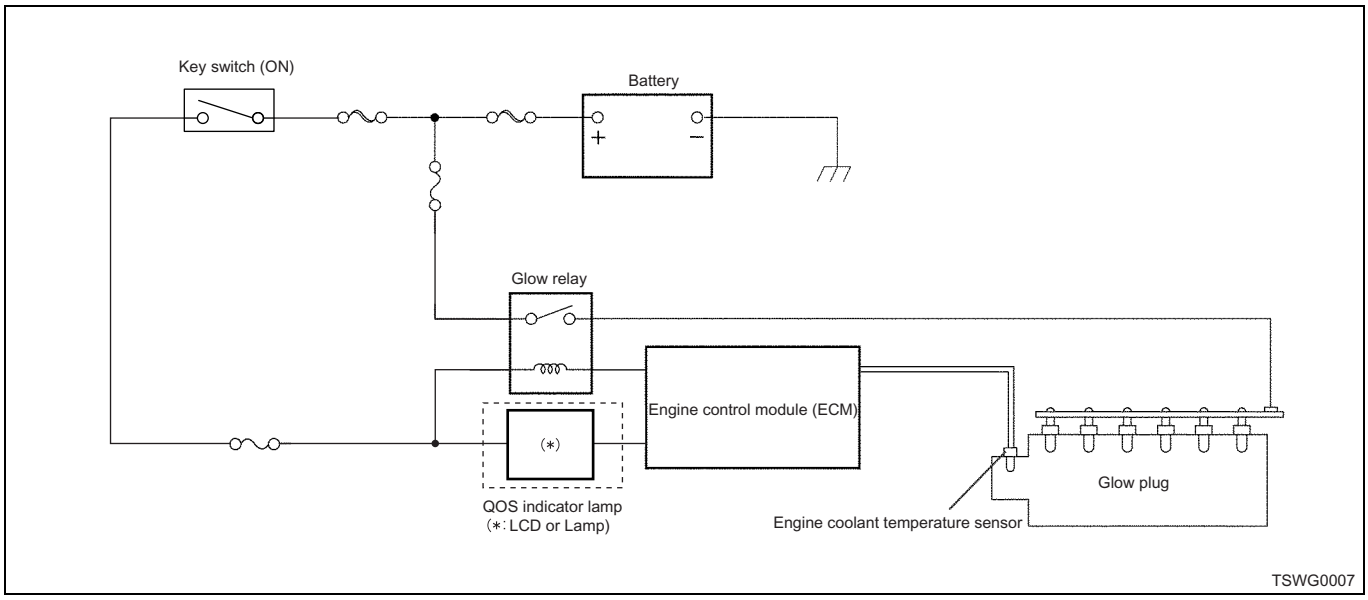
The engine control module (ECM) outputs the engine speed pulse (4 pulses per engine revolution) as a tachometer output to tachometer. Tachometer shows the engine speed using the engine speed pulse sent from ECM.



Preheating control

QOS (Quick On Start) system

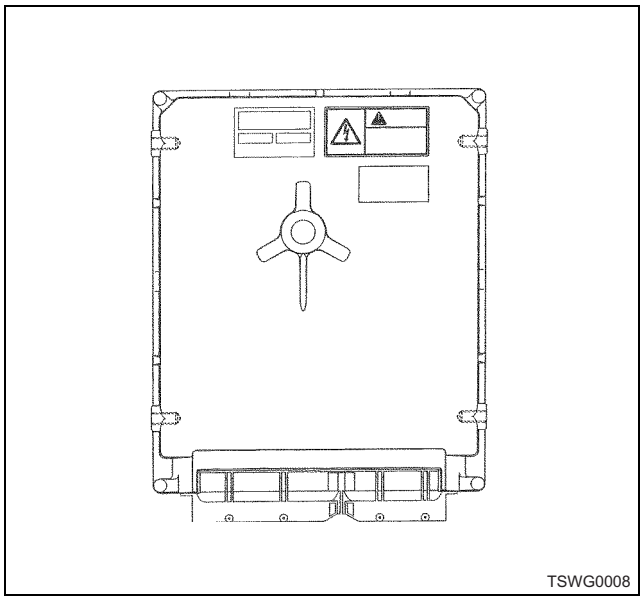
The ECM determines the period required for glow (pre-glow, glow, after-glow), and operates the glow relay and QOS indicator lamp. QOS system allows to make the starting at cold weather easier and reduce white smoke and noise at starting. When turning the key switch to ON, the ECM detects the engine coolant 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.

ECM voltage

The ECM energizes standard voltage to various switches and sensors. The resistance value of the ECM is quite high so that the ECM can energize a voltage like this. The voltage actually applied to the circuit is low, and it does not sometimes comes on even if the test light is connected to the circuits. The voltmeter usually used in a service shop may not indicate a correct reading because the input impedance is too low. A digital multi-meter which has an input impedance of 10 MΩ (e.g. 5-8840-2691-0) should be used to get an correct reading of the voltage.

Electrically erasable programmable read only memory (EEPROM)

EEPROM has programs which is necessary for ECM to control the operation of powertrain and information for calibration.
If fault is found in the EEPROM, replace the ECM.
Examples of programs to control powertrain and information for calibration in ECM are the following items.

- Engine model
- Engine number
- ECM part number
- DTC
- Learning value for interval correction of cylinders
- QR
- Q-key
- Learning value for EGR correction

Precautions on ECM service work

Note:

- **Be sure to use the ECM with the part number corresponding to the machine.**
- **If performing welding on the machine, disconnect the battery cable from the negative terminal beforehand.**

The ECM is designed to sustain normal consumption of current relating to the operation of the machine. Circuits should not be overloaded. In case of testing of open and short circuits, the circuits of the ECM must not be connected to the ground or be supplied with voltage except that there is such an instruction. Be sure to use a digital multi-meter (5-8840-2691-0) when performing the tests of these circuits.

Removal of ECM

1. Turn the key switch to OFF.
2. Disconnect the battery cable from negative terminal.
3. Remove the parts (relay etc.) around the ECM to facilitate removal of it.
4. Disconnect the ECM connector from ECM. (81-pin, 40-pin connectors)
5. Loosen the installing bolts (nuts) and remove the ECM.

Note:
Installation method and locations vary depending on each machine. Refer to the machine's manual.

Installation of ECM

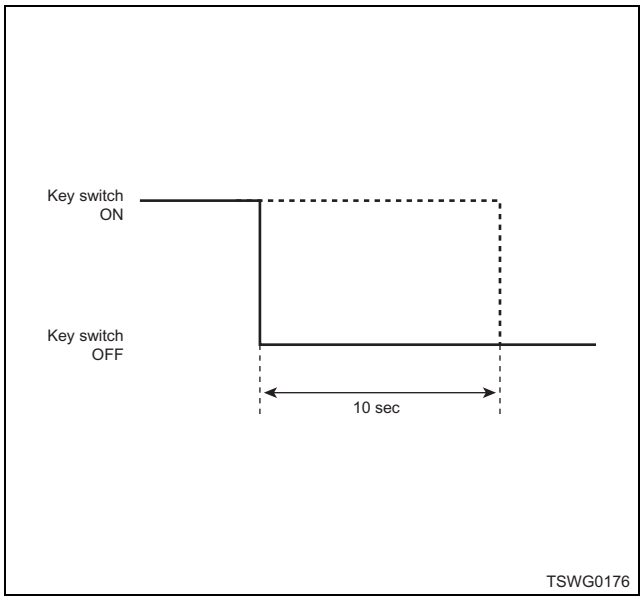
Install the ECM in the reverse order of removal.
EGR valve position learning is required after replacing the ECM.

1. Turn the key switch to "ON".
2. Turn the key switch to "OFF".
3. Leave as it is for 10 seconds.

Failure to perform the EGR valve position learning may result in detection of DTC for EGR.

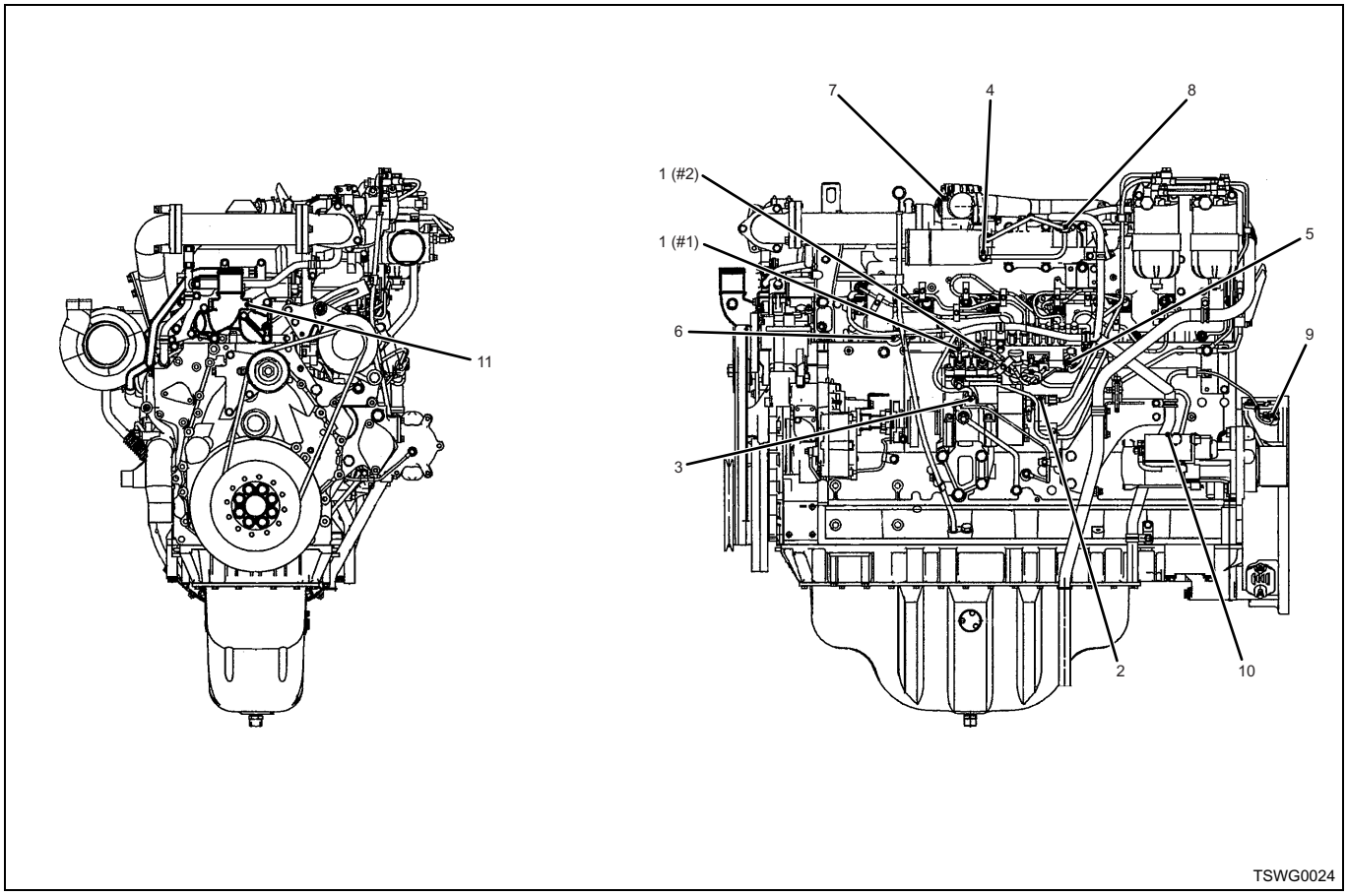
About ECM power off

The power supply inside the ECM does not go off for about 10 seconds after turning the key switch OFF. If the ECM power needs to be off such as for memory clear, wait for more than 10 seconds after turning the key switch OFF.



Engine component location diagram

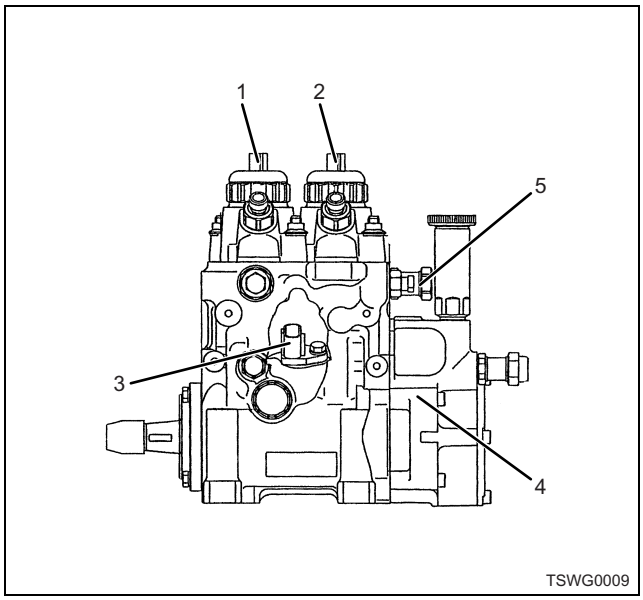
(Component location, its form and parts to be used vary depending on each machine.)



Name

1. Pressure control valve (PCV #1, PCV #2)
2. Fuel temperature (FT) sensor
3. G sensor
4. Boost temperature sensor
5. Common rail pressure sensor
6. Engine coolant temperature (ECT) sensor
7. EGR valve
8. Boost pressure sensor
9. CKP sensor
10. Engine oil pressure sensor
11. Overheating switch

Supply pump

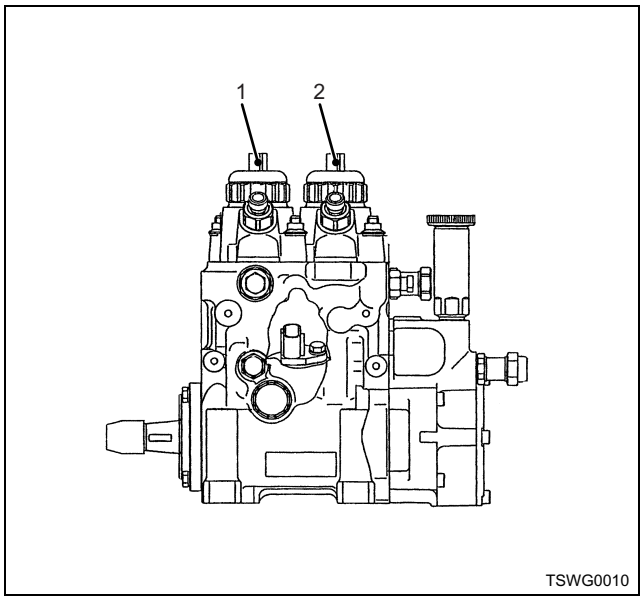


Name
1. PCV #1
2. PCV #2
3. G sensor
4. Feed pump
5. Fuel temperature (FT) sensor

The supply pump pressurizes fuel using engine output, and pressure-feeds fuel to common rail. Supply pump has also PCV (pressure control valve), fuel temperature (FT) sensor and feed pump.

Note:
For work procedure, refer to "Engine section" in the service manual.

PCV (pressure control valve)

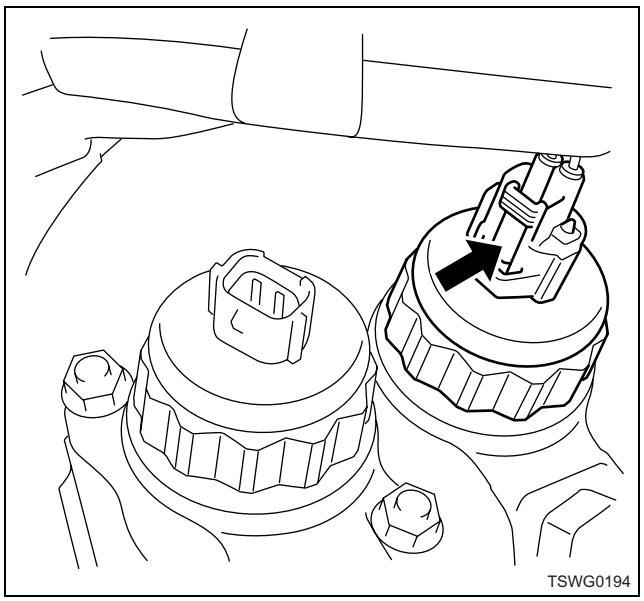


Name
1. PCV #1
2. PCV #2

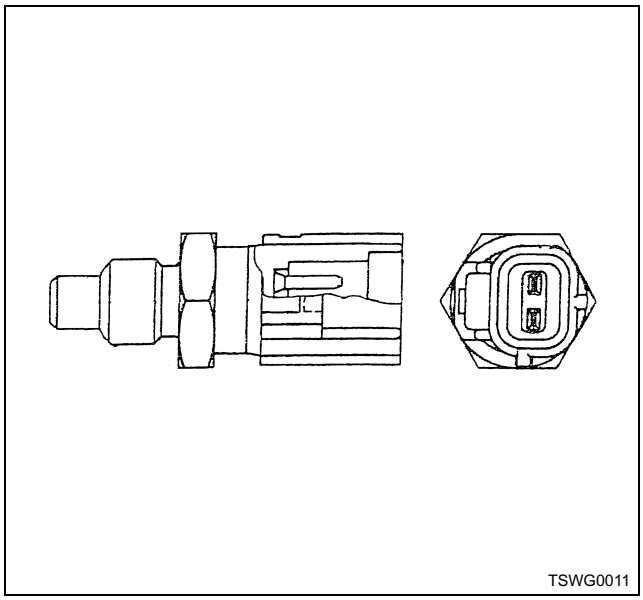
The PCV (pressure control valve) is installed onto supply pump section and controls pressure feed of fuel (discharge amount) to common rail. The engine control module (ECM) regulates period of electric conduction of PCV to regulate the fuel discharge amount.

Removal

- Do not replace the PCV.
- If it is faulty, replace it as supply pump ASM.



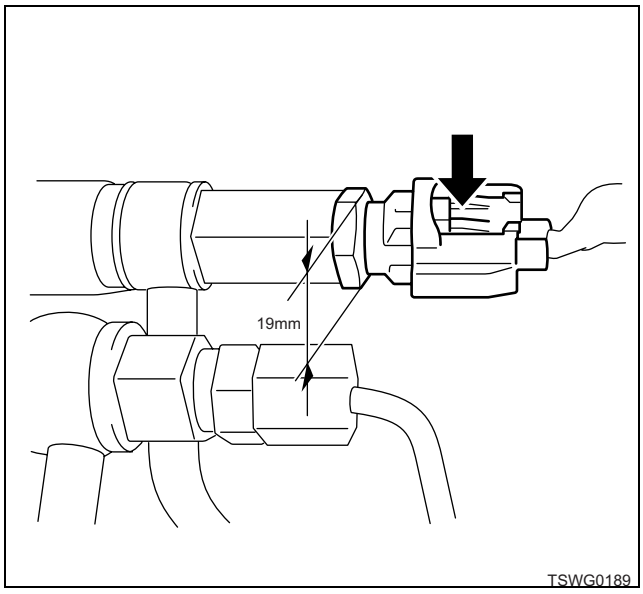
Fuel temperature (FT) sensor



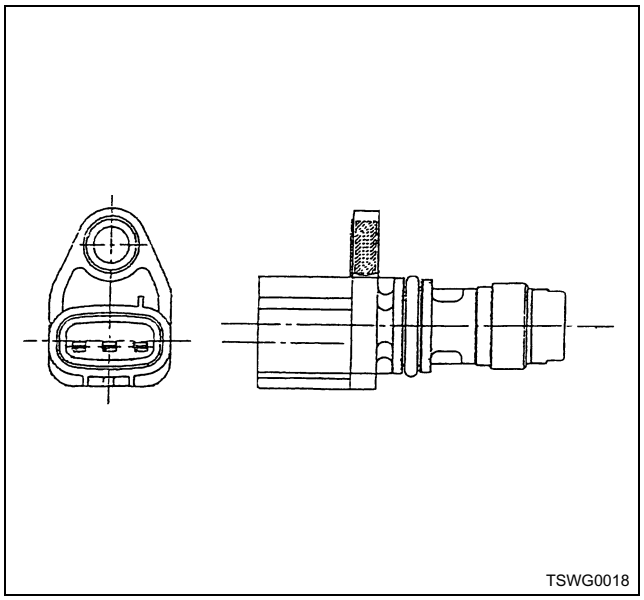
The fuel temperature (FT) sensor is installed onto fuel inlet port of supply pump, and the thermistor changes the resistance according to the temperature. The resistance is low when the fuel temperature is high, and is high when the temperature is low. The engine control module (ECM) energizes the voltage (5 V) to the FT sensor through pull up resistance, and calculates fuel temperature based on change of voltage to use for various controls such as supply pump 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.

Removal

- Disconnect the connector and remove it with 19mm-wrench



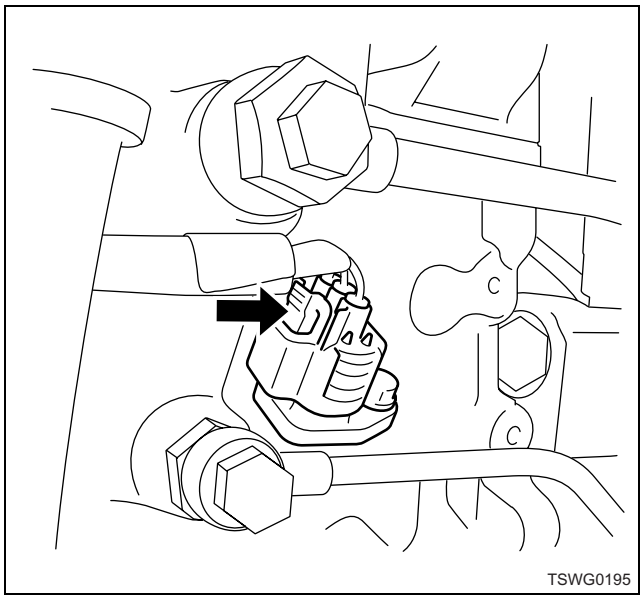
G sensor



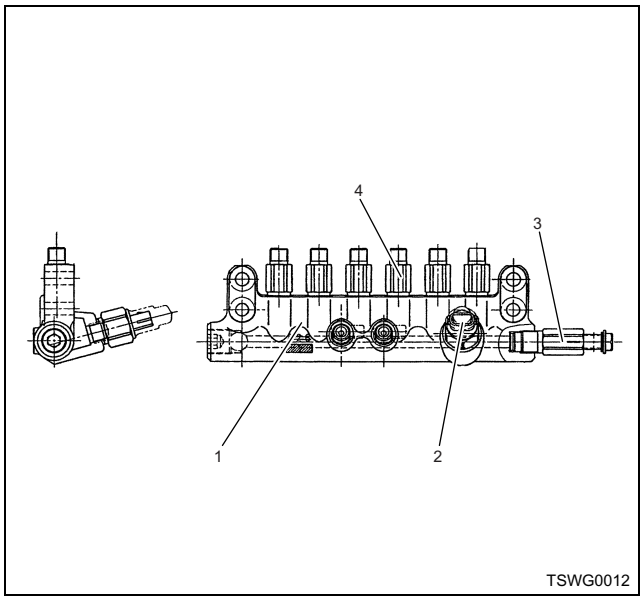
The G sensor is installed onto supply pump and produces the CMP signal when the cam portion of camshaft passes the sensor. The engine control module (ECM) distinguishes the cylinders by the G signal input from G sensor, determines the crank angle and uses the signal to control fuel injection and calculate the engine speed. These controls is performed, usually based on CKP signal. However it is done by G sensor if the CKP sensor is faulty.

Removal

- Do not replace the G sensor.
- If it is faulty, replace it as supply pump ASM.



Common rail

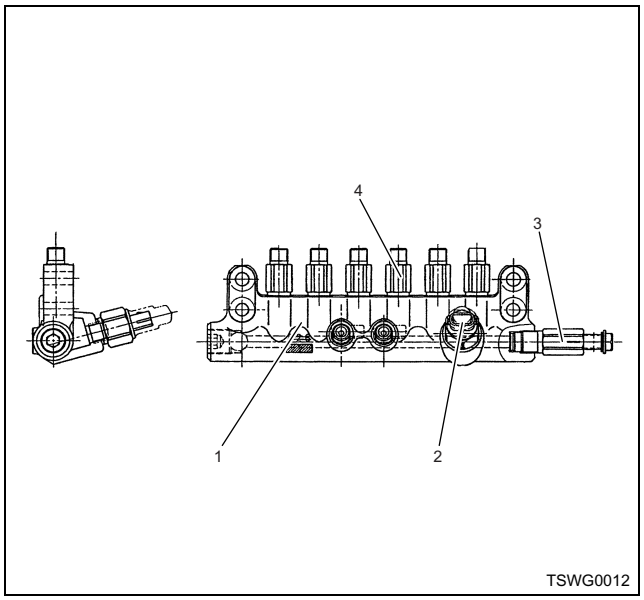


Name
1. Common rail
2. Common rail pressure sensor
3. Pressure limiter
4. Flow damper

The common rail receives fuel from supply pump, holds the common rail (fuel) pressure and distributes fuel to each cylinder. The common rail has common rail pressure sensor, flow damper and pressure limiter.

Note:
For work procedure, refer to "Engine section" in the service manual.

Flow damper



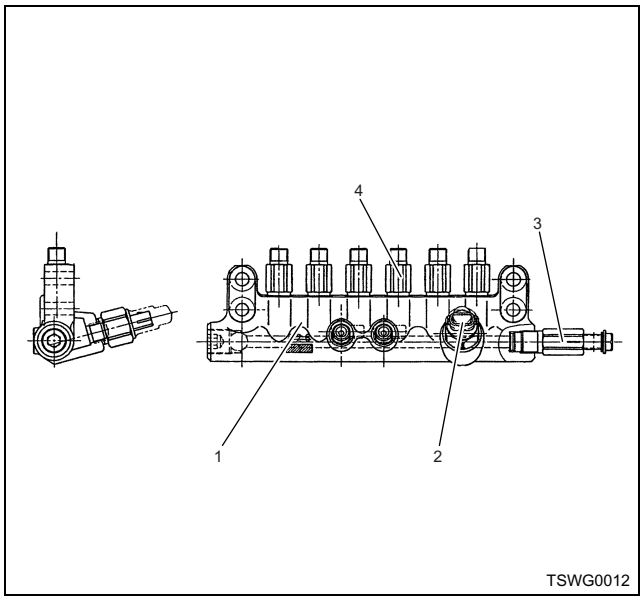
Name
1. Common rail
2. Common rail pressure sensor
3. Pressure limiter
4. Flow damper

The flow damper is installed onto outlet port to each injector of common rail, limits pressure pulsation in common rail and prevents over-injected fuel from injector. When the flow damper operates, fuel supply to injector is stopped.

Removal

- Do not replace the flow damper.
- If it is damaged, replace it as common rail ASM.

Pressure limiter



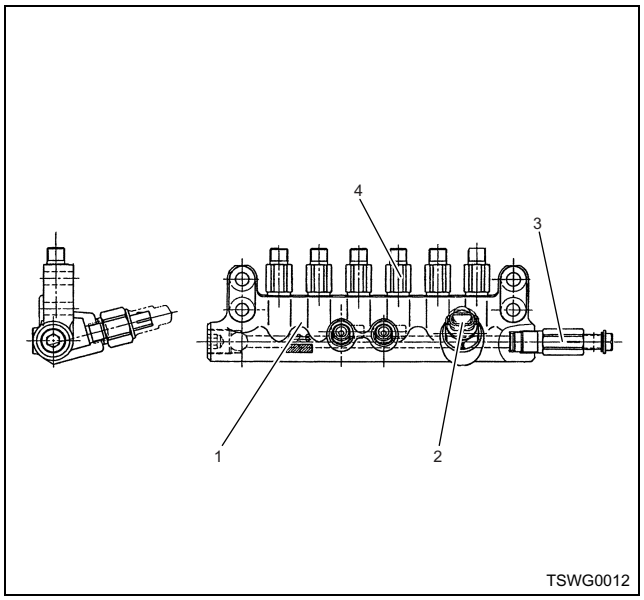
Name
1. Common rail
2. Common rail pressure sensor
3. Pressure limiter
4. Flow damper

The pressure limiter operates to release the pressure in common rail when the pressure becomes extremely high.

Removal

- Do not replace the pressure limiter.
- If it is damaged, replace it as common rail ASM.

Common rail pressure sensor

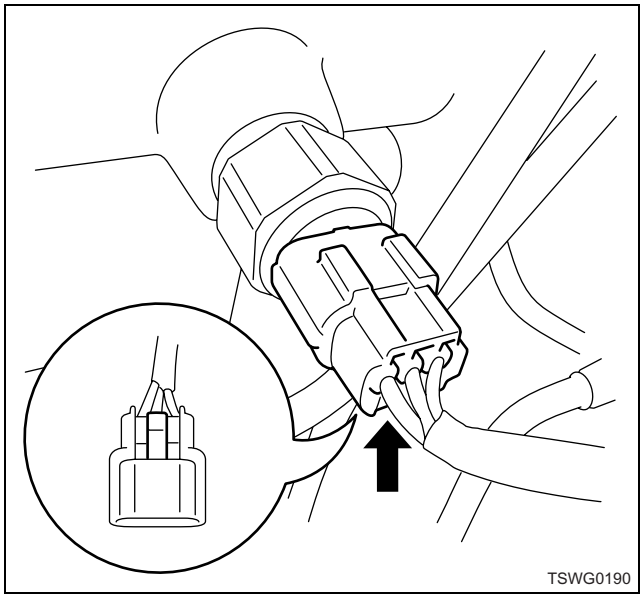


Name
1. Common rail
2. Common rail pressure sensor
3. Pressure limiter
4. Flow damper

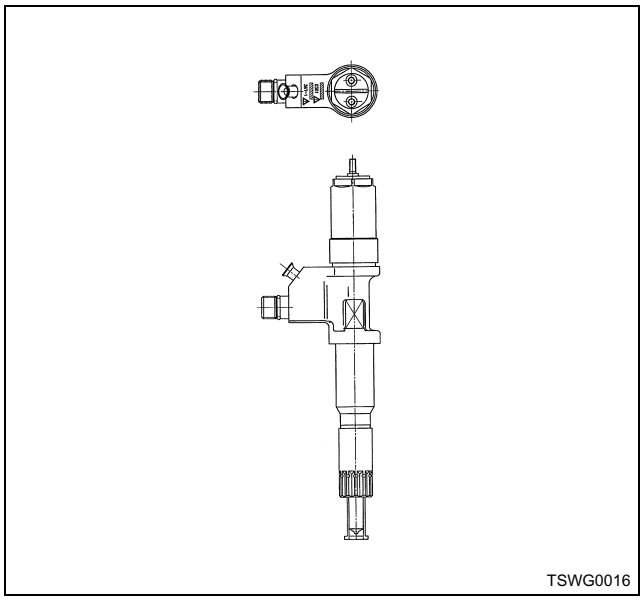
The common rail pressure sensor is installed onto common rail, detects fuel pressure in common rail, converts the pressure into the voltage signal and sends it to engine control module (ECM). Voltage becomes higher as pressure becomes higher, and lower as one does lower. ECM calculates the actual common rail pressure (fuel pressure) based on the voltage signal sent from sensors and uses it for fuel injection control etc.

Removal

- Do not replace the common rail pressure sensor.
- If it is damaged, replace it as common rail ASM.



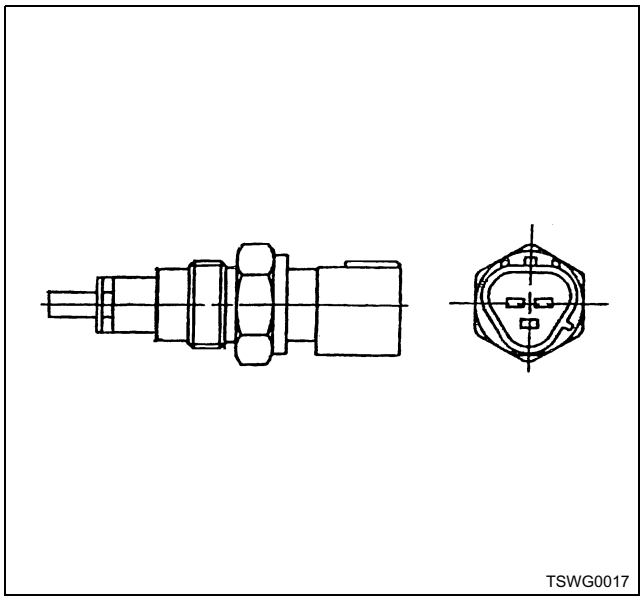
Injector



The injector is installed onto cylinder head section and is controlled by engine control module (ECM) to inject fuel. The ECM raises the voltage for operating injectors internally, energizes to injector, and regulates period of electric conduction of injector to control fuel injection amount and injection timing.

Note:
For work procedure, refer to "Engine section" in the service manual.

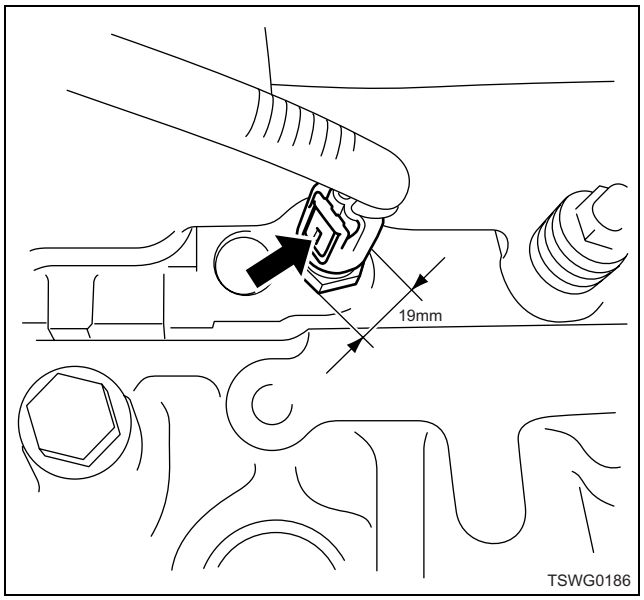
Engine coolant temperature (ECT) sensor



The engine coolant temperature (ECT) sensor is installed onto engine block, and the thermistor changes the resistance according to the temperature. Resistance is low at high engine coolant temperature and high at low engine coolant temperature. The engine control module (ECM) energizes the voltage (5 V) to the ECT sensor through pull up resistance, and calculates engine coolant temperature based on change of voltage to use for various controls such as fuel injection 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.

Removal

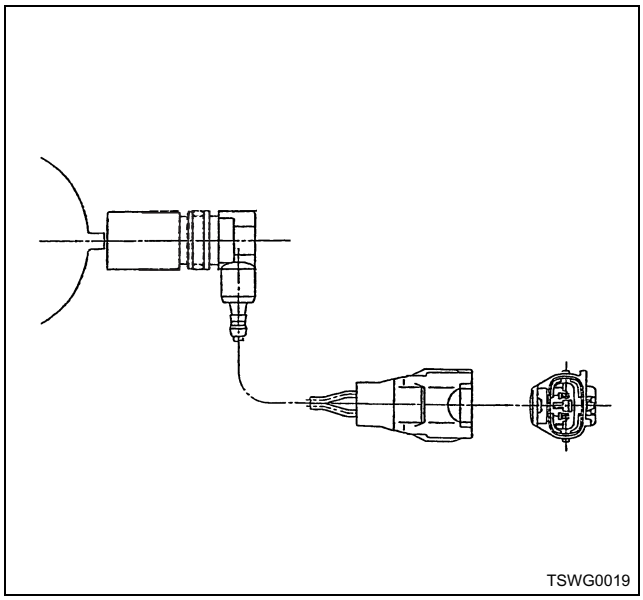
- Disconnect the connector and remove it with 19mm-wrench



Installation

- Apply Loctite 572 before installing it.
  Tightening torque: 19.6 — 29.4 N·m {2 — 3 kg·m/ 14 — 22 lb·ft}

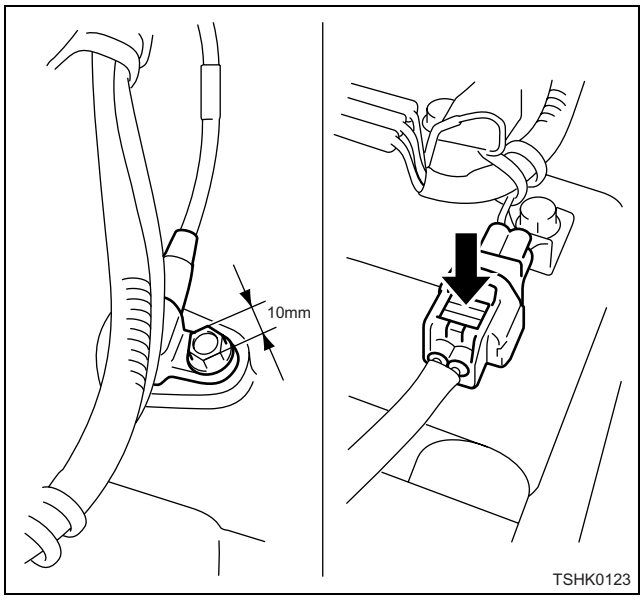
Crankshaft position (CKP) sensor



The crankshaft position (CKP) sensor is installed onto flywheel housing and produces the CKP signal when the convex portion of flywheel passes the sensor. The engine control module (ECM) distinguishes the cylinders by the G signal input from G sensor, determines the crank angle and uses it to control fuel injection and calculate the engine speed. These controls is performed, usually based on CKP signal. However it is done by G sensor if the CKP sensor is faulty.

Removal

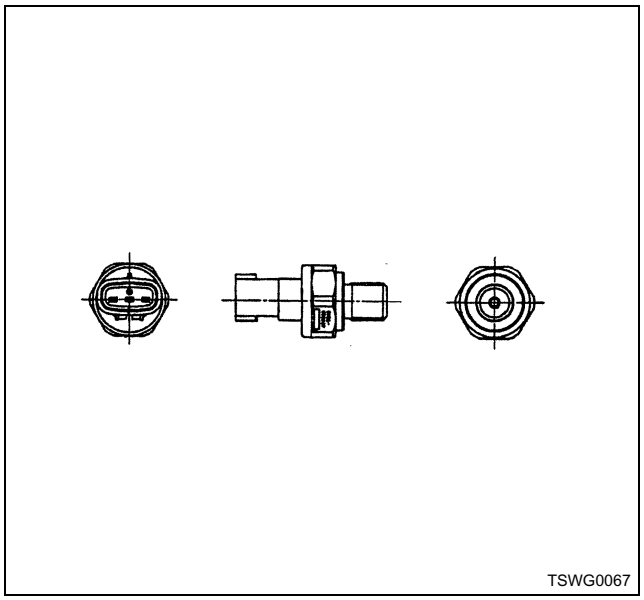
- Disconnect the connector, and remove the 10mm-mounting bolt and sensor.



Installation

Tightening torque: 14.7 — 24.5 N·m {1.5 — 2.5 kg·m/11 — 18lb·ft}

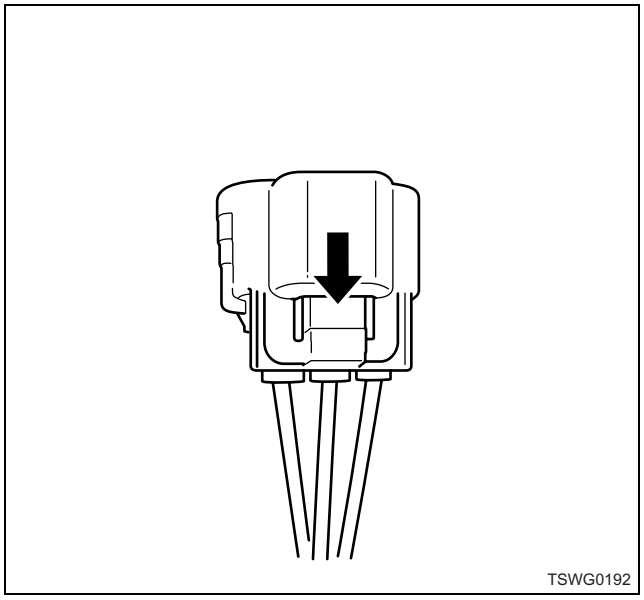
Engine oil pressure sensor



The engine oil pressure sensor is installed near the starter motor of the cylinder block; it detects engine oil 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.

Removal

- Disconnect the connector, and remove the 27mm-mounting bolt and sensor. (Lock position of the connector is the lower side)



Installation

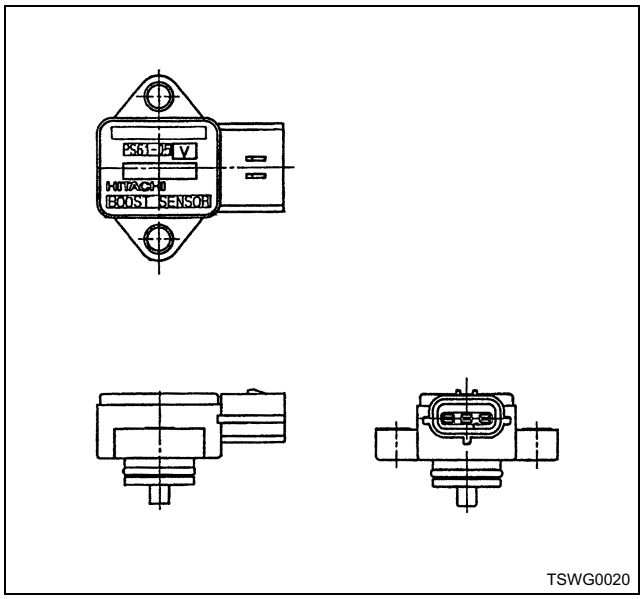
Tightening torque: 41 N·m{4.2 kg·m/30 lb·ft}

Accelerator position (AP) sensor

The accelerator position (AP) sensor is installed onto machine console panel and supplies the voltage signal, which changes according to the accelerator volume angle, to engine control module (ECM). The ECM calculates accelerator position by voltage signal and use it for various controls such as fuel injection amount control.

Note:
Refer to the machine's manual for the location of accelerator position sensor.

Barometric pressure sensor

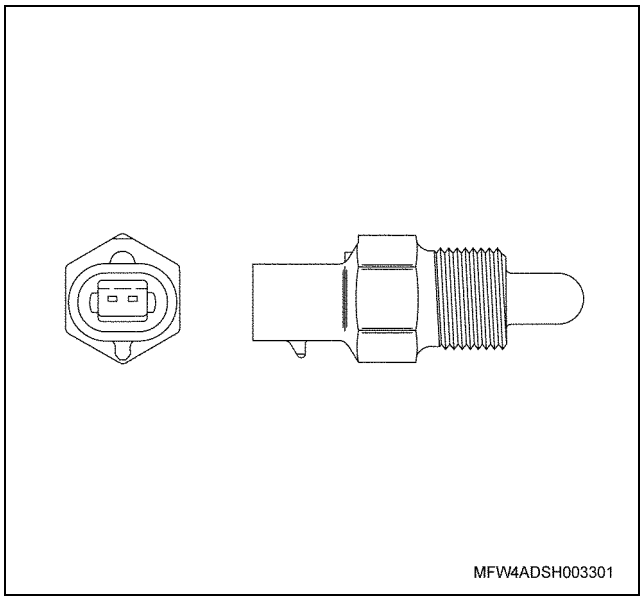


TSWG0020

The barometric pressure sensor is installed onto the machine side and converts the barometric pressure into voltage signal. The ECM calculates barometric pressure by voltage signal and performs fuel injection amount correction (high-altitude correction) etc. by barometric pressure.

Note:
Refer to the machine's manual for the location of barometric pressure sensor.

Intake air temperature (IAT) sensor

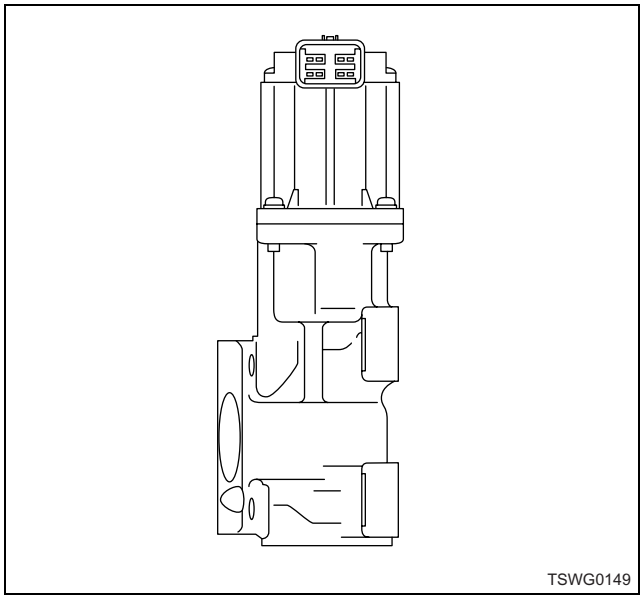

MFW4ADSH003301

The intake air temperature (IAT) sensor is installed onto the machine side and detects the temperature of intake air for optimum fuel injection control.

Tightening torque: 10.8 — 16.3 N·m {1.1 — 1.7 kg·m/96 — 144 lb·in}

Note:
Refer to the machine's manual for the location of intake air temperature (IAT) sensor.

EGR position sensor

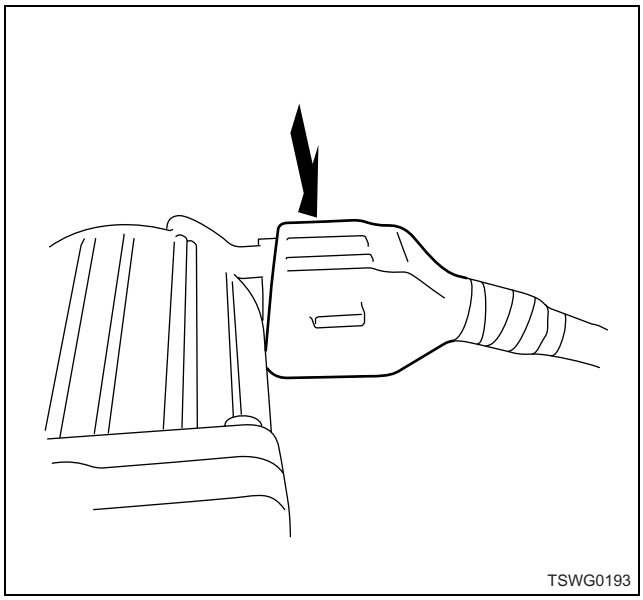

TSWG0149

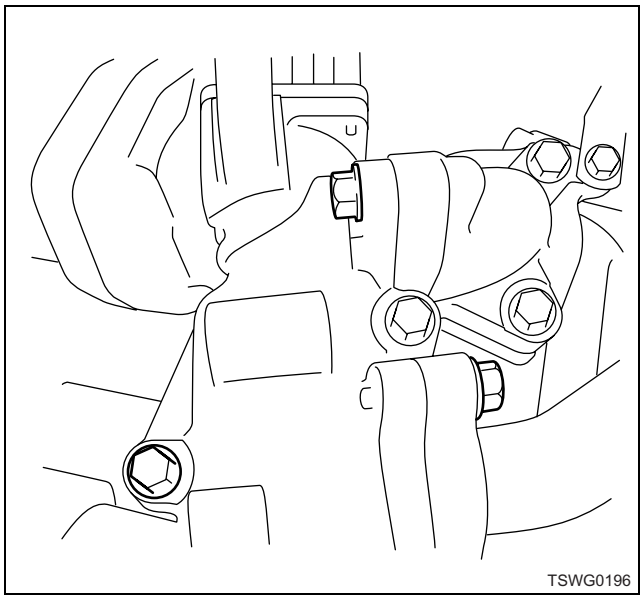
It is installed in EGR valve and detects the valve lift amount of EGR.

Note:
Do not disassemble the EGR position sensor. If it is faulty, replace it as EGR valve ASM.

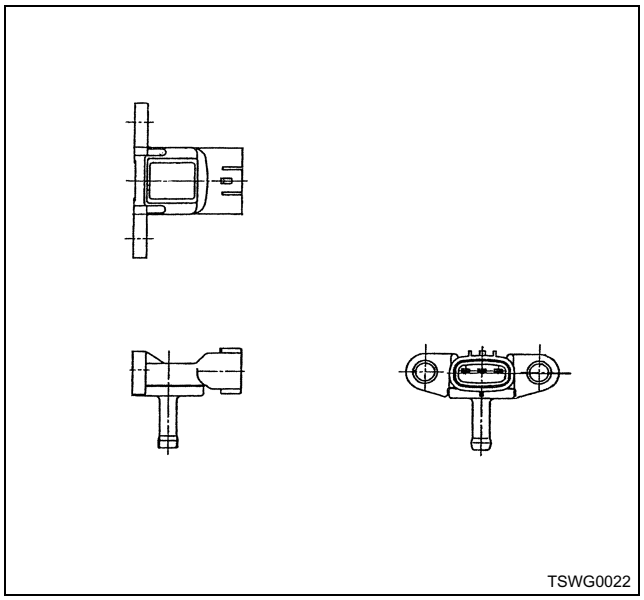
Removal

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


TSWG0193


TSWG0196

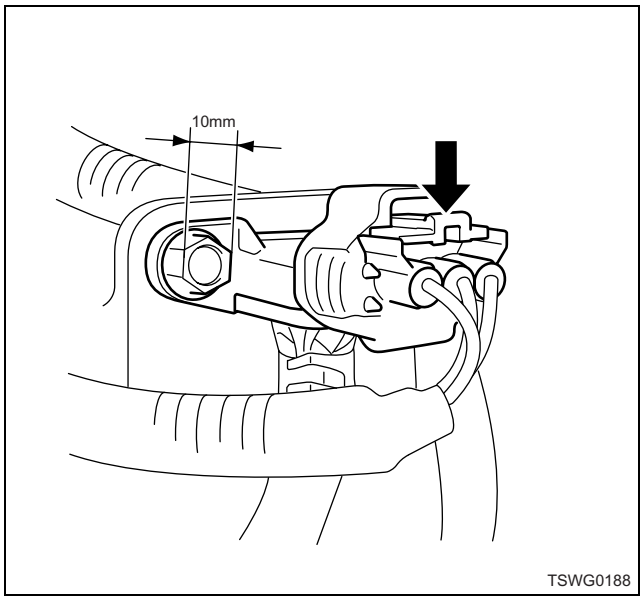
Boost pressure sensor


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.

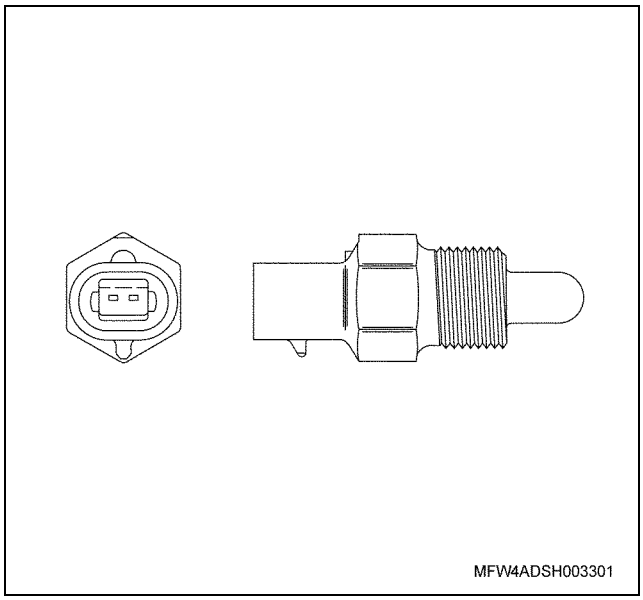


TSWG0188

Installation

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

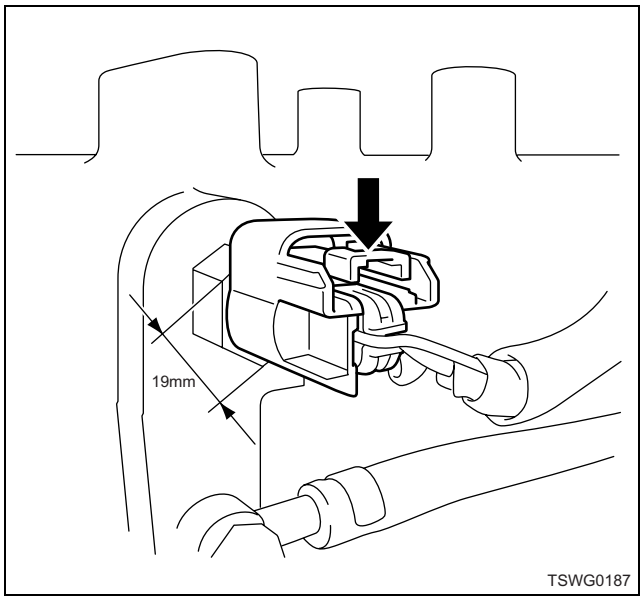
Boost temperature sensor



The boost temperature sensor is installed onto the EGR valve upstream side of intake manifold. The sensor is thermistor type. The resistance in the sensor changes as the temperature changes.

Removal

- Disconnect the connector and remove it with 19mm-wrench



Installation

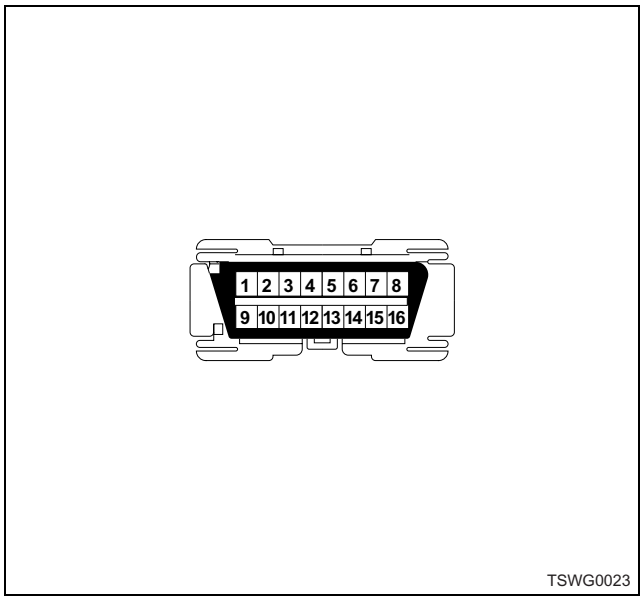
Tightening torque: 10.8 — 16.3 N·m {1.1 — 1.7 kg·m/96 — 144 lb·in}

Diagnosis lamp

It indicates DTC by blinking after the diagnosis switch is turned to ON.

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

DLC (data link connector)



The DLC (data link connector) is a connector for communication and connection between the external diagnostic device (scan tool) and each controller.

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

Diagnostic switch

The diagnosis switch shorts the DLC terminals No. 1 and No. 4 (or No. 5) to make the diagnosis lamp blink to indicate DTC.

Note:
Refer to the machine's manual for the locations and form of diagnosis switch.

Memory clear switch

The diagnosis switch and memory clear switch are used to clear the DTC stored in ECM.

Note:
Refer to the machine's manual for the locations of memory clear switch.

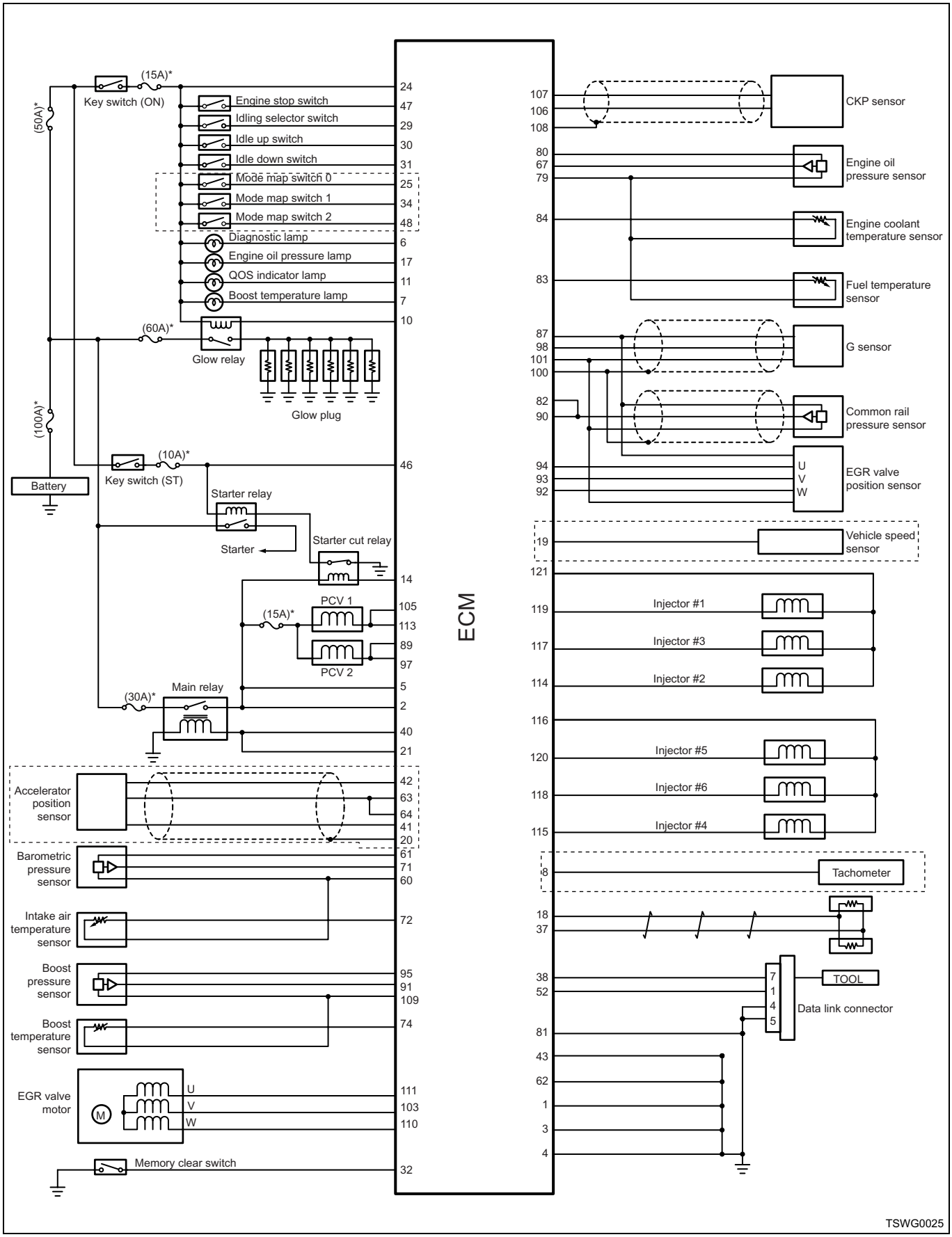
Mode selector switch (1, 2, 3)

The mode selector switch allows to operate at the engine speed set by each mode.

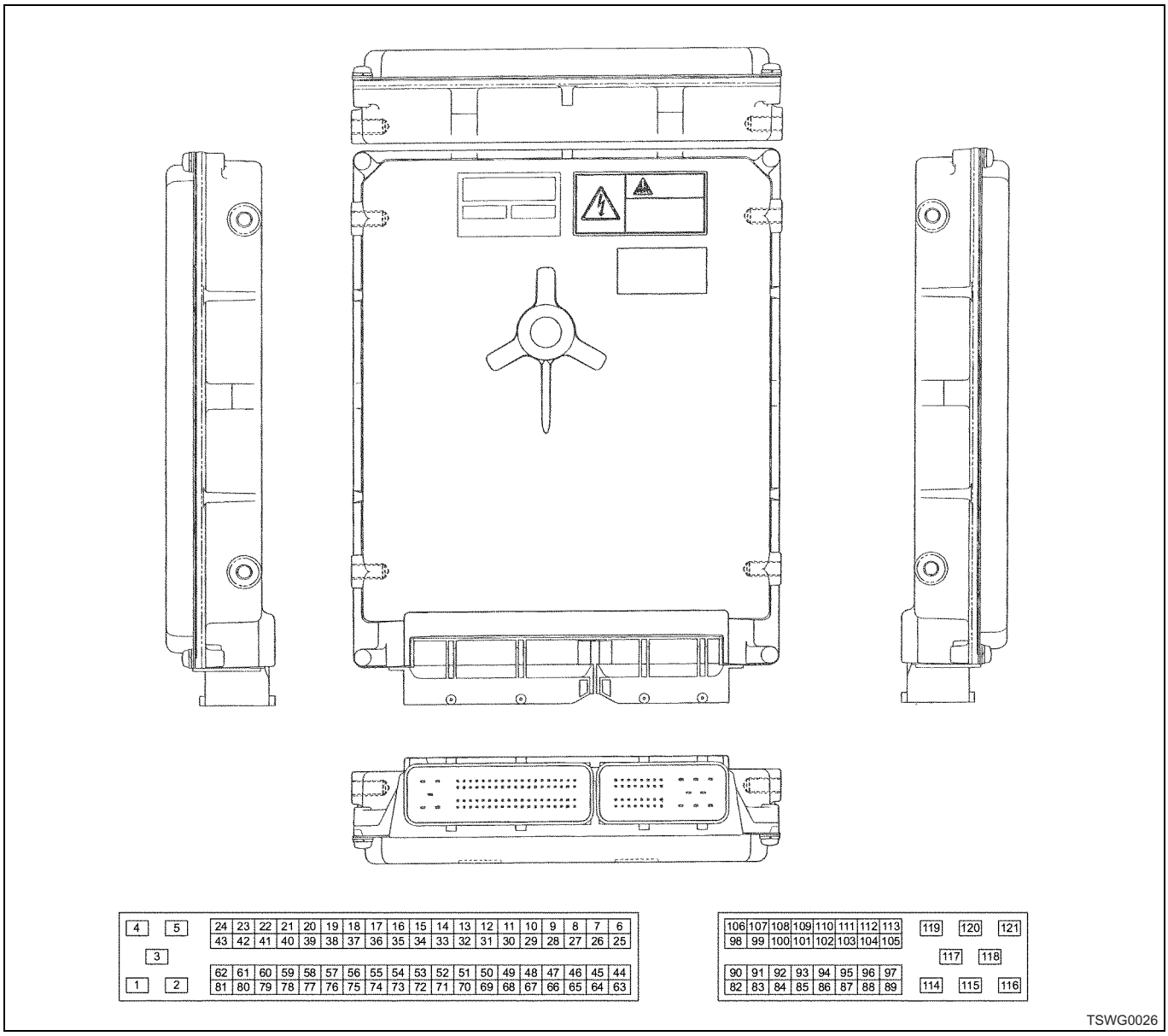
Note:
Refer to the machine's manual for the locations of mode selector switch.

Wiring diagram of engine control module (ECM)

(*: Refer to the machine's manual for fuse capacity.)



Pin arrangement of engine control module (ECM)



81-pin connector

Pin No.	Terminal name	Connection
1	PG-POWER	GND
2	PS-+B	Power supply
3	PG-POWER	GND
4	PG-POWER	GND
5	PS-+B	Power supply
6	OS-DIAGL	Diagnosis lamp
7	OS-BOOSTL	Boost temperature sensor pilot lamp
8	OF-TACHO	Tachometer
9	—	—
10	OS-GLOWR	Glow Relay
11	OS-GLOWL	QOS indicator lamp

Pin No.	Terminal name	Connection
12	—	—
13	—	—
14	OS-STARTR	Starter cut relay
15	—	—
16	—	—
17	OS-OILPL	Engine oil pressure lamp
18	CC-CAN-H	CAN-HIGH
19	IF-SPD	Vehicle speed sensor signal
20	SG-SLD1	Accelerator position sensor 1 GND
21	OS-MAINR	ECM main relay
22	—	—
23	—	—
24	IS-IGKEY	Key switch ON signal
25	IS-MDMAP0	Mode selector switch MAP0
26	—	—
27	—	—
28	—	—
29	IS-IDLMNL	Idling control selector switch
30	IS-IDLUP	Idling control switch-up signal
31	IS-IDLDWN	Idling control switch-down signal
32	IS-MEMCL	Memory clear switch
33	—	—
34	IS-MDMAP1	Mode selector switch MAP1
35	—	—
36	—	—
37	CC-CAN-L	CAN-LOW
38	CC-KW2000	Data Link Connector
39	—	—
40	OS-MAINR	ECM main relay
41	SG-5VRT1	Accelerator position (AP) sensor GND
42	SP-5V1	Accelerator position (AP) sensor power supply
43	PG-SIGN	GND
44	—	—
45	—	—
46	IS-START	Key switch start signal
47	ENGSTP	Engine stop switch
48	IS-MDMAP2	Mode selector switch MAP2
49	—	—
50	—	—

Pin No.	Terminal name	Connection
51	—	—
52	IS-DIAG	Diagnostic switch
53	—	—
54	—	—
55	—	—
56	—	—
57	—	—
58	—	—
59	—	—
60	SG-5VRT2	Barometric pressure sensor, intake air temperature (IAT) sensor GND
61	SP-5V2	Barometric pressure sensor power supply
62	PG-SIGN	GND
63	IA-ACCEL1	Accelerator position (AP) sensor 1 signal
64	IA-ACCEL2	Accelerator position (AP) sensor 2 signal
65	—	—
66	—	—
67	IA-OILPRESS	Engine oil pressure sensor signal
68	—	—
69	—	—
70	—	—
71	IA-BARO	Barometric pressure sensor signal
72	IA-IAT	Intake air temperature sensor signal
73	—	—
74	IA-THBST	Boost temperature signal
75	—	—
76	—	—
77	—	—
78	—	—
79	SG-5VRT3	Engine oil pressure sensor, fuel temperature sensor, engine coolant temperature sensor GND
80	SP-5V3	Engine oil pressure sensor power supply
81	PG-CASE	GND

40-pin connector

Pin No.	Terminal name	Connection
82	IA-PFUEL	Common rail pressure sensor signal
83	IA-THL	Fuel temperature sensor signal
84	IA-THW	Engine coolant temperature sensor signal
85	—	—

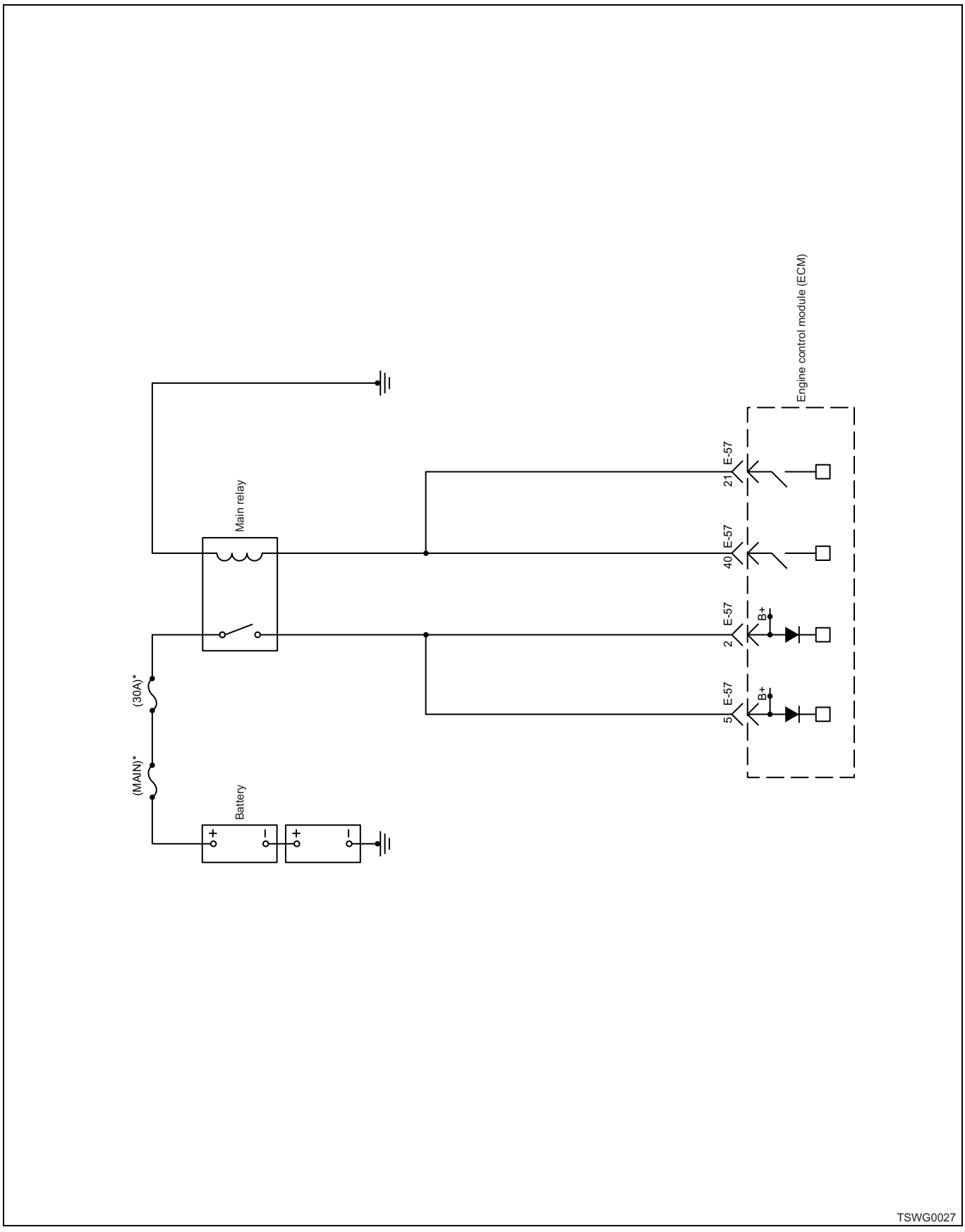
Pin No.	Terminal name	Connection
86	—	—
87	SP-5V5	G sensor power supply
88	—	—
89	OS-PCV2	PCV2 drive
90	IA-PFUEL	Common rail pressure sensor signal
91	IA-BPRESS	Boost pressure sensor signal
92	IA-EBMPOS3	EGR valve EGR position sensor W
93	IA-EBMPOS2	EGR valve EGR position sensor V
94	IA-EBMPOS1	EGR valve EGR position sensor U
95	SP-5V4	Boost pressure sensor power supply
96	—	—
97	OS-PCV2	PCV2 drive
98	IF-G	G sensor signal
99	—	—
100	SG-SLD5	G sensor, common rail pressure sensor shield
101	SG-5VRT5	Common rail pressure sensor GND
102	—	—
103	OM-EBM2	EGR valve DC servomotor power supply input V
104	—	—
105	OS-PCV1	PCV1 drive
106	IF-CRANK-	Crankshaft position (CKP) sensor (–)
107	IF-CRANK+	Crankshaft position (CKP) sensor (+)
108	SG-SLD4	Crankshaft position (CKP) sensor shield
109	SG-5VRT4	Boost pressure sensor, engine coolant temperature sensor, fuel temperature sensor GND
110	OM-EBM3	EGR valve DC servomotor power supply input W
111	OM-EBM1	EGR valve DC servomotor power supply input U
112	—	—
113	OS-PCV1	PCV1 drive
114	OS-INJ5	Injector 2 (No. 2 cylinder)
115	OS-INJ6	Injector 4 (No. 4 cylinder)
116	OP-COM2	Injector power supply 2 (No. 4, No. 5, No. 6 cylinders)
117	OS-INJ3	Injector 3 (No. 3 cylinder)
118	OS-INJ4	Injector 6 (No. 6 cylinder)
119	OS-INJ1	Injector 1 (No. 1 cylinder)
120	OS-INJ2	Injector 5 (No. 5 cylinder)
121	OP-COM1	Injector power supply 1 (No. 1, No. 2, No. 3 cylinders)

Circuit diagram

(Refer to “Wiring diagrams” for a way to read the diagram.)

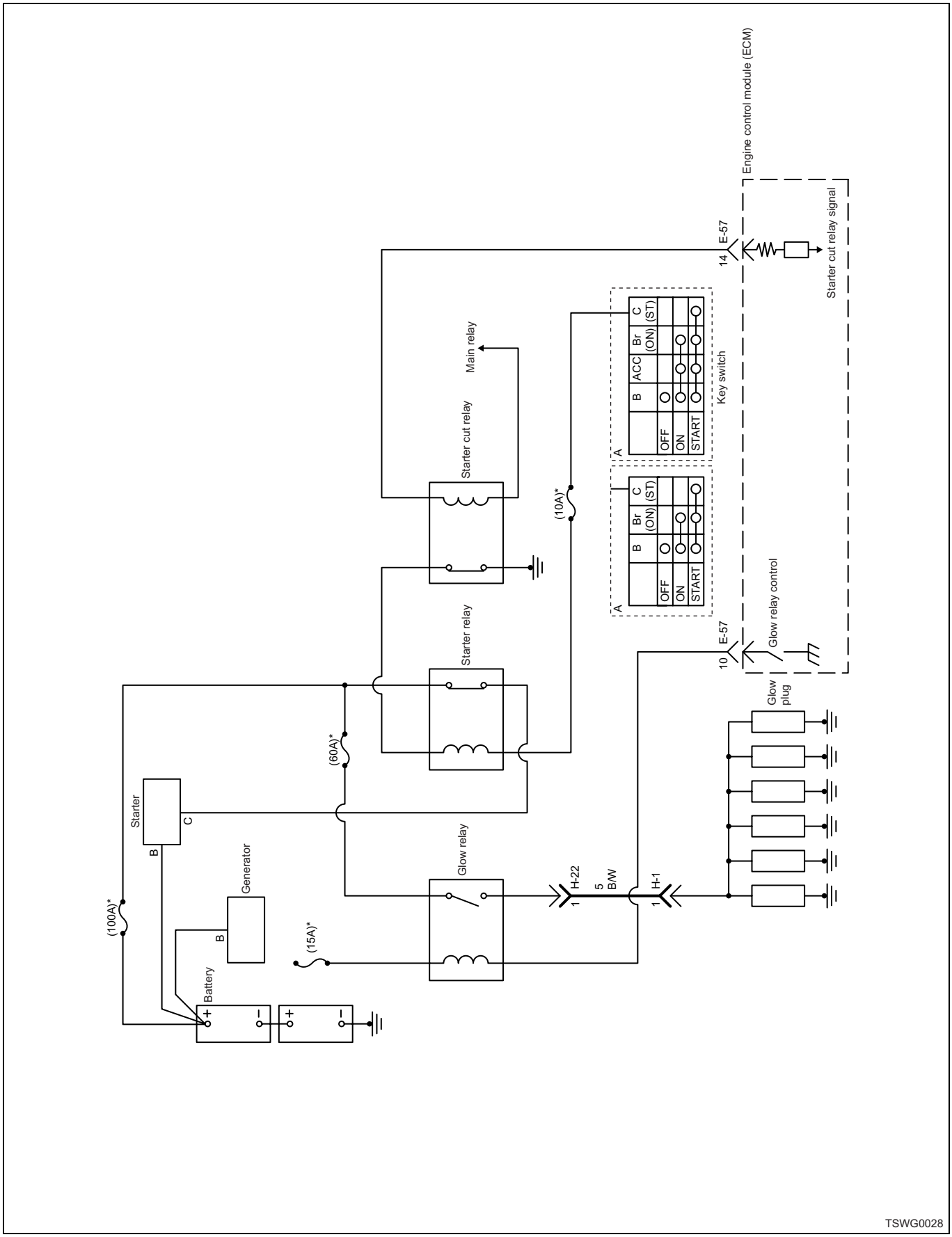
Main relay circuit

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



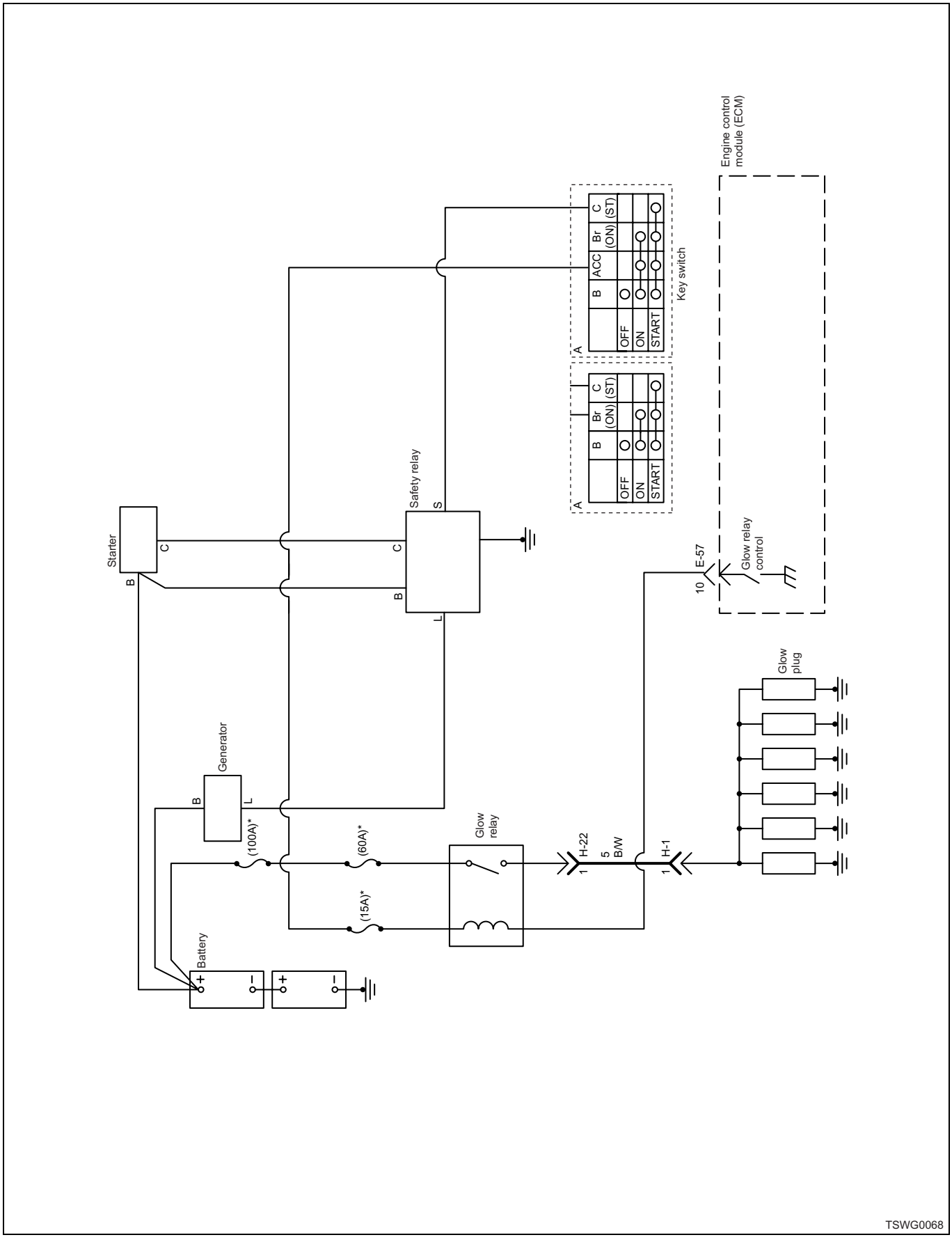
Starter for ECM control, glow circuit

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)

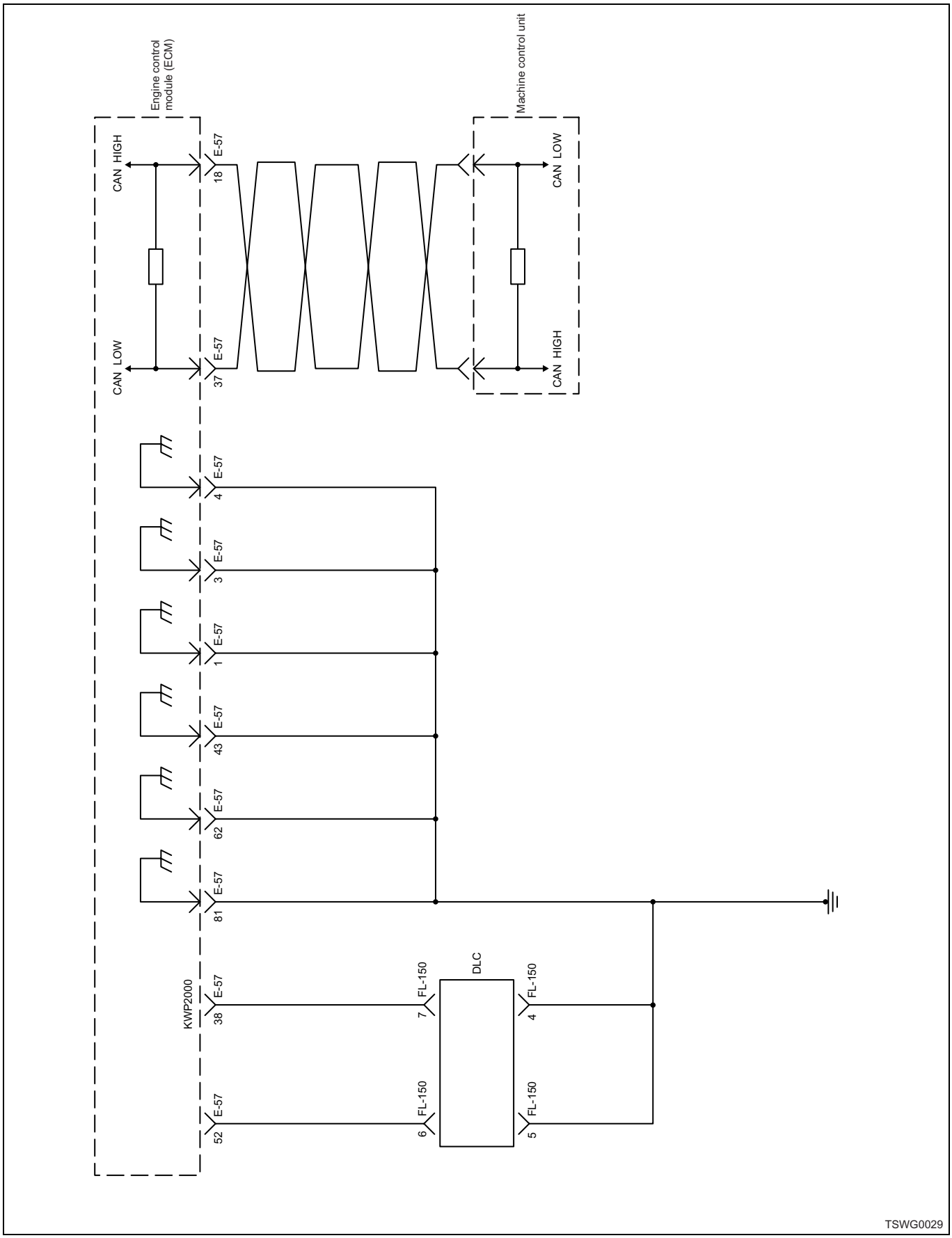


Starter for safety relay, glow circuit

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)

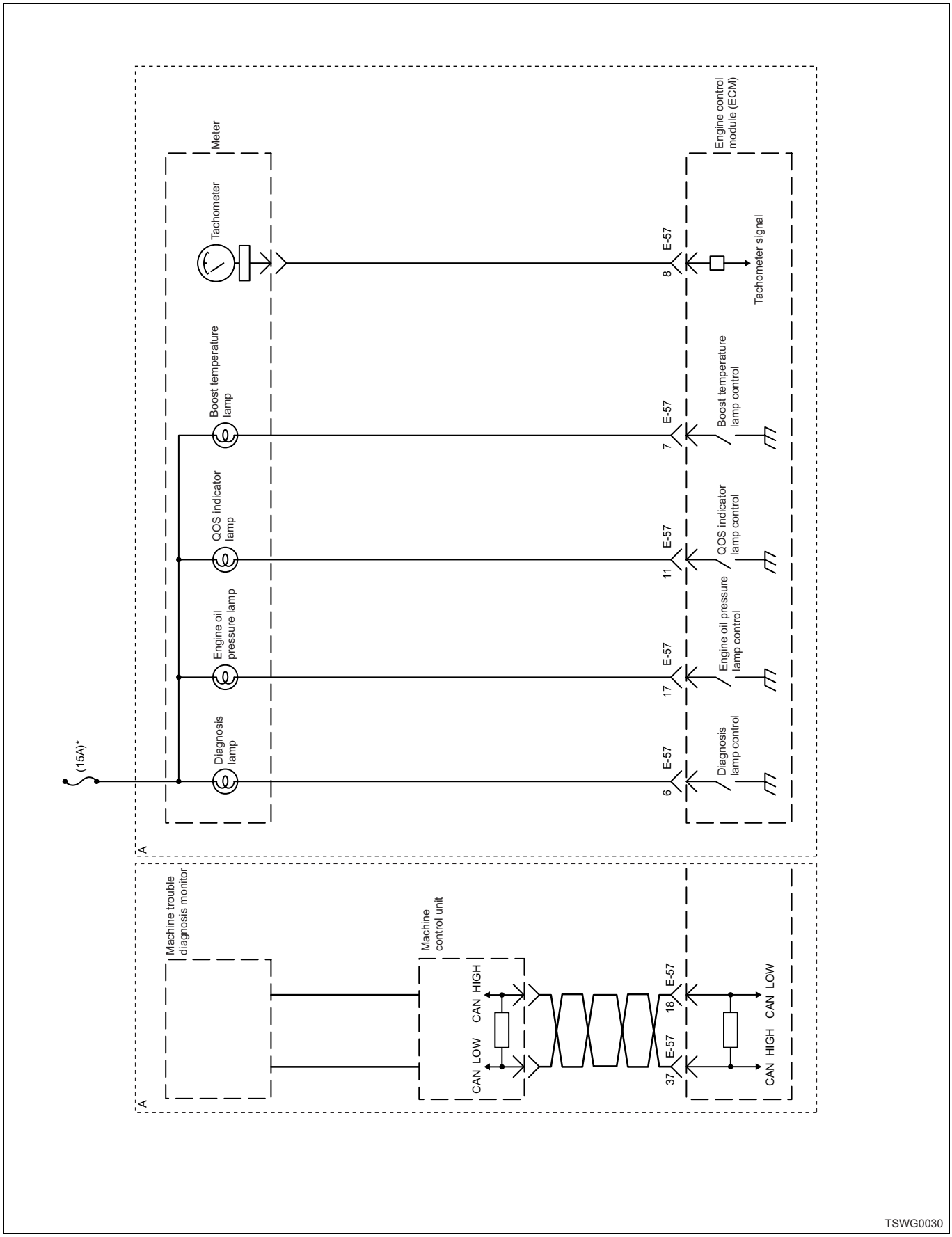


CAN, GND, DLC circuits

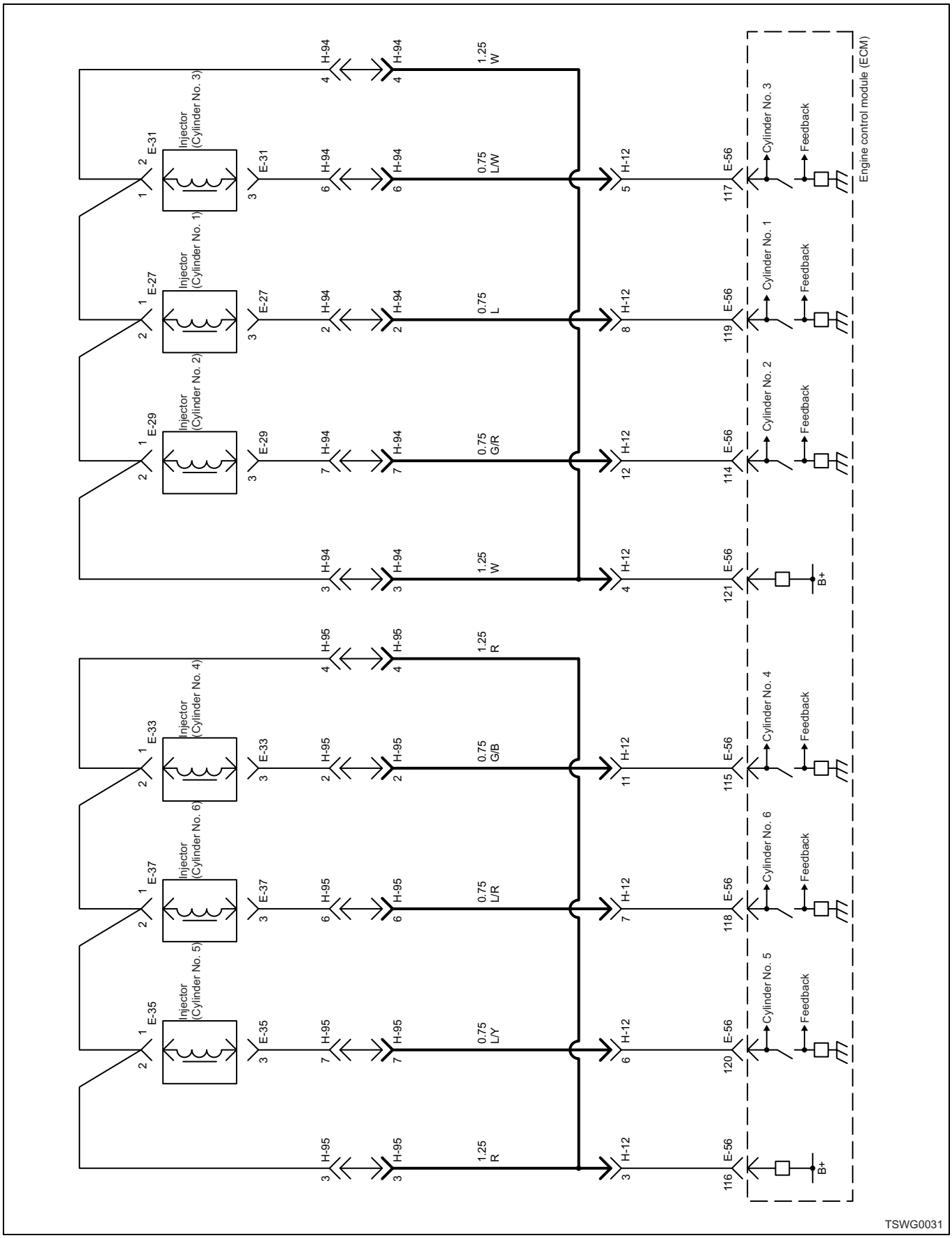


Indicator lamp, tachometer circuit

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)

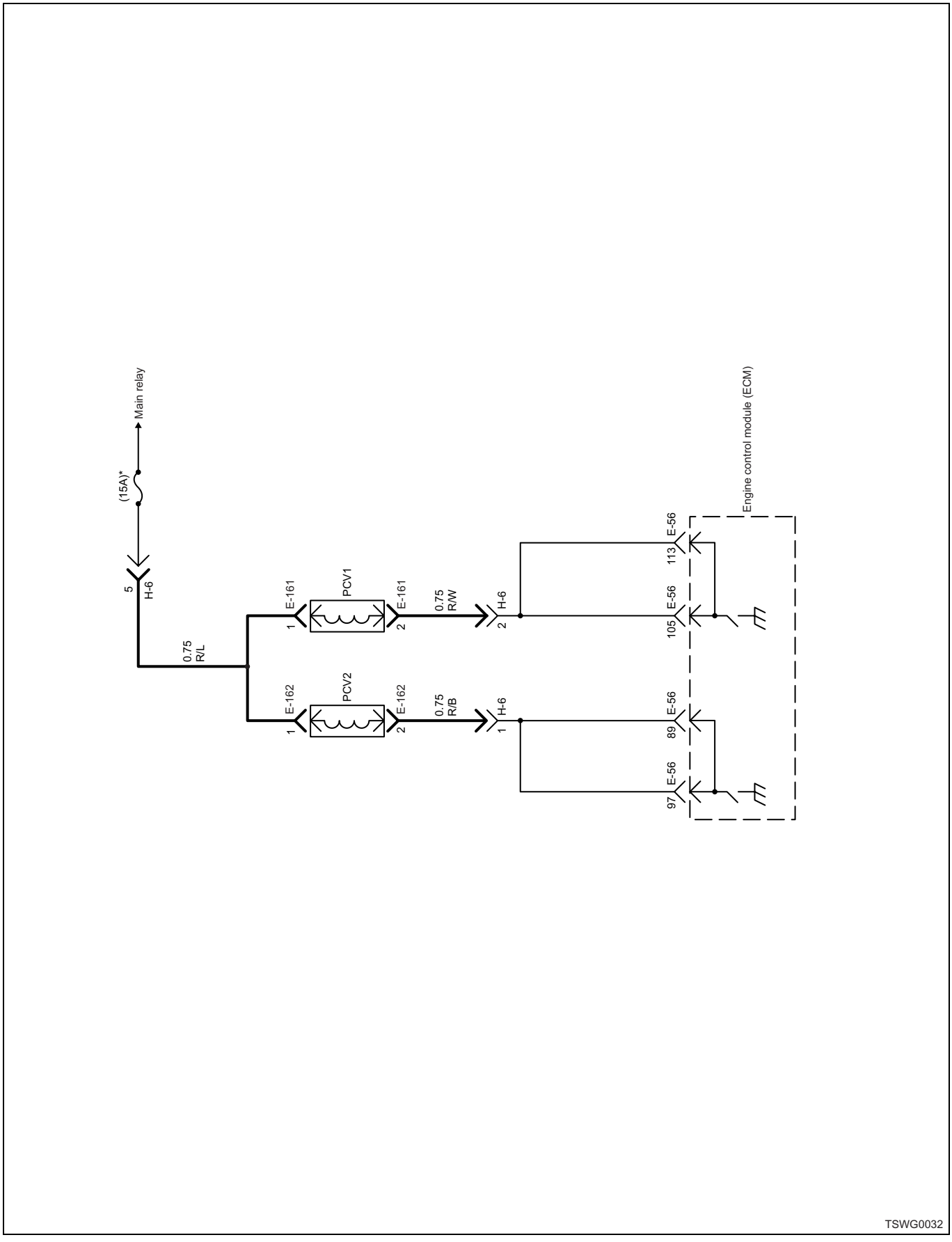


Injector circuit



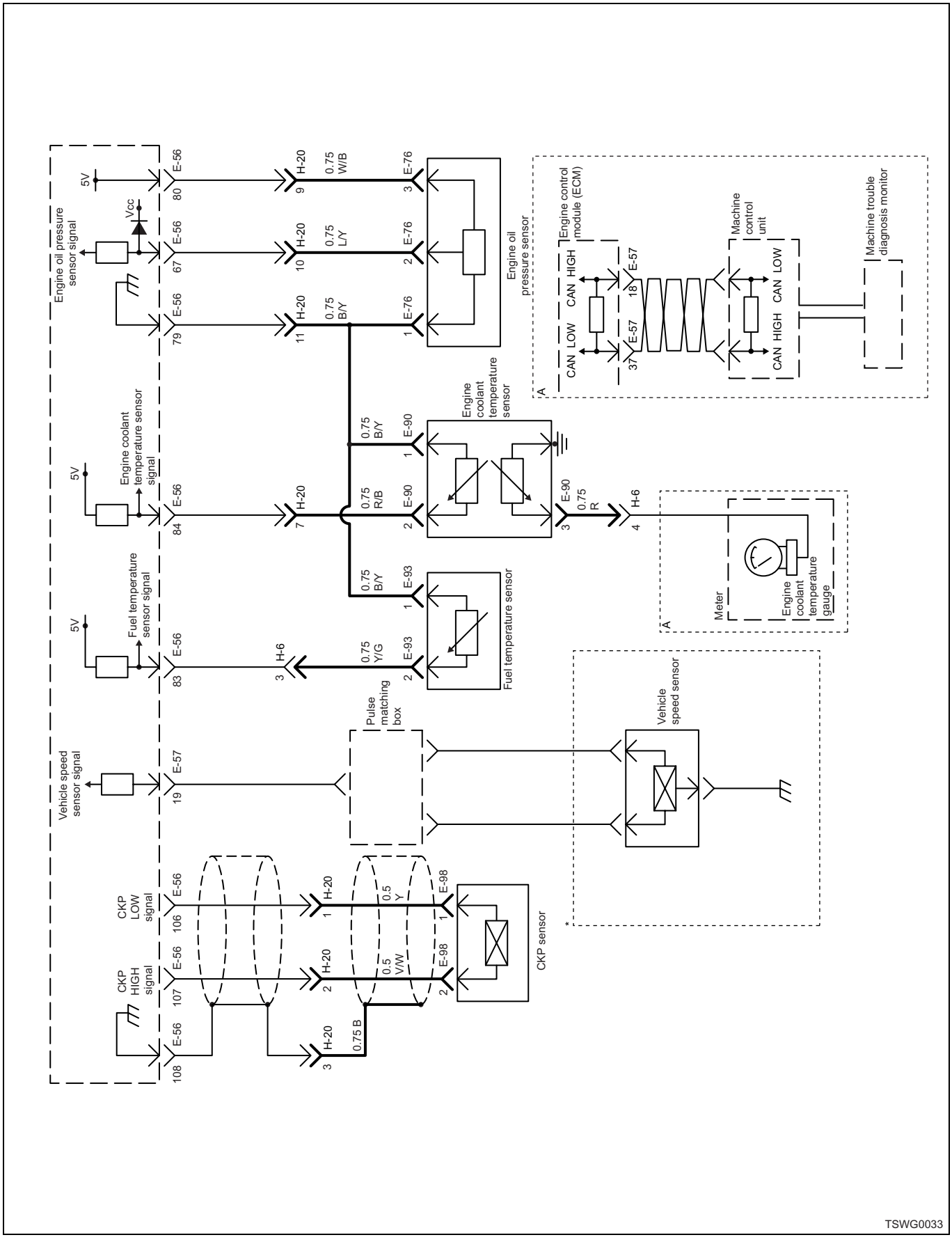
PCV circuit

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)

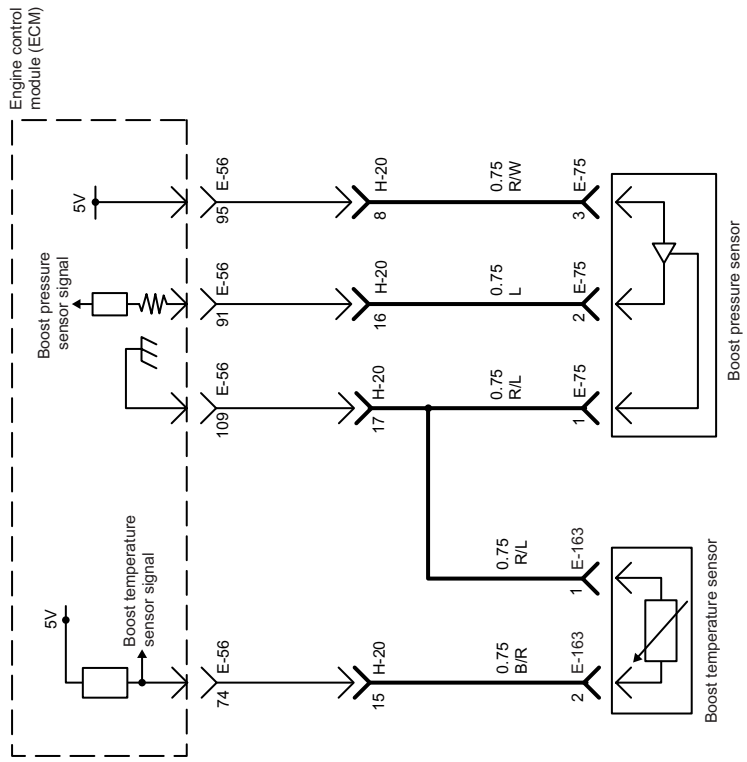


CKP sensor, vehicle speed sensor, fuel temperature sensor, engine coolant temperature sensor, engine oil pressure sensor circuit

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

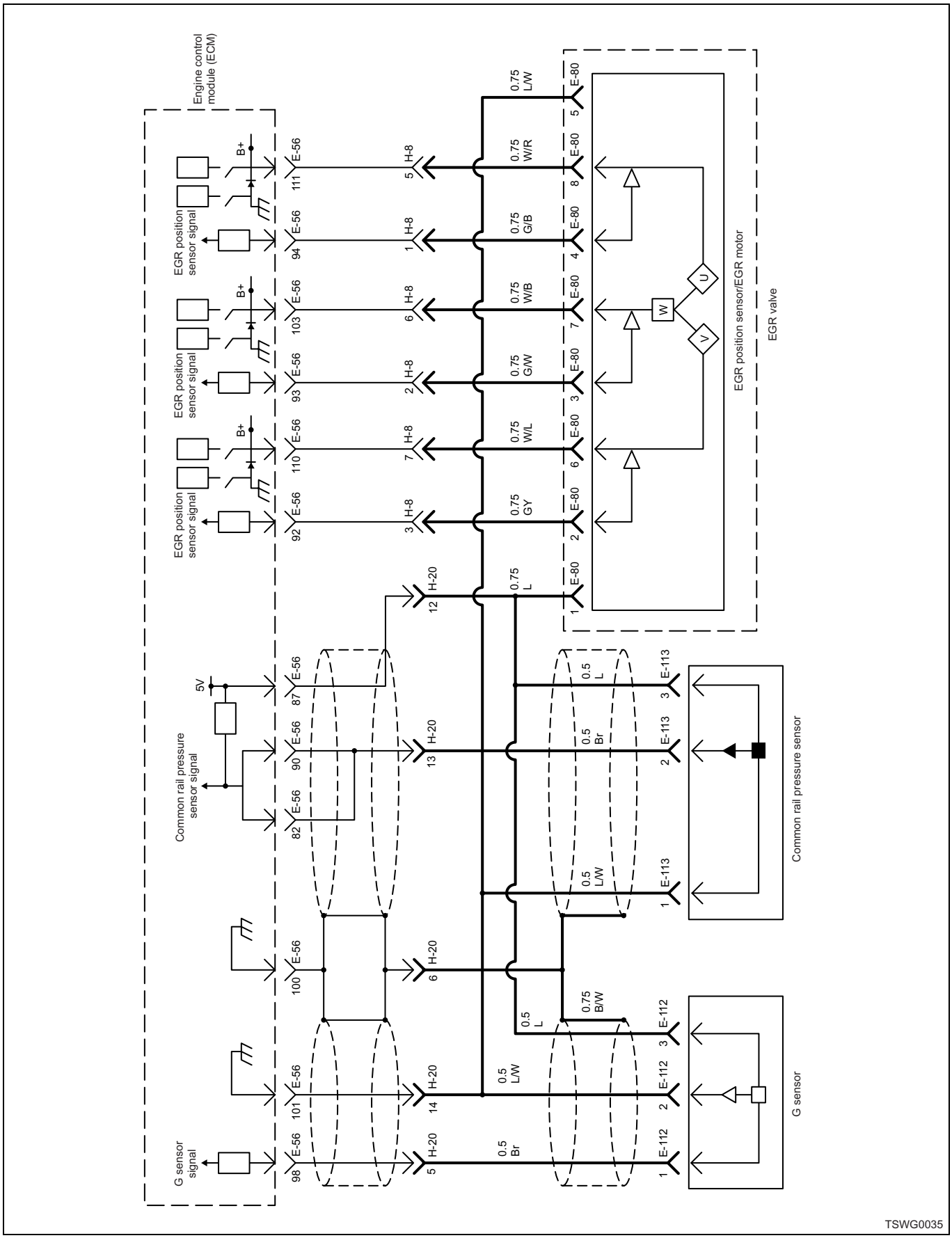


Boost temperature sensor, boost pressure sensor circuit

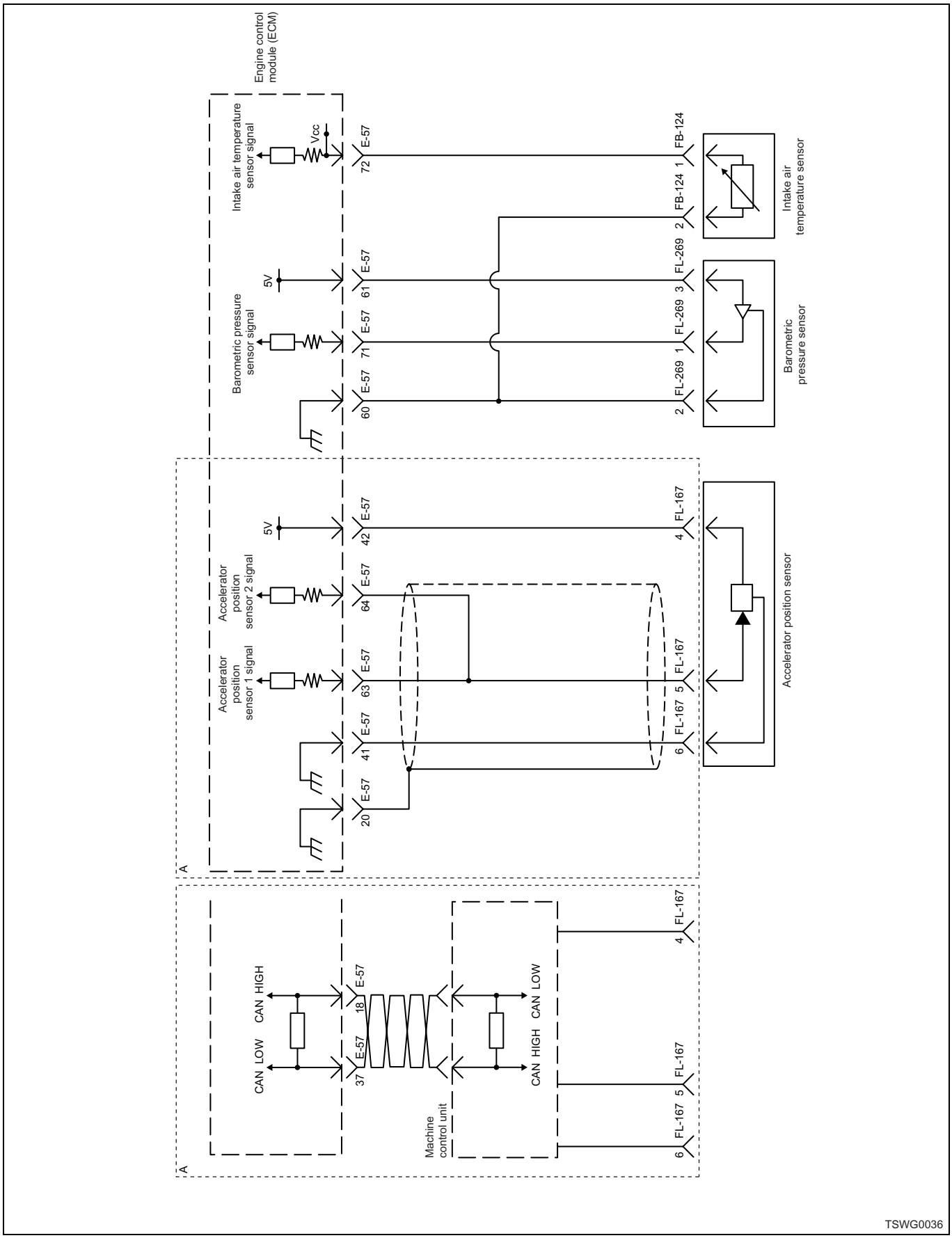


TSWG0034

G sensor, common rail pressure sensor, EGR circuit

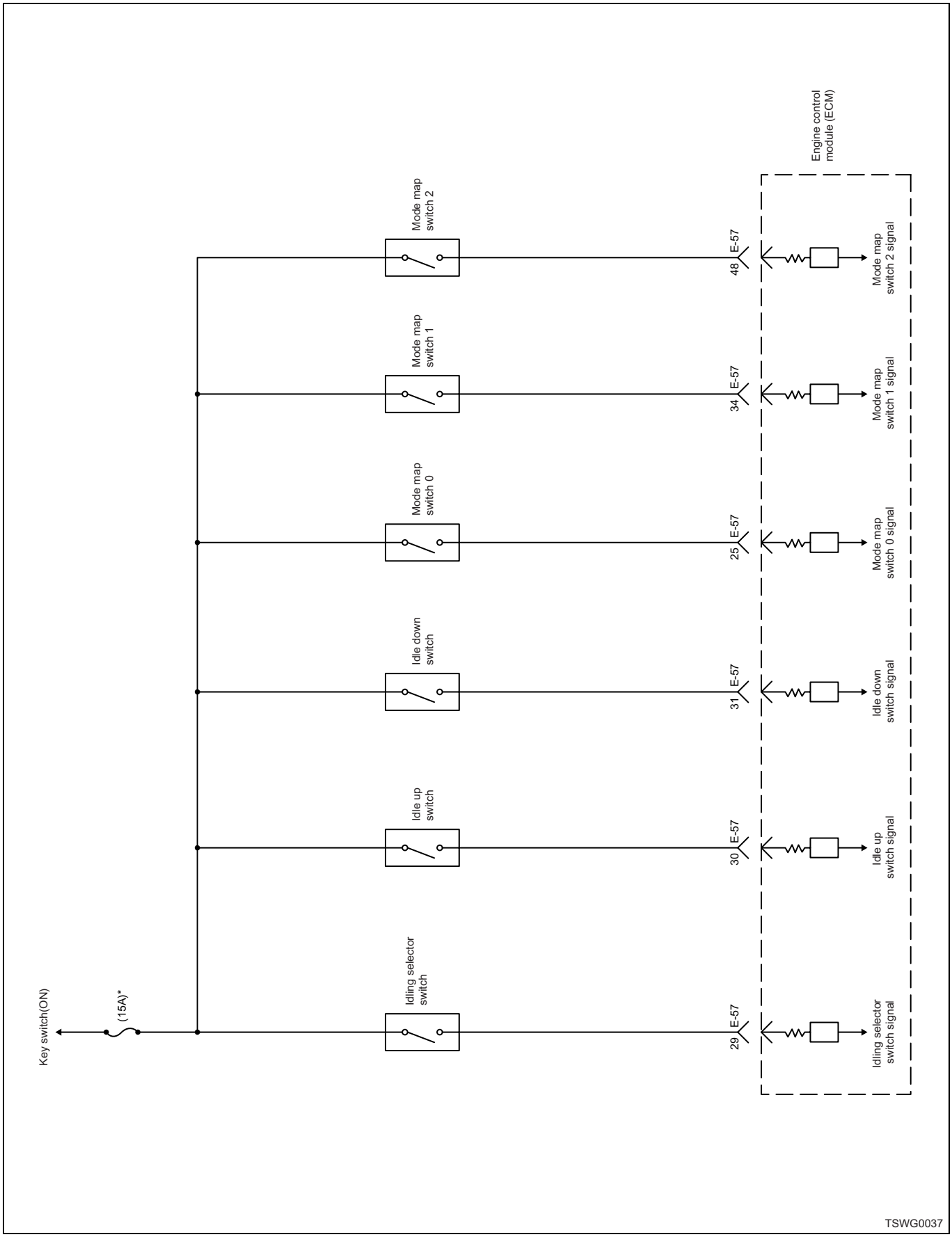


Accelerator position sensor, barometric pressure sensor, intake air temperature sensor circuit



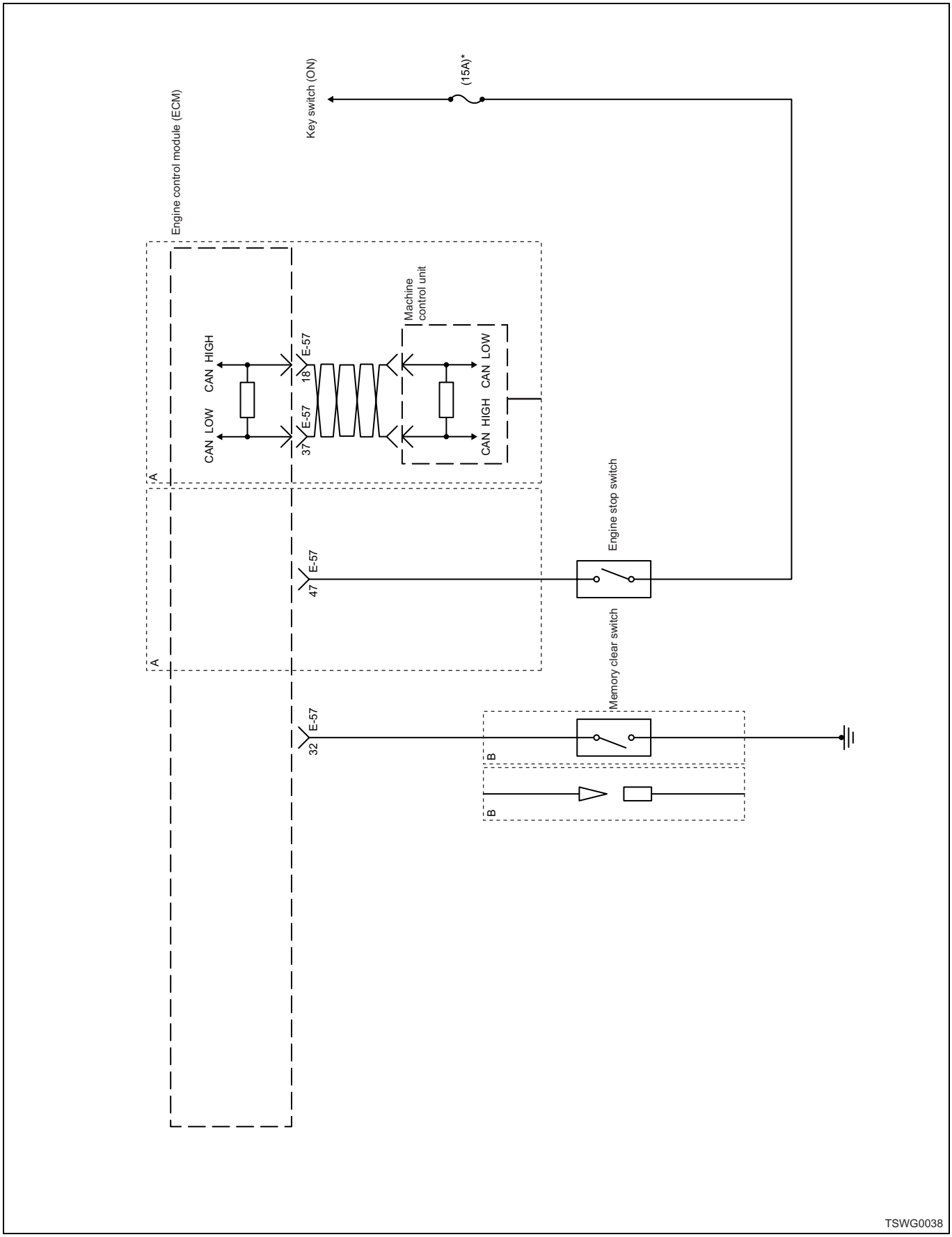
Idling selector switch, idle up switch, idle down switch, mode map switch circuit

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)

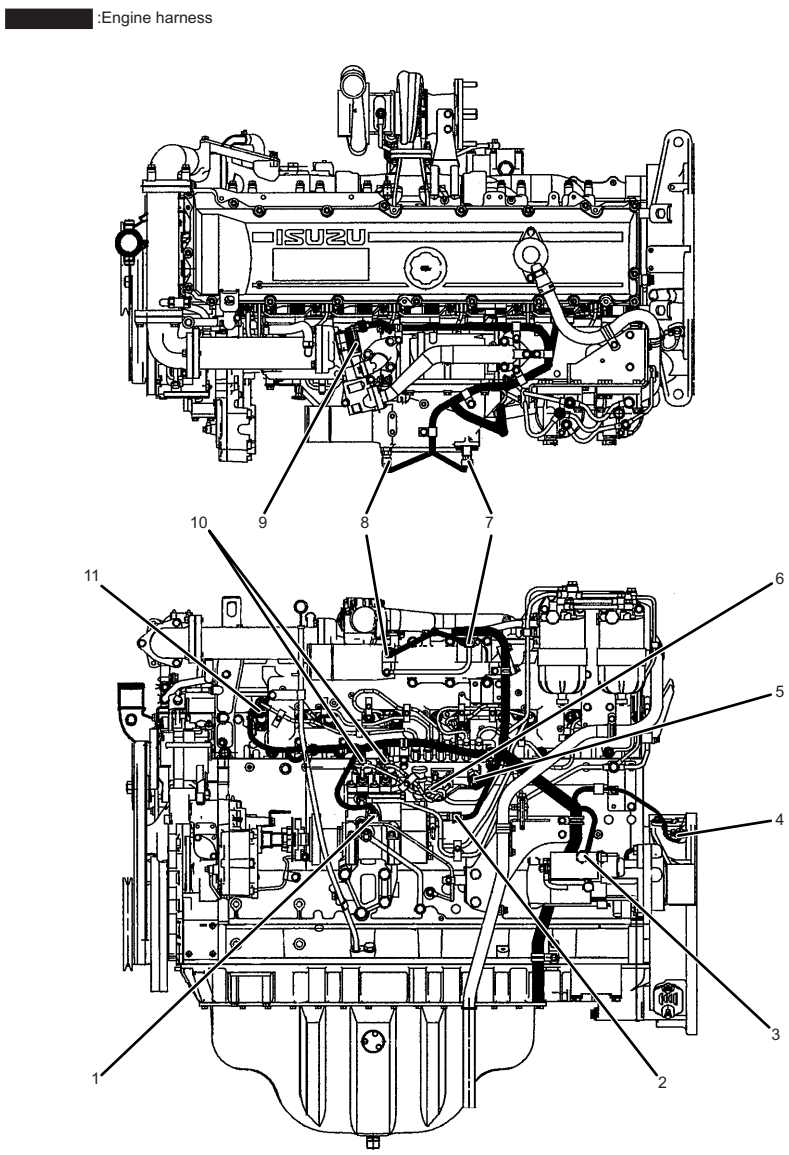


Memory clear switch, engine stop switch circuit

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)

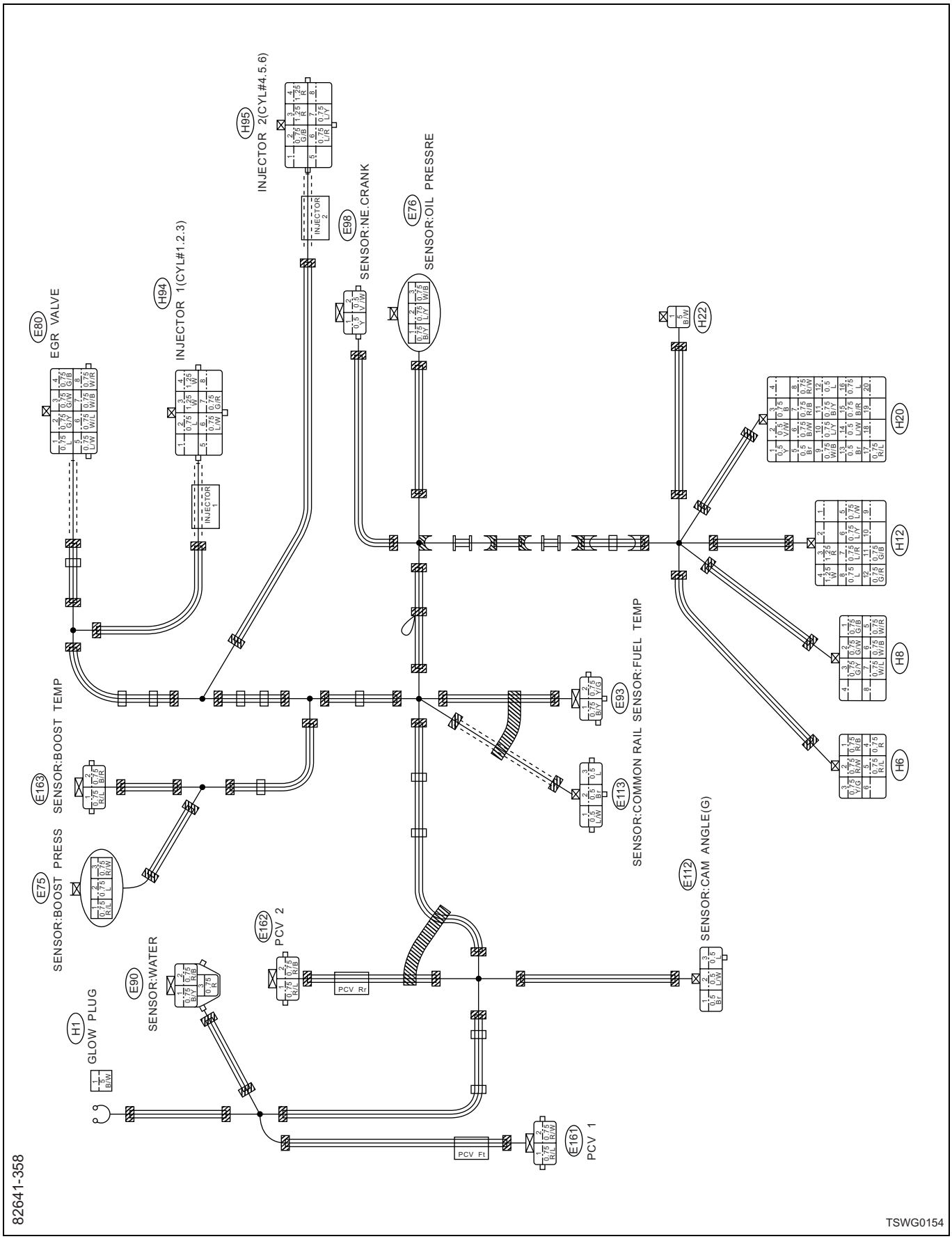


Engine harness location



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


82641-358
TSWG0154
H95 INJECTOR 2(CYL#4.5.6)
H94 INJECTOR 1(CYL#1.2.3)
E80 EGR VALVE
E98 SENSOR:NE.CRANK
E76 SENSOR:OIL PRESSRE
H22
H20
H12
H8
H6
E93 SENSOR:FUEL TEMP
E113 SENSOR:COMMON RAIL
E112 SENSOR:CAM ANGLE(G)
E163 SENSOR:BOOST TEMP
E75 SENSOR:BOOST PRESS
E162 PCV 2
E90 SENSOR:WATER
H1 GLOW PLUG
E161 PCV 1
INJECTOR 1
INJECTOR 2
PCV F1
PCV F2

E75

Terminal Number	
1	Boost pressure sensor GND
2	Boost pressure sensor Vout
3	Boost pressure sensor Vcc

E76

Terminal Number	
1	Engine oil pressure sensor GND
2	Engine oil pressure sensor Vout
3	Engine oil pressure sensor Vcc

E80

Terminal Number	
1	EGR Vcc
2	EGR hall sensor W
3	EGR hall sensor V
4	EGR hall sensor U
5	EGR GND
6	EGR motor W
7	EGR motor V
8	EGR motor U

E90

Terminal Number	
1	ECT GND
2	ECT +
3	ECT (meter)

E93

Terminal Number	
1	Fuel temperature sensor GND
2	Fuel temperature sensor +

E98

Terminal Number	
1	CKP GND
2	CKP +

E112

Terminal Number	
1	G sensor +
2	G sensor GND
3	G sensor Vcc

E113

Terminal Number	
1	Common rail pressure sensor GND
2	Common rail pressure sensor Vout
3	Common rail pressure sensor Vcc

E161

Terminal Number	
1	PCV +B
2	PCV 1

E162

Terminal Number	
1	PCV +B
2	PCV 2

E163

Terminal Number	
1	Boost temperature sensor GND
2	Boost temperature sensor +

H1

Terminal Number	
1	Glow

H6

Terminal Number	
1	PCV 2
2	PCV 1
3	Fuel temperature sensor +
4	ECT (meter)
5	PCV +B
6	—

H8

Terminal Number	
1	EGR hall sensor U
2	EGR hall sensor V
3	EGR hall sensor W
4	—
5	EGR motor U
6	EGR motor V
7	EGR motor W
8	—

H12

Terminal Number	
1	—
2	—
3	Injector power supply 2
4	Injector power supply 1
5	OS — INJ3 signal/Injector #3
6	OS — INJ2 signal/Injector #5
7	OS — INJ4 signal/Injector #6
8	OS — INJ1 signal/Injector #1
9	—
10	—
11	OS — INJ6 signal/Injector #4
12	OS — INJ5 signal/Injector #2

H20

Terminal Number	
1	CKP GND
2	CKP +
3	CKP shield
4	—
5	G sensor +
6	G sensor shield
7	ECT +
8	Boost pressure sensor Vcc
9	Engine oil pressure sensor Vcc
10	Engine oil pressure sensor Vout
11	Engine oil pressure sensor GND
12	Common rail pressure sensor Vcc
13	Common rail pressure sensor Vout
14	Common rail pressure sensor GND
15	Boost temperature sensor +
16	Boost pressure sensor Vout
17	Boost pressure sensor GND
18	—
19	—
20	—

H22

Terminal Number	
1	Glow

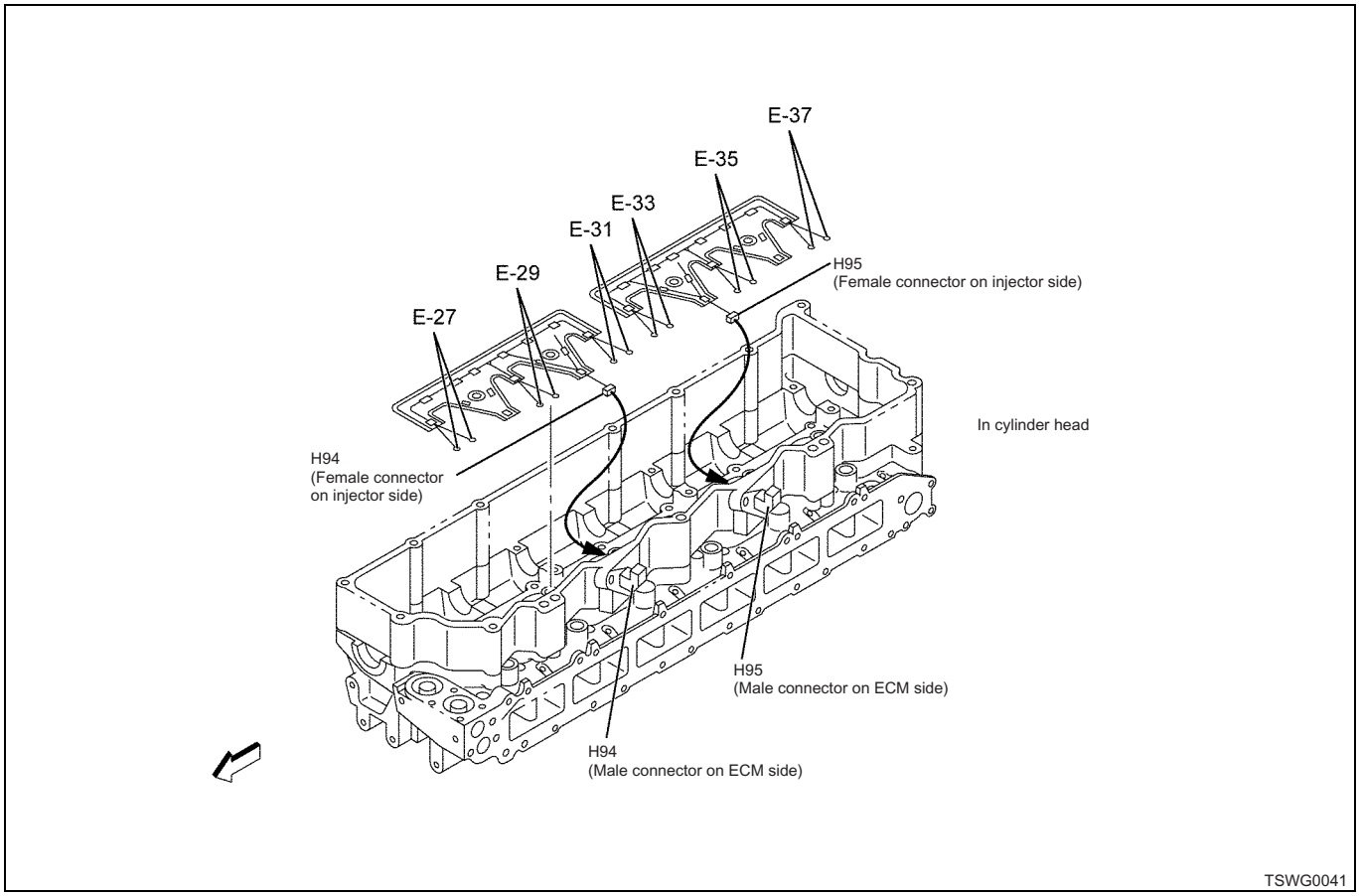
H94

Terminal Number	
1	—
2	OS — INJ1 signal/Injector #1
3	Injector power supply 1
4	Injector power supply 2
5	—
6	OS — INJ3 signal/Injector #3
7	OS — INJ5 signal/Injector #2
8	—

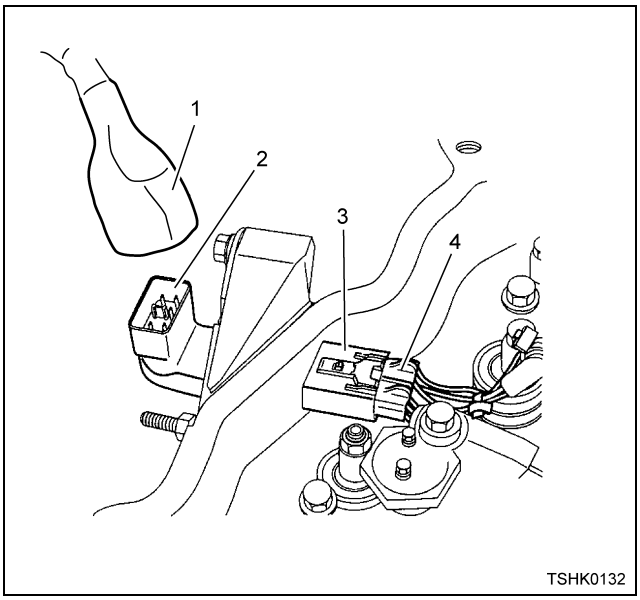
H95

Terminal Number	
1	—
2	OS — INJ6 signal/Injector #4
3	Injector power supply 2
4	Injector power supply 1
5	—
6	OS — INJ4 signal/Injector #6
7	OS — INJ2 signal/Injector #5
8	—

Cylinder head



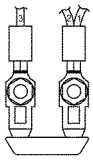
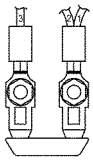
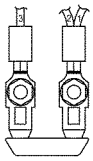
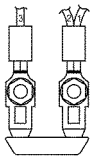
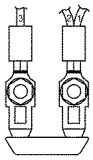
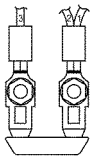
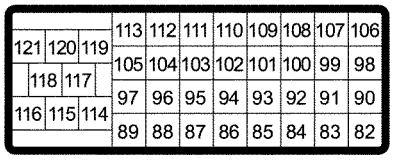
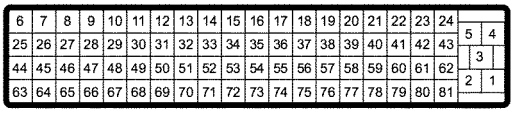
H94/H95 connector

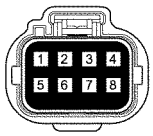
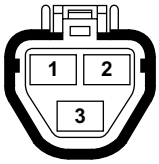
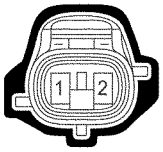
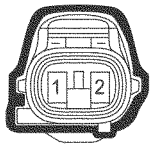
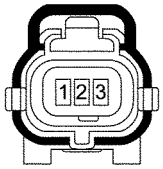
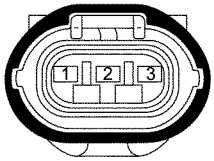


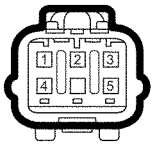
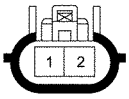
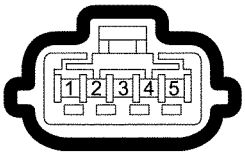
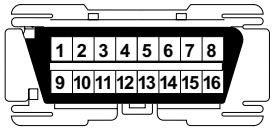
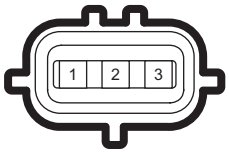
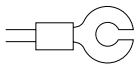
Name

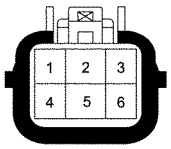
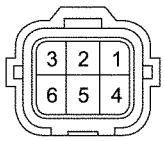
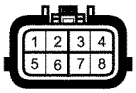
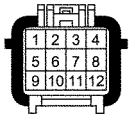
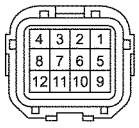
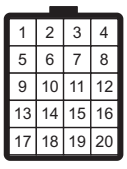
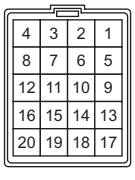
1. Engine harness-side connector
2. Cylinder head outside connector
3. Cylinder head inside connector
4. Injector harness-side connector

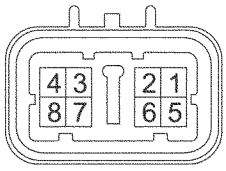
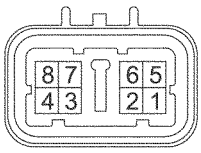
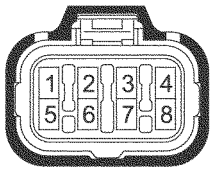
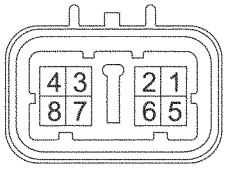
Connector list

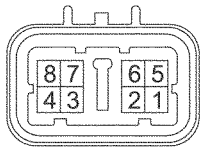
No.	Connector Face
E-27	 003-128 #1 injector (Silver)
E-29	 003-128 #2 injector (Silver)
E-31	 003-128 #3 injector (Silver)
E-33	 003-128 #4 injector (Silver)
E-35	 003-128 #5 injector (Silver)
E-37	 003-128 #6 injector (Silver)
E-56 Machine harness side (female terminal)	 040-004
E-57 Machine harness side (female terminal)	 081-001

No.	Connector Face
E-75 Engine harness side (male terminal)	 003-501 (Black)
E-76 Engine harness side (male terminal)	 003-501 (Black)
E-80 Engine harness side (male terminal)	 008-031 (Black)
E-90 Engine harness side (male terminal)	 003-500 (Light gray)
E-93 Engine harness side (male terminal)	 002-232 (Green)
E-98 Engine harness side (male terminal)	 002-233 (Dark gray)
E-112 Engine harness side (male terminal)	 003-067 (Black)
E-113 Engine harness side (male terminal)	 003-097 (Black)

No.	Connector Face
E-114 Engine harness side (male terminal)	 005-034 (Black)
E-161 Engine harness side (male terminal)	 002-178 (Light gray)
E-162 Engine harness side (male terminal)	 002-178 (Dark gray)
E-163 Engine harness side (male terminal)	 002-006 (Gray)
FB-124 Engine harness side (male terminal)	 005-029 (Black)
FL-150 Engine harness side (male terminal)	 016-500
FL-269 Engine harness side (male terminal)	 003-502
H1	 000-009 (Silver)

No.	Connector Face
H-6 Engine harness side (male terminal)	 006-001 (Black)
H-6 Machine harness side (female terminal)	 006-011
H-8 Engine harness side (male terminal)	 008-009 (Black)
H-8 Machine harness side (female terminal)	 008-010
H-12 Engine harness side (male terminal)	 012-013 (Black)
H-12 Machine harness side (female terminal)	 012-014
H-20 Machine harness side (male terminal)	 020-500
H-20 Engine harness-side (female terminal)	 020-501 (Light gray)

No.	Connector Face
H22 Engine harness-side (female terminal)	 001-034 (Light gray)
H22 Machine harness side (male terminal)	 001-003
H-94 Engine harness side (male terminal)	 008-046 (Gray)
H-94 Cylinder head outside (female terminal)	 008-047 (Dark gray)
H-94 Cylinder head inside (female terminal)	 008-052 (Dark gray)
H-94 Injector harness side (male terminal)	 008-051
H-95 Engine harness side (male terminal)	 008-046 (Gray)
H-95 Cylinder head outside (female terminal)	 008-047 (Dark gray)

No.	Connector Face
H-95 Cylinder head inside (female terminal)	 008-052 (Dark gray)
H-95 Injector harness side (male terminal)	 008-051

List of function checks

Interview	Inspection to comprehend the trouble symptom and diagnose properly based on a customer's complaint.
OBD system check	Inspection to identify defective point of engine control system (inspection procedure)
Diagnosis lamp illumination circuit system check	Inspection when diagnosis lamp does not come on when starter switch is turned ON.
Diagnosis lamp blinking circuit system check	Inspection when diagnosis lamp does not blink (remains on) when diagnostic switch is turned ON.
Scan tool power supply circuit system check	Inspection when scan tool (Tech2) does not operate.
Scan tool communication circuit system check	Inspection when scan tool (Tech2) cannot communicate with ECM.
Starting circuit system check	Inspection when starter does not operate.
Starting system check	Inspection when starter operates but engine does not start.
Fuel system check	Inspection when relevant points to fuel system may be faulty (inspection procedure).
Intake system check	Inspection when relevant points to intake system may be faulty (inspection procedure).
Exhaust system check	Inspection when relevant points to exhaust system may be faulty (inspection procedure).
EGR control system check	Inspection when relevant points to EGR may be faulty (inspection procedure).
QOS control system check	Inspection when relevant points to QOS (glow) may be faulty (inspection procedure).
CAN communication check	Inspection when fault relevant to machine control unit and CAN communication between scan tool and ECM may exist.
Machine-side check	Inspection when fault relevant to machine function (inspection procedure) may exist.

In the subsequent part of this manual, "scan tool" indicates scan tools including Tech2.

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:

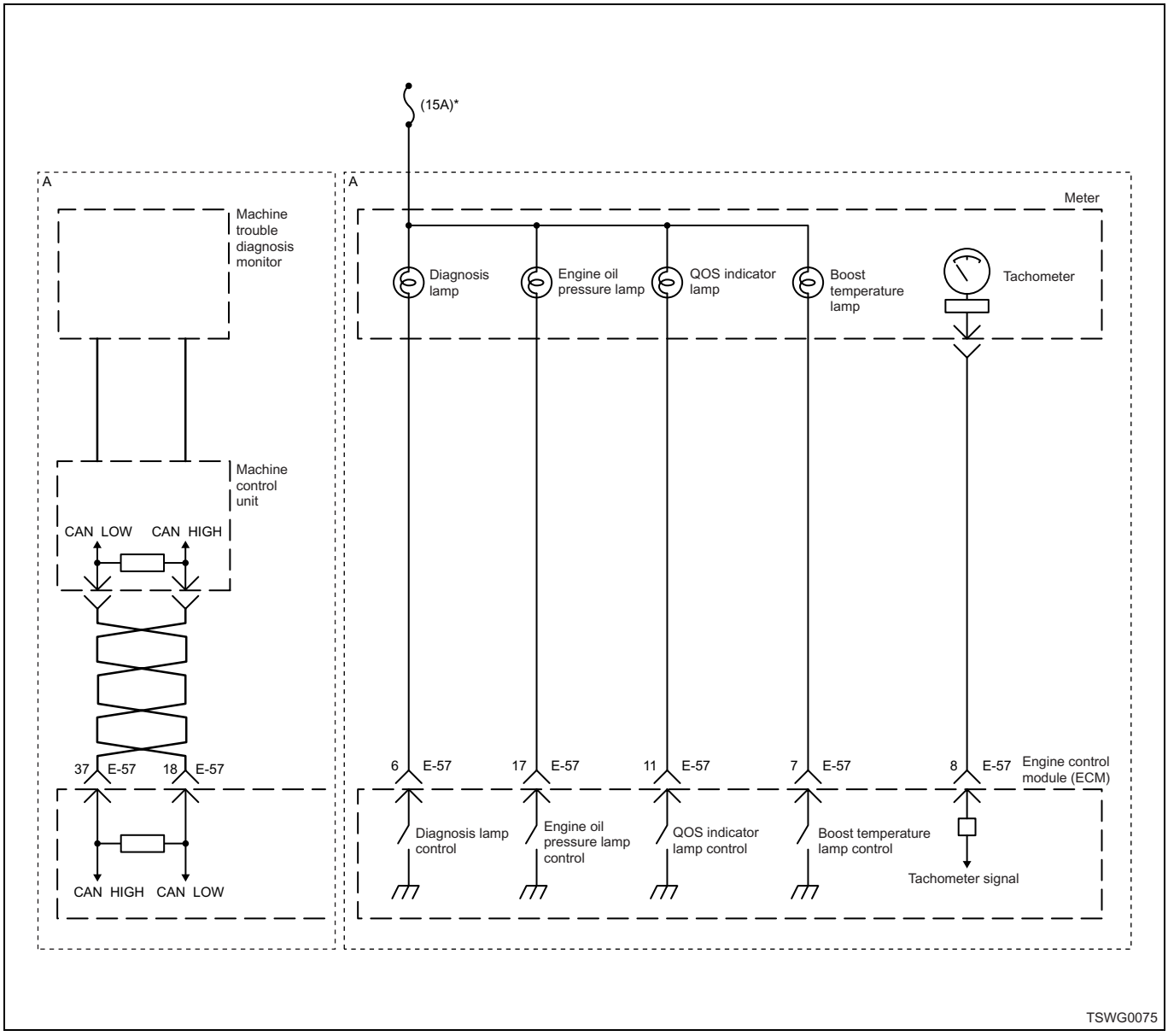
- **If there is no complaint for operationality, never perform this diagnostic step unless otherwise instructed in other items.**
- **Before the diagnosis, check the service information.**
- **Never erase DTCs unless otherwise instructed in the diagnostic step.**
- **If fault is found in the engine starting 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
9	1. Check for following troubles. • Engine stall • Engine hunting, rough idling • Engine output lowering, blow up fault, engine breathing • Exhaust gas contains a lot of white smoke. • Exhaust gas contains a lot of black smoke. • Idling rotation cannot be adjusted. • Idling rotation cannot be reduced. Is the trouble detected?	—	Go to the relevant trouble symptom diagnosis.	Normal system

Diagnosis lamp illumination circuit system check

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



Description of circuit

The power supply voltage is supplied to the diagnosis lamp via key switch, and the signal from ECM will turn the lamp on. The ECM turns the diagnosis lamp on during lamp check with the key switch “ON” and when DTC is detected. Also when the diagnosis connector is connected, it blinks the diagnosis lamp according to the DTC detected. A monitor circuit is provided inside the ECM to monitor the lamp operation.

Diagnostic aid

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

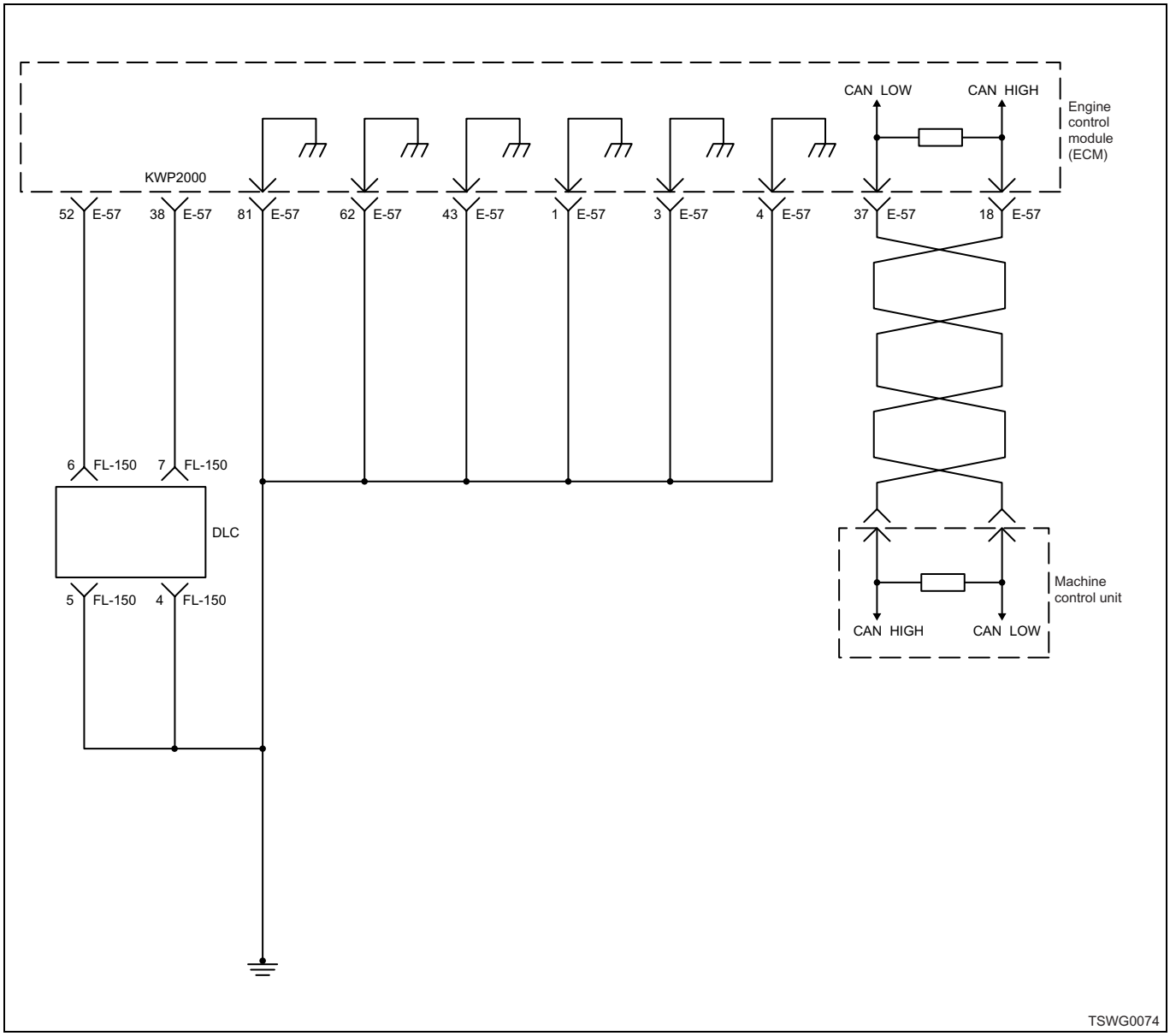
- Improper connection of harness connector
- Defective harness routing
- Worn harness cladding
- Wire disconnection inside harness cladding

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.

Step	Action	Value	YES	NO
1	1. Turn the key switch to “ON”. 2. Check the diagnosis lamp. Does the diagnosis lamp come on?	—	Go to “Diagnostic aid”.	Go to Step 2.
2	Remove the diagnosis lamp to check its condition. Is the trouble detected?	—	Replace the diagnosis lamp.	Go to Step 3.
3	Check for open/short circuit between the diagnosis lamp and ECM and power supply circuit using DMM. Is the trouble detected?	—	Repair the harness.	Go to Step 4.
4	Is EMPS available?	—	Go to Step 5.	Go to Step 6.
5	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?	—	Check the repair, and Go to “OBD system check”.	—
6	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?	—	Check the repair, and Go to “OBD system check”.	—

Diagnosis lamp blinking circuit system check



Description of circuit

The power supply voltage is supplied to the diagnosis lamp via key switch, and the signal from ECM will turn the lamp on. The ECM turns the diagnosis lamp on during lamp check with the key switch “ON” and when DTC is detected. Also when the diagnosis connector is connected, it blinks the diagnosis lamp according to the DTC detected. A monitor circuit is provided inside the ECM to monitor the lamp operation.

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.

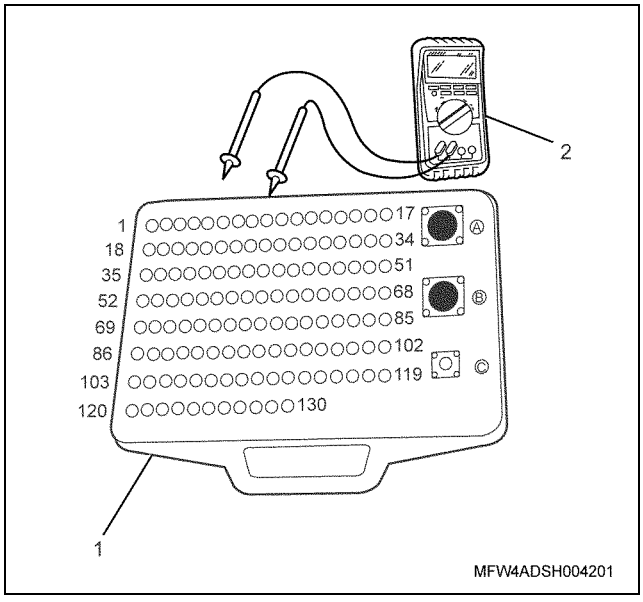
- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items 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.

Step	Action	Value	YES	NO
1	1. Turn the key switch to “OFF”. 2. Connect the DMM between the diagnosis connector (male-side) and the ground. 3. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	0V	Go to Step 2.	Go to Step 3.
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?	—	Verify repair.	Go to Step 3.
3	1. Check for followings in the circuit between ECM and diagnosis connector 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?	—	Verify repair.	Go to Step 4.
4	1. Check for following in the circuit between diagnosis connector and ground. • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Verify repair.	Go to Step 5.
5	Check the diagnosis lamp blinking condition again. 1. Turn the key switch to “ON”. 2. Connect the diagnosis connector. 3. Check the diagnosis lamp. Does the diagnosis lamp blink?	—	Go to “Diagnostic aid”.	Go to Step 6.
6	Is EMPS available?	—	Go to Step 7.	Go to Step 8.

Step	Action	Value	YES	NO
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?	—	Verify repair.	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?	—	Verify repair.	—

Breaker box inspection procedure

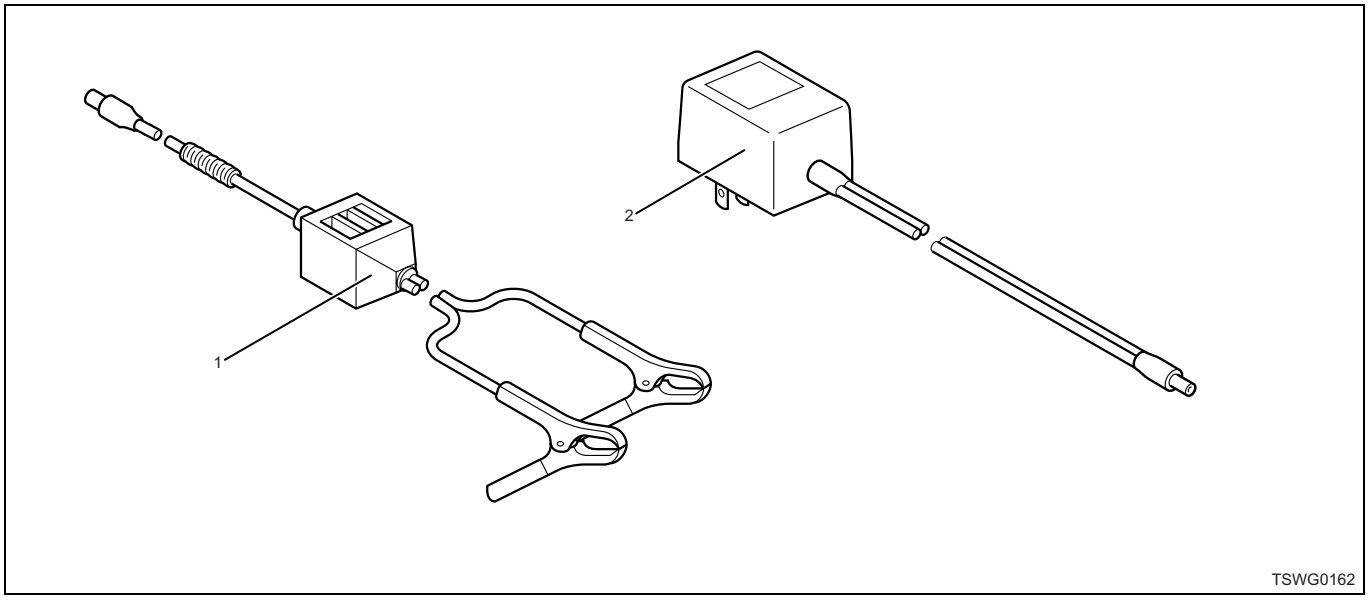
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
3	Open circuit/ high resistance	Resistance measurement	• Key switch “OFF”	52 - Diagnosis connector terminal	100 Ω or less	10 MΩ or more
	Short circuit to ground	Resistance measurement	• Key switch “OFF”	52 - Ground	10 MΩ or more	100 Ω or less

Scan tool power supply circuit system check



Name
1. Battery cable
2. Power socket cable (AC/DC adapter)

Circuit description

The ECM and other ECUs communicate with the scan tool via data link connector (DLC). Power supply voltage for the scan tool is provided from the battery.

Caution:
Use a 12-V battery from the chassis ground side for the power supply to the scan tool.

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.

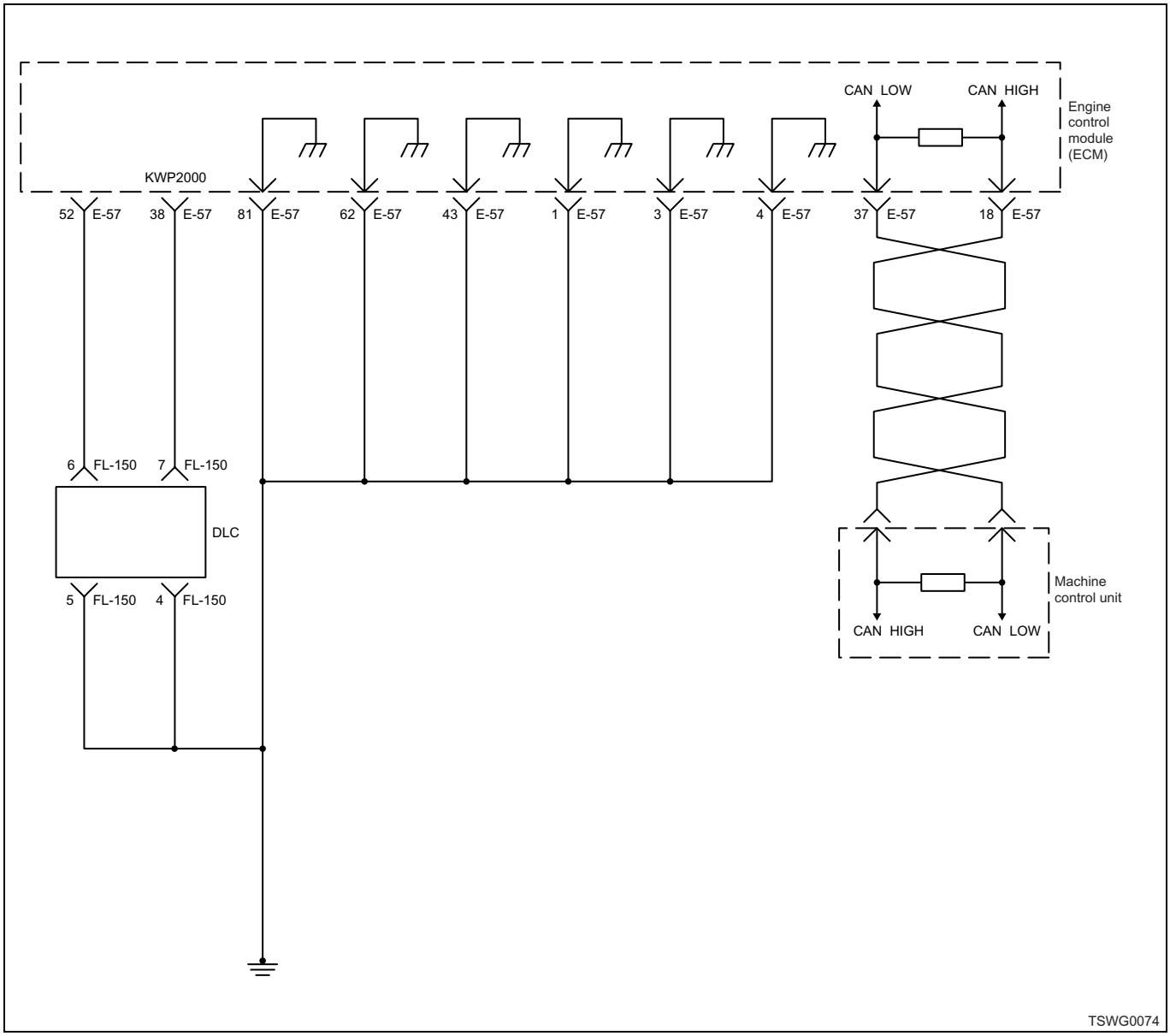
- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items 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

Important:
Before starting this diagnostic step, check if the scan tool operates properly on other machine.

Step	Action	Value	YES	NO
1	Check the voltage of battery on the machine using DMM. Is the voltage more than specified value?	10V	Go to Step 2.	Charge or replace the battery.
2	Check for poor contact in the scan tool-side cable. Is the trouble detected?	—	Go to Step 3.	Go to Step 4.
3	Correct the connection of the scan tool. Is the procedure completed?	—	Go to Step 4.	—
4	Check for open/short circuit in the cable between scan tool and battery. Is the trouble detected?	—	Request for repair by referring to the operation manual of the scan tool.	Go to Step 5.
5	1. Connect the scan tool to the machine. 2. Turn the power switch of the scan tool to “ON”. Does the scan tool powered “ON”?	—	Check the repair, and Go to “OBD system check”.	Go to Step 1.

Scan tool communication circuit system check



Circuit description

The engine control module (ECM) performs KW communication with the scan tool via 16-pin data link connector (DLC).

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.

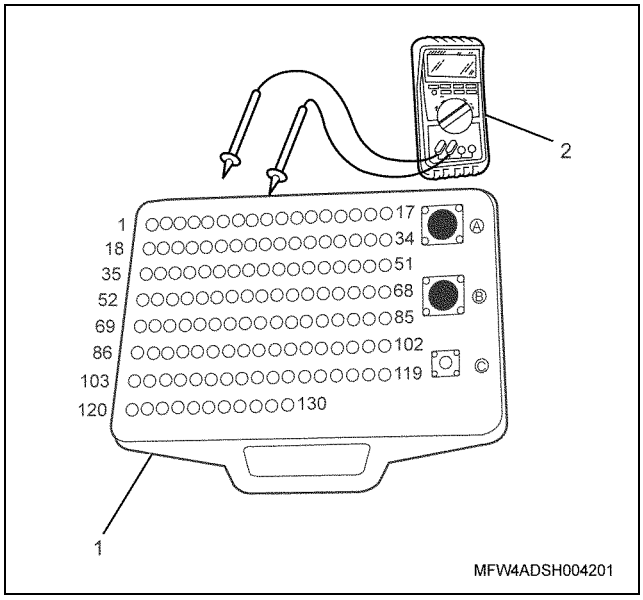
- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items 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.

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	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	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?	—	Verify repair.	Go to Step 2.

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.



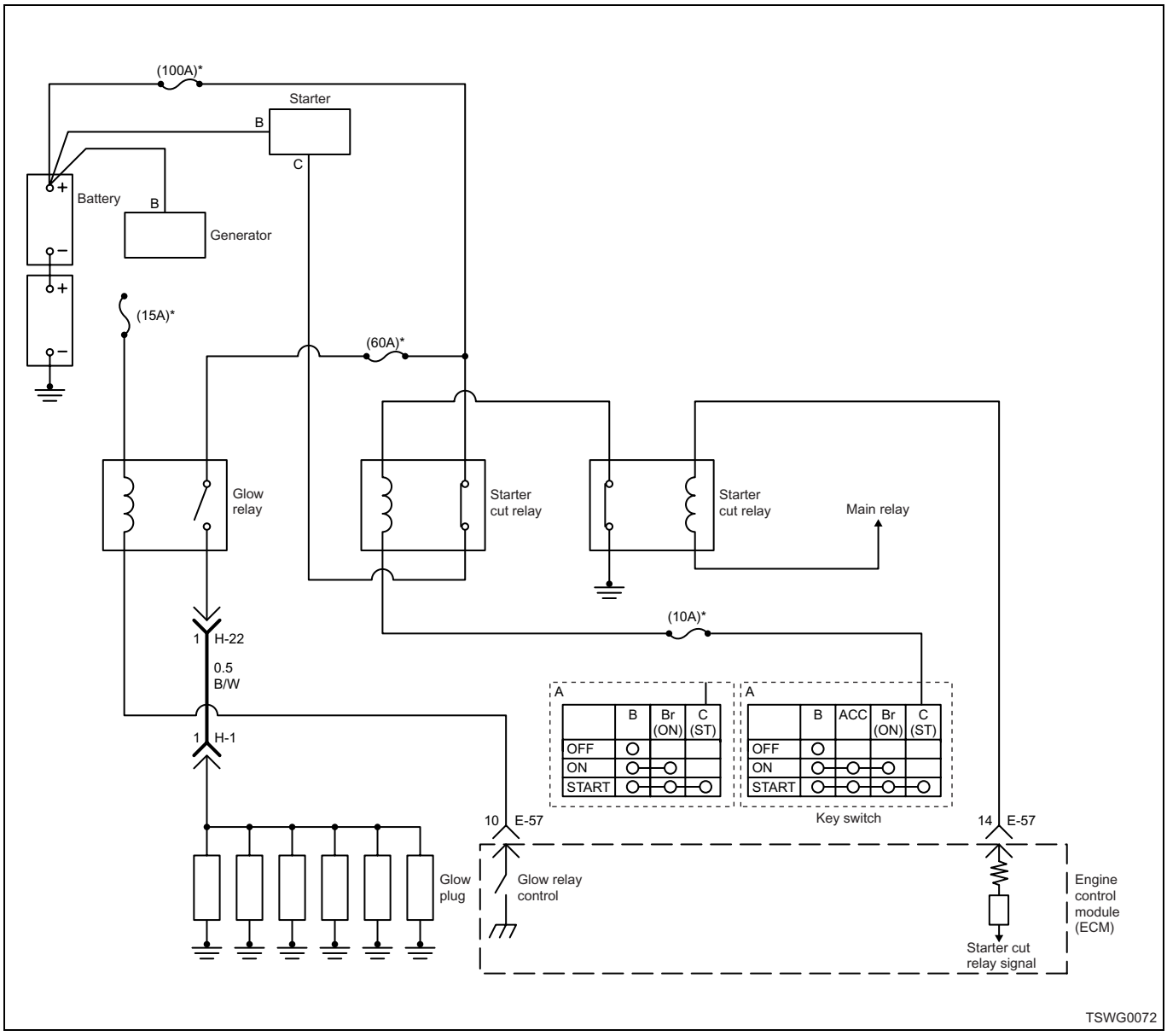
Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
4	Open circuit/ high resistance	Resistance measurement	• Key switch "OFF"	38 - DLC terminal No. 7	100Ω or less	10 MΩ or more
	Short circuit to ground	Resistance measurement	• Key switch "OFF"	38 - Ground	10 MΩ or more	100Ω or less

Starting circuit system check

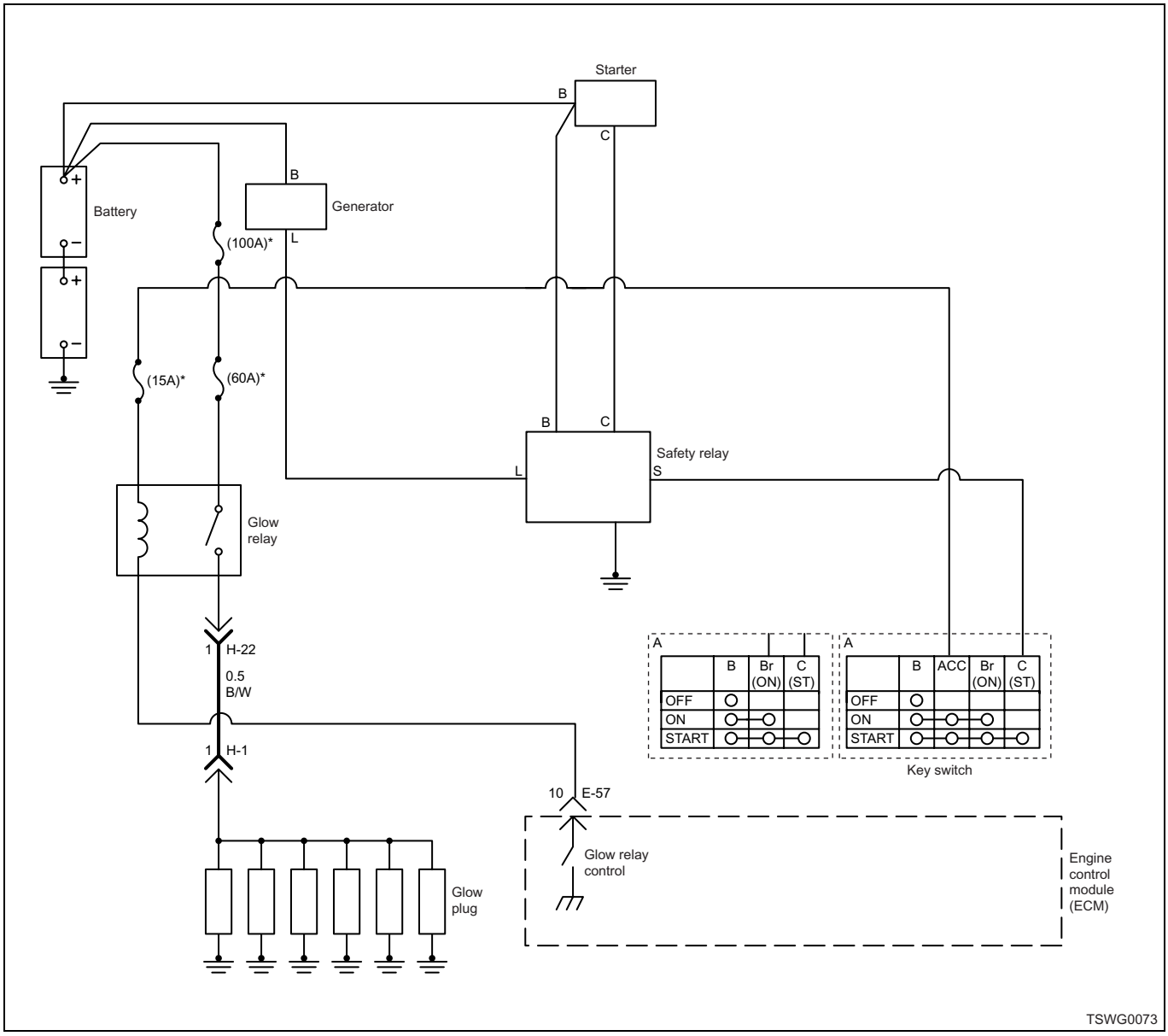
Starter ECM control

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



Starter safety relay control

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



Circuit description

ECM turns the starter relay “ON” when the key switch is turned to “START” position. When the starter relay is “ON”, the starter operates to start the engine.

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 diagnostic chart.
1. If these DTCs are detected, engine may not start.
3. When the ECM does not recognize the “START” position signal from the key switch, the starter cut relay is set “OFF”. Therefore, the starter relay will not turn “ON”.

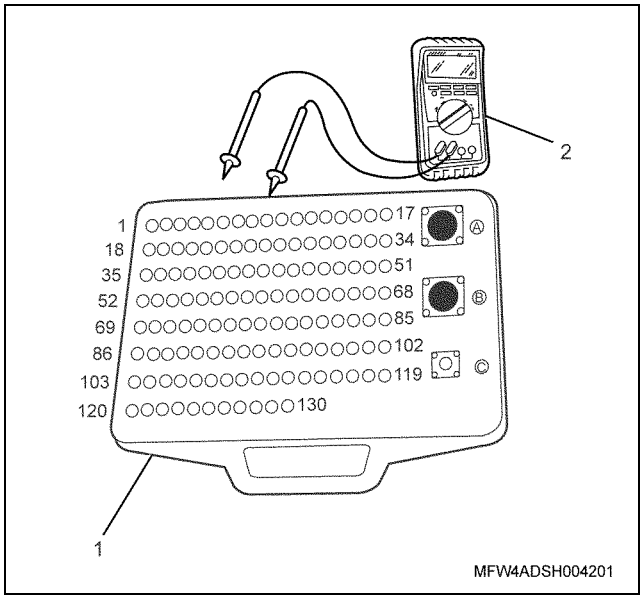
Step	Action	Value	YES	NO
1	1. Turn the key switch to “ON”. 2. Check the DTC. Is the DTC P0340, P0341, P0615, P1345 or P1625 detected?	—	Go to the relevant diagnosis of DTC detected.	Go to Step 2.
2	Is the scan tool available?	—	Go to Step 3.	Go to Step 16.
3	1. Turn the key switch to “START”. 2. Check for “Starter switch (ST)” on the data display using scan tool. Is the “Starter switch (ST)” displayed “ON”?	—	Go to Step 5.	Go to Step 4.
4	1. Check for followings in the circuit between key switch and ECM 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 11.
5	1. Turn the key switch to “OFF”. 2. Remove the starter cut relay. 3. Check for continuity between the starter cut relay switch-side terminals. Is the trouble detected?	—	Go to Step 6.	Go to Step 7.
6	Replace the starter cut relay. Is the procedure completed?	—	Go to Step 12.	—
7	1. Turn the key switch to “OFF”. 2. Remove the starter relay. 3. Connect the battery to the starter relay coil-side terminal. 4. Check for continuity between the starter relay switch-side terminals. Is the trouble detected?	—	Go to Step 8.	Go to Step 9.
8	Replace the starter relay. Is the procedure completed?	—	Go to Step 12.	—

Step	Action	Value	YES	NO
9	Turn the key switch to “START”. Does the starter operate?	—	Go to “Diagnostic aid”.	Go to Step 10.
10	1. Check the following circuits for open circuit or high resistance. • Between key switch and starter cut relay • Between starter cut relay and starter relay • Between starter relay and ground • Between starter relay and starter 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 15.	Go to Step 11.
11	1. Inspect by referring to “Electrical system” in the service manual “Engine section” 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 15.	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?	—	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	Turn the key switch to “START”. Does the starter operate?	—	Check the repair, and Go to “OBD system check”.	Go to Step 1.

Step	Action	Value	YES	NO
16	1. Check for followings in the circuit between key switch and ECM 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 17.
17	1. Turn the key switch to “OFF”. 2. Remove the starter cut relay. 3. Check for continuity between the starter cut relay switch-side terminals. Is the trouble detected?	—	Go to Step 18.	Go to Step 19.
18	Replace the starter cut relay. Is the procedure completed?	—	Go to Step 12.	—
19	1. Turn the key switch to “OFF”. 2. Remove the starter relay. 3. Connect the battery to the starter relay coil-side terminal. 4. Check for continuity between the starter relay switch-side terminals. Is the trouble detected?	—	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.

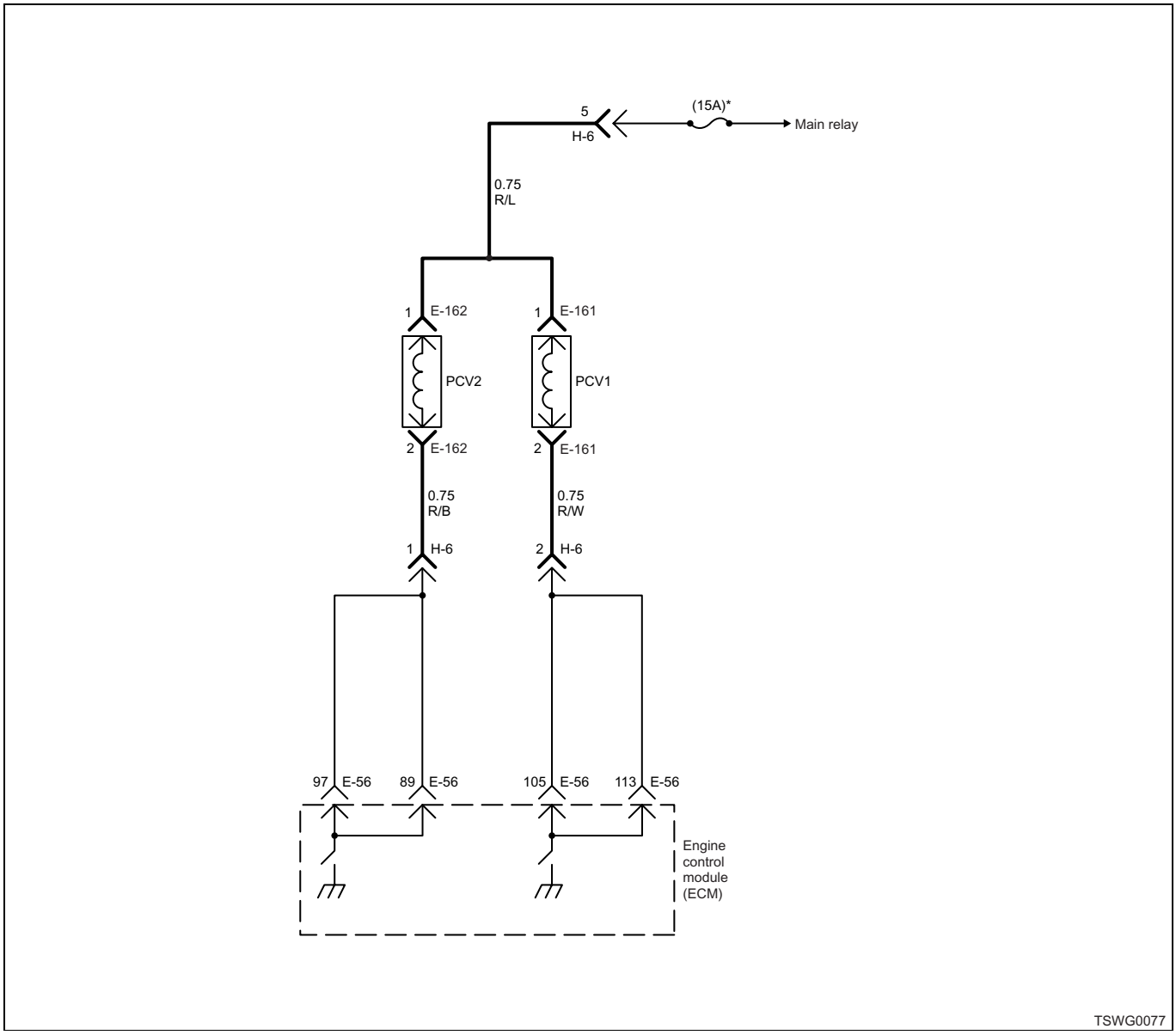


Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
4, 16	Open circuit/ high resistance	Resistance measurement	• Key switch “OFF”	46 - Key switch “START” terminal	100Ω or less	10 MΩ or more
	Short circuit to ground	Resistance measurement	• Key switch “OFF”	46 - Ground	10 MΩ or more	100Ω or less
5, 17	Open circuit/ high resistance	Resistance measurement	• Key switch “OFF” • Relay alone	Starter cut relay Switch-side terminal	100Ω or less	10 MΩ or more
7, 19	Open circuit/ high resistance	Resistance measurement	• Key switch “OFF” • Relay alone • Relay “ON”	Starter relay Switch-side terminal	100Ω or less	10 MΩ or more

Starting system check

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



About starting system check

Starting system check is systematic method to detect the cause of that engine does not start. Followings are the preconditions for performing this diagnosis.

- Battery is fully charged, and battery cable is securely connected.
- Engine speed at cranking is normal.
- Sufficient amount of fuel is supplied.
- No air mixed in the fuel.
- Air cleaner element and fuel filter is normal.
- Correct fuel is used.

Important:
Start with the DTC diagnosis relevant to fuel system if there is any.

Diagnostic aid

If there is relevant DTC to CKP sensor and G sensor, the engine will not start until memory clear is performed.
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

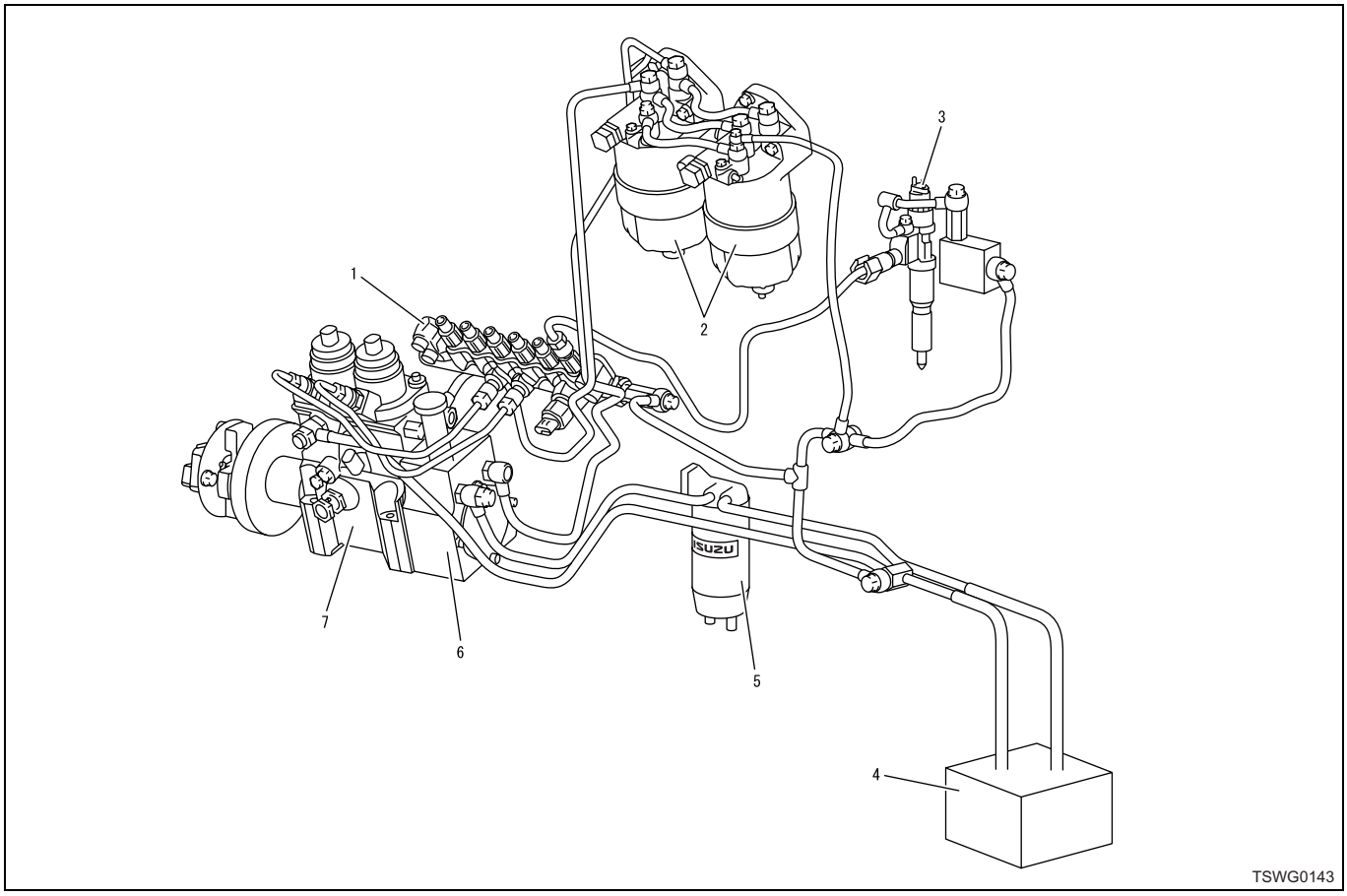
Test description

Numbers below indicate step numbers in the chart.
3. If the PCV-LOW circuit is shorted to ground, the PCV drive current will not increase to more than 900mA.
4. If the engine starts with the PCV connector disconnected, PCV system may be faulty. Also, if the engine does not start, the fuel system may be faulty.
6. Check the signal and operation of each sensor and injector.

Step	Action	Value	YES	NO
1	1. Turn the key switch to “ON”. 2. Crank the engine for 15 seconds. 3. Check the DTC. Is DTC detected?	—	Go to the relevant diagnosis of DTC detected.	Go to Step 2.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 10.
3	While cranking the engine, check for “PCV F/B” on the data display using scan tool. Is the “PCV F/B” less than the specified value?	900mA	Go to Step 4.	Go to Step 5.
4	1. Remove the PCV connector. 2. Crank the engine. Does the engine start?	—	Go to DTC P0091/P1291.	Go to “Fuel system check”.
5	Repair the PCV-LOW circuit between the ECM and the PCV. Is the procedure completed?	—	Go to Step 7.	—
6	1. Check the relevant items to the following using scan tool to see if the values are normal. (Refer to “Tech2 data reference value” for specified value.) • Engine coolant temperature (ECT) sensor • Common rail pressure sensor • EGR position sensor • Injector 2. If the trouble is detected, replace the circuit or sensor as required. Is the trouble detected?	—	Go to Step 8.	Go to Step 7.
7	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.	—

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.	—

Fuel system check



Name
1. Common rail
2. Fuel filter
3. Injector
4. Fuel tank
5. Pre-filter
6. Feed pump
7. Supply pump

About fuel system

Fuel system consists of the fuel tank, fuel filter, supply pump, common rail, and injector each of which is connected by the fuel pipe.

Diagnostic aid

Followings are considered as the major possible cause of the fault in fuel system.

- Air mixed in the fuel system.
- Clogged fuel filter
- Damage, clogging, improper connection of fuel pipe
- Fuel tank fault
- Supply pump fault
- Injector fault
- Pressure limiter fault

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

Step	Action	Value	YES	NO
1	Check the fuel quality. 1. Drain fuel from the fuel tank. 2. Add proper fuel. 3. Bleed air from the fuel. 4. Start the engine. Does the engine start?	—	Go to Step 6.	Go to Step 2.
2	Check the fuel quantity. Is sufficient amount of fuel supplied?	—	Go to Step 3.	Supply fuel, and Go to Step 3.
3	Check if there are additional filters or parts, other than genuine fuel filter, pre-filter and electromagnetic pump, in the machine's fuel pipe. Are there any additional filters or parts?	—	Go to Step 4.	Go to Step 5.
4	1. Remove the additional filter and bleed air. • If the fuel resistance is increased, the DTC P1093 or 1094 may be detected. 2. Start the engine. Does the engine start?	—	Go to Step 6.	Go to Step 5.
5	1. Check for excessive dirt or clogging in the (main and pre-) fuel filters. 2. Check for excessive dirt or clogging in the electromagnetic pump (main and pre-) filter. 3. If the trouble is detected, clean or replace. 4. If air is entered in the main filter, examine the cause and repair. Is the procedure completed?	—	Go to Step 6.	—
6	1. Check for damage, clogging, or improper connection in the fuel pipe. 2. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 7.	—
7	1. Check for following troubles in the fuel tank. • Foreign matter mixed in the fuel • Disconnection or damage in fuel supply pipe • Crush or damage in tank • Wrong assembly of fuel pipe • Clogging at filler neck • Water mixed in fuel 2. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 8.	—

Step	Action	Value	YES	NO
8	Bleed air from the fuel. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the procedure completed?	—	Verify repair.	—

Intake system check

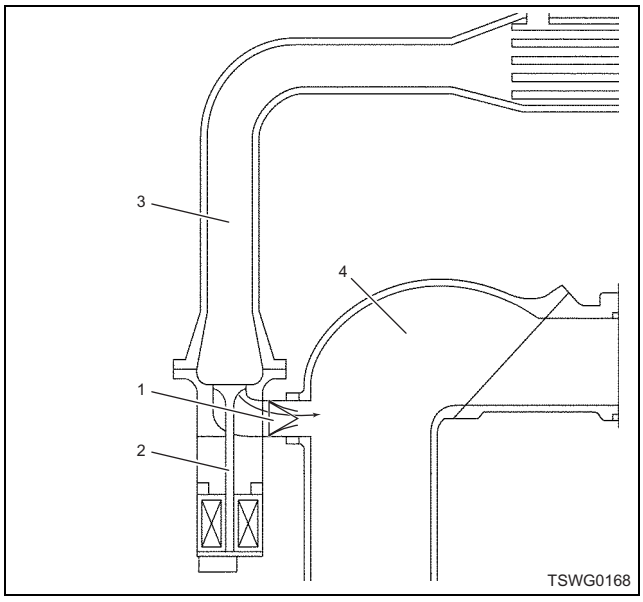
About intake system

(If intake system parts are installed by the machine manufacturer, refer to the machine's manual.)

The intake system consists of the air cleaner, intake pipe, turbocharger, etc. Intake air is supplied to the engine through the air cleaner and intake manifold.

Step	Action	Value	YES	NO
1	Check for excessive dirt or clogging in the air cleaner. Is the trouble detected?	—	Go to Step 2.	Go to Step 3.
2	Clean or replace the air cleaner. Is the procedure completed?	—	Go to Step 3.	—
3	1. Check for crush, breakage, or air leakage in the intake pipe. 2. Make sure that the intake pipe is a genuine part. • Check for bend or improper piping that may cause increasing in intake air resistance. 3. Check the reed valve for breakage. Is the trouble detected?	—	Go to Step 4.	Go to Step 5.
4	Repair or replace the intake pipe or reed valve. Is the procedure completed?	—	Go to Step 5.	—
5	Check the turbocharger. • Check for abnormal rattling in the turbine shaft. • Check for oil leakage. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the procedure completed?	—	Go to Step 6.	Go to Step 7.
6	Repair or replace the turbocharger. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the procedure completed?	—	Go to Step 7.	—
7	Repair the machine. Is the procedure completed?	—	Verify repair.	—

Reed valve check



Name
1. Reed valve
2. EGR valve
3. Exhaust side
4. Intake side

If the reed valve is broken, bypass of intake air deteriorates air-fuel ratio (A/F), resulting in output lowering.
Check the reed valve for deformation or breakage.

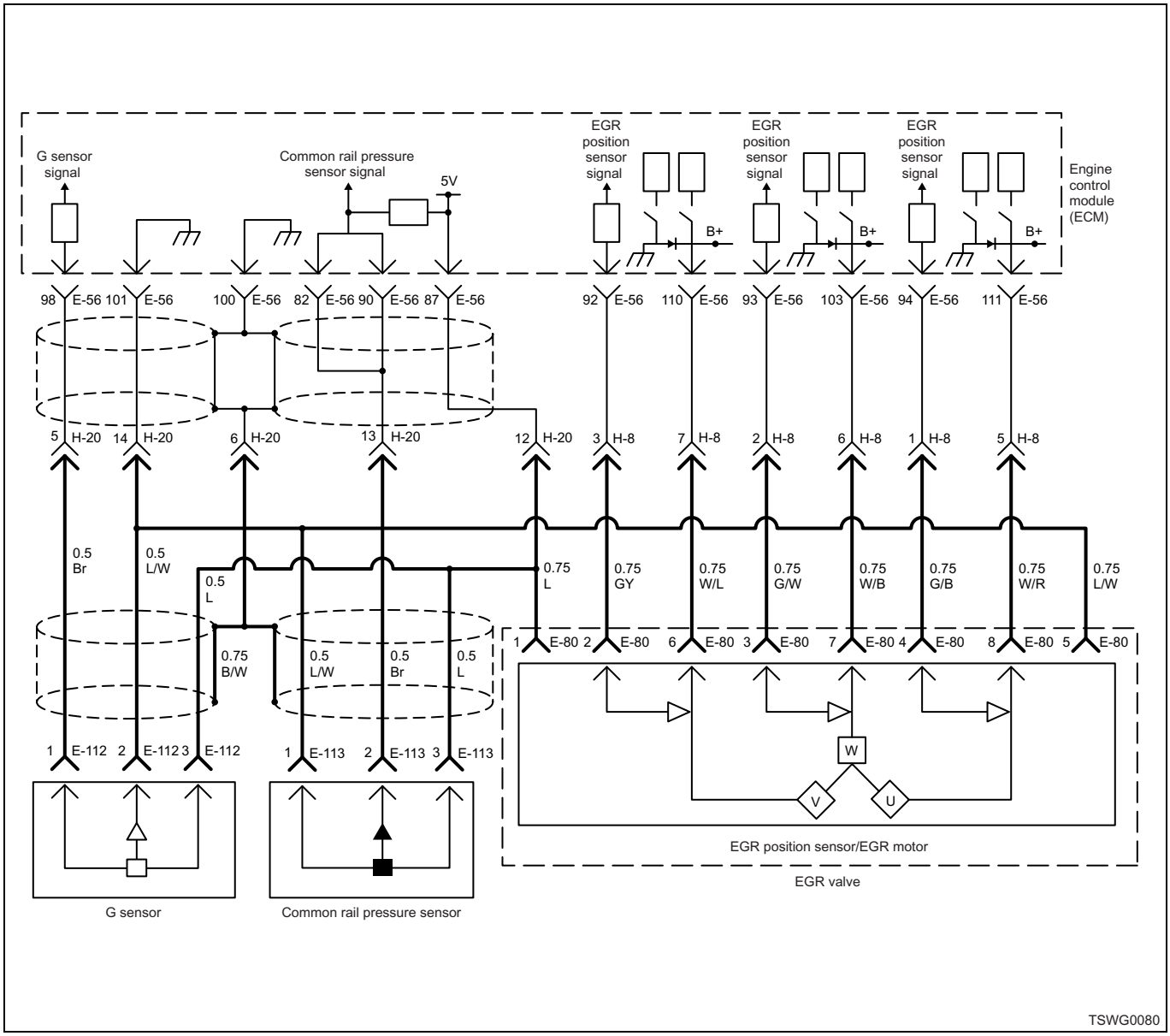
Exhaust system check

About exhaust system

The exhaust system consists of the exhaust pipe, tail pipe, etc.

Step	Action	Value	YES	NO
1	Check for crush, breakage, or exhaust leakage in the exhaust pipe and tail pipe. Is the trouble detected?	—	Go to Step 2.	Go to Step 3.
2	Repair or replace the exhaust pipe or tail pipe. Is the procedure completed?	—	Go to Step 3.	—
3	Repair the machine. Is the procedure completed?	—	Verify repair.	—

EGR control system check



Circuit description

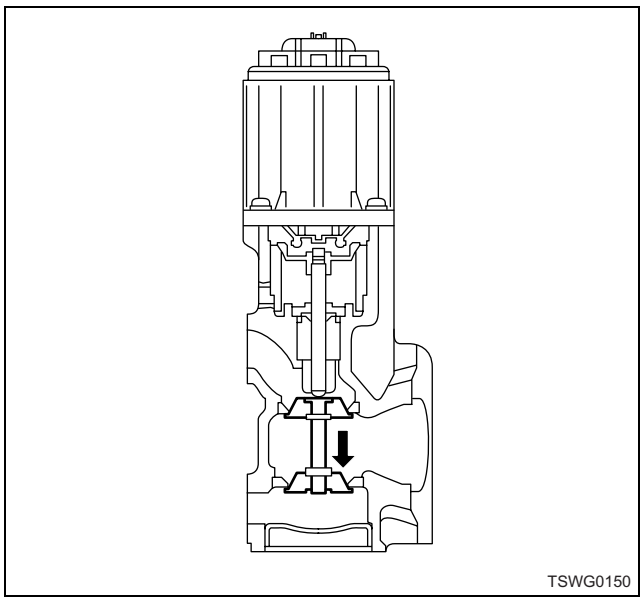
The ECM operates the EGR valve based on engine speed, engine coolant temperature, intake air temperature, fuel injection amount, and barometric pressure. The EGR motor drives the EGR valve, and the EGR position sensor detects the EGR valve opening angle.

Step	Action	Value	YES	NO
1	1. Turn the key switch to “ON”. 2. Check the DTC. Is DTC detected?	—	Go to the relevant diagnosis of DTC detected.	Go to Step 2.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 8.

Step	Action	Value	YES	NO
3	1. Start the engine. 2. Warm-up the engine until the engine coolant temperature is 70°C (158°F). 3. Check the value for “EGR position” using scan tool. Is “EGR position” within the specified value?	±3%	Normal system	Go to Step 4.
4	1. Perform “EGR control test” using scan tool. 2. Press the “Up” “Down” soft key. 3. Check the value for “EGR position”. Is “EGR position” within the specified value?	±3%	Go to Step 6.	Go to Step 5.
5	Replace the EGR valve. After replacing the EGR valve or ECM, the EGR valve position learning must be performed in the following procedure. 1. Turn the key switch to “ON”. 2. Turn the key switch to “OFF”. 3. Leave as it is for 10 seconds. Failure to perform above procedure may result in detection of DTC for EGR. Is the procedure completed?	—	Go to Step 6.	—
6	1. Check for damage or gas leakage in the EGR pipe. 2. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 7.	—
7	1. Start the engine. 2. Warm-up the engine until the engine coolant temperature is 70°C (158°F). 3. Check the value for “EGR position” using scan tool. Is “EGR position” within the specified value?	±3%	Verify repair.	Go to Step 3.
8	1. Remove the EGR valve. 2. Check the EGR valve for anchoring, clogging, etc. 3. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	Normal system
9	Replace the EGR valve. After replacing the EGR valve or ECM, the EGR valve position learning must be performed in the following procedure. 1. Turn the key switch to “ON”. 2. Turn the key switch to “OFF”. 3. Leave as it is for 10 seconds. Failure to perform above procedure may result in detection of DTC for EGR. Is the procedure completed?	—	Go to Step 10.	—

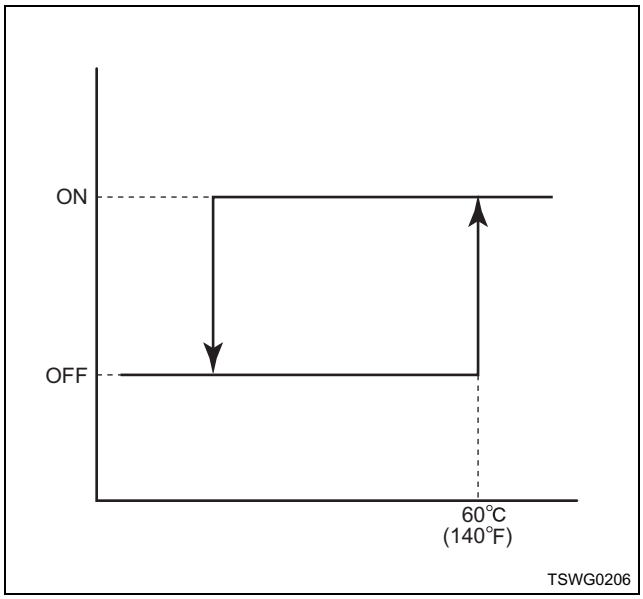
Step	Action	Value	YES	NO
10	1. Check for damage or gas leakage in the EGR pipe. 2. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 11.	—
11	1. Turn the key switch to “ON”. 2. Check the DTC. Is DTC detected?	—	Go to the relevant diagnosis of DTC detected.	Go to Step 2.

EGR valve check



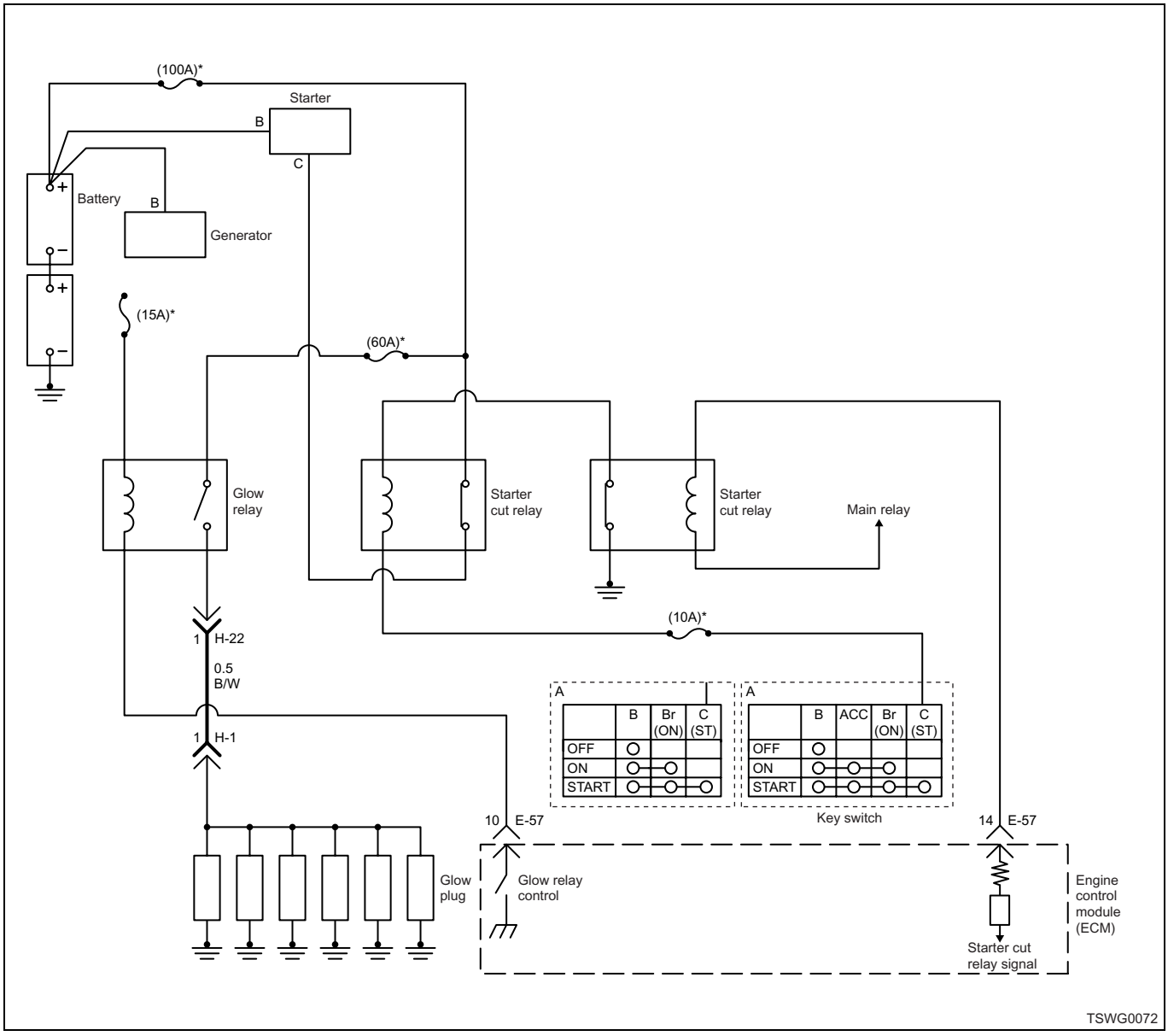
Push the EGR valve with finger to make sure it opens/ closes smoothly. Also, make sure that the valve closes completely when the finger is released.

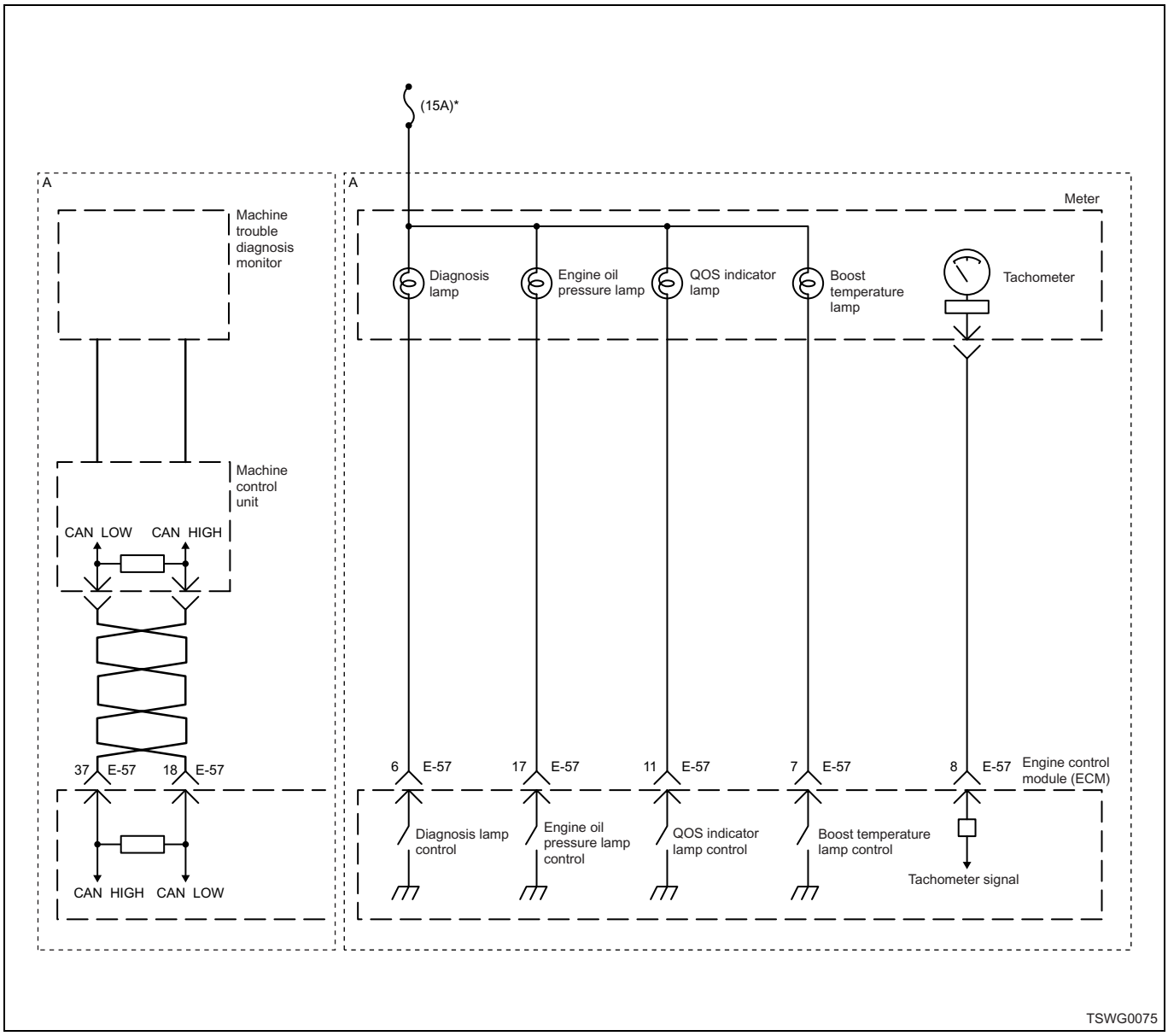
EGR hysteresis



QOS system check

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)





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”.

Step	Action	Value	YES	NO
2	1. Turn the key switch to “ON”. 2. Check the DTC. Is relevant DTC to the engine coolant temperature sensor, QOS indicator lamp, or glow reply detected?	—	Go to the relevant diagnosis of DTC detected.	Go to Step 3.
3	Check the fuse. Check for blown out fuse relevant to the QOS system. Is the trouble detected?	—	If the fault still remains after repair, go to step 4.	Go to Step 7.
4	Check for short circuit between the fuse, ECM, glow plug, and QOS indicator lamp. 1. Disconnect the harness from the fuse, glow relay, ECM, glow plug, and QOS indicator lamp. 2. Measure the resistance between each glow relay terminal, each QOS indicator lamp terminal, and the ground. Is the resistance specified value?	10 MΩ or more	Go to Step 6.	Go to Step 5.
5	Repair the short circuit between the fuse, ECM, glow plug, and QOS indicator lamp. Is the procedure completed?	—	—	Go to Step 6.
6	1. Replace the fuse. 2. Turn the key switch to “ON”. 3. Make sure that the fuse is not blown. Is the procedure completed?	—	—	Go to Step 7.
7	1. Turn the key switch to “OFF”. 2. Turn the key switch to “ON”. 3. Check the QOS indicator lamp. Does the QOS indicator lamp come on?	—	Go to Step 12.	Go to Step 8.
8	1. Turn the key switch to “OFF”. 2. Remove the QOS indicator lamp. 3. Check the QOS indicator lamp for blow out. Is the trouble detected?	—	Go to Step 9.	Go to Step 10.
9	1. Replace the QOS indicator lamp. 2. Turn the key switch to “ON”. 3. Check the QOS indicator lamp. Does the QOS indicator lamp come on?	—	Go to Step 12.	Go to Step 10.
10	1. Disconnect the ECM connector. 2. Measure the resistance between the QOS indicator lamp terminal and the harness between ECM and the ground. Is the resistance specified value?	10 MΩ or more	Go to Step 7.	Go to Step 11.
11	Repair the QOS indicator lamp terminal-to-ECM harness. Is the procedure completed?	—	Go to Step 7.	—

Step	Action	Value	YES	NO
12	1. Turn the key switch to “OFF”. 2. Turn the key switch to “ON”. 3. Check the QOS indicator lamp. Does the QOS indicator lamp go OFF within 10 seconds?	—	Go to Step 14.	Go to Step 13.
13	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. If rewriting is not necessary, go to step 3. 3. Replace the ECM. Refer to “How to use flash tool” in this section for check and rewriting of ECM. Is the procedure completed?	—	Go to Step 14.	—
14	1. Perform “Glow plug relay” test using scan tool. When the scan tool is not available, remove the relay and test it by itself. 2. Press the “ON” and “OFF” softkeys. Does the glow relay display (contact) “ON” and “OFF”?	—	Go to Step 15.	Go to Step 13.
15	1. Turn the key switch to “OFF”. 2. Remove all the glow plugs. 3. Measure the resistance between each glow plug terminal and the ground. Is the resistance specified value?	6Ω (Normal temperature)	Go to Step 16.	Go to Step 20.
16	1. Turn the glow relay “ON” using the “Glow plug relay” test of the scan tool. When the scan tool is not available, remove the glow relay and short between the terminals. 2. Measure the voltage between each cylinder glow plug harness terminal and the ground using DMM. Are the voltages at all the cylinders more than specified value?	18V	Go to Step 17.	Go to Step 18.
17	1. Turn the glow relay “OFF” using the “Glow plug test” of the scan tool. When the scan tool is not available, remove the glow relay. 2. Measure the voltage between each cylinder glow plug harness terminal and the ground using DMM. Are the voltages at all the cylinders specified value?	0V	Normal system	Go to Step 19.
18	Repair the open circuit between the glow relay and the glow plug, or the short circuit to the ground circuit. Is the procedure completed?	—	Go to Step 21.	—

Step	Action	Value	YES	NO
19	Repair the power supply circuit between the glow relay and the glow plug, or the short circuit to the ignition power supply circuit. Is the procedure completed?	—	Go to Step 21.	—
20	Replace the glow plug. Is the procedure completed?	—	Go to Step 21.	—
21	1. Turn the glow relay “ON” using the “Glow plug test” of the scan tool. When the scan tool is not available, remove the glow relay and short between the terminals. 2. Measure the voltage between each cylinder glow plug harness terminal and the ground using DMM. Are the voltages at all the cylinders more than specified value?	18V	Go to Step 22.	Go to Step 16.
22	1. Turn the glow relay “OFF” using the “Glow plug test” of the scan tool. When the scan tool is not available, remove the glow relay. 2. Measure the voltage between each cylinder glow plug harness terminal and the ground using DMM. Are the voltages at all the cylinders specified value?	0V	Verify repair.	Go to Step 17.

List of diagnostic trouble code

List of diagnostic trouble codes

On some machines, the diagnosis lamp comes on instead of trouble display monitor on the machine.

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
P0088	118	Common rail pressure fault (1st stage)	Common rail pressure abnormal increase	• Key switch input voltage is 16V or more. • DTC P0088, P0192, P0193, or P1635 is not detected. • Actual rail pressure is 2 MPa (290 psi) or more, and 70 rpm or more.	Rail pressure is more than 150 MPa (21756 psi).	Approx. 5 sec.	Intense engine vibration, rough idling, output lowering, blow up fault, black smoke emitted, and excessive output are possible. Back-up: Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})	ON	*1
		Common rail pressure fault (2nd stage)	Common rail pressure abnormal increase	• Key switch input voltage is 16V or more. • DTC P0088, P0192, P0193, or P1635 is not detected. • Actual rail pressure is 2 MPa (290 psi) or more, and 70 rpm or more.	Common rail pressure fault (1st stage) is completed, and rail pressure is more than 155 MPa (22481 psi).	Approx. 5 sec.	Intense engine vibration, rough idling, output lowering, blow up fault, black smoke emitted, and excessive output are possible. Back-up: Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})	ON	*1
P0089	151	Common rail pressure fault (Excessive pressure feed in the pump)		• Key switch input voltage is 16V or more. • DTC P0089, P0192, P0193, or P1635 is not detected. • Coolant temperature is 60°C (140°F) or more, and 375 rpm or more.	Actual rail pressure higher than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more. Or actual rail pressure higher than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more, during indication of no pressure feed.	Approx. 8 sec.	Intense engine vibration, rough idling, output lowering, blow up fault, black smoke emitted, and excessive output are possible. Back-up: Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})	ON	*1
P0091	247	PCV1 open circuit or ground short	PCV1 electrical wiring open circuit/ ground short	• Main relay power supply voltage is 16V or more. • DTC P0092 is not detected. • 300 rpm or more, or actual rail pressure exceeds target rail pressure	PCV1 monitor signal is fixed to Low-side.	Approx. 1 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault, black smoke emitted Back-up: Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})	ON	*2

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
P0092	217	PCV1+B short circuit	PCV1 electrical wiring +B short	• Main relay power supply voltage is 16V or more. • DTC P0091 or P0092 is not detected. • 300 rpm or more, or actual rail pressure exceeds target rail pressure	PCV1 monitor signal is fixed to High-side.	Approx. 1 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault, black smoke emitted Back-up: PCV1 stop	ON	*1
P0107	71	Barometric pressure sensor fault (low voltage fault)	Open/short circuit/ deterioration of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1632 is not detected.	Barometric pressure sensor voltage is lower than 0.5 V.	Approx. 5 sec.	Due to back-up equivalent to 2500m (8200ft) Black smoke emitted at high altitude Output shortage at low altitude Back-up: Specified back-up value	ON	*2
P0108		Barometric pressure sensor fault (high voltage fault)	Short circuit in sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1632 is not detected.	Barometric pressure sensor voltage is more than 3.8 V.	Approx. 5 sec.	Due to back-up equivalent to 2500m (8200ft) Black smoke emitted at high altitude Output shortage at low altitude Back-up: Specified back-up value	ON	*2
P0112	22	Intake air temperature sensor fault (low voltage fault)	Short circuit in sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1632 is not detected.	Intake air temperature sensor voltage is less than 0.1 V.	Approx. 4 sec.	White smoke emission possible when starting at low temperatures Back-up: Intake air temperature default setting (at starting: −10°C {14°F}, at running: 25°C {77°F}) EGR stopped	ON	*2
P0113		Intake air temperature sensor fault (high voltage fault)	Open/short circuit/ deterioration of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1632 is not detected. • 3 minutes or more has elapsed after starting engine.	Intake air temperature sensor voltage is more than 4.95 V.	Approx. 4 sec.	White smoke emission possible when starting at low temperatures Back-up: Intake air temperature default setting (at starting: −10°C {14°F}, at running: 25°C {77°F}) EGR stopped	ON	*2

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
P0117	23	Engine coolant temperature sensor fault (low voltage fault)	Short circuit in sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1633 is not detected.	Engine coolant temperature sensor voltage is less than 0.1 V.	Approx. 4 sec.	Start ability deteriorates at low temperatures or black smoke emission is possible, output lowering depending on conditions. Back-up: Coolant temperature default setting. (at starting: −20°C {−4°F}, at running: 80°C {176°F}) EGR stopped	ON	*2
P0118		Engine coolant temperature sensor fault (high voltage fault)	Open/short circuit/ breakage of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1633 is not detected. • 3 minutes or more has elapsed after starting engine.	Engine coolant temperature sensor voltage is more than 4.85 V.	Approx. 4 sec.	At normal temperature: Black smoke emission, greater engine combustion noise possible. During idling at low atmospheric temperatures: Rough idling, engine stall, white smoke emission possible. Back-up: Coolant temperature default setting. (at starting: −20°C {−4°F}, at running: 80°C {176°F}) EGR stopped	ON	*2
P0182	211	Fuel temperature sensor fault (low voltage fault)	Short circuit in sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1633 is not detected.	Combustion temperature sensor voltage is less than 0.1 V.	Approx. 4 sec.	Operationality is affected. Back-up: Fuel temperature default setting. (at starting: −20°C {−4°F}, at running: 70°C {158°F})	ON	*2
P0183		Fuel temperature sensor fault (high voltage fault)	Open/short circuit/ breakage of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1633 is not detected. • 3 minutes or more has elapsed after starting engine.	Combustion temperature sensor voltage is more than 4.85 V.	Approx. 4 sec.	Not in particular Back-up: Fuel temperature default setting. (at starting: −20°C {−4°F}, at running: 70°C {158°F})	ON	*2

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
P0192	245	Common rail pressure sensor fault (low voltage fault)	Short circuit in sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1635 is not detected.	Common rail pressure sensor voltage is less than 0.7 V.	Nearly simultaneous to fault occurrence	Engine blow up Back-up: Specified back-up value	ON	*2
P0193		Common rail pressure sensor fault (high voltage fault)	Open/short circuit/ breakage of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1635 is not detected.	Common rail pressure sensor voltage is more than 4.5 V.	Nearly simultaneous to fault occurrence	Output lowering, Black smoke emitted Engine stall possible Back-up: Specified back-up value	ON	*2
P0201	271	Open circuit in injection nozzle #1 drive system	Open/short circuit in electrical wiring No. 1 cylinder injector	• Main relay power supply voltage is 16V or more. • 70 rpm or more • DTC P0611, P1261 or P0201 is not detected.	No injector 1 monitor input signal exists.	Approx. 2.4 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Specified back-up value	ON	*1
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. 2.4 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Specified back-up value	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. 2.4 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Specified back-up value	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. 2.4 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Specified back-up value	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. 2.4 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Specified back-up value	ON	*1

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
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. 2.4 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Specified back-up value	ON	*1
P0219	543	Overrun	Engine speed abnormally high	• Key switch input voltage is 16V or more.	When the engine speed exceeds setting value	Nearly simultaneous to fault occurrence	Output lowering Back-up: Limited injection amount 1; Limitation is lifted if the speed decreases	ON	*2
P0237	32	Boost pressure sensor fault (low voltage fault)	Open/short circuit/ breakage of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1634 is not detected.	Boost pressure sensor voltage less than 0.1 V	Approx. 3 sec.	Operationality is affected. Back-up: Boost pressure default setting (200 kPa {29.0 psi}) Boost pressure correction/EGR stopped	ON	*2
P0238		Boost pressure sensor fault (high voltage fault)	Short circuit in sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1634 is not detected.	Boost pressure sensor voltage is more than 4.9 V.	Approx. 3 sec.	Black smoke emitted Back-up: Boost pressure default setting (200 kPa {29.0 psi}) Boost pressure correction/EGR stopped	ON	*2
P0335	15	Crank sensor fault (no signal)	Open circuit in sensor/ wiring	• G sensor pulse is normal. • DTC P0335, P0336, P0340, P0341 or P1345 is not detected. • Engine is running.	G sensor signal exists but no crank signal.	When trouble occurs 14 out of 21 samples.	Output lowering, white smoke emission, intense engine vibration possible Engine stall possible (restart is possible when G sensor is normal.) Back-up: Control based on G sensor when it is normal	ON	*1
P0336		Crank sensor fault (signal fault)	Broken teeth/ unnecessary signal mixed (such as short circuit with other wiring)	• G sensor pulse is normal. • DTC P0335, P0336, P0340, P0341 or P1345 is not detected. • Engine is running.	Number of pulse for crank signal is mismatched.	When trouble occurs 14 out of 21 samples.	Output lowering, white smoke emission, intense engine vibration possible Engine stall possible (restart is possible when G sensor is normal.) Back-up: Control based on G sensor when it is normal	ON	*1

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
P0340	14	G sensor fault (no signal)	Open circuit in sensor/ wiring	• Key switch input voltage is 16V or more. • Crank pulse is normal. • DTC P0335, P0336, P0340, P0341, P1345, or P1635 is not detected. • Engine is running.	Crank signal exists but no G sensor signal.	When trouble occurs 7 out of 8 samples.	Behavior does not change during engine running. After engine stalls, engine will not start. Back-up: Engine running based on crank when it is normal After engine stops: Unable to identify cylinder (unable to restart)	ON	*1
P0341		G sensor fault (signal fault)	Broken teeth/ unnecessary signal mixed (such as short circuit with other wiring)	• Key switch input voltage is 16V or more. • Crank pulse is normal. • DTC P0335, P0336, P0340, P0341, P1345, or P1635 is not detected. • Engine is running.	Number of pulse for G sensor signal is mismatched.	When trouble occurs 7 out of 8 samples.	Behavior does not change during engine running. After engine stalls, engine will not start. Back-up: Engine running based on crank when it is normal After engine stops: Unable to identify cylinder (unable to restart)	ON	*1
P0380	66	Glow relay fault	Open/short circuit/ damage of relay or harness	• Key switch input power supply voltage is higher than 16 V but lower than 32 V.	Glow relay drive indication signal is unmatched with glow relay monitor signal.	When trouble occurs 25 out of 30 samples.	Operationality is not affected. Startability deteriorates at low temperatures. Back-up: No back-up	ON	*1
P0381	67	Glow lamp fault	Open/short circuit/ damage of lamp or harness	• Key switch input voltage is 16V or more. • DTC P0381 is not detected.	Glow lamp drive indication signal is unmatched with glow lamp monitor signal.	When trouble occurs 25 out of 30 samples.	Operationality is not affected. Back-up: No back-up	ON	
P0487	44	EGR position sensor fault (Brushless specification)	Open/short circuit/ damage of sensor harness	• Main relay input voltage is 16V or more. • DTC P1630 or P1635 is not detected.	EGR position output signal is abnormal.	Approx. 3 sec.	Operationality is not affected. Back-up: Instruction to fully close EGR valve	ON	*2
P0488	45	EGR valve control fault	Trouble/ open circuit or valve engage/ stuck in drive motor side	• DTC P1630, P1635, P0487, or P0488 is not detected. • Main relay voltage is between 20 — 32 V. • Difference between target EGR opening angle and actual one is 20% or less.	EGR drive duty is 90% or more, and difference between target valve lift and actual position is more than 20%.	Approx. 10 sec.	Operationality is not affected. Back-up: Instruction to fully close EGR valve	ON	*1

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

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
P1093	227	No pump pressure feed (2nd stage)	Fuel leakage (large amount)	• Key switch input voltage is 16V or more. • Coolant temperature is 60°C (140°F) or more, and 375 rpm or more. • DTC P0192, P0193, P1093, P0091, P0092, P1291, P1292, or P1635 is not detected.	Actual rail pressure lower than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more, when judgment of "No pump pressure feed (1st stage)" is completed. Or pressure feed indication is limit +1°CA or less, and actual rail pressure lower than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more.	Approx. 8 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault, black smoke emitted, engine stall Back-up: Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})	ON	*1
P1094	226	No pump pressure feed (1st stage)	Fuel leakage (small amount), others	• Key switch input voltage is 16V or more. • Coolant temperature is 60°C (140°F) or more, and 375 rpm or more. • DTC P0192, P0193, P1094, P0091, P0092, P1291, P1292, or P1635 is not detected.	Actual rail pressure lower than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more. Or pressure feed indication is limit +1°CA or less, and actual rail pressure lower than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more.	Approx. 8 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})	ON	*1
P1095	225	Pressure limiter open	Pressure limiter is opened.	• Key switch input voltage is 16V or more. • DTC P1095, P0192, P0193, P1630, or P1635 is not detected. • 50 rpm or more	Pressure limiter is opened.	Approx. 1 sec.	Output lowering Hunting Back-up: Limited injection amount 1	ON	*1
P1112	295	Boost temperature sensor fault (low voltage fault)	Open/short circuit/ breakage of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1634 is not detected.	Boost temperature sensor voltage is less than 0.1 V.	Approx. 4 sec.	Operationality is not affected. Back-up: No back-up	ON	*2
P1113		Boost temperature sensor fault (high voltage fault)	Short circuit in sensor or harness	• Key switch input voltage is 16V or more. • Coolant temperature is 50°C (122°F) or more. • 3 (or 5) minutes have passed after engine starting • DTC P1634 is not detected.	Boost temperature sensor voltage is more than 4.94V.	Approx. 4 sec.	Operationality is not affected. Back-up: No back-up	ON	*2

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
P1173	542	Overheat	Overheat condition	• Key switch input voltage is 16V or more. • DTC P1630, P1633, P0117, or P0118 is not detected. • Under operation	Coolant temperature is more than 120°C (248°F).	Approx. 5 sec.	Output lowering Back-up: No back-up	ON	*2
P1225	31	Idle up/down switch fault	Fault in switch operation	• Key switch input voltage is 16V or more.	Idle up switch and idle down switch is turned ON simultaneously.	When trouble occurs 10 out of 15 samples.	Operationality is not affected. Back-up: Unable to change the speed in mode driving	ON	*2
P1261	158	Injection nozzle common 1 drive system fault	Open/short circuit in injector common 1-side electrical wiring, EDU output part fault	• Main relay power supply voltage is 16V or more. • 70 rpm or more • None of the following DTC sets are detected; DTC P0611, P1261 and P0201; DTC P0611, P1261 and P0202; DTC P0611, P1261 and P0203.	No injector 1, 2, 3 monitor input signal exists.	Approx. 3 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Engine stall is possible. Back-up: Specified back-up value	ON	*1
P1262	159	Injection nozzle common 2 drive system fault	Open/short circuit in injector common 2-side electrical wiring, EDU output part fault	• Main relay power supply voltage is 16V or more. • 70 rpm or more • None of the following DTC sets are detected; DTC P0612, P1262, and P0204; DTC P0612, P1262, and P0205; DTC P0612, P1262, and P0206.	No injector 4, 5, 6 monitor input signal exists.	Approx. 3 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Engine stall is possible. Back-up: Specified back-up value	ON	*1

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
P1271	24	Accelerator sensor 1-2 comparison fault	Difference in opening angle between accelerator sensors 1-2 is 45% or more.	• Key switch input voltage is 16V or more. • DTC P1630, P1631, P1271, P1277, P1278, P1282, or P1283 is not detected.	Difference in opening angle between accelerator sensors 1 and 2 is 45% or more.	Approx. 3 sec.	1 system fault...No back-up 2 system fault...Accelerator opening angle is controlled to 0%. Back-up: 1 system fault...No back-up 2 system fault...Accelerator opening angle is controlled to 0%.	Does not come on.	*1
P1277		Accelerator sensor 1 fault (low voltage fault)	Open/short circuit/ breakage of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630, P1277, or P1631 is not detected.	Accelerator sensor 1 voltage is lower than 0.2 V.	Approx. 1 sec.	1 system fault...No back-up 2 system fault...Accelerator opening angle is controlled to 0%. Back-up: 1 system fault...No back-up 2 system fault...Accelerator opening angle is controlled to 0%.	Does not come on.	*1
P1278		Accelerator sensor 1 fault (high voltage fault)	Open/short circuit/ breakage of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630, P1278, or P1631 is not detected.	Accelerator sensor 1 voltage is more than 4.9 V.	Approx. 1 sec.	1 system fault...No back-up 2 system fault...Accelerator opening angle is controlled to 0%. Back-up: 1 system fault...No back-up 2 system fault...Accelerator opening angle is controlled to 0%.	Does not come on.	*1
P1282		Accelerator sensor 2 fault (low voltage fault)	Open/short circuit/ breakage of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630, P1282, or P1631 is not detected.	Accelerator sensor 2 voltage is lower than 0.2 V.	Approx. 1 sec.	1 system fault...No back-up 2 system fault...Accelerator opening angle is controlled to 0%. Back-up: 1 system fault...No back-up 2 system fault...Accelerator opening angle is controlled to 0%.	Does not come on.	*1
P1283		Accelerator sensor 2 fault (high voltage fault)	Open/short circuit/ breakage of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630, P1283, or P1631 is not detected.	Accelerator sensor 2 voltage is more than 4.9 V.	Approx. 1 sec.	1 system fault...No back-up 2 system fault...Accelerator opening angle is controlled to 0%. Back-up: 1 system fault...No back-up 2 system fault...Accelerator opening angle is controlled to 0%.	Does not come on.	*1

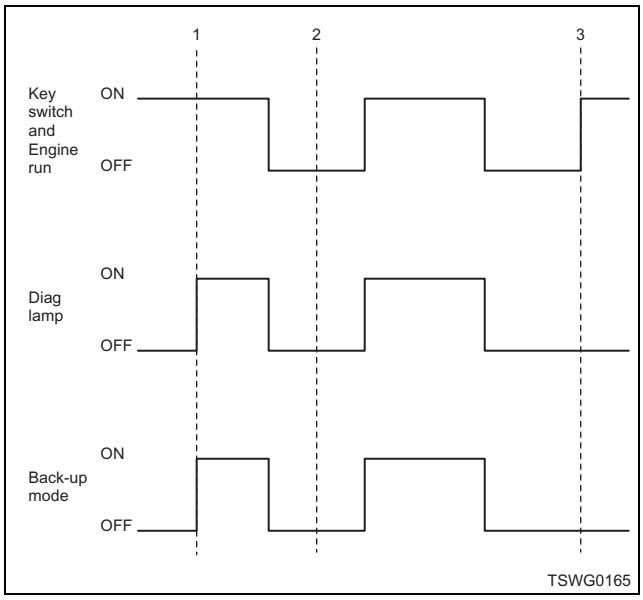
DTC	Flash code	DTC description	Item to be detected	Preconditions when DTC is set	DTC set condition	Judgment Time	Behavior when trouble occurs	Diagnos is lamp	Recovery from failure
P1291	248	PCV2 open circuit or ground short	PCV2 electrical wiring open circuit/ ground short	• Main relay power supply voltage is 16V or more. • DTC P1292 is not detected. • 300 rpm or more, or actual rail pressure exceeds target rail pressure	PCV2 monitor signal is fixed to Low-side.	Approx. 1 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault, black smoke emitted Back-up: Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})	ON	*2
P1292	218	PCV2+B short circuit	PCV2 electrical wiring +B short	• Main relay power supply voltage is 16V or more. • DTC P1291 or P1292 is not detected. • 300 rpm or more, or actual rail pressure exceeds target rail pressure	PCV2 monitor signal is fixed to High-side.	Approx. 1 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault, black smoke emitted Back-up: PCV2 stop	ON	*1
P1345	16	Cam sensor out of phase	Camshaft gear/ crankshaft gear installing angle is out of phase, or damage in gear.	• Key switch input voltage is 16V or more. • DTC P0335, P0336, P0340, P0341, P1345, or P1635 is not detected. • G sensor pulse is normal. • Crank pulse is normal.	Correct G sensor pulse does not exist in crank gap position.	When trouble occurs 7 out of 8 samples.	Behavior does not change during engine running. After engine stalls, engine will not start. Back-up: Engine running based on crank when it is normal After engine stops: Unable to identify cylinder (unable to restart)	ON	*1
P1625	416	Main relay system fault	Open/ ground short circuit in harness, relay OFF anchoring	• Key switch input voltage is 16V or more. • DTC P1630 is not detected. • 3 seconds or more has elapsed after key switch ON. • Main relay drive indication ON	• Main relay voltage is 1 V or less.	Approx. 2 sec.	Engine does not start. Back-up: No back-up	ON	*2
			Harness +B short, relay ON anchoring	• DTC P1625 or P0606 is not detected.	Relay does not cut off despite of main relay coil output OFF indication.	Approx. 5 sec.	Power supply cannot be shut off. Back-up: No back-up	ON	*1
P1630	36	A/D conversion fault	A/D conversion fault	—	A/D conversion failure	Immediatel y	Output lowering, Black smoke emitted Analog sensor system default processing Limited injection amount 3 (multi-injection stopped) Target RP upper limit (80 MPa {11603 psi})	ON	*2

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
P1631	55	Voltage fault in 5-V power supply 1	Power supply wiring short to sensor, or breakage in element/ circuit for power supply regulation inside ECM.	• DTC P1630 is not detected. • Key switch input power supply voltage is between 16 — 32 V.	5-V 1 power supply voltage is 5.5 V or more, or 4.5 V or less.	Approx. 0.5 sec.	Accelerator opening angle is controlled to 0%. Back-up: Same to accelerator sensor fault	ON	*2
P1632		Voltage fault in 5-V power supply 2		• DTC P1630 is not detected. • Key switch input power supply voltage is between 16 — 32 V.	5-V 2 power supply voltage is 5.5 V or more, or 4.5 V or less.	Approx. 0.5 sec.	Due to back-up equivalent to 2500m (8200ft) • Black smoke emitted at high altitude • Output lowers at low altitude Back-up: Same to barometric pressure and intake air temperature sensor fault	ON	*2
P1633		Voltage fault in 5-V power supply 3		• DTC P1630 is not detected. • Key switch input power supply voltage is between 16 — 32 V.	5-V 3 power supply voltage is 5.5 V or more, or 4.5 V or less.	Approx. 0.5 sec.	Deterioration of startability, black smoke emission possible Operationality is affected. Back-up: Same to oil pressure, coolant temperature, and combustion temperature sensor fault	ON	*2
P1634		Voltage fault in 5-V power supply 4		• DTC P1630 is not detected. • Key switch input power supply voltage is between 16 — 32 V.	5-V 4 power supply voltage is 5.5 V or more, or 4.5 V or less.	Approx. 0.5 sec.	Operationality is affected. Back-up: Specified back-up value	ON	*2
P1635		Voltage fault in 5-V power supply 5		• DTC P1630 is not detected. • Key switch input power supply voltage is between 16 — 32 V.	5-V 5 power supply voltage is 5.5 V or more, or 4.5 V or less.	Approx. 0.5 sec.	Engine blow up, output lowering, black smoke emission, engine stall are possible. Back-up: Same to rail pressure sensor fault and EGR position sensor fault	ON	*2
U2104	84	CAN Bus fault	CAN communicati on fault	• Key switch input voltage is 12V or more.	Bus-off is detected.	At 3 sec. continuous ly	Vary depending on setting. Back-up: Specified back-up value	ON	*3
U2106	85	CAN timeout fault	CAN communicati on fault	• DTC U2104 is not detected. • Key switch input voltage is 12V or more.	CAN data reception does not complete at a set time.	At 1 sec. continuous ly	Vary depending on setting. Back-up: Specified back-up value	ON	*3

About recovery from failure

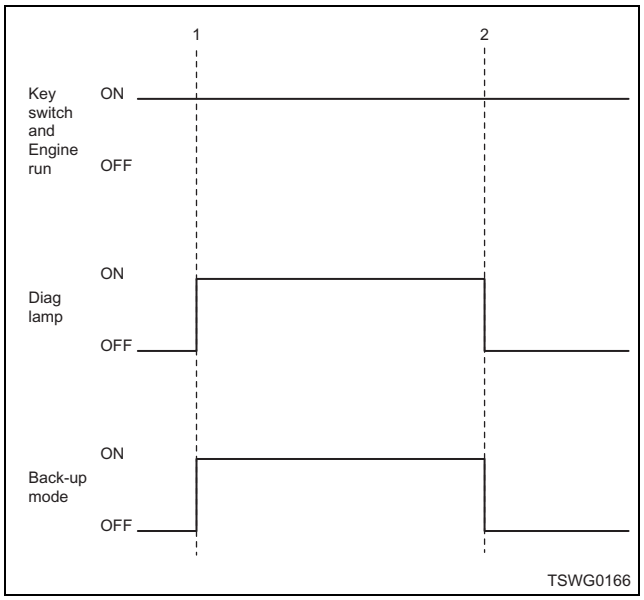
There are three modes for recovery from failure.
To clear the trouble displayed on the monitor of the machine, one more ignition cycle may be needed after the following ignition cycle.

*1
Even if the DTC has restored normally, the diagnosis lamp and back-up mode are not restored in the ignition cycle that the DTC is detected. After turning the key switch OFF, DTC diagnosis is performed when the vehicle starts again. If it is judged as normal, everything will be recovered to normal from the next ignition cycle.



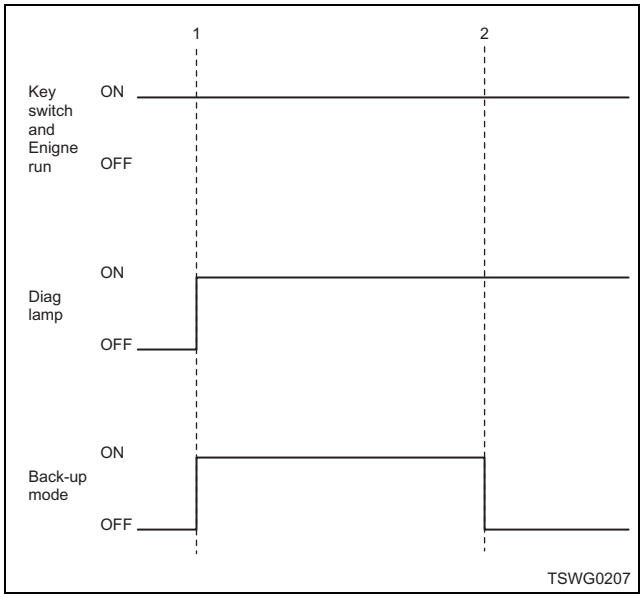
Name
1. DTC is detected.
2. Repair and inspection
3. Returned to normal.

*2
When the DTC has recovered to normal condition in the ignition cycle that the DTC is detected, the diagnosis lamp and back up mode will also be recovered.



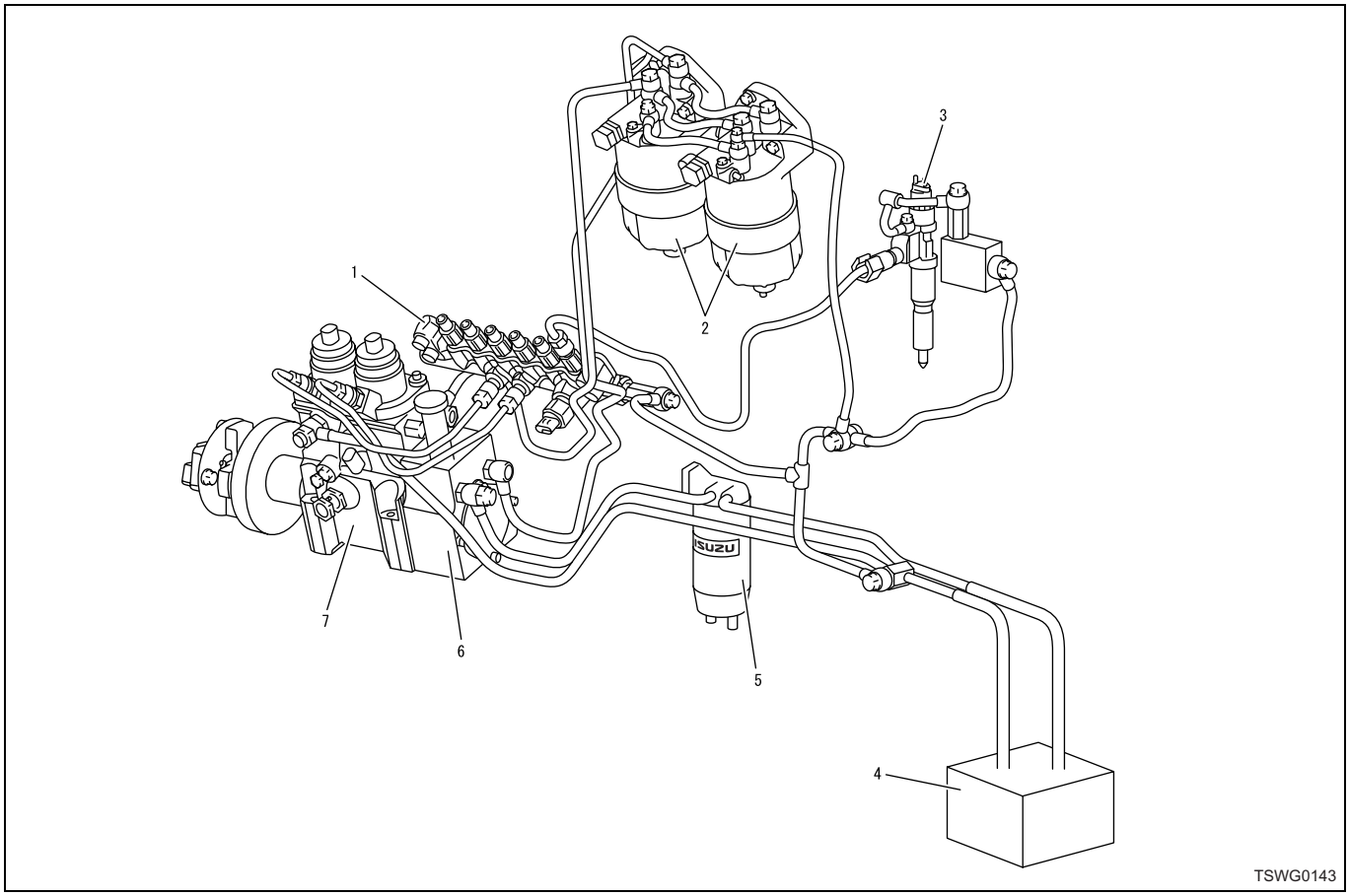
Name
1. DTC is detected.
2. Recovery to normal.

*3
When the DTC has recovered to normal in the ignition cycle that the DTC is detected, the back-up mode will be recovered normally, but the diagnosis lamp does not go off.



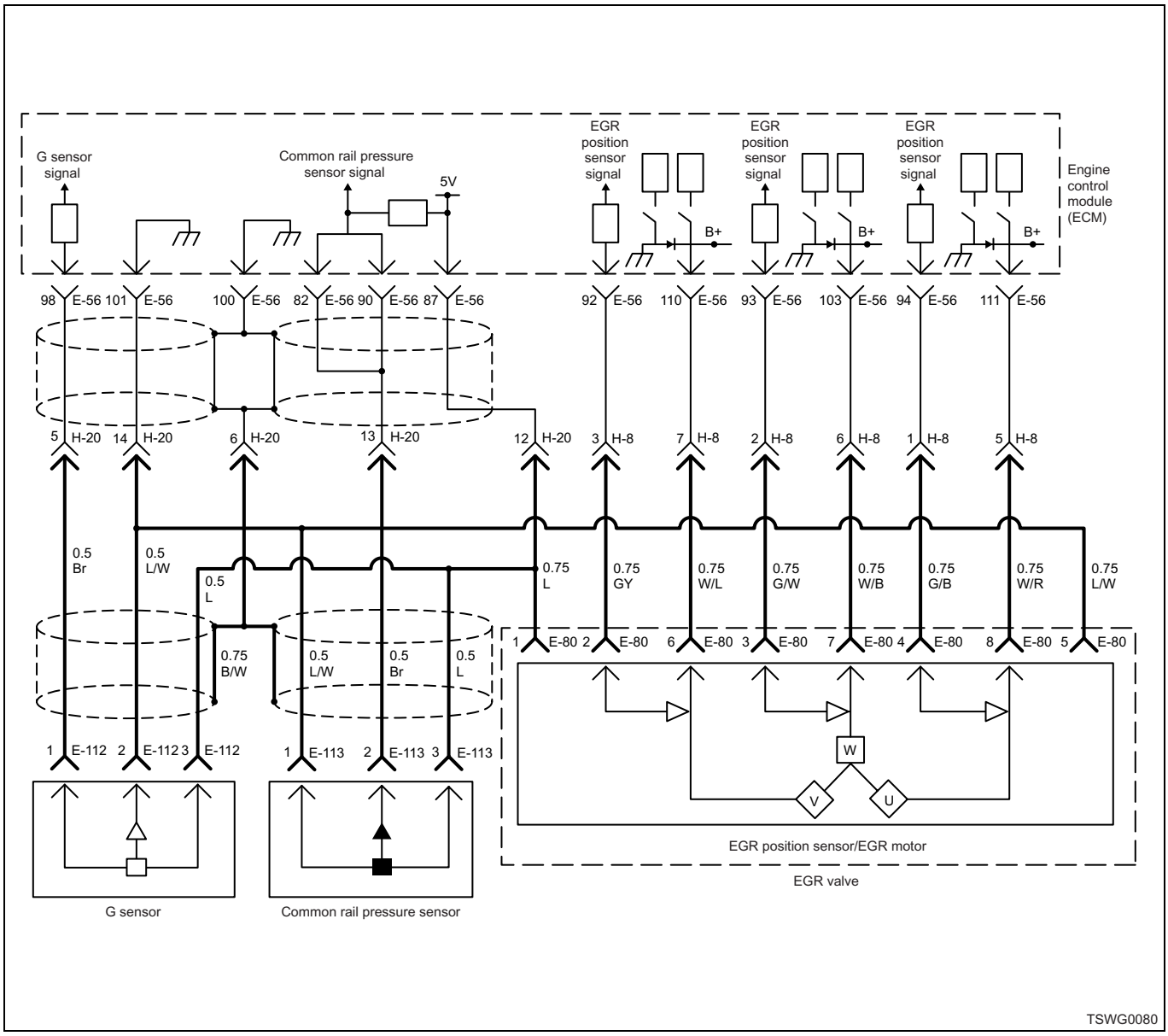
Name
1. DTC is detected.
2. Recovery to normal.

DTC: P0088 (Flash code 118) Common rail pressure is abnormally high (1st or 2nd stage)



Name

1. Common rail
2. Fuel filter
3. Injector
4. Fuel tank
5. Pre-filter
6. Feed pump
7. Supply pump



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

- Intense engine vibration
- Rough idling
- Output lowering
- Engine blow up fault
- Black smoke emitted
- Excessive output possible

Preconditions when DTC is set

1st step

- Key switch input voltage is 16V or more.
- DTC P0088, P0192, P0193, or P1635 is not detected.
- Actual rail pressure is 2 MPa (290 psi) or more, and 70 rpm or more.

2nd step

- Battery voltage is normal.
- DTC P0088, P0192, P0193, or P1635 is not detected.
- Actual rail pressure is 2 MPa (290 psi) or more, and 70 rpm or more.

DTC set condition

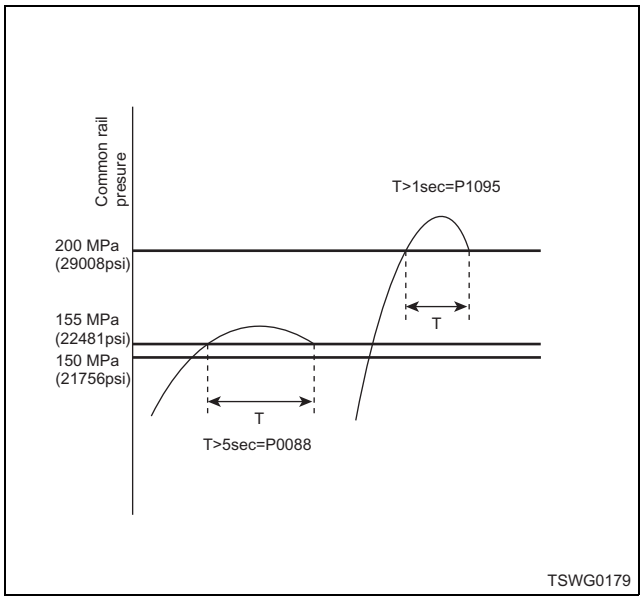
1st step

- Rail pressure is more than 150 MPa (21756 psi) for 5 seconds or more.
- Common rail pressure sensor voltage is 3.9 V or more.

2nd step

- 1st stage is completed, and rail pressure is more than 155 MPa (22481 psi) for 5 seconds or more.
- Common rail pressure sensor voltage is 4.0 V or more.

Note:
Pressure limiter opens at 200 MPa (29008 psi), and DTC P1095 is detected in this case.



Action taken when DTC is set

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

Back-up mode

- Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})

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

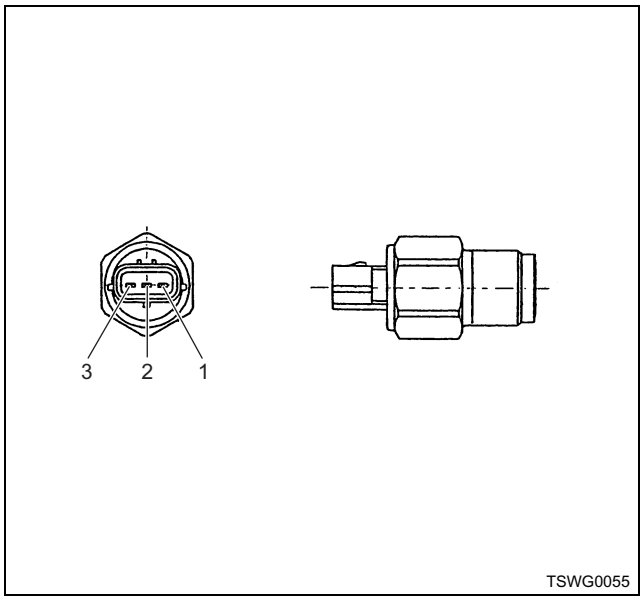
Following inspections are necessary to detect these causes.

- 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.

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	1. Start the engine. 2. Check the DTC. 3. Are the fuel-related parts only just replaced? Air bleeding may not be performed sufficiently after replacing fuel-related parts. Bleed air again. Check the DTC after bleeding air. Is any of the P0088, P0192, P0193, or P1635 detected?	—	Go to the relevant DTC detected.	Go to Step 3.

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.

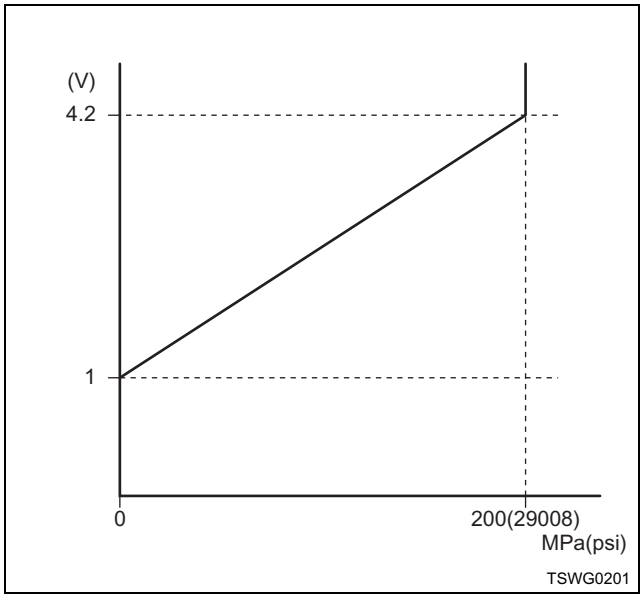
About common rail pressure sensor



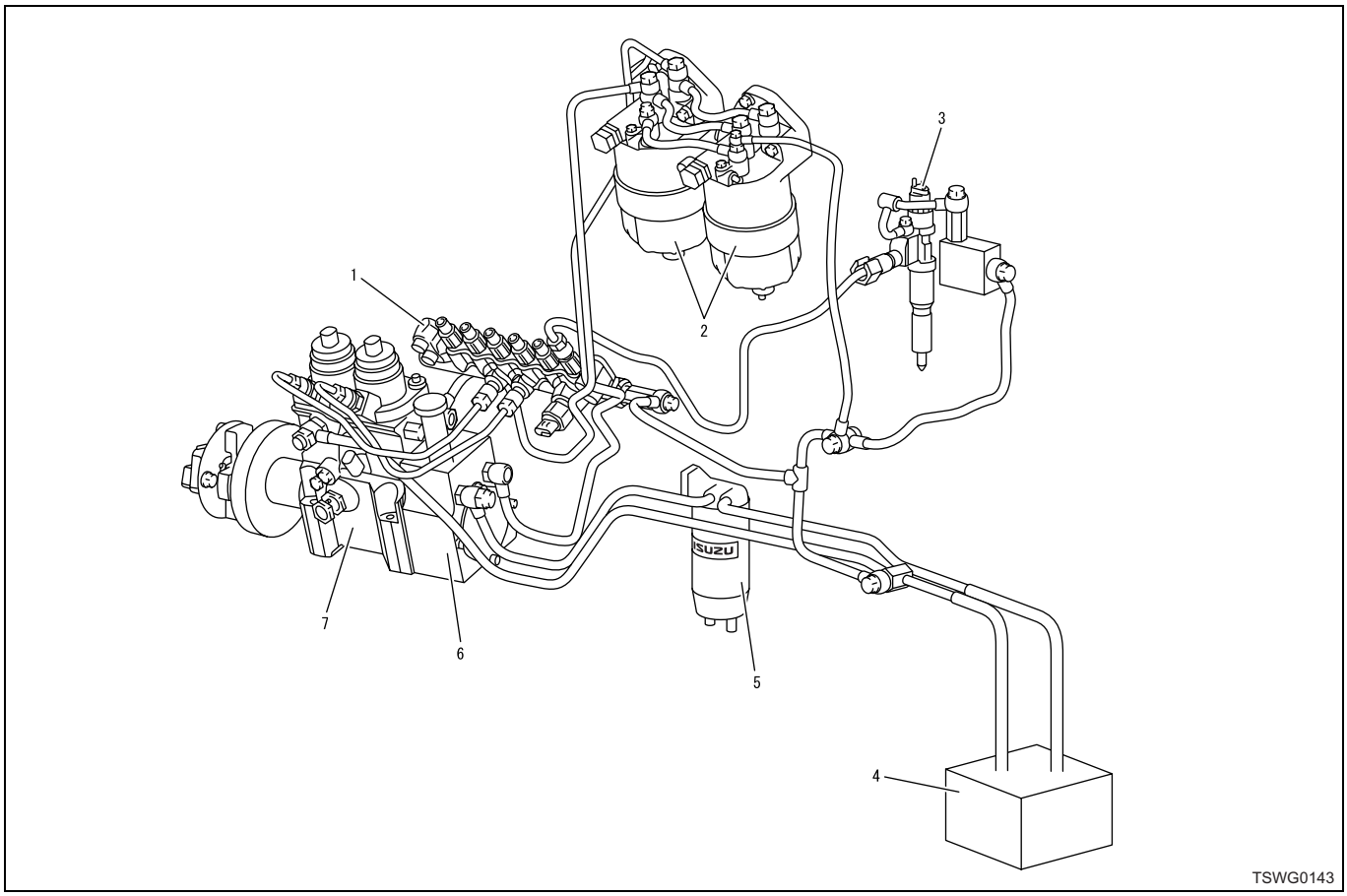
Name

1. Power supply
2. Signal
3. GND

Characteristics of common rail pressure sensor

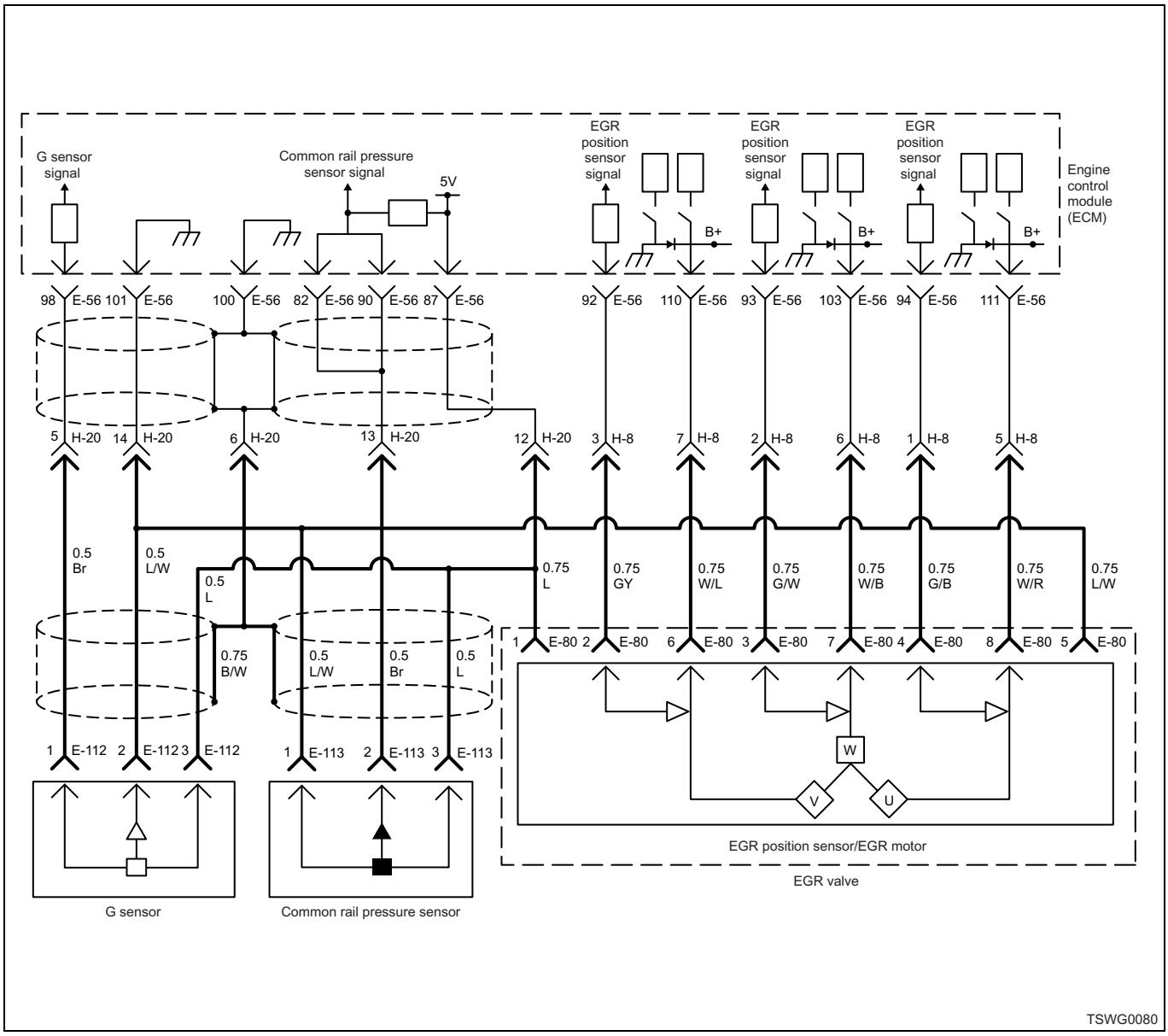


DTC: P0089 (Flash code 151) Common rail pressure fault (Excessive pressure feed in supply pump)



Name

1. Common rail
2. Fuel filter
3. Injector
4. Fuel tank
5. Pre-filter
6. Feed pump
7. Supply pump



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

- Intense engine vibration
- Rough idling
- Output lowering
- Engine blow up fault
- Black smoke emitted
- Excessive output possible

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P0089, P0192, P0193, or P1635 is not detected.
- Coolant temperature is 60°C (140°F), and 375 rpm or more.

DTC set condition

- Actual rail pressure higher than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more.

- Actual rail pressure higher than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more during indication of no pressure feed.

Action taken when DTC is set

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

Back-up mode

- Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})

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.

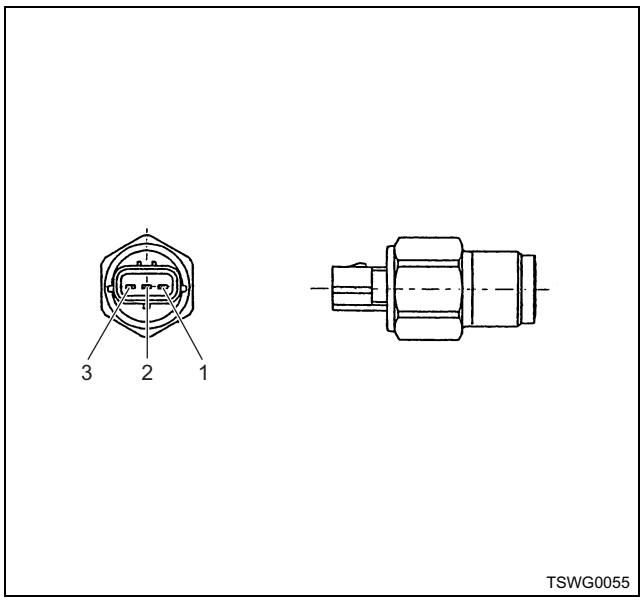
- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items 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.

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	1. Start the engine. 2. Check the DTC. Is any of the P0089, P0192, P0193, or 1635 detected?	—	Go to the relevant DTC detected.	Go to Step 3.
3	Is the scan tool (KW communication) available?	—	Go to Step 4.	Go to Step 12.
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)	Go to “Diagnostic aid”.	Go to Step 5.
5	1. Turn the key switch to “OFF”. 2. Wait for 2 minutes before the common rail internal pressure goes down. 3. Turn the key switch to “ON”. Do not start engine. 4. Check for “Differential fuel rail pressure” on the data display using scan tool. Is “Differential fuel rail pressure” the specified value?	Differential pressure −30 MPa (−4351 psi)	Go to Step 6.	Go to Step 7.

Step	Action	Value	YES	NO
6	1. Turn the key switch to “OFF”. 2. Disconnect the PCV connector. 3. Check the PCV harness connector terminal for poor contact, intermittent trouble, etc. 4. Disconnect the ECM harness connector. 5. Check the ECM harness connector terminal for poor contact, intermittent trouble, etc. 6. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 10.	Go to Step 9.
7	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Check the common rail pressure sensor harness connector terminal for poor contact, intermittent trouble, etc. 4. Disconnect the ECM harness connector. 5. Check the ECM harness connector terminal for poor contact, intermittent trouble, etc. 6. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 10.	Go to Step 8.
8	Replace the common rail (common rail pressure sensor). **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 10.	—
9	Replace the supply pump. **Note:** **For work procedure, refer to “Engine section” in the service manual.** 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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is the DTC P1093 detected?	—	Go to Step 2.	Go to Step 11.

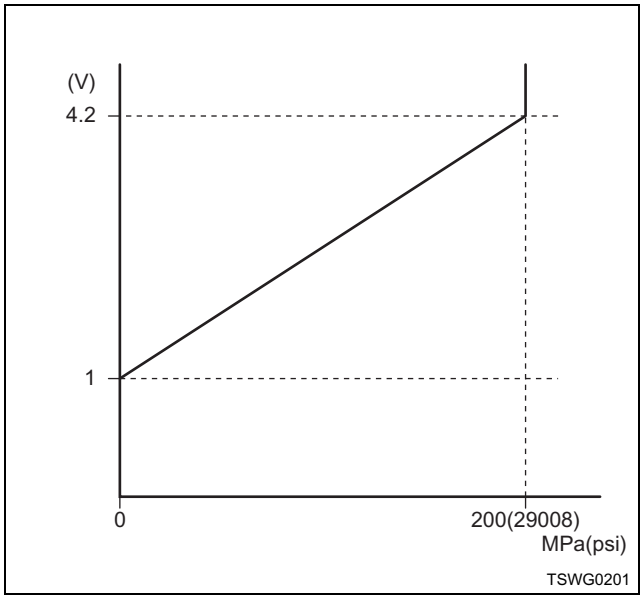
Step	Action	Value	YES	NO
11	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
12	1. Visually check the harness between the ECM and the common rail pressure sensor for damage. 2. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 5.	Go to Step 6.

About common rail pressure sensor



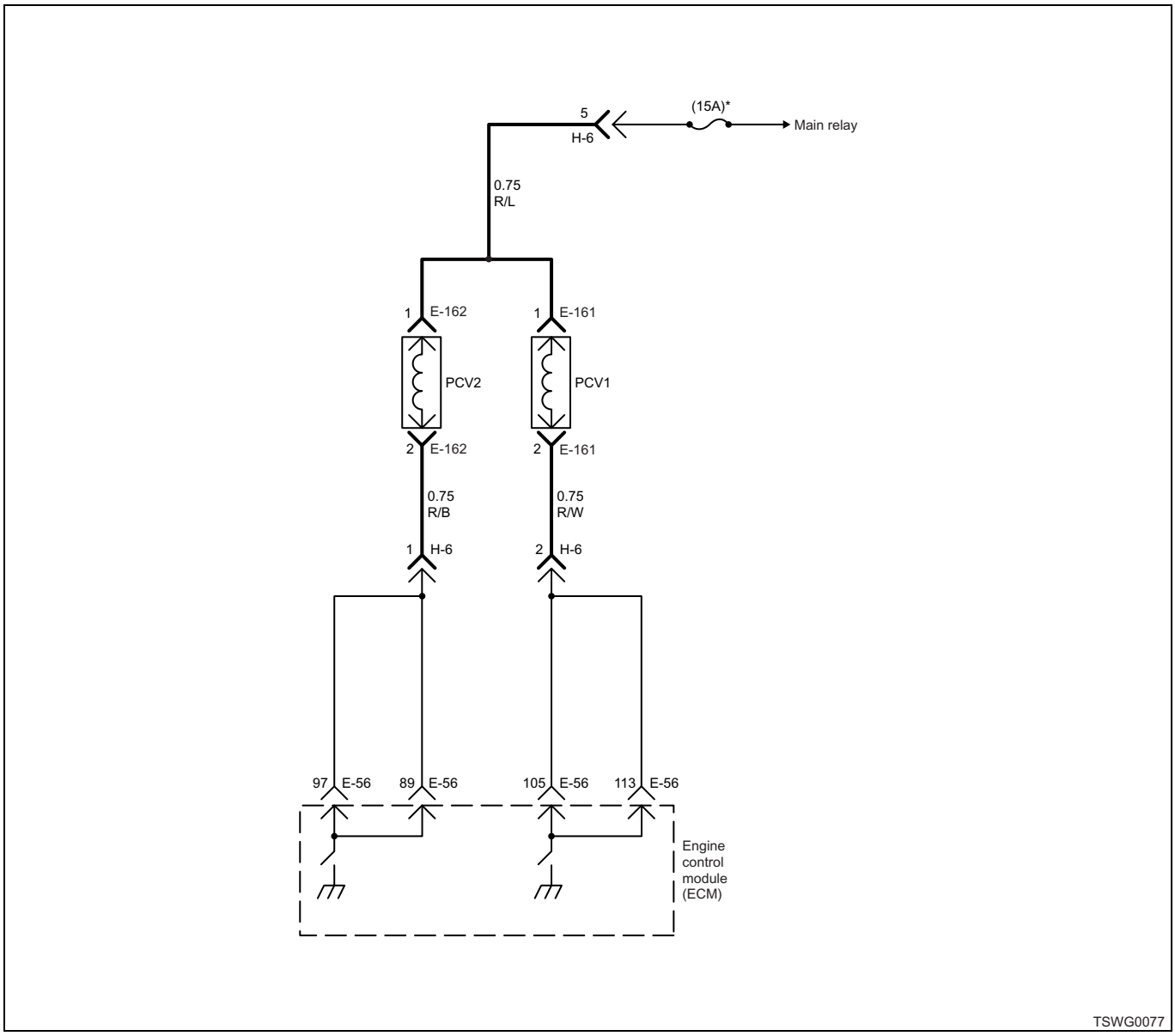
Name
1. Power supply
2. Signal
3. GND

Characteristics of common rail pressure sensor



DTC: P0091/P1291 (Flash code 247/248) PCV circuit fault (PCV1 open circuit or GND short circuit/PCV2 open circuit or GND short circuit)

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



Description of circuit

The pressure control valve (PCV) controls the fuel feed pressure amount to the common rail. Once the PCV installed to the supply pump receives the signal (voltage), the PCV closes the valve and pressure feed the fuel from the supply pump to the common rail. The engine control module (ECM) operates the PCV to adjust the common rail pressure.

Main trouble symptom

- Intense engine vibration
- Rough idling
- Output lowering
- Engine blow up fault
- Black smoke emitted

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.
- DTC P0091 or P0092 is not detected.
- DTC P1292 is not detected.
- 300 rpm or more, or actual rail pressure exceeds target rail pressure.

DTC set condition

PCV1,2 monitor signal fault (fixed to Low)

Action taken when DTC is set

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

Back-up mode

- Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})

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.

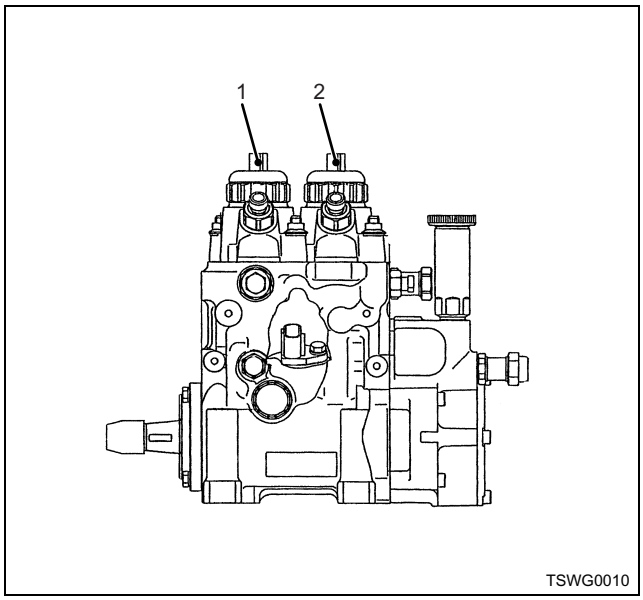
- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items 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.

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 4.
3	1. Connect the scan tool. 2. Start the engine. 3. Check for “PCV F/B” on the data display using scan tool. Is the “PCV F/B” less than the specified value?	50mA	Go to Step 4.	Go to Step 5.
4	1. Check for followings in the circuit between PCV and ECM 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 • 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 6.

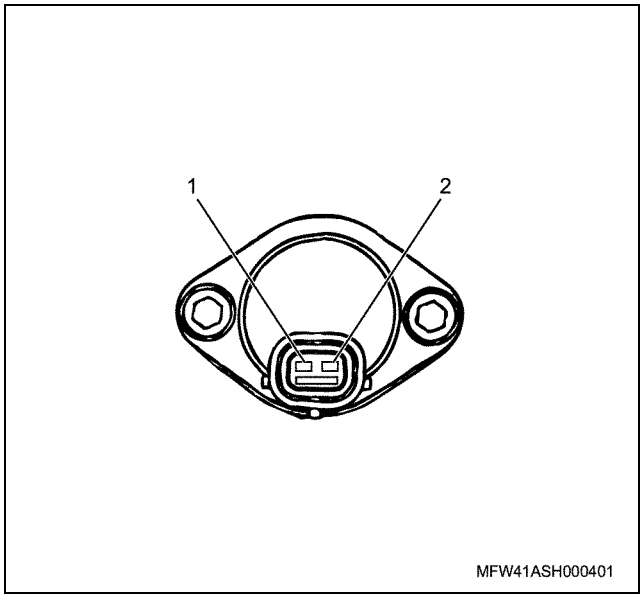
Step	Action	Value	YES	NO
5	1. Check for followings in the circuit between PCV and ECM using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Short circuit between terminals • Short circuit to power supply circuit or ignition power supply circuit • Short circuit to other signal circuit 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 6.
6	Check the PCV body. 1. Turn the key switch to “OFF”. 2. Remove the harness from the PCV. 3. Measure the resistance between the PCV connector terminals. Is the resistance specified value?	Between terminals: 3.2±0.3 Ω; Each terminal to PCV body: ∞Ω (at normal temperature)	Go to Step 8.	Go to Step 7.
7	Replace the supply pump (PCV). **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 12.	—
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. 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 9.	Go to “Diagnostic aid”.
9	Is EMPS available?	—	Go to Step 10.	Go to Step 11.

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.

About PCV



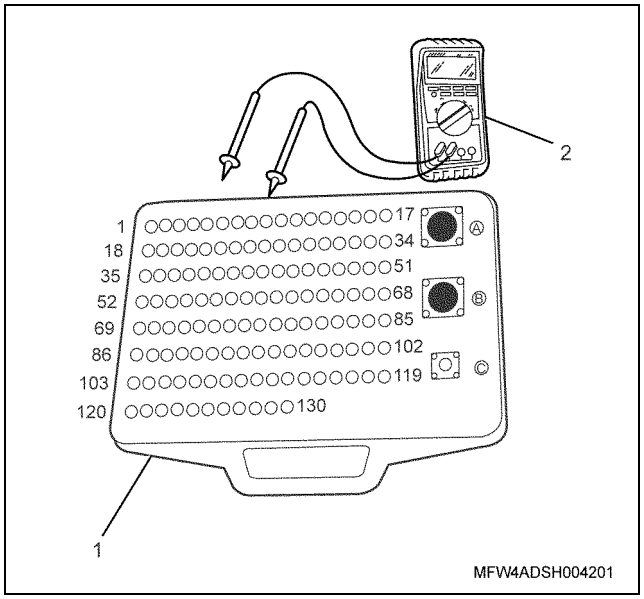
Name
1. PCV #1
2. PCV #2



Name
1. PCV-HI
2. PCV-LO

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.

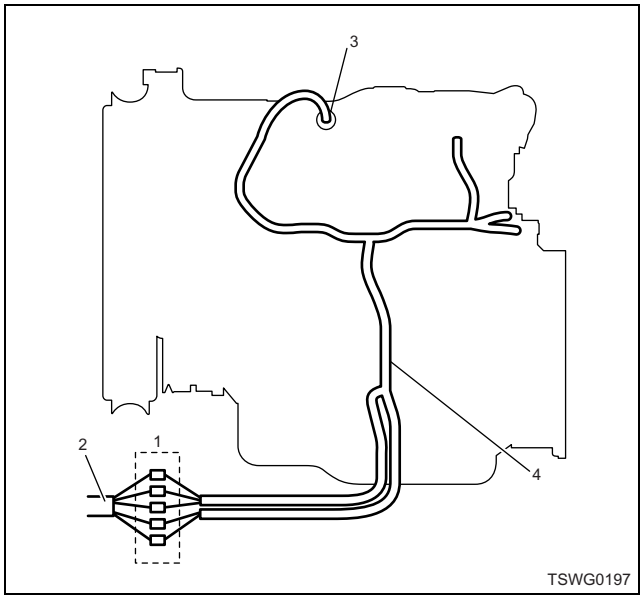


Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
4	Open circuit/ high resistance	Resistance measurement	• Remove the PCV connector. • Key switch “OFF”	105 - PCV terminal 113 - PCV terminal 89 - PCV terminal 97 - PCV terminal	5 Ω or less	10 MΩ or more
	Short circuit to ground	Resistance measurement	• Remove the PCV connector. • Key switch “OFF”	105 - Ground 113 - Ground 89 - Ground 97 - Ground	10 MΩ or more	100 Ω or less

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
5	Short circuit between terminals	Resistance measurement	• Remove the PCV connector. • Key switch “OFF”	105 - 89 105 - 97 113 - 89 113 - 97	10 MΩ or more	100 Ω or less
	Short circuit to power supply circuit	Voltage measurement	• Remove the PCV connector. • Key switch “ON”	105 - Ground 113 - Ground 89 - Ground 97 - Ground	0V	18V or more
	Short circuit to other signal circuit	Voltage measurement	• Remove the PCV connector. • Key switch “ON”	105 - Ground 113 - Ground 89 - Ground 97 - Ground	0V	1V or more

On-board check procedure for sensors



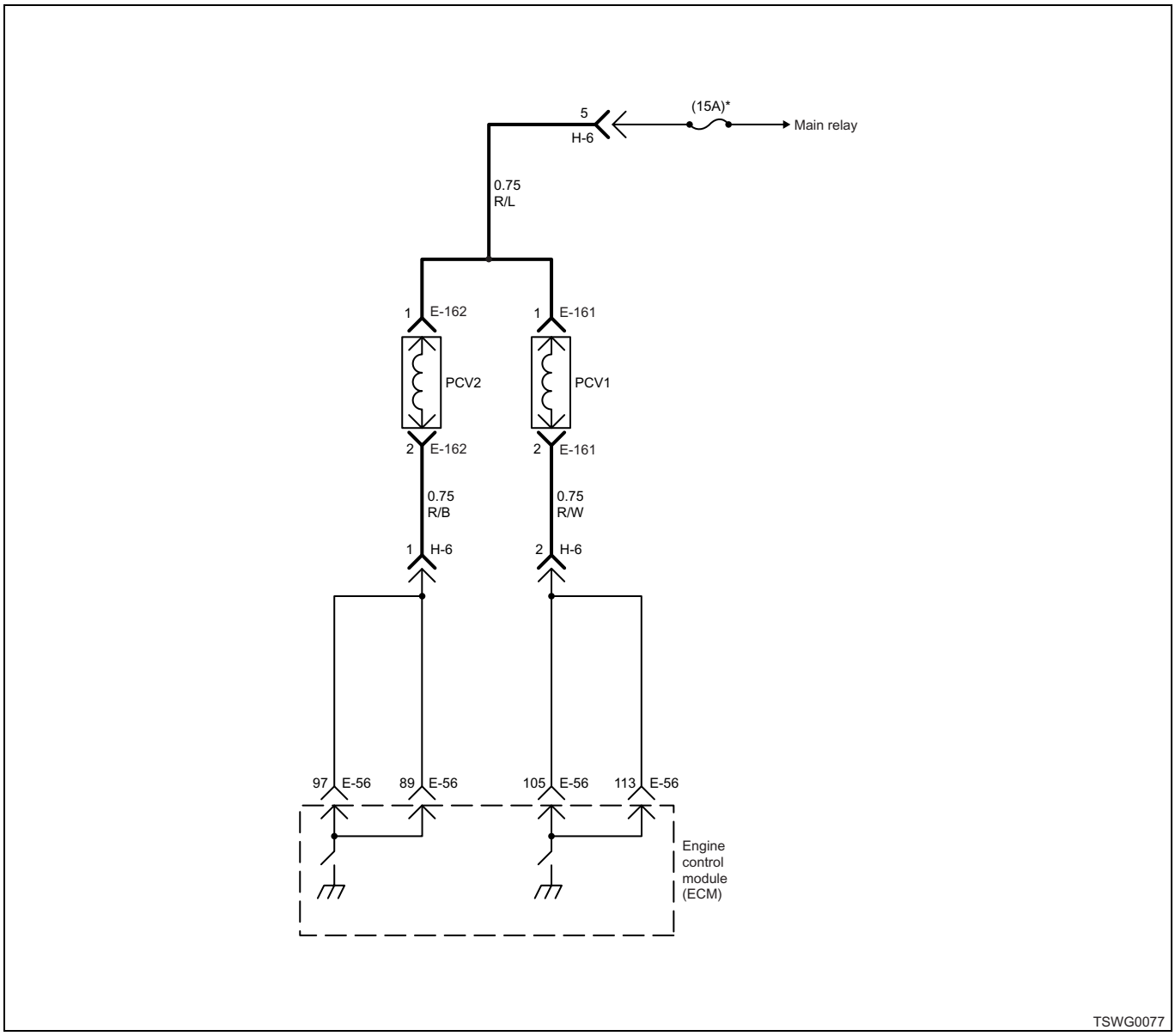
Name

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.

DTC: P0092/P1292 (Flash code 217/218) PCV circuit fault (PCV1+B short circuit / PCV2+B short circuit)

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



Description of circuit

The pressure control valve (PCV) controls the fuel feed pressure amount to the common rail. Once the PCV installed to the supply pump receives the signal (voltage), the PCV closes the valve and pressure feed the fuel from the supply pump to the common rail. The engine control module (ECM) operates the PCV to adjust the common rail pressure.

Main trouble symptom

- Intense engine vibration
- Rough idling
- Output lowering
- Engine blow up fault
- Black smoke emitted

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.
- DTC P0091 or P0092 is not detected.
- DTC P1292 is not detected.
- 300 rpm or more, or actual rail pressure exceeds target rail pressure.

DTC set condition

PCV1, 2 monitor signal fault (fixed to High)

Action taken when DTC is set

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

Back-up mode

- P0092: PCV1 stop
- P1292: PCV2 stop

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

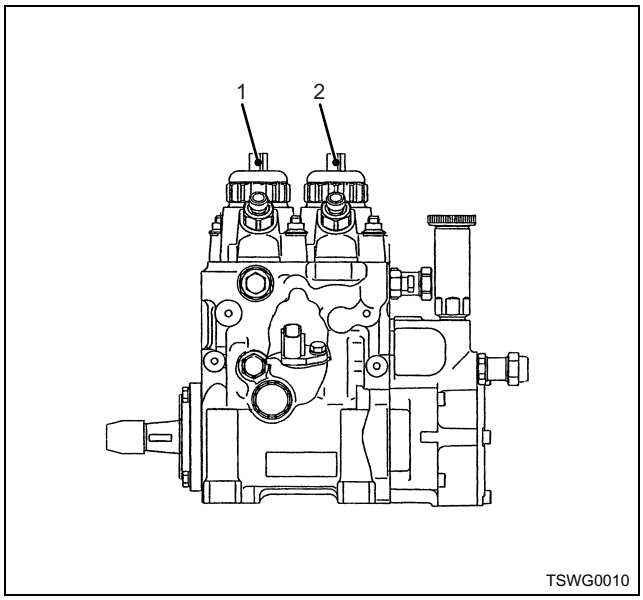
Following inspections are necessary to detect these causes.

- 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.

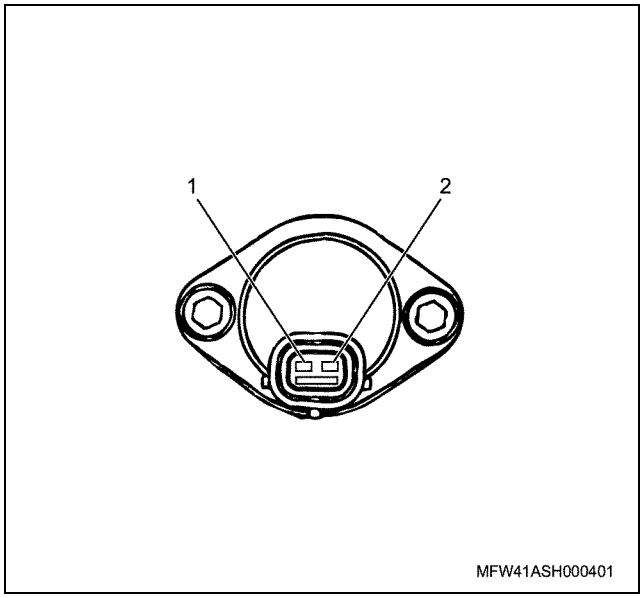
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	1. Check for followings in the circuit between PCV and ECM using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Short circuit to power supply circuit or ignition power supply circuit • Short circuit to other signal circuit 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 3.
3	Check the PCV body. 1. Turn the key switch to “OFF”. 2. Remove the harness from the PCV. 3. Measure the resistance between the PCV connector terminals. Is the resistance specified value?	Between terminals: 3.2±0.3 Ω; Each terminal to PCV body: ∞Ω (at normal temperature)	Go to Step 5.	Go to Step 4.
4	Replace the supply pump (PCV). **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 9.	—

Step	Action	Value	YES	NO
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. Start the engine, and test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is the DTC P0092/1292detected?	—	Go to Step 6.	Go to “Diagnostic aid”.
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. Start the engine, and test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is the DTC P0092/1292detected?	—	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.

About PCV



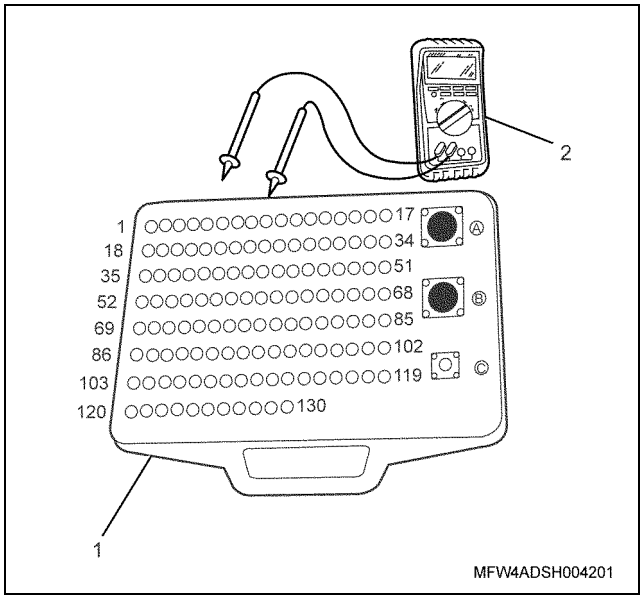
Name
1. PCV #1
2. PCV #2



Name
1. PCV-HI
2. PCV-LO

Breaker box inspection procedure

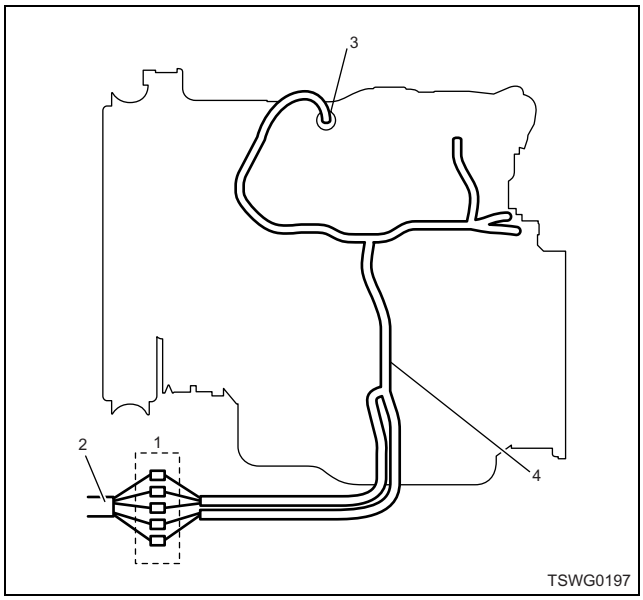
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
2	Short circuit to power supply circuit	Voltage measurement	• Remove the PCV connector. • Key switch “ON”	105 - Ground 113 - Ground 89 - Ground 97 - Ground	0V	18V or more
	Short circuit to other signal circuit	Voltage measurement	• Remove the PCV connector. • Key switch “ON”	105 - Ground 113 - Ground 89 - Ground 97 - Ground	0V	1V or more

On-board check procedure for sensors



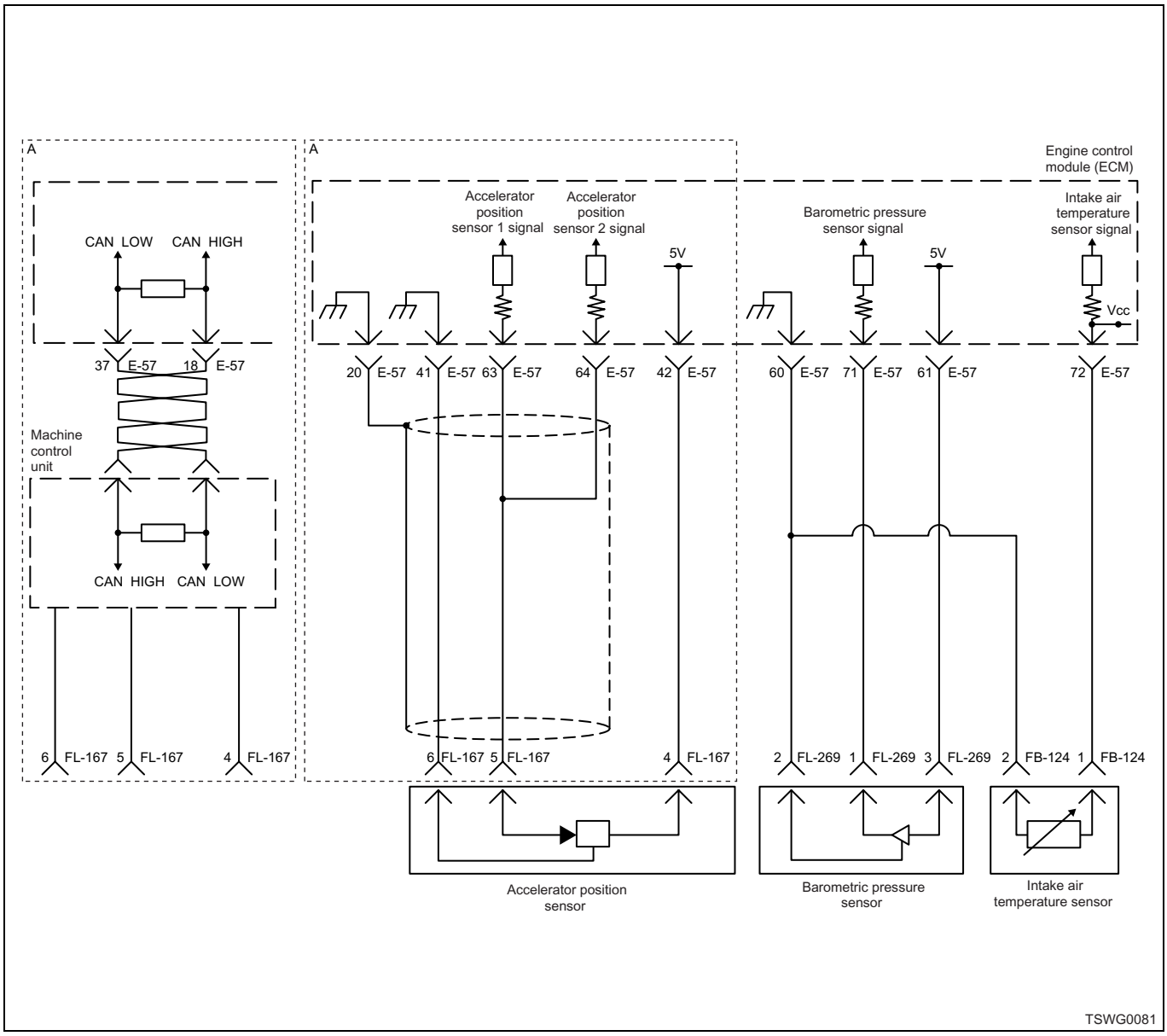
Name

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.

DTC: P0107 (Flash code 71) Barometric pressure sensor circuit input is low (open circuit or ground short)



Description of circuit

The barometric pressure sensor detects the barometric pressure. The barometric pressure sensor is installed to the machine. As the barometric pressure changes depending on altitude and weather condition, output voltage of the barometric pressure sensor will change (if the barometric pressure is low, output voltage becomes low, if the barometric pressure is high, the output voltage becomes high as well). The engine control module (ECM) reads this output voltage change, converting it into barometric pressure, to utilize for optimizing the fuel injection control and for calculating the relative boost pressure.

Main trouble symptom

Due to back-up equivalent to 2500m (8200ft)

- Black smoke emitted at high altitude
- Output shortage at low altitude

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630 or P1632 is not detected.

DTC set condition

- Barometric pressure sensor voltage is 0.5 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

- Specified back-up value

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 “Barometric pressure sensor” displays less than the specified value. If more than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If the “Barometric pressure sensor” displays more than the specified value when terminals between the barometric pressure sensor connector are shorted, the circuit beyond the sensor is normal including ECM.

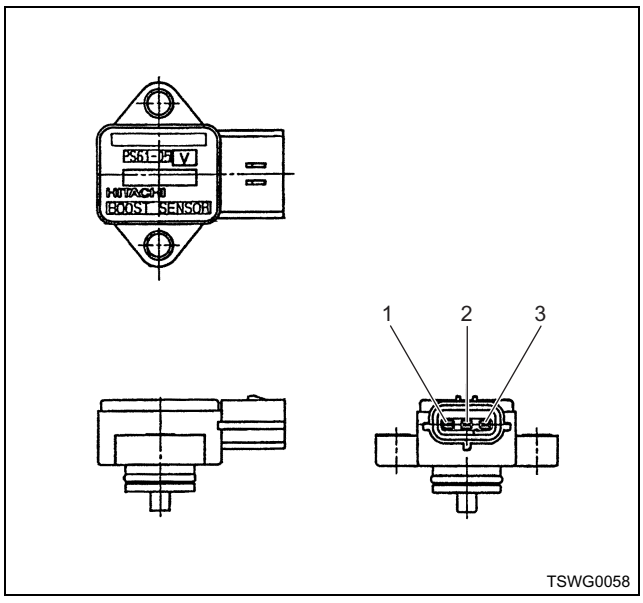
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Perform “OBD system check”, and Go to Step 2.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 14.
3	Check the value for barometric pressure sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. 3. Check the value for “Barometric pressure sensor” using scan tool. Is the “Barometric pressure sensor” less than the specified value?	0.5V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the barometric 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 9.	Go to Step 5.

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.

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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P0107 detected?	—	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.
14	1. Start the engine. 2. Check the display of barometric pressure. Does the display of “Barometric pressure” show error value?	127 kPa (18.4 psi) (Displayed error value)	Go to Step 15.	Go to “Diagnostic aid”.
15	Check for installation condition of the barometric pressure sensor, ECM and coupling connector. (Check the barometric pressure sensor circuit for open circuit or ground short.) 1. Check for disconnection, play or looseness in the connection. 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 16.

Step	Action	Value	YES	NO
16	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 12.	Go to Step 17.
17	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 8.

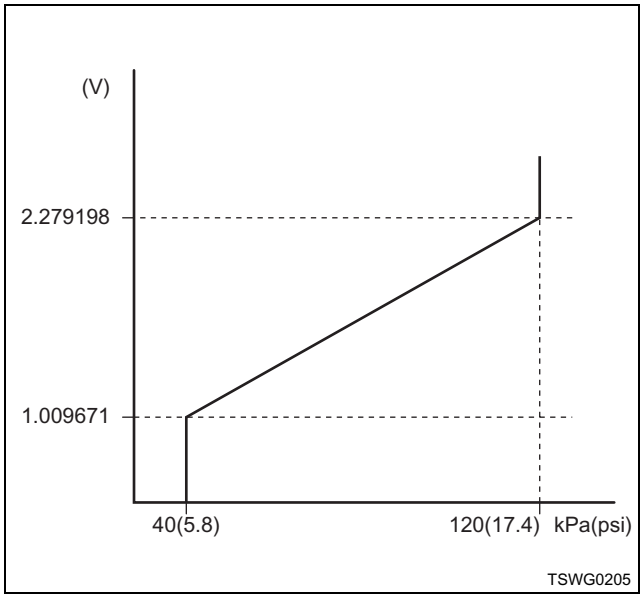
About barometric pressure sensor



Name
1. Power supply
2. GND
3. Signal

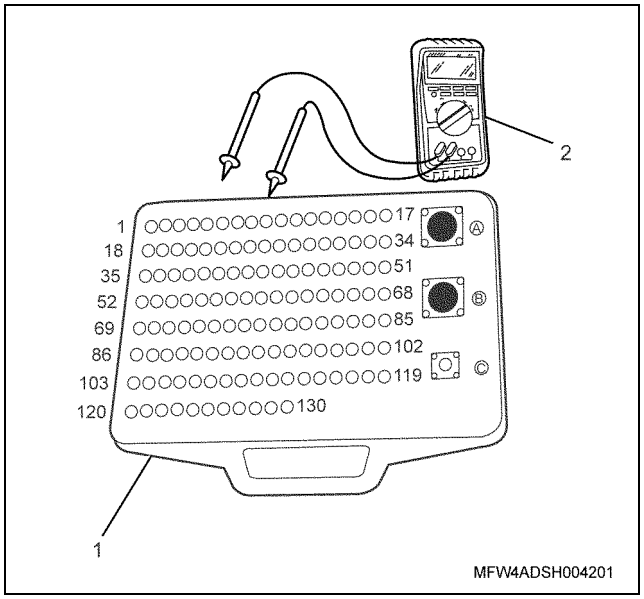
Characteristics of barometric pressure sensor

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.



Breaker box inspection procedure

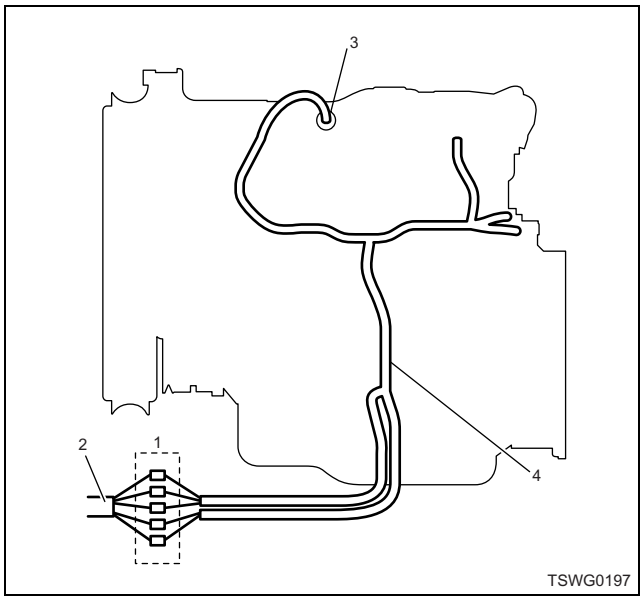
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	61 - Sensor connector power supply terminal	100 Ω or less	10 MΩ or more
7	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	71 - 60 71 - Ground	10 MΩ or more	100 Ω or less
	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	71 - Sensor connector signal terminal	100 Ω or less	10 MΩ or more

On-board check procedure for sensors

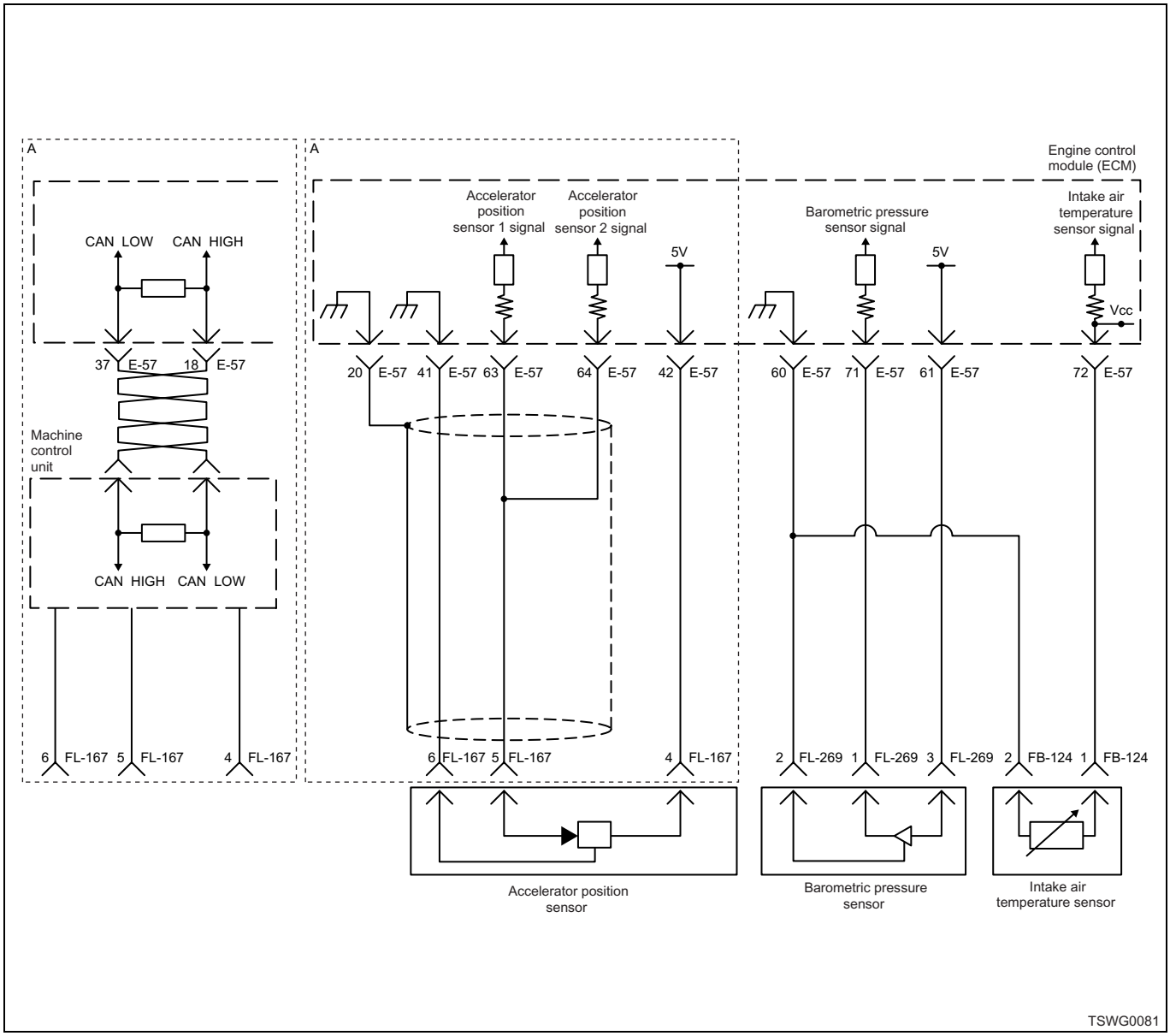


Name

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.

DTC: P0108 (Flash code 71) Barometric pressure sensor circuit input is high (+5V short)



Description of circuit

The barometric pressure sensor detects the barometric pressure. The barometric pressure sensor is installed to the machine. As the barometric pressure changes depending on altitude and weather condition, output voltage of the barometric pressure sensor will change (if the barometric pressure is low, output voltage becomes low, if the barometric pressure is high, the output voltage becomes high as well). The engine control module (ECM) reads this output voltage change, converting it into barometric pressure, to utilize for optimizing the fuel injection control and for calculating the relative boost pressure.

Main trouble symptom

Due to back-up equivalent to 2500m (8200ft)

- Black smoke emitted at high altitude
- Output shortage at low altitude

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630 or P1632 is not detected.

DTC set condition

- Barometric pressure sensor voltage is 3.8 V or more.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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 “Barometric pressure sensor” displays more than the specified value. If less than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If the “Barometric pressure sensor” displays more than the specified value when the barometric pressure sensor connector is removed, the circuit beyond the sensor is normal including ECM.

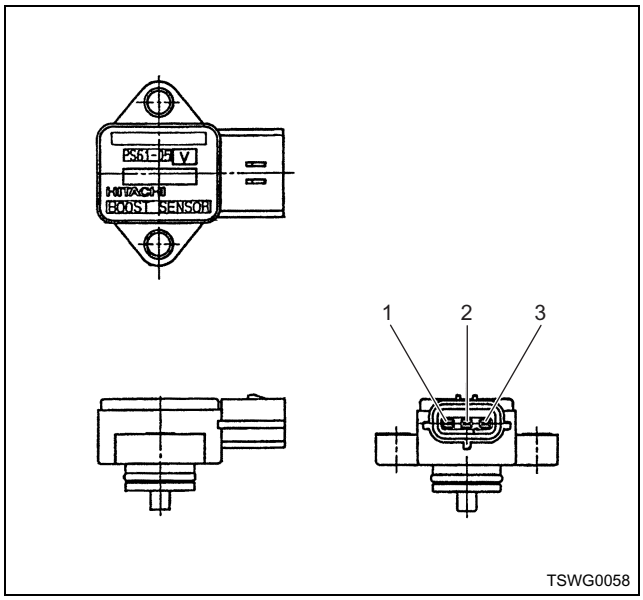
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Perform “OBD system check”, and Go to Step 2.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 14.
3	Check the value for barometric pressure sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. 3. Check the value for “Barometric pressure sensor” using scan tool. Is the “Barometric pressure sensor” more than the specified value?	3.8V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the barometric 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 12.	Go to Step 5.

Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the barometric pressure sensor connector. 3. Turn the key switch to “ON”. 4. Check the value for “Barometric pressure sensor” using scan tool. Is the “Barometric pressure sensor” less than the specified value?	0V	Go to Step 8.	Go to Step 6.
6	1. Check the signal circuit between ECM and barometric 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 barometric 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 7.
7	1. Check for followings in the ground 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 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.

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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P0108 detected?	—	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.
14	1. Start the engine. 2. Check the display of barometric pressure. Does the display of “Barometric pressure” show error value?	127 kPa (18.4 psi) (Displayed error value)	Go to Step 15.	Go to “Diagnostic aid”.

Step	Action	Value	YES	NO
15	Check for installation condition of the barometric pressure sensor, ECM and coupling connector. (Check the barometric pressure sensor circuit for short to +5V line or battery power supply circuit.) 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 12.	Go to Step 16.
16	1. Check the signal circuit between ECM and barometric 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 barometric 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 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 12.	Go to Step 8.

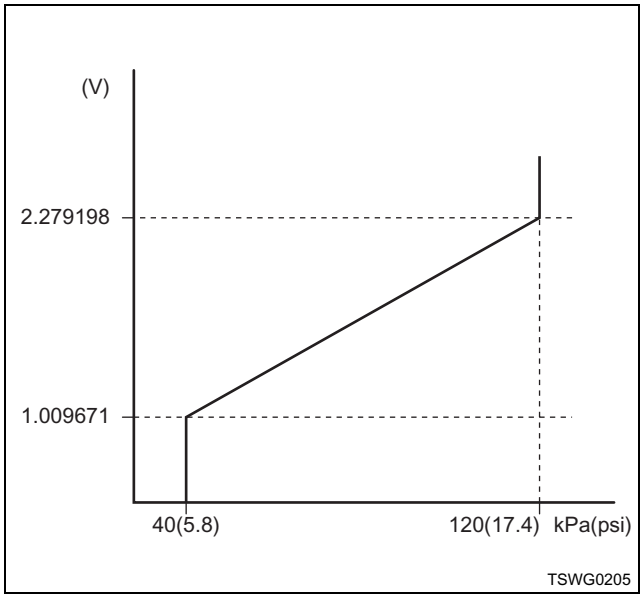
About barometric pressure sensor



Name
1. Power supply
2. GND
3. Signal

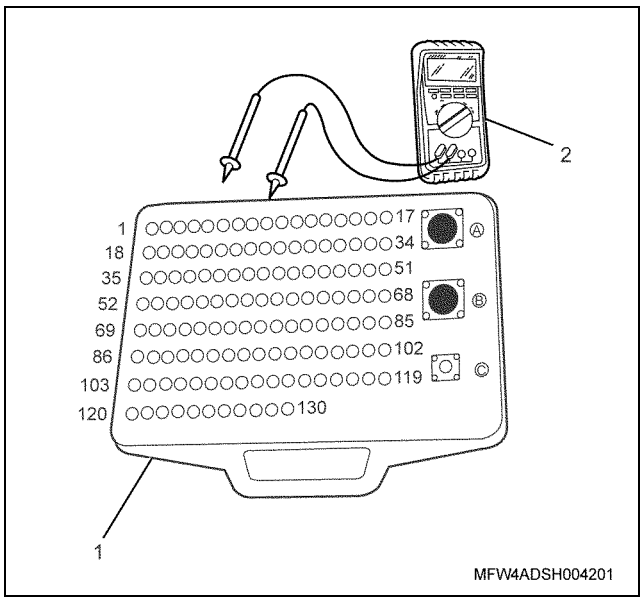
Characteristics of barometric pressure sensor

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.



Breaker box inspection procedure

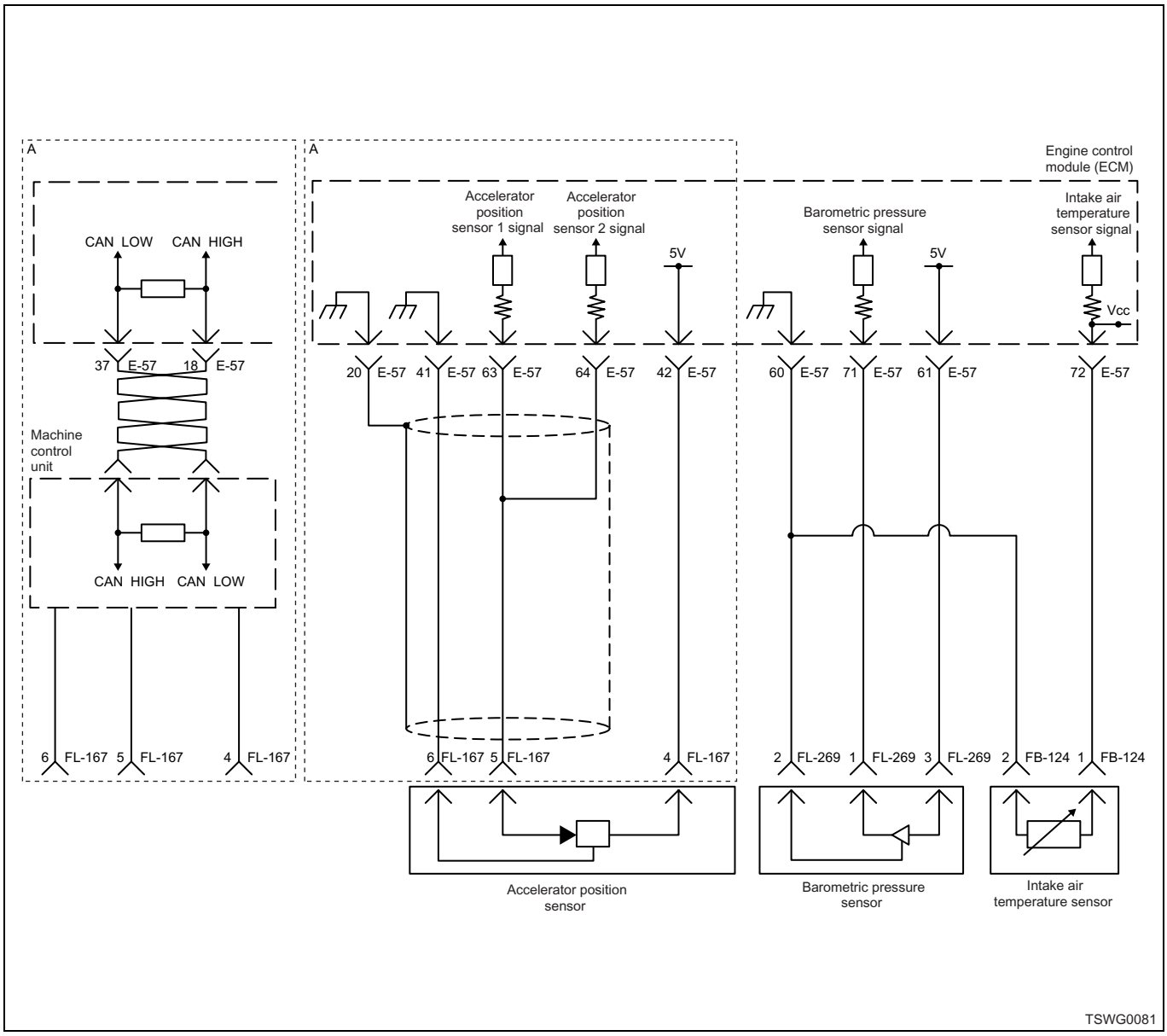
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	71 - Ground	0V	18V or more
7	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	60 - Sensor connector ground terminal	100Ω or less	10 MΩ or more

DTC: P0112 (Flash code 22) Intake air temperature sensor fault (low voltage fault, GND short, short circuit)



Description of circuit

The intake air temperature (IAT) sensor is the thermistor type and the value of resistance changes according to the temperature. The resistance is low when the intake air temperature is high, and is high when the temperature is low. The ECM energizes 5 V to the IAT sensor through the pull up resistance, and calculate the intake air temperature from the change in voltage, to utilize various control such as fuel injection control. 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

- White smoke emission possible when starting at low temperatures

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630 or P1632 is not detected.

DTC set condition

- IAT 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

- Intake air temperature default setting
  (at starting: −10°C {14°F}, at running: 25°C {77°F})
- 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).
- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

Diagnostic aid

- To make sure the correct performance of the IAT sensor, check with various temperatures using the reckoner table between temperature and resistance. If the sensor is faulty, operationality may be affected.

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

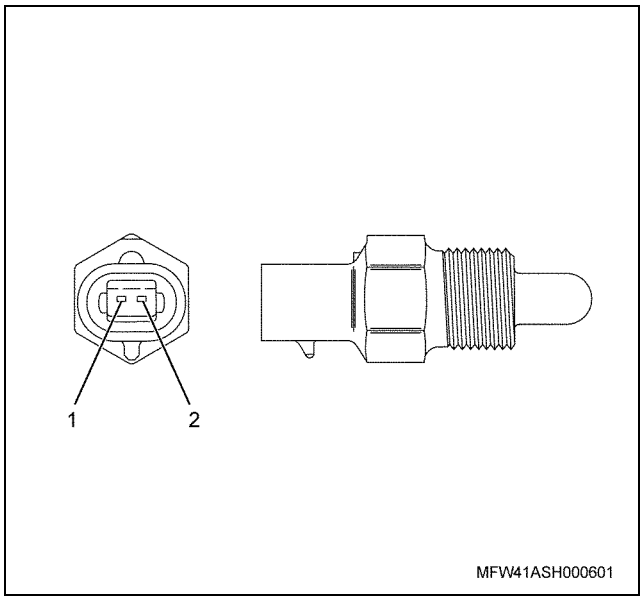
Numbers below indicate step numbers in the chart.
3. In the case of present trouble, the “Intake air temperature sensor” displays less than the specified value. If more than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If the “Intake air temperature sensor” displays more than the specified value when the IAT 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 13.
3	Check the value for IAT sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. 3. Check the value for “Intake air temperature sensor” using scan tool. Is the “Intake air temperature sensor” less than the specified value?	0.1V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the IAT 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.
5	1. Turn the key switch to “OFF”. 2. Disconnect the IAT sensor connector. 3. Turn the key switch to “ON”. 4. Check the value for “Intake air temperature sensor” using scan tool. Is the “Intake air temperature sensor” more than the specified value?	4.8V	Go to Step 7.	Go to Step 6.

Step	Action	Value	YES	NO
6	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”.** • Short circuit to IAT sensor ground circuit • Short circuit to ground 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 8.
7	Replace the IAT sensor. Is the procedure completed?	—	Go to Step 11.	—
8	Is EMPS available?	—	Go to Step 9.	Go to Step 10.
9	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 11.	Go to Step 10.
10	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 11.	—

Step	Action	Value	YES	NO
11	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 P0112 detected?	—	Go to Step 3.	Go to Step 12.
12	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
13	1. Start the engine. 2. Check the display of intake air temperature. Does the display of “Intake air temperature” show error value?	214°C (419°F) (Displayed error value)	Go to Step 14.	Go to “Diagnostic aid”.
14	Check for installation condition of the IAT sensor, ECM and coupling connector. (Check the IAT sensor circuit for ground short.) 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 15.
15	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”.** • Short circuit to IAT sensor ground circuit • Short circuit to ground 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 7.

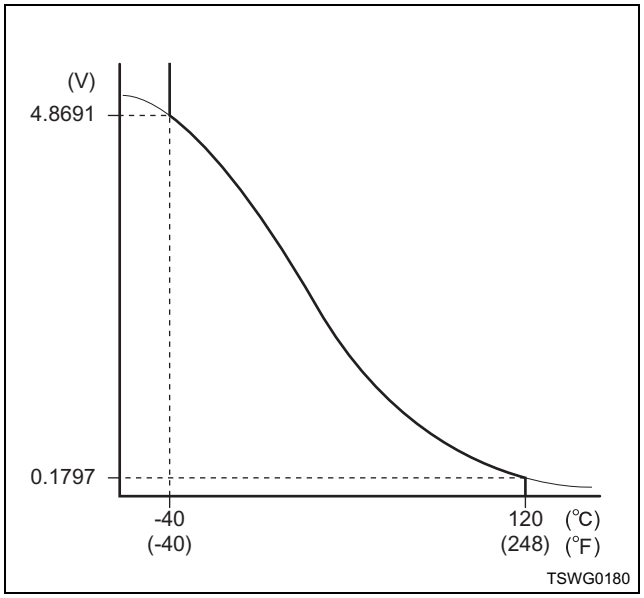
About IAT sensor

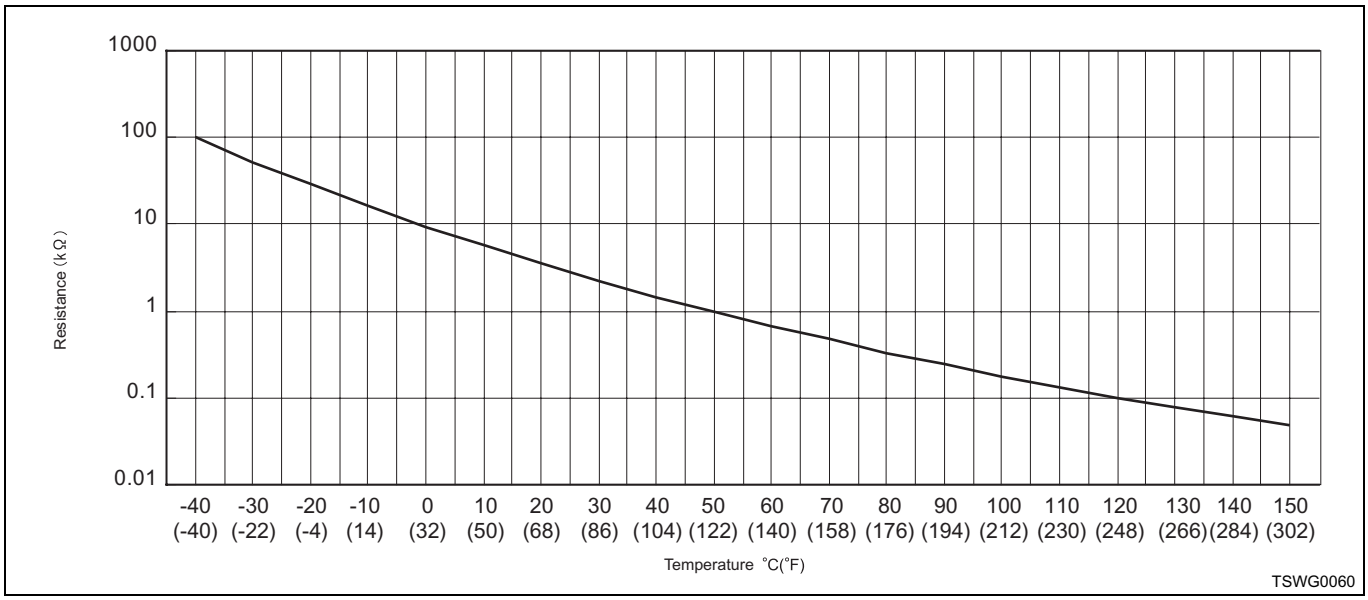


Name
1. Signal
2. GND

Characteristics of intake air temperature sensor

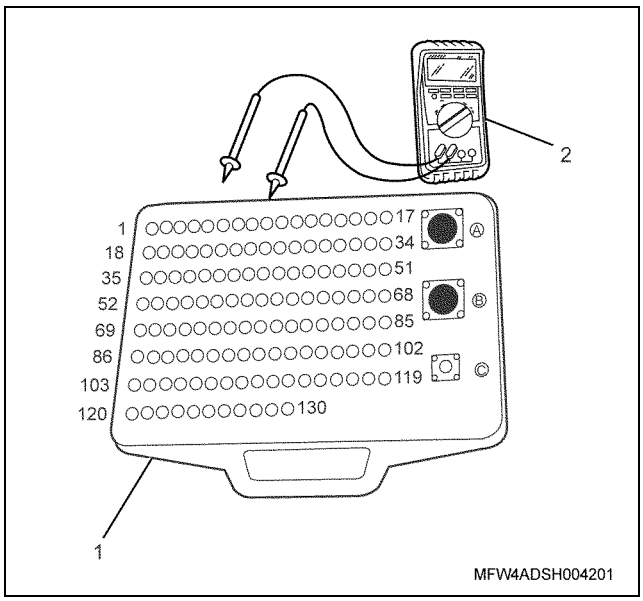
The output voltage of IAT sensor changes according to the intake air. The scan tool with CAN communication displays a fixed value when the value exceeds the threshold voltage. Therefore, judge as it is more than the threshold value if the value of –40°C (–40°F) or 120°C (248°F) is not changed.
When error 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

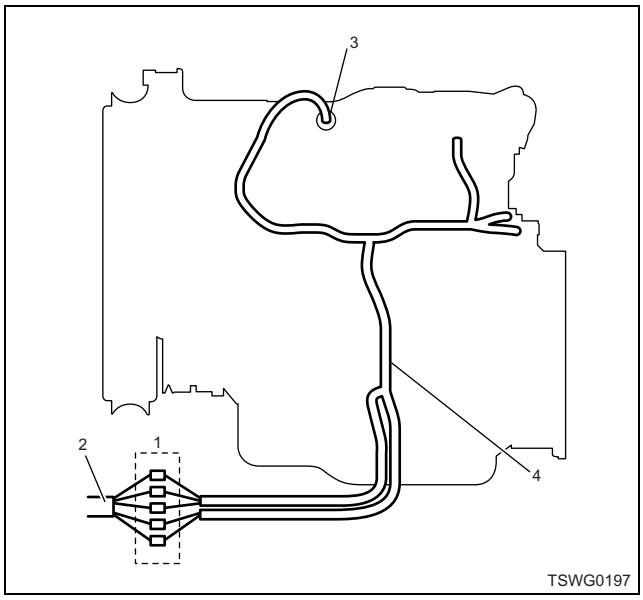
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	72 - 60 72 - Ground	10 MΩ or more	100Ω or less

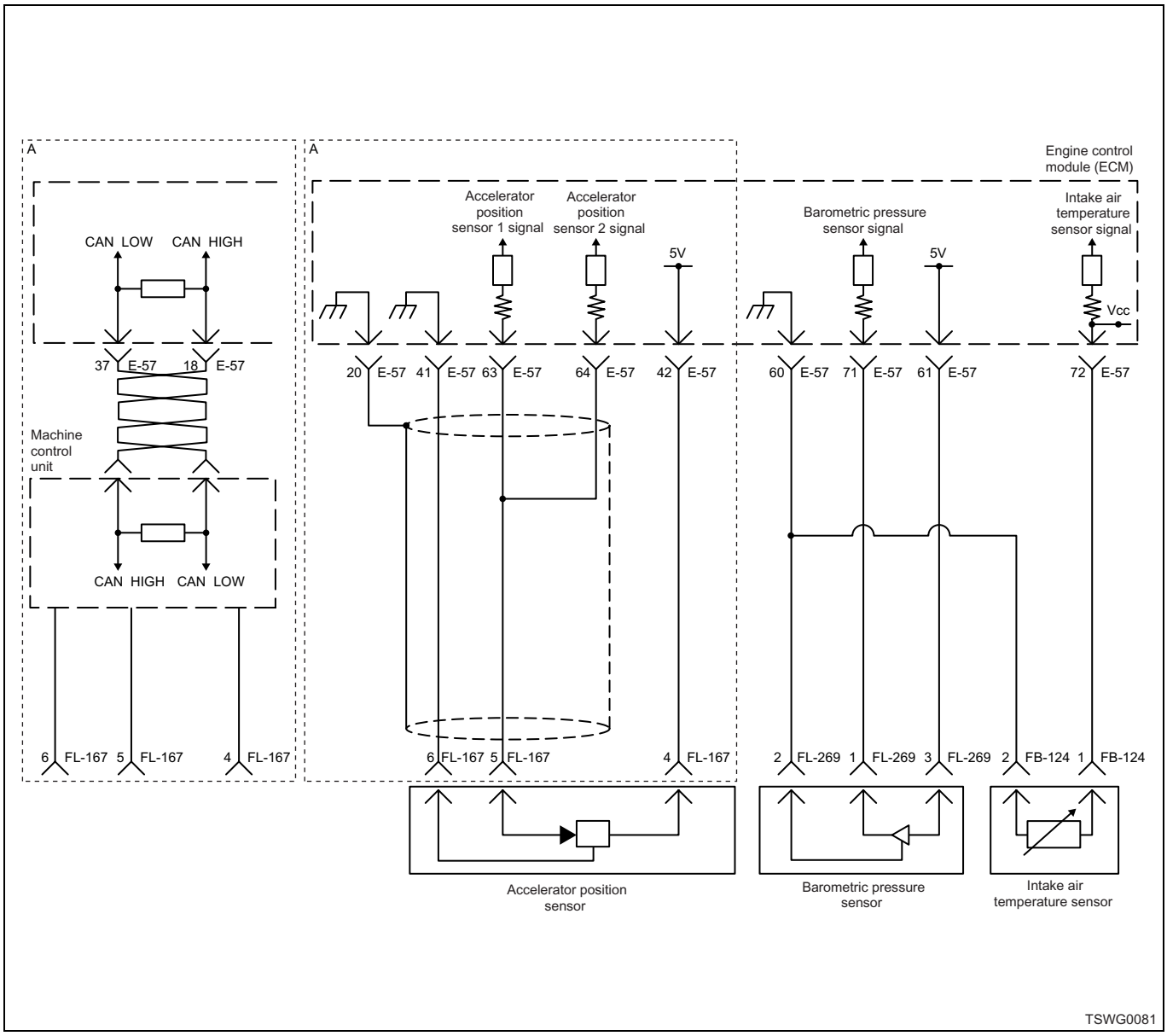
On-board check procedure for sensors



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.

DTC: P0113 (Flash code 22) Intake air temperature sensor fault (high voltage fault, open circuit or short to power supply circuit)



Description of circuit

The intake air temperature (IAT) sensor is the thermistor type and the value of resistance changes according to the temperature. The resistance is low when the intake air temperature is high, and is high when the temperature is low. The ECM energizes 5 V to the IAT sensor through the pull up resistance, and calculate the intake air temperature from the change in voltage, to utilize various control such as fuel injection control. 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

- White smoke emission possible when starting at low temperatures

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630 or P1632 is not detected.
- 3 minutes or more has elapsed after starting engine.

DTC set condition

- IAT sensor voltage is 4.95V or more.

Action taken when DTC is set

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

Back-up mode

- Intake air temperature default setting
  (at starting: −10°C {14°F}, at running: 25°C {77°F})
- 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).
- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

Diagnostic aid

- To make sure the correct performance of the IAT sensor, check with various temperatures using the reckoner table between temperature and resistance. If the sensor is faulty, operationality may be affected.

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 case of present trouble, the “Intake air temperature sensor” displays more than the specified value. In this case, identify the cause by referring to “Diagnostic aid”.
5. If the “Intake air temperature sensor” displays less than the specified value when terminals between the IAT 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.	Perform “OBD system check”, and Go to Step 2.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 15.
3	Check the value for IAT sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. 3. Check the value for “Intake air temperature sensor” using scan tool. Is the “Intake air temperature sensor” more than the specified value?	4.95V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the IAT 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 5.

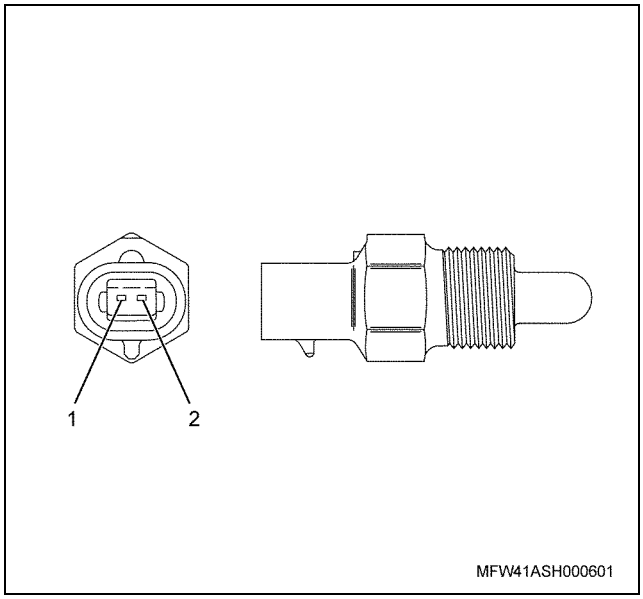
Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the IAT sensor connector. 3. Short the IAT sensor connector signal terminal to the ground terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check the value for “Intake air temperature sensor” using scan tool. Is the “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.

Step	Action	Value	YES	NO
8	1. Check for followings in the ground 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 10.
9	Replace the IAT sensor. 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.	—
13	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 P0113 detected?	—	Go to Step 2.	Go to Step 14.

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 intake air temperature. Display of intake air temperature is 214°C (419°F) due to back-up mode after fault judgment. Does the display of “Intake air 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 IAT 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 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 18.
18	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 19.

Step	Action	Value	YES	NO
19	1. Check for followings in the ground 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 9.

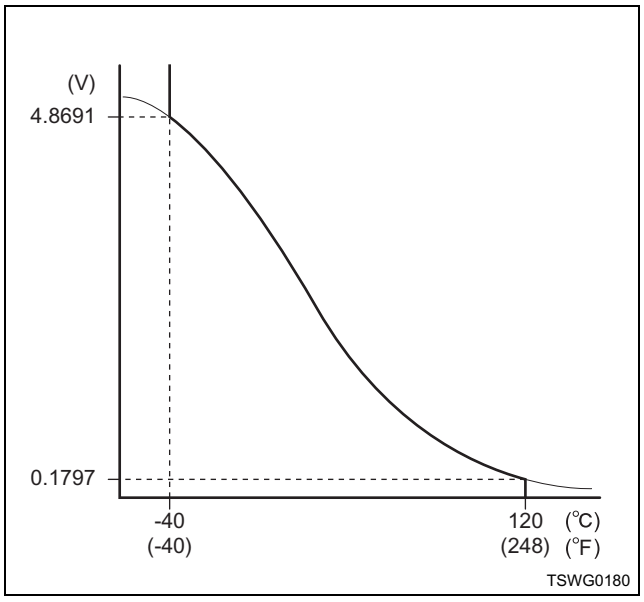
About IAT sensor



Name
1. Signal
2. GND

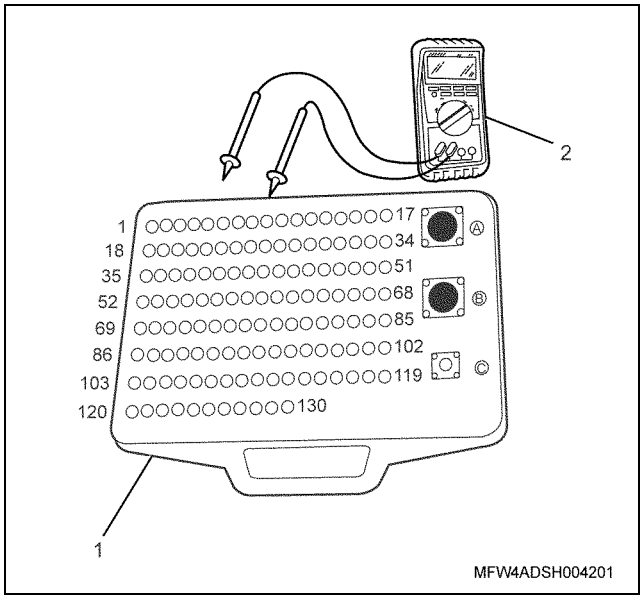
Characteristics of intake air temperature sensor

The output voltage of IAT sensor changes according to the intake air. 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.
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.

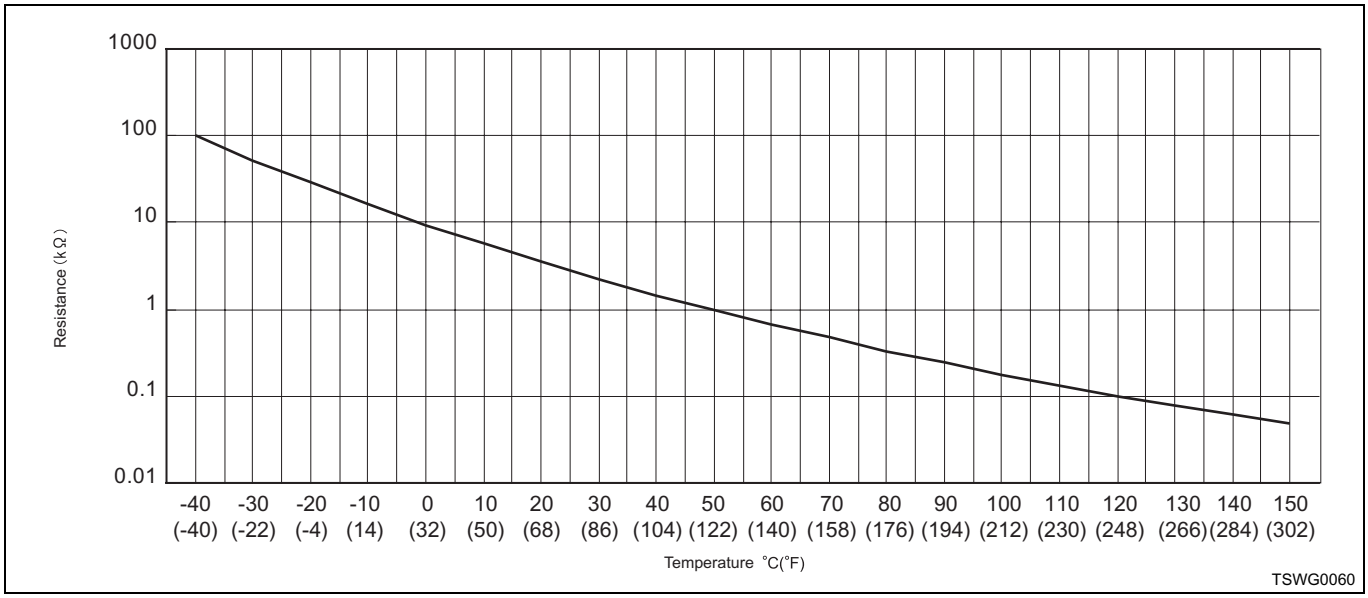


Breaker box inspection procedure

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.

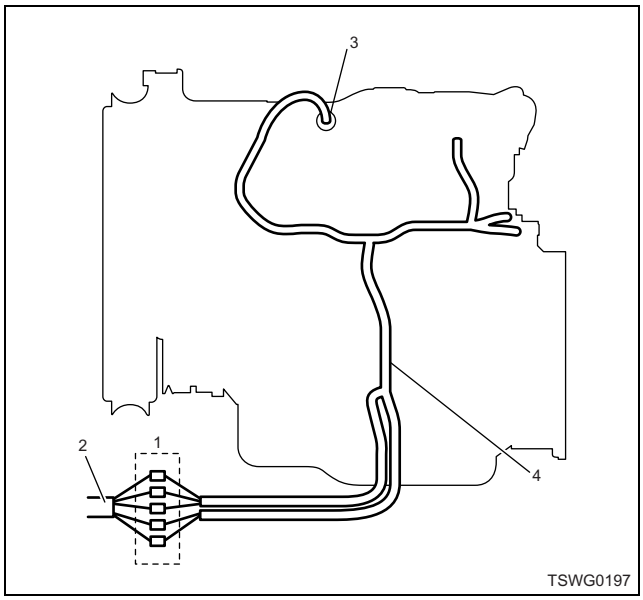


Name
1. Breaker box
2. DMM



Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	72 - Ground	0V	18V or more
7	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	72 - Sensor connector signal terminal	100Ω or less	10 MΩ or more
8	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	60 - Sensor connector ground terminal	100Ω or less	10 MΩ or more

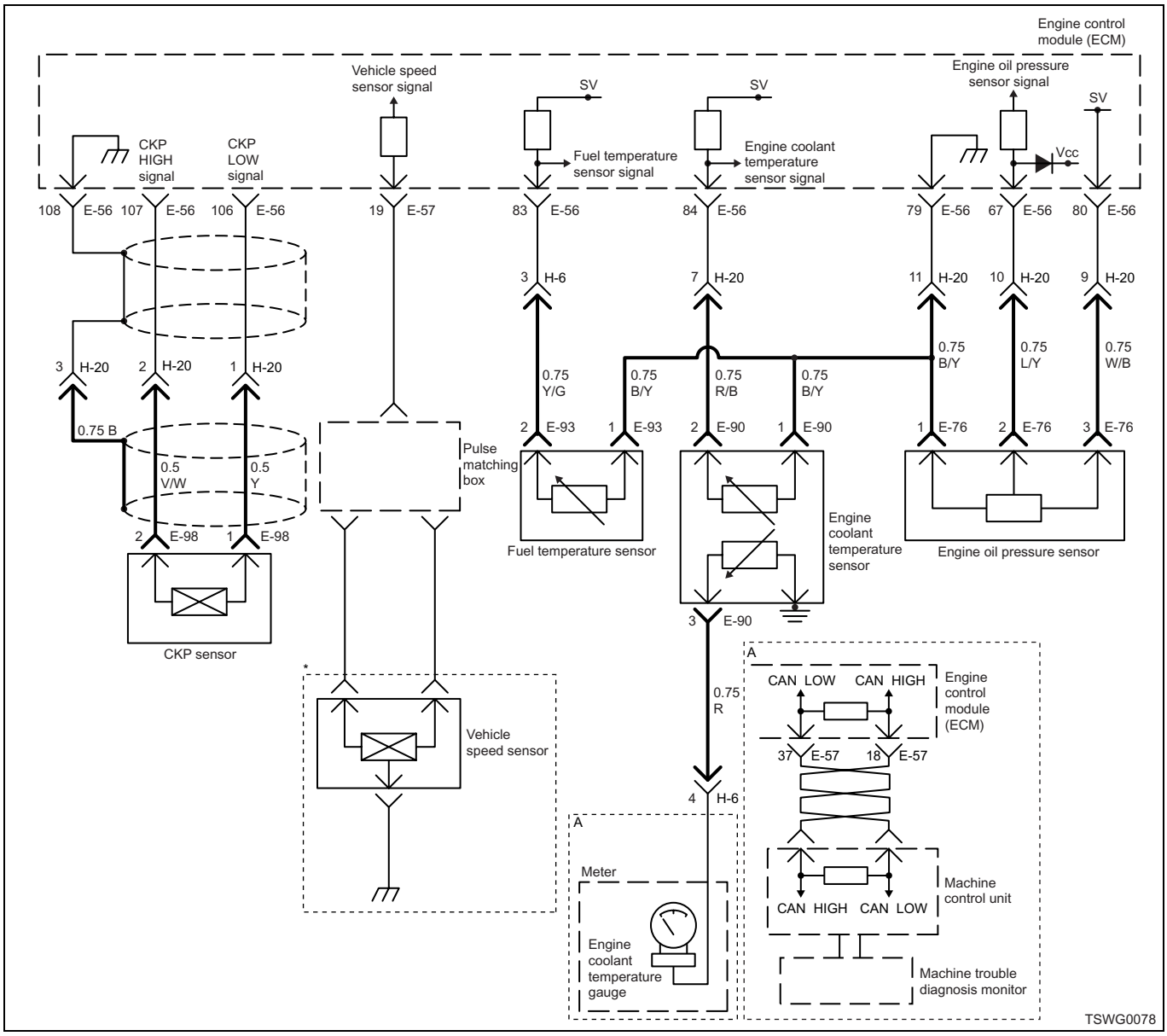
On-board check procedure for sensors



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.

DTC: P0117 (Flash code 23) Engine coolant temperature sensor fault (low voltage fault, GND short, short circuit)



Description of circuit

The engine coolant temperature (ECT) sensor detects the engine coolant temperature. The ECT sensor is installed near the thermostat housing. The ECT sensor is the thermistor type and the value of resistance inside the sensor changes according to the temperature. If the temperature is high, the resistance becomes low; if the temperature is low, the resistance becomes high. The engine control module (ECM) is connected to the ECT sensor via signal circuit and ground circuit, and energizes +5 V power supply to the signal circuit. ECM recognizes the applied voltage, which varies with change in the resistance of ECT sensor according to temperature (If the temperature is high, the voltage becomes low; if the temperature is low, the voltage becomes high), as an input signal.

Main trouble symptom

- Deterioration of startability at low temperatures
- Black smoke emitted
- Output lowering depending on conditions

Preconditions when DTC is set

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

DTC set condition

- ECT 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

- Coolant temperature default setting (at starting: −20°C {−4°F}, at running: 80°C {176°F})
- 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).
- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

Diagnostic aid

- DTC may be set at a overheat condition.
- After starting the engine, the engine coolant temperature rises and when it exceeds 82°C (180°F), the thermostat begins to open and the engine coolant temperature is stabilized.
- To make sure the correct performance of the ECT sensor, check with various temperatures using the reckoner table between temperature and resistance. If the sensor is faulty, operationality may be affected.

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

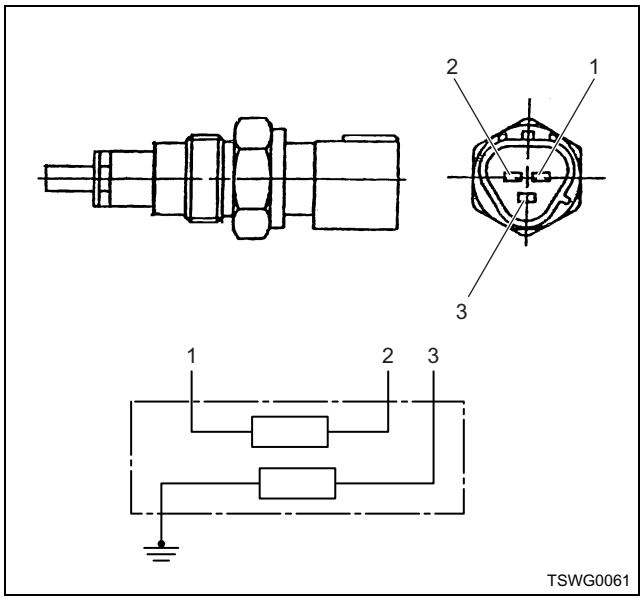
Numbers below indicate step numbers in the chart.
3. In case of present trouble, the “Engine coolant temperature sensor” displays more than the specified value. In this case, identify the cause by referring to “Diagnostic aid”.
5. If the “Engine coolant temperature sensor” displays more than the specified 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 13.
3	Check the value for ECT sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. 3. Check the value for “Engine coolant temperature sensor” using scan tool. Is the “Engine coolant temperature sensor” less than the specified value?	0.1V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the ECT 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 6.

Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the ECT sensor connector. 3. Turn the key switch to “ON”. 4. Check the value for “Engine coolant temperature sensor” using scan tool. Is the “Engine coolant temperature sensor” more than the specified value?	4.8V	Go to Step 7.	Go to Step 6.
6	1. Check for followings in the signal circuit between ECM and ECT 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 ECT sensor ground circuit • Short circuit to ground 2. Measure the resistance of ECT sensor to check that the value is within normal range. 3. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 8.
7	Replace the ECT sensor. Is the procedure completed?	—	Go to Step 11.	—
8	Is EMPS available?	—	Go to Step 9.	Go to Step 10.
9	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 11.	Go to Step 10.
10	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 11.	—

Step	Action	Value	YES	NO
11	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 P0117 detected?	—	Go to Step 2.	Go to Step 12.
12	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
13	1. Start the engine. 2. Check the display of the engine coolant temperature. Display of engine coolant temperature is 214°C (419°F) due to back-up mode after fault judgment. 3. Does the display of “Engine coolant temperature” show error value?	214°C (419°F) (Displayed error value)	Go to Step 14.	Go to Step 11.
14	Check for installation condition of the ECT 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 15.
15	1. Check for followings in the signal circuit between ECM and ECT 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 ECT sensor ground circuit • Short circuit to ground 2. Measure the resistance of ECT sensor to check that the value is within normal range. 3. If the trouble is detected, repair or replace as required. Is the procedure completed?	—	—	Go to Step 7.

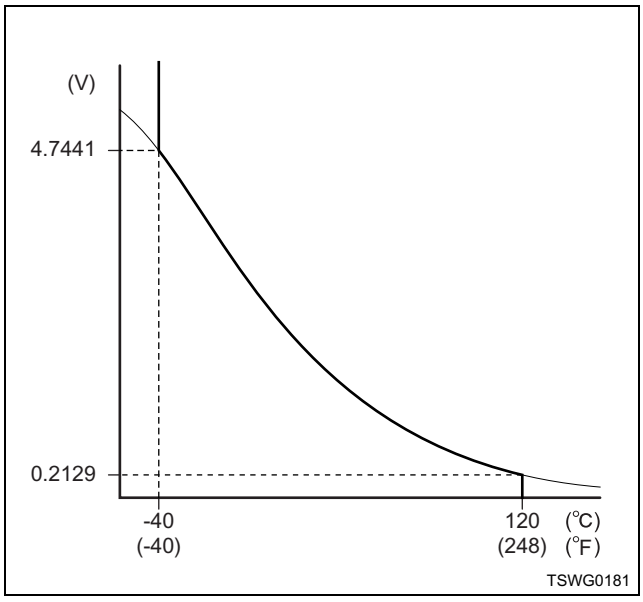
About ECT sensor

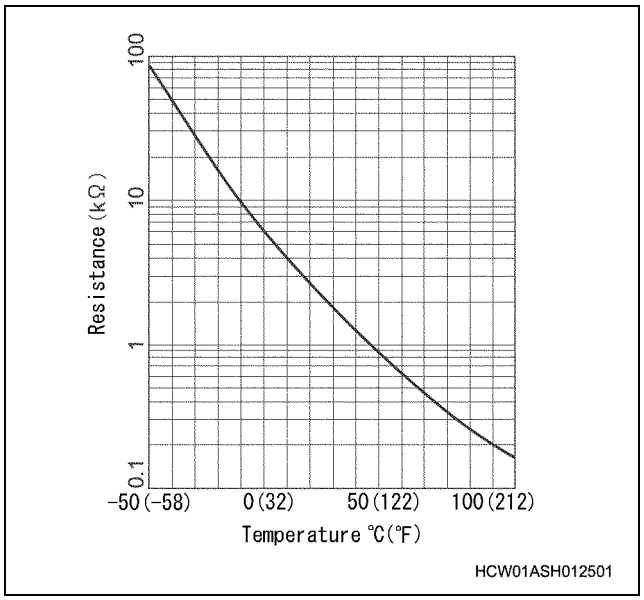


Name
1. Sensor ground (for engine control)
2. Sensor signal (for engine control)
3. Sensor signal (for meter)

Characteristics of ECT sensor

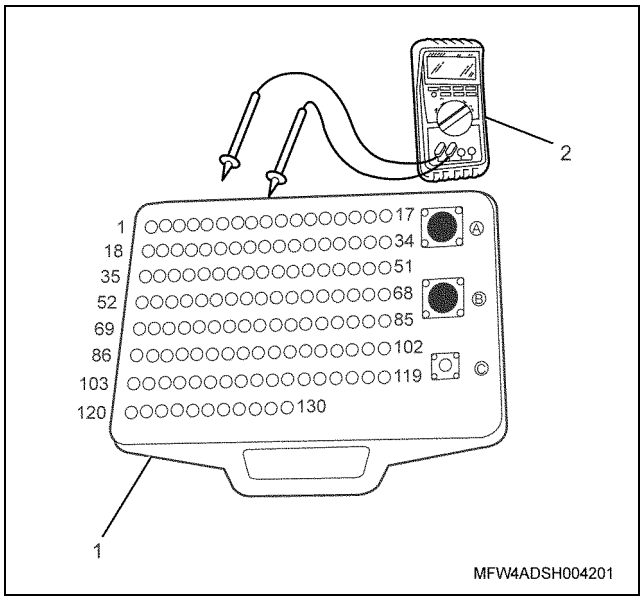
The output voltage of ECT sensor changes according to the engine coolant temperature. The scan tool with CAN communication displays a fixed value when the value exceeds the threshold voltage. Therefore, judge as it is more than the threshold value if the value of −40°C (−40°F) or 120°C (248°F) is not 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

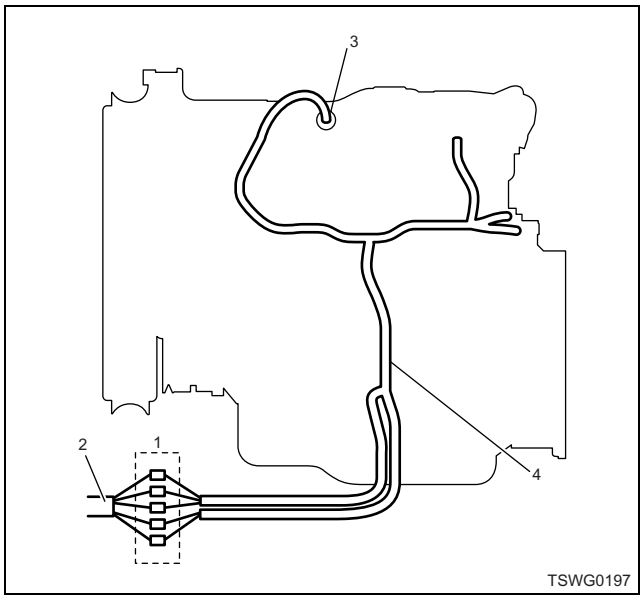
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	84 - 79 84 - Ground	10 MΩ or more	100Ω or less

On-board check procedure for sensors



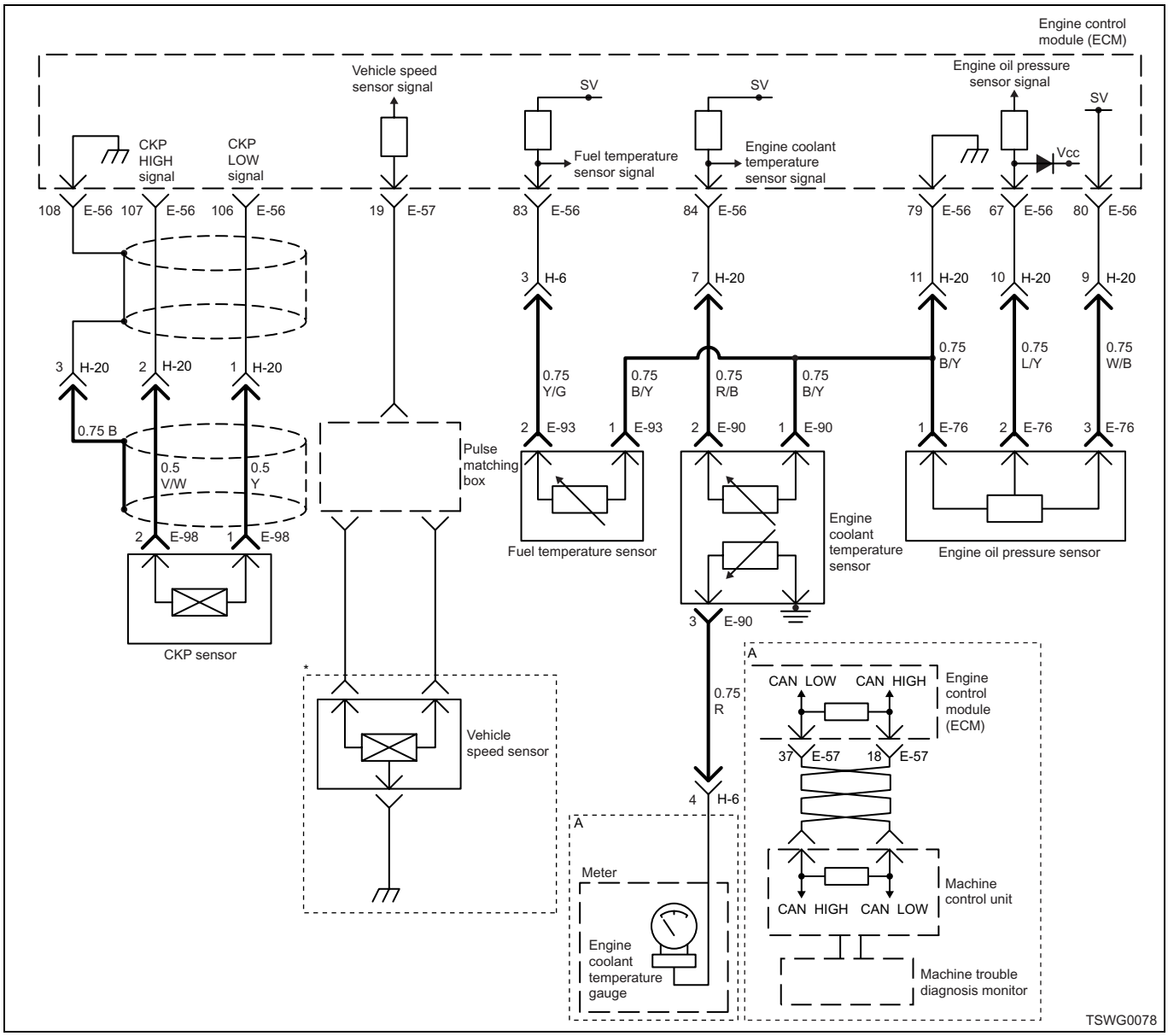
Name
1. Coupling connector between engine — the machine
2. Machine harness
3. Sensor connector
4. Engine harness

---

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.

DTC: P0118 (Flash code 23) Engine coolant temperature sensor input is high (open circuit or short to power supply)

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



Description of circuit

The engine coolant temperature (ECT) sensor detects the engine coolant temperature. The ECT sensor is installed near the thermostat housing. The ECT sensor is the thermistor type and the value of resistance inside the sensor changes according to the temperature. If the temperature is high, the resistance becomes low; if the temperature is low, the resistance becomes high. The engine control module (ECM) is connected to the ECT sensor via signal circuit and ground circuit, and energizes +5 V power supply to the signal circuit. ECM recognizes the applied voltage, which varies with change in the resistance of ECT sensor according to temperature (If the temperature is high, the voltage becomes low; if the temperature is low, the voltage becomes high), as an input signal.

Main trouble symptom

- Noise deteriorates.
- White smoke emitted at low temperatures.
- Rough idling

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630 or P1633 is not detected.
- 3 minutes or more has elapsed after starting engine.

DTC set condition

- When the ECT sensor voltage keeps more than 4.85V for 3 minutes or more.

Action taken when DTC is set

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

Back-up mode

- Coolant temperature default setting (at starting: −20°C {−4°F}, at running: 80°C {176°F})
- 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).
- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

Diagnostic aid

- After starting the engine, the engine coolant temperature rises and when it exceeds 82°C (180°F), the thermostat begins to open and the engine coolant temperature is stabilized.
- To make sure the correct performance of the ECT sensor, check with various temperatures using the reckoner table between temperature and resistance. If the sensor is faulty, operationality may be affected.

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 case of present trouble, the “Engine coolant temperature sensor” displays more than the specified value. If less than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If the “Engine coolant temperature sensor” displays less than the specified value when terminals between the ECT 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.	Perform “OBD system check”, and Go to Step 2.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 15.
3	Check the value for ECT sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. 3. Check the value for “Engine coolant temperature sensor” using scan tool. Is the “Engine coolant temperature sensor” more than the specified value?	4.85V	Go to Step 4.	Go to “Diagnostic aid”.

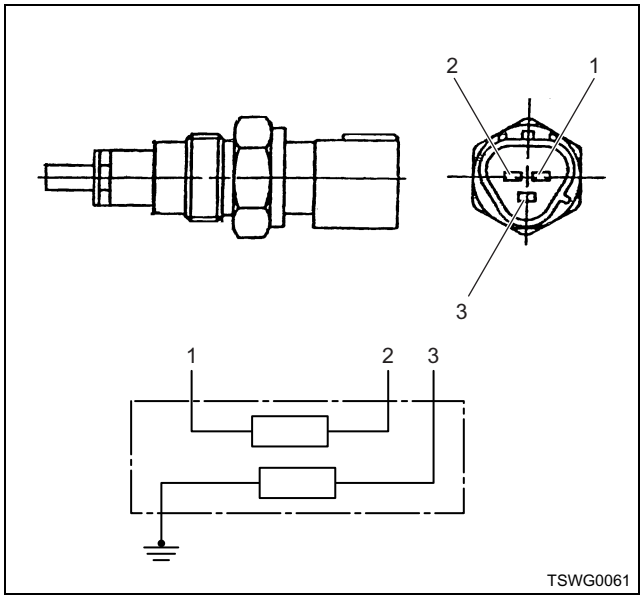
Step	Action	Value	YES	NO
4	Check for installation condition of the ECT sensor, ECM and coupling connector. 1. Check for play or looseness in the connection. 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 5.
5	1. Turn the key switch to “OFF”. 2. Disconnect the ECT sensor connector. 3. Short the ECT sensor connector signal terminal to the ground terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check the value for “Engine coolant temperature sensor” using scan tool. Is the “Engine coolant 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 ECT 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 ECT 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 ECT 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.

Step	Action	Value	YES	NO
8	1. Check for followings in the ground circuit between ECM and ECT 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 10.
9	Replace the ECT sensor. Is the procedure completed?	—	Go to Step 13.	—
10	Is EMPS available?	—	Go to Step 10.	Go to Step 11.
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 11.
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.	—
13	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 P0118 detected?	—	Go to Step 2.	Go to Step 14.

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 the engine coolant temperature. Display of engine coolant temperature is 214°C (419°F) due to back-up mode after fault judgment. 3. Does the display of “Engine coolant 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 ECT 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 ECT 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 ECT 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 ECT 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.

Step	Action	Value	YES	NO
19	1. Check for followings in the ground circuit between ECM and ECT 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.

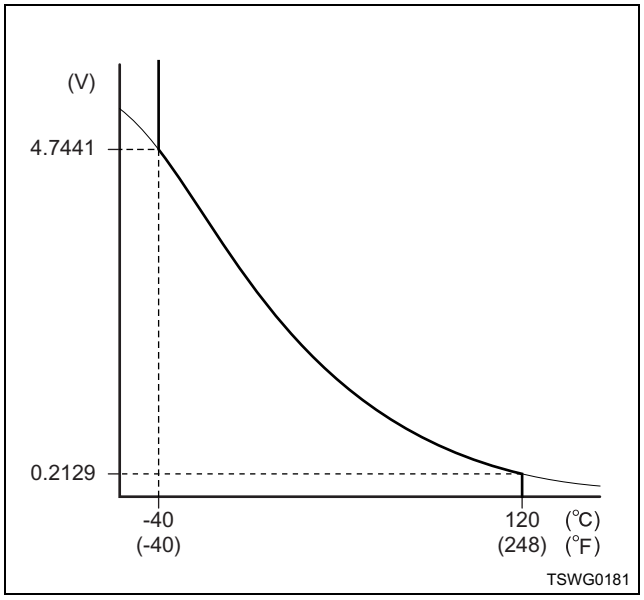
About ECT sensor

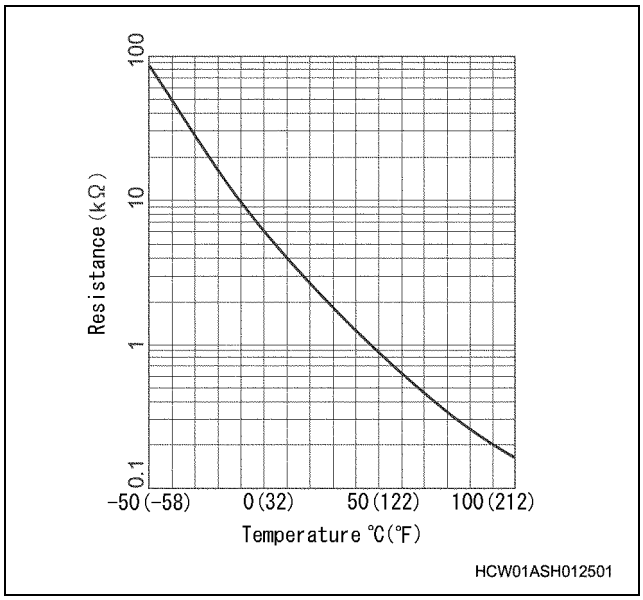


Name
1. Sensor GND (for engine control)
2. Sensor signal (for engine control)
3. Sensor signal (for meter)

Characteristics of ECT sensor

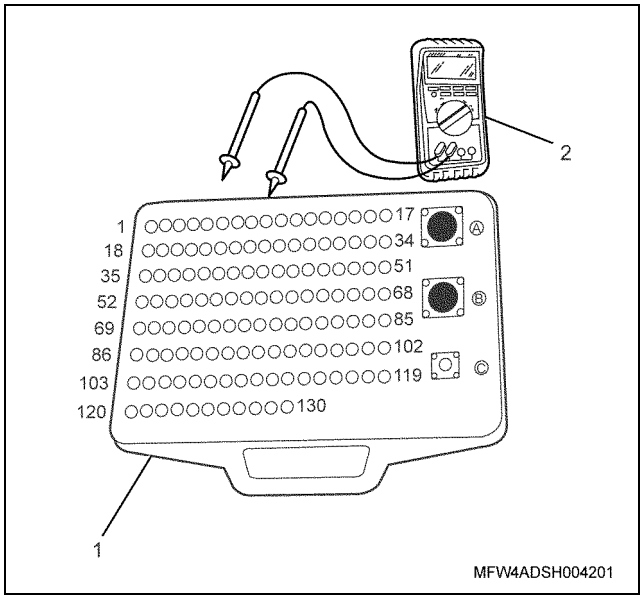
The output voltage of ECT sensor changes according to the engine coolant temperature. The scan tool with CAN communication displays a fixed value when the value exceeds the threshold voltage. Therefore, judge as it is more than the threshold value if the value of –40°C (–40°F) or 120°C (248°F) is not 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

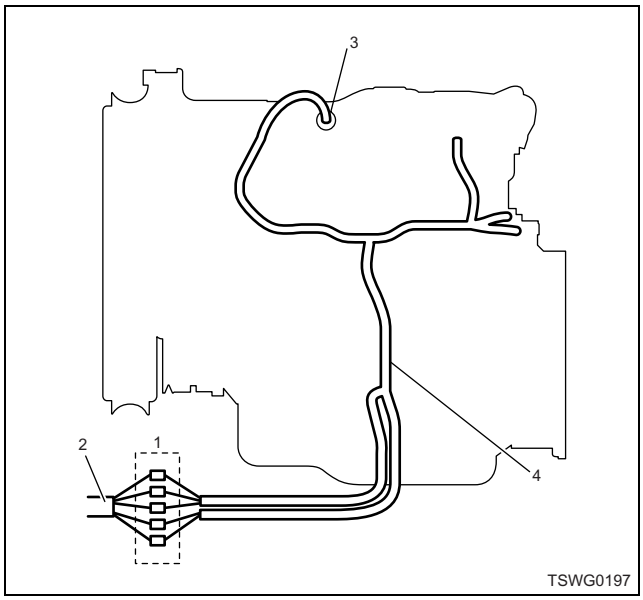
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	84 - Ground	0V	18V or more
7	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	84 - Sensor connector signal terminal	100 Ω or less	10 MΩ or more
8	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	79 - Sensor connector ground terminal	100 Ω or less	10 MΩ or more

On-board check procedure for sensors



Name

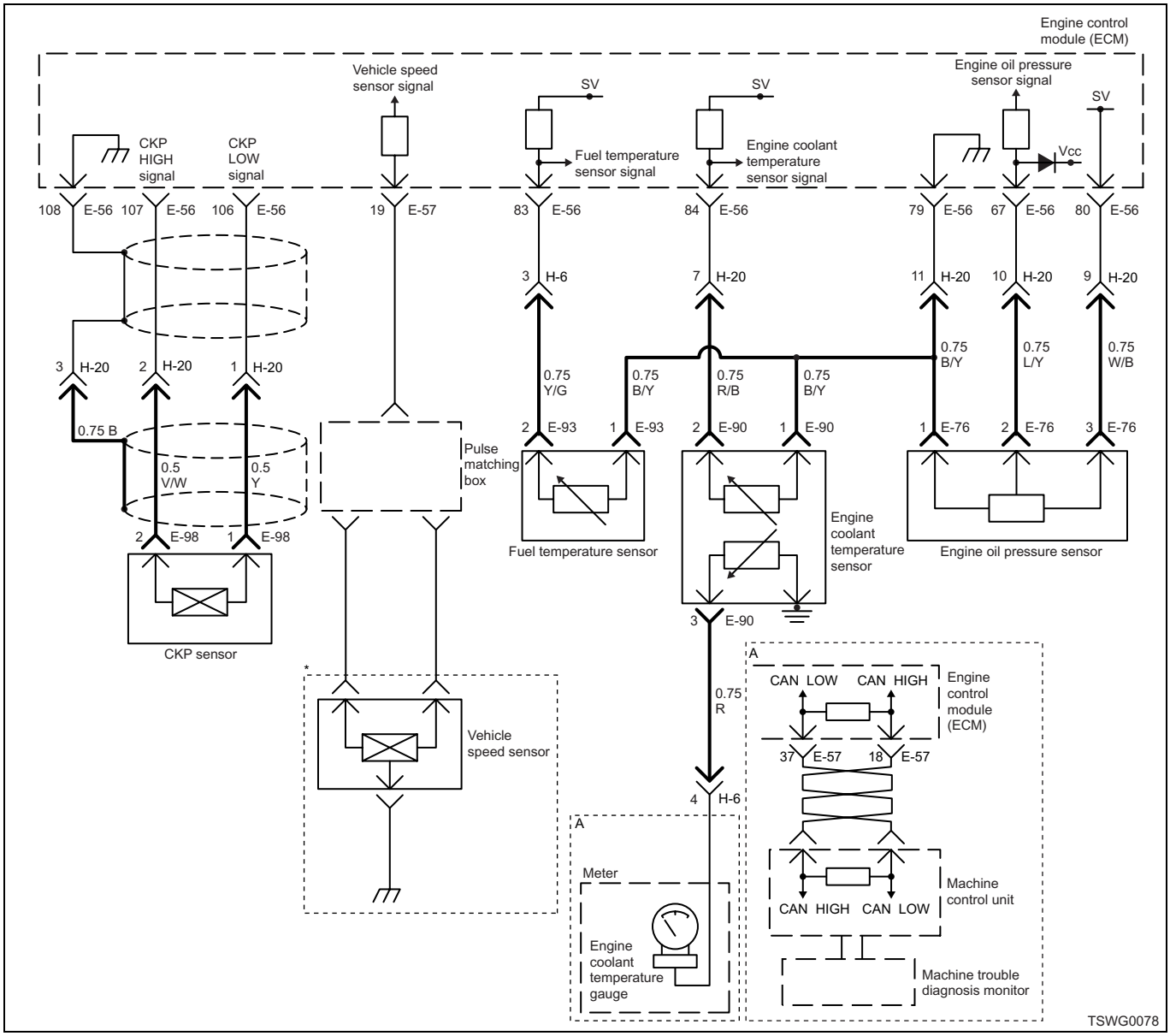
1. Coupling connector between engine — the machine
2. Machine harness
3. Sensor connector
4. Engine harness

---

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.

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})

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

- When the engine cold (before starting engine), check if the temperatures of the FT sensor and IAT sensor are close.

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

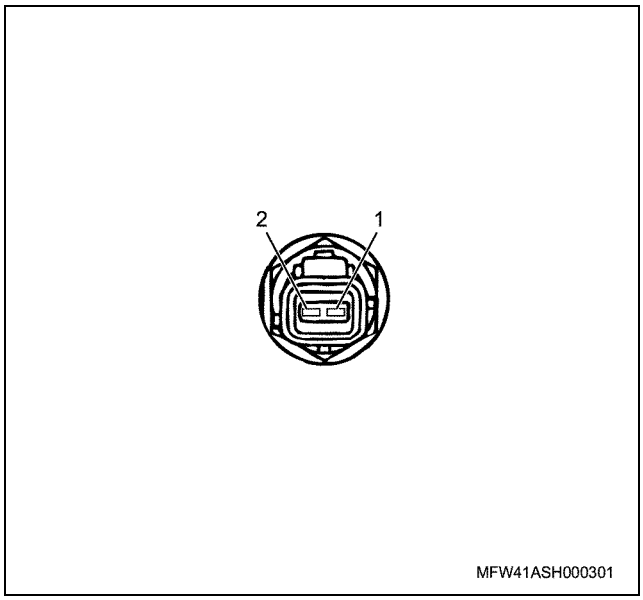
Numbers below indicate step numbers in the chart.
3. In the case of present trouble, the “Fuel temperature sensor” displays more than the specified value. In this case, identify the cause by referring to “Diagnostic aid”.
5. If the “Fuel temperature sensor” displays more than the specified value when the FT 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 13.
3	Check the value for FT sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. 3. Check the value for “Fuel temperature sensor” using scan tool. Is the “Fuel temperature sensor” less than the specified value?	0.1V	Go to Step 4.	Go to “Diagnostic aid”.
4	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 11.	Go to Step 5.
5	1. Turn the key switch to “OFF”. 2. Disconnect the FT sensor connector. 3. Turn the key switch to “ON”. 4. Check the value for “Fuel temperature sensor” using scan tool. Is the “Fuel temperature sensor” more than the specified value?	4.8V	Go to Step 7.	Go to Step 6.

Step	Action	Value	YES	NO
6	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”.** • Short circuit to FT sensor ground circuit • Short circuit to ground 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 8.
7	Replace the FT sensor. Is the procedure completed?	—	Go to Step 11.	—
8	Is EMPS available?	—	Go to Step 9.	Go to Step 10.
9	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 11.	Go to Step 10.
10	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 11.	—

Step	Action	Value	YES	NO
11	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 P0182 detected?	—	Go to Step 2.	Go to Step 12.
12	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
13	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 14.	Go to “Diagnostic aid”.
14	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 11.	Go to Step 15.
15	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”.** • Short circuit to FT sensor ground circuit • Short circuit to ground 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 7.

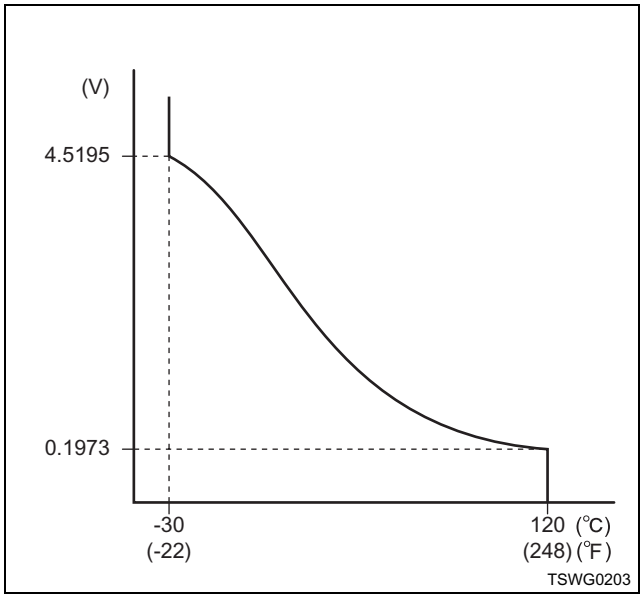
About FT sensor

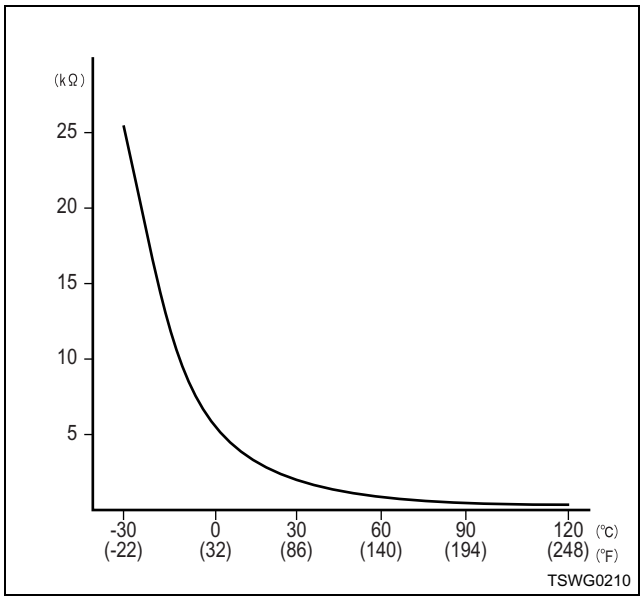


Name
1. GND
2. Signal

Characteristics of FT sensor

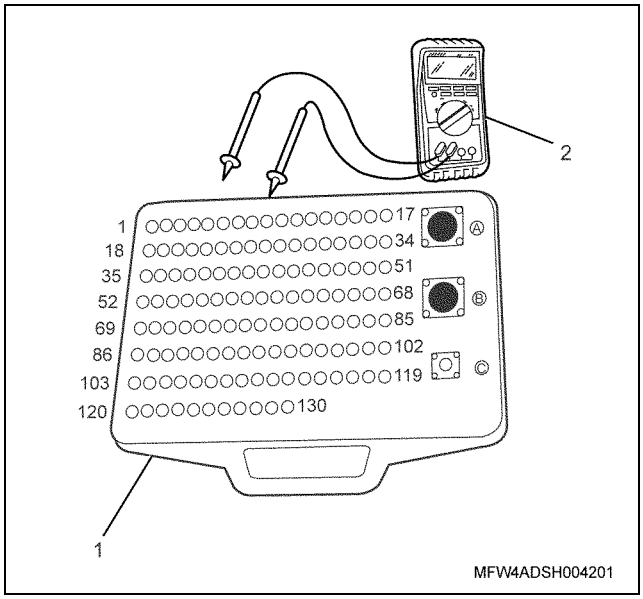
The output voltage of FT sensor changes according to the fuel temperature. The scan tool with CAN communication displays a fixed value when the value exceeds the threshold voltage. Therefore, judge as it is more than the threshold value if the value of −30°C (−22°F) or 120°C (248°F) is not changed.
When 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

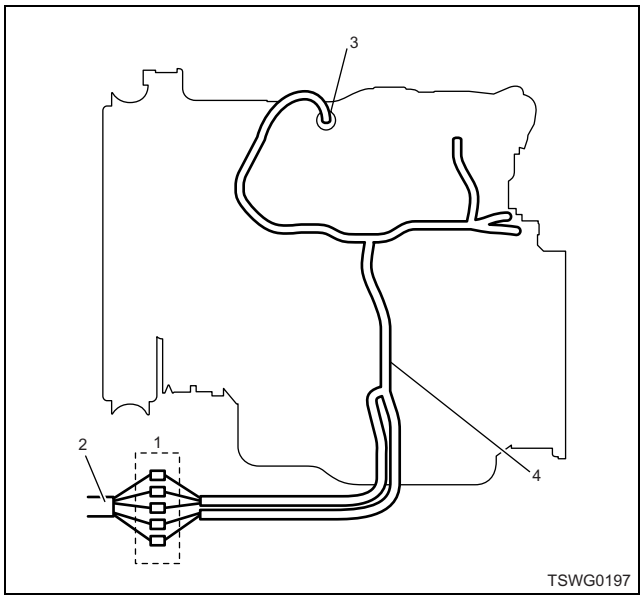
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	83 - 109 83 - Ground	10 MΩ or more	100Ω or less

On-board check procedure for sensors

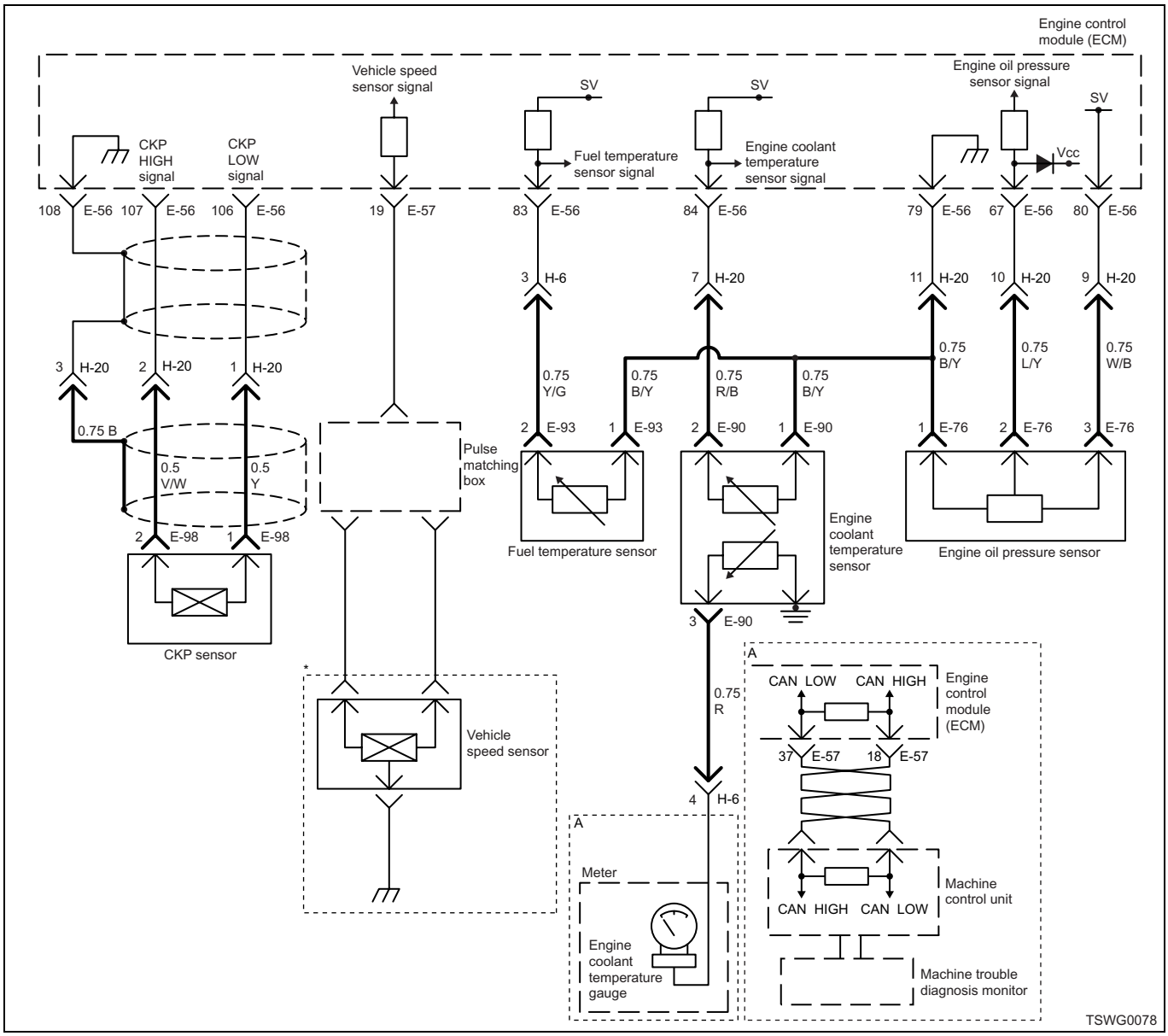


Name
1. Coupling connector between engine — the machine
2. Machine harness
3. Sensor connector
4. Engine harness

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.

DTC: P0183 (Flash code 211) Fuel temperature sensor fault (high voltage fault, open circuit or short to power supply circuit)

(*: 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

Not in particular

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630 or P1633 is not detected.
- 3 minutes or more has elapsed after starting engine.

DTC set condition

- FT sensor voltage is 4.85 V or more.

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})

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

- When the engine cold (before starting engine), check if the temperatures of the FT sensor and IAT sensor are close.

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 “Fuel temperature sensor” displays more than the specified value. In this case, identify the cause by referring to “Diagnostic aid”.
5. If the “Fuel temperature sensor” displays less than the specified value when terminals between the FT 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.	Perform “OBD system check”, and Go to Step 2.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 15.
3	Check the value for FT sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. 3. Check the value for “Fuel temperature sensor” using scan tool. Is the “Fuel temperature sensor” more than the specified value?	4.85V	Go to Step 4.	Go to “Diagnostic aid”.
4	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 5.

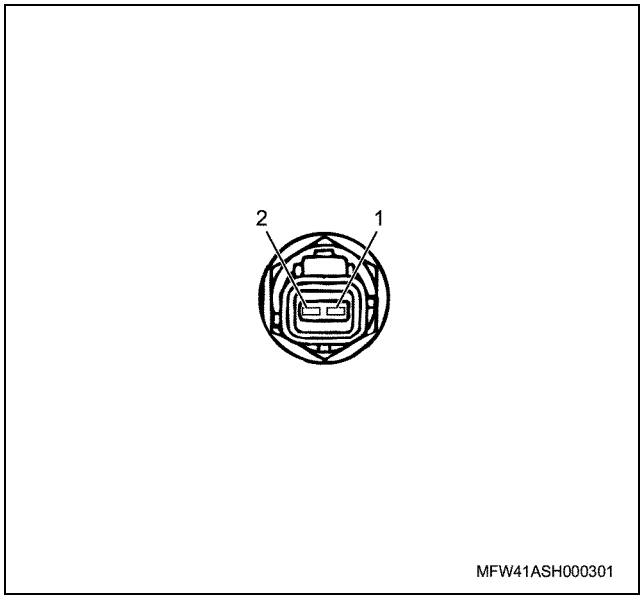
Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the FT sensor connector. 3. Short the FT sensor connector signal terminal to the ground terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check the value for “Fuel temperature sensor” using scan tool. Is the “Fuel temperature sensor” less than the specified value?	0V	Go to Step 9.	Go to Step 6.
6	1. Check the signal circuit between ECM and 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 7.
7	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 8.

Step	Action	Value	YES	NO
8	1. Check for followings in the ground 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 10.
9	Replace the FT sensor. 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.	—
13	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 P0183 detected?	—	Go to Step 2.	Go to Step 14.

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.

Step	Action	Value	YES	NO
19	1. Check for followings in the ground 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 9.

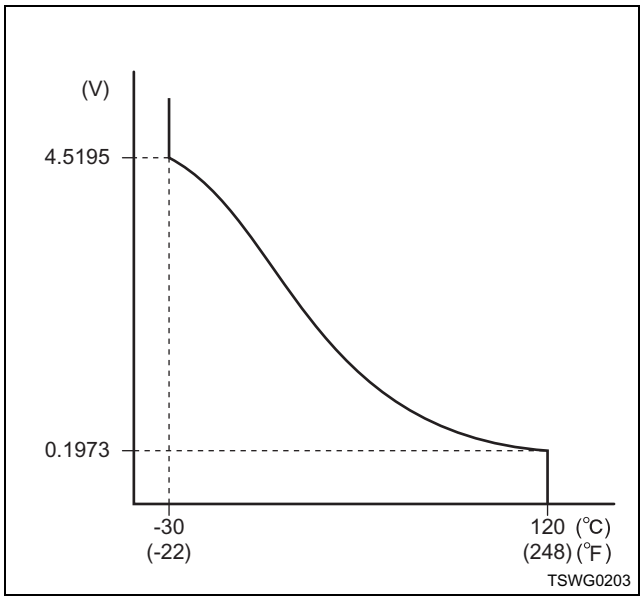
About FT sensor

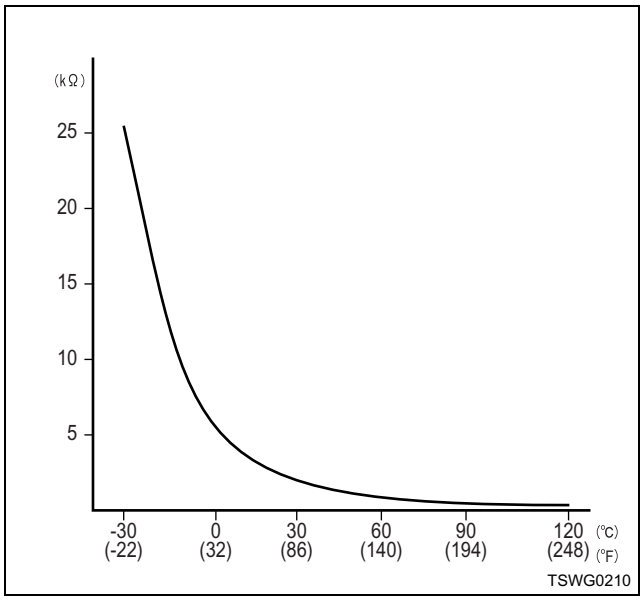


Name
1. GND
2. Signal

Characteristics of FT sensor

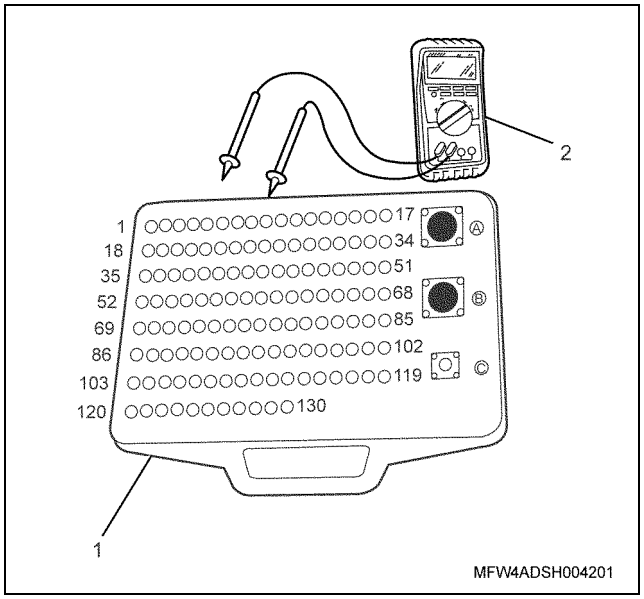
The output voltage of FT sensor changes according to the fuel temperature. The scan tool with CAN communication displays a fixed value when the value exceeds the threshold voltage. Therefore, judge as it is more than the threshold value if the value of –30°C (–22°F) or 120°C (248°F) is not changed.
The 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

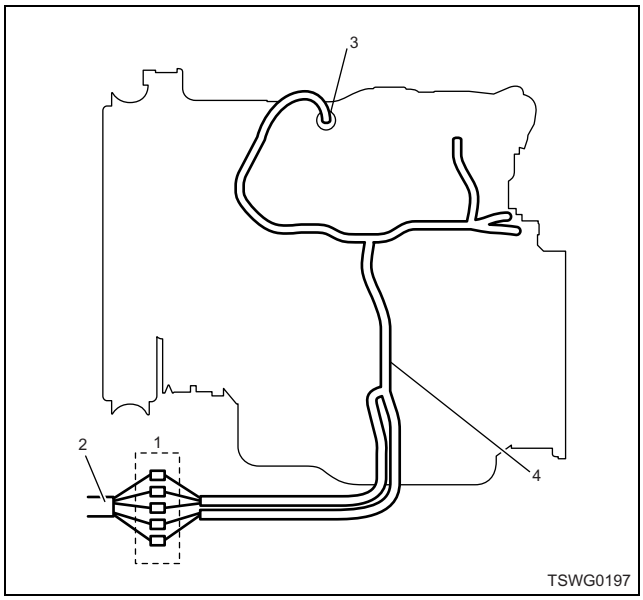
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	83 - Ground	0V	18V or more
7	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	83 - Sensor connector signal terminal	100Ω or less	10 MΩ or more
8	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	109 - Sensor connector ground terminal	100 Ω or less	10 MΩ or more

On-board check procedure for sensors



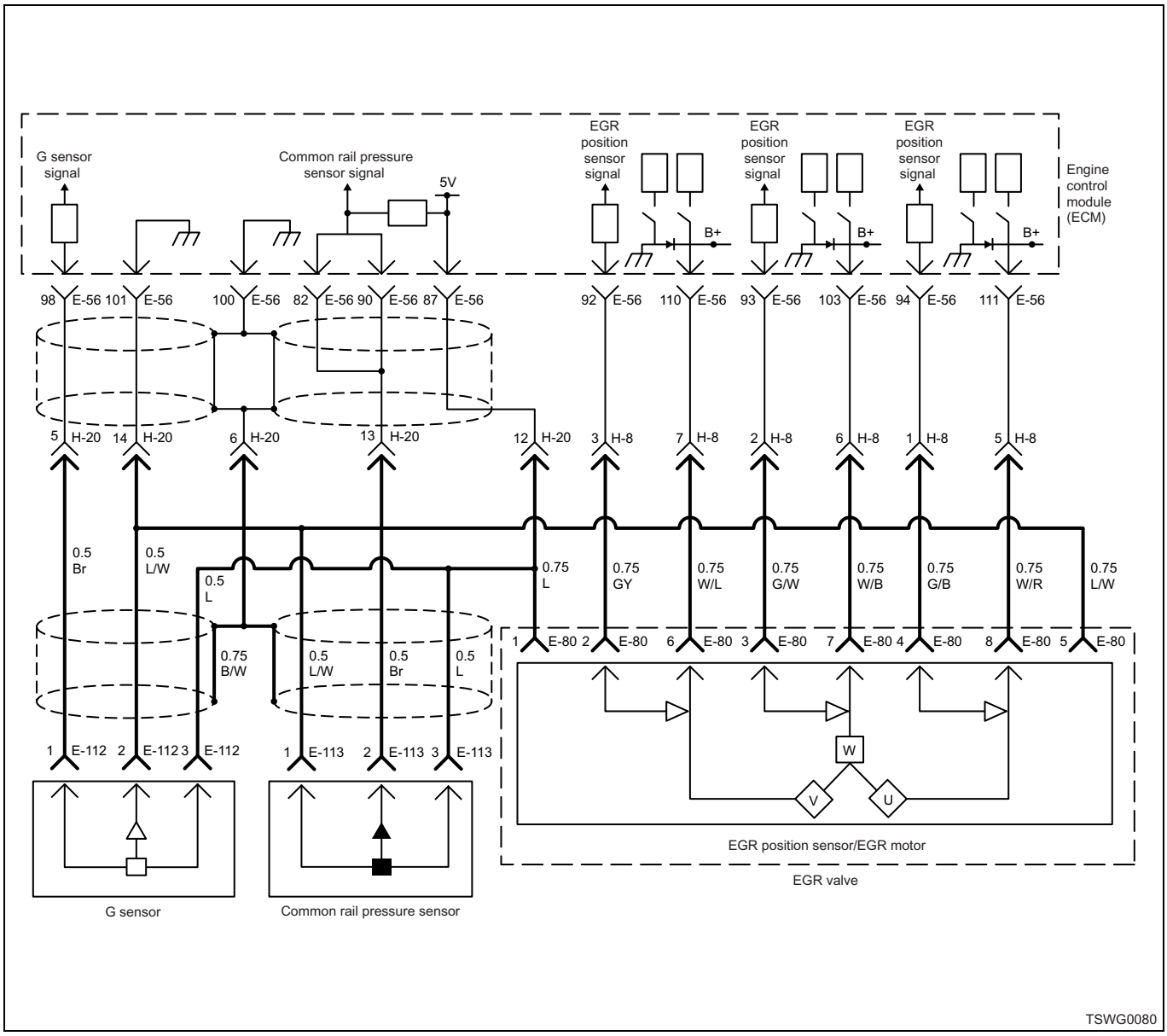
Name

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.

DTC: P0192 (Flash code 245) Common rail pressure sensor fault (low voltage fault, short 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

- Engine blow up
- 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 0.7 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

- Specified back-up value

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 “Common rail pressure sensor” displays more than the specified value. If more than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If the “Common rail pressure sensor” displays more than the specified value when the common rail pressure sensor connector is removed, the circuit beyond the sensor is normal including ECM.

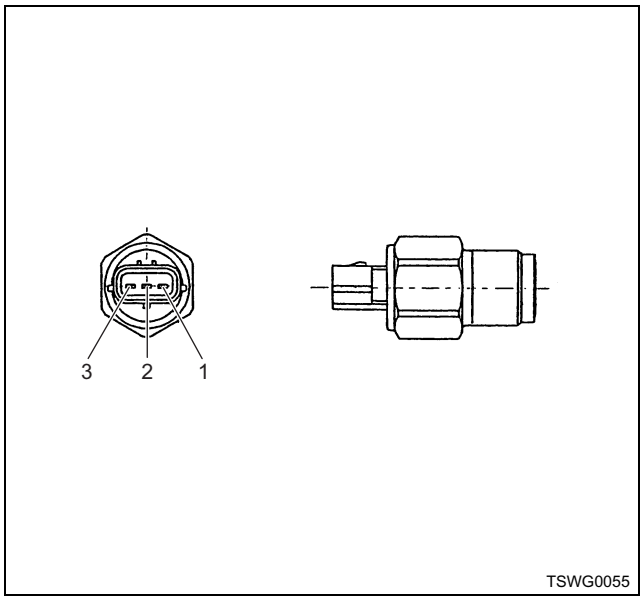
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Perform “OBD system check”, and Go to Step 2.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 14.
3	Check the value for common rail pressure sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. 3. Check the value for “Common rail pressure sensor” using scan tool. Is the “Common rail pressure sensor” output voltage less than the specified value?	0.7V (at idle)	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the common rail 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 12.	Go to Step 5.

Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Turn the key switch to “ON”. 4. Check the value for “Common rail pressure sensor” using scan tool. Is the “Common rail pressure sensor” output voltage specified value?	0V	Go to Step 8.	Go to Step 6.
6	1. Check for followings in the power supply circuit between ECM and common rail 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 12.	Go to Step 7.
7	1. Check for followings in the signal circuit between ECM and common rail 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 common rail pressure sensor ground circuit • Short circuit to ground 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 common rail (common rail pressure sensor). **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 12.	—
9	Is EMPS available?	—	Go to Step 10.	Go to Step 11.

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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P0192 detected?	—	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.
14	Check for installation condition of the common rail 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 12.	Go to Step 15.

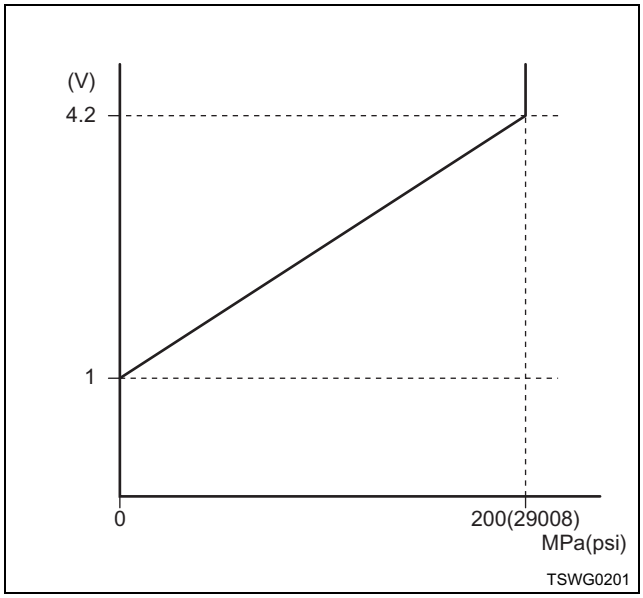
Step	Action	Value	YES	NO
15	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Turn the key switch to “ON”. 4. Connect the DMM between the common rail pressure sensor signal terminal and the ground. Does the DMM indicate the specified value?	0V	Go to Step 8.	Go to Step 6.

About common rail pressure sensor



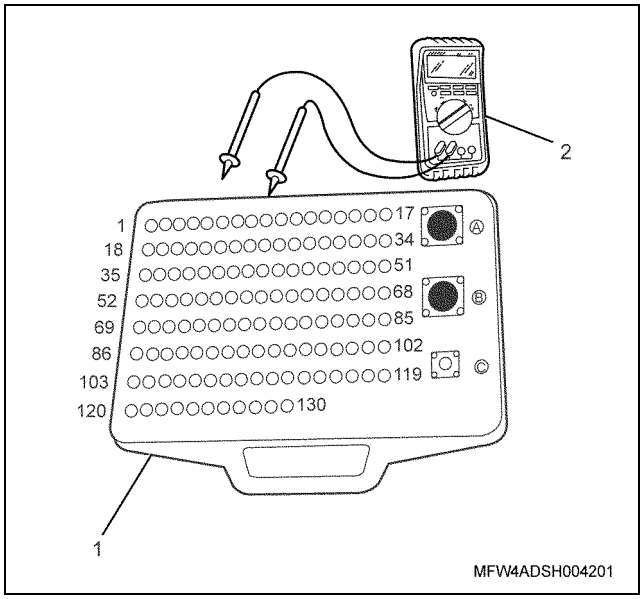
Name
1. GND
2. Signal
3. Power supply

Characteristics of common rail pressure sensor



Breaker box inspection procedure

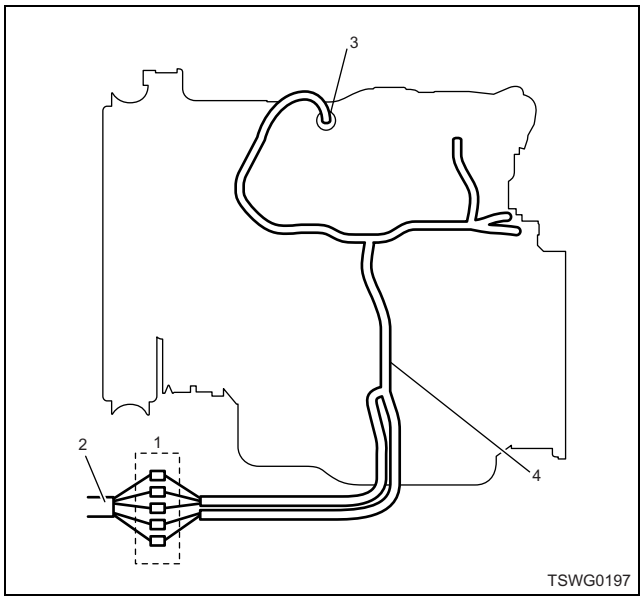
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	87 - Sensor connector power supply terminal	100 Ω or less	10 MΩ or more
7	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	82 - 101 90 - 101 82 - Ground 90 - Ground	10 MΩ or more	100 Ω or less
	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	82 - Sensor connector signal terminal 90 - Sensor connector signal terminal	100 Ω or less	10 MΩ or more

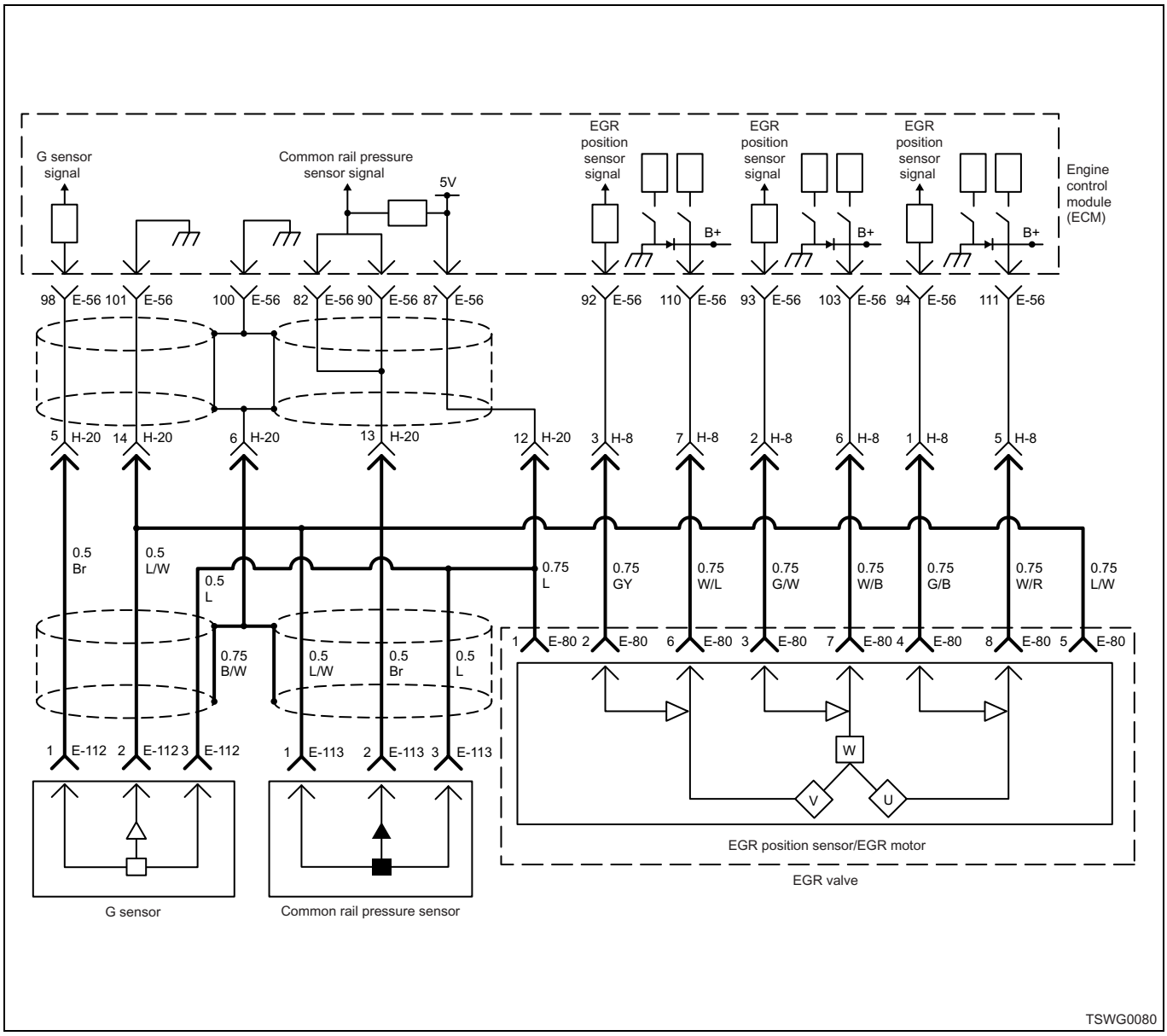
On-board check procedure for sensors



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.

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.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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 “Common rail pressure sensor” displays more than the specified value. If more than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If the “Common rail pressure sensor” displays less than the specified value when terminals between the common rail pressure sensor connector are shorted, the circuit beyond the sensor is normal including ECM.

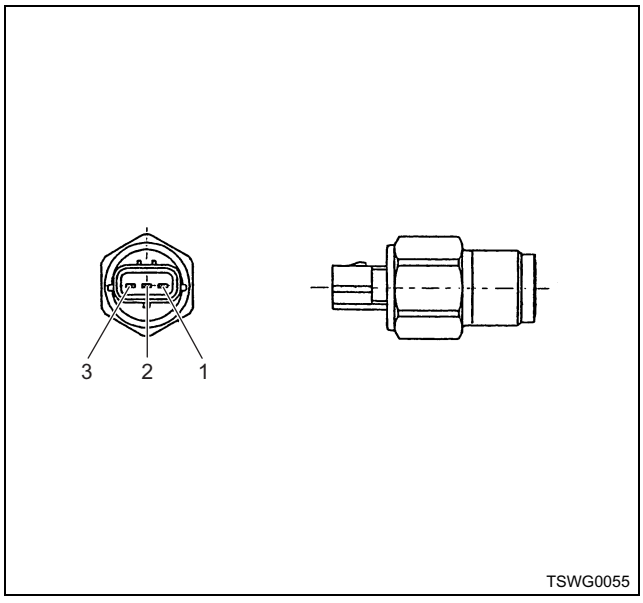
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Perform “OBD system check”, and Go to Step 2.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 15.
3	Check the value for common rail pressure sensor using scan tool. 1. Connect the scan tool. 2. Start the engine. 3. Check the value for “Common rail pressure sensor” using scan tool. Is the “Common rail pressure sensor” more than the specified value?	4.5V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the common rail 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 13.	Go to Step 5.

Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Short the common rail 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 “Common rail pressure sensor” using scan tool. Is the “Common rail pressure sensor” less than the specified value?	4.8V	Go to Step 9.	Go to Step 6.
6	1. Check the signal circuit between ECM and common rail 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 common rail 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 13.	Go to Step 7.
7	1. Check for followings in the signal circuit between ECM and common rail 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 8.

Step	Action	Value	YES	NO
8	1. Check for followings in the ground circuit between ECM and common rail 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 10.
9	Replace the common rail (common rail pressure sensor). **Note:** **For work procedure, refer to “Engine section” in the service manual.** 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.	—

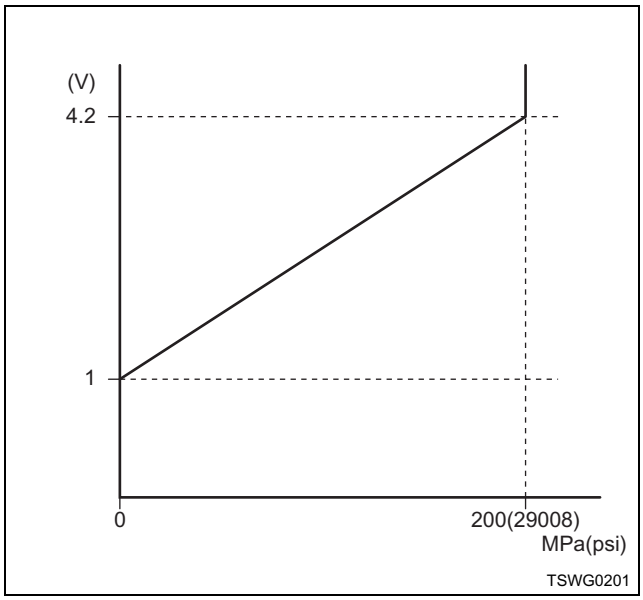
Step	Action	Value	YES	NO
13	Check the DTC again. 1. Connect all the harnesses. 2. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 3. Turn the key switch to “OFF” for more than 10 seconds. 4. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P0193 detected?	—	Go to Step 2.	Go to Step 14.
14	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
15	Check for installation condition of the common rail 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 13.	Go to Step 16.
16	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Turn the key switch to “ON”. 4. Connect the DMM between the common rail pressure sensor power supply terminal and the signal terminal. Is the DMM indication less than the specified value?	4.8V	Go to Step 9.	Go to Step 6.

About common rail pressure sensor



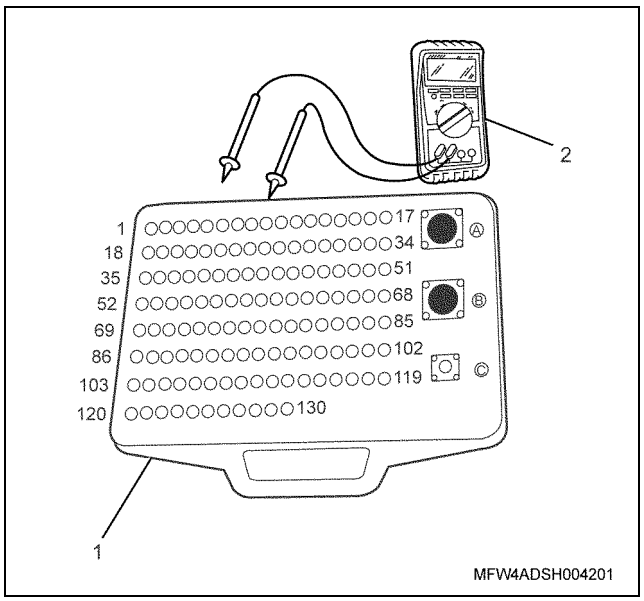
Name
1. GND
2. Signal
3. Power supply

Characteristics of common rail pressure sensor



Breaker box inspection procedure

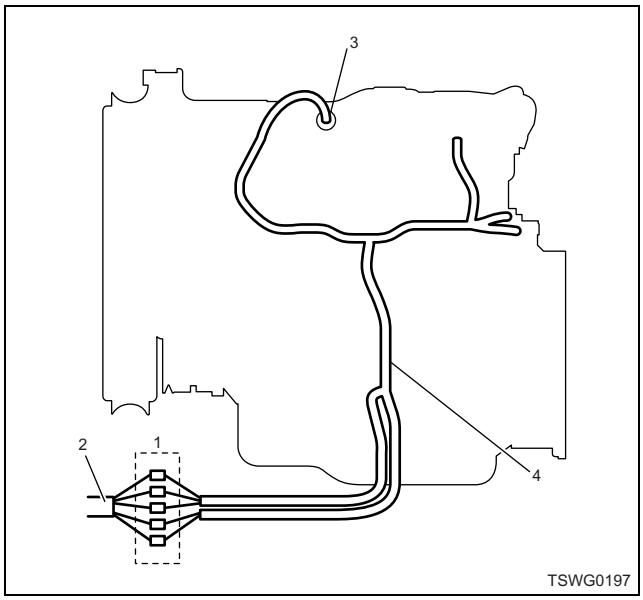
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	82 - Ground 90 - Ground	0V	18V or more
7	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	82 - Sensor connector signal terminal 90 - Sensor connector signal terminal	100 Ω or less	10 MΩ or more
8	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	101 - Sensor connector ground terminal	100 Ω or less	10 MΩ or more

On-board check procedure for sensors

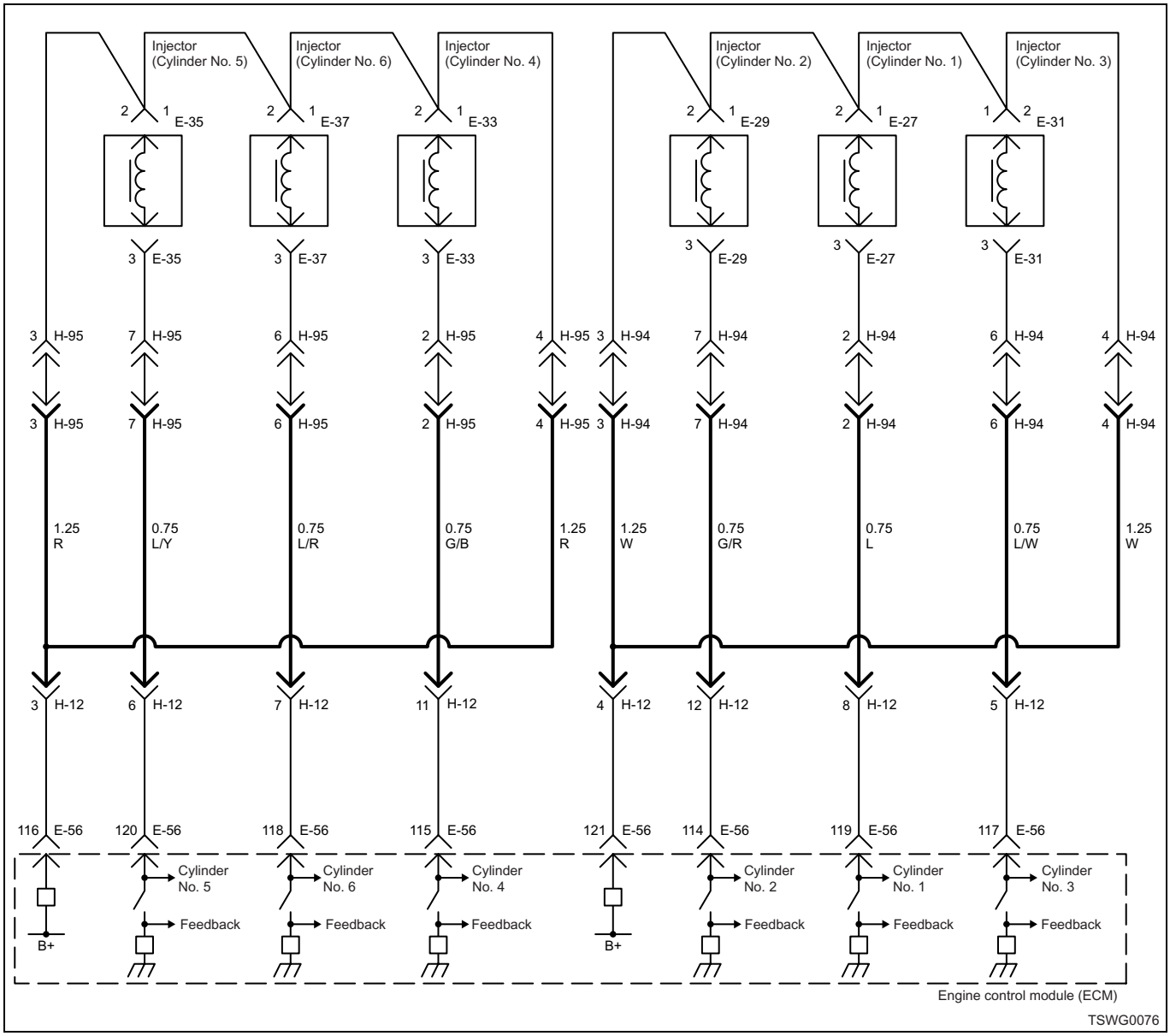


Name

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.

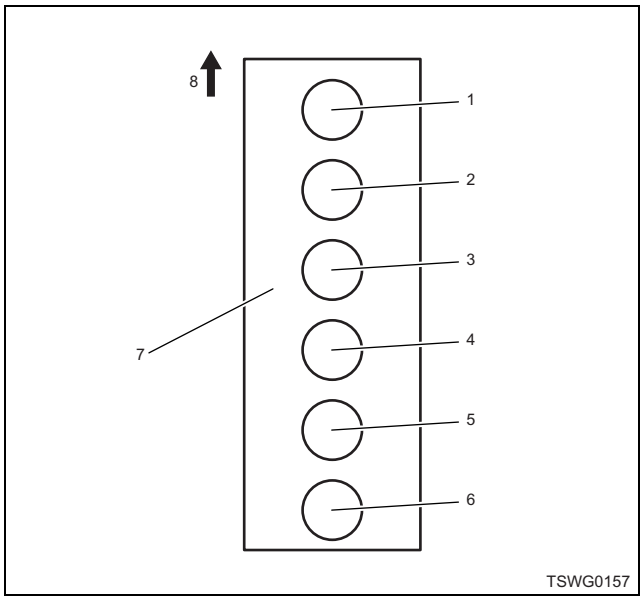
DTC: P0201 (Flash code 271) Open circuit in injection nozzle #1 drive system



Description of circuit

The injector performs fuel injection. The injector is installed in the engine head. The engine control module (ECM) controls the fuel injection amount and timing by controlling the energizing time to the injector. Also, it generates the voltage for injector operation and energizes the pressurized voltage (more than 100 V) to the injector. For injector operation, the voltage applied to the injector will be sent back the to the ECM through injector as a signal, and the ECM controls this signal.

Cylinder No. and injection order



Name
1. Cylinder No. 1
2. Cylinder No. 2
3. Cylinder No. 3
4. Cylinder No. 4
5. Cylinder No. 5
6. Cylinder No. 6
7. Cylinder block
8. Engine front

Fuel injection is performed to each cylinder in the order of 1 — 5 — 3 — 6 — 2 — 4.

Main trouble symptom

- Unstable idling
- Output shortage

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.
- 70 rpm or more
- DTC P0611, P1261, or P0201 is not detected.

DTC set condition

- Open/short circuit is detected in No. 1 cylinder injector drive circuit.
- No. 1 cylinder injector monitor input signal does not exist for 2.4 seconds or more.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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.

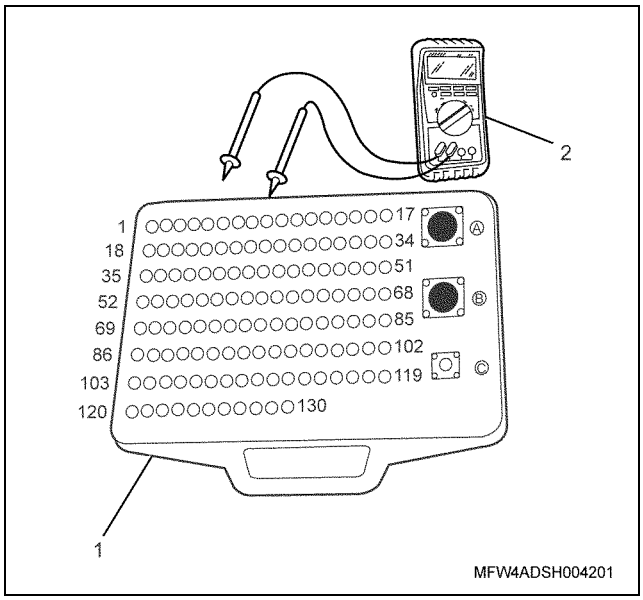
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Perform “OBD system check”, and Go to Step 2.
2	Check the DTC. 1. Turn the key switch to “OFF” for more than 10 seconds. 2. Start the engine. 3. Check the DTC. Is DTC detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	1. Turn the key switch to “OFF”. 2. Remove the coupling connector (H-94) from the cylinder head cover case. 3. Measure the resistance between the coupling connector terminals (power supply terminal — No. 1 cylinder injector drive signal terminal). Is the resistance less than the specified value?	0.45±0.1Ω (20°C {68°F})	Go to Step 4.	Go to Step 5.
4	1. Check for followings in the circuit between ECM and coupling connector (H-94) 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 13.	Go to Step 8.
5	Check for installation condition of the injector terminal nut. 1. Remove the cylinder head cover. 2. Check the injector terminal nut for looseness etc. 3. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 6.
6	Check for installation condition of the 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 13.	Go to Step 7.

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
13	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 P0201 detected?	—	Go to Step 2.	Go to Step 14.
14	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

Breaker box inspection procedure

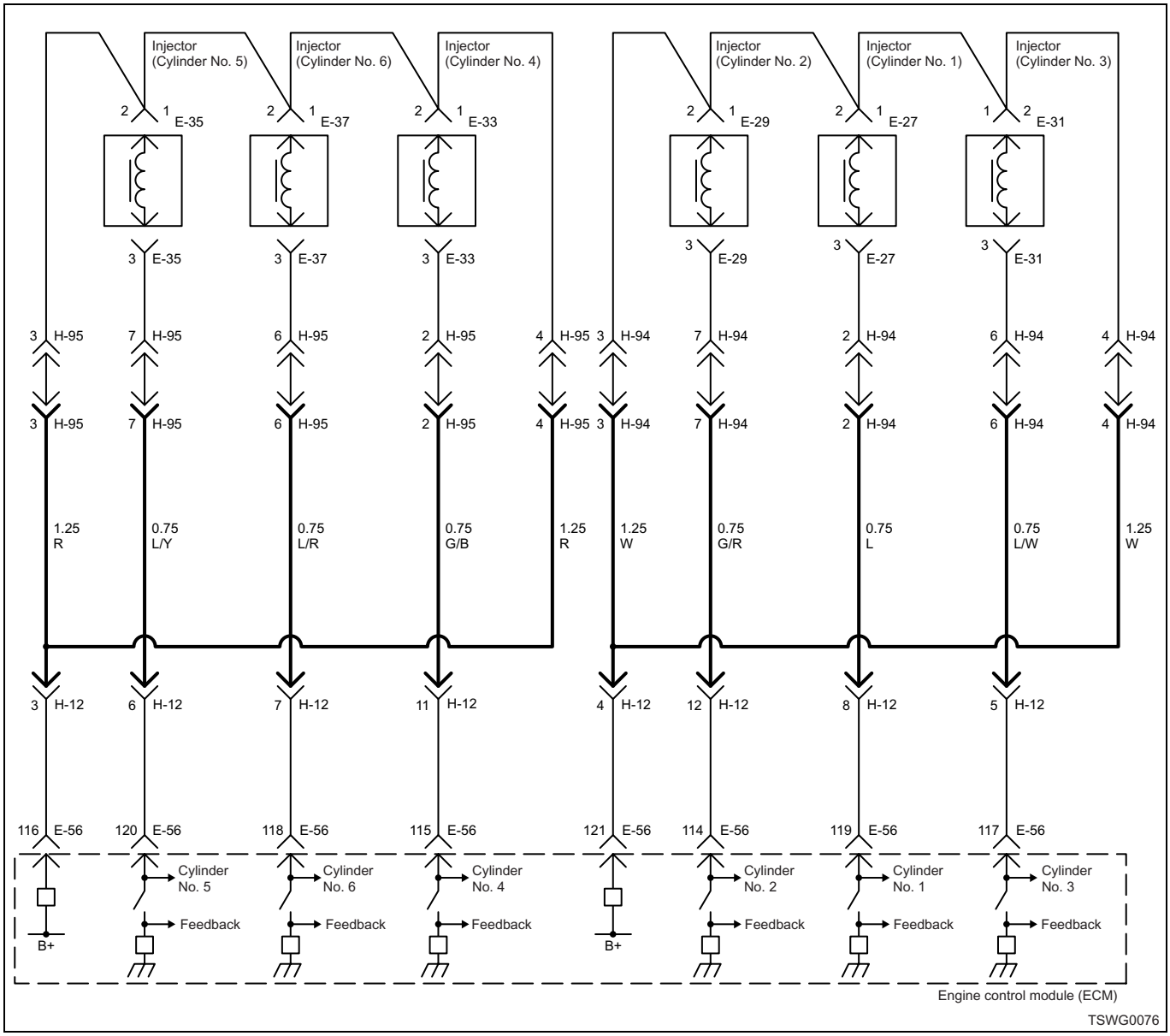
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
4	Open circuit/ high resistance	Resistance measurement	• Remove the coupling connector. • Key switch “OFF”	119 - Coupling connector (H-94) No. 2 terminal	100 Ω or less	10 MΩ or more

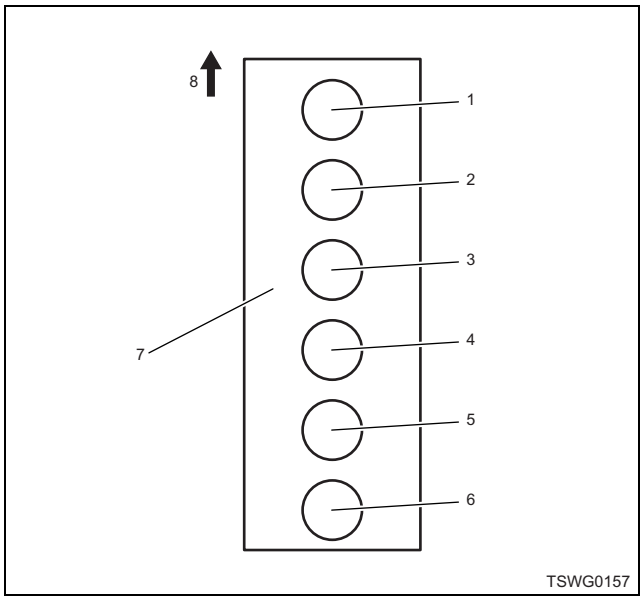
DTC: P0202 (Flash code 272) Open circuit in injection nozzle #2 drive system



Description of circuit

The injector performs fuel injection. The injector is installed in the engine head. The engine control module (ECM) controls the fuel injection amount and timing by controlling the energizing time to the injector. Also, it generates the voltage for injector operation and energizes the pressurized voltage (more than 100 V) to the injector. For injector operation, the voltage applied to the injector will be sent back the to the ECM through injector as a signal, and the ECM controls this signal.

Cylinder No. and injection order



Name
1. Cylinder No. 1
2. Cylinder No. 2
3. Cylinder No. 3
4. Cylinder No. 4
5. Cylinder No. 5
6. Cylinder No. 6
7. Cylinder block
8. Engine front

Fuel injection is performed to each cylinder in the order of 1 — 5 — 3 — 6 — 2 — 4.

Main trouble symptom

- Unstable idling
- Output shortage

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.
- 70 rpm or more
- DTC P0611, P1261, or P0202 is not detected.

DTC set condition

- Open/short circuit is detected in No. 2 cylinder injector drive circuit.
- No. 2 cylinder injector monitor input signal does not exist for 2.4 seconds or more.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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.

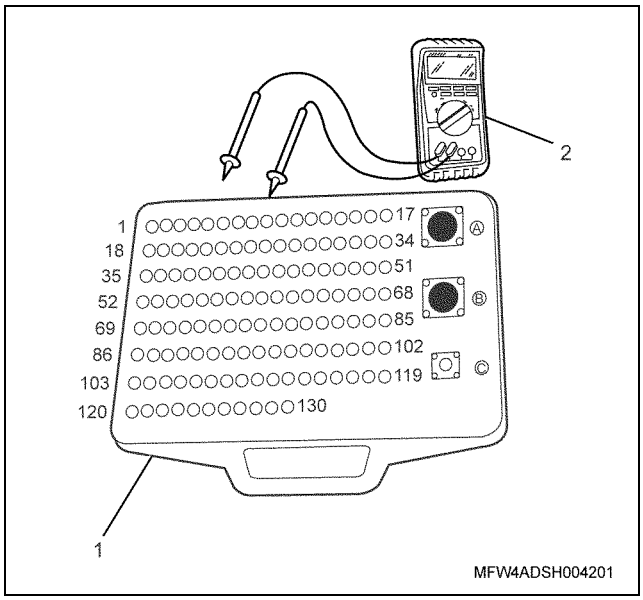
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Perform “OBD system check”, and Go to Step 2.
2	Check the DTC. 1. Turn the key switch to “OFF” for more than 10 seconds. 2. Start the engine. 3. Check the DTC. Is DTC detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	1. Turn the key switch to “OFF”. 2. Remove the coupling connector (H-94) from the cylinder head cover case. 3. Measure the resistance between the coupling connector terminals (power supply terminal — No. 2 cylinder injector drive signal terminal). Is the resistance less than the specified value?	0.45±0.1Ω (20°C {68°F})	Go to Step 4.	Go to Step 5.
4	1. Check for followings in the circuit between ECM and coupling connector (H-94) 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 13.	Go to Step 8.
5	Check for installation condition of the injector terminal nut. 1. Remove the cylinder head cover. 2. Check the injector terminal nut for looseness etc. 3. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 6.
6	Check for installation condition of the 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 13.	Go to Step 7.

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. 2 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
13	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 P0202 detected?	—	Go to Step 2.	Go to Step 14.
14	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

Breaker box inspection procedure

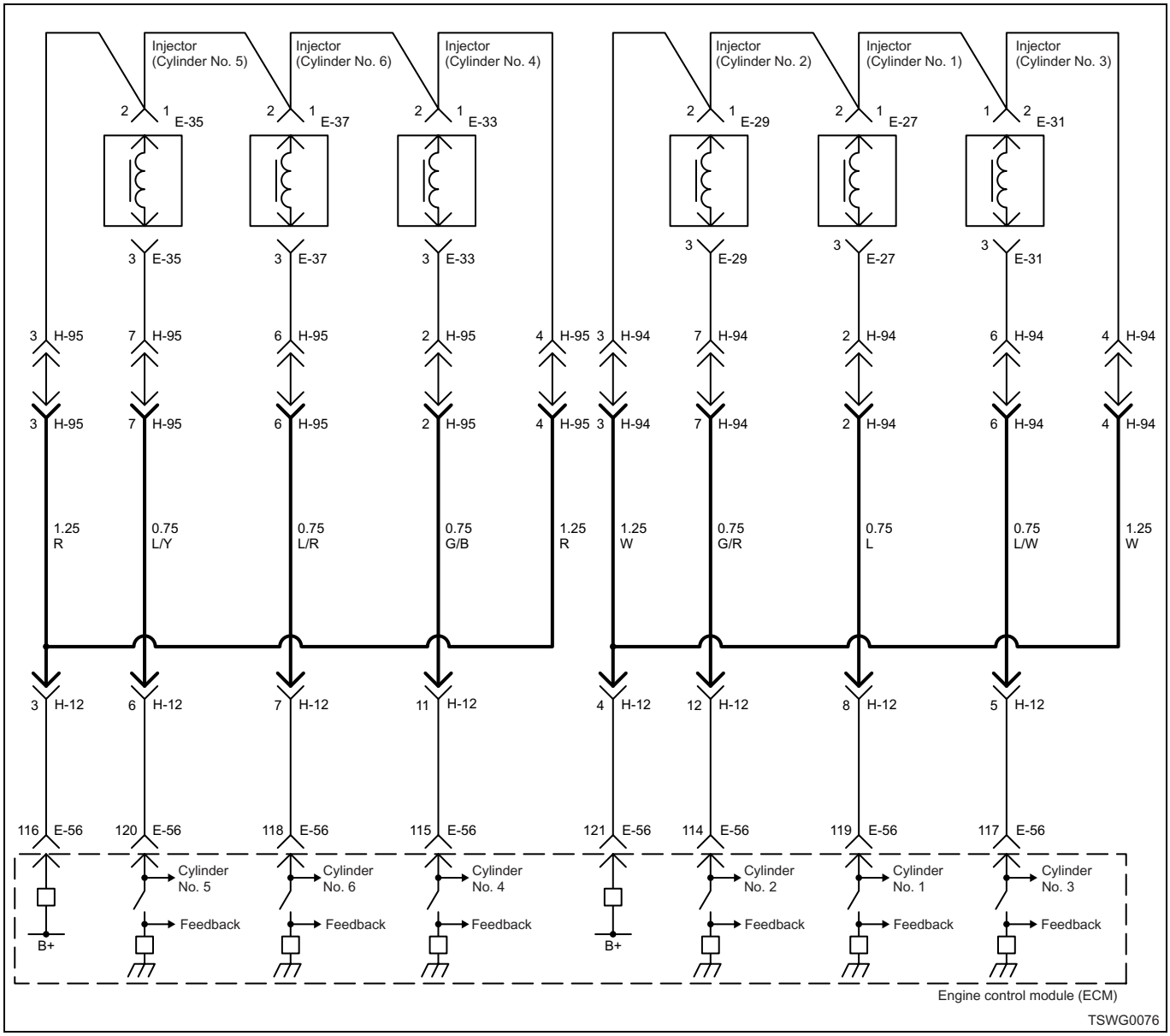
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
4	Open circuit/ high resistance	Resistance measurement	• Remove the coupling connector. • Key switch “OFF”	114 - Coupling connector (H-94) No. 7 terminal	100 Ω or less	10 MΩ or more

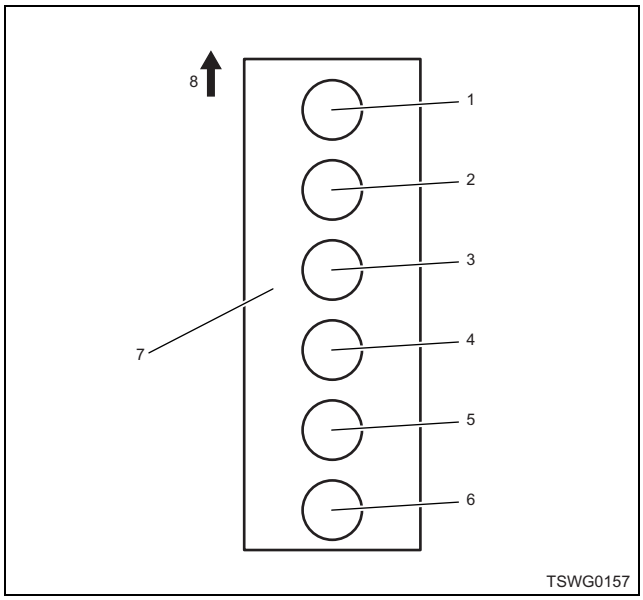
DTC: P0203 (Flash code 273) Open circuit in injection nozzle #3 drive system



Description of circuit

The injector performs fuel injection. The injector is installed in the engine head. The engine control module (ECM) controls the fuel injection amount and timing by controlling the energizing time to the injector. Also, it generates the voltage for injector operation and energizes the pressurized voltage (more than 100 V) to the injector. For injector operation, the voltage applied to the injector will be sent back the to the ECM through injector as a signal, and the ECM controls this signal.

Cylinder No. and injection order



Name
1. Cylinder No. 1
2. Cylinder No. 2
3. Cylinder No. 3
4. Cylinder No. 4
5. Cylinder No. 5
6. Cylinder No. 6
7. Cylinder block
8. Engine front

Fuel injection is performed to each cylinder in the order of 1 — 5 — 3 — 6 — 2 — 4.

Main trouble symptom

- Unstable idling
- Output shortage

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.
- 70 rpm or more
- DTC P0611, P1261, or P0203 is not detected.

DTC set condition

- Open/short circuit is detected in No. 3 cylinder injector drive circuit.
- No. 3 cylinder injector monitor input signal does not exist for 2.4 seconds or more.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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.

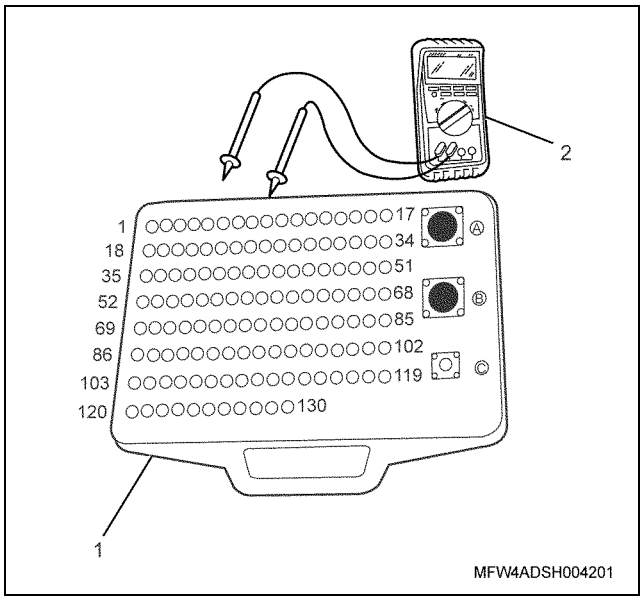
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Perform “OBD system check”, and Go to Step 2.
2	Check the DTC. 1. Turn the key switch to “OFF” for more than 10 seconds. 2. Start the engine. 3. Check the DTC. Is DTC detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	1. Turn the key switch to “OFF”. 2. Remove the coupling connector (H-94) from the cylinder head cover case. 3. Measure the resistance between the coupling connector terminals (power supply terminal — No. 3 cylinder injector drive signal terminal). Is the resistance less than the specified value?	0.45±0.1Ω (20°C {68°F})	Go to Step 4.	Go to Step 5.
4	1. Check for followings in the circuit between ECM and coupling connector (H-94) 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 13.	Go to Step 8.
5	Check for installation condition of the injector terminal nut. 1. Remove the cylinder head cover. 2. Check the injector terminal nut for looseness etc. 3. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 6.
6	Check for installation condition of the 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 13.	Go to Step 7.

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
13	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 P0203 detected?	—	Go to Step 2.	Go to Step 14.
14	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

Breaker box inspection procedure

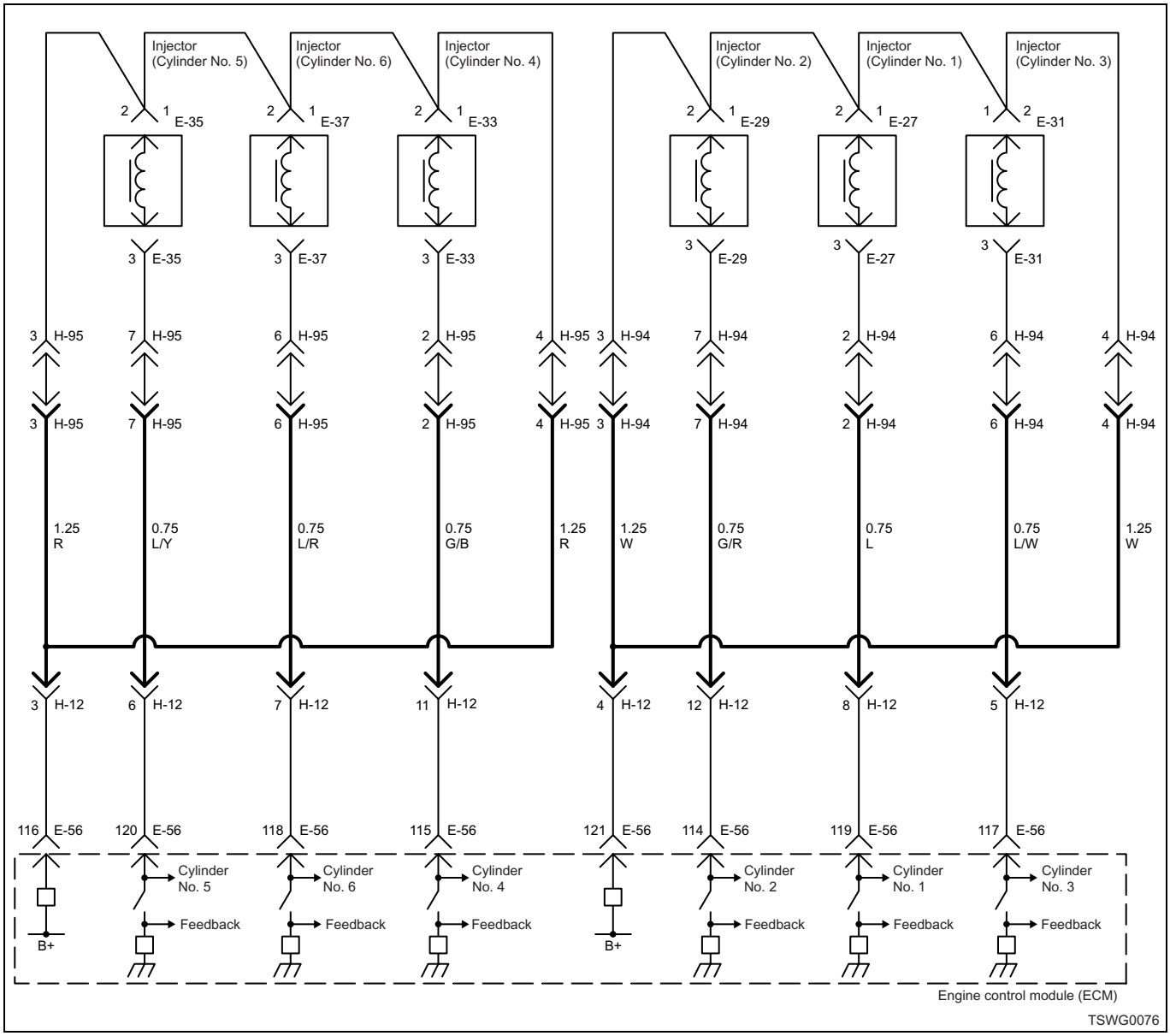
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
4	Open circuit/ high resistance	Resistance measurement	• Remove the coupling connector. • Key switch “OFF”	117 - Coupling connector (H-94) No. 6 terminal	100 Ω or less	10 MΩ or more

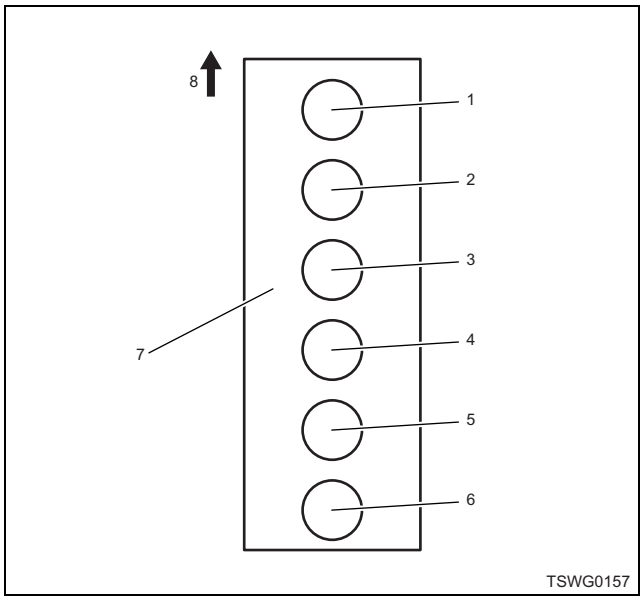
DTC: P0204 (Flash code 274) Open circuit in injection nozzle #4 drive system



Description of circuit

The injector performs fuel injection. The injector is installed in the engine head. The engine control module (ECM) controls the fuel injection amount and timing by controlling the energizing time to the injector. Also, it generates the voltage for injector operation and energizes the pressurized voltage (more than 100 V) to the injector. For injector operation, the voltage applied to the injector will be sent back the to the ECM through injector as a signal, and the ECM controls this signal.

Cylinder No. and injection order



Name
1. Cylinder No. 1
2. Cylinder No. 2
3. Cylinder No. 3
4. Cylinder No. 4
5. Cylinder No. 5
6. Cylinder No. 6
7. Cylinder block
8. Engine front

Fuel injection is performed to each cylinder in the order of 1 — 5 — 3 — 6 — 2 — 4.

Main trouble symptom

- Unstable idling
- Output shortage

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.
- 70 rpm or more
- DTC P0612, P1262, or P0204 is not detected.

DTC set condition

- Open/short circuit is detected in No. 4 cylinder injector drive circuit.
- No. 4 cylinder injector monitor input signal does not exist for 2.4 seconds or more.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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.

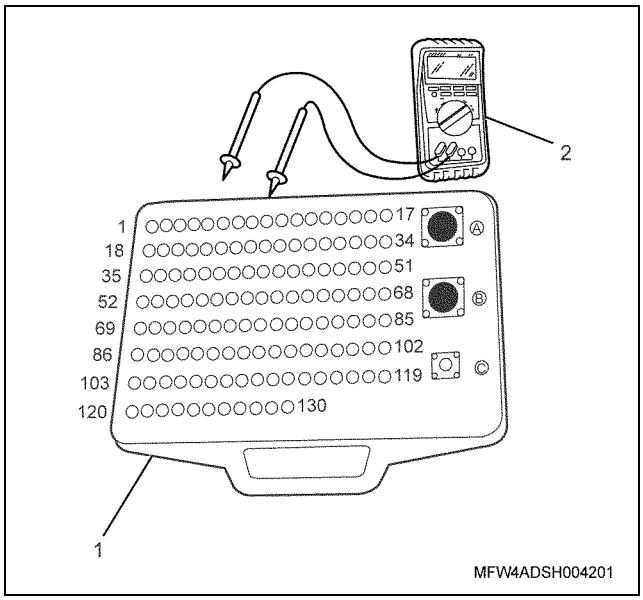
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Perform “OBD system check”, and Go to Step 2.
2	Check the DTC. 1. Turn the key switch to “OFF” for more than 10 seconds. 2. Start the engine. 3. Check the DTC. Is DTC detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	1. Turn the key switch to “OFF”. 2. Remove the coupling connector (H-95) from the cylinder head cover case. 3. Measure the resistance between the coupling connector terminals (power supply terminal — No. 4 cylinder injector drive signal terminal). Is the resistance less than the specified value?	0.45±0.1Ω (20°C {68°F})	Go to Step 4.	Go to Step 5.
4	1. Check for followings in the circuit between ECM and coupling connector (H-95) 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 13.	Go to Step 8.
5	Check for installation condition of the injector terminal nut. 1. Remove the cylinder head cover. 2. Check the injector terminal nut for looseness etc. 3. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 6.
6	Check for installation condition of the 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 13.	Go to Step 7.

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. 4 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
13	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 P0204 detected?	—	Go to Step 2.	Go to Step 14.
14	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

Breaker box inspection procedure

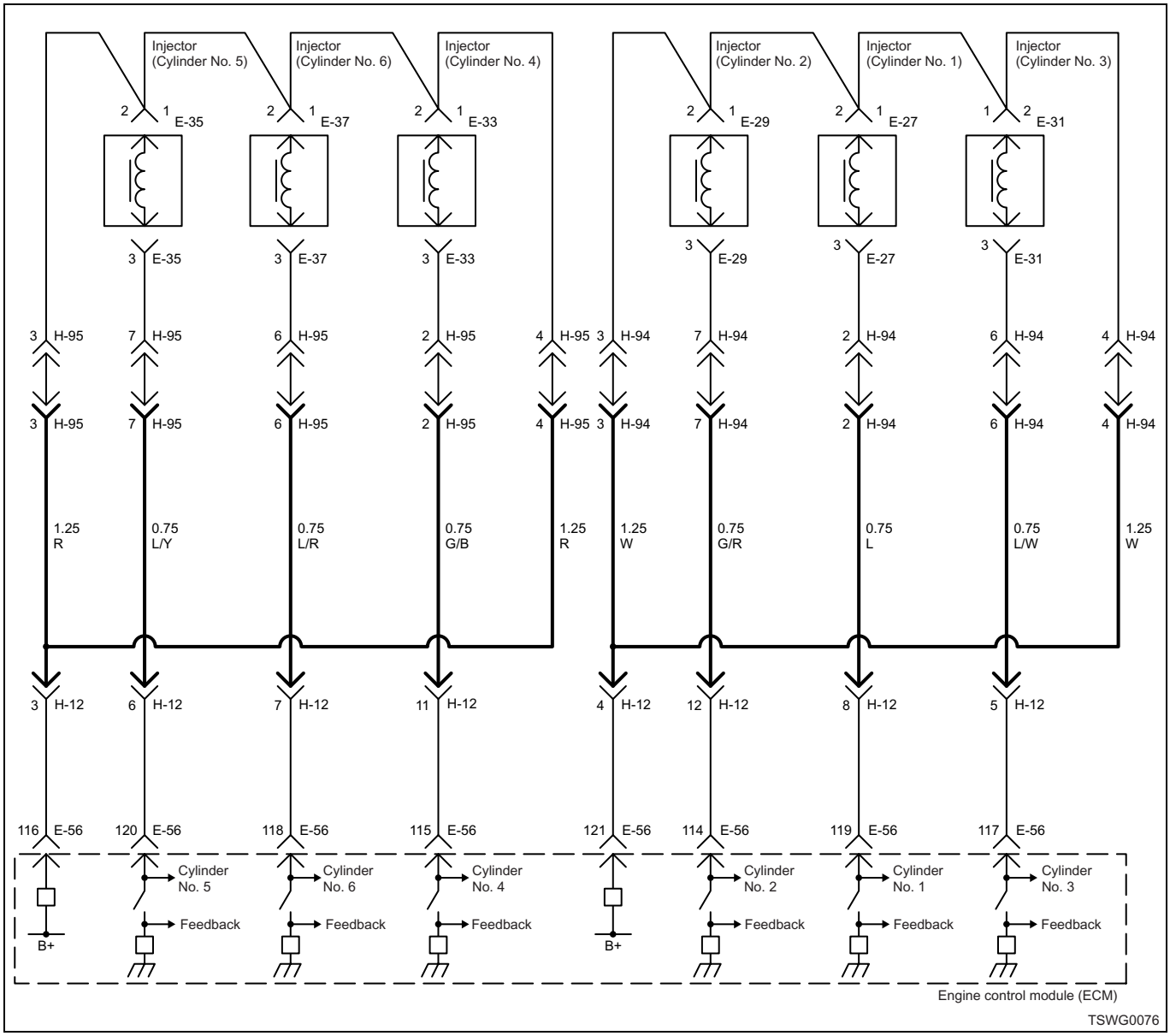
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
4	Open circuit/ high resistance	Resistance measurement	• Remove the coupling connector. • Key switch “OFF”	115 - Coupling connector (H-95) No. 2 terminal	100 Ω or less	10 MΩ or more

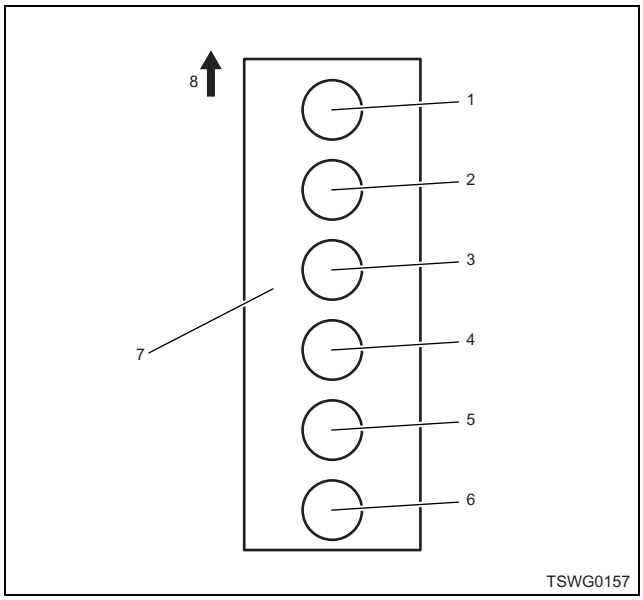
DTC: P0205 (Flash code 275) Open circuit in injection nozzle #5 drive system



Description of circuit

The injector performs fuel injection. The injector is installed in the engine head. The engine control module (ECM) controls the fuel injection amount and timing by controlling the energizing time to the injector. Also, it generates the voltage for injector operation and energizes the pressurized voltage (more than 100 V) to the injector. For injector operation, the voltage applied to the injector will be sent back the to the ECM through injector as a signal, and the ECM controls this signal.

Cylinder No. and injection order



Name
1. Cylinder No. 1
2. Cylinder No. 2
3. Cylinder No. 3
4. Cylinder No. 4
5. Cylinder No. 5
6. Cylinder No. 6
7. Cylinder block
8. Engine front

Fuel injection is performed to each cylinder in the order of 1 — 5 — 3 — 6 — 2 — 4.

Main trouble symptom

- Unstable idling
- Output shortage

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.
- 70 rpm or more
- DTC P0612, P1262, or P0205 is not detected.

DTC set condition

- Open/short circuit is detected in No. 5 cylinder injector drive circuit.
- No. 5 cylinder injector monitor input signal does not exist for 2.4 seconds or more.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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.

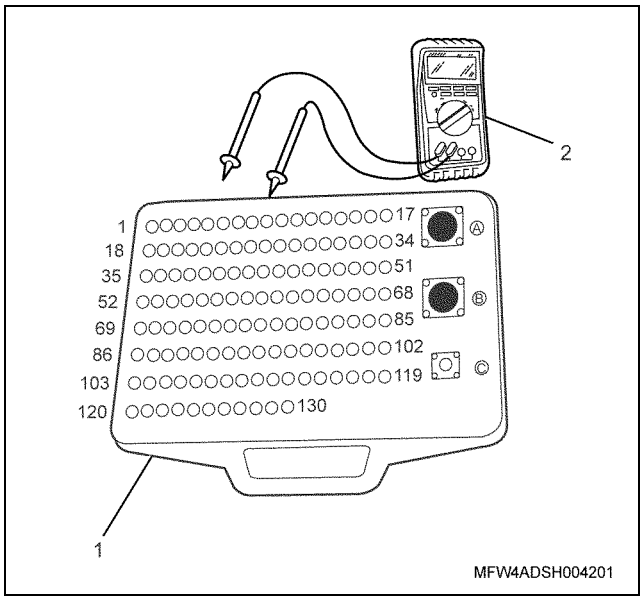
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Perform “OBD system check”, and Go to Step 2.
2	Check the DTC. 1. Turn the key switch to “OFF” for more than 10 seconds. 2. Start the engine. 3. Check the DTC. Is DTC detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	1. Turn the key switch to “OFF”. 2. Remove the coupling connector (H-95) from the cylinder head cover case. 3. Measure the resistance between the coupling connector terminals (power supply terminal — No. 5 cylinder injector drive signal terminal). Is the resistance less than the specified value?	0.45±0.1Ω (20°C {68°F})	Go to Step 4.	Go to Step 5.
4	1. Check for followings in the circuit between ECM and coupling connector (H-95) 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 13.	Go to Step 8.
5	Check for installation condition of the injector terminal nut. 1. Remove the cylinder head cover. 2. Check the injector terminal nut for looseness etc. 3. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 6.
6	Check for installation condition of the 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 13.	Go to Step 7.

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.	—

Step	Action	Value	YES	NO
13	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 P0205 detected?	—	Go to Step 2.	Go to Step 14.
14	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

Breaker box inspection procedure

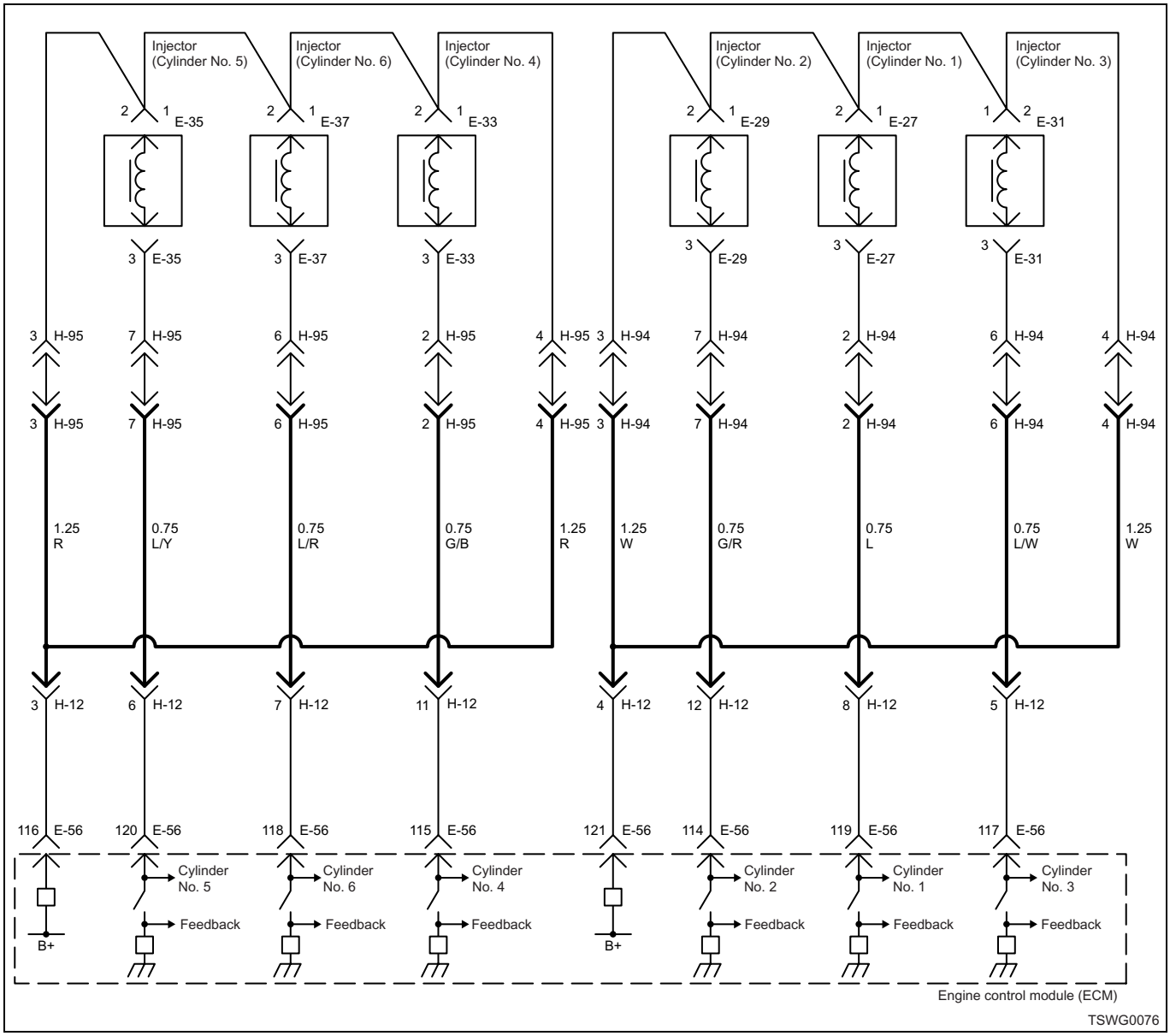
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
4	Open circuit/ high resistance	Resistance measurement	• Remove the coupling connector. • Key switch “OFF”	120 - Coupling connector (H-95) No. 7 terminal	100 Ω or less	10 MΩ or more

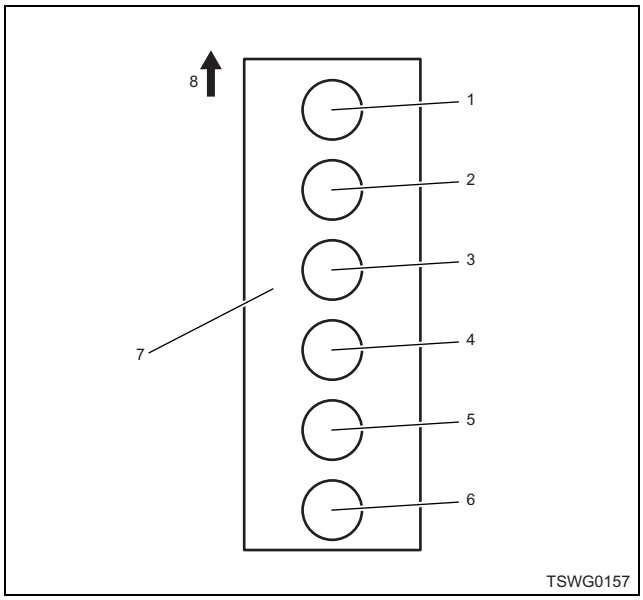
DTC: P0206 (Flash code 276) Open circuit in injection nozzle #6 drive system



Description of circuit

The injector performs fuel injection. The injector is installed in the engine head. The engine control module (ECM) controls the fuel injection amount and timing by controlling the energizing time to the injector. Also, it generates the voltage for injector operation and energizes the pressurized voltage (more than 100 V) to the injector. For injector operation, the voltage applied to the injector will be sent back the to the ECM through injector as a signal, and the ECM controls this signal.

Cylinder No. and injection order



Name
1. Cylinder No. 1
2. Cylinder No. 2
3. Cylinder No. 3
4. Cylinder No. 4
5. Cylinder No. 5
6. Cylinder No. 6
7. Cylinder block
8. Engine front

Fuel injection is performed to each cylinder in the order of 1 — 5 — 3 — 6 — 2 — 4.

Main trouble symptom

- Unstable idling
- Output shortage

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.
- 70 rpm or more
- DTC P0612, P1262, or P0206 is not detected.

DTC set condition

- Open/short circuit is detected in No. 6 cylinder injector drive circuit.
- No. 6 cylinder injector monitor input signal does not exist for 2.4 seconds or more.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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.

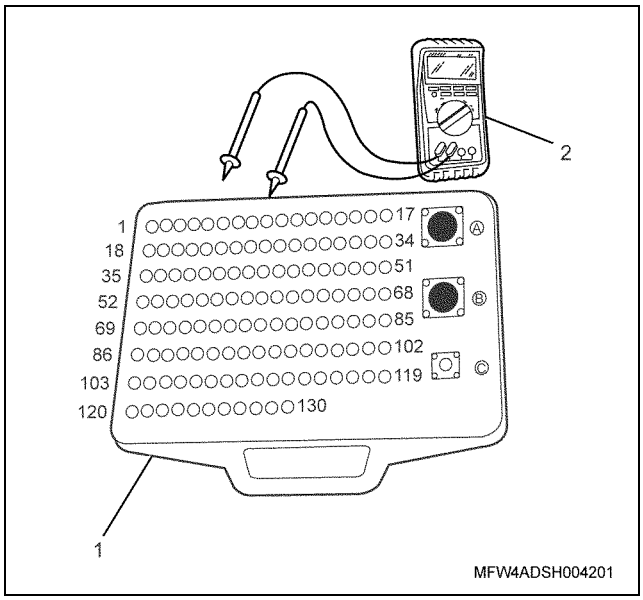
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Perform “OBD system check”, and Go to Step 2.
2	Check the DTC. 1. Turn the key switch to “OFF” for more than 10 seconds. 2. Start the engine. 3. Check the DTC. Is DTC detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	1. Turn the key switch to “OFF”. 2. Remove the coupling connector (H-95) from the cylinder head cover case. 3. Measure the resistance between the coupling connector terminals (power supply terminal — No. 6 cylinder injector drive signal terminal). Is the resistance less than the specified value?	0.45±0.1Ω (20°C {68°F})	Go to Step 4.	Go to Step 5.
4	1. Check for followings in the circuit between ECM and coupling connector (H-95) 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 13.	Go to Step 8.
5	Check for installation condition of the injector terminal nut. 1. Remove the cylinder head cover. 2. Check the injector terminal nut for looseness etc. 3. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 6.
6	Check for installation condition of the 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 13.	Go to Step 7.

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. 6 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
13	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 P0206 detected?	—	Go to Step 2.	Go to Step 14.
14	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

Breaker box inspection procedure

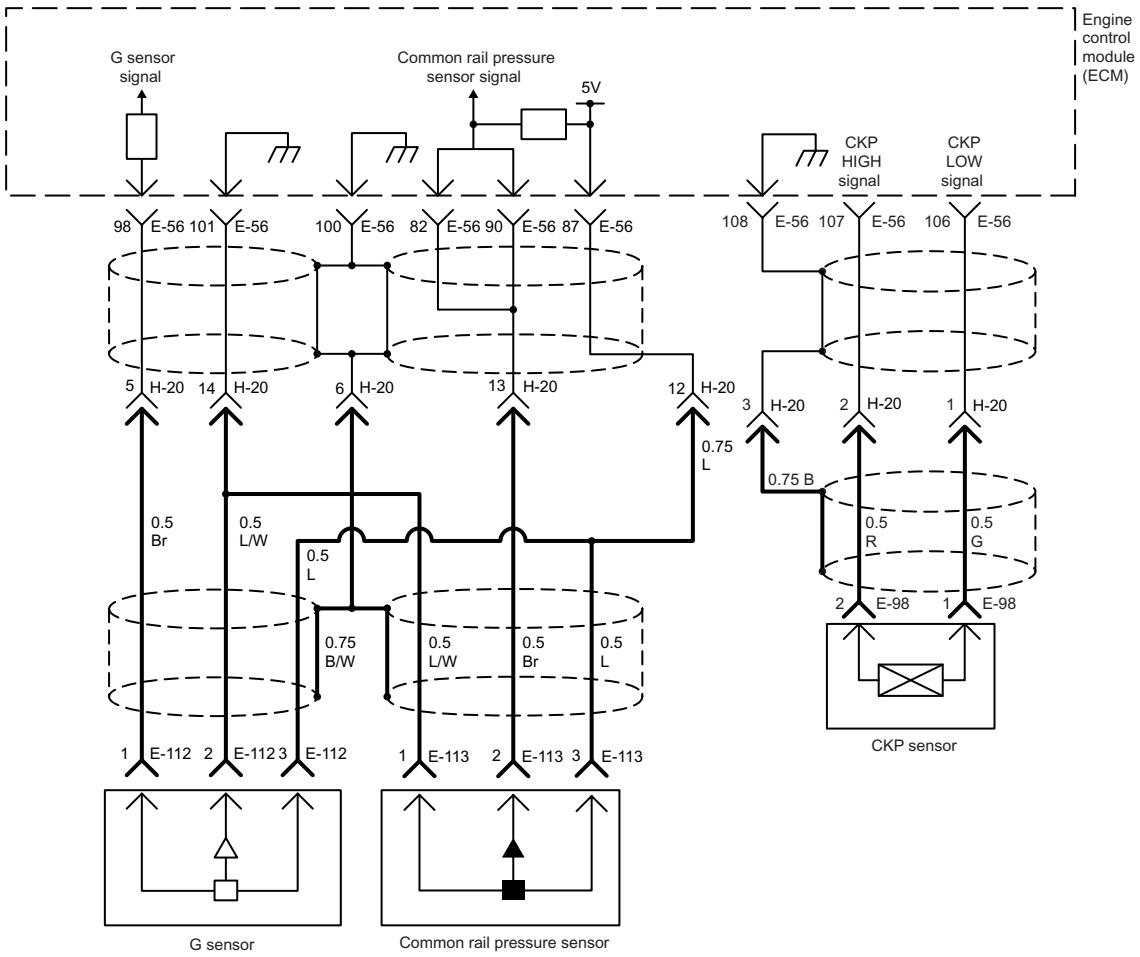
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
4	Open circuit/ high resistance	Resistance measurement	• Remove the coupling connector. • Key switch “OFF”	118 - Coupling connector (H-95) No. 6 terminal	100 Ω or less	10 MΩ or more

DTC: P0219 (Flash code 543) Overrun



Description of circuit

The engine control module (ECM) detects the engine speed based on the crankshaft position (CKP) sensor signal. The ECM stops the fuel injection to lower the engine speed when the engine speed exceeds the specified value.

Main trouble symptom

Output lowering

Preconditions when DTC is set

- Key switch input voltage is 16V or more.

DTC set condition

- The engine speed exceeds setting value

Action taken when DTC is set

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

Back-up mode

- Limited injection amount 1
  Limitation is lifted if the speed decreases

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

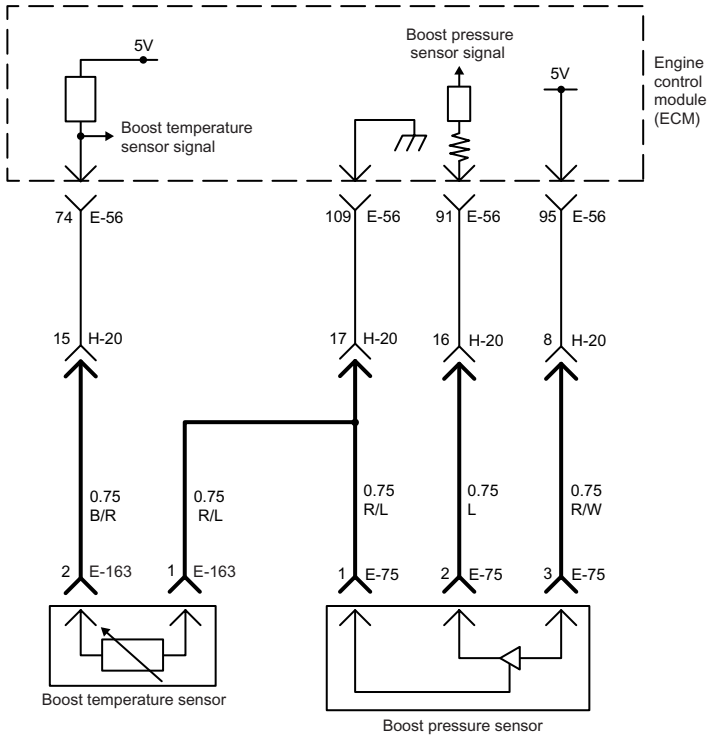
- The present trouble turns to history trouble when the condition is out of the range from DTC set condition (recovery from failure).
- The diagnosis lamp will go off after the code turns to history trouble and the key switch is turned “OFF” then “ON” again.
- Using the scan tool, or memory clear switch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

Diagnostic aid

- Load (fluid pressure pump etc.) is light.
- Crankshaft position (CKP) sensor, G sensor fault (signal fault etc.)
- Engine body fault (supply pump, injector, body, etc.)
- ECM internal trouble
- Check the connector for poor contact, the harness for fault such as wear or bend, and the wire inside the harness for loosened wire causing short circuit to other circuits. Also, perform the function diagnosis to check the operation and control of each part. Repair if faulty.
- When this DTC is detected, check the engine body for trouble such as seizure and breakage.

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	Confirm the driving status (improper operation of the vehicle due to engine over speed). (Interview the operator for driving status in the past.) Has the vehicle been operated improperly?	—	Go to Step 3.	Go to Step 4.
3	Tell the operator that it is the over speed caused by improper operation, and give a driving instruction. Is the procedure completed?	—	Go to Step 4.	—
4	Check for adverse effect (fault in the engine body) caused by the engine over speed. Repair or replace if fault is found. Is the procedure completed?	—	Go to Step 5.	—
5	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 detected?	—	Go to each DTC diagnosis.	Verify repair.

DTC: P0237 (Flash code 32) Boost sensor pressure fault (low voltage fault, open circuit)



TSWG0079

Description of circuit

The boost pressure sensor is installed to the intake manifold. The boost pressure sensor outputs the voltage corresponding to the internal pressure of the intake manifold, and the ECM detects the boost by this signal. The boost pressure sensor includes following circuits.

- 5-V power supply circuit
- Ground circuit
- Boost pressure sensor signal circuit

The ECM provides 5 V to the boost pressure sensor through 5-V power supply circuit, and grounds to the inside of the ECM through ground circuit. Also, the boost pressure sensor outputs the signal voltage to the ECM through boost pressure sensor signal circuit. The ECM detects a low boost condition (the engine load is low) when the signal voltage from the boost pressure sensor is low, and a high boost condition (the engine load is high) when the signal voltage from the boost pressure sensor is high.

The ECM sets the DTC when the signal voltage from the boost pressure sensor is less than the normal range.

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.

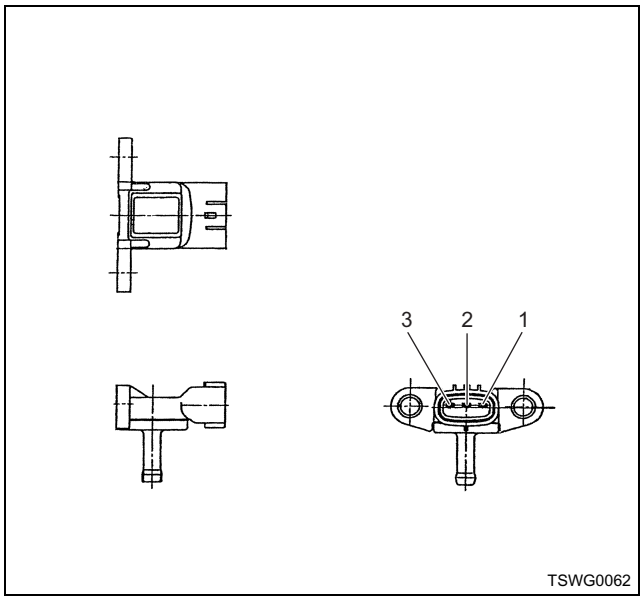
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 14.
3	1. Turn the key switch to “ON”. 2. Check for “MAP (manifold absolute pressure) sensor” on the 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
4	Check for installation condition of the boost pressure 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 boost pressure sensor connector. 3. Short between the boost pressure sensor connector power supply terminal and the signal terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check for “MAP (manifold absolute pressure) sensor” on the data display using scan tool. Is the “MAP (manifold absolute pressure) sensor” more than the specified value?	4.8V	Go to Step 8.	Go to Step 9.
6	1. Check for followings in the power supply 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 7.
7	1. Check for followings in the signal 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”.** • Short circuit to boost pressure sensor ground circuit • Short circuit to ground • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 9.

Step	Action	Value	YES	NO
8	Replace the boost pressure sensor. Is the procedure completed?	—	Go to Step 12.	—
9	Is EMPS available?	—	Go to Step 10.	Go to Step 11.
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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P0237 detected?	—	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.
14	1. Start the engine. 2. Check the display of boost pressure sensor. Does the display of “Boost pressure sensor” show error value?	508 MPa (73679 psi) (Displayed error value)	Go to Step 15.	Go to “Diagnostic aid”.

Step	Action	Value	YES	NO
15	Check for installation condition of the boost pressure 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 13.	Go to Step 16.
16	1. Check for followings in the power supply 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 17.
17	1. Check for followings in the signal 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”.** • Short circuit to boost pressure sensor ground circuit • Short circuit to ground • 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.

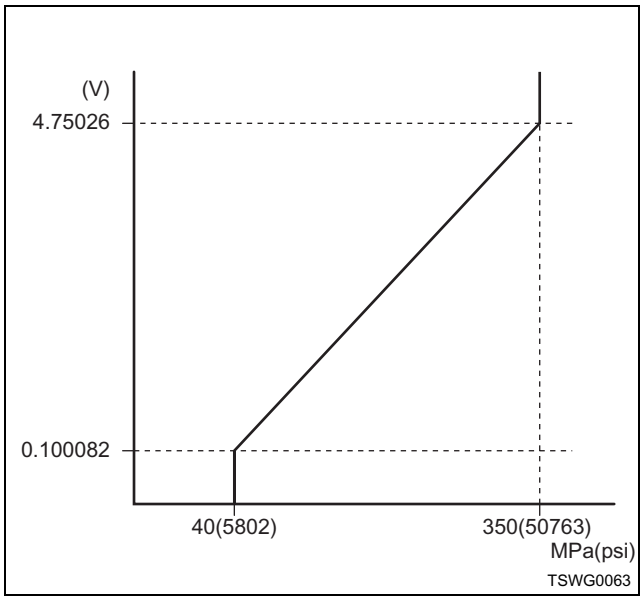
About boost pressure sensor



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

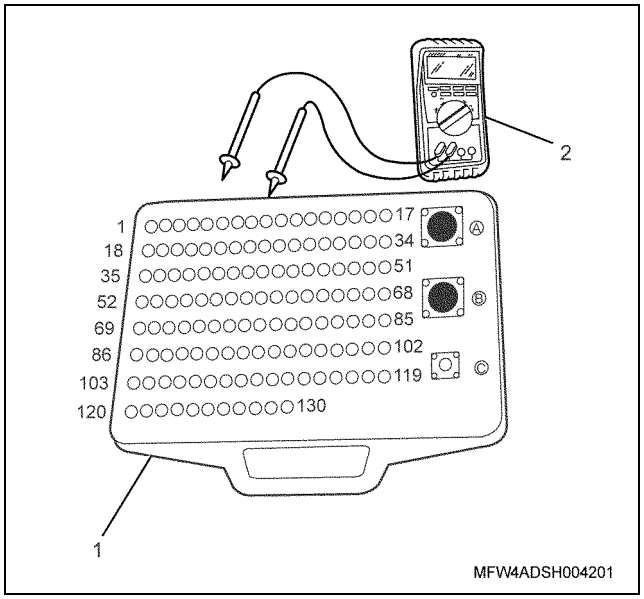
Characteristics of boost pressure sensor

The output voltage of boost pressure sensor changes according to the boost 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 MPa (5802 psi) or 350 MPa (50763 psi) is not changed.
When error occurs, error value (508 MPa {73679 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.



Breaker box inspection procedure

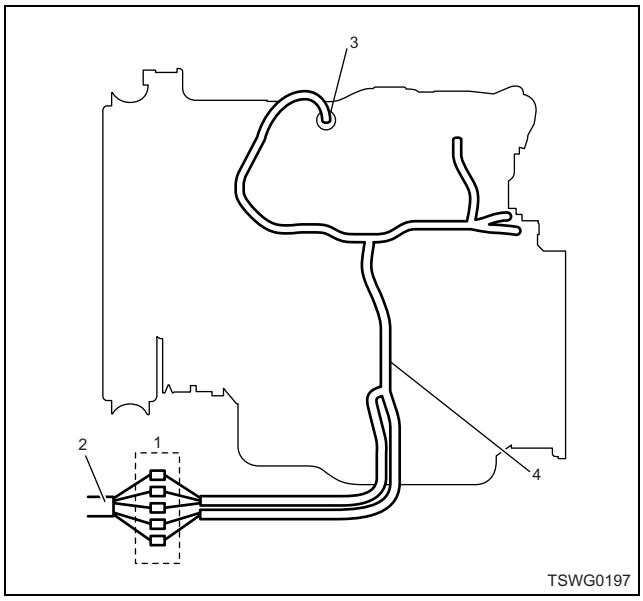
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	95 - Sensor connector power supply terminal	100 Ω or less	10 MΩ or more
7	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	91 - 109 91 - Ground	10 MΩ or more	100 Ω or less
	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	91 - Sensor connector signal terminal	100 Ω or less	10 MΩ or more

On-board check procedure for sensors

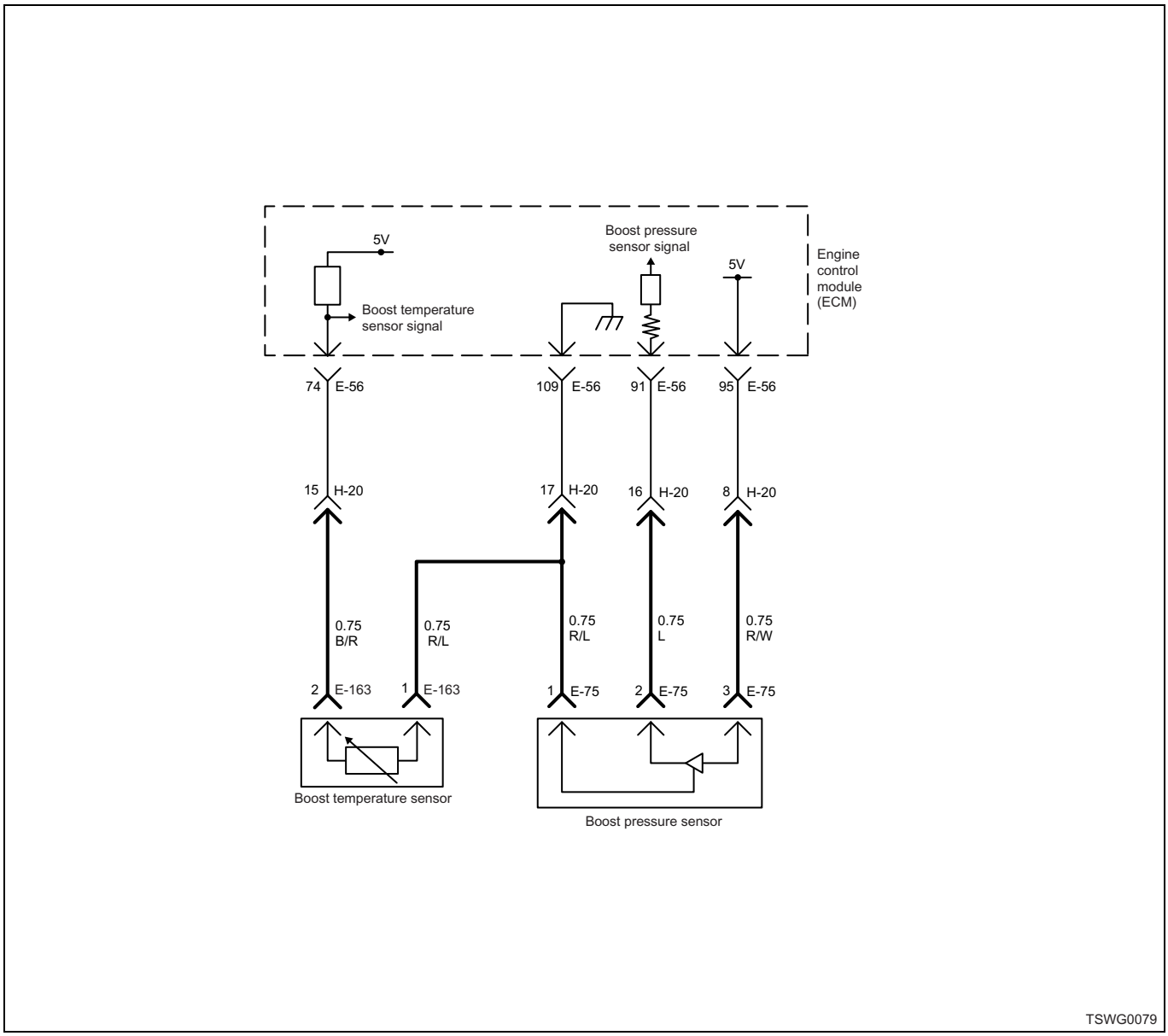


Name

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.

DTC: P0238 (Flash code 32) Boost pressure sensor fault (high voltage fault, short to power supply circuit, ground open circuit)



Description of circuit

The boost pressure sensor is installed to the intake manifold. The boost pressure sensor outputs the voltage corresponding to the internal pressure of the intake manifold, and the ECM detects the boost by this signal. The boost pressure sensor includes following circuits.

- 5-V power supply circuit
- Ground circuit
- Boost pressure sensor signal circuit

The ECM provides 5 V to the boost pressure sensor through 5-V power supply circuit, and grounds to the inside of the ECM through ground circuit. Also, the boost pressure sensor outputs the signal voltage to the ECM through boost pressure sensor signal circuit. The ECM detects a low boost condition (the engine load is low) when the signal voltage from the boost pressure sensor is low, and a high boost condition (the engine load is high) when the signal voltage from the boost pressure sensor is high.
The ECM sets the DTC when the signal voltage from the boost pressure sensor is more than the normal range.

Main trouble symptom

Black smoke emitted

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 4.9 V or more.

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 turns off when the trouble code turns to the history trouble.
- Using the scan tool, or accelerator pedal operation enables to clear history trouble.

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 more than the specified value. If less than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If “MAP (manifold absolute pressure) sensor” displays less than the specified value when the boost pressure sensor connector is removed, the circuit beyond the sensor is normal including ECM.

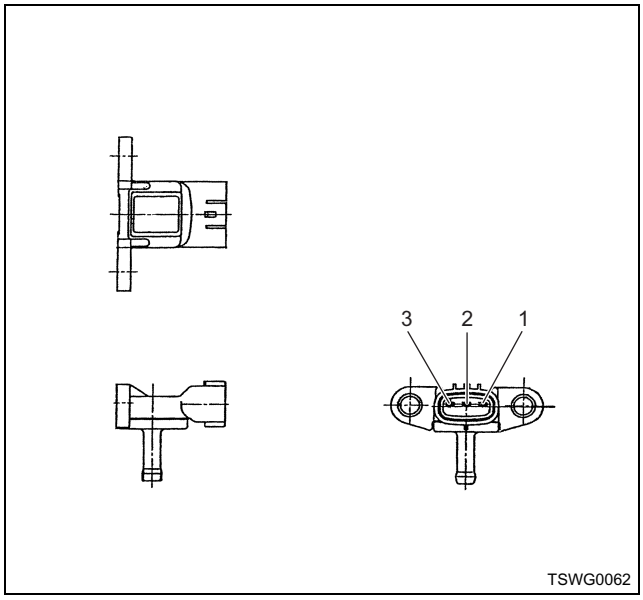
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 14.
3	1. Turn the key switch to “ON”. 2. Check for “MAP (manifold absolute pressure) sensor” on the data display using scan tool. Is the “MAP (manifold absolute pressure) sensor” more than the specified value?	4.9V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the boost pressure 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.

Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the boost pressure sensor connector. 3. Turn the key switch to “ON”. 4. Check for “MAP (manifold absolute pressure) sensor” on the data display using scan tool. Is the “MAP (manifold absolute pressure) sensor” less than the specified value?	0.1V	Go to Step 8.	Go to Step 6.
6	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 7.
7	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 9.
8	Replace the boost pressure sensor. Is the procedure completed?	—	Go to Step 12.	—
9	Is EMPS available?	—	Go to Step 10.	Go to Step 11.

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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P0238 detected?	—	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.
14	1. Start the engine. 2. Check the display of boost pressure sensor. Does the display of “Boost pressure sensor” show error value?	508 MPa (73679 psi) (Displayed error value)	Go to Step 15.	Go to “Diagnostic aid”.
15	Check for installation condition of the boost pressure 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 16.

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.

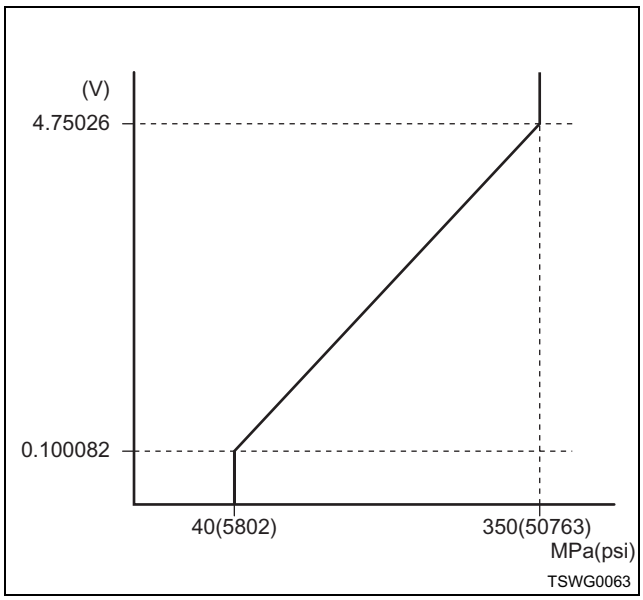
About boost pressure sensor



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

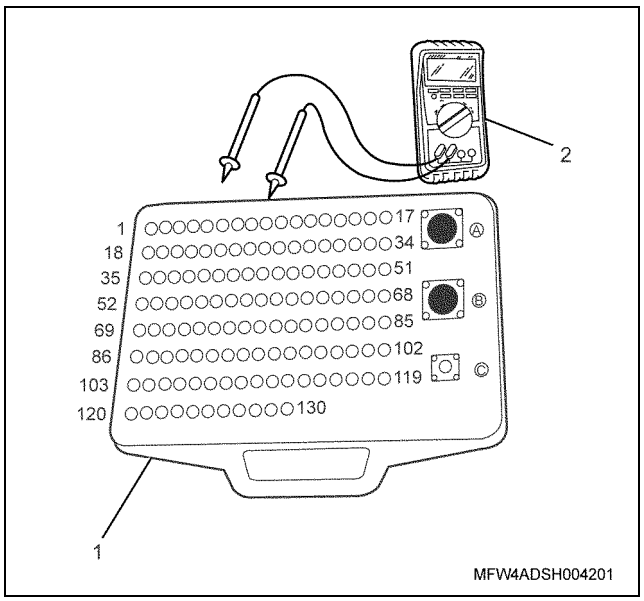
Characteristics of boost pressure sensor

The output voltage of boost pressure sensor changes according to the boost 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 MPa (5802 psi) or 350 MPa (50763 psi) is not changed.
When error occurs, error value (508 MPa {73679 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.



Breaker box inspection procedure

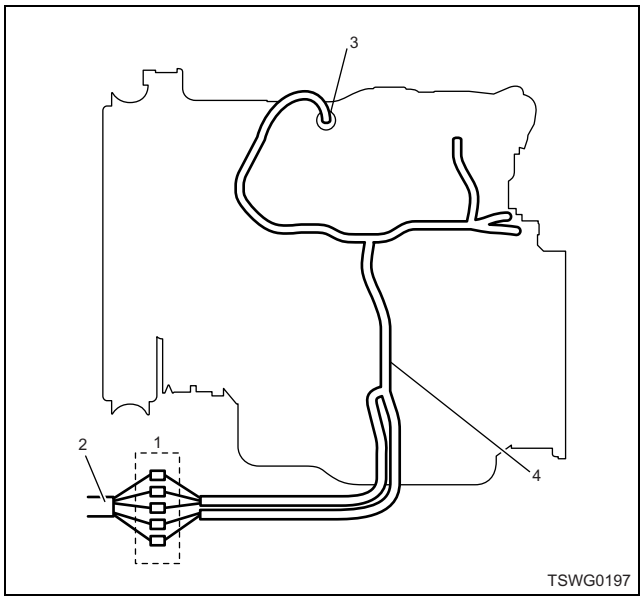
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	91 - Ground	0V	18V or more
7	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	109 - Sensor connector ground terminal	100 Ω or less	10 MΩ or more

On-board check procedure for sensors

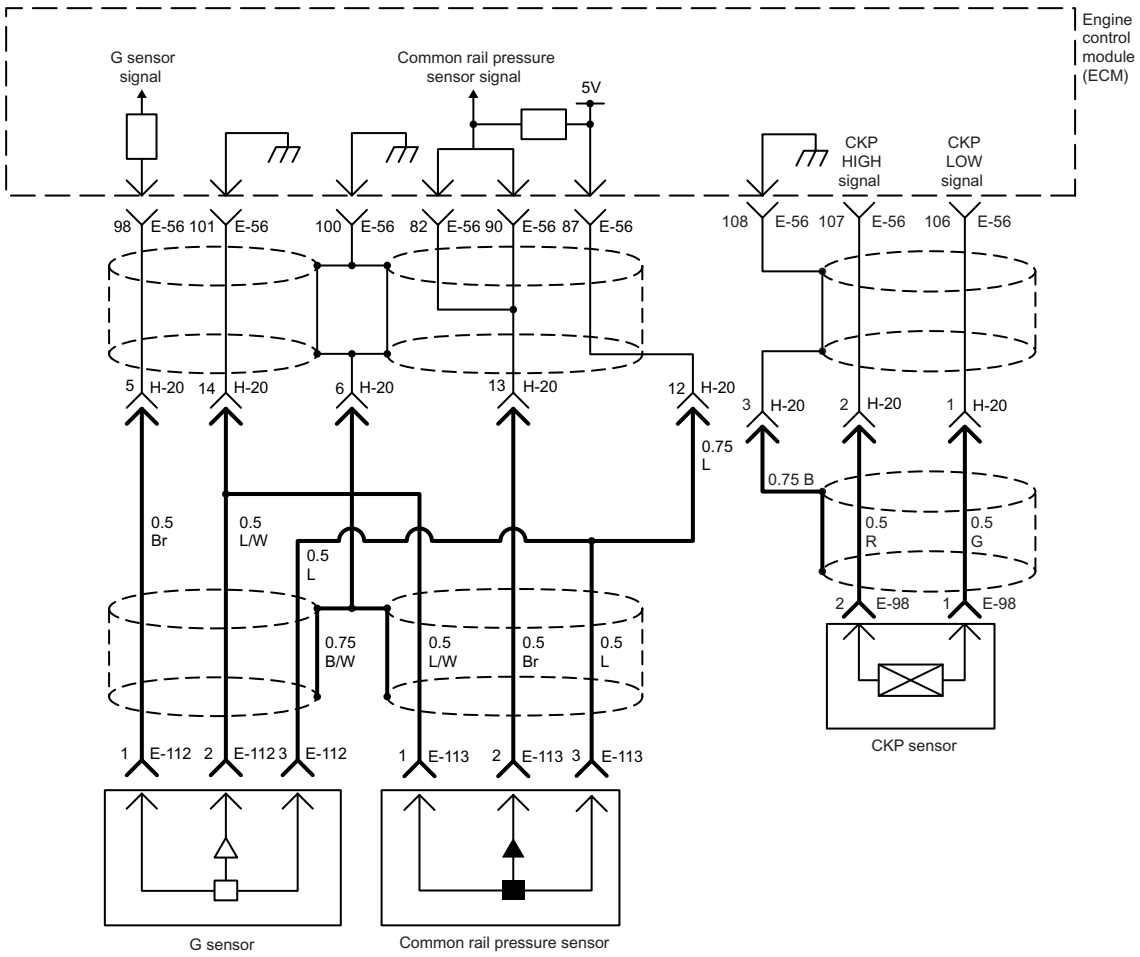


Name

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.

DTC: P0335 (Flash code 15) Crank sensor fault (no signal)



Description of circuit

The crankshaft position (CKP) sensor detects the engine speed. When the sensing hole installed in the flywheel passes the tip of the CKP sensor, a voltage is generated and turned into a pulse signal. The engine control module (ECM) reads this pulse signal, and obtains the engine speed and injection timing based on the signal.

Main trouble symptom

- Output lowering
- White smoke emitted
- Intense engine vibration possible
- Engine stall possible (restart is possible when G sensor is normal.)

Preconditions when DTC is set

- Cam pulse is normal.
- DTC P0335, P0336, P0340, P0341, or P1345 is not detected.
- Engine under operation

DTC set condition

- G sensor signal exists but no crank signal.

Action taken when DTC is set

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

Back-up mode

- Control based on G sensor when it is normal

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.

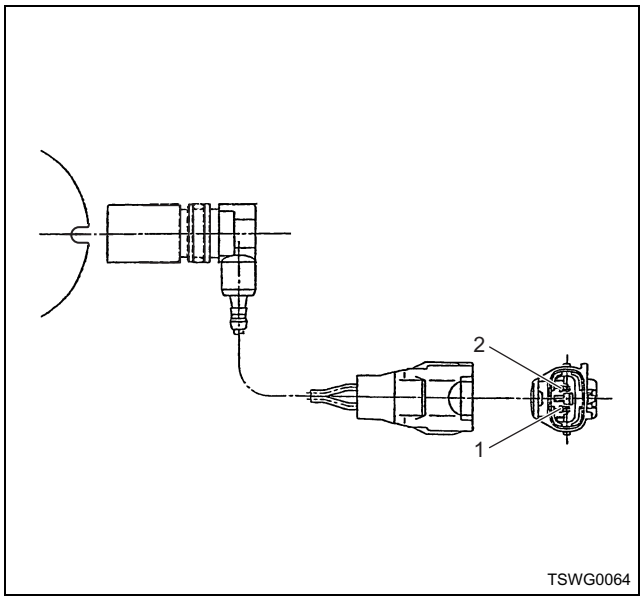
- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items 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	Action	Value	YES	NO
4	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. Start the engine, and test run with the “Preconditions when DTC is set”. 4. Check the DTC. Is DTC detected?	—	Go to Step 5.	Go to Step 12.
5	Check the CKP sensor body. 1. Turn the key switch to “OFF”. 2. Remove the harness from the CKP sensor. 3. Measure the resistance between the sensor connector terminals. Is the resistance within the specified value?	Between terminals: 108.5 — 142.5Ω; Each terminal — ground: ∞Ω (at normal temperature)	Go to Step 6.	Go to Step 7.
6	1. Check for followings in the circuit between ECM and CKP 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 • Short circuit to ground • Short circuit between terminals • Short circuit to power supply circuit or ignition power supply circuit 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 8.
7	Replace the CKP sensor. Is the procedure completed?	—	Go to Step 11.	—
8	Is EMPS available?	—	Go to Step 9.	Go to Step 10.

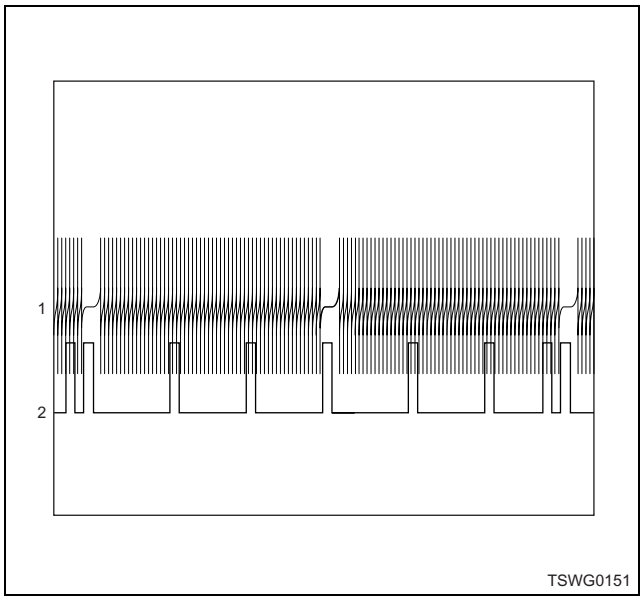
Step	Action	Value	YES	NO
9	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer 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 11.	Go to Step 10.
10	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 11.	—
11	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 P0335 detected?	—	Go to Step 2.	Go to Step 12.
12	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

About CKP sensor

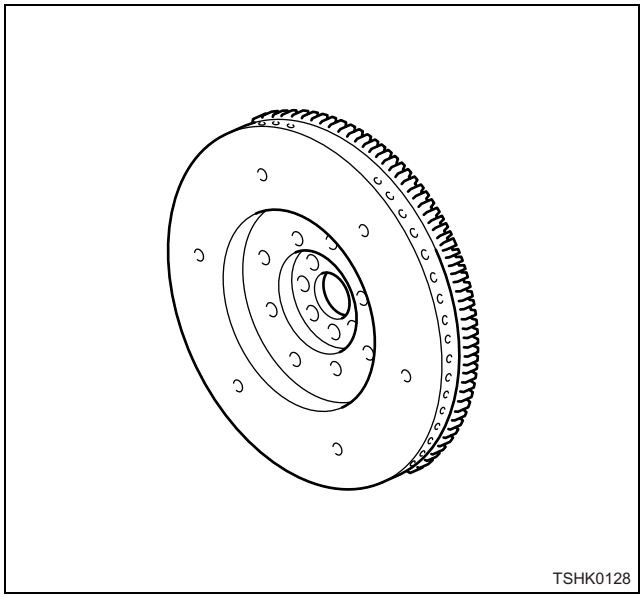


Name
1. GND
2. Power supply

About CKP sensor and G sensor signals

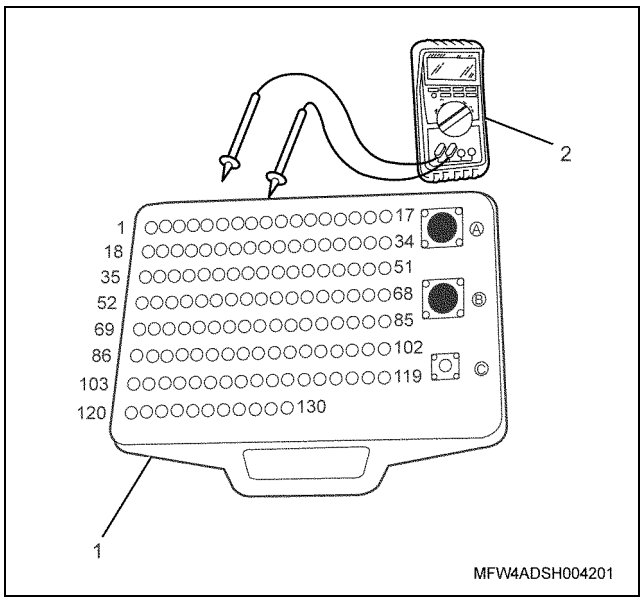


Name
1. CKP signal
2. G sensor signal



Breaker box inspection procedure

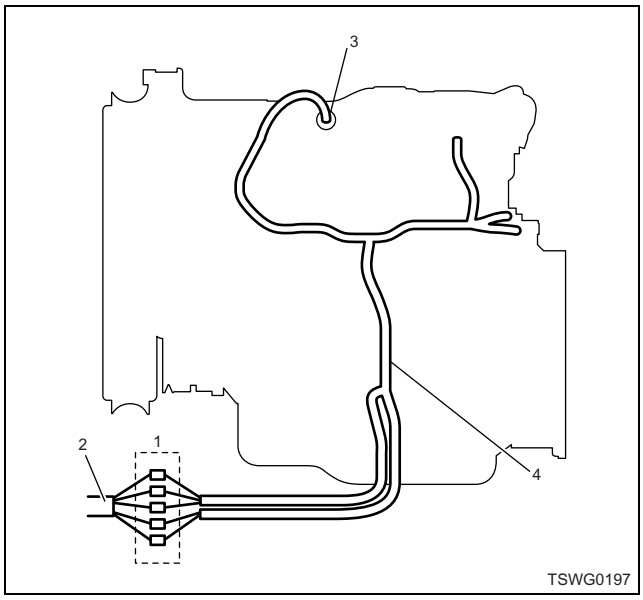
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	106 - Sensor connector (–) terminal 107 - Sensor connector (+) terminal	100 Ω or less	10 MΩ or more
	Short circuit to ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	106 - Ground 107 - Ground	10 MΩ or more	100 Ω or less
	Short circuit between terminals	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	106 - 107	10 MΩ or more	100 Ω or less
	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	106 - Ground 107 - Ground	0V	18V or more

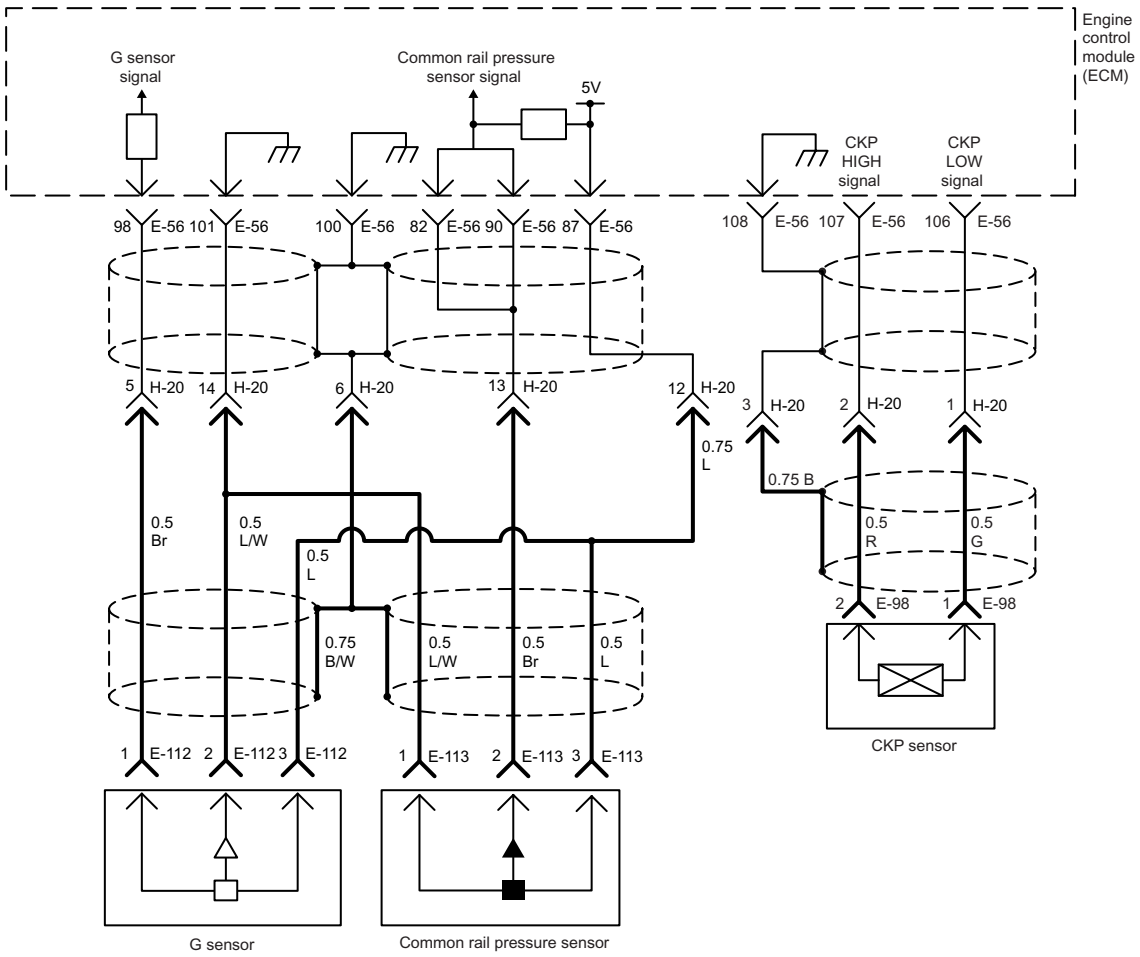
On-board check procedure for sensors



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.

DTC: P0336 (Flash code 15) Crank sensor fault (signal fault)



Description of circuit

The crankshaft position (CKP) sensor detects the engine speed. When the sensing hole installed in the flywheel housing passes the tip of the CKP sensor, a voltage is generated and turned into a pulse signal. The engine control module (ECM) reads this pulse signal, and obtains the engine speed and injection timing based on the signal.

Main trouble symptom

- Output lowering
- White smoke emitted
- Intense engine vibration possible
- Engine stall possible (restart is possible when G sensor is normal.)

Preconditions when DTC is set

- Cam pulse is normal.
- DTC P0335, P0336, P0340, P0341, or P1345 is not detected.
- Engine under operation

DTC set condition

- Number of pulse for crank signal is mismatched.

Action taken when DTC is set

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

Back-up mode

- Control based on G sensor when it is normal

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.

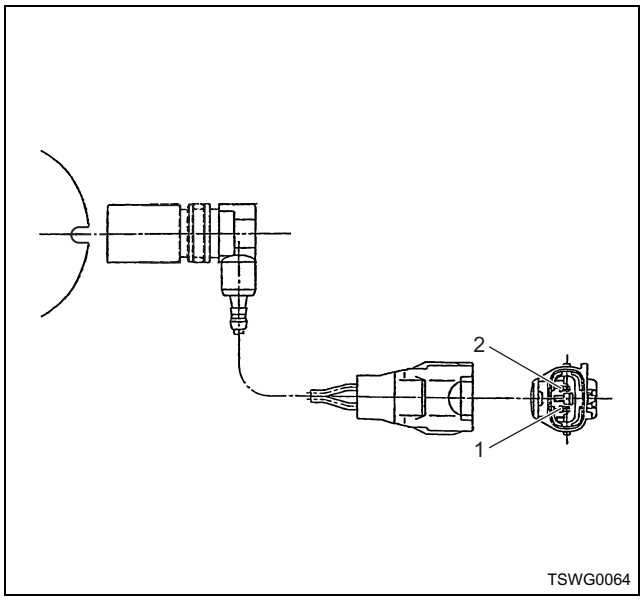
- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items 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	Action	Value	YES	NO
4	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. Start the engine, and test run with the “Preconditions when DTC is set”. 4. Check the DTC. Is DTC detected?	—	Go to Step 5.	Go to Step 12.
5	1. Check the CKP sensor circuit for short circuit to other signal 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”.** 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 6.
6	Check the CKP sensor body. 1. Turn the key switch to “OFF”. 2. Remove the harness from the CKP sensor. 3. Measure the resistance between the sensor connector terminals. 4. Remove the CKP sensor, and check the sensor tip for scratch or damage. Is the CKP sensor normal?	Between terminals: 108.5 — 142.5Ω; Each terminal to ground: ∞Ω (at normal temperature)	Go to Step 8.	Go to Step 7.
7	Replace the CKP sensor. Is the procedure completed?	—	Go to Step 12.	—
8	1. Visually check the flywheel for chipped tooth. 2. If the trouble is detected, replace it. Is the trouble detected?	—	Go to Step 12.	Go to Step 9.
9	Is EMPS available?	—	Go to Step 10.	Go to Step 11.

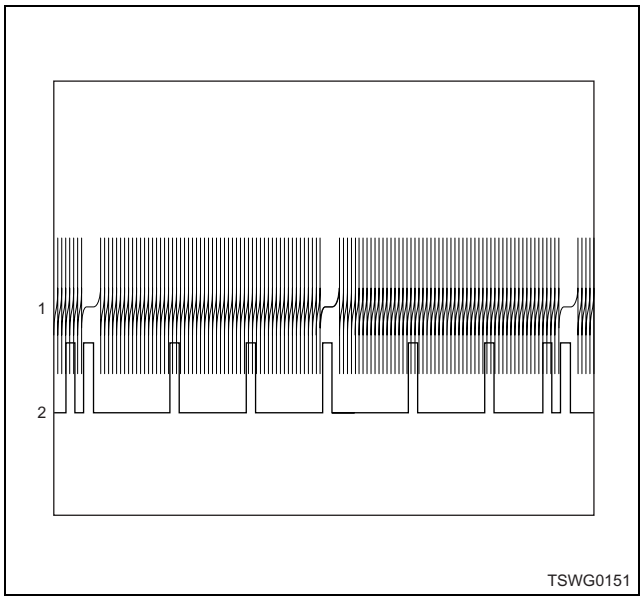
Step	Action	Value	YES	NO
10	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer 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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P0336 detected?	—	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.

About CKP sensor

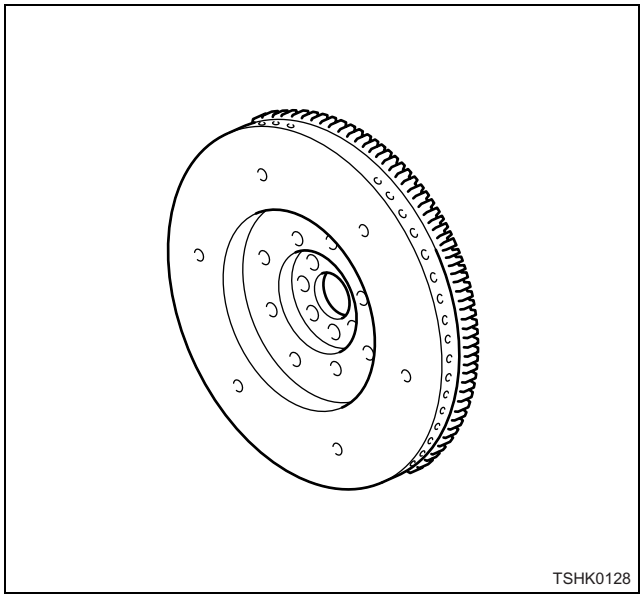


Name
1. GND
2. Power supply

About CKP sensor and G sensor signals

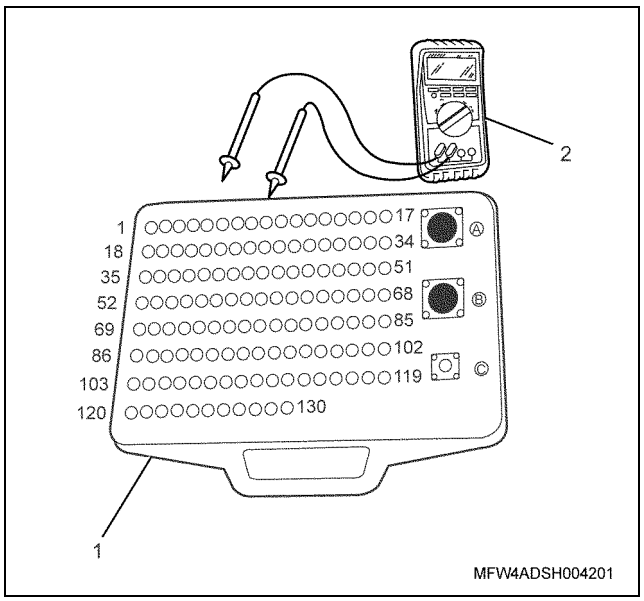


Name
1. CKP signal
2. G sensor signal



Breaker box inspection procedure

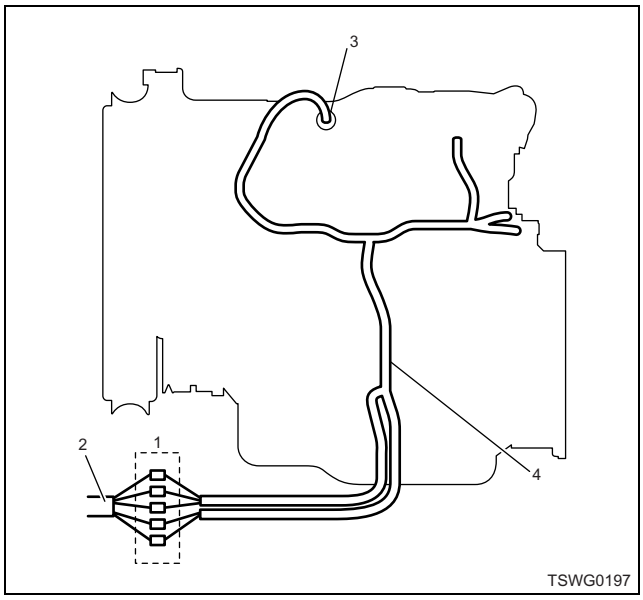
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
5	Short circuit to other signal circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	106 - Ground 107 - Ground	0V	1V or more

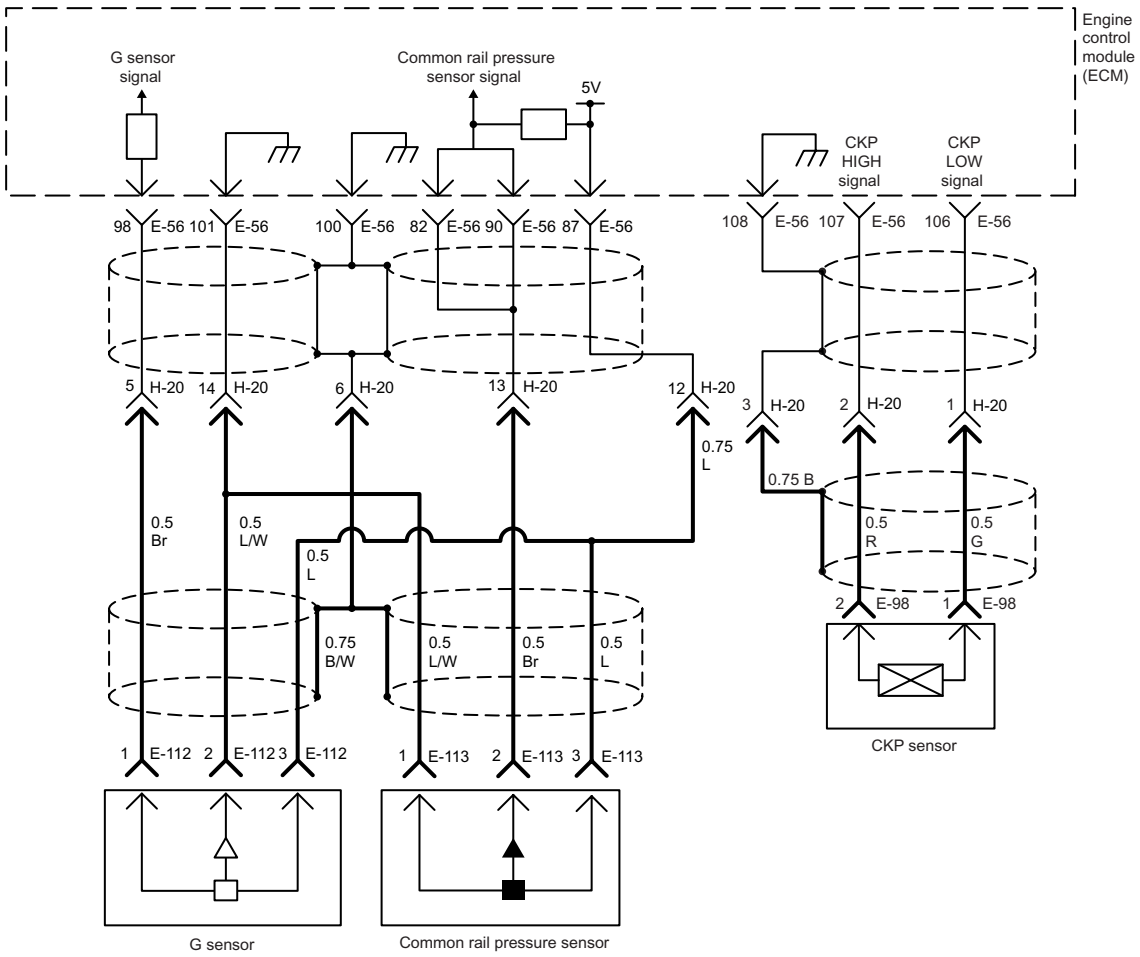
On-board check procedure for sensors



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.

DTC: P0340 (Flash code 14) G sensor fault (no signal)



Description of circuit

The G sensor is installed to supply pump and identifies the cylinder. When the pulser passes the tip of the G sensor, a voltage is generated and turned into a pulse signal. The engine control module (ECM) reads this pulse signal, and identifies the cylinder based on the signal.

Main trouble symptom

- Engine does not start.
- Behavior does not change during engine running.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- Crank pulse is normal.
- DTC P0335, P0336, P0340, P0341, or P1345 is not detected.
- Engine under operation

DTC set condition

- Crank signal exists but no G sensor signal.

Action taken when DTC is set

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

Back-up mode

- Engine running based on crank when it is normal
- After engine stops: Unable to identify cylinder (unable to restart)

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.

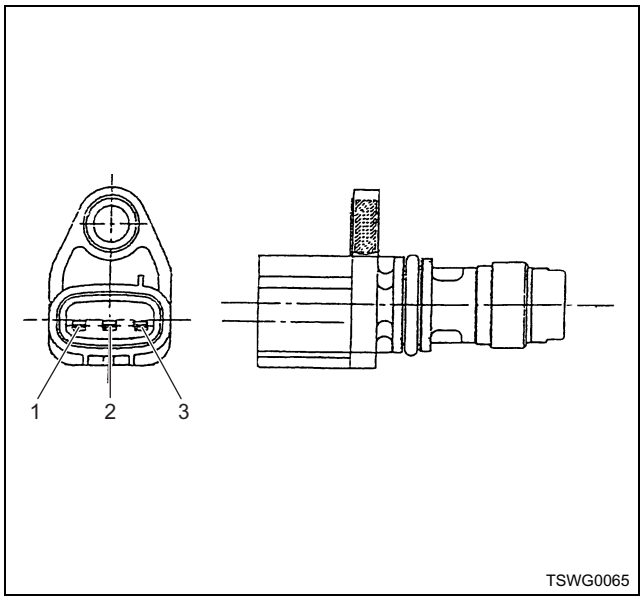
- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items 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.
  - The cam gears are out of installation phase by one tooth.
- The cam gears are out of installation phase by one tooth.

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 G 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 G 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.	—
4	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. Start the engine, and test run with the “Preconditions when DTC is set”. 4. Check the DTC. Is DTC detected?	—	Go to Step 5.	Go to Step 15.
5	Remove the G sensor, and check the sensor tip for scratch or damage. Is the G sensor normal?	—	Go to Step 6.	Go to Step 9.

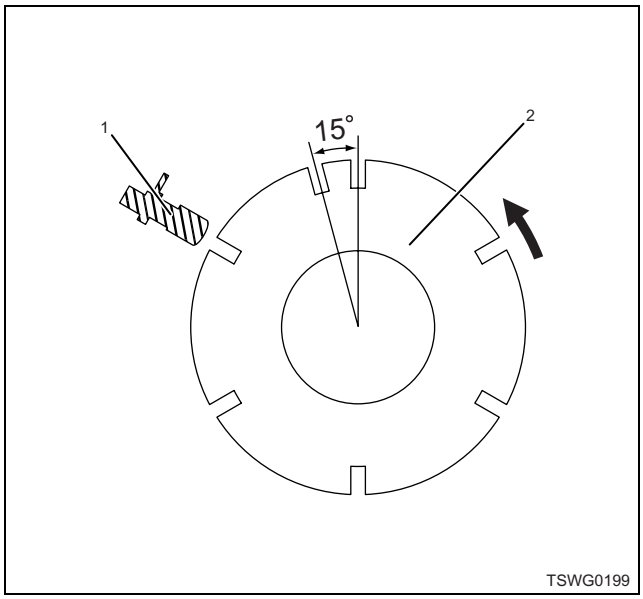
Step	Action	Value	YES	NO
6	1. Check for followings in the power supply circuit between ECM and G sensor using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Open circuit • High resistance • Short circuit to ground 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 15.	Go to Step 7.
7	1. Check for followings in the signal circuit between ECM and G 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 • Short circuit to power supply circuit or ignition power supply circuit 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 15.	Go to Step 8.
8	1. Check for followings in the shield circuit between ECM and G 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 • Short circuit to power supply circuit or ignition power supply circuit 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 15.	Go to Step 10.
9	Replace the G sensor. Is the procedure completed?	—	Go to Step 10.	—

Step	Action	Value	YES	NO
10	1. Visually check the camshaft gear for fault. 2. Check the alignment mark in the timing gear. 3. If the trouble is detected, repair or replace it. Is the trouble detected?	—	Go to Step 15.	Go to Step 11.
11	Replace the supply pump. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the procedure completed?	—	Go to Step 14.	—
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?	—	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 P0340 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.

About G sensor

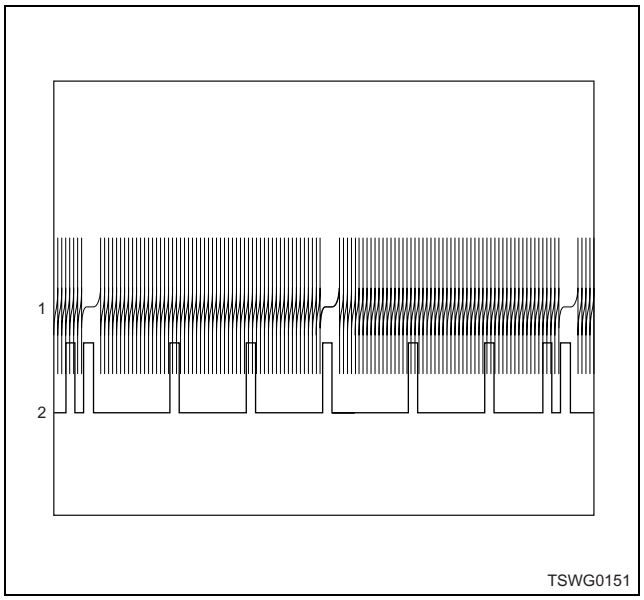


Name
1. Signal
2. GND
3. Power supply



Name
1. G sensor
2. Pulser

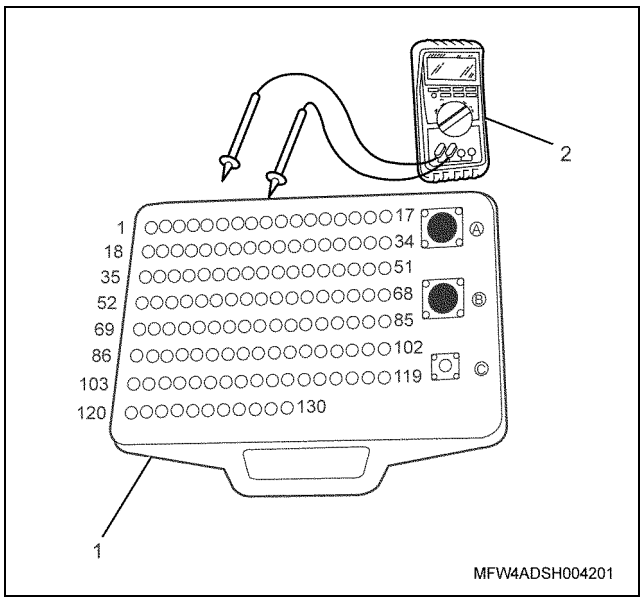
About CKP sensor and G sensor signals



Name
1. CKP signal
2. G sensor signal

Breaker box inspection procedure

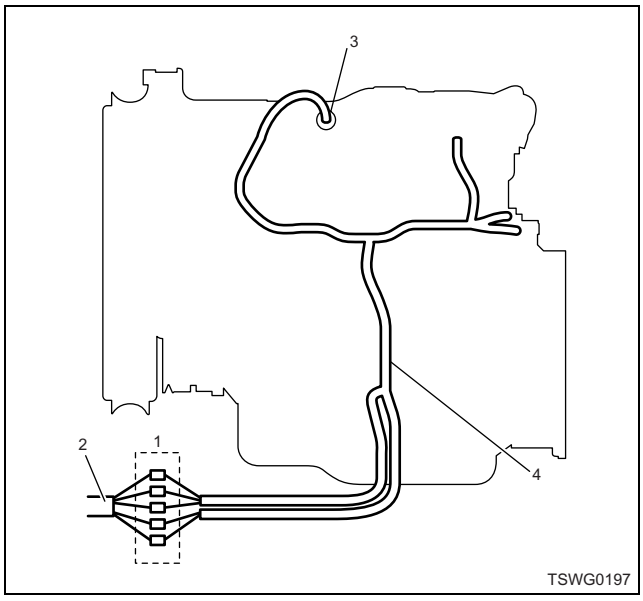
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
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

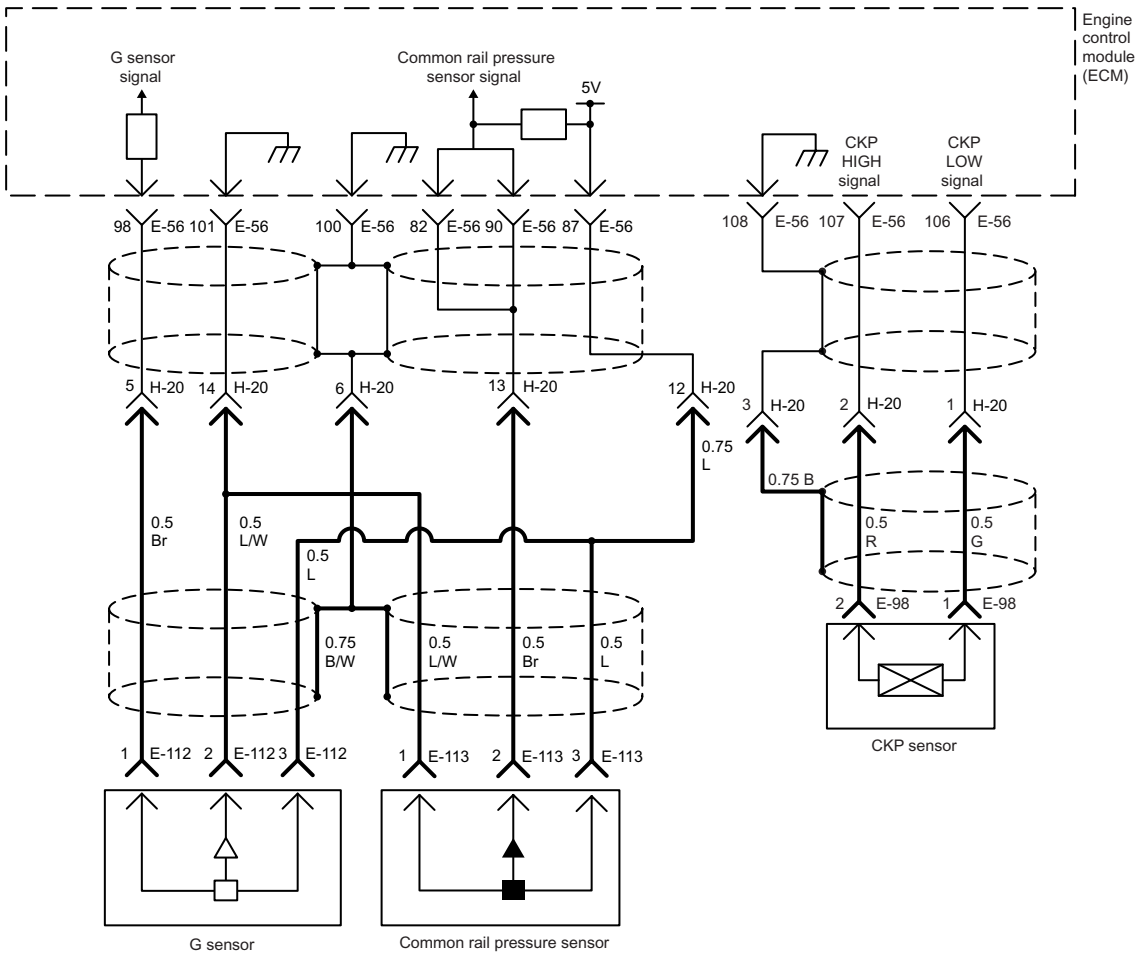
On-board check procedure for sensors



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.

DTC: P0341 (Flash code 14) G sensor fault (signal fault)



Description of circuit

The G sensor is installed to supply pump and identifies the cylinder. When the pulser passes the tip of the G sensor, a voltage is generated and turned into a pulse signal. The engine control module (ECM) reads this pulse signal, and identifies the cylinder based on the signal.

Main trouble symptom

- Engine does not start.
- Behavior does not change during engine running.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- Crank pulse is normal.
- DTC P0335, P0336, P0340, P0341, P1345, or P1635 is not detected.
- Engine under operation

DTC set condition

- When unnecessary G sensor pulse is detected, or when shortage of G sensor pulse is detected.

Action taken when DTC is set

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

Back-up mode

- Engine running based on crank when it is normal
- After engine stops: Unable to identify cylinder (unable to restart)

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.

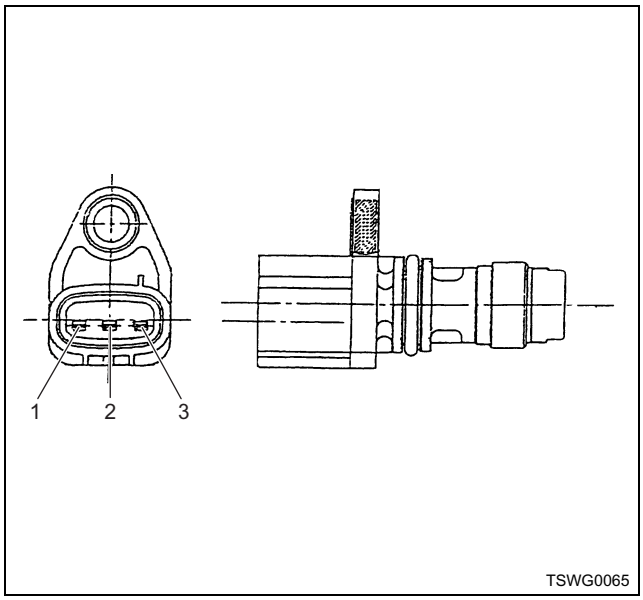
- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items 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.

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 G 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 G 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.	—
4	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. Start the engine, and test run with the “Preconditions when DTC is set”. 4. Check the DTC. Is DTC detected?	—	Go to Step 5.	Go to Step 11.
5	Remove the G sensor, and check the sensor tip for scratch or damage. Is the G sensor normal?	—	Go to Step 6.	Go to Step 8.

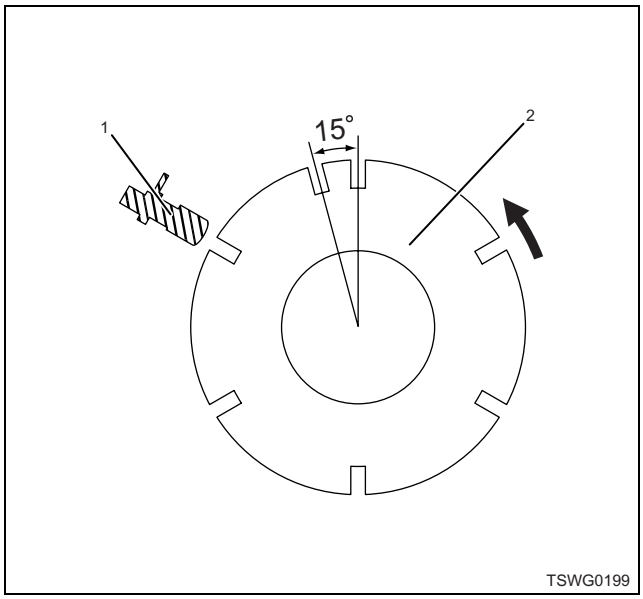
Step	Action	Value	YES	NO
6	1. Turn the key switch to “OFF”. 2. Remove the harness from the G sensor. 3. Connect the breaker box or DMM between the G sensor terminals. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** 4. Turn the key switch to “ON”. Is the DMM indication specified value?	0V	Go to Step 8.	Go to Step 7.
7	1. Check the G sensor circuit for short circuit to other signal 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”.** 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 14.	Go to Step 9.
8	Replace the G sensor. Is the procedure completed?	—	Go to Step 14.	—
9	1. Visually check the camshaft gear for fault. 2. Check the alignment mark in the timing gear. 3. If the trouble is detected, repair or replace it. Is the trouble detected?	—	Go to Step 14.	Go to Step 10.
10	Replace the supply pump. **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 11.	—
11	Is EMPS available?	—	Go to Step 12.	Go to Step 13.

Step	Action	Value	YES	NO
12	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 14.	Go to Step 13.
13	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 14.	—
14	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 P0341 detected?	—	Go to Step 2.	Go to Step 15.
15	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

About G sensor

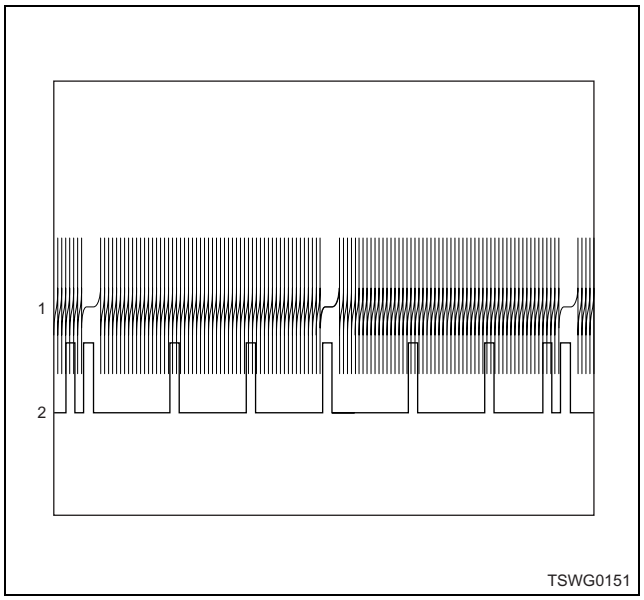


Name
1. Signal
2. GND
3. Power supply



Name
1. G sensor
2. Pulser

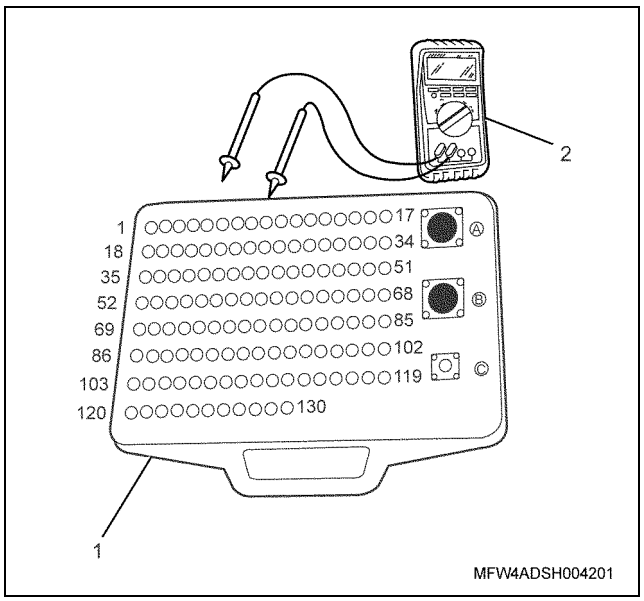
About CKP sensor and G sensor signals



Name
1. CKP signal
2. G sensor signal

Breaker box inspection procedure

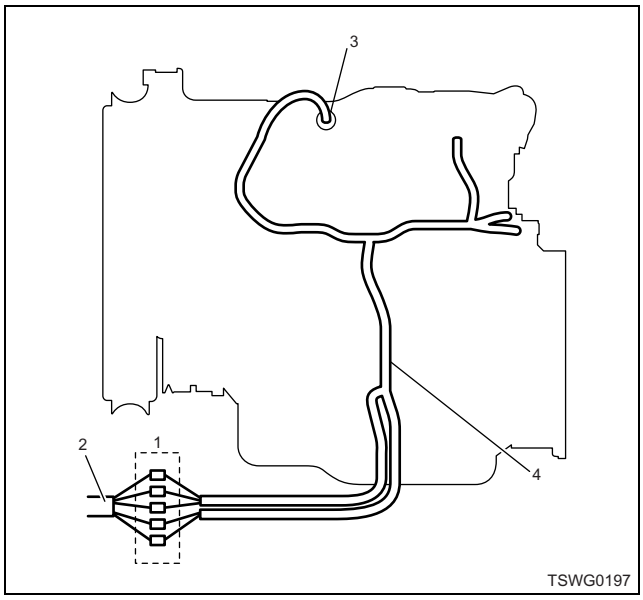
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



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 other signal circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	98 - Ground	0V	1V or more

On-board check procedure for sensors

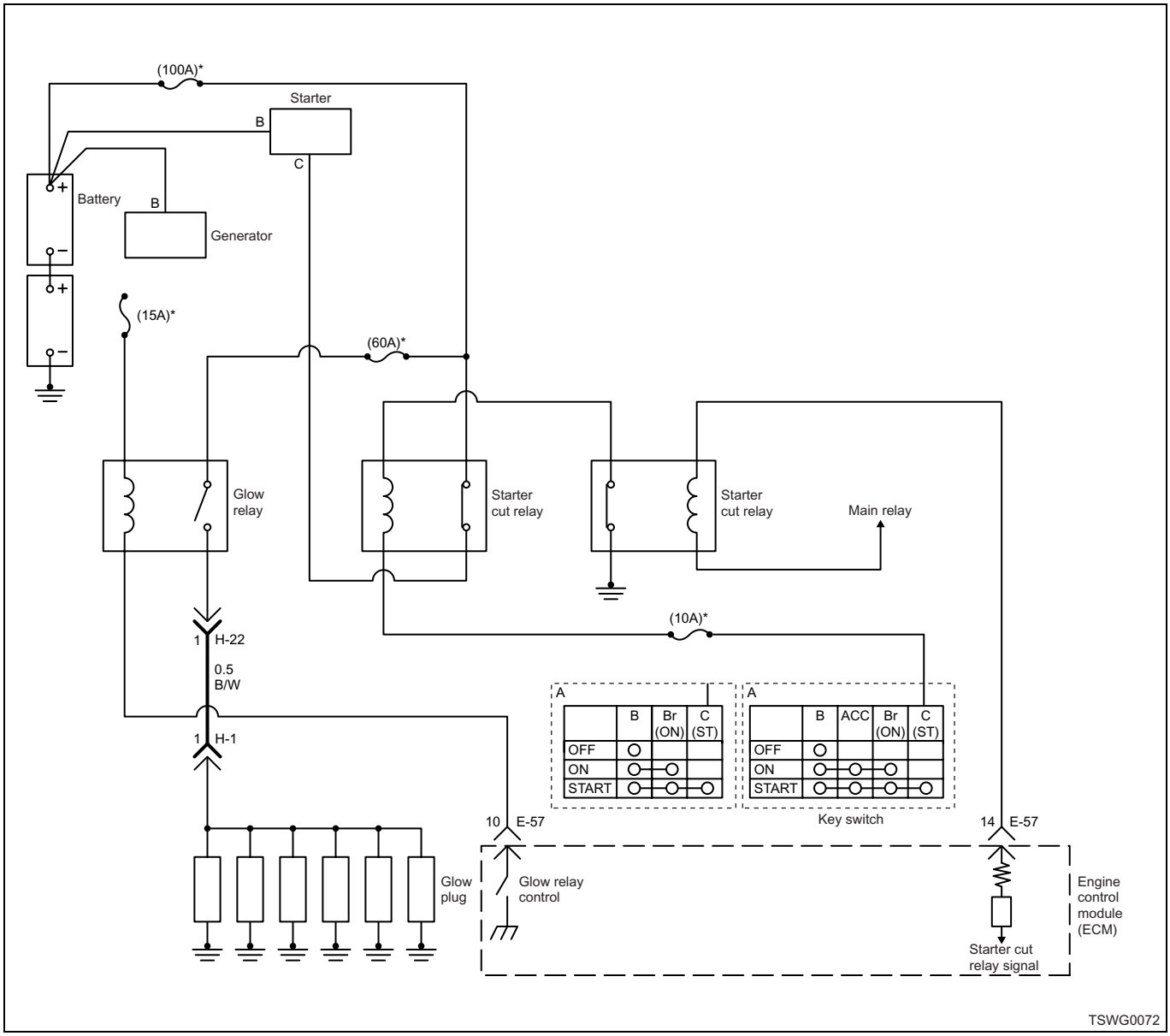


Name
1. Coupling connector between engine — the machine
2. Machine harness
3. Sensor connector
4. Engine harness

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.

DTC: P0380 (Flash code 66) Glow relay circuit fault

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



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

Description of circuit

The glow relay cuts off the power supply voltage (24 V) to the glow plug, and turns “ON” when the signal from ECM is input. The ECM recognizes the starter switch “ON” signal, and outputs the “ON” signal to the glow relay.

Main trouble symptom

- Startability deteriorates at low temperatures.

Preconditions when DTC is set

- Key switch input power supply voltage is 16 V or more and 32 V or less.

DTC set condition

- Glow relay drive indication signal is unmatched with glow relay monitor signal.

Action taken when DTC is set

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

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).
- The diagnosis lamp turns off when the trouble code turns to the history trouble.
- Using the scan tool, or accelerator pedal operation enables to clear history trouble.

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.
6. If the “Glow relay” displays “ON” when terminals between the glow relay are shorted, the circuit beyond the relay is normal including ECM.
9. If the “Glow relay” displays “OFF” when the glow relay is removed, the circuit beyond the relay is normal including ECM.

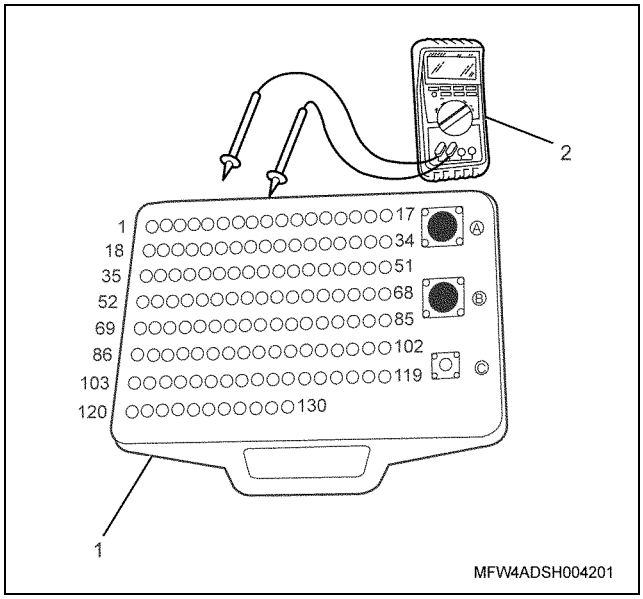
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 17.
3	1. Turn the key switch to ON position. 2. Check for “Glow relay” on the data display using scan tool. Is the “Glow relay” displayed “ON”?	—	Go to Step 4.	Go to Step 5.
4	1. Turn the key switch to ON position. 2. Hold it for more than 10 seconds. 3. Check for “Glow relay” on the data display using scan tool. Is the “Glow relay” displayed “OFF”?	—	Go to “Diagnostic aid”.	Go to Step 9.
5	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 6.
6	1. Turn the key switch to “OFF”. 2. Remove the glow relay. 3. Short between the terminals 2 - 4 in the glow relay installing portion using jump cable. 4. Turn the key switch to “ON”. 5. Check for “Glow relay” on the data display using scan tool. Is the “Glow relay” displayed “ON”?	—	Go to Step 11.	Go to Step 7.

Step	Action	Value	YES	NO
7	1. Check for following in the circuit between the fuse and the glow relay. • Open circuit • Short circuit to ground circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 8.
8	1. Check for followings in the circuit between glow relay and ECM 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 • Short circuit to ground circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 9.
9	1. Turn the key switch to “OFF”. 2. Remove the glow relay. 3. Turn the key switch to “ON”. 4. Check for “Glow relay” on the data display using scan tool. Is the “Glow relay” displayed “OFF”?	—	Go to Step 11.	Go to Step 10.
10	1. Check the circuit between glow relay and ECM 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 11.
11	Replace the glow relay. Is the procedure completed?	—	Go to Step 12.	—
12	Is EMPS available?	—	Go to Step 13.	Go to Step 14.

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.

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.

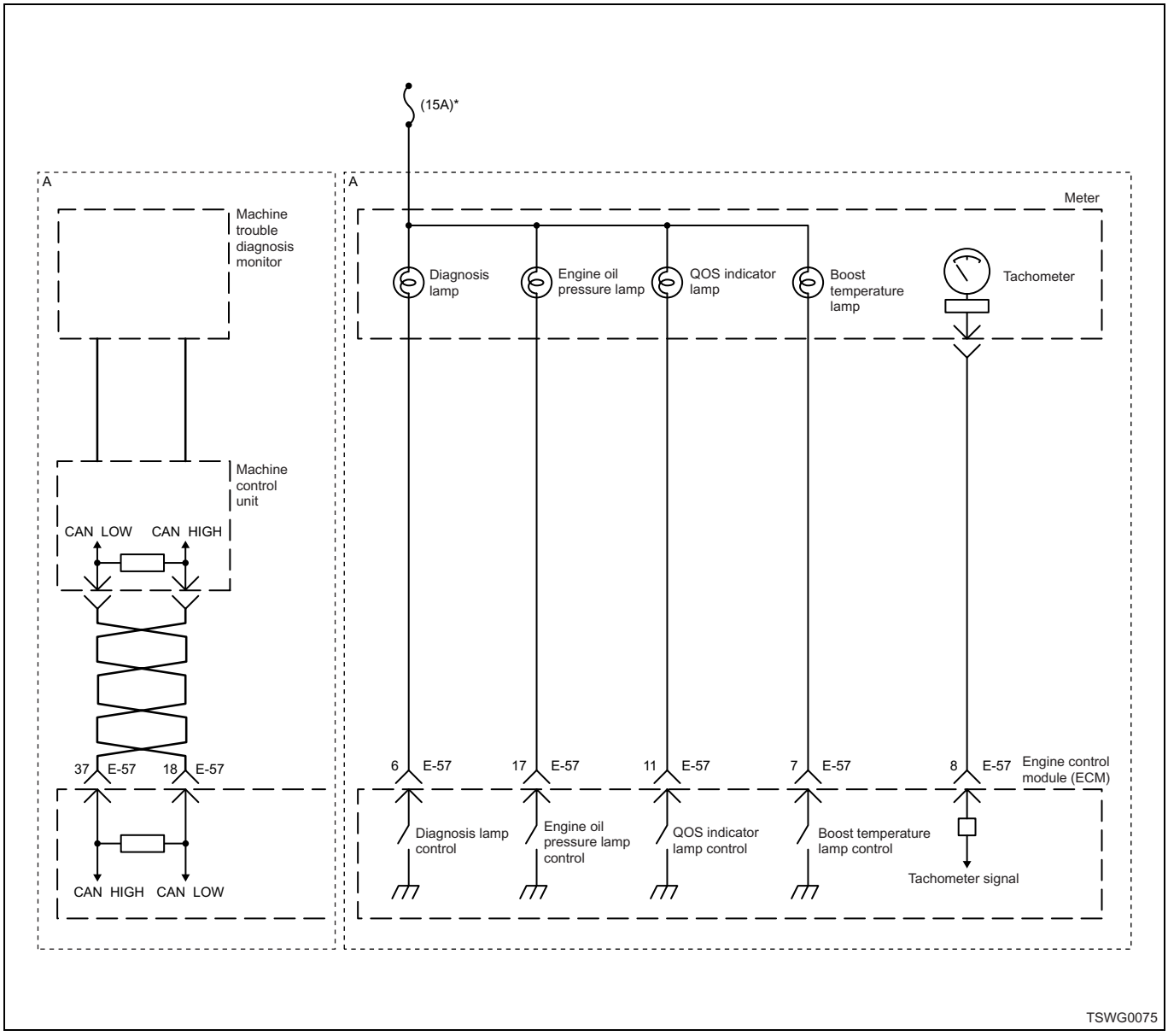


Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
8	Open circuit/ high resistance	Resistance measurement	• Disconnect the relay. • Key switch “OFF”	10 - FL 12 connector terminal No. 1	10MΩ or less	10 MΩ or more
	Short circuit to ground	Resistance measurement	• Disconnect the relay. • Key switch “OFF”	10 - Ground	10 MΩ or more	10MΩ or less
10	Short circuit to power supply circuit	Voltage measurement	• Disconnect the relay. • Key switch “ON”	10 - Ground	0V	18V or more

DTC: P0381 (Flash code 67) Glow plug lamp circuit fault

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



Description of circuit

The QOS indicator lamp is installed in the meter. The engine control module (ECM) turns the QOS indicator lamp on to tell the glow plug operation when the key switch is turned “ON”. The ECM detects the glow plug operating condition, and turns the lamp off upon completion of preheat.

Main trouble symptom

Operationality is not affected.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P0381 is not detected.

DTC set condition

- Glow lamp indication signal is unmatched with glow lamp monitor signal.

Action taken when DTC is set

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

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).
- 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.

- Blown lamp bulb
- 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.
2. If the lamp does not come on with the key switch “ON”, open circuit, short circuit to the ground circuit, blown light bulb, or ECM fault is suspected.
2. If the lamp does not go OFF, short circuit to the ground circuit, meter circuit fault, or ECM fault is suspected.
4. If the lamp goes off when the ECM connector is removed, the circuit beyond the ECM is normal including meter.
7. If the lamp comes on when the lamp control terminal is shorted to the ground, the circuit beyond the ECM is normal including meter.

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	1. Turn the key switch to “ON”. 2. Check if the QOS indicator lamp is ON. Does the QOS indicator lamp come on?	—	Go to Step 3.	Go to Step 7.
3	Turn the key switch “ON” and wait for 10 seconds. Does the QOS indicator lamp go OFF?	—	Go to “Diagnostic aid”.	Go to Step 4.
4	1. Turn the key switch to “OFF”. 2. Remove the connector from the ECM. 3. Turn the key switch to “ON”. 4. Check if the QOS indicator lamp is ON. Does the QOS indicator lamp go OFF?	—	Go to Step 12.	Go to Step 5.
5	Check for installation condition of the meter, 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 14.	Go to Step 6.

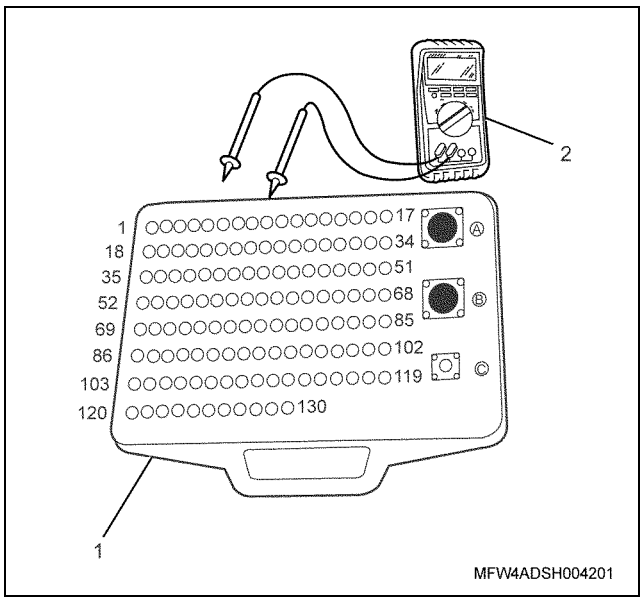
Step	Action	Value	YES	NO
6	1. Check the circuit between QOS indicator lamp and ECM for ground short circuit using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 14.	Go to Step 11.
7	1. Turn the key switch to “OFF”. 2. Remove the connector from the ECM. 3. Short between the QOS indicator lamp control terminal of the ECM and the ground using breaker box. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** 4. Turn the key switch to “ON”. 5. Check if the QOS indicator lamp is ON. Does the QOS indicator lamp come on?	—	Go to Step 13.	Go to Step 8.
8	Check for installation condition of the meter, 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 14.	Go to Step 9.
9	1. Check for following in the circuit between the fuse and the QOS indicator lamp. • Open circuit • Short circuit to ground circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 14.	Go to Step 10.

Step	Action	Value	YES	NO
10	1. Check for followings in the circuit between QOS indicator lamp and ECM 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 14.	Go to Step 12.
11	Replace the meter. Is the procedure completed?	—	Go to Step 14.	—
12	Replace the QOS indicator lamp bulb. Is the procedure completed?	—	Go to Step 14.	—
13	Is EMPS available?	—	Go to Step 14.	Go to Step 15.
14	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 16.	Go to Step 15.
15	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 16.	—

Step	Action	Value	YES	NO
16	Check if DTC is not detected 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 the procedure completed?	—	Go to Step 17.	—
17	Check if DTC is detected. (DTC for entire engine control) Is DTC detected?	—	Go to the related “Inspection method by DTC”.	Verify repair.

Breaker box inspection procedure

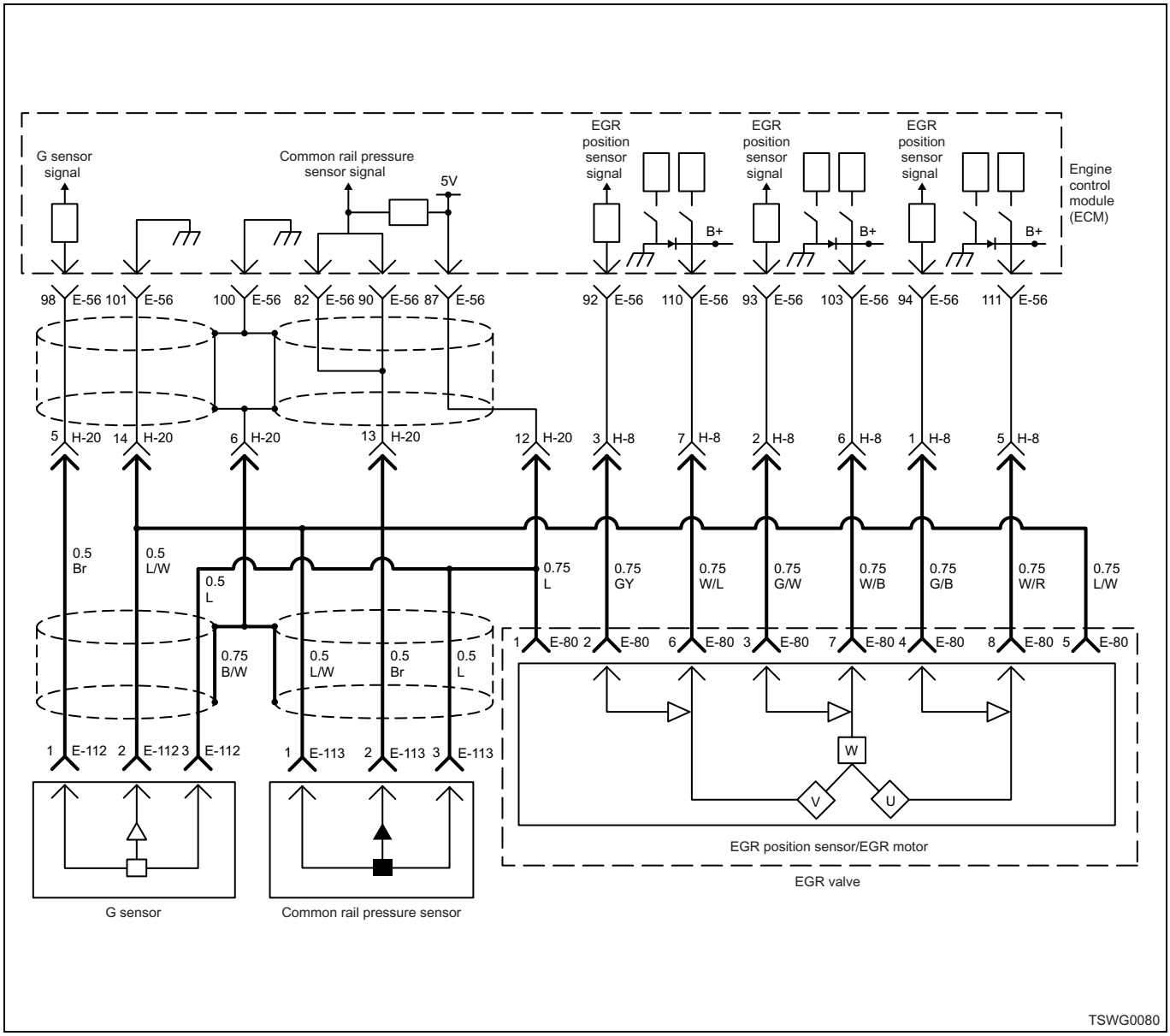
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to ground	Resistance measurement	• Remove the meter connector. • Key switch “OFF”	11 - Ground	10 MΩ or more	10MΩ or less
10	Open circuit/ high resistance	Resistance measurement	• Remove the meter connector. • Key switch “OFF”	11 - Meter connector QOS indicator lamp terminal	10MΩ or less	10 MΩ or more

DTC: P0487 (Flash code 44) EGR position sensor fault



Description of circuit

The EGR position sensor is installed inside the EGR valve. The EGR position sensor is the hall IC type sensor and is installed to 3 locations. It detects the motor phase based on each polarity output (ON/OFF). The EGR position sensor includes following circuits.

- 5-V power supply circuit
- Ground circuit
- EGR position sensor U signal circuit
- EGR position sensor V signal circuit
- EGR position sensor W signal circuit

The ECM provides 5 V to the EGR position sensors U, V, and W through 5-V power supply circuit, and grounds to the inside of the ECM through ground circuit. Also, the EGR position sensor outputs polarity (ON/OFF) of any one of the EGR position sensors U, V, and W through respective signal circuit, to the ECM. The ECM detects the EGR valve position by counting the number of change in polarity.
The ECM sets the DTC when all of the EGR position sensors U, V, and W output “ON” or “OFF” simultaneously.

Main trouble symptom

Operationality is not affected.

Preconditions when DTC is set

- Main relay input voltage is 16V or more.
- DTC P1630 or P1635 is not detected.

DTC set condition

- Input signals from EGR position sensors U, V, and W are all ON or all OFF.

Action taken when DTC is set

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

Back-up mode

- Instruction to fully close EGR valve

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. Check all the signal circuits of the EGR position sensors U, V, and W.

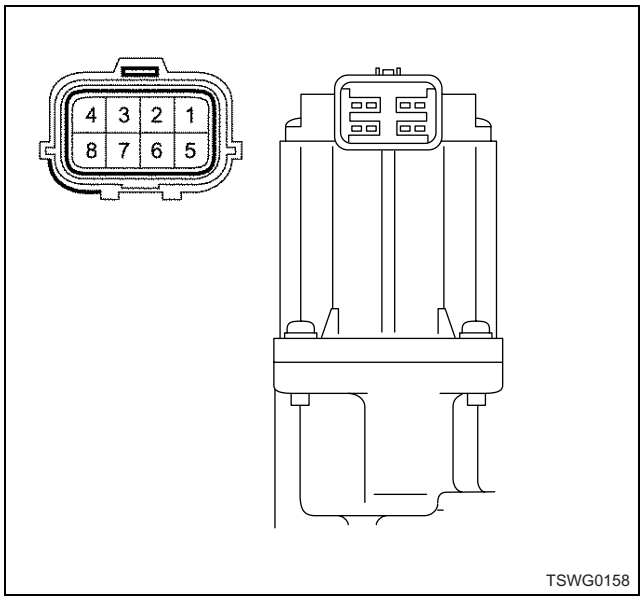
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Check for installation condition of the EGR valve connector, ECM connector and coupling connector. 1. Check for play or looseness in the connection. 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 10.	Go to Step 3.

Step	Action	Value	YES	NO
3	1. Check for followings in the circuit between ECM and EGR position 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 EGR position sensor ground circuit • Short circuit to ground • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 10.	Go to Step 4.
4	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 5.	Go to “Diagnostic aid”.
5	Replace the EGR valve (EGR position sensor). **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 6.	—

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.

Step	Action	Value	YES	NO
11	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

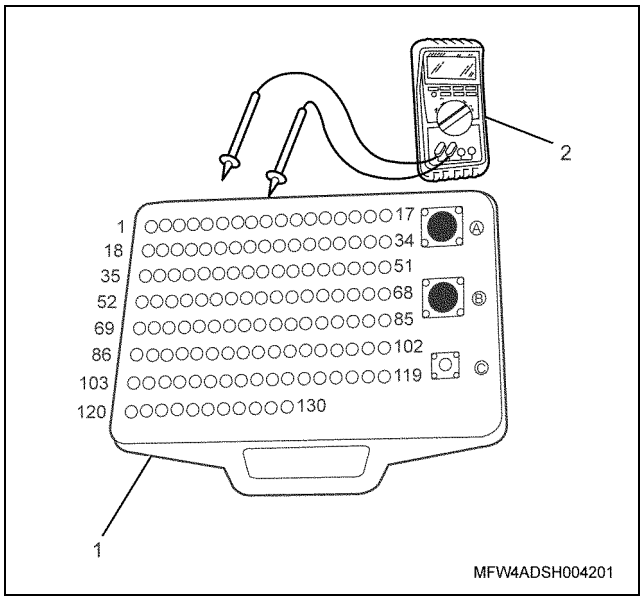
About EGR position sensor



Name
1. Position sensor power supply (5 V)
2. Position sensor signal W
3. Position sensor signal V
4. Position sensor signal U
5. Position sensor ground
6. Motor drive W
7. Motor drive V
8. Motor drive U

Breaker box inspection procedure

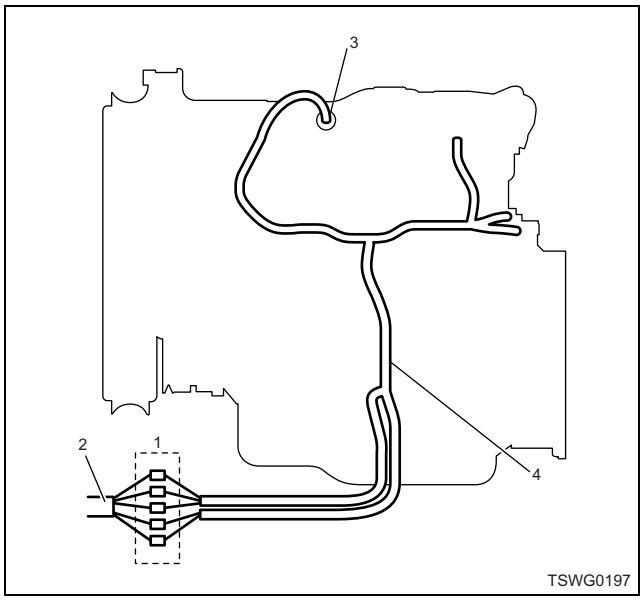
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
3	Open circuit/ high resistance	Resistance measurement	• Disconnect the EGR valve connector. • Key switch “OFF”	87 - EGR valve connector sensor power supply terminal	100 Ω or less	10 MΩ or more
4	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the EGR valve connector. • Key switch “OFF”	92 - 101 93 - 101 94 - 101 92 - Ground 93 - Ground 94 - Ground	10 MΩ or more	100 Ω or less
	Open circuit/ high resistance	Resistance measurement	• Disconnect the EGR valve connector. • Key switch “OFF”	92 - EGR valve connector position sensor signal W terminal 93 - EGR valve connector position sensor signal V terminal 94 - EGR valve connector position sensor signal U terminal	100 Ω or less	10 MΩ or more

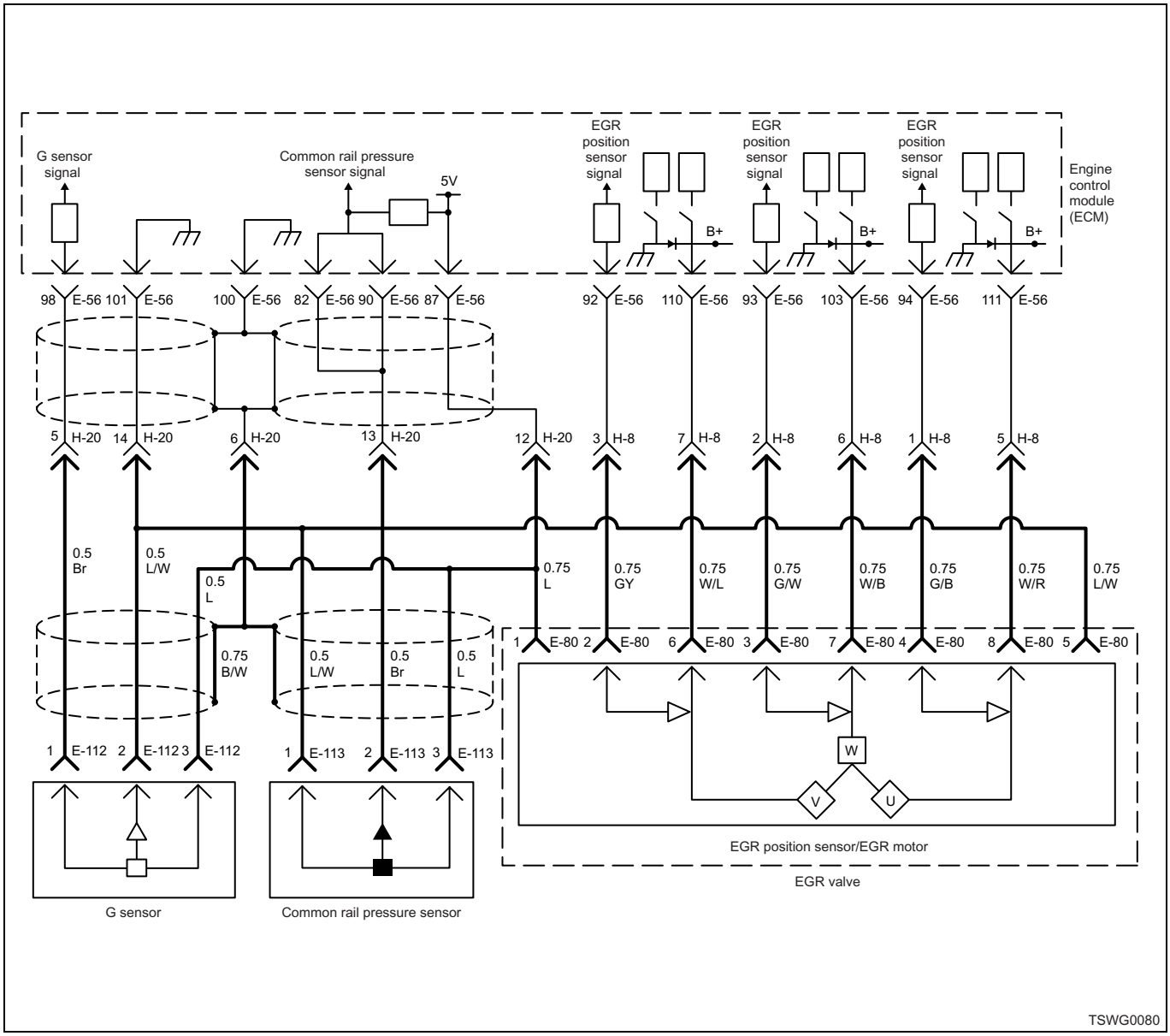
On-board check procedure for sensors



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.

DTC: P0488 (Flash code 45) EGR valve control fault



Description of circuit

The EGR motor is installed inside the EGR valve. The EGR motor is the brushless DC motor, and is driven by three phases. The EGR position sensor includes following circuits.

- EGR motor drive circuit U
- EGR motor drive circuit V
- EGR motor drive circuit W

The ECM drives the EGR motor through the EGR motor drive circuits U, V, and W. The ECM outputs drive signals by the switching inside the ECM, and the motor rotates with the combination of three-phase signals. Also, the valve opening angle is controlled by duty.
The ECM sets the DTC when the EGR motor drive duty is high and the difference between the target EGR position and actual EGR position is large.

Main trouble symptom

Operationality is not affected.

Preconditions when DTC is set

- DTC P1630, P1635, P0487, or P0488 is not detected.
- Main relay input power supply voltage is higher than 20 V but lower than 32 V.
- Difference between target EGR opening angle and actual one is 20% or less.

DTC set condition

- Difference between target valve lift and actual position is more than 20%.

Action taken when DTC is set

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

Back-up mode

- Instruction to fully close EGR valve

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

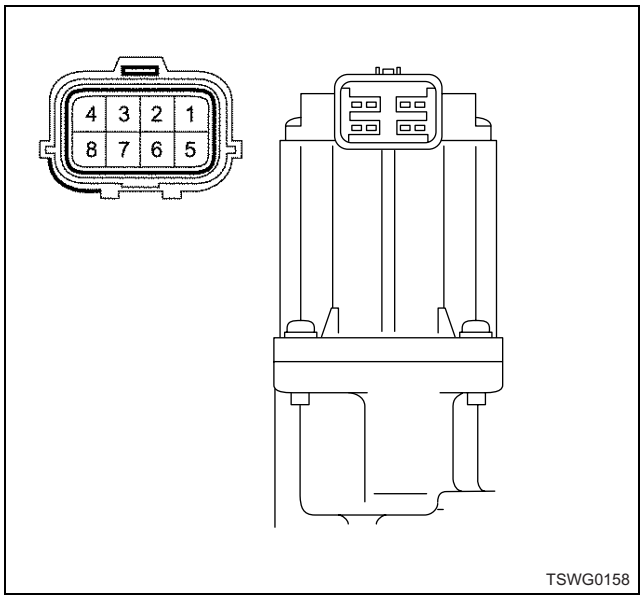
Numbers below indicate step numbers in the chart.
5. Check all the EGR motor drive circuits U, V, and W.

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 13.
3	1. Perform “EGR control test” using scan tool. 2. Press the “Up” “Down” soft key. 3. Check the value for “EGR position”. Is “EGR position” within the specified value?	±3%	Go to Step 4.	Go to Step 5.
4	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, and then start the engine. 3. Warm-up the engine until the engine coolant temperature exceeds 80°C (176°F). 4. Check the DTC. Is DTC P0488 detected?	—	Go to Step 8.	Go to “Diagnostic aid”.

Step	Action	Value	YES	NO
5	1. Check for followings in the motor drive circuit between ECM and EGR motor 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 • Short circuit to ground • Short circuit to power supply circuit or ignition power supply circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 6.
6	Replace the EGR valve. **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 7.	—
7	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 P0488 detected?	—	Go to Step 8.	Go to Step 12.
8	Is EMPS available?	—	Go to Step 9.	Go to Step 10.
9	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 11.	Go to Step 10.

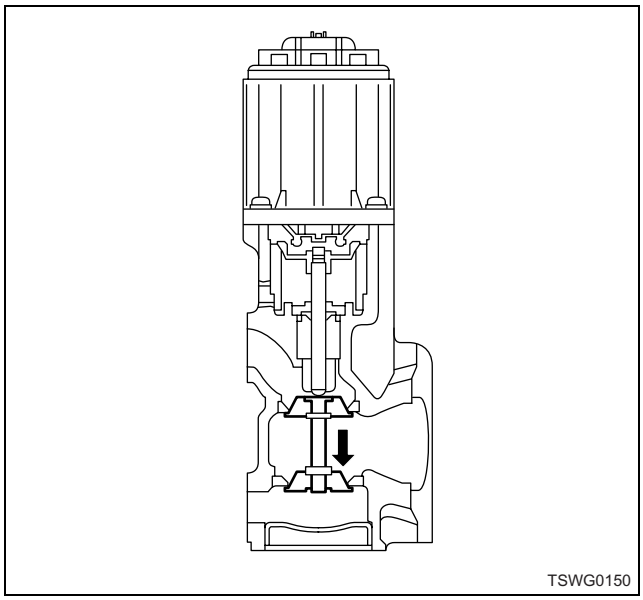
Step	Action	Value	YES	NO
10	Replace the ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer to "Engine Control System, Engine control module (ECM), Installation of ECM" in this section for learning of EGR.** Is the procedure completed?	—	Go to Step 11.	—
11	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 P0488 detected?	—	Go to Step 2.	Go to Step 12.
12	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
13	1. Remove the EGR valve. 2. Check the EGR valve for anchoring, clogging, etc. 3. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 5.	Go to Step 4.

About EGR valve



Name
1. Position sensor power supply (5 V)
2. Position sensor signal W
3. Position sensor signal V
4. Position sensor signal U
5. Position sensor ground
6. Motor drive W
7. Motor drive V
8. Motor drive U

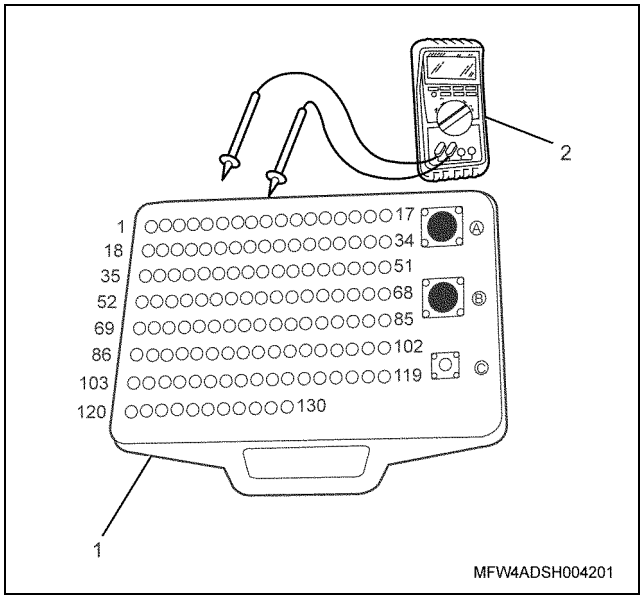
EGR valve check



Push the EGR valve with finger to make sure it opens/ closes smoothly. Also, make sure that the valve closes completely when the finger is released.

Breaker box inspection procedure

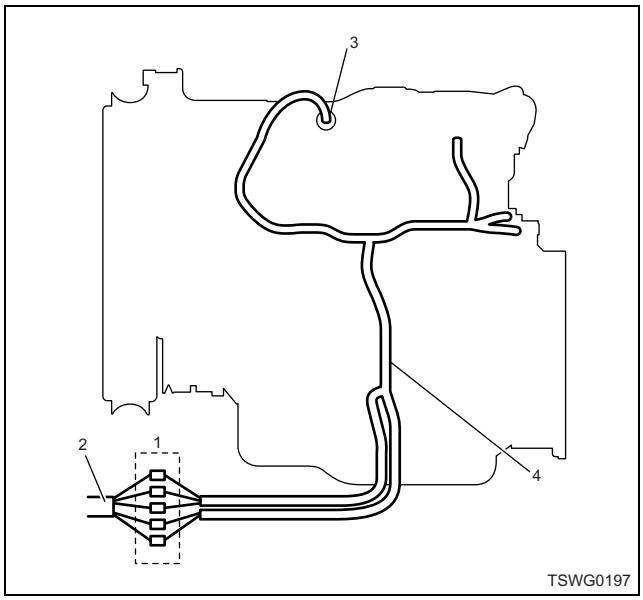
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
5	Short circuit to power supply circuit	Voltage measurement	• Disconnect the EGR valve connector. • Key switch “ON”	111 - Ground 103 - Ground 110 - Ground	0V	18V or more
	Short circuit to ground	Resistance measurement	• Disconnect the EGR valve connector. • Key switch “OFF”	111 - Ground 103 - Ground 110 - Ground	10 MΩ or more	100 Ω or less
	Open circuit/ high resistance	Resistance measurement	• Disconnect the EGR valve connector. • Key switch “OFF”	111 - EGR valve connector motor drive U terminal 103 - EGR valve connector motor drive V terminal 110 - EGR valve connector motor drive W terminal	100 Ω or less	10 MΩ or more

On-board check procedure for sensors

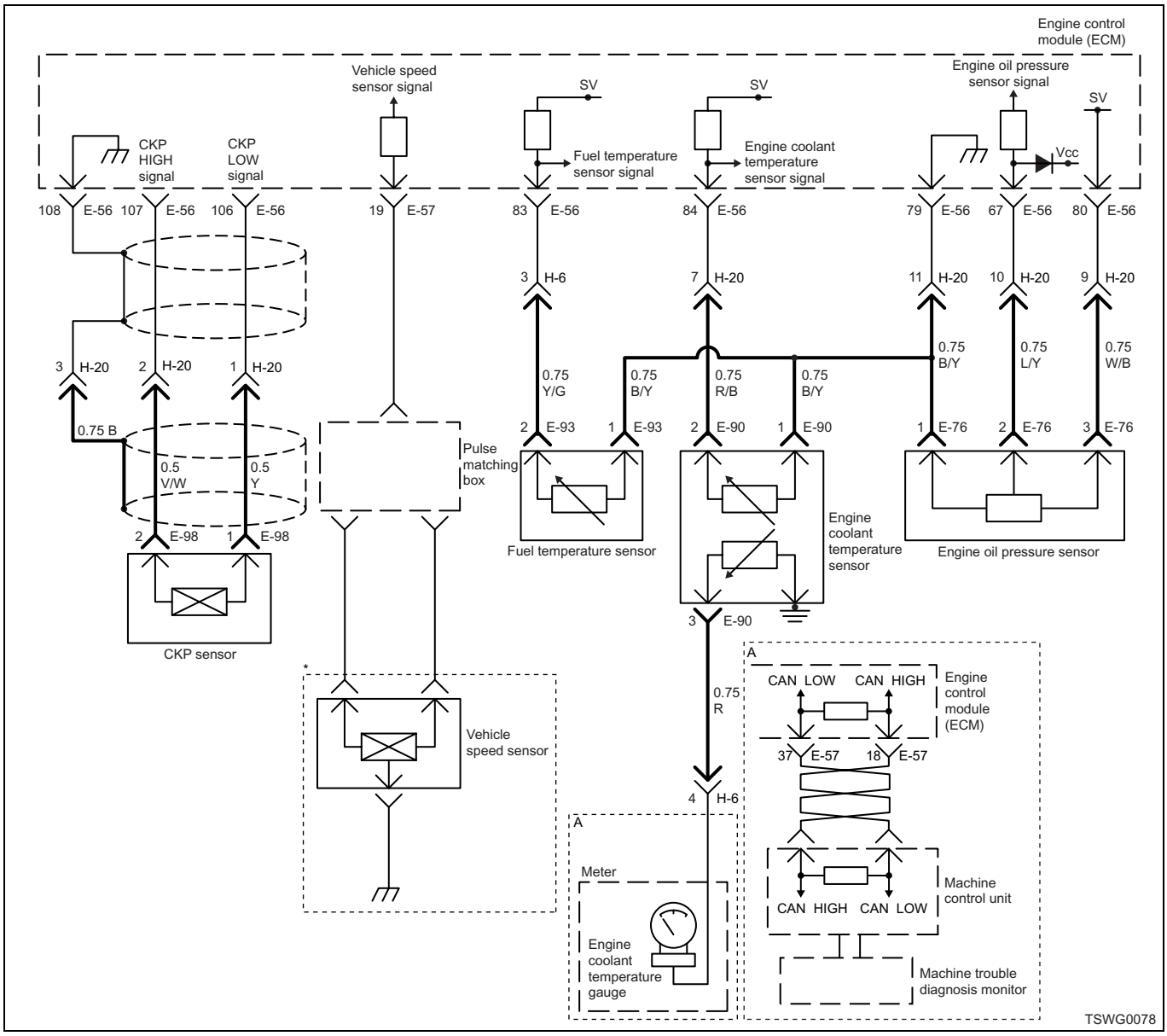


Name

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.

DTC: P0522 (Flash code 294) Engine oil pressure sensor fault (low voltage fault, open circuit, ground short)



Description of circuit

The engine oil pressure sensor detects the engine oil pressure. The engine oil pressure sensor is installed near the starter motor of the cylinder block. The resistance value in the engine oil pressure sensor changes according to the pressure. If the pressure is high, the resistance becomes low; if the pressure is low, the resistance becomes high.

The engine control module (ECM) is connected to the engine pressure sensor via power supply circuit, signal circuit and ground circuit, and energizes +5 V power supply to the power supply circuit. The ECM detects the signal voltage change in response to the change in resistance according to the engine pressure sensor pressure (If the pressure is high, the voltage becomes high; if the pressure is low, the voltage becomes low) as a signal.

Main trouble symptom

Operationality is not affected.

Preconditions when DTC is set

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

DTC set condition

- Engine oil 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

- 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

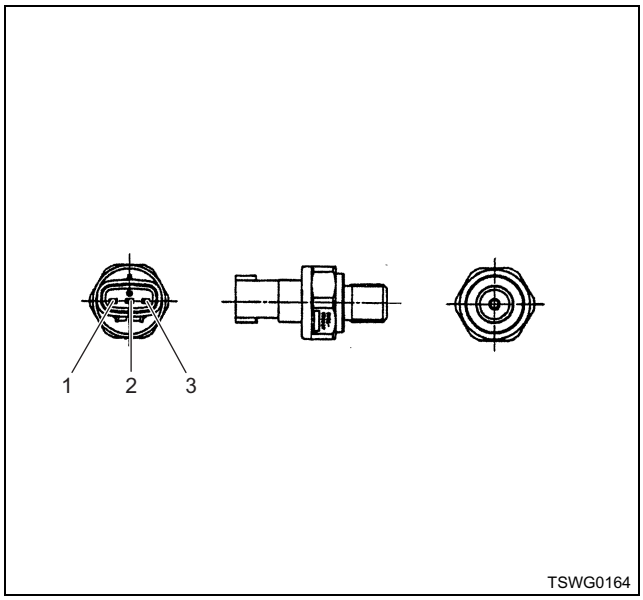
Numbers below indicate step numbers in the chart.
3. In the case of present trouble, the “Engine oil pressure sensor” displays more than the specified value. In this case, identify the cause by referring to “Diagnostic aid”.
5. If the “Engine oil pressure sensor” displays more than the specified value 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
5	1. Turn the key switch to “OFF”. 2. Disconnect the engine oil pressure sensor connector. 3. Turn the key switch to “ON”. 4. Check the value for “Engine oil pressure sensor” using scan tool. Is the “Engine oil pressure sensor” more than the specified value?	0V	Go to Step 7.	Go to Step 6.
6	1. Check for followings in the signal 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”.** • Short circuit to engine oil pressure sensor ground circuit • Short circuit to ground 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 8.
7	Replace the engine oil pressure sensor. Is the procedure completed?	—	Go to Step 11.	—
8	Is EMPS available?	—	Go to Step 9.	Go to Step 10.
9	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 11.	Go to Step 10.
10	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 11.	—

Step	Action	Value	YES	NO
11	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 the DTC P0522 detected?	—	Go to Step 2.	Go to Step 12.
12	1. Start the engine. 2. Check the display of engine oil pressure. Does the display of engine oil pressure show error value?	1016 kPa (147.4 psi) (Displayed error value)	Go to Step 13.	Go to “Diagnostic aid”.
13	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 14.
14	1. Check for followings in the signal 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”.** • Short circuit to engine oil pressure sensor ground circuit • Short circuit to ground 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 7.

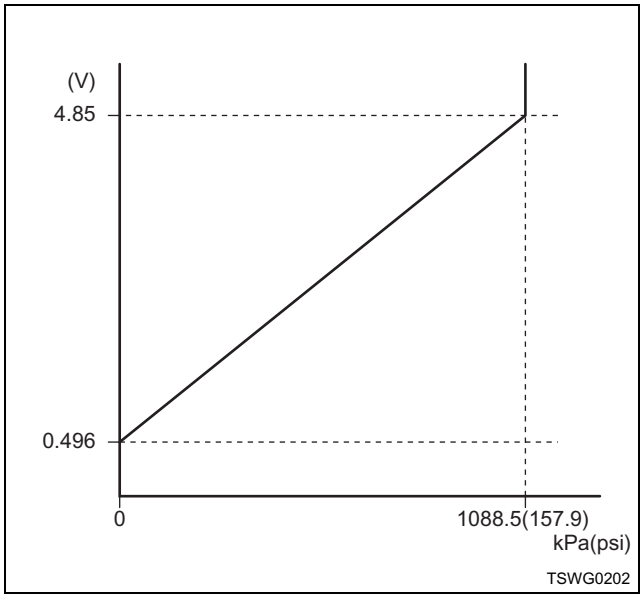
About engine oil pressure sensor



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

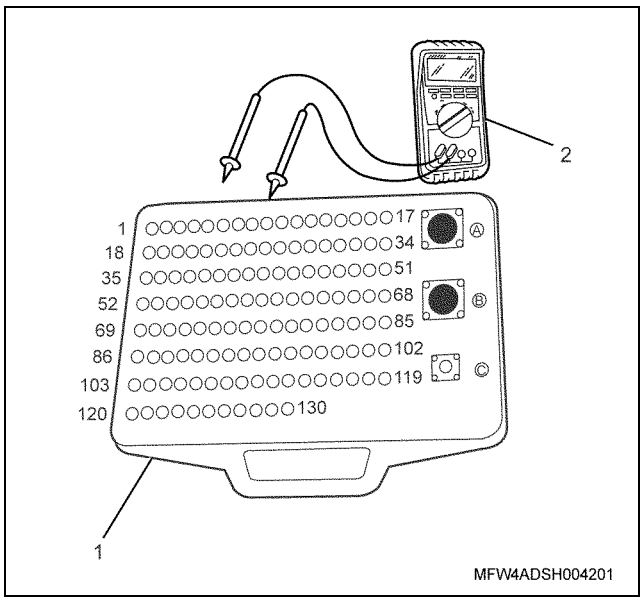
Characteristics of engine oil pressure sensor

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.



Breaker box inspection procedure

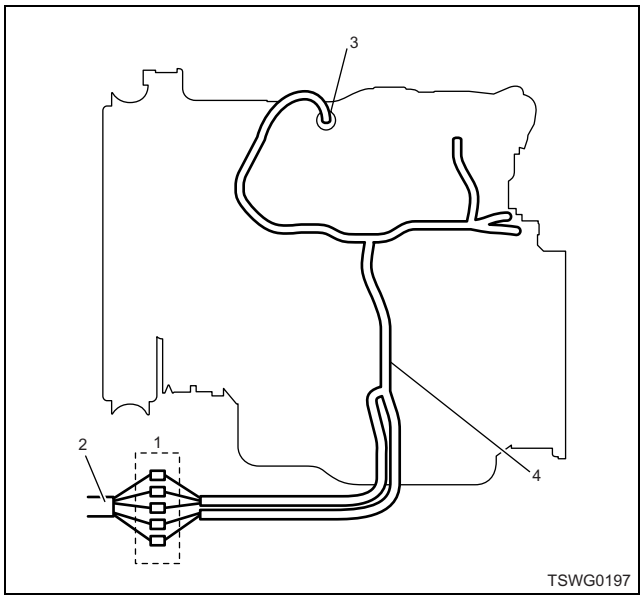
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	67 - 79 67 - GND 80 - 79 80 - GND	10 MΩ or more	100Ω or less

On-board check procedure for sensors

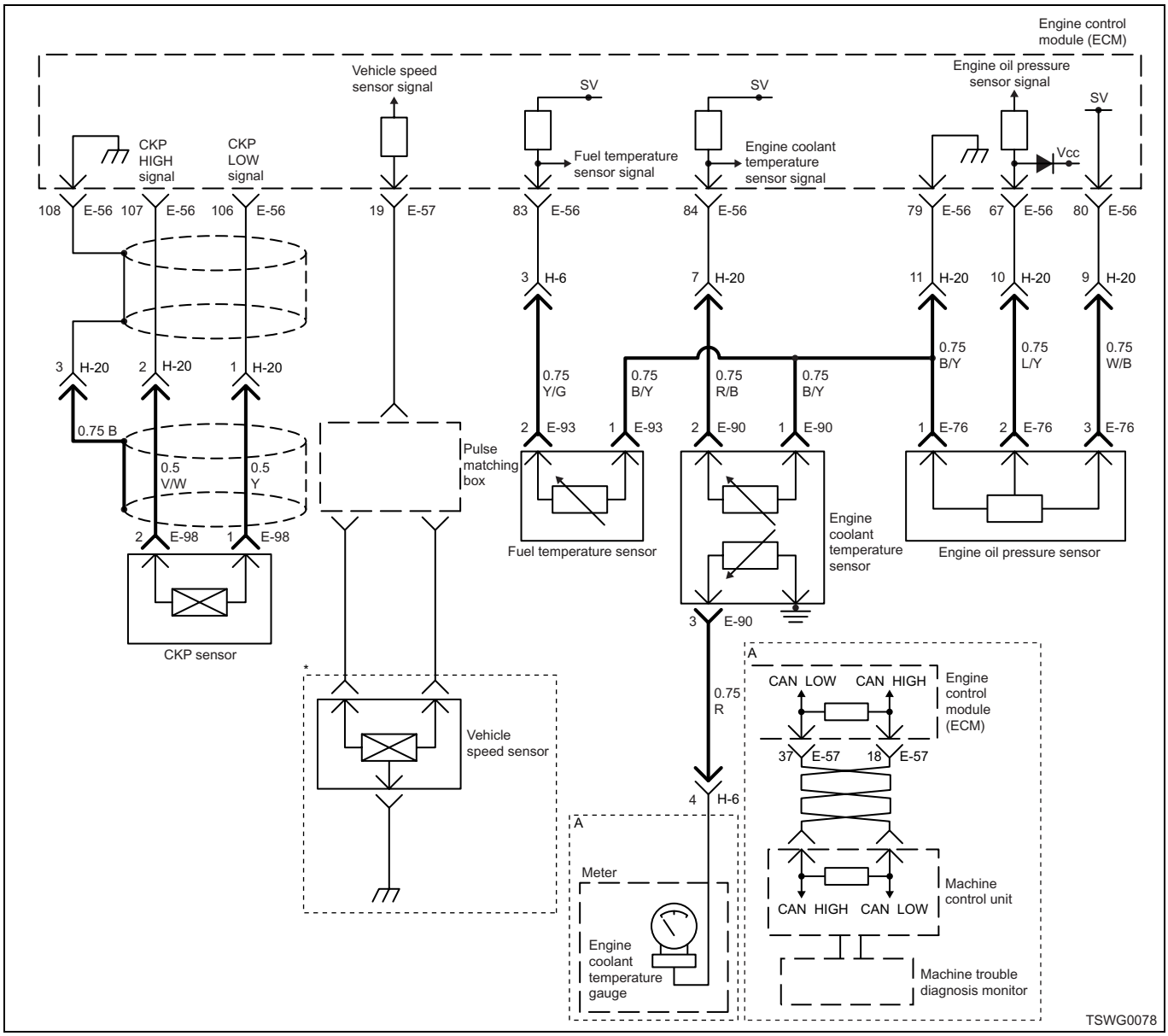


Name
1. Coupling connector between engine — the machine
2. Machine harness
3. Sensor connector
4. Engine harness

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.

DTC: P0523 (Flash code 295) Engine oil pressure sensor fault (high voltage fault, short to power supply, ground short)

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



Description of circuit

The engine oil pressure sensor detects the engine oil pressure. The engine oil pressure sensor is installed near the starter motor of the cylinder block. The resistance value in the engine oil pressure sensor changes according to the pressure. If the pressure is high, the resistance becomes low; if the pressure is low, the resistance becomes high.

The engine control module (ECM) is connected to the engine pressure sensor via power supply circuit, signal circuit and ground circuit, and energizes +5 V power supply to the power supply circuit. The ECM detects the signal voltage change in response to the change in resistance according to the engine pressure sensor pressure (If the pressure is high, the voltage becomes high; if the pressure is low, the voltage becomes low) as a signal.

Main trouble symptom

Operationality is not affected.

Preconditions when DTC is set

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

DTC set condition

- Engine oil pressure sensor voltage is 4.85 V or more.

Action taken when DTC is set

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

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 less than the specified value when terminals between the engine oil 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.	Perform “OBD system check”, and Go to Step 2.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 15.
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” more than the specified value?	4.85V	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 13.	Go to Step 5.

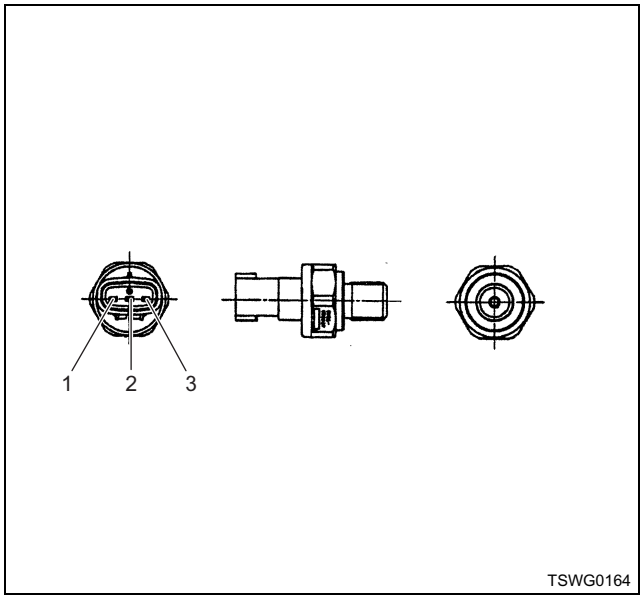
Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the engine oil pressure sensor connector. 3. Short the engine oil pressure sensor connector signal terminal to the ground terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check the value for “Engine oil pressure sensor” using scan tool. Is the “Engine oil pressure sensor” less than the specified value?	0V	Go to Step 9.	Go to Step 6.
6	1. Check the signal circuit between ECM and engine oil 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 engine oil 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 13.	Go to Step 7.
7	1. Check for followings in the signal 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 8.

Step	Action	Value	YES	NO
8	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 10.
9	Replace the engine oil pressure sensor. Is the procedure completed?	—	Go to Step 13.	—
10	Is EMPS available?	—	Go to Step 10.	Go to Step 11.
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 11.
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.	—
13	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 the DTC P0523 detected?	—	Go to Step 2.	Go to Step 14.

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 engine oil pressure. Does the display of engine oil pressure show error value?	1016 kPa (147.4 psi) (Displayed error value)	Go to Step 16.	Go to “Diagnostic aid”.
16	1. Check the signal circuit between ECM and engine oil 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 engine oil 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 13.	Go to Step 17.
17	1. Check for followings in the signal 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 18.

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.

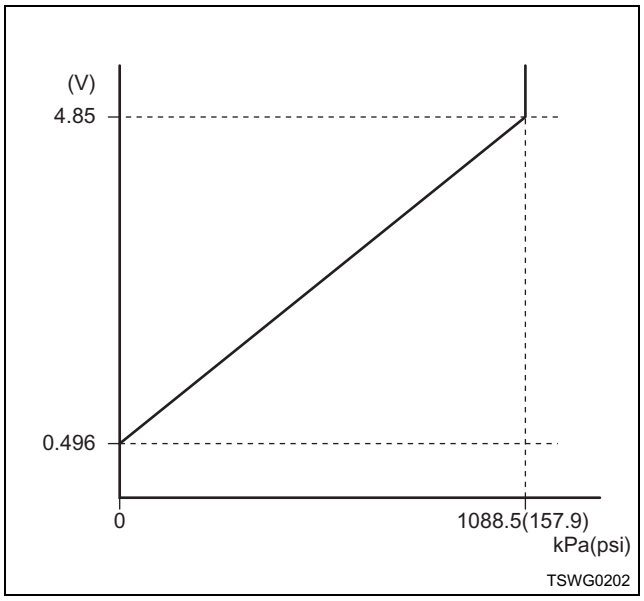
About engine oil pressure sensor



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

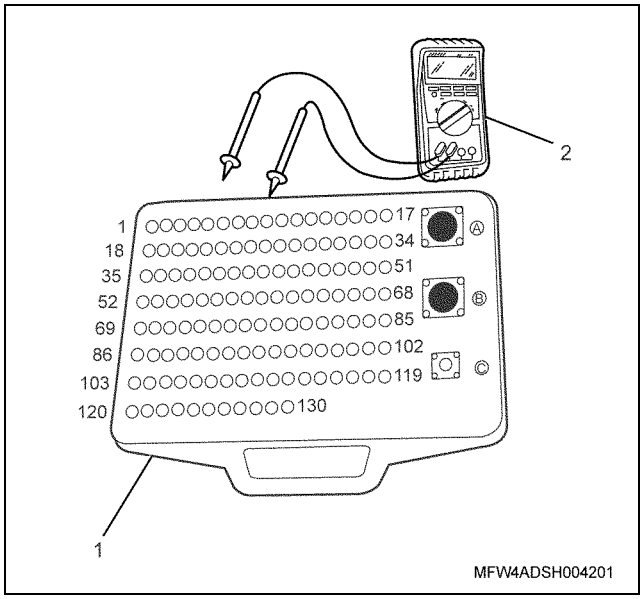
Characteristics of engine oil pressure sensor

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.



Breaker box inspection procedure

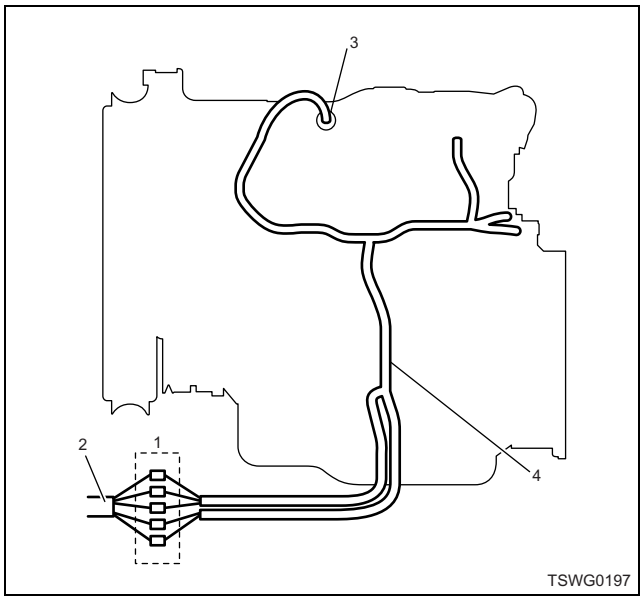
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	67 - GND	0V	18V or more
7	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	67 - Sensor connector signal terminal	100 Ω or less	10 MΩ or more
8	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	79 - Sensor connector ground terminal	100 Ω or less	10 MΩ 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.

DTC: P0601 (Flash code 53) ROM fault

Description of circuit

The internal part of the ECM consists of ROM, EEPROM, CPU, and Sub-CPU, which perform data storage, data clear and various controls.
The ECM sets the DTC when the ROM fault inside the ECM is detected.

Main trouble symptom

Engine stopped

DTC set condition

- ROM fault is detected.
- Reflash failure

Action taken when DTC is set

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

Back-up mode

- Engine 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.

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 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 P0601 detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	Is EMPS available?	—	Go to Step 4.	Go to Step 5.
4	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 6.	Go to Step 5.

Step	Action	Value	YES	NO
5	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 6.	—
6	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

DTC: P0603 (Flash code 54) EEPROM fault

Description of circuit

The internal part of the ECM consists of ROM, EEPROM, CPU, and Sub-CPU, which perform data storage, data clear and various controls.
The ECM sets the DTC when the EEPROM fault inside the ECM is detected.

Main trouble symptom

Operationality is not affected.

DTC set condition

- EEPROM fault is detected.

Action taken when DTC is set

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

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).
- 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	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 P0603 detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	Is EMPS available?	—	Go to Step 4.	Go to Step 5.
4	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 6.	Go to Step 5.

Step	Action	Value	YES	NO
5	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 6.	—
6	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

DTC: P0606 (Flash code 51/52) CPU fault

Description of circuit

The internal part of the ECM consists of ROM, EEPROM, CPU, and Sub-CPU, which perform data storage, data clear and various controls.
The ECM sets the DTC when the CPU fault or Sub-CPU fault inside the ECM is detected.

Main trouble symptom

Output lowering

Preconditions when DTC is set

- 480 msec or more has elapsed after key switch ON.
- Key switch input power supply voltage is higher than 16 V.

DTC set condition

- Sub-CPU detects main CPU fault in 10 msec after key switch ON.
- RUN-SUB pulse does not change for 20 msec or more.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value
- SUB-CPU stops control
- Limited injection amount 1

Recovery from failure

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

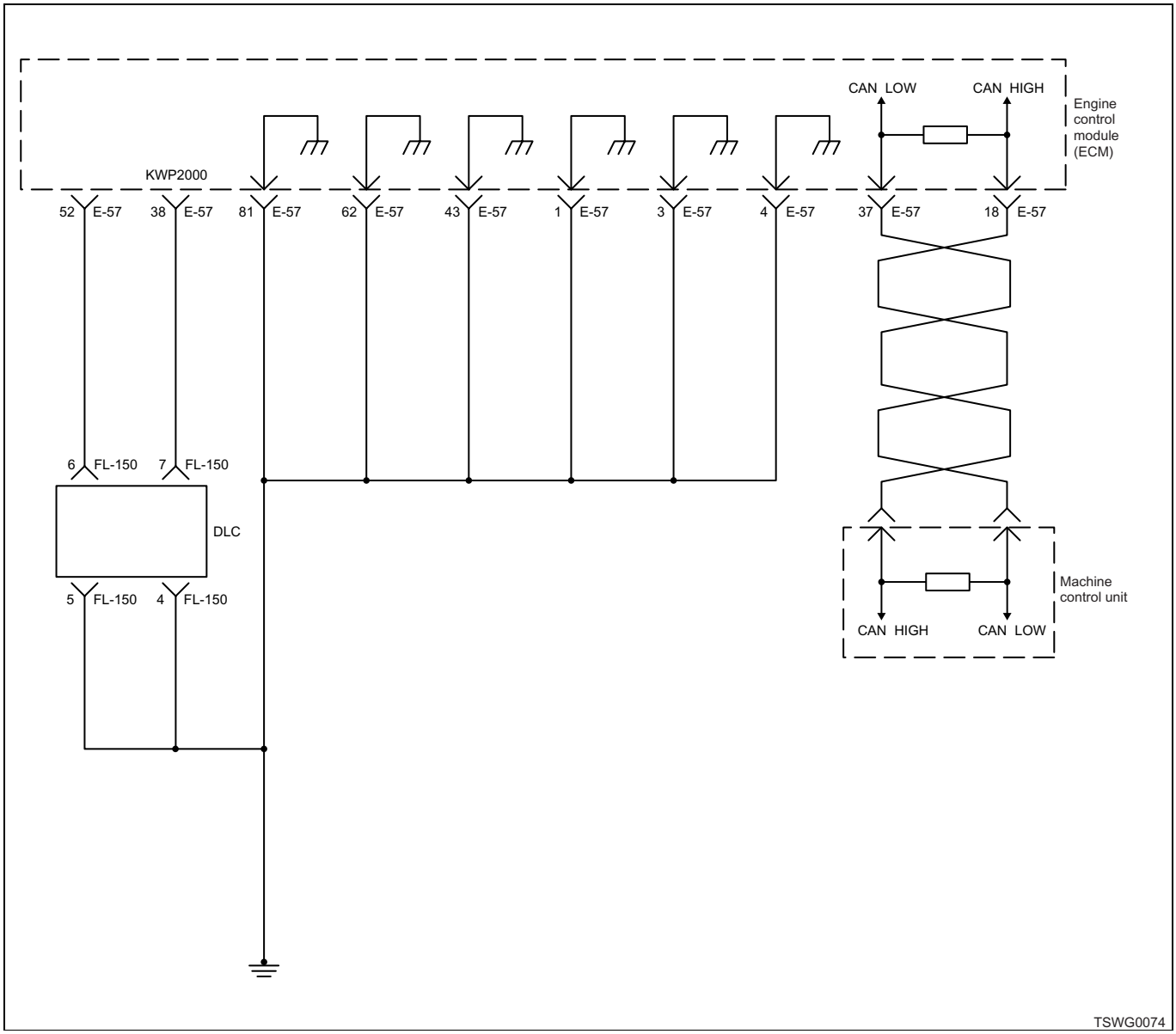
The conditions to clear the MIL/DTC

- 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	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 P0606 detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	Is EMPS available?	—	Go to Step 4.	Go to Step 5.

Step	Action	Value	YES	NO
4	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 6.	Go to Step 5.
5	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 6.	—
6	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

DTC: P0611 (Flash code 34) Charge circuit fault (bank 1)



Description of circuit

The charge circuit inside the ECM is the voltage pressurizing circuit to apply voltage to the injector, and is divided in to two systems for each 3 cylinder. The charge circuit 1 supplies the power supply voltage to the injectors of No. 1 cylinder, No. 2 cylinder, and No. 3 cylinder. The ECM sets the DTC when the voltage in the charge circuit 1 is excessively high or excessively low.

Main trouble symptom

- Intense engine vibration
- Rough idling
- Output lowering
- Engine blow up fault
- Engine stall possible

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.

DTC set condition

- When charge circuit bank 1 voltage inside ECM is low.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

Recovery from failure

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

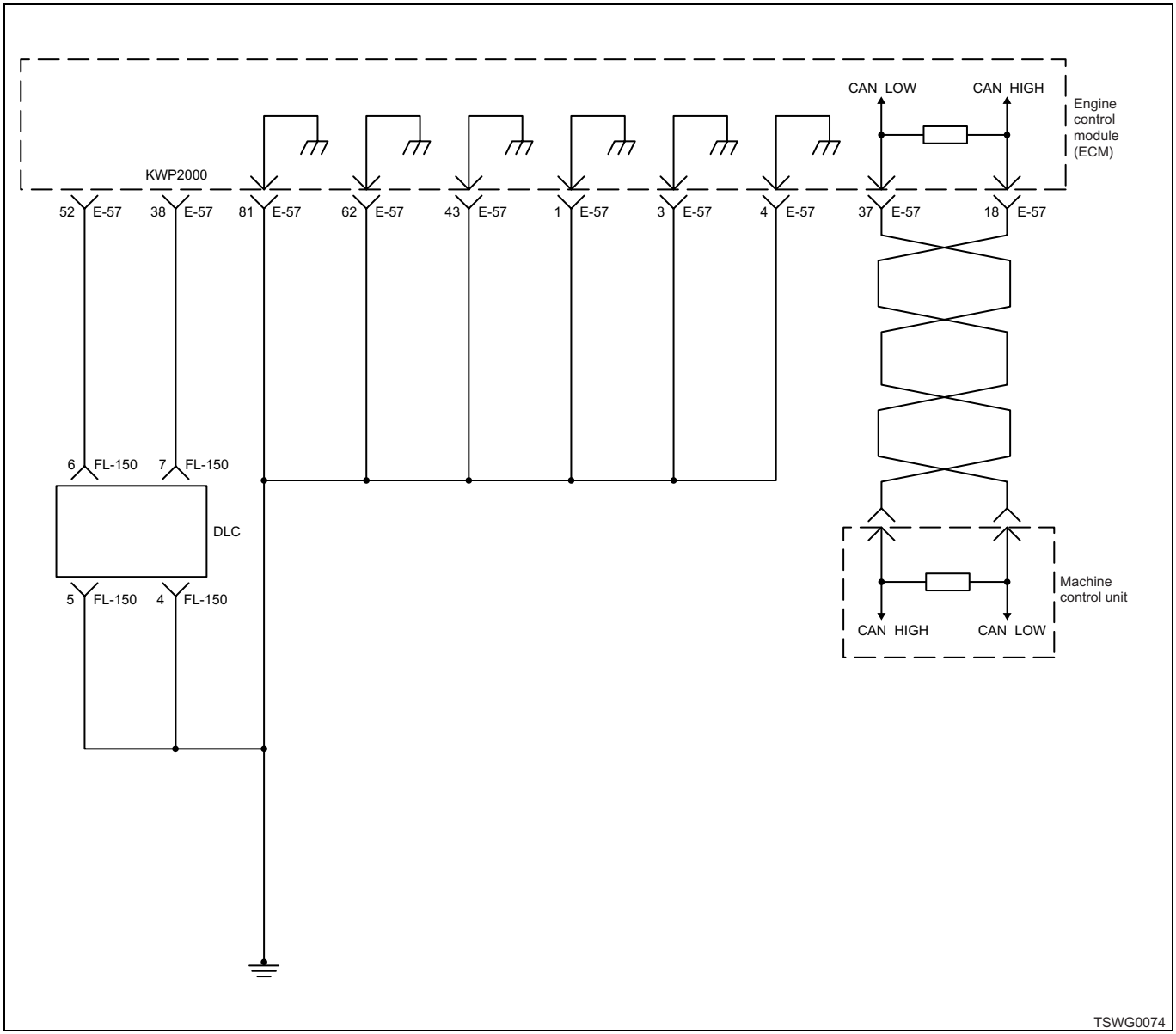
The conditions to clear the MIL/DTC

- 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.

Step	Action	Value	YES	NO
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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P0611 detected?	—	Go to Step 2.	Go to Step 11.
11	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
12	Is DTC P0611 detected?	—	Go to Step 4.	Go to Step 10.

DTC: P0612 (Flash code 34) Charge circuit fault (bank 2)



Description of circuit

The charge circuit inside the ECM is the voltage pressurizing circuit to apply voltage to the injector, and is divided in to two systems for each 3 cylinder. The charge circuit 2 supplies the power supply voltage to the injectors of No. 4 cylinder, No. 5 cylinder, and No. 6 cylinder. The ECM sets the DTC when the voltage in the charge circuit 2 is excessively high or excessively low.

Main trouble symptom

- Intense engine vibration
- Rough idling
- Output lowering
- Engine blow up fault
- Engine stall possible

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.

DTC set condition

- When ECU charge circuit bank 2 voltage is low.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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

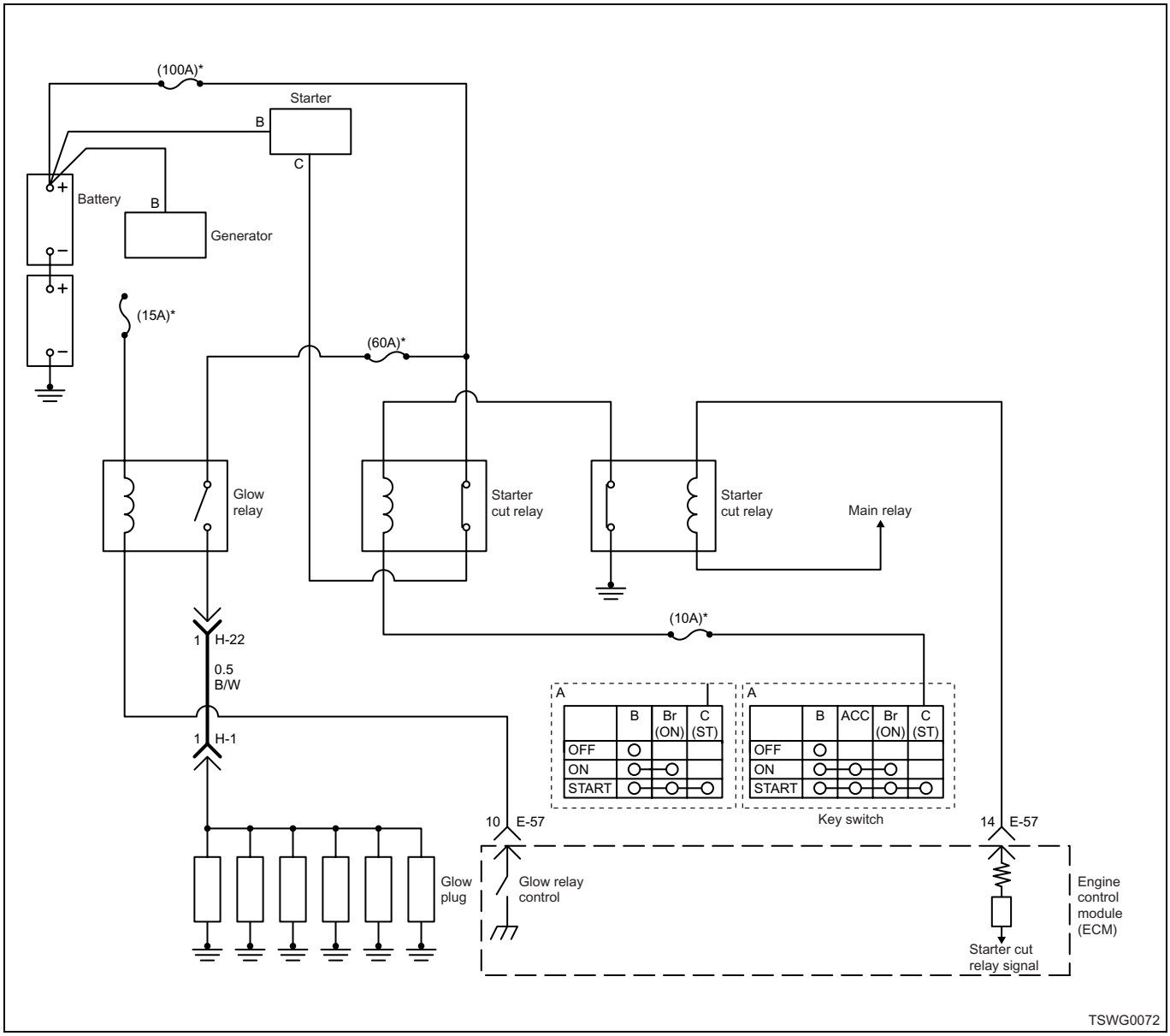
- The present trouble turns to history trouble when the condition is out of the range from DTC set condition (recovery from failure).
- The diagnosis lamp will go off after the code turns to history trouble and the key switch is turned “OFF” then “ON” again.
- Using the scan tool, or memory clear switch 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 P0612 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.

Step	Action	Value	YES	NO
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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P0612 detected?	—	Go to Step 2.	Go to Step 11.
11	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
12	Is DTC P0612 detected?	—	Go to Step 4.	Go to Step 10.

DTC: P0615 (Flash code 19) Starter cut relay circuit fault

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



Description of circuit

The starter cut switch is provided to prevent the starter from operating while the engine is running. The starter cut relay is the normal-close relay, and is located between the main relay and the starter relay. When the key switch is turned to “ON”, the ECM sends the signal to the starter cut relay to turn the relay “OFF”. When starting the engine, once the key switch is turned to “START” position, the ECM stops the signal output to the starter cut relay, and this enables the relay to turn “ON”. After starting the engine, when the key switch returns to “ON” position, the ECM sends the signal to the starter cut relay again to turn the relay “OFF”. A monitor circuit is provided inside the ECM to monitor the relay operation.
The ECM sets the DTC when the output to the starter cut relay does not match with the starter cut relay operation.

Main trouble symptom

Operationality is not affected.

Preconditions when DTC is set

- Key switch input power supply voltage is higher than 16 V but lower than 32 V.

DTC set condition

- No starter cut relay monitor signal exists against starter cut relay drive signal.

Action taken when DTC is set

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

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).
- 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.
7. Measure using the breaker box.
10. Measure using the breaker box.
12. Measure using the breaker box.

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	1. Turn the key switch to “OFF”. 2. Remove the ECM connector, and install the breaker box. 3. Connect the DMM between the starter cut relay drive terminal and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	24V	Go to Step 3.	Go to Step 4.
3	1. Connect the DMM between the starter cut relay drive terminal and the ground. 2. Turn the key switch to “START” position, and crank the engine. Is the DMM indication less than the specified value?	0V	Go to “Diagnostic aid”.	Go to Step 8.
4	Check for installation condition of the starter cut 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 16.	Go to Step 5.

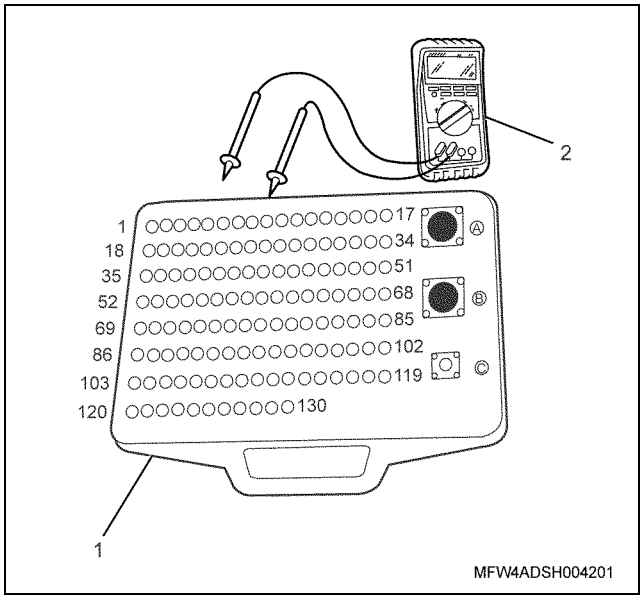
Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Remove the starter cut relay. 3. Short between the terminals 2 - 4 in the starter cut relay installing portion using jump cable. 4. Connect the DMM between the starter cut relay drive terminal of the ECM and the ground. 5. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	24V	Go to Step 12.	Go to Step 6.
6	1. Check for following in the circuit between the fuse and the starter cut relay. • Open circuit • Short circuit to ground circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 16.	Go to Step 7.
7	1. Check for followings in the circuit between starter cut relay and ECM 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 • Short circuit to ground circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 16.	Go to Step 13.
8	Is the scan tool (KW communication) available?	—	Go to Step 9.	Go to Step 10.
9	1. Turn the key switch to “START” position, and crank the engine. 2. Check for “Starter switch (ST)” on the data display using scan tool. Is the “Starter switch (ST)” displayed “ON”?	—	Go to Step 11.	Go to Step 10.

Step	Action	Value	YES	NO
10	1. Check for followings in the circuit between the ST terminal of the key switch and the ECM 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 • Short circuit to ground circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 17.	Go to Step 14.
11	1. Turn the key switch to “OFF”. 2. Remove the starter cut relay. 3. Connect the DMM between the starter cut relay drive terminal of the ECM and the ground. 4. Turn the key switch to “ON”. Is the DMM indication less than the specified value?	0V	Go to Step 13.	Go to Step 12.
12	1. Check the circuit between starter cut relay and ECM 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 13.	Go to Step 14.
13	Replace the starter cut relay. Is the procedure completed?	—	Go to Step 17.	—
14	Is EMPS available?	—	Go to Step 15.	Go to Step 16.

Step	Action	Value	YES	NO
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.	—
17	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. Check the DTC. Is DTC P0615 detected?	—	Go to Step 2.	Go to Step 16.
18	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

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.

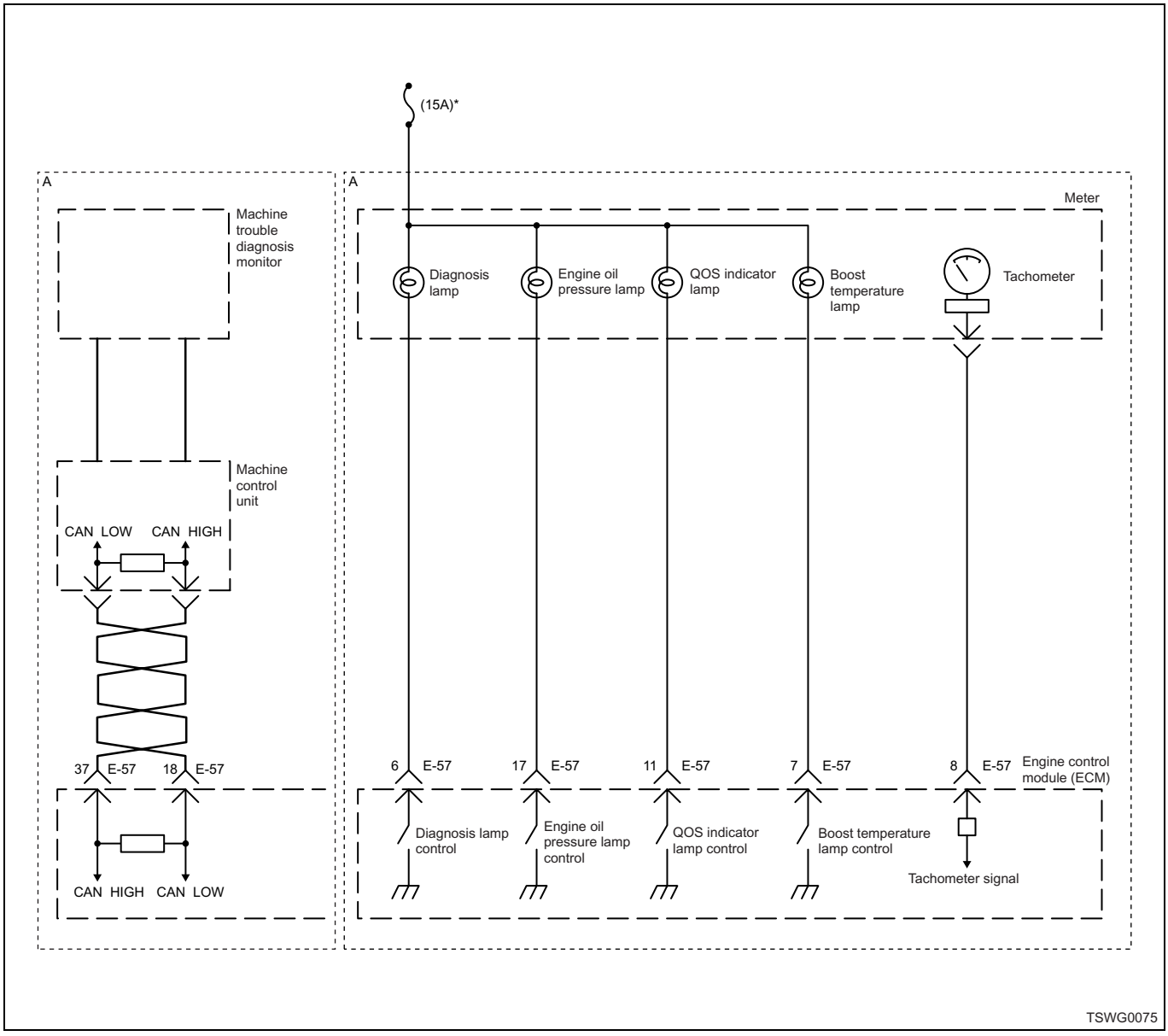


Name
1. Breaker box
2. DMM

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

DTC: P0650 (Flash code 77) Diagnosis lamp circuit fault

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



Description of circuit

The power supply voltage is supplied to the diagnosis lamp via key switch, and the signal from ECM will turn the lamp on. The ECM turns the diagnosis lamp on during lamp check with the key switch “ON” and when DTC is detected. Also when the diagnosis connector is connected, it blinks the diagnosis lamp according to the DTC detected. A monitor circuit is provided inside the ECM to monitor the lamp operation.
The ECM sets the DTC when the output to the diagnosis lamp does not match with the check engine lamp operation.

Main trouble symptom

Operationality is not affected.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P0650 is not detected.

DTC set condition

- No diagnosis lamp monitor signal exists.

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).
- 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.
2. If the lamp does not come on with the key switch “ON”, open circuit, short circuit to the ground circuit, blown light bulb, or ECM fault is suspected.
2. If the lamp does not go OFF, short circuit to the ground circuit, meter circuit fault, or ECM fault is suspected.
4. If the lamp goes off when the ECM connector is removed, the circuit beyond the ECM is normal including meter.
7. If the lamp comes on when the lamp control terminal is shorted to the ground, the circuit beyond the ECM is normal including meter.

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	1. Turn the key switch to “ON”. 2. Check if the diagnosis lamp is ON. Does the diagnosis lamp come on?	—	Go to Step 3.	Go to Step 7.
3	Turn the key switch “ON” and wait for 30 seconds. Does the diagnosis lamp go OFF?	—	Go to “Diagnostic aid”.	Go to Step 4.
4	1. Turn the key switch to “OFF”. 2. Remove the connector from the ECM. 3. Turn the key switch to “ON”. 4. Check if the diagnosis lamp is ON. Does the diagnosis lamp go OFF?	—	Go to Step 12.	Go to Step 5.
5	Check for installation condition of the meter, 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 16.	Go to Step 6.

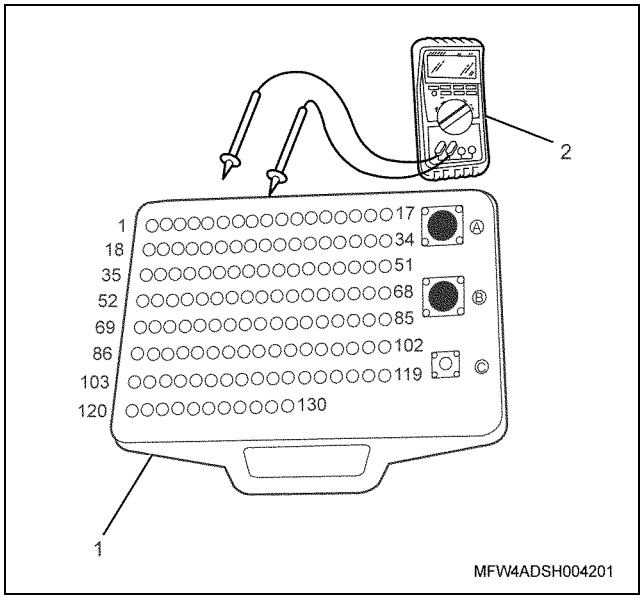
Step	Action	Value	YES	NO
6	1. Check the circuit between diagnosis lamp and ECM for ground short circuit using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 16.	Go to Step 11.
7	1. Turn the key switch to “OFF”. 2. Remove the connector from the ECM. 3. Short between the diagnosis lamp control terminal of the ECM and the ground 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”.** 4. Turn the key switch to “ON”. 5. Check if the diagnosis lamp is ON. Does the diagnosis lamp come on?	—	Go to Step 13.	Go to Step 8.
8	Check for installation condition of the meter, 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 16.	Go to Step 9.
9	1. Check for following in the circuit between the fuse and the diagnosis lamp. • Open circuit • Short circuit to ground circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 16.	Go to Step 10.

Step	Action	Value	YES	NO
10	1. Check for followings in the circuit between diagnosis lamp and ECM 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 16.	Go to Step 12.
11	Replace the meter. Is the procedure completed?	—	Go to Step 16.	—
12	Replace the diagnosis lamp bulb. Is the procedure completed?	—	Go to Step 16.	—
13	Is EMPS available?	—	Go to Step 14.	Go to Step 15.
14	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 16.	Go to Step 15.
15	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 16.	—

Step	Action	Value	YES	NO
16	Check if DTC is not detected 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 the procedure completed?	—	Go to Step 17.	—
17	Check if DTC is detected. (DTC for entire engine control) Is DTC detected?	—	Go to the related “Inspection method by DTC”.	Verify repair.

Breaker box inspection procedure

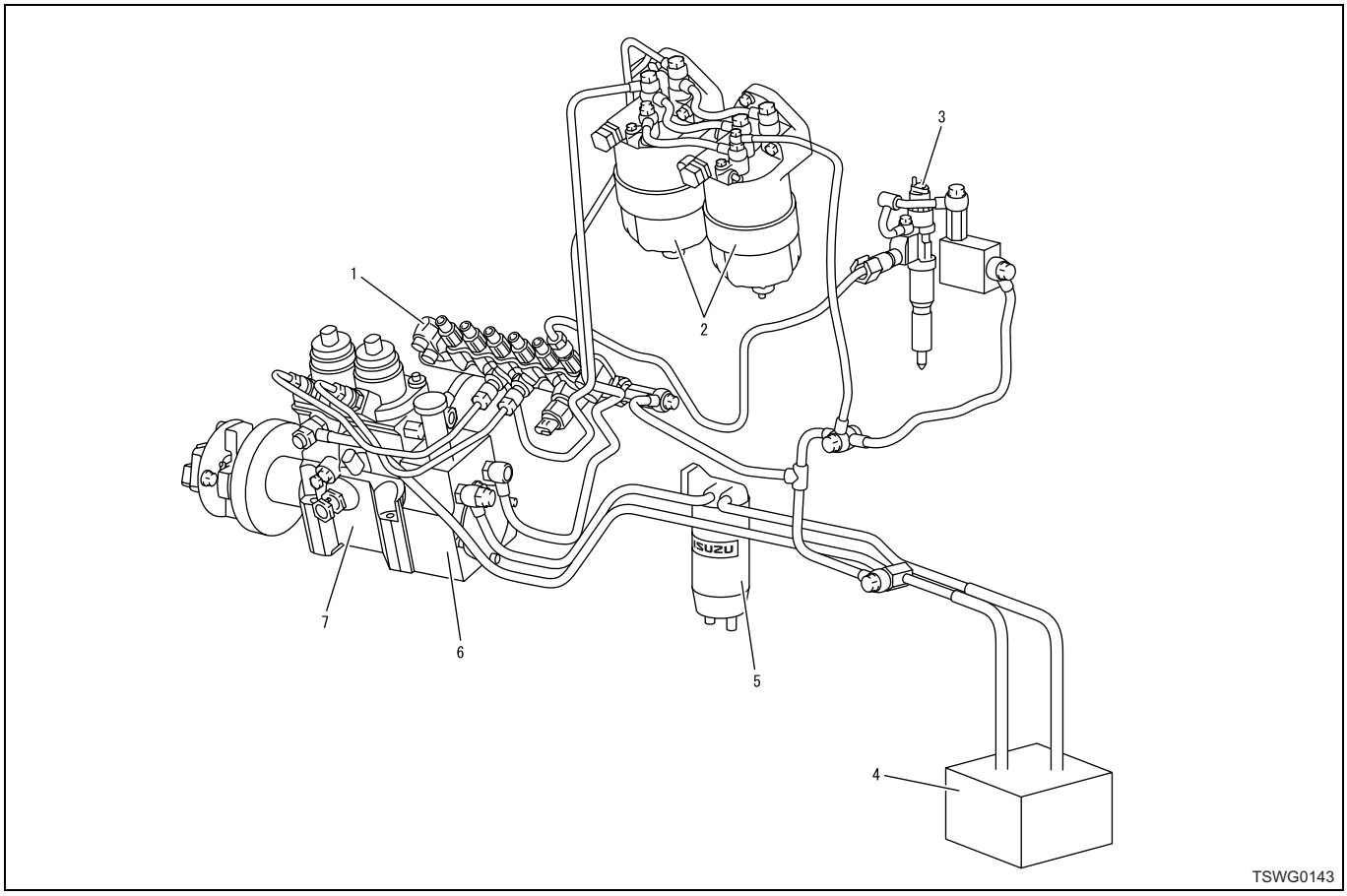
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

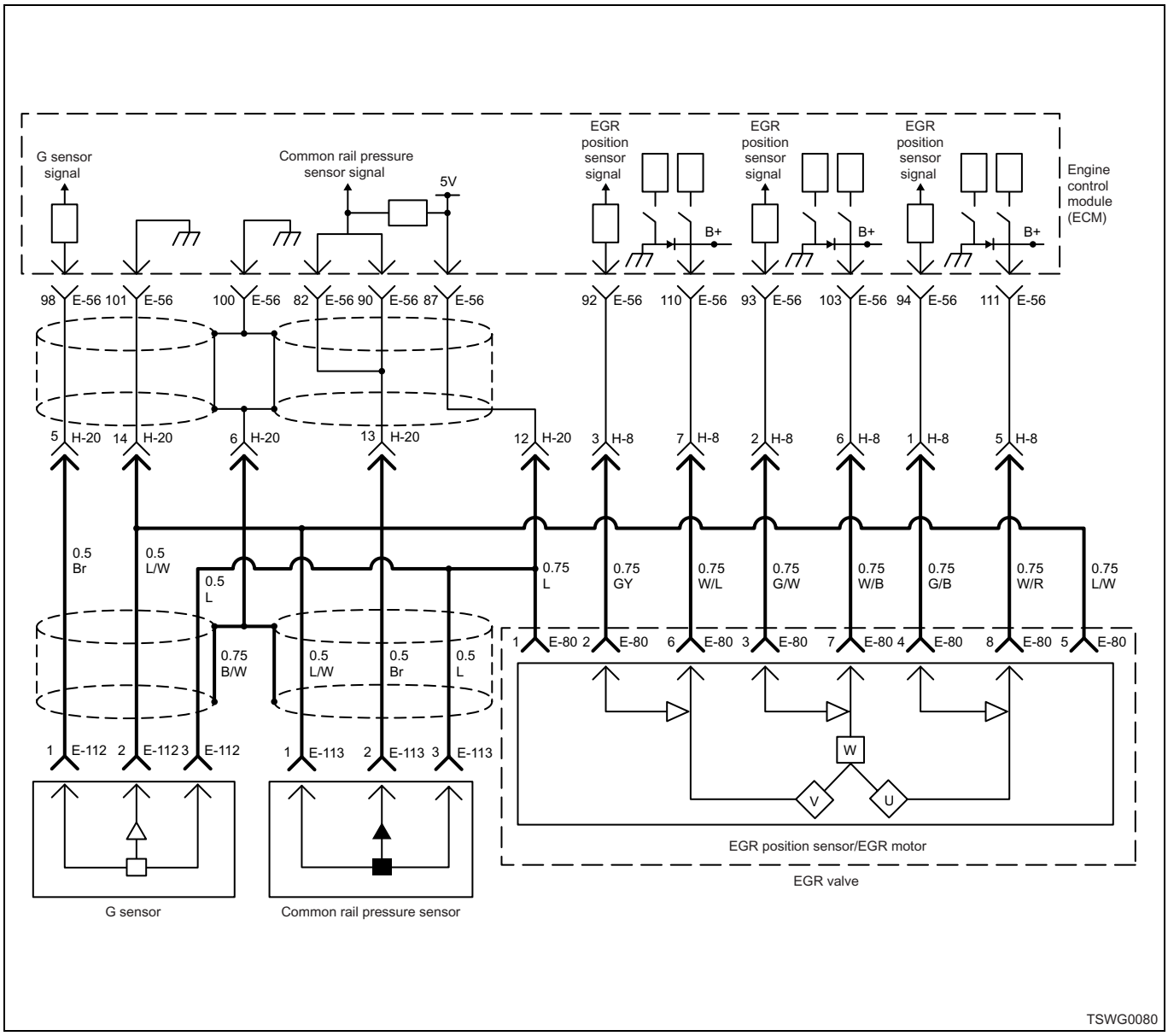
Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to ground	Resistance measurement	• Remove the meter connector. • Key switch “OFF”	6 - Ground	10 MΩ or more	100 Ω or less
10	Open circuit/ high resistance	Resistance measurement	• Remove the meter connector. • Key switch “OFF”	6 - Meter connector diagnosis lamp terminal	100 Ω or less	10 MΩ or more

DTC: P1093 (Flash code 227) No pump pressure feed (2nd stage)



Name

1. Common rail
2. Fuel filter
3. Injector
4. Fuel tank
5. Pre-filter
6. Feed pump
7. Supply pump



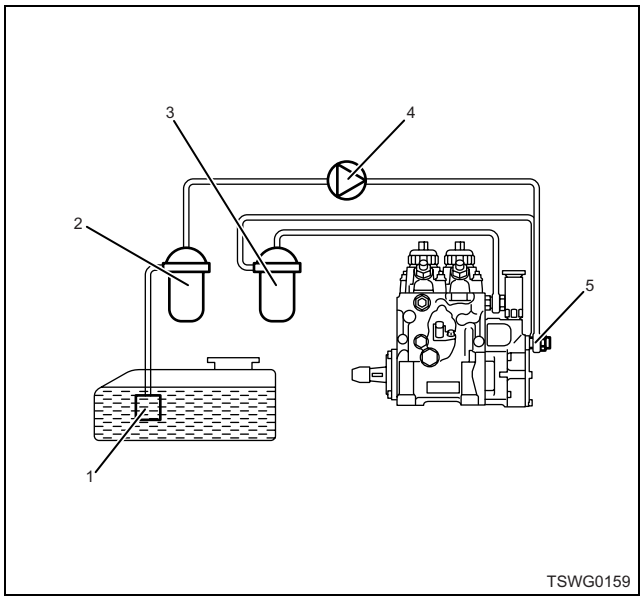
Description of circuit

The supply pump sucks fuel from the fuel tank using the trochoid-type feed pump located inside of the supply pump. The sucked fuel is sent through the PCV to the two plungers located inside the supply pump, and is pressurized and sent to the common rail. The PCV opening angle controls the fuel flow; if the PCV drive duty is large, the PCV opening angle becomes small resulting in less fuel flow. The ECM drives the PCV by calculating the target common rail pressure, target fuel flow, etc. based on the information from each sensor.
The ECM sets the DTC when the PCV drive duty, or the target fuel flow and target common rail pressure exceed certain amount.

Main trouble symptom

- Intense engine vibration
- Rough idling
- Output lowering
- Engine blow up fault
- Black smoke emitted
- Engine stall

Fuel system filter



Name
1. Fuel pump strainer
2. Pre-fuel filter
3. Main fuel filter
4. Electromagnetic pump filter
5. Gauze filter

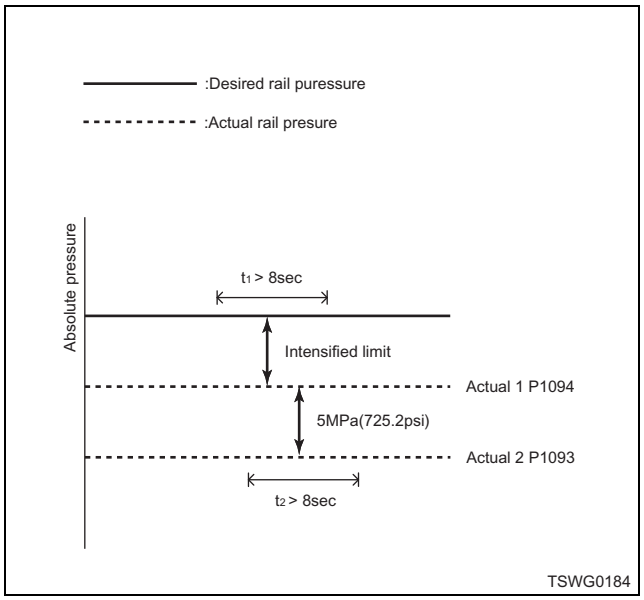
Filter clogging in the fuel system may establish the DTC set condition. Check as required.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P0192, P0193, P1093, P0091, P0092, P1291, P1292, or P1635 is not detected.
- Coolant temperature is 60°C (140°F) or more, and 375 rpm or more.

DTC set condition

- When “No pump pressure feed (1st stage)” is completed, actual rail pressure lower than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more.
- Pressure feed indication is limit +1°CA or less, and actual rail pressure lower than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more.



Action taken when DTC is set

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

Back-up mode

- Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})

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

Followings are suspected as the cause.

- Injector internal trouble
- Supply pump internal trouble
- Fuel system pipe fault (fuel leakage, clogging, crush, etc.)
- Fuel filter fault (clogging)
- Fuel tank fault (clogging)
- Pressure limiter trouble (operation under specified pressure, degradation of sealability)
- ECM trouble
- Common rail pressure sensor trouble

Test description

Numbers below indicate step numbers in the chart.
6. When rise of fuel level or diesel fuel odor is confirmed, fuel leakage in the injector portion may be the cause of the DTC detection.
12. If the “Common rail pressure sensor” displays more than the specified value when the common rail pressure sensor connector is removed, the circuit beyond the sensor is normal including ECM.

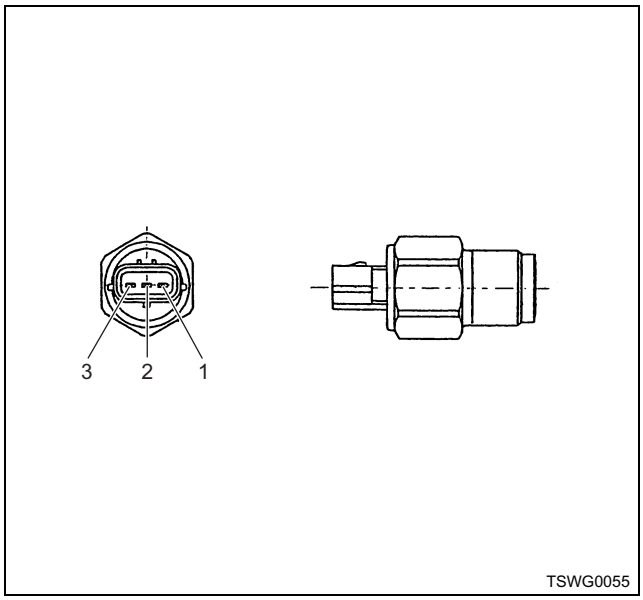
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Check the fuel system in the following procedure. 1. Check the high pressure pipe and low pressure pipe for looseness in the connection (fuel leakage), crush or clogging. Check 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. Is the fuel system normal?	—	Go to Step 6.	Go to Step 3.
3	Check the electromagnetic pump. 1. Turn the key switch to ON. 2. Press the fuel hose with finger to check for pulsation. **Note:** **The electromagnetic pump may not be installed depending on specifications of the machine.** Is the trouble detected?	—	Go to Step 4.	Go to Step 6.
4	Check the electromagnetic pump power supply. 1. Turn the key switch to OFF. 2. Disconnect the electromagnetic pump connector. 3. Turn the key switch to ON. 4. Check for voltage of the electromagnetic pump connector using DMM. Is the voltage specified value?	24V	Go to Step 5.	—
5	Repair or replace the faulty part. Is the procedure completed?	—	Go to Step 19.	—

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
12	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Turn the key switch to “ON”. 4. Check for “Common rail pressure sensor” on the data display using scan tool. Is the “Common rail pressure sensor” more than the specified value?	4.8V	Go to Step 17.	Go to Step 13.
13	1. Check the signal circuit between common rail pressure 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 20.	Go to Step 14.
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 20.	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 20.	—
17	Replace the common rail (common rail pressure sensor). **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 20.	—

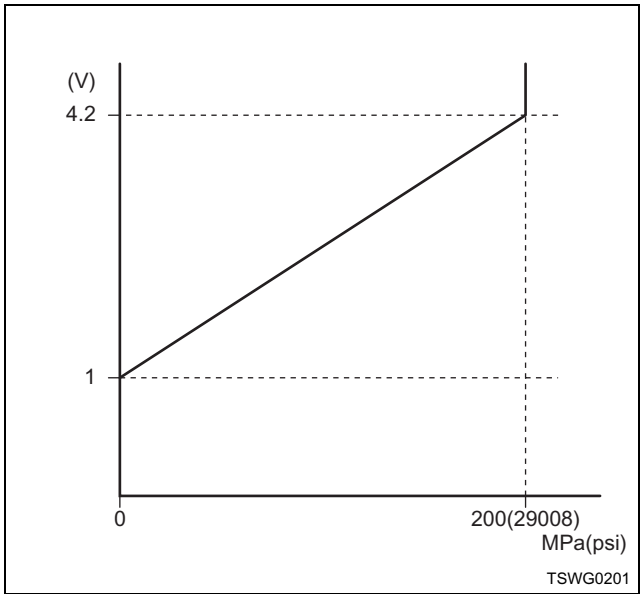
Step	Action	Value	YES	NO
18	1. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 2. Start the engine. 3. Select the “Actuator test” from the menu. 4. Select the “Rail pressure control” in the “Common rail system”. 5. Press the “Up” soft key to check the value of “Common rail pressure”. Is “Common rail pressure” within the specified value?	±5 MPa (±725 psi)	Go to Step 20.	Go to Step 19.
19	Replace the supply pump. **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 20.	—
20	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 P1093 detected?	—	Go to Step 2.	Go to Step 21.
21	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
22	Check the injector using injector checker. Refer to “How to use injector checker” in this section for how to use injector checker. 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 13.

About common rail pressure sensor



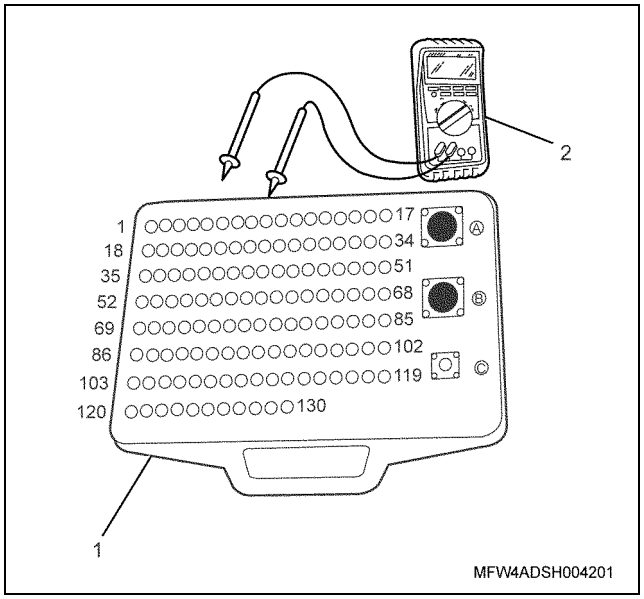
Name
1. Sensor ground
2. Sensor signal
3. Sensor power supply

Characteristics of common rail pressure sensor



Breaker box inspection procedure

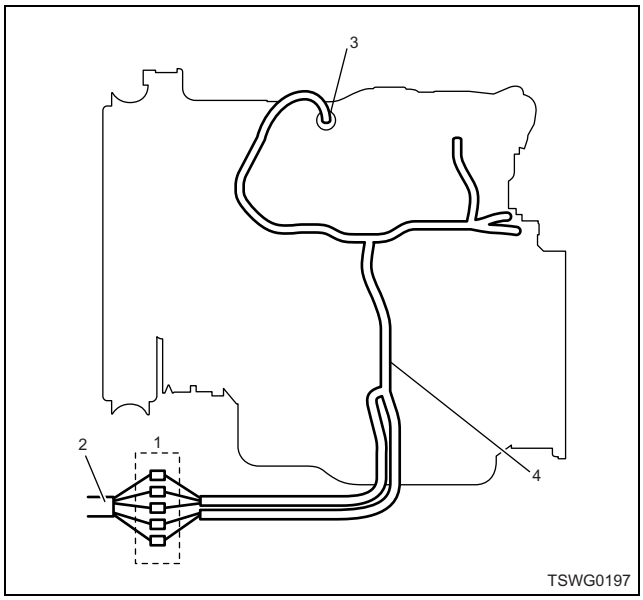
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
13	Short circuit to other signal circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	82 - Ground 90 - Ground	0V	1V or more

On-board check procedure for sensors

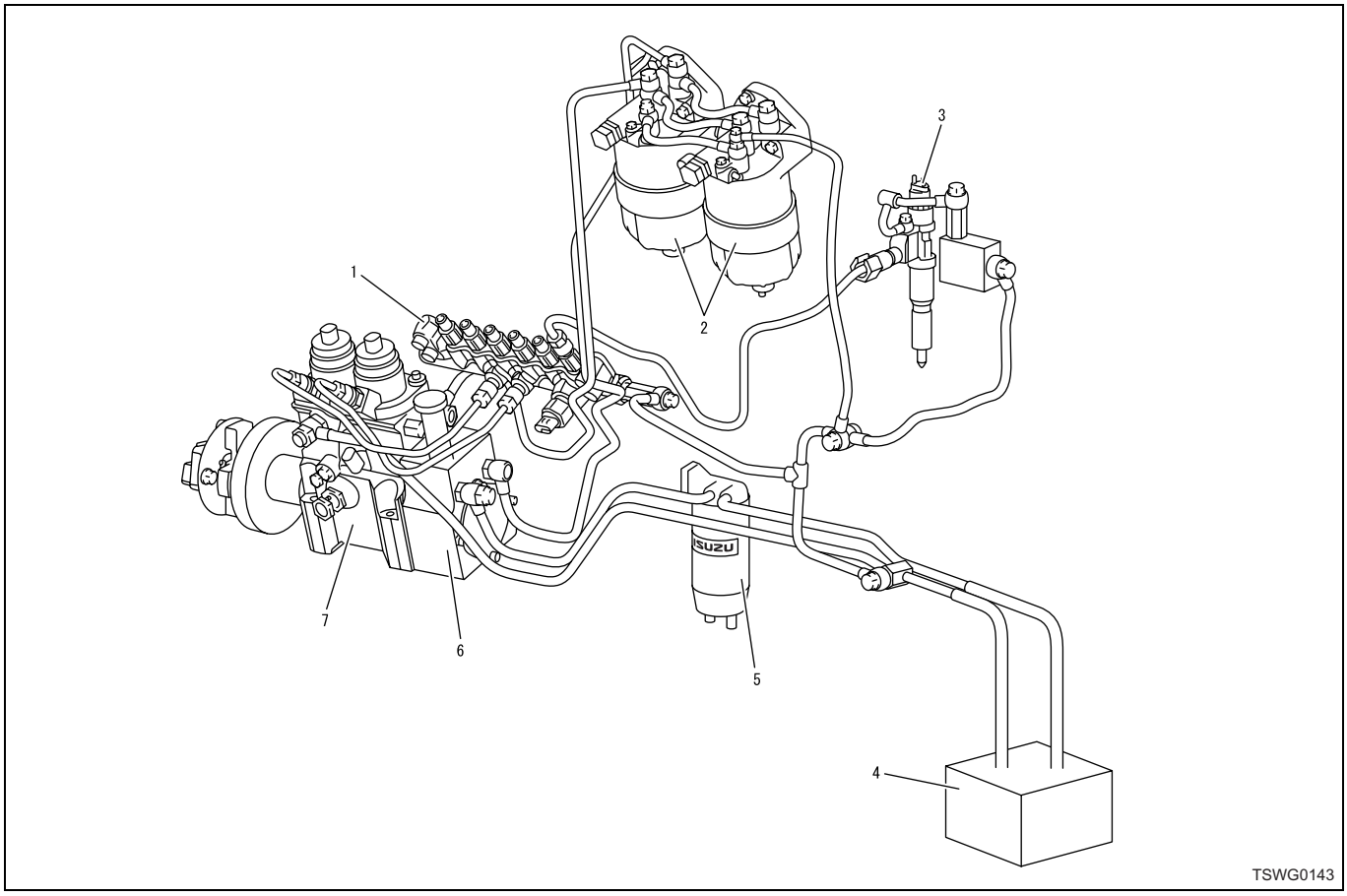


Name

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

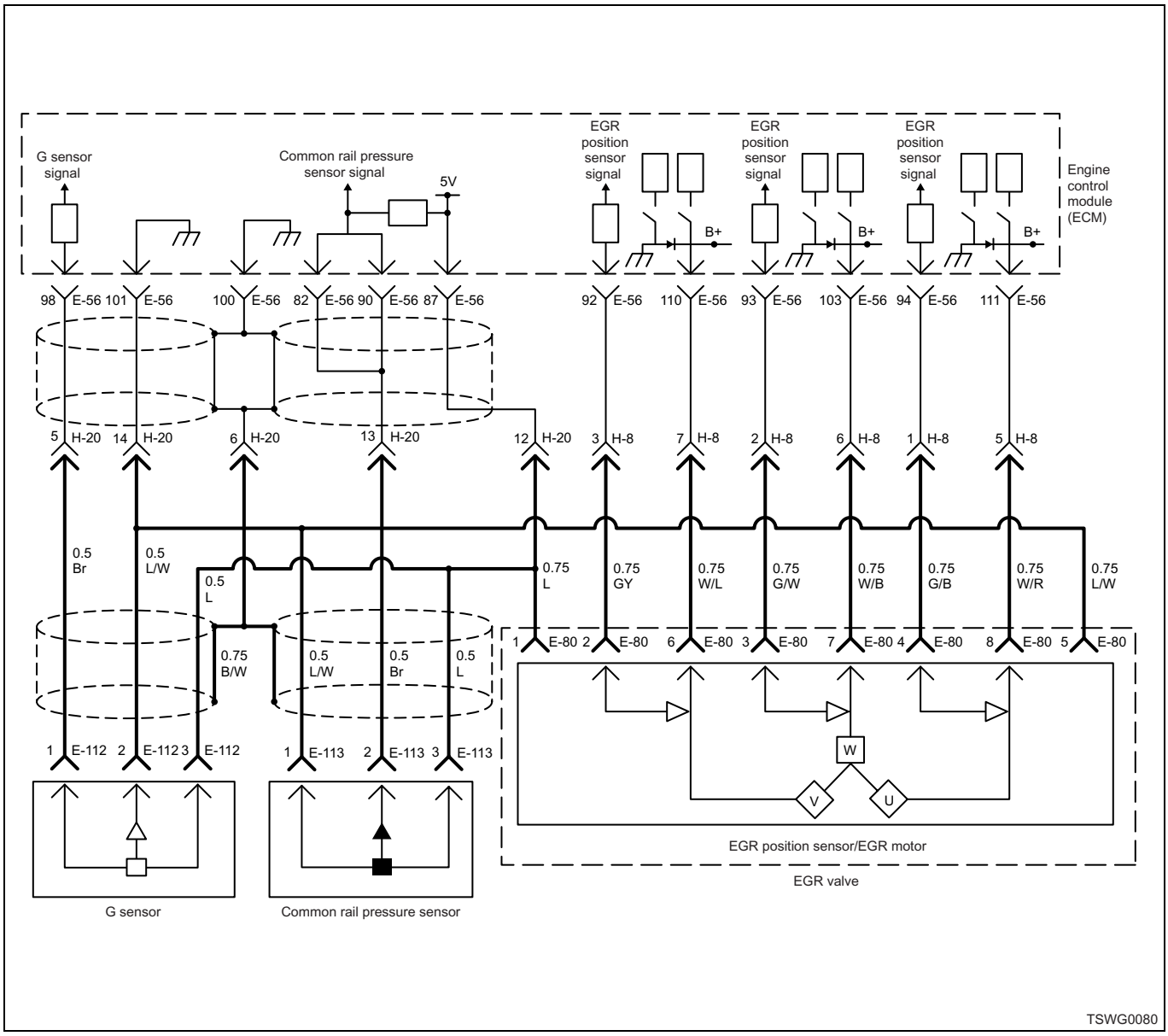
1. Disconnect the coupling connector, and check the sensor from engine harness connector.
2. Disconnect the connector from sensor, and short the wiring of sensor connector.
3. Check the harness from coupling connector for open circuit.
   - If both steps 1 and 2 are faulty, repair the harness. Check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

DTC: P1094 (Flash code 226) No pump pressure feed (1st stage)



Name

1. Common rail
2. Fuel filter
3. Injector
4. Fuel tank
5. Pre-filter
6. Feed pump
7. Supply pump



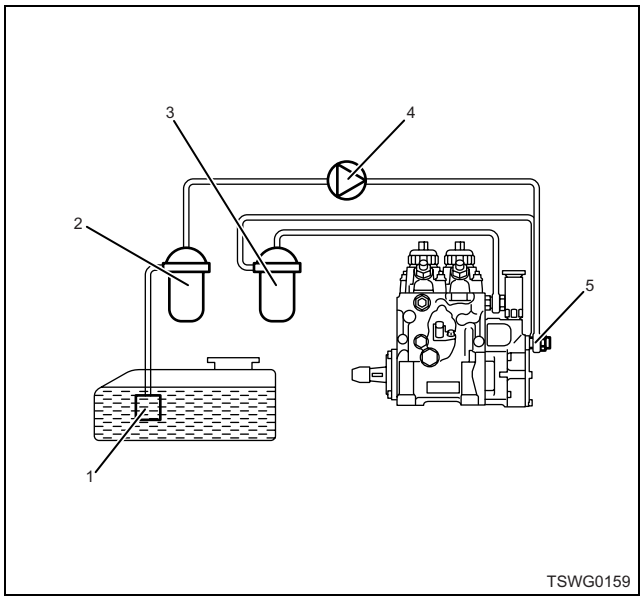
Description of circuit

The supply pump sucks fuel from the fuel tank using the trochoid-type feed pump located inside of the supply pump. The sucked fuel is sent through the PCV to the two plungers located inside the supply pump, and is pressurized and sent to the common rail. The PCV opening angle controls the fuel flow; if the PCV drive duty is large, the PCV opening angle becomes small resulting in less fuel flow. The ECM drives the PCV by calculating the target common rail pressure, target fuel flow, etc. based on the information from each sensor.
The ECM sets the DTC when the actual fuel flow is lower than the target fuel flow, or when the common rail pressure drops sharply.

Main trouble symptom

- Intense engine vibration
- Rough idling
- Output lowering
- Engine blow up fault

Fuel system filter



Name
1. Fuel pump strainer
2. Pre-fuel filter
3. Main fuel filter
4. Electromagnetic pump filter
5. Gauze filter

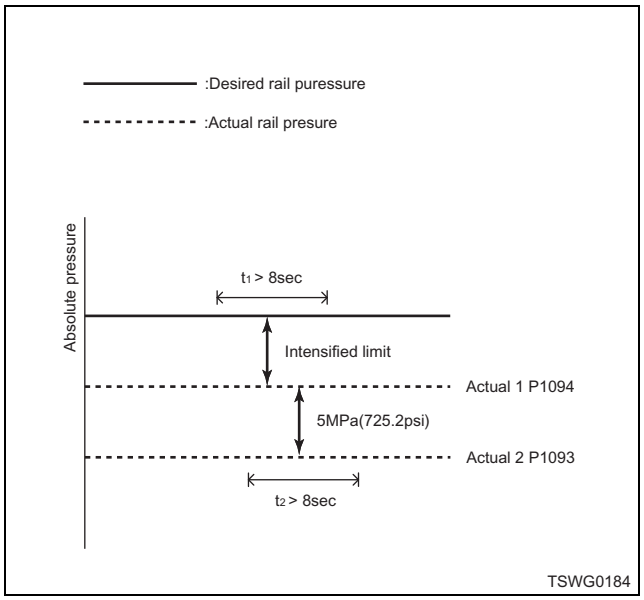
Filter clogging in the fuel system may establish the DTC set condition. Check as required.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P0192, P0193, P1094, P0091, P0092, P1291, P1292, or P1635 is not detected.
- Coolant temperature is 60°C (140°F) or more, and 375 rpm or more.

DTC set condition

- Actual rail pressure lower than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more.
- Pressure feed indication is limit +1°CA or less, and actual rail pressure lower than target rail pressure for 10 MPa (1450 psi) or more holds 8 seconds or more.



Action taken when DTC is set

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

Back-up mode

- Limited injection amount 3 (multi-injection stopped) target RP upper limit (80 MPa {11603 psi})

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
- Excessive air mixed in the fuel.

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 no DTC is detected, mixing of air in the fuel may be the cause of DTC detection.
7. If the “Common rail pressure sensor” displays more than the specified value when the common rail pressure sensor connector is removed, the circuit beyond the sensor is normal including ECM.

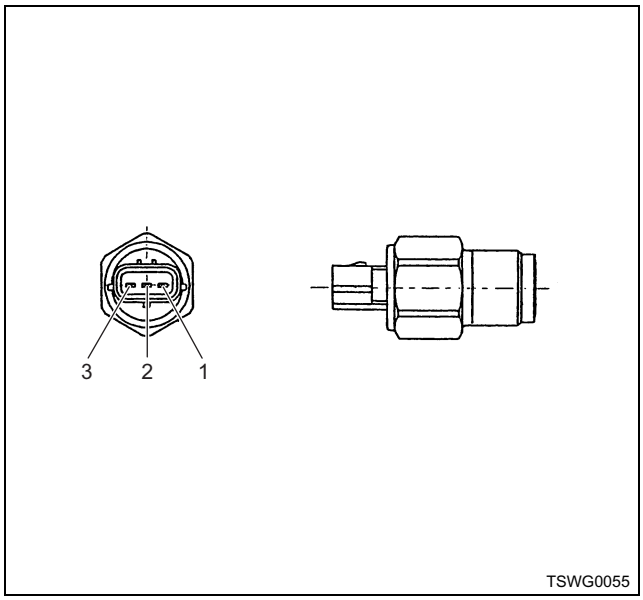
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	1. Start the engine. 2. Check the DTC. Is DTC P0091, P1291, or P1093 not detected?	—	Go to DTC P0091, P1291, or P1093.	Go to Step 3.
3	1. Perform the fuel system check. Check the fuel filter for clogging. If it is dirty, replace the main fuel filter and pre-fuel filter. 2. If the trouble is detected, repair as required. Is the procedure completed?	—	—	Go to Step 4.
4	1. Turn the key switch to “OFF” for more than 10 seconds. 2. Start the engine, and run with the “Preconditions when DTC is set”. 3. Check the DTC. Is DTC P1094 detected?	—	Go to Step 5.	Go to “Diagnostic aid”.
5	Is the scan tool (KW communication) available?	—	Go to Step 6.	Go to Step 19.
6	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 “Rail pressure control” in the “Common rail system”. 5. Press the “Up” soft key to check the value of “Common rail pressure”. Is “Common rail pressure” within the specified value?	±5 MPa (±725 psi)	Go to Step 13.	Go to Step 7.

Step	Action	Value	YES	NO
7	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Turn the key switch to “ON”. 4. Check for “Common rail pressure sensor” on the data display using scan tool. Is the “Common rail pressure sensor” more than the specified value?	4.8V	Go to Step 8.	Go to Step 9.
8	Replace the common rail (common rail pressure sensor). **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 17.	—
9	1. Check the signal circuit between common rail pressure 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 17.	Go to Step 10.
10	1. Connect the common rail pressure sensor connector. 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. Start the engine. 4. Select the “Actuator test” from the menu. 5. Select the “Injection stop at each injector” in the “Common rail system”. 6. 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 11.	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.	—

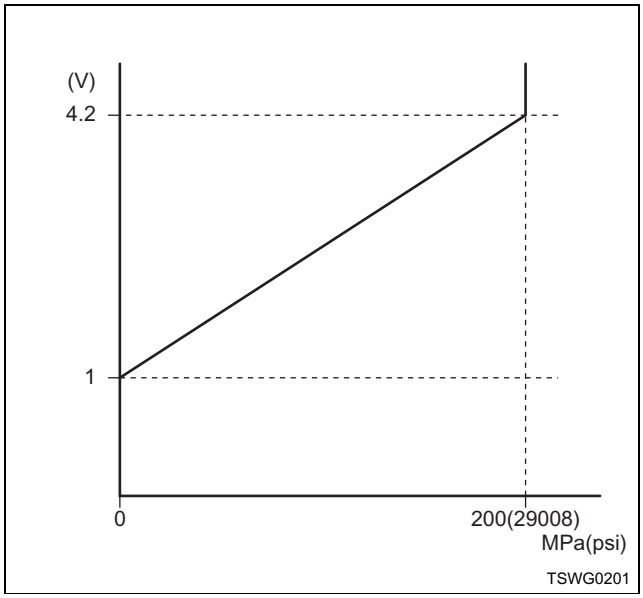
Step	Action	Value	YES	NO
17	Check the DTC again. 1. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 2. Turn the key switch to “OFF” for more than 10 seconds. 3. Start the engine, and run with the “Preconditions when DTC is set”. 4. Check the DTC. Is DTC P1094 detected?	—	Go to Step 2.	Go to Step 18.
18	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
19	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Turn the key switch to “ON”. 4. Connect the DMM between the common rail pressure sensor connector power supply terminal and the ground. Is the DMM indication more than the specified value?	4.8V	Go to Step 8.	Go to Step 20.
20	1. Check the signal circuit between common rail pressure 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 17.	Go to Step 21.
21	Check the injector using injector checker. Refer to “How to use injector checker” in this section for how to use injector checker. Is there any cylinder of which engine vibration and engine sound did not change when it is stopped?	—	Go to Step 11.	Go to Step 12.

About common rail pressure sensor



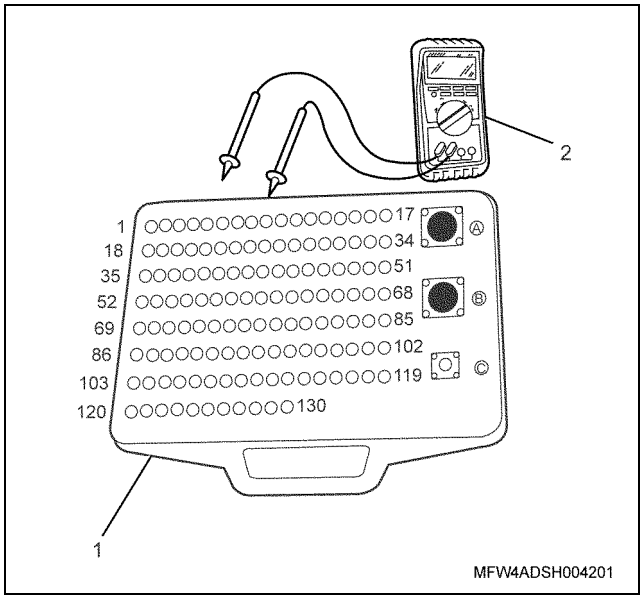
Name
1. Sensor ground
2. Sensor signal
3. Sensor power supply

Characteristics of common rail pressure sensor



Breaker box inspection procedure

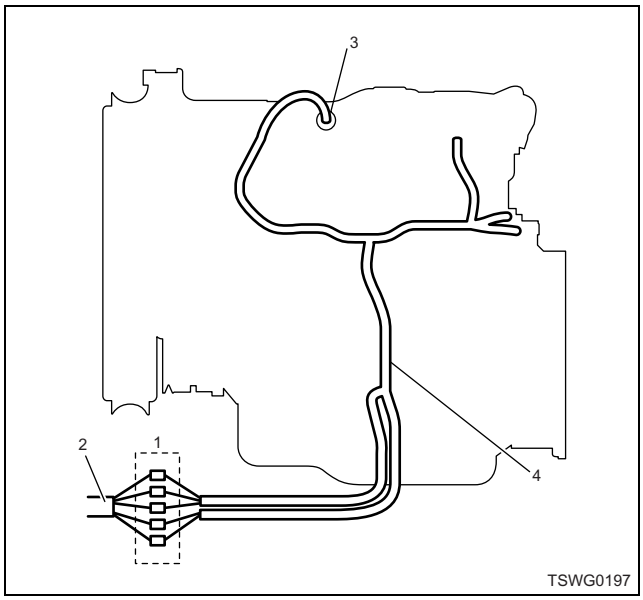
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
9	Short circuit to other signal circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	82 - Ground 90 - Ground	0V	1V or more

On-board check procedure for sensors



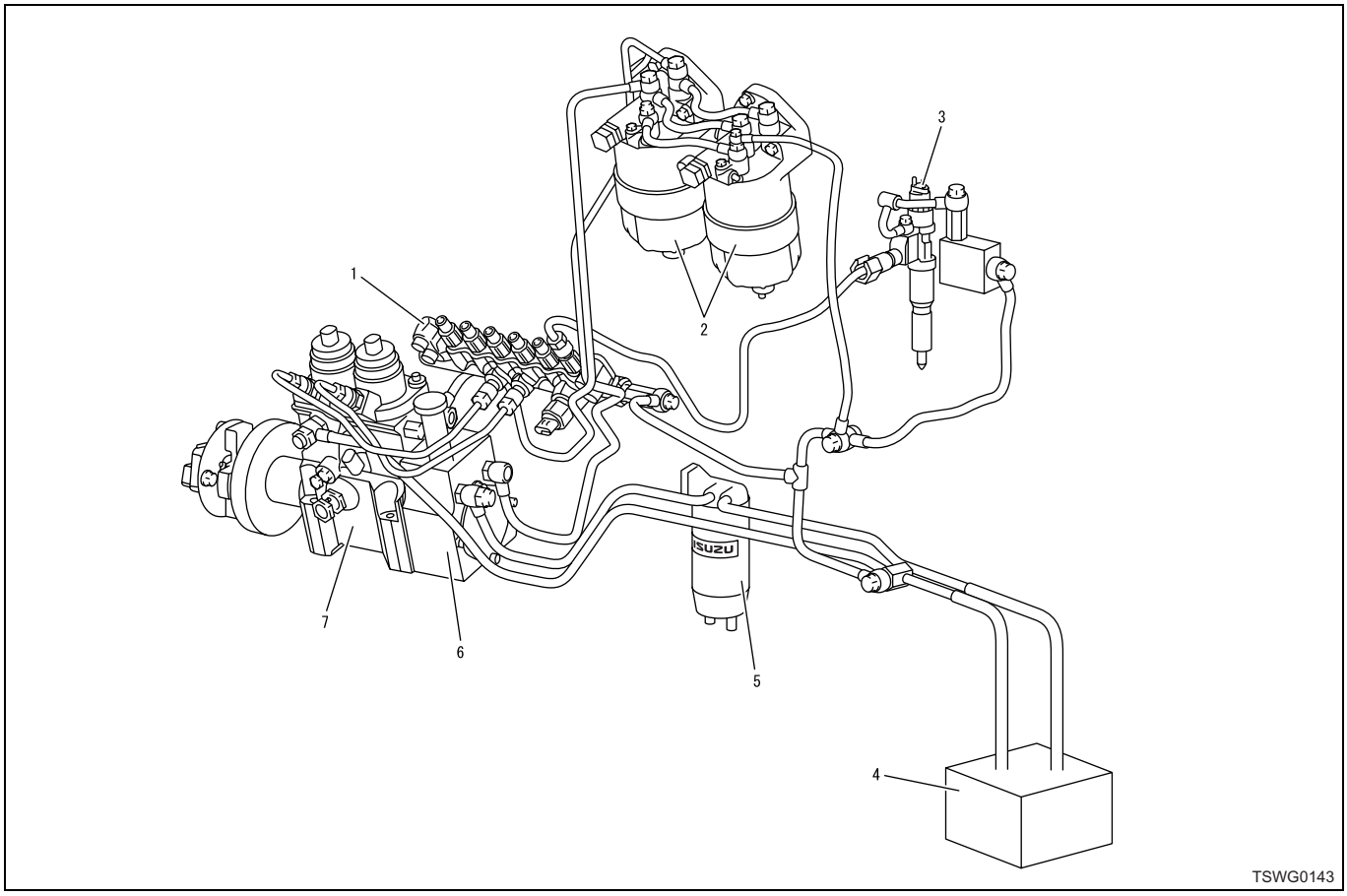
Name

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

---

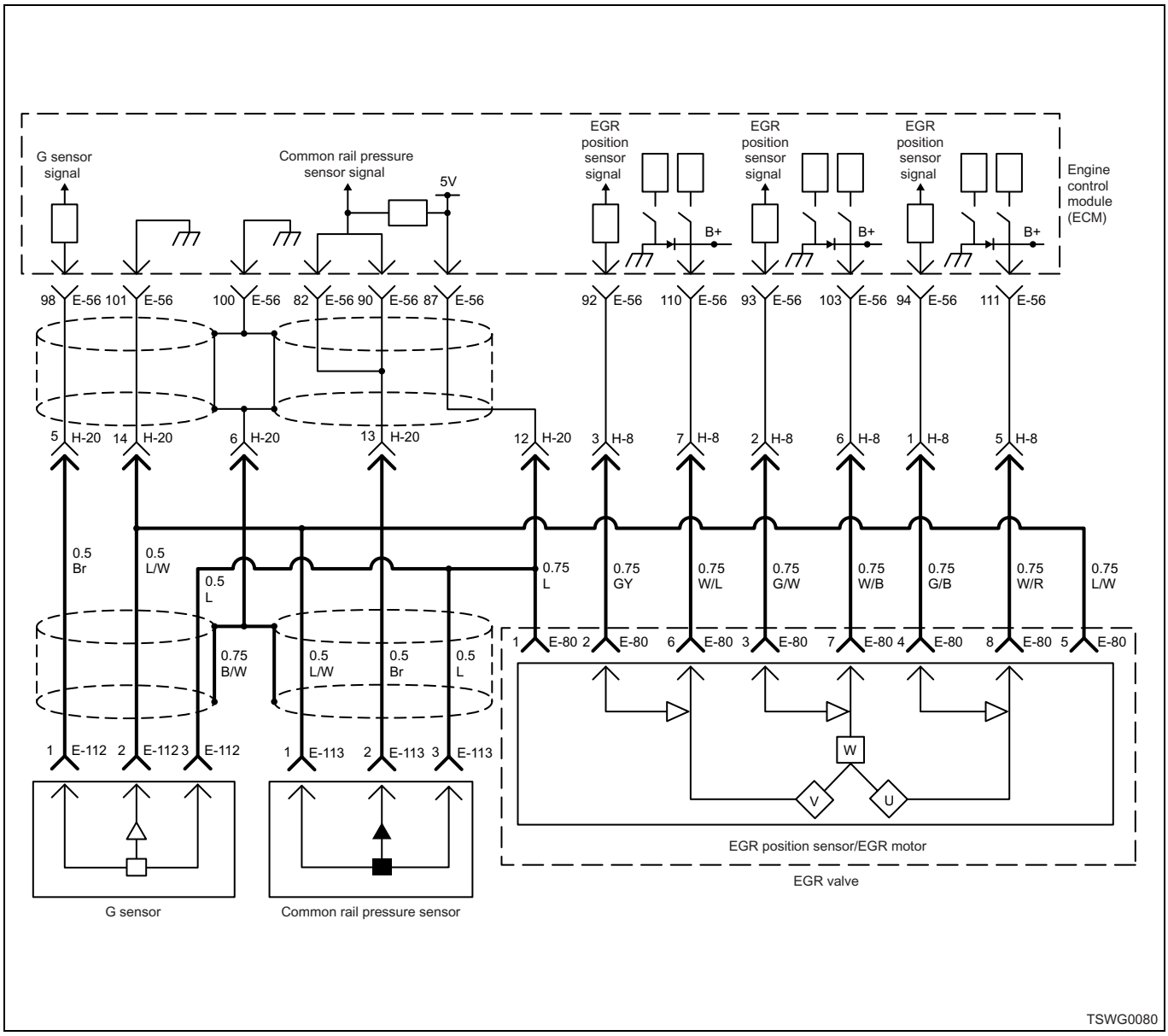
1. Disconnect the coupling connector, and check the sensor from engine harness connector.
2. Disconnect the connector from sensor, and short the wiring of sensor connector.
3. Check the harness from coupling connector for open circuit.
   - If both steps 1 and 2 are faulty, repair the harness. Check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

DTC: P1095 (Flash code 225) Pressure limiter open



Name

1. Common rail
2. Fuel filter
3. Injector
4. Fuel tank
5. Pre-filter
6. Feed pump
7. Supply pump



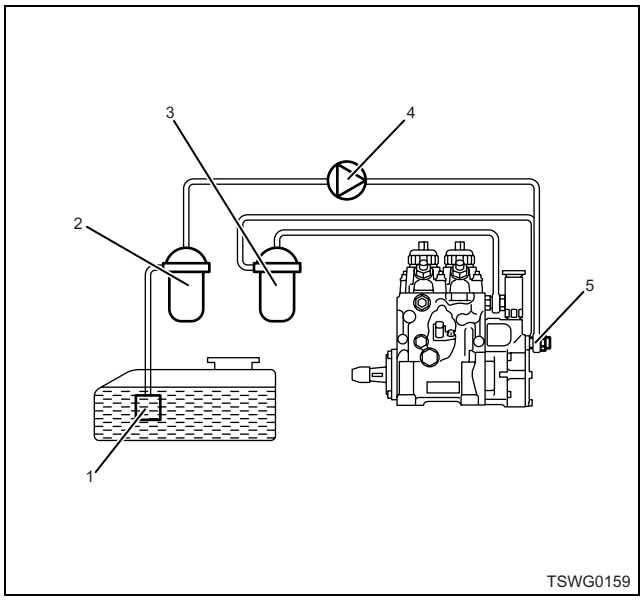
Description of circuit

The supply pump sucks fuel from the fuel tank using the trochoid-type feed pump located inside of the supply pump. The sucked fuel is sent through the PCV to the two plungers located inside the supply pump, and is pressurized and sent to the common rail. The PCV opening angle controls the fuel flow; if the PCV drive duty is large, the PCV opening angle becomes small resulting in less fuel flow. The ECM drives the PCV by calculating the target common rail pressure, target fuel flow, etc. based on the information from each sensor.
The ECM sets the DTC when the common rail pressure increases to certain level then lowers sharply, as it recognizes that the pressure limiter is activated.

Main trouble symptom

- Output lowering
- Hunting

Fuel system filter



Name
1. Fuel pump strainer
2. Pre-fuel filter
3. Main fuel filter
4. Electromagnetic pump filter
5. Gauze filter

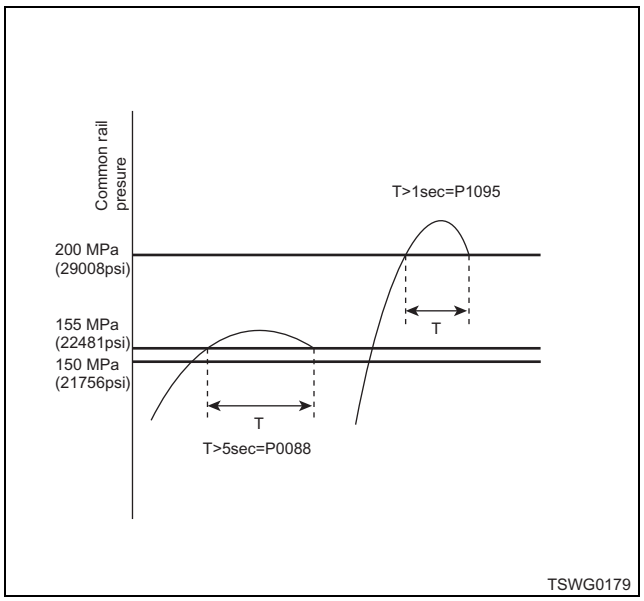
Filter clogging in the fuel system may establish the DTC set condition. Check as required.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1095, P0192, P0193, P1630, or P1635 is not detected.
- 50 rpm or more

DTC set condition

- When pressure limiter is opened.
- When common rail pressure is more than 200 MPa (29008 psi) for 1 second or more.
- DTC set condition in the case of high common rail pressure is described below.
  Only P1095 is detected if the fuel pressure overshoots due to entry of air.



Action taken when DTC is set

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

Back-up mode

- Limited injection amount 1
- Output goes down to about 50% since fuel flow is limited.

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

Followings are suspected as the cause.

- Air mixed in the high-pressure fuel pipe.
- Injector internal trouble
- Supply pump internal trouble
- Fuel system pipe fault (clogging etc.)
- Fuel filter fault (temporary clogging due to waxing at low temperatures, improper tightening of filter cartridge, etc.)
- Fuel tank fault (temporary clogging, air mixed due to fuel shortage, air mixed due to modified fuel pipe for additional tank etc.)
- Pressure limiter trouble (operation under specified pressure, degradation of sealability)
- ECM trouble
- Common rail pressure sensor trouble
- Running out of fuel

Test description

Numbers below indicate step numbers in the chart.
8. If the “Common rail pressure sensor” displays more than the specified value when the common rail pressure 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	Check the DTC again. 1. Check and record the DTC. 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. Check the fuel amount, and add fuel as required. If fuel is low, P1095 may be detected due to entry of air. 4. Bleed air from the fuel. • If air bleeding is insufficient, overshoot exceeds 200 MPa (29008 psi) and DTC will be detected. **Note:** • **Bleeding air from fuel must be performed correctly, following the procedure.** • **For work procedure, refer to “Engine section” in the service manual.** 5. Race it quickly for about 5 times. 6. Check the DTC. Is DTC P1095 detected?	—	Go to Step 3.	Refer to “Diagnostic aid” and Go to Step 4.

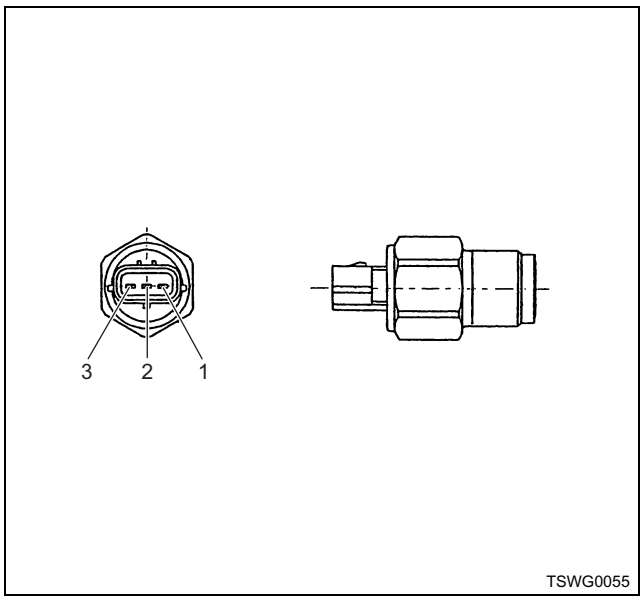
Step	Action	Value	YES	NO
3	Narrow down the cause. 1. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 2. Connect another pipe to the supply pump inlet duct, and test run while supplying fuel. (At this time, replace the fuel hose with a transparent hose to visually check for air mixture in the fuel.) 3. Check the DTC. Is DTC P1095 detected?	—	Go to Step 16.	Go to Step 4.
4	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. Is the fuel system normal?	—	Go to Step 6.	Go to Step 5.
5	Repair or replace the faulty part. Is the procedure completed?	—	Go to Step 17.	—
6	Is the scan tool (KW communication) available?	—	Go to Step 7.	Go to Step 20.
7	Check the common rail pressure. 1. Turn the key switch to “ON”. 2. Check for “Differential fuel rail pressure” on the data display using scan tool. 3. Start the engine and run it at idle. 4. Check for “Differential fuel rail pressure” on the data display using scan tool. 5. Race it quickly for about 5 times. 6. Check for “Differential fuel rail pressure” on the data display using scan tool. Is each value of “Fuel rail pressure” (at engine stopped, idling and racing) around the specified value?	At engine stopping: −30 MPa (−4351 psi); At idling, racing: ±5 MPa (±725 psi)	Go to Step 14.	Go to Step 8.

Step	Action	Value	YES	NO
8	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Turn the key switch to “ON”. 4. Check for “Common rail pressure sensor” on the data display using scan tool. Is the “Common rail pressure sensor” specified value?	0V	Go to Step 13.	Go to Step 9.
9	1. Check the signal circuit between common rail pressure 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 18.	Go to Step 10.
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.	—
13	Replace the common rail (common rail pressure sensor). **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 18.	—

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.	—

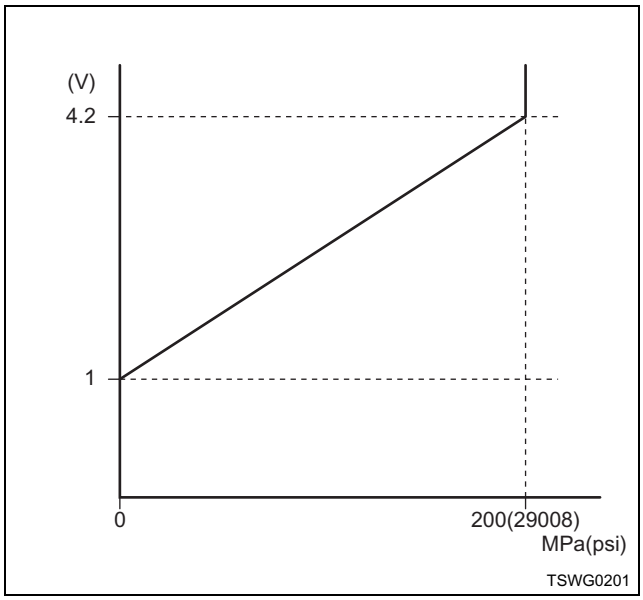
Step	Action	Value	YES	NO
18	Check the DTC again. 1. Connect all the harnesses. 2. Clear the DTC. Refer to “How to clear diagnosis trouble code (DTC)” of “Procedure of trouble diagnosis” in this section for how to clear DTCs. 3. Turn the key switch to “OFF” for more than 10 seconds. 4. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P1095 detected?	—	Go to Step 2.	Go to Step 19.
19	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
20	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Turn the key switch to “ON”. 4. Connect the DMM between the common rail pressure sensor connector signal terminal and the ground. Is the DMM indication specified value? **Note:** **If the display of DMM is not specified value, ECM side wiring, wrap-around in ECM or short circuit may be the cause.** **If it is specified value, ECM side wiring is normal.**	0V	Go to Step 13.	Go to Step 9.

About common rail pressure sensor



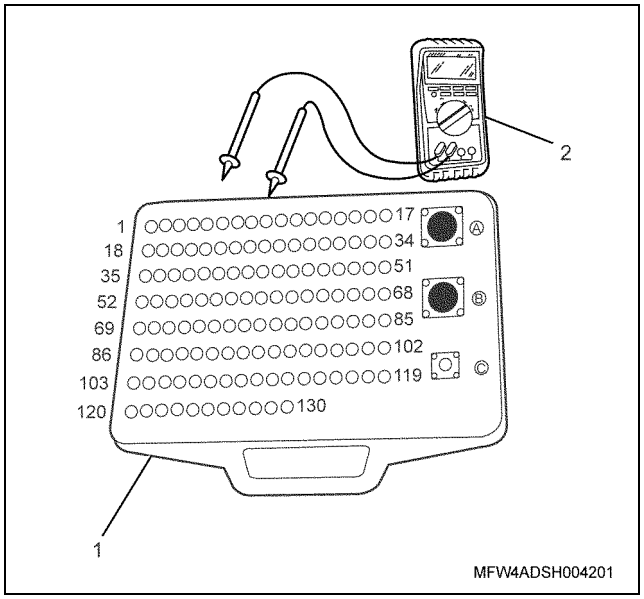
Name
1. Sensor ground
2. Sensor signal
3. Sensor power supply

Characteristics of common rail pressure sensor



Breaker box inspection procedure

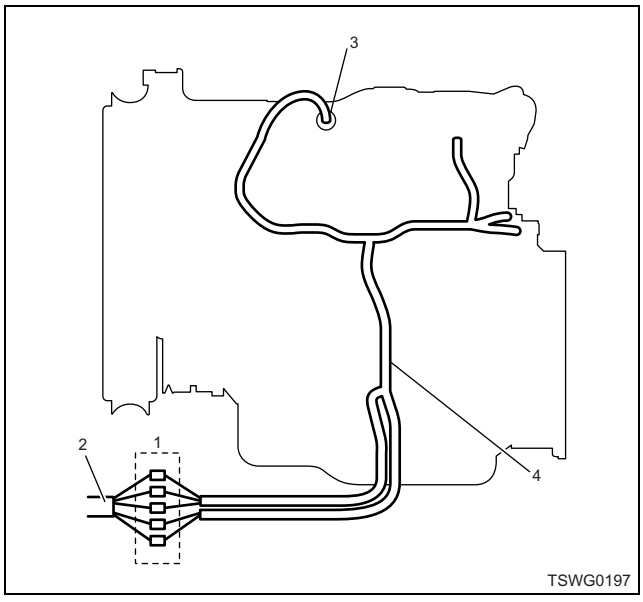
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
9	Short circuit to other signal circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	82 - Ground 90 - Ground	0V	1V or more

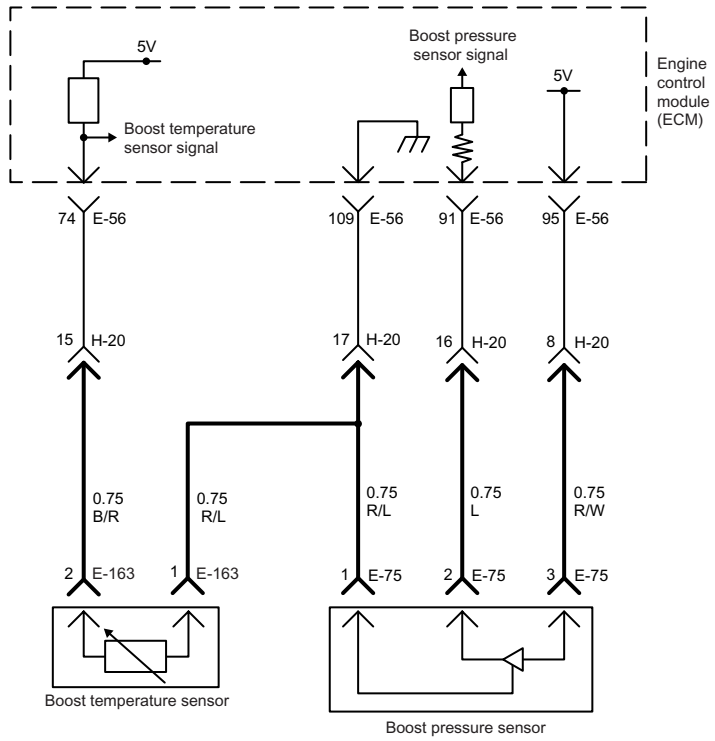
On-board check procedure for sensors



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.

DTC: P1112 (Flash code 295) Boost temperature sensor fault (low voltage fault, ground short)



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Description of circuit

The boost temperature sensor is installed to the intake manifold. The resistance value of boost temperature sensor changes according to the temperature in intake manifold.
The resistance is low when the intake air temperature is high, and is high when the temperature is low. The ECM energizes 5 V to the boost temperature sensor through the pull up resistance, and calculates the boost temperature from the change in voltage, to utilize various control such as fuel injection control. 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 not affected.

Preconditions when DTC is set

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

DTC set condition

- Boost temperature 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

- 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).
- 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 “Boost temperature sensor” displays less than the specified value. If more than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If the “Boost temperature sensor” displays more than the specified value when terminals between the boost temperature sensor connector are shorted, the circuit beyond the sensor is normal including ECM.

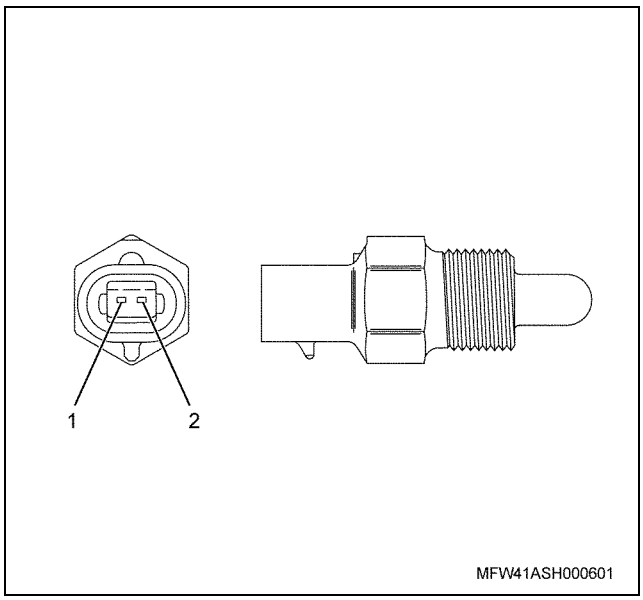
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	Is the scan tool (KW communication) available?	—	Go to Step 3.	Go to Step 13.
3	1. Turn the key switch to “ON”. 2. Check for “Boost temperature sensor” on the data display using scan tool. Is the “Boost temperature sensor” less than the specified value?	0.1V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the boost temperature 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.

Step	Action	Value	YES	NO
5	1. Turn the key switch to “OFF”. 2. Disconnect the boost temperature sensor connector. 3. Short between the boost temperature sensor connector ground terminal and the signal terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check for “Boost temperature” on the data display using scan tool. Is the “Boost temperature” more than the specified value?	4.8V	Go to Step 8.	Go to Step 9.
6	1. Check for followings in the power supply circuit between ECM and boost temperature 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 7.
7	1. Check for followings in the signal circuit between ECM and boost temperature 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 boost temperature sensor ground circuit • Short circuit to ground • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 9.
8	Replace the boost temperature sensor. Is the procedure completed?	—	Go to Step 12.	—
9	Is EMPS available?	—	Go to Step 10.	Go to Step 11.

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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is the DTC P1112 detected?	—	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.
14	1. Start the engine. 2. Check the display of boost temperature. Does the display of “Boost temperature” show error value?	214°C (419°F) (Displayed error value)	Go to Step 15.	Go to “Diagnostic aid”.
15	Check for installation condition of the boost temperature 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 16.

Step	Action	Value	YES	NO
16	1. Check for followings in the power supply circuit between ECM and boost temperature 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 17.
17	1. Check for followings in the signal circuit between ECM and boost temperature 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 boost temperature sensor ground circuit • Short circuit to ground • 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.

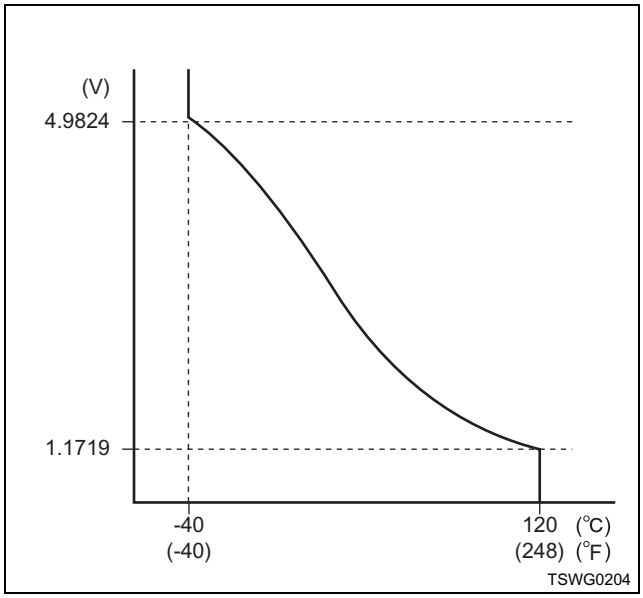
About boost temperature sensor

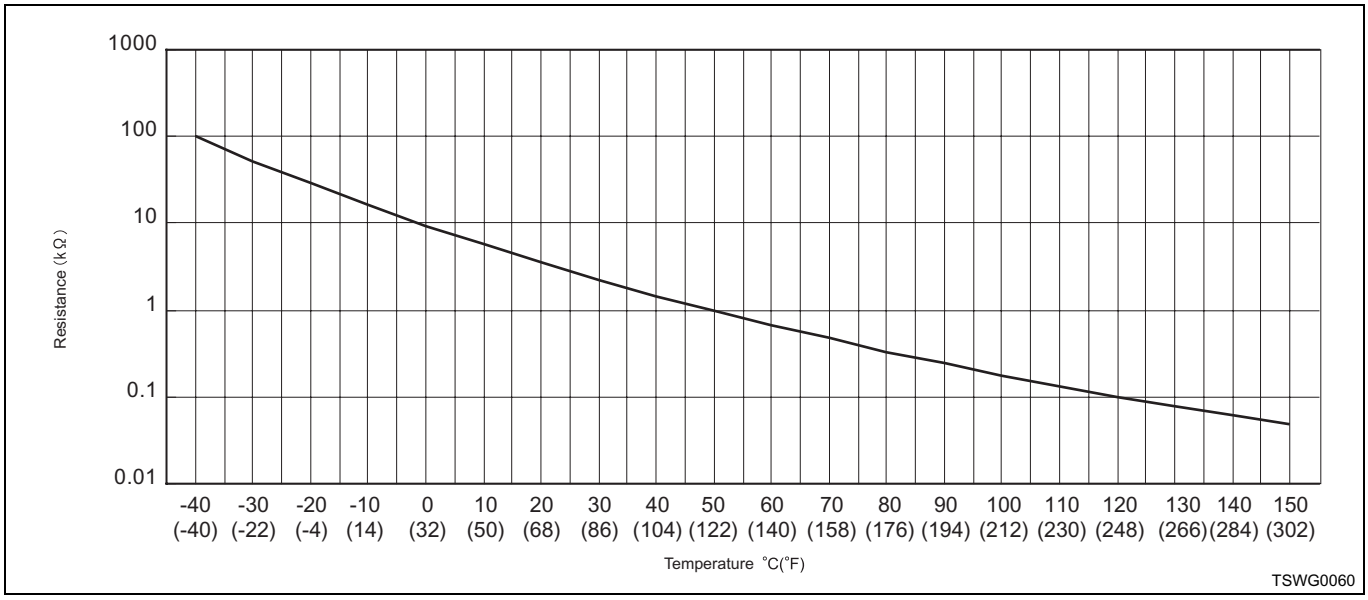


Name
1. Signal
2. GND

Characteristics of boost temperature sensor

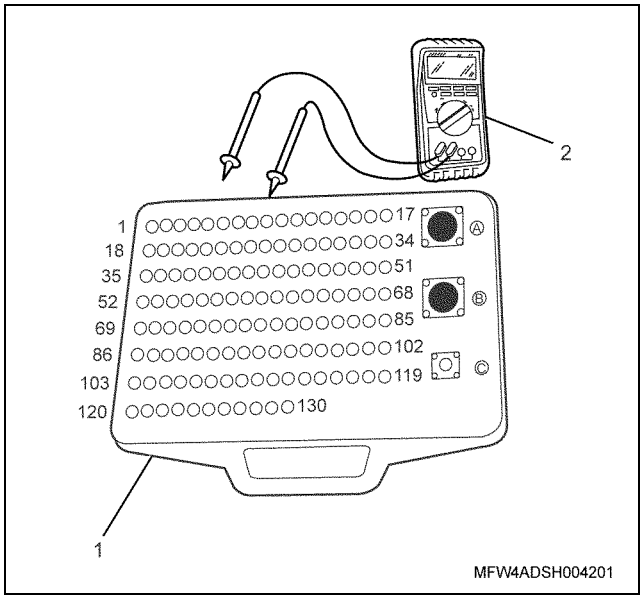
The output voltage of boost temperature sensor changes according to the boost temperature. The scan tool with CAN communication displays a fixed value when the value exceeds the threshold voltage. Therefore, judge as it is more than the threshold value if the value of –40°C (–40°F) or 120°C (248°F) is 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

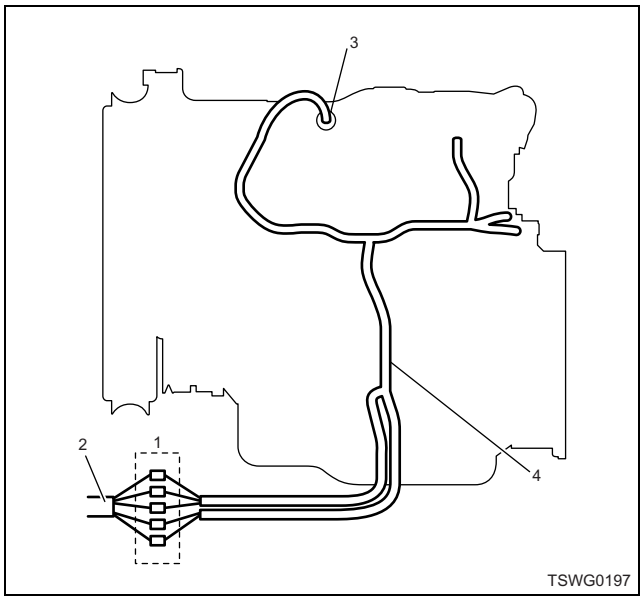
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

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”	74 - Sensor connector signal terminal	100 Ω or less	10 MΩ or more
7	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	74 - 109 74 - GND	10 MΩ or more	100 Ω or less
	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	74 - Sensor connector signal terminal	100 Ω or less	10 MΩ or more

On-board check procedure for sensors



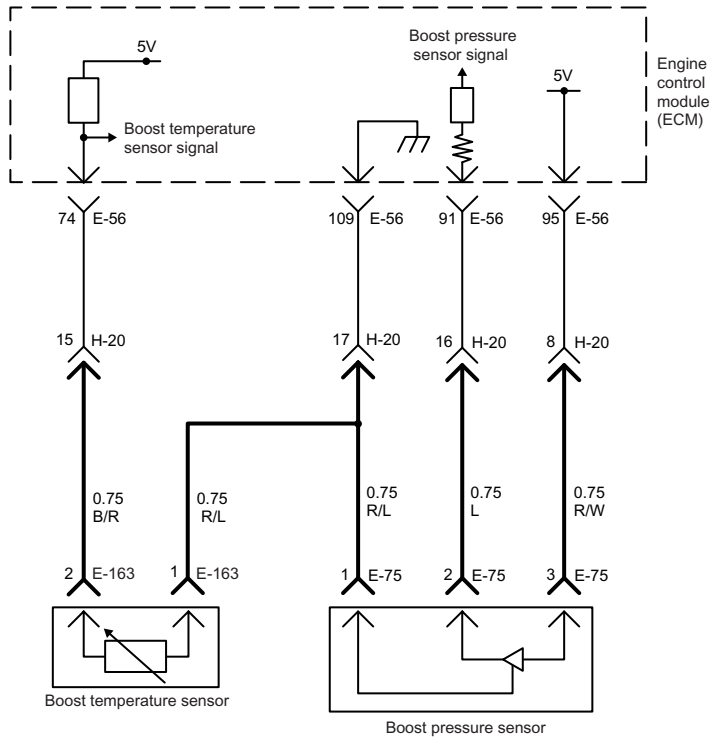
Name

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.

DTC: P1113 (Flash code 295) Boost temperature sensor fault (high voltage fault, open circuit, short to power supply circuit)



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Description of circuit

The boost temperature sensor is installed to the intake manifold. The resistance value of boost temperature sensor changes according to the temperature in intake manifold.
The resistance is low when the intake air temperature is high, and is high when the temperature is low. The ECM energizes 5 V to the boost temperature sensor through the pull up resistance, and calculates the boost temperature from the change in voltage, to utilize various control such as fuel injection control. 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 not affected.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1634 is not detected.
- Coolant temperature is 50°C (122°F) or more.
- 3 (or 5) minutes have passed after engine starting

DTC set condition

- Boost pressure sensor voltage is 4.94 V or more.

Action taken when DTC is set

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

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).
- The diagnosis lamp turns off when the trouble code turns to the history trouble.
- 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

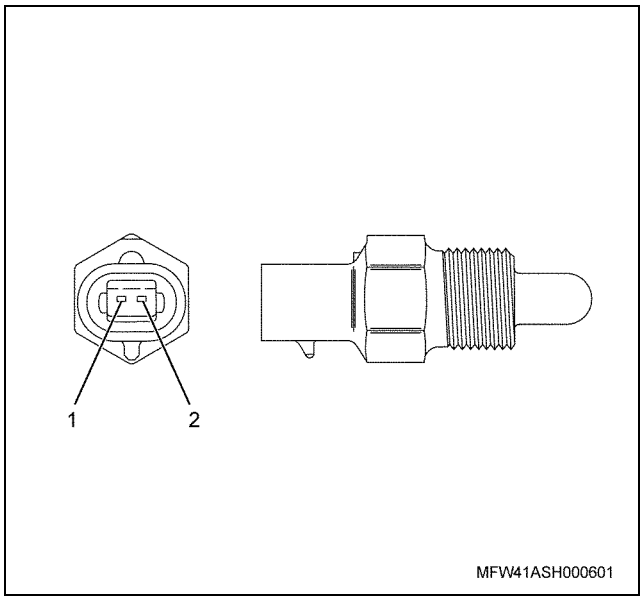
Numbers below indicate step numbers in the chart.
3. In the case of present trouble, the “Boost temperature sensor” displays more than the specified value. If less than the specified value, identify the cause by referring to “Diagnostic aid”.

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 “Boost temperature sensor” on the data display using scan tool. Is the “Boost temperature sensor” more than the specified value?	4.95V	Go to Step 4.	Go to “Diagnostic aid”.
4	Check for installation condition of the boost temperature 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.

Step	Action	Value	YES	NO
5	1. Check the signal circuit between ECM and boost temperature 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 temperature 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 11.	Go to Step 6.
6	1. Check for followings in the ground circuit between ECM and boost temperature 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 11.	Go to Step 8.
7	Replace the boost temperature sensor. Is the procedure completed?	—	Go to Step 11.	—
8	Is EMPS available?	—	Go to Step 9.	Go to Step 10.
9	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 11.	Go to Step 10.

Step	Action	Value	YES	NO
10	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 11.	—
11	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 P0238 detected?	—	Go to Step 2.	Go to Step 12.
12	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
13	1. Start the engine. 2. Check the display of boost temperature. Does the display of "Boost temperature" show error value?	214°C (419°F) (Displayed error value)	Go to Step 14.	Go to "Diagnostic aid".
14	Check for installation condition of the boost temperature 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 11.	Go to Step 15.
15	1. Check for followings in the ground circuit between ECM and boost temperature 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 11.	Go to Step 7.

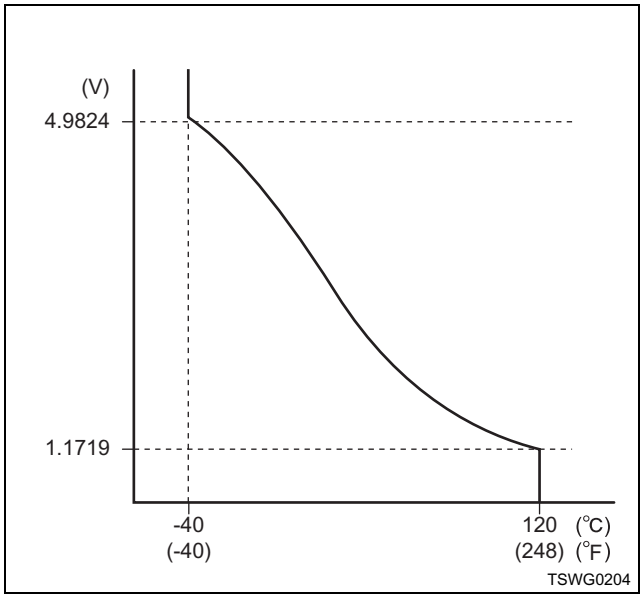
About boost temperature sensor

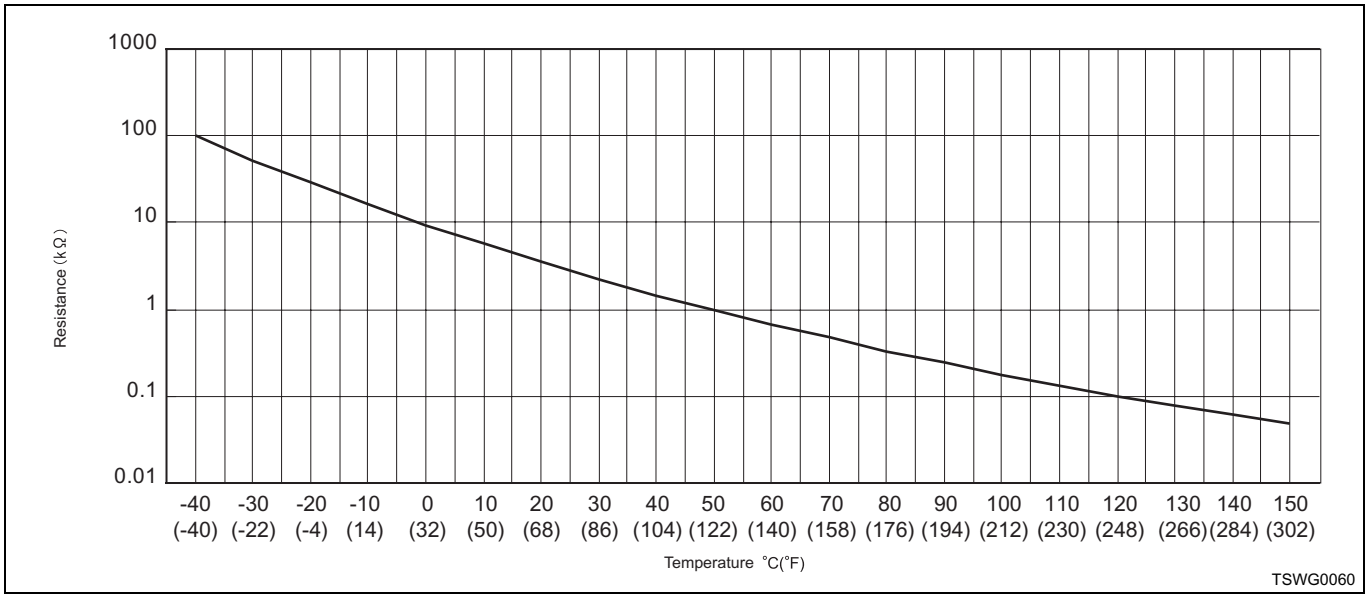


Name
1. Signal
2. GND

Characteristics of boost temperature sensor

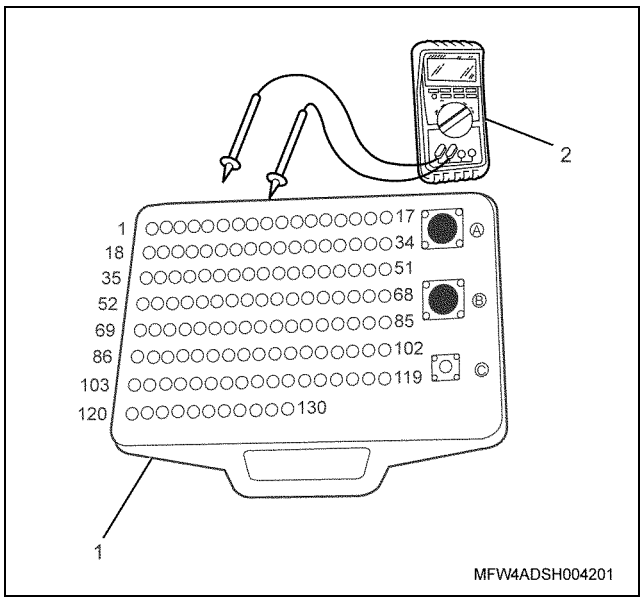
The output voltage of boost temperature sensor changes according to the boost temperature. The scan tool with CAN communication displays a fixed value when the value exceeds the threshold voltage. Therefore, judge as it is more than the threshold value if the value of −40°C (−40°F) or 120°C (248°F) is 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

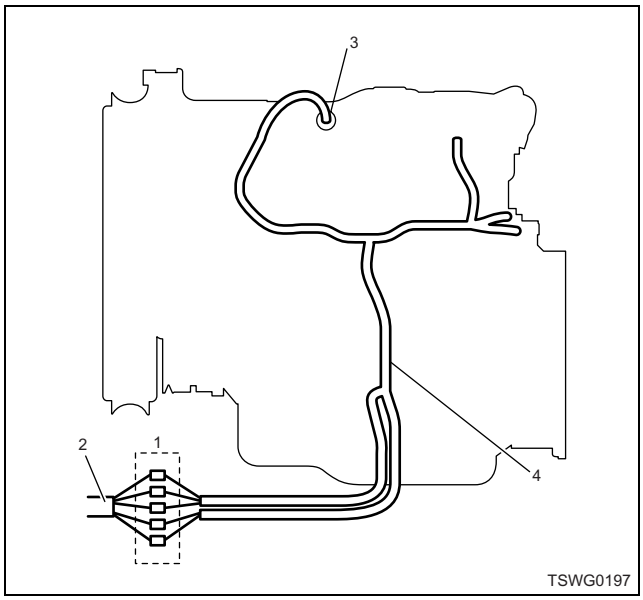
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
5	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	74 - GND	0V	18V or more
6	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	109 - Sensor connector ground terminal	100 Ω or less	10 MΩ or more

On-board check procedure for sensors



Name

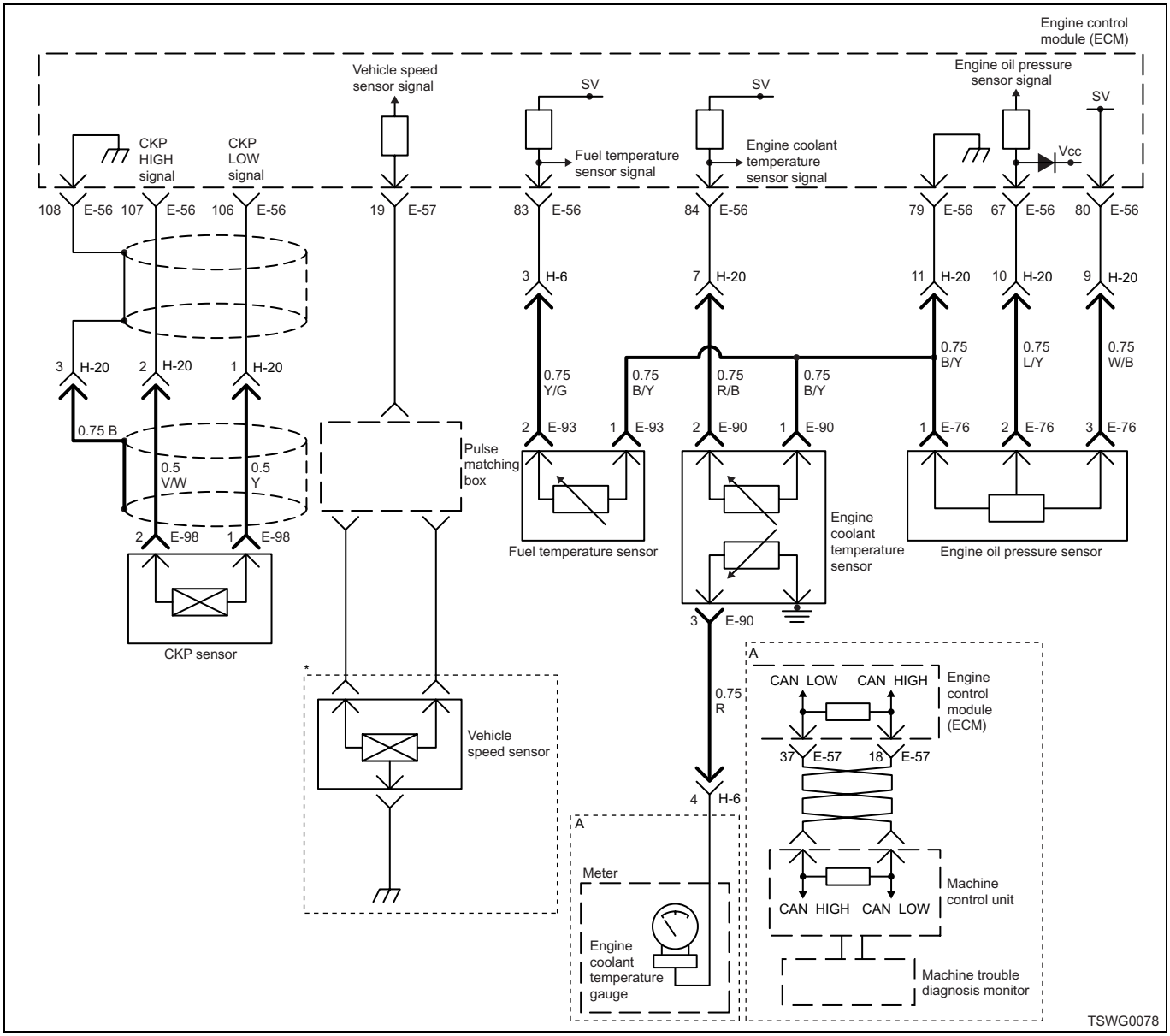
1. Coupling connector between engine — the machine
2. Machine harness
3. Sensor connector
4. Engine harness

---

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.

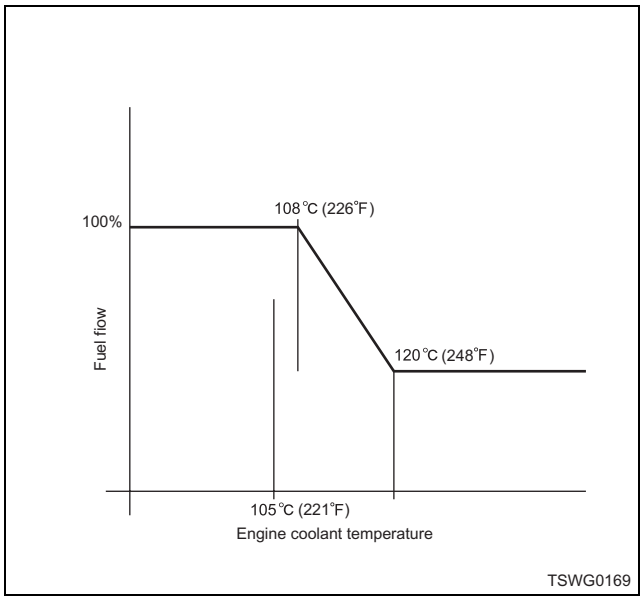
DTC: P1173 (Flash code 542) Overheat

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



Description of circuit

The engine coolant temperature (ECT) sensor is installed in the thermostat housing. The ETC sensor is the thermistor-type sensor, and the value of resistance and output voltage change according to the engine coolant temperature. As the engine coolant temperature increases, the resistance becomes small, and the voltage lowers. The ECM detects the engine coolant temperature based on the signal from the ECT sensor to perform various controls.
The ECM sets the DTC when it judges that the engine coolant temperature exceed certain level based on the signal from the ECT sensor.



Main trouble symptom

- Output lowering
- Fuel flow is regulated during overheat when the temperature exceeds 108°C (226°F).

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630, P1633, P0117, or P0118 is not detected.
- Engine under operation

DTC set condition

- Engine coolant temperature is more than 120°C (248°F).

Action taken when DTC is set

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

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).
- 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

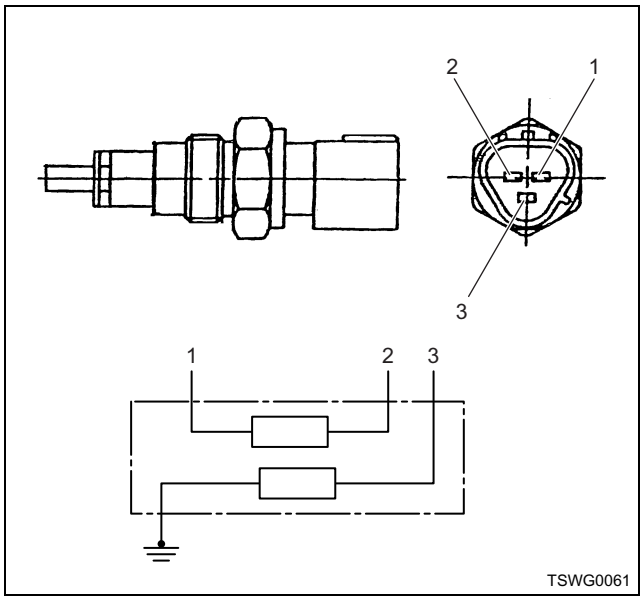
Numbers below indicate step numbers in the chart.
4. If the “Engine coolant temperature sensor” displays less than the specified value when the ECT sensor connector is removed, the sensor is faulty.
9. If no DTC is detected, intermittent trouble is suspected. Identify the cause by referring to “Diagnostic aid”.

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	1. Start the engine. 2. Check the DTC. Is DTC P0088, P1093, or P1094 not detected?	—	Go to the relevant DTC detected.	Go to Step 3.
3	Is the scan tool available?	—	Go to Step 4.	Go to Step 14.
4	1. Turn the key switch to “OFF”. 2. Disconnect the ECT sensor connector. 3. Turn the key switch to “ON”. 4. Check for “Engine coolant temperature sensor” on the data display using scan tool. Is the “Engine coolant temperature sensor” more than the specified value?	4.9V/−40°C (−40°F)	Go to Step 6.	Go to Step 5.

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
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.	—
13	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
14	1. Turn the key switch to “OFF”. 2. Disconnect the ECT sensor connector. 3. Turn the key switch to “ON”. 4. Check the display of the “Engine coolant temperature”. Is the “Engine coolant temperature” more than the specified value?	−40°C (−40°F)	Go to Step 6.	Go to Step 5.

About ECT sensor

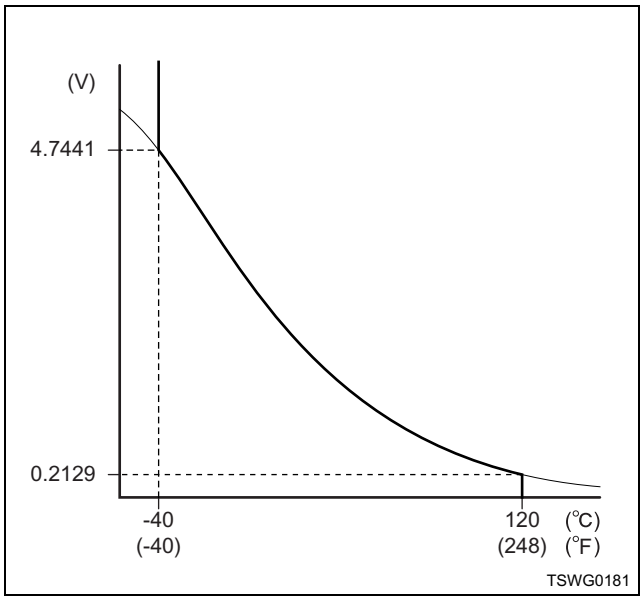


Name
1. Sensor GND (for engine control)
2. Sensor signal (for engine control)
3. Sensor signal (for meter)

Characteristics of ECT sensor

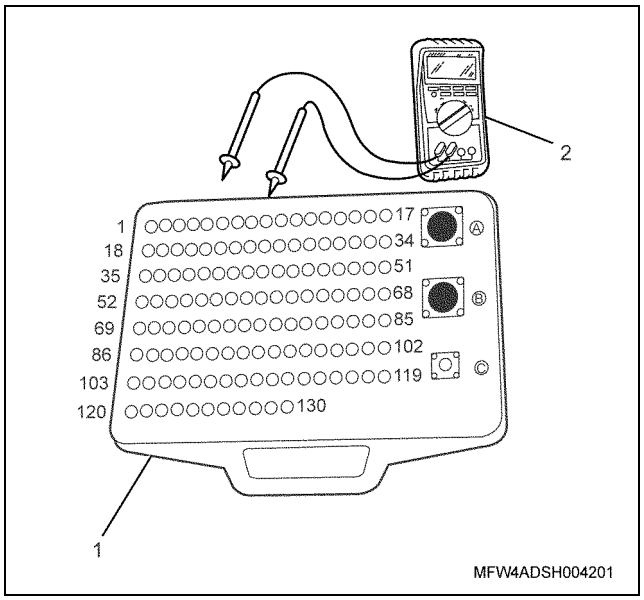
The output voltage of ECT sensor changes according to the engine coolant temperature. The scan tool with CAN communication displays a fixed value when the value exceeds the threshold voltage. Therefore, judge as it is more than the threshold value if the value of −40°C (−40°F) or 120°C (248°F) is not changed.

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

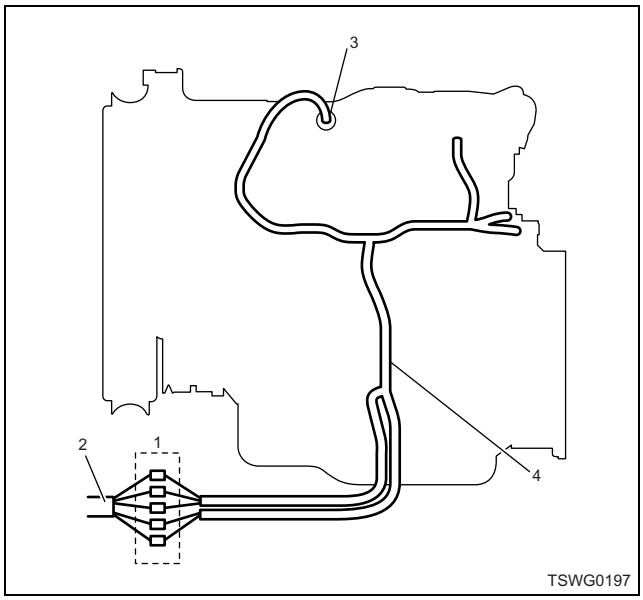
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
5	Short circuit to other signal circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	84 - Ground	0V	1V or more

On-board check procedure for sensors



Name

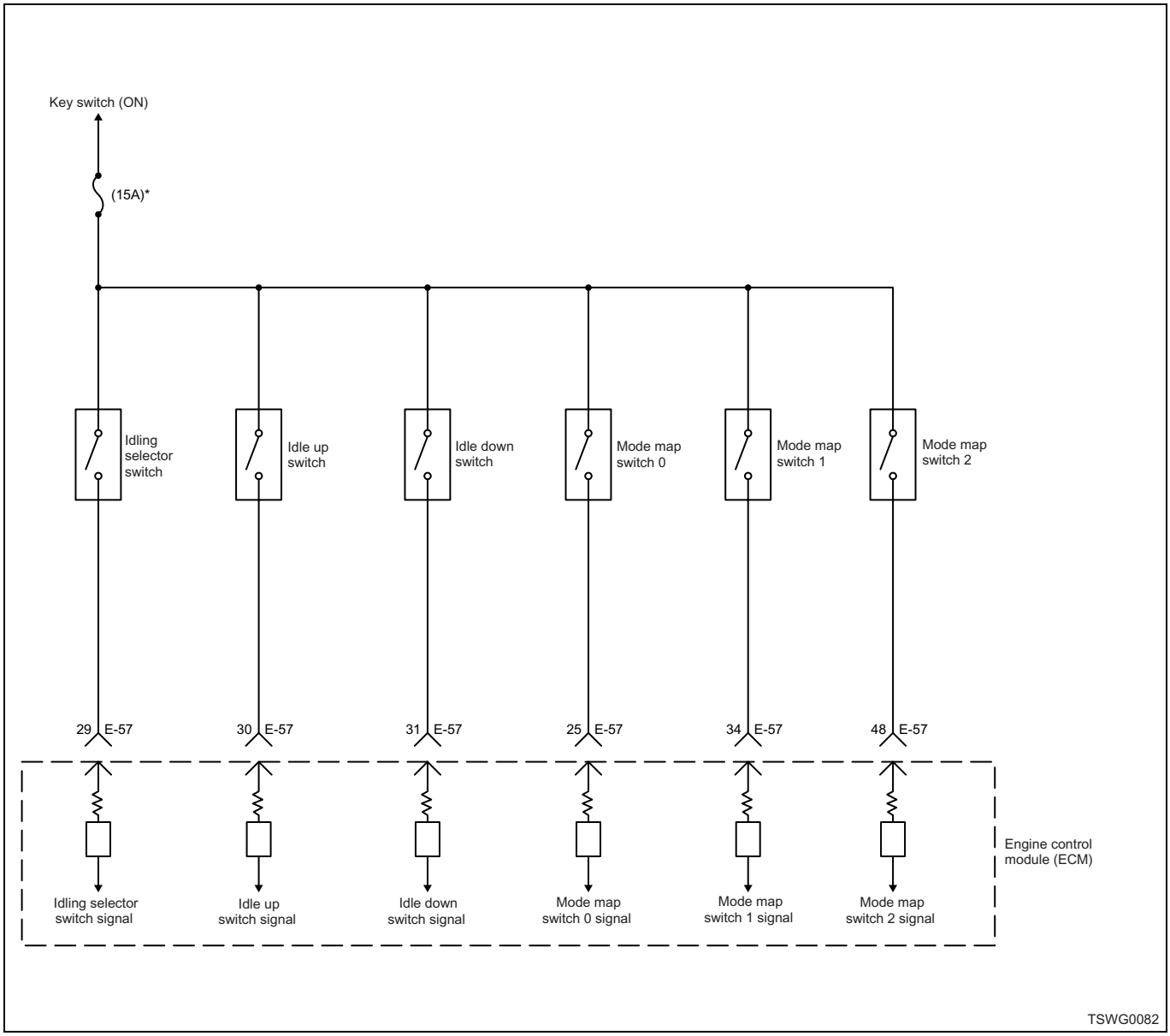
1. Coupling connector between engine — the machine
2. Machine harness
3. Sensor connector
4. Engine harness

---

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.

DTC: P1225 (Flash code 31) Idle UP/DOWN switch fault

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



Description of circuit

The idling control switch is provided to adjust idle speed during warming-up, and is available for use when the idling control selector switch is in “Manual”. The power supply voltage is supplied to the idling control switch through the key switch. By pressing the “Up” or “Down”, each ground circuit is completed and the signal is input to the ECM.
The ECM sets the DTC when the signal inputs are detected for idling control switch “Up” side and “Down” side at the same time.

Main trouble symptom

Operationality is not affected.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.

DTC set condition

- When both of idling control up signal and idling control down signal are ON.

Action taken when DTC is set

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

Back-up mode

- Unable to change the speed in mode driving

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.

- 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.
3. If the “Idle up switch” and “Idle down switch” display “OFF” when the idling control switch connector is removed, the circuit is shorted between idle up circuit and idle down circuit, or the switch is faulty.

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 4.
3	1. Turn the key switch to “OFF”. 2. Disconnect the idling control switch connector. 3. Turn the key switch to “ON”. 4. Check for “Idle up switch” and “Idle down switch” on the data display using scan tool. Are the “Idle up switch” and “Idle down switch” displayed “OFF”?	—	Go to Step 6.	Go to Step 4.
4	1. Check the idle up-side circuit between idling control switch and ECM 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 10.	Go to Step 5.

Step	Action	Value	YES	NO
5	1. Check the idle down-side circuit between idling control switch and ECM 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 10.	Go to Step 7.
6	Replace the idling control switch. Is the procedure completed?	—	Go to Step 10.	—
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 if DTC is not detected 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 15 seconds, and then start the engine. 4. Check the DTC. Is the procedure completed?	—	Go to Step 11.	—

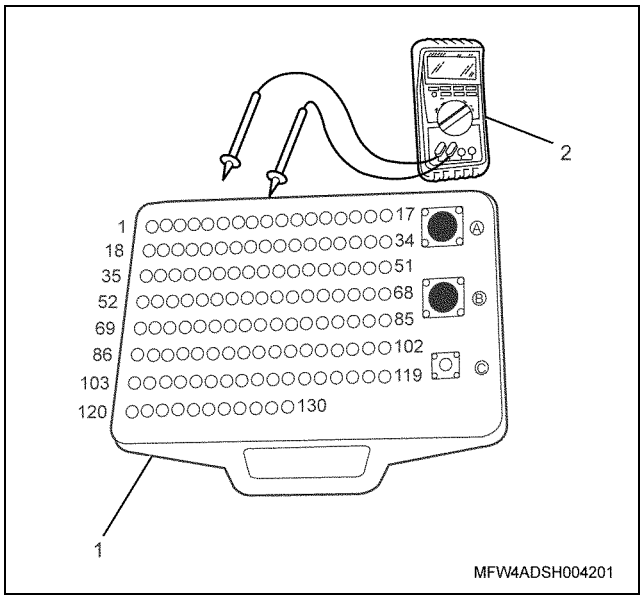
Step	Action	Value	YES	NO
11	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

About idling control switch

Note:
Refer to the machine's manual for installing position of the idling control switch.

Breaker box inspection procedure

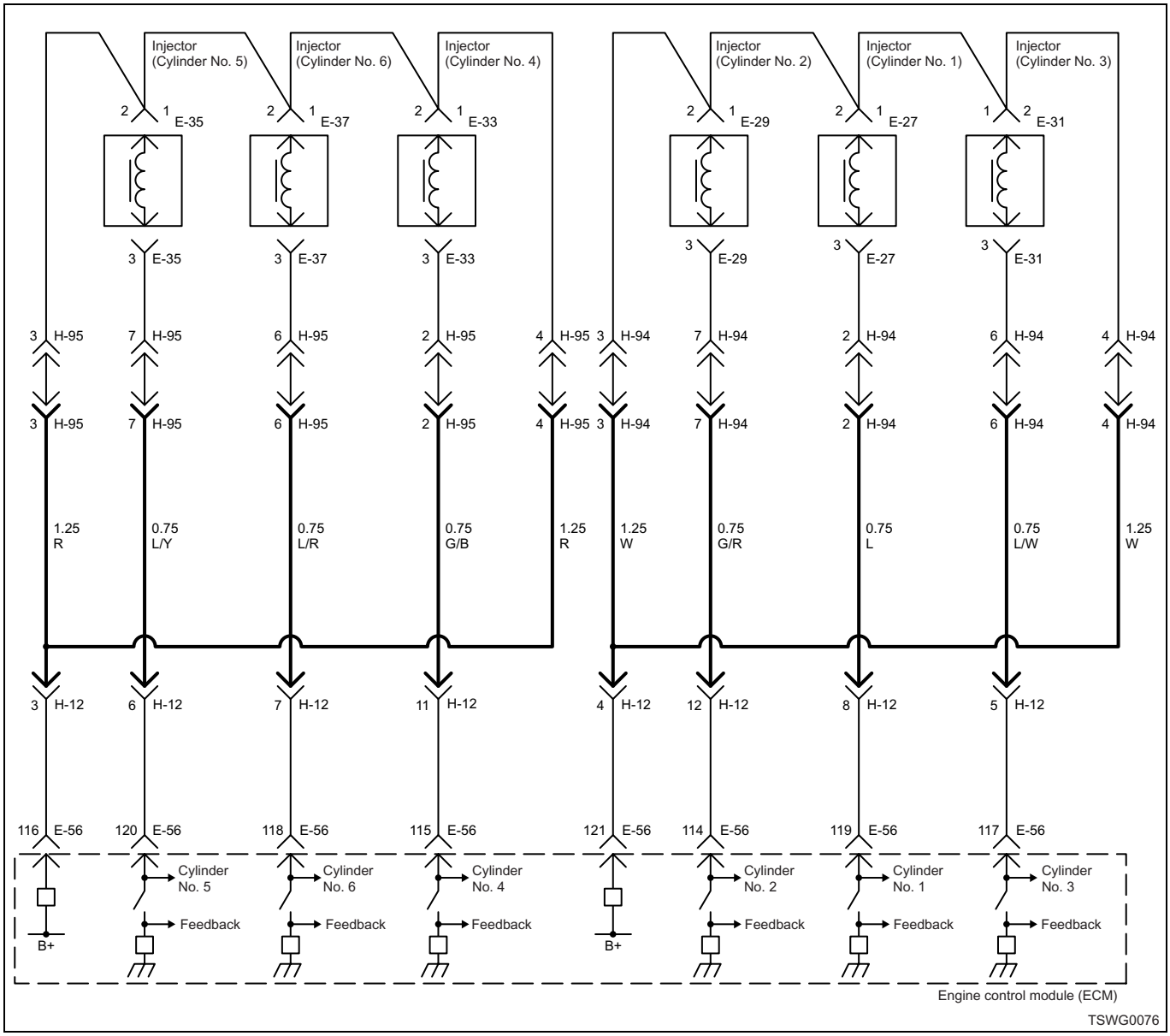
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
4	Short circuit to power supply circuit	Voltage measurement	• Disconnect the switch connector. • Key switch "ON"	30 - Ground	0V	18V or more
5	Short circuit to power supply circuit	Voltage measurement	• Disconnect the switch connector. • Key switch "ON"	31 - Ground	0V	18V or more

DTC: P1261 (Flash code 158) Injection nozzle common 1 drive system fault



Description of circuit

The COMMON circuit is provided to supply the power supply voltage pressurized in the charge circuit inside the ECM to the injector, and is divided in to two systems for each 3 cylinder. The COMMON 1 circuit supplies the power supply voltage to the injectors of No. 1 cylinder, No. 2 cylinder, and No. 3 cylinder. The ECM sets the DTC when the injector drive circuit faults are detected in No. 1 cylinder, No. 2 cylinder, and No. 3 cylinder at the same time.

Main trouble symptom

- Intense engine vibration
- Rough idling
- Output lowering
- Engine blow up fault
- Engine stall possible

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.
- 70 rpm or more
- None of the following DTC sets are detected; DTC P0611 and P1261 and P201; DTC P0611 and P1261 and P0202; DTC P0611 and P1261 and P0203.

DTC set condition

- When none of injector monitor input signal for No. 1 cylinder, No. 2 cylinder, or No. 3 cylinder exist.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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.

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	1. Turn the key switch to “OFF”. 2. Remove the ECM-side harness connector from the coupling connector (H-94). 3. Connect the DMM between the injector power supply 1 circuit (H94 female-side No. 3) and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	7.0V	Go to Step 3.	Go to Step 4.
3	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 injector harness connector terminals (H94 male-side No. 3 and No. 4). Is the resistance less than the specified value?	1.0Ω	Go to Step 6.	Go to Step 22.
4	Check for installation condition of the injector harness 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 27.	Go to Step 5.

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
9	1. Check the No. 1 cylinder injector drive circuit between ECM and coupling connector (H-94) for ground short 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".** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
10	1. Check the No. 2 cylinder injector drive circuit between ECM and coupling connector (H-94) for ground short 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".** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
11	1. Check the No. 3 cylinder injector drive circuit between ECM and coupling connector (H-94) for ground short 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".** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
12	1. Remove the cylinder head cover. 2. Check for installation condition of the injector harness. 3. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 13.
13	1. Remove the injector harnesses from the injectors of No. 1 cylinder, No. 2 cylinder, and No. 3 cylinder. 2. Measure the resistance between each injector terminal and the ground. Is the resistance more than the specified value?	10MΩ	Go to Step 14.	Go to Step 23.

Step	Action	Value	YES	NO
14	1. Turn the key switch to “OFF”. 2. Remove the injector-side harness connector from the coupling connector (H-94). 3. Connect the DMM between the No. 1 cylinder injector drive circuit (H94 female-side No. 2) and the ground. 4. Turn the key switch to “ON”. Is the DMM indication specified value?	0V	Go to Step 18.	Go to Step 15.
15	1. Turn the key switch to “OFF”. 2. Remove the injector-side harness connector from the coupling connector (H-94). 3. Connect the DMM between the No. 2 cylinder injector drive circuit (H94 female-side No.7) and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	0V	Go to Step 19.	Go to Step 16.
16	1. Turn the key switch to “OFF”. 2. Remove the injector-side harness connector from the coupling connector (H-94). 3. Connect the DMM between the No. 3 cylinder injector drive circuit (H94 female-side No.6) and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	0V	Go to Step 20.	Go to Step 17.
17	1. Turn the key switch to “OFF”. 2. Remove the injector-side harness connector from the coupling connector (H-94). 3. Connect the DMM between the injector power supply 1 circuit (H94 female-side No. 3) and the ground. 4. Turn the key switch to “ON”. Is the DMM indication less than the specified value?	7.0V	Go to Step 22.	Go to Step 21.

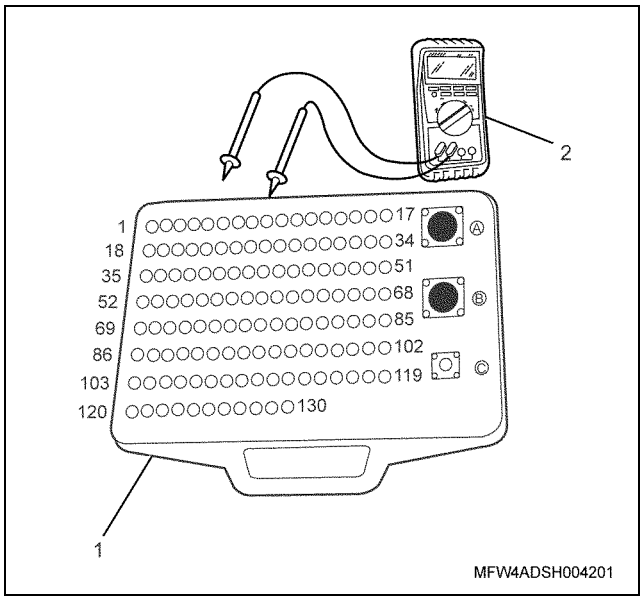
Step	Action	Value	YES	NO
18	1. Check the No. 1 cylinder injector drive circuit between ECM and coupling connector (H-94) for short circuit to the power supply circuit or ignition power supply circuit using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
19	1. Check the No. 2 cylinder injector drive circuit between ECM and coupling connector (H-94) 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
20	1. Check the No. 3 cylinder injector drive circuit between ECM and coupling connector (H-94) 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.

Step	Action	Value	YES	NO
21	1. Check the injector power supply 1 circuit between ECM and coupling connector (H-94) 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
22	Replace the injector harness. Is the procedure completed?	—	Go to Step 27.	—
23	Replace the injector. **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 27.	—
24	Is EMPS available?	—	Go to Step 25.	Go to Step 26.
25	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 27.	Go to Step 26.
26	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 27.	—

Step	Action	Value	YES	NO
27	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 P1261 detected?	—	Go to Step 2.	Go to Step 28.
28	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

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.

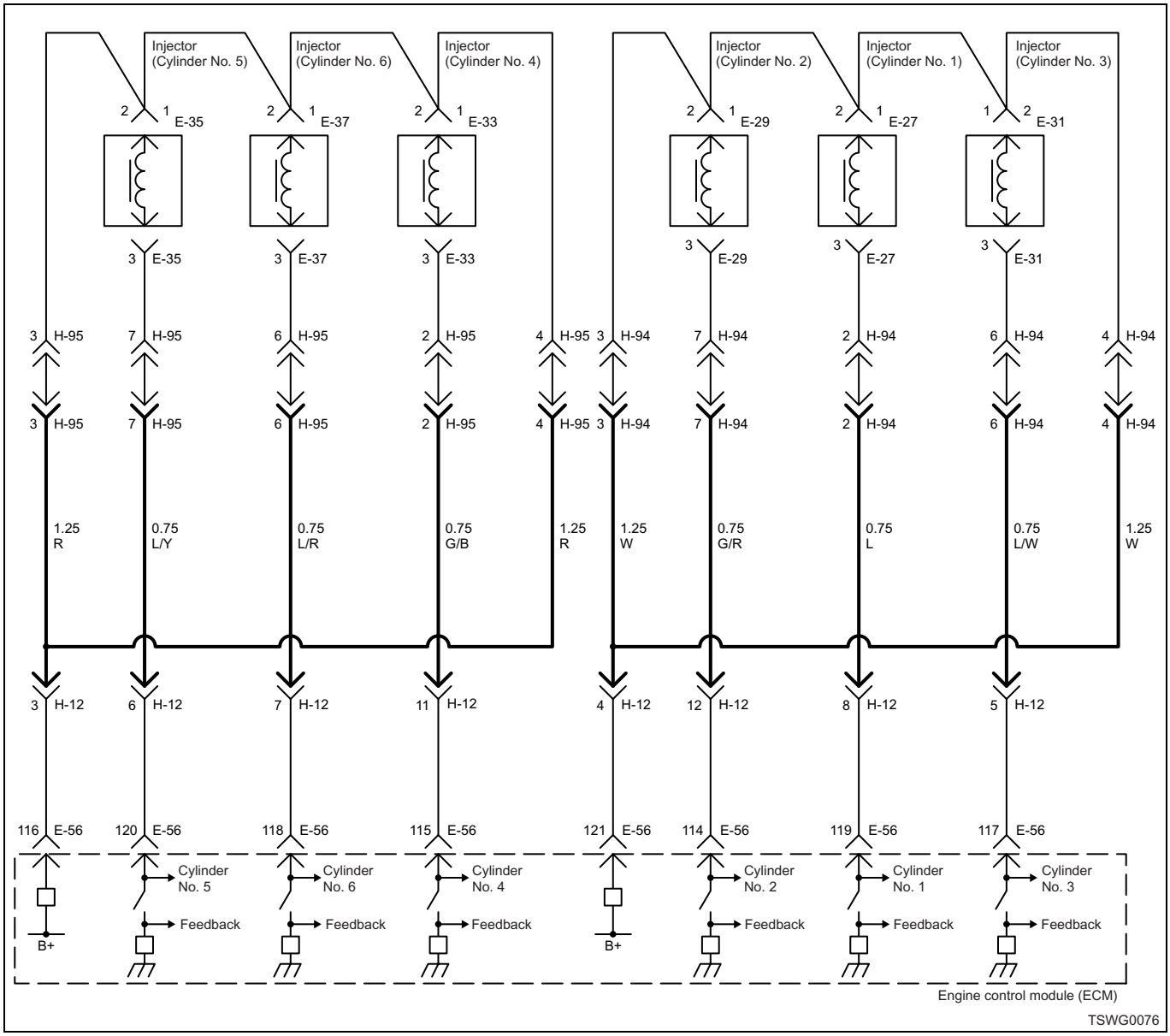


Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
5	Open circuit/ high resistance	Resistance measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	121 - Female-side No. 3 Terminal	100 Ω or less	10 MΩ or more
	Short circuit to ground	Resistance measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	121 - Ground	10 MΩ or more	100 Ω or less
9	Short circuit to ground	Resistance measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	119 - Ground	10 MΩ or more	100 Ω or less
10	Short circuit to ground	Resistance measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	114 - Ground	10 MΩ or more	100 Ω or less
11	Short circuit to ground	Resistance measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	117 - Ground	10 MΩ or more	100 Ω or less
18	Short circuit to power supply circuit	Voltage measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	119 - Ground	0V	18V or more
19	Short circuit to power supply circuit	Voltage measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	114 - Ground	0V	18V or more

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
20	Short circuit to power supply circuit	Voltage measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	117 - Ground	0V	18V or more
21	Short circuit to power supply circuit	Voltage measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	121 - Ground	0V	18V or more

DTC: P1262 (Flash code 159) Injection nozzle common 2 drive system fault



Description of circuit

The COMMON circuit is provided to supply the power supply voltage pressurized in the charge circuit inside the ECM to the injector, and is divided in to two systems for each 3 cylinder. The COMMON 2 circuit supplies the power supply voltage to the injectors of No. 4 cylinder, No. 5 cylinder, and No. 6 cylinder. The ECM sets the DTC when the injector drive circuit faults are detected in No. 4 cylinder, No. 5 cylinder, and No. 6 cylinder at the same time.

Main trouble symptom

- Intense engine vibration
- Rough idling
- Output lowering
- Engine blow up fault
- Engine stall possible

Preconditions when DTC is set

- Main relay power supply voltage is 16V or more.
- 70 rpm or more
- None of the following DTC sets are detected; P0612, P1262 and P0204; P0612, P1262 and P0205; P0612, P1262 and P0206.

DTC set condition

- When none of injector monitor input signal for No. 4 cylinder, No. 5 cylinder, or No. 6 cylinder exist.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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.

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	1. Turn the key switch to “OFF”. 2. Remove the ECM-side harness connector from the coupling connector (H-95). 3. Connect the DMM between the injector power supply 2 circuit (H95 female-side No. 3) and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	7.0V	Go to Step 3.	Go to Step 4.
3	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 injector harness connector terminals (H95 male-side No. 3 and No. 4). Is the resistance less than the specified value?	1.0Ω	Go to Step 6.	Go to Step 22.
4	Check for installation condition of the injector harness 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 27.	Go to Step 5.

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
9	1. Check the No. 4 cylinder injector drive circuit between ECM and coupling connector (H-95) for ground short 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
10	1. Check the No. 5 cylinder injector drive circuit between ECM and coupling connector (H-95) for ground short 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
11	1. Check the No. 6 cylinder injector drive circuit between ECM and coupling connector (H-95) for ground short 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
12	1. Remove the cylinder head cover. 2. Check for installation condition of the injector harness. 3. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 13.
13	1. Remove the injector harnesses from the injectors of No. 4 cylinder, No. 5 cylinder, and No. 6 cylinder. 2. Measure the resistance between each injector terminal and the ground. Is the resistance more than the specified value?	10MΩ	Go to Step 14.	Go to Step 23.

Step	Action	Value	YES	NO
14	1. Turn the key switch to “OFF”. 2. Remove the injector-side harness connector from the coupling connector (H-95). 3. Connect the DMM between the No. 4 cylinder injector drive circuit (H95 female-side No. 2) and the ground. 4. Turn the key switch to “ON”. Is the DMM indication specified value?	0V	Go to Step 18.	Go to Step 15.
15	1. Turn the key switch to “OFF”. 2. Remove the injector-side harness connector from the coupling connector (H-95). 3. Connect the DMM between the No. 5 cylinder injector drive circuit (H95 female-side No. 7) and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	0V	Go to Step 19.	Go to Step 16.
16	1. Turn the key switch to “OFF”. 2. Remove the injector-side harness connector from the coupling connector (H-95). 3. Connect the DMM between the No. 6 cylinder injector drive circuit (H95 female-side No. 6) and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	0V	Go to Step 20.	Go to Step 17.
17	1. Turn the key switch to “OFF”. 2. Remove the injector-side harness connector from the coupling connector (H-95). 3. Connect the DMM between the injector power supply 2 circuit (H95 female-side No. 3) and the ground. 4. Turn the key switch to “ON”. Is the DMM indication less than the specified value?	7.0V	Go to Step 22.	Go to Step 21.

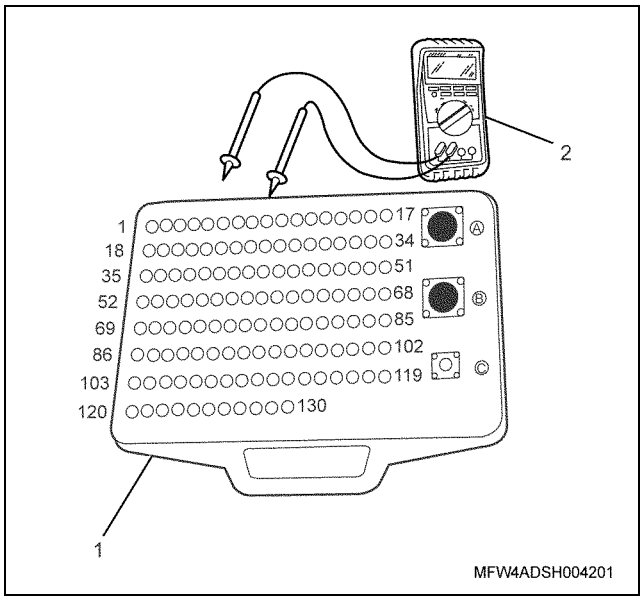
Step	Action	Value	YES	NO
18	1. Check the No. 4 cylinder injector drive circuit between ECM and coupling connector (H-95) for short circuit to the power supply circuit or ignition power supply circuit using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
19	1. Check the No. 5 cylinder injector drive circuit between ECM and coupling connector (H-95) 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
20	1. Check the No. 6 cylinder injector drive circuit between ECM and coupling connector (H-95) 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.

Step	Action	Value	YES	NO
21	1. Check the injector power supply 2 circuit between ECM and coupling connector (H-95) 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 27.	Go to Step 24.
22	Replace the injector harness. Is the procedure completed?	—	Go to Step 27.	—
23	Replace the injector. **Note:** **For work procedure, refer to “Engine section” in the service manual.** Is the procedure completed?	—	Go to Step 27.	—
24	Is EMPS available?	—	Go to Step 25.	Go to Step 26.
25	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 27.	Go to Step 26.
26	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 27.	—

Step	Action	Value	YES	NO
27	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 P1262 detected?	—	Go to Step 2.	Go to Step 28.
28	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

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.

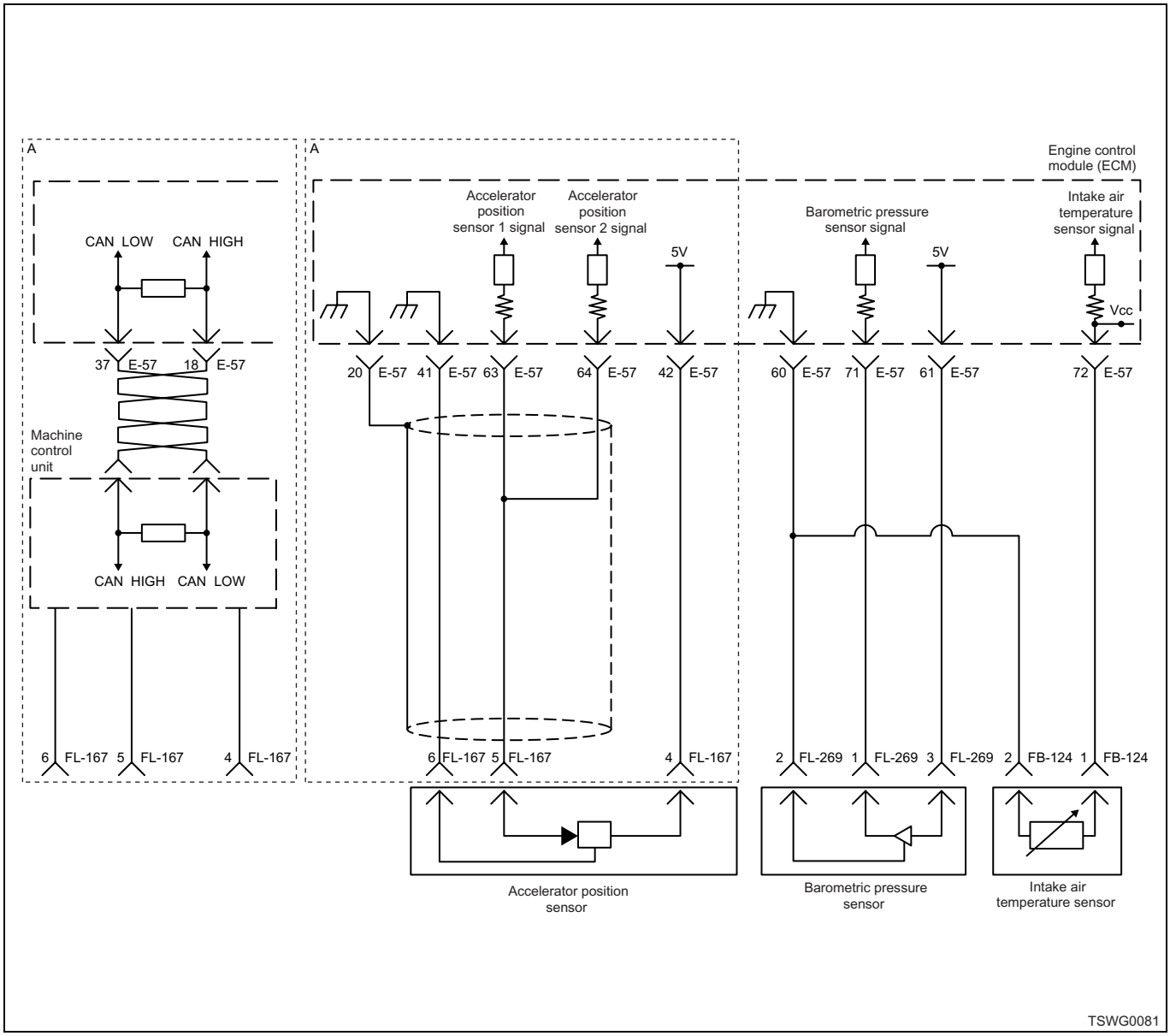


Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
5	Open circuit/ high resistance	Resistance measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	116 - Female-side terminal No. 3	100 Ω or less	10 MΩ or more
	Short circuit to ground	Resistance measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	116 - Ground	10 MΩ or more	100 Ω or less
9	Short circuit to ground	Resistance measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	115 - Ground	10 MΩ or more	100 Ω or less
10	Short circuit to ground	Resistance measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	120 - Ground	10 MΩ or more	100 Ω or less
11	Short circuit to ground	Resistance measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	118 - Ground	10 MΩ or more	100 Ω or less
18	Short circuit to power supply circuit	Voltage measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	115 - Ground	0V	18V or more
19	Short circuit to power supply circuit	Voltage measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	120 - Ground	0V	18V or more

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
20	Short circuit to power supply circuit	Voltage measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	118 - Ground	0V	18V or more
21	Short circuit to power supply circuit	Voltage measurement	• Remove the ECM-side harness connector from the coupling connector. • Key switch “OFF”	116 - Ground	0V	18V or more

DTC: P1271 (Flash code 24) Accelerator sensor 1-2 comparison fault



Description of circuit

The accelerator position (AP) sensor is installed to the accelerator pedal. The AP sensor is the potentiometer-type sensor, and the value of output voltage changes according to the accelerator opening angle. Two AP sensors are installed, each of which includes following circuits.

- 5-V power supply circuit
- Ground circuit
- AP sensor signal circuit

The ECM provides 5 V to the AP sensor through 5-V power supply circuit, and grounds to the inside of the ECM through ground circuit. Also, the AP sensor outputs the signal voltage to the ECM through AP sensor signal circuit. When the accelerator opening angle is large, the AP sensor 1 outputs high voltage, whereas the AP sensor 2 outputs low voltage.
The ECM sets the DTC when the difference in the accelerator opening angle is large between which is detected based on the AP sensor 1 signal, and which is detected based on the AP sensor 2 signal.

Main trouble symptom

1 system fault: No backup
2 systems fault: Accelerator opening angle is controlled to 0%.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630, P1631, P1271, P1277, P1278, P1282, or P1283 is not detected.

DTC set condition

Difference in opening angle between accelerator sensors 1 and 2 is 45% or more.

- [Accelerator sensor 1 voltage + Accelerator sensor 2 voltage] is higher than 6.4 V.
- [Accelerator sensor 1 voltage + Accelerator sensor 2 voltage] is lower than 3.6 V.

Action taken when DTC is set

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

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

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. Measure at the harness connector-side.

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	1. Turn the key switch to “OFF” for more than 10 seconds. 2. Start the engine. 3. Check the DTC. Is DTC P1271 detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	1. Turn the key switch to “OFF”. 2. Disconnect the AP sensor connector. 3. Connect the DMM between the sensor power supply terminal of the AP sensor connector and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	4.7V	Go to Step 5.	Go to Step 6.
4	Is the scan tool available?	—	Go to Step 5.	Go to Step 18.

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.

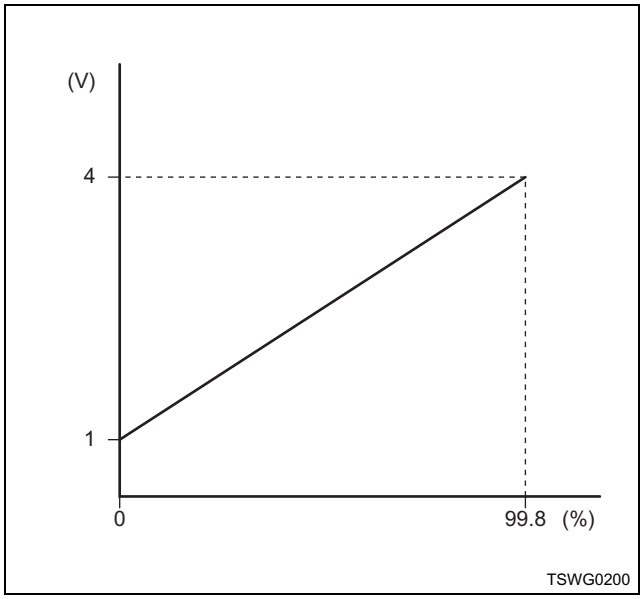
Step	Action	Value	YES	NO
9	1. Check for high resistance in the signal circuit between ECM and AP sensor using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 16.	Go to Step 11.
10	1. Turn the key switch to “OFF”. 2. Disconnect the AP sensor connector. 3. Check the AP sensor connector terminal for intermittent trouble or poor contact. 4. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 16.	Go to Step 12.
11	1. Turn the key switch to “OFF”. 2. Remove the ECM. 3. Check the ECM terminals (41, 63, 42, 60, 64, 61) for intermittent trouble or poor contact. 4. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 16.	Go to Step 13.
12	Replace the AP sensor. Is the procedure completed?	—	Go to Step 16.	—
13	Is EMPS available?	—	Go to Step 14.	Go to Step 15.
14	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 16.	Go to Step 15.

Step	Action	Value	YES	NO
15	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 16.	—
16	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 P1271 detected?	—	Go to Step 2.	Go to Step 17.
17	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
18	1. Turn the key switch to "OFF". 2. Disconnect the AP sensor connector. 3. Turn the key switch to "ON". 4. Connect the DMM between the sensor power supply terminal of the AP sensor connector and the signal circuit. Is the DMM indication more than the specified value?	4.7V	Go to Step 8.	Go to Step 7.

About AP sensor

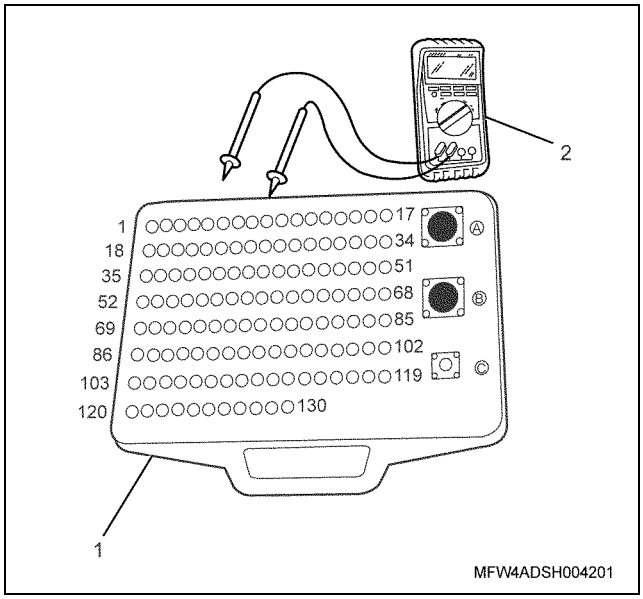
Refer to the machine's manual for installing position of the AP sensor.

Characteristics of AP sensor



Breaker box inspection procedure

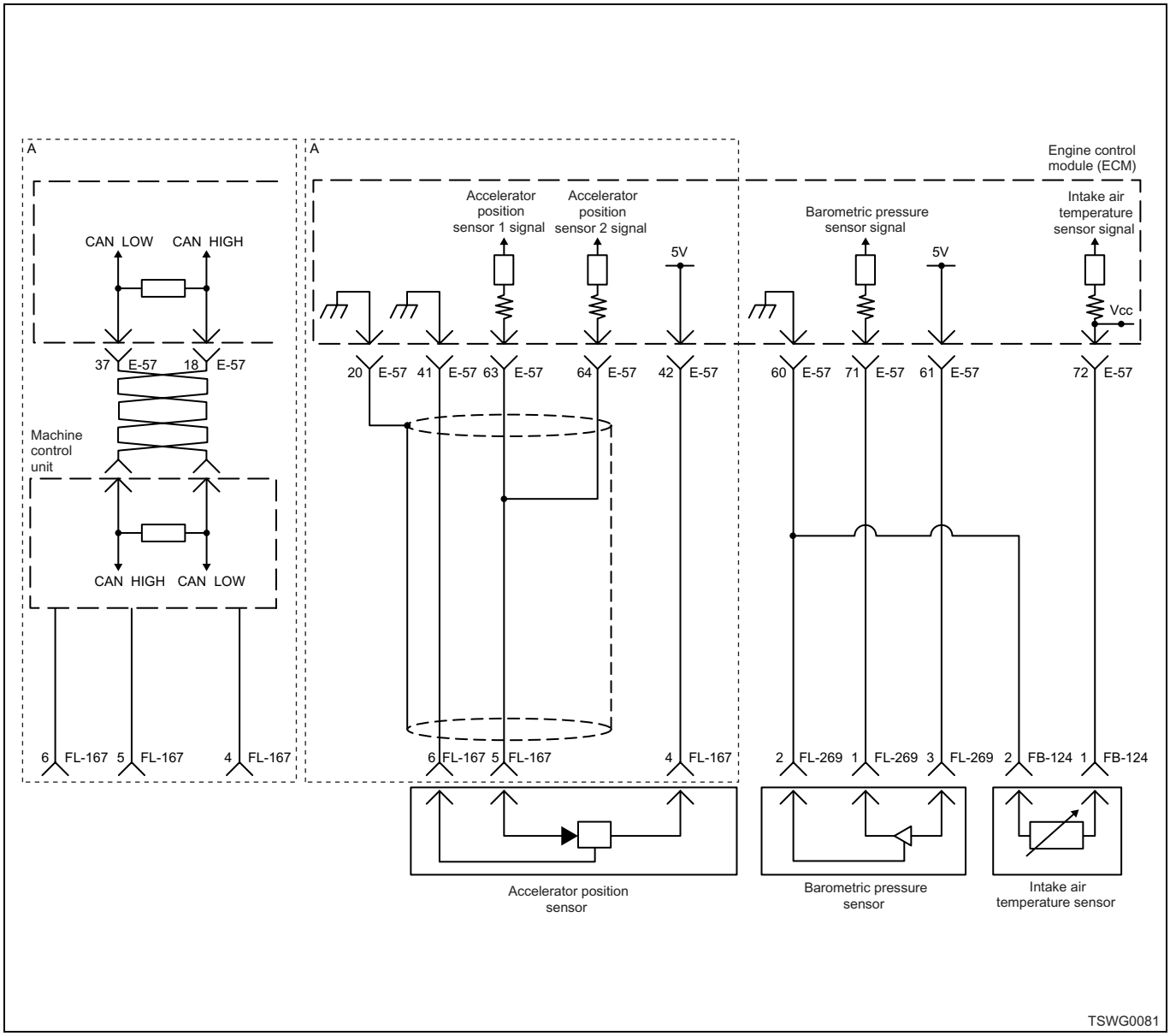
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	42 - Sensor connector sensor power supply terminal	100 Ω or less	10 MΩ or more
7	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	41 - Sensor connector sensor ground terminal	100 Ω or less	10 MΩ or more
8	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	63 - Sensor connector sensor signal terminal	100 Ω or less	10 MΩ or more
9	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	64 - Sensor connector sensor signal terminal	100 Ω or less	10 MΩ or more

DTC: P1277 (Flash code 24) Accelerator sensor 1 fault (low voltage fault)



Description of circuit

The accelerator position (AP) sensor is installed to the accelerator pedal. The AP sensor is the potentiometer-type sensor, and the value of output voltage changes according to the accelerator opening angle. The AP sensor includes following circuits.

- 5-V power supply circuit
- Ground circuit
- AP sensor signal circuit

The ECM provides 5 V to the AP sensor through 5-V power supply circuit, and grounds to the inside of the ECM through ground circuit. Also, the AP sensor outputs the signal voltage to the ECM through AP sensor signal circuit. The AP sensor 1 outputs high voltage when the accelerator opening angle is large.
The ECM sets the DTC when the signal voltage from the AP sensor 1 is less than the normal range.

Main trouble symptom

1 system fault: No backup
2 systems fault: Accelerator opening angle is controlled to 0%.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630, P1277, or P1631 is not detected.

DTC set condition

- AP sensor 1 voltage is 0.2 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

- 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 P1282 is detected at the same time, the accelerator pedal position sensor and the 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 less than the specified value. If more than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If the “Accelerator sensor 1” displays more than the specified value when terminals between the AP 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 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” less than the specified value?	0.2V	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.

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 sensor 1 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?	4.8V	Go to Step 8.	Go to Step 6.
6	1. Check for followings 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”.** • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 7.
7	1. Check for followings 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”.** • Short circuit to AP sensor ground circuit • Short circuit to ground • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 9.
8	Replace the AP sensor. Is the procedure completed?	—	Go to Step 12.	—
9	Is EMPS available?	—	Go to Step 10.	Go to Step 11.

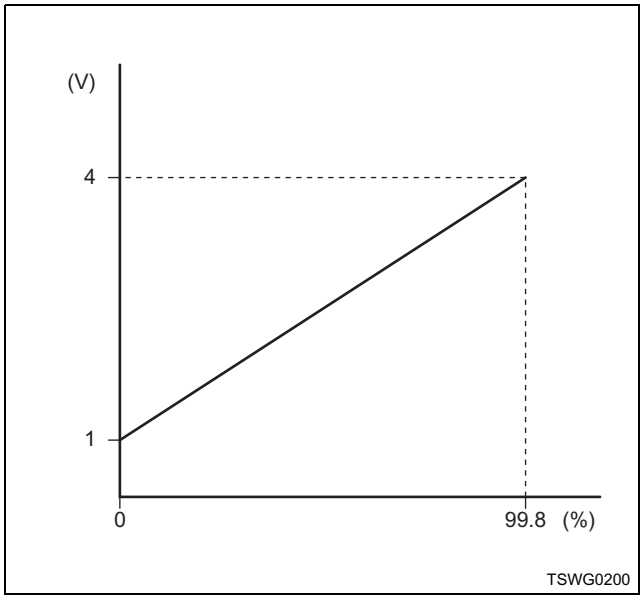
Step	Action	Value	YES	NO
10	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer 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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P1277 detected?	—	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.
14	1. Turn the key switch to “ON”. 2. Check for “Accelerator sensor 1” on the data display. Is the “Accelerator sensor 1” less than the specified value?	0.2V	Go to Step 15.	Go to “Diagnostic aid”.
15	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 16.

Step	Action	Value	YES	NO
16	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 sensor 1 signal terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check for “Accelerator sensor 1” on the data display. Is the “Accelerator sensor 1” more than the specified value?	4.8V	Go to Step 8.	Go to Step 6.

About AP sensor

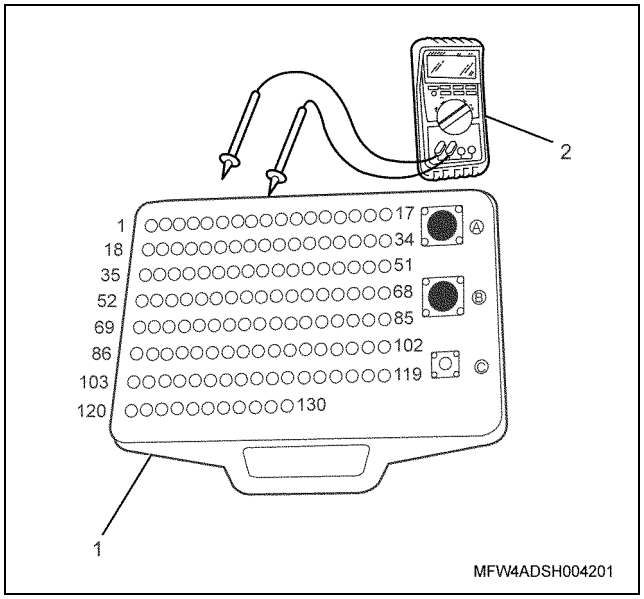
Refer to the machine’s manual for installing position of the AP sensor.

Characteristics of AP sensor



Breaker box inspection procedure

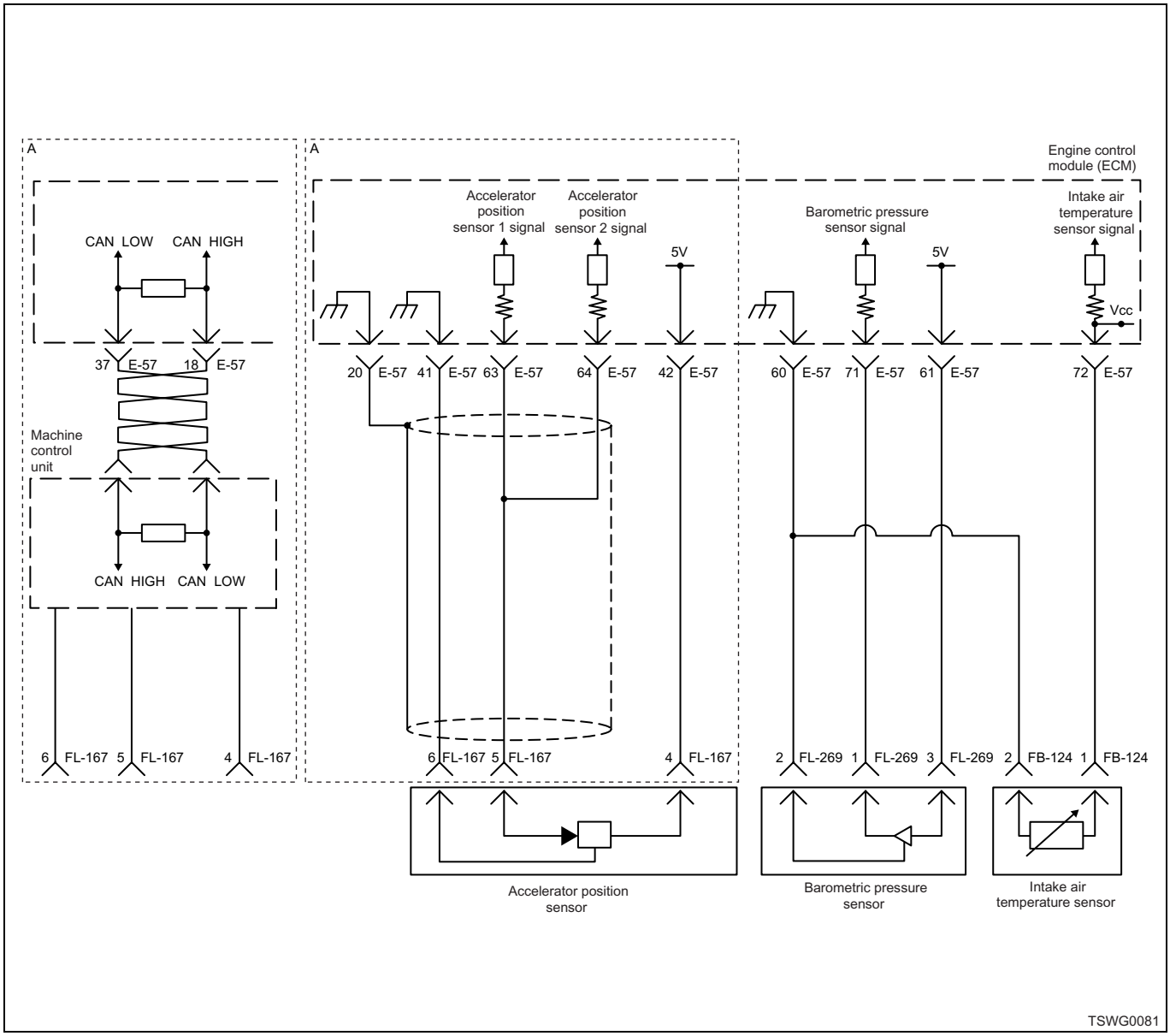
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	42 - Sensor connector sensor 1 power supply terminal	100 Ω or less	10 MΩ or more
7	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	63 - 41 63 - Ground	10 MΩ or more	100 Ω or less
	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	63 - Sensor connector sensor 1 signal terminal	100 Ω or less	10 MΩ or more

DTC: P1278 (Flash code 24) Accelerator sensor 1 fault (high voltage fault)



Description of circuit

The accelerator position (AP) sensor is installed to the accelerator pedal. The AP sensor is the potentiometer-type sensor, and the value of output voltage changes according to the accelerator opening angle. The AP sensor includes following circuits.

- 5-V power supply circuit
- Ground circuit
- AP sensor signal circuit

The ECM provides 5 V to the AP sensor through 5-V power supply circuit, and grounds to the inside of the ECM through ground circuit. Also, the AP sensor outputs the signal voltage to the ECM through AP sensor signal circuit. The AP sensor 1 outputs high voltage when the accelerator opening angle is large.
The ECM sets the DTC when the signal voltage from the AP sensor 1 is more than the normal range.

Main trouble symptom

1 system fault: No backup
2 systems fault: Accelerator opening angle is controlled to 0%.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630, P1278, or P1631 is not detected.

DTC set condition

- AP sensor 1 voltage is 4.9 V or more.

Action taken when DTC is set

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

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.

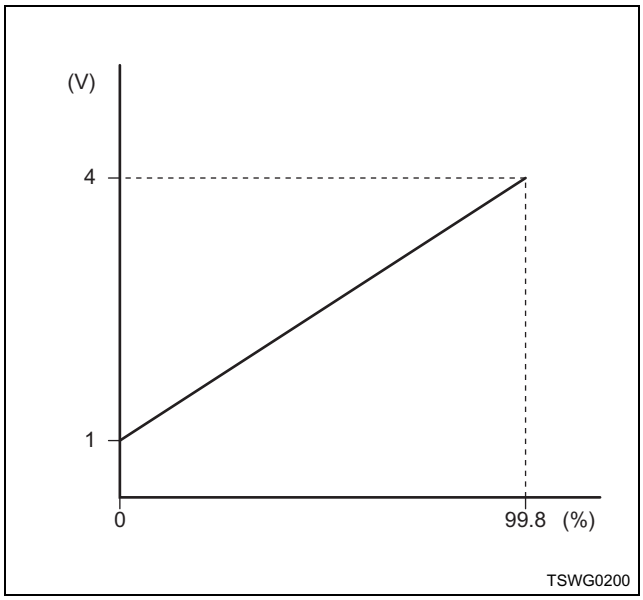
Step	Action	Value	YES	NO
6	1. Check the signal circuit between ECM and AP sensor 1 for short circuit to the power supply circuit or ignition power supply circuit using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** **Important:** If the AP 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 7.
7	1. Check for followings 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”.** • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 9.
8	Replace the AP sensor. Is the procedure completed?	—	Go to Step 12.	—
9	Is EMPS available?	—	Go to Step 10.	Go to Step 11.
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.

Step	Action	Value	YES	NO
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. Test run with the "Preconditions when DTC is set". 5. Check the DTC. Is DTC P1278 detected?	—	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.
14	1. Turn the key switch to "ON". 2. Check for "Accelerator sensor 1" on the data display. Is the "Accelerator sensor 1" more than the specified value?	4.9V	Go to Step 15.	Go to "Diagnostic aid".
15	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 16.
16	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. Is the "Accelerator sensor 1" less than the specified value?	0.1V	Go to Step 8.	Go to Step 6.

About AP sensor

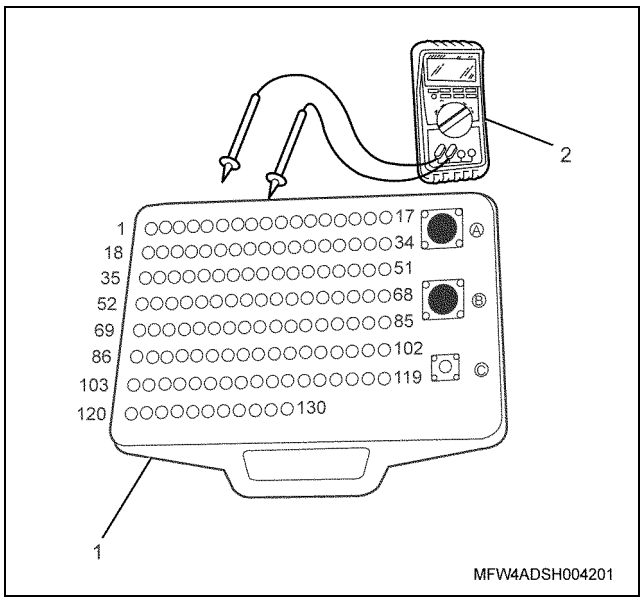
Refer to the machine's manual for installing position of the AP sensor.

Characteristics of AP sensor



Breaker box inspection procedure

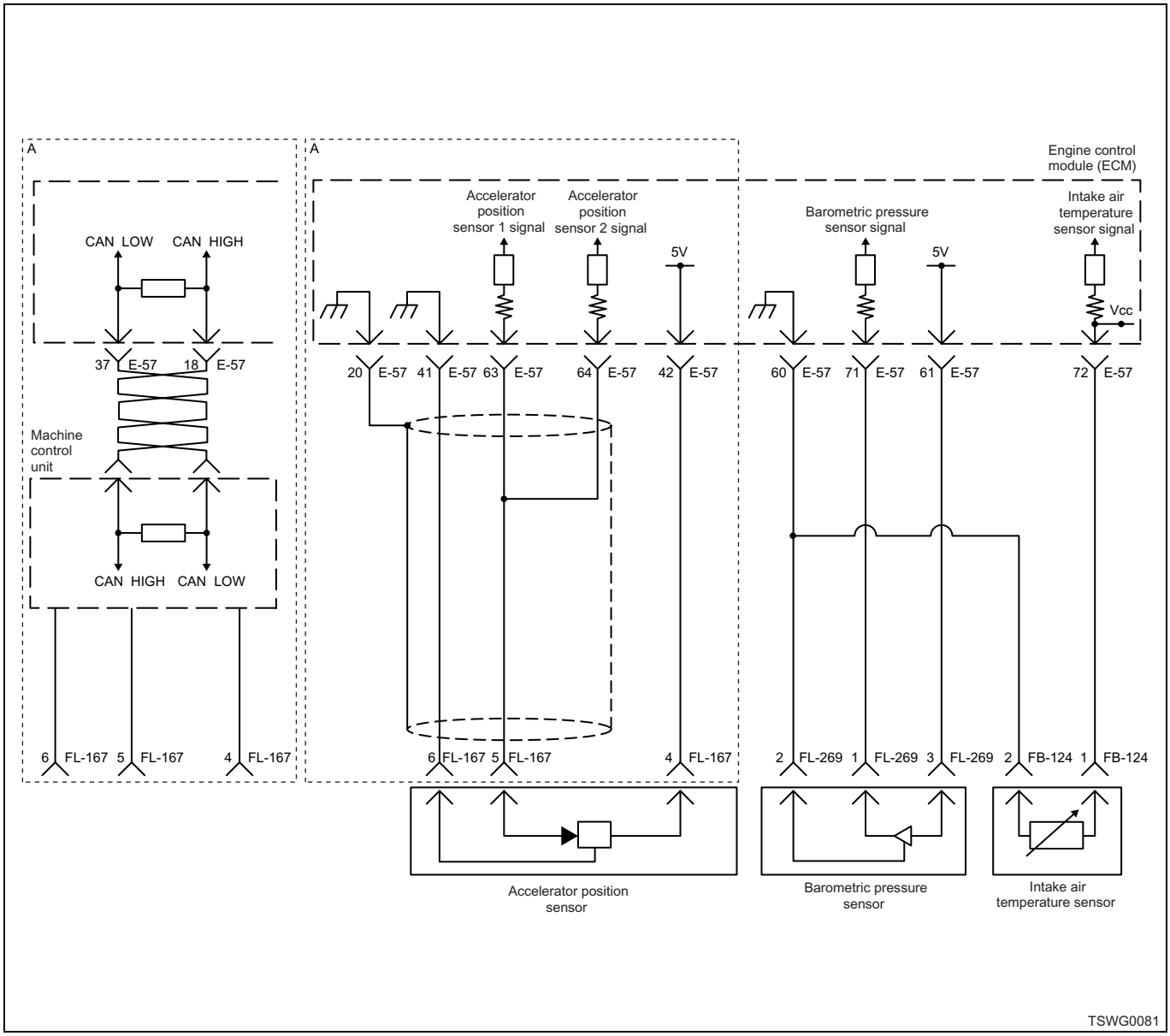
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	63 - Ground	0V	18V or more
7	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	41 - Sensor connector sensor 1 ground terminal	100 Ω or less	10 MΩ or more

DTC: P1282 (Flash code 24) Accelerator sensor 2 fault (low voltage fault)



Description of circuit

The accelerator position (AP) sensor is installed to the accelerator pedal. The AP sensor is the potentiometer-type sensor, and the value of output voltage changes according to the accelerator opening angle. The AP sensor includes following circuits.

- 5-V power supply circuit
- Ground circuit
- AP sensor signal circuit

The ECM provides 5 V to the AP sensor through 5-V power supply circuit, and grounds to the inside of the ECM through ground circuit. Also, the AP sensor outputs the signal voltage to the ECM through AP sensor signal circuit. The AP sensor 1 outputs high voltage when the accelerator opening angle is large.
The ECM sets the DTC when the signal voltage from the AP sensor 2 is less than the normal range.

Main trouble symptom

1 system fault: No backup
2 systems fault: Accelerator opening angle is controlled to 0%.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630, P1282, P1631 is not detected.

DTC set condition

- AP sensor 2 voltage is 0.2 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

- 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 P1277 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 less than the specified value. If more than the specified value, identify the cause by referring to “Diagnostic aid”.
5. If the “Accelerator sensor 2” displays more than the specified value when terminals between the AP 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 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” less than the specified value?	0.2V	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.

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 sensor 2 signal terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check for “Accelerator sensor 2” on the data display using scan tool. Is the “Accelerator sensor 2” 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 AP sensor 1 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 7.
7	1. Check for followings in the signal circuit between ECM and AP sensor 1 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 AP sensor 1 ground circuit • Short circuit to ground • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 9.
8	Replace the AP sensor. Is the procedure completed?	—	Go to Step 12.	—
9	Is EMPS available?	—	Go to Step 10.	Go to Step 11.

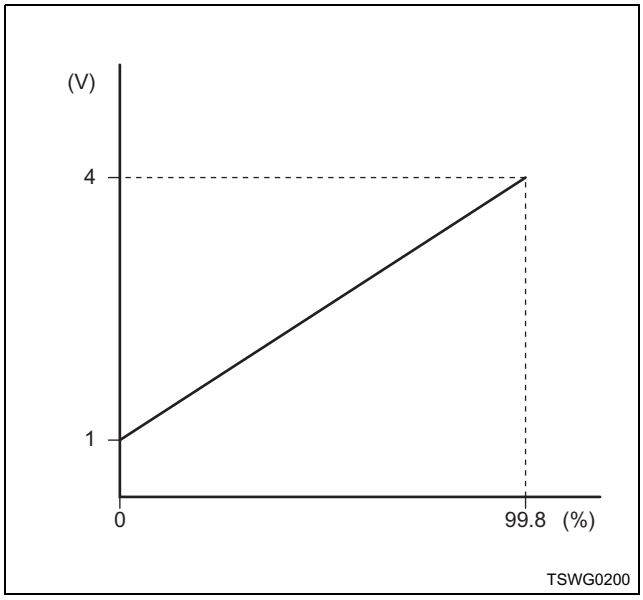
Step	Action	Value	YES	NO
10	1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to “How to use flash tool” in this section for check and rewriting of ECM. **Note:** **EGR valve position learning is required after replacing or rewriting the ECM.** **Refer 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. Test run with the “Preconditions when DTC is set”. 5. Check the DTC. Is DTC P1282 detected?	—	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.
14	1. Turn the key switch to “ON”. 2. Check for “Accelerator sensor 2” on the data display. Is the “Accelerator sensor 2” less than the specified value?	0.2V	Go to Step 15.	Go to “Diagnostic aid”.
15	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 16.

Step	Action	Value	YES	NO
16	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 sensor 2 signal terminal using jump cable. 4. Turn the key switch to “ON”. 5. Check for “Accelerator sensor 2” on the data display. Is the “Accelerator sensor 2” more than the specified value?	4.8V	Go to Step 8.	Go to Step 6.

About AP sensor

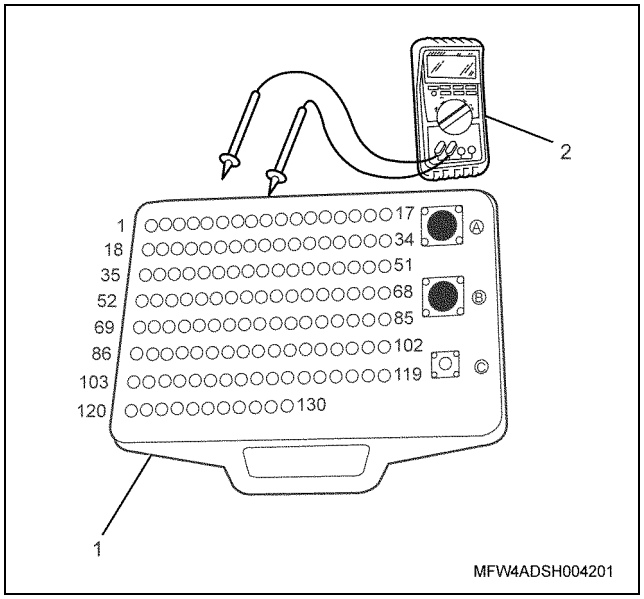
Refer to the machine’s manual for installing position of the AP sensor.

Characteristics of AP sensor



Breaker box inspection procedure

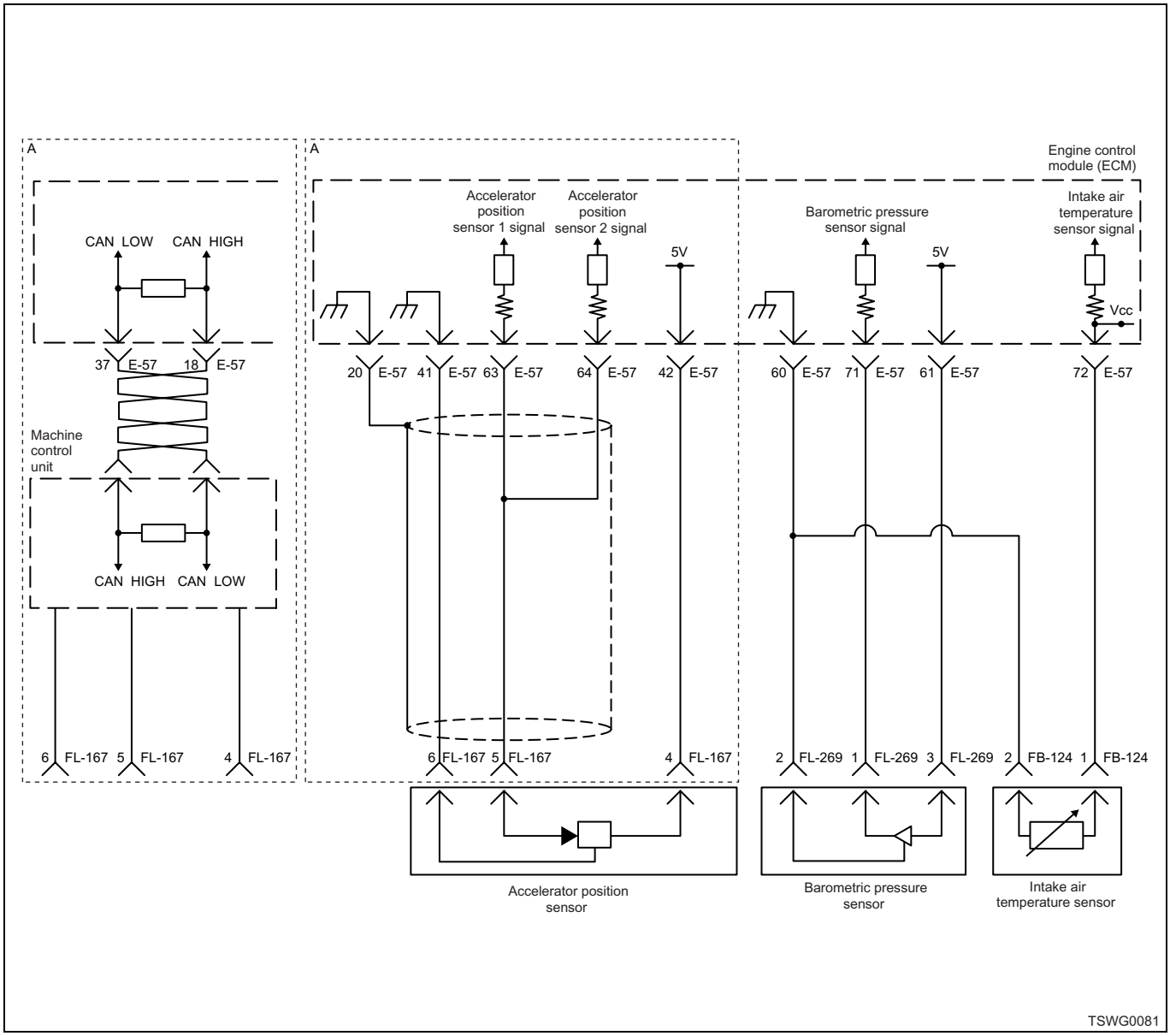
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	61 - Sensor connector sensor 1 power supply terminal	100Ω or less	10 MΩ or more
7	Short circuit to ground circuit/ ground	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	64 - 61 64 - Ground	10 MΩ or more	100 Ω or less
	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	64 - Sensor connector sensor 1 signal terminal	100 Ω or less	10 MΩ or more

DTC: P1283 (Flash code 24) Accelerator sensor 2 fault (high voltage fault)



Description of circuit

The accelerator position (AP) sensor is installed to the accelerator pedal. The AP sensor is the potentiometer-type sensor, and the value of output voltage changes according to the accelerator opening angle. The AP sensor includes following circuits.

- 5-V power supply circuit
- Ground circuit
- AP sensor signal circuit

The ECM provides 5 V to the AP sensor through 5-V power supply circuit, and grounds to the inside of the ECM through ground circuit. Also, the AP sensor outputs the signal voltage to the ECM through AP sensor signal circuit. The AP sensor 1 outputs high voltage when the accelerator opening angle is large.
The ECM sets the DTC when the signal voltage from the AP sensor 2 is more than the normal range.

Main trouble symptom

1 system fault: No backup
2 systems fault: Accelerator opening angle is controlled to 0%.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630, P1283, or P1631 is not detected.

DTC set condition

- AP sensor 2 voltage is 4.9 V or more.

Action taken when DTC is set

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

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.

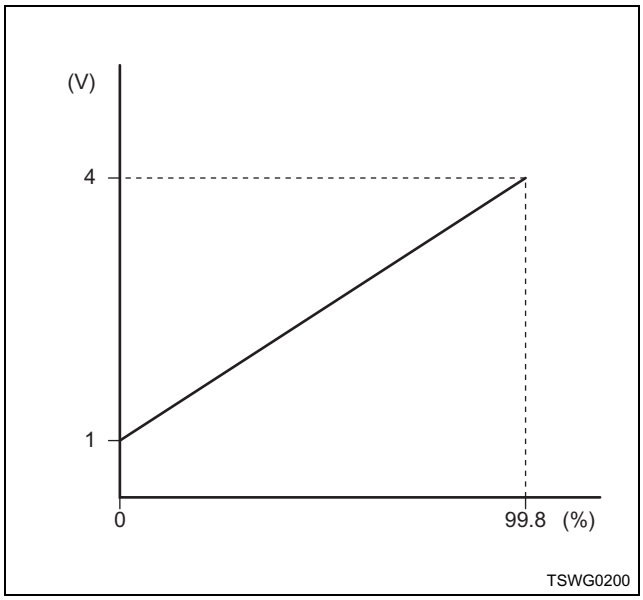
Step	Action	Value	YES	NO
6	1. Check the signal circuit between ECM and AP sensor 1 for short circuit to the power supply circuit or ignition power supply circuit using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** **Important:** If the AP 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 7.
7	1. Check for followings 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”.** • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 9.
8	Replace the AP sensor. Is the procedure completed?	—	Go to Step 12.	—
9	Is EMPS available?	—	Go to Step 10.	Go to Step 11.
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.

Step	Action	Value	YES	NO
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. Test run with the "Preconditions when DTC is set". 5. Check the DTC. Is DTC P1283 detected?	—	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.
14	1. Turn the key switch to "ON". 2. Check for "Accelerator sensor 2" on the data display. Is the "Accelerator sensor 2" more than the specified value?	4.9V	Go to Step 15.	Go to "Diagnostic aid".
15	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 16.
16	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. Is the "Accelerator sensor 2" less than the specified value?	0.1V	Go to Step 8.	Go to Step 6.

About AP sensor

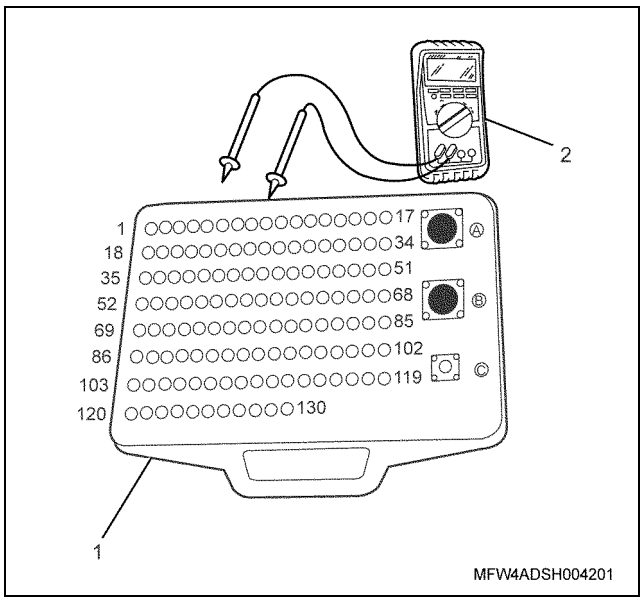
Refer to the machine's manual for installing position of the AP sensor.

Characteristics of AP sensor



Breaker box inspection procedure

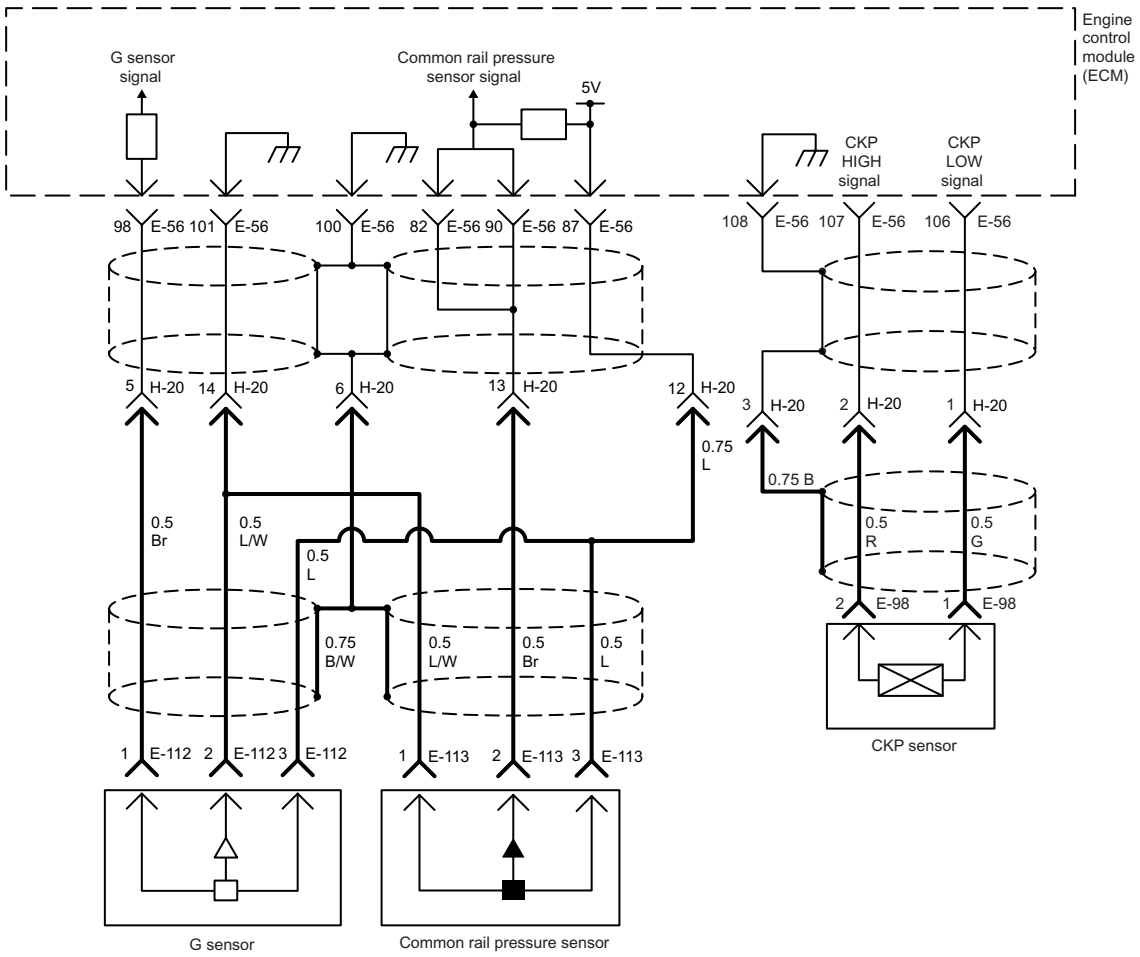
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to power supply circuit	Voltage measurement	• Disconnect the sensor connector. • Key switch “ON”	64 - Ground	0V	18V or more
7	Open circuit/ high resistance	Resistance measurement	• Disconnect the sensor connector. • Key switch “OFF”	60 - Sensor connector sensor 1 ground terminal	100 Ω or less	10 MΩ or more

DTC: P1345 (Flash code 16) Cam sensor out of phase



Description of circuit

The crankshaft position (CKP) sensor generates pulse when the tooth of the flywheel passes the sensor. Also, the G sensor, the same as CKP sensor, generates pulse when the sensing hole for signal detection installed in the supply pump camshaft gear passes the sensor.
The ECM sets the DTC when the number of pulses for CKP sensor and G sensor are normal but mutual pulses do not synchronize.

Main trouble symptom

- Behavior does not change during engine running.
- After engine stops, engine will not start.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P0335, P0336, P0340, P0341, P1345, or P1635 is not detected.
- G sensor pulse is normal.
- Crank pulse is normal.

DTC set condition

- Correct G sensor pulse does not exist in crank gap position.

Action taken when DTC is set

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

Back-up mode

- Engine running based on crank when it is normal

- After engine stops: Unable to identify cylinder (unable to restart)

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
- Excessive air mixed in the fuel.

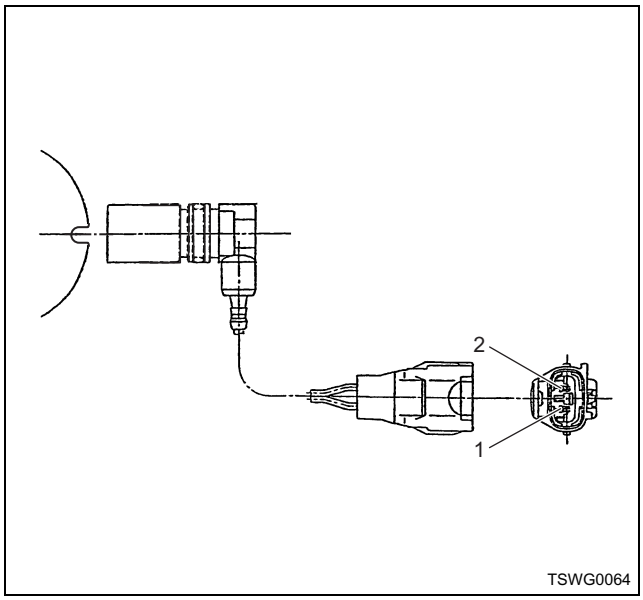
Following inspections are necessary to detect these causes.

- 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.

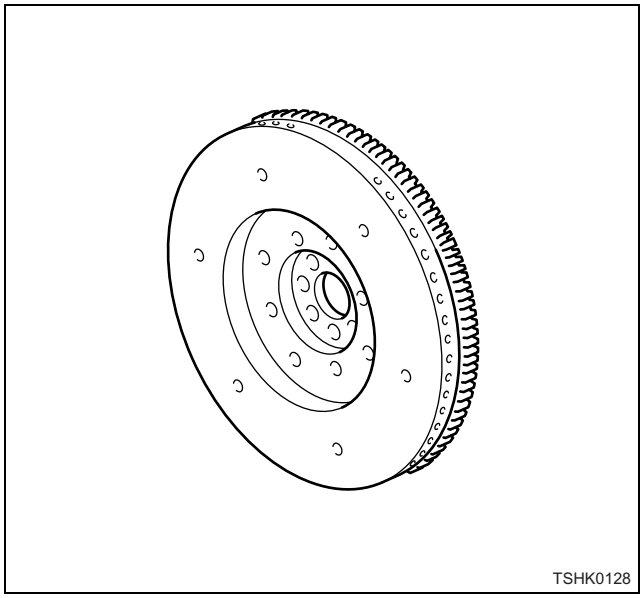
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	1. Check for the condition of the G sensor. • Improper connection of harness connector • Loose installation and rattling of sensor 2. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 3.	—
3	1. Check for the condition of the CKP sensor. • Improper connection of harness connector • Loose installation and rattling of sensor 2. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 4.	—

Step	Action	Value	YES	NO
4	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. • Stop the engine once, crank the engine for 4 to 5 seconds, and then check if P0340 is detected. • When DTC P0340 is detected, judge as an open circuit in G sensor, and check and repair the open circuit in G sensor. After repair, crank the engine for 10 seconds, and confirm that P0340 and P1345 disappear. Is DTC P1345 detected?	—	Go to Step 5.	—
5	1. Check that the camshaft gear is installed properly. 2. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 6.	—
6	1. Check that the flywheel is installed properly. 2. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 7.	—
7	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 15 seconds. 3. Test run with the “Preconditions when DTC is set”. 4. Check the DTC. Is DTC P1345 detected?	—	Go to Step 2.	Go to Step 8.
8	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

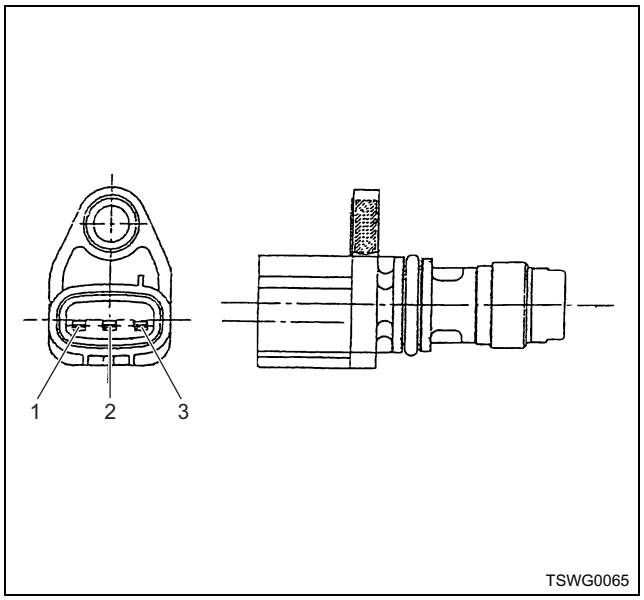
About CKP sensor



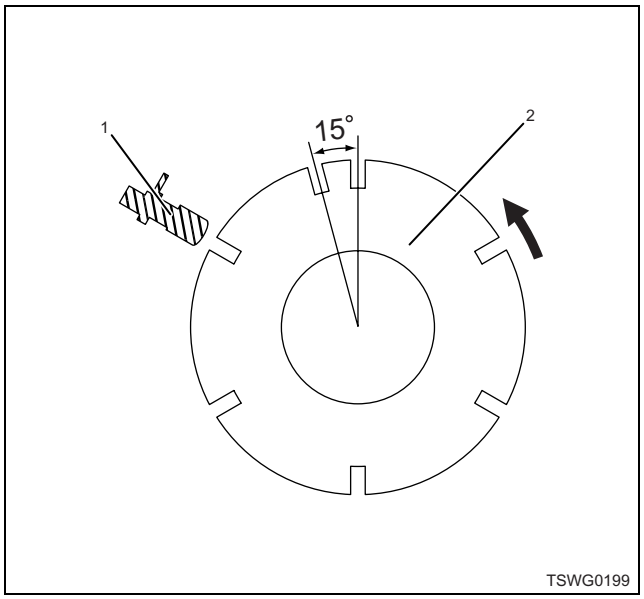
Name
1. GND
2. Power supply



About G sensor

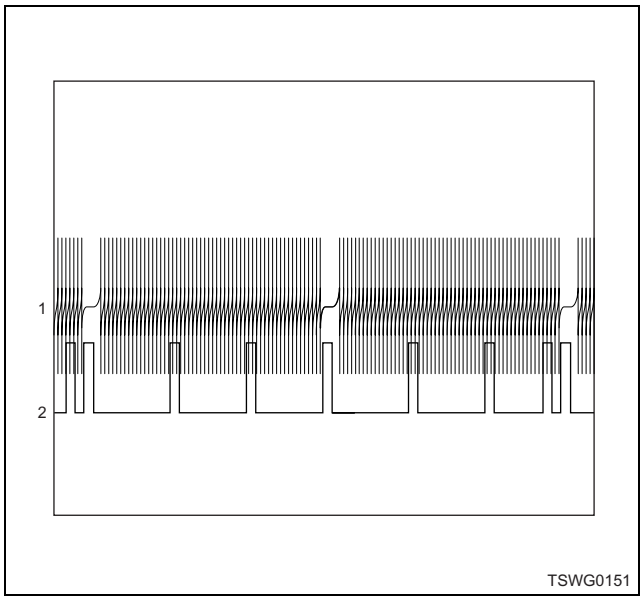


Name
1. Signal
2. GND
3. Power supply



Name
1. G sensor
2. Pulser

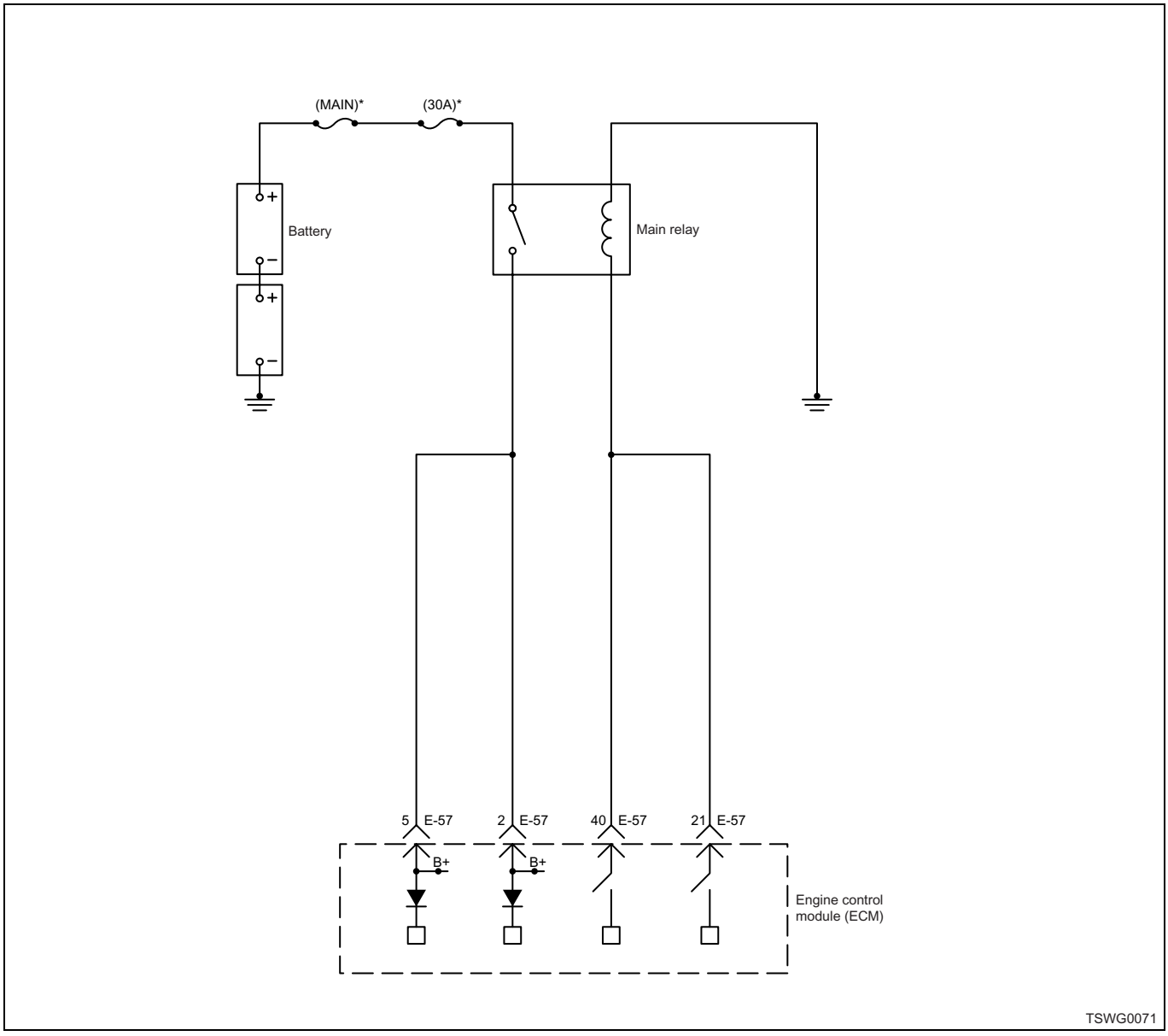
About CKP sensor and G sensor signals



Name
1. CKP signal
2. G sensor signal

DTC: P1625 (Flash code 416) Main relay fault

(*: Specifications (fuse current value etc.) vary depending on each machine. Refer to the machine manual.)



Description of circuit

The main relay is installed near the blower motor inside the instrument panel. The ECM turns the main relay "ON" when the key switch inputs "ON" signal, and turns the main relay "OFF" when the key switch is "OFF". The battery voltage is supplied to the main relay via fuse, and turning the main relay "ON" will supply the power supply voltage to the ECM.
The ECM sets the DTC when the output to/input from the main relay do not match.

Main trouble symptom

Engine does not start or power supply cannot be shut off.

Preconditions when DTC is set

- Key switch input voltage is 16V or more.
- DTC P1630 is not detected.
- 3 seconds or more has elapsed after key switch ON.
- Main relay drive indication ON
- DTC P1625, or P0606 is not detected.

DTC set condition

- Main relay input power supply voltage is 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

- 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).
- 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	1. Check the circuit (contact point side) between main relay and ECM 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 15.
7	Check for installation condition of the main 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 15.	Go to Step 8.
8	1. Turn the key switch to “OFF”. 2. Remove the main relay. 3. Short between the terminals 1 - 2 and 3 - 5 in the main relay installing portion respectively using jump cable. 4. Turn the key switch to “ON”. 5. Check for “Main relay voltage” on the data display using scan tool. Is the “Main relay voltage” more than the specified value?	24V	Go to Step 11.	Go to Step 9.
9	1. Check for following in the circuit between slow-blow fuse and main relay. • Open circuit • Short circuit to ground circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 15.	Go to Step 10.

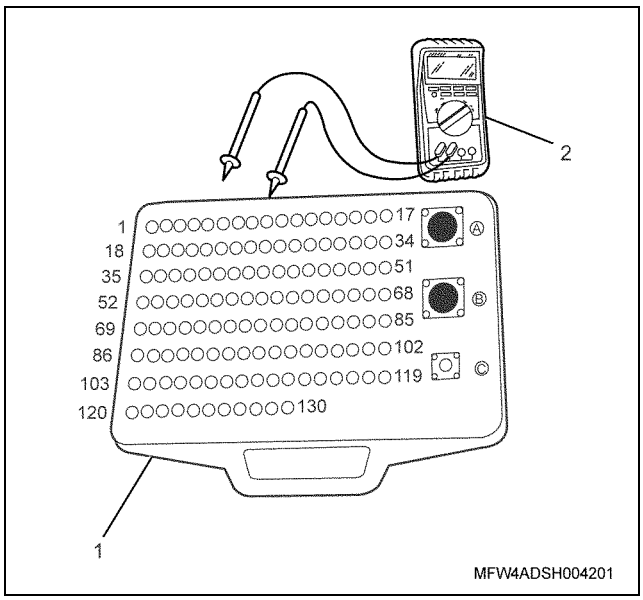
Step	Action	Value	YES	NO
10	1. Check for followings in the circuit between main relay and ECM using breaker box or DMM. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** • Open circuit • Short circuit to ground circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 15.	Go to Step 12.
11	Replace the main relay. Is the procedure completed?	—	Go to Step 15.	—
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?	—	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.	—

Step	Action	Value	YES	NO
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 P1625 detected?	—	Go to Step 2.	Go to Step 15.
16	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
17	1. Turn the key switch to “OFF”. 2. Remove the main relay. 3. Turn the key switch to “ON”. 4. Connect the DMM between the main relay connector coil-side terminal and the ground. Is the DMM indication more than the specified value?	1V	Go to Step 18.	Go to Step 21.
18	1. Turn the key switch to “OFF”. 2. Check the DTC. Is DTC P1625 detected?	—	Go to Step 19.	Go to “Diagnostic aid”.
19	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 20.	Go to Step 11.
20	1. Check the circuit (contact point side) between main relay and ECM 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 12.	Go to Step 15.

Step	Action	Value	YES	NO
21	Check for installation condition of the main 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 15.	Go to Step 22.
22	1. Turn the key switch to “OFF”. 2. Remove the main relay. 3. Turn the key switch to “ON”. 4. Connect the DMM between the main relay connector terminal (contact point side) and the ground.	24V	Go to Step 11.	Go to Step 9.

Breaker box inspection procedure

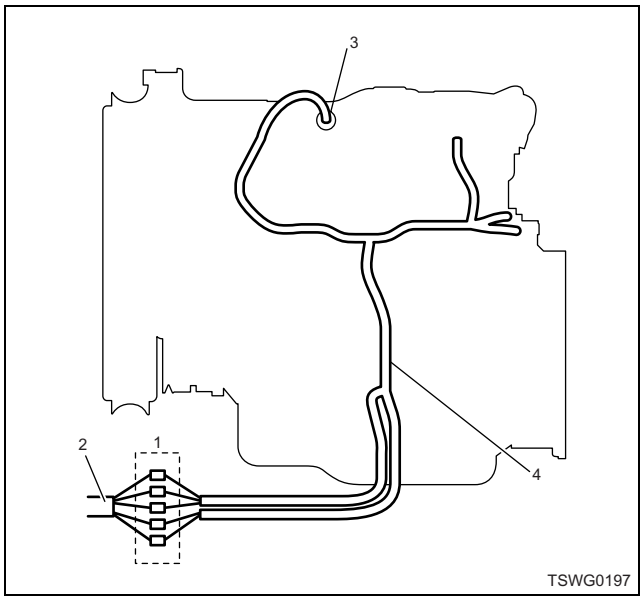
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6	Short circuit to power supply circuit	Voltage measurement	• Disconnect the relay. • Key switch “ON”	2 - Ground 5 - Ground	0V	18V or more
10	Open circuit/ high resistance	Resistance measurement	• Disconnect the relay. • Key switch “OFF”	2 - Relay installing terminal No. 2 5 - Relay installing terminal No. 2 21 - Relay installing terminal No. 5 40 - Relay installing terminal No. 5	100 Ω or less	10 MΩ or more
	Short circuit to ground	Resistance measurement	• Disconnect the relay. • Key switch “OFF”	2 - Ground 5 - Ground 21 - Ground 40 - Ground	10 MΩ or more	100 Ω or less

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.

DTC: P1630 (Flash code 36) A/D conversion fault

Description of circuit

The ECM processes the analog signals (voltage signal etc.) which are input from each sensor into digital signals, to perform various controls and calculations.
The ECM sets the DTC when the fault is detected for the analog-digital conversion.

Main trouble symptom

- Output lowering
- Black smoke emitted

DTC set condition

- Analog/digital conversion failure

Action taken when DTC is set

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

Back-up mode

- Analog sensor system default processing
- Limited injection amount 3 (multi-injection stopped)
- Target RP upper limit (80 MPa {11603 psi})

Recovery from failure

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

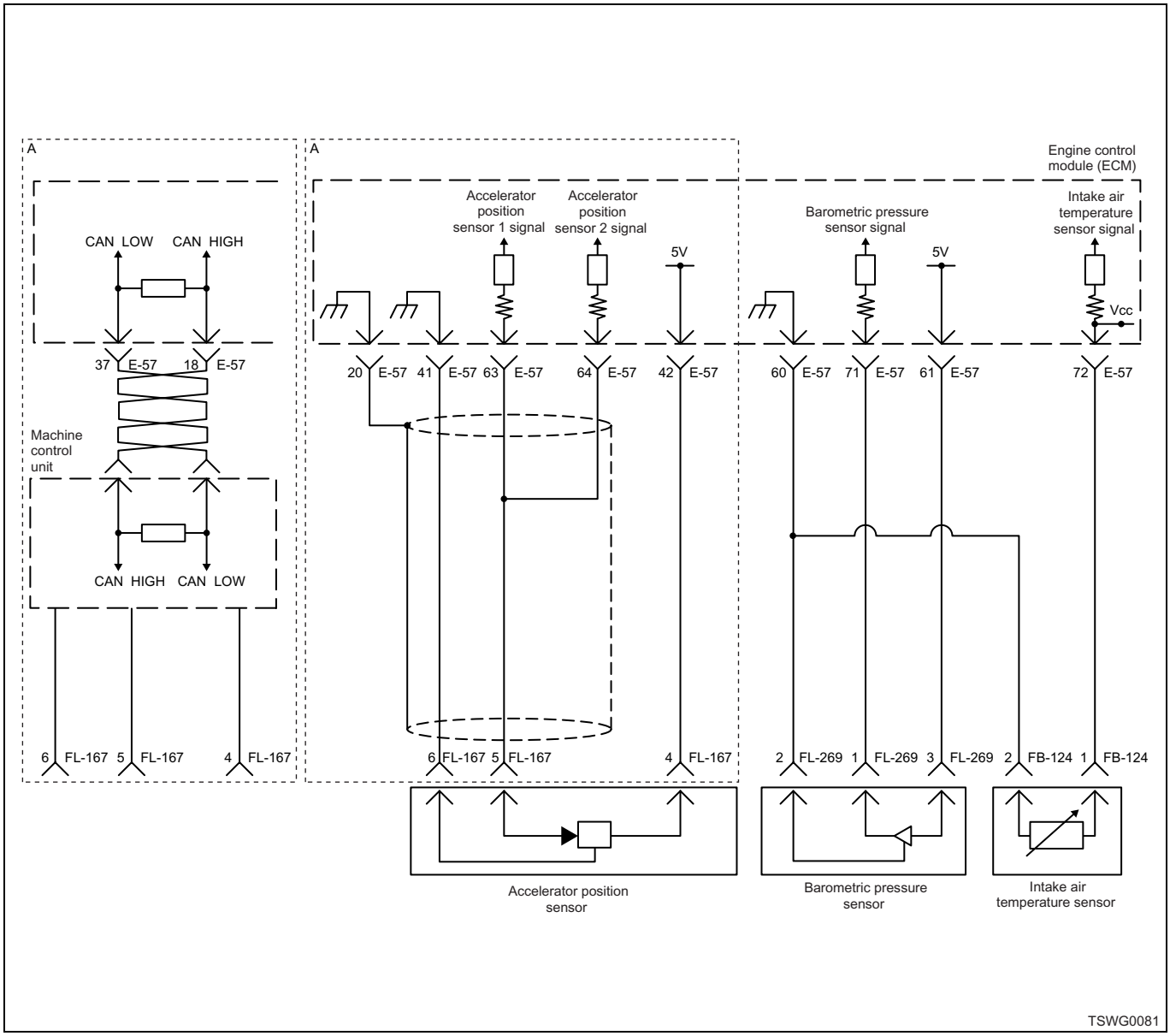
The conditions to clear the MIL/DTC

- 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	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 P1630 detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	Is EMPS available?	—	Go to Step 4.	Go to Step 5.
4	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 6.	Go to Step 5.

Step	Action	Value	YES	NO
5	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 6.	—
6	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

DTC: P1631 (Flash code 55) Voltage fault in 5-V power supply 1



Description of circuit

The 5-V power supply circuit is provided to the ECM for 5 systems. The 5-V power supply circuit 1 supplies power to the accelerator position (AP) sensor.
The ECM sets the DTC when the voltage in the 5-V power supply circuit 1 is higher or lower than the normal range.

Main trouble symptom

Accelerator opening angle is controlled to 0%.

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 accelerator sensor fault

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.

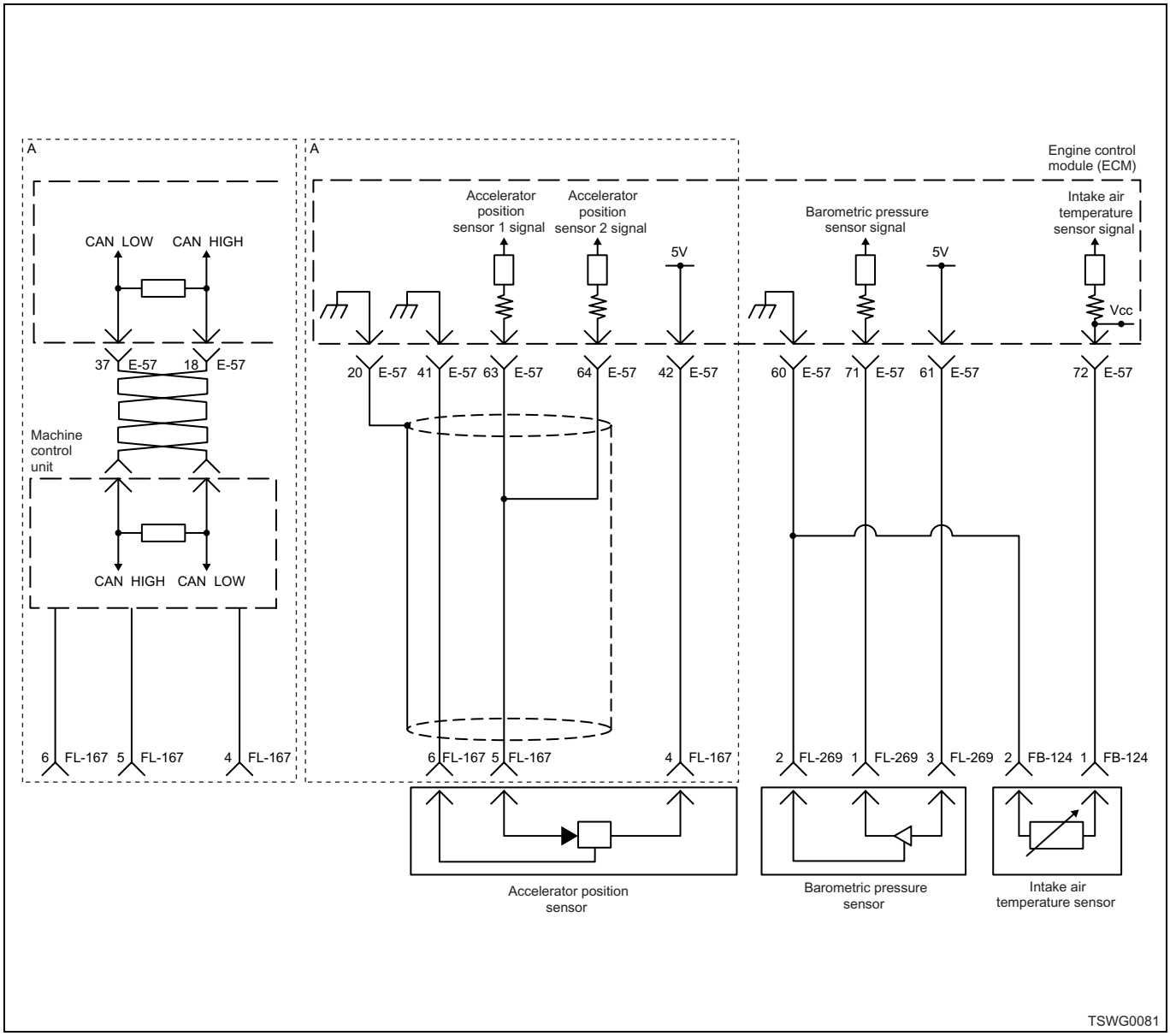
Test description

Numbers below indicate step numbers in the chart.
2. Measure at the harness connector-side.
3. Measure at the harness connector-side.

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	1. Turn the key switch to "OFF". 2. Disconnect the AP sensor connector. 3. Connect the DMM between the AP sensor power supply terminal and the ground. 4. Turn the key switch to "ON". Is the DMM indication more than the specified value?	5.5V	Go to Step 4.	Go to Step 3.
3	1. Turn the key switch to "OFF". 2. Disconnect the AP sensor connector. 3. Connect the DMM between the AP sensor power supply terminal and the ground. 4. Turn the key switch to "ON". Is the DMM indication less than the specified value?	4.5V	Go to Step 5.	Go to Step 9.
4	1. Check the power supply circuit between AP sensor 1 and ECM for short circuit to the battery 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".** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 6.
5	1. Check the power supply circuit between AP sensor 1 and ECM for ground short 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".** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 6.

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: P1632 (Flash code 55) Voltage fault in 5-V power supply 2



Description of circuit

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

Main trouble symptom

Due to back-up equivalent to 2500m (8200ft)

- Black smoke emitted at high altitude
- Output shortage at low altitude

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 barometric pressure and intake air temperature sensor fault

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.

Test description

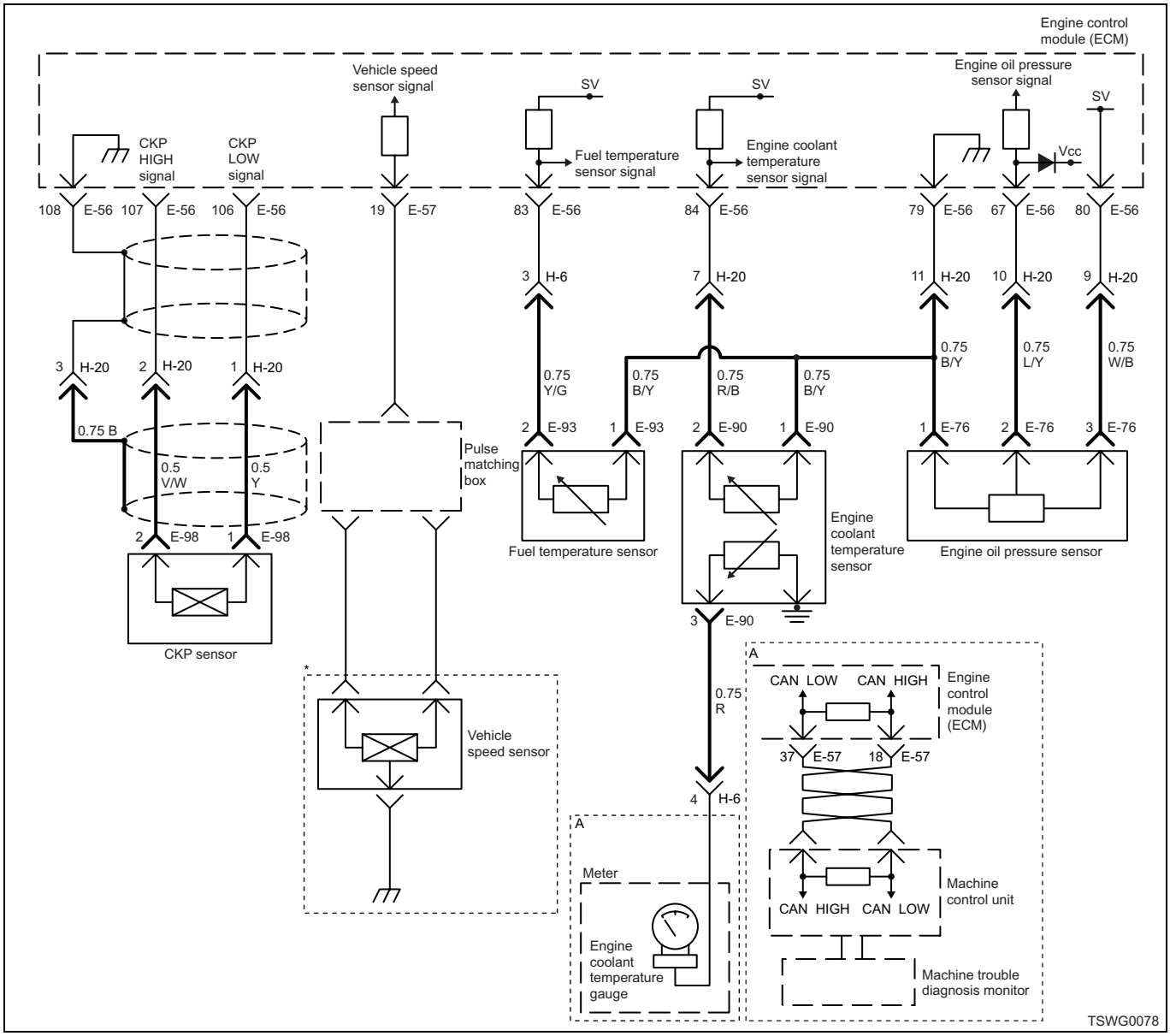
Numbers below indicate step numbers in the chart.
2. Measure at the harness connector-side.
3. Measure at the harness connector-side.

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	1. Turn the key switch to “OFF”. 2. Disconnect the barometric pressure sensor connector. 3. Connect the DMM between the barometric pressure sensor power supply terminal and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	5.5V	Go to Step 4.	Go to Step 3.
3	1. Turn the key switch to “OFF”. 2. Disconnect the barometric pressure sensor connector. 3. Connect the DMM between the barometric pressure sensor power supply terminal and the ground. 4. Turn the key switch to “ON”. Is the DMM indication less than the specified value?	4.5V	Go to Step 5.	Go to “Diagnostic aid”.
4	1. Check the power supply circuit between barometric pressure sensor and ECM for short circuit to the battery 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 6.

Step	Action	Value	YES	NO
5	1. Check the power supply circuit between barometric pressure sensor and ECM for ground short 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	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.
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 P1632 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: P1633 (Flash code 55) Voltage fault in 5-V power supply 3

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



Description of circuit

The 5-V power supply circuit is provided to the ECM for 5 systems. The 5-V power supply circuit 3 supplies power to the engine oil pressure sensor.
The ECM sets the DTC when the voltage in the 5-V power supply circuit 3 is higher or lower than the normal range.

Main trouble symptom

- Startability deteriorates at low temperatures.
- Black smoke emission possible
- Operationality is affected.

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 oil pressure, coolant temperature, and combustion temperature sensor fault

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.

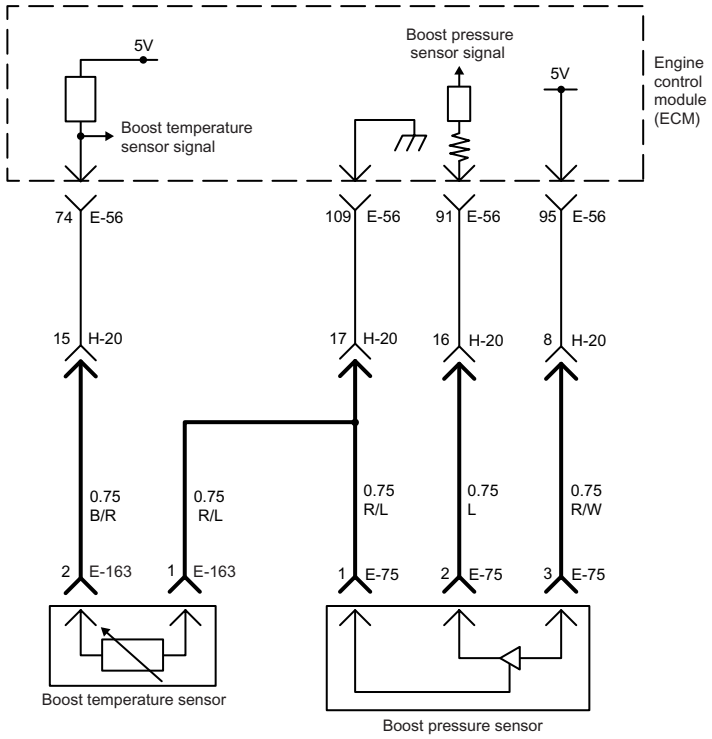
Test description

Numbers below indicate step numbers in the chart.
2. Measure at the harness connector-side.
3. Measure at the harness connector-side.

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	1. Turn the key switch to “OFF”. 2. Disconnect the engine oil pressure sensor connector. 3. Connect the DMM between the engine oil pressure sensor power supply terminal and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	5.5V	Go to Step 4.	Go to Step 3.
3	1. Turn the key switch to “OFF”. 2. Disconnect the engine oil pressure sensor connector. 3. Connect the DMM between the engine oil pressure sensor power supply terminal and the ground. 4. Turn the key switch to “ON”. Is the DMM indication less than the specified value?	4.5V	Go to Step 5.	Go to “Diagnostic aid”.
4	1. Check the power supply circuit between engine oil pressure sensor and ECM for short circuit to the battery 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 6.

Step	Action	Value	YES	NO
5	1. Check the power supply circuit between engine oil pressure sensor and ECM for ground short 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	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.
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 P1633 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: P1634 (Flash code 55) Voltage fault in 5-V power supply 4



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Description of circuit

The 5-V power supply circuit is provided to the ECM for 5 systems. The 5-V power supply circuit 4 supplies power to the boost pressure sensor.
The ECM sets the DTC when the voltage in the 5-V power supply circuit 4 and 3 is higher or lower than the normal range.

Main trouble symptom

Operationality is affected.

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 boost pressure and boost temperature sensor fault

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.

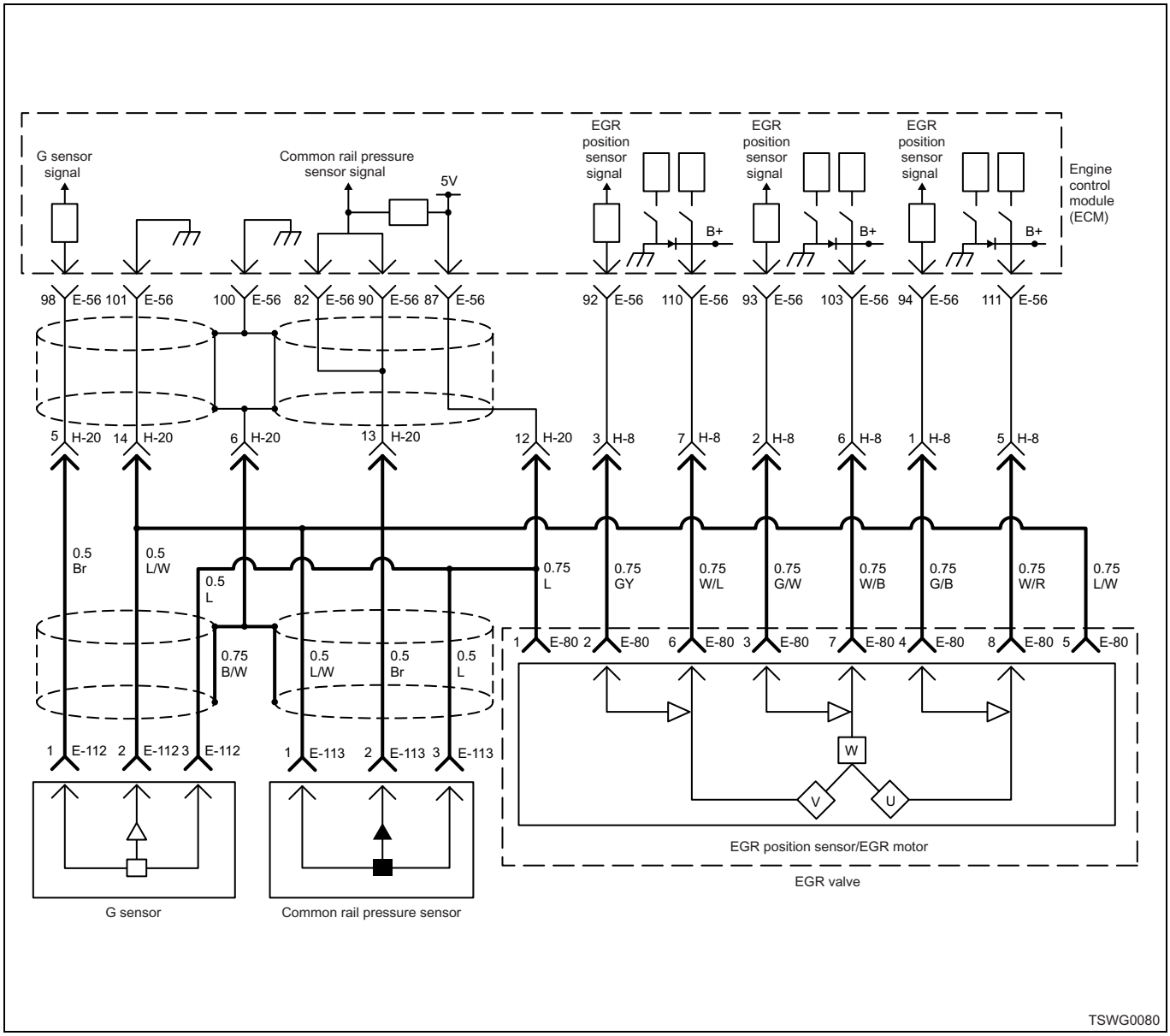
Test description

Numbers below indicate step numbers in the chart.
2. Measure at the harness connector-side.
3. Measure at the harness connector-side.

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	1. Turn the key switch to “OFF”. 2. Disconnect the boost pressure sensor connector. 3. Connect the DMM between the boost pressure sensor power supply terminal and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	5.5V	Go to Step 4.	Go to Step 3.
3	1. Turn the key switch to “OFF”. 2. Disconnect the boost pressure sensor connector. 3. Connect the DMM between the boost pressure sensor power supply terminal and the ground. 4. Turn the key switch to “ON”. Is the DMM indication less than the specified value?	4.5V	Go to Step 5.	Go to “Diagnostic aid”.
4	1. Check the power supply circuit between boost pressure sensor and ECM for short circuit to the battery 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 6.

Step	Action	Value	YES	NO
5	1. Check the power supply circuit between boost pressure sensor and ECM for ground short 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	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.
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 P1634 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

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.

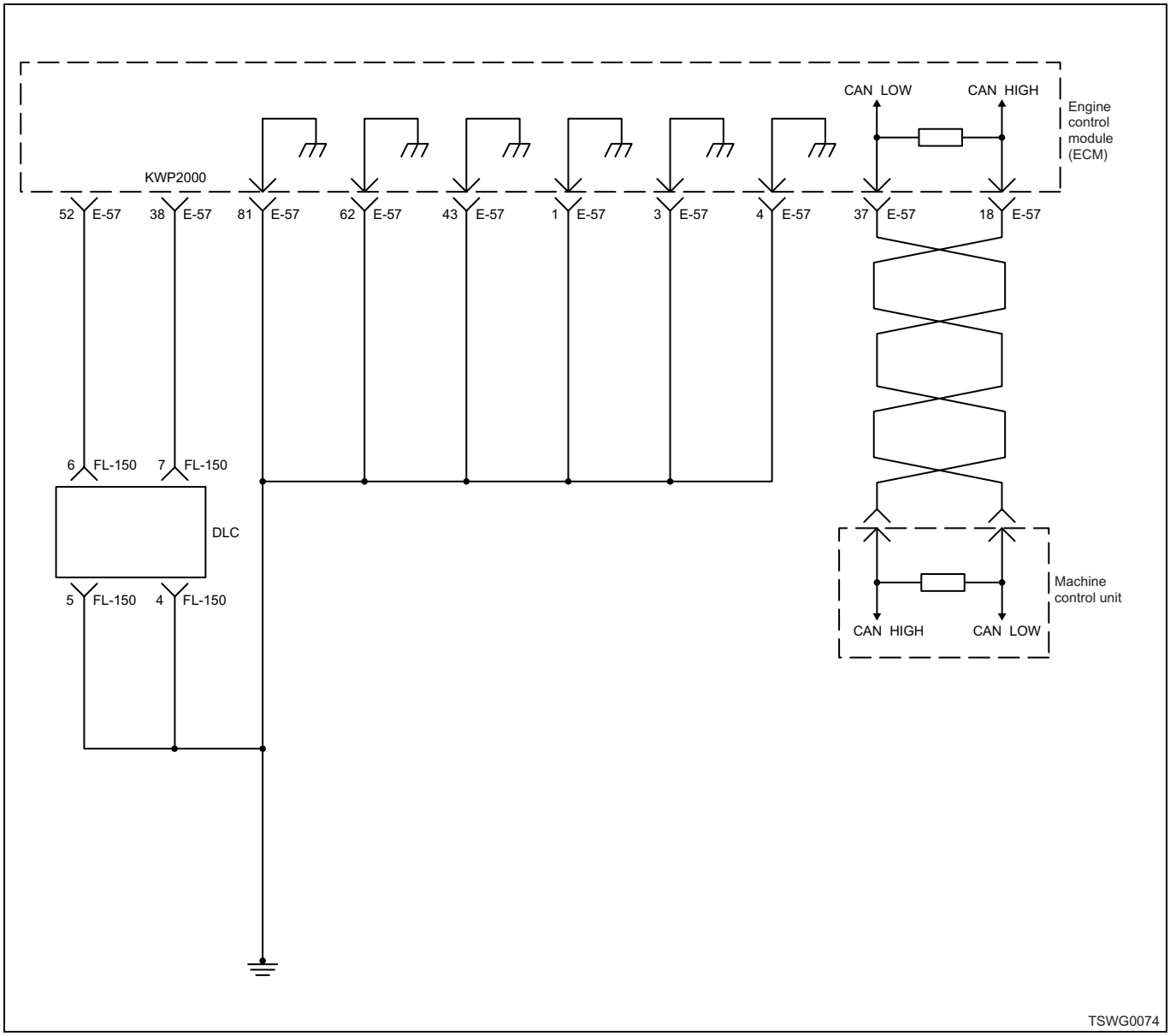
Test description

Numbers below indicate step numbers in the chart.
2. Measure at the harness connector-side.
3. Measure at the harness connector-side.

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	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Connect the DMM between the common rail pressure sensor power supply terminal and the ground. 4. Turn the key switch to “ON”. Is the DMM indication more than the specified value?	5.5V	Go to Step 4.	Go to Step 3.
3	1. Turn the key switch to “OFF”. 2. Disconnect the common rail pressure sensor connector. 3. Connect the DMM between the common rail pressure sensor power supply terminal and the ground. 4. Turn the key switch to “ON”. Is the DMM indication less than the specified value?	4.5V	Go to Step 5.	Go to “Diagnostic aid”.
4	1. Check the power supply circuit between common rail pressure sensor and ECM for short circuit to the battery 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 6.

Step	Action	Value	YES	NO
5	1. Check the power supply circuit between common rail pressure sensor and ECM for ground short 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”.** 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 9.	Go to Step 61.
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 P1635 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: U2104 (Flash code 84) CAN Bus fault



Description of circuit

The ECM communicates with the machine control unit (ECU) through CAN communication circuit. The ECM data outputs through the CAN-High circuit, and other ECU data inputs through the CAN-Low circuit. The CAN communication performs at a constant speed without interruption, and the number of data outputs and inputs must always be the same.
The ECM sets the DTC when the fault is detected for the CAN communication.

Main trouble symptom

Vary depending on setting.

DTC set condition

- CAN communication fault

Preconditions when DTC is set

- Key switch input voltage is 12V or more.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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.

Test description

Numbers below indicate step numbers in the chart.
2. If no DTC is detected, intermittent trouble is suspected. Identify the cause by referring to "Diagnostic aid".
5. Measure at the harness connector-side.

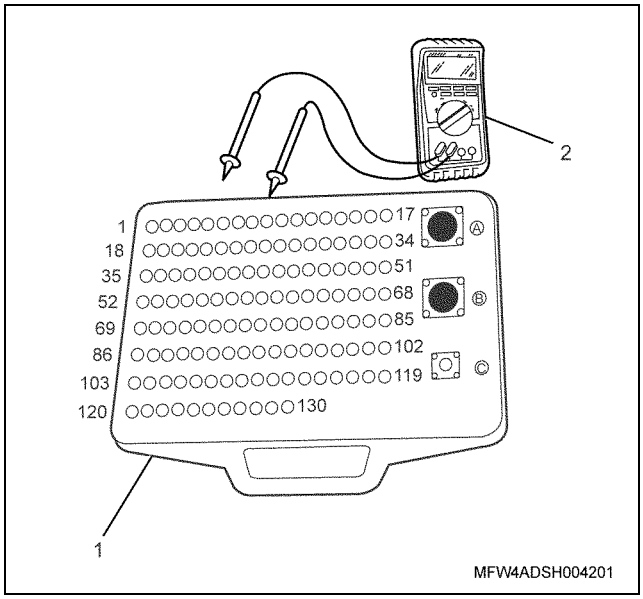
Step	Action	Value	YES	NO
1	Perform the OBD check. Is the procedure completed?	—	Go to Step 2.	Go to "OBD system check".
2	1. Turn the key switch to "OFF" for more than 10 seconds. 2. Start the engine. 3. Check the DTC. Is DTC U2104 detected?	—	Go to Step 3.	Go to "Diagnostic aid".
3	1. If the DTC U2104 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 4.
4	Is the breaker box available?	—	Go to Step 5.	Go to Step 15.
5	1. Turn the key switch to "OFF". 2. Remove the ECM. 3. Connect the breaker box to the ECM. 4. Connect the breaker box with the ECM harness. 5. Measure the resistance between the CAN-High-side terminal and CAN-Low-side terminal using breaker box. Refer to "Breaker box inspection procedure". **Note:** **If breaker box is not available, refer to "On-board check procedure for sensors".** Is the resistance within the specified value?	50 — 70Ω	Go to Step 13.	Go to Step 6.
6	1. Remove the ECM from the breaker box. 2. Measure the resistance between the CAN-High-side terminal and CAN-Low-side terminal using breaker box. Refer to "Breaker box inspection procedure". **Note:** **If breaker box is not available, refer to "On-board check procedure for sensors".** Is the resistance specified value?	Approx. 120Ω	Go to Step 7.	Go to Step 8.

Step	Action	Value	YES	NO
7	1. Connect the ECM to the breaker box. 2. Remove the machine control unit and the harness. 3. Measure the resistance between the CAN-High-side terminal and CAN-Low-side terminal using breaker box. Refer to “Breaker box inspection procedure”. **Note:** **If breaker box is not available, refer to “On-board check procedure for sensors”.** Is the resistance specified value?	Approx. 120Ω	Go to Step 13.	Go to Step 10.
8	1. Check the CAN-Low circuit and CAN-High circuit between ECM and machine control unit 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”.** 2. If the trouble is detected, replace the harness. Is the trouble detected?	—	Go to Step 2.	Go to Step 9.
9	1. Check for followings in the CAN-Low circuit and CAN-High circuit between ECM and machine control unit 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 2.	Replace the machine control unit.
10	Is EMPS available?	—	Go to Step 11.	Go to Step 12.

Step	Action	Value	YES	NO
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?	—	Verify repair.	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.	—
13	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 U2104 detected?	—	Go to Step 2.	Go to Step 14.
14	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.
15	Remove the ECM, and measure the resistance between the CAN-High-side terminal and CAN-Low-side terminal of the ECM connector. Is the resistance specified value?	Approx. 120Ω	Go to Step 16.	Go to Step 8.
16	1. Install the ECM, and remove the machine control unit. 2. Measure the resistance between the CAN-High-side terminal and CAN-Low-side terminal of the machine control unit connector. Is the resistance specified value?	Approx. 120Ω	Go to Step 13.	Go to Step 10.

Breaker box inspection procedure

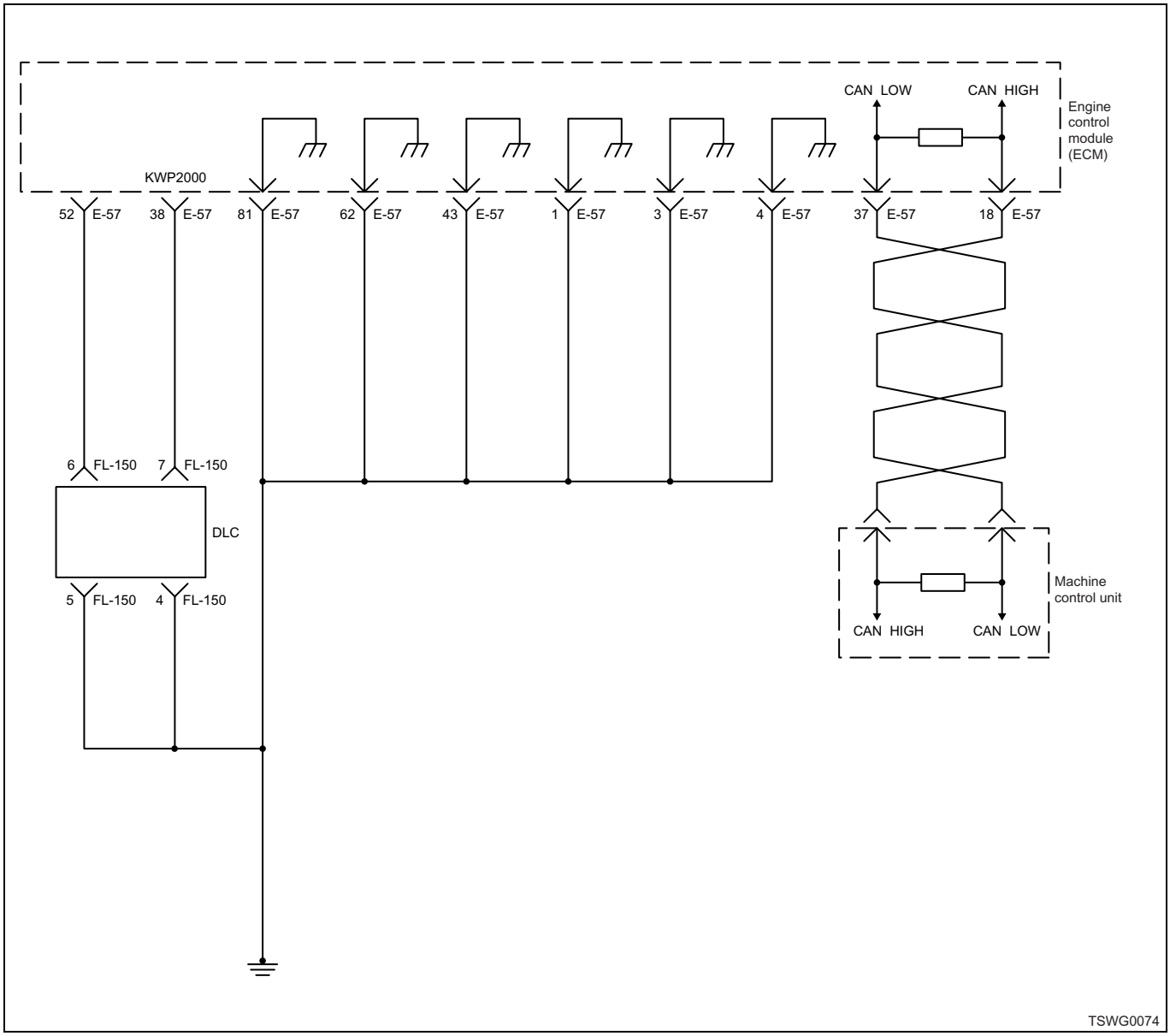
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



Name
1. Breaker box
2. DMM

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
8	Short circuit to power supply circuit	Voltage measurement	• Remove all the relevant ECU connectors. • Key switch “ON”	18 - Ground 37 - Ground	0V	18V or more
9	Open circuit/ high resistance	Resistance measurement	• Remove all the relevant ECU connectors. • Key switch “OFF”	37 - Machine control unit 18 - Machine control unit	100Ω or less	10 MΩ or more
	Short circuit to ground	Resistance measurement	• Remove all the relevant ECU connectors. • Key switch “OFF”	18 - Ground 37 - Ground	10 MΩ or more	100 Ω or less

DTC: U2106 (Flash code 85) CAN timeout fault



Description of circuit

The ECM communicates with the machine control unit (ECU) through CAN communication circuit. The ECM data outputs through the CAN-High circuit, and other ECU data inputs through the CAN-Low circuit. The CAN communication performs at a constant speed without interruption, and the number of data outputs and inputs must always be the same.
The ECM sets the DTC when the CAN communication is disrupted with the machine control unit (ECU).

Main trouble symptom

- Vary depending on setting.
- It cannot be controlled from the machine side since CAN communication is disabled. The engine speed becomes back-up speed specified by each machine manufacturer.

DTC set condition

- Instruction message on CAN communication to run is disrupted for 1 second or more.

Preconditions when DTC is set

- DTC U2104 is not detected.
- Key switch input voltage is 12V or more.

Action taken when DTC is set

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

Back-up mode

- Specified back-up value

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.
2. If no DTC is detected, intermittent trouble is suspected. Identify the cause by referring to “Diagnostic aid”.

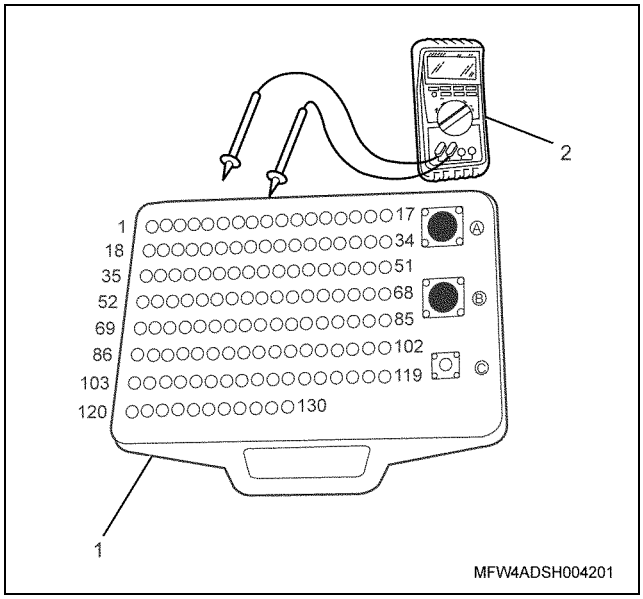
Step	Action	Value	YES	NO
1	Perform the OBD system check. Is the procedure completed?	—	Go to Step 2.	Go to “OBD system check”.
2	1. Turn the key switch to “OFF” for more than 10 seconds. 2. Start the engine. 3. Check the DTC. Is DTC U2106 detected?	—	Go to Step 3.	Go to “Diagnostic aid”.
3	1. Check for 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”.** • Open circuit • High resistance 2. If the trouble is detected, repair as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 4.

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
9	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 11.	Go to Step 10.
10	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 11.	—
11	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 2.	Go to Step 12.
12	Check if other DTC is detected. Is other DTC detected?	—	Go to each DTC diagnosis.	Verify repair.

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
4	Open circuit/ high resistance	Resistance measurement	• Remove the machine control unit (ECU) connector. • Key switch “OFF”	18 - Machine control unit (ECU) connector terminal 37 - Machine control unit (ECU) connector terminal	100 Ω or less	10 MΩ or more
5	Short circuit to ground	Resistance measurement	• Remove the machine control unit (ECU) connector. • Key switch “OFF”	18 - Ground 37 - Ground	10 MΩ or more	100 Ω or less
	Short circuit to power supply circuit	Voltage measurement	• Remove the machine control unit (ECU) connector. • Key switch “ON”	18 - Ground 37 - Ground	0V	18V or more

List of trouble symptom

Symptom	Description
Engine start failure	Crank speed is slow. Crank speed is normal but engine does not start (no first combustion). Engine starts (first combustion exists) but cannot maintain stable engine speed, or no blow up.
Engine stall	Engine cranks but take long time before start. It operates eventually, or starts but stops immediately.
Engine hunting, rough idling	Engine idle speed is rough, or idle speed changes. In a more severe case, engine or machine vibrates. In any serious situations, the engine stalls.
Engine output shortage, lag down	Engine output is lower than expected, and output does not change with the accelerator lever (throttle lever) released, engine response deteriorates.
Exhaust gas contains a lot of white smoke.	A lot of white smoke emitted while running.
Exhaust gas contains a lot of black smoke.	A lot of black smoke emitted while running.
Noise	Abnormal sound occurs from the engine.
Fuel consumption deteriorates.	Fuel consumption is remarkably more than that indicated in the machine's manual. The situation shown here is that the problem is not found on the machine side and the engine needs to be checked.
Oil consumption deteriorates.	Oil consumption is remarkably lower than that indicated in the machine's manual. The situation shown here is that the problem is not found on the machine side and the engine needs to be checked.

Engine start failure

Pre-inspection

Before using this paragraph, perform the “OBD system check” and check all the following items.

- Check if excessive load is applied to the machine side.
- ECM and diagnosis lamp operate properly.
- Check the DTC.
- Scan tool data shows normal operating range.
- Check the condition of the machine to identify the applicable symptom from “List of trouble symptom”. Perform the procedure described in the symptom chart.
- Check with the customer if correct engine oil and fuel are used.

Visual check

Careful visual check is required for some symptom procedures. By this inspection, the problem can be corrected without performing further inspection, and time can be saved.
This inspection includes the following items.

- There is no dirt or clogging in fuel filter.
- There is no poor contact in connector (it must be connected with click sound). Especially for CKP sensor and G sensor.
- The terminal voltage of battery is not low.
- Wire is connected, tightened or cut properly.
- Commercial accessory power supply is not bifurcated from ECM power supply.
- ECM ground is not contaminated and installed to the proper position securely.
- Pipes and hoses relevant to fuel, air and oil are free of crack or twist, and are properly connected. Thoroughly check for any oil leakage and clogging.
- Fuel system is free from oil leakage, and pipe is not damaged or dent.
- Intake system parts for fault.
- Exhaust system parts for fault.

Diagnostic aid

- If the crank sensor is faulty, crank more than 60 rpm for 14 seconds or more since it is not judged on cranking for less than 14 revolutions.
- When the engine is running at low speed, the DTC of crank sensor fault may not be detected. If an intermittent trouble is found, raise the engine speed up to No Load Max, and check if DTC related to crank sensor is detected.
- Fuel system fault (run out of fuel, frozen fuel, air mixed in fuel pipe, faulty filter [clog in main filter, gauze filter], pipe fault, fuel quality, fuel tank [foreign matter, fuel suction fault])
- Intake system fault (clogging in filter, intake pipe fault, etc.)
- Supply pump fault (no fuel pressure feed)
- Common rail fault (flow damper or pressure limiter is activated, degradation of sealability)
- Injector fault (no fuel injection)
- System down due to trouble
- Engine body fault
  (seizure, compression pressure shortage, other mechanical trouble)
- ACG trouble
- Machine side related equipment trouble
  (oil pressure pump etc.)
- Effect of commercial electrical equipment (radio, lamp, etc.)
- ECM trouble
  (body, power supply, ground, etc.)
- Check the connector for poor contact, the harness for fault such as wear or bend, and the wire inside the harness for loosened wire causing short circuit to other circuits. Also, perform the function diagnosis to check the operation and control of each part. Repair if faulty.

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 if DTC is detected. Check if following DTCs are detected. DTC: P0335, P0336, P0340, P0341, P0601, P1261, P1262 Is DTC detected?	—	Go to the related “Inspection method by DTC”.	Go to Step 3.
3	Check the crank speed. Check if the crank speed is more than the necessary speed for ECM to identify engine rotation. Is the crank speed more than specified value?	60 rpm	Go to Step 4.	Go to Step 5.

Step	Action	Value	YES	NO
4	Check the crank speed. Check if the crank speed is more than the necessary speed to start the engine (first combustion). Is the crank speed more than specified value?	80 rpm	Go to Step 6.	Go to Step 5.
5	Check the starting system. Is the procedure completed?	—	Go to Step 6.	Go to “Starting system check”.
6	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 7.	—
7	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 scan tool menu. When the scan tool is not available, refer to “How to Inspect Injector” in this section. 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 8.	Go to Step 9.

Step	Action	Value	YES	NO
8	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 9.
9	Check the ACG. Check if the charge warning lamp turns on while engine is running. **Note:** **Refer to the machine's manual for charge warning.** Does the charge warning operate?	—	Go to Step 11.	Go to Step 10.
10	Replace the ACG. Also, check the charge warning system, and repair or replace if faulty. Is the procedure completed?	—	—	Go to Step 11.
11	Check the condition of commercial electrical equipment such as radio and lights. Does the engine start when the commercial electrical equipment is powered OFF?	—	Go to Step 12.	Go to Step 13.
12	Correct the installation condition of the electrical equipment, or remove the electrical equipment. Is the procedure completed?	—	—	Go to Step 13.
13	Check the mechanical part of the engine, and repair if faulty. • Compression pressure • Valve system • Injector • Timing gear • Related part of piston/crank **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the procedure completed?	—	—	Go to Step 14.
14	Is EMPS available?	—	Go to Step 15.	Go to Step 16.

Step	Action	Value	YES	NO
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?	—	Verify repair.	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?	—	Verify repair.	Go to Step 2.

Engine stall

Pre-inspection

Before using this paragraph, perform the “OBD system check” and check all the following items.

- Check if excessive load is applied to the machine side.
- ECM and diagnosis lamp operate properly.
- To detect crank sensor fault, crank more than 60 rpm for 14 seconds or more since it is not judged on cranking for less than 14 revolutions.
- Check the DTC.
- When the engine is running at low speed, the DTC of crank sensor fault may not be detected. If an intermittent trouble is found, raise the engine speed up to No Load Max, and check if DTC related to crank sensor is detected.
- Scan tool data shows normal operating range.
- Check the condition of the machine to identify the applicable symptom from “List of trouble symptom”. Perform the procedure described in the symptom chart.
- Check with the customer if correct engine oil and fuel are used.

Visual check

Careful visual check is required for some symptom procedures. By this inspection, the problem can be corrected without performing further inspection, and time can be saved.
This inspection includes the following items.

- There is no poor contact in connector (it must be connected with click sound). Especially for CKP sensor and G sensor.
- Wire is connected, tightened or cut properly.
- Commercial accessory power supply is not bifurcated from ECM power supply.
- ECM ground is not contaminated and installed to the proper position securely.
- Pipes and hoses relevant to fuel, air and oil are free of crack or twist, and are properly connected. Thoroughly check for any oil leakage and clogging.
- Fuel system is free from oil leakage, and pipe is not damaged or dent.
- Intake system parts for fault.
- Exhaust system parts for fault.

Diagnostic aid

- Fuel system fault (run out of fuel, frozen fuel, air mixed in fuel pipe, faulty filter [clog in main filter, gauze filter], pipe fault, fuel quality, fuel tank [foreign matter, fuel suction fault])
- Intake system fault (clogging in filter, intake pipe fault, etc.)
- Supply pump fault (no fuel pressure feed)
- Common rail fault (flow damper or pressure limiter is activated, degradation of sealability)
- Injector fault (no fuel injection)
- System down due to trouble
- Engine body fault
  (seizure, compression pressure shortage, other mechanical trouble)
- ACG trouble
- Machine side related equipment trouble
  (oil pressure pump etc.)
- Effect of commercial electrical equipment (radio, lamp, etc.)
- ECM trouble
  (body, power supply, ground, etc.)
- Check the connector for poor contact, the harness for fault such as wear or bend, and the wire inside the harness for loosened wire causing short circuit to other circuits. Also, perform the function diagnosis to check the operation and control of each part. Repair if faulty.

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 if excessive load is applied to the machine side. Repair or replace the faulty part. **Note:** **Refer to the machine’s manual for check and repair.** Is the procedure completed?	—	Go to Step 3.	—

Step	Action	Value	YES	NO
3	Check the electrical system. 1. Crank sensor fault is not judged on cranking for less than 14 revolutions. Crank the engine at 60 rpm or more for 14 seconds or more, or raise the engine speed up to No Load Max, and check if DTC is detected. 2. Check the connectors of the ECM, fuel pump, ACG and electronic governor for poor contact or play. **Note:** **Poor contact in the connector, especially CKP sensor and G sensor, causes engine stall. It must be connected with click sound.** 3. Check the harness for open or short circuit. 4. Repair or replace the faulty part. Is the procedure completed?	—	Go to Step 4.	—
4	Check the ACG. Check if the charge warning lamp turns on while engine is running. **Note:** **Refer to the machine's manual for charge warning.** Does the charge warning operate?	—	Go to Step 6.	Go to Step 5.
5	Replace the ACG. Also, check the charge warning system, and repair or replace if faulty. Is the procedure completed?	—	Go to Step 6.	—
6	Check the condition of commercial electrical equipment such as radio and lights. Does the engine stall when the commercial electrical equipment is powered OFF?	—	Go to Step 7.	Go to Step 8.
7	Correct the installation condition of the electrical equipment, or remove the electrical equipment. Is the procedure completed?	—	Go to Step 8.	—

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
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?	—	Verify repair.	—

Engine hunting, rough idling

Pre-inspection

Before using this paragraph, perform the “OBD system check” and check all the following items.

- ECM and diagnosis lamp operate properly.
- Check the DTC.
- Scan tool data shows normal operating range.
- Check the condition of the machine to identify the applicable symptom from “List of trouble symptom”. Perform the procedure described in the symptom chart.
- Check with the customer if correct engine oil and fuel are used.

Visual check

Careful visual check is required for some symptom procedures. By this inspection, the problem can be corrected without performing further inspection, and time can be saved.
This inspection includes the following items.

- There is no poor contact in connector (it must be connected with click sound).
- The terminal voltage of battery is not low.
- Wire is connected, tightened or cut properly.
- Commercial accessory power supply is not bifurcated from ECM power supply.
- ECM ground is not contaminated and installed to the proper position securely.
- Pipes and hoses relevant to fuel, air and oil are free of crack or twist, and are properly connected. Thoroughly check for any oil leakage and clogging.
- Fuel system is free from oil leakage, and pipe is not damaged or dent.
- Intake system parts for fault.
- Exhaust system parts for fault.

Diagnostic aid

- Fuel system fault (run out of fuel, frozen fuel, air mixed in fuel pipe, faulty filter [clog in main filter, gauze filter], pipe fault, fuel quality, fuel tank [foreign matter, fuel suction fault])
- Intake system fault (clogging in filter, intake pipe fault, etc.)
- Supply pump (including feed pump) fault (no fuel pressure feed)
- Switch input circuit system fault
- Sensor input circuit system fault (accelerator position (AP) sensor, harness, engine coolant temperature (ECT) sensor, etc.)
- AP sensor system fault (sensor, harness, etc.)
- Engine body fault (seizure, compression pressure shortage, other mechanical trouble)
- Machine side related equipment trouble (oil pressure pump etc.)
- Effect of commercial electrical equipment (radio, lamp, etc.)
- Check the connector for poor contact, the harness for fault such as wear or bend, and the wire inside the harness for loosened wire causing short circuit to other circuits. Also, perform the function diagnosis to check the operation and control of each part. Repair if faulty.

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 if excessive load is applied to the machine side. Repair or replace the faulty part. **Note:** **Refer to the machine’s manual for check and repair.** Is the procedure completed?	—	Go to Step 3.	—
3	Check the fuel. 1. Supply fuel from a container other than the fuel tank. 2. Start the engine, operate the machine, and check for trouble symptom. 3. Replace the fuel in the fuel tank and pipe. Is the engine symptom corrected?	—	Go to Step 24.	Go to Step 4.

Step	Action	Value	YES	NO
4	Bleed air from fuel, and check for trouble symptom again. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the engine symptom corrected?	—	Go to Step 24.	Go to Step 5.
5	Check the intake system. Is the procedure completed?	—	Go to Step 6.	Go to "Intake system check".
6	Check the fuel system. Is the procedure completed?	—	Go to Step 7.	Go to "Fuel system check".
7	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 scan tool menu. When the scan tool is not available, refer to "How to Inspect Injector" in this section. 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 8.	Go to Step 9.
8	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 9.	—
9	Check for the engine symptom again. Is the engine symptom corrected?	—	Go to Step 22.	Go to Step 10.
10	Check the condition of commercial electrical equipment such as radio and lights. Does the engine symptom change when the commercial electrical equipment is powered OFF?	—	Go to Step 11.	Go to Step 12.
11	Correct the installation condition of the electrical equipment, or remove the electrical equipment. Is the procedure completed?	—	Go to Step 12.	—

Step	Action	Value	YES	NO
12	Check for installation condition of the crankshaft position (CKP) sensor and G sensor. Check the CKP sensor and G sensor for improper installation such as play. Is it properly installed?	—	Go to Step 14.	Go to Step 13.
13	Correct the installation condition of the CKP sensor and G sensor. Is the procedure completed?	—	Go to Step 14.	—
14	Is the scan tool available?	—	Go to Step 15.	Go to Step 16.
15	Check the signal conditions of CKP sensor and G sensor using scan tool. 1. Connect the scan tool. 2. Crank the engine. 3. Correct the data list on the scan tool. Is the speed displayed?	—	Go to Step 18.	Go to Step 16.
16	Check for signal detection condition of the CKP sensor. 1. Start the engine. 2. Remove the harness from the G sensor. (The DTC is detected when this procedure is performed. Be sure to clear the DTC after repairing the machine.) Is the idle condition normal?	—	Go to Step 23.	Go to Step 17.
17	Check for signal detection condition of the G sensor. 1. Start the engine. 2. Remove the harness from the CKP sensor. (The DTC is detected when this procedure is performed. Be sure to clear the DTC after repairing the machine.) Is the idle condition normal?	—	Go to Step 23.	Go to Step 18.
18	Check for the engine symptom again. Is the engine symptom corrected?	—	Go to Step 24.	Go to Step 19.
19	Is EMPS available?	—	Go to Step 20.	Go to Step 21.
20	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 24.	Go to Step 21.

Step	Action	Value	YES	NO
21	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 24.	Go to Step 22.
22	Restore the ECM to its original condition of before replacement. **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 23.	—
23	Check the mechanical part of the engine, and repair if faulty. • Compression pressure • Valve system • Flywheel • Camshaft gear • Timing gear • Related part of piston/crank Is the procedure completed?	—	Go to Step 24.	Go to Step 2.
24	Repair the machine, and check the repair. Is the procedure completed?	—	Verify repair.	—

Engine output shortage

Pre-inspection

Before using this paragraph, perform the “OBD system check” and check all the following items.

- ECM and diagnosis lamp operate properly.
- Check the DTC.
- Scan tool data shows normal operating range.
- Check the condition of the machine to identify the applicable symptom from “List of trouble symptom”. Perform the procedure described in the symptom chart.
- Check with the customer if correct engine oil and fuel are used.

Various kinds of causes are assumed for output shortage, therefore thoroughly investigate the relation between engine body and machine.

- Check what operation triggers the output shortage.

If hesitations or lag down is included in the symptom of the output shortage, the fault is related to the machine-side control. Contact with Hitachi Construction Machinery.
If Tech2 is available, checking the boost of Q enables to check the engine output at rated point as a simplified method.

Visual check

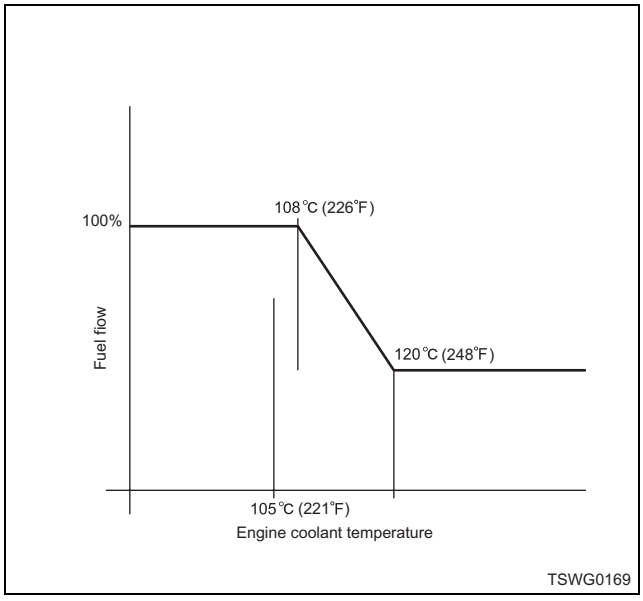
Careful visual check is required for some symptom procedures. By this inspection, the problem can be corrected without performing further inspection, and time can be saved.
This inspection includes the following items.

- There is no dirt or clogging in air cleaner element.
- Wire is connected, tightened or cut properly.
- Commercial accessory power supply is not bifurcated from ECM power supply.
- ECM ground is not contaminated and installed to the proper position securely.
- Pipes and hoses relevant to fuel, air and oil are free of crack or twist, and are properly connected. Thoroughly check for any oil leakage and clogging.
- Fuel system is free from oil leakage, and pipe is not damaged or dent.
- Increase in resistance due to dirt or clogging in intake system parts (especially air cleaner element) and crushed intake pipes
- Exhaust system parts for fault.

Diagnostic aid

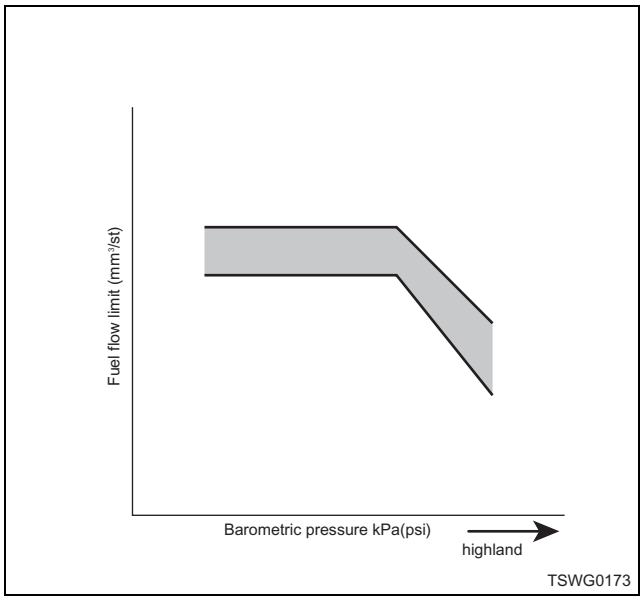
- Fuel system fault (run out of fuel, frozen fuel, air mixed in fuel pipe, faulty filter [clog in main filter, gauze filter], pipe fault, fuel quality, fuel tank [foreign matter, fuel suction fault])
- Intake system fault (clogging in filter, intake pipe fault, etc.)
- Exhaust system fault (exhaust brake, exhaust pipe fault, etc.)
- Sensor input circuit system fault (accelerator position (AP) sensor, harness, etc.)
- Switch input circuit system fault
- Engine body fault (compression pressure, valve clearance, turbocharger, supply pump, injector, common rail and other mechanical trouble, etc.)
- Machine side related equipment trouble (oil pressure pump etc.)
- Effect of commercial electrical equipment (radio, lamp, etc.)
- Check the connector for poor contact, the harness for fault such as wear or bend, and the wire inside the harness for loosened wire causing short circuit to other circuits. Also, perform the function diagnosis to check the operation and control of each part. Repair if faulty.
- Output lowering due to regulated fuel flow during overheat
- Output shortage due to regulated fuel flow at high altitude

Control during overheat
In overheating, ECM begins to limit fuel flow when the engine coolant temperature exceeds 108°C (226°F), for engine protection. It limits fuel flow further as the engine coolant temperature goes up. Fuel flow is limited to a certain level at around 120°C (248°F).
The system raises an alarm from 105°C (221°F) for some machines. In addition to alarm, by reducing the load to the machine, it enables to avoid such conditions that the fuel flow is limited.



About high-altitude correction

ECM calculates the current altitude based on the barometric pressure sensor signal.
It regulates the opening/closing period of PCV or electric conduction of injector according to the altitude etc. at this time, to correct the optimum fuel flow.



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	1. Make sure that the engine coolant temperature does not exceed 108°C (226°F). 2. Examine and repair the cause of overheat. 3. Lower the engine coolant temperature to make sure that the output lowering has corrected. Is the procedure completed?	—	Go to Step 22.	Go to Step 3.
3	Check driving environment. Fuel flow may be limited by correction when driving at high altitude. Did you drive at high altitude?	—	Contact Hitachi Construction Machinery for countermeasure.	Go to Step 4.
4	Check if excessive load is applied to the machine side. Repair or replace the faulty part. **Note:** **Refer to the machine’s manual for check and repair.** Is the procedure completed?	—	Go to Step 5.	—
5	Check the fuel. 1. Replace the fuel in the fuel tank and pipe. 2. Start the engine, operate the machine, and check for trouble symptom. Is the engine symptom corrected?	—	Go to Step 22.	Go to Step 6.

Step	Action	Value	YES	NO
6	Bleed air from fuel, and check for trouble symptom again. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the engine symptom corrected?	—	Go to Step 22.	Go to Step 7.
7	Check the fuel system. Is the procedure completed?	—	Go to Step 8.	Go to "Fuel system check".
8	Check the intake system. Is the procedure completed?	—	Go to Step 9.	Go to "Intake system check".
9	Check the exhaust system. Is the procedure completed?	—	Go to Step 10.	Go to "Exhaust system check".
10	Check for the engine symptom again. Is the engine symptom corrected?	—	Go to Step 22.	Go to Step 11.
11	Check the condition of commercial electrical equipment such as radio and lights. Does the engine symptom change when the commercial electrical equipment is powered OFF?	—	Go to Step 12.	Go to Step 13.
12	Correct the installation condition of the electrical equipment, or remove the electrical equipment. Is the procedure completed?	—	Go to Step 13.	—
13	Check for the engine symptom again. Is the engine symptom corrected?	—	Go to Step 22.	Go to Step 14.
14	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 scan tool menu. When the scan tool is not available, refer to "How to Inspect Injector" in this section. 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 15.	Go to Step 16.

Step	Action	Value	YES	NO
15	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 15.	—
16	Is EMPS available?	—	Go to Step 17.	Go to Step 18.
17	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 20.	Go to Step 18.
18	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 20.	Go to Step 19.
19	Restore the ECM to its original condition of before replacement. **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 20.	—
20	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 21.	—
21	Check the machine-side equipment (trouble of oil pressure pump etc.), and repair if faulty. Is the procedure completed?	—	Go to Step 22.	—

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

Exhaust gas contains a lot of white smoke.

Pre-inspection

Before using this paragraph, perform the “OBD system check” and check all the following items.

- ECM and diagnosis lamp operate properly.
- Check the DTC.
- Scan tool data shows normal operating range.
- Check the condition of the machine to identify the applicable symptom from “List of trouble symptom”. Perform the procedure described in the symptom chart.
- Check with the customer if correct engine oil and fuel are used.

Visual check

Careful visual check is required for some symptom procedures. By this inspection, the problem can be corrected without performing further inspection, and time can be saved.
This inspection includes the following items.

- There is no poor contact in injector connector (it must be connected with click sound).
- Wire is connected, tightened or cut properly.
- Commercial accessory power supply is not bifurcated from ECM power supply.
- ECM ground is not contaminated and installed to the proper position securely.
- Pipes and hoses relevant to fuel, air and oil are free of crack or twist, and are properly connected. Thoroughly check for any oil leakage and clogging.
- Fuel system is free from oil leakage, and pipe is not damaged or dent.
- Intake system parts for fault.
- Exhaust system parts for fault.

Diagnostic aid

- Fuel quality (use of fuel other than specified)
- Long-term idling
- Trouble of engine coolant temperature (ECT) sensor, fuel temperature (FT) sensor, intake air temperature (IAT) sensor, boost pressure sensor, or barometric pressure sensor.
- Engine body trouble (compression pressure shortage, related to piston, turbocharger, rise/decline of oil, etc.)
- ECM trouble (body, power supply, ground, etc.)

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 the fuel. 1. Replace the fuel tank and the fuel in the pipe, or supply the specified oil suitable for current environment from the fuel container. 2. Start the engine, operate the machine, and check for trouble symptom. Is the engine symptom corrected?	—	Go to Step 17.	Go to Step 3.
3	Check the fuel system. Is the procedure completed?	—	Go to Step 4.	Go to “Fuel system check”.
4	Check if oil is mixed in the intake air. 1. Is the blow-by emitted excessively? • Excessive engine oil • Clogged or deformed oil return pipe • Clogged or crushed breather hose 2. Wear of turbocharger seal ring 3. Repair or replace the faulty part. Is the procedure completed?	—	Go to Step 5.	—
5	Is the scan tool available?	—	Go to Step 6.	Go to Step 8.

Step	Action	Value	YES	NO
6	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 scan tool 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 9.	Go to Step 7.
7	Perform the pre-injection stop test. Select the “Stop pre-injection” from the scan tool menu to perform the test. Is there any cylinder of which engine vibration and engine sound did not change when it is stopped?	—	Go to Step 9.	Go to Step 10.
8	Check the injector using injector checker. Refer to “How to use injector checker” in this section for how to use injector checker. Is there any cylinder of which engine vibration and engine sound did not change when it is stopped?	—	Go to Step 9.	Go to Step 10.
9	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 10.	—
10	Check the coupling of the supply pump for damage. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 11.	—
11	Check for the engine symptom again. Is the engine symptom corrected?	—	Go to Step 17.	Go to Step 12.
12	Is EMPS available?	—	Go to Step 13.	Go to Step 14.

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 16.	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 16.	Go to Step 15.
15	Restore the ECM to its original condition of before replacement. Is the procedure completed?	—	Go to Step 16.	—
16	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 17.	—
17	Repair the machine, and check the repair. Is the procedure completed?	—	Verify repair.	Go to Step 2.

Exhaust gas contains a lot of black smoke.

Pre-inspection

Before using this paragraph, perform the “OBD system check” and check all the following items.

- ECM and diagnosis lamp operate properly.
- Check the DTC.
- Scan tool data shows normal operating range.
- Check the condition of the machine to identify the applicable symptom from “List of trouble symptom”. Perform the procedure described in the symptom chart.
- Check with the customer if correct engine oil and fuel are used.

Visual check

Careful visual check is required for some symptom procedures. By this inspection, the problem can be corrected without performing further inspection, and time can be saved.
This inspection includes the following items.

- There is no dirt or clogging in air cleaner element.
- Wire is connected, tightened or cut properly.
- Commercial accessory power supply is not bifurcated from ECM power supply.
- ECM ground is not contaminated and installed to the proper position securely.
- Pipes and hoses relevant to fuel, air and oil are free of crack or twist, and are properly connected. Thoroughly check for any oil leakage and clogging.
- Fuel system is free from oil leakage, and pipe is not damaged or dent.
- Intake system parts for fault.
- Exhaust system parts for fault.

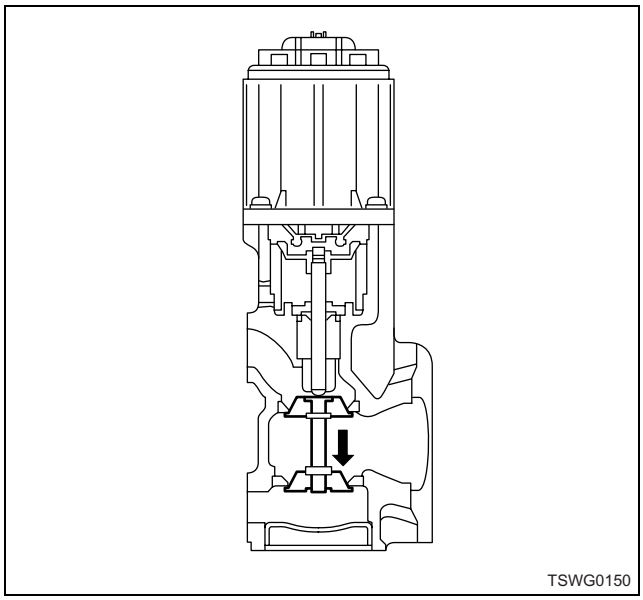
Diagnostic aid

- Fuel quality (use of fuel other than specified)
- Intake system fault (clogging in filter, intake pipe fault, etc.)
- EGR control system fault
- Exhaust system fault (exhaust pipe fault etc.)
- Engine coolant temperature (ECT) sensor fault
- Boost pressure sensor fault (sensor, pipe, etc.)
- Engine body trouble (compression pressure shortage, related to the piston, turbocharger, rise of oil)

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 the intake system. Is the procedure completed?	—	Go to Step 3.	Go to “Intake system check”.
3	Check the EGR control system. Is the procedure completed?	—	Go to Step 4.	Go to “EGR control system check”.
4	Check the reed valve of the EGR. If the trouble is detected, repair as required. Is the procedure completed?	—	Go to Step 5.	—
5	Check the fuel system. Is the procedure completed?	—	Go to Step 6.	Go to “Fuel system check”.
6	Check the exhaust system. Is the procedure completed?	—	Go to Step 7.	Go to “Exhaust system check”.
7	Check for the engine symptom again. Is the engine symptom corrected?	—	Go to Step 15.	Go to Step 8.
8	Check the mechanical part of the engine, and repair if faulty. • Valve system (valve clearance) Is the procedure completed?	—	Go to Step 9.	—
9	Check for the engine symptom again. Is the engine symptom corrected?	—	Go to Step 15.	Go to Step 10.
10	Is EMPS available?	—	Go to Step 11.	Go to Step 12.

Step	Action	Value	YES	NO
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.	—
13	Check for the engine symptom again. Is the engine symptom corrected?	—	Go to Step 15.	Go to Step 14.
14	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 15.	—
15	Repair the machine, and check the repair. Is the procedure completed?	—	Verify repair.	—

EGR valve check



Push the EGR valve with finger to make sure it opens/ closes smoothly. Also, make sure that the valve closes completely when the finger is released.

Noise

Pre-inspection

Before using this paragraph, perform the “OBD system check” and check all the following items.

- Check for noise by referring to the machine’s manual.
- ECM and diagnosis lamp operate properly.
- Check the DTC.
- Scan tool data shows normal operating range.
- Check the condition of the machine to identify the applicable symptom from the table of contents. Perform the procedure described in the symptom chart.
- Check with the customer if correct engine oil and fuel are used.

Visual check

Careful visual check is required for some symptom procedures. By this inspection, the problem can be corrected without performing further inspection, and time can be saved. This inspection includes the following items.

- Wire is connected, tightened or cut properly.
- ECM ground is not contaminated and installed to the proper position securely.
- Pipes and hoses relevant to fuel, air and oil are free of crack or twist, and are properly connected. Thoroughly check for any oil leakage and clogging.
- Fuel system is free from oil leakage, and pipe is not damaged or dent.
- Intake system parts for fault.
- Exhaust system parts for fault.

Diagnostic aid

- Fuel system fault (run out of fuel, frozen fuel, air mixed in fuel pipe, faulty filter [clog in main filter, gauze filter], pipe fault, fuel quality, fuel tank [foreign matter, fuel suction fault])
- Intake system fault (EGR valve fault)
- Injector fault (no fuel injection)
- Engine body fault (seizure, compression pressure shortage, other mechanical trouble)
- Machine side related equipment trouble (oil pressure pump etc.)
- ECM trouble (body, power supply, ground, etc.)
- Check the connector for poor contact, the harness for fault such as wear or bend, and the wire inside the harness for loosened wire causing short circuit to other circuits. Also, perform the function diagnosis to check the operation and control of each part. Repair if faulty.

Step	Action	Value	YES	NO
1	Identify the source of the noise and confirm the noise. Is the noise metallic noise?	—	Repair or replace the faulty parts.	Go to Step 2.
2	Is the scan tool available?	—	Go to Step 3.	Go to Step 8.
3	Perform the pre-injection stop test. Select the “Stop pre-injection” from the scan tool menu to perform the test. Is there any cylinder of which engine vibration and engine sound did not change when it is stopped?	—	Go to Step 5.	Go to Step 4.
4	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 5.	Go to Step 6.

Step	Action	Value	YES	NO
5	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?	—	Verify repair.	—
6	Check the EGR valve. • Fault in reed valve • Fault in EGR valve body Repair or replace the faulty part. Is the procedure completed?	—	Verify repair.	Go to Step 7.
7	Refer to "Engine section" in the service manual to check the engine trouble. Repair or replace the faulty part. Is the procedure completed?	—	Verify repair.	—
8	Check the injector using injector checker. Refer to "How to use injector checker" in this section for how to use injector checker. Is there any cylinder of which engine vibration and engine sound did not change when it is stopped?	—	Go to Step 5.	Go to Step 6.

Fuel consumption deteriorates.

Pre-inspection

Before using this paragraph, perform the “OBD system check” and check all the following items.

- Fuel consumption varies depending on handling of each machine. Check Hitachi Construction Machinery's measure of fuel consumption (A).
  Measure of fuel consumption (ℓ {qts}/hour)
- Check the actual fuel consumption (B).
  Actual fuel consumption (ℓ {qts}/hour)
- If B is bigger than A, check the machine’s setting by referring to the machine’s manual.
- Check if excessive load is applied to the machine.
- Refer to the list of inspection and maintenance items of the operation manual for proper inspection depending on the operation time.
- If the operation time exceeds 3000 hours, inspect by referring to the machine’s manual.
- ECM and diagnosis lamp operate properly.
- Check the DTC.
- Check the condition of the machine to identify the applicable symptom from “List of trouble symptom”. Perform the procedure described in the symptom chart.
- Check with the customer if correct engine oil and fuel are used.
- Check if periodic maintenance has been performed for engine oil replacement, air cleaner filter, fuel filter, etc.

Visual check

Careful visual check is required for some symptom procedures. By this inspection, the problem can be corrected without performing further inspection, and time can be saved. This inspection includes the following items.

- Wire is connected, tightened or cut properly.
- ECM ground is not contaminated and installed to the proper position securely.
- Pipes and hoses relevant to fuel, air and oil are free of crack or twist, and are properly connected. Thoroughly check for any oil leakage and clogging.
- Fuel system is free from oil leakage, and pipe is not damaged or dent.
- Intake system parts for fault.
- Exhaust system parts for fault.

Diagnostic aid

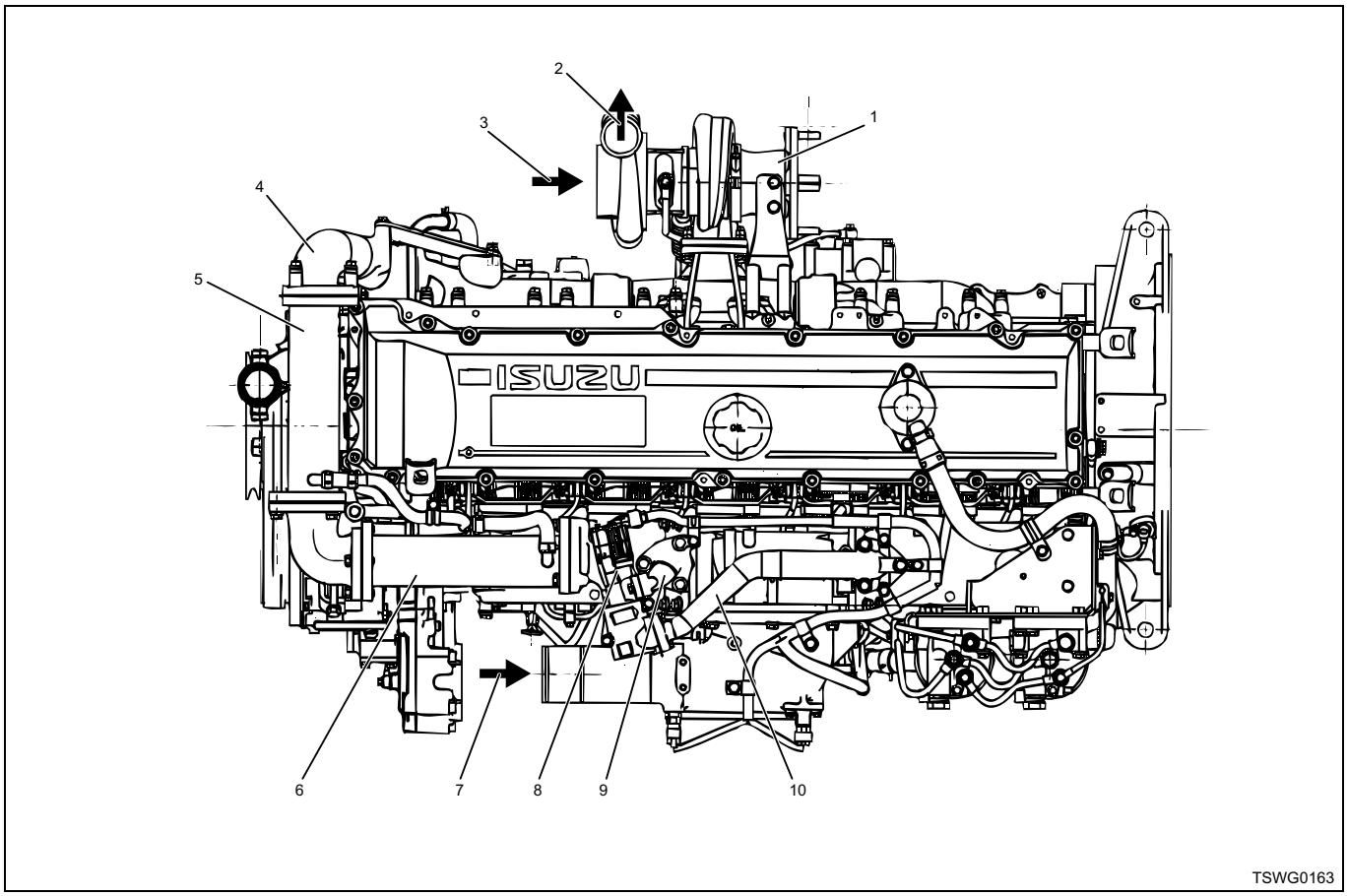
- Fuel system fault (run out of fuel, frozen fuel, air mixed in fuel pipe, faulty filter [clog in main filter, gauze filter], pipe fault, fuel quality, fuel tank [foreign matter, fuel suction fault])
- Intake system fault (EGR valve fault)
- Injector fault (excessive fuel injection etc.)
- Engine body fault (seizure, compression pressure shortage, other mechanical trouble)
- Machine side related equipment trouble (oil pressure pump etc.)
- ECM trouble (body, power supply, ground, etc.)
- Check the connector for poor contact, the harness for fault such as wear or bend, and the wire inside the harness for loosened wire causing short circuit to other circuits. Also, perform the function diagnosis to check the operation and control of each part. Repair if faulty.

Step	Action	Value	YES	NO
1	1. Compare the measure of fuel consumption with the actual fuel consumption. A: Measure of fuel consumption (ℓ {qts}/hour) B: Actual fuel consumption (ℓ {qts}/hour) 2. If B is bigger than A, check the machine’s setting or if excessive load is applied to the machine by referring to the machine’s manual. 3. Repair or replace the faulty part. Is the procedure completed?	—	Verify repair.	Go to Step 2.
2	Check for fuel leakage. Repair or replace the faulty part. Is the procedure completed?	—	Verify repair.	Go to Step 3.

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.	—

Step	Action	Value	YES	NO
14	Check the valve clearance. Repair or replace the faulty part. Is the procedure completed?	—	Go to Step 15.	—
15	Has the engine operated for more than 3000 hours? If more than 3000 hours, check or repair the engine friction by referring to “Engine section” in the service manual. Is the procedure completed?	—	Verify repair.	—
16	Check the injector using injector checker. Refer to “How to use injector checker” in this section for how to use injector checker. 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.

Inspection location of engine intake/exhaust system



Name

1. Exhaust pipe
2. To intercooler
3. From air cleaner
4. EGR duct
5. Primary EGR cooler
6. Secondary EGR cooler
7. From intercooler
8. EGR valve
9. EGR duct
10. EGR duct

Check the above intake/exhaust system for fault such as clogging, crush or breakage.
Besides the inspection location of engine body, check the air cleaner, intercooler and muffler.

Oil consumption deteriorates.

Pre-inspection

Before using this paragraph, perform the “OBD system check” and check all the following items.

- Oil consumption varies depending on handling of each machine. Check Hitachi Construction Machinery's measure of oil consumption (A).
  Measure of oil consumption/hour
  Measure of oil consumption for engine alone:
  4 ℓ {4.2qts}/100 hours
- Check the actual oil consumption (B).
  Actual oil consumption /hour
- Refer to the list of inspection and maintenance items of the operation manual for proper inspection depending on the operation time.
- If the operation time exceeds 3000 hours, inspect by referring to the machine’s manual.
- ECM and diagnosis lamp operate properly.
- Check the DTC.
- Check the condition of the machine to identify the applicable symptom from the table of contents. Perform the procedure described in the symptom chart.
- Check with the customer if correct engine oil and fuel are used.

Visual check

Careful visual check is required for some symptom procedures. By this inspection, the problem can be corrected without performing further inspection, and time can be saved. This inspection includes the following items.

- If bluish-white smoke is emitted continuously while engine running.
- If blow-by gas is emitted.
- If oil is mixed in the coolant.
- Pipes and hoses relevant to oil are free of crack or twist, and are properly connected. Thoroughly check for any oil leakage and clogging.
- Lubrication system is free from oil leakage, and pipe is not damaged or dent.
- Intake system parts for fault (turbocharger check).

Diagnostic aid

- Intake system fault (rise/decline of oil, excessive blow-by gas)
- Engine body fault (oil combustion, excessive blow-by gas)

Also, perform the function diagnosis to check the operation and control of each part. Repair if faulty.

Step	Action	Value	YES	NO
1	Check the following for trouble occurrence: • Engine speed • Operational pattern (continuous/intermittent) • Operating load (mode in use) • Oil consumption /hour • If more than 100 hours has elapsed since initial operation. Compare with the specified value of oil consumption by referring to the machine’s manual. **Note:** **Use the operation mode mentioned in the machine’s manual to make comparison.** Is the oil consumption within specified value?	—	Explain this to the customer.	Go to Step 2.
2	Check for oil leakage. Repair or replace the faulty part. Is the procedure completed?	—	Verify repair.	Go to Step 3.
3	Check if bluish-white smoke is emitted while engine running. If it is emitted only at the starting, go to “Exhaust gas contains a lot of white smoke.” Is bluish-white smoke emitted?	—	Go to Step 4.	Go to Step 6.
4	Check the blow-by gas quantity. Is it more than the specified value?	—	Go to Step 7.	Go to Step 5.

Step	Action	Value	YES	NO
5	Check for oil leakage from the turbocharger. Repair or replace the faulty part. Is the procedure completed?	—	Verify repair.	Go to Step 6.
6	Check if oil is mixed in the coolant. Is oil mixed in the coolant?	—	Go to Step 10.	Go to Step 11.
7	Check the engine compression pressure. Repair or replace the faulty part. Is the trouble detected?	—	Go to Step 8.	Go to Step 9.
8	Check the engine for wear around the piston or wear of the cylinder liner. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Repair or replace the faulty part. Is the procedure completed?	—	Verify repair.	Go to Step 9.
9	Check for oil decline from the valve stem or oil seal. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Repair or replace the faulty part. Is the procedure completed?	—	Verify repair.	Go to Step 10.
10	Overhaul the water pump. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the procedure completed?	—	Verify repair.	—
11	Check for oil leakage from the engine external/internal. Repair or replace the faulty part. **Note:** **For work procedure, refer to "Engine section" in the service manual.** Is the procedure completed?	—	Verify repair.	—

Special tool

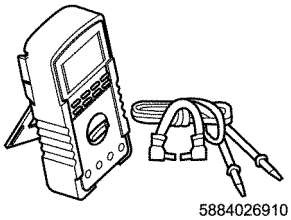
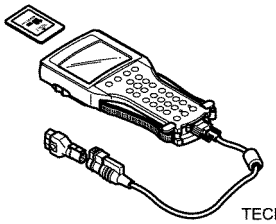
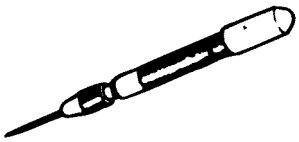
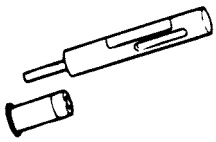
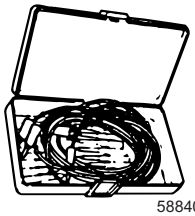
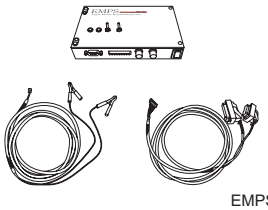
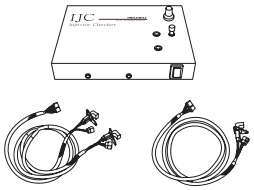
Illustration	Tool No. Tool name
 5884026910	5-8840-2691-0 Digital multimeter
 TECH2	Tech2 Scan tool
 5884006320	5-8840-0632-0 Terminal remover
 5884003880	5-8840-0388-0 Weather pack terminal remover
 5884003850	5-8840-0385-0 Breaker box
 EMPS	Engine module programming system

Illustration	Tool No. Tool name
 IJC	Injector checker

Difference by each machine manufacturer

Hitachi Construction Machinery Co., Ltd.

List of DTC

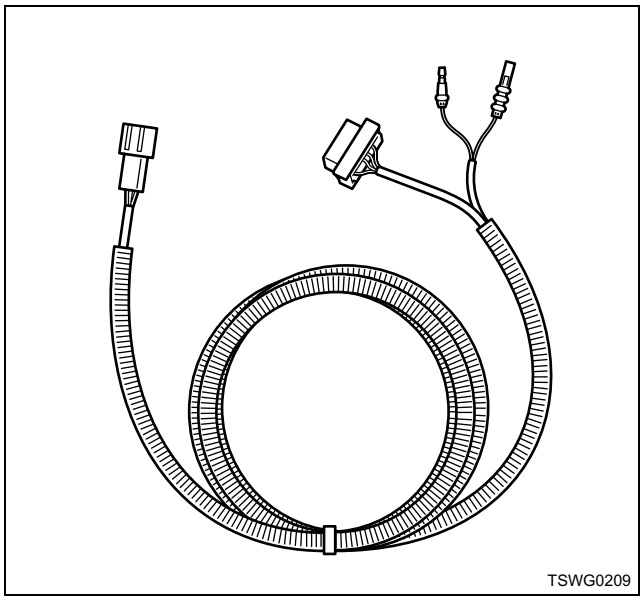
SPN	FMI	ISUZU P Code	DTC description	Trouble display on monitor
91	2	P1271	Accelerator sensor 1-2 comparison fault	❍
91	3	P1277	Accelerator sensor 1 fault (low voltage fault)	❍
91	4	P1278	Accelerator sensor 1 fault (high voltage fault)	❍
91	3	P1282	Accelerator sensor 2 fault (low voltage fault)	❍
91	4	P1283	Accelerator sensor 2 fault (high voltage fault)	❍
100	3	P0522	Engine oil pressure sensor fault (low voltage fault)	❍
100	4	P0523	Engine oil pressure sensor fault (high voltage fault)	❍
102	3	P0237	Boost pressure sensor fault (low voltage fault)	❍
102	4	P0238	Boost pressure sensor fault (high voltage fault)	❍
105	4	P1112	Boost temperature sensor fault (low voltage fault)	❍
105	3	P1113	Boost temperature sensor fault (high voltage fault)	❍
108	3	P0107	Barometric pressure sensor fault (low voltage fault)	❍
108	4	P0108	Barometric pressure sensor fault (high voltage fault)	❍
110	4	P0117	Engine coolant temperature sensor fault (low voltage fault)	❍
110	3	P0118	Engine coolant temperature sensor fault (high voltage fault)	❍
110	0	P1173	Overheat	❍
157	0	P0088	Common rail pressure fault (1st stage)	❍
157	0	P0088	Common rail pressure fault (2nd stage)	❍
157	2	P0089	Common rail pressure fault (Excessive pressure feed in pump)	❍
157	4	P0192	Common rail pressure sensor fault (low voltage fault)	❍
157	3	P0193	Common rail pressure sensor fault (high voltage fault)	❍
172	4	P0112	Intake air temperature sensor fault (low voltage fault)	❍
172	3	P0113	Intake air temperature sensor fault (high voltage fault)	❍
174	4	P0182	Fuel temperature sensor fault (low voltage fault)	❍
174	3	P0183	Fuel temperature sensor fault (high voltage fault)	❍
190	0	P0219	Overrun	❍
628	2	P0601	ROM fault	❍
633	7	P1095	Pressure limiter open	❍
636	2	P0340	Cam sensor fault (no signal)	❍

SPN	FMI	ISUZU P Code	DTC description	Trouble display on monitor
636	2	P0341	Cam sensor fault (signal fault)	❍
636	7	P1345	Cam sensor out of phase	❍
639	2	U2104	CAN Bus fault	❍
639	3	U2106	CAN timeout fault	❍
651	3	P0201	Open circuit in injection nozzle #1 drive system	❍
652	3	P0202	Open circuit in injection nozzle #2 drive system	❍
653	3	P0203	Open circuit in injection nozzle #3 drive system	❍
654	3	P0204	Open circuit in injection nozzle #4 drive system	❍
655	3	P0205	Open circuit in injection nozzle #5 drive system	❍
656	3	P0206	Open circuit in injection nozzle #6 drive system	❍
675	3	P0381	Glow lamp fault	❍
676	3	P0380	Glow relay fault	❍
677	3	P0615	Starter cut relay fault	❍
723	2	P0335	Crank sensor fault (no signal)	❍
723	2	P0336	Crank sensor fault (signal fault)	❍
968	2	P1225	Idle up/down switch fault	❍
987	3	P0650	Check engine lamp fault	❍
1077	2	P0606	CPU monitoring IC fault	❍
1079	2	P1631	Voltage fault in 5-V power supply 1	❍
1080	2	P1632	Voltage fault in 5-V power supply 2	❍
1239	1	P1094	No pump pressure feed (1st stage)	❍

SPN	FMI	ISUZU P Code	DTC description	Trouble display on monitor
1240	1	P1093	No pump pressure feed (fuel leakage)	❍
1347	0	P0091	PCV1 open circuit or ground short	❍
1347	0	P0092	PCV1 +B short	❍
1348	0	P1291	PCV2 open circuit or ground short	❍
1348	4	P1292	PCV2 +B short	❍
1485	2	P1625	Main relay system fault (Not enter)	❍
10001	3	P0487	EGR position fault (Brushless specification)	❍
10002	2	P0488	EGR valve control fault	❍
10003	2	P1261	Injection nozzle common 1 drive system fault	❍
10004	2	P1262	Injection nozzle common 2 drive system fault	❍
10005	1	P0611	Charge circuit fault (bank 1)	❍
10006	1	P0612	Charge circuit fault (bank 2)	❍
10007	2	P0606	CPU fault	❍
10008	2	P1630	A/D conversion fault	❍
10009	2	P1633	Voltage fault in 5-V power supply 3	❍
10010	2	P1634	Voltage fault in 5-V power supply 4	❍
10011	2	P1635	Voltage fault in 5-V power supply 5	❍
10013	2	P0603	EEPROM fault	❍

How to clear DTC

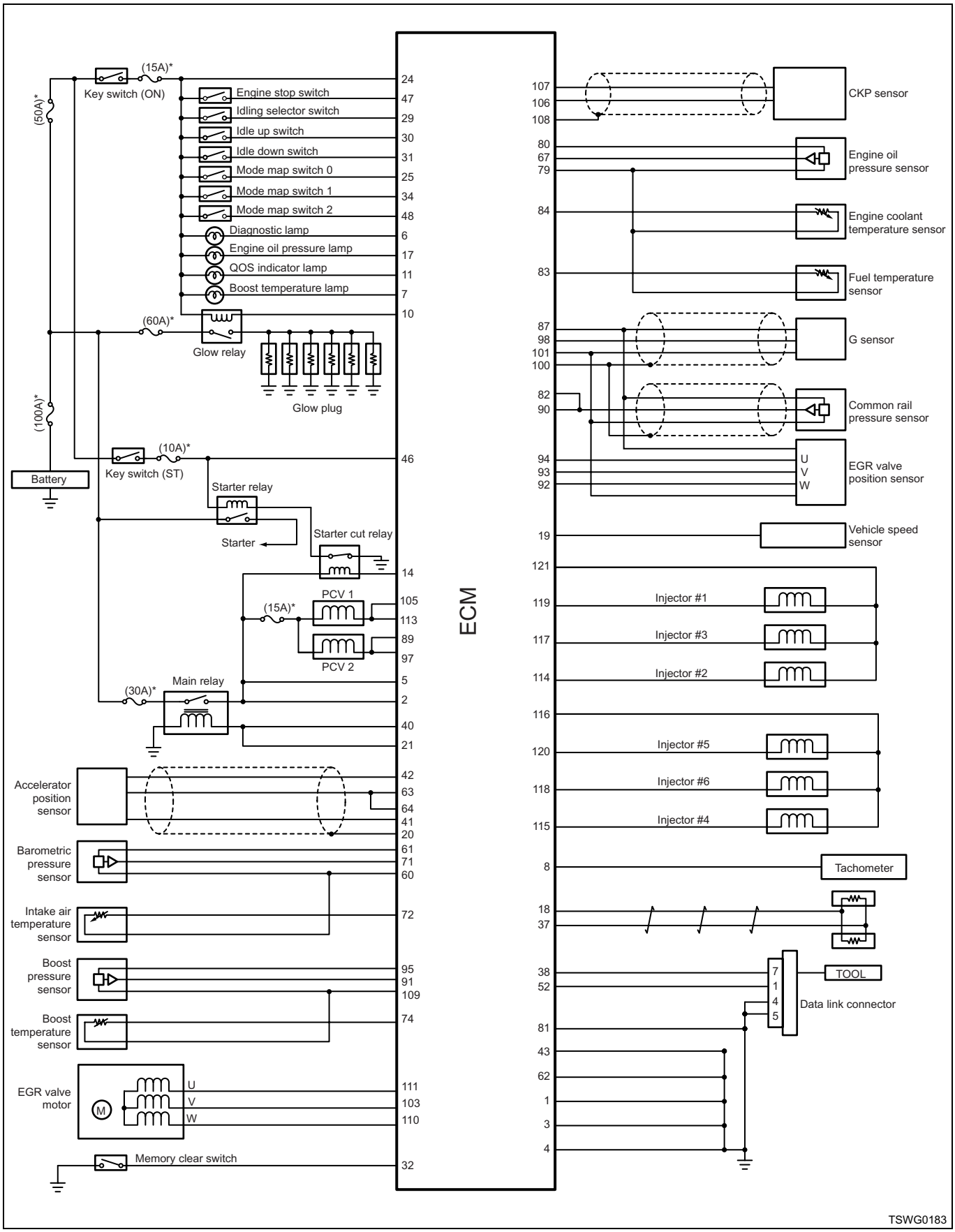
1. Connect the harness for memory clear to the data link connector.



2. Turn the key switch to ON.
3. Connect the memory clear terminal to the ground for 1 second or more.
4. Turn the key switch to OFF. (Memory will be cleared when the key switch is OFF.)
5. Disconnect the diagnosis switch terminal.

About wiring diagrams

- There are some sensors which are not connected to the ECM depending on the machine.
- Check the specifications of the machine, since some sensors input/output to ECM via CAN communication.



List of DTC of which behavior varies depending on the machine manufacturer

On some machines, the diagnosis lamp comes on instead of trouble display monitor on the machine.

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
P0107	71	Barometric pressure sensor fault (low voltage fault)	Open/short circuit/ deterioration of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1632 is not detected.	Barometric pressure sensor voltage is lower than 0.5 V.	Approx. 5 sec.	Due to back-up equivalent to 2500m (8200ft) Black smoke emitted at high altitude Output shortage at low altitude Back-up: Barometric pressure default setting (80 kPa {11.6 psi}) EGR stopped	ON	*2
P0108		Barometric pressure sensor fault (high voltage fault)	Short circuit in sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1632 is not detected.	Barometric pressure sensor voltage is more than 3.8 V.	Approx. 5 sec.	Due to back-up equivalent to 2500m (8200ft) Black smoke emitted at high altitude Output shortage at low altitude Back-up: Barometric pressure default setting (80 kPa {11.6 psi}) EGR stopped	ON	*2
P0192	245	Common rail pressure sensor fault (low voltage fault)	Short circuit in sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1635 is not detected.	Common rail pressure sensor voltage is less than 0.7 V.	Nearly simultaneous to fault occurrence	Engine blow up Back-up: Actual rail pressure default setting (80 MPa {11603 psi}) Rail pressure feedback control stopped Limited injection amount 2 (multi-injection stopped)	ON	*2
P0193		Common rail pressure sensor fault (high voltage fault)	Open/short circuit/ breakage of sensor or harness	• Key switch input voltage is 16V or more. • DTC P1630 or P1635 is not detected.	Common rail pressure sensor voltage is more than 4.5 V.	Nearly simultaneous to fault occurrence	Output lowering, Black smoke emitted Engine stall possible Back-up: Actual rail pressure default setting (80 MPa {11603 psi}) Rail pressure feedback control stopped Limited injection amount 2 (multi-injection stopped)	ON	*2
P0201	271	Open circuit in injection nozzle #1 drive system	Open/short circuit in electrical wiring No. 1 cylinder injector	• Main relay power supply voltage is 16V or more. • 70 rpm or more • DTC P0611, P1261 or P0201 is not detected.	No injector 1 monitor input signal exists.	Approx. 3 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Back-up: Injection for cylinder #5 stopped	ON	*1

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

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
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: Common 1 stop (#1, #2, #3 cylinders stopped)	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: Common 2 stop (#4, #5, #6 cylinders stopped)	ON	*2
P1113	295	Boost temperature sensor fault (high voltage fault)	Short circuit in sensor or harness	• Key switch input voltage is 16V or more. • Coolant temperature is 50°C (122°F) or more. • 3 (or 5) minutes have passed after engine starting • DTC P1634 is not detected.	Boost temperature sensor voltage is more than 4.94V.	Approx. 4 sec.	Operationality is not affected. Back-up: No back-up	ON	*2
P1261	158	Injection nozzle common 1 drive system fault	Open/short circuit in injector common 1-side electrical wiring, EDU output part fault	• Main relay power supply voltage is 16V or more. • 70 rpm or more • None of the following DTC sets are detected; DTC P0611, P1261 and P0201; DTC P0611, P1261 and P0202; DTC P0611, P1261 and P0203.	No injector 1, 2, 3 monitor input signal exists.	Approx. 3 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Engine stall is possible. Back-up: Common 1 stop (#1, #2, #3 cylinders stopped)	ON	*1
P1262	159	Injection nozzle common 2 drive system fault	Open/short circuit in injector common 2-side electrical wiring, EDU output part fault	• Main relay power supply voltage is 16V or more. • 70 rpm or more • None of the following DTC sets are detected; DTC P0612, P1262, and P0204; DTC P0612, P1262, and P0205; DTC P0612, P1262, and P0206.	No injector 4, 5, 6 monitor input signal exists.	Approx. 3 sec.	Intensive engine vibration, rough idling, output lowering, blow up fault Engine stall is possible. Back-up: Common 2 stop (#4, #5, #6 cylinders stopped)	ON	*1

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
P1634	55	Voltage fault in 5-V power supply 4	Power supply wiring short to sensor, or breakage in element/ circuit for power supply regulation inside ECM.	• DTC P1630 is not detected. • Key switch input power supply voltage is between 16 — 32 V.	5-V 4 power supply voltage is 5.5 V or more, or 4.5 V or less.	Approx. 0.5 sec.	Operationality is affected. Back-up: Same to boost pressure sensor fault	ON	*2
U2104	84	CAN Bus fault	CAN communicati on fault	• Key switch input voltage is 12V or more.	Bus-off is detected.	At 3 sec. continuo usly	Vary depending on setting. Back-up: Switched to drive control by accelerator sensor input voltage	ON	*3
U2106	85	CAN timeout fault	CAN communicati on fault	• DTC U2104 is not detected. • Key switch input voltage is 12V or more.	CAN data reception does not complete at a set time.	At 1 sec. continuo usly	Vary depending on setting. Back-up: Switched to drive control by accelerator sensor input voltage	ON	*3

*1, *2, *3: Refer to “About recovery from failure” in “List of diagnostic trouble code”.

List of items displayed on scan tool

Display item	Tech2 display item
Engine torque	—
Actual engine speed	Engine Speed
Target engine speed	Desired Idle Speed
Glow signal	Glow Relay
Coolant temperature	Engine Coolant Temperature
Engine oil pressure	Engine Oil Pressure
Fuel flow	—
Barometric pressure	Barometric Pressure
Intake air temperature	Intake Air Temperature
Boost pressure	MAP Sensor
Boost temperature	Boost Temperature
Battery voltage	Main Relay Voltage
Cumulative used fuel amount	—

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

HITACHI

Engine Manual (2/2)

6WG1

6WG1 ENGINE MANUAL (2/2)

Hitachi Construction Machinery Co., Ltd.

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

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This manual consists of the following sections.
Disassemble and Assemble Engine

Introduction

This Manual describes the structure and the troubleshooting of electronic control fuel injection system (common rail type) in 6WG1 industrial engines. Use this manual sufficiently to perform service work properly and quickly.

Hitachi Construction Machinery Co., Ltd

General Contents

Disassemble and Assemble Engine

General Information

Engine Mechanical (6WG1(Common rail))

Cooling System (6WG1(Common rail))

Fuel System (6WG1(Common rail))

Electrical System (6WG1(Common rail))

Lubricating System (6WG1(Common rail))

Intake System (6WG1(Common rail))

Preheating System (6WG1(Common rail))

Engine Manual (1/2)

Control System

Engine Control

(Electronic control fuel injection system (Common rail type))

Disassemble and Assemble Engine

General Information

Contents

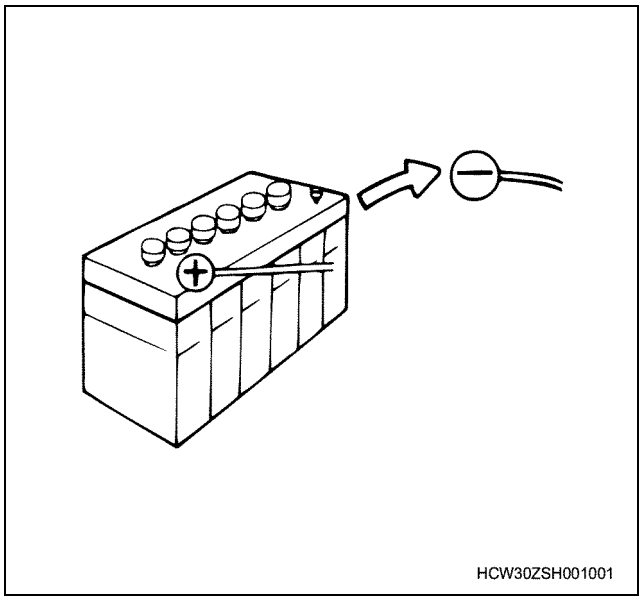
General Information 0A-2
Service Precautions 0A-2
Reading the model 0A-6
General information 0A-6

General Information

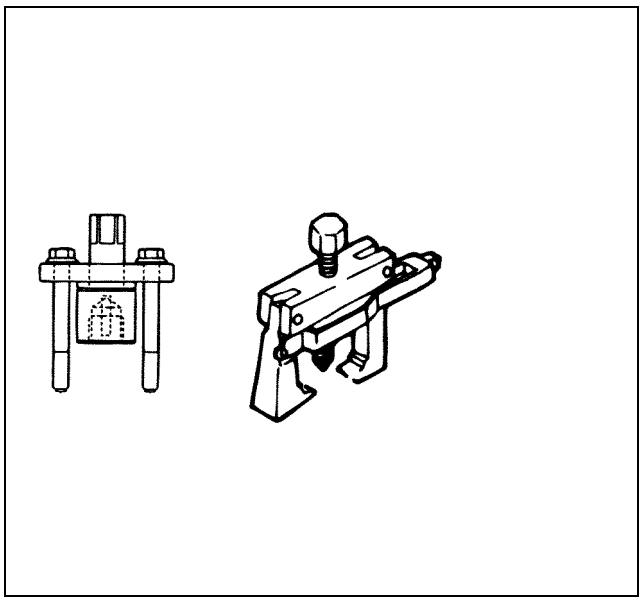
Service Precautions

In order to carry out work safely

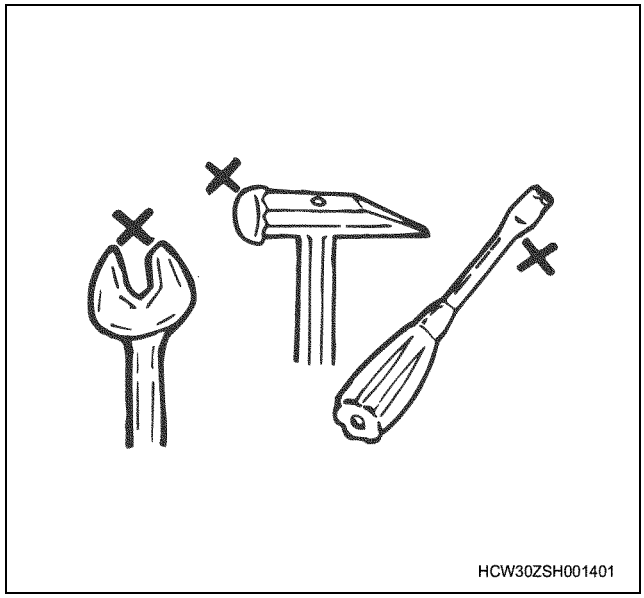
1. Always use an engine stand when taking the engine down from the vehicle.
   Do not place the engine directly onto the ground, or place in a manner that interferes with the oil pan.
2. If you are working together with others, always pay attention to each other's safety.
3. If you are repairing any part of the electrical system, always remove the minus side cable from the battery terminal before starting work. If you are removing the battery cover, always remove the cover in a place that is away from sources of fire/heat.



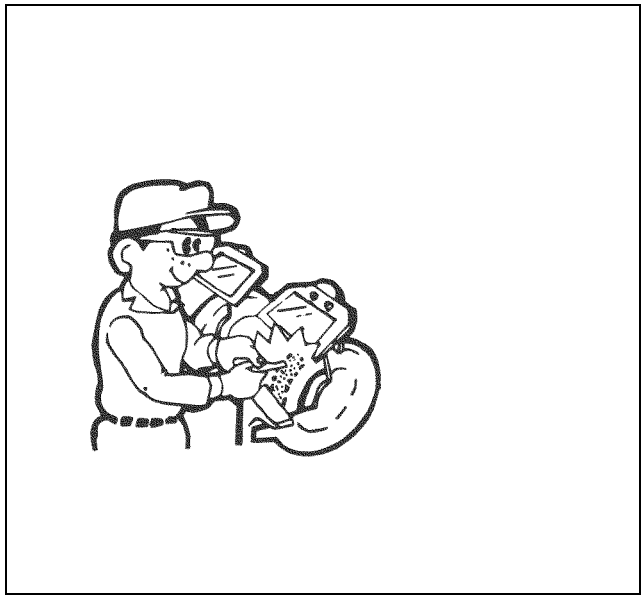
4. Do not perform painting work or leave the engine running for long periods of time in an enclosed or badly ventilated indoor workshop.
5. Always use the correct specialized tool indicated in the instructions. Using the incorrect tool may cause damage to the parts or injury to the person using the tool.



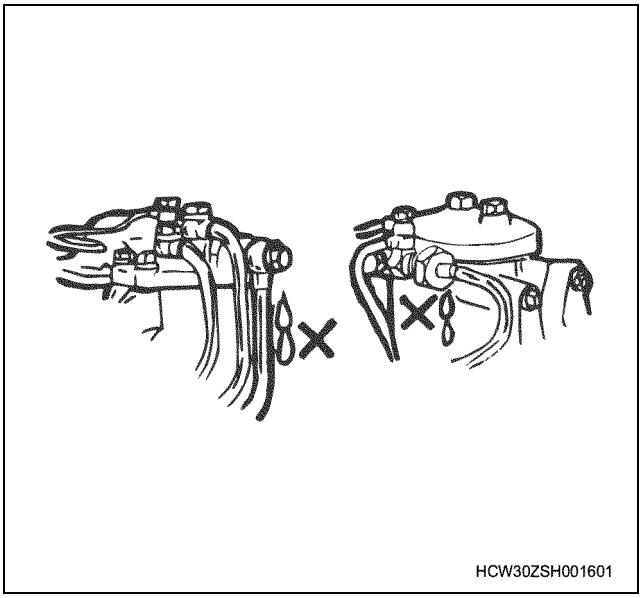
6. All regular tools, gauges and special tools should be regularly inspected, and prepared before starting work. Do not use bent spanners, hammers with damaged edges, chipped chisels, or any other faulty or damaged tools.



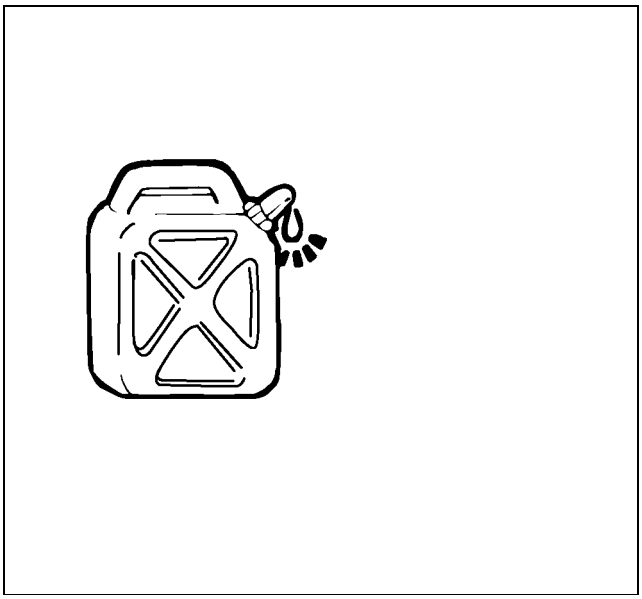
7. Always pay close attention to safety and handling requirements when using grinders, cranes, welders, and other such equipment.
   Moreover, always wear the correct protective garments and use the necessary safety tools for the job in hand.



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

Seal section	Product name	Manufacturer's name
Between gear case (block) – Cylinder block	FMD–127	Loctite
Between cylinder block and – Gear case and – Gear case	FMD–127	Loctite
Between idle gear A shaft and – Gear case	FMD–127	Loctite
Between cylinder block and – Flywheel housing	FMD–127	Loctite
Between cylinder block and – Flywheel housing and – Crankcase	FMD–127	Loctite
Between cylinder block and – Crank case	FMD–127	Loctite
Crankcase and – flywheel housing joint underside	1207B	Three Bond
Crankcase and – gear case joint underside	1207B	Three Bond
Cylinder head nozzle sleeve force fit and strike sections	TL290	Loctite
Cylinder block and – head cylinder cup section force fit section	1386 962T 123T	Three Bond Loctite Nihon Hermetics
Cylinder block, head plug nipple, unit, switches	#271	Loctite
O-ring omission prevention agent	1208 CH Dyne #290	Three Bond Cement dyne

- Always use the liquid gasket products listed above, or a liquid gasket identical to the ones listed above.
- Use the correct quantity of liquid gasket. Always follow the handling instructions for each product.

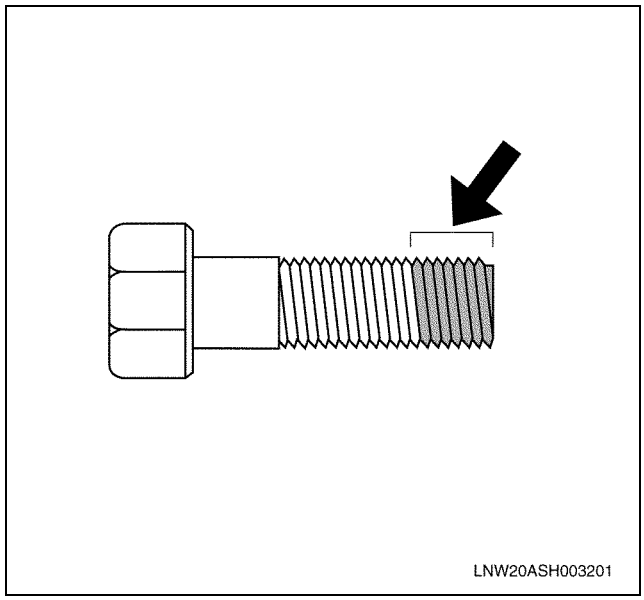
Application procedure

1. Wipe the contact surfaces clean of all water, fat or oil. The contact surfaces should be dry.
2. Apply a regular bead width of liquid gasket to one of the contact surfaces. Make sure that the bead does not break at this point.

Notes:
If there are special regulations concerning the application procedure in the repair document, please follow those regulations.

Work procedure

1. Wipe the joint surfaces of the bolt, bolt hole, and screw thread section clean of water, fat, and oil. The contact surfaces should be dry.
2. Apply Loctite to the top 1/3 of the screw.
3. Tighten the bolt to the correct tightening torque.



Important:
After tightening the bolt, do not apply excessive torque or try to rotate the bolt until at least one hour has passed, and the Loctite has hardened.

Procedure for using the Plastiguage

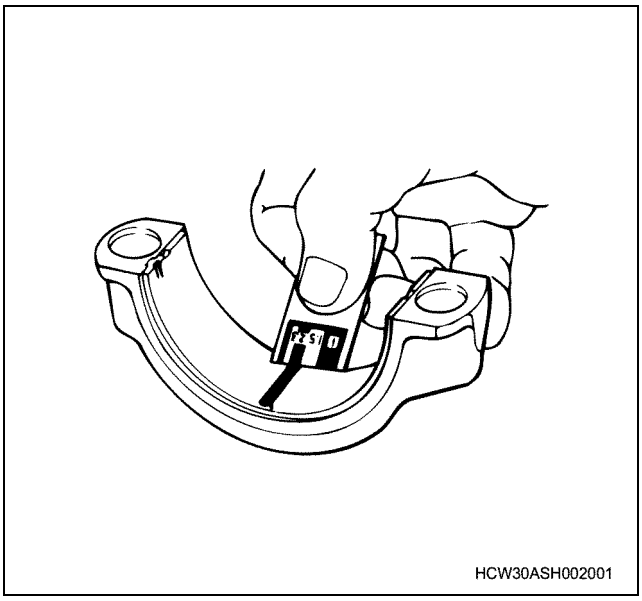
Type	Measurable range (mm)
PG-1 (Green)	0.025 – 0.076
PR-1 (Red)	0.051 – 0.152
PB-1 (Blue)	0.102 – 0.229

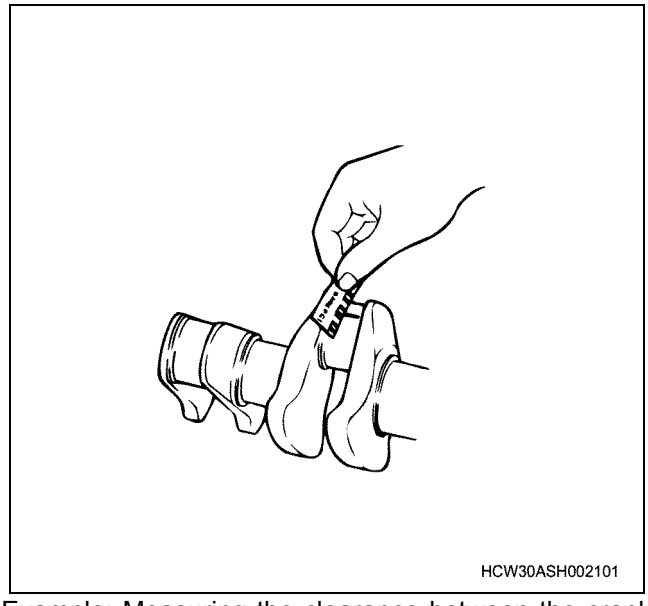
Example: Procedure for measuring the clearance between the connecting rod bearing and crank pin.

- Clean the connecting rod and bearing, and install the bearing to the rod.
- Cut the plastiguage to the same width as the crank pin, and while avoiding the oil pore of the crank pin lay the gauge parallel to the pin.
- Line up the marks on the connecting rod and cap and install the crank pin, apply molybdenum disulphide to the thread section and bearing surface of the fastening bolt, and rotate both cap and bolt to the correct torque.

Important:
Do not move the connecting rod while using the plastiguage.

- Gently remove the cap and connecting rod, and measure the crushed width of the plastiguage (clearance between rod and pin) using the scale printed on the bag.



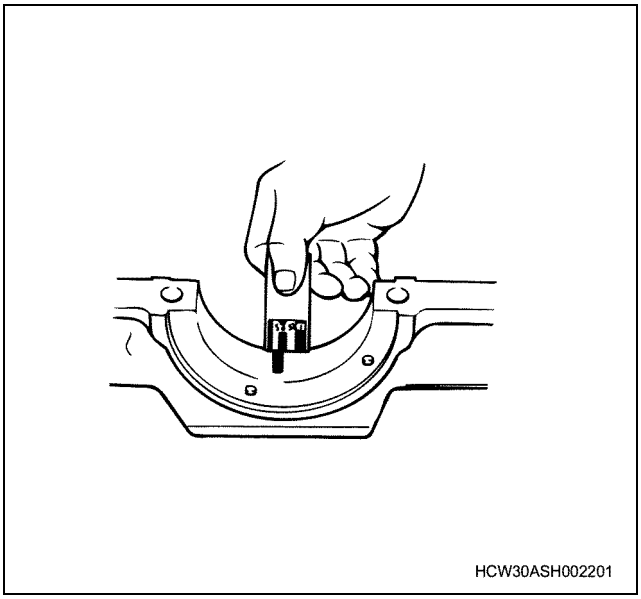


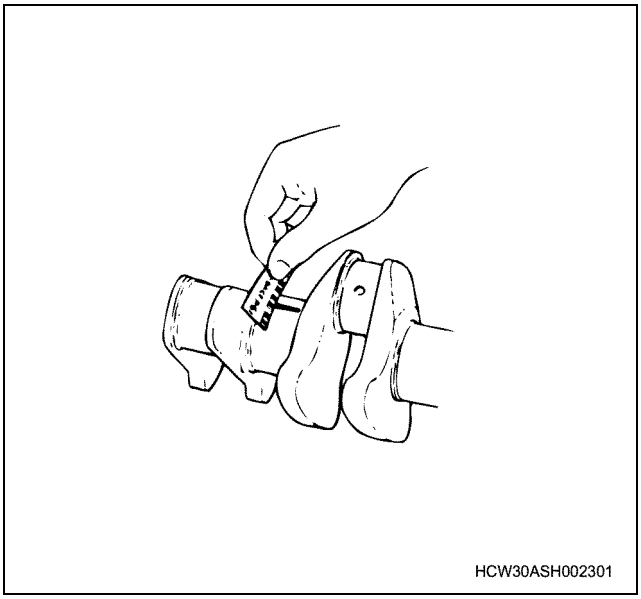
Example: Measuring the clearance between the crank bearing and crank journal

- Clean the clamp face of the cylinder block and crankcase bearing, and also the bearing, and install the cylinder block to the crankcase.
- Gently rest the crankshaft on the cylinder block, and rotate it approximately 30 degree to stabilize it.
- Cut the plastiguage to the same size as the journal width, and while avoiding the oil pore of the journal lay the gauge parallel to the journal.
- Gently rest the crank case on the cylinder block, apply molybdenum disulphide to the thread section and bearing surface of the fastening bolt, and tighten in sequence to the correct torque.

Important:
Do not rotate the crankshaft while using the plastiguage.

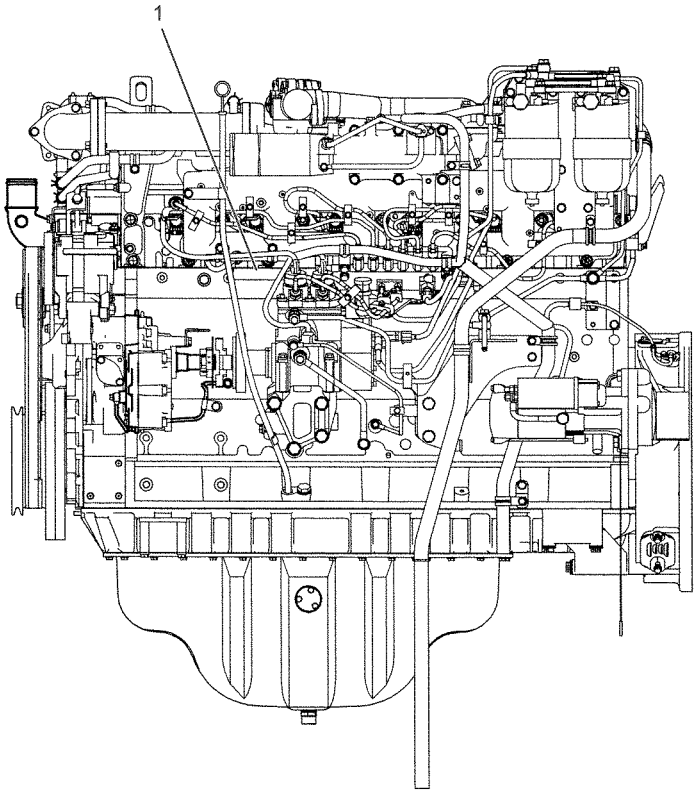
- Gently remove the crankcase, and measure the crushed width of the plastiguage (clearance between bearing and journal) using the scale printed on the bag.





Reading the model

Engine number stamping position



Legend

1. Engine number stamp (6WG1-·····)

General information

Terminology, description of abbreviations

Terminology definitions

Term	Explanation
Maintenance standard	The generic name for reference values required for maintenance, such as nominal dimension, selection of a reference point, and limit.
Nominal dimension	Shows the standard value at the point of manufacture that does not include the common difference.
Selection of a reference point	Shows the standard value after assembling, repairing, or adjusting.
Limit	When this value (dimensions) is reached, it shows that the part has reached its full limit and must be replaced or repaired.
Front · rear, left · right, upper · lower	These show each orientations of parts installed to the vehicle when looking from the vehicle's forward direction.
Unit	Units written to SI conventions (mainly torque, pressure, force) [Example] Length: mm, Torque: N·m {kgf·m}
Warning	Items that carry the warning mark pose a danger to life or threat of serious injury if not strictly observed.

Term	Explanation
Caution	Items that carry the caution mark may cause injury or lead to accidents if not strictly observed.
Important	Items that carry the important mark may cause the vehicle to break down, or may prevent the guaranteed normal operation of the system or related parts if not strictly observed.
Notes	Items that should receive special mention within a work procedure.

Description of abbreviations

Abbreviation	Description
AC	Alternating Current Alternating Current
ACC	Accessory Accessory
ACG	Alternating Current Generator Alternating current generator
API	American Petrol Institute American Petroleum Institute
ASM (Assy)	Assembly Assembly
ATDC	After Top Dead Center After Top Dead Center
BAT, BATT	Battery Battery
BRG, Brg	Bearing Bearing
BKT, BRKT	Bracket Bracket
BTDC	Before Top Dead Center Before Top Dead Center
CO	Carbon Oxide Carbon Monoxide
CONN	Connector Connector
CPU	Central Processing Unit Central processing unit
C/U	Control Unit Control unit
DC	Direct Current Direct current
DI	Direct Injection Direct injection
ECU	Engine Control Unit / Electronic Control Unit Engine control unit / control unit
ECM	Engine Control Module Engine control module

Abbreviation	Description
EGR	Exhaust Gas Recirculation Exhaust gas recirculation
Exh, EXH	Exhaust Exhaust
Ft, FRT	Front Front
FWD	Forward Forward
F/C	Fuel Cut Fuel Cut
GND	Ground Earth
IC	Integrated Circuit Integrated circuit
ID Plate	Identification plate Identification plate, ID plate
IN	Intake, Intake Intake
ISO	International Organization for Standardization International Organization for Standardization
I/PUMP	Injection Pump Injection Pump
JIS	Japanese Industrial Standard Japanese Industrial Standard
L/H, LH	Left Hand Left hand side
M/V	Magnetic Valve Magnetic valve
NOx	Nitrogen Oxide Nitrogen Oxide
N-TDC	Number - Top Dead Center Top dead center rotational frequency
OPT	Option Option
P	Pole(S) Pole

Abbreviation	Description
PCV	Pump Control Valve/ Positive Crankcase Ventilation Pump control valve/ Positive crankcase ventilation
PM	Particulate Matter Particulate matter
PS	Pre-Stroke Pre-stroke
PTO	Power Take Off Power take off
QOS	Quick On System Rapid preheating system
Rr, RR	Rear Rear
R/H, RH	Right Hand Right hand side
R/L	Relay Relay
STD	Standard Standard
SW	Switch Switch

Abbreviation	Description
TICS	Timing & Injection rate Control System A type of injection system
VGS Turbo	Variable Geometry turbocharger System Adjustable turbo, VGS turbo
W/L	Warning Lamp Warning lamp

SI (International System of Units)

With regards the conversion to SI (International System of Units)

The introduction of the SI systems aims to internationally unify the metric system and the various units used by different countries (traditional weights and measures, the foot pound method etc.), and to curb the confusion that occurs between the different units (conversion calculations etc.).
The new calculating method which adopted SI units was completely adopted in Japan in 1992, and is standardized by JIS-Z-8203.
All of the units in this manual are written in line with the International System of Units SI units, and conventional units are written in { } brackets.

SI
French) Abbreviated name of Le Systeme International d'Unites

Connection between main SI units and conventional units

	SI	Conventional Unit	Item, unit conversion
Length	m	m	Same as the conventional unit
Weight (Mass)	kg	kg	Same as the conventional unit
Force	N	* kg, kgf	1 kgf = 9.80665 N
Torque	N·m	* kg·m, gf·m	1 kgf·m = 9.80665 N·m
Pressure	Pa	*kg/cm^2, mmHg	1 kgf/cm^2 = 9.80665 kPa, 1 mmHg = 133.3 Pa
Dynamic force, horsepower	W	PS	1 PS = 0.74 kW
Capacity, air volume displacement	m^3	Litle, L, cc	1 Litle = 1 dm^3, 1 cc = 1mLitle = 1cm^3
Fuel consumption	g/(kW·h)	g/(PS·h)	1 g/(PS·h) = 1.360 g/(kW·h)

*1 Published service data may conveniently use kg for force and mass (weight) instead of kgf.
*2 Some conversion results may be rounded off to 1 or 2 decimal places.

Converting expressions of quantity

When converting, prefixes such as k (kilo) or m (mili) are used.

M	Mega	10^6	1,000,000
k	Kilo	10^3	1,000
h	Hecto	10^2	100
d	Deci	10^{-1}	0.1
c	Centi	10^{-2}	0.01
m	Milli	10^{-3}	0.001
μ	Micro	10^{-6}	0.000001

- 200 kgf/cm^2 = 19,620 kPa = 19.6 MPa
- 40 mmHg = 5,332 Pa = 5.3 kPa

Table of standard Isuzu tightening torque

The tightening torque values in the table below apply to all situations unless a special tightening torque is specified.

Isuzu standard bolts, nuts

N·m {kgf·m}

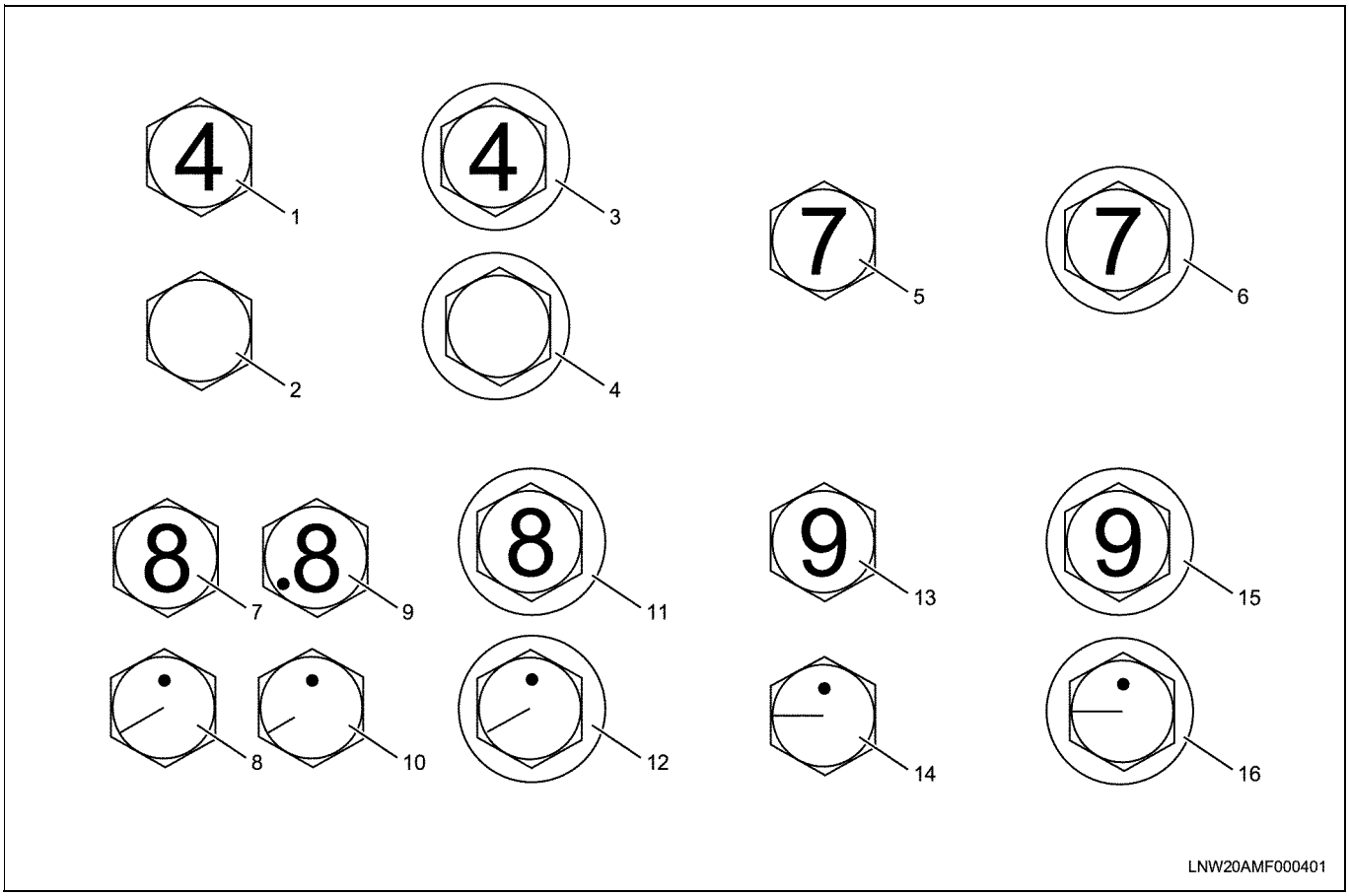
Strength classification	4.8 4T		7T	
Bolt head section shape	Hexagon head bolt	Flange bolt	Hexagon head bolt	Flange bolt
* M10 × 1.5	19.6 ~ 33.3 {2.0 ~ 3.4}	22.3 ~ 37.2 {2.3 ~ 3.8}	27.5 ~ 45.1 {2.8 ~ 4.6}	30.3 ~ 50.4 {3.1 ~ 5.1}
M12 × 1.25	49.0 ~ 73.5 {5.0 ~ 7.5}	54.9 ~ 82.3 {5.6 ~ 8.4}	60.8 ~ 91.2 {6.2 ~ 9.3}	68.1 ~ 102.1 {6.9 ~ 10.4}
* M12 × 1.75	45.1 ~ 68.6 {4.6 ~ 7.0}	51.0 ~ 76.5 {5.2 ~ 7.8}	56.9 ~ 84.3 {5.8 ~ 8.6}	62.7 ~ 94.0 {6.4 ~ 9.6}
M14 × 1.5	76.5 ~ 114.7 {7.8 ~ 11.7}	83.0 ~ 124.5 {8.5 ~ 12.7}	93.2 ~ 139.3 {9.5 ~ 14.2}	100.8 ~ 151.1 {10.3 ~ 15.4}
* M14 × 2	71.6 ~ 106.9 {7.3 ~ 10.9}	77.2 ~ 115.8 {7.9 ~ 11.8}	88.3 ~ 131.4 {9.0 ~ 13.4}	94.9 ~ 142.3 {9.7 ~ 14.5}
M16 × 1.5	104.0 ~ 157.0 {10.6 ~ 16.0}	115.6 ~ 173.3 {11.8 ~ 17.7}	135.3 ~ 204.0 {13.8 ~ 20.8}	150.1 ~ 225.2 {15.3 ~ 23.0}
* M16 × 2	100.0 ~ 149.1 {10.2 ~ 15.2}	109.4 ~ 164.2 {11.2 ~ 16.7}	129.4 ~ 194.2 {13.2 ~ 19.8}	142.5 ~ 213.8 {14.5 ~ 21.8}
M18 × 1.5	151.0 ~ 225.6 {15.4 ~ 23.0}	—	195.2 ~ 293.2 {19.9 ~ 29.9}	—
* M18 × 2.5	151.0 ~ 225.6 {15.4 ~ 23.0}	—	196.1 ~ 294.2 {20.0 ~ 30.0}	—
M20 × 1.5	206.0 – 310.0 {21.0 ~ 31.6}	—	269.7 ~ 405.0 {27.5 ~ 41.3}	—
* M20 × 2.5	190.2 ~ 286.4 {19.4 – 29.2}	—	249.1 ~ 374.6 {25.4 ~ 38.2}	—
M22 × 1.5	251.1 – 413.8 {25.6 ~ 42.2}	—	362.8 ~ 544.3 {37.0 ~ 55.5}	—
* M22 × 2.5	217.7 ~ 327.5 {22.2 ~ 33.4}	—	338.3 ~ 507.0 {34.5 ~ 51.7}	—
M24 × 2	358.9 ~ 539.4 {36.6 ~ 55.0}	—	430.5 ~ 711.0 {43.9 ~ 72.5}	—
* M24 × 3	338.3 ~ 507.0 {34.5 ~ 51.7}	—	406.0 ~ 608.0 {41.4 ~ 62.0}	—

The * mark indicates where soft materials have been used for internal thread sections, such as castings.

				N·m {kgf·m}
Strength classification	8.8		9.8 9T	
Bolt head section shape	Hexagon head bolt	Flange bolt	Hexagon head bolt	Flange bolt
M6 × 1	5.6 ~ 11.2 {0.6 ~ 1.1}	6.6 ~ 12.2 {0.6 ~ 1.2}	—	—
M8 × 1.25	13.4 ~ 25.7 {1.4 ~ 2.6}	15.3 ~ 28.4 {1.6 ~ 2.9}	16.7 ~ 30.4 {1.7 ~ 3.1}	18.1 ~ 33.6 {1.9 ~ 3.4}
M10 × 1.25	31.3 ~ 52.5 {3.2 ~ 5.4}	35.4 ~ 58.9 {3.6 ~ 6.1}	37.3 ~ 62.8 {3.8 ~ 6.4}	42.3 ~ 70.5 {4.3 ~ 7.2}
* M10 × 1.5	31.3 ~ 51.4 {3.2 ~ 5.2}	34.5 ~ 57.5 {3.5 ~ 5.8}	36.3 ~ 59.8 {3.7 ~ 6.1}	40.1 ~ 66.9 {4.1 ~ 6.8}
M12 × 1.25	69.3 ~ 104.0 {7.1 ~ 10.6}	77.7 ~ 116.5 {7.9 ~ 11.9}	75.5 ~ 113.8 {7.7 ~ 11.6}	85.0 ~ 127.5 {8.7 ~ 13.0}
* M12 × 1.75	64.8 ~ 96.1 {6.6 ~ 9.8}	71.4 ~ 107.2 {7.3 ~ 10.9}	71.6 ~ 106.9 {7.3 ~ 10.9}	79.5 ~ 119.2 {8.1 ~ 12.2}
M14 × 1.5	106.2 ~ 158.8 {10.8 ~ 16.2}	114.9 ~ 172.3 {11.7 ~ 17.6}	113.8 ~ 170.6 {11.6 ~ 17.4}	123.4 ~ 185.1 {12.6 ~ 18.9}
* M14 × 2	100.6 ~ 149.8 {10.3 ~ 15.3}	108.2 ~ 162.2 {11.1 ~ 16.6}	106.9 ~ 160.0 {10.9 ~ 16.3}	115.5 ~ 173.3 {11.8 ~ 17.7}
M16 × 1.5	154.3 ~ 232.5 {15.7 ~ 23.7}	171.1 ~ 256.7 {17.4 ~ 26.2}	160.0 ~ 240.3 {16.3 ~ 24.5}	176.9 ~ 265.3 {18.0 ~ 27.1}
* M16 × 2	147.6 ~ 221.4 {15.0 ~ 22.6}	162.5 ~ 243.8 {16.6 ~ 24.9}	153.0 ~ 229.5 {15.6 ~ 23.4}	168.5 ~ 252.7 {17.2 ~ 25.8}
M18 × 1.5	222.5 ~ 334.3 {22.7 ~ 34.1}	—	229.5 ~ 345.2 {23.4 ~ 35.2}	—
* M18 × 2.5	223.6 ~ 335.4 {22.8 ~ 34.2}	—	230.5 ~ 346.2 {23.6 ~ 35.3}	—
M20 × 1.5	307.4 ~ 461.7 {31.4 ~ 47.1}	—	316.8 ~ 475.6 {32.3 ~ 48.5}	—
* M20 × 2.5	284.0 ~ 472.1 {29.0 ~ 43.5}	—	293.2 ~ 440.3 {29.2 ~ 44.9}	—
M22 × 1.5	413.6 ~ 620.5 {42.2 ~ 63.3}	—	424.6 ~ 636.5 {43.3 ~ 64.9}	—
* M22 × 2.5	385.7 ~ 578.0 {39.3 ~ 58.9}	—	394.2 ~ 592.3 {40.0 ~ 60.4}	—
M24 × 2	490.8 ~ 810.5 {50.0 ~ 82.7}	—	554.1 ~ 830.6 {56.5 ~ 84.7}	—
* M24 × 3	462.8 ~ 693.1 {47.2 ~ 70.7}	—	520.7 ~ 781.6 {53.1 ~ 79.7}	—

The * mark indicates where soft materials have been used for internal thread sections, such as castings.

Designations for Isuzu standard bolt heads



Legend

1. Hexagon head bolt(4.8, 4T)
2. Hexagon head bolt(4.8, 4T)
3. Flange bolt(4.8, 4T)
4. Flange bolt(4.8, 4T)
5. Hexagon head bolt(7T)
6. Flange bolt(7T)
7. Hexagon head bolt (refined 8.8)
8. Hexagon head bolt (refined 8.8)
9. Hexagon head bolt(Un-refined 8.8)
10. Hexagon head bolt(Un-refined 8.8)
11. Flange bolt(8.8)
12. Flange bolt(8.8)
13. Hexagon head bolt(9.8, 9T)
14. Hexagon head bolt(9.8, 9T)
15. Flange bolt(9.8, 9T)
16. Flange bolt(9.8, 9T)

Flare nut

	Pipe diameter	tightening torque (for medium and large size vehicles)	Flare nut 2 side width (mm)	
			Old	New
Flare nut tightening torque (service standard value) N·m {kgf·m}	ϕ4.76 mm	12.8 ~ 18.6 {1.3 ~ 1.9}	14	14
	ϕ6.35 mm	23.5 ~ 49 {2.4 ~ 5.0}	17	17
	ϕ8.0 mm	23.5 ~ 49 {2.4 ~ 5.0}	19	17
	ϕ10.0 mm	44.1 ~ 93.2 {4.5 ~ 9.5}	22	19
	ϕ12.0 mm	58.8 ~ 137.3 {6.0 ~ 14.0}	27	24
	ϕ15.0 mm	78.5 ~ 156.9 {8.0 ~ 16.0}	30	30

Taper screw from connectors (brass)

				N·m {kgf·m}
Screw size	PT(R) 1/8	PT(R) 1/4	PT(R) 3/8	PT(R) 1/12
—	2.0 ~ 14.7 (0.2 ~ 1.5)	4.9 ~ 15.7 (0.5 ~ 1.6)	9.8 ~ 16.7 (1.0 ~ 1.7)	9.8 ~ 17.7 (1.0 ~ 1.8)

Disassemble and Assemble Engine

Engine mechanical
(6WG1 (Common rail))

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6WG1-TC Engine

Service Precautions

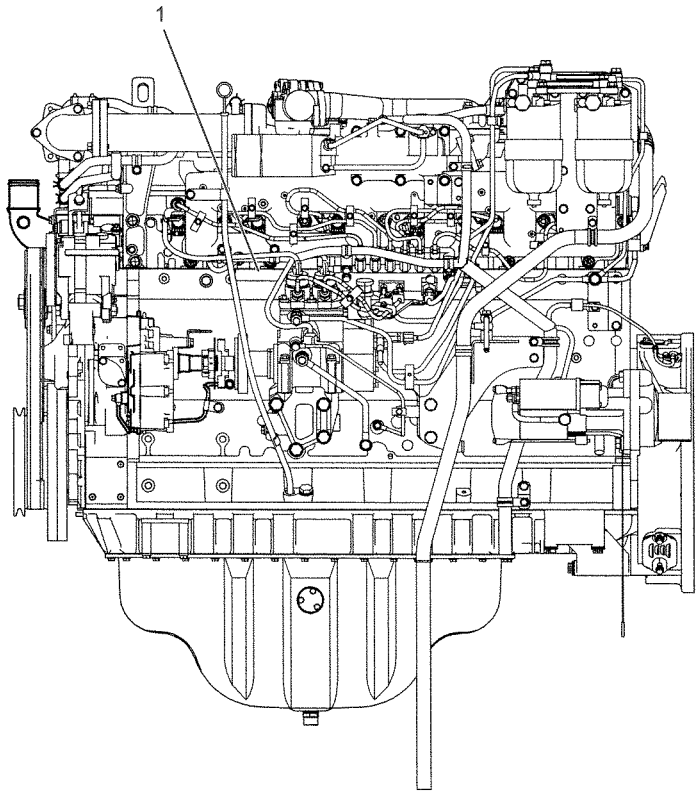
In order to prevent damage to the engine and to guarantee the reliability of engine performance, pay close attention to the following points when performing engine maintenance.

- Do not put the jack on the oil pan when lifting or supporting the engine.
  When lowering the engine onto a base, use an engine pallet or wooden frame and rest the engine on the engine foot and flywheel housing.
- When removing the intake system, cover the intake port to prevent dust particles from getting into the cylinder. If dust particles get into the cylinders, they can cause a large amount of damage to cylinders etc. when the engine is running.
- Always remove the battery earth cable when performing maintenance work on the main engine body. Be careful not to cause short circuits etc. when performing inspections or other such work that requires the electricity flow to be connected.
- In order to protect and lubricate the sliding surfaces during the first stage of the engine's life, ensure that enough engine oil is applied to all sliding surfaces.
- When removing parts surrounding the valves, pistons, piston rings, connecting rods, connecting rod bearings, and crankshaft journal bearings, arrange and keep the removed parts in order.
- When re-installing the parts, install the same part to the same position it was in when it was removed.
- Every time gaskets, oil seals, O-rings and other such parts are disassembled, they should always be replaced with brand new parts.
- When using liquid gasket, make sure that all of the old liquid gasket is completely removed, clean the parts so that there is no oil, fat, water, or dirt on any of the surfaces, and apply the specified type of liquid gasket when re-assembling the parts.
- 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 a new layer.
- When assembling or installing parts, tighten bolts to the appropriate tightening torque, and perform all part fitting work correctly.

Precautions on specialized work for this engine

The holes and clearances that form part of the fuel supply lines inside the injectors and other parts of the fuel system have been made to a very precise standard. The system is therefore highly sensitive to dust particles, and dust particles getting into the system may cause the vehicle to breakdown while on the road. For that reason, you should aim to completely prevent any dust particles from getting into the system.

Reading the model

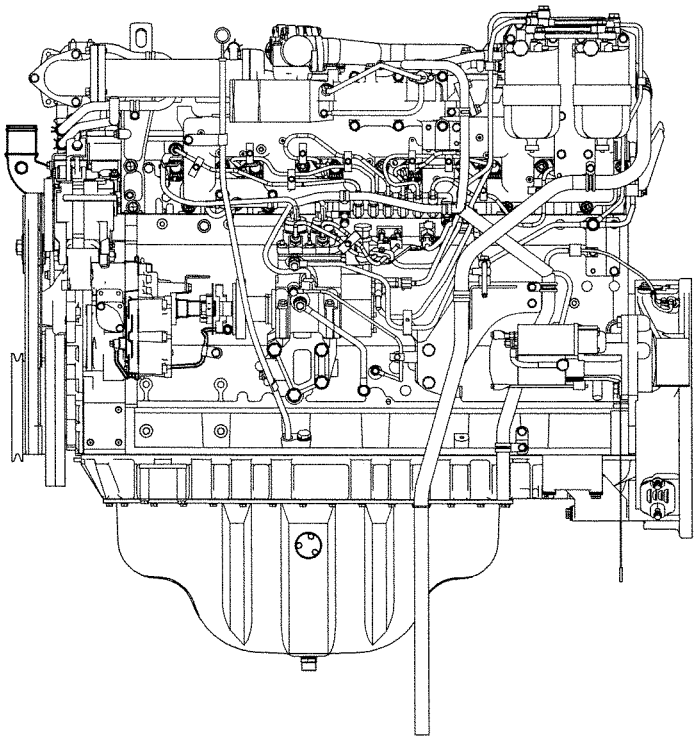


Legend

1. Engine number stamp (6WG1-·····)

Explanation of functions and operations

Engine structural drawing



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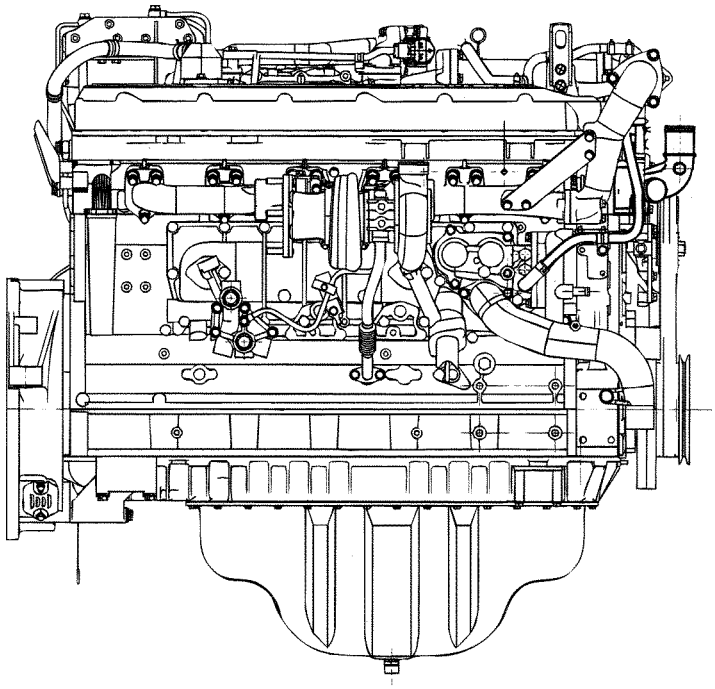

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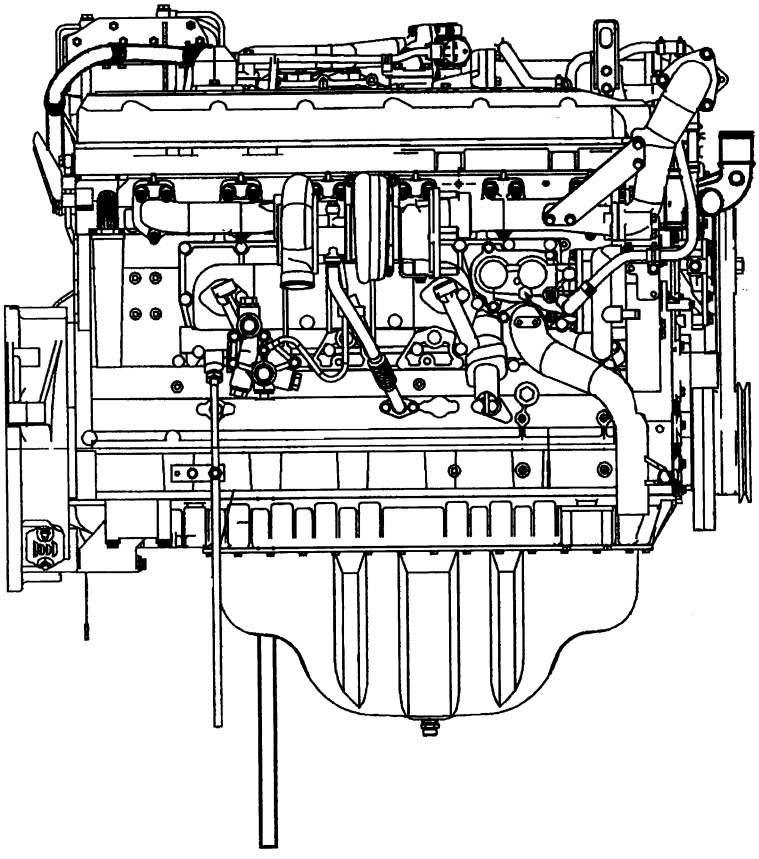
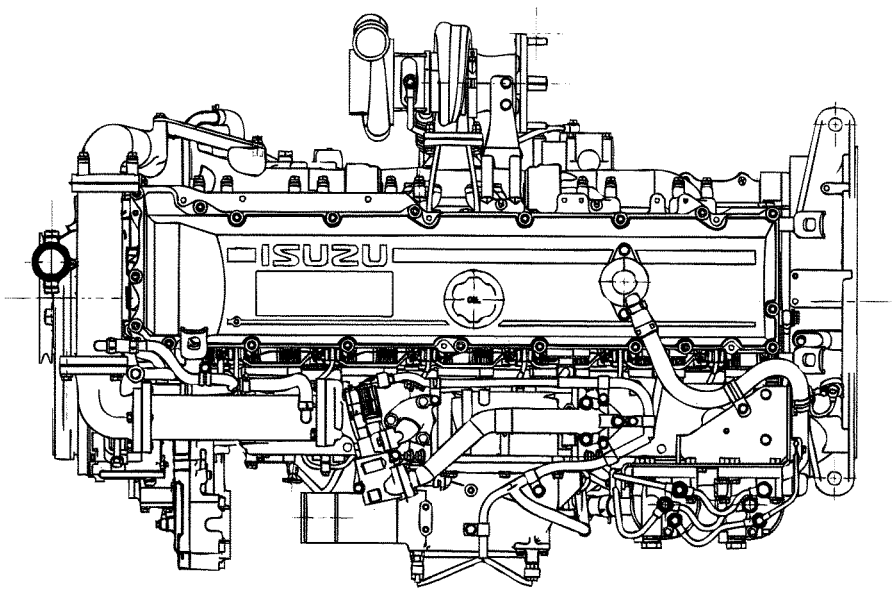


Installing position of the turbocharger differs depending upon the engine.



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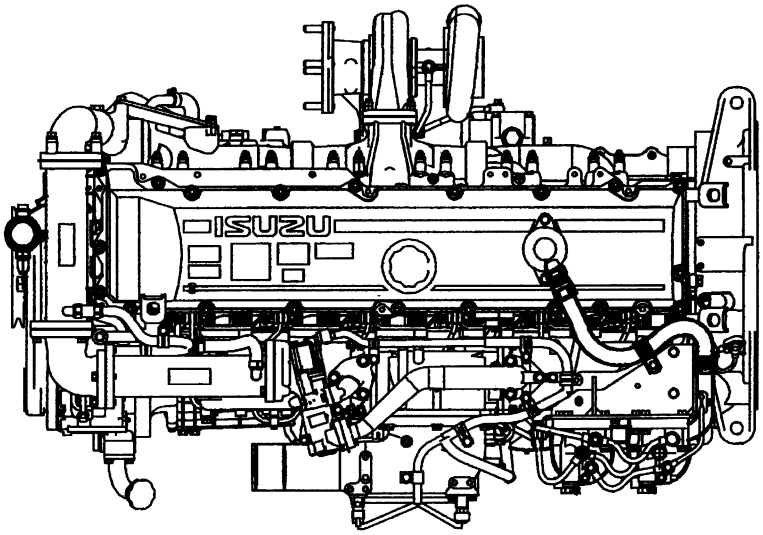


Installing position of the turbocharger differs depending upon the engine.

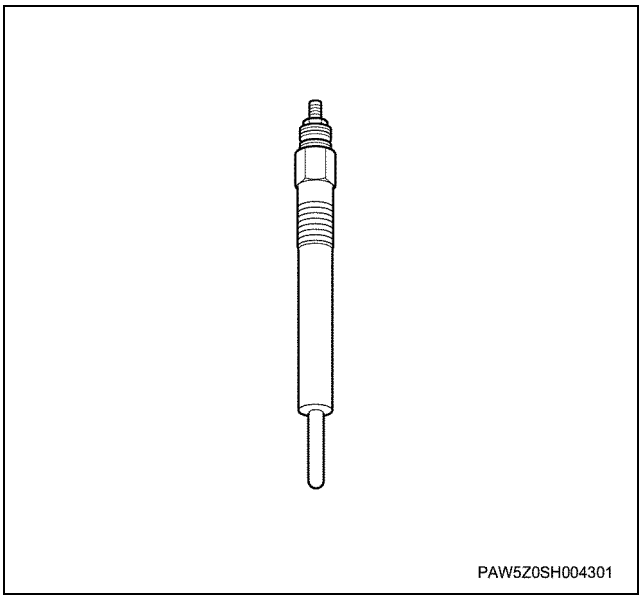
Functional check:

Compression pressure measurement

Compression pressure measurement should be performed when the engine is cool (water temperature 20°C) and there are no abnormalities occuring with the battery or starter motor.

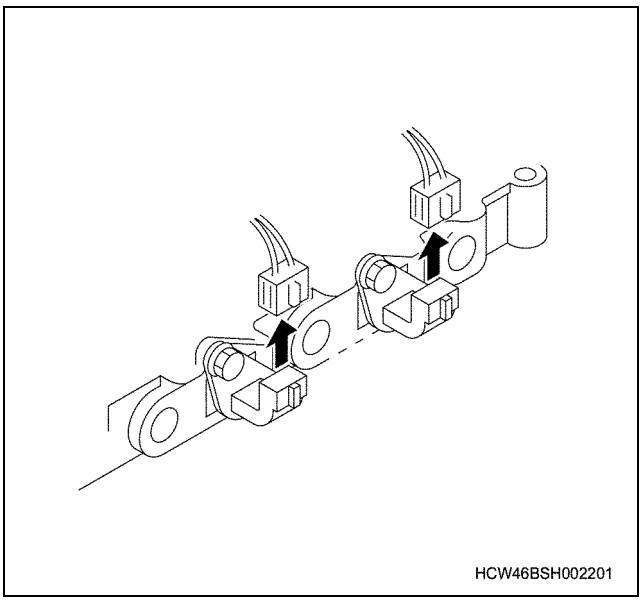
Remove the glow plugs

- Remove all of the glow plugs.



Remove the injector and harness connector

- Remove the injector harness connector from the lower head cover (no fuel injection).

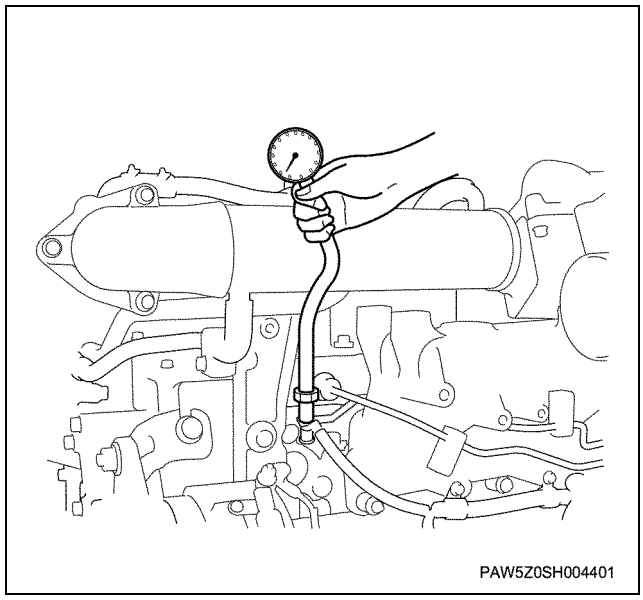


Install a compression gauge

- Insert the compression gauge adapter into the glow plug installation opening and install the compression gauge.

Special tools

Compression gauge adapter:	1-8531-7019-0
Compression gauge:	5-8840-2675-0



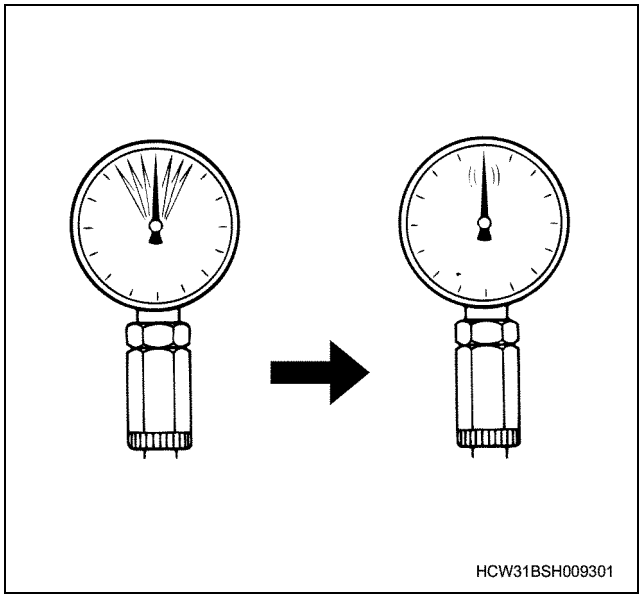
Compression pressure measurement

- Turn the starter motor (200 rpm), and take the compression pressure measurement when the compression gauge needle has settled.

Caution:

- **Care must be taken as air is violently ejected from the glow openings while the engine is running.**
- **Measure the compression pressure for all cylinders.**
- **When the harness connector is removed, the ECU judges the removal as a failure and records an error code. Always clear the ECU memory after completing the compression pressure measurements. (Refer to the troubleshooting manual for details on the ECU memory clear procedure)**

Item	Compression pressure kPa/rpm {kgf/ cm^2/rpm}	Disparity between cylinders kPa/rpm {kgf/ cm^2/rpm}
Selection of a reference point	2750/ 200 {28 / 200}	196 {2.0}
Limit	2260 / 200 {23 /200}	–



Judging the correct timing for an overhaul

Overhaul is required in the following cases

Decline in compression pressure

When the compression pressure is below 2260 kPa (23 kgf/cm^2) when measured using the measuring procedure shown in Compression pressure measurement.

Rate of engine oil consumption increase

Taking the consumption of a new engine as 100%, overhaul is required when oil consumption goes over 200%.

Rate of fuel consumption increase

Taking the fuel consumption of a new engine as 100%, overhaul is required when the fuel consumption goes over 140%.

Abnormal noises from inside the engine

When abnormal noises from within the engine occur. Perform an overhaul as soon as possible and repair the fault.

Notes:
Some examples of the causes of engine noise can include the wear, burning, or overheating of each of the engine parts.

Maintenance precautions

1. Most of the engine parts are still hot directly after operation, so make sure that the engine has cooled sufficiently before touching it.
2. When performing sensor inspection work, Diag-codes (Self-diagnostic codes) are recorded to the ECU memory. Using a scan tool, check the ECU for details of the Diag-codes.
3. Always take off the battery terminal to prevent damage or fire to electronic parts such as sensors etc.
4. The injector harness and electromagnetic valve sections use a high voltage which may cause electric shocks. When performing maintenance work, always switch the starter switch to the Off position and remove the key.

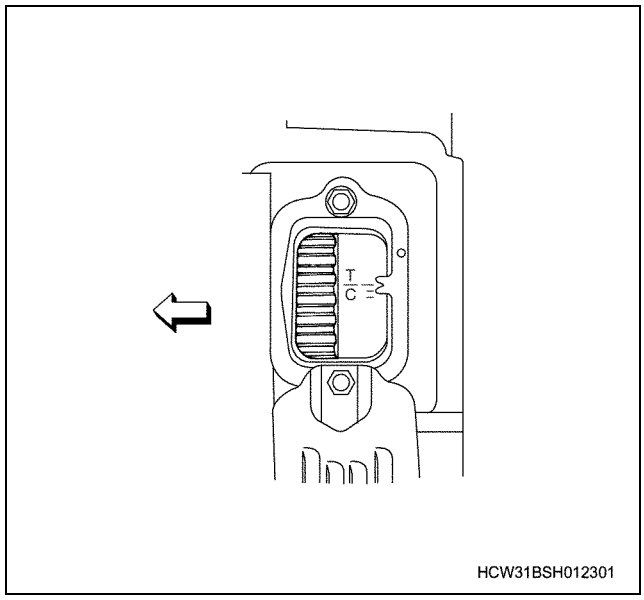
Valve clearance adjustment

Valve clearance adjustment is split into 2 adjustments, setting to the number 1 cylinder compression top dead center and setting to the number 6 cylinder top dead center.

Valve clearance adjustment

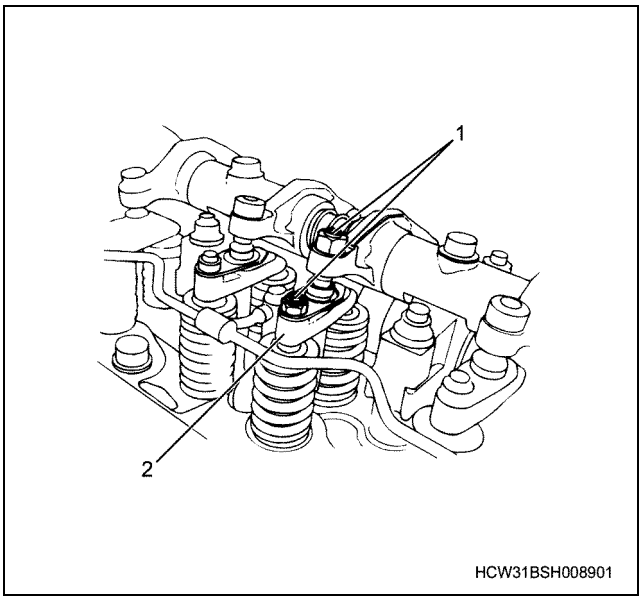
Adjust to the number 1 cylinder (or number 6 cylinder) compression top dead center.

Rotate the crankshaft forwards, and line up the flywheel T/C line and pointer. At this point, check that there is a clearance (compression top dead center) between the number 1 cylinder (or the number 6 cylinder) locker arm and cam.

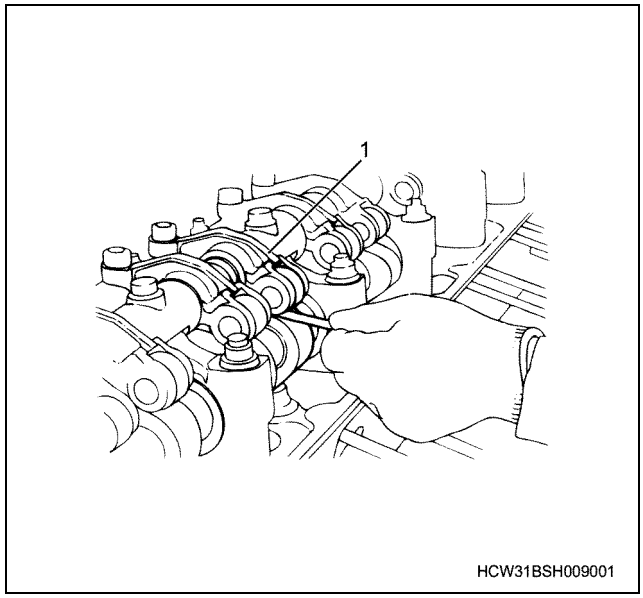


Valve clearance adjustment

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.**

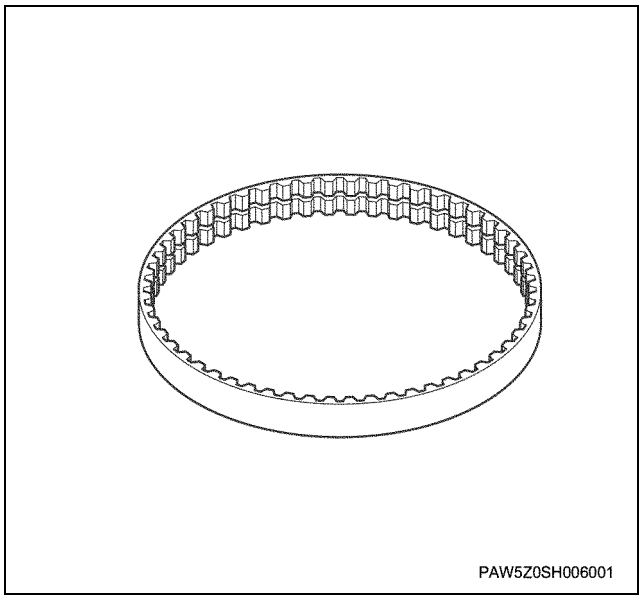
Valve clearance adjustment table

	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)

Inspection and adjustment of the belt

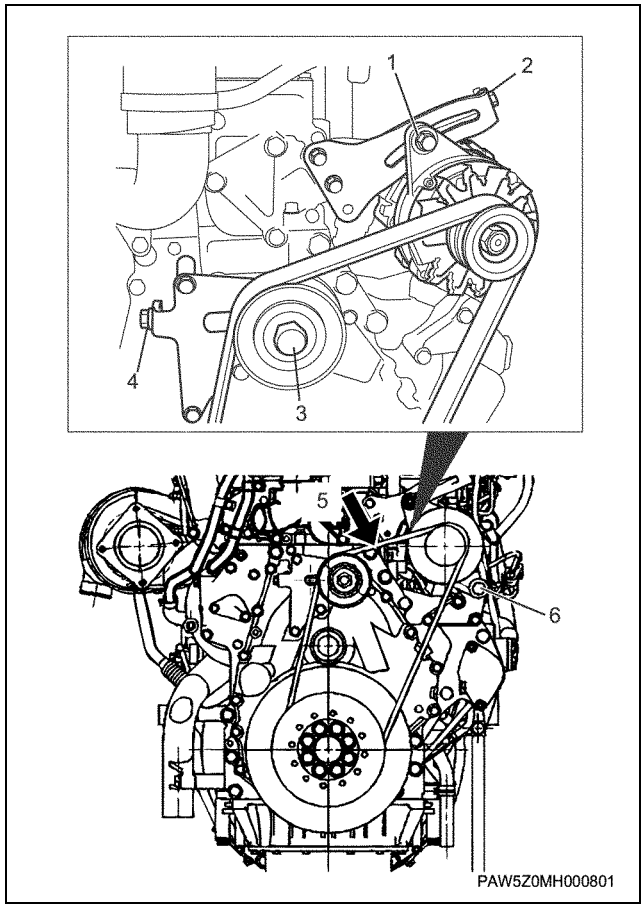
Inspect for belt wear and cracking.



Tension adjustments of the generator drive belt

1. Tighten the idle pulley lock nut and generator section lock nut.
2. Adjust the belt tension so it becomes equal to the standard value by adjusting the idling pulley adjustment bolt and generator section adjustment bolt.
3. The amount of tension when 98N {10kgf·m} is applied to the centre between the idling pulley and generator pulley.

Standard value mm
6 ~ 8



Legend

1. Lock nut (generator)
2. Adjustment bolt (generator)
3. Lock nut
4. Adjustment bolt (Idling pulley)
5. Belt tension measurement position
6. Installation bolt

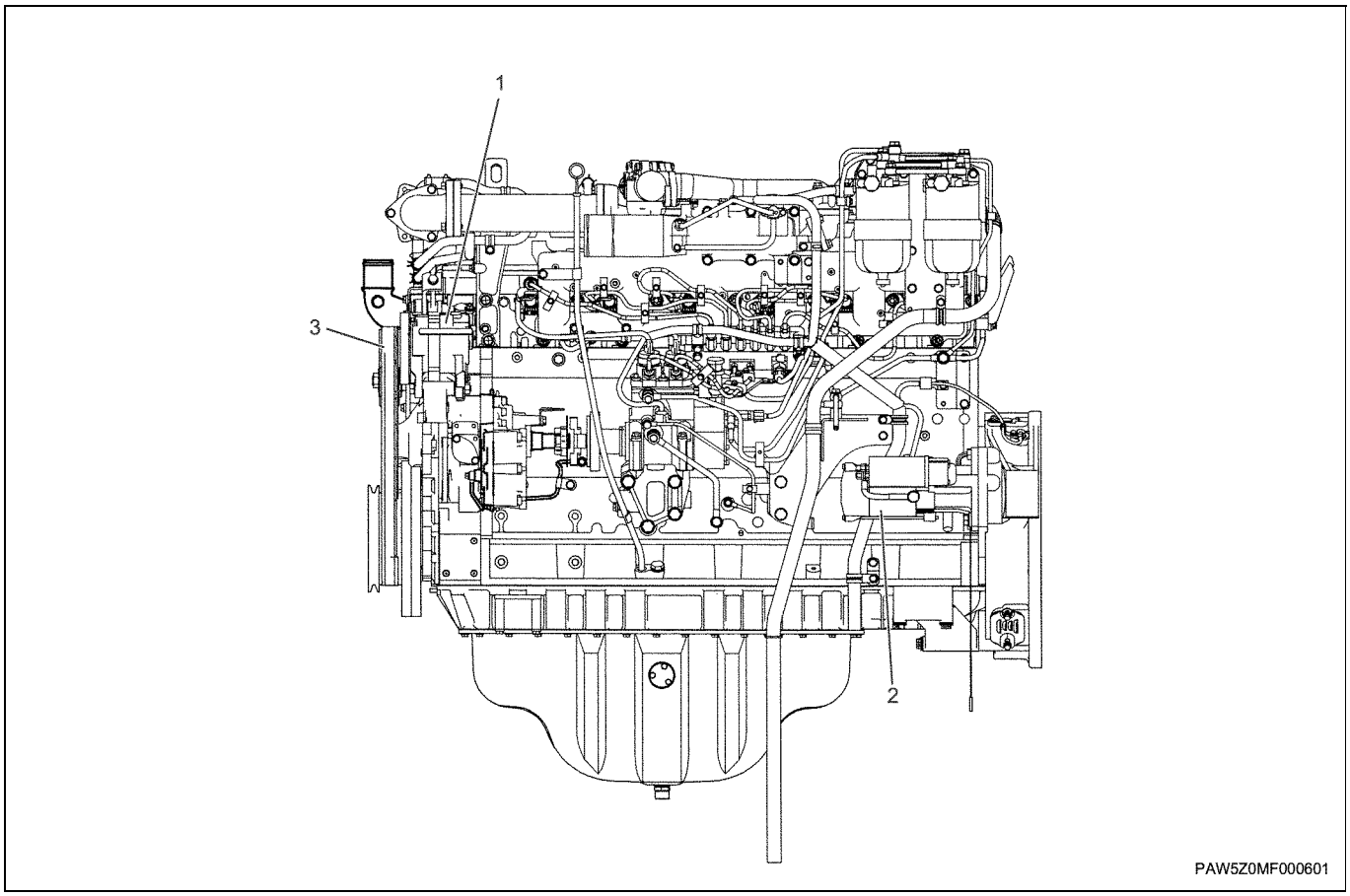
Main data and specifications

	Model	6WG1-TC
Item		
Engine model		Water cooled 4 cycle series connected type 6 cylinder 24 valve OHC direct injection diesel
Cylinder array and number – bore × stroke	(mm)	L6 – ϕ147 × 154
Displacement	(L)	15.681
Compression ratio		16.0
Compression pressure	kPa/rpm (kgf/cm^2/rpm)	2750(28)/200
Dimensions (length × width × height)	(mm)	1463 × 1036 × 1432
Weight	(kg)	1185
Fuel injection order		1-5-3-6-2-4

Model		6WG1-TC
Item		
Injection pump type		Electronic control fuel-injection system (common rail type)
Governor type		Electronic type
Timer type		Electronic type
Nozzle type		DLL-P
Intake/exhaust valve clearance (while cool)	(mm)	0.4
Intake valve opening and closing time	(Open)	21 degree (BTDC)
Intake valve opening and closing time	(Closed)	27 degree (ABDC)
Exhaust valve opening and closing time	(Open)	52 degree (BBDC)
Exhaust valve opening and closing time	(Closed)	17.5 degree (ATDC)
Fuel filter type		Filter paper type
Oil filter type		Filter paper type
Oil pump type		Gear type
Oil cooler type		Water cooling type
Amount of engine oil	(L)	Oil pan :37 ~ 52
Cooling system method		Water-cooled controlled circulation type
Cooling water full capacity	(L)	36
Water pump type		Centrifugal gear type
Thermostat type		Wax type
Air cleaner type		Filter paper type
Generator capacity	(V-A)	24 – 50
Starter	(V-kW)	24 – 7.0
Turbocharger type		TD08H (Made by Mitsubishi)
Intercooler type		Aluminium tube and endplate type
Thermostat valve open temperature	(°C)	80 ~ 84
Thermostat all open temperature/ amount of lift	(°C/mm)	95 (10mm lift when at 95 °C)
Oil thermostat all open temperature/ Amount of lift	(°C/mm)	98 (8 mm lift when at 110 °C)
Exhaust gas recirculation device (EGR)		Installed

Engine accessories

Component parts



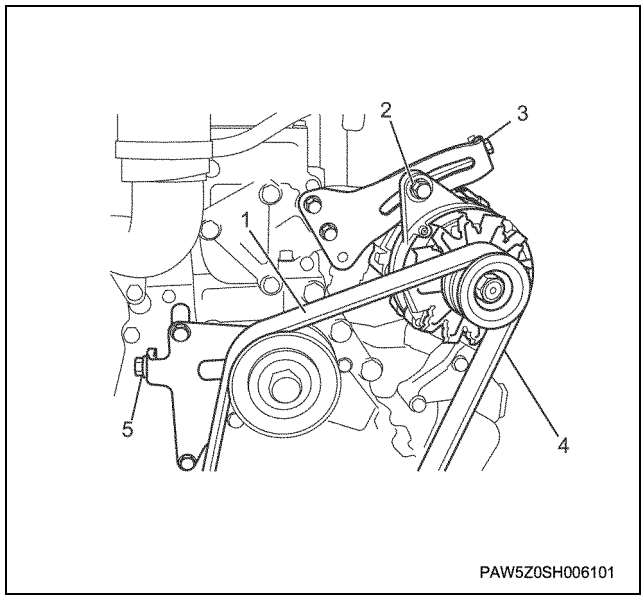
Legend

1. Generator
2. Starter motor
3. Belt (generator)

Removal

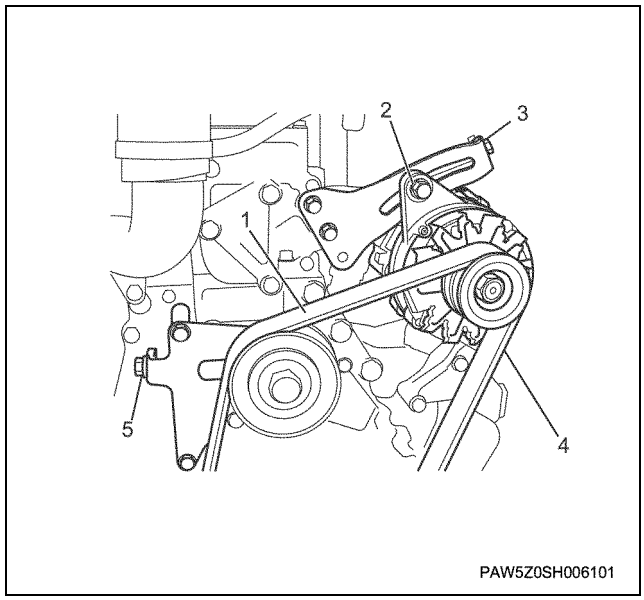
1. Remove the V belt (for generator)
   - Loosen the generator installation bolt and nut, and push the adjustment bolt down on the engine side.
   - Loosen the idling pulley adjustment.

- After completing the work above, remove the belt.



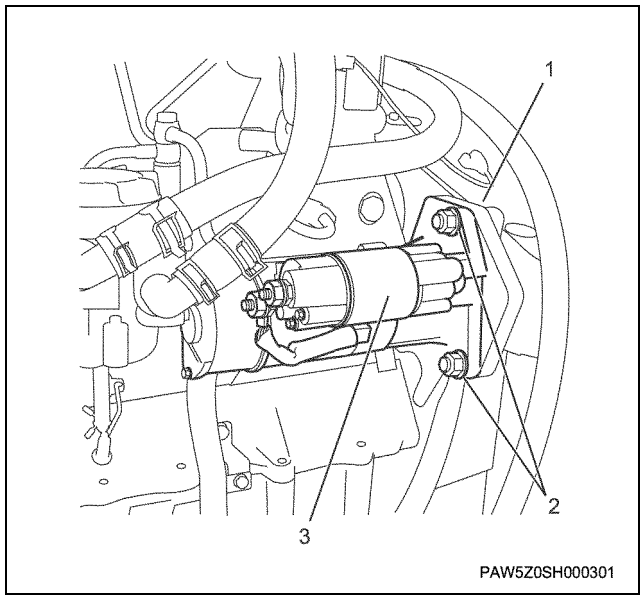
Legend
1. V belt
2. Adjustment nut
3. Adjustment bolt (generator)
4. Bolt (generator)
5. Adjustment bolt (Idling pulley)

2. Remove the generator.
   - Remove the generator installation bolt, nut and adjustment nut, and remove the generator from the bracket.



Legend
1. V belt
2. Adjustment nut
3. Adjustment bolt (generator)
4. Bolt (generator)
5. Adjustment bolt (Idling pulley)

3. Remove the Starter motor.

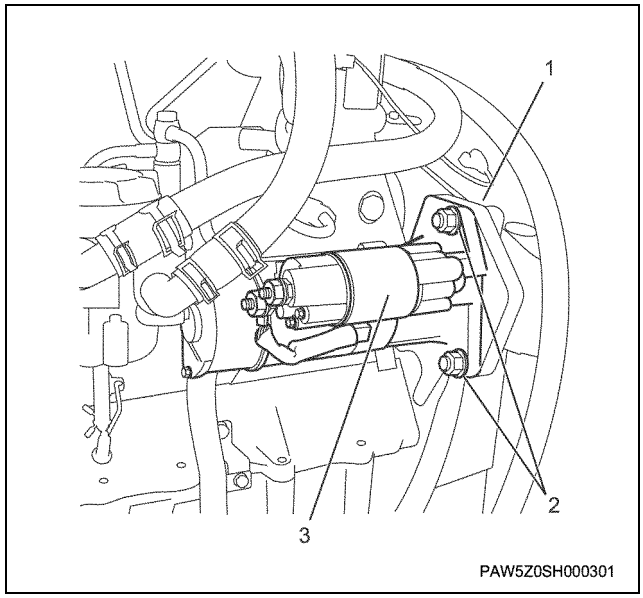


Legend
1. Flywheel housing
2. Nut
3. Starter motor

Installation

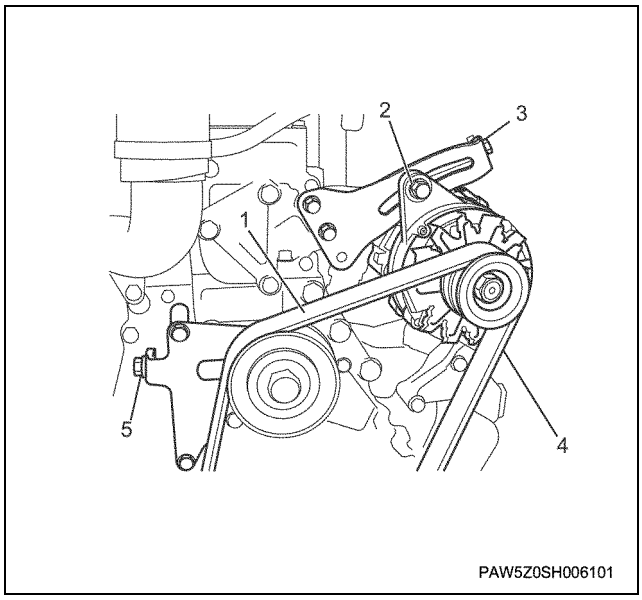
1. Install the Starter motor.
   - Install the starter cable to the lower section, and tighten it by nut to the starter and lower section.

Tightening torque: 103 N·m {10.5 kgf·m}



Legend
1. Flywheel housing
2. Nut
3. Starter motor

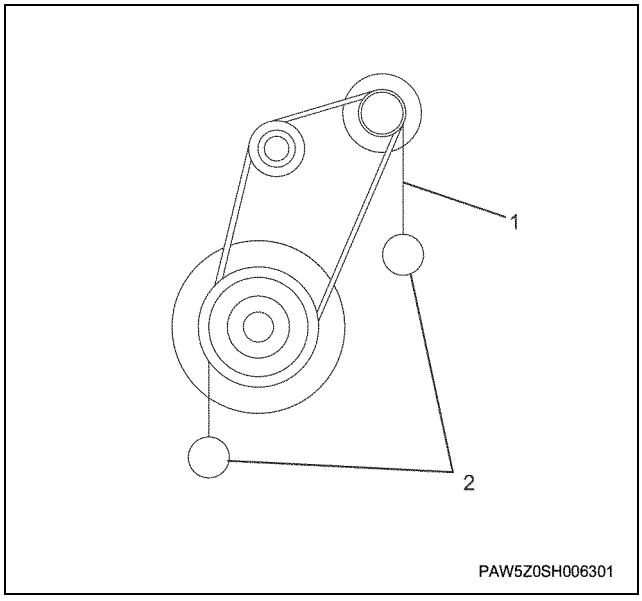
2. Install the generator to the bracket and adjustment plate.



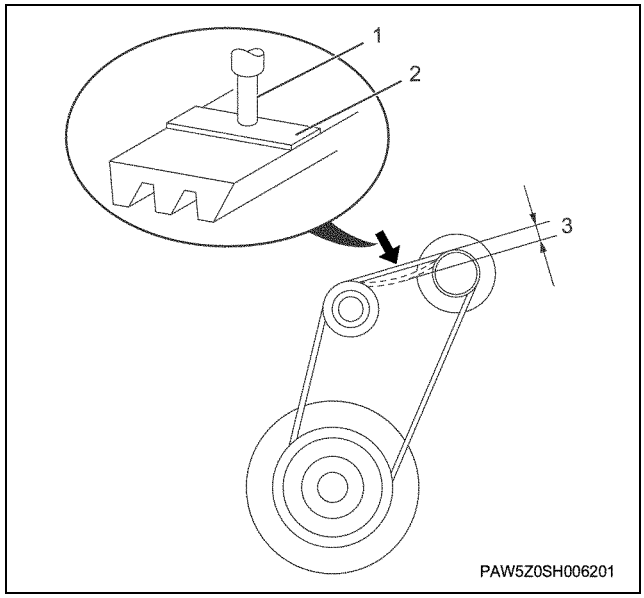
Legend

1. Belt
2. Adjustment nut
3. Adjustment bolt (generator)
4. Bolt (generator)
5. Adjustment bolt (Idling pulley)

3. Install the belt (for the generator) and adjust the tension of the belt.
   - Secure the reliable standard position by setting a standard string (1) or a weighted at both ends string (2) on the back of the belt.



   - Arrange the push gauge so that the edge of the push gauge presses uniformly on the overall width of the belt, or set an iron plate with a thickness of about 2 mm on the belt.

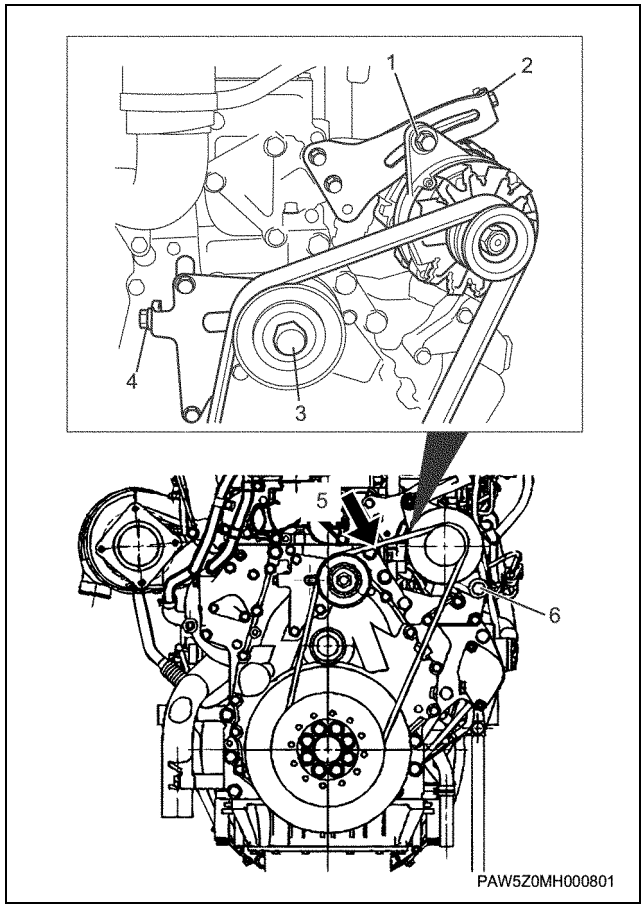


Legend

1. Push gauge
2. Iron plate
3. Amount of tension

   - Loosen the generator's installation bolt and lock nut, then loosen the idling pulley lock nut.
   - In order to set the amount of tension to within the standard value range when approximately 98 N {10 kgf} of force is applied to the central section of the belt, correctly adjust the balance using the generator adjustment bolt and idling pulley adjustment bolt.
   - After adjusting the tension of the belt, tighten the locknuts (1) and (3), and the installation bolt (6).

Idling pulley tightening torque: 147N·m {15kgf·m}



Legend

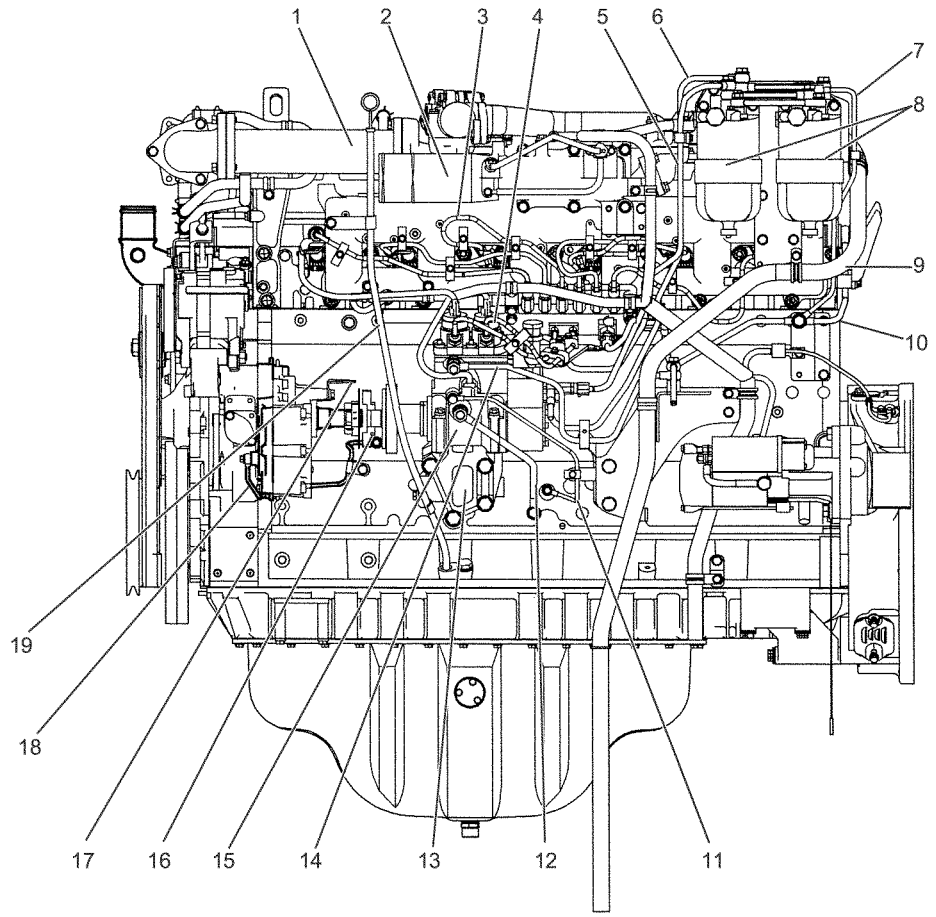
1. Lock nut (generator)
2. Adjustment bolt (generator)
3. Lock nut (Idling pulley)
4. Adjustment bolt (Idling pulley)
5. Belt tension measurement position
6. Bolt

Amount of belt tension

Standard value mm
6 ~ 8

Engine exterior equipment

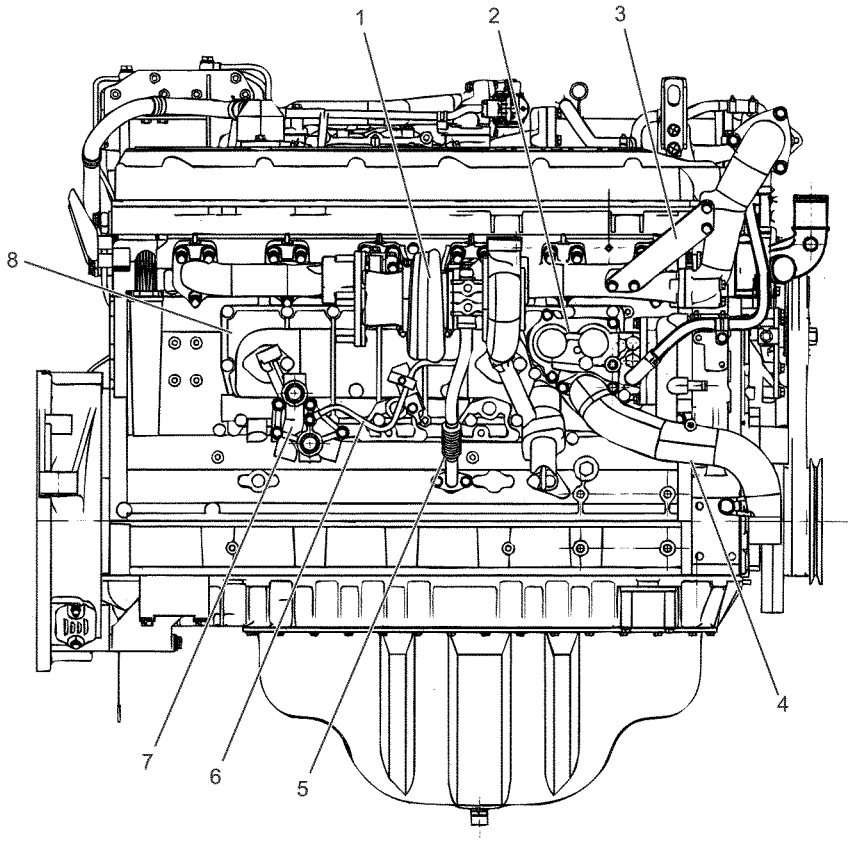
Component parts



PAW5Z0LF000901

Legend

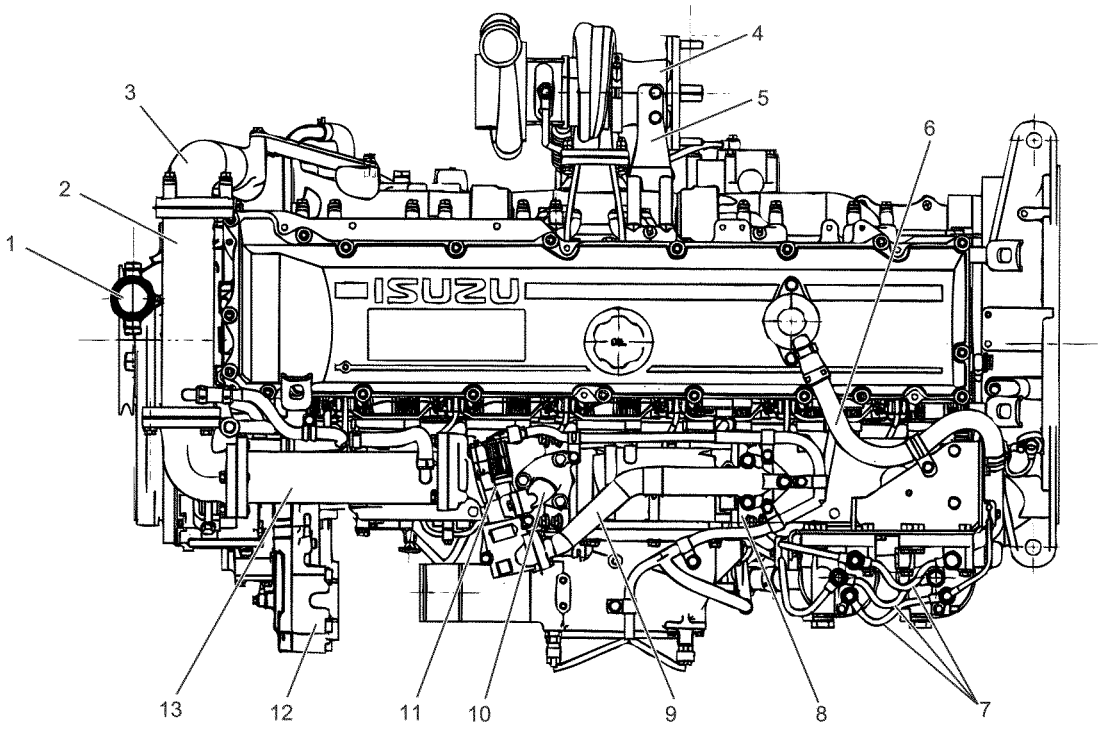
1. Secondary EGR cooler
2. Intake pipe
3. Injection Pipe
4. Fuel pipe (supply pump ~ common rail)
5. Fuel pipe (Feed pump ~ fuel filter)
6. Fuel pipe (fuel filter ~ Supply pump)
7. Fuel return pipe
8. Fuel filter
9. Air breather hose
10. Nozzle leak off pipe
11. Oil feed pipe (supply pump)
12. Oil return pipe (supply pump)
13. Oil port
14. Fuel return pipe (supply pump)
15. Supply pump
16. Coupling
17. Pointer
18. Oil pipe (PTO gear)
19. Level gauge, guide tube



PAW5Z0LF001001

Legend

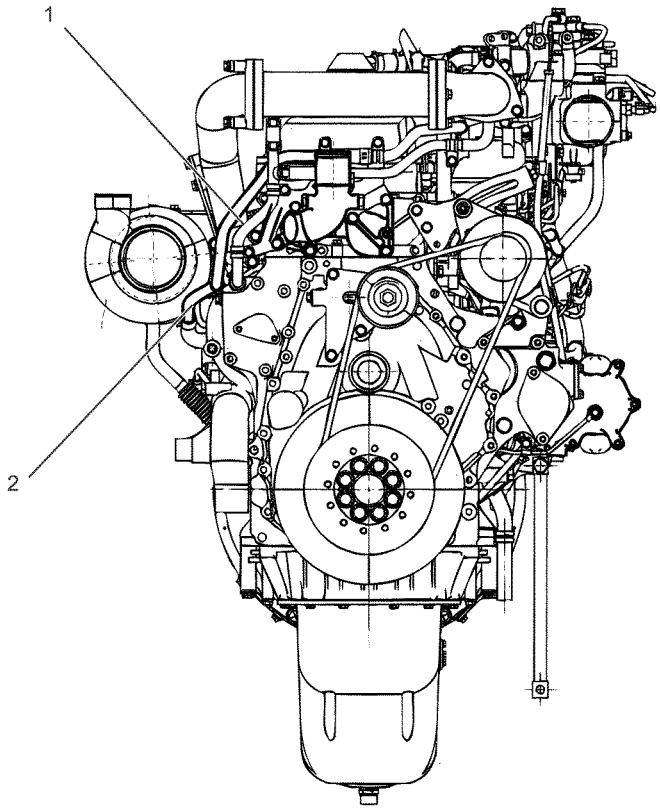
1. Turbocharger
2. Thermostat housing
3. Plate (EGR duct)
4. Water intake pipe
5. Oil return pipe (turbocharger)
6. Oil feed pipe (turbocharger)
7. Oil port
8. Oil cooler



PAW5Z0LF001101

Legend

1. Water outlet pipe
2. Primary EGR cooler
3. EGR duct
4. Exhaust pipe
5. Bracket
6. Breather hose
7. Fuel pipe (fuel filter ~ fuel filter)
8. Lead valve duct
9. EGR duct
10. EGR duct
11. EGR valve
12. PTO gear ASM
13. Secondary EGR cooler



PAW5Z0LF001201

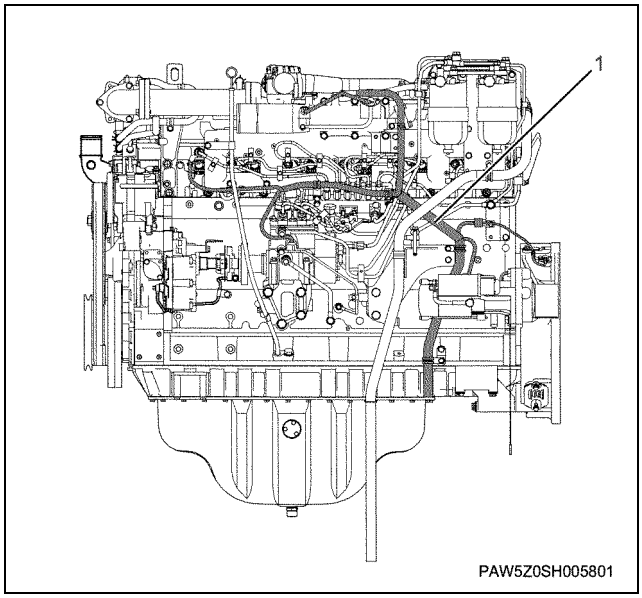
Legend

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

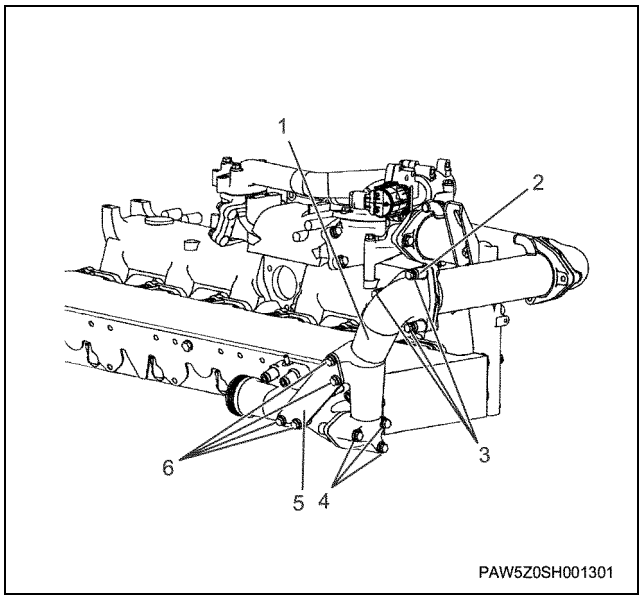
Removal

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.



2. Remove the EGR duct fixing plate.
3. Remove the EGR duct.

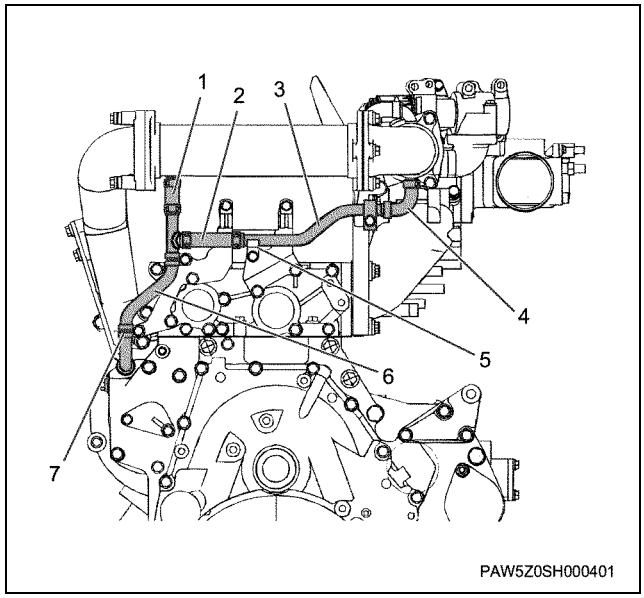


Legend

1. EGR pipe
2. Distance tube, washer
3. Bolt
4. Bolt
5. Plate
6. Bolt

4. Unfasten the EGR pipe fixing clip, and remove the cooling water pipe for the EGR cooler and rubber hose (feed side).

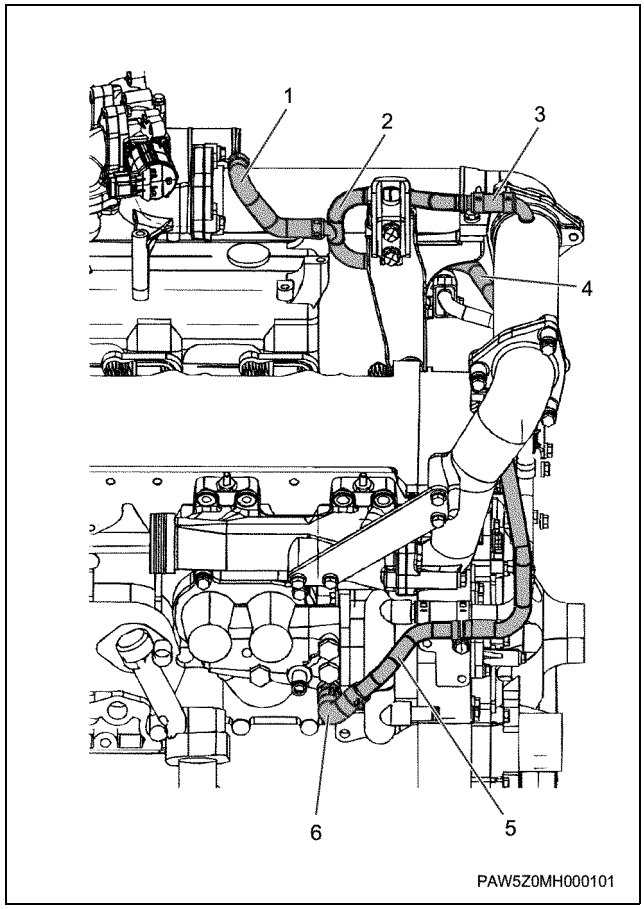
Notes:
Before performing this work, drain off water from the engine interior.



Legend

1. Rubber hose
2. Rubber hose
3. Water pipe for EGR cooler (LH) (feed side)
4. Rubber hose
5. Clip
6. Water pipe for EGR cooler (FT) (feed side)
7. Clip

5. Unfasten the EGR pipe fixing clip, and remove the cooling water pipe for the EGR cooler and rubber hose (return side).

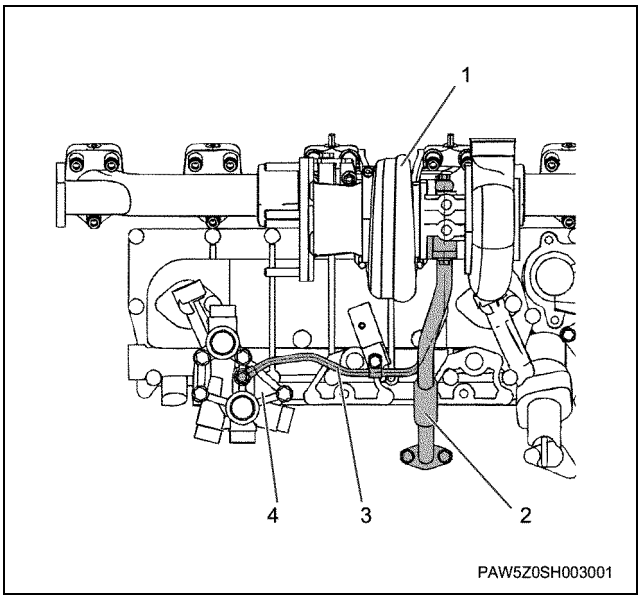


Legend

1. Rubber hose
2. Water pipe for EGR cooler (RR) (Return side)
3. Rubber hose
4. Water pipe for EGR cooler (LH) (return side)
5. Water pipe for EGR cooler (FT) (Return side)
6. Rubber hose

6. Remove the oil return pipe (turbocharger).

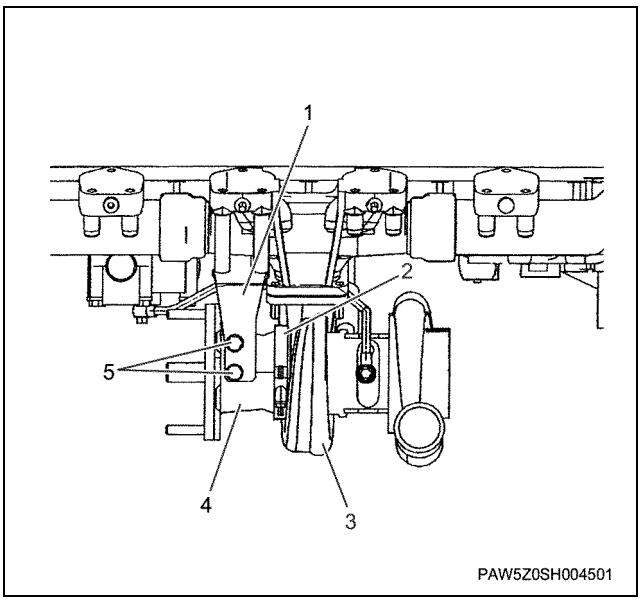
7. Remove the oil feed pipe (turbocharger).



Legend

1. Turbocharger
2. Oil return pipe (turbocharger)
3. Oil feed pipe (turbocharger)
4. Oil port

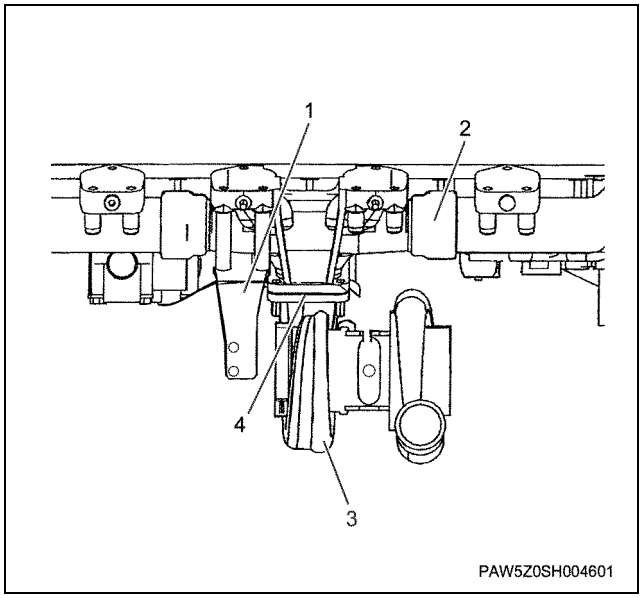
8. Remove the bolts for the exhaust pipe installation bracket, and remove the exhaust pipe.



Legend

1. Exhaust pipe bracket
2. Clamp
3. Turbocharger
4. Exhaust pipe
5. Bolt, washer

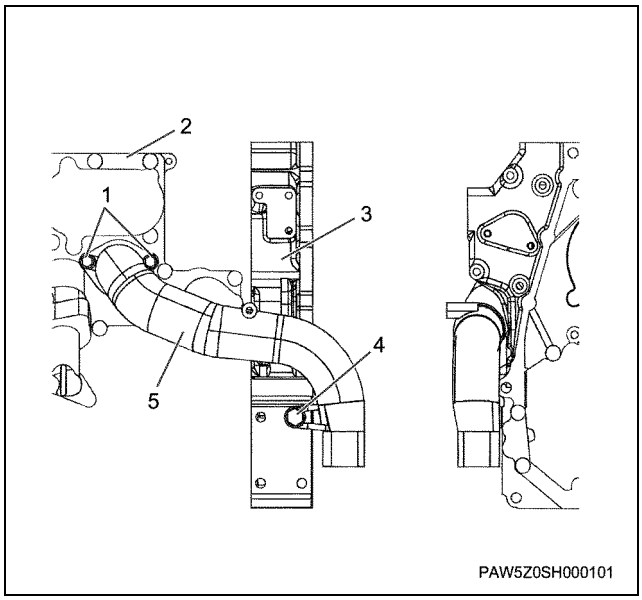
9. Remove the turbocharger.
   - Cover the turbocharger's oil opening after removing the turbocharger. Also cover the compressor and turbine openings with gum tape or something similar.



Legend

1. Exhaust bracket
2. Exhaust manifold
3. Turbocharger
4. Gasket

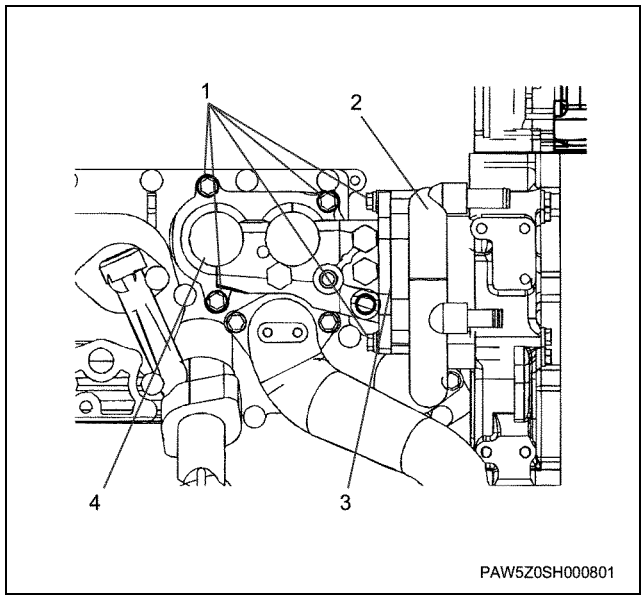
10. Remove the water intake pipe.



Legend

1. Bolt
2. Oil cooler
3. Gear case
4. Bolt
5. Water intake pipe

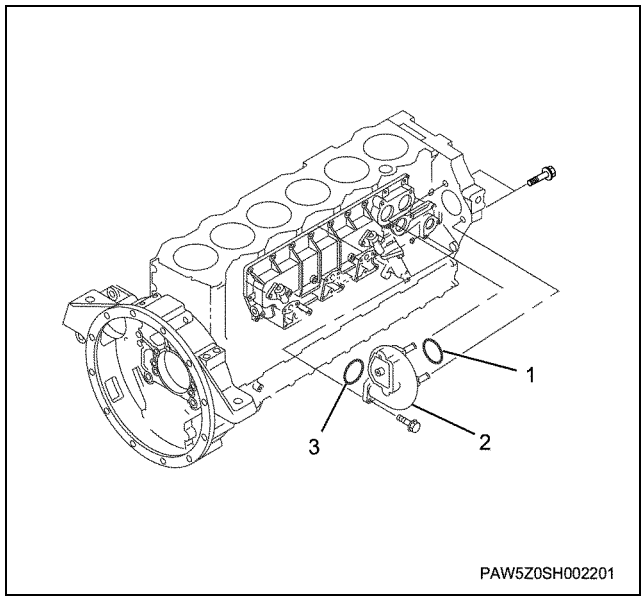
11. Remove the thermostat housing.



Legend

1. Bolt
2. Water pump
3. Gasket
4. Thermostat housing

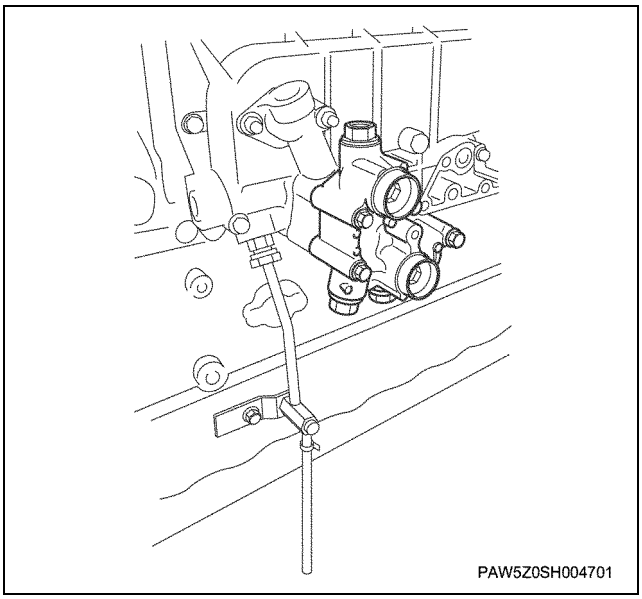
12. Remove the water pump.



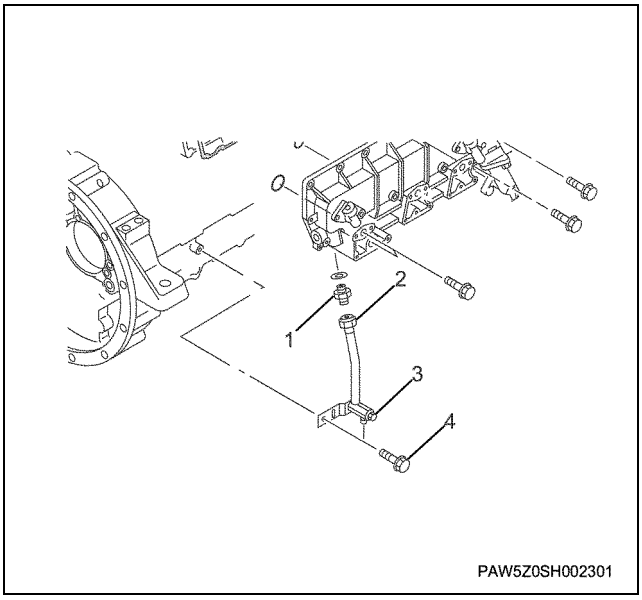
Legend

1. O-ring
2. Water pump
3. O-ring

13. Remove the oil port.



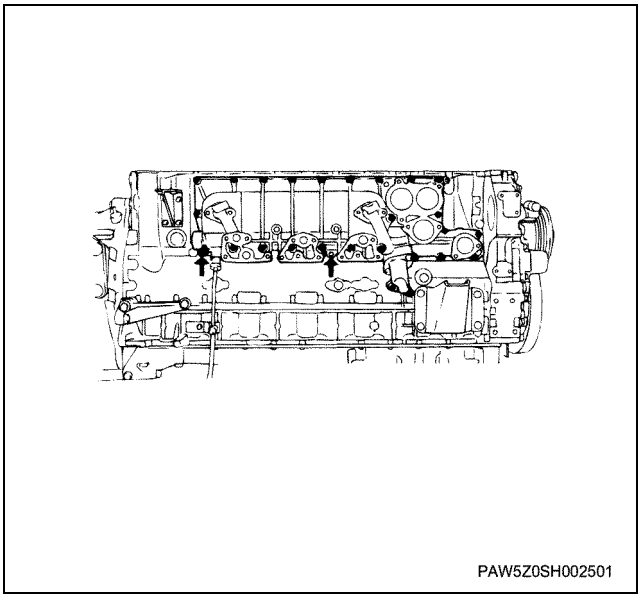
14. Remove the water drain pipe and connector for the drain pipe.



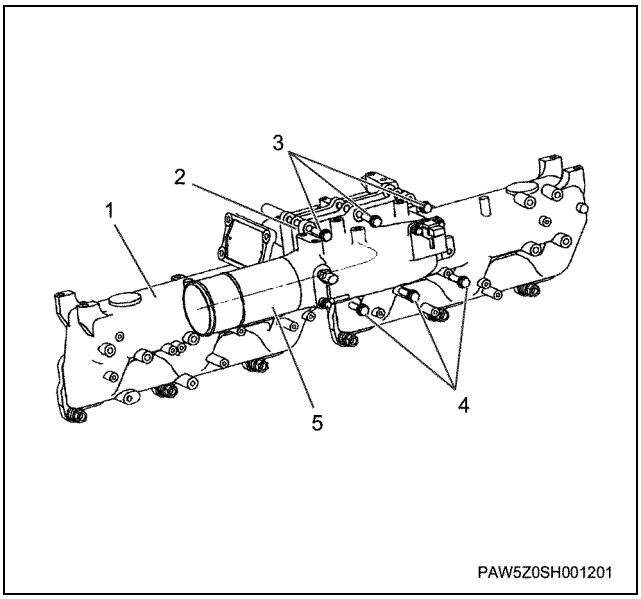
Legend

1. Connector
2. Water drain pipe
3. Drain cock
4. Bolt

15. Remove the oil cooler.
    - Remove the oil cooler locking bolt, insert and tighten the removed bolts into the replacer holes (2 places) and remove the oil cooler.



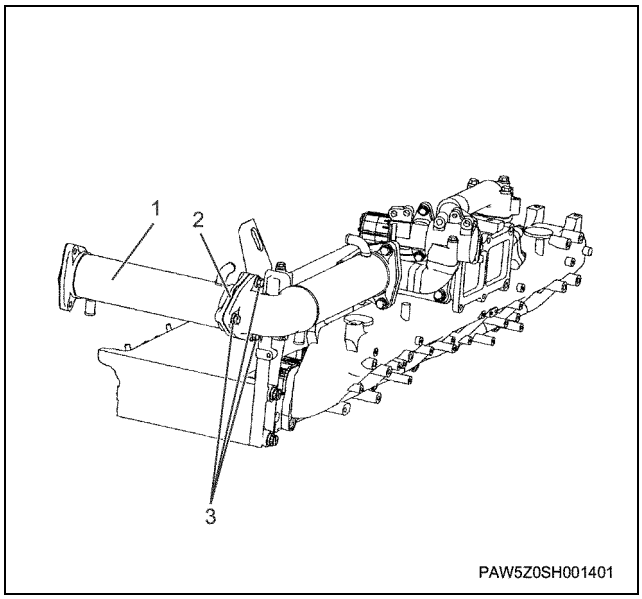
16. Remove the level gauge and guide tube.
17. Remove the intake pipe.



Legend

1. Intake manifold
2. Gasket
3. Bolt
4. Bolt
5. Intake pipe

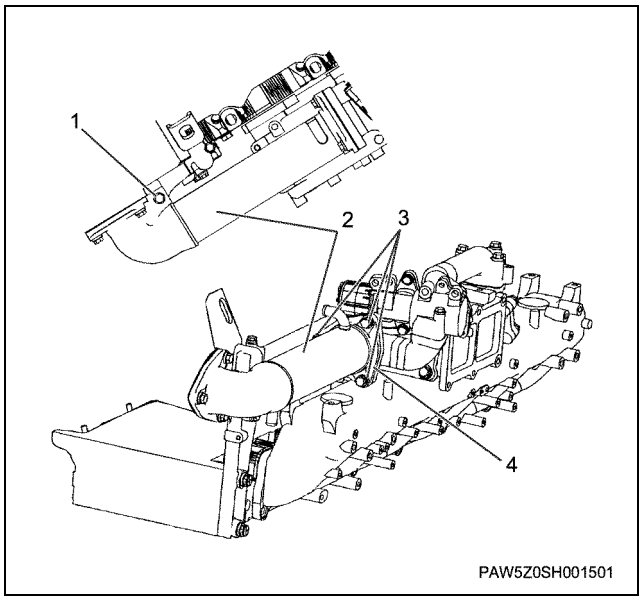
18. Remove the primary EGR cooler.



Legend

1. Primary EGR cooler
2. Gasket
3. Bolt

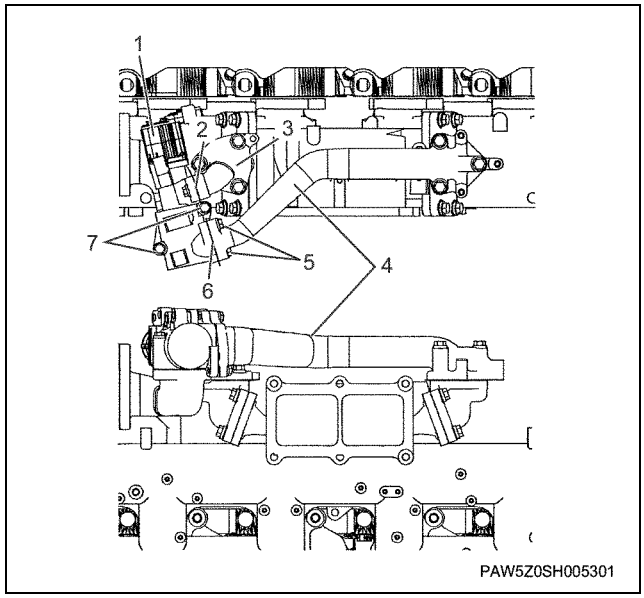
19. Remove the secondary EGR cooler.
    - Remove the primary side (entrance side) fixing bolts.



Legend

1. Bolt
2. Secondary EGR cooler
3. Bolt
4. Gasket

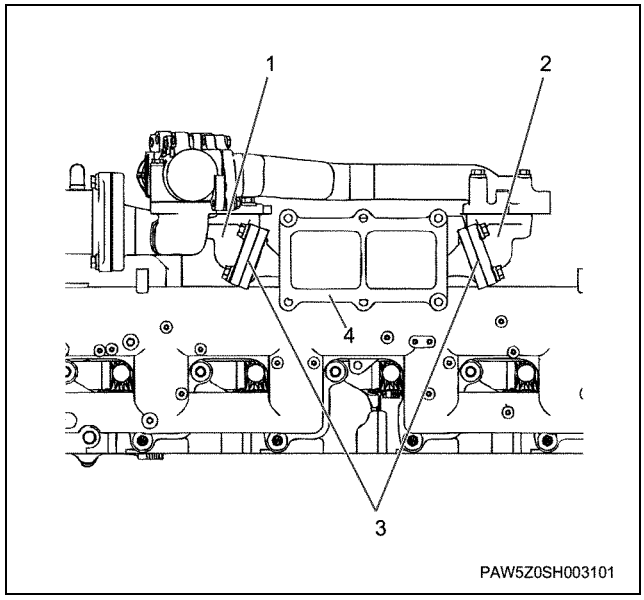
20. Remove the EGR valve.
21. Remove the EGR duct.



Legend

1. EGR valve
2. Gasket
3. EGR duct
4. EGR duct
5. Bolt, washer
6. Gasket
7. Bolt

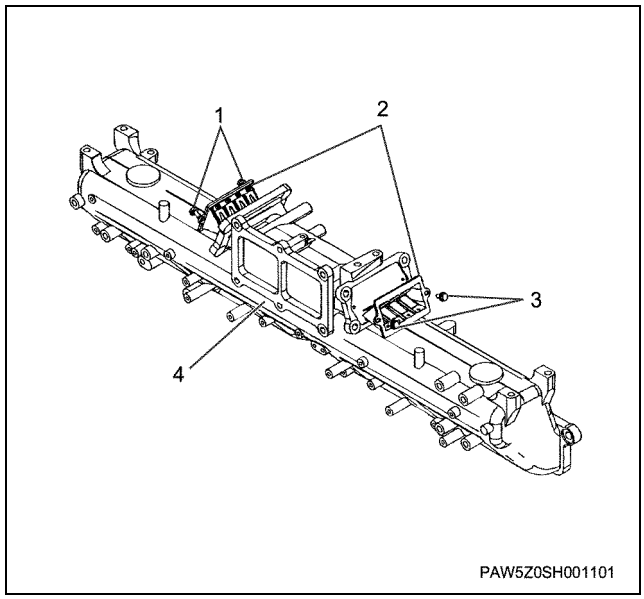
22. Remove the left and right lead valve ducts.



Legend

1. Lead valve duct
2. Lead valve duct
3. Gasket
4. Intake manifold

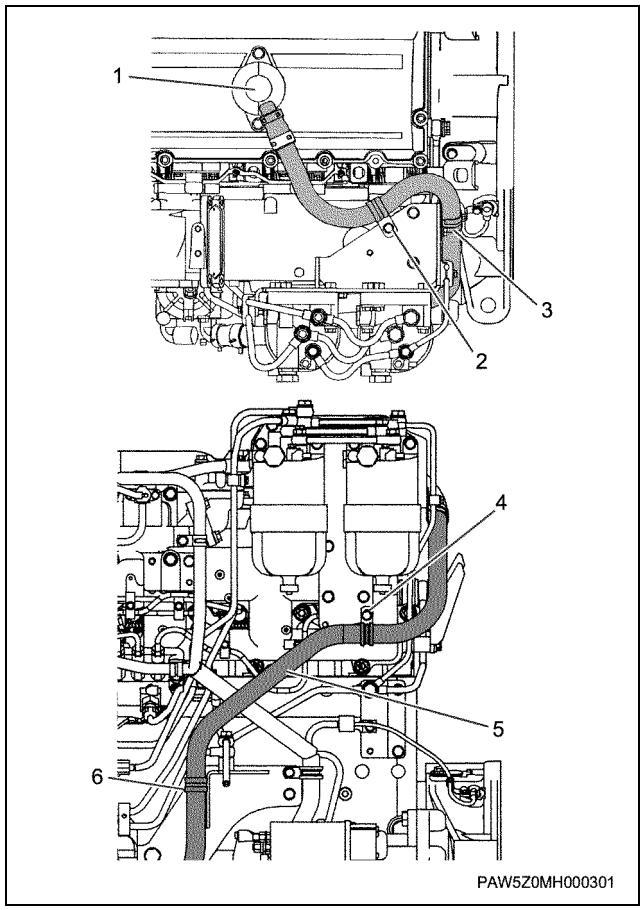
23. Remove the lead valve.



Legend

1. Bolt
2. Lead valve
3. Bolt
4. Intake manifold

24. Release the clips in each position and remove the air breather hose.

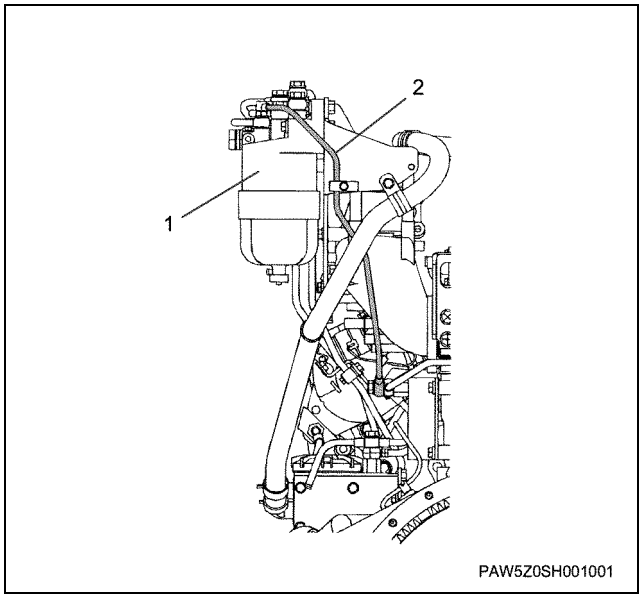


Legend

1. Air breather
2. Clip
3. Clip
4. Clip
5. Hose

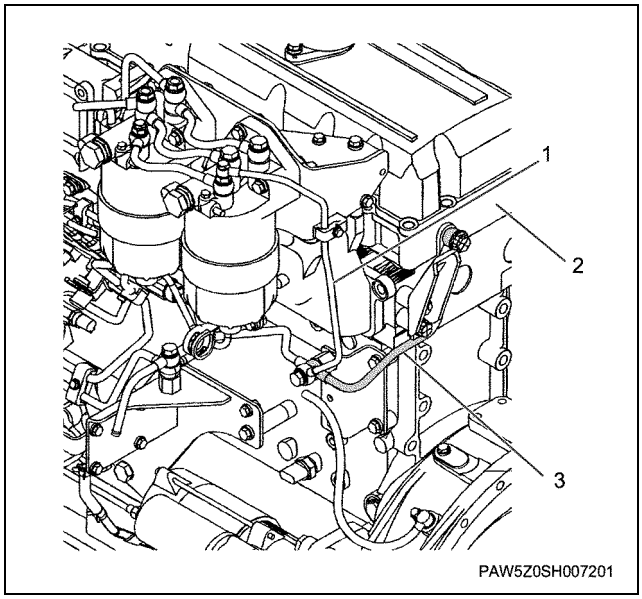
25. Release the clips and remove the fuel return pipe (filter).

Important:
Seal the installation sections of the removed pipe to prevent it from becoming dirty.



Legend
1. Fuel filter
2. Fuel return pipe

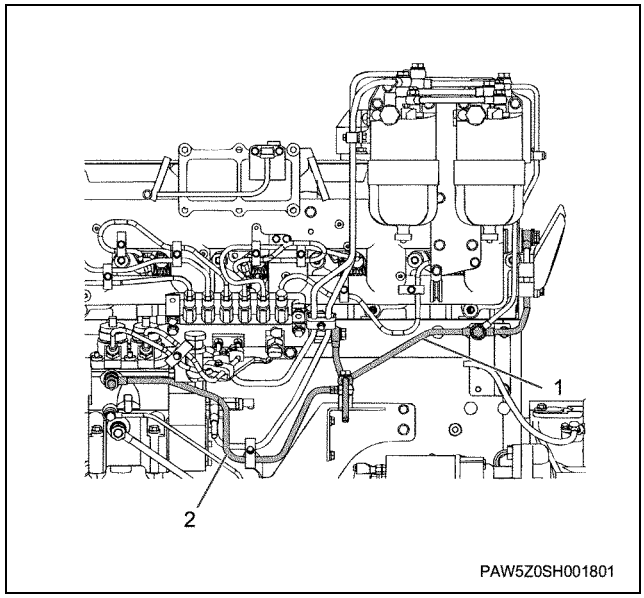
26. Remove the nozzle leak off pipe.



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

27. Remove the fuel return pipe.
    - Some fuel may spill, so hold the pipe with a rag when removing it.

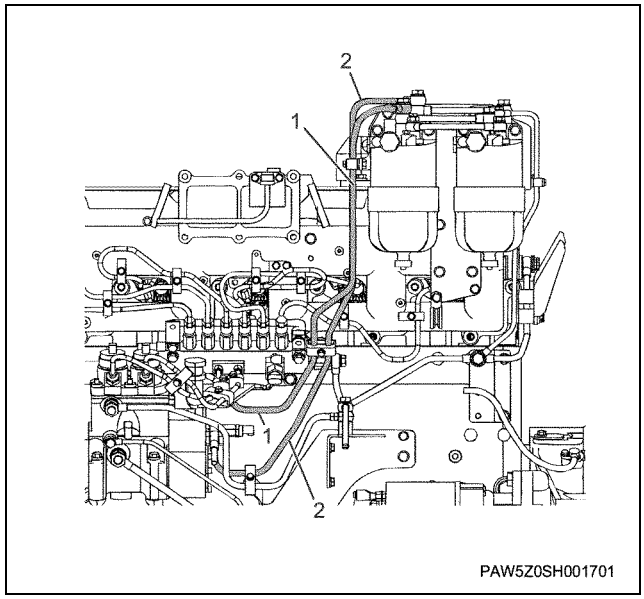
Important:
Seal the installation sections of the removed pipe to prevent it from becoming dirty.



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

28. Remove the fuel pipe (feed pump ~ fuel filter).
29. Remove the fuel pipe (fuel filter ~ supply pump).

Important:
Seal the installation sections of the removed pipe to prevent it from becoming dirty.

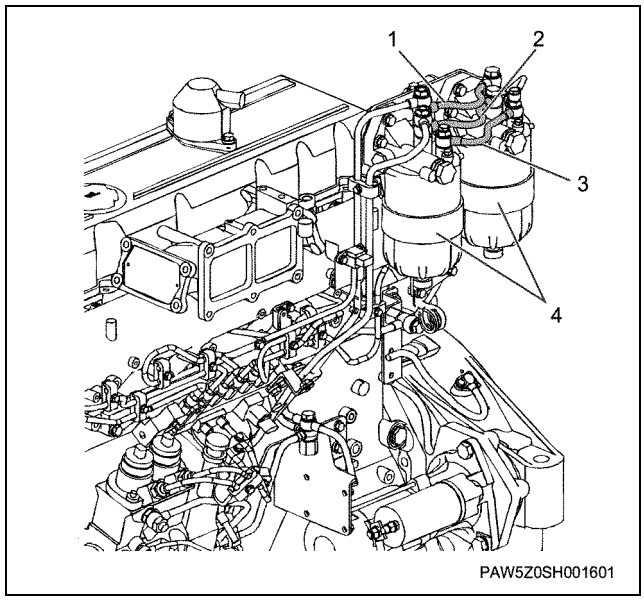


Legend
1. Fuel pipe (fuel filter ~ Supply pump)
2. Fuel pipe (feed pump~ fuel filter)

30. Remove the fuel pipe (fuel filter ~ fuel filter).

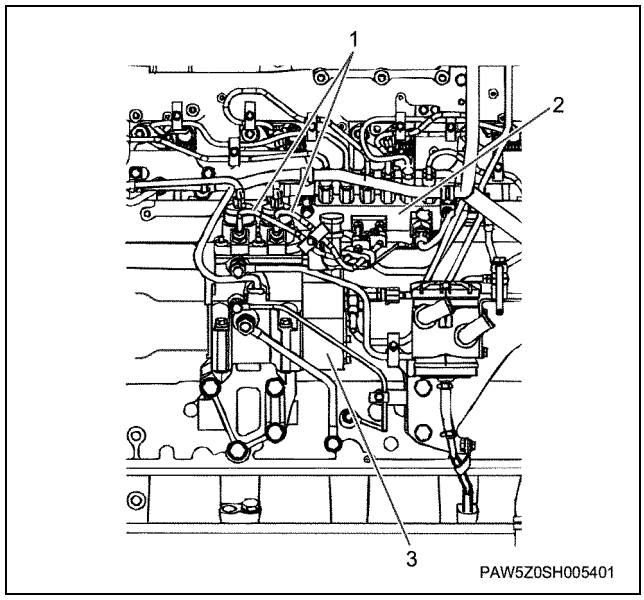
31. Remove the fuel filter from the bracket.

Important:
Seal the installation sections of the removed pipe to prevent it from becoming dirty.



Legend
1. Fuel pipe (IN)
2. Fuel pipe (OUT)
3. Fuel pipe (OVER FLOW)
4. Fuel filter

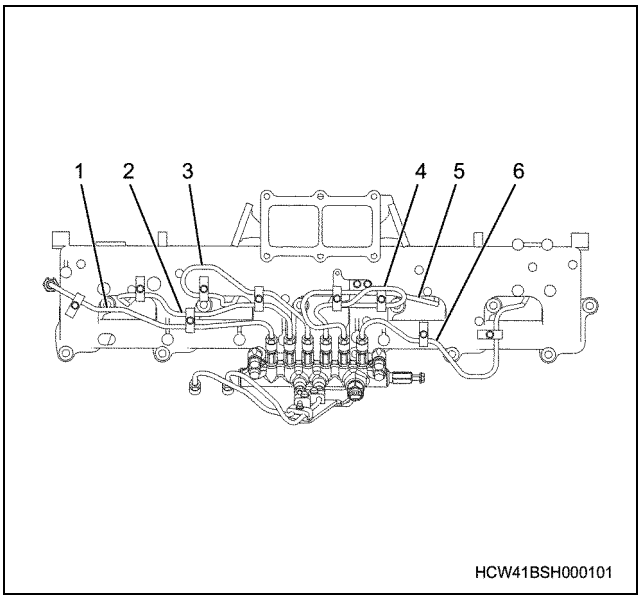
32. Remove the fuel pipe (supply pump ~ common rail).



Legend
1. Fuel pipe (supply pump ~ common rail)
2. Common rail
3. Supply pump

33. Release the injection pipe clips and remove the injection pipe.

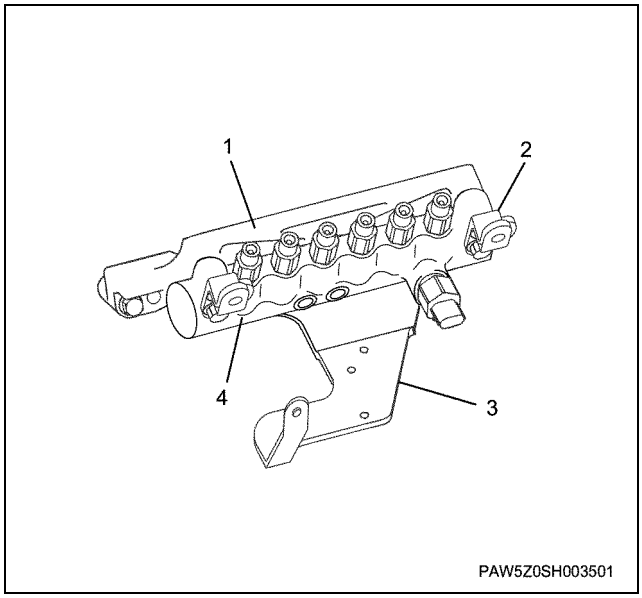
Important:
- **Hang a spanner on the common rail flow dumper (2 side width 19mm) and rotate and stop it, then loosen the injection pipe sleeve nut.**
- **Seal the pipe and pump to prevent dust particles from getting in.**
- **Take care not to damage the shape of the injection pipe when removing it. Furthermore, a small amount of oil may spill from the head section, which should be cleaned with a rag etc.**
- **Check that there are no cracks or damage to the clip rubber.**



Legend
1. Injection pipe No.1
2. Injection pipe No.2
3. Injection pipe No.3
4. Injection pipe No.4
5. Injection pipe No.5
6. Injection pipe No.6

34. Remove the fuel pipe clip BRKT and remove the common rail.

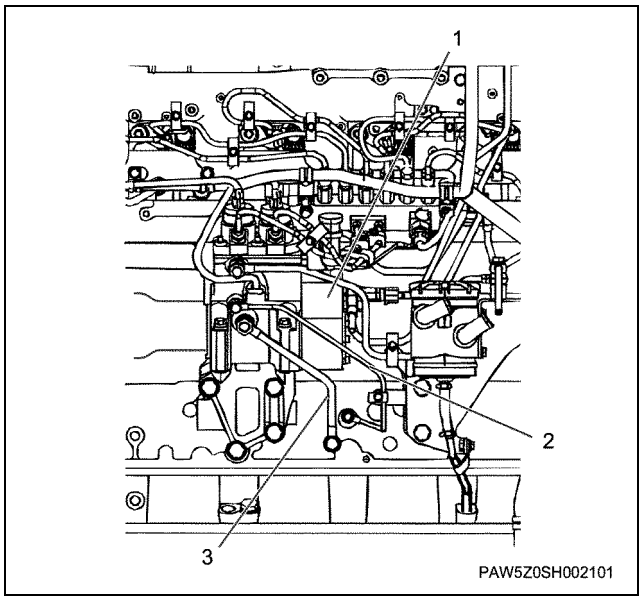
Important:
Seal the common rail installation opening to prevent it from becoming dirty.



Legend

1. Common rail BRKT
2. Fuel pipe BRKT
3. Fuel pipe BRKT
4. Common rail

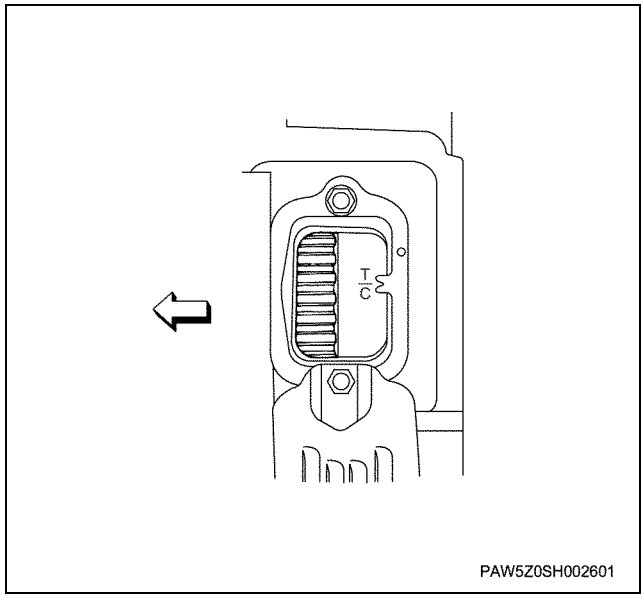
35. Remove the oil pipe for the supply pump.

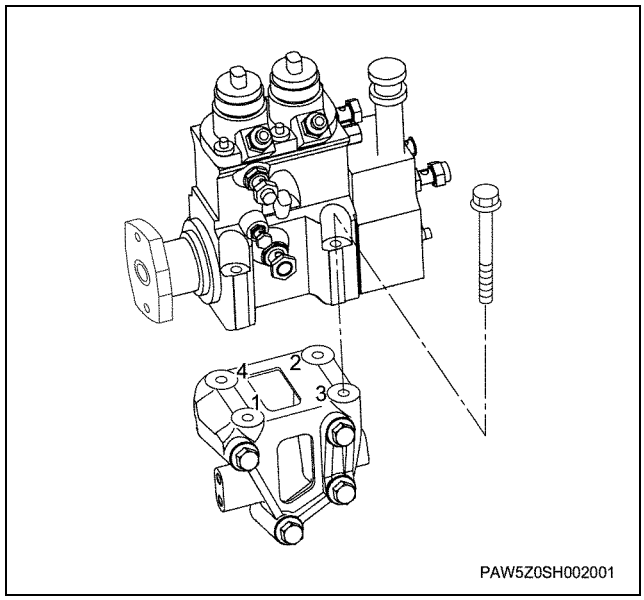


Legend

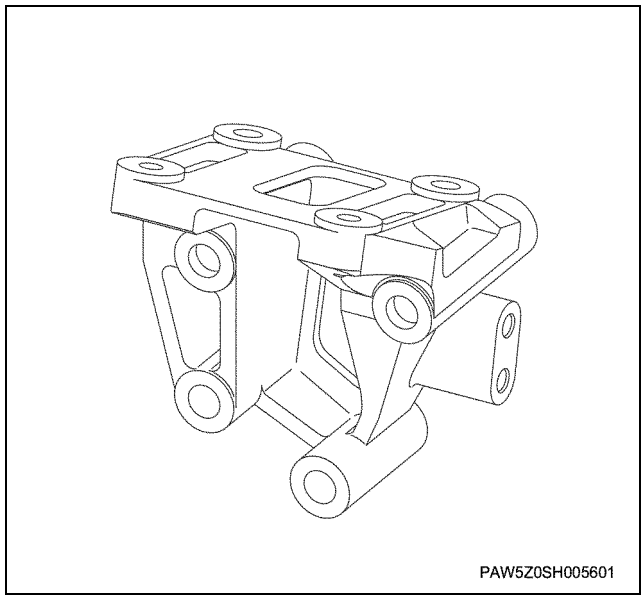
1. Supply pump
2. Oil feed pipe
3. Oil return pipe

36. Rotate the crankshaft and line up the number 1 cylinder compression top dead center, then loosen the coupling locking bolt and remove the supply pump.

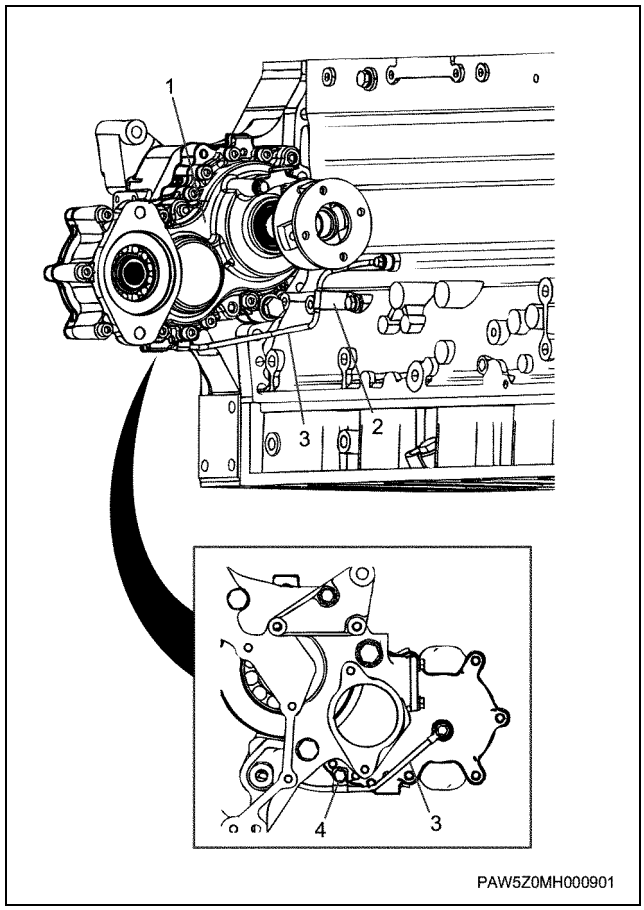




37. Loosen the bolt and remove the supply pump bracket.



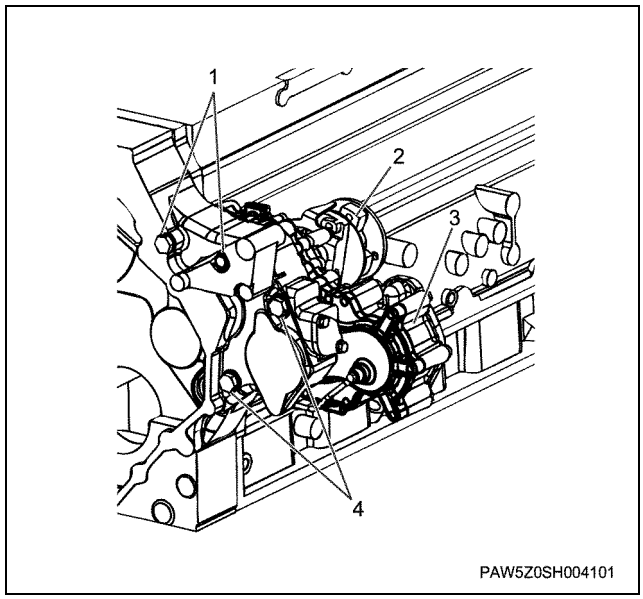
38. Release the clips and remove the oil pipe for the PTO.



Legend

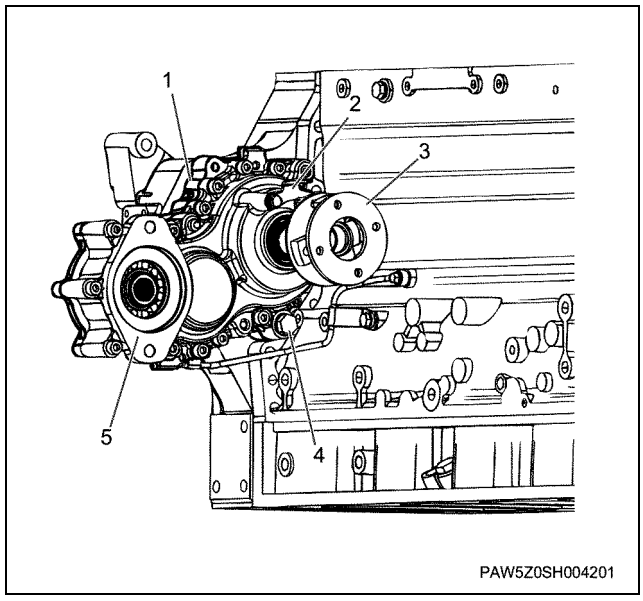
1. PTO gear ASM
2. Clip
3. Oil pipe
4. Clip

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



Legend

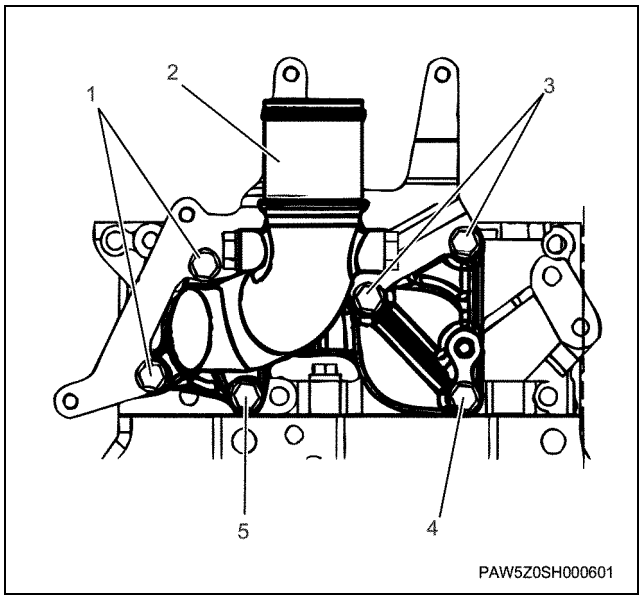
1. Bolt
2. Coupling
3. PTO gear ASM
4. Bolt



Legend

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

40. Remove the water outlet pipe.

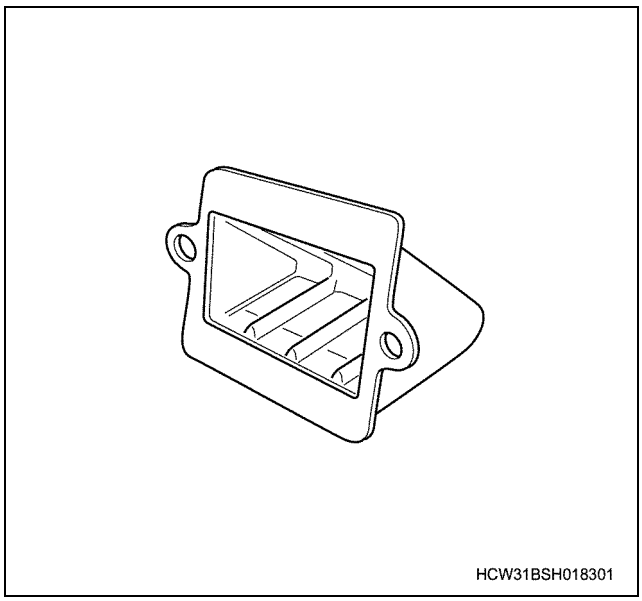


Legend
1. Bolt
2. Water outlet pipe
3. Bolt
4. Bolt
5. Bolt

Inspection

EGR lead valve

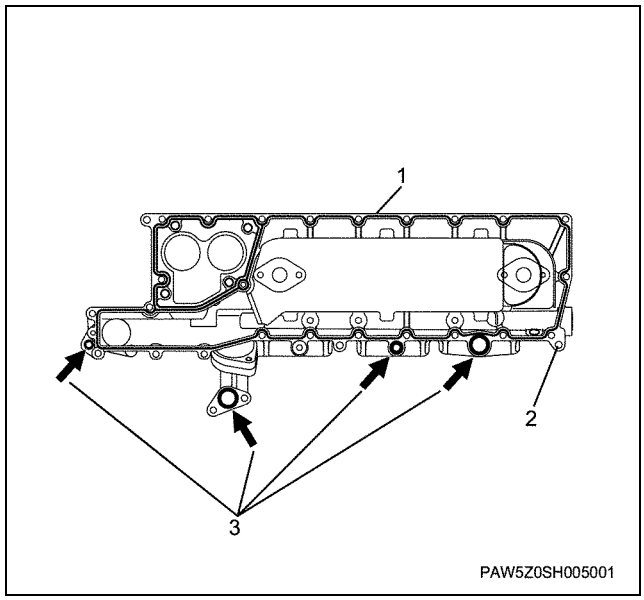
- Check the outer appearance of the valve for damage.
- Inspect between the stopper and valve for carbon accumulation.



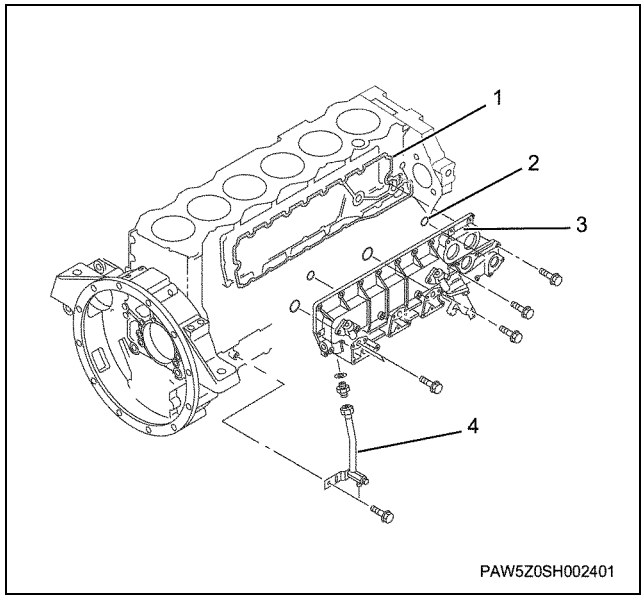
Installation

1. Install the oil cooler.
   - Insert 4 O-rings. (2 each of 2 types)
   - Fix the gasket into the installation flange side groove towards the cylinder block, and install the oil cooler.

tightening torque: 50N·m {5.1kgf·m}



Legend
1. Gasket
2. Oil cooler
3. O-ring

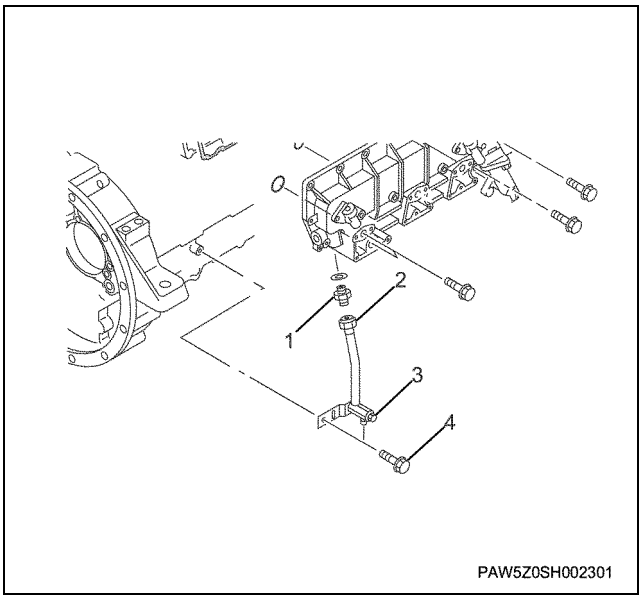


Legend
1. Gasket
2. O-ring
3. Oil cooler
4. Water drain pipe

2. Install the water drain pipe and connector.

- Temporarily install then fully tighten the connector (A), water drain pipe (B) and locking bolt (C) in this order.

		N·m {kg·m}
Tightening torque	A section:	78 {8.0}
	B section:	68 {6.9}
	C section:	43 {4.4}
	D Section:	4 {0.4}

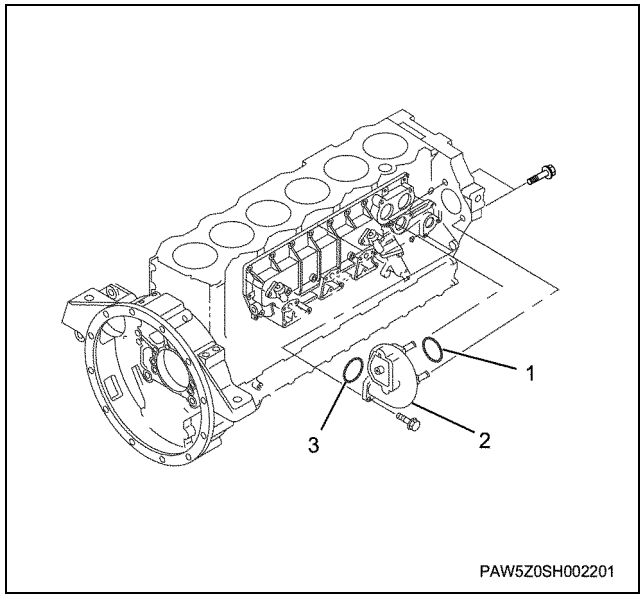


Legend

1. Connector (A section)
2. Water drain pipe (B section)
3. Water drain cock (D section)
4. Bolt (C section)

3. Install the water pump.
   - Insert O-rings (2) into the water pump; hold the water pump against the gear case side while tightening the oil cooler side bolts (2), then tighten the 4 bolts from the gear case side.

Tightening torque: 39 N·m {4.0 kgf·m}

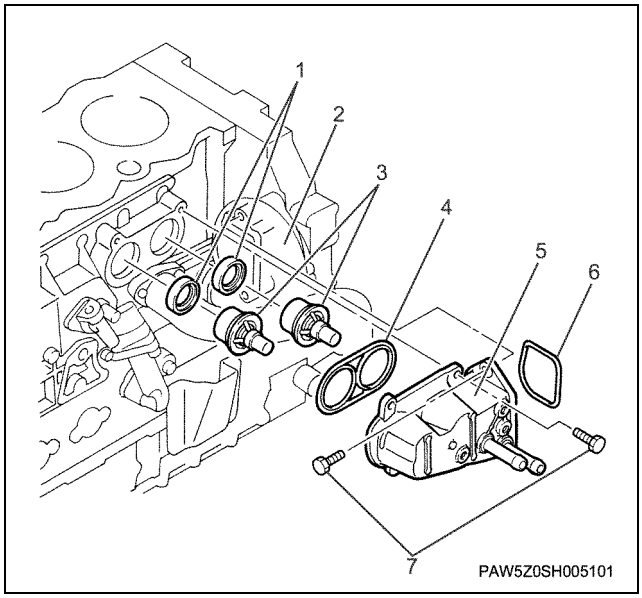


Legend

1. O-ring
2. Water pump
3. O-ring

4. Install the thermostat housing.
   - Install the 2 thermostats to the oil cooler.
   - For details on installing the seal ring and thermostat, please see the section on installing the thermostat.
   - Fit gasket into the thermostat housing, and tighten the 2 water pump side bolts while holding the thermostat housing against the oil cooler side, then tighten the oil cooler side 3 bolts.

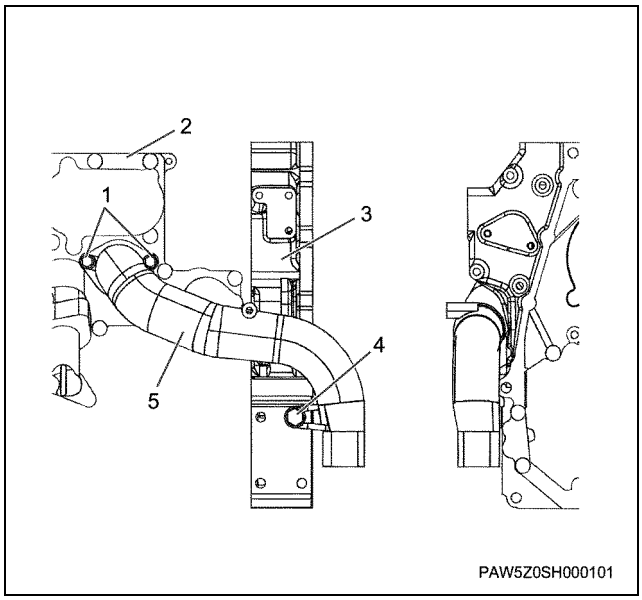
Tightening torque: 39 N·m {4.0 kgf·m}



Legend
1. Seal ring
2. Water pump
3. Thermostat
4. Gasket
5. Thermostat housing
6. O-ring
7. Bolt

5. Install the water intake pipe to the oil cooler.

Tightening torque: Oil cooler side: 39 N·m {4.0 kgf·m}
Gear case side: 88 N·m {9.0 kgf·m}

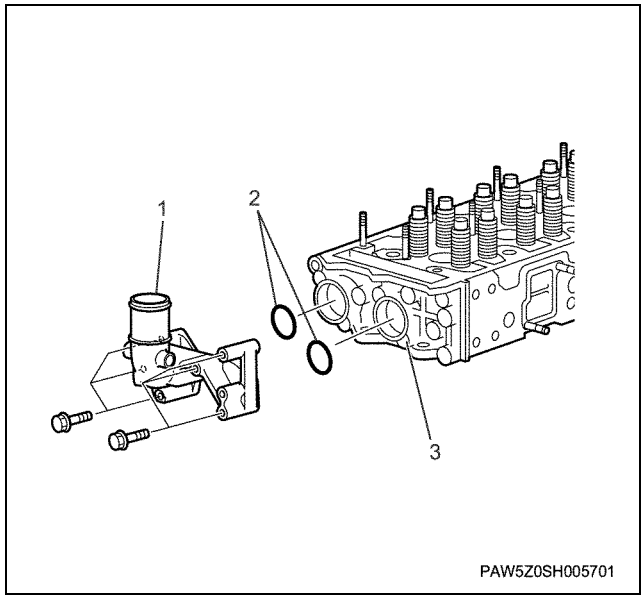


Legend
1. Bolt
2. Oil cooler
3. Gear case
4. Bolt
5. Water intake pipe

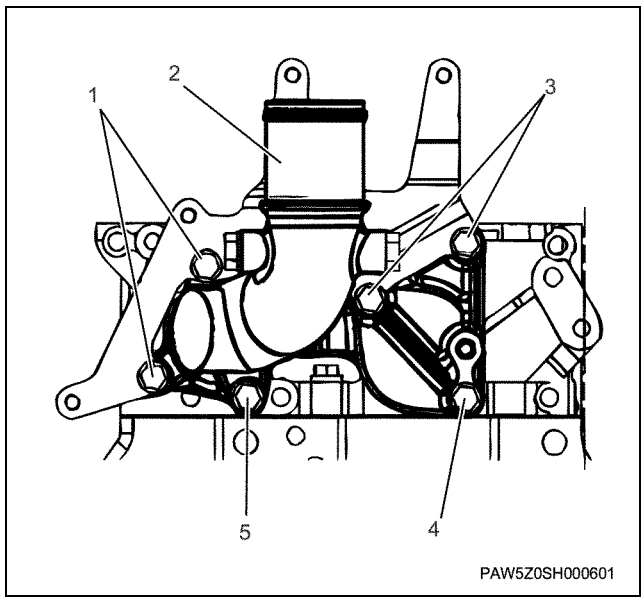
6. Install the water outlet pipe.

- Install O-rings (2) to the head section gear case, and install the water outlet pipe.

Tightening torque: 39 N·m {4.0 kgf·m}



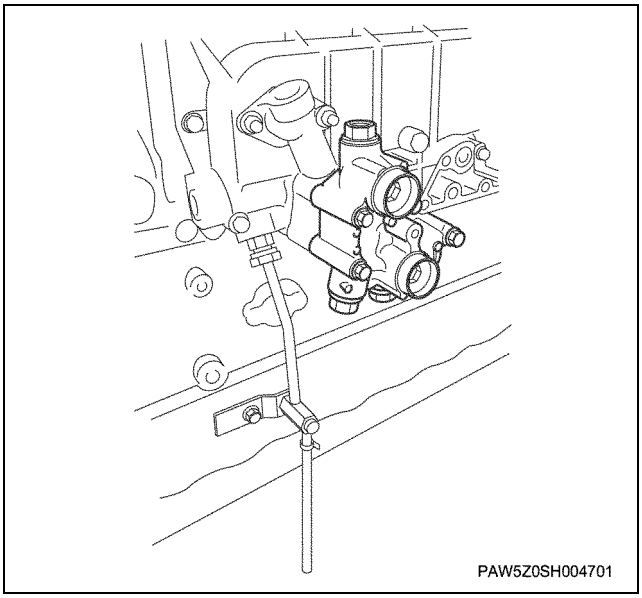
Legend
1. Water outlet pipe
2. O-ring
3. Gear case



Legend
1. Bolt
2. Water outlet pipe
3. Bolt
4. Bolt
5. Bolt

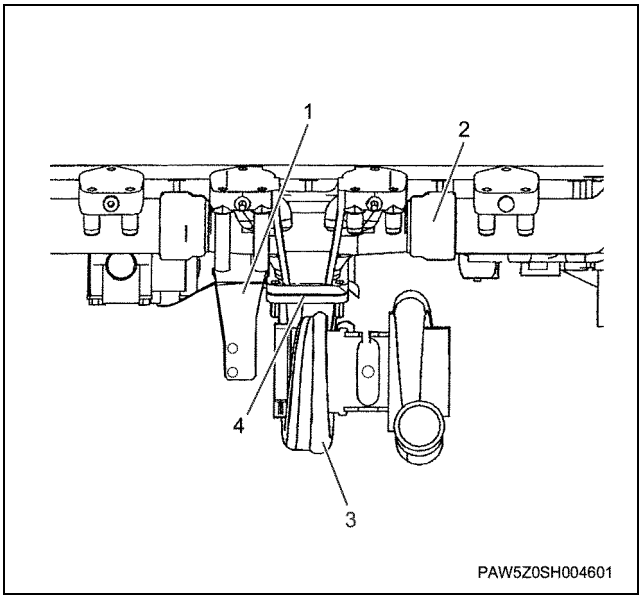
7. Install the oil port to the oil cooler.

Tightening torque: 43 N·m {4.4 kgf·m}



8. Clip the gasket and install the turbocharger to the exhaust manifold.
   - Supply a suitable quantity of engine oil from the turbocharger lubrication opening, gently rotate the turbine axis and lubricate the bearings.
   - Tighten the turbocharger with a double nut.

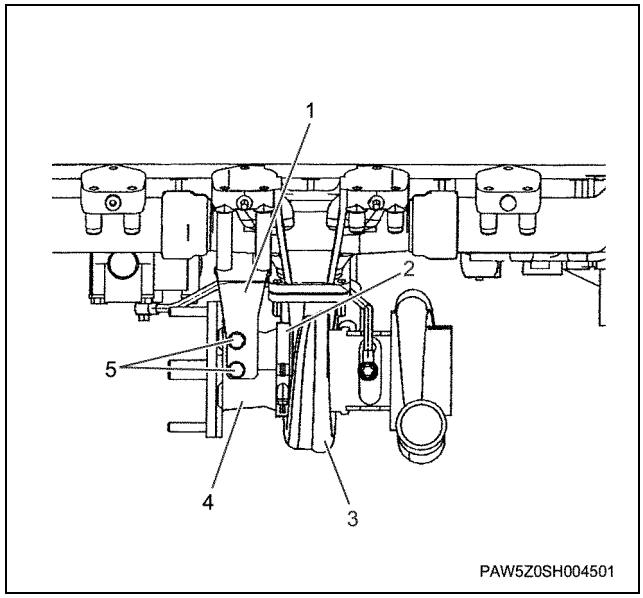
Tightening torque: 40 N·m {4.1 kgf·m}



Legend
1. Exhaust bracket
2. Exhaust manifold
3. Turbocharger
4. Gasket

9. Install the exhaust pipe.
   - Bolt the exhaust pipe to the turbocharger with clamps, and fix to the bracket with bolts.

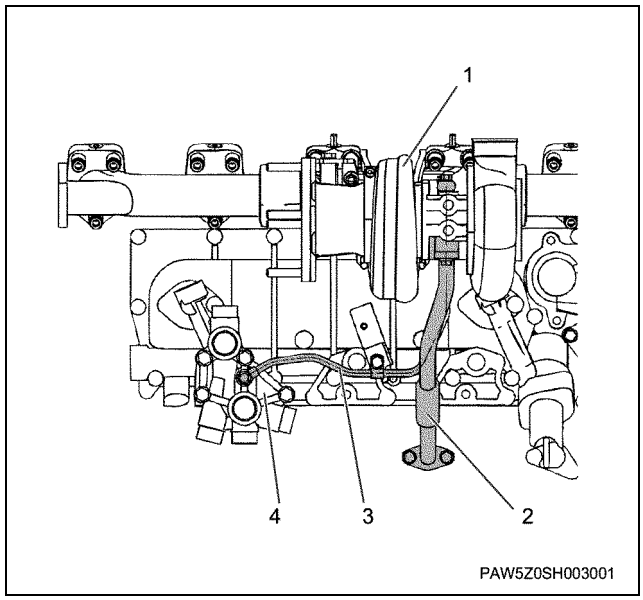
Clamp tightening torque: 14.7 N·m {1.5 kgf·m}



Legend
1. Exhaust pipe bracket
2. Clamp
3. Turbocharger
4. Exhaust pipe
5. Bolt

10. Install the oil feed pipe (turbocharger) and fix with clips.

Eyebolt tightening torque: 34 N·m {3.5 kgf·m}

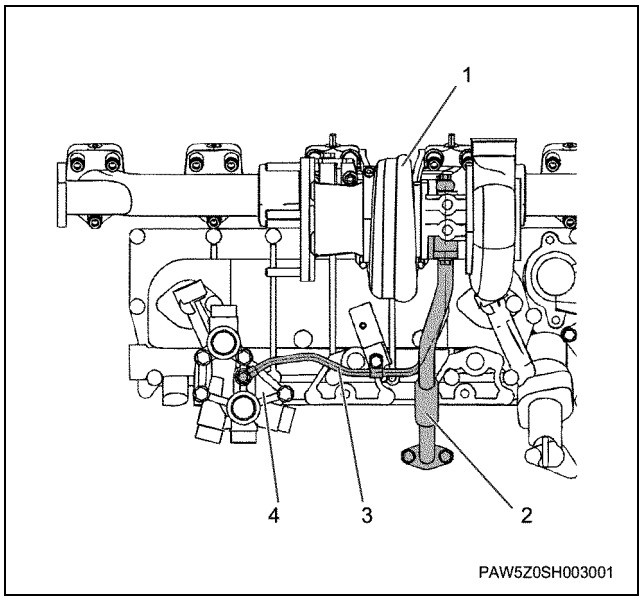


Legend
1. Turbocharger
2. Oil return pipe (turbocharger)
3. Oil feed pipe (turbocharger)
4. Oil port

11. Install the oil return pipe (turbocharger).

- Apply a small amount of liquid gasket to the two O-ring slots on the oil pipe, then install the O-rings.

Tightening torque: 50 N·m {5.1 kgf·m}

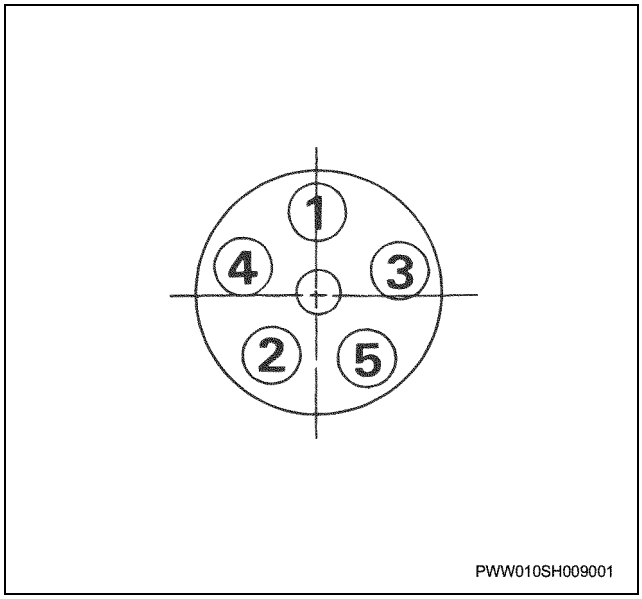


Legend

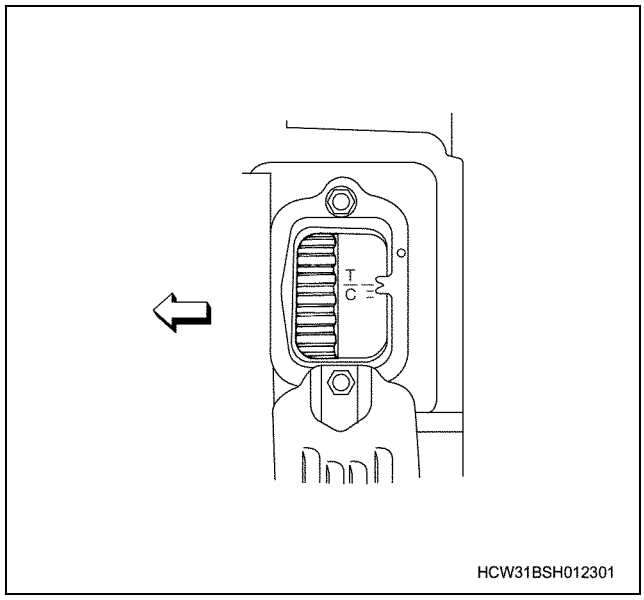
1. Turbocharger
2. Oil return pipe (turbocharger)
3. Oil feed pipe (turbocharger)
4. Oil port

12. Install the PTO gear ASM.
    - Install the PTO gear ASM shaft to the gears beforehand.
      Apply molybdenum disulphide to the bolt screw section and bearing surface, and tighten to the correct tightening torque in the order shown in the diagram.

Tightening torque: 39 N·m {4.0 kgf·m} → angle method 90° ~ 120°

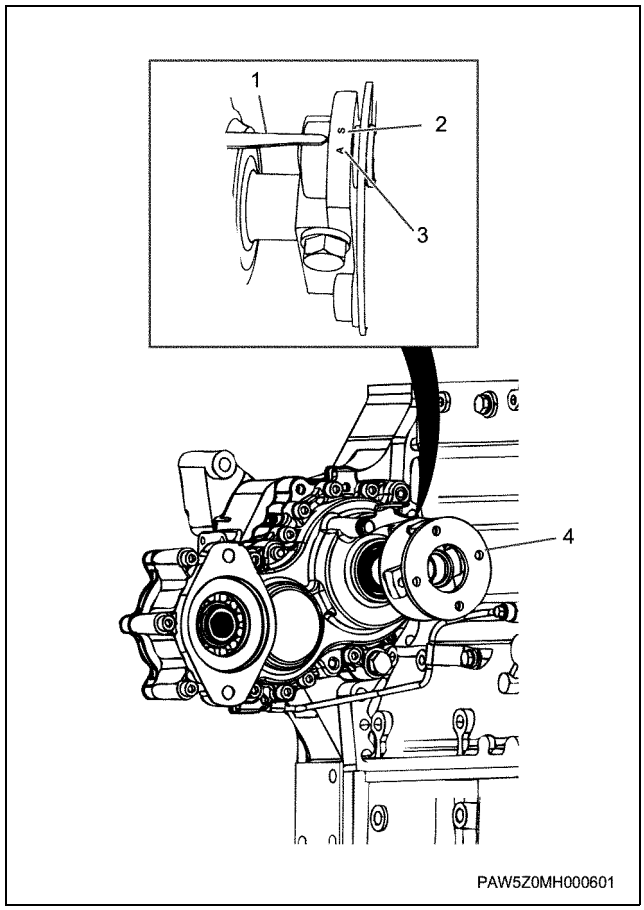


- Rotate the crankshaft forwards and line up the flywheel carved line with the dynamic pointer so that the number 1 cylinder reaches the compression top dead center. At this time check that the number 1 cylinder intake and exhaust gas valve has clearance.



- Install the pointer to the PTO gear ASM side.
- Insert an O-ring into the gear case installation section.
- Line up the PTO gear ASM axel key, install the coupling, line up the pointer and coupling side marking [A] and fit the gears. After fitting the gears, move so that the coupling [S] mark position and pointer tip line up.

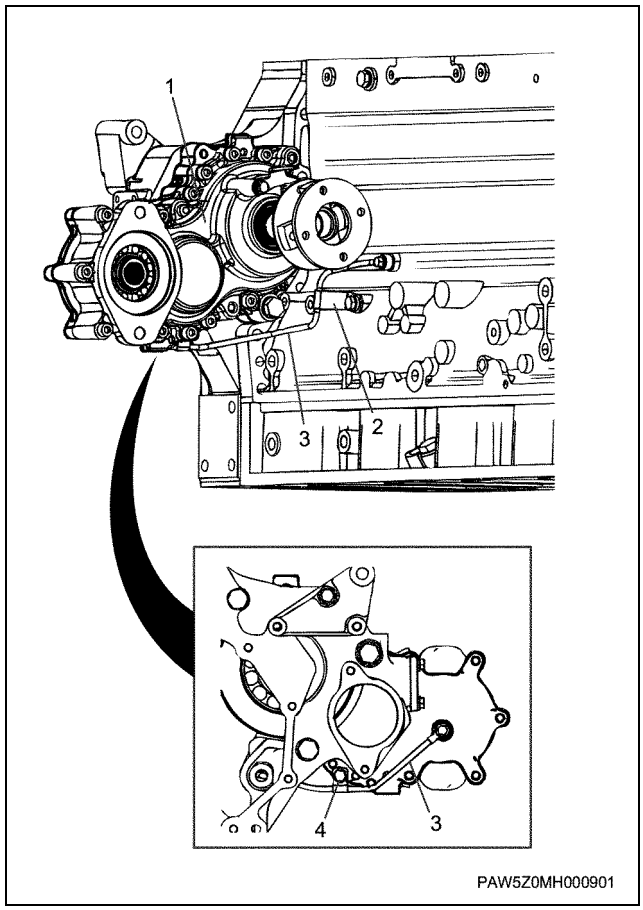
- Rotate the PTO shaft a very small amount, and after the gears engage, completely press the gear case in until it adheres. At this time, check that the pointer and coupling mark [S] are lined up. If they are out of line, the gears have shifted so the process needs to be re-done.



Legend

1. Pointer
2. S mark (marking)
3. A mark (marking)
4. Coupling

13. Install the oil pipe for the PTO and fix it with clips.

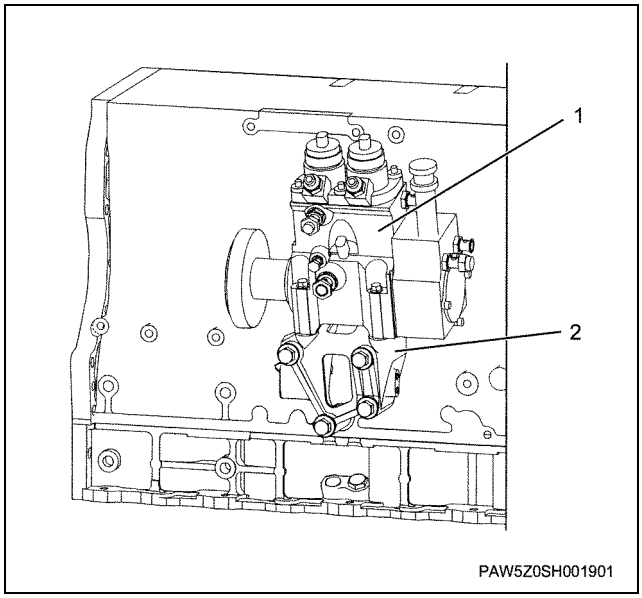


Legend

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

14. Line up and install the supply pump bracket with the dowel hole.

Bracket tightening torque: 108 N·m {11.0 kgf·m}

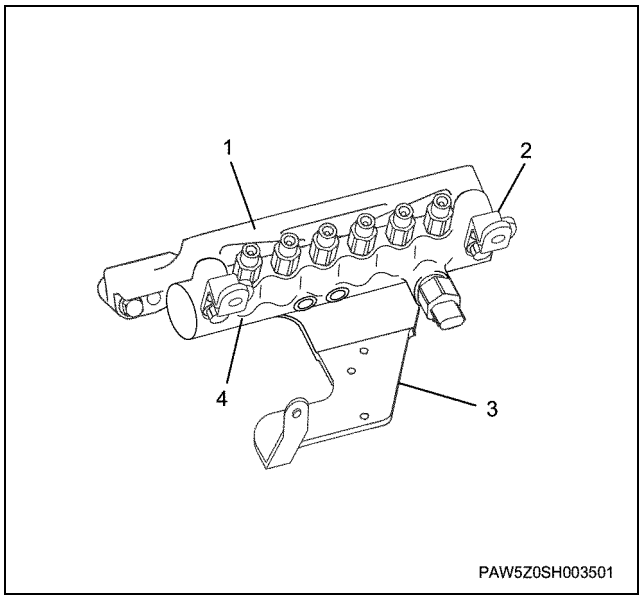


Legend
1. Supply pump
2. Bracket

15. Install the common rail.
    - Install the common rail installation bracket to the cylinder block.
    - Install the common rail to the bracket. Tighten the fuel pump bracket at the same time.

Tightening torque: 22 N·m {2.2 kgf·m}

Notes:
Tighten the bracket after installing the pipe clip.

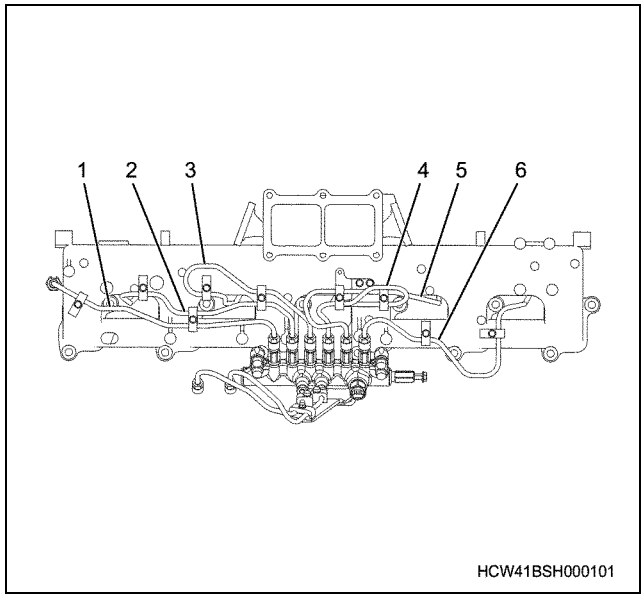


Legend
1. Bracket
2. Fuel pipe bracket
3. Fuel pipe bracket
4. Common rail

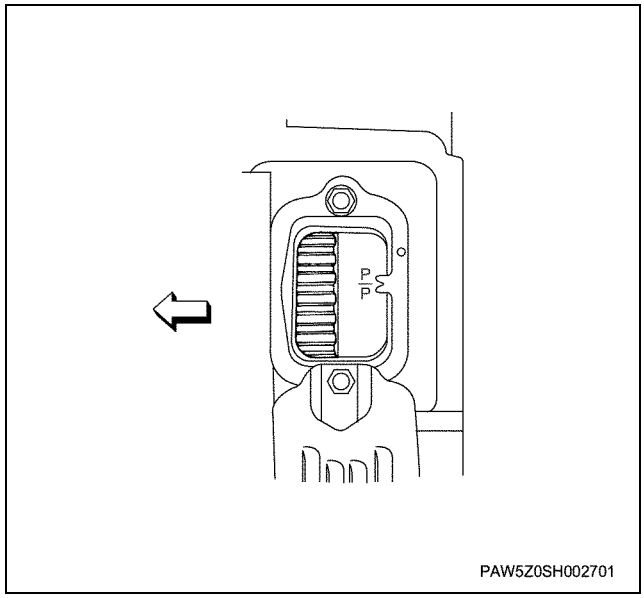
16. Install the injection pipes (1) ~ (6).
    - Clip the injection pipe in the positions shown in the installation diagram.
    - When installing the injection pipes, install No3 and No4 first.

Injection pipe tightening torque

Sleeve nut: 39 N·m {4.0 kgf·m}

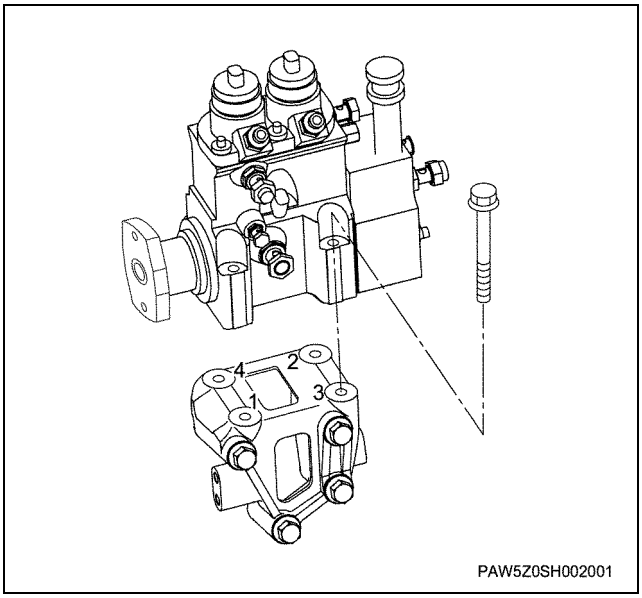


17. Install the supply pump.
    - Reverse the crank shaft one time to the before top dead center 90° position, next rotate it forwards and line up the flywheel carved line P-P mark and timing pointer line up. At this time, check that the number one cylinder is near the compression top dead center.



    - Line up the supply pump mark.
    - Install the supply pump bracket to the supply pump, and tighten it diagonally.

Tightening torque: 31 N·m {3.2 kgf·m}

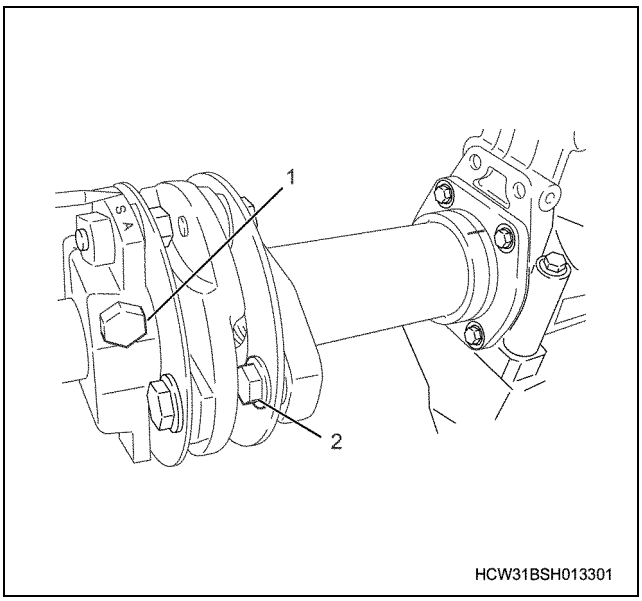


- Slide the coupling, check that it has joined to the supply pump, and tighten the coupling bolts (2).

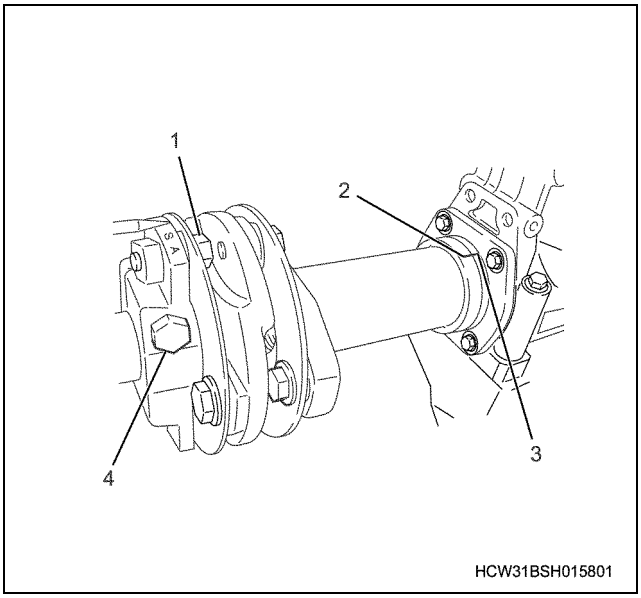
Tightening torque: 62 N·m {6.3 kgf·m}

- Check that there are no bends in the coupling lamination, and tighten the Cotter bolt (1).

Tightening torque: 91 N·m {9.3 kgf·m}



- Check the supply pump line-up mark.
  Reverse the crank shaft one time to the before top dead center 90° position, next rotate it forwards and line up the flywheel carved line P-P mark and timing pointer line up. At this time, check that the supply pump body carved line and coupling side carved line coincide.
  If the carved lines do not coincide, loosen the 2 long hole coupling bolts.
  Rotate the coupling and line up the carved lines of the supply pump body and coupling side, then tighten the coupling.



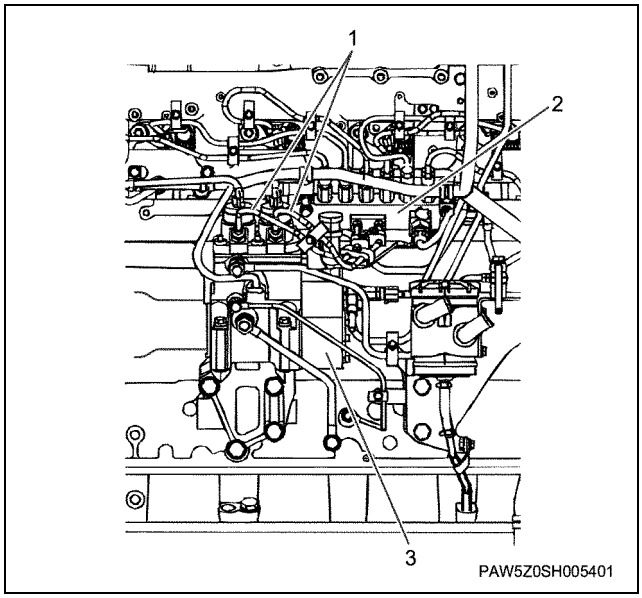
Legend

1. Coupling bolt
2. Coupling side carved line
3. Pump side carved line
4. Cotter bolt

18. Install the fuel pipe (supply pump ~ common rail).
    - Fuel pump installation order
      - Temporarily tighten both sides of the pump.
      - Fully tighten the common rail side.
      - Fully tighten the supply pump side.

Tightening torque

Common rail side:	54 N·m {5.5 kgf·m}
Supply pump side:	44 N·m {4.5 kgf·m}



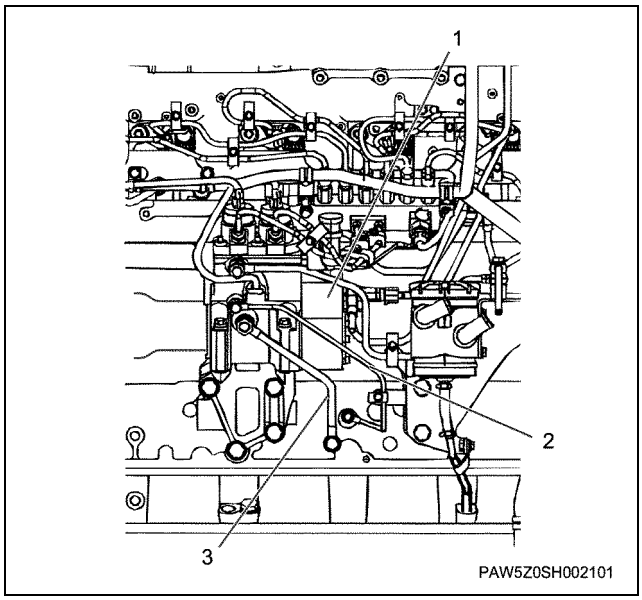
Legend

1. Fuel pipe (supply pump ~ common rail)
2. Common rail
3. Supply pump

19. Install the oil feed pipe and oil return pipe to the supply pump.

Eyebolt tightening torque

M10:	10 N·m {1.0 kgf·m}
M14:	27 N·m {2.8 kgf·m}



Legend

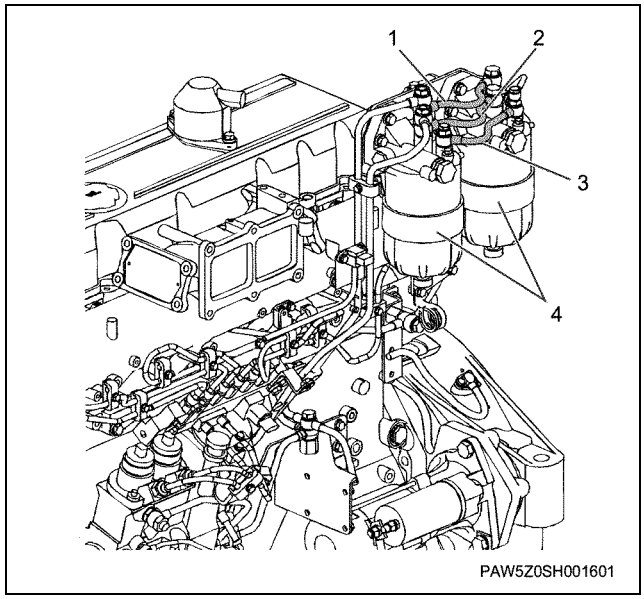
1. Oil feed pipe
2. Oil return pipe
3. Supply pump

20. Install each fuel pipe by using procedures 21 ~ 27.
    - Fix each of the fuel pipe installation positions with clips.

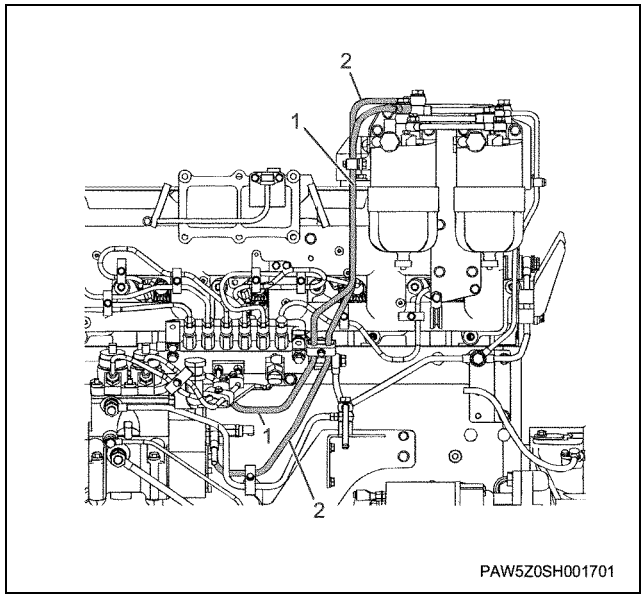
Eyebolt tightening torque

	N·m {kg·m}
M8:	15 {1.5}
M10:	28 {2.9}
M12:	35 {3.6}
M14:	41 {4.2}

21. Install the fuel pipe (fuel filter ~ fuel filter) to the fuel filter.
22. Install the fuel filter to the bracket.



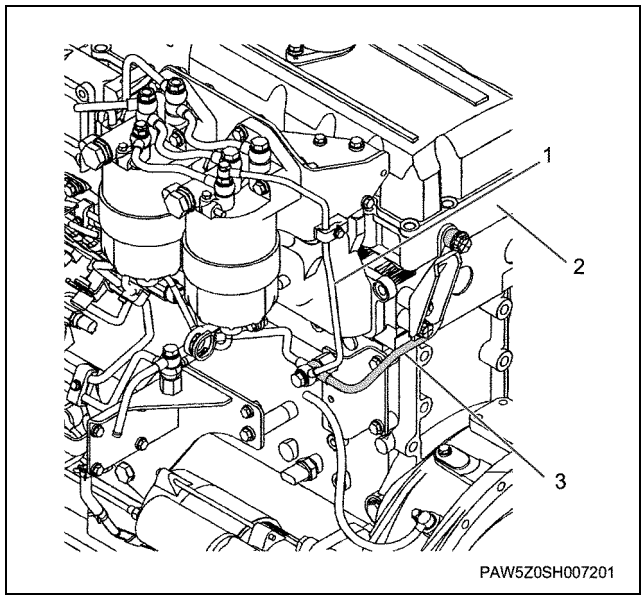
23. Install the fuel pipe (feed pump ~ fuel filter).
24. Install the fuel pipe (fuel filter ~ supply pump).
    - Fix the fuel pipe with clips.



Legend

1. Fuel pipe (fuel filter ~ Supply pump)
2. Fuel pipe (feed pump~ fuel filter)

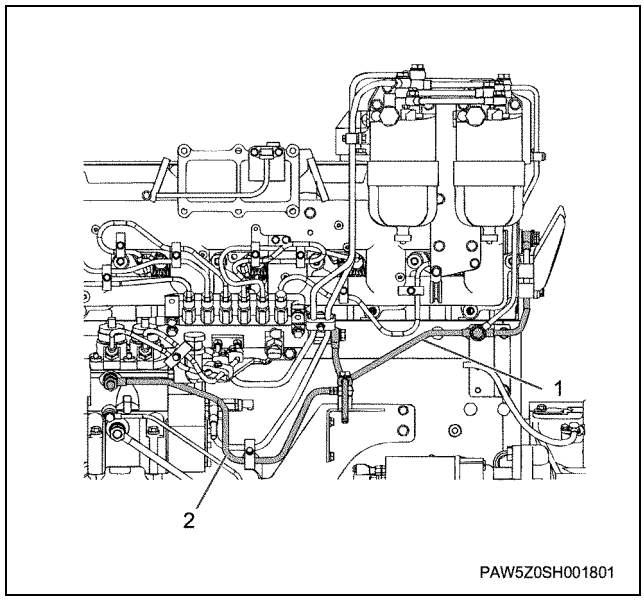
25. Install the nozzle leak off pipe.



Legend

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

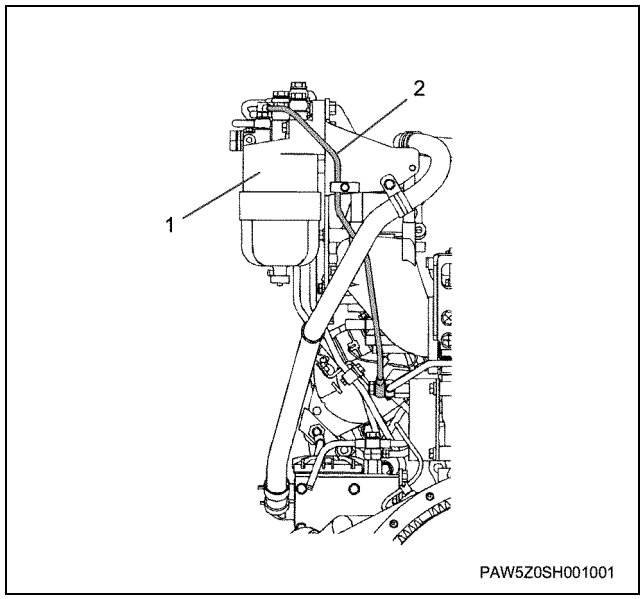
26. Install the fuel return pipe.



Legend

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

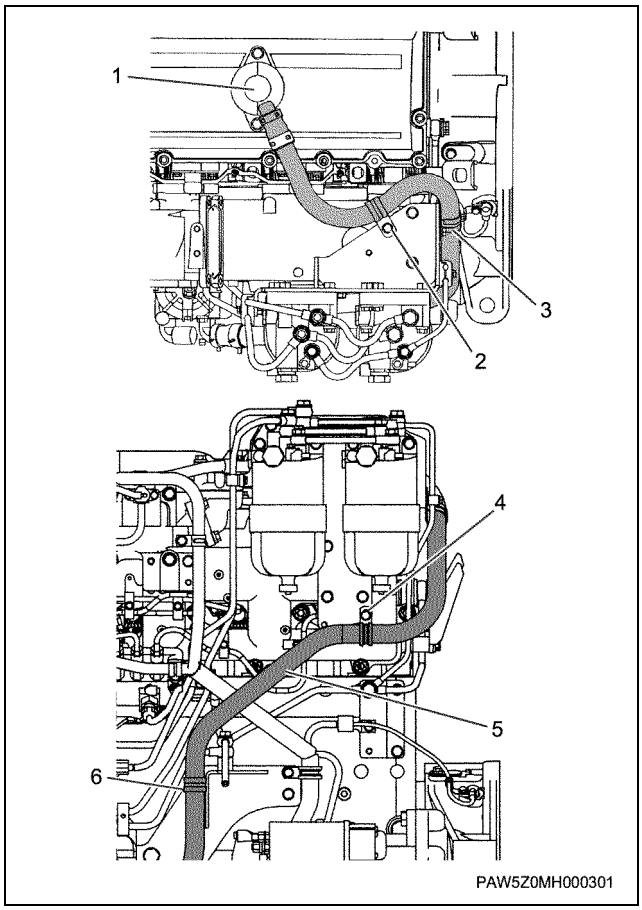
27. Install the fuel return pipe (for the filter).



Legend

1. Fuel filter
2. Fuel return pipe

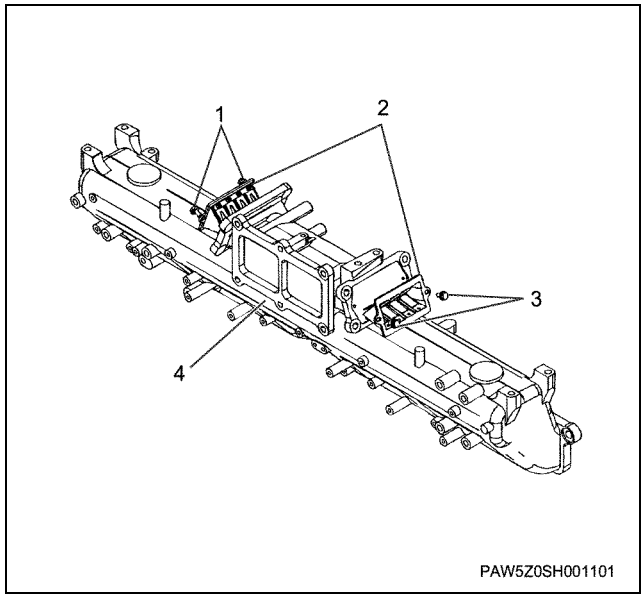
28. Fix the air breather with clips.



Legend
1. Air breather
2. Clip
3. Clip
4. Clip
5. Breather hose
6. Clip

29. Install the lead valve to the intake manifold.

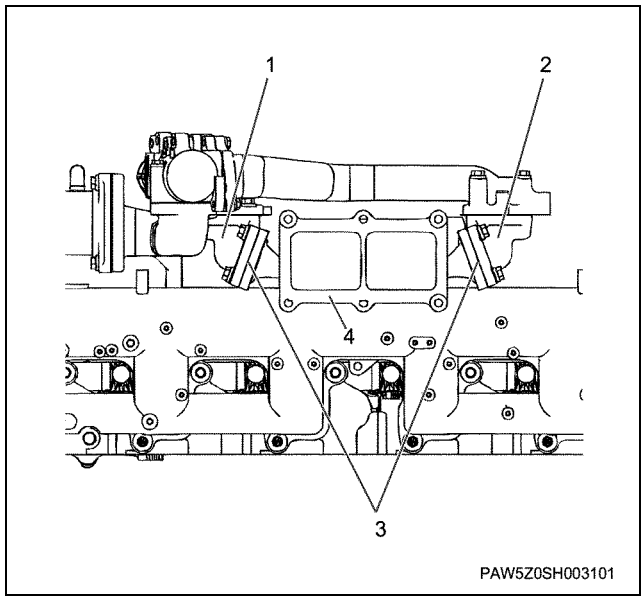
Tightening torque: 10 N·m {1.0 kgf·m}



Legend
1. Bolt
2. Lead valve
3. Bolt
4. Intake manifold

30. Clip the gasket and Install the right and left lead valve ducts.

Tightening torque: 39 N·m {4.0 kgf·m}

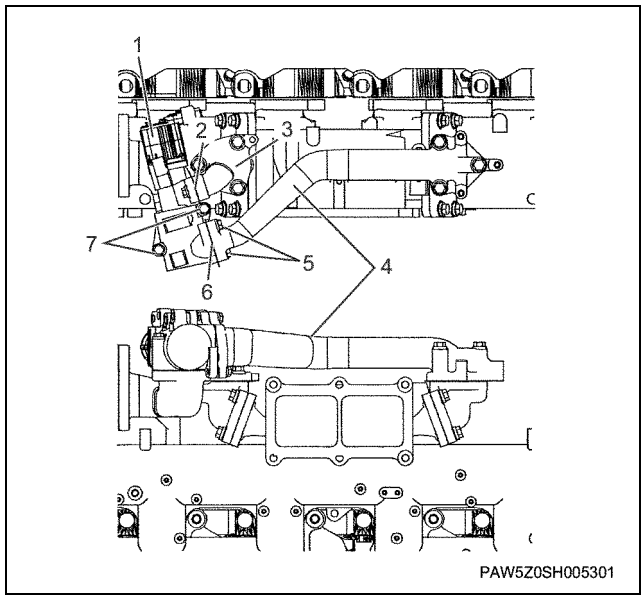


Legend
1. Lead valve duct
2. Lead valve duct
3. Gasket
4. Intake manifold

31. Clip the gasket and Install the EGR duct.

Notes:
Gently tighten the bolts to a position so that each EGR duct and EGR cooler hit face contact, position the seal face has no clearance, then fully tighten the bolts.

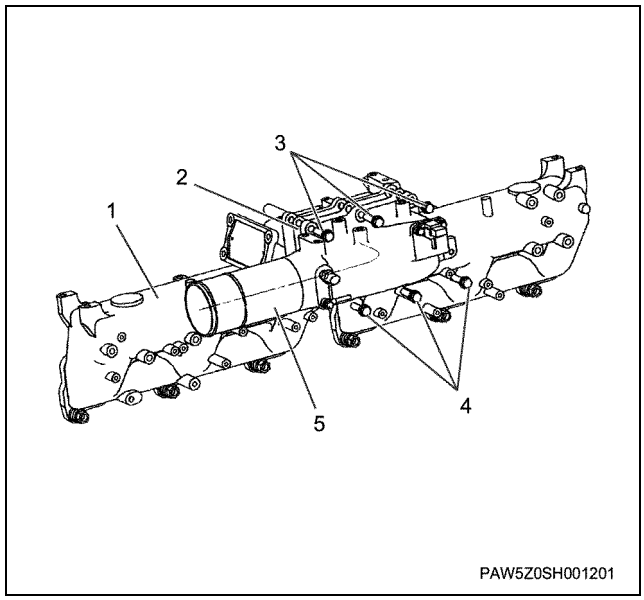
32. Clip the gasket and Install the EGR valve.



Legend

1. EGR valve
2. Gasket
3. EGR duct
4. EGR duct
5. Bolt
6. Gasket
7. Bolt

33. Install the intake pipe.

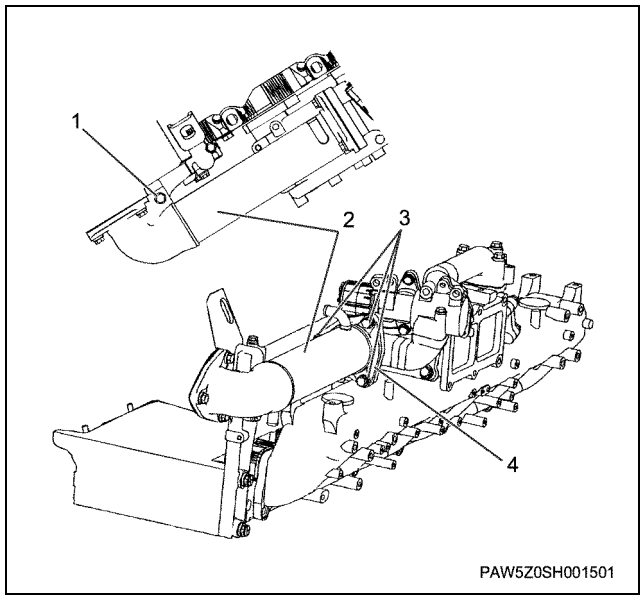


Legend

1. Intake manifold
2. Gasket
3. Bolt
4. Bolt
5. Intake pipe

34. Install the secondary EGR cooler.
    - Always clip the gasket.
    - Tighten the primary side (entrance side) fixing bolts.

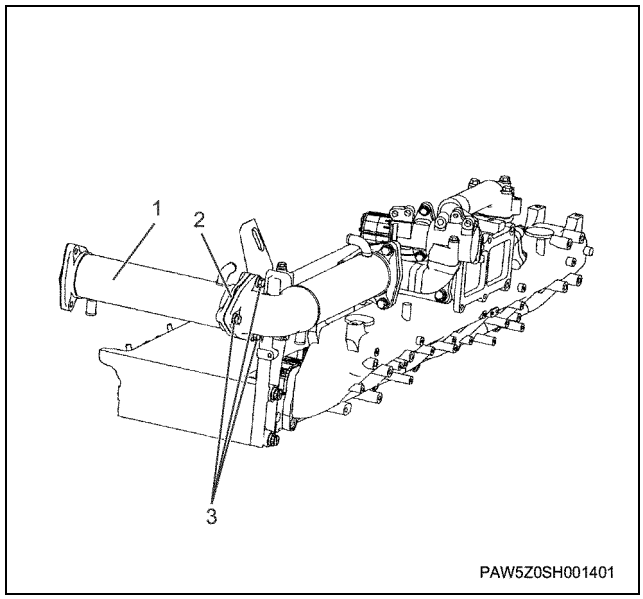
Notes:
Gently tighten the bolts to a position so that each EGR duct and EGR cooler hit face contact, position the seal face has no clearance, then fully tighten the bolts.



Legend

1. Bolt
2. Secondary EGR cooler
3. Bolt
4. Gasket

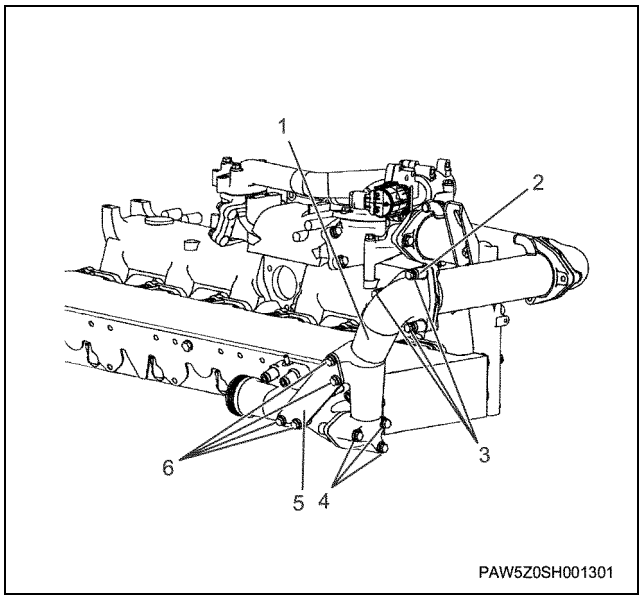
35. Clip the gasket and install the primary EGR cooler.



Legend

1. Primary EGR cooler
2. Gasket
3. Bolt

36. Clip the gasket and install the EGR pipe.

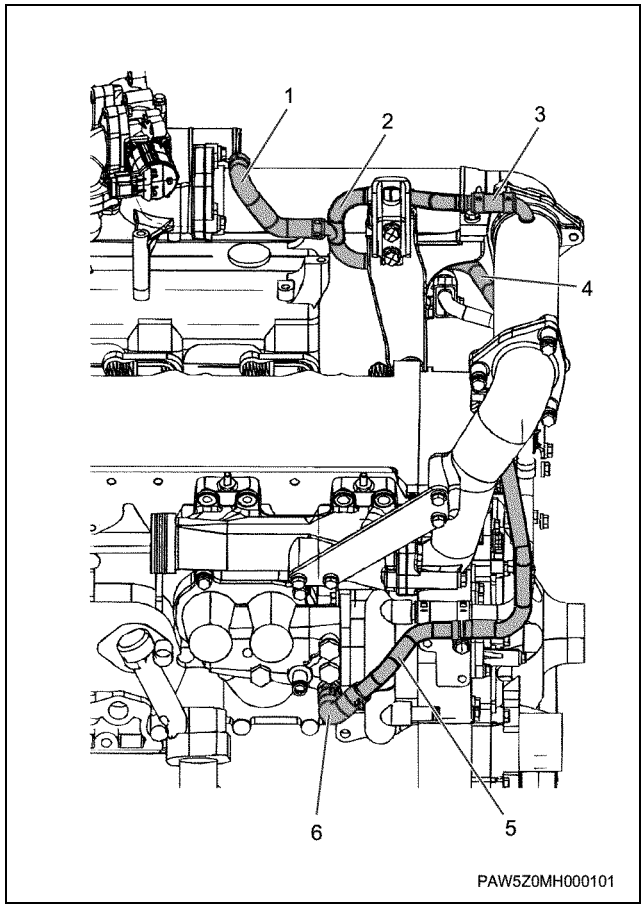


Legend

1. EGR pipe
2. Distance tube
3. Bolt
4. Bolt
5. Plate
6. Bolt

37. Install the EGR pipe fixing plate.
38. Install the cooler water pipe for the EGR cooler and rubber hose (return side) and fix with clips.

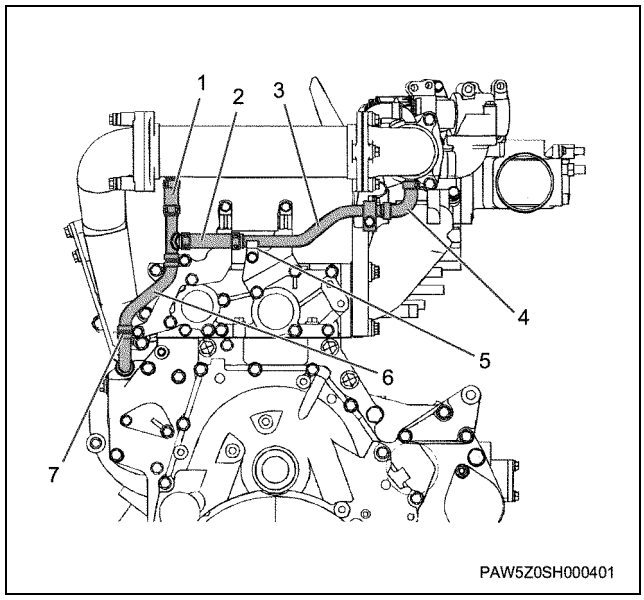
Notes:
When inserting rubber hose, apply soapsuds to the inner surface of the hose.



Legend

1. Rubber hose
2. Water pipe for EGR cooler (RR) (Return side)
3. Rubber hose
4. Water pipe for EGR cooler (LH) (return side)
5. Water pipe for EGR cooler (FT) (Return side)
6. Rubber hose

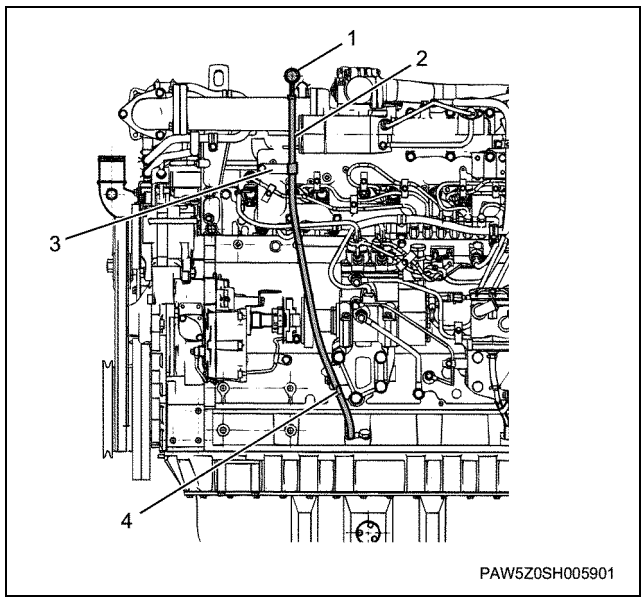
39. Install the cooler water pipe for the EGR cooler and rubber hose (feed side) and fix it with clips.



Legend

1. Rubber hose
2. Rubber hose
3. Water pipe for EGR cooler (LH) (feed side)
4. Rubber hose
5. Clip
6. Water pipe for EGR cooler (FT) (feed side)
7. Clip

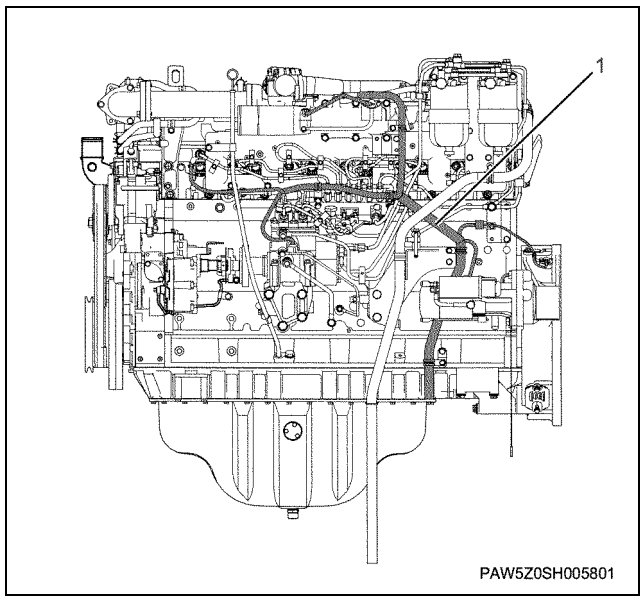
40. Install the oil level gauge guide tube.
    - Apply a thin coating of oil to the O-ring, and insert it carefully without damaging it.



Legend

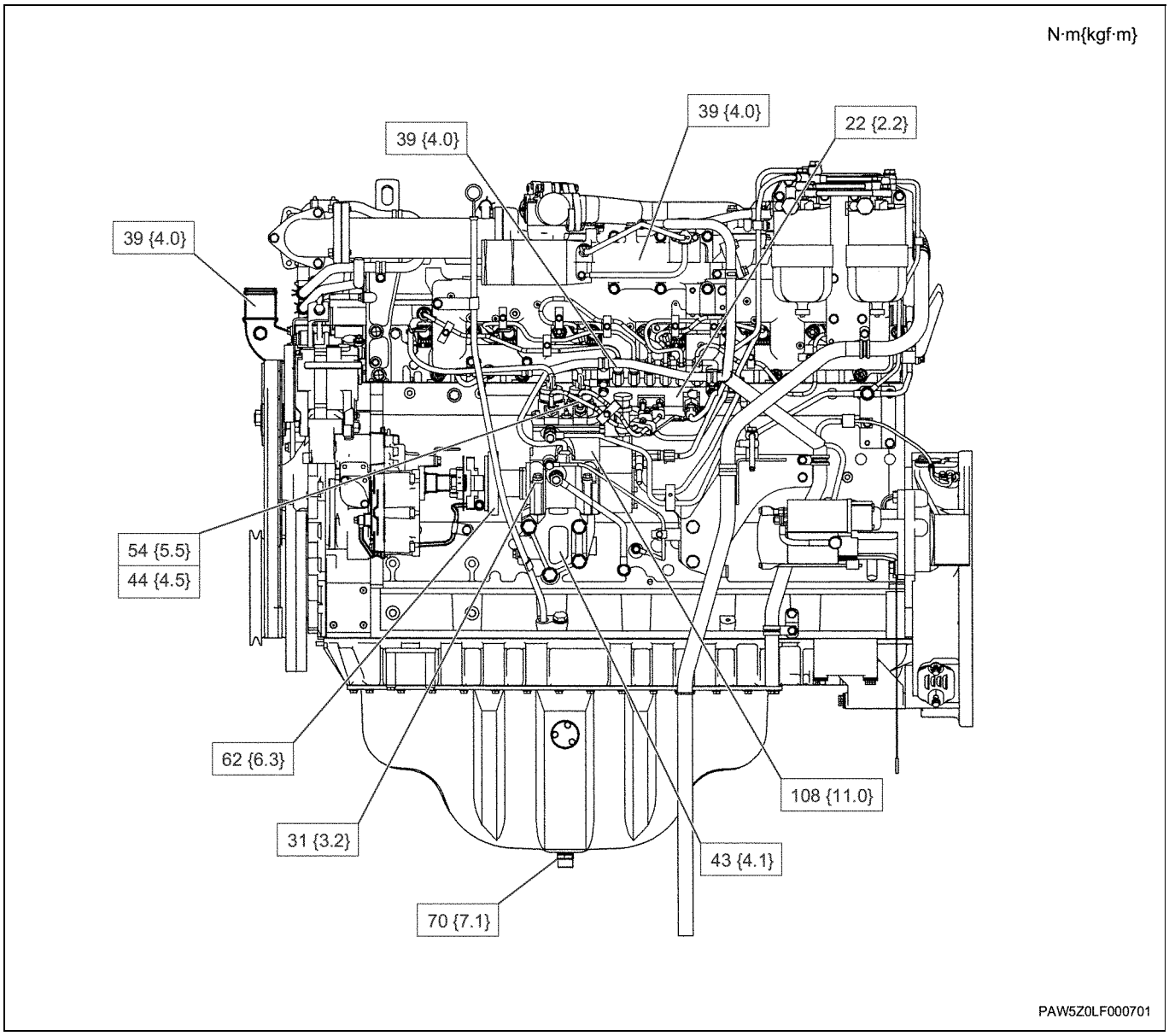
1. Oil level gauge
2. Guide tube
3. Stay
4. Stay

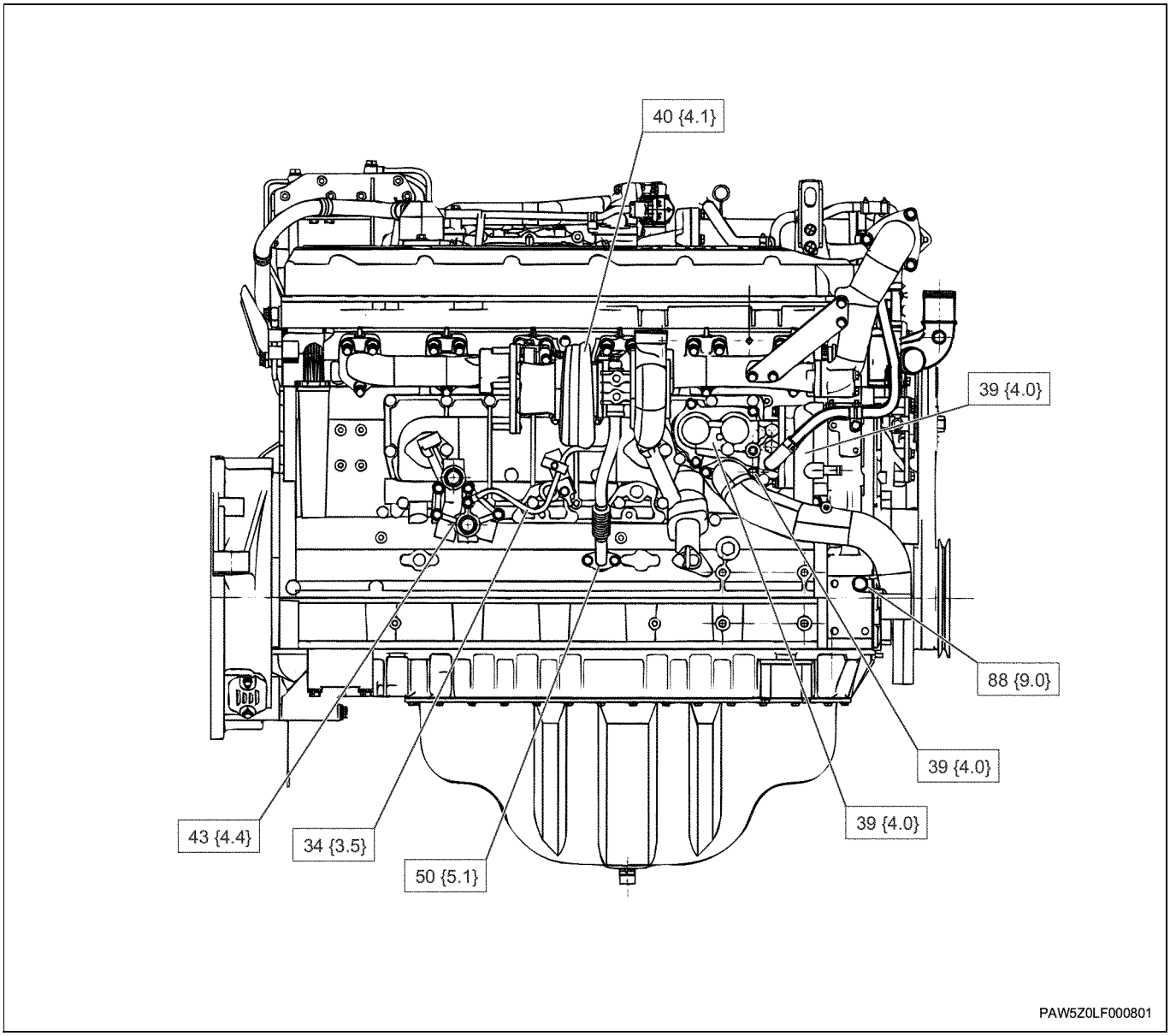
41. Install the engine harness.
    - Install the engine harness as shown in figure (1), then fix it with clips in the position marked when it was disassembled.



Torque specifications

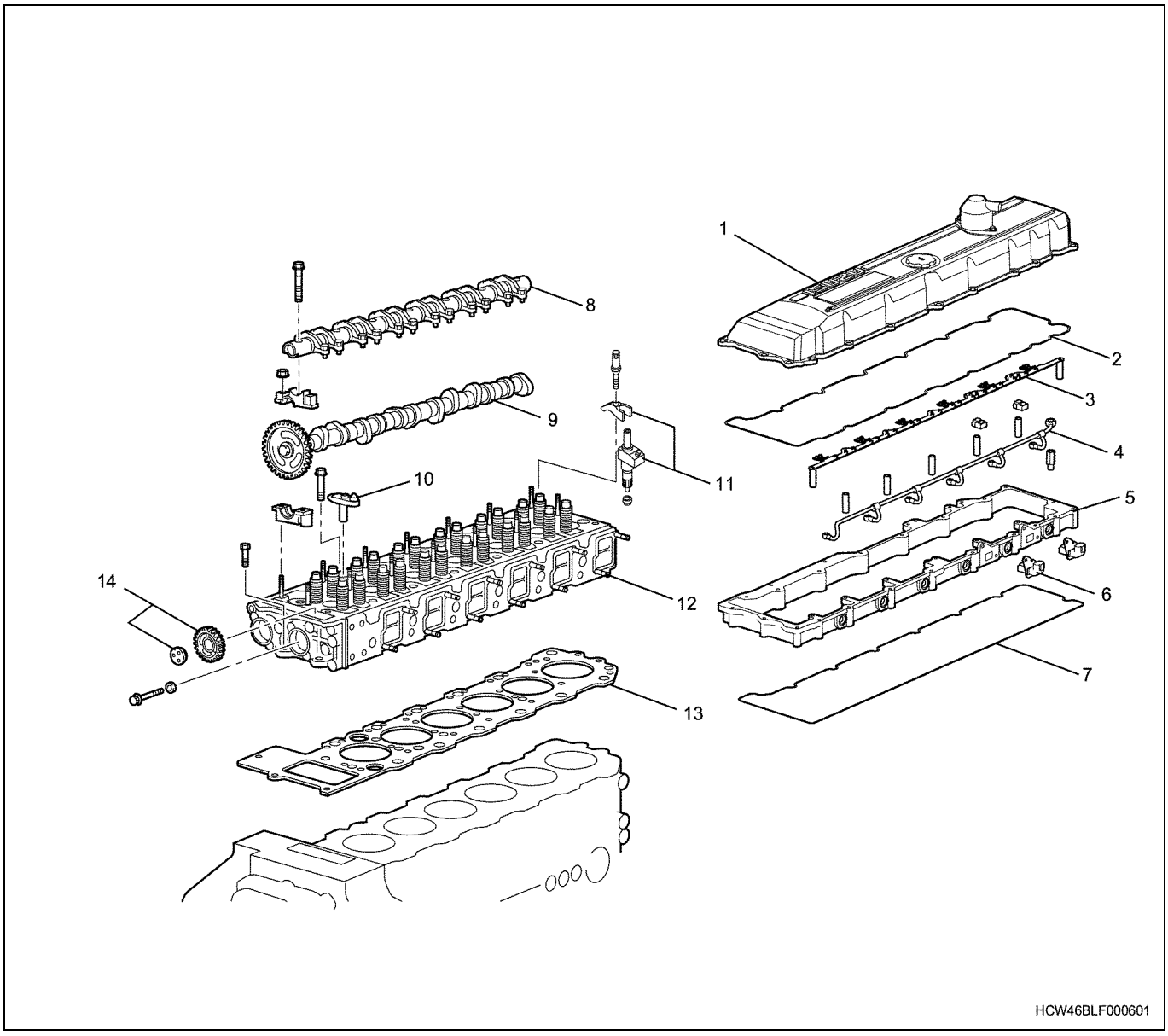
Engine exterior equipment




40 {4.1}
39 {4.0}
88 {9.0}
39 {4.0}
39 {4.0}
43 {4.4}
34 {3.5}
50 {5.1}
PAW5Z0LF000801

Cylinder head

Component parts

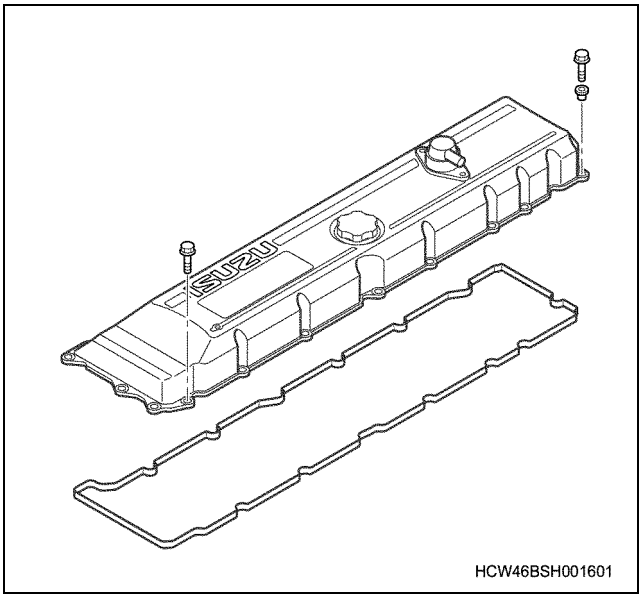


Legend

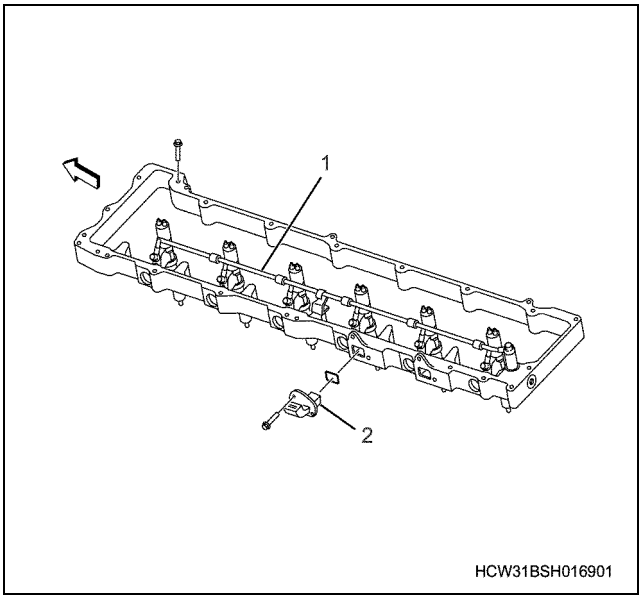
1. Head cover
2. Head cover gasket
3. Injector harness
4. Nozzle leak off pipe
5. Head lower cover
6. Harness connector
7. Head lower cover gasket
8. Rocker arm ASM
9. Cam shaft
10. Bridge
11. Injector & clamp
12. Cylinder head ASM
13. Cylinder head gasket
14. Idle gear C

Removal

1. Remove the air breather hose, then remove the head cover.
2. Remove the head cover gasket.



3. Remove the injector harness.
4. Remove the nozzle leak off pipe.
5. Remove the harness connector.

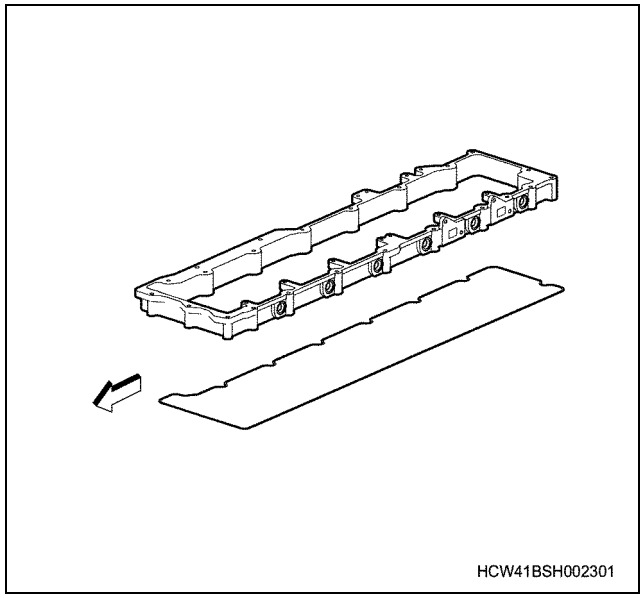


Legend

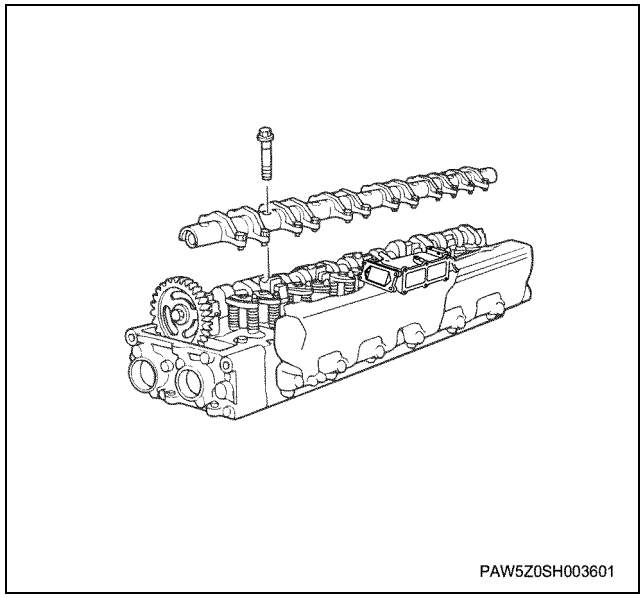
1. Nozzle leak off pipe
2. Harness connector

6. Remove the head lower cover.
7. Remove the head lower cover gasket.

Notes:
When removing the lower cover, a small amount of oil may spill, so be prepared to clean it with a rag.

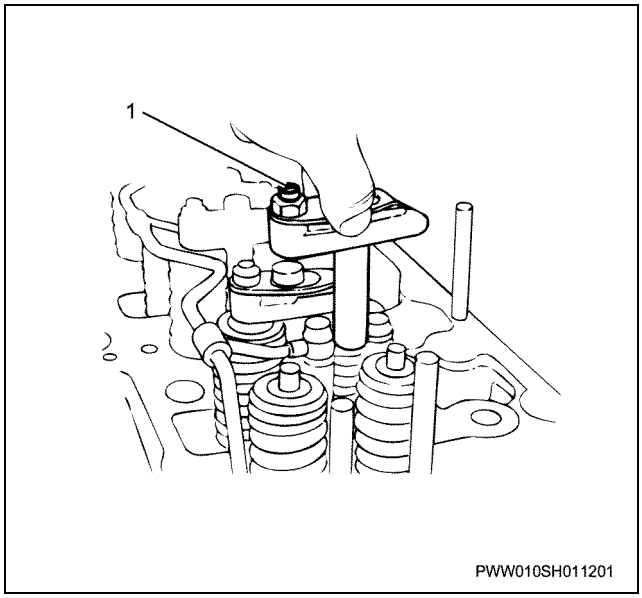


8. Remove the rocker arm ASM.
   - While maintaining the bracket's balance, loosen and remove the tightening bolts from both sides of the rocker arm ASM bracket.

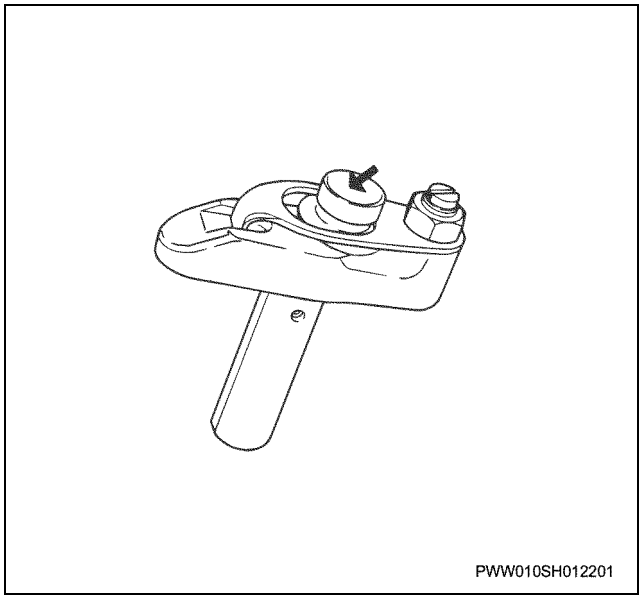


9. Remove the bridge (1).

Notes:
Install numbered tags to each cylinder in the bridge.



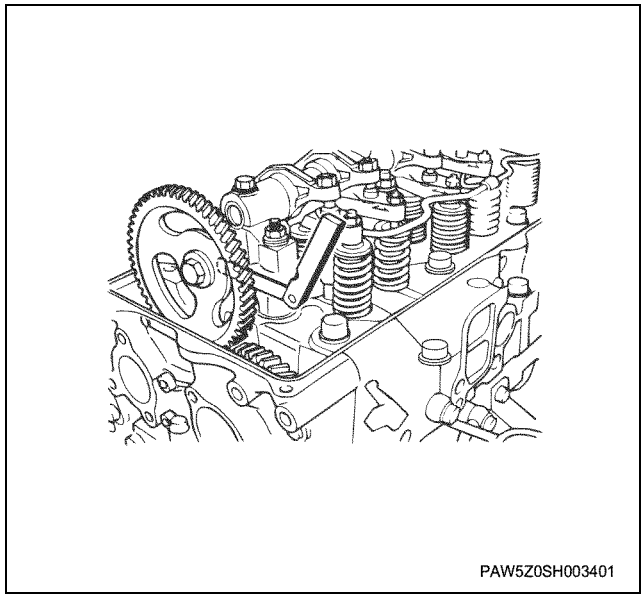
- Inspect the contact surfaces for wear and de-bonding, and the bridge for cracks or damage.



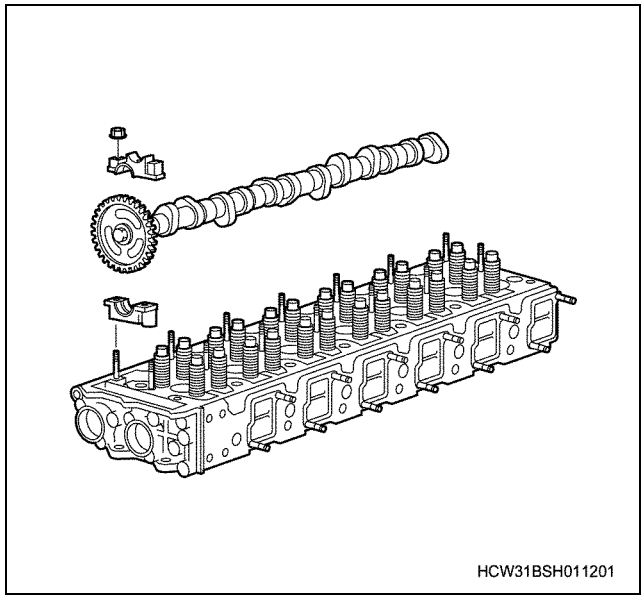
10. Remove the cam shaft.
    - Before removing the cam shaft, measure the clearances of the camshaft orientations.

Camshaft orientation clearance (mm)

Standard	Limit
0.085 ~ 0.170	0.25



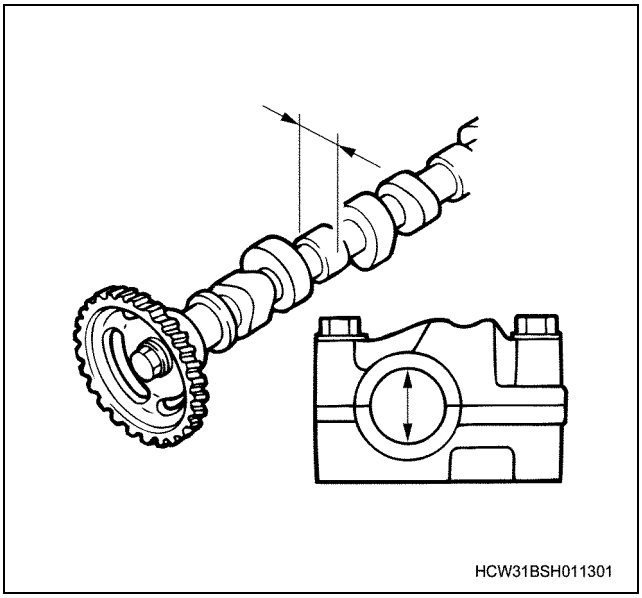
- While maintaining the bracket's balance, loosen and remove the tightening bolts from both sides of the camshaft bracket.



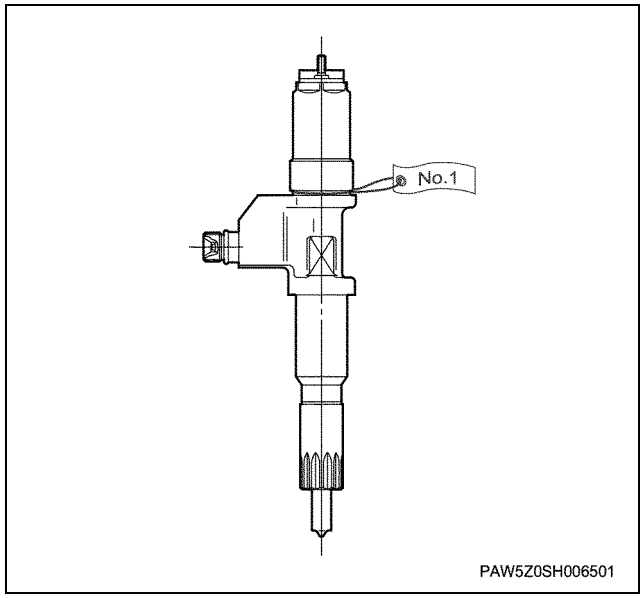
- Measure the clearance between the cam shaft journal and bracket.

Clearance between journal and bracket (mm)

Selection of a reference point	Limit
0.065 ~ 0.125	0.15



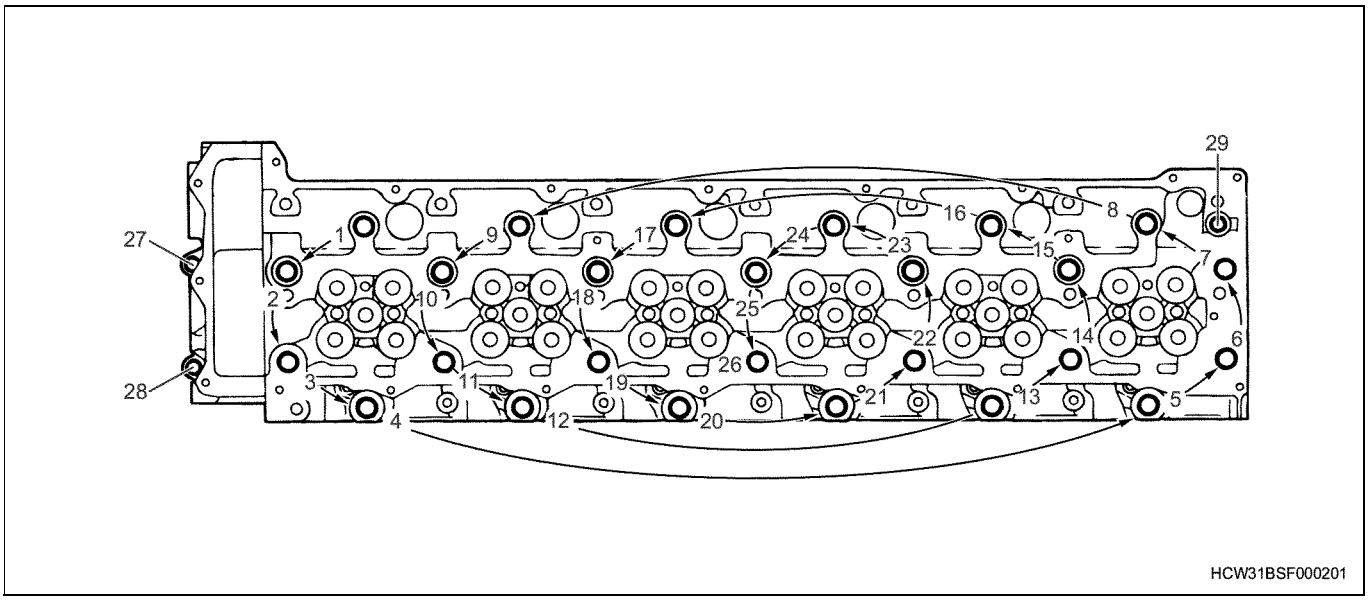
11. Remove the injector & clamp.
    - Loosen the clamp, and use a replacer to remove the injector.
    - Install a number to each injection before removing.



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.

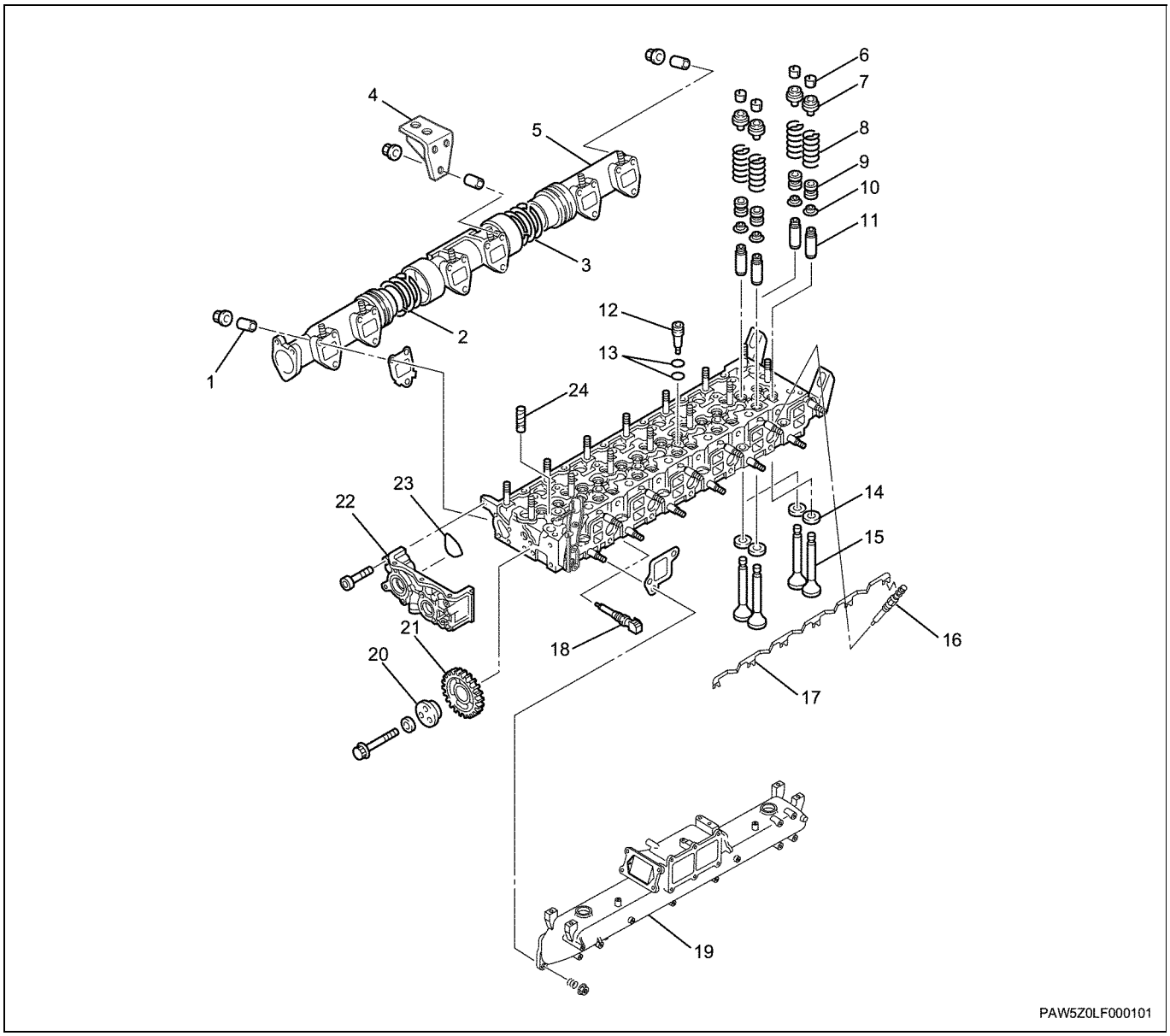
Important:

- **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.

Disassembly



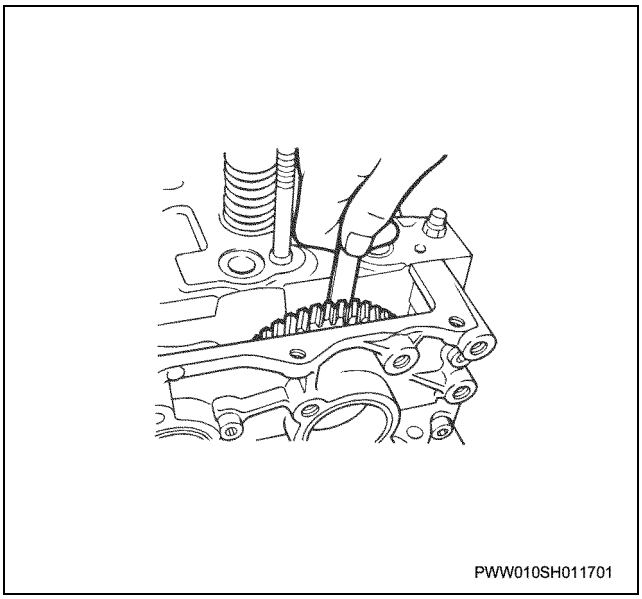
Legend

1. Distance tube
2. Seal ring
3. Seal ring
4. Exhaust pipe bracket
5. Exhaust manifold ASM
6. Split collar
7. Spring sheet (upper)
8. Valve spring
9. Valve stem oil seal
10. Spring sheet (lower)
11. Valve guide
12. Nozzle sleeve
13. O-ring
14. Valve seat insert
15. Valve
16. Glow plug
17. Glow plug connector
18. Thermo sensor
19. Intake manifold
20. Idle gear shaft C
21. Idle gear C
22. Gear case
23. O-ring
24. Bridge guide

1. Remove the glow plug connector.
2. Remove the glow plug.
3. Remove the thermo sensor.
4. Remove the gear case.
   - Before removing the gear case, measure the clearances of the idle gear C shaft orientations.

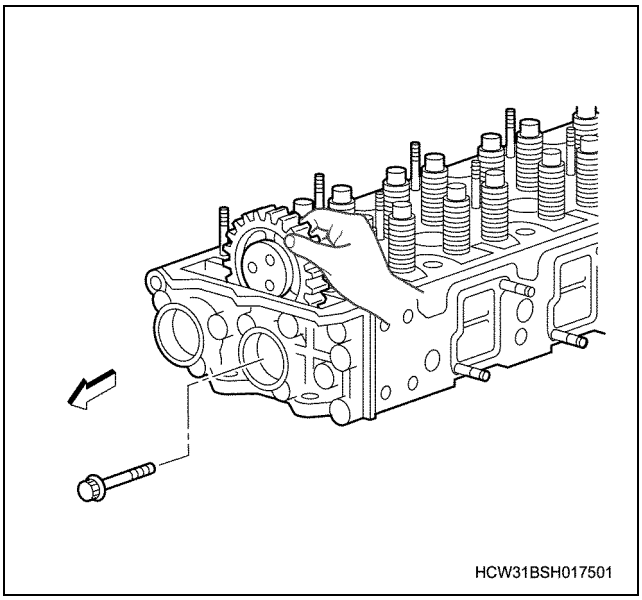
Shaft orientation clearances (mm)

Standard	Limit
0.05 ~ 0.14	0.25

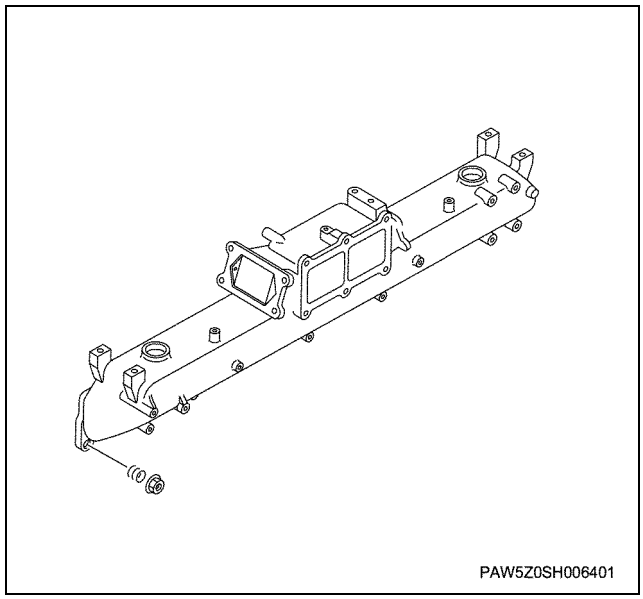


5. Remove the O-ring for the gear case.
6. Remove idle gear shaft C.
7. Remove idle gear C.
   - Extract the idle gear shaft, and remove idle gear C from the cylinder head.

Important:
Be careful not to damage the idle gear shaft bush.



8. Remove the intake manifold.



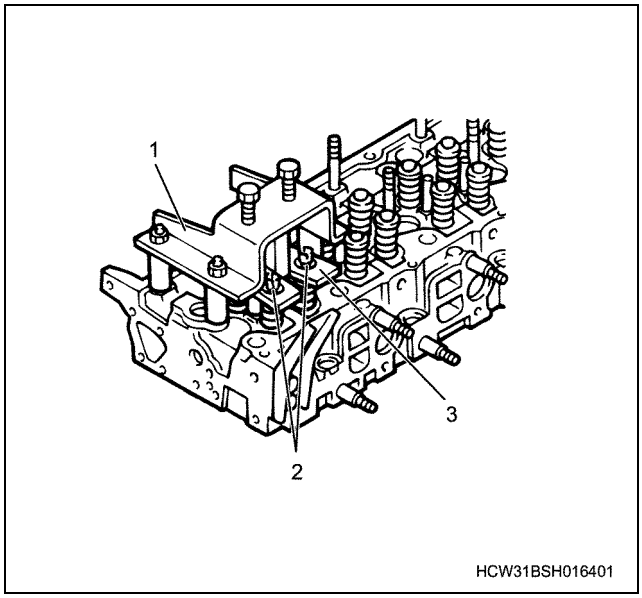
9. Remove the exhaust pipe bracket.
10. Remove the engine carrier (Ft) bracket.
11. Remove the exhaust manifold ASM.

Important:
Do not re-use the locking nut.

12. Remove the seal ring for the exhaust manifold.
13. Remove the split collar.
14. Remove the spring sheet (upper).
    - Place the cylinder head on a wooden board, use a compressor to remove the split collar, then remove the spring sheet, valve spring, and valve.

Notes:
Install numbered tags to each valve cylinder.

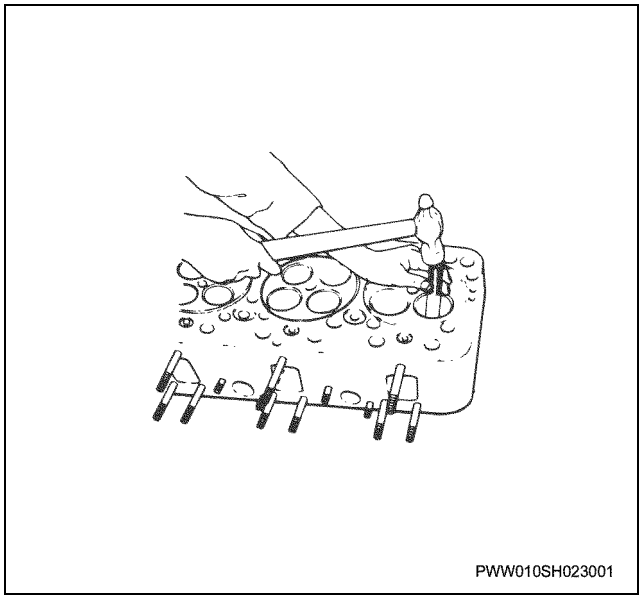
Compressor; Valve spring: 1-8523-5013-0



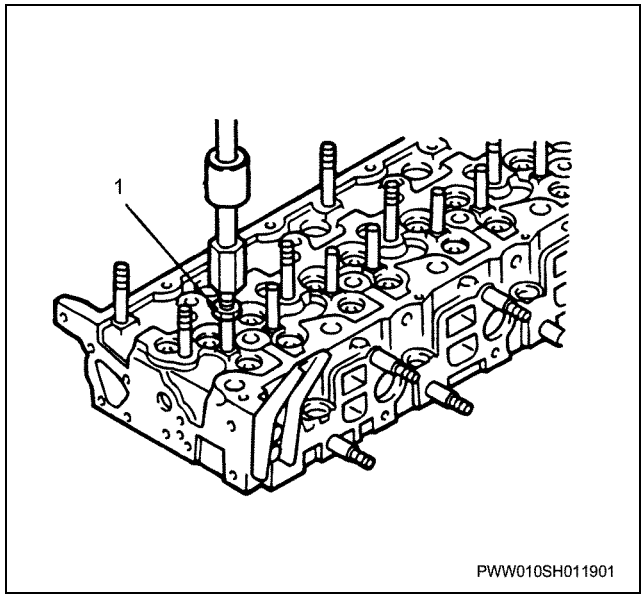
Legend
1. Bracket
2. Split collar
3. Bridge

15. Remove the valve spring.
16. Remove the spring sheet (lower).
17. Remove the valve.
18. Remove the valve stem oil seal.
19. Remove the valve guide.
    - Insert a replacer into the guide from the head underside, and hit it with a hammer.

Replacer; Valve guide: 9-8523-1202-0

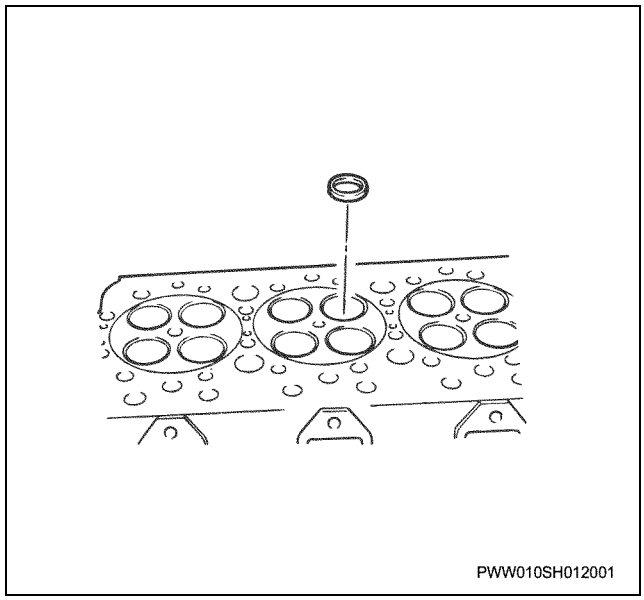


20. Remove the bridge guide.
    - Do not remove the bridge guide unless it is worn.
    - Electrically weld (1) the bridge guide to the bolt, install a sliding hammer to the bolt and extract it.

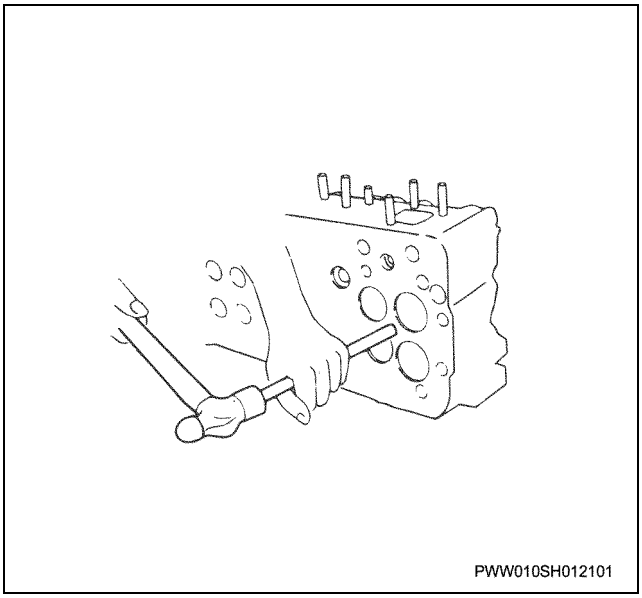


21. Remove the valve seat insert.
    - Use a gas welding burner to heat the 2 points on the inside of the insert until they are red hot (600~700 °C), then leave to cool naturally for 3~5 minutes and extract with a screwdriver.

Important:
Do not cool the hot points down too rapidly.



22. Remove the nozzle sleeve.
    - Removing the nozzle sleeve
      Strike from the head lower side to extract.



23. Remove the nozzle sleeve O-ring.

Inspection

Idle gear/ shaft C

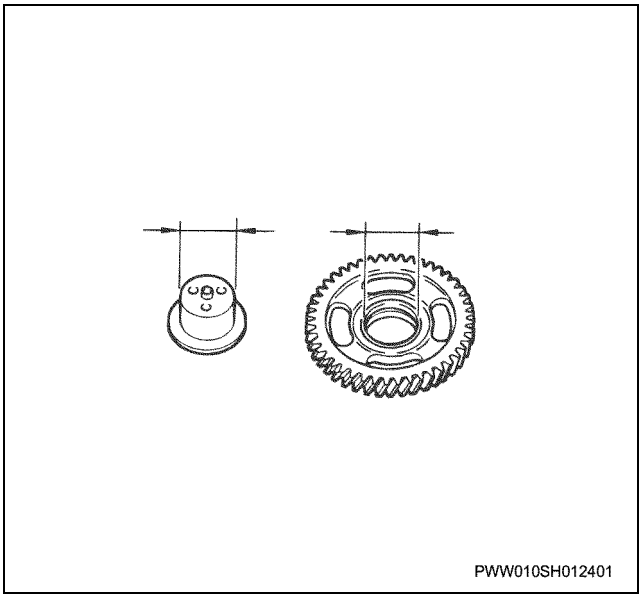
- Measure the outer diameter of the idle gear shaft and clearance between shaft and bush.
  Inspect the bush for damage.

Shaft outer diameter (mm)

Nominal dimension	Limit
49	48.85

Clearance between shaft and bush (mm)

Standard	Limit
0.04 ~ 0.105	0.20

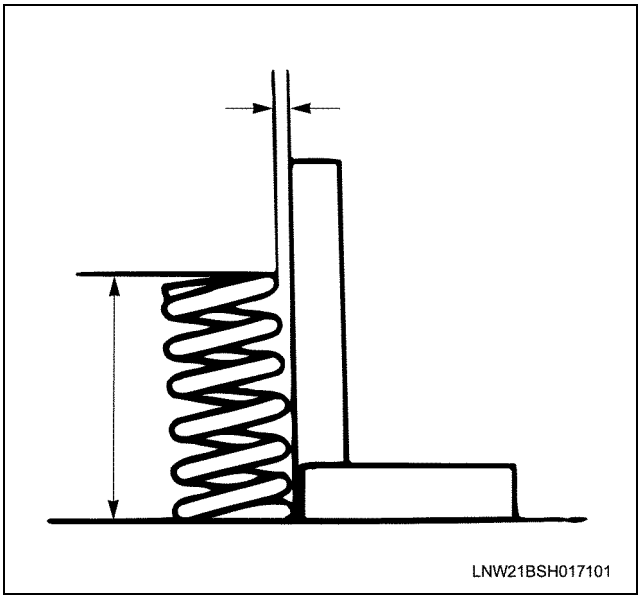


Valve spring

- Measure the perpendicularity of the valve spring.

Valve spring perpendicularity (mm)

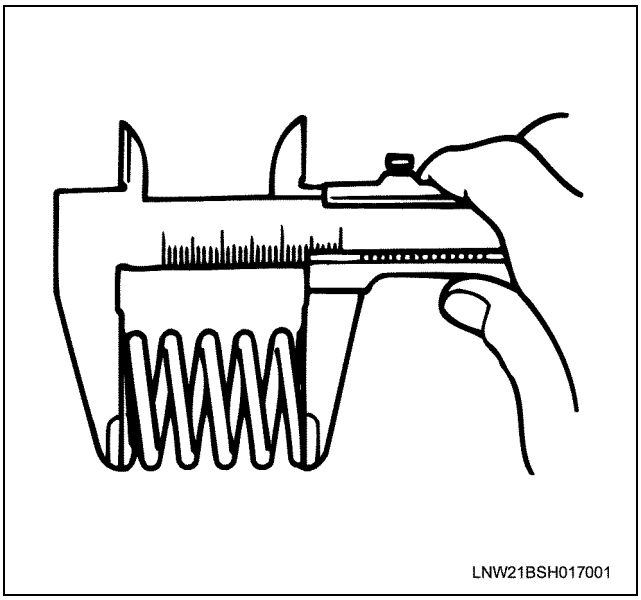
	Standard	Limit
Intake	3.5	4.8
Exhaust	4.5	6.2



- Measure the free length of the valve spring.

Valve spring free length (mm)

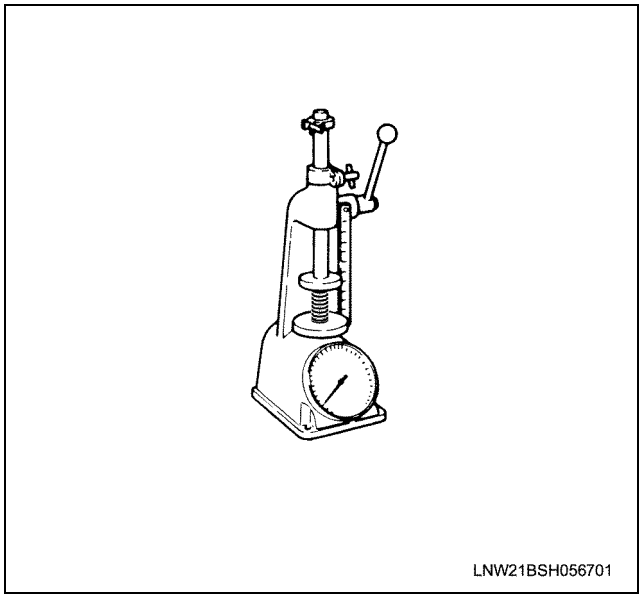
	Nominal dimension	Limit
Intake	79.3	75.3
Exhaust	102.7	97.6



- Measure the tension of the spring when installing it.

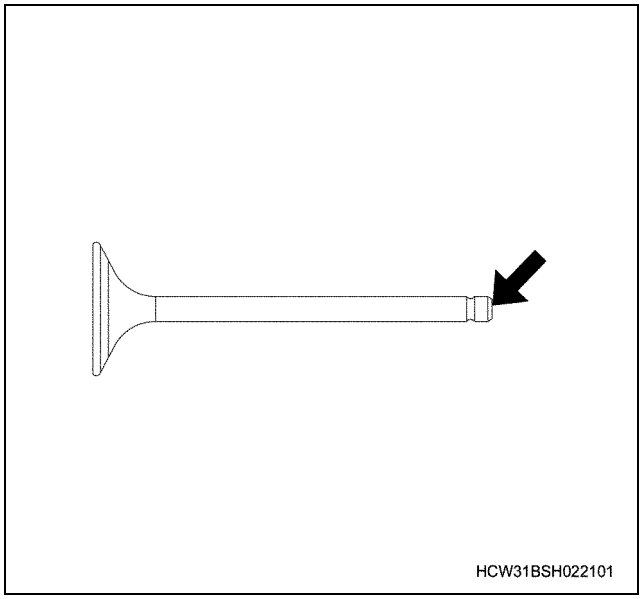
Valve spring tension. N {kgf}/mm

	Nominal dimension	Limit
Intake	392 {40.0}/64	372 {38.0}/64
Exhaust	610 {62.2}/69	578 {59.0}/69



Valve

- Inspect the valve stem end for wear. Repair any slight abrasions with an oil stone.

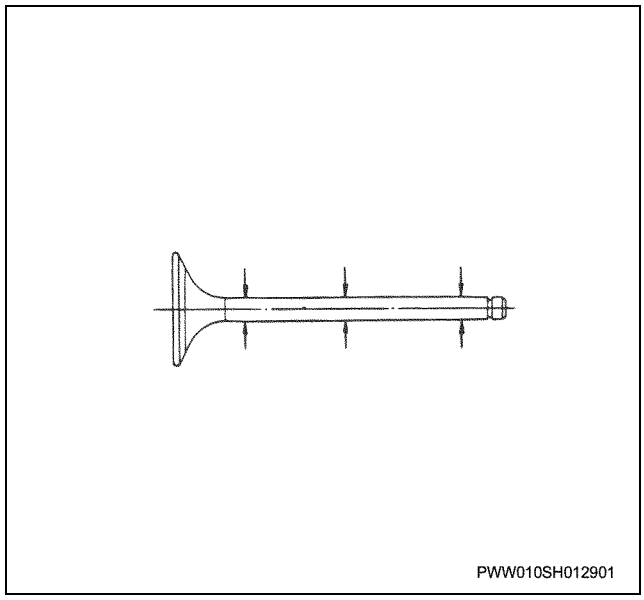


- Measure the amount of wear of the valve stem. Measure the 3 points shown on the diagram.

Valve stem outer diameter (mm)

	Nominal dimension	Limit
Intake	ϕ10	ϕ 9.92
Exhaust	ϕ10	ϕ 9.90

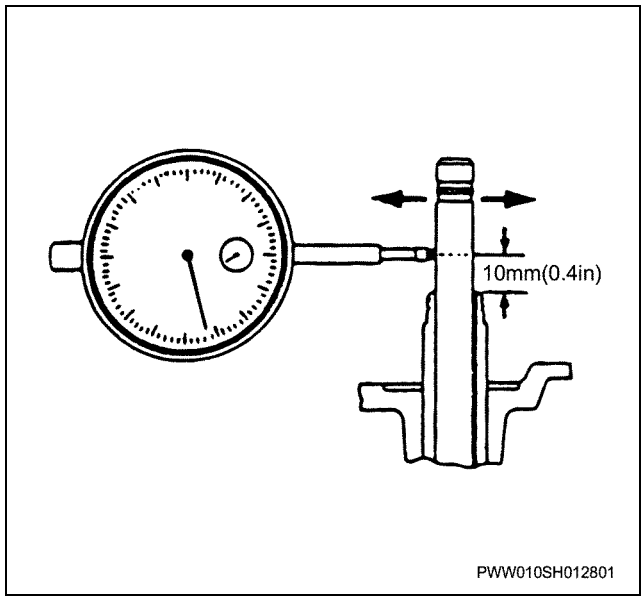
If the amount of valve stem wear is more than the allowed limit, replace it along with the guide.



- Measure the clearance between the valve guide and valve stem.
  Insert the guide into the valve, and measure the valve clearance at a position 10mm from the guide tip.

Guide and valve stem clearance (mm)

	Selection of a reference point	Limit
Intake	0.040 ~ 0.077	0.15
Exhaust	0.065 ~ 0.102	0.25



- Inspect the hit of the valve seat face, and measure the sheet thickness.
  Inspect the sheet face for damage or staged abrasion, and measure the sheet thickness.

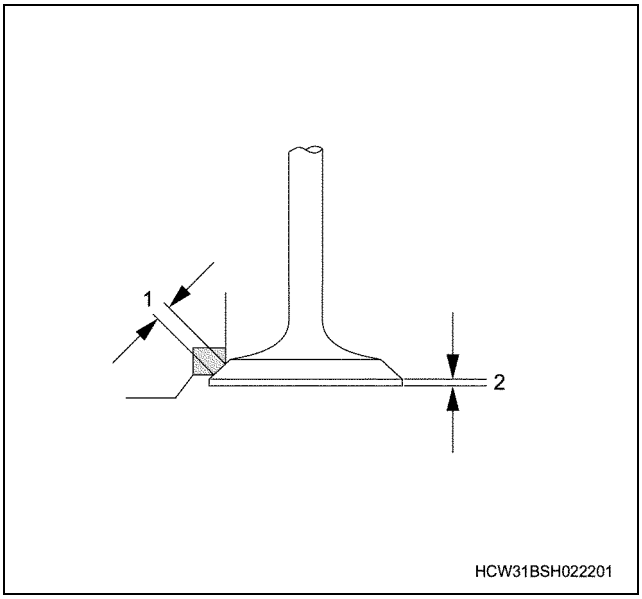
Valve thickness (mm)

	Nominal dimension	Limit
Intake	2.02	1.52
Exhaust	2.48	1.98

Valve seat hit width (mm)

	Nominal dimension	Limit
Intake	3.3	3.7
Exhaust	2.6	3.0

Important:
After repairing by grinding, if the thickness of the valve is greater than that specified by the limit, replace it.



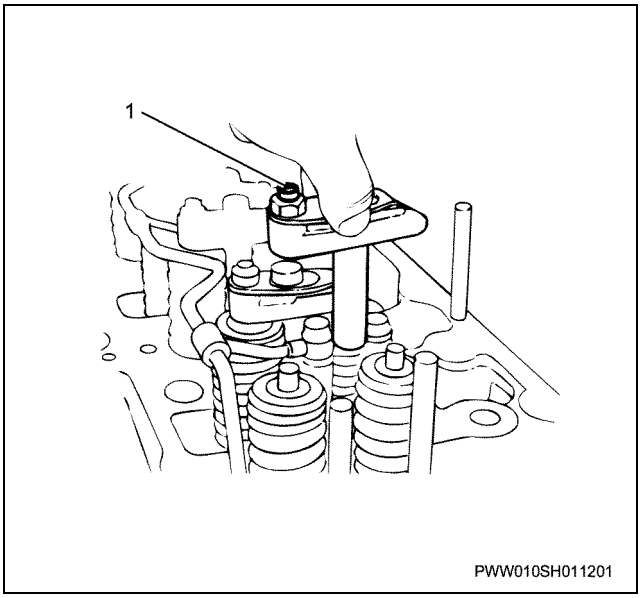
Legend
1. Hit width
2. Valve thickness

Bridge guide

- Measure the clearance between the bridge guide and bridge (1).

Clearance between guide and bridge (mm)

Standard	Limit
0.020 ~ 0.057	0.10

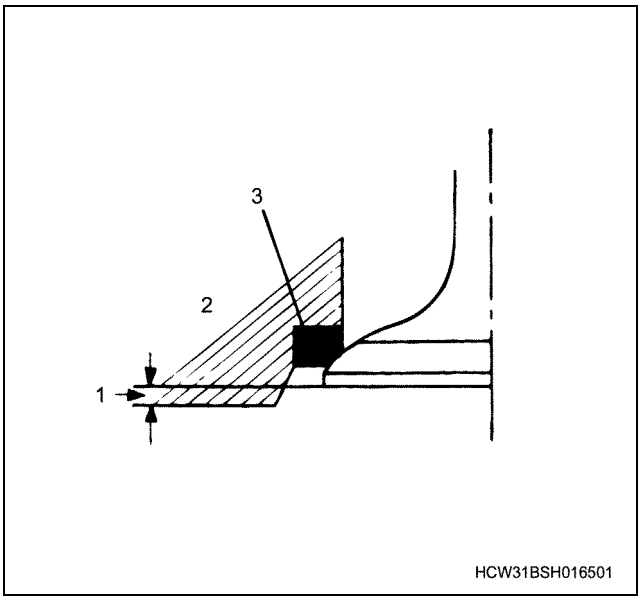


Valve seat insert

- Measure the amount of valve sink.
  Insert a new valve into the guide, and measure the sink amount from the cylinder head installation face to the valve surface.

Amount of valve sink (mm)

	Nominal dimension	Limit
Intake	0.4	1.4
Exhaust	0.3	1.3



Legend
1. Amount of sink
2. Cylinder head
3. Valve seat insert

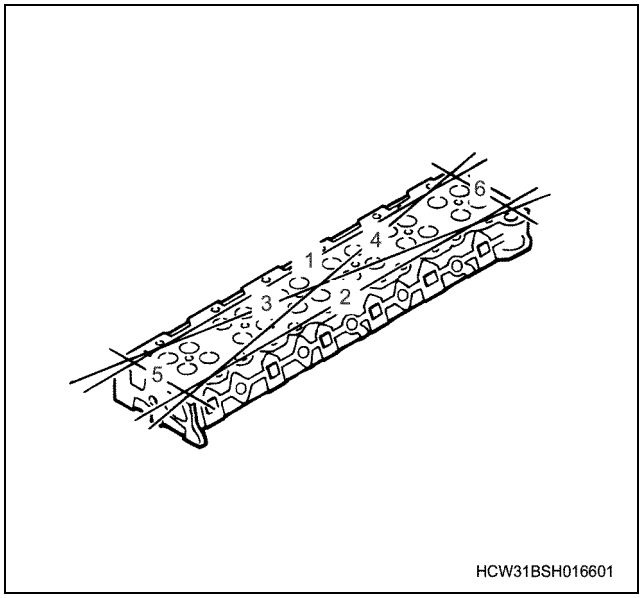
Cylinder head

- Measure the cylinder head distortion
  Taking care not to damage machining surfaces such as the head, valve seat, and insert, and clean off any carbon deposits. Next, put a straight edge on the head installation surface, and measure 1 ~ 4 on the diagram with a thickness gauge. Replace if it is over the limit.

Amount of distortion

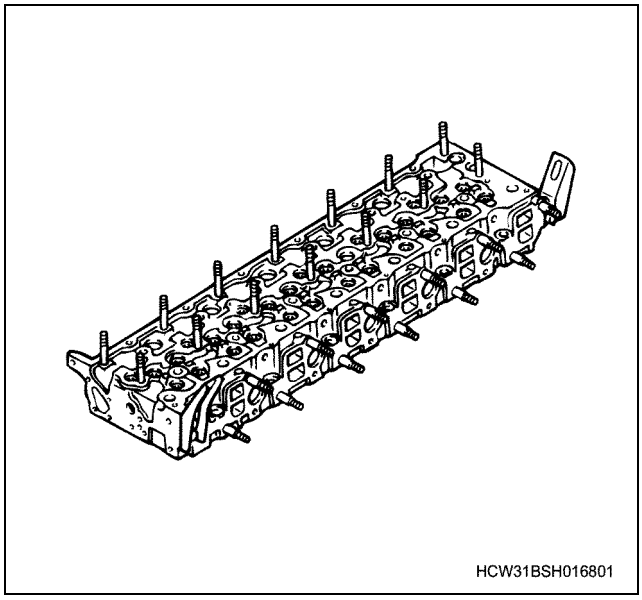
Limit:	Less that 0.2 mm

Important:
It is not possible to correct this because it will cause a change in the timing gear backlash.



HCW31BSH016601

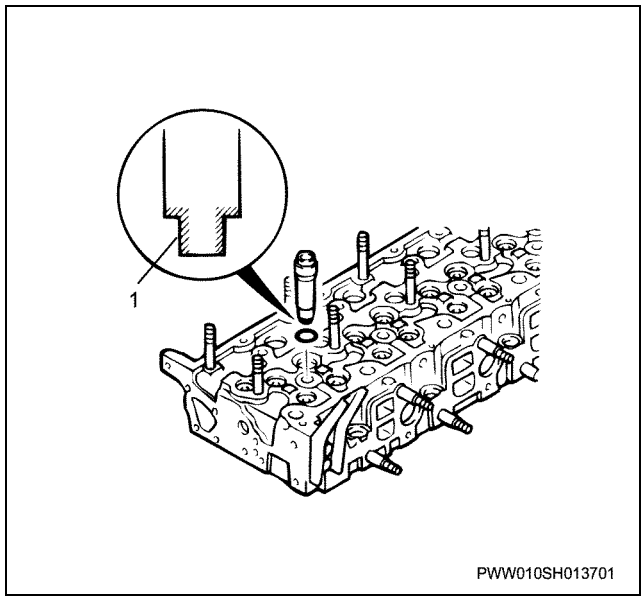
- Cylinder head crack /damage inspection
  Perform magnetic flux method or red check method inspections whenever necessary.


HCW31BSH016801

- Water jacket crack inspection
  Apply water pressure of 490 kPa {5 kgf/cm^2} from a hydraulic test machine for 3 minutes, and inspect each head section for water leaks.

Assembly

1. Apply engine oil to the O-ring and insert into the sleeve.
2. Apply Loctite No.TL290 to the nozzle sleeve outer diameter surface and end-bearing surface, and force fit it into the cylinder head.

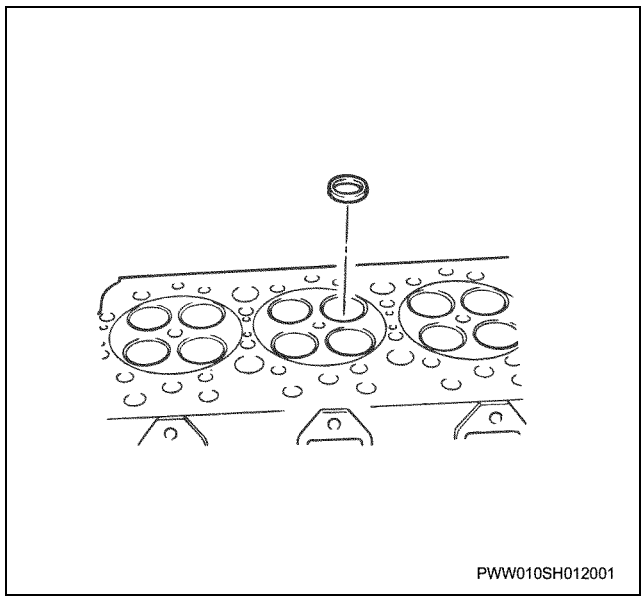


PWW010SH013701

Legend
1. Apply Loctite

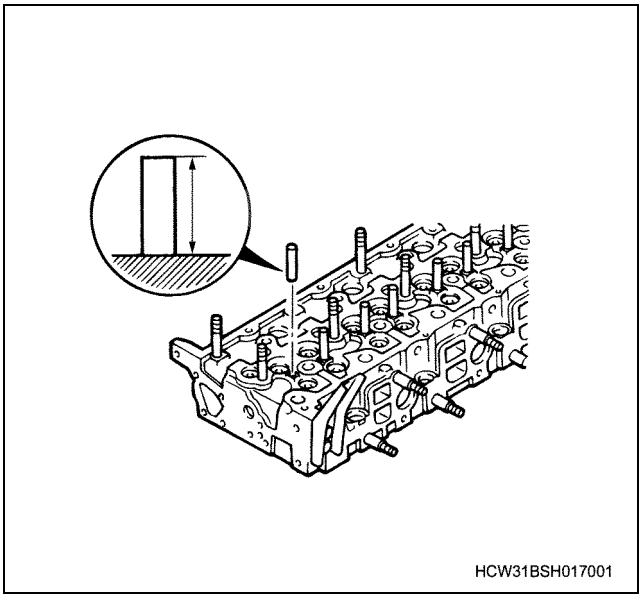
Notes:
Insert the O-ring so that the red part is up and black part is down.

3. Clean the installation face of the valve seat insert, and force the valve seat insert with a press.


PWW010SH012001

4. Install the bridge guide to the head.
   - Apply engine oil to the outer diameter of the guide. Force the bridge guide into the head with a installer so that the guide is 49 mm higher than the top face of the head.

Installer; Valve bridge guide: 9-8522-1324-0



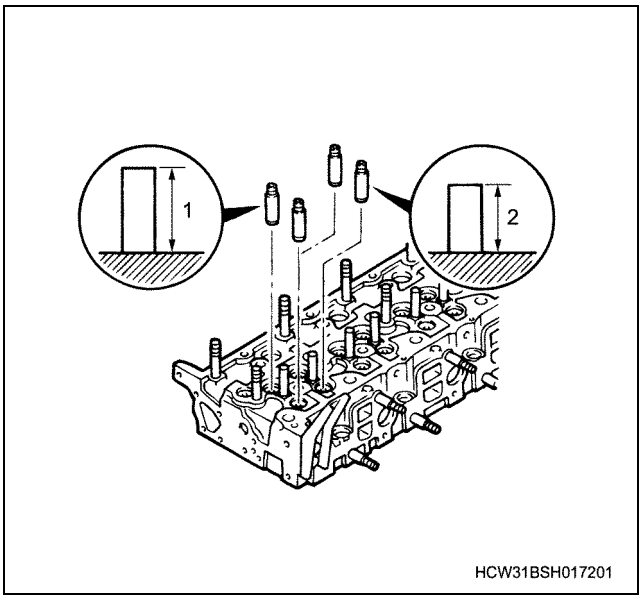
5. Install the valve guide.
   - Apply engine oil to the full outer circumference of the valve guide. Use a replacer to force in the valve guide so that it is the standard height from the cylinder head surface.

Valve guide height from the cylinderhead surface.

(mm)

	Standard
Intake	27.0
Exhaust	29.0

Replacer; Valve guide: 9-8523-1202-0



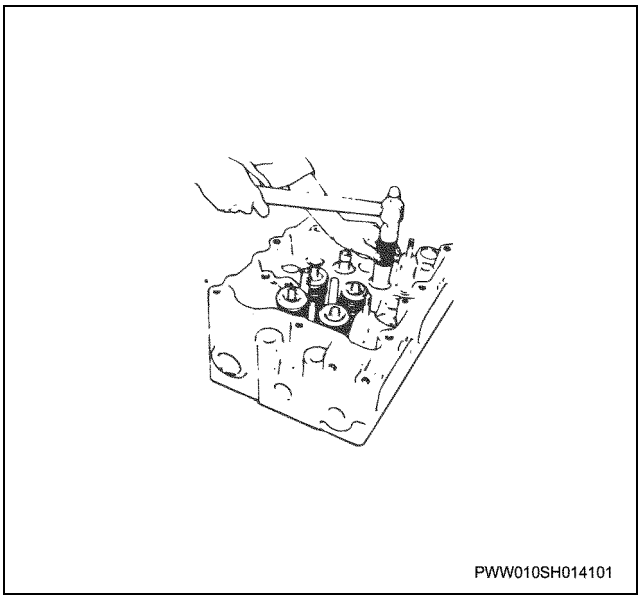
Legend
1. 29.0 mm
2. 27.0 mm

6. Use a installer to install the valve guide to the valve stem seal.

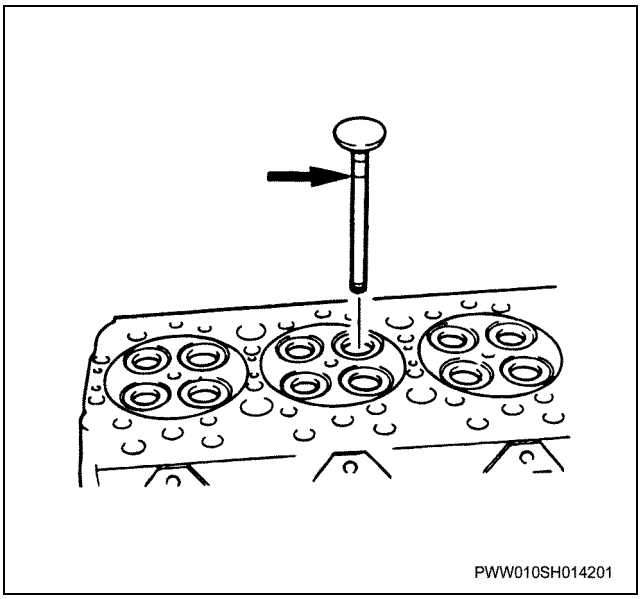
Notes:
After installing the valve seal, check that the spring is not loose or deformed.

Installer; Valve stem seal for intake: 1-8522-1140-1

Installer; Valve stem seal for exhaust: 1-8522-1184-0



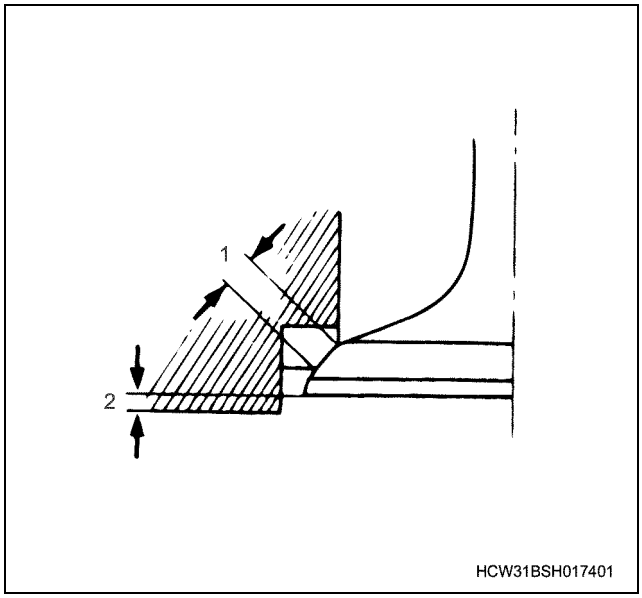
7. Install the valve.
   Inserting the valve
   - Apply engine oil to the valve stem, and insert the valve into the cylinder head.



Valve hit inspection
- Apply a red lead primer to the valve insert, and inspect the hit width on the sheet surface. Also inspect whether the hit position is in the center of the valve seat.
  Insert and valve hit width

Valve seat surface valve hit width (mm)

	Standard	Limit
Intake valve	3.3	3.7
Exhaust valve	2.6	3.0



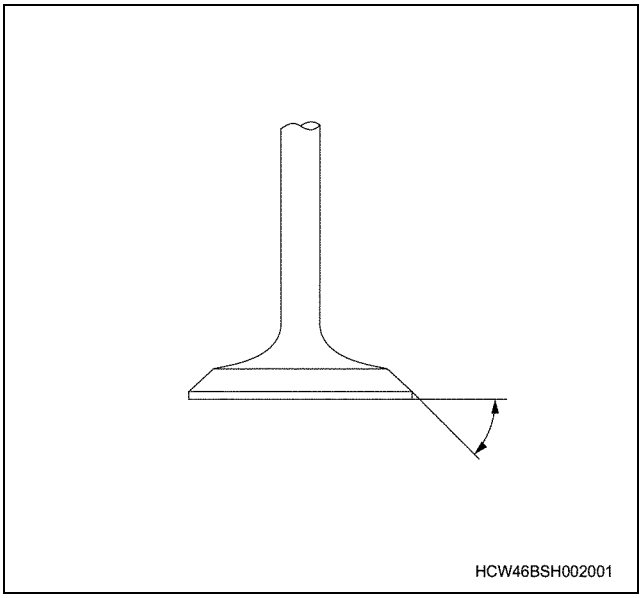
Legend
1. Hit width
2. Amount of sink

- If the valve hit width or contact surface is defective, use a seat cutter that suits the seat angle and stem diameter to correct the problem.

Valve seat angle

Intake valve:	30°
Exhaust valve:	45°

Valve stem outer diameter:	ϕ10.0 mm



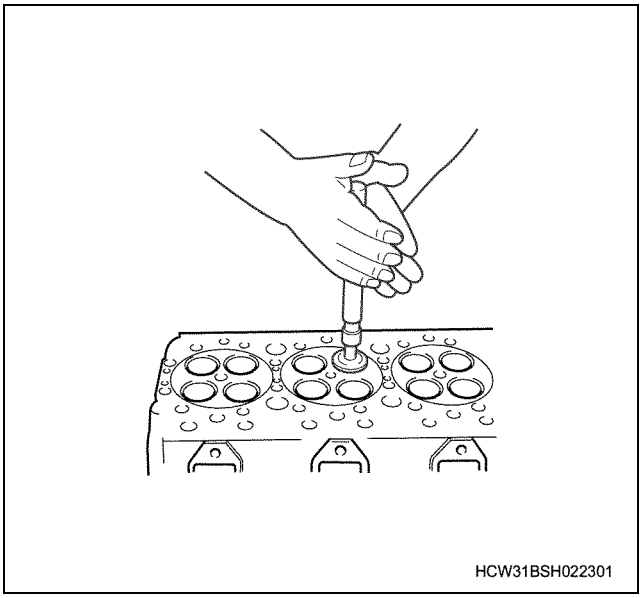
- After correcting the valve seat by grinding, measure the valve sink to make sure it is within the limit.

Amount of valve sink (mm)

	Standard	Limit
Intake valve	0.4	1.4
Exhaust valve	0.3	1.3

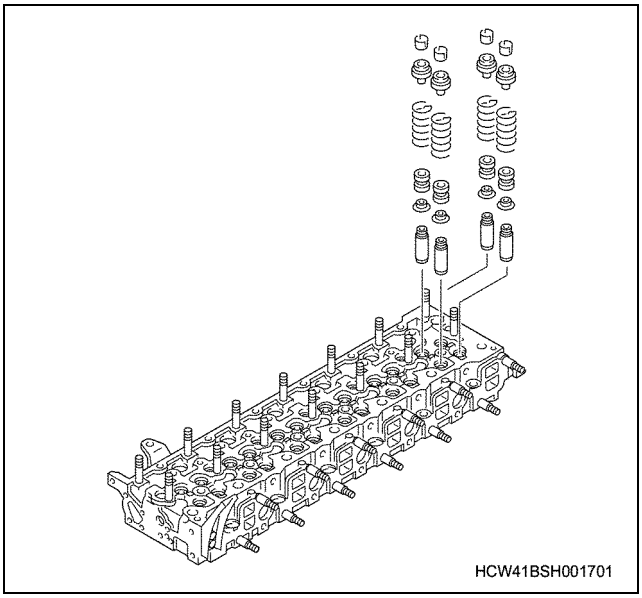
Valve grinding

- Apply compound to the contact surfaces of the insert and valve seat, and rotate and hit lightly to grind them evenly. After grinding is completed, thoroughly clean both the cylinder head and the valve.



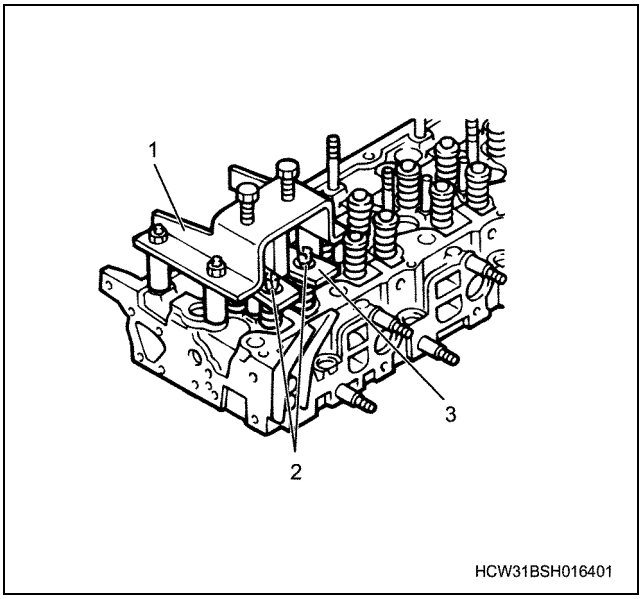
8. Install the spring sheet (lower).
9. Install the valve spring.
10. Install the spring sheet (upper).

- 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.

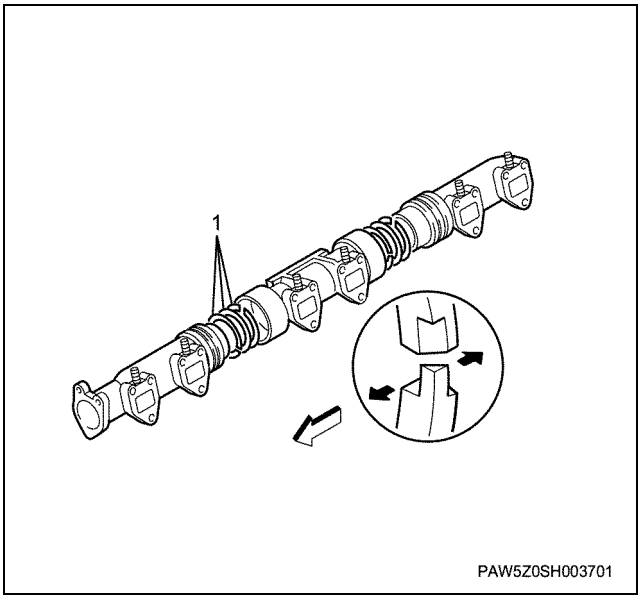
Compressor; Valve spring: 1-8523-5013-0



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.

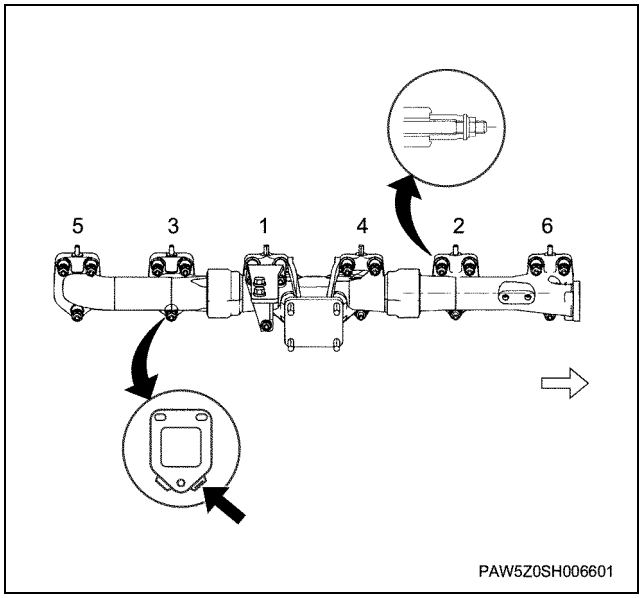


13. Install the exhaust manifold.
    - Clip the gasket, install the manifold to the cylinder head, and tighten in the numbered order shown in the diagram.
      (When tightening the flanges, start with the under side flanges and proceed to tighten in a clockwise direction.)

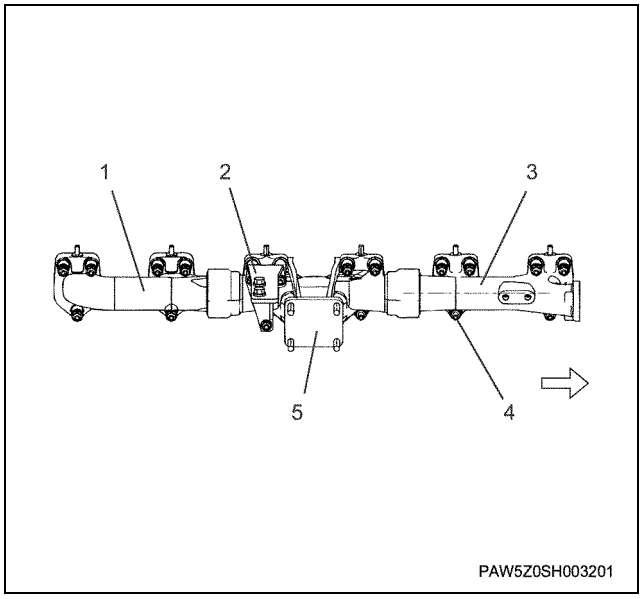
Tightening torque: 48 N·m {4.9 kgf·m}

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.**



14. Install the exhaust pipe bracket.
    - Do this at the same time as installing the exhaust manifold.

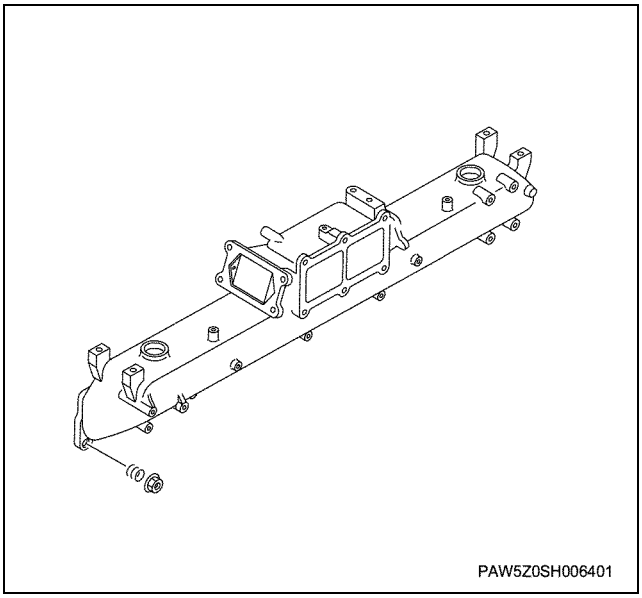


Legend

1. Exhaust manifold (Rr)
2. Bracket
3. Exhaust manifold (Ft)
4. Nut
5. Exhaust manifold (C)

15. Install the engine carrier (front) bracket.
16. Install the intake manifold.

Tightening torque: 19.6 N·m {2.0 kgf·m}

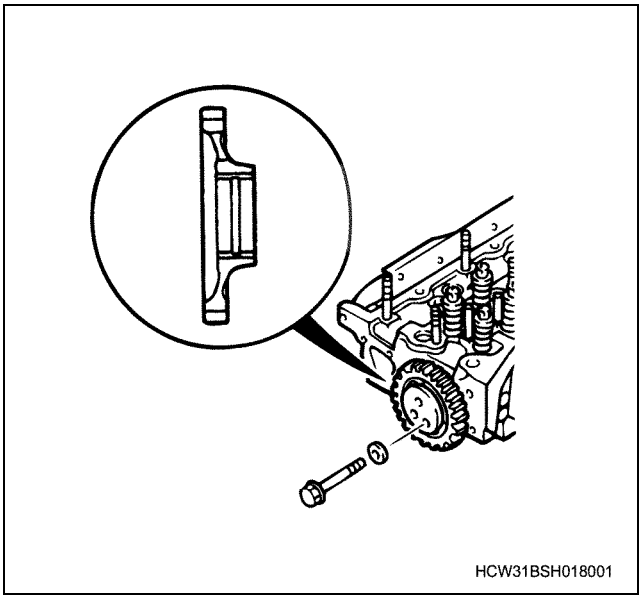


17. Apply engine oil to the idle gear C and insert it into the idle gear shaft.
18. With the idle gear C assembled with the idle gear shaft C, assemble and tighten the cylinder head.
    - Do not forget to apply engine oil to the idle gear shaft.

Notes:
Check that the gears rotate smoothly.

Important:
As the gear tooth side sticks out from the cylinder head, make sure that it does not get damaged.

Tightening torque: 46 N·m {8.0 kgf·m}

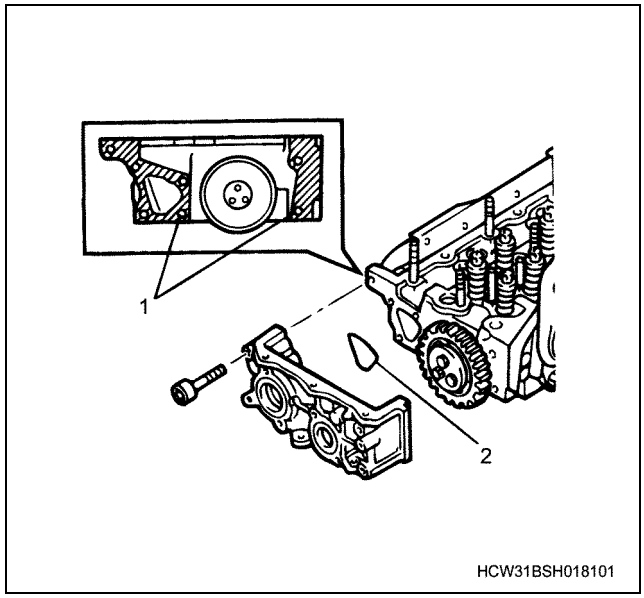


19. Install the O-ring to the gear case.
20. Install the gear case to the head and tighten the bolts.

- Apply approx. 0.3 mm thickness, approx. 5 mm width of FMD-127 to the gear case installation surface of the cylinder head.

Notes:
Make sure that the FMD-127 does not touch the bolt hole.

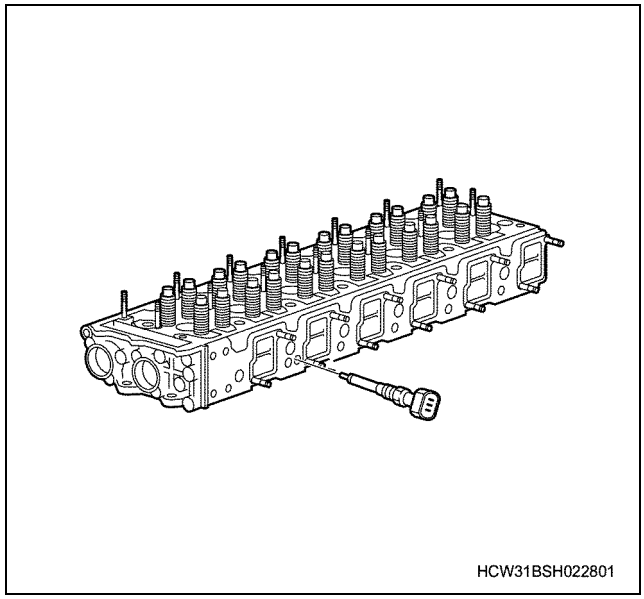
Tightening torque: 38 N·m {3.9 kgf·m}



Legend
1. Liquid gasket application
2. O-ring

21. Install the thermo sensor to the cylinder head.
    - Apply Loctite No.271 or Three bond No.1241 to the thermometer unit screw section, and install the unit.

Tightening torque: 20 N·m {2.0 kgf·m}



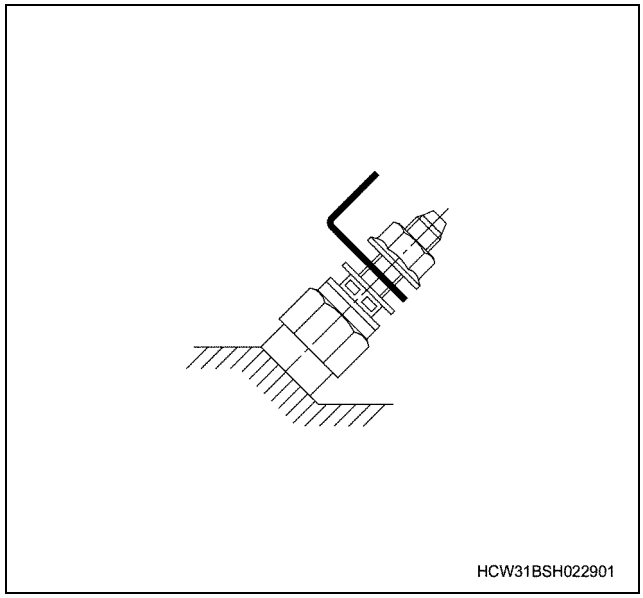
22. Install the glow plug to the cylinder head.

Tightening torque: 25 N·m {2.5 kgf·m}

Important:
Over tightening can cause damage, so please do not over tighten anything.

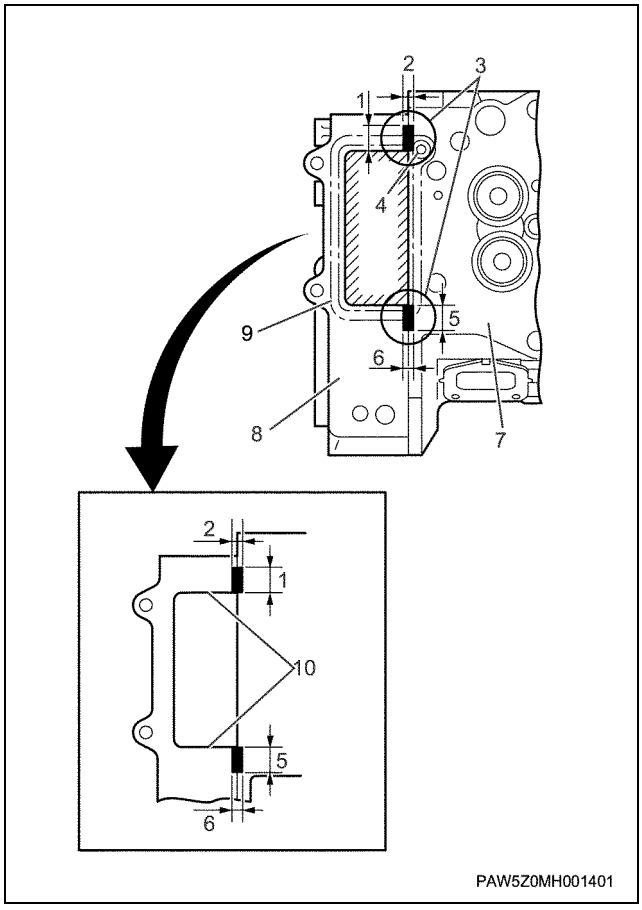
23. Insert the glow plug connector between the glow plug nut and flat washer and tighten the nut.

Tightening torque: 1.0 N·m {0.1 kgf·m}



Installation

1. Install the head gasket to the cylinder block.
   - Use brand new parts when re-assembling.
2. Install the cylinder head ASM.
   a. Apply liquid gasket to the cylinder head side.
      - In line with the gear case and cylinder head match surfaces, apply liquid gasket using the edge of the gear case hole as a standard, with a width of approx. 5 mm, height of approx. 3 ~ 4 mm, and length of approx. 30 mm. (1)
        Liquid gasket : TB1207B
      - Assemble the parts within 15 minutes of applying the liquid gasket.

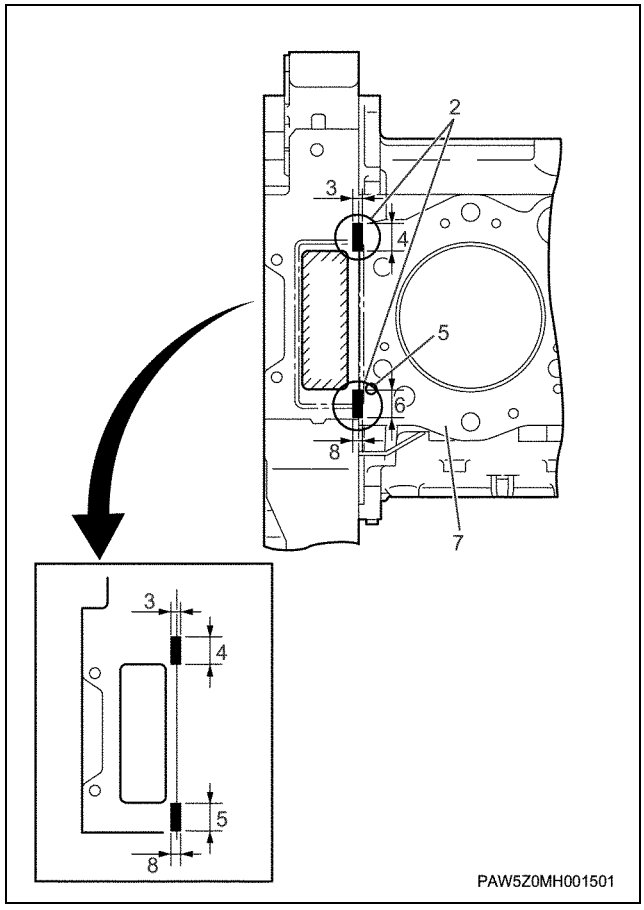


Legend

1. Liquid gasket length
2. Liquid gasket width
3. Liquid gasket application position
4. Oil hole
5. Liquid gasket length
6. Liquid gasket width
7. Cylinder head
8. Gear case (head)
9. Head gasket rubber ring position
10. Edge of the gear case (head) hole as a standard

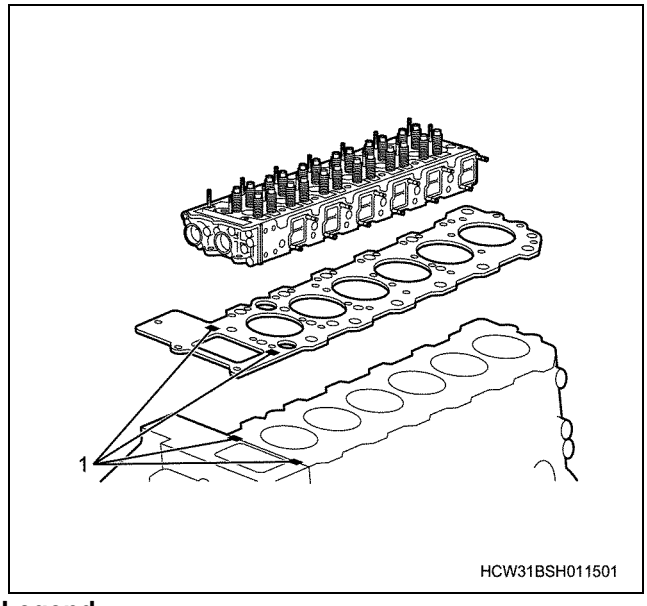
b. Apply liquid gasket to the cylinder block side.

- In line with the gear case and cylinder head match surfaces, apply liquid gasket using the edge of the gear case hole as a standard, with a width of approx. 5 mm, height of approx. 3~4 mm, and length of approx. 30 mm.
  Liquid gasket : TB1207B
- Be careful not to plug-up the oil hole shown in the diagram.
- Assemble the cylinder head within 15 minutes of applying the liquid gasket.



Legend

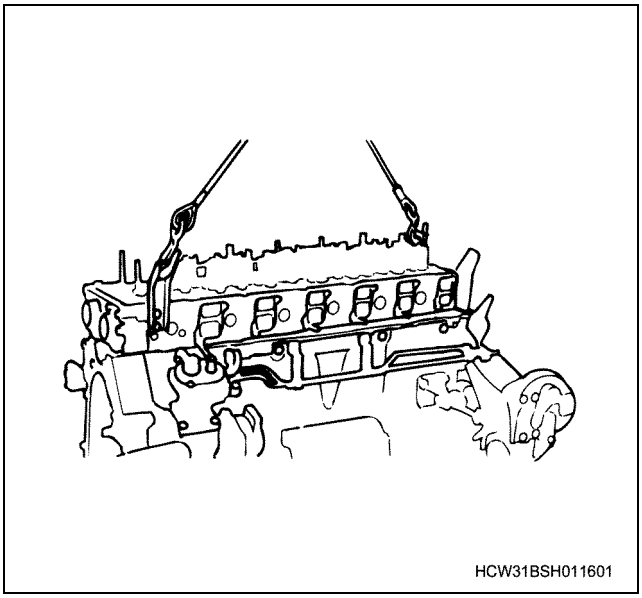
1. Gear case
2. Liquid gasket application position
3. Liquid gasket width
4. Liquid gasket length
5. Oil hole
6. Liquid gasket length
7. Cylinder block
8. Edge of the gear case hole as a standard



Legend

1. Liquid gasket application position

c. Assembling the cylinder head.
Assemble the head gasket, line up the cylinder head with the knock pin, and gently put it down.


HCW31BSH011601

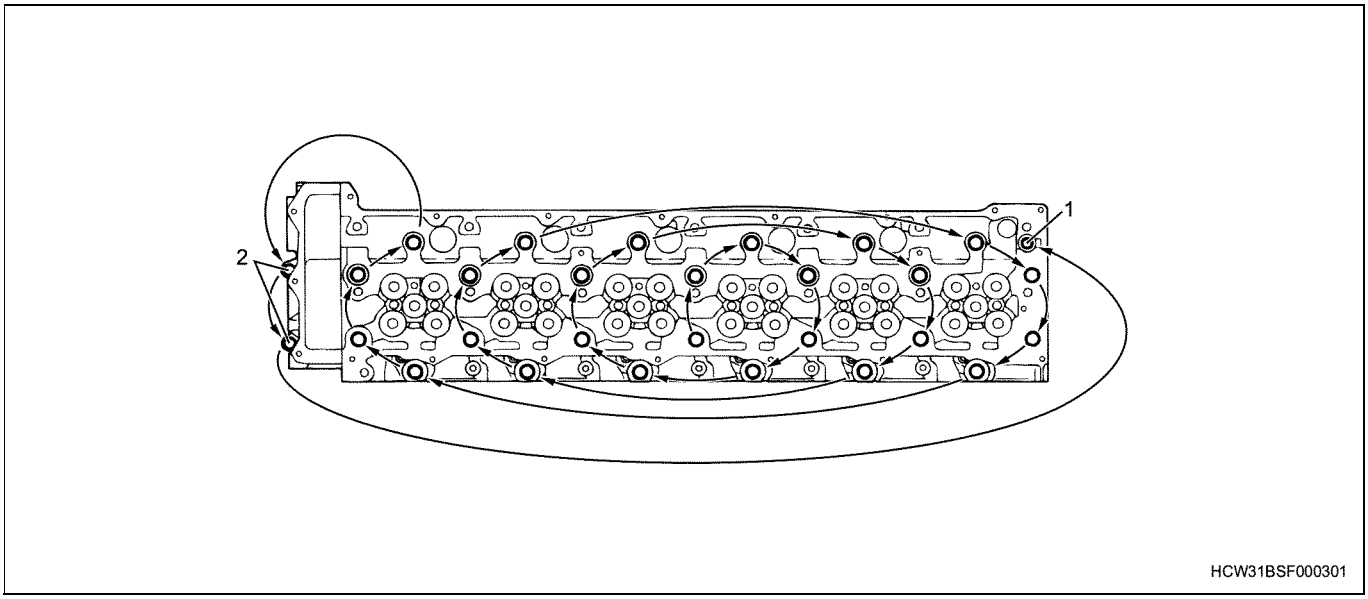
d. Tightening the cylinder head ASM.
Apply molybdenum disulphide to the M18 bolt screw section and bearing surface, and tighten as shown in the diagram spiralling out from the center. After that, tighten the M10 and M12 bolts.

Tightening torque

M18:	177 N·m {18 kgf·m} → 245 N·m {25.0 kgf·m} → angle 60 ~ 90°
M10:	38 N·m {4.0 kgf·m}
M12:	97 N·m {9.9 kgf·m}

Important:

- **Do not apply molybdenum disulphide to the M10 or M12 bolts.**
- **Use a rag etc. to cover the timing gear hole.**
- **The head bolts can be re-used up to 4 times.**



HCW31BSF000301

Legend
1. M12
2. M10

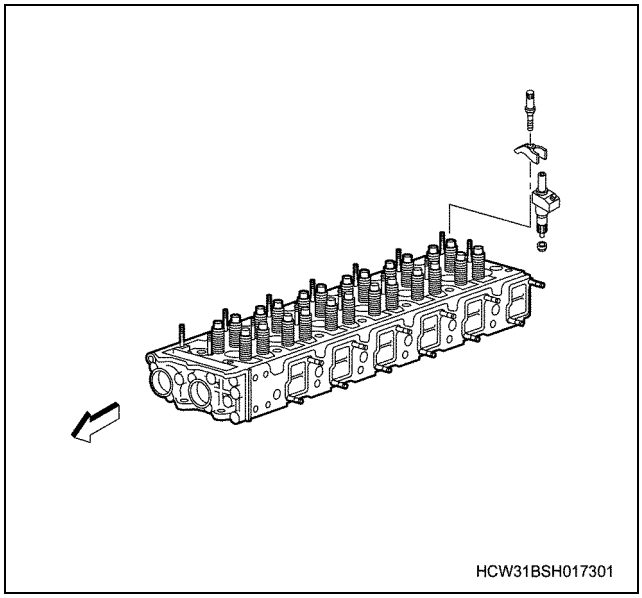
3. Install the injector & clamp.
   - Install the injector to the cylinder head, and temporarily tighten the injection pipe. Next, tighten the clamp using the clamp tightening bolt, and finally tighten the injection pipe.

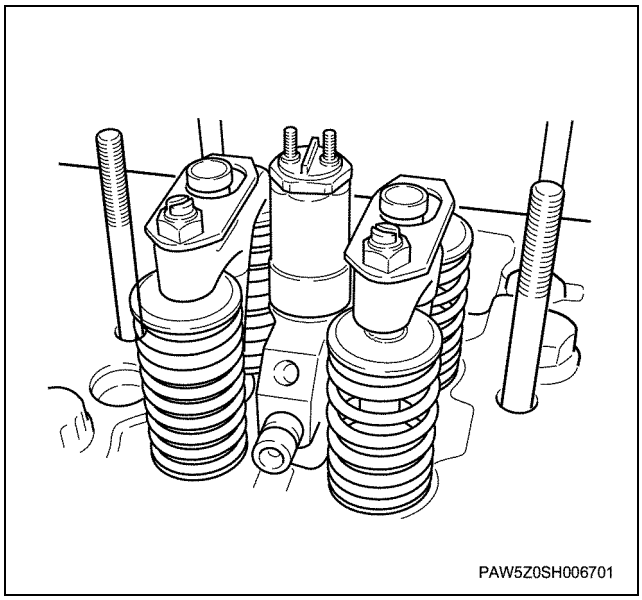
Important:
Do not re-use the gasket.

Notes:
Securely install the gasket.

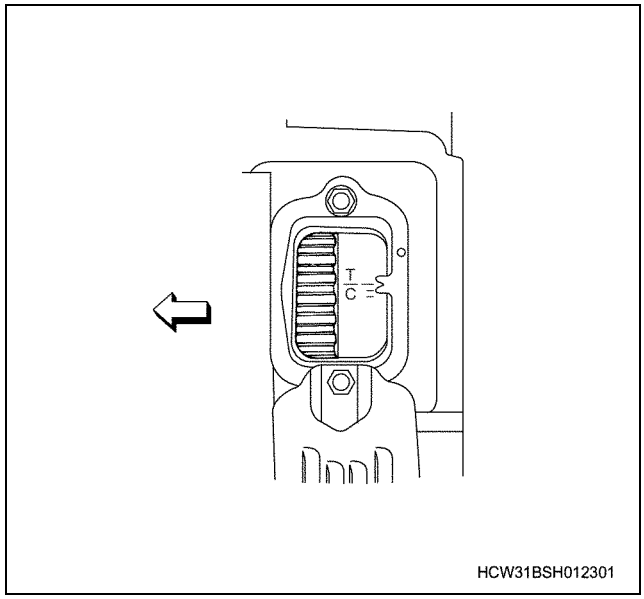
Tightening torque

Clamp:	49 N·m {5.0 kgf·m}
Injection Pipe:	39 N·m {4.0 kgf·m}


HCW31BSH017301

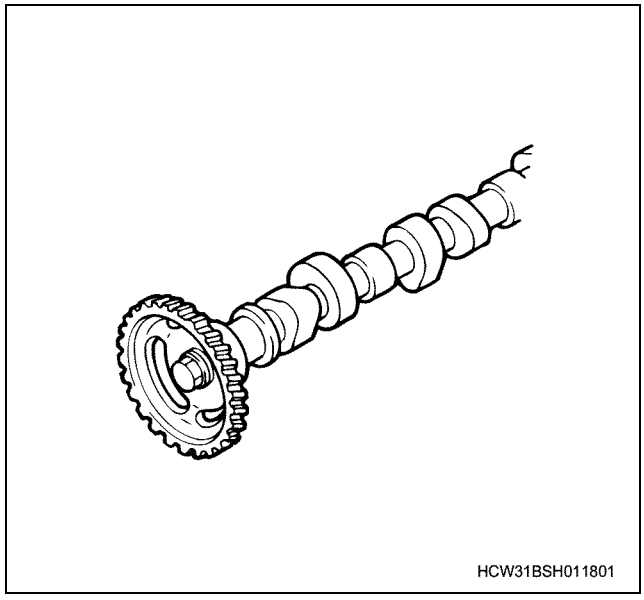

PAW5Z0SH006701

4. Install the camshaft.
   a. Set the number 1 cylinder to the compression top dead center.
      Rotate the crankshaft forwards, and line up the flywheel T/C mark to the pointer.
      At this time, check that the carved lines on the coupling and pump line up.

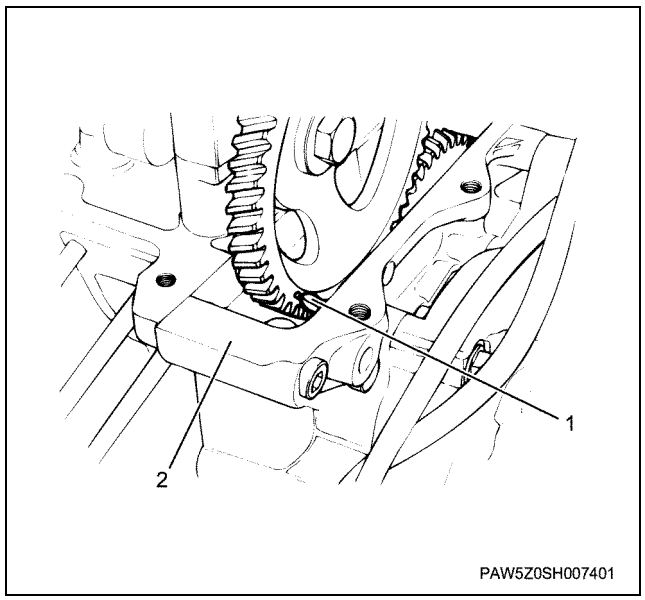


HCW31BSH012301

   b. Apply engine oil to the camshaft's cam surface and cam gear tooth surface.


HCW31BSH011801

c. Installing the camshaft
Apply oil to the camshaft bracket. Set the camshaft so that the camshaft gear mark and pointer line up.
At this time, check that the carved lines on the rear side of the camshaft are horizontal and vertical respectively.



Legend
1. Pointer
2. Gear case (head)

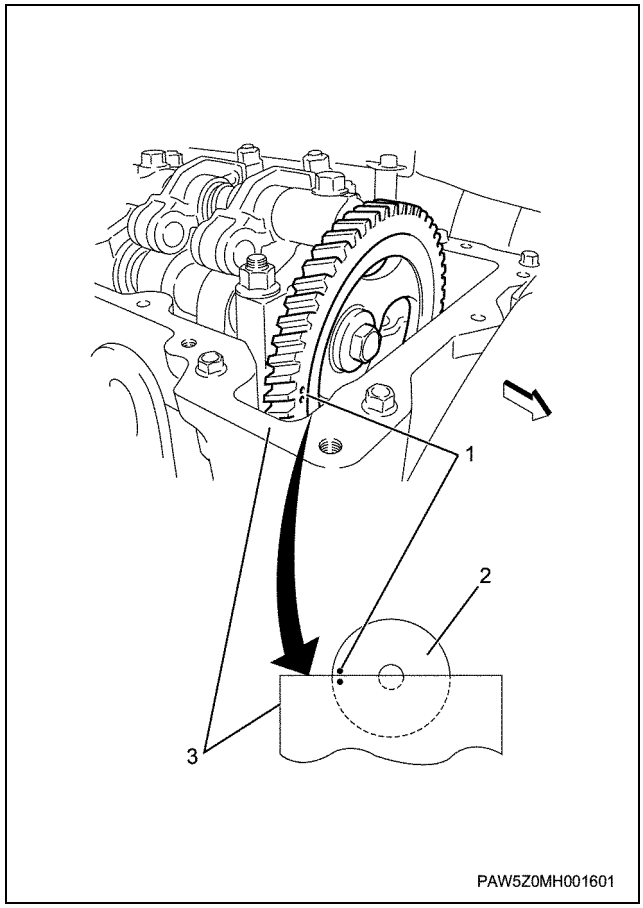
d. Installing the camshaft with the lower cover installed
When assembling with the lower cover installed, set the camshaft so that one of the 2 camshaft gear eye-marks is hidden by the lower cover as shown in the diagram.

e. Installing the camshaft bracket
Apply engine oil to the nut-bearing surface and screw section, line up the bracket marking number and install the bracket, temporarily tighten from the camshaft gear side then retighten to the standard torque.

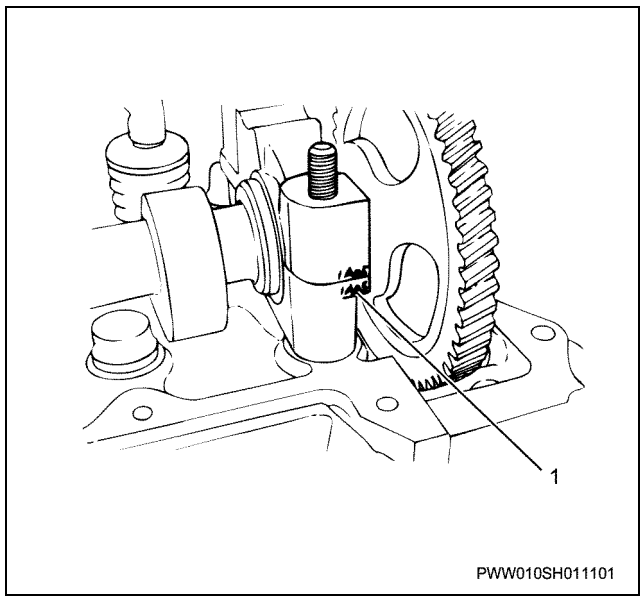
Notes:

- **Be sure to install the No.1 camshaft bracket to the No.1 position.**
- **After installing the cylinder head bolt, tighten the bracket.**

Tightening torque: 76 N·m {7.7 kgf·m}



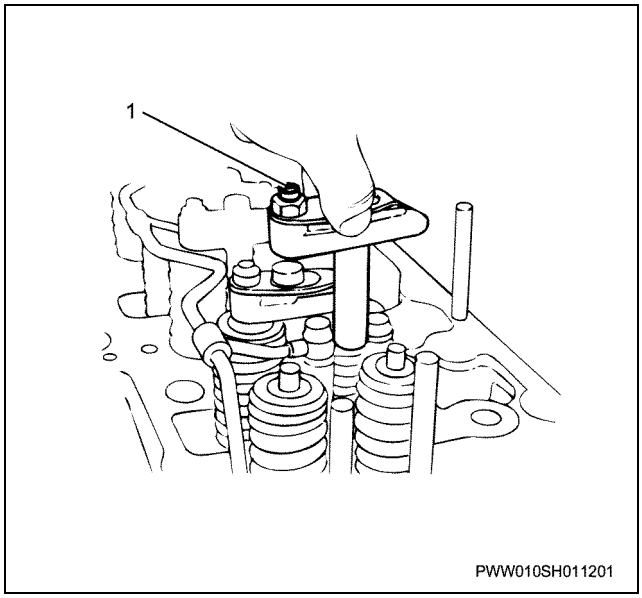
Legend
1. Eye mark
2. Cam gear
3. Lower cover (head)



Legend
1. Marking number

5. Install the bridge.

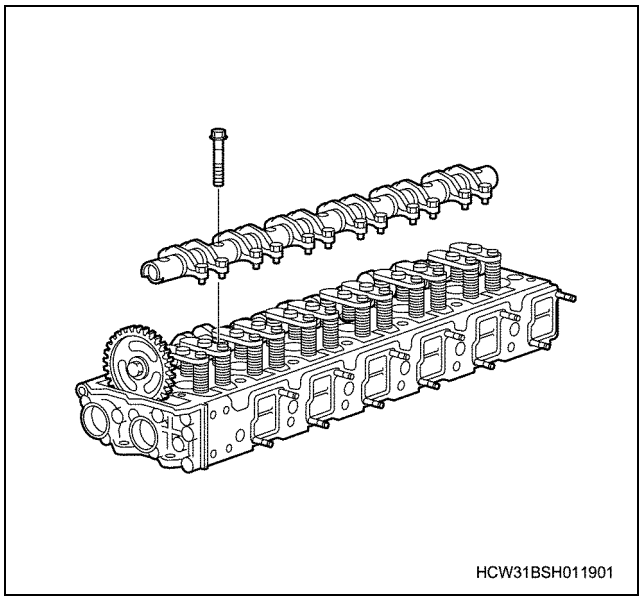
- Loosen the adjustment screw to the full limit, apply engine oil to the bridge guide and install the bridge.



Notes:

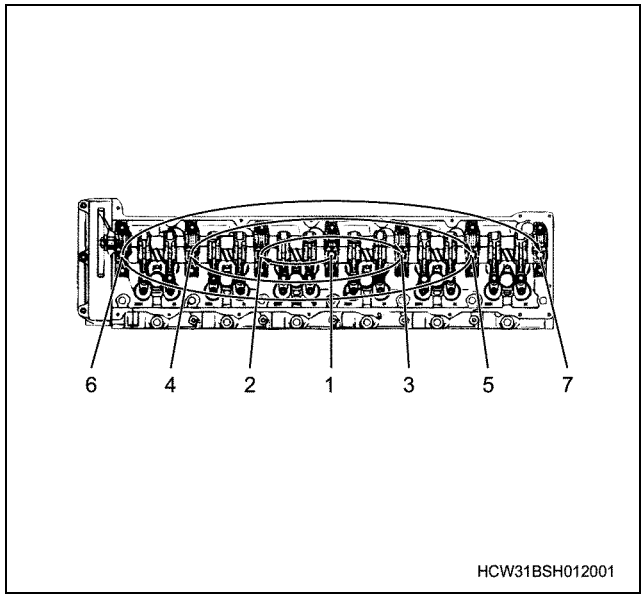
- **Assemble the parts to exactly the same cylinder number that you recorded when you disassembled them.**
- **Install the adjustment screws so that they face the intake manifold side.**

6. Install the rocker arm ASM.
   a. Loosen the adjustment screw to the full limit, apply engine oil to the roller section and adjustment screw tip section, and install the rocker arm ASM.

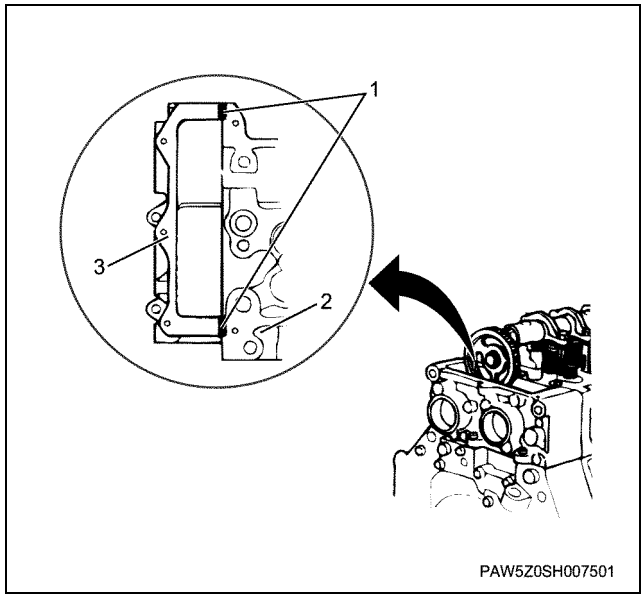


   b. After temporarily tightening in the number order shown in the diagram, tighten and fix to the standard torque in the number order shown in the diagram.

Tightening torque: 90 N·m {9.2 kgf·m}



   c. Valve clearance adjustment
      Refer to the adjustment outline that can be found in the valve clearance adjustment item in the functional check section.
7. Install the head lower cover gasket to the head lower cover.
8. Install the head lower cover.
   a. Clean the upper surface of the cylinder head, and apply liquid gasket to the upper surface of the joint between the timing gear case and cylinder head.
      - Apply approx. ϕ4 bead width of Three Bond 1207B liquid gasket along the joint surface between the cylinder head and gear case (head).
      - Install the head lower cover immediately after applying the liquid gasket.
      - Assemble the head lower cover within 15 minutes of applying the liquid gasket. If the parts are left for more than 15 minutes, remove all of the liquid gasket, re-apply the liquid gasket, then assemble the head lower cover.
      - If you have removed the head lower cover, remove the old liquid gasket while taking care not to allow any to go into the gear case, then reapply liquid gasket and assemble the parts.

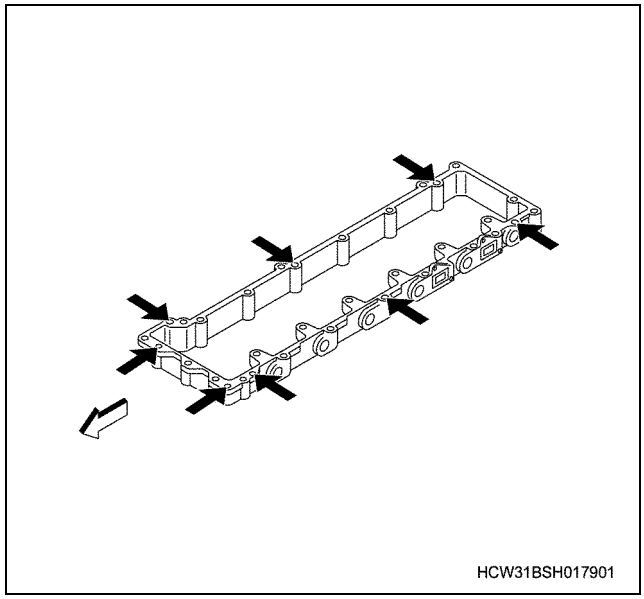


Legend

1. Liquid gasket application position
2. Cylinder head
3. Gear case (head)

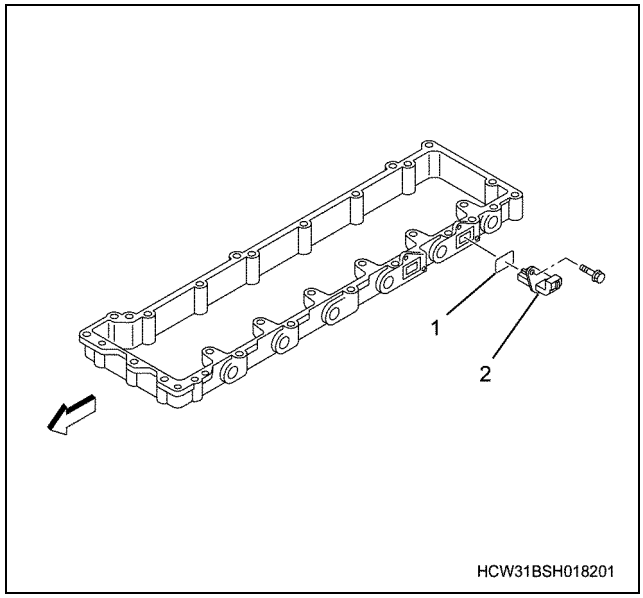
b. Tighten the insert arrow bolt in the gasket cover slot.

Tightening torque: 15 N·m {1.5 kgf·m}



9. Install the harness connector.
   - Insert the O-ring and install the connector to the lower cover.

Tightening torque: 20 N·m {2.0 kgf·m}



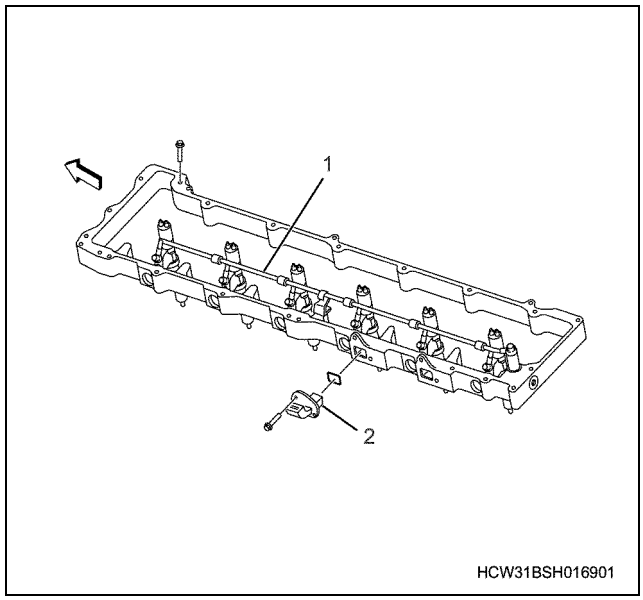
Legend

1. O-ring
2. Connector

10. Install the nozzle leak off pipe.
    - Install the adapter to the lower cover rear side and install the nozzle leak off pipe to the injector.

Tightening torque

Adapter:	20 N·m {2.0 kgf·m}
Eyebolt:	15 N·m {1.5 kgf·m}



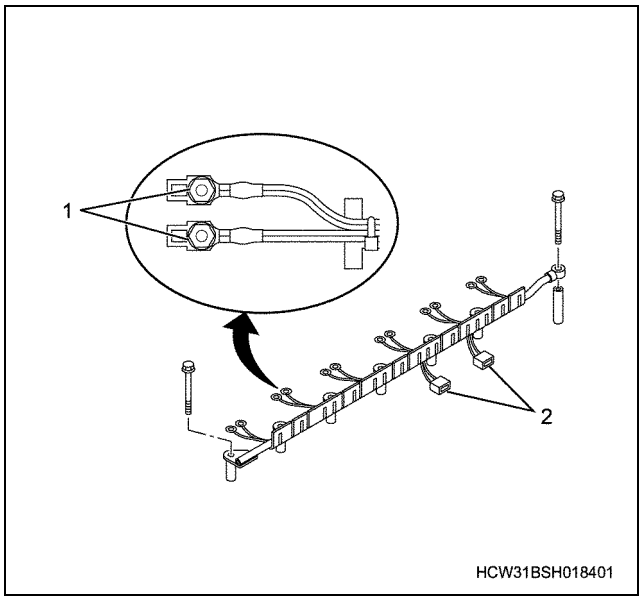
Legend

1. Nozzle leak off pipe
2. Connector

11. Install the injector harness.

a. insert the injector side connector to the connector installed to the lower cover until you hear a click sound, then install the injector harness to the lower cover.

Tightening torque: 22 N·m {2.2 kgf·m}

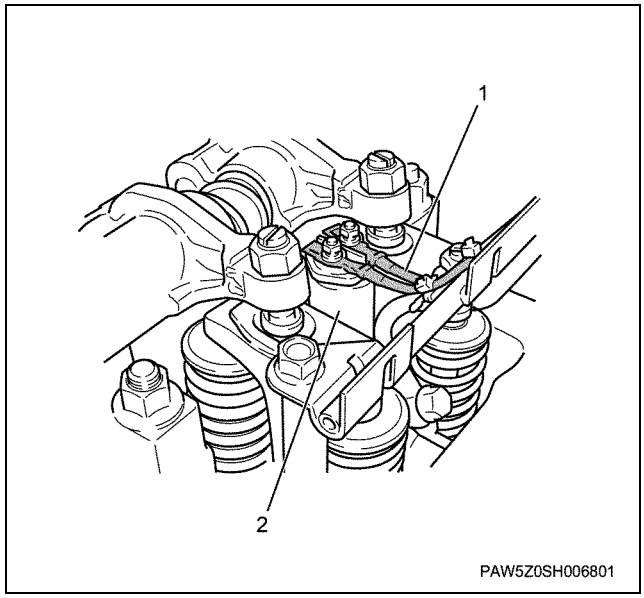


Legend
1. Nut
2. Connector

b. Insert the harness (1) terminal into the head of each cylinder injector (2), then tighten the nut to the correct torque.

Tightening torque: 2.0 N·m {0.2 kgf·m}

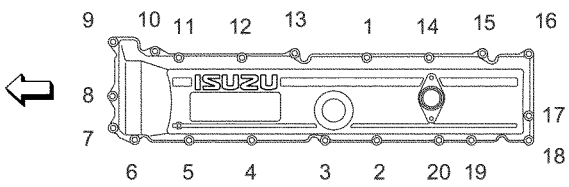
Caution:
Tightening the nut too much will cause damage to the injector, therefore it should never be tightened too much.



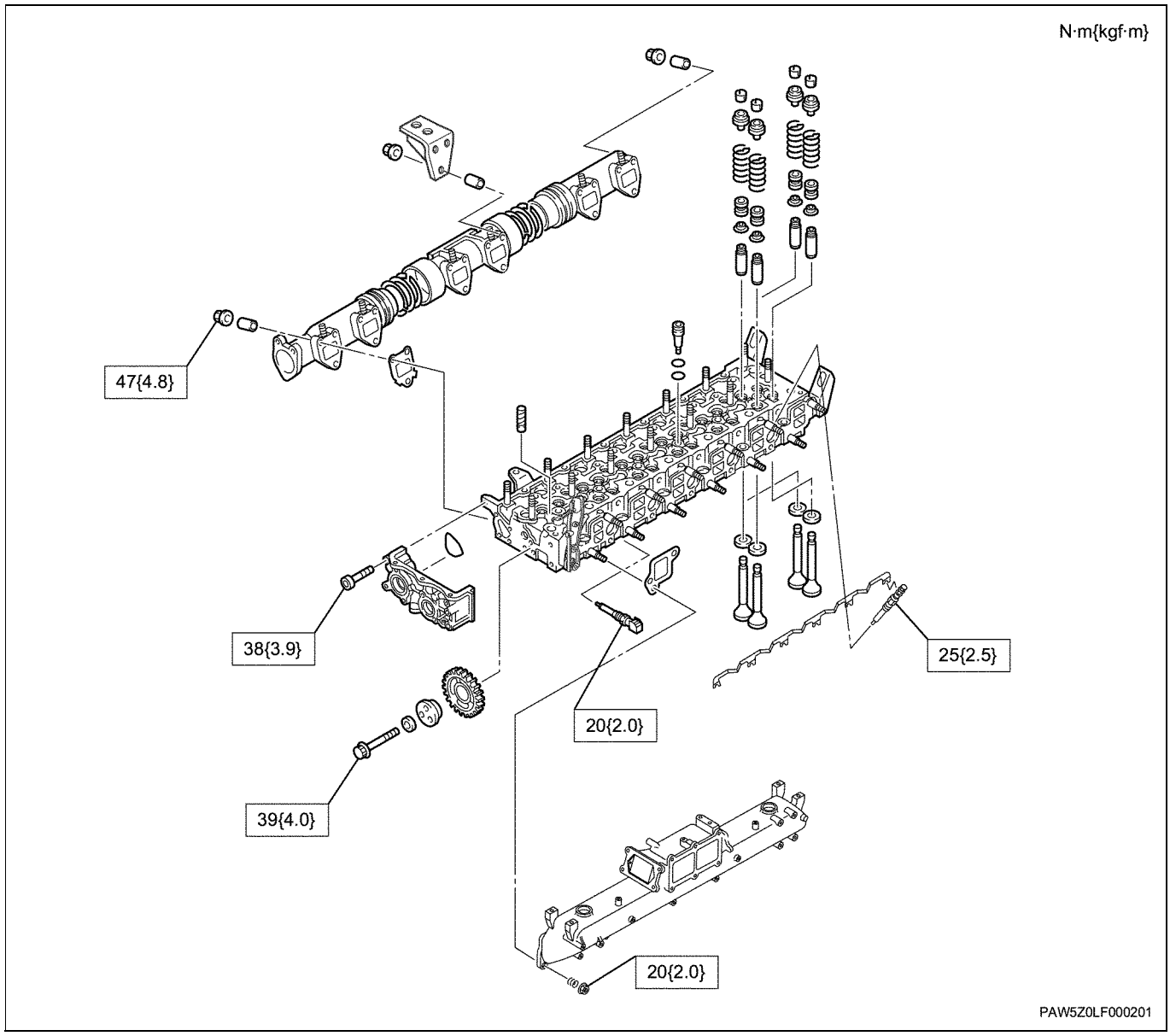
Legend
1. Injector harness
2. Injector

12. Install the head cover gasket.
13. Install the head cover.
    a. Insert the gasket into the head cover and install the head cover.
    b. Tighten in the number order shown in the diagram.

Tightening torque: 15 N·m {1.5 kgf·m}

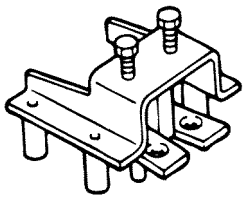
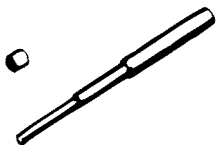
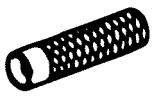
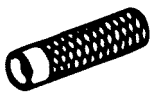


Torque specifications



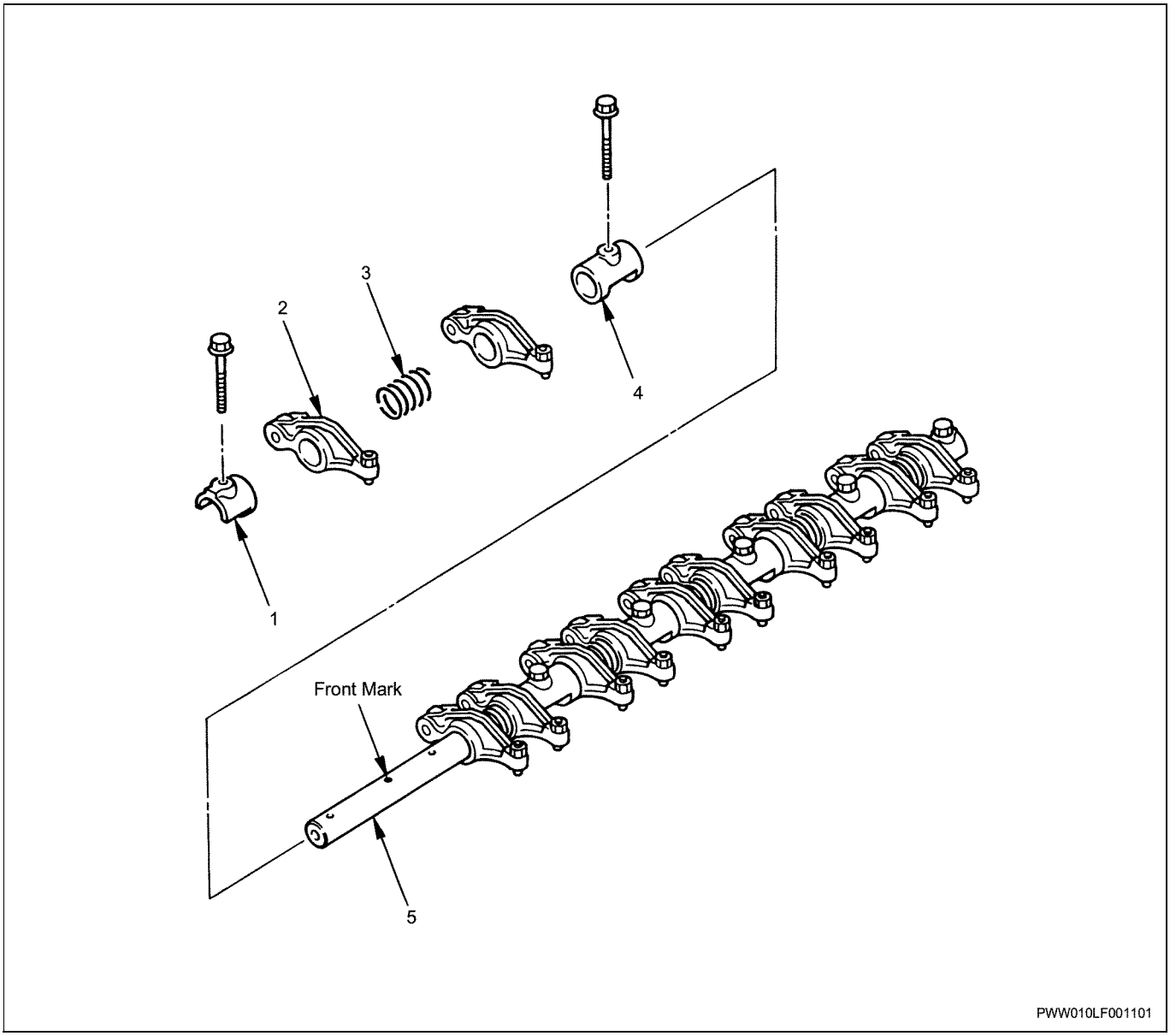
Special tools

Cylinder head

Illustration	Tool number Tool name
 1852350130	1-8523-5013-0 Compressor; Valve spring
 9852312020	9-8523-1202-0 Replacer; Valve guide
 9852213240	9-8522-1324-0 Installer; Valve bridge guide
 1852211840	1-8522-1140-1 Installer; Valve stem seal for intake
 1852211840	1-8522-1184-0 Installer; Valve stem seal for exhaust

Rocker arm

Component parts



Legend

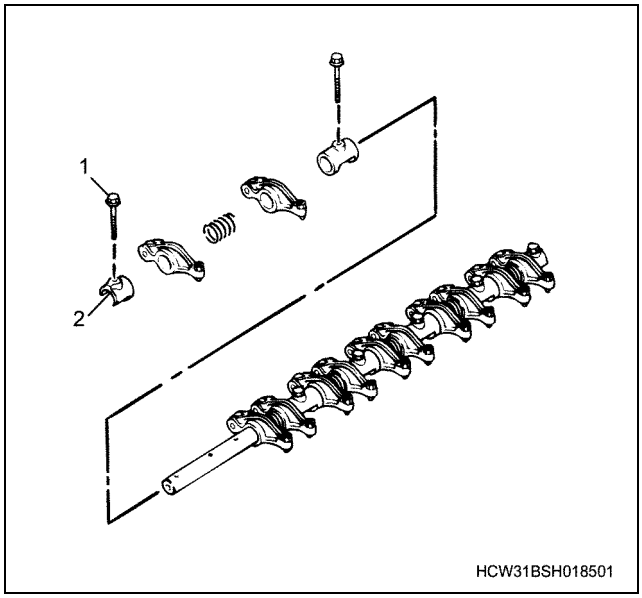
1. Bracket
2. Rocker arm
3. Spring
4. Bracket
5. Rocker arm shaft

Disassembly

1. Remove the bracket.
2. Remove the rocker arm.
3. Remove the spring.
4. Remove the bracket.
5. Remove the rocker arm shaft.
   - While holding the locker arm shaft bracket, pull out the tightening bolts (1) from the bracket (2), and remove the rocker arm, spring, and bracket.

Notes:

- **If you remove the bracket's tightening bolt, the rocker arm etc. will fly out under the force of the spring.**
- **Therefore, all of the bolts should be gradually loosened at an equal balanced rate.**



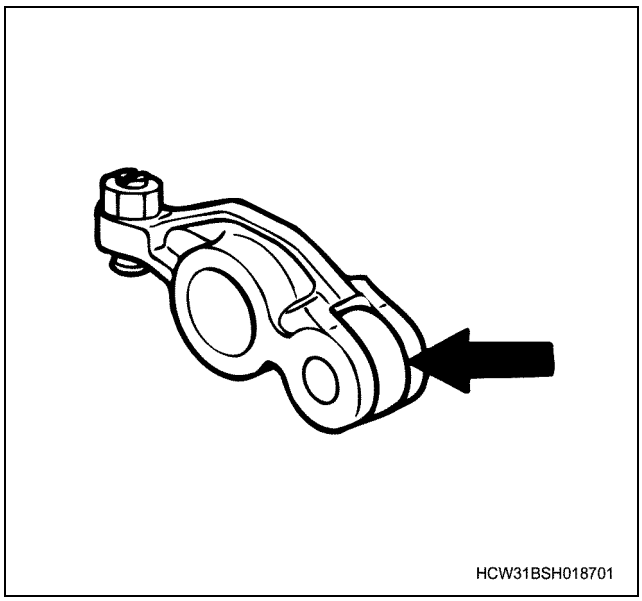
Inspection

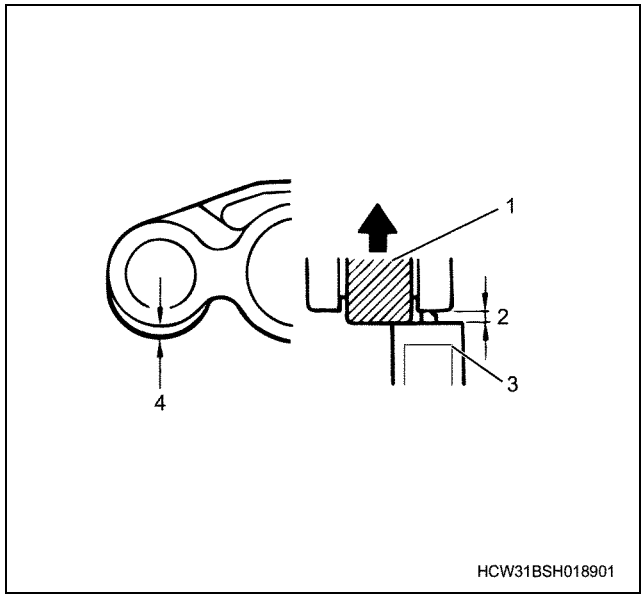
Rocker arm

- Inspect the roller surface for wear or damage, and measure the clearance between the roller pin and roller.
  Mark the measurement place when the rocker arm roller is pushed out to its limit, and measure the level difference (A measurement) between the rocker arm and roller. Next, push the roller in to its limit, then measure the level difference (B measurement) at the position of the measurement place mark.
  The difference between the A measurement and B measurement above is the clearance between the roller pin and roller.

Clearance between roller pin and roller

Standard mm	Limit mm
0.036 ~ 0.069	0.15



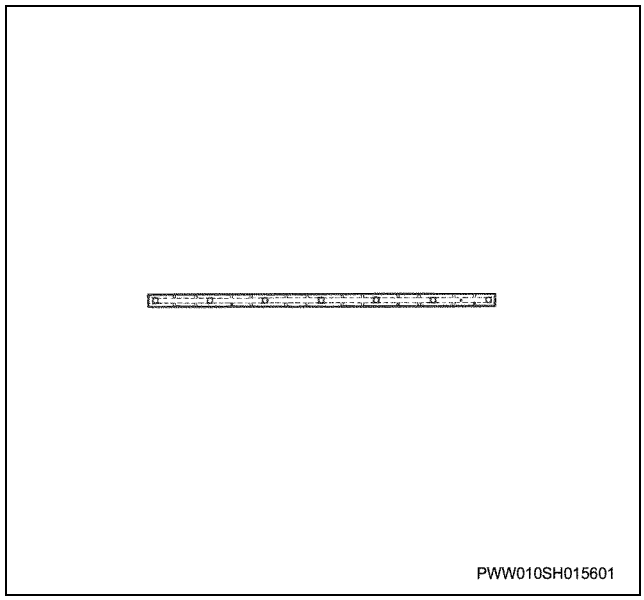


Legend

1. Roller
2. B measurement
3. Callipers
4. A measurement

Rocker arm shaft

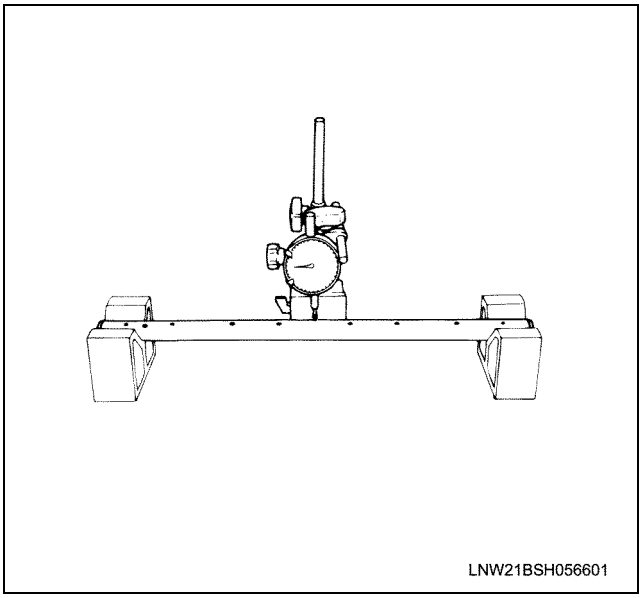
- Inspect the oil pore of the rocker arm shaft



- Inspect the bend of the rocker arm shaft

Shaft bend

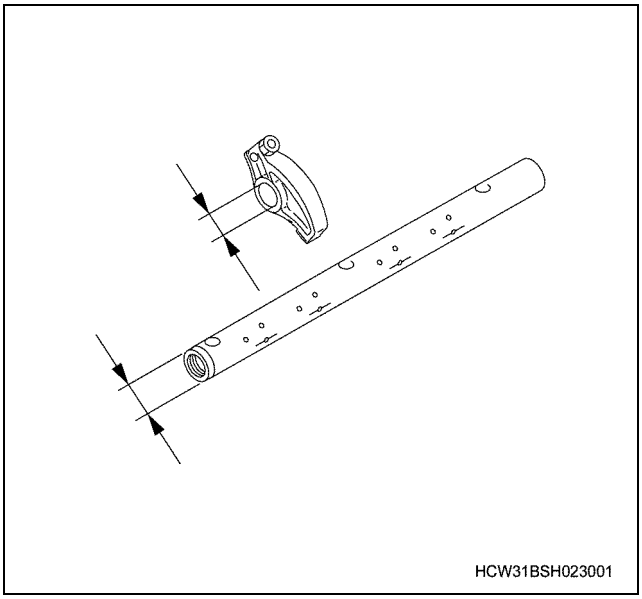
Limit:	0.3 mm



- Measure the outer diameter of the rocker arm shaft and clearance between shaft and rocker arm bush.

(mm)

	Nominal dimension	Standard	Limit
Clearance between shaft and rocker arm	—	0.02 ~ 0.074	0.20
Shaft outer diameter	ϕ28	—	ϕ27.85

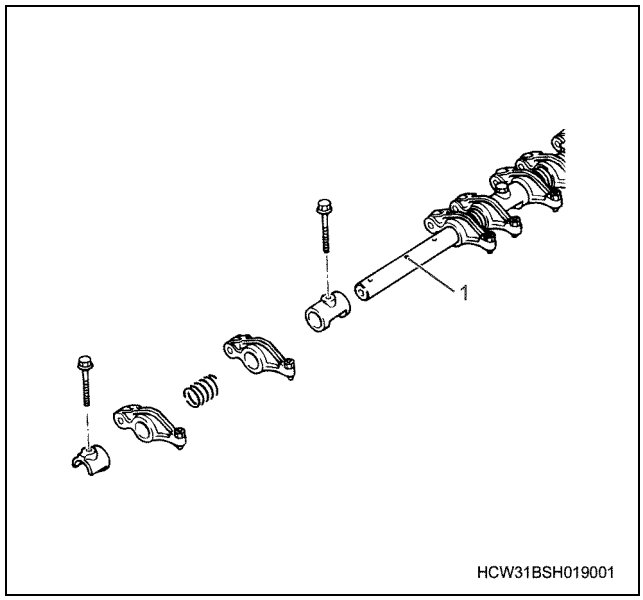


Assembly

1. Apply a thin layer of oil to the rocker arm shaft.
2. Install the bracket.
3. Apply engine oil to the bush section and roller section, and install the rocker arm.
4. Install the spring.
5. Install the bracket.
   - Install each part in the direction shown in the diagram.

Notes:

- **Check the front mark (1) on the rocker arm shaft.**



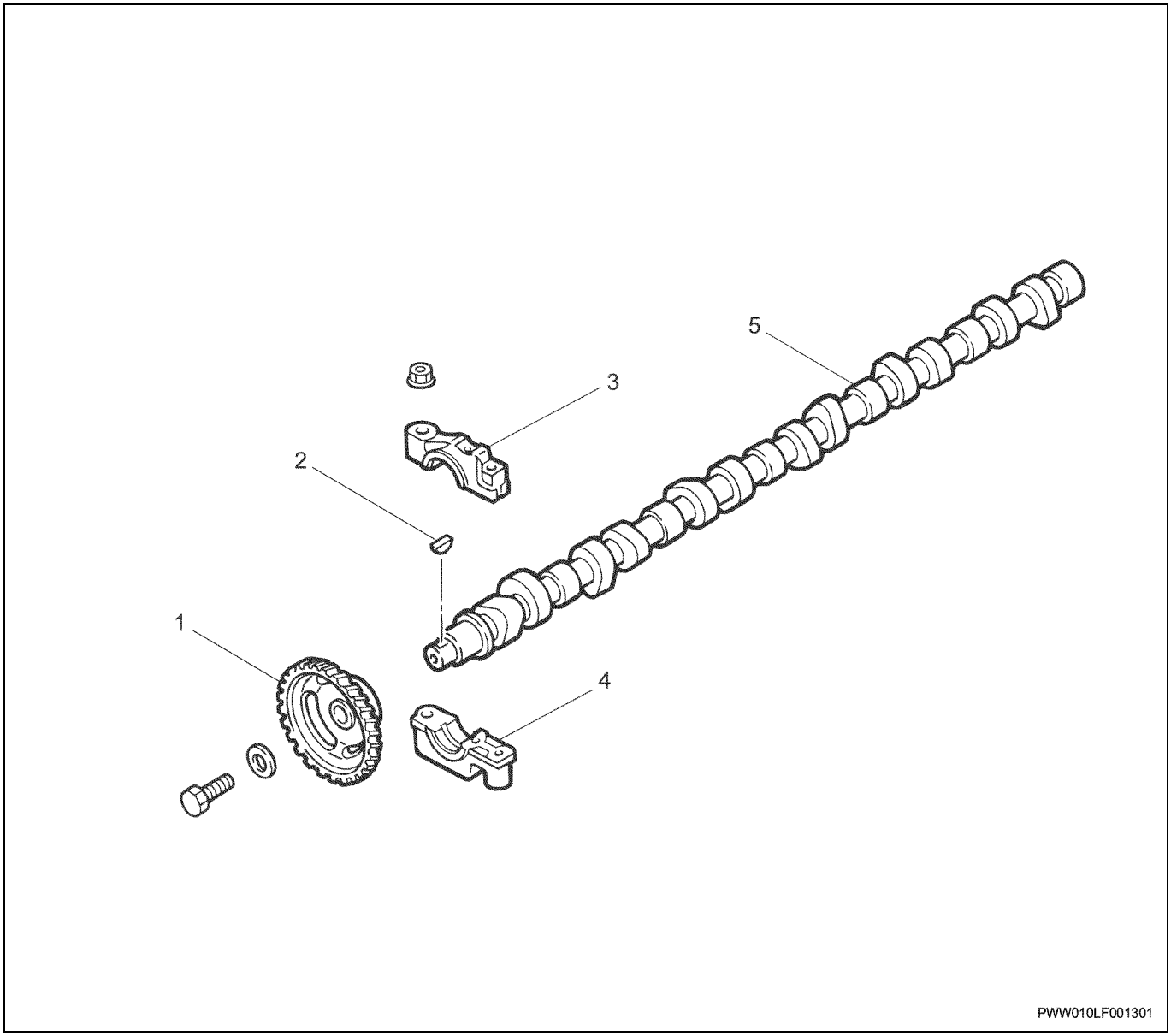
Legend

1. Front mark

Camshaft

Component parts

Camshaft



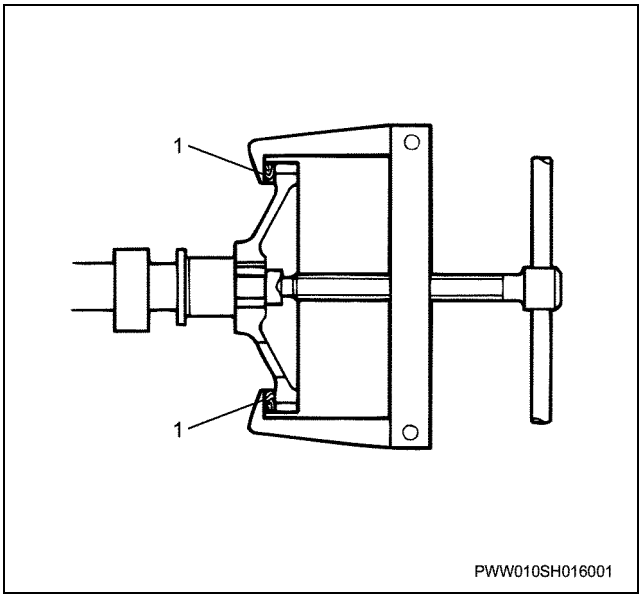
Legend

1. Cam shaft gear
2. Key
3. Upper cam shaft bracket
4. Lower cam shaft bracket
5. Cam shaft

Disassembly

1. Remove the camshaft gear.
   - Rest the gear on a wooden block (1) to avoid damaging it, and use a puller to remove it.

Caution:
Inspect the gears for damage. If there are no problems with it, do not remove it.

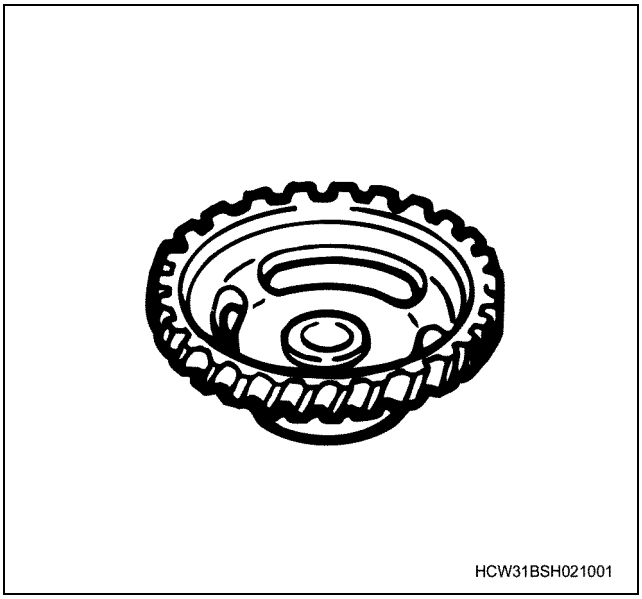


2. Remove the key from the camshaft.

Inspection

Camshaft gear

- Inspect for damage.

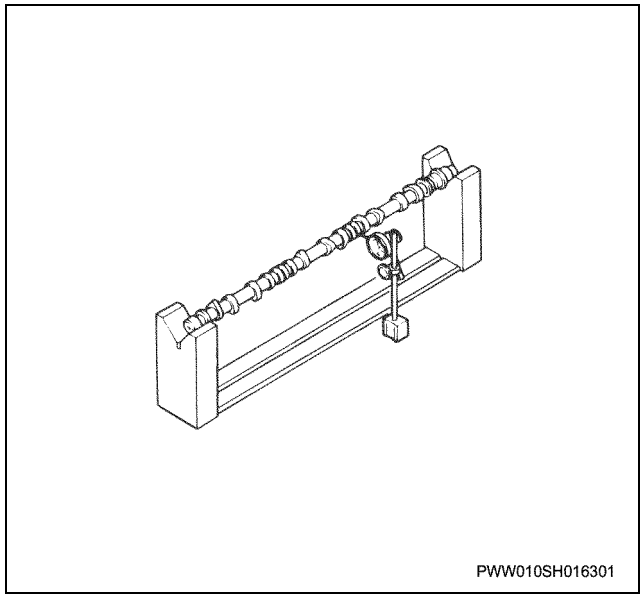


Camshaft

- Measure the bend of the camshaft
  Hold the No.1 and No.7 journal sections with a V block, and use a dial gauge on the No.4 journal to gently turn the camshaft through 1 revolution and measure the camshaft.

Amount of camshaft runout (mm)

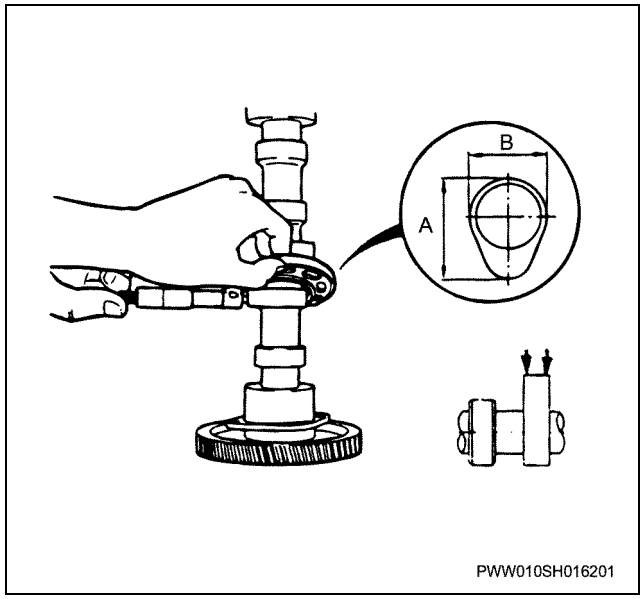
Standard	Limit
0.08	0.1



- Inspect the cam surface for damage, and measure the amount of cam lift.
  Repair any slight abrasions or wear with an oilstone.
  Measure A-B, and determine the amount of lift.

Amount of cam lift (A-B) (mm)

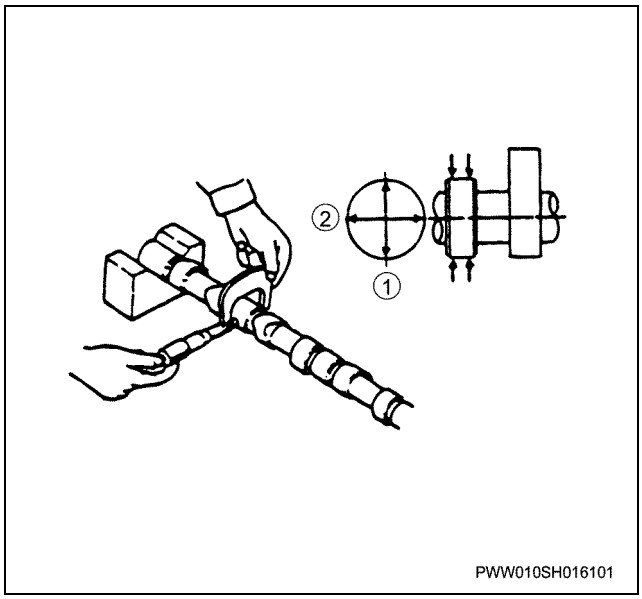
	Nominal dimension	Limit
Intake	9.4	8.85
Exhaust	10.4	9.75



- Measure the outer diameter of the journal.
  Measure in the position shown in the diagram with a micrometer.

Journal diameter (mm)

Nominal dimension	Limit
ϕ40.0	ϕ39.89

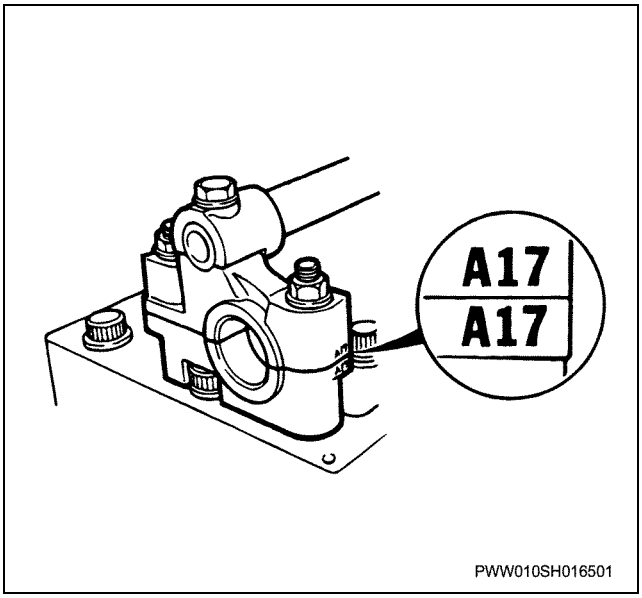


Measure the clearance between the camshaft journal and camshaft bracket.

- Measure the inner diameter of the camshaft bracket, and outer diameter of the camshaft, and calculate the clearance.
- Clean the cam shaft bracket, check the markings on the side surface and assemble, apply engine oil to the screw section and tighten to the correct tightening torque. Next, install the rocker arm shaft, apply oil to the screw section and tighten to the correct tightening torque.
  Measure each of the 4 positions in the diagram with a cylinder gauge and calculate the camshaft bracket's bore diameter.

Tightening torque

Camshaft bracket: 75.5 N·m {7.7 kgf·m}
Rocker arm shaft: 90.0 N·m {9.2 kgf·m}



- Work out the cam shaft journal external diameter by measuring each of the 4 points shown on the diagram with a micrometer.

Clearance between camshaft journal and camshaft bracket

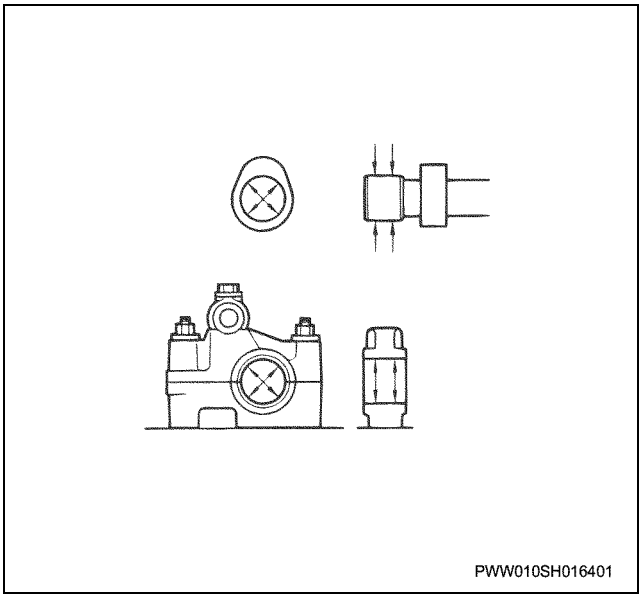
(mm)

Standard	Limit
0.065 ~ 0.125	0.15

*Refer to the general remarks section when using a plastiguage to measure the clearance.

Caution:

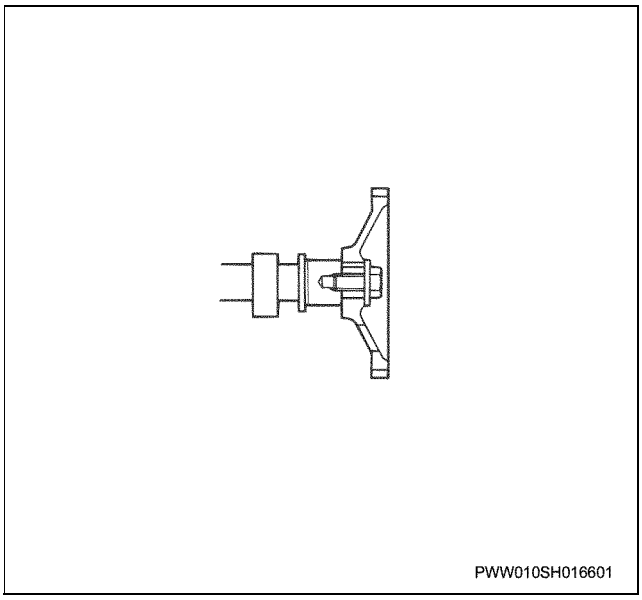
- Be sure to install the No.1 camshaft bracket to the No.1 position.
- The marking on the side of the camshaft bracket is not the journal number.



Assembly

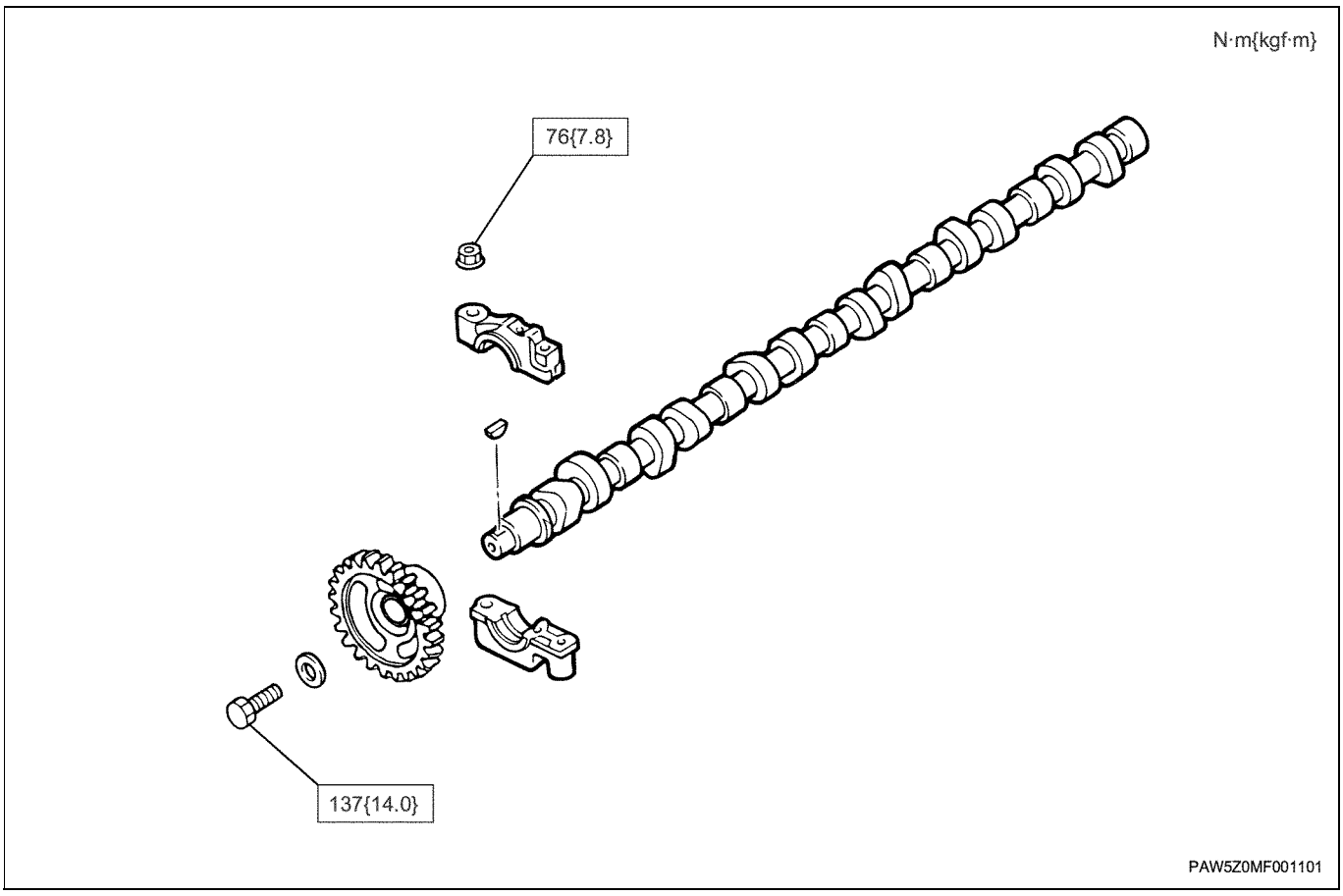
1. Install the key to the camshaft.
2. Install the camshaft gear.
   - Assemble the larger gear center boss facing the camshaft side. Next, apply oil to the screw section and bearing surface, and tighten the screws.

Tightening torque: 137 N·m {14.0 kgf·m}



Torque specifications

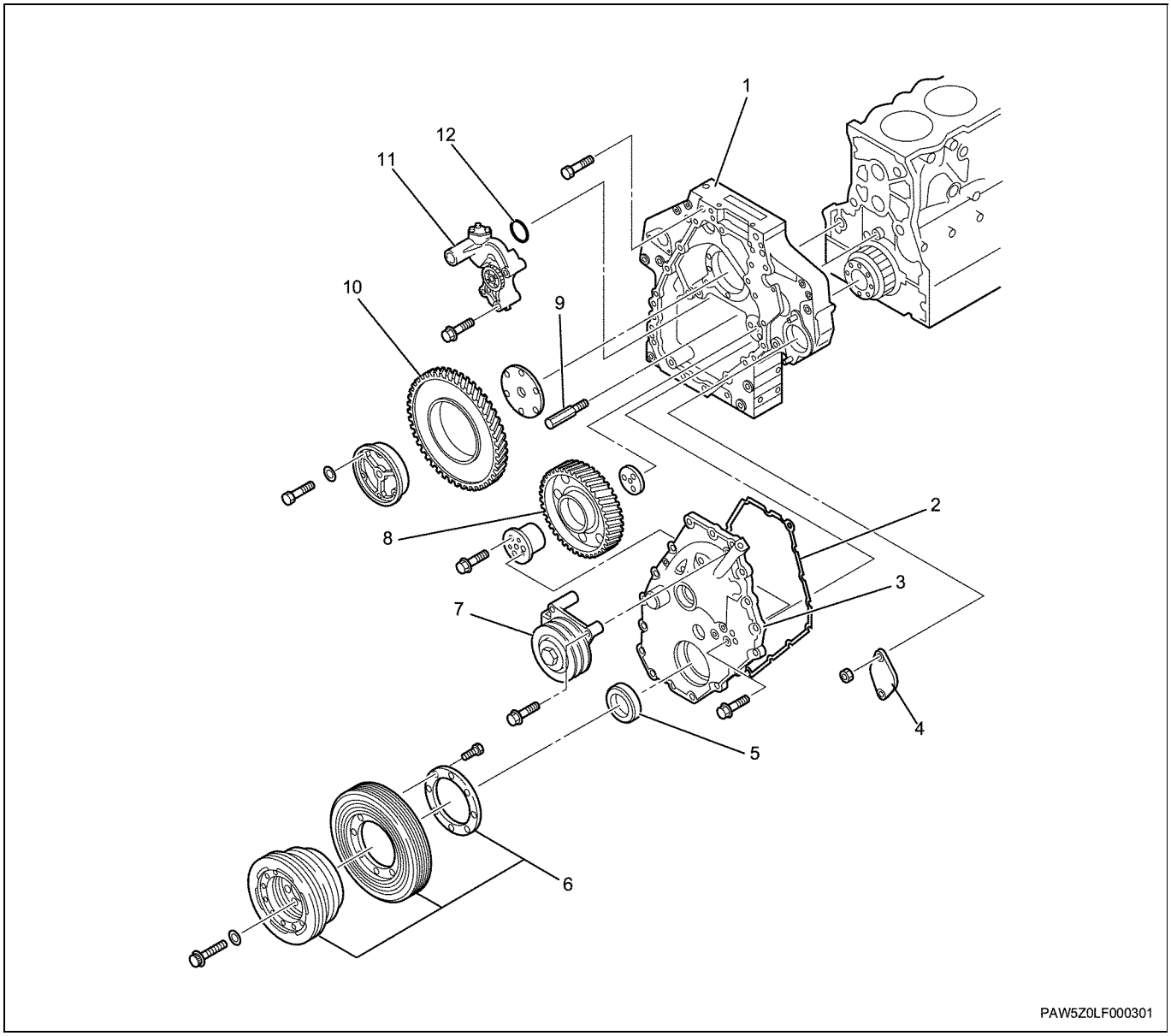
Camshaft



Timing gear

Component parts

Timing gear



Legend

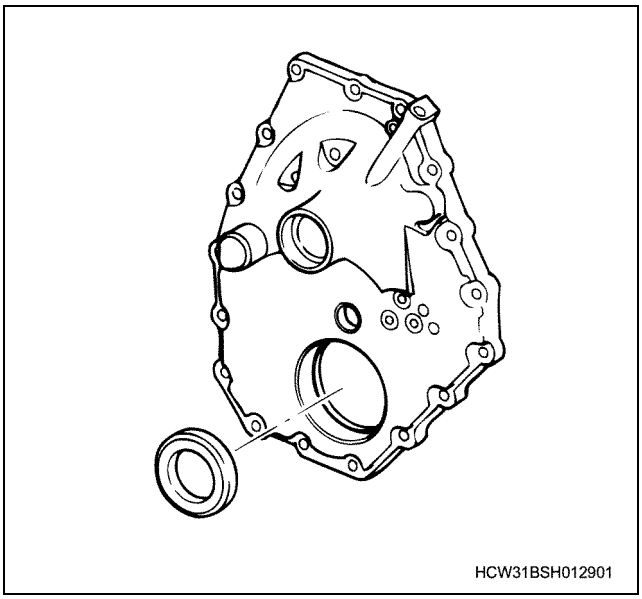
1. Timing gear case
2. Gasket
3. Gear case cover
4. Cover
5. Oil seal (crankshaft)
6. Crank pulley ASM
7. Idling pulley
8. Idle gear A
9. Distance bolt
10. Idle gear B
11. Oil pump
12. O-ring

Removal

1. Remove the crank pulley ASM.
2. Remove the idle pulley.
3. Remove the gear case cover.
4. Remove the gasket.
5. Remove the oil seal (crankshaft Ft).

- Be careful not to damage or scratch the force-fit surface of the front cover's oil seal when removing the oil seal.

- The oil seal cannot be re-used.

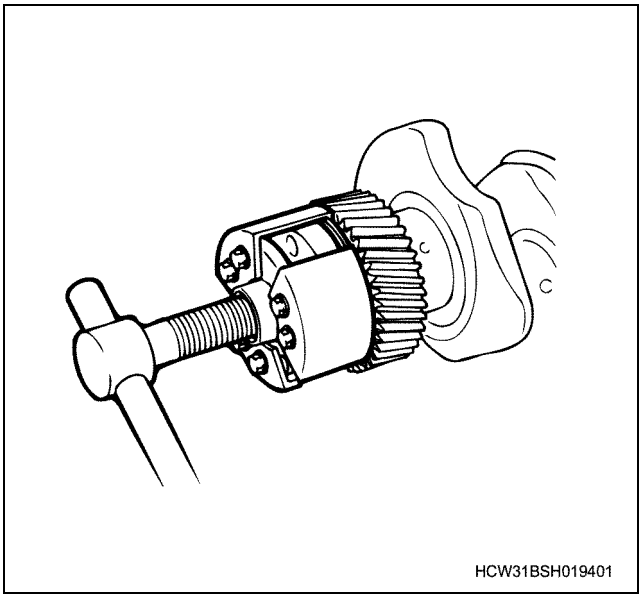


- Use a remover to remove the slinger.
- The slinger cannot be re-used.

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.**

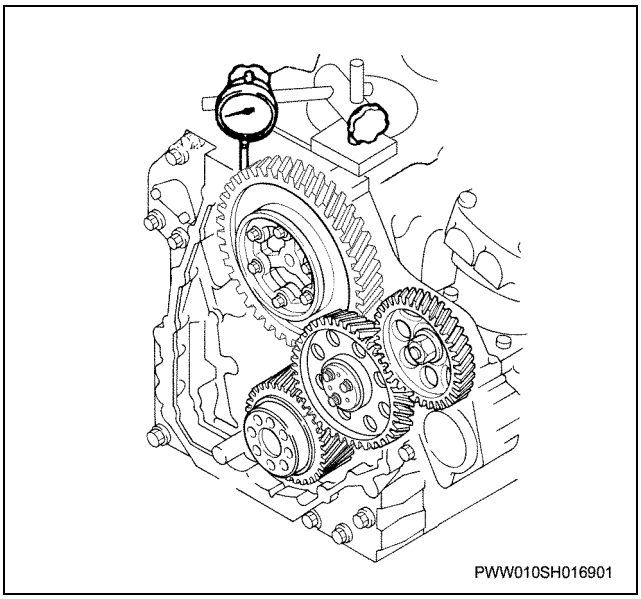
Remover; Slinger: 1-8521-0027-0



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.

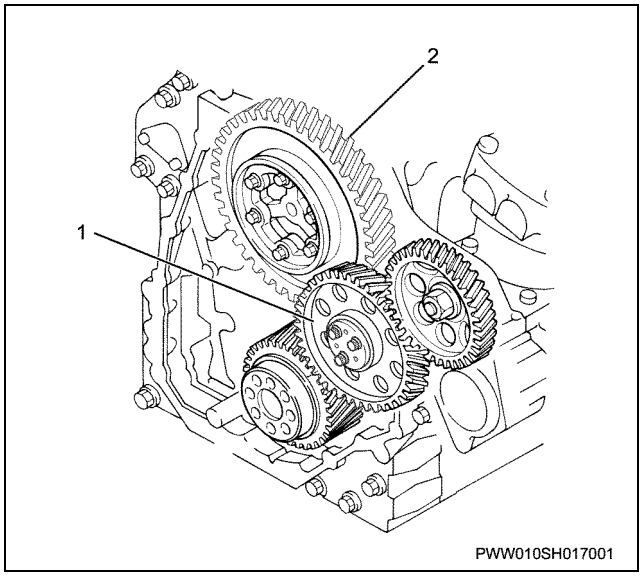
Shaft orientation clearances (mm)

Standard	Limit
0.165 ~ 0.230	0.35

- Measure the idle gear B shaft orientation clearance.

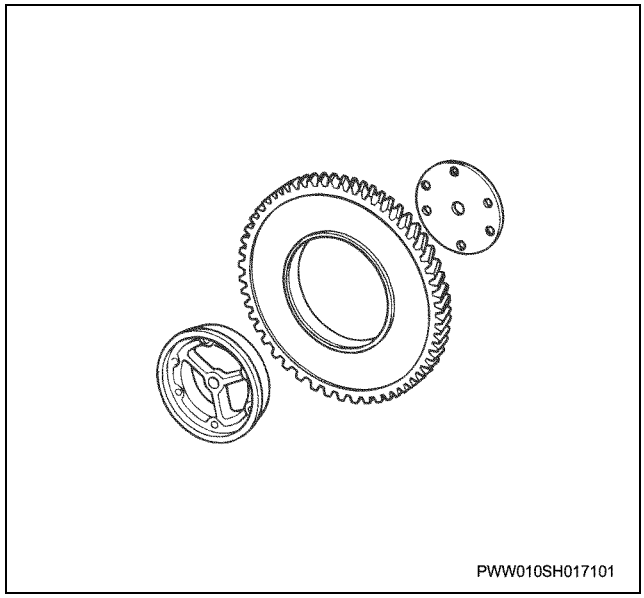
Shaft orientation clearances (mm)

Standard	Limit
0.050 ~ 0.140	0.25



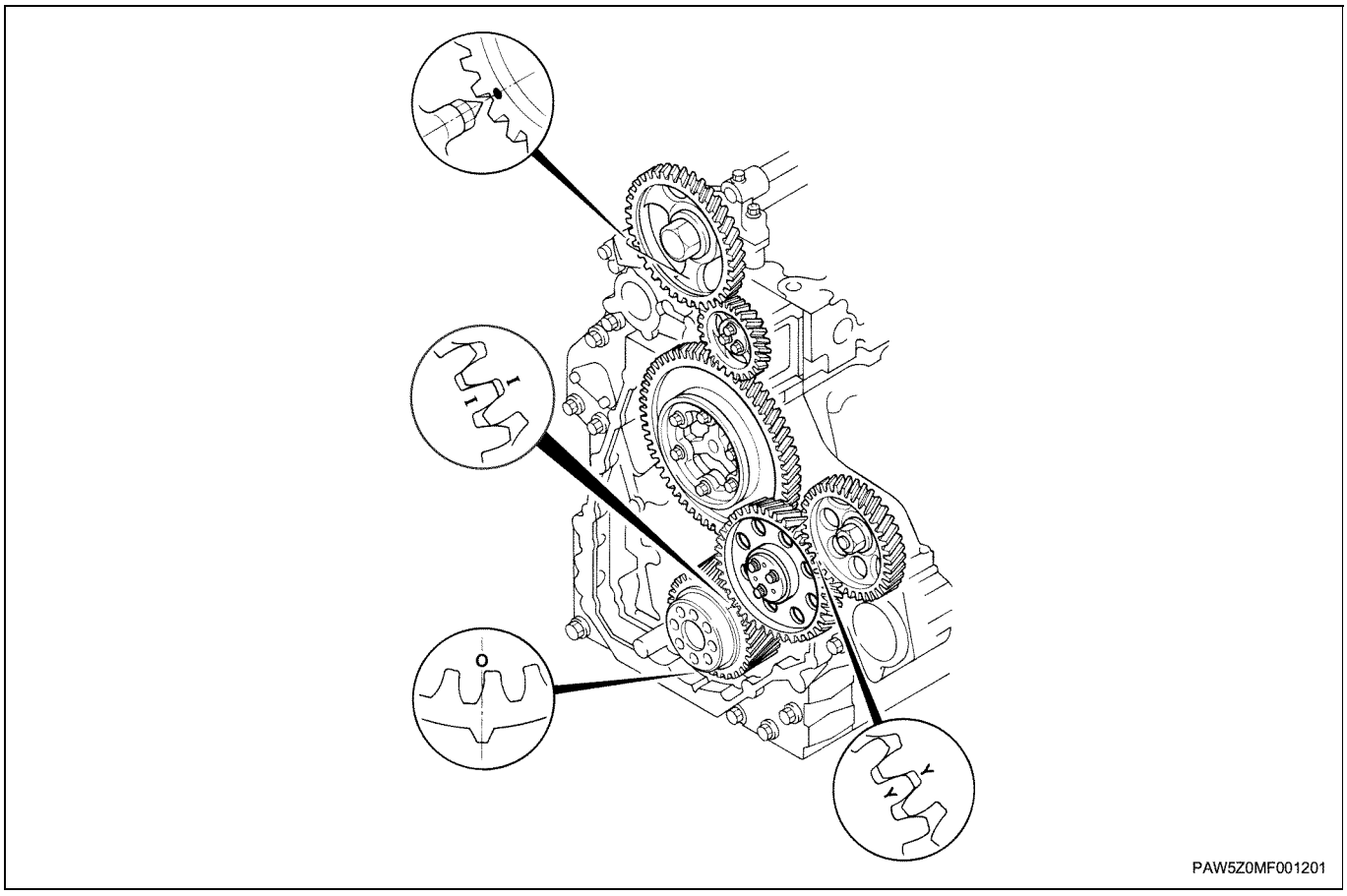
Legend
1. Idle gear A
2. Idle gear B

- Remove idle gear A and idle gear B.
  Both the idle gear and thrust plate have a front and back direction, so remember to mark these directions when removing these parts.



10. Remove the cover.
    - Do not remove if there is no oil leakage.
11. Remove the timing gear case.

Inspection



Idle gear

- Measure the spindle diameter and clearance between gear and spindle for each idle gear.

Idle gear spindle diameter (mm)

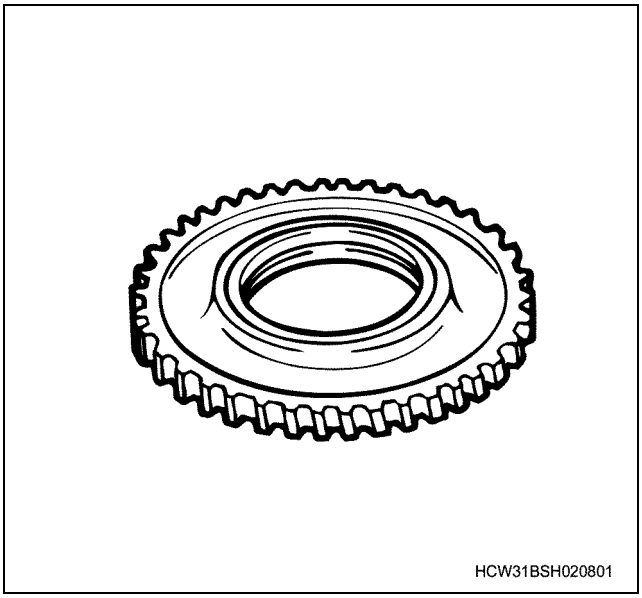
Idle gear	Nominal dimension	Limit
A	ϕ79	ϕ78.85
	ϕ57	ϕ56.85
B	ϕ142	ϕ141.85
C	ϕ49	ϕ48.85

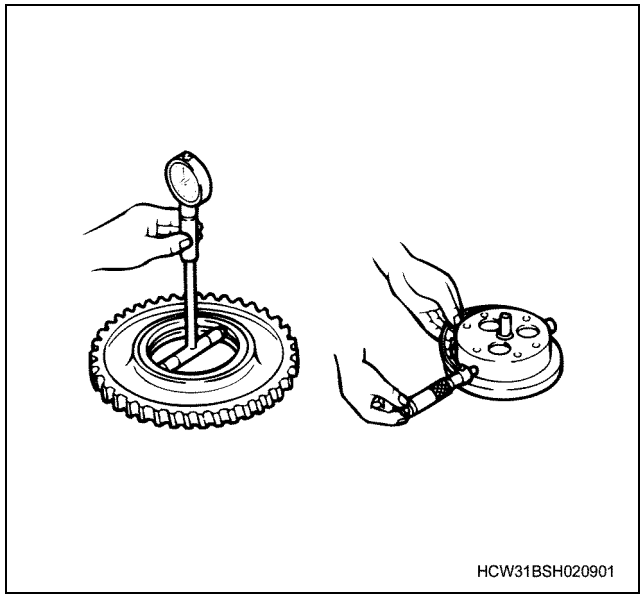
Idle gear (A,B,C) and spindle clearance (mm)

Standard	Limit
0.04 ~ 0.105	0.20

Pin outer diameter of idle A large gear (mm)

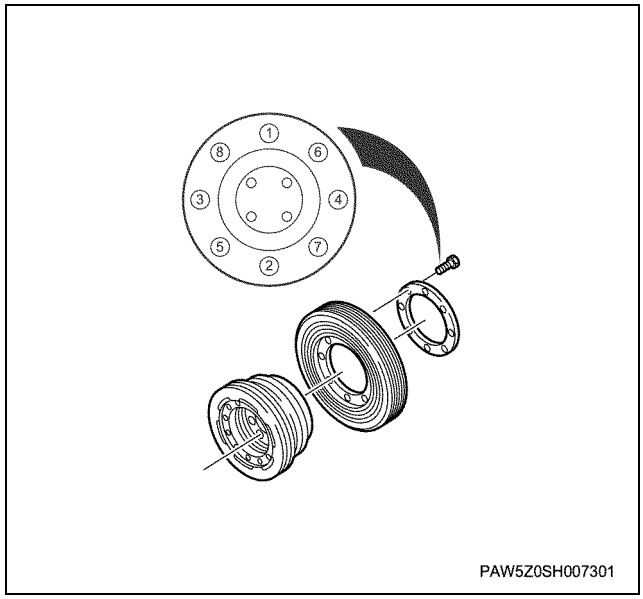
Nominal dimension	Limit
ϕ22.2	ϕ22.0


HCW31BSH020801


HCW31BSH020901

Disassembly

1. Disassemble the crank pulley ASM.
   Loosen the installation bolts and remove the damper from the crank pulley.

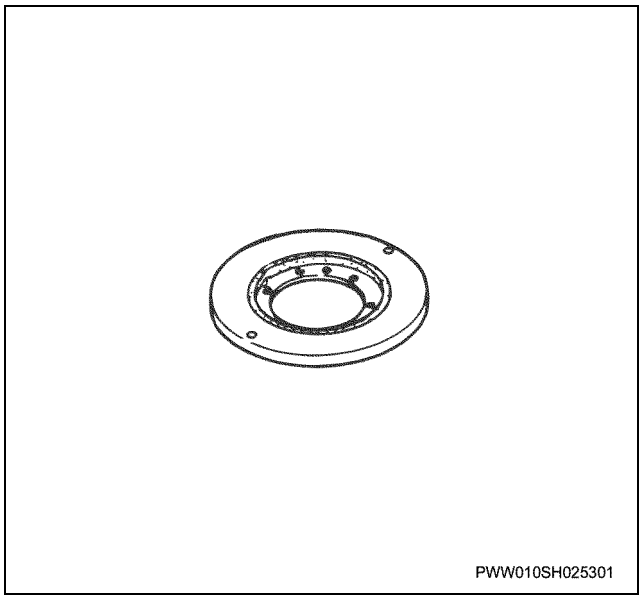


PAW5Z0SH007301

Inspection

1. Inspect the crank shaft pulley slot for wear or damage.

2. Inspect the crankshaft damper for cracks.


PWW010SH025301

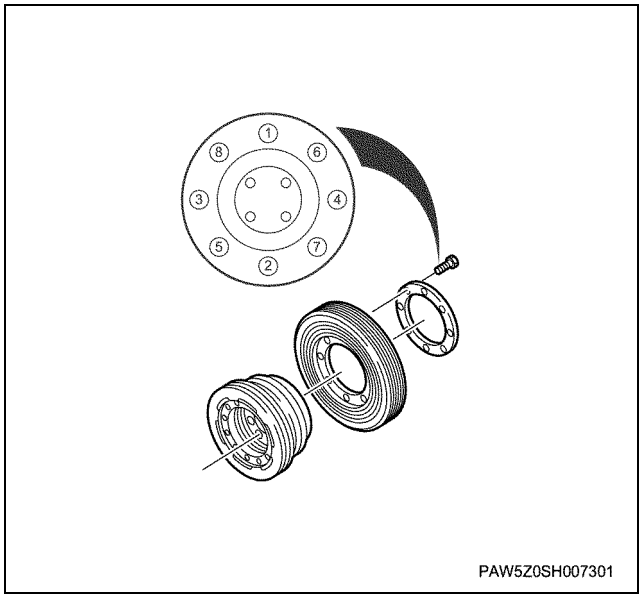
Assembly

1. Install the crankshaft damper to the crank pulley.
   - Tighten the bolts in order in a diagonal line.

Caution:

- **Install the crankshaft damper so that the side with the caution label faces forward.**
- **Make sure that the crankshaft damper does not come into contact with oil or fat.**

Tightening torque: 118 N·m {12.0 kgf·m}



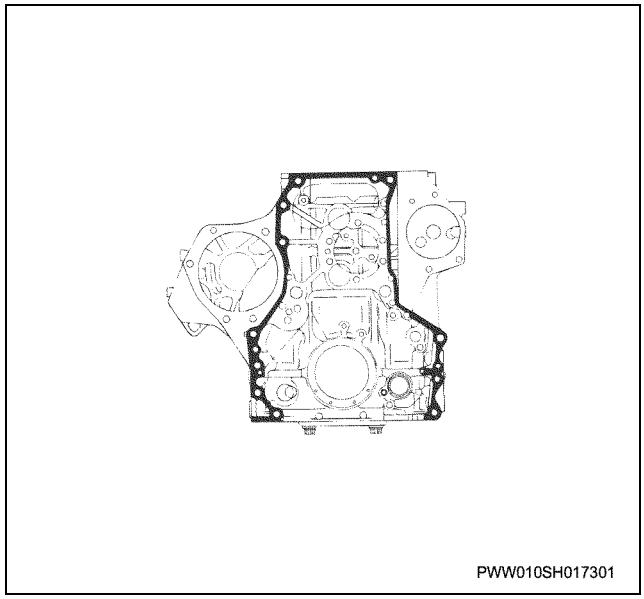
PAW5Z0SH007301

Installation

1. Install the timing gear case.
   a. Apply approx. 0.3mm thickness, approx. 4mm width of Loctite No.FMD127 liquid gasket to the installation surface. Also apply liquid gasket to the cylinder block and crank case match surfaces.

Notes:

- **Make sure that no liquid gasket gets into the bolt holes.**
- **Install the parts promptly after applying the liquid gasket.**


PWW010SH017301

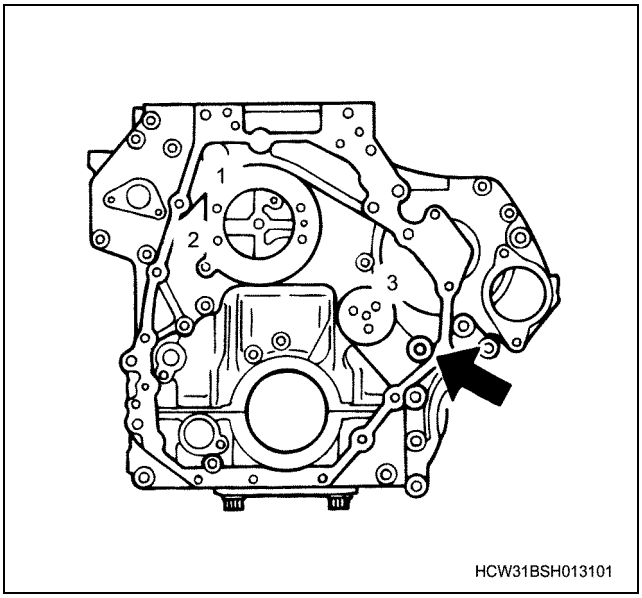
   b. Install the timing gear case.

Tightening torque

M14:	135 N·m {13.8 kgf·m}
M10:	43 N·m {4.4 kgf·m}

Important:

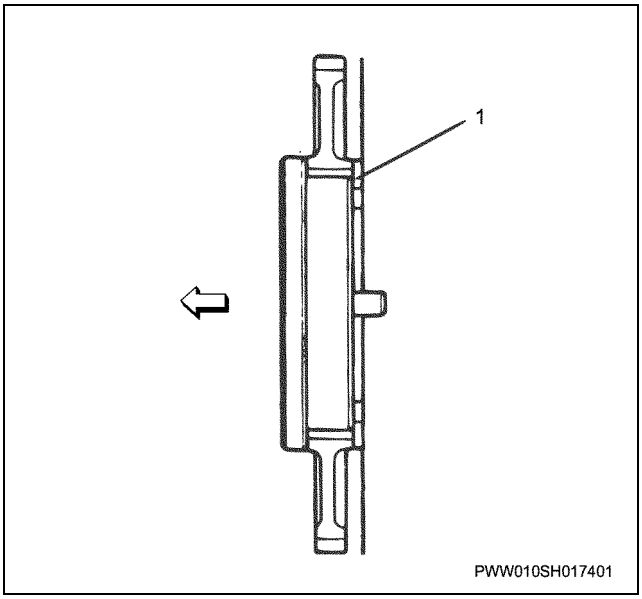
- **To re-use the installation bolts in the arrow section, apply Loctite 271 to the screw section.**
- **After installing the timing gear case, if there will be an interval of more than 30 minutes until the idle gear A and B installation work, temporarily install M10 × 1.5 bolts at the correct torque to sections 1~3 in the diagram.**



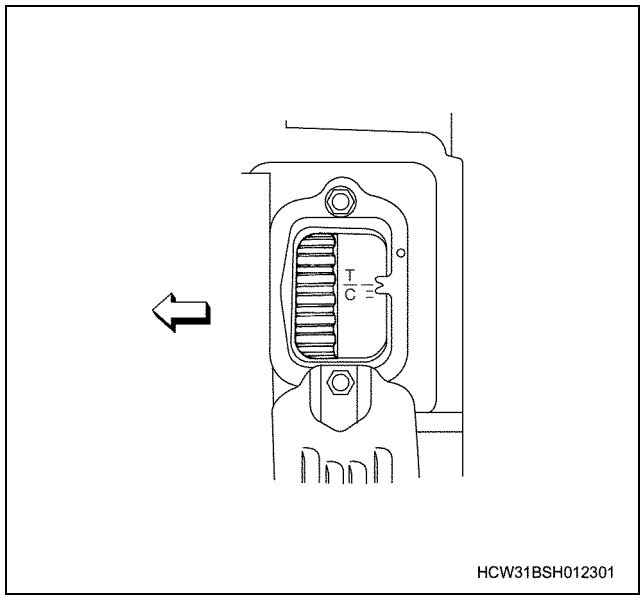
2. Install the cover.
3. Install idle gear B.
   - Apply engine oil to idle gear B bore and thrust sections, check the front/back markings that you made when disassembling the idle gear B and thrust plate, and install them.

Notes:
If you have temporarily installed the bolts, do not forget to remove them when installing the idle gear.

Tightening torque: 46 N·m {4.7 kgf·m}

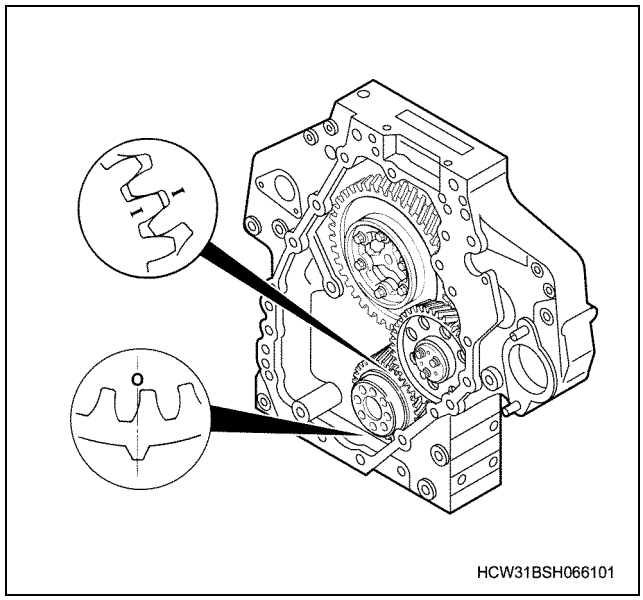


4. Install idle gear A.
   a. Set the number 1 cylinder compression top dead center.
      Rotate the crankshaft forwards, and line up the flywheel T/C mark to the pointer. At this time, check that the carved lines on the coupling and pump roughly line up.



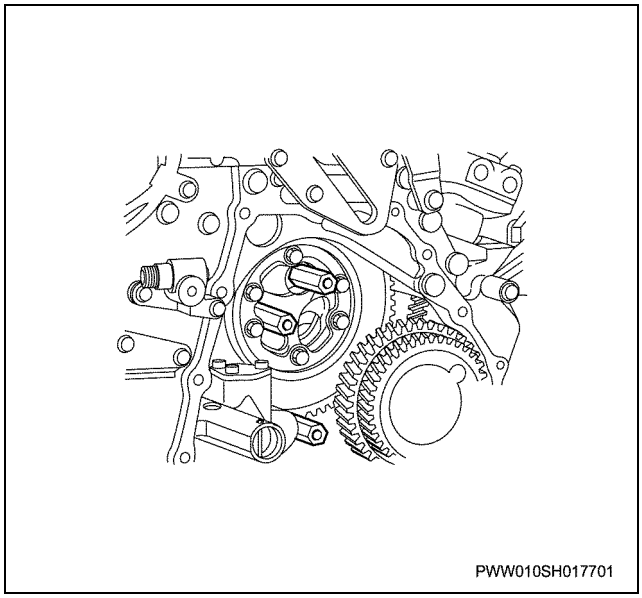
   b. Apply engine oil to timing gear A bore, line up the timing marks for each gear, then assemble timing gear A, spindle, and thrust plate.

Tightening torque: 108 N·m {11.0 kgf·m}



5. Install the distance bolt.
   - Install 3 distance bolts to the positions shown in the diagram.

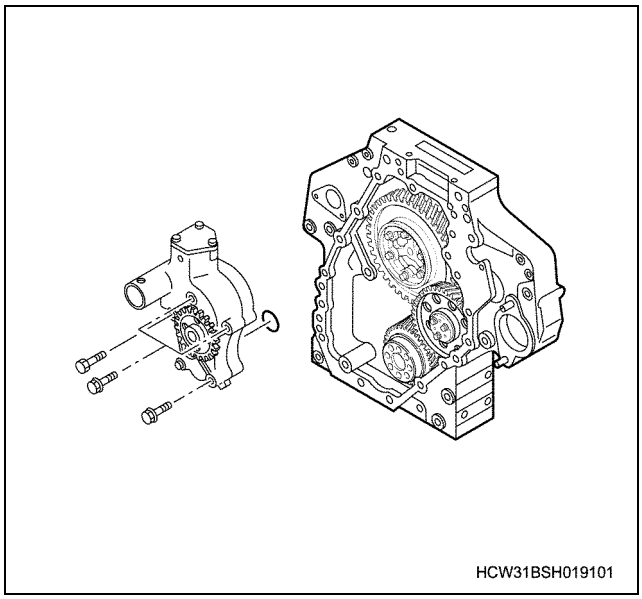
Tightening torque: 43 N·m {4.4 kgf·m}



6. Install the O-ring to the oil pump.
7. Line up the oil pump with the dowel position and install it.

Notes:
Do not mistakenly tighten the yellow painted bolt in the head section to the tightening torque shown above. This bolt is only for installing the oil pump cover.

Tightening torque: 49 N·m {5.0 kgf·m}

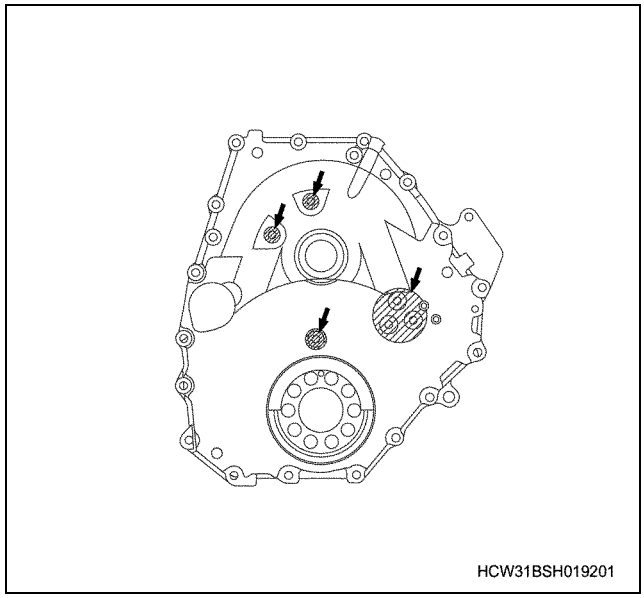


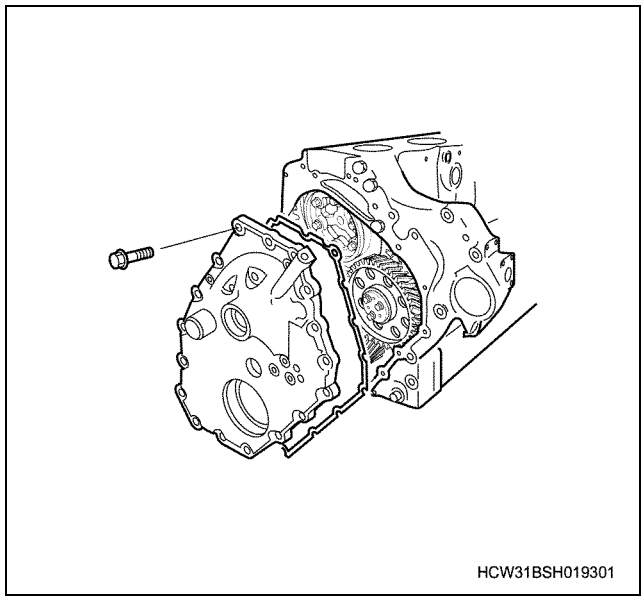
8. Install the gasket and gear case cover together.
9. Install the gear case harness.
   Apply Loctite No.FMD127 liquid gasket to the idle gear A spindle bearing surface and distance bolt bearing surface, and promptly install them both.
   Apply Loctite No.FMD127 to the arrow diagonal section
   .

Important:
Press the gasket securely into the slot and over all protruding sections.

Tightening torque

M10:	43 N·m {4.4 kgf·m}
M8:	26 N·m {2.6 kgf·m}



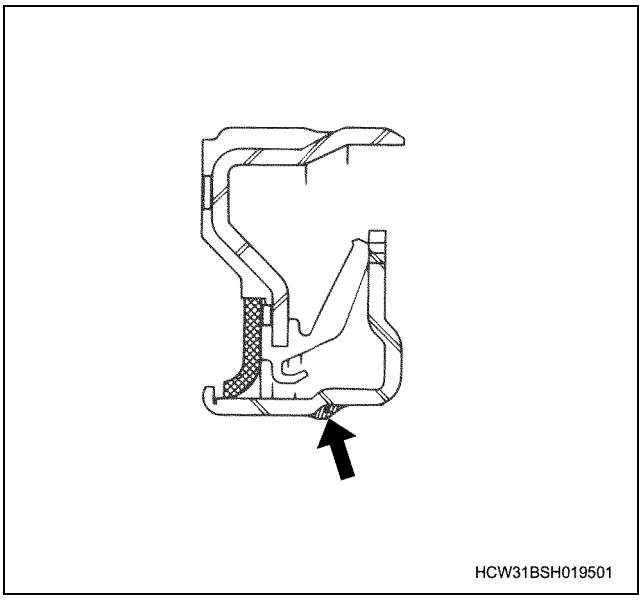


10. Install the oil seal (crankshaft Ft) to the gear case cover.

Important:

- **When replacing the slinger and oil seal, always replace as a pair.**
- **Take care not to damage the oil seal lip section and slinger 4-section screw machining surface.**

- **If there is damage or scratches on the axel section after extracting the slinger, apply liquid gasket (Loctite FDM125) in the limits shown in the diagram to the inner circumference surface of the slinger before re-installation.**

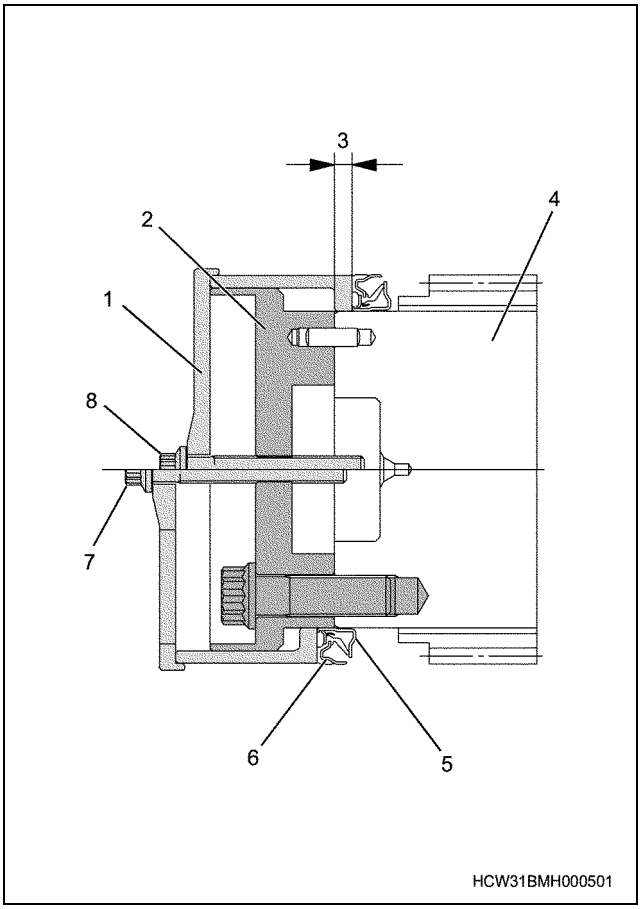


a. Apply a thin later of engine oil to the inner periphery of the oil seal.
b. Use a installer and install the oil seal and slinger simultaneously.
c. Tighten the center bolt until the sleeve touches the adapter.

Installer; Oil seal: 1-8522-0043-0

Basic dimensions:	7.0 ± 0.3mm

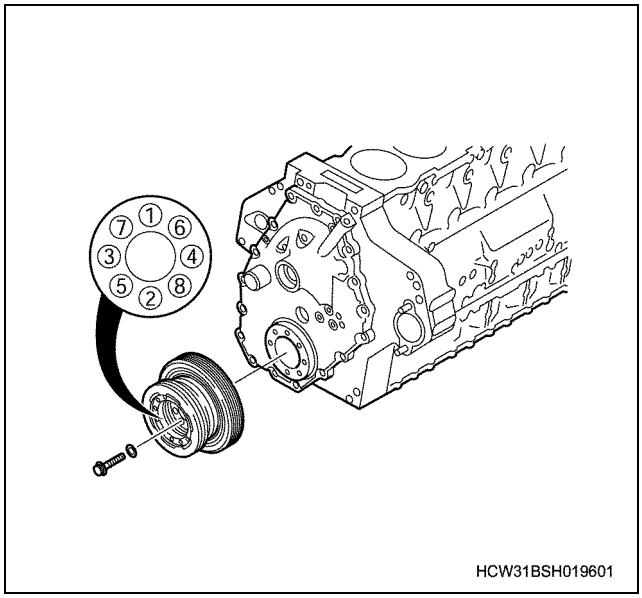
d. After pressing the parts in, wipe clean any traces of remaining oil.
e. After installing the oil seal, measure the size from the tip of the crankshaft to the oil seal surface.



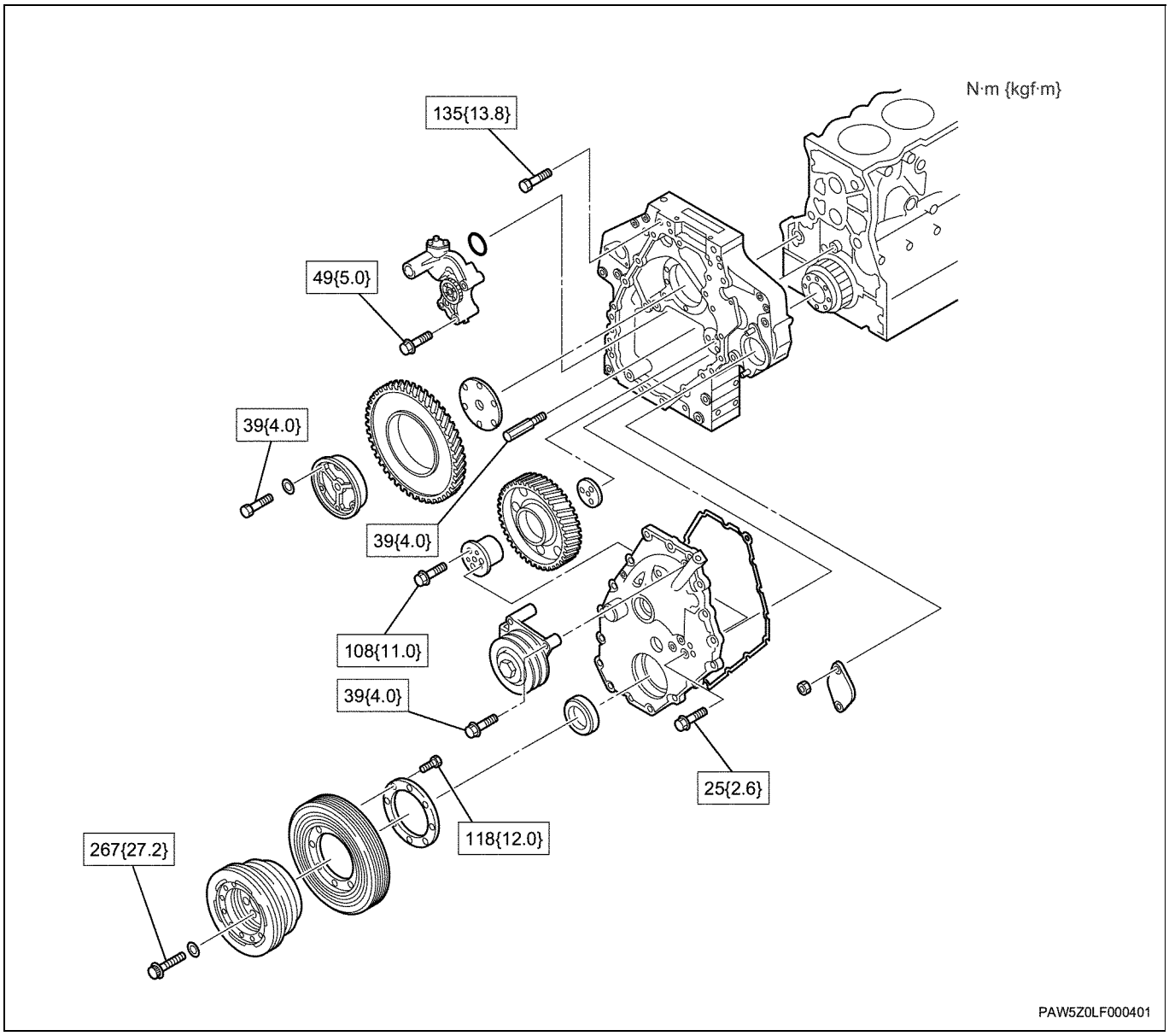
Legend
1. Special tool (sleeve)
2. Special tool (adapter)
3. Basic dimensions
4. Crankshaft
5. Slinger
6. Oil seal
7. Location of special tool before press fitting
8. Location of special tool after press fitting

11. Install the idle pulley.
12. Install the crank pulley ASM.
    - Apply engine oil to the installation bolt screw section, and tighten the bolts in a diagonal line.

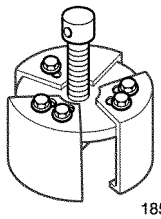
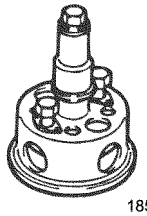
Tightening torque: 267 N·m {27.0 kgf·m}



Torque specifications

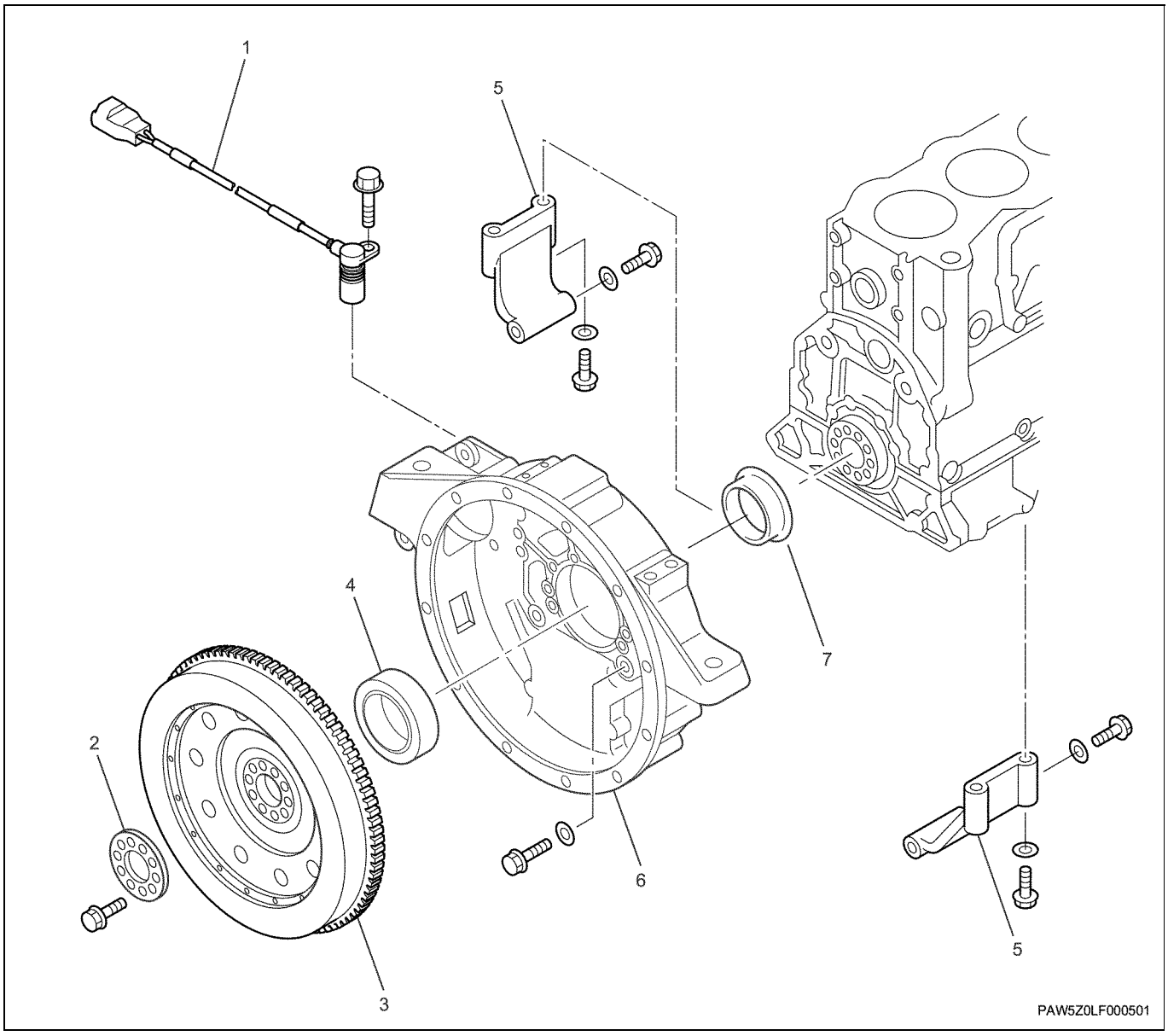


Special tools

Illustration	Tool number Tool name
 1852100270	1-8521-0027-0 Remover; Slinger
 1852200430	1-8522-0043-0 Installer; Oil seal

Flywheel, flywheel housing

Component parts

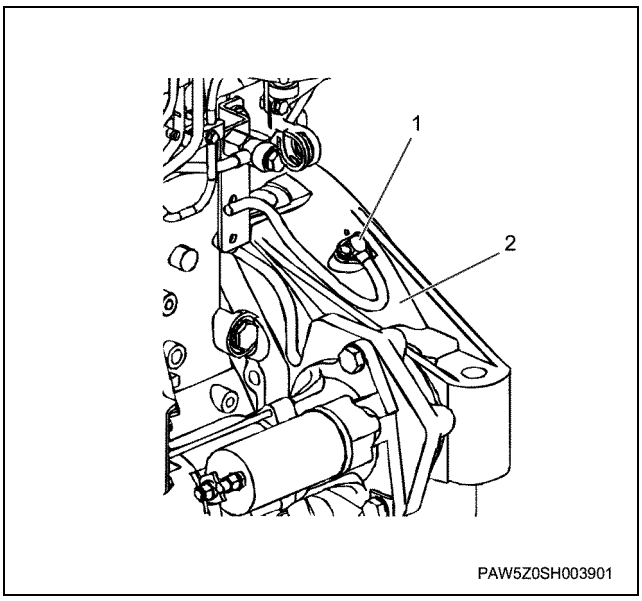


Legend

1. NE sensor
2. Washer
3. Flywheel
4. Oil seal
5. Flywheel housing stay
6. Flywheel housing
7. Slinger

Removal

1. Remove the NE sensor.

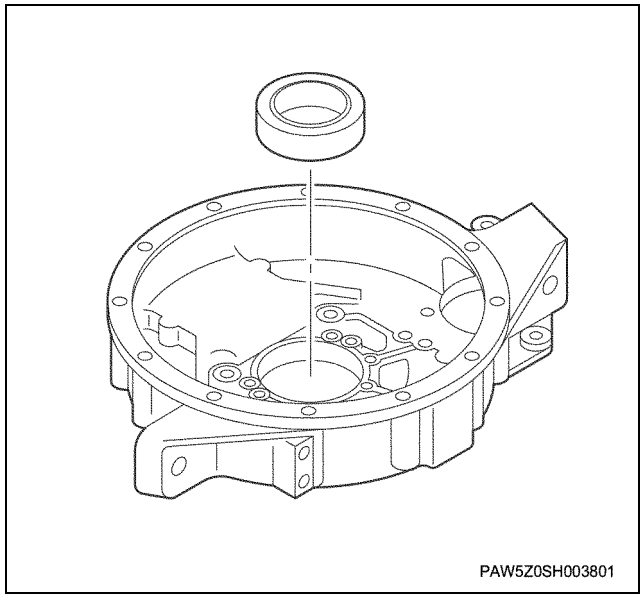


Legend
1. NE sensor
2. Flywheel housing

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.

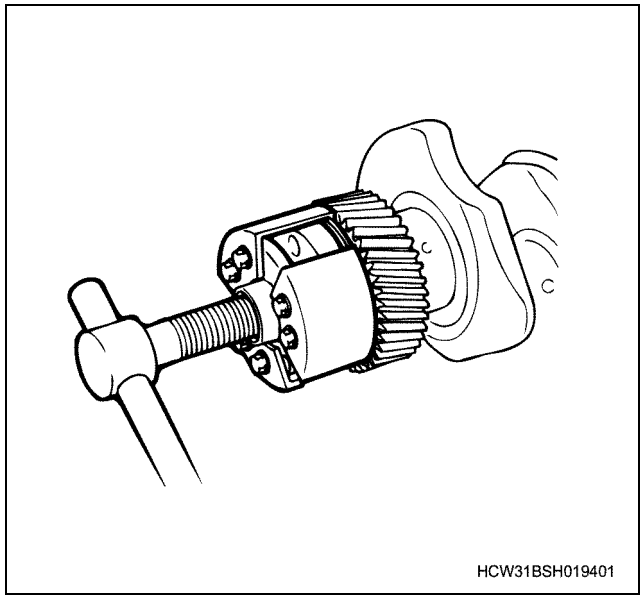
Notes:
If the remover separates easily from the slinger, tightening the jig's perimeter with a clip band to makes it easier to remove the slinger.



7. Use a slinger remover to remove the slinger.

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

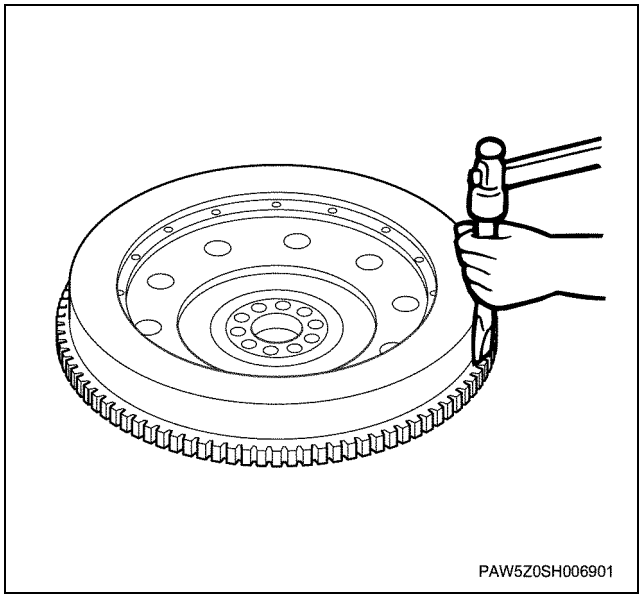
Remover; Slinger: 1-8521-0027-0



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.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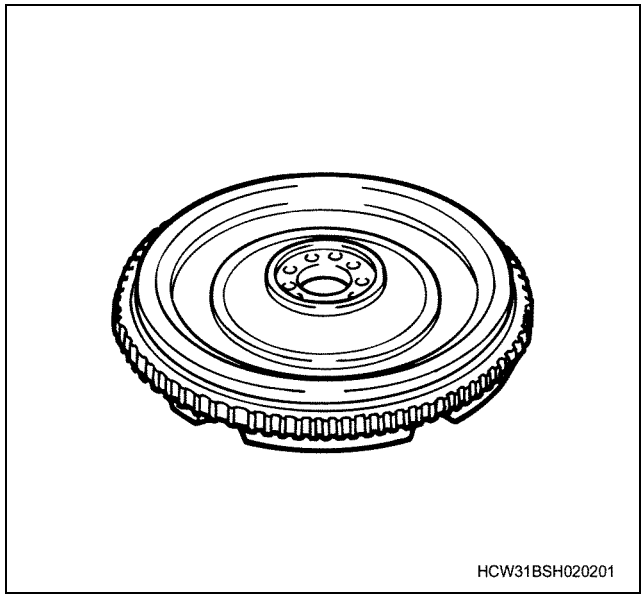

HCW31BSH020201

Inspection

Flywheel

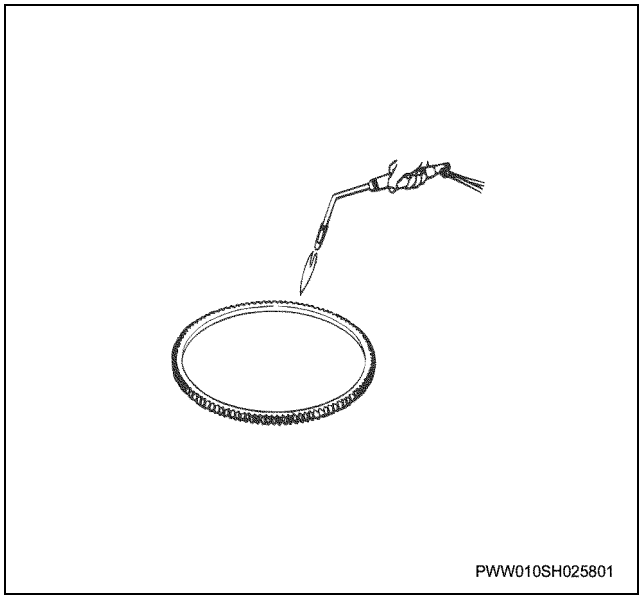
- Inspect the flywheel for cracks or scratches, and replace if either is found.

Flywheel starter gear

- Inspect the flywheel starter gear for damage.
  If there are no problems with it, do not remove it.

Assembly

1. Assemble the flywheel.
   - Use a gas burner to uniformly heat the flywheel starter gear (less than 200°C), and install to the flywheel, with the gear that has the largest bevelling to the nearside.


PWW010SH025801

Installation

1. Install the flywheel housing.
   - After applying approx. 0.3 mm thickness and approx. 4 mm width of Loctite No.FMD127 liquid gasket, promptly install the flywheel housing.

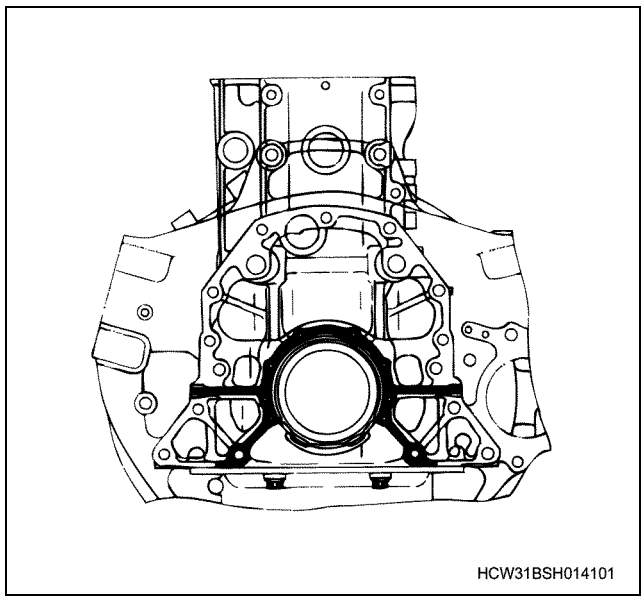
Tightening torque

M14:	123 N·m {12.5 kgf·m}
M8:	22 N·m {2.2 kgf·m}

Notes:
Tighten the bolt next to the knock pin first.

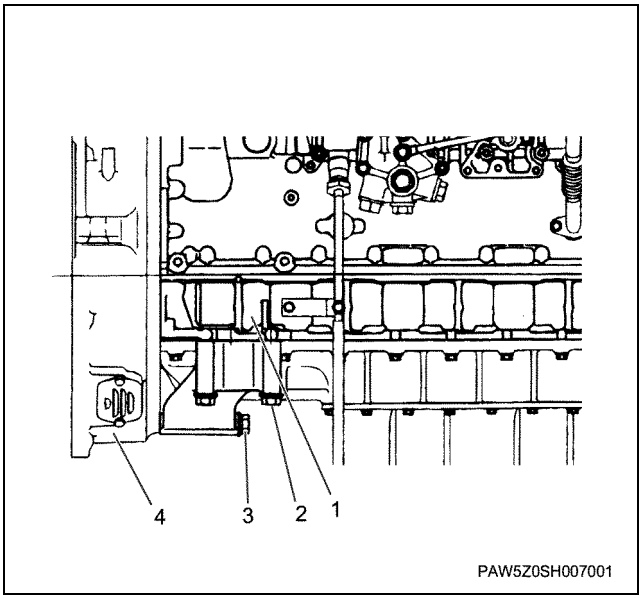
Important:

- **Also apply ample liquid gasket to the joint between the cylinder block and crankcase.**
- **Make sure that no liquid gasket gets into the bolt holes.**


HCW31BSH014101

2. Install the flywheel housing stay.

Tightening torque: 109 ~ 163 N·m {11.1 ~ 16.6 kgf·m}



Legend

1. Cylinder block
2. Bolt (cylinder block side)
3. Bolt (flywheel housing side)
4. Flywheel housing

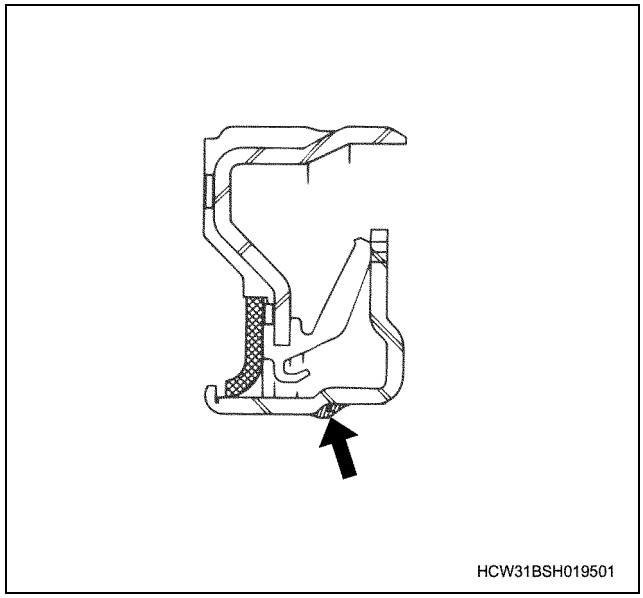
3. Install the oil seal.

Notes:

- **The installation position for the oil seal is set and classified by color.**
  Engine front side …black purple
  Engine rear side …… gray
- **Check that the felt dust lip is being held inside the outward section of the slinger.**

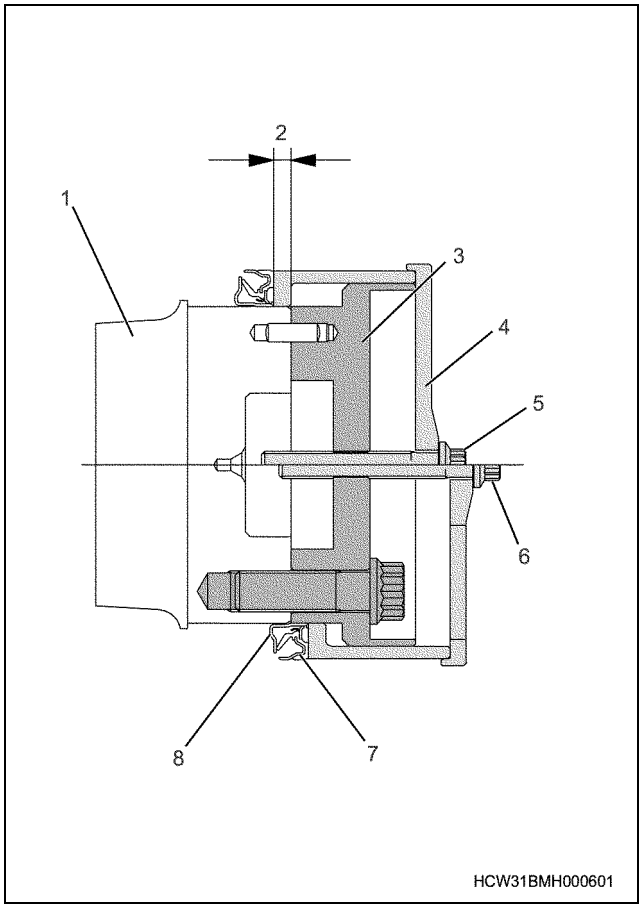
Important:

- **When replacing the slinger and oil seal, always replace as a pair.**
- **Take care not to damage the oil seal lip section and slinger 4-section screw machining surface.**
- **If there is damage or scratches on the axel section after extracting the slinger, apply liquid gasket (Loctite FDM127) in the limits shown in the diagram to the inner circumference surface of the slinger before re-installation.**



a. Apply a thin later of engine oil to the inner periphery of the oil seal.
b. Use a installer and install the oil seal and slinger simultaneously.
c. Tighten the center bolt until the sleeve touches the adapter.

Installer; Oil seal: 1-8522-0043-0



Legend

1. Crankshaft
2. Basic dimensions
3. Special tool (adapter)
4. Special tool (sleeve)
5. Location of special tool after press fitting
6. Location of special tool before press fitting
7. Oil seal
8. Slinger

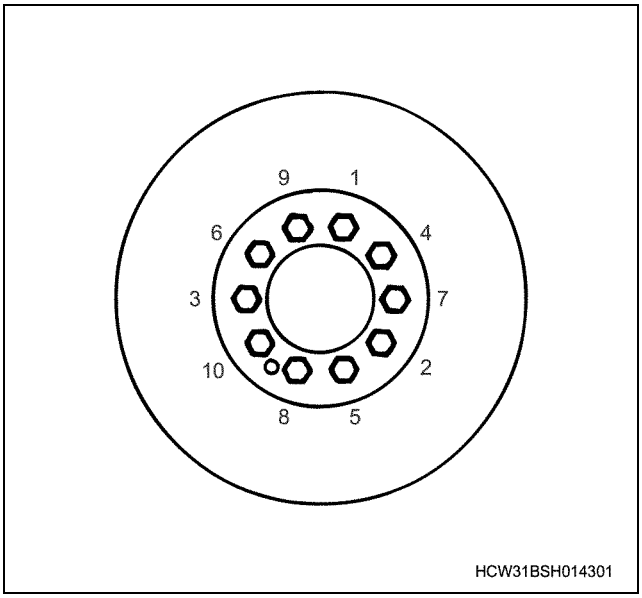
d. After pressing the parts in, wipe clean any traces of remaining oil.

e. After installing the oil seal, measure the size (2) from the tip of the crankshaft to the oil seal surface.

Basic dimensions: 7.0 ± 0.3 mm

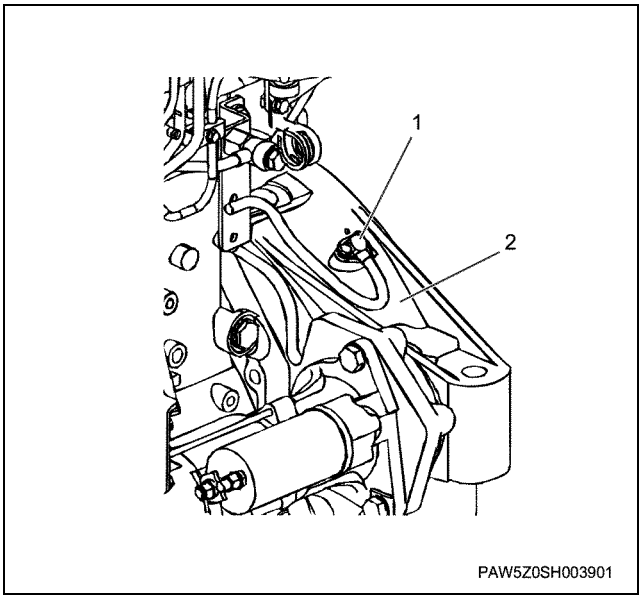
4. Install the flywheel.
5. Install the washer and tighten the bolts.
   - Apply molybdenum disulphide to the bolt screw section and bearing surface, and tighten in the numbered order shown in the diagram.

Tightening torque: 79 N·m {8.1 kgf·m}
→ angle method 60° → 30°

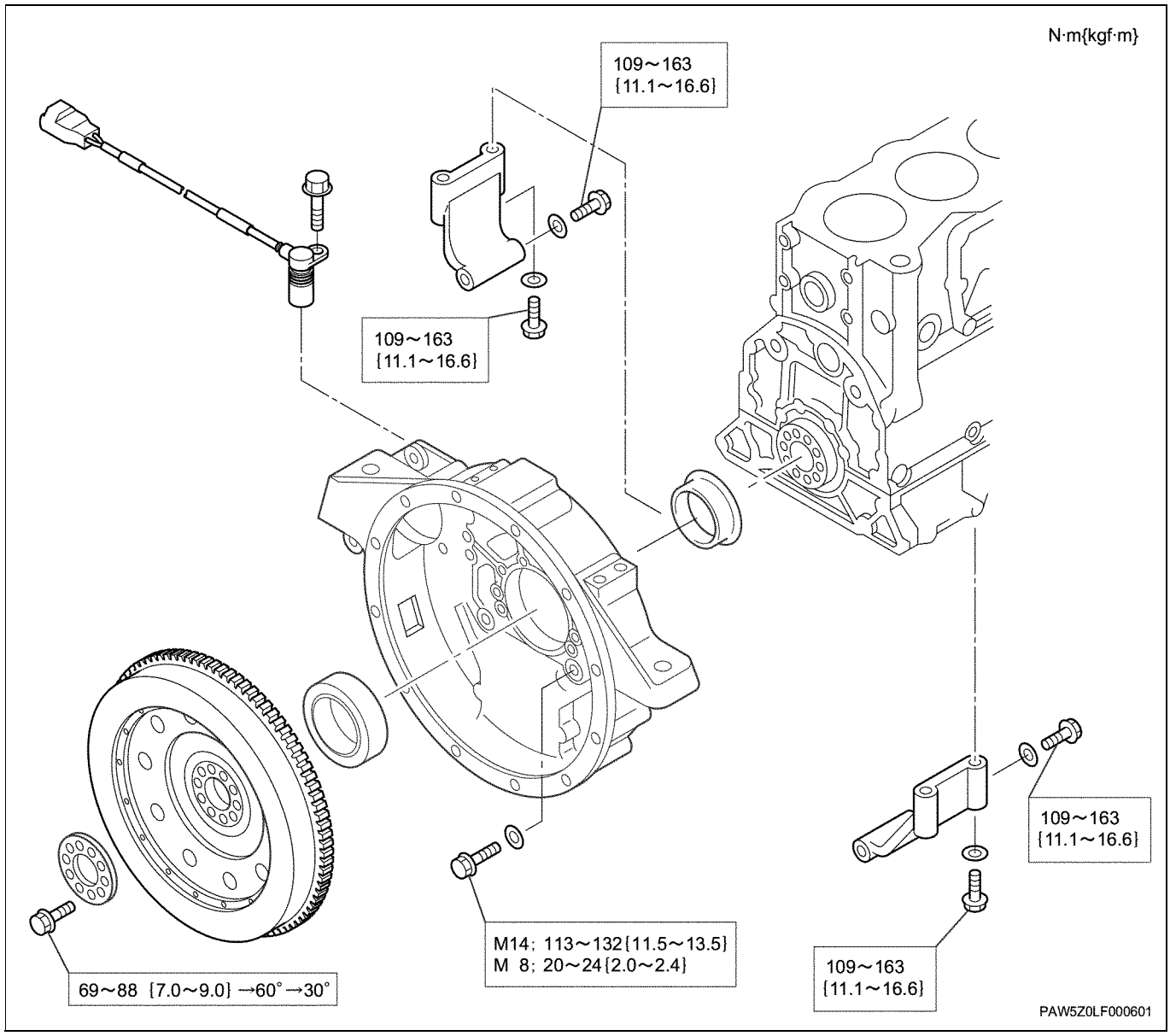


6. Install the NE sensor to the flywheel housing.

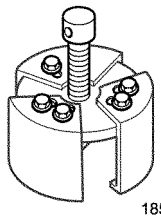
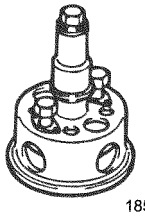
Important:
Always install the sensor after assembling the flywheel, not before.



Torque specifications

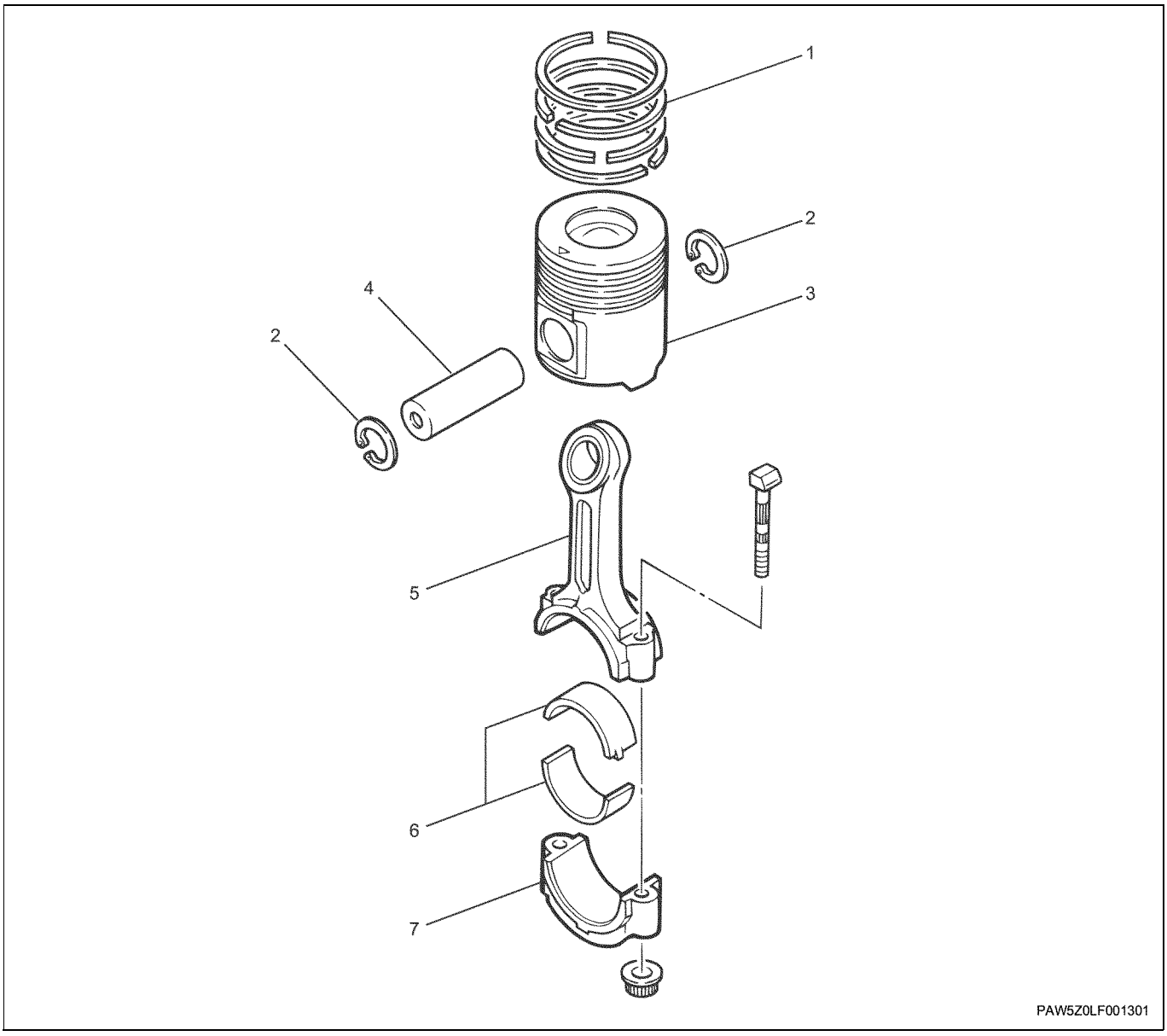


Special tools

Illustration	Tool number Tool name
 1852100270	1-8521-0027-0 Remover; Slinger
 1852200430	1-8522-0043-0 Installer; Oil seal

Piston, connecting rod

Component parts



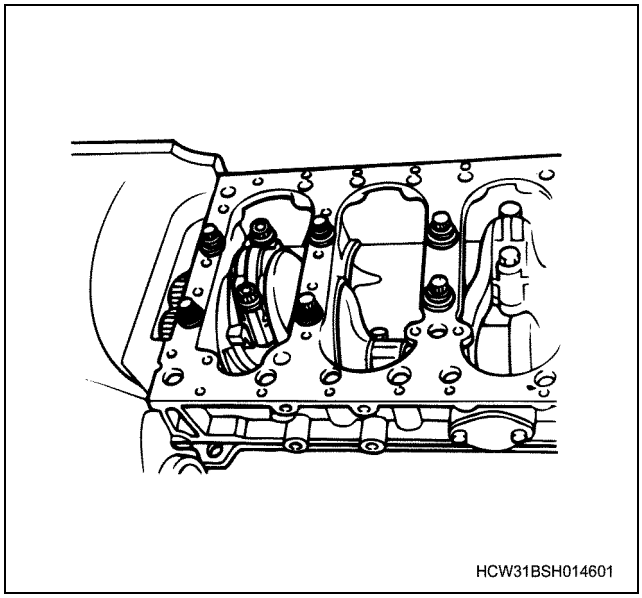
Legend

1. Piston ring
2. Snap ring
3. Piston
4. Piston pin
5. Connecting rod
6. Bearing
7. Connecting rod cap

Removal

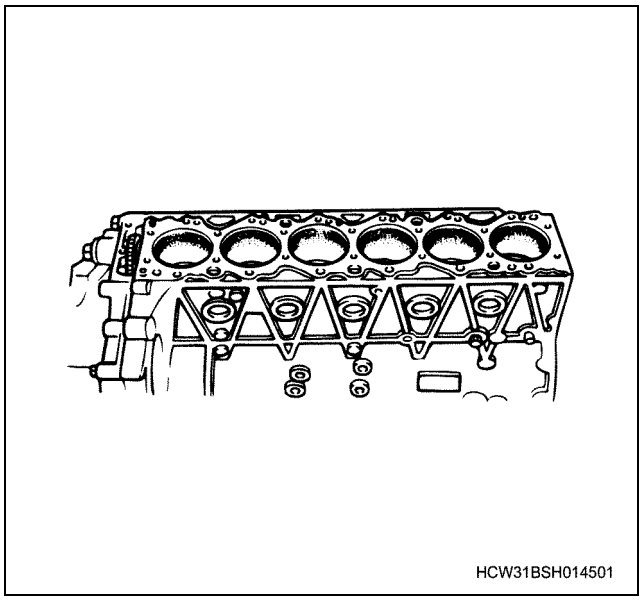
1. Remove the connecting rod cap & bearing (lower side).
   - Loosen the installation nuts, and remove by lightly striking with a copper hammer or other such tool. Next, rotate the crankshaft and move the piston to be extracted to the top dead center position.

Important:
Be careful not to damage the oil jet.



2. Extract the piston and connecting rod from inside the cylinder.
   - Use a scraper or other such tool to remove carbon from the upper section of the liner.

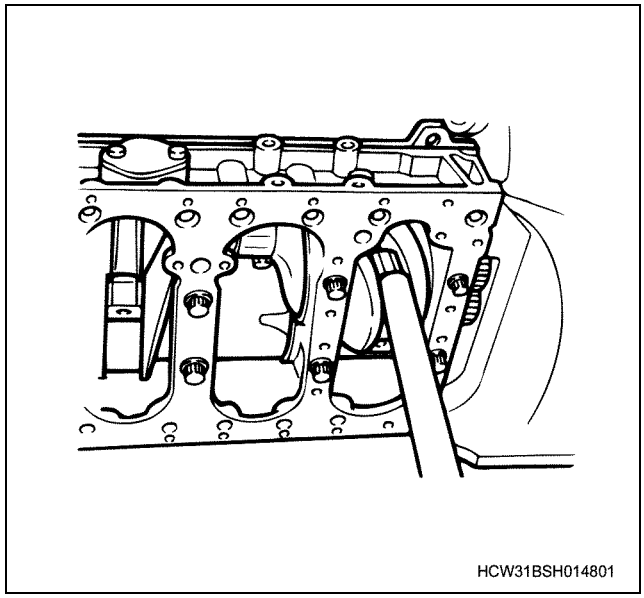
Notes:
When rotating the crankshaft and when extracting the piston, prevent the liner from being extracted too.



   - Use the handle of a hammer or other such tool to push the underside of the connecting rod out.

Important:

- **Do not allow the connecting rod or liner to obstruct each other.**
- **Be careful not to damage the oil jet.**
- **In order to avoid confusion, assemble the removed cap, bearing and connecting rod as a set.**



3. Remove the connecting rod bearing.

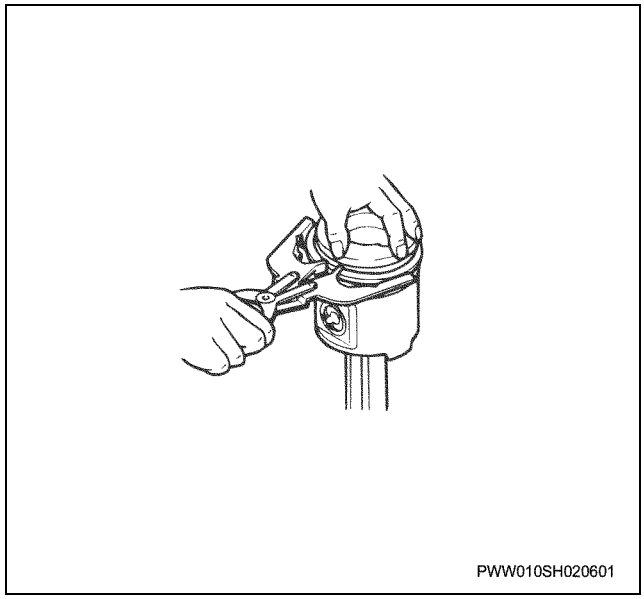
Notes:
Install the cylinder number and store it safely.

Disassembly

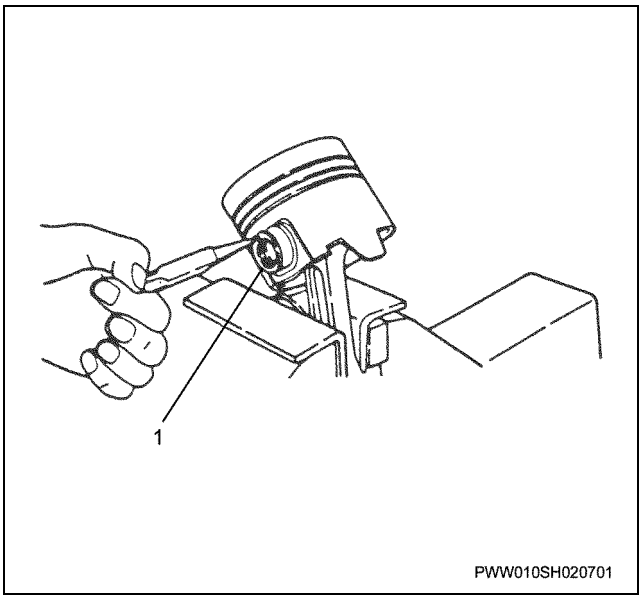
1. Use a setting tool to remove the piston ring.

Notes:
Add a distinguishing mark for each piston to each removed piston ring.

Setting tool; Piston ring: 1-8522-1025-0



2. Remove the snap ring (1).



3. Rest a hit-stick on the piston pin and gently strike with a hammer to extract it.

Notes:
Add a distinguishing mark for each piston to each removed piston pin.

4. Store the pistons in a safe place where they will not get damaged.
5. Assemble the connecting rod and connecting rod cap, and store in a safe place where the contact surface will not get damaged or scratched.
6. Assemble the connecting rod cap and connecting rod, and store in a safe place where the contact surface will not get damaged or scratched.
7. Remove the bearing from the connecting rod.

Notes:
Add a distinguishing mark for each piston to each removed connecting rod bearing.

Inspection

Piston ring

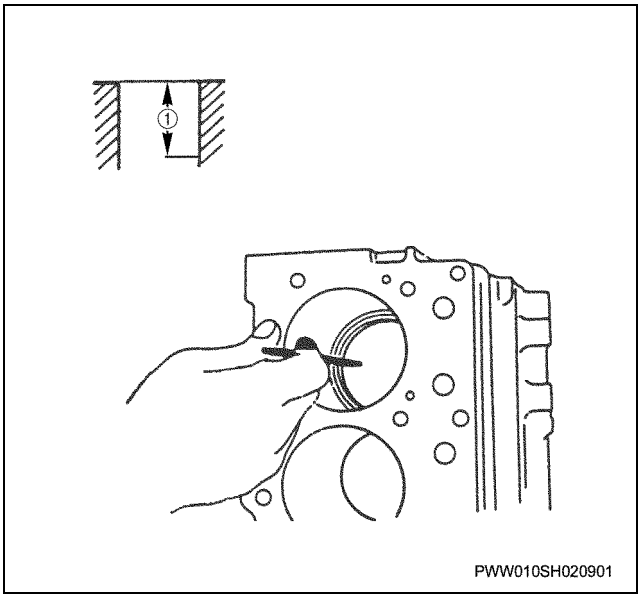
- Piston ring inspection, mitre clearance measurement
  Clean off any carbon from the piston ring. Insert the piston ring into the cylinder liner, and push in using the piston head to the minimum wear part (lower part) of the liner.
  Next, insert a thickness gauge into the ring mitre and measure the clearance.

Piston ring mitre clearance (mm)

	Standard	Limit
Top ring	0.35 ~ 0.50	1.0
Second ring	0.80 ~ 0.95	1.5

Piston ring mitre clearance (mm)

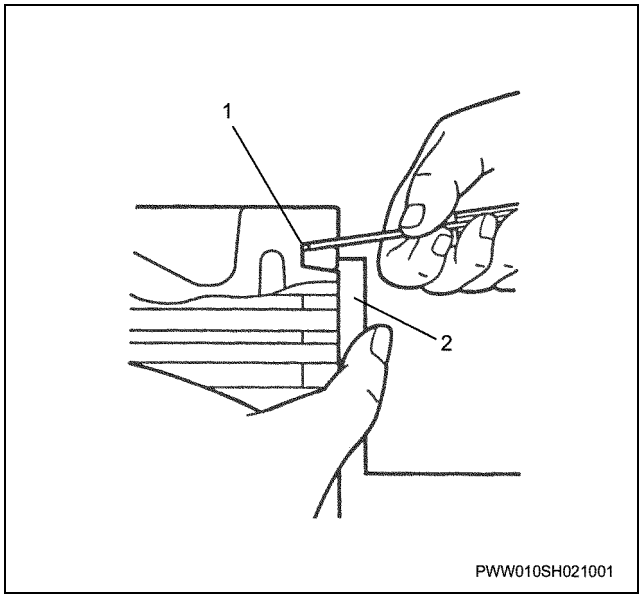
	Standard	Limit
Third ring	0.35 ~ 0.50	1.0
Oil ring	0.3 ~ 0.50	1.0

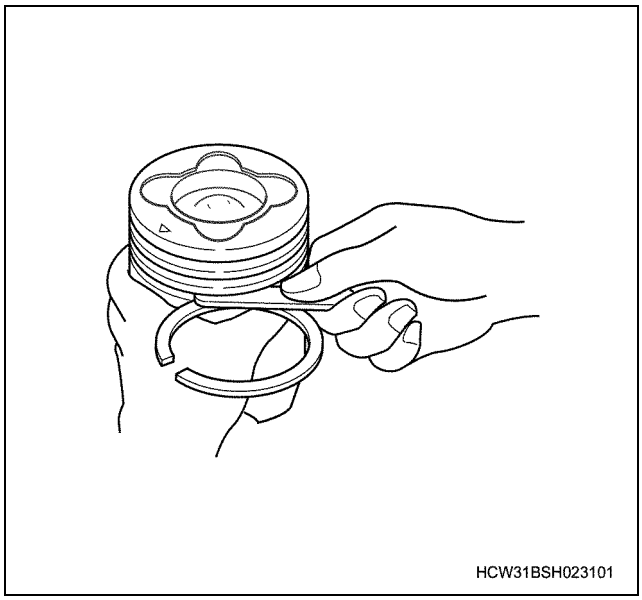


- Measurement of clearance between piston ring slot and piston ring.
  Clean off any carbon from the piston head and ring slot. Next, insert a ring into the ring slot and measure the clearance using a thickness gauge.
  While pressing down the top ring into the piston with a straight edge (2), measure the clearance with a thickness gauge (1).

Clearance between ring slot and ring (mm)

	Standard	Limit
Top ring	0.115 ~ 0.160	0.24
Second ring	0.85 ~ 0.12	0.20
Third ring	0.85 ~ 0.12	0.20
Oil ring	0.025 ~ 0.065	0.15

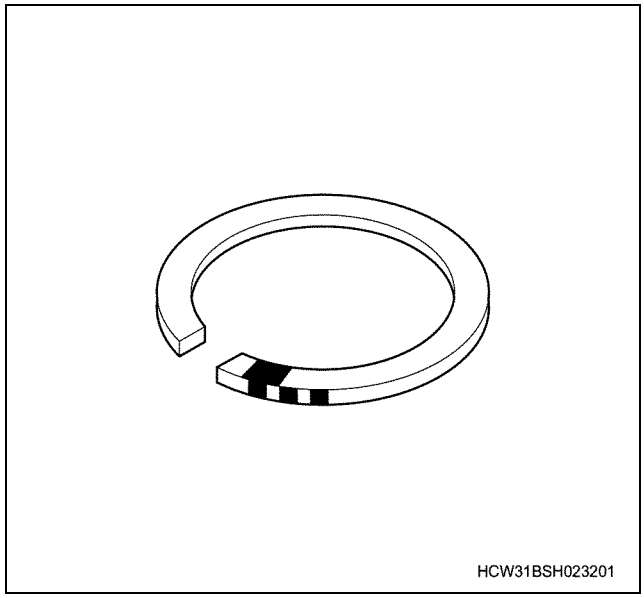




- Piston ring tension measurement
  Use a piston ring tension gauge to measure the tension.
  Measure the oil ring with a coil expander ring mounted.

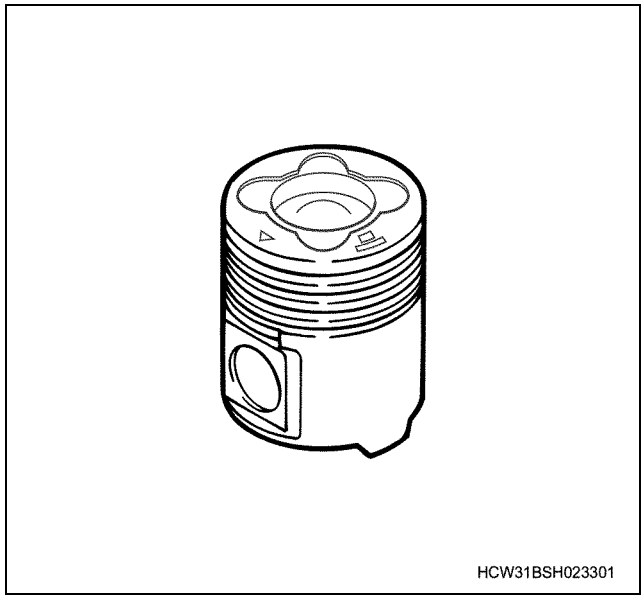
Piston ring tension

	Standard N {kgf}	Limit N {kgf}
Top ring	27.5 ~ 41.2 {2.81 ~ 4.20}	24.5 {2.5}
Second ring	22.8 ~ 34.1 {2.32 ~ 3.48}	19.6 {2.0}
Third ring	28.1 ~ 36.6 {2.87 ~ 3.73}	19.6 {2.0}
Oil ring	46.3 ~ 57.7 {4.72 ~ 5.88}	39.2 {4.0}



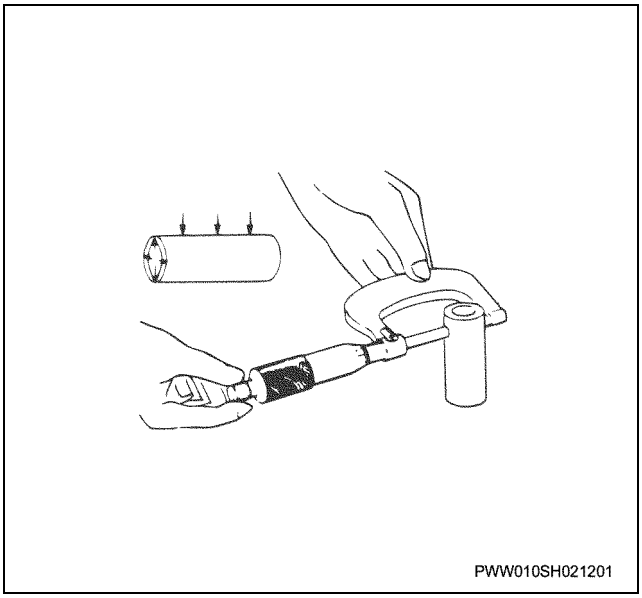
Piston

- Piston abrasion and cracking inspection
  Wipe off any carbon sludge from the piston and clean the piston.
  Places that are difficult to see such as the piston ring slot should be carefully inspected.
  Perform red check method inspections whenever necessary.



- Piston pin outer diameter measurement
  Measure the outer diameter of the piston pin, and measure the clearance between the piston pin and piston pin hole, and the clearance between the piston pin and connecting rod bush.
  Measure the 6 points of the piston pin shown in the diagram.

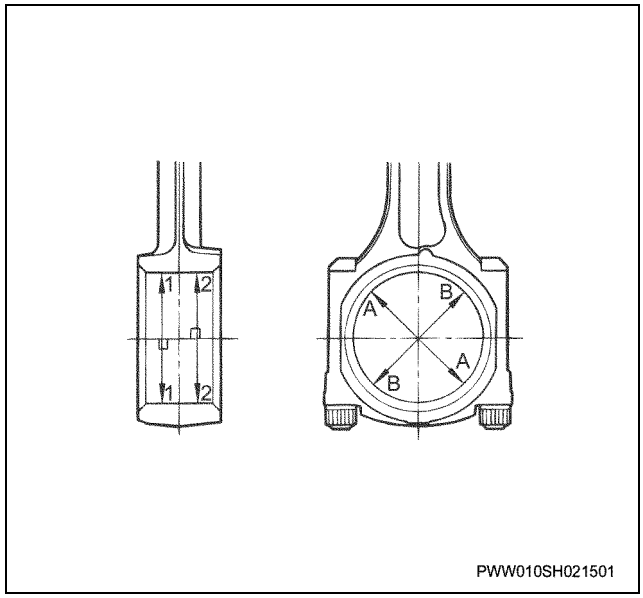
	Nominal dimension mm	Standard mm	Limit mm
Piston pin outer diameter	ϕ56	—	ϕ55.97
Clearance between piston pin and piston pin hole	—	0.008 ~ 0.021	0.05
Clearance between piston pin and connecting rod bush	—	0.020 ~ 0.037	0.10



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°

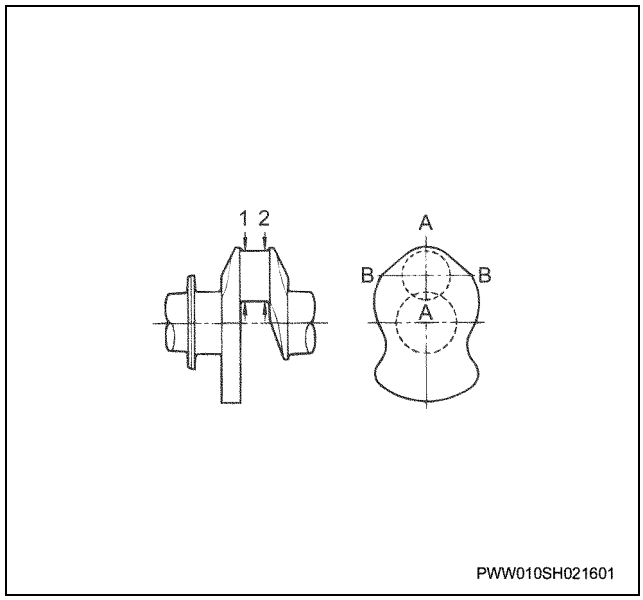


Measure the 4 points of the crank pin diameter shown in the diagram with a micrometer.

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.**

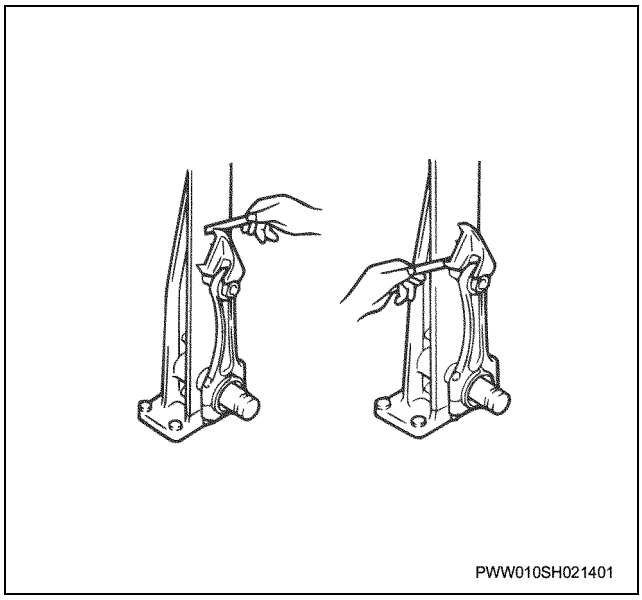


- Connecting rod deformation measurement
  Use a connecting rod aligner to measure the torsion of the large and small pore edges and the parallelism.

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

Torsion and parallelism (per 100mm) (mm)

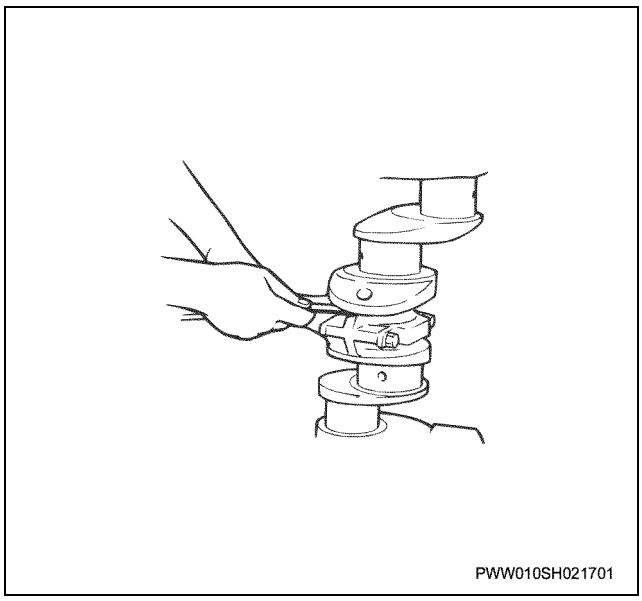
Standard	Limit
0.05	0.1



- Measure the connecting rod large edge section shaft orientation clearance.
  Install the connecting rod to the crank pin, and measure the shaft orientation clearance with a thickness gauge.

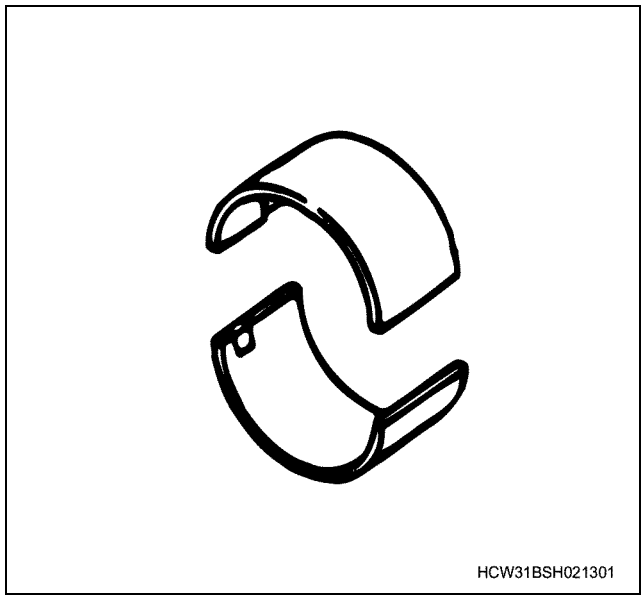
Shaft orientation clearances (mm)

Standard	Limit
0.175 ~ 0.290	0.35



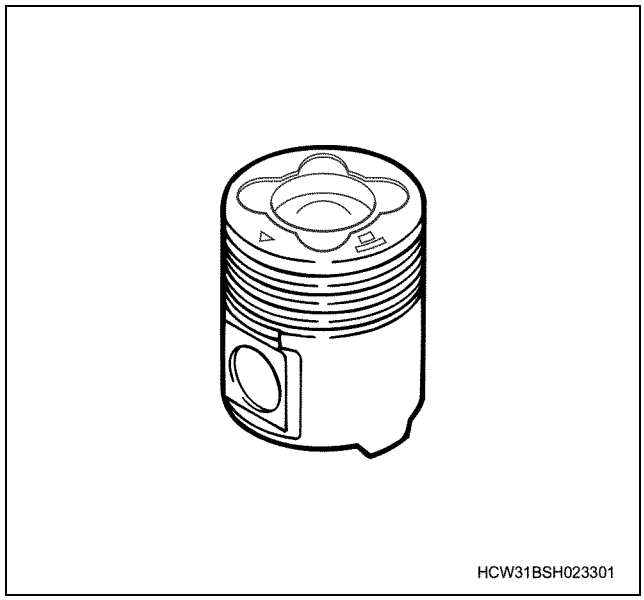
Bearing

- Inspect for wear, damage, scratches, de-bonding etc.
- Install the bearing and check that there is tension.



Assembly

1. Select the correct piston grade.
   - When using a brand new piston, always use the specified type of replacement piston.
   - When replacing a piston it is not necessary to select the grade. (Because there is just 1 type)

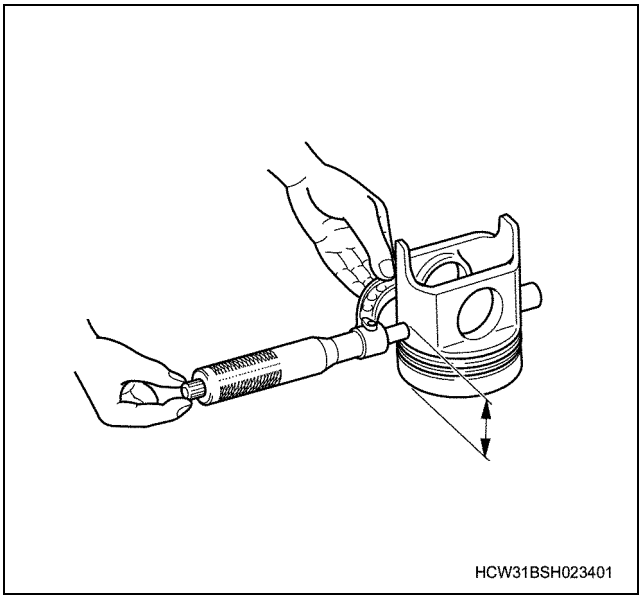


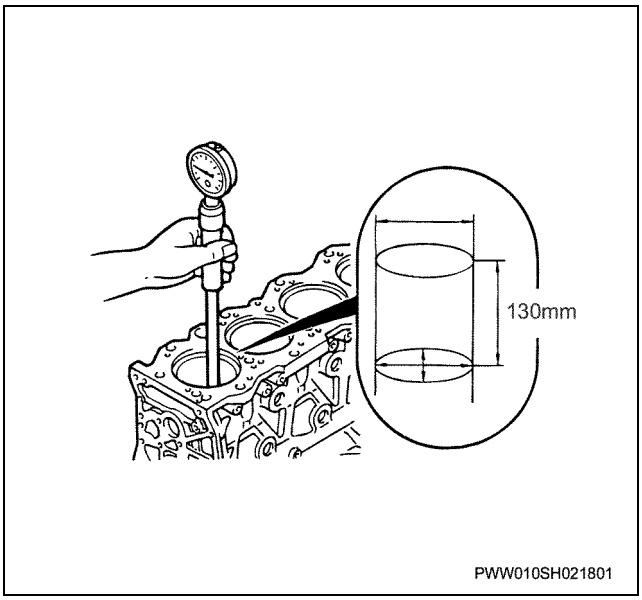
   - When re-using a piston, measure the clearance between the piston and liner.
   - Measurement procedure
     Measure the piston's outer diameter in the grade position. Clean off any carbon from the liner, measure 130 ~ 275 mm of maximum wear section (cylinder block horizontal direction) from the top surface of the liner, and check that the clearance between the piston and liner is within the standard value.
   - When replacing just the liner, select the new liner by grade.

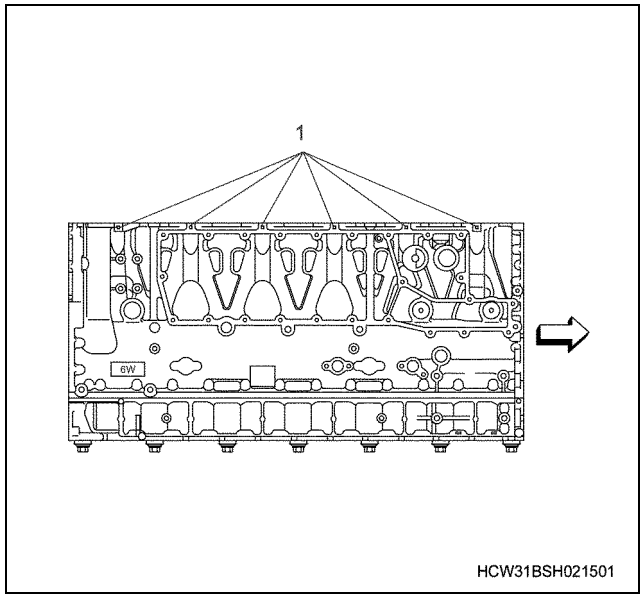
Grade selection measurement position (from major-axis piston head):	113 mm

Clearance between piston and liner (major axis direction)

Standard (replacement parts):	0.156 ~ 0.190 mm







Legend

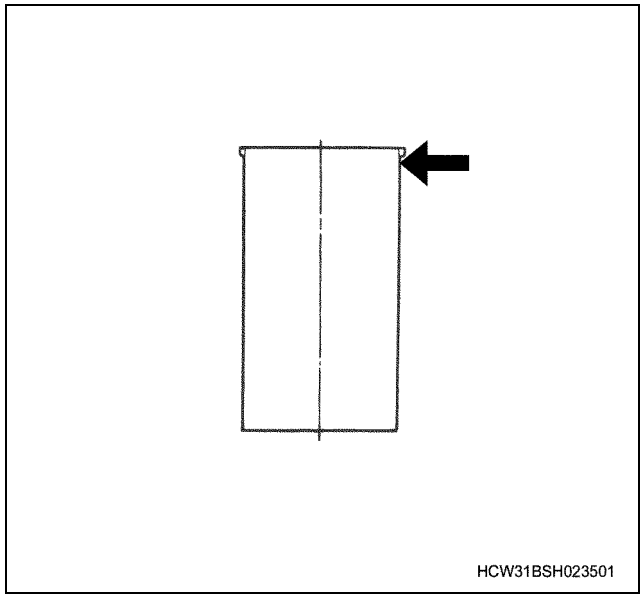
1. Cylinder block inner diameter bore grade marking position

liner replacement (Reference)

- Match the cylinder block bore diameter and liner diameter grade.
- Using the number written on the right side surface of the cylinder block, select a 1x for 1 or 2, or a 3x for 3 liner and install it.

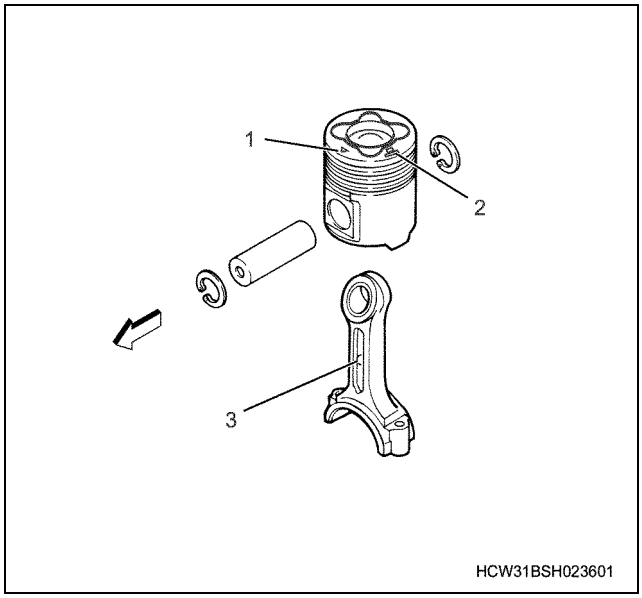
Cylinder block and liner combination

Block inscribed number	Liner grade
1 ·2	1x
3	3x



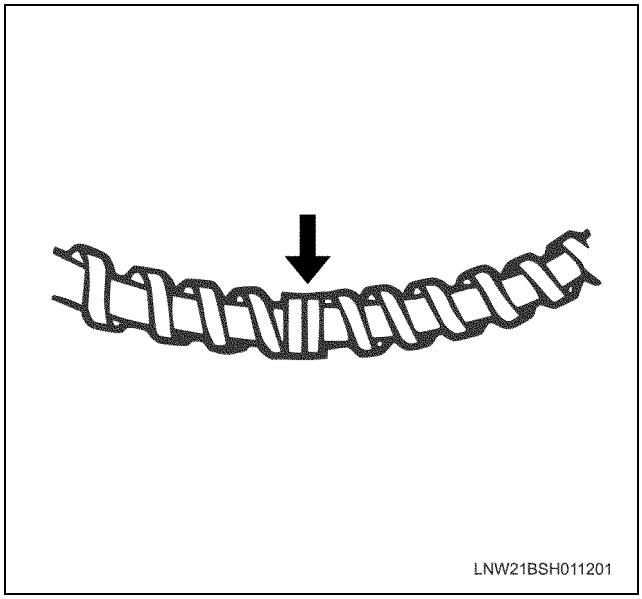
2. Apply oil to the piston boss.
3. Install the piston pin and connecting rod to the piston.

- Line up the piston head arrow mark and connecting rod front mark as shown in the diagram (same direction) and assemble. Next, apply engine oil to the piston pin and insert it.



Legend
1. Front mark
2. Grade section
3. Front mark

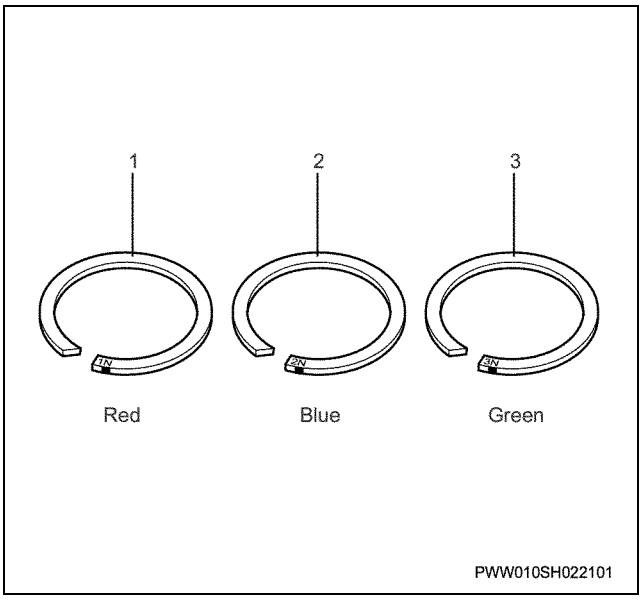
4. Fix the piston pin firmly with a snap ring.
   - Finally, check that the piston and connecting rod can move smoothly.
5. Install the piston ring.
   - Installing the expander ring
     Insert the expander ring so there is no clearance in the ring mitre, and insert into the piston slot.



Installing the piston ring

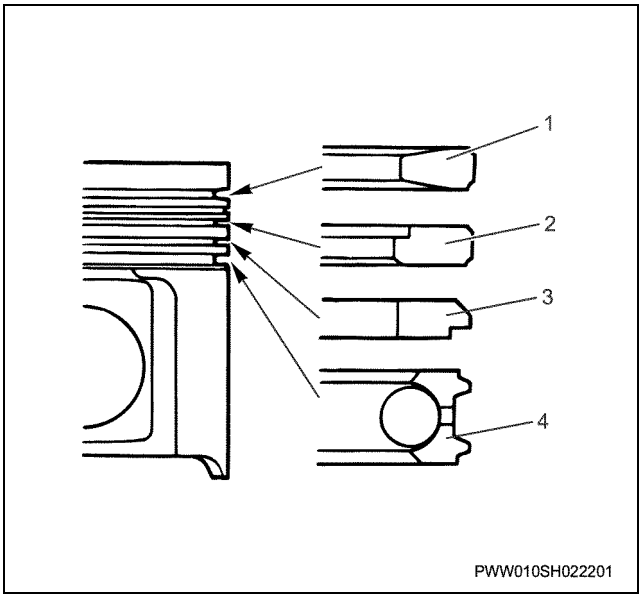
- Put the joining section identification color of the top ring, second ring, and third ring to the right, and use a setting tool to Install them.
- Each top ring, second ring and third ring is identified by the markings on the joining section side face.
- Install the piston rings so that each joining section is 90° apart.
- Take care not to remove any of the coating from the piston card section.

	Identification	Vertical
Top ring	Red paint (1)	No markings
Second ring	Blue paint (2)	2 N
Third ring	Green paint (3)	3 N



- There is no distinction between the upper and lower oil rings, but the expander ring should be installed so that the joining section is 180 degree reverse.
- Apply engine oil to the whole periphery of each ring and rotate the rings. At this time, check that the rings rotate smoothly and do not catch.

Setting tool; Piston ring: 1-8522-1025-0



Legend

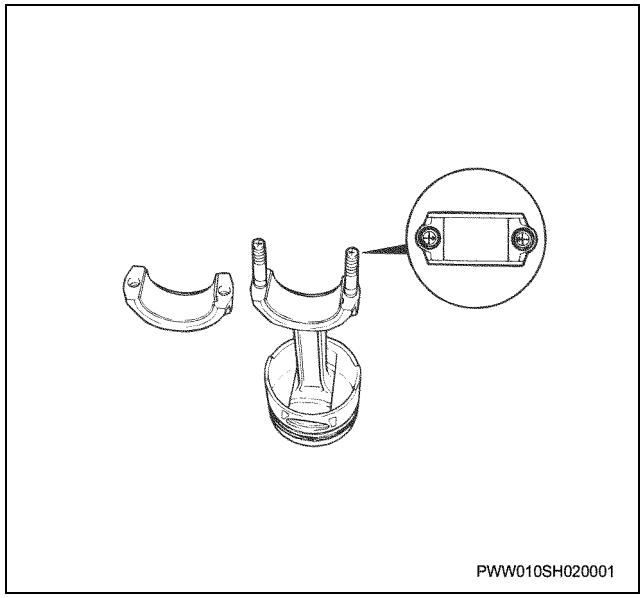
1. Top ring
2. Second ring
3. Third ring
4. Oil ring

6. Install the connecting rod bearing to the connecting rod.

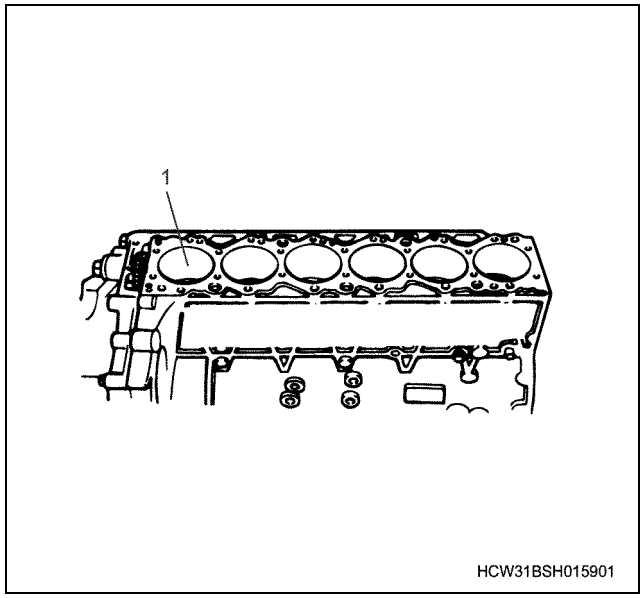
Installation

1. Install the connecting rod bearing to the connecting rod.
   - Thoroughly clean the cap and connecting rod bearing installation surface and install the bearing, then apply engine oil to the sliding surfaces.
   - Apply oil to the piston pin.

Important:
The connecting rod side bearings have slits and oil pores on each section.
The cap side bearing has oil slits on all peripheries but no oil hole.

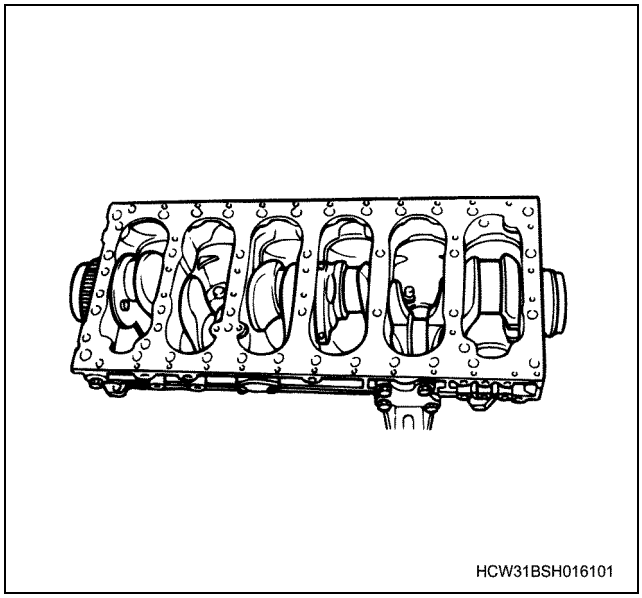


2. Insert the piston and connecting rod into the cylinder.
   a. Apply engine oil to the full outer circumference of the cylinder liner (1).



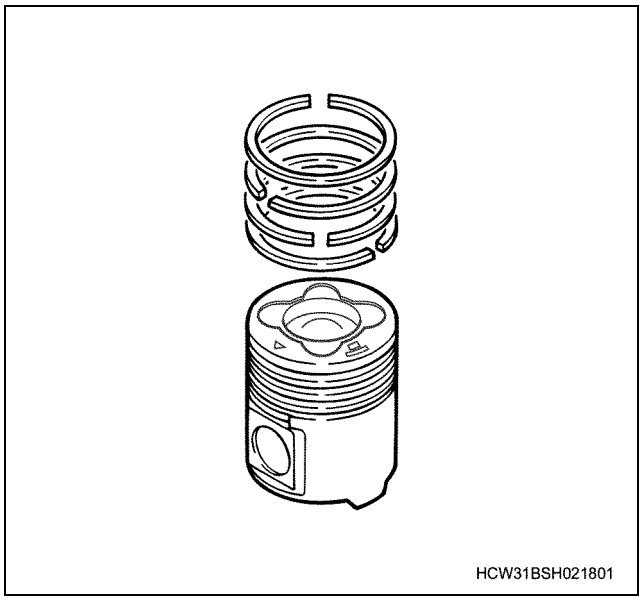
   b. Rotate the crankshaft, insert the piston, and set the cylinder crank pin to the top dead center.

Notes:
Stopper the liner so that it does not get extracted.


HCW31BSH016101

c. Avoid making the piston ring mitre direction the same as the side pressure direction, and divide into 4.

Notes:
Set the oil ring joint to the opposite side to the expander ring joint.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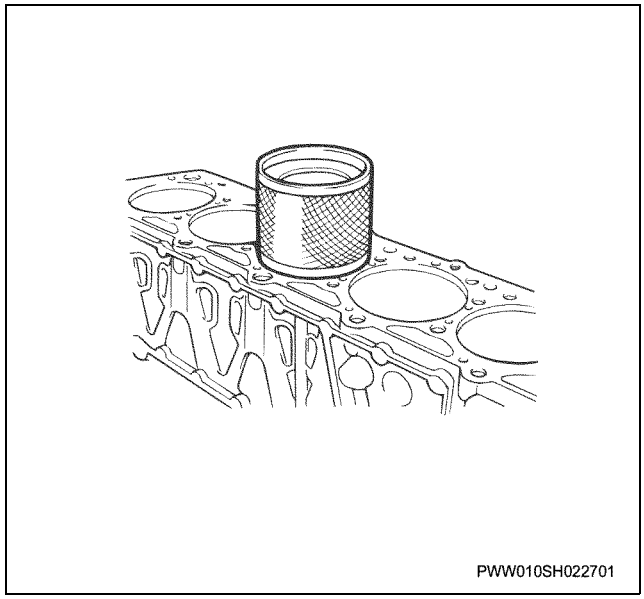
d. Apply oil to the piston and entire ring periphery.
e. Check the cylinder number of the connecting rod, point the piston head arrow mark in the cylinder block front direction, and insert the piston by hand. At this time, rotate the piston 5 ~10 degree to the right and insert, and return to the correct direction when in a position that no longer interferes with the oil jet.
f. Use a setting tool, and insert the piston until it touches the crank pin using the handle of a hammer. Also, rotate the crank shaft while inserting the piston head, and set to the bottom dead center position.

Important:

- **Make sure that the piston and the connecting rod front mark are in the same direction.**
- **Install the setting tool to the cylinder block when using it. The piston ring will become damaged if the setting tool is not installed.**
- **Be careful not to damage the crank pin and oil when installing the piston connecting rod.**

Setting tool; Piston: 1-8522-0059-0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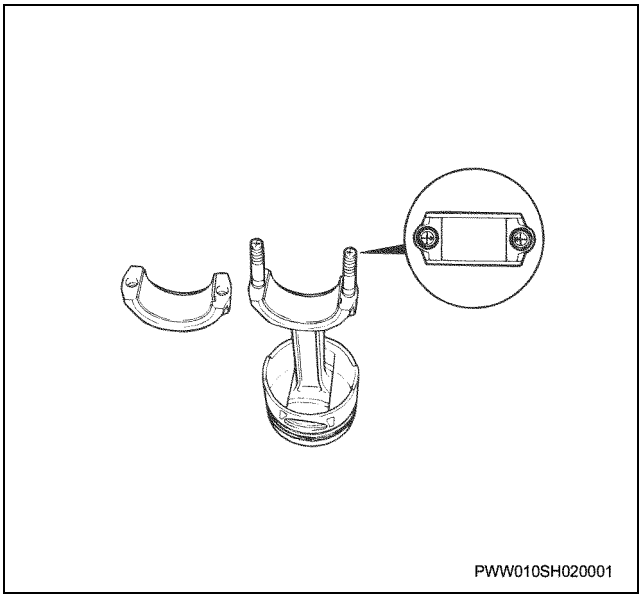
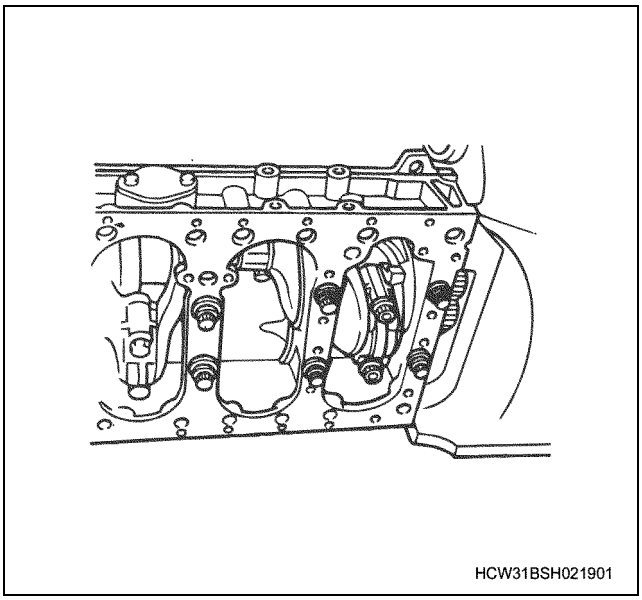
3. Install the connecting rod cap and bearing.
   - Install the bolts so that the arrows on the connecting bolt tip are in the direction shown in the diagram.
   - Match the connecting rod cylinder number and cap cylinder number, apply molybdenum disulphide to the nut screw section and bearing surface, alternately tighten the nuts. At this time, check that the connecting rod cylinder number and cap cylinder number are facing to the right of the cylinder block.

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

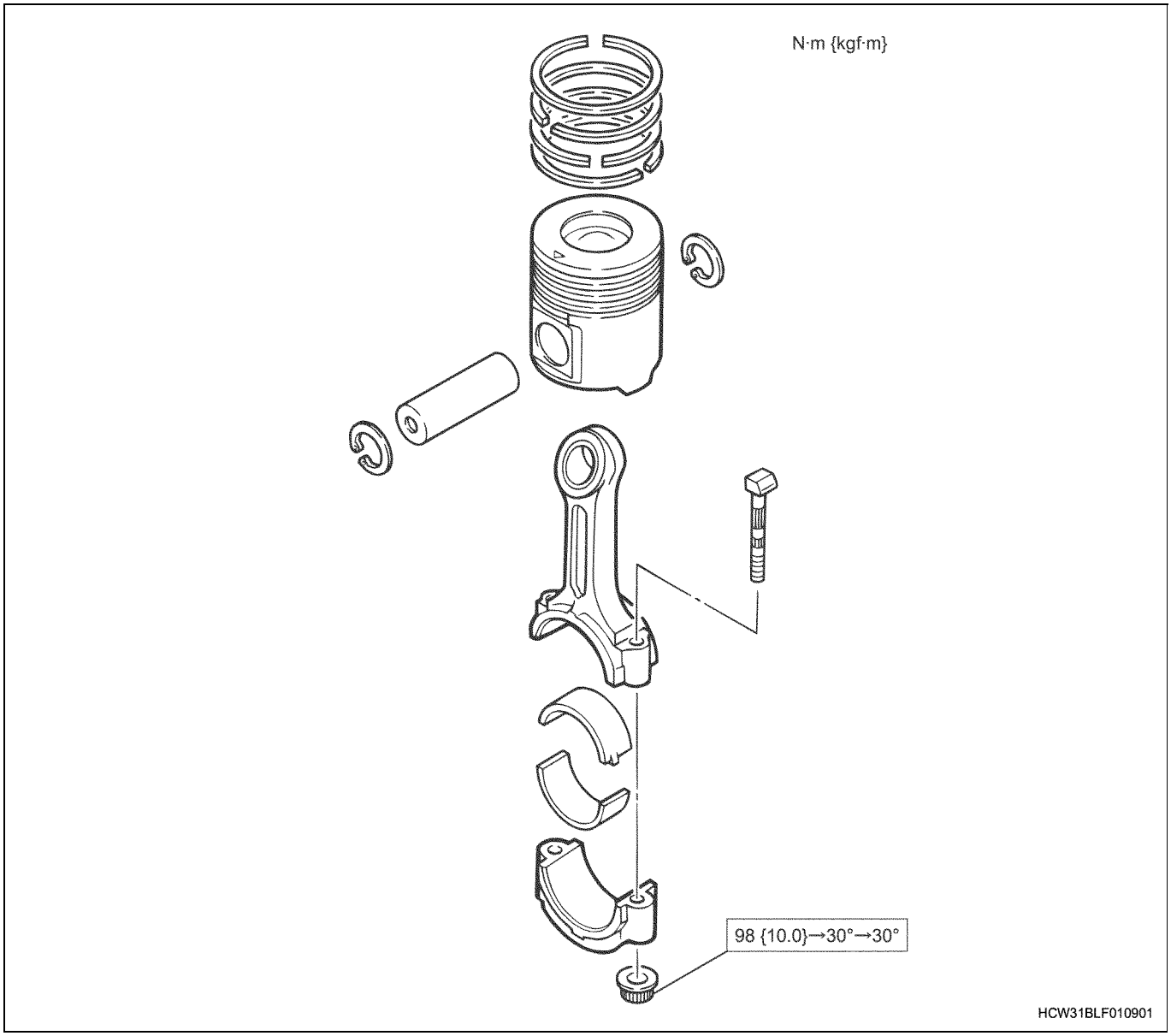


- Rotate the crankshaft, and inspect to make sure that it rotates smoothly without catching. Also check that it doesn't interfere with the oil jet.

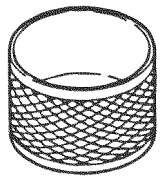
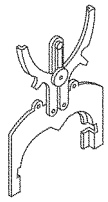
Notes:
Fasten the liner so that it does not get extracted.



Torque specifications

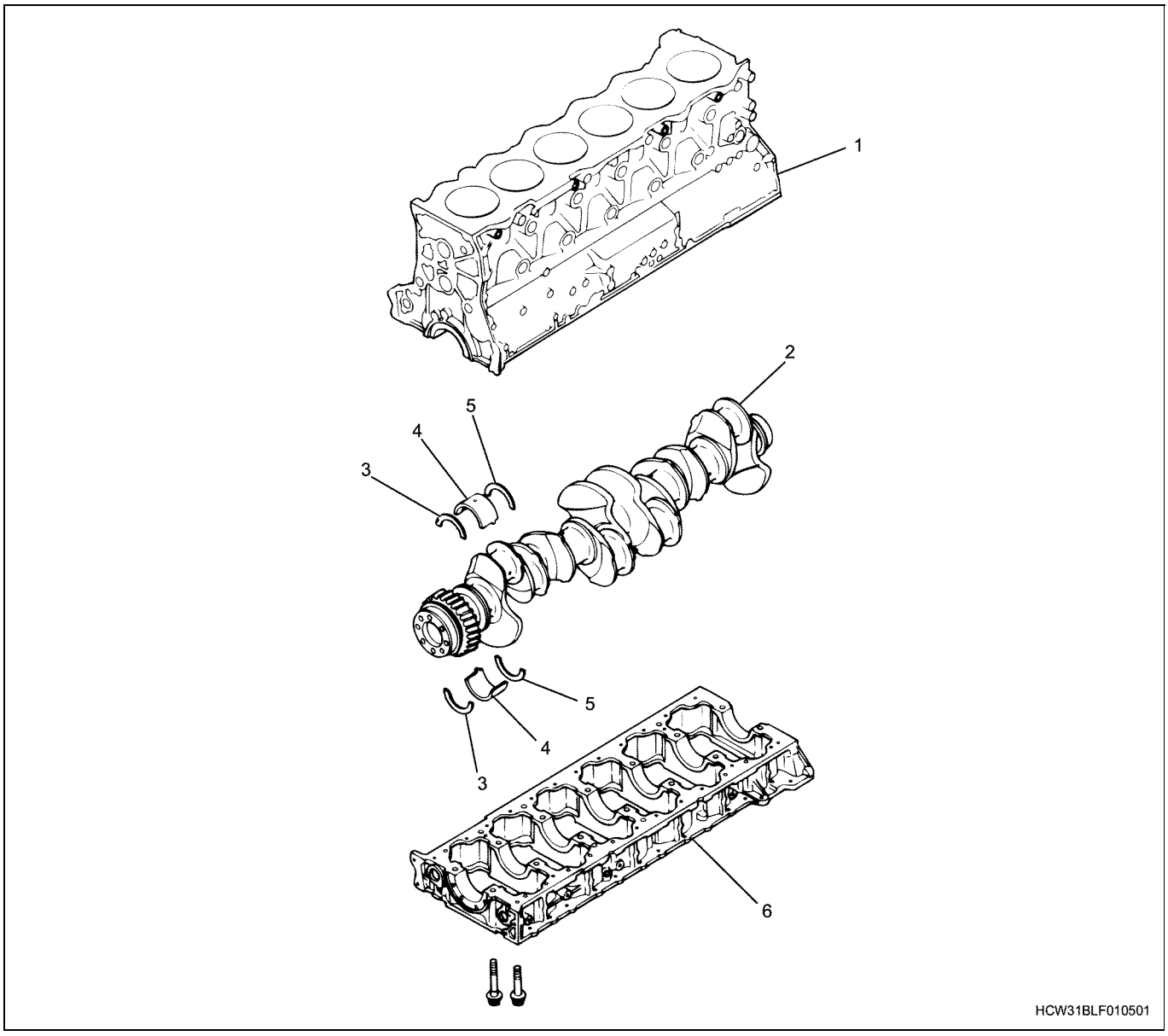


Special tools

Illustration	Tool number Tool name
 1852200590	1-8522-0059-0 Setting tool; Piston
 1852210250	1-8522-1025-0 Setting tool; Piston ring

Crankshaft

Component parts



Legend

1. Cylinder block
2. Crankshaft
3. Thrust bearing
4. Main bearing
5. Thrust bearing
6. Crankcase

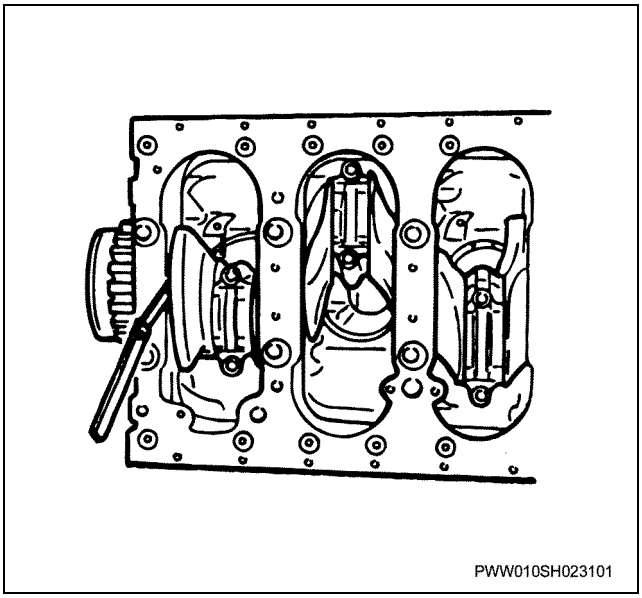
Removal

1. Remove the crankcase.
   - Before removing the crankcase, measure the clearances of the crankshaft shaft orientations. Measure the No.1 bearing thrust surface.

Crankshaft shaft orientation clearance (mm)

Standard	Limit
0.10 ~ 0.28	0.30

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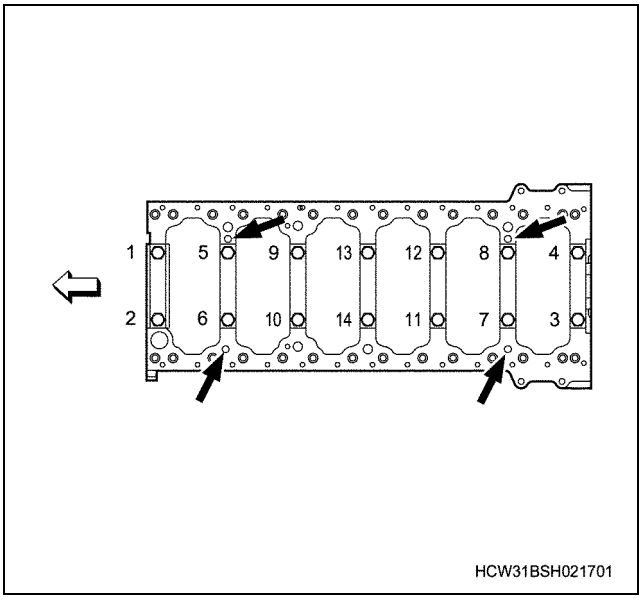
- Loosen and remove the bearing installation bolt from the outside. Next, extract the crank case installation bolt, screw in a M10 × 1.5 bolt with a neck lower length longer than 105mm into the crankcase replacer hole (arrow in the diagram), raise the crankcase, lift it horizontally and remove it.

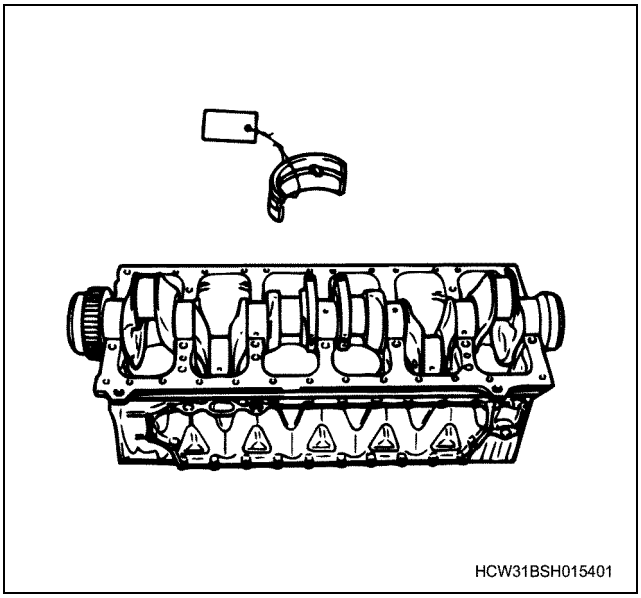


HCW31BSH021701

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.

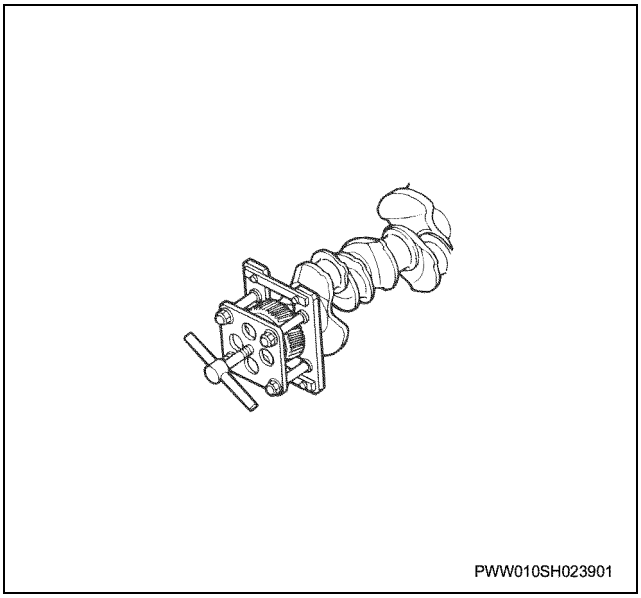
Disassembly

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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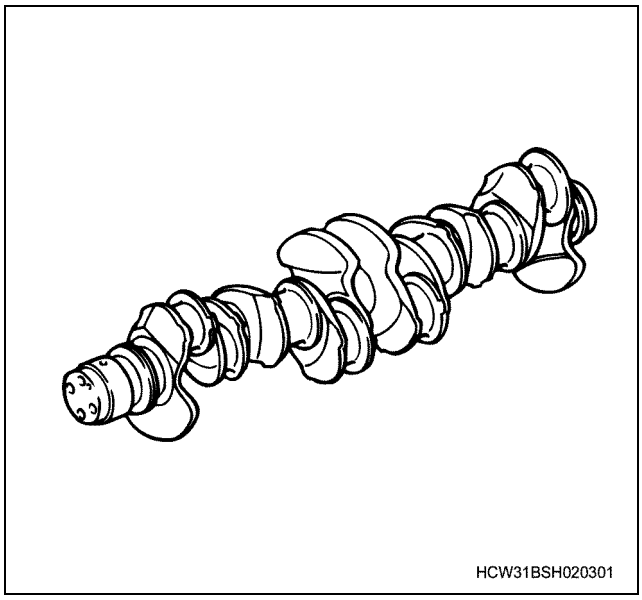
Inspection

Crankshaft

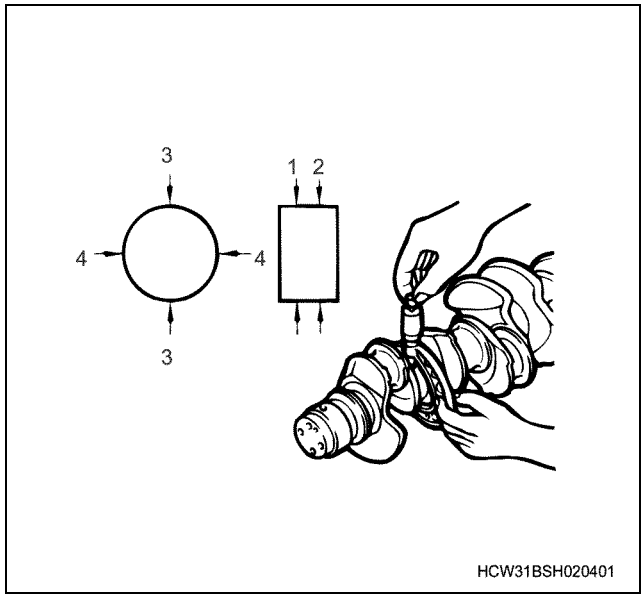
- Inspect the crankshaft for cracks and the bearing contact surface for damage.
  Perform magnetic flux method or red check method inspections whenever necessary.



- Crank journal and pin wear measurement
  Measure each of the 4 points shown on the diagram.

	Nominal dimension mm	Standard mm	
Journal diameter	ϕ105	No.4	ϕ104.850 ~ ϕ104.875
		Others	ϕ104.880 ~ ϕ104.905
Pin outer diameter	ϕ92	ϕ91.895 ~ ϕ91.925	

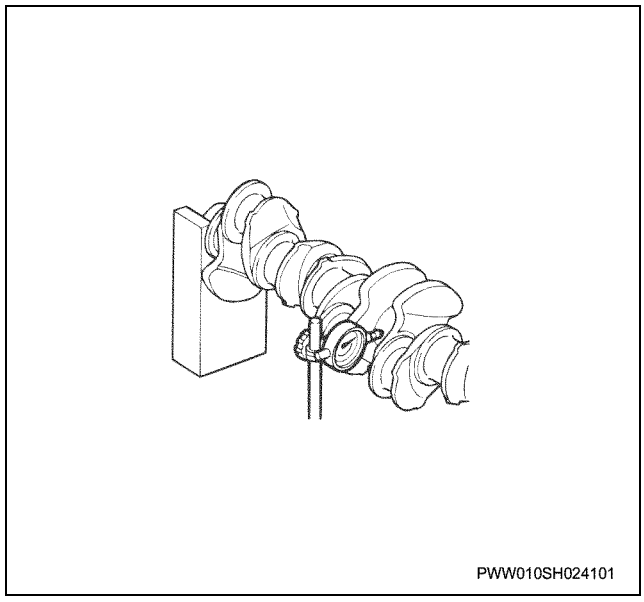
Important:
Do not modify the crankshaft as it has been treated with soft-nitrating treatment.



- Crankshaft runout measurement
  Preserve the No.1 journal and No.7 journal using a crankshaft aligner or V block. Place a dial gauge on the crankshaft No.4 journal and gently rotate the crankshaft once to measure the amount of crankshaft runout.

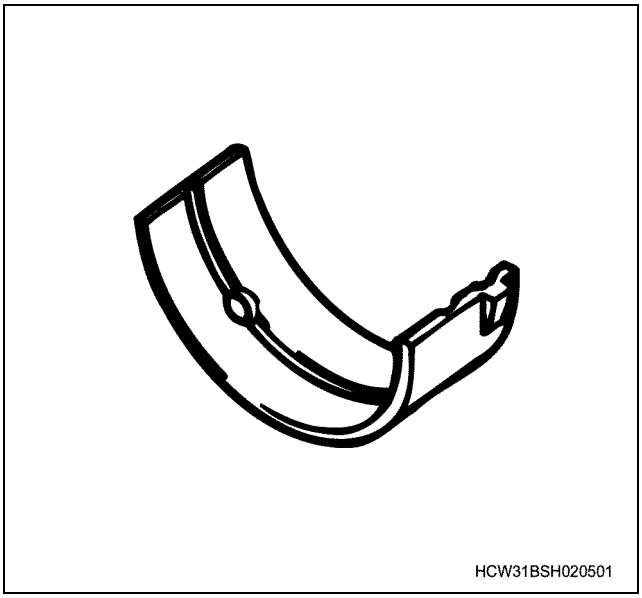
Amount of crankshaft runout

Limit: 0.15 mm



Bearing

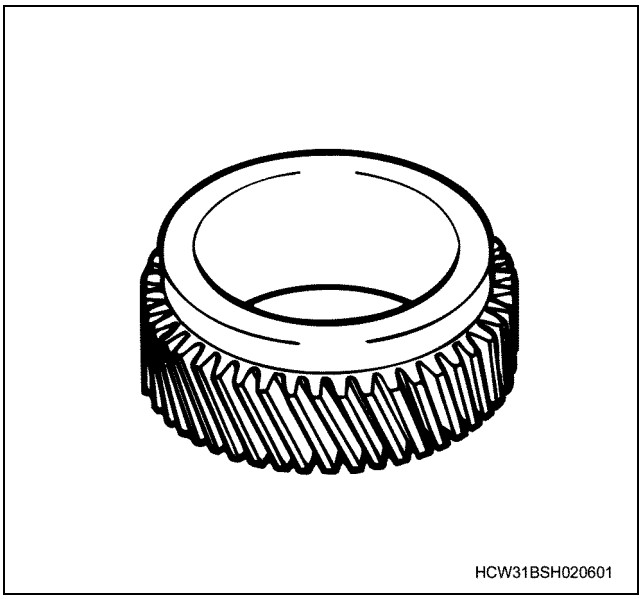
- Inspect for wear, damage, scratches, de-bonding etc.
- Install the bearing and check that there is tension.


HCW31BSH020501

Crankshaft gear

- Inspect the crankshaft gear for damage.

Notes:
Always perform inspections before removing from the crankshaft, and if there are no problems, do not remove it.


HCW31BSH020601

Measuring the clearance between the crank bearing and crank journal

- Measure the crank bearing inner diameter and crank journal inner diameter while they are installed to the crank case, and calculate the clearance.
- Clean the bearing and bearing installation surface, assemble the bearing and install the crank case. Apply molybdenum disulphide to the M18 bolt screw section and bearing surface, and tighten to the correct tightening torque.
  The tightening order for the crankcase is shown in the diagram.
  Also, apply molybdenum disulphide to the M12 bolt screw section and bearing surface and tighten them, then measure the 4 points shown in the diagram with a cylinder gauge.

Tightening torque

N·m {kg·m}

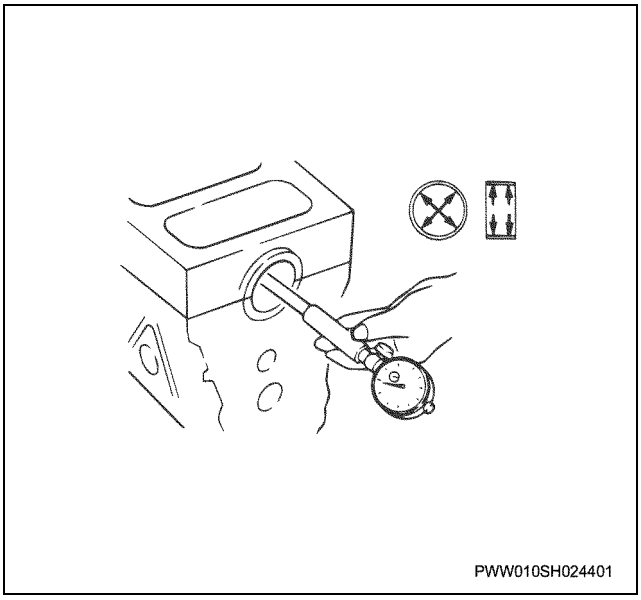
M18: 49 {5} → 88 {9.0} → Angle method 90° ~ 120°
M12: 96 {9.8}

M18: Molybdenum disulphide application

M12: Engine oil application

		Standard mm	Limit mm
Clearance between bearing and crank journal	No.4 Journal	0.075 ~ 0.150	0.16
	Others	0.045 ~ 0.120	

Notes:
*** Refer to the general remarks section when using a plastiguage to measure the clearance.**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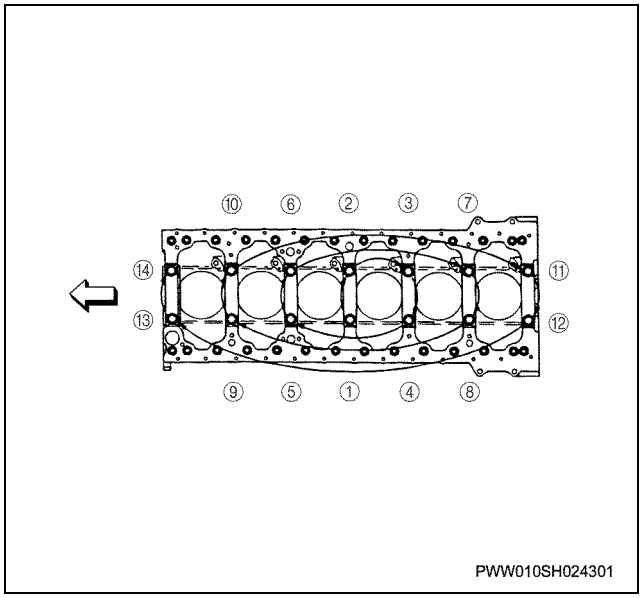
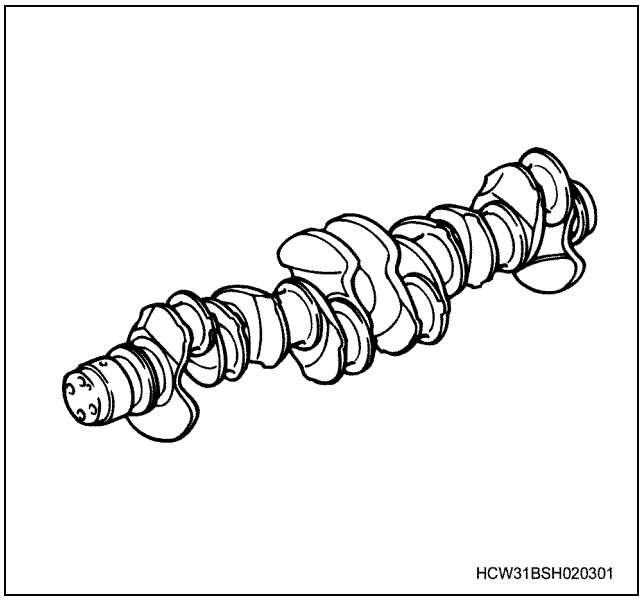
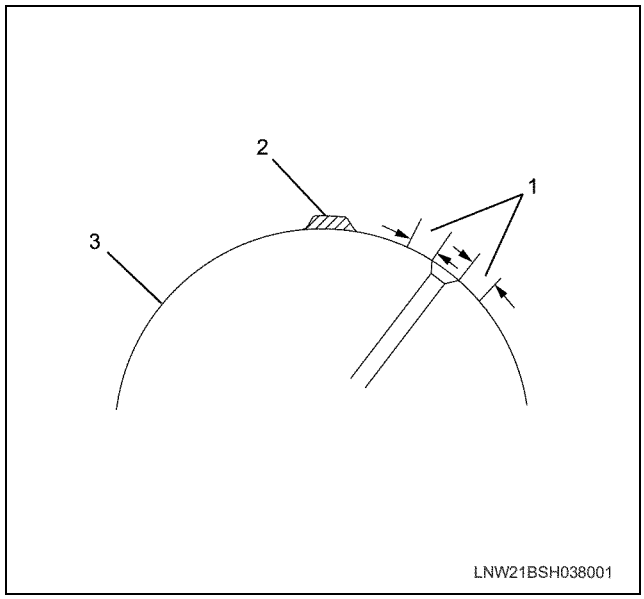


Presence of soft-nitrating process layer

- Crankshaft cleaning
  Clean the crankshaft. Especially in inspection points (excluding a 10mm range around the perimeter of the oil pore) remove oil using organic solvents.



- Soft-nitrating process layer inspection
  Use a syringe or glass rod to drop the inspection solution onto the inspection section. At this time, make sure that the drop sections are kept level and that the inspection solution does not run or drip off.
  * Inspection solution…a 5~10% solution of chlorinated-2-copper ammonium dissolved in distilled water.



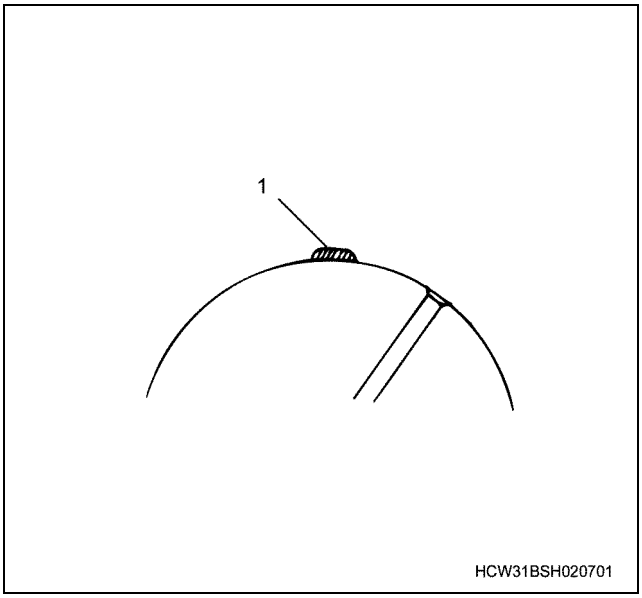
Legend

1. Do not inspect the range within 10mm of the oil pore
2. Inspection solution
3. Crankshaft

- Judgement
  Crankshaft re-usable: No change is visible after 30~40 seconds has elapsed.
  Crankshaft is not re-usable: After 30~40 seconds has elapsed, the inspection solution (light blue color) becomes transparent, and the applied section of crankshaft changes to copper color.
- Process after inspection
  The inspection solution (1) is highly corrosive, so should be wiped from the inspection surface immediately after inspection and the surface should be cleaned with water or steam.

Caution:

- **Do not allow the solution to come into contact with eyes, hands, or clothing. Should the liquid get into someone's eye, immediately wash with large amounts of fresh water and seek immediate medical attention.**

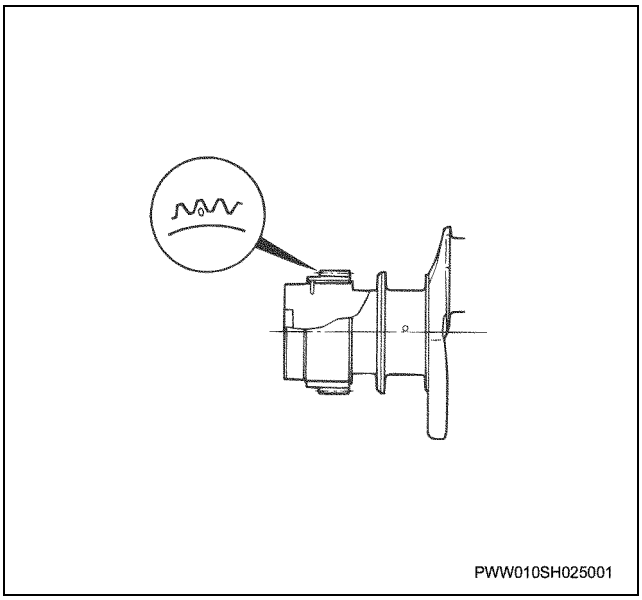


Assembly

1. Install the crankshaft gear.
   - Install the crankshaft and knock pin.
   - Warm the gears using an oil heater (oil temperature 170°C ~ 180 °C) Next, point the gear's timing alignment mark “0” to the near side, line up the gear's key slot to the crank knock pin, and use a installer to insert until it contacts with the crankshaft collar section.

Notes:
Pay attention to the direction of the gears when installing.

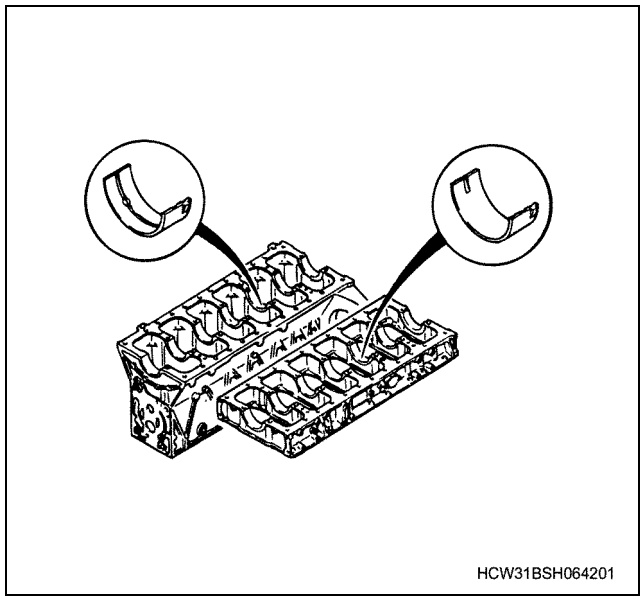
Installer; Crankshaft gear: 1-8522-0045-0



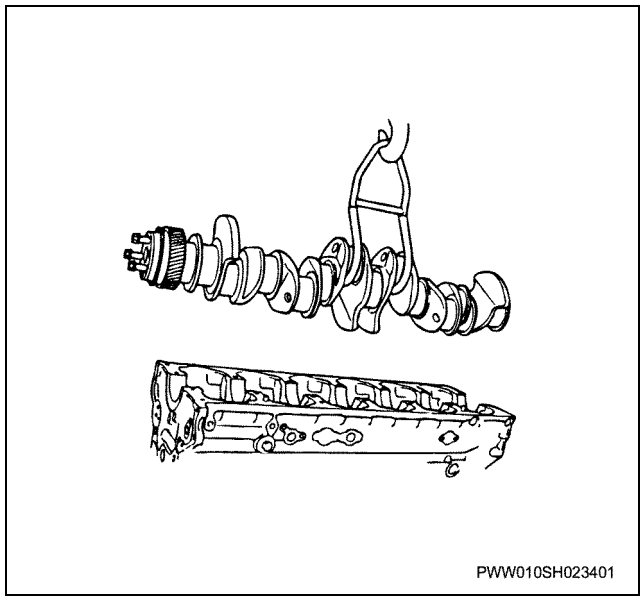
Installation

1. Install the crankshaft bearing.
   - Check the installation position from when it was disassembled, and thoroughly clean the bearing and bearing installation surface, then install the bearing.

Important:
The cylinder block side bearings have slits and oil pores on all peripheries. The crankcase side bearing doesn't have slits or oil pores.

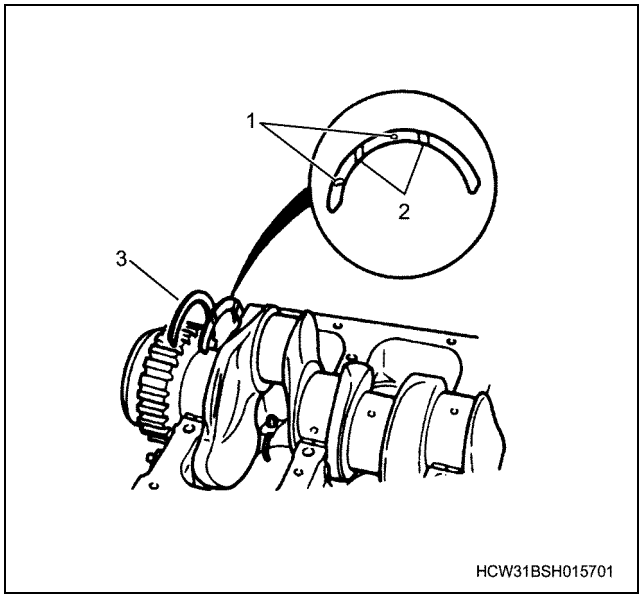


2. Install the crankshaft.
   - Apply engine oil to the bearing's sliding parts surface, level the crankshaft and rest it on the bearings.



3. Install the thrust bearing.

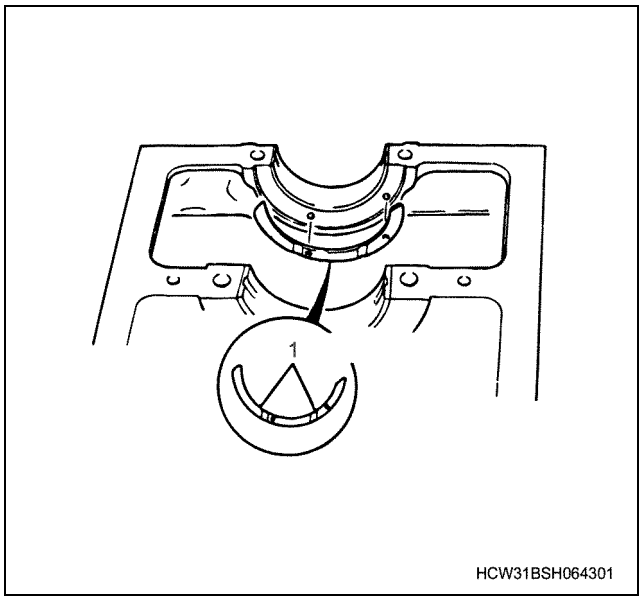
- Apply oil to the engine oil slit side of the thrust bearing, and with the oil slit facing the outside, push it in to both sides of the cylinder block No.1 journal by hand.



Legend

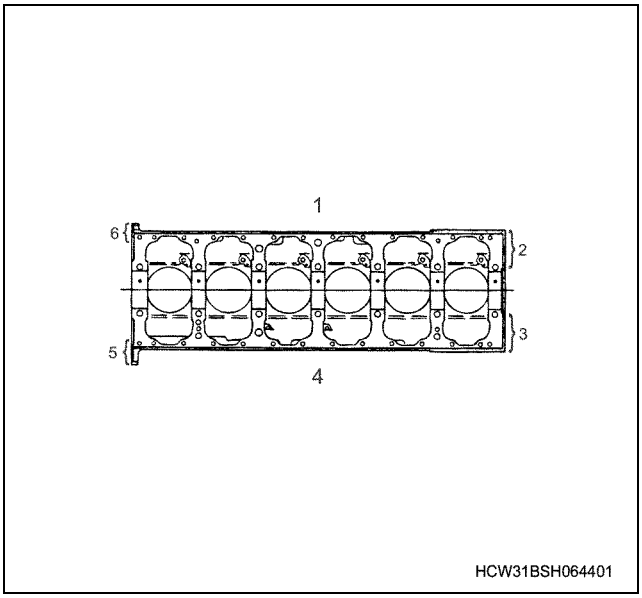
1. Knock pin hole alignment
2. Oil slit
3. Oil application

- Apply engine oil to the thrust bearing oil slit (1) side. With the oil slit facing the outside, line up and install to the crankcase outward section.



4. Install the crankcase.

- Apply approx. 4 mm width and more than 0.3 mm thickness of Loctite FMD-127 liquid gasket to the points on the underside of the cylinder block shown in the diagram (1,2,3,4,5,6) and install promptly.



- Apply molybdenum disulphide to the M18 bolt screw section and bearing surface, and tighten in the numbered order shown in the diagram. Also, apply oil to the M12 bolt screw section and bearing surface, and tighten the bolts.

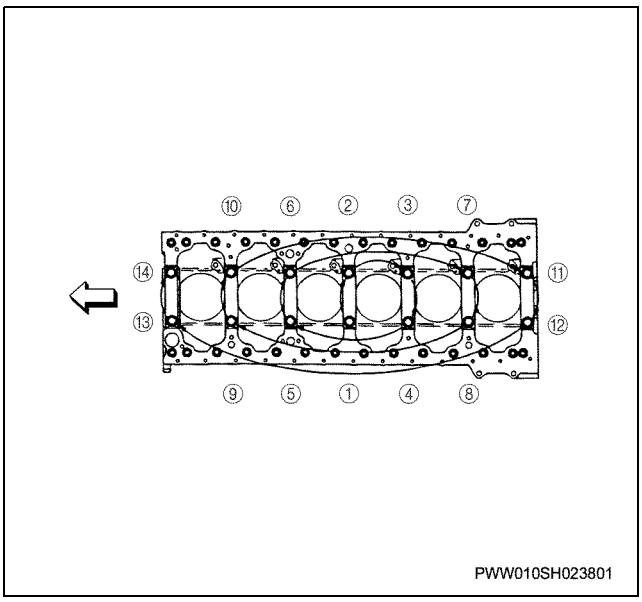
Notes:

- **Check that the thrust bearing is securely installed.**
- **Check that the crankshaft rotates smoothly.**

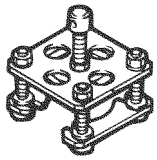
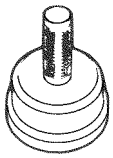
Tightening torque

	N·m {kg·m}
M18:	49 {5} → 88 {9.0} → Angle method 90° ~ 120°
M12:	96{9.8}

M18:	Molybdenum disulphide application
M12:	Engine oil application

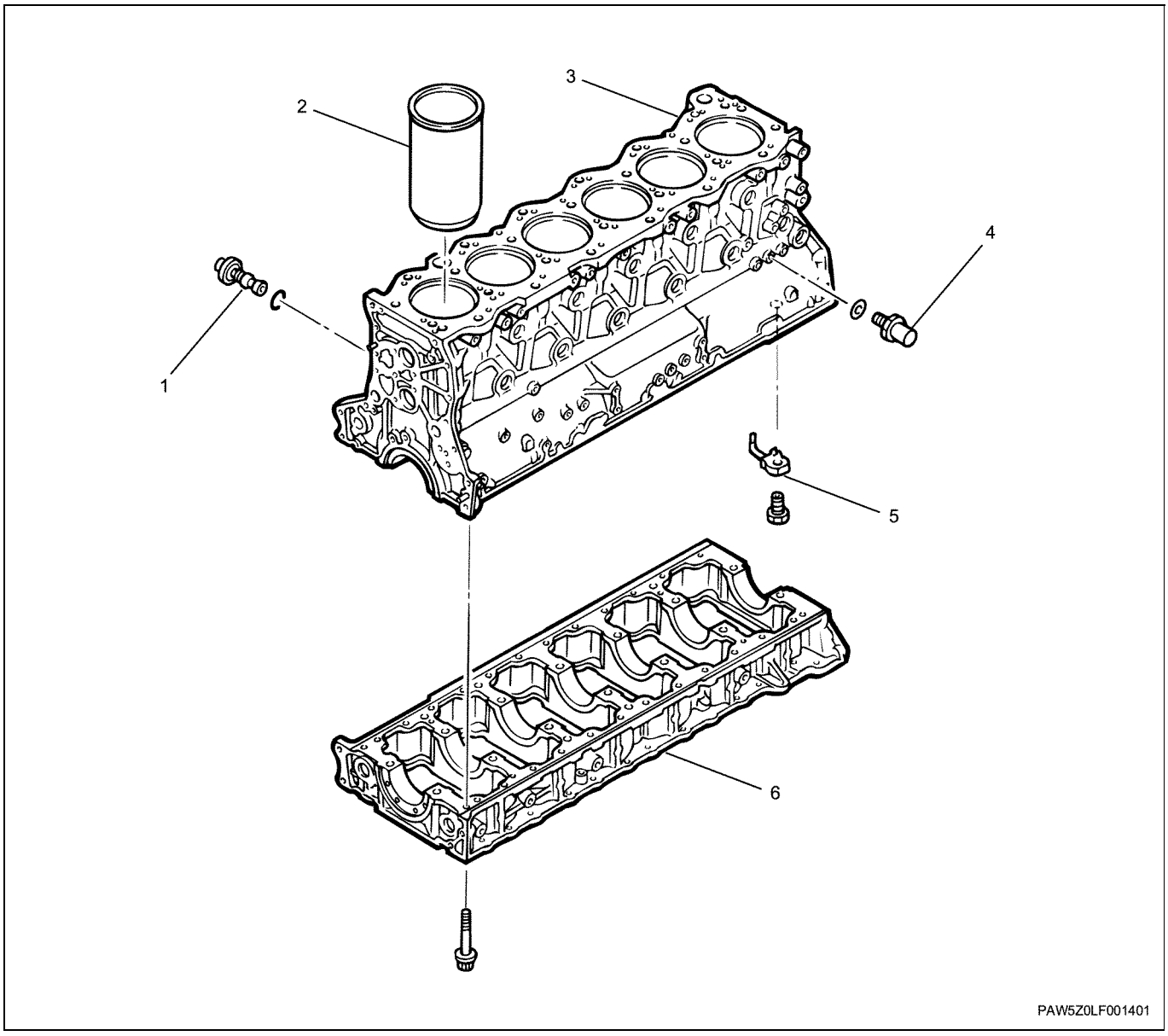


Special tools

Illustration	Tool number Tool name
 1852100640	1-8521-0064-0 Remover; Crankshaft gear
 1852200450	1-8522-0045-0 Installer; Crankshaft gear

Cylinder block

Component parts



Legend

1. Oil relief valve
2. Cylinder liner
3. Cylinder block
4. Oil pressure sensor
5. Oil jet
6. Crankcase

Disassembly

1. Remove the oil pressure unit.
2. Remove the oil relief valve.
3. Remove the crankcase.
4. Remove the oil jet.
5. Remove the cylinder liner.
   Measuring the cylinder liner inner diameter
   - Inspect the inner surface of the liner for damage or scratches.
   - With the liner inner diameter still installed to the cylinder block, measure the maximum wear section in the position approx. 20 ~ 25 mm from the liner upper surface, and replace the liner if this exceeds the limit.

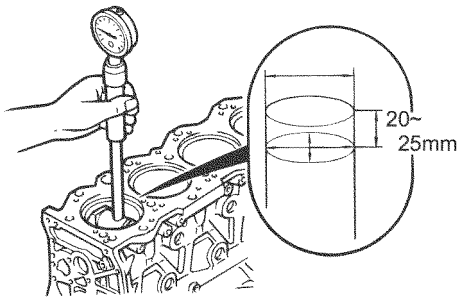
Cylinder liner inner diameter

Nominal dimension mm	Limit mm
ϕ147	ϕ147.3

- When re-using the liner, clean off any carbon from the liner upper section using a scraper or other such tool.

Important:

- **It is not possible to repair liner boring or honing.**
- **Prevent the liner from being extracted.**



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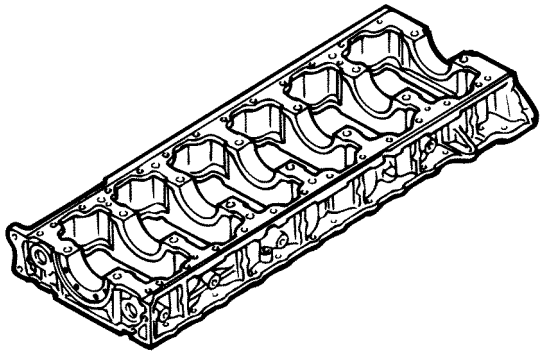
Inspection

Crankcase

- Inspect the crankcase for cracks or damage.
  Perform magnetic flux method or red check method inspections whenever necessary.



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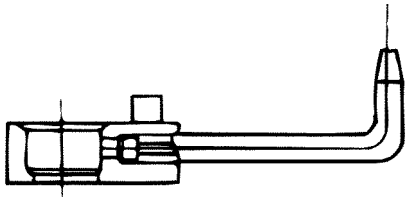
Oil jet

- Inspect the oil pore of the oil jet and joint bolt.



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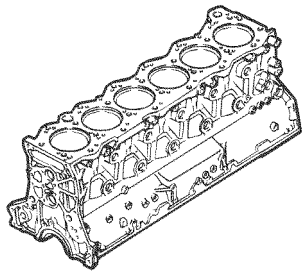
Cylinder block

- Inspection for blockage or corrosion of the coolant and oil lines
  Carefully inspect between each of the cylinders for blockages in the coolant lines.
- Inspect the cylinder block for cracks or damage.
  Perform magnetic flux method or red check method inspections whenever necessary.
- Inspection for water leakage from the water jacket
  Apply water pressure of 490 kPa {5 kgf/cm^2} from a hydraulic test machine for 3 minutes, and inspect each cylinder block for water leaks.



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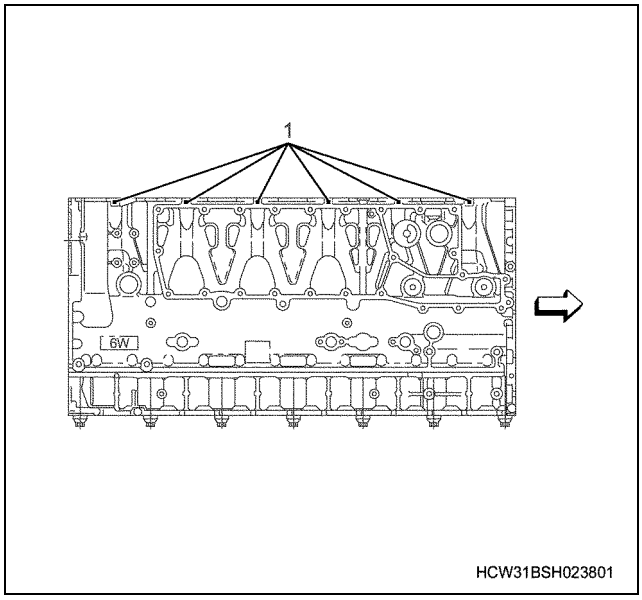
Assembly

1. Assemble the cylinder block.

Cylinder liner grade selection

- Match the cylinder block bore diameter (1) and liner diameter grade.
- Using the number written on the right side surface of the cylinder block, select a 1x for 1 or 2, or a 3x for 3 liner and install it.

Important:
If you do not select the correct grade of liner when installing new liner, it can cause a lack of coolant (large clearance), liner insertion difficulties (small clearance) and distortion.



Cylinder block and liner combination

Block inscribed number	Liner grade
1 ·2	1x
3	3x

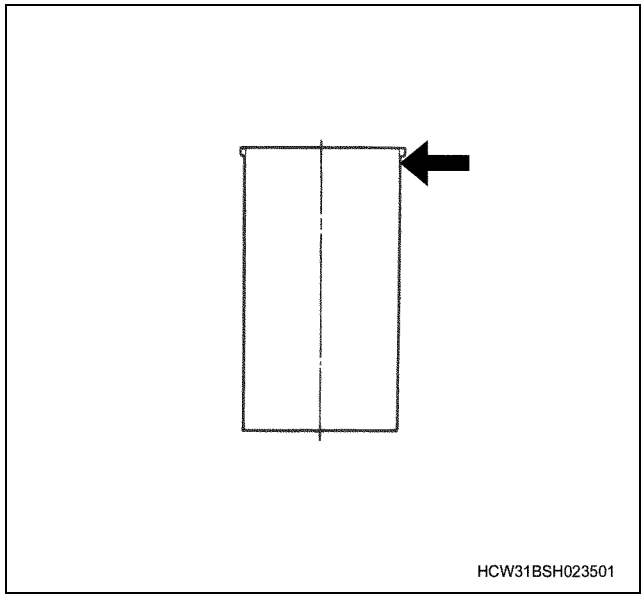
Clearance between cylinder block and liner

Selection of a reference point:	0.001 ~ 0.030mm

- Cylinder block and liner cleaning
  Adequately clean the cylinder block and liner, and after cleaning thoroughly wipe off all traces of cleaning fluid.

Notes:

- **The liner is very thin and should be handled with care.**
- **Arrow liner outer diameter grade marking position.**



2. Install the cylinder liner.
   - Installing the cylinder liner
     Apply engine oil to the outer surface of the cylinder liner, and install straight along the cylinder block.

Important:

- **When inserting the liner, do not strike or apply too much force.**
- **After inserting the liner, make sure that the liner does not come out when reversing the cylinder block.**

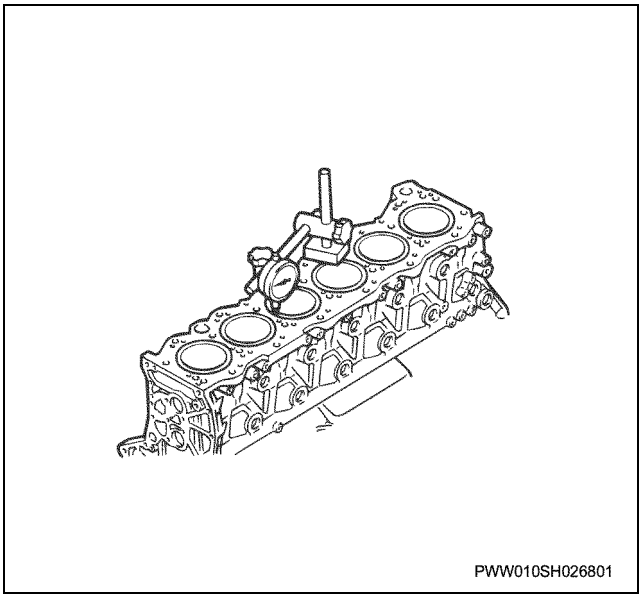
- Measuring the amount of cylinder liner projection
  Use a dial gauge to measure the amount of liner that is protruding.

Amount of cylinder liner projection

Standard:	0.05 ~ 0.09mm

Difference to adjoining cylinder

Standard:	Less that 0.025mm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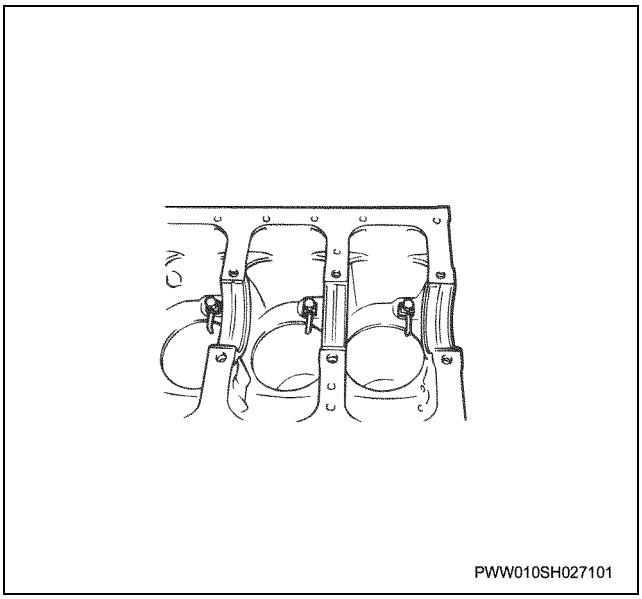
3. Install the oil jet.
   - Check that the tip of the oil jet is facing the entrance to the piston cooling cavity and install it.

Tightening torque: 69 N·m {7.0 kgf·m}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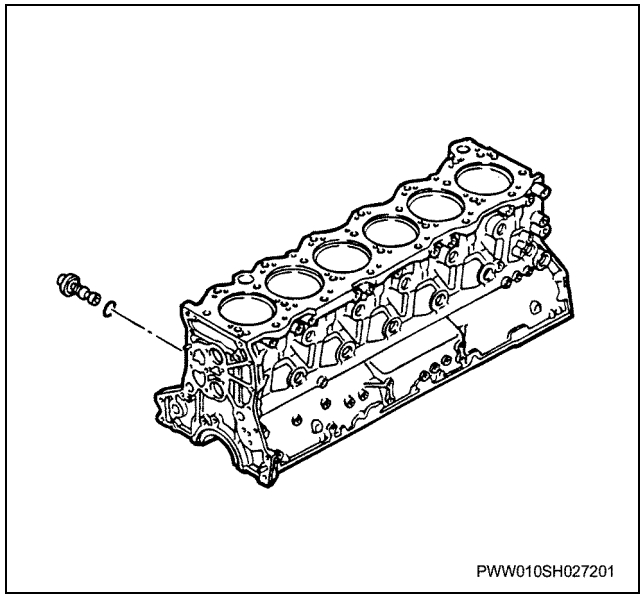
Important:
Do not bend the oil jet tip out of shape.

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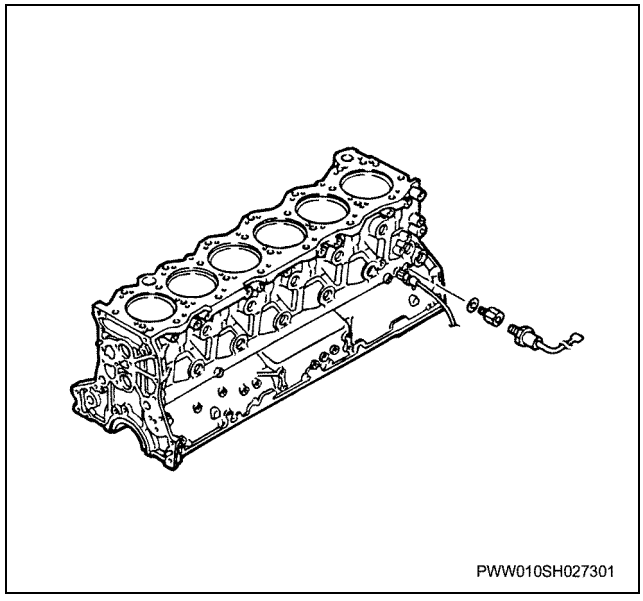
6. Install the oil pressure unit.
   - Install the adapter and oil pressure unit through the gasket.

Tightening torque

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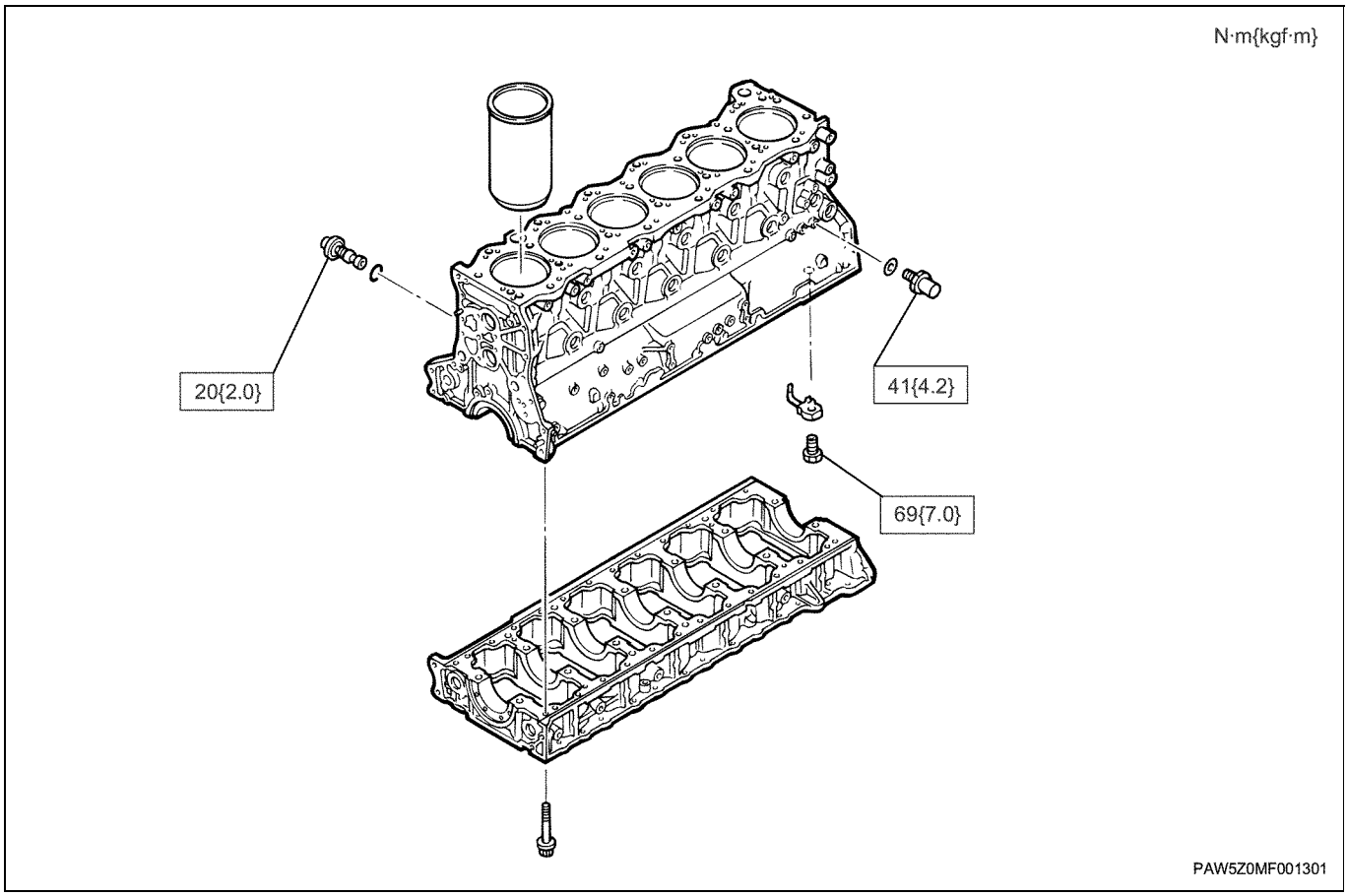
Torque specifications



Disassemble and Assemble Engine

Cooling system
(6WG1 (Common rail))
Contents

Cooling system 1C-2
Service Precautions 1C-2
Explanation of functions and operations 1C-2
Trouble shooting 1C-4
Engine overheats 1C-5
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Disassembly 1C-12
Inspection 1C-14
Assembly 1C-14
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Special tools 1C-18

Cooling system

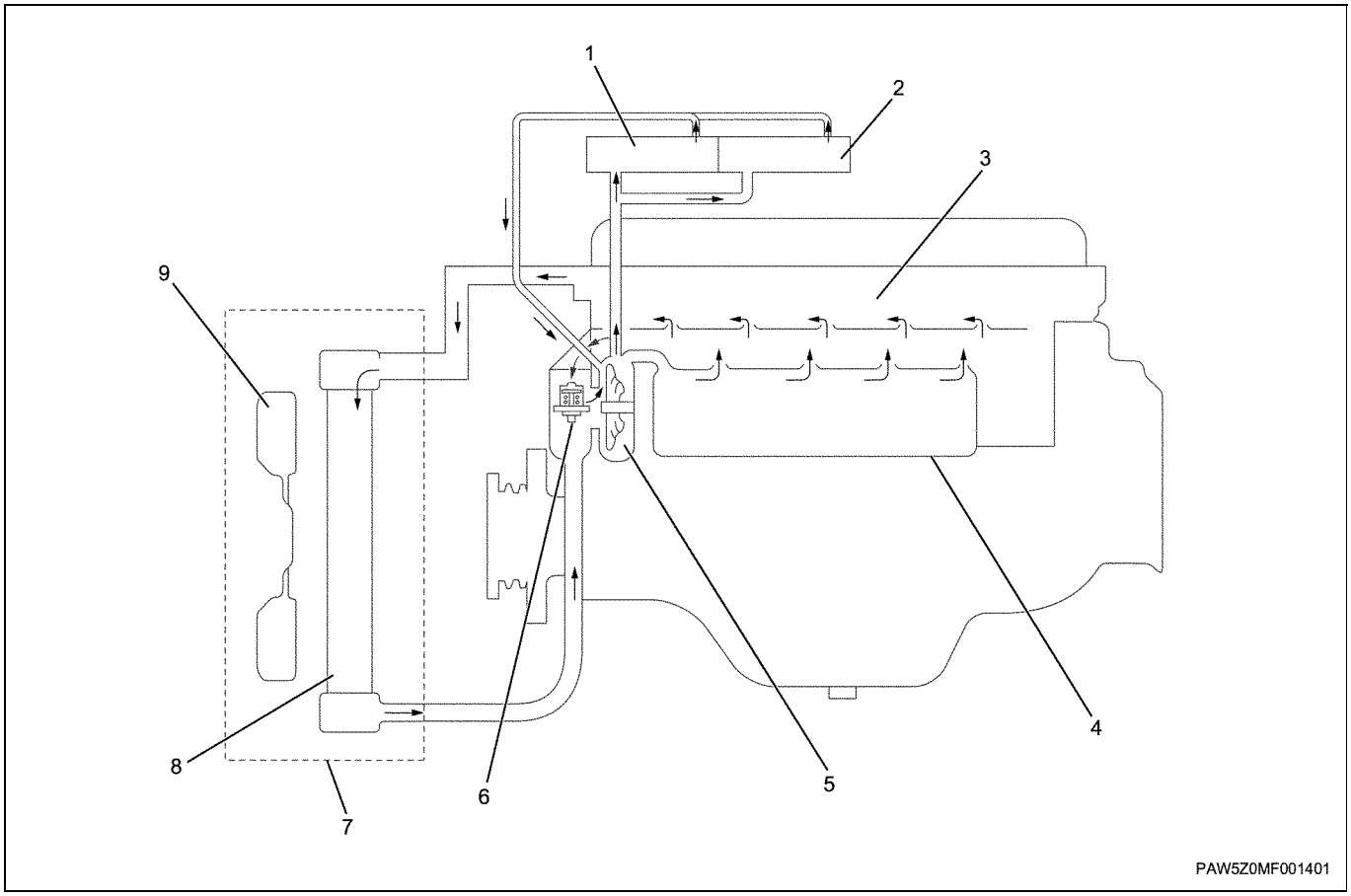
Service Precautions

Warning:
Do not put on or take off the radiator cap when the coolant water is hot. Steam or boiling water may spurt out and cause scolding. When opening the radiator cap, do so when the coolant water is cold, cover the cap with a thick cloth, and rotate the cap slowly to release pressure before removing it.

Explanation of functions and operations

Cooling system

The cooling system is a forced circulation type system, and is constructed of the following main parts: Water pump, thermostat, and radiator (machine side component).

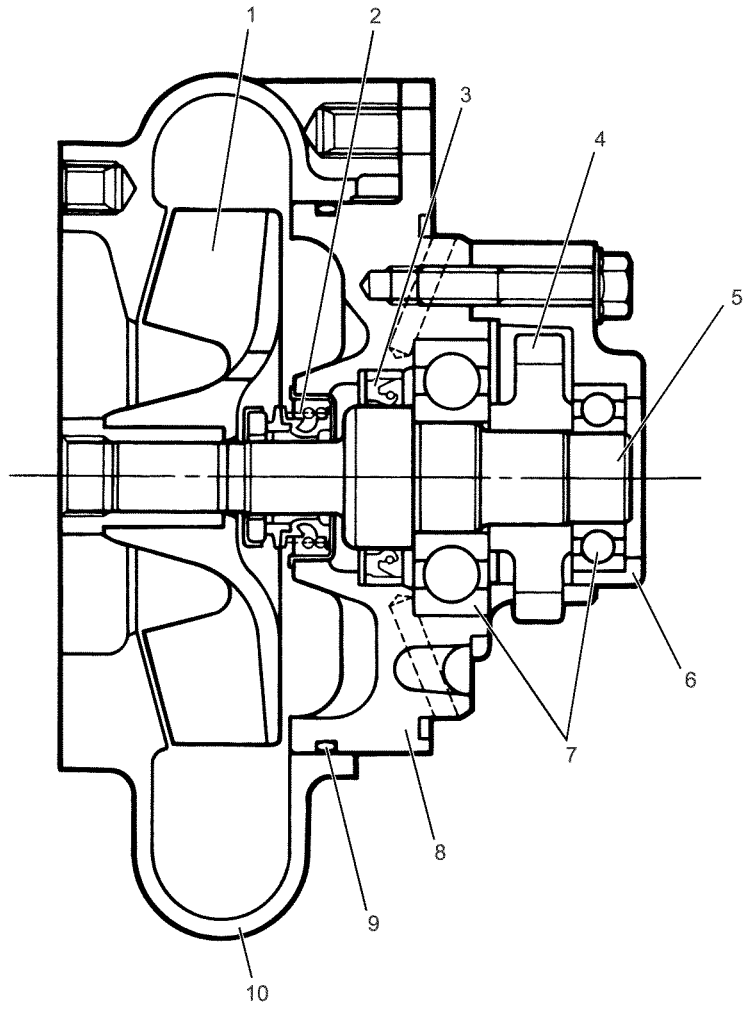


Legend

1. EGR cooler
2. EGR cooler
3. Cylinder head
4. Oil cooler
5. Water pump
6. Thermostat
7. Machine side Installation parts
8. Radiator
9. Cooling fan

Water pump

The water pump is a centrifugal impeller type pump, and is driven by the engine's front gear.



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Legend

1. Impeller
2. Seal unit
3. Oil seal
4. Gear
5. Shaft
6. Rear cover
7. Bearing
8. Water pump body
9. O-ring
10. Front cover

Trouble shooting

- Engine overheats
- Engine overcools

Engine overheats

Condition	Probable cause	Correction
Engine overheat	Belt is damaged or slips	Either replace or adjust the belt
	Low coolant water level	Add coolant
	Water temperature gauge or water supply apparatus is faulty	Replace the water temperature gauge
	Exhaust pipe or silencer is blocked	Repair the exhaust pipe or silencer
	Oil level is low	Add more oil
	Wear or damage to the radiator cap	Replace the radiator cap
	Radiator core or grill are blocked or dirty	Clean or repair the radiator core or grill
	Rust or dust is blocking the radiator tube	Clean or replace the radiator core
	Faulty thermostat	Replace the thermostat
	Fan clutch fault	Replace the fan clutch
	Faulty water pump	Repair or replace the water pump
	Water jacket is blocked	Clean the water jacket

Engine overcools

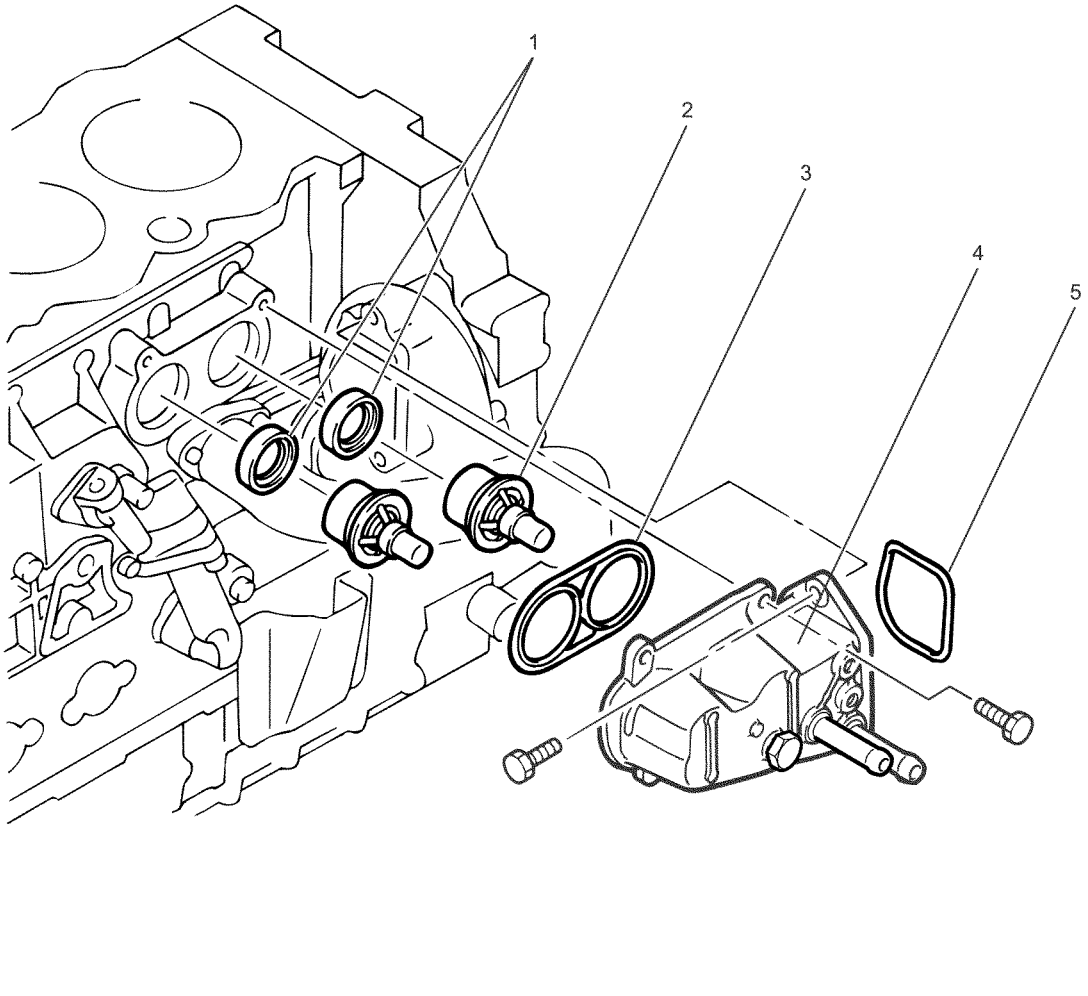
Condition	Probable cause	Correction
Engine overcools	Faulty thermostat	Replace

Main data and specifications

Heading		Item
Cooling system		Water-cooled controlled circulation type
Radiator type		This machine side
Water pump	Type	Centrifugal gear type
	Amount of discharge (L/min)	383 (2849 rpm)
Thermostat valve open start temperature (°C)		82 ~ 84
Cooling water capacity (L)		36.1

Thermostat

Component parts



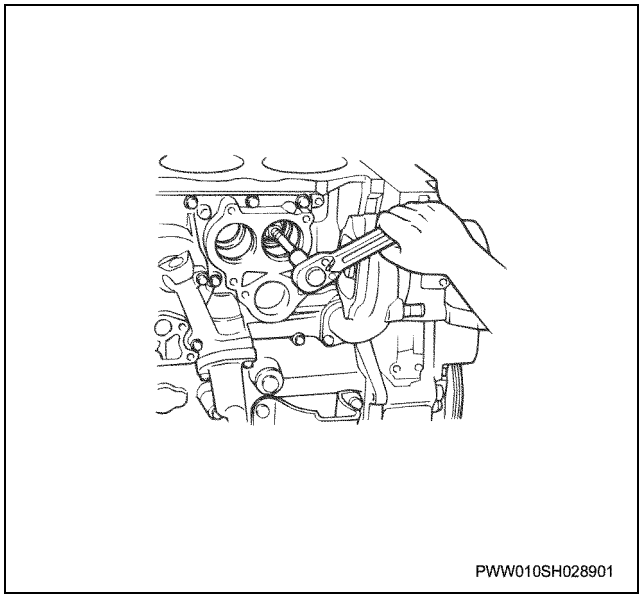
Legend

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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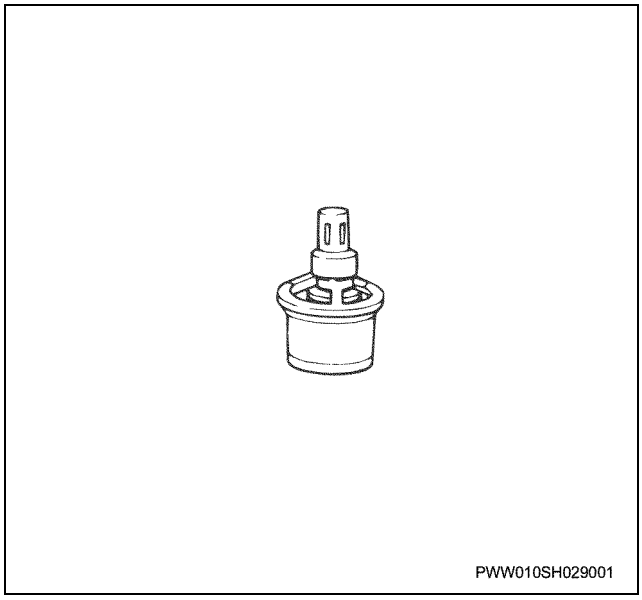
Inspection

Thermostat

- Inspect the thermostat's pellet, spring, and caulking parts for damage.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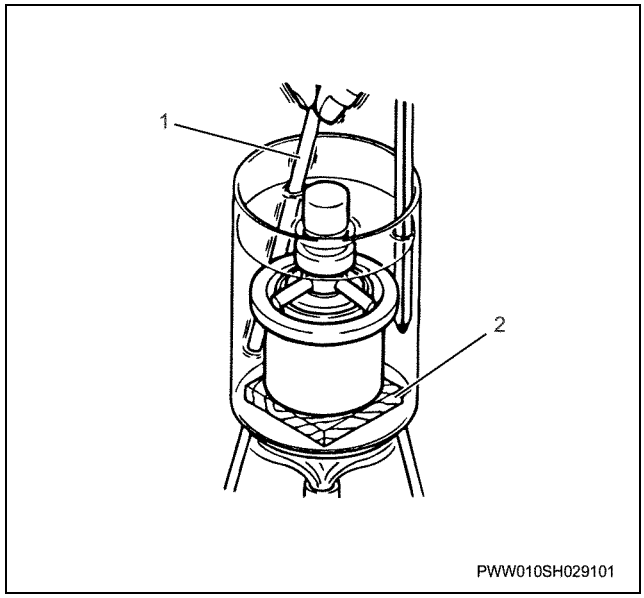
- Thermostat operational checks
  Put the thermostat into water and gradually increase the water temperature. Measure the temperature at which it starts to open, temperature at which it is fully open, and amount of lift.

Open start temperature	82°C
Temperature when fully open	95°C
Amount of lift	95°C / 11 mm

Notes:
Do not directly heat the thermostat. Either perform the measurements by covering the bottom of the thermostat container with a plate (2), or hanging and lowering it into water. When performing measurements, constantly stir the water (1) to prevent differences of temperature from happening.



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Legend
1. Stirring rod
2. Block

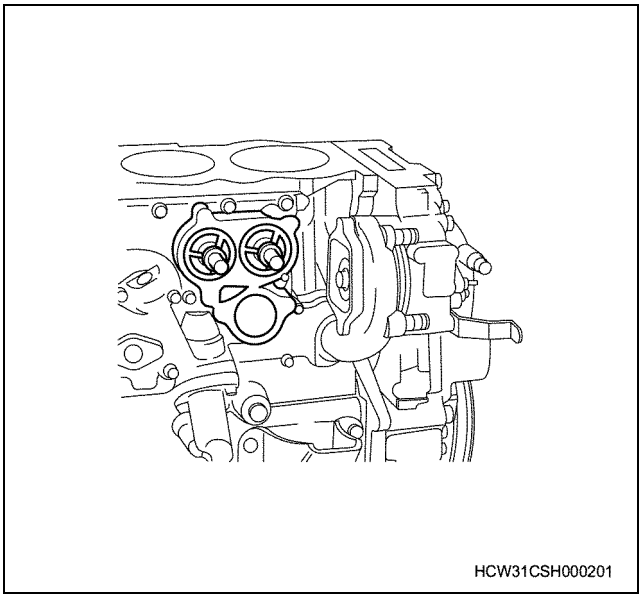
- As wax type thermostats have a large heat capacity, the action of the valve has a certain amount of time lag compared to the fluctuation in water temperature.

Installation

1. Install the seal ring.
   - Face the lip section of the seal ring as shown in the diagram, and use a installer to install it.

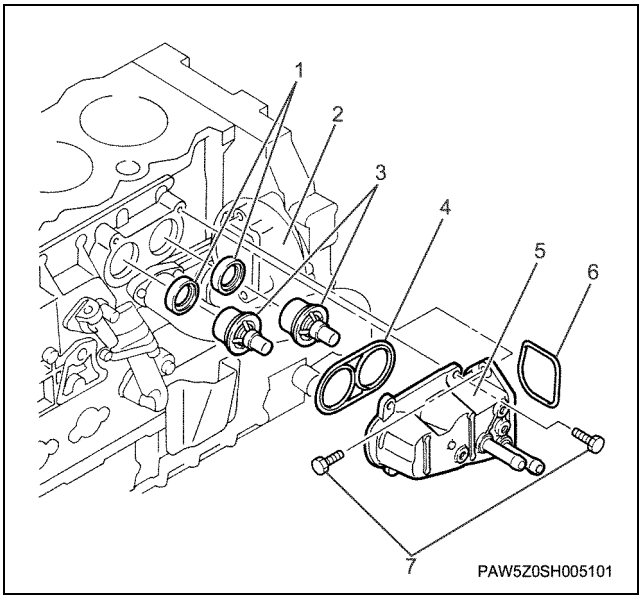
Installer; Thermostat seal ring: 1-8522-1034-0

2. Install the thermostat.
   - Take care not to damage or scratch the seal ring and install the thermostat as shown in the diagram.



3. Install the O-ring.
4. Install the gasket.
5. Install the thermostat housing.
   - Tighten the water pump side bolts while holding down the thermostat housing in the oil cooler. Next, tighten the oil cooler side bolts.

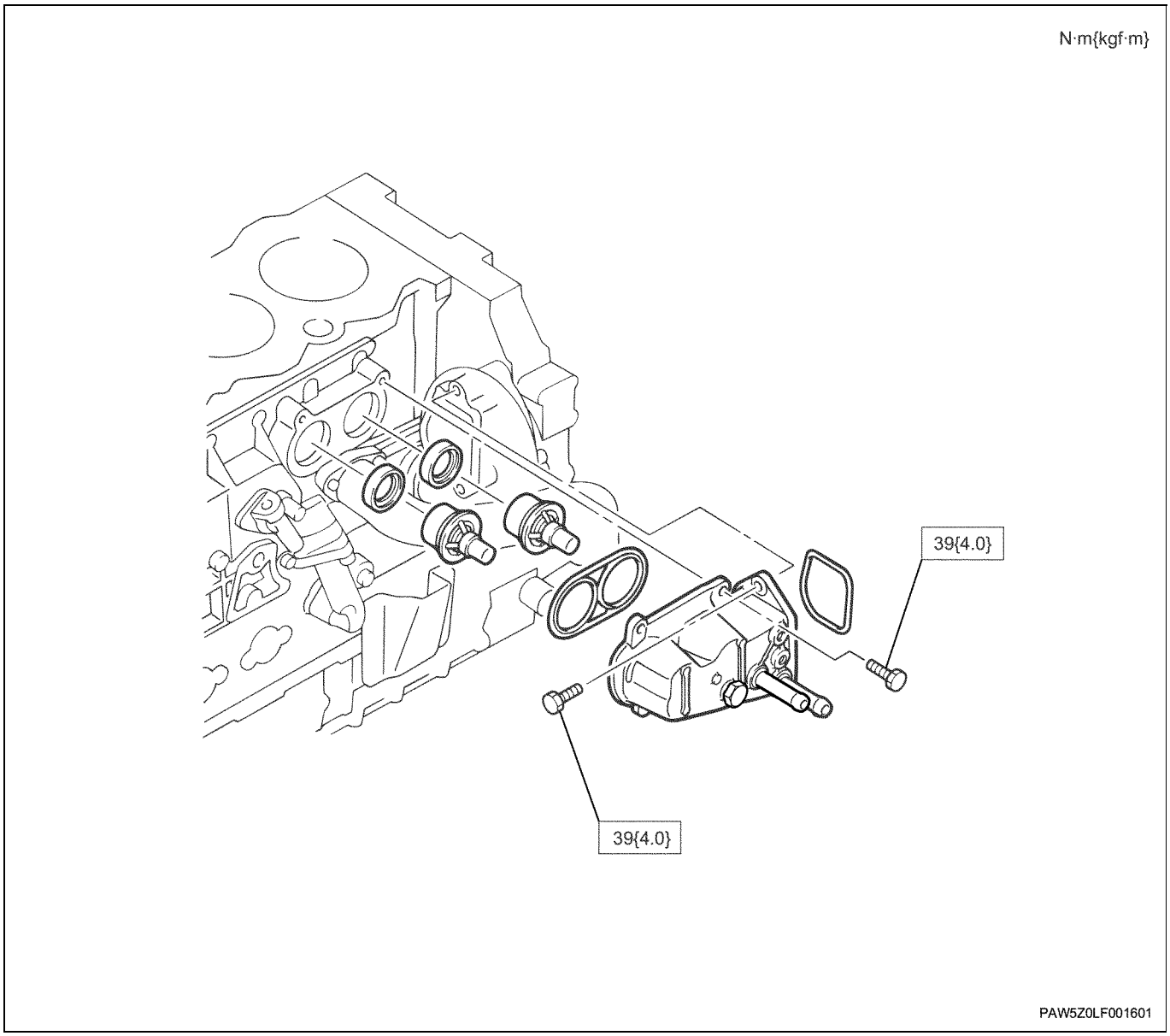
Tightening torque: 39N·m {4.0kgf·m}



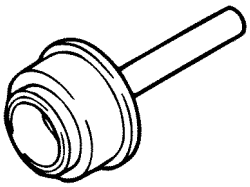
Legend

1. Seal ring
2. Thermostat
3. Gasket
4. Bolt (C section)
5. Thermostat housing
6. O-ring

Torque specifications

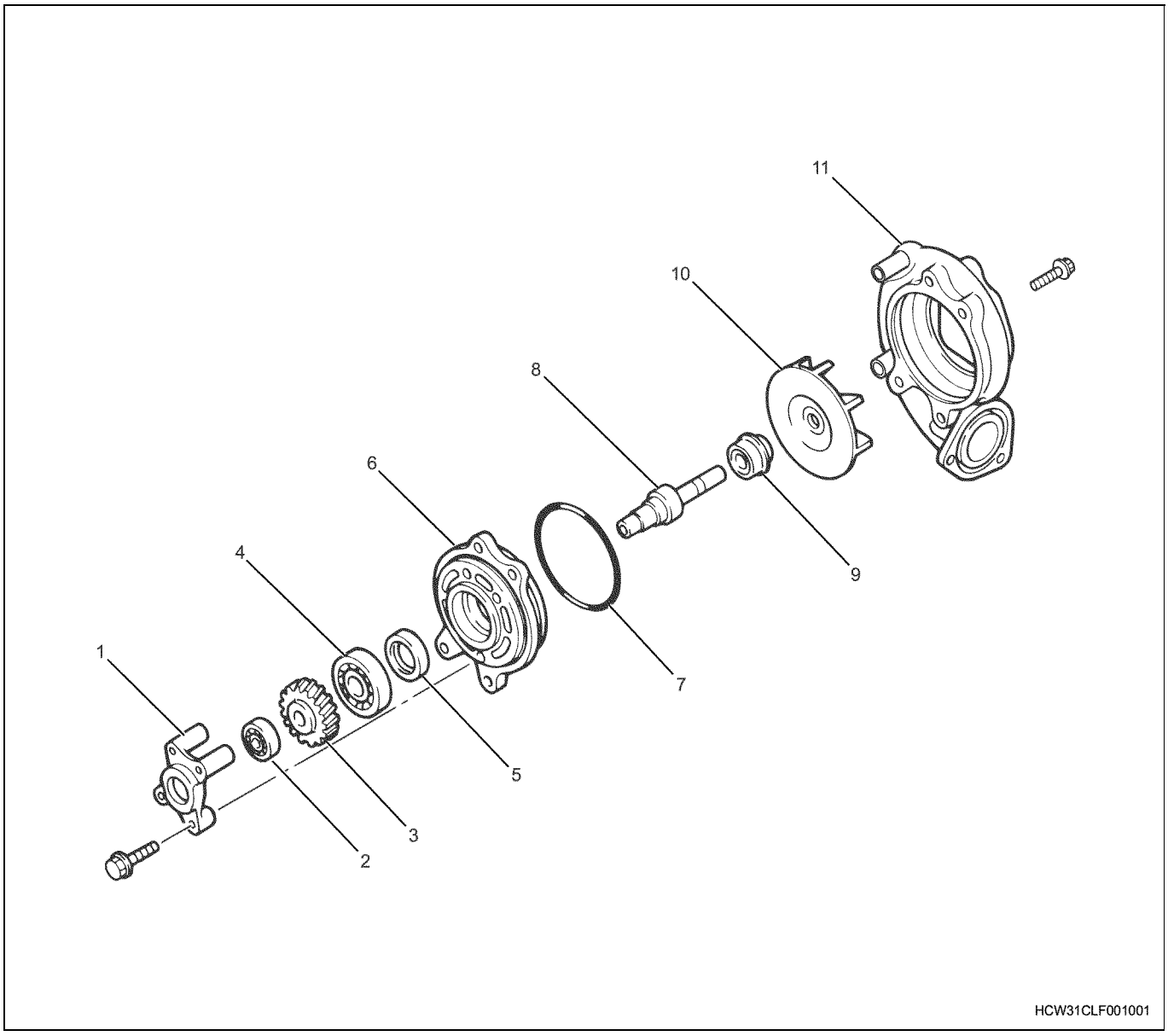


Special tools

Illustration	Tool number Tool name
 1852100670	1-8521-0067-0 Puller; Thermostat seal ring
 1852210340	1-8522-1034-0 Installer; Thermostat seal ring

Water pump

Component parts



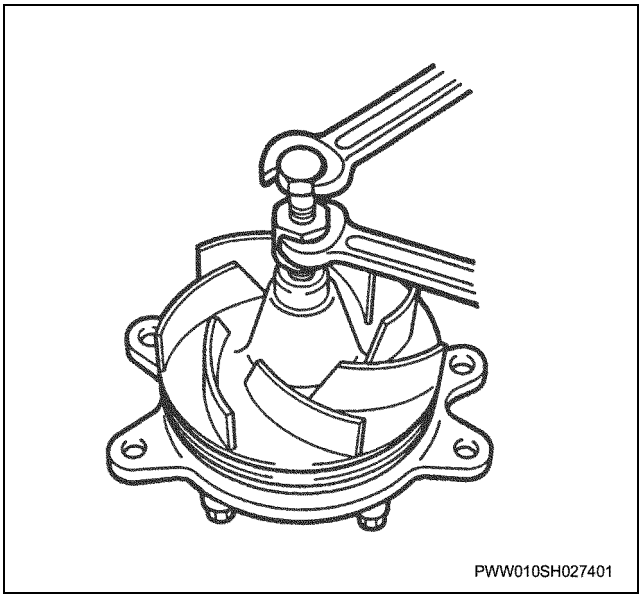
Legend

1. Rear cover
2. Bearing (small)
3. Gear
4. Bearing (large)
5. Oil seal
6. Water pump body
7. O-ring
8. Shaft
9. Seal unit
10. Impeller
11. Front cover

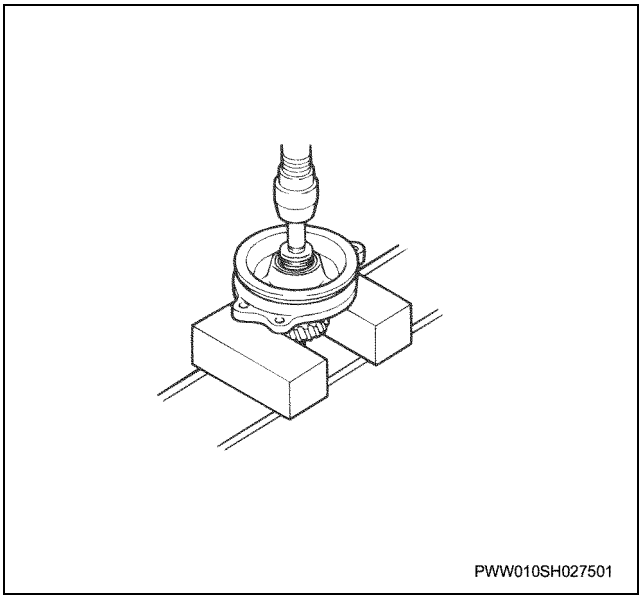
Disassembly

1. Remove the front cover.
2. Remove the O-ring.
   The O-ring cannot be re-used.
3. Remove the impeller.
   - Install an impeller remover to the impeller, and while the remover is fixed with a spanner, screw in the bolts and extract the impeller.

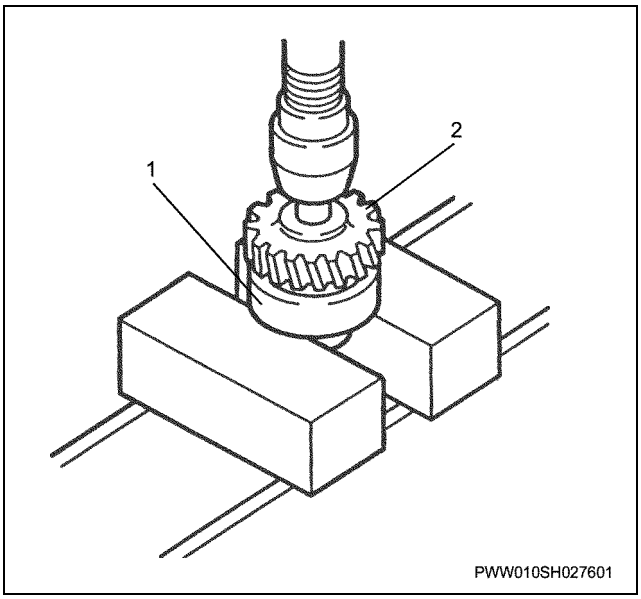
Remover; Impeller: 1-8521-0062-0



4. Remove the rear cover.
5. Remove the bearing (small).
6. Remove the gear.
7. Remove the bearing (large).
8. Remove the shaft.
   - Use a press and extract the shaft with bearing installed from the impeller side.

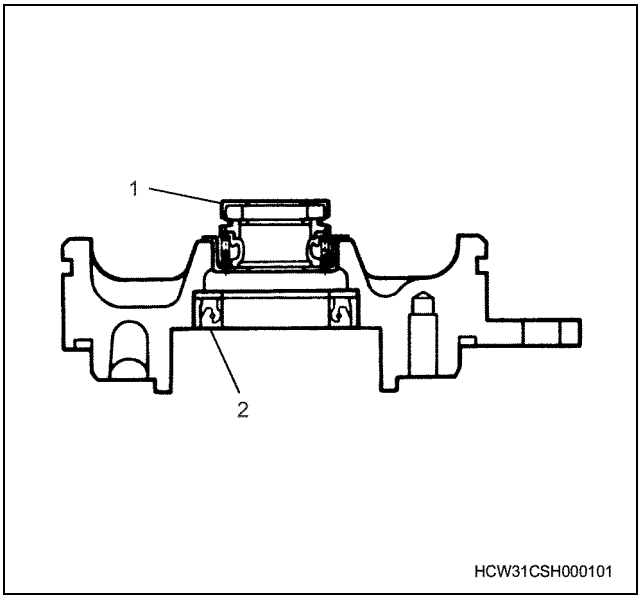


   - Use a press from the gear side and extract the shaft.



Legend
1. Bearing
2. Gear

9. Remove the oil seal (2).
10. Remove the seal unit (1).
    - Remove the oil seal (2) while being careful not to damage the force fit section.
    - Also, remove the seal unit (1) while being careful not to damage the force fit section.

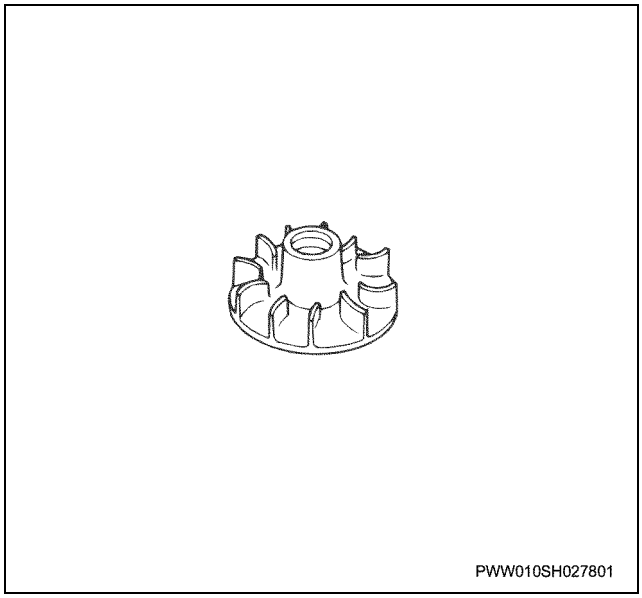


Legend
1. Seal unit
2. Oil seal

Inspection

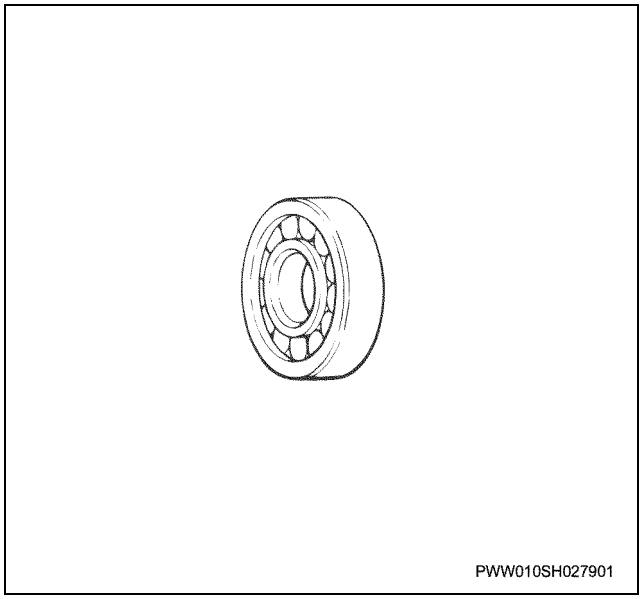
Impeller

- Inspect the impeller for corrosion, and the seal unit contact surface for wear, damage etc.



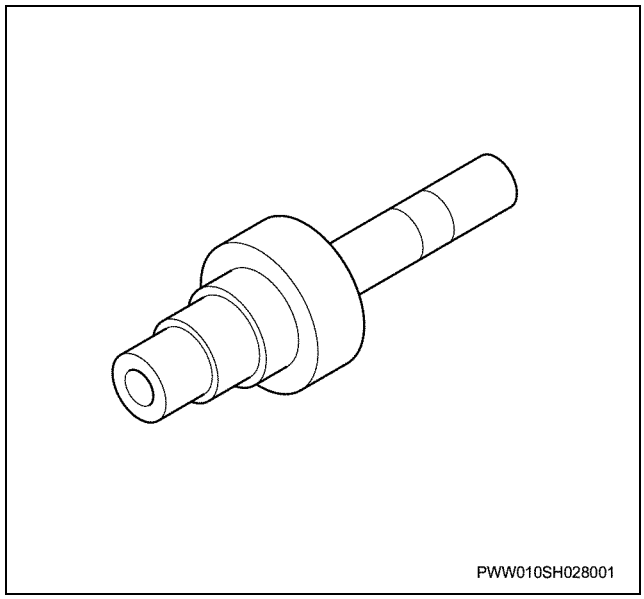
Bearing

- Inspecting the bearing for de-bonding, wear, and abnormal noises
- For de-bonding inspections: Inspect the full circumference from the ball clearance to the lace for scratches or de-bonding.
- For wear inspections: Inspect the ball and lace sections for unusual shakiness or rattling.
- For abnormal noise inspections: Rotate the bearing with your hand to see if you can feel anything unusual.



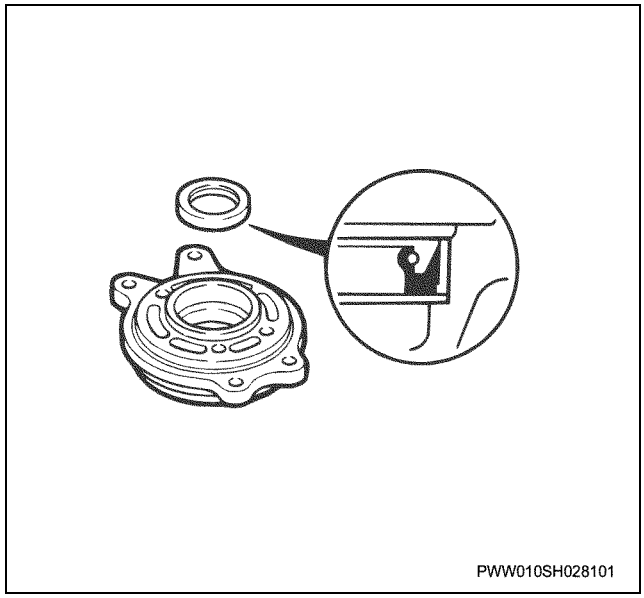
Shaft

- Inspect the shaft damage or wear.

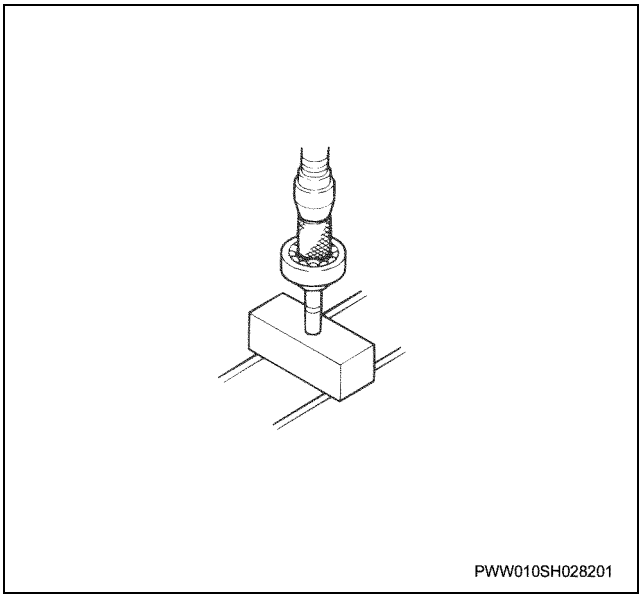


Assembly

1. Set the water pump body.
2. Install the oil seal.
   - Apply engine oil to the inner side and outer circumference part of the oil seal lip. While taking care not to bend it out of shape, face the lip section upwards and push it into the water pump body.

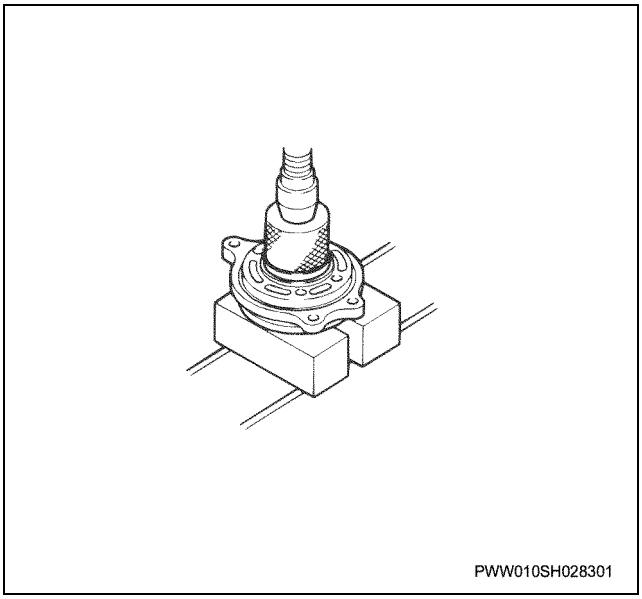


3. Install the bearing (large).
4. Install the shaft.
   - Apply engine oil to the shaft, and push the bearing into the shaft using a press.



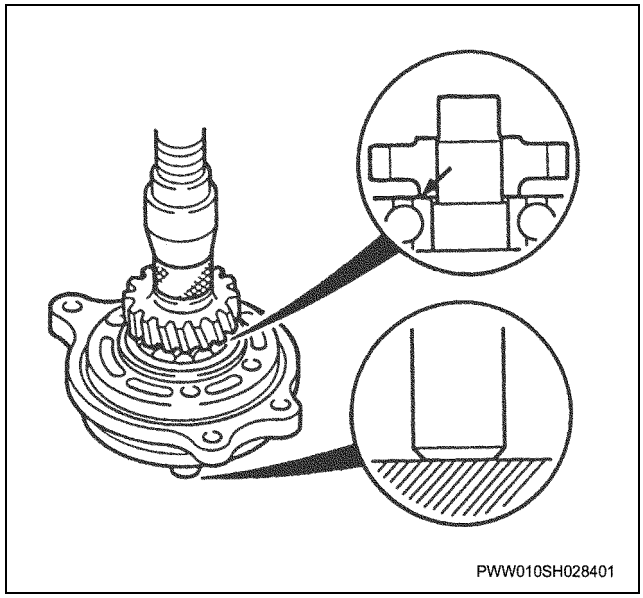
5. Install the shaft ASM.
   - Use a press to push the shaft ASM into the water pump body.

Important:
Be careful not to damage the oil seal.

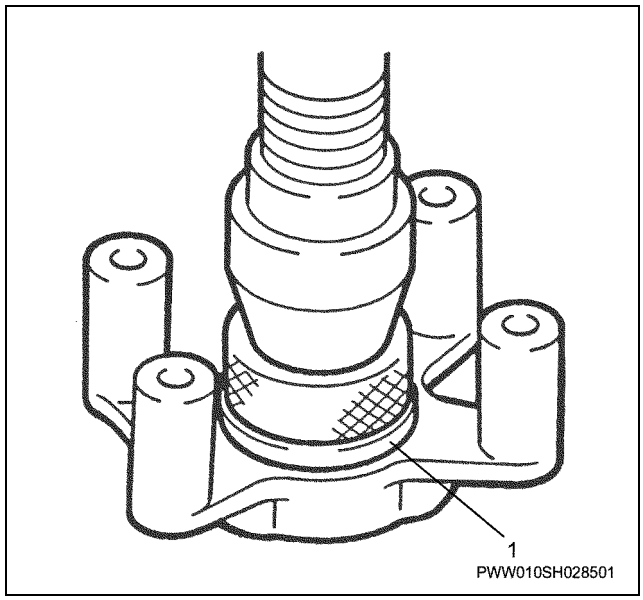


6. Install the gear.
   - Using a press, face the large side of the projecting center boss section towards the seal unit side, and push in until it contacts with the bearing.

Notes:
To prevent damage to the bearing, press it in while it contacts with the impeller insertion side shaft edge.



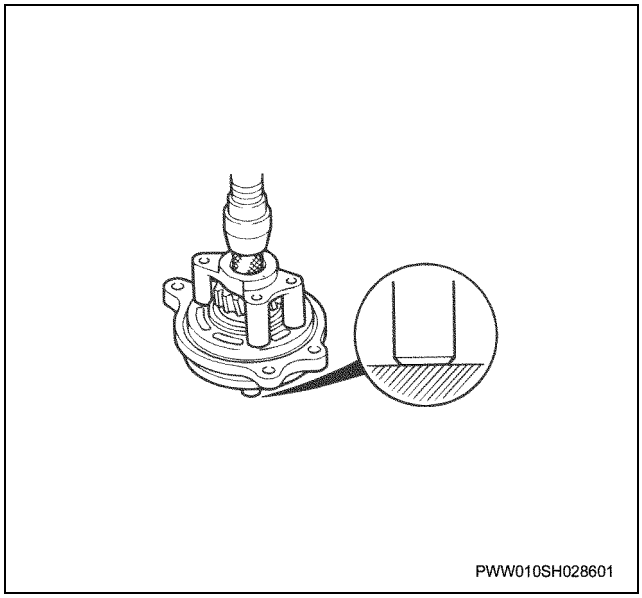
7. Install the bearing (small).
8. Install the rear cover.
   - Apply piping etc. to the bearing's outer lace, and press it in while taking care not to damage the rear cover.



9. Install the rear cover ASM.
   - Using a press, apply piping etc. to the bearing (small) inner lace and press it into the shaft. At this time, line up the bolt Installation positions on the rear cover.

Tightening torque: 27 N·m {2.8 kgf·m}

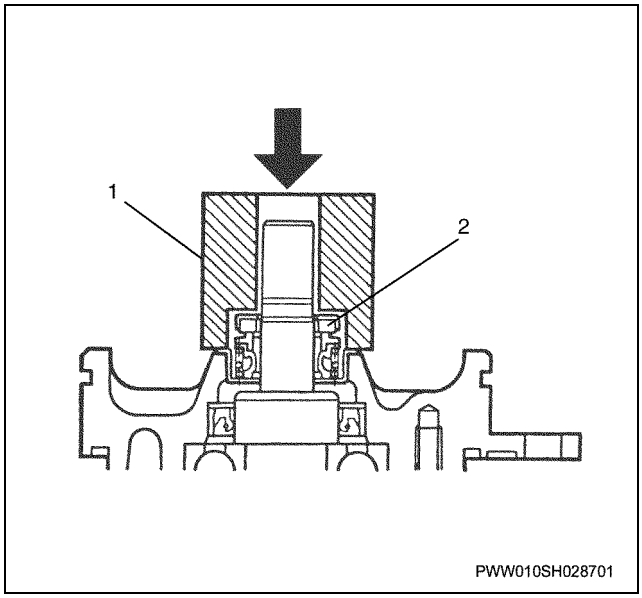
Notes:
To prevent damage to the bearing and rear cover, press the ASM cover in while it contacts with the impeller insertion side shaft edge.



10. Install the seal unit.
    - Using a installer, press the seal unit in until the seal unit collar section contacts with the water pump body.

Important:
Be careful not to damage the seal unit.

Installer; Seal unit: 1-8522-0047-0

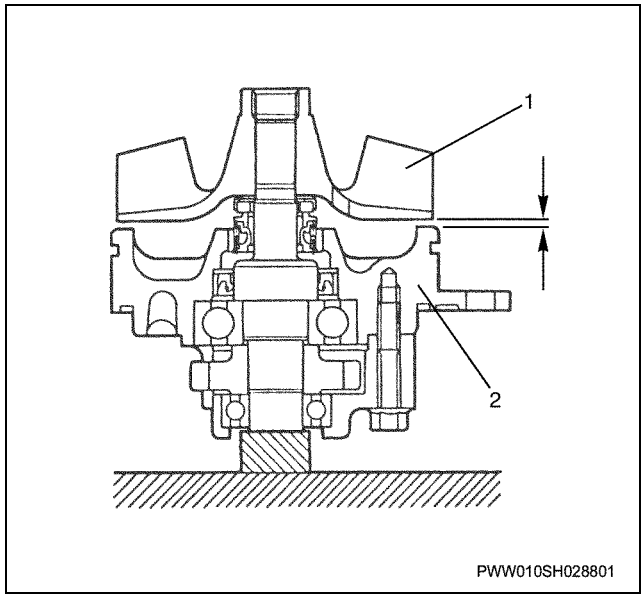


Legend
1. Installer
2. Seal unit

11. Install the impeller.
    - Using a press, press in so that the clearance between the water pump body edge and impeller reaches the stipulated value.

Clearance between body end surface and impeller

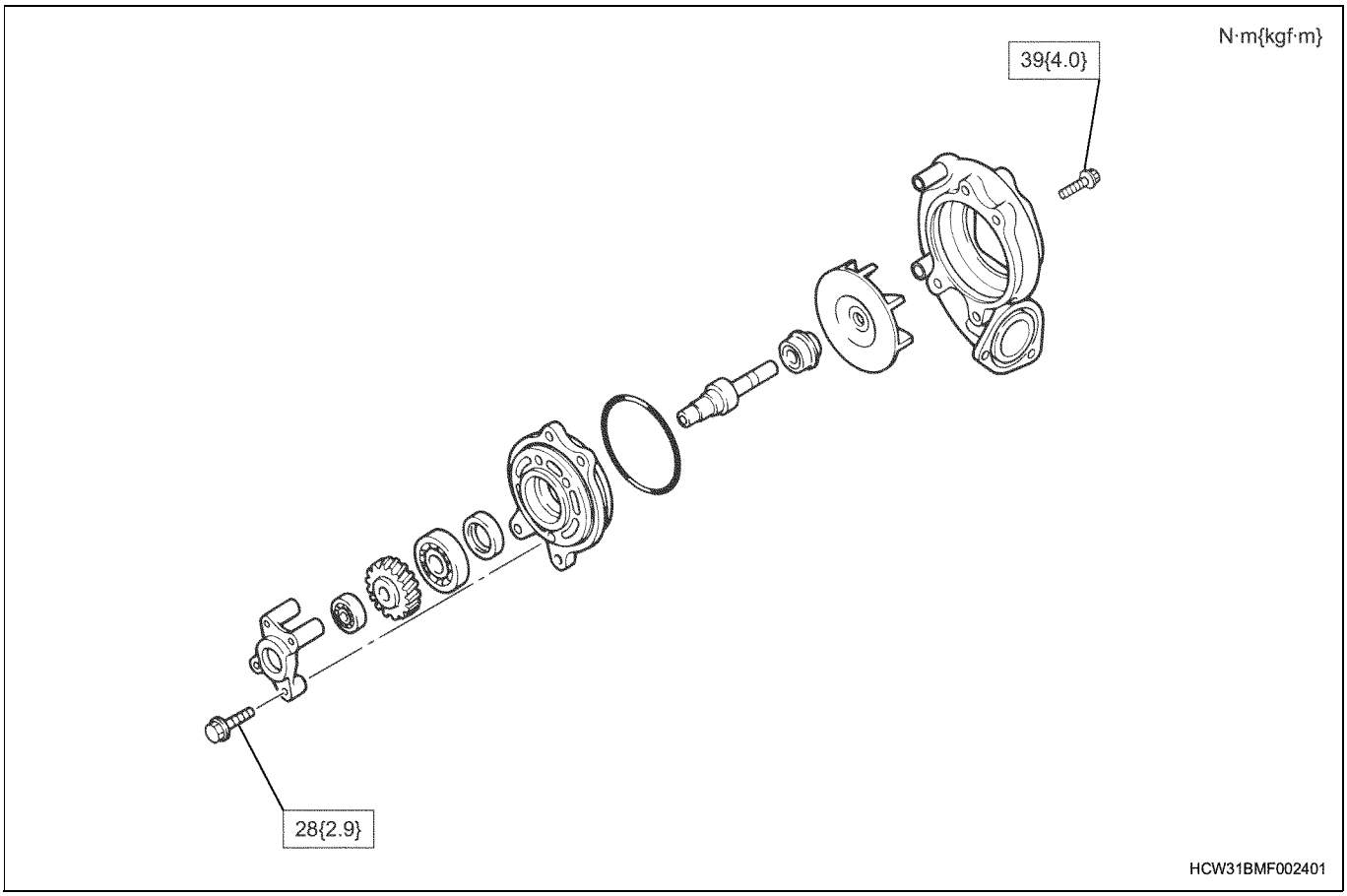
Standard:	1.7 mm ~ 2.7 mm



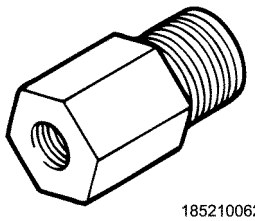
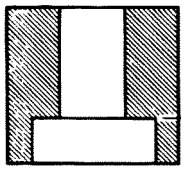
Notes:
To prevent damage to the bearing, press it in while it contacts with the impeller insertion side shaft edge.

12. Install the O-ring.
13. Install the front cover.

Torque specifications



Special tools

Illustration	Tool number Tool name
 1852100620	1-8521-0062-0 Remover; Impeller
 1852200470	1-8522-0047-0 Installer; Seal unit

Disassemble and Assemble Engine

Fuel system

(6WG1 (Common rail))

Contents

Fuel system 1D-2
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Fuel system

Service Precautions

Precautionary notes on the handling of fuel related parts

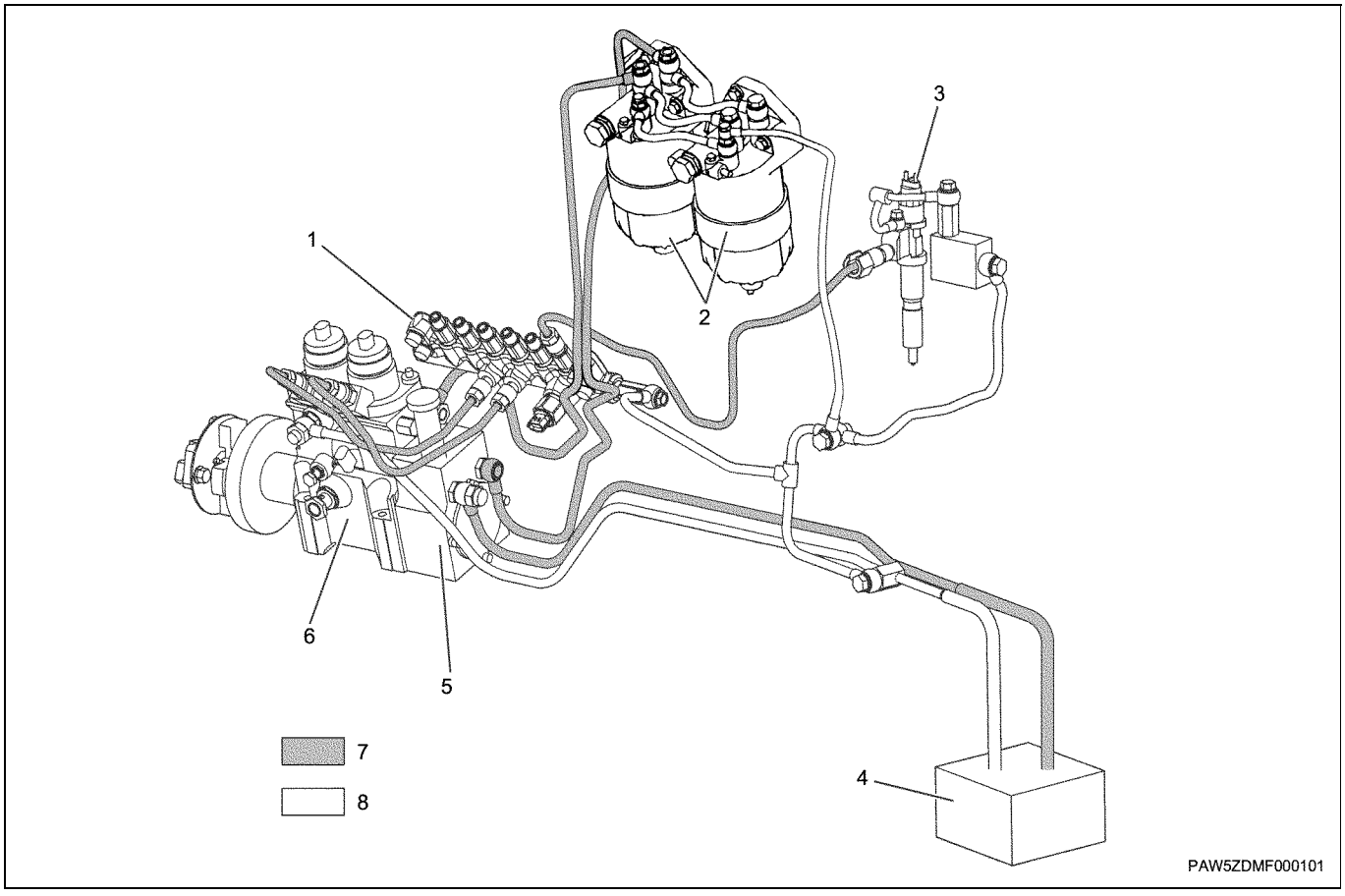
The electronic control fuel-injection system (common rail type) achieves a far higher injection pressure and far higher level of control than conventional systems. For this reason, all parts of the fuel supply lines from the injector internal sections to the holes and clearance sections have been made to an exceptionally precise standard.
The sensitivity to dust particles is therefore also far higher than in the past, and because the inclusion of dust into the fuel system can cause fatal injury or breakdown on the road, thorough measures must be taken to prevent dust from entering the fuel system.

Work outline

1. When removing the injector, supply pump or common rail, the fuel opening must be quickly sealed.
2. The fuel pipes and injection pipes should also be handled as in 1. above.
3. It is also important to keep parts used in installing fuel pipes such as eyebolts or gaskets in covered clean parts boxes so that they do not become dusty. Furthermore, the parts boxes should be cleaned regularly.
4. When handling the parts, using rubber gloves or ones bare hands is most desirable. If it is absolutely necessary, working gloves can be used, but they should be constantly checked for dirt or dust, and brand new gloves should be used if possible.
5. Spilt fuel can cause fire, so after completing work make sure that any spilt fuel is completely wiped up, and always check that there are no fuel leaks after starting the engine.

Explanation of functions and operations

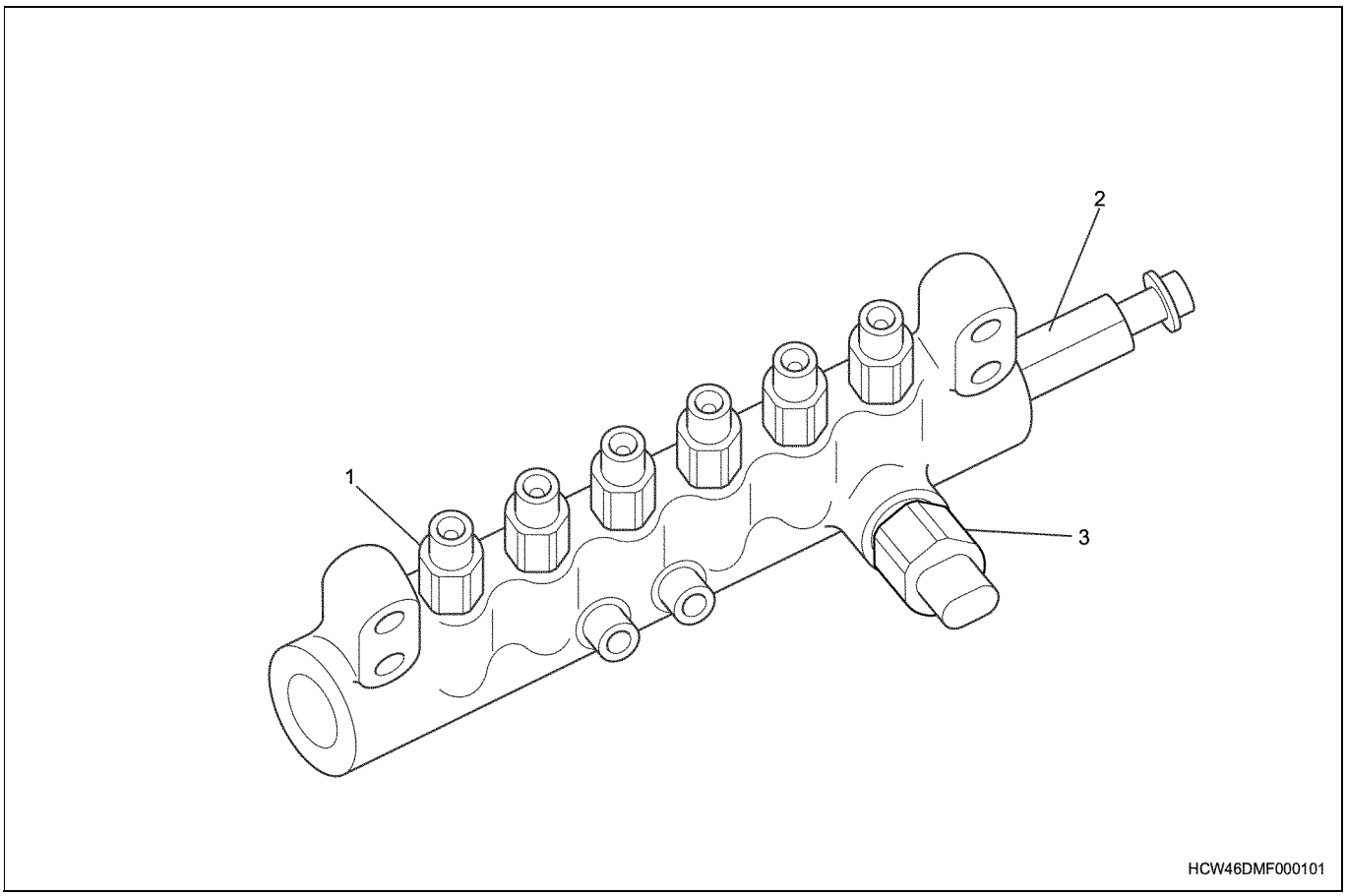
Fuel system diagram



Legend

1. Common rail
2. Fuel filter
3. Injector
4. Fuel tank
5. Feed pump
6. Supply pump
7. Feed line
8. Return line

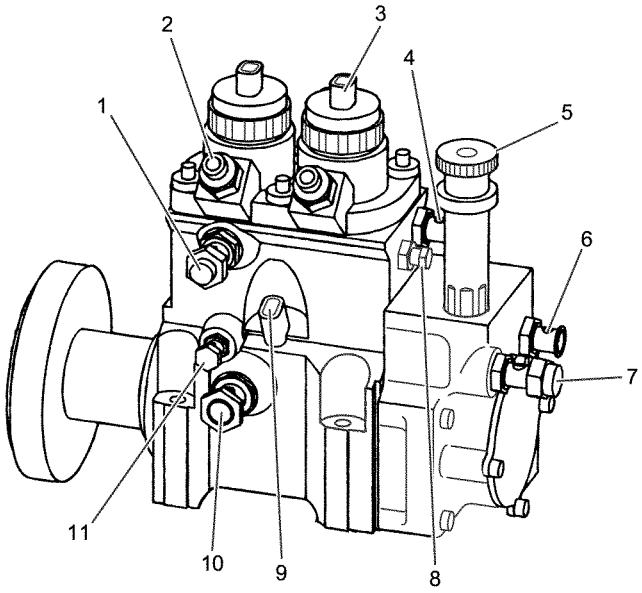
Common rail



Legend

1. Flow damper
2. Pressure limiter
3. Pressure sensor

Supply pump



HCW46BMF000301

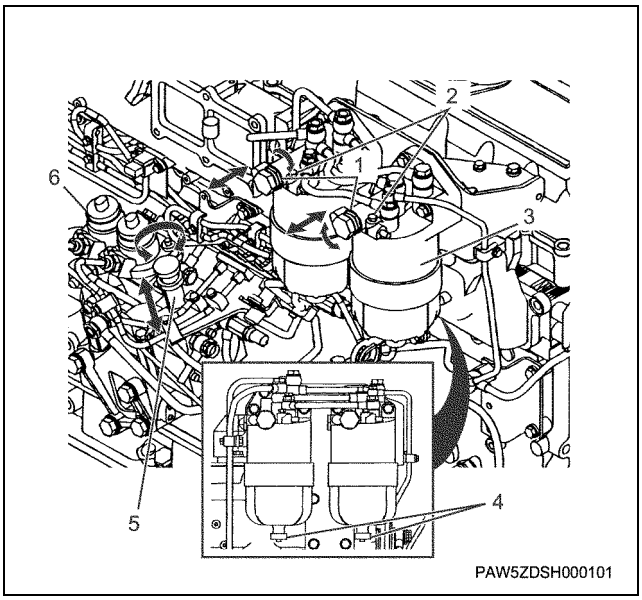
Legend

1. Overflow valve
2. Fuel outlet : to common rail
3. Pressure control valve (PCV)
4. Fuel entry : pump body
5. Priming pump
6. Fuel outlet : feed pump
7. Fuel entry : feed pump
8. Air bleed screw
9. G sensor
10. Oil outlet
11. Oil entry

Functional check:

Fuel filter water drainage

1. Loosen the fuel filter air bleed plugs (2).
2. Loosen the fuel filter drain plugs (4) and perform water drainage.
3. Loosen the drain plugs (4).
4. Perform air bleeding from the fuel.



Legend

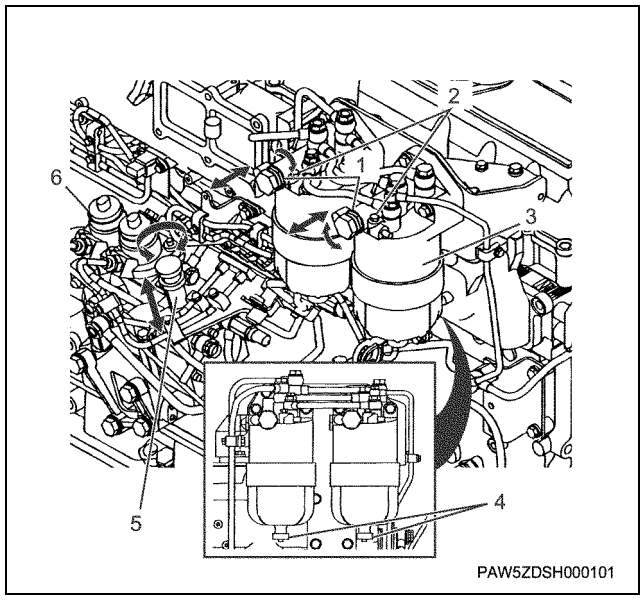
1. Priming pump (Fuel filter)
2. Air bleed plug
3. Fuel filter
4. Drain plug
5. Priming pump (supply pump)
6. Supply pump

Fuel air bleeding

1. Loosen the fuel filter air bleed plugs (2).
2. Move the supply pump's priming pump, bleed the air from the fuel filter, and fix the priming pump.
   - Move the fuel filter's priming pump and bleed the remaining air.
   - Tighten the air bleed plugs (2).

Notes:
Fuel filter air bleeding should be done one side at a time.

Important:
Over tightening the air bleed plugs can cause damage.

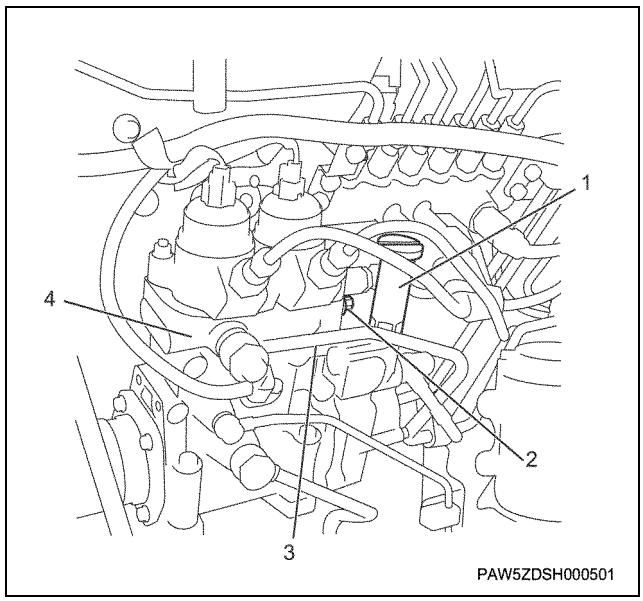


Legend

1. Priming pump (Fuel filter)
2. Air bleed plug
3. Fuel filter
4. Drain plug
5. Priming pump (supply pump)
6. Supply pump

---

3. Loosen the supply pump's air bleeder and continue to move the priming pump until air bubbles stop coming out.



Legend

1. Priming pump (supply pump)
2. Air bleed plug
3. Overflow pipe (supply pump)
4. Drain plug
5. Priming pump
6. Supply pump

---

4. Tighten the supply pump's air bleeder.

Important:
Do not over tighten the air bleeder plug.

5. After tightening all of the plugs, move the priming pump until it becomes heavy.
   - The priming pump needs to be moved a total of more than 150 times.
6. Tighten the priming pump in its previous position and start the engine. If the engine doesn't start, repeat once again from step 5.

Main data and specifications

Fuel pump specifications

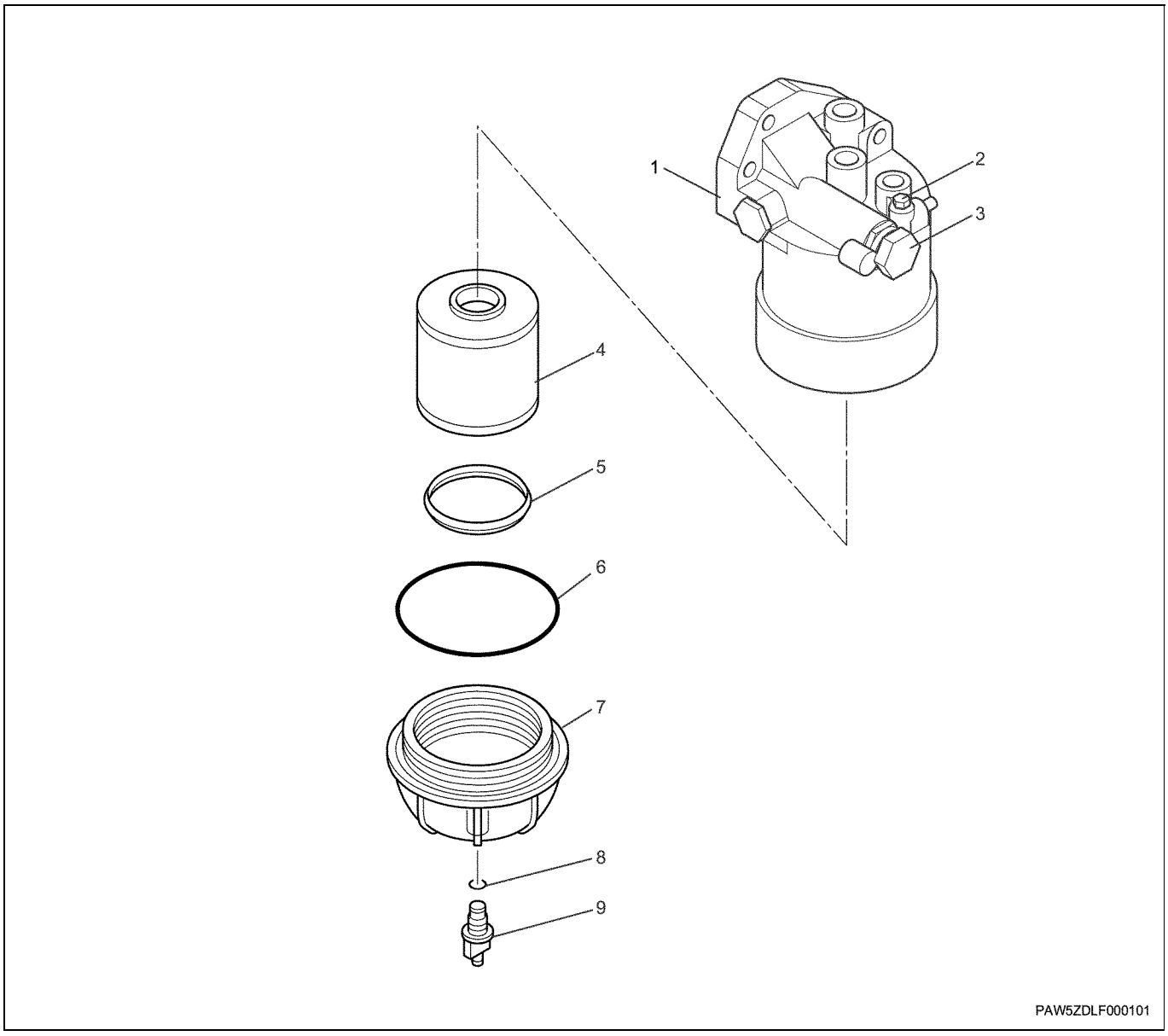
	Engine Model	6WG1-TC
Heading		
Fuel injection pump type		Electronic control fuel-injection system (common rail type)
Supply pump type		SP160-6HD
Pump maximum discharge amount		490mm^3/ST
Direction of rotation		Rotates to the right when looking from the drive side
Pressurized discharge sequence		1-2-1-2-1-2 (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

Fuel filter

Component parts



Legend

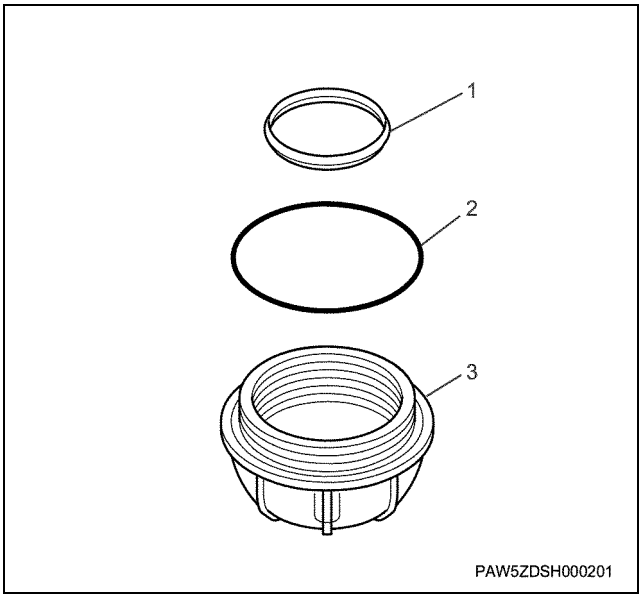
1. Head ASM
2. Air bleed valve
3. Priming pump
4. Element
5. Level ring
6. O-ring
7. Case
8. O-ring
9. Drain plug

Disassembly

1. Loosen the air bleed plug.
2. Loosen the drain plug.
   - Loosen the drain plug, and have the fuel discharged from the filter in advance.
3. Use a wrench to remove the case.

Wrench; Main filter: 8-9801-3170-0

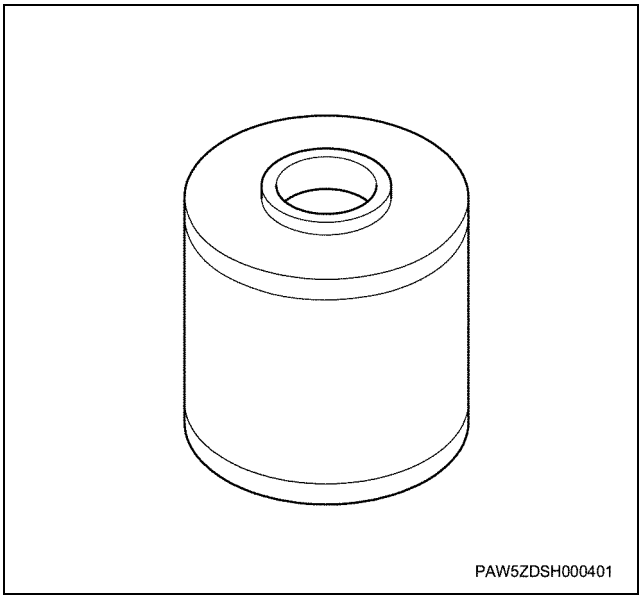
4. Remove the O-ring for the case.
5. Remove the level ring.



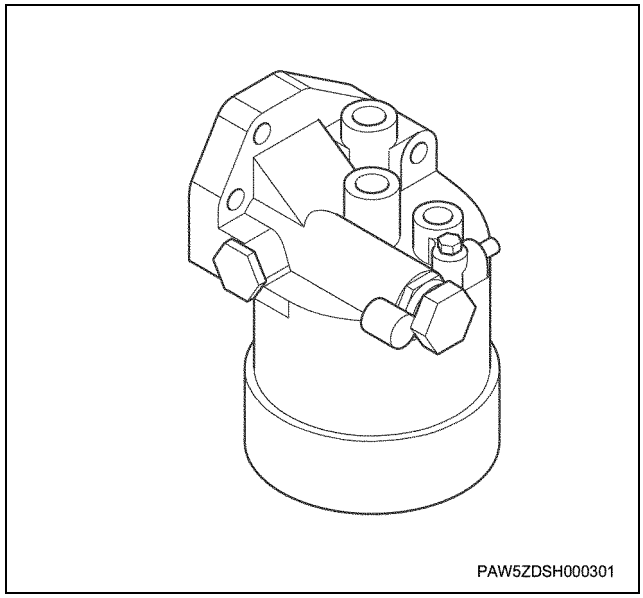
Legend

1. Level ring
2. O-ring
3. Case

6. Remove the element.



7. The head ASM cleans each fuel line.
   - You cannot disassemble the priming pump.

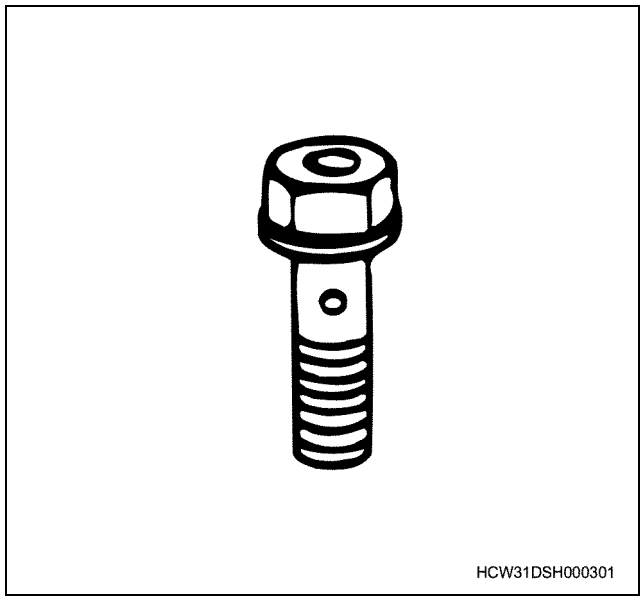


Inspection

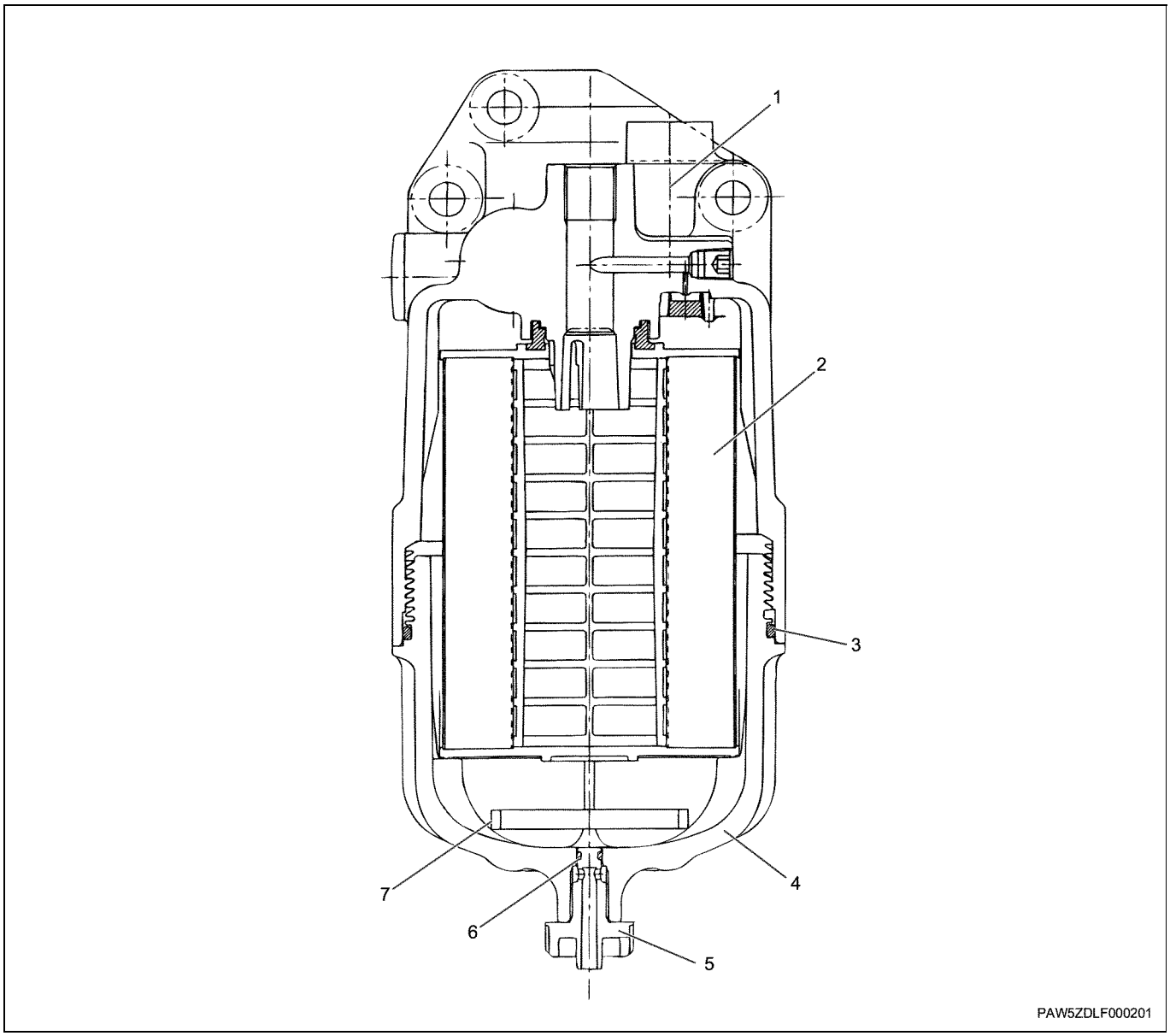
Overflow valve

- This overflow valve is not a content part of the fuel filter.
- Inspect the overflow valve for blockages, and for leakage from the ball seat.

Overflow valve opening pressure:	275 ~ 314 kPa {2.8 ~ 3.2 kgf/cm^2}



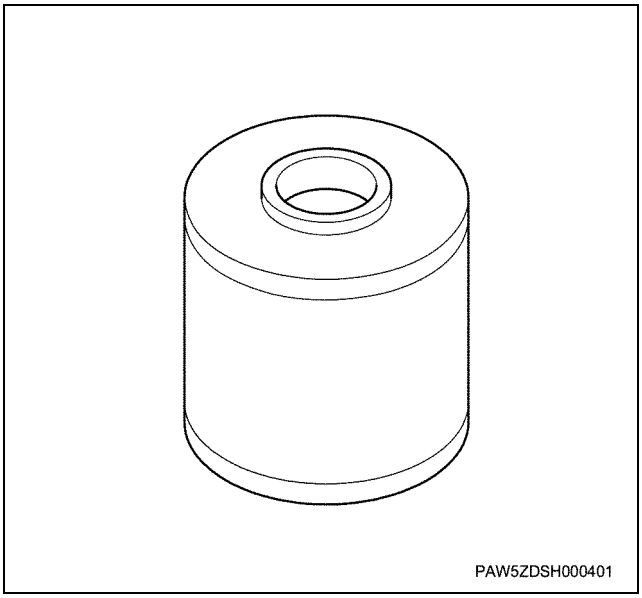
Assembly



Legend

1. Head ASM
2. Element
3. O-ring
4. Case
5. Drain plug
6. O-ring
7. Level ring

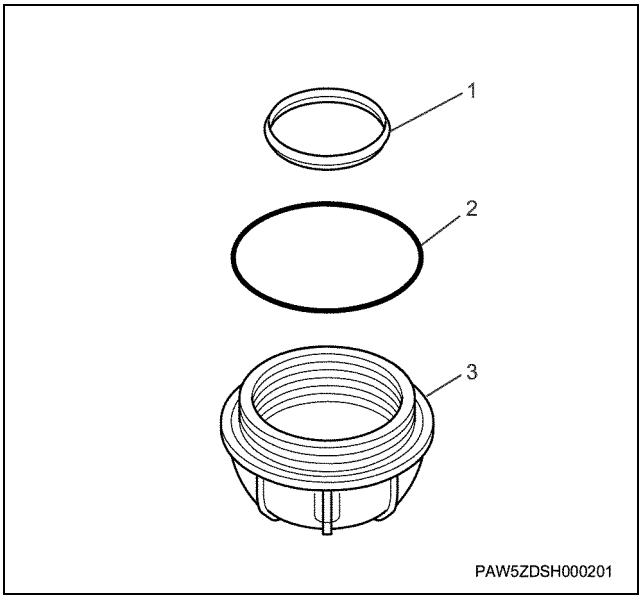
1. Install the element to the head ASM.
   - Insert the element's seal rubber to the head ASM.



2. Install the O-ring to the case.
   - Always use a brand new O-ring.
3. Insert a level ring into the case.
4. Use a wrench and tighten the case.

Wrench; Main filter: 8-9801-3170-0

Tightening torque: 29.4 N·m {3.0 kgf·m}



Legend
1. Level ring
2. O-ring
3. Case

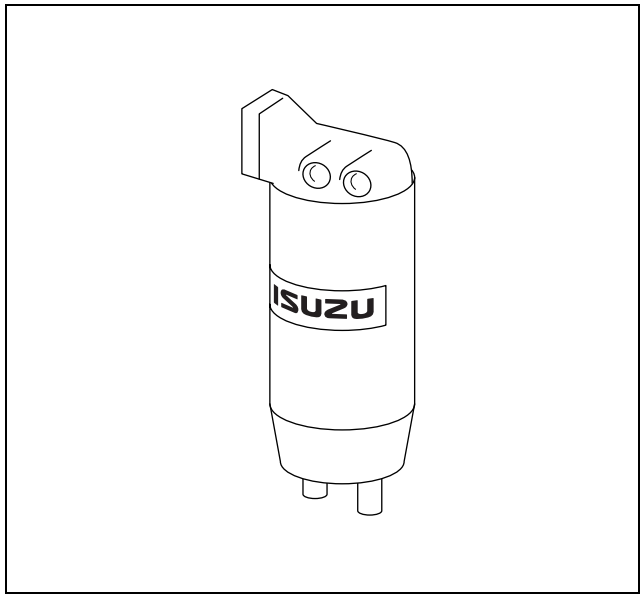
5. Install an O-ring to the drain plug.
   - Always use a brand new O-ring.
6. Tighten the drain plug to the tightening torque.

Tightening torque: 2 N·m {0.2 kgf·m}

7. Tighten the air bleed plug to the tightening torque.

Tightening torque: 9.8 N·m {1.0 kgf·m}

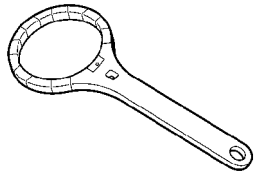
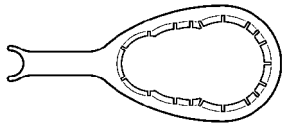
Pre-filter



Use a wrench to exchange the cartridge.

Wrench; Pre-filter: 8-9802-1941-0

Special tools

Illustration	Tool number Tool name
 8980131700	8-9801-3170-0 Wrench; Main filter
 8980219410	8-9802-1941-0 Wrench; Pre-filter

Disassemble and Assemble Engine

Electrical system

(6WG1 (Common rail))

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Starting system

Service Precautions

Cautions when handling parts

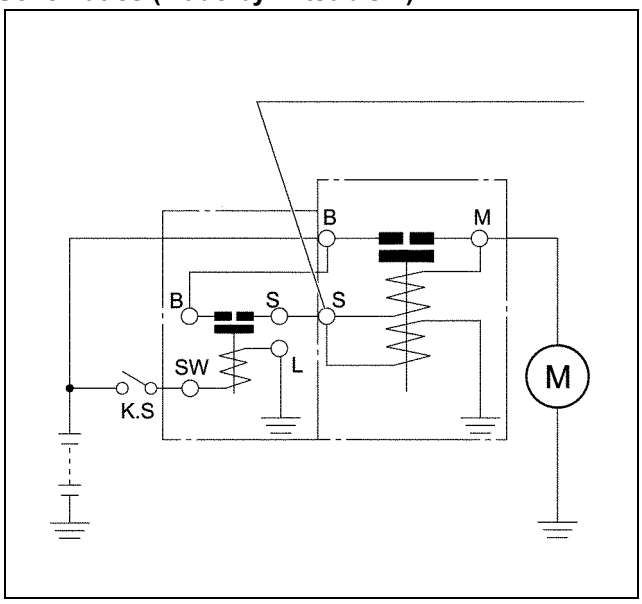
- If the gap between the pinion and ring gear is inadequate, the engagement will become bad. (Gap 2 ~ 5 mm)
  Also, firmly fix the front bracket to the engine side when installing it.
- Always turn off the battery switch before removing or installing the starter.
- Always firmly install or insert electrical wiring. If the wiring is not firmly installed/inserted, contact resistance increases and starting difficulties may occur.

Cautions when starting

- Pay attention to the battery's charge condition. A lack of charge can cause starting difficulties.
- Once you have confirmed the engine has started, promptly switch off the starter switch.
- The continuous use time limit is 10 seconds per time. Wait until the pinion has completely stopped before restarting the engine.
- If the starter switch is switched off but the starter doesn't stop revolving, promptly switch off the battery switch. In this situation, inspect the electrical wiring, switches etc.

Explanation of functions and operations

Schematics (Made by Mitsubishi)



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

Even if the starter switch is switched on, the starter does not function

Condition	Probable cause	Correction
Even if the starter switch is switched on, the starter does not function.	Battery is completely discharged	Replace the battery
	Broken wire or bad connection in the wiring circuit	Repair
	Loose connection in the starter switch contact, or badly installed terminal	Repair or replace
	Loose connection in the starter relay contact, or bad connection in a plug terminal	Repair or replace
	Short or broken wire in the magnetic switch coil	Replace

The pinion advances but does not engage the ring gear

Condition	Probable cause	Correction
The pinion advances but does not engage the ring gear	Lack of battery capacity	Recharge the battery
	Worn pinion or flywheel starter gear tip	Replace the pinion or flywheel starter gear
	Adhesion of dirt to the pinion shaft	Repair

The pinion engagement motor turns but the engine does not turn

Condition	Probable cause	Correction
The pinion engagement motor turns but the engine does not turn	Clutch slipping	Replace the clutch or starter
	Deceleration gear damage	Replace the gear or starter

The pinion engages but the engine does not turn

Condition	Probable cause	Correction
The pinion engages but the engine does not turn	Lack of battery capacity	Recharge the battery
	Badly installed terminal in the wiring circuit	Repair
	Short in the armature or field coil	Replace the starter
	Dirty commutator	Repair the problem or replace the starter
	Settling of the brush spring or worn brush	Replace the brush spring or brush
	Bearing lock	Replace the bearing or starter
	Loose connection in the magnetic switch contact	Replace the magnetic switch

After starting the engine, the starter doesn't stop when the starter switch is turned off

Condition	Probable cause	Correction
After starting the engine, the starter doesn't stop when the starter switch is turned off	Bad return of the starter switch contact	Replace the starter switch
	Bad return of the starter relay contact	Replace the starter relay
	Short in the magnetic switch coil	Replace the magnetic switch

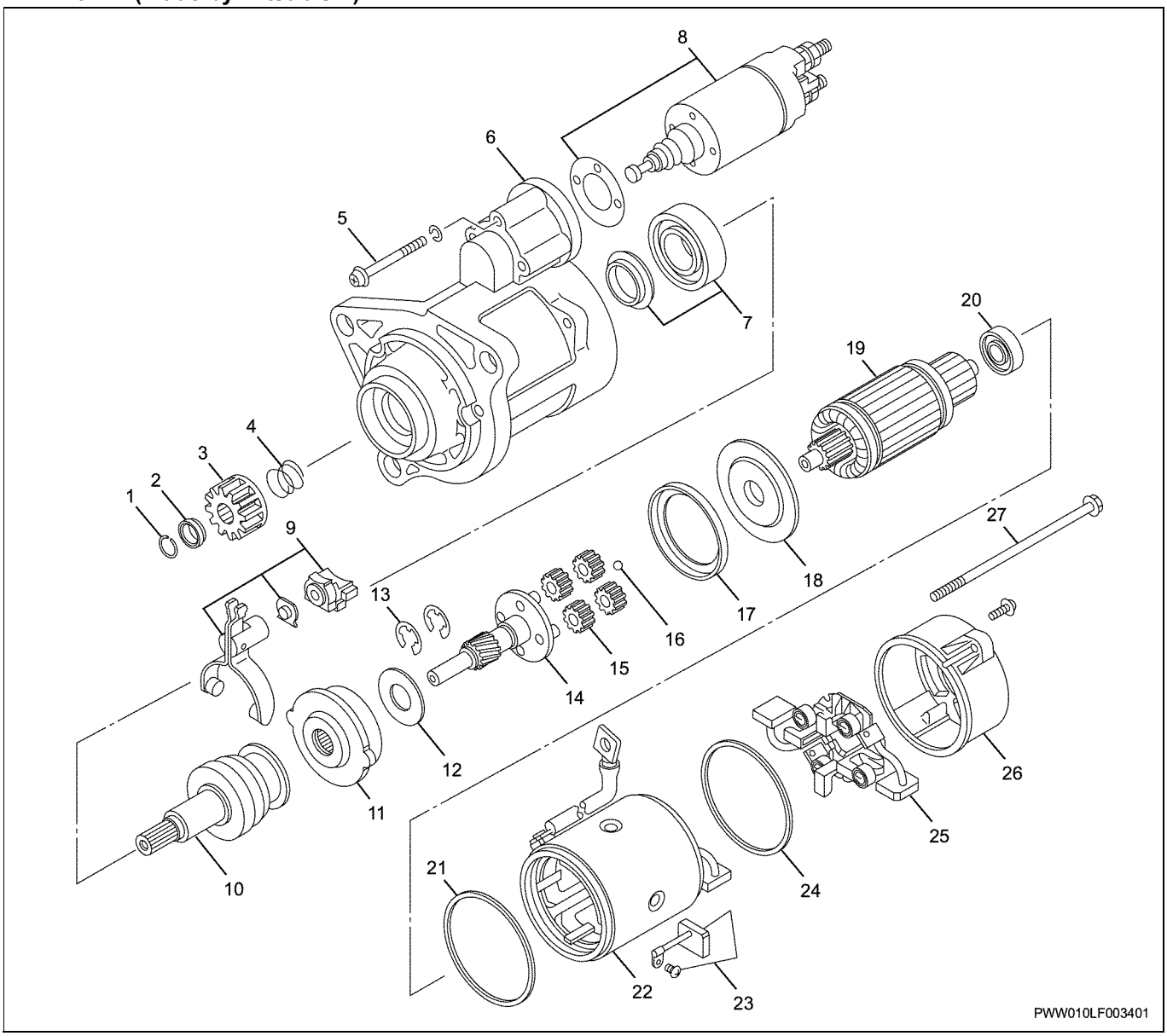
Main data and specifications

Model (maker)		Mitsubishi
Rating		
Voltage	(V)	24
Power output	(kW)	7.0
Time	(Seconds)	30
Number of pinion teeth		11
Rotation direction (viewed from the pinion side)		Right
Mass (approximate)	(kg)	12.7
No load characteristic		
Voltage/current	(V/A)	Less than 23.5/125
Number of revolutions	(rpm)	Over 3000
Load characteristic		
Voltage/current	(V/A)	Less than 15.8/500
Torque	N·m {kg·m}	Over 51.5 {5.25}
Number of revolutions	(rpm)	Over 900
Locking characteristics		
Voltage/current	(V/A)	Less than 5/1600
Torque	N·m {kg·m}	Over 117.0 {11.9}

Starter

Component parts

24 V 7.0 kW (made by Mitsubishi)



Legend

1. Snap ring
2. Stop ring
3. Pinion
4. Pinion spring
5. Screw
6. Front bracket
7. Bearing
8. Magnet switch
9. Lever
10. Overrunning clutch
11. Internal gear
12. Washer
13. E shape retaining ring
14. Gear shaft
15. Planet gear
16. Ball
17. Gasket
18. Plate
19. Armature
20. Bearing
21. O-ring
22. Yoke ASM
23. Brush
24. O-ring
25. Brush holder
26. Rear bracket
27. Through bolt

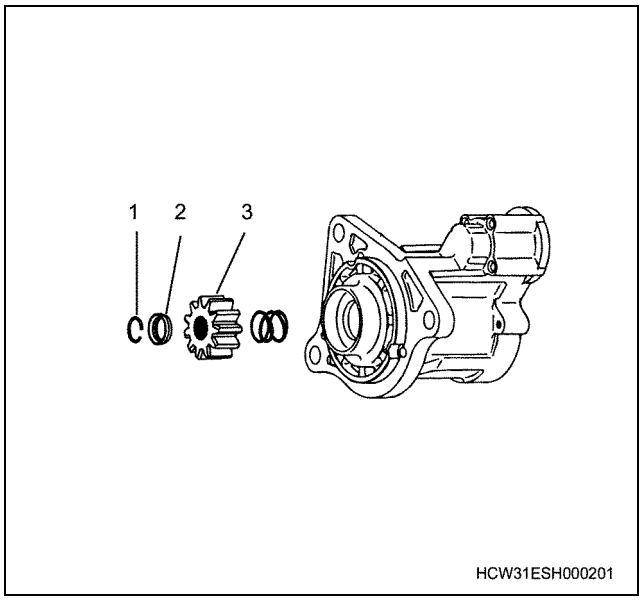
Disassembly

Notes:

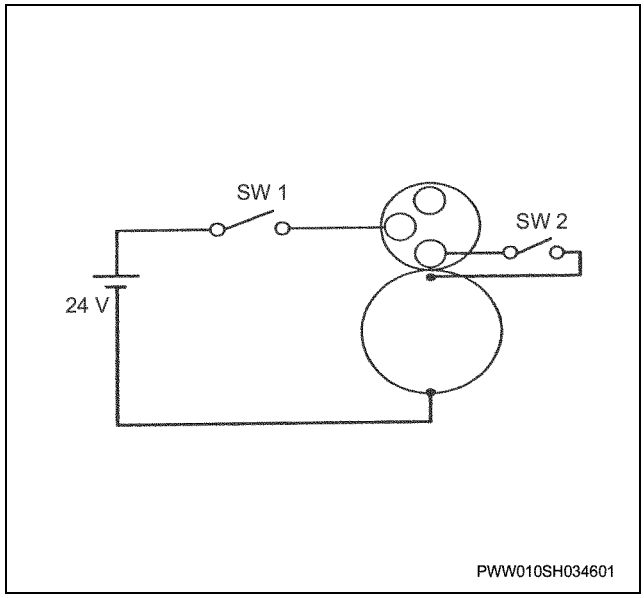
- **Before disassembling the starter, install temporary markers to the magnet switch, yoke, front bracket and rear bracket to make it easier to reassemble them.**
- **First, remove the pinion. If you proceed with the disassembly without removing the pinion first, the method for removing the pinion will be lost, and you will be unable to disassemble the starter.**
  However, the motor section and magnet switch can be removed without first removing the pinion.

1. Remove the snap ring.
2. Remove the stop ring.
3. Remove the pinion.
   - Under normal circumstances, if the pinion or stop ring is hit towards the front bracket side, the front bracket will break. Hit the stop ring when the pinion is out in the cranking position.
   - Connect the starter to the battery as shown in the diagram.
     When switch SW1 and SW2 are closed, the pinion advances to the cranking position and the armature rotates.
     Then open switch SW2 to stop the armature from rotating.

Important:
Remove the pinion within 10 seconds because it will generate heat if the electric current is left on.

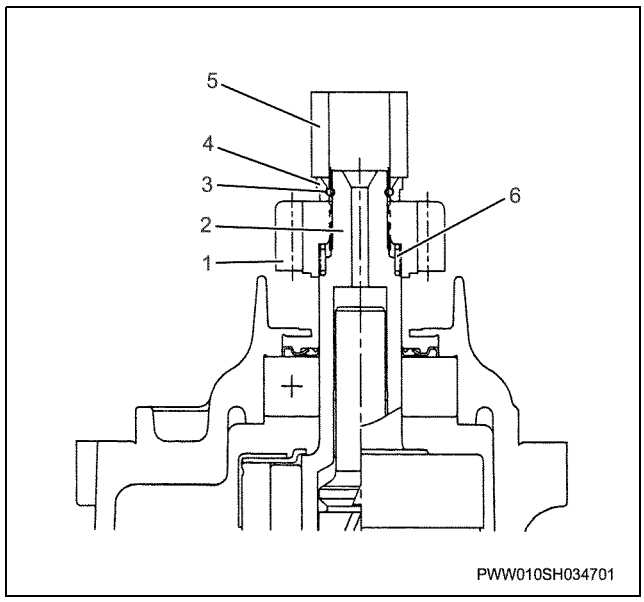


Legend
1. Snap ring
2. Stop ring
3. Pinion gear



   - Select a pipe that is a perfect fit size to the stop ring and put it against the stop ring, hit the pipe with a hammer and remove the stop ring to the pinion side one time.
     Next, remove the snap ring, stop ring, pinion, and pinion spring.

Important:
Do not re-use the snap ring.

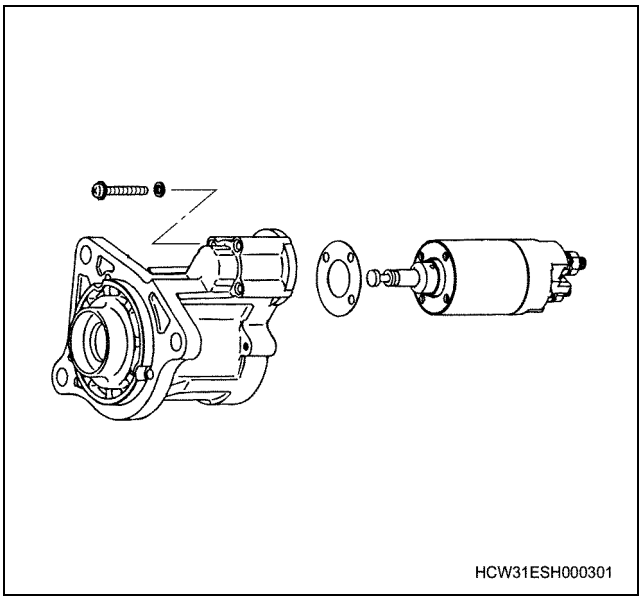


Legend
1. Pinion
2. Crankshaft
3. Snap ring
4. Stop ring
5. Pipe
6. Pinion spring

4. Remove the pinion spring.
5. Remove the screw.
6. Remove the magnet switch.

- Remove the magnetic switch's M terminal nut, and remove the lead wire with the terminal installed.
  Next, remove the magnetic switch Installation screw and remove the magnetic switch.

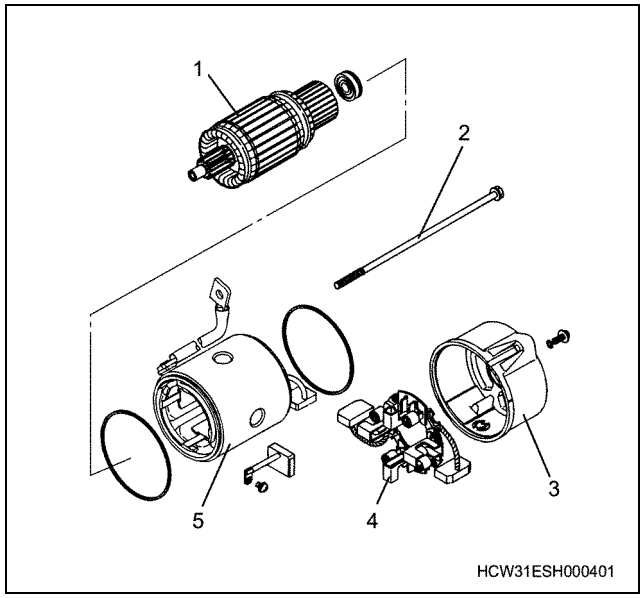
Notes:
The Installation screw is very tight, so an impact driver should be used to loosen it.



7. Remove the screw.
8. Remove the through bolt.
   - Remove the brush holder Installation screw and through bolt.
     Next, remove the rear bracket. At the same time, remove the O-ring.

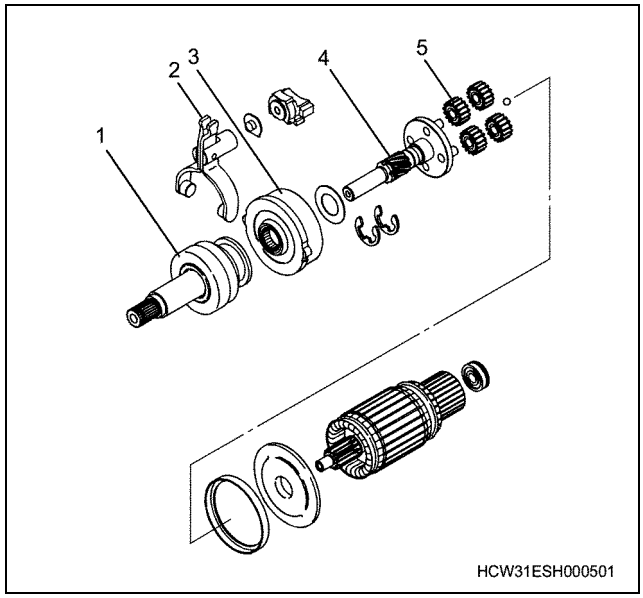
Important:
Do not re-use the O-ring.

9. Remove the rear bracket.
10. Remove the yoke ASM.
11. Remove the O-ring.
    - Place a socket (outer diameter 38mm) against the armature commutator.
      Next, allow the brush to slide on the top of the socket, and with the brush rested on the socket, remove the yoke ASM.
      Remove the O-ring at the same time.
12. Remove the brush holder.
    - Pull the brush spring upwards, and remove the brush from the brush holder.
      Next, remove the brush holder.
13. Remove the armature.
14. Remove the ball.
    - Remove the armature.
      The ball also comes out at the same time, but sometimes it becomes stuck in grease and doesn't come out.
      The bearing can be removed using a common puller.



Legend
1. Armature
2. Through bolt
3. Rear bracket
4. Brush holder
5. Yoke ASM

15. Remove the plate.
16. Remove the gasket.
17. Remove the planet gear.
    - Remove the four planetary gears.
    - Pull the internal gear, gear shaft, overrunning clutch and lever out of the front bracket together as one.



Legend
1. Overrunning clutch
2. Lever
3. Internal gear
4. Gear shaft
5. Planetary gear

18. Remove the lever.

Notes:
Remember the direction of the lever.

19. Remove the E shape retaining ring.
    - Remove the 2 E shape-retaining rings. Turn the spline for just 1 gear tooth amount, and remove the overrunning clutch from the gear shaft ASM.

Important:
Do not re-use the E shaft retaining ring after it has been removed.

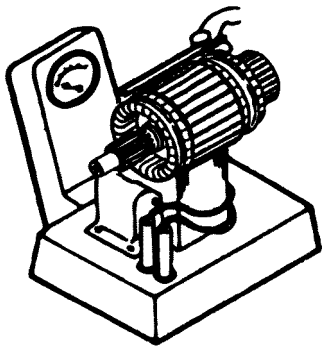
20. Remove the overrunning clutch.
21. Remove the internal gear.
22. Remove the washer.
    - Detach the internal gear. At this time, take out the washer that adjusts the gear shaft direction play.
23. Remove the gear shaft.
24. Remove the front bracket.
25. Remove the bearing (component parts table 20).
26. Remove the brush.
27. Remove the bearing (component parts table 7).

Inspection

1. Armature

Growler test

- Internal short circuits in the armature coil are inspected using the growler test.
  If a short circuit is detected, replace the armature.



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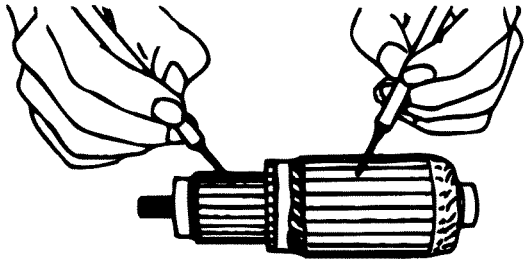
Earth inspection

- The armature coil earth (bad insulation) is inspected using a circuit tester.
  If the armature is grounded it must be replaced.



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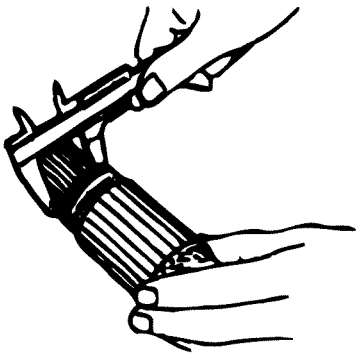
Commutator inspection

- Inspect the outer periphery of the commutator for wear.
  If the commutator is worn beyond the limit, it must be replaced.



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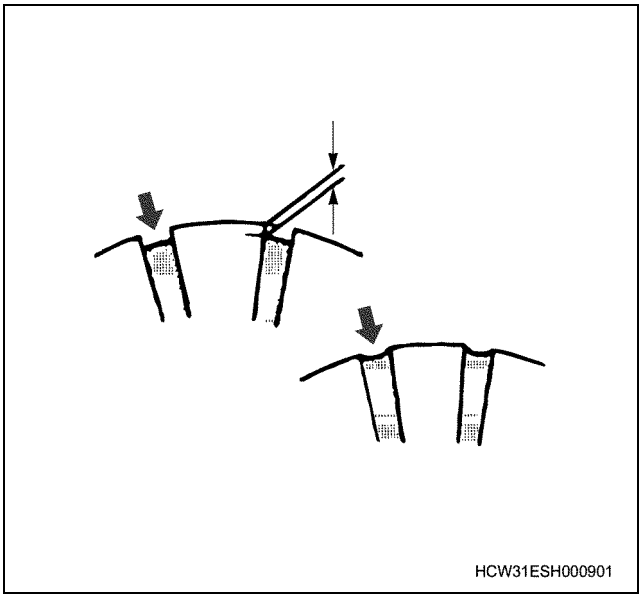
- Inspect the depth of the commutator insulation mold (undercut).
  Remove dirt and powder etc. caused by wear from the brushes, and repair if there are any faults.



Gear inspection

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

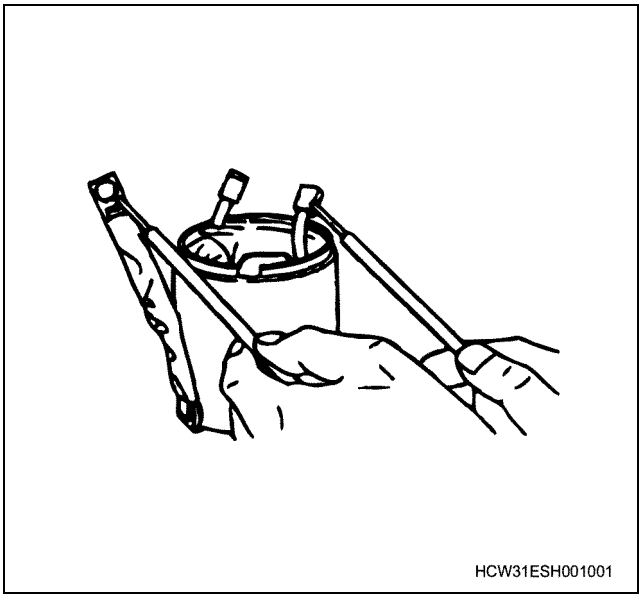
Bearing inspection

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

2. Field coil

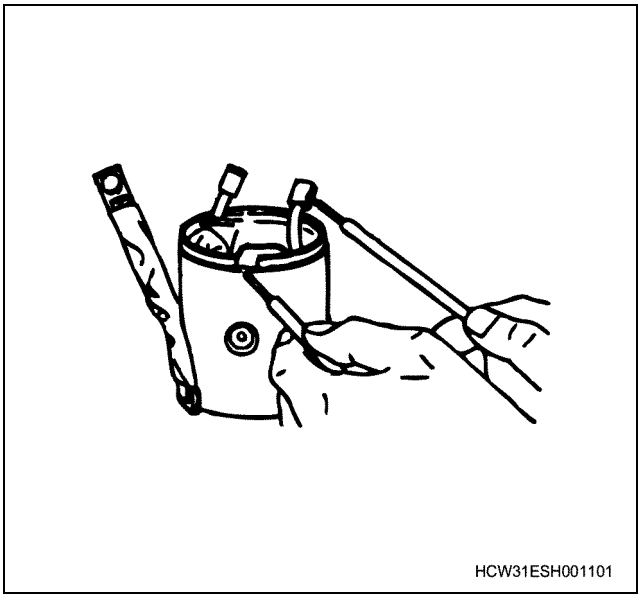
Conduction inspection

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



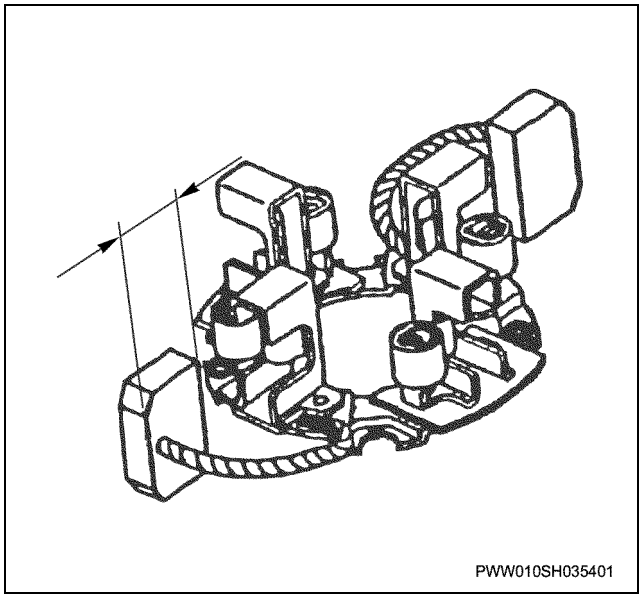
Earth inspection

- 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.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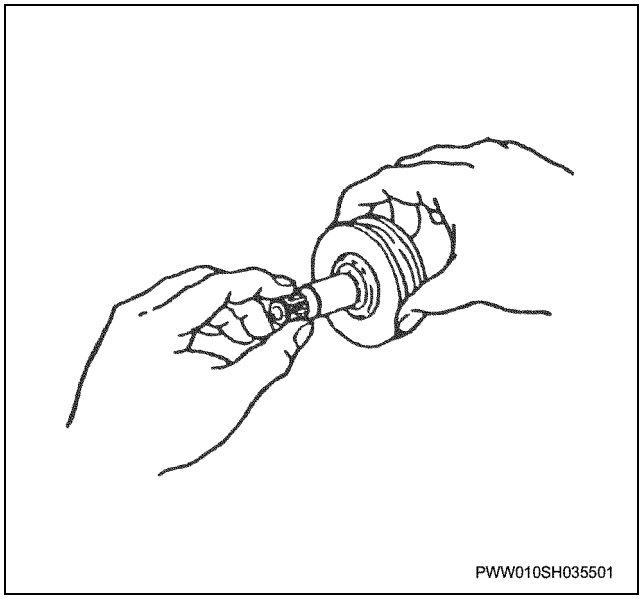
4. Overrunning clutch and pinion

Overrunning clutch inspection

- Hold the overrunning clutch housing with one hand and rotate the pinion with the other hand. In one direction, the pinion should gently rotate with a certain amount of resistance, but it should not rotate at all in the opposite direction. If this is not the case, the overrunning clutch must be replaced.
  Inspect the pinion, and replace it if there is any wear or damage.

Notes:
The overrunning clutch interior is filled with grease. If you wash the overrunning clutch with oil remover of detergents that remove oil, the grease may be washed out of the overrunning clutch. Therefore, the overrunning clutch should only be cleaned with a cloth.


PWW010SH035501

5. Front bracket

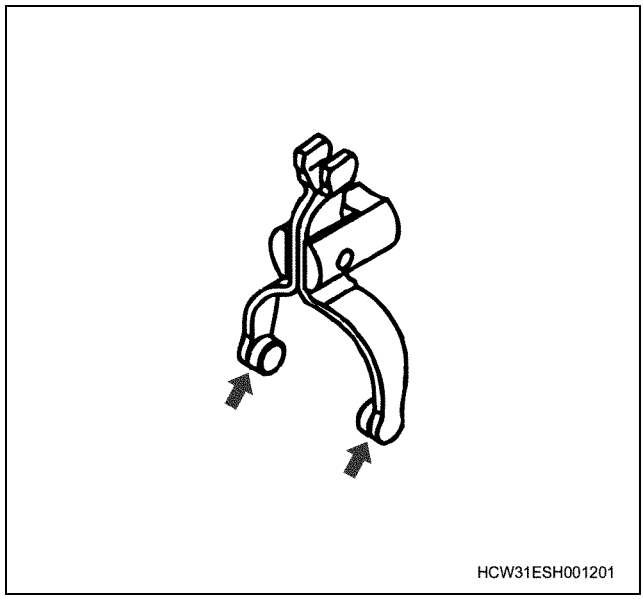
- Inspect the bearing and oil seal, and replace the front bracket ASM (including the bearing and oil seal) if a fault is discovered.

6. Internal gear and planetary gear

- Inspect the gear teeth, and replace the internal gear or planetary gear if there is any abnormal wear or damage.

7. Lever

- If parts that rub against the overrunning clutch become worn, the pinion's pulled out position will be upset.
  Refer to the re-assembly section for details on adjustments to the pinion's pulled out position.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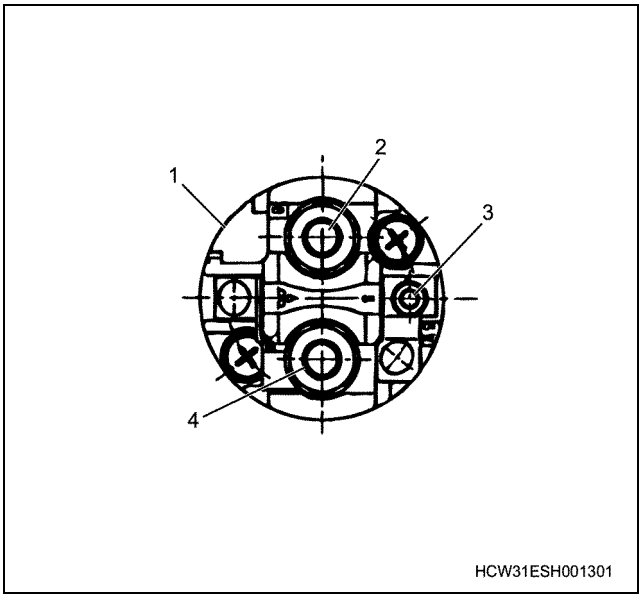
8. Magnetic switch

- Inspect the conductance between the M terminals (4) and the body, and replace the magnetic switch if there is no conductance.
  Also check that there is no conductance between the B terminals (2) and M terminals (4).
  If there is conductance, replace the magnetic switch.



Legend

1. Magnetic switch
2. B terminal
3. S terminal
4. M terminal

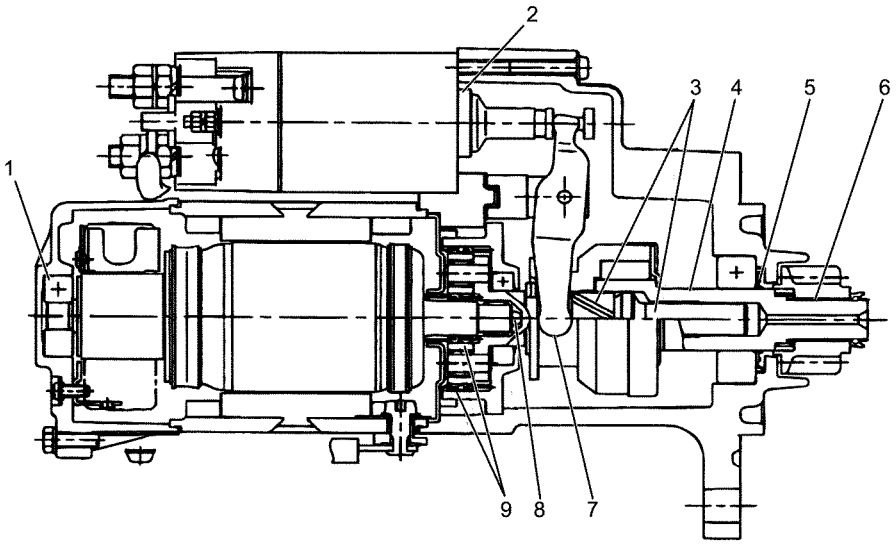
Assembly

Re-assembly can be done in the opposite order to disassembly, but the following cautions must be followed.

Notes:
The following parts should be replaced with brand new parts.

- **Snap ring (fixing the stop ring)**
- **E shape retaining ring**
- **O-ring (gasket on both ends of the yoke, and each screw section)**

1. The parts that require oiling are as follows. The following brands of grease are recommended: MULTEMP 0A-171 (Kyodo Yushi Co., Ltd.) for 1,2,3,4,5,6 on the diagram, and Moricote R AG650 (Dow Corning) for 7,8,9 on the diagram.

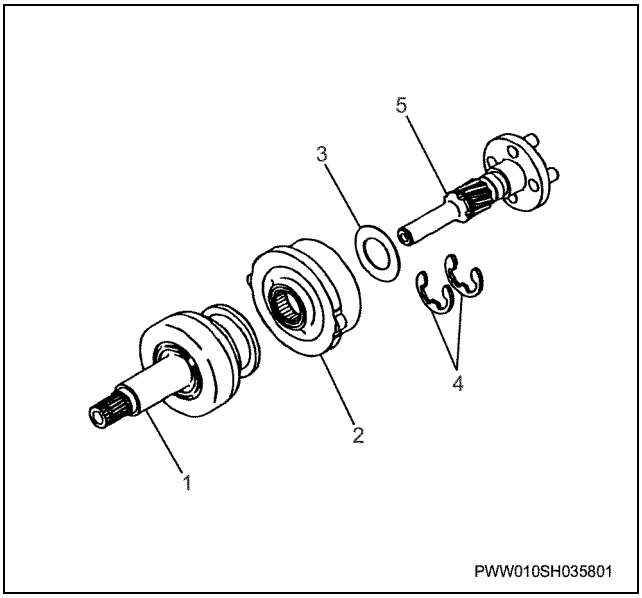


HCW31EMF000101

Legend

1. Armature bearing outer periphery surface (very little)
2. Plunger (very little)
3. Gear shaft spline section and slide section
4. Clutch shaft slide section
5. Oil seal
6. Under the pinion
7. Lever and overrunning clutch sliding parts
8. Sleeve bearing and ball
9. Armature shaft gear, planetary gear, internal gear

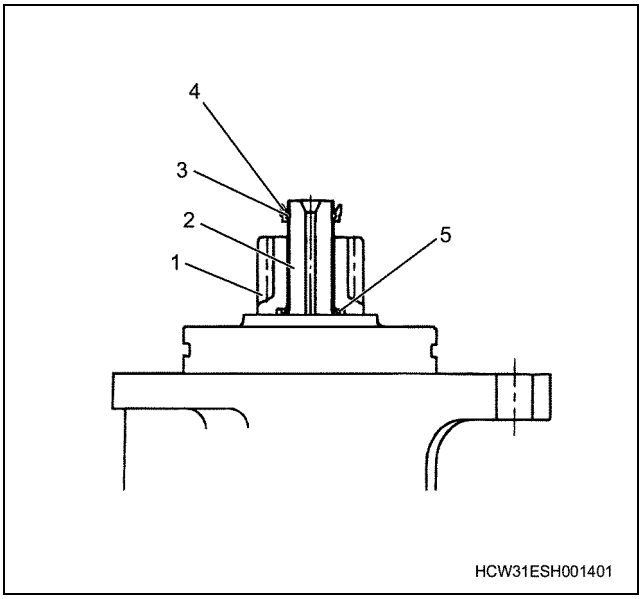
2. Tightening torque
   See the correct torque specifications for the correct tightening torques.
3. Armature shaft direction play
   - No need for adjustment. Insert the ball into the shaft tip section.
4. Gear shaft direction play
   - By inserting one washer between the internal gear and gear shaft, the required gap is automatically preserved.
   - Pass the washer, internal gear and overrunning clutch through the gear shaft.
     Next, move the overrunning clutch 1 spline tooth amount and check that the overrunning clutch does not slip out, then install the E shape retaining ring.



Legend

1. Overrunning Clutch
2. Internal gear
3. Washer
4. E shape retaining ring
5. Gear shaft

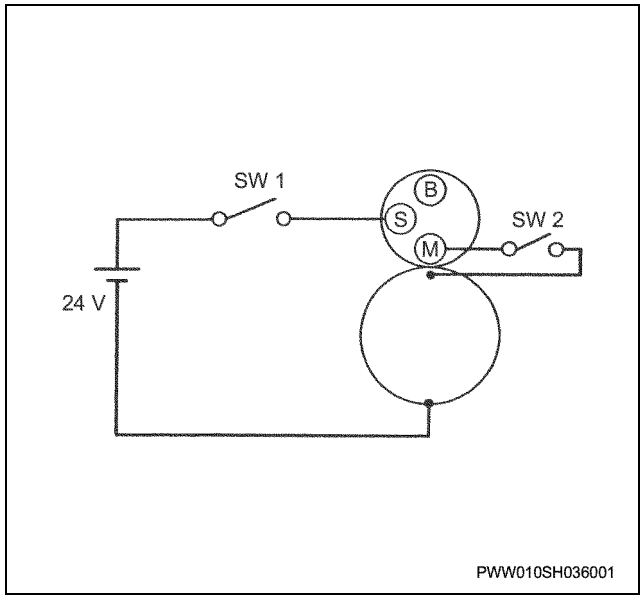
5. Installing the pinion
   - Install the pinion before installing the magnetic switch to the front bracket.
     Install the pinion spring, pinion, and stop ring to the clutch shaft in order. Last, install the snap ring to the clutch shaft slot tightly.
     Next, pull the stop ring tightly onto the stop ring side with a gear puller, and fix them both.



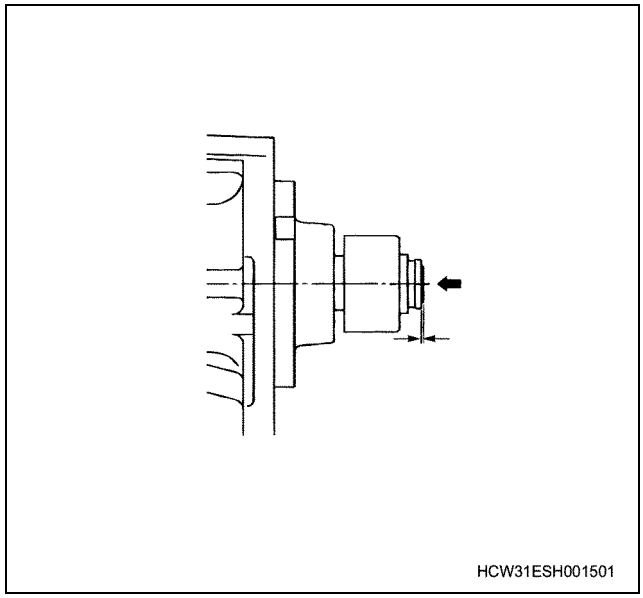
Legend

1. Pinion
2. Crankshaft
3. Snap ring
4. Stop ring
5. Pinion spring

6. Pinion's pulled out position inspection
   After installing the starter, inspect the pinion's pulled out position.
   Measurement and inspection procedures should be carried out as follows.
   - Connect the starter to the battery as shown in the diagram.
     When switch SW1 and SW2 are closed, the pinion advances to the cranking position and the armature rotates.
     Then open switch SW2 to stop the armature from rotating.



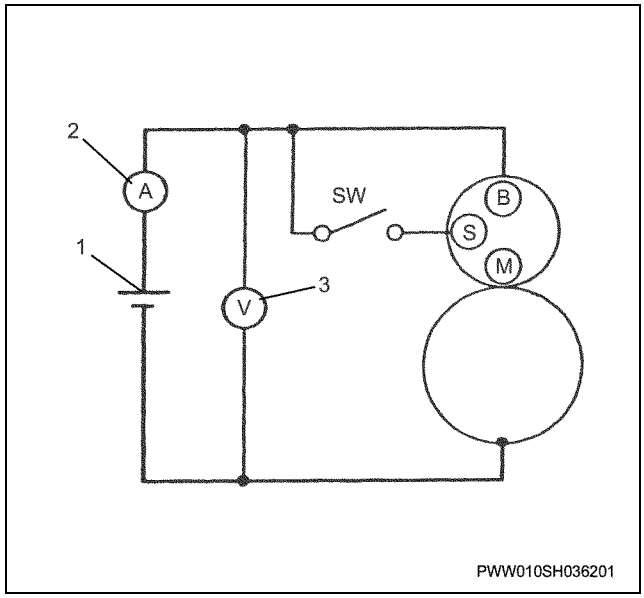
   - Gently press the tip of the crankshaft by hand (press and release) and measure the size of crankshaft movement (return movement).
     This value should be 0.5 ~ 2.0 mm. If the measured size is outside this limit, adjust the number (up to 2) of gaskets (thickness 0.5 mm) between the magnetic switch and front bracket, or replace the lever.



7. No-load test

- After adjusting the pinion's pulled out position, connect the starter as shown in the diagram.

Notes:
Use an electrical wire that is thick enough, and make sure that connection sections are thoroughly tightened.



Legend
1. Battery
2. Ampere meter
3. Voltmeter

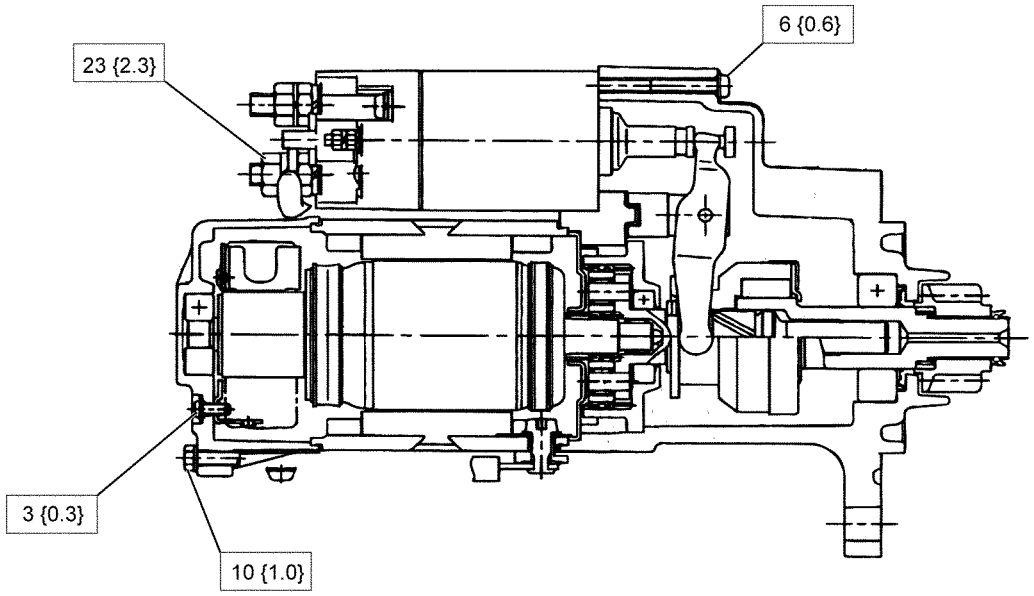
- Close the switch and read-off the number of revolutions, current, and voltage. Compare the read values to the maintenance standard.
  If the values differ from the maintenance standard values, disassemble and inspect again.

8. Maintenance standard

Heading			Standard values and limitation values
No load characteristic	Voltage	(V)	23.5
	Current	(A)	Less than 125
	Number of revolutions	(r/min)	Over 3000
Commutator	Outer diameter	(mm)	38.7
	Reduced dimensions limit	(mm)	38.1
Commutator	Undercut	(mm)	0.8
	Limit	(mm)	0.2
Brush	Length	(mm)	23
	Reduced dimensions limit	(mm)	12
Brush spring	Pressure	(N)	33 – 45
	Limit	(N)	20
Pinion's pulled out position		(mm)	0.5 – 2.0

Torque specifications

Starter



Charging system

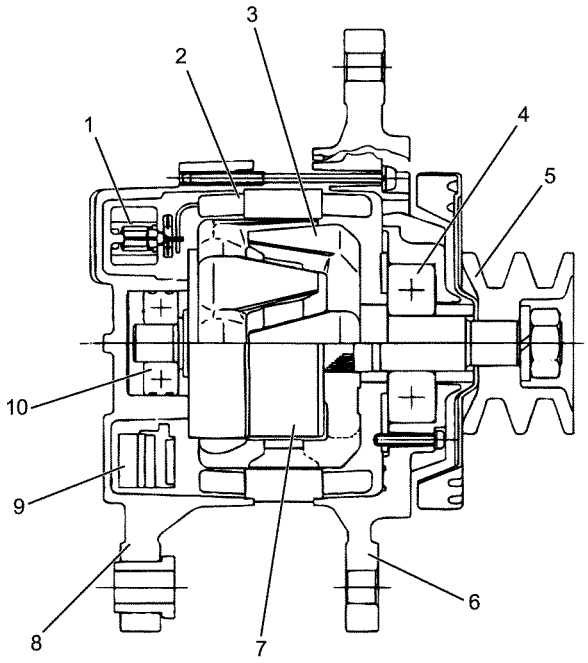
Service Precautions

The following precautions apply when handling the generator.

- Connecting to the reverse battery polarities will cause damage to the generator diodes.
- Do not under any circumstances remove the battery terminals or an electrical wire from the charging circuit while the engine is rotating.
- Install each of the terminal wires to the correct terminal without mistakes.
- Do not perform a Megger test on semiconductor devices.
- Always detach the battery terminal (-) before inspecting equipment.
- Do not open and close the battery relay switch while the engine is rotating.
- If using a quick charger etc. or recharging from an external source, always detach the battery terminals first.
- To not use a steam cleaner or apply water directly.
- After wiring, tighten the B terminal and E terminal to the correct tightening torque shown below.
  B terminal 4.9 ~ 6.9 N·m {0.5 ~ 0.7 kgf·m}
  E terminal 2.0 ~ 5.3 N·m {0.2 ~ 0.5 kgf·m}
- For details on adjusting the belt tension, refer to the section on belt adjustment.

Explanation of functions and operations

Generator cross section diagram



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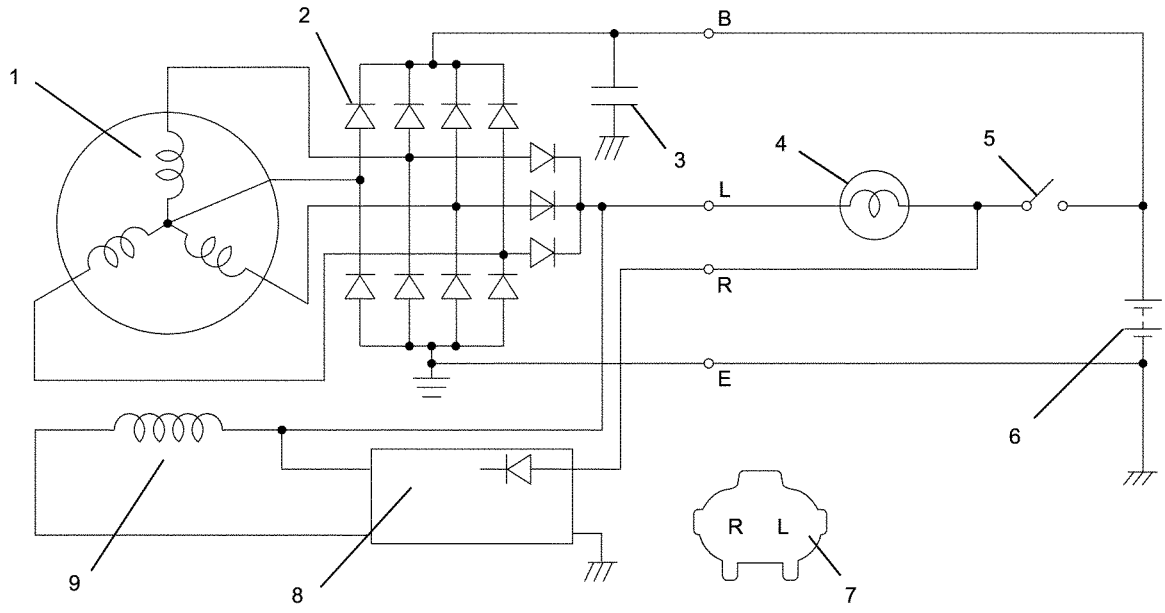
Legend

1. Rectifier
2. Stator
3. Rotor
4. Bearing
5. Pulley
6. Front bracket
7. Coil ASM
8. Rear bracket
9. IC regulator
10. Bearing

Charging circuit



Legend

1. Coil
2. Diode
3. Condenser
4. Indicator lamp
5. Key switch
6. Battery
7. Connector
8. Regulator
9. Field coil

Generator main configuration and functions

- This is a brush less generator.
  The generator mainly consists of a rotor, starter, rectifier ASM, front bracket, rear bracket, IC regulator, bearing, and pulley etc.
- In order to change the 3 phase Alternating Current generated by the starter coil into Direct Current, the generator uses 6 main diodes and 2 additional diodes. 3 of the 6 main diodes are called plus diodes, and the remaining 3 are called minus diodes.
  Furthermore, 3 smaller diodes called trio diodes are used, and these diodes provide the field current.
  The generator has 3 terminals, B terminal (direct current output terminal), L terminal and R terminal.
  The L terminal is connected to the field coil. Until the generator starts to generate power, the L and R terminals are used for the input of initial excitation current.
  They also function as output terminals. (1 ampere current capacity)
  When the L terminal voltage reaches the battery voltage, the charging lamp goes out.

Trouble shooting

- Does not charge at all
- Lack of electrical charge
- Overcharge
- Charging current is unstable
- Abnormal noises come from the generator

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

Lack of electrical charge

Condition	Probable cause	Correction
Lack of electrical charge	Battery fault	Replace
	Broken wire in electrical wiring, short, disconnected connection section	Repair
	Generator drive belt loose	Adjust the tension of the belt
	Layer short circuit in the stator coil	Replace
	Faulty diode	Replace
	Bad connection in each terminal	Repair
	Regulator fault	Replace
	Bad connection in the regulator terminal	Repair

Overcharged

Condition	Probable cause	Correction
Overcharge	Regulator fault	Repair

Charging current is unstable

Condition	Probable cause	Correction
Charging current is unstable	Intermittent contact in electrical wiring or wire is beginning to break	Repair
	Generator drive belt loose	Adjust the tension of the belt
	Stator coil short circuit, wire is starting to break	Repair
	Loose connection in each terminal	Repair
	Regulator fault	Replace
	Bad connection in the regulator terminal	Repair

Abnormal noises come from the generator

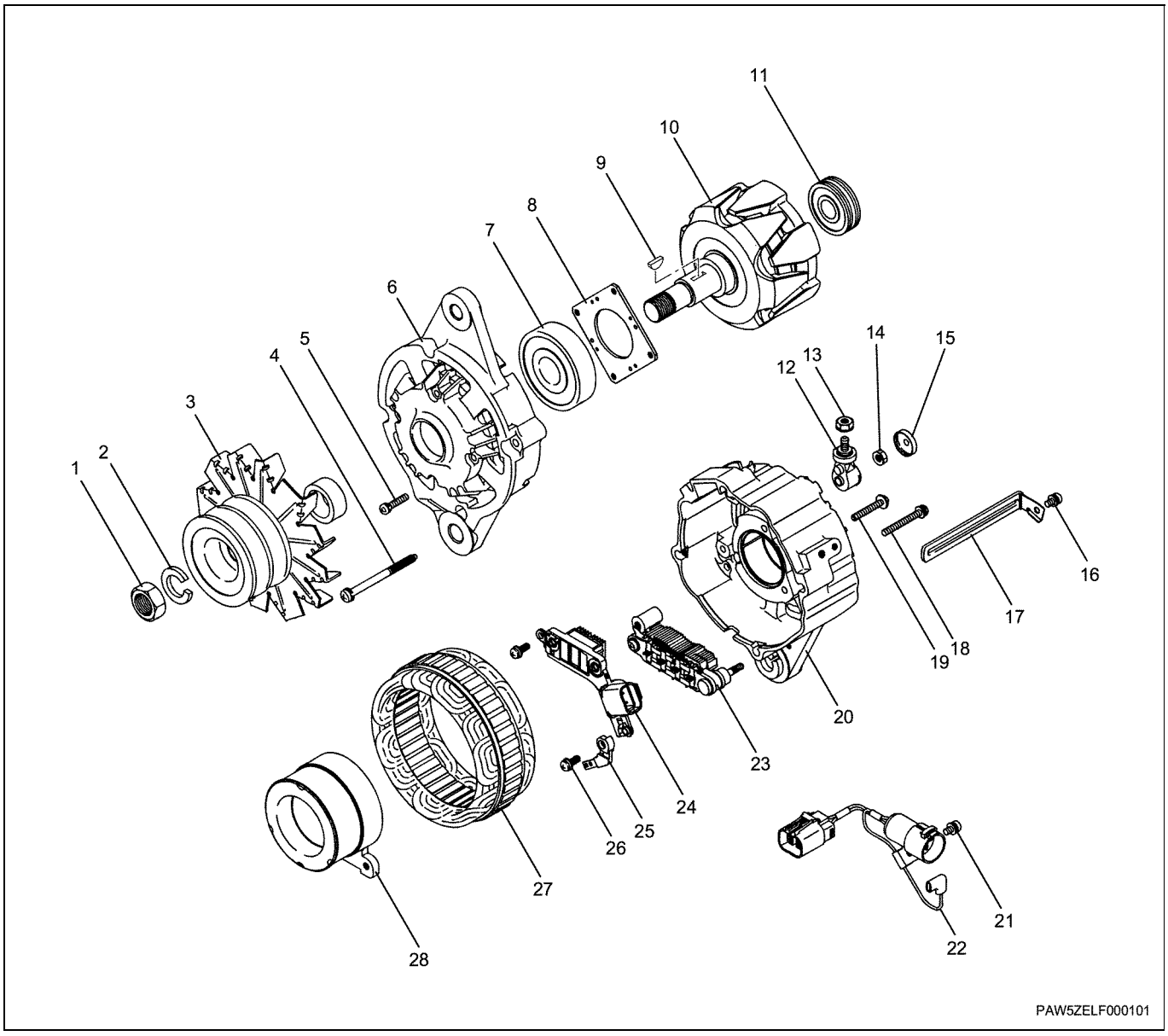
Condition	Probable cause	Correction
Abnormal noises come from the generator	Belt tension is loose	Adjust the tension of the belt
	Bearing fault	Replace the bearing
	Rotor core and stator core connection	Repair
	Faulty diode	Replace
	Stator coil short circuit, wire is starting to break	Replace

Main data and specifications

Official power output	(V – A)	24 – 50
Declared speed	(rpm)	5000
Regulator type		IC type
Adjustment voltage	(V)	28.5 ± 0.5
Mass	(kg)	9.7
		Made by Mitsubishi Electric

Generator

Component parts



Legend

1. Nut
2. Spring washer
3. Pulley
4. Through bolt
5. Screw (for retainer tightening)
6. Front bracket
7. Front bearing
8. Retainer
9. Key
10. Roller
11. Rear bearing
12. B terminal bolt
13. B terminal Installation nut
14. Nut for B terminal bolt
15. B terminal cap
16. Screw (for installing the clamp)
17. Clamp
18. Screw (for installing the coil ASM)
19. Screw (for installing the regulator)
20. Rear bracket
21. Screw (for installing the connector)
22. Connector ASM
23. Rectifier
24. Regulator
25. Plate (L)
26. Screw (for installing the regulator)
27. Stator
28. Coil ASM

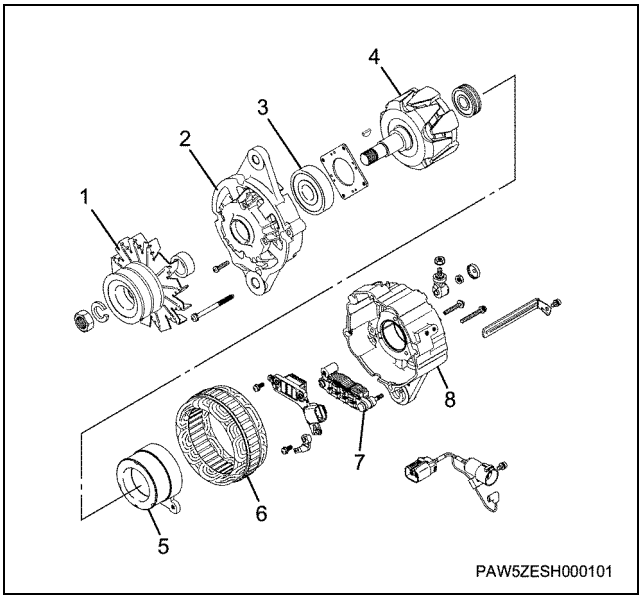
Disassembly

- Only important points are described.

Caution:
In order to make the re-assembly easier, install identification marks to the front bracket and rear bracket before disassembly.

1. Front & rear bracket connection
   - Remove the 4 through bolts, then insert the tip of a minus screwdriver between the stator and front bracket, and very carefully pry the front bracket from the rear bracket to separate them.

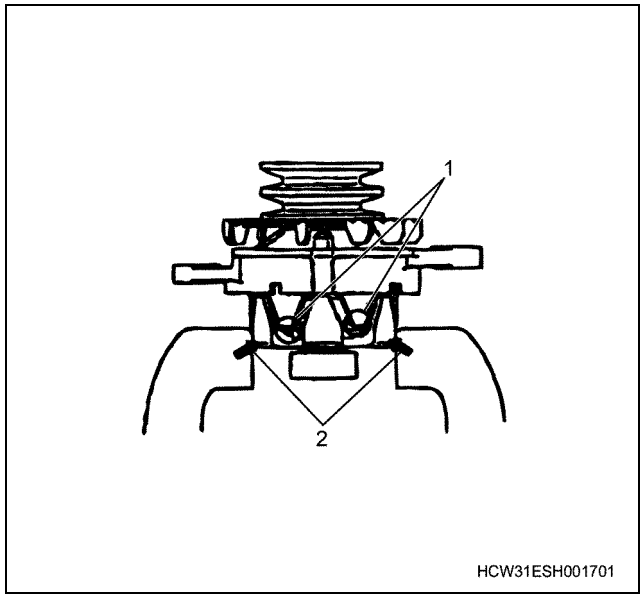
Caution:
Take care not to damage or scratch the stator coil.



Legend
1. Pulley
2. Front bracket
3. Front bearing
4. Roller
5. Coil ASM
6. Stator
7. Rectifier
8. Rear bracket

2. Rotor related
   - Fix the rotor in place with a vice without deforming the rotor ball.
     Remove the pulley Installation nut, and remove the pulley, fan, clearancer and front bracket.

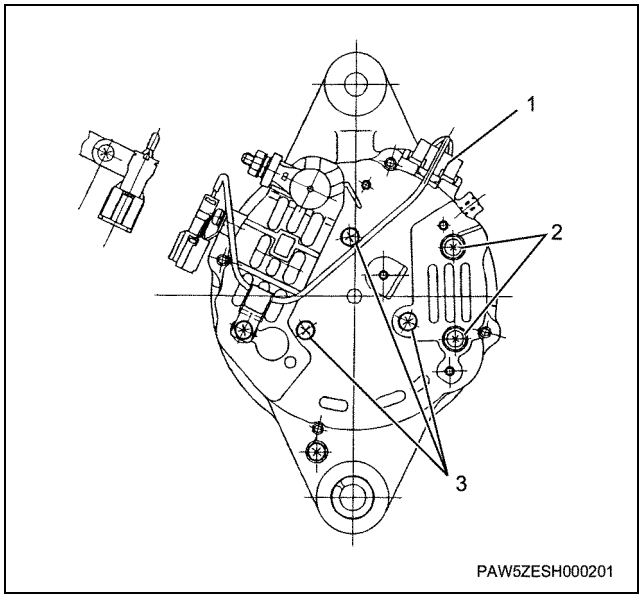
Caution:
Always clamp the (2) section in the vice when tightening the rotor. Do not clamp section (1) because it has weak reinforcement.



3. Bearing related
   - If you need to remove the front bearing, remove the retainer Installation screws, and press the bearing out using an appropriate socket.
   - If you need to remove the rotor bearing, a common bearing puller can be used to remove it.

Caution:
Only remove when it is completely necessary to do so. Do not re-use bearings that have been removed.

4. Coil ASM related
   - To remove the coil ASM, you first need to remove screw A (which fixes the coil terminal section to the IC regulator).
     Removing screw B (which fixes the coil ASM to the bracket) before removing screw A can cause the terminal section to break.
     Support the coil ASM by hand to prevent damage to the terminal section.
     Next, remove screw B and remove the coil ASM.



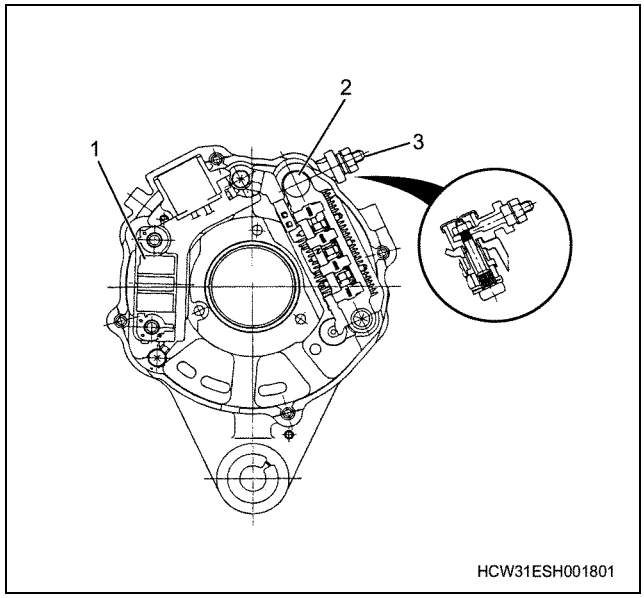
Legend
1. Connector
2. Screw A
3. Screw B

5. B Terminal ASM related
   - Remove the connector & clamp.
   - Remove the cap and nut from the rectifier terminal bolt.
     Remove the B terminal ASM by prying between the rear bracket and B terminal ASM. The tube remains on the rear bracket.

Caution:
Do not lose the tube.

6. Rectifier ASM related
   - Remove the 1 rectifier Installation screw and 2 regulator Installation screws.
     Remove the stator and rectifier ASM together from the rear bracket.
     Then, remove the IC regulator.
   - Remove the 4 stator coil lead wires, and remove the stator coil from the stator rectifier.

Caution:
The stator coil lead wires are soldered on to the rectifier terminal with high-temperature solder (230°C melting point specification).
Super heat the rectifier, and without damaging the diode, use a 180 ~ 270 watt soldering iron to quickly (within approx. 5 seconds) remove the wires.



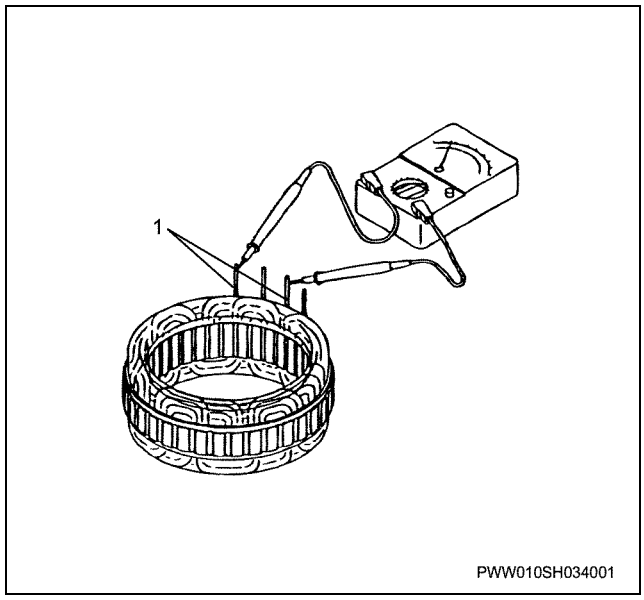
Legend
1. IC regulator
2. Terminal bolt
3. B terminal

Inspection

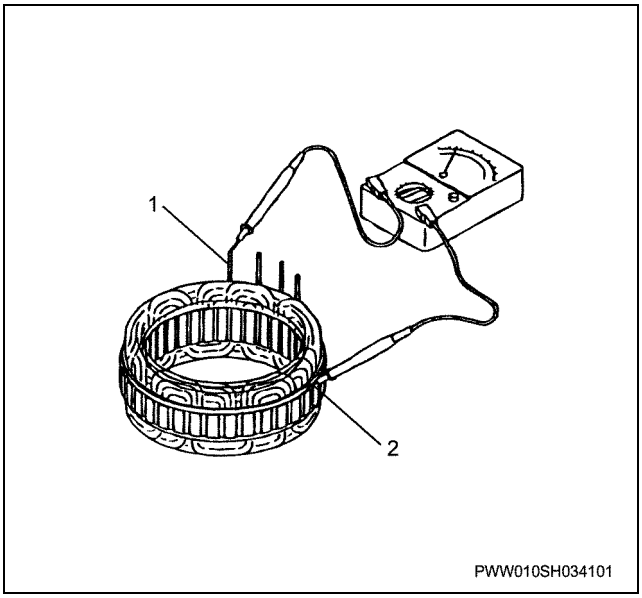
Generator inspection and adjustment

Stator

- Perform a visual inspection for damage, loose connections, and discoloration of winding wires.
- Check the conductance between the two stator coil lead wires (1) using a circuit tester.
  Replace the stator if there is no conductance.



- Check the conductance between the stator coil lead wires (1) and core (2) using a circuit tester. Replace the stator if there is conductance.

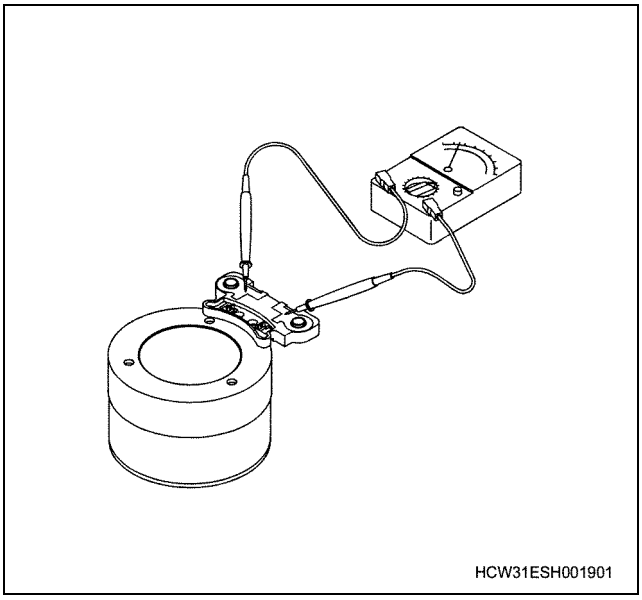


Rotor

- Inspect the bearing for abnormal noises, rattling, and leaking grease (if there is just a small amount of grease, it can be wiped off), and replace it if there is a fault. It is easier to check for abnormal noises and rattling if you check when the shaft is pushed into the main unit.

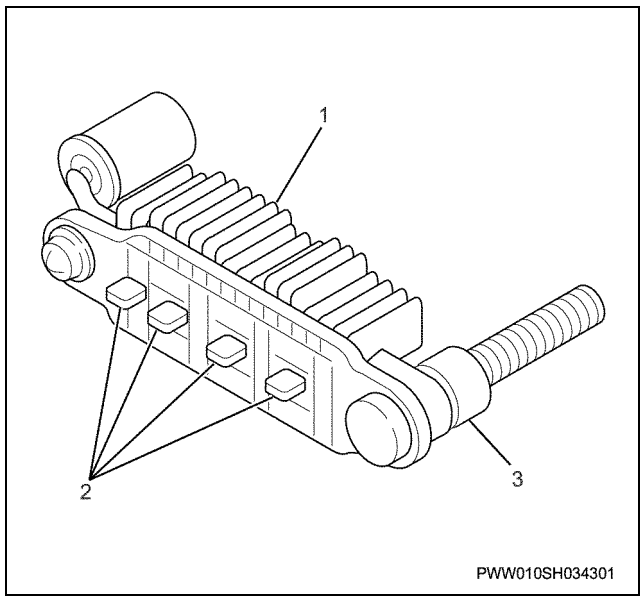
Coil ASM

- Measure the resistance between both ends of the terminal in the terminal section.
  Replace the coil ASM if the measured value is outside the reference value.



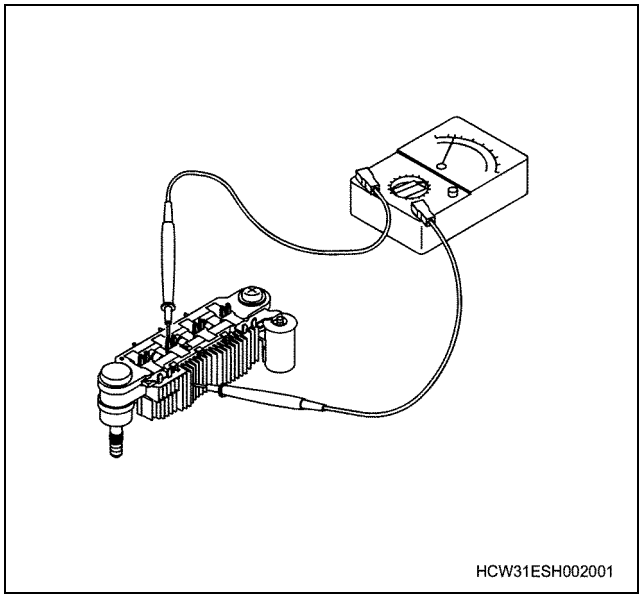
Rectifier ASM

- Inspect the conductance between the plus diode, plus side additional diode plus heat sync, and 4 diode terminals with a circuit tester.
  If there is conductance in both directions, the plus diode has a short circuit and the rectifier ASM must be replaced.
  If there is no conductance in either direction, the plus diode is open and the rectifier ASM must be replaced.
- Minus diode and minus side additional diode
  Inspect the conductance between the minus heat sync and 4 diode terminals with a circuit tester.
  If there is conductance in both directions, the minus diode has a short circuit and the rectifier ASM must be replaced.
  If there is no conductance in either direction, the minus diode is open and the rectifier ASM must be replaced.
- Diode trio (3 small diodes)
  Use a circuit tester to inspect the conductance in both directions.
  If there is conductance in both direction or neither direction, the diode has a fault and the rectifier ASM needs replacing.



Legend

1. Plus diode
2. Diode terminal
3. Minus diode section



Front bearing

- Inspect the bearing for abnormal noises, rattling, and leaking grease (if there is just a small amount of grease, it can be wiped off), and replace it if there is a fault.
  It is easier to check for abnormal noises and rattling if you check when the bearing is pushed into the bracket as opposed to checking the bearing by itself.

Regulator

- The regulator cannot be tested with a circuit tester.
  After re-assembling the generator, test the generator and test whether the regulator is controlling the generator's voltage.

Assembly

Re-assembly can be done in the opposite order to disassembly, but the following cautions must be followed.

1. The bearing is filled with grease and sealed, so there is no need to apply oil or grease.

Caution:
The use of oil on the rotor shaft bearing that has a resin band is strictly prohibited. Oil on the bearing box section of the rear bracket can cause creeping, and should be completely wiped off.

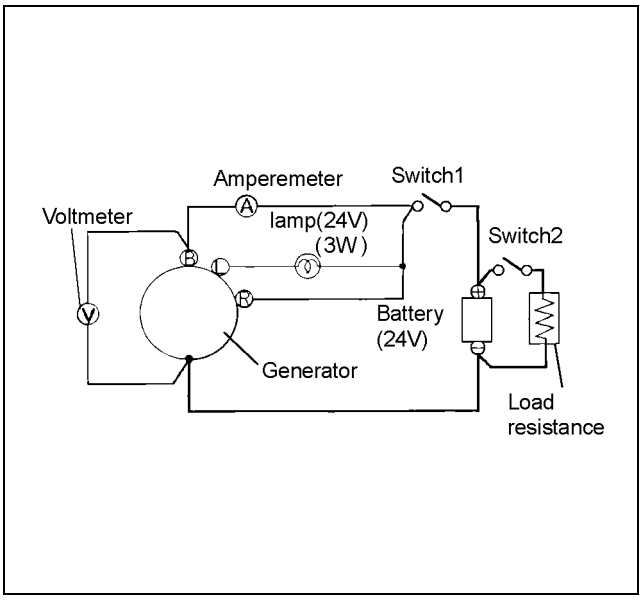
2. Use high-temperature solder (230°C melting point specification).
   Use a 180 ~ 270-watt soldering iron for soldering, perform the soldering work quickly (within approx. 5 seconds) and do not allow the rectifier to overheat.
3. Tightening torques for various sections
   Tightening torque reference list

Caution:
Be careful not to over-tighten screws, nuts, bolts etc.

4. Assembling the rear bracket, stator ASM and front bracket rotor
   - The joint between the rotor bearing and rear bracket is tight. Heat the bearing box section of the rear bracket beforehand to 50~60°C, then assemble.
   - After re-assembling the generator, rotate the pulley by hand and check that the rotor rotates smoothly.

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

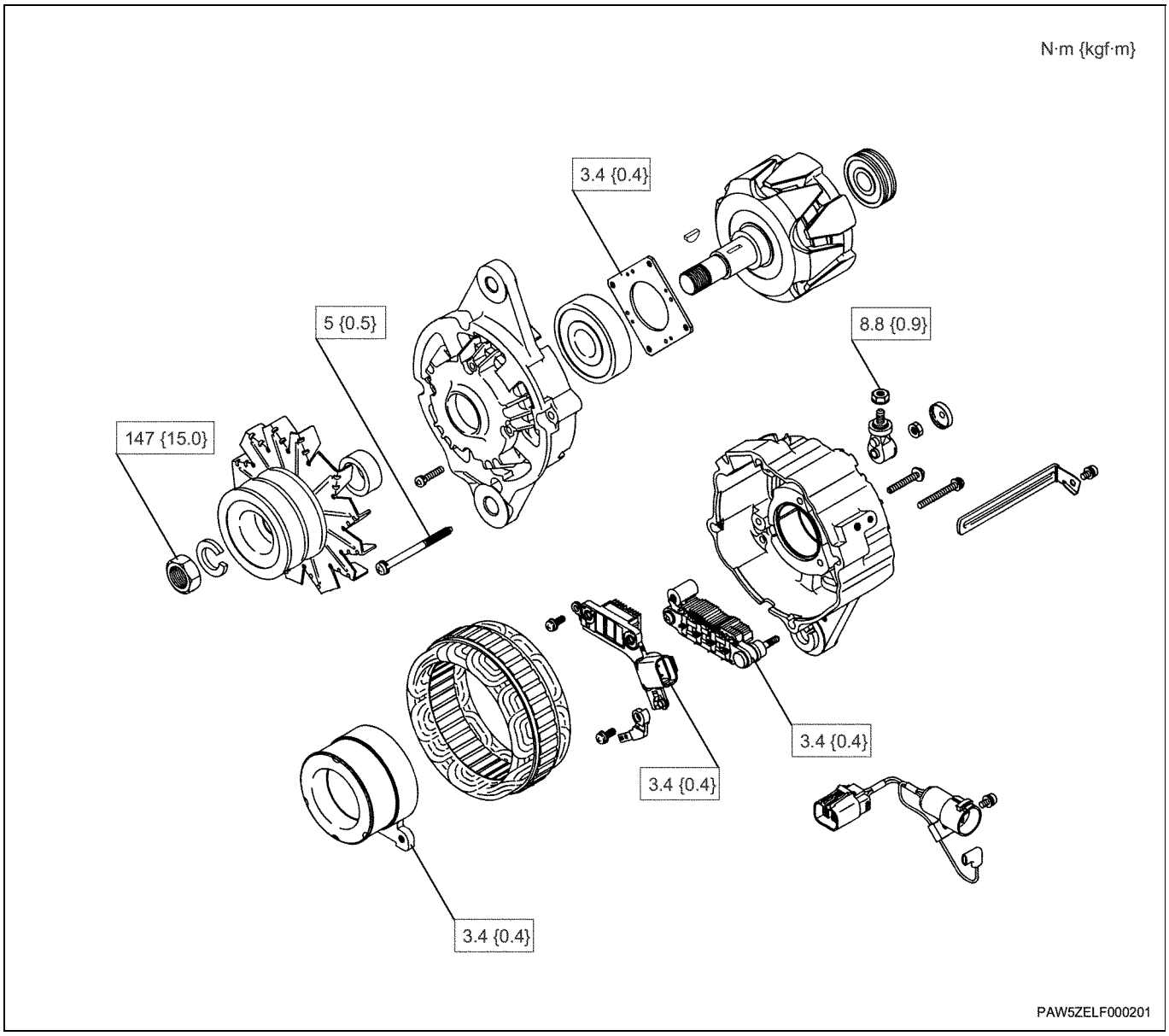
The output voltage test inspects whether the generator can give out the rated output or not.

- 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	

Torque specifications



Disassemble and Assemble Engine

Lubricating system
(6WG1 (Common rail))
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Lubricating system

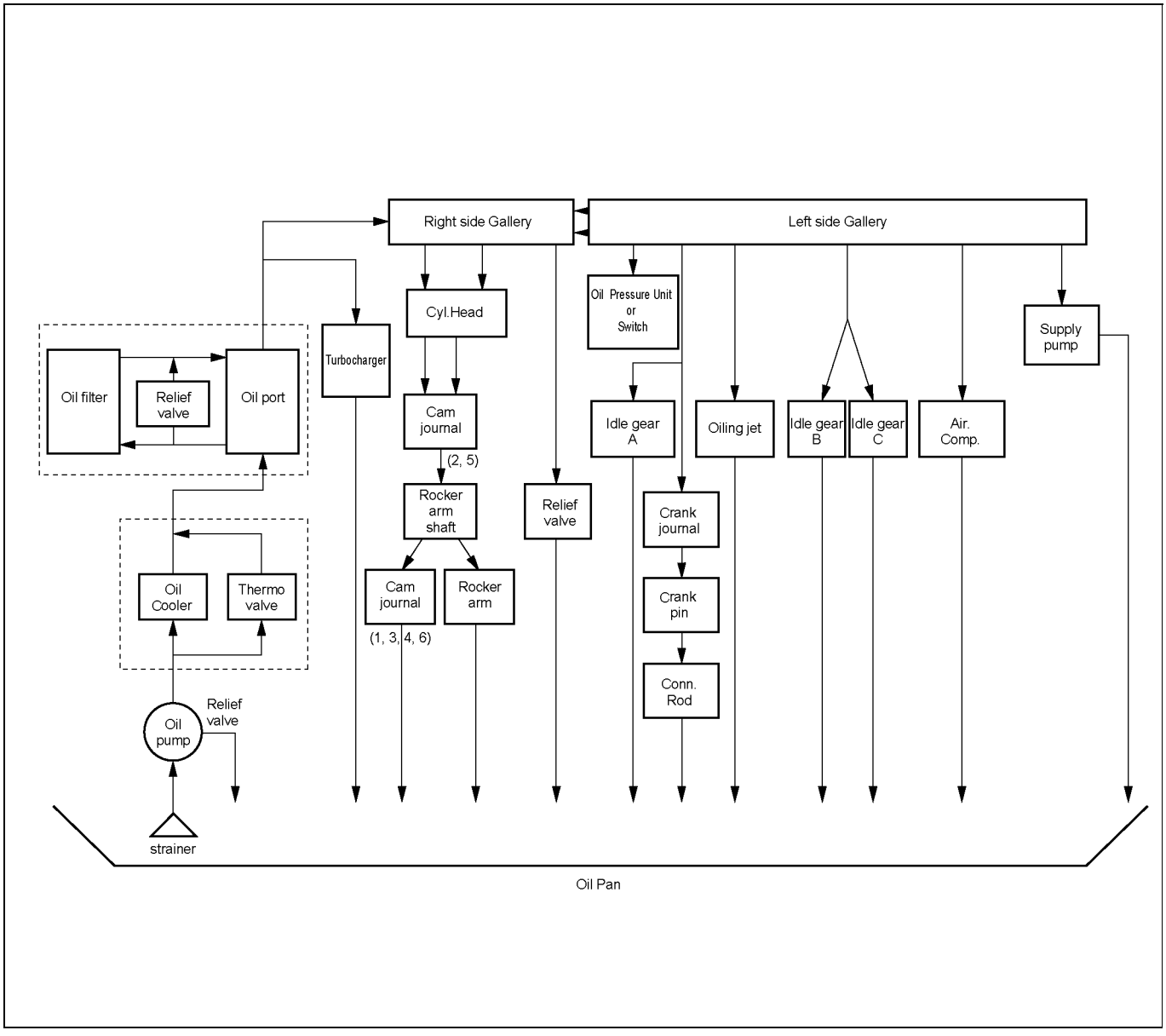
Service Precautions

- 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 re-assembling the parts.
- Always apply the correct amount of liquid gasket. Care must be taken, as over-application of liquid gasket can cause burning due to a blocked oil gallery or oil jet. Under-application of liquid gasket can cause oil or water leakage.
- Always re-apply the liquid gasket upon itself when starting and finishing liquid gasket application.

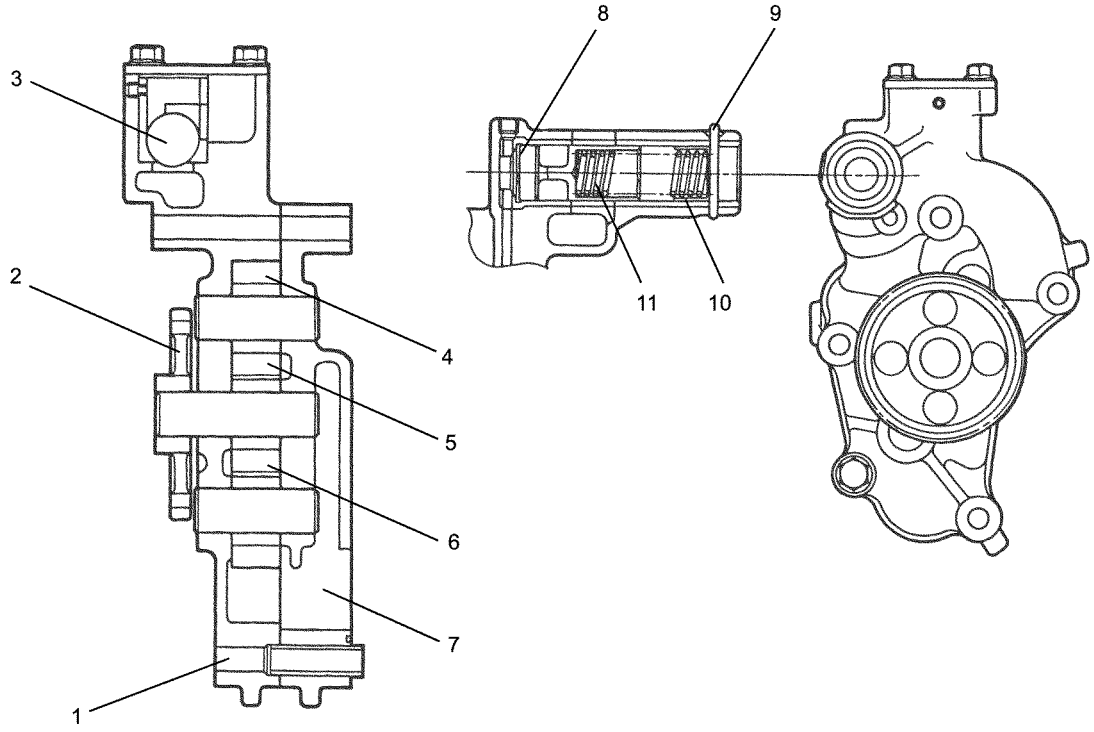
Explanation of functions and operations

The lubricating system consists of an oil pump, full flow filter, water cooled oil cooler, and oil jet for piston cooling.

Lubricating system diagram



Oil pump structural drawing



Legend

1. Oil pump body
2. Oil pump drive gear
3. Ball
4. Driven gear
5. Drive gear
6. Driven gear
7. Oil pump cover
8. Relief valve
9. Split pin
10. Spring seat
11. Spring

Main data and specifications

Heading	Item
Lubricating system	Forced circulation type

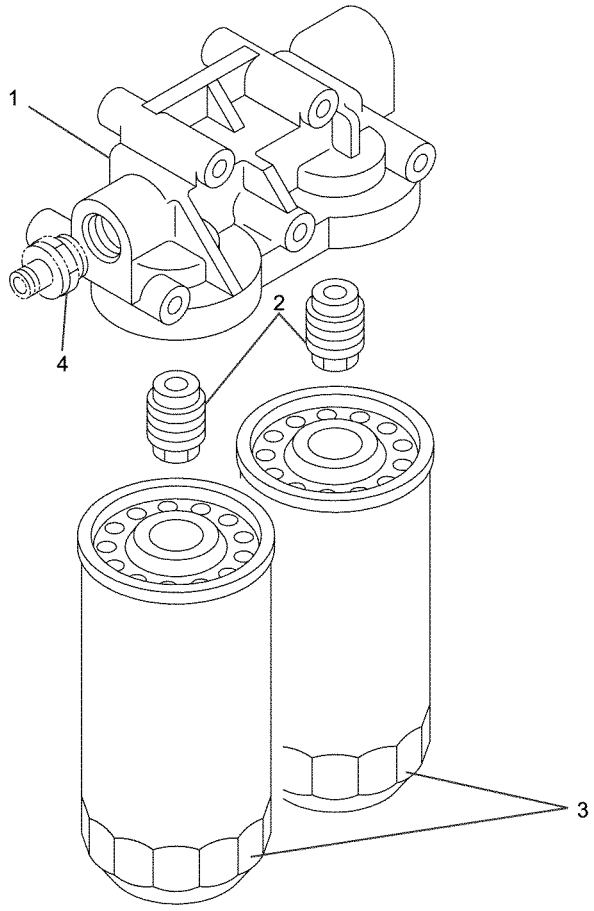
Heading			Item
Oil pump	Type		Gear type
	Discharge amount	(L/min)	154 (pump revolutions 3,200 rpm discharge pressure 539 kPa {5.5 kgf/cm^2}
	Relief valve opening pressure	kPa {kgf/cm^2}	686 {7}
Oil gallery relief valve opening pressure		kPa {kgf/cm^2}	441 {4.5}
Main oil filter type			Full flow filter paper type
Main oil filter bypass valve opening pressure (intake/outlet oil pressure difference)		kPa {kgf/cm^2}	98 {1.0}
Oil cooler type			Water cooling multi-sheet type 6 layer
Oil thermo valve opening temperature		(°C)	98
Amount of engine oil	Oil pan	(L)	37 ~ 52
	Full capacity	(L)	42 ~ 57

Maintenance standard table

Heading		Nominal dimension mm	Standard mm	Limit mm
Oil pump	Clearance between oil pump body wall and gear tip	–	0.050 ~ 0.098	0.15
	Clearance between oil pump body cover and gear	–	0.040 ~ 0.094	–
	Driven gear shaft outer diameter	ϕ20	–	ϕ19.9
	Clearance between driven gear shaft and pump body	–	0.040 ~ 0.074	–
	Driven gear shaft and driven gear interference	–	0.019 ~ 0.047	–

Oil filter

Component parts



PAW5ZHLF000101

Legend

1. Body
2. Nipple
3. Cartridge oil filter
4. Splicing fittings (machine side components)

Disassembly

The oil filter is not installed to the engine by a sub oil filter (machine side Installation)

1. Use a filter wrench to remove the cartridge filter.

   Wrench; Main filter: 8-9801-3170-0

2. Remove the nipple.
   - If there are no problems with the screw thread of the nipple screw, do not remove it.
3. Clean the oil lines within the body.

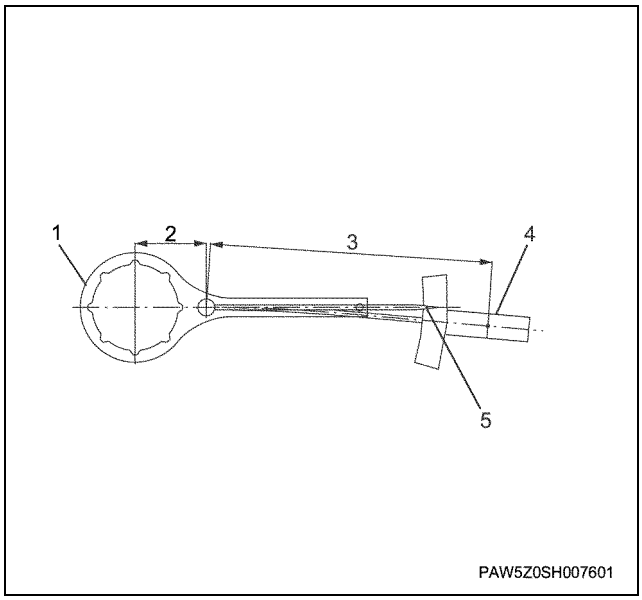
Assembly

1. Set the body.
2. Apply Loctite to the nipple and install it.
3. Install the cartridge oil filter.
   - Apply engine oil to the O-ring section of the cartridge oil filter, screw the nipple into the body, and tighten to the correct tightening torque.
   - If you use the filter wrench shown in the diagram below and tighten with a torque wrench, the torque must be converted.

- Conversion formula
  Actual torque = displayed torque × (effective length + 87) / effective length

Wrench; Main filter: 8-9801-3170-0

Correct tightening torque: 64 N·m {6.5 kgf·m}



Legend

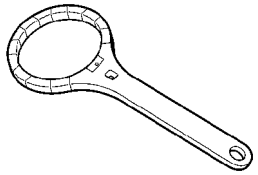
1. Filter wrench
2. 87mm
3. Effective length
4. Torque wrench
5. Display torque

---

4. Port opening splicing fittings (machine side components)
   - The port opening splicing fittings are not installed to the engine.
   - The correct tightening torques for the splicing fittings are shown below.

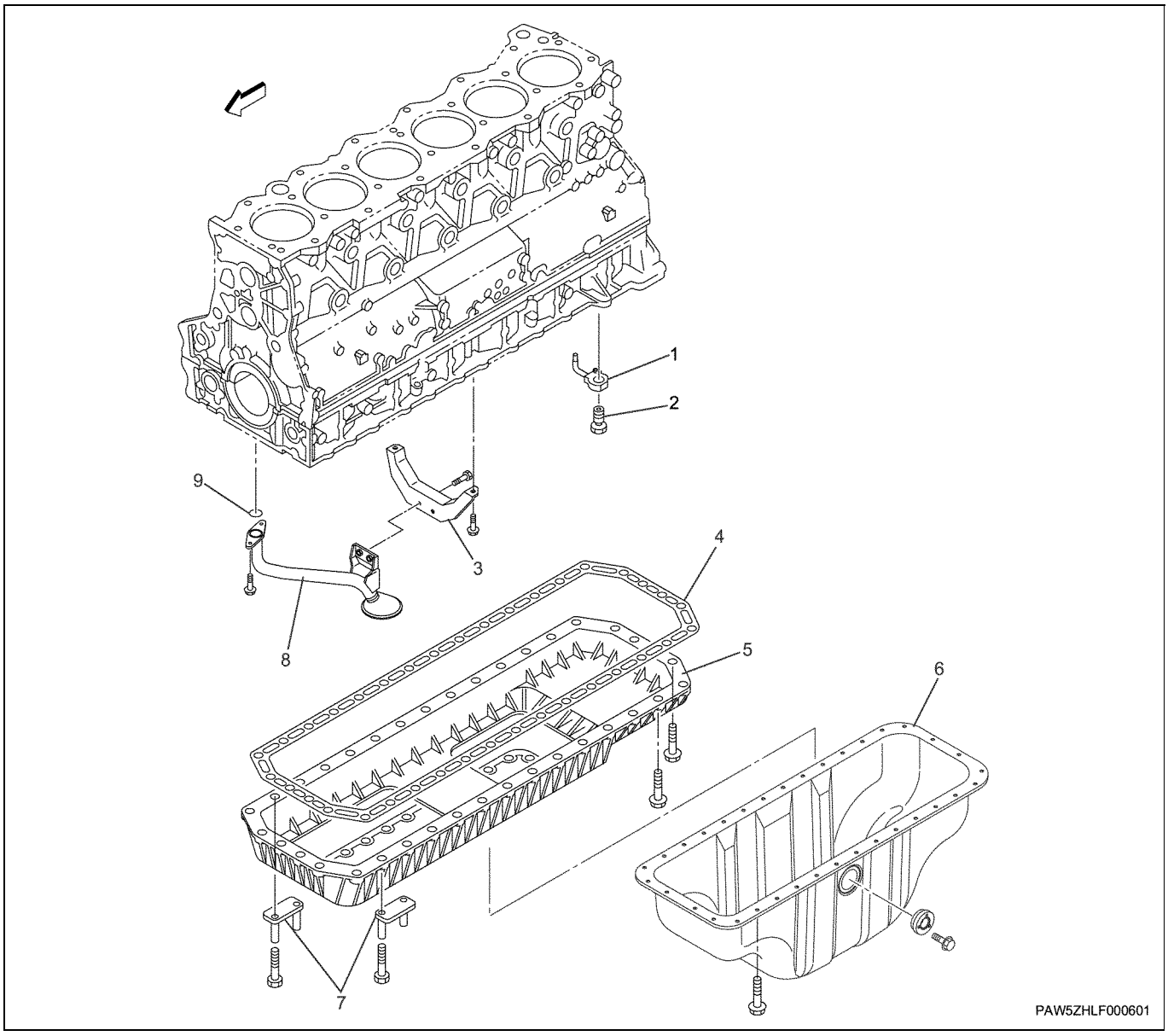
Correct tightening torque: 70 N·m {7.1 kgf·m}

Special tools

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

Oil pan, oil jet

Component parts



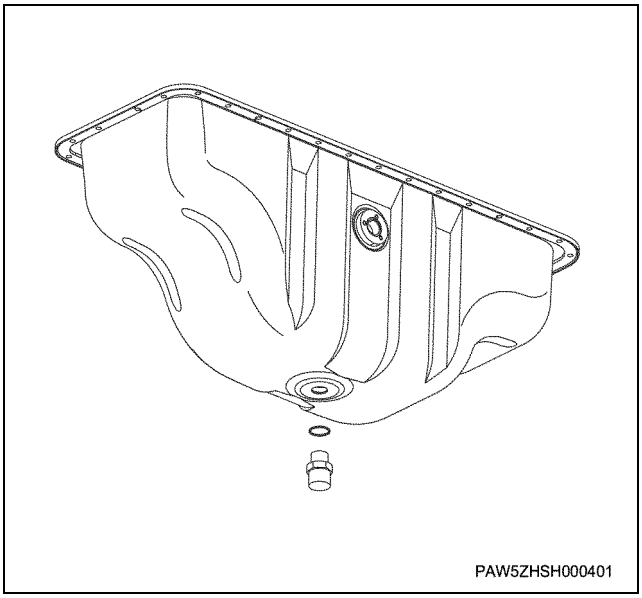
Legend

1. Oil jet
2. Joint bolt
3. Oil strainer bracket
4. Gasket
5. Clearancer (crank case – oil pan)
6. Oil pan
7. Bracket (oil pan clearancer)
8. Oil strainer
9. O-ring

Removal

Oil pan and oil jet removal procedure

1. Remove the oil pan.

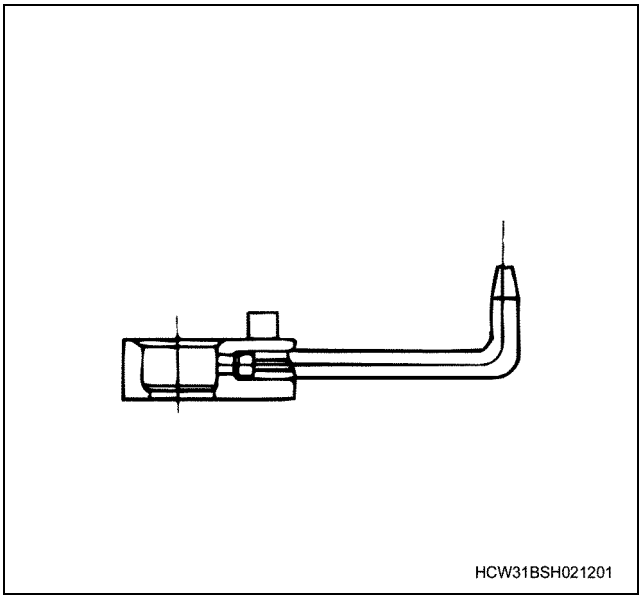


2. Remove the clearancer and bracket (oil pan).
3. Remove the gasket.
4. Remove the oil strainer.
5. Remove the O-ring for the oil strainer.
6. Remove the oil strainer bracket.
7. Remove the joint bolt for the oil jet.
8. Remove the oil jet.

Installation

1. Install the oil jet.
   - Set the outward section of the oil jet to the positioning hole on the cylinder block, and fix it by tightening the joint bolt to the correct tightening torque. (6 places)

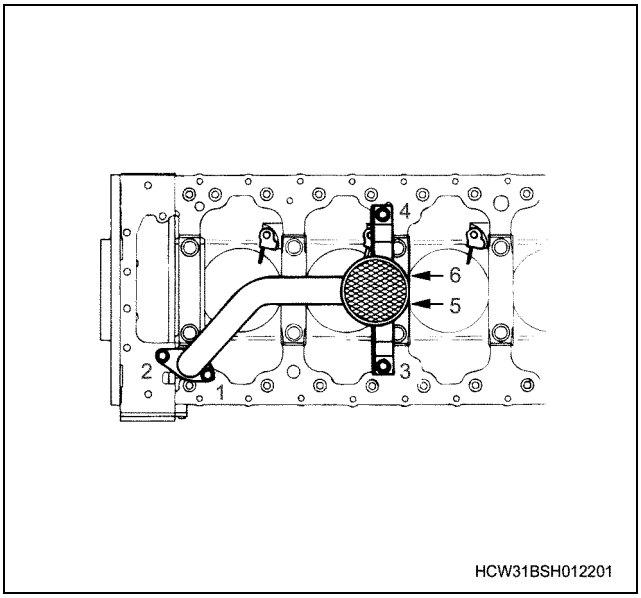
Correct tightening torque: 70 N·m {7.1 kgf·m}



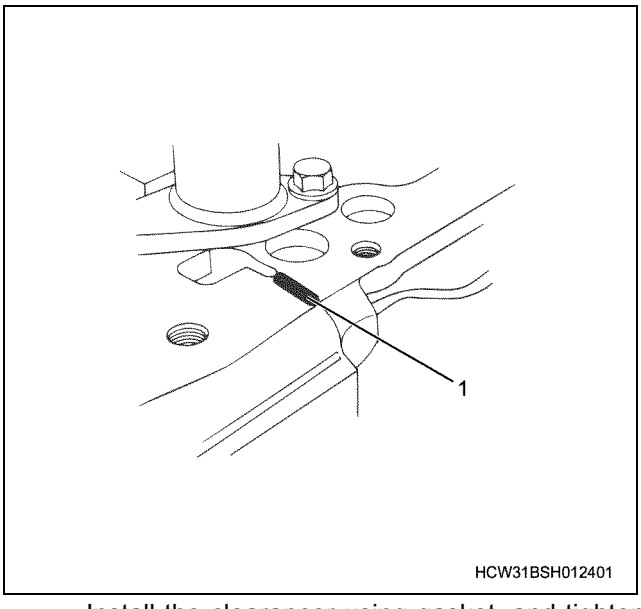
Important:
Be careful when handling the oil jet's pipe as it deforms easily.

2. Install the oil strainer bracket.
3. Install the O-ring to the oil strainer.
4. Install the oil strainer, and tighten in the numbered order shown in the diagram.

Correct tightening torque: 49 N·m {5.0 kgf·m}

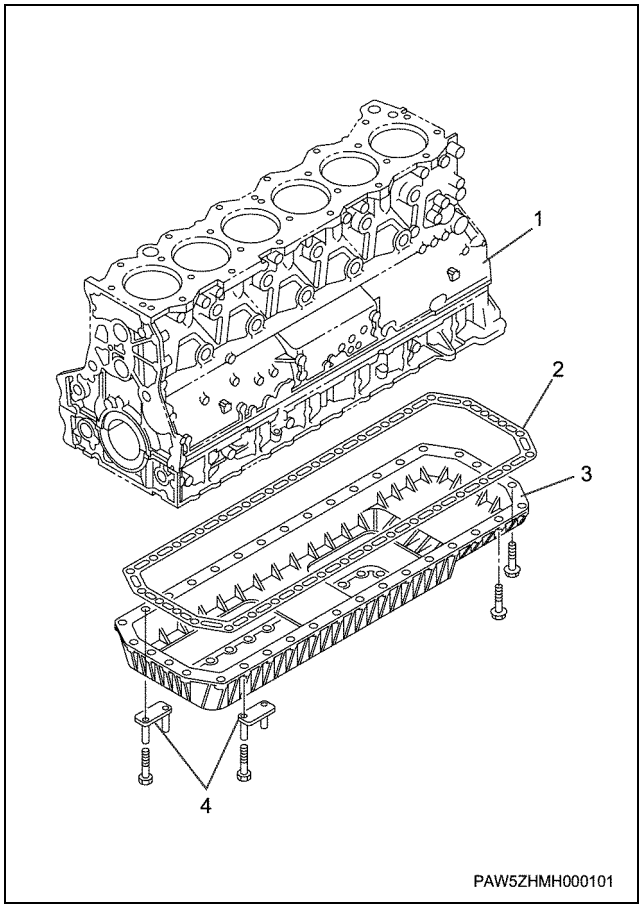


5. Install the clearancer and gasket to the crankcase.
   - Apply approx. 3 ~ 4mm thickness and width of Three Bond TB1207B liquid gasket to the lower surface of the joints (1) of the cylinder block and flywheel housing, and of the gear case.



   - Install the clearancer using gasket, and tighten in a clockwise direction starting with the center of the side.
   - Lastly, re-tighten the bolts to the correct tightening torque.

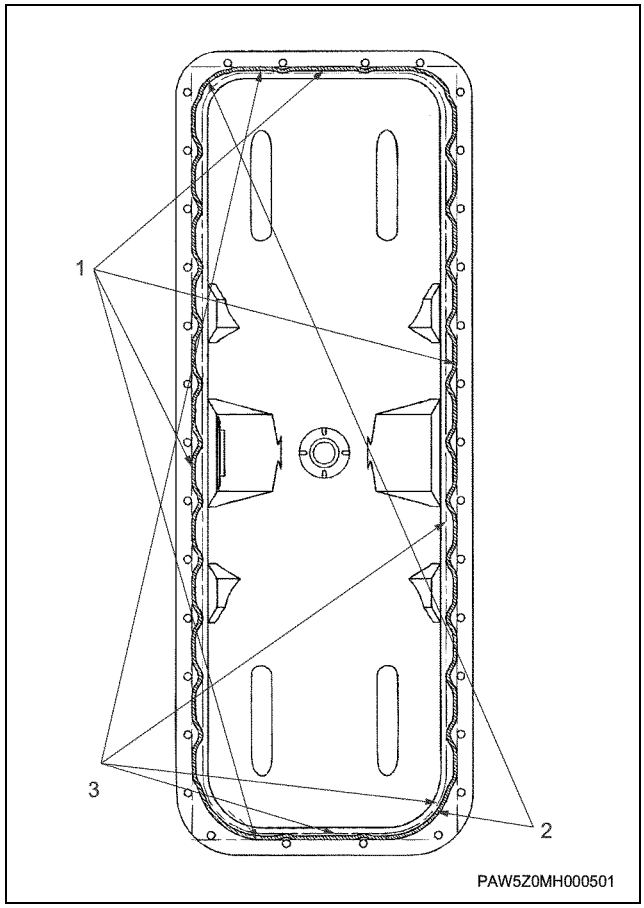
Correct tightening torque: 38 N·m {3.9 kgf·m}



6. Install the clearancer to the oil pan.
   - Degrease the Installation surface of the oil pan flange side, flange R, and oil pan clearancer.
   - Apply liquid gasket along the line on the diagram below.

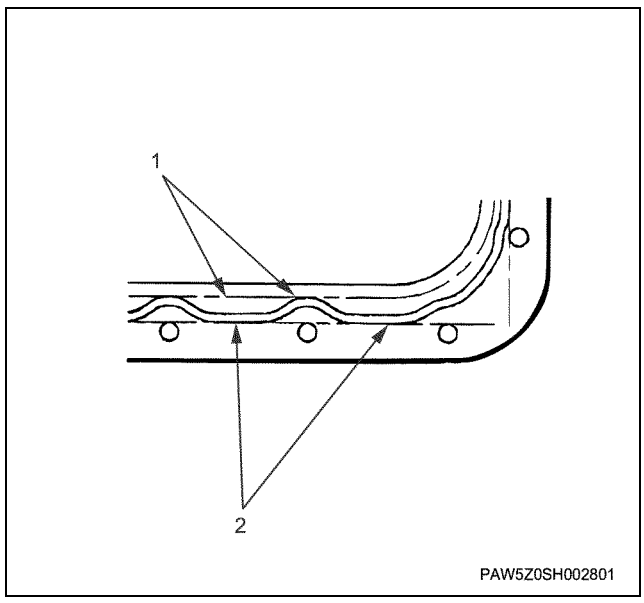
Liquid gasket: TB1207B

- Aim for a liquid gasket diameter of ϕ4mm (ϕ3.5~ϕ4.5).
- Install the oil pan within 15 minutes of applying the liquid gasket. If more than 15 minutes passes, use a gasket remover to completely remove all of the gasket, then re-apply the gasket and proceed to re-assemble the parts.
- When installing the oil pan, erect approx. 4 guide stands for positioning in the oil pan clearancer bolt holes.
- After tightening the oil pan, do not remove any of the protruding gasket from the inner or outer circumference of the oil pan.
- Do not fill the engine with oil or start the engine until at least 30 minutes has passed since the parts were installed.



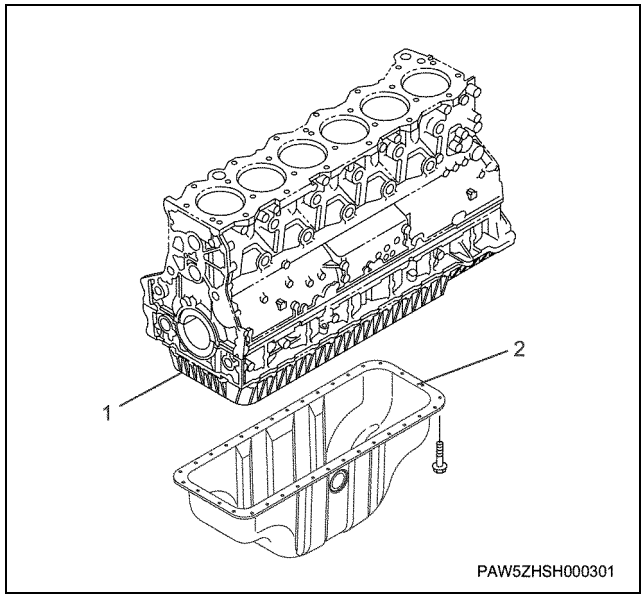
Legend

1. Line connected to the bolt hole perimeter line (inner side)
2. Oil pan R finish line
3. Apply to the constant clearance along the oil pan angle R



Legend

1. Aim to apply so that the edge of the gasket is on the R finish line
2. Aim to apply the liquid gasket so that the edge of the gasket includes the bolt hole outer circumference



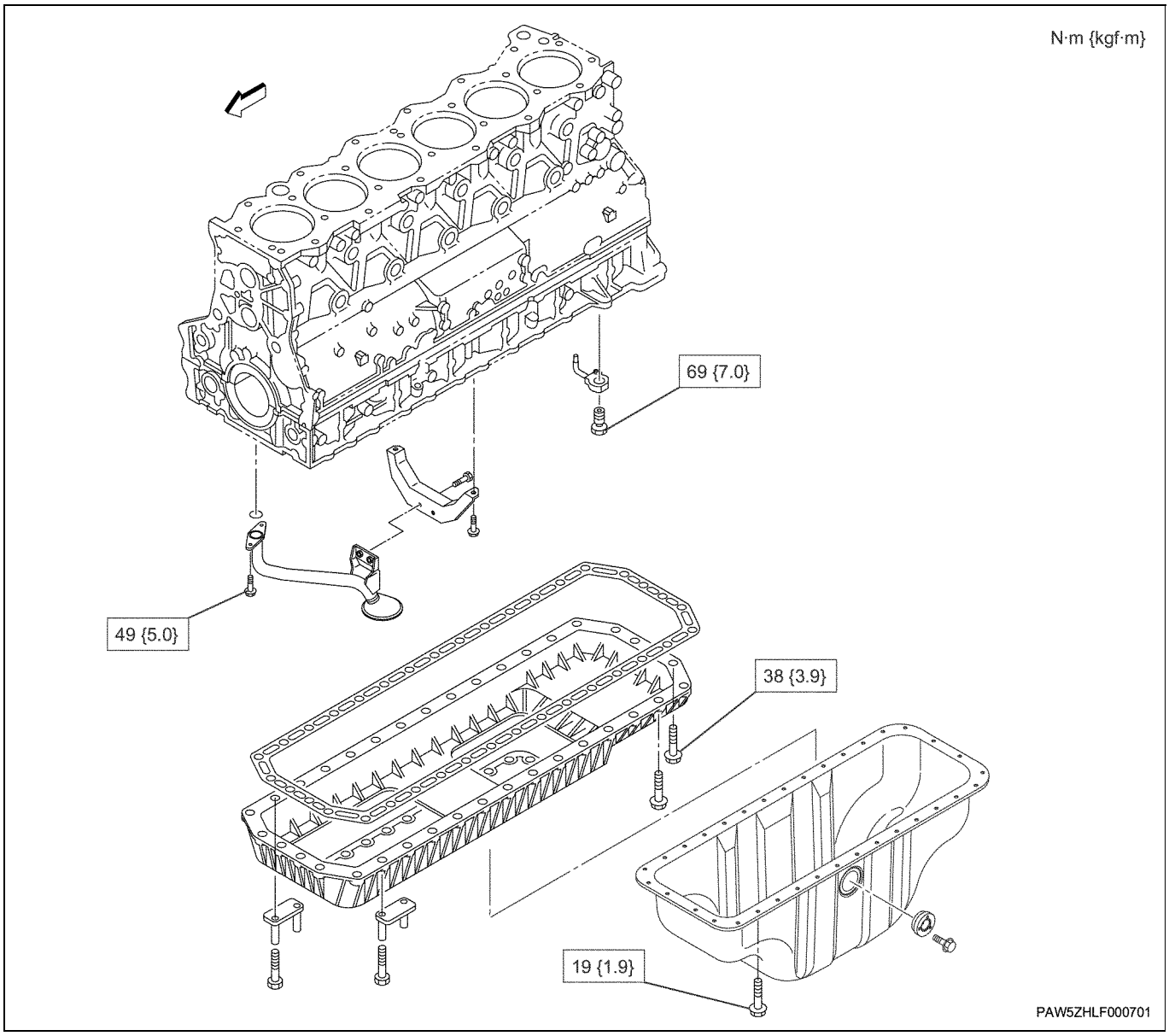
Legend

1. Clearancer
2. Oil pan

- Install the oil pan using gasket, and tighten in a clockwise direction starting with the center of the side.
- Lastly, re-tighten the bolts to the correct tightening torque.

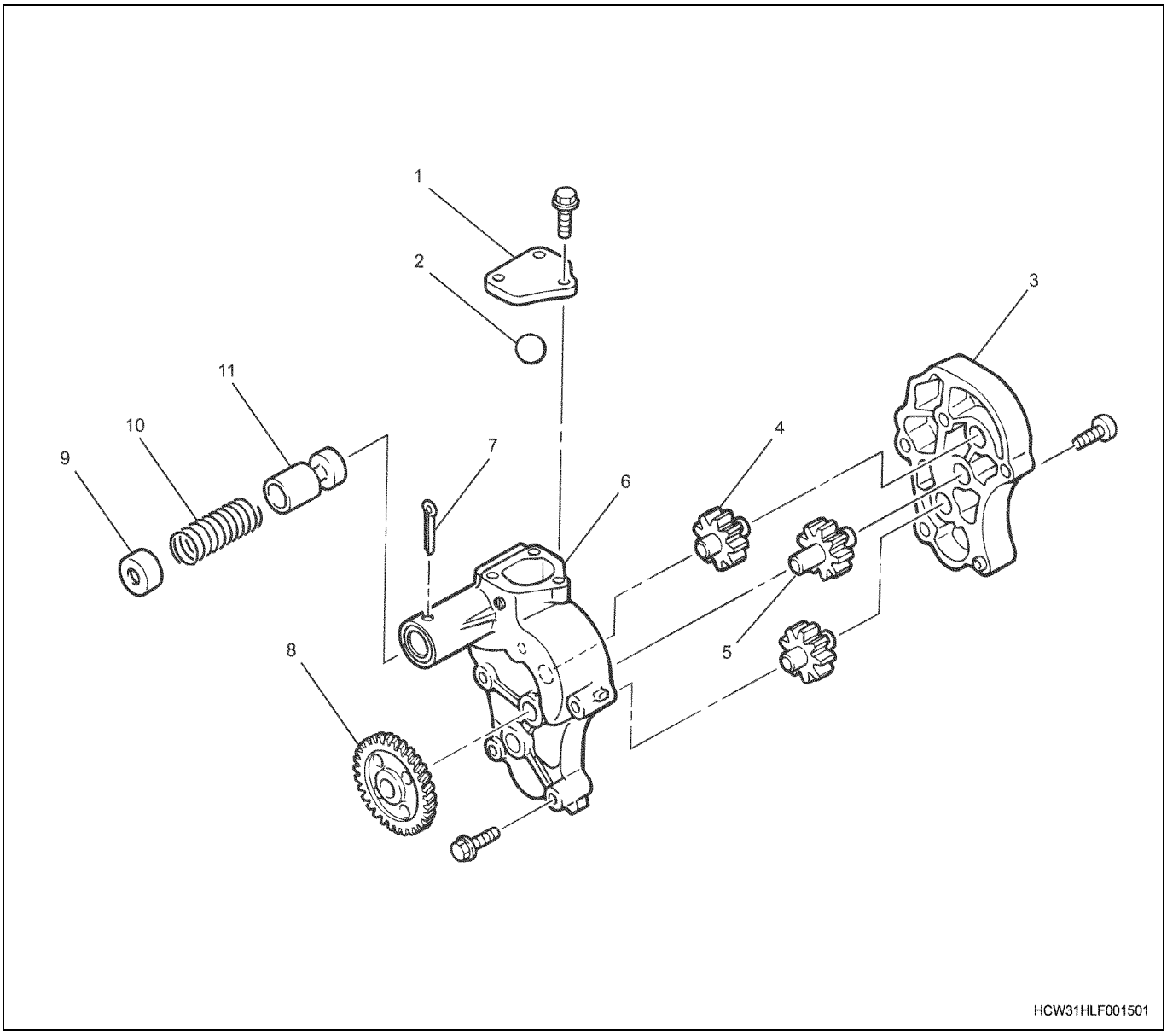
Correct Tightening torque: 19 N·m {1.9 kgf·m}

Torque specifications



Oil pump

Component parts



Legend

1. Cover
2. Ball
3. Oil pump cover
4. Driven gear
5. Drive gear shaft
6. Oil pump body
7. Split pin
8. Oil pump drive gear
9. Spring seat
10. Spring
11. Oil relief valve

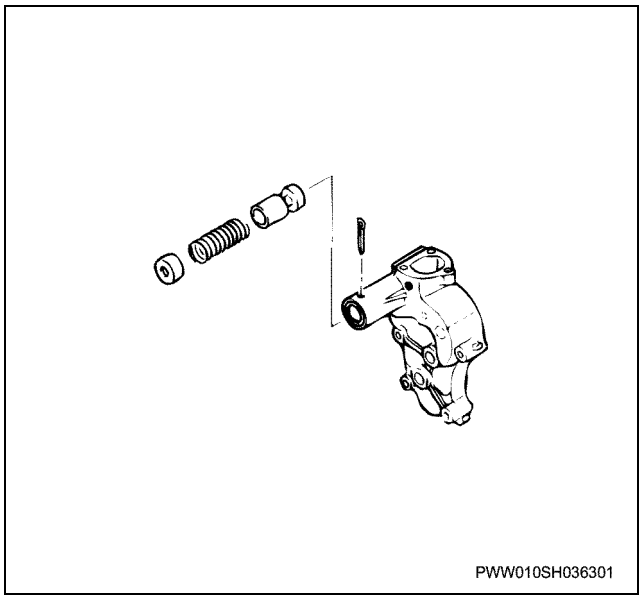
Disassembly

1. Remove the cover.
2. Extract the ball.
3. Remove the split pin.

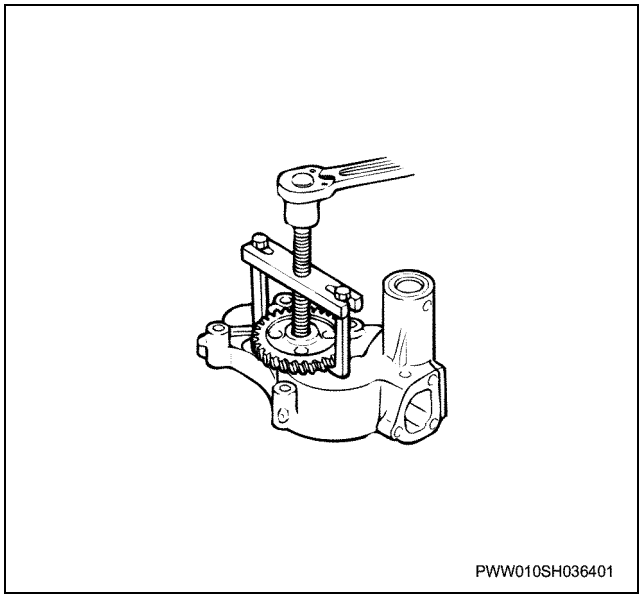
Notes:
Be careful when extracting the split pin as the spring may also fly out and become lost.

4. Remove the spring seat.
5. Remove the spring.

6. Remove the oil relief valve.



7. Remove the oil pump drive gear.
   - Use a gear puller to remove the drive gear.

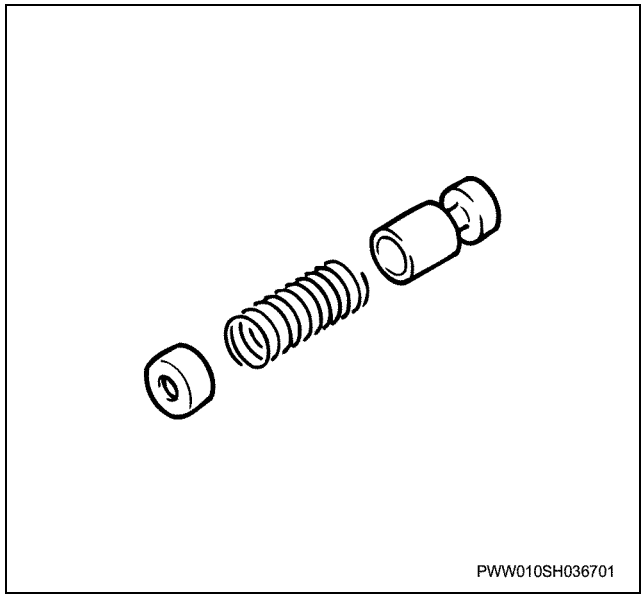


8. Remove the oil pump cover.
9. Remove the driven gear.
10. Remove the drive gear shaft.
11. Pay special attention to cleaning the inside of the oil pump body.

Inspection

Oil relief valve

- Inspect the oil relief valve and spring for damage.



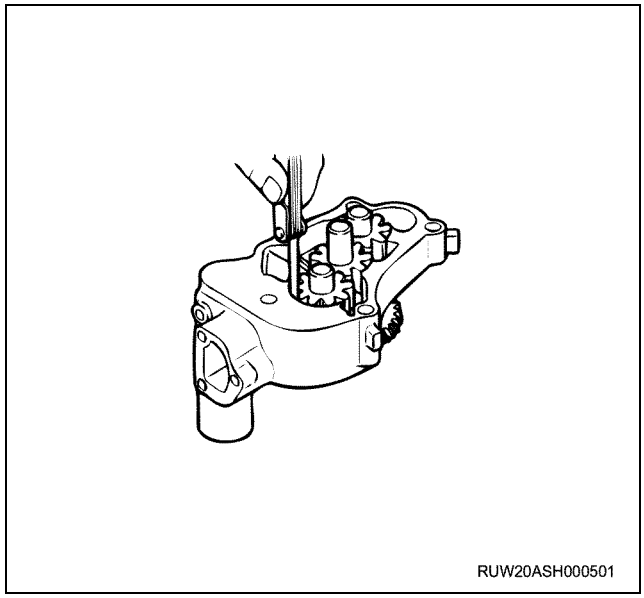
Driven gear

- Measure the clearance between the pump body wall and gear.

Clearance between body wall and gear

Standard:	0.050 ~ 0.098mm

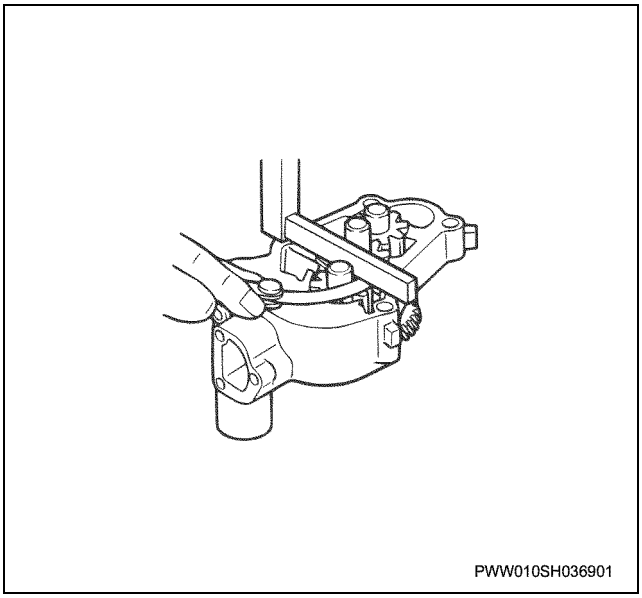
Measure the clearance with the driven gear in the same way.



- Measure the clearance between the oil pump cover and gear.

Clearance between cover and gear

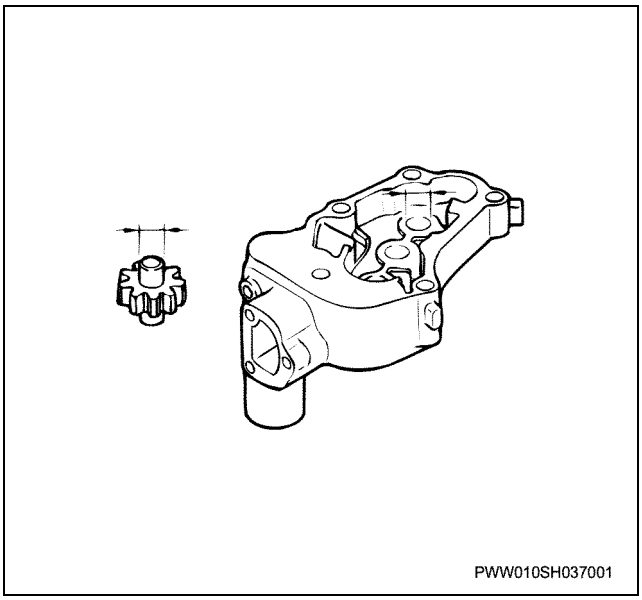
Standard:	0.040 ~ 0.094 mm


PWW010SH036901

- Measure the outer diameter of the driven gear shaft and clearance between the shaft and pump body.

	Nominal dimension mm	Selection of a reference point mm	Limit mm
Shaft outer diameter	ϕ20	—	ϕ19.9
Clearance between shaft and pump body	—	0.04 ~ 0.074	—

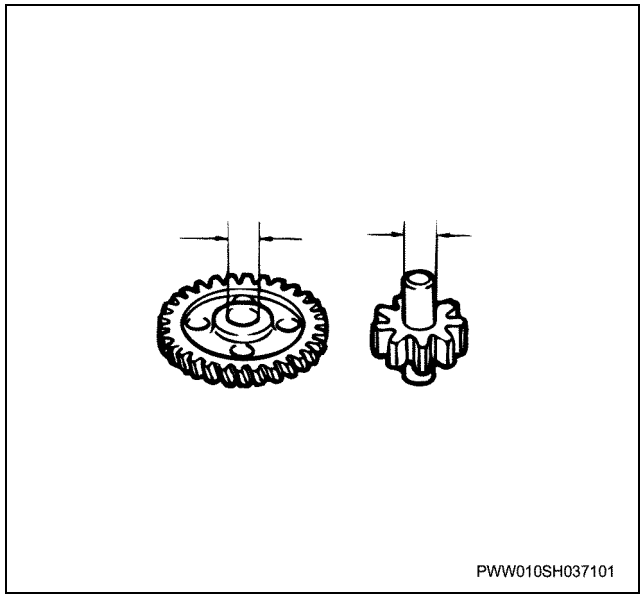
Measure the outer circumference and clearance of the drive gear side in the same way.


PWW010SH037001

- Measure the interference of the shaft and drive gear.

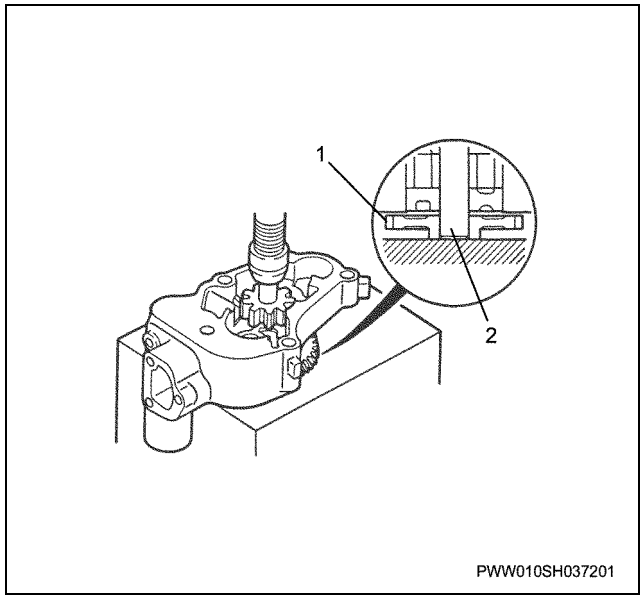
Interference

Standard:	0.019 ~ 0.047mm


PWW010SH037101

Assembly

1. Apply a small amount of engine oil to the oil pump body wall.
2. Apply engine oil to the drive gear shaft and insert into the body.
3. Install the oil pump drive gear.
   - Turn the drive gear in the same direction as shown in the diagram, and force it with a press until the gear end face is the same flat surface as the shaft head side.

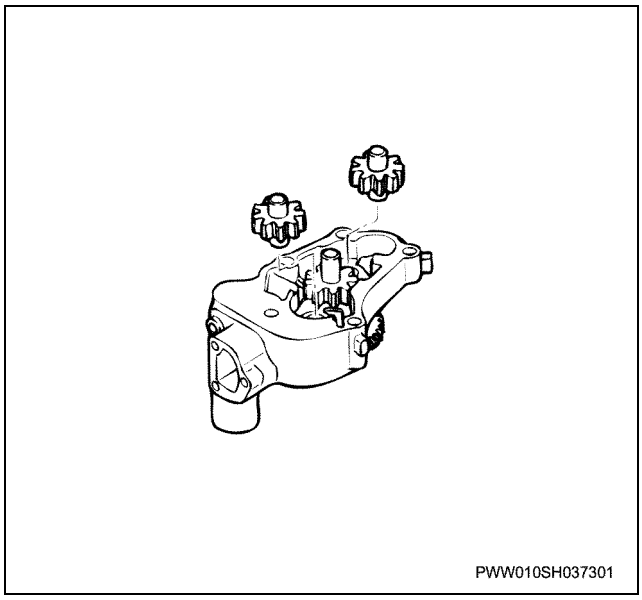


PWW010SH037201

Legend

1. Drive gear
2. Drive gear shaft

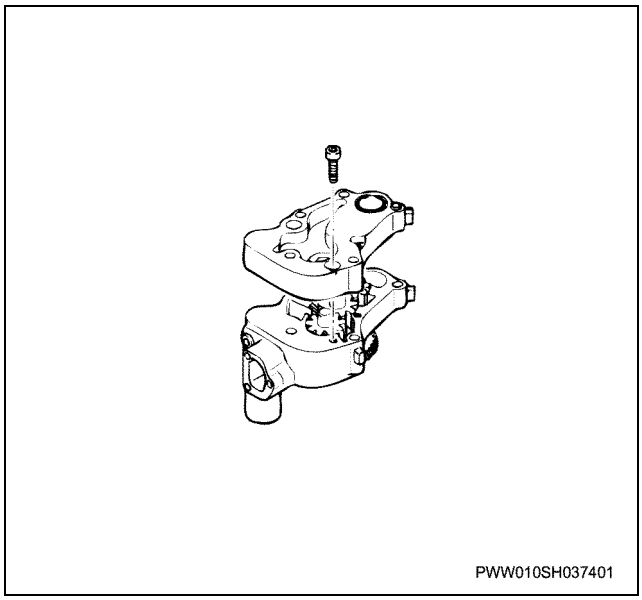
4. Apply engine oil to the driven gear and install it to the pump body.



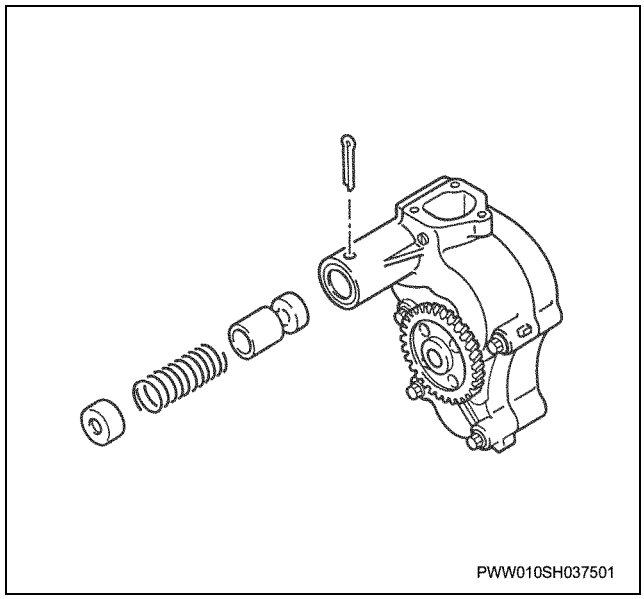
5. Install the oil pump cover.

Tightening torque

M10:	39 N·m {4.0 kgf·m}
M8:	18 N·m {1.8 kgf·m}



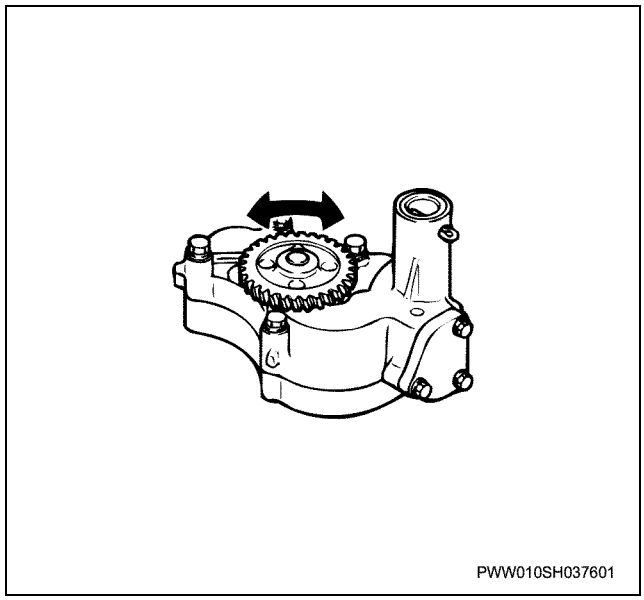
6. Apply oil to the oil relief valve and install it.
7. Apply oil to the spring and install it.
8. Apply oil to the spring seat and install it.
9. Install the split pin and fix each of the parts.



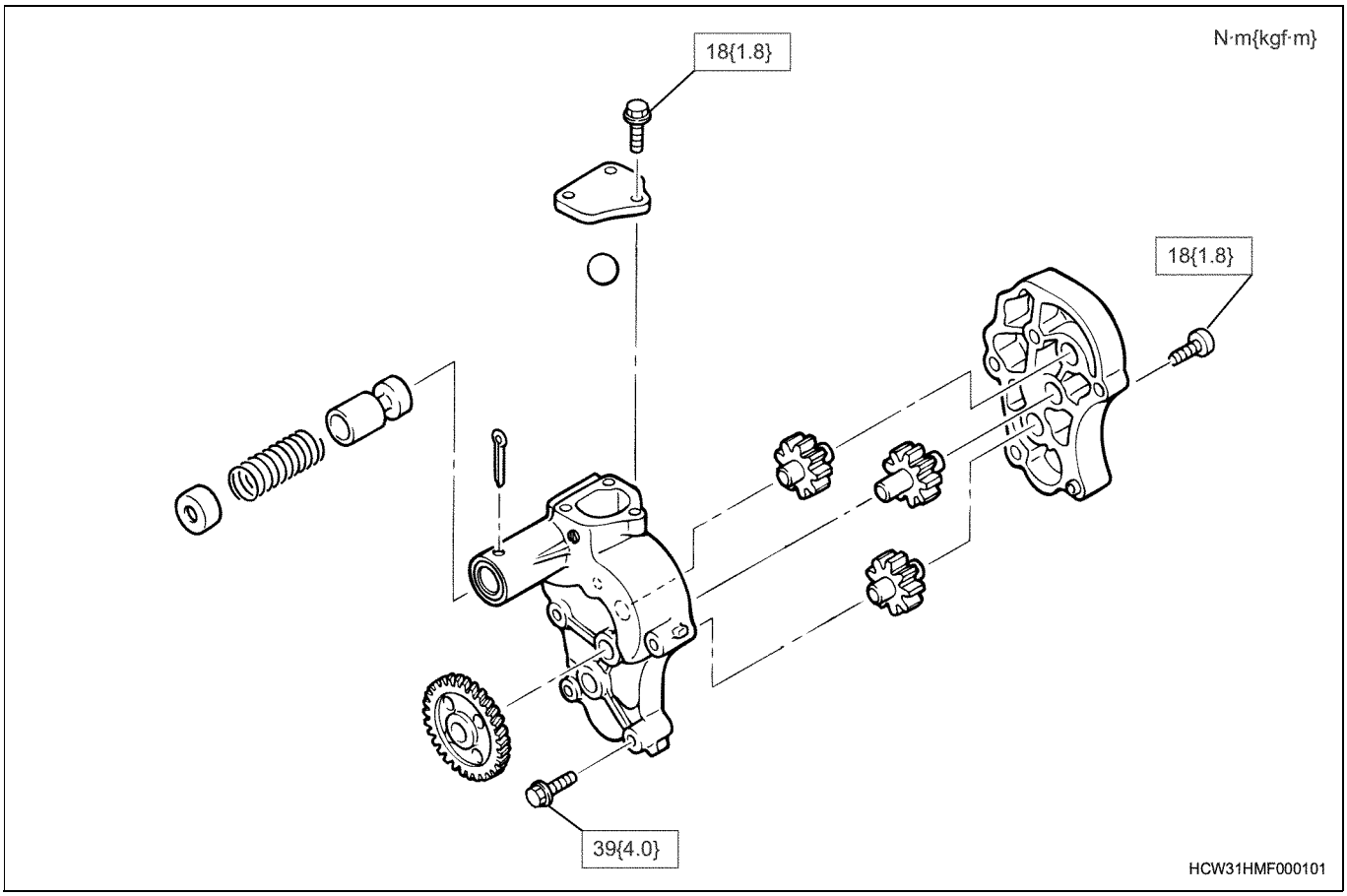
10. Insert the ball.
11. Install the cover.

Oil pump operational checks

- After completing the re-assembly, rotate the drive gear by hand and check that it operates smoothly.

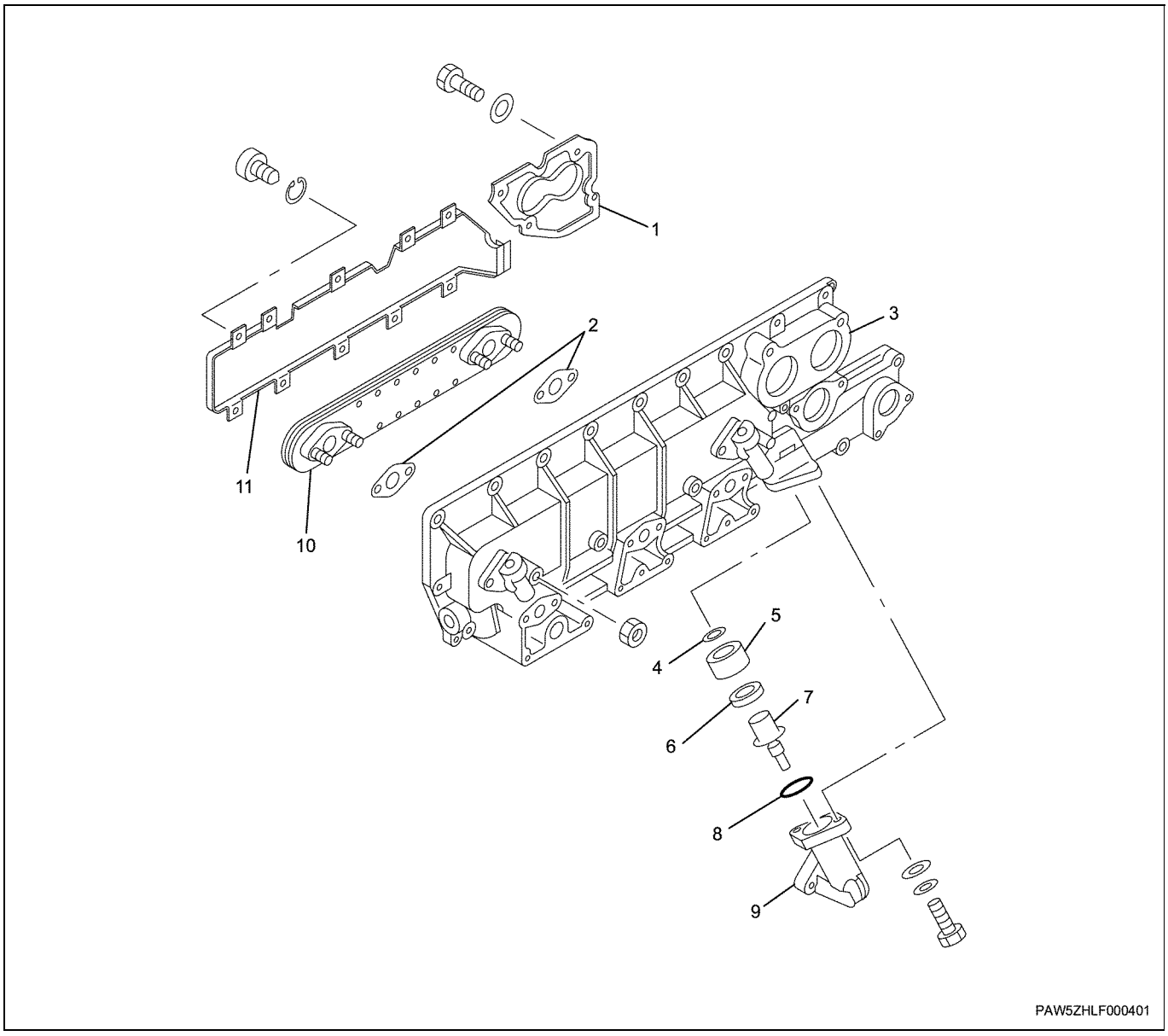


Torque specifications



Oil cooler

Component parts



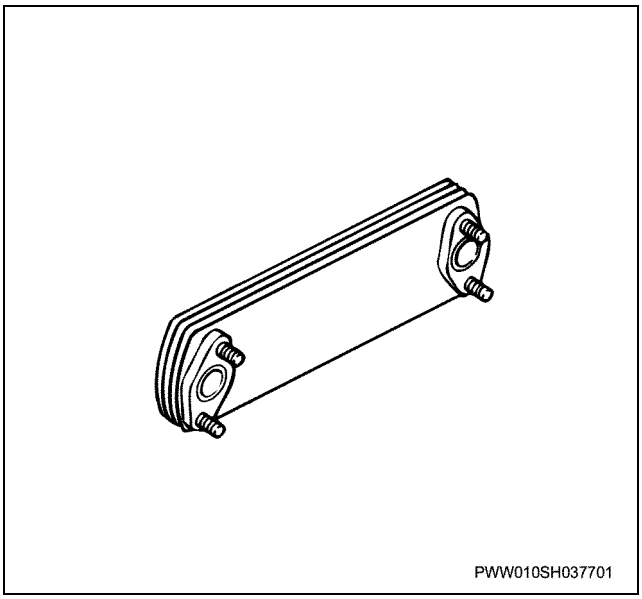
Legend

1. Cover
2. Gasket
3. Body Case
4. Seal ring
5. Oil thermo valve support
6. Clearancer
7. Oil thermo valve
8. O-ring
9. Oil pipe
10. Oil cooler element
11. Water guide

Disassembly

1. Remove the cover.
2. Remove the water guide.

3. Remove the oil cooler element.



Oil cooler element cleaning

- Pour cleaning fluid into the element and soak the inside for approx. 10 hours. After that remove approx. 1/3 of the cleaning fluid, then eject the rest from the oil port by blowing through approx. 196 Kpa {2 kgf/cm^2} of compressed air. This operation can be repeated a number of times depending on how dirty the element is.

Caution:
Fire is strictly prohibited near the cleaning fluid. Masks and protective glasses must be worn, and the work must not be carried out in a closed room.

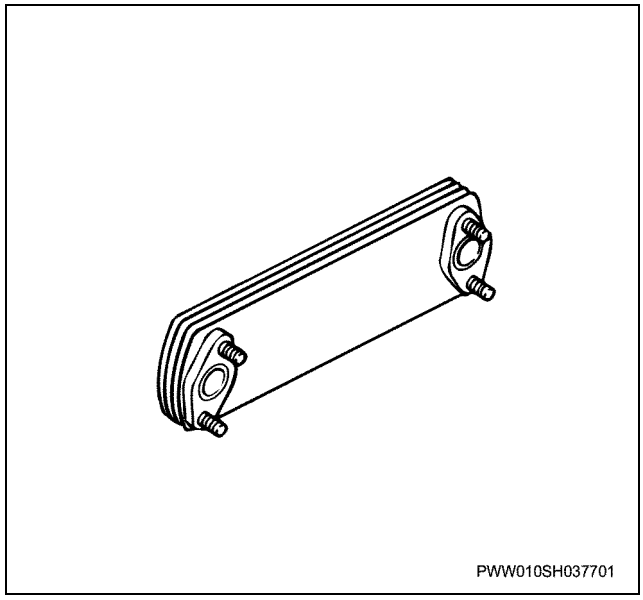
	Using undiluted solution	Using diluted with light oil (white spirit)
Hi-aromu 2S (New Nippon Oil)	○	—
Suwazoru 310 (Maruzen)	○	—
Hi-zoru (Showa)	○	—
Mobile Zol A (Mobil Sekiyu)	—	○

4. Remove the gasket.
5. Remove the oil pipe.
6. Remove the O-ring for the oil pipe.
7. Remove the oil thermo valve.
8. Remove the clearancer.
9. Remove the oil thermo valve support.
10. Remove the seal ring.
11. Clean the wall of the body case and inspect for corrosion etc.

Inspection

Oil cooler element

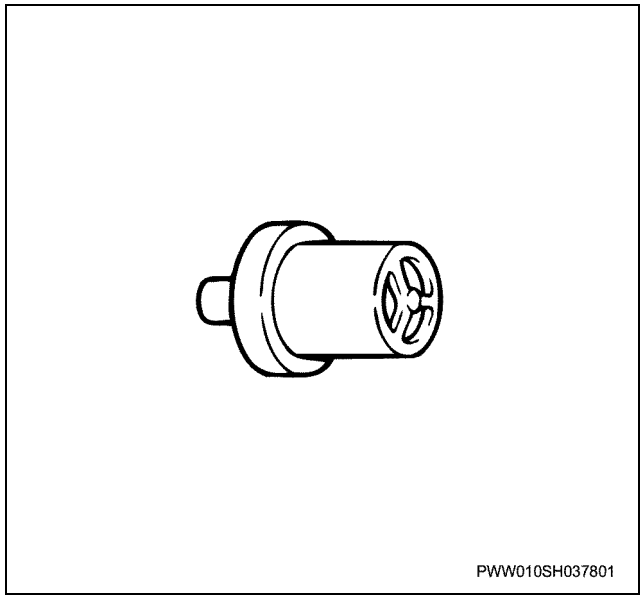
- Inspect the oil cooler element for cracks.
- Perform red check method inspections whenever necessary.



Oil thermo valve

- Inspecting the oil thermo valve for blockages/ damage
  Inspect the piston and valve seat surface for wear or damage.
  Also, inspect the spring for damage and weakness.
- Oil thermo valve operational checks
  Inspect whether the valve opens at 98°C.

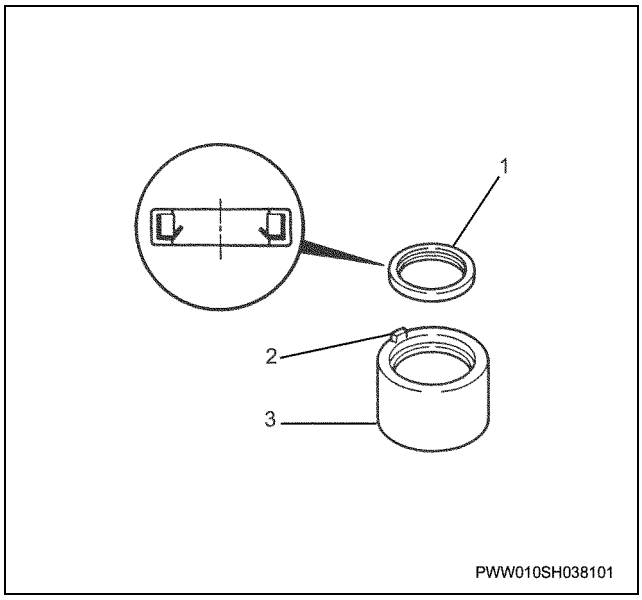
Oil thermo valve opening temperature: 98°C



Assembly

1. Set the body case.

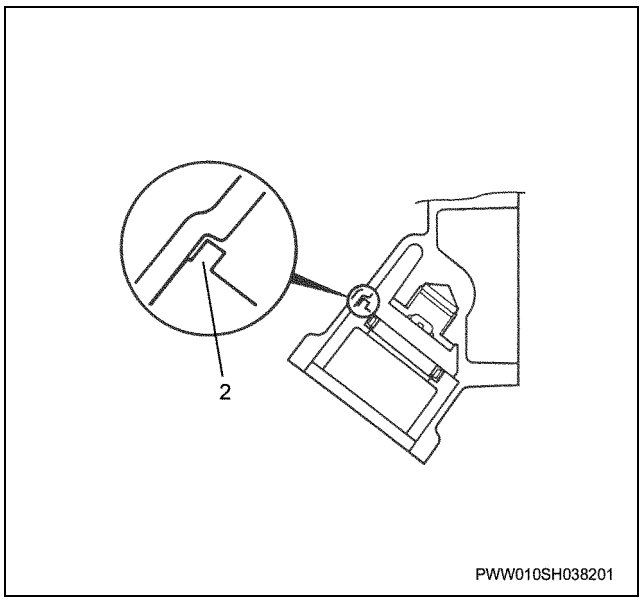
2. Pay attention to the direction of the seal ring when installing it.



Legend

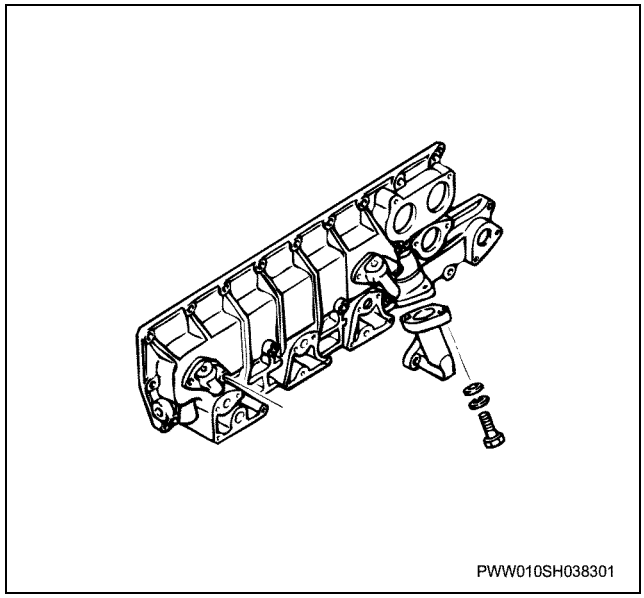
1. Seal ring
2. Anti-rotation stopper
3. Oil thermo valve support

- Line up the anti rotation stopper section and install the oil thermo valve.



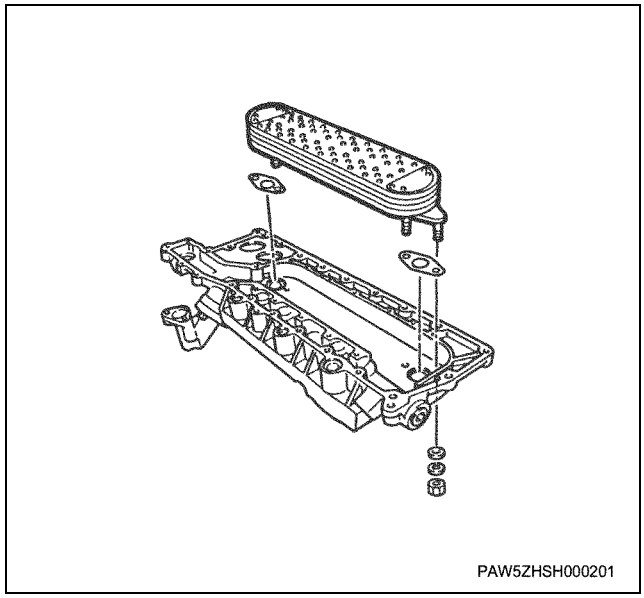
3. Install the oil thermostat support.
4. Install the clearancer.
5. Install the oil thermostat.
6. Install the O-ring to the oil pipe.
7. Install the oil pipe and tighten the bolts.

Correct tightening torque: 37 N·m {3.8 kgf·m}



8. Install the gasket to the oil cooler element.
9. Install the oil cooler element and tighten the nuts.

Correct tightening torque: 25 N·m {2.5 kgf·m}



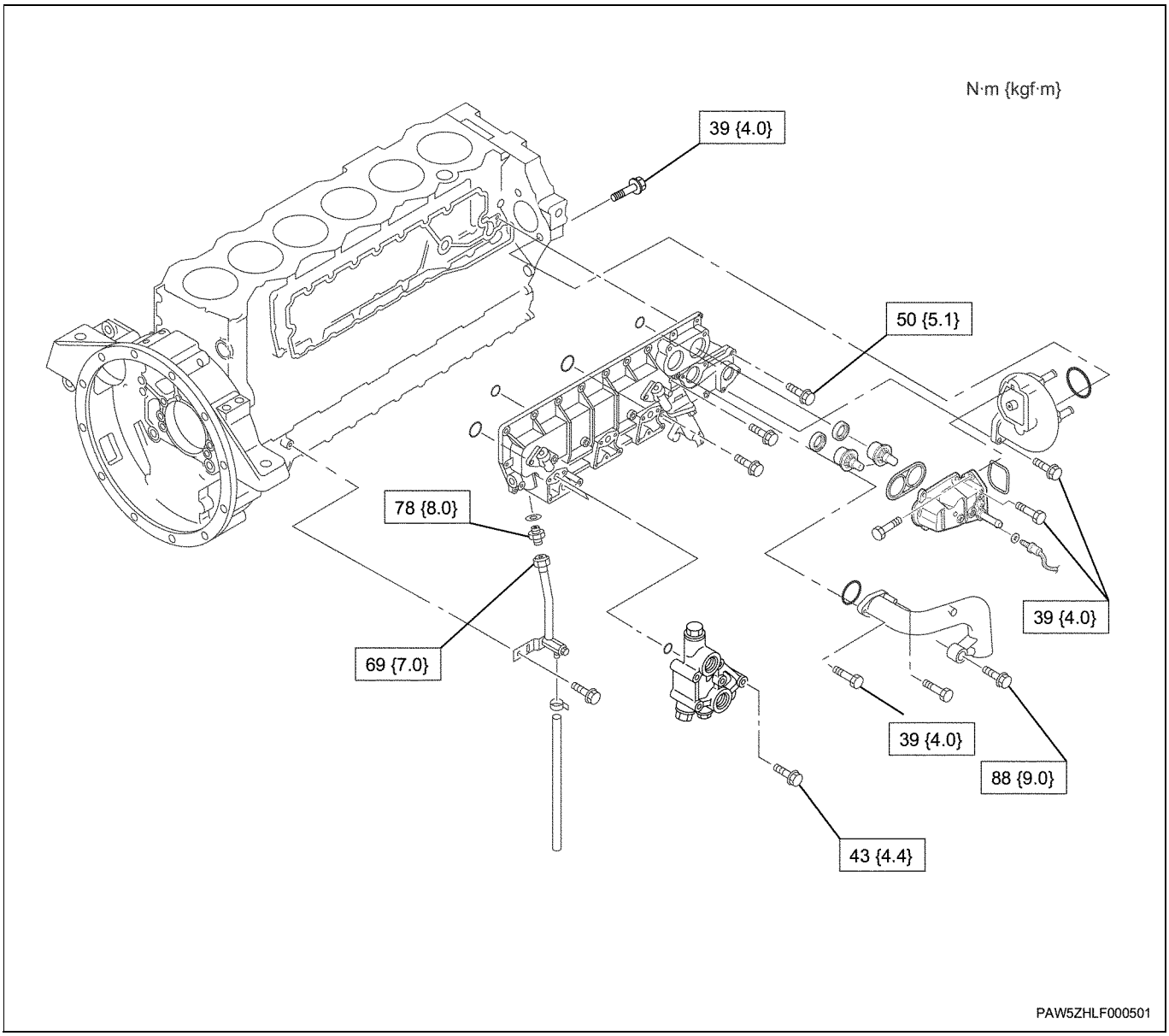
10. Install the water guide and tighten the screw.

Correct tightening torque: 4 N·m {0.4 kgf·m}

11. Install the cover and tighten the bolts.

Correct tightening torque: 18 N·m {1.8 kgf·m}

Torque specifications



Disassemble and Assemble Engine

Intake system
(6WG1 (Common rail))

Contents

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Service Precautions 1J-2
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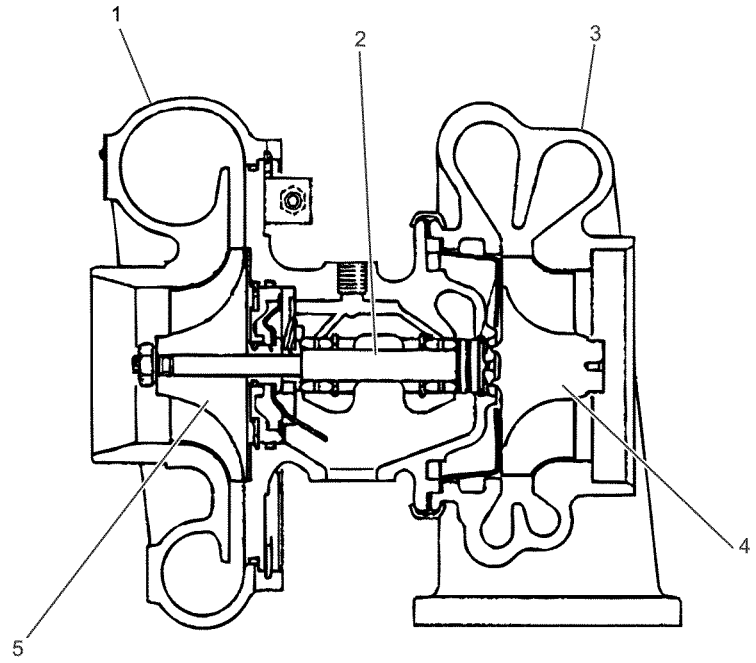
Turbocharging system

Service Precautions

- The turbocharger has been completed to a very precise specification (approx. 100,000rpm) and therefore cannot be disassembled. If a fault is discovered, the turbocharger ASM must be replaced.
- When removing or installing the turbocharger, seal the turbine housing, compressor housing, and oil supply intake and outlet to prevent dust particles getting inside.
- When replacing the turbocharger and after installing the new turbocharger, inject 3~5cc of engine oil before installing the oil pipe.

Explanation of functions and operations

Turbocharger structural drawing



PAW5ZGMF000101

Legend

1. Compressor cover
2. Shaft
3. Turbine housing
4. Turbine wheel
5. Compressor wheel

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

If faults or vibrations occur

Condition	Probable cause	Correction
If faults or vibrations occur	The cause is bearing failure and contact between the revolving section and its surroundings Bearing failure is caused by: Neglecting oil changes, dust particles in the feed pipe, clogged oil filter, driving when the engine has a failure, and repeated sudden starts and stops.	Inspection and repair
	If there are no faults in the lubricating system, and damage due to the revolving section making contact with its surroundings is discovered, it is possible to assume that either a loss of balance in the revolving section or bent shaft is the cause. This is probably because a worn-out bearing was used, or because dust particles have gotten into the turbine wheel or compressor wheel and caused damage	Inspection and repair

When the turbocharger is thought to be mainly fine but output power is low

Condition	Probable cause	Correction
When the turbocharger is thought to be mainly fine but output power is low	Gas leakage from various parts of the exhaust	Repair or replace
	Distortion of the exhaust pipe silencer, excessive exhaust resistance due to carbon build-up	Repair or replace
	Air leakage from the compressor discharge side, dirty air cleaner	Clean or replace
	Compressor internal section dirty	Clean
	Rotor shaft section dirty	Disassemble and clean

Oil is leaking in the exhaust pipe or intake pipe, exhaust gas is white

Condition	Probable cause	Correction
Oil is leaking in the exhaust pipe or intake pipe Exhaust gas is white	Oil is raising up due to dirty or clogged oil separator	Clean or replace
	Oil drainage pipe blocked, crushed, or deformed	Repair or replace
	Worn piston ring, or too much abrasion of the ring slots	Replace
	Bad bearing is the cause for piston ring section damage	Repair or replace
	Breather hose blocked, crushed, or deformed	Repair or replace
	Intake duct crushed or deformed	Repair or replace
	Air cleaner blocked	Replace the element

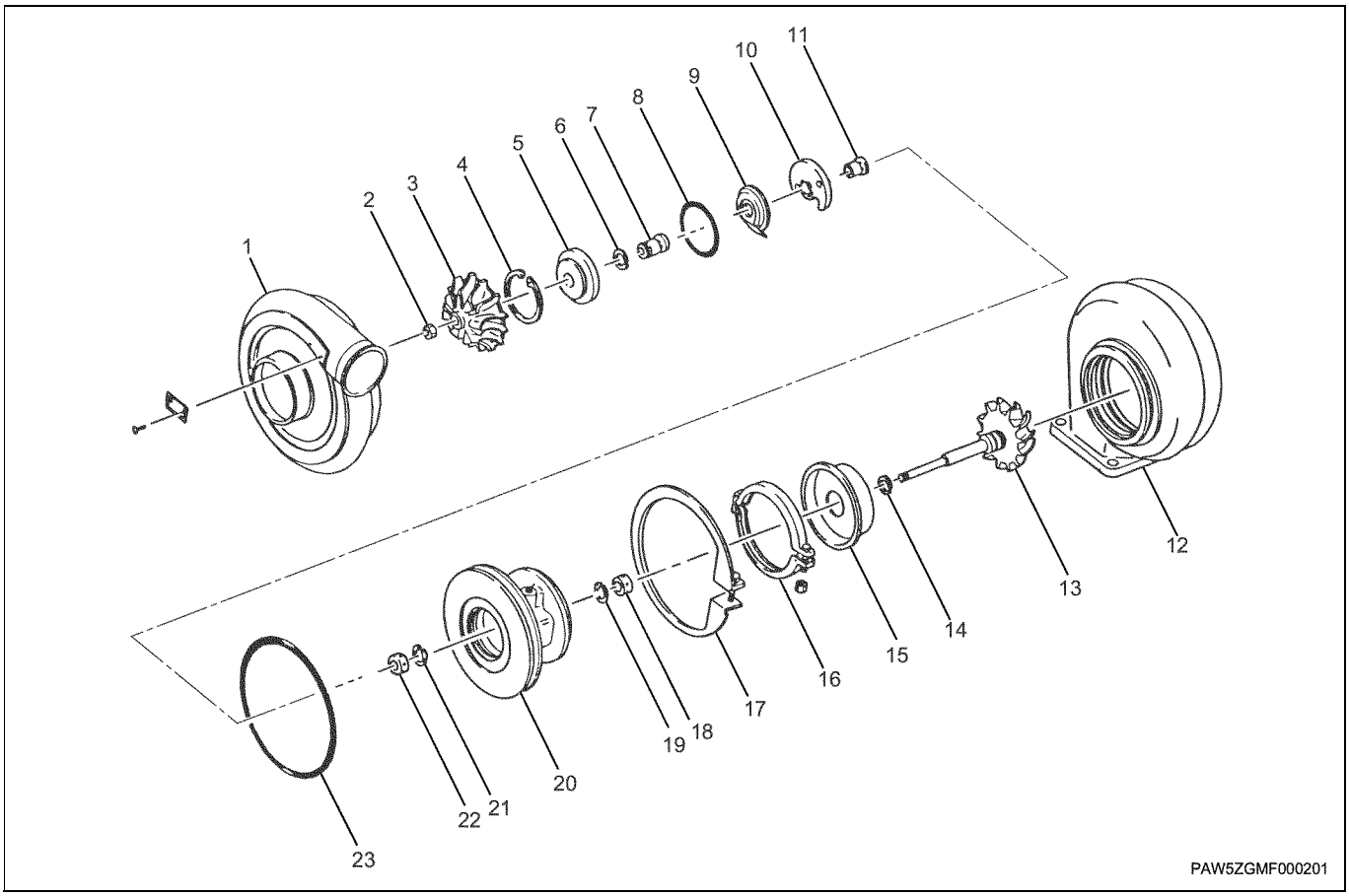
Main data and specifications

Maintenance standard table

Maintenance items	Name value mm	Standard [ ] Internal standard mm	Notes
Shaft orientation play		[0.075 ~ 0.115]	

Turbocharger

Component parts



Legend

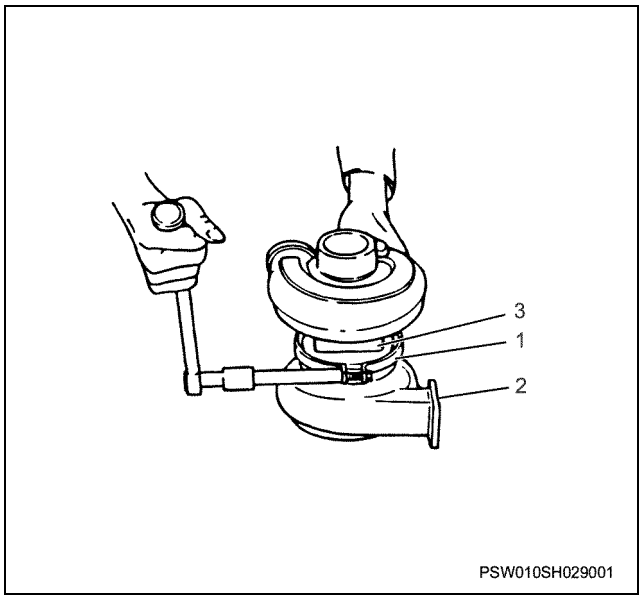
1. Compressor cover
2. Nut
3. Compressor wheel
4. Snap ring
5. Insert
6. Piston ring
7. Thrust sleeve
8. O-ring
9. Oil deflector
10. Thrust bearing
11. Thrust ring
12. Turbine housing
13. Shaft & turbine wheel
14. Piston ring
15. Turbine back plate
16. Coupling ASM
17. Snap ring
18. Bearing
19. Snap ring
20. Bearing housing
21. Snap ring
22. Bearing
23. O-ring

Disassembly

Caution:
Take care not to drop or knock the compressor wheel or turbine wheel during the time from disassembly to reassembly, because the blades of these parts are bent easily.

Caution:
When re-assembling, the relationships between the positions of the compressor cover, bearing housing, and turbine housing are very important. Always use a punch or marker pen to mark where the parts line up with each other.

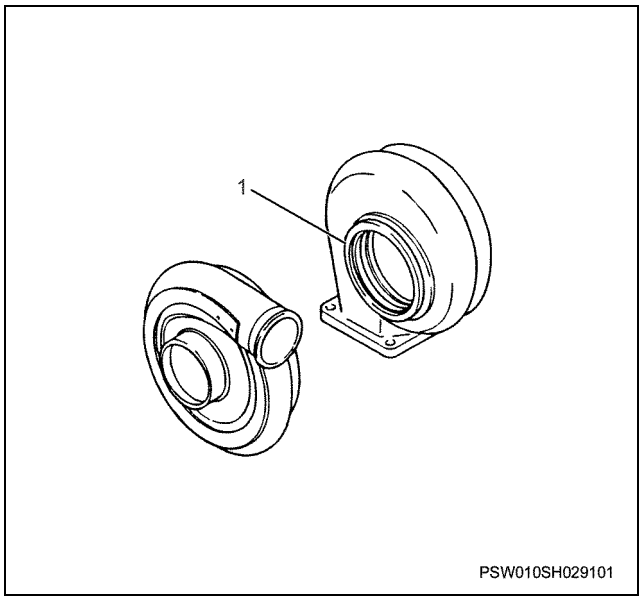
1. Remove the coupling ASM.



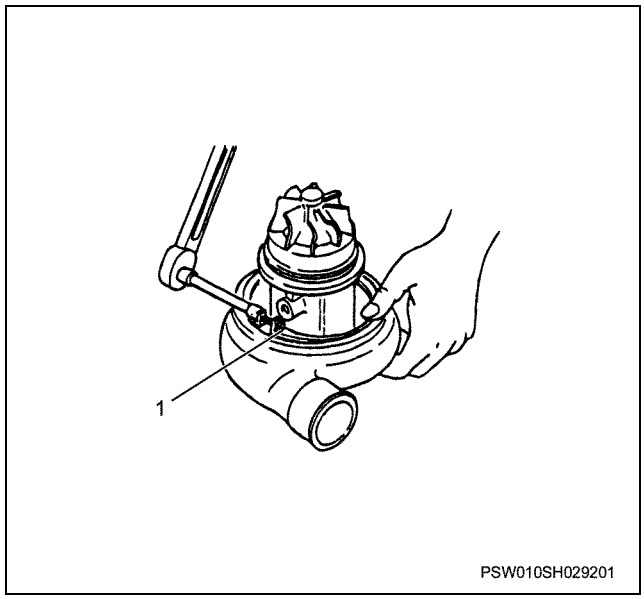
Legend

1. Bearing housing
2. Coupling ASM
3. Turbine housing

2. Remove the turbine housing (1).

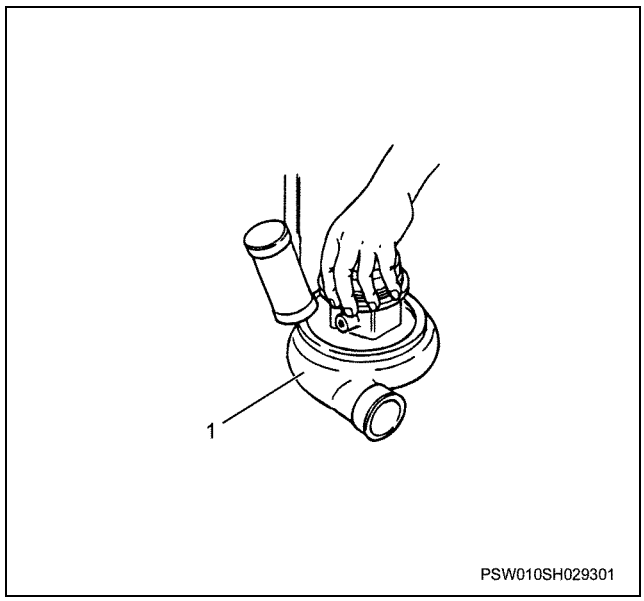


3. Unfasten the snap ring (1).

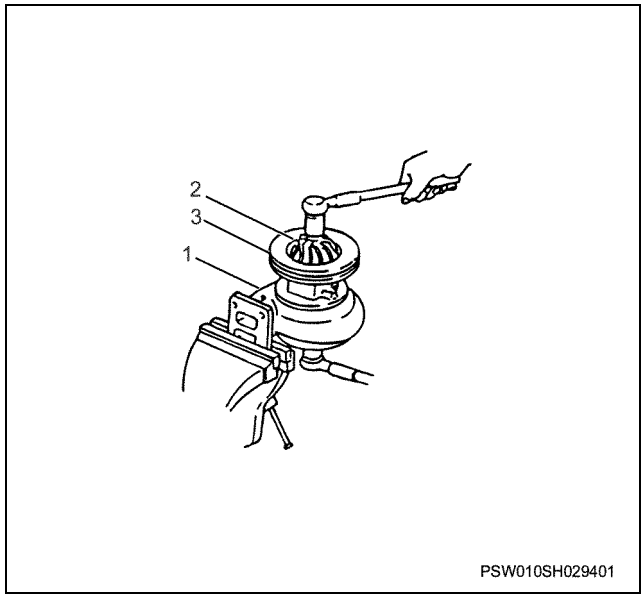


4. Remove the compressor cover (1) by gently tapping around its circumference with a plastic hammer or similar tool.

Caution:
Make sure that the compressor wheel doesn't hit the compressor cover.



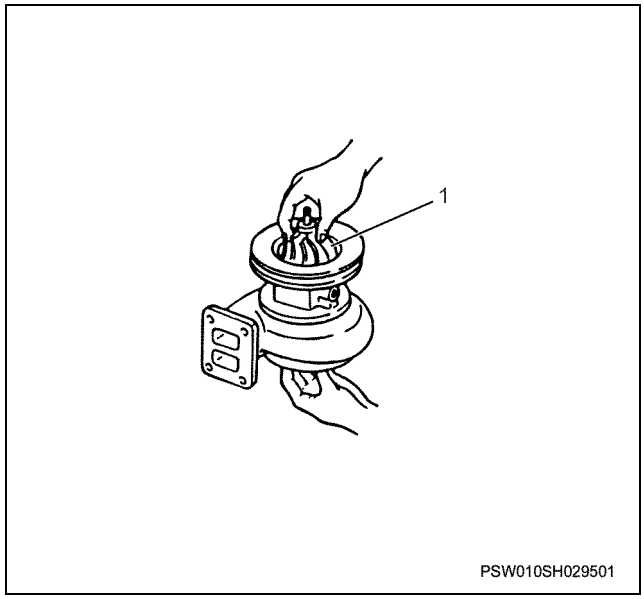
5. Remove the nut.
   - Hold the turbine housing in a vice, and insert the bearing housing into the turbine housing. Press the shaft & turbine wheel boss with a 17 mm box, and use a 14 mm box to remove the locknut that is fixing the compressor wheel.



Legend
1. Turbine housing
2. Compressor wheel
3. Bearing housing

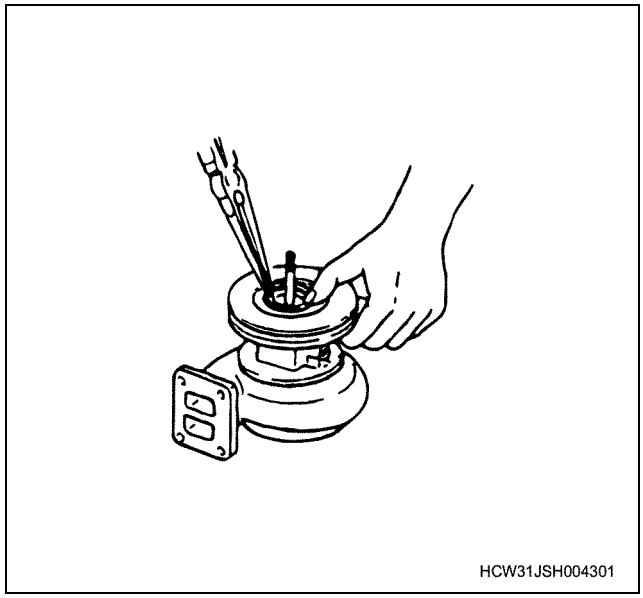
6. Remove the compressor wheel (1).
   - Hold the turbine wheel with one hand, and gently rotate the compressor wheel with the other hand to remove it.

Caution:
Do not attempt to repair bent blades or blades that have many scratches etc. Replace them with new parts.



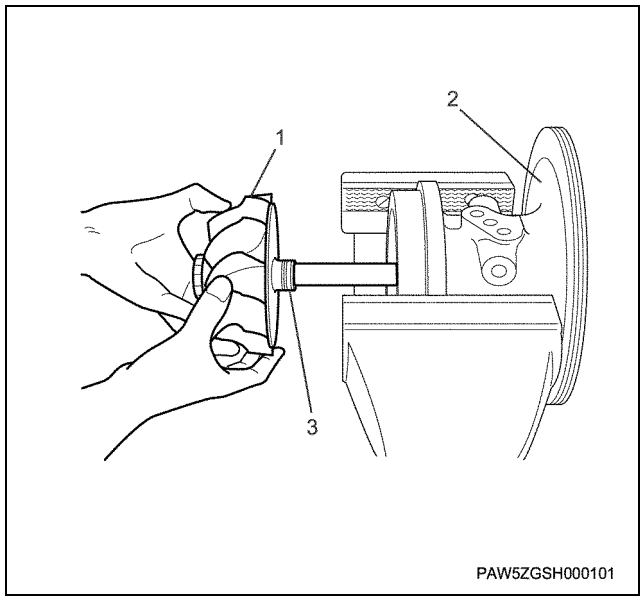
7. Use snap ring pliers to remove the snap ring.

Caution:
Just in case the snap ring pliers slip off the snap ring, cover with your hand to stop the snap ring from flying-off and getting lost.



8. Extract the shaft and turbine wheel from the bearing housing.

Caution:
Do not attempt to repair bent blades or blades that have many scratches etc. Replace them with new parts.



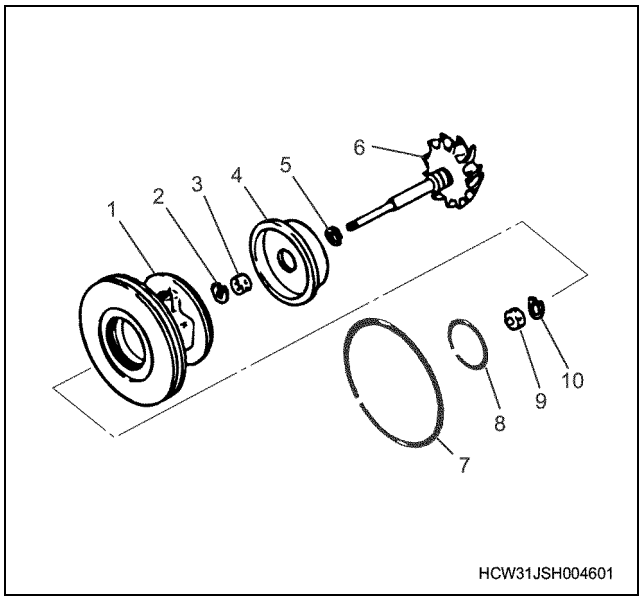
Legend
1. Turbine wheel
2. Bearing housing
3. Piston ring

9. Remove the insert.
   - Use two screwdrivers to gently extract the insert from the bearing housing, then remove the next component.
10. Remove the piston ring.
11. Remove the oil deflector.
12. Remove the thrust sleeve.
13. Remove the thrust ring (C).

14. Remove the thrust bearing.
15. Remove the thrust ring (T).
16. Remove the piston ring from the shaft & turbine wheel.
17. Remove the turbine back plate.

Remove the following parts from the bearing housing.

18. Remove the bearing.
19. Remove the snap ring.
20. Remove the bearing housing.
21. Remove the O-ring.
22. Remove the O-ring.

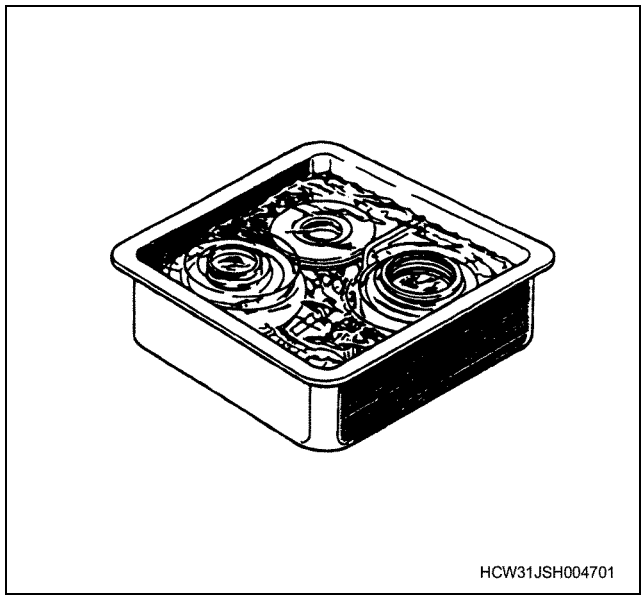


Legend

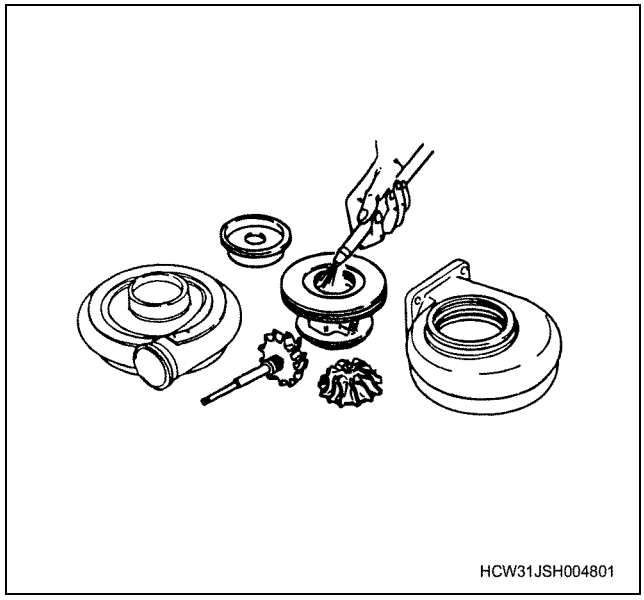
1. Bearing housing
2. Snap ring
3. Bearing
4. Turbine back plate
5. Piston ring (T)
6. Shaft & turbine wheel
7. O-ring
8. O-ring
9. Bearing
10. Snap ring

Cleaning

1. Visually inspect all of the parts before cleaning, and examine any discoloring or scratches that may become difficult to see after cleaning.
2. Soak the disassembled parts in a non-flammable solvent (Daido Chemical Industry CO., Ltd. Dai-cleaner T-30) to remove any oily dirt or carbon from the parts. Do not soak the O-ring, bearing, or thrust bearing.

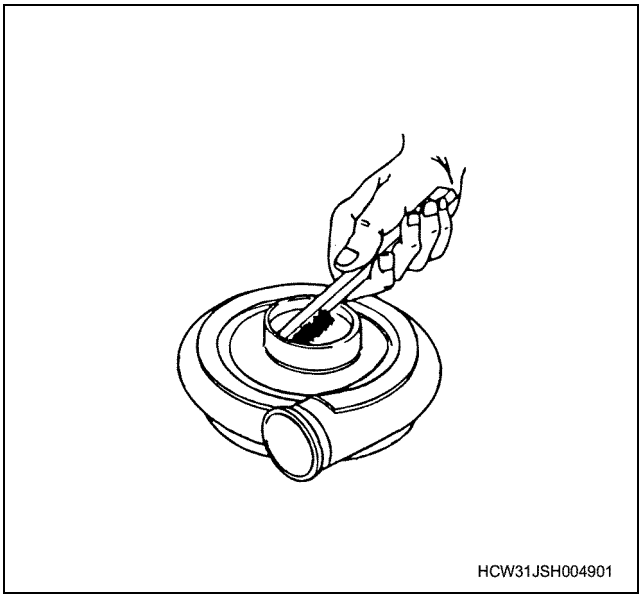


3. Blow all inside and outside surfaces with compressed air.

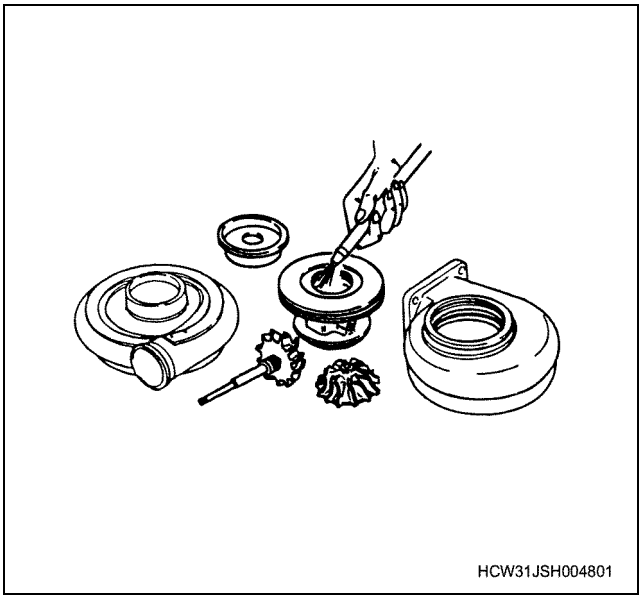


4. Use a plastic scraper or stiff bristled brush to clean off dirt deposits.

Caution:
Do not scratch or damage any of the parts.
When using shot blasting, always cover both sides of the compressor wheel, shaft & turbine wheel screw section, shaft section and ring slot section beforehand, and protect the rear side against becoming rough or weakened.


HCW31JSH004901

5. Blow all inside and outside surfaces again with clean compressed air.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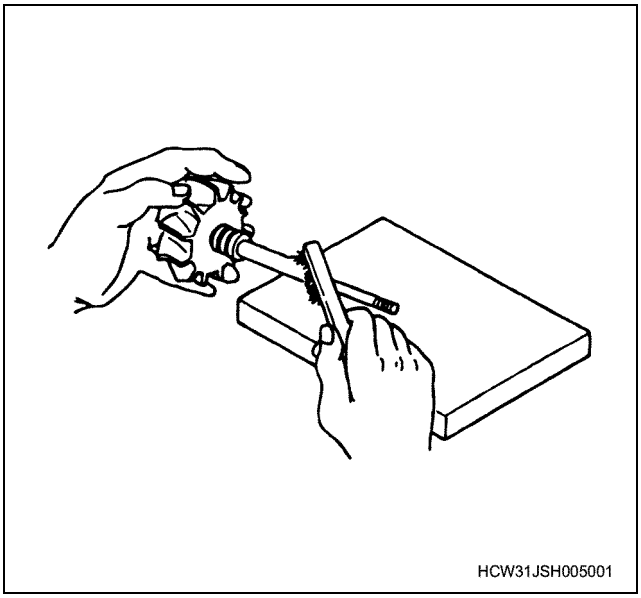
6. Apply clean engine oil to all sliding sections.
   If the thread sections, shaft section, or ring slot section rust, buff the rusty sections to remove the rust. Do not damage the surfaces with the file.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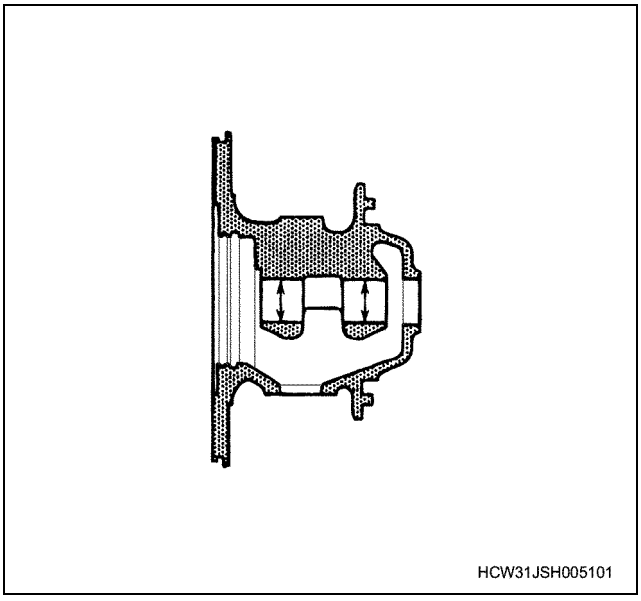
Inspection

Bearing housing

- Measure the internal diameter of the bearing insert section.
  Replace the bearing housing if the measured diameter falls outside the limit value.

Bearing housing inner diameter

Limit:	ϕ20.506 mm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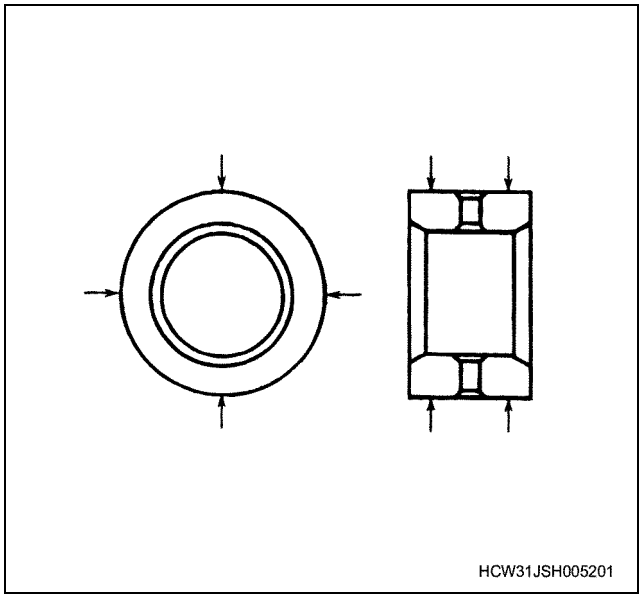
Bearing

- Measure the external diameter of the bearing.
  Replace the bearing if the measured diameter is below the limit value.

Bearing outer diameter

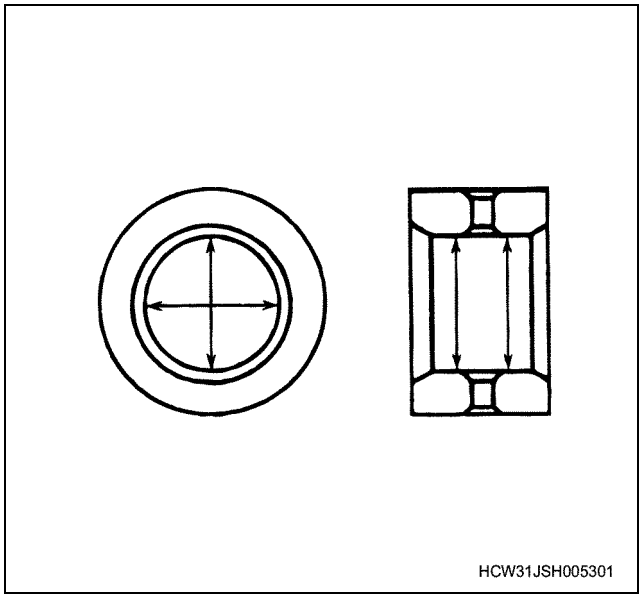
Limit:	ϕ20.382 mm



- Measure the internal diameter of the bearing.
  Replace the bearing if the measured diameter is larger than the limit value.

Bearing internal diameter

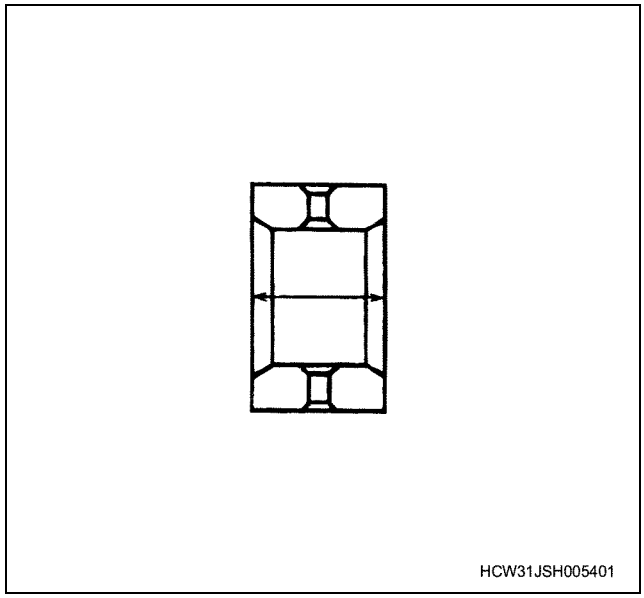
Limit:	ϕ12.042 mm



- Measure the length of the bearing.
  Replace the bearing if the measured length is below the limit value.

Bearing length

Limit:	11.94 mm

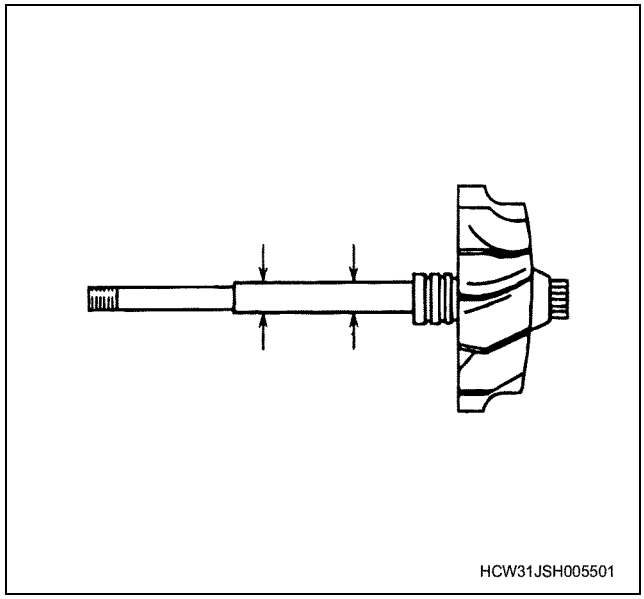


Shaft & turbine wheel

- Measure internal diameter of the shaft and turbine wheel journal section.
  Replace the shaft & turbine wheel if the measured diameter is below the limit value.

Shaft outer diameter

Limit:	ϕ11.996 mm

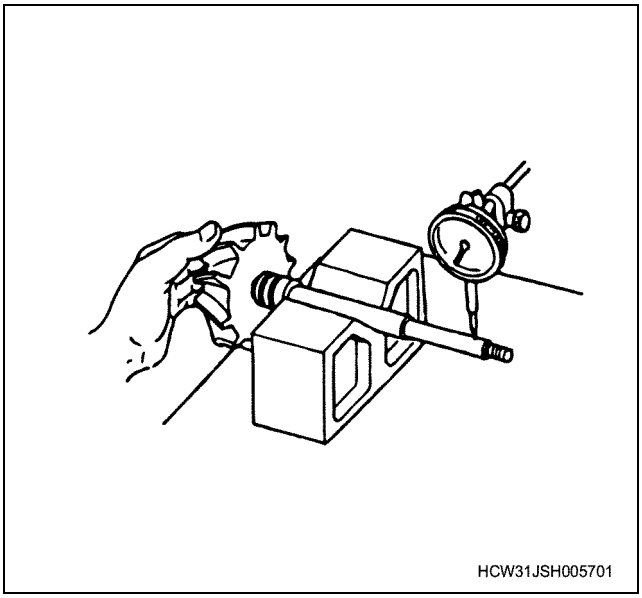


- Set a dial gauge to the immediate width of the shaft thread section and measure the amount of bend.
  Replace the shaft & turbine wheel if the dial gauge runout width is greater than the limit value.

Shaft bend

Limit:	0.015 mm

Caution:
Replace the shaft. Do not attempt to repair the shaft bend.

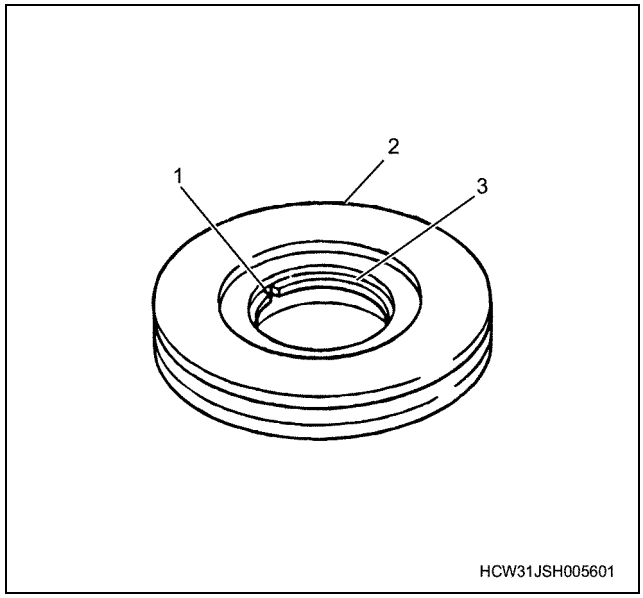


Insert

- 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

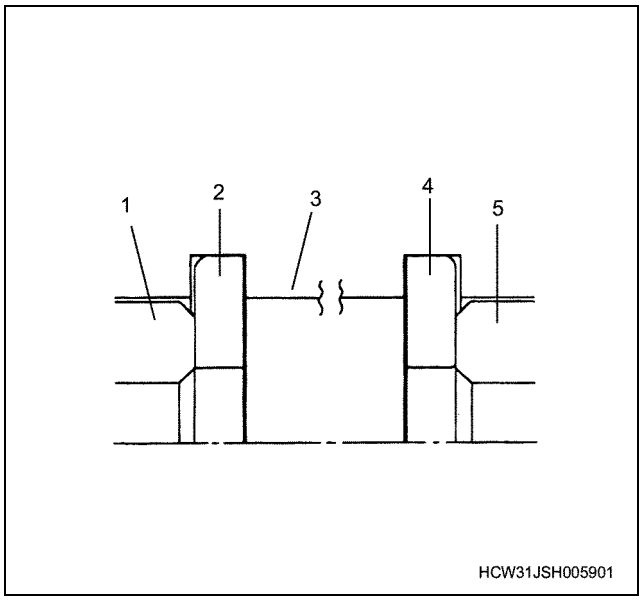
- Piston ring (C)
- Piston ring (T)
- O-ring
- O-ring

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		

Assembly

1. Inspect the bearing housing for dirt, then set it.
2. Install the snap ring.
   - Insert each of the snap rings into the bearing housing, and select the rounder shaped rings to insert first.



Legend

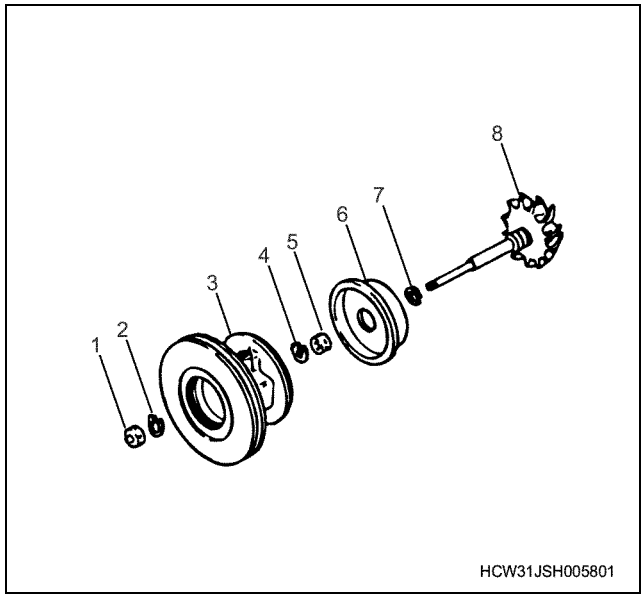
1. Bearing
2. Snap ring
3. Bearing housing
4. Snap ring
5. Bearing

3. Install the bearing.
   - Apply engine oil to the inner and outer surfaces of the bearing and install it.
4. Install the turbine back plate.
5. Install the piston ring to the shaft & turbine wheel.
   - Apply engine oil to the piston ring, and install to the shaft & turbine wheel. Do not allow the oil to become too spread, and do not twist the join section.
6. Install the bearing housing to the shaft & turbine wheel.

Caution:

- **Do not over apply pressure or install to the shaft & turbine wheel when the core is not sticking out. Pressing in with too much pressure will cause damage to the ring and cause the shaft to bend.**
- **Take care not to damage the shaft & turbine wheel blades section.**

8. Install the thrust bearing.

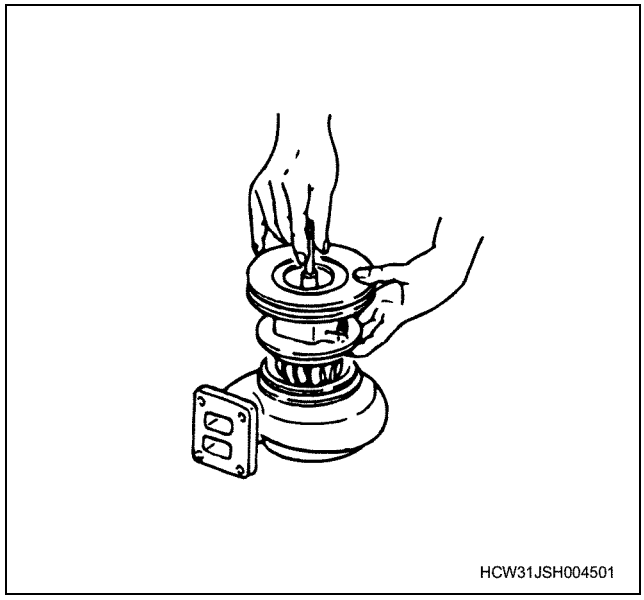


Legend

1. Bearing
2. Snap ring
3. Bearing housing
4. Snap ring
5. Bearing
6. Turbine back plate
7. Piston ring
8. Shaft & turbine wheel

Temporary assembly

- After assembly, temporarily install the bearing housing to the turbine housing, and temporarily tighten the coupling ASM.



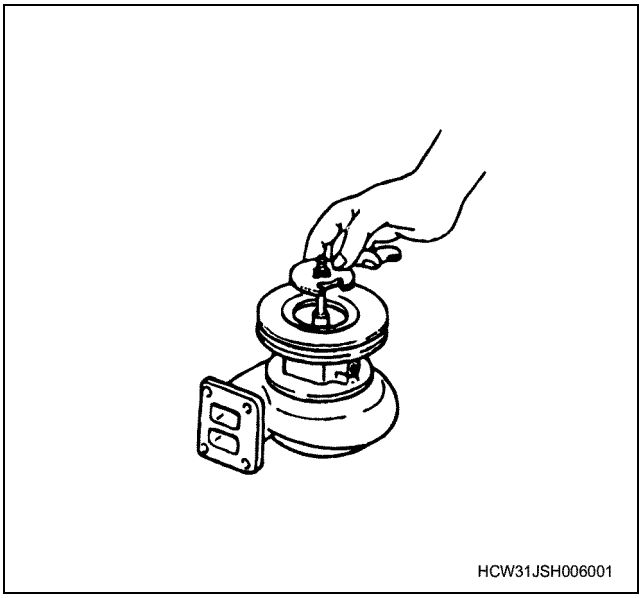
7. Install the thrust ring.

Caution:

- **Wipe the end surface of the thrust ring and both end surfaces of the thrust sleeve with dry tissue paper to completely remove dirt and oil.**

   - Apply engine oil to the inner surface of the thrust bearing and install it.

Caution:
Wipe the layered section of the shaft, and both end surfaces of the thrust ring with dry tissue paper to completely remove dirt and oil.

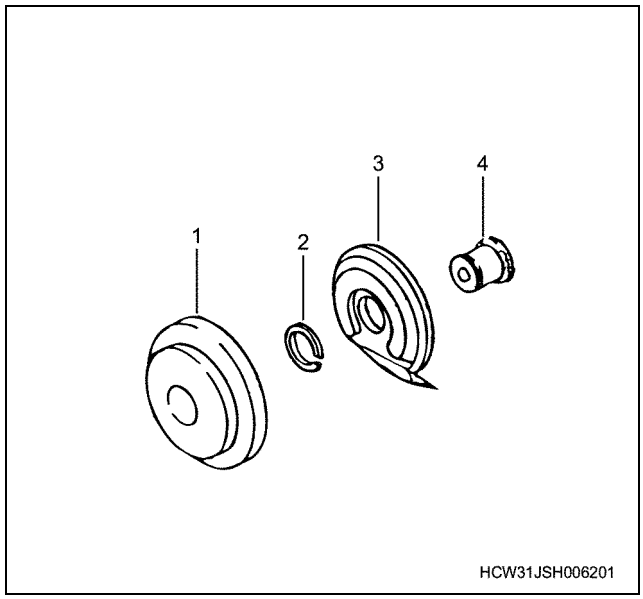


9. Install the oil deflector.
10. Apply grease to the O-ring inside the bearing housing and install it.
11. Install the piston ring to the thrust sleeve.

Caution:

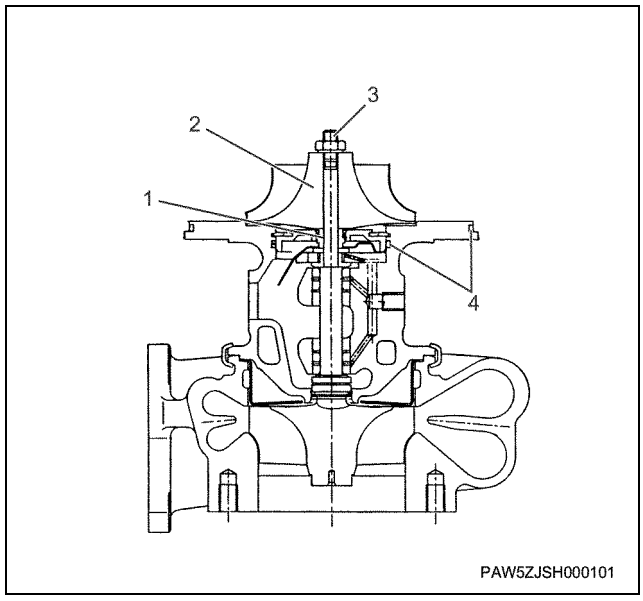
- **When installing the piston ring to the thrust sleeve, do not allow the grease to become too spread, and do not twist the join section.**
- **Apply engine oil to the piston ring installed to the thrust sleeve. Insert the thrust sleeve through the join section first and carefully install it. Take care not to damage or scratch the piston ring.**

12. Install the thrust sleeve to the insert.
13. Install the insert.



Legend

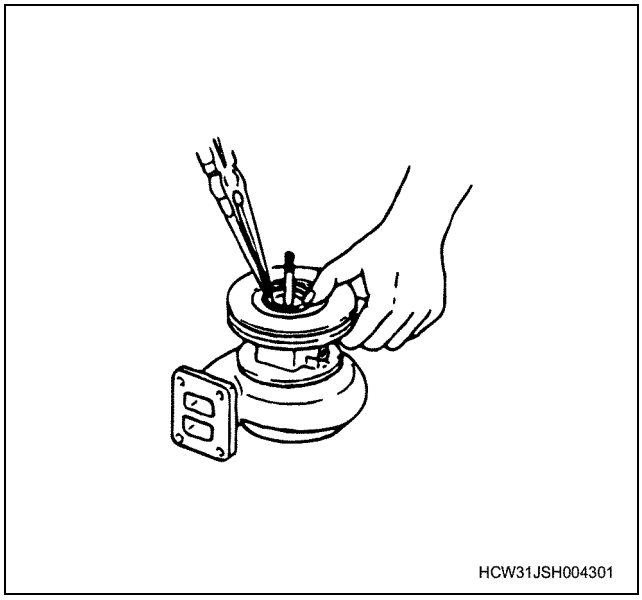
1. Insert
2. Piston ring
3. Oil deflector
4. Thrust sleeve



Legend

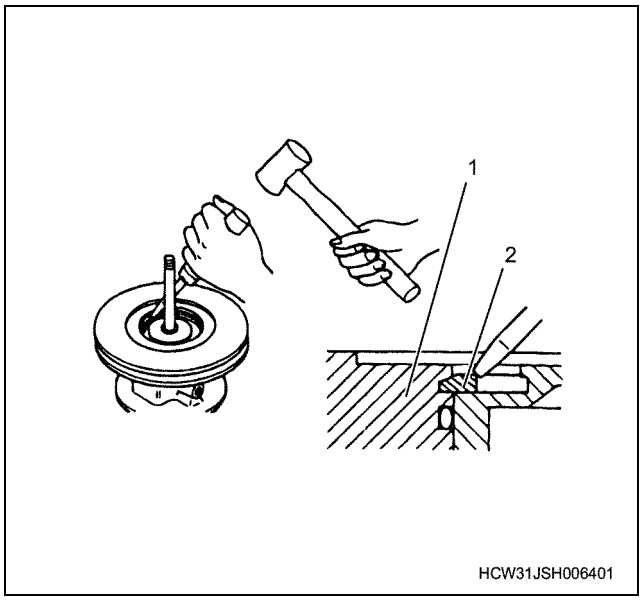
1. Shaft
2. Compressor wheel
3. Nut section molybdenum application
4. O-ring section grease application

14. Install the snap ring.
    - Turn the taper side of the snap ring upwards, and install it to the bearing housing using snap ring pliers.



Caution:

- **Do not make a mistake with the snap rings Installation direction.**
- **Insert the snap ring into the bearing housing slot by gently tapping both division openings with a screwdriver.**
- **When tapping the snap ring with a screwdriver and hammer, be careful not to allow the screwdriver to hit the bearing housing.**



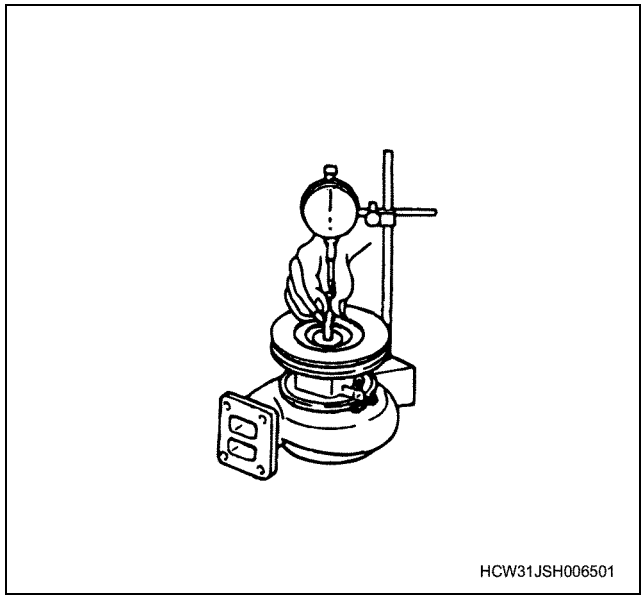
Legend

1. Bearing housing
2. Snap ring

- Set the dial gauge to the shaft & turbine wheel tip. Move the shaft & turbine wheel in the shaft direction and measure the clearance between the shaft & turbine wheel and turbine housing.
- If the measured value is outside of the standard value, disassemble once again and investigate the cause.

Shaft axis direction clearance

Standard clearance:	0.39 ~ 1.0mm



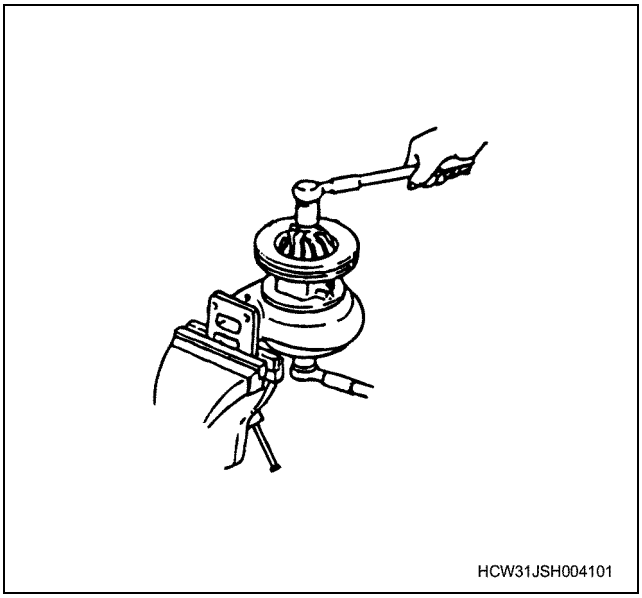
15. Install the compressor wheel.
    - Install the sub-assembled turbine housing to a vice.
    - Wipe the end surface of the thrust ring and both end surfaces of the compressor wheel with dry tissue paper to completely remove dirt and oil.
    - Install the compressor wheel.

Caution:

- **Wipe off all oil from the shaft's compressor wheel fit insert section.**

16. Tighten the nuts.
    - Apply molybdenum disulphide to the thread section of the locknut, and tighten to the correct torque.

Correct tightening torque: 20 N·m {2.0 kgf·m}

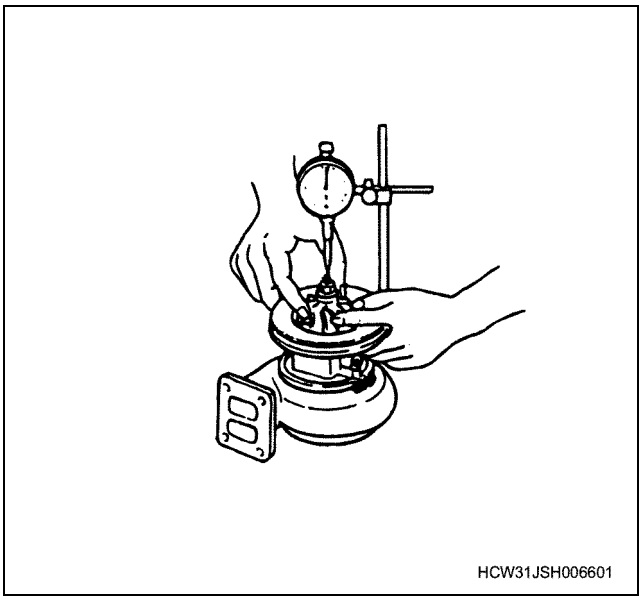


Caution:
The shaft cannot be installed to the compressor wheel after molybdenum disulphide has been applied to the shaft screw section.

- Set the dial gauge to the shaft & turbine wheel tip.
  Move the compressor wheel in the shaft direction and measure the amount of play.
- If the measured play value is outside of the standard value, disassemble once again and investigate the cause.

Shaft axis direction clearance

Standard clearance:	0.075 ~ 0.155 mm

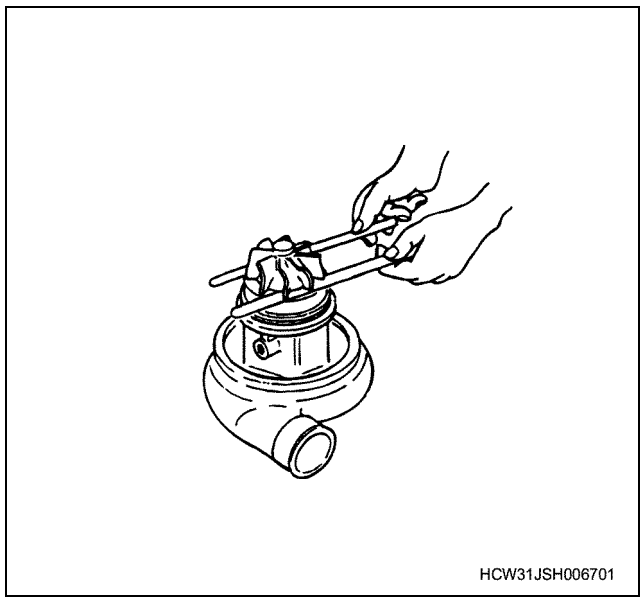


- Remove the turbine housing from the bearing housing, install the compressor cover, and take the following measurements. Using a thickness gauge, measure the clearance between the turbine back plate and rear side of the turbine wheel.
- If the measured value is outside of the standard value, disassemble once again and investigate the cause.

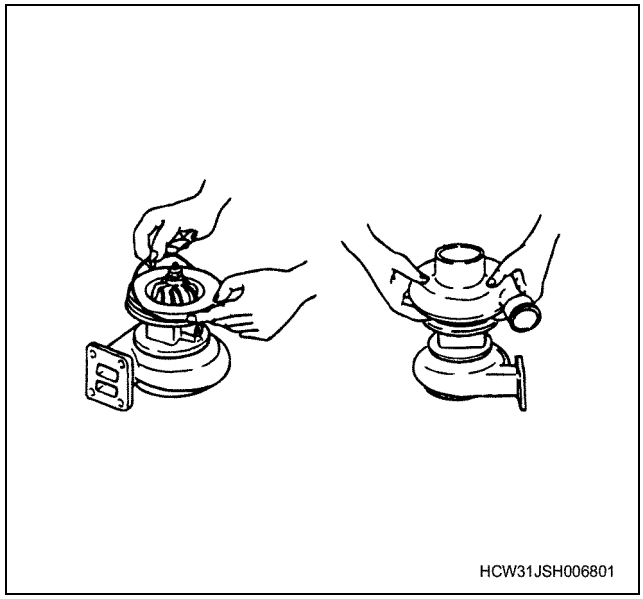
Clearance between back plate and wheel rear side

Standard clearance	0.48 ~ 0.92 mm

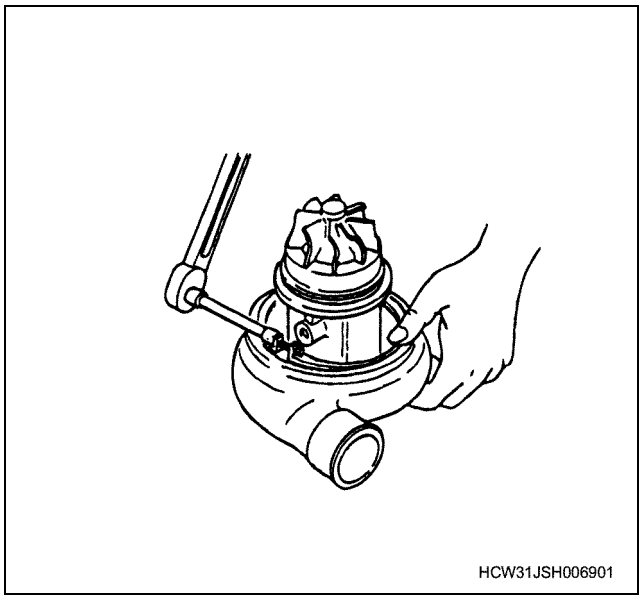
Caution:
Always use 2 thickness gauges, and measure at the tips of the blades.



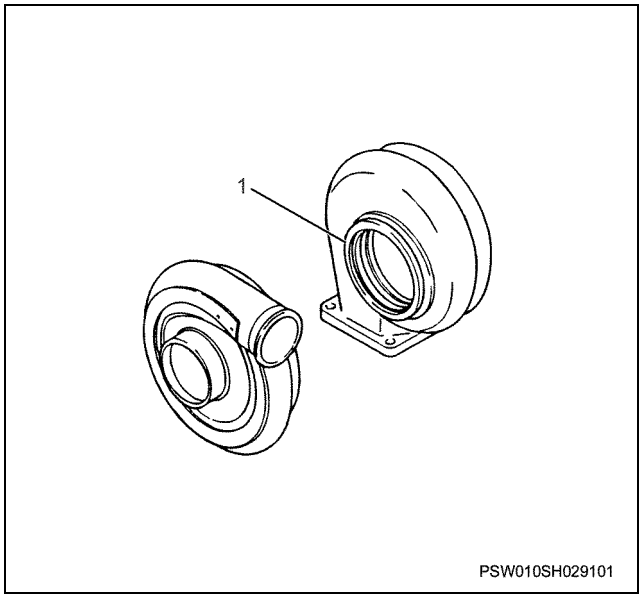
17. Apply grease to the O-ring (bearing case outer circumference) and install it.
18. Check the assembly direction of the compressor cover when installing it.



19. Install the snap ring.

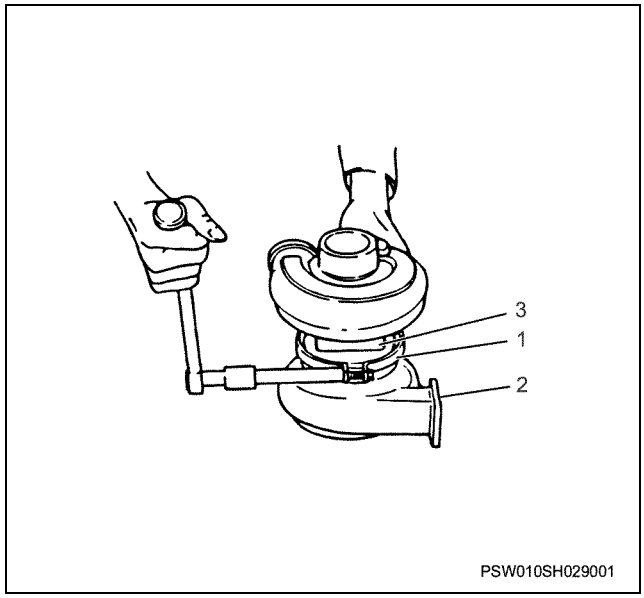


20. Install the turbine housing (1).
    - Check the assembly direction of the turbine housing and install it to the bearing housing.



21. Apply Mol coat to the thread section of the coupling ASM, and tighten to the correct torque.

Correct tightening torque: 6 N·m {0.6 kgf·m}



Legend

1. Coupling ASM
2. Turbine housing
3. Bearing housing

Disassemble and Assemble Engine

Preheating system
(6WG1 (Common rail))
Contents

Preheating system 1K-2
Service Precautions 1K-2
Explanation of functions and operations 1K-2
Functional check 1K-3
Trouble shooting 1K-4
Glow indicator lamp doesn't light 1K-5
Preheating doesn't function 1K-6
Preheating time is either too long or too short . . 1K-7
Main data and specifications 1K-7

Preheating system

Service Precautions

Do not over-tighten the glow plugs as over-tightening may damage the glow plugs.

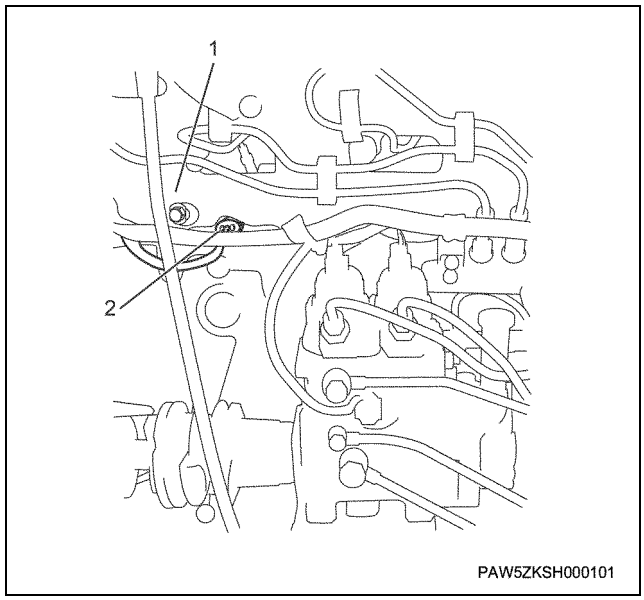
Explanation of functions and operations

The QOS-II system has been adopted for the preheating system. The timer is controlled by the controller.

Functional check

QOS II Inspection and adjustment

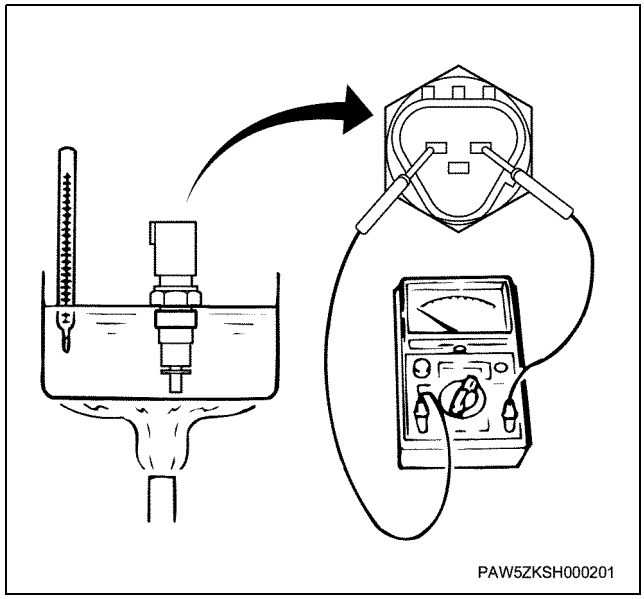
1. Thermo sensor inspection
   - The sensor Installation position is on the left side of the cylinder head.



Name

1. Intake manifold
2. Sensor

   - Put the temperature sensing element of the sensor into water, and check that the resistance value changes with the change in water temperature as shown in the graph.



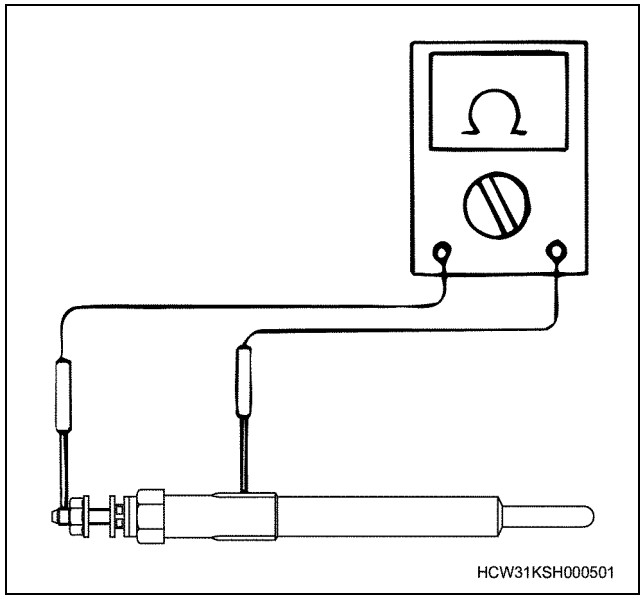
Sensor and temperature resistance values (for engine control)

Temperature (°C)	Resistance value (kΩ)
- 10	9.20
20	2.50
50	0.84
90	0.247
100	0.190
110	0.148

2. Glow plug inspection
   - Use a circuit tester to measure the resistance value of the glow plugs.
   - Replace the glow plugs if the measured results are different to the stipulated values.

     Glow plug resistance value = approx 4.3 Ω (room temperature)

Caution:
Always use a set of 6 glow plugs from the same manufacturer.



Trouble shooting

- Glow indicator lamp doesn't light
- Preheating doesn't function
- Preheating time is either too long or too short

Glow indicator lamp doesn't light

Condition	Probable cause	Correction
Glow indicator lamp doesn't light	Slow blow fuse has blown	Replace the slow blow fuse
	Blown fuse	Replace the fuse
	Burnt out injector valve	Replace the injector valve

Preheating doesn't function

Condition	Probable cause	Correction
Preheating doesn't function	Blown fuse	Replace the fuse

Preheating time is either too long or too short

Condition	Probable cause	Correction
Preheating time is either too long or too short	Thermo sensor fault and broken wire or short circuit in the circuit	Replace the thermo sensor, repair the circuit
	Glow plug fault	Re-tighten or replace the glow plugs

Main data and specifications

Heading	Model
Preheating equipment type	Glow plug. QOS timer
Glow plug rated voltage and current	23V - 3.0A