

# ENGINE

## ENGINE MECHANICAL (4HK1, 6HK1)

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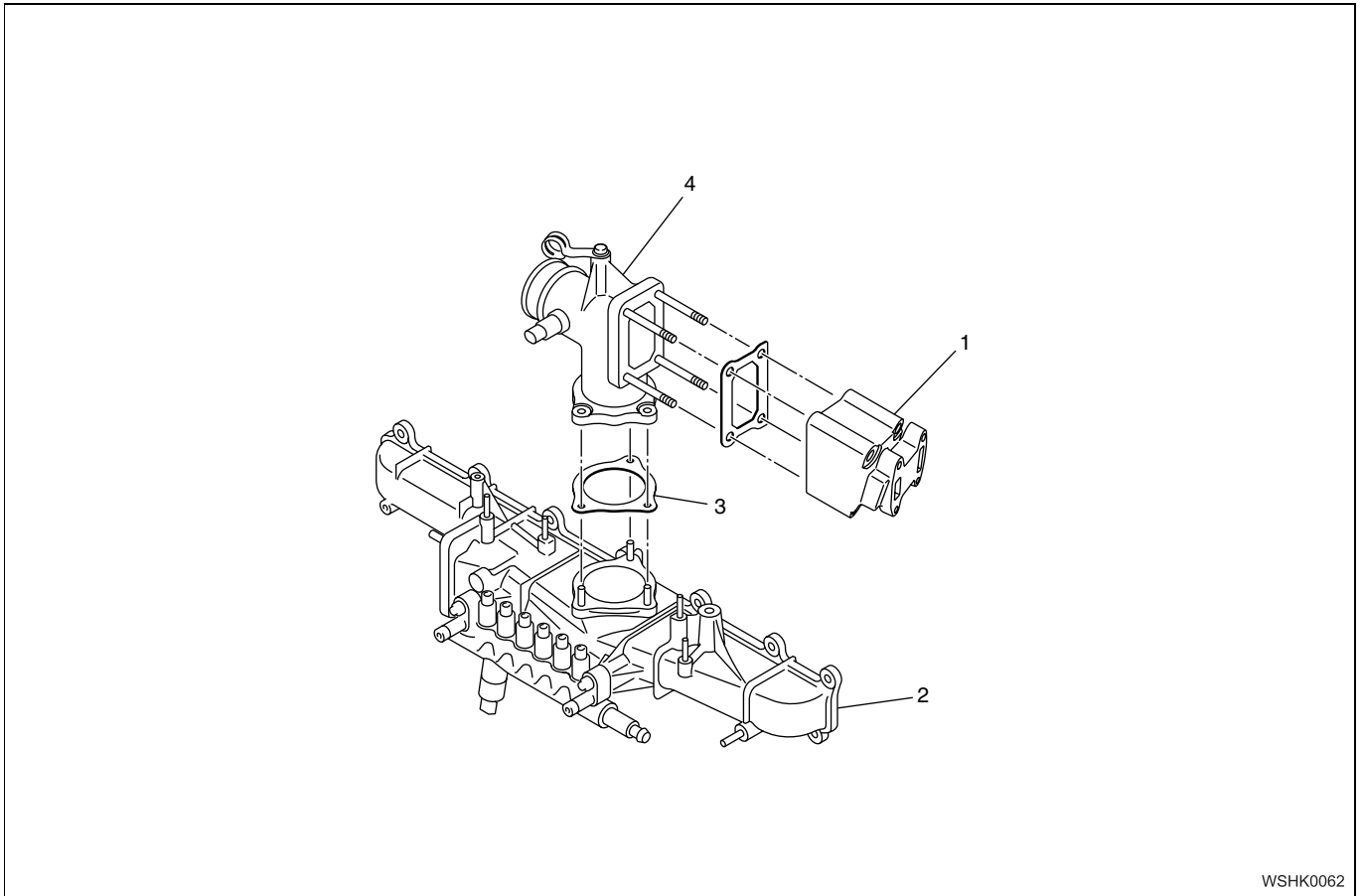
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**Main Data and Specifications**

Item		Engine model 4HK1
Type		Diesel/4-cycle/water cooled-type, inline four-cylinder OHC
Combustion chamber form		Direct injection type
Cylinder liner type		Dry type
Number of cylinders - cylinder bore × strokes	mm (in)	4-115 (4.53) × 125 (4.92)
Displacement	cc (cu.in)	5193 (317)
Compression ratio		17.5
Compression pressure	MPa (psi)/rpm	3.23 (468)/200
Idle speed	rpm	800
Valve clearance	Intake	0.4 (0.016) (cold)
	Exhaust	0.4 (0.016) (cold)
Ignition type		Compressed ignition
Injection order		1 - 3 - 4 - 2
Lubricating system		
Lubricating type		Pressure type
Oil pump type		Gear type
Volume of lubricating oil	L (qts)	13.0 (13.7) — 20.5 (21.7)
Oil filter type		Full flow filter (cartridge type)
Oil cooling type		Built-in, water-cooling
Cooling system		
Cooling type		Water cooling type
Radiator type		Corrugated fin (pressure type)
Water pump type		Centrifugal, belt type
Thermostat type		2 wax-type units
Thermostat valve-opening temperature	°C (°F)	85 (185)
Volume of coolant	L (qts)	14 (14.8) (incl. radiator)
Fuel system		
Injection pump type		Electronic control common rail type
Governor type		Electronic type
Timer type		Electronic type
Injection nozzle type		Multi-hole type 7-hole and $\phi$ 0.16 mm (0.0063 in) inside diameter
Charging system		
Generator type		AC type
Power output	V/A	24 - 50
Regulator type		IC

## 6HK1



WSHK0062

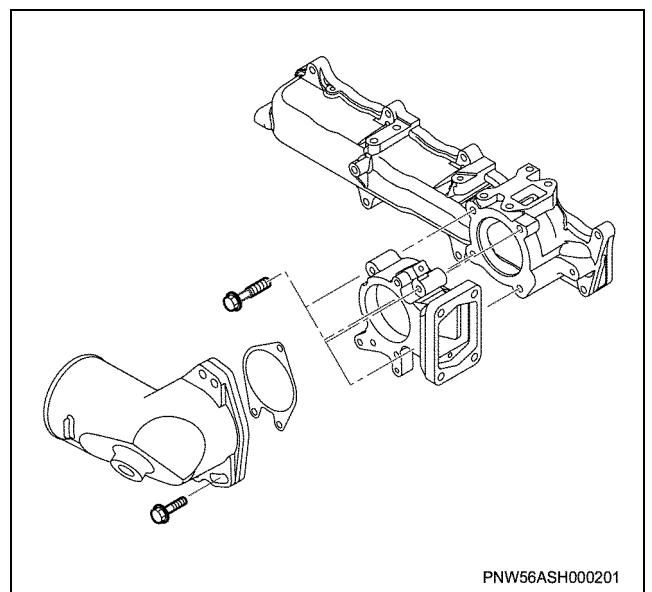
**Name**

1. Case ASM
2. Inlet Cover

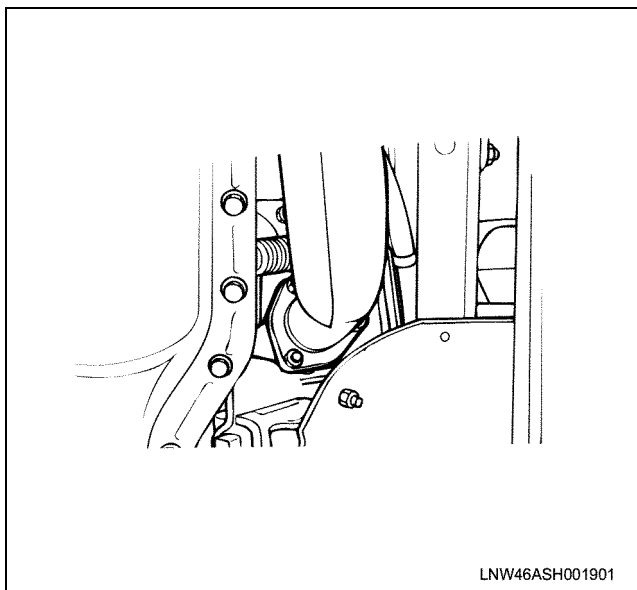
3. Inlet Pipe Gasket
4. Inlet Pipe

**Removal**

1. Remove the common rail.  
Refer to the "Common Rail" in the fuel system section.
2. Remove the inlet pipe.
3. Remove the case ASM.

**4HK1**

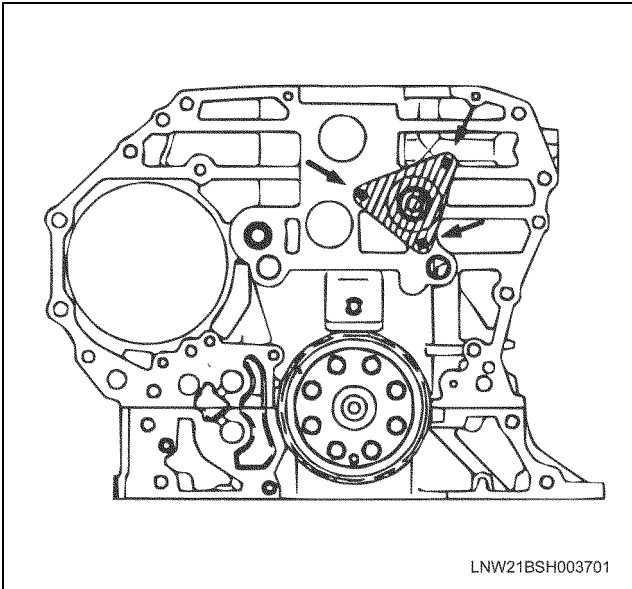
PNW56ASH000201



12. Add cooling water to the radiator. (4HK1 only)
13. Install the EGR pipe.
  - Put the gasket between both ends of the EGR pipe and install to the specified torque.

Tightening torque: 24 N·m (17 lb ft)

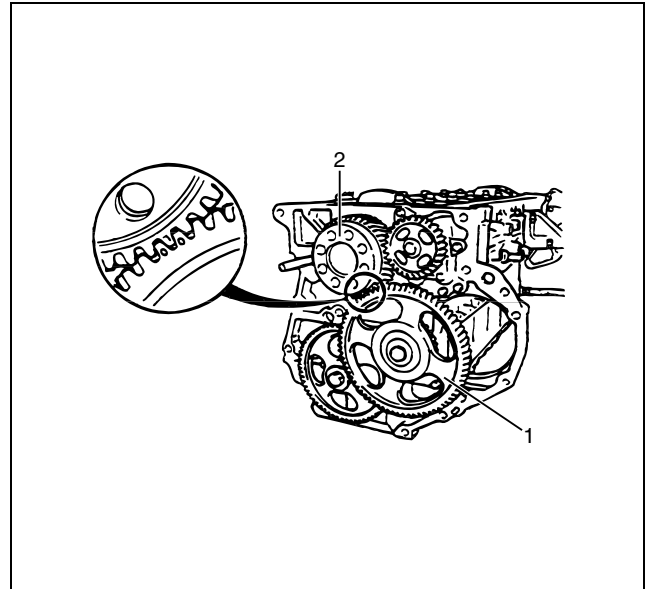
14. Replenish the coolant. (4HK1 only)



\* 4HK1 is shown for illustration.

2. Install the idle gear B.
  - Install the idle gear B in the direction given on the figure and tighten up the fastening bolts with the specified torque.

Tightening torque: 4HK1: 110 N·m (81 lb ft),  
6HK1: 95 N·m (70 lb ft)

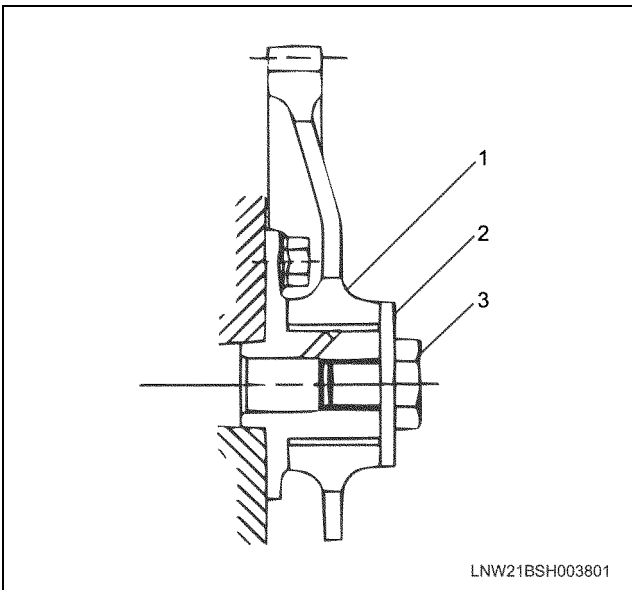


**Name**

1. Crank Gear
2. Idle Gear A

- Align the crankshaft gear (2) L mark and idle gear A (1) 0 marks.
- Tighten the installing bolt to the specified torque.

Tightening torque: 133 N·m (98 lb ft)



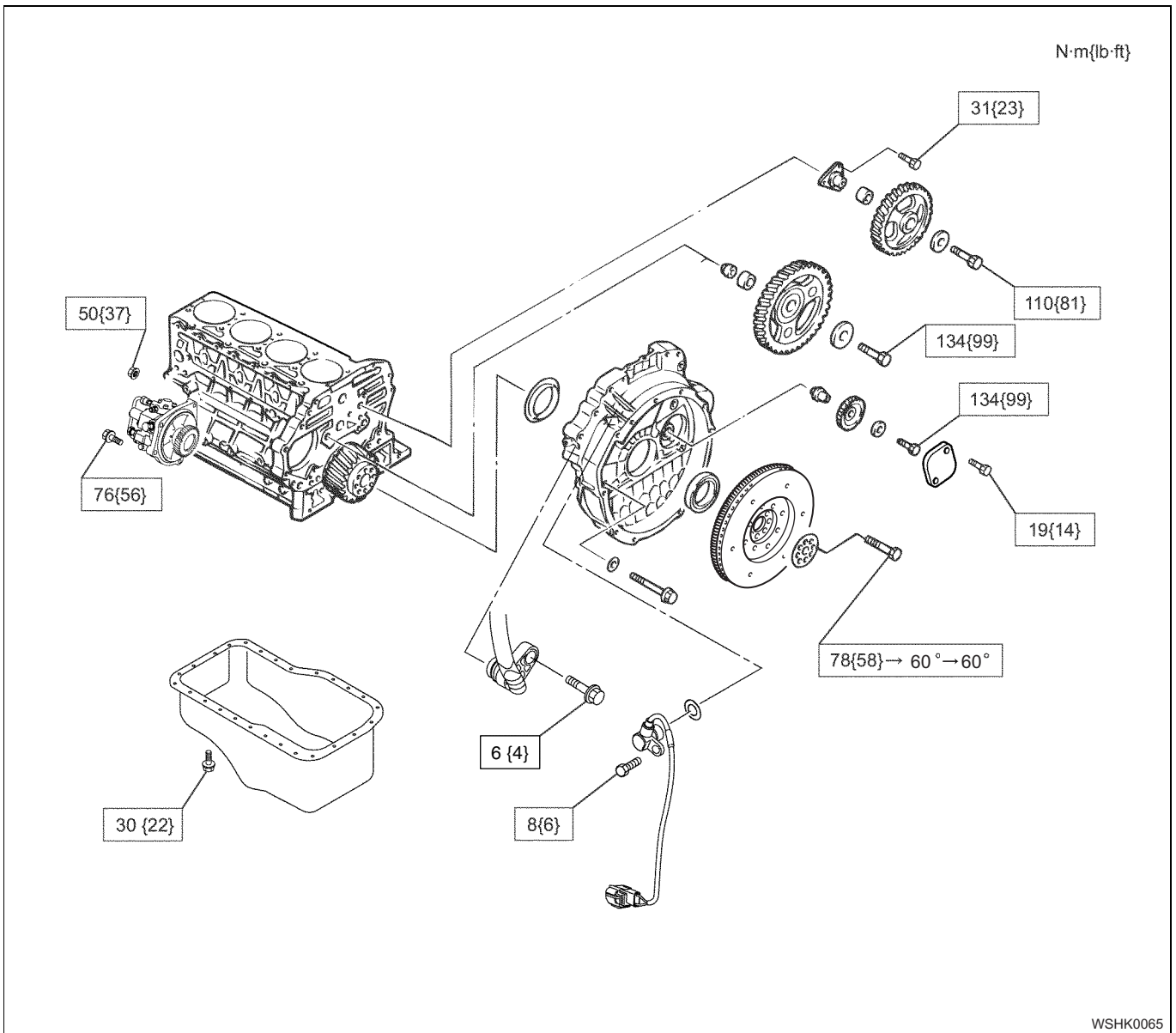
\* 4HK1 is shown for illustration.

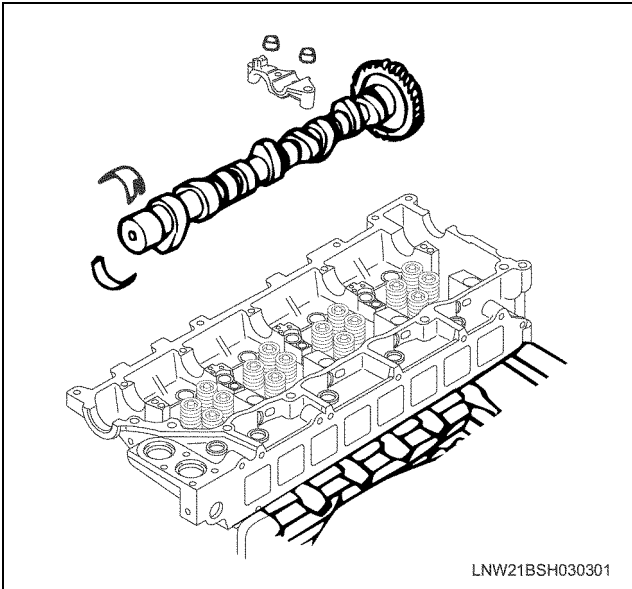
**Name**

1. Idle Gear
2. Thrust Collar
3. Bolt

3. Install the oil pump.
4. Install the idle gear A shaft. (6HK1)
5. Install the idling gear A.
  - Rotate the crankshaft to make the No.1 cylinder meet the compression top dead center (TDC).

Torque Specifications



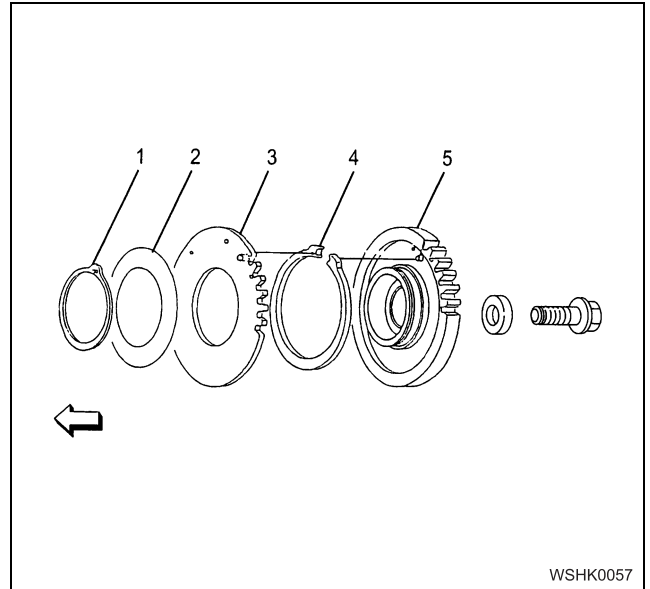
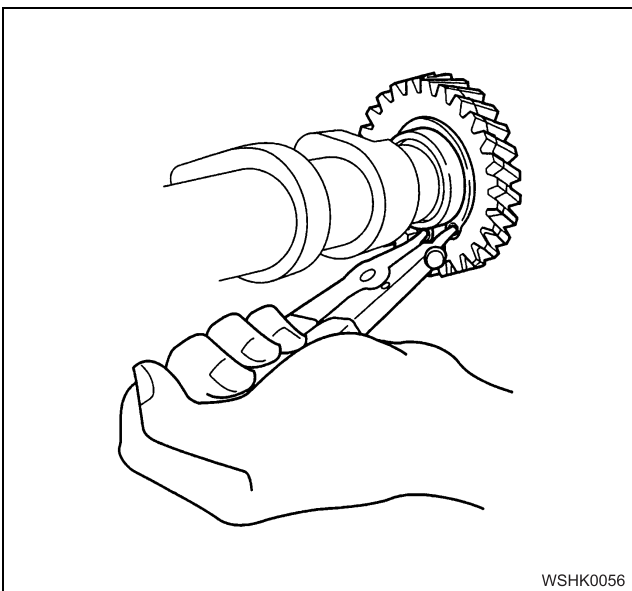


### Disassembly

1. Remove the scissors gear ASM. (6HK1)
  - Fix the hexagon portion of the camshaft in a vise using a mouth ring. Use snap ring pliers to remove the sub gear.

### Caution:

Take care not to damage to the cam portion and the journal portion of the camshaft.

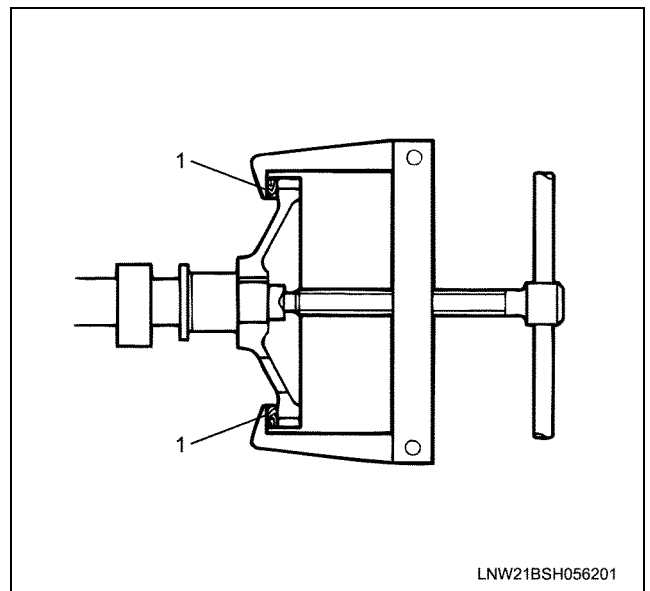


### Name

1. Snap Ring
2. Dish Spring
3. Sub Gear
4. Spring
5. Camshaft Gear

2. Remove the camshaft gear.

- Remove the fastening bolts of the camshaft gear and put the block of wood in a puller to remove the camshaft gear.



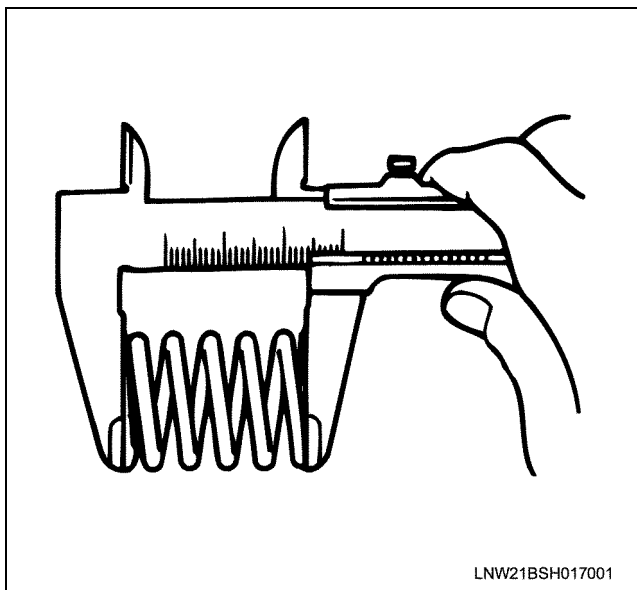
### Name

1. Wood

3. Remove the knock pin.

4. Inspect the camshaft visually.

- Check if the journal and cam parts of the camshaft are worn or damaged, if so, replace it.



### 2. Valve spring squareness

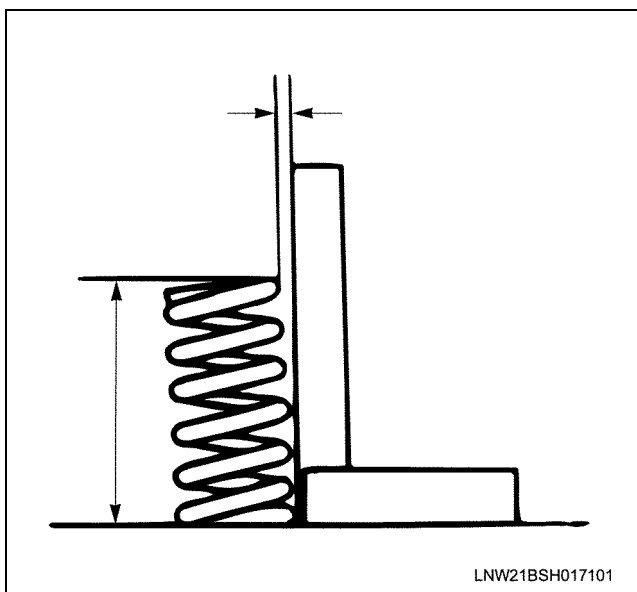
- Use a surface plate and a square to measure the valve spring squareness. If the measured value exceeds the specified limit, the valve spring must be replaced.

#### 4HK1

Valve spring squareness	mm (in)
Limit	3.0 (0.12)

#### 6HK1

Valve spring squareness	mm (in)
Limit	3.4 (0.13)



### 3. Tension

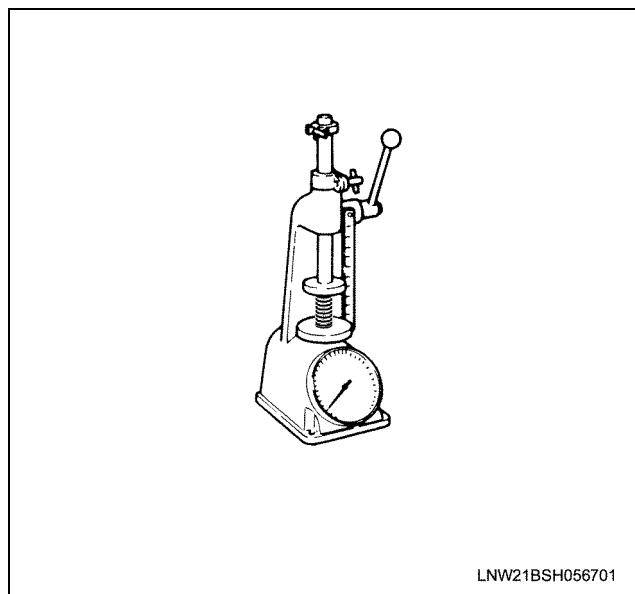
- Use a spring tester to compress the spring to the installation height. Measure tension of the compressed spring. If the measurement is lower than the limit, replace the spring.

#### 4HK1

	Tension of the valve spring N (lb)	
	Intake air	Exhaust
Installation length mm (in)	46.0 (1.81)	46.0 (1.81)
Standard	348 (78)	383 (86)
Limit	330 (74)	356 (80)

#### 6HK1

	Tension of the valve spring N (lb)	
	Intake air	Exhaust
Installation length mm (in)	46.0 (1.81)	46.0 (1.81)
Standard	348 (78)	378 (38.5)
Limit	309 (31.5)	329 (33.5)

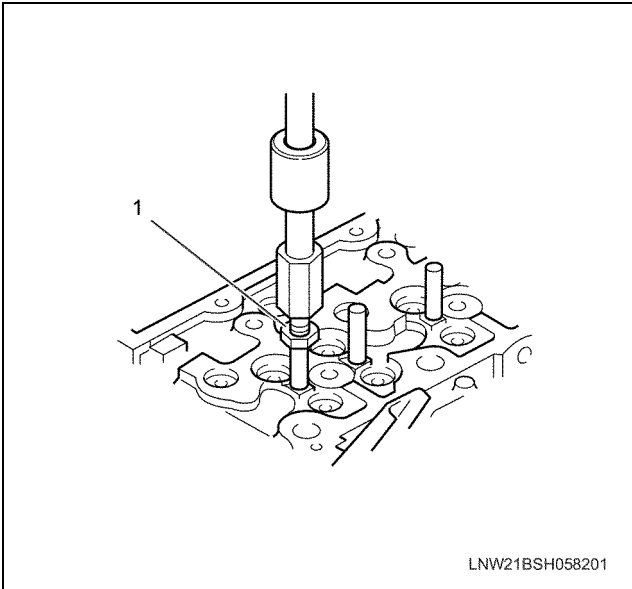


### Installation

- Install the valve stem oil seal.
  - Apply engine oil over the peripheral part of the valve guide and install the oil seal by using a valve stem seal installer.

#### Caution:

After installing the valve stem oil seal, check if it is inserted nice and deep and the oil seal is not tilted or the garter spring has not come off.

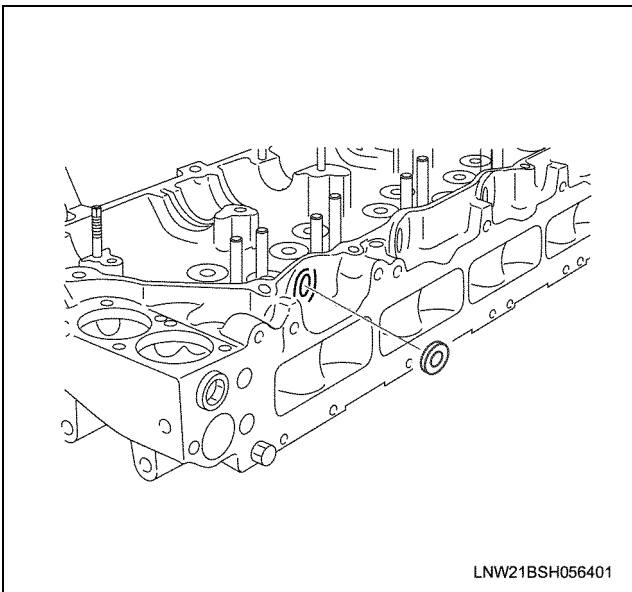


**Name**

1. Nut

**18. Remove the oil seal.**

- Press the tool against the oil seal. Strike the tool to remove the seal from the inside of the cylinder head.



**Inspection**

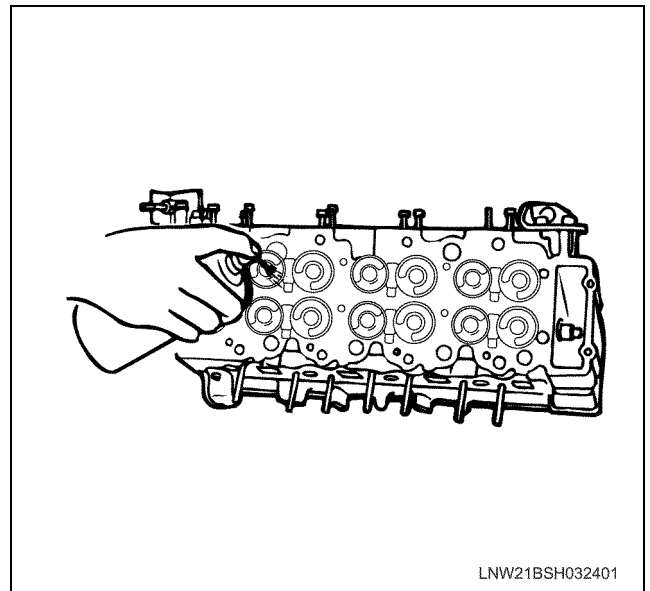
1. Check the cylinder head ASM.
  - Remove varnish, soot and others adhered on the metal surface completely. Use metal brush and others so that the seal surface of the surface where the gasket is installed is not hurt.

- Check the following causes in the case of leak of the seal surface of the cylinder head, corrosion, air leak and defective gasket.
  - Improper installation
  - Defective tightening of the cylinder head.
  - Winding seal surface of the cylinder block.
- a. Damage on the screw surface or extracted cylinder head bolt due to extra tightening torque

**Caution:**

Replace suspicious bolt.

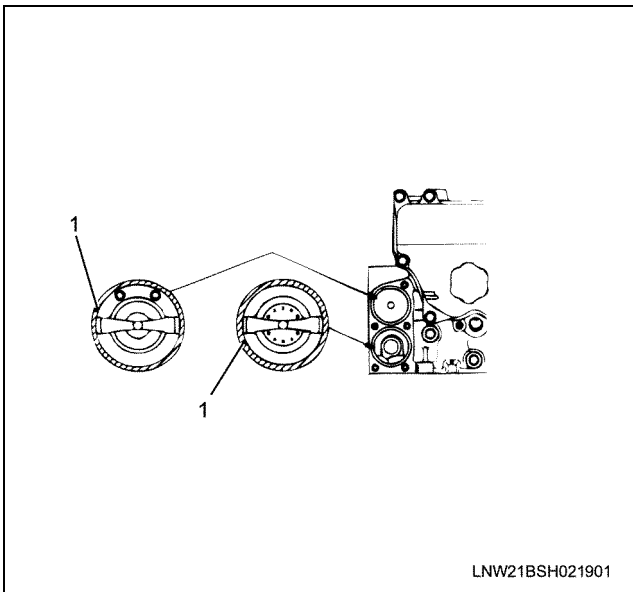
- b. Inside the combustion chamber, glow plug hole.
  - Check whether there is a crack between the valve seats and in the cylinder head of the exhaust port part, and replace the cylinder head if there is serious damage or crack. Check the collar if necessary.



- c. Flatness of the under surface of the cylinder head
  - Use a straight edge ruler and sickness gauge to measure the four sides and diagonal lines as shown in the drawing, and replace if they exceed the limit.

Distortion of the under surface of the cylinder head		mm (in)
Standard	0.05 (0.002) or less	
Limit	0.20 (0.0079)	

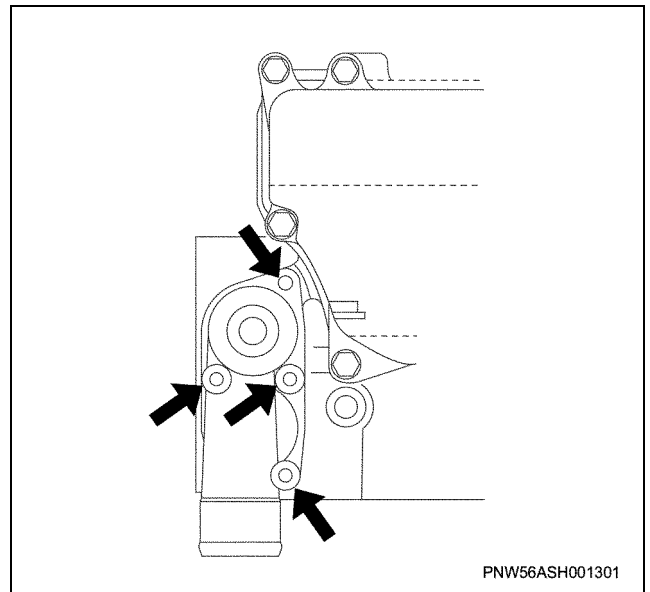
4HK1



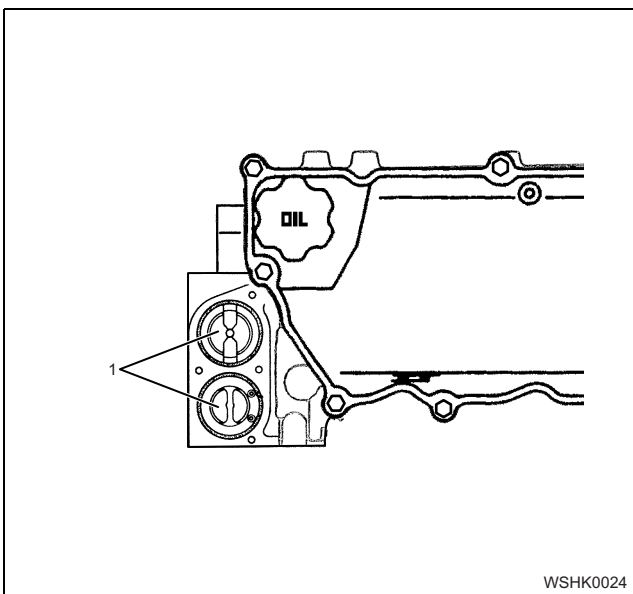
Name

1. Thermostat

4HK1



6HK1



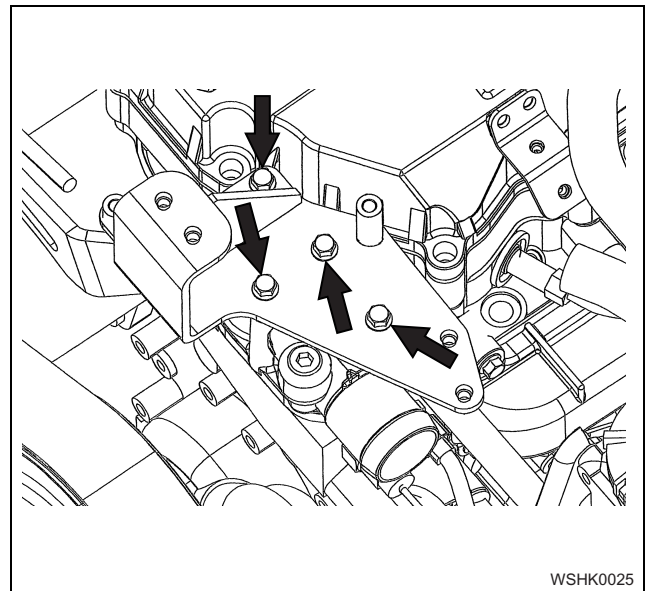
Name

1. Thermostat

13. Connect the water outlet pipe.
  - Tighten the water outlet pipe to the specified torque.
  - Tighten it up together with the fan shroud bracket.

Tightening torque: 24 N·m (18 lb ft)

6HK1



14. Install the exhaust gasket.
15. Install the exhaust manifold.
  - Install the distance tube conical spring and the nut on the stud of the cylinder head in this order.

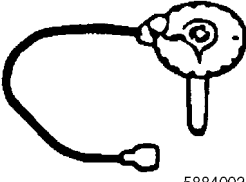
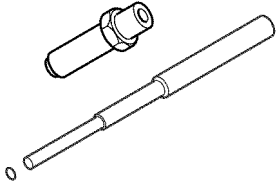
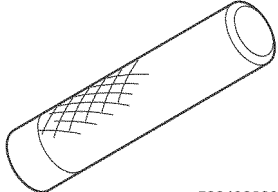
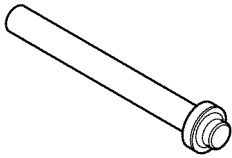
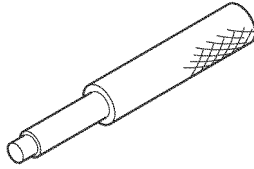
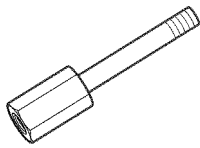
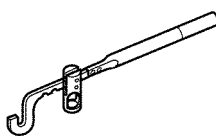
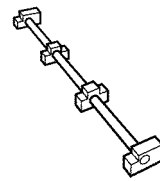
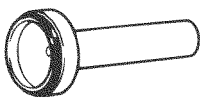
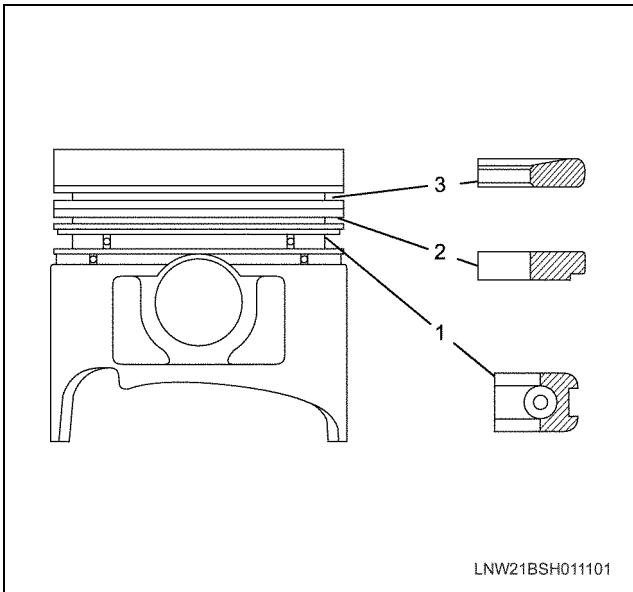
Illustration	Tool Number/Description
 <p>5884002660</p>	<p>5-8840-0266-0 J-45059 KM470-B Angle gauge</p>
 <p>5884026240</p>	<p>5-8840-2624-0 J-43266 Nozzle sleeve installer</p>
 <p>5884026260</p>	<p>5-8840-2626-0 J-43268 Bridge guide installer</p>
 <p>5884026270</p>	<p>5-8840-2627-0 J-43269 Oil seal installer</p>
 <p>5884026230</p>	<p>5-8840-2623-0 J-43265 Nozzle sleeve remover</p>
 <p>EN46720</p>	<p>5-8840-2826-0 EN-46720 Fuel injector remover</p>

Illustration	Tool Number/Description
 <p>5884026210</p>	<p>5-8840-2621-0 J-43263 Valve spring replacer</p>
 <p>8943968620</p>	<p>8-9439-6862-0 EN-46721 Pivot ASM</p>
 <p>5884022220</p>	<p>5-8840-2222-0 EN-47690 Sealing cup installer</p>

**Special tool**

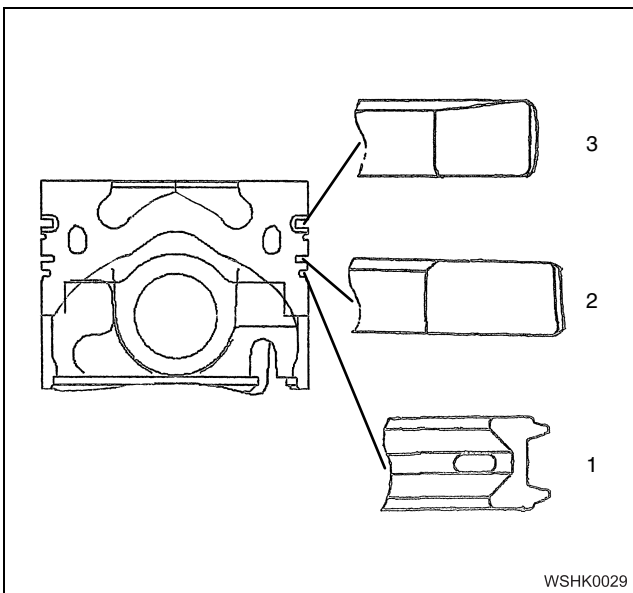
Piston ring setting tool: 1-8522-1029-0



**Name**

1. Oil ring
2. Second Ring
3. Top Ring

**6HK1**



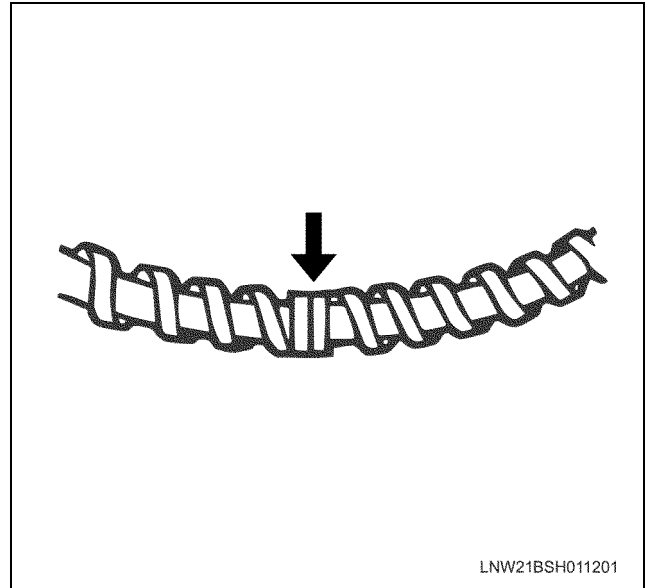
**Name**

1. Oil ring
2. Second Ring
3. Top Ring

**Caution:**

Note that the shapes are different for top ring and second ring. (Second ring has undercut)

Make sure that there is not gap in the position indicated in the drawing when the oil ring coil expander was installed.

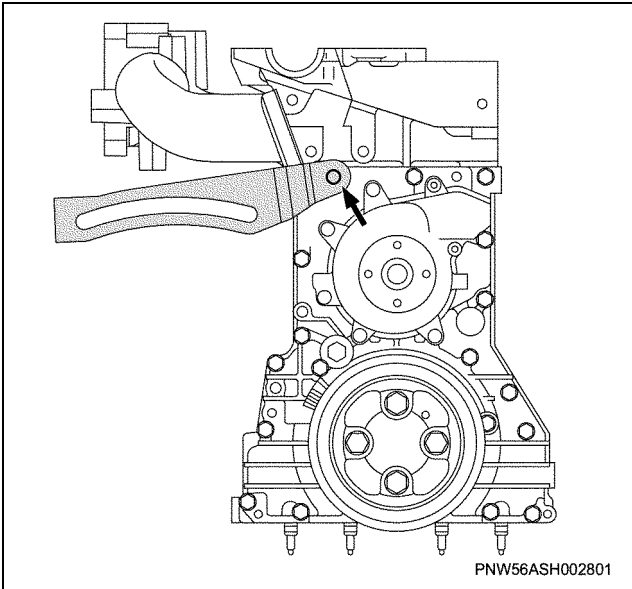


**Installation**

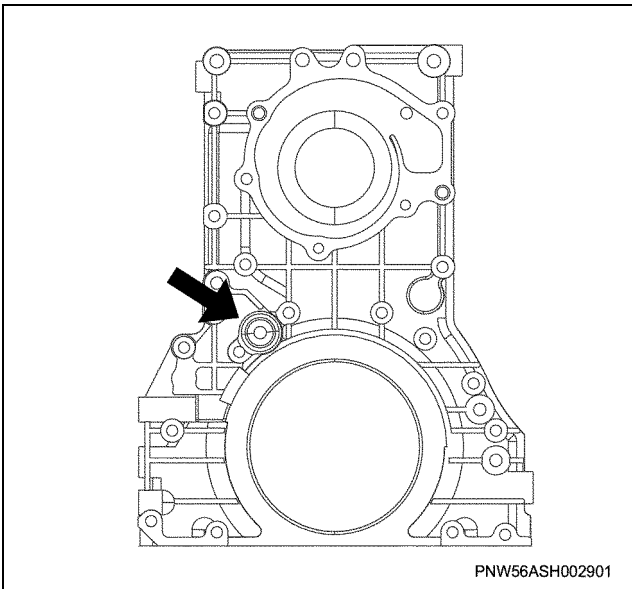
1. Install the connecting rod bearing.
  - Install the bearing on the connecting rod, apply engine oil on the bearing.
2. Install pistons and connecting rod ASM.
  - Apply enough engine oil on the piston ring, ring groove and piston side surface.
  - Dislocate the piston ring joint so that (1) is top ring, (3) is 2nd ring and (2) is oil ring, as shown in the drawing.
  - Face the piston front mark cut to forward, use the piston ring compressor to insert the piston in the cylinder liner.

**Caution:**

- Be sure not to make the connecting rod touch the oil jet when pushing in the piston.
- Be sure not to hurt the inside of the liner when pushing in the piston.



- Remove the oil relief valve (arrow), loosen the front cover installation bolts and remove the front cover.



### Installation

1. Install the front cover.
  - Clean the cylinder block front surface. In particular, remove liquid gasket leaked during installation of the crankcase.
  - Install two O-rings and apply liquid gasket (ThreeBond 1207B or equivalent), or each equivalent along with the groove of the front cover installation surface.

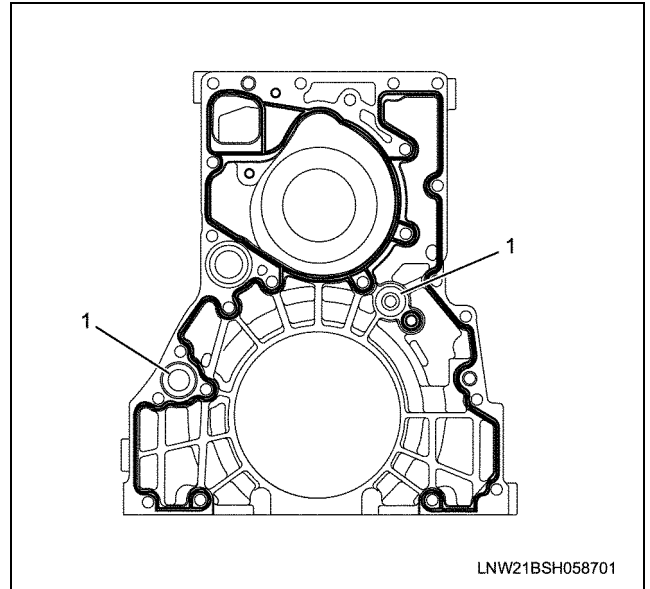
Beat width      1.5 ~ 5mm (0.059 ~ 0.20 in)  
 Beat height    0.3 mm ~ 1.5 mm  
                          (0.012 ~ 0.059 in) from the joint surface

- Install within seven minutes after applying liquid gasket.

### Caution:

Apply liquid gasket so that it does not adhere to the O-ring.

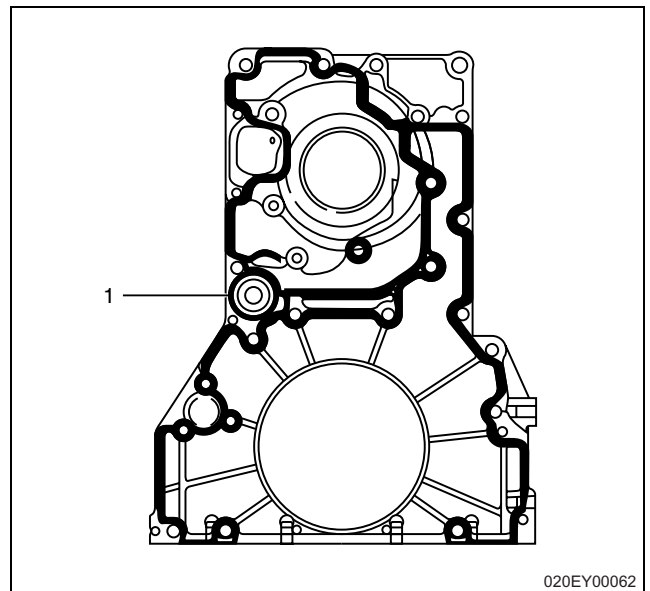
### 4HK1



### Name

1. O-Ring

### 6HK1



### Name

1. O-Ring

- Align with the knock pin of the cylinder block and install the front cover.

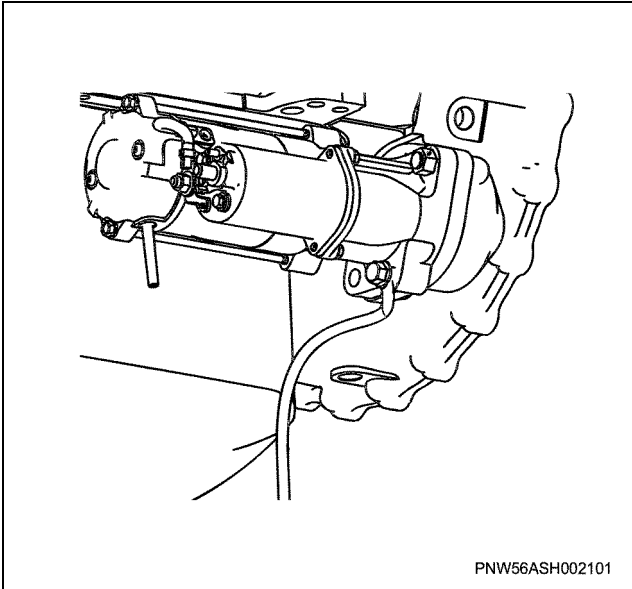
### Caution:

Along with the front cover, install the water pump ASM (before liquid gasket hardens).

8. Connect the lower radiator hose.
9. Connect the coolant reserve tank hose.
10. Connect the upper radiator hose.
11. Install the starter in the flywheel housing with nuts and tighten to the specified tightening torque.

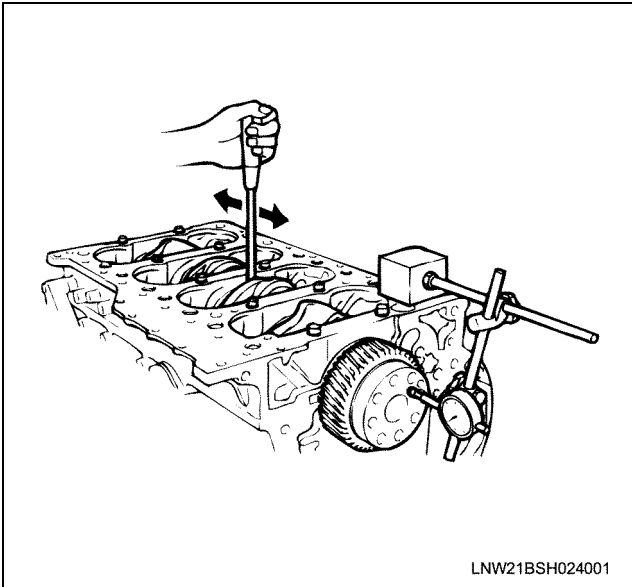
Tightening torque: 76 N·m (56 lb ft)

- Connect the starter ground cable.



\* 4HK1 is shown for illustration.

12. Fill the radiator with coolant.



\* 4HK1 is shown for illustration.

## 2. Main bearing clearance

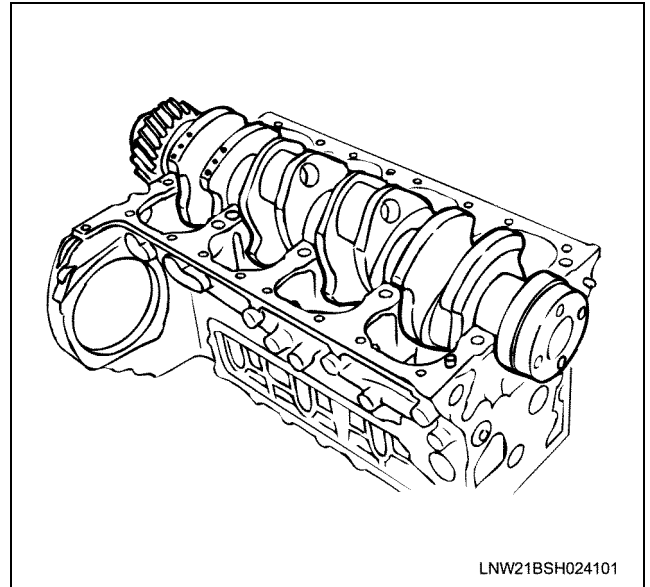
- Remove the crankcase.  
Set out disassembled main bearings in the order of the numbers.
- Remove the crankshaft. Remove the main bearing.
- Clean the crankshaft journal and the upper and lower bearings.
- Check the bearings for damage or excessive wear.

If you find damage or excessive wear in the check, replace the bearings in pairs.

- Place the upper bearings and the crankshaft on the cylinder block. Install the crankshaft so that it becomes horizontal.

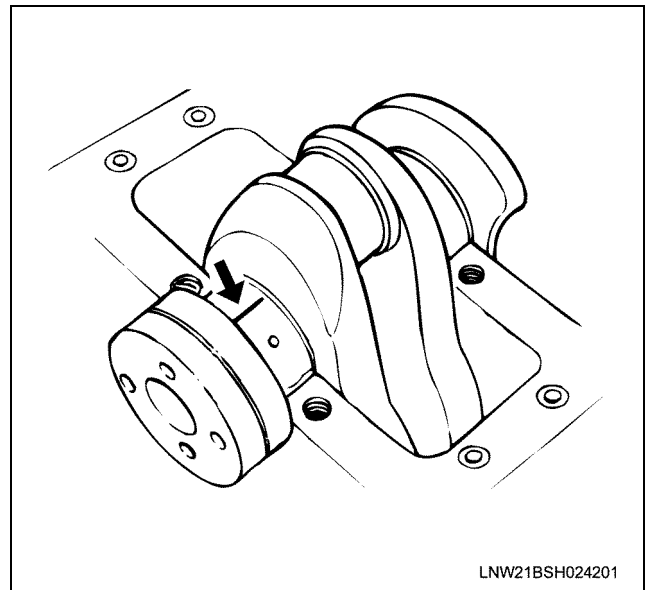
### Caution:

Turn the crankshaft about 30° to allow the bearings to settle in.



\* 4HK1 is shown for illustration.

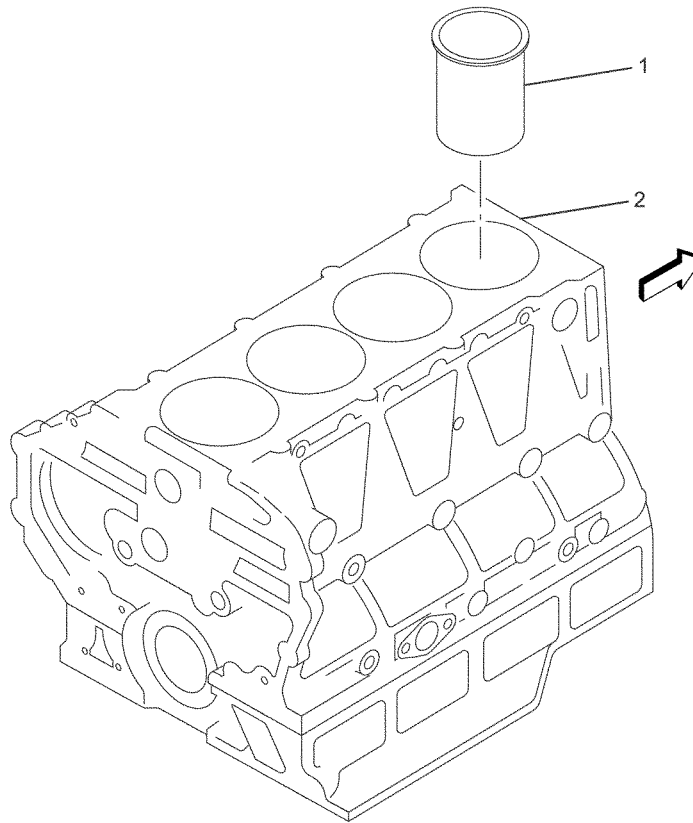
- Place Plastigauge on the crankshaft journal as shown.
- Place the lower bearings at original positions on the crankcase.



- Install the crankcase and tighten bolts to the specified tightening torque.
- Tighten the crankcase in the sequence shown using a torque wrench and an angle gauge.

## Cylinder Block

### Components



PNW56ALF001801

\* 4HK1 is shown for illustration.

### Name

1. Cylinder Liner

2. Cylinder Block

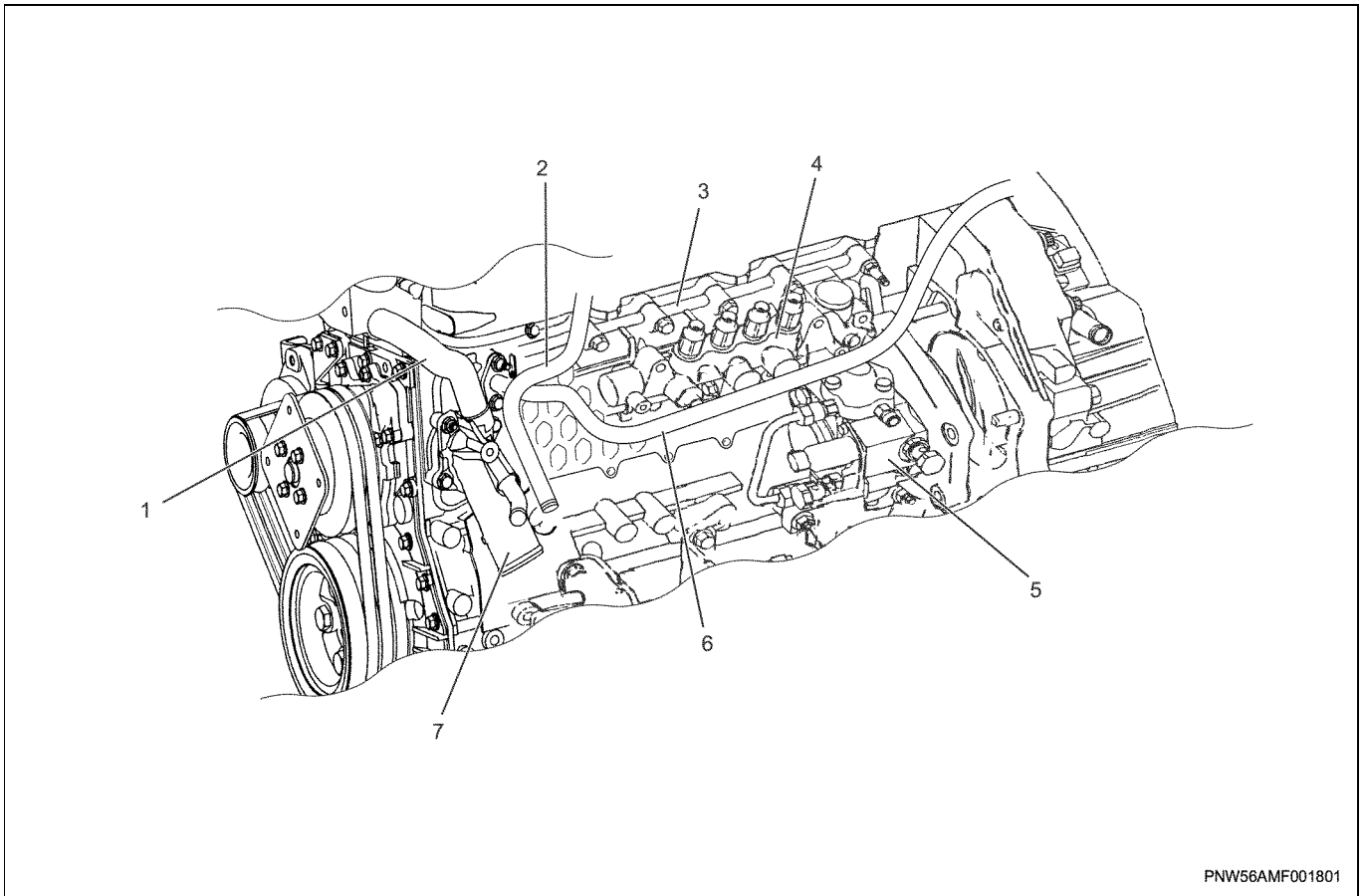
### Removal

1. Remove the cylinder head cover.  
Refer to "Cylinder Head Cover".
2. Remove the rocker arm shaft ASM.  
Refer to "Rocker Arm Shaft ASM".
3. Remove the camshaft ASM.  
Refer to "Camshaft ASM".
4. Remove the cylinder head.  
Refer to the "Cylinder Head".
5. Remove the fuel supply pump.  
Refer to "Fuel Supply Pump" in the fuel system section.
6. Remove the crankshaft front oil seal.  
Refer to "Crankshaft Front Oil Seal".
7. Remove the crankshaft rear oil seal.  
Refer to the "Crankshaft Rear Oil Seal".
8. Remove the oil pan.  
Refer to "Oil Pan".

## Oil Cooler

### Components

#### 4HK1



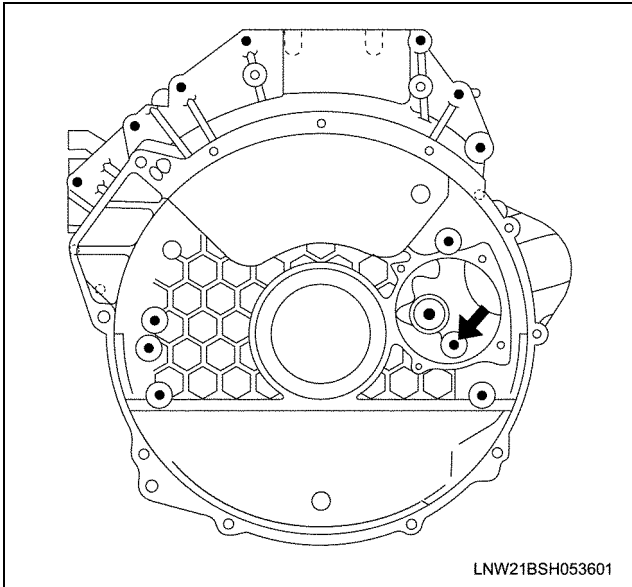
PNW56AMF001801

#### Name

- |                                 |                               |
|---------------------------------|-------------------------------|
| 1. Bypass Hose                  | 5. Fuel Supply Pump           |
| 2. EGR Cooler Water Return Pipe | 6. EGR Cooler Water Feed Pipe |
| 3. Oil Cooler                   | 7. Suction Pipe               |
| 4. Common Rail                  |                               |

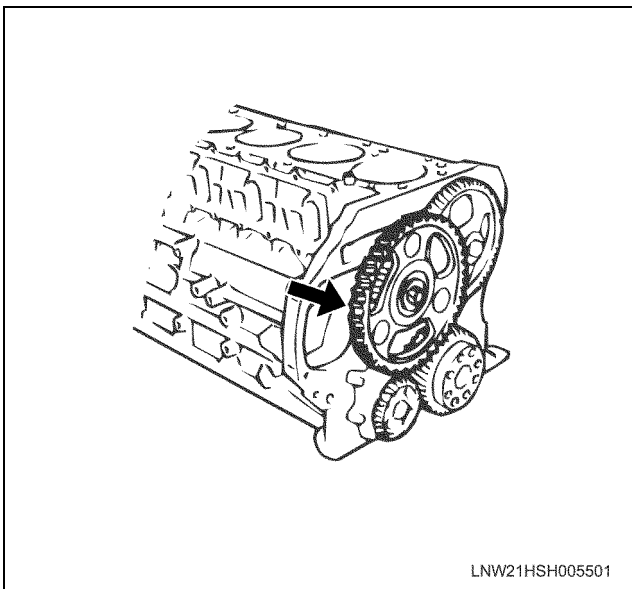
## 11. Remove the flywheel housing.

- Make sure you remove the bolts shown in the figure.

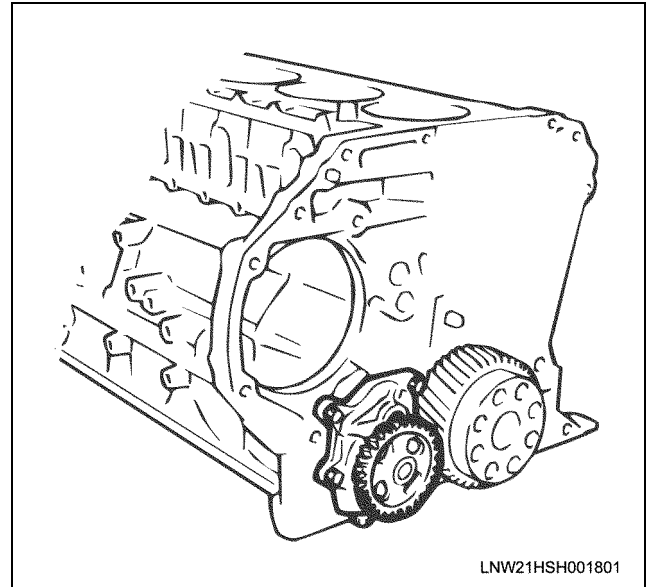


\* 4HK1 is shown for illustration.

## 12. Remove the idle gear A.



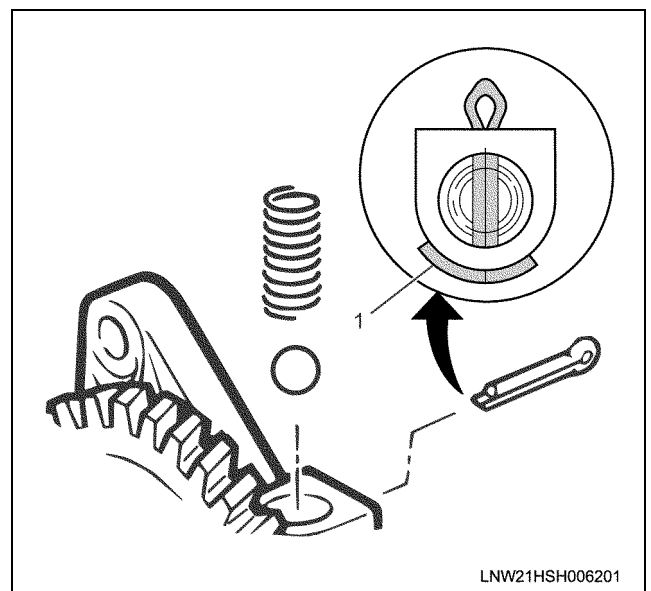
## 13. Remove the oil pump ASM and gasket.

**Disassembly**

1. Remove the driven gear and shaft.
2. Remove the split pin.
3. Remove the spring.
4. Remove the ball.

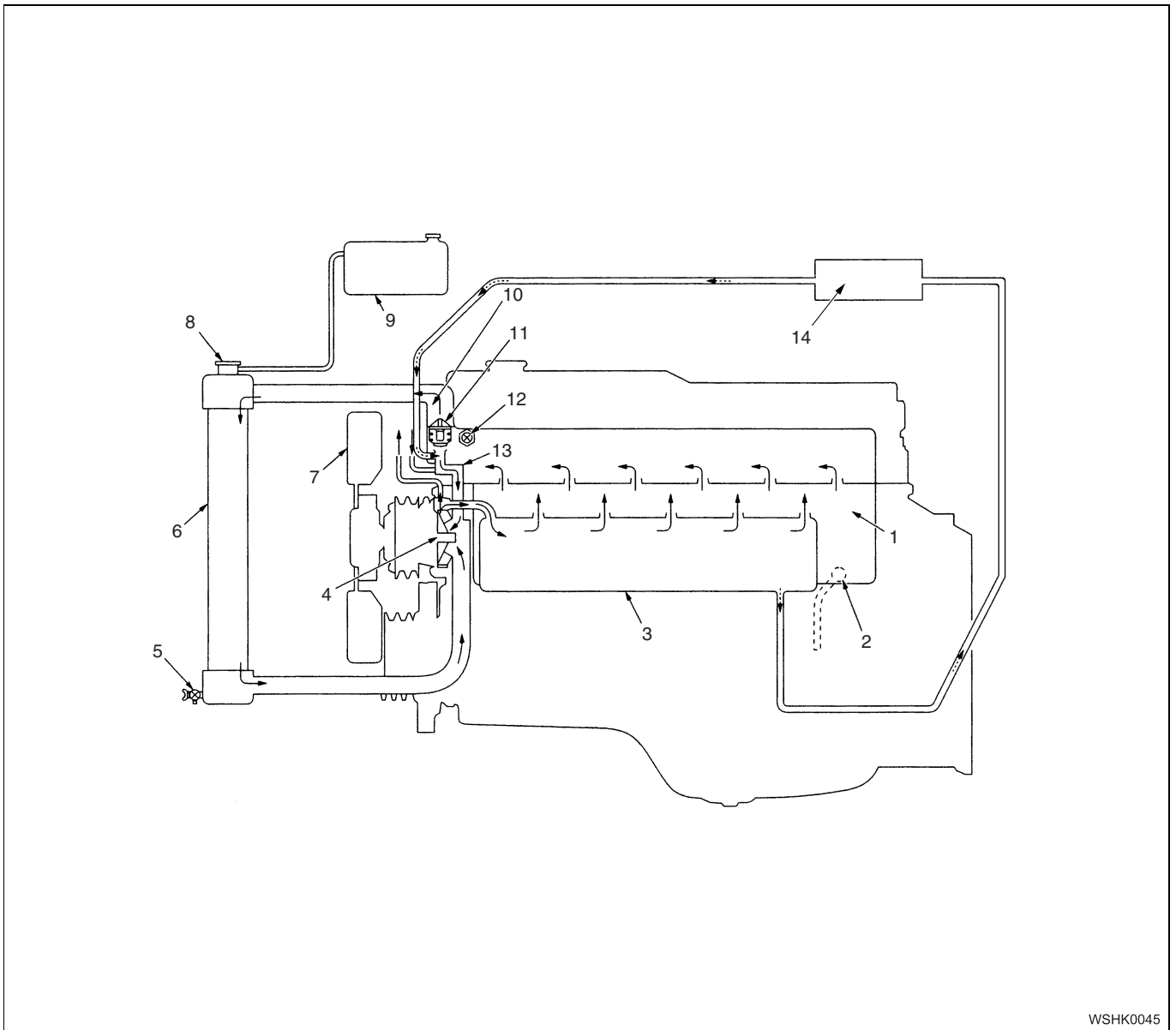
**Reassembly**

1. Install the ball.
2. Install the spring.
3. Install the split pin and fold it according to (1).



4. Apply engine oil on the driven gear and shaft and mount them on the oil pump body.

## 6HK1

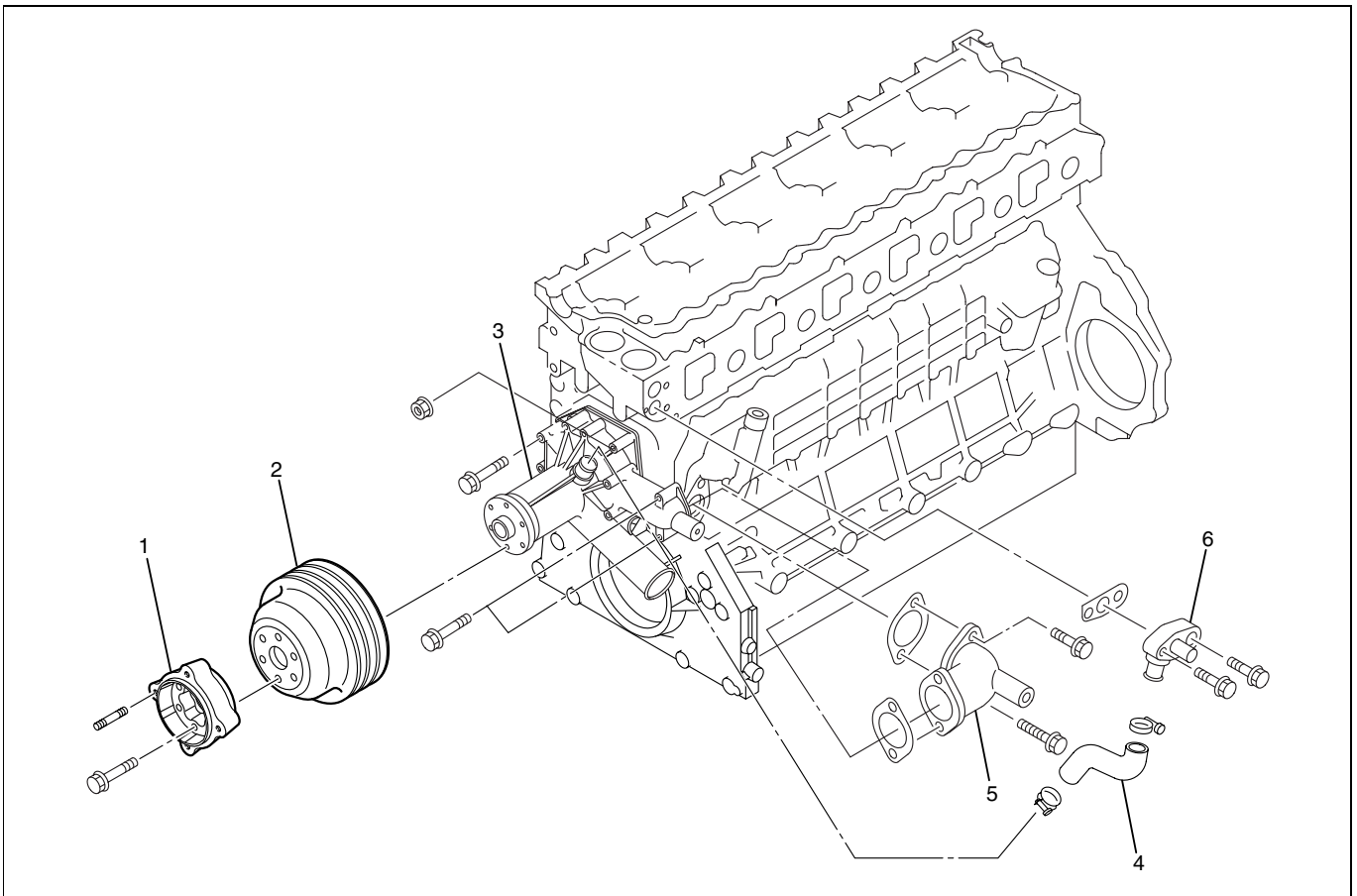


WSHK0045

**Name**

- |                 |                          |
|-----------------|--------------------------|
| 1. Water Jacket | 8. Radiator Cap          |
| 2. Drain Plug   | 9. Reservoir Tank        |
| 3. Oil Cooler   | 10. Water Outlet Pipe    |
| 4. Water Pump   | 11. Thermostat (2 units) |
| 5. Drain Cock   | 12. Thermometer Unit     |
| 6. Radiator     | 13. Bypass Route         |
| 7. Cooling Fan  | 14. EGR Cooler           |

5. Remove the adapter and fan pulley.



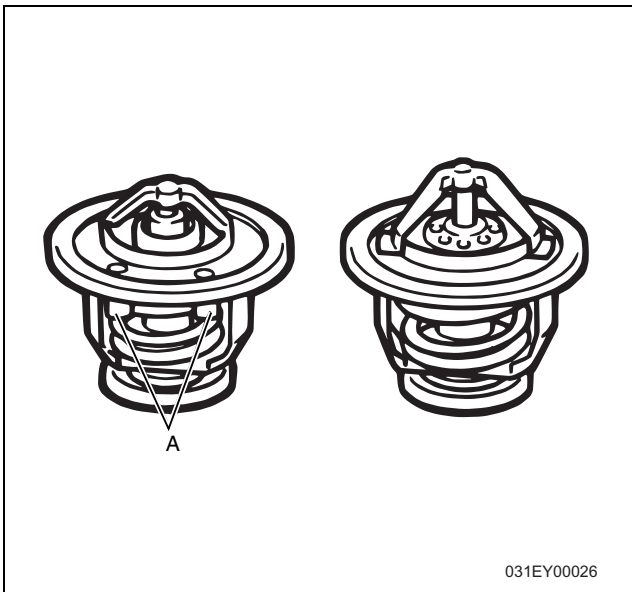
**Name**

- |               |                |
|---------------|----------------|
| 1. Adapter    | 4. Bypass hose |
| 2. Fan pulley | 5. Water duct  |
| 3. Water pump | 6. Water duct  |

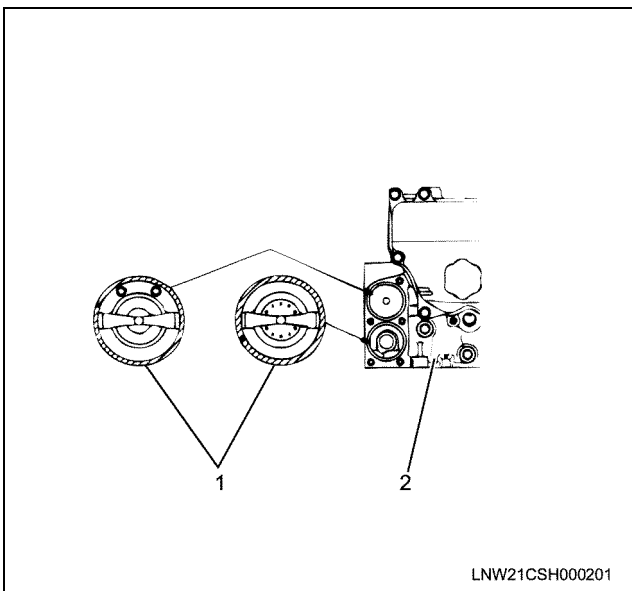
6. Disconnect the bypass hose.
7. Loosen the fixing nuts and bolts from the water pump.
8. Remove the water pump from the front plate.
9. Discard the gaskets.

## Installation

1. Mount the gasket on the thermostat and mount it at the position shown in the figure.
  - The thermostat with the jiggle valve (A) is installed to the left side of the engine. The jiggle valve faces the rear of engine.
  - Fit the thermostat gasket ensuring that it does not come out of and on top of the external housing on the cylinder head side.



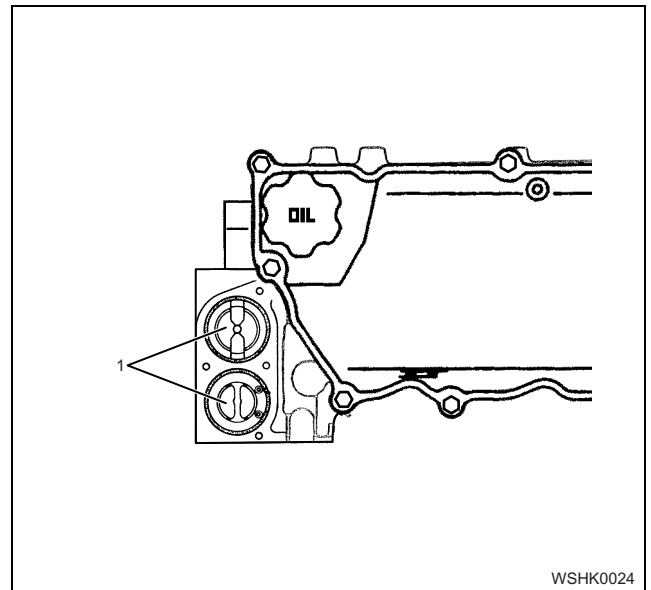
## 4HK1



### Name

1. Thermostat
2. Cylinder Head

## 6HK1

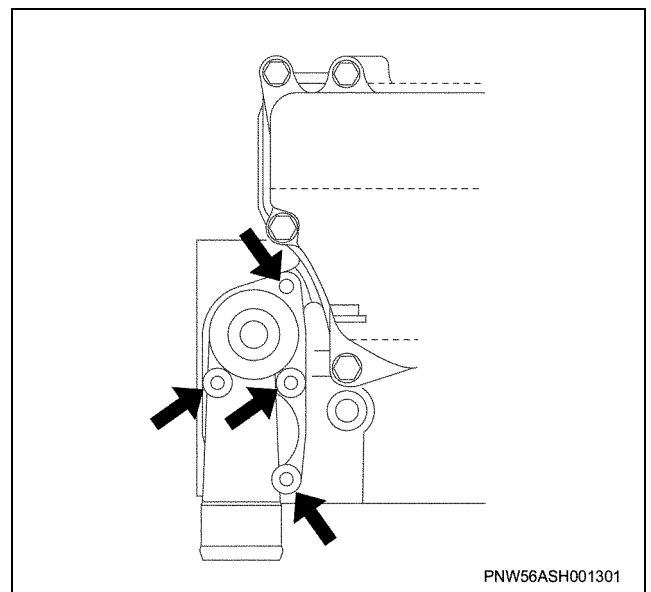


### Name

1. Thermostat

2. Connect the water outlet pipe.

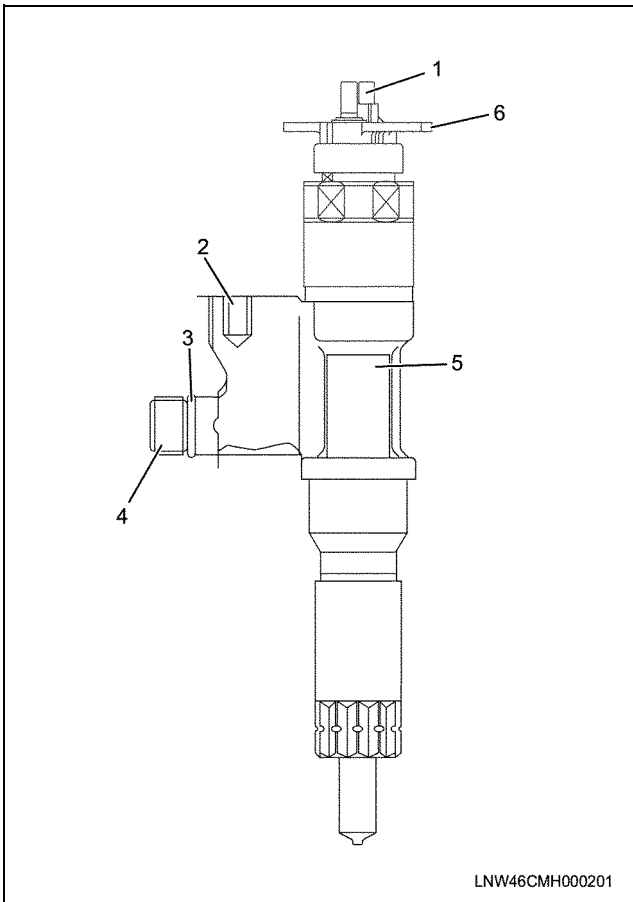
Tightening torque: 24 N·m (17 lb ft)



\* 4HK1 is shown for illustration.

3. Replenish the cooling water stored during the discharge, and check the volume of the cooling water.

**Fuel injector**

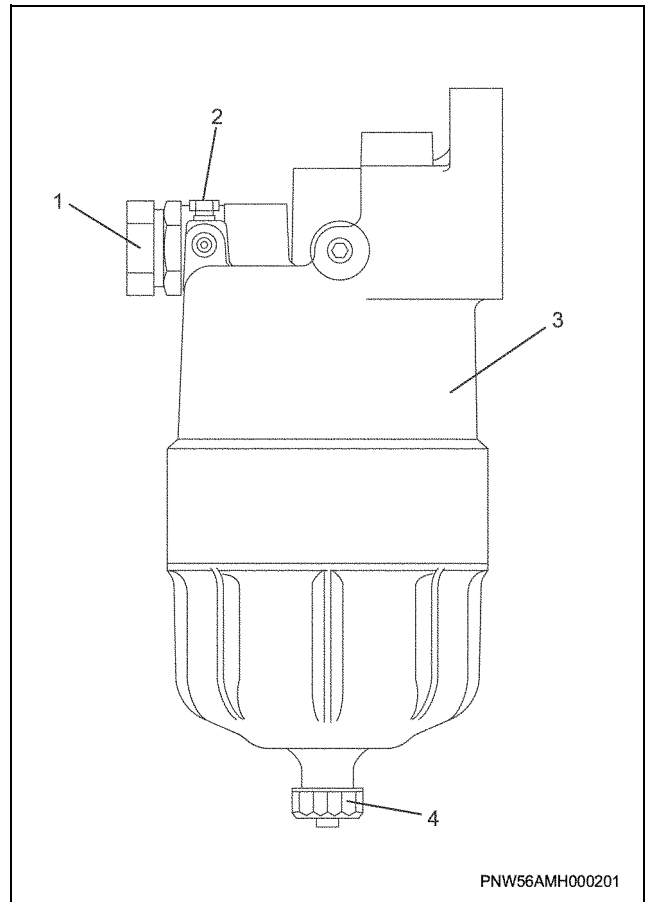


LNW46CMH000201

**Name**

1. Terminal Stud
2. Part for Mounting Leak Off Pipe
3. O-ring
4. Part for Mounting Injection Pipe
5. Parts Number
6. ID Code Plate

**Fuel filter**



PNW56AMH000201

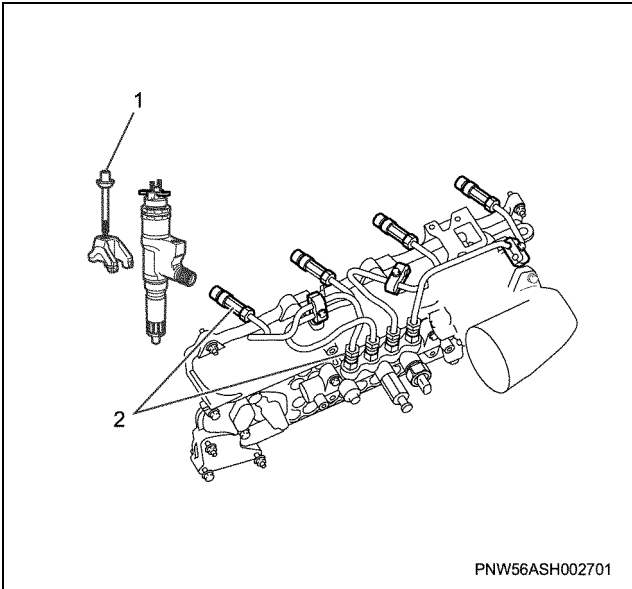
**Name**

1. Priming Pump
2. Air Bleed
3. Case
4. Drain Plug

**Function check**

**Air bleeding**

1. Before starting the engine
  - a. Fit a tray below the fuel filter (below the air bleed plug).
  - b. Loosen the plug adequately and operate the priming pump more than 20 times until the fuel near the plug overflows.
  - c. Tighten the plug, and operate the priming pump more than 10 times until it is filled with fuel. After waiting for approximately a minute, loosen the plug and bleed out the air in the fuel filter. (This work must be repeated a minimum of three times until no more air comes out from the plug.)
  - d. Tighten the plug firmly and wipe the fuel in the surrounding area. Operate the priming pump (10 to 15 times) till it is filled with fuel and then send fuel to the engine.



PNW56ASH002701

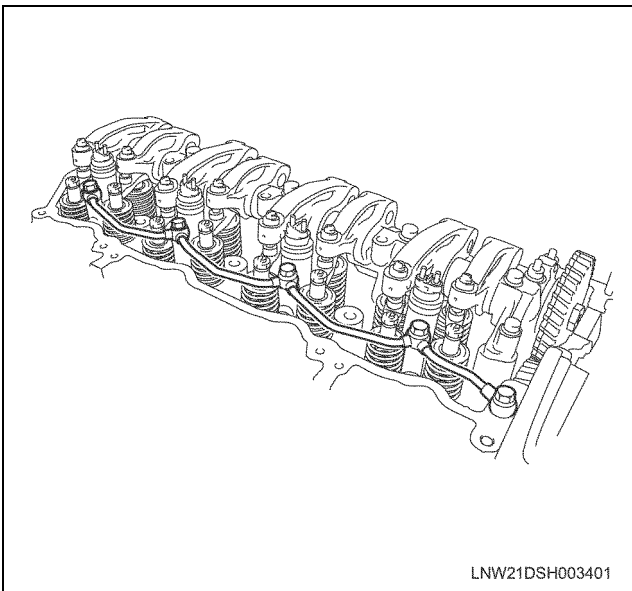
\* 4HK1 is shown for illustration.

**Name**

1. Clamp Bolt
2. Sleeve Nut

11. Install the nozzle leak off pipes together with the new gaskets. Tighten the pipes to the specified torque.

Tightening torque: 12 N·m (104 lb in)



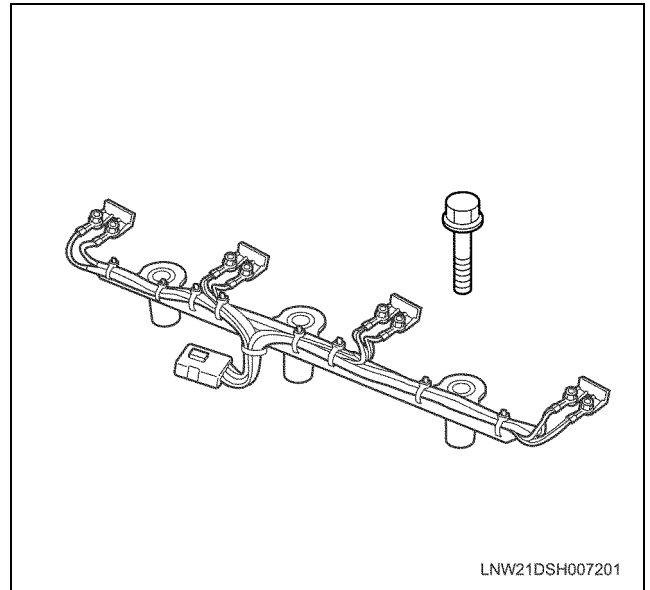
LNW21DSH003401

\* 4HK1 is shown for illustration.

12. Install the fuel injector harness connectors. Work from the inside out.
13. Install the harness bracket and tighten the bolts to the specified torque.

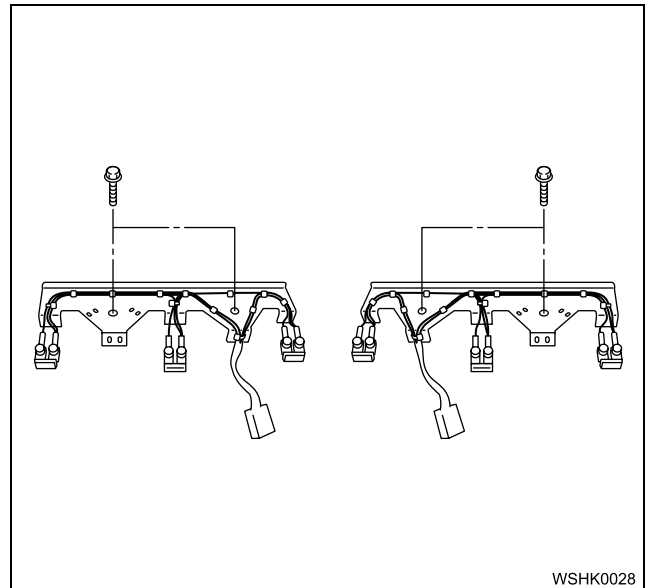
Tightening torque: 4HK1: 48 N·m (35 lb ft)  
6HK1: 22 N·m (16 lb ft)

**4HK1**



LNW21DSH007201

**6HK1**



WSHK0028

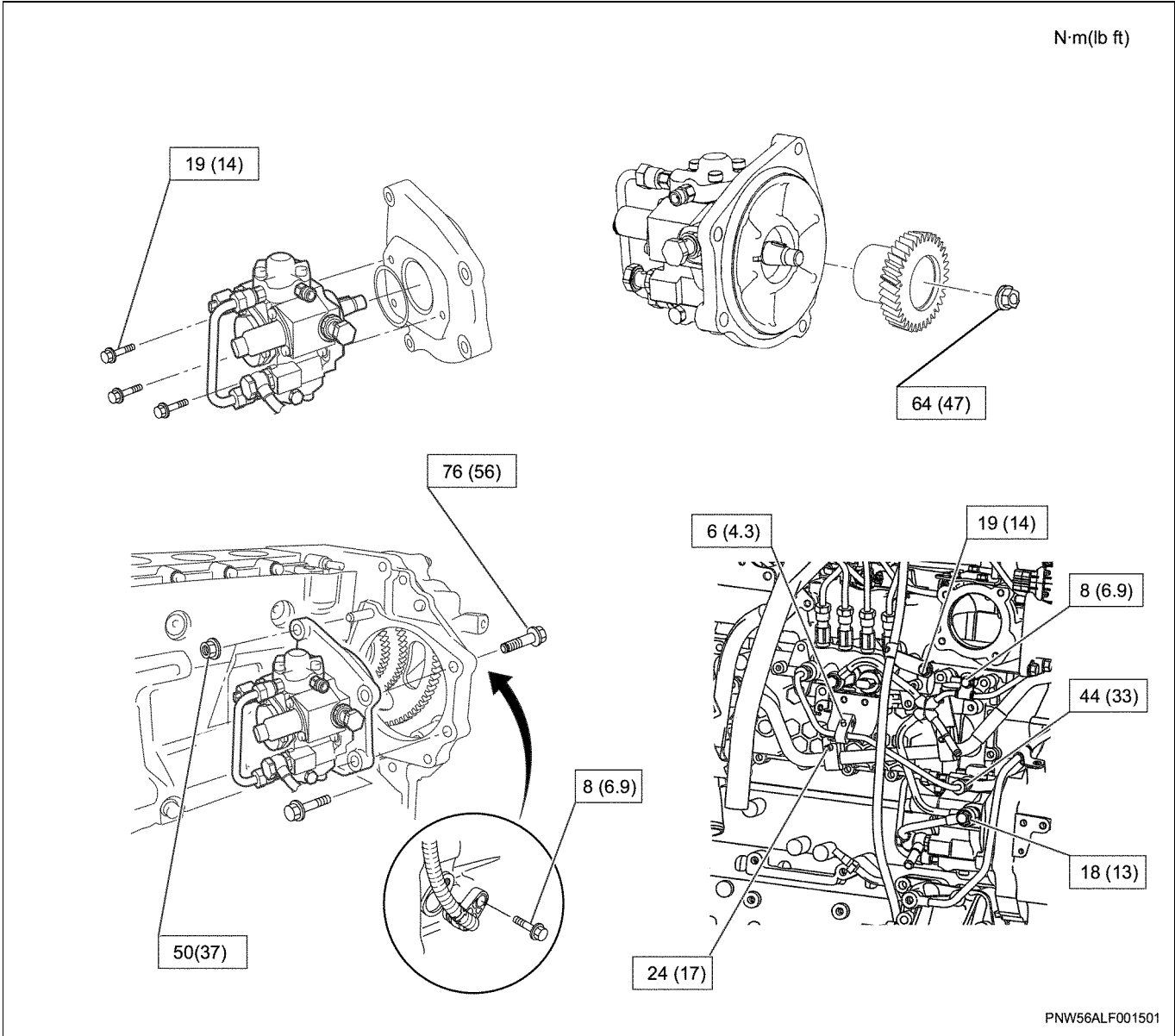
14. Install the fuel injector terminal nuts to the injector.
15. Alternately tighten each nut 2 or 3 turns at a time until the specified torque is reached.

Tightening torque: 2 N·m (17 lb in)

**Caution:**

Do not overtighten the nuts. Damage to the terminal studs will result.

Torque Specifications



\* 4HK1 is shown for illustration.

# ENGINE

## Engine Electrical

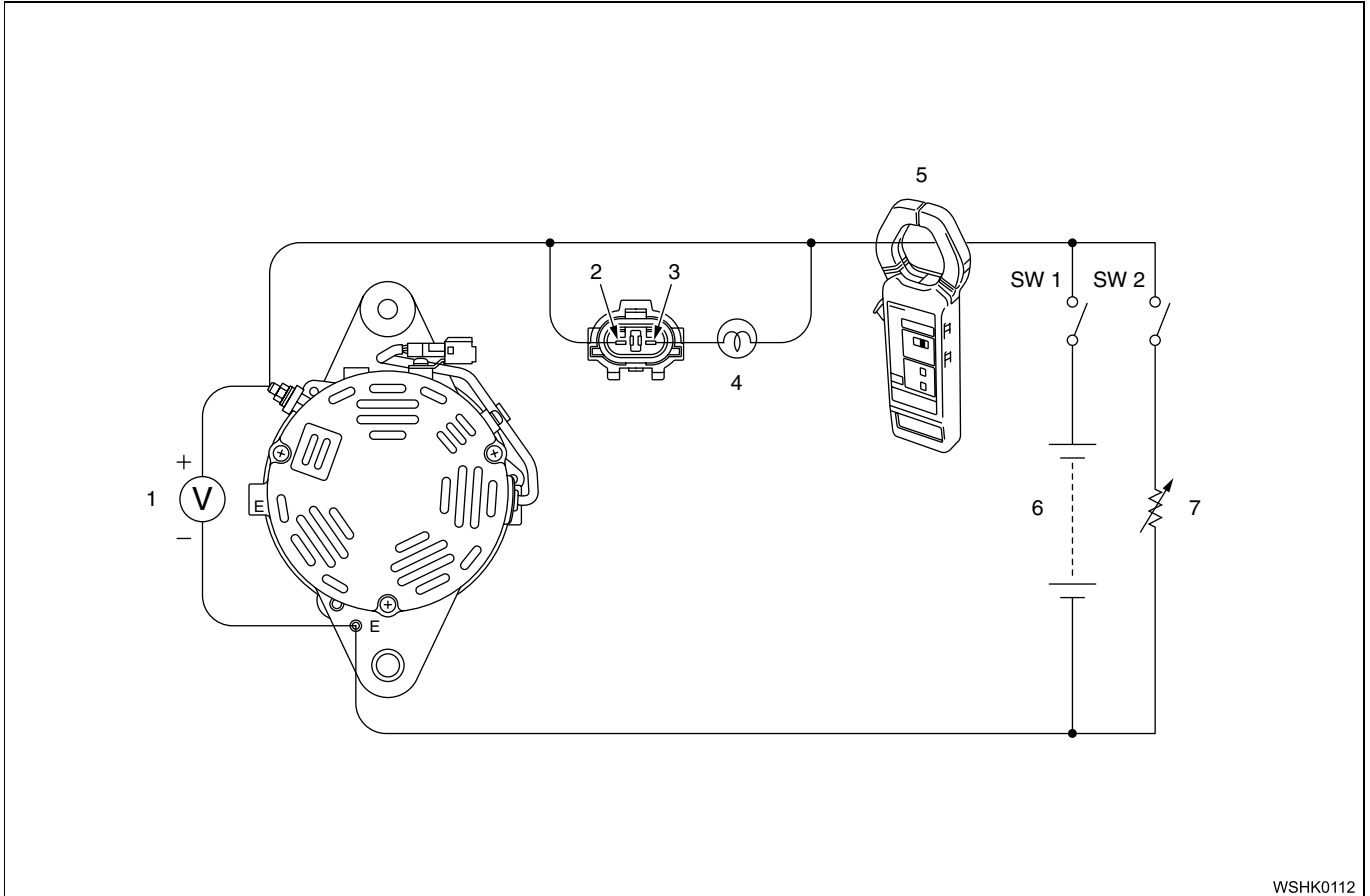
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## Performance test

In the performance test of generator, connect as follows and measure the regulated voltage and output current.

### Actual wiring diagram for performance test of IC regulator built-in generator



WSHK0112

### Disassembly Procedure

- |                           |                         |
|---------------------------|-------------------------|
| 1. Voltmeter              | 5. Clamp Tester Ammeter |
| 2. R Terminal             | 6. Battery 24 V         |
| 3. L Terminal             | 7. Variable Resistor    |
| 4. Charging Lamp 24 V-3 W |                         |

### Regulated voltage measurement of regulator

Close SW1 switch, and warm-up five to ten minutes at approx. 1500 rpm in generator until an ammeter shows 6 A or less.

After confirming that an ammeter shows between 2 and 6 A, set the generator between approx. 3000 to 4000 rpm. If an voltmeter shows between 27.5 and 29.5 V, the regulated voltage of regulator is normal.

If the ammeter shows 6 A or more, charge the battery for a while or replace it with full-charged battery. Replace the regulator if the voltmeter shows out of range between 27.5 and 29.5 V.

Specified value of regulated voltage
27.5 V — 29.5 V (+25°C)

### Measurement of the output current

Close SW1 and SW2 switches, and raise the generator speed to 5000 rpm. While keeping the voltmeter showing 27 V, measure the maximum value of output current with a variable resistor.

In this time, judge as normal if the output current is 50 A or more.

### Caution:

- Do not cut off battery circuit during generator rotating.
- Do not connect to L terminal if the charging lamp (24 V-3 W) is not used. Never connect L terminal and B circuit directly. Diode for excitation may be broken.

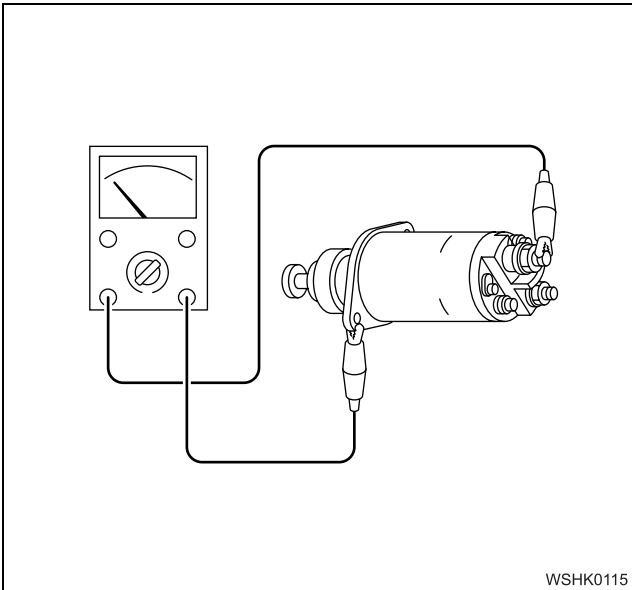
## Inspection and repair of starter

### 1. Magnetic switch

Never perform operational check on magnetic switch as single unit.

### Inspection of coil

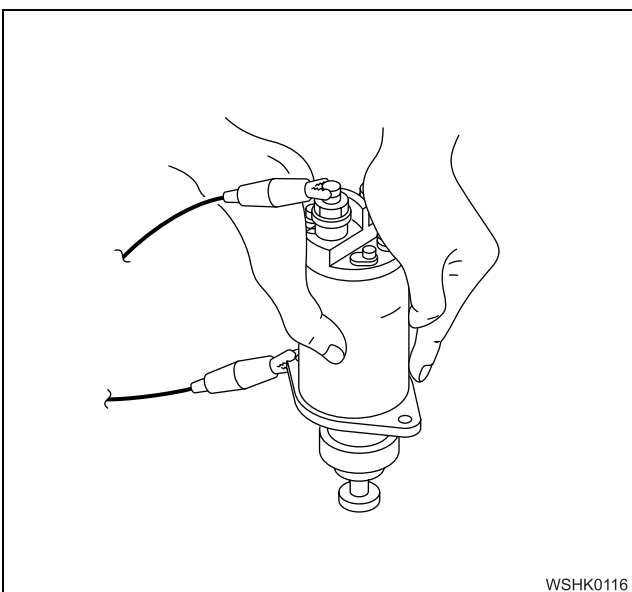
- Check the pressure coil C1 and holding coil C2 for open circuit using a tester. Check the continuity between magnetic switch and M terminal. It has open circuit if no continuity. (Resistance approx.  $1.6\Omega$ )



- Supply 24 V between M terminal of magnetic switch and case, push the plunger by hand, and then release it. It is normal if it is not sucked. Coil is defective if it is sucked.

### Caution:

Perform this while the magnetic switch is set up.

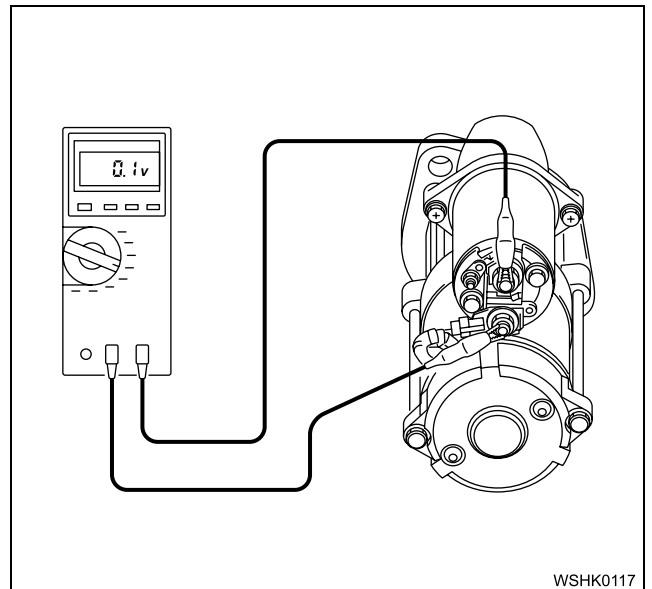


### Contact Point Check

Service limit of contact point is judged by damaged condition on contact surface in the following procedure. Measure the load current on starter. Replace it if voltage drop between terminals B and M is 0.3 V or more per 100 A.

### Caution:

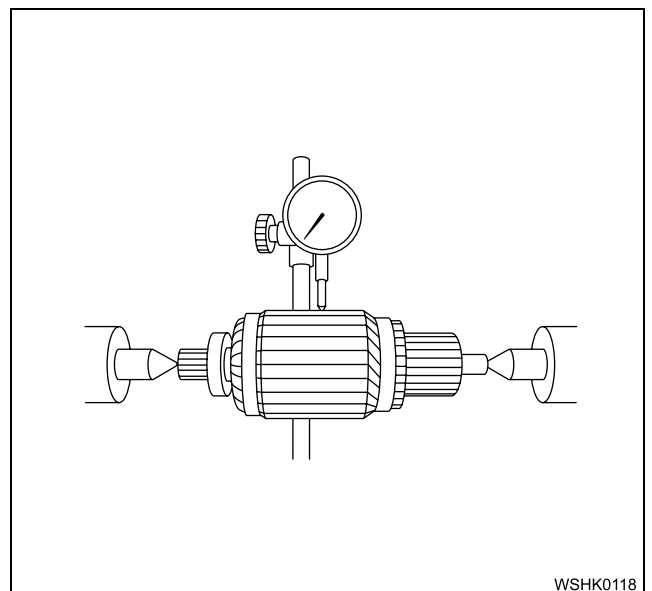
Use a digital voltmeter to measure voltage drop. Using an analog voltmeter may damage itself.



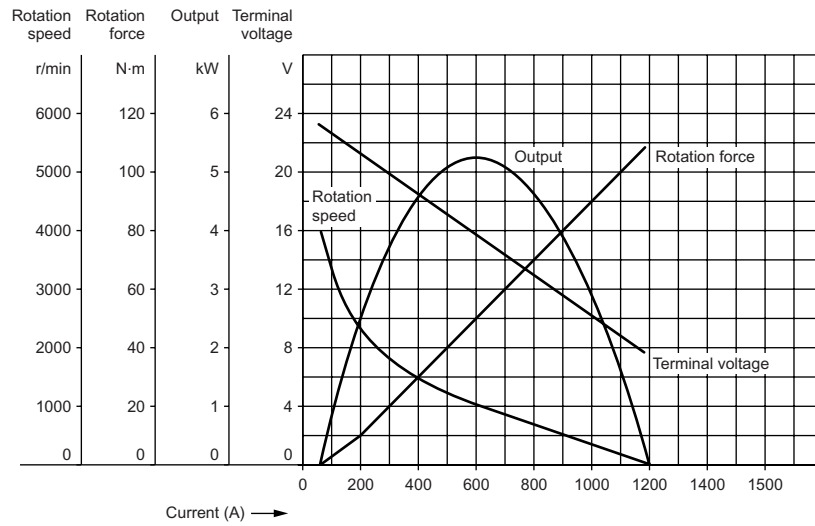
### 2. Armature

#### Bentness measurement of shaft

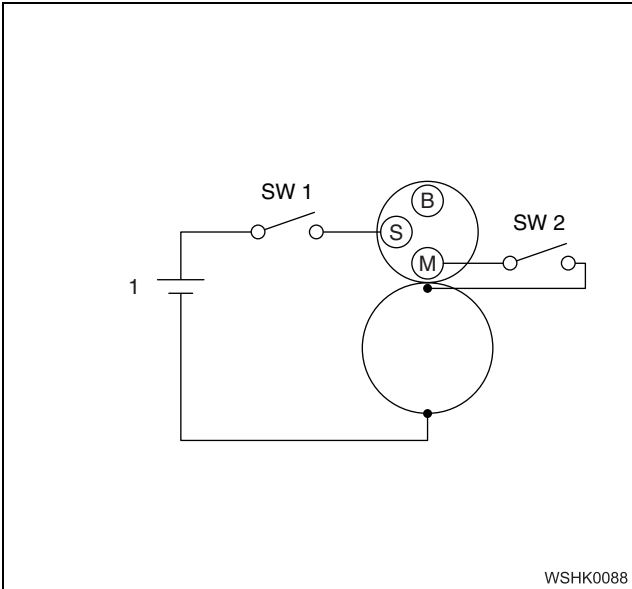
Measure with a dial gauge, and repair or replace if bentness is 0.05mm or more.



Output Characteristic (reference)

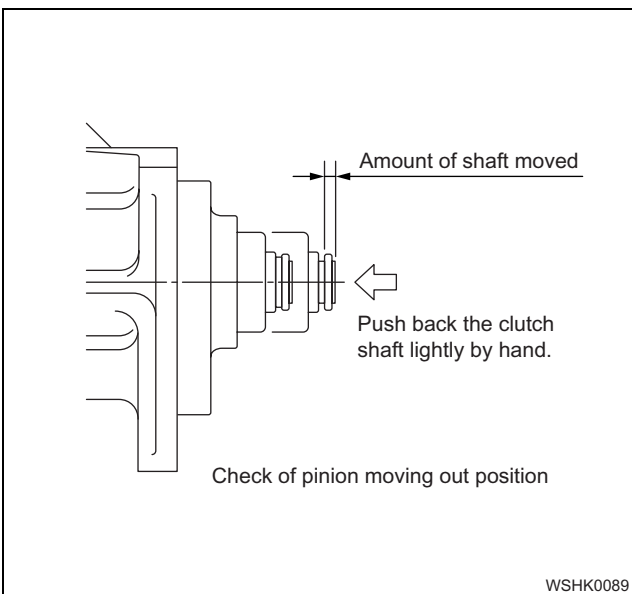


- Push into or pull back a tip of the crankshaft lightly by hand and measure the moving distance of it.  
Adjust by using one or two packings (0.5mm) of magnet switch and front bracket so that this measurement value is between 0.5 — 2.0mm.  
If this adjustment cannot be done, replace the lever.



**Name**

1. Battery 24 V



## 6. Regulator

The regulator cannot be checked with a circuit tester. After re-assembling the generator, check it to make sure that regulator controls the voltage for generator.

## Assembly

Assembly can be performed in the reverse order of disassembly. However, be careful with the following.

1. Lubrication is not necessary. Bearing is filled with grease and is sealed.

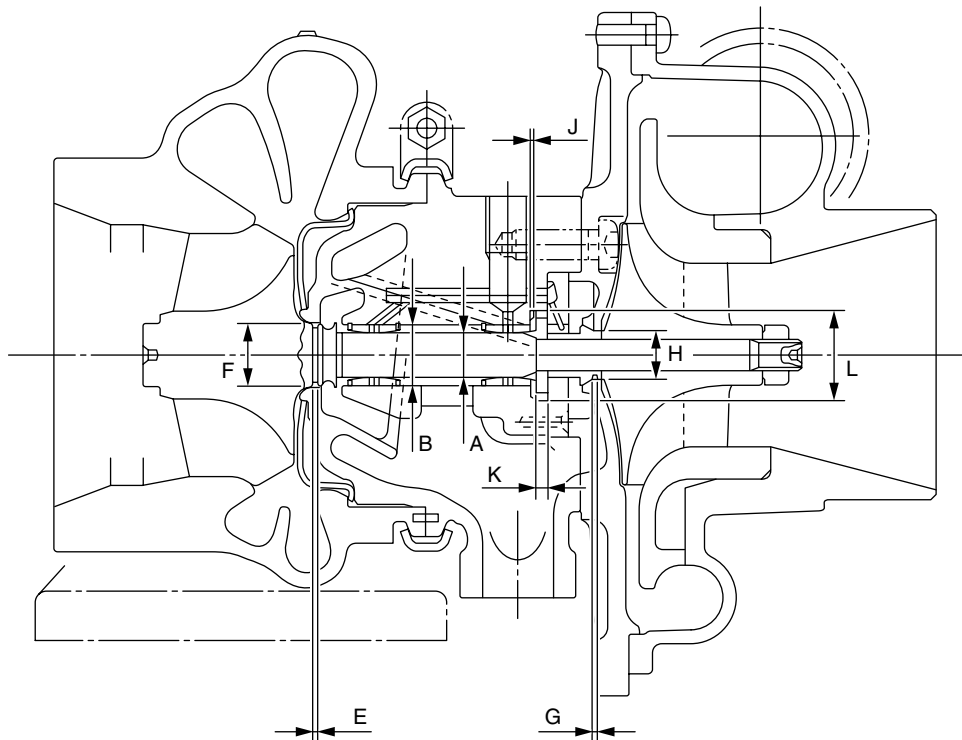
### Caution:

Keep a bearing with resin band for rotor shaft away from oil. Wipe off oil on bearing box area of rear bracket. Oil may cause creep.

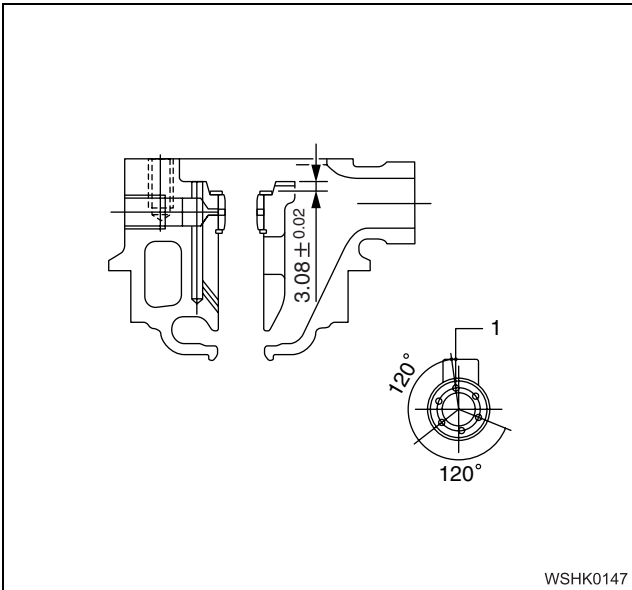
2. Use a high temperature solder (melting point: 230°C).  
Using a soldering iron (with 180 — 270 watt), soldering must be performed quickly (within five seconds) not to heat the rectifier.
3. Tightening torque
  - Pulley fixing nut:  
132 — 162 N·m {13.5 — 16.5 kgf·cm}
  - Through bolt:  
12.8 — 18.6 N·m {1.3 — 1.9 kgf·cm}
  - Bearing retainer fixing screw:  
2 — 5.3 N·m {20 — 54 kgf·cm}
  - Coil assembly fixing screw:  
2 — 5.3 N·m {20 — 54 kgf·cm}
  - Rectifier fixing screw:  
2 — 5.3 N·m {20 — 54 kgf·cm}
  - Regulator fixing screw:  
2 — 5.3 N·m {20 — 54 kgf·cm}
  - Nut for B terminal bolt:  
4.9 — 8.7 N·m {0.5 — 0.9 kgf·cm}
4. Assembly of rear bracket to stator assembly and front bracket to rotor assembly
  - The rotor bearing and rear bracket are engaged tightly. Heat the bearing box area of rear bracket to 50 — 60°C prior to assembly.
  - After re-assembling the generator, rotate the pulley to confirm that the rotor rotates smoothly.

## Table of Specifications

Item		Nominal dimension	Assembly specifications	Service limit
Turbine shaft	Axial play (mm)	—	0.06 — 0.09	0.11
	Radial play (mm)	—	0.10 — 0.17	0.205
	Journal outside diameter (A) (mm)	—	—	$\phi$ 11.380
	Sealing groove width (B) (mm)	—	—	1.33
	Runout (mm)	—	—	0.11
Sealing insertion part	Turbine side (bearing housing) (F) (mm)	—	—	17.03
	Compressor side (seal plate) (H) (mm)	—	—	14.05
Oil thrower	Sealing groove width (G) (mm)	—	—	1.52
Bearing housing	Bearing housing inner diameter (B) (mm)	—	—	$\phi$ 16.11
	Thrust bearing inside diameter for press-fit portion (L) (mm)	—	—	$\phi$ 23.020
Thrust bearing	Bearing pad height at compressor side (J) (mm)	—	0.0 — 0.060	—
	Thrust collar thickness (K) (mm)	—	—	2.950



- b. After press-fitting, check the depth and flatness of the turbine-side thrust bearing.  
(Depth  $3.08 \pm 0.02$ , Flatness is below 0.01: See illustration)

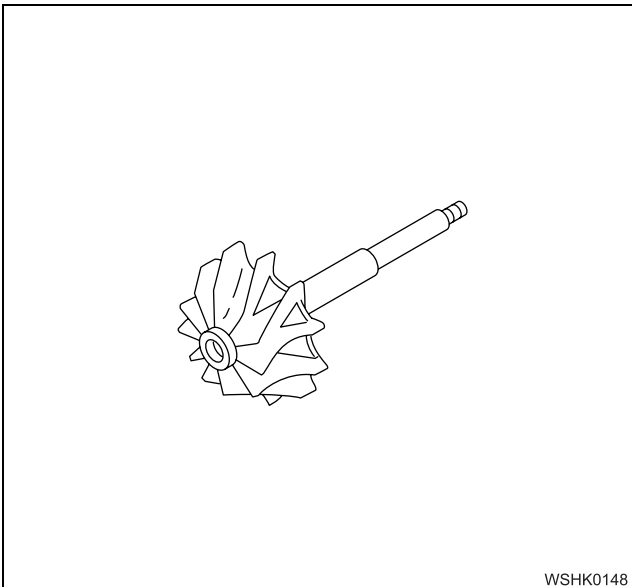


WSHK0147

**Name**

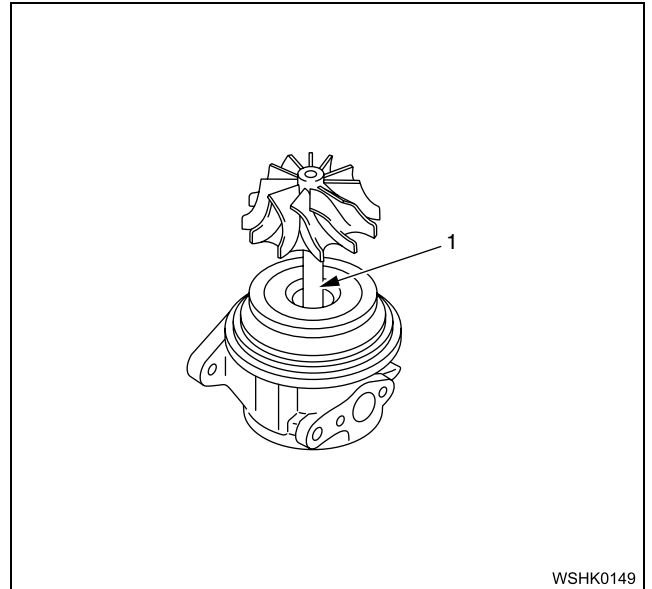
1. Common Tolerance

5. Seal ring
- Insert the seal ring to the turbine shaft.
  - Use new seal ring.
6. Heat protector
- Install the heat protector to the bearing housing.
7. Turbine shaft
- Apply engine oil to the journal portion of the turbine shaft, and insert it from the turbine side of the bearing housing.
  - Take care not to damage the floating metal with the turbine shaft. Also, insert with the end gap of the seal ring facing to the oil inlet side so that its core matches with the turbine shaft.



WSHK0148

8. Thrust collar
- Apply engine oil to the thrust collar, and install it to the turbine shaft.



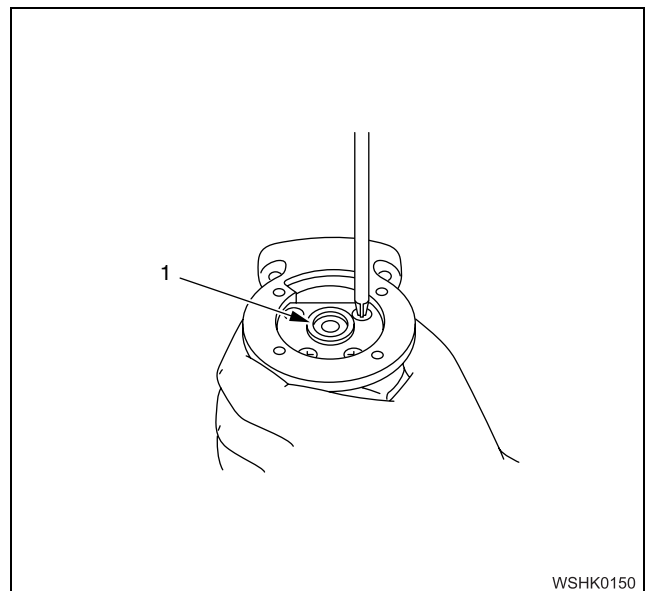
WSHK0149

**Name**

1. Apply Oil.

9. Thrust bearing
- Apply engine oil to the metal portion of the thrust bearing, and insert it to the bearing housing.
  - Apply Loctite to the Plate small screw threads, and install it using torque screwdriver.

Tightening torque: 3.7 N·m (0.38 kgf·m)



WSHK0150

**Name**

1. Apply Oil.

10. Gasket
- Set the gasket to the turbine housing, and install it to the bearing housing.

Electronic control fuel injection system (Common rail type) 10D-6

Abbreviation	Name	Meaning and remarks
SIG	Signal	Signal
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.)

## 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. Past trouble
  - Trouble codes which occurred under the following conditions are called "Past 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. Current trouble
  - Trouble codes which occurred under the following conditions are called "Current 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.

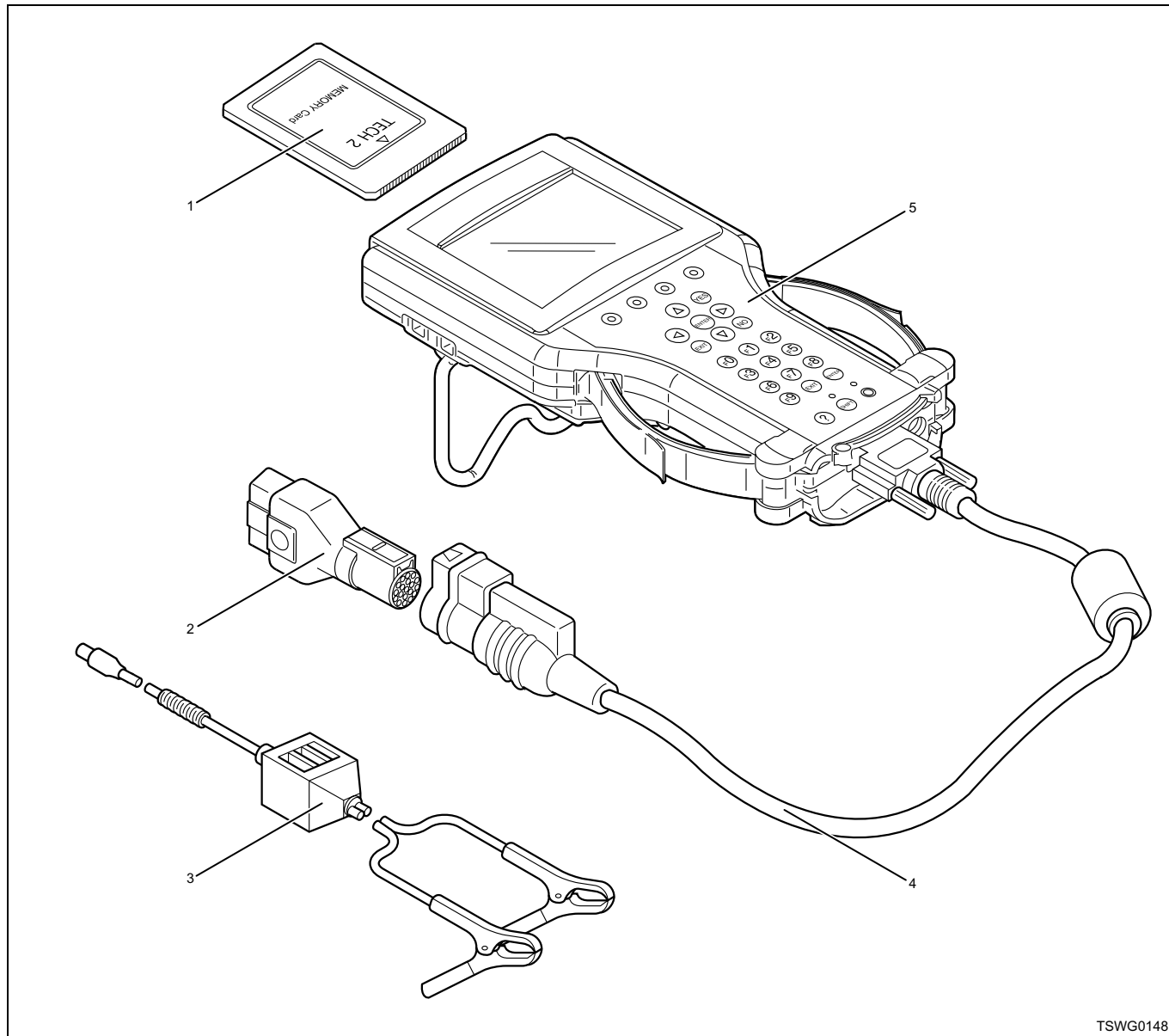
### Diagnosis lamp

Basically, the diagnosis lamp comes on when a fault is detected in electronic control, such as engine control module (ECM).

## How to use trouble diagnosis-related tool

### How to use Tech2

#### Components of Tech2

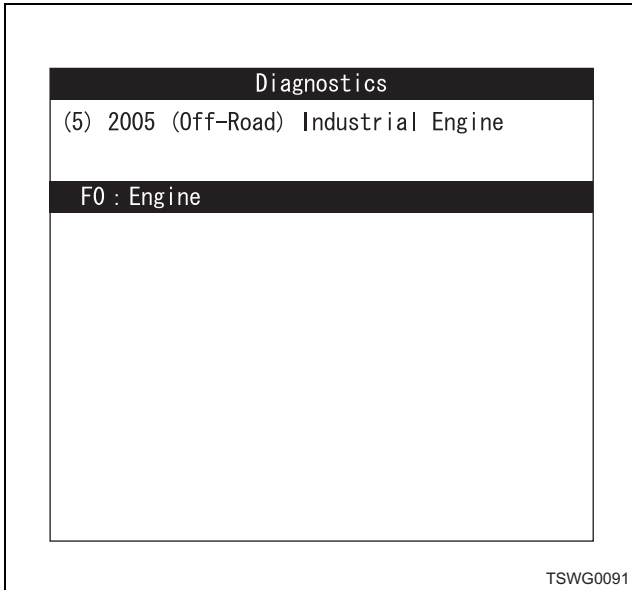


TSWG0148

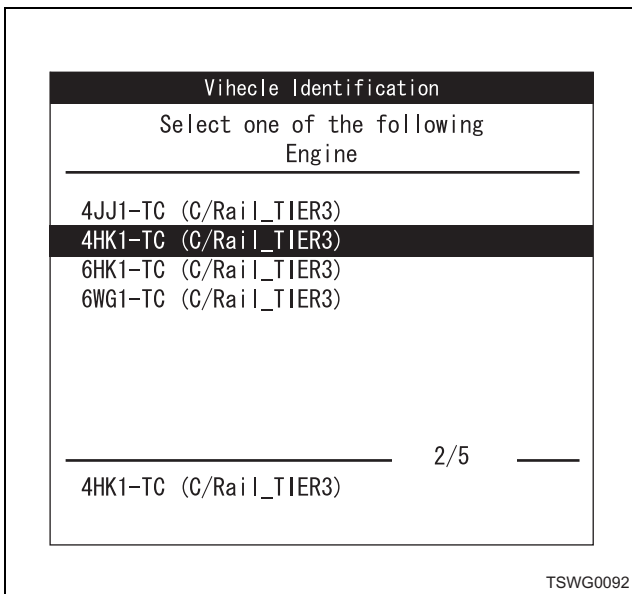
#### Name

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

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



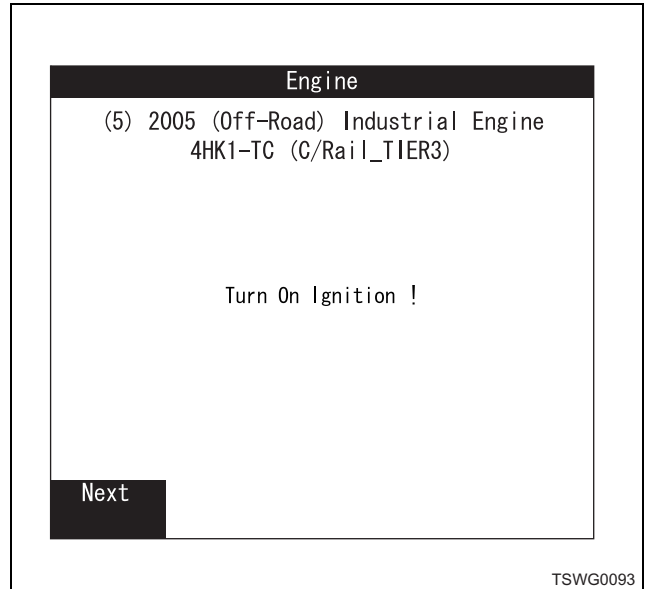
- Select Powertrain (Eng. name) on the "Vehicle Identification" screen and press the [ENTER] key.



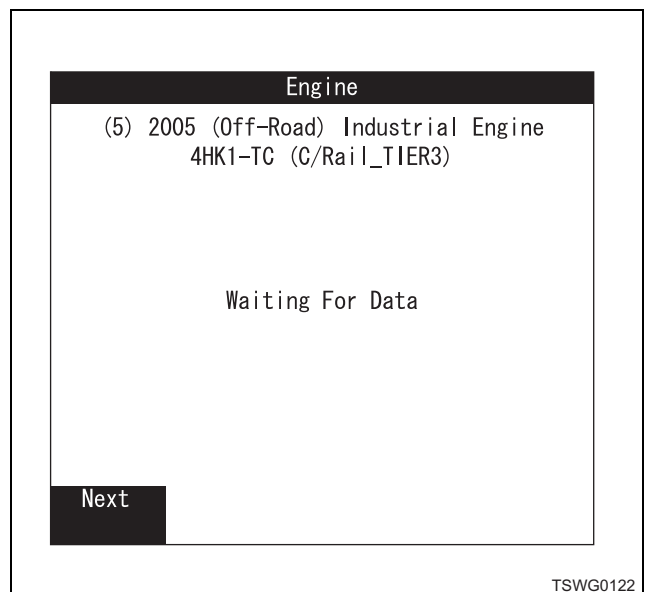
- The items chosen in steps 3 to 6 are shown in the Message Area display section. If the identification of the machine is OK, turn the ignition key "ON" to "START" and press "Next" by following instructions given on the screen.

**Note:**

If you make any mistake, pressing the [EXIT] key will return you to the "Main Menu".



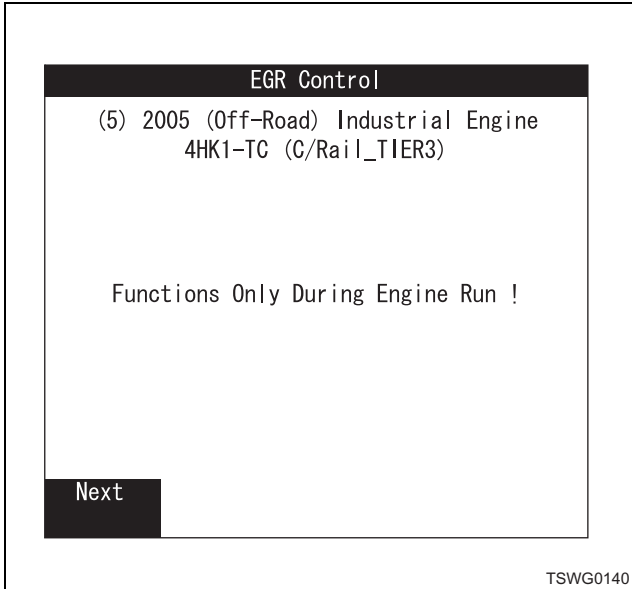
- The following illustration shows the state in which the Tech2 is waiting for communication with the machine controller. If the softkey "Next" is pressed with the ignition key in "OFF", this display will stay forever. (State of communication disabled) However, turning the ignition key "ON" to "START"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



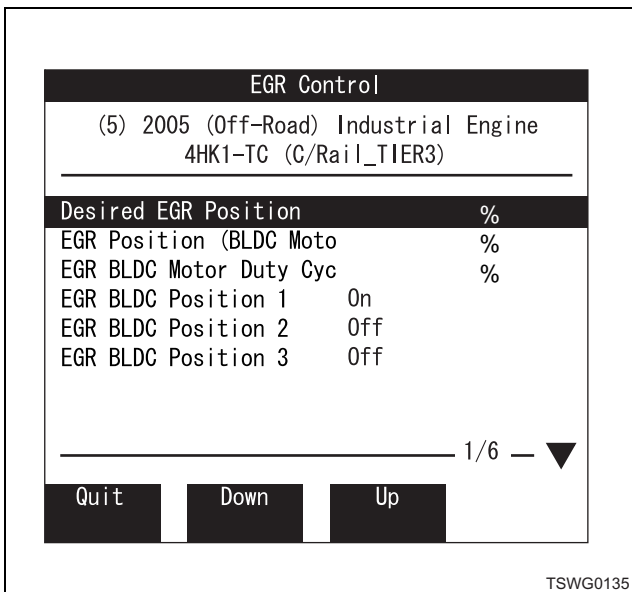
- Once the communication is established, the unit will show the part No. and DDI (Diagnostic Data Identification) (which varies from a system to another). Press the softkey "Confirm" and go on to the application. If any mistake was made in the selection of the vehicle type, despite that the communication 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.

**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.

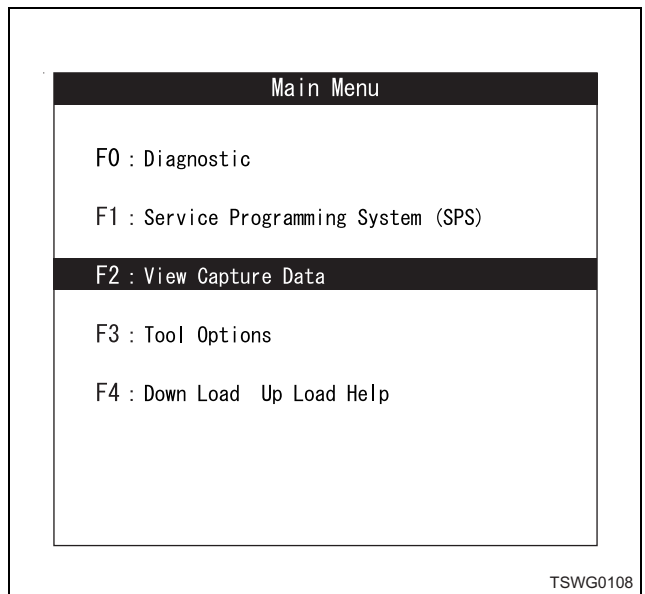
Since the data is saved on the PCMCIA card, it can be viewed after disconnecting the Tech2 (DLC) from the machine. Two data items can be saved there. The internal clock of the Tech2 needs to be set precisely, since the data are identified with dates and times.

**Sample use of snapshot data replay**

1. Turn on the power.

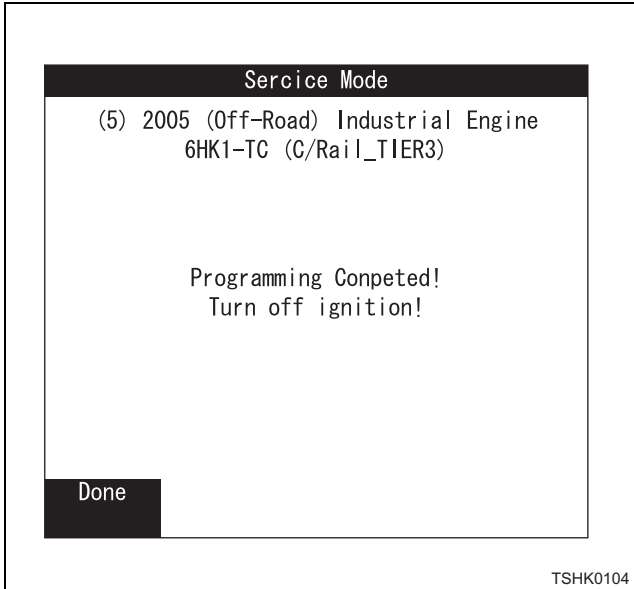


2. Press [ENTER].



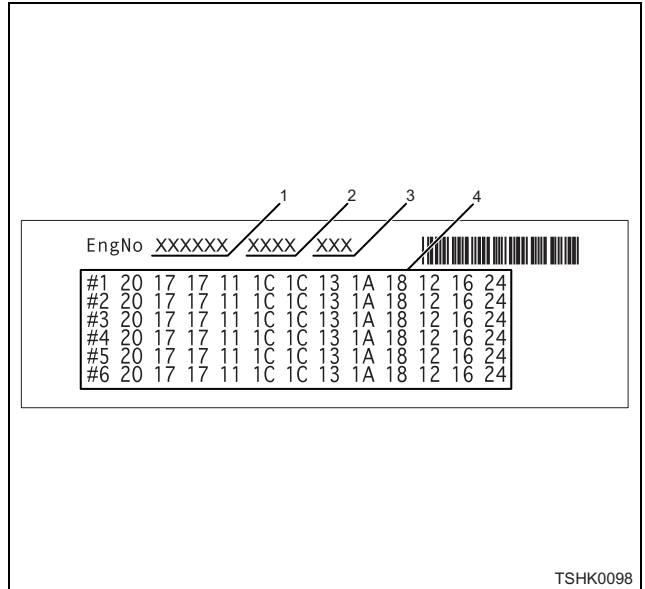
Step 17

- 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.



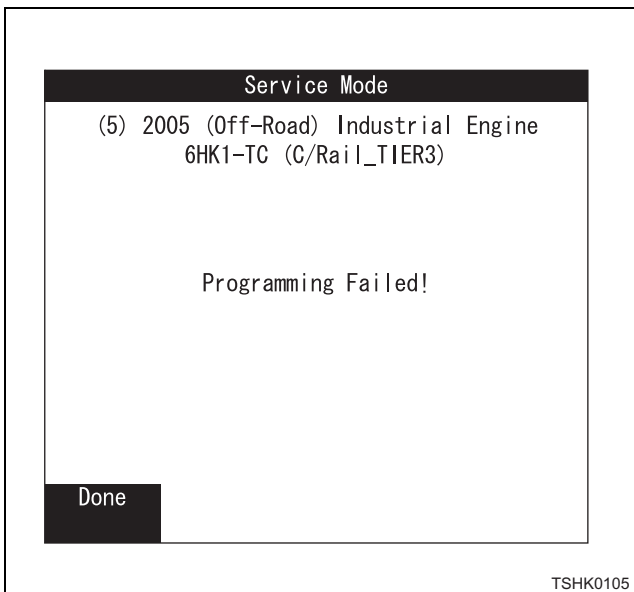
**Injector ID code (No. 1 cylinder – No. 6 cylinder) registration setting using Tech2**

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



Step 17-1

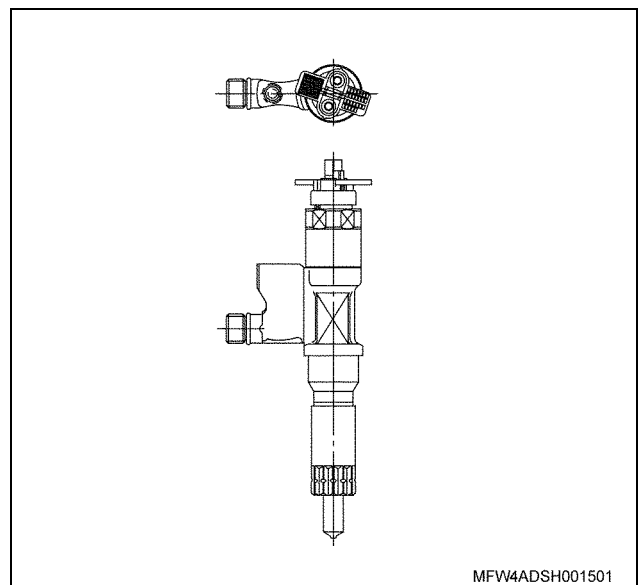
- If the entered Q-key data in Step 15-1 does not correspond to that written in the EEPROM of the ECM, the following message will appear. Pressing the softkey [End] returns you to Step 11.



Name

- Engine number
- Typical engine model
- Q-key information
- Injector information

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



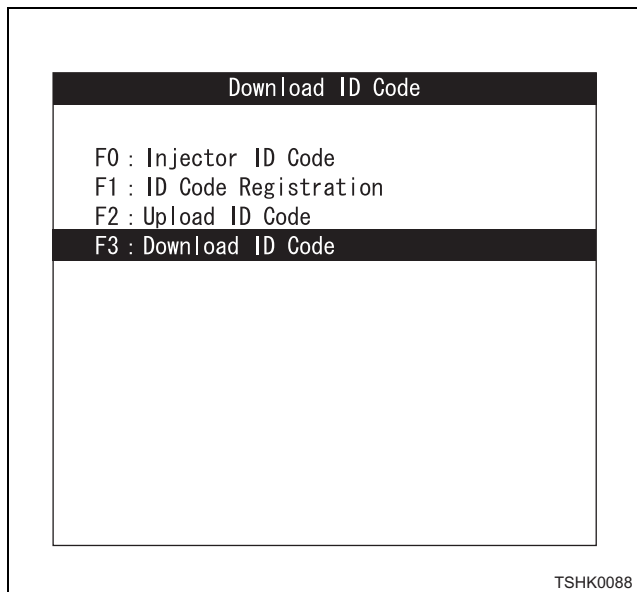
- Refer to the following instruction for how to register Injector ID code.

## ID code download (Tech2)

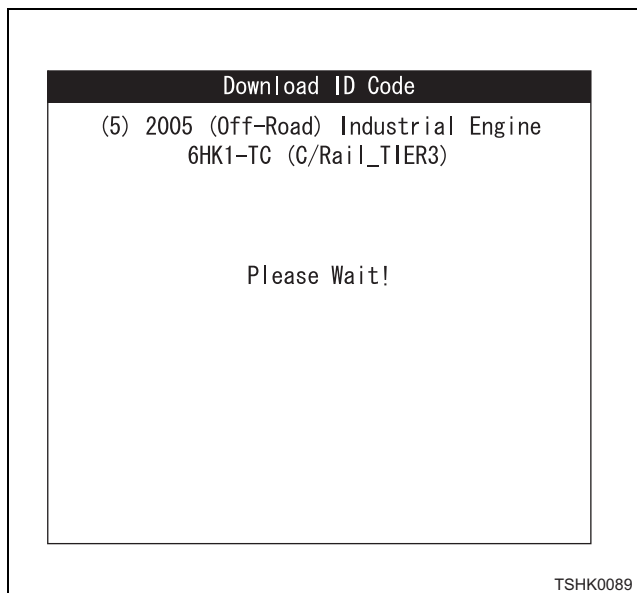
### Step 11

- This step 11 describes ID code registration continued from the step right before.

- Choose the menu F3: ID code download (ECM) with  $\Delta$ ,  $\nabla$  (up/down) keys or F2 (function) key, and press [ENTER].

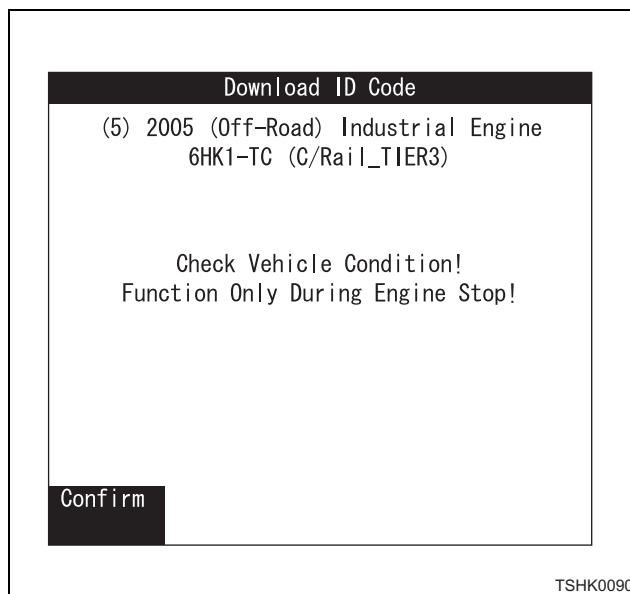


### Step 11-1



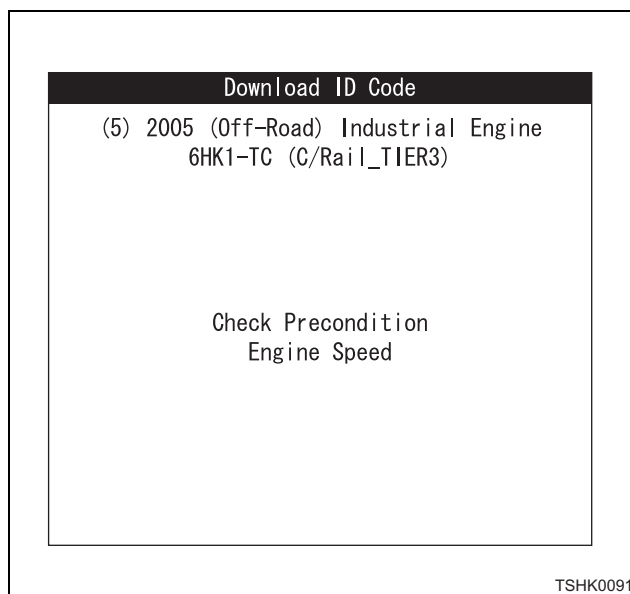
### Step 12

- 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.

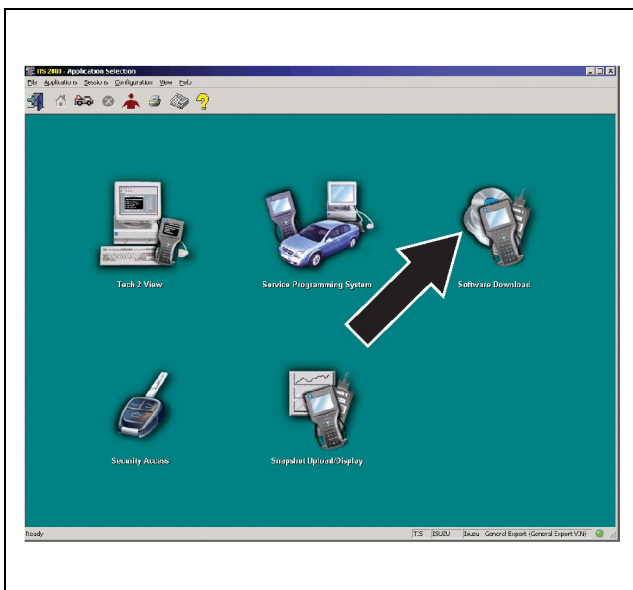


**TIS 2000 navigation**

TIS 2000 application can be operated using the following icons.

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

**Software download**



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

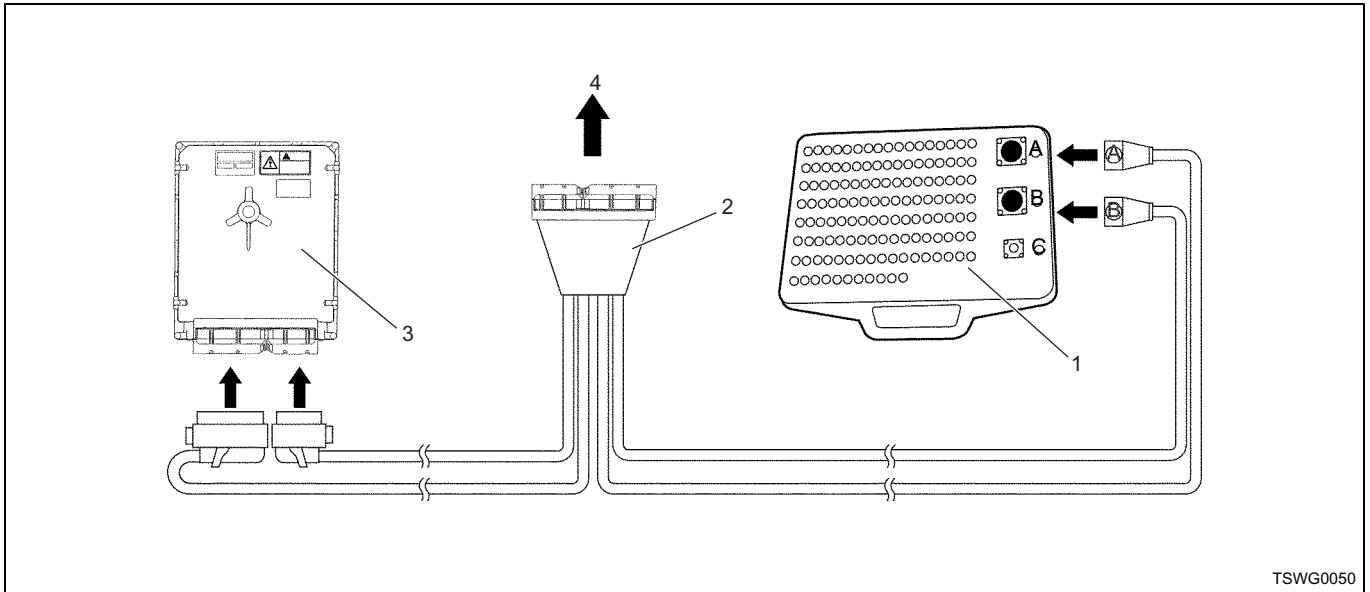
**Updating Tech2 (Software download)**

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”.

Fig. 1: “Application Selection” screen



TSWG0050

Name

1. Breaker box
2. Adapter harness

3. ECM
4. To machine-side harness

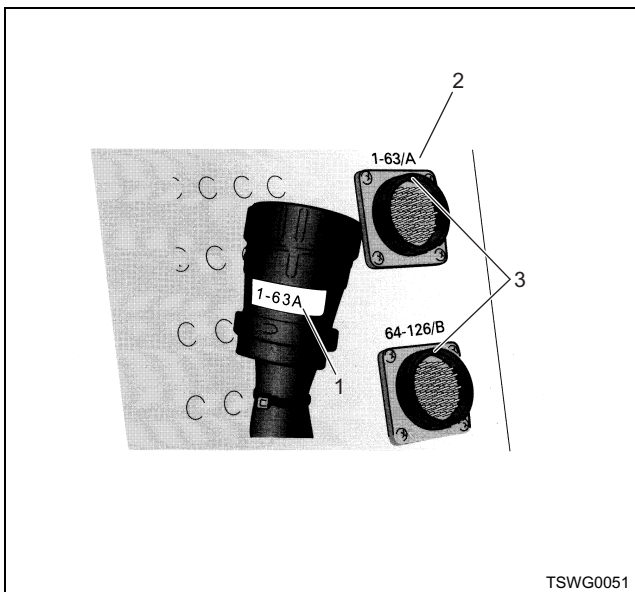
**Caution:**

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.

**Example of use for breaker box**

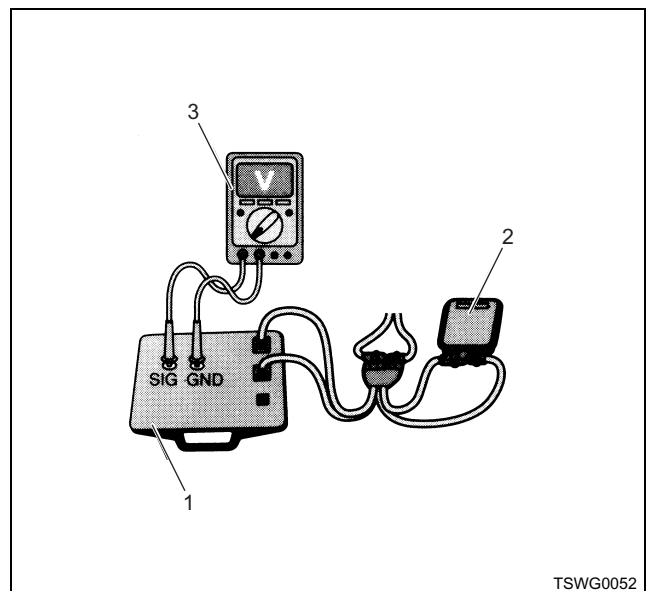
1. Inspection and measurement of voltage
  - Accelerator position sensor
  - Engine coolant temperature sensor
  - Intake air temperature sensor etc.



TSWG0051

Name

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



TSWG0052

Name

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

2. Inspection and measurement of resistance

- Crankshaft position sensor
- Camshaft position sensor
- SCV etc.

**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**

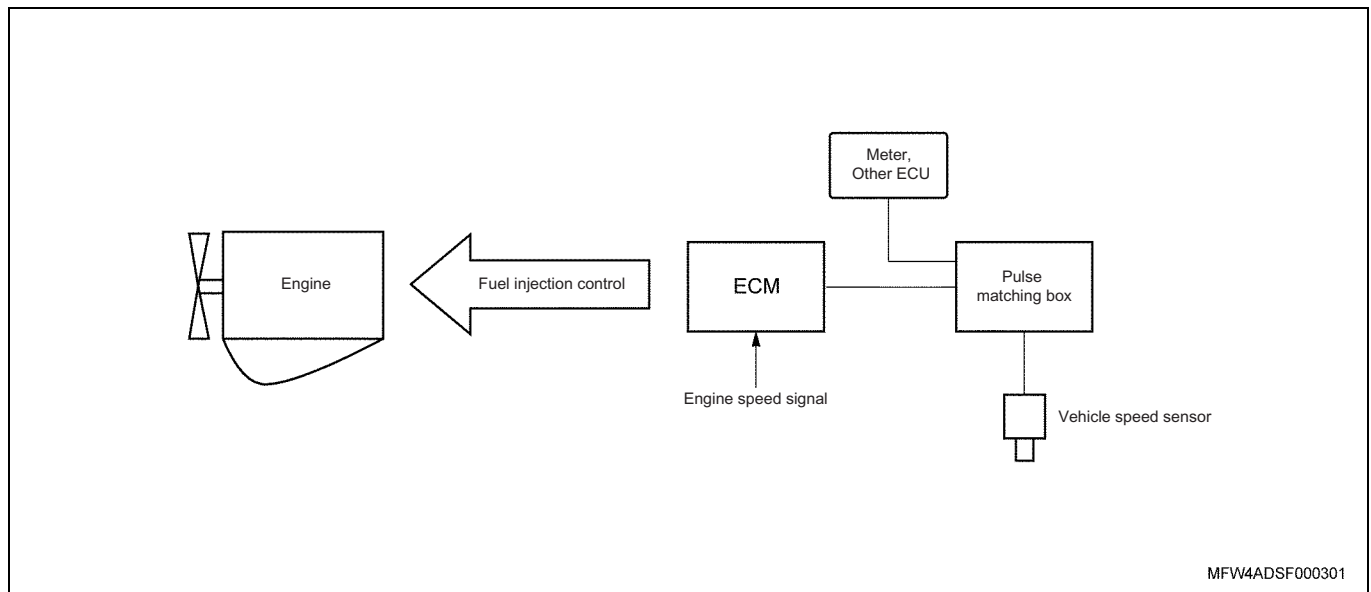
While pressing the “DOWN” side of switch, the engine speed decreases, resulting in decreasing the idling speed. However, the idling speed does not decrease below the lowest speed.

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**

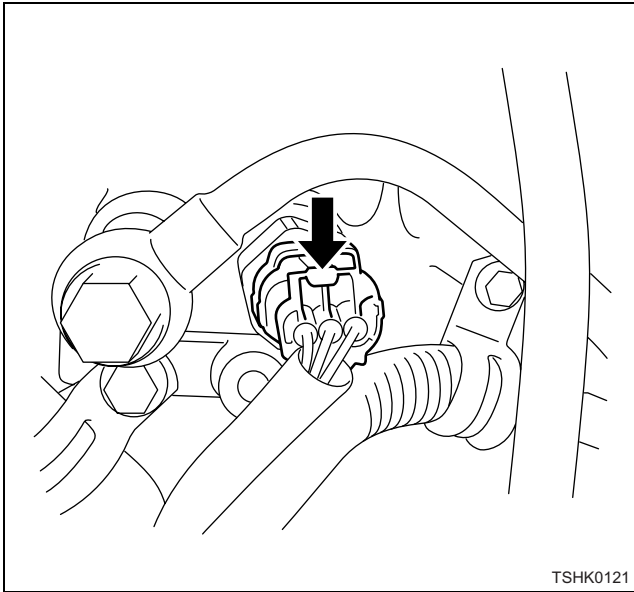
Speed limit control means that the engine control module (ECM) controls fuel injection amount, based on vehicle speed signal and engine speed, so that the machine speed does not exceed the setting value.

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.

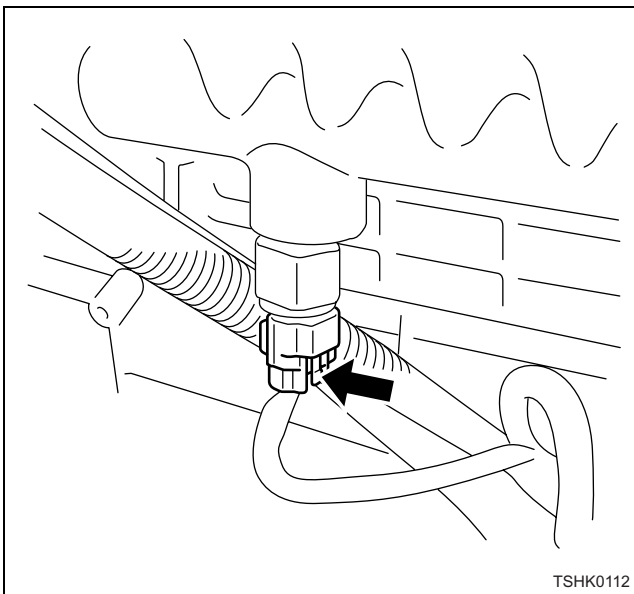


- If it is damaged, replace it as common rail ASM.

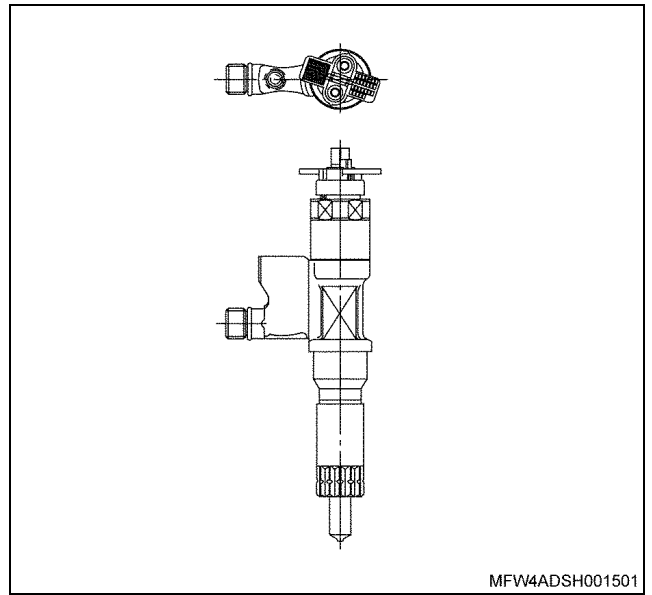
**4HK1**



**6HK1**



**Injector**

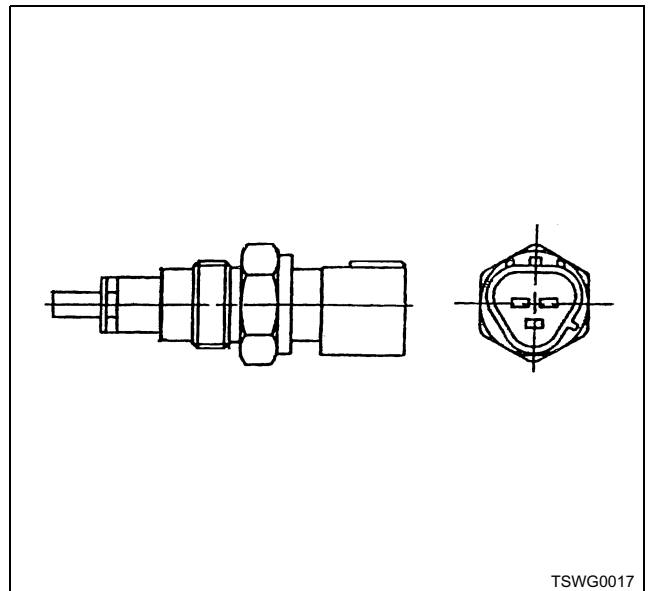


The injector is installed onto cylinder head section and is controlled by engine control module (ECM) to inject fuel. The ECM raises the voltage for operating injectors internally, energizes to injector, and regulates period of electric conduction of injector to control fuel injection amount and injection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

**Note:**

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

**Engine coolant temperature (ECT) sensor**

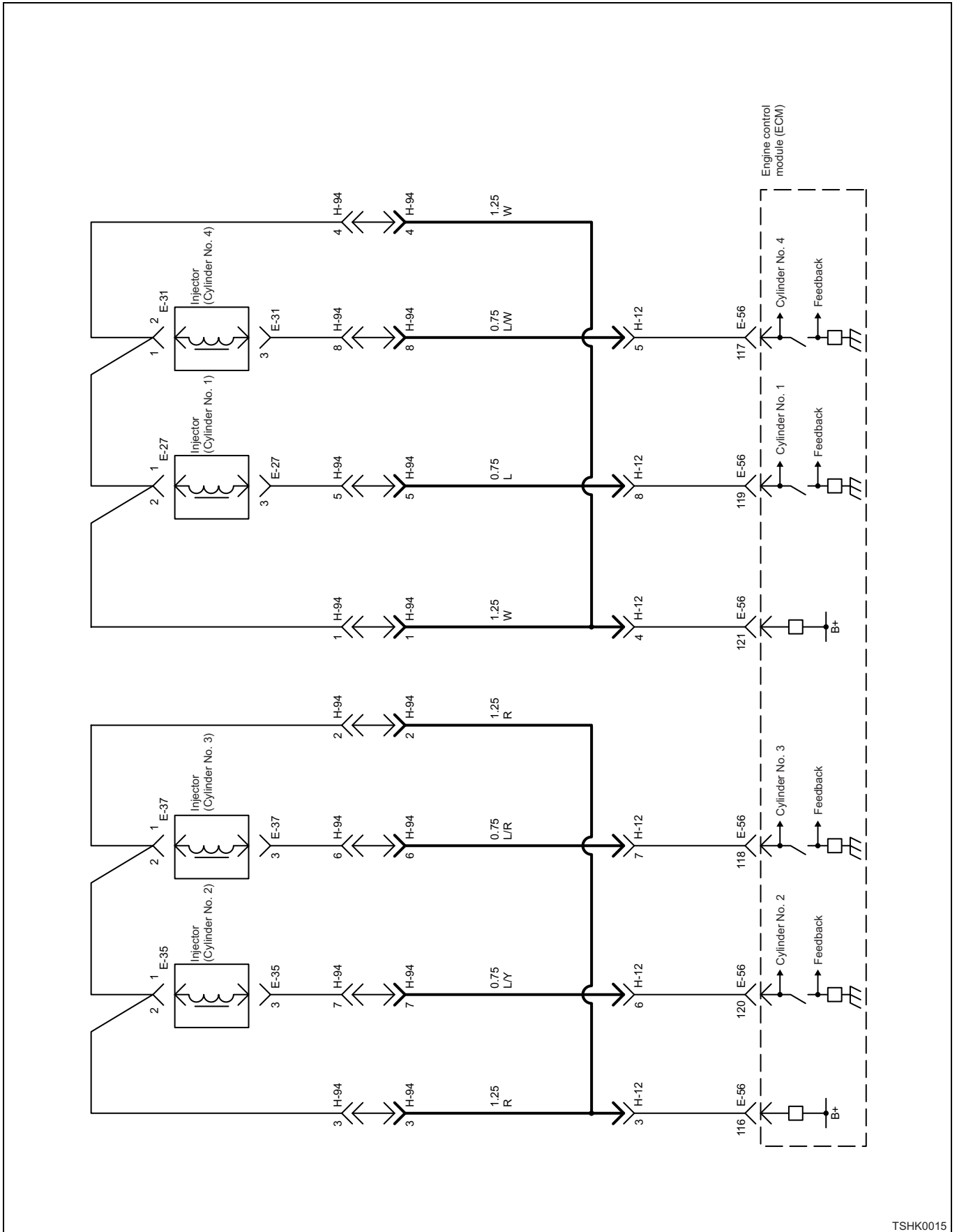


Electronic control fuel injection system (Common rail type) 10D-116

Pin No.	Terminal name	Connection
12	—	—
13	—	—
14	—	—
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	—	—
26	—	—
27	—	—
28	—	—
29	—	—
30	—	—
31	—	—
32	IS-MEMCL	Memory clear switch
33	—	—
34	—	—
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	—	—
49	—	—
50	—	—

Injector circuit

4HK1



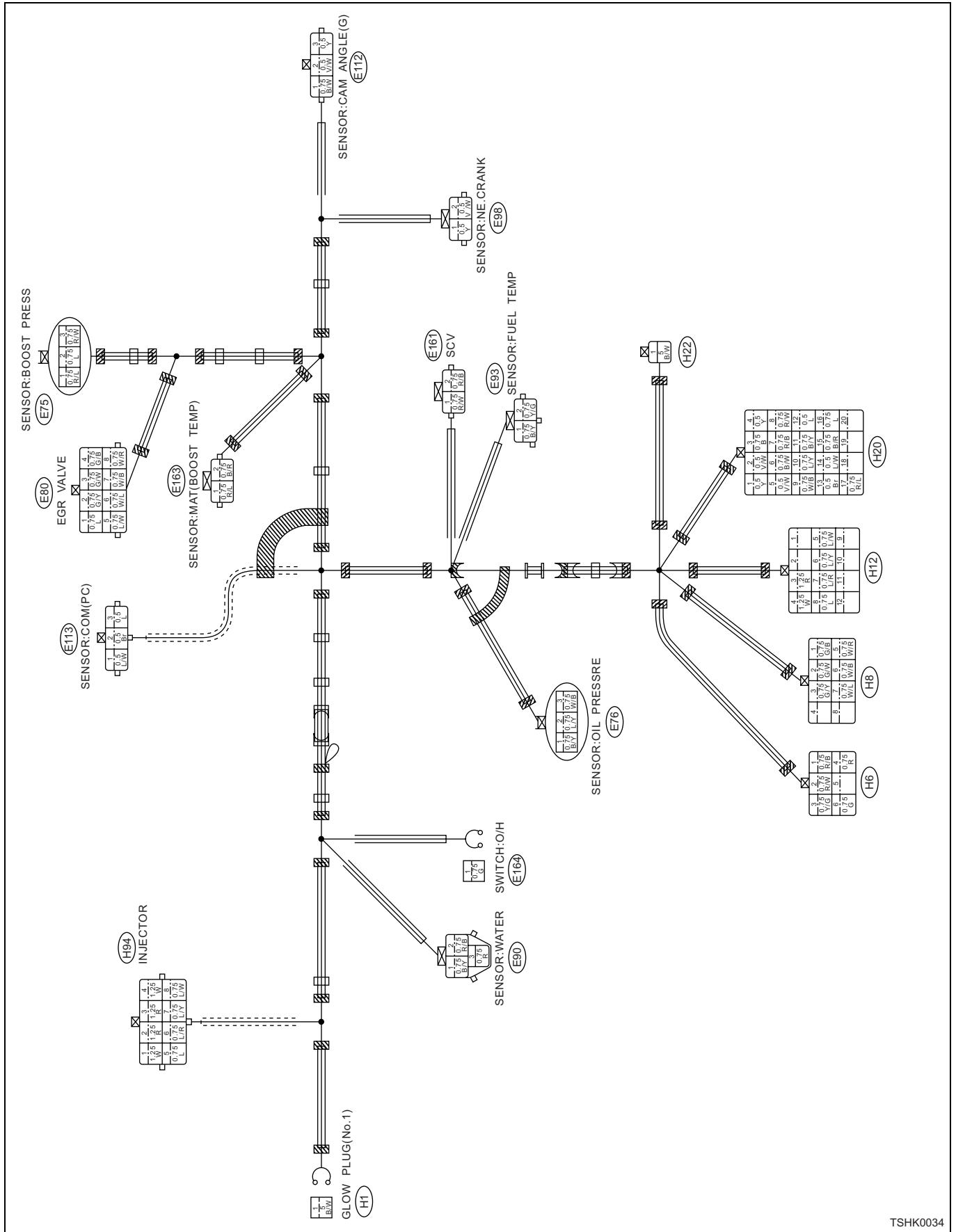
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- You can download the complete manual from: [www.heydownloads.com](http://www.heydownloads.com) by clicking the link below

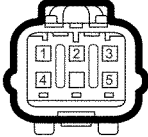


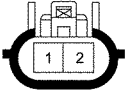
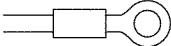
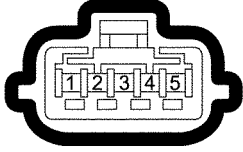
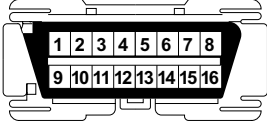
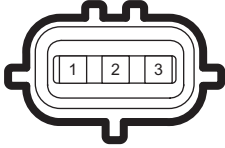


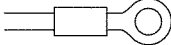
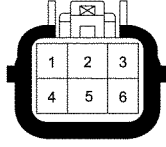
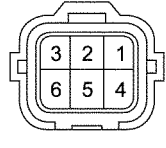
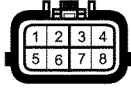

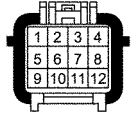
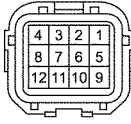
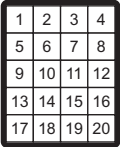
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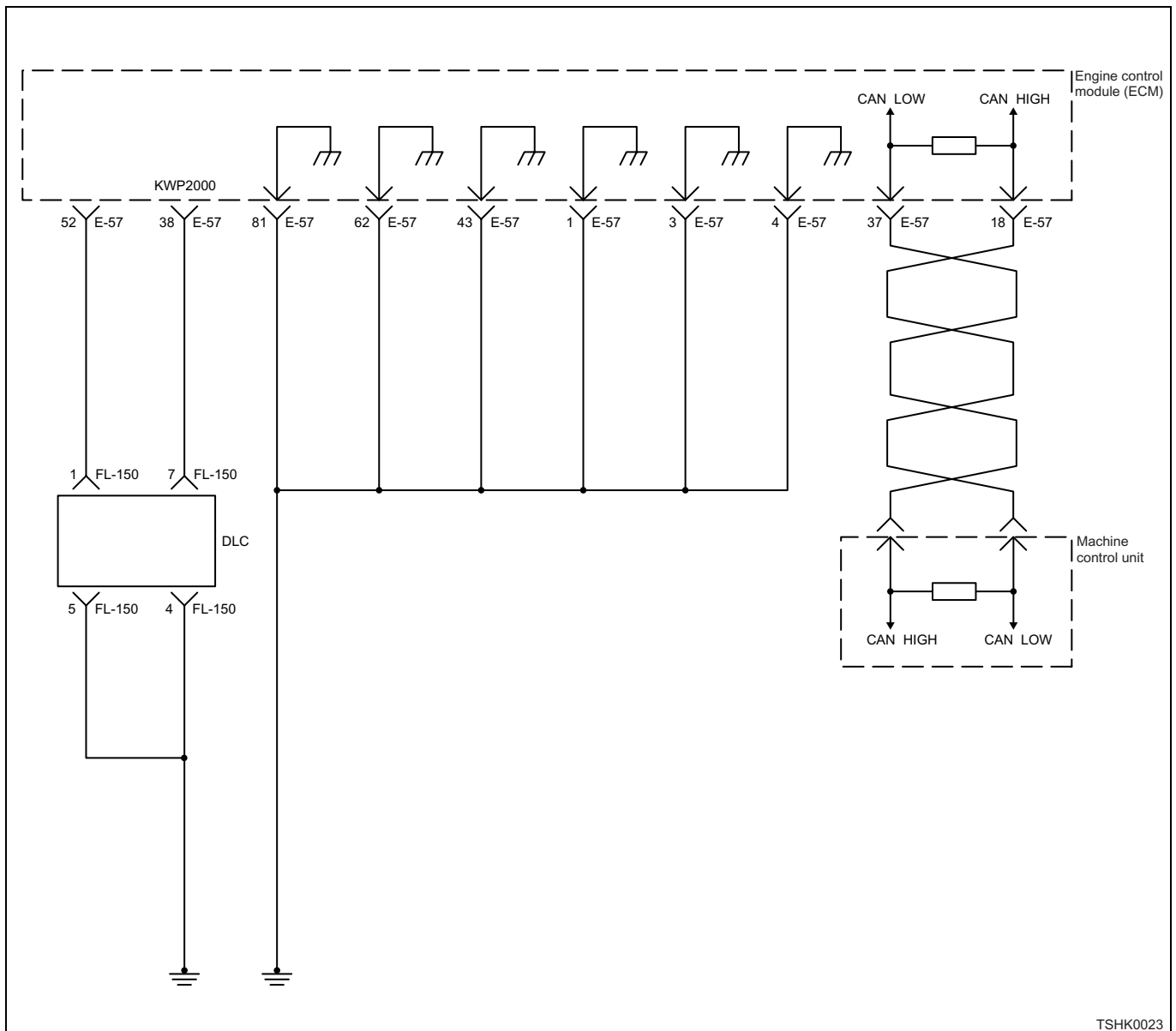


Electronic control fuel injection system (Common rail type) 10D-146

No.	Connector Face
E-114	 <p>(Black)</p> <p>005-034</p>
E-161	 <p>(Brown)</p> <p>002-178</p>
E-162	 <p>(Dark gray)</p> <p>002-178</p>
E-163	 <p>(Gray)</p> <p>002-006</p>
E-164	 <p>000-012</p>
FB-124	 <p>(Black)</p> <p>005-029</p>
FL-150	 <p>016-500</p>
FL-269	 <p>003-502</p>

No.	Connector Face
H1	 <p>(Black)</p> <p>000-012</p>
H-6	 <p>(Gray)</p> <p>006-001</p>
H-6	 <p>(Gray)</p> <p>006-011</p>
H-8	 <p>(Black)</p> <p>008-009</p>
H-8	 <p>(Black)</p> <p>008-010</p>
H-12	 <p>(Gray)</p> <p>012-013</p>
H-12	 <p>(Gray)</p> <p>012-014</p>
H-20	 <p>020-500</p>

## Scan tool power supply circuit system check



TSHK0023

**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:**

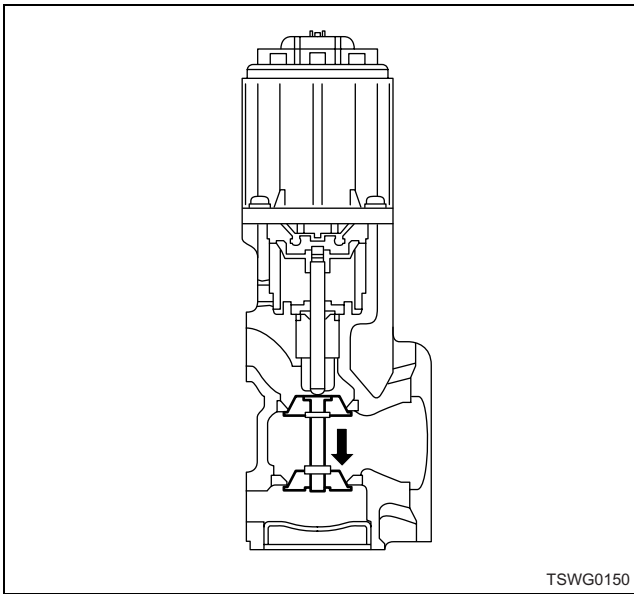
**Before starting this diagnostic step, check if the scan tool operates properly on other machine.**

Electronic control fuel injection system (Common rail type) 10D-166

Step	Item to be checked	Inspection method	Measuring condition	Terminal No.	Normal value	Abnormal value
6, 18	Open circuit/ high resistance	Resistance measureme nt	<ul style="list-style-type: none"> <li>• Key switch "OFF"</li> <li>• Relay alone</li> </ul>	Starter cut relay Switch-side terminal	100Ω or less	10MΩ or more
8, 20	Open circuit/ high resistance	Resistance measureme nt	<ul style="list-style-type: none"> <li>• Key switch "OFF"</li> <li>• Relay alone</li> <li>• Relay "ON"</li> </ul>	Starter relay Switch-side terminal	100Ω or less	10MΩ or more

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.

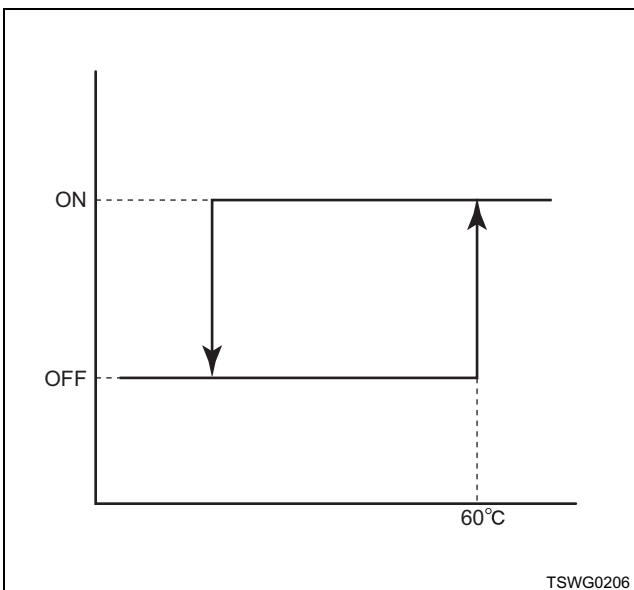
**EGR valve check**



TSWG0150

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**



TSWG0206

Electronic control fuel injection system (Common rail type) 10D-186

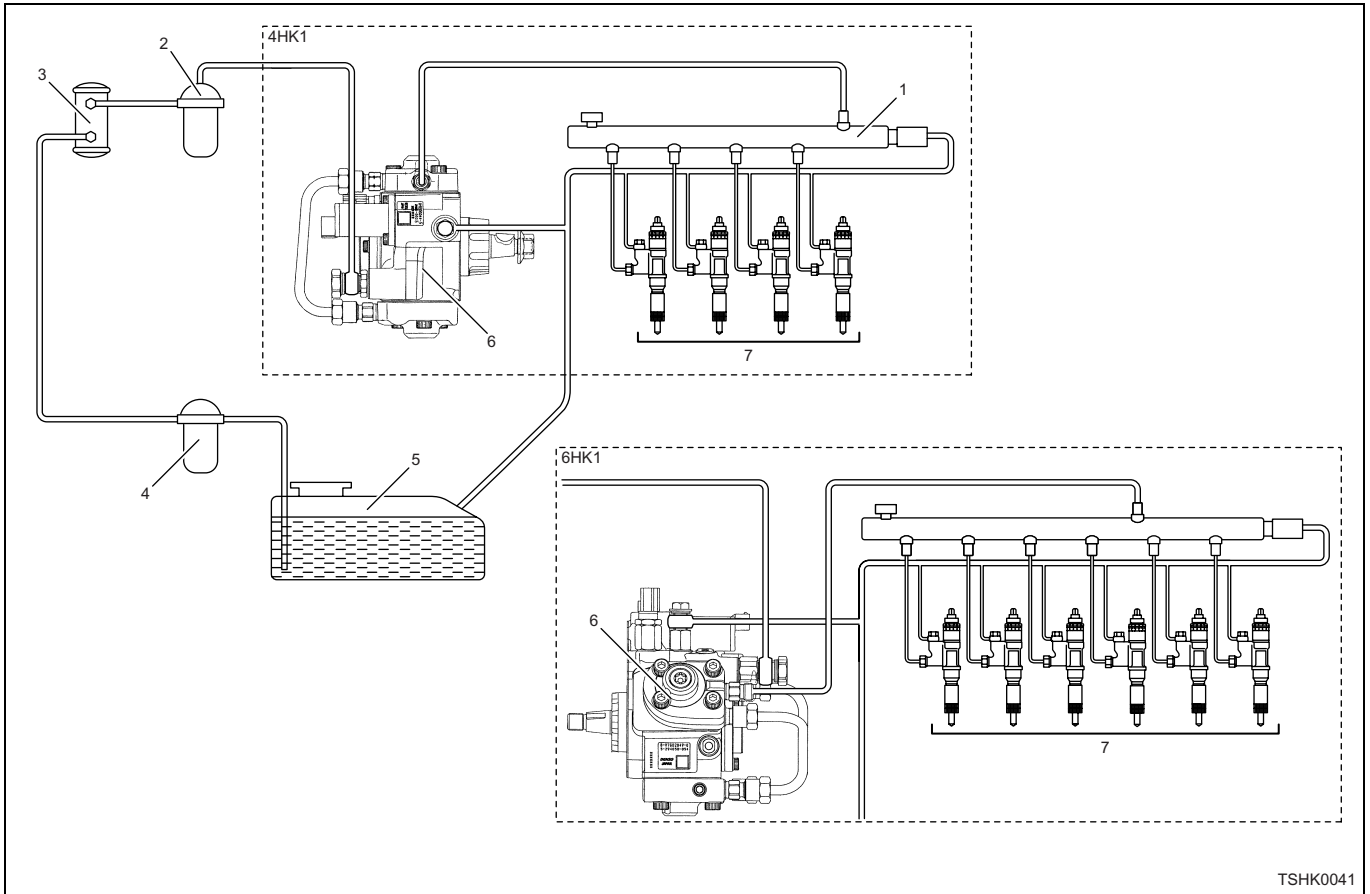
DTC	Flash code	DTC description	Item to be detected	Preconditions when DTC is set	DTC set condition	Fault judgment period	Behavior when trouble occurs	Diagnosis lamp	Recovery from failure
P0487	44	EGR position fault (Brushless specification)	Open/short circuit/ damage of sensor harness	<ul style="list-style-type: none"> <li>Main relay input voltage is 18V or more.</li> <li>DTC P1630 or P1635 is not detected.</li> </ul>	EGR position output signal is abnormal.	Approx. 3 sec.	Operationality is not affected. Back-up: Instruction to fully close EGR valve	ON	*1
P0488	45	EGR valve control fault	Trouble/ open circuit or valve engage/ stuck in drive motor side	<ul style="list-style-type: none"> <li>DTC P1630, P1635, P0487, P0488, or P1635 is not detected.</li> <li>Main relay voltage is between 20 — 32 V.</li> <li>Difference between target EGR opening angle and actual one is 20% or less.</li> </ul>	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	*2
P0522	294	Engine oil pressure sensor fault (low voltage fault)	Open/short circuit/ breakage of sensor or harness	<ul style="list-style-type: none"> <li>Key switch input voltage is 18V or more.</li> <li>DTC P1633 is not detected.</li> </ul>	Engine oil pressure sensor voltage is less than 0.1V.	Approx. 4 sec.	Operationality is not affected. Back-up: Back-up: No back-up action	ON	*1
P0523		Engine oil pressure sensor fault (high voltage fault)	Short circuit in sensor or harness	<ul style="list-style-type: none"> <li>Key switch input voltage is 18V or more.</li> <li>DTC P1633 is not detected.</li> </ul>	Engine oil pressure sensor voltage is more than 4.85V.	Approx. 4 sec.	Operationality is not affected. Back-up: Back-up: No back-up action	ON	*2
P0601	53	ROM fault	ROM fault	—	ROM is faulty.	—	Engine stopped Back-up: Engine stopped	ON	*2
P0603	54	EEPROM fault	EEPROM fault	—	EEPROM is faulty.	—	Operationality is not affected. Back-up: Back-up: No back-up action	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 CPU.	ON	*2
					Sub-CPU detects main CPU fault in 100 msec after key switch ON. (SUB-CPU resets CPU.)	Nearly simultaneous to fault occurrence	Unable to start Back-up: Limited injection amount 2 (multi-injection stopped) SUB-CPU stops CPU.	ON	Diagnosed for 100msec only after KEY-ON.
	52	CPU monitoring IC fault	Sub-CPU fault	<ul style="list-style-type: none"> <li>480 msec or more has elapsed after key switch ON.</li> <li>Key switch input power supply voltage is higher than 16 V.</li> </ul>	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

## Electronic control fuel injection system (Common rail type) 10D-196

DTC	Flash code	DTC description	Item to be detected	Preconditions when DTC is set	DTC set condition	Fault judgment period	Behavior when trouble occurs	Diagnosis lamp	Recovery from failure
P0117	23	Engine coolant temperature sensor fault (low voltage fault)	Short circuit in sensor or harness	<ul style="list-style-type: none"> <li>• Key switch input voltage is 18V or more.</li> <li>• DTC P1630 or P1633 is not detected.</li> </ul>	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: Specified back-up value (depending on the machine manufacturer)	ON	*2
P0118		Engine coolant temperature sensor fault (high voltage fault)	Open/short circuit/breakage of sensor or harness	<ul style="list-style-type: none"> <li>• Key switch input voltage is 18V or more.</li> <li>• DTC P1630 or P1633 is not detected.</li> <li>• 3 minutes or more has elapsed after starting engine.</li> </ul>	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, at driving: 80°C) EGR stopped	ON	*2
P0182	211	Fuel temperature sensor fault (low voltage fault)	Short circuit in sensor or harness	<ul style="list-style-type: none"> <li>• Key switch input voltage is 18V or more.</li> <li>• DTC P1630 or P1633 is not detected.</li> </ul>	Combustion temperature sensor voltage is less than 0.1 V.	Approx. 4 sec.	Operationality is affected. Back-up: Specified back-up value (depending on the machine manufacturer)	ON	*2
P0183		Fuel temperature sensor fault (high voltage fault)	Open/short circuit/breakage of sensor or harness	<ul style="list-style-type: none"> <li>• Key switch input voltage is 18V or more.</li> <li>• DTC P1630 or P1633 is not detected.</li> <li>• 3 minutes or more has elapsed after starting engine.</li> </ul>	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, at running: 70°C)	ON	*2
P0192	245	Common rail pressure sensor fault (low voltage fault)	Short circuit in sensor or harness	<ul style="list-style-type: none"> <li>• Key switch input voltage is 18V or more.</li> <li>• DTC P1630 or P1635 is not detected.</li> </ul>	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 (depending on the machine manufacturer)	ON	*2
P0193		Common rail pressure sensor fault (high voltage fault)	Open/short circuit/breakage of sensor or harness	<ul style="list-style-type: none"> <li>• Key switch input voltage is 18V or more.</li> <li>• DTC P1630 or P1635 is not detected.</li> </ul>	Common rail pressure sensor voltage is more than 4.5 V.	Nearly simultaneous to fault occurrence	Engine stall possible Output lowering Back-up: Specified back-up value (depending on the machine manufacturer)	ON	*2

**DTC: P0087 (Flash code 227)**

**Common rail low pressure fault (No pressure feed in supply pump)**



TSHK0041

**Name**

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

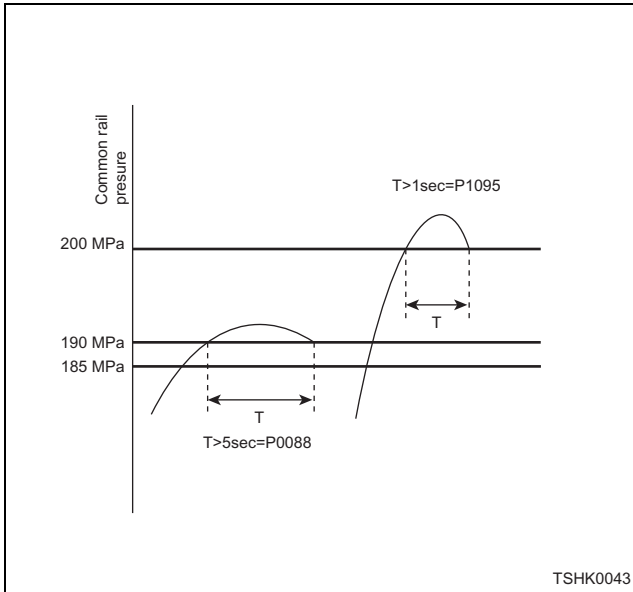
**DTC set condition**

1st step

- Rail pressure is more than 185MPa 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 190MPa for 5 seconds or more.
- Common rail pressure sensor voltage is 4.0 V or more.



**Action taken when DTC is set**

- Fault indication\* is displayed on the monitor of the machine or diagnosis lamp comes on. (\* Nothing is displayed depending on the machine manufacturer)

**Back-up mode**

- Limited injection amount 3 (multi-injection stopped)

- Target RP upper limit (80MPa)

**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 current trouble turns to past trouble (history) 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 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 routing
- Worn harness cladding
- Wire disconnection inside harness cladding

Following inspections are necessary to detect these causes.

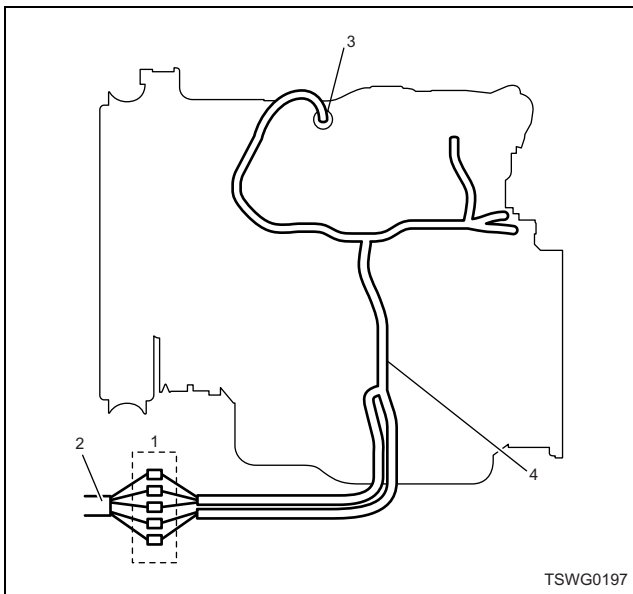
- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items 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.
3	Is the scan tool (KW communication) available?	—	Go to Step 4.	Go to Step 5.

Electronic control fuel injection system (Common rail type) 10D-226

Step	Action	Value	YES	NO
5	<p>1. Check for followings in the circuit between SCV and ECM using breaker box or DMM. Refer to "Breaker box inspection procedure".</p> <ul style="list-style-type: none"> <li>• Short circuit between terminals</li> <li>• Short circuit to power supply circuit or ignition power supply circuit</li> <li>• Short circuit to other signal circuit</li> </ul> <p>2. If the trouble is detected, repair or replace as required.</p> <p>Is the trouble detected?</p>	—	Go to Step 12.	Go to Step 6.
6	<p>Check the SCV body.</p> <ol style="list-style-type: none"> <li>1. Turn the key switch to "OFF".</li> <li>2. Disconnect the harness from the SCV.</li> <li>3. Measure the resistance between the SCV connector terminals.</li> </ol> <p>Is the resistance specified value?</p>	<p>Between terminals: 3.2±0.3 Ω; Each terminal to SCV body: ∞Ω (at normal temperature)</p>	Go to Step 8.	Go to Step 7.
7	<p>Replace the supply pump (SCV).</p> <p><b>Note:</b> <b>For work procedure, refer to "Engine section" in the service manual.</b></p> <p>Is the procedure completed?</p>	—	Go to Step 12.	—
8	<p>Check the DTC again.</p> <ol style="list-style-type: none"> <li>1. Connect all the harnesses.</li> <li>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.</li> <li>3. Turn the key switch to "OFF" for more than 10 seconds.</li> <li>4. Start the engine, and test run with the "Preconditions when DTC is set".</li> <li>5. Check the DTC.</li> </ol> <p>Is the DTC P0090 detected?</p>	—	Go to Step 9.	Go to "Diagnostic aid".
9	<p>Is EMPS available?</p>	—	Go to Step 10.	Go to Step 11.
10	<ol style="list-style-type: none"> <li>1. Check the version of ECM software.</li> <li>2. Rewrite the software if version upgraded is necessary.</li> </ol> <p>Refer to "How to use flush tool" in this section for check and rewriting of ECM.</p> <p><b>Note:</b> <b>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.</b></p> <p>Is the procedure completed?</p>	—	Go to Step 12.	Go to Step 11.

**On-board check of sensors**



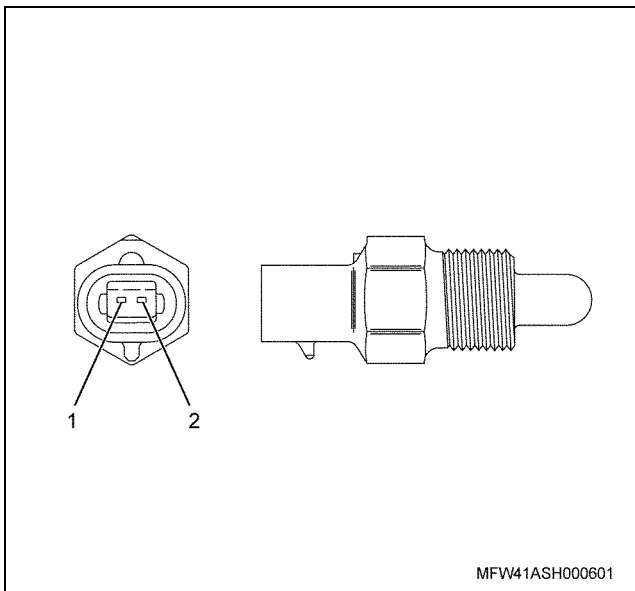
**Name**

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.
  - If only step 1 is faulty, replace the sensor.

Step	Action	Value	YES	NO
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 (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". <ul style="list-style-type: none"> <li>• Short circuit to IAT sensor ground circuit</li> <li>• Short circuit to ground</li> </ul> 2. If the trouble is detected, repair or replace as required. Is the trouble detected?	—	Go to Step 11.	Go to Step 7.

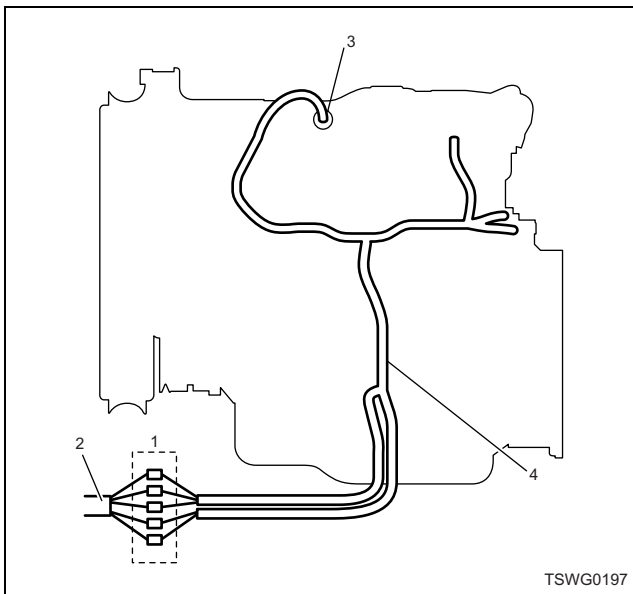
**About IAT sensor**



Name

1. Signal
2. GND

**On-board check of sensors**



**Name**

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

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

Step	Action	Value	YES	NO
11	<p>1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to "How to use flush tool" in this section for check and rewriting of ECM.</p> <p><b>Note:</b> <b>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.</b></p> <p>Is the procedure completed?</p>	—	Go to Step 13.	Go to Step 11.
12	<p>Replace the ECM.</p> <p><b>Note:</b> <b>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.</b></p> <p>Is the procedure completed?</p>	—	Go to Step 13.	—
13	<p>Check the DTC again.</p> <p>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.</p> <p>Is DTC P0118 detected?</p>	—	Go to Step 2.	Go to Step 14.
14	<p>Check if other DTC is detected.</p> <p>Is other DTC detected?</p>	—	Go to each DTC diagnosis.	Verify repair.
15	<p>1. Start the engine. 2. Check the display of the "Engine coolant temperature".</p> <p>Is the "Engine coolant temperature" more than the specified value?</p>	-40°C	Go to Step 16.	Go to "Diagnostic aid".
16	<p>Check for installation condition of the ECT sensor, ECM and coupling connector.</p> <p>1. Check for play or looseness in the connection. 2. If the trouble is detected, repair or replace as required.</p> <p>Is the trouble detected?</p>	—	Go to Step 13.	Go to Step 17.

**Back-up mode**

- Fuel temperature default setting (at starting: -20°C, at running: 70°C)

**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 current trouble turns to past trouble (history) 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.

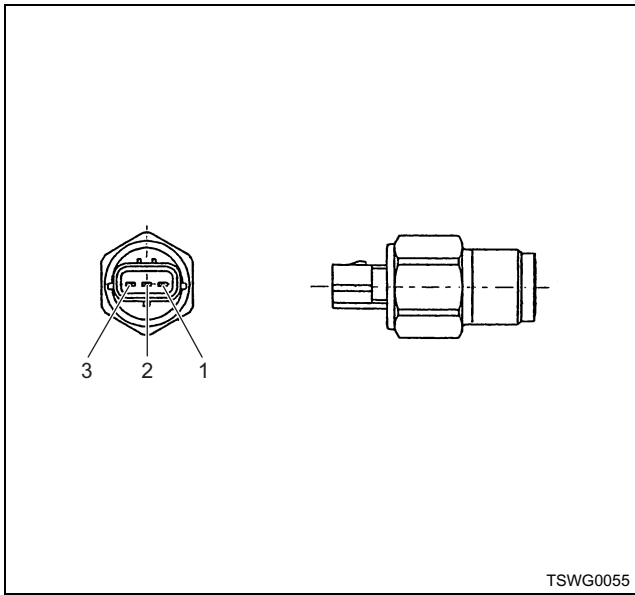
- Improper connection of harness connector and ECM connector
  - Poor connection of terminal from connector
  - Unmatched terminals are fitted.
  - Damage of connector lock
  - Poor contact between terminal and wire
- Damaged harness
  - Visually check the harness for damage.
  - Check the relevant items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

**About common rail pressure sensor**

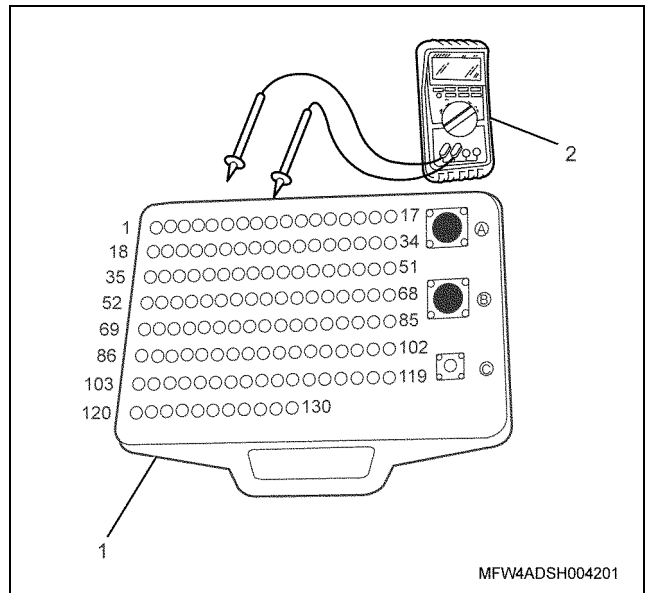


Name

1. GND
2. Signal
3. Power supply

**Breaker box inspection procedure**

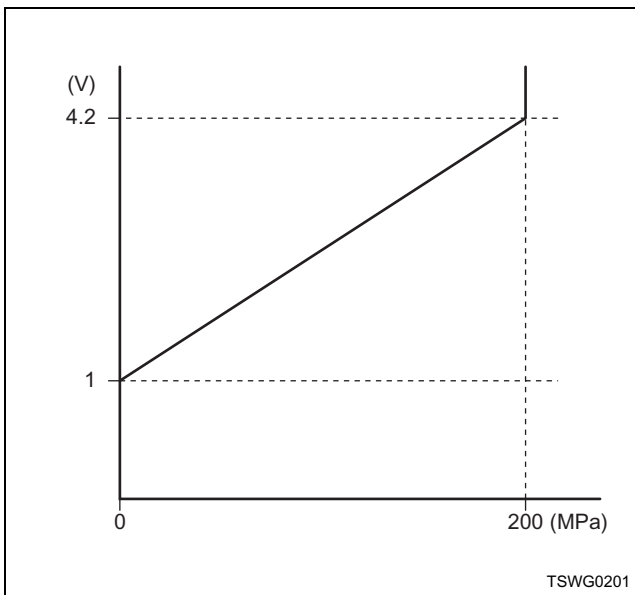
Perform the inspection in the following procedure if there is such an instruction to use breaker box in the step. After inspection, return to the diagnostic step.



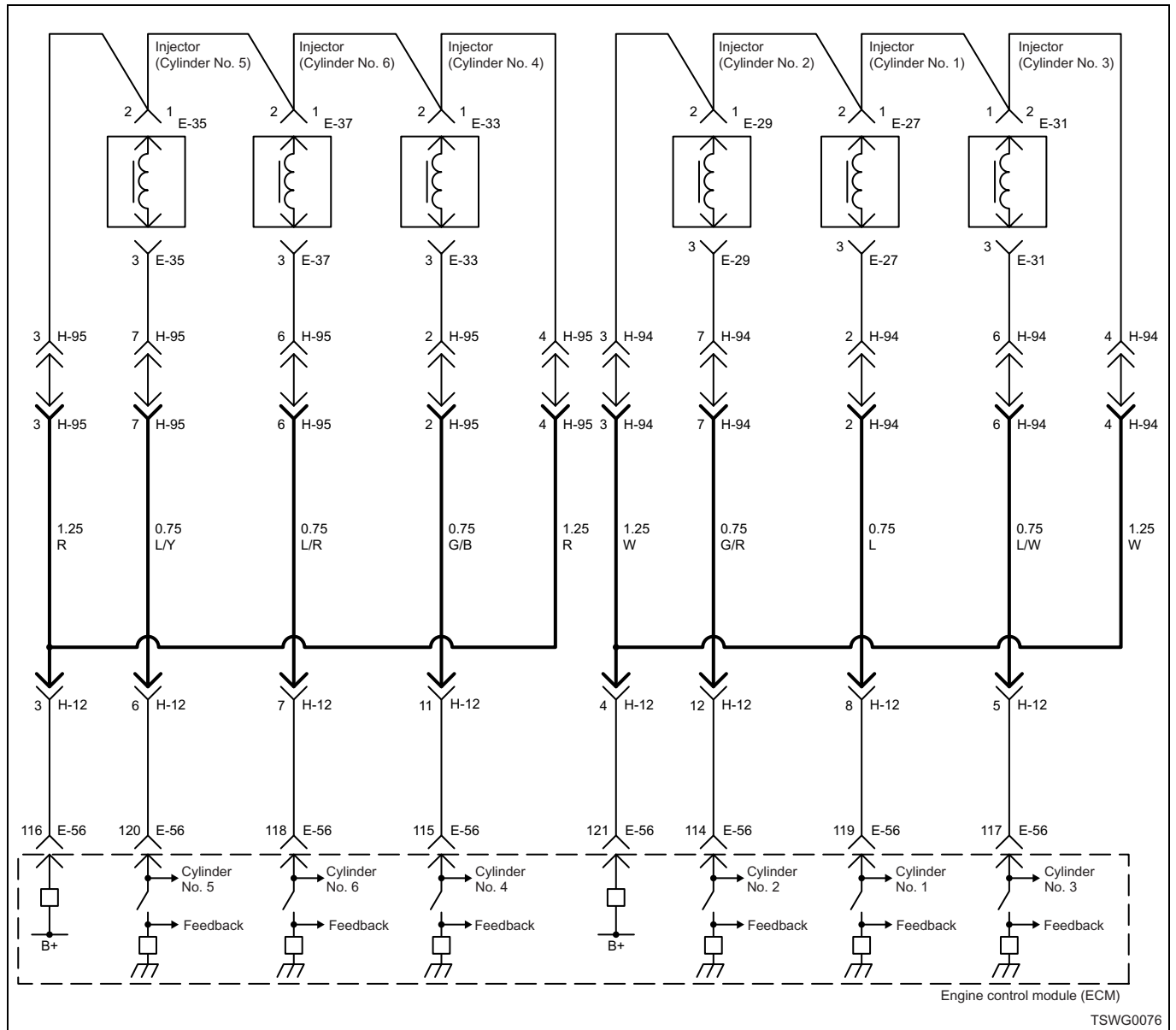
Name

1. Breaker box
2. DMM

**About common rail pressure sensor**



6HK1



TSWG0076

**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 to the ECM through injector as a signal, and the ECM controls this signal.

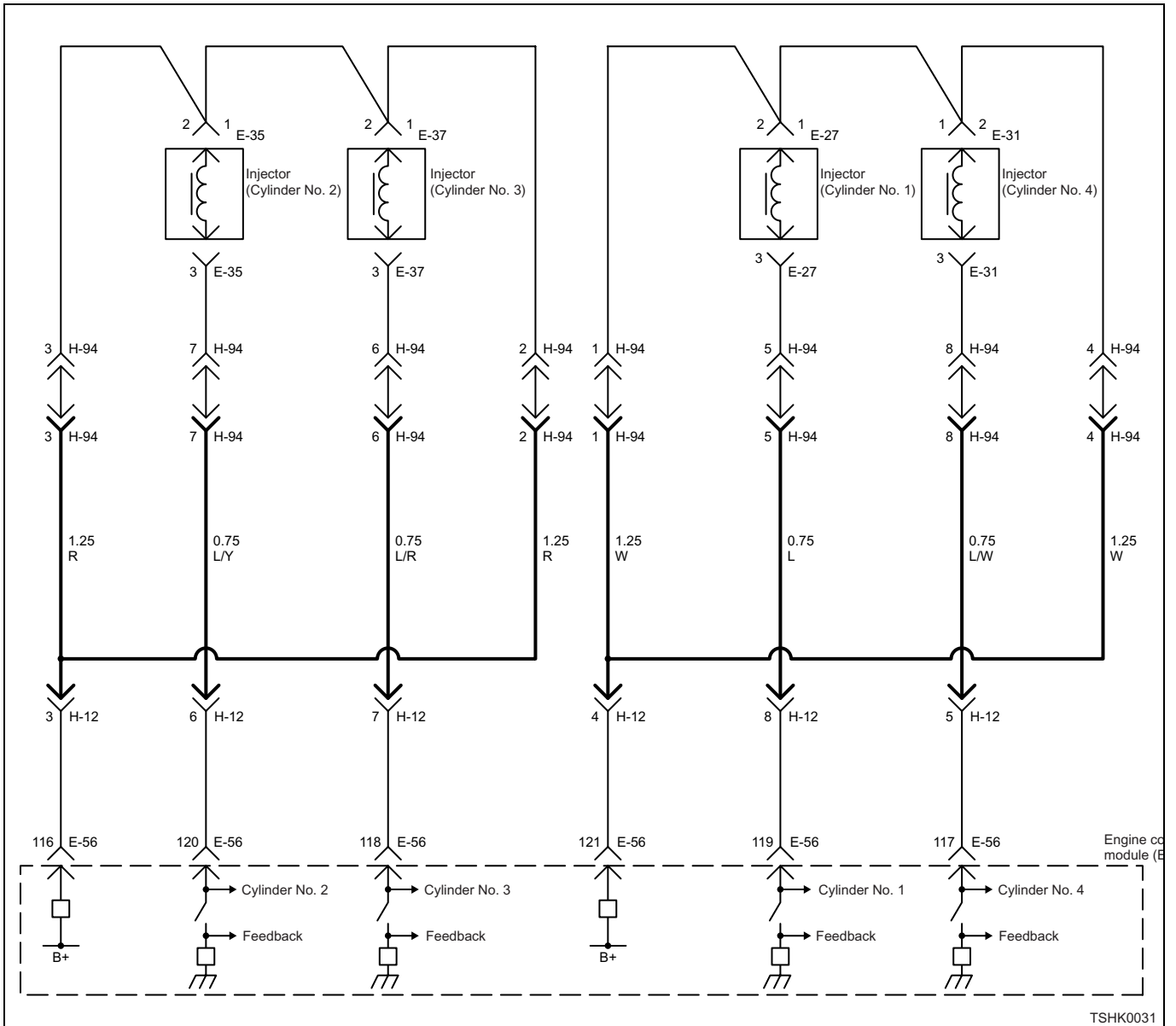
## Electronic control fuel injection system (Common rail type) 10D-306

Step	Action	Value	YES	NO
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.
7	1. Check for following in the circuit between injector terminal and coupling connector. <ul style="list-style-type: none"> <li>• Open circuit</li> <li>• High resistance</li> </ul> 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.  <b>Note:</b> <b>For work procedure, refer to "Engine section" in the service manual.</b>  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 flush tool" in this section for check and rewriting of ECM.  <b>Note:</b> <b>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.</b>  Is the procedure completed?	—	Go to Step 13.	Go to Step 12.

**DTC: P0204 (Flash code 274)**

**Open circuit in injection nozzle #4 drive system**

4HK1



## Electronic control fuel injection system (Common rail type) 10D-326

Step	Action	Value	YES	NO
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.  <b>Note:</b> <b>For work procedure, refer to "Engine section" in the service manual.</b>  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 flush tool" in this section for check and rewriting of ECM.  <b>Note:</b> <b>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.</b>  Is the procedure completed?	—	Go to Step 13.	Go to Step 12.
12	Replace the ECM.  <b>Note:</b> <b>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.</b>  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 P0205 detected?	—	Go to Step 2.	Go to Step 14.

**Main trouble symptom**

Operationality is affected.

- Using the scan tool, or memory clear switch and diagnostic switch operation enables to clear DTCs.

**Preconditions when DTC is set**

- Key switch input voltage is 18V or more.
- DTC P1630 or P1634 is not detected.

**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

**DTC set condition**

- Boost pressure sensor voltage is 0.1V or less for 3 seconds or more.

Following inspections are necessary to detect these causes.

**Action taken when DTC is set**

- Fault indication\* is displayed on the monitor of the machine or diagnosis lamp comes on. (\* Nothing is displayed depending on the machine manufacturer)

- 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.

**Back-up mode**

- Specified back-up value (depending on the machine manufacturer) (4HK1)
- Boost pressure default setting (150kPa) (6HK1)
- Boost pressure correction/EGR stopped (6HK1)

**Recovery from failure**

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

**Test description**

Numbers below indicate step numbers in the chart.  
 3. In the case of current trouble, the “MAP (manifold absolute pressure) sensor” displays less than the specified 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 specified value when terminals between the boost pressure sensor connector are shorted, the circuit beyond the sensor is normal including ECM.

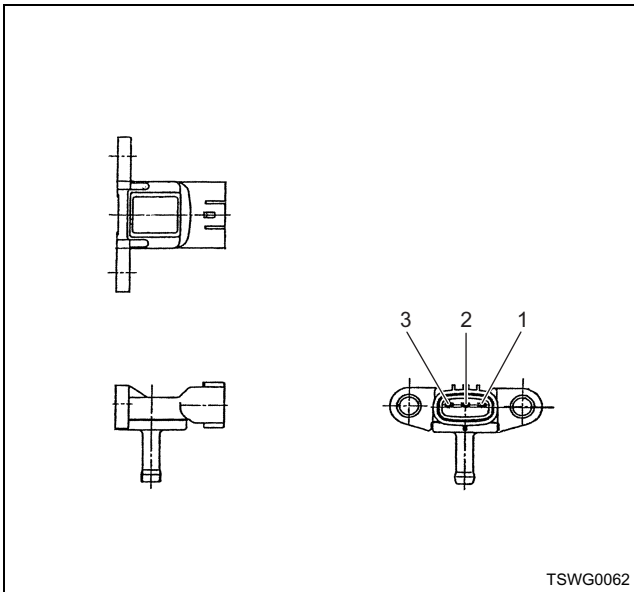
**The conditions to clear the MIL/DTC**

- The current trouble turns to past trouble (history) when the condition is out of the range from DTC set condition (recovery from failure).
- The diagnosis lamp will go off after the code turns to history code and the key switch is turned “OFF” then “ON” again.

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 specified value?	0.18V	Go to Step 4.	Go to “Diagnostic aid”.

Step	Action	Value	YES	NO
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". <ul style="list-style-type: none"> <li>• Open circuit</li> <li>• High resistance</li> </ul> 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

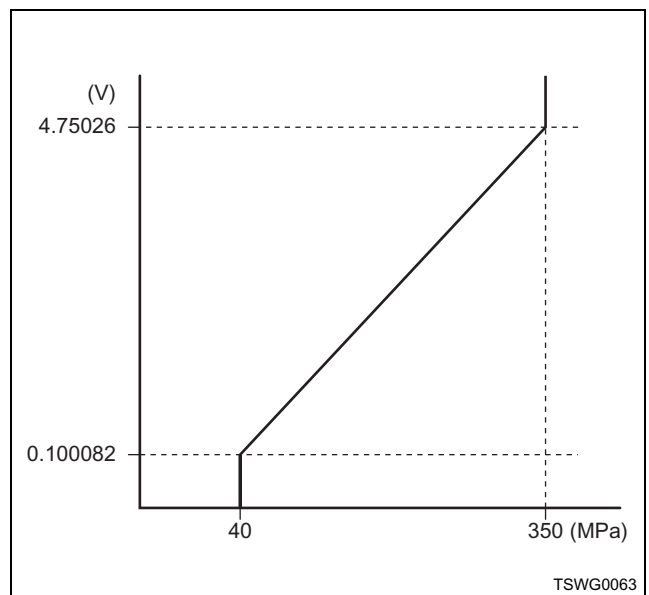
**Characteristics of boost pressure sensor**

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 40MPa or 350MPa is not changed.

When error occurs, error value (508MPa) 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 voltage and physical 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 current trouble turns to past trouble (history) 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 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.

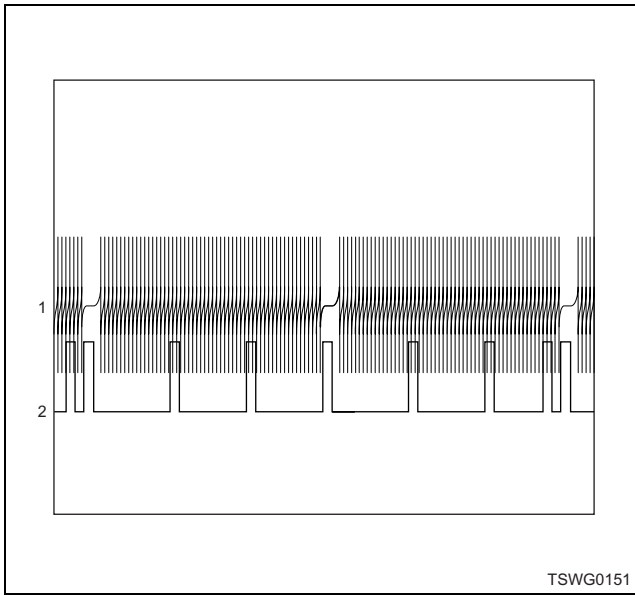
- Improper connection of harness connector
- Defective harness routing
- Worn harness cladding
- Wire disconnection inside harness cladding

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 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.	—
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.

6HK1

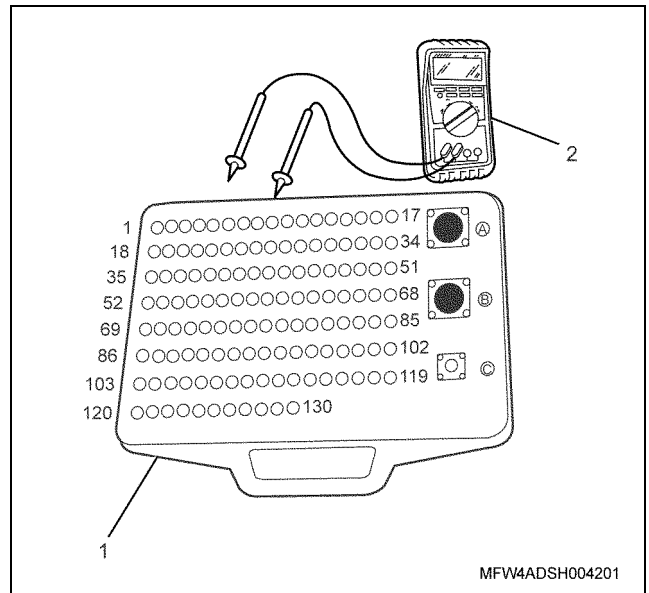


Name

1. CKP signal
2. CMP 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	<ul style="list-style-type: none"> <li>• Disconnect the sensor connector.</li> <li>• Key switch "OFF"</li> </ul>	99 - Sensor connector power supply terminal	100Ω or less	10MΩ or more
	Short circuit to ground	Resistance measurement	<ul style="list-style-type: none"> <li>• Disconnect the sensor connector.</li> <li>• Key switch "OFF"</li> </ul>	99 - Ground	10MΩ or more	100Ω or less
7	Open circuit/ high resistance	Resistance measurement	<ul style="list-style-type: none"> <li>• Disconnect the sensor connector.</li> <li>• Key switch "OFF"</li> </ul>	98 - Sensor connector signal terminal	100Ω or less	10MΩ or more
	Short circuit to power supply circuit	Voltage measurement	<ul style="list-style-type: none"> <li>• Disconnect the sensor connector.</li> <li>• Key switch "ON"</li> </ul>	98 - Ground	0V	18V or more
8	Open circuit/ high resistance	Resistance measurement	<ul style="list-style-type: none"> <li>• Disconnect the sensor connector.</li> <li>• Key switch "OFF"</li> </ul>	100 - Sensor connector shield terminal	100Ω or less	10MΩ or more
	Short circuit to power supply circuit	Voltage measurement	<ul style="list-style-type: none"> <li>• Disconnect the sensor connector.</li> <li>• Key switch "ON"</li> </ul>	100 - Ground	0V	18V or more

Electronic control fuel injection system (Common rail type) 10D-376

Step	Action	Value	YES	NO
6	<ol style="list-style-type: none"> <li>1. Turn the key switch to "OFF".</li> <li>2. Remove the glow relay.</li> <li>3. Short between the terminals 2 - 4 in the glow relay installing portion using jump cable.</li> <li>4. Turn the key switch to "ON".</li> <li>5. Check for "Glow relay" on the data display using scan tool.</li> </ol> <p>Is the "Glow relay" displayed "ON"?</p>	—	Go to Step 11.	Go to Step 7.
7	<ol style="list-style-type: none"> <li>1. Check for following in the circuit between the fuse and the glow relay. <ul style="list-style-type: none"> <li>• Open circuit</li> <li>• Short circuit to ground circuit</li> <li>• High resistance</li> </ul> </li> <li>2. If the trouble is detected, repair as required.</li> </ol> <p>Is the trouble detected?</p>	—	Go to Step 12.	Go to Step 8.
8	<ol style="list-style-type: none"> <li>1. Check for followings in the circuit between glow relay and ECM using breaker box or DMM. Refer to "Breaker box inspection procedure". <ul style="list-style-type: none"> <li>• Open circuit</li> <li>• Short circuit to ground circuit</li> <li>• High resistance</li> </ul> </li> <li>2. If the trouble is detected, repair as required.</li> </ol> <p>Is the trouble detected?</p>	—	Go to Step 12.	Go to Step 9.
9	<ol style="list-style-type: none"> <li>1. Turn the key switch to "OFF".</li> <li>2. Remove the glow relay.</li> <li>3. Turn the key switch to "ON".</li> <li>4. Check for "Glow relay" on the data display using scan tool.</li> </ol> <p>Is the "Glow relay" displayed "OFF"?</p>	—	Go to Step 11.	Go to Step 10.
10	<ol style="list-style-type: none"> <li>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".</li> <li>2. If the trouble is detected, repair as required.</li> </ol> <p>Is the trouble detected?</p>	—	Go to Step 12.	Go to Step 11.
11	<p>Replace the glow relay.</p> <p>Is the procedure completed?</p>	—	Go to Step 12.	—
12	<p>Is EMPS available?</p>	—	Go to Step 13.	Go to Step 14.

Step	Action	Value	YES	NO
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. 5. Check the DTC. Is DTC P0487 detected?	—	Go to Step 5.	Go to "Diagnostic aid".
5	Replace the EGR valve (EGR position sensor). <b>Note:</b> <b>For work procedure, refer to "Engine section" in the service manual.</b> Is the procedure completed?	—	Go to Step 6.	—
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. 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 flush tool" in this section for check and rewriting of ECM. <b>Note:</b> <b>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.</b> Is the procedure completed?	—	Go to Step 10.	Go to Step 9.

**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 current trouble turns to past trouble (history) 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**

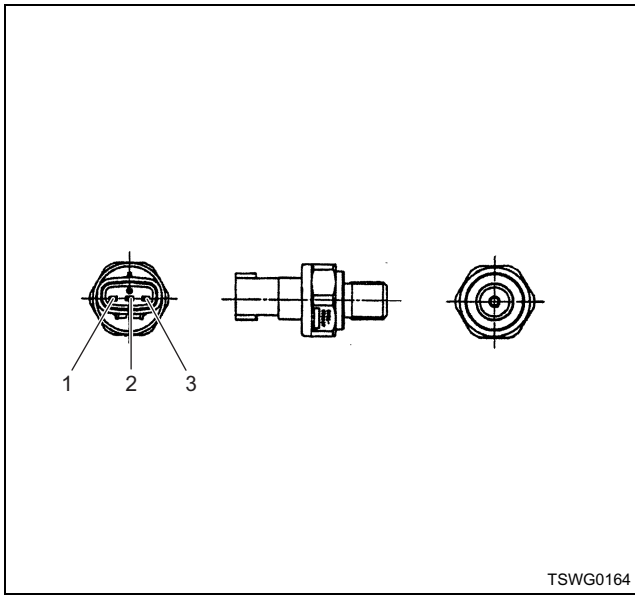
Numbers below indicate step numbers in the chart.

3. In the case of current 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.

**About engine oil pressure sensor**



Name

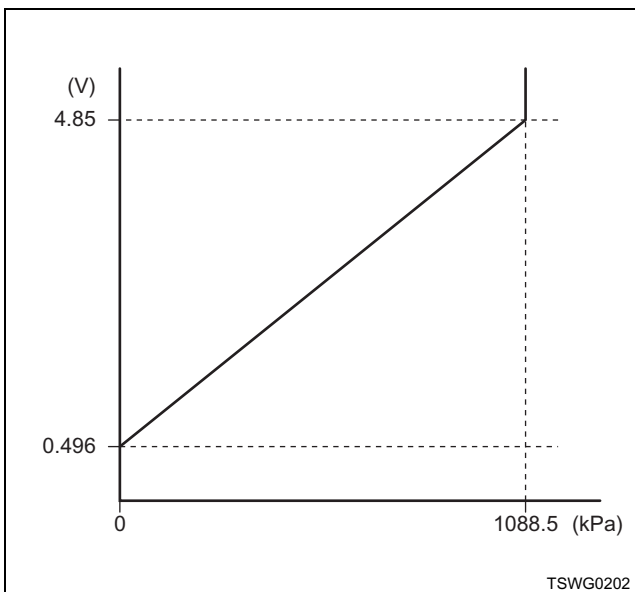
1. Sensor GND
2. Sensor signal
3. Sensor power supply

**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 0kPa or 1088.5kPa is not changed.

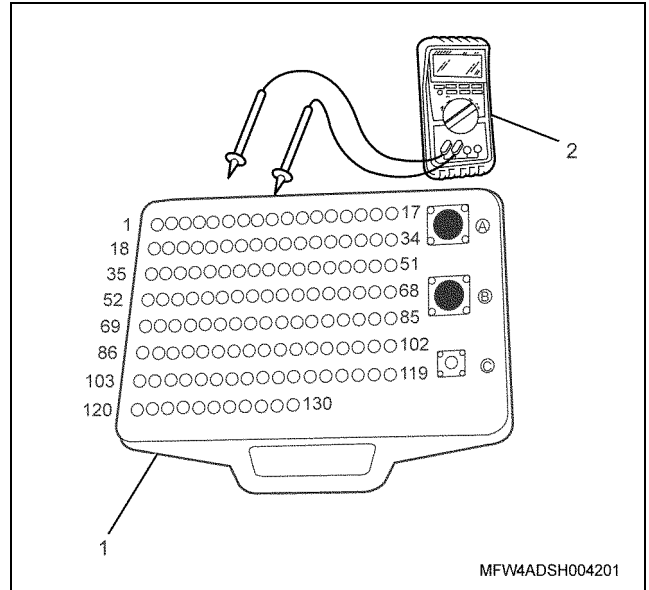
When error occurs, error value (1016kPa) is displayed. The following illustration shows the correlation between physical value and voltage displayed in the scan tools with CAN communication.

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.

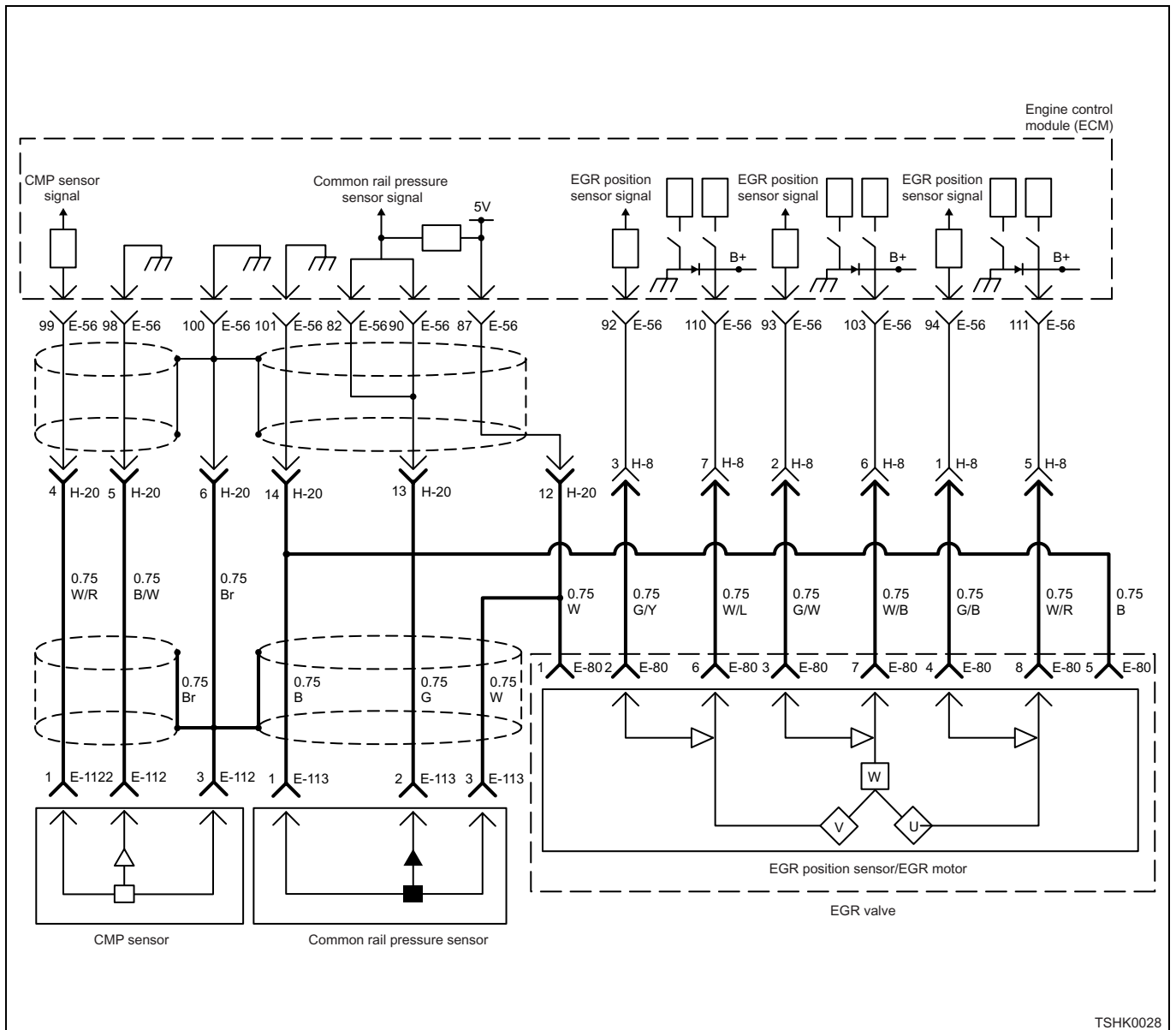


Name

1. Breaker box
2. DMM

## Electronic control fuel injection system (Common rail type) 10D-416

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 flush tool" in this section for check and rewriting of ECM.  <b>Note:</b> <b>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.</b>  Is the procedure completed?	—	Go to Step 10.	Go to Step 9.
9	Replace the ECM.  <b>Note:</b> <b>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.</b>  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.



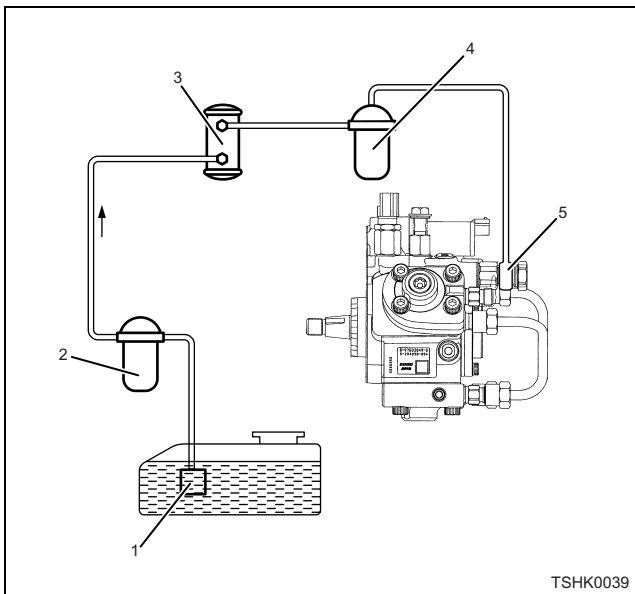
### Description of circuit

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 SCV to the two plungers located inside the supply pump, and is pressurized and sent to the common rail. The SCV opening angle controls the fuel flow; if the SCV drive duty is large, the SCV opening angle becomes small resulting in less fuel flow. The ECM drives the SCV 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 SCV 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. Electromagnetic pump filter
4. Main fuel filter
5. Gauze filter

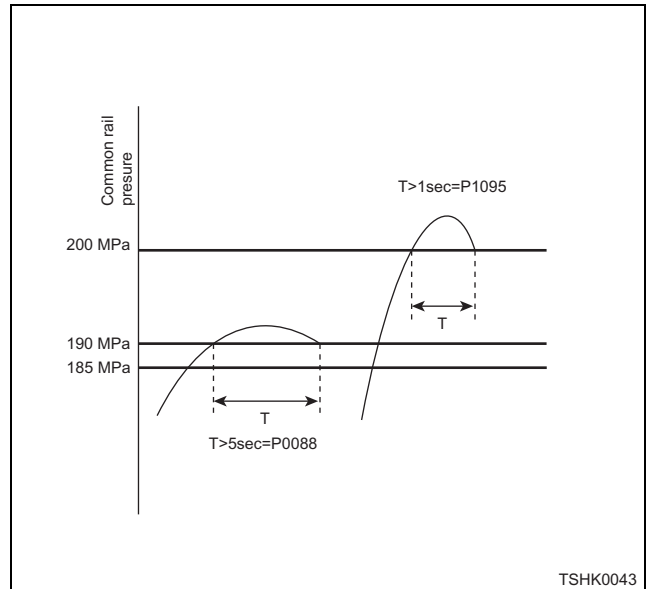
Filter clogging in the fuel system may establish the DTC set condition. Check as required.

#### Preconditions when DTC is set

- Key switch input voltage is 18V 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 the common rail pressure is more than 200MPa 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

- Turns the diagnosis lamp 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 current trouble turns to past trouble (history) 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 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

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.)

Electronic control fuel injection system (Common rail type) 10D-446

Step	Action	Value	YES	NO
6	<p>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".</p> <ul style="list-style-type: none"> <li>• Open circuit</li> <li>• High resistance</li> </ul> <p>2. If the trouble is detected, repair as required.</p> <p>Is the trouble detected?</p>	—	Go to Step 12.	Go to Step 7.
7	<p>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".</p> <ul style="list-style-type: none"> <li>• Short circuit to boost temperature sensor ground circuit</li> <li>• Short circuit to ground</li> <li>• Open circuit</li> <li>• High resistance</li> </ul> <p>2. If the trouble is detected, repair as required.</p> <p>Is the trouble detected?</p>	—	Go to Step 12.	Go to Step 9.
8	<p>Replace the boost temperature sensor.</p> <p>Is the procedure completed?</p>	—	Go to Step 12.	—
9	<p>Is EMPS available?</p>	—	Go to Step 10.	Go to Step 11.
10	<p>1. Check the version of ECM software. 2. Rewrite the software if version upgraded is necessary. Refer to "How to use flush tool" in this section for check and rewriting of ECM.</p> <p><b>Note:</b> <b>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.</b></p> <p>Is the procedure completed?</p>	—	Go to Step 12.	Go to Step 11.
11	<p>Replace the ECM.</p> <p><b>Note:</b> <b>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.</b></p> <p>Is the procedure completed?</p>	—	Go to Step 12.	—

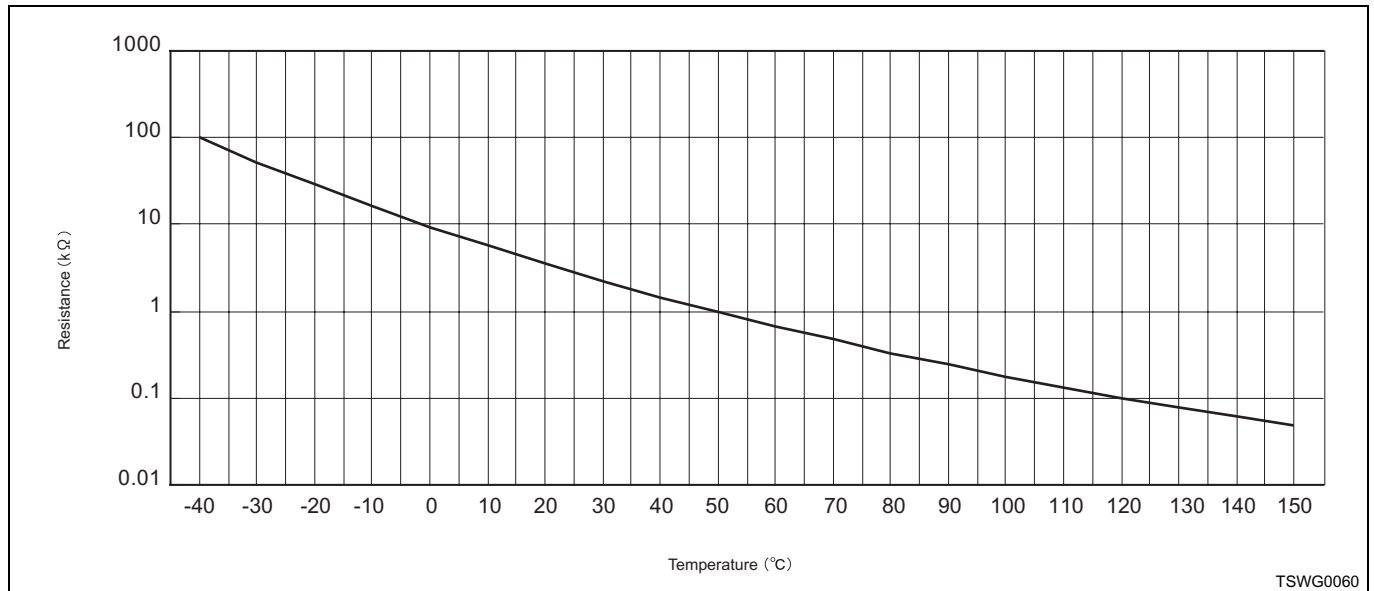
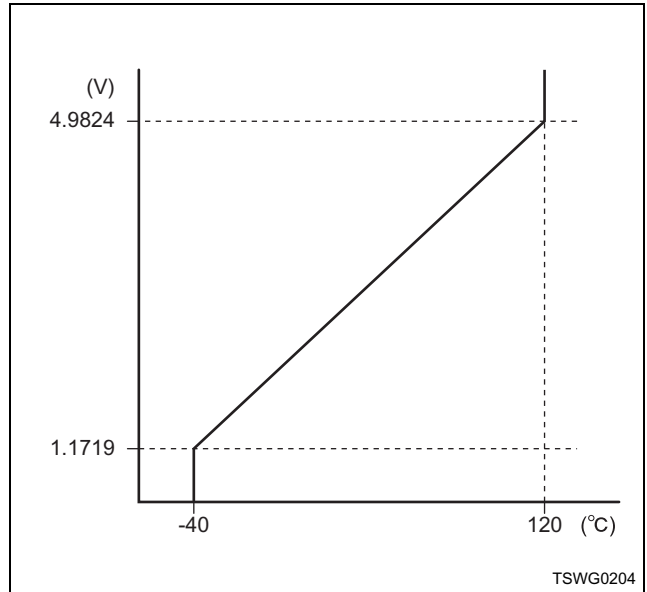
**Characteristics of boost temperature sensor**

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  $-40^{\circ}\text{C}$  or  $120^{\circ}\text{C}$  is not changed.

When error occurs, error value ( $214^{\circ}\text{C}$ ) 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.

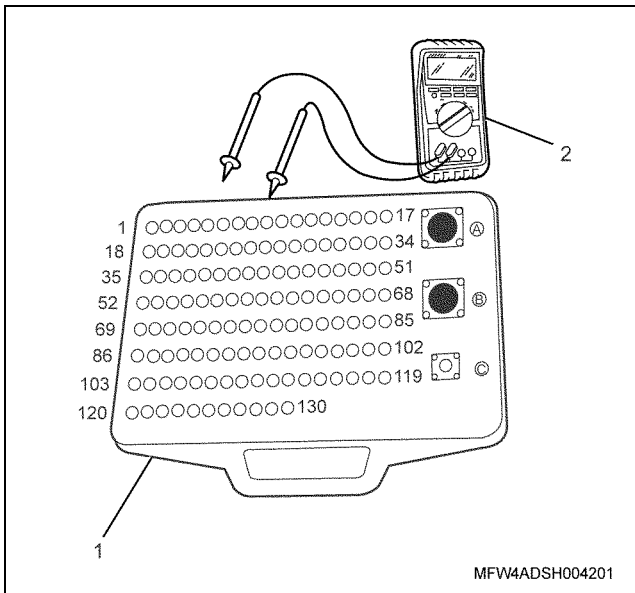


## Electronic control fuel injection system (Common rail type) 10D-466

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". 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 flush tool" in this section for check and rewriting of ECM.  <b>Note:</b> <b>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.</b>  Is the procedure completed?	—	Go to Step 10.	Go to Step 9.
9	Replace the ECM.  <b>Note:</b> <b>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.</b>  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.	—
11	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.



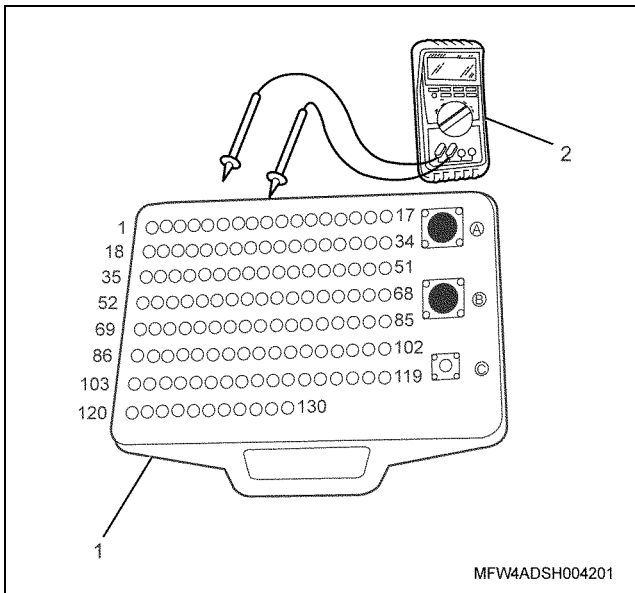
Name

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	<ul style="list-style-type: none"> <li>• Remove the ECM-side harness connector from the coupling connector.</li> <li>• Key switch "OFF"</li> </ul>	121 - Female-side terminal (4H: No. 1, 6H: No. 3)	100Ω or less	10MΩ or more
	Short circuit to ground	Resistance measurement	<ul style="list-style-type: none"> <li>• Remove the ECM-side harness connector from the coupling connector.</li> <li>• Key switch "OFF"</li> </ul>	121 - Ground	10MΩ or more	100Ω or less
9	Short circuit to ground	Resistance measurement	<ul style="list-style-type: none"> <li>• Remove the ECM-side harness connector from the coupling connector.</li> <li>• Key switch "OFF"</li> </ul>	119 - Ground	10MΩ or more	100Ω or less

**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	<ul style="list-style-type: none"> <li>• Remove the ECM-side harness connector from the coupling connector.</li> <li>• Key switch "OFF"</li> </ul>	116 - Female-side terminal (4H: H94 No.3, 6H: H95 No.3)	100Ω or less	10MΩ or more
	Short circuit to ground	Resistance measurement	<ul style="list-style-type: none"> <li>• Remove the ECM-side harness connector from the coupling connector.</li> <li>• Key switch "OFF"</li> </ul>	116 - Ground	10MΩ or more	100Ω or less
9	Short circuit to ground	Resistance measurement	<ul style="list-style-type: none"> <li>• Remove the ECM-side harness connector from the coupling connector.</li> <li>• Key switch "OFF"</li> </ul>	115 - Ground	10MΩ or more	100Ω or less

## Electronic control fuel injection system (Common rail type) 10D-496

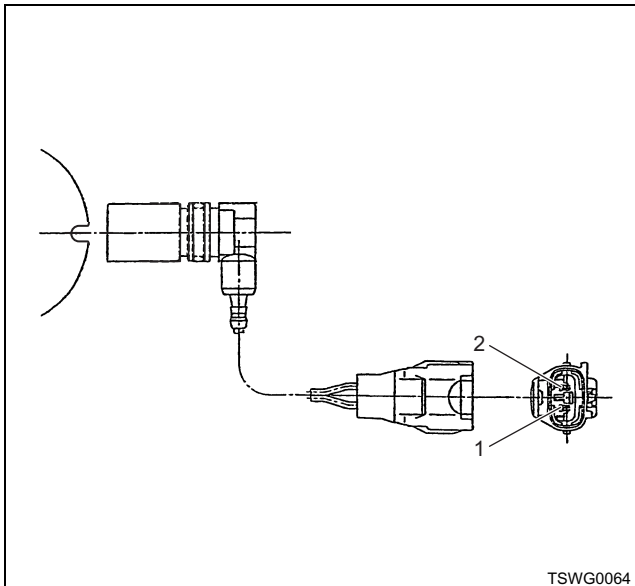
Step	Action	Value	YES	NO
5	1. Turn the key switch to "OFF". 2. Disconnect the AP sensor connector. 3. Short between the sensor power supply terminal of the AP sensor connector and the sensor 1 signal terminal using jump cable. 4. Turn the key switch to "ON". 5. Check for "Accelerator sensor 1" on the 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". <ul style="list-style-type: none"> <li>• Open circuit</li> <li>• High resistance</li> </ul> 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". <ul style="list-style-type: none"> <li>• Short circuit to AP sensor ground circuit</li> <li>• Short circuit to ground</li> <li>• Open circuit</li> <li>• High resistance</li> </ul> 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 flush tool" in this section for check and rewriting of ECM.  <b>Note:</b> <b>EGR valve position learning is required after replacing or rewriting the ECM.</b> <b>Refer to "Engine Control System, Engine control module (ECM), Installation of ECM" in this section for learning of EGR.</b>  Is the procedure completed?	—	Go to Step 12.	Go to Step 11.

## Electronic control fuel injection system (Common rail type) 10D-506

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". <ul style="list-style-type: none"> <li>• Open circuit</li> <li>• High resistance</li> </ul> 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". <ul style="list-style-type: none"> <li>• Short circuit to AP sensor 1 ground circuit</li> <li>• Short circuit to ground</li> <li>• Open circuit</li> <li>• High resistance</li> </ul> 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 flush tool" in this section for check and rewriting of ECM.  <b>Note:</b> <b>EGR valve position learning is required after replacing or rewriting the ECM.</b> <b>Refer to "Engine Control System, Engine control module (ECM), Installation of ECM" in this section for learning of EGR.</b>  Is the procedure completed?	—	Go to Step 12.	Go to Step 11.

Step	Action	Value	YES	NO
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.

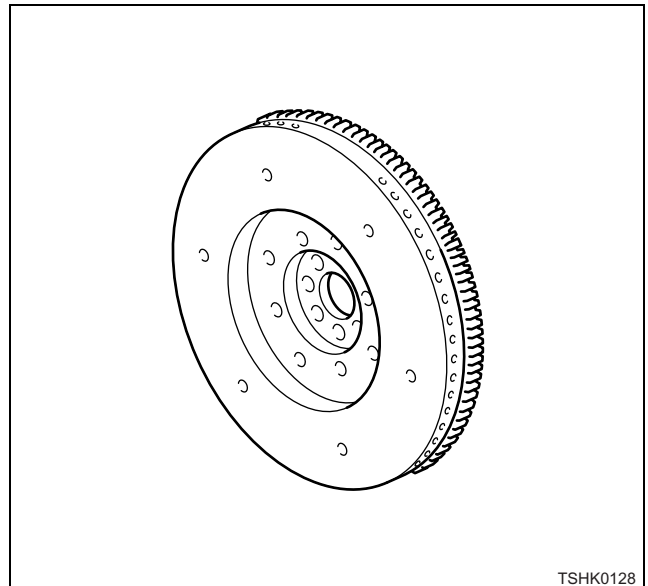
**About CKP sensor**



Name

1. GND
2. Power supply

**4HK1**



**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**

- Turns the diagnosis lamp ON.

**Back-up mode**

- Analog sensor system default processing
- Limited injection amount 3 (multi-injection stopped)
- Target RP upper limit (80MPa)

**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 current trouble turns to past trouble (history) 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 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.

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 flush tool” in this section for check and rewriting of ECM. <b>Note:</b> <b>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.</b> Is the procedure completed?	—	Go to Step 6.	Go to Step 5.

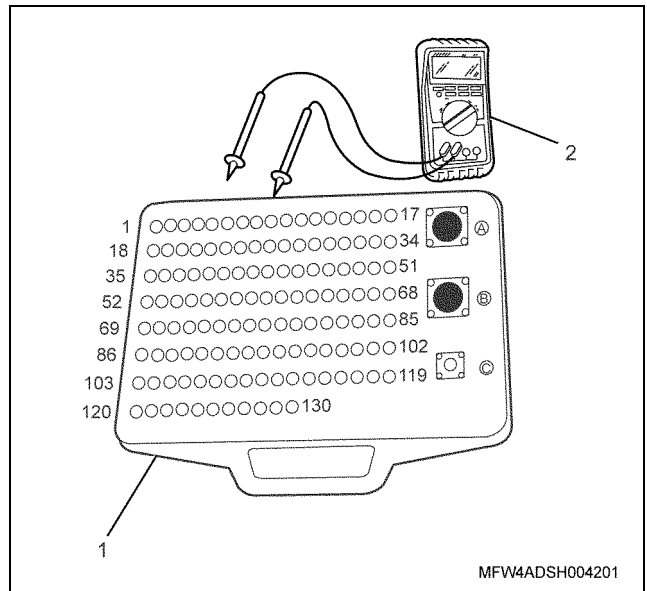
## Electronic control fuel injection system (Common rail type) 10D-536

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 flush tool" in this section for check and rewriting of ECM.  <b>Note:</b> <b>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.</b>  Is the procedure completed?	—	Go to Step 9.	Go to Step 8.
8	Replace the ECM.  <b>Note:</b> <b>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.</b>  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.

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 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

## Electronic control fuel injection system (Common rail type) 10D-556

Step	Action	Value	YES	NO
9	Replace the injector in the cylinder of which engine sound did not change when it is stopped.  <b>Note:</b> <b>For work procedure, refer to “Engine section” in the service manual.</b>  Is the procedure completed?	—	Go to Step 10.	—
10	Check the ACG. Check if the charge warning lamp turns on while engine is running.  <b>Note:</b> <b>Refer to the machine’s manual for charge warning.</b>  Does the charge warning operate?	—	Go to Step 17.	Go to Step 11.
11	Replace the ACG. Also, check the charge warning system, and repair or replace if faulty.  Is the procedure completed?	—	Go to Step 12.	—
12	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 13.	Go to Step 14.
13	Correct the installation condition of the electrical equipment, or remove the electrical equipment.  Is the procedure completed?	—	Go to Step 14.	—
14	Check the mechanical part of the engine, and repair if faulty. <ul style="list-style-type: none"> <li>• Compression pressure</li> <li>• Valve system</li> <li>• Injector</li> <li>• Timing gear</li> <li>• Related part of piston/crank</li> </ul> <b>Note:</b> <b>For work procedure, refer to “Engine section” in the service manual.</b>  Is the procedure completed?	—	Go to Step 15.	—
15	Is EMPS available?	—	Go to Step 16.	Go to Step 17.

## 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 the machine manufacturer.

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

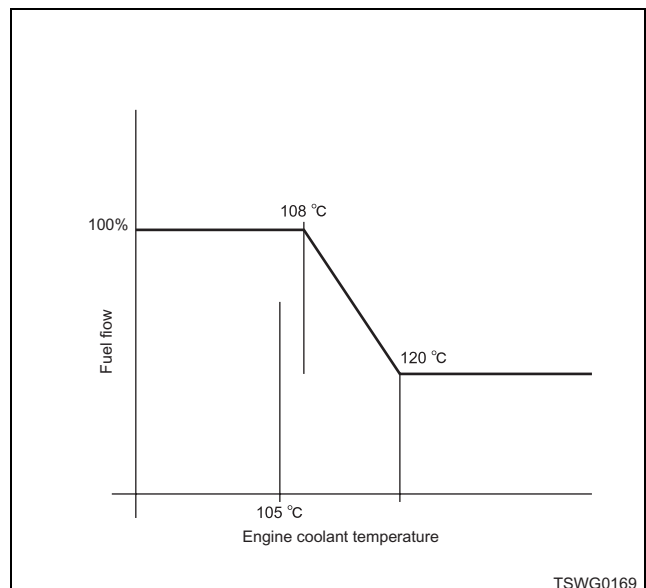
- Fuel system fault (run out of fuel, frozen fuel, air mixed in fuel pipe, faulty filter [clog in main filter, gauze filter], pipe fault, fuel quality, fuel tank [foreign matter, fuel suction fault])
- Intake system fault (clogging in filter, intake pipe fault, etc.)
- Exhaust system fault (exhaust brake, 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

### Control during overheat

In overheating, ECM begins to limit fuel flow when the engine coolant temperature exceeds 108°C, 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\*. (\* Setting varies depending on the machine manufacturer)

The system raises an alarm from 105°C 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.



## 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 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 sound did not change when it is stopped?	—	Go to Step 5.	Go to Step 6.

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