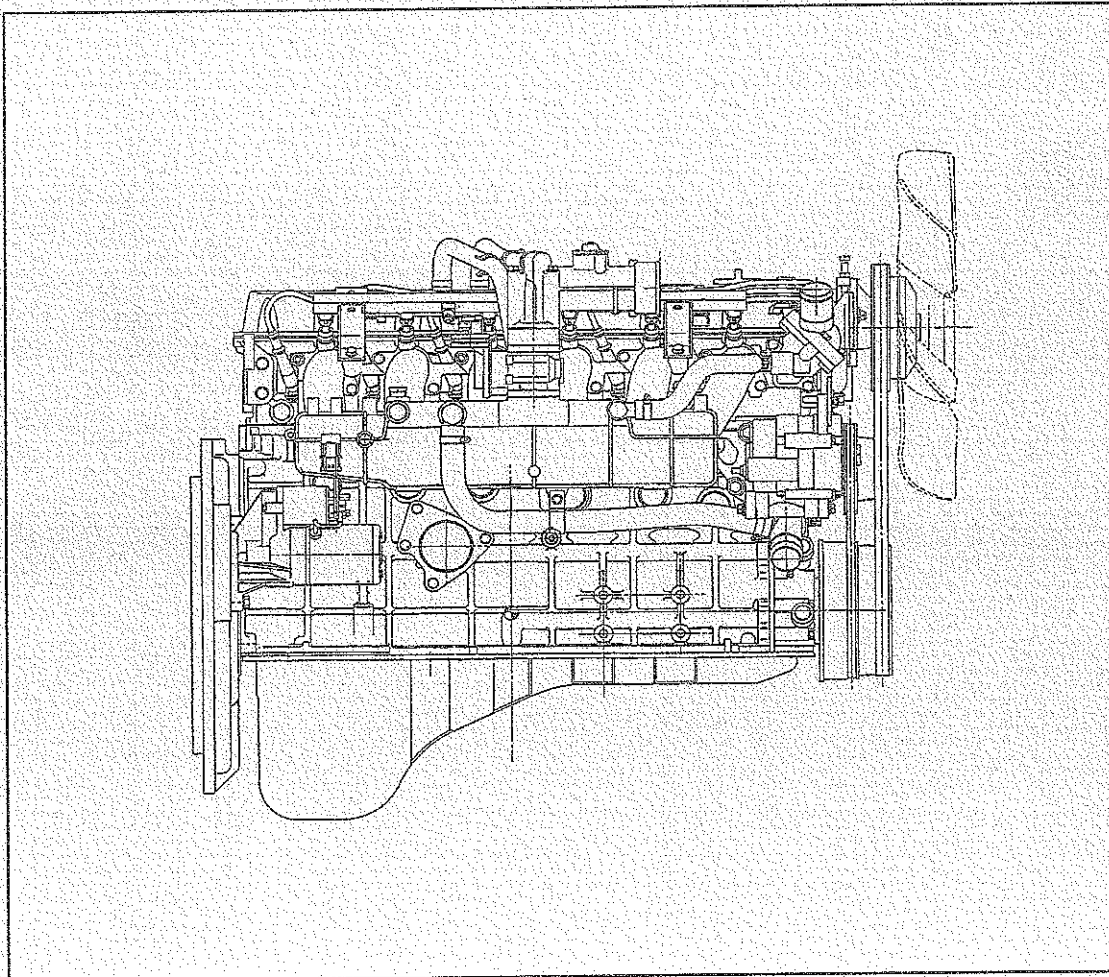


No. ME-TB45AE

# TCM<sup>®</sup>

## SHOP MANUAL

MODEL: NISSAN TB45  
GASOLINE ENGINE



TCM CORPORATION





## ***SAFETY PRECAUTIONS***

### ***MAINTENANCE & REPAIR***

Take special attention when jacking up the truck. Fix it safely by using stands or wood blocks.

Confirm the safety of the surrounding. Use ropes having an extra load margin when lifting heavy objects.

Make sure bolts, nuts, pipes and wires are completely removed when using power tools to dismount parts.

To carry heavy articles, use tools or machines. Never attempt to do so with hand.

Your TCM machine requires TCM genuine parts. Designate TCM genuine parts when ordering parts for your machine.

Use clean tools and select a clean, dust free place when servicing hydraulic devices and other precision parts.

Make sure battery terminals are disconnected when servicing electric system parts or welding. (First remove the negative terminal, and then the positive one.)

Particular attention should be paid to keep oils, gases and flammables away from the workshop. Tidy up and fix the disassembled parts and tools.

A sign post or caution board should be set up to arouse attention for prohibition of engine or lever operation while servicing.

Do not attempt to remove any components while the engine is running.

Never stand beneath a upraised fork or carriage. Block machine and carriage when servicing.

Keep the servicing tools always in good order. Check them regularly, and handle properly.

In a poorly ventilated room (workshop), never operate the engine for a long while.

**TCM<sup>®</sup>**



## FOREWORD

This manual is written to give the information about maintenance procedures for the model TB45 gasoline engine, which is mounted on our forklift trucks. It is compiled based on the work shop manual published by NISSAN MOTOR CO., LTD. The relationship of the engine models and our applicable trucks is as follows:

| Engine model | Applicable truck model |                    |                    |
|--------------|------------------------|--------------------|--------------------|
| TB45         | FG35T <sub>2</sub>     | FG40T <sub>2</sub> | FG45T <sub>2</sub> |

This shop manual consists of eight sections as shown in the following table, which gives the updated symbols.

| Section                  | Symbol |
|--------------------------|--------|
| ENGINE GENERAL           | (EG)   |
| ENGINE TUNE-UP           | (ET)   |
| ENGINE MECHANICAL        | (EM)   |
| ENGINE LUBRICATION       | (LU)   |
| ENGINE COOLING SYSTEM    | (CO)   |
| ENGINE FUEL SYSTEM       | (FL)   |
| ENGINE CONTROL           | (EC)   |
| ENGINE ELECTRICAL SYSTEM | (EL)   |

December 2004

**TCM** CORPORATION



# ENGINE GENERAL

## SECTION **EG**

### CONTENTS

|                                              |              |
|----------------------------------------------|--------------|
| <b>PRECAUTIONS FOR SAFETY AND QUALITY</b>    | <b>EG-2</b>  |
| Safe Operation                               | EG-2         |
| Correct Operation                            | EG-3         |
| Precautions for Radio Equipment Installation | EG-3         |
| <b>HOW TO USE THIS MANUAL</b>                | <b>EG-4</b>  |
| Description                                  | EG-4         |
| Definition of Terms                          | EG-4         |
| Definition of Units                          | EG-4         |
| Description                                  | EG-5         |
| Component Parts Location                     | EG-5         |
| <b>TROUBLE DIAGNOSIS</b>                     | <b>EG-7</b>  |
| ECM Trouble Diagnosis                        | EG-7         |
| ECM Abbreviations List                       | EG-10        |
| <b>ECM GENERAL SERVICE INFORMATION</b>       | <b>EG-11</b> |
| Connector Terminal Inspection                | EG-11        |
| Inspection for Electrical System             | EG-12        |
| Control Unit and Electronic Component        | EG-13        |
| SST                                          | EG-14        |

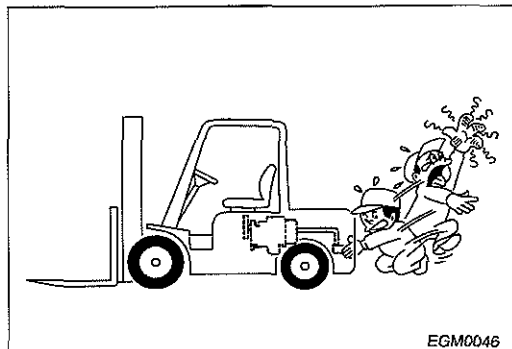
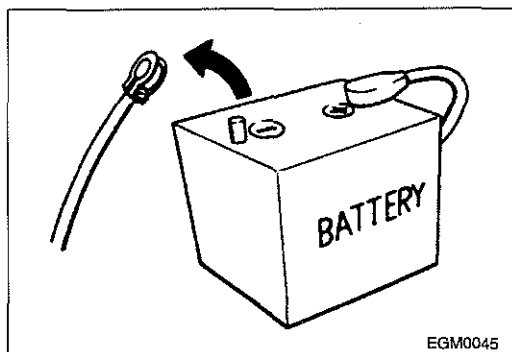
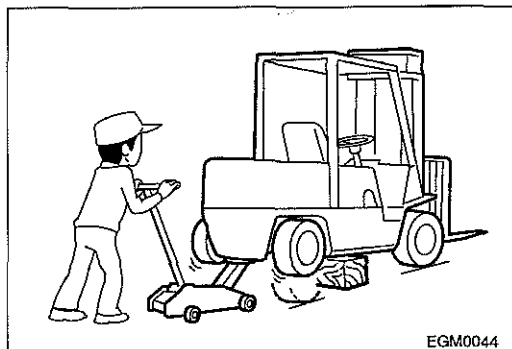
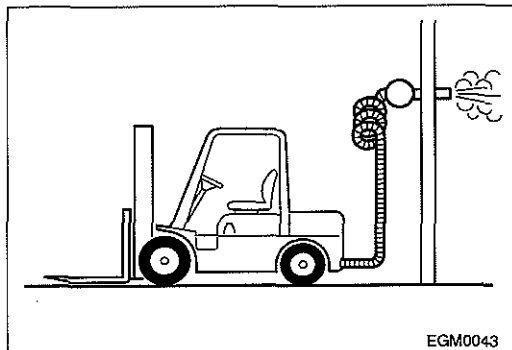
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|---------------------------------------------------------|--------------|
| <b>PRECAUTIONS</b>                                      | <b>EG-15</b> |
| Precautions in Draining Engine Coolant                  | EG-15        |
| Precautions for Disconnecting Fuel Piping               | EG-15        |
| Precautions for Removing and Disassembling              | EG-15        |
| Precautions for Inspection, Correction, and Replacement | EG-15        |
| Precautions for Assembly and Installation               | EG-15        |
| Caution for Use of Power Tools                          | EG-16        |
| Precautions for Liquid Gasket Application               | EG-16        |
| Parts Requiring Angle Tightening                        | EG-17        |
| <b>PREPARATION</b>                                      | <b>EG-18</b> |
| Special Service Tools                                   | EG-18        |
| Service Parts                                           | EG-20        |
| <b>SERVICE DATA</b>                                     | <b>EG-21</b> |
| Periodical Inspection                                   | EG-21        |
| Standard, Repair Limit                                  | EG-23        |
| Tightening Torque                                       | EG-24        |

## PRECAUTIONS FOR SAFETY AND QUALITY

- The following precautions must be carefully observed for safe and appropriate service work.
- Only the qualified and designated personnel must perform inspections, repairs and adjustments.
- Always keep the workplace clean, and store the tools neatly in the specified places.

### Safe Operation

- Do not run an engine inside the workshop without proper ventilation (ex. no ventilation ducts).
- Keep the workshop well ventilated and free of any flammable materials. Special care should be taken when flammable or poisonous materials such as gasoline are handled.
- Discard waste oil after oil changes or parts treatment in accordance with local laws and regulations.
- Be careful of burns and injury when working on high-temperature parts, rotating parts, or sliding portions.
- Ensure that adequate ventilation is provided for discharging any hazardous emissions when working in a pit or enclosed area.
- Do not work underneath a vehicle supported only by a jack. Always use safety stands at the prescribed points to support the vehicle.
- Support it at the prescribed points and lock it in position with safety devices before lifting the vehicle.
- Be careful that the vehicle body does not become off balance and fall when removing a heavy component such as the engine.
- Do not smoke during service work.
- Do not wear any rings and necklaces when working. These objects may cause electric short.
- Before starting repair work that requires no battery power, always turn OFF the ignition switch, and disconnect the negative battery cable.
- Do not touch any metal portions immediately after the engine is stopped. Otherwise the heated metals may cause burns. Do not attempt to remove any cooling system parts such as the radiator cap while the engine is hot.
- To perform repair work safely and efficiently, always use appropriate commercial service tools and specified Special Service Tools wherever required.



## **PRECAUTIONS FOR SAFETY AND QUALITY**

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### **Correct Operation**

- Make sure that you understand the symptoms before starting trouble diagnosis.
- Check correct installation status prior to removal or disassembly. Make sure that they do not interfere with the function of the parts they are applied to if matching marks are required.
- Once they are removed, always replace parts indicated as "do not reuse" with new ones. This includes: oil seals, gaskets, packings, O-rings, lock washers, cotter pins, and self-locking nuts.
- Replace inner and outer races of tapered or needle roller bearings as a set.
- Arrange disassembled parts in order and prevent them from being mixed-up.
- Clean or flush disassembled parts prior to inspection or assembly.
- Use Genuine NISSAN parts for replacement.
- Use authorized grease and sealer.
- Release the pressure before disconnecting pressurized piping or hoses.
- Be sure to check for leakage after repairing fuel, oil, coolant, exhaust, or vacuum systems.

### **Precautions for Radio Equipment Installation**

Check the following when installing a commercial/ham radio or mobile phone. If mounting position is not chosen carefully, the unit may interfere with the electronic control system.

- Separate the antenna as far from the ECM as possible.
- Route an antenna feeder line at least 20 cm (7.87 in) apart from the control unit harness.
- Adjust an antenna and feeder line to eliminate radio wave interference.

## HOW TO USE THIS MANUAL

### Description

This manual explains how to perform "removal, installation, disassembly, assembly, inspection and adjustment" and "diagnosis".

### Definition of Terms

**WARNING** : Instructions and precautions that may lead to fatal hazards and/or serious injuries if not observed properly.

**CAUTION** : Instructions and precautions that require special attention and may lead to problems and/or accidents as well as damages to the vehicle and/or components.

**NOTE** : Supplementary information to facilitate the service work.

**Standard** : Indicates tolerances for inspection and adjustment.

**Repair limit** : Indicates maximum or minimum values allowed for inspection and adjustment.

### Definition of Units

The units and numerical values in this Standard are SI units, and those given in ( ) in this Standard are based on the conventional unit system and are appended for informative reference.

Example:  $\square$  : 59 - 78 N•m (6.0 - 8.0 kg-m, 43 - 58 ft-lb)  
SI (Metric system, yard-pound system)

#### MAIN UNIT CHANGES

| Measure          | SI               | Conventional unit  | Conversion factor to SI |
|------------------|------------------|--------------------|-------------------------|
| Acceleration     | m/s <sup>2</sup> | G                  | 9.80665                 |
| Torque, moment   | N•m              | kg-m               | 9.80665                 |
| Force            | N                | kgf                | 9.80665                 |
| Pressure         | kPa              | kg/cm <sup>2</sup> | 98.07                   |
|                  | kPa              | mmHg               | 0.133322                |
| Power efficiency | kW               | PS                 | 0.735499                |
|                  | W                | kcal/h             | 1.16279                 |
| Volume           | cm <sup>3</sup>  | cc                 | 1                       |
| Spring constant  | N/mm             | kg/mm              | 9.80665                 |
| Fuel consumption | g/kW•h *         | g/PS•h             | 1.3596                  |

\* The conventional unit can be used for SI.

## HOW TO USE THIS MANUAL

### Description

**CAUTION :** At the beginning of each section, the precautions exclusive to the section are described.

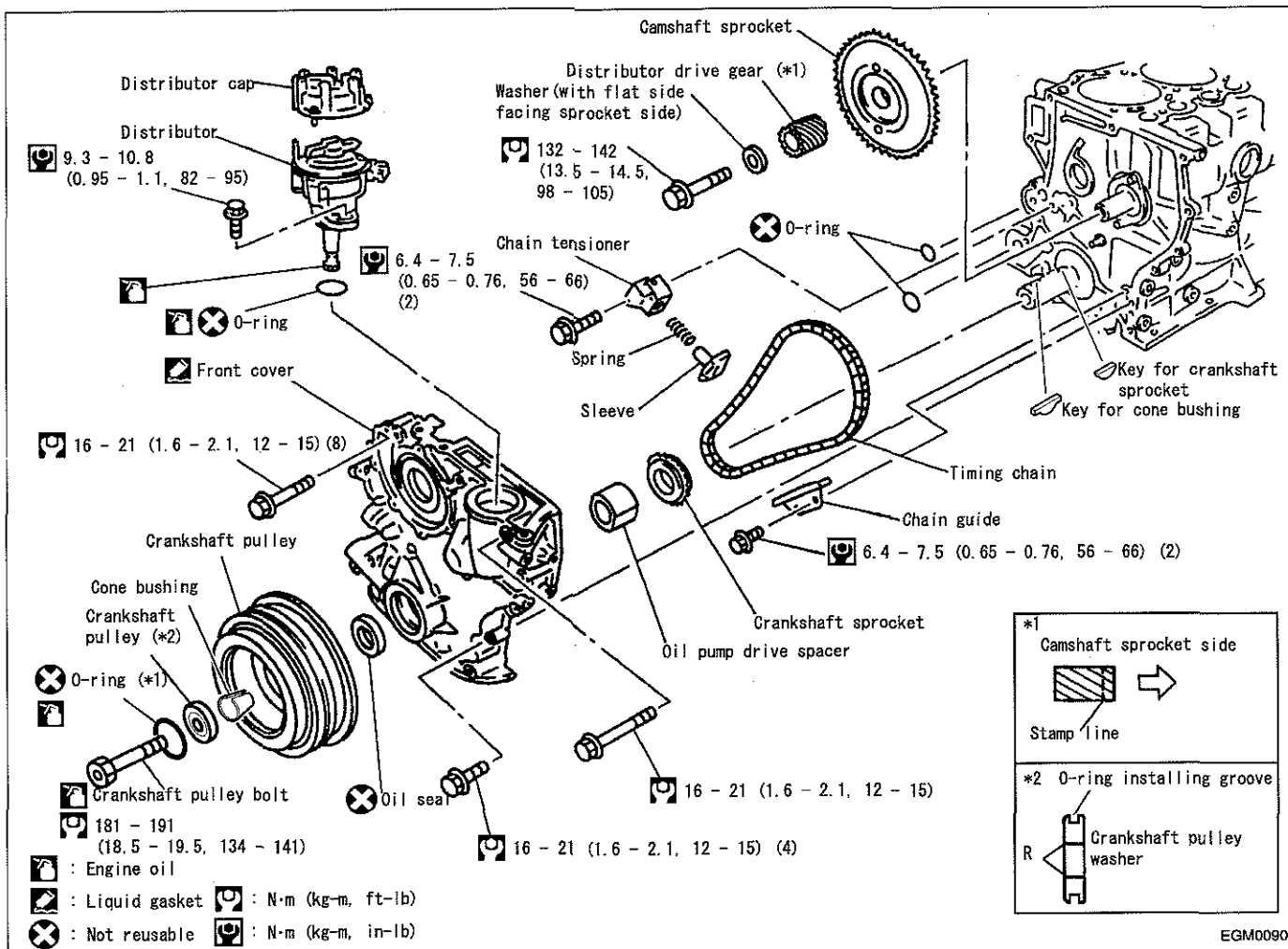
**Preparation:** At the beginning of each section and during the trouble diagnosis items, the SSTs, gauges, and other tools to be prepared before operation are described. Some commercial service tools, assumed to be available in any workshop, are omitted.

**Description:** To perform correct operations, operational procedures, notes, SSTs, and other service information are described.

**CAUTION :** Descriptions of visual inspections and cleaning of removed parts are generally omitted. Please remember that actual operations require these processes.

### Component Parts Location

The "Component Parts Location" diagram (refer to the figure) includes information for removal, installation, disassembly, and assembly (tightening torque, grease points, non-reusable parts) as well as other information important for repair work.



## HOW TO USE THIS MANUAL

### Component Parts Location (Cont'd) COMPONENT SYMBOLS

| Symbols                                                                           | Description                    | Symbols                                                                           | Description              |
|-----------------------------------------------------------------------------------|--------------------------------|-----------------------------------------------------------------------------------|--------------------------|
|  | Tightening torque              |  | Not reusable             |
|  | Should be lubricated with oil. |  | Select proper thickness. |
|  | Searing point                  |                                                                                   |                          |

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## **TROUBLE DIAGNOSIS**

---

### **ECM Trouble Diagnosis**

#### **CAUTION:**

- The following trouble diagnosis procedures are designed to identify the trouble causes efficiently. When performing diagnoses, carefully observe the following instructions.
- Before starting a trouble diagnosis, carefully read and understand the contents in "Basic Inspection", "Diagnosis Chart by Symptom" and "Trouble Diagnosis Flowchart".
- After the repair work, always verify that the trouble is eliminated.
- For the locations of the parts and harness connectors, refer to "Component Parts Location" in the relevant section.
- To perform a simple inspection, utilize the circuit diagrams. To inspect the circuit for continuity in details including the sub-harnesses, identify the relevant connectors and harness layouts referring to the "Wiring Diagrams".
- Before inspecting a circuit for continuity, always turn the ignition switch to OFF.
- Before measuring voltage at a connector, always measure the battery voltage.
- After finishing diagnoses or inspections, always ensure that all removed harness connectors are reconnected correctly.

# TROUBLE DIAGNOSIS

## ECM Trouble Diagnosis (Cont'd)

### SYMBOLS

| Symbols        | Description                                             | Symbols                                                                                     | Description                               |
|----------------|---------------------------------------------------------|---------------------------------------------------------------------------------------------|-------------------------------------------|
| DISCONNECT<br> | Check after disconnecting the connector to be measured. |                                                                                             | Procedure with SST                        |
| CONNECT<br>    | Check after connecting the connector to be measured.    |                                                                                             | Procedure without SST                     |
|                | Insert key into ignition switch.                        |                                                                                             | A/C switch is "ON".                       |
|                | Remove key from ignition switch.                        |                                                                                             | A/C switch is "OFF".                      |
|                | Turn ignition switch to "OFF" position.                 |                                                                                             | Connect to battery power supply directly. |
|                | Turn ignition switch to "ON" position.                  |                                                                                             | Drive condition                           |
|                | Turn ignition switch to "START" position.               |                                                                                             | Disconnect battery negative terminal.     |
|                | Turn ignition switch from "OFF" to "ACC" position.      |                                                                                             | Brake pedal depressed                     |
|                | Turn ignition switch from "ACC" to "OFF" position.      |                                                                                             | Release brake pedal.                      |
|                | Turn ignition switch from "OFF" to "ON" position.       |                                                                                             | Depress accelerator pedal.                |
|                | Turn ignition switch from "ON" to "OFF" position.       |                                                                                             | Release accelerator pedal.                |
|                | Do not start engine, or check with engine stopped.      | <p>Shows connector terminals of ECM or other control units that have several terminals.</p> |                                           |
|                | Start engine, or check with engine running.             |                                                                                             |                                           |
|                | Apply parking brake.                                    |                                                                                             |                                           |
|                | Release parking brake.                                  |                                                                                             |                                           |
|                | Check after engine is warmed up sufficiently.           |                                                                                             |                                           |
|                | Voltage should be measured with a voltmeter.            |                                                                                             |                                           |
|                | Circuit resistance should be measured with an ohmmeter. |                                                                                             |                                           |
|                | Current should be measured with an ammeter.             |                                                                                             |                                           |

EGM0049

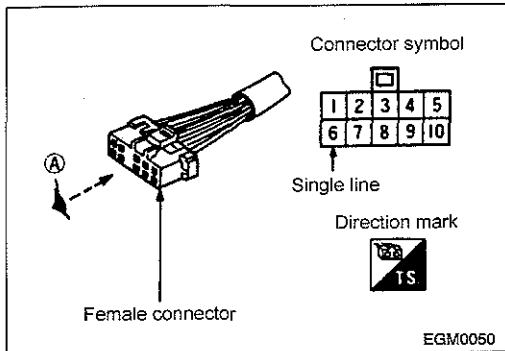
## TROUBLE DIAGNOSIS

### ECM Trouble Diagnosis (Cont'd)

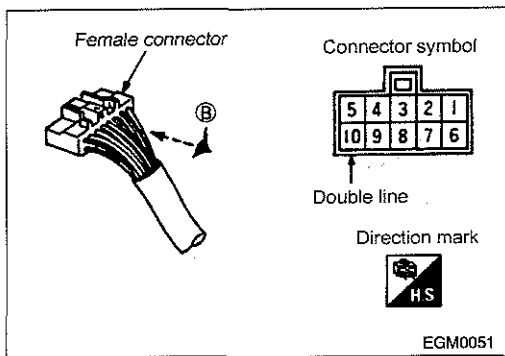
#### SYMBOLS FOR HARNESS CONNECTOR

##### FEMALE CONNECTOR

- When a harness connector is viewed from A (terminal side), the outer frame of the connector symbol is indicated with a single line. In addition, the direction indicator shows "TS" (Terminal Side) in description type font.

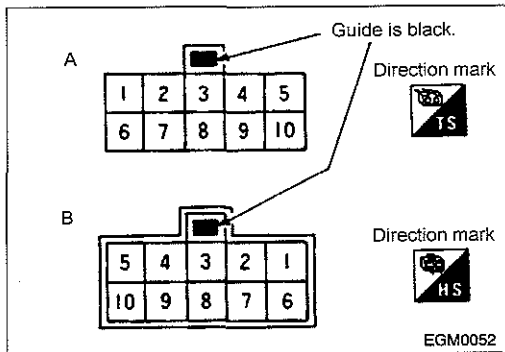


- When a harness connector is viewed from B (harness side), the outer frame of the connector symbol is indicated with double lines. In addition, the direction indicator shows "HS" (Harness Side) in description type font.
- Terminal assignments of a connector viewed from A and B are mirror images, indicating just as they are seen.



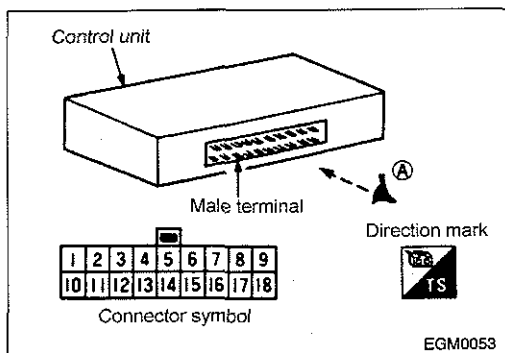
##### MALE CONNECTOR

The illustration method is the same as that for a female connector, the black guide box, however, indicates a male connector (the white guide box a female connector).



##### SINGLE UNIT (CONTROL UNIT)

A single control unit is viewed only from A, and the illustration is as shown in the figure.



## TROUBLE DIAGNOSIS

### ECM Abbreviations List

| Abbreviations | Description            | Abbreviations | Description           |
|---------------|------------------------|---------------|-----------------------|
| A/C           | Air conditioner        | INT           | Intake                |
| A/T           | Automatic transmission | LH            | Left                  |
| ALT           | Alternator             | LED           | Light emitting diode  |
| ASSY          | Assembly               | LLC           | Long-life coolant     |
| BAT           | Battery                | M/T           | Manual transmission   |
| C/P           | Crankshaft pulley      | OHV           | Overhead valve        |
| C/U           | Control unit           | OS            | Oversize              |
| Cyl           | Cylinder               | P/S           | Power steering        |
| ENG           | Engine                 | PTO           | Power take-off        |
| EXH           | Exhaust                | RH            | Right                 |
| F/L           | Fusible link           | RR            | Rear                  |
| FR            | Front                  | TAS           | Throttle adjust screw |
| I/P           | Idler pulley           | Tr            | Transistor            |
| IGN           | Ignition               | US            | Undersize             |

## ECM GENERAL SERVICE INFORMATION

### Connector Terminal Inspection

#### CONNECTOR INSPECTION PROCEDURE

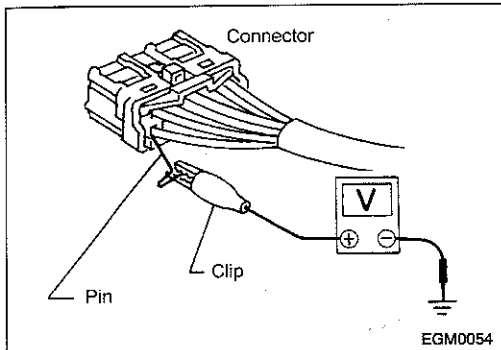
In circuit inspection, inappropriate connector probing will cause connector damages and/or poor connection. The probes provided with the circuit tester may be too large to probe connector terminals without damaging them. Always use alligator clips and "T" pins according to following the procedure.

#### INSPECTION FROM HARNESS SIDE

For a standard connector without any waterproofing, use "T" pins from the harness side.

##### CAUTION:

- For a connector with a rear cover, such as ECM connectors, remove the rear cover before the inspection.
- For a waterproof connector, do not probe the terminals from the harness side. Doing so may damage the seal.

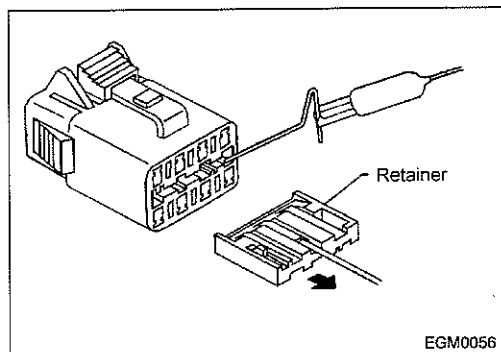
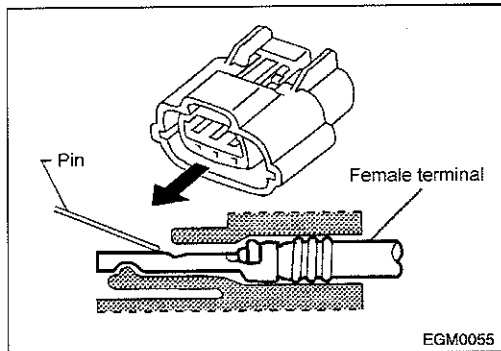


#### INSPECTION FROM TERMINAL SIDE

1. Female terminal
- Female connector terminals have a small notch difference inside. Insert a "T" pin along the step to inspect.

##### CAUTION:

- Do not insert any objects to a female connector terminal other than the corresponding male connector terminal.



- In case of a female connector terminal without any notches, remove the retainer before probing.

## ECM GENERAL SERVICE INFORMATION

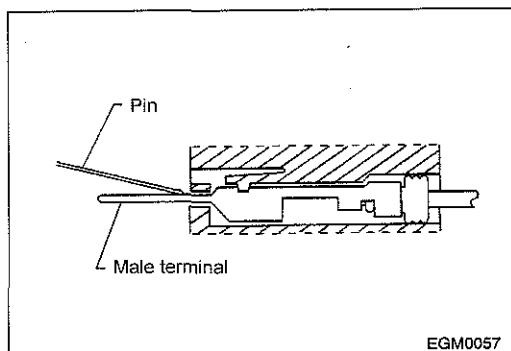
### Connector Terminal Inspection (Cont'd)

#### 2. Male terminal

For a male connector terminal, apply a "T" pin to the surface of the terminal.

#### CAUTION:

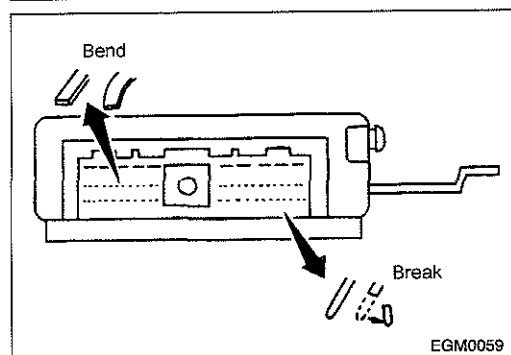
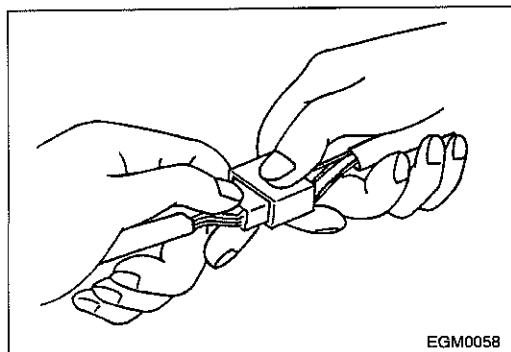
- Do not bend terminals.



### Inspection for Electrical System

#### DESCRIPTION

- If the malfunction can be traced directly to the electrical system, first check for items such as burned-out fuses and fusible links, broken wires or loose connectors, pulled-out terminals, and improper connections.
- If a fuse or a fusible link is blown out, determine the possible cause and restore it. Always replace it with a new fuse or fusible link of the specified capacity.
- When removing a connector, do not apply excessive force to the main body by grasping and twisting.
- Do not pull a connector off by tugging on the harness.
- For a lock-type connector, disengage its lock first, then disconnect the connector by holding the main body of the connector.
- Before connecting a connector, check terminals for bends or breakage. Connect it securely.
- For a lock-type connector, press it until its lock is securely engaged.
- When installing parts, prevent harnesses from being snagged or overextended.

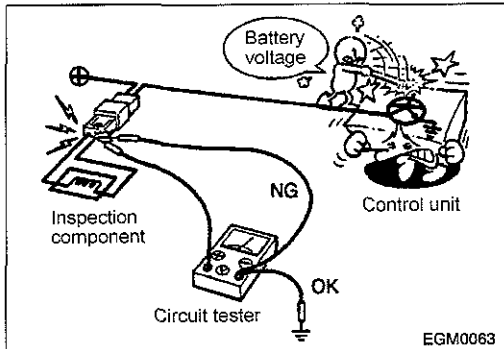
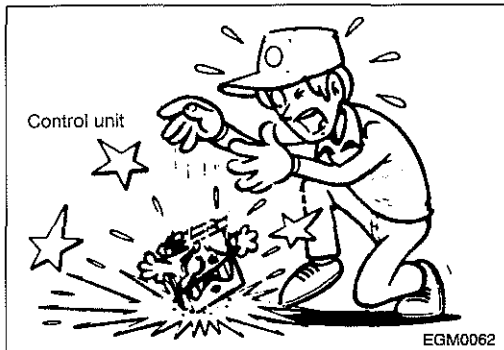


## ECM GENERAL SERVICE INFORMATION

### Control Unit and Electronic Component

#### PRECAUTIONS

- Never reverse polarity of battery terminals.
  - Install only parts specified for each model.
  - Before replacing a control unit, check input and output signals to/from the control unit, and component functions.
  - When disconnecting a connector, do not twist or apply excessive force.
  - For a bolt-type connector, loosen the bolt first, then hold the main body of the connector to disconnect.
  - Before connecting a connector, check terminals for bends or breakage. Connect it securely. For a bolt-type connector, screw in the bolt until the colored lug is flush with the surface to be sure it is securely connected.
  - Do not drop, hit, or subject control units to impact.
  - Be sure to protect control units from condensation caused by a sudden shift in temperature, or from raindrops or splashes. If any water drops adhere to the unit, dry it well prior to installation.
  - Be sure to protect control unit connectors from oil.
  - Avoid cleaning control units with benzine.
  - Do not open a top or bottom cover on a control unit.
- 
- When using a circuit tester, ensure the appropriate distance between test probes. A longer distance is recommended, because if the distance is too short, it may cause contact of the test probes, resulting in a short circuit. A short circuit allows battery voltage to be applied directly to the control unit, resulting in damage to its internal power transistors.
  - Use the specified check adapter to check input and output signals to/from control units.



## ECM GENERAL SERVICE INFORMATION

### SST

#### DESCRIPTION

- SST is a small, lightweight handheld tester. When connected to the vehicle-side data link connector, it communicates with control units installed on the vehicle and performs a variety of diagnostic tests.

#### FUNCTION AND APPLIED SYSTEM

| Items                           | Function                                                                                                                    |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| WORK SUPPORT                    | Sends command to control unit to set status suitable for inspection and service.                                            |
| FUNCTION SYSTEM                 | Checks each system as ECM basic inspection.                                                                                 |
| SELF-DIAG RESULTS               | Receives self-diagnostic results from control unit and indicates DTCs and number of occurrences.                            |
| SELF-DIAG RESULTS [MEMORY]      | DTCs (Diagnostic Trouble Codes) recorded in control unit's memory are displayed.                                            |
| DATA MONITOR                    | Receives input/output signals from control unit and indicates and stores them to facilitate locating cause of malfunctions. |
| DATA MONITOR [SPEC]             |                                                                                                                             |
| Active test                     | Sends command to control unit to change output signals and check operation of output system.                                |
| DTC RECORD DISPLAY              | Indicates self-diagnostic results stored in ECM prior to the most recent "ERASE MEMORY".                                    |
| Control unit part No.           | Displays control unit part number.                                                                                          |
| Control unit identification No. | Displays control unit identification number.                                                                                |

| Diagnostic systems              | Engine |
|---------------------------------|--------|
| WORK SUPPORT                    | ○      |
| SELF-DIAG RESULTS               | ○      |
| SELF-DIAG RESULTS [MEMORY]      |        |
| DATA MONITOR                    | ○      |
| DATA MONITOR [SPEC]             | ○      |
| Active test                     | ○      |
| DTC RECORD DISPLAY              |        |
| Control unit part No.           | ○      |
| Control unit identification No. |        |

## **PRECAUTIONS**

---

### **Precautions in Draining Engine Coolant**

- Drain coolant only after the engine has cooled down.

### **Precautions for Disconnecting Fuel Piping**

- Operation should be done in a place free from fire.
- Relieve fuel pressure before operation. Refer to EC section, "Release of fuel pressure".
- After disconnecting, plug the pipe to prevent fuel from draining.

### **Precautions for Removing and Disassembling**

- Use correct Special Service Tool in the specified position. Always pay attention to safety.
- Be careful not to lose surface accuracy of mating or sliding surfaces.
- To prevent foreign material from entering the engine, close openings with appropriate tape as necessary.
- Arrange disassembled parts in their normal positions in order to simplify locating the cause of damage or excessive wear and to ensure correct reassembly.
- Unless otherwise specified, loosen bolts and nuts from outside to inside in a crisscross pattern.

### **Precautions for Inspection, Correction, and Replacement**

- Thoroughly inspect each part following the inspection procedure, then correct or replace as necessary. Inspect new parts in the same way, and replace if necessary.

### **Precautions for Assembly and Installation**

- Always use a torque wrench when tightening bolts and nuts.
- Unless otherwise specified, tighten bolts and nuts from inside to outside in a crisscross pattern. Tighten them gradually and evenly in 2 to 3 steps.
- Always replace gasket, packing, oil seals, and O-rings with new ones.
- Thoroughly wash, clean, and blow-dry each part. Be sure that engine oil and coolant passages are free of clogs.
- Remove any dirt and lint on sliding and mating surfaces. Before assembly, apply ample amount of engine oil to sliding surfaces.
- If coolant was drained, bleed air from the system.
- After assembly, start engine and increase the engine speed, then check coolant, fuel, oil, grease, and exhaust gas for leakage.

## PRECAUTIONS

### Caution for Use of Power Tools

Do not use any power tools (e.g. air ratchet, impact wrench) to tighten the bolts and nuts. Use these tools only for loosening the bolts and nuts. However, do not use power tools in any event and for any purposes on the parts subject to heat (catalyst, muffler, and other exhaust parts) and the tapping screws. These parts may also be damaged when loosened with a power tool.

### Precautions for Liquid Gasket Application

#### REMOVING PARTS ATTACHED WITH LIQUID GASKET

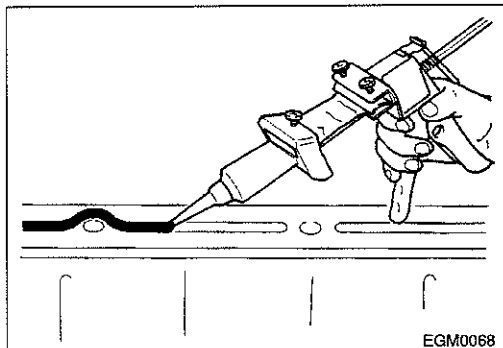
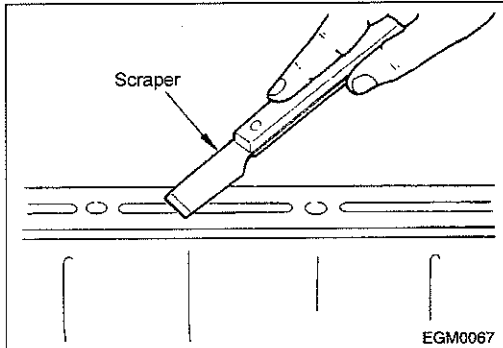
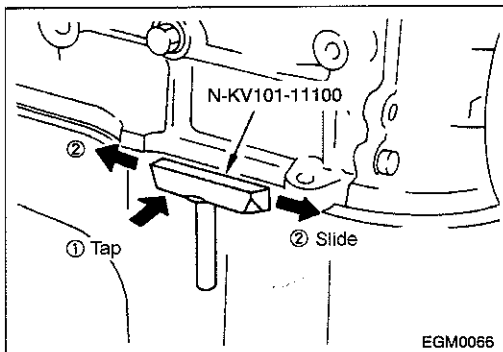
- Remove mounting nuts and bolts. Using a seal cutter (SST), remove liquid gasket.

#### CAUTION:

- Be careful not to damage the mating surfaces.
- In positions where a seal cutter is difficult to use, lightly tap with a plastic hammer, and remove.

#### CAUTION:

- When using a screwdriver, be careful not to scratch the mating surfaces.



#### LIQUID GASKET APPLICATION INSTRUCTION

1. Using a scraper, remove any old liquid gasket remaining on the gasket application surface and its mating surface.
  - Remove any old liquid gasket remaining in the gasket application groove and on the threads of bolts and bolt holes.
2. Using Isozole, wipe the gasket application surface and its mating surface to remove any moisture, oil, and foreign material.
3. Set genuine liquid gasket to tube presser (commercial service tool).
4. Apply a continuous bead of liquid gasket to the specified position at the specified diameter.
  - Apply liquid gasket in the application groove.
  - Apply liquid gasket inside bolt holes. Always refer to the directions specified in the text when applying liquid gasket outside the bolt holes.
  - Attaching should be done within 5 minutes after gasket application.
  - Immediately wipe off any protruding liquid gasket.
  - Do not retighten nuts and bolts after installation.
  - After finishing work, wait at least 30 minutes before refilling engine oil and coolant.

#### CAUTION:

- Follow any directions specified in the text on the following pages.

## **PRECAUTIONS**

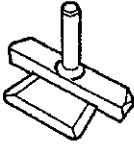
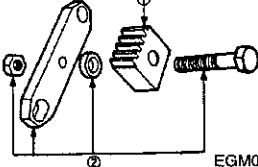
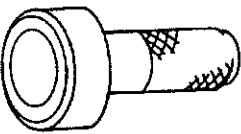
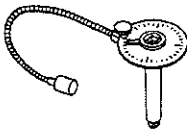
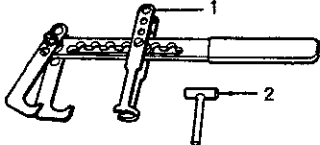
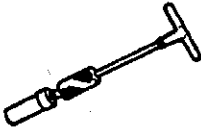
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### **Parts Requiring Angle Tightening**

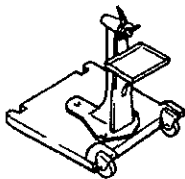
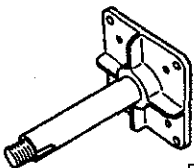
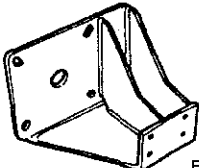
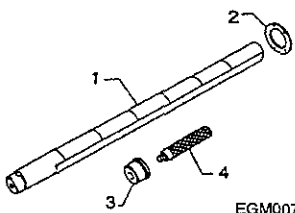
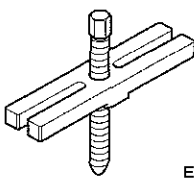
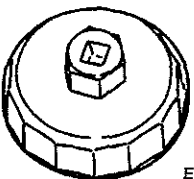
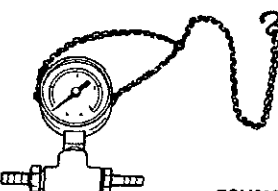
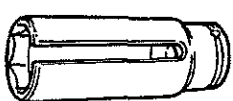
- When tightening the following parts, use an angle wrench (SST).
- Cylinder head bolt
- Connecting rod cap nut
- Specified torque described for these parts is not the final tightening value but the tightening torque used before angle tightening.
- Before tightening, make sure that there are no foreign materials on thread and mating surface, and apply engine oil.

## PREPARATION

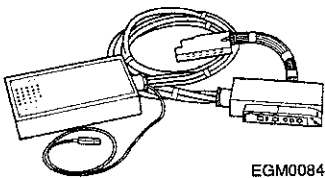
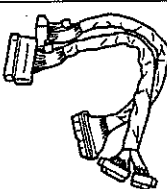
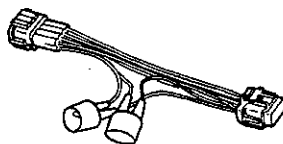
### Special Service Tools

| Description                                                                                                                                                                                                   | Application                                | Remarks             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------------|
| Seal cutter<br>(N-KV101-11110-0)<br><br>EGM0069                                                                              | Removing parts attached with liquid gasket |                     |
| Ring gear stopper<br>(N-KV I10-1056S-0)<br>1 Adapter<br>(N-KV101-05630)<br>2 Stopper plate<br>(N-KV101-05610)<br><br>EGM0070 | Removing and installing crankshaft pulley  |                     |
| Oil seal drift<br>(N-KV101-04900)<br><br>EGM0071                                                                            | Installing front oil seal                  |                     |
| Angle wrench<br>(N-KV101-12100)<br><br>EGM0072                                                                             | Checking tightening angle                  | Already established |
| 1. Valve spring compressor<br>(N-KV101-09210)<br>2. Adapter<br>(N-KV101-11200)<br><br>EGM0073                              | Removing and installing valve collet       |                     |
| Valve oil seal puller<br>(N-KV101-07901)<br><br>EGM0074                                                                    | Removing valve oil seal                    |                     |
| Valve oil seal drift<br>(N-KV101-13000)<br><br>EGM0075                                                                     | Installing valve oil seal                  |                     |

## PREPARATION

| Description                                                                                                                                                                                                                                                                       | Application                                  | Remarks             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---------------------|
| Engine stand assembly<br>(N-ST0501-S000)<br><br> EGM0076                                                                                                                                         | Overhauling engine                           | Already established |
| Engine attachment<br>(N-KV101-06500)<br><br> EGM0077                                                                                                                                             |                                              |                     |
| Engine sub-attachment<br>(N-KV111-04800)<br><br> EGM0078                                                                                                                                         |                                              |                     |
| Camshaft bushing tool set<br>(N-KV111-045S0)<br>1. Bar<br>(N-KV111-04510)<br>2. Guide plate<br>(N-KV111-04520)<br>3. Adapter<br>(N-KV111-04530)<br>4. Drift<br>(N-ST1524-3000)<br><br> EGM0079 | Removing and installing camshaft bushing     |                     |
| Pulley puller<br>(N-KV111-03000)<br><br> EGM0080                                                                                                                                               | Removing crankshaft pulley.                  | Already established |
| Oil filter wrench<br>(N-KV101-15801)<br><br> EGM0081                                                                                                                                           | Removing oil filter                          | Already established |
| EGI fuel pressure indicator<br>(N-ST1959-0000)<br><br> EGM0082                                                                                                                                 | For measuring fuel pressure gauge            |                     |
| Heated oxygen sensor wrench<br>(N-KV101-13700)<br><br> EGM0083                                                                                                                                 | Removing and installing heated oxygen sensor |                     |

## PREPARATION

| Description                                                                                                                                                                | Application                                     | Remarks |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---------|
| Maintenance tool<br>1. DIAGNOSIS KIT<br>(N-SKVEE-GY010)<br>2. SOFT WARE<br>(N-SKVEE-GY100)                                                                                 | For system inspection and diagnosis             |         |
| Check adapter V<br>(N-EG1755-0000)<br>(for SMJ 150-pin connector) <br>EGM0084             | For control unit input/output signal inspection |         |
| Harness adapter<br>(N-EG1755-0200)<br>(150-pin to 121-pin conversion adapter) <br>EGM0085 |                                                 |         |
| For molding coil<br>Adapter harness<br>(N-EG101-17500) <br>EGM0086                       | Checking engine speed                           |         |

## Service Parts

### Piston oversize

0.5 mm (0.020 in) OS [0.5 mm (0.020 in) oversize]

1.0 mm (0.039 in) OS [1.0 mm (0.039 in) oversize]

### Main bearing undersize

Unit: mm (in)

| Size             | Thickness      |
|------------------|----------------|
| STD              | 2.000 (0.0787) |
| US 0.25 (0.0098) | 2.125 (0.0837) |
| US 0.50 (0.0197) | 2.250 (0.0886) |
| US 0.75 (0.0295) | 2.375 (0.0935) |
| US 1.00 (0.0394) | 2.500 (0.0984) |

## SERVICE DATA

### Periodical Inspection

To maintain the initial performance of the TCM FORKLIFT, make sure to perform appropriate maintenance and service work.

### PERFORM INSPECTION

Make sure to perform the periodical inspections at the appropriate times, according to the month basis or the operating hour basis, whichever comes first.

Refer to the following notes for values in ( ).

| Engine system inspection (except LPG fuel systems) |                                                       |                           |                               |   |   |   |   |    |    |    |    |    |    |    |    |
|----------------------------------------------------|-------------------------------------------------------|---------------------------|-------------------------------|---|---|---|---|----|----|----|----|----|----|----|----|
| No.                                                | Inspection items                                      | Applicable control system | Months of use                 | 1 | 2 | 3 | 4 | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 |
|                                                    |                                                       |                           | Operation hours (x 100 hours) | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| 1                                                  | Intake/exhaust valve clearance<br>Electronic controls | Electronic controls       |                               | A |   | A |   |    | A  |    |    | A  |    |    | A  |
| 2                                                  | Engine drive belt tension                             | Electronic controls       |                               | I | I | I | I | I  | I  | I  | I  | I  | I  | I  | I  |
| 3                                                  | Engine oil                                            | Electronic controls       | (1)                           | R | R | R | R | R  | R  | R  | R  | R  | R  | R  | R  |
| 4                                                  | Oil filter                                            | Electronic controls       | (1)                           | R |   | R |   |    | R  |    |    | R  |    |    | R  |
| 5                                                  | Engine coolant                                        | Electronic controls       |                               |   |   |   |   |    |    |    |    |    |    |    | R  |
| 6                                                  | Air cleaner element                                   | Electronic controls       |                               | C | C | C | C | C  | C  | C  | C  | C  | C  | C  | C  |
| 7                                                  | Spark plug                                            | Electronic controls       |                               | I | I | I | I | I  | I  | I  | I  | I  | I  | I  | I  |
| 8                                                  | PCV valve                                             | Electronic controls       | (1)                           |   |   | I |   |    | I  |    |    | I  |    |    | I  |
| 9                                                  | PCV hose                                              | Electronic controls       |                               |   |   | I |   |    | I  |    |    | I  |    |    | I  |

## SERVICE DATA

### Periodical Inspection (Cont'd)

| No. | Engine system inspection (LPG models)     |                         |   |   |   |   |   |   |   |   |   |   |   |   |
|-----|-------------------------------------------|-------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| 1   | Gas leakage from piping and piping joints | Electronic controls (2) | I | I | I | I | I | I | I | I | I | I | I | I |
| 2   | Damage to piping and piping joints        | Electronic controls     | I | I | I | I | I | I | I | I | I | I | I | I |
| 3   | Tar in vaporizer                          | Electronic controls     | D | D | D | D | D | D | D | D | D | D | D | D |
| 4   | Ignition nozzle                           | Electronic controls     | I |   | I |   |   | I |   |   | I |   |   | I |
| 5   | LPG filter                                | Electronic controls     |   |   |   | C |   | C |   |   | C |   |   | R |

**CAUTION:**

(1) If the vehicle is being used in dusty and dirty environments, the maintenance work should be performed more frequently.

(2) After replacing the LPG tank, apply soapsuds to the piping joints to check for any gas leakage.

Meanings of symbols: I = Inspection. Repair or replace if necessary.

R = Replacement

A = Adjustment

C = Cleaning

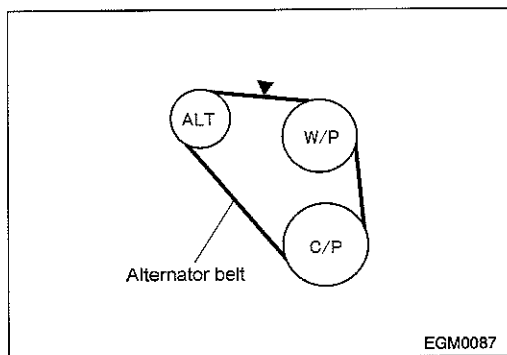
D = Draining

T = Tightening (Retightening)

## SERVICE DATA

### Standard, Repair Limit

|                                                                  |                                  |                 |                                                                                                |                             |           |
|------------------------------------------------------------------|----------------------------------|-----------------|------------------------------------------------------------------------------------------------|-----------------------------|-----------|
| Fuel in use                                                      | Gasoline specification           |                 | Unleaded gasoline, octane rating: 91 or more                                                   |                             |           |
|                                                                  | LPG specification                |                 | 100P                                                                                           |                             |           |
| Engine weight (without water, with oil) kg (lb)                  |                                  |                 | Approx. 290 (639)                                                                              |                             |           |
| Firing order                                                     |                                  |                 | 1 - 5 - 3 - 6 - 2 - 4                                                                          |                             |           |
| Compression pressure<br>kPa (bar, kgf/cm <sup>2</sup> , psi)/rpm | Standard                         |                 | 1,187 (11.87, 12.1, 172)/200                                                                   |                             |           |
|                                                                  | Repair limit                     |                 | 892 (8.92, 9.1, 129)/200                                                                       |                             |           |
|                                                                  | Difference limit among cylinders |                 | 98 (0.98, 1.0, 14)/200                                                                         |                             |           |
| Distortion limit mm (in)                                         | Intake manifold                  |                 | 0.2 (0.008)                                                                                    |                             |           |
|                                                                  | Exhaust manifold                 |                 | 0.3 (0.012)                                                                                    |                             |           |
|                                                                  | Cylinder head                    |                 | 0.2 (0.008)                                                                                    |                             |           |
|                                                                  | Cylinder block                   |                 | 0.1 (0.004)                                                                                    |                             |           |
| Engine oil amount l (Imp qt)<br>(SL class)                       | When replacing oil only          |                 | Approx. 7.3 (6-3/8)                                                                            |                             |           |
|                                                                  | When replacing oil and filter    |                 | Approx. 7.6 (6-3/4)                                                                            |                             |           |
| Spark plug                                                       | Manufacturer/type/gap            | mm (in)         | NGK/BPR4ES/0.8 - 0.9 (0.031 - 0.035)                                                           |                             |           |
| Resistance on high-tension cable                                 |                                  | (kΩ)            | #1: Approx. 2.7 #2: Approx. 2.8 #3: Approx. 4<br>#4: Approx. 5 #5: Approx. 5.2 #6: Approx. 6.1 |                             |           |
| Ignition advance device                                          |                                  |                 | Electronically controlled ignition advance                                                     |                             |           |
| Onboard idle speed                                               |                                  | (rpm)           | 650 ± 50 (N or P position)                                                                     |                             |           |
| Onboard idling pace speed (When feedback control is stopped)     |                                  | (rpm)           | 650 (N or P position)                                                                          |                             |           |
| Density of CO at idle speed/Density of HC at idle speed          |                                  | (%/ppm)         | 0.1 or less/50 or less                                                                         |                             |           |
| Ignition timing (When feedback control is stopped)               |                                  | (BTDC°/rpm)     | 10 ± 1/650                                                                                     |                             |           |
| Valve clearance                                                  | mm (in)                          | INT/EXH         | Hot                                                                                            | 0.35 (0.0138)/0.35 (0.0138) |           |
| Thermostat opening valve temperature (Start - Full open)         |                                  |                 | °C (°F)<br>82 - 95 (180 - 203)                                                                 |                             |           |
| Engine drive belt deflection                                     |                                  |                 | New belt                                                                                       | After adjustment            | Limit     |
| [Measured by pressing<br>with 98 N (10 kg, 22 lb)]               | mm (in)                          | Alternator belt | 10 - 12<br>(0.39 - 0.47)                                                                       | 13 - 15<br>(0.51 - 0.59)    | 16 (0.63) |



## SERVICE DATA

### Tightening Torque

#### STANDARD BOLT TIGHTENING TORQUE

<Hexagon head> <No lubrication> Unit: N•m (kg-m, ft-lb)

N•m (kg-m, in-lb)\*

| Normal size<br>d | Pitch<br>P | 4T                  |                     | 7T                 |                    | 9T                  |                     |
|------------------|------------|---------------------|---------------------|--------------------|--------------------|---------------------|---------------------|
|                  |            | Non-flanged<br>bolt | Flanged bolt        | Non-flanged bolt   | Flanged bolt       | Non-flanged<br>bolt | Flanged bolt        |
| M3               | 0.5        | 0.6<br>(0.06, 5)*   | 0.7<br>(0.07, 6)*   | 1.1<br>(0.11, 10)* | 1.3<br>(0.13, 11)* | 1.6<br>(0.16, 14)*  | 1.9<br>(0.19, 16)*  |
| M3.5             | 0.6        | 1.0<br>(0.10, 9)*   | 1.2<br>(0.12, 10)*  | 1.7<br>(0.17, 15)* | 2.1<br>(0.21, 18)* | 2.5<br>(0.25, 22)*  | 2.8<br>(0.29, 25)*  |
| M4               | 0.7        | 1.5<br>(0.15, 13)*  | 1.7<br>(0.17, 15)*  | 2.5<br>(0.25, 22)* | 2.9<br>(0.30, 26)* | 3.5<br>(0.36, 31)*  | 4.2<br>(0.43, 37)*  |
| M5               | 0.8        | 2.9<br>(0.30, 26)*  | 3.5<br>(0.36, 31)*  | 5.0<br>(0.51, 44)* | 5.9<br>(0.6, 52)*  | 7.2<br>(0.73, 63)*  | 8.5<br>(0.87, 76)*  |
| M6               | 1.0        | 5.0<br>(0.51, 44)*  | 6.0<br>(0.61, 53)*  | 8.4<br>(0.86, 75)* | 10<br>(1.0, 87)*   | 11.8<br>(1.2, 8.7)  | 14.7<br>(1.5, 10.8) |
| M8               | 1.25       | 12.7<br>(1.3, 9.4)  | 14.7<br>(1.5, 10.8) | 20.6<br>(2.1, 15)  | 24.5<br>(2.5, 18)  | 29.4<br>(3.0, 22)   | 35.3<br>(3.6, 26)   |
|                  | 1.0        | 13.7<br>(1.4, 10)   | 15.7<br>(1.6, 12)   | 21.6<br>(2.2, 16)  | 26.5<br>(2.7, 20)  | 31.4<br>(3.2, 23)   | 37.3<br>(3.8, 27)   |
| M10              | 1.5        | 24.5<br>(2.5, 18)   | 29.4<br>(3.0, 22)   | 41.2<br>(4.2, 30)  | 49<br>(5, 36)      | 58.8<br>(6.0, 43)   | 69.6<br>(7.1, 51)   |
|                  | 1.25       | 25.5<br>(2.6, 19)   | 30.4<br>(3.1, 22)   | 43.1<br>(4.4, 32)  | 51<br>(5.2, 38)    | 61.8<br>(6.3, 46)   | 73.6<br>(7.5, 54)   |
| M12              | 1.75       | 42.2<br>(4.3, 31)   | 51<br>(5.2, 38)     | 70.6<br>(7.2, 52)  | 84.3<br>(8.6, 62)  | 98.1<br>(10, 72)    | 118<br>(12, 87)     |
|                  | 1.25       | 46.1<br>(4.7, 34)   | 55.9<br>(5.7, 41)   | 77.5<br>(7.9, 57)  | 92.2<br>(9.4, 68)  | 108<br>(11, 80)     | 137<br>(14, 101)    |
| M14              | 1.5        | 73.6<br>(7.5, 54)   | 87.3<br>(8.9, 64)   | 127<br>(13, 94)    | 147<br>(15, 108)   | 177<br>(18, 130)    | 206<br>(21, 152)    |
| M16              | 1.5        | 108<br>(11, 80)     | 137<br>(14, 101)    | 186<br>(19, 137)   | 226<br>(23, 166)   | 265<br>(27, 195)    | 324<br>(33, 239)    |
| M18              | 1.5        | 167<br>(17, 123)    | 196<br>(20, 145)    | 275<br>(28, 203)   | 324<br>(33, 239)   | 392<br>(40, 289)    | 471<br>(48, 34)     |
| M20              | 1.5        | 226<br>(23, 166)    | 275<br>(28, 203)    | 382<br>(39, 282)   | 451<br>(46, 333)   | 549<br>(56, 405)    | 657<br>(67, 485)    |
| M22              | 1.5        | 304<br>(31, 224)    | 363<br>(37, 268)    | 510<br>(52, 376)   | 608<br>(62, 448)   | 736<br>(75, 542)    | 883<br>(90, 651)    |

#### CAUTION:

- Except special parts.
- The bolt applicable to the list has the following number embossed on the head.

Model Number

4T ... 4 or none

7T ... 7

9T ... 9

#### CAUTION FOR USE OF POWER TOOLS

Do not use any power tools (e.g. air ratchet, impact wrench) to tighten the bolts and nuts. Use these tools only for loosening the bolts and nuts. However, do not use power tools in any event and for any purposes on the parts subject to heat (catalyst, muffler, and other exhaust parts) and the tapping screws. These parts may also be damaged when loosened with a power tool.

## SERVICE DATA

### Tightening Torque (Cont'd)

#### MAIN TIGHTENING TORQUE

- : Parts with tightening sequence  
 1) - : Tighten separately in several turns.  
 Unit : N•m (kg-m, ft-lb)  
 N•m (kg-m, in-lb)\*

| Parts name or location            | Tightening torque                                                                                         |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------|
| Adjusting screw Lock nut          | 16 - 22 (1.6 - 2.2, 12 - 16)                                                                              |
| Alternator Adjusting bar side     | 17.5 - 23.7 (1.8 - 2.4, 13 - 17)                                                                          |
| Bracket side                      | 50.0 - 67.6 (5.1 - 6.9, 37 - 50)                                                                          |
| Oil pan drain plug                | 54 - 59 (5.5 - 6.0, 40 - 43)                                                                              |
| Spark plug                        | 19.6 - 29.4 (2.0 - 3.0, 14 - 22)                                                                          |
| * Intake manifold                 | 15.7 - 18.6 (1.6 - 1.9, 12 - 14)                                                                          |
| * Air horn                        | 22 - 37 (2.2 - 3.8, 16 - 27)                                                                              |
| Exhaust manifold cover            | 6.37 - 7.45 (0.65 - 0.76, 56 - 66)*                                                                       |
| * Exhaust manifold                | 27 - 31 (2.8 - 3.2, 20 - 23)                                                                              |
| Exhaust manifold connector        | 59 - 78 (6.0 - 8.0, 43 - 58)                                                                              |
| * Oil pan [M6]                    | 6.3 - 8.3 (0.64 - 0.85, 56 - 74)*                                                                         |
| [M8]                              | 15.7 - 20.6 (1.6 - 2.1, 12 - 15)                                                                          |
| Oil strainer                      | 16 - 19 (1.6 - 1.9, 12 - 14)                                                                              |
| * Rocker cover                    | 0.89 - 2.9 (0.1 - 0.3, 9 - 26)*                                                                           |
| Rocker shaft bracket              | 15.6 - 21.6 (1.6 - 2.2, 12 - 16)                                                                          |
| * Cylinder head bolt              | 1) 29.4 (3, 22)<br>2) 61.7 (6.3, 46)<br>3) 0 (0, 0)<br>4) 29.4 (3, 22)<br>5) 69° - 74° (Angle tightening) |
| Cylinder head additional bolt     | 6.4 - 7.5 (0.65 - 0.76, 56 - 66)*                                                                         |
| Crankshaft pulley                 | 181 - 191 (18.5 - 19.5, 134 - 141)                                                                        |
| * Front cover                     | 15.7 - 20.6 (1.6 - 2.1, 12 - 15)                                                                          |
| Camshaft sprocket                 | 132 - 142 (13.5 - 14.5, 98 - 105)                                                                         |
| Chain tensioner                   | 6.4 - 7.5 (0.65 - 0.76, 56 - 66)*                                                                         |
| Distributor                       | 9.35 - 11 (0.95 - 1.1, 82 - 95)*                                                                          |
| Camshaft locating plate           | 6.4 - 7.5 (0.65 - 0.76, 56 - 66)                                                                          |
| * Flywheel                        | 147 - 167 (15 - 17, 108 - 123)                                                                            |
| * Main bearing cap                | 162 - 172 (16.5 - 17.5, 119 - 127)                                                                        |
| Connecting rod nut                | 1) 38 - 40 (3.9 - 4.1, 28 - 30)<br>2) 40° - 45° (Angle tightening)                                        |
| Engine coolant drain plug         | 34 - 44 (3.5 - 4.5, 25 - 33)                                                                              |
| Water pump                        | 15.7 - 18.6 (1.6 - 1.9, 12 - 14)                                                                          |
| Engine coolant temperature sensor | 20 - 29 (2.0 - 3.0, 14 - 22)                                                                              |
| PCV valve                         | 20 - 29 (2.0 - 3.0, 14 - 22)                                                                              |
| * Fuel tube                       | 1) 9.3 - 20.6 (0.9 - 2.1, 78 - 182)*<br>2) 20.6 - 26.5 (2.1 - 2.7, 15 - 20)                               |
| Starter motor                     | 41.2 - 52 (4.2 - 5.3, 30 - 38)                                                                            |
| Heated oxygen sensor 1            | 40 - 60 (4.1 - 6.1, 30 - 44)                                                                              |



# ENGINE TUNE-UP

## SECTION **ET**

### CONTENTS

|                                |             |
|--------------------------------|-------------|
| <b>VALVE CLEARANCE</b> .....   | <b>ET-2</b> |
| Inspection .....               | ET-2        |
| Adjustment .....               | ET-3        |
| <b>ENGINE DRIVE BELT</b> ..... | <b>ET-4</b> |
| Inspection .....               | ET-4        |
| Belt Tension Adjustment .....  | ET-4        |

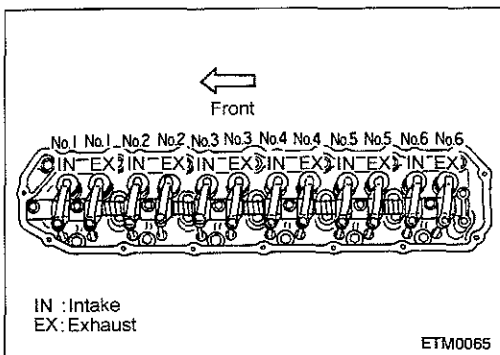
|                                   |              |
|-----------------------------------|--------------|
| <b>ENGINE OIL</b> .....           | <b>ET-5</b>  |
| Engine Oil Inspection .....       | ET-5         |
| Engine Oil Replacement .....      | ET-6         |
| Oil Filter Replacement .....      | ET-7         |
| <b>COMPRESSION PRESSURE</b> ..... | <b>ET-9</b>  |
| <b>SPARK PLUG</b> .....           | <b>ET-10</b> |
| Removal and Installation .....    | ET-10        |
| Inspection After Removal .....    | ET-10        |

## VALVE CLEARANCE

- Whenever rocker arm and rocker shaft assembly are removed and installed, or symptoms due to changes in valve clearance as a result of aging (poor starting, rough idle, unusual noise) are obvious, check and adjust valve clearance with the following procedure:

### Inspection

- Stop the engine after warming up.
- Remove rocker cover.
- Rotate the crankshaft pulley clockwise (as viewed from crankshaft pulley side) and align orange notch with the timing indicator (protrusion) on the front cover.
- Make sure that there is valve clearance in intake/exhaust side of No. 1 cylinder. (No. 1 cylinder is at TDC on its compression stroke.)
  - If not, rotate the crankshaft pulley one more turn.



- Refer to the figure, and measure valve clearance for the table item below with a circle using a feeler gauge.

#### Standard:

0.35 mm (0.0138 in) (Hot, intake/exhaust)

#### CAUTION:

- Make sure that the standard under hot condition is appropriate if adjustment is made under cold condition.

| Cylinder                                    | No. 1  |         | No. 2  |         | No. 3  |         | No. 4  |         | No. 5  |         | No. 6  |         |
|---------------------------------------------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|
| Valve                                       | Intake | Exhaust | Intake | Exhaust | Intake | Exhaust | Intake | Exhaust | Intake | Exhaust | Intake | Exhaust |
| 1 cylinder at TDC of its compression stroke | ○      | ○       | ○      |         |        | ○       | ○      |         |        | ○       |        |         |

#### NOTE:

- Firing order: 1 - 5 - 3 - 6 - 2 - 4
- Turn crankshaft 360 degrees to set No. 6 cylinder at TDC of its compression stroke.

## VALVE CLEARANCE

### Inspection (Cont'd)

7. Measure valve clearance at points marked with ○ in the following table.

| Cylinder                                    | No. 1  |         | No. 2  |         | No. 3  |         | No. 4  |         | No. 5  |         | No. 6  |         |
|---------------------------------------------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|
| Valve                                       | Intake | Exhaust | Intake | Exhaust | Intake | Exhaust | Intake | Exhaust | Intake | Exhaust | Intake | Exhaust |
| 6 cylinder at TDC of its compression stroke |        |         |        | ○       | ○      |         |        | ○       | ○      |         | ○      | ○       |

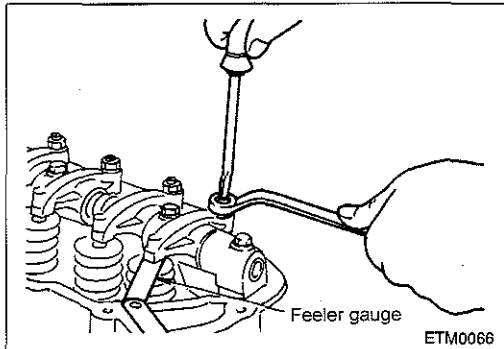
#### NOTE:

- If No. 1 cylinder is not at TDC on its compression stroke in step 4, it is acceptable to measure the item with No. 6 cylinder at TDC on its compression stroke (step 7) without rotating crankshaft pulley.
8. Adjust with the following if outside the standard value.

### Adjustment

- Adjust the same measuring points in the same condition of "Inspection" with the following procedure:
  - Loosen valve clearance adjusting screw lock nut.
  - Turn adjusting screw in the loosening direction using a screwdriver.
  - Insert a standard feeler gauge in between rocker arm and valve stem end surface, and then tighten until it contacts with adjusting screw.
  - Tighten lock nut while securing it using a screwdriver so as not to rotate adjusting screw.

Ⓐ: 16 - 21 N·m (1.6 - 2.2 kg-m, 12 - 15 ft-lb)
- Crank engine several times, check valve clearance again, and make sure that it is within the standard.



## ENGINE DRIVE BELT

### Inspection

- Inspection should be done only when engine is cold or over 30 minutes after the engine is stopped.
- Measure the belt deflection by applying load of 98 N (10 kg, 22 lb) to ▼ as shown in the figure.

#### CAUTION:

- **First set the tension to the standard when measuring belt tension immediately after the belt is installed. Rotate the crankshaft more than two turns in order to eliminate variance in the belt deflection between pulleys. Then measure and adjust tension to the standard.**
- **Visually check belts for wear, damage, and cracks on inside and edges.**
- **Retighten if belt deflection is too low (excessive tension) and too high (outside retightening limit).**

Unit: mm (in)

| Location<br>Item | Belt specification      | Belt deflection<br>[When pressed by a force of 98 N (10 kg, 22 lb)] |                          |           |
|------------------|-------------------------|---------------------------------------------------------------------|--------------------------|-----------|
|                  |                         | New belt                                                            | After adjustment         | Limit     |
| Alternator belt  | Low-edge belt (FM type) | 10 - 12<br>(0.39 - 0.47)                                            | 13 - 15<br>(0.51 - 0.59) | 16 (0.63) |

#### CAUTION:

- **Tighten slightly stronger than used belt when belt is replaced with new one, because new belt will not fully seat in the pulley groove.**
- **Adjust the tension to the value after adjustment when used belt tension exceeds retightening limit.**
- **Make sure that belt is correctly engaged with the pulley groove when installing.**
- **Adjust the belt by applying tension, but do not rotate pulley in each pulley stop condition.**
- **Do not tighten with excessive tension.**
- **Do not allow oil or water to get on the belt.**
- **Do not twist or bend the belt strongly.**

### Belt Tension Adjustment

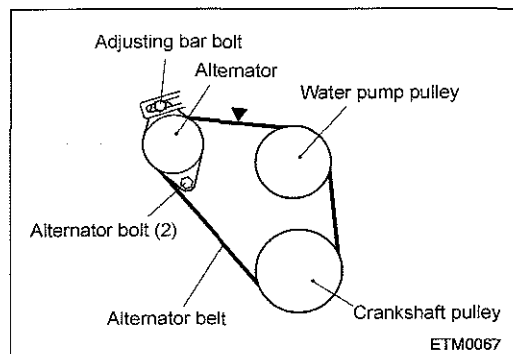
- Loosen alternator bolt and adjusting bar bolt, and adjust them with alternator installing angle.
- Tighten adjusting bar bolt and alternator bolt.

#### Adjusting bar bolt:

☞: 18 - 23 N·m (1.8 - 2.4 kg-m, 13 - 17 ft-lb)

#### Alternator bolts (2):

☞: 50 - 67 N·m (5.1 - 6.9 kg-m, 37 - 49 ft-lb)



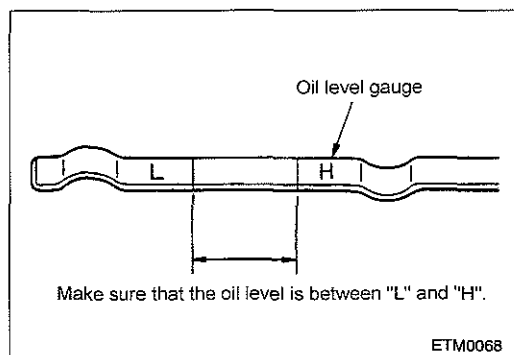
## ENGINE OIL

### Engine Oil Inspection

#### OIL LEVEL AND CONTAMINATION

##### CAUTION:

- **Forklift must be level when checking oil level.**
- Check oil level before starting engine. Stop engine and leave it at least 10 minutes if engine has been started. Then check level.
- Check if the oil level is within the range shown on the left.
- Check engine oil for white contamination or considerable dirt.
- If oil has white or pale contamination, it may be caused by *mixing with engine coolant*. Repair the suspect parts.
- Adjust oil level if it is outside the range.



#### OIL LEAKAGE

Check the following parts for engine oil leakage.

- Oil pan
- Oil pan drain plug
- Oil pressure switch
- Oil filter bracket
- Oil filter
- Lower side of cylinder block back
- Mating surfaces of cylinder block and cylinder head
- Mating surfaces of cylinder head and rocker cover
- Front cover
- Around crankshaft pulley

#### OIL PRESSURE

1. Check oil level.
2. Remove oil pressure switch and connect an oil pressure gauge.
3. Make sure that the proper oil pressure corresponding to engine speed is obtained after warming up the engine.

##### NOTE:

- Oil pressure is displayed highish when low oil temperature.

#### ENGINE OIL PRESSURE

| Engine speed (rpm)                  | At Idle                              | 2,000                                  |
|-------------------------------------|--------------------------------------|----------------------------------------|
| kPa (bar, kg/cm <sup>2</sup> , psi) | Approx. 49 (0.49, 0.5, 7)<br>or more | Approx. 118 (1.18, 1.2, 17)<br>or more |

4. Install oil pressure switch after checking the oil pressure with the following procedure.
  - 1) Remove old sealant on the switch and engine.
  - 2) Apply Three Bond 1201 or equivalent to the threads and then tighten.  
 $\square$ : 13 - 17 N•m (1.25 - 1.75 kg-m, 9 - 12 ft-lb)

##### CAUTION:

- **Be careful not to get burned when engine or engine oil is heated.**

## ENGINE OIL

### Engine Oil Replacement

#### NOTE:

- Perform inspection "after refilling oil and after replacing oil" after replacing oil filter if engine oil and oil filter have been replaced.

### PERIODIC REPLACEMENT INTERVAL

- Replace with the following period:  
Oil grade SJ, SL: 1 month or every 200 hours  
(50 hours for first time only)

### REPLACEMENT PROCEDURE

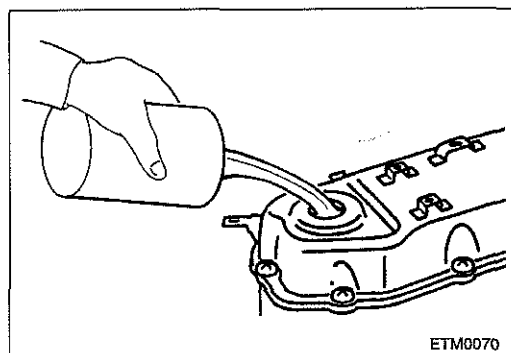
#### CAUTION:

- Be careful not to get burned when engine or engine oil is heated.

1. Warm up engine, and check that there is no oil leakage.
2. Stop the engine. Leave it for 10 minutes.
3. Remove oil filler cap, and remove drain plug of oil pan.
4. Drain engine oil.
5. Install drain plug. Refill with new engine oil.

#### Drain plug tightening torque:

Ⓐ: 54 - 59 N•m (5.5 - 6.0 kg-m, 40 - 43 ft-lb)



### OIL LEVEL

Unit: ℓ (Imp qt)

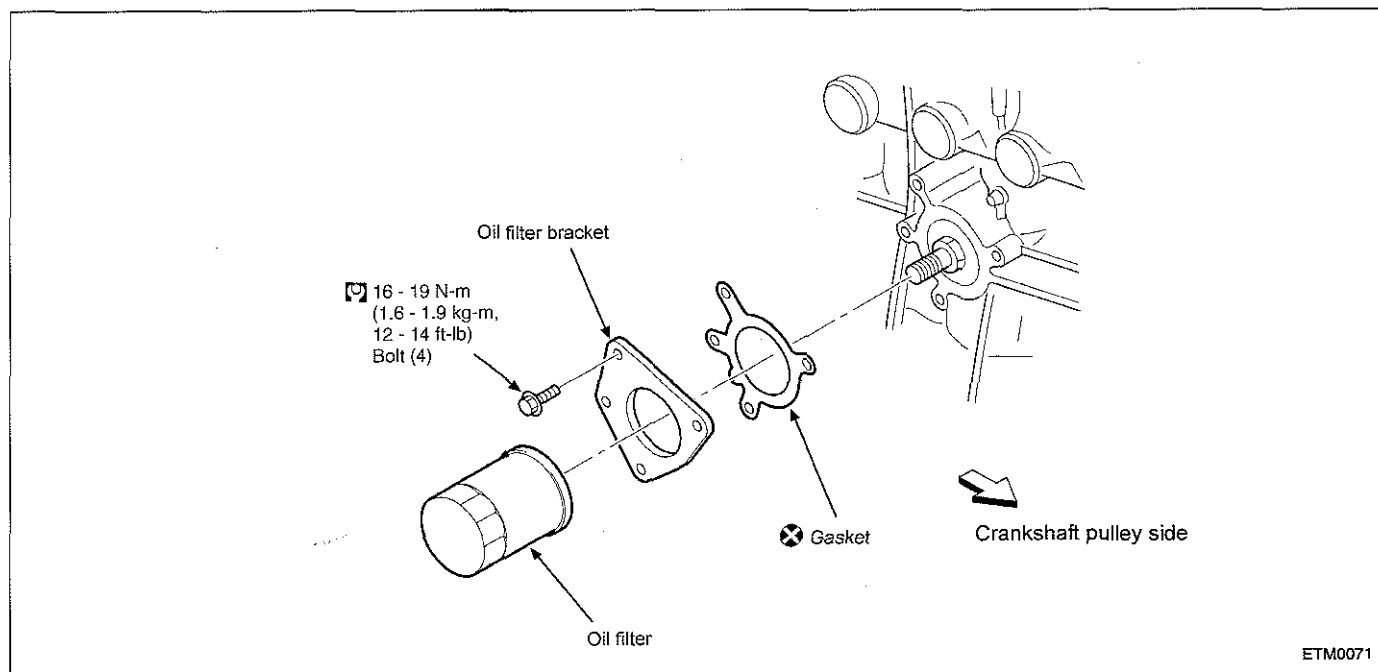
|                                                                                      |                     |
|--------------------------------------------------------------------------------------|---------------------|
| H-level                                                                              | Approx. 7.7 (6-3/4) |
| L-level                                                                              | Approx. 6.7 (5-7/8) |
| Only refill level when changing oil<br>(When drained from drain plug)                | Approx. 7.3 (6-3/8) |
| Refill level when changing both oil filter and oil<br>(When drained from drain plug) | Approx. 7.6 (6-3/4) |

### INSPECTION AFTER REPLACING OIL

1. Check oil filter for engine oil leakage when replacing oil drain plug and oil filter after warming up engine.
2. Check oil level with the engine oil inspection procedure described above.

## ENGINE OIL

### Oil Filter Replacement COMPONENT PARTS LOCATION



### PERIODIC REPLACEMENT INTERVAL

- Replace with the following period:  
Oil grade SJ, SL: 3 months or every 600 hours  
(200 hours for first time only)

### REMOVAL

Remove oil filter using an oil filter wrench (SST).

#### CAUTION:

- Be careful not to get burned when engine or engine oil is heated.
- Use a shop cloth to absorb engine oil leakage when removing.
- Be careful not to spill engine oil on the engine drive belt.
- Completely wipe off any engine oil spilled on the engine and vehicle.

## ENGINE OIL

---

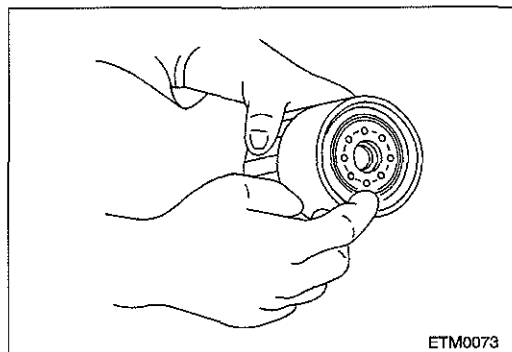
### Oil Filter Replacement (Cont'd)

#### INSTALLATION

1. Completely remove any foreign materials on the attaching surfaces of oil filter.
2. Apply engine oil to the full circumference of an oil seal on a new oil filter.
3. Screw in the oil filter by hand until it contacts oil filter bracket surface, and then add another  $2/3$  of a turn.

#### NOTE:

- Tightening torque is 15 - 20 N•m (1.5 - 2.1 kg-m, 11 - 15 ft-lb).
4. Check for engine oil leakage after warming up the engine.



## COMPRESSION PRESSURE

---

1. Warm up the engine sufficiently.
2. Release the fuel pressure. (Refer to EC section, "Release of fuel pressure".)
3. Turn ignition switch OFF.
4. Disconnect air hose from throttle body and move it out of position.
5. Remove all spark plugs.

### CAUTION:

- **Blow spark plug clean with compressed air when removing it.**
6. Install a rev counter or electronic system diagnosis tester (SST). (Refer to EC-11, "Inspection of idle speed, ignition timing, and air-fuel ratio" in EC section.)
  7. Remove injector harness connector.
  8. Attach an adapter to Allen compression gauge (commercial service tool) and set it to the engine.
  9. Depress accelerator pedal fully. Turn ignition switch to "START" and crank the engine. Record the compression pressure and the engine speed after the gauge indication stabilizes. Repeat the measurement on each cylinder.

**Compression pressure kPa (bar, kg/cm<sup>2</sup>, psi)/rpm**

**Standard:**

**1,187 (11.87, 12.1, 172)/200**

**Repair limit:**

**892 (8.92, 9.1, 129)/200**

**Difference limit among cylinders:**

**98 (0.98, 1.0, 14)/200**

- Check battery for the specific gravity if engine speed is not within the standard, and measure again under normal conditions.
  - Check valve clearance and components around the combustion chamber (valve, valve seat, pistons, piston rings, cylinder bore, cylinder head, cylinder head gasket) if compression pressure is not within the standard, and measure again.
  - Add a small amount of engine oil from spark plug hole if compression pressure of some cylinders is low, and measure again.
  - It is possible that piston ring is worn or damaged if compression pressure is improved by adding engine oil. Check piston ring, and replace it if necessary.
  - There may be a valve malfunction if compression pressure is not improved by adding engine oil. Check valve, and then replace valve or cylinder head if necessary.
  - If compression pressures of adjacent two cylinders are low, and if pressures cannot be improved by adding engine oil, gasket is leaking. Replace cylinder head gasket.
10. Install removed parts.

## SPARK PLUG

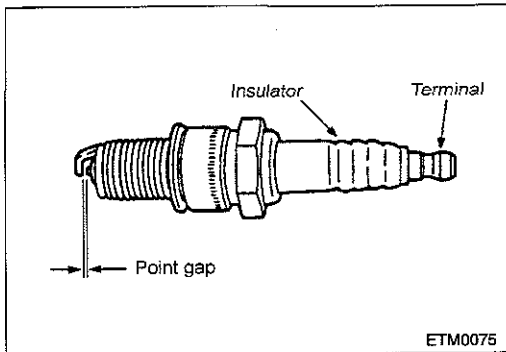
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### Removal and Installation

- Use a spark plug wrench (commercial service tool).  
Blow compressed air around spark plug when removing it.  
⚠: 20 - 29 N•m (2.0 - 3.0 kgf-m, 15 - 21 ft-lb)

### Inspection After Removal

- Visually check electrode for dirt and damage and insulator for burning.
- Check if the electrode gap is within the standard using a plug gap gauge.  
**Standard:**  
0.8 - 0.9 mm (0.031 - 0.035 in)
- Adjust if outside the standard.
- Replace if necessary.



# ENGINE LUBRICATION

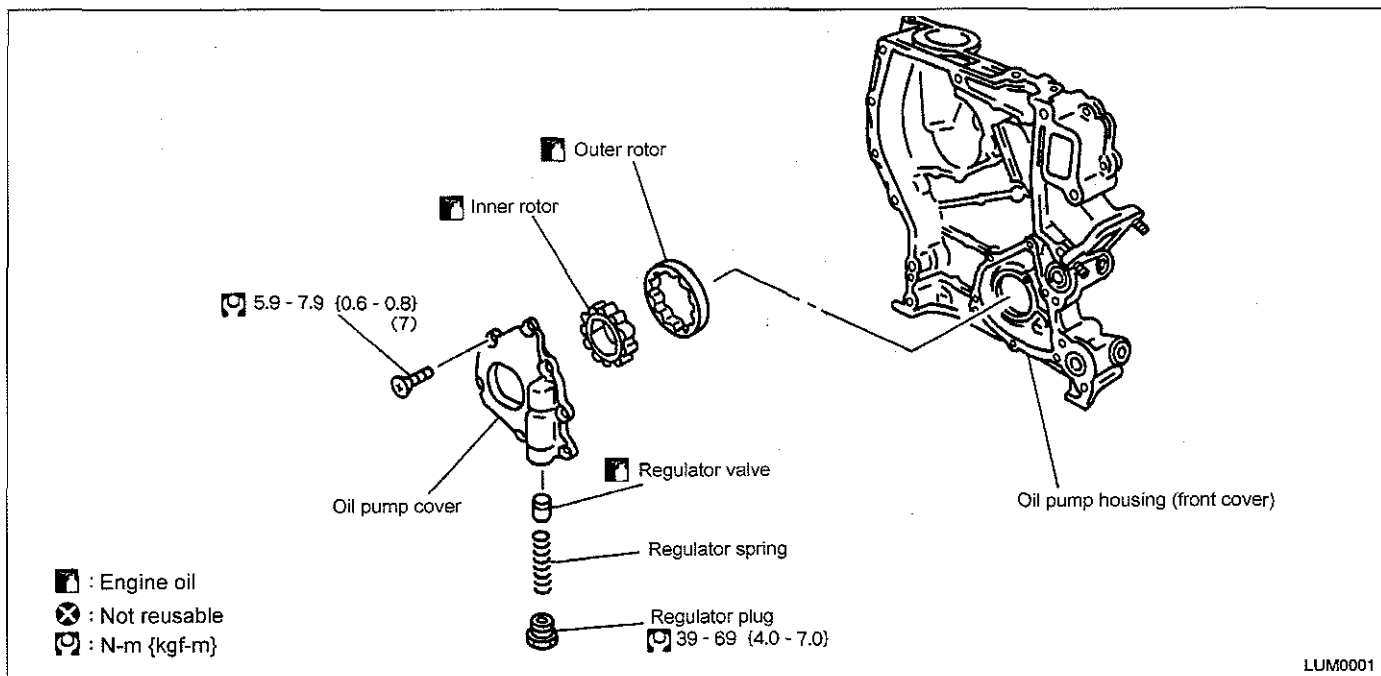
## SECTION LU

### CONTENTS

|                                |             |                                       |             |
|--------------------------------|-------------|---------------------------------------|-------------|
| <b>OIL PUMP</b> .....          | <b>LU-2</b> | <b>Disassembly and Assembly</b> ..... | <b>LU-2</b> |
| Component Parts Location ..... | LU-2        | Inspection .....                      | LU-3        |

# OIL PUMP

## Component Parts Location



### CAUTION:

- Apply new engine oil to the parts marked in the figure prior to installation.

## Disassembly and Assembly

### PREPARATION

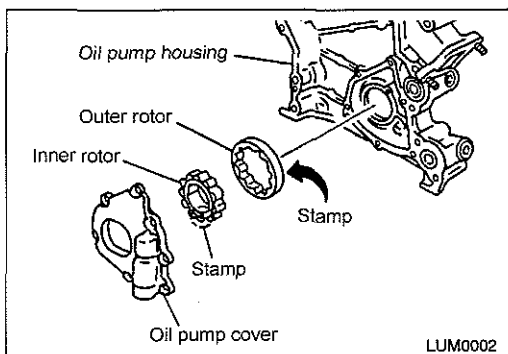
- Front cover (Refer to "TIMING CHAIN" in EM section.)

### NOTE:

- Oil pump is integrated in front cover.

### INSTALLATION OF INNER ROTOR AND OUTER ROTOR

- Install inner rotor with its mark facing rearward (cover side).
- Install outer rotor with its mark facing frontward (housing side).

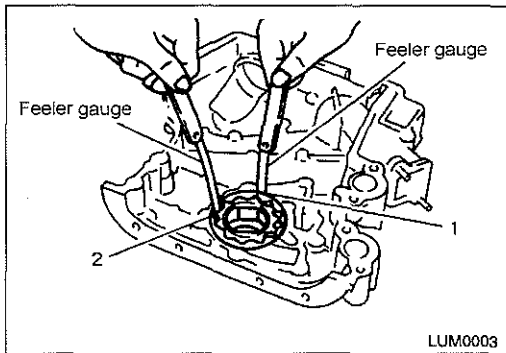


# OIL PUMP

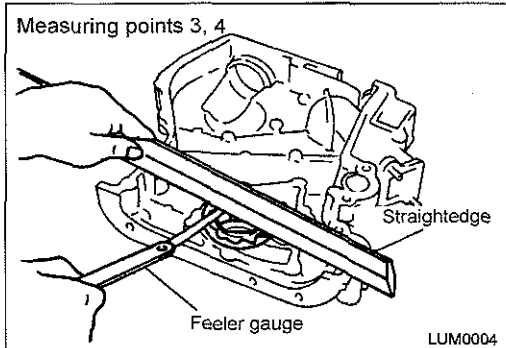
## Inspection

### OIL PUMP COMPONENTS INSPECTION

- Measure each clearance using a feeler gauge.  
**Outer rotor to housing clearance (1 in the figure)**  
Standard:  
0.114 - 0.260 mm (0.0045 - 0.0102 in)  
**Outer rotor to inner rotor tip clearance (2 in the figure)**  
Standard:  
0.180 mm (0.0071 in) or less

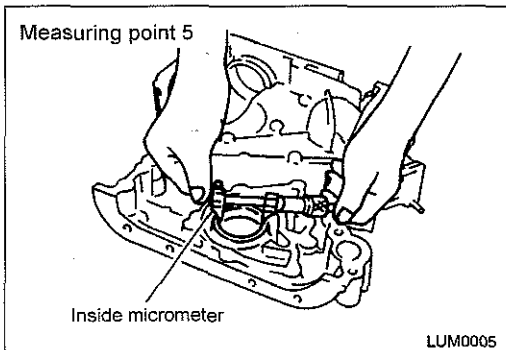


- Measure each clearance using a feeler gauge and straightedge.  
**Inner rotor to housing side clearance (3 in the figure)**  
Standard:  
0.030 - 0.070 mm (0.0012 - 0.0028 in)  
**Outer rotor to housing side clearance (4 in the figure)**  
Standard:  
0.030 - 0.190 mm (0.0012 - 0.0075 in)

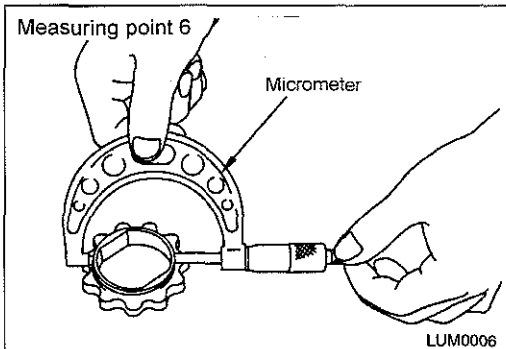


### INNER ROTOR TO HOUSING SOCKET CLEARANCE

- Measure the inner diameter of oil pump housing socket using an inside micrometer. (5 in the figure)



- Measure the outer diameter of inner rotor socket using a micrometer. (6 in the figure)  
(Clearance) = (Inner diameter of front cover socket) – (outer diameter of inner rotor socket)  
Standard:  
0.045 - 0.091 mm (0.0018 - 0.0914 in)



## OIL PUMP

### Inspection (Cont'd)

#### REGULATOR VALVE CLEARANCE

- Measure inner diameter of regulator valve cylinder using an inside micrometer.
  - Measure regulator valve outer diameter using a micrometer.
- (Clearance) = (Cylinder bore inner diameter) – (Valve outer diameter)

**Standard:**

**0.040 - 0.097 mm (0.0016 - 0.0965 in)**

#### CAUTION:

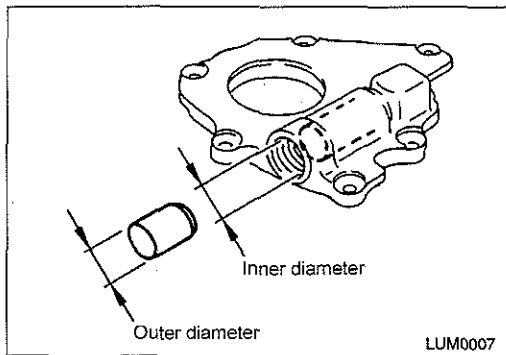
- Apply engine oil to regulator valve. Make sure that the valve moves smoothly.

#### REGULATOR VALVE SPRING

- Check spring for sagging.

**Free length:**

**Approx. 63 mm (2.48 in)**



# ENGINE COOLING SYSTEM

## SECTION **CO**

### CONTENTS

|                                      |             |
|--------------------------------------|-------------|
| <b>CHANGING ENGINE COOLANT .....</b> | <b>CO-2</b> |
| Draining Engine Coolant .....        | CO-2        |
| Refilling Engine Coolant .....       | CO-2        |
| <b>WATER PUMP .....</b>              | <b>CO-3</b> |
| Component Parts Location .....       | CO-3        |

|                                |             |
|--------------------------------|-------------|
| Removal and Installation ..... | CO-3        |
| Water Pump Inspection .....    | CO-3        |
| <b>THERMOSTAT .....</b>        | <b>CO-4</b> |
| Component Parts Location ..... | CO-4        |
| Removal and Installation ..... | CO-4        |

## CHANGING ENGINE COOLANT

### Draining Engine Coolant

#### WARNING:

- Do not drain coolant when engine is still hot. It may cause burns.
- Remove exhaust manifold side drain plug of cylinder block and drain the coolant in cylinder block.

### Refilling Engine Coolant

- Refer to the following for LLC density.

Engine coolant level [including the reservoir tank (MAX level) volume]

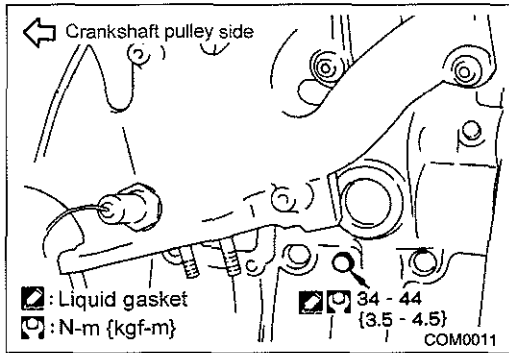
Unit: l (Imp qt)

| Engine type         | TB45E                 |
|---------------------|-----------------------|
| Without rear heater | Approx. 11.2 (9-7/8)  |
| With rear heater    | Approx. 12.3 (10-7/8) |

#### LLC density (%):

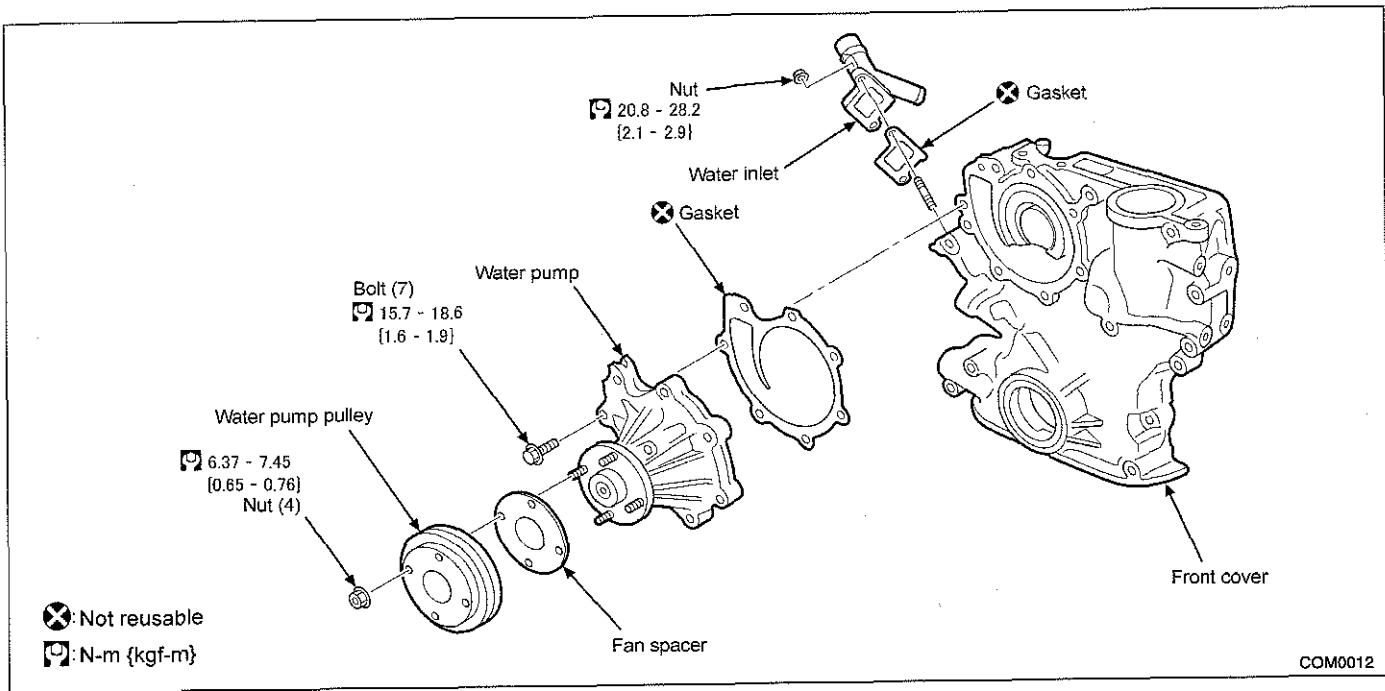
**50 (Standard and cold area)**

- Install cylinder block drain plug.
- Apply sealant (Three Bond 1215B or equivalent) to the threads of cylinder block drain plug.  
□: 34 - 44 N•m (3.5 - 4.5 kgf-m, 26 - 32 ft-lb)
- Make sure that each clamp and drain plug is securely tightened.



# WATER PUMP

## Component Parts Location



## Removal and Installation

### PREPARATION

#### WARNING:

- Do not drain coolant when engine is still hot. It may cause burns.

- Engine drive belts

#### CAUTION:

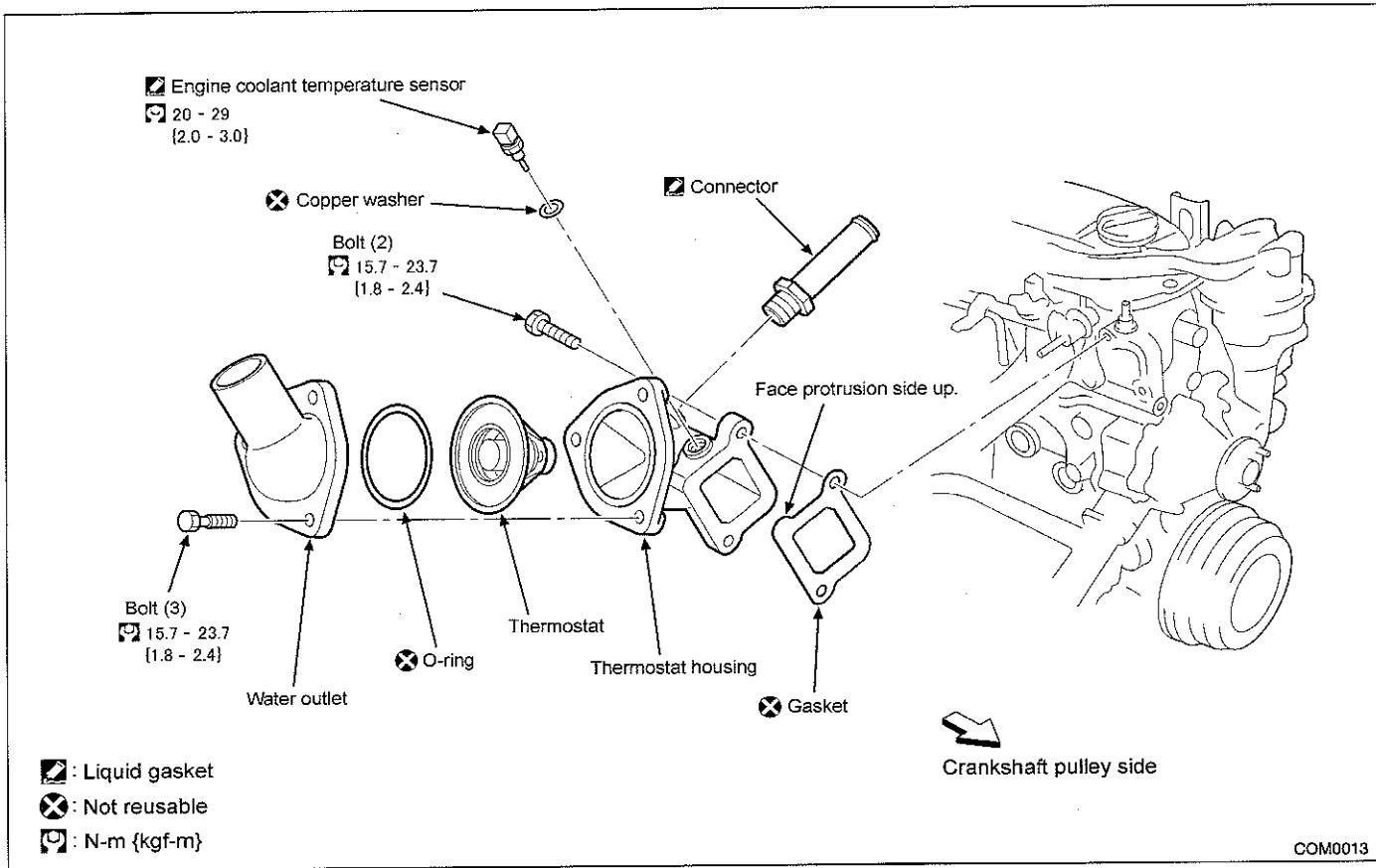
- Handle water pump vane so that it does not contact with other parts.

### Water Pump Inspection

- Check water pump body and vanes for severe corrosion and dirt.
- Make sure that water pump shaft turns smoothly without roughness.

# THERMOSTAT

## Component Parts Location



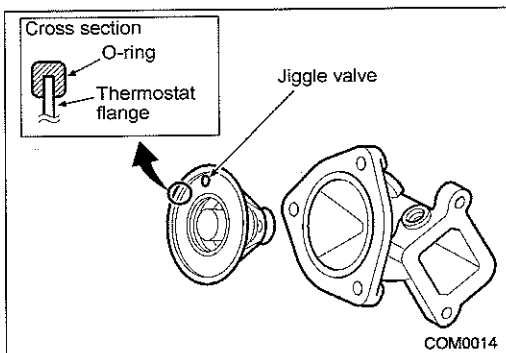
## Removal and Installation

### WARNING:

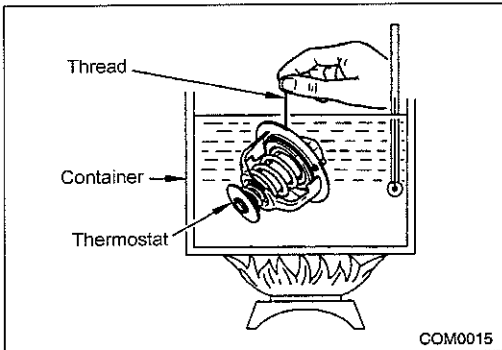
- Do not touch thermostat or container and hot water until they get cold. They may cause burns.

### INSTALLATION OF THERMOSTAT

- Install thermostat with jiggle valve facing upward.
- Make sure that thermostat flange is securely inserted to seal ring.



## THERMOSTAT



### Removal and Installation (Cont'd)

#### THERMOSTAT INSPECTION

##### WARNING:

- Do not touch thermostat or container and hot water until they get cold. They may cause burns.
- Put a thread through thermostat valve and submerge it in a water-filled container, then heat it up while stirring the water.
- Read the water temperature when thermostat drops. This is the valve opening temperature.

##### Valve opening temperature standard:

82° C (180° F) (Standard and cold area)

##### Maximum valve lift standard:

8 mm or more/95° C (0.31 in or more/203° F)  
(Standard and cold area)



# ENGINE FUEL SYSTEM

## SECTION **FL**

### CONTENTS

|                                                   |             |
|---------------------------------------------------|-------------|
| <b>DESCRIPTION .....</b>                          | <b>FL-2</b> |
| Gasoline Specification .....                      | FL-2        |
| LPG Specification .....                           | FL-3        |
| Specification for Combined Gasoline and LPG ..... | FL-3        |

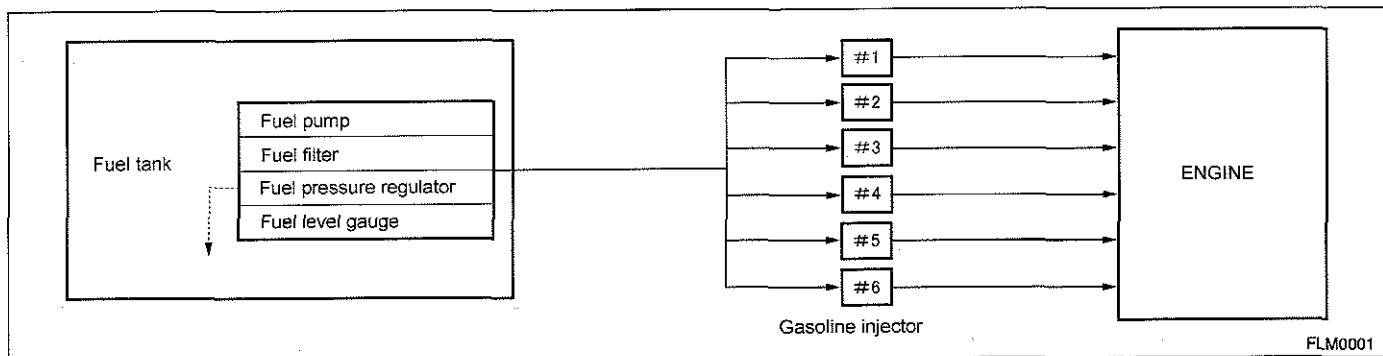
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|----------------------------------------------------------------------------------------|-------------|
| <b>REMOVAL AND INSTALLATION OF FUEL<br/>INJECTOR (GASOLINE AND COMBINED USE) .....</b> | <b>FL-4</b> |
| Preparation .....                                                                      | FL-4        |
| Removal and Installation of Fuel Hose .....                                            | FL-4        |
| Removal and Installation of Fuel Tube and<br>Fuel Injector .....                       | FL-4        |
| Check for Fuel Leakage After Installation .....                                        | FL-6        |

## DESCRIPTION

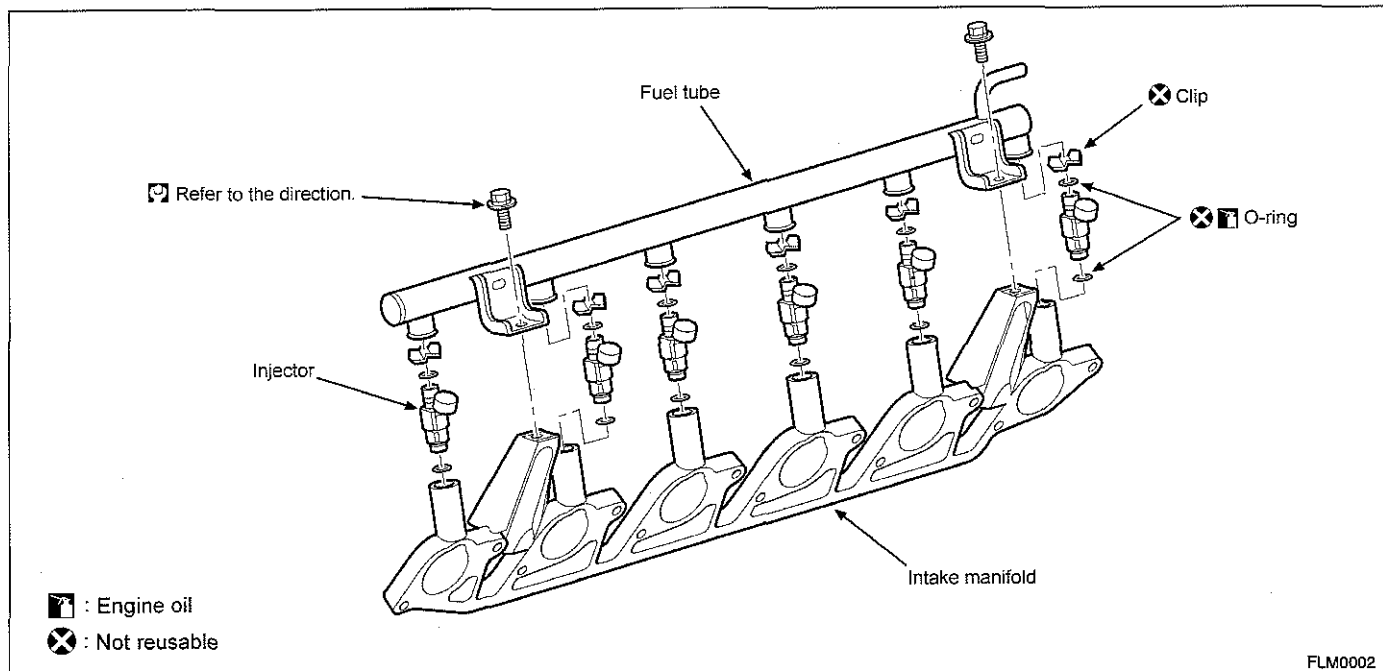
- Three fuel system specifications ("Gasoline", "LPG", "Combined gasoline and LPG") have been applied.

### Gasoline Specification

- Fuel pump type integrated with fuel tank has been adopted. Complete pump is composed of fuel pump, fuel filter, pressure regulator, and fuel gauge. All of them together are called returnless fuel supply system.



### ENGINE COMPONENT PARTS LOCATION



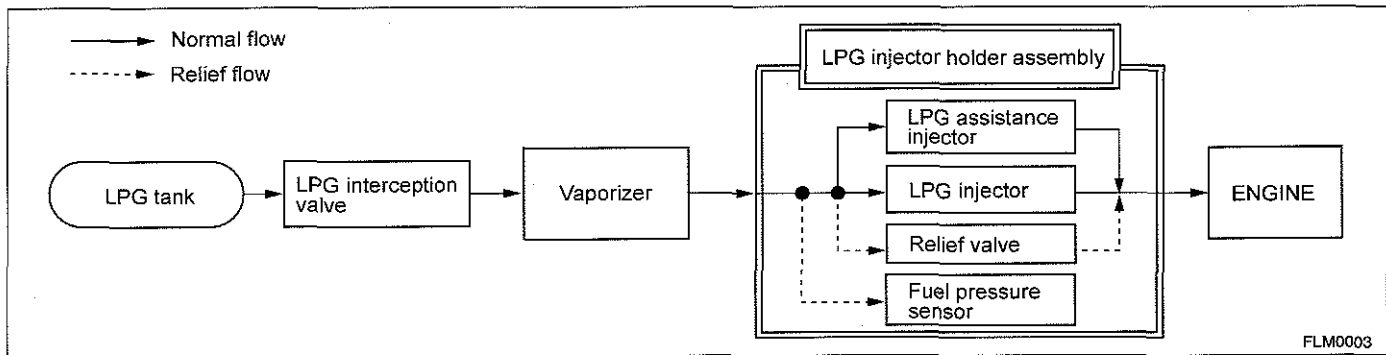
### CAUTION:

- Apply new engine oil to the parts marked in the figure before installation.

## DESCRIPTION

### LPG Specification

- LPG gas injection system has been adopted.
- LPG injector holder is equipped with injector, assistance injector, fuel pressure sensor, and relief valve, and they are composed as an assembly. All of them are installed on electronic throttle control actuator.



### Specification for Combined Gasoline and LPG

This specification is for combined gasoline specification and LPG specification that are both described above.

## **REMOVAL AND INSTALLATION OF FUEL INJECTOR (GASOLINE AND COMBINED USE)**

---

### **Preparation**

- Air hose
- Moving engine harness connector

### **Removal and Installation of Fuel Hose**

#### **REMOVAL**

- Release the fuel pressure. Refer to EC section, "Release of fuel pressure".

#### **CAUTION:**

- Plug the fuel hose to prevent the fuel from draining after removal.

#### **INSTALLATION**

- Insert hose until its end reaches 25 mm (0.98 in) or more from fuel tube end. Install a clamp and securely tighten it. Do not install the clamp on top of the bulge.
- Start engine, increase the engine speed, and make sure that there is no fuel leakage after repairing.

### **Removal and Installation of Fuel Tube and Fuel Injector**

#### **REMOVAL**

#### **CAUTION:**

- Fuel remaining in the tube leaks during operation. This operation should be done in a place free from fire.
- Remove fuel gallery bolts.
- Remove fuel gallery. Remove fuel injector and fuel gallery as a set.
- Remove clips (6) using long-nose pliers. Disconnect fuel injector and fuel gallery.

#### **CAUTION:**

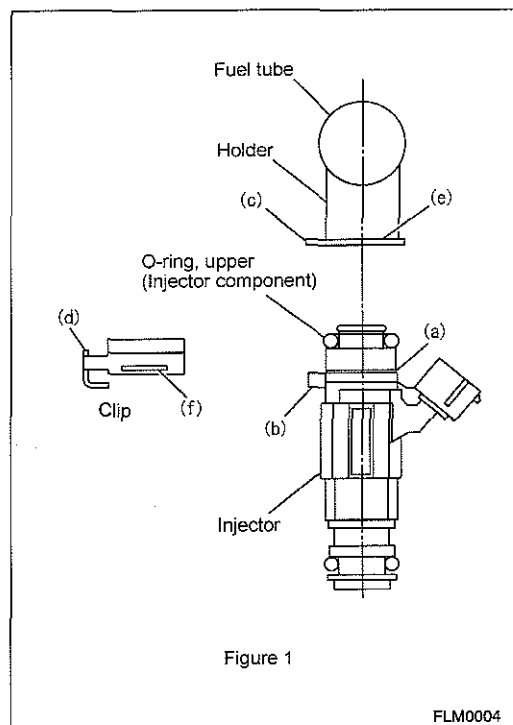
- Do not reuse clips.

#### **INSTALLATION OF FUEL INJECTOR**

- Install fuel injector to fuel tube as shown in figure 1.

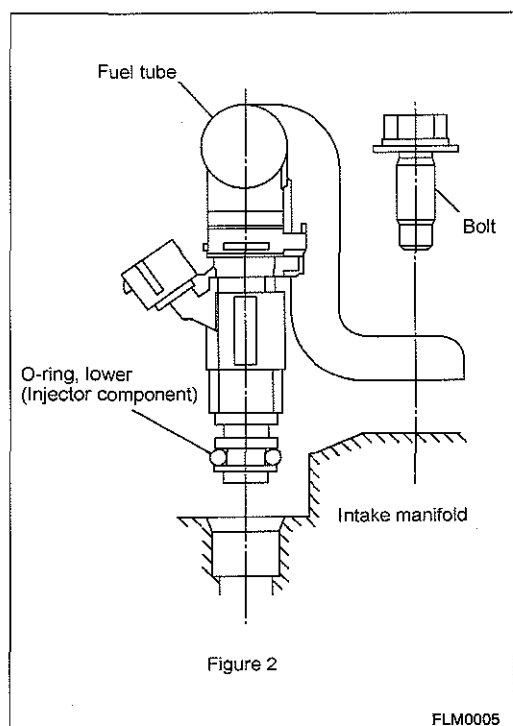
## REMOVAL AND INSTALLATION OF FUEL INJECTOR (GASOLINE AND COMBINED USE)

### Removal and Installation of Fuel Tube and Fuel Injector (Cont'd)



1. *Precautions for installation of fuel injector*
- 1) There is no contamination nor damage in O-ring contact area that is caused by dirt. Do not clean O-ring with solvent.
- 2) Do not reuse removed O-ring.
- 3) Handle O-ring with bare hands.
- 4) Apply engine oil into O-ring and holder for assembly. (Do not apply engine oil into fuel passages of fuel injector.)
- 5) Do not use damaged O-ring.
- 6) Do not apply excessive force that could damage O-ring.
- 7) Press clips into fuel injector when assembling. Securely fit clips to fuel injector locating grooves (a) and (b). (Do not reuse clips.)
- 8) Always replace O-ring when clips contact O-ring.
- 9) Assemble fuel injector to fuel tube after installing clips to fuel injector.
- 10) Fuel injector is pressed by a force of 196 N (20 kgf, 44 lb) or less. Stop operation if a force of 147 N (15 kgf, 33 lb) or more is necessary.)
- 11) Insert fuel injector to fuel tube while aligning fuel tube stopper (c) with clip cutout (d) before installing. Securely fit (c) to (d) and holder rib (e) to clip hole (f) after inserting.
- 12) Make sure that fuel injector is securely installed without rotation and disconnection after installing to fuel tube.

### FUEL TUBE INSTALLATION



1. Install fuel tube to intake manifold as shown in figure 2.
2. Satisfy precautions 1) to 6) for installation of fuel injector.
3. Insertion of fuel injector is performed by a force of 196 N (20 kgf, 44 lb) or less per fuel injector. Stop operation if a force of 147 N (15 kgf, 33 lb) or more is necessary.
4. Do not contact O-ring with the edge that is made by each process of intake manifold for assembly.

## REMOVAL AND INSTALLATION OF FUEL INJECTOR (GASOLINE AND COMBINED USE)

### Removal and Installation of Fuel Tube and Fuel Injector (Cont'd)

5. First tighten fuel tube bolt in position "a" in figure 3, and then tighten it in position "b" in the same figure. Repeat above tightening procedure 2 times.

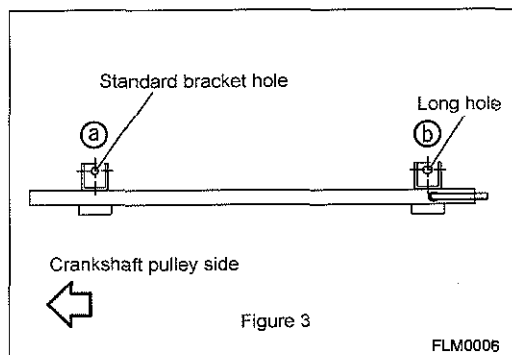
#### Tightening torque

##### First tightening:

☐: 9 - 20 N·m (0.9 - 2.1 kgf-m, 7 - 15 ft-lb)

##### Second tightening:

☐: 21 - 26 N·m (2.1 - 2.7 kgf-m, 16 - 19 ft-lb)



### Check for Fuel Leakage After Installation

Check for fuel leakage by racing several times after idling for 5 to 10 minutes.

# ENGINE MECHANICAL

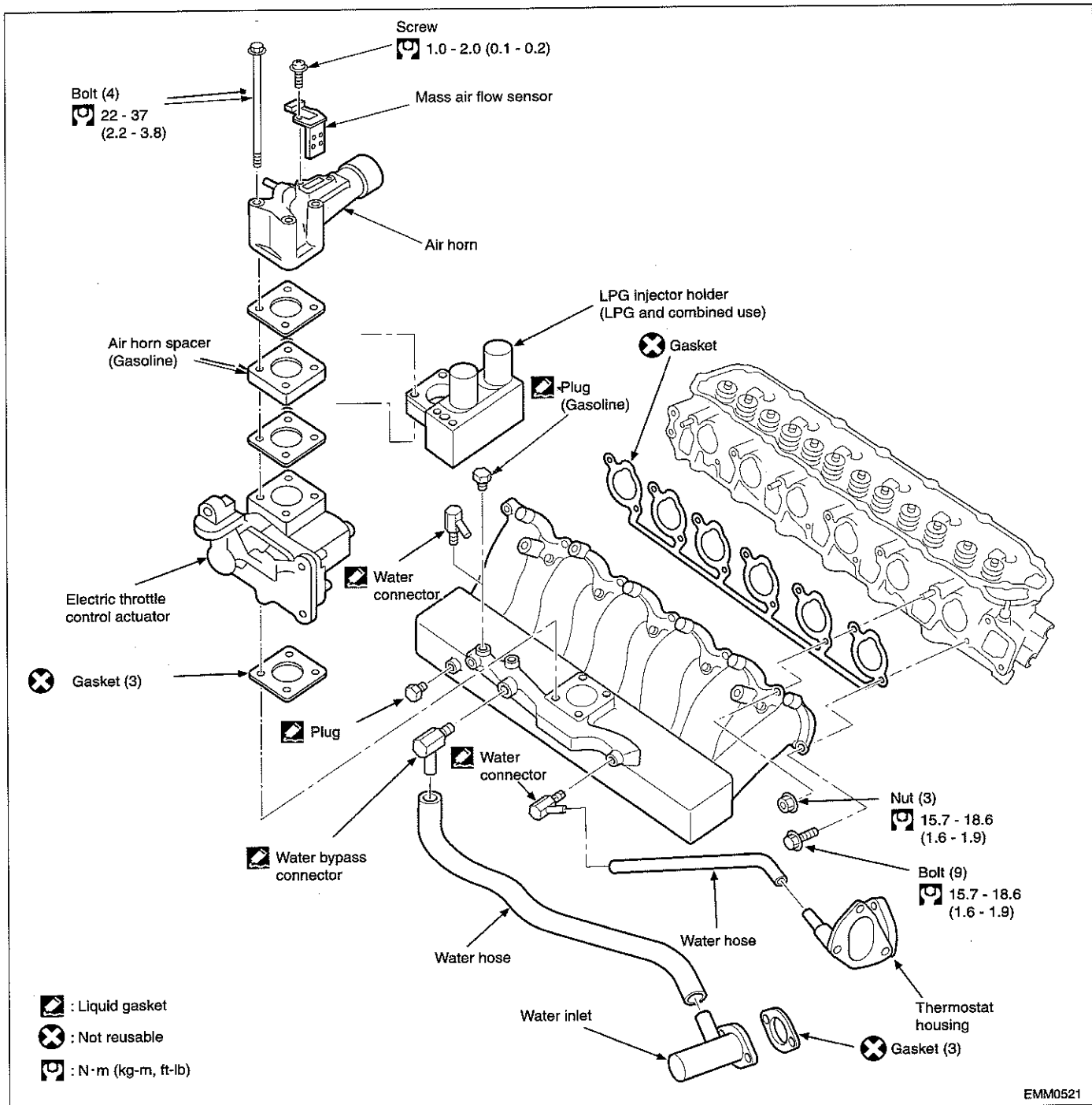
## SECTION **EM**

### CONTENTS

|                                                 |             |                                           |              |
|-------------------------------------------------|-------------|-------------------------------------------|--------------|
| <b>INTAKE MANIFOLD .....</b>                    | <b>EM-2</b> | <b>CYLINDER HEAD .....</b>                | <b>EM-11</b> |
| Component Parts Location .....                  | EM-2        | Component Parts Location .....            | EM-11        |
| Removal and Installation of Intake Manifold ... | EM-3        | Removal and Installation of Cylinder Head |              |
| Removal and Installation of Air Horn Bolt ..... | EM-3        | Assembly .....                            | EM-11        |
| Inspection .....                                | EM-3        | Cylinder Head Assembly .....              | EM-14        |
| <b>EXHAUST MANIFOLD .....</b>                   | <b>EM-4</b> | <b>TIMING CHAIN .....</b>                 | <b>EM-19</b> |
| Component Parts Location .....                  | EM-4        | Component Parts Location .....            | EM-19        |
| Removal and Installation .....                  | EM-4        | Removal .....                             | EM-19        |
| <b>OIL PAN AND OIL STRAINER .....</b>           | <b>EM-5</b> | Installation .....                        | EM-22        |
| Component Parts Location .....                  | EM-5        | <b>REMOVAL AND INSTALLATION OF</b>        |              |
| Removal and Installation .....                  | EM-5        | <b>ENGINE .....</b>                       | <b>EM-26</b> |
| <b>ROCKER COVER .....</b>                       | <b>EM-7</b> | Removal .....                             | EM-26        |
| Component Parts Location .....                  | EM-7        | Installation .....                        | EM-28        |
| Removal and Installation .....                  | EM-7        | Inspection .....                          | EM-28        |
| <b>ROCKER ARM AND ROCKER SHAFT</b>              |             | <b>CYLINDER BLOCK .....</b>               | <b>EM-29</b> |
| <b>ASSEMBLY .....</b>                           | <b>EM-8</b> | Component Parts Location .....            | EM-29        |
| Component Parts Location .....                  | EM-8        | Disassembly .....                         | EM-29        |
| Removal and Installation .....                  | EM-8        | Selective-Fit Service Parts .....         | EM-33        |
| Disassembly and Assembly .....                  | EM-9        | Inspection After Disassembly .....        | EM-33        |
| Inspection .....                                | EM-9        | Assembly .....                            | EM-46        |

# INTAKE MANIFOLD

## Component Parts Location



## INTAKE MANIFOLD

### Removal and Installation of Intake Manifold

#### PREPARATION

- Drain engine coolant
- Oil level gauge
- Wiring, disconnecting lines, moving

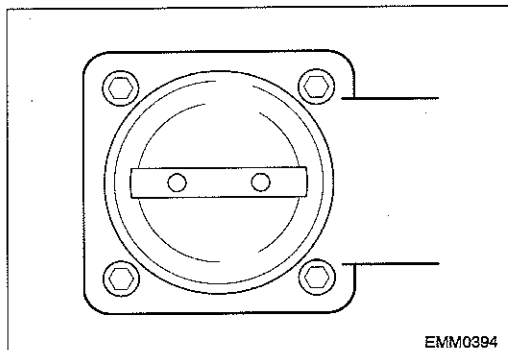
### Removal and Installation of Air Horn Bolt

#### REMOVAL

- Loosen bolts in the reverse of the order shown in the figure.

#### INSTALLATION

- Tighten bolts evenly in two steps in the order shown in the figure.  
☐: 1st: 9 - 10 N•m (0.9 - 1.1 kg-m, 6.5 - 7.9 ft-lb)  
2nd: 18 - 21 N•m (1.8 - 2.2 kg-m, 13 - 16 ft-lb)



### Inspection

#### CHECK INTAKE MANIFOLD DISTORTION.

- Check distortion of mounting surface in 6 directions using straightedge and feeler gauge.  
Limit: 0.2 mm (0.008 in)

### MASS AIR FLOW SENSOR

Refer to "Mass air flow sensor system" in EC section.

### LPG INJECTOR HOLDER (LPG AND COMBINED USE)

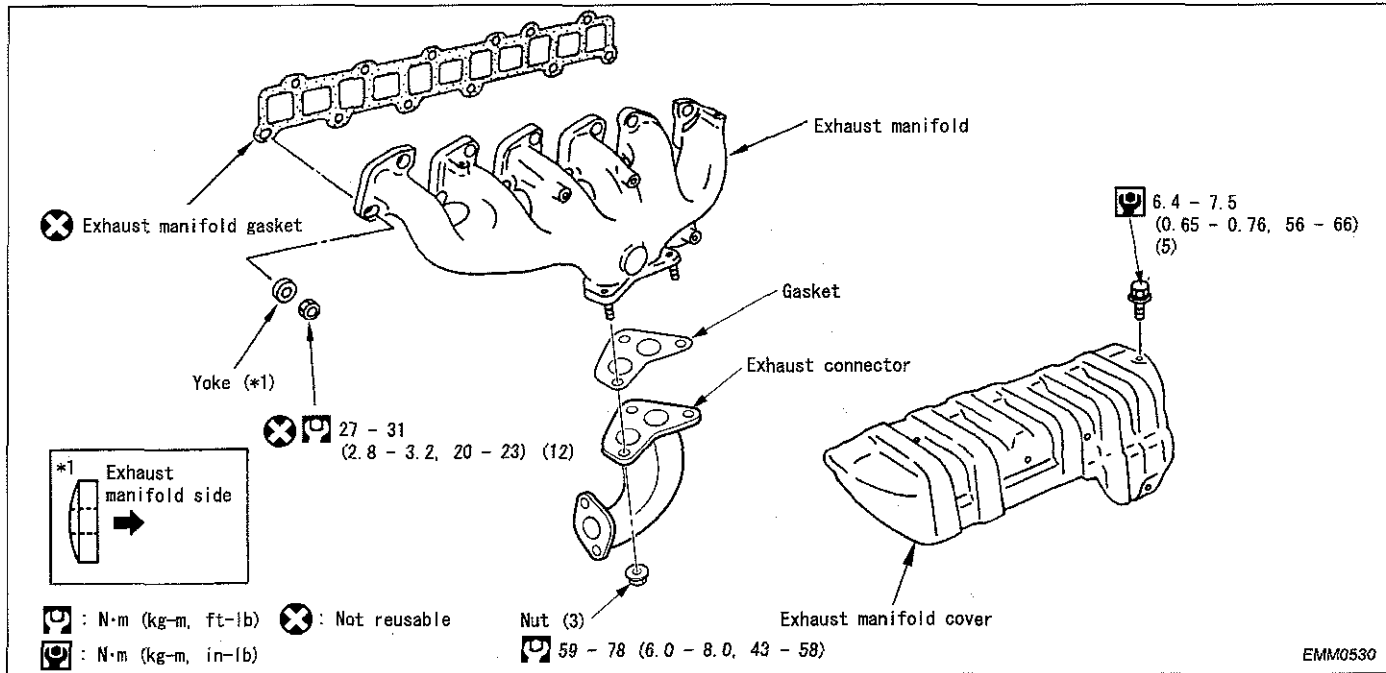
Refer to "LPG injector system" and "LPG assistance injector system" in EC section.

### ELECTRIC THROTTLE CONTROL

Refer to "Throttle position sensor system" and "Throttle control motor system" in EC section.

# EXHAUST MANIFOLD

## Component Parts Location



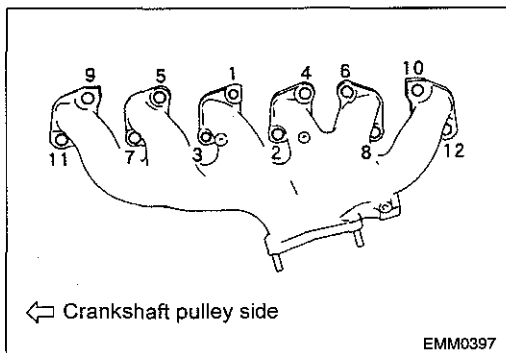
## Removal and Installation

### PREPARATION

- Disassemble exhaust front tube
- Exhaust manifold cover

### REMOVAL AND INSTALLATION OF EXHAUST MANIFOLD

1. Removal
  - Loosen nuts in the reverse of the order shown in the figure.
2. Installation
  - Install yoke with flat side facing exhaust manifold. (Refer to "Component Parts Location".)
  - Tighten nuts in the numerical order shown in the figure.

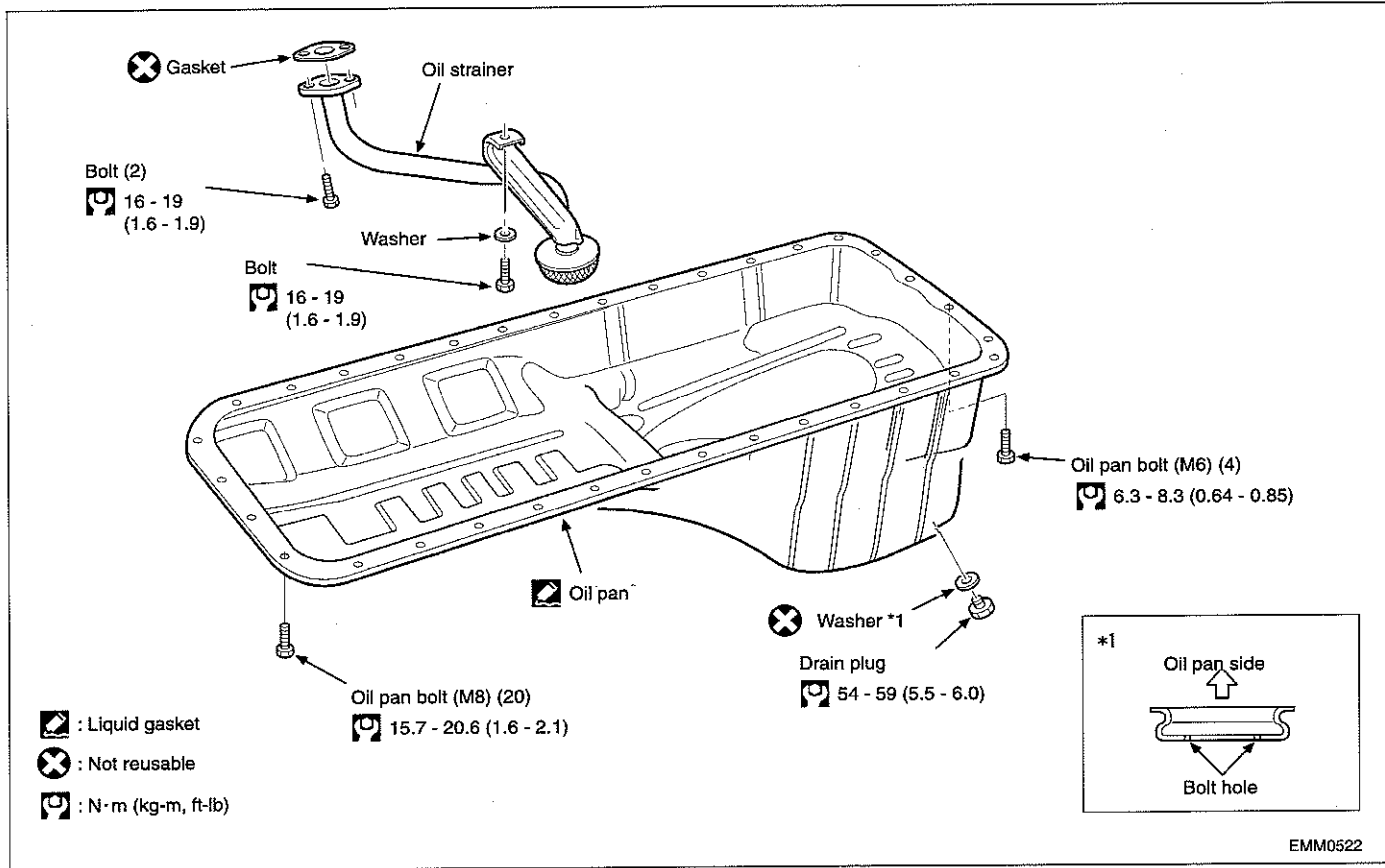


### INSPECTION

1. Exhaust manifold distortion
  - Check distortion of mounting surface in 4 directions using straightedge and feeler gauge.  
Limit: 0.3 mm (0.012 in)

# OIL PAN AND OIL STRAINER

## Component Parts Location



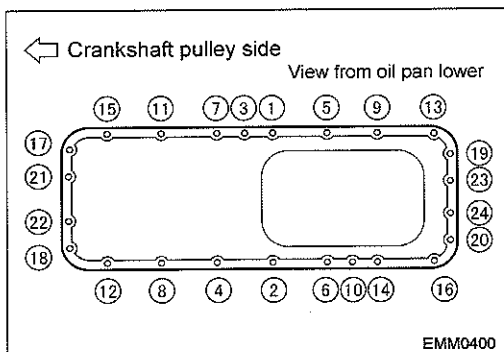
## Removal and Installation

### PREPARATION

- Drain engine oil.

### REMOVAL OF OIL PAN

- Loosen bolts in the reverse of the order shown in the figure.
- Use a seal cutter (SST).



## OIL PAN AND OIL STRAINER

---

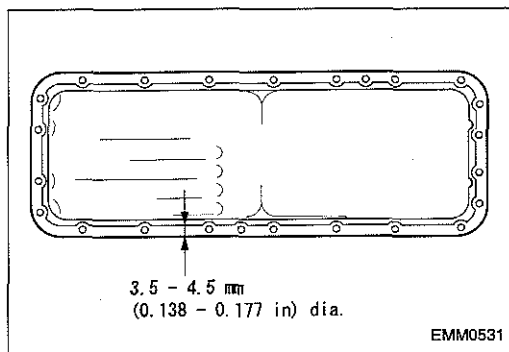
### Removal and Installation (Cont'd)

#### INSTALLATION OF OIL PAN

- Apply a continuous bead of Three Bond 1207C (N-KP510-00150) to the positions shown in the figure.
- Tighten bolts in the numerical order shown in the figure.

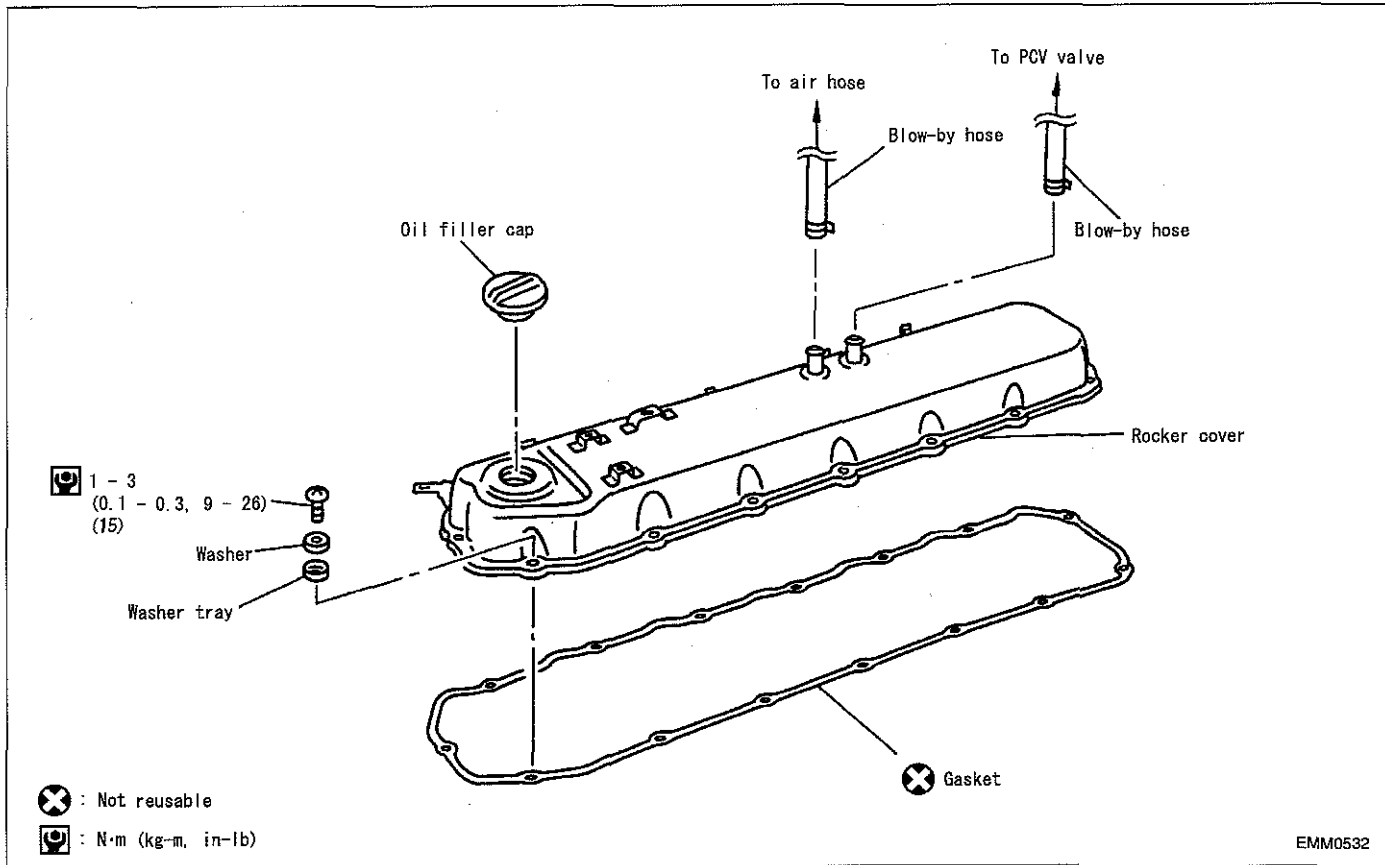
#### INSTALLATION OF OIL PAN DRAIN PLUG WASHER

- Install it with bending side facing oil pan. (Refer to "Component Parts Location".)



# ROCKER COVER

## Component Parts Location



## Removal and Installation

### PREPARATION

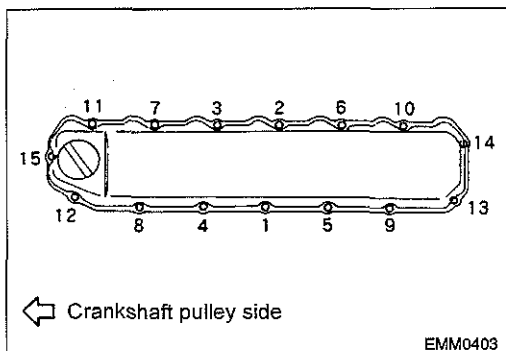
- Move high-tension core
- Wiring, disconnecting lines, moving

### REMOVAL AND INSTALLATION OF ROCKER COVER

1. Removal
  - Loosen screws in the reverse of the order shown in the figure.
2. Installation
  - Make sure that gasket is not missing from rocker cover mounting groove.
  - Tighten screws in the numerical order shown in the figure.

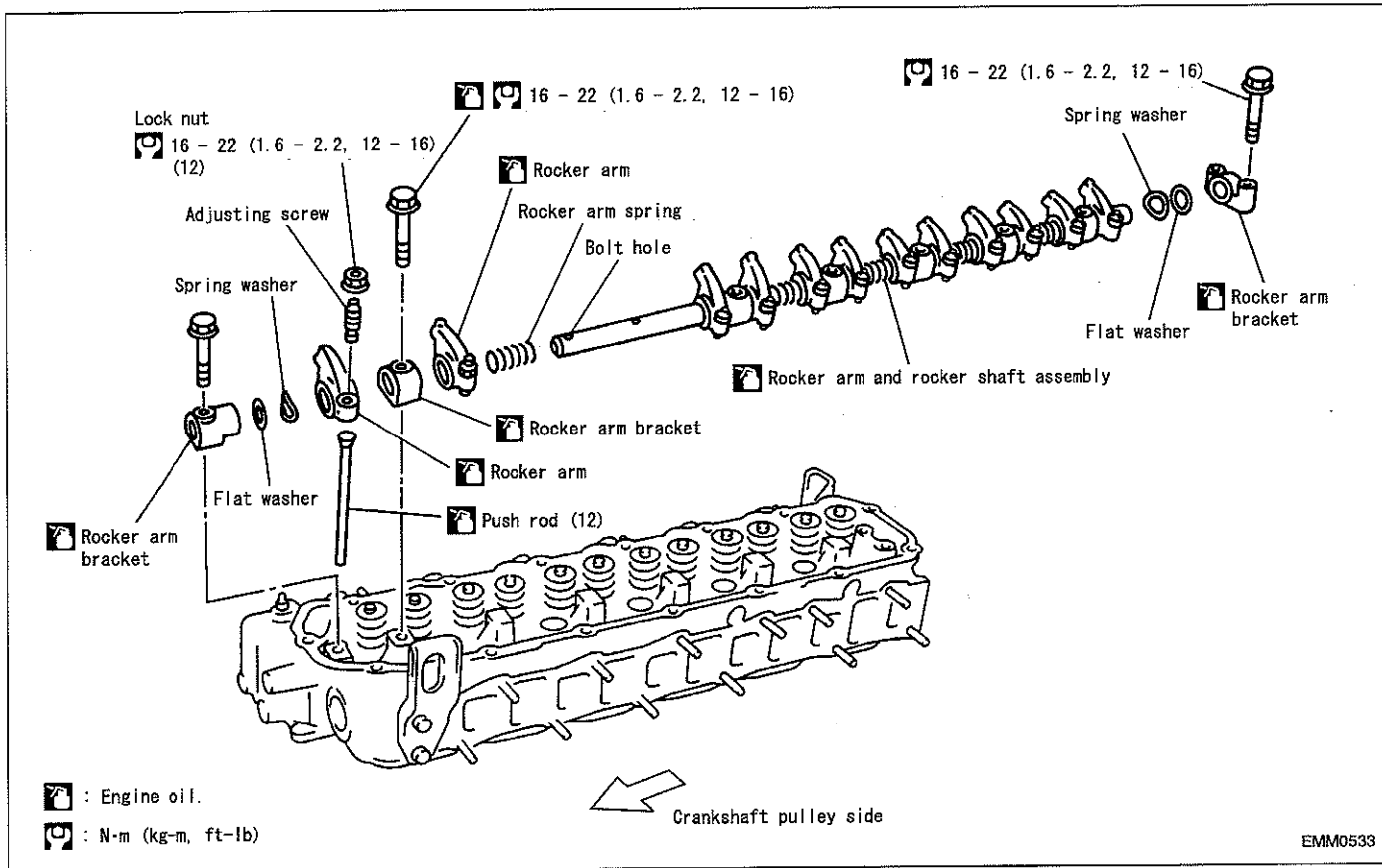
### CAUTION:

- Tightening torque of the first screw may decrease after tightening all screws. Retighten all screws.



# ROCKER ARM AND ROCKER SHAFT ASSEMBLY

## Component Parts Location



### CAUTION:

- Apply new engine oil to the parts marked in the figure before installation.

## Removal and Installation

### PREPARATION

- Rocker cover
- Adjusting valve clearance (after installation)

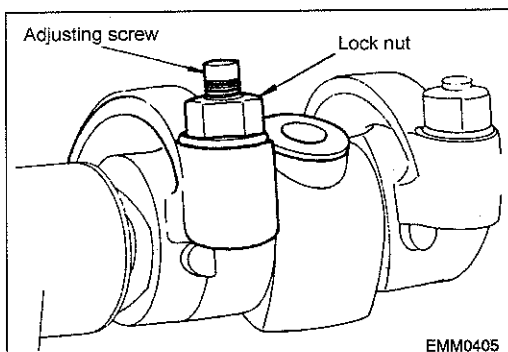
### REMOVAL AND INSTALLATION OF ROCKER ARM AND ROCKER SHAFT ASSEMBLY

#### 1. Removal

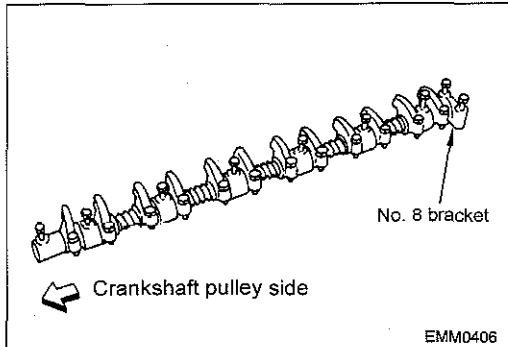
- Loosen lock nut, and then fully loosen valve clearance adjusting screw.
- Loosen bolts evenly in several steps from outside to center.
- Carry each bracket with mounting bolts.

### CAUTION:

- Hold No. 8 bracket (end) only so as not to drop it when carrying.



## ROCKER ARM AND ROCKER SHAFT ASSEMBLY



### Removal and Installation (Cont'd)

#### 2. Installation

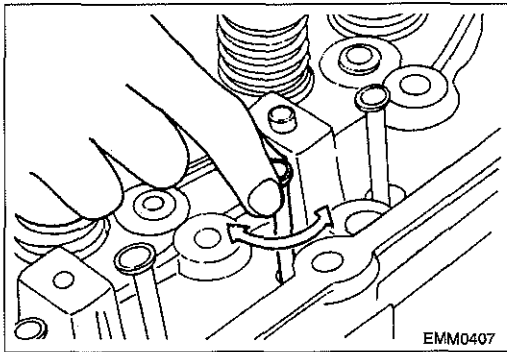
- Tighten bolts evenly in several steps from center to outer side in this order.

#### CAUTION:

- **Make sure that valve clearance adjusting screw is securely inserted to push rod head.**
- **Perform installation with valve clearance adjusting screw fully loosened so as not to be affected by valve spring tension.**
- **Adjust valve clearance after installation.**  
Refer to "Inspection and adjustment of valve clearance" in ET section.

### INSTALLATION OF PUSH ROD

- Rotate push rod after inserting, and then make sure that push rod tip is securely inserted into valve lifter sphere surface.



### Disassembly and Assembly

#### DISASSEMBLY AND ASSEMBLY OF ROCKER ARM AND ROCKER SHAFT ASSEMBLY

- Remove each part individually and avoid mixing.
- Install them to the original position.

### INSTALLATION OF SPRING WASHER

- Install with each convex surface facing flat washer side. (Refer to "Component Parts Location".)

### INSTALLATION OF ROCKER ARM

- Assemble rocker shaft with bolt hole side facing engine front side and oil hole facing downward. (Refer to "Component Parts Location".)

### Inspection

#### CHECKING FOR ROCKER SHAFT BEND

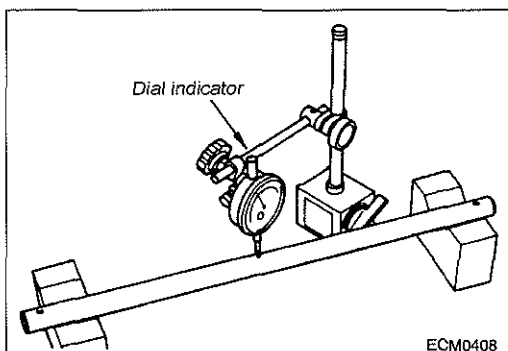
- Hold both ends of rocker shaft with V-blocks, and then set dial indicator on the center.
- Rotate the rocker shaft in one direction by hand and read indication on the dial indicator.
- Half of the reading is the rocker shaft bend.

#### Standard:

0.15 mm (0.0059 in) or less

#### Limit:

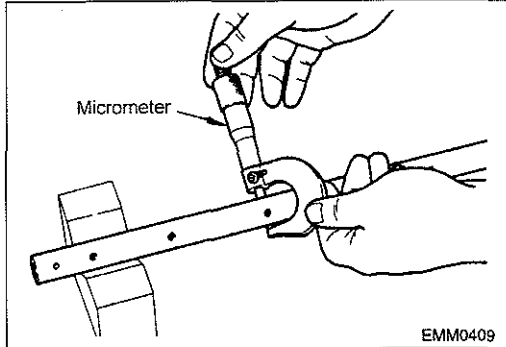
0.3 mm (0.012 in)



## ROCKER ARM AND ROCKER SHAFT ASSEMBLY

### Inspection (Cont'd)

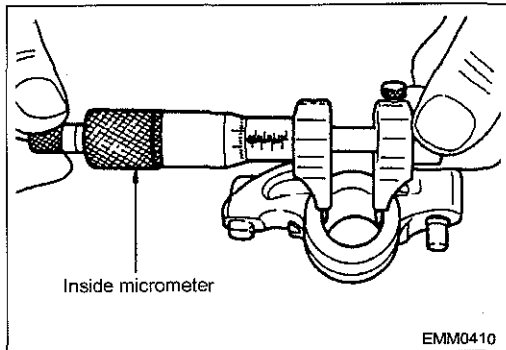
#### ROCKER ARM OIL CLEARANCE



1. Rocker shaft outer diameter
  - Measure outer diameter around rocker arm mounting using a micrometer.

**Standard:**

**19.988 - 20.000 mm (0.7869 - 0.7874 in) dia.**



2. Rocker arm inner diameter
  - Measure rocker arm shaft hole inner diameter using an inside micrometer.

**Standard:**

**20.020 - 20.038 mm (0.7882 - 0.7889 in) dia.**

3. How to calculate rocker arm oil clearance
  - (Clearance)

$$= (\text{Rocker arm inner diameter}) - (\text{Rocker shaft outer diameter})$$

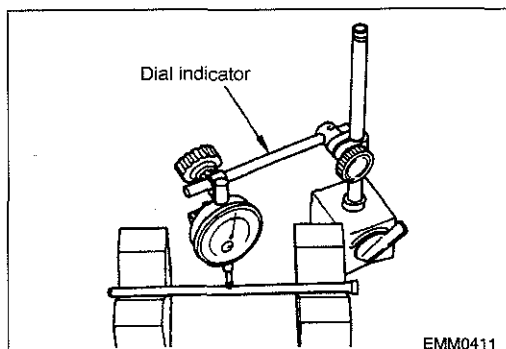
**Standard:**

**0.020 - 0.050 mm (0.0008 - 0.0020 in)**

**Limit:**

**0.15 mm (0.0059 in)**

- Replace rocker arm and/or rocker shaft if outside the repair limit. Refer to standards for the outer diameter and inner diameter.



#### CHECKING PUSH ROD BEND

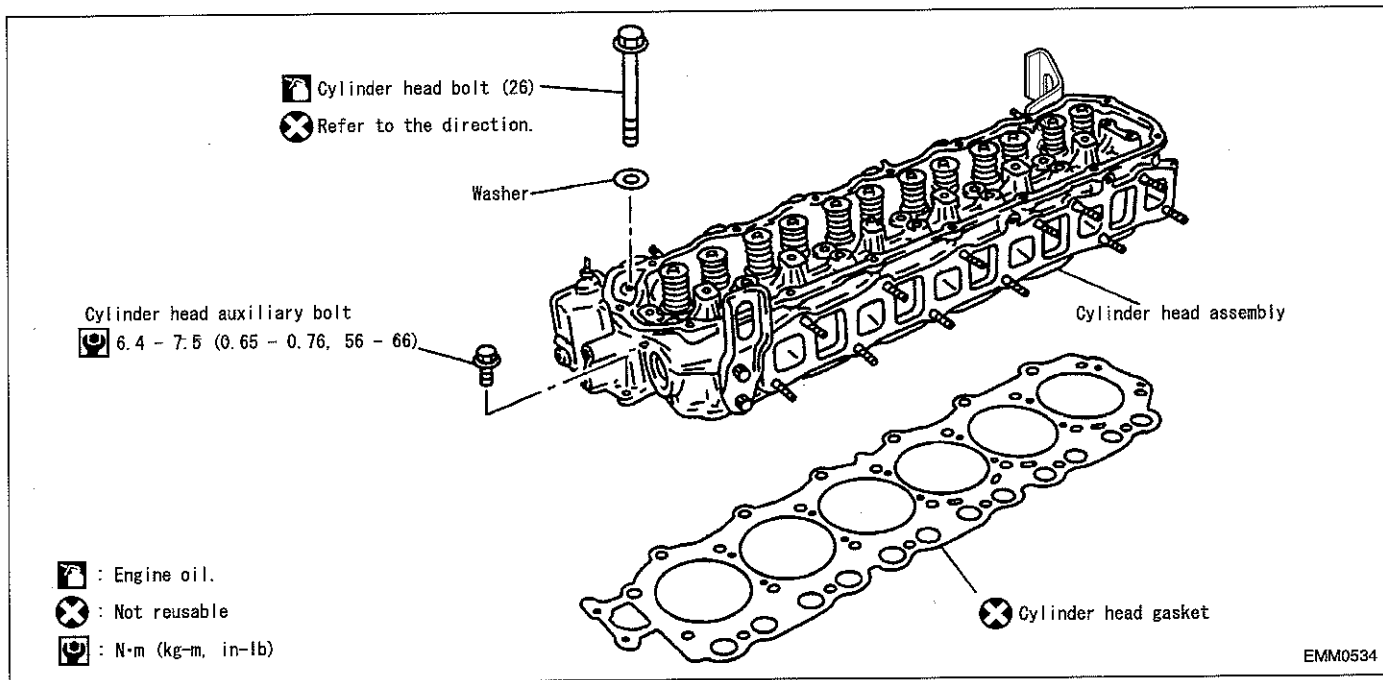
- Hold both ends of push rod with V-blocks, and then set dial indicator on the center.
- Rotate push rod in one direction by hand and read indication on the dial indicator.
- Half of the reading is the push rod bend.

**Limit:**

**0.2 mm (0.008 in)**

## CYLINDER HEAD

### Component Parts Location



#### CAUTION:

- Apply new engine oil to the parts marked in the figure before installation.

### Removal and Installation of Cylinder Head Assembly

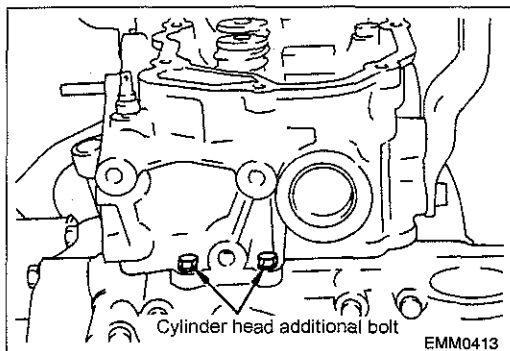
#### PREPARATION

- Drain engine coolant
- Exhaust manifold
- Intake manifold
- High tension core
- Rocker cover
- Rocker arm and rocker shaft assembly
- Push rod
- Wiring, disconnecting lines, moving
- Alternator adjusting bar

## CYLINDER HEAD

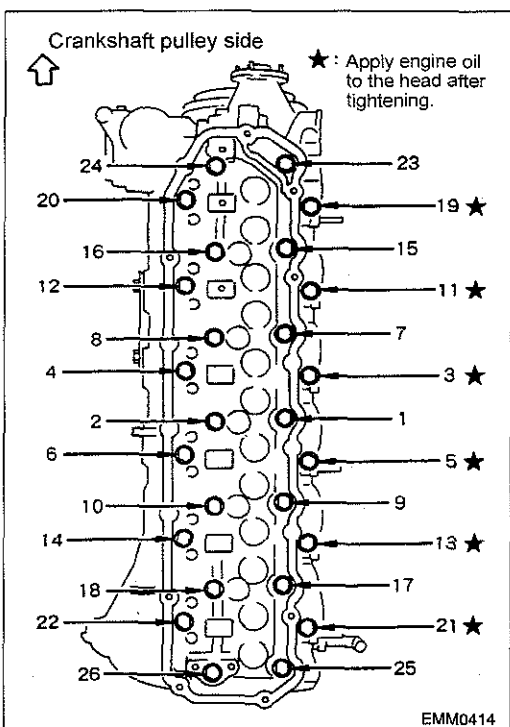
### Removal and Installation of Cylinder Head Assembly (Cont'd)

#### REMOVAL AND INSTALLATION OF CYLINDER HEAD AUXILIARY BOLT



1. Removal
  - Remove before loosening cylinder head bolt.
2. Installation
  - Install after tightening cylinder head bolt.

#### REMOVAL AND INSTALLATION OF CYLINDER HEAD BOLT

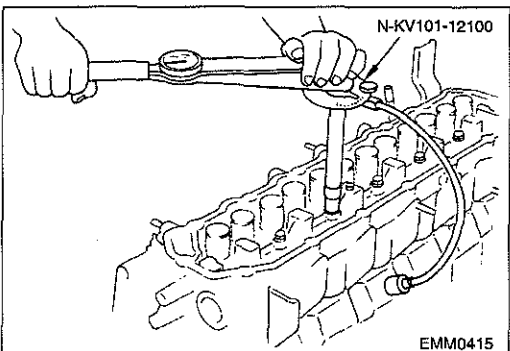


1. Removal
  - Loosen bolts in the reverse of the order shown in the figure.
2. Installation
  - Lubricate threads and seat surface of each cylinder head bolt with new engine oil.
  - Tighten bolts in the numerical order shown in the figure with the following steps.

#### CAUTION:

- In step 3), loosen all bolts in the reverse of the order shown in the figure.

- 1) Tighten to 29.4 N•m (3.0 kg-m, 22 ft-lb)
- 2) Tighten to 61.8 N•m (6.3 kg-m, 46 ft-lb).
- 3) Fully loosen to 0 N•m (0 kg-m, 0 in-lb).
- 4) Tighten to 29.4 N•m (3.0 kg-m, 22 ft-lb).
- 5) Tighten to 69° to 74°



Check tightening angle with an angle wrench (SST) or a protractor. Do not simply estimate tightening angle.

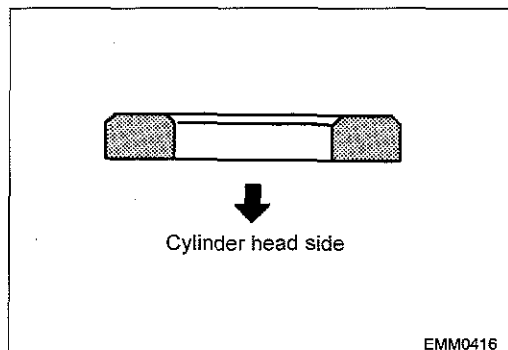
- Tighten 64 - 74 N•m (6.5 - 7.5 kgf-m, 47 - 54 ft-lb) in step 5) if checking tightening angle is difficult.
- Apply anticorrosive or engine oil after installation onto entire head surfaces of cylinder head bolts (3, 5, 11, 13, 19, 21 in the figure) that expose rocker cover exterior.

## CYLINDER HEAD

### Removal and Installation of Cylinder Head Assembly (Cont'd)

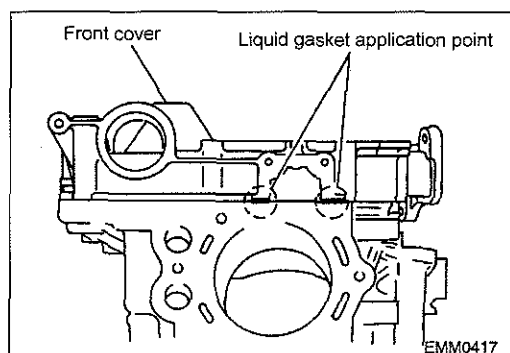
#### INSTALLATION OF CYLINDER HEAD BOLT WASHER

- Washer installing direction is not specified if cylinder head bolt angle-tightens in step 5).
- Install it in the direction shown in the figure if it does not angle-tighten in step 5).



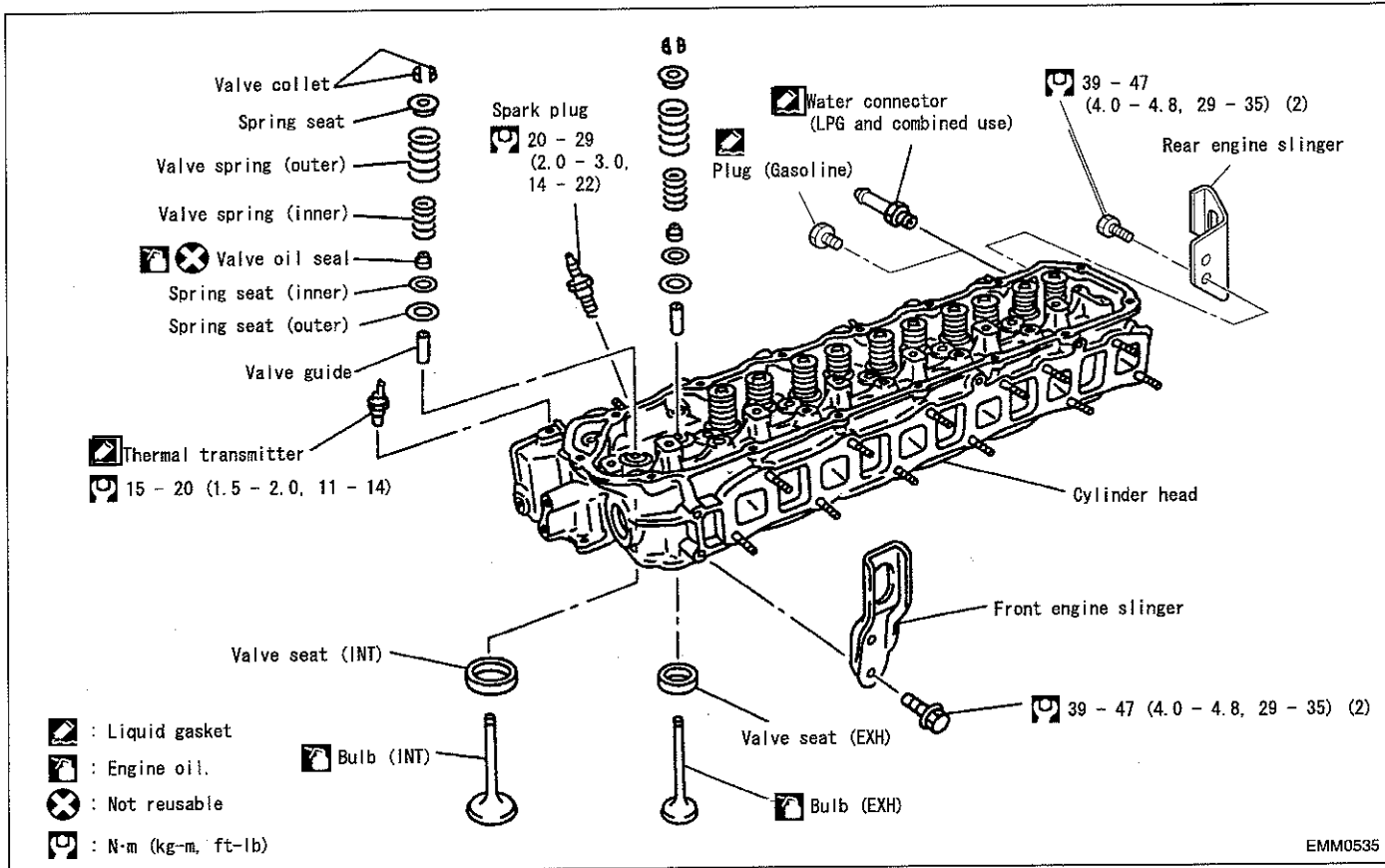
#### INSTALLATION OF CYLINDER HEAD GASKET

- After applying Three Bond 1207C (N-KP510-00150) to the position shown in the figure, install cylinder head gasket.



## CYLINDER HEAD

### Cylinder Head Assembly COMPONENT PARTS LOCATION

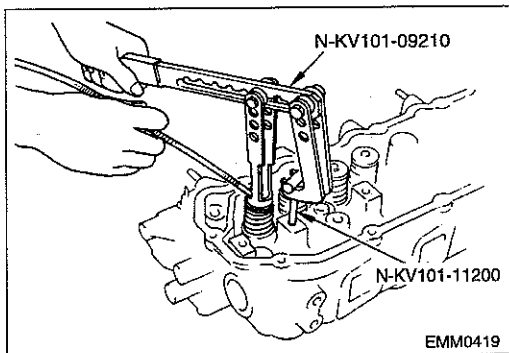


#### CAUTION:

- Apply new engine oil to the parts marked in the figure before installation.

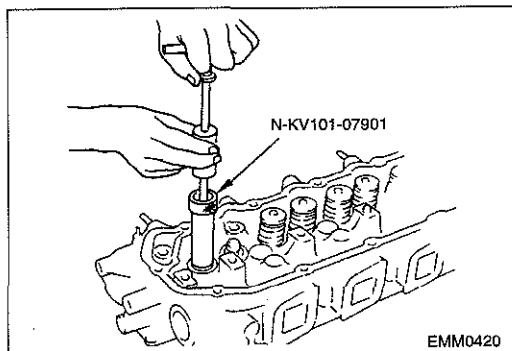
#### DISASSEMBLY

- Compress the valve spring with a valve spring compressor (SST), and remove the valve collet with a magnetic driver.
  - Remove valve spring retainer.
  - Remove valve spring.
  - Push the valve stem toward the combustion chamber side and remove valve.
- Check valve guide clearance before removal.
  - Check the location, and store individually.



## CYLINDER HEAD

### Cylinder Head Assembly (Cont'd)



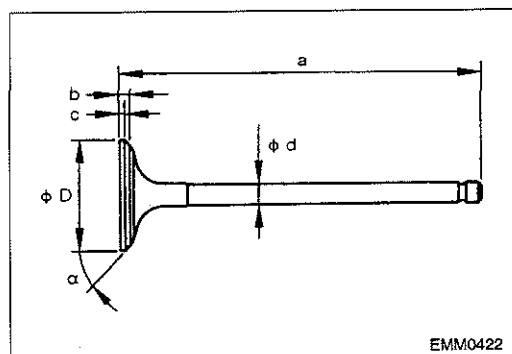
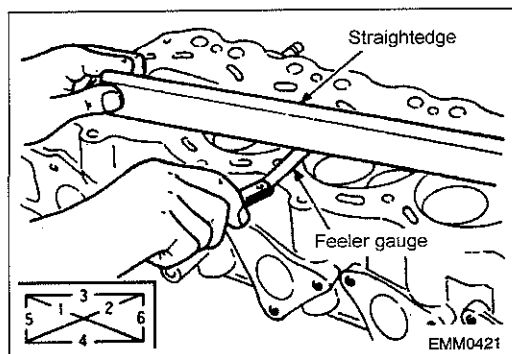
5. Remove valve oil seal using a valve oil seal puller (SST) when removing.
6. Remove valve spring seats.
7. Refer to (EM section), "Valve seat contact inspection" when removing valve seat.
8. Blow compressed air around spark plug and use a spark plug wrench (commercial service tool) when removing spark plug.

### INSPECTION

1. Cylinder head distortion
  - Remove oil, scale, gasket, sealant, and carbon deposits from surface of cylinder head using a scraper.

#### CAUTION:

- Do not allow gasket fragments to enter oil or engine coolant passages.
- Check flatness of cylinder head lower surface. Measure distortion in 6 directions shown in the figure, at several points in each direction.  
Limit: 0.2 mm (0.008 in)

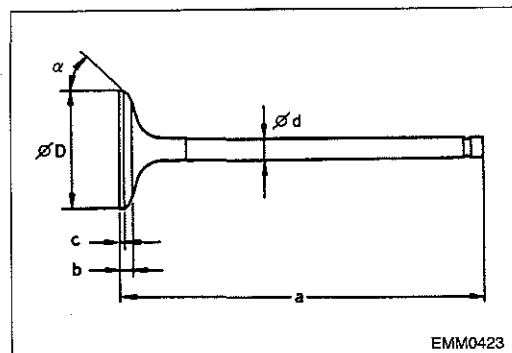


#### 2. Bulb Dimensions

- Measure dimensions at the points shown in the figure using a micrometer.

#### Standard Unit: mm (in)

|                   | Intake                           | Exhaust                         |
|-------------------|----------------------------------|---------------------------------|
| a                 | :118.15 (4.65)                   | 118.8 (4.677)                   |
| b                 | :3.1 - 3.5 (0.122 - 0.138)       | 3.1 - 3.5 (0.122 - 0.138)       |
| c                 | :1.15 - 1.45 (0.0453 - 0.0571)   | 1.35 - 1.65 (0.0531 - 0.0650)   |
| D (diameter)      | :47.0 - 47.2 (1.850 - 1.8583)    | 38.0 - 38.2 (1.496 - 1.504)     |
| d (diameter)      | :7.965 - 7.980 (0.3136 - 0.3142) | 7.945 - 7.960 (0.3128 - 0.3134) |
| $\alpha$ (degree) | :45°15' - 45°45'                 | 45°15' - 45°45'                 |

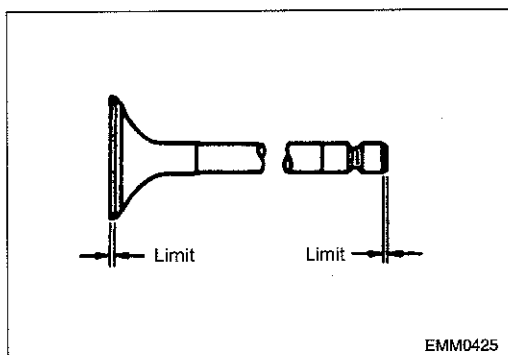
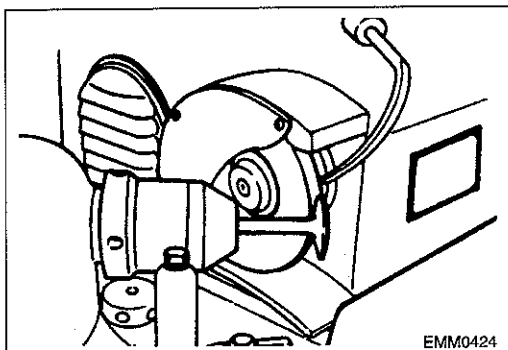


- Valve face is corrected using valve surface grinder.

## CYLINDER HEAD

### Cylinder Head Assembly (Cont'd)

- Stem edge surface is corrected using oilstone.
- Keep corrections to a minimum due to surface reduction. Replace if outside the repair limit.



#### CORRECTION REPAIR LIMIT

##### Face correction length:

###### Intake valve:

0.5 mm (0.020 in) or less

###### Exhaust valve:

0.5 mm (0.020 in) or less

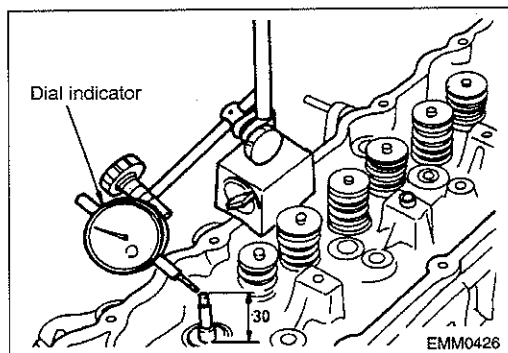
##### Stem edge surface correction length:

###### Intake valve:

0.2 mm (0.008 in)

###### Exhaust valve:

0.2 mm (0.008 in)



#### 3. Valve guide clearance

- Check before removing the valve guide.
- Make sure the valve stem diameter is within the standard. Refer to "Valve direction inspection (previous page)".
- Push the valve out toward the combustion chamber. Measure runout while pushing the stem edge surface toward the dial indicator.
- 1/2 of the dial indicator reading is the valve guide clearance.

##### Standard:

###### Intake:

0.020 - 0.053 mm (0.0008 - 0.0021 in)

###### Exhaust:

0.040 - 0.073 mm (0.0016 - 0.0029 in)

##### Repair limit:

###### Intake:

0.1 mm (0.004 in)

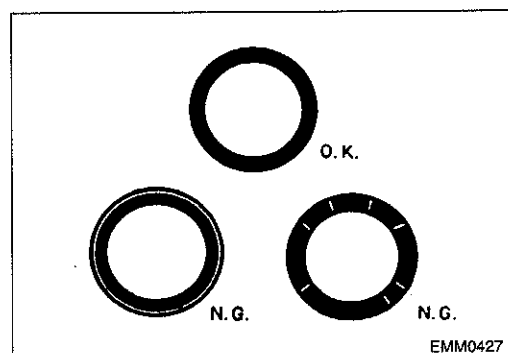
###### Exhaust:

0.1 mm (0.004 in)

- Replace cylinder head if it exceeds the limit.

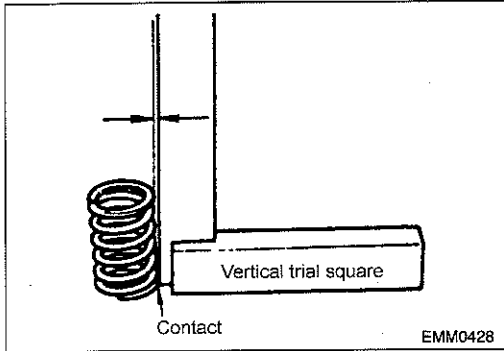
#### 4. Valve seat contact

- This inspection must be done after ensuring that the dimensions of the valve guide and the valve are within the standard. This inspection must be done after ensuring that the dimensions of the valve guide and the valve are within the standard.
- Check valve contact by applying DICATOL PL-1 to valve seat contact surface.
- Make sure that contact surfaces are connected all around.
- Reseat the valve and check again if seating condition is not correct. Replace cylinder head if seating condition cannot be corrected by reseating.



## CYLINDER HEAD

### Cylinder Head Assembly (Cont'd)



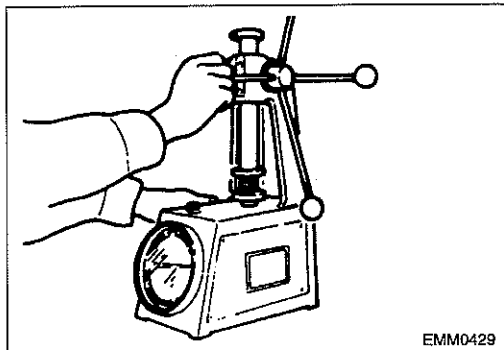
#### 5. Valve spring squareness

- Set the valve spring against a square. Rotate the spring and record the maximum gap between spring upper end and the square.

##### Limit:

1.9 mm (0.075 in) (Inner)

2.1 mm (0.083 in) (Outer)



#### 6. Free length and compression load of valve spring

- Check with a valve spring tester.

##### Standard mm (in)

##### Inner

##### Outer

##### Free length mm (in):

42.72 (1.6819)

48.02 (1.8905)

##### Length at installation mm (in):

35.0 (1.378)

40.0 (1.57)

##### Load at installation N (kg, lb):

105 - 115

219 - 240

(10.7 - 11.7, 23.6 - 25.8)

(22.3 - 24.4, 49.2 - 53.8)

##### Valve opening length mm (in):

24.7 (0.972)

29.7 (1.169)

##### Valve opening load N (kg, lb):

292 - 319

584 - 638

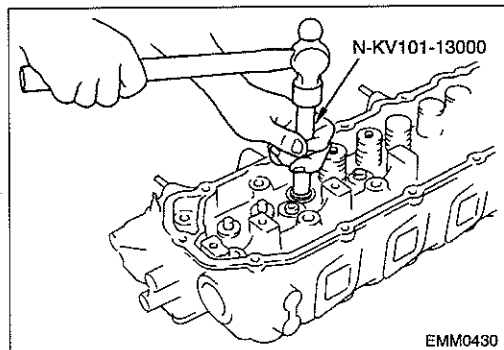
(29.8 - 32.5, 65.7 - 71.7)

(59.6 - 65.1, 131.4 - 143.5)

##### Identification paint:

Green

Green



### ASSEMBLY

#### 1. Install valve spring seats.

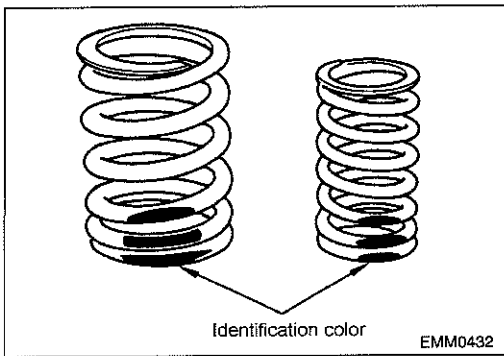
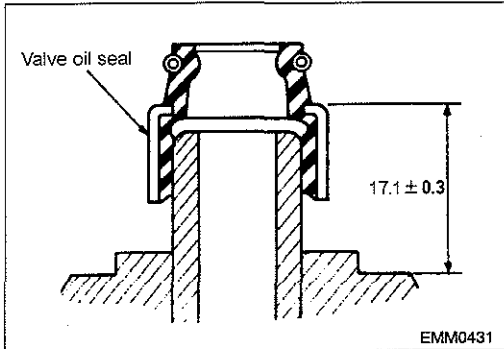
- Install valve spring seat (outer) with rounded side facing upward.

#### 2. Install valve oil seals.

- Install valve oil seal to the dimensions specified in the figure using a valve oil seal drift (SST).

## CYLINDER HEAD

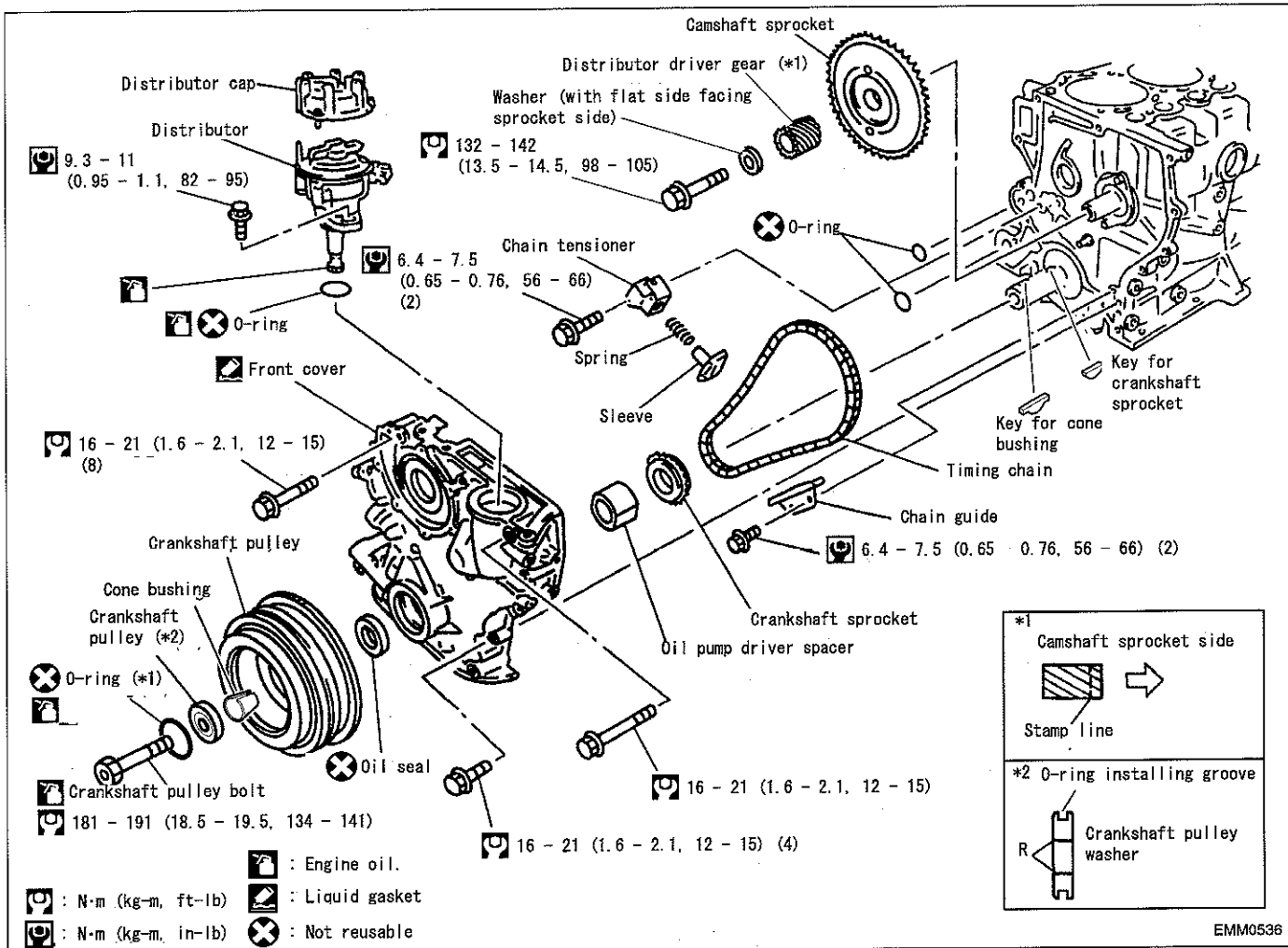
### Cylinder Head Assembly (Cont'd)



3. Install valves.
  - Apply engine oil to valve stem.
4. Install valve springs.
  - Face the narrower pitch side of valve spring (with identification paint mark) toward cylinder head.
5. Install valve spring retainers.
6. Compress the valve spring with a valve spring compressor (SST), and install the valve collet with a magnetic driver.
  - Tap valve stem tip with a plastic hammer to ensure a proper fit after installing valve collet.
7. Install water connector (gasoline) or plug (LPG or combined use).
  - Apply Three Bond 1386B or equivalent to the threads, and then connect the connector.
8. Install spark plug if it is removed.

# TIMING CHAIN

## Component Parts Location



### CAUTION:

- Apply new engine oil to the parts marked in the figure prior to installation.

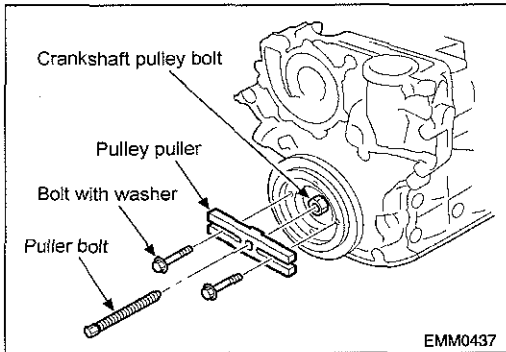
### Removal

1. Remove the following parts. (Refer to the appropriate section for each preparation.)
  - Engine drive belt
  - Water pump pulley
  - Oil pan
  - Rocker cover
  - Rocker arm
  - Rocker shaft assembly
  - Push rod
  - Cylinder head

## TIMING CHAIN

### Removal (Cont'd)

2. Make sure that No. 1 cylinder is at TDC on its compression stroke with the following procedure:
  - 1) Rotate the crankshaft pulley clockwise (as viewed from the front) and align orange notch with the timing indicator (protrusion) on the front cover.
  - 2) Make sure that distributor rotor is facing the direction (front side) as shown in the figure.
    - Turn crankshaft pulley 360 degrees in the direction shown in the figure if the rotor is facing rear side.
3. Remove distributor.
4. Remove crankshaft pulley with the following procedure.
  - 1) Remove starter motor.
  - 2) Secure crankshaft by installing a ring gear stopper (SST) to starter mounting hole.
    - Use approximately 10 mm spacer between plate and stopper.
- 3) Loosen crankshaft pulley bolts, and then remove crankshaft pulley washer.
- 4) Screw crankshaft bolt by hand until it stops, and then rotate it 2 or 3 turns back.
- 5) Position a pulley puller (SST) to crankshaft pulley with M8 bolts (2).
- 6) Set puller bolt to a pulley puller, and then tighten it until it contacts with crankshaft pulley bolt.
- 7) Tighten M8 bolts (2) temporarily installed.
- 8) Tighten puller bolt approximately 2 turns after feeling that sticking of crankshaft pulley is released.
- 9) Remove the pulley puller, place it to front surface of crankshaft pulley, and tap it with a hammer. Release sticking of cone bushing.
- 10) Remove cone bushing using long-nose pliers.
- 11) Remove crankshaft pulley.
- 12) Remove key for cone bushing.



## TIMING CHAIN

### Removal (Cont'd)

5. Remove front cover bolt in the reverse of the order on EM section, and then remove front cover using a seal cutter (SST).

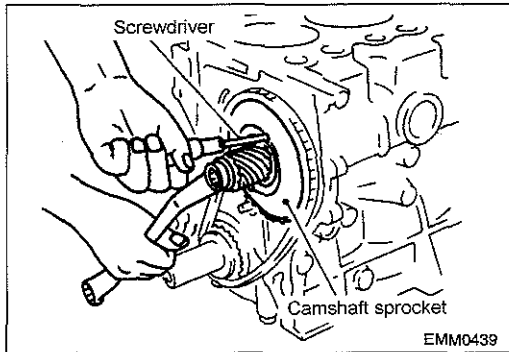
#### CAUTION:

- Be careful not to damage mounting surface.

6. Remove key for cone bushing.
7. Remove oil pump drive spacer.
8. Remove crankshaft sprocket.
9. Remove key for crankshaft sprocket.
10. Lift and remove front seal on front cover using a screwdriver if it needs to be replaced.
11. Remove O-ring of crankshaft pulley washer.

#### CAUTION:

- Do not reuse O-ring.



12. Remove camshaft sprocket bolt.
  - Insert a screwdriver wrapped in a shop cloth to the hole on camshaft sprocket, secure camshaft sprocket by attaching the tip of screwdriver to camshaft locating plate bolt, and then loosen the bolt.

13. Remove chain tensioner and chain guide.

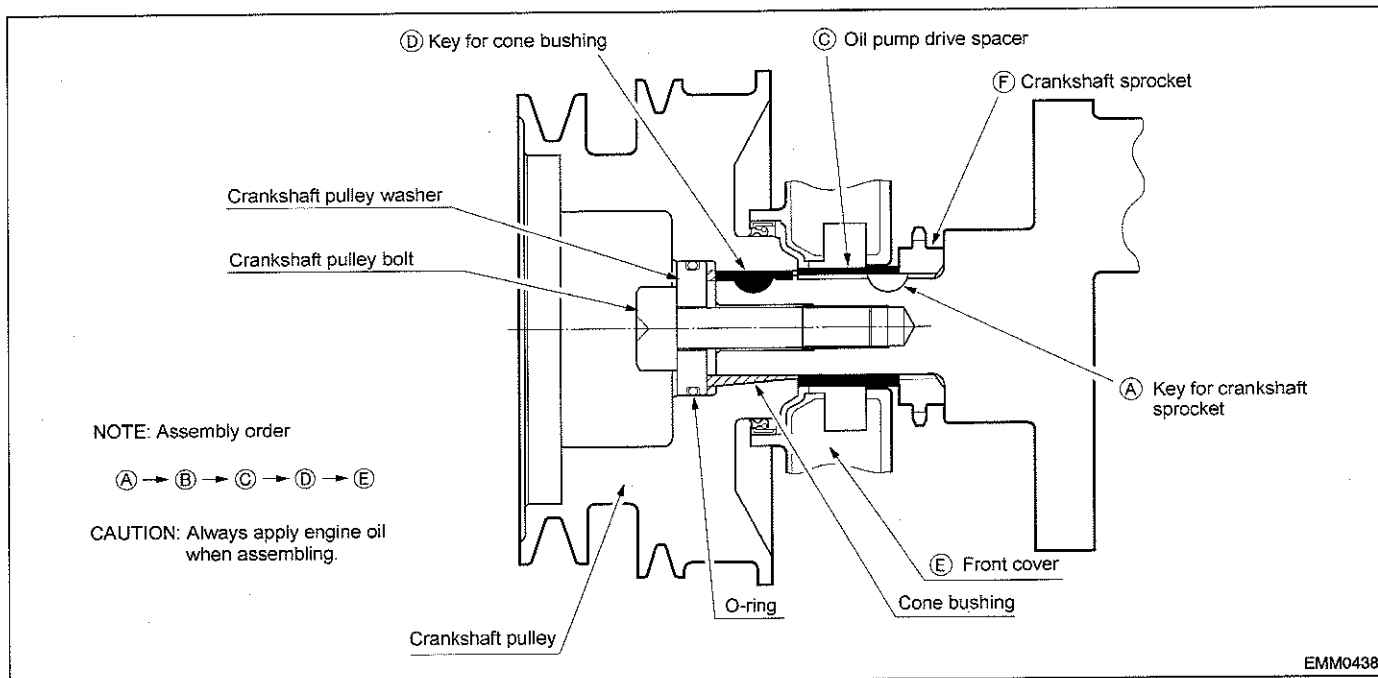
#### CAUTION:

- Hold the sleeve with a finger to prevent it from popping out when removing.

14. Remove distributor drive gear.
15. Remove camshaft sprocket and crankshaft sprocket together with timing chain.

## TIMING CHAIN

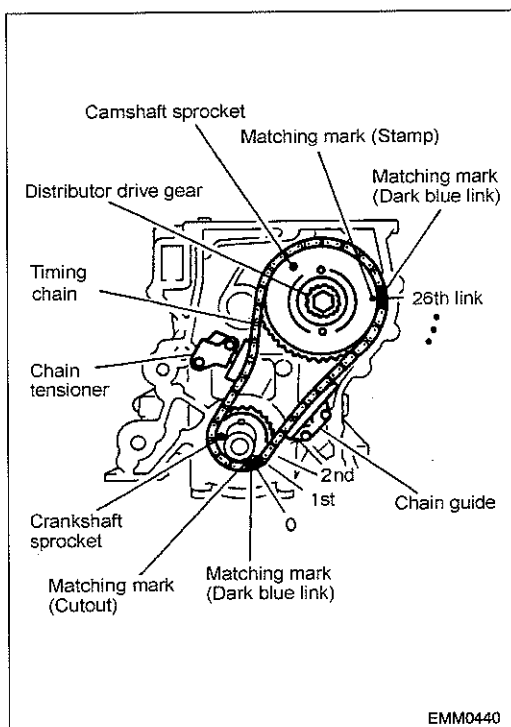
### Removal (Cont'd)



### Installation

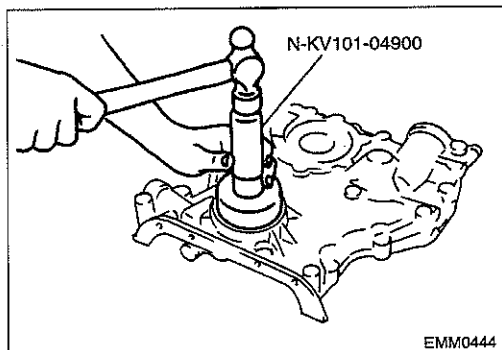
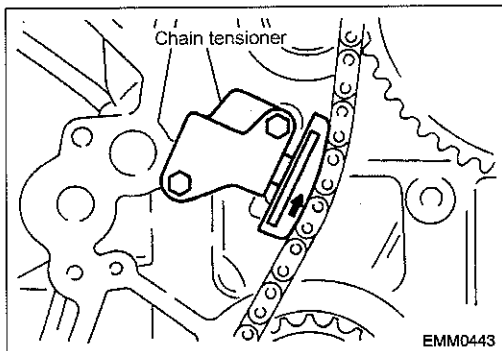
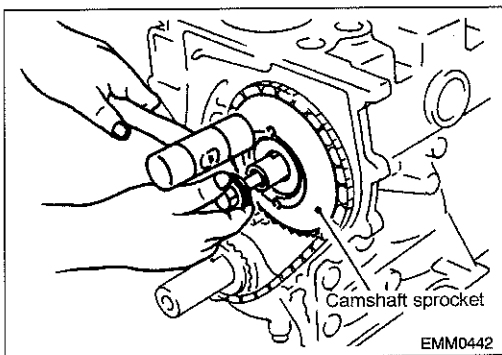
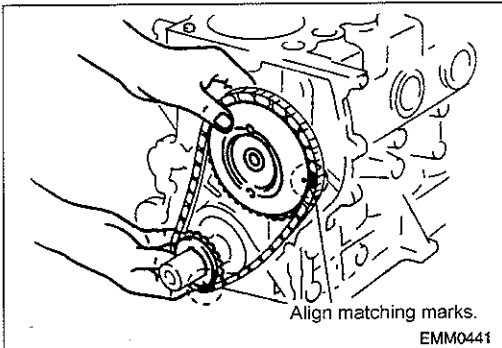
#### NOTE:

- Installing condition and matching mark location of each part are shown in the figure.
1. Install the key for crankshaft sprocket after making sure that crankshaft key groove and camshaft key point straight up.



## TIMING CHAIN

### Installation (Cont'd)



2. Install camshaft sprocket and crankshaft sprocket aligning with matching mark on timing chain.
- Insert each sprocket to the shaft in turn and in several steps.

- Move camshaft into cylinder block when inserting camshaft sprocket. Hold camshaft by temporarily tightening bolts, tap it using a plastic hammer, and then fully insert camshaft sprocket.

#### NOTE:

- Key for distributor drive gear to camshaft.
3. Install distributor drive gear is not visible if camshaft sprocket insertion is insufficient.
  - Install so that indication stamp mark side is facing camshaft sprocket side. (Refer to "Component Parts Location".)
  4. Install camshaft sprocket bolt.
  - Install washer with flat side facing camshaft sprocket side. (Refer to "Component Parts Location".)
  - Secure camshaft sprocket in the same procedure as removal, and tighten bolts.
  5. Install chain guide and chain tensioner.
  - Install chain tensioner sleeve with the arrow on sliding portion facing chain rotating direction (up).
  6. Install oil pump drive spacer to crankshaft.
  7. Install key for cone bushing.

8. Install front oil seal to front cover when replacing front oil seal.
- Install with the arrow facing outside.
- Press oil seal in until it is flush with the end surface of front cover using an oil seal drift (SST) or 78 mm (3.07 in) dia. drift.

#### CAUTION:

- Make sure that the circumference of oil seal is not damaged and there is no burr.

## TIMING CHAIN

### Installation (Cont'd)

9. Install front cover.

- Remove oil, scale, and sealant completely from flange surface and water hole.
- Apply a continuous bead of Three Bond 1207C (N-KP510-00150) to the positions shown in the figure.

#### CAUTION:

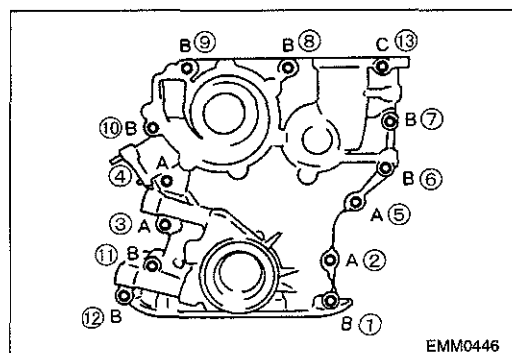
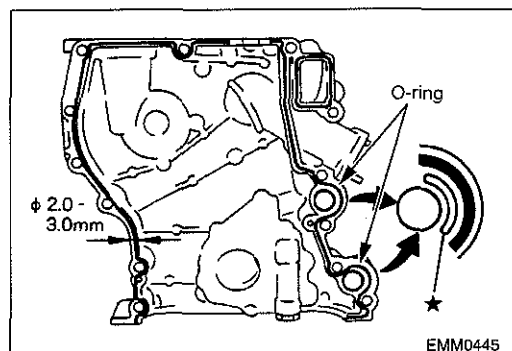
- Do not apply to inlet/outlet side groove of oil pump inlet/outlet. (2 at ★ mark)

#### NOTE:

- Grooves at ★ mark prevent liquid gasket from spreading into oil pump inlet/outlet when installing.
- Install O-rings (2).

#### CAUTION:

- Be careful to prevent O-ring from dropping and dislocating when installing front cover to cylinder block.
- Do not reuse O-ring.
- Refer to the figure for location and tightening order of bolts.
  - A: M8 X Length under head: 35 mm (1.38 in) (4)
  - B: M8 X Length under head: 65mm (2.56 in) (8)
  - C: M8 X Length under head: 80mm (3.15 in) (1)



10. Insert a crankshaft pulley guide (SST) to crankshaft, and then install crankshaft pulley.

#### CAUTION:

- Front oil seal may be damaged if crankshaft pulley is installed directly. Always use crankshaft pulley guide.

11. Install cone bushing.

12. Apply engine oil to O-ring, and then install O-ring to the O-ring groove on crankshaft pulley washer. (Refer to "Component Parts Location".)

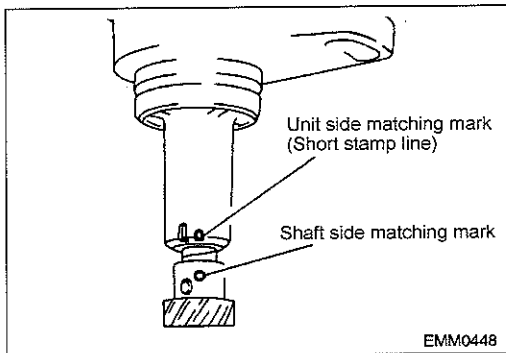
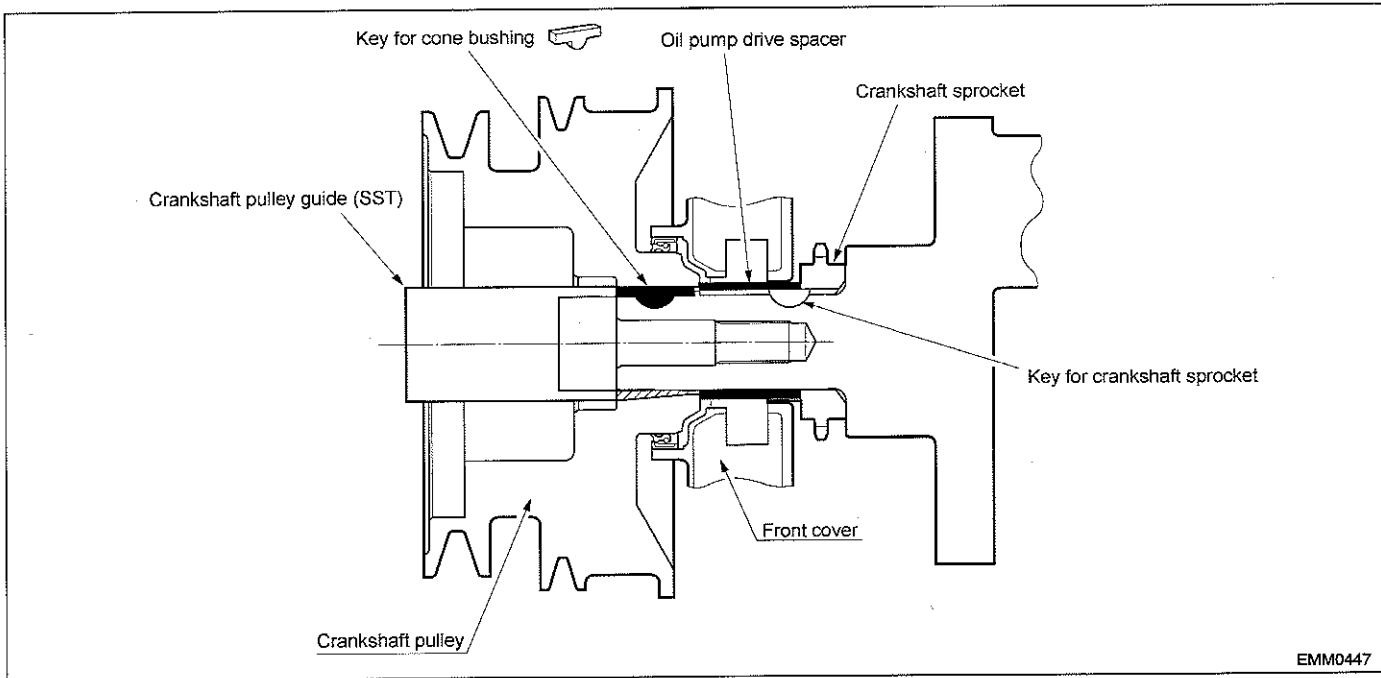
#### CAUTION:

- Do not reuse O-ring.

13. Install crankshaft pulley washer, and then tighten crankshaft pulley bolt using a ring gear stopper (SST) following the procedures above.

## TIMING CHAIN

### Installation (Cont'd)



#### 14. Install distributor.

- Check TDC on compression stroke with matching mark on crankshaft pulley.
- Insert distributor shaft to front cover aligning distributor shaft matching mark (circle stamp mark) with unit side matching mark (short stamp line).

#### NOTE:

- Matching mark on shaft is aligned with unit side matching mark (long stamp line) by engagement of helical gear after inserting.

#### 15. Reinstall removed parts in the reverse order of removal.

## REMOVAL AND INSTALLATION OF ENGINE

---

### CAUTION:

- Always pay attention to safety.
- Do not remove engine until exhaust system and engine coolant has completely cooled down.
- Support the vehicle at the specified lift points.
- Refer to appropriate sections for operation procedures for components other than engine.

### Removal

#### [OPERATION DESCRIPTION]

- Remove transmission, and remove engine by pulling up.

#### [PREPARATION WORK]

1. Release the fuel pressure. Refer to EC section, "Release of fuel pressure".
2. Remove radiator drain plug and drain engine coolant.
3. Remove the following parts.
  - Engine hood
  - Battery
  - Radiator, shroud, and radiator hose
  - Engine drive belt
  - Cooling fan
4. Disconnect accelerator cable from throttle drum and move it out of position.

## REMOVAL AND INSTALLATION OF ENGINE

---

### Removal (Cont'd)

#### [LEFT SIDE OF ENGINE ROOM]

5. Remove air duct and air cleaner case.
6. Disconnect heated oxygen sensor harness connector and ground (between exhaust manifold cover and body).
7. Disconnect harness connector from A/C compressor.
8. Remove A/C compressor from bracket and secure it onto body with a rope.
9. Disconnect heater hose. Plug the hose immediately to prevent engine coolant from draining.
10. Remove power steering reservoir tank from bracket and secure it onto body with a rope.

#### CAUTION:

- **Levelly secure reservoir tank. Tilting may cause oil leakage.**

#### [RIGHT SIDE OF ENGINE ROOM]

11. Disconnect vacuum hose (for brake booster and for differential lock) on engine side.
12. Remove fuel hose.

#### CAUTION:

- **After disconnecting hoses, plug them immediately to prevent fuel from draining.**

13. Disconnect all harness connectors on engine side, and then move harnesses to body side.
14. Disconnect heater hose from body side clamp, and then move it to engine side.
15. Remove starter motor.

#### [UNDER VEHICLE]

16. Remove exhaust front tube.
17. Disconnect A/T oil cooler piping from oil pan.
18. Remove rear propeller shafts.
19. Remove transmission.

#### [REMOVAL]

20. Engage chain block hook in front/rear engine slingers and support.

#### CAUTION:

- **Be careful not to contact hook and chain with body and piping when engaging hook in slingers.**

21. Remove engine mount insulator LH/RH nuts.
22. Pull up and remove engine by adjusting the position carefully.

#### CAUTION:

- **Make sure that all wires and piping were disconnected while removing.**
- **Be careful not to contact with body side parts.**

## REMOVAL AND INSTALLATION OF ENGINE

---

### Installation

Install in the reverse order of removal and note the following.

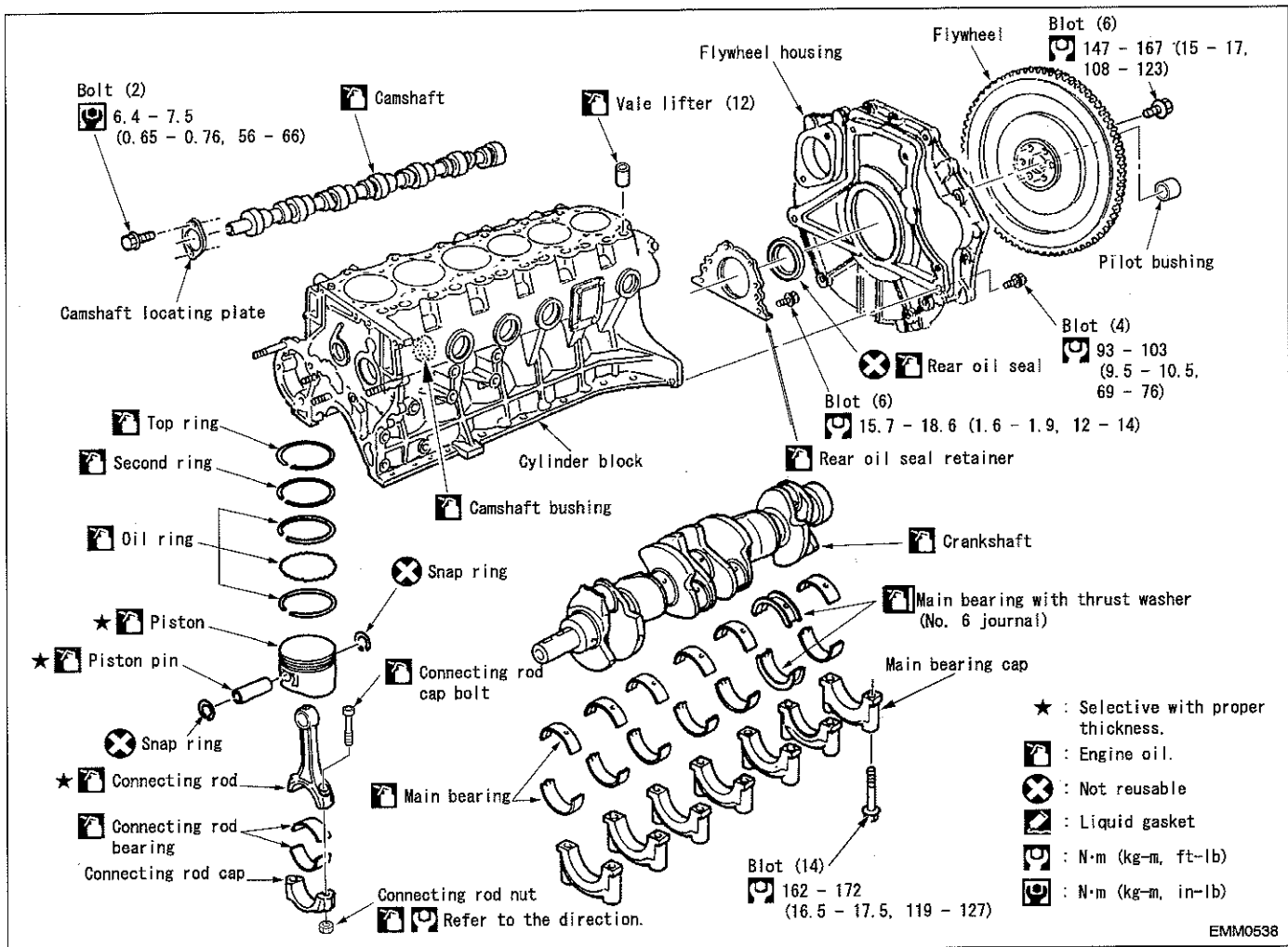
- Do not allow oil to get on the engine mount insulator. Be careful not to damage the engine mount insulator.
- Securely insert positioning stopper pin into mating side hole.
- Make sure all mount insulators are seated properly, then tighten mount bolts and nuts.

### Inspection

- Check amount of engine coolant, oil and grease before starting engine. Refill as necessary.
- Start engine and check for any unusual noise and vibration.
- Warm up engine, and then check engine coolant, oil and grease, fuel, and exhaust gas for leakage.

# CYLINDER BLOCK

## Component Parts Location



### CAUTION:

- Apply new engine oil to the parts marked in the figure prior to installation.

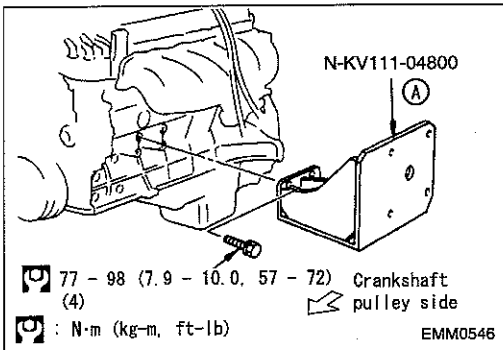
### Disassembly

1. Remove engine assembly from the vehicle.  
(Refer to EM section, "Removal and Installation of Engine".)
2. Keep the position using a hoist so as not to tilt engine.
3. Remove engine mount bracket.
4. Install engine assembly to engine stand (SST) with the following procedure:

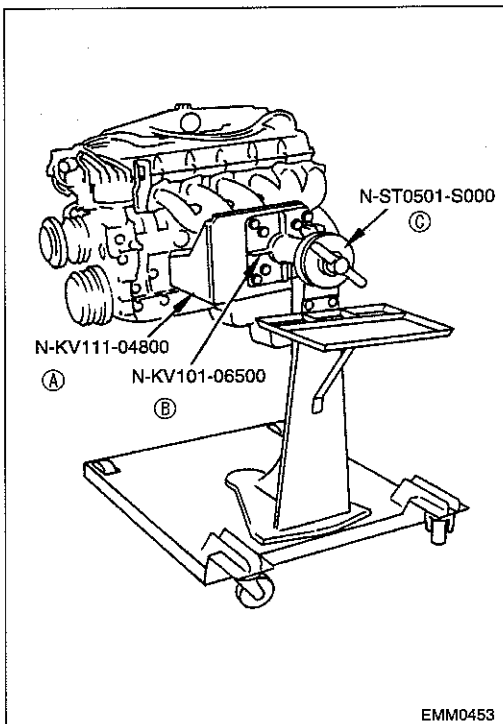
## CYLINDER BLOCK

### Disassembly (Cont'd)

- 1) Install engine sub-attachment (SST, A shown in the figure) to engine mount bracket mounting hole on exhaust manifold side.
- 2) Install engine attachment (SST, B shown in the figure) to engine sub-attachment.



- 3) Hoist engine and mount it on engine stand (SST, C shown in the figure).
  - It is possible to set engine attachment and sub-attachment to engine stand, and then install hoisting engine later.
5. Drain engine oil from oil pan drain plug.
6. Drain engine coolant from cylinder block drain plug. (Refer to "Coolant Replacement" in CO section.)
7. Remove the following parts.
  - Auxiliary brackets
  - Exhaust manifold
  - Thermostat housing
  - Water pipe
  - Intake manifold
  - Distributor
  - Rocker cover
  - Rocker shaft assembly
  - Cylinder assembly
  - Oil pan
  - Oil strainer
  - Timing chain
  - Oil filter and oil filter bracket



8. Remove flywheel.
  - Secure crankshaft using a stopper plate (SST), and then remove bolts.

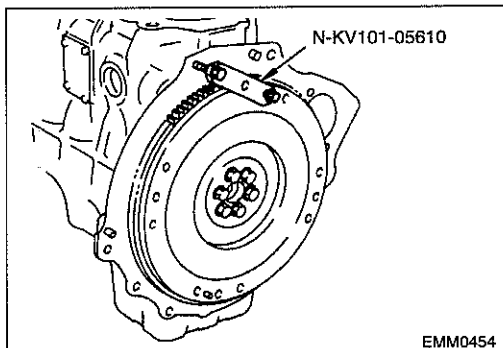
#### CAUTION:

- Place a shop cloth on flywheel surface to prevent damage.
- Loosen bolts diagonally and remove them.

9. Remove flywheel housing.
10. Remove rear oil seal and retainer assembly.

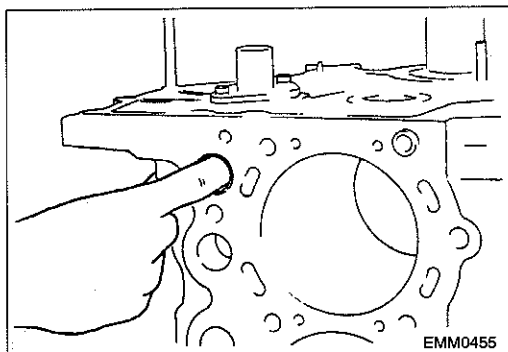
#### NOTE:

- Oil seal is integrated with retainer.

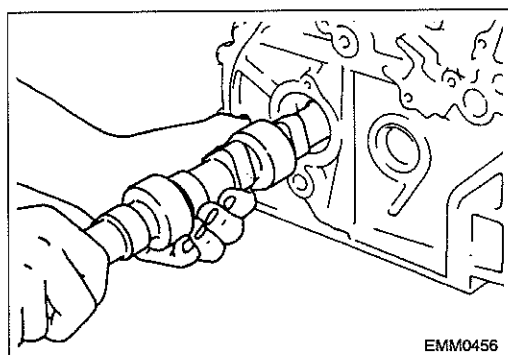


## CYLINDER BLOCK

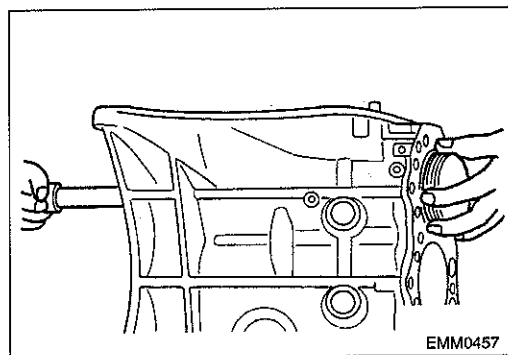
### Disassembly (Cont'd)



11. Remove valve lifter.
  - Pull out from block upper surface with a finger and remove it.
  - Remove camshaft with valve lifter in non-contact condition if removal is difficult, and then remove valve lifter after tapping from crankshaft side hole.
  - Check the location, and store individually.



12. Remove camshaft.
  - Pull camshaft straight out so as not to damage bushing.

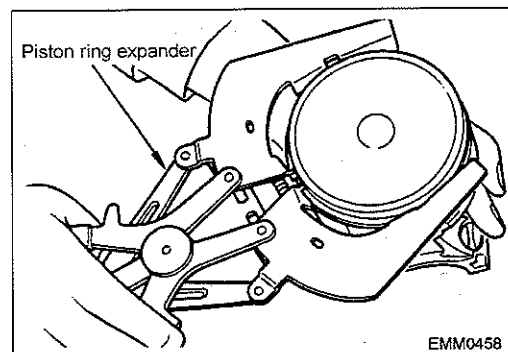


13. Remove piston and connecting rod assembly.
  - 1) Set crankshaft at removal piston assembly to BDC on compression stroke.
  - 2) Remove connecting rod cap and push piston and connecting rod assembly out toward cylinder head side with handle of a hammer.
    - Before loosening connecting rod nuts, check connecting rod side clearance. (Refer to EM section, "Inspection of connecting rod side clearance".)

- 3) Remove connecting rod bearing.

#### CAUTION:

- Check installation position of each part. Arrange removed valves to prevent mixing them up.



14. Remove piston ring using piston ring expander (commercial service tool).

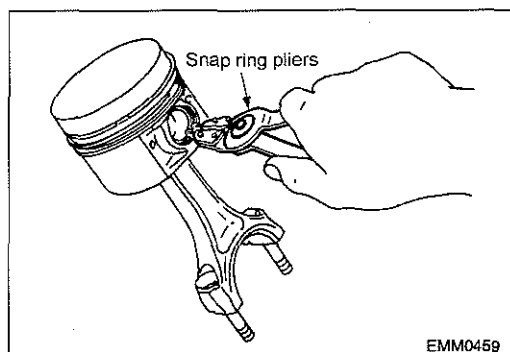
#### CAUTION:

- Be careful not to damage piston.
- Do not expand piston rings excessively. It can damage piston rings
- Check piston ring side clearance before removing piston ring. (Refer to EM section, "Inspection of piston ring side clearance".)

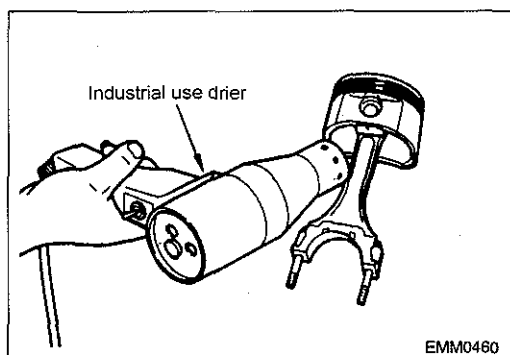
## CYLINDER BLOCK

### Disassembly (Cont'd)

15. Remove connecting rod from piston.  
1) Remove snap ring using snap ring pliers.



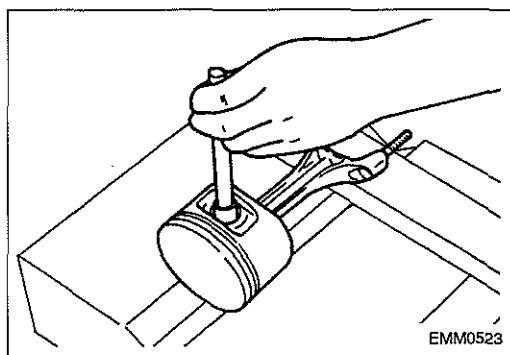
- 2) Heat piston to between 60 and 70°C (140 and 158°F) using a drier.



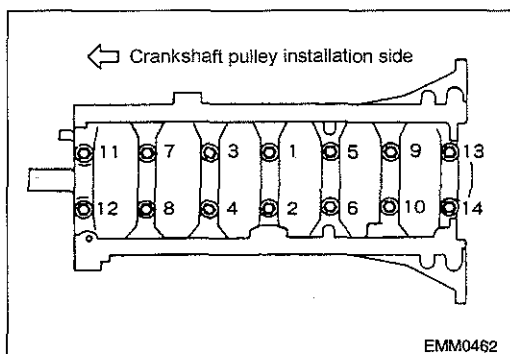
- 3) Push out piston pin from piston using a round bar with outer diameter of approximately 20 mm (0.79 in).

#### CAUTION:

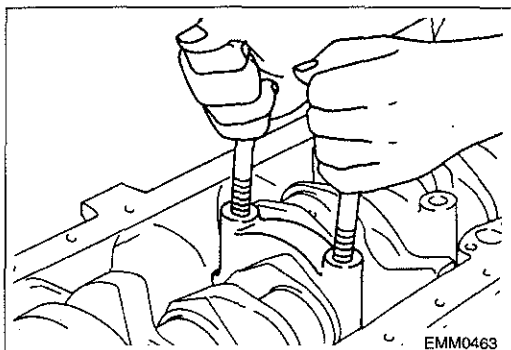
- Do not remove connecting rod bolt from connecting rod.



16. Remove main bearing caps.  
1) Loosen bolts in the reverse of the order shown in the figure.



## CYLINDER BLOCK



### Disassembly (Cont'd)

- 2) Remove main bearing cap while shaking it left/right using main bearing bolts.
17. Remove crankshaft.
18. Remove main bearing from main bearing cap and cylinder block.

#### CAUTION:

- Check installation position of each part. Arrange removed parts to prevent mixing them up.
- Before loosening main bearing cap bolts, check crankshaft side clearance.  
(Refer to EM section, "Inspection of crankshaft side clearance".)

### Selective-Fit Service Parts

#### SELECTION METHOD

| Position                 | Selective-fit service parts                                                                                            | Item to be selected                     | Selection method                                         |
|--------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|----------------------------------------------------------|
| Cylinder block to piston | Piston and piston pin assembly<br>NOTE: Piston and piston pin are a matched set. They make up one part as an assembly. | Piston grade<br>(Piston outer diameter) | Piston grade = Cylinder bore grade (Bore inner diameter) |

- Identification grade stamped on each part shows the dimension measured when it was new as a grade. It is not applicable when it has been reused.
- When part is used or corrected, measure its dimension and decide appropriate grade by referring to Selective-fit Service Parts Table in this section.
- Refer to the direction specified in the text for details of measurement method for each part, reusable standard, and selection method for selective-fit service parts.

### Inspection After Disassembly

#### CRANKSHAFT SIDE CLEARANCE

- Move crankshaft to front or rear and measure clearance between thrust bearing (journal 6) and crank arm using a dial indicator or a feeler gauge.

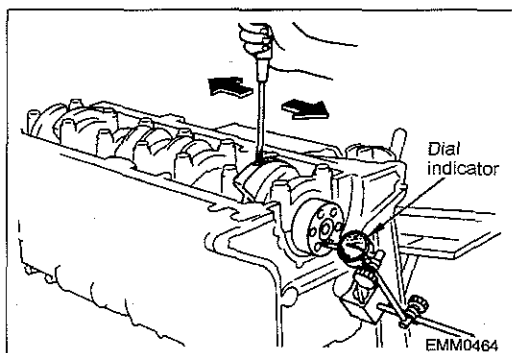
##### Standard:

0.05 - 0.17 mm (0.0020 - 0.0067 in)

##### Repair limit:

0.30 mm (0.0118 in)

- Replace main bearing (integrated with thrust bearing) of journal 6, and then measure clearance again if outside the repair limit.
- Replace crankshaft if it still exceeds the limit.



## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)

#### CONNECTING ROD SIDE CLEARANCE

- Measure connecting rod-to-crank arm side clearance using a feeler gauge.

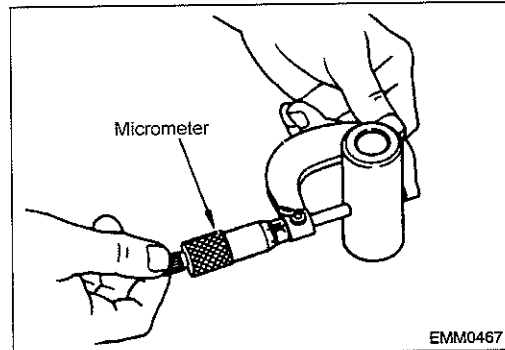
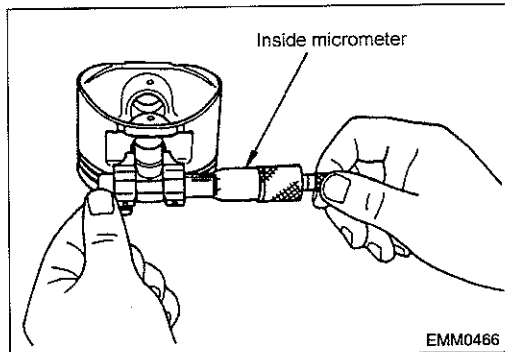
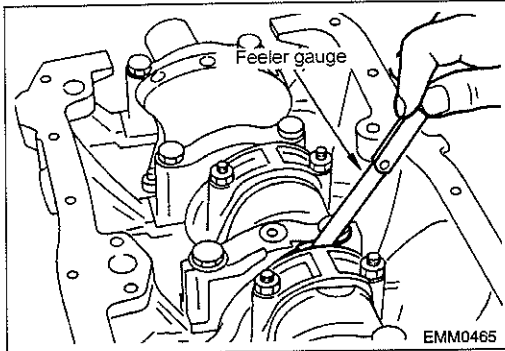
**Standard:**

**0.20 - 0.35 mm (0.0020 - 0.0138 in)**

**Repair limit:**

**0.40 mm (0.0157 in)**

- Replace connecting rod, and then measure clearance again if outside the repair limit.
- Replace crankshaft if it still exceeds the limit.



#### PISTON-TO-PISTON PIN CLEARANCE

1. Piston pin hole diameter
- Measure inner diameter of piston pin hole using an inside micrometer

**Standard:**

**22.993 - 23.005 mm (0.9052 - 0.9057 in) dia.**

2. Piston pin outer diameter
  - Measure piston pin outer diameter using a micrometer.
- Standard:**
- 22.989 - 23.001 mm (0.9051 - 0.9055 in) dia.**
3. How to calculate piston-to-piston pin clearance
  - (Piston pin clearance)  
= (Piston pin hole diameter) - (Piston pin outer diameter)
- Standard clearance at room temperature [20° C (68° F)]:**
- 0.001 to 0.009 mm (0 to 0.0004 in)**
- Replace piston and piston pin assembly if clearance exceeds the standard.

#### PISTON RING SIDE CLEARANCE

- Measure piston ring-to-piston ring groove clearance using a feeler gauge.

**Standard:**

**Top ring 0.040 - 0.073 mm (0.0016 - 0.0029 in)**

**Second ring 0.030 - 0.063 mm (0.0012 - 0.0025 in)**

**Oil ring 0.065 - 0.135 mm (0.0026 - 0.0053 in)**

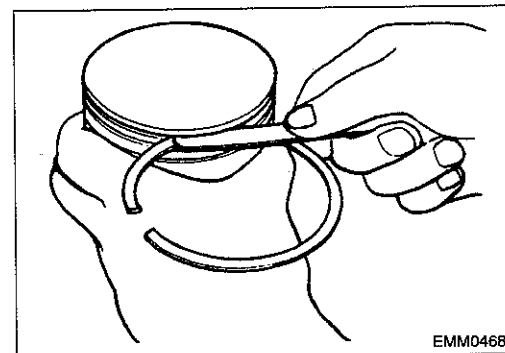
**Repair limit:**

**Top ring 0.1 mm (0.004 in)**

**Second ring 0.1 mm (0.004 in)**

**Oil ring -**

- Replace piston and/or piston ring assembly if outside the repair limit.



## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)

#### PISTON RING END GAP

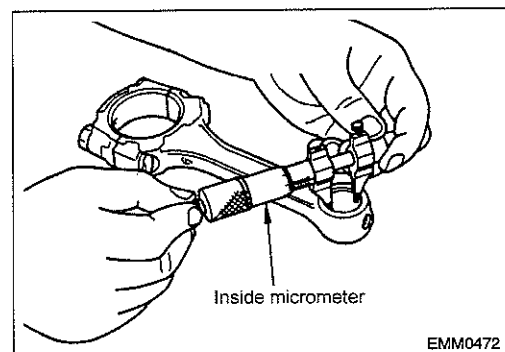
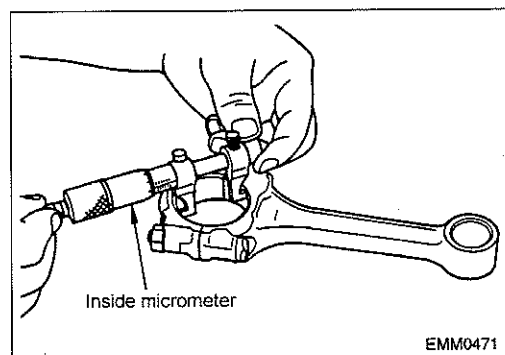
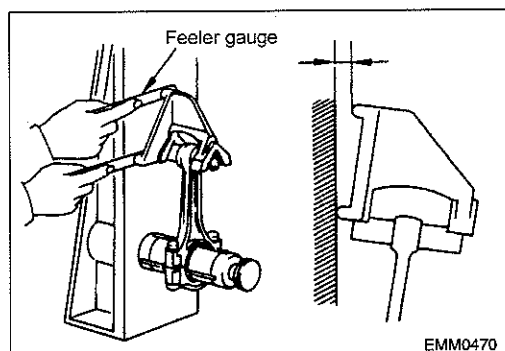
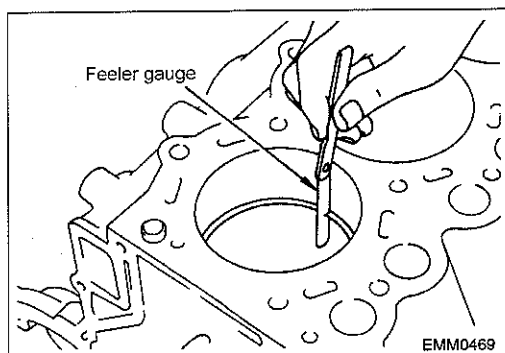
- Make sure cylinder bore inner diameter is within the standard. (Refer to EM section, "Piston and Cylinder Bore Clearance".)
- Press-fit piston rings in cylinder halfway using a piston, and measure end gap.

##### Standard:

|             |                                   |
|-------------|-----------------------------------|
| Top ring    | 0.30 - 0.45 mm (0.012 - 0.018 in) |
| Second ring | 0.30 - 0.45 mm (0.012 - 0.018 in) |
| Oil ring    | 0.20 - 0.60 mm (0.008 - 0.024 in) |

##### Repair limit:

|             |                   |
|-------------|-------------------|
| Top ring    | 1.5 mm (0.059 in) |
| Second ring | 1.5 mm (0.059 in) |
| Oil ring    | -                 |



#### CONNECTING ROD BEND AND TORSION

- Check connecting rod bend and torsion using a connecting rod alignment tool.

##### Bend limit:

0.15 mm (0.0059 in) [per 100 mm (3.9370 in)]

##### Torsion limit:

0.30 mm (0.0118 in) [per 100 mm (3.9370 in)]

#### CONNECTING ROD LARGE END DIAMETER

- Install connecting rod cap without connecting rod bearing. Tighten connecting rod nuts to the specified torque.
- Measure connecting rod large end diameter using an inside micrometer.

##### Standard:

59.987 - 60.000 mm (2.3617 - 2.3622 in) dia.

#### CONNECTING ROD BUSHING OIL CLEARANCE (AT SMALL END)

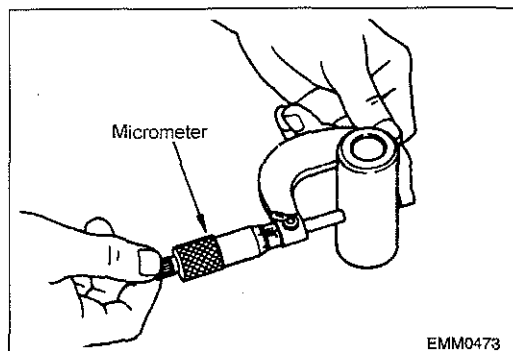
1. Connecting rod small end inner diameter
- Measure inner diameter of connecting rod small end using an inside micrometer.

##### Standard:

23.000 - 23.012 mm (0.9055 - 0.9060 in) dia.

## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)



2. Piston pin outer diameter
- Measure piston pin outer diameter using a micrometer.

**Standard:**

**22.989 - 23.001 mm (0.9051 - 0.9055 in) dia.**

3. How to calculate connecting rod bushing oil clearance
- (Connecting rod small end oil clearance)  
= (Connecting rod small end inner diameter) - (Piston pin outer diameter)

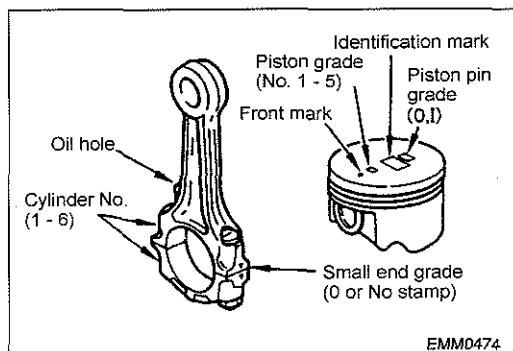
**Standard:**

**0.005 - 0.017 mm (0.0002 - 0.0007 in)**

- Refer to standards for each part if clearance was not within the standard. Replace connecting rod and/or piston and piston pin assembly.
- Refer to EM section, "Piston Selective-fit Service Parts" if reusing connecting rod and replacing piston and piston assembly with new one. Select piston fitted to the bore grade of cylinder block.

**NOTE:**

- Piston and piston pin are a matched set. They make up one part as an assembly.



### CYLINDER BLOCK UPPER SURFACE DISTORTION

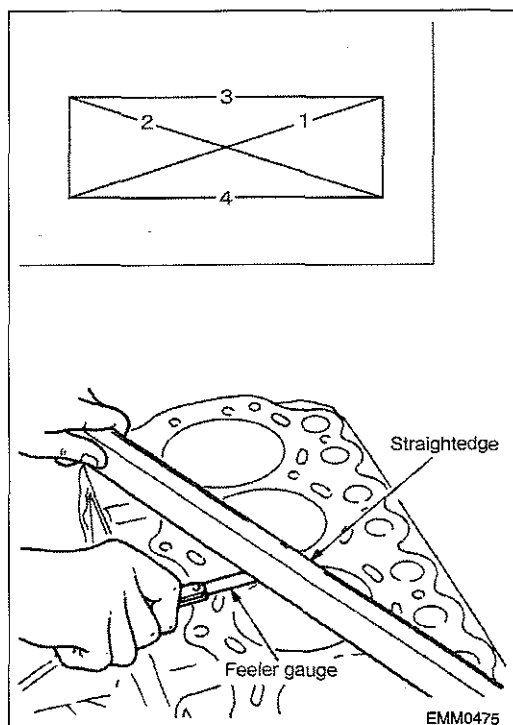
- Completely remove old gasket on cylinder block surface using a scraper. Also remove oil, water stains, and carbon deposits.

**CAUTION:**

- Do not allow gasket fragments to enter oil or engine coolant passages.
- Check flatness of cylinder block upper surface. Measure distortion in 4 directions shown in the figure, at several points in each direction.

**Repair limit:**

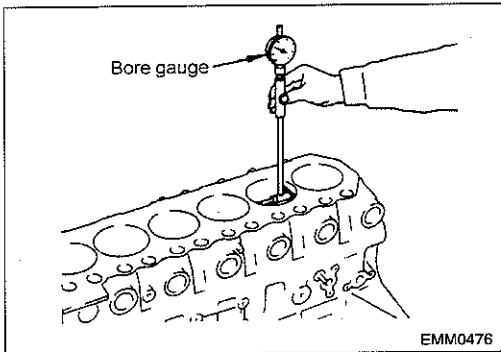
**0.1 mm (0.004 in)**



## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)

#### PISTON-TO-CYLINDER BORE CLEARANCE



1. Cylinder bore diameter
  - Measure cylinder bore at 2 points (A and B) in 2 directions (X and Y) using a bore gauge.

**Cylinder bore inner diameter standard:**

**99.500 - 99.550 mm (3.9173 - 3.9193 in) dia.**

**Wear limit:**

**0.2 mm (0.008 in)**

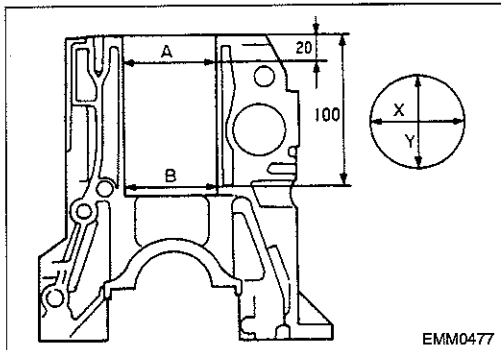
**Out-of-round limit**

**(difference between measurements X and Y):**

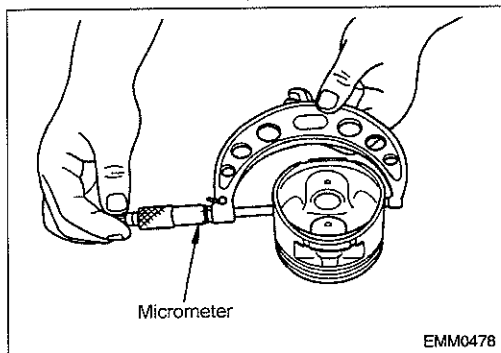
**0.015 mm (0.0006 in)**

**Taper limit (difference between measurements A and B):**

**0.01 mm (0.0004 in)**



- Hone or bore cylinder if outside the repair limit or cylinder inner wall is found with damage and seizure.
- 0.5 (0.020) OS [0.5 mm (0.020 in) oversize] and 1.0 (0.039) OS [1.0 mm (0.039 in) oversize] pistons are available for service. Be sure to use the same oversize piston rings with piston cylinder clearance size piston when using oversize piston.



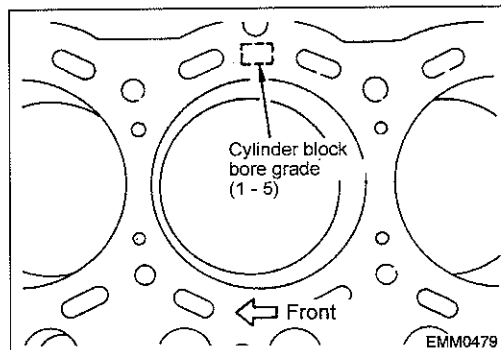
2. Piston outer diameter
  - Measure piston skirt outer diameter using a micrometer.  
**Measuring point:**  
**20 mm (0.79 in) up from piston bottom**  
**Standard:**  
**99.460 - 99.510 mm (3.9157 - 3.9177 in) dia.**

#### HOW TO CALCULATE PISTON-TO-CYLINDER BORE CLEARANCE

- (Clearance) =  
(Cylinder bore inner diameter) - (Piston skirt outer diameter)  
**Standard clearance at room temperature [20° C (68° F)]:**  
**0.030 - 0.050 mm (0.0012 - 0.0020 in)**
  - Replace piston and piston pin assembly if clearance is outside the standard.
3. Piston selective-fit service parts
    - When using new cylinder block
  - 1) Check cylinder bore grade number (1 to 5) stamped on cylinder block upper surface and select piston from selective-fit service parts table.

#### NOTE:

- Piston and piston pin are a matched set. They make up one part as an assembly.



## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)

- When reusing cylinder block
  - 1) Measure cylinder bore inner diameter.
  - 2) Find grade number of the measured cylinder bore in "Cylinder Bore Inner Diameter Selective-fit Service Parts Table", and select piston (grades 1 to 5) from selective-fit service parts table.

Selective-fit service parts table

Unit: mm (in)

| Grade number (stamping)      | 1                  | 2                  | 3                  | 4                  | 5                  |
|------------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Cylinder bore inner diameter | 99.510<br>(3.9117) | 99.520<br>(3.9181) | 99.530<br>(3.9185) | 99.540<br>(3.9189) | 99.550<br>(3.9193) |
|                              | 99.500<br>(3.9173) | 99.510<br>(3.9177) | 99.520<br>(3.9181) | 99.530<br>(3.9185) | 99.540<br>(3.9189) |
| Piston outer diameter        | 99.470<br>(3.9161) | 99.480<br>(3.9165) | 99.490<br>(3.9169) | 99.500<br>(3.9173) | 99.510<br>(3.9177) |
|                              | 99.460<br>(3.9157) | 99.470<br>(3.9161) | 99.480<br>(3.9165) | 99.490<br>(3.9169) | 99.500<br>(3.9173) |

### CRANKSHAFT JOURNAL DIAMETER

- Measure the journal outer diameter using a micrometer.

**Standard:**

**70.907 - 70.920 mm (2.7916 - 2.7921 in) dia.**

### CRANKSHAFT PIN DIAMETER

- Measure the pin outer diameter using a micrometer.

**Standard:**

**56.913 - 56.926 mm (2.2407 - 2.2412 in) dia.**

### OUT-OF-ROUND AND TAPER OF CRANKSHAFT

- Measure each journal and pin at 4 positions shown in the figure using a micrometer.
- Out-of-round is indicated by the difference between dimensions A and B measured at points 1 and 2.
- Taper is indicated by difference between dimensions 1 and 2 measured in directions A and B.

**Repair limit:**

**0.06 mm (0.0024 in) dia.**

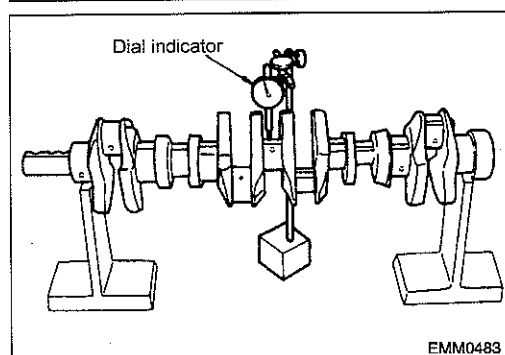
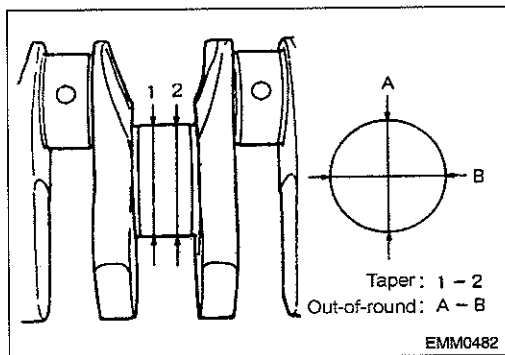
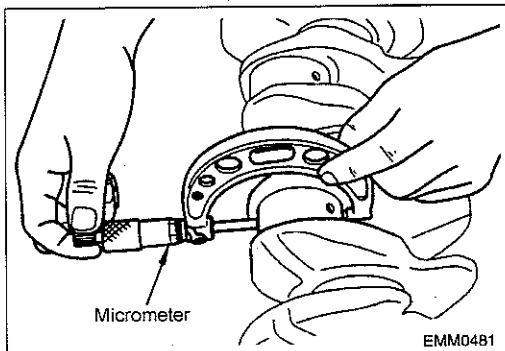
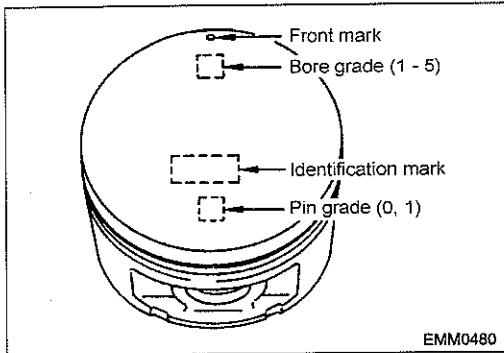
**(both out-of-round and taper)**

### CRANKSHAFT BEND

- Set a pair of V-blocks on a level surface and support journals 1 and 7 of crankshaft.
- Set a dial indicator vertically onto journal 4.
- Rotate crankshaft and read indication on the indicator.
- Half of the reading is the bend.

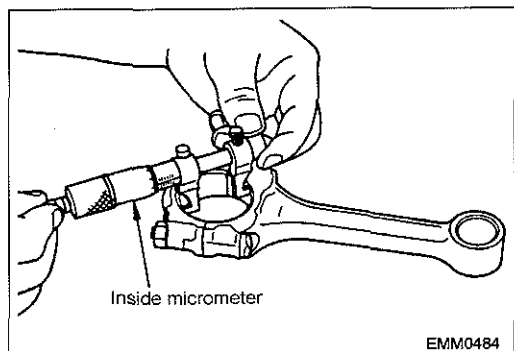
**Repair limit:**

**0.2 mm (0.008 in)**



## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd) CONNECTING ROD BEARING OIL CLEARANCE



1. Measuring method
  - Install connecting rod bearing to connecting rod and connecting rod cap. Tighten connecting rod nuts to the specified torque. Measure connecting rod inner diameter using an inside micrometer.

(Oil clearance)

$$= (\text{Connecting rod bearing inner diameter}) \\ - (\text{Crankshaft pin outer diameter})$$

**Standard:**

**0.027 - 0.061 mm (0.0011 - 0.0024 in)**

**Repair limit:**

**0.09 mm (0.0035 in)**

- Replace connecting rod bearing and/or crankshaft according to judgement from values measured at previous steps 11 and 15-1) if connecting rod bearing oil clearance is outside the repair limit.
2. Using plastigage
    - Completely clean off oil and dust on crankshaft pins and bearing surfaces.
    - Cut a piece of plastigage slightly shorter than bearing width, and place it in axial direction avoiding oil hole.
    - Install connecting rod bearing to connecting rod cap. Tighten connecting rod nuts to the specified torque.

#### CAUTION:

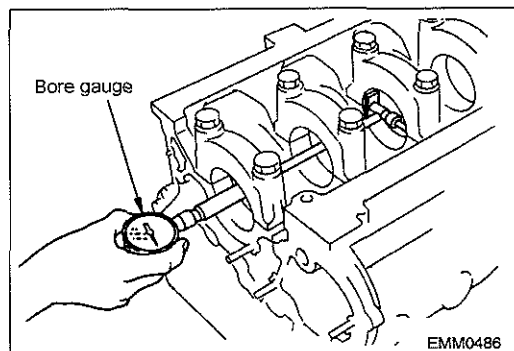
- **Do not rotate crankshaft while plastigage is in place.**

- Remove connecting rod cap and bearing. Measure width of the plastigage using scale printed on its bag.

#### CAUTION:

- Follow the method outlined in "By measuring" if clearance is standard and repair limit, and if clearance exceeds repair limit, but remeasure if clearance is less than standard.

### MAIN BEARING OIL CLEARANCE



1. Measuring method
  - Install main bearing to cylinder block and bearing cap. Tighten bearing cap bolts to the specified torque and measure main bearing inner diameter.

(Oil clearance)

$$= (\text{Main bearing inner diameter}) - (\text{Crankshaft journal outer diameter})$$

**Standard:**

**0.030 - 0.087 mm (0.0012- 0.0034 in)**

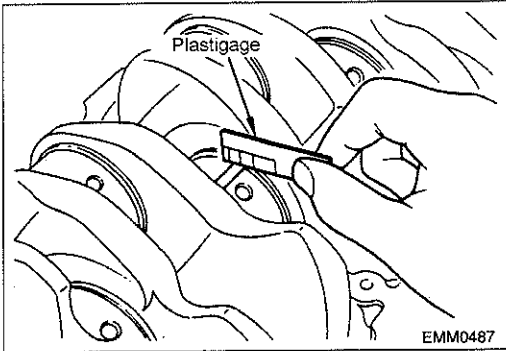
**Repair limit:**

**0.09 mm (0.0035 in)**

- Replace undersized bearing upper and lower as a set if standard size main bearing oil clearance is outside the standard.  
(Refer to EM section, "Using Undersized Bearing".)

## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)



2. Using plastigage
  - Completely clean off oil and dust on crankshaft journal and bearing surfaces.
  - Cut a piece of plastigage slightly shorter than bearing width, and place it in axial direction avoiding oil hole.
  - Tighten main bearing to the specified torque.

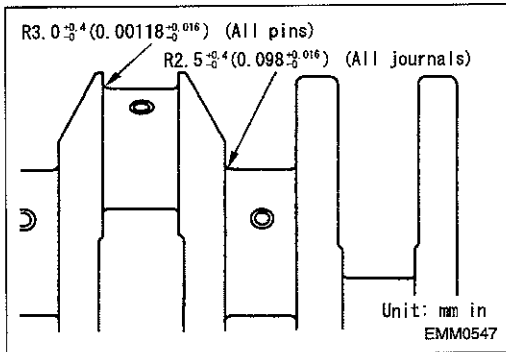
#### CAUTION:

- Do not rotate crankshaft while plastigage is in place.
- Remove bearing cap and bearing. Measure width of the plastigage using scale printed on its bag.

#### CAUTION:

- Follow the method outlined in "By measuring" if clearance is standard and repair limit, and if clearance exceeds repair limit, but remeasure if clearance is less than standard.

3. Using undersized bearing
  - Use undersized bearing if standard size main bearing oil clearance is outside the standard.
  - When using undersize bearing, install it, measure bearing inner diameter, and grind journal to obtain specified oil clearance.



Main bearing undersize table

Unit: mm (in)

| Size            | Thickness      |
|-----------------|----------------|
| STD             | 2.000 (0.0787) |
| US0.25 (0.0098) | 2.125 (0.0837) |
| US0.50 (0.0197) | 2.250 (0.0886) |
| US0.75 (0.0295) | 2.375 (0.0935) |
| US1.00 (0.0394) | 2.500 (0.0984) |

#### NOTE:

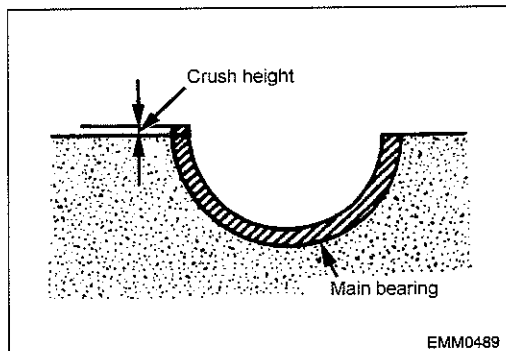
- Each tolerance is +0.008 to +0.012 (+0.0003 to +0.0005).

#### CAUTION:

- Be careful not to damage fillet-roll area when grinding crankshaft journal in order to use undersize bearing.

### MAIN BEARING CRUSH HEIGHT

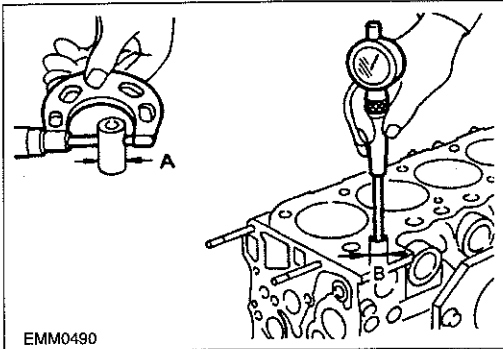
- Tighten bearing cap to the specified torque with main bearing installed. Remove bearing cap and make sure that the main bearing edges protrude (There must be crush height.).



## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)

#### VALVE LIFTER OIL CLEARANCE



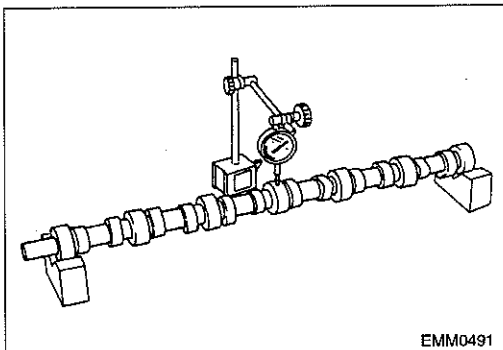
- Check sliding surfaces with camshaft and lifter bore for uneven wear and damage.
  - Replace valve lifter if necessary.
1. Valve lifter outer diameter
    - Measure the valve lifter outer diameter using a micrometer. (A in the figure)  
**Standard:**  
**24.960 - 24.970 mm (0.9827 - 0.9844 in) dia.**
  2. Valve lifter bore inner diameter
    - Measure valve lifter bore inner diameter using a bore gauge. (B in the figure)  
**Standard:**  
**25.000 - 25.003 mm (0.9843 - 0.9844 in) dia.**
  3. How to calculate valve lifter oil clearance
    - (Clearance) = (Valve lifter bore inner diameter) - (Valve lifter outer diameter)  
**Standard:**  
**0.030 - 0.073 mm (0.0012 - 0.0029 in)**  
**Repair limit:**  
**0.1 mm (0.004 in)**
- Refer to standards for each part and replace valve lifter and/or cylinder block if clearance exceeds the repair limit.

#### VISUAL INSPECTION OF CAMSHAFT

- Check camshaft nose or journal for damage and uneven wear.
- Replace camshaft as necessary.

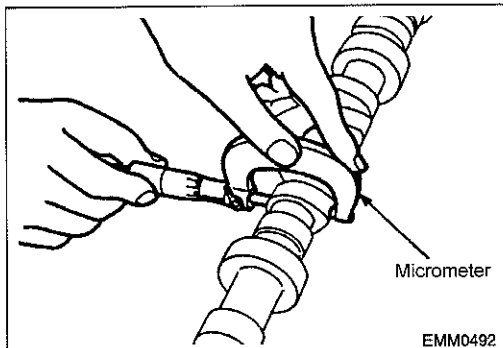
#### CHECKING FOR CAMSHAFT BEND

- Set a pair of V-blocks on a level surface and support journals (1 and 7) of camshaft.
- Set a dial indicator vertically onto center of journal 4.
- Rotate the camshaft in one direction by hand and read indication on the dial indicator. (Half of the reading is the bend.)  
**Repair limit:**  
**0.03 mm (0.0012 in)**



#### CAM NOSE HEIGHT

- Measure with a micrometer.  
**Standard (intake side):**  
**42.126 - 42.376 mm (1.6585 - 1.6683 in)**  
**Standard (exhaust side):**  
**42.126 - 42.376 mm (1.6585 - 1.6683 in)**



## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)

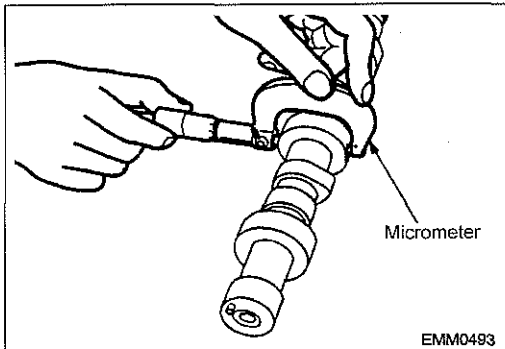
#### CAMSHAFT OIL CLEARANCE

1. Camshaft journal outer diameter

- Measure with a micrometer.

**Standard:**

|                  |                                                |
|------------------|------------------------------------------------|
| <b>Journal 1</b> | <b>50.721 - 50.740 mm (1.9969 - 1.9976 in)</b> |
| <b>Journal 2</b> | <b>50.521 - 50.540 mm (1.9890 - 1.9898 in)</b> |
| <b>Journal 3</b> | <b>50.321 - 50.340 mm (1.9811 - 1.9819 in)</b> |
| <b>Journal 4</b> | <b>50.121 - 50.140 mm (1.9733 - 1.9740 in)</b> |
| <b>Journal 5</b> | <b>49.921 - 49.940 mm (1.9654 - 1.9661 in)</b> |
| <b>Journal 6</b> | <b>49.721 - 49.740 mm (1.9575 - 1.9583 in)</b> |
| <b>Journal 7</b> | <b>49.521 - 49.540 mm (1.9496 - 1.9504 in)</b> |

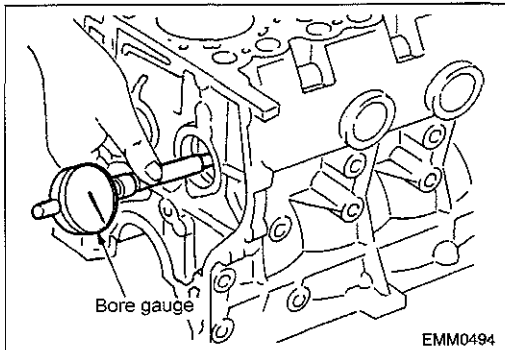


2. Camshaft bushing inner diameter

- Measure using a bore gauge.

**Standard:**

|                  |                                              |
|------------------|----------------------------------------------|
| <b>Journal 1</b> | <b>50.76 - 50.83 mm (1.9984 - 2.0012 in)</b> |
| <b>Journal 2</b> | <b>50.56 - 50.63 mm (1.9905 - 1.9933 in)</b> |
| <b>Journal 3</b> | <b>50.36 - 50.43 mm (1.9827 - 1.9854 in)</b> |
| <b>Journal 4</b> | <b>50.16 - 50.23 mm (1.9748 - 1.9776 in)</b> |
| <b>Journal 5</b> | <b>49.96 - 50.03 mm (1.9669 - 1.9697 in)</b> |
| <b>Journal 6</b> | <b>49.76 - 49.83 mm (1.9591 - 1.9618 in)</b> |
| <b>Journal 7</b> | <b>49.56 - 49.63 mm (1.9512 - 1.9539 in)</b> |



3. How to calculate camshaft oil clearance

- Oil clearance = Camshaft bushing inner diameter - Camshaft journal outer diameter

**Standard:**

**0.020 - 0.109 mm (0.0008 - 0.0043 in)**

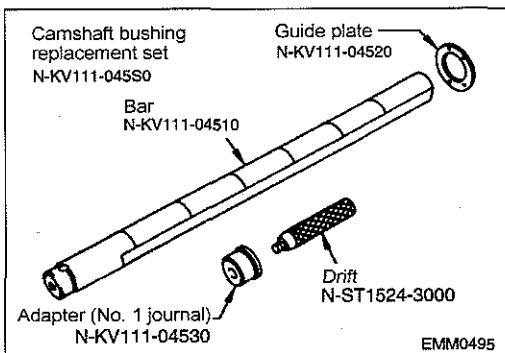
**Repair limit:**

**0.15 mm (0.0059 in)**

- Refer to the standards if clearance exceeds the repair limit. Replace camshaft and/or camshaft bushing.

#### REPLACEMENT OF CAMSHAFT BUSHING

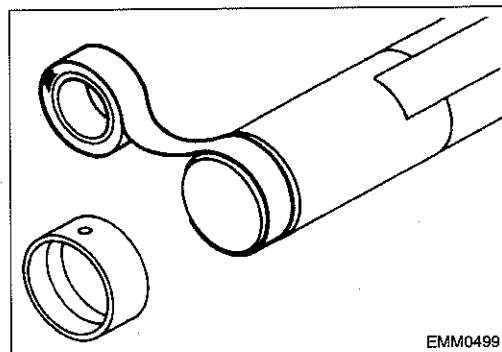
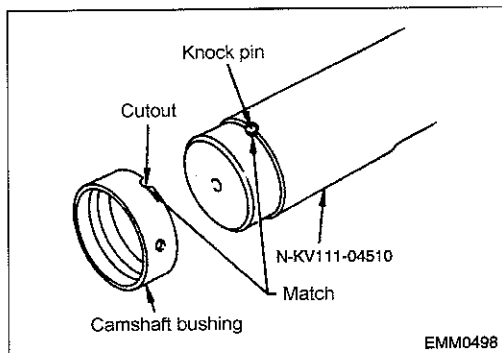
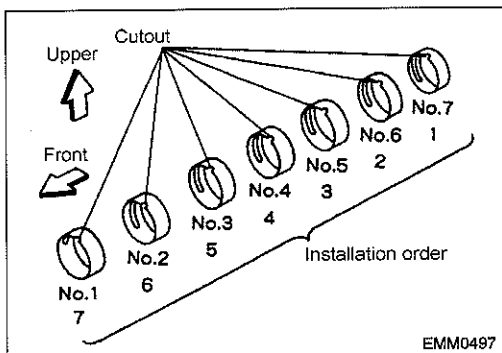
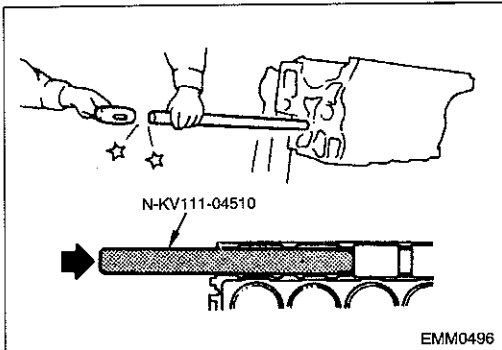
1. Remove welch plug.



## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)

2. Pull out camshaft bushings from cylinder block using a bar (SST).

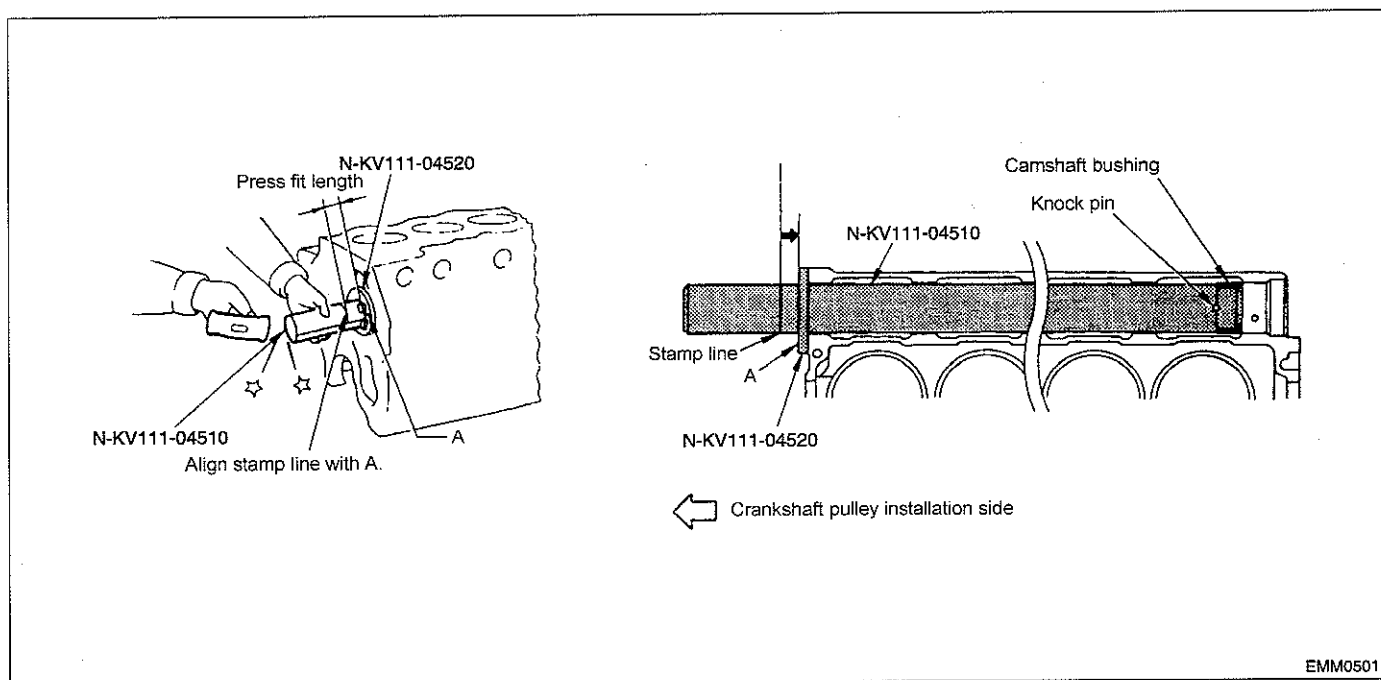
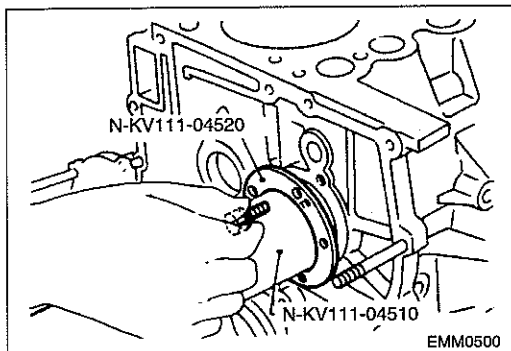


3. Install camshaft bushings (journals 7 to 2).
- Install journals 7 to 2 in the order from cylinder block front side holes.
  - Install camshaft bushings with cutout facing frontward and upward. (It is same as journal 1.)
- 
- Align camshaft bushing notches with knock pin of a bar (SST) when installing.
- 
- Secure journals 4 to 2 wrapped in tape so as not to dislocate bushings.

## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)

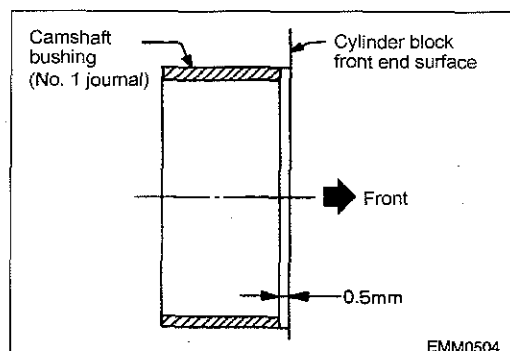
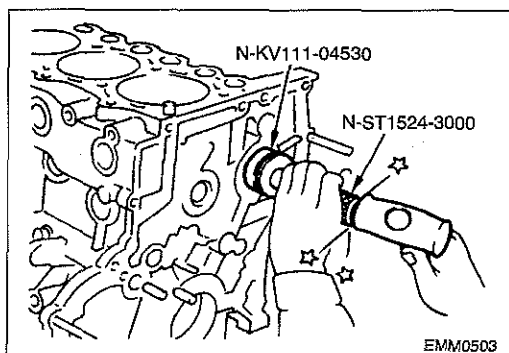
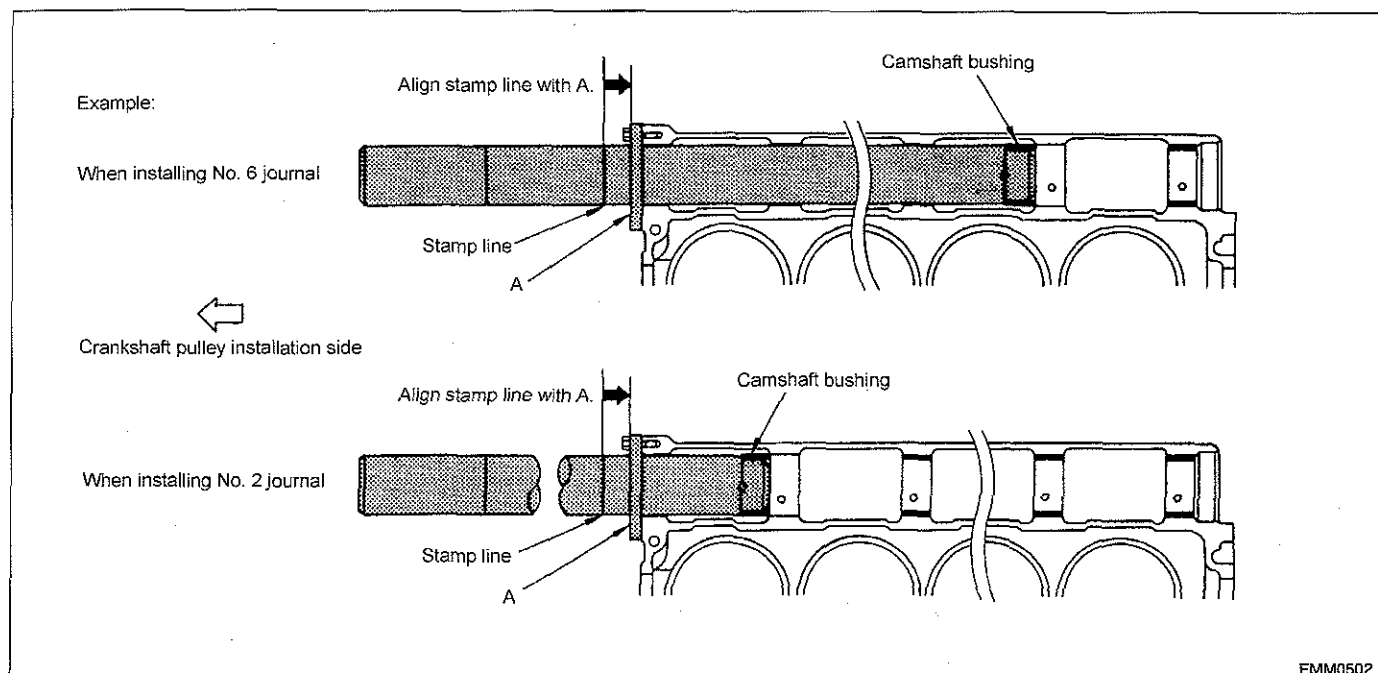
- Insert bar with bushings into cylinder block, and then install a guide plate (SST).
- Tighten bolts with "TB" mark stamped on guide plate facing up.
- Press-fit until bar matching mark (stamp line) is in the same position as guide plate edge surface A.



- Slide bar matching mark (stamp line) in order depending on journal position.

## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)

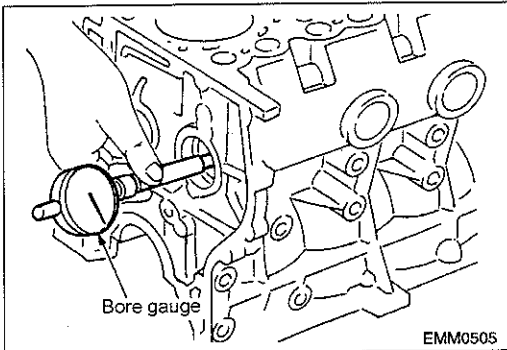


- Make sure that oil holes in each journal and cylinder block oil holes are aligned after installing each journal.
4. Install camshaft bushing (journal 1).
    - Align journal oil hole with cylinder block oil hole.
    - Press-fit until journal front end is 0.5 mm inside from cylinder block front end surface using a drift (SST).
    - Make sure that journal oil hole and cylinder block oil hole are aligned after installing journal.

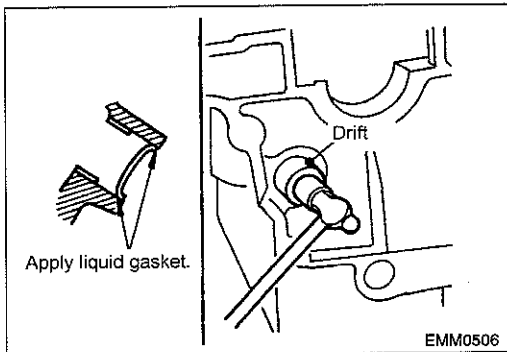
## CYLINDER BLOCK

### Inspection After Disassembly (Cont'd)

5. Check camshaft bushing inner diameter and make sure that it is within the standard.



6. Install welch plug.
  - Apply liquid gasket (Three Bond TB1303) to welch plug.
  - Press-fit using a drift (commercial service tool).



### CAMSHAFT END PLAY

- Install locating plate and camshaft gear to camshaft, and tighten bolt to the specified torque.
- Measure clearance between locating plate and camshaft front end surface using a feeler gauge.

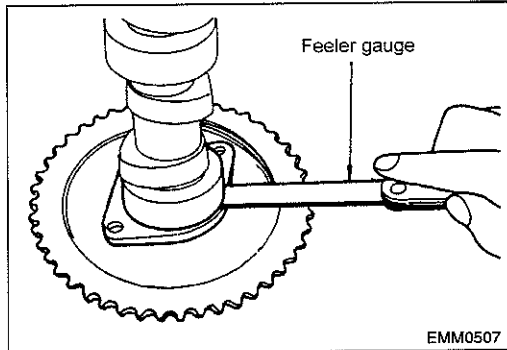
**Standard:**

**0.08 - 0.28 mm (0.0031 - 0.0110 in)**

**Repair limit:**

**0.5 mm (0.020 in)**

- Replace locating plate and measure again if outside the repair limit.
- Replace camshaft if it still exceeds the limit.

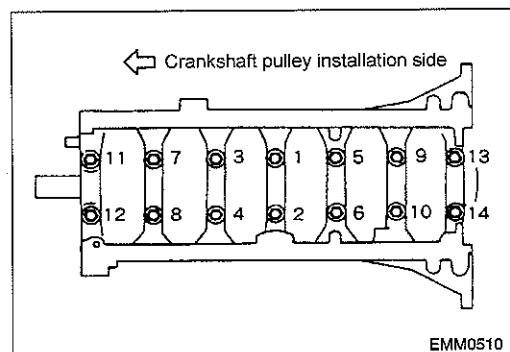
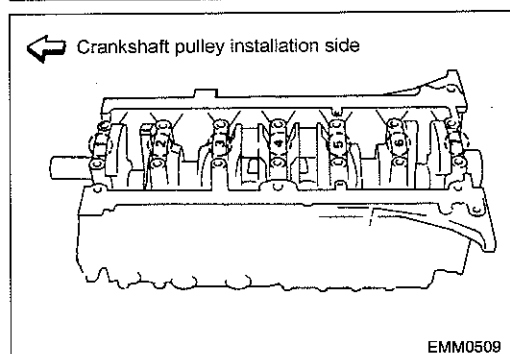
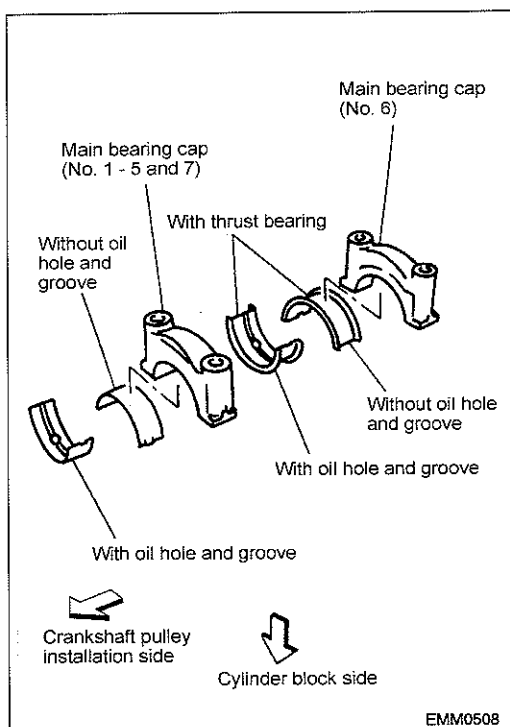


### Assembly

1. Thoroughly clean engine coolant and oil passages in cylinder block, as well as inside of crank case and cylinder bores using compressed air.

## CYLINDER BLOCK

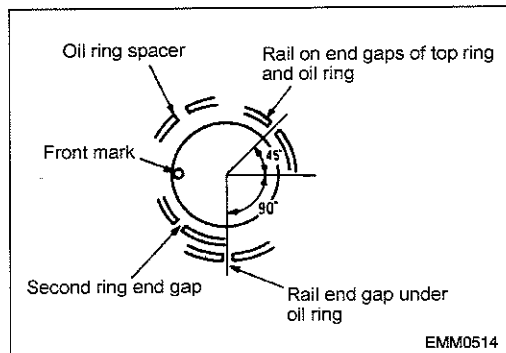
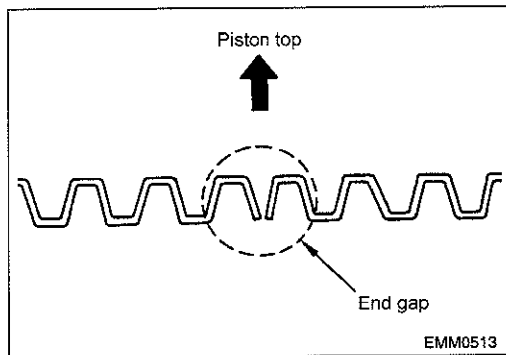
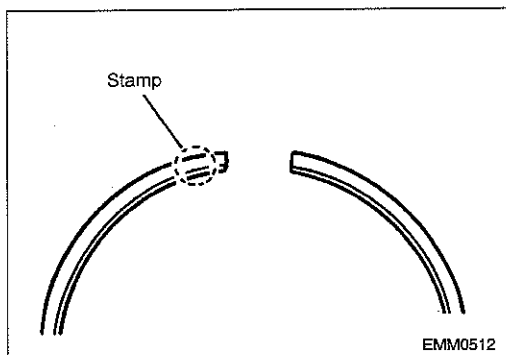
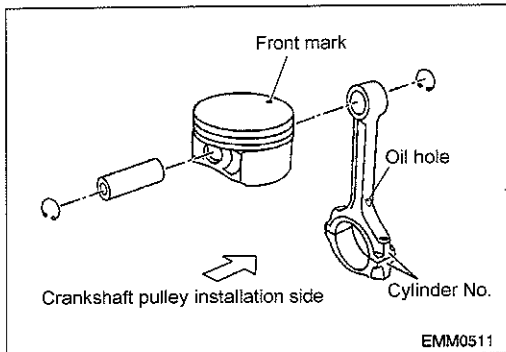
### Assembly (Cont'd)



2. Install main bearing.
  - 1) Clean bearing mounting surfaces on cylinder block and main bearing cap to remove any foreign material, dust, and oil.
  - 2) Install main bearing in the correct direction.
    - Install main bearing half with oil groove and oil hole to cylinder block, and the half without oil groove and oil hole to main bearing cap.
    - Install integrated thrust bearing to journal 6.
    - Apply engine oil to bearing surface (inside) and thrust outside when installing bearing. Do not apply engine oil to reverse side of bearing, but thoroughly clean it.
    - Install by aligning main bearing detent with the notch.
    - Make sure the oil holes in cylinder block and main bearing are aligned.
  3. Install crankshaft to cylinder block.
    - Make sure that it turns smoothly by hand.
4. Install main bearing caps.
  - Install it by aligning main bearing identification number with journal position.
  - Install so that upper identification number faces the front of engine.
  - Tap with a plastic hammer and install it.
5. Tighten main bearing cap bolts.
  - Lubricate threads and seat surface of bolt with new engine oil.
  - Tighten bolts evenly in several steps in the order shown in the figure.
  - Rotate crankshaft by hand and make sure it turns smoothly after tightening.
6. Install piston to connecting rod.
  - 1) Install snap ring in snap ring installation groove on rear side of piston using snap ring pliers.
    - Make sure snap ring is securely seated in the groove.

## CYLINDER BLOCK

### Assembly (Cont'd)



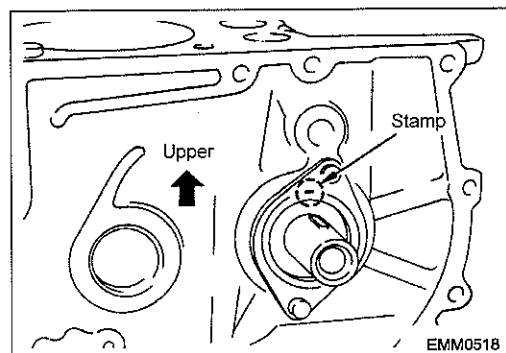
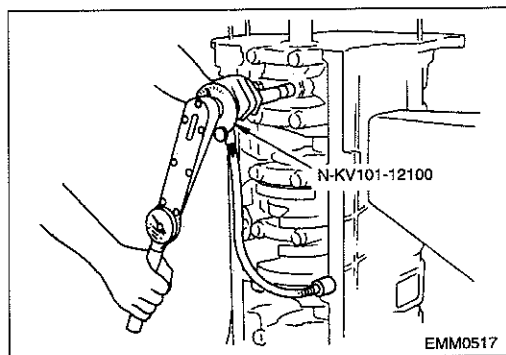
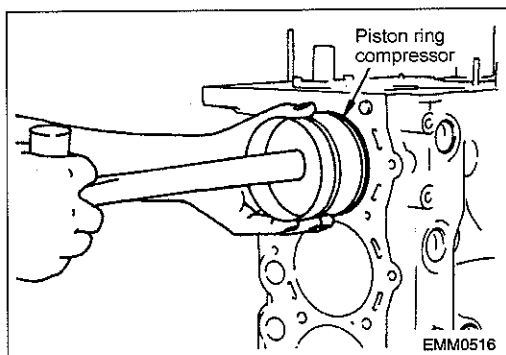
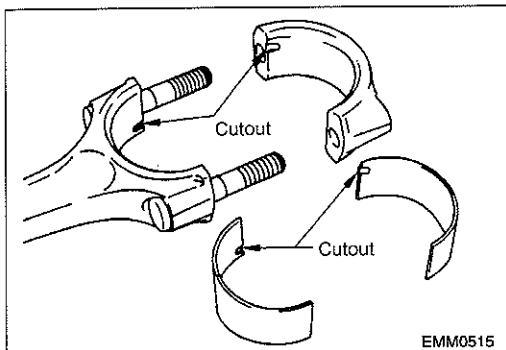
- 2) Install piston to connecting rod.
  - Heat piston [to between 60 and 70°C (140 and 178°F)] using a dryer so that piston pin can be easily inserted by hand. Insert piston pin in piston and connecting rod from front side of piston.
  - Assemble so that front mark on position head, oil hole in connecting rod, and cylinder No. stamped on connecting rod are positioned as shown in the figure.
- 3) Install snap ring onto piston front side.
  - Make sure that the connecting rod swings freely after completing work.
7. Install piston rings with piston ring expander (commercial service tool).

#### CAUTION:

- **Be careful not to damage piston.**
- Install top and second rings with stamp marks on end gaps facing up.
- Install oil ring with ring end gap as shown in the figure.
- Position end gaps of each piston ring as shown in the figure.

## CYLINDER BLOCK

### Assembly (Cont'd)



8. Install connecting rod bearing to connecting rod and connecting rod cap.

- Apply engine oil to bearing surface (inside) when installing connecting rod bearing. Do not apply engine oil to reverse side of bearing, but thoroughly clean it.
- Install connecting rod bearing by aligning the projection with detent notch on connecting rod.

9. Install piston and connecting rod assembly to crankshaft.

- Set crankshaft pin at the installation position to BDC on compression stroke.
- Apply engine oil to cylinder bore, piston, and crankshaft pin sufficiently.
- Install connecting rod to cylinder position corresponding to cylinder stamped on it.
- Install piston so that front mark on piston head faces toward crankshaft pulley mounting side using a piston ring compressor (commercial service tool).

#### CAUTION:

- **Be careful not to damage crankshaft pin with connecting rod large end by contact.**

10. Install connecting rod cap.

- Be sure that cylinder on connecting rod and connecting rod cap match.

11. Tighten connecting rod nut.

- Angle-tighten as described below.

- 1) Apply new engine oil to threads and seat surfaces of connecting rod.
- 2) Tighten to 38 - 40 N•m (3.9 - 4.1 kg-m, 28 - 30 ft-lb).
- 3) Tighten 40 to 45° using an angle wrench (SST) or a protractor.

#### CAUTION:

- **Do not just estimate tightening angle.**

#### NOTE:

- Tighten to 67 to 71 N•m (6.8 to 7.2 kg-m, 49 to 52 ft-lb) if checking tightening angle is difficult.
- 4) Rotate crankshaft and make sure it turns smoothly after all cylinders are tightened.

12. Install camshaft.

- Apply engine oil to camshaft machining surface.
- Install camshaft straightly so as not to damage bushing.

13. Install locating plate.

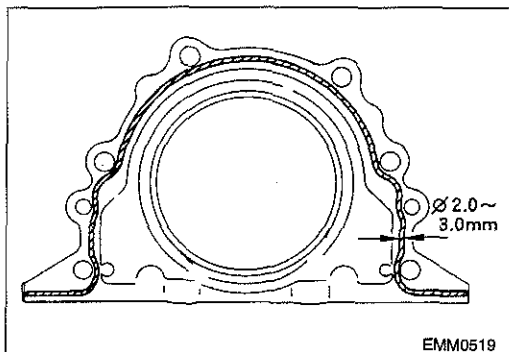
- Install locating plate with its mark (concave mark) facing up.

14. Install valve lifter.

- Apply engine oil to valve lifter.
- Install them in their original positions.

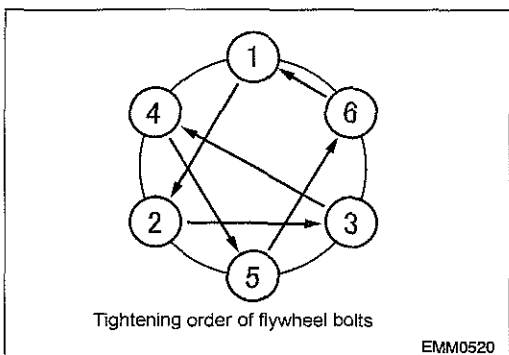
## CYLINDER BLOCK

### Assembly (Cont'd)



15. Install rear oil seal and retainer assembly.

- Apply a continuous bead of Three Bond 1207C (N-KP510-00150) to the positions shown in the figure.



16. Install flywheel housing.

17. Install flywheel.

- Secure crankshaft using a ring gear stopper (SST).
- Tighten bolts evenly in several steps in the order shown in the figure.

18. Assemble other parts in reverse order of disassembly.

# ENGINE CONTROL

## SECTION **EC**

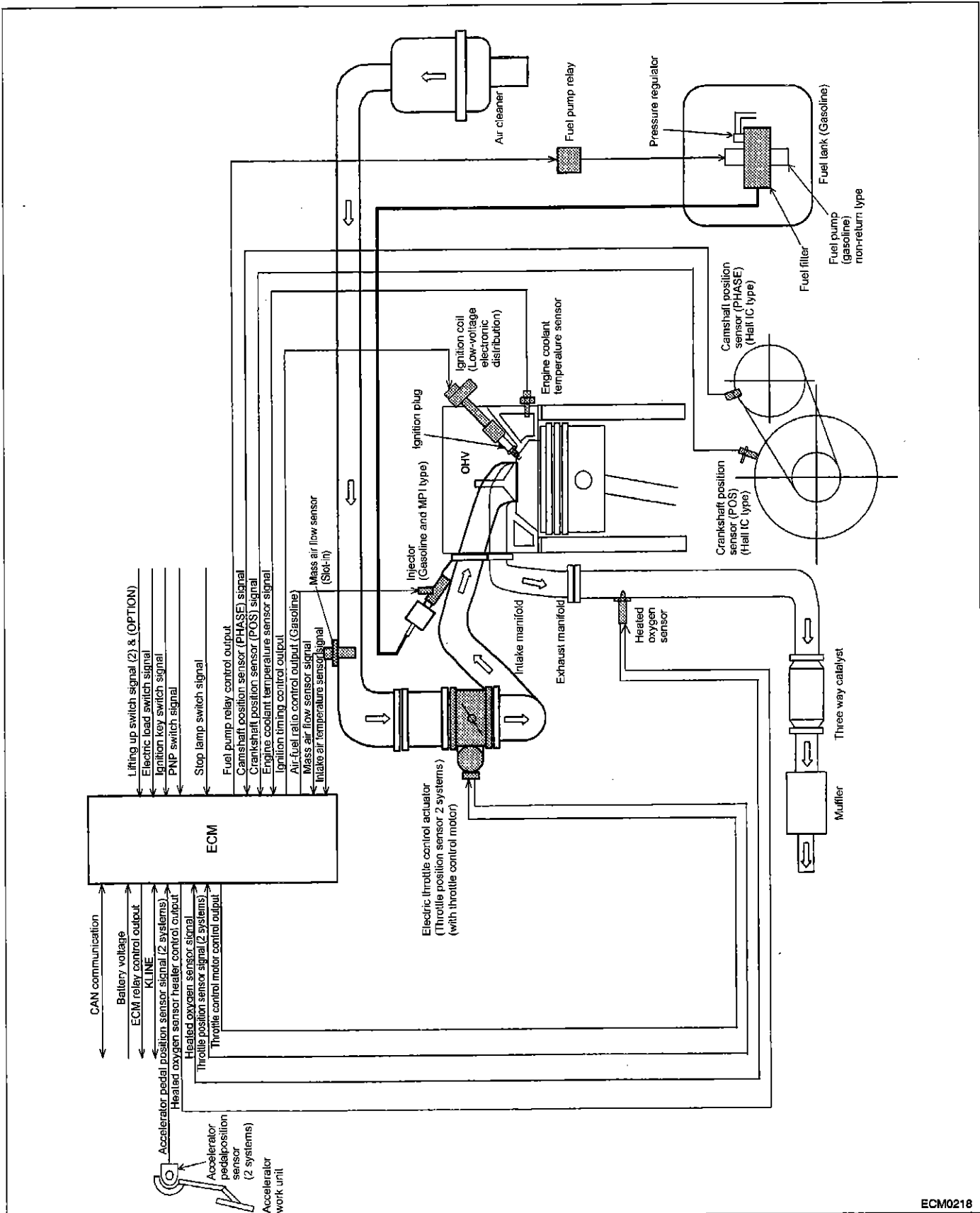
### CONTENTS

|                                                  |              |                                              |              |
|--------------------------------------------------|--------------|----------------------------------------------|--------------|
| <b>PRECAUTIONS</b> .....                         | <b>EC-3</b>  | SST Data Monitor Display .....               | EC-67        |
| General Precautions for Service Operations ..    | EC-3         | ECM Input/Output Signal Specifications ..... | EC-67        |
| <b>ENGINE CONTROL SYSTEM</b> .....               | <b>EC-4</b>  | Circuit Diagram .....                        | EC-67        |
| Description .....                                | EC-4         | Component Parts Inspection .....             | EC-67        |
| System Diagram .....                             | EC-5         | <b>ENGINE COOLANT TEMPERATURE SENSOR</b>     |              |
| Sensors and Actuators Control Items .....        | EC-8         | <b>SYSTEM</b> .....                          | <b>EC-68</b> |
| <b>BASIC INSPECTION</b> .....                    | <b>EC-9</b>  | SST data monitor display .....               | EC-68        |
| Inspection of Idle Speed, Ignition Timing, and   |              | ECM Input/Output Signal Specifications ..... | EC-68        |
| Air-Fuel Ratio .....                             | EC-9         | Circuit Diagram .....                        | EC-68        |
| Throttle Valve Closed Position Learning and      |              | Component Parts Inspection .....             | EC-68        |
| Idle Air Volume Learning .....                   | EC-11        | <b>HEATED OXYGEN SENSOR SYSTEM</b> .....     | <b>EC-69</b> |
| Fuel Pressure Inspection .....                   | EC-13        | SST Data Monitor Display .....               | EC-69        |
| <b>TROUBLE DIAGNOSIS</b> .....                   | <b>EC-15</b> | ECM Input/Output Signal Specifications ..... | EC-69        |
| How to Proceed with Trouble Diagnosis .....      | EC-15        | Circuit Diagram .....                        | EC-69        |
| Diagnosis Chart by Symptom .....                 | EC-19        | <b>VEHICLE SPEED SENSOR SYSTEM</b> .....     | <b>EC-70</b> |
| Component Parts Location .....                   | EC-29        | SST Data Monitor Display .....               | EC-70        |
| Circuit Diagram .....                            | EC-34        | ECM Input/Output Signal Specifications ..... | EC-70        |
| ECM Terminal Layout .....                        | EC-37        | <b>THROTTLE POSITION SENSOR SYSTEM</b> ..... | <b>EC-71</b> |
| ECM Input/Output Signal Specifications .....     | EC-40        | SST Data Monitor Display .....               | EC-71        |
| SST .....                                        | EC-46        | ECM Input/Output Signal Specifications ..... | EC-71        |
| Self-diagnosis Function (without SST) .....      | EC-55        | Circuit Diagram .....                        | EC-71        |
| SST Reference Value in Data Monitor .....        | EC-61        | Component Parts Inspection .....             | EC-71        |
| Fail-Safe Function .....                         | EC-63        | <b>ACCELERATOR PEDAL POSITION SENSOR</b>     |              |
| <b>POWER SUPPLY AND GROUND SYSTEM</b> .....      | <b>EC-64</b> | <b>SYSTEM</b> .....                          | <b>EC-72</b> |
| ECM Input/Output Signal Specifications .....     | EC-64        | SST Data Monitor Display .....               | EC-72        |
| Circuit Diagram .....                            | EC-64        | ECM Input/Output Signal Specifications ..... | EC-72        |
| <b>CRANKSHAFT POSITION SENSOR 1° (POS)</b> ..... | <b>EC-65</b> | Circuit Diagram .....                        | EC-72        |
| ECM Input/Output Signal Specifications .....     | EC-65        | Component Parts Inspection .....             | EC-73        |
| Circuit Diagram .....                            | EC-65        | <b>PNP SWITCH SYSTEM</b> .....               | <b>EC-74</b> |
| Component Parts Inspection .....                 | EC-65        | SST Data Monitor Display .....               | EC-74        |
| <b>CRANKSHAFT POSITION SENSOR 120° (REF)</b>     |              | ECM Input/Output Signal Specifications ..... | EC-74        |
| <b>SIGNAL CIRCUIT</b> .....                      | <b>EC-66</b> | Circuit Diagram .....                        | EC-74        |
| ECM Input/Output Signal Specifications .....     | EC-66        | Component Parts Inspection .....             | EC-74        |
| Circuit Diagram .....                            | EC-66        | <b>STOP LAMP SWITCH SYSTEM</b> .....         | <b>EC-75</b> |
| Component Parts Inspection .....                 | EC-66        | SST Data Monitor Display .....               | EC-75        |
| <b>MASS AIR FLOW SENSOR SYSTEM</b> .....         | <b>EC-67</b> | ECM Input/Output Signal Specifications ..... | EC-75        |

# ENGINE CONTROL SYSTEM

## System Diagram

1.



ECM0218

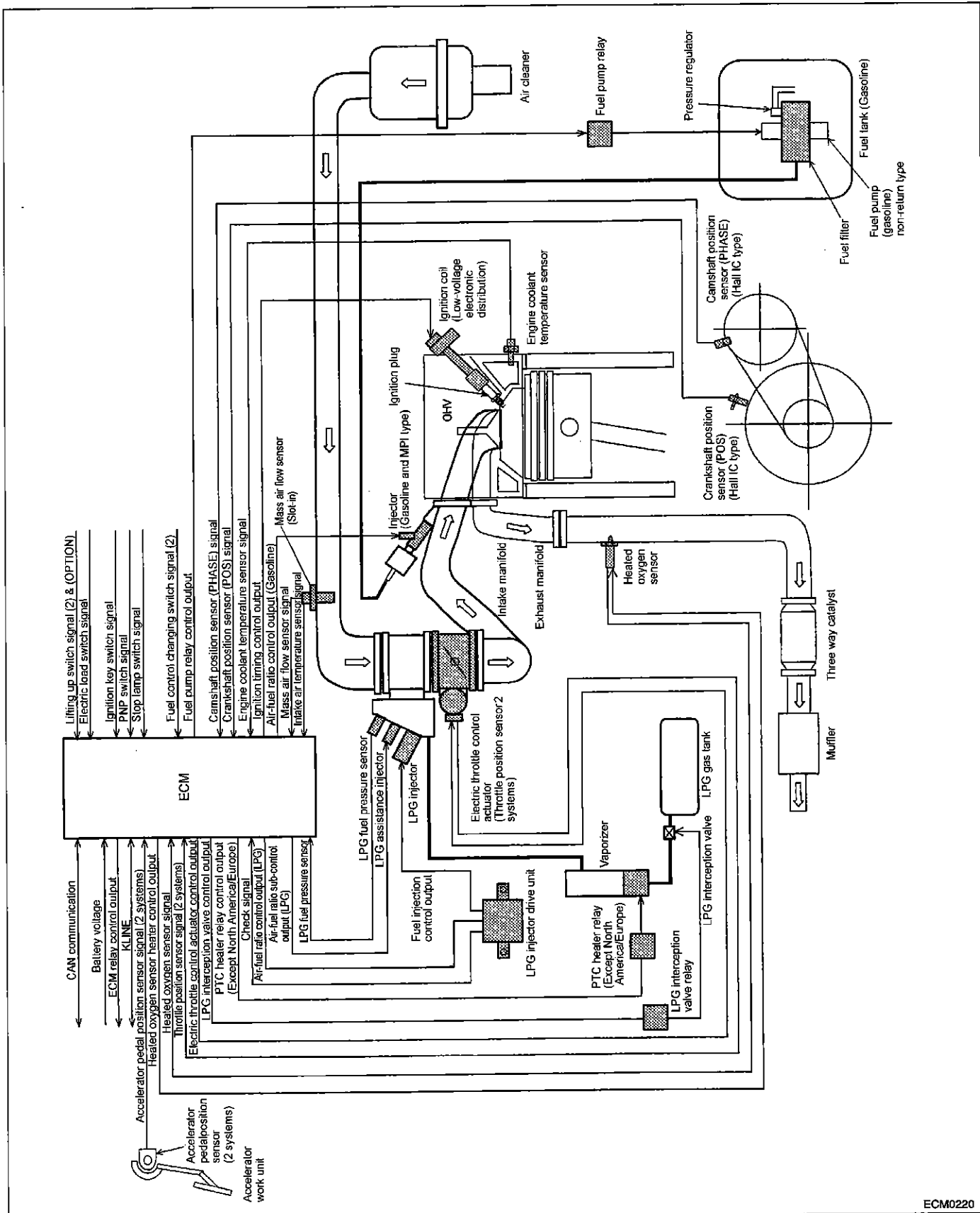
**2.**



## ENGINE CONTROL SYSTEM

## System Diagram (Cont'd)

**3.**



# ENGINE CONTROL SYSTEM

## Sensors and Actuators Control Items

Main sensors and actuators related to the ECM are listed below.

| Fuel         | Gasoline                              | std                    | std                  | std                  | std               | std                     | std                | std                          | opt                           | Combined                         | std            | std       |
|--------------|---------------------------------------|------------------------|----------------------|----------------------|-------------------|-------------------------|--------------------|------------------------------|-------------------------------|----------------------------------|----------------|-----------|
|              | LPG                                   | std                    | std                  | std                  | -                 | std                     | std                | std                          | opt                           | Combined                         | std            | std       |
| Control Item |                                       | Fuel injection control |                      |                      | Fuel pump control | Ignition timing control | Idle speed control | Maximum engine speed control | Maximum vehicle speed control | Fuel changing (Gasoline and LPG) | Self-diagnosis | Fail-safe |
|              |                                       | Fuel injection control | A/F feedback control | Fuel cut-off control |                   |                         |                    |                              |                               |                                  |                |           |
| Sensors      | Crankshaft position sensor (POS, REF) | ⊕                      | ⊕                    | ⊕                    | ⊕                 | ⊕                       | ⊕                  | ⊕                            | ⊕                             |                                  | ◆              |           |
|              | Mass air flow sensor                  | ⊕                      | ⊕                    | ◆                    |                   | ⊕                       |                    |                              |                               |                                  | ◆              | ◆         |
|              | Intake air temperature sensor         | ◆                      |                      |                      |                   |                         | ◆                  |                              |                               |                                  |                |           |
|              | Engine coolant temperature sensor     | ◆                      | ⊕                    | ◆                    |                   | ◆                       | ◆                  |                              |                               |                                  | ◆              | ◆         |
|              | Heated oxygen sensor                  |                        | ⊕                    |                      |                   |                         |                    |                              |                               |                                  | ◆              | ◆         |
|              | Vehicle speed sensor                  | ◆                      | ◆                    | ◆                    |                   |                         | ◆                  |                              | ⊕                             |                                  |                | ◆         |
|              | Throttle position sensor              | ◆                      | ◆                    | ◆                    |                   | ◆                       | ◆                  | ◆                            | ◆                             |                                  | ◆              | ◆         |
|              | Accelerator pedal position sensor     | ◆                      | ◆                    | ◆                    |                   | ◆                       | ◆                  | ◆                            | ◆                             |                                  | ◆              | ◆         |
|              | Ignition switch IGN                   | ⊕                      | ⊕                    | ⊕                    | ⊕                 | ⊕                       | ⊕                  | ⊕                            | ⊕                             |                                  |                |           |
|              | PNP switch                            | ◆                      | ◆                    | ◆                    |                   | ◆                       | ◆                  |                              |                               |                                  |                |           |
|              | Stop lamp switch                      |                        |                      |                      |                   |                         |                    |                              |                               |                                  | ◆              |           |
|              | Headlamp (electrical load) switch     |                        |                      |                      |                   |                         | ◆                  |                              |                               |                                  |                |           |
|              | Battery voltage                       | ◆                      |                      |                      |                   | ◆                       | ◆                  | ◆                            | ◆                             |                                  |                |           |
|              | LPG fuel pressure sensor              | ◆                      | ⊕                    |                      |                   |                         |                    |                              |                               |                                  | ◆              |           |
|              | LPG injector drive unit check signal  |                        |                      |                      |                   |                         |                    |                              |                               |                                  |                | ◆         |
|              | Fuel changing switch                  | ⊕                      | ⊕                    | ⊕                    | ⊕                 |                         |                    |                              |                               | ⊕                                |                |           |
|              | Gasoline injector                     | ⊕                      | ⊕                    | ⊕                    |                   |                         |                    |                              |                               |                                  |                |           |
| Actuators    | Ignition system                       | Power transistor       |                      |                      |                   | ⊕                       |                    |                              |                               |                                  | ◆              |           |
|              |                                       | Ignition coil          |                      |                      |                   | ⊕                       |                    |                              |                               |                                  |                |           |
|              | Throttle control motor relay          |                        |                      |                      |                   |                         | ⊕                  |                              |                               |                                  | ◆              |           |
|              | Throttle control motor                |                        |                      |                      |                   |                         | ⊕                  |                              |                               |                                  | ◆              | ◆         |
|              | Gasoline fuel pump relay              |                        |                      |                      | ⊕                 |                         |                    |                              |                               | ⊕                                |                |           |
|              | Gasoline fuel pump                    |                        |                      |                      | ⊕                 |                         |                    |                              |                               | ◆                                |                |           |
|              | Ignition relay                        |                        |                      |                      | ⊕                 |                         |                    |                              |                               |                                  |                |           |
|              | ECM relay                             | ⊕                      | ⊕                    | ⊕                    | ⊕                 | ⊕                       | ⊕                  | ⊕                            | ⊕                             | ⊕                                |                |           |
|              | LPG injector drive unit               | ⊕                      | ⊕                    | ⊕                    |                   |                         |                    |                              |                               |                                  |                |           |
|              | LPG injector                          | ⊕                      | ⊕                    | ⊕                    |                   |                         |                    |                              |                               |                                  | ◆              |           |
|              | LPG assistance injector               | ⊕                      | ⊕                    | ⊕                    |                   |                         |                    |                              |                               |                                  |                | ◆         |
|              | LPG interception valve relay          | ⊕                      |                      |                      |                   |                         |                    |                              |                               | ⊕                                |                | ◆         |
|              | LPG interception valve                | ⊕                      |                      |                      |                   |                         |                    |                              |                               | ◆                                |                |           |

⊕ : Significant Impact to control

◆ : Impact to control

## BASIC INSPECTION

### Inspection of Idle Speed, Ignition Timing, and Air-Fuel Ratio

#### STANDARD AT IDLE

|                               |              |
|-------------------------------|--------------|
| Idle speed [N position] (rpm) | 650±50       |
| Ignition timing (BTDC/rpm)    | 10±2/650     |
| CO density (%)                | 00.1 or less |
| HC density(ppm)               | 50 or less   |

#### CAUTION:

- Perform "Idle Air Volume Learning" (EC section) when idle speed or ignition timing is outside the standard.
- Turn ignition switch ON, and then make sure that no malfunction is detected by self-diagnosis.
- Make sure that engine is free of oil pressure pump loads and any electrical loads. Perform the inspection with the shift lever in the N position.
- Warm up engine and transaxle to the normal operating temperature.

#### IDLE SPEED

##### WITH SST

1. Connect SST to vehicle side data link connector.
2. Select "ENG SPEED" in "DATA MONITOR" mode. Make sure that the idle speed is 650±50 rpm.

#### CAUTION:

- Perform "Idle Air Volume Learning" (EC section) when idle speed is outside the standard.

##### WITHOUT SST

1. Connect an adapter harness for molded coils (SST) between the distributor harness connectors, and install a tachometer.
2. Make sure that idle speed is 650±50 rpm.

#### CAUTION:

- Perform "Idle Air Volume Learning" (EC section) when Idle speed is outside the standard.

#### CO/HC DENSITY INSPECTION

The vehicle uses an air-fuel ratio feedback system with a self-learning function. Because a wide compensation range is available, no additional CO/HC density adjustment is necessary.

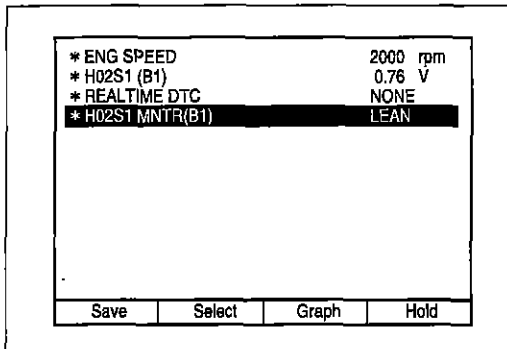
- Warm up engine to normal operating temperature. Confirm idle speed and ignition timing are within the standards. Then, check CO/HC density with a CO/HC measuring device.
- Check condition of air-fuel ratio feedback with the following steps when measured values are outside the standard:

## BASIC INSPECTION

### Inspection of Idle Speed, Ignition Timing, and Air-Fuel Ratio (Cont'd)

#### WITH SST

1. Select "HO2S1 MNTR (B1)" in "DATA MONITOR" mode.
2. Keep engine speed at approximately 2,000 rpm, and make sure that "RICH" and "LEAN" are alternately displayed.

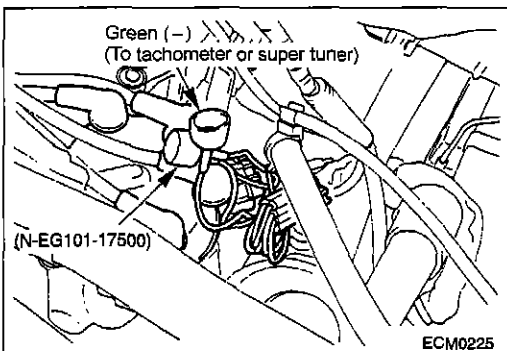


#### WITHOUT SST

1. Inspect using heated oxygen sensor monitor mode. (Refer to EC section, "DIAGNOSTIC TEST MODE II ? HEATED OXYGEN SENSOR MONITOR" for operation procedure.)
2. Keep engine speed at approximately 2,000 rpm, and make sure that MIL blinks at least 5 times within 10 seconds.

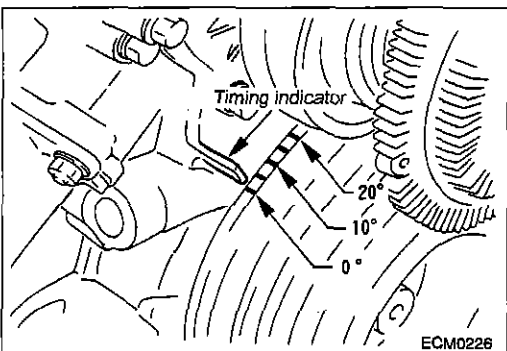
#### NOTE:

- Increase engine speed when inspecting while air-fuel ratio feedback control is activated during idle.



### INSPECTION AND ADJUSTMENT OF IGNITION TIMING

- Connect a timing light (super tuner, etc.) to receive a signal from the ignition primary system using an adapter harness for molded coils (SST).  
(Attach pickup to the 1 high-tension cable for general timing lights.)



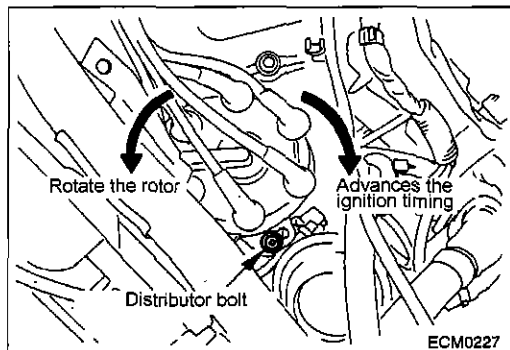
-  • Perform "AAC Valve Adjustment" in WORK SUPPORT mode.

-  • Remove harness connector from throttle position sensor.

(The operation above stops idle speed and ignition timing feedback control.)

- Make sure that ignition timing and base idle speed is BTDC 10° ±2°/650 rpm.

## BASIC INSPECTION



### Inspection of Idle Speed, Ignition Timing, and Air-Fuel Ratio (Cont'd)

- Perform adjustment following the procedures described below if ignition timing is outside the standard.
- Loosen distributor bolts, and rotate the distributor so that the ignition timing meets BTDC  $10^{\circ} \pm 2^{\circ}$  / 650 rpm.
- Clockwise rotation of the distributor advances the ignition timing.



- Cancel "AAC Valve Adjustment" in WORK SUPPORT mode.



- Connect throttle position sensor harness connector.

- Make sure that ignition timing advances synchronously when racing the engine.

### Throttle Valve Closed Position Learning and Idle Air Volume Learning

#### DESCRIPTION

When electric throttle control actuator or ECM connector is removed, it is necessary for ECM to learn throttle valve closed position (throttle position sensor output with throttle valve fully closed) after reinstallation. Thus, throttle valve closed position learning is performed.

When electric throttle control actuator or ECM is replaced, the minimum required idle air volume needs to be learned. Thus, throttle valve closed position learning and idle air volume learning are performed.

Idle air volume learning is necessary even when idle speed or ignition timing is outside the standard. Note that idle air volume learning is equivalent to the base idle speed adjustment by conventional throttle adjusting screw of carburetor or LPG mixer.

#### OPERATION PROCEDURE FOR THROTTLE VALVE CLOSED POSITION LEARNING

1. Turn ignition switch ON → OFF. (And hold it for approximately 5 seconds after turning it OFF.)
2. Make sure that throttle valve operates. (Check for operating sound.)
3. Upon completion of above, learning is complete.

#### CAUTION:

- Throttle valve closed position learning cannot be performed with SST.

## BASIC INSPECTION

### Throttle Valve Closed Position Learning and Idle Air Volume Learning (Cont'd)

#### OPERATION PROCEDURE FOR IDLE AIR VOLUME LEARNING

1. Perform throttle valve closed position learning.
2. Fully warm up engine and transaxle. [Engine coolant temperature: 70 - 99°C (158 - 194°F)]
3. Make sure that engine is free of oil pressure load and any electrical loads with the shift lever in the N position.
4. Execute the following contents while idling using SST.
  - 1) Touch "START" on "IDLE AIR VOL LEARN (NORMAL)" in WORK SUPPORT.

#### CAUTION:

- "IDLE AIR VOL LEARN (PLANT)" is the original setting on the vehicle. Do not use it.

- 2) When learning is completed, "CMPLT" is displayed.

#### CAUTION:

- It will take approximately 20 seconds to complete the idle air volume learning. Do not turn OFF the ignition switch until completion.

- 3) Make sure that the learning has been completed by checking the "IDL A/V LEARN" screen in DATA MONITOR mode.

Learning completed : CMPLT  
Learning not yet completed : YET
- 4) Make sure that idle speed and ignition timing are within the standard.
- 5) Perform "Idle Air Volume Learning" again if values are outside the standard.

### ACCELERATOR PEDAL RELEASED POSITION LEARNING

#### DESCRIPTION

When the accelerator pedal assembly has been replaced or the accelerator pedal position sensor connector has been disconnected, the accelerator pedal released position needs to be learned after being repaired, so learn accelerator pedal in fully-released position.

#### OPERATION PROCEDURE

- 1) Turn ignition switch ON and wait at least 2 seconds.
- 2) Turn ignition switch OFF and wait at least 10 seconds.
- 3) Then turn ignition switch ON again and wait at least 2 seconds (learning completed).

## BASIC INSPECTION

---

### Fuel Pressure Inspection

#### QUICK INSPECTION

##### WITH SST

1. Turn ignition switch ON (engine stopped).
2. Press "ON" or "ON/OFF" of "FUEL PUMP RELAY" on the ACTIVE TEST screen.
3. Pinch the fuel feed hose with fingers. Hose should feel hard and pulsating.

##### WITHOUT SST

- When the fuel feed hose is squeezed while fuel pump is operating (immediately after the ignition switch is turned ON or while cranking), the hose should be swelling with pressure or pulsating.

#### FUEL PRESSURE RELEASE

##### CAUTION:

- Relieve fuel pressure before removing fuel piping to secure safety.

##### WITH SST

1. Start engine.
2. Select "FUEL PRESSURE RELEASE, and touch "START" in WORK SUPPORT.
3. Crank engine 2 or 3 times to consume the fuel in the fuel line after it stalls.
4. Turn ignition switch OFF.

##### WITHOUT SST

1. Disconnect fuel pump fuse.
2. Start engine.
3. Crank engine 2 or 3 times to consume the fuel in the fuel line after it stalls.
4. Turn OFF the ignition switch, and install the fuel pump fuse.

#### FUEL PRESSURE INSPECTION

##### CAUTION:

- Safely and securely remove and install fuel hose referring to (??), "Removal and Installation".
- Use the fuel pressure gauge for fuel pressure inspection.
- Do not inspect fuel pressure while other systems are operating. Malfunctions may occur in fuel pressure value.

## BASIC INSPECTION

---

### Fuel Pressure Inspection (Cont'd)

1. Release the fuel pressure.
2. Install fuel pressure gauge using fuel hose for fuel pressure inspection.
3. Remove fuel hose, and then install fuel hose for fuel pressure inspection.

#### CAUTION:

- **Usable period of fuel hose for fuel pressure inspection is 30 times or less. (Fuel hoses that are damaged and allow fuel leakage are not contained above.)**

4. Turn ignition switch ON, and then make sure that there is no fuel leakage.
5. Start engine, and check for fuel leakage.
6. Make sure that fuel pressure is within the standard.

#### At idle:

**353 kPa (3.53 bar, 3.6 kg/cm<sup>2</sup>, 51 psi)**

- If the vehicle shows poor starting, check fuel pressure with fuel pump operating for approximately 1 second after ignition switch is turned ON, and during cranking.

#### For 1 second after ignition switch is turned ON and during cranking:

**353 kPa (3.53 bar, 3.6 kg/cm<sup>2</sup>, 51 psi)**

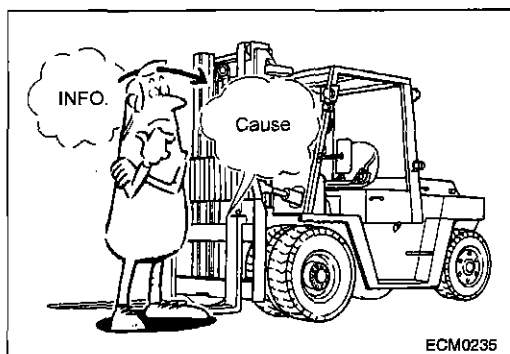
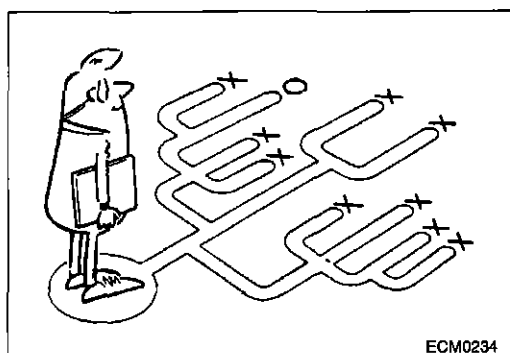
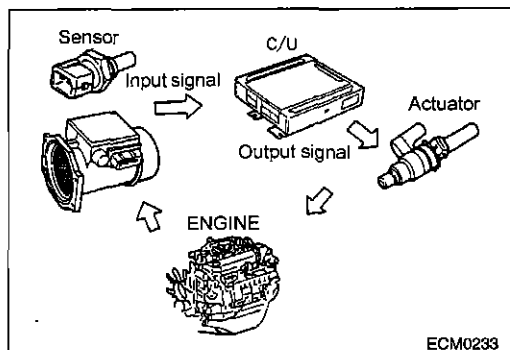
- Check the following items if a malfunction is detected.

#### CAUTION:

- **Also check fuel pressure at increased engine speed.**
  - Malfunctioning pressure regulator (integrated with fuel pump)
  - Clogged fuel piping
  - Clogged fuel filter
  - Poor fuel pump discharge

## TROUBLE DIAGNOSIS

### How to Proceed with Trouble Diagnosis



1. The most important point in performing trouble diagnosis of malfunctions is to thoroughly understand the vehicle systems (both control and mechanical).  
An ECM-based engine controls actuators such as injectors and the ignition coil according to information from sensors. Then through actuator operation, the engine (mechanical system) runs. Sensors transmit information on the running condition, which changes constantly, to ECM. It is important to understand these cycles.

2. It is also important to clarify customer concerns before starting the inspection. First of all, reproduce the symptom, and understand it fully. Ask the customer about his/her complaints carefully. In some cases, it will be necessary to check the symptoms by driving the vehicle with the customer.

#### CAUTION:

- **Customers are not professionals. Do not assume "maybe the customer means ..." or "maybe the customer mentioned this symptom".**

3. It is essential to confirm symptoms right from the beginning in order to ensure all malfunctions are completely repaired.  
For an intermittent malfunction, it is important to reproduce the symptom based on an interview with the customer and past examples. Do not perform an inspection on an ad hoc basis. Most intermittent malfunctions are caused by poor contacts. In this case, it will be effective to shake the suspected harness or connector by hand. When repairs are performed without any symptom check, no one can judge if the malfunction has actually been eliminated.
4. The next important thing is to find which system among the following is causing the malfunction: ECCS control signal system, or a mechanical system (such as the engine main body and auxiliary component). It is important to inspect the system using SST or by checking the ECM input/output signals. When checking the ECM input/output signals, connect a check adapter (SST) to ECM in order to prevent misdiagnosis.

#### Special Service Tools (SST):

Check adapter V (N-EG175-30000)

(for SMJ 150-pin connector)

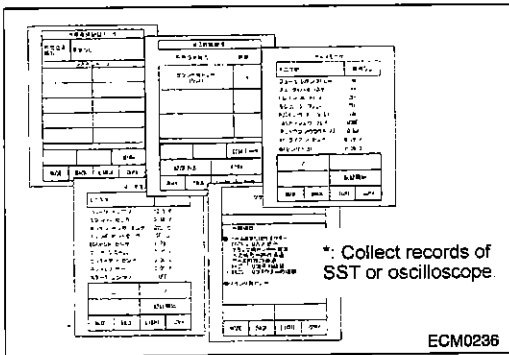
Harness adapter (N-EG175-50200)

(150-pin → 121-pin conversion adapter)

## TROUBLE DIAGNOSIS

### How to Proceed with Trouble Diagnosis (Cont'd)

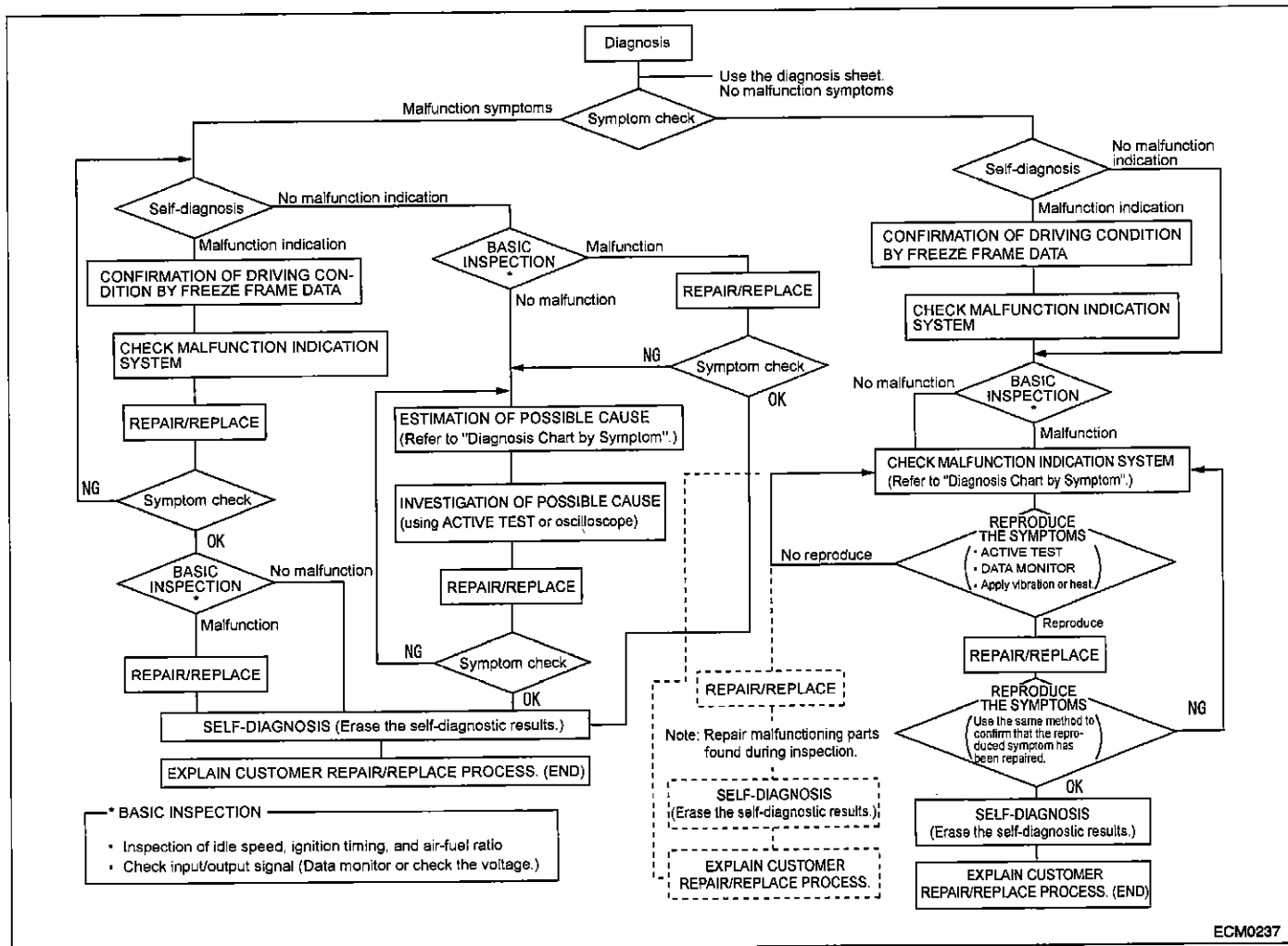
5. Use the reference value of input/output data (guideline) in this manual in order to judge the ECM input/output signals. Measure the data of another vehicle of the same model under the same conditions when it is difficult to judge, and compare the data. It is advisable to collect sufficient data of a normally operating vehicle.



### TROUBLE DIAGNOSIS FLOW CHART

There are many different malfunction symptoms. So there is no perfect trouble diagnosis technique applicable to all malfunctions. Experience is also important to achieving an accurate trouble diagnosis.

Nonetheless, an accurate trouble diagnosis can be performed by applying similar procedures, regardless of the malfunction symptom. Perform trouble diagnosis following the flow chart shown below.



## TROUBLE DIAGNOSIS

### How to Proceed with Trouble Diagnosis (Cont'd)

#### DIAGNOSTIC WORK SHEET

##### DESCRIPTION

- *In order to clarify the malfunction symptom, it is important to ask the customer and collect information about their concerns.*
- Ask the customer about what symptoms are present under what conditions. Use the information to clarify the symptom.
- Use the trouble diagnosis sheet to be certain not to miss any vital information.

| Question point                                      |
|-----------------------------------------------------|
| • WHAT ..... Vehicle & engine model                 |
| • WHEN ..... Date, Frequencies                      |
| • WHERE ..... Road conditions                       |
| • HOW .... Operating conditions, Weather conditions |
| • WHAT BECAME ..... Symptom                         |

ECM0238

# TROUBLE DIAGNOSIS

## How to Proceed with Trouble Diagnosis (Cont'd)

### Trouble Diagnosis Information Memo

## Trouble Diagnosis Information Memo

|                 |     |
|-----------------|-----|
| Memo serial No. |     |
| Date            | No. |

|               |  |
|---------------|--|
| Issue of memo |  |
|               |  |

|                    |      |                             |                |            |                   |             |                       |                                                                                                                                                                                                                                 |                                                                     |                                                             |                        |                                                             |
|--------------------|------|-----------------------------|----------------|------------|-------------------|-------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------|------------------------|-------------------------------------------------------------|
| Date of occurrence |      | Weather                     |                | Location   |                   | Operator    |                       |                                                                                                                                                                                                                                 |                                                                     |                                                             |                        |                                                             |
| Vehicle type       |      | Model class (in-house code) | Vehicle ID No. | Model year | Travel time (hr.) | Engine type | No. stamped on engine | Fuel                                                                                                                                                                                                                            | Transmission                                                        | Heater                                                      | Oil pump capacity (cc) | A/C                                                         |
| Vehicle model      | Type |                             |                |            |                   |             |                       | <input type="checkbox"/> Gasoline<br><input type="checkbox"/> LPG<br><input type="checkbox"/> Propane<br><input type="checkbox"/> Fuel ratio<br><input type="checkbox"/> Fuel supplier<br><input type="checkbox"/> Combined use | <input type="checkbox"/> M/T (gear)<br><input type="checkbox"/> A/T | <input type="checkbox"/> Yes<br><input type="checkbox"/> No |                        | <input type="checkbox"/> Yes<br><input type="checkbox"/> No |

|                                  |                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
|----------------------------------|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------------------------------------------------------------------------|------------------|------------------------------------------------------------------------------------------------------------------|---|-------------------------------------------------|---------------------|-------------------------------------------------------------|--|-------------|---|--|---------------------------|---|--|--------------------|--|
| Trouble diagnosis condition item |                           | Description (Enter a check mark, value, or comment in the dashed or solid-line box for the applicable item.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| Symptom                          | 1                         | Poor starting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <input type="checkbox"/> Cranking not possible<br><input type="checkbox"/> Does not start at all.                                  |                          | <input type="checkbox"/> No initial combustion<br><input type="checkbox"/> Inconsistent |                  | <input type="checkbox"/> Does not start smoothly.<br><input type="checkbox"/> Hunting (steady speed fluctuation) |   | <input type="checkbox"/> Does not start at all. |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
|                                  | 2                         | Poor idle                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <input type="checkbox"/> Occurs without a symptom.<br><input type="checkbox"/> Occurs after engine stumbles.                       |                          | <input type="checkbox"/> Stalls but restarts quickly                                    |                  | <input type="checkbox"/> Occurs when steering.                                                                   |   | <input type="checkbox"/> Occurs when loading.   |                     | <input type="checkbox"/> Occurs after cold start.           |  |             |   |  |                           |   |  |                    |  |
|                                  | 3                         | Engine stall                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <input type="checkbox"/> Poor hill-climbing ability<br><input type="checkbox"/> Inappropriate lifting speed during lifting control |                          | <input type="checkbox"/> Insufficient speed                                             |                  | <input type="checkbox"/> Loading not possible                                                                    |   | <input type="checkbox"/> Governor hunting       |                     | <input type="checkbox"/> Loading slow, difficult to operate |  |             |   |  |                           |   |  |                    |  |
|                                  | 4                         | Poor power output                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
|                                  | 5                         | Poor acceleration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
|                                  | 6                         | Hesitation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
|                                  | 7                         | Surge (vibration in fwd and bwd direction)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
|                                  | 8                         | Knocking (pinging sound)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
|                                  | 9                         | Backfire (blowback noise)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
|                                  | 10                        | After-burn (exhaust detonation)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| 11                               | Poor fuel economy         | (LPG hr./tank)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    | 12                       |                                                                                         | Poor oil economy | (hr./L)                                                                                                          |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| 13                               | Overheat                  | <input type="checkbox"/> Not overheated, but engine coolant temperature gauge indicates high.<br><input type="checkbox"/> Overheated                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| 14                               | Coolant/oil leakage       | Location:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| 15                               | Noise                     | Location:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| 16                               | Warning lamp illumination | <input type="checkbox"/> No<br><input type="checkbox"/> Yes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| First occurrence                 |                           | <input type="checkbox"/> With new vehicle<br><input type="checkbox"/> Recently Approx. date:<br><input type="checkbox"/> After brought back for servicing Approx. date:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| Frequency of occurrence          |                           | <input type="checkbox"/> At all times<br><input type="checkbox"/> Under certain conditions<br><input type="checkbox"/> Sometimes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| Conditions of vehicle            | Temperature condition     | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                    | Temperature (°deg.C)     | 2                                                                                       |                  | Humidity (%)                                                                                                     | 3 |                                                 | Coolant temp.       | 4                                                           |  | Cold engine | 5 |  | When engine is warming up | 6 |  | High coolant temp. |  |
|                                  |                           | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                    | Engine compartment temp. | °C                                                                                      |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
|                                  | Operating condition, etc. | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                    | Irrelevant               | 2                                                                                       |                  | At idle                                                                                                          | 3 |                                                 | With engine racing  |                                                             |  |             |   |  |                           |   |  |                    |  |
|                                  |                           | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                    | During acceleration      | 5                                                                                       |                  | At constant speed                                                                                                | 6 |                                                 | During deceleration |                                                             |  |             |   |  |                           |   |  |                    |  |
| 7                                |                           | When going up a hill                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| 8                                |                           | When loading                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| 9                                |                           | Unladen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Capacity                                                                                                                           |                          | kg. lbs.                                                                                |                  | Tilting                                                                                                          |   | Lifting                                         |                     | Steering                                                    |  |             |   |  |                           |   |  |                    |  |
| 10                               |                           | Laden                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Capacity                                                                                                                           |                          | kg. lbs.                                                                                |                  | Tilting                                                                                                          |   | Lifting                                         |                     | Steering                                                    |  |             |   |  |                           |   |  |                    |  |
| 11                               |                           | Other                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Inching/braking                                                                                                                    |                          | Steering                                                                                |                  | Other                                                                                                            |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| Attachment                       |                           | 1 Standard  2 Side shifter  3 Hinged fork  4 Bale clamp <br>5 Roll clamp  6 Rotating fork  7 Stabilizer  8 Other  |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |
| Other; Enter comments, etc.      |                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                    |                          |                                                                                         |                  |                                                                                                                  |   |                                                 |                     |                                                             |  |             |   |  |                           |   |  |                    |  |

ECM0037

# TROUBLE DIAGNOSIS

## Diagnosis Chart by Symptom

### TB45 ENGINE RELATIONSHIP BETWEEN MALFUNCTIONING SYMPTOMS AND THE SENSOR CIRCUIT

- The table below shows the possible symptoms caused by the malfunction of each sensor circuit.

| Symptoms                                                    |        | Im-possible to start                    | Im-possible to start | Poor idle           |                           | Poor driving control       |               |              |                                        |                                   |                   |                   | Engine stall                           |                               | Other                                 |          | Check that symptoms are detected with self-diagnosis. | Check that symptoms are in fail-safe condition. | Description/notable characteristics of the symptom |          |            |         |         |                     |                     |                                                                                                                                             |                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                      |
|-------------------------------------------------------------|--------|-----------------------------------------|----------------------|---------------------|---------------------------|----------------------------|---------------|--------------|----------------------------------------|-----------------------------------|-------------------|-------------------|----------------------------------------|-------------------------------|---------------------------------------|----------|-------------------------------------------------------|-------------------------------------------------|----------------------------------------------------|----------|------------|---------|---------|---------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                             |        | No initial combustion                   | Initial combustion   | When engine is cold | When engine is warming up | Fast idle is not effective | High idle rpm | Low idle rpm | Inconsistent idle when engine is cold. | Inconsistent idle when warming up | Poor power output | Poor acceleration | Engine rpm does not increase smoothly. | During surge and acceleration | During surge and constant speed drive | Knocking |                                                       |                                                 |                                                    | Backfire | After-burn | At idle | Driving | During deceleration | During a heavy load | Overheat                                                                                                                                    | Poor fuel                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                      |
| Actuator malfunction<br>⊕ : Highly possible<br>◆ : Possible |        | Crankshaft position sensor (POS, PHASE) | OPEN                 | ⊕                   |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |                                                       |                                                 | ⊕                                                  | ⊕        | ⊕          | ⊕       |         |                     |                     | ◆                                                                                                                                           | <ul style="list-style-type: none"><li>• An open circuit in either POS or PHASE signal makes it impossible for the vehicle to start.</li><li>• Control signals for fuel system and ignition system are not output.</li></ul> |                                                                                                                                                                                                                                                      |
|                                                             |        |                                         | Momentarily open     |                     |                           | ◆                          | ◆             |              |                                        | ◆                                 | ◆                 |                   | ◆                                      | ◆                             | ◆                                     | ◆        |                                                       |                                                 |                                                    | ⊕        | ◆          | ◆       | ◆       |                     |                     |                                                                                                                                             | ◆                                                                                                                                                                                                                           | <ul style="list-style-type: none"><li>• The symptom depends on the duration of momentarily open circuit and the operating conditions. Slight shocks and surges may be sensed during driving, while engine stall may be caused during idle.</li></ul> |
| Mass air flow sensor                                        | Signal | OPEN                                    |                      | ◆                   | ◆                         |                            | ⊕             |              | ◆                                      | ◆                                 | ◆                 | ◆                 | ◆                                      | ◆                             |                                       |          |                                                       |                                                 |                                                    |          |            |         | ◆       | ◆                   | ◆                   | <ul style="list-style-type: none"><li>• It will be fail-safe condition, and vehicle runs at an engine speed of 2,400 rpm or less.</li></ul> |                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                      |
|                                                             |        |                                         | High output          |                     |                           | ◆                          | ◆             |              |                                        | ◆                                 | ◆                 | ◆                 | ◆                                      | ◆                             | ◆                                     |          |                                                       |                                                 |                                                    | ◆        | ◆          | ◆       | ◆       |                     | ◆                   | ◆                                                                                                                                           | ◆                                                                                                                                                                                                                           | <ul style="list-style-type: none"><li>• The air-fuel ratio becomes rich. Black smoke may accompany. Poor connection of grounding may be a possible cause.</li></ul>                                                                                  |
|                                                             |        |                                         | Low output           |                     |                           | ◆                          | ◆             |              |                                        | ◆                                 | ◆                 | ◆                 | ◆                                      | ◆                             | ◆                                     | ◆        | ◆                                                     |                                                 |                                                    | ◆        | ◆          | ◆       | ◆       |                     | ◆                   | ◆                                                                                                                                           | ◆                                                                                                                                                                                                                           | <ul style="list-style-type: none"><li>• The air-fuel ratio becomes lean. Contaminated hot wire or suction of air may be suspected.</li></ul>                                                                                                         |
|                                                             | Ground | OPEN                                    | ⊕                    |                     |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |                                                       |                                                 | ⊕                                                  | ⊕        | ⊕          | ⊕       |         | ◆                   |                     |                                                                                                                                             | <ul style="list-style-type: none"><li>• It will be over-rich.</li></ul>                                                                                                                                                     |                                                                                                                                                                                                                                                      |
|                                                             |        | Power supply                            | OPEN                 |                     | ◆                         | ◆                          |               | ⊕            |                                        | ◆                                 | ◆                 | ◆                 | ◆                                      | ◆                             | ◆                                     |          |                                                       |                                                 |                                                    |          |            |         | ◆       |                     |                     |                                                                                                                                             |                                                                                                                                                                                                                             | <ul style="list-style-type: none"><li>• It will be fail-safe condition, and vehicle runs at an engine speed of 2,400 rpm or less.</li></ul>                                                                                                          |
| Intake air temperature sensor                               |        | OPEN/SHORT                              |                      |                     |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |                                                       |                                                 |                                                    |          |            |         |         | ◆                   | ◆                   |                                                                                                                                             |                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                      |
| Engine coolant temperature sensor                           |        | OPEN/SHORT                              |                      | ◆                   | ◆                         | ◆                          |               | ◆            | ◆                                      | ◆                                 | ◆                 | ◆                 | ◆                                      | ◆                             | ◆                                     |          |                                                       |                                                 |                                                    |          |            |         |         | ◆                   | ◆                   | ◆                                                                                                                                           | <ul style="list-style-type: none"><li>• It will be fail-safe condition, and then MIL turns ON. This malfunction tends to occur when engine is cold or when the engine coolant temperature is high.</li></ul>                |                                                                                                                                                                                                                                                      |
|                                                             |        |                                         | Resistance is large. |                     | ◆                         | ◆                          | ◆             |              | ◆                                      |                                   |                   | ◆                 | ◆                                      | ◆                             | ◆                                     | ◆        |                                                       |                                                 |                                                    | ◆        | ◆          | ◆       | ◆       | ◆                   |                     | ◆                                                                                                                                           |                                                                                                                                                                                                                             | <ul style="list-style-type: none"><li>• The engine coolant temperature is judged as low. This malfunction tends to occur after warming up.</li></ul>                                                                                                 |
|                                                             |        |                                         | Resistance is small. |                     | ◆                         | ◆                          | ◆             | ◆            | ◆                                      | ◆                                 |                   | ◆                 | ◆                                      | ◆                             | ◆                                     | ◆        | ◆                                                     | ◆                                               | ◆                                                  | ◆        | ◆          | ◆       | ◆       |                     | ◆                   | ◆                                                                                                                                           |                                                                                                                                                                                                                             | <ul style="list-style-type: none"><li>• The engine coolant temperature is judged as high. This malfunction tends to occur when engine is cold.</li></ul>                                                                                             |
| Heated oxygen sensor                                        |        | OPEN/SHORT                              |                      |                     |                           |                            |               |              | ◆                                      | ◆                                 | ◆                 |                   |                                        |                               |                                       |          |                                                       |                                                 | ◆                                                  |          | ◆          | ◆       |         | ◆                   | ◆                   |                                                                                                                                             | <ul style="list-style-type: none"><li>• It will be base air-fuel ratio.</li></ul>                                                                                                                                           |                                                                                                                                                                                                                                                      |
| Vehicle speed sensor                                        |        | OPEN/SHORT                              |                      |                     |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |                                                       | ◆                                               |                                                    |          | ◆          | ◆       |         | ◆                   | ◆                   |                                                                                                                                             | <ul style="list-style-type: none"><li>• Duration of fuel cut becomes shorter or fuel may not be cut.</li></ul>                                                                                                              |                                                                                                                                                                                                                                                      |

## TROUBLE DIAGNOSIS

Actuator malfunction  
⊕: Highly possible  
●: Possible

# TROUBLE DIAGNOSIS

## Diagnosis Chart by Symptom (Cont'd)

### TB45 ENGINE RELATIONSHIPS BETWEEN MALFUNCTIONING SYMPTOMS AND ACTUATOR CIRCUITS

The table below shows the possible symptoms caused by the malfunction of each actuator circuit.

| Symptoms                                                    |                          |                            | Im-possible to start  |                    | Im-possible to start |                           | Poor idle                  |               |              |                                        | Poor driving control              |                   |                   |                                        |                               |                                       | Engine stall |          |            |         | Other   |                     | Description/notable characteristics of the symptom |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
|-------------------------------------------------------------|--------------------------|----------------------------|-----------------------|--------------------|----------------------|---------------------------|----------------------------|---------------|--------------|----------------------------------------|-----------------------------------|-------------------|-------------------|----------------------------------------|-------------------------------|---------------------------------------|--------------|----------|------------|---------|---------|---------------------|----------------------------------------------------|---------------------|----------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                             |                          |                            | No initial combustion | Initial combustion | When engine is cold  | When engine is warming up | Fast idle is not effective | High idle rpm | Low idle rpm | Inconsistent idle when engine is cold. | Inconsistent idle when warming up | Poor power output | Poor acceleration | Engine rpm does not increase smoothly. | During surge and acceleration | During surge and constant speed drive | Knocking     | Backfire | After-burn | At idle | Driving | During deceleration |                                                    | During a heavy load | Overheat | Poor fuel | Check that symptoms are detected with self-diagnosis.                                                                                                                                                                                                                               | Check that symptoms are in fail-safe condition.                                                                                                                                            |                                                                                                                                                                                        |
| Actuator malfunction<br>⊕ : Highly possible<br>◆ : Possible | Gasoline injector        | Power supply circuit       | OPEN                  | ◆                  | ◆                    | ◆                         | ◆                          |               |              |                                        | ⊕                                 | ⊕                 | ◆                 | ◆                                      | ◆                             | ◆                                     |              |          |            | ◆       | ◆       | ◆                   | ◆                                                  |                     |          |           |                                                                                                                                                                                                                                                                                     | • No fuel injection to cylinder with open circuit, resulting in LEAN output of heated oxygen sensors.<br>• Starting engine is impossible when the circuits for all the cylinders are open. |                                                                                                                                                                                        |
|                                                             |                          |                            | Momentarily open      |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               | ◆                                     |              |          |            |         | ◆       |                     | ◆                                                  | ◆                   |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             | Coil                     | OPEN                       | ◆                     | ◆                  | ◆                    | ◆                         |                            |               |              | ⊕                                      | ⊕                                 | ◆                 | ◆                 | ◆                                      | ◆                             |                                       |              |          |            | ◆       | ◆       | ◆                   | ◆                                                  |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            | • Continuous fuel injection to cylinder with short circuit, resulting in OVER-RICH and misfiring.<br>• Starting engine is impossible when the circuits for all the cylinders are open. |
|                                                             |                          | Momentarily open           |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               | ◆                                     |              |          |            | ◆       |         | ◆                   | ◆                                                  |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             | Drive circuit (C/U side) | OPEN                       | ◆                     | ◆                  | ◆                    | ◆                         |                            |               |              | ◆                                      | ⊕                                 | ⊕                 | ◆                 | ◆                                      | ◆                             | ◆                                     |              |          |            | ◆       | ◆       | ◆                   | ◆                                                  |                     |          |           |                                                                                                                                                                                                                                                                                     | • The symptom depends on clogging status. The correction factor of air-fuel ratio becomes larger.                                                                                          |                                                                                                                                                                                        |
|                                                             |                          | Momentarily open           |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               | ◆                                     |              |          |            |         |         |                     |                                                    |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             |                          | SHORT                      | ◆                     | ◆                  | ◆                    | ◆                         |                            |               |              | ⊕                                      | ⊕                                 | ◆                 | ◆                 | ◆                                      | ◆                             |                                       |              |          |            | ◆       | ◆       | ◆                   | ◆                                                  |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             | Nozzle hole              | Foreign material intrusion | ◆                     | ◆                  | ◆                    | ◆                         |                            |               |              |                                        | ⊕                                 | ◆                 | ◆                 | ◆                                      |                               | ◆                                     |              |          |            | ◆       | ◆       | ◆                   | ◆                                                  |                     |          |           |                                                                                                                                                                                                                                                                                     | • The cylinder with foreign material will keep injecting.                                                                                                                                  |                                                                                                                                                                                        |
|                                                             |                          | Clogging                   | ◆                     | ◆                  | ◆                    | ◆                         |                            |               |              | ⊕                                      | ⊕                                 | ◆                 | ◆                 | ◆                                      |                               | ◆                                     | ◆            | ◆        |            | ◆       | ◆       | ◆                   | ◆                                                  |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             | Ground circuit (C/U)     | OPEN                       | ◆                     |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |              |          |            | ◆       | ◆       | ◆                   |                                                    |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             |                          | Momentarily open           |                       |                    |                      |                           |                            |               |              |                                        | ◆                                 | ◆                 | ◆                 | ◆                                      |                               | ◆                                     | ◆            |          |            | ◆       |         | ◆                   |                                                    |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
| Ignition signal circuit                                     |                          |                            | OPEN                  | ⊕                  |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |              |          | ◆          | ⊕       | ⊕       | ⊕                   | ⊕                                                  | ◆                   |          |           | • Open<br>• Immediately engine stalls during engine running, and then does not restart.                                                                                                                                                                                             |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             |                          |                            | Momentarily open      |                    | ◆                    | ◆                         | ◆                          |               |              | ◆                                      | ◆                                 | ◆                 | ◆                 | ◆                                      | ◆                             |                                       |              |          | ◆          | ◆       | ◆       | ◆                   | ◆                                                  |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
| Ignition coil                                               | Power supply circuit     | OPEN                       | ⊕                     |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |              |          | ◆          | ⊕       | ⊕       | ⊕                   | ⊕                                                  | ◆                   |          |           | • Injects fuel toward spark plug during cranking.<br>• Momentarily open<br>• Slight shocks and surges may be sensed depending on the duration of momentarily open circuit and the operating conditions. Engine stall may occur if duration of momentarily open circuit is too long. |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             |                          | Momentarily open           |                       | ◆                  | ◆                    | ◆                         |                            |               |              | ◆                                      | ◆                                 | ◆                 | ◆                 | ◆                                      | ◆                             | ◆                                     |              |          |            | ◆       | ◆       | ◆                   | ◆                                                  | ◆                   |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             | Coil                     | OPEN                       | ⊕                     |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |              |          | ◆          | ⊕       | ⊕       | ⊕                   | ⊕                                                  | ◆                   |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             |                          | Momentarily open           |                       | ◆                  | ◆                    | ◆                         |                            |               |              | ◆                                      | ◆                                 | ◆                 | ◆                 | ◆                                      | ◆                             | ◆                                     |              |          |            | ◆       | ◆       | ◆                   | ◆                                                  | ◆                   |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             | Ground circuit           | OPEN                       | ⊕                     |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |              |          |            | ◆       | ⊕       | ⊕                   | ⊕                                                  | ⊕                   | ◆        |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             |                          | Momentarily open           |                       | ◆                  | ◆                    | ◆                         |                            |               |              | ◆                                      | ◆                                 | ◆                 | ◆                 | ◆                                      | ◆                             | ◆                                     |              |          |            | ◆       | ◆       | ◆                   | ◆                                                  | ◆                   |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
| ECM relay circuit                                           |                          |                            | OPEN                  | ⊕                  |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |              |          | ◆          | ⊕       | ⊕       | ⊕                   | ⊕                                                  |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
| Throttle control motor circuit                              |                          |                            | OPEN/SHORT            |                    |                      | ◆                         | ◆                          | ◆             |              |                                        | ◆                                 | ◆                 |                   |                                        |                               |                                       |              |          |            |         |         |                     |                                                    | ◆                   |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
| Throttle control motor relay circuit                        |                          |                            | OPEN                  |                    |                      |                           |                            | ◆             | ◆            | ◆                                      | ◆                                 |                   |                   | ◆                                      | ◆                             |                                       |              | ◆        |            | ◆       | ◆       | ◆                   |                                                    | ◆                   |          |           | • The same malfunction may occur as power supply open of throttle control motor and throttle position sensor.                                                                                                                                                                       |                                                                                                                                                                                            |                                                                                                                                                                                        |
|                                                             |                          |                            |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |              |          |            |         |         |                     |                                                    |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |
| Heated oxygen sensor heater circuit                         |                          |                            | OPEN                  |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |              |          |            |         |         |                     |                                                    |                     |          |           |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                            |                                                                                                                                                                                        |

# TROUBLE DIAGNOSIS

| Symptoms                                                    |                 |                         | Im-possible to start  | Im-possible to start | Poor Idle           |                           | Poor driving control       |               |              |                                       |                                   |                   | Engine stall      |                                       |                               | Other                                 |          | Description/notable characteristics of the symptom |          |            |         |         |                     |                     |          |           |                                                       |
|-------------------------------------------------------------|-----------------|-------------------------|-----------------------|----------------------|---------------------|---------------------------|----------------------------|---------------|--------------|---------------------------------------|-----------------------------------|-------------------|-------------------|---------------------------------------|-------------------------------|---------------------------------------|----------|----------------------------------------------------|----------|------------|---------|---------|---------------------|---------------------|----------|-----------|-------------------------------------------------------|
|                                                             |                 |                         | No initial combustion | Initial combustion   | When engine is cold | When engine is warming up | Fast idle is not effective | High idle rpm | Low idle rpm | Inconsistent idle when engine is cold | Inconsistent idle when warming up | Poor power output | Poor acceleration | Engine rpm does not increase smoothly | During surge and acceleration | During surge and constant speed drive | Knocking |                                                    | Backfire | After-burn | At idle | Driving | During deceleration | During a heavy load | Overheat | Poor fuel | Check that symptoms are detected with self-diagnosis. |
| Actuator malfunction<br>⊕ : Highly possible<br>◆ : Possible |                 |                         |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
| Fuel pump relay circuit                                     |                 | OPEN                    | ⊕                     |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    | ⊕        | ⊕          |         | ⊕       |                     |                     |          |           | • Impossible to start                                 |
| Fuel pump circuit                                           |                 |                         |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           | • Surge may occur.                                    |
| Ignition relay circuit                                      |                 | Momentarily open        |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   | ◆                 | ◆                                     |                               |                                       |          |                                                    | ◆        |            | ◆       | ◆       |                     |                     |          |           |                                                       |
| Fuel pump pressure regulator                                |                 | Stuck                   |                       |                      |                     |                           |                            | ◆             | ◆            | ◆                                     | ◆                                 |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
| LPG injector drive unit                                     | TI circuit      | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             |                 | SHORT                   |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             | Tip circuit     | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             |                 | SHORT                   |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             | PWM circuit     | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             |                 | SHORT                   |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             | Power supply    | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             | Ground          | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
| LPG injector                                                | HI side circuit | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             |                 | SHORT                   |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             | Coil            | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             | LO side circuit | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             |                 | SHORT                   |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
| LPG assistance injector                                     |                 | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             |                 | Control unit side short |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
| LPG interception valve relay                                |                 | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
|                                                             |                 | Control unit side short |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
| LPG interception valve                                      |                 | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
| MIL                                                         |                 | OPEN                    |                       |                      |                     |                           |                            |               |              |                                       |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |
| Improper TAS learning                                       |                 |                         |                       |                      |                     |                           | ◆                          | ◆             | ◆            | ◆                                     |                                   |                   |                   |                                       |                               |                                       |          |                                                    |          |            |         |         |                     |                     |          |           |                                                       |

## TROUBLE DIAGNOSIS

### Diagnosis Chart by Symptom (Cont'd)

#### TB45 ENGINE RELATIONSHIP BETWEEN MALFUNCTIONING SYMPTOM AND THE ENGINE MAIN BODY/AUXILIARY COMPONENT

When the three elements of combustion, compression pressure, fuel mixture, and sparking are all normal, no malfunctions are caused in the gasoline-type engine.

The ECM controls the fuel mixture and sparking (ignition timing). But with malfunctions on the part of engine main body, malfunctioning symptoms result.

The table below shows the possible symptoms caused by the malfunction of engine main body system. It will be helpful in malfunction trouble diagnosis. (The table lists general symptoms and some may not be applicable.)

| Symptoms                                                                       |                                                       | Im-possible to start            | Im-possible to start | Poor idle           |                           | Poor driving control       |               |              |                                        |                                   |                   | Engine stall      |                                        |                               |                                       | Other    |          | Description/notable characteristics of the symptom |            |         |         |                     |                     |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|--------------------------------------------------------------------------------|-------------------------------------------------------|---------------------------------|----------------------|---------------------|---------------------------|----------------------------|---------------|--------------|----------------------------------------|-----------------------------------|-------------------|-------------------|----------------------------------------|-------------------------------|---------------------------------------|----------|----------|----------------------------------------------------|------------|---------|---------|---------------------|---------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
|                                                                                |                                                       | No initial combustion           | Initial combustion   | When engine is cold | When engine is warming up | Fast idle is not effective | High idle rpm | Low idle rpm | Inconsistent idle when engine is cold. | Inconsistent idle when warming up | Poor power output | Poor acceleration | Engine rpm does not increase smoothly. | During surge and acceleration | During surge and constant speed drive | Knocking | Backfire |                                                    | After-burn | At idle | Driving | During deceleration | During a heavy load | Overheat | Poor fuel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |
| Main unit symptom<br>⊕: Highly possible<br>●: Possible<br>▽: Not very possible | Fuel mixture                                          | Air sucked from oil level gauge |                      |                     |                           |                            |               | ♦            | ▽                                      |                                   | ♦                 | ♦                 |                                        |                               |                                       |          |          |                                                    | ▽          |         |         | ▽                   |                     | ▽        | Air-fuel ratio becomes LEAN.<br>High air-fuel correction factor.<br>Low suction power (vacuum pressure) of intake manifold.<br>Use a pressure gauge to check the suction.<br>Generally applicable to air suction in air intake system<br><br>♦ Noise (high hissing tone)<br><br>♦ Symptom depends on clogging status.<br>This tends to happen during high-speed or high load operation.<br><br>♦ Symptom varies depending on combustion pressure.<br><br>♦ Symptom varies depending on oil quality.<br><br>♦ Starting ability at cold area is changed depending on propane ratio.<br>♦ Use LPG with proper propane ratio.<br><br>♦ If the pressure is low, it is caused by poor output during high-speed or high load operation.<br>♦ If the pressure is excessively high, relief valve operates and engine stalls at rich.<br><br>♦ Symptom depends on fuel temperature.<br>This tends to happen during engine stall and is impossible to restart during engine warming up.<br><br>♦ Symptom depends on clogging status.<br>This tends to happen during high-speed or high load operation.<br><br>♦ The malfunction tends to happen during high-speed or high load operation (low vacuum). |   |
|                                                                                | Air sucked from oil filler cap                        |                                 |                      |                     |                           |                            |               | ♦            | ▽                                      |                                   | ♦                 | ♦                 |                                        |                               |                                       |          |          |                                                    | ▽          |         |         | ▽                   |                     | ▽        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|                                                                                | Air sucked from PCV hose (downstream of PCV)          |                                 | ♦                    | ▽                   |                           |                            |               | ♦            | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     | ▽        | ▽        |                                                    | ♦          | ♦       |         | ♦                   |                     | ▽        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|                                                                                | Air sucked from intake manifold and gasket            |                                 | ♦                    | ▽                   |                           |                            |               | ♦            | ▽                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     | ▽        | ▽        |                                                    | ♦          | ♦       |         | ♦                   |                     | ▽        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|                                                                                | PCV kept open                                         |                                 |                      |                     |                           | ♦                          |               | ♦            | ▽                                      |                                   | ♦                 | ♦                 | ♦                                      | ♦                             |                                       |          |          |                                                    |            |         |         |                     |                     | ♦        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|                                                                                | Clogged fuel strainer                                 |                                 | ♦                    | ▽                   |                           |                            |               | ♦            | ▽                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     | ♦        | ♦        |                                                    | ▽          | ♦       |         | ♦                   |                     |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|                                                                                | Clogged air cleaner element                           |                                 |                      |                     |                           |                            |               |              |                                        |                                   | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     |          |          |                                                    |            |         |         |                     |                     | ♦        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|                                                                                | Malfunctioning gasoline pressure regulator            | ▽                               | ♦                    | ♦                   | ♦                         |                            |               | ♦            | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     |          |          |                                                    | ♦          | ♦       | ♦       | ♦                   |                     |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|                                                                                | Poor quality gasoline                                 | ▽                               | ♦                    | ♦                   | ♦                         |                            |               | ♦            | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     | ♦        | ▽        |                                                    |            | ♦       | ♦       | ♦                   | ♦                   |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ▽ |
|                                                                                | Improper LPG fuel (cold area and propane ratio)       | ⊕                               | ♦                    | ♦                   |                           |                            |               | ♦            | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     | ♦        | ▽        |                                                    |            | ♦       | ♦       | ♦                   | ♦                   |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|                                                                                | Malfunctioning LPG vaporizer pressure adjusting valve | ▽                               | ♦                    | ♦                   | ♦                         |                            |               | ♦            | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     |          |          |                                                    | ♦          | ♦       | ♦       | ♦                   |                     |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|                                                                                | Clogged LPG vaporizer hot water circuit               |                                 |                      |                     |                           | ♦                          |               | ♦            | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     |          |          |                                                    | ♦          | ♦       | ♦       | ♦                   |                     |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|                                                                                | Clogged LPG interception valve filter                 |                                 | ♦                    | ▽                   |                           |                            |               | ♦            | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     | ♦        |          |                                                    | ▽          | ♦       |         | ♦                   |                     |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |
|                                                                                | Valve deposit                                         |                                 | ♦                    | ♦                   |                           |                            |               | ▽            | ▽                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     | ♦        | ♦        |                                                    | ♦          | ♦       | ♦       | ♦                   |                     |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ▽ |

# TROUBLE DIAGNOSIS

| Symptoms                                                                          |                                                       | Im-possible to start  |                    | Im-possible to start |                           | Poor Idle                  |               |              | Poor driving control                   |                                   |                   |                   |                                        |                               | Engine stall                          |          |          | Other      |         | Description/notable characteristics of the symptom |         |                     |                     |          |           |                                                                                                                         |
|-----------------------------------------------------------------------------------|-------------------------------------------------------|-----------------------|--------------------|----------------------|---------------------------|----------------------------|---------------|--------------|----------------------------------------|-----------------------------------|-------------------|-------------------|----------------------------------------|-------------------------------|---------------------------------------|----------|----------|------------|---------|----------------------------------------------------|---------|---------------------|---------------------|----------|-----------|-------------------------------------------------------------------------------------------------------------------------|
|                                                                                   |                                                       | No initial combustion | Initial combustion | When engine is cold  | When engine is warming up | Fast idle is not effective | High idle rpm | Low idle rpm | Inconsistent idle when engine is cold. | Inconsistent idle when warming up | Poor power output | Poor acceleration | Engine rpm does not increase smoothly. | During surge and acceleration | During surge and constant speed drive | Knocking | Backfire | After-burn | At idle |                                                    | Driving | During deceleration | During a heavy load | Overheat | Poor fuel |                                                                                                                         |
| Main unit symptom<br>⊕ : Highly possible<br>♦ : Possible<br>▽ : Not very possible |                                                       |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |         |                                                    |         |                     |                     |          |           |                                                                                                                         |
|                                                                                   |                                                       |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |         |                                                    |         |                     |                     |          |           |                                                                                                                         |
|                                                                                   |                                                       |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |         |                                                    |         |                     |                     |          |           |                                                                                                                         |
|                                                                                   |                                                       |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |         |                                                    |         |                     |                     |          |           |                                                                                                                         |
|                                                                                   |                                                       |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |         |                                                    |         |                     |                     |          |           |                                                                                                                         |
| Spark-<br>ing                                                                     | Improper high-tension cord connection                 |                       |                    | ⊕                    | ⊕                         |                            |               |              | ⊕                                      | ⊕                                 | ⊕                 | ⊕                 | ⊕                                      | ⊕                             | ⊕                                     |          |          |            | ⊕       | ⊕                                                  | ⊕       | ⊕                   | ⊕                   | ⊕        | ⊕         | • Check the igniting sequence.                                                                                          |
|                                                                                   | Improper Ignition timing adjustment                   |                       |                    | ♦                    | ♦                         |                            |               |              | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     | ♦        | ♦        | ♦          | ♦       | ♦                                                  | ▽       | ♦                   | ♦                   |          | ♦         | —                                                                                                                       |
|                                                                                   | Malfunctioning spark plug                             |                       |                    | ♦                    | ♦                         |                            |               |              | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     |          |          |            | ▽       |                                                    | ▽       | ▽                   |                     |          |           | • Check that the gap is proper. Check plug for soil (smoking).                                                          |
|                                                                                   | Leakage from high-tension cord                        | ▽                     | ♦                  | ♦                    | ♦                         |                            |               |              | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     |          |          |            | ♦       | ♦                                                  | ♦       |                     | ♦                   |          | ♦         | • Symptom varies depending on the level of leakage.                                                                     |
|                                                                                   | Leakage from distributor cap.                         | ▽                     | ♦                  | ♦                    | ♦                         |                            |               |              | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     |          |          |            | ♦       | ♦                                                  | ♦       |                     | ♦                   |          | ♦         | —                                                                                                                       |
|                                                                                   | Loose or open of primary wire connection              |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |         |                                                    |         |                     |                     |          |           | —                                                                                                                       |
| Com-<br>pres-<br>sion<br>pres-<br>sure                                            | Improper bulb contact                                 | ▽                     | ♦                  | ⊕                    | ⊕                         |                            |               |              | ⊕                                      | ⊕                                 | ⊕                 | ⊕                 | ⊕                                      | ⊕                             | ⊕                                     |          |          |            | ♦       | ♦                                                  | ♦       | ♦                   | ♦                   |          |           | • Symptom varies depending on contact condition and the number of cylinders.                                            |
|                                                                                   | Worn piston ring                                      | ▽                     | ♦                  | ⊕                    | ⊕                         |                            |               |              | ⊕                                      | ⊕                                 | ⊕                 | ⊕                 | ⊕                                      | ⊕                             | ⊕                                     |          |          |            | ♦       | ♦                                                  | ♦       |                     | ♦                   |          |           | • Symptom varies depending on degree of wear and the number of cylinders.                                               |
| Other                                                                             | Clogged three-way catalytic converter /exhaust system |                       | ▽                  | ♦                    | ♦                         |                            |               |              | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     |          |          |            | ♦       | ♦                                                  | ♦       | ♦                   |                     | ♦        |           | • In some cases, after engine stall, restarting is possible.                                                            |
|                                                                                   | Low idle base speed                                   |                       |                    |                      | ▽                         | ▽                          |               |              | ▽                                      | ▽                                 |                   |                   |                                        |                               |                                       |          |          |            | ♦       | ♦                                                  | ♦       | ♦                   |                     |          |           | • Engine stall may occur by power steering load and cargo load during deceleration or at idling.                        |
|                                                                                   | Dragging of brakes                                    |                       |                    |                      |                           |                            |               |              |                                        |                                   | ♦                 | ♦                 | ♦                                      |                               |                                       |          |          |            |         |                                                    |         |                     |                     | ♦        |           | • Tires/wheels are hot.                                                                                                 |
|                                                                                   | Belt tension too high (excessive tension)             |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            | ♦       | ♦                                                  | ♦       | ♦                   |                     |          | ♦         | —                                                                                                                       |
|                                                                                   | High A/T load                                         |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   | ▽                 |                                        |                               |                                       |          |          |            | ▽       |                                                    | ♦       | ▽                   |                     |          | ♦         | • Insufficient ATF amount, Improper oil specification (This symptom may especially occur in the cold.)                  |
|                                                                                   | High HYD PUMP load (PS, Cargo)                        |                       |                    |                      |                           |                            |               |              | ▽                                      | ▽                                 | ▽                 | ♦                 | ♦                                      |                               |                                       |          |          |            |         |                                                    |         | ▽                   |                     |          |           | • Malfunctioning oil pressure relief valve, improper oil specification (This symptom may especially occur in the cold.) |
|                                                                                   | Foreign substance in fuel tank (such as dust)         | ▽                     | ♦                  | ♦                    | ♦                         |                            |               |              | ♦                                      | ♦                                 | ♦                 | ♦                 | ♦                                      | ♦                             | ♦                                     |          |          |            | ♦       | ♦                                                  | ♦       | ♦                   |                     |          |           | • With low fuel, this may easily occur.                                                                                 |
|                                                                                   | Damaged fan, malfunctioning water pump                |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |         |                                                    |         |                     |                     | ♦        |           | • Noise                                                                                                                 |
|                                                                                   | Clogged/restricted radiator/condenser                 |                       |                    |                      |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |         |                                                    |         |                     |                     | ♦        |           | —                                                                                                                       |

Also check the following items other than the above:

- Check harness tension. • Check each connector connection. • Check ground wire for looseness. • Check battery connection for looseness or corrosion.
- Check water and oil condition. • Check fan belts for looseness.

## TROUBLE DIAGNOSIS

### Diagnosis Chart by Symptom (Cont'd)

#### TB45 ENGINE RELATIONSHIP BETWEEN MALFUNCTIONING SYMPTOM AND THE ENGINE MAIN BODY/AUXILIARY COMPONENT

When the three elements of combustion, compression pressure, fuel mixture, and sparking are all normal, no malfunctions are caused in the engine.

The ECM controls the fuel mixture and sparking (ignition timing). But with malfunctions on the part of engine main body, malfunctioning symptoms result.

The table below shows the possible symptoms caused by the malfunction of engine main body system. It will be helpful in malfunction trouble diagnosis. The table lists general symptoms and some may not be applicable.

| Symptoms                                                                       |                                                       | Im-possible to start  | Im-possible to start | Poor Idle           |                           | Poor driving control       |               |              |                                        |                                   |                   | Engine stall      |                                        | Other                         |                                       |          |          | Description/notable characteristics of the symptom |         |         |                     |                     |          |          |           |                  |                              |                                                                                          |                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------------------|-------------------------------------------------------|-----------------------|----------------------|---------------------|---------------------------|----------------------------|---------------|--------------|----------------------------------------|-----------------------------------|-------------------|-------------------|----------------------------------------|-------------------------------|---------------------------------------|----------|----------|----------------------------------------------------|---------|---------|---------------------|---------------------|----------|----------|-----------|------------------|------------------------------|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                |                                                       |                       |                      |                     |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |                                                    |         |         |                     |                     |          |          |           |                  |                              |                                                                                          |                                                                                                                                                                                                                                         |
|                                                                                |                                                       | No initial combustion | Initial combustion   | When engine is cold | When engine is warming up | Fast idle is not effective | High idle rpm | Low idle rpm | Inconsistent idle when engine is cold. | Inconsistent idle when warming up | Poor power output | Poor acceleration | Engine rpm does not increase smoothly. | During surge and acceleration | During surge and constant speed drive | Knocking | Backfire | After-burn                                         | At Idle | Driving | During deceleration | During a heavy load | Overheat | Overcool | Poor fuel | High oil consume | Oil pressure warning lamp ON | Mechanical noise                                                                         |                                                                                                                                                                                                                                         |
| Main unit symptom<br>⊕: Highly possible<br>⬆: Possible<br>▽: Not very possible |                                                       |                       |                      |                     |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |                                                    |         |         |                     |                     |          |          |           |                  |                              |                                                                                          |                                                                                                                                                                                                                                         |
| Fuel mixture                                                                   | Air sucked from oil level gauge                       |                       |                      |                     |                           |                            |               |              | ⬆                                      | ▽                                 |                   | ⬆                 | ⬆                                      |                               |                                       |          |          |                                                    | ▽       |         |                     | ▽                   |          | ▽        |           |                  |                              |                                                                                          | • Air-fuel ratio becomes LEAN.<br>• High air-fuel correction factor.<br>• Low suction power (vacuum pressure) of Intake manifold.<br>Check the suction using a pressure gauge. Generally applicable to air suction in air intake system |
|                                                                                | Air sucked from oil filler cap                        |                       |                      |                     |                           |                            |               |              | ⬆                                      | ▽                                 |                   | ⬆                 | ⬆                                      |                               |                                       |          |          |                                                    | ▽       |         |                     | ▽                   |          | ▽        |           |                  |                              |                                                                                          |                                                                                                                                                                                                                                         |
|                                                                                | Air sucked from PCV hose (downstream of PCV)          |                       |                      | ⬆                   | ▽                         |                            |               |              | ⬆                                      | ▽                                 |                   | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     | ⬆        | ▽        | ▽                                                  | ⬆       | ⬆       |                     | ⬆                   |          | ▽        |           |                  |                              |                                                                                          |                                                                                                                                                                                                                                         |
|                                                                                | Air sucked from Intake manifold and gasket            |                       |                      | ⬆                   | ▽                         |                            |               |              | ⬆                                      | ▽                                 |                   | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     | ⬆        | ▽        | ▽                                                  | ⬆       | ⬆       |                     | ⬆                   |          | ▽        |           |                  |                              |                                                                                          |                                                                                                                                                                                                                                         |
|                                                                                | PCV kept open                                         |                       |                      |                     |                           | ⬆                          |               |              | ⬆                                      | ▽                                 |                   | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     |          |          |                                                    |         |         |                     |                     | ⬆        |          |           |                  |                              |                                                                                          | • Noise (high hissing tone)                                                                                                                                                                                                             |
|                                                                                | Clogged fuel strainer                                 |                       |                      | ⬆                   | ▽                         |                            |               |              | ⬆                                      | ▽                                 |                   | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     | ⬆        | ⬆        | ⬆                                                  | ⬆       | ▽       | ⬆                   |                     | ⬆        |          |           |                  |                              |                                                                                          | • Symptom depends on clogging status. This tends to happen during high-speed or high load operation.                                                                                                                                    |
|                                                                                | Clogged air cleaner element                           |                       |                      |                     |                           |                            |               |              |                                        |                                   | ⬆                 | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     |          |          |                                                    |         |         |                     |                     |          | ⬆        |           |                  |                              |                                                                                          | • Symptom varies depending on oil quality.                                                                                                                                                                                              |
|                                                                                | Malfunctioning gasoline pressure regulator            | ▽                     | ⬆                    | ⬆                   | ⬆                         |                            |               |              | ⬆                                      | ⬆                                 | ⬆                 | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     | ⬆        |          |                                                    |         | ⬆       | ⬆                   | ⬆                   | ⬆        |          |           |                  |                              |                                                                                          | • Symptom varies depending on oil quality.                                                                                                                                                                                              |
|                                                                                | Poor quality gasoline                                 | ▽                     | ⬆                    | ⬆                   | ⬆                         |                            |               |              | ⬆                                      | ⬆                                 | ⬆                 | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     | ⬆        | ⬆        |                                                    |         | ⬆       | ⬆                   | ⬆                   | ⬆        | ▽        |           |                  |                              |                                                                                          | • Starting ability in cold area is changed depending on propane ratio.<br>• Use LPG with proper propane ratio.                                                                                                                          |
|                                                                                | Improper LPG fuel (cold area and propane ratio)       | ⊕                     | ⬆                    | ⬆                   |                           |                            |               |              | ⬆                                      | ⬆                                 | ⬆                 | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     | ⬆        | ⬆        | ▽                                                  |         | ⬆       | ⬆                   | ⬆                   | ⬆        |          |           |                  |                              |                                                                                          | • If the pressure is low, it is caused by poor output during high-speed or high load operation.<br>• If the pressure is excessively high, relief valve operates and engine stalls at rich.                                              |
|                                                                                | Malfunctioning LPG vaporizer pressure adjusting valve | ▽                     | ⬆                    | ⬆                   | ⬆                         |                            |               |              | ⬆                                      | ⬆                                 | ⬆                 | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     | ⬆        |          |                                                    |         | ⬆       | ⬆                   | ⬆                   | ⬆        |          |           |                  |                              |                                                                                          | • Symptom depends on fuel temperature. This tends to happen during engine stall and is impossible to restart during engine warming up.                                                                                                  |
|                                                                                | Clogged LPG vaporizer hot water circuit               |                       |                      |                     |                           | ⬆                          |               |              | ⬆                                      | ⬆                                 | ⬆                 | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     | ⬆        |          |                                                    |         | ⬆       | ⬆                   | ⬆                   | ⬆        |          |           |                  |                              |                                                                                          | • Symptom depends on clogging status. This tends to happen during high-speed or high load operation.                                                                                                                                    |
| Clogged LPG interception valve filter                                          |                                                       |                       | ⬆                    | ▽                   |                           |                            |               | ⬆            | ⬆                                      | ⬆                                 | ⬆                 | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     | ⬆        | ⬆        |                                                    | ▽       | ⬆       |                     | ⬆                   |          |          |           |                  |                              | • The malfunction tends to happen during high-speed or high load operation (low vacuum). |                                                                                                                                                                                                                                         |
| Valve deposit                                                                  |                                                       |                       | ⬆                    | ⬆                   |                           |                            |               | ⬆            | ▽                                      | ⬆                                 | ⬆                 | ⬆                 | ⬆                                      | ⬆                             | ⬆                                     | ⬆        | ⬆        |                                                    | ⬆       | ⬆       | ⬆                   | ⬆                   | ▽        |          |           |                  |                              |                                                                                          |                                                                                                                                                                                                                                         |

Main unit symptom  
⊕ : Highly possible  
+ : Possible  
▽ : Not very possible

# TROUBLE DIAGNOSIS

| Symptoms                                                                          | Im-possible to start                      | Im-possible to start                                                                                 | Poor idle                     |                                                                             | Poor driving control                                                                                                                                       |                                    |                                                                  |                                                                                                           |   |   | Engine stall |   | Other |   |   | Description/notable characteristics of the symptom |                                                                                                                                                 |                                                 |                                                                                         |  |
|-----------------------------------------------------------------------------------|-------------------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|---|---|--------------|---|-------|---|---|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------------------------------------------------------------------|--|
|                                                                                   | No initial combustion                     | Initial combustion<br>When engine is cold<br>When engine is warming up<br>Fast idle is not effective | High idle rpm<br>Low idle rpm | Inconsistent idle when engine is cold.<br>Inconsistent idle when warming up | Poor power output<br>Poor acceleration<br>Engine rpm does not increase smoothly.<br>During surge and acceleration<br>During surge and constant speed drive | Knocking<br>Backfire<br>After-burn | At idle<br>Driving<br>During deceleration<br>During a heavy load | Overheat<br>Overcool<br>Poor fuel<br>High oil consume<br>Oil pressure warning lamp ON<br>Mechanical noise |   |   |              |   |       |   |   |                                                    |                                                                                                                                                 |                                                 |                                                                                         |  |
| Main unit symptom<br>⊕ : Highly possible<br>◆ : Possible<br>▽ : Not very possible |                                           |                                                                                                      |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    |                                                                                                                                                 |                                                 |                                                                                         |  |
| Spark-<br>ing                                                                     | Improper high-tension cord connection     |                                                                                                      |                               | ⊕                                                                           | ⊕                                                                                                                                                          |                                    | ⊕                                                                | ⊕                                                                                                         | ⊕ | ⊕ | ⊕            | ⊕ | ⊕     | ⊕ | ⊕ | ⊕                                                  | • Check the igniting sequence.                                                                                                                  |                                                 |                                                                                         |  |
|                                                                                   | Improper ignition timing adjustment       |                                                                                                      |                               | ◆                                                                           | ◆                                                                                                                                                          |                                    | ◆                                                                | ◆                                                                                                         | ◆ | ◆ | ◆            | ◆ | ◆     | ◆ | ◆ | ◆                                                  | -                                                                                                                                               |                                                 |                                                                                         |  |
|                                                                                   | Malfunctioning spark plug                 |                                                                                                      |                               | ◆                                                                           | ◆                                                                                                                                                          |                                    | ◆                                                                | ◆                                                                                                         | ◆ | ◆ | ◆            |   | ▽     | ▽ | ▽ |                                                    | • Check that the gap is proper. Check plug for soil (smoking).                                                                                  |                                                 |                                                                                         |  |
|                                                                                   | Leakage from high-tension cord            |                                                                                                      | ▽                             | ◆                                                                           | ◆                                                                                                                                                          | ◆                                  | ◆                                                                | ◆                                                                                                         | ◆ | ◆ |              | ◆ | ◆     | ◆ | ◆ | ◆                                                  | • Symptom varies depending on the level of leakage.                                                                                             |                                                 |                                                                                         |  |
|                                                                                   | Leakage from distributor cap.             |                                                                                                      | ▽                             | ◆                                                                           | ◆                                                                                                                                                          | ◆                                  | ◆                                                                | ◆                                                                                                         | ◆ | ◆ |              | ◆ | ◆     | ◆ | ◆ | ◆                                                  | -                                                                                                                                               |                                                 |                                                                                         |  |
|                                                                                   | Loose or open of primary wire connection  |                                                                                                      |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    | -                                                                                                                                               |                                                 |                                                                                         |  |
| Com-<br>pres-<br>sion<br>pres-<br>sure                                            | Improper bulb contact                     |                                                                                                      | ▽                             | ◆                                                                           | ⊕                                                                                                                                                          | ⊕                                  |                                                                  | ⊕                                                                                                         | ⊕ | ⊕ | ⊕            | ⊕ | ⊕     | ◆ | ◆ | ◆                                                  | • The symptom occurs depending on malfunctioning grade and the number of malfunctioning cylinders.                                              |                                                 |                                                                                         |  |
|                                                                                   | Worn, stuck, broken piston ring           |                                                                                                      | ▽                             | ◆                                                                           | ⊕                                                                                                                                                          | ⊕                                  |                                                                  | ⊕                                                                                                         | ⊕ | ⊕ | ⊕            | ⊕ | ⊕     | ◆ | ◆ | ◆                                                  | • The symptom occurs depending on malfunctioning grade and the number of malfunctioning cylinders. Precautions for head bolt tightening torque. |                                                 |                                                                                         |  |
|                                                                                   | Blow out from head gasket                 |                                                                                                      | ▽                             | ◆                                                                           | ◆                                                                                                                                                          | ◆                                  |                                                                  | ◆                                                                                                         | ◆ | ◆ | ◆            | ◆ |       | ◆ | ◆ | ◆                                                  | • The symptom occurs depending on malfunctioning grade and the number of malfunctioning cylinders.                                              |                                                 |                                                                                         |  |
|                                                                                   | Broken or deterioration valve spring      |                                                                                                      | ▽                             | ◆                                                                           | ◆                                                                                                                                                          | ◆                                  |                                                                  | ◆                                                                                                         | ◆ | ◆ | ◆            | ◆ |       | ◆ | ◆ | ◆                                                  | • The symptom occurs depending on malfunctioning grade and the number of malfunctioning cylinders.                                              |                                                 |                                                                                         |  |
|                                                                                   | Stuck and upthrust valve stem             |                                                                                                      | ▽                             | ◆                                                                           | ⊕                                                                                                                                                          | ⊕                                  |                                                                  | ⊕                                                                                                         | ⊕ | ⊕ | ⊕            | ⊕ |       | ◆ | ◆ | ◆                                                  | • The symptom occurs depending on malfunctioning grade and the number of malfunctioning cylinders.                                              |                                                 |                                                                                         |  |
|                                                                                   | Pressure leakage from spark plug          |                                                                                                      |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  | ⊕                                                                                                         |   |   |              |   |       |   |   |                                                    | • Check gasket and tightening condition.                                                                                                        |                                                 |                                                                                         |  |
| Other                                                                             | Low idle base speed                       |                                                                                                      |                               | ▽                                                                           | ▽                                                                                                                                                          |                                    | ▽                                                                | ▽                                                                                                         |   |   |              |   | ◆     | ◆ | ◆ | ◆                                                  | • Engine stall may occur by power steering load and cargo load during deceleration or at idling.                                                |                                                 |                                                                                         |  |
|                                                                                   | Crack and water leakage on cylinder block |                                                                                                      |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   | ◆ |                                                    |                                                                                                                                                 |                                                 |                                                                                         |  |
|                                                                                   | Main motor system                         | Excessive crankshaft end play                                                                        |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    | ◆                                                                                                                                               |                                                 |                                                                                         |  |
|                                                                                   |                                           | Crankshaft and connecting rod bearing clearance task                                                 |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    | ◆                                                                                                                                               | • Oil leakage around front or rear crankshaft.  |                                                                                         |  |
|                                                                                   |                                           | Broken crankshaft front/rear oil seal                                                                |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    | ◆                                                                                                                                               | • Oil leakage around front or rear crankshaft.  |                                                                                         |  |
|                                                                                   |                                           | Excessive clearance between piston and cylinder                                                      |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    | ◆                                                                                                                                               | • Whitish exhaust gas. Worn piston or cylinder. |                                                                                         |  |
|                                                                                   | Main motor system                         | Excessive piston pin clearance                                                                       |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    |                                                                                                                                                 | ◆                                               |                                                                                         |  |
|                                                                                   |                                           | Improper piston ring installation                                                                    |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    |                                                                                                                                                 | ◆                                               | • Whitish exhaust gas. Improper location of connecting end and assemble it upside down. |  |
|                                                                                   |                                           | Excessive piston ring clearance                                                                      |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    |                                                                                                                                                 | ◆                                               | • Whitish exhaust gas. Worn piston ring groove or piston ring.                          |  |
|                                                                                   |                                           | Worn torque converter pilot bushing                                                                  |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    |                                                                                                                                                 |                                                 | ◆                                                                                       |  |
|                                                                                   | Heads                                     | Crack and water leakage on cylinder block                                                            |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   | ◆                                                  |                                                                                                                                                 |                                                 |                                                                                         |  |
|                                                                                   |                                           | Carbon deposit in combustion chamber                                                                 |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              | ◆ |       |   |   |                                                    |                                                                                                                                                 |                                                 |                                                                                         |  |
|                                                                                   |                                           | Worn valve stem or guide                                                                             |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    |                                                                                                                                                 | ◆                                               | • Whitish exhaust gas                                                                   |  |
|                                                                                   |                                           | Deterioration of valve oil seal lip                                                                  |                               |                                                                             |                                                                                                                                                            |                                    |                                                                  |                                                                                                           |   |   |              |   |       |   |   |                                                    |                                                                                                                                                 | ◆                                               |                                                                                         |  |

# TROUBLE DIAGNOSIS

Main unit symptom  
 ⊕ : Highly possible  
 ● : Possible  
 ▽ : Not very possible

| Symptoms                                                                          |              | Im-possible to start                        | Im-possible to start                         | Poor idle           |                           |                            | Poor driving control |              |                                        |                                   |                   |                   | Engine stall                           |                               |                                       | Other    |          |            | Description/notable characteristics of the symptom |         |         |                     |                     |          |          |           |                  |                              |                                                                                                          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|-----------------------------------------------------------------------------------|--------------|---------------------------------------------|----------------------------------------------|---------------------|---------------------------|----------------------------|----------------------|--------------|----------------------------------------|-----------------------------------|-------------------|-------------------|----------------------------------------|-------------------------------|---------------------------------------|----------|----------|------------|----------------------------------------------------|---------|---------|---------------------|---------------------|----------|----------|-----------|------------------|------------------------------|----------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-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|                                                                                   |              | No initial combustion                       | Initial combustion                           | When engine is cold | When engine is warming up | Fast idle is not effective | High idle rpm        | Low idle rpm | Inconsistent idle when engine is cold. | Inconsistent idle when warming up | Poor power output | Poor acceleration | Engine rpm does not increase smoothly. | During surge and acceleration | During surge and constant speed drive | Knocking | Backfire | After-burn |                                                    | At idle | Driving | During deceleration | During a heavy load | Overheat | Overcool | Poor fuel | High oil consume | Oil pressure warning lamp ON | Mechanical noise                                                                                         |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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| Main unit symptom<br>⊕ : Highly possible<br>⬆ : Possible<br>▽ : Not very possible |              |                                             |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  |                              |                                                                                                          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  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| Others                                                                            | Valves       | Excessive or clogged valve clearance        |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | ⬆                            | • Excessive clearance:<br>Chattering noise at idling<br>• Clogged clearance:<br>Engine leakage at idling |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|                                                                                   |              | Rocker cover gasket oil leakage             |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | •                            | • Loose or broken gasket                                                                                 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|                                                                                   | Chains       | Slack of timing chain                       |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | •                            | • Worn chain tensioner shoe<br>• Dropped chain guide                                                     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|                                                                                   |              | Improper valve timing                       |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | •                            | • Check timing mark related to timing chain for dislocation.                                             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|                                                                                   |              | Front cover oil leakage                     |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | •                            | • Loose or broken gasket                                                                                 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|                                                                                   | Lubrications | Improper engine oil                         |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | •                            | • Insufficient oil amount, improper grade, deterioration<br>• Refill full recommended oil.               |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|                                                                                   |              | Malfunctioning oil pump                     |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | •                            | • Worn or broken rotor<br>• Operation malfunction or oil leakage of regulator                            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|                                                                                   |              | Oil leakage around oil pan                  |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | •                            | • Loose or broken oil pan gasket<br>• Loose oil pan drain plug                                           |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|                                                                                   |              | Clogged/restricted oil strainer             |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | •                            | • Dirt or entry of foreign material in engine oil                                                        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|                                                                                   |              | Oil leakage of oil filter                   |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | ⊕                            | • Loose or broken gasket<br>• Apply oil to gasket when replacing oil filter.                             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|                                                                                   |              | Clogged/restricted oil filter               |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | •                            | • Dirt or entry of foreign material in engine oil                                                        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   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|                                                                                   |              | Loose or malfunctioning oil pressure switch |                                              |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  | •                            |                                                                                                          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  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|                                                                                   |              | Fuels                                       | Foreign material in fuel tank (such as dust) |                     |                           |                            |                      |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |            |                                                    |         |         |                     |                     |          |          |           |                  |                              | ▽                                                                                                        | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | 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# TROUBLE DIAGNOSIS

| Symptoms                                                                          | Im-possible to start  | Im-possible to start           | Poor Idle           |                           | Poor driving control       |               |              |                                        |                                   |                   | Engine stall      |                                        | Other                         |                                       |          |          | Description/notable characteristics of the symptom |            |         |         |                     |                     |          |          |           |                  |                              |                  |   |                                                                                                                       |
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|                                                                                   | No initial combustion | Initial combustion             | When engine is cold | When engine is warming up | Fast idle is not effective | High idle rpm | Low idle rpm | Inconsistent idle when engine is cold. | Inconsistent idle when warming up | Poor power output | Poor acceleration | Engine rpm does not increase smoothly. | During surge and acceleration | During surge and constant speed drive | Knocking | Backfire |                                                    | After-burn | At idle | Driving | During deceleration | During a heavy load | Overheat | Overcool | Poor fuel | High oil consume | Oil pressure warning lamp ON | Mechanical noise |   |                                                                                                                       |
| Main unit symptom<br>⊕ : Highly possible<br>● : Possible<br>▽ : Not very possible |                       |                                |                     |                           |                            |               |              |                                        |                                   |                   |                   |                                        |                               |                                       |          |          |                                                    |            |         |         |                     |                     |          |          |           |                  |                              |                  |   |                                                                                                                       |
|                                                                                   | Others                | High A/T load                  |                     |                           |                            |               |              |                                        |                                   |                   | ▽                 |                                        |                               |                                       |          |          |                                                    | ▽          |         | ●       | ▽                   |                     |          | ●        |           |                  |                              |                  | ● | Insufficient ATF amount, improper oil specification (This symptom may especially occur in the cold.)                  |
|                                                                                   |                       | High HYD PUMP load (PS, Cargo) |                     |                           |                            |               |              | ▽                                      | ▽                                 | ▽                 | ●                 | ●                                      |                               |                                       |          |          |                                                    |            |         |         | ▽                   |                     |          |          |           |                  |                              |                  | ● | Malfunctioning oil pressure relief valve, improper oil specification (This symptom may especially occur in the cold.) |

Also check the following items other than the above:

- Check harness tension.   • Check ground for looseness.   • Check each connector connection.   • Check battery connection for looseness or corrosion.
- Check engine drive belt for looseness.   • Check water and oil condition.

## TROUBLE DIAGNOSIS

### Component Parts Location

|           | Main component part                        | Type                             | Location                                                         | Specifications |     |          |
|-----------|--------------------------------------------|----------------------------------|------------------------------------------------------------------|----------------|-----|----------|
|           |                                            |                                  |                                                                  | Gasoline       | LPG | Combined |
| Actuators | Gasoline injector                          | High resistance                  | Intake manifold                                                  | ○              |     | ○        |
|           | LPG injector                               | Gas injection                    | Integrated in injector holder (on intake manifold)               | ○              | ○   |          |
|           | Fuel pump                                  | Electric motor/turbine           | Integrated in fuel tank                                          | ○              |     | ○        |
|           | Fuel pressure regulator                    | Diaphragm                        |                                                                  | ○              |     | ○        |
|           | Throttle control motor                     | Electric DC motor (DC motor)     | Integrated in electronic throttle control actuator               | ○              | ○   | ○        |
|           | Ignition coil                              | Molded                           | Integrated in distributor                                        | ○              | ○   | ○        |
|           | Power transistor                           | 1-channel                        |                                                                  |                |     |          |
| Sensors   | Crankshaft position sensor                 | Photoelectric                    | Integrated in distributor                                        | ○              | ○   | ○        |
|           | Mass air flow sensor                       | Hot wire                         | Air horn                                                         | ○              | ○   | ○        |
|           | Accelerator pedal position sensors 1 and 2 | Variable resistance              | Integrated in accelerator work unit (accelerator pedal assembly) | ○              | ○   | ○        |
|           | Throttle position sensors 1 and 2          |                                  | Integrated in electronic throttle control actuator               | ○              | ○   | ○        |
|           | Engine coolant temperature sensor          | Thermistor                       | Thermostat housing                                               | ○              | ○   | ○        |
|           | Intake air temperature sensor              |                                  | With air flow meter                                              | ○              | ○   | ○        |
|           | Heated oxygen sensor                       | Zirconia (with heater)           |                                                                  | ○              | ○   | ○        |
|           | Vehicle speed sensor                       | Electromagnetic power generation |                                                                  | ○              | ○   | ○        |
| ECM       |                                            | 121-pin digital control          |                                                                  | ○              | ○   | ○        |
| ECM relay |                                            | Compact relay                    |                                                                  | ○              | ○   | ○        |

## TROUBLE DIAGNOSIS

### Component Parts Location (Cont'd)

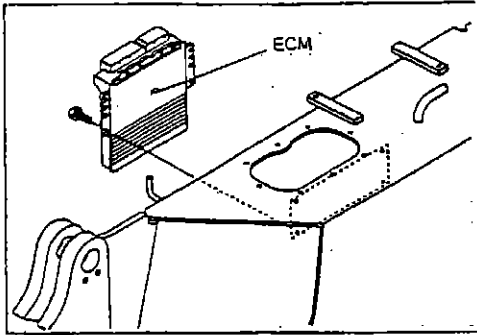
#### ECM COMPONENT PARTS LOCATION: TB45 ENG

| Component                                  | Location                                                         | Specifications |     |          | Reference |        |       |
|--------------------------------------------|------------------------------------------------------------------|----------------|-----|----------|-----------|--------|-------|
|                                            |                                                                  | Gasoline       | LPG | Combined | Actuator  | Sensor | Other |
| Gasoline injector                          | Intake manifold                                                  | ○              |     | ○        | ○         |        |       |
| LPG injector                               | Integrated in injector holder (on intake manifold)               |                | ○   | ○        | ○         |        |       |
| Throttle control motor                     | Integrated in electronic throttle control actuator               | ○              | ○   | ○        | ○         |        |       |
| Throttle position sensors 1 and 2          | Integrated in electronic throttle control actuator               | ○              | ○   | ○        |           | ○      |       |
| Ignition coil                              | Integrated in distributor                                        | ○              | ○   | ○        | ○         |        |       |
| Crankshaft position sensor                 |                                                                  | ○              | ○   | ○        |           | ○      |       |
| Power transistor                           |                                                                  | ○              | ○   | ○        | ○         |        |       |
| Mass air flow sensor                       | Air horn                                                         | ○              | ○   | ○        |           | ○      |       |
| Intake air temperature sensor              | With air flow meter                                              | ○              | ○   | ○        |           | ○      |       |
| Engine coolant temperature sensor          | Thermostat housing                                               | ○              | ○   | ○        |           | ○      |       |
| Accelerator pedal position sensors 1 and 2 | Integrated in accelerator work unit (accelerator pedal assembly) | ○              | ○   | ○        |           | ○      |       |
| Fuel pump                                  | Integrated in fuel tank                                          | ○              |     | ○        | ○         |        |       |
| Fuel pressure regulator                    |                                                                  | ○              |     | ○        | ○         |        |       |
| Heated oxygen sensor                       | (Vehicle side)                                                   | ○              | ○   | ○        |           | ○      |       |
| Vehicle speed sensor                       | (Vehicle side)                                                   | ○              | ○   | ○        |           | ○      |       |
| ECM                                        | (Vehicle side)                                                   | ○              | ○   | ○        |           | ○      |       |
| ECM & IGN coil relay                       | (Vehicle side)                                                   | ○              | ○   | ○        |           | ○      |       |
| Stop lamp switch                           | (Vehicle side)                                                   | ○              | ○   | ○        |           |        | ○     |
| Throttle control motor relay               | (Vehicle side)                                                   | ○              | ○   | ○        |           |        | ○     |
| Fuel pump relay                            | (Vehicle side)                                                   | ○              |     |          |           |        | ○     |
| Vaporizer                                  | (Vehicle side)                                                   |                | ○   | ○        |           |        | ○     |
| LPG interception valve                     | (Vehicle side)                                                   |                | ○   | ○        |           |        | ○     |

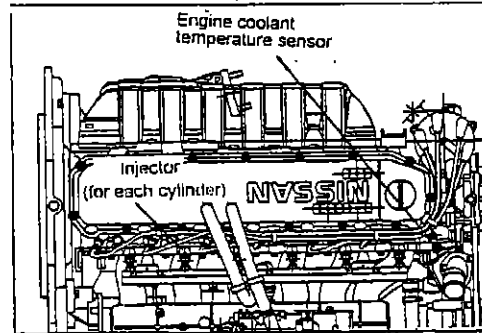
## TROUBLE DIAGNOSIS

### ECM Component (Cont'd)

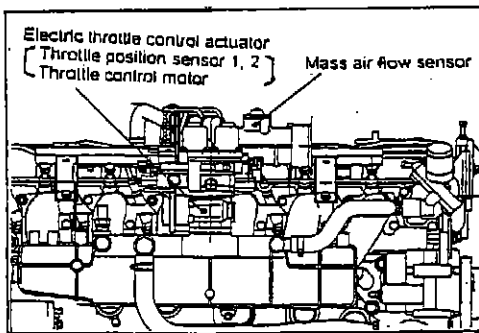
ECM



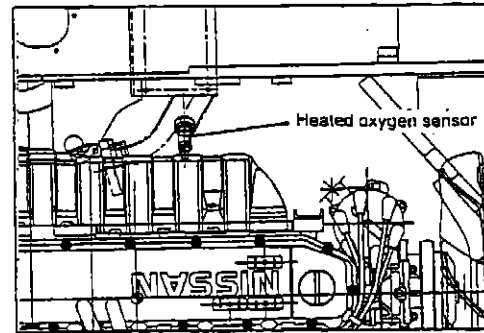
Engine coolant temperature sensor  
Fuel injector



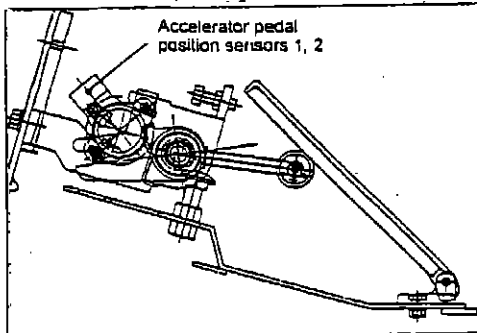
Electric throttle control actuator  
Mass air flow sensor



Heated oxygen sensor



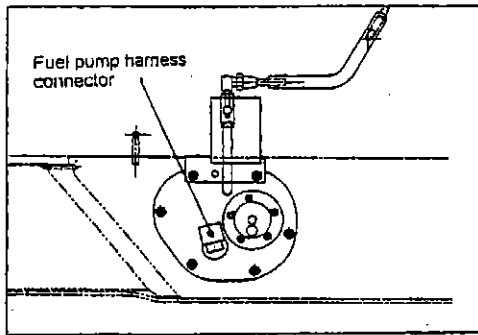
Accelerator pedal position sensors 1, 2



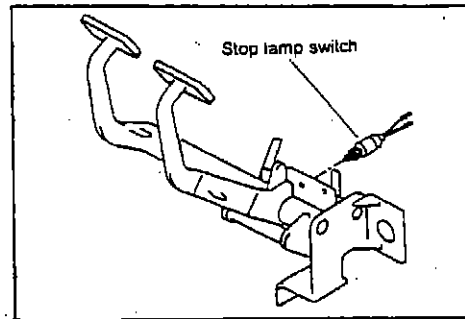
## TROUBLE DIAGNOSIS

### Component Parts Location (Cont'd)

Fuel pump

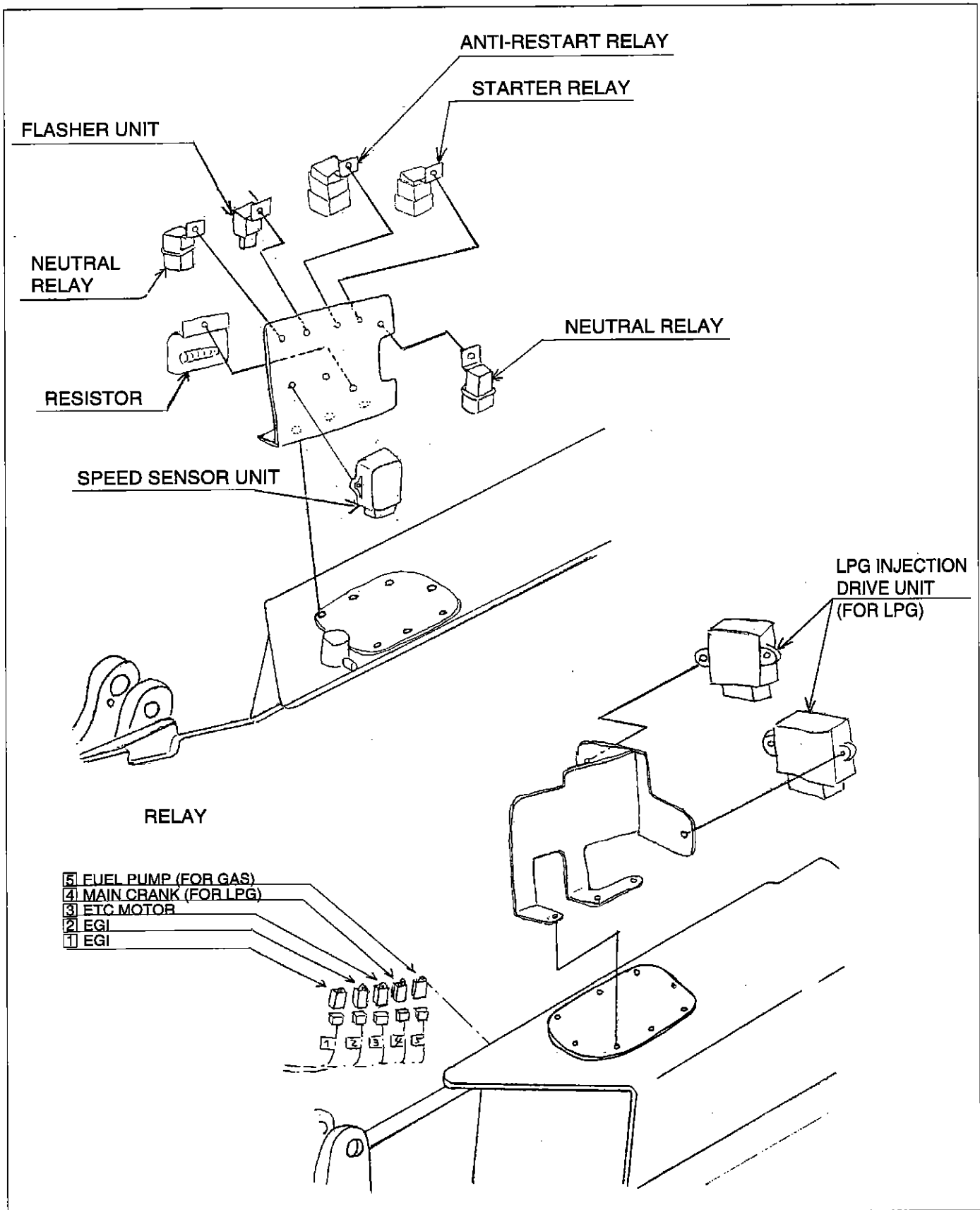


Stop lamp switch



## TROUBLE DIAGNOSIS

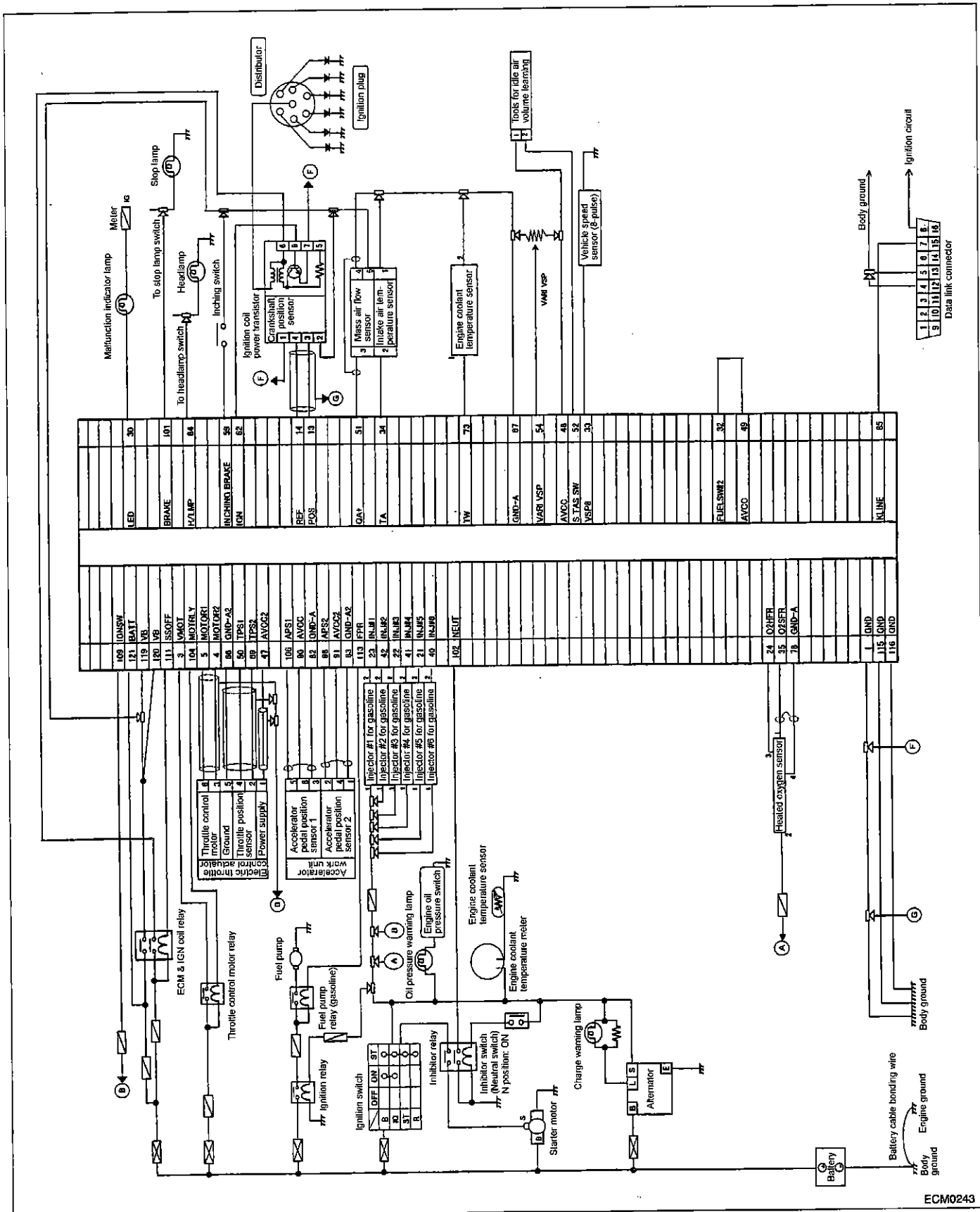
### ELECTRIC PARTS



# TROUBLE DIAGNOSIS

## Circuit Diagram

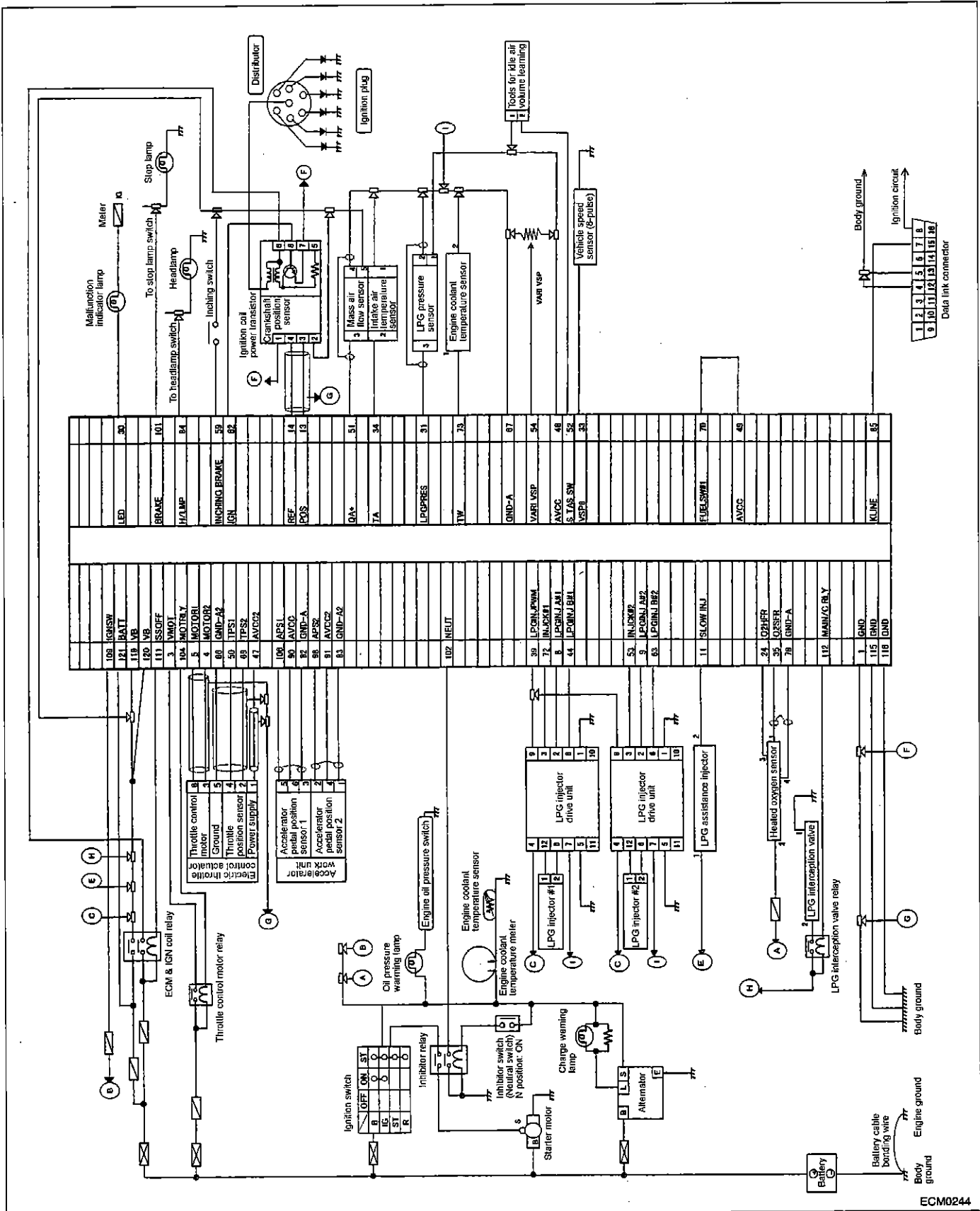
1.



# TROUBLE DIAGNOSIS

## Circuit Diagram (Cont'd)

2.

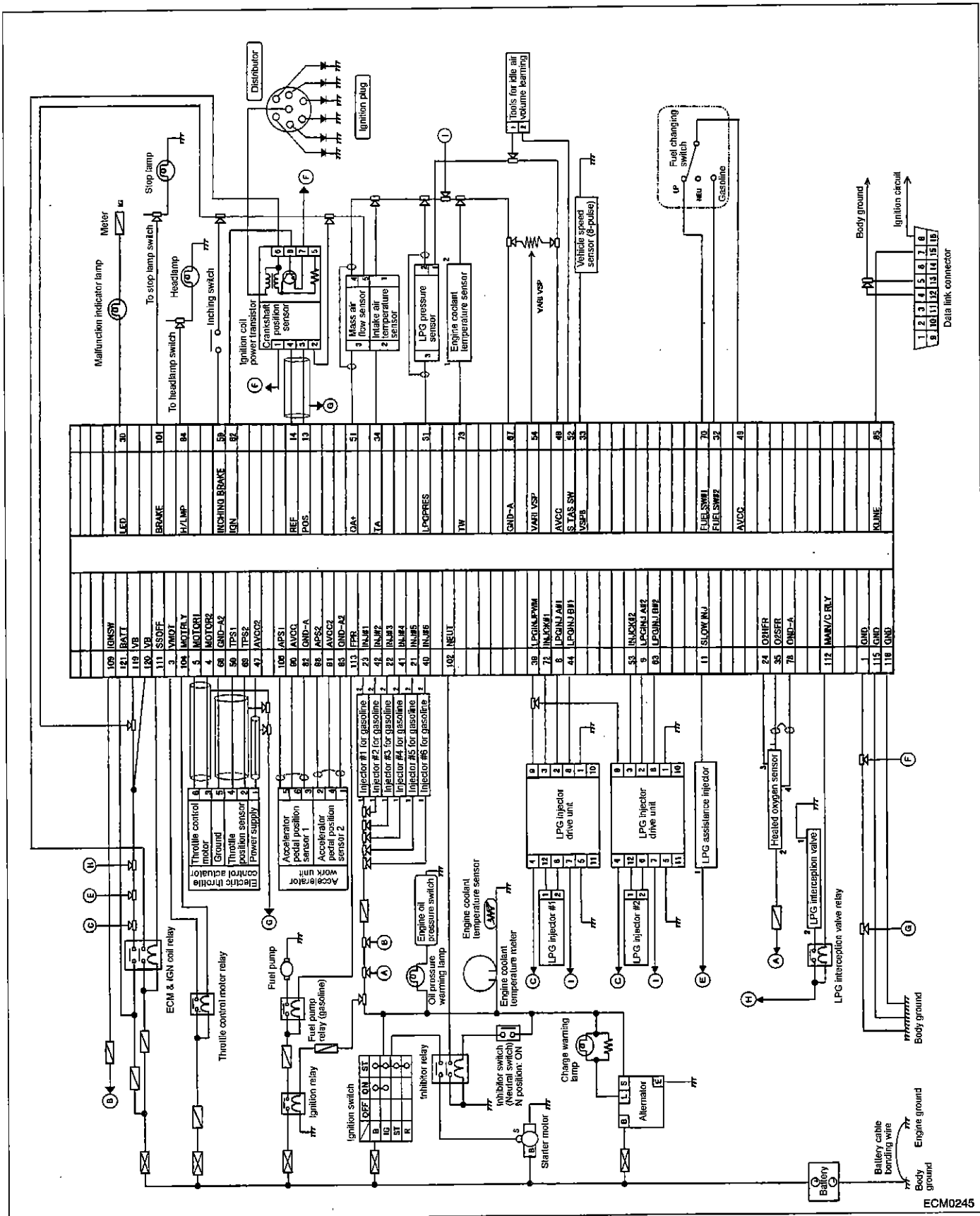


ECM0244

# TROUBLE DIAGNOSIS

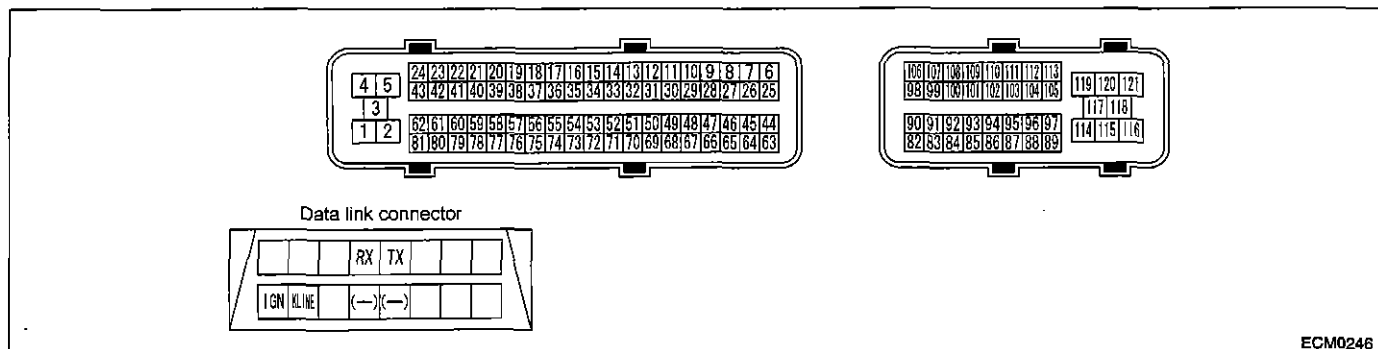
## Circuit Diagram (Cont'd)

3.



## TROUBLE DIAGNOSIS

### ECM Terminal Layout



ECM0246

The symbol in ( ) next to terminal numbers indicates the data link connector.

| Terminal | Description                               |
|----------|-------------------------------------------|
| 1        | ECM ground                                |
| 2        | —                                         |
| 3        | Throttle control motor relay power supply |
| 4        | Throttle control motor (Close)            |
| 5        | Throttle control motor (Open)             |
| 6        | —                                         |
| 7        | —                                         |
| 8        | LPG injector 1                            |
| 9        | LPG injector 2                            |
| 10       | —                                         |
| 11       | LPG assistance injector                   |
| 12       | —                                         |
| 13       | Crankshaft position sensor 1° (POS)       |
| 14       | Crankshaft position sensor 120° (REF)     |
| 15       | —                                         |
| 16       | —                                         |
| 17       | —                                         |
| 18       | —                                         |
| 19       | —                                         |
| 20       | —                                         |
| 21       | Injector No. 5                            |
| 22       | Injector No. 3                            |
| 23       | Injector No. 1                            |
| 24       | Heated oxygen sensor heater               |
| 25       | —                                         |
| 26       | —                                         |
| 27       | —                                         |
| 28       | —                                         |
| 29       | —                                         |
| 30       | MIL                                       |
| 31       | LPG fuel pressure sensor                  |
| 32       | Fuel changing switch 2 (Gasoline)         |
| 33       | Vehicle speed                             |
| 34       | Intake air temperature sensor             |

## TROUBLE DIAGNOSIS

| Terminal    | Description                                         |
|-------------|-----------------------------------------------------|
| 35          | Heated oxygen sensor                                |
| 36          | -                                                   |
| 37          | -                                                   |
| 38          | -                                                   |
| 39          | LPG injector drive keeping                          |
| 40          | Injector No. 6                                      |
| 41          | Injector No. 4                                      |
| 42          | Injector No. 2                                      |
| 43          | -                                                   |
| 44          | LPG injector drive intake 1                         |
| 45          | -                                                   |
| 46          | -                                                   |
| 47          | Sensor power supply (Throttle position sensor)      |
| 48          | Sensor power supply                                 |
| 49          | Fuel changing switch power supply                   |
| 50          | Throttle position sensor 1                          |
| 51          | Mass air flow sensor                                |
| 52          | Idle air volume learning operation                  |
| 53          | LPG injector check 2                                |
| 54          | Maximum vehicle speed shifting                      |
| 55          | -                                                   |
| 56          | -                                                   |
| 57          | -                                                   |
| 58          | -                                                   |
| 59          | Inching switch                                      |
| 60          | -                                                   |
| 62          | Ignition signal (power transmission drive signal)   |
| 63          | LPG injector drive intake 2                         |
| 64          | -                                                   |
| 65          | -                                                   |
| 66          | Sensor ground (Throttle position sensor)            |
| 67          | Sensor ground                                       |
| 68          | -                                                   |
| 69          | Throttle position sensor 2                          |
| 70          | Fuel changing switch 1 (LPG)                        |
| 71          | -                                                   |
| 72          | LPG injector check 1                                |
| 73          | Engine coolant temperature sensor                   |
| 74          | -                                                   |
| 75          | -                                                   |
| 76          | -                                                   |
| 77          | -                                                   |
| 78          | Sensor ground (Heated oxygen sensor)                |
| 79          | -                                                   |
| 82          | Sensor ground (Accelerator pedal position sensor 1) |
| 83          | Sensor ground (Accelerator pedal position sensor 2) |
| 84          | Headlamp switch                                     |
| 85 (K LINE) | K-line (ECM data transmit/receive)                  |

## TROUBLE DIAGNOSIS

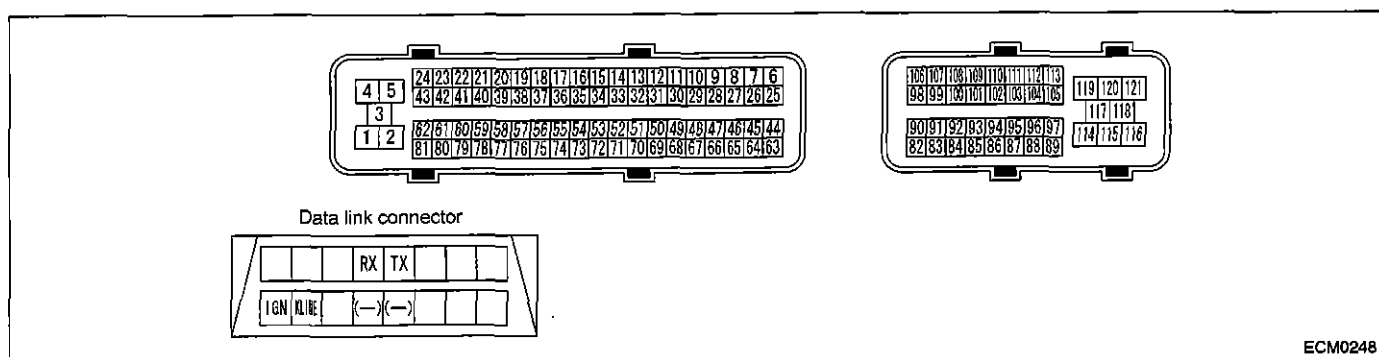
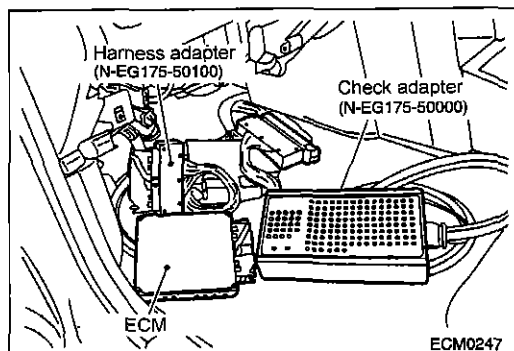
| Terminal  | Description                                      |
|-----------|--------------------------------------------------|
| 86        | —                                                |
| 87        | —                                                |
| 88        | —                                                |
| 89        | —                                                |
| 90        | Accelerator pedal position sensor 1 power supply |
| 91        | Accelerator pedal position sensor 2 power supply |
| 92        | —                                                |
| 93        | —                                                |
| 94        | —                                                |
| 95        | —                                                |
| 96        | —                                                |
| 97        | —                                                |
| 98        | Accelerator pedal position sensor 2              |
| 99        | —                                                |
| 100       | —                                                |
| 101       | Stop lamp switch                                 |
| 102       | PNP switch                                       |
| 103       | —                                                |
| 104       | Throttle control motor relay                     |
| 105       | —                                                |
| 106       | Accelerator pedal position sensor 1              |
| 107       | —                                                |
| 108       | —                                                |
| 109 (IGN) | Ignition switch                                  |
| 110       | —                                                |
| 111       | ECM & IGN coil relay                             |
| 112       | LPG interception valve relay                     |
| 113       | Fuel pump relay                                  |
| 114       | —                                                |
| 115 (—)   | ECM ground                                       |
| 116 (—)   | ECM ground                                       |
| 117       | —                                                |
| 118       | —                                                |
| 119       | Power supply for ECM                             |
| 120       | Power supply for ECM                             |
| 121       | Power supply for ECM (Back-up)                   |

## TROUBLE DIAGNOSIS

### ECM Input/Output Signal Specifications

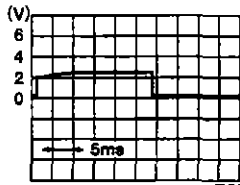
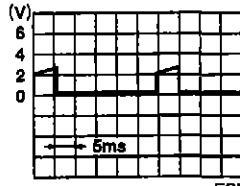
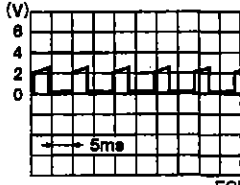
#### REFERENCE VALUE LIST

- Voltages is measured with a circuit tester, and the sample waveforms obtained with an oscilloscope are shown below for each ECM terminal. Measurement data varies depending on variation in parts as well as many other factors. Such factors include vehicle history, driving conditions, environmental conditions, maintenance status, measuring instrument/method, etc. Data shown below are reference values.

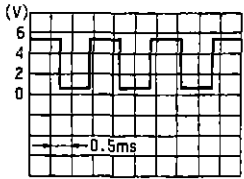
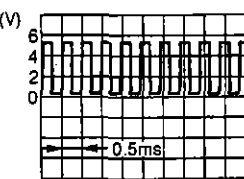
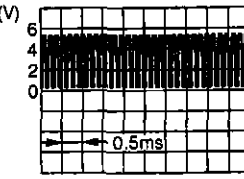


| Terminal | Signal name                 | Condition                                                                          | Data (DC value) |
|----------|-----------------------------|------------------------------------------------------------------------------------|-----------------|
| 24       | Heated oxygen sensor heater | At idle after warming up                                                           | Approx. 0.3V    |
|          |                             | Approx. ? rpm or more                                                              | Battery voltage |
| 113      | Fuel pump relay             | For approximately 1 second after ignition switch ON                                | Approx. 1V      |
|          |                             | After that                                                                         | Battery voltage |
|          |                             | At cranking, engine running                                                        | Approx. 1V      |
| 111      | ECM & IGN coil relay        | For approximately 10 seconds when ignition switch ON and after ignition switch OFF | Approx. 1V      |
|          |                             | Ignition switch OFF                                                                | Battery voltage |

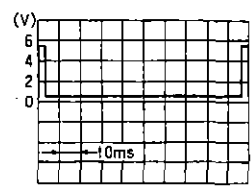
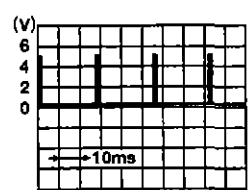
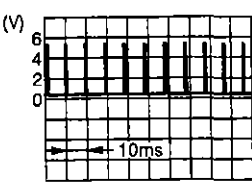
## TROUBLE DIAGNOSIS

| Terminal    | Signal name                                       | Condition                 | Data (DC value)                                                                                                             |
|-------------|---------------------------------------------------|---------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| 62          | Ignition signal (power transmission drive signal) | At cranking               | At cranking: Approx. 0.5V<br><br>ECM0249 |
|             |                                                   | At idle after warming up  | At idling: Approx. 0.5V<br><br>ECM0250   |
|             |                                                   | At approx. 2,000 rpm      | Approx. 0.9V<br><br>ECM0251             |
| 101         | Stop lamp switch                                  | Brake pedal released      | Approx. 0V                                                                                                                  |
|             |                                                   | Brake pedal depressed     | Battery voltage                                                                                                             |
| 109 (IGN)   | Ignition switch                                   | Ignition switch OFF       | Approx. 0V                                                                                                                  |
|             |                                                   | Ignition switch ON        | Battery voltage                                                                                                             |
| 102         | PNP switch                                        | N position                | Approx. 0V                                                                                                                  |
|             |                                                   | Other than above          | Battery voltage (A/T models)<br>Approx. 4.8V (M/T models)                                                                   |
| 85 (K LINE) | K-line (ECM data transmit/receive)                | When connected to SST     | Approx. 6.6 - Battery voltage                                                                                               |
|             |                                                   | When not connected to SST | Approx. 6V                                                                                                                  |
| 84          | Headlamp switch                                   | Lighting switch OFF       | Approx. 0V                                                                                                                  |
|             |                                                   | Lighting switch ON        | Battery voltage                                                                                                             |
| 67          | Sensor ground                                     | Always                    | Approx. 0V                                                                                                                  |
| 115         | ECM ground                                        | Always                    | Approx. 0V                                                                                                                  |
| 116         |                                                   |                           |                                                                                                                             |
| 1           |                                                   |                           |                                                                                                                             |

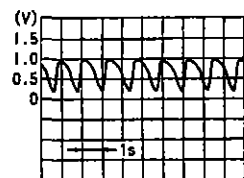
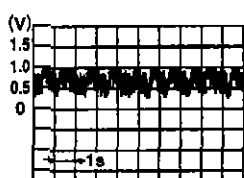
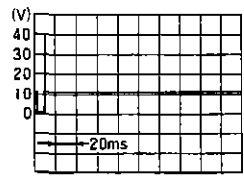
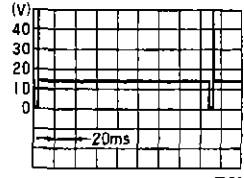
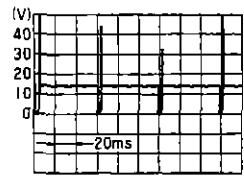
## TROUBLE DIAGNOSIS

| Terminal | Signal name                                      | Condition                          | Data (DC value)                                                                                                             |
|----------|--------------------------------------------------|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| 13       | Crankshaft position sensor 1* (POS)              | At cranking                        | At cranking: Approx. 2.6V<br><br>ECM0252 |
|          |                                                  | At idle after warming up           | At idling: Approx. 2.5V<br><br>ECM0253   |
|          |                                                  | At approx. 2,000 rpm               | Approx. 2.5V<br><br>ECM0254             |
| 91       | Accelerator pedal position sensor 2 power supply | Ignition switch ON, engine running | Approx. 2.5V                                                                                                                |
| 48       | Sensor power supply                              | Ignition switch ON, engine running | Approx. 5V                                                                                                                  |
| 121      | Power supply for ECM (Back-up)                   | Always                             | Battery voltage                                                                                                             |
| 47       | Electric throttle control actuator power supply  | Ignition switch ON, engine running | Approx. 5V                                                                                                                  |
| 78       | Heated oxygen sensor ground                      | Always                             | Approx. 0V                                                                                                                  |
| 82       | Accelerator pedal position sensor 1 ground       | Always                             | Approx. 0V                                                                                                                  |
| 90       | Accelerator pedal position sensor 1 power supply | Ignition switch ON, engine running | Approx. 5V                                                                                                                  |

## TROUBLE DIAGNOSIS

| Terminal | Signal name                           | Condition                                                                      | Data (DC value)                                                                                                             |
|----------|---------------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| 14       | Crankshaft position sensor 120° (REF) | At cranking                                                                    | At cranking: Approx. 0.5V<br><br>ECM0255 |
|          |                                       | At idle after warming up                                                       | At idling: Approx. 0.5V<br><br>ECM0256   |
|          |                                       | At approx. 2,000 rpm                                                           | Approx. 0.5V<br><br>ECM0257             |
| 51       | Mass air flow sensor                  | Ignition switch ON                                                             | Approx. 1V                                                                                                                  |
|          |                                       | At cranking                                                                    | Approx. 1.5V                                                                                                                |
|          |                                       | At idle after warming up                                                       | Approx. 1.3V                                                                                                                |
|          |                                       | At approx. 2,000 rpm                                                           | Approx. 1.5V                                                                                                                |
| 50       | Throttle position sensor 1            | At idle after warming up                                                       | Approx. 0.6V                                                                                                                |
|          |                                       | Ignition switch ON with engine stopped<br>Accelerator pedal is fully depressed | Approx. 0.75V                                                                                                               |
|          |                                       | Ignition switch ON with engine stopped<br>Accelerator pedal is released        | Approx. 0.75V                                                                                                               |
|          |                                       | At approx. 2,000 rpm                                                           | Approx. 0.7V                                                                                                                |
| 69       | Throttle position sensor 2            | At idle after warming up                                                       | Approx. 4.5V                                                                                                                |
|          |                                       | Ignition switch ON with engine stopped<br>Accelerator pedal is fully depressed | Approx. 4.35V                                                                                                               |
|          |                                       | Ignition switch ON with engine stopped<br>Accelerator pedal is released        | Approx. 4.35V                                                                                                               |
|          |                                       | At approx. 2,000 rpm                                                           | Approx. 4.4V                                                                                                                |
| 106      | Accelerator pedal position sensor 1   | At Idle                                                                        | Approx. 0.6V                                                                                                                |
|          |                                       | Ignition switch ON with engine stopped<br>Accelerator pedal is fully depressed | Approx. 0.6V                                                                                                                |
|          |                                       | Ignition switch ON with engine stopped<br>Accelerator pedal is released        | Approx. 4.2V                                                                                                                |
|          |                                       | At approx. 2,000 rpm                                                           | Approx. 0.65V                                                                                                               |
| 98       | Accelerator pedal position sensor 2   | At Idle                                                                        | Approx. 0.3V                                                                                                                |
|          |                                       | Ignition switch ON with engine stopped<br>Accelerator pedal is fully depressed | Approx. 0.3V                                                                                                                |
|          |                                       | Ignition switch ON with engine stopped<br>Accelerator pedal is released        | Approx. 2V                                                                                                                  |
|          |                                       | At approx. 2,000 rpm                                                           | Approx. 0.35V                                                                                                               |

## TROUBLE DIAGNOSIS

| Terminal                         | Signal name                                | Condition                                       | Data (DC value)                                                                                                                                                                                                                  |
|----------------------------------|--------------------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 34                               | Intake air temperature sensor              | Intake air temperature is approx. 20°C (68°F).  | Approx. 3.5V                                                                                                                                                                                                                     |
|                                  |                                            | Intake air temperature is approx. 80°C (176°F). | Approx. 1.2V                                                                                                                                                                                                                     |
| 83                               | Accelerator pedal position sensor 2 ground | Always                                          | Approx. 0V                                                                                                                                                                                                                       |
| 35                               | Heated oxygen sensor                       | At idle after warming up                        | Air conditioner OFF:<br>Clamp between 0 - 0.7V<br>Air conditioner ON:<br>Changes between approx. 0 - 0.3V ↔ approx. 0.5 - 1.0V<br><br>ECM0258 |
|                                  |                                            | At approx. 2,000 rpm                            | Changes between approx. 0 - 0.3V ↔ approx. 0.5 - 1.0V<br><br>ECM0259                                                                         |
| 73                               | Engine coolant temperature sensor          | Engine coolant temperature is approx. 20°C.     | Approx. 5V                                                                                                                                                                                                                       |
|                                  |                                            | Engine coolant temperature is approx. 80°C.     | Approx. 1.2V                                                                                                                                                                                                                     |
| 21<br>22<br>23<br>40<br>41<br>42 | Injector drive signal                      | At cranking                                     | Approx. 10.5V<br><br>ECM0260                                                                                                                |
|                                  |                                            | At idle after warming up                        | Battery voltage<br><br>ECM0261                                                                                                              |
|                                  |                                            | At approx. 2,000 rpm                            | Relatively lower than battery voltage<br><br>ECM0262                                                                                        |

## TROUBLE DIAGNOSIS

| Terminal   | Signal name                               | Condition                                                                                                       | Data (DC value)                           |
|------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| 119<br>120 | Power supply for ECM                      | Ignition switch ON, engine running                                                                              | Battery voltage                           |
| 104        | Throttle control motor relay              | Ignition switch ON, engine running                                                                              | Approx. 1V                                |
| 3          | Throttle control motor relay power supply | Always                                                                                                          | Battery voltage                           |
| 5          | Throttle control motor (Open)             | At idle after warming up<br>At approx. 2000 rpm                                                                 | Approx. 0.1 to 0.15V                      |
| 4          | Throttle control motor (Close)            | At idle after warming up<br>At approx. 2000 rpm                                                                 | Approx. 2 - 2.5V                          |
| 32         | Fuel changing switch 2 (Gasoline)         | Changing switch ON (At gasoline side)<br>Changing switch ON (At LPG side or neutral)                            | Approx. 5V<br>Approx. 0V                  |
| 49         | Fuel changing switch power supply         | Changing switch ON<br>Changing switch OFF (At neutral)                                                          | Approx. 5V<br>Approx. 0V                  |
| 70         | Fuel changing switch 1 (LPG)              | Changing switch ON (At LPG side)<br>Changing switch OFF (At LPG side or neutral)                                | Approx. 5V<br>Approx. 0V                  |
| 112        | LPG interception valve relay              | When ignition switch is ON and for approximately 10 seconds after ignition switch is OFF<br>Ignition switch OFF | Battery voltage<br>Approx. 0V             |
| 52         | Idle air volume learning operation        | When connecting tools for idle air volume learning<br>When not connecting tools for idle air volume learning    | Approx. 1.5V<br>Approx. 0V                |
| 54         | Maximum speed shifting                    |                                                                                                                 | It varies depending on setting condition. |
| 33         | Vehicle speed sensor signal               | Vehicle stopped                                                                                                 | Approx. 11V or approx. 1V                 |
| 59         | Inching switch                            | Inching switch ON<br>Inching switch OFF                                                                         | Battery voltage<br>Approx. 0V             |

## TROUBLE DIAGNOSIS

### SST

#### DESCRIPTION

- SST executes the following functions using the combination of data reception, instructions, and transmission from the ECM via the communication line.

| Diagnosis test mode | Function                                                                                                                                                                                                                                                                                                                |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WORK SUPPORT        | <ul style="list-style-type: none"> <li>• Reduces the preparation work necessary for inspecting.</li> <li>• Displays input/output signal data related to the work.</li> <li>• Allows setting control target values of idle speed or ignition timing.</li> <li>• Allows performing "Idle Air Volume Learning".</li> </ul> |
| SELF-DIAG RESULTS   | <ul style="list-style-type: none"> <li>• Displays names of freeze frame data and basic inspection stored in ECM.</li> <li>• Displays data recorded when DTC is detected.</li> <li>• Erases DTCs recorded in memory.</li> </ul>                                                                                          |
| DATA MONITOR        | <ul style="list-style-type: none"> <li>• Provides useful data along with self-diagnosis results to determine the main cause.</li> <li>• Displays input/output data of ECM in real time.</li> <li>• Records and stores data.</li> <li>• Detects malfunctions in real time.</li> </ul>                                    |
| ACTIVE TEST         | <ul style="list-style-type: none"> <li>• Can be used to determine and identify the primary sources of malfunctions based on self-diagnosis results and data from DATA MONITOR.</li> <li>• Each actuator is activated after receiving a drive signal.</li> </ul>                                                         |
| ECM PART NUMBER     | <ul style="list-style-type: none"> <li>• ECM part number can be read.</li> </ul>                                                                                                                                                                                                                                        |

#### OPERATION PROCEDURE

1. Turn ignition switch OFF.
  2. Connect SST to data link connector.
  3. Turn ignition switch ON.
  4. Turn main body power supply switch ON.
  5. Displays main menu 2 seconds after displaying initial screen.
  6. Perform the necessary trouble diagnosis mode.
- Refer to "CONSULT-II Operation Manual" for further information.

#### WORK SUPPORT

SST assists with idle adjustment work. With SST, it sends an operation command to ECM, and adjustment control is performed accordingly. However, inspector performs actual adjustment work.

#### DISPLAY ITEM LIST

| Work support item                 | Description                                                                                                                                                                              |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. TARGET IDLE TIM ADJ (*)        | Allows control target value for initial ignition timing (-15 to 5°).<br>Note: To make sure that ignition timing and actual timing are the same, inspectors must use timing light.        |
| 2. FUEL PRESSURE RELEASE          | Shuts down the fuel pump and stops the engine. (While cranking, pressure in the fuel piping can be released.)                                                                            |
| 3. TARGET IGN RPM ADJ (*)         | Sets a control target value for the idle speed (0 to 250 rpm).                                                                                                                           |
| 4. "IDLE AIR VOL LEARN" clear     | Learns the minimum idle air flow amount required for idle speed control when predetermined conditions are specified following replacement of electric throttle control actuator and ECM. |
| 5. "SELF-LEARNING CONT" clear     | Clears air-fuel ratio feedback control correction coefficient.                                                                                                                           |
| 6. LPG FUEL PRESSURE RELEASE      | Operate fuel interception valve before removing fuel piping, and then operate and control ignition. Engine is stopped when the fuel is consumed.                                         |
| 7. "LPG SELF-LEARNING CONT" clear | Initialize (clear) air-fuel ratio learned value.                                                                                                                                         |

\*: This function is not necessary in the usual service procedure.

## TROUBLE DIAGNOSIS

### SST (Cont'd)

#### SELF-DIAGNOSTIC RESULTS

When a malfunction occurs in ECM input/output signal circuit, the malfunctioning circuit is recorded. Then, that particular system name and basic inspection items are displayed. Also, malfunction data recorded is displayed.

#### OPERATION PROCEDURE

##### [EXAMPLE: WHEN THERE IS A MALFUNCTION IN MASS AIR FLOW SENSOR]

1. Select cursor on SELF-DIAG RESULTS screen with direction key, and then push "YES".

| SELF-DIAG RESULTS MENU       |    |    |    |
|------------------------------|----|----|----|
| 1. DISPLAY SELF-DIAG RESULTS |    |    |    |
| 2. ERASE SELF-DIAG RESULTS   |    |    |    |
| 3. DISPLAY FREEZE FRAME DATA |    |    |    |
| F1                           | F2 | F3 | F4 |

2. Basic inspection items are displayed.

#### CAUTION:

- Inspection items are not displayed in some self-diagnostic results.

| DTC                     | RESULT            | TIME |    |
|-------------------------|-------------------|------|----|
| P0102                   | MAF SEN/CIRCUIT   | 0    |    |
| P0110                   | AIR TEMP SEN/CIRC | 1st  |    |
| Number of Diag. Code: 1 |                   |      |    |
| Press "YES"             |                   |      |    |
| Print                   | F2                | F3   | F4 |

3. When "3. RECORDED DATA" on SELF-DIAG RESULTS screen in step 1 is touched, "FREEZE FRAME DATA", which shows the operation state when the malfunction is detected, is displayed.

|               |           |    |    |
|---------------|-----------|----|----|
| ENGINE SPEED  | 1038 rpm  |    |    |
| FREEZE CODE   | P0102     |    |    |
| FUEL SYS-B1   | MODE5     |    |    |
| COOLANT TEMP  | 85 °C     |    |    |
| L-FUEL TRM-B1 | 100 %     |    |    |
| S-FUEL TRM-B1 | 100 %     |    |    |
| VEHICL SPEED  | 0 km/h    |    |    |
| B/FUEL SCHDL  | 7.9 msec. |    |    |
| INT/A TEMP SE | -45 °C    |    |    |
| Print         | F2        | F3 | F4 |

4. Select "2. MEMORY ERASE" and push "YES", and then erase self-diagnostic result.

|                        |    |    |    |
|------------------------|----|----|----|
| CLEAR DIAGNOSTIC CODE? |    |    |    |
| Press "YES" or "NO"    |    |    |    |
| F1                     | F2 | F3 | F4 |

## TROUBLE DIAGNOSIS

### SST (Cont'd) DISPLAY ITEM LIST

| Diagnosis item                                     | Malfunction Return Condition                                                                                                                                                                                                                                                                                                                                       | Display                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | MIL | Trip |
|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|
| NO DTC                                             | • No malfunction is detected in any of the circuits.                                                                                                                                                                                                                                                                                                               | NO DTC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | -   | -    |
| Mass air flow sensor (MAFS)                        | <ul style="list-style-type: none"> <li>• When engine is stopped (ignition switch ON) and mass air flow sensor output voltage has been 9V or more for predetermined period.</li> <li>• When engine is running and mass air flow sensor output voltage has been 5V or less for predetermined period.</li> </ul>                                                      | Mass air flow sensor<br>LOW INPUT OPEN [P0102]<br>HIGH INPUT SHORT [P0103]                                                                                                                                                                                                                                                                                                                                                                                                                        | ON  | 1    |
| Engine coolant temperature sensor (ECTS) (CIRCUIT) | • Engine coolant temperature sensor output voltage has been approximately 8V or more (open) or less than 0.06V (short) for predetermined period.                                                                                                                                                                                                                   | Engine coolant temperature sensor<br>LOW INPUT OPEN [P0117]<br>HIGH INPUT SHORT [P0118]                                                                                                                                                                                                                                                                                                                                                                                                           | ON  | 2    |
| Throttle position sensor signal circuit            | <ul style="list-style-type: none"> <li>• Sensor power supply voltage has a malfunction.</li> <li>• Throttle position sensor signal circuit is open or shorted.</li> <li>• A malfunction occurs in relation between throttle position sensors 1 and 2.</li> <li>• When the fully-closed position learning value was unusually small or was not learning.</li> </ul> | Throttle position sensor<br>TPS2 LOW INPUT OPEN [P0122]<br>TPS2 HIGH INPUT SHORT [P0123]<br>TPS1 LOW INPUT [P0222]<br>TPS1 HIGH INPUT [P0223]<br>Electric throttle control motor power supply short [P1124]<br>Electric throttle control motor power supply open [P1126]<br>Electric throttle control motor short [P1128]<br>TSP1-2 fully-closed learned value decrease [P1225]<br>TSP fully-closed learned value malfunctioning update [P1226]<br>TSP1-2 [P2135]<br>TPSFThrottle position sensor | ON* | 1    |
| Acceleration sensor signal circuit                 | <ul style="list-style-type: none"> <li>• Accelerator pedal position sensor signal circuit is open or shorted.</li> <li>• A malfunction occurs in relation between accelerator pedal position sensors 1 and 2.</li> </ul>                                                                                                                                           | APP SENSOR<br>APS1 LOW INPUT [P2122]<br>APS1 HIGH INPUT [P2123]<br>APS2 LOW INPUT [P2127]<br>APS2 HIGH INPUT [P2128]<br>APS1 [P2138]<br>APSFAccelerator position sensor                                                                                                                                                                                                                                                                                                                           | ON* | 1    |
| O <sub>2</sub> Sensor signal (open circuit)        | • Heated oxygen sensor signal circuit is open.                                                                                                                                                                                                                                                                                                                     | O <sub>2</sub> Sensor B1<br>Fr O <sub>2</sub> /S Open [P0134]                                                                                                                                                                                                                                                                                                                                                                                                                                     | ON  | 2    |
| O <sub>2</sub> Sensor signal (short circuit)       | • Heated oxygen sensor output voltage is higher than normal (2V or more).                                                                                                                                                                                                                                                                                          | O <sub>2</sub> Sensor B1<br>FR O <sub>2</sub> /S VOLTAGE [P0132]                                                                                                                                                                                                                                                                                                                                                                                                                                  | ON  | 2    |
| O <sub>2</sub> Sensor heater signal circuit        | • Heated oxygen sensor signal circuit is open.                                                                                                                                                                                                                                                                                                                     | O <sub>2</sub> HTR_B1<br>Fr O <sub>2</sub> HEATER LOW INPUT [P0031]<br>Fr O <sub>2</sub> HEATER HIGH INPUT [P0032]                                                                                                                                                                                                                                                                                                                                                                                | ON  | 2    |
| OVERHEAT (STEP 1)                                  | • When engine coolant temperature is 110°C.                                                                                                                                                                                                                                                                                                                        | OVERHEAT STEP #1 [P1218]                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ON  | 1    |

## TROUBLE DIAGNOSIS

| Diagnosis item                                           | Malfunction Return Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Display                                                                                                                                               | MIL | Trip |
|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|
| LPG injector 1 malfunction                               | <ul style="list-style-type: none"> <li>LPG injector signal circuit is open.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                           | LPG F/INJ 1 MALFUNCTION (INJECTION) [P1240]                                                                                                           | -   | -    |
| LPG injector 1 malfunction                               | <ul style="list-style-type: none"> <li>LPG injector signal circuit is open.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                           | LPG F/INJ 1 malfunction (No injection) [P1241]                                                                                                        | -   | -    |
| LPG injector 2 malfunction                               | <ul style="list-style-type: none"> <li>LPG injector signal circuit is open.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                           | LPG F/INJ 2 MALFUNCTION (INJECTION) [P1242]                                                                                                           | -   | -    |
| LPG injector 2 malfunction                               | <ul style="list-style-type: none"> <li>LPG injector signal circuit is open.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                           | LPG F/INJ 2 MALFUNCTION (NO INJECTION) [P1243]                                                                                                        | -   | -    |
| LPG fuel pressure sensor malfunction                     | <ul style="list-style-type: none"> <li>LPG fuel pressure sensor output voltage is higher than normal (?V or more).</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                    | LPG FUEL PRESSURE SENSOR HIGH INPUT MALFUNCTION [P1245]                                                                                               | -   | -    |
| LPG vaporizer malfunction                                | <ul style="list-style-type: none"> <li>LPG fuel pressure is excessively high.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                         | LPG FUEL PRESSURE EXCESSIVELY HIGH MALFUNCTION [P1249]                                                                                                | -   | -    |
| Throttle/Accelerator position sensor power supply        | <ul style="list-style-type: none"> <li>Power supply of accelerator position sensor and throttle position sensor is shorted.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                           | AVCC SHORT [P1229]                                                                                                                                    | -   | -    |
| Crankshaft position sensor 1&deg; (POS) signal circuit   | <ul style="list-style-type: none"> <li>The crankshaft position sensor (POS) signal is not detected for a predetermined time at the engine start or during engine running (during camshaft position sensor (REF) signal input).</li> <li>The crankshaft position sensor (POS) signal irregular waveform is detected for a predetermined time during engine running (during camshaft position sensor (REF) signal input).</li> </ul>                                                                                               | CKP SEN/CIRCUIT [P0335]<br>HALL POS SENSOR POPEN DIAGNOSIS AT START [P0335]<br>Hall POS SENSOR INSTANTANEOUS/NOISE/DAMAGED TEETH DIAGNOSIS [P0335]    | ON  | 2    |
| Crankshaft position sensor 120&deg; (REF) signal circuit | <ul style="list-style-type: none"> <li>At start-up, no camshaft position sensor (REF) signal has been detected for more than a predetermined period.</li> <li>The camshaft position sensor (REF) signal is not detected for a predetermined time during engine running (during crankshaft position sensor (POS) signal input).</li> <li>A camshaft position sensor (REF) signal irregular waveform is detected for a predetermined time during engine running (during crankshaft position sensor (POS) signal input).</li> </ul> | CMP SEN/CIRCUIT [P0340]<br>Hall PHASE SENSOR OPEN DIAGNOSIS AT START [P0340]<br>Hall PHASE SENSOR INSTANTANEOUS/NOISE/DAMAGED TEETH DIAGNOSIS [P0335] | ON  | 2    |
| Vehicle speed sensor                                     | <ul style="list-style-type: none"> <li>Vehicle sensor signal has not been input under some condition for a predetermined time during driving after warming up.</li> </ul>                                                                                                                                                                                                                                                                                                                                                        | VEH SPEED SEN/CIRC [P0500]<br>ECM VEH SPEED SEN/CIRC [P0500]                                                                                          | ON  | 2    |

## TROUBLE DIAGNOSIS

| Diagnosis item             | Malfunction Return Condition                                                                         | Display                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | MIL | Trip          |
|----------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|---------------|
| Engine control module      | <ul style="list-style-type: none"> <li>CPU system or circuits in ECM have a malfunction.</li> </ul>  | ECM [P0605]<br>SYNC MONITORING<br>PARTS DIAGNOSIS<br>[P0605]<br>PARTS SETTING<br>CALCULATION<br>EXERCISE DIAGNOSIS<br>[P0605] ALU FUNCTION<br>DIAGNOSIS [P0605]<br>CALCULATION RESULT<br>COLLECTION FUNCTION<br>DIAGNOSIS [P0605]<br>AD DIAGNOSIS [P0605]<br>CPU FUNCTION<br>DIAGNOSIS [P0605]<br>TPS 4 TIME INPUT<br>DIAGNOSIS [P0605]<br>VAPO M-S diagnosis<br>[P0605]<br>VAPO M-S diagnosis<br>[P0605]<br>THROTTLE TARGET<br>POSITION DIAGNOSIS<br>[P0605]<br>Engine coolant temperature<br>sensor M-S diagnosis<br>[P0605]<br>TQH0AP MALFUNCTION<br>DIAGNOSIS [P0605]<br>TTEPTD DIAGNOSIS<br>[P0605]<br>TATE DIAGNOSIS [P0605]<br>TTEP DIAGNOSIS [P0605]<br>S/SOFF system diagnosis<br>[P0605]<br>TASK EXECUTION<br>CYCLE DIAGNOSIS<br>(MAIN) [P0605]<br>ROM FUNCTION<br>DIAGNOSIS (MAIN)<br>[P0605]<br>RAM FUNCTION<br>DIAGNOSIS (MAIN)<br>[P0605]<br>WTD FUNCTION<br>DIAGNOSIS (MAIN)<br>[P0605]<br>TIMER/CLOCK<br>FUNCTION DIAGNOSIS<br>(MAIN) [P0605]<br>EEP-ROM WRITING<br>DIAGNOSIS (MAIN)<br>[P0605]<br>EEP-ROM READING<br>DIAGNOSIS (MAIN)<br>[P0605]<br>ROM FUNCTION<br>DIAGNOSIS (SUB) [P0605]<br>RAM FUNCTION<br>DIAGNOSIS 2 (MAIN)<br>[P0605] | ON* | 1 or 2 (NOTE) |
| Malfunction indicator lamp | <ul style="list-style-type: none"> <li>Valve or circuit malfunction occurs several times.</li> </ul> | MIL/CIRC [P0650]<br>WARNING LAMP (VALVE<br>SYSTEM) [P0650]<br>WARNING LAMP<br>(CIRCUIT SYSTEM)<br>[P0650]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | -   | 2             |

## TROUBLE DIAGNOSIS

| Diagnosis item                       | Malfunction Return Condition                                                                                                                                                                                                                 | Display                                                                                                                                    | MIL                | Trip                          |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------|
| ECM power supply circuit             | <ul style="list-style-type: none"> <li>Power is not supplied to ECM for some time.</li> </ul>                                                                                                                                                | ECM BACK UP/CIRC [P1065]<br>BACKUP RAM SYSTEM DIAGNOSIS (MAIN) [P1065]                                                                     | ON                 | 2                             |
| Electric throttle control actuator   | <ul style="list-style-type: none"> <li>Because of mechanical malfunction of electric throttle control actuator, electric throttle control actuator does not operate normally.</li> </ul>                                                     | ETC ACTR [P1121]<br>RETURN SPRING DIAGNOSIS [P1121]<br>DEFAULT MECHANISM DIAGNOSIS [P1121]<br>THROTTLE OPEN LOCKING DIAGNOSIS [P1121]      | ON*                | 1                             |
| Electric throttle control function   | <ul style="list-style-type: none"> <li>When a malfunction occurred due to the correlation between the target throttle position and the actual throttle position.</li> <li>Over current flows into throttle motor control circuit.</li> </ul> | ETC FUNCTION/CIRC [P1122]<br>ETC FUNCTION/CIRC CONTROL SYSTEM MONITORING DIAGNOSIS [P1122]<br>THROTTLE SERVO MALFUNCTION DIAGNOSIS [P1122] | ON*                | 1                             |
| Throttle control motor relay circuit | <ul style="list-style-type: none"> <li>When throttle control motor relay has been locked ON or OFF.</li> </ul>                                                                                                                               | ETC MOT RLY/CIRC [P1123]<br>RELAY ON LOCKING DIAGNOSIS [P1123]                                                                             | ON*<br>(Locked ON) | Locked ON: 1<br>Locked OFF: 2 |
| Engine over temperature (Overheat)   | <ul style="list-style-type: none"> <li>Engine coolant temperature sensor output voltage has been approximately 0.35V or lower for a predetermined period of time. (with the coolant temperature sensor normal).</li> </ul>                   | ENG OVER TEMP [P1217]                                                                                                                      | ON                 | 1                             |
| Ignition signal system               | <ul style="list-style-type: none"> <li>Ignition signal has not been continuously generated while the engine is running.</li> </ul>                                                                                                           | IGN_SIGNAL-PRIMARY DIAGNOSIS [P0350]                                                                                                       | ON                 | 2                             |
| Brake switch signal circuit          | <ul style="list-style-type: none"> <li>Brake switch signal circuit is open or shorted.</li> </ul>                                                                                                                                            | BRAKE SW/CIRCUIT [P1805]<br>BRAKE SW/CIRCUIT [P1805]                                                                                       | ON                 | 2                             |

Note: Number of trips varies depending on diagnosis content.

## TROUBLE DIAGNOSIS

### SST (Cont'd)

Trip 1: If a malfunction is detected by self-diagnosis between the time ignition switch is turned ON (engine is running) and then turned OFF (this is defined as "trip"), MIL is lit. The corresponding DTC is recorded immediately after detection.

Trip 2: When a malfunction is detected by self-diagnosis for the first time in the first trip, a tentative DTC is recorded. If the same malfunction is detected again by self-diagnosis in the next trip (second trip), MIL is lit and the corresponding final DTC is recorded.

### SST SELF-DIAGNOSTIC RESULTS TIMING

- For items of trip 1, timing "0" is displayed immediately after detection of a malfunction.
- For items of trip 2, when a malfunction is detected for the first time (trip 1), timing "1st" is displayed. When a malfunction is detected again in the next trip (trip 2), it is displayed as "0". Accumulative counting is performed at the end of warming-up operation.

### CONDITIONS TO TURN OFF MIL

- The MIL, marked with \*, is turned off when ignition switch is turned ON (engine starts) again after normal state is resumed.
- For other self-diagnostic items, self-diagnostic results shall be erased by turning ignition switch to OFF after normal operation is resumed.

### FREEZE FRAME DATA

- Driving conditions stored at the moment a malfunction is detected and displayed.
- This data can be used to reproduce conditions leading up to the malfunction.
- If multiple DTCs exist, only the first one detected will be stored and displayed. If the same malfunction is detected several different times, the data stored first will be displayed.

### DISPLAY ITEM LIST

| Stored data item                 | Unit | Description                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FUEL SYS-B1<br>FUEL SYS-B2       | -    | Displays air-fuel ratio feedback conditions at the time a malfunction occurred.<br>Mode 2: No feedback control performed because of the system malfunction.<br>Mode 3: Feedback control did not respond to driving conditions.<br>Mode 4: Feedback control performed using heated oxygen sensor.<br>Mode 5: Conditions to shift into the feedback control not established after ignition switch was turned ON. |
| CLV: Calculated Load Value       | %    | Based on the fuel injection amount, it calculates and displays the engine load at the time a malfunction is detected.                                                                                                                                                                                                                                                                                          |
| COOLANT TEMP                     | °C   | Displays engine coolant temperature at the time a malfunction is detected.                                                                                                                                                                                                                                                                                                                                     |
| L-FUEL TRIM-B1<br>L-FUEL TRIM-B2 | %    | Displays air-fuel ratio feedback learned value at the time a malfunction is detected.                                                                                                                                                                                                                                                                                                                          |
| S-FUEL TRIM-B1<br>S-FUEL TRIM-B2 |      | Displays air-fuel ratio feedback corrected value at the time a malfunction is detected.                                                                                                                                                                                                                                                                                                                        |
| ENGINE SPEED                     | rpm  | Displays engine speed at the time a malfunction is detected.                                                                                                                                                                                                                                                                                                                                                   |
| VEHICLE SPEED                    | km/h | Displays vehicle speed at the time a malfunction is detected.                                                                                                                                                                                                                                                                                                                                                  |

Show B1: No. 1 and 4 cylinders, B2: No. 2 and 3 cylinders.

## TROUBLE DIAGNOSIS

### SST (Cont'd)

#### DATA MONITOR

- Allows determination and identification of the possible source of a malfunction based on self-diagnosis test results.
- Displays ECM input/output signal data in real time.
- Records and prints out the data before and after the engine malfunction or stall, either automatically or manually.

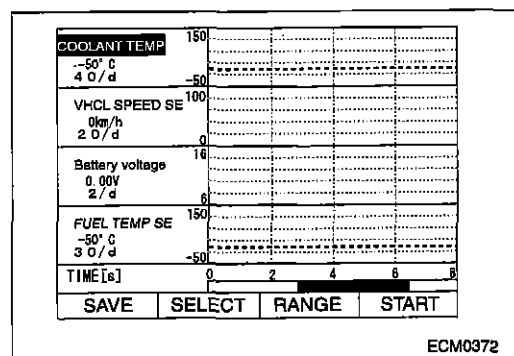
#### DISPLAY ITEM LIST

| Monitor item                         | Unit                                       | Description                                                                                                                                                                                                                                                                                        |
|--------------------------------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ENG SPEED                            | rpm                                        | Engine speed computed from crankshaft angle sensor signal                                                                                                                                                                                                                                          |
| MAS A/F SE-B1                        | V                                          | Mass air flow sensor output voltage                                                                                                                                                                                                                                                                |
| B/FUEL SCHDL                         | msec                                       | Value calculated by ECM                                                                                                                                                                                                                                                                            |
| A/F ALPHA                            | %                                          | Average of cycles for air-fuel ratio feedback correction coefficient                                                                                                                                                                                                                               |
| COOLANT TEMP/S                       | °C                                         | Value converted into temperature from the output voltage of the engine coolant temperature sensor.                                                                                                                                                                                                 |
| HO2S1                                | V                                          | Output voltage of heated oxygen sensor                                                                                                                                                                                                                                                             |
| HO2S1 MNTR                           | RICH/LEAN                                  | Air-fuel ratio is given as heated oxygen sensor output signal during air-fuel ratio feedback control.<br>RICH: Heated oxygen sensor output is high. Controlling to lower the value for leaner ratio.<br>LEAN: Heated oxygen sensor output is low. Controlling to raise the value for richer ratio. |
| VHCL SPEED SE                        | km/h                                       | Value computed from vehicle speed sensor                                                                                                                                                                                                                                                           |
| BATTERY VOLT                         | V                                          | ECM battery voltage                                                                                                                                                                                                                                                                                |
| ACCEL SEN 1                          |                                            | Accelerator pedal position sensor 1 output voltage                                                                                                                                                                                                                                                 |
| ACCEL SEN 2                          |                                            | Accelerator pedal position sensor 2 output voltage                                                                                                                                                                                                                                                 |
| THRTL SEN 1                          |                                            | Throttle position sensor 1 output voltage                                                                                                                                                                                                                                                          |
| THRTL SEN 2                          |                                            | Throttle position sensor 2 output voltage                                                                                                                                                                                                                                                          |
| START SIGNAL                         |                                            | ON/OFF status as judged by each input signal                                                                                                                                                                                                                                                       |
| P/N POSI SW                          |                                            |                                                                                                                                                                                                                                                                                                    |
| IGNITION SW                          |                                            |                                                                                                                                                                                                                                                                                                    |
| BRAKE SW                             |                                            |                                                                                                                                                                                                                                                                                                    |
| INJ PULSE                            | msec                                       | Value calculated by ECM                                                                                                                                                                                                                                                                            |
| IGN TIMING                           | °BTDC                                      |                                                                                                                                                                                                                                                                                                    |
| Incalculable                         | %                                          | Value is calculated engine load based on the fuel injection amount.                                                                                                                                                                                                                                |
| FUEL PUMP RLY                        | ON/OFF                                     | Status of each control as calculated by ECM.                                                                                                                                                                                                                                                       |
| THRTL RELAY                          |                                            |                                                                                                                                                                                                                                                                                                    |
| HO2S1 HTR                            |                                            |                                                                                                                                                                                                                                                                                                    |
| IDL A/V LEARN                        | DONE/YET                                   | State of "Idle Air Volume Learning".                                                                                                                                                                                                                                                               |
| Battery voltage                      | Displays values measured by voltage probe. |                                                                                                                                                                                                                                                                                                    |
| Vehicle speed maximum limit          | km/h                                       | Vehicle speed maximum value                                                                                                                                                                                                                                                                        |
| LPG fuel injection width             | ms                                         | Value calculated by ECM                                                                                                                                                                                                                                                                            |
| LPG basic fuel injection             |                                            |                                                                                                                                                                                                                                                                                                    |
| Air-fuel ratio correction (Gasoline) | %                                          |                                                                                                                                                                                                                                                                                                    |
| Air-fuel ratio correction (LPG)      | %                                          |                                                                                                                                                                                                                                                                                                    |
| Fuel type                            | GASOLINE/<br>LPG/NEUTRAL                   | Fuel changing switch connecting condition                                                                                                                                                                                                                                                          |
| LPG fuel pressure                    | kg/cm <sup>2</sup>                         | Value converted into pressure from the output voltage of LPG fuel pressure sensor.                                                                                                                                                                                                                 |

## TROUBLE DIAGNOSIS

| Monitor item                 | Unit   | Description                                  |
|------------------------------|--------|----------------------------------------------|
| Inching switch               | ON/OFF | ON/OFF status as judged by each input signal |
| Fuel changing switch 1       |        |                                              |
| Fuel changing switch 2       |        |                                              |
| LPG interception valve relay |        |                                              |

### 4CH GRAPH DISPLAY (HOLD) OUTPUT SPECIFICATION



| Condition                  | Condition                                                                                                                                                          |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Normal                     | (1) Supported by support data.<br>(2) Graph is supported.<br>Data value that is not applied to communication in RUN mode is displayed as "- - -".                  |
| Selection narrowing        | (1) Supported by support data.<br>(2) Graph is supported.<br>(3) Selected.<br>Data value that is not applied to communication in RUN mode is displayed as "- - -". |
| Normal (LOAD)              | (1) Saved.                                                                                                                                                         |
| Selection narrowing (LOAD) | (1) Saved.<br>(2) Selected.                                                                                                                                        |

### ACTIVE TEST

Use this mode to determine and identify the details of a malfunction, based on self-diagnosis test results and data obtained from DATA MONITOR mode. SST, instead of the ECM on the vehicle, sends a drive signal to actuators to check their operation.

#### DISPLAY ITEM LIST

| Active test item                               | Description                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fuel injection test<br>LPG fuel injection test | <ul style="list-style-type: none"> <li>Can increase or decrease the amount of fuel injection (<math>\pm 25\%</math>).</li> <li>Can reproduce conditions resulting from air-fuel ratio related malfunctions (e.g. hesitation, poor acceleration, poor racing, etc.) and help solve these malfunctions by pinpointing the causes.</li> </ul> |
| Ignition timing test                           | <ul style="list-style-type: none"> <li>Allows setting a correction coefficient for retarding (<math>-10 - 0^\circ</math>)</li> </ul>                                                                                                                                                                                                       |
| POWER BALANCE (Gasoline)<br>(LPG, Neutral)     | <ul style="list-style-type: none"> <li>Stops operation of specified injector. Also, displays engine speed at that time.</li> <li>Mainly used to inspect for misfiring cylinders.</li> </ul>                                                                                                                                                |

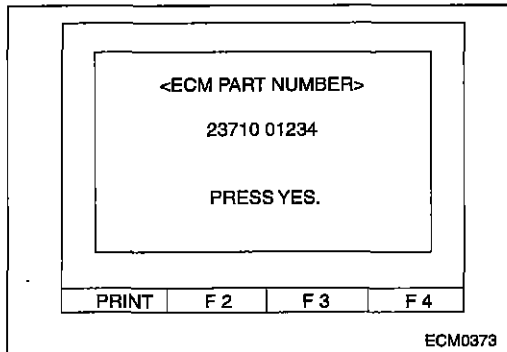
## TROUBLE DIAGNOSIS

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### SST (Cont'd)

#### CONTROL UNIT PART NUMBER

Displays part number of ECM mounted on vehicle.



### Self-diagnosis Function (without SST)

#### DESCRIPTION

- In self-diagnosis, when any of the critical sensors or actuator and exhaust gas control systems necessary for ECM control return a malfunction and self-diagnosis detection conditions are satisfied, a DTC corresponding to the suspect system is stored in ECM for easier trouble diagnosis. Self-diagnostic results can be displayed with MIL in the combination meter.
- Diagnosis test mode

#### OPERATION PROCEDURE

- Refer to the following for how to activate self-diagnosis mode or erase self-diagnostic results.

#### CAUTION:

- When a malfunction occurs in accelerator pedal position sensors, self-diagnosis (without SST) cannot be activated. Thus, use SST to perform self-diagnosis, and repair malfunctioning part.

## TROUBLE DIAGNOSIS

### Self-diagnosis Function (without SST) (Cont'd)

#### [Diagnostic test mode (self-diagnostic results) starting procedure]

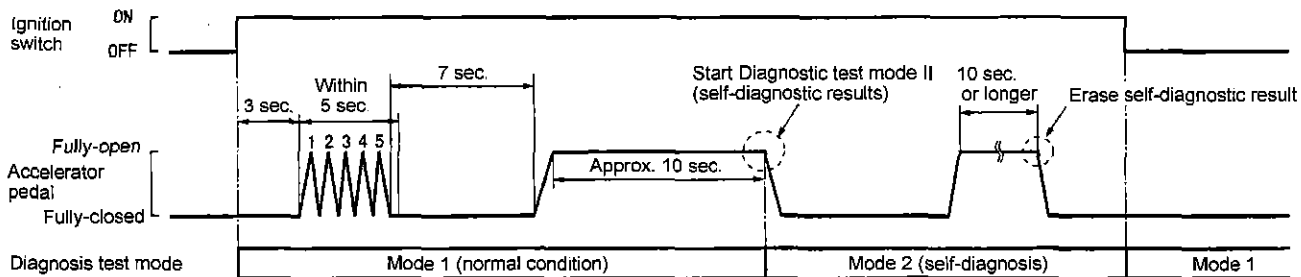
- 1 Turn ignition switch ON with accelerator pedal released.
- 2 After 3 seconds, fully depress accelerator pedal and then release it. Quickly repeat this cycle 5 times within 5 seconds (end in released position).
- 3 Fully depress accelerator pedal 7 seconds after releasing it, and keep that position approximately 10 seconds (until MIL blinks). Diagnostic test mode II self-diagnostic results starts.
- 4 Return accelerator pedal. Execute self-diagnosis.
  - Perform self-diagnosis with ignition switch ON. [Diagnostic test mode II (self-diagnostic results)]
  - Starting engine in Diagnostic test mode II (self-diagnostic results) opens heated oxygen sensor monitor. [Diagnostic test mode II (heated oxygen sensor monitor)]
  - Turning ignition switch OFF returns to mode 1 automatically. [Normal condition]

CAUTION: Count time accurately with watch or equivalent.

If mode 1 does not turn to mode 2, turn ignition switch OFF and wait for at least 10 seconds.

#### [Self-diagnosis results erasing procedure]

- 1 Fully depress accelerator pedal in Diagnostic test mode II (self-diagnostic results), and keep the position at least 10 seconds. Self-diagnostic results are erased.
  - Release accelerator pedal. Make sure self-diagnostic results are erased.
  - Turning ignition switch OFF returns to mode 1.



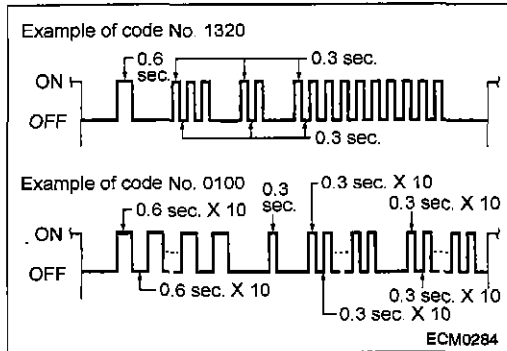
ECM0282



## TROUBLE DIAGNOSIS

### Self-diagnosis Function (without SST) (Cont'd)

## DIAGNOSTIC TEST MODE II - SELF-DIAGNOSTIC RESULTS



- In this mode, the MIL blinks (indicating the DTC) to identify the system that returned a malfunction.
- If no DTC is detected, DTC "0000" is displayed.

## DISPLAY ITEM LIST

| DTC<br>(code<br>number) | Diagnosis item                                     | Malfunction Return Condition                                                                                                                                                                                                                                                                                                                               | MIL | Trip |
|-------------------------|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|
| 0000                    | NO DTC                                             | <ul style="list-style-type: none"> <li>No malfunction is detected in any of the circuits.</li> </ul>                                                                                                                                                                                                                                                       | -   | -    |
|                         | Mass air flow sensor (MAFS)                        | <ul style="list-style-type: none"> <li>When engine is stopped (ignition switch ON) and mass air flow sensor output voltage has been 9V or more for predetermined period.</li> </ul>                                                                                                                                                                        | ON  | 1    |
| P0102                   | Mass air flow sensor                               | <ul style="list-style-type: none"> <li>Mass air flow sensor Low Input (open)</li> </ul>                                                                                                                                                                                                                                                                    |     |      |
| P0103                   | Mass air flow sensor                               | <ul style="list-style-type: none"> <li>Mass air flow sensor High Input (short)</li> </ul>                                                                                                                                                                                                                                                                  |     |      |
|                         | Engine coolant temperature sensor (ECTS) (CIRCUIT) | <ul style="list-style-type: none"> <li>Engine coolant temperature sensor output voltage has been approximately 8V or more (open) or less than 0.66V (short) for predetermined period.</li> </ul>                                                                                                                                                           | ON  | 2    |
| P0117                   | Engine coolant temperature sensor                  | <ul style="list-style-type: none"> <li>Engine coolant temperature sensor Low Input (open)</li> </ul>                                                                                                                                                                                                                                                       |     |      |
| P0118                   | Engine coolant temperature sensor                  | <ul style="list-style-type: none"> <li>Engine coolant temperature sensor High Input (short)</li> </ul>                                                                                                                                                                                                                                                     |     |      |
|                         | Throttle position sensor signal circuit            | <ul style="list-style-type: none"> <li>Sensor power supply voltage has a malfunction.</li> <li>Throttle position sensor signal circuit is open or shorted.</li> <li>A malfunction occurs in relation between throttle position sensors 1 and 2.</li> <li>When the fully-closed position learning value was unusually small or was not learning.</li> </ul> | ON* | 1    |
| P0122                   | Throttle position sensor                           | <ul style="list-style-type: none"> <li>TPS2 Low Input malfunction</li> </ul>                                                                                                                                                                                                                                                                               |     |      |
| P0123                   | Throttle position sensor                           | <ul style="list-style-type: none"> <li>TPS2 High Input malfunction</li> </ul>                                                                                                                                                                                                                                                                              |     |      |
| P0222                   | Throttle position sensor 1                         | <ul style="list-style-type: none"> <li>TPS1 Low Input malfunction</li> </ul>                                                                                                                                                                                                                                                                               |     |      |
| P0223                   | Throttle position sensor 1                         | <ul style="list-style-type: none"> <li>TPS1 High Input malfunction</li> </ul>                                                                                                                                                                                                                                                                              |     |      |

## TROUBLE DIAGNOSIS

| DTC<br>(code<br>number) | Diagnosis Item                                           | Malfunction Return Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | MIL | Trip |
|-------------------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|
|                         | Acceleration sensor signal circuit                       | <ul style="list-style-type: none"> <li>Accelerator pedal position sensor signal circuit is open or shorted.</li> <li>A malfunction occurs in relation between accelerator pedal position sensors 1 and 2.</li> </ul>                                                                                                                                                                                                                                                                                                             | ON* | 1    |
| P2138                   | Accelerator pedal position sensor non adjustment         | <ul style="list-style-type: none"> <li>APS1-2 conformity malfunction</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |      |
| P2122                   | Accelerator pedal position sensor 1                      | <ul style="list-style-type: none"> <li>APS1 Low Input malfunction</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |      |
| P2123                   | Accelerator pedal position sensor 1                      | <ul style="list-style-type: none"> <li>APS1 High Input malfunction</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |      |
| P2127                   | Accelerator pedal position sensor 2                      | <ul style="list-style-type: none"> <li>APS2 Low Input malfunction</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |      |
| P2128                   | Accelerator pedal position sensor 2                      | <ul style="list-style-type: none"> <li>APS2 High Input malfunction</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |      |
|                         | Heated oxygen sensor (circuit)                           | <ul style="list-style-type: none"> <li>Heated oxygen sensor signal circuit is open.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                   | ON  | 2    |
| P0134                   | Heated oxygen sensor B1                                  | <ul style="list-style-type: none"> <li>Fr O2/S open diagnosis (bank 1)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                |     |      |
|                         | Heated oxygen sensor signal (short circuit)              | <ul style="list-style-type: none"> <li>Heated oxygen sensor output voltage is higher than normal (2V or more).</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                        | ON  | 2    |
| P0132                   | Heated oxygen sensor B1                                  | <ul style="list-style-type: none"> <li>Fr O2/S malfunctioning voltage diagnosis (bank 1)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                              |     |      |
|                         | Heated oxygen sensor heater                              | <ul style="list-style-type: none"> <li>Heated oxygen sensor signal circuit is open.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                   | ON  | 2    |
| P0171                   | Fuel system LEAN B1                                      | <ul style="list-style-type: none"> <li>After warming up engine, mixture ratio is too lean and heated oxygen sensor output is stuck and not inverted.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                  | ON  | 2    |
| P0172                   | Fuel system RICH B1                                      | <ul style="list-style-type: none"> <li>After warming up engine, mixture ratio is too rich and heated oxygen sensor output is stuck and not inverted.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                  | ON  | 2    |
|                         | Crankshaft position sensor 1&deg; (POS) signal circuit   | <ul style="list-style-type: none"> <li>The crankshaft position sensor (POS) signal is not detected for a predetermined time at the engine start or during engine running (during camshaft position sensor (REF) signal input).</li> <li>The crankshaft position sensor (POS) signal irregular waveform is detected for a predetermined time during engine running (during camshaft position sensor (REF) signal input).</li> </ul>                                                                                               | ON  | 2    |
| P0335                   | Ring gear open circuit POS                               | <ul style="list-style-type: none"> <li>Hall POS sensor open diagnosis at start</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |      |
| P0335                   | Ring gear open circuit POS                               | <ul style="list-style-type: none"> <li>Hall POS sensor open diagnosis after start</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |      |
| P0335                   | Ring gear open circuit POS                               | <ul style="list-style-type: none"> <li>Hall POS sensor instantaneous/noise/damaged teeth diagnosis</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                    |     |      |
|                         | Crankshaft position sensor 120&deg; (REF) signal circuit | <ul style="list-style-type: none"> <li>At start-up, no camshaft position sensor (REF) signal has been detected for more than a predetermined period.</li> <li>The camshaft position sensor (REF) signal is not detected for a predetermined time during engine running (during crankshaft position sensor (POS) signal input).</li> <li>A camshaft position sensor (REF) signal irregular waveform is detected for a predetermined time during engine running (during crankshaft position sensor (POS) signal input).</li> </ul> | ON  | 2    |
| P0340                   | Crankshaft position sensor                               | <ul style="list-style-type: none"> <li>Hall PHASE sensor open diagnosis at start</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |      |
| P0340                   | Crankshaft position sensor                               | <ul style="list-style-type: none"> <li>Hall PHASE sensor open diagnosis after start</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |      |
| P0340                   | Crankshaft position sensor                               | <ul style="list-style-type: none"> <li>Hall PHASE sensor instantaneous/noise/damaged teeth diagnosis</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                  |     |      |
| P0350                   | Ignition primary signal                                  | <ul style="list-style-type: none"> <li>Ignition primary signal diagnosis</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |      |
| P0500                   | Vehicle speed signal system                              | <ul style="list-style-type: none"> <li>Vehicle sensor signal has not been input under some condition for a predetermined time during driving after warming up.</li> </ul>                                                                                                                                                                                                                                                                                                                                                        | ON  | 2    |

1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 26

## TROUBLE DIAGNOSIS

| DTC<br>(code<br>number) | Diagnosis item                                                                            | Malfunction Return Condition                                                                                                                                               | MIL | Trip |
|-------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|
|                         | Engine over temperature<br>(Overheat)                                                     | ••Engine coolant temperature sensor output voltage has been approximately 0.35V or lower for a predetermined period of time. (with the coolant temperature sensor normal). | ON  | 1    |
| P1217                   | Engine over temperature<br>(Overheat)                                                     | ••Engine over temperature (Overheat)                                                                                                                                       |     |      |
|                         | Overheat (STEP1)                                                                          | ••When engine coolant temperature is 110°                                                                                                                                  | -   | -    |
| P1218                   | Overheat (STEP 1)                                                                         | ••Overheat (STEP 1)                                                                                                                                                        |     |      |
|                         | LPG injector 1 malfunction                                                                | • LPG injector signal circuit is open.                                                                                                                                     | -   | -    |
| P1240                   | LPG F/INJ 1 malfunction<br>(Injection)                                                    | ••LPG F/INJ 1 malfunction (Injection)                                                                                                                                      |     |      |
|                         | LPG injector 1 malfunction                                                                | • LPG injector signal circuit is open.                                                                                                                                     | -   | -    |
| P1241                   | LPG F/INJ 2 malfunction (No<br>injection)                                                 | ••LPG F/INJ 2 malfunction (No injection)                                                                                                                                   |     |      |
| P1242                   | LPG injector 2 malfunction                                                                | • LPG injector signal circuit is open.                                                                                                                                     | -   | -    |
| P1243                   | LPG injector 2 malfunction                                                                | ••LPG injector signal circuit is open.                                                                                                                                     | -   | -    |
| P1244                   | LPG fuel pressure sensor<br>malfunction                                                   | ••LPG fuel pressure sensor signal circuit is open.                                                                                                                         | -   | -    |
|                         | LPG fuel pressure sensor<br>malfunction                                                   | • LPG fuel pressure sensor output voltage is higher than normal (?V or more).                                                                                              | -   | -    |
| P1245                   | LPG fuel pressure sensor High<br>Input malfunction                                        | ••LPG fuel pressure sensor High Input malfunction                                                                                                                          |     |      |
|                         | LPG vaporizer malfunction                                                                 | ••LPG fuel pressure is excessively high.                                                                                                                                   | -   | -    |
| P1249                   | LPG malfunctioning fuel<br>pressure is detected and fuel<br>pressure is excessively high. | ••LPG malfunctioning fuel pressure is detected and fuel pressure is excessively high.                                                                                      |     |      |
| P1250                   | LPG vaporizer malfunction                                                                 | • LPG fuel pressure is excessively low.                                                                                                                                    | -   | -    |
| P1320                   | Ignition signal system                                                                    | ••Ignition signal has not been continuously generated while the engine is running.                                                                                         | ON  | 2    |
| P1805                   | Brake switch signal circuit                                                               | • Brake switch signal circuit is open or shorted.                                                                                                                          | ON  | 2    |
| P1812                   | Inching brake switch<br>malfunction                                                       | • When inching brake switch has been locked ON.                                                                                                                            | -   | -    |
| P1813                   | Inching brake switch<br>malfunction                                                       | ••When inching brake switch has been locked OFF.                                                                                                                           | -   | -    |

Note: Number of trips varies depending on diagnosis content.

## TROUBLE DIAGNOSIS

### Self-diagnosis Function (without SST) (Cont'd)

Trip 1: If a malfunction is detected by self-diagnosis between the time ignition switch is turned ON (engine is running) and then turned OFF (this is defined as "trip"), MIL is lit. The corresponding DTC is recorded immediately after detection.

Trip 2: When a malfunction is detected by self-diagnosis for the first time in the first trip, a tentative DTC is recorded. If the same malfunction is detected again by self-diagnosis in the next trip (second trip), MIL is lit and the corresponding final DTC is recorded. Even when 1st trip DTC is being memorized, the appropriate trouble code is displayed as self-diagnostic results by MIL.

#### CONDITIONS TO TURN OFF MIL

- The MIL, marked with \*, is turned off when ignition switch is turned ON (engine starts) again after normal state is resumed.
- For other self-diagnostic items, self-diagnostic results shall be erased by turning ignition switch to OFF after normal operation is resumed.

### DIAGNOSTIC TEST MODE II - HEATED OXYGEN SENSOR MONITOR

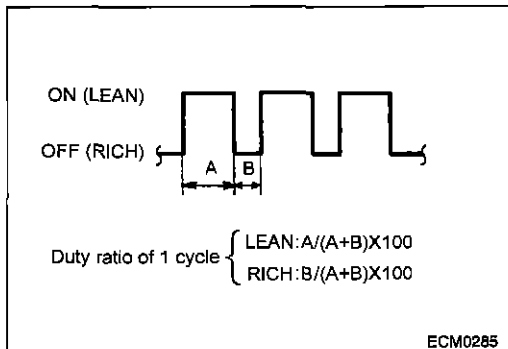
- In this mode, status of air-fuel ratio is displayed by blinking of MIL.
- Make sure that MIL blinks at least 5 times within 10 seconds after warming up engine and keeping engine speed at approximately 2,000 rpm.

#### NOTE:

- Although air-fuel ratio feedback control is active at idle, increase engine speed and check.
- During air-fuel ratio feedback control  
Heated oxygen sensor output is large (rich): OFF  
Heated oxygen sensor output is small (lean): ON
- Air-fuel ratio feedback control is stopped: OFF
- Air-fuel ratio feedback control is clamped: State immediately before clamping is maintained.

### SST Reference Value in Data Monitor

- Values in the table are reference values.
- Values in the table are values detected in ECM or input/output values sent from ECM. Thus, they may differ from actual part values. [Example: ignition timing checked using timing light and display on "IGN TIMING" screen in "DATA MONITOR" mode could be different. This happens because values on "IGN TIMING" screen is calculated by ECM using input signal from various sensors. They are crankshaft position sensor (POS) and other ignition timing related sensors.]



## TROUBLE DIAGNOSIS

### SST Reference Value in Data Monitor (Cont'd)

| Monitor item               | Measuring condition                                                                                                                      |                                                                           | Reference value                                               |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------|
| ENG SPEED                  |                                                                                                                                          |                                                                           | Almost in accordance                                          |
| MAS A/F SE                 | <ul style="list-style-type: none"> <li>After engine warming up</li> <li>Selector lever: N</li> <li>No load</li> </ul>                    | At Idle                                                                   | Approx. 1.3V                                                  |
|                            |                                                                                                                                          | At approx. 2,000 rpm                                                      | Approx. 1.6V                                                  |
| B/FUEL SCHDL               | <ul style="list-style-type: none"> <li>After engine warming up</li> <li>Selector lever: N</li> <li>No load</li> </ul>                    | At Idle                                                                   | Approx. 2.5 - 4 msec                                          |
|                            |                                                                                                                                          | At approx. 2,000 rpm                                                      |                                                               |
| A/F ALPHA                  | After engine warming up                                                                                                                  | At Idle                                                                   | Approx. 90 - 110%                                             |
| COOLANT TEMP/S             | After engine warming up                                                                                                                  |                                                                           | Approx. 80°C or more                                          |
| HO2S1                      | After engine warming up                                                                                                                  | At Idle                                                                   | Changes between approx. 0.1 - 0.4V ⇄ 0.6 - 0.9V               |
|                            |                                                                                                                                          | Maintain at approx. 2,000 rpm                                             | Changes between approx. 0.1 - 0.4V ⇄ 0.6 - 0.9V               |
| HO2S1 MNTR                 | After engine warming up                                                                                                                  | At Idle                                                                   | Switches slowly between LEAN ⇄ RICH.                          |
|                            |                                                                                                                                          | Maintain at approx. 2,000 rpm                                             | Switches between LEAN ⇄ RICH at least 5 times for 10 seconds. |
| VHCL SPEED SE              | Drive, and compare with the value displayed on speedometer.                                                                              |                                                                           | Almost in accordance                                          |
| BATTERY VOLT               | Ignition switch: ON (with engine stopped)                                                                                                |                                                                           | Approx. 11 - 14V                                              |
| ACCEL SEN 1<br>ACCEL SEN 2 | After engine warming up                                                                                                                  | At Idle                                                                   | Approx. 0.6 - 0.65V                                           |
|                            |                                                                                                                                          | Approx. 2,000 rpm                                                         | Approx. 0.75 - 0.8V                                           |
|                            |                                                                                                                                          | Ignition switch ON with accelerator pedal depressed (With engine stopped) | Approx. 4.1 - 4.3V                                            |
| THRTL SEN 1<br>THRTL SEN 2 | After engine warming up                                                                                                                  | At Idle                                                                   | Approx. 0.5 - 0.55V                                           |
|                            |                                                                                                                                          | Approx. 2,000 rpm                                                         | Approx. 0.65 - 0.7V                                           |
|                            |                                                                                                                                          | Ignition switch ON with accelerator pedal depressed (With engine stopped) | Approx. 0.7 - 0.75V                                           |
| P/N POSI SW                | Ignition switch: ON                                                                                                                      | N position                                                                | ON                                                            |
|                            |                                                                                                                                          | Other than above                                                          | OFF                                                           |
| LOAD SIGNAL                | Ignition switch: ON                                                                                                                      | Headlamp switch: ON                                                       | ON                                                            |
|                            |                                                                                                                                          | Above switch: OFF                                                         | OFF                                                           |
| IGNITION SW                | Ignition switch: ON → OFF                                                                                                                |                                                                           | ON → OFF                                                      |
| BRAKE SW                   | Ignition switch: ON                                                                                                                      | Brake pedal depressed                                                     | ON                                                            |
|                            |                                                                                                                                          | Brake pedal released                                                      | OFF                                                           |
| INJ PULSE                  | <ul style="list-style-type: none"> <li>After engine warming up</li> <li>Selector lever: N</li> <li>No load</li> </ul>                    | At Idle                                                                   | Approx. 2 - 4 msec                                            |
|                            |                                                                                                                                          | At approx. 2,000 rpm                                                      |                                                               |
| IGN TIMING                 | <ul style="list-style-type: none"> <li>After engine warming up</li> <li>Selector lever: N</li> <li>No load</li> </ul>                    | At Idle                                                                   | Approx. 15° BTDC                                              |
|                            |                                                                                                                                          | At approx. 2,000 rpm                                                      | Approx. 30 - 40° BTDC                                         |
| Incalculable               | <ul style="list-style-type: none"> <li>After engine warming up</li> <li>Selector lever: N</li> <li>No load</li> </ul>                    | At Idle                                                                   | Approx. 0 - 20%                                               |
|                            |                                                                                                                                          | At approx. 2,000 rpm                                                      | Approx. 14 - 28%                                              |
| FUEL PUMP RLY              | <ul style="list-style-type: none"> <li>For 1 second after ignition switch is ON</li> <li>While engine is running and cranking</li> </ul> |                                                                           | ON                                                            |
|                            | Other than above                                                                                                                         |                                                                           | OFF                                                           |
| THRTL RELAY                | Ignition switch: ON → OFF                                                                                                                |                                                                           | ON → OFF                                                      |
| HO2S1 HTR                  | After engine warmed up (at idle)                                                                                                         | Approx. ? rpm or more                                                     | OFF                                                           |
|                            |                                                                                                                                          | Other than above                                                          | ON                                                            |

## TROUBLE DIAGNOSIS

| Monitor item  | Measuring condition                                                                                                            | Reference value                                    |
|---------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| IDL A/V LEARN | <ul style="list-style-type: none"> <li>After engine warmed up (at idle)</li> <li>All electrical load switches: OFF</li> </ul>  | Idle air volume learning completed.<br>DONE        |
|               | <ul style="list-style-type: none"> <li>Selector lever: N</li> <li>Throttle valve closed position learning completed</li> </ul> | Idle air volume learning not yet completed.<br>YET |

### Fail-Safe Function

- When any of the critical sensors or systems sends a malfunction message, the fail-safe function estimates the driving conditions with other input signals and selects safer conditions for engine (vehicle) control, based on data previously stored in ECM.

| Related sensors                   | Malfunction condition                                    | Fail-safe                                                                                                                                                                                                                                                                                                      | MIL |
|-----------------------------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Mass air flow sensor              | Same as self-diagnosis malfunction detection conditions. | <ul style="list-style-type: none"> <li>Selects fuel injection pulse width depending on engine speed and throttle position so the vehicle can be driven. However, fuel injection will be inhibited (fuel cut-off) when engine speed exceeds approximately 2,400 rpm.</li> <li>Idle speed is 800 rpm.</li> </ul> | ON  |
| Engine coolant temperature sensor |                                                          | <ul style="list-style-type: none"> <li>Uses the estimated engine coolant temperature (varies with elapsed time after start) to perform controls so the vehicle can be driven.</li> </ul>                                                                                                                       | ON  |
| Accelerator pedal position sensor |                                                          | <ul style="list-style-type: none"> <li>Fuel injection will be inhibited when 1 circuit is opened. Release valve mechanically until it can drive at low speed when disconnecting connector.</li> </ul>                                                                                                          | ON  |
| Throttle position sensor          |                                                          | <ul style="list-style-type: none"> <li>Fixes output to a preset value so the vehicle can be driven. However, fuel injection will be inhibited (fuel cut-off) when engine speed exceeds approximately 2,500 rpm.</li> </ul>                                                                                     | ON  |
| MIL                               |                                                          | <ul style="list-style-type: none"> <li>Fuel Injector will be inhibited at approximately 2,500 rpm to prevent MIL malfunction if exhaust performance and driving performance malfunctions are occurring.</li> </ul>                                                                                             | -   |

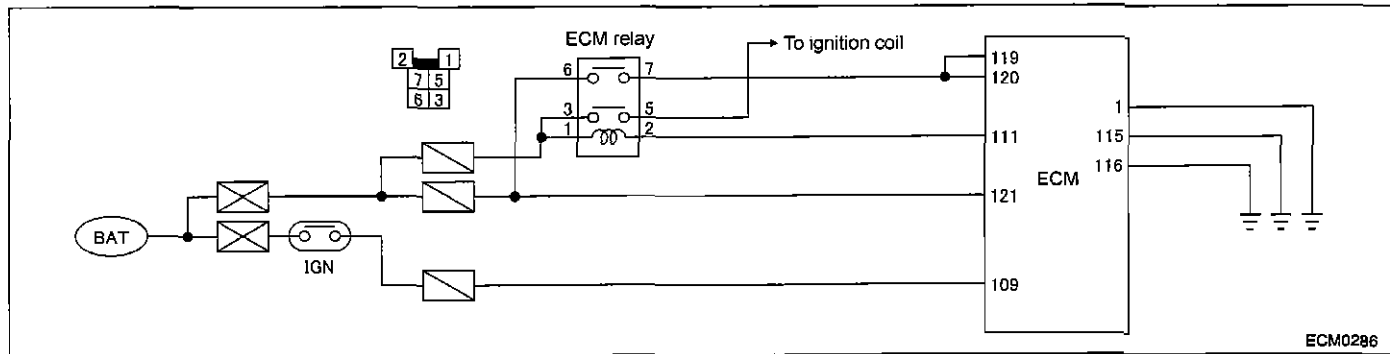
## POWER SUPPLY AND GROUND SYSTEM

### ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

| Terminal        | Signal name                    | Measurement condition                                                              | Measured value  |
|-----------------|--------------------------------|------------------------------------------------------------------------------------|-----------------|
| 111             | ECM & IGN coil relay           | For approximately 10 seconds with ignition switch ON and after ignition switch OFF | Approx. 1V      |
|                 |                                | Approximately 10 seconds or more after ignition switch OFF                         | Battery voltage |
| 109             | Ignition switch                | Ignition switch ON                                                                 |                 |
| 119<br>120      | Power supply for ECM           |                                                                                    |                 |
| 121             | Power supply for ECM (Back-up) |                                                                                    |                 |
| 1<br>115<br>116 | Ground                         |                                                                                    | Approx. 0V      |

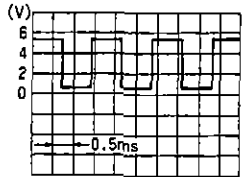
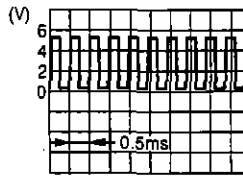
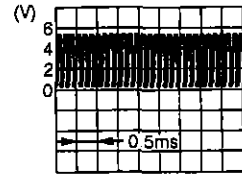
### Circuit Diagram



## CRANKSHAFT POSITION SENSOR 1° (POS)

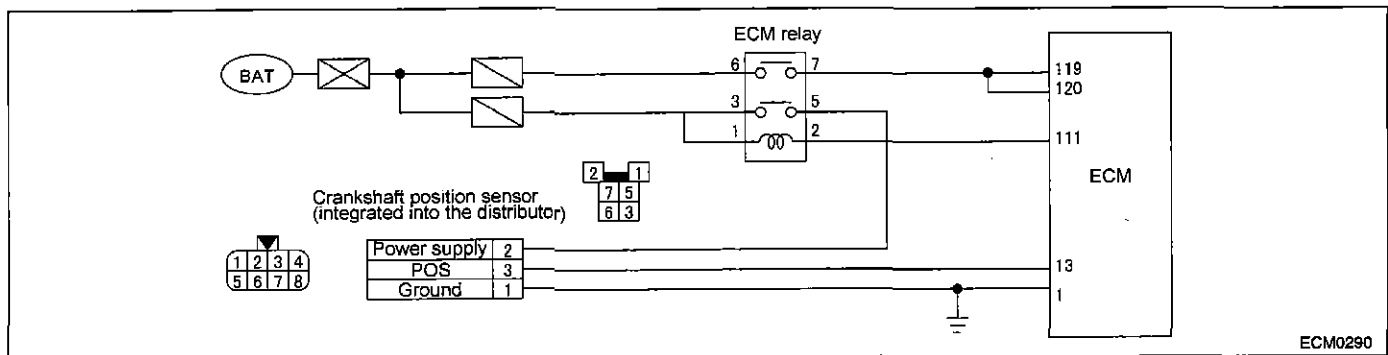
### ECM Input/Output Signal Specifications

Check waveform between terminals shown below and ground using an oscilloscope.

| Terminal | Signal name                         | At cranking                                                                                                               | At idle after warming up                                                                                                 | At approx. 2,000 rpm                                                                                           |
|----------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| 13       | Crankshaft position sensor 1° (POS) | At cranking: Approx. 2.6V<br><br>ECM0287 | At idling: Approx. 2.5V<br><br>ECM0288 | Approx. 2.5V<br><br>ECM0289 |

Numerical values (reference values) are obtained using an analog circuit tester.

### Circuit Diagram



### Component Parts Inspection

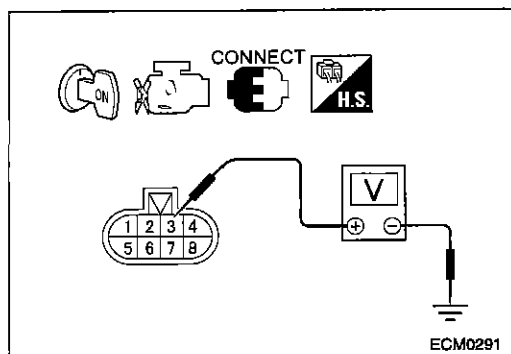
#### CRANKSHAFT POSITION SENSOR

- Remove distributor (with the harness connector connected) from the engine.
- Turn ignition switch ON.
- Slowly turn the crankshaft position sensor shaft by hand and check voltage between terminal 3 and ground.

**3 - Ground (1° signal):**  
**Approx. 0.2 or 5V**

#### CAUTION:

- Check voltage after disconnecting the injector fuse to inhibit injector operation. Malfunctions may or may not be accurately detected by self-diagnosis depending on how the shaft is turned. Note that there is no malfunction in this case.

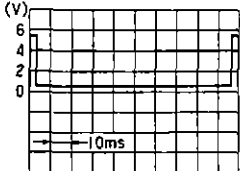
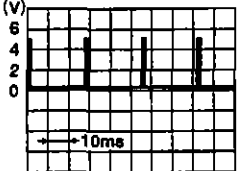
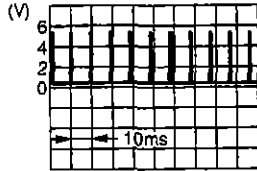


## CRANKSHAFT POSITION SENSOR 120° (REF) SIGNAL CIRCUIT

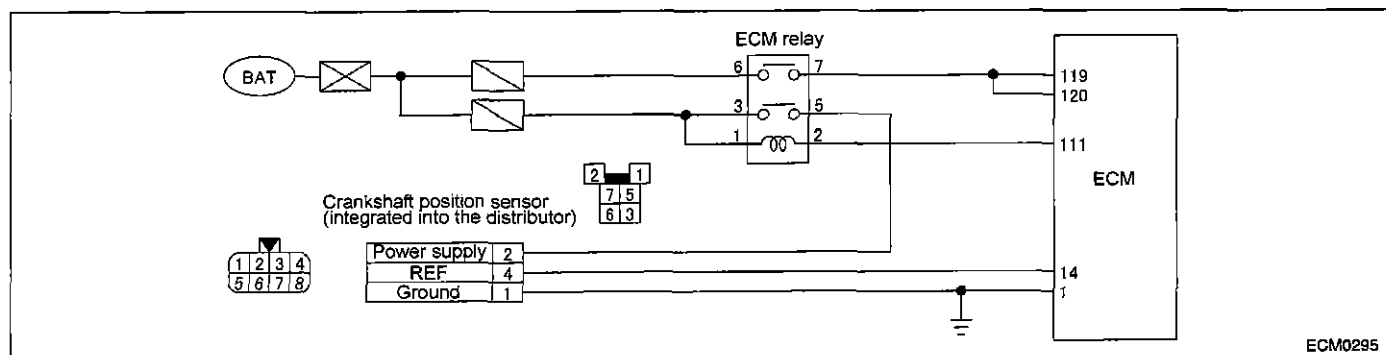
### ECM Input/Output Signal Specifications

Check waveform between terminals shown below and ground using an oscilloscope.

Numerical values (reference values) are obtained using an analog circuit tester.

| Terminal | Signal name                           | At cranking                                                                                                               | At idle after warming up                                                                                                 | At approx. 2,000 rpm                                                                                           |
|----------|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| 14       | Crankshaft position sensor 120° (REF) | At cranking: Approx. 0.5V<br><br>ECM0292 | At idling: Approx. 0.5V<br><br>ECM0293 | Approx. 0.5V<br><br>ECM0294 |

### Circuit Diagram



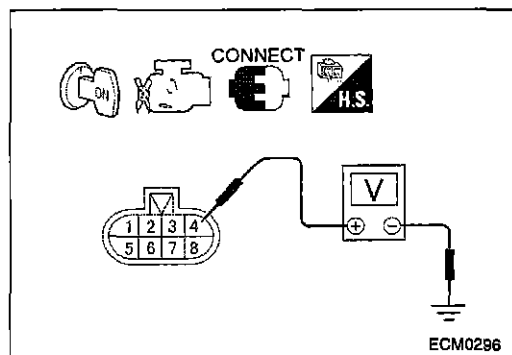
### Component Parts Inspection

#### CRANKSHAFT POSITION SENSOR

- Remove distributor (with the harness connector connected) from the engine.
- Turn ignition switch ON.
- Slowly turn the crankshaft position sensor shaft by hand and check voltage between terminal 4 and ground.  
**4 - Ground (120° signal): Approx. 0.2 or 5V**

#### CAUTION:

- Check voltage after disconnecting the injector fuse to inhibit injector operation.  
Malfunctions may or may not be accurately detected by self-diagnosis depending on how the shaft is turned. Note that there is no malfunction in this case.



## MASS AIR FLOW SENSOR SYSTEM

### SST Data Monitor Display

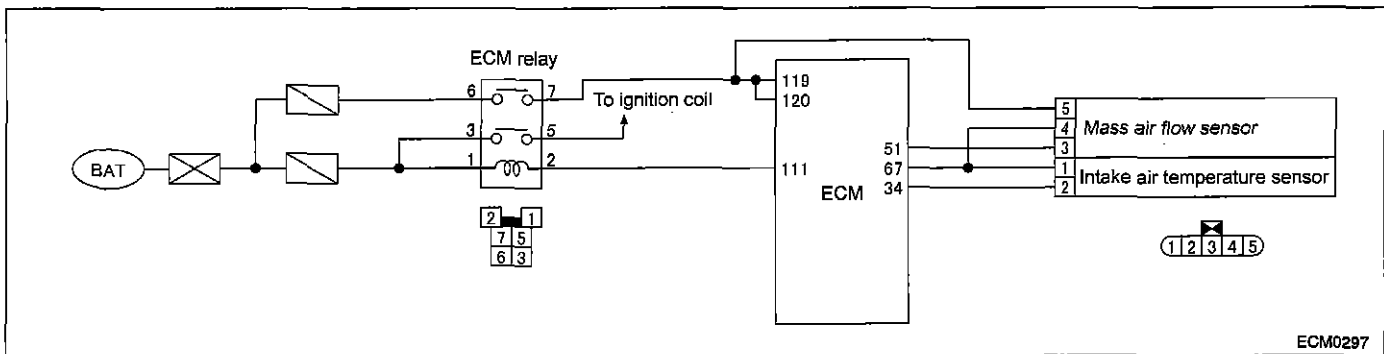
| Monitor item | At idle after warming up | At approx. 2,000 rpm |
|--------------|--------------------------|----------------------|
| MAS A/F SE   | Approx. 1.3V             | Approx. 1.6V         |

### ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

| Terminal | Signal name                 | At cranking  | At idle after warming up | At approx. 2,000 rpm |
|----------|-----------------------------|--------------|--------------------------|----------------------|
| 51       | Mass air flow sensor        | Approx. 1.5V | Approx. 1.3V             | Approx. 1.5V         |
| 67       | Mass air flow sensor ground | Approx. 0V   |                          |                      |

### Circuit Diagram



### Component Parts Inspection

#### MASS AIR FLOW SENSOR

1. Remove mass air flow sensor.
2. Turn ignition switch to ON. While blowing air into the mass air flow sensor from the air cleaner case side, check output voltage between terminal 3 and ground.

**No air blowing:**

**Approx. 1V**

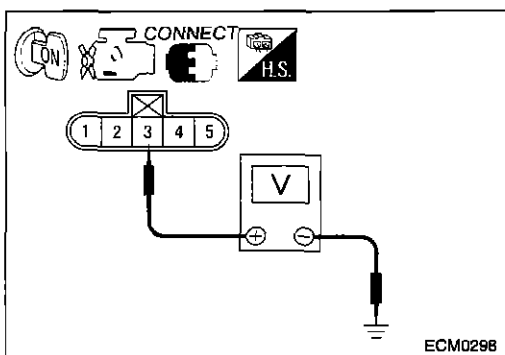
**With air blowing:**

**Approx. 1.3V**

**(The more the air is blown, the higher the voltage is.)**

**NOTE:**

- If air is blown from the air duct side, the voltage becomes lower.



# ENGINE COOLANT TEMPERATURE SENSOR SYSTEM

## SST data monitor display

| Monitor Item   | At Idle                                               | At approx. 2,000 rpm |
|----------------|-------------------------------------------------------|----------------------|
| COOLANT TEMP/S | After warming up engine: Approx. 80°C (176°F) or more |                      |

## ECM Input/Output Signal Specifications

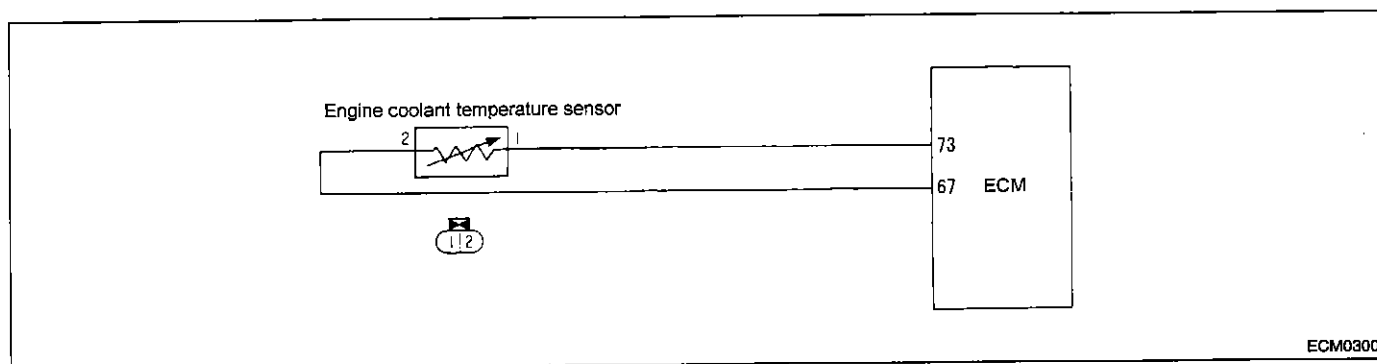
Measure voltage between terminals shown below and ground using a circuit tester.

| Terminal | Signal name                       | At Idle                                                                                                                             | At approx. 2,000 rpm |
|----------|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| 73       | Engine coolant temperature sensor | Engine coolant temperature at approx. 20°C (68°F): Approx. 3.5V<br>Engine coolant temperature at approx. 80°C (176°F): Approx. 1.2V |                      |

### NOTE:

- If engine coolant temperature sensor has a malfunction, the value of engine coolant temperature signal is changed along with start-up time by fail-safe to enable normal operation.

## Circuit Diagram



## Component Parts Inspection

### ENGINE COOLANT TEMPERATURE SENSOR

Check resistance between terminals 1 and 2 on the engine coolant temperature sensor.

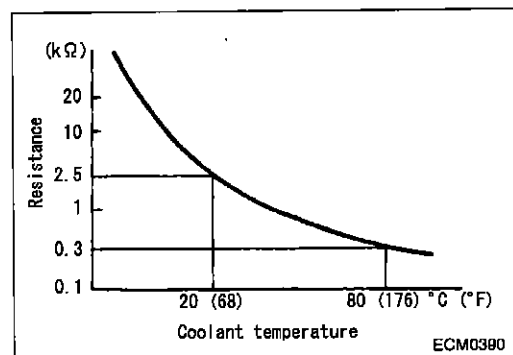
#### Resistance

Coolant temperature at approx. 20°C (68°F):

Approx. 2.5 kΩ

Coolant temperature at approx. 80°C (176°F):

Approx. 0.3 kΩ



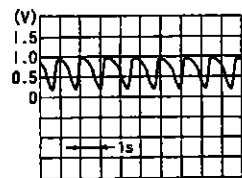
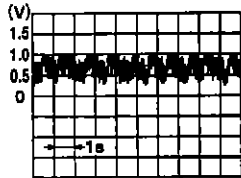
## HEATED OXYGEN SENSOR SYSTEM

### SST Data Monitor Display

| Monitor item | At idle after warming up                                                | At approx. 2,000 rpm                                    |
|--------------|-------------------------------------------------------------------------|---------------------------------------------------------|
| H02S1        | Changes between approx. 0.1 - 0.4V $\leftrightarrow$ approx. 0.6 - 0.9V |                                                         |
| H02S1 MNTR   | RICH and LEAN alternate slowly.                                         | RICH and LEAN alternate at least 5 times in 10 seconds. |

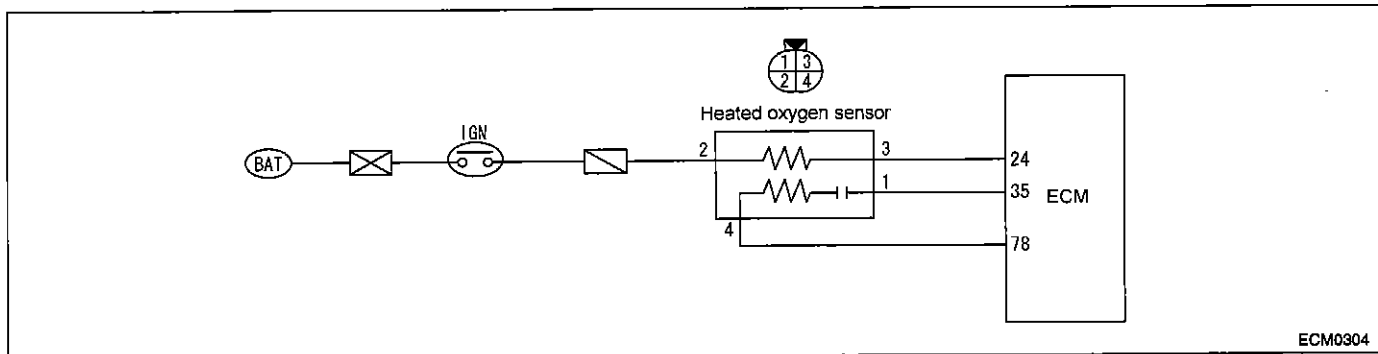
### ECM Input/Output Signal Specifications

Check waveform between terminals shown below and ground using an oscilloscope.

| Terminal | Signal name          | At idle after warming up                                                                                                                                                                                                                                                      | At approx. 2,000 rpm                                                                                                                                                                    |
|----------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 35       | Heated oxygen sensor | <p>Air conditioner OFF<br/>: Clamps between approx. 0 - 0.7V.<br/>Air conditioner ON<br/>: Changes between approx. 0 - 0.3V <math>\rightarrow</math> approx. 0.5 - 1.0V</p>  <p>ECM0302</p> | <p>Changes between approx. 0 - 0.3V <math>\rightarrow</math> approx. 0.5 - 1.0V</p>  <p>ECM0303</p> |

Numerical values (reference values) are obtained using an analog circuit tester.

### Circuit Diagram



## VEHICLE SPEED SENSOR SYSTEM

### SST Data Monitor Display

| Monitor item  | At Idle                                           | Driving |
|---------------|---------------------------------------------------|---------|
| VHCL SPEED SE | Almost in accordance with the speedometer display |         |

### ECM Input/Output Signal Specifications

Check waveform between terminals shown below and ground using an oscilloscope.

| Terminal | Signal name          | At Idle            | Vehicle running at approx. 40 km/h                                             |
|----------|----------------------|--------------------|--------------------------------------------------------------------------------|
| 63       | Vehicle speed signal | Approx. 4.6V or 0V | Approx. 2.3V<br><div> </div> |

# THROTTLE POSITION SENSOR SYSTEM

## SST Data Monitor Display

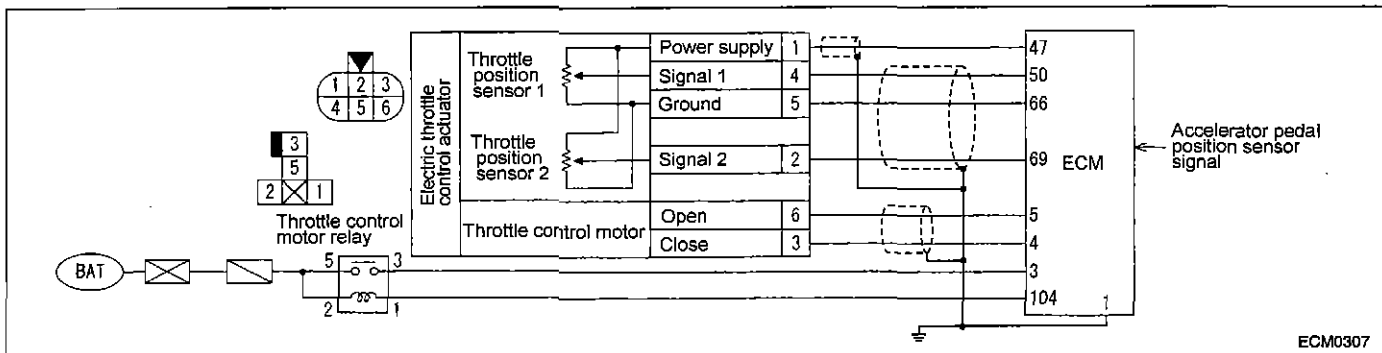
| Monitor item | At idle after warming up | At approx. 2,000 rpm |
|--------------|--------------------------|----------------------|
| THRTL SEN 1  | Approx. 0.5 - 0.55V      | Approx. 0.65 - 0.7V  |
| THRTL SEN 2  |                          |                      |

## ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

| Terminal | Signal name                                    | At idle after warming up | At approx. 2,000 rpm |
|----------|------------------------------------------------|--------------------------|----------------------|
| 47       | Sensor power supply (Throttle position sensor) | Approx. 5V               |                      |
| 66       | Sensor ground (Throttle position sensor)       | Approx. 0V               |                      |
| 50       | Throttle position sensor 1                     | Approx. 0.6V             | Approx. 0.7V         |
| 69       | Throttle position sensor 2                     | Approx. 4.5V             | Approx. 4.4V         |

## Circuit Diagram



## Component Parts Inspection

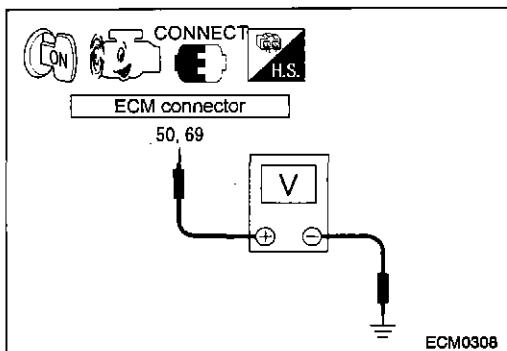
### THROTTLE POSITION SENSOR 1, 2 (ELECTRIC THROTTLE CONTROL ACTUATOR ASSEMBLY)

Check voltage between ECM terminal 50, 69 and ground.

Refer to EC section, "ECM Input/Output Signal Specifications" for the voltage.

#### CAUTION:

- Make sure that there is no moisture around connector when removing and installing throttle position sensor connector. If there are any water drops, completely wipe them off.
- Do not apply voltage to throttle position sensor terminal.
- Perform "Throttle Valve Closed Position Learning" if disconnecting connector. Perform if replacing electric throttle control actuator. (Refer to EC section, "Throttle Valve Closed Position Learning and Idle Air Volume Learning".)
- Do not disassemble electric throttle control actuator.



# ACCELERATOR PEDAL POSITION SENSOR SYSTEM

## SST Data Monitor Display

| Monitor item | At Idle             | At approx. 2,000 rpm |
|--------------|---------------------|----------------------|
| ACCEL SEN 1  | Approx. 0.6 - 0.65V | Approx. 0.75 - 0.8V  |
| ACCEL SEN 2  |                     |                      |

## ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

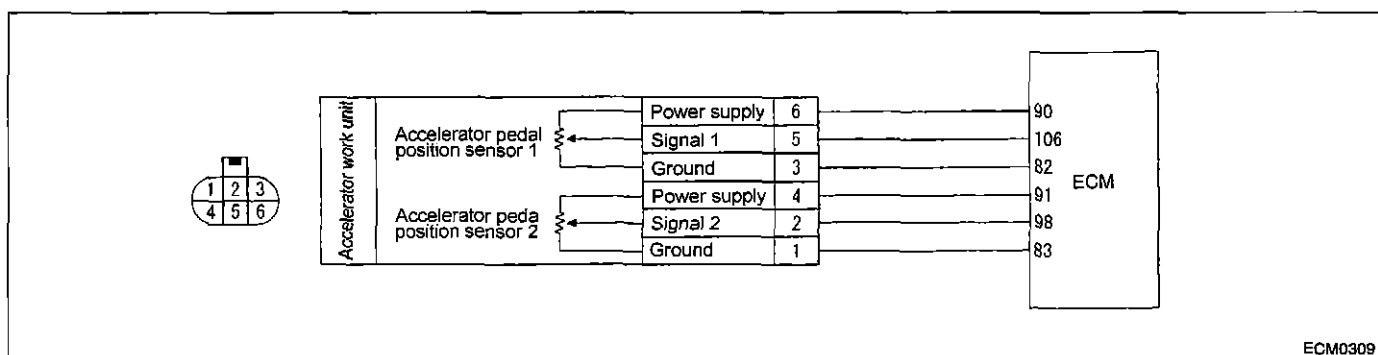
| Terminal | Signal name                                      | At Idle      | At approx. 2,000 rpm |
|----------|--------------------------------------------------|--------------|----------------------|
| 82       | Sensor ground                                    | Approx. 0V   |                      |
| 83       | Accelerator pedal position sensor 2 ground       | Approx. 0V   |                      |
| 90       | Sensor power supply                              | Approx. 5V   |                      |
| 91       | Accelerator pedal position sensor 2 power supply | Approx. 2.5V |                      |
| 98       | Accelerator pedal position sensor 2              | Approx. 0.3V | Approx. 0.35V        |
| 106      | Accelerator pedal position sensor 1              | Approx. 0.6V | Approx. 0.65V        |

### NOTE:

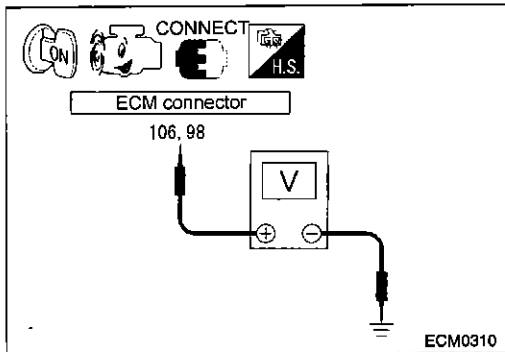
- When the accelerator pedal is depressed slowly from the fully-closed position, the voltage must increase in proportion to the opening of the throttle. [Ignition switch ON (engine stopped)]

| Terminal | Signal name                         | Ignition switch ON with engine stopped Accelerator pedal is fully depressed | Ignition switch ON with engine stopped Accelerator pedal is fully released |
|----------|-------------------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------|
| 98       | Accelerator pedal position sensor 2 | Approx. 0.3V                                                                | Approx. 2V                                                                 |
| 106      | Accelerator pedal position sensor 1 | Approx. 0.6V                                                                | Approx. 4.2V                                                               |

## Circuit Diagram



## ACCELERATOR PEDAL POSITION SENSOR SYSTEM



### Component Parts Inspection

#### ACCELERATOR PEDAL POSITION SENSORS 1, 2 (ACCELERATOR WORK UNIT)

Check voltage between ECM terminal 98, 106 and ground.

Refer to EC section, "ECM Input/Output Signal Specifications" for the voltage.

#### CAUTION:

- Do not apply voltage to accelerator pedal position sensor terminal.
- Do not disassemble accelerator work unit.

## PNP SWITCH SYSTEM

### SST Data Monitor Display

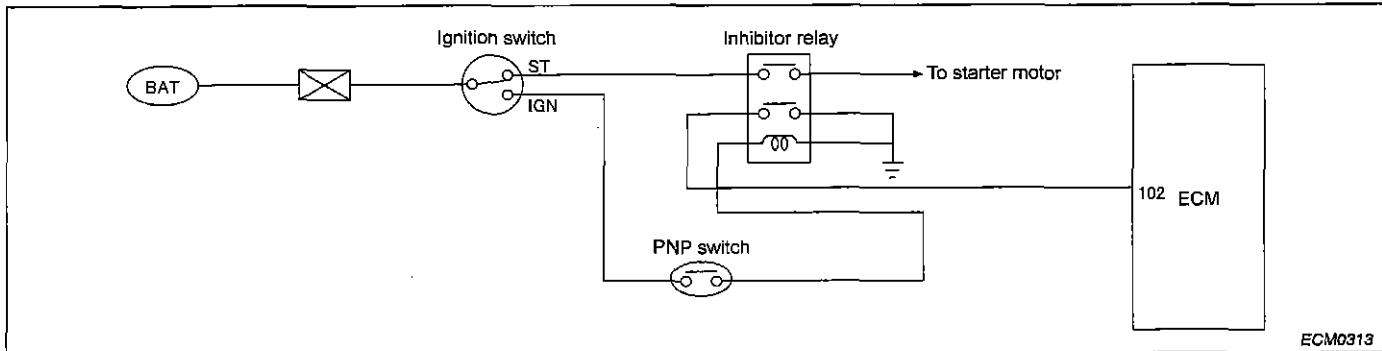
| Monitor item | Neutral or N/P position | Other than the left |
|--------------|-------------------------|---------------------|
| P/N POSI SW  | ON                      | OFF                 |

### ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

| Terminal | Signal name | Neutral or N/P position | Other than the left                                       |
|----------|-------------|-------------------------|-----------------------------------------------------------|
| 102      | PNP switch  | Approx. 0V              | Battery voltage (A/T models)<br>Approx. 4.8V (M/T models) |

### Circuit Diagram



### Component Parts Inspection

#### INHIBITER SWITCH

Refer to "INHIBITER SWITCH".

#### NEUTRAL SWITCH

Refer to "POSITION SWITCH".

## STOP LAMP SWITCH SYSTEM

### SST Data Monitor Display

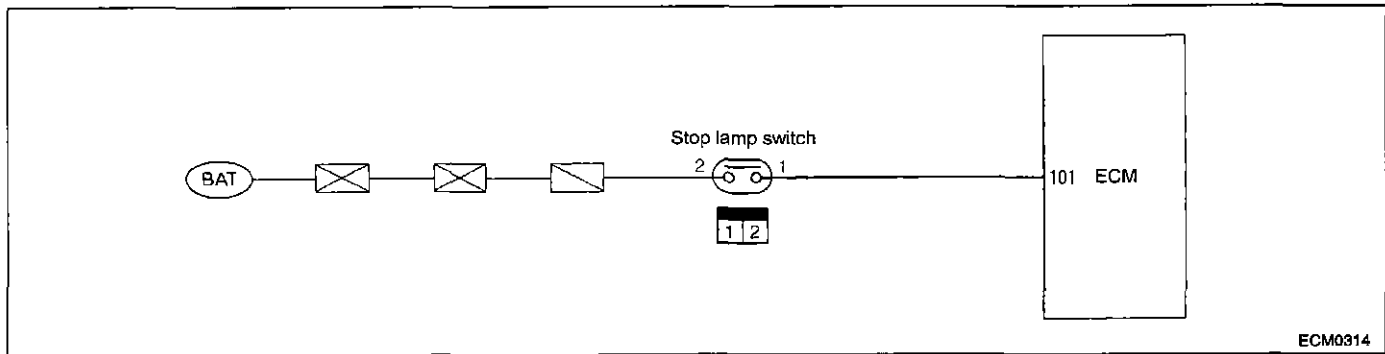
| Monitor item | Brake pedal released | Brake pedal depressed |
|--------------|----------------------|-----------------------|
| BRAKE SW     | OFF                  | ON                    |

### ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

| Terminal | Signal name      | Brake pedal released | Brake pedal depressed |
|----------|------------------|----------------------|-----------------------|
| 101      | Stop lamp switch | Approx. 0V           | Battery voltage       |

### Circuit Diagram



### Component Parts Inspection

#### STOP LAMP SWITCH

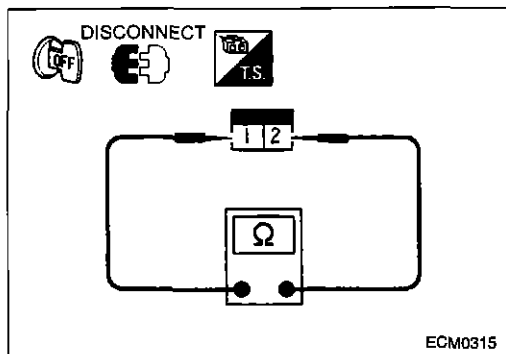
Check continuity between stop lamp switch terminals 1 and 2.

**Brake pedal released:**

**Continuity should not exist.**

**Brake pedal depressed:**

**Continuity should exist.**



## ELECTRIC LOAD SWITCH SYSTEM

### SST Data Monitor Display

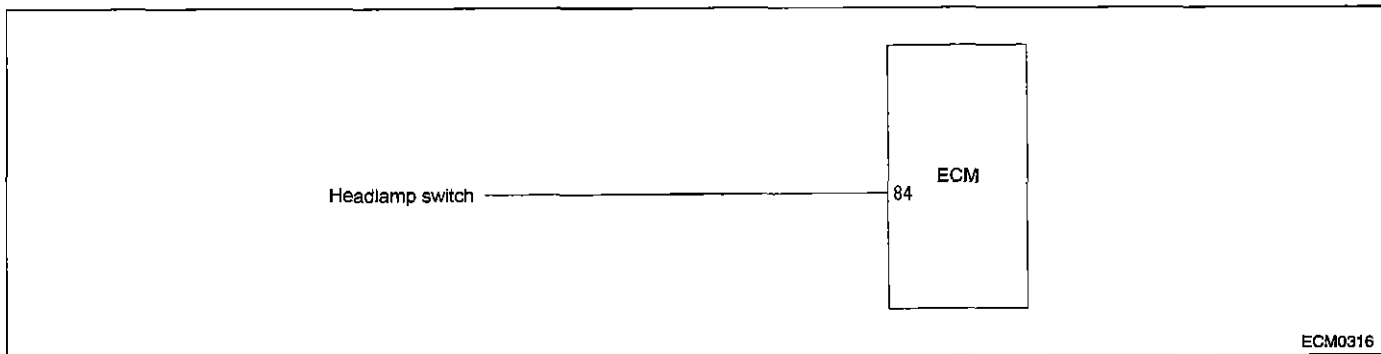
| Monitor item | Headlamp switch OFF | Headlamp switch ON |
|--------------|---------------------|--------------------|
| LOAD SIGNAL  | OFF                 | ON                 |

### ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

| Terminal | Signal name     | Headlamp switch OFF | Headlamp switch ON |
|----------|-----------------|---------------------|--------------------|
| 84       | Headlamp switch | Approx. 0V          | Battery voltage    |

### Circuit Diagram



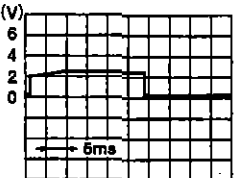
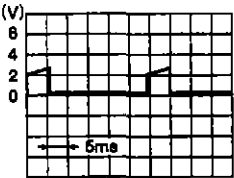
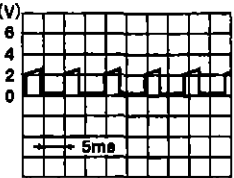
## IGNITION SYSTEM

### SST Data Monitor Display

| Monitor item | At idle after warming up | At approx. 2,000 rpm  |
|--------------|--------------------------|-----------------------|
| IGN TIMING   | Approx. 15° BTDC         | Approx. 30 - 40° BTDC |

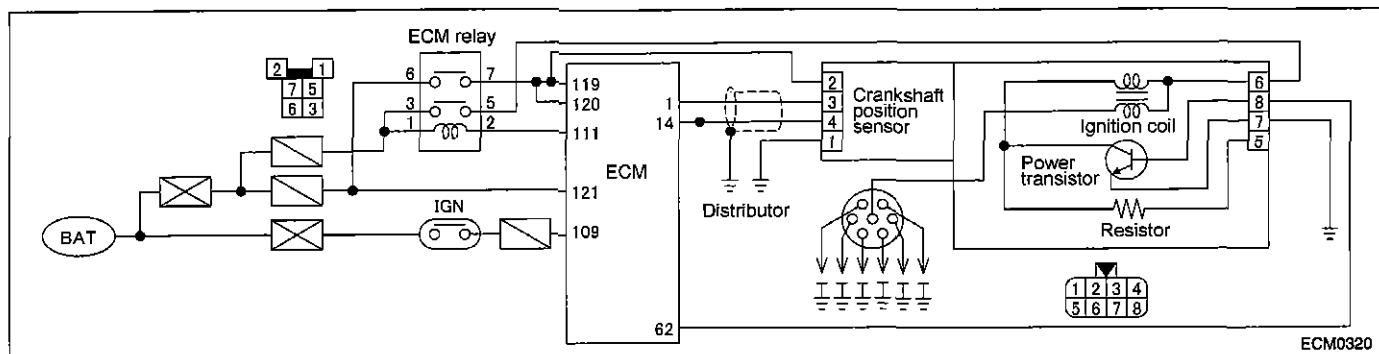
### ECM Input/Output Signal Specifications

Check waveform between terminals shown below and ground using an oscilloscope.

| Terminal | Signal name                                       | At cranking                                                                                       | At idle after warming up                                                                           | At approx. 2,000 rpm                                                                                |
|----------|---------------------------------------------------|---------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| 62       | Ignition signal (power transmission drive signal) | Approx. 0.5V<br> | Approx. 0.5V<br> | Approx. 0.9V<br> |

Numerical values (reference values) are obtained using an analog circuit tester.

### Circuit Diagram



### Component Parts Inspection

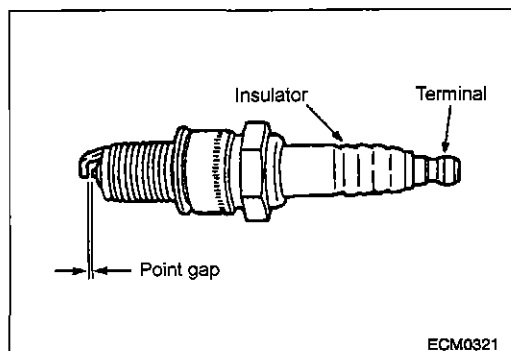
#### SPARK PLUG

- Check electrode for dirt, damage, and wear and insulator for damage.
- Replace spark plug if necessary.

#### CAUTION:

- Check terminals for looseness.
- Check insulator for cracks or damage.
- Check for contamination by oil, water, and dust.
- Make sure that the spark plug gap is normal, using a feeler gauge.

Spark plug gap:  
0.8 - 0.9 mm (0.031 - 0.035 in)



## IGNITION SYSTEM

### Component Parts Inspection (Cont'd)

#### POWER TRANSISTOR

- Check resistance between terminals of the power transistor by applying and exchanging (+ and -) the inspection rods of an analog circuit tester.

##### Inspection Terminals and Results (at room temperature)

Positive probe to 8 and negative probe to 7:

Except 0 or  $\infty\Omega$

Positive probe to 7 and negative probe to 8:

Except 0 or  $\infty\Omega$

Positive probe to 5 and negative probe to 8:

Except 0 or  $\infty\Omega$

Positive probe to 8 and negative probe 5:

$\infty\Omega$

Positive probe to 7 and negative probe 5:

$\infty\Omega$

Positive probe to 5 and negative probe to 7:

Except 0 or  $\infty\Omega$

##### CAUTION:

- Do not use a digital circuit tester because the standard is different.
- Check distribution functions (rotor and distributor cap) of the distributor.

#### IGNITION COIL

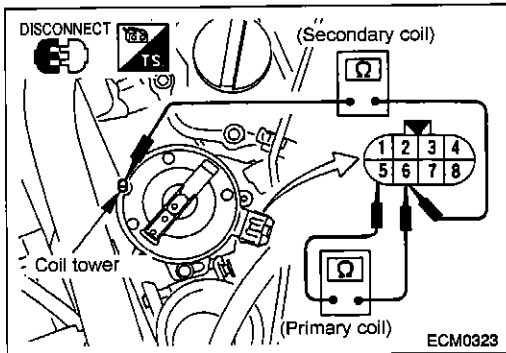
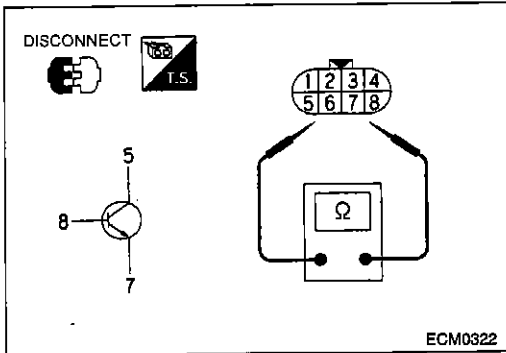
- Check resistance of the following:  
Primary coil resistance (5 - 6):  
Approx. 2.2 k $\Omega$   
Secondary coil resistance:  
Approx. 11.5 k $\Omega$   
(Between coil tower tip metal and 6 with the distributor cap removed.)

#### HIGH-TENSION CABLE

1. Removal and installation
  - 1) Remove intake manifold cover.
  - 2) Disconnect spark plug side.
  - 3) Disconnect distributor side and remove high-tension cable.

##### CAUTION FOR INSTALLATION

- Securely install distributor cap and high-tension code when matching both cylinder numbers.
- 2. Inspection
  - Check resistance of high-tension cable.  
For No. 1 cylinder: Approx. 2.7 k $\Omega$   
For No. 2 cylinder: Approx. 2.8 k $\Omega$   
For No. 3 cylinder: Approx. 4 k $\Omega$   
For No. 4 cylinder: Approx. 5 k $\Omega$   
For No. 5 cylinder: Approx. 5.2 k $\Omega$   
For No. 6 cylinder: Approx. 6.1 k $\Omega$



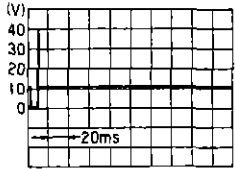
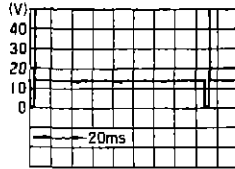
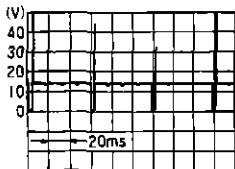
## FUEL INJECTOR SYSTEM

### SST Data Monitor Display

| Monitor item | At idle after warming up | At approx. 2,000 rpm |
|--------------|--------------------------|----------------------|
| INJ PULSE    | Approx. 2 - 4 msec       |                      |
| B/FUEL SCHDL | Approx. 2.5 - 4 msec     |                      |

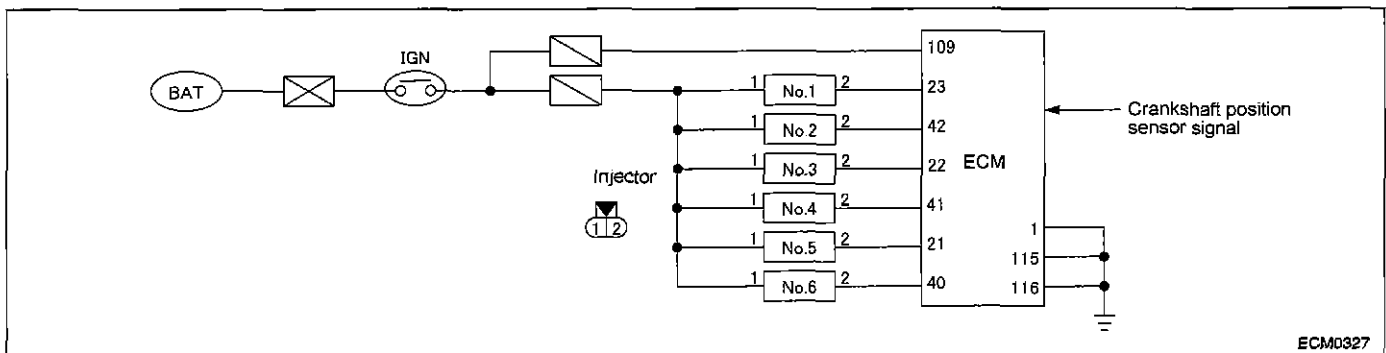
### ECM Input/Output Signal Specifications

Check waveform between terminals shown below and ground using an oscilloscope.

| Terminal                         | Signal name           | At cranking                                                                                                   | At idle after warming up                                                                                         | At approx. 2,000 rpm                                                                                                                    |
|----------------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 21<br>22<br>23<br>40<br>41<br>42 | Injector drive signal | Approx. 10.5V<br><br>ECM0324 | Battery voltage<br><br>ECM0325 | Relatively lower than battery voltage<br><br>ECM0326 |

Numerical values (reference values) are obtained using an analog circuit tester.

### Circuit Diagram



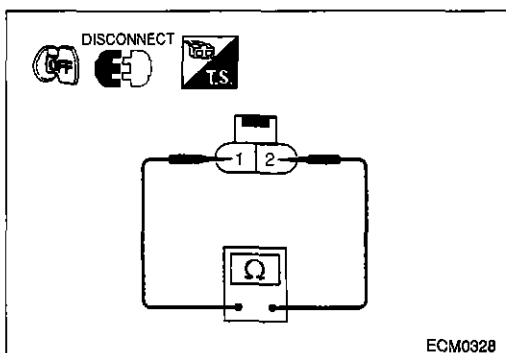
### Component Parts Inspection

#### INJECTOR

- Check resistance between each cylinder injector terminals 1 and 2.

**Standard resistance (all cylinders):**

**Approx. 14.5Ω; (at room temperature)**



## FUEL PUMP SYSTEM

### SST Data Monitor Display

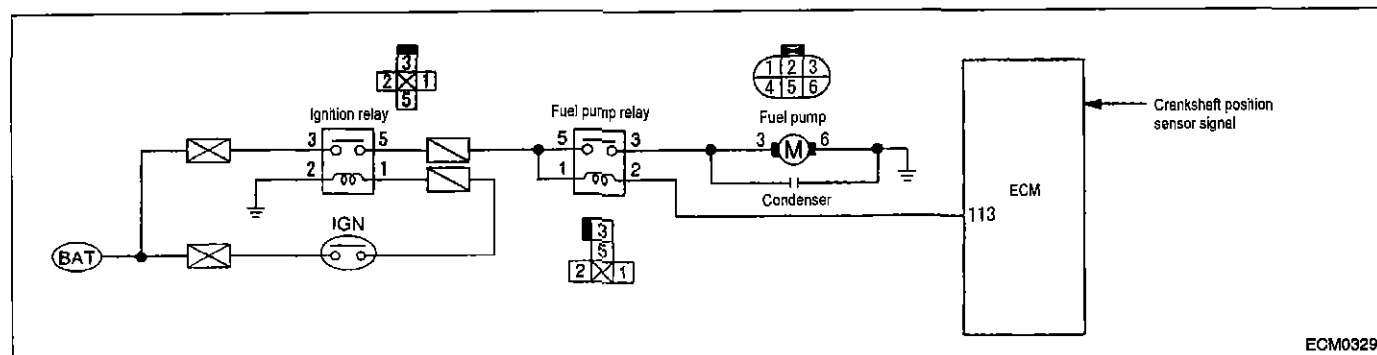
| Monitor item | Fuel pump is not activated | Fuel pump is operated |
|--------------|----------------------------|-----------------------|
| Fuel pump    | OFF                        | ON                    |

### ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

| Terminal | Signal name     | For approx. 1 second after ignition switch is turned ON | At cranking, engine running |
|----------|-----------------|---------------------------------------------------------|-----------------------------|
| 113      | Fuel pump relay | Approx. 1V<br>(After approx. 1 second: Battery voltage) | Approx. 1V                  |

### Circuit Diagram



### Component Parts Inspection

#### FUEL PUMP

Check resistance between terminals 3 and 6.

**Resistance: Approx. 1Ω (at room temperature)**

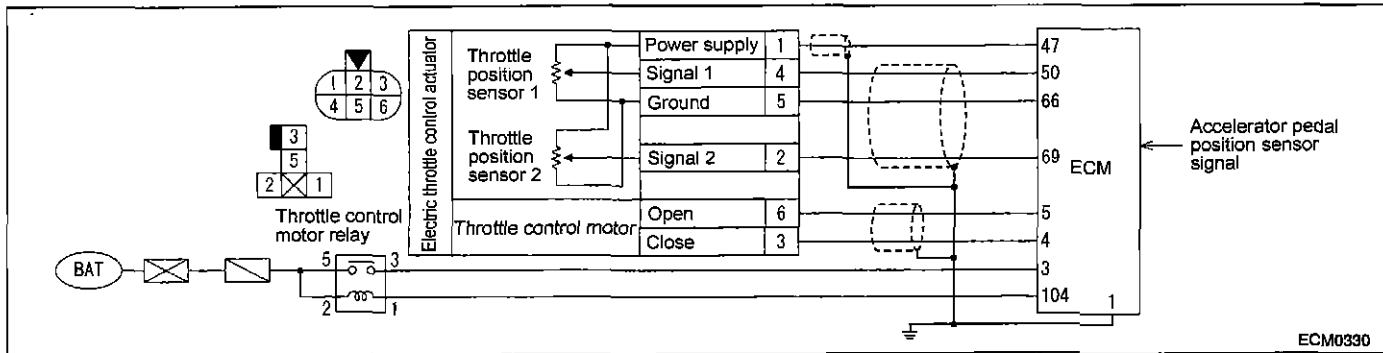
# THROTTLE CONTROL MOTOR SYSTEM

## ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

| Terminal | Signal name                      | At idle after warming up | At approx. 2,000 rpm |
|----------|----------------------------------|--------------------------|----------------------|
| 5        | Throttle control motor 2 (Close) | Approx. 2 - 2.5V         |                      |
| 4        | Throttle control motor 1 (Open)  | Approx. 0.1 - 0.15V      |                      |

## Circuit Diagram



## Component Parts Inspection

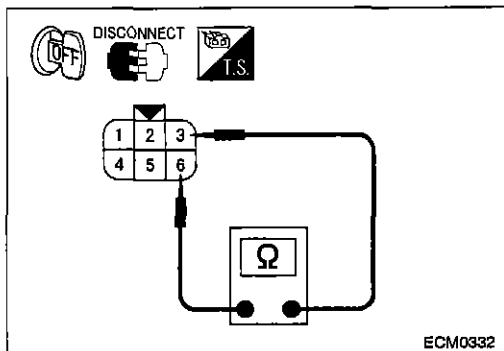
### ELECTRIC THROTTLE CONTROL MOTOR (ELECTRIC THROTTLE CONTROL ACTUATOR ASSEMBLY)

Check resistance between electric throttle control motor (throttle position sensor connector) terminals 3 and 6.

**Resistance: Approx. 1 -15Ω; [at 25°C (77°F)]**

#### CAUTION:

- Make sure that there is no moisture around connector when removing and installing throttle position sensor connector. If there are any water drops, completely wipe them off.
- Do not apply voltage to electric throttle control motor terminal.
- Perform "Throttle Valve Closed Position Learning" if disconnecting connector. Perform if replacing electric throttle control actuator. (Refer to EC section), "Throttle Valve Closed Position Learning and Idle Air Volume Learning".)
- Do not disassemble electric throttle control actuator.



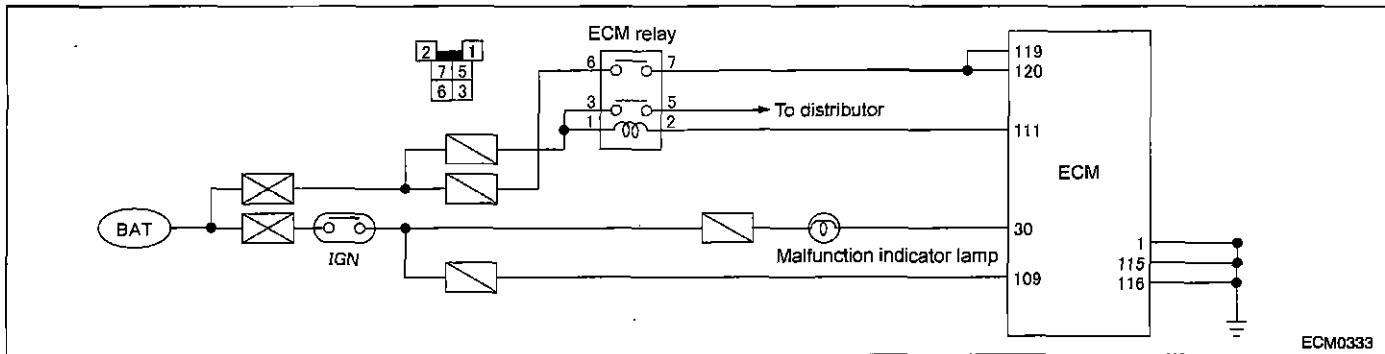
## MIL SYSTEM

### ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

| Terminal | Signal name | Warning lamp ON | Warning lamp OFF |
|----------|-------------|-----------------|------------------|
| 30       | MIL         | Approx. 0.1V    | Battery voltage  |

### Circuit Diagram



## HEATED OXYGEN SENSOR HEATER SYSTEM

### SST Data Monitor Display

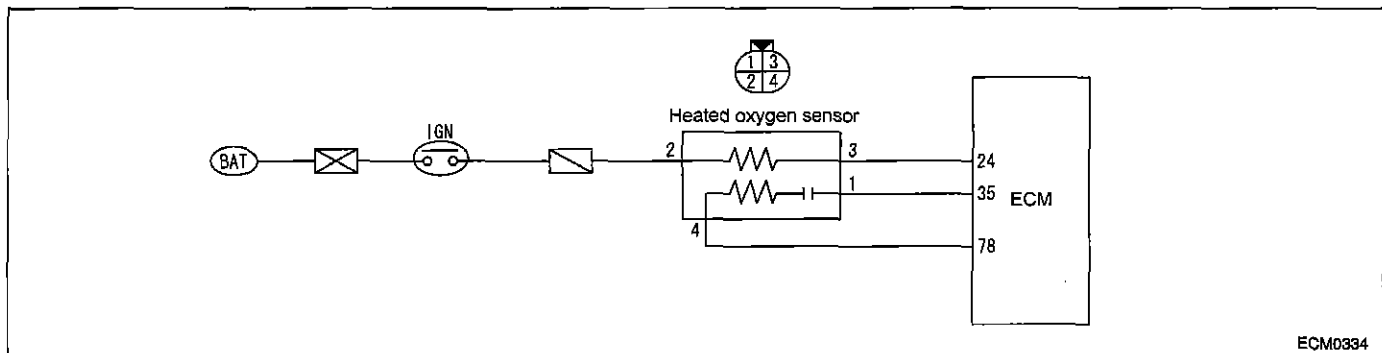
| Monitor Item | At idle after warming up |
|--------------|--------------------------|
| HO2S1 MTR    | ON                       |

### ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

| Terminal | Signal name                             | At idle after warming up | Approx. 3,600 rpm or more |
|----------|-----------------------------------------|--------------------------|---------------------------|
| 24       | Heated oxygen sensor heater open signal | Approx. 0.3V             | Battery voltage           |

### Circuit Diagram

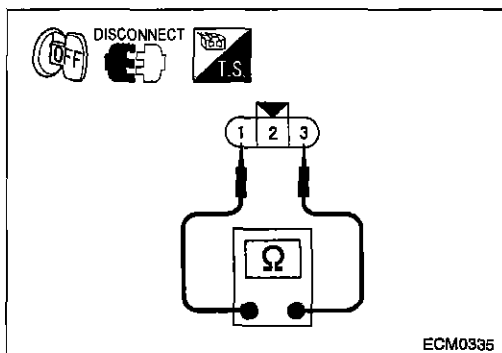


### Component Parts Inspection

#### HEATED OXYGEN SENSOR HEATER

Check resistance between heated oxygen sensor terminals 2 and 3.

**Resistance: Approx. 3.3 - 3.5Ω**



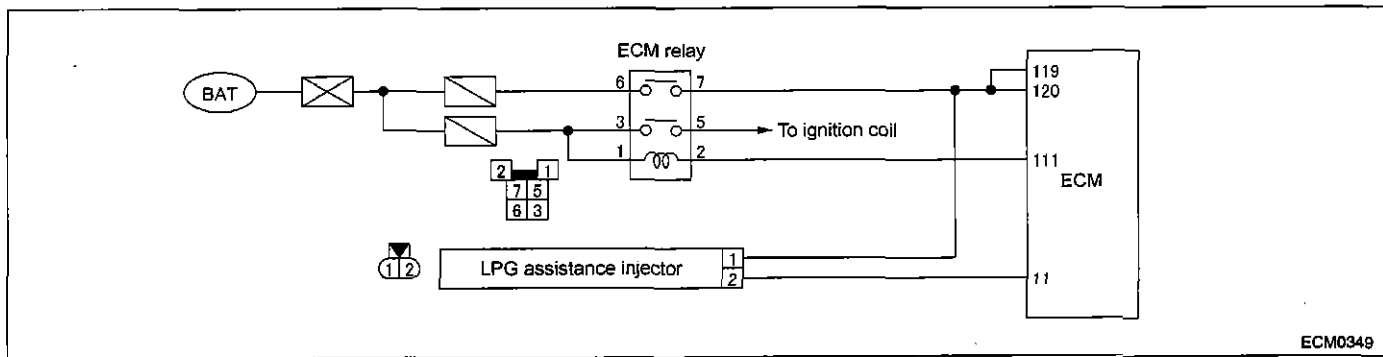
## LPG ASSISTANCE INJECTOR SYSTEM

### ECM Input/Output Signal Specifications

Check waveform between terminals shown below and ground using an oscilloscope.

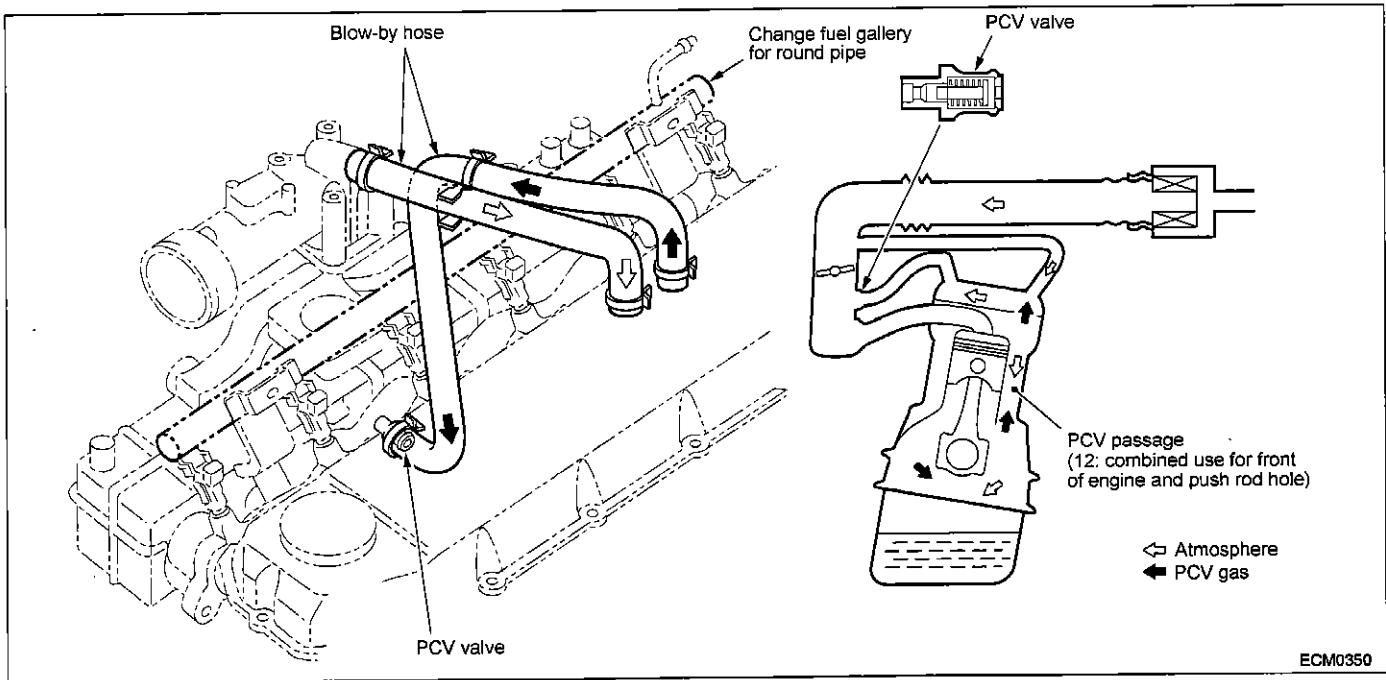
| Terminal | Signal name             | At Idle         |
|----------|-------------------------|-----------------|
| 24       | LPG assistance injector | Battery voltage |

### Circuit Diagram



# PCV GAS RESTORATION DEVICE

## System Diagram



## Removal and Installation of PCV Valve

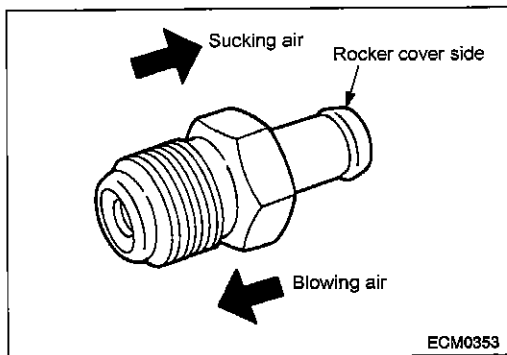
1. Remove and install PCV hose.
2. Remove and install PCV valve.

## PCV Valve Inspection

- Hissing noises should be heard from the air passage of the valve.
- Check continuity when blowing/sucking air to/from PCV valve rocker cover side.

**Blowing air: Air flow exists**

**Sucking air: No air flow**

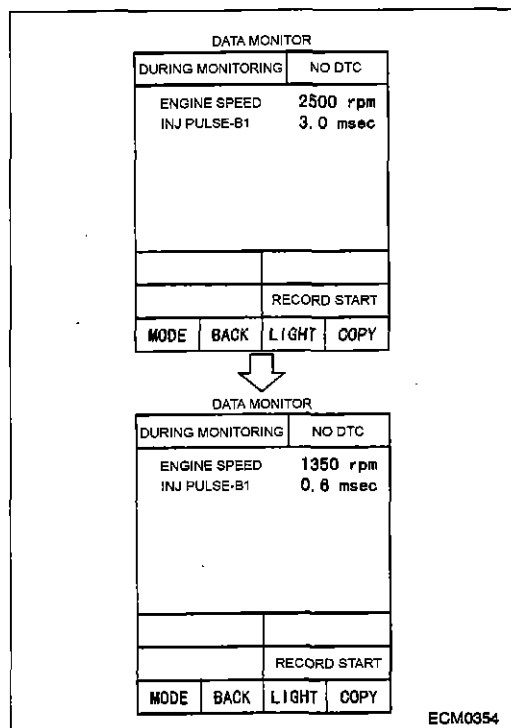


## FUEL CUT FUNCTION

### Inspection Procedure

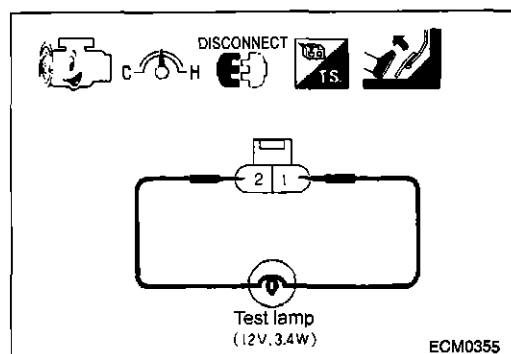
#### ④ WITH SST

1. Check "INJ PULSE" in DATA MONITOR mode, and increase the engine speed to approximately 2,500 rpm after warming up engine.
2. Make sure that "INJ PULSE" instantly drops to approximately 0.6 msec when accelerator pedal is released.



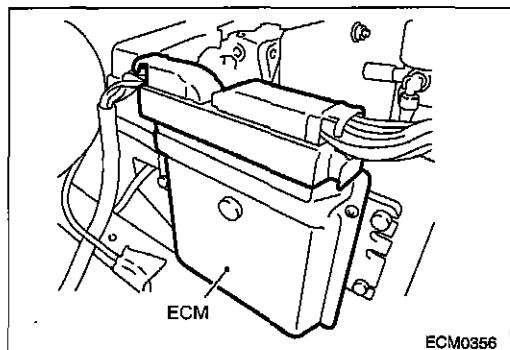
#### ④ WITHOUT SST

1. Warm up the engine sufficiently.
2. Disconnect harness connector of the injector and connect a test lamp.
3. Release the accelerator pedal at the engine speed of approximately 2,500 rpm or more, and confirm test lamp goes out for a moment.



## REMOVAL AND INSTALLATION OF ECM COMPONENTS

### Removal and Installation of ECM



1. Disconnect ECM connector.
2. Remove ECM together with ECM bracket.
3. Remove ECM bracket.
4. Install in the reverse order of removal.

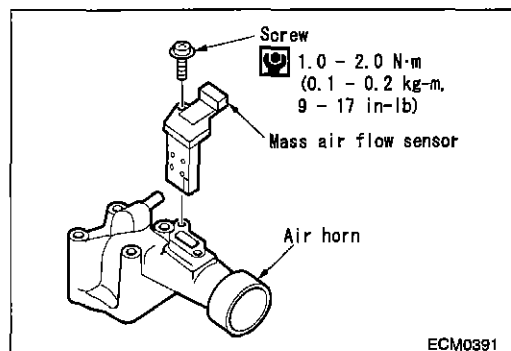
#### CAUTION:

- Perform "Throttle Valve Closed Position Learning and Idle Air Volume Learning" after installation if replacing ECM. (Refer to EC section, "Throttle Valve Closed Position Learning and Idle Air Volume Learning".)

### Removal and Installation of Crankshaft Position Sensor (Integrated Into the Distributor)

Refer to EM section, "Removal and Installation".

### Removal and Installation of Mass Air Flow Sensor



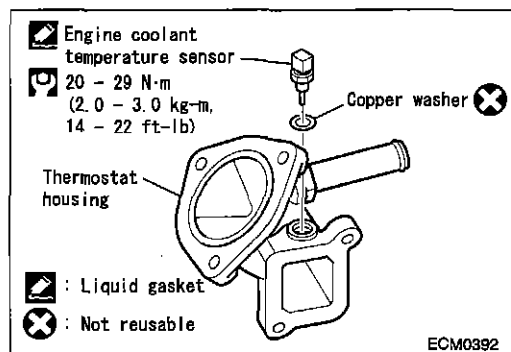
1. Remove harness connector.
2. Remove mass air flow sensor assembly from air horn.

### Removal and Installation of Engine Coolant Temperature Sensor

1. Disconnect radiator drain plug, and drain coolant.

#### CAUTION:

- Make sure to drain when the coolant temperature is cold.
2. Remove harness connector.
  3. Remove coolant temperature sensor using a socket specially designed for removing and installing coolant temperature sensors [commercially available: thermosensor socket manufactured by KTC (part No.: B20T-19)] and similar parts.



## REMOVAL AND INSTALLATION OF ECM COMPONENTS

### Removal and Installation of Heated Oxygen Sensor (With Heated Oxygen Sensor Heater)

1. Remove harness connector from heated oxygen sensor.
2. Remove heated oxygen sensor using a socket designed for heated oxygen sensor removal and installation (SST).

#### CAUTION:

- Handle it carefully and avoid impacts.

### Removal and Installation of Throttle Position Sensor (Electric Throttle Control Actuator Assembly)

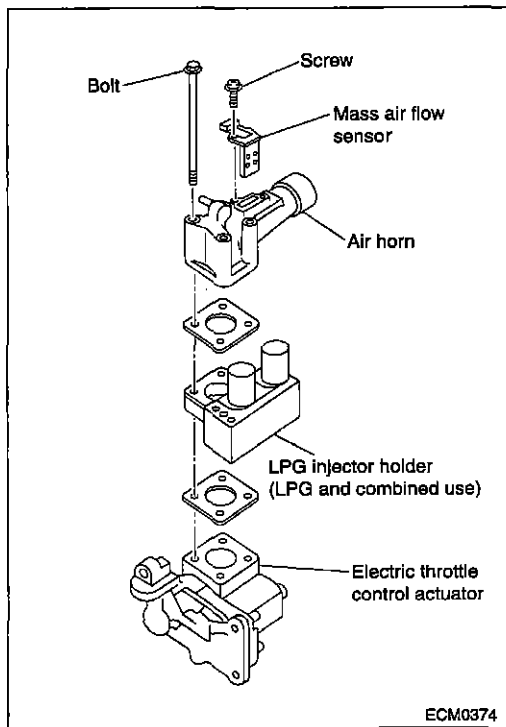
#### REMOVAL

1. Remove air duct from air horn.
2. Remove harness connector.

#### CAUTION:

- Also, remove harness connectors of mass air flow sensor, LPG injector, and LPG fuel pressure sensor so that when removing and installing air horn, LPG injection holder (LPG and Combined) is performed at the same time.

3. Loosen bolts diagonally, remove air horn, LPG injection holder (LPG or Combined) or air horn spacer (Gasoline), and then remove electric throttle control actuator.



#### INSTALLATION

##### CAUTION FOR INSTALLATION

- Uniformly tighten bolts diagonally in several steps.

#### CAUTION:

- Make sure that there is no moisture around connector when removing and installing throttle position sensor connector. If there are any water drops, completely wipe them off.
- Do not apply voltage to throttle position sensor terminal.
- Perform "Throttle Valve Closed Position Learning" if disconnecting connector. Perform if replacing electric throttle control actuator. (Refer to EC section, "Throttle Valve Closed Position Learning and Idle Air Volume Learning".)
- Do not disassemble electric throttle control actuator.

## REMOVAL AND INSTALLATION OF ECM COMPONENTS

---

### **Removal and Installation of Accelerator Pedal Position Sensor (Accelerator Pedal Assembly)**

Refer to "Removal and Installation".

#### **CAUTION:**

- Do not disassemble accelerator pedal assembly and remove sensors and switches.

### **Removal and Installation of Intake Air Temperature Sensor (With Mass Air Flow Sensor)**

- Refer to EC section, "Removal and Installation of Mass Air Flow Sensor" because intake air temperature sensor is joined with mass air flow sensor.

### **Removal and Installation of Ignition Coil (Integrated in Distributor)**

Refer to EM section, "Removal and Installation".

### **Removal and Installation of Fuel Injector**

Refer to EF section, "Removal and Installation".

### **Removal and Installation of Fuel Pump**

Refer to FL section, "Fuel Gauge, Fuel Filter, and Fuel Pump Assembly".

### **Removal and Installation of Throttle Control Motor (Electric Throttle Control Actuator Assembly)**

Refer to EF section, "Removal and installation of throttle position sensor (electric throttle control actuator assembly)".

## REMOVAL AND INSTALLATION OF ECM COMPONENTS

### Removal and Installation of LPG Injector Holder

#### REMOVAL

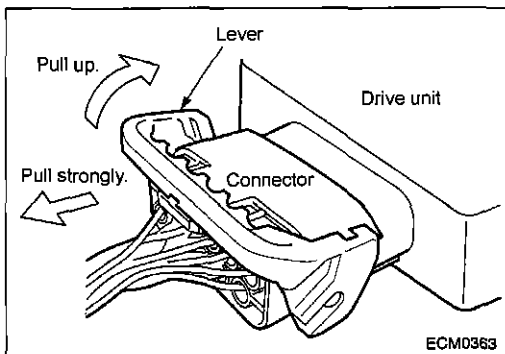
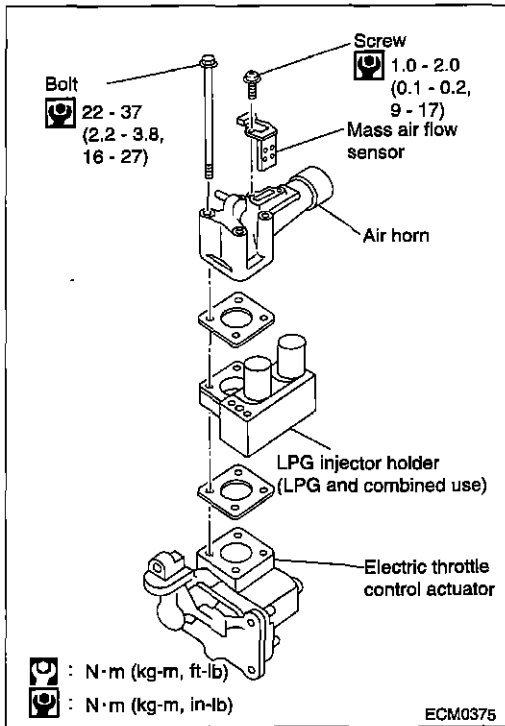
1. Remove air duct from air horn.
2. Remove harness connectors of mass air flow sensor, LPG injector, and LPG fuel pressure sensor.
3. Loosen bolts in turn, remove air horn, and then remove injector holder.

#### INSTALLATION

1. Caution for installation
  - Uniformly tighten bolts diagonally in several steps.

#### CAUTION:

- Make sure that there is no moisture around connector when removing and installing each connector. If there are any water drops, completely wipe them off.
- Do not apply voltage to each terminal.



### LPG Injector Drive Unit

#### HOW TO DISCONNECT LPG INJECTOR DRIVE UNIT CONNECTOR

1. Pull center of lever forward, and then disconnect tab from lever and lift it up.
2. Raise the lever until it clicks, and fully press the lever to drive unit side.
3. Pull connector forward, and then disconnect it from unit.

#### HOW TO CONNECT LPG INJECTOR DRIVE UNIT CONNECTOR

1. Press the lever in drive unit connector while pressing it to connector end.
2. Press in the lever until it clicks.
3. Raise the lever until it clicks, engage the tabs to the back of the lever and connector, and then securely connect them.

## SERVICE DATA AND SPECIFICATIONS (SDS)

### Standard, Repair Limit

|                                                                    |                                 |                                            |
|--------------------------------------------------------------------|---------------------------------|--------------------------------------------|
| Fuel pressure [kPa (bar, kg/cm <sup>2</sup> , psi)]                |                                 | 353 (3.53, 3.6, 51)                        |
| Idle speed (rpm)                                                   | N position                      | 650±50                                     |
| Ignition timing (°BTDC/rpm)                                        | N position                      | 10±2/650                                   |
| Firing order                                                       |                                 | 1-5-3-6-2-4                                |
| Spark plug                                                         | Manufacturer/type/gap [mm (in)] | BPR4ES [0.8 - 0.9 (0.31 - 0.35)]           |
| Ignition advance device                                            |                                 | Electronically controlled ignition advance |
| Density of CO at idle speed (%) /Density of HC at idle speed (ppm) |                                 | 0.1/50 or less                             |



# ENGINE ELECTRICAL SYSTEM

## SECTION **EL**

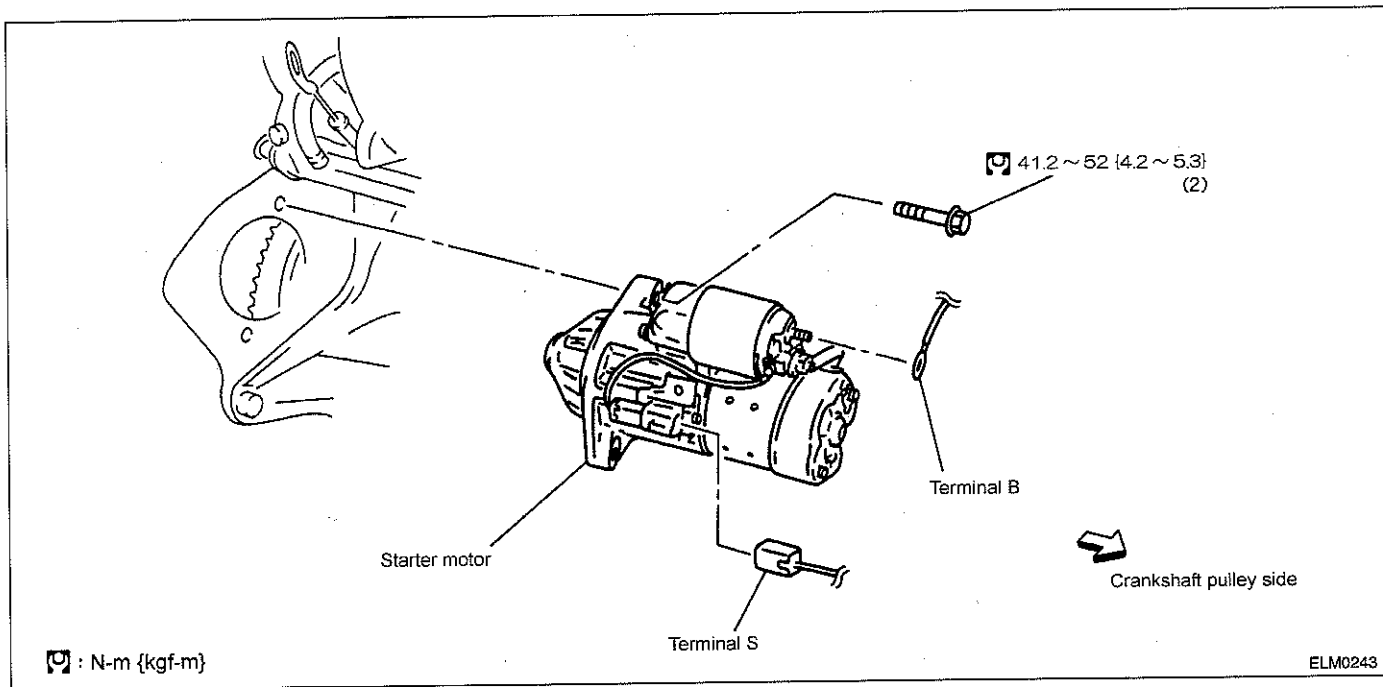
### CONTENTS

|                                |             |
|--------------------------------|-------------|
| <b>STARTING SYSTEM .....</b>   | <b>EL-2</b> |
| Component Parts Location ..... | EL-2        |
| Starter Motor .....            | EL-2        |

|                                             |              |
|---------------------------------------------|--------------|
| <b>CHARGING SYSTEM .....</b>                | <b>EL-3</b>  |
| Component Parts Location .....              | EL-3         |
| Components of Alternator .....              | EL-5         |
| Alternator .....                            | EL-5         |
| <b>ASSEMBLY OF HIGH-TENSION CABLE .....</b> | <b>EL-12</b> |

## STARTING SYSTEM

### Component Parts Location



#### CAUTION:

- Be sure to disconnect negative battery cable before operation.

### Starter Motor

#### REMOVAL

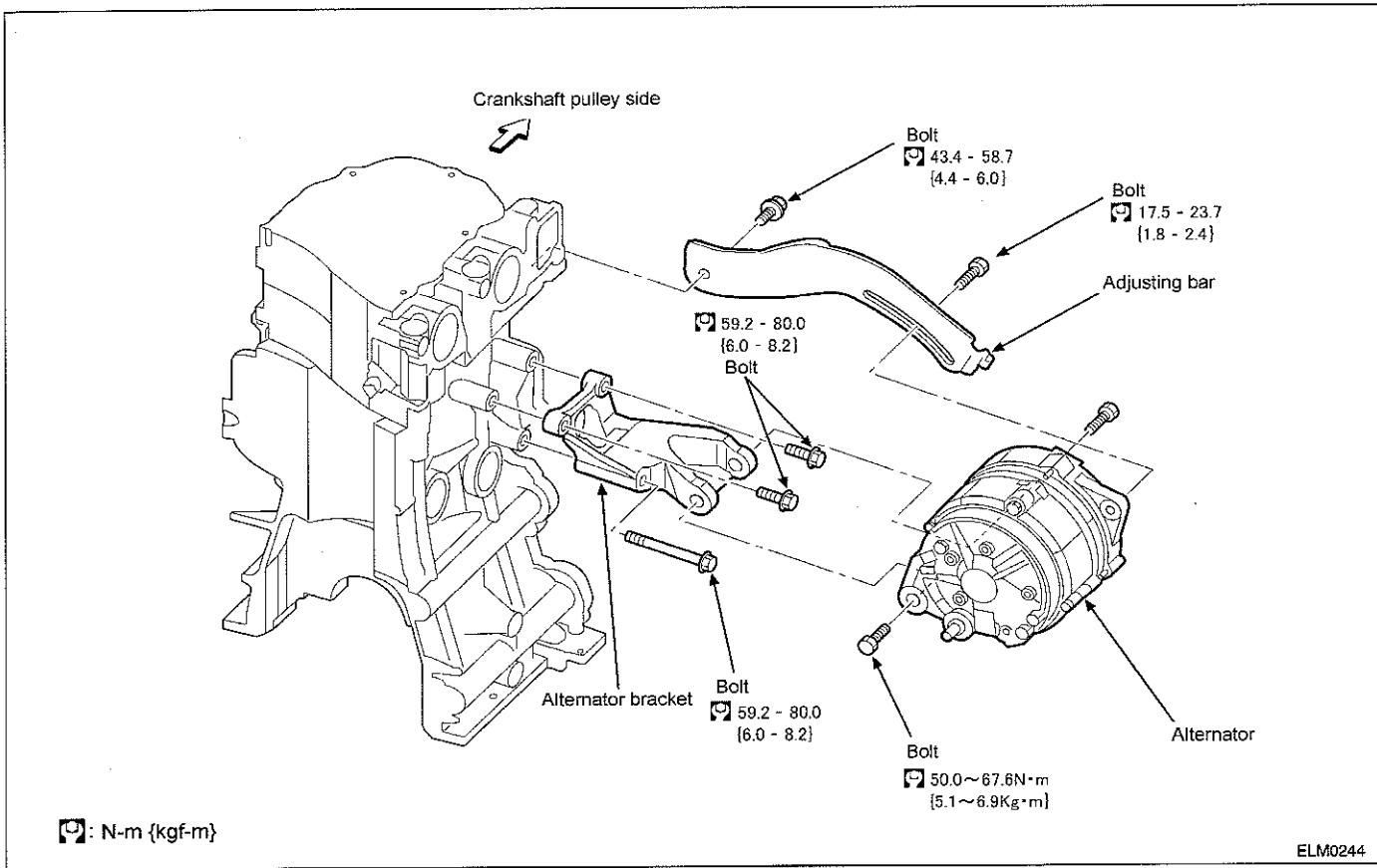
1. Disconnect terminals S and B.
2. Remove bolts (2).
3. Remove starter motor.

#### INSTALLATION

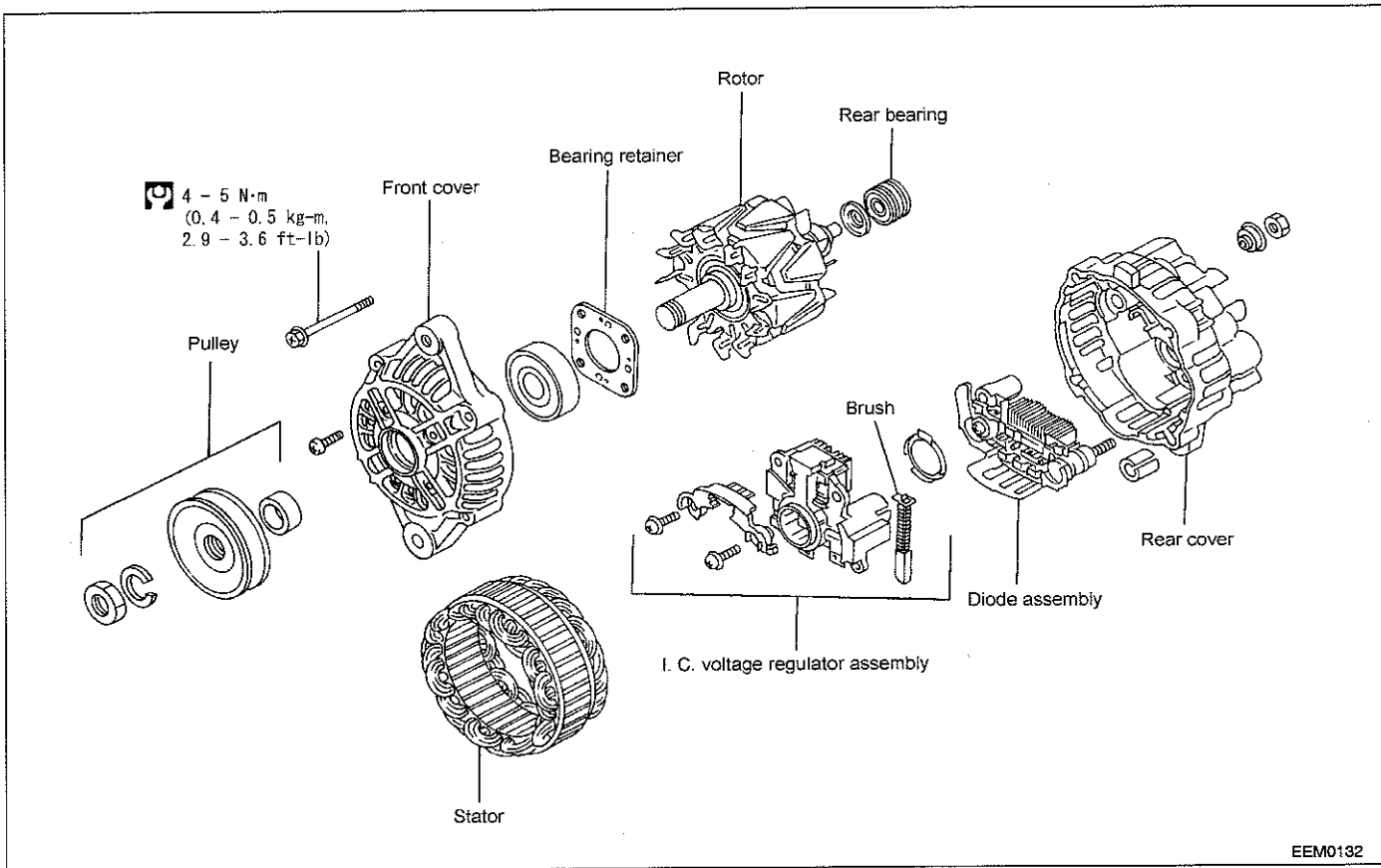
- Install in the reverse order of removal.

## CHARGING SYSTEM

### Component Parts Location

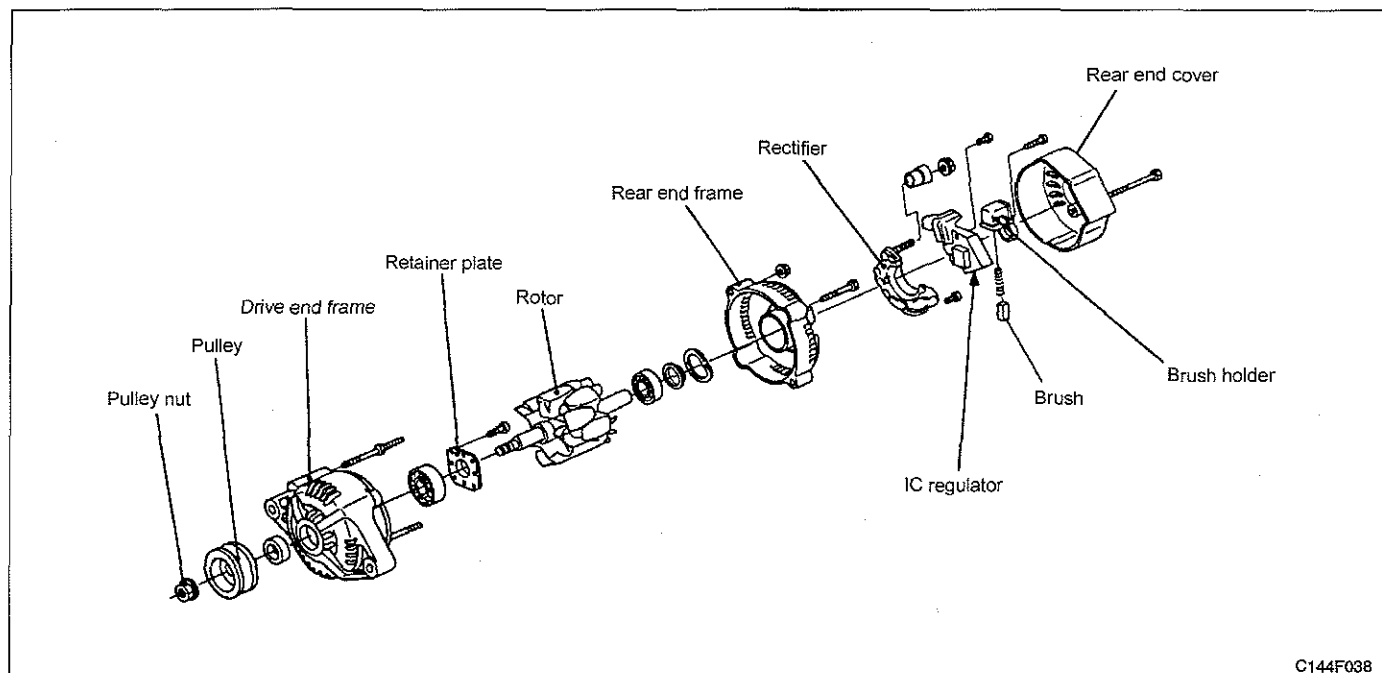


## CHARGING SYSTEM



## CHARGING SYSTEM

### Components of Alternator



### Alternator

#### REMOVAL

1. Disconnect negative battery cable.
2. Loosen alternator bolt, and disconnect alternator belt.
3. Remove adjusting bar.
4. Remove alternator bolt.
5. Disconnect ground point bolt, alternator connector, and nuts for terminal B.
6. Remove alternator from the vehicle.

#### INSTALLATION

- Install alternator, and adjust tension of the alternator belt. (Refer to "Engine drive belt" in ET section.)

#### CAUTION:

- Tighten the terminal B nut carefully.

## CHARGING SYSTEM

### Alternator (Cont'd)

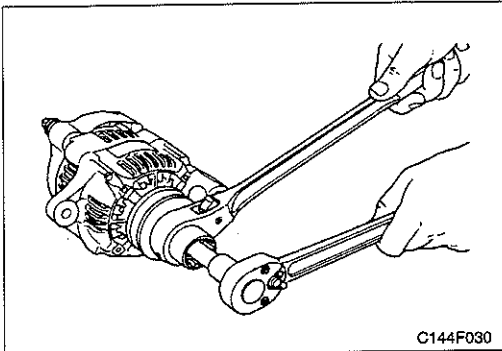
#### DISASSEMBLY

##### PULLEY

- Secure shaft hexagonal part with a box wrench, loosen pulley nut, and remove pulley.

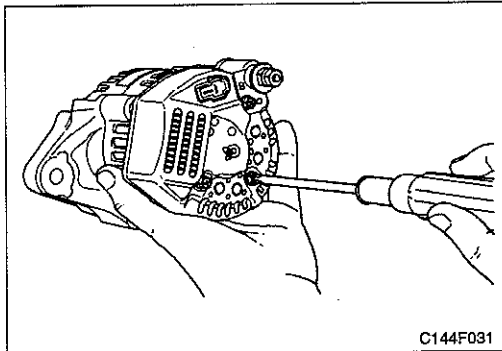
##### CAUTION:

- Hexagonal box wrench must be used. Twelve-fold box wrench may crush shaft head and slip.



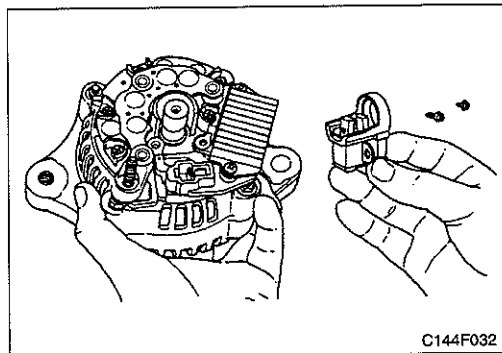
##### REAR END COVER

- Remove screw and terminal B nut, and then remove rear end cover.



##### BRUSH HOLDER

- Remove screw, and then remove brush holder.

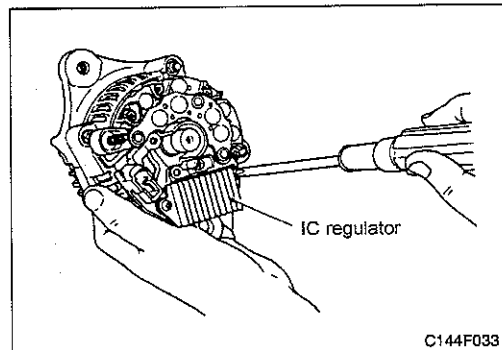


##### IC REGULATOR

- Remove screw, and then remove IC regulator.

##### CAUTION:

- Lengths of screws are difficult. Arrange removed screws, and securely install in the original position.

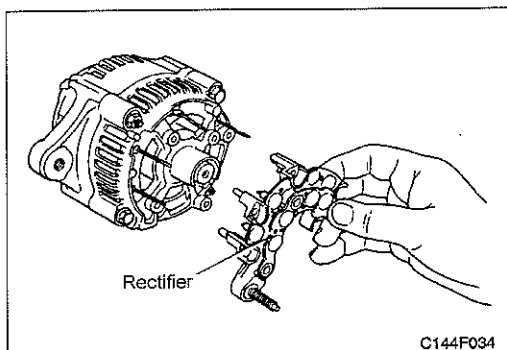


## CHARGING SYSTEM

### Alternator (Cont'd)

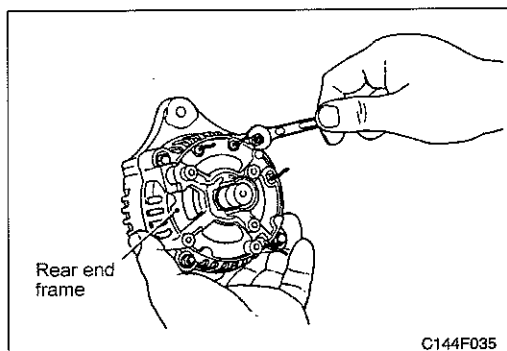
#### RECTIFIER

- Remove screws securing wires of rectifier and stator, and remove rectifier.



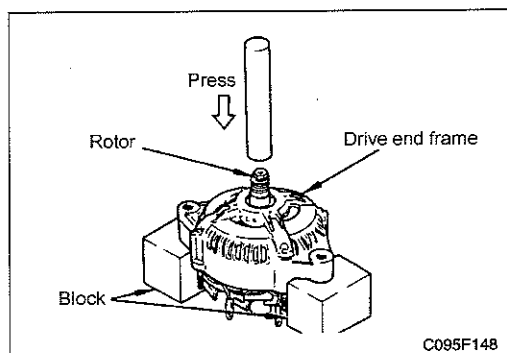
#### REAR END FRAME

- Remove bolts and nuts, and then remove rear end frame.



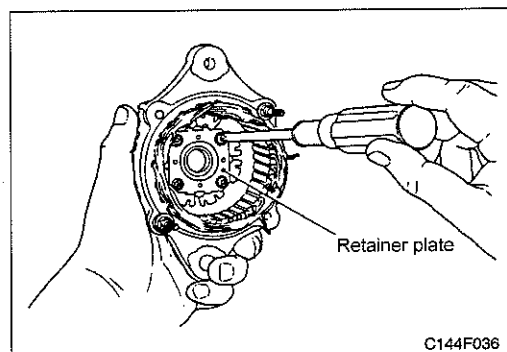
#### ROTOR

- Keep drive end frame on a level using blocks, and then press out rotor.



#### RETAINER PLATE

- Remove screws, and remove retainer plate.



## CHARGING SYSTEM

### Alternator (Cont'd)

#### BEARING

##### DRIVE END SIDE

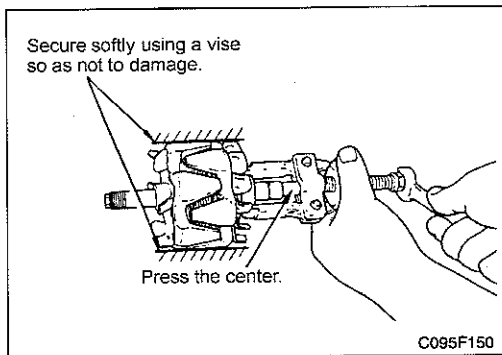
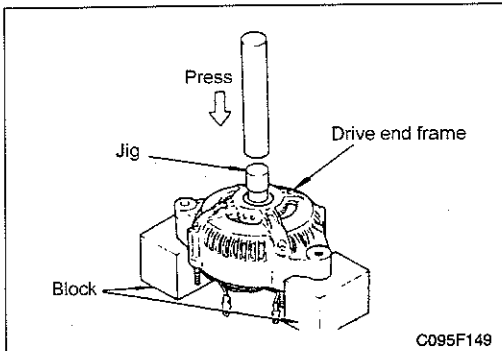
- Keep drive end frame on a level using blocks, and then press out bearing using a jig.

##### SNAP RING SIDE

- Pull out bearing using a puller.

- **CAUTION:**

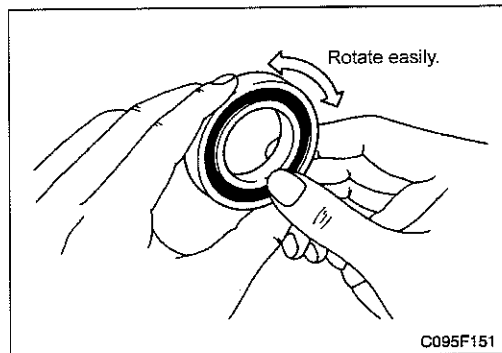
- **Specification uses bearing for high speed. Always use it when replacing, and avoid impact to it.**



#### INSPECTION

##### BEARING

- Rotate bearing by hand.
- Check for noise or binding.
- Replace if necessary.

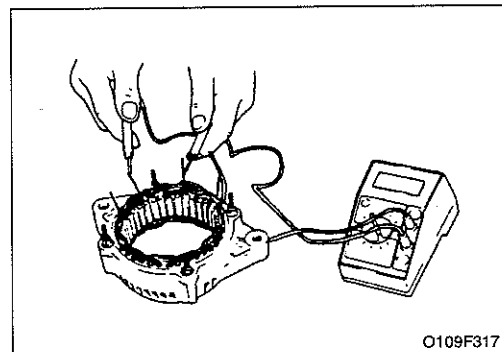


##### STATOR

- Measure resistance between each lead wire using a circuit tester.  
**Standard: 1Ω or less**
- Measure resistance between stator core and lead wire.  
**Standard: ∞**
- Replace if necessary.

##### CAUTION:

- **Open of stator coil itself is not considerable. Check the connection part of wires if continuity should not exist.**

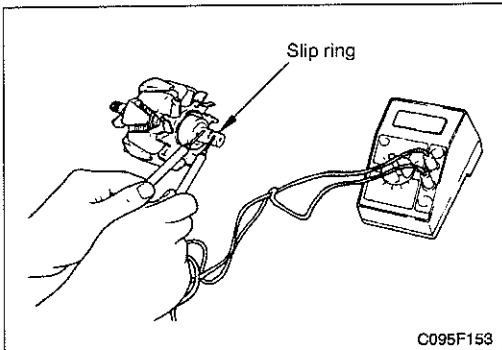


## CHARGING SYSTEM

### Alternator (Cont'd)

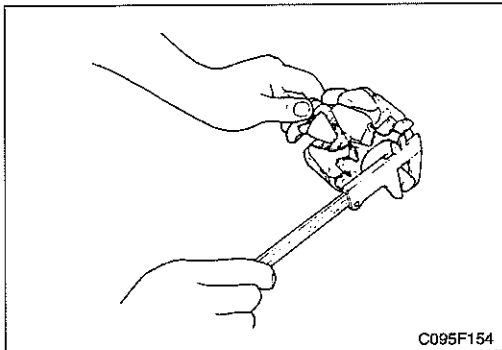
#### ROTOR COIL

- Measure resistance between each snap ring using a circuit tester.  
**Standard:  $2.9\Omega$**
- Measure resistance between snap ring and rotor core using a circuit tester.  
**Standard:  $\infty$**
- Replace if necessary.



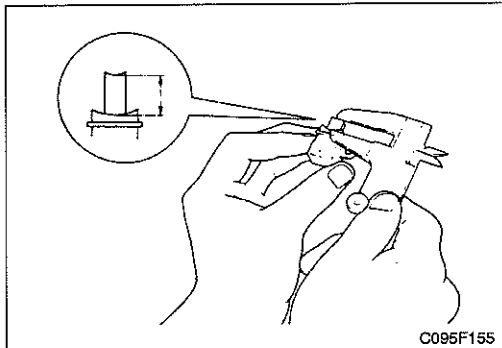
#### SNAP RING

- Check snap ring for dirt and damage.
- Wipe it clean with a cloth that is dipped in alcohol if it is dirty.
- Polish with sandpaper (#500 to 600) if there is slight damage.
- Measure snap ring outer diameter.  
**Snap ring outer diameter:**  
**Standard: 14.4mm**  
**Usable limit: 14.4mm**
- Replace if outside the usable limit.



#### BRUSH

- Measure excessive brush length from brush holder.  
**Excessive length of brush:**  
**Standard: 10.0mm**  
**Usable limit: 2.0mm**
- Replace if outside the usable limit.
- Make sure that brush is slightly moving in brush holder.

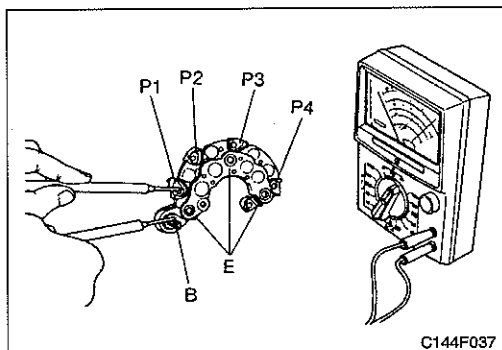


#### RECTIFIER

- Check continuity between each rectifier diode with circuit tester in  $k\Omega$  range.
- It is normal that continuity should exist in one side of diode and continuity should not exist in another side of diode.

#### CAUTION:

- Do not use 500V mega tester that breaks rectifier.

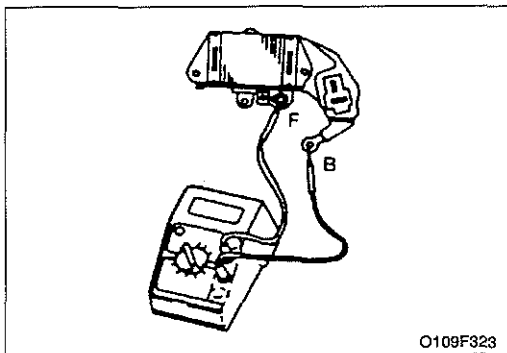
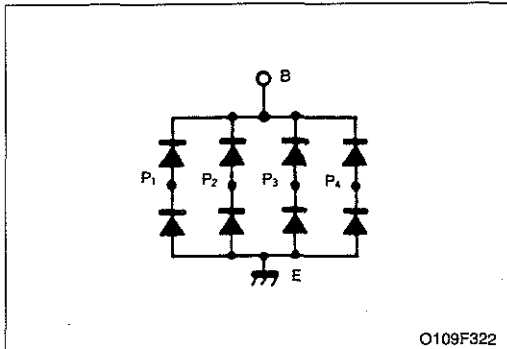


## CHARGING SYSTEM

### Alternator (Cont'd)

#### NOTE:

- Rectifier condition cannot be judged by forward resistance. On the characteristic of a diode, forward current is greatly changed by battery voltage. Indication of tester changes with differences of tester type and resistance range. Rectifier condition is judged by resistance differences between forward and reverse currents.



### IC REGULATOR

Check continuity between IC regulator terminal B and F with circuit tester in  $k\Omega$  range.

- It is normal that continuity should exist in one side and continuity should not exist in another side.

#### CAUTION:

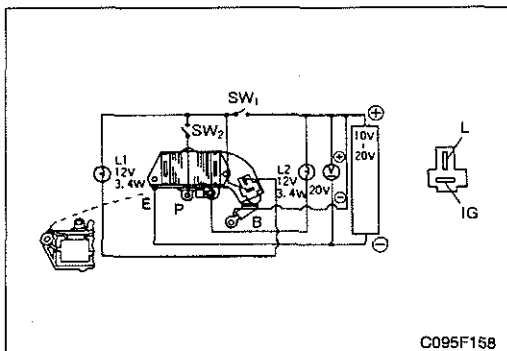
- Do not use 500V mega tester that breaks IC regulator.**

#### NOTE:

- IC regulator can be checked with the following procedure if there is a constant voltage power supply that can change voltage between 10 to 20V range.

#### CAUTION:

- Regulator may be destroyed if IC regulator misconnects only for a moment. Perform inspection after checking wiring.**



- Connect IC regulator unit with constant voltage power supply, circuit tester, and lamps.
- (Turn SW 1 and 2 OFF.)
- Set a power supply voltage to 12V.
- Turn SW 1 ON. Make sure that L1 turns ON brightly, and L2 turns ON dimly at this time.
- Turn SW 2 ON while SW 1 stays ON. Make sure that L1 turns OFF, and L2 turns ON brightly at this time.
- Raise battery voltage from 12V gradually. Make sure that L2 turns OFF when battery voltage is approximately  $14.5 \pm 0.6V$ .

## TROUBLE DIAGNOSIS

### PRELIMINARY PRECAUTIONS

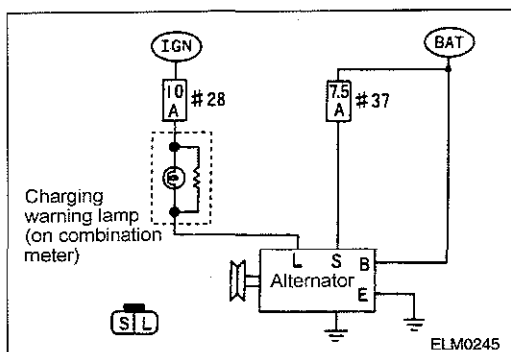
- The trouble diagnosis contents are for onboard trouble diagnosis.
- Be careful of sudden cooling fan rotation while the engine is running.
- Check if the fuse to the S-terminal is burned-out before performing the trouble diagnosis.

## CHARGING SYSTEM

### Alternator (Cont'd)

#### SYSTEM DESCRIPTION

Circuit diagram



#### ALTERNATOR INPUT/OUTPUT SIGNAL SPECIFICATIONS

| Terminal | Signal name         | Measuring condition                      | Standard (V)                |
|----------|---------------------|------------------------------------------|-----------------------------|
|          |                     | Operation or condition                   |                             |
| B        | Alternator output   | Ignition switch OFF                      | Approx. 12                  |
|          |                     | Engine idling                            | Approx. 13 - Approx. 14     |
|          |                     | Engine Speed: Approx. 2,500 - 3,000      | Approx. 14.1 - Approx. 14.7 |
| S        | Rotor excitation    | Ignition switch OFF                      | Approx. 12                  |
|          |                     | Engine idling                            | Approx. 13 - Approx. 14     |
| L        | Charge warning lamp | Engine stopped                           | Approx. 0 - Approx. 2.5     |
|          |                     | Engine idling                            | Approx. 13 - Approx. 14     |
| E        | Ground              | Ignition switch ON (with engine stopped) | Approx. 0                   |

#### CAUTION:

- The measurements above are made with no electrical load applied.

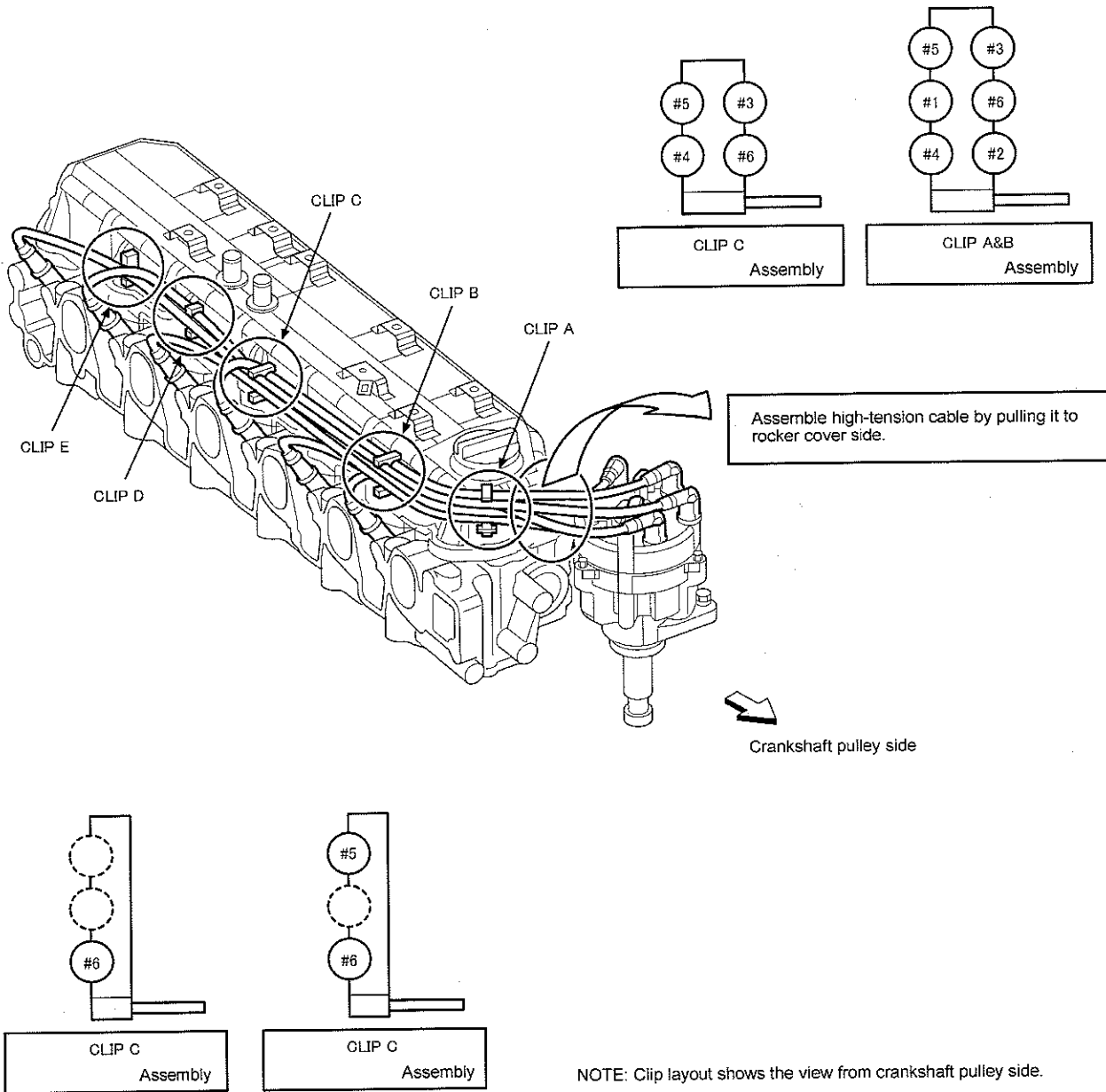
#### TROUBLE DIAGNOSIS CHART

| Symptom                                                                                                        | Inspection         |                              | Possible cause                                                                                                                                                                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------|--------------------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Charge warning lamp does not turn ON with ignition switch ON. (Other warning lamps and indicators are normal.) | Terminal voltage   | At idle: Approx. 13 - 14V    | Blown charging warning lamp bulb.                                                                                                                                                                                                                                                 |
|                                                                                                                |                    | At idle: Approx. 12V or less | <ul style="list-style-type: none"> <li>Warning lamp circuit open or shorted.</li> <li>Open or short in harness between combination meter and alternator.</li> <li>Alternator voltage control circuit open or shorted.</li> <li>Malfunctioning alternator + side diode.</li> </ul> |
| Charging warning lamp does not turn OFF if engine starts.                                                      | Terminal S voltage | At idle: 13V or more         | <ul style="list-style-type: none"> <li>Alternator voltage control circuit open or shorted.</li> </ul>                                                                                                                                                                             |
|                                                                                                                | Terminal voltage   | At idle: Approx. 12V or less | <ul style="list-style-type: none"> <li>Malfunctioning alternator rotor coil or diode.</li> <li>Malfunctioning alternator brush.</li> </ul>                                                                                                                                        |

#### CAUTION:

- The diagnoses above are made with no electrical load applied.

# ASSEMBLY OF HIGH-TENSION CABLE



ELM0246

No. ME-TB45AE

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