SECTION 6

ENGINE GENERAL INFORMATION AND DIAGNOSIS

WARNING:

For vehicles equipped with Supplemental Restraint (Air Bag) System :

- **Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to “Air Bag System Components and Wiring Location View” under “General Description” in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and “Service Precautions” under “On-Vehicle Service” in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.**
- **Technical service work must be started at least 90 seconds after the ignition switch is turned to the “LOCK” position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).**

NOTE:

Whether the following systems (parts) are used in the particular vehicle or not depends on vehicle specifications. Be sure to bear this in mind when performing service work.

- **EGR valve**
- **Heated oxygen sensor(s) or CO adjusting resistor**
- **Three-way catalytic converter (TWC) and warm up three-way catalytic converter (WU-TWC)**

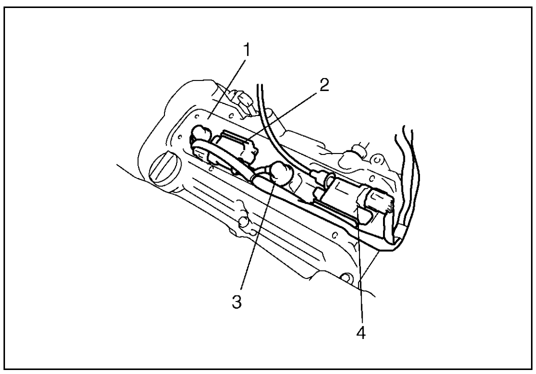
CONTENTS

General Information

Statement on Cleanliness and Care

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the thousands of an millimeter (ten thousands of an inch).
Accordingly, when any internal engine parts are serviced, care and cleanliness are important.
Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.

- A liberal coating of engine oil should be applied to friction areas during assembly to protect and lubricate the surfaces on initial operation.
- Whenever valve train components, pistons, piston rings, connecting rods, rod bearings, and crankshaft journal bearings are removed for service, they should be retained in order.
  At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.
- Battery cables should be disconnected before any major work is performed on the engine.
  Failure to disconnect cables may result in damage to wire harness or other electrical parts.



- Throughout this manual, the four cylinders of the engine are identified by numbers; No.1 (1), No.2 (2), No.3 (3) and No.4 (4) counted from crankshaft pulley side to flywheel side.

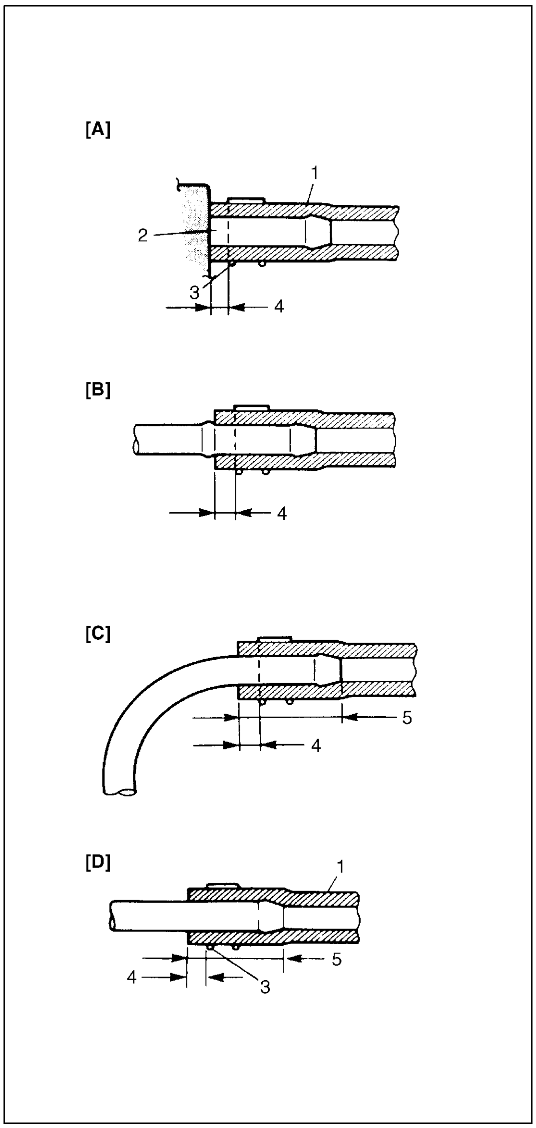
General Information on Engine Service

THE FOLLOWING INFORMATION ON ENGINE SERVICE SHOULD BE NOTED CAREFULLY, AS IT IS IMPORTANT IN PREVENTING DAMAGE, AND IN CONTRIBUTING TO RELIABLE ENGINE PERFORMANCE.

- When raising or supporting engine for any reason, do not use a jack under oil pan. Due to small clearance between oil pan and oil pump strainer, jacking against oil pan may cause it to be bent against strainer resulting in damaged oil pick-up unit.
- It should be kept in mind, while working on engine, that 12-volt electrical system is capable of violent and damaging short circuits.
  When performing any work where electrical terminals can be grounded, ground cable of the battery should be disconnected at battery.
- Any time the air cleaner, throttle body or intake manifold is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material which could follow intake passage into cylinder and cause extensive damage when engine is started.

Precaution on fuel system service

- Work must be done with no smoking, in a well-ventilated area and away from any open flames.
- As fuel feed line (between fuel pump and fuel delivery pipe) is still under high fuel pressure even after engine was stopped, loosening or disconnecting fuel feed line directly may cause dangerous spout of fuel to occur where loosened or disconnected.
  Before loosening or disconnecting fuel feed line, make sure to release fuel pressure according to “FUEL PRESSURE RELIEF PROCEDURE”. A small amount of fuel may be released after the fuel line is disconnected. In order to reduce the chance of personal injury, cover the fitting to be disconnected with a shop cloth. Put that cloth in an approved container when disconnection is completed.
- Never run engine with fuel pump relay disconnected when engine and exhaust system are hot.



- Fuel or fuel vapor hose connection varies with each type of pipe. When reconnecting fuel or fuel vapor hose, be sure to connect and clamp each hose correctly referring to the figure Hose Connection.
  After connecting, make sure that it has no twist or kink.

[A] :	With short pipe, fit hose as far as it reaches pipe joint as shown.
[B] :	With following type pipe, fit hose as far as its peripheral projection as shown.
[C] :	With bent pipe, fit hose as its bent part as shown or till pipe is about 20 to 30 mm (0.79 – 1.18 in.) into the hose.
[D] :	With straight pipe, fit hose till pipe is, about 20 to 30 mm (0.79 – 1.18 in.) into the hose.
1.	Hose
2.	Pipe
3.	Clamp
4.	Clamp securely at a position 3 to 7 mm (0.1 2 – 0.27 in.) from hose end.
5.	20 to 30 mm (0.79 – 1.18 in.)

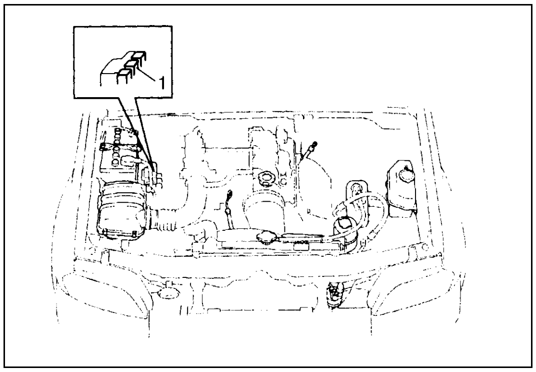
- When installing injector or fuel delivery pipe, lubricate its O-ring with spindle oil or gasoline.
- When connecting fuel pipe flare nut, first tighten flare nut by hand and then tighten it to specified torque.

Fuel pressure relief procedure

CAUTION:
This work must not be done when engine is hot. If done so, it may cause adverse effect to catalyst.

After making sure that engine is cold, release fuel pressure as follows.

1) Place transmission gear shift lever in “Neutral” (Shift selector lever to “P” range for A/T model), set parking brake, and block drive wheels.
2) Remove relay box cover.



3) Disconnect fuel pump relay (1) from its connector.
4) Remove fuel filler cap to release fuel vapor pressure in fuel tank and then reinstall it.
5) Start engine and run it till it stops for lack of fuel. Repeat cranking engine 2-3 times for about 3 seconds each time to dissipate fuel pressure in lines. Fuel connections are now safe for servicing.
6) Upon completion of servicing, connect fuel pump relay (1) to its connector.

Fuel leakage check procedure

After performing any service on fuel system, check to make sure that there are no fuel leakages as follows.

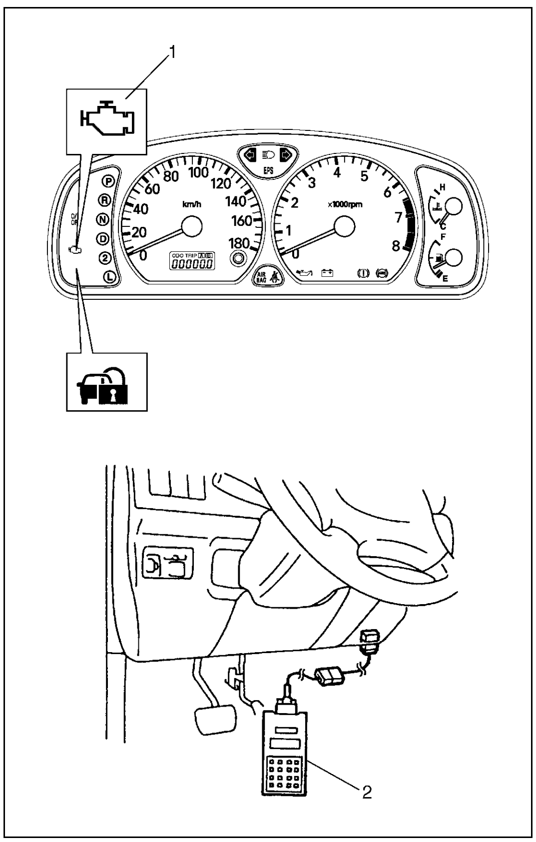
1) Turn ON ignition switch for 3 seconds (to operate fuel pump) and then turn it OFF.
   Repeat this (ON and OFF) 3 or 4 times and apply fuel pressure to fuel line. (till fuel pressure is felt by hand placed on fuel feed hose.)
2) In this state, check to see that there are no fuel leakages from any part of fuel system.

Engine Diagnosis

General Description

This vehicle is equipped with an engine and emission control system which are under control of ECM.
The engine and emission control system in this vehicle are controlled by ECM. ECM has an On-Board Diagnostic system which detects a malfunction in this system and abnormality of those parts that influence the engine exhaust emission. When diagnosing engine troubles, be sure to have full understanding of the outline of "On-Board Diagnostic System" and each item in "Precaution in Diagnosing Trouble" and execute diagnosis according to "ENGINE DIAGNOSTIC FLOW TABLE".
There is a close relationship between the engine mechanical, engine cooling system, ignition system, exhaust system, etc. and the engine and emission control system in their structure and operation. In case of an engine trouble, even when the malfunction indicator lamp (MIL) doesn't turn ON, it should be diagnosed according to this flow table.

On-Board Diagnostic System (Vehicle with Immobilizer Indicator Lamp)



ECM in this vehicle has following functions.

- When the ignition switch is turned ON with the engine at a stop, malfunction indicator lamp (MIL) (1) turns ON to check the bulb of the malfunction indicator lamp (1).
- When ECM detects a malfunction which gives an adverse effect to vehicle emission while the engine is running, it makes the malfunction indicator lamp (1) in the meter cluster of the instrument panel turn ON or flash (flashing only when detecting a misfire which can cause damage to the catalyst) and stores the malfunction area in its memory.
  (If it detects that continuously 3 driving cycles are normal after detecting a malfunction, however, it makes MIL (1) turn OFF although DTC stored in its memory will remain.)
- As a condition for detecting a malfunction in some areas in the system being monitored by ECM and turning ON the malfunction indicator lamp (1) due to that malfunction, 2 driving cycle detection logic is adopted to prevent erroneous detection.
- When a malfunction is detected, engine and driving conditions then are stored in ECM memory as freeze frame data. (For the details, refer to description on Freeze frame data.)
- It is possible to communicate by using not only SUZUKI scan tool (2) but also generic scan tool. (Diagnostic information can be accessed by using a scan tool.)

WARM-UP CYCLE

A warm-up cycle means sufficient vehicle operation such that the coolant temperature has risen by at least 22 °C (40 °F) from engine starting and reaches a minimum temperature of 70 °C (160 °F).

DRIVING CYCLE

A “Driving Cycle” consists of engine startup and engine shutoff.

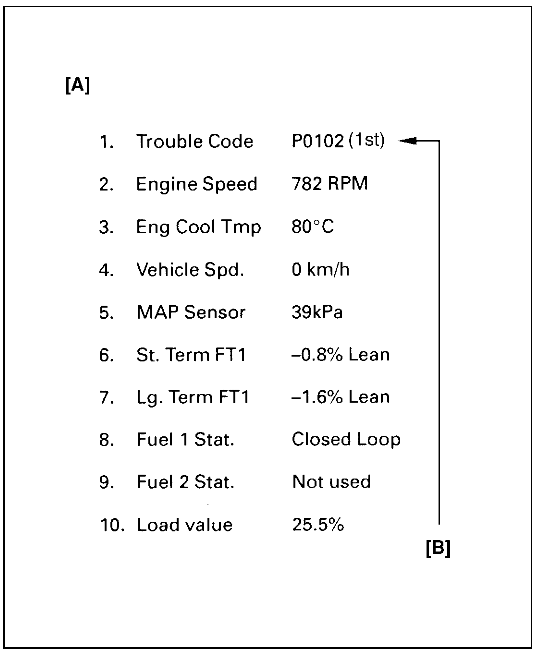
2 DRIVING CYCLES DETECTION LOGIC

The malfunction detected in the first driving cycle is stored in ECM memory (in the form of pending DTC and freeze frame data) but the malfunction indicator lamp does not light at this time. It lights up at the second detection of same malfunction also in the next driving cycle.

PENDING DTC

Pending DTC means a DTC detected and stored temporarily at 1 driving cycle of the DTC which is detected in the 2 driving cycle detection logic.

FREEZE FRAME DATA



ECM stores the engine and driving conditions (in the from of data as shown in the figure) at the moment of the detection of a malfunction in its memory. This data is called “Freeze frame data”. Therefore, it is possible to know engine and driving conditions (e.g., whether the engine was warm or not, where the vehicle was running or stopped, where air / fuel mixture was lean or rich) when a malfunction was detected by checking the freeze frame data. Also, ECM has a function to store each freeze frame data for three different malfunctions in the order as the malfunction is detected. Utilizing this function, it is possible to know the order of malfunctions that have been detected. Its use is helpful when rechecking or diagnosing a trouble.

[A] :	An Example of Freeze Frame Data
[B] :	1st, 2nd or 3rd in parentheses here represents which position in the order the malfunction is detected.

Priority of freeze frame data :

ECM has 4 frames where the freeze frame data can be stored. The first frame stores the freeze frame data of the malfunction which was detected first. However, the freeze frame data stored in this frame is updated according to the priority described below. (If malfunction as described in the upper square “1” below is detected while the freeze frame data in the lower square “2” has been stored, the freeze frame data “2” will be updated by the freeze frame data “1”.)

PRIORITY	FREEZE FRAME DATA IN FRAME 1
1	Freeze frame data at initial detection of malfunction among misfire detected (P0300 – P0304), fuel system too lean (P0171) and fuel system too rich (P0172)
2	Freeze frame data when a malfunction other than those in “1” above is detected

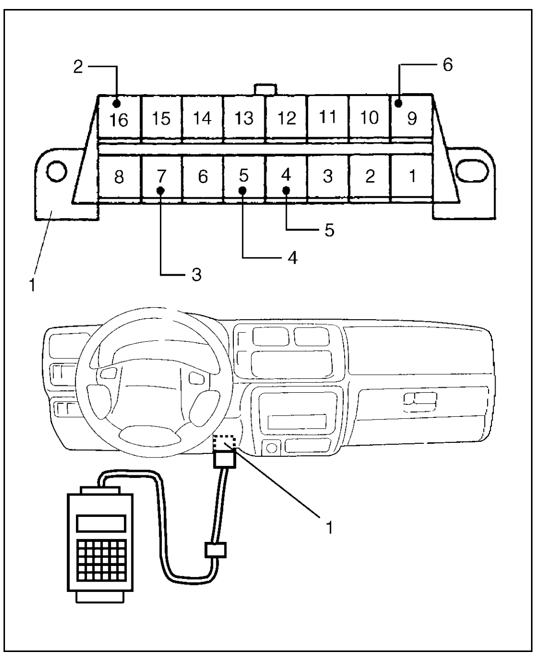
In the 2nd through the 4th frames, the freeze frame data of each malfunction is stored in the order as the malfunction is detected. These data are not updated.
Shown in the table below are examples of how freeze frame data are stored when two or more malfunctions are detected.

			FRAME			
			FRAME 1	FRAME 2	FRAME 3	FRAME4
			FREEZE FRAME DATA to be updated	1st FREEZE FRAME DATA	2nd FREEZE FRAME DATA	3rd FREEZE FRAME DATA
MALFUNCTION DETECTED ORDER		No malfunction	No freeze frame data			
	1	P0400 (EGR) detected	Data at P0400 detection	Data at P0400 detection	–	–
	2	P0171 (Fuel system) detected	Data at P0171 detection	Data at P0400 detection	Data at P0171 detection	–
	3	P0300 (Misfire) detected	Data at P0171 detection	Data at P0400 detection	Data at P0171 detection	Data at P0300 detection
	4	P0301 (Misfire) detected	Data at P0171 detection	Data at P0400 detection	Data at P0171 detection	Data at P0300 detection

Freeze Frame Data Clearance :

The freeze frame data is cleared at the same time as clearance of diagnostic trouble code (DTC).

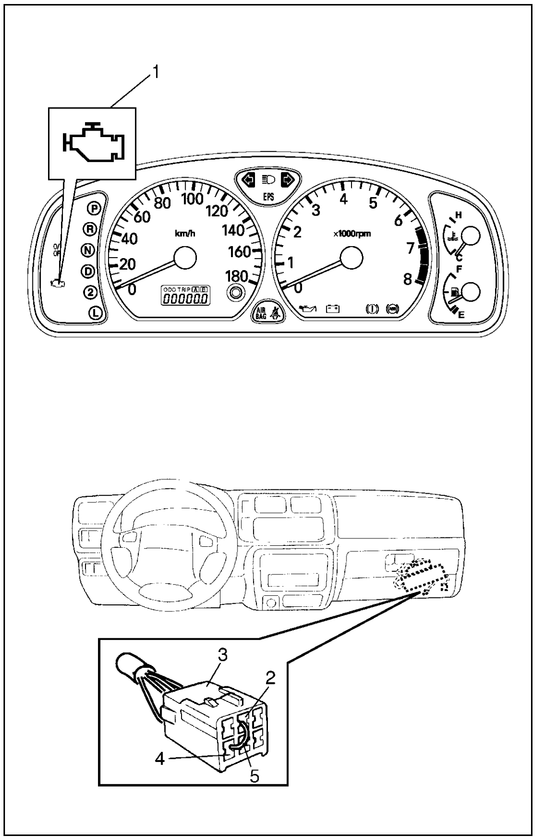
DATA LINK CONNECTOR (DLC)



DLC (1) is in compliance with SAEJ1962 in its installation position, the shape of connector and pin assignment.
Serial data line (K line of ISO 9141) (3) is used for SUZUKI scan tool or generic scan tool to communicate with ECM, TCM, Air Bag SDM and ABS control module.
SUZUKI serial data line (6) is used for SUZUKI scan tool to communicate with immobilizer control module.

2.	B+
4.	ECM ground
5.	Body ground

On-Board Diagnostic System (Vehicle without Immobilizer Indicator Lamp)



ECM diagnosis troubles which may occur in the area including the following parts when the ignition switch is ON and the engine is running, and indicates the result by turning on or flashing malfunction indicator lamp (1).

- Heated oxygen sensor (if equipped)
- ECT sensor
- TP sensor
- IAT sensor
- MAP sensor
- CMP sensor
- CKP sensor
- Knock sensor
- VSS
- CPU (Central Processing Unit) of ECM

ECM and malfunction indicator lamp (1) operate as follows.

- Malfunction indicator lamp (1) lights when the ignition switch is turned ON (but the engine at stop) with the diagnosis switch terminal ungrounded regardless of the condition of Engine and Emission Control system. This is only to check the malfunction indicator lamp (1) bulb and its circuit.
- If the above areas of Engine and Emission Control system is free from any trouble after the engine start (while engine is running), malfunction indicator lamp (1) turns OFF.
- When ECM detects a trouble which has occurred in the above areas, it makes malfunction indicator lamp (1) turn ON while the engine is running to warn the driver of such occurrence of trouble and at the same time it stores the trouble area in ECM back-up memory. (The memory is kept as it is even if the trouble was only temporary and disappeared immediately. And it is not erased unless the power to ECM is shut off for specified time below.)

  ECM also indicates trouble area in memory by means of flashing of malfunction indicator lamp (1) at the time of inspection. (i.e. when connecting diagnosis switch terminal (2) and ground terminal (4) of monitor connector (3) with a service wire (5) and ignition switch is turned ON.)

NOTE:

- **When a trouble occurs in the above areas and disappears soon while the diagnosis switch terminal is ungrounded and the engine is running, malfunction indicator lamp (1) lights and remains ON as long as the trouble exists but it turns OFF when the normal condition is restored.**
- **Time required to erase diagnostic trouble code memory thoroughly varies depending on ambient temperature as follows.**

AMBIENT TEMPERATURE	TIME TO CUT POWER TO ECM
Over 0 °C (32 °F)	60 sec. or longer
Under 0 °C (32 °F)	Not specifiable. Select a place with higher than 0 °C (32 °F) temperature.

Precaution in Diagnosing Trouble

- Don't disconnect couplers from ECM, battery cable at battery, ECM ground wire harness from engine or main fuse before confirming diagnostic information (DTC, freeze frame data, etc.) stored in ECM memory. Such disconnection will erase memorized information in ECM memory.
- Diagnostic information stored in ECM memory can be cleared as well as checked by using SUZUKI scan tool or generic scan tool. Before using scan tool, read its Operator's (Instruction) Manual carefully to have good understanding as to what functions are available and how to use it.
- Priorities for diagnosing troubles (Vehicle with Immobilizer indicator lamp).
  If multiple diagnostic trouble codes (DTCs) are stored, proceed to the flow table of the DTC which has detected earliest in the order and follow the instruction in that table.
  If no instructions are given, troubleshoot diagnostic trouble codes according to the following priorities.
  – Diagnostic trouble codes (DTCs) other than DTC P0171/P0172 (Fuel system too lean / too rich), DTC P0300/P0301/P0302/P0303/P0304 (Misfire detected) and DTC P0400 (EGR flow malfunction)
  – DTC P0171/P0172 (Fuel system too lean / too rich) and DTC P0400 (EGR flow malfunction)
  – DTC P0300/P0301/P0302/P0303/P0304 (Misfire detected)
- Be sure to read "Precautions for Electrical Circuit Service" in Section 0A before inspection and observe what is written there.
- ECM Replacement
  When substituting a known-good ECM, check for following conditions. Neglecting this check may cause damage to a known-good ECM.
  – Resistance value of all relays, actuators is as specified respectively.
  – MAP sensor and TP sensor are in good condition and none of power circuits of these sensors is shorted to ground.

Engine Diagnostic Flow Table

Refer to the following pages for the details of each step.

<table>
<tr><th>Step</th><th>Action</th><th>Yes</th><th>No</th></tr>
<tr><td>1</td><td>Customer Complaint Analysis
1) Perform customer complaint analysis referring to the followings.
Was customer complaint analysis performed?</td><td>Go to Step 2.</td><td>Perform customer complaint analysis.</td></tr>
<tr><td>2</td><td>Diagnostic Trouble Code (DTC) and Freeze Frame Data Check, Record and Clearance
1) Check for DTC (including pending DTC) referring to the followings.
Is there any DTC(s)?</td><td>Print DTC and freeze frame data or write them down and clear them by referring to “DTC Clearance” section.
Go to Step 3.</td><td>Go to Step 4.</td></tr>
<tr><td>3</td><td>Visual Inspection
1) Perform visual inspection referring to the followings.
Is there any faulty condition?</td><td rowspan="2">Repair or replace malfunction part.
Go to Step 11.</td><td>Go to Step 5.</td></tr>
<tr><td>4</td><td>Visual Inspection
1) Perform visual inspection referring to the followings.
Is there any faulty condition?</td><td>Go to Step 8.</td></tr>
<tr><td>5</td><td>Trouble Symptom Confirmation
1) Confirm trouble symptom referring to the followings.
Is trouble symptom identified?</td><td>Go to Step 6.</td><td>Go to Step 7.</td></tr>
<tr><td>6</td><td>Rechecking and Record of DTC / Freeze Frame Data
1) Recheck for DTC and freeze frame data referring to “DTC Check” section.
Is there any DTC(s)?</td><td rowspan="2">Go to Step 9.</td><td>Go to Step 8.</td></tr>
<tr><td>7</td><td>Rechecking and Record of DTC / Freeze Frame Data
1) Recheck for DTC and freeze frame data referring to “DTC Check” section.
Is there any DTC(s)?</td><td>Go to Step 10.</td></tr>
<tr><td>8</td><td>Engine Basic Inspection and Engine Diagnosis Table
1) Check and repair according to “Engine Basic Inspection” and “Engine Diagnosis Table” section.
Are check and repair complete?</td><td rowspan="2">Go to Step 11.</td><td rowspan="2">Check and repair malfunction part(s).
Go to Step 11.</td></tr>
<tr><td>9</td><td>Trouble shooting for DTC
1) Check and repair according to applicable DTC diag. flow table.
Are check and repair complete?</td></tr>
<tr><td>10</td><td>Check for Intermittent Problems
1) Check for intermittent problems referring to the followings.
Is there any faulty condition?</td><td>Repair or replace malfunction part(s).
Go to Step 11.</td><td>Go to Step 11.</td></tr>
<tr><td>11</td><td>Final Confirmation Test
1) Clear DTC if any.
2) Perform final confirmation test referring to the followings.
Is there any problem symptom, DTC or abnormal condition?</td><td>Go to Step 6.</td><td>End.</td></tr>
</table>

1. CUSTOMER COMPLAINT ANALYSIS

Record details of the problem (failure, complaint) and how it occurred as described by the customer. For this purpose, use of such an inspection form will facilitate collecting information to the point required for proper analysis and diagnosis.

2. DIAGNOSTIC TROUBLE CODE (DTC) / FREEZE FRAME DATA CHECK, RECORD AND CLEARANCE

First, check DTC (including pending DTC), referring to "DTC check" section. If DTC is indicated, print it and freeze frame data or write them down and then clear them by referring to "DTC clearance" section. DTC indicates malfunction that occurred in the system but does not indicate whether it exists now or it occurred in the past and the normal condition has been restored now. To check which case applies, check the symptom in question according to Step 4 and recheck DTC according to Step 5.
Attempt to diagnose a trouble based on DTC in this step only or failure to clear the DTC in this step will lead to incorrect diagnosis, trouble diagnosis of a normal circuit or difficulty in troubleshooting.

NOTE:
If only Automatic transmission DTCs (P0702-P1717) or Immobilizer DTCs (P1620-P1623) are indicated in this step, perform trouble diagnosis according to "Diagnosis" in Section 7B or Section 8G.

3. AND 4. VISUAL INSPECTION

As a preliminary step, be sure to perform visual check of the items that support proper function of the engine referring to "Visual Inspection" section.

5. TROUBLE SYMPTOM CONFIRMATION

Based on information obtained in Step 1 Customer complaint analysis and Step 2 DTC / freeze frame data check, confirm trouble symptoms. Also, reconfirm DTC according to "DTC Confirmation Procedure" described in each DTC Diagnosis section.

6. AND 7. RECHECKING AND RECORD OF DTC / FREEZE FRAME DATA

Refer to "DTC Check" section for checking procedure.

8. ENGINE BASIC INSPECTION AND ENGINE DIAGNOSIS TABLE

Perform basic engine check according to the "Engine Basic Inspection" first. When the end of the flow table has been reached, check the parts of the system suspected as a possible cause referring to "Engine Diagnosis Table" and based on symptoms appearing on the vehicle (symptoms obtained through steps of customer complaint analysis, trouble symptom confirmation and / or basic engine check) and repair or replace faulty parts, if any.

9. TROUBLESHOOTING FOR DTC (SEE EACH DTC DIAG. FLOW TABLE)

Based on the DTC indicated in Step 5 and referring to the applicable DTC diag. flow table in this section, locate the cause of the trouble, namely in a sensor, switch, wire harness, connector, actuator, ECM or other part and repair or replace faulty parts.

10. CHECK FOR INTERMITTENT PROBLEM

Check parts where an intermittent trouble is easy to occur (e.g., wire harness, connector, etc.), referring to "Intermittent and Poor Connection" in Section 0A and related circuit of DTC recorded in Step 2.

11. FINAL CONFIRMATION TEST

Confirm that the problem symptom has gone and the engine is free from any abnormal conditions. If what has been repaired is related to the DTC, clear the DTC once, perform DTC confirmation procedure and confirm that no DTC is indicated.

Customer problem inspection form (example)

User name:	Model:	VIN:	
Date of issue:	Date Reg.	Date of problem:	Mileage:

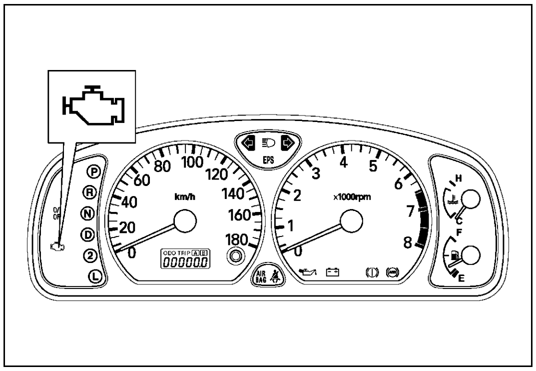
PROBLEM SYMPTOMS	
☐ **Difficult Starting** ☐ No cranking ☐ No initial combustion ☐ No combustion ☐ Poor starting at (☐cold ☐warm ☐always) ☐ Other ____________	☐ **Poor Driveability** ☐ Hesitation on acceleration ☐ Back fire/☐After fire ☐ Lack of power ☐ Surging ☐ abnormal knocking ☐ Other ____________
☐ **Poor Idling** ☐ Poor fast idle ☐ Abnormal idling speed (☐High ☐Low) (r/min.) ☐ Unstable ☐ Hunting (r/min. to r/min.) ☐ Other ____________	☐ **Engine Stall when** ☐ Immediately after start ☐ Accel. pedal is depressed ☐ Accel. pedal is released ☐ Load is applied ☐ A/C ☐Electric load ☐P/S ☐ Other ____________ ☐ Other ____________
☐ OTHERS:	

VEHICLE/ENVIRONMENTAL CONDITION WHEN PROBLEM OCCURS	
Environmental Condition	
Weather	☐Fair ☐Cloudy ☐Rain ☐Snow ☐Always ☐Other ____________
Temperature	☐Hot ☐Warm ☐Cool ☐Cold (°F/ °C) ☐Always
Frequency	☐Always ☐Sometimes (times/ day, month) ☐Only once ☐Under certain condition
Road	☐Urban ☐Suburb ☐Highway ☐Mountainous (☐Uphill ☐Downhill) ☐Tarmacadam ☐Gravel ☐Other ____________
Vehicle Condition	
Engine condition	☐Cold ☐Warming up phase ☐Warmed up ☐Always ☐Other at starting ☐Immediately after start ☐Racing without load ☐Engine speed (r/min)
Vehicle condition	During driving: ☐Constant speed ☐Accelerating ☐Decelerating ☐Right hand corner ☐Left hand corner ☐When shifting (Lever position) ☐At stop ☐Vehicle speed when problem occurs (km/h, Mile/h) ☐Other

Malfunction indicator lamp condition	☐Always ON ☐Sometimes ON ☐Always OFF ☐Good condition	
Diagnostic trouble code	First check:	☐No code ☐Malfunction code ( )
	Second check:	☐No code ☐Malfunction code ( )

NOTE:

The above form is a standard sample. It should be modified according to conditions characteristic of each market.

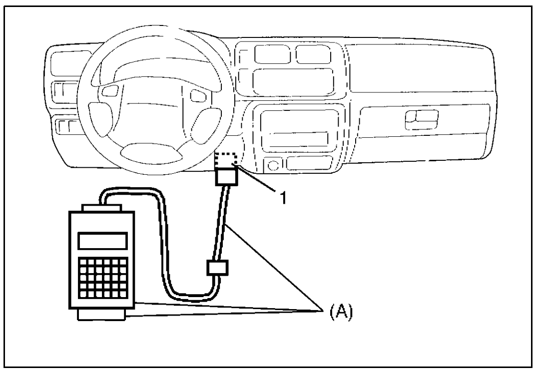


Malfunction indicator lamp (MIL) check

1) Turn ON ignition switch (but the engine at stop) and check that MIL lights.
   If MIL does not light up (or MIL dims), go to “Diagnostic Flow Table A-1” for troubleshooting.
   If MIL flushes, go to “Diagnostic Flow Table A-3” for trouble shooting (vehicle without immobilizer indicator lamp).
2) Start engine and check that MIL turns OFF.
   If MIL remains ON and no DTC is stored in ECM, go to “Diagnostic Flow Table A-2” for troubleshooting.

Diagnostic trouble code (DTC) check

[Using SUZUKI Scan Tool]



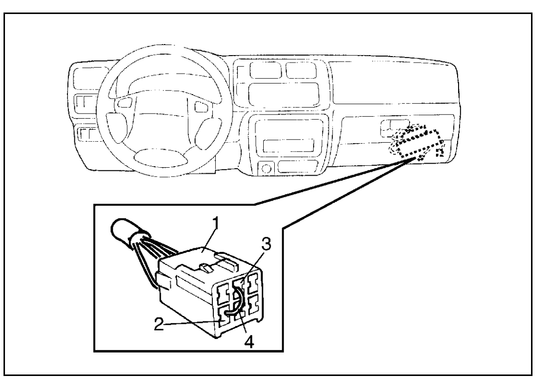
1) Prepare SUZUKI scan tool.
2) With ignition switch OFF, connect it to data link connector (DLC) (1) located on underside of instrument panel at driver’s seat side.

   Special tool
   (A) : SUZUKI scan tool

3) Turn ignition switch ON and confirm that MIL lights.
4) Read DTC, pending DTC and freeze frame data according to instructions displayed on scan tool and print it or write it down.
   Refer to scan tool operator’s manual for further details.
   If communication between scan tool and ECM is not possible, check if scan tool is communicable by connecting it to ECM in another vehicle. If communication is possible in this case, scan tool is in good condition. Then check data link connector and serial data line (circuit) in the vehicle with which communication was not possible.
5) After completing the check, turn ignition switch off and disconnect scan tool from data link connector.

[Without Using SUZUKI Scan Tool] (Vehicle Without Immobilizer Indicator Lamp)

1) Check malfunction indicator lamp referring to “Malfunction Indicator Lamp Check” in this section.



2) With the ignition switch OFF position, connect diagnosis switch terminal (3) and ground terminal (2) in monitor connector (1) with service wire (4).
3) With the ignition switch ON position and leaving engine OFF, read DTC from flashing pattern of malfunction indicator lamp. Refer to “Diagnostic Trouble Code Table”.
   If lamp does not flash or remains ON or OFF, go to “Diagnostic Flow Table A-4”.

NOTE:

- **If abnormality or malfunction lies in two or more areas, malfunction indicator lamp indicates applicable codes three times each.**
  And flashing of these codes is repeated as long as diagnosis terminal is grounded and ignition switch is held at ON position.
- **Take a note of diagnostic trouble code indicated first.**

4) After completing the check, turn the ignition switch OFF position and disconnect service wire from monitor coupler.

Diagnostic trouble code (DTC) clearance

[Using SUZUKI Scan Tool]

1) Connect SUZUKI scan tool to data link connector in the same manner as when making this connection for DTC check.
2) Turn ignition switch ON.
3) Erase DTC and pending DTC according to instructions displayed on scan tool. Refer to scan tool operator's manual for further details.
4) After completing the clearance, turn ignition switch off and disconnect scan tool from data link connector.

NOTE:

DTC and freeze frame data stored in ECM memory are also cleared in following cases. Be careful not to clear them before keeping their record.

- **When power to ECM is cut off (by disconnecting battery cable, removing fuse or disconnecting ECM connectors)**
- **When the same malfunction (DTC) is not detected again during 40 engine warm-up cycles.**

[Without Using SUZUKI Scan Tool]

1) Turn the ignition switch OFF position.
2) Disconnect battery negative cable for specified time below to erase diagnostic trouble code stored in ECM memory and reconnect it.

Time required to erase DTC

Ambient temperature	Time to cut power to ECM
Over 0 °C (32 °F)	30 sec. or longer
Under 0 °C (32 °F)	Not specifiable. Select a place with higher than 0 °C (32 °F) temperature.

Diagnostic trouble code (DTC) table

DTC NO.	DETECTING ITEM	DETECTING CONDITION (DTC will set when detecting :)	MIL (vehicle with immobilizer indicator lamp)	MIL (vehicle without immobilizer indicator lamp)
P0105 (No.11)	Manifold absolute pressure circuit malfunction	Low pressure-high vacuum-low voltage (or MAP sensor circuit shorted to ground) High pressure-low vacuum-high voltage (or MAP sensor circuit open)	1 driving cycle	1 driving cycle
P0110 (No.18)	Intake air temp. circuit malfunction	Intake air temp. circuit low input Intake air temp. circuit high input	1 driving cycle	1 driving cycle
P0115 (No.19)	Engine coolant temp. circuit malfunction	Engine coolant temp. circuit low input Engine coolant temp. circuit high input	1 driving cycle	1 driving cycle
P0120 (No.13)	Throttle position circuit malfunction	Throttle position circuit low input Throttle position circuit high input	1 driving cycle	1 driving cycle
P0121	Throttle position circuit performance problem	Poor performance of TP sensor	2 driving cycles	Not applicable
P0130 (No.14)	HO2S circuit malfunction (Sensor-1)	Min. output voltage of HO2S-higher than specification Max. output voltage of HO2S-lower than specification	2 driving cycles	1 driving cycle
P0133	HO2S circuit slow response (Sensor-1)	Response time of HO2S-1 output voltage between rich and lean is longer than specification.	2 driving cycles	Not applicable
P0135 (No.14)	HO2S heater circuit malfunction (Sensor-1)	Terminal voltage is lower than specification at heater OFF or it is higher at heater ON.	2 driving cycles	1 driving cycle
P0136	HO2S circuit malfunction (Sensor-2)	HO2S-2 voltage is higher than specification	2 driving cycles	Not applicable
P0141	HO2S heater circuit malfunction (Sensor-2)	Terminal voltage is lower than specification at heater OFF or it is higher at heater ON. (or heater circuit or short)	2 driving cycles	Not applicable
P0171	Fuel system too lean	Short term fuel trim or total fuel trim (short and long terms added) is larger than specification for specified time or longer. (fuel trim toward rich side is large.)	2 driving cycles	Not applicable
P0172	Fuel system too rich	Short term fuel trim or total fuel trim (short and long term added) is smaller than specification for specified time or longer. (fuel trim toward lean side is large.)	2 driving cycles	Not applicable
P0300 P0301 P0302 P0303 P0304	Random misfire detected Cylinder 1 misfire detected Cylinder 2 misfire detected Cylinder 3 misfire detected Cylinder 4 misfire detected	Misfire of such level as to cause damage to three way catalyst	MIL flashing during misfire detection	Not applicable
		Misfire of such level as to deteriorate emission but not to cause damage to three way catalyst	2 driving cycles	Not applicable
P0325 (No.17)	Knock sensor circuit malfunction	Knock sensor circuit low input Knock sensor circuit high input	1 driving cycle	1 driving cycle

DTC NO.	DETECTING ITEM	DETECTING CONDITION (DTC will set when detecting :)	MIL (vehicle with immobilizer indicator lamp)	MIL (vehicle without immobilizer indicator lamp)
P0335 (No.23)	Crankshaft position sensor circuit malfunction	No signal for 2 sec. During engine cranking	1 driving cycle	1 driving cycle
P0340 (No.15)	Camshaft position sensor circuit malfunction	No signal during engine running	1 driving cycle	1 driving cycle
P0400	Exhaust gas recirculation flow malfunction detected	Excessive or insufficient EGR flow	2 driving cycles	Not applicable
P0420	Catalyst system efficiency below threshold	Output waveforms of HO2S-1 and HO2S-2 are similar. (Time from output voltage change of HO2S-1 to that of HO2S-2 is shorter than specification.)	2 driving cycles	Not applicable
P0443	Purge control valve circuit malfunction	Purge control valve circuit is open or shorted to ground	2 driving cycles	Not applicable
P0481	A/C condenser fan control circuit malfunction	A/C condenser fan relay terminal voltage is low when fan command is not outputted	2 driving cycles	Not applicable
P0500 (No.16)	Vehicle speed sensor malfunction	No signal while running in “D” range or during fuel cut at decelerating	2 driving cycles	1 driving cycle
P0505	Idle control system malfunction	No closed signal to IAC valve is detected	2 driving cycles	Not applicable
P0601 (No.71)	Internal control module memory check sum error	Data write error (or check sum error) when written into ECM	2 driving cycles	Not applicable
P1450	Barometric pressure sensor circuit malfunction	Barometric pressure is lower or higher than specification. (or sensor malfunction)	1 driving cycle	Not applicable
P1451	Barometric pressure sensor performance problem	Difference between manifold absolute pressure (MAP sensor value) and barometric pressure (barometric pressure sensor value) is larger than specification during cranking.	2 driving cycles	Not applicable
P1500	Starter signal circuit malfunction	Starter signal is not inputted from engine cranking till its start and after or it is always inputted	2 driving cycles	Not applicable
P1510	ECM backup power source malfunction	No backup power after starting engine	1 driving cycle	Not applicable
P1600	Serial communication problem between ECM and TCM	No signal or check sum error while engine running	1 driving cycle	Not applicable
P1717	AT D-range signal circuit malfunction	No “D” range (park / neutral position signal) is inputted while vehicle running	2 driving cycles	Not applicable
P1570	ABS signal circuit malfunction	ABS signal ON (low voltage) when engine start	Not applicable	1 driving cycle

DTC NO.	DETECTING ITEM	DETECTING CONDITION (DTC will set when detecting :)	MIL
P0702	Transmission Control System Electrical	Refer to Section 7B. These DTCs can not be read on vehicle without Immobilizer indicator lamp (by ECM application of SUZUKI scan tool).	
P0705	Temperature Sensor Circuit Malfunction		
P0710	Transmission Temperature Sensor Circuit Malfunction		
P0715	Input / Turbine Speed Sensor Circuit Malfunction		
P0720	Output Shaft Speed Sensor Circuit Malfunction		
P0725	Engine Speed Input Circuit Malfunction		
P0730	Incorrect Gear Ratio		
P0743	Torque Converter Clutch Circuit Electrical		
P0753	Shift Solenoid A Electrical		
P0758	Shift Solenoid B Electrical		
P0763	Shift Solenoid C Electrical		
P0768	Shift Solenoid D Electrical		
P1700	Throttle Position Signal Input Malfunction		
P1702	Internal Control Module Memory Check Some Error		
P1709	Engine Coolant Temperature Signal Input Malfunction		
P1887	Transfer Signal		
P1620 (No.84)	ECU code not registered	Refer to Section 8G.	
P1621 (No.83)	No ECU code transmitted from Immobilizer Control Module		
P1622 (No.82)	Faulty in ECM		
P1623 (No.81)	ECU code not matched		

NOTE:

- **For ( ) marked No. in DTC column, it is used for vehicle without Immobilizer indicator lamp.**
- **DTC No.12 appears when none of the other codes is identified (vehicle without Immobilizer indicator lamp).**

Fail-safe table

When any of the following DTCs is detected, ECM enters fail-safe mode as long as malfunction continues to exist but that mode is canceled when ECM detects normal condition after that.

DTC NO.	DETECTED ITEM	FAIL-SAFE OPERATION (SYMPTOM)
P0105 (No.11)	Manifold absolute pressure sensor circuit malfunction	ECM uses value determined by throttle opening and engine speed.
P0110 (No.18)	Intake air temp. sensor circuit malfunction	ECM controls actuators assuming that intake air temperature is 20 °C (68 °F).
P0115 (No.19)	Engine coolant temp. sensor circuit malfunction	ECM controls actuators assuming that engine coolant temperature is 80 °C (176 °F).
P0120 (No.13)	Throttle position sensor circuit malfunction	ECM controls actuators assuming that throttle opening is 20°. (High idle speed)
P0335 (No.23)	Crankshaft position sensor circuit malfunction	ECM controls injection system sequential injection to synchronous injection. (Cranking for a few seconds to start engine)
P0340 (No.15)	Camshaft position sensor circuit malfunction	ECM controls injection system sequential injection to synchronous injection. (Cranking for a few seconds to start engine)
P0500 (No.16)	Vehicle speed sensor malfunction	ECM stops idle air control.
P1450	Barometric pressure sensor low / high input	ECM controls actuators assuming that barometric pressure is 100 kPa (760 mmHg).
P1570 (No.21)	ABS signal circuit malfunction	ECM controls actuators assuming that ABS signal is OFF.

Visual inspection

Visually check following parts and systems.

INSPECTION ITEM	REFERRING SECTION
• Engine oil – level, leakage	Section 0B
• Engine coolant – level, leakage	Section 0B
• Fuel – level, leakage	Section 0B
• A/T fluid – level, leakage	Section 0B
• Air cleaner element – dirt, clogging	Section 0B
• Battery – fluid level, corrosion of terminal	
• Water pump belt – tension, damage	Section 0B
• Throttle cable – play, installation	
• Vacuum hoses of air intake system – disconnection, looseness, deterioration, bend	Section 6E
• Connectors of electric wire harness – disconnection, friction	
• Fuses – burning	Section 8
• Parts – installation, bolt – looseness	
• Parts – deformation	
• Other parts that can be checked visually	
Also check following items at engine start, if possible	
• Malfunction indicator lamp – operation	Section 6
• Charge warning lamp – operation	Section 6H
• Engine oil pressure warning lamp – operation	Section 8 (Section 6 for pressure check)
• Engine coolant temp. meter – operation	Section 8
• Fuel level meter – operation	Section 8
• Tachometer, if equipped – operation	
• Abnormal air being inhaled from air intake system	
• Exhaust system – leakage of exhaust gas, noise	
• Other parts that can be checked visually	

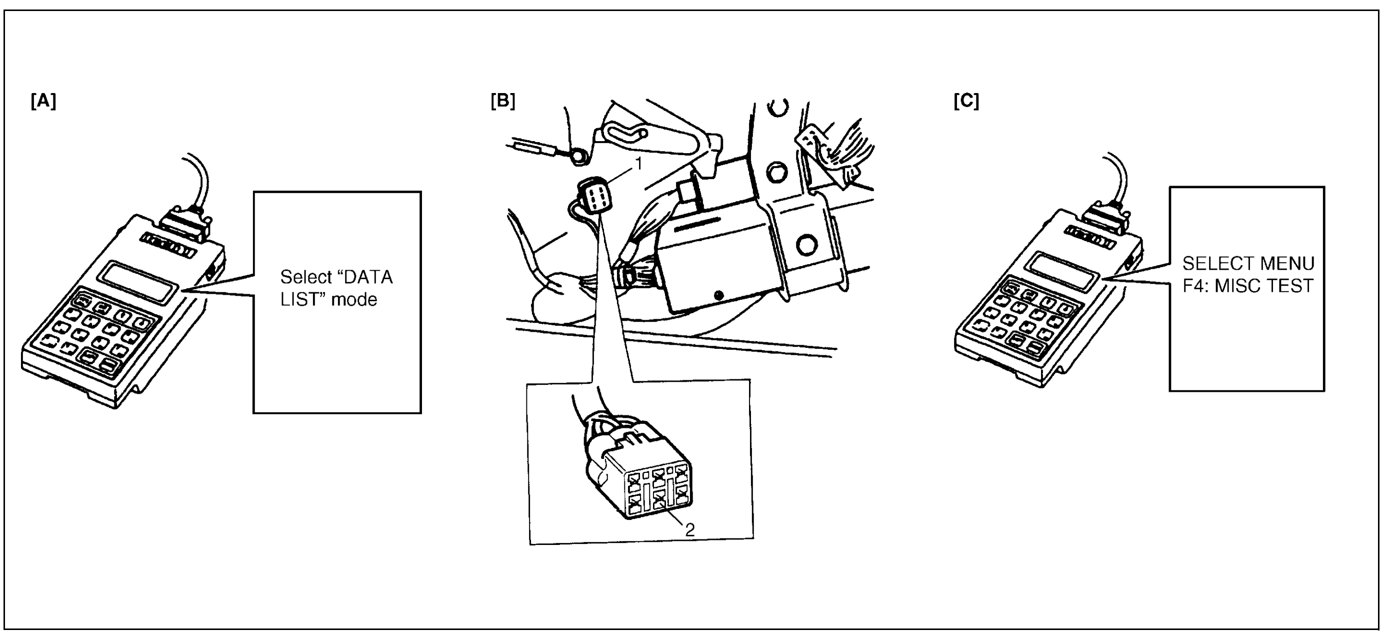
Engine basic inspection

This check is very important for troubleshooting when ECM has detected no DTC and no abnormality has been found in visual inspection.
Follow the flow table carefully.

Step	Action	Yes	No
1	Was "Engine Diag. Flow Table" performed?	Go to Step 2.	Go to "Engine Diag. Flow Table".
2	Check battery voltage. Is it 11 V or more?	Go to Step 3.	Charge or replace battery.
3	Is engine cranked?	Go to Step 4.	Go to "Diagnosis" in Section 6G.
4	Does engine start?	Go to Step 5.	Go to Step 9.
5	Check idle speed as follows : 1) Warm up engine to normal operating temp. 2) Shift transmission to neutral position for M/T ("P" position for A/T). 3) All of electrical loads are switched off. 4) Check engine idle speed with scan tool. See Fig. 1. Is it 650 – 750 r/min (700 – 800 r/min. for A/T vehicle)?	Go to Step 6.	Go to "Engine Diagnosis Table".
6	Is SUZUKI scan tool available?	Go to Step 8.	Go to Step 7.
7	Check ignition timing as follows : 1) Connect test switch terminal (2) of monitor coupler (1) to ground. See Fig. 2. 2) Remove air cleaner bolt and crips and shift air cleaner position to observe ignition timing. 3) Using timing light (1), check initial ignition timing. See Fig. 4. Is it 5° ± 3° BTDC at specified idle speed?	Go to "Engine Diagnosis Table".	Check ignition control related parts referring to Section 6F.
8	Check ignition timing as follows : 1) Select "MISC" mode on SUZUKI scan tool and fix ignition timing to initial one. See Fig. 3. 2) Remove air cleaner bolt and crips and shift air cleaner position to observe ignition timing. 3) Using timing light (1), check initial ignition timing. See Fig. 4. Is it 5° ± 3° BTDC at specified idle speed?	Go to "Engine Diagnosis Table".	Check ignition control related parts referring to Section 6F.
9	Check immobilizer system malfunction as follows (if equipped) : 1) Check immobilizer indicator lamp or MIL (malfunction indicator lamp) for flashing. Is it flashing when ignition switch is turned to ON position?	Go to "Diagnosis" in Section 8G.	Go to Step 10.

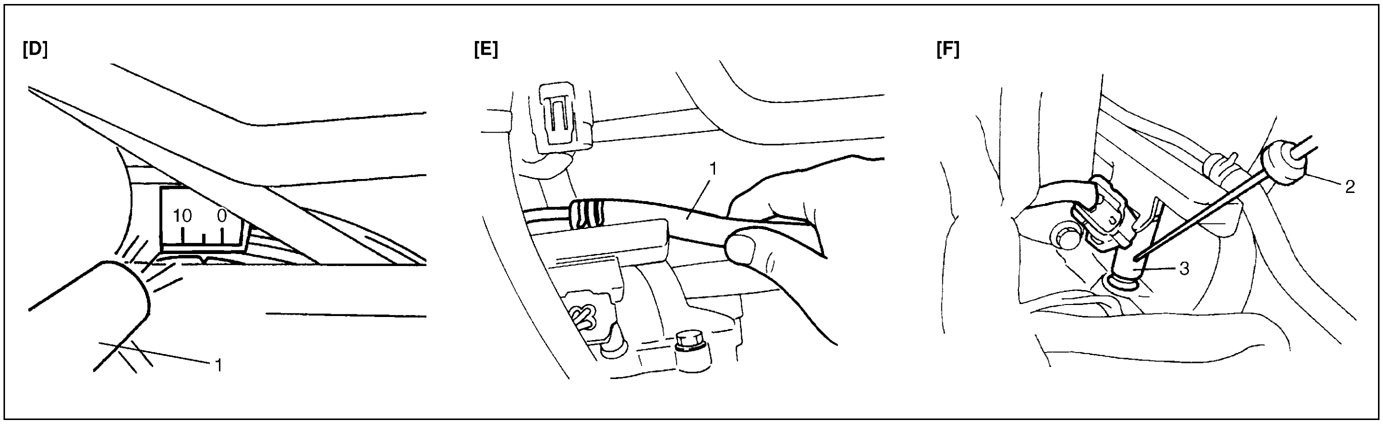
Step	Action	Yes	No
10	Check fuel supply as follows : 1) Check to make sure that enough fuel is filled in fuel tank. 2) Turn ON ignition switch for 2 seconds and then OFF. See Fig. 5. Is fuel return pressure (returning sounds) felt from fuel feed hose (1) when ignition switch is turned ON?	Go to Step 12.	Go to Step 11.
11	Check fuel pump for operating. 1) Was fuel pump operating sound heard from fuel filler for about 2 seconds after ignition switch ON and stop?	Go to “Diag. Flow Table B-3”.	Go to “Diag. Flow Table B-2”.
12	Check ignition spark as follows : 1) Disconnect injector couplers. 2) Remove spark plugs and connect them to high tension cords. 3) Ground spark plugs. 4) Crank engine and check if each spark plug sparks. Is it in good condition?	Go to Step 13.	Go to “Ignition Spark Test” in Section 6F.
13	Check fuel injector for operation as follows : 1) Install spark plugs and connect injector connectors. 2) Using sound scope (2), check operating sound of each injector (3) when cranking engine. See Fig. 6. Was injector operating sound heard from all injectors?	Go to “Engine Diagnosis Table”.	Go to “Diag. Flow Table B-1”.

[A] Fig. 1 for Step 5 / [B] Fig. 2 for Step 7 / [C] Fig. 3 for Step 8



[B] :	When not using SUZUKI scan tool :
[C] :	When using SUZUKI scan tool

[D] Fig. 4 for Step 7 or 8 / [E] Fig. 5 for Step 10 / [F] Fig. 6 for Step 13



Engine diagnosis table

Perform troubleshooting referring to following table when ECM has no DTC and no abnormality found in visual inspection and engine basic inspection previously.

Condition	Possible Cause	Reference Item
Hard Starting (Engine cranks OK)	• Faulty ignition coil	Ignition coil assembly in Section 6F.
	• Faulty CMP sensing rotor or CKP sensing rotor	CMP sensing rotor or CKP sensing rotor inspection in Section 6E.
	• Faulty idle air control system	Diagnostic Flow Table B-4
	• Faulty ECT sensor, TP sensor, CKP sensor, CMP sensor or MAP sensor	ECT sensor, TP sensor, CKP sensor, CMP sensor or MAP sensor in Section 6E.
	• Fuel pressure out of specification	Diagnostic Flow Table B-3
	• Faulty fuel injector	Diagnostic Flow Table B-1
	• Faulty ECM	Inspection of ECM and its circuit in this section.
	• Malfunctioning PCV system	PCV system in Section 6E.
	Low compression	Compression check in Section 6A1.
	• Improper valve lash	Valve lash in Section 6A1.
	• Improper valve timing	Timing chain and chain tensioner in Section 6A1.
	• Compression leak from valve seat	Valves and cylinder head in Section 6A1.
	• Sticky valve stem	Valves and cylinder head in Section 6A1.
	• Weak or damaged valve springs	Valves and cylinder head in Section 6A1.
	• Compression leak at cylinder head gasket	Valves and cylinder head in Section 6A1.
	• Sticking or damaged piston ring	Pistons, piston rings, connecting rods and cylinders in Section 6A1.
	• Worn piston, ring or cylinder	Pistons, piston rings, connecting rods and cylinders in Section 6A1.

Condition	Possible Cause	Reference Item
Engine has no power	Engine overheating	Refer to “Overheating” of this table.
	• Faulty ignition coil	Ignition coil assembly in Section 6F.
	• Faulty knock sensor	Knock sensor malfunction in this section.
	• Fuel pressure out of specification	Diagnostic Flow Table B-3
	• Faulty injector	Diagnostic Flow Table B-1
	• Faulty TP sensor, ECT sensor or MAP sensor	TP sensor, ECT sensor or MAP sensor in Section 6E.
	• Faulty ECM	Inspection of ECM and its circuit in this section.
	• Malfunctioning EGR valve (if equipped)	EGR system in Section 6E.
	• Maladjusted accelerator cable play	Accelerator cable adjustment in Section 6E.
	Low compression	Previously outlined.
	• Dragging brakes	Diagnosis table in Section 5.
	• Slipping clutch	Diagnosis table in Section 7C.
Improper engine idling or engine fails to idle	• Faulty ignition coil	Ignition coil assembly in Section 6F.
	Engine overheating	Refer to “Overheating” of this table.
	• Fuel pressure out of specification	Diagnostic Flow Table B-3
	• Faulty idle air control system	Diagnostic Flow Table B-4
	• Faulty evaporative emission control system	EVAP control system in Section 6E.
	• Faulty injector	Diagnostic Flow Table B-1
	• Faulty ECT sensor, TP sensor or MAP sensor	ECT sensor, TP sensor or MAP sensor in Section 6E.
	• Malfunctioning PCV system	PCV system in Section 6F.
	• Faulty ECM	Inspection of ECM and its circuit in this section.
	• Faulty EGR system (if equipped)	EGR system in Section 6E.
	Low compression	Previously outlined.
Engine hesitates (Momentary lack of response as the accelerator is depressed. Can occur at all vehicle speeds. Usually most severe when first trying to make the vehicle move, as from a stop sign.)	• Faulty ignition coil	Ignition coil assembly in Section 6F.
	Engine overheating	Refer to “Overheating” of this table.
	• Fuel pressure out of specification	Diagnostic Flow Table B-3
	• Faulty injector	Diagnostic Flow Table B-1
	• Faulty TP sensor, ECT sensor or MAP sensor	TP sensor, ECT sensor or MAP sensor in Section 6E.
	• Faulty ECM	Inspection of ECM and its circuit in this section.
	• Malfunctioning EGR valve (if equipped)	EGR system in Section 6E.
	Low compression	Previously outlined.
Surges (Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and down with no change in the accelerator pedal.)	• Faulty ignition coil or high-tension cord	Ignition coil assembly or high-tension cords in Section 6F.
	• Variable fuel pressure	Diagnostic Flow Table B-3
	• Faulty MAP sensor	MAP sensor in Section 6E.
	• Faulty injector	Diagnostic Flow Table B-1
	• Faulty ECM	Inspection of ECM and its circuit in this section.
	• Malfunctioning EGR valve (if equipped)	EGR system in Section 6E.

Condition	Possible Cause	Reference Item
Excessive detonation (The engine makes sharp metallic knocks that change with throttle opening. Sounds like pop corn popping.)	Engine overheating	Refer to “Overheating” of this table.
	• Faulty spark plug	Spark plugs in Section 6F.
	• Clogged fuel filter and fuel lines	Diagnostic Flow Table B-3
	• Malfunctioning EGR valve (if equipped)	EGR system in Section 6E.
	• Poor performance of knock sensor, ECT sensor or MAP sensor	Knock sensor in this section, ECT sensor or MAP sensor in Section 6E.
	• Faulty injector	Diagnostic Flow Table B-1
	• Faulty ECM	Inspection of ECM and its circuit in this section.
	• Excessive combustion chamber deposits	Piston and cylinder head in Section 6A1.
Overheating	• Inoperative thermostat	Thermostat in Section 6B.
	• Faulty A/C condenser fan motor or its circuit	A/C condenser fan control system check in Section 6E.
	• Loose or slip water pump belt	ITEM1-1 Drive belt inspection and change in Section 0B.
	• Poor water pump performance	Water pump in Section 6B.
	• Clogged or leaky radiator	Radiator in Section 6B.
	• Improper engine oil grade	ITEM1-3 Engine oil and oil filter change in Section 0B.
	• Clogged oil filter or oil strainer	Oil pressure check in Section 6A1.
	• Poor oil pump performance	Oil pressure check in Section 6A1.
	• Dragging brakes	Diagnosis Table in Section 5.
	• Slipping clutch	Diagnosis Table in Section 7C.
	• Blown cylinder head gasket	Valves and cylinder head in Section 6A1.
Poor gasoline mileage	• Faulty ignition coil	Ignition coil assembly in Section 6F.
	• Fuel pressure out of specification	Diagnostic Flow Table B-3
	• Faulty TP sensor, ECT sensor or MAP sensor	TP sensor, ECT sensor or MAP sensor in Section 6E.
	• Faulty injector	Diagnostic Flow Table B-1
	• Faulty ECM	Inspection of ECM and its circuit in this section.
	• Malfunctioning EGR valve (if equipped)	EGR system in Section 6E.
	• High idle speed	Refer to item “Improper Engine Idle Speed” previously outlined.
	Low compression	Previously outlined.
	• Poor valve seating	Valves and cylinder head in Section 6A1.
	• Dragging brakes	Diagnosis Table in Section 5.
	• Slipping clutch	Diagnosis Table in Section 7C.
	• Thermostat out of order	Thermostat in Section 6B.
	• Improper tire pressure	Refer to Section 3F.

Condition	Possible Cause	Reference Item
Excessive engine oil consumption	• Sticky piston ring	Pistons, piston rings, connecting rods and cylinders in Section 6A1.
	• Worn piston and cylinder	Pistons, piston rings, connecting rods and cylinders in Section 6A1.
	• Worn piston ring groove and ring	Pistons, piston rings, connecting rods and cylinders in Section 6A1.
	• Improper location of piston ring gap	Pistons, piston rings, connecting rods and cylinders in Section 6A1.
	• Worn or damaged valve stem seal	Valves and cylinder head in Section 6A1.
	• Worn valve stem	Valves and cylinder head in Section 6A1.
Low oil pressure	• Improper oil viscosity	ITEM1-3 Engine oil and oil filter change in Section 0B.
	• Malfunctioning oil pressure switch	Oil pressure switch in Section 8.
	• Clogged oil strainer	Oil pan and oil pump strainer in Section 6A1.
	• Functional deterioration of oil pump	Oil pump in Section 6A1.
	• Worn oil pump relief valve	Oil pump in Section 6A1.
	• Excessive clearance in various sliding parts	Refer to Section 6A1.
Engine noise **See NOTE below.**	• Improper valve lash	Valve lash in Section 6A1.
	• Worn valve stem and guide	Valves and cylinder head in Section 6A1.
	• Weak or broken valve spring	Valve springs in Section 6A1.
	• Warped or bent valve	Valves and cylinder head in Section 6A1.
	• Loose camshaft housing bolts	Camshaft in Section 6A1.
	• Worn piston, ring and cylinder bore	Pistons and cylinders in Section 6A1.
	• Worn crankpin bearing	Crankpin and connecting rod bearing in Section 6A1.
	• Worn crankpin	Crankpin and connecting rod bearing in Section 6A1.
	• Loose connecting rod nuts	Connecting rod in Section 6A1.
	• Low oil pressure	Previously outlined.
	• Worn crankshaft journal bearing	Main bearings, Crankshaft and cylinder block in Section 6A1.
	• Worn crankshaft journal	Main bearings, Crankshaft and cylinder block in Section 6A1.
	• Loose lower crankcase (bearing cap) bolts	Main bearings, Crankshaft and cylinder block in Section 6A1.
	• Excessive crankshaft thrust play	Main bearings, Crankshaft and cylinder block in Section 6A1.

NOTE:

Before checking the mechanical noise, make sure that :

- **Ignition timing is properly adjusted.**
- **Specified spark plug is used.**
- **Specified fuel is used.**

Condition	Possible Cause	Reference Item
Excessive hydrocarbon (HC) emission or Excessive carbon monoxide (CO) emission	• Faulty ignition coil • Fuel pressure out of specification • Lead contamination of three way catalytic converter • Malfunctioning PCV system • Faulty EVAP control system • Closed loop system (A/F feed back compensation) fails – Faulty TP sensor – Faulty ECT sensor or MAP sensor – Faulty oxygen sensor • Faulty injector • Faulty ECM Low compression	Ignition coil assembly in Section 6F. Diagnostic Flow Table B-3 Maintenance in Section 6K. PCV system in Section 6E. EVAP control system in Section 6E. Check oxygen sensor output voltage. Refer to DTC P0130 (No.14) Table in this section. Diagnostic Flow Table B-1 Inspection of ECM and its circuit in this section. Previously outlined.
Excessive nitrogen oxides (NOx) emission	• Fuel pressure out of specification • Lead contamination of three way catalytic converter • Closed loop system (A/F feed back compensation) fails – Faulty TP sensor – Faulty ECT sensor or MAP sensor – Faulty oxygen sensor • Faulty injector • Faulty ECM • Faulty EGR system (if equipped)	Diagnostic Flow Table B-3 Maintenance in Section 6K. Check oxygen sensor output voltage Refer to DTC P0130 (No.14) Table in this section. Diagnostic Flow Table B-1 Inspection of ECM and its circuit in this section. EGR system in Section 6E.

Scan Tool Data

As the data values given below are standard values estimated on the basis of values obtained from the normally operating vehicles by using a scan tool, use them as reference values. Even when the vehicle is in good condition, there may be cases where the checked value does not fall within each specified data range. Therefore, judgment as abnormal should not be made by checking with these data alone.
Also, conditions in the below table that can be checked by the scan tool are those detected by ECM and output from ECM as commands and there may be cases where the engine or actuator is not operating (in the condition) as indicated by the scan tool. Be sure to use the timing light to check the ignition timing.

NOTE:

- **With the generic scan tool, only star (✱) marked data in the table below can be read.**
- **The triangle (∆) marked data in the table below can not be read for vehicle without immobilizer indicator lamp at combination meter.**
- **When checking the data with the engine running at idle or racing, be sure to shift M/T gear to the neutral gear position and A/T gear to the "Park" position and pull the parking brake fully. Also, if nothing or "no load" is indicated, turn OFF A/C, all electric loads, P/S and all the other necessary switches.**

		SCAN TOOL DATA	CONDITION		REFERENCE VALUES
	✱	FUEL SYSTEM B1 (FUEL SYSTEM STATUS)	At specified idle speed after warming up		CLOSED (closed loop)
	✱	CALC LOAD (CALCULATED LOAD VALUE)	At specified idle speed with no load after warming up		3 – 9 %
			At 2500 r/min with no load after warming up		12 – 17 %
	✱	COOLANT TEMP. (ENGINE COOLANT TEMP.)	At specified idle speed after warming up		80 – 100 °C, 176 – 212 °F
	✱	SHORT FT B1 (SHORT TERM FUEL TRIM)	At specified idle speed after warming up		– 20 – +20 %
	✱	LONG FT B1 (LONG TERM FUEL TRIM)	At specified idle speed after warming up		– 15 – +15 %
	✱	MAP (INTAKE MANIFOLD ABSOLUTE PRESSURE)	At specified idle speed with no load after		30 – 37 kPa, 220 – 340 mmHg
	✱	ENGINE SPEED	At idling with no load after warming up		Desired idle speed ±50 r/min
	✱	VEHICLE SPEED	At stop		0 km/h, 0 MPH
	✱	IGNITION ADVANCE (IGNITION TIMING ADVANCE FOR NO.1 CYLINDER)	At specified idle speed with no load after warming up		5 – 16° BTDC
	✱	INTAKE AIR TEMP.	At specified idle speed after warming up		Ambient temp. : +15 °C (59 °F) –5 °C (23 °F)
	✱	MAF (MASS AIR FLOW RATE)	At specified idle speed with no load after warming up		1 – 4 gm/sec
	✱	THROTTLE POS (THROTTLE POSITION)	Ignition switch ON / engine stopped	Throttle valve fully closed	7 – 18 %
				Throttle valve fully open	70 – 90 %
	✱	O2S B1 S1 (HEATED OXYGEN SENSOR-1)	At specified idle speed after warming up		0.01 – 0.95 V

		SCAN TOOL DATA	CONDITION		REFERENCE VALUES	
Δ	✱	O2S B1 S2 (HEATED OXYGEN SENSOR-2)	When engine is running at 2000 r/min. for 3 min or longer after warming up.		0.01 – 0.95 V	
Δ	✱	PSP SW	No load to power steering.		OFF	
		DESIRED IDLE (DESIRED IDLE SPEED)	At idling with no load after warming up, M/T at neutral, A/T at “P” range		M/T	700 r/min
					A/T	750 r/min
		TP SENSOR VOLT (THROTTLE POSITION SENSOR OUTPUT VOLTAGE)	Ignition switch ON / engine stopped	Throttle valve fully closed	More than 0.2 V	
				Throttle valve fully open	Less than 4.8 V	
		INJ PULSE WIDTH (FUEL INJECTION PULSE WIDTH)	At specified idle speed with no load after warming up		2.0 – 3.6 msec.	
			At 2500 r/min with no load after warming up		2.0 – 3.6 msec.	
		IAC FLOW DUTY (IDLE AIR CONTROL FLOW DUTY)	At idling with no load after warming up		5 – 25 %	
		TOTAL FT B1	At specified idle speed after warming up		– 35 – +35 %	
		BATTERY VOLTAGE	Ignition switch ON / engine stop		12 – 15 V	
		CANIST PRG DUTY (EVAP CANISTER PURGE FLOW DUTY)	–		0 – 100 %	
		CLOSED THROT POS (CLOSED THROTTLE POSITION)	Throttle valve at idle position		ON	
			Throttle valve opens larger than idle position		OFF	
		FUEL CUT	When engine is at fuel cut condition		ON	
			Other than fuel cut condition		OFF	
		A/C CONDENSER FAN	Ignition switch ON	A/C not operating	OFF	
				A/C operating	ON	
		ELECTRIC LOAD	Ignition switch ON / Headlight, small light, heater fan and rear window defogger all turned OFF		OFF	
			Ignition switch ON / Headlight, small light, heater fan or rear window defogger turned ON		ON	
		A/C SWITCH	Engine running after warming up, A/C not operating		OFF	
			Engine running after warming up, A/C operating		ON	
		PNP SIGNAL (PARK / NEUTRAL POSITION SIGNAL) A/T only	Ignition switch ON	Selector lever in “P” or “N” position	P/N Range	
				Selector lever in “R”, “D”, “2” or “L” position	D Range	
		EGR VALVE	At specified idle speed after warming up		0 %	
Δ		FUEL TANK LEVEL	–		0 – 100 %	
		BAROMETRIC PRESS	–		Display the barometric pressure	
		FUEL PUMP	Within 3 seconds after ignition switch ON or engine running		ON	
			Engine stop at ignition switch ON.		OFF	

		SCAN TOOL DATA	CONDITION		REFERENCE VALUES
		BRAKE SW	Ignition switch ON	Brake pedal is depressing	ON
				Brake pedal is releasing	OFF
		BLOWER FAN	Ignition switch ON	Blower fan switch ON	ON
				Blower fan switch OFF	OFF
		A/C MAG CLUTCH	Ignition switch ON	A/C operating	ON
				A/C not operating	OFF

Scan tool data definitions

FUEL SYSTEM (FUEL SYSTEM STATUS)

Air / fuel ratio feedback loop status displayed as either open or closed loop. Open indicates that ECM ignores feedback from the exhaust oxygen sensor.
Closed indicates final injection duration is corrected for oxygen sensor feedback.

CALC LOAD (CALCULATED LOAD VALUE, %)

Engine load displayed as a percentage of maximum possible load. Value is calculated mathematically using the formula : actual (current) intake air volume ÷ maximum possible intake air volume x 100%.

COOLANT TEMP. (ENGINE COOLANT TEMPERATURE, °C, °F)

It is detected by engine coolant temp. sensor

SHORT FT B1 (SHORT TERM FUEL TRIM, %)

Short term fuel trim value represents short term corrections to the air / fuel mixture computation. A value of 0 indicates no correction, a value greater than 0 means an enrichment correction, and a value less than 0 implies an enleanment correction.

LONG FT B1 (LONG TERM FUEL TRIM, %)

Long term fuel trim Value represents long term corrections to the air / fuel mixture computation. A value of 0 indicates no correction, a value greater than 0 means an enrichment correction, and a value less than 0 implies an enleanment correction.

MAP (INTAKE MANIFOLD ABSOLUTE PRESSURE, kPa, inHg)

It is detected by manifold absolute pressure sensor and used (among other things) to compute engine load.

ENGINE SPEED (rpm)

It is computed by reference pulses from crankshaft position sensor.

VEHICLE SPEED (km/h, MPH)

It is computed based on pulse signals from vehicle speed sensor.

IGNITION ADVANCE (IGNITION TIMING ADVANCE FOR NO.1 CYLINDER, °)

Ignition timing of NO.1 cylinder is commanded by ECM. The actual ignition timing should be checked by using the timing light.

INTAKE AIR TEMP. (°C, °F)

It is detected by intake air temp. sensor and used to determine the amount of air passing into the intake manifold as air density varies with temperature.

MAF (MASS AIR FLOW RATE, gm/s, lb/min)

It represents total mass of air entering intake manifold which is computed based on signals from MAP sensor, IAT sensor, TP sensor, etc.

THROTTLE POS (ABSOLUTE THROTTLE POSITION, %)

When throttle position sensor is fully closed position, throttle opening is indicated as 0% and 100% full open position.

OXYGEN SENSOR B1 S1 (HEATED OXYGEN SENSOR-1, V)

It indicates output voltage of HO2S-1 installed on exhaust manifold (pre-catalyst).

OXYGEN SENSOR B1 S2 (HEATED OXYGEN SENSOR-2, V)

It indicates output voltage of HO2S-2 installed on exhaust pipe (post-catalyst). It is used to detect catalyst deterioration.

DESIRED IDLE (DESIRED IDLE SPEED, rpm)

The Desired Idle Speed is an ECM internal parameter which indicates the ECM requested idle. If the engine is not running, this number is not valid.

TP SENSOR VOLT (THROTTLE POSITION SENSOR OUTPUT VOLTAGE, V)

The Throttle Position Sensor reading provides throttle valve opening information in the form of voltage.

INJ PULSE WIDTH (FUEL INJECTION PULSE WIDTH, msec.)

This parameter indicates time of the injector drive (valve opening) pulse which is output from ECM (but injector drive time of NO.1 cylinder for multiport fuel injection).

IAC FLOW DUTY (IDLE AIR (SPEED) CONTROL DUTY, %)

This parameter indicates current flow time rate within a certain set cycle of IAC valve (valve opening rate) which controls the amount of bypass air (idle speed).

TOTAL FUEL TRIM (%)

The value of Total Fuel Trim is obtained by putting values of short Term Fuel Trim and Long Term Fuel Trim together. This value indicates how much correction is necessary to keep the air / fuel mixture stoichiometrical.

BATTERY VOLTAGE (V)

This parameter indicates battery positive voltage inputted from main relay to ECM.

CANIST PURGE DUTY (EVAP CANISTER PURGE FLOW DUTY, %)

This parameter indicates valve ON (valve open) time rate within a certain set cycle of EVAP purge solenoid valve which controls the amount of EVAP purge.
0% means that the purge valve is completely closed while 100% is a fully open valve.

CLOSED THROTTLE POSITION (ON / OFF)

This parameter will read ON when throttle valve is fully closed, or OFF when the throttle is not fully closed.

FUEL CUT (ON / OFF)

ON : Fuel being cut (output signal to injector is stopped)
OFF : Fuel not being cut

A/C CONDENSER FAN (A/C CONDENSER FAN RELAY, ON / OFF)

ON : Command for condenser fan relay operation being output.
OFF : Command for relay operation not being output.

ELECTRIC LOAD (ON / OFF)

ON : Headlight, small light, heater fan or rear window defogger ON signal inputted.
OFF : Above electric loads all turned OFF.

A/C SWITCH (ON / OFF)

ON : Command for A/C operation being output from ECM to A/C amplifier.
OFF : Command for A/C operation not being output.

FUEL TANK LEVEL (%)

This parameter indicates approximate fuel level in the fuel tank. As the detectable range of the fuel level sensor is set as 0 to 100%, however, with some models whose fuel tank capacity is smaller, the indicated fuel level may be only 70% even when the fuel tank is full.

PNP SIGNAL (PARK / NEUTRAL POSITION SIGNAL, P/N RANGE or D RANGE)

It is detected by signal from TCM.
D range : A/T is in “R”, “D”, “2” or “L” range.
P/N range : A/T is in “P” or “N” range or the above signal is not inputted from TCM.

EGR VALVE (%)

This parameter indicates opening rate of EGR valve which controls the amount of EGR flow.

PSP SW

The Power Steering Pressure switch parameter displays ON when steering wheel is turned all the way to the right or left.

Inspection of ECM and Its Circuits

ECM and its circuits can be checked at ECM wiring connectors by measuring voltage and resistance.

CAUTION:

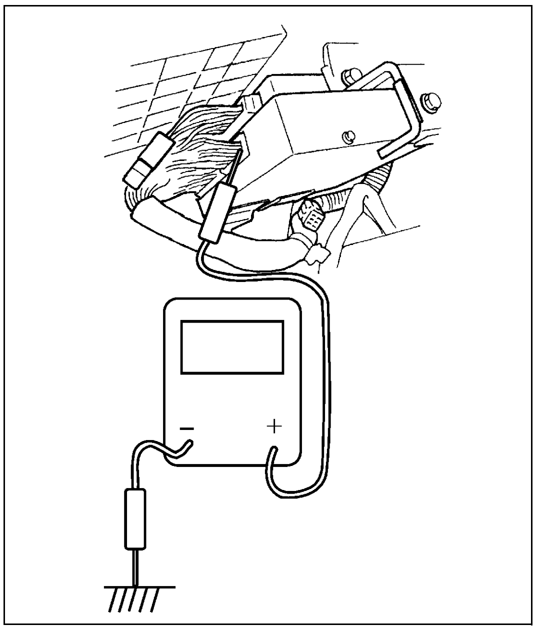
ECM cannot be checked by itself. It is strictly prohibited to connect voltmeter or ohmmeter to ECM with connector disconnected from it.

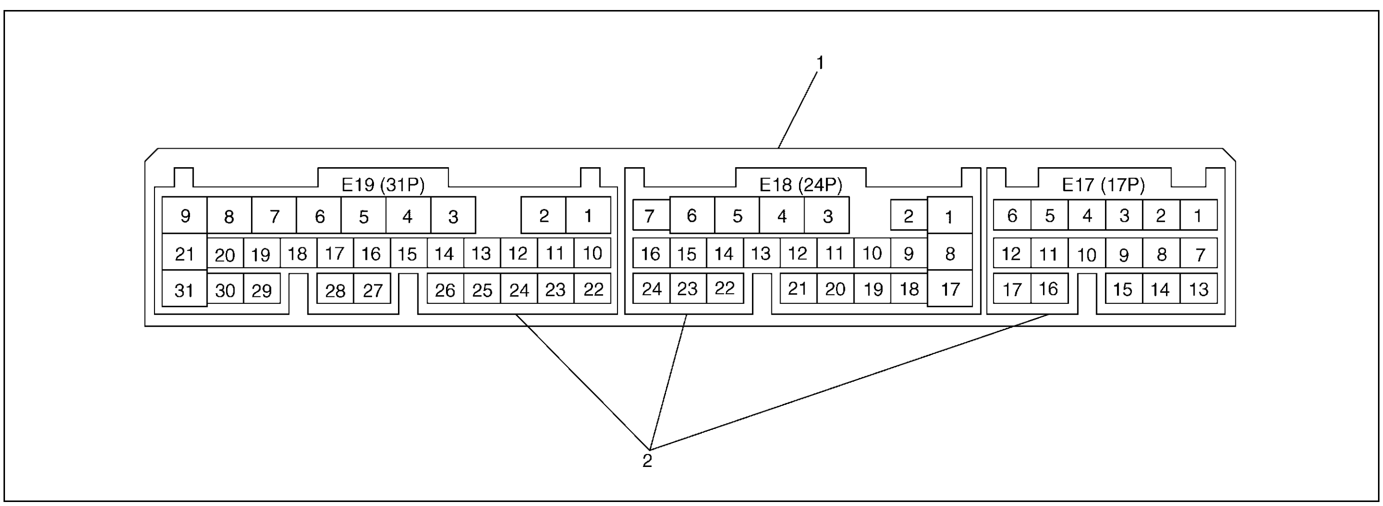
VOLTAGE CHECK

1) Remove ECM from body referring to Section 6E.
2) Check voltage at each terminal of connectors connected.

NOTE:

As each terminal voltage is affected by the battery voltage, confirm that it is 11 V or more when ignition switch is ON.





1.	ECM
2.	ECM connectors (Viewed from harness side)

ECM TERMINAL VOLTAGE VALUES TABLE
For TYPE A (See NOTE)

NOTE:
- **Type A is other than follows.**
- **Type B is left hand steering vehicle equipped with fasten seat belt light and EGR valve or right hand steering vehicle equipped with fasten seat belt light and immobilizer control system.**

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E19	1	Ground	–	–
	2	Ground	–	–
	3	Ground	–	–
	4	EVAP canister purge valve	10 – 14 V	Ignition switch ON
	5	Power steering pressure switch (if equipped)	0 – 1.3 V	While engine running at idle speed, turn steering wheel to right or left as far as it stops
			10 – 14 V	Ignition switch ON
	6	Idle air control valve	0 – 13 V	At specified idle speed after engine warmed up
	7	Heater of HO2S-1	10 – 14 V	Ignition switch ON
	8	Fuel injector NO.4	10 – 14 V	Ignition switch ON
	9	Fuel injector NO.1	10 – 14 V	Ignition switch ON
	10	Sensor ground	–	–
	11	Camshaft position sensor	0 – 0.8 V and 4 – 6 V	Ignition switch ON
	12	–	–	–
	13	Heater oxygen sensor-1	Refer to DTC P0130 diag. flow table	
		CO adjusting resistor (w/o HO2S)	0 – 5 V	Ignition switch ON position
	14	Engine coolant temp. sensor	0.55 - 0.95 V	Ignition switch ON Engine coolant temp. : 80 °C (176 °F)
	15	Intake air temp. sensor	2.0 – 2.7 V	Ignition switch ON Intake air temp. : 20 °C (68 °F)
	16	Throttle opening signal	0.2 – 1.0 V	Ignition switch ON position and throttle valve at idle position
			2.8 – 4.8 V	Ignition switch ON position and throttle valve fully open
	17	EGR valve (stepper motor coil 3, if equipped)	10 – 14 V	Ignition switch ON position leaving engine OFF
	18	EGR valve (stepper motor coil 1, if equipped)	10 – 14 V	Ignition switch ON position leaving engine OFF
	19	Ignition coil #2	–	–
	20	Ignition coil #1	–	–
	21	Fuel injector NO.2	10 – 14 V	Ignition switch ON
	22	Power source for sensors	4.75 – 5.25 V	Ignition switch ON
	23	Crankshaft position sensor	0 – 0.8 or 4 – 5 V	Ignition switch ON position
	24	–	–	–
	25	Knock sensor	About 2.5 V	At specified idle speed after engine warmed up

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E19	26	Manifold absolute pressure sensor	3.3 – 4.0 V	Ignition switch ON Barometric pressure : 100 kPa (760 mmHg)
	27	A/C evaporator temp. sensor	2.0 – 2.3 V	Ignition switch ON A/C evaporation temp. sensor at 25 °C (77 °F)
	28	EGR valve (stepper motor coil 4, if equipped)	10 – 14 V	Ignition switch ON position leaving engine OFF
	29	EGR valve (stepper motor coil 2, if equipped)	10 – 14 V	Ignition switch ON position leaving engine OFF
	30	–	–	–
	31	Fuel injector NO.3	10 – 14 V	Ignition switch ON

For TYPE B (See NOTE)

NOTE:
See NOTE in "ECM TERMINAL VOLTAGE VALUES TABLE" for applicable model.

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E19	1	Ground	–	–
	2	Ground	–	–
	3	Ground	–	–
	4	EVAP canister purge valve	10 – 14 V	Ignition switch ON
	5	Power steering pressure switch (if equipped)	0 – 1.3 V	While engine running at idle speed, turn steering wheel to right or left as far as it stops
			10 – 14 V	Ignition switch ON
	6	Idle air control valve	0 – 13 V	At specified idle speed after engine warmed up
	7	Heater of HO2S-1	10 – 14 V	Ignition switch ON
	8	Fuel injector NO.4	10 – 14 V	Ignition switch ON
	9	Fuel injector NO.1	10 – 14 V	Ignition switch ON
	10	Sensor ground	–	–
	11	Camshaft position sensor	0 – 0.8 V and 4 – 6 V	Ignition switch ON
	12	–	–	–
	13	Heater oxygen sensor-1	Refer to DTC P0130 diag. flow table	
		CO adjusting resistor (w/o HO2S)	0 – 5 V	Ignition switch ON position
	14	Engine coolant temp. sensor	0.55 - 0.95 V	Ignition switch ON Engine coolant temp. : 80 °C (176 °F)
	15	Intake air temp. sensor	2.0 – 2.7 V	Ignition switch ON Intake air temp. : 20 °C (68 °F)
	16	Throttle opening signal	0.2 – 1.0 V	Ignition switch ON position and throttle valve at idle position
			2.8 – 4.8 V	Ignition switch ON position and throttle valve fully open
	17	EGR valve (stepper motor coil 3, if equipped)	10 – 14 V	Ignition switch ON position leaving engine OFF

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E19	18	EGR valve (stepper motor coil 1, if equipped)	10 – 14 V	Ignition switch ON position leaving engine OFF
	19	Ignition coil #2	–	–
	20	Ignition coil #1	–	–
	21	Fuel injector NO.2	10 – 14 V	Ignition switch ON
	22	Power source for sensors	4.75 – 5.25 V	Ignition switch ON
	23	Crankshaft position sensor	0 – 0.8 or 4 – 5 V	Ignition switch ON position
	24	–	–	–
	25	Knock sensor	About 2.5 V	At specified idle speed after engine warmed up
	26	Manifold absolute pressure sensor	3.3 – 4.0 V	Ignition switch ON Barometric pressure : 100 kPa (760 mmHg)
	27	–	–	–
	28	EGR valve (stepper motor coil 4, if equipped)	10 – 14 V	Ignition switch ON position leaving engine OFF
	29	EGR valve (stepper motor coil 2, if equipped)	10 – 14 V	Ignition switch ON position leaving engine OFF
	30	–	–	–
	31	Fuel injector NO.3	10 – 14 V	Ignition switch ON

For TYPE A (See NOTE)

NOTE:
See NOTE in “ECM TERMINAL VOLTAGE VALUES TABLE” for applicable model.

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E18	1	A/C compressor clutch	0 V	Ignition switch ON
	2	Malfunction indicator lamp	10 – 14 V	Engine running
			0 – 1.0 V	Ignition switch ON leaving engine OFF
	3	Data link connector	10 – 14 V	Ignition switch ON
	4	Heater of HO2S-2 (if equipped)	10 – 14 V	Ignition switch ON
	5	Power source	10 – 14 V	Ignition switch ON
	6	Power source	10 – 14 V	Ignition switch ON
	7	Power source for buck-up	10 – 14 V	Ignition switch ON and OFF
	8	Immobilizer indicator lamp (with immobilizer indicator lamp)	10 – 14 V	Engine running
			0 – 1.0 V	Ignition switch ON leaving engine OFF
		Duty output terminal (without immobilizer indicator lamp)	0 – 1.0 V	Ignition switch ON
	9	–	–	–
	10	Main relay	10 – 14 V	Ignition switch OFF
			0.4 – 1.5 V	Ignition switch ON
	11	Tachometer	–	–
	12	Data link connector	4 – 5 V	Ignition switch ON
	13	Heated oxygen sensor-2	Refer to DTC P0130 diag. flow table	

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E18	14	Diag. Switch terminal (without immobilizer indicator lamp)	4 – 5 V	Ignition switch ON
	15	Test switch terminal (without immobilizer indicator lamp)	4 – 5 V	Ignition switch ON
	16	A/C (input) signal	10 – 14 V	Ignition switch ON A/C switch OFF
			0 – 2 V	Ignition switch ON A/C switch ON
	17	Lighting switch	10 – 14 V	Lighting switch ON
			0 – 1.3 V	Lighting switch OFF
	18	A/C condenser fan motor relay (if equipped)	0 – 1.0 V	A/C is operating
			10 – 14 V	A/C is not operating
	19	Fuel pump relay	0 – 1 V	For 2 seconds after ignition switch ON
			10 – 14 V	After the above time
	20	Sensor ground	–	–
	21	Throttle opening signal for TCM (A/T)	Indication deflection repeated 0 V and 10 – 14 V	Ignition switch ON
	22	Fuel level sensor (gauge) (with immobilizer indicator lamp)	0 – 2 V	Ignition switch ON Fuel tank fully filled
			4.5 – 7.5 V	Ignition switch ON Fuel tank emptied
	23	–	–	–
	24	Heater blower switch	0 – 2.0 V	Ignition switch ON and heater blower switch ON
			10 – 14 V	Ignition switch ON and heater blower switch OFF

For TYPE B (See NOTE)

NOTE:
See NOTE in “ECM TERMINAL VOLTAGE VALUES TABLE” for applicable model.

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E18	1	A/C compressor clutch	0 V	Ignition switch ON
	2	–	–	–
	3	–	–	–
	4	–	–	–
	5	Power source	10 – 14 V	Ignition switch ON
	6	Power source	10 – 14 V	Ignition switch ON
	7	Power source for buck-up	10 – 14 V	Ignition switch ON and OFF
	8	Immobilizer indicator lamp (with immobilizer indicator lamp)	10 – 14 V	Engine running
			0 – 1.0 V	Ignition switch ON leaving engine OFF
		Duty output terminal (without immobilizer indicator lamp)	0 – 1.0 V	Ignition switch ON

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E18	9	Ignition switch	10 – 14 V	Ignition switch ON
	10	Main relay	10 – 14 V	Ignition switch OFF
			0.4 – 1.5 V	Ignition switch ON
	11	Ignition switch	10 – 14 V	Ignition switch ON
	12	Rear defogger switch (if equipped)	10 – 14 V	Ignition switch ON and rear defogger switch ON
			0 – 1.3 V	Ignition switch ON and rear defogger switch OFF
	13	–	–	–
	14	Diag. Switch terminal (without immobilizer indicator lamp)	4 – 5 V	Ignition switch ON
	15	Test switch terminal (without immobilizer indicator lamp)	4 – 5 V	Ignition switch ON
	16	A/C (input) signal	10 – 14 V	Ignition switch ON A/C switch OFF
			0 – 2 V	Ignition switch ON A/C switch ON
	17	Lighting switch	10 – 14 V	Lighting switch ON
			0 – 1.3 V	Lighting switch OFF
	18	A/C condenser fan motor relay (if equipped)	0 – 1.0 V	A/C is operating
			10 – 14 V	A/C is not operating
	19	Fuel pump relay	0 – 1 V	For 2 seconds after ignition switch ON
			10 – 14 V	After the above time
	20	Engine start signal	6 – 14 V	While engine cranking
	21	Stop lamp switch	0 V	Ignition switch ON Stop lamp switch OFF
			10 – 14 V	Ignition switch ON Stop lamp switch ON
	22	Vehicle speed sensor	deflect between 0 – 1.6 and 4 – 14 V	Ignition switch ON and rear right wheel turned slowly with rear left wheel locked
	23	–	–	–
	24	–	–	–

For TYPE A (See NOTE)

NOTE:

See NOTE in “ECM TERMINAL VOLTAGE VALUES TABLE” for applicable model.

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E17	1	–	–	–
	2	R-range signal (A/T)	10 – 14 V	Ignition switch ON and shift select switch in R range
			0 – 1.3 V	Ignition switch ON and shift select switch in other than R range
	3	Blank	–	–

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E17	4	Blank	–	–
	5	Overdrive cut signal (A/T)	0 – 1.0 V	Ignition switch ON and ECT less than 60 °C
			10 – 14 V	Ignition switch ON and ECT more than 60 °C
	6	D-range idle up signal (A/T)	10 – 14 V	Ignition switch ON and shift select switch in other than P and N range
			0 – 1.6 V	Ignition switch ON and shift select switch in P and N range
	7	Stop lamp switch	0 V	Ignition switch ON Stop lamp switch OFF
			10 – 14 V	Ignition switch ON Stop lamp switch ON
	8	–	–	–
	9	Ignition switch	10 – 14 V	Ignition switch ON
	10	–	–	–
	11	Vehicle speed sensor	deflect between 0 – 1.6 and 4 – 14 V	Ignition switch ON and rear right wheel turned slowly with rear left wheel locked
	12	ABS signal (if equipped)	10 – 14 V	Ignition switch ON
	13	Engine start signal	6 – 14 V	While engine cranking
	14	–	–	–
	15	–	–	–
	16	Rear defogger switch (if equipped)	10 – 14 V	Ignition switch ON and rear defogger switch ON
			0 – 1.3 V	Ignition switch ON and rear defogger switch OFF
	17	A/T failure signal (with immobilizer indicator lamp) (A/T)	–	–

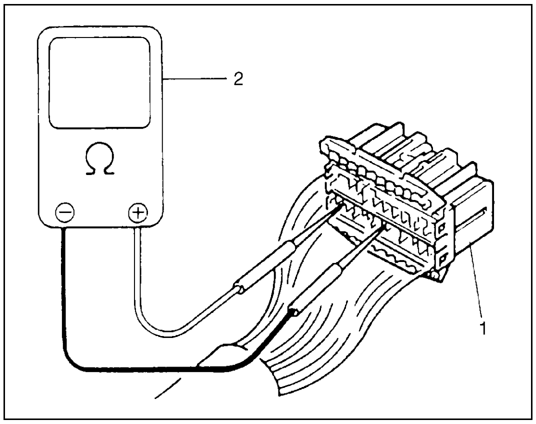
For TYPE B (See NOTE)

NOTE:
See NOTE in “ECM TERMINAL VOLTAGE VALUES TABLE” for applicable model.

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E17	1	A/C evaporator temp. sensor	2.0 – 2.3 V	Ignition switch ON A/C evaporator temp. sensor at 25 °C (77 °F)
	2	R-range signal (A/T)	10 – 14 V	Ignition switch ON and shift select switch in R range
			0 – 1.3 V	Ignition switch ON and shift select switch in other than R range
	3	Blank	–	–
	4	Blank	–	–

TERMINAL NO.		CIRCUIT	NORMAL VOLTAGE	CONDITION
E17	5	Overdrive cut signal (A/T)	0 – 1.0 V	Ignition switch ON and ECT less than 60° C
			10 – 14 V	Ignition switch ON and ECT more than 60 °C
	6	D-range idle up signal (A/T)	10 – 14 V	Ignition switch ON and shift select switch in other than P and N range
			0 – 1.6 V	Ignition switch ON and shift select switch in P and N range
	7	Data link connector	4 – 5 V	Ignition switch ON
	8	–	–	–
	9	Malfunction indicator lamp	10 – 14 V	Engine running
			0 – 1.0 V	Ignition switch ON leaving engine OFF
	10	–	–	–
	11	Data link connector	10 – 14 V	Ignition switch ON
	12	ABS signal (if equipped)	10 – 14 V	Ignition switch ON
	13	Heater blower switch	0 – 2.0 V	Ignition switch ON and heater blower switch ON
			10 – 14 V	Ignition switch ON and heater blower switch OFF
	14	Sensor ground	–	–
	15	Throttle opening signal for TCM (A/T)	Indication deflection repeated 0 V and 10 - 14 V	Ignition switch ON
	16	Tachometer	–	–
	17	–	–	–

Resistance Check



1) Disconnect ECM couplers (1) from ECM with ignition switch OFF.

> **CAUTION:**
> **Never touch terminals of ECM itself or connect voltmeter or ohmmeter (2).**

2) Check resistance between each terminal of couplers disconnected.

> **CAUTION:**
> - **Be sure to connect ohmmeter probe from wire harness side of coupler.**
> - **Be sure to turn OFF ignition switch for this check.**
> - **Resistance in table below represents that when parts temperature is 20 °C (68 °F).**

1.	ECM coupler disconnected
2.	Ohmmeter

TERMINALS	CIRCUIT	STANDARD RESISTANCE
E19-7 to E17-9 (For TYPE A) (See NOTE)	HO2S-1 heater	5 – 6.4 Ω
E19-7 to E18-11 (For TYPE B) (See NOTE)		
E18-4 to E17-9 (For TYPE A) (See NOTE)	HO2S-2 heater	11.7 – 14.3 Ω
E19-9 to E19-2	No.1 injector	12.0 – 13.0 Ω
E19-21 to E19-2	No.2 injector	12.0 – 13.0 Ω
E19-31 to E19-2	No.3 injector	12.0 – 13.0 Ω
E19-8 to E19-2	No.4 injector	12.0 – 13.0 Ω
E19-28 to E19-2	EGR valve (stepper motor coil 4)	20 – 24 Ω
E19-17 to E19-2	EGR valve (stepper motor coil 3)	20 – 24 Ω
E19-29 to E19-2	EGR valve (stepper motor coil 2)	20 – 24 Ω
E19-18 to E19-2	EGR valve (stepper motor coil 1)	20 – 24 Ω
E19-4 to E19-2	EVAP canister purge valve	30 – 34 Ω
E18-19 to E17-9 (For TYPE A) (See NOTE)	Fuel pump relay	70 – 110 Ω
E18-19 to E18-11 (For TYPE B) (See NOTE)		
E18-1 to Body ground	A/C compressor clutch	3 – 4.5 Ω
E18-18 to E19-2	A/C condenser fan control relay	70 – 110 Ω
E18-10 to E18-7	Main relay	70 – 110 Ω
E19-1 to Body ground	Ground	Continuity
E19-2 to Body ground	Ground	Continuity
E19-3 to Body ground	Ground	Continuity

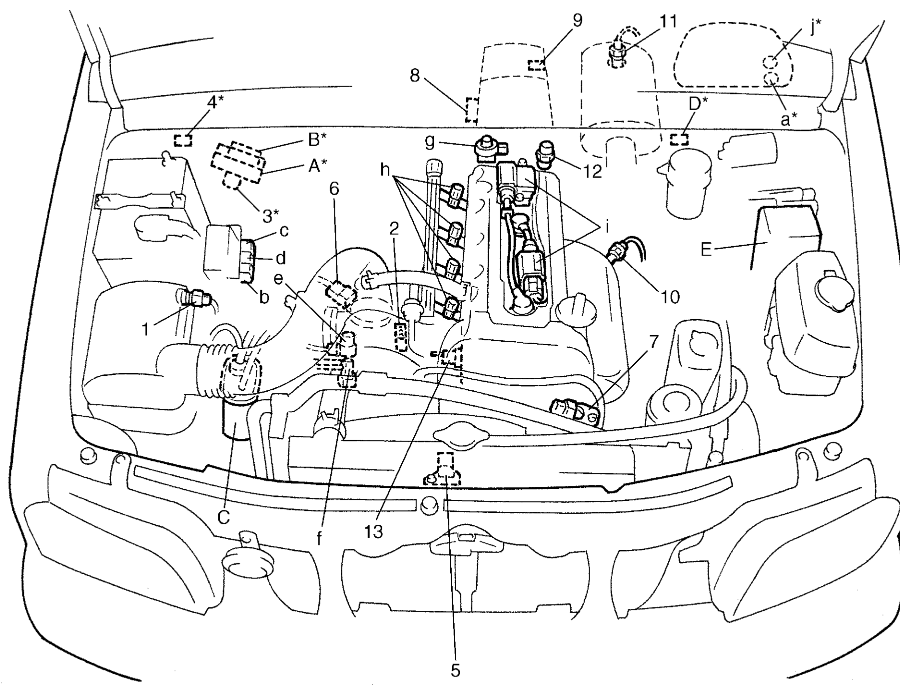
NOTE:

For TYPE A and TYPE B, refer to the NOTE in “ECM Terminal Voltage Values Table” for applicable model.

Component Location

NOTE:

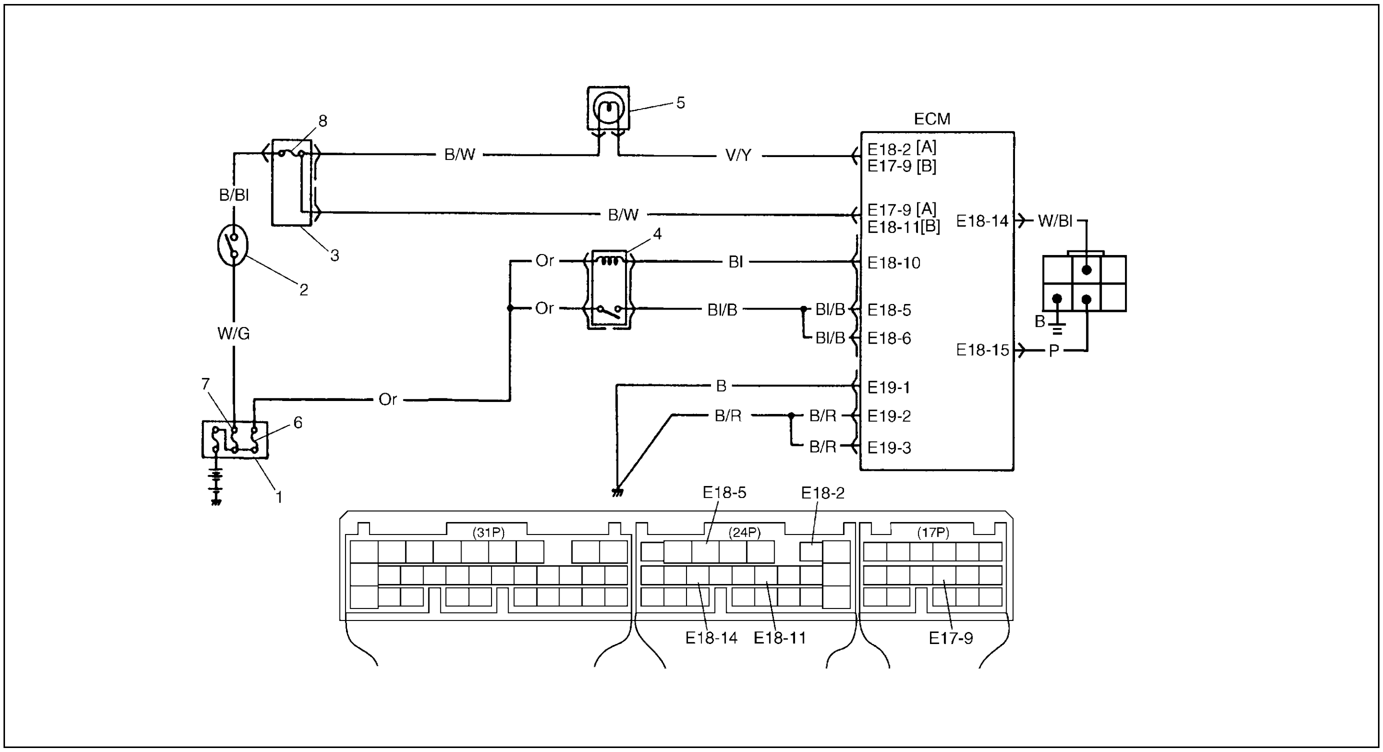
The figure shows left-hand steering vehicle.
For right-hand steering vehicle, parts with (*) are installed at the other side.



1.	IAT sensor	a :	Immobilizer indicator lamp (if equipped)	A :	ECM
2.	TP sensor	b :	A/C condenser fan motor relay (if equipped)	B :	A/T control module
3.	Monitor connector	c :	Main relay	C :	EVAP canister
4.	CO adjusting resistor (if equipped)	d :	Fuel pump relay	D :	DLC
5.	CKP sensor	e :	IAC valve	E :	ABS control module (if equipped)
6.	MAP sensor	f :	EVAP canister purge valve		
7.	CMP sensor	g :	EGR valve (if equipped)		
8.	Transmission range switch	h :	Fuel injector		
9.	VSS	i :	Ignition coil assemblies		
10.	HO2S-1 (if equipped)	j :	MIL		
11.	HO2S-2 (if equipped)				
12.	ECT sensor				
13.	Knock sensor				

Table A-1 Malfunction Indicator Lamp Circuit Check - Lamp Does Not Come "ON" at Ignition Switch ON (But Engine at Stop)

CIRCUIT DESCRIPTION



1. Main fuse	4. Main relay	7. "IG" fuse	[A] : Case of TYPE A is shown (See NOTE)
2. Ignition switch	5. Malfunction indicator lamp in combination meter	8. "IG COIL METER" fuse	[B] : Case of TYPE B is shown (See NOTE)
3. Fuse box	6. "FI" fuse		

NOTE:

For TYPE A and TYPE B, refer to the NOTE in "ECM Terminal Voltage Values Table" for applicable model.

When the ignition switch is turned ON, ECM causes the main relay to turn ON (close the contact point). Then, ECM being supplied with the main power, turns ON the malfunction indicator lamp (MIL). When the engine starts to run and no malfunction is detected in the system, MIL goes OFF but if a malfunction was or is detected, MIL remains ON even when the engine is running.

INSPECTION

Step	Action	Yes	No
1	MIL Power Supply Check 1) Turn ignition switch ON. Do other indicator / warning lights in combination meter comes ON?	Go to Step 2.	"IG" fuse blown, main fuse blown, ignition switch malfunction, "B/W" circuit between "IG" fuse and combination meter or poor coupler connection at combination meter.

Step	Action	Yes	No
2	ECM Power and Ground Circuit Check Does engine start?	Go to Step 3.	Go to “Table A-5 ECM Power and Ground Circuit Check”. If engine is not cranked, go to “Diagnosis” in Section 8G.
3	MIL Circuit Check 1) Turn ignition switch OFF and disconnect connectors from ECM. 2) Check for proper connection to ECM at terminal E18-2 (Case of TYPE A) (See NOTE) or E17-9 (Case of TYPE B) (See NOTE). 3) If OK, then using service wire, ground terminal E18-2 (Case of TYPE A) (See NOTE) or E17-9 (Case of TYPE B) (See NOTE) in connector disconnected. Does MIL turn on at ignition switch ON?	Substitute a known-good ECM and recheck.	Bulb burned out, “V/Y” wire circuit open or “P” wire shorted to ground.

Table A-2 Malfunction Indicator Lamp Circuit Check - Lamp Remains “ON” after Engine Starts

WIRING DIAGRAM / CIRCUIT DESCRIPTION

Refer to table A-1.

INSPECTION

Step	Action	Yes	No
1	Diagnostic Trouble Code (DTC) check 1) Check DTC referring to DTC CHECK section. Is there any DTC(s)?	Go to Step 2 of “Engine Diag. Flow Table”.	Go to Step 2.
2	DTC check 1) Start engine and recheck DTC while engine running. Is there any DTC(s)?		Go to Step 3.
3	MIL Circuit check 1) Turn OFF ignition switch. 2) Disconnect connectors from ECM. Does MIL turn ON at ignition switch ON?	“V/Y” wire circuit shorted to ground.	Substitute a known-good ECM and recheck.

Table A-3 Malfunction Indicator Lamp Circuit Check - Mil Flashes at Ignition Switch ON

WIRING DIAGRAM / CIRCUIT DESCRIPTION

Refer to table A-1.

INSPECTION

Step	Action	Yes	No
1	MIL flashing pattern check : 1) With the ignition switch ON position, check MIL flashing pattern. Does MIL flashing pattern indicate DTC (diagnostic trouble code)?	Go to Step 2.	Go to “Diagnosis” in Section 8G.
2	Diagnosis switch terminal check : 1) With the ignition switch ON position, check voltage between E18-14 terminal of ECM coupler and ground. Is voltage 4 – 5 V?	Substitute a known-good ECM and recheck.	“W/Bl” wire (diagnosis switch terminal) shorted to ground circuit. If OK, substitute a known-good ECM and recheck.

Table A-4 Malfunction Indicator Lamp Circuit Check - MIL Does Not Flash, Just Remains ON or Just Remains OFF Even with Grounding Diagnosis Switch Terminal

WIRING DIAGRAM / CIRCUIT DESCRIPTION

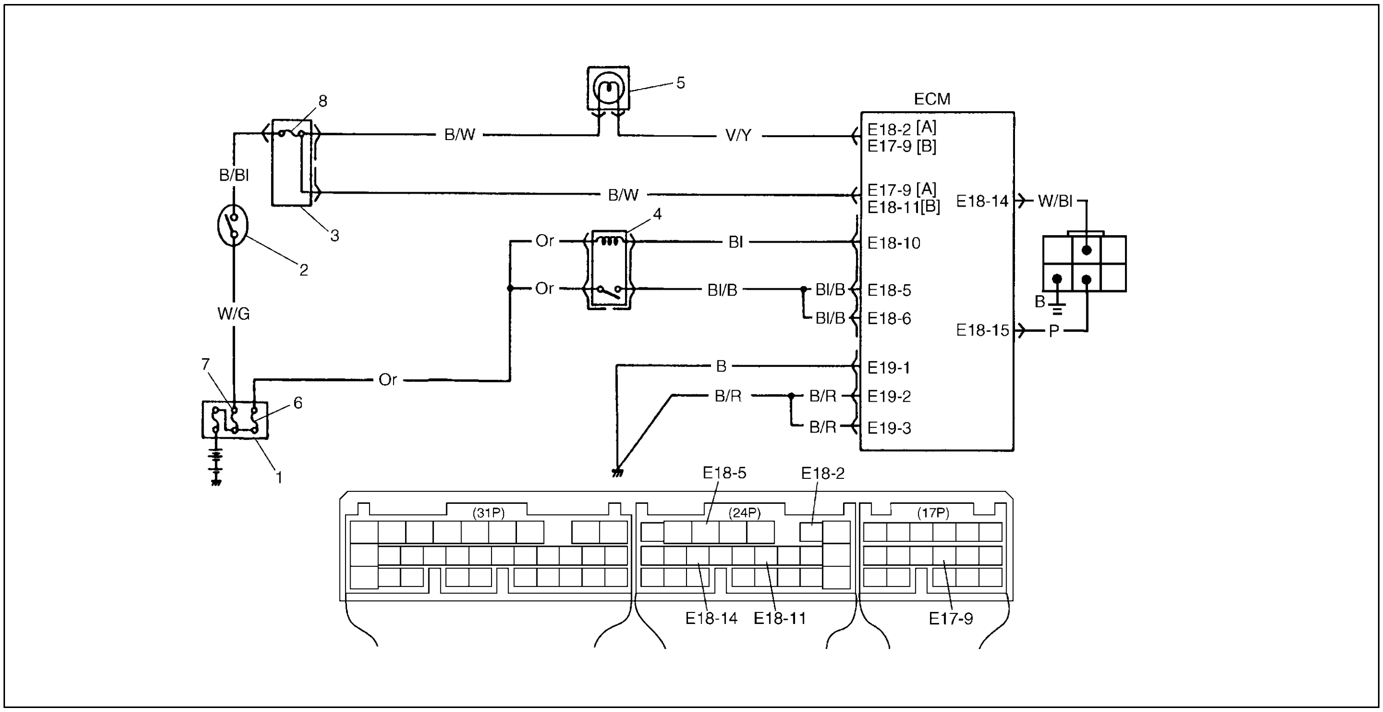
Refer to table A-1.

INSPECTION

Step	Action	Yes	No
1	MIL flashing pattern check : 1) With grounding diagnosis switch terminal and turn the ignition switch ON position, check voltage between E18-14 terminal of ECM connector and ground. Is voltage 0 – 1 V?	Go to Step 2.	“W/Bl” wire (diagnosis switch terminal), “B” wire of monitor connector open. If OK, substitute a known-good ECM and recheck.
2	Test switch terminal circuit check : 1) With the ignition switch ON position, check voltage between E18-15 terminal of ECM connector and ground. Is voltage 4 – 5 V?	Substitute a known-good ECM and recheck.	“P” wire (test switch terminal) shorted to ground circuit. If OK, substitute a known-good ECM and recheck.

Table A-5 ECM Power and Ground Circuit Check - MIL Doesn't Light at Ignition Switch ON and Engine Doesn't Start Though It Is Cranked Up

CIRCUIT DESCRIPTION



1. Main fuse	4. Main relay	7. "IG" fuse	[A] : Case of TYPE A is shown (See NOTE)
2. Ignition switch	5. Malfunction indicator lamp in combination meter	8. "IG COIL METER" fuse	[B] : Case of TYPE B is shown (See NOTE)
3. Fuse box	6. "FI" fuse		

NOTE:

For TYPE A and TYPE B, refer to the NOTE in "ECM Terminal Voltage Values Table" for applicable model.

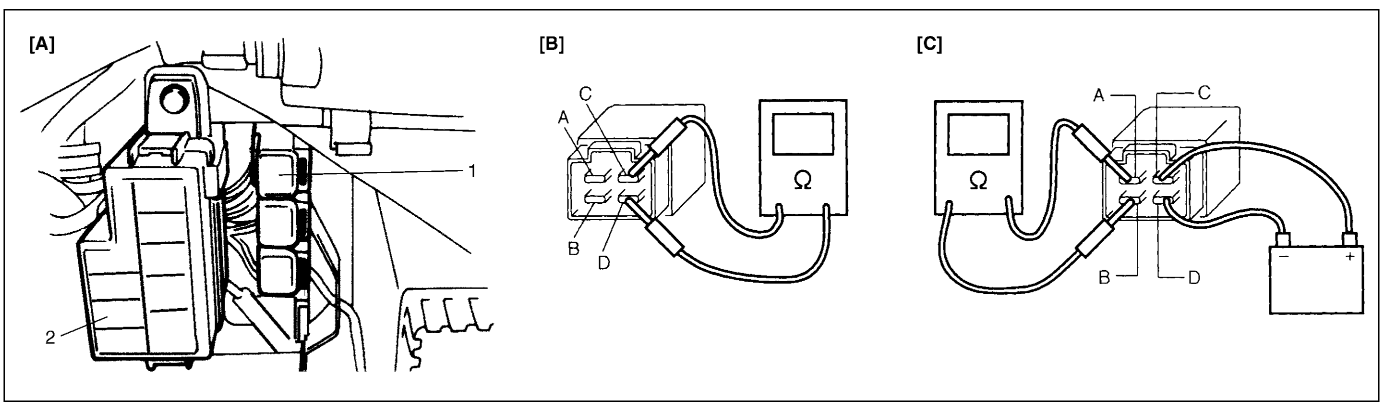
When the ignition switch tuned ON, the main relay turns ON (the contact point closes) and the main power is supplied to ECM.

INSPECTION

Step	Action	Yes	No
1	Main Relay Operating Sound Check Is operating sound of main relay heard at ignition switch ON?	Go to Step 5.	Go to Step 2.
2	Main Relay Check 1) Turn OFF ignition switch and remove main relay (1). 2) Check for proper connection to main relay (1) at terminal 3 and 4. 3) Check resistance between each two terminals. See Fig. 1 and 2. **Main relay resistance** **Between terminals A and B : Infinity** **Between terminals C and D : 70 – 110 Ω (at 20 °C, 68 °F)** 4) Check that there is continuity between terminals 1 and 2 when battery is connected to terminals 3 and 4. See Fig. 3. Is main relay in good condition?	Go to Step 3.	Replace main relay.

Step	Action	Yes	No
3	Fuse Check Is main "FI" fuse in good condition? See Fig. 1.	Go to Step 4.	Check for short in circuits connected to this fuse.
4	ECM Power Circuit Check 1) Turn OFF ignition switch, disconnect connectors from ECM and install main relay. 2) Check for proper connection to ECM at terminals E17-9 (Case of TYPE A) (See NOTE) or E18-11 (Case of TYPE B) (See NOTE), E18-10, E18-5 and E18-6. 3) If OK, then measure voltage between terminal E18-10 and ground, E17-9 (Case of TYPE A) (See NOTE) or E18-11 (Case of TYPE B) (See NOTE) and ground with ignition switch ON. Is each voltage 10 – 14 V?	Go to Step 5.	"B/W", "Or" or "Bl/B" circuit open.
5	ECM Power Circuit Check 1) Using service wire, ground terminal E18-10 and measure voltage between terminal E18-5 and ground at ignition switch ON. Is it 10 – 14 V?	Check ground circuits "B" and "B/R" for open. If OK, then substitute a known-good ECM and recheck.	Go to Step 6.
6	Is operating sound of main relay heard in Step 1?	Go to Step 7.	"Bl/B" or "B/R" wire open.
7	Main Relay Check 1) Check main relay according to procedure in Step 2. Is main relay in good condition?	"Or" or "Bl/B" wire open.	Replace main relay.

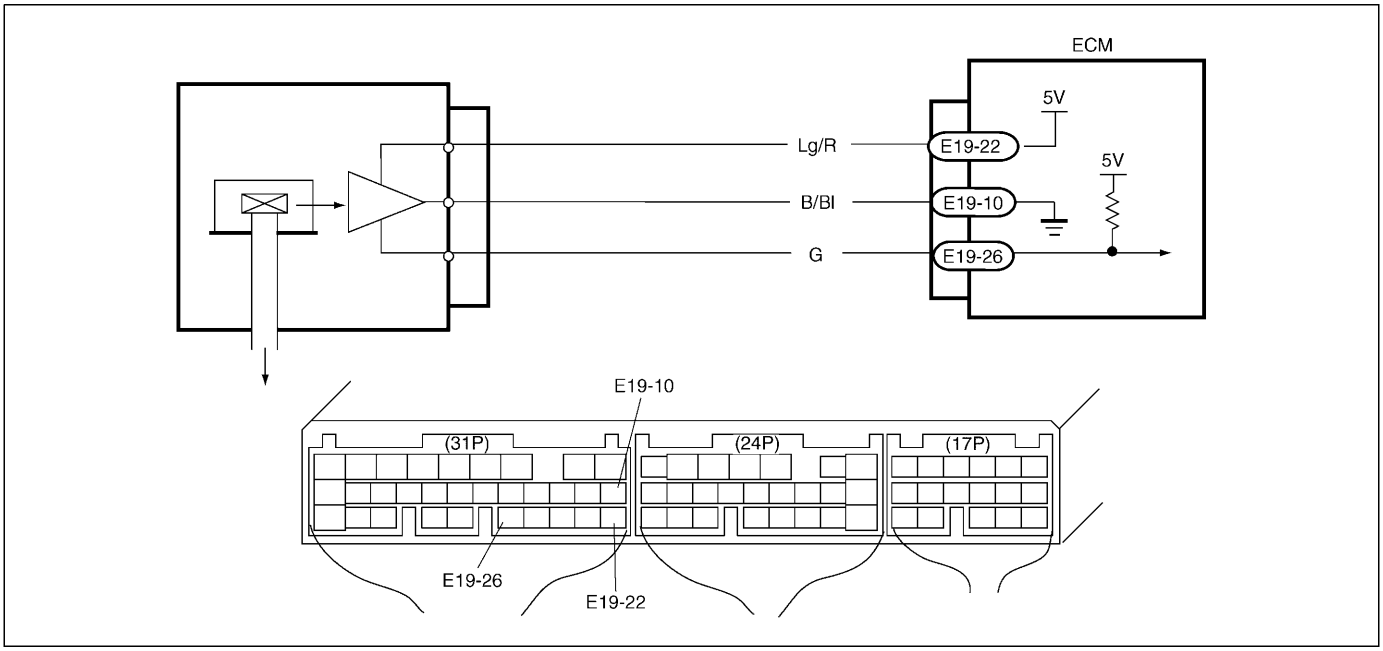
[A] Fig. 1 for Step 2 and 3 / [B] Fig. 2 for Step 2 / [C] Fig. 3 for Step 2



2. "F1" fuse

DTC P0105 (DTC No.11) Manifold Absolute Pressure (MAP) Circuit Malfunction

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
• MAP sensor signal is 0.19 V or lower. (Low pressure – High vacuums – Low voltage) • MAP sensor signal is 4.5 V or higher. (High pressure – Low vacuums – High voltage)	• “B/Bl” circuit open • “Lg/R” circuit open or shorted to ground • “G” circuit open or shorted to ground • MAP sensor malfunction • ECM malfunction

NOTE:
- **When DTC P0120 is indicated together, it is possible that “Lg/R” circuit is open.**
- **When DTC P0105 (No.11), P0110 (No.18) P0115 (No.19) P0120 (No.13) and P0460 are indicated together, it is possible that “B/Bl” circuit is open.**

DTC CONFIRMATION PROCEDURE

1) Clear DTC, start engine and keep it at idle for 1 min.
2) Select “DTC” mode on scan tool and check DTC.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Check MAP Sensor and Its Circuit. 1) Connect scan tool to DLC with ignition switch OFF. See Fig. 1. 2) Turn ignition switch ON. 3) Check intake manifold pressure. Is it 126 kPa (37.2 inHg) or 0 kPa (0 inHg)?	Go to Step 3.	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.

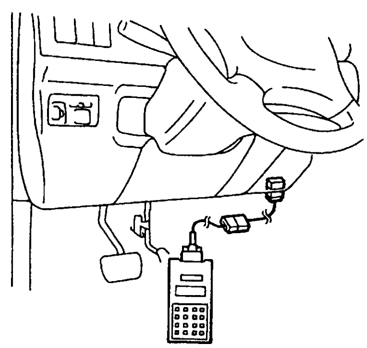
Step	Action	Yes	No
3	Check Wire Harness. 1) Disconnect MAP sensor connector with ignition switch OFF. 2) Check for proper connection of MAP sensor at "G" and "B/Bl" wire terminals. 3) If OK, then with ignition switch ON, check voltage at each of "Lg/R" and "G" wire terminals and body ground. See Fig. 2. Is voltage about 4 – 6 V at each terminal?	Go to Step 4.	"Lg/R" wire open or shorted to ground circuit or shorted to power circuit (See NOTE), "G" wire open or shorted to ground, poor E19-26 connection or E19-22 connection. If wire and connection are OK, confirm that MAP sensor is normal and then substitute a known-good ECM and recheck.
4	Check MAP sensor according to "MAP Sensor Individual Check" below. Is it in good condition?	"Lg/R" wire shorted to "G" wire, "B/Bl" wire open, poor E19-10 connection. If wire and connection are OK, substitute a known-good ECM and recheck.	Replace MAP sensor.

NOTE:

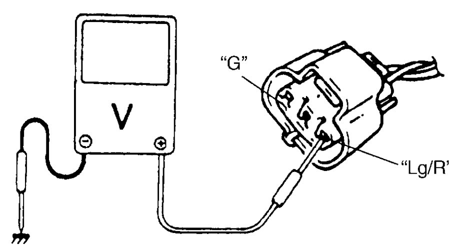
When battery voltage is applied to "Lg/R" wire, it is possible that MAP sensor is also faulty.

[A] Fig. 1 for Step 2 / [B] Fig. 2 for Step 3

[A]

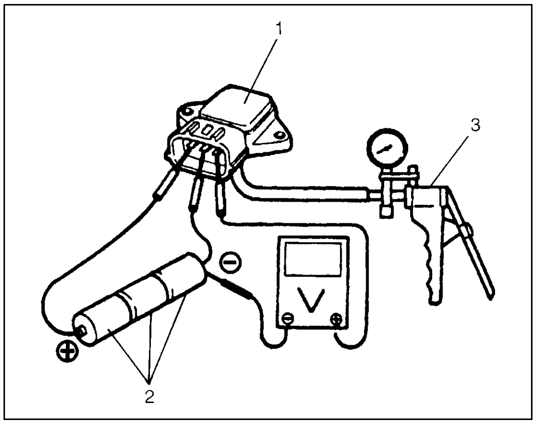


[B]



MAP Sensor Individual Check

1) Disconnect connector from MAP sensor (1).
2) Remove MAP sensor (1).



3) Arrange 3 new 1.5 V batteries (2) in series (check that total voltage is 4.5 – 5.0 V) and connect its positive terminal to “Vin” terminal of sensor and negative terminal to “Ground” terminal. Then check voltage between “Vout” and “Ground”. Also, check if voltage reduces when vacuum is applied up to 400 mmHg by using vacuum pump (3).

If check result is not satisfactory, replace MAP sensor (1).

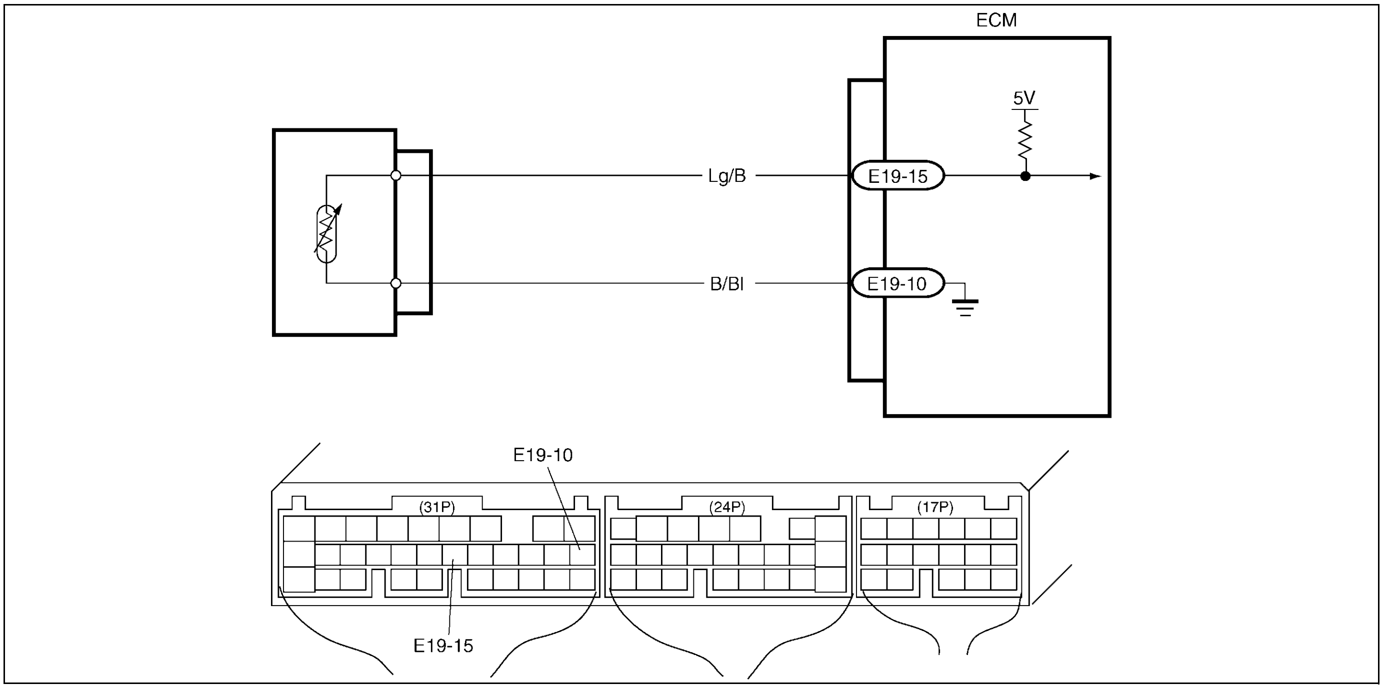
Output voltage (When input voltage is 4.5 – 5.5 V, ambient temp. 20 – 30 °C, 68 – 86 °F)

ALTITUDE (Reference)		BAROMETRIC PRESSURE		OUTPUT VOLTAGE
(ft)	(m)	(mmHg)	(kPa)	(V)
0 | 2 000	0 | 610	760 | 707	100 | 94	3.3 – 4.3
2 001 | 5 000	611 | 1 524	Under 707 over 634	94 | 85	3.0 – 4.1
5 001 | 8 000	1 525 | 2 438	Under 634 over 567	85 | 76	2.7 – 3.7
8 001 | 10 000	2 439 | 3 048	Under 567 over 526	76 | 70	2.5 – 3.3

4) Install MAP sensor (1) securely.
5) Connect MAP sensor (1) connector securely.

DTC P0110 (DTC No.18) Intake Air Temp. (IAT) Circuit Malfunction

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
• Low intake air temperature (High voltage-High resistance) • High intake air temperature (Low voltage-Low resistance)	• “Lg/R” circuit open or shorted to power. • “B/Bl” circuit open • IAT sensor malfunction • ECM malfunction

NOTE:
- **When DTC P0105 (No.11), P0110 (No.18), P046, P0115 (No.19) and P0120 (No.13) are indicated together, it is possible that “B/Bl” circuit is open.**
- **Before inspecting, be sure to check that ambient temperature is higher than –40 °C (–40 °F).**

DTC CONFIRMATION PROCEDURE

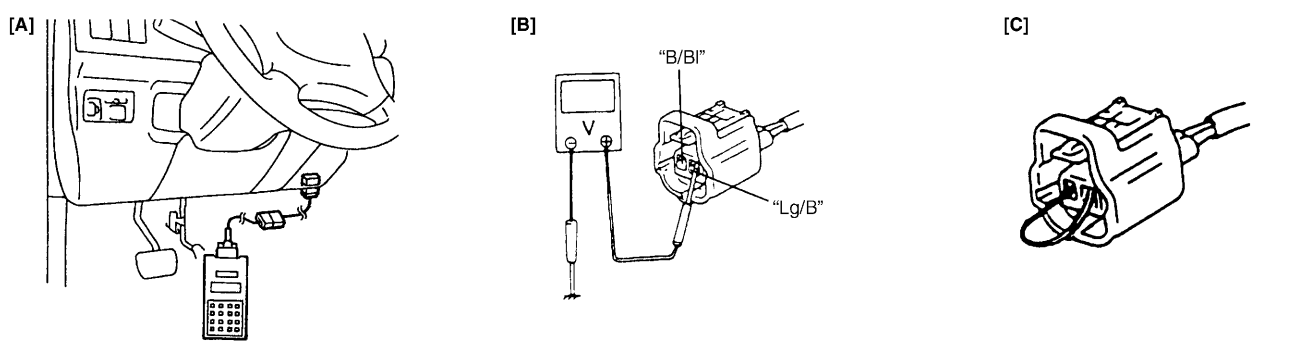
1) Clear DTC, start engine and keep it at idle for 1 min.
2) Select “DTC” mode no scan tool and check DTC.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Check IAT Sensor and Its Circuit. 1) Connect scan tool to DLC with ignition switch OFF. See Fig. 1. 2) Turn ignition switch ON. 3) Check intake air temp. displayed on scan tool. Is –40 °C (–40 °F) or 119 °C (246 °F) indicated?	Go to Step 3.	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.

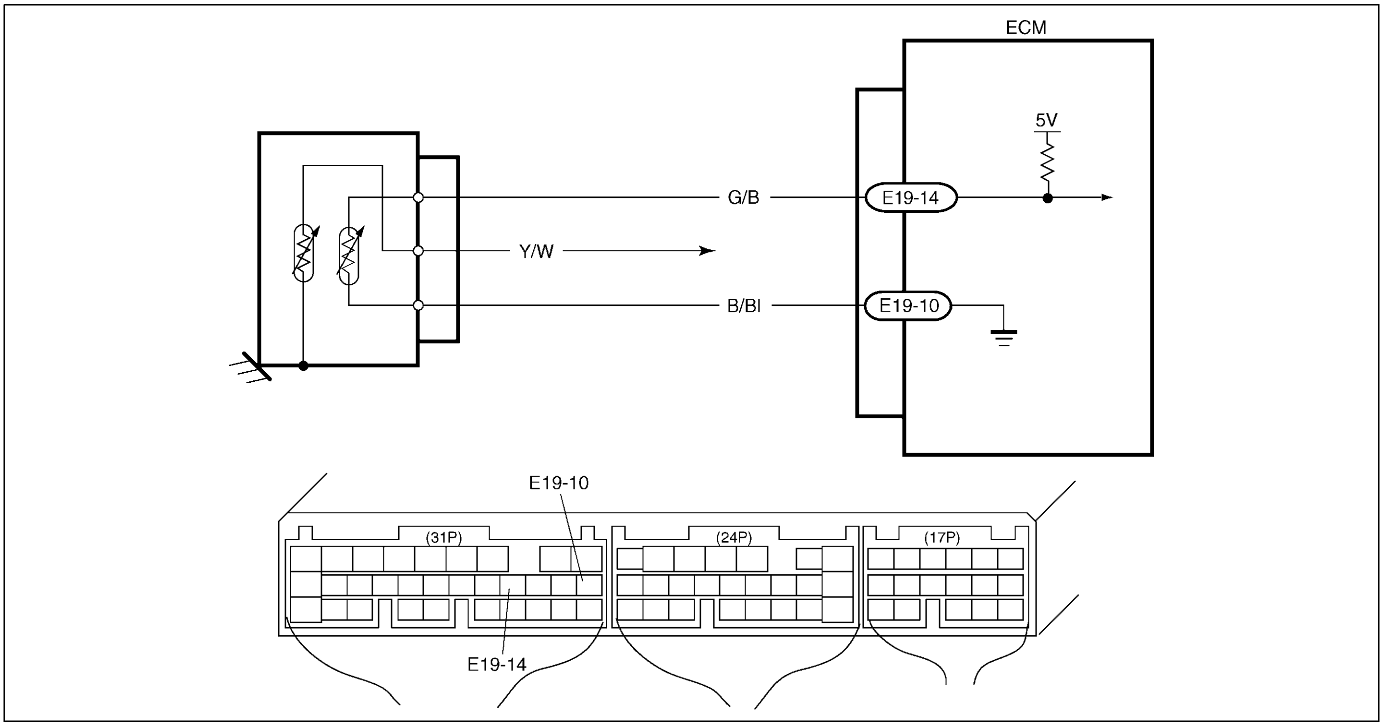
Step	Action	Yes	No
3	Check Wire Harness. 1) Disconnect IAT sensor connector with ignition switch OFF. 2) Check for proper connection to IAT sensor at “Lg/B” and “B/Bl” wire terminals. See Fig. 2. 3) If OK, then with ignition switch ON. Is voltage applied to “Lg/B” wire terminal about 4 – 6 V?	Go to Step 5.	“Lg/B” wire open or shorted to power, or poor E19-15 connection. If wire and connection are OK, substitute a known-good ECM and recheck.
4	Does scan tool indicate –40 °C (–40 °F) at Step 2.	Go to Step 6.	Go to Step 5.
5	Check Wire Harness 1) Check intake air temp. displayed on scan tool with ignition switch ON. Is –40 °C (–40 °F) indicated?	Replace IAT sensor.	“Lg/B” wire shorted to ground. If wire is OK, substitute a known-good ECM and recheck.
6	Check Wire Harness. 1) Using service wire, connect IAT sensor connector terminals. 2) Check intake air temp. displayed on scan tool with ignition switch ON. See Fig. 3. Is 119 °C (246 °F) indicated?	Replace IAT sensor.	“Lg/B” wire open or poor E19-10 connection. If wire and connection are OK, substitute a known-good ECM and recheck.

[A] Fig. 1 for Step 2 / [B] Fig. 2 for Step 3 / [C] Fig. 3 for Step 6



DTC P0115 (DTC No.19) Engine Coolant Temperature (ECT) Circuit Malfunction

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
• Low engine coolant temperature (High voltage-High resistance) • High engine coolant temperature (Low voltage-Low resistance)	• "G/B" circuit open or shorted to power • "B/Bl" circuit open • ECT sensor malfunction • ECM malfunction

NOTE:
- **When DTC P0105 (No.11), P0110 (No.18), P0115 (No.19), P0120 (No.13) and P0460 are indicated together, it is possible that "B/Bl" circuit is open.**
- **Before inspecting, be sure to check that coolant temp. meter in combination meter indicates normal operating temperature (Engine is not overheating).**
- **When this DTC and P1709 are stored together, also clear DTC stored in TCM after completion of repair.**

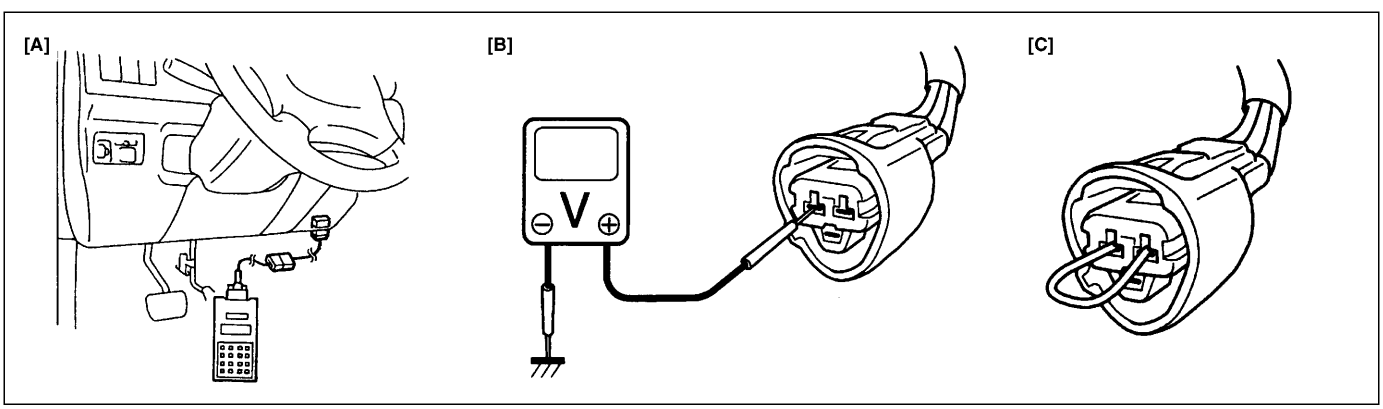
DTC CONFIRMATION PROCEDURE

1) Clear DTC, start engine and keep it at idle for 1 min.
2) Select "DTC" mode on scan tool and check DTC.

INSPECTION

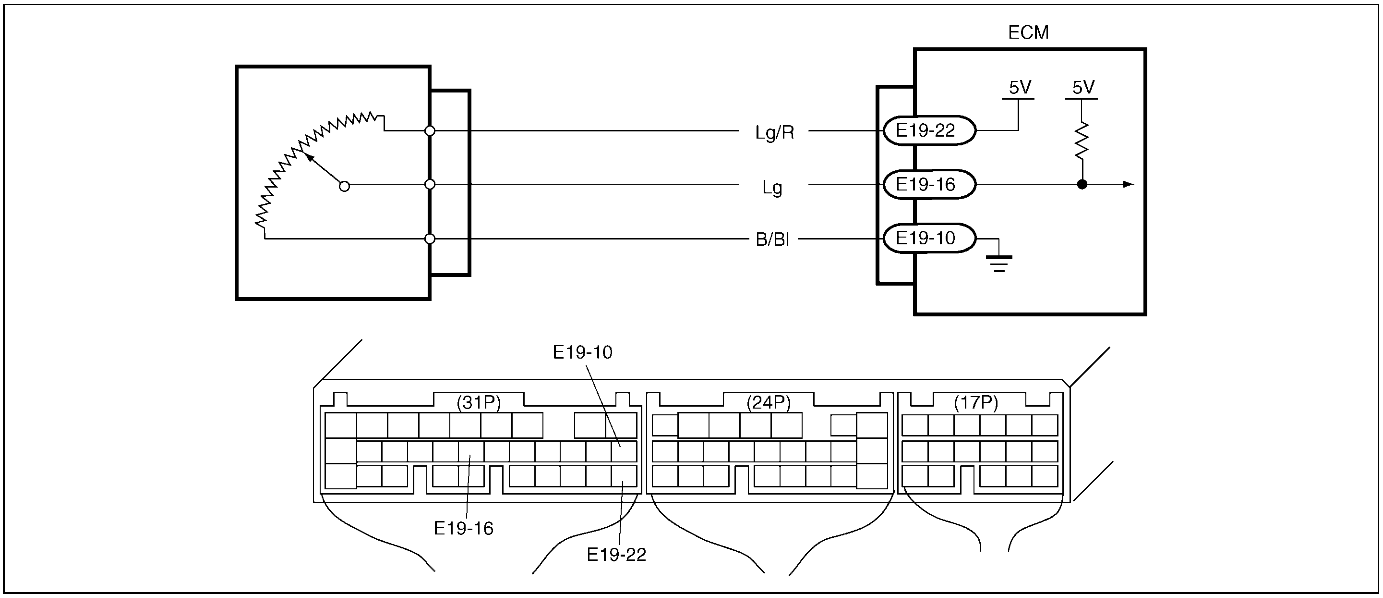
Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Check ECT Sensor and Its Circuit. 1) Connect scan tool with ignition switch OFF. See Fig. 1. 2) Turn ignition switch ON. 3) Check engine coolant temp. displayed on scan tool. Is –40 °C (–40 °F) or 119 °C (246 °F) indicated?	Go to Step 3.	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.
3	Check Wire Harness. 1) Disconnect ECT sensor connector. 2) Check engine coolant temp. displayed on scan tool. Is –40 °C (–40 °F) indicated?	Replace ECT sensor.	“G/B” wire shorted to ground. If wire is OK, substitute a known-good ECM and recheck.
4	Does scan tool indicate –40 °C (–40 °F) at Step 2.	Go to Step 6.	Go to Step 5.
5	Check Wire Harness. 1) Disconnect ECT sensor connector with ignition switch OFF. 2) Check for proper connection to ECT sensor at “B/Bl” and “G/B” wire terminals. See Fig. 2. 3) If OK, then with ignition switch ON. Is voltage applied to “B/Bl” wire terminal about 4 – 6 V?	Go to Step 4.	“G/B” wire open or shorted to power, or poor E19-14 connection. If wire and connection are OK, substitute a known-good ECM and recheck.
6	Check Wire Harness. 1) Using service wire, connect ECT sensor connector terminals. See Fig. 3. 2) Turn ignition switch ON and check engine coolant temp. displayed on scan tool. Is 119 °C (246 °F) indicated?	Replace ECT sensor.	“B/Bl” wire open or poor E19-10 connection. If wire and connection are OK, substitute a known-good ECM and recheck.

[A] Fig. 1 for Step 2 / [B] Fig. 2 for Step 5 / [C] Fig. 3 for Step 6



DTC P0120 (DTC No.13) Throttle Position Circuit Malfunction

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
• Signal voltage high • Signal voltage low	• "B/Bl" circuit open • "Lg" circuit open or shorted to ground • "B/Bl" circuit open or shorted to power or ground • TP sensor malfunction • ECM malfunction

NOTE:

- **When DTC P0105 (No.11), P0110 (No.18), P0115 (No.19), P0120 (No.13) and/or P0460 are indicated together, it is possible that "B/Bl" or "Lg/R" circuit is open.**
- **When this DTC and P1700 are stored together, also clear DTC stored in TCM after completion of repair.**

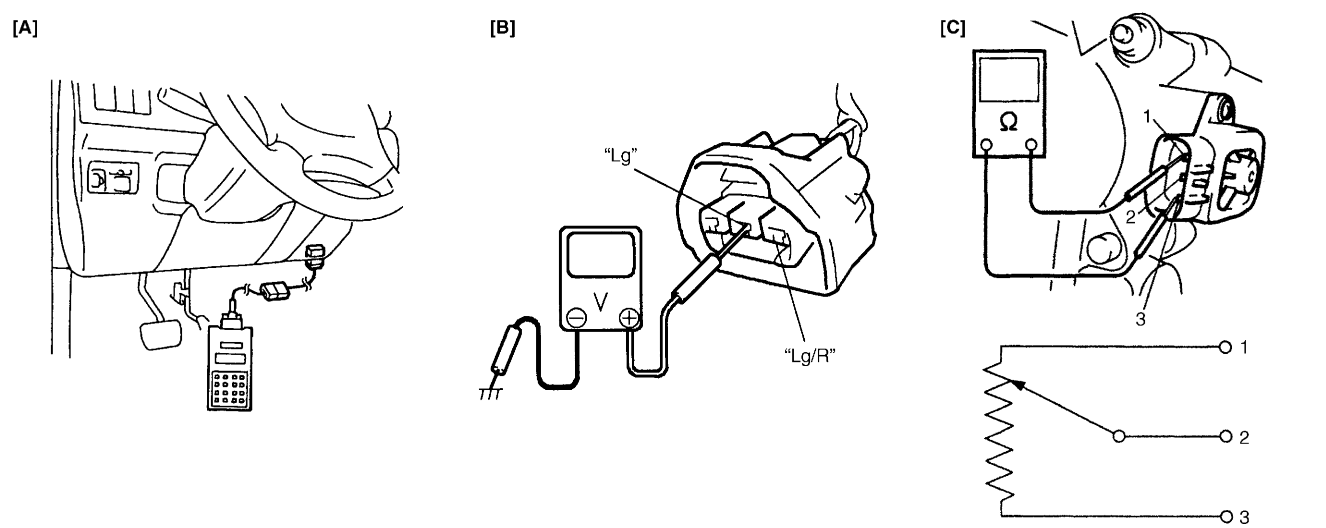
DTC CONFIRMATION PROCEDURE

1) Clear DTC, start engine and keep it at idle for 1 min.
2) Select "DTC" mode on scan tool and check DTC.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Check TP Sensor and Its Circuit. 1) Connect scan tool to DLC with ignition switch OFF and then turn ignition switch ON. See Fig. 1. 2) Check throttle valve opening percentage displayed on scan tool. Is it displayed 0% or 100%?	Go to Step 3.	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.
3	Check Wire Harness. 1) Disconnect connector from TP sensor with ignition switch OFF. 2) Check for proper connection to TP sensor at “Lg/R”, “Lg” and “B/Bl” wire terminal. 3) If OK, then with ignition switch ON, check voltage at each of “Lg/R” and “Lg” wire terminals and body ground. See Fig. 2. Is voltage about 4 – 6 V at each terminal?	Go to Step 4.	“Lg/R” wire open, “Lg/R” wire shorted to ground circuit or power circuit or “B/Bl” wire, “Lg” wire open or shorted to ground circuit or poor E19-22 or E19-16 connection. If wire and connection are OK, substitute a known-good ECM and recheck.
4	Check TP Sensor. 1) Check resistance between terminals of TP sensor. See Fig. 3. **TP sensor resistance** **Between 1 and 3 : 4.0 – 6.0 kΩ** **Between 2 and 3 : Varying according to throttle valve opening (0.02 – 6.0 kΩ)** Are measured values within specifications?	“B/Bl” wire open or poor E19-10 connection. If wire and connection are OK, substitute a known-good ECM and recheck.	Replace TP sensor.

[A] Fig. 1 for Step 2 / [B] Fig. 2 for Step 3 / [C] Fig. 3 for Step 4



DTC P0121 Throttle Position Circuit Range / Performance Problem

WIRING DIAGRAM

Refer to DTC P0120 section.

CIRCUIT DESCRIPTION

DTC DETECTING CONDITION	POSSIBLE CAUSE
• After engine warmed up. • Difference between actual throttle opening (detected from TP sensor) and opening calculated by ECM (Obtained on the basis of engine speed and intake manifold pressure) in larger than specified value. ✱2 driving cycle detection logic, continuous monitoring	• TP sensor malfunction • High resistance in the circuit • ECM malfunction

DTC CONFIRMATION PROCEDURE

WARNING:

- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester, on a level road.**

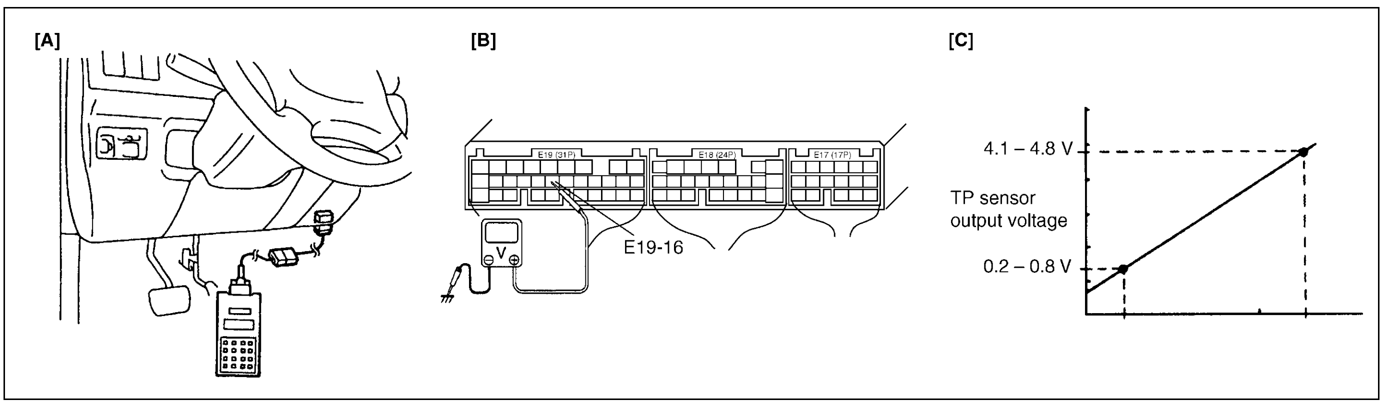
1) Turn ignition switch OFF. Clear DTC with ignition switch ON, check vehicle and environmental condition for :
   – Altitude (barometric pressure) : 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)
   – Ambient temp. : –10 °C, 14 °F or higher
   – Intake air temp. : 70 °C, 158 °F or lower
   – Engine coolant temp. : 70 °C, 158 °F or higher
2) Warm up engine to normal operating temperature.
3) Increase vehicle speed to 30 – 40 mph, 50 – 60 km/h in 3rd gear or “D” range and hold throttle valve at that opening position for 1 min.
4) Stop vehicle.
5) Check DTC in “DTC” mode and pending DTC in “ON BOARD TEST” or “PENDING DTC” mode.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Is SUZUKI scan tool available?	Go to Step 3.	Go to Step 4.
3	Check TP Sensor and Its Circuit. 1) Turn ignition switch OFF and connect SUZUKI scan tool to DLC. See Fig. 1. 2) Turn ignition switch ON and check TP sensor output voltage when throttle valve is at idle position and fully opened. See Fig. 3. Dose voltage vary within specified value linearly as shown in figure?	Substitute a known-good ECM and recheck.	Go to Step 5.

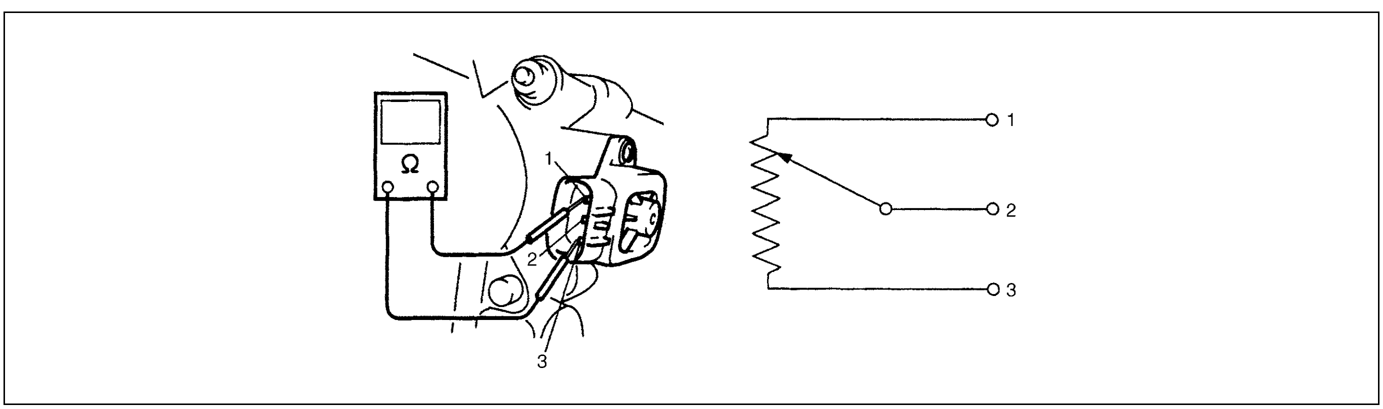
Step	Action	Yes	No
4	Check TP Sensor and its Circuit. 1) Turn ignition switch ON. 2) Check voltage at terminal E19-16 of ECM connector connected, when throttle valve is at idle position and fully opened. See Fig. 2 and 3. Dose voltage vary within specified value linearly as shown in figure?	If voltmeter was used, check terminal E19-16 for poor connection. If OK, substitute a known-good ECM and recheck.	Go to Step 5.
5	Check TP Sensor. 1) Turn ignition switch OFF. 2) Disconnect TP sensor connector. 3) Check for proper connection to TP sensor at each terminal. 4) If OK, then measure resistance between terminals and check if each measured value is as specified below. See Fig. 4. **TP sensor resistance** **Between 1 and 2 : 4.0 – 6.0 kΩ** **Between 1 and 3 : 0.02 – 6.0 kΩ, varying according to throttle valve opening.** Are measured values as specified?	High resistance in “Lg/R”, “Lg” or “B/Bl” circuit. If wire and connection are OK, substitute a known-good ECM and recheck.	Replace TP sensor.

[A] Fig. 1 for Step 3 / [B] Fig. 2 for Step 4 / [C] Fig. 3 for Step 3 and 4



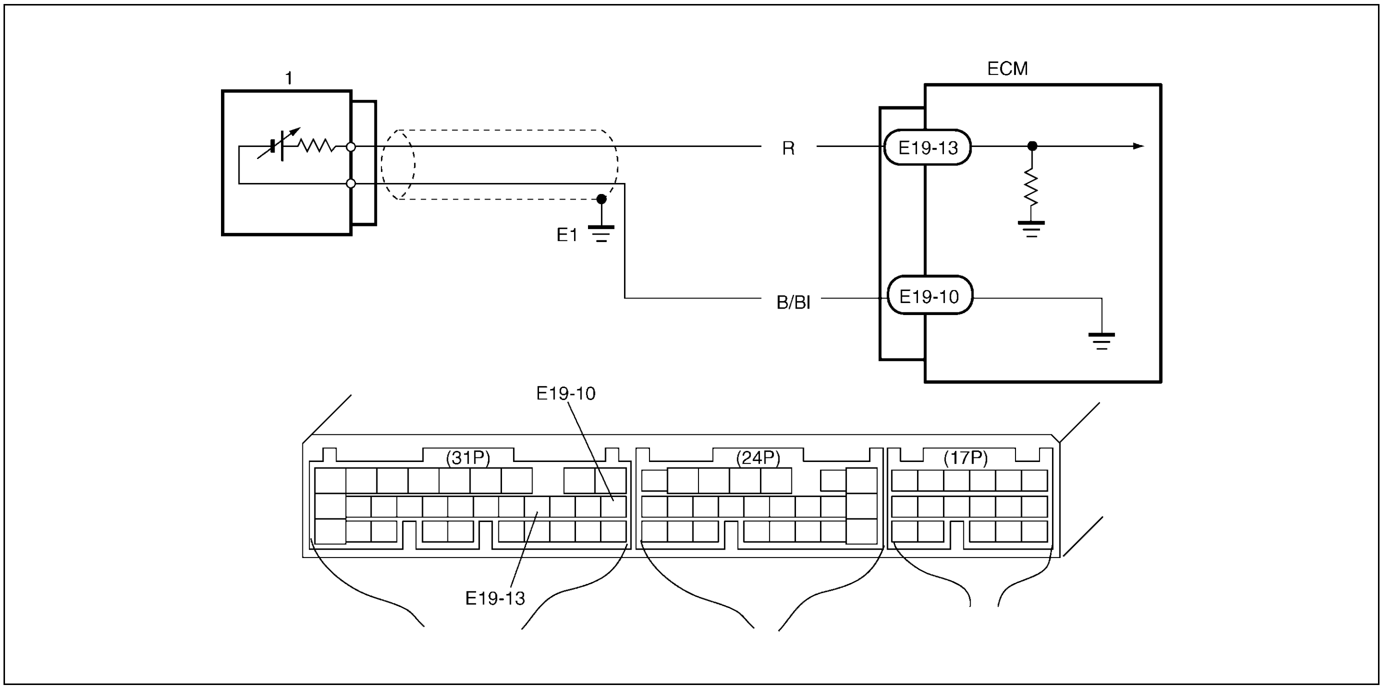
[A] :	When using SUZUKI scan tool.
[B] :	When not using SUZUKI scan tool.

Fig. 4 for Step 5



DTC P0130 (DTC No.14) Heated Oxygen Sensor (HO2S) Circuit Malfunction (Sensor-1)

CIRCUIT DESCRIPTION



1. Heated oxygen sensor-1 (HO2S-1)

DTC DETECTING CONDITION	POSSIBLE CAUSE
• When running at idle speed after engine warmed up and running at specified vehicle speed, HO2S-1 output voltage does not go below 0.3 V or over 0.6 V. ✱2 driving cycle detection logic, Monitoring once / 1 driving.	• Heated oxygen sensor-1 malfunction • “B/BI” or “R” circuit open (poor connection) or short

DTC CONFIRMATION PROCEDURE

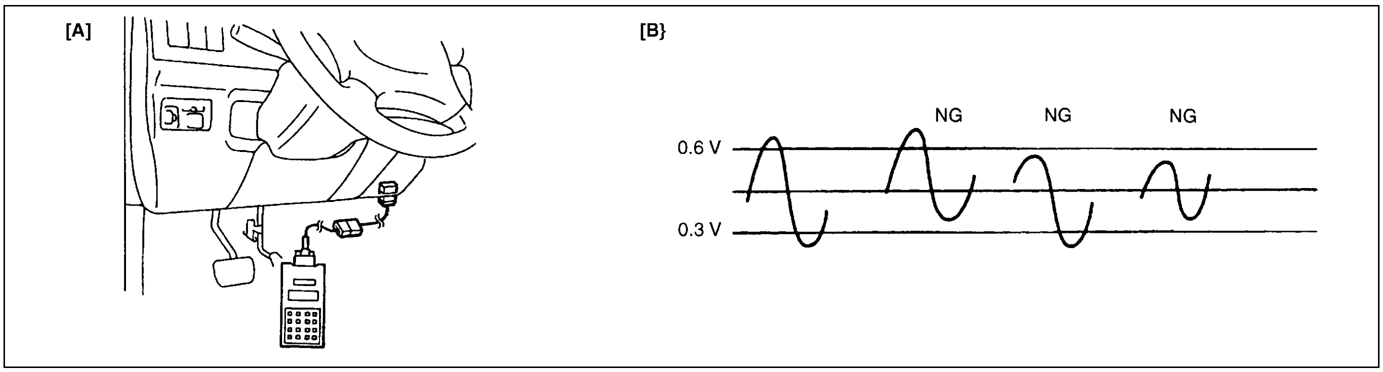
WARNING:
- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester.**

1) Turn ignition switch OFF. Clear DTC with ignition switch ON, check vehicle and environmental condition for :
   - Altitude (barometric pressure) : 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)
   - Ambient temp. : –10 °C, 14 °F or higher
   - Intake air temp. : 70 °C, 158 °F or lower
2) Warm up engine to normal operating temperature.
3) Drive vehicle at 30 – 40 mph, 50 – 60 km/h for 2 min.
4) Stop vehicle and run engine at idle for 2 min.
5) Check DTC in “DTC” mode and pending DTC in “ON BOARD TEST” or “PENDING DTC” mode.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “ENGINE DIAG. FLOW TABLE”.
2	Is there DTC(s) other than HO2S-1 (DTC P0130)?	Go to applicable DTC Diag. Flow Table.	Go to Step 3.
3	1) Connect scan tool to DLC with ignition switch OFF. See Fig. 1. 2) Warm up engine to normal operating temperature and keep it at 2000 r/min. for 60 sec. 3) Repeat racing engine (Repeat depressing accelerator pedal 5 to 6 times continuously and take foot off from pedal to enrich and enlean A/F mixture). See Fig. 2. Does HO2S-1 output voltage deflect between 0.3 V and over 0.6 V repeatedly?	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.	Check “R” and “B/Bl” wires for open and short, and connections for poor connection. If wires and connections are OK, replace HO2S-1.

[A] Fig. 1 for Step 3 / [B] Fig. 2 for Step 3



DTC P0133 Heated Oxygen Sensor (HO2S) Circuit Slow Response (Sensor-1)

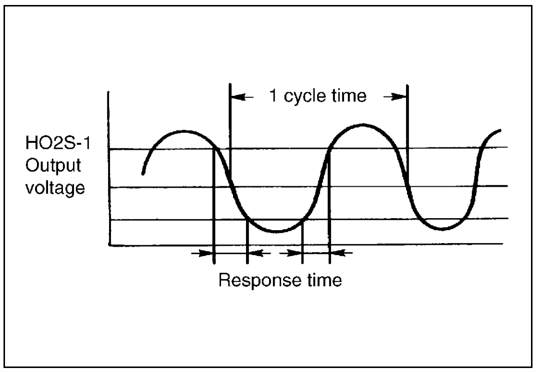
WIRING DIAGRAM

Refer to DTC P0130 section.

CIRCUIT DESCRIPTION

DTC DETECTING CONDITION	POSSIBLE CAUSE
• When running at specified idle speed after engine warmed up and running at specified vehicle speed, response time (time to change from lean to rich or from rich to lean) of HO2S-1 output voltage is about 1 sec. at minimum or average time of 1 cycle is 5 sec. at minimum. See. Fig. 1 ✱2 driving cycle detection logic, Monitoring once / 1 driving.	• Heated oxygen sensor-1 malfunction

Fig. 1



DTC CONFIRMATION PROCEDURE

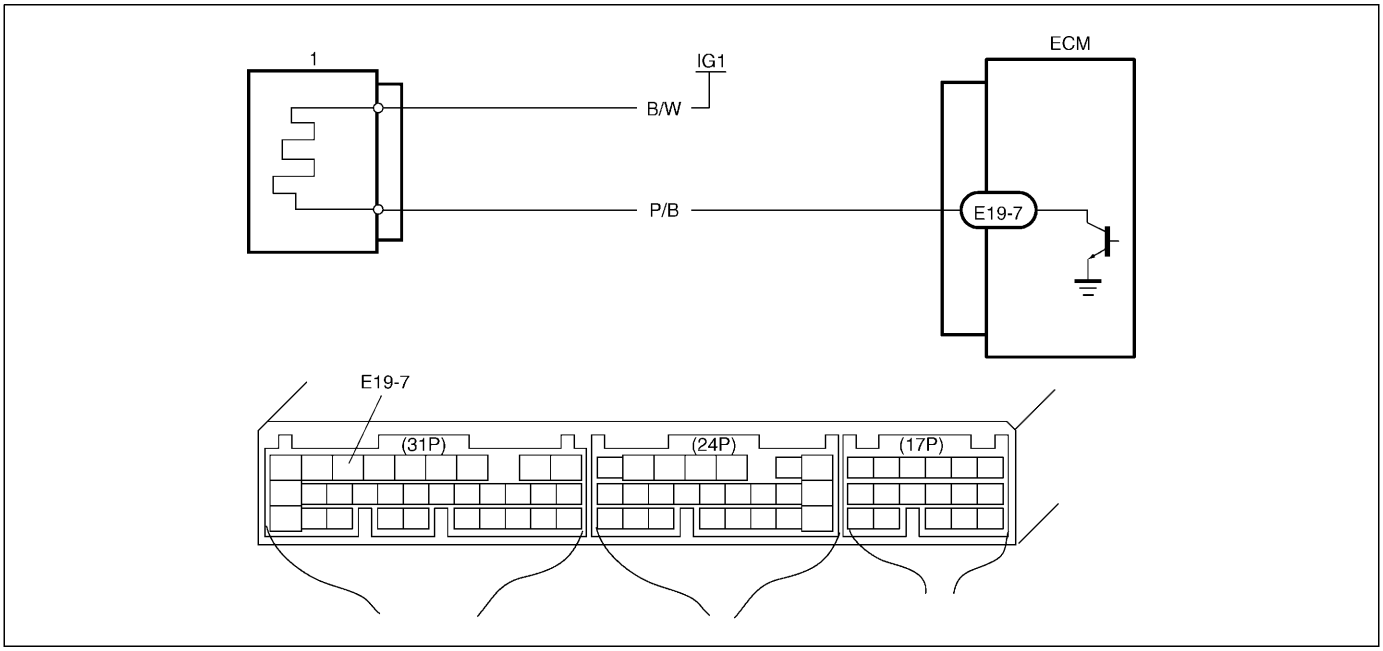
Refer to DTC P0130 section.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Is there DTC(s) other than HO2S-1 (DTC P0133)?	Go to applicable DTC Diag. Flow Table.	Replace HO2S-1.

DTC P0135 (DTC No.14) Heated Oxygen Sensor (HO2S) Heater Circuit Malfunction (Sensor-1)

CIRCUIT DESCRIPTION



1. Heated oxygen sensor-1 (HO2S-1) heater

DTC DETECTING CONDITION	POSSIBLE CAUSE
DTC will set when A or B condition is met. A : • Low voltage at terminal E19-7 when engine is running at high load. B : • High voltage at terminal E19-7 when engine is running under condition other than above. ✱2 driving cycle detection logic, Continuous monitoring.	• HO2S-1 heater circuit open or shorted to ground • ECM malfunction

DTC CONFIRMATION PROCEDURE

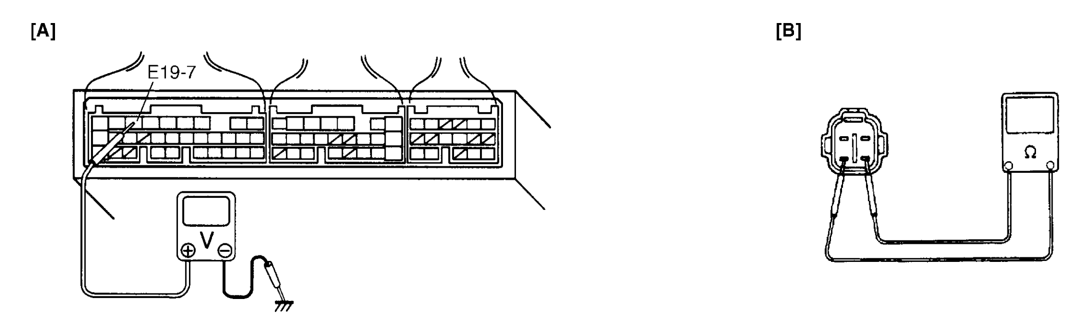
WARNING:
- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester.**

1) Turn ignition switch OFF.
2) Clear DTC with ignition switch ON, start engine and keep it at idle for 1 min.
3) Start vehicle and depress accelerator pedal fully for 5 sec. or longer.
4) Stop vehicle.
5) Check DTC in “DTC” mode and pending DTC in “ON BOARD TEST” or “PENDING DTC” mode.

INSPECTION

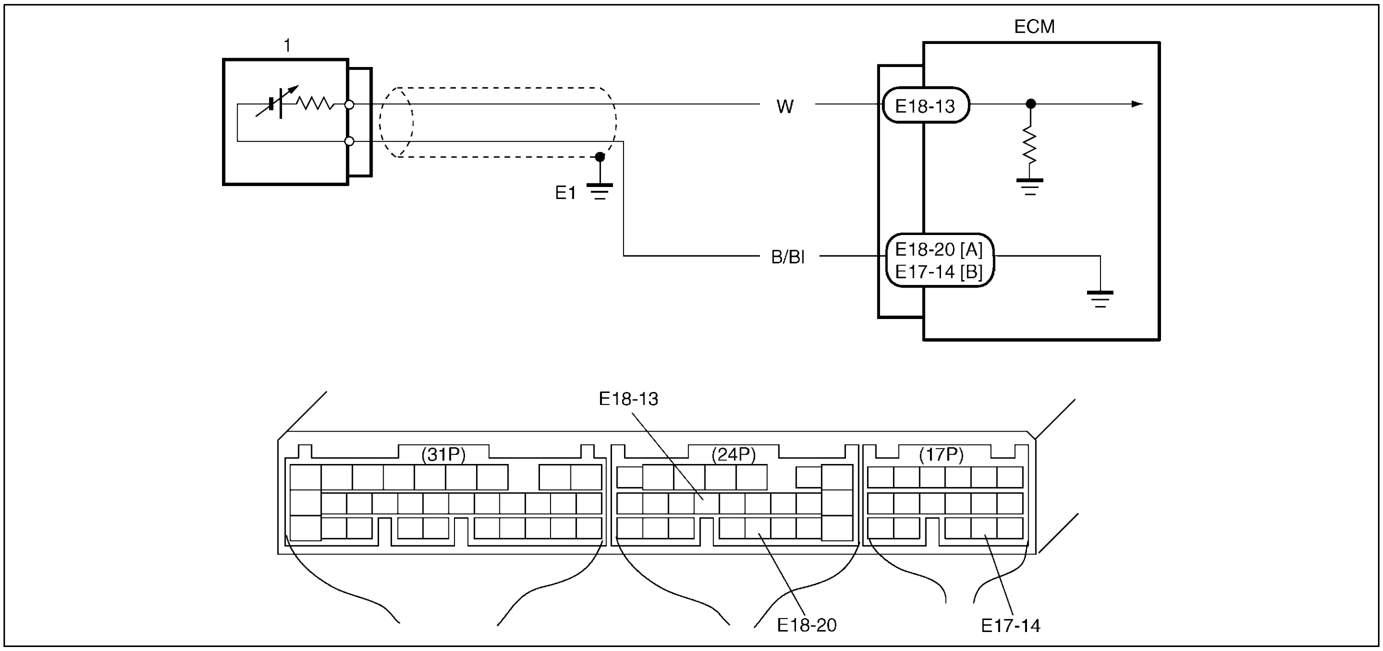
Step	Action	Yes	No
1	Was "Engine Diag. Flow Table" performed?	Go to Step 2.	Go to "Engine Diag. Flow Table".
2	Check Heater for Operation. 1) Check voltage at terminal E19-7. See Fig. 1. 2) Warm up engine to normal operating temperature. 3) Stop engine. 4) Turn ignition switch ON and Check voltage at terminal E19-7. See Fig. 1. Voltage should be over 10 V. 5) Start engine, run it at idle and check voltage at the same terminal. Voltage should be below 1.9 V. Are check results are specified?	Intermittent trouble Check for intermittent referring to "Intermittent and Poor Connection" in Section 0A.	Go to Step 3.
3	Check Heater of Sensor-1. 1) Disconnect HO2S-1 coupler with ignition switch OFF. 2) Check for proper connection to HO2S-1 at "B/W" and "P/B" wire terminals. 3) If OK, then check heater resistance. See Fig. 2. Is it 5 – 6.4 Ω at 20 °C, 68 °F?	"P/B" wire open or shorted to ground or poor connection at E19-7. If wire and connection are OK, substitute a known-good ECM and recheck.	Replace HO2S-1.

[A] Fig. 1 for Step 2 / [B] Fig. 2 for Step 3



DTC P0136 Heated Oxygen Sensor (HO2S) Circuit Malfunction (Sensor-2)

CIRCUIT DESCRIPTION



1. Heated oxygen sensor-2 (HO2S-2)	[A] : Case of TYPE A is shown (See NOTE)	[B] : Case of TYPE B is shown (See NOTE)

NOTE:

For TYPE A and TYPE B, refer to the NOTE in "ECM Terminal Voltage Values Table" for applicable model.

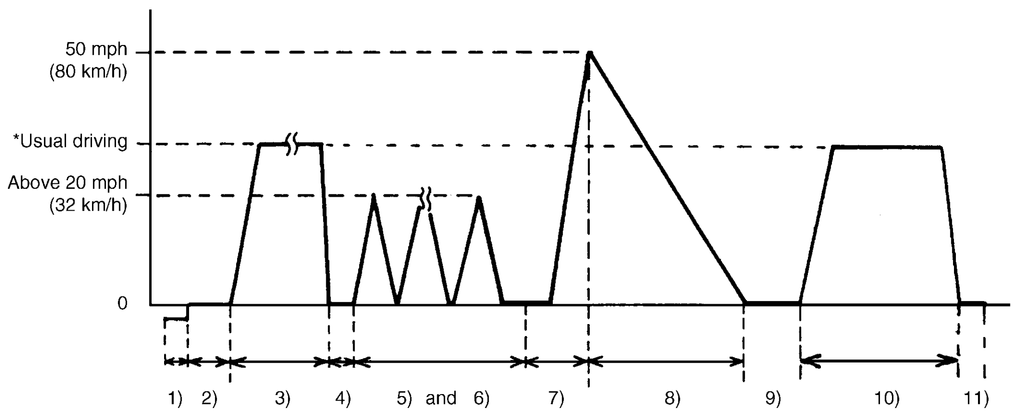
DTC DETECTING CONDITION	POSSIBLE CAUSE
Engine is warmed up and HO2S-2 voltage is 4.5 V or more. (circuit open) ✱2 driving cycle detection logic, monitoring once / 1 driving.	• Exhaust gas leakage • "W" or "B/Bl" circuit open or short • Heated oxygen sensor-2 malfunction • Fuel system malfunction

DTC CONFIRMATION PROCEDURE

WARNING:
- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester, on a level road.**

1) Turn ignition switch OFF.
   Clear DTC with ignition switch ON, check vehicle and environmental condition for :
   – Altitude (barometric pressure) : 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)
   – Ambient temp. : –10 °C, 14 °F or higher
   – Intake air temp. : 70 °C, 158 °F or lower
   – No exhaust gas leakage and loose connection
2) Warm up engine to normal operating temperature.
3) Drive vehicle under usual driving condition for 5 min. and check HO2S-2 output voltage and "short term fuel trim" with "Data List" mode on scan tool, and write it down.
4) Stop vehicle (don't turn ignition switch OFF).
5) Increase vehicle speed to higher than 20 mph, 32 km/h and then stop vehicle.

6) Repeat above steps 5) 4 times.
7) Increase vehicle speed to about 50 mph (80 km/h) in 3rd gear or 2 range.
8) Release accelerator pedal and with engine brake applied, keep vehicle coasting (fuel cut condition) for 10sec. or more.
9) Stop vehicle (don't turn ignition switch OFF) and run engine at idle for 2 min. After this step 9), if "Oxygen Sensor Monitoring TEST COMPLETED" is displayed in "READINESS TESTS" mode and DTC is not displayed in "DTC" mode, confirmation test is completed.
   If "TEST NOT COMPLTD" is still being displayed, proceed to next step 10).
10) Drive vehicle under usual driving condition for 10 min. (or vehicle is at a stop and run engine at idle for 10 min. or longer)
11) Stop vehicle (don't turn ignition switch OFF). Confirm test results according to "Test Result Confirmation Flow Table" in "DTC CONFIRMATION PROCEDURE" of DTC P0420.



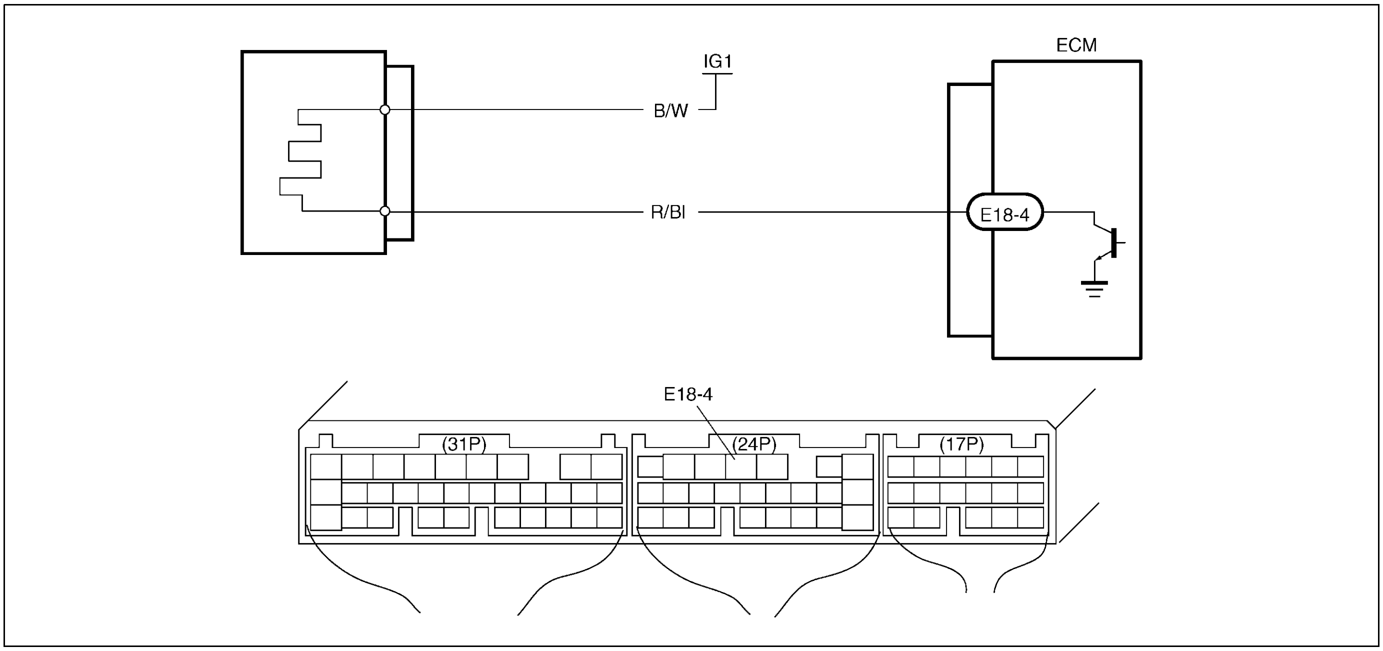
*Usual driving : Driving at 30 – 40 mph, 50 – 60 km/h including short stop according to traffic signal. (under driving condition other than high-load, high-engine speed, rapid accelerating and decelerating)

INSPECTION

Step	Action	Yes	No
1	Was "Engine Diag. Flow Table" performed?	Go to Step 2.	Go to "Engine Diag. Flow Table".
2	Check exhaust system for leakage, loose connection and damage. Is it good condition?	Go to Step 3.	Repair or replace.
3	Check HO2S-2 and Its Circuit. Was HO2S-2 output voltage indicated on scan tool in step 3) of DTC confirmation test less than 1.275 V?	Go to Step 4.	"B/Bl" or "W" circuit open or HO2S-2 malfunction.
4	Check Short Term Fuel Trim. Did short term fuel trim very within –20 – + 20% range in step 3) of DTC confirmation test?	Check "W" and "B/Bl" wire for open and short, and connection for poor connection. If wire and connection are OK, replace HO2S-2.	Check fuel system. Go to DTC P0171 / P0172 Diag. Flow Table.

DTC P0141 Heated Oxygen Sensor (HO2S) Heater Circuit Malfunction (Sensor-2)

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
DTC will set when A or B condition it met. 1) Low voltage at terminal E18-4 for specified time after engine start or while engine running at high load. 2) High voltage at terminal E18-4 while engine running under other than above condition. ✱2 driving cycle detection logic, continuous monitoring.	• HO2S-2 heater circuit open or shorted to ground • ECM malfunction

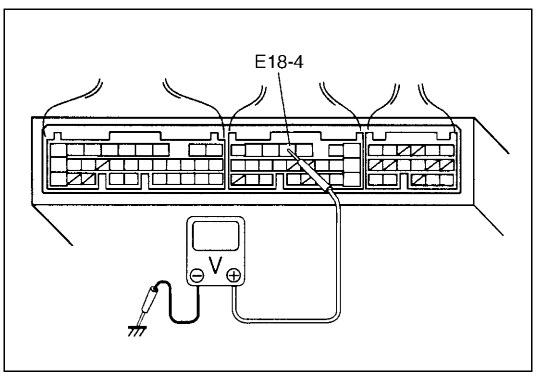
DTC CONFIRMATION PROCEDURE

1) Turn ignition switch OFF once and then ON.
2) Clear DTC, start engine and warm up engine to normal operating temperature.
3) Keep it at 2000 r/min for 2 min.
4) Check pending DTC in “ON BOARD TEST” or “PENDING DTC” mode and DTC in “DTC” mode.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Check HO2S-2 Heater and Its Circuit. 1) Warm up engine to normal operating temperature. 2) Stop engine. 3) Turn ignition switch ON and check voltage at terminal E18-4. See Fig. 1. Voltage should be over 10 V. 4) Start engine, run it at idle and check voltage at the same terminal after 1 min. from engine start. Voltage should be below 1.9 V. Are check result as specified?	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.	Go to Step 3.
3	Check Heater or Sensor-2. 1) Disconnect HO2S-2 coupler with ignition switch OFF. 2) Check for proper connection to HO2S-2 at “B/W” and “R/Bl” wire terminals. 3) If OK, then check heater for resistance. Is it 11.7 – 14.3 Ω at 20 °C, 68 °F?	“R/Bl” wire open or shorted to ground or poor connection at E18-4. If wire and connection are OK, substitute a known-good ECM and recheck.	Replace HO2S-2.

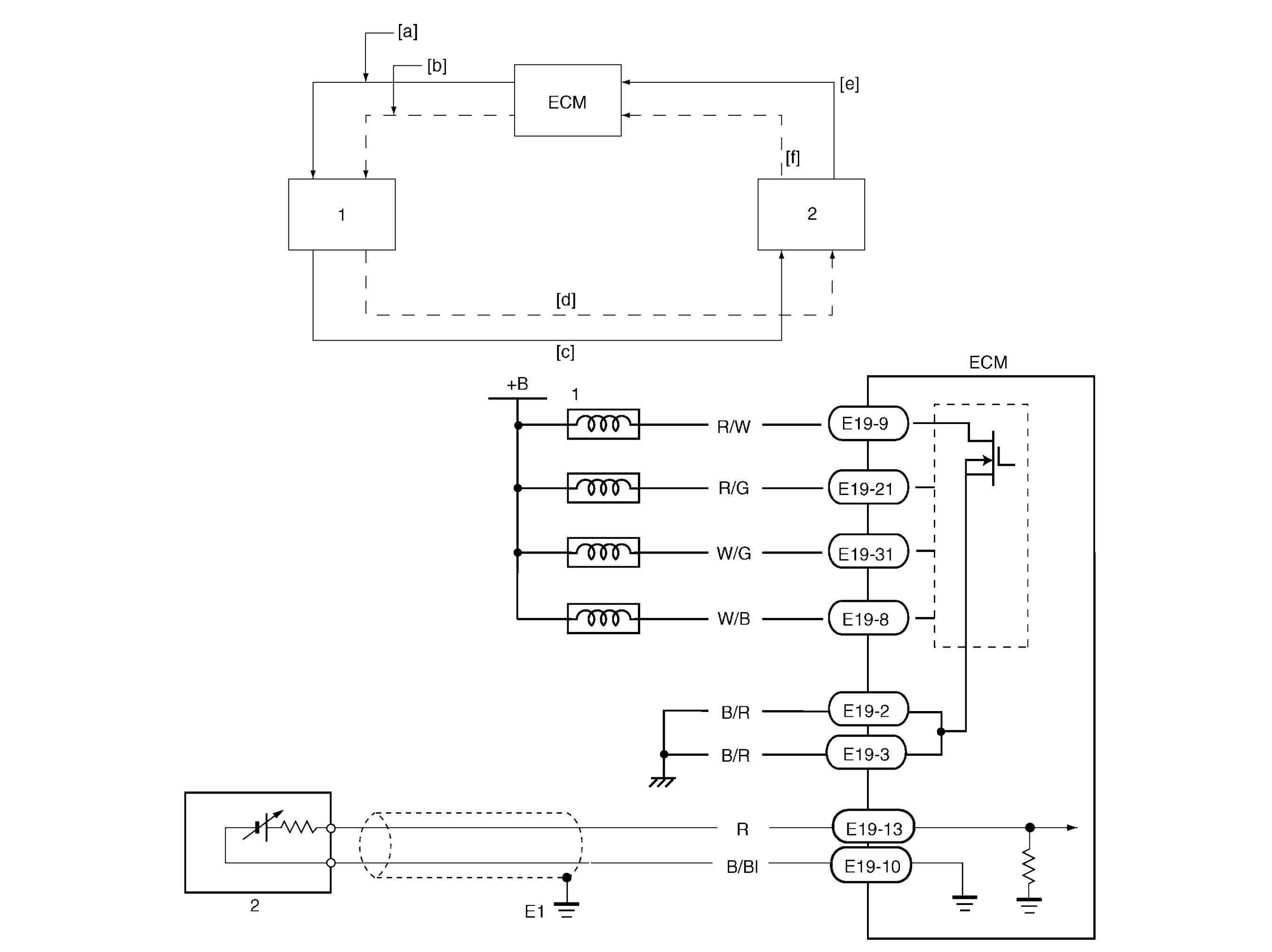
Fig. 1 for Step 2



DTC P0171 Fuel System Too Lean

DTC P0172 Fuel System Too Rich

CIRCUIT DESCRIPTION



[a] : Signal to decrease amount of fuel injection	[d] : A/F mixture becomes richer (Oxygen concentration decreases)	1. Injector
[b] : Signal to increase amount of fuel injection	[e] : High voltage	2. Heated oxygen sensor-1 (HO2S-1)
[c] : A/F mixture becomes leaner (Oxygen concentration increases)	[f] : Low voltage	

DTC DETECTING CONDITION	POSSIBLE CAUSE
• When following condition occurs while engine running under closed loop condition. – Air / fuel ratio too lean (Total fuel trim (short and long terms added) is more than 30%) or – Air / fuel ratio too rich (Total fuel trim is less than –30%) ✱2 driving cycle detection logic, continuous monitoring.	• Vacuum leaks (air drawn in). • Exhaust gas leakage. • Heated oxygen sensor-1 circuit malfunction. • Fuel pressure out of specification. • Fuel injector malfunction (clogged or leakage). • MAP sensor poor performance. • ECT sensor poor performance. • IAT sensor poor performance. • TP sensor poor performance. • EVAP control system malfunction. • PCV valve malfunction.

DTC CONFIRMATION PROCEDURE

WARNING:
- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester on a level road.**

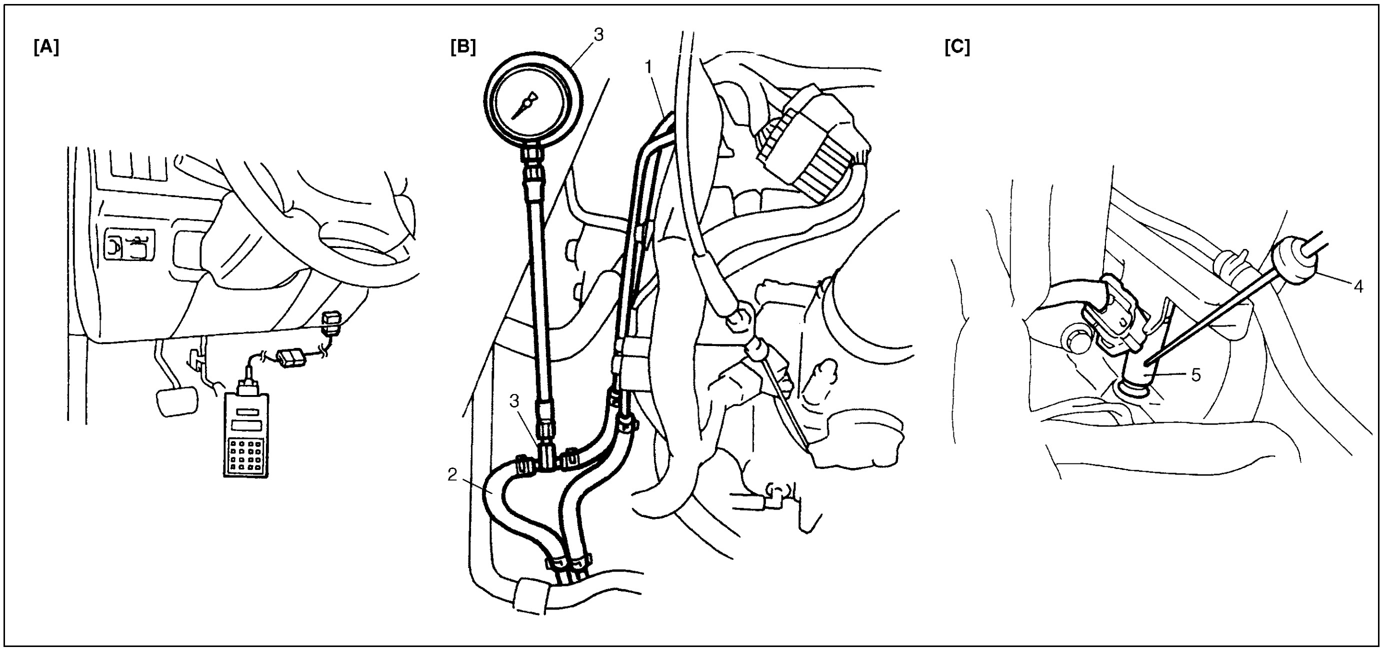
1) Turn ignition switch OFF.
2) Clear DTC with ignition switch ON.
3) Check vehicle and environmental condition for :
   – Altitude (barometric pressure) : 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)
   – Ambient temp. : –10 °C, 14 °F or higher
   – Intake air temp. : 70 °C, 158 °F or lower
4) Start engine and drive vehicle under usual driving condition (described in DTC confirmation procedure of DTC P0136) for 5 min. or longer and until engine is warmed up to normal operating temperature.
5) Keep vehicle speed at 30 – 40 mph, 50 – 60 km/h in 5th gear or “D” range for 5 min. or more.
6) Stop vehicle (do not turn ignition switch OFF).
7) Check pending DTC in “ON BOARD TEST” or “PENDING DTC” mode and DTC in “DTC” mode.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Is there DTC(s) other than fuel system (DTC P0171 / P0172)?	Go to applicable DTC Diag. Flow Table.	Go to Step 3.
3	Check HO2S-1 Output Voltage. 1) Connect scan tool to DLC with ignition switch OFF. See Fig. 1. 2) Warm up engine to normal operating temperature and keep it at 2000 r/min. for 60 sec. 3) Repeat racing engine (Repeat depressing accelerator pedal 5 to 6 times continuously and take foot off from pedal to enrich and enlean A/F mixture). Does HO2S-1 output voltage deflect between below 0.3 V and over 0.6 V repeatedly?	Go to Step 4.	Go to DTC P0130 Diag. Flow Table (HO2S-1 circuit check).
4	Check Fuel Pressure (Refer to Section 6E for details). 1) Release fuel pressure from fuel feed line. 2) Install fuel pressure gauge. See Fig. 2. 3) Check fuel pressure. **Fuel pressure specification** **With fuel pump operating and engine at stop :** **270 – 310 kPa, 2.7 – 3.1 kg/cm^2, 38.4 – 44.0 psi.** **At specified idle speed :** **210 – 260 kPa, 2.1 – 2.6 kg/cm^2, 29.8 – 37.0 psi.** Is measured value as specified?	Go to Step 5.	Go to Diag. Flow Table B-3 Fuel Pressure Check.

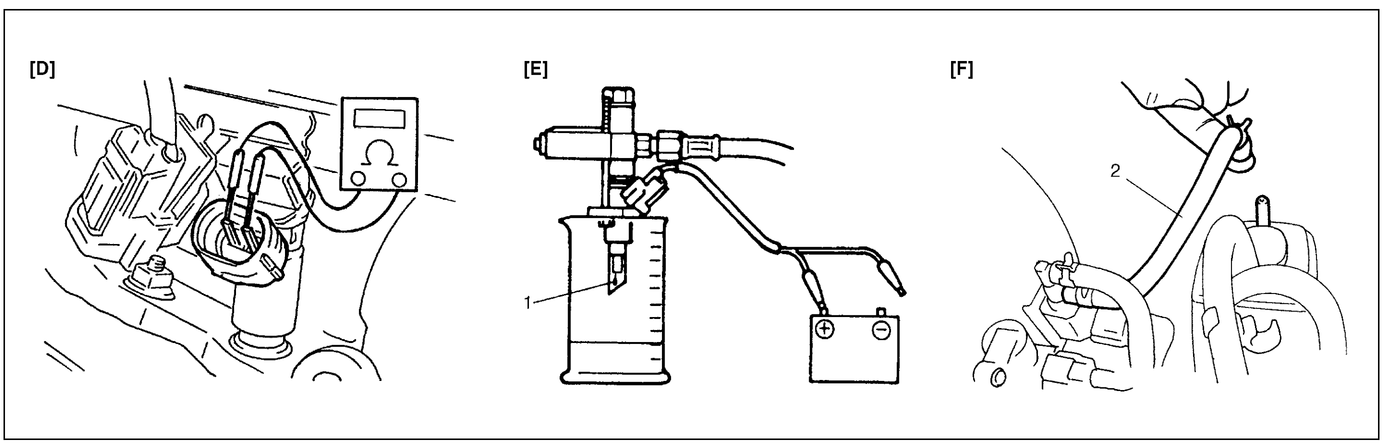
Step	Action	Yes	No
5	Check Fuel Injectors and Circuit. 1) Using sound scope (4) or such, check operating sound of each injector (5) when engine is running. Cycle of operating sound should vary according to engine speed. See Fig. 3. If no sound or an unusual sound is heard, check injector circuit (wire or coupler) or injector. 2) Turn ignition switch OFF and disconnect a fuel injector connector. 3) Check for proper connection to fuel injector at each terminal. 4) If OK, then check injector resistance. See Fig. 4. **Injector resistance** **11.3 – 13.8 ohm at 20 °C (68 °F)** 5) Carry out steps 1) and 3) on each injector. 6) Check each injector for injected fuel volume referring to Section 6E. See Fig. 5. **Injected fuel volume** **43 – 47 cc/15 sec (1.45/1.51 – 1.58/1.65 US/ Imp.oz/15 sec)** 7) Check each injector for fuel leakage after injector closed. **Fuel leakage** **Less than 1 drop / min. (1)** Is check result in step 1) and 3) to 7) satisfactory?	Go to Step 6.	Check injector circuit or replace fuel injector(s).
6	Check EVAP Canister Purge Valve. 1) Disconnect purge hose (2) from EVAP canister. 2) Place finger against the end of disconnected hose. 3) Check that vacuum is not felt there when engine is cool and running at idle. See Fig. 6. Is vacuum felt?	Check EVAP control system (See Section 6E).	Go to Step 7.
7	Check intake manifold absolute pressure sensor for performance (See step 4) of DTC P0105 (No.11) Diag. Flow Table). Is it in good condition?	Go to Step 8.	Repair or replace.
8	Check engine coolant temp. sensor for performance (See Section 6E). Is it in good condition?	Go to Step 9.	Replace engine coolant temp. sensor.
9	Check intake air temp. sensor for performance (See Section 6E). Is it in good condition?	Go to Step 10.	Replace intake air temp. sensor.
10	Check throttle position sensor for performance (See step 5) of DTC P0121 Diag. Flow Table). Is it in good condition?	Go to Step 11.	Replace throttle position sensor.
11	Check PCV valve for valve clogging (See Section 6E). Is it good condition?	Substitute a known-good ECM and recheck.	Replace PCV valve.

[A] Fig. 1 for Step 3 / [B] Fig. 2 for Step 4 / [C] Fig. 3 for Step 5

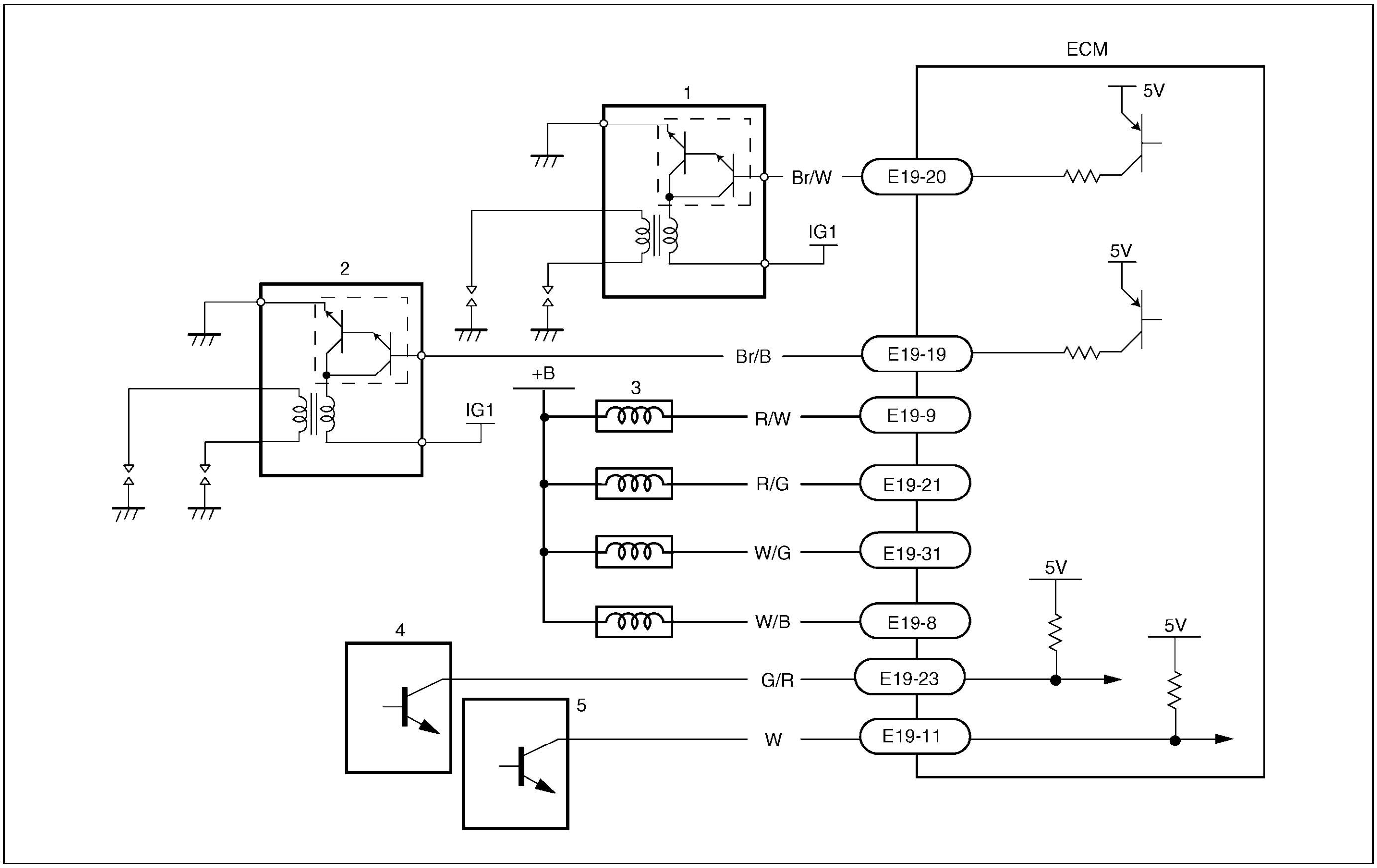


1.	Fuel delivery pipe
2.	Fuel feed hose
3.	Fuel pressure gauge & 3 way joint

[D] Fig. 4 for Step 5 / [E] Fig. 5 for Step 5 / [F] Fig. 6 for Step 6



DTC P0300 Random Misfire Detected (Misfire Detected at 2 or More Cylinders)
DTC P0301 Cylinder 1 Misfire Detected
DTC P0302 Cylinder 2 Misfire Detected
DTC P0303 Cylinder 3 Misfire Detected
DTC P0304 Cylinder 4 Misfire Detected



1.	Ignition coil assembly (for No.1 and No.4 cylinder)
2.	Ignition coil assembly (for No.2 and No.3 cylinder)
3.	Fuel injector
4.	CKP sensor
5.	CMP sensor

CIRCUIT DESCRIPTION

ECM monitors crankshaft revolution speed and engine speed via the crankshaft position sensor and cylinder No. via the camshaft position sensor. Then it calculates the change in the crankshaft revolution speed and from how many times such change occurred in every 200 or 1000 engine revolutions, it detects occurrence of misfire.

When ECM detects a misfire (misfire rate per 200 revolutions) which can cause overheat and damage to the three way catalytic converter, it makes the malfunction indicator lamp (MIL) flash as long as misfire occurs at that rate.

After that, however, when the misfire rate drops, MIL remains ON until it has been judged as normal 3 times under the same driving conditions.

Also, when ECM detects a misfire (misfire rate per 1000 revolutions) which will not cause damage to three way catalytic converter but can cause exhaust emission to be deteriorated, it makes MIL light according to the 2 driving cycle detection logic.

DTC DETECTING CONDITION	POSSIBLE CAUSE
• Engine under other than high revolution condition • Not on rough road • Engine speed changing rate (below specified value) • Manifold absolute pressure changing rate (below specified value) • Throttle opening changing rate (below specified value) • Misfire rate per 200 or 1000 engine revolutions (how much and how often crankshaft revolution speed changes) is higher than specified value	• Engine overheating • Vacuum leaks (air inhaling) from air intake system • Ignition system malfunction (spark plug(s), high-tension cord(s), ignition coil assembly) • Fuel pressure out of specification • Fuel injector malfunction (clogged or leakage) • Engine compression out of specification • Valve lash (clearance) out of specification • Manifold absolute pressure sensor malfunction • Engine coolant temp. sensor malfunction • PCV valve malfunction • EVAP control system malfunction • EGR system malfunction

DTC CONFIRMATION PROCEDURE

NOTE:

Among different types of random misfire, if misfire occurs at cylinders 1 and 4 or cylinders 3 and 2 simultaneously, it may not possible to reconfirm DTC by using the following DTC confirmation procedure. When diagnosing the trouble of DTC P0300 (Random misfire detected) of the engine which is apparently misfiring, even if DTC P0300 cannot be reconfirmed by using the following DTC confirmation procedure, proceed to the following Diag. Flow Table.

WARNING:

- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester.**

1) Turn ignition switch OFF.
2) Clear DTC with ignition switch ON.
3) Check vehicle and environmental condition for :
   – Altitude (barometric pressure) : 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)
   – Ambient temp. : –10 °C, 14 °F or higher
   – Intake air temp. : 70 °C, 158 °F or lower
   – Engine coolant temp. : – 10 – 110 °C, 14 – 230 °F
4) Start engine and keep it at idle for 2 min. or more.
5) Check DTC in “DTC” mode and pending DTC in “ON BOARD TEST” or “PENDING DTC” mode.
6) If DTC is not detected at idle, consult usual driving based on information obtained in “Customer complaint analysis” and “Freeze frame data check”.

INSPECTION

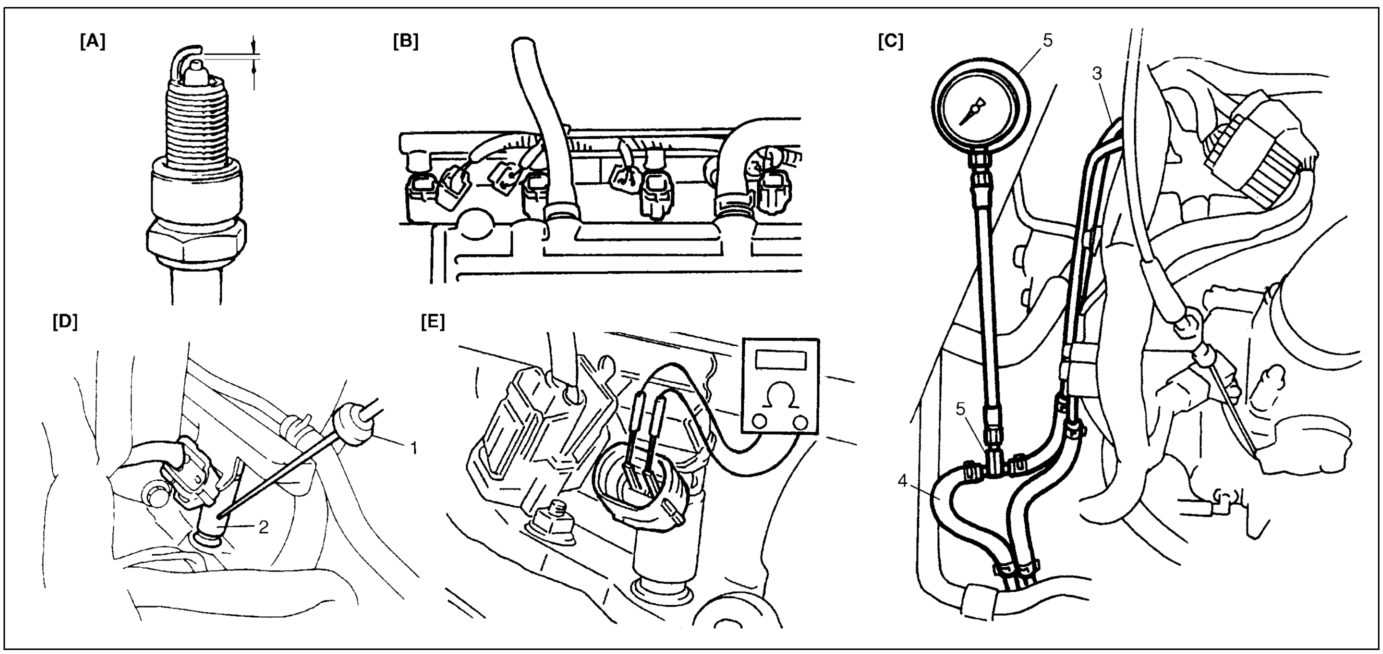
Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Is there DTC other than Fuel system (DTC P0171/ P0172) and misfire (DTC P0300 – P0304)?	Go to applicable DTC Diag. Flow Table.	Go to Step 3.

Step	Action	Yes	No
3	Check Ignition System. 1) Remove spark plugs and check them for; • Air gap : 1.0 – 1.1 mm (0.040 – 0.043 in.) See Fig. 1. • Carbon deposits / Insulator damage / Plug type If abnormality is found, adjust, clean or replace by referring to Section 6F. (See CAUTION) 2) Disconnect all injector connectors. See Fig. 2. 3) Connect spark plugs to high tension cords and then ground spark plugs. 4) Crank engine and check that each spark plug sparks. Are above check results satisfactory?	Go to Step 4.	Check ignition system parts (Refer to Section 6F).
4	Check Fuel Pressure (Refer to Section 6E for details). 1) Release fuel pressure from fuel feed line. 2) Install fuel pressure gauge. See Fig. 3. 3) Check fuel pressure. **Fuel pressure specification** **With fuel pump operating and engine at stop :** **270 – 310 kPa, 2.7 – 3.1 kg/cm^2, 38.4 – 44.0 psi.** **At specified idle speed :** **210 – 260 kPa, 2.1 – 2.6 kg/cm^2, 29.8 – 37.0 psi.** Is measured value as specified?	Go to Step 5.	Go to Diag. Flow Table B-3 fuel pressure check.
5	Check Fuel Injectors and Circuit. 1) sing sound scope (1) or such, check operating sound of each injector (2) when engine is running. Cycle of operating sound should very according to engine speed. See Fig 4. If no sound or an unusual sound is heard, check injector circuit (wire or coupler) or injector. 2) Turn ignition switch OFF and disconnect a fuel injector connector. 3) Check for proper connection to fuel injector at each terminal. 4) If OK, then check injector resistance. See Fig. 5. **Injector resistance** **11.3 – 13.8 ohm at 20 °C (68 °F)** 5) Carry out steps 1) and 3) on each injector. 6) Check each injector for injected fuel volume referring to Section 6E. See Fig. 6. **Injected fuel volume** **43 – 47 cc/15 sec (1.45/1.51 – 1.58/1.65 US/Imp. oz/ 15 sec)** 7) Check each injector for fuel leakage after injector closed. **Fuel leakage** **Less than 1 drop/min.** Is check result in step 1) and 3) to 7) satisfactory?	Go to Step 6.	Check injector circuit or replace fuel injector(s).
6	Check PCV valve for clogging (See Section 6E). Is it in good condition?	Go to Step 7.	Replace PCV valve.

Step	Action	Yes	No
7	Check EVAP Canister Purge Valve for Closing. 1) Disconnect purge hose (1) from EVAP canister. 2) Place finger against the end of disconnected hose. 3) Check that vacuum is not felt there, when engine is cool and running at idle. See Fig. 7. Is vacuum felt?	Check EVAP control system (See Section 6E).	Go to Step 8.
8	Check manifold absolute pressure sensor for performance (See step 4) DTC P0105 Diag. Flow Table). Is it in good condition?	Go to Step 9.	Repair or replace.
9	Check engine coolant temp. sensor for performance (See Section 6E). Is it in good condition?	Go to Step 10.	Replace engine coolant temp. sensor.
10	Check parts or system which can cause engine rough idle or poor performance. • Engine compression (See Section 6A1). • Valve lash (See Section 6A1). • Valve timing (Timing belt installation. See Section 6A1). Are they in good condition?	Check wire harness and connection of ECM ground, ignition system and fuel injector for intermittent open and short.	Repair or replace.

CAUTION:
For iridium spark plugs, do not adjust air gap or clean.

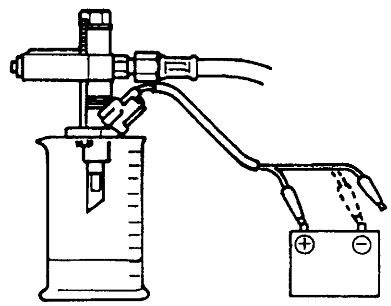
[A] Fig. 1 for Step 3 / [B] Fig. 2 for Step 3 / [C] Fig. 3 for Step 4 / [D] Fig. 4 for Step 5 / [E] Fig. 5 for Step 4



3.	Fuel delivery pipe
4.	Fuel feed hose
3.	Fuel pressure gauge & 3 way joint

[F] Fig. 6 for Step 5 / [G] Fig. 7 for Step 7

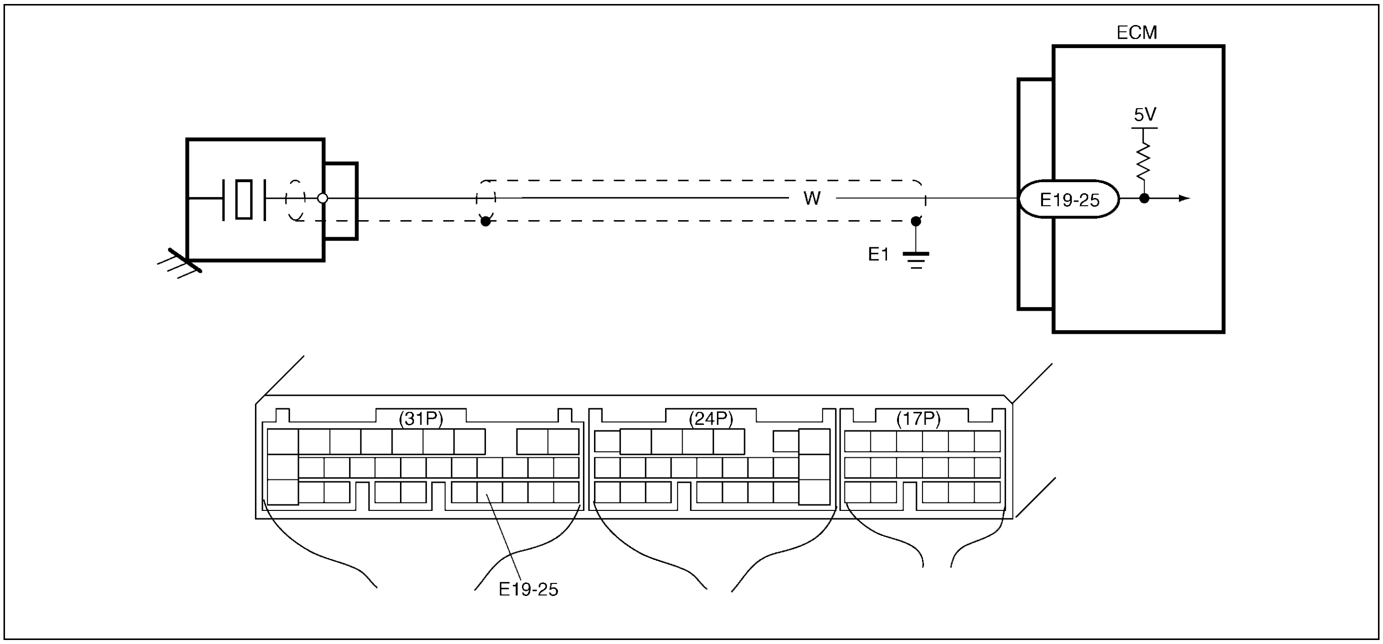
[F]



[G]

DTC P0325 (DTC No.17) Knock Sensor Circuit Malfunction

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
• Knock sensor voltage is 3.91 V or more • Knock sensor voltage is 1.23 V or less	• “W” circuit open or shorted to ground • Knock sensor malfunction • ECM malfunction

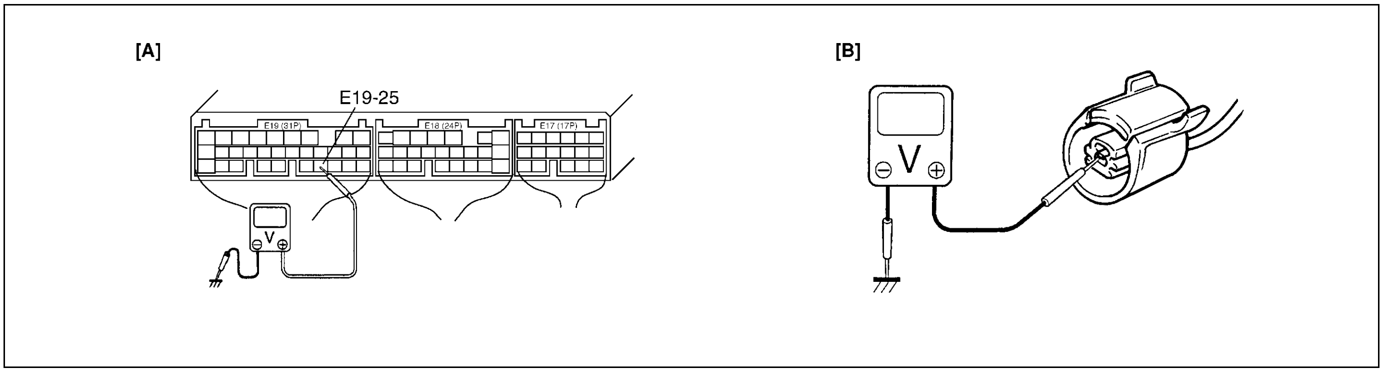
DTC CONFIRMATION PROCEDURE

1) Clear DTC, start engine and keep it at idle for 1 min.
2) Select “DTC” mode on scan tool and check DTC.

INSPECTION

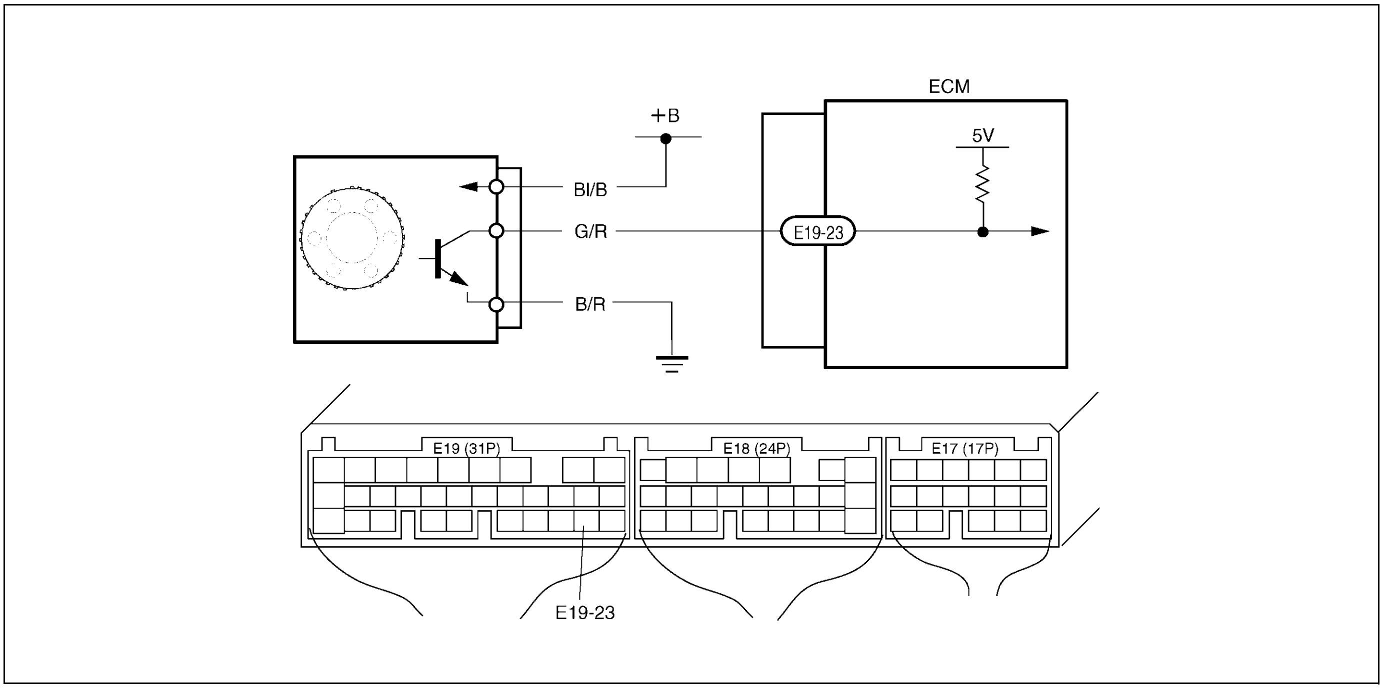
Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	1) With engine running, check voltage from “E19-25” terminal of ECM connector to body ground. See Fig. 1. 2) Is voltage about 1.25 – 3.75 V?	Knock sensor and its circuit are in good condition. Intermittent trouble or faulty ECM. Recheck, referring to “Intermittent Trouble” in Section 0A.	Go to Step 3.
3	1) Stop engine. 2) With ignition switch at OFF position, disconnect knock sensor connector. 3) With ignition switch at ON position, check voltage from “W” to body ground terminal of knock sensor connector. See Fig. 2. Is it 4 – 5 V?	Faulty knock sensor. Substitute a known-good knock sensor and recheck.	“W” wire open, shorted to ground circuit or poor “E19-25” connection. If wire and connection are OK, substitute a known-good ECM and recheck.

[A] Fig. 1 for Step 2 / [B] Fig. 2 for Step 3



DTC P0335 (DTC No.23) Crankshaft Position (CKP) Sensor Circuit Malfunction

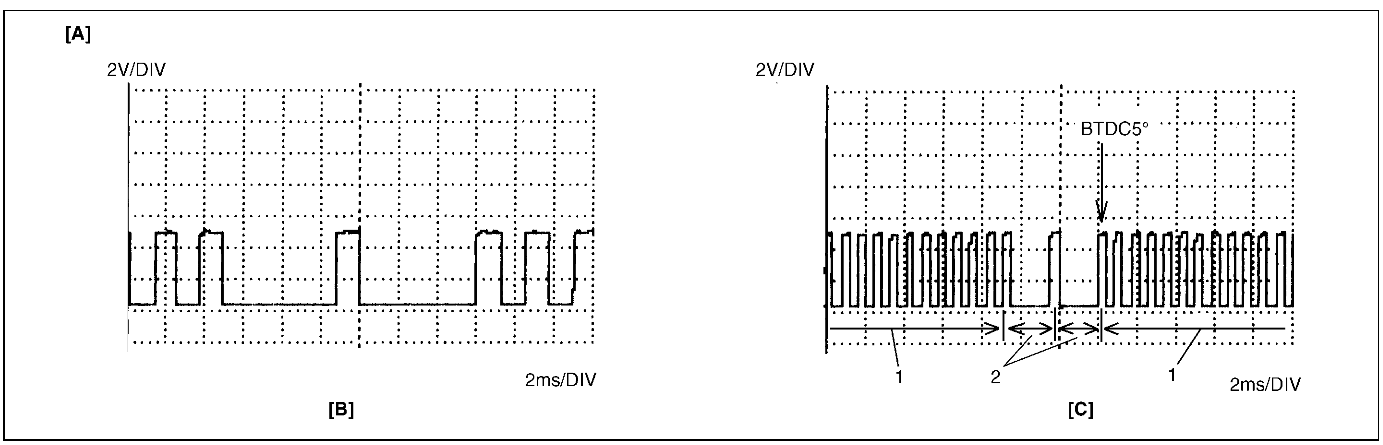
CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
• NO CKP sensor signal for 2 seconds at engine cranking.	• CKP sensor circuit open or short. • Signal teeth damaged. • CKP sensor malfunction, foreign material being attached or improper installation. • ECM malfunction.

REFERENCE

Connect oscilloscope between terminals E19-23 of ECM connector connected to ECM and body ground and check CKP sensor signal.



1. 10° signal	[A] : Oscilloscope Waveforms	[C] : Waveforms at 2000 rpm
2. 30° signal	[B] : Waveforms at idle speed	

DTC CONFIRMATION PROCEDURE

1) Clear DTC and crank engine for 2 sec.
2) Select “DTC” mode on scan tool and check DTC.

INSPECTION

Step	Action	Yes	No
1	Was "Engine Diag. Flow Table" performed?	Go to Step 2.	Go to "Engine Diag. Flow Table".
2	Check CKP Sensor and connector for proper installation. Is CKP sensor installed properly and connector connected securely?	Go to Step 3.	Correct.
3	Check Wire Harness and Connection. 1) Disconnect connector from CKP sensor. 2) Check for proper connection to CKP sensor at each terminal. 3) If OK, turn ignition switch ON and check for voltage at each terminal of sensor connector disconnected. See Fig. 1. Terminal "B+" : 10 – 14 V Terminal "Vout" : 4 – 5 V Terminal "GND" : 0 V Is check result satisfactory?	Go to Step 5.	Go to Step 4.
4	Was terminal "Vout" voltage out of specification in Step 3 check?	"G/R" wire open, short or poor connection. If wire and connection are OK, substitute a known-good ECM and recheck.	"Bl/B" or "B/R" wire open, short or poor connection.
5	Check Ground Circuit for Open. 1) Turn ignition switch OFF. 2) Check for continuity between "GND" terminal of CKP sensor connector and engine ground. Is continuity indicated?	Go to Step 6.	"B/R" wire open or poor ground connection.
6	Check CKP Sensor for Operation. 1) Remove CKP sensor from sensor case. 2) Remove metal particles on end face of CKP sensor, if any. 3) Connect each connector to ECM and CKP sensor. 4) Turn ignition switch ON. 5) Check for voltage at terminal E19-23 of connector connected to ECM by passing magnetic substance (iron) (1) while keeping approximately 1 mm (0.03 in.) gap with respect to end face of CKP sensor. See Fig. 2 and 3. Does voltage vary from low (0 – 1 V) to high (4 – 5 V) or from high to low?	Go to Step 7.	Replace CKP sensor.
7	Check signal rotor for the following. See Fig. 4. • Damage • No foreign material attached Is it in good condition?	Intermittent trouble or faulty ECM. Check for intermittent referring to "Intermittent and Poor Connection" in Section 0A.	Clean rotor teeth or replace CKP sensor.

[A] Fig. 1 for Step 3 / [B] Fig. 2 for Step 6 / [C] Fig. 3 for Step 6

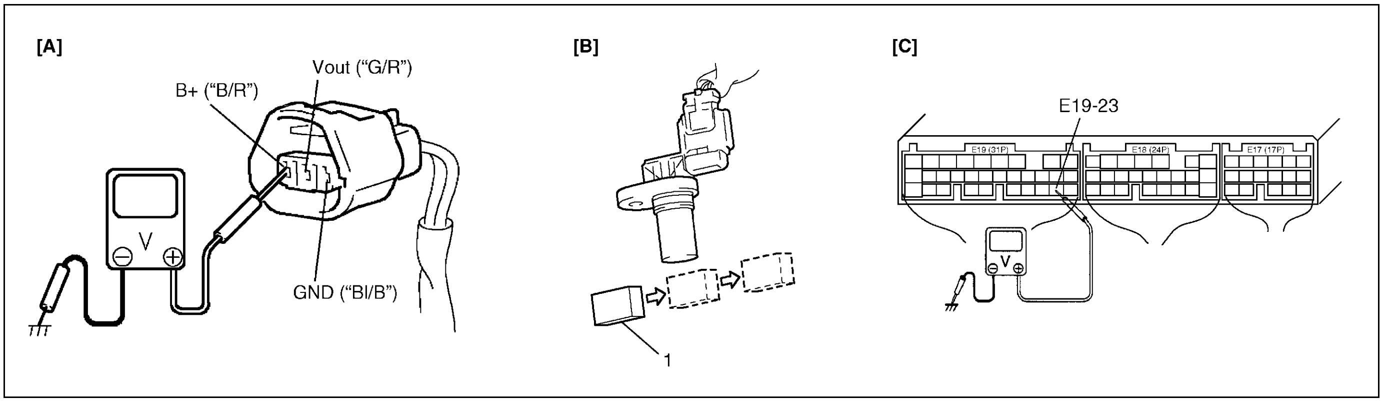
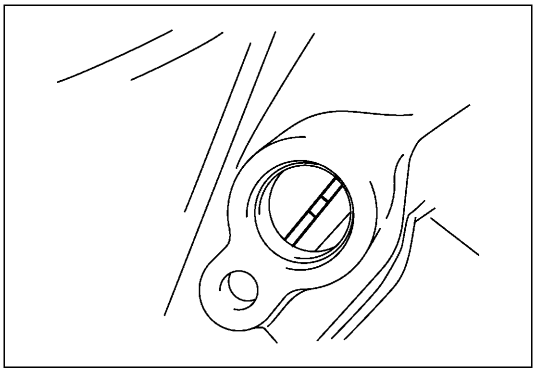
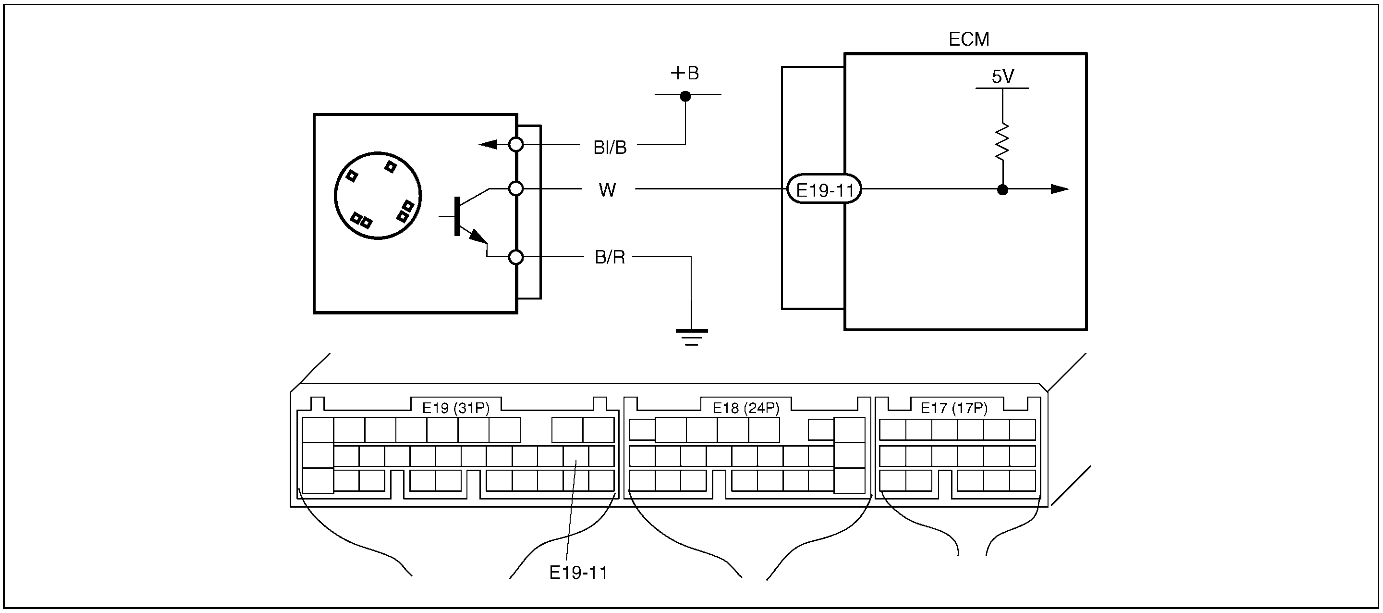


Fig. 4 for Step 7



DTC P0340 (DTC No.15) Camshaft Position (CMP) Sensor Circuit Malfunction

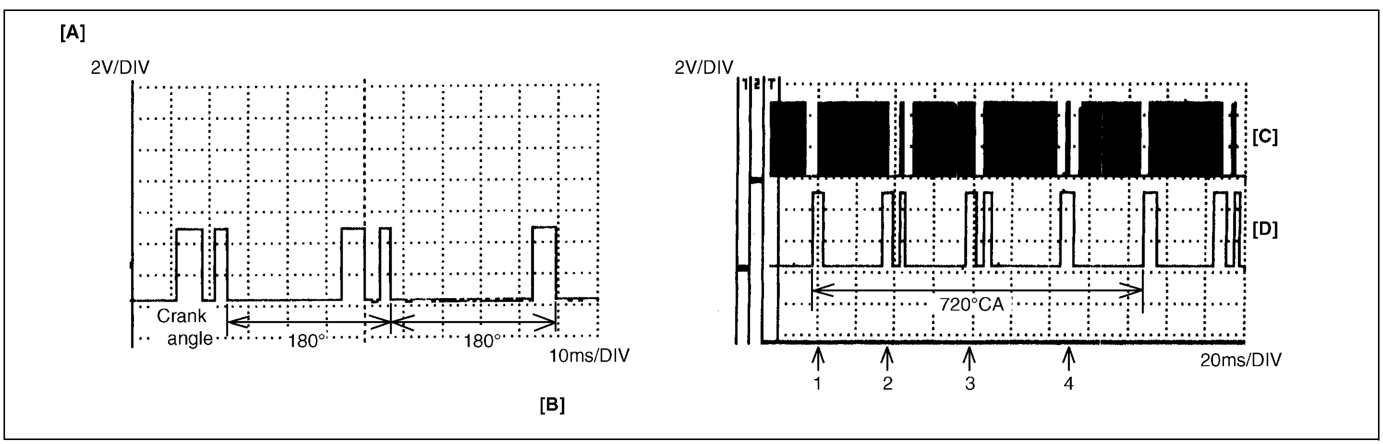
CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
• The number of CMP sensor signal pulses is incorrect during 8 revolution of crankshaft.	• CMP sensor circuit open or short. • Signal rotor teeth damaged. • CMP sensor malfunction, foreign material being attached or improper installation. • ECM malfunction. • CMP sensor phase lag.

REFERENCE

Connect oscilloscope between terminals E19-11 of ECM connector connected to ECM and body ground and check CMP sensor signal.



1. No.1 cylinder	3. No.3 cylinder	[A] : Oscilloscope Waveforms	[C] : CKP sensor waveform
2. No.2 cylinder	4. No.4 cylinder	[B] : Waveforms at specified idle speed	[D] : CMP sensor waveform

DTC CONFIRMATION PROCEDURE

1) Clear DTC.
2) Start engine and keep it at idle for 1 min.
3) Select “DTC” mode on scan tool and check DTC.

INSPECTION

Step	Action	Yes	No
1	Was "Engine Diag. Flow Table" performed?	Go to Step 2.	Go to "Engine Diag. Flow Table".
2	Check CMP Sensor and connector for proper installation. Is CMP sensor installed properly and connector connected securely?	Go to Step 3.	Correct.
3	Check Wire Harness and Connection. 1) Disconnect connector from CMP sensor. 2) Check for proper connection to CMP sensor at each terminal. 3) If OK, turn ignition switch ON and check for voltage at each terminal of sensor connector disconnected. See Fig. 1. Terminal "B+" : 10 – 14 V Terminal "Vout" : 4 – 5 V Terminal "GND" : 0 V Is check result satisfactory?	Go to Step 5.	Go to Step 4.
4	Was terminal "Vout" voltage out of specification in Step 3 check?	"W" wire open, short or poor connection. If wire and connection are OK, substitute a known-good ECM and recheck.	"Bl/B" or "B/R" wire open, short or poor connection.
5	Check Ground Circuit for Open. 1) Turn ignition switch OFF. 2) Check for continuity between "GND" terminal of CMP sensor connector and engine ground. Is continuity indicated?	Go to Step 6.	"B/R" wire open or poor ground connection.
6	Check CMP Sensor for Operation. 1) Remove CMP sensor from sensor case. 2) Remove metal particles on end face of CMP sensor, if any. 3) Connect each connector to ECM and CMP sensor. 4) Turn ignition switch ON. 5) Check for voltage at terminal E19-11 of connector connected to ECM by passing magnetic substance (iron) (1) while keeping approximately 1 mm (0.03 in.) gap with respect to end face of CMP sensor. See Fig. 2 and 3. Does voltage vary from low (0 – 1 V) to high (4 – 5 V) or from high to low?	Go to Step 7.	Replace CMP sensor.
7	Check signal rotor for the following. See Fig. 4. • Damage • No foreign material attached Is it in good condition?	Intermittent trouble or faulty ECM. Check for intermittent referring to "Intermittent and Poor Connection" in Section 0A.	Clean rotor teeth or replace CMP sensor.

[A] Fig. 1 for Step 3 / [B] Fig. 2 for Step 6 / [C] Fig. 3 for Step 6

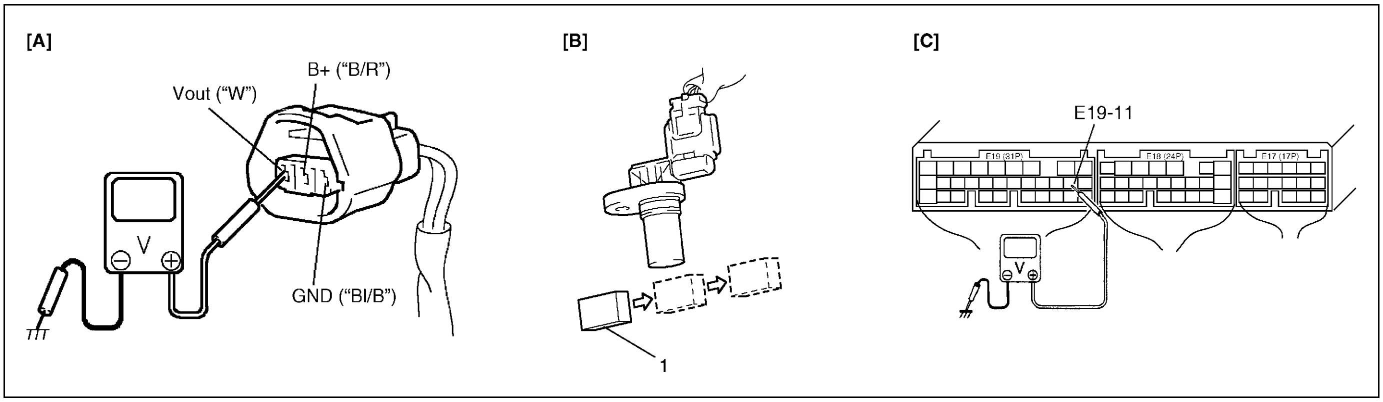
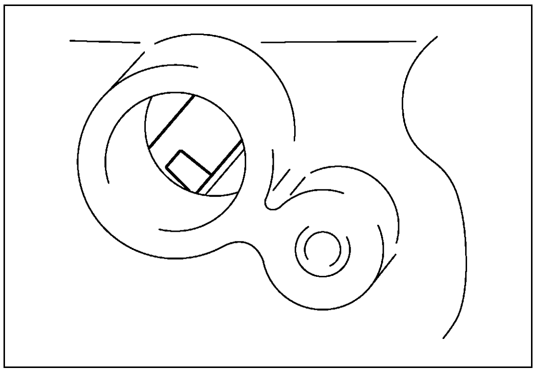
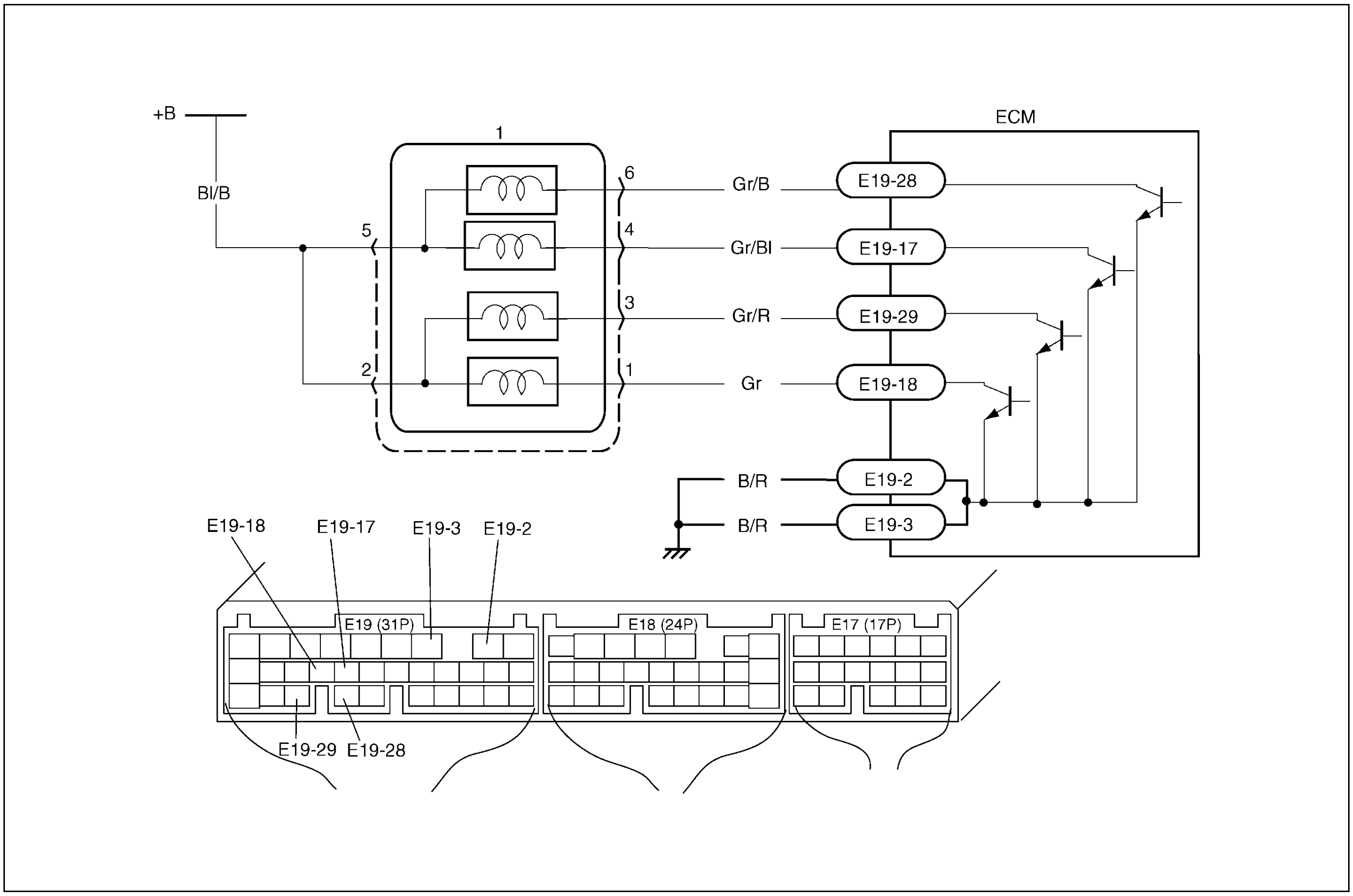


Fig. 4 for Step 7



DTC P0400 Exhaust Gas Recirculation Flow Malfunction

CIRCUIT DESCRIPTION



1. EGR valve

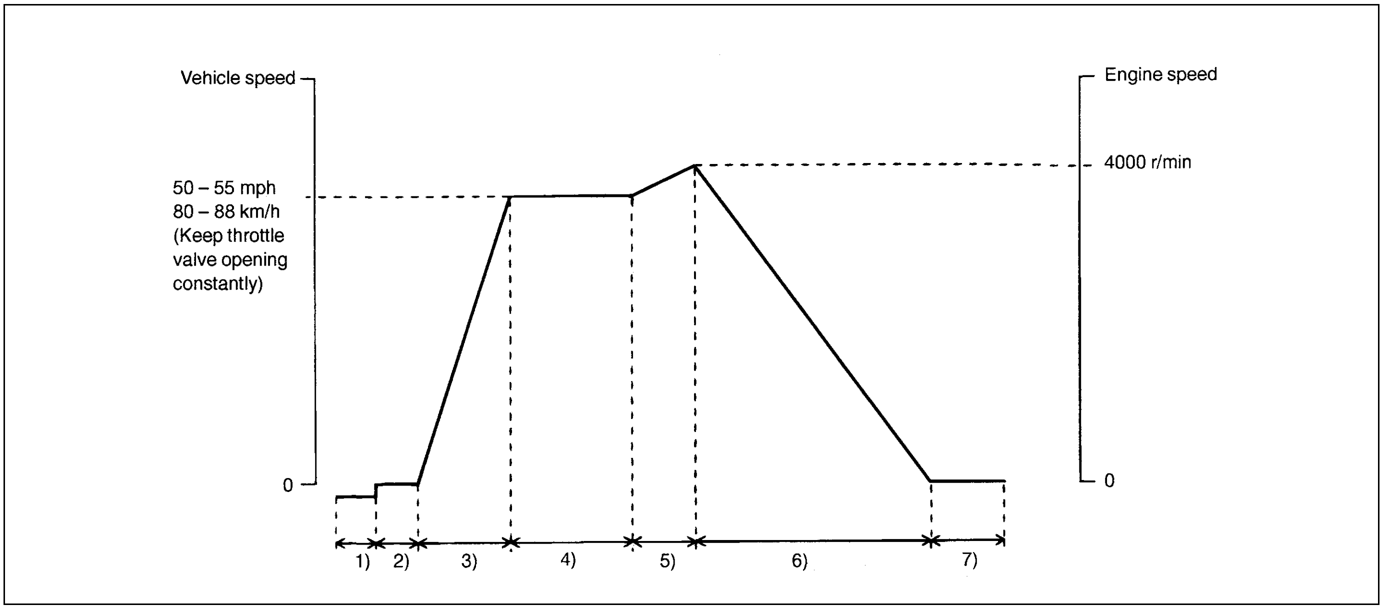
DTC DETECTING CONDITION	POSSIBLE CAUSE
• While running at specified vehicle speed after engine warm-up • During deceleration (engine speed high with closed throttle position ON) in which fuel cut is involved, difference in intake manifold absolute pressure between when EGR valve is opened at specified value and when it is closed is larger or smaller than specified value. ✱2 driving cycle detection logic, monitoring once / 1 driving	• EGR valve or its circuit • EGR passage • ECM

DTC CONFIRMATION PROCEDURE

WARNING:
- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester, on a level road.**

1) Turn ignition switch OFF.
   Clear DTC with ignition switch ON, check vehicle and environmental condition for :
   – Altitude (barometric pressure) : 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)
   – Ambient temp. : –10 °C, 14 °F or higher
   – Intake air temp. : 70 °C, 122 °F or lower

2) Start engine and warm it up to normal operating temperature (70 – 110 °C, 158 – 230 °F) and run it at idle for 5 min.
3) Increase vehicle speed to 50 – 55 mph, 80 – 88 km/h in 5th gear or in “D” range.
4) Hold throttle valve at that opening position for 2 min. or longer.
5) Increase engine speed to 4000 r/min. in 3rd gear or in “2” range.
6) Release accelerator pedal and with engine brake applied, keep vehicle coasting (fuel cut condition) till engine speed reaches 1500 r/min.
7) Stop vehicle (don’t turn ignition switch OFF) and confirm test results according to following “Test Result Confirmation Flow Table.”



Test Result Confirmation Flow Table

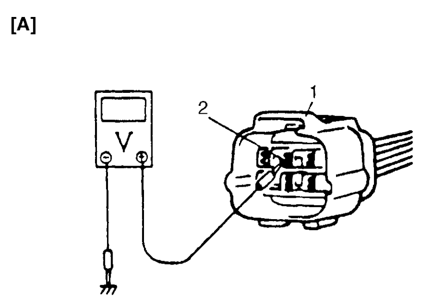
Step	Action	Yes	No
1	Check DTC in “DTC” mode and pending DTC in “ON BOARD TEST”. Is DTC or pending DTC displayed?	Proceed to applicable DTC flow table.	Go to Step 2.
2	Set scan tool to “READINESS TESTS” mode and check if testing has been completed. Is test completed?	No DTC is detected. (Confirmation test is completed)	Repeat DTC confirmation procedure.

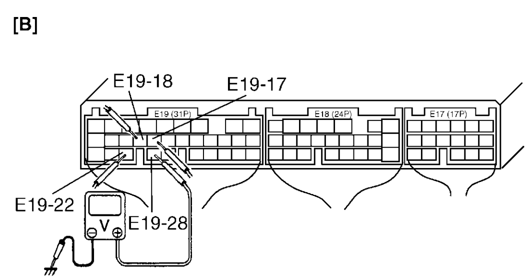
INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	1) Turn ignition switch ON. 2) Does EGR stepper motor operation for 0.6 second after ignition switch OFF?	Go to Step 3.	Go to Step 6.
3	With ignition switch at OFF, check voltage between E19-28, 17, 29, 18 terminals of ECM and body ground. See Fig. 2. Is voltage about 0 V?	Go to Step 4.	Go to Step 8.

Step	Action	Yes	No
4	With ignition switch at ON, check voltage between E19-28, 17, 29, 18 terminals of ECM and body ground. See Fig. 2. Is voltage within 10 – 14 V?	Go to Step 5.	Go to Step 8.
5	Do you have SUZUKI scan tool?	Go to Step 6.	Stuck or faulty EGR valve or clogged EGR gas passage. If all above are OK, substitute a known-good ECM and recheck.
6	Check EGR system referring to “EGR System” in Section 6E. Is check result satisfactory?	Substitute a known-good ECM and recheck.	Stuck or faulty EGR valve or clogged EGR gas passage.
7	1) Disconnect EGR valve connector with ignition switch OFF. 2) Check voltage between “Bl/B” wire terminal (2) of EGR valve connector (1) and body ground with ignition switch ON. See Fig. 1. 3) Are they about 10 – 14 V?	Go to Step 3.	“Bl/B” wire open or short.
8	Check EGR valve referring to “EGR System” in Section 6E. Is it good condition?	EGR valve harness (“Gr/B”, “Gr/Bl”, “Gr/R” or “Gr” wire) open or short or poor connector connection (EGR valve connector, E19-28, 17, 29, 18) If wire harness and connection are OK, substitute a known-good ECM and recheck.	Faulty EGR valve.

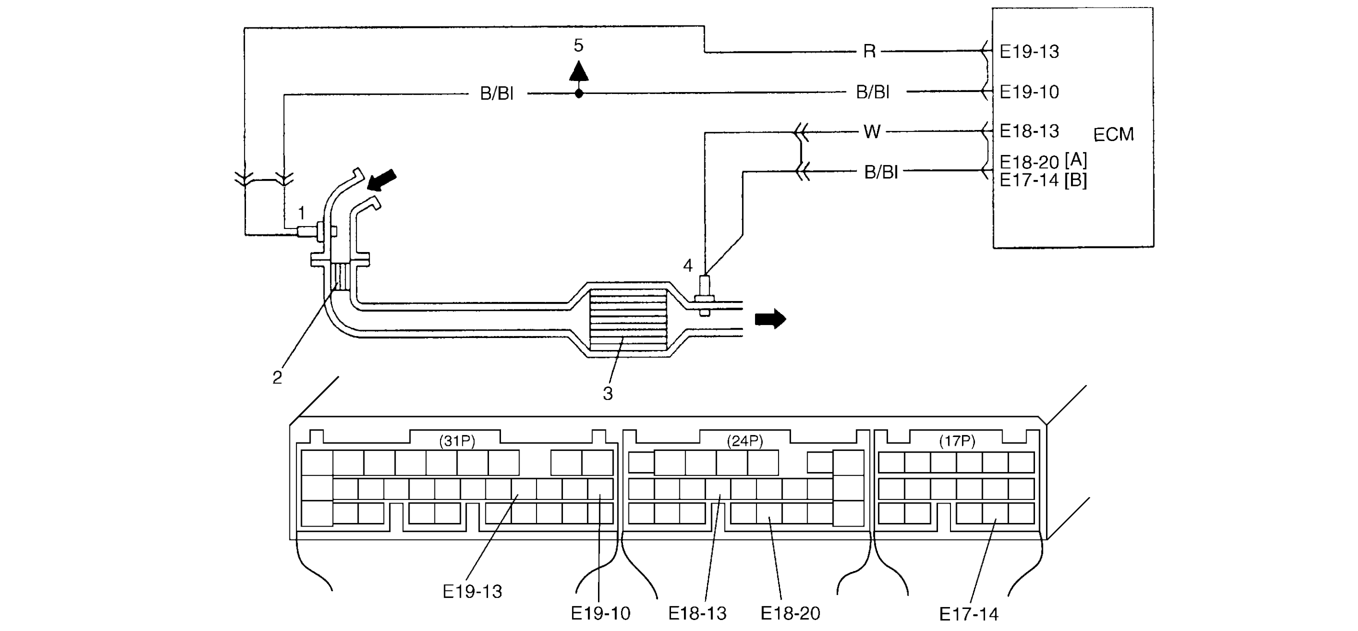
[A] Fig. 1 for Step 7 / [B] Fig. 2 for Step 3 and 4





DTC P0420 Catalyst System Efficiency below Threshold

CIRCUIT DESCRIPTION



1. Heated oxygen sensor-1	3. Three way catalytic converter	5. To the sensor	[B] : Case of TYPE B is shown (See NOTE)
2. Warm up three way catalytic converter	4. Heated oxygen sensor-2	[A] : Case of TYPE A is shown (See NOTE)	

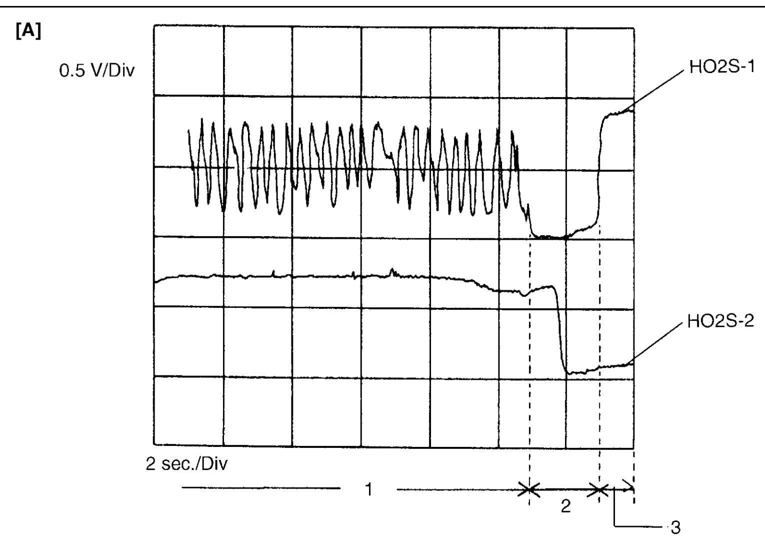
NOTE:

For TYPE A and TYPE B, refer to the NOTE in "ECM Terminal Voltage Values Table" for applicable model.

ECM monitors oxygen concentration in the exhaust gas which has passed the three way catalytic converter by HO2S-2.

When the catalyst is functioning properly, the variation cycle of HO2S-2 output voltage (oxygen concentration) is slower than that of HO2S-1 output voltage because of the amount of oxygen in the exhaust gas which has been stored in the catalyst.

REFERENCE



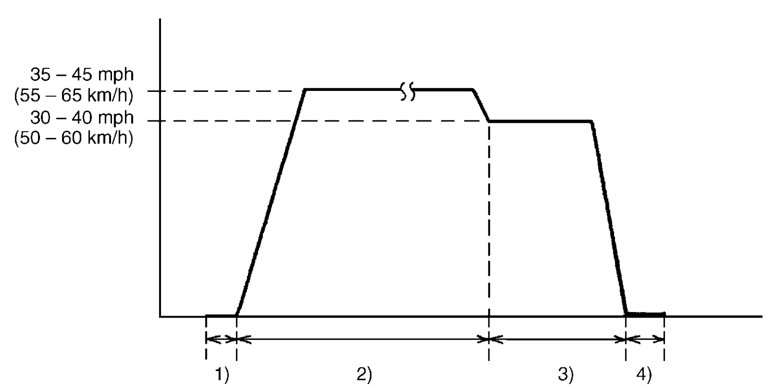
1. Engine running at closed loop condition	2. Fuel cut	3. Idle after fuel cut	[A] : Oscilloscope waveforms

DTC DETECTING CONDITION	POSSIBLE CAUSE
• While vehicle running at constant speed under other than high load. • Time from rich or lean switching command is output till HO2S-2 output voltage crosses 0.45 V less than specified value. ✱2 driving cycle detection logic, monitoring once / 1 driving.	• Exhaust gas leak • Three way catalytic converter malfunction • Fuel system malfunction • HO2S-2 malfunction • HO2S-1 malfunction

DTC CONFIRMATION PROCEDURE

WARNING:
- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester, on a level road.**

1) Turn ignition switch OFF.
   Clear DTC with ignition switch ON, check vehicle and environmental condition for :
   – Altitude (barometric pressure) : 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)
   – Ambient temp. : –10 °C, 14 °F or higher
   – Intake air temp. : 70 °C, 158 °F or lower
   – Engine coolant temp. : 70 – 110 °C, 158 – 230 °F
2) Start engine and drive vehicle at 35 – 45 mph, 55 – 65 km/h for 8 min. or longer.
   While this driving, if “Catalyst Monitoring TEST COMPLETED” is displayed in “READINESS TESTS” mode and DTC is not displayed in “DTC” mode, confirmation test is completed.
   If “TEST NOT COMPLTD” is still being displayed, continue test driving.
3) Decrease vehicle speed at 30 – 40 mph, 50 – 60 km/h, and hold throttle valve at that opening position for 2 min. and confirm that short term fuel trim vary within – 20% – +20% range.
4) Stop vehicle (do not turn ignition switch OFF) and confirm test results according to following “Test Result Confirmation Flow Table”.



Test Result Confirmation Flow Table

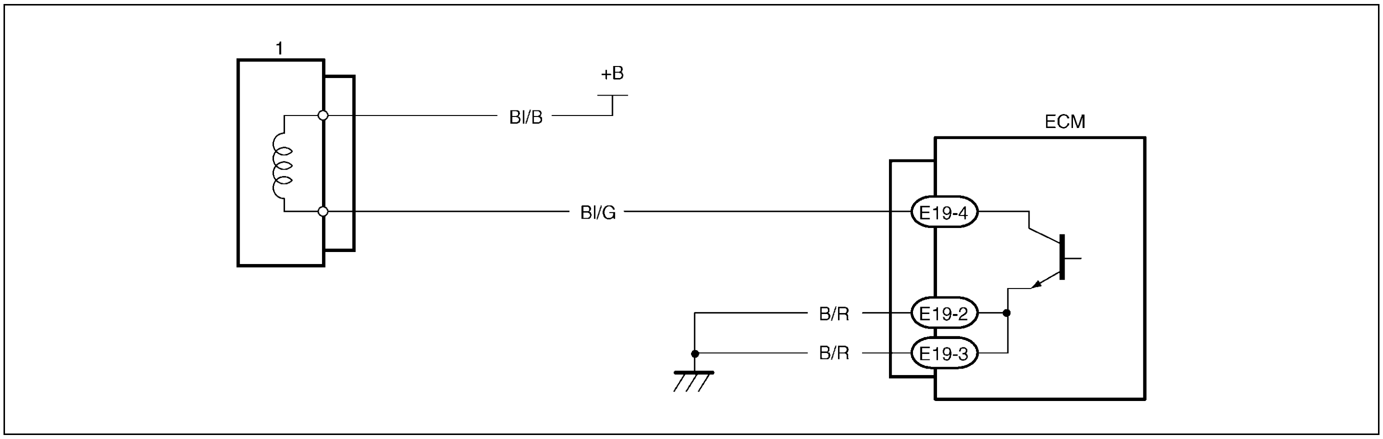
Step	Action	Yes	No
1	Check DTC in “DTC” mode and pending DTC in “ON BOARD TEST” or “PENDING DTC” mode. Is DTC or pending DTC displayed?	Proceed to applicable DTC Diag. Flow Table.	Go to Step 2.
2	Set scan tool to “READINESS TESTS” mode and check if testing has been completed. Is test completed?	No DTC is detected (confirmation test is completed).	Repeat DTC confirmation procedure.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Check Short Term Fuel Trim. Did short term fuel trim vary within –20 % – +20 % range in step 3) of DTC confirmation test?	Go to Step 3.	Check fuel system. Go to DTC P0171/P0172 Diag. Flow Table.
3	Check HO2S-2 for Output Voltage. Perform steps 1) through 9) of DTC confirmation procedure for DTC P0136 (HO2S-2 malfunction) and check output voltage of HO2S-2 then. Is over 0.6 V and below 0.3 V indicated?	Replace three way catalytic converter.	Check “W” and “B/Bl” wires for open and short, and connections for poor connection. If wires and connections are OK, replace HO2S-2.

DTC P0443 Purge Control Valve Circuit Malfunction

CIRCUIT DESCRIPTION



1. EVAP canister purge vale

DTC DETECTING CONDITION	POSSIBLE CAUSE
Canister Purge control valve circuit is opened or shorted.	• "Bl/G" circuit open or short • "Bl/B" circuit open or short • Canister purge valve malfunction

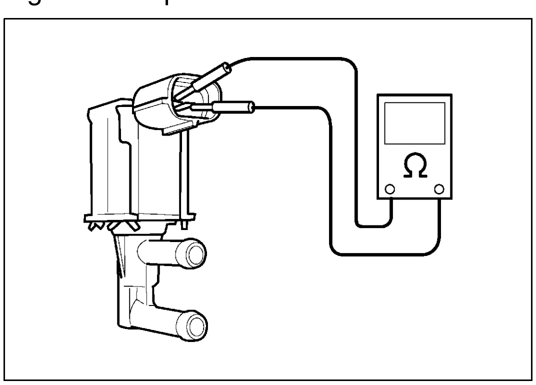
DTC CONFIRMATION PROCEDURE

1) Clear DTC with ignition switch ON.
2) Select "DTC" mode on scan tool and check DTC.

INSPECTION

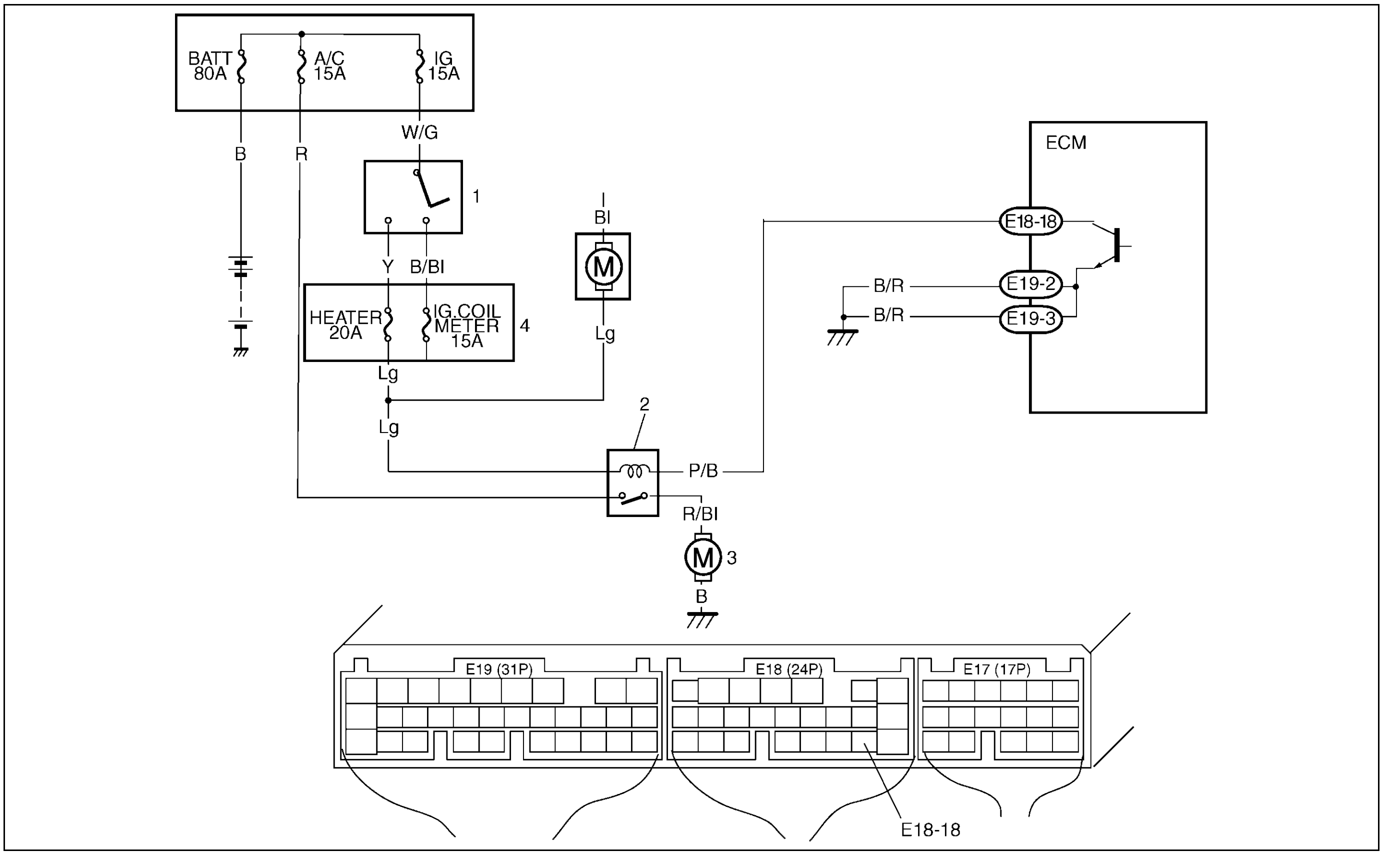
Step	Action	Yes	No
1	Was "Engine Diag. Flow Table" performed?	Go to Step 2	Go to "Engine Diag. Flow Table".
2	Check EVAP canister purge valve operation 1) With ignition switch OFF, disconnect coupler from canister purge valve. 2) Check resistance of EVAP canister purge valve. See Fig.1 **EVAP canister purge valve resistance** **Between two terminals : 30 – 34 Ω at 20 °C (68 °F)** **Between terminal and body : 1M Ω or higher** Is it as specified?	"Bl/G" circuit open or short.	Replace EVAP canister purge valve.

Fig. 1 for Step 2



DTC P0481 A/C Condenser Fan Control Circuit Malfunction

CIRCUIT DESCRIPTION



1. Ignition switch	3. A/C condenser fan relay	5. A/C condenser fan	7. Fuse box

DTC DETECTING CONDITION	POSSIBLE CAUSE
• Low voltage at terminal E18-18 when ECM doesn't output A/C ON signal to A/C amplifier or when engine coolant temp. is not 110 °C (230 °F) or more. ✱2 driving cycle detection logic, continuous monitoring.	• "P/B" or "Lg" circuit open or short • Condenser fan motor relay malfunction • ECM malfunction

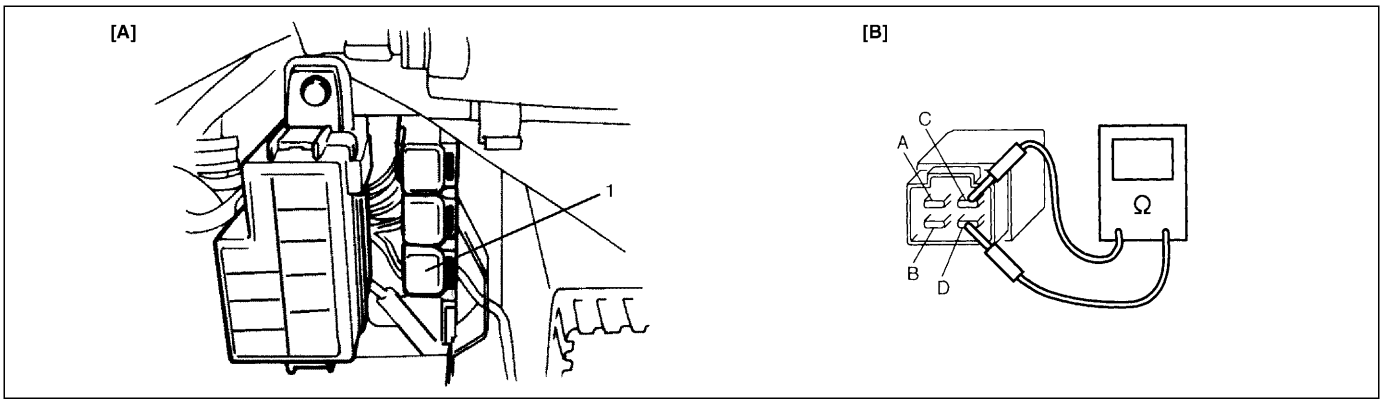
DTC CONFIRMATION PROCEDURE

1) Turn ignition switch OFF.
2) Clear DTC with ignition switch ON.
3) Start engine and then turn both A/C switch and heater blower switch ON for 2 sec or more.
4) Run engine at idle for 5 sec or more which A/C switch and heater blower switch OFF.
5) Check DTC and pending DTC.

INSPECTION

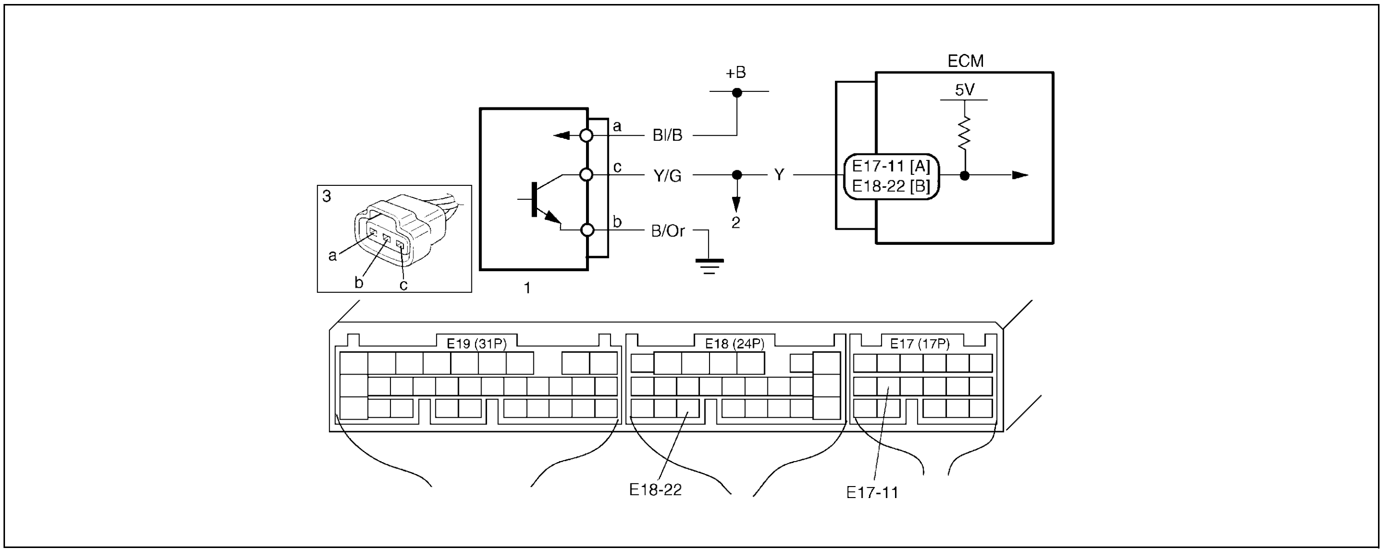
Step	Action	Yes	No
1	Was "Engine Diag. Flow Table" performed?	Go to Step 2.	Go to "Engine Diag. Flow Table".
2	Check A/C Condenser Fan Control Relay and its Circuit. 1) Turn ignition switch ON. 2) Check for voltage at terminal E18-18 of ECM connector connected, under following condition. When A/C switch turns OFF : 10 – 14 V Is voltage as specified?	Intermittent trouble or faulty ECM. Check for intermittent referring to "Intermittent and Poor Connection" in Section 0A.	Go to Step 3.
3	Check A/C Condenser Fan Control Relay. 1) Turn ignition switch OFF and remove A/C condenser fan control relay (1). See Fig.1. 2) Check for proper connection to the relay at "P/B" and "Lg" wire terminals. 3) If OK, then measure resistance between terminals C and D. See Fig.2. Is it 70 - 110Ω?	"Lg" or "P/B" circuit open or short. If wires and connections are OK, substitute a known-good ECM and recheck.	Replace A/C condenser fan control relay.

[A] Fig. 1 for Step 3 / [B] Fig. 2 for Step 3



DTC P0500 (DTC No.16) Vehicle Speed Sensor (VSS) Malfunction

CIRCUIT DESCRIPTION



1. VSS	3. VSS connector	[B] : Case of TYPE B is shown (See NOTE)
2. Combination meter	[A] : Case of TYPE A is shown (See NOTE)	

NOTE:

For TYPE A and TYPE B, refer to the NOTE in “ECM Terminal Voltage Values Table” for applicable model.

DTC DETECTING CONDITION	POSSIBLE CAUSE
• VSS signal not inputted while vehicle running in “D” range or during fuel cut at deceleration. ✱2 driving cycle detection logic, continuous monitoring	• “B/Or” circuit open • “Y” or “Bl/B” circuit open or short • VSS malfunction • ECM malfunction • Speedometer malfunction

DTC CONFIRMATION PROCEDURE

WARNING:

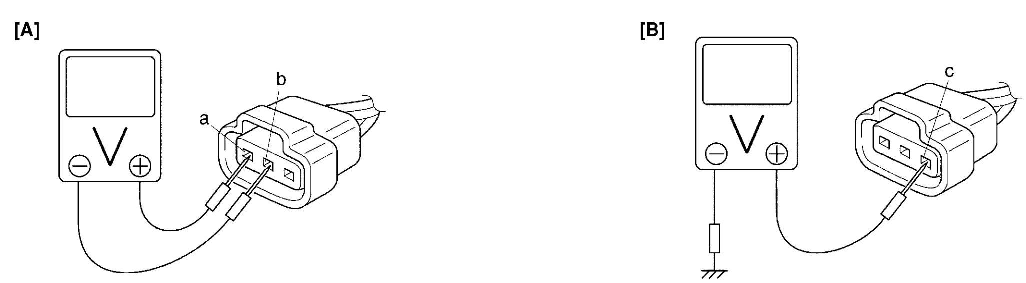
- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester.**

1) Clear DTC and warm up engine to normal operating temperature.
2) Increase vehicle speed to 50 mph, 80 km/h in 3rd gear or “2” range while observing vehicle speed displayed on scan tool.
3) Release accelerator pedal and with engine brake applied, keep vehicle coasting (fuel cut condition) for 4 sec. or more.
4) Check pending DTC and DTC.

INSPECTION

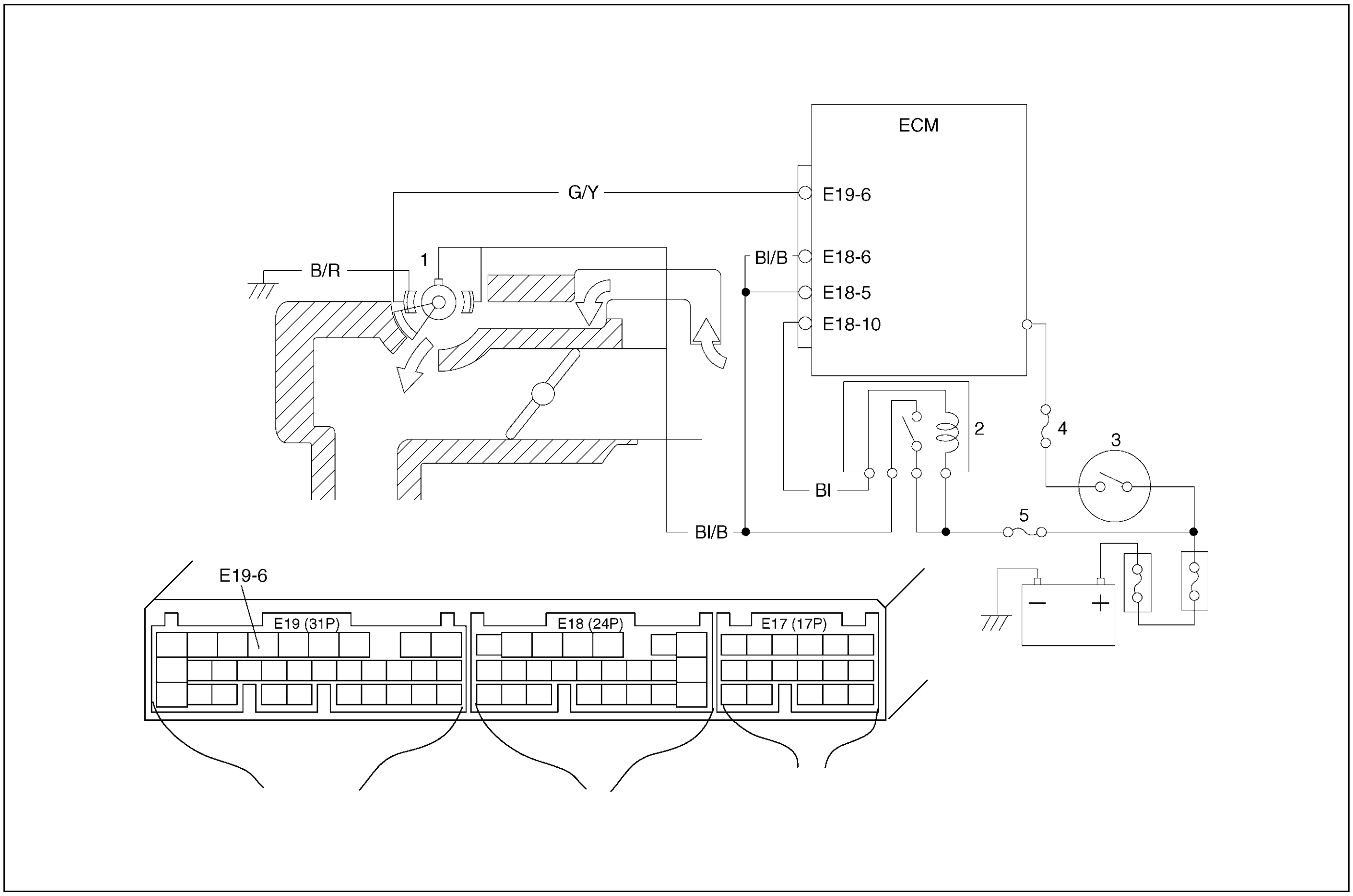
Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Does speedometer indicate vehicle speed?	Go to Step 3.	Go to Step 5.
3	Check Vehicle Speed Signal. Is vehicle speed displayed on scan tool in step 2) and 3) of DTC confirmation procedure?	Intermittent trouble or faulty ECM. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.	Go to Step 4.
4	1) Turn ignition switch to OFF position. 2) Disconnect combination meter connectors.Refer to Section 8. 3) Turn ignition switch to ON position, without running engine. 4) Measure voltage from terminal “c” of VSS connector to ground. See Fig.2. Is voltage within 4 – 5 V?	Faulty speedometer.	“Y” or “Y/G” wire open or short. Poor connection of ECM connector terminal. If OK, substitute a known-good ECM and recheck.
5	1) With ignition switch at OFF position, disconnect VSS connector. 2) Turn ignition switch to ON position, without running engine. 3) Measure voltage from terminal “a” to “b” of VSS connector. See Fig.1. Is voltage within 10 – 14 V?	Go to Step 6.	“Bl/B” or “B/Or” wire open or short.
6	1) Measure voltage from terminal “c” of VSS connector to ground. See Fig.2. Is voltage more than 4 V?	Go to Step 7.	“Y” or “Y/G” wire open or short. Poor connection of ECM connector terminal. If OK, substitute a known-good ECM and recheck.
7	1) Remove VSS. 2) Visually inspect VSS sensor signal rotor for damage. Was any damage found?	Faulty VSS signal rotor.	Poor connection of VSS connector terminal. If OK, substitute a known-good VSS and recheck.

[A] Fig. 1 for Step 5 / [B] Fig. 2 for Step 4 and Step 6



DTC P0505 Idle Control System Malfunction

CIRCUIT DESCRIPTION



1. IAC valve	3. Ignition switch	5. "FI" fuse
2. Main relay	4. "IG COIL METER" fuse	.

DTC DETECTING CONDITION	POSSIBLE CAUSE
• No closed signal to IAC valve is detected after engine start. ✱2 driving cycle detection logic, continuous monitoring.	• "Bl/B", "G/Y" or "B/R" circuit open or short • IAC valve malfunction • ECM malfunction

DTC CONFIRMATION PROCEDURE

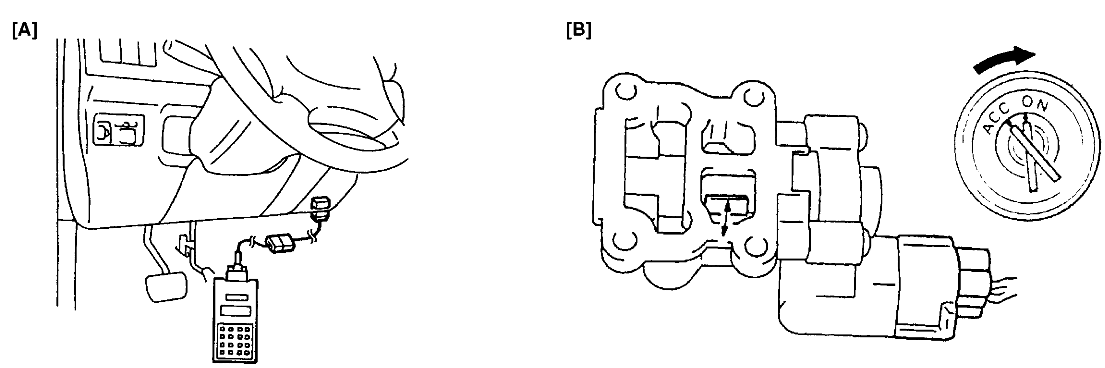
1) Turn ignition switch OFF.
2) Clear DTC with ignition switch ON.
3) Start engine and run it at idle for 1 min.
4) Check DTC and pending DTC.

INSPECTION

Step	Action	Yes	No
1	Was "Engine Diag. Flow Table" performed?	Go to Step 2.	Go to "Engine Diag. Flow Table".
2	Is SUZUKI scan tool available?	Go to Step 3.	Go to Step 4.

Step	Action	Yes	No
3	Check Idle Air Control System. 1) Connect SUZUKI scan tool to DLC with ignition switch OFF, set parking brake and block drive wheels. See Fig. 1. 2) Warm up engine to normal operating temperature. 3) Clear DTC and select “MISC TEST” mode on SUZUKI scan tool. Is it possible to control (increase and reduce) engine idle speed by using SUZUKI scan tool?	Intermittent trouble or faulty ECM. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.	Go to Step 5.
4	Check Idle Air Control System. 1) Remove IAC valve from throttle boy referring to “IAC Valve” in Section 6E. 2) Check IAC valve for operation referring to “IAC Valve” in Section 6E. See Fig. 2. Is check result satisfactory?	Intermittent trouble or faulty ECM. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.	Go to Step 5.
5	Check Wire Harness for Open and Short. 1) Turn ignition switch OFF. 2) Disconnect IAC valve connector. 3) Check for proper connection to IAC valve at each terminals. 4) If OK, disconnect ECM connector. 5) Check for proper connection to ECM at E19-6 terminal. 6) If OK, check “Bl/B”, “G/Y” and “B/R” circuit for open and short. Are they in good condition?	Replace IAC valve and recheck.	Repair or replace.

[A] Fig. 1 for Step 3 / [B] Fig. 2 for Step 4



DTC P0601 Internal Control Module Memory Check Sum Error (DTC No.71)

DTC DETECTING CONDITION	POSSIBLE CAUSE
DTC P0601 : Data write error (or check sum error) when written into ECM ✱2 driving cycle detection logic, continuous monitoring.	ECM

DTC CONFIRMATION PROCEDURE

1) Turn ignition switch OFF.
2) Clear DTC with ignition switch ON and then turn ignition switch OFF.
3) Start engine and run it at idle if possible.
4) Check pending DTC in “ON BOARD TEST” or “PENDING DTC” mode and DTC in “DTC” mode.

INSPECTION

Substitute a known-good ECM and recheck.

DTC P1450 Barometric Pressure Sensor Low / High Input

DTC P1451 Barometric Pressure Sensor Performance Problem

WIRING DIAGRAM / CIRCUIT DESCRIPTION

Barometric pressure sensor is installed in ECM.

DTC DETECTING CONDITION	POSSIBLE CAUSE
DTC P1450 : • Barometric pressure sensor voltage is 4.7 V or higher, or 1.6 V or lower	• ECM (barometric pressure sensor) malfunction
DTC P1451 : • Vehicle stopped • Engine cranking • Difference between barometric pressure and intake manifold absolute pressure is 26 kPa, 200 mmHg or more. • Difference between intake manifold absolute pressure at engine start and pressure after engine start is less than 1.3 kPa, 10 mmHg. ✱2 driving cycle detection logic, monitoring once / 1 driving.	• ECM (barometric pressure sensor) malfunction

DTC CONFIRMATION PROCEDURE

1) Turn ignition switch OFF.
2) Clear DTC with ignition switch ON.
3) Turn ignition switch ON for 2 sec., crank engine for 2 sec. and run it at idle for 1 min.
4) Check pending DTC in “ON BOARD TEST” or “PENDING DTC” mode and DTC in “DTC” mode.

INSPECTION

DTC P1450 :

Substitute a known-good ECM and recheck.

DTC P1451 :

NOTE:

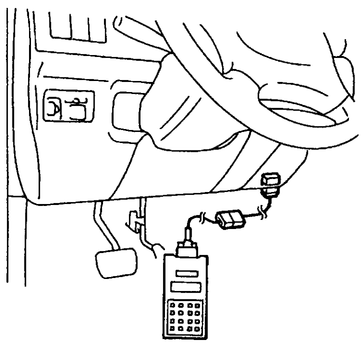
Note that atmospheric pressure varies depending on weather conditions as well as altitude. Take that into consideration when performing these check.

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	1) Connect scan tool to DLC with ignition switch OFF. See Fig.1. 2) Turn ignition switch ON and select “DATA LIST” mode on scan tool. 3) Check manifold absolute pressure. Is it barometric pressure (approx. 100 kPa, 760 mmHg) at sea level?	Substitute a known-good ECM and recheck.	Go to Step 3.

Step	Action	Yes	No
3	Check MAP Sensor 1) Remove MAP sensor from intake manifold and connect vacuum pump gauge to MAP sensor. See Fig. 2. 2) Connect scan tool to DLC and turn ignition switch ON. 3) Check intake manifold absolute pressure displayed on scan tool for specified value. See Table 1. Is check result satisfactory?	Check air intake system for air being drawn in and engine compression. If OK, then substitute a known-good ECM and recheck.	Replace MAP sensor.

[A] Fig. 1 for Step 2 / [B] Fig. 2 for Step 3

[A]



[B]

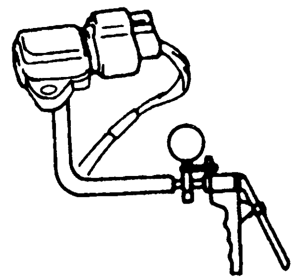
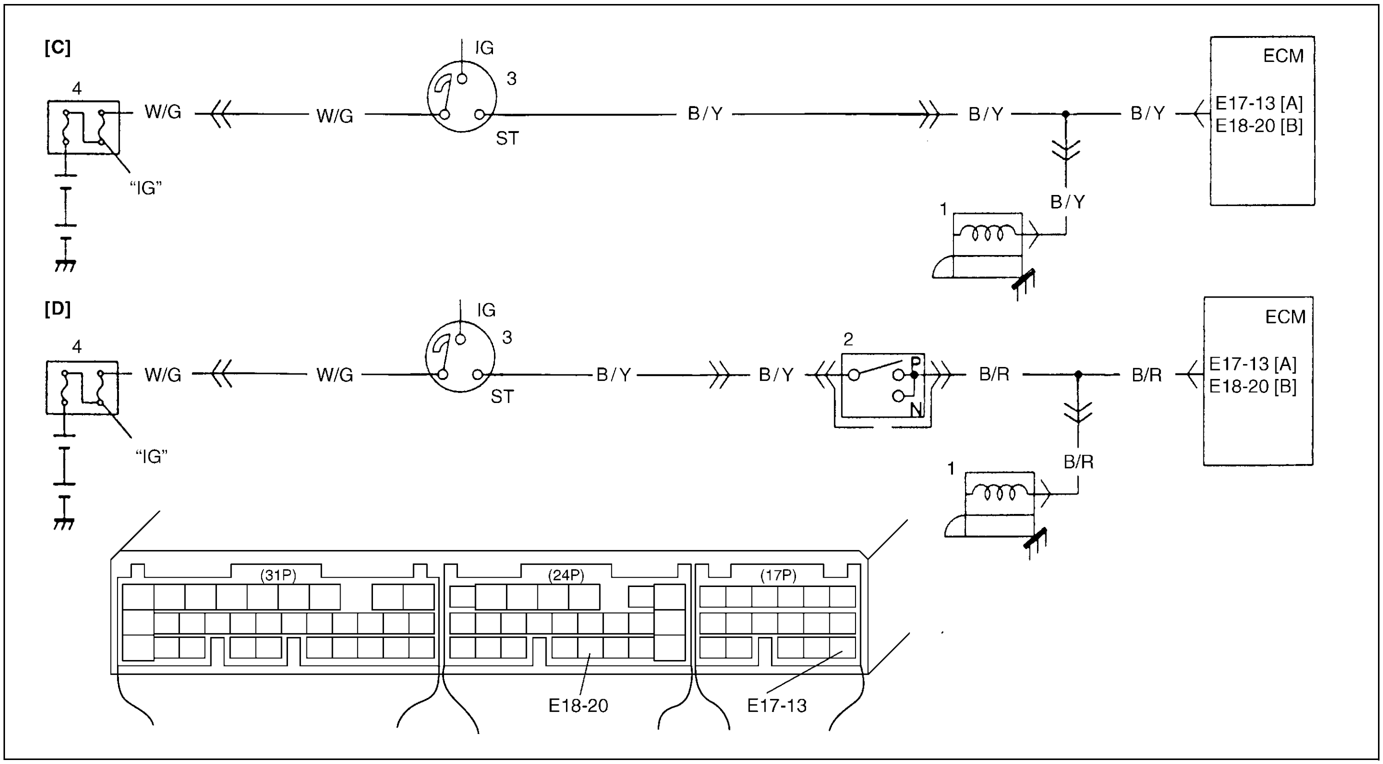


Table 1

Applying Vacuum	Displayed Value on Scan Tool
0	Barometric pressure (Approx. 100 kPa, 760 mmHg)
027 kPa 200 mmHg	Barometric pressure – 27 kPa (Approx. 73 kPa, 560 mmHg)
67 kPa 500 mmHg	Barometric pressure – 67 kPa (Approx. 33 kPa, 260 mmHg)

DTC P1500 Engine Starter Signal Circuit Malfunction

CIRCUIT DESCRIPTION



1. Starter	3. Ignition switch (starter switch)	[A] : Case of TYPE A is shown (See NOTE)	[C] : M/T vehicle
2. Transmission range sensor (switch)	4. Main fuse	[B] : Case of TYPE B is shown (See NOTE)	[D] : A/T vehicle

NOTE:

For TYPE A and TYPE B, refer to the NOTE in "ECM Terminal Voltage Values Table" for applicable model.

DTC DETECTING CONDITION	POSSIBLE CAUSE
• Low voltage at terminal E17-13 or E18-20 when cranking engine or • High voltage at terminal E17-13 or E18-20 after starting engine. ✱2 driving cycle detection logic, continuous monitoring.	• "B/Y" circuit open • ECM malfunction

DTC CONFIRMATION PROCEDURE

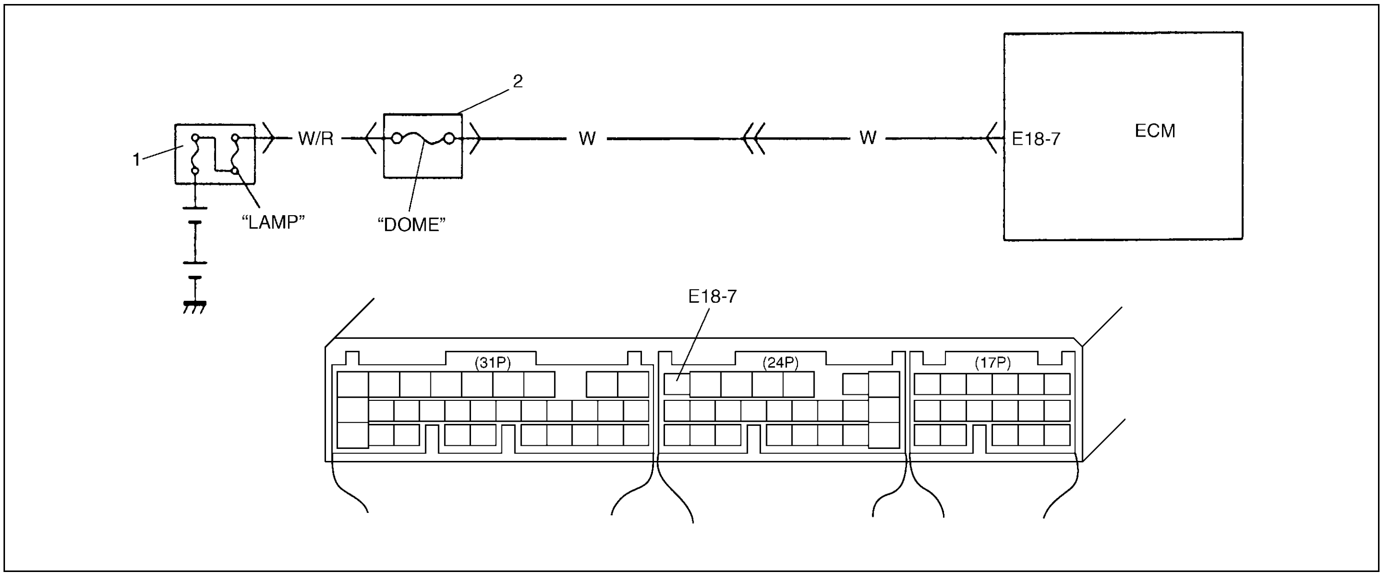
1) Turn ignition switch OFF.
2) Clear DTC with ignition switch ON, crank engine and run it at idle for 3 min.
3) Check pending DTC in "ON BOARD TEST" or "PENDING DTC" mode and DTC in "DTC" mode.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Check for voltage at terminal E17-13 (Case of TYPE A) (See NOTE) or E18-20 (Case of TYPE B) (See NOTE) of ECM connector connected, under following condition. **Engine starter signal specification** **While engine cranking : 6 – 10 V** **After starting engine : 0 V** Is voltage as specified?	Poor E17-13 (Case of TYPE A) (See NOTE) or E18-20 (Case of TYPE B) (See NOTE) connection or intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A. If wire and connections are OK, substitute a known-good ECM and recheck.	“B/Y” or “B/R” circuit open.

DTC P1510 ECM Back-up Power Supply Malfunction

CIRCUIT DESCRIPTION



1.	Main fuse
2.	Fuse box

Battery voltage is supplied so that diagnostic trouble code memory, values for engine control learned by ECM, etc. are kept in ECM even when the ignition switch is turned OFF.

DTC DETECTING CONDITION	POSSIBLE CAUSE
• Low voltage at terminal E18-7 after starting engine.	• "W" circuit open • ECM malfunction

DTC CONFIRMATION PROCEDURE

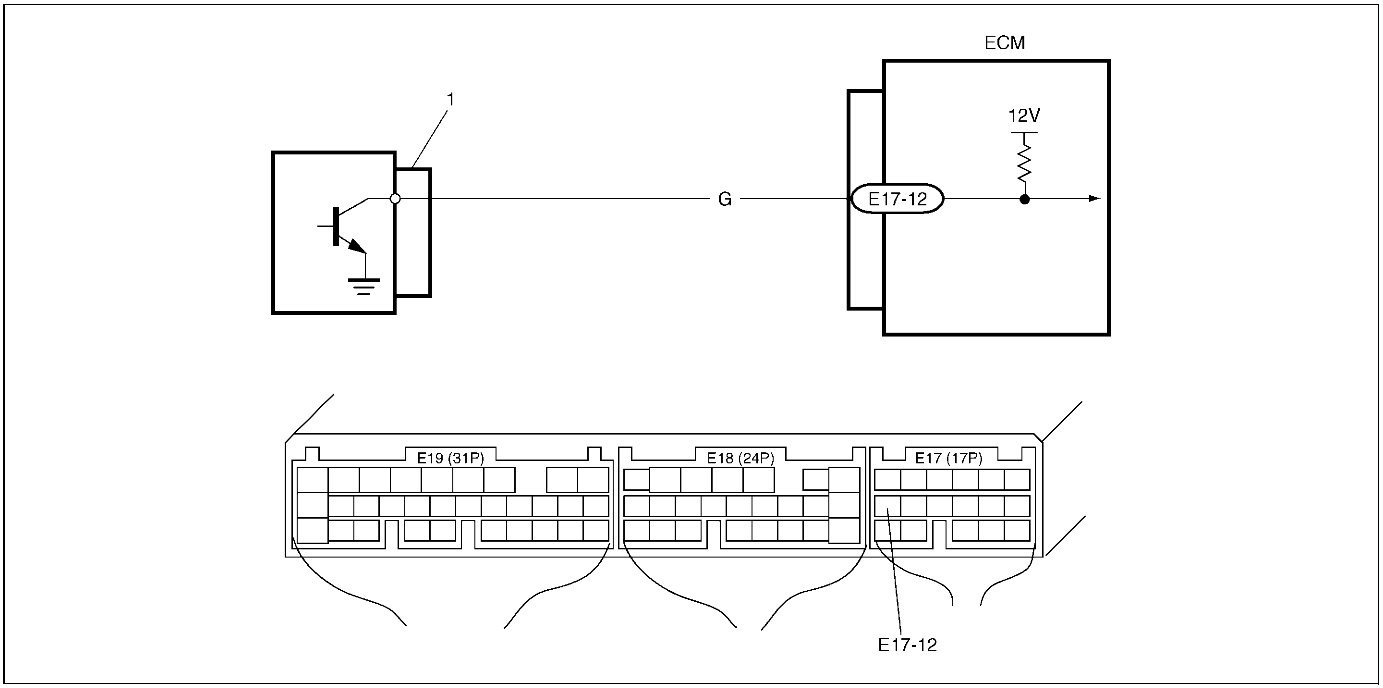
1) Clear DTC, start engine and run it at idle for 1 min.
2) Select "DTC" mode on scan tool and check DTC.

INSPECTION

Step	Action	Yes	No
1	Check for voltage at terminal E18-7 of ECM connector connected, under each condition, ignition switch OFF and engine running. Is it 10 – 14 V at each condition?	Poor E18-7 connection or intermittent trouble. Check for intermittent referring to "Intermittent and Poor Connection" in Section 0A. If wire and connections are OK, substitute a known- good ECM and recheck.	"W" circuit open.

DTC P1570 (DTC No.21) ABS Signal Circuit Malfunction

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
• ABS signal input is low when engine start.	• ABS signal circuit short to ground • ABS control module

DTC CONFIRMATION PROCEDURE

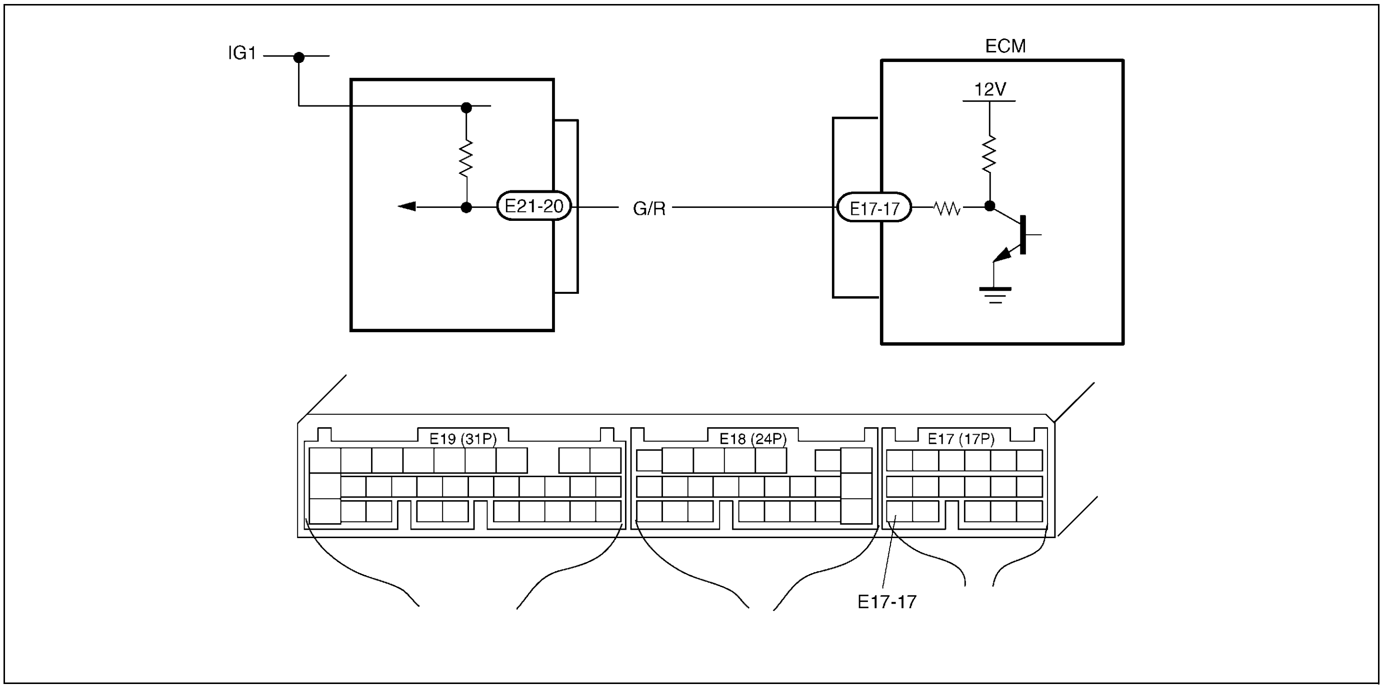
1) Clear DTC, start engine and keep it at idle for 1 min.
2) Select "DTC" mode on scan tool and check DTC.

INSPECTION

Step	Action	Yes	No
1	Was "Engine Diag. Flow Table" performed?	Go to Step 2.	Go to "Engine Diag. Flow Table".
2	1) With the ignition switch ON position, check voltage between E17-12 terminal of ECM coupler and ground. Is voltage within 10 – 14 V?	Intermittent trouble. If OK, substitute a known-good ECM and recheck.	Go to Step 3.
3	1) Check "G" wire for shorted to ground circuit. Is "G" wire in good condition?	Go to Step 4.	Repair or replace.
4	1) Disconnect coupler of ABS control module. 2) Clear DTC. 3) Start engine and check DTC. Is DTC P1570 (No.21) detected?	Substitute a known-good ECM and recheck.	Substitute a known-good ABS control module and recheck.

DTC P1600 Serial Communication Problem Between ECM and TCM

CIRCUIT DESCRIPTION



The serial data line is pulled up to about 12 V by ECM and TCM transmits information to ECM through it by controlling its grounding.
TCM constantly sends information while ignition switch is ON as to whether judgement was made or not with respect to all detectable DTCs as well as whether or not abnormality exists after judgement.

DTC DETECTING CONDITION	POSSIBLE CAUSE
No signal inputted from TCM to ECM or check sum error while engine running	• “G/R” circuit open or short • TCM power or ground circuit open. • TCM malfunction • ECM malfunction

DTC CONFIRMATION PROCEDURE

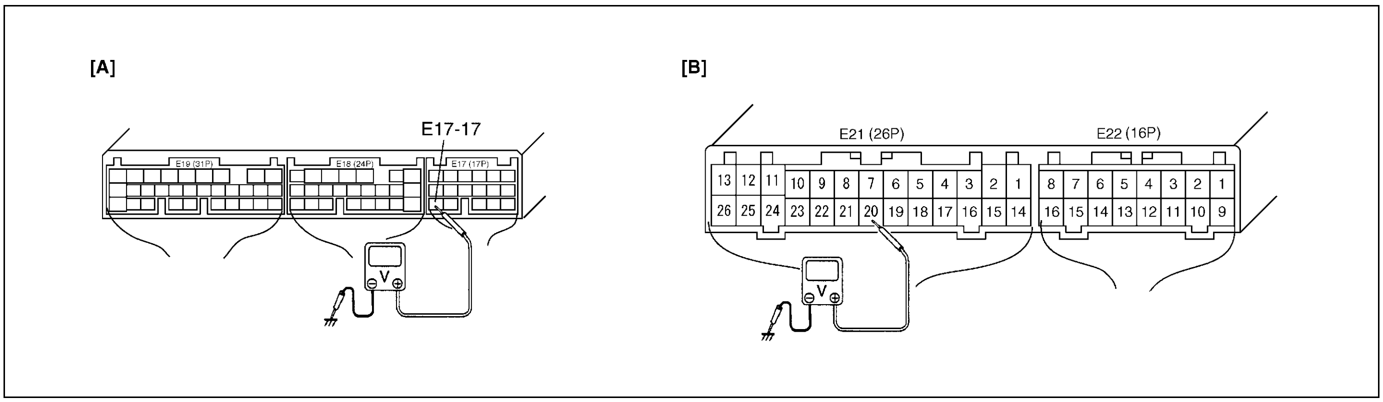
1) Turn ignition switch OFF.
2) Clear DTC with ignition switch ON.
3) Start engine and run it at idle for 1 min.
4) Select “DTC” mode on scan tool and check DTC.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Check signal voltage. Check voltage between terminal E17-17 and body ground with ignition switch ON. See Fig. 1. Does it change between 0 – 12 V?	Intermittent trouble or faulty ECM or TCM. Check for intermittent trouble referring to “Intermittent and Poor Connection” in Section 0A.	Go to Step 3.

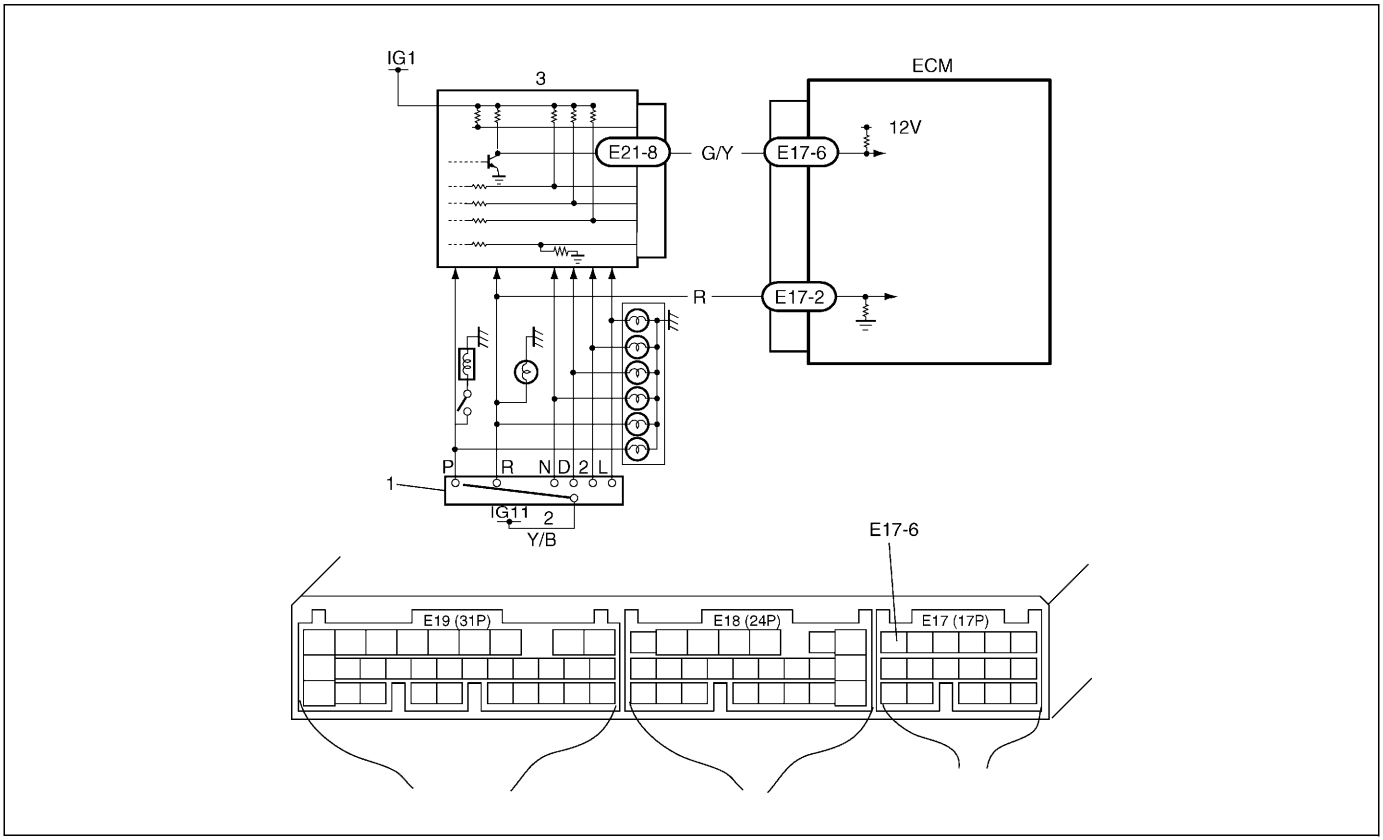
Step	Action	Yes	No
3	Is it about 12 V at Step 2?	"B/R" wire open, poor E21-11 connection or TCM power or ground circuit open. If wires and connections are OK, substitute a known-good TCM and recheck.	Go to Step 4.
4	Check signal circuit. 1) Disconnect TCM coupler with ignition switch OFF. 2) Check voltage between E21-20 terminal and body ground with ignition switch ON. See Fig. 2. Is it about 12 V?	Check TCM power and ground circuit for open. If OK, substitute a known-good TCM and recheck.	"B/R" wire shorted to ground or poor E17-17 terminal connection. If wire and connection are OK, substitute a known-good ECM and recheck.

[A] Fig. 1 for Step 2 / [B] Fig. 2 for Step 4



DTC P1717 A/T Drive Range (Park / Neutral Position) Signal Circuit Malfunction

CIRCUIT DESCRIPTION



1. Transmission range switch	2. From ignition switch	3. TCM

DTC DETECTING CONDITION	POSSIBLE CAUSE
• "D" range signal not inputted (Park / Neutral position signal inputted) to ECM while vehicle running ✱2 driving cycle detection logic, Continuous monitoring.	• "G/Y" circuit open • Transmission range switch malfunction • "R", "D", "2" or "L" range signal circuit open • TCM power or ground circuit open • TCM malfunction • ECM malfunction

DTC CONFIRMATION PROCEDURE

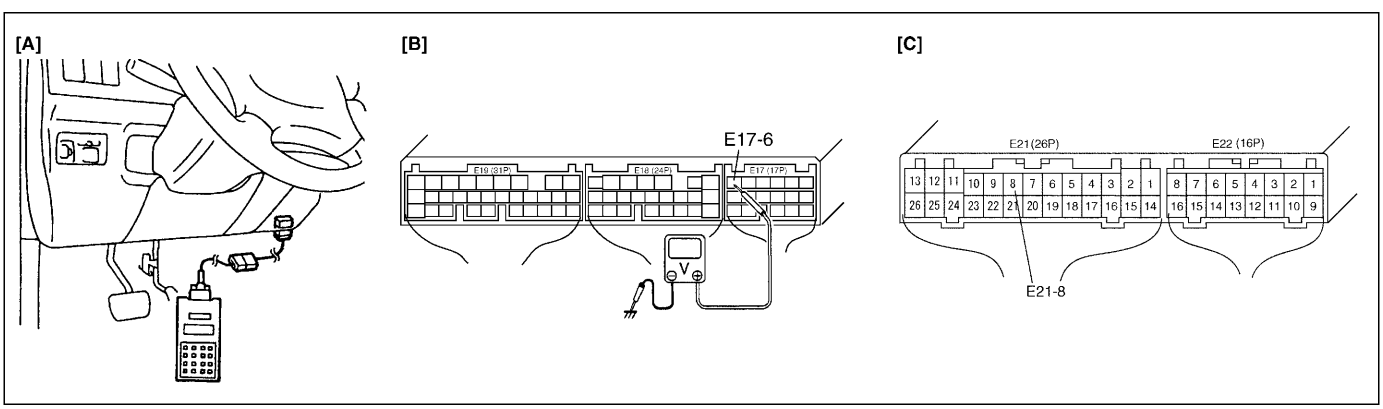
WARNING:
- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester.**

1) Turn ignition switch OFF.
2) Clear DTC with ignition switch ON.
3) Start engine and shift selector lever to "D" range.
4) Increase vehicle speed to higher than 20 mph, 32 km/h and then stop vehicle.
5) Repeat above step 4) 9 times.
6) Shift selector lever to "2" range and repeat above step 4) and 5).
7) Shift selector lever to "L" range and repeat above step 4) and 5).
8) Check DTC in "DTC" mode and pending DTC in "ON BOARD TEST" or "PENDING DTC" mode.

INSPECTION

Step	Action	Yes	No
1	Was “Engine Diag. Flow Table” performed?	Go to Step 2.	Go to “Engine Diag. Flow Table”.
2	Is SUZUKI scan tool available?	Go to Step 3.	Go to Step 4.
3	Check PNP signal (“D” range signal). 1) Connect SUZUKI scan tool to DLC with ignition switch OFF. See Fig. 1. 2) Turn ignition switch ON and check PNP signal (“P/N” or “D” range) on display when shifting selector lever to each range. Is “D” range on display (Is 0 – 1 V indicated) no matter which of “R”, “D”, “2” and “L” range positions selector lever may be at? See Table 1.	Intermittent trouble or faulty ECM. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.	Go to Step 5.
4	Check PNP Signal (“D” range signal). 1) Turn ignition switch ON. 2) Check voltage at terminal E17-6 of ECM connector connected. See Fig. 2. Is “D” range on display (Is 0 – 1 V indicated) no matter which of “R”, “D”, “2” and “L” range positions selector lever may be at? See Table 1.	Intermittent trouble or faulty ECM. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.	Go to Step 5.
5	Is “P/N” range on display (Is 10 – 14 V indicated) when selector lever is at one of “R”, “D”, “2” and “L” range positions only?	Check transmission range switch and circuits referring to Section 7B.	Go to Step 6.
6	Check PNP signal circuit. 1) Turn ignition switch OFF. 2) Disconnect TCM connectors. 3) Check for proper connection to TCM at terminal E21-5. 4) If OK, then check voltage at terminal E21-8 in TCM connector disconnected, with ignition switch ON. See Fig. 3 Is it 10 – 14 V?	“Y/B” circuit open, poor transmission range sensor connector connection, select cable maladjusted, transmission range sensor maladjusted or transmission range sensor malfunction. If all above are OK, substitute a known-good TCM and recheck.	“G/Y” circuit open or poor E17-6 connection. If wire and connection are OK, substitute a known-good ECM and recheck.

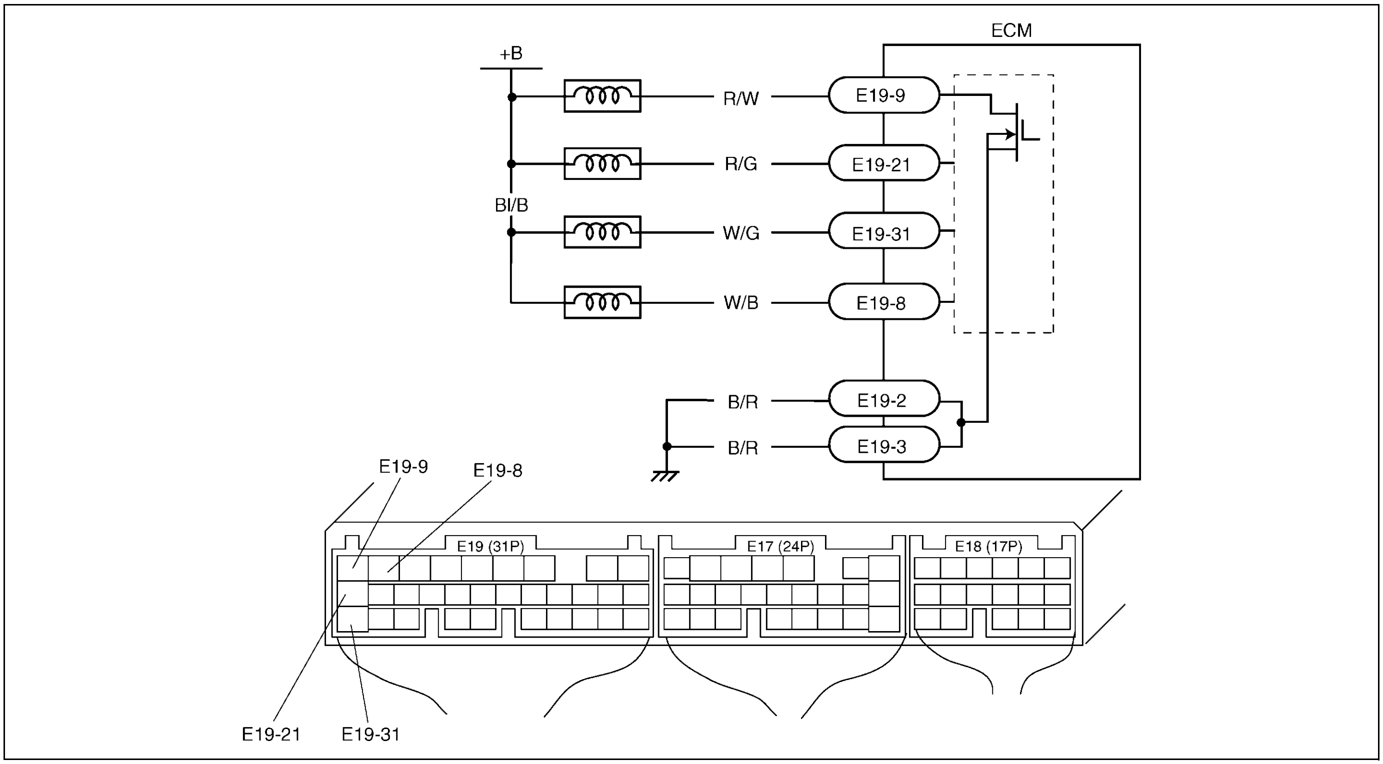
[A] Fig. 1 for Step 3 / [B] Fig. 2 for Step 4 / [C] Fig. 3 for Step 6



[D] Table 1 for Step 3 and 4

		Scan tool voltmeter	
		SUZUKI SCAN TOOL DISPLAY	VOLTAGE AT E17-6
Selector lever position	"P" and "N" range	P/N range	10 – 14V
	"R", "D", "2" and "L" range	D range	0 – 1V

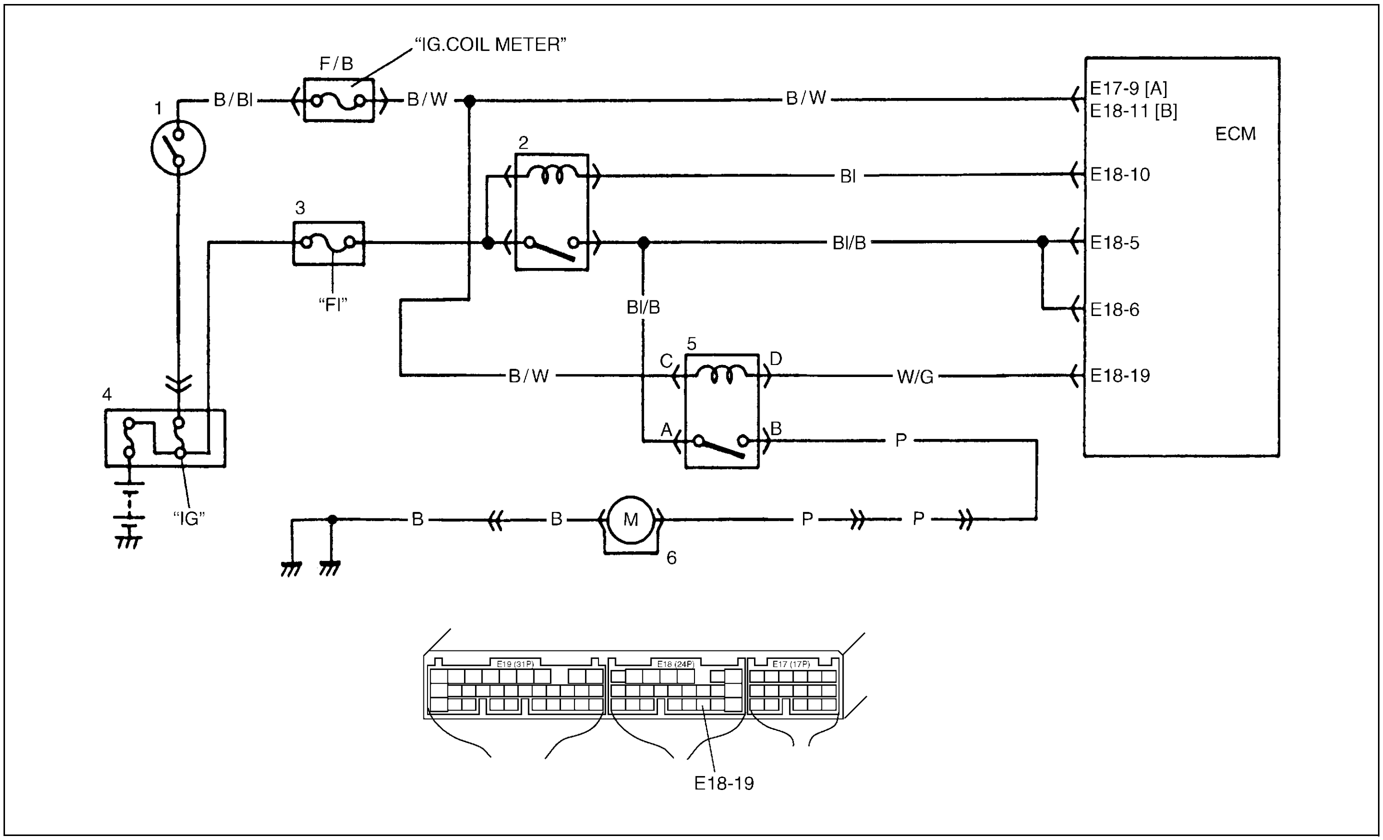
Table B-1 Fuel Injector Circuit Check



INSPECTION

Step	Action	Yes	No
1	Was "Engine Diag. Flow Table" performed?	Go to Step 2.	Go to "Engine Diag. Flow Table".
2	Check Injector for Operating Sound. Using sound scope, check each injector for operating sound at engine cranking. Do all 4 injector make operating sound?	Fuel injector circuit is in good condition.	Go to Step 3.
3	Dose none of 4 injectors make operating sound at Step 2?	Go to Step 4.	Check coupler connection and wire harness of injector not making operating sound and injector itself (Refer to Section 6E).
4	Check power circuit of injectors for open and short. Is it normal?	Check all 4 injectors for resistance respectively. If resistance is OK, substitute a known-good ECM and recheck.	Power circuit open or short.

Table B-2 Fuel Pump and Its Circuit Check



1. Ignition switch	3. Main relay	5. Fuel pump relay	[A] : Case of TYPE A is shown (See NOTE)
2. Main relay	4. Main fuse	6. Fuel pump	[B] : Case of TYPE B is shown (See NOTE)

NOTE:

For TYPE A and TYPE B, refer to the NOTE in "ECM Terminal Voltage Values Table" for applicable model.

INSPECTION

Step	Action	Yes	No
1	Was "Engine Diag. Flow Table" performed?	Go to Step 2.	Go to "Engine Diag. Flow Table".
2	Check Fuel Pump Control System for Operation. See Fig. 1. Is fuel pump heard to operate for 2 sec. after ignition switch ON?	Fuel pump circuit is in good condition.	Go to Step 3.
3	Check Fuel Pump for Operation. 1) Remove fuel pump relay from relay box with ignition switch OFF. 2) Check for proper connection to relay at each terminals. 3) If OK, using service wire, connect terminals "A" and "B" of relay connector. See Fig. 2 and CAUTION. Is fuel pump heard to operate at ignition switch ON?	Go to Step 4.	"P", "B" or "Bl/B" circuit open or fuel pump malfunction.

Step	Action	Yes	No
4	Check Fuel Pump Relay for Operation. 1) Check resistance between each two terminals of fuel pump relay. See Fig.3. **Fuel pump relay resistance** **Between terminals “A” and “B” : Infinity** **Between terminals “C” and “D”: 100 – 150 Ω** 2) Check that there is continuity between terminals “A” and “B” when battery is connected to terminals “C” and “D”. See Fig. 3. Is fuel pump relay in good condition?	“W/G” circuit open or poor E18-19 connection. If wire and connection are OK, substitute a known-good ECM and recheck.	Replace fuel pump relay.

CAUTION:

Check to make sure that connection is made between correct terminals. Wrong connection can cause damage to ECM, wire harness, etc.

[A] Fig. 1 for Step 2 / [B] Fig. 2 for Step 3 / [C] Fig. 3 for Step 4

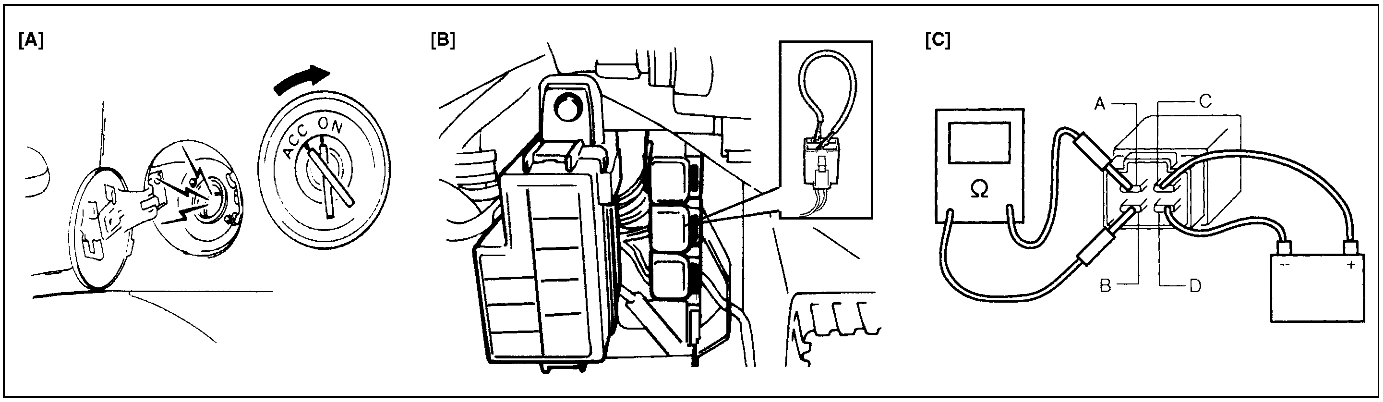
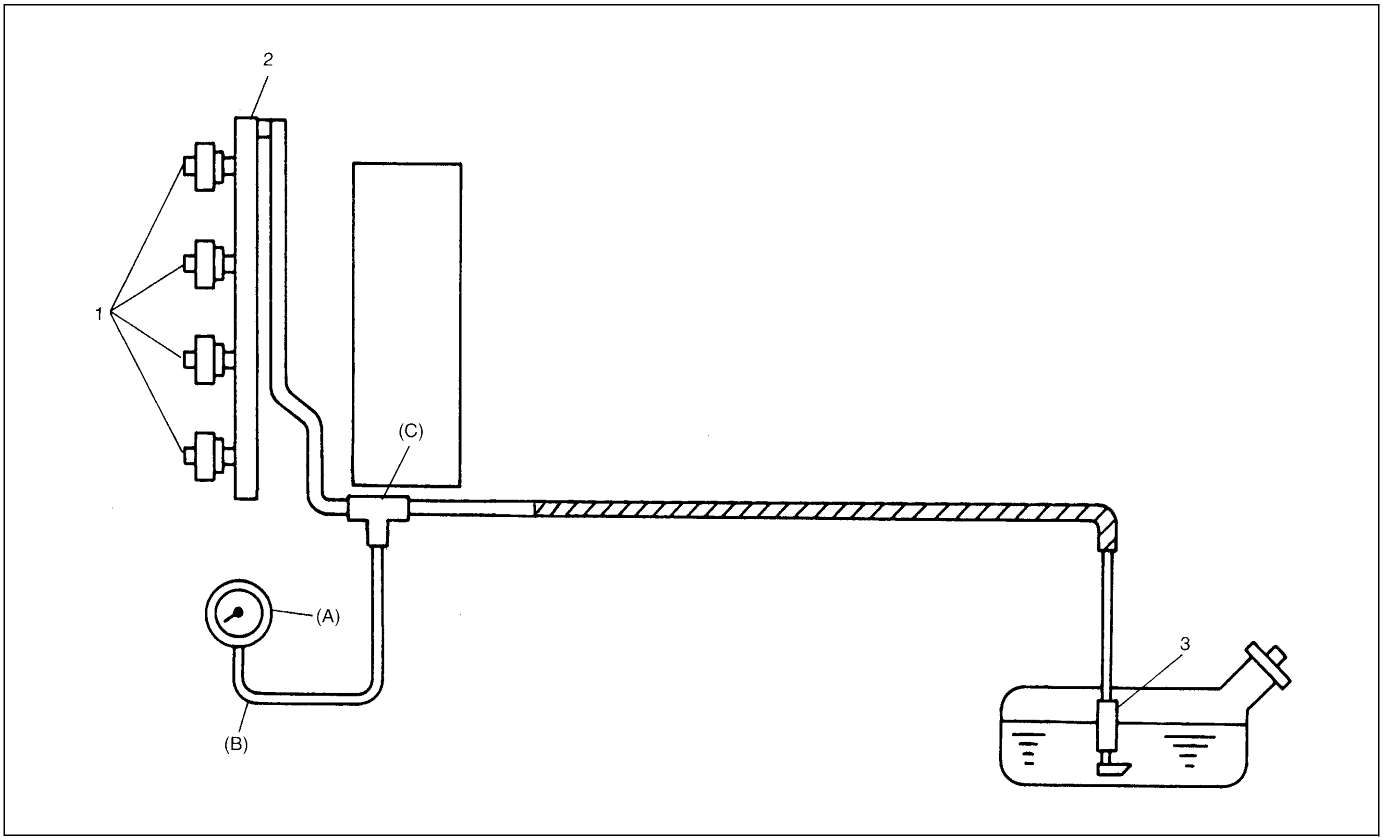


Table B-3 Fuel Pressure Check

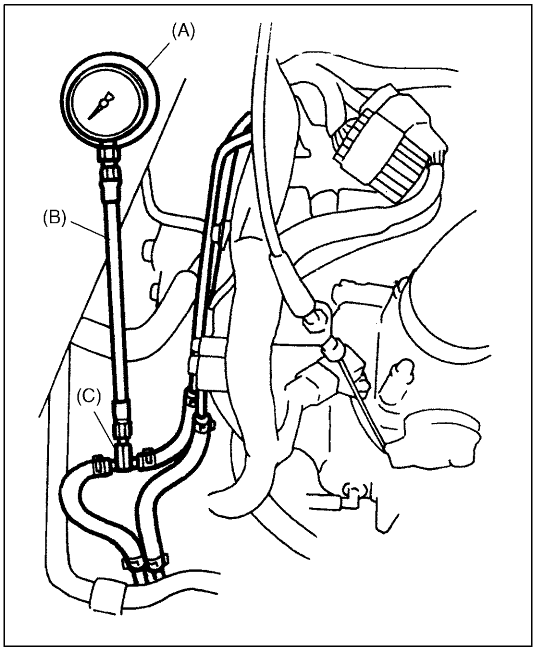


1. Injector	3. Fuel pump	(B) : Hose
2. Delivery pipe	(A) : Fuel pressure gauge	(C) : Attachment

INSPECTION

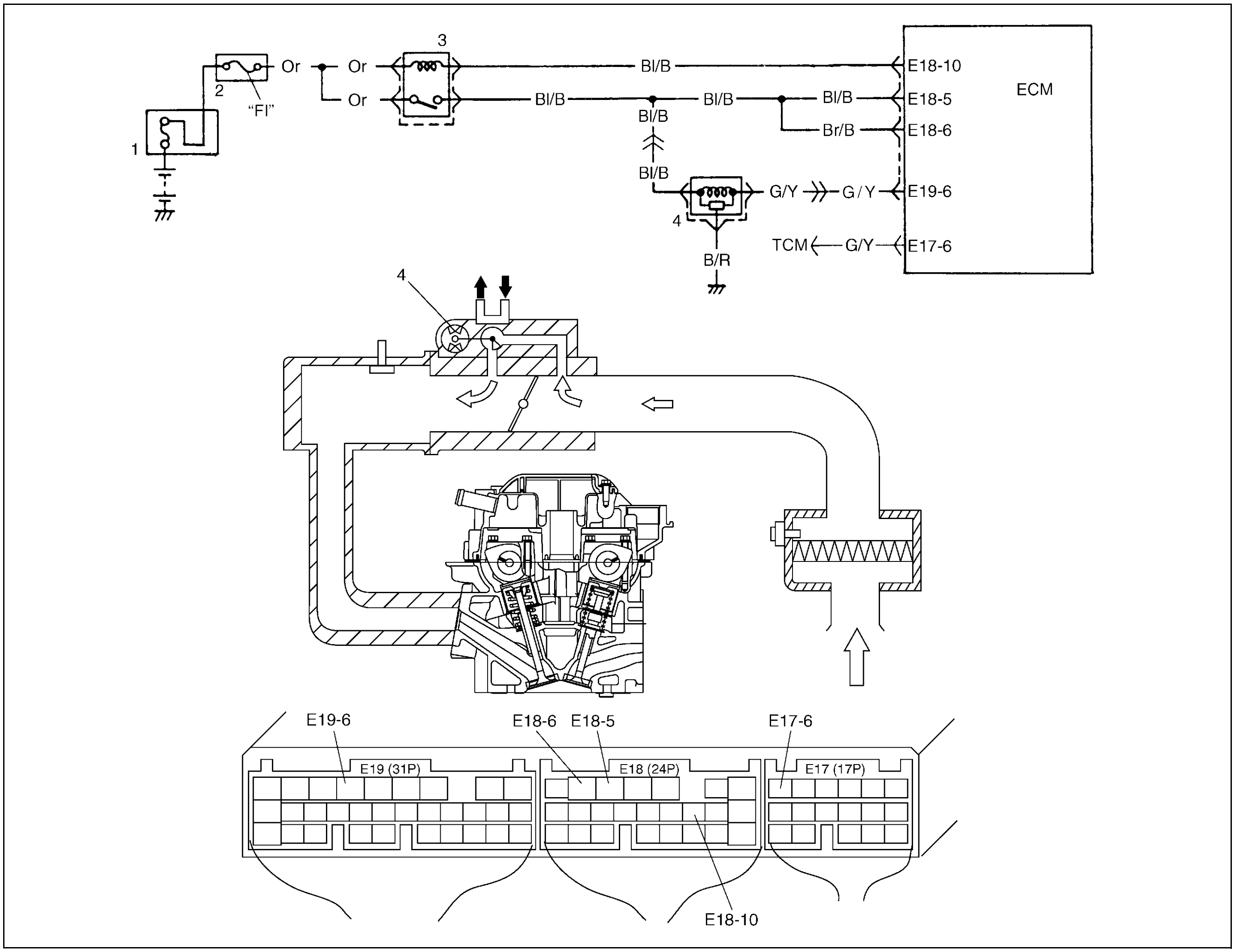
Step	Action	Yes	No
1	Check Fuel Pressure (Refer to Section 6E for details). 1) Release fuel pressure from fuel feed line. 2) Install fuel pressure gauge. See Fig.1. 3) Check fuel pressure by repeating ignition switch ON and OFF. Is fuel pressure then 270 – 310 kPa (2.7 - 3.1 kg/cm^2, 38.4 – 44.0 psi)?	Go to Step 2.	Go to Step 4.
2	Is 250 kPa (2.5 kg/cm^2, 35.6 psi) or higher fuel pressure retained for 1 minute after fuel pump is stopped at Step 1?	Normal fuel pressure.	Go to Step 3.
3	Is there fuel leakage from fuel feed line hose, pipe or their joint?	Fuel leakage from hose, pipe or joint.	Faulty fuel pressure regulator.
4	Was fuel pressure higher than spec. in Step 1?	Faulty fuel pressure regulator.	Clogged fuel filter, Restricted fuel feed hose or pipe, Faulty fuel pump or Fuel leakage from hose connection in fuel tank.

Fig. 1 for Step 1



Special tool
(A) : 09912-58441
(B) : 09912-58431
(C) : 09912-58490

Table B-4 Idle Air Control System Check



1. Main fuse	2. Fuse box	3. Main relay	4. IAC valve

INSPECTION

Step	Action	Yes	No
1	Check engine idle speed and IAC duty referring to "Idle Speed / IAC Duty Inspection" in Section 6E. Is idle speed within specification?	Go to Step 2.	Go to Step 4.
2	Is IAC duty within specification in Step 1?	Go to Step 3.	Check for followings : • Vacuum leak • EVAP canister purge control system • Clog of IAC air passage • Accessory engine load • Closed throttle position (TP sensor) • Stuck of PCV valve

Step	Action	Yes	No
3	Is engine idle speed kept specified speed even with headlight ON?	System is in good condition.	Check IAC system for operation referring to Step 3 or Step 4 of DTC P0505 Diag. Flow Table.
4	Was idle speed higher than specification in Step 1?	Go to Step 5.	Go to Step 8.
5	Check A/C (input) signal circuit referring to Step 1 of Table B-5 A/C Signal Circuit Check, if equipped. (A/C signal can be also checked by using SUZUKI scan tool.) Is it in good condition?	Go to Step 6.	Repair or replace A/C signal circuit or A/C system.
6	Check IAC system referring to Step 2 to Step 4 of DTC P0505 Diag. Flow Table. Is check result satisfactory?	Go to Step 7.	Go to Step 5 of DTC P0505 Diag. Flow Table.
7	Was IAC duty less than about 3% (or more than about 97% for OFF duty meter) in Step 1 of this table?	Check abnormal air inhaling from air intake system, PCV valve and EVAP canister purge control system.	Check TP sensor (closed throttle position) and ECT sensor for performance. If sensors are OK, substitute a known-good ECM.
8	Is SUZUKI scan tool available?	Go to Step 9.	Go to Step 10.
9	Check PNP signal ("D" range signal). 1) Connect SUZUKI scan tool to DLC with ignition switch OFF. 2) Turn ignition switch ON and check PNP signal ("P/N" and "D" range) on display when shifting selector lever to each range. See Table 1. Is check result satisfactory?	Go to Step 11.	Repair or replace.
10	Check PNP signal ("D" range signal). 1) Turn ignition switch ON. 2) Check voltage at terminal E17-6 of ECM connector connected. See Fig. 1 and Table 1. Is check result satisfactory?	Go to Step 11.	Repair or replace.
11	Check IAC system referring to Step 2 to Step 4 of DTC P0505 Diag. Flow Table. Is check result satisfactory?	Go to Step 12.	Go to Step 5 of DTC P0505 Diag. Flow Table.
12	Was IAC duty more than about 30% or ✱40% (or less than 70% or ✱60% for OFF duty meter) in Step 1 of this table? See NOTE.	Check parts or system which can cause engine low idle. • Accessory engine load • Clog of air passage • Etc.	Substitute a known-good ECM and recheck.

NOTE:

Duty value with (✱) are applicable to vehicle used at high altitude (higher than 2000 m or 6560 ft).

Fig. 1 for Step 10

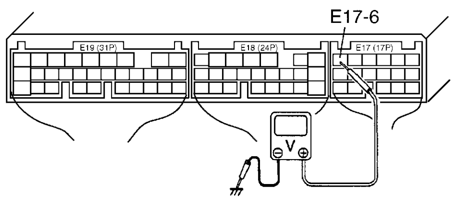
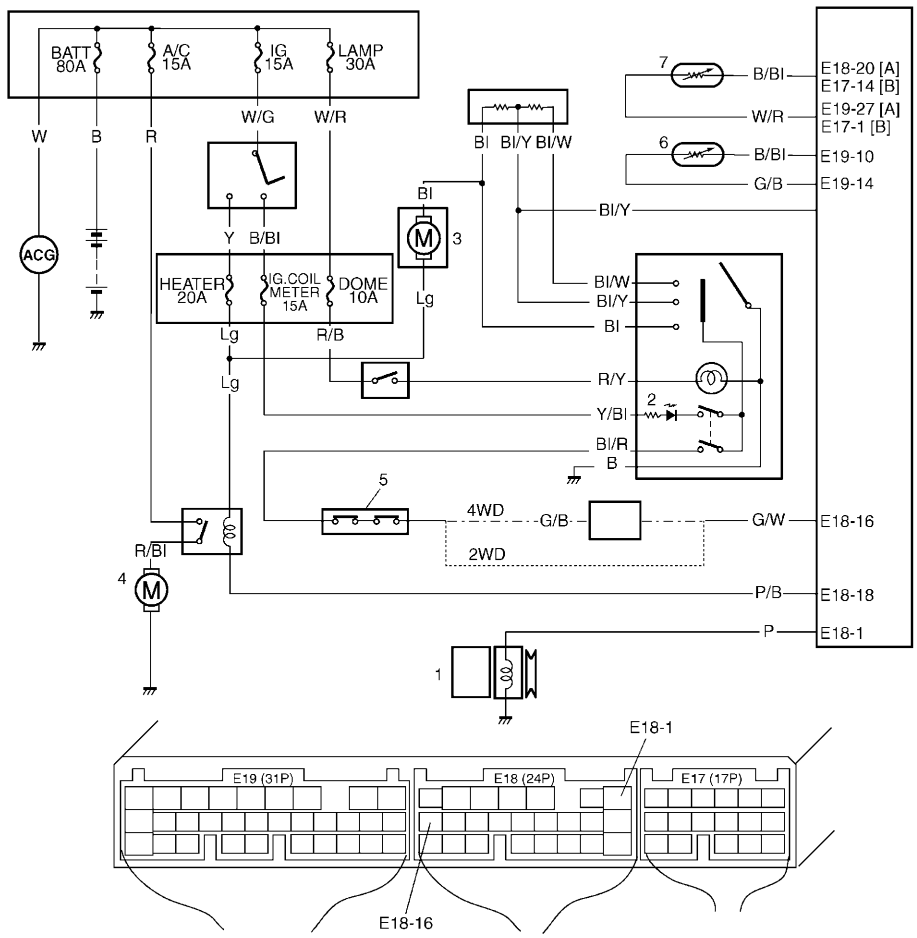


Table 1 for Step 9 and 10

		Scan tool or voltmeter	
		SUZUKI SCAN TOOL DISPLAY	VOLTAGE AT E17-6
Selector lever position	“P” and “N” range	P/N range	10 – 14V
	“R”, “D”, “2” and “L” range	D range	0 – 1V

Table B-5 A/C Signal Circuits Check (Vehicle with A/C)



1. A/C compressor magnet clutch	4. A/C condenser fan	7. Evaporator temp. sensor
2. A/C switch	5. Refrigerant pressure switch	[A] : Case of TYPE A is shown (See NOTE)
3. Blower fan	6. ECT sensor	[B] : Case of TYPE B is shown (See NOTE)

NOTE:

For TYPE A and TYPE B, refer to the NOTE in "ECM Terminal Voltage Values Table" for applicable model.

INSPECTION

Step	Action	Yes	No
1	Check evaporator temp. sensor. 1) Disconnect ECM connectors with ignition switch at OFF position. 2) Check resistance between E19-14 terminal and E19-10 terminal. Reference value (Refer to characteristic curve below) **ECT sensor resistance** **At 0°C 6.3 – 6.9 kΩ** **At 25°C 1.8 – 2.2 kΩ** Is it within specification?	Go to Step 2.	Faulty A/C evaporator thermistor or its circuit.
2	Check A/C switch circuit. 1) Check voltage at E18-16 terminal under each condition given below. **A/C switch signal specification** **Ignition switch ON A/C switch OFF** **: 10 – 14 V** **Ignition switch ON A/C switch ON** **: 0 – 1 V** Is check result satisfactory?	Go to Step 3.	"G/W" wire open or short Poor E18-16 terminal connection If wire and connection are OK, substitute a known-good ECM and recheck. Go to Step 3.
3	Check A/C compressor signal. 1) Check voltage at E18-1 terminal under each condition given below. See NOTE. **A/C compressor signal specification** **While engine running, A/C switch OFF** **: 0 V** **While engine running, A/C switch ON** **: 10 – 14 V** Is check result satisfactory?	A/C control system circuits are in good condition.	"P" wire open or short Poor E18-1 terminal connection If wire and connection are OK, substitute a known-good ECM and recheck.

NOTE:

When A/C evaporator thermistor temp. is below 2.5 °C (36.5 °F), A/C remain OFF (E18-1 terminal voltage become 0 – 1 V). This condition is not abnormal.

Fig. 1 for Step 1

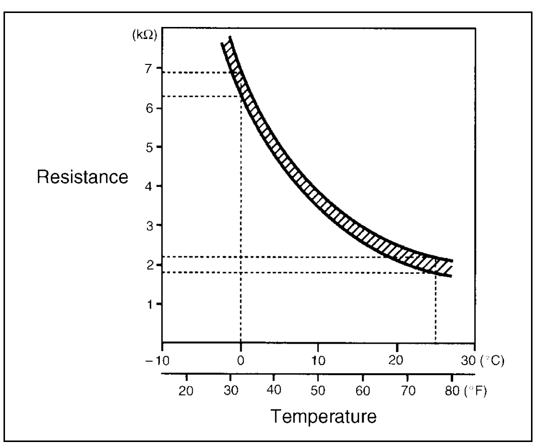
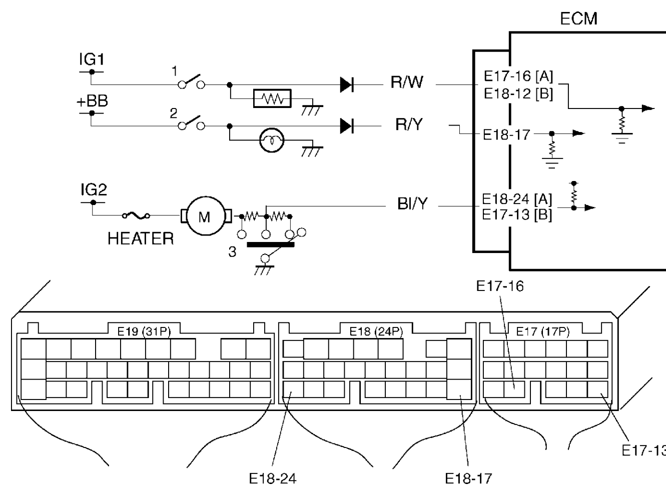


Table B-6 Electric Load Signal Circuit Check



1. Rear defogger switch	3. Blower fan switch	[B] : Case of TYPE B is shown (See NOTE)
2. Light switch	[A] : Case of TYPE A is shown (See NOTE)	

NOTE:

For TYPE A and TYPE B, refer to the NOTE in "ECM Terminal Voltage Values Table" for applicable model.

INSPECTION

Step	Action	Yes	No
1	Is SUZUKI scan tool available?	Go to Step 2.	Go to Step 3.
2	Check Electric Load Signal Circuit. 1) Connect SUZUKI scan tool to DLC with ignition switch OFF. See Fig.1. 2) Start engine and select "DATA LIST" mode on scan tool. 3) Check electric load signal under following each condition. See Table 1. Is check result satisfactory?	Electric load signal circuit is in good condition.	"R/W", "R/Y" and/or "Bl/Y" circuit open or short, Electric load diodes malfunction or Each electric load circuit malfunction.
3	Check Electric Load Signal Circuit. 1) Turn ignition switch ON. 2) Check voltage at each terminals E17-16, E18-17 and E18-24 (Case of TYPE A) or E18-12, E18-17 and E17-13 (Case of TYPE B) (See NOTE) of ECM connector connected, under above each condition. See Fig. 2. and Table 1. Is each voltage as specified?	Electric load signal circuit is in good condition.	"R/W", "R/Y" and/or "Bl/Y" circuit open or short, Electric load diodes malfunction or Each electric load circuit malfunction.

[A] Fig. 1 for Step 2 / [B] Fig. 2 for Step 3

[A] [B]

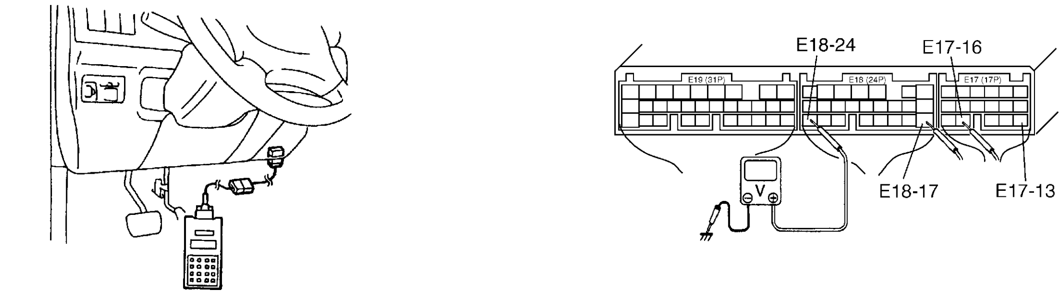
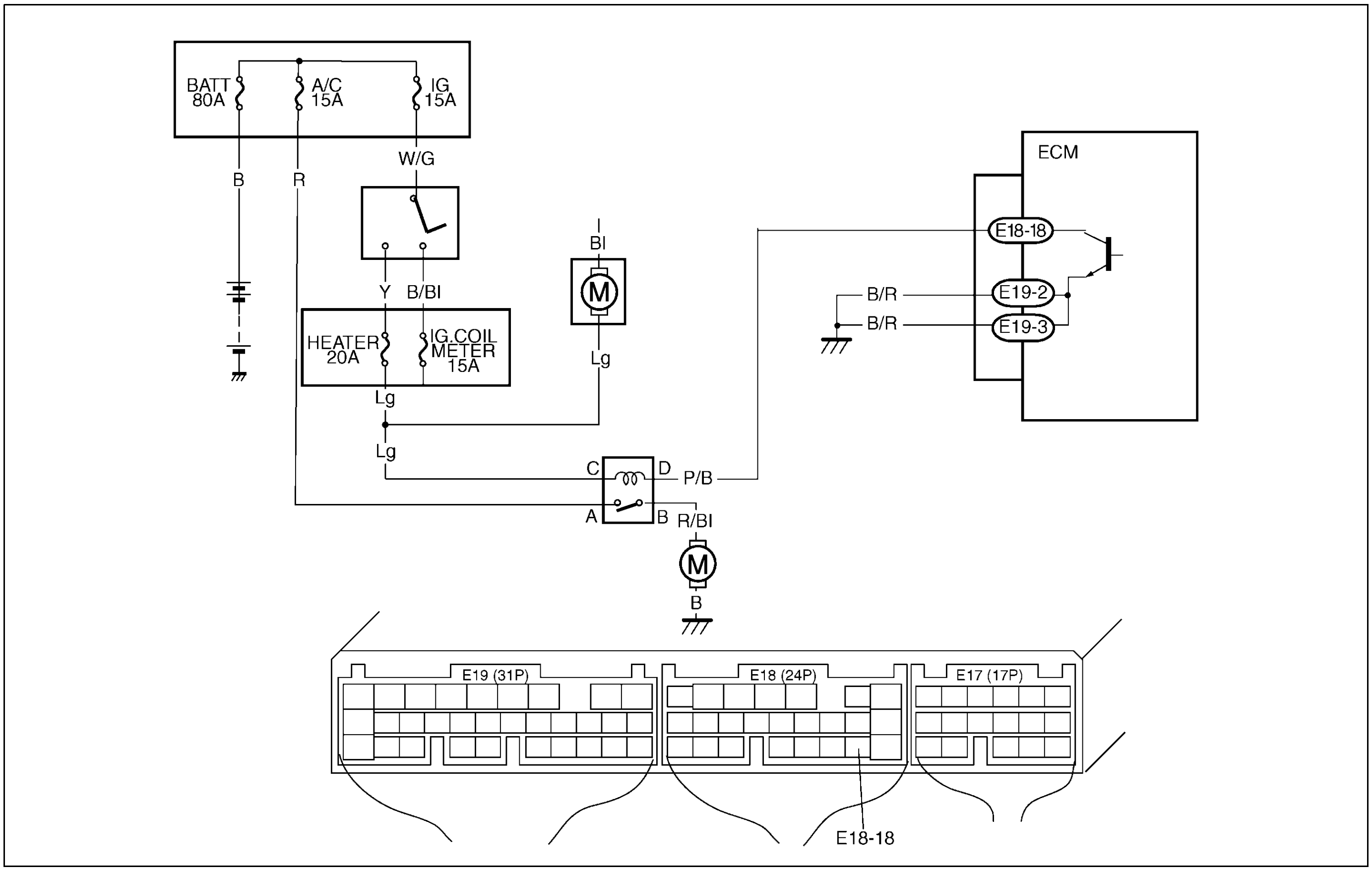


Table 1 for Step 2 and 3

		Scan tool or voltmeter		
		SUZUKI SCAN TOOL	VOLTAGE AT E18-17, E17-16 or E18-12	VOLTAGE AT E18-24 or E17-13
Ignition switch ON, Small light, heater blower fan and rear defogger all turned	OFF	OFF	0V	10 – 14V
	ON	ON	10 – 14V	0V

TAble B-7 A/C Condenser Fan Control System Check



INSPECTION

Step	Action	Yes	No
1	Check Fan Control System. 1) Connect scan tool to DLC with ignition switch OFF. See Fig. 1. 2) Start engine and select "DATA LIST" mode on scan tool. 3) Warm up engine until coolant temp. is 110 °C, 230 °F or higher and A/C switch turn OFF. (If engine coolant temp. does not rise, check engine cooling system or ECT sensor.) Is A/C condenser fan started when engine coolant temp. reached above temp.?	A/C condenser fan control system is in good condition.	Go to Step 2.
2	Check A/C Condenser Fan Relay and Its Circuit. 1) Check DTC and pending DTC with scan tool. Is DTC P0481 displayed?	Go to DTC P0481 Diag. Flow Table.	Go to Step 3.
3	Check A/C Condenser Fan Relay (1). 1) Turn ignition switch OFF and remove A/C condenser fan relay. 2) Check for proper connection to relay at terminals "A" and "B". 3) If OK, check that there is continuity between "A" and "B" when battery is connected to terminals "C" and "D". See Fig. 2. Is check result satisfactory?	Go to Step 4.	Replace A/C condenser fan relay.

Step	Action	Yes	No
4	Check A/C Condenser Fan (1). 1) Turn ignition switch OFF. 2) Disconnect fan motor connector (2). 3) Check for proper connection to motor at “R/Bl” and “B” terminals. 4) If OK, connect battery to motor and check for operation. See Fig. 3. Is it in good condition?	“R”, “R/Bl” or “B” circuit open.	Replace A/C condenser fan motor.

[A] Fig. 1 for Step 1 / [B] Fig. 2 for Step 3

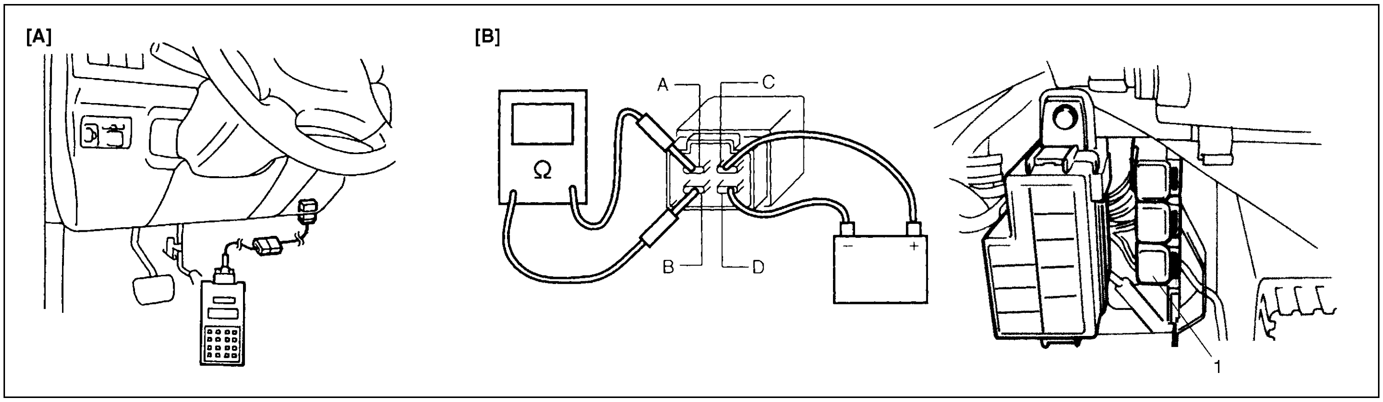
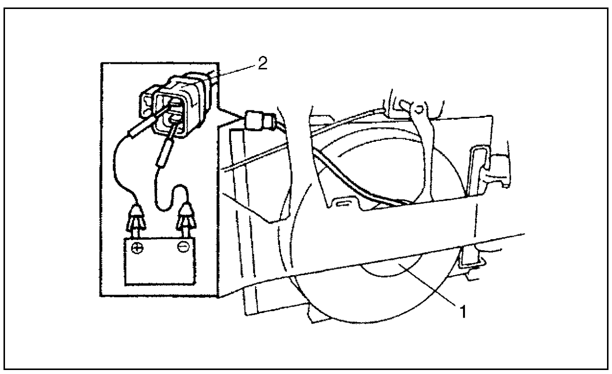
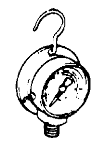
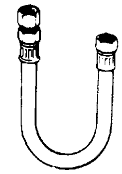
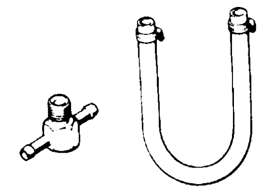
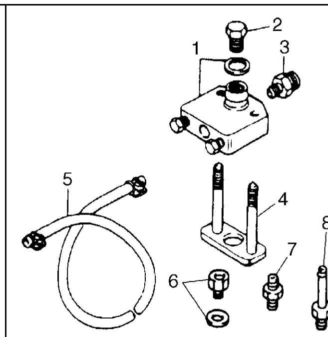
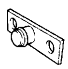
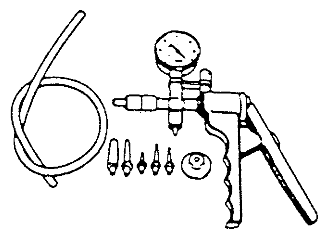
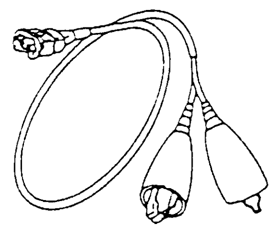
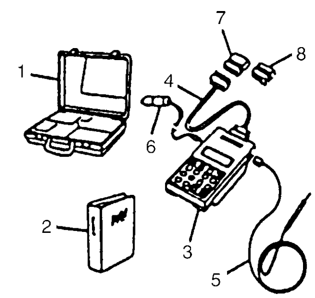
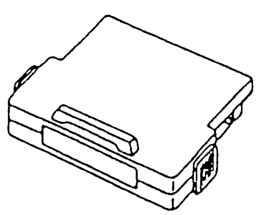
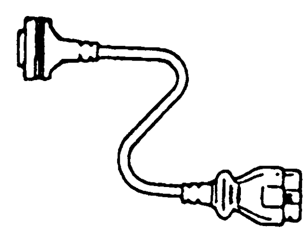
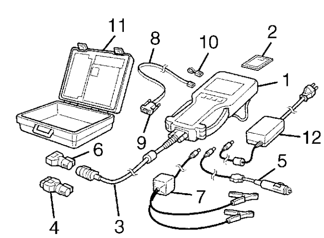


Fig. 3 for Step 4



Special Tool

 09912-58441 Pressure gauge	 09912-58431 Pressure hose	 09912-58490 3-way joint & hose	 09912-58421 Checking tool set (See NOTE “A”.)
 09912-57610 Checking tool plate	 09917-47010 Vacuum pump gauge	 09930-88530 Injector test lead	 09931-76011 SUZUKI scan tool (Tech 1A) kit (See NOTE “B”.)
 Mass storage cartridge	 09931-76030 16 / 14 pin DLC cable	 Tech 2 kit (SUZUKI scan tool) (See NOTE “C”.)	

NOTE:

- **“A” : This kit includes the following items.**
  1. Tool body & washer, 2. Body plug, 3. Body attachment, 4. Holder, 5. Return hose & clamp, 6. Body attachment-2 & washer, 7. Hose attachment-1, 8. Hose attachment-2
- **“B” : This kit includes the following items and substitutes for the Tech 2 kit.**
  1. Storage case, 2. Operator’s manual, 3. Tech 1A, 4. DLC cable, 5. Test lead / probe, 6. Power source cable, 7. DLC cable adaptor, 8. Self–test adaptor
- **“C” : This kit includes the following items and substitutes for the Tech 1A kit.**
  1. Tech 2, 2. PCMCIA card, 3. DLC cable, 4. SAE 16/19 adapter, 5. Cigarette cable, 6. DLC loopback adapter, 7. Battery power cable, 8. RS232 cable, 9. RS232 adapter, 10. RS232 loopback connector, 11. Storage case, 12. Power supply

SECTION 6A1

ENGINE MECHANICAL (M13 ENGINE)

WARNING:

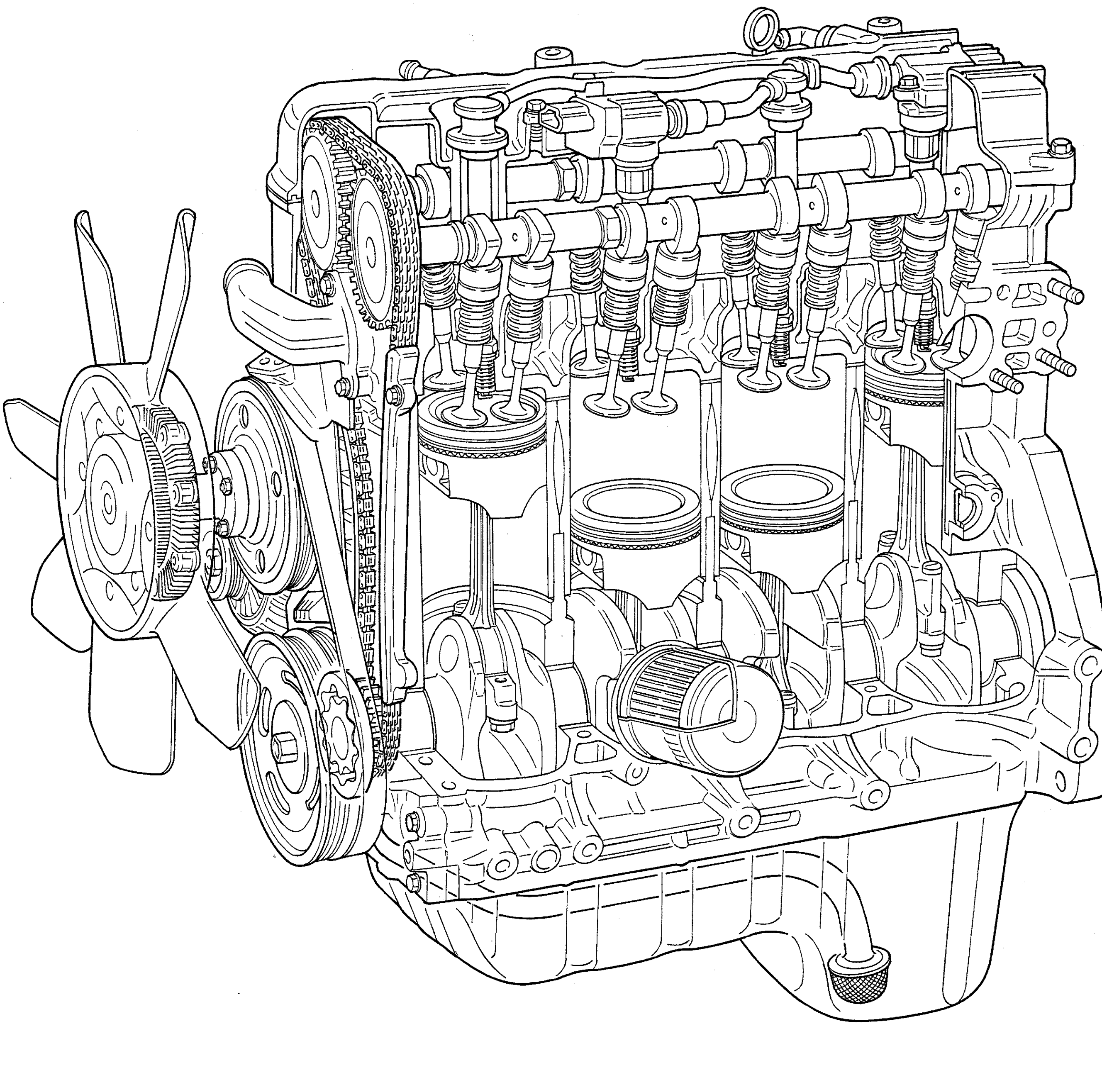
For vehicles equipped with Supplemental Restraint (Air Bag) System:
- **Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to "Air Bag System Components and Wiring Location View" under "General Description" in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and "Service Precautions" under "On-Vehicle Service" in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.**
- **Technical service work must be started at least 90 seconds after the ignition switch is turned to the "LOCK" position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).**

CONTENTS

General Description

Engine

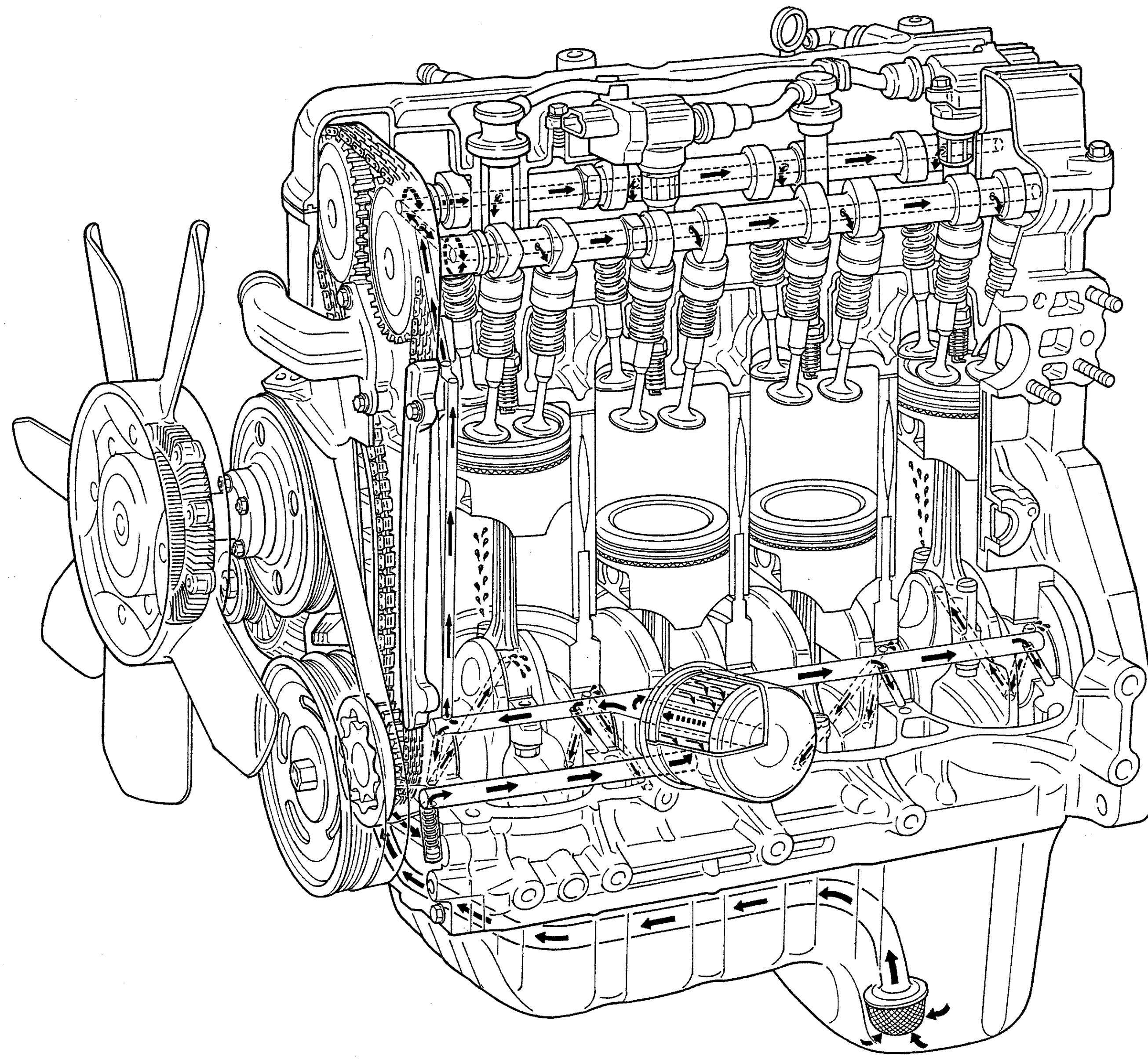
The engine is water-cooled, in line 4 cylinders, 4 stroke cycle gasoline unit with its DOHC (Double overhead camshaft) valve mechanism arranged for “V” type valve configuration and 16 valves (4 valves / one cylinder). The double overhead camshaft is mounted over the cylinder head; it is driven from crankshaft through timing chain, and no push rods are provided in the valve train system.



Engine Lubrication

The oil pump is of a trochoid type, and mounted under the crankshaft. Oil is drawn up through the oil pump strainer and passed through the pump to the oil filter.
The filtered oil flows into 2 paths in cylinder block.
In one path, oil reaches the crankshaft journal bearings. Oil from the crankshaft journal bearings is supplied to the connecting rod bearings by means of intersecting passages drilled in the crankshaft, and then injected from the big end of connecting rod to lubricate piston, rings, and cylinder wall.
In other path oil goes up to the cylinder head and lubricates valves and camshafts, etc., after passing through the internal oilway of camshafts.

An oil relief valve is provided on the oil pump. This valve starts relieving oil pressure when the pressure exceeds about 400 kPa (4.0 kg/cm^2, 56.9 psi).



Diagnosis

Diagnosis Table

Refer to "Engine Diagnosis Table" in Section 6.

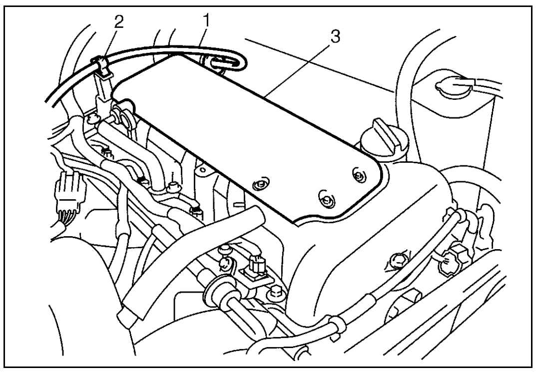
Compression Check

Check compression pressure on all 4 cylinders as follows:

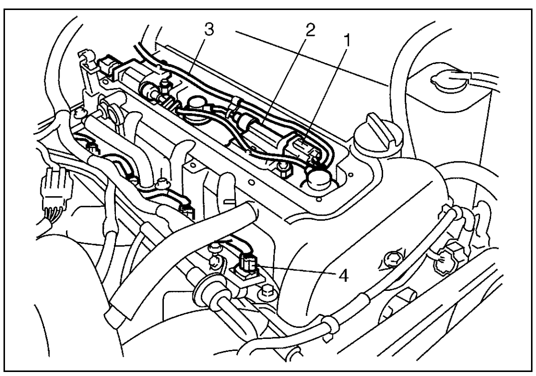
1) Warm up engine.
2) Stop engine after warming up.

NOTE:

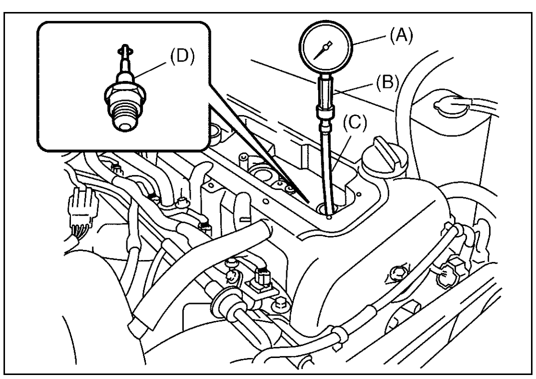
After warming up engine, place transmission gear shift lever in "Neutral" (shift selector lever to "P" range for A/T model), and set parking brake and block drive wheels.



3) Disconnect accelerator cable (1) from clamp (2) (For left hand steering vehicle only).
4) Remove cylinder head upper cover (3).

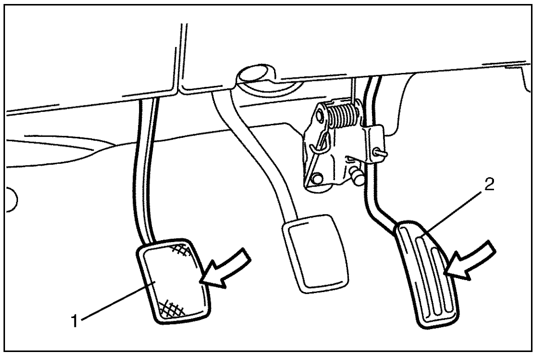


5) Disconnect ignition coil couplers (1).
6) Remove ignition coil assemblies (2) with high-tension cord (3).
7) Remove all spark plugs.
8) Disconnect fuel injector wires (4) at the coupler.



9) Install special tools (Compression gauge) into spark plug hole.

Special tool
(A) : 09915-64510-001
(B) : 09915-64510-002
(C) : 09915-64530
(D) : 09915-67010



10) Disengage clutch (1) (to lighten starting load on engine) for M/T vehicle, and depress accelerator pedal (2) all the way to make throttle fully open.

11) Crank engine with fully charged battery, and read the highest pressure on compression gauge.

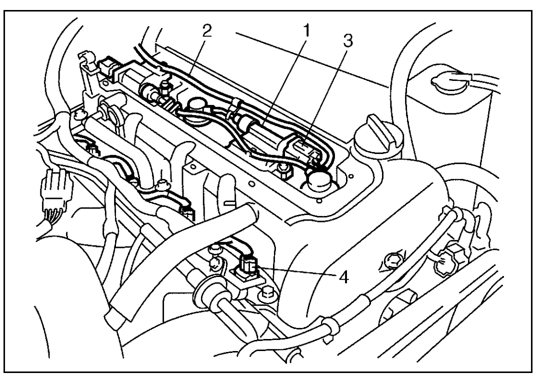
NOTE:

- **For measuring compression pressure, crank engine at least 250 rpm by using fully charged battery.**
- **If check results are below the limit valve, check installation condition for special tool.**

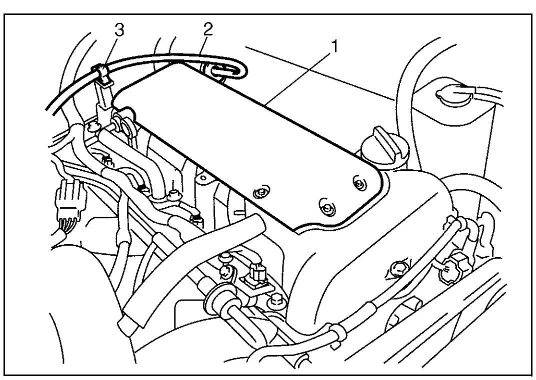
Compression pressure specification

Standard	**1400 kPa (14.0 kg/cm^2, 199.0 psi)**
Limit	**1100 kPa (11.0 kg/cm^2, 156.0 psi)**
Max. difference between any two cylinders	**100 kPa (1.0 kg/cm^2, 14.2 psi)**

12) Carry out Steps 9) through 11) on each cylinder to obtain 4 readings.



13) After checking, install spark plugs and ignition coil assemblies (1) with high-tension cord (2).
14) Connect ignition coil couplers (3).
15) Connect fuel injector wires (4) at the coupler.



16) Check cylinder head upper cover gasket for deterioration and then install it into groove of cylinder head upper cover (1) securely.
17) Install cylinder head upper cover with gasket on to cylinder head cover.
18) Connect accelerator cable (2) to clamp (3) (For left hand steering vehicle only).

Engine Vacuum Check

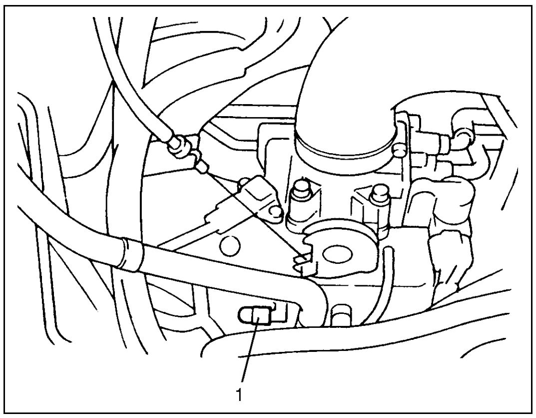
The engine vacuum that develops in the intake line is a good indicator of the condition of the engine. The vacuum checking procedure is as follows:

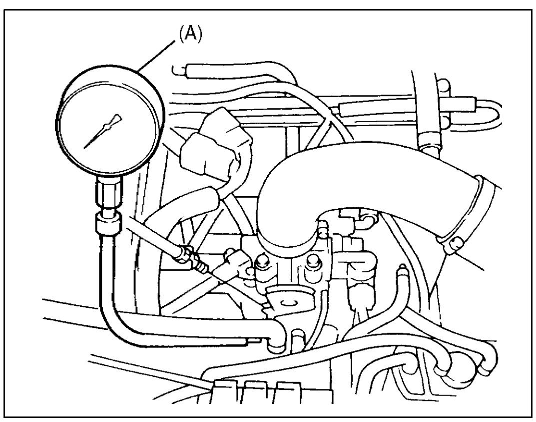
1) Warm up engine to normal operating temperature.

NOTE:

After warming up engine, be sure to place transmission gear shift lever in “Neutral” (shift selector lever to “P” range for A/T model), and set parking brake and block drive wheels.

2) Stop engine and turn off the all electric switches.
3) Remove cap (1) from intake manifold.





4) Connect special tool (Vacuum gauge) to intake manifold.

Special tool
(A) : 09915-67310

5) Run engine at specified idle speed and read vacuum gauge. Vacuum should be within specification.

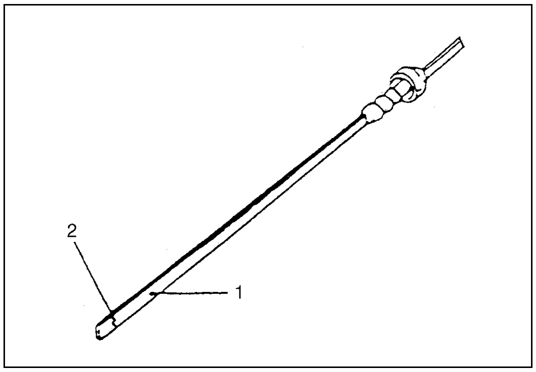
Vacuum specification (at sea level)
59 – 73 kPa (45 – 55 cm Hg, 17.7 – 21.6 in. Hg)
at specified idle speed

6) After checking, disconnect special tool (Vacuum gauge) from intake manifold.
7) Install cap to intake manifold.

Oil Pressure Check

NOTE:

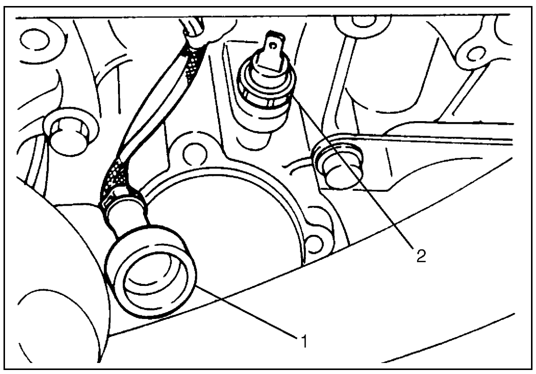
Prior to checking oil pressure, check the following items.



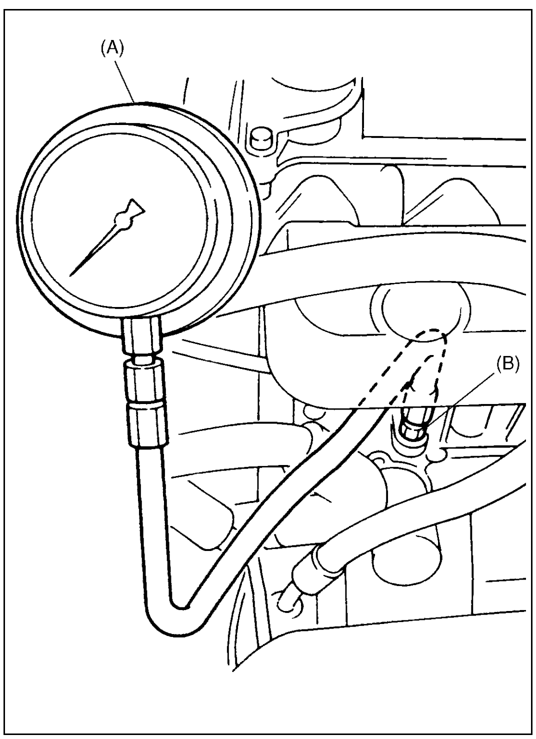
- Oil level in oil pan.
  If oil level is low, add oil up to Full level mark (hole) (1) on oil level gauge.

2. Low level mark (hole)

- Oil quality.
  If oil is discolored, or deteriorated, change it.
  For particular oil to be used, refer to the table in Section 0B.
- Oil leaks.
  If leak is found, repair it.



1) Disconnect oil pressure switch coupler (1) and remove oil pressure switch (2) from cylinder block.



2) Install special tools (Oil pressure gauge) to vacated threaded hole.

Special tool
(A) : 09915-77310
(B) : 09915-78211

3) Start engine and warm it up to normal operating temperature.

NOTE:

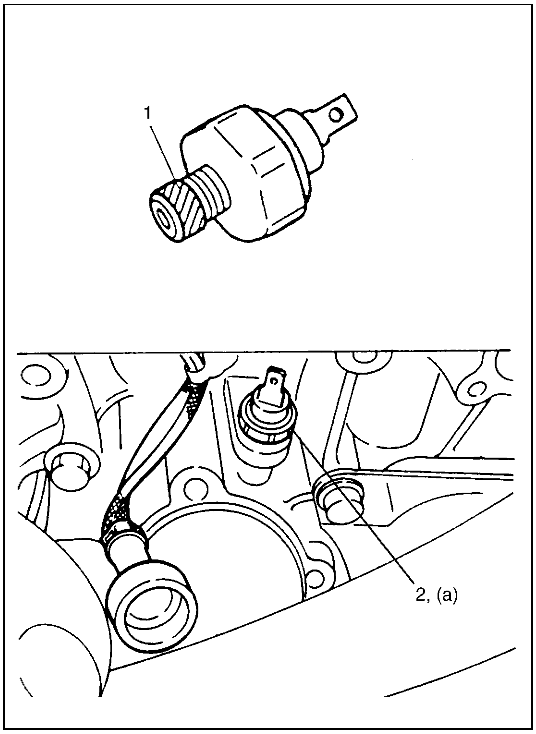
Be sure to place transmission gear shift lever in “Neutral” (shift selector lever to “P” range for A/T model), and set parking brake and block drive wheels.

4) After warming up, raise engine speed to 4,000 rpm and measure oil pressure.

Oil pressure specification

280 – 430 kPa (2.8 – 4.3 kg/cm^2, 39.8 – 61.1 psi) at 4,000 rpm

5) Stop engine and remove oil pressure gauge and attachment.



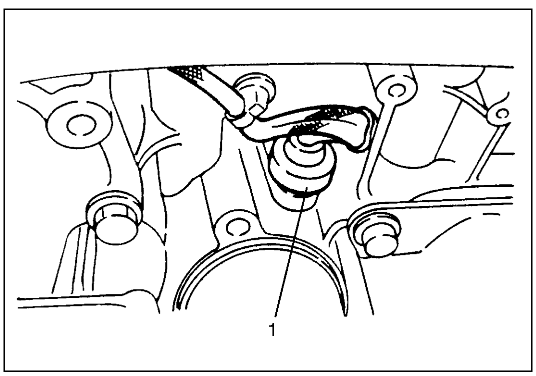
6) Before reinstalling oil pressure switch (2), be sure to wrap its screw threads with sealing tape (1) and tighten switch to specified torque.

NOTE:

If sealing tape edge is bulged out from screw threads of switch, cut it off.

Tightening torque
Oil pressure switch (a) : 14 N.m (1.4 kg-m, 10.5 lb-ft)

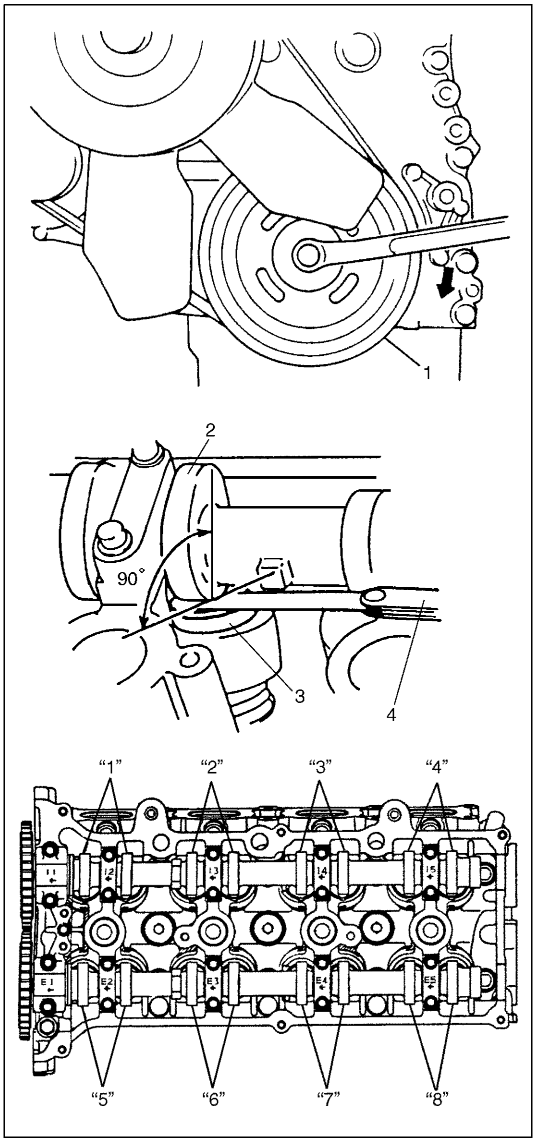
7) Start engine and check oil pressure switch for oil leakage. If oil leakage is found, repair it.



8) Connect oil pressure switch coupler (1).

Valve Lash (Clearance)

1) Remove negative cable at battery.
2) Remove cylinder head cover referring to "Cylinder Head Cover" in this section.

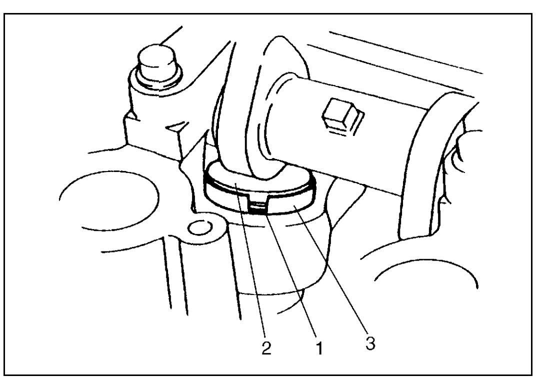


3) Using 17 mm wrench, turn crankshaft pulley (1) clockwise until cam lobes (2) become perpendicular to shim faces (3) at valves "1" and "7" as shown in figure.
4) Check valve lashes with thickness gauge (4) according to the following procedure.
   If valve lash is out of specification, record valve lash and adjust it to specification by replacing shim.
   a) Check valve lashes at valves "1" and "7".
   b) Turn camshafts by 90° (by turning crankshaft with wrench).
   c) Make sure that cam lobes are perpendicular to shim faces at valves to be checked (in this case, "3" and "8"), if not, adjust it by turning crankshaft. Check valve lashes.
   d) In the same manner as b) – c), check valve lashes at valves "4" and "6".
   e) In the same manner as b) – c) again, check valve lashes at valves "2" and "5".

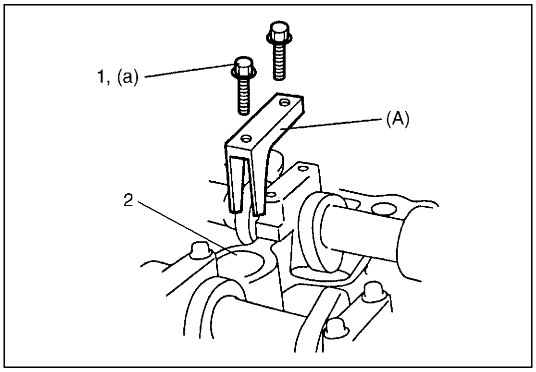
Valve clearance specification

	When cold (Coolant temperature is 15 – 25°C or 59 –77°F)	When hot (Coolant temperature is 60 – 68°C or 140 – 154°F)
Intake	0.18 – 0.22 mm (0.007 – 0.009 in.)	0.21 – 0.27 mm (0.008 – 0.011 in.)
Exhaust	0.28 – 0.32 mm (0.011 – 0.013 in.)	0.30 – 0.36 mm (0.012 – 0.014 in.)

REPLACEMENT OF SHIM



1) Close the valve whose shim (2) is to be replaced by turning crankshaft, then turn tappet (3) till its cut section (1) faces inside as shown in figure.



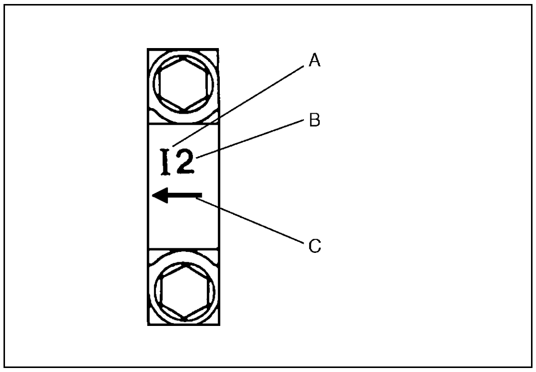
2) Lift valve by turning crankshaft and then remove camshaft housing bolts (1) where the shim to be replaced.

2.	Plug hole

3) Install special tool with camshaft housing bolts as shown in figure.

Special tool
(A) : 09916-67020

Tightening torque
Camshaft housing bolts (for tightening of special tool)
(a) : 8 N·m (0.8 kg-m, 6.0 lb-ft)



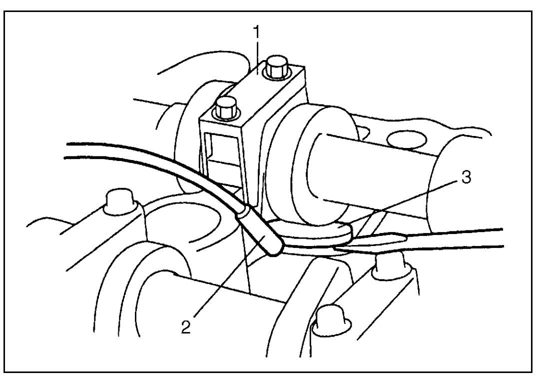
NOTE:

- **Check the special tools carved seal as shown, and then install special tool in accordance with the location of each camshaft housing.**
- **If special tool is holding down the shim, adjust special tool position so as not to hold down the shim by loosening camshaft housing bolt.**

Special tool selection table

No. on camshaft housing	Embossed mark on special tool
I2	IN2
I3, I4, I5	IN345
E2	EX2
E3, E4, E5	EX345

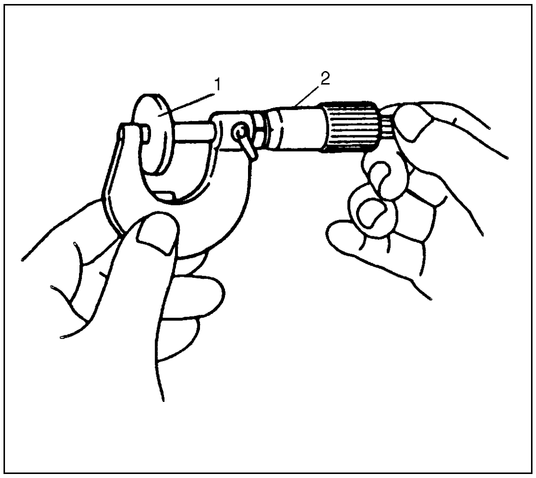
A:	I : Intake side or E : Exhaust side
B:	Position from timing chain side
C:	Pointing to timing chain side



4) Turn camshaft by approximately 90° clockwise and remove shim (3).

WARNING:
Never put in the hand between camshaft and tappet.

1.	Special tool
2.	Magnet

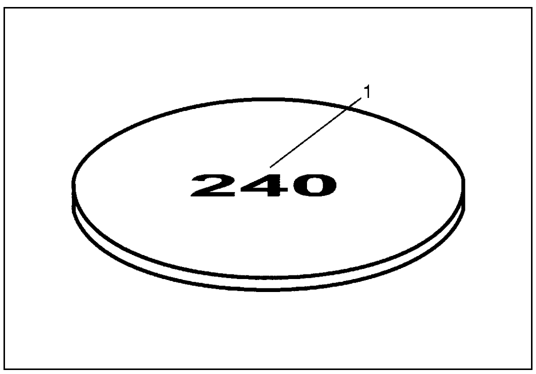


5) Using a micrometer (2), measure the thickness of the removed shim (1), and determine replacement shim by calculating the thickness of new shim with the following formula and table.

Intake side
A = B + C – 0.20 mm (0.008 in.)
Exhaust side
A = B + C – 0.30 mm (0.012 in.)

A : Thickness of new shim
B : Thickness of removed shim
C : Measured valve clearance

Example of intake side :
When thickness of removed shim is 2.40 mm (0.094 in.), and measured valve clearance is 0.45 mm (0.018 in.).
A = 2.40 mm (0.094 in.) + 0.45 mm (0.018 in.) – 0.20 mm (0.008 in.) = 2.65 mm (0.104 in.)
Calculated thickness of new shim = 2.65 mm (0.104 in.)

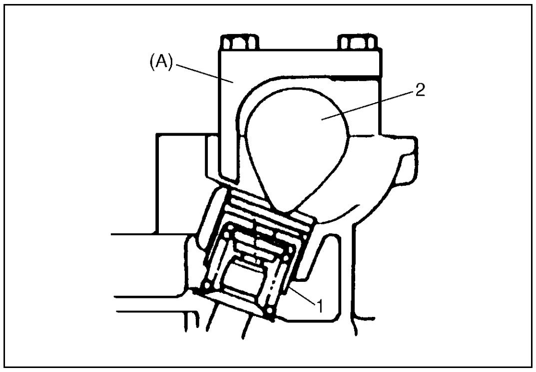


6) Select new shim No. (1) with a thickness as close as possible to calculated value.

Available new shims No.

Thickness mm (in.)	Shim No.	Thickness mm (in.)	Shim No.
2.175 (0.0856)	218	2.675 (0.1053)	268
2.200 (0.0866)	220	2.700 (0.1063)	270
2.225 (0.0876)	223	2.725 (0.1073)	273
2.250 (0.0886)	225	2.750 (0.1083)	275
2.275 (0.0896)	228	2.775 (0.1093)	278
2.300 (0.0906)	230	2.800 (0.1102)	280
2.325 (0.0915)	233	2.825 (0.1112)	283
2.350 (0.0925)	235	2.850 (0.1122)	285
2.375 (0.0935)	238	2.875 (0.1132)	288
2.400 (0.0945)	240	2.900 (0.1142)	290
2.425 (0.0955)	243	2.925 (0.1152)	293
2.450 (0.0965)	245	2.950 (0.1161)	295
2.475 (0.0974)	248	2.975 (0.1171)	298
2.500 (0.0984)	250	3.000 (0.1181)	300
2.525 (0.0994)	253		
2.550 (0.1004)	255		
2.575 (0.1014)	258		
2.600 (0.1024)	260		
2.625 (0.1033)	263		
2.650 (0.1043)	265		

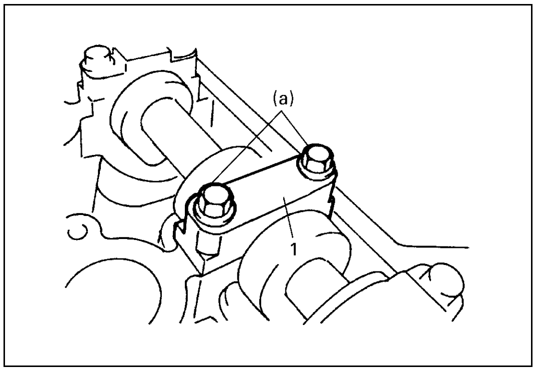
7) Install new shim facing shim No. side with tappet.



8) Lift valve by turning crankshaft counterclockwise (in opposite direction against above Step 4) and remove special tool.

Special tool
(A) : 09916-67020

1.	Tappet
2.	Camshaft



9) Install camshaft housing (1) and tighten them to specified torque.

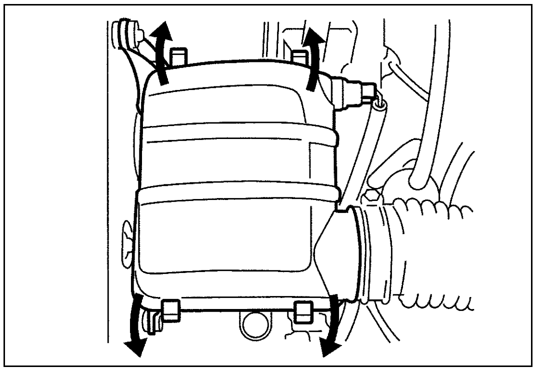
Tightening torque
Camshaft housing bolts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)

10) Check valve clearance again.
11) Install cylinder head cover, referring to “Cylinder Head Cover” in this section.

On-Vehicle Service

Air Cleaner Element

REMOVAL

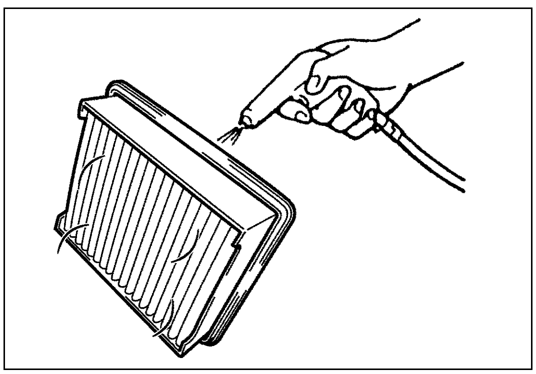


1) Open air cleaner case by unhooking its clamps.
2) Remove air cleaner element from case.

INSPECTION

Check air cleaner element for dirt. Replace excessively dirty element.

CLEANING



Blow off dust by compressed air from air outlet side of element.

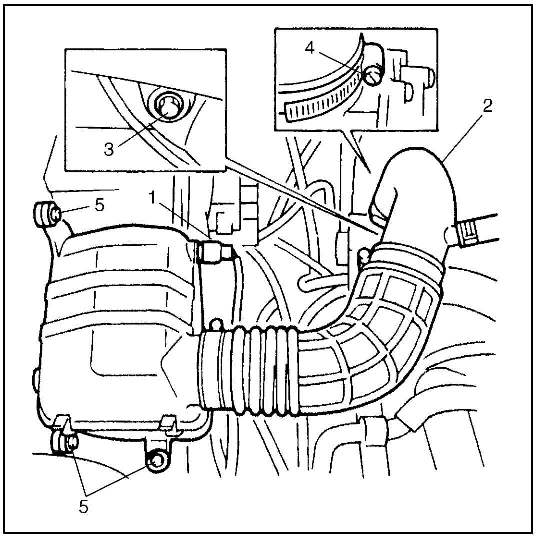
INSTALLATION

Reverse removal procedure for installation.

Air Cleaner Assembly

REMOVAL

1) Disconnect negative cable at battery.



2) Disconnect IAT sensor coupler (1).
3) Disconnect breather hose from air cleaner outlet No.2 hose (2).
4) Remove air cleaner outlet No.2 hose fastening bolt (3).
5) Loosen air cleaner outlet No.2 hose clamp bolt (4).
6) Remove air cleaner case fastening bolts (5).
7) Remove air cleaner assembly with outlet hoses.

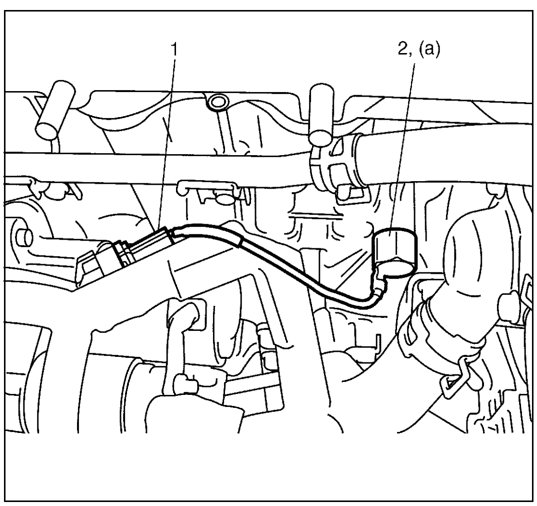
INSTALLATION

Reverse removal procedure for installation.

Knock Sensor

REMOVAL

1) Disconnect negative cable at battery.
2) Remove intake manifold referring to “Throttle Body and Intake Manifold” in this section.



3) Disconnect knock sensor connector (1).
4) Remove knock sensor (2) from cylinder block.

INSPECTION

Check sensor for damage.
If any faulty is found, replace.

INSTALLATION

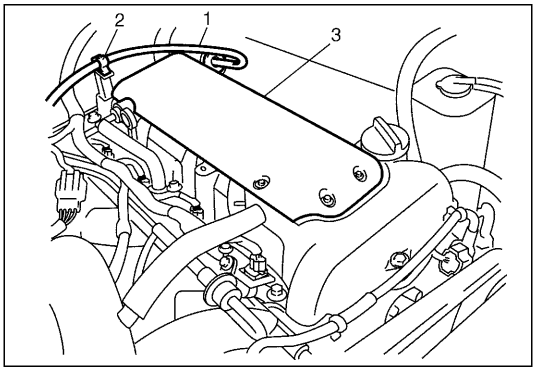
Reverse removal procedure for installation.

Tightening torque
Knock sensor (a) : 23 N·m (2.3 kg-m, 16.5 lb-ft)

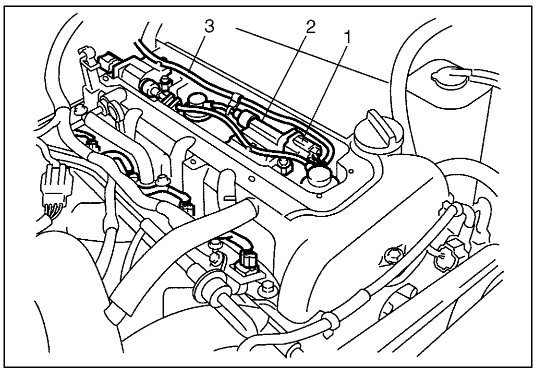
Cylinder Head Cover

REMOVAL

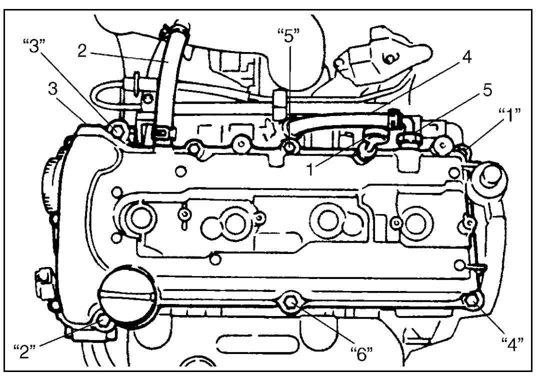
1) Disconnect negative cable at battery.



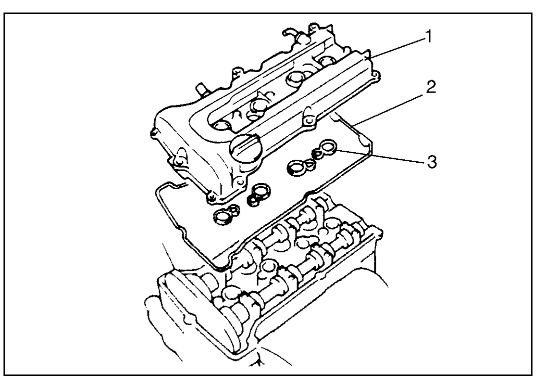
2) Disconnect accelerator cable (1) from clamp (2) (For left hand steering vehicle only).
3) Remove cylinder head upper cover (3).



4) Disconnect ignition coil couplers (1).
5) Remove ignition coil assemblies (2) with high-tension cord (3).

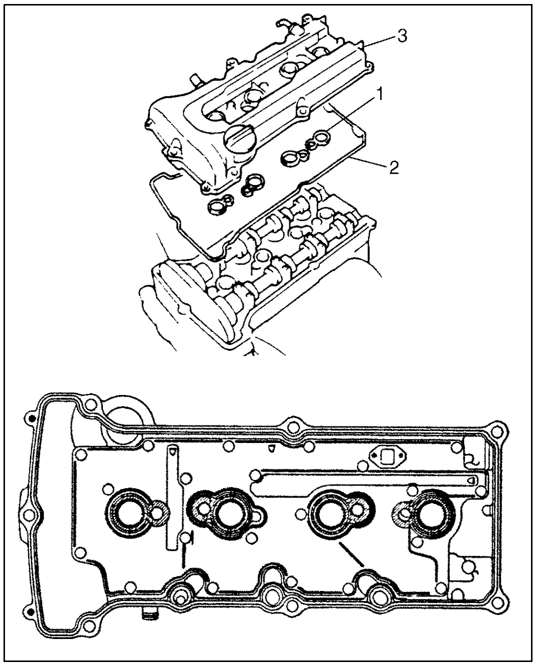


6) Remove oil level gauge (1).
7) Disconnect breather hose (2) from cylinder head cover (3) and PCV hose (4) from PCV valve (5).
8) Remove cylinder head cover mounting bolts in such order as indicated in figure.



9) Remove cylinder head cover (1) with cylinder head cover gasket (2) and spark plug hole gasket (3).

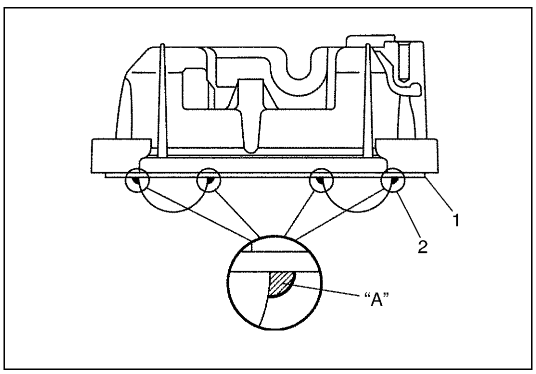
INSTALLATION



1) Install new spark plug hole gaskets (1) and new cylinder head cover gasket (2) to cylinder head cover (3) as shown in figure.

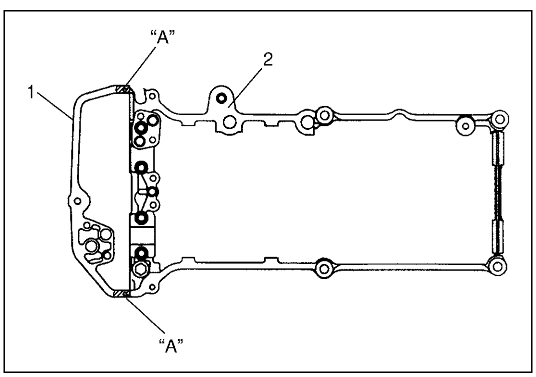
NOTE:

Be sure to check each of these parts for deterioration or any damage before installation and replace if found defective.



2) Remove oil, old sealant, and dust from sealing surface on cylinder head and cover. After cleaning, apply sealant "A" to the following point.
   - Cylinder head gasket (1) sealing surface area (2) as shown.

   "A" : Sealant 99000-31150



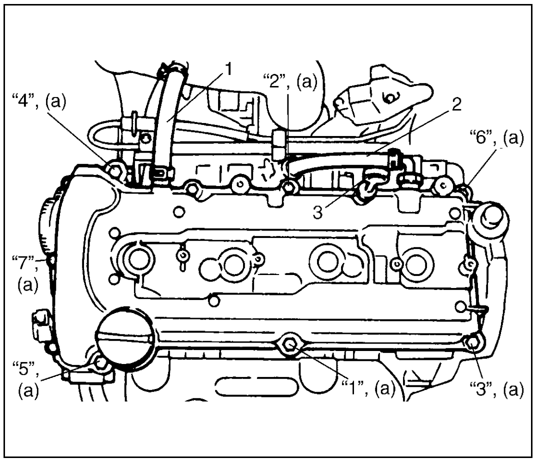
   - Timing chain cover (1) and cylinder head (2) matching surface as shown.

   "A" : Sealant 99000-31150

3) Install cylinder head cover to cylinder head.

NOTE:

When installing cylinder head cover, use care so that cylinder head cover gasket or spark plug hole gaskets will not get out of place or fall off.



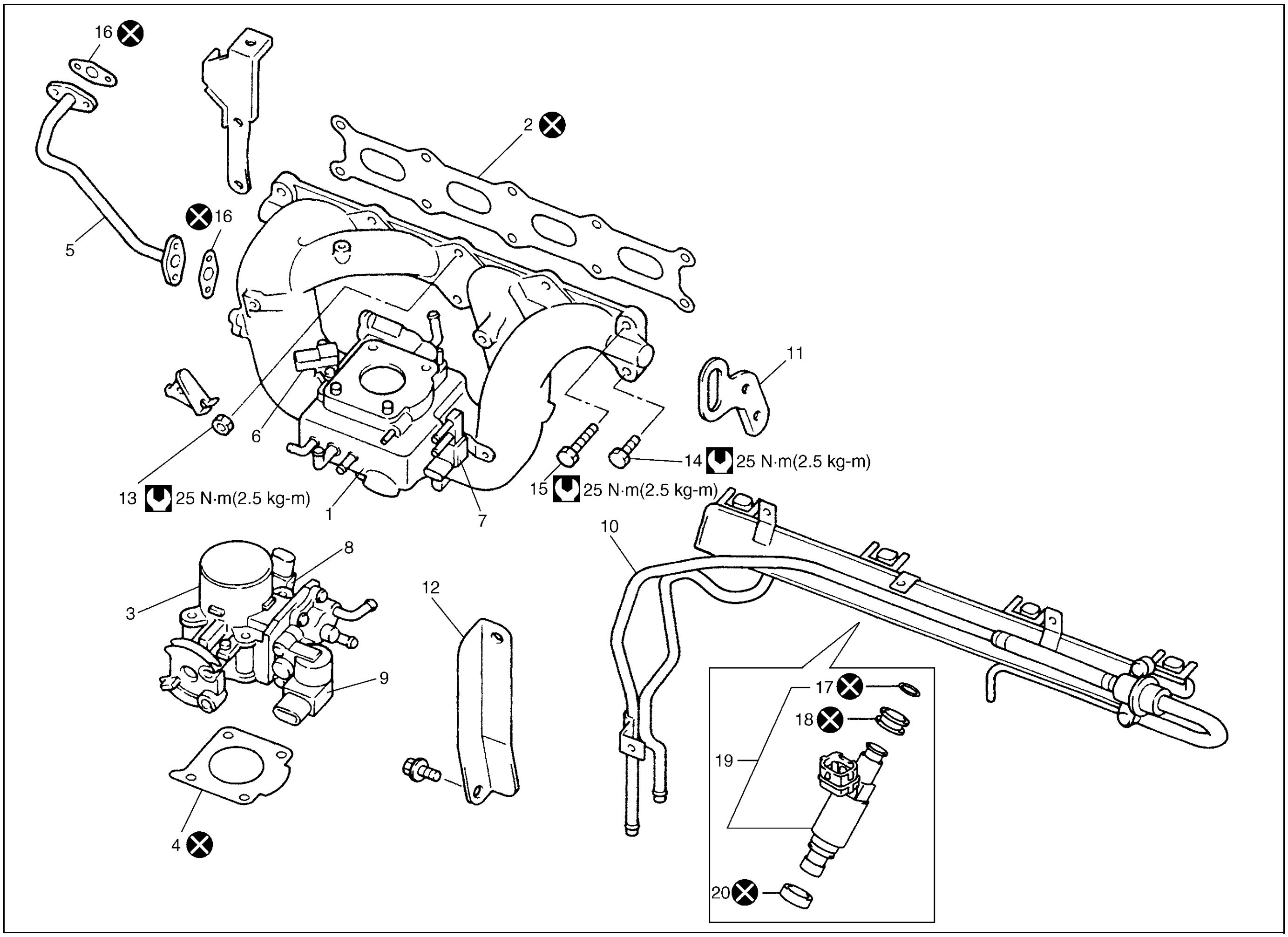
4) Tighten bolts in such order as indicated in figure a little at a time till they are tightened to specified torque.

Tightening torque
Cylinder head cover bolts (a) : 8 N·m (0.8 kg-m, 6.0 lb-ft)

5) Connect breather hose (1) and PCV hose (2).
6) Install oil level gauge (3).

7) Install ignition coil assemblies with high-tension cord.
8) Connect ignition coil couplers.
9) Install cylinder head upper cover.
10) Connect accelerator cable to clamp (For left hand steering vehicle only).
11) Connect negative cable at battery.

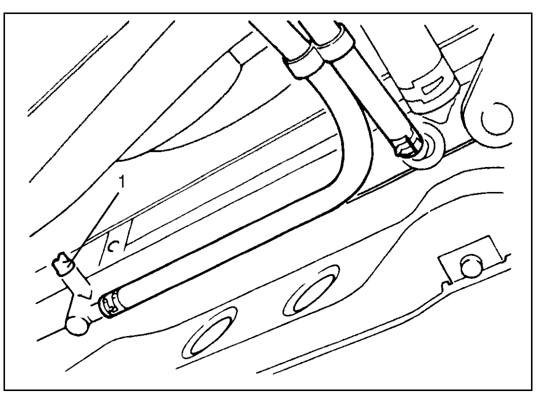
Throttle Body and Intake Manifold



1. Intake manifold	7. EVAP canister purge valve	13. Intake manifold mounting nut	19. Injector assembly
2. Intake manifold gasket	8. TP sensor	14. Intake manifold mounting bolt (short)	20. Cushion
3. Throttle body	9. IAC valve	15. Intake manifold mounting bolt (long)	Tightening torque
4. Gasket	10. Fuel delivery pipe	16. EGR pipe gasket	Do not reuse
5. EGR pipe	11. Engine hook	17. O-ring	
6. MAP sensor	12. Intake manifold stiffener	18. Grommet	

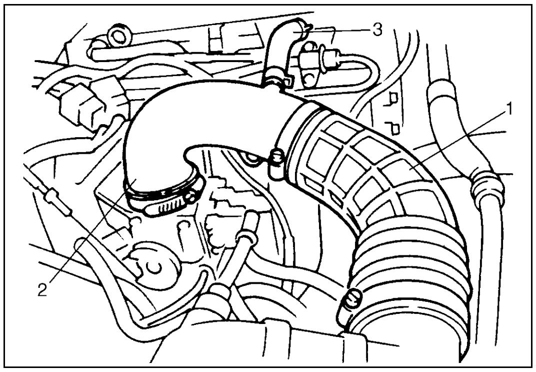
REMOVAL

1) Relieve fuel pressure referring to “Fuel Pressure Relief Procedure” in Section 6.
2) Disconnect negative cable at battery.
3) Drain coolant by loosening drain plug (1).

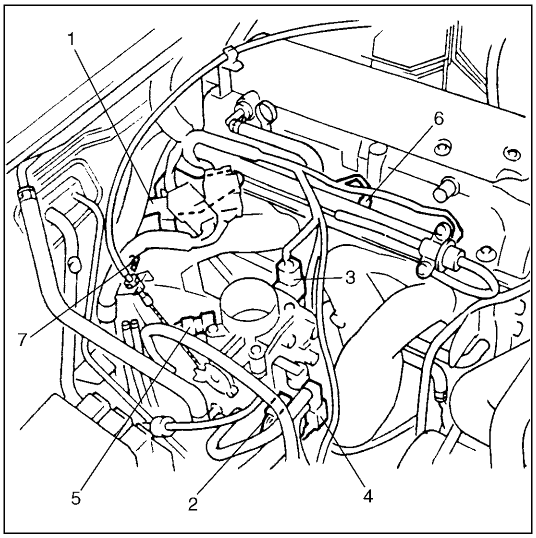


WARNING:

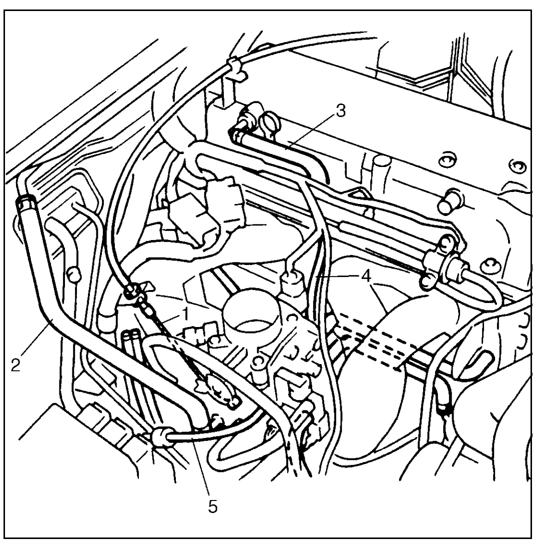
To help avoid danger of being burned, do not remove drain plug (1) and radiator cap while engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if plug and cap are taken off too soon.



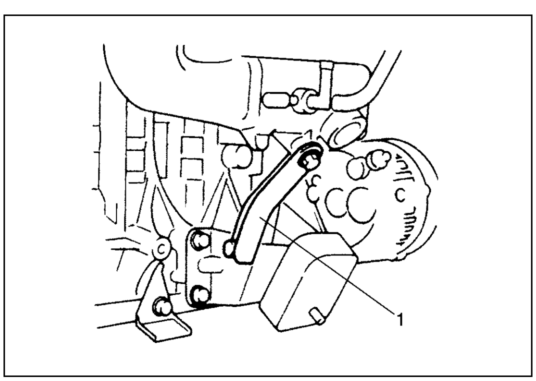
4) Remove air cleaner outlet No.1 (1) and No.2 (2) hoses and breather hose (3).



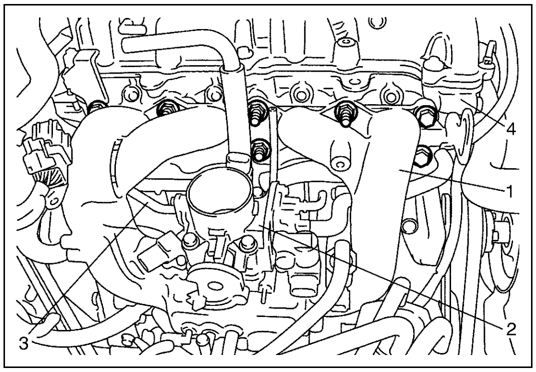
5) Remove intake manifold bracket (1) with main harness from intake manifold.
6) Disconnect the following electric lead wires:
   - IAC valve (2)
   - TP sensor (3)
   - EVAP canister purge valve (4)
   - MAP sensor (5)
   - Fuel injector wire harness at couplers (6)
   - Ground terminal (7) from intake manifold



7) Disconnect accelerator cable (1) from throttle body.
8) Disconnect the following hoses:
   - Brake booster hose (2) from intake manifold
   - PCV hose (3) from PCV valve
   - Fuel pressure regulator vacuum hose (4) from intake manifold
   - Canister purge hose from EVAP canister purge valve
   - Water hoses from throttle body
   - Vacuum hose (5) (to check valve) from throttle body
   - Fuel feed hose and return hose from each pipe
9) Remove fuel delivery pipe with fuel injectors from cylinder head and intake manifold.
10) Remove canister purge hose bracket.
11) Disconnect EGR pipe from EGR valve.



12) Remove intake manifold stiffener (1).

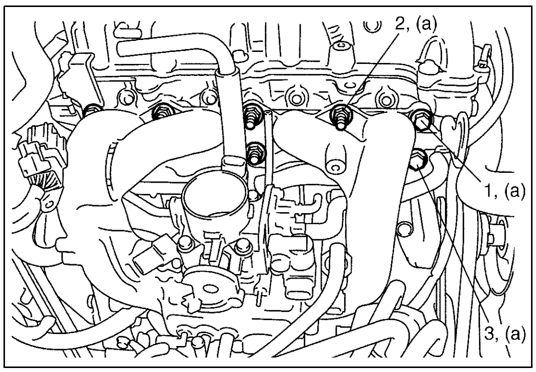


13) Remove intake manifold (1) with throttle body (2) and EGR pipe (3) from cylinder head (4), and then its gasket.

INSTALLATION

Reverse removal procedure for installation noting the followings.

- Use new intake manifold gasket and EGR pipe gasket.

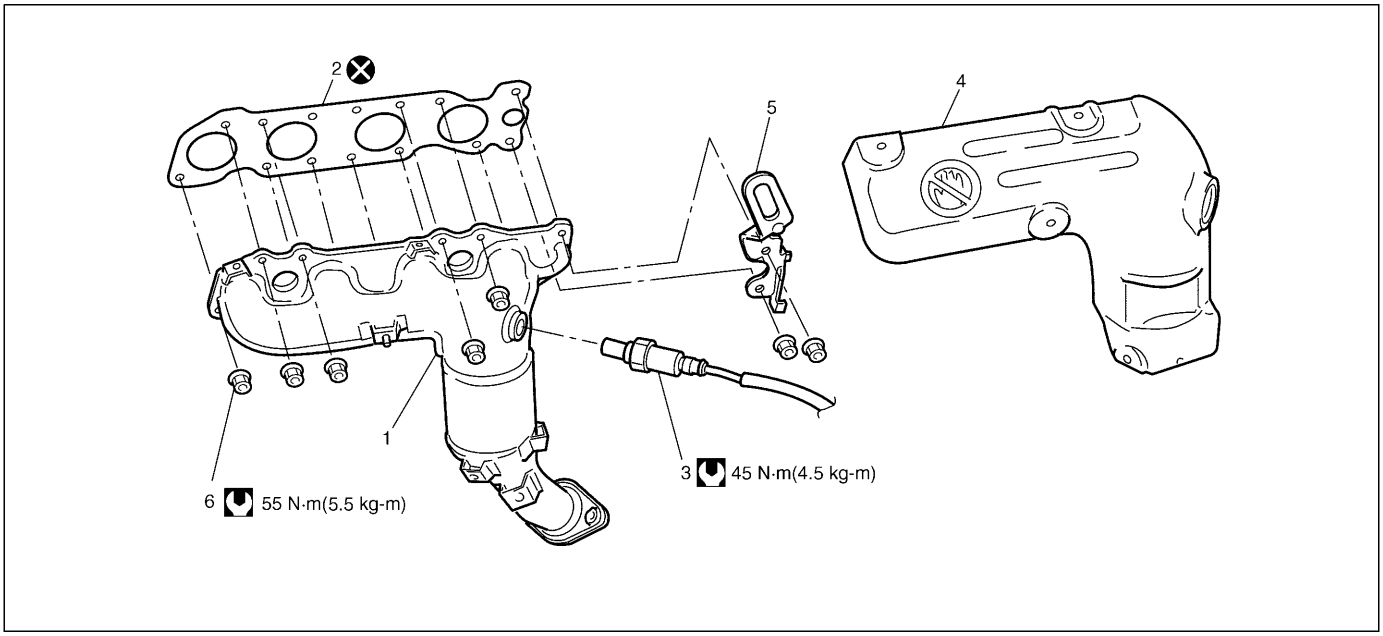


- Tighten long bolt (1), short bolt (3) and nuts (2) to specified torque.

Tightening torque
Intake manifold bolts and nuts
(a) : 25 N·m (2.5 kg-m, 18.0 lb-ft)

- Check to ensure that all removed parts are back in place. Reinstall any necessary parts which have not been reinstalled.
- Adjust accelerator cable play referring to “Accelerator Cable Adjustment” in Section 6E.
- Refill cooling system referring to “Cooling System Flush and Refill” in Section 6B.
- Upon completion of installation, turn ignition switch ON but engine OFF and check for fuel leaks.
- Finally, start engine and check for engine coolant leaks.

Exhaust Manifold



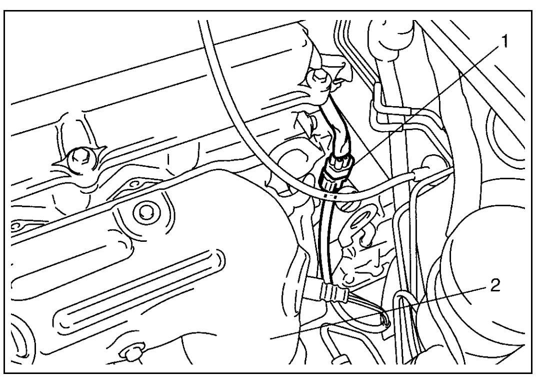
1. Exhaust manifold	4. Exhaust manifold cover	Tightening torque
2. Exhaust manifold gasket	5. Engine hook	Do not reuse.
3. Heated oxygen sensor (if equipped)	6. Exhaust manifold mounting nut	

WARNING:

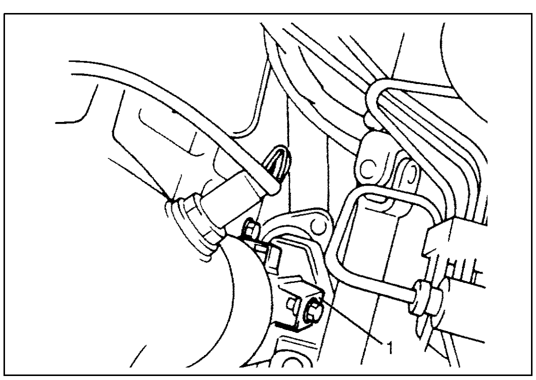
To avoid danger of being burned, do not service exhaust system while it is still hot. Service should be performed after system cools down.

REMOVAL

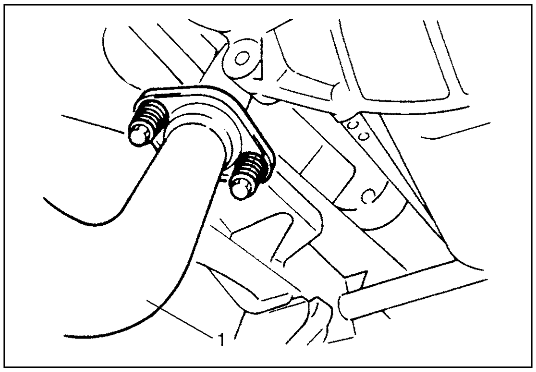
1) Disconnect negative cable at battery.



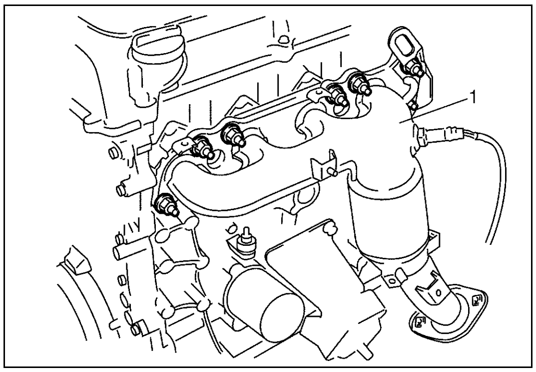
2) Disconnect heated oxygen sensor coupler (1) (if equipped) and detach it from its stay.
3) Remove exhaust manifold cover (2).



4) Remove exhaust manifold stiffener (1).

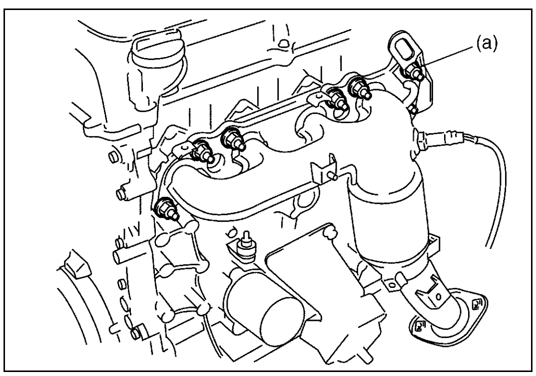


5) Disconnect exhaust pipe (1) from exhaust manifold.



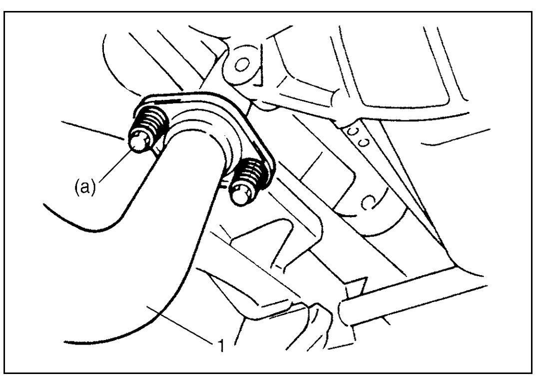
6) Remove exhaust manifold (1) and its gasket from cylinder head.

INSTALLATION



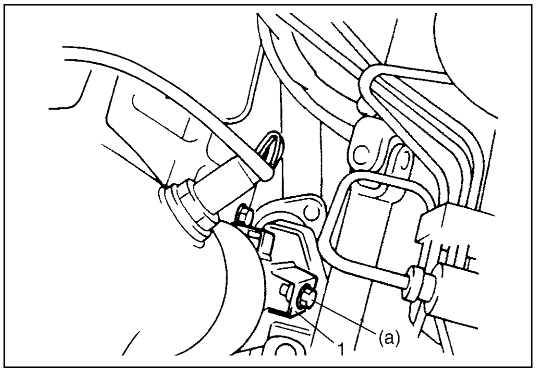
1) Install new gasket to cylinder head.
   Then install exhaust manifold.
   Tighten manifold nuts to specified torque.

Tightening torque
Exhaust manifold nuts (a) : 55 N·m (5.5 kg-m, 40.0 lb-ft)



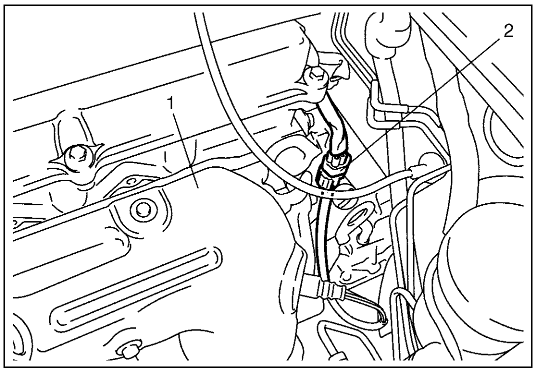
2) Install seal ring and install exhaust pipe (1) to exhaust manifold.
   Before installing seal ring, check it for deterioration or damage, and replace as necessary.
   Tighten pipe fasteners to specified torque.

Tightening torque
Exhaust pipe bolts (a) : 50 N·m (5.0 kg-m, 36.5 lb-ft)



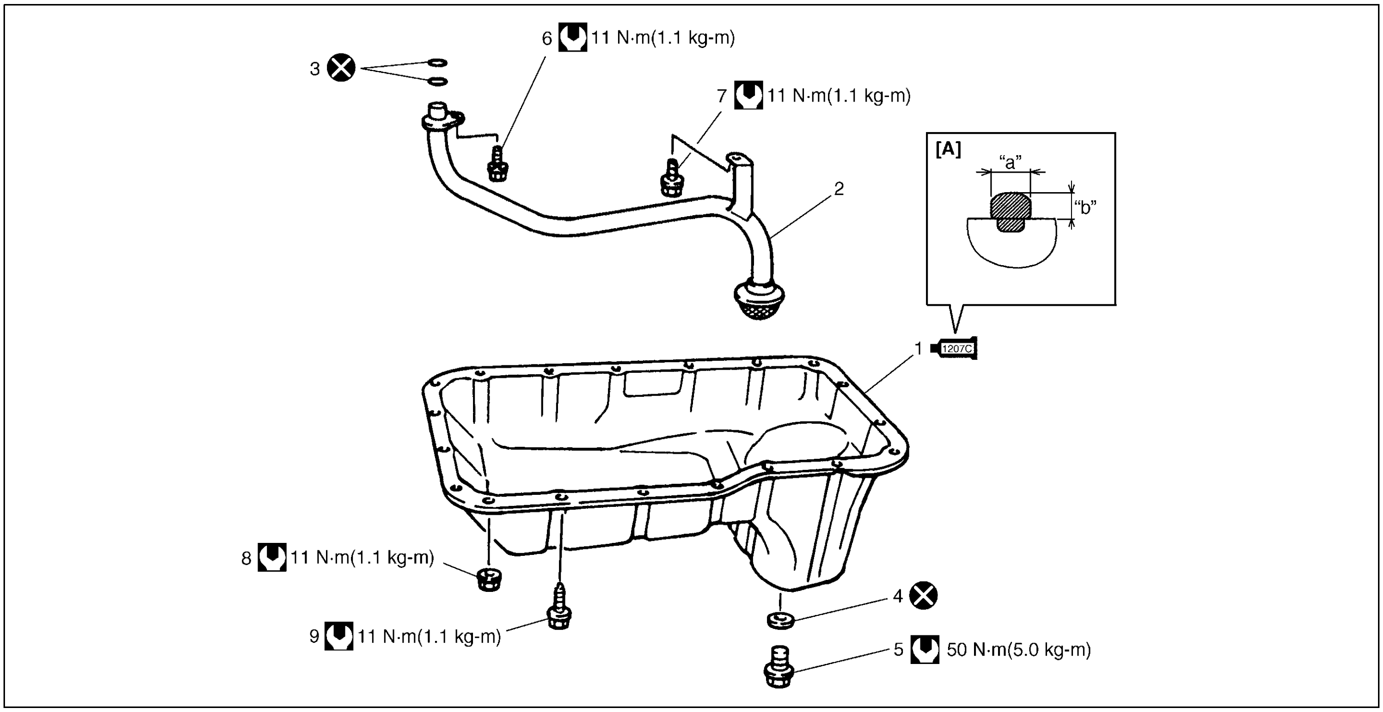
3) Install exhaust manifold stiffener (1).
   Tighten exhaust manifold stiffener bolts to specified torque.

   Tightening torque
   Exhaust manifold stiffener bolts
   (a) : 50 N·m (5.0 kg-m, 36.5 lb-ft)



4) Install exhaust manifold cover (1).
5) Connect heated oxygen sensor coupler (2) and fit coupler to bracket securely (if equipped).
6) Connect negative cable at battery.
7) Check exhaust system for exhaust gas leakage.

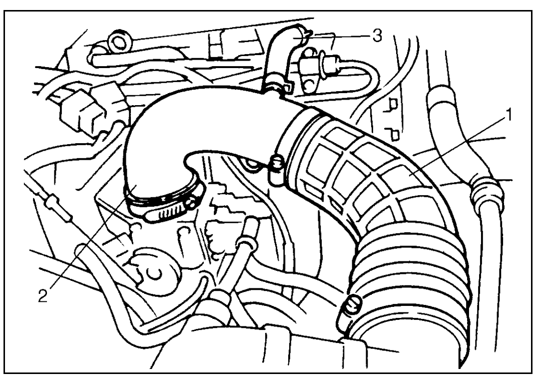
Oil Pan and Oil Pump Strainer



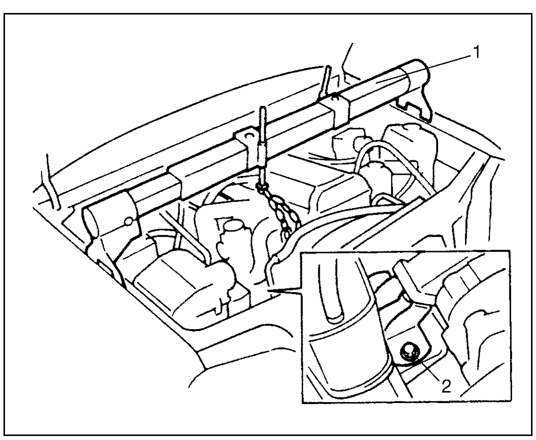
	[A] : Sealant application amount	3. O-ring	8. Oil pan nut
	"a" : 3 mm (0.12 in.)	4. Gasket	9. Oil pan bolt
	"b" : 2 mm (0.08 in.)	5. Drain plug	Tightening torque
1207C	1. Oil pan : Apply sealant 99000-31150 to mating surface.	6. Strainer bolt	Do not reuse.
	2. Strainer	7. Bracket bolt	

REMOVAL

1) Remove oil level gauge.



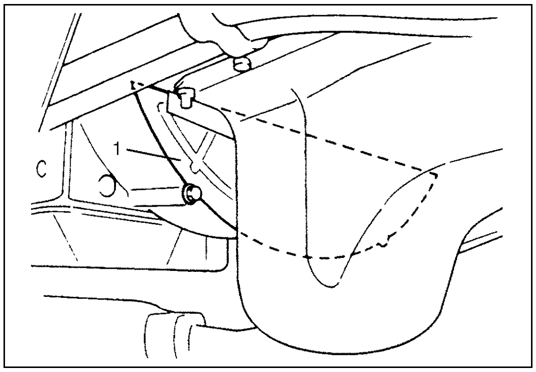
2) Remove air cleaner outlet No.1 (1) and No.2 (2) hoses and breather hose (3).



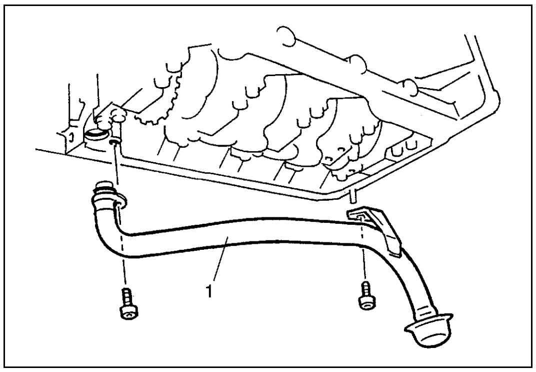
3) To facilitate and ensure removal of oil pan, increase clearance between engine and vehicle body according to the following procedure.
   a) Install support device (1).
   b) Loosen engine mounting bracket bolts (2), but do not remove them.
   c) Hoist engine 10 – 15 mm (0.4 – 0.6 in.).

CAUTION:

Do not hoist engine more than instructed above. That may cause trouble to engine or transmission.

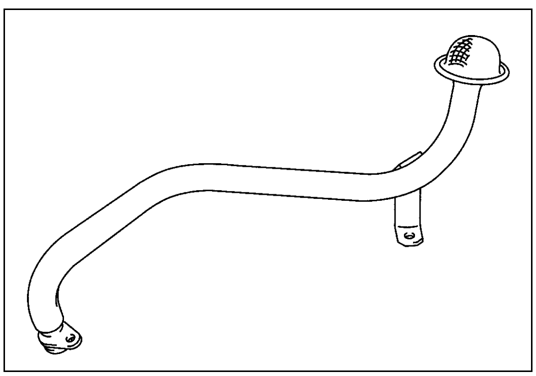


4) Drain engine oil by removing drain plug.
5) Remove clutch housing (torque converter housing for A/T vehicle) lower plate (1).

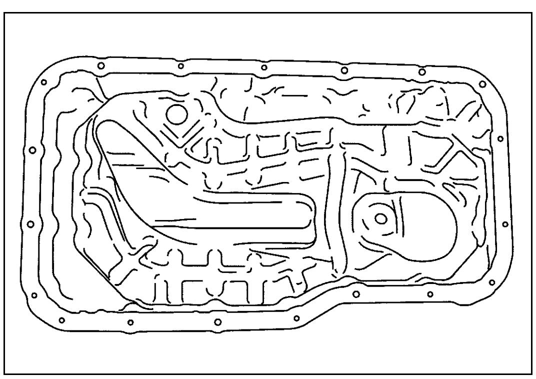


6) Remove oil pan and then oil pump strainer (1) from cylinder block.

CLEAN

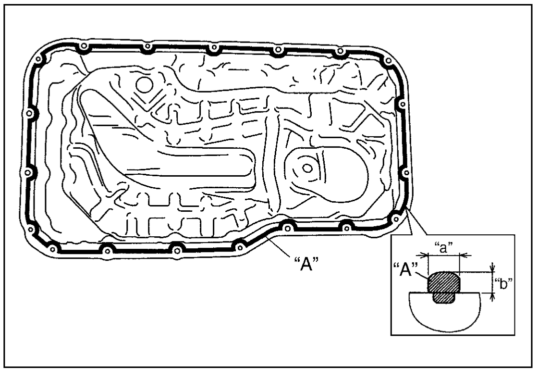


- Inside of oil pan and oil pump strainer screen.



- Clean sealing surface on oil pan and cylinder block.
  Remove oil, old sealant and dust from sealing surface.

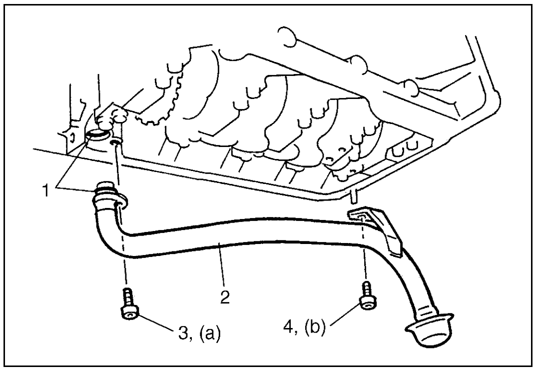
INSTALLATION



1) Apply sealant continuously to oil pan mating surface as shown in figure.

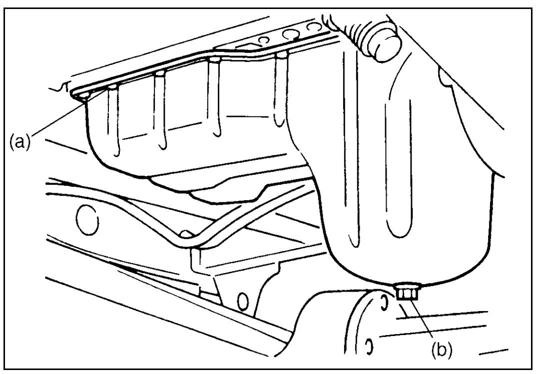
"A" sealant : 99000-31150

Sealant amount for oil pan
Width "a" : 3 mm, 0.12 in.
Height "b" : 2 mm, 0.08 in.



2) Install new O-rings (1) in the position as shown in figure and install oil pump strainer (2).
   Tighten strainer bolt (3) first and then bracket bolt (4) to specified torque.

Tightening torque
Oil pump strainer bolt (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)
Oil pump strainer bracket bolt
(b) : 11 N·m (1.1 kg-m, 8.0 lb-ft)

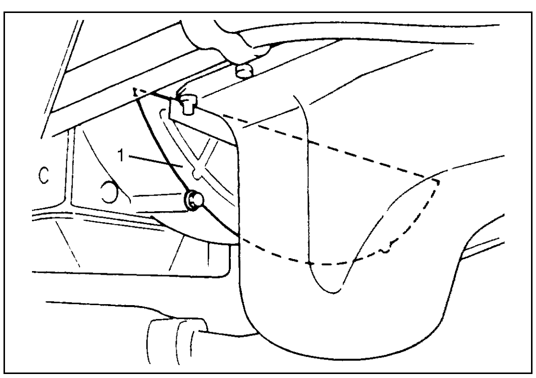


3) After fitting oil pan to cylinder block, run in securing bolts and start tightening at the center:
   move wrench outward, tightening one bolt at a time. Tighten bolts and nuts to specified torque.

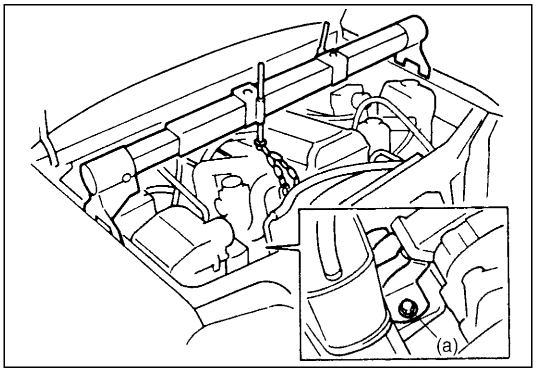
Tightening torque
Oil pan bolts and nuts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)

4) Install new gasket and drain plug to oil pan.
   Tighten drain plug to specified torque.

Tightening torque
Oil pan drain plug (b) : 50 N·m (5.0 kg-m, 36.5 lb-ft)



5) Install clutch housing (torque converter housing for A/T vehicle) lower plate (1).

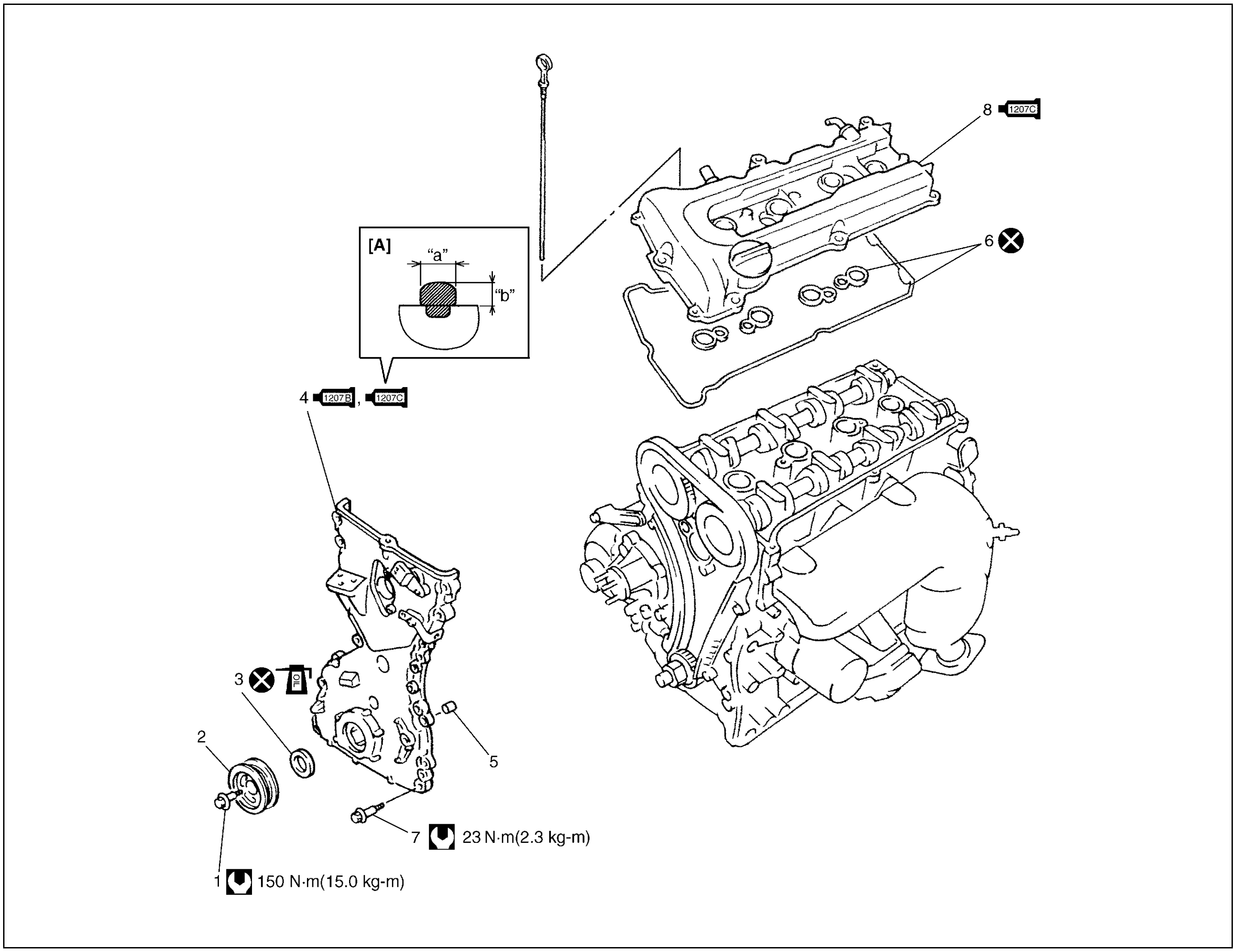


6) Lower engine and tighten engine mounting bracket bolts to specified torque.

Tightening torque
Engine mounting bracket bolts
(a) : 50 N·m (5.0 kg-m, 36.5 lb-ft)

7) Install oil level gauge.
8) Refill engine with engine oil referring to “Engine Oil and Filter Change” in Section 0B.
9) Verify that there is no engine oil leakage at each connection.

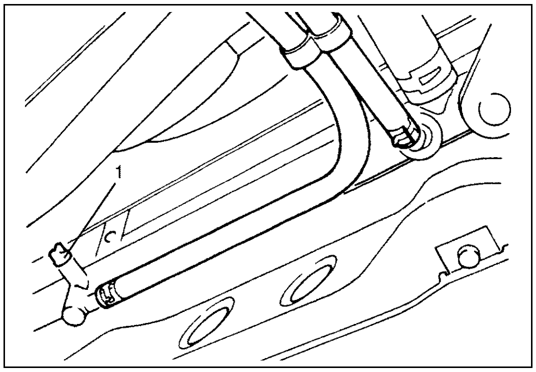
Timing Chain Cover



[A] : Sealant application amount	OIL 3. Oil seal : Apply engine oil to oil seal lip.	1207C 8. Cylinder head cover : Apply sealant 99000-31150 to the sealing point for timing chain cover mating surface and cylinder head gasket sealing point. Refer to "Cylinder Head Cover Installation".
"a" : 3 mm (0.12 in.)	4. Timing chain cover 1207B : Apply sealant 99000-31140 to the mating surface of cylinder and cylinder head. 1207C : Apply sealant 99000-31150 to the mating surface of timing chain cover referring to the figure of Step 1) in INSTALLATION.	Tightening torque
"b" : 2 mm (0.08 in.)	5. Pin	Do not reuse.
1. Crankshaft pulley bolt	6. Cylinder head cover gasket	
2. Crankshaft pulley	7. Timing chain cover mounting bolts	

REMOVAL

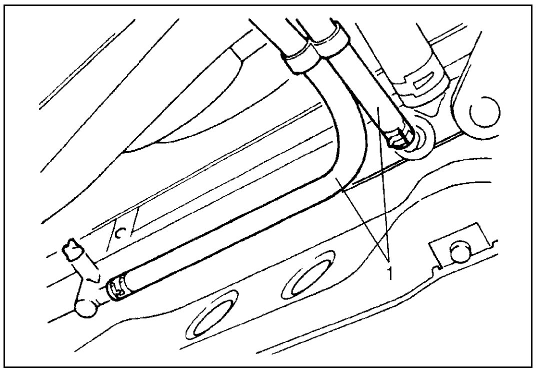
1) Disconnect negative cable at battery.
2) Remove A/C compressor and/or P/S pump belt (if equipped).
3) Remove generator belt.
4) Drain engine oil.



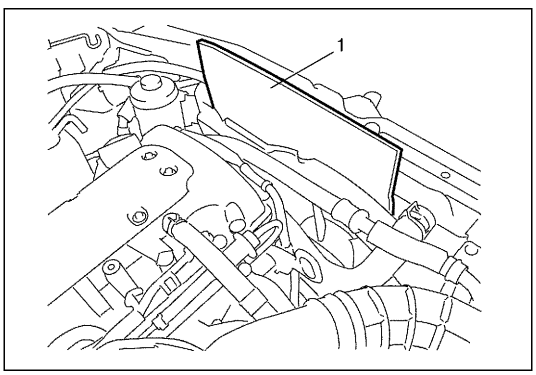
5) Drain coolant.

WARNING:

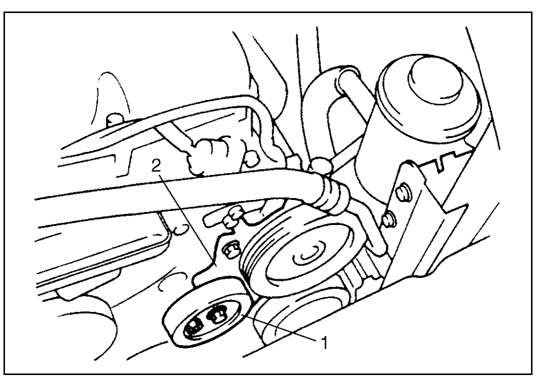
To help avoid danger of being burned, do not remove drain plug (1) and radiator cap while engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if plug and cap are taken off too soon.



6) Disconnect radiator inlet and outlet hoses from each pipe.
7) Disconnect A/T fluid hoses (1) (vehicle with A/T) and release its clamps. Place some container under radiator to receive A/T fluid which will flow out when hose is disconnected.



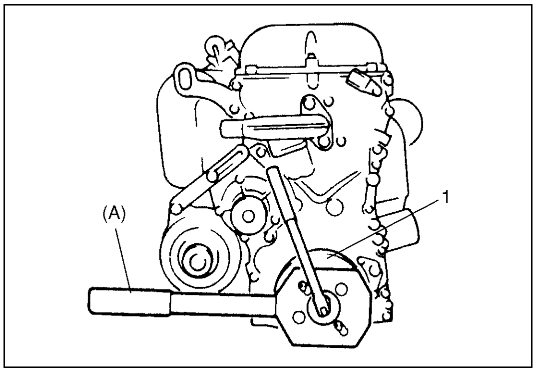
8) Remove fan shroud upper bolts and install board (1) or the like. This prevents damage to radiator fins when removing and installing radiator.
9) Remove radiator with cooling fan. Then remove water pump pulley. Refer to “Radiator” and “Water Pump Belt and Cooling Fan” in Section 6B.



10) Remove A/C compressor and/or P/S pump belt tension pulley (1) (if equipped).
11) With hose connected, detach P/S pump from its bracket and then remove P/S pump bracket (2) (if equipped) referring to “Power Steering Pump” in Section 3B1.

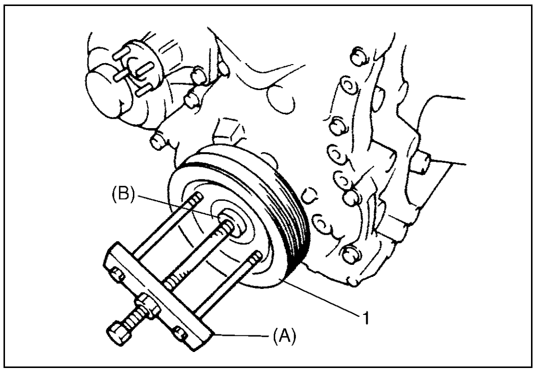
NOTE:

Suspend removed P/S pump at a place where no damage will be caused during removal and installation of timing chain cover.



12) Remove crankshaft pulley bolt.
    To lock crankshaft pulley (1), use special tool with it as shown in figure.

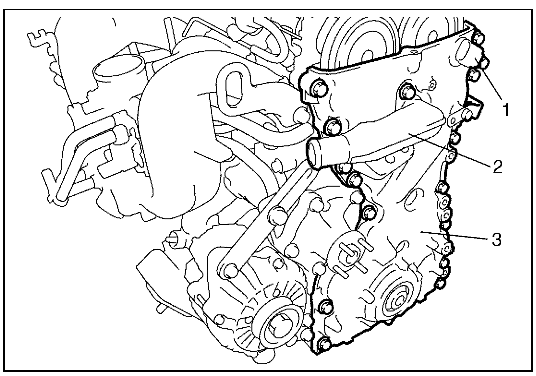
Special tool
(A) : 09917-68221



13) Remove crankshaft pulley (1).
    If it is hard to remove, use special tools as shown in figure.
    If bolts of special tool are too long, replace them with those of suitable length.

Special tool
(A) : 09944-36011
(B) : 09926-58010

14) Remove oil pan referring to “Oil Pan and Oil Pump Strainer” in this section.
15) Remove cylinder head cover referring to “Cylinder Head Cover” in this section.

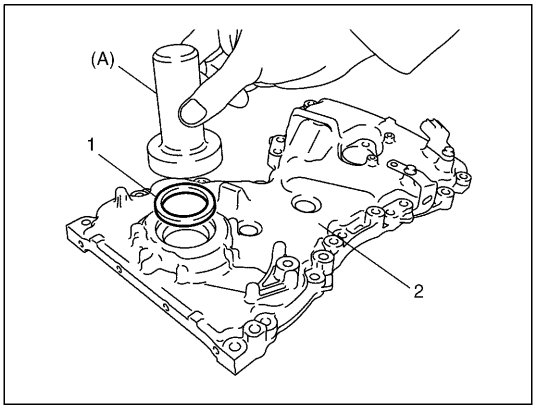


16) Disconnect CMP sensor coupler (1) and release its harness clamps.
17) Remove water outlet pipe (2).
18) Remove timing chain cover (3).

CLEANING

- Clean sealing surface on timing chain cover, cylinder block and cylinder head.
  Remove oil, old sealant and dust from sealing surface.

INSPECTION



- Check oil seal (1) lip for fault or other damage.
  Replace as necessary.

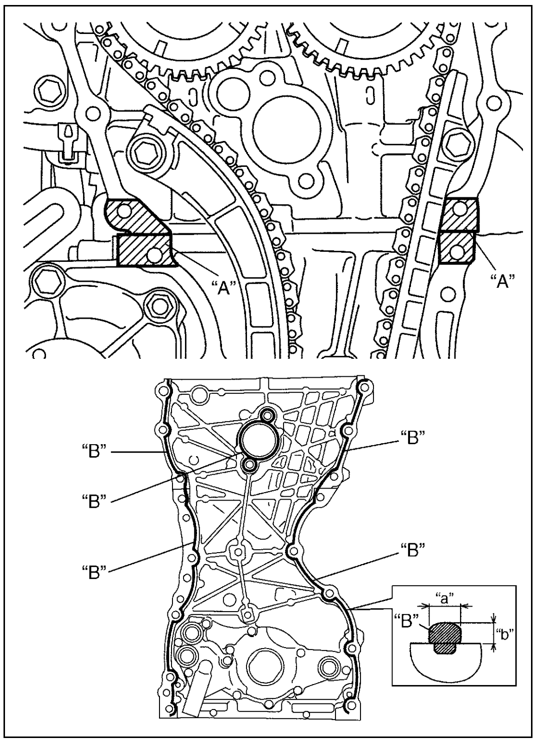
NOTE:

When installing new oil seal, tap it in until its surface is flash with edge of timing chain cover (2).
To install oil seal, use special tool (Bearing installer).

Special tool
(A) : 09913-75520

INSTALLATION

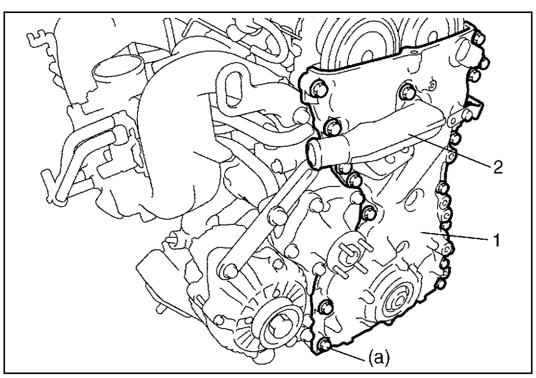
Reverse removal procedure to install timing chain cover, noting the following points.



1) Apply sealant "A" to mating surface of cylinder and cylinder head and "B" to mating surface of timing chain cover as shown in figure.

"A" : Sealant 99000-31140
"B" : Sealant 99000-31150

Sealant amount for timing chain cover
Width "a" : 3 mm, 0.12 in.
Height "b" : 2 mm, 0.08 in.

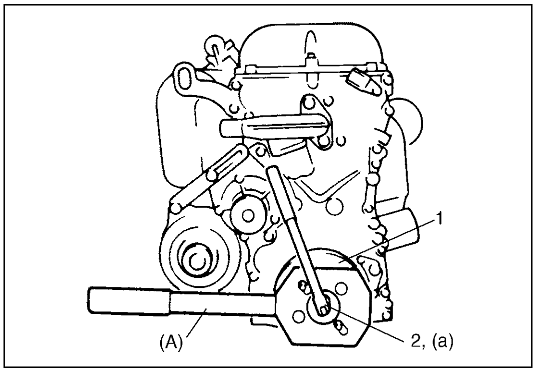


2) Apply engine oil to oil seal lip, then install timing chain cover (1) and water outlet pipe (2).
   Tighten bolts and nut to specified torque.

NOTE:

Before installing timing chain cover, check that pin is securely fitted.

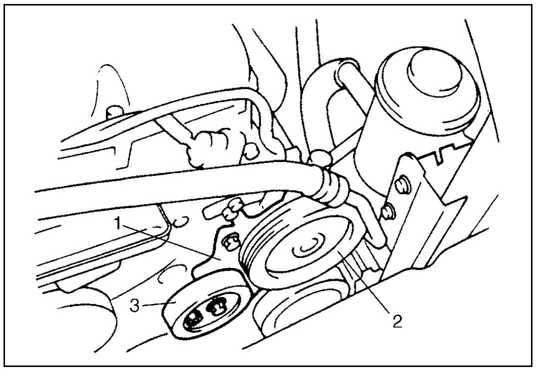
Tightening torque
Timing chain cover bolts and nut
(a) : 23 N·m (2.3 kg-m, 17.0 lb-ft)



3) Install crankshaft pulley (1). Tighten bolt (2) to specified torque.
   To lock crankshaft pulley, use special tool with it as shown in figure.

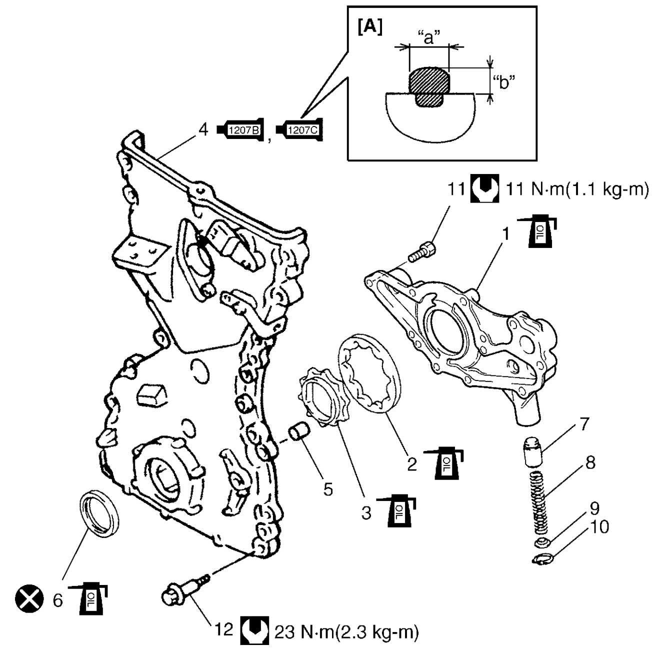
Special tool
(A) : 09917-68221

Tightening torque
Crankshaft pulley bolt (a) : 150 N·m (15.0 kg-m, 108.5 lb-ft)



4) Install P/S pump bracket (1), P/S pump (2) and A/C compressor and/or P/S pump belt tension pulley (3) (if equipped) referring to “Power Steering Pump” in Section 3B1.
5) Install cylinder head cover referring to “Cylinder Head Cover” in this section.
6) Install oil pan referring to “Oil Pan and Oil Pump Strainer” in this section.
7) Install radiator with cooling fan and connect A/T fluid hoses (vehicle with A/T), radiator inlet and outlet hoses referring to “Water Pump Belt and Cooling Fan” and “Radiator” in Section 6B.
8) Adjust generator belt tension referring to “Water Pump Belt Tension” in Section 6B for adjusting procedure.
9) Adjust A/C compressor and/or P/S pump belt tension (if equipped) referring to “Compressor Drive Belt” in Section 1B or “Power Steering Belt” in Section 3B1 for adjusting procedure.
10) Refill cooling system with coolant, engine with engine oil and A/T with specified A/T fluid (vehicle with A/T).
11) Verify that there is no coolant leakage, oil leakage and A/T fluid leakage (vehicle with A/T) at each connection.

Oil Pump

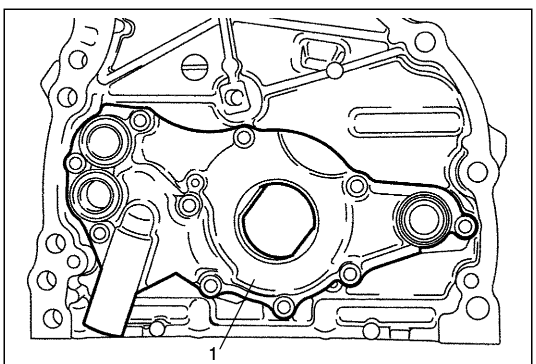


[A] :	Sealant application amount	4.	Timing chain cover	10.	Circlip
		1207B	: Apply sealant 99000-31140 to the mating surface of cylinder and cylinder head.		
		1207C	: Apply sealant 99000-31150 to mating surface of timing chain cover referring to the figure of Step 1) in “Timing Chain Cover Installation”.		
“a” :	3 mm (0.12 in.)	5.	Pin	11.	Oil pump mounting bolt
“b” :	2 mm (0.08 in.)	6.	Oil seal	12.	Timing chain cover mounting bolts
1.	Rotor plate	7.	Relief valve		Tightening torque
2.	Outer rotor	8.	Spring		Do not reuse.
3.	Inner rotor	9.	Retainer	OIL	Apply thin coat of engine oil to sliding surface of each parts.

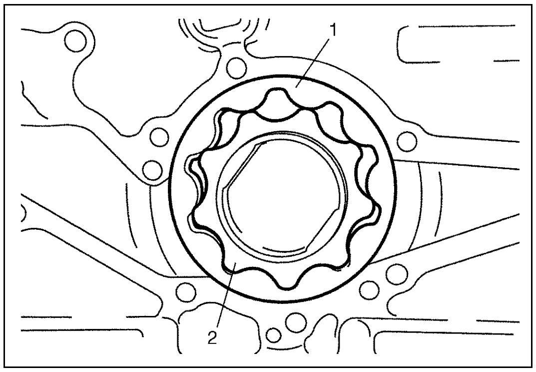
REMOVAL

1) Disconnect negative cable at battery.
2) Remove timing chain cover, referring to “Timing Chain Cover” in this section.

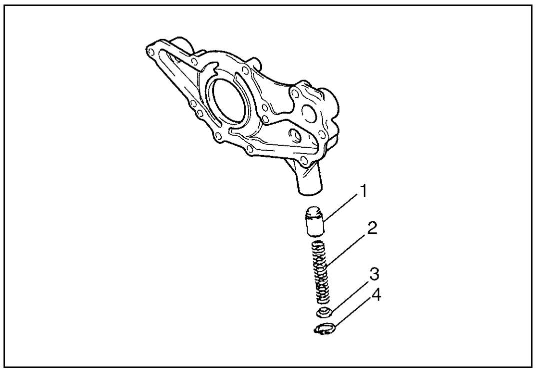
DISASSEMBLY



1) Remove rotor plate (1) by removing its mounting bolts.

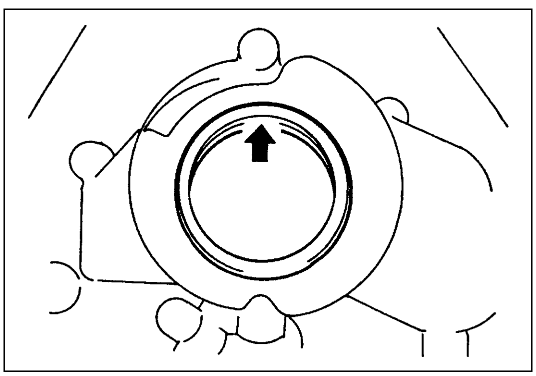


2) Remove outer rotor (1) and inner rotor (2).

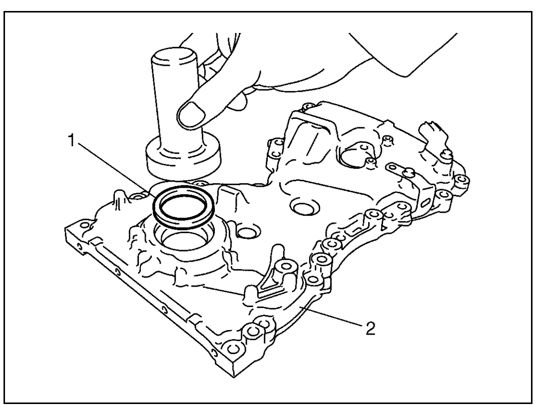


3) Remove relief valve (1), spring (2) and retainer (3) by removing circlip (4).

INSPECTION

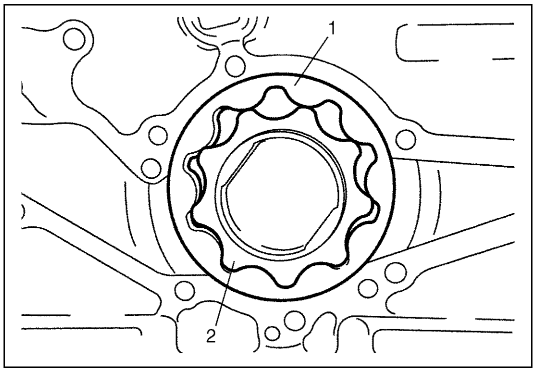


- Check oil seal lip for fault or other damage. Replace as necessary.

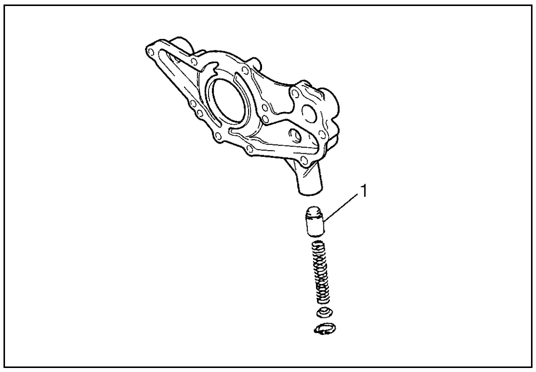


NOTE:
When installing new oil seal (1), press-fit it till its end face is flush with oil pump case (2) end face.

Special tool
(A) : 09913-75520



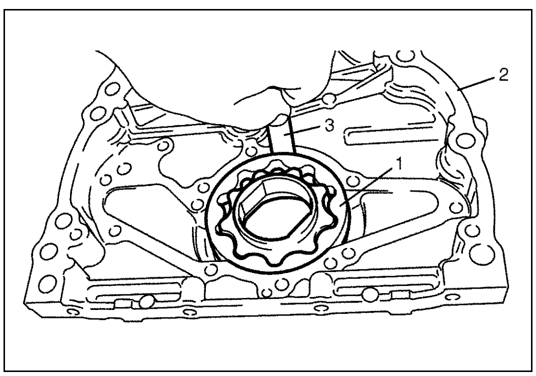
- Check outer (1) and inner rotors (2), rotor plate, and oil pump case for excessive wear or damage.



- Check relief valve (1) for excessive wear or damage and operates smoothly.

MEASUREMENT

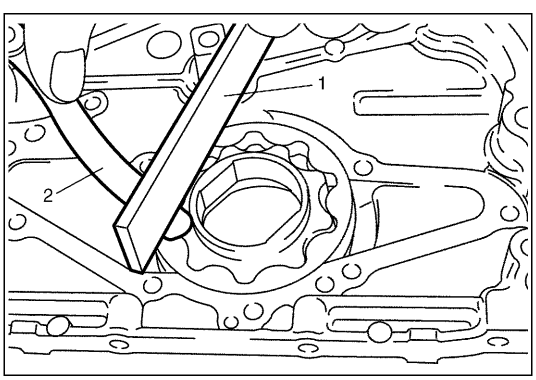
Radial clearance



Check radial clearance between outer rotor (1) and case (2), using thickness gauge (3).
If clearance exceeds its limit, replace outer rotor or case.

Limit on radial clearance between outer rotor and case for oil pump
0.310 mm (0.0122 in.)

Side clearance

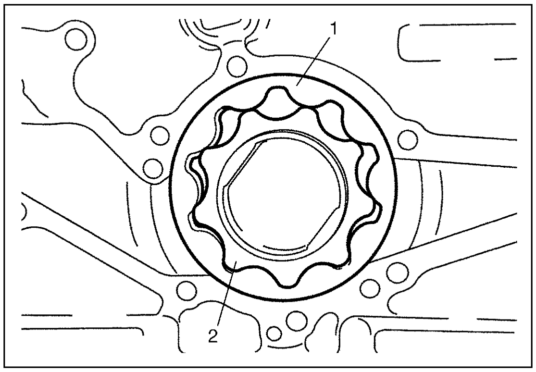


Using straight edge (1) and thickness gauge (2), measure side clearance.

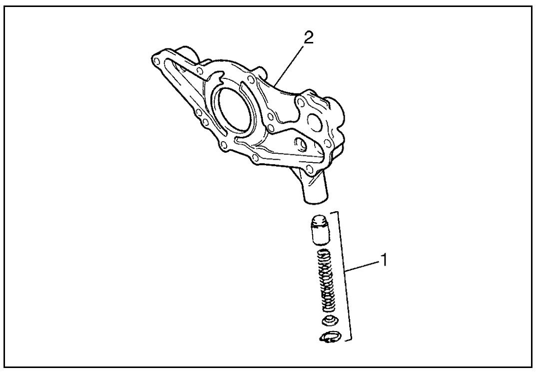
Limit on side clearance for oil pump inner rotor
0.15 mm (0.0059 in.)

ASSEMBLY

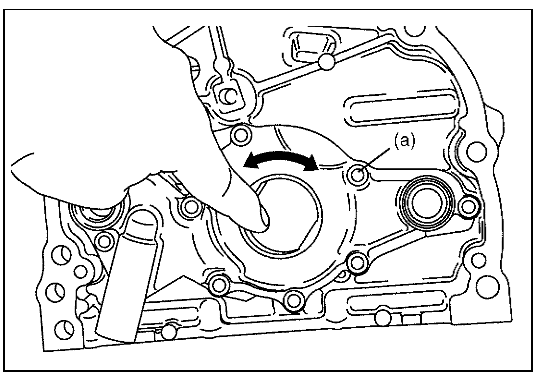
1) Wash, clean and then dry all disassembled parts.
2) Apply thin coat of engine oil to inner and outer rotors, oil seal lip portion, and inside surfaces of oil pump case and plate.



3) Install outer (1) and inner rotors (2) to oil pump case.



4) Install relief valve component (1) to rotor plate (2).



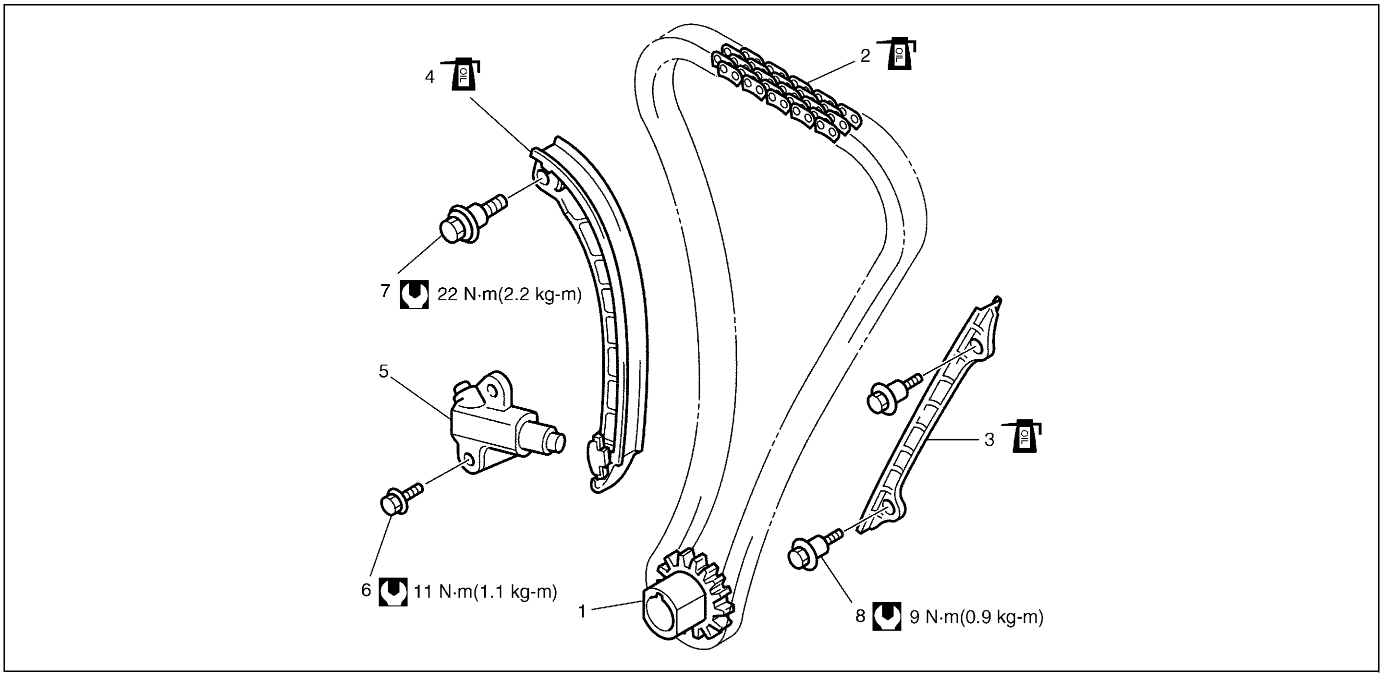
5) Install rotor plate and tighten all bolts to specified torque.
   After installing plate, check to be sure that rotors turn smoothly by hand (0.3 N·m (0.03 kg-m, 0.25 lb-ft) torque or below).

Tightening torque
Oil pump rotor plate bolts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)

INSTALLATION

For installation referring to “Timing Chain Cover” in this section.

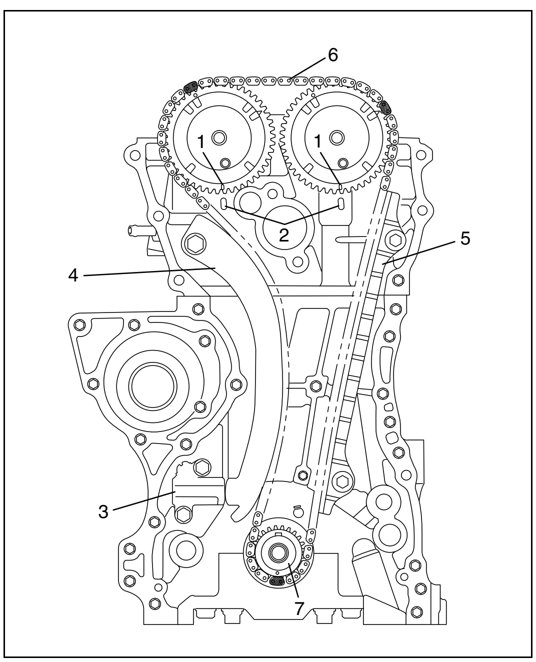
Timing Chain and Chain Tensioner



1. Crankshaft timing sprocket	5. Timing chain tensioner adjuster assembly	Tightening torque
2. Timing chain	6. Chain tensioner adjuster mounting bolt	Apply engine oil to sliding surface.
3. Timing chain No.1 guide	7. Chain tensioner mounting bolt	
4. Timing chain tensioner	8. Chain guide mounting bolt	

REMOVAL

1) Remove timing chain cover referring to “Timing Chain Cover”.

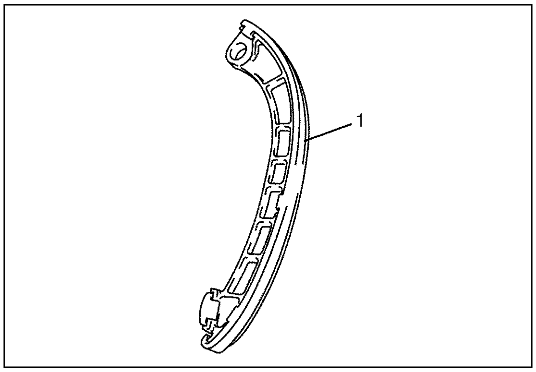


2) Align both intake and exhaust camshaft timing sprocket marks (1) with notches (2) of cylinder head respectively by turning crankshaft.
3) Remove timing chain tensioner adjuster assembly (3).
4) Remove timing chain tensioner (4).
5) Remove timing chain No.1 guide (5).
6) Remove timing chain (6) with crankshaft timing sprocket (7).

CAUTION:

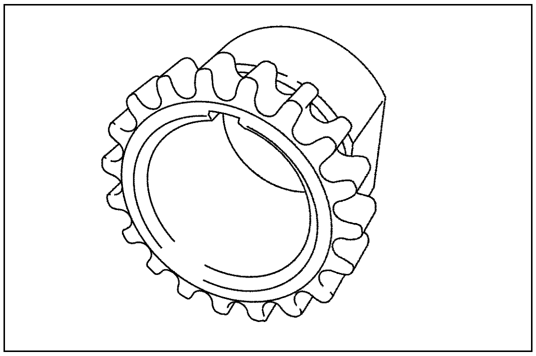
After timing chain is removed, never turn crankshaft and camshafts independently more than its allowable turning range described in “INSTALLATION” section.
If turned, interference may occur between piston and valves and valves themselves, and parts related to piston and valves may be damaged.

INSPECTION



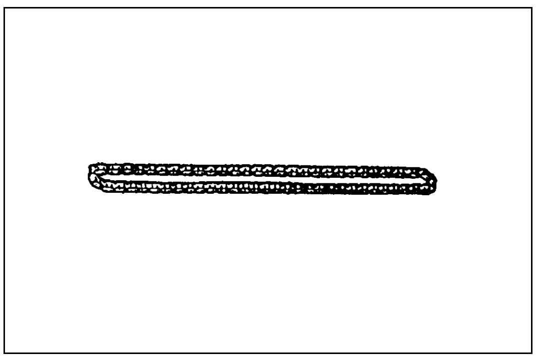
Timing chain tensioner

- Check shoe (1) for wear or damage.



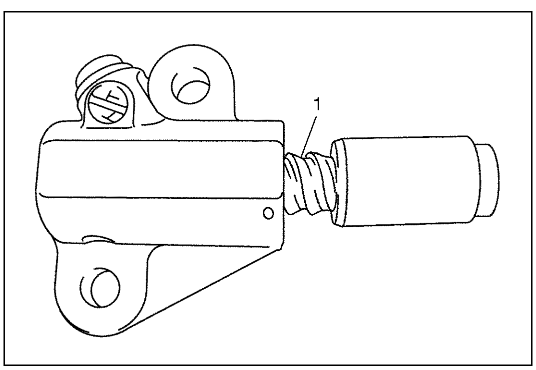
Crankshaft timing sprocket

- Check teeth of sprocket for wear or damage.



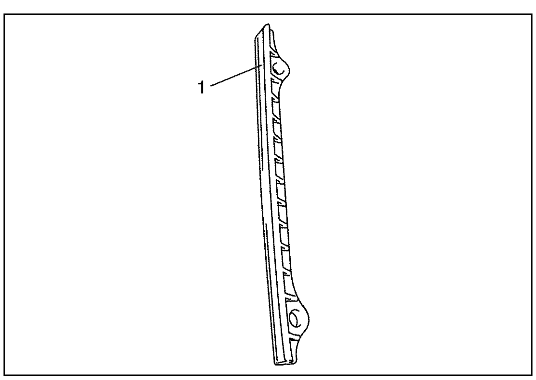
Timing chain

- Check timing chain for wear or damage.



Timing chain tensioner adjuster

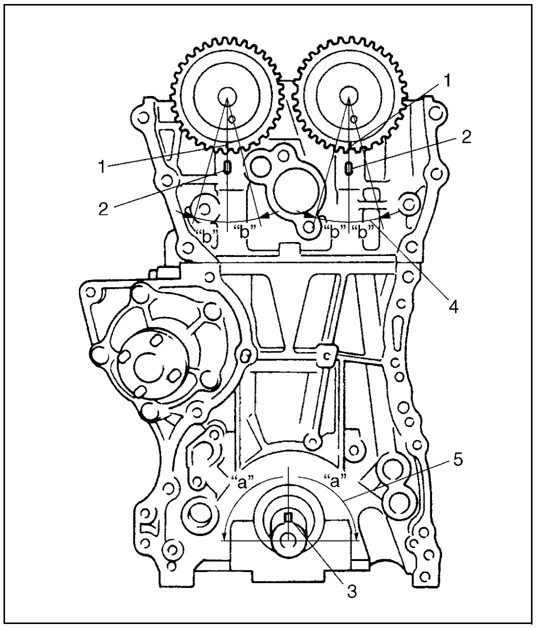
- Check that tooth surface (1) are free from damage.



Timing chain No.1 guide

- Check shoe (1) for wear or damage.

INSTALLATION

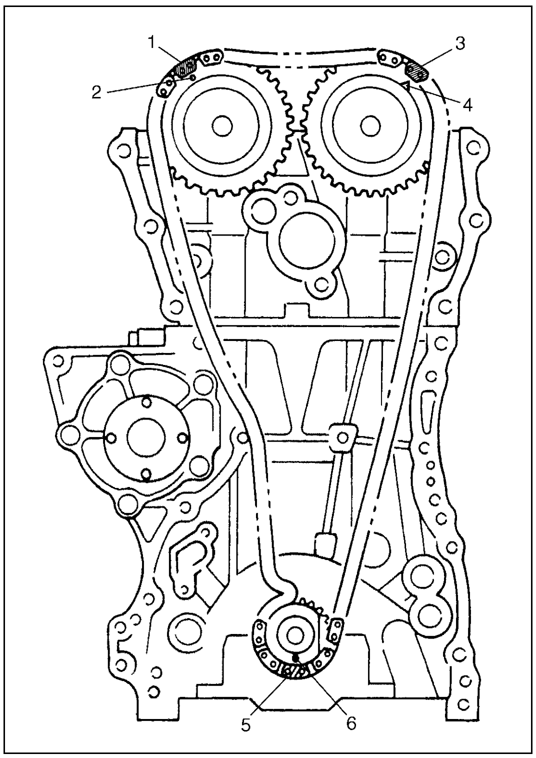


CAUTION:

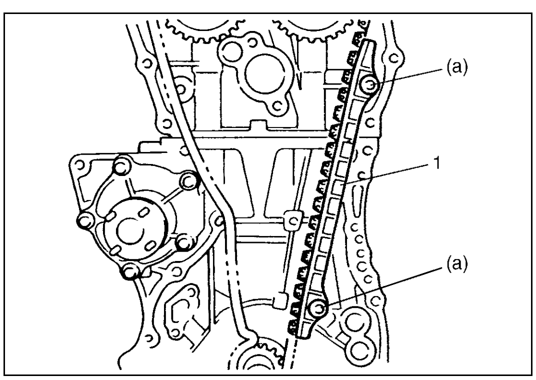
After timing chain is removed, never turn crankshaft and camshafts independently more than such an extent ("a", "b") as shown in figure.
If turned, interference may occur between piston and valves and valves themselves, and parts related to piston and valves may be damaged.

1) Check that match marks (1) on intake and exhaust camshaft timing sprockets are in match with notches (2) on cylinder head as shown in figure.
2) Set key (3) and turn crankshaft to position key on upside of crankshaft.

"a" : 90°	5. Crankshaft allowable turning range. By key on crankshaft, within 90° from top on both right and left.
"b" : 15°	4. Camshaft (IN and EX) allowable turning range. By marks on camshaft timing sprocket within 15° from notches on cylinder head on both right and left.

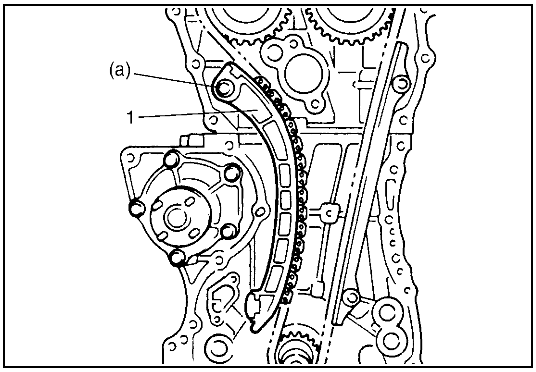


3) Install timing chain by aligning dark blue plate (1) of timing chain and mark (2) on camshaft timing sprocket and then aligning dark blue plate (3) and triangle mark (4) as shown in figure.
4) Fit crankshaft timing sprocket to timing chain by aligning gold plate (5) of timing chain and mark (6) on crankshaft timing sprocket. Then install crankshaft timing sprocket fitted with chain to crankshaft.



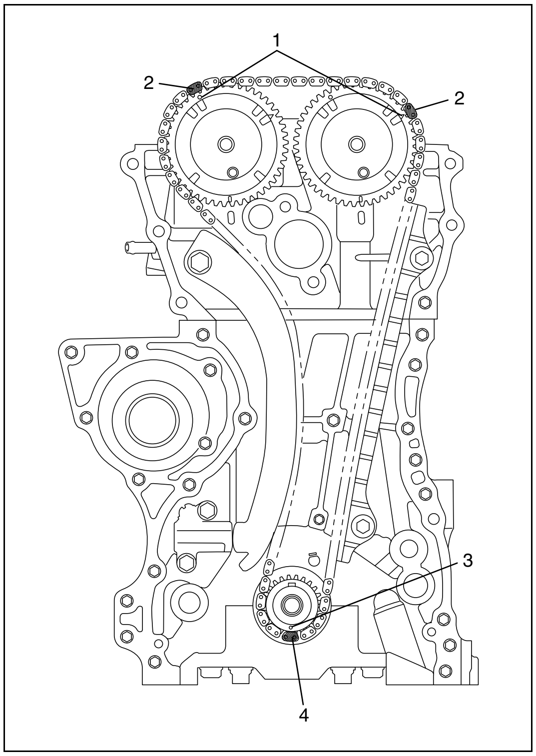
5) Apply engine oil to sliding surface of timing chain No.1 guide (1) and install it as shown in figure.
Tighten guide bolts to specified torque.

Tightening torque
Timing chain No.1 guide bolts
(a) : 9 N·m (0.9 kg-m, 6.5 lb-ft)

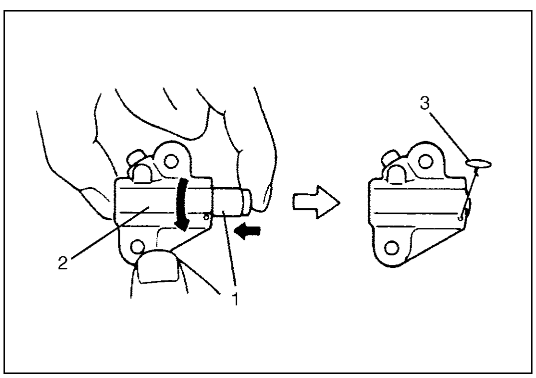


6) Apply engine oil to sliding surface of chain tensioner (1) and install chain tensioner and spacer.
   Tighten tensioner bolt to specified torque

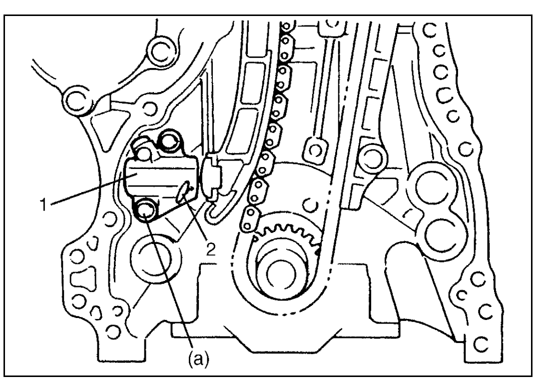
Tightening torque
Timing chain tensioner bolt
(a) : 22 N·m (2.2 kg-m, 16.0 lb-ft)



7) Check that match marks (1) on intake and exhaust camshaft timing sprockets are in match with dark blue plates (2) of timing chain and match mark (3) on crankshaft timing sprocket is in match with gold plate (4) of timing chain.

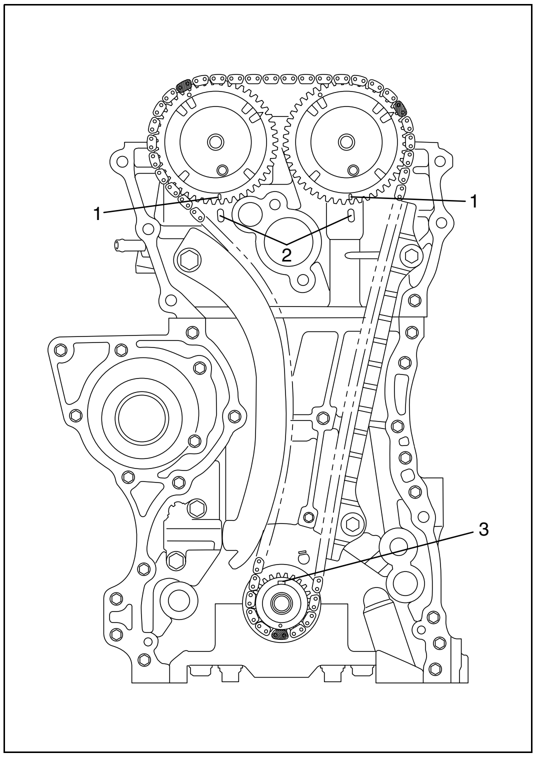


8) Screw in plunger (1) by turning timing chain tensioner adjuster (2) in arrow direction and install a retainer (3) (wire) to hold plunger in place.



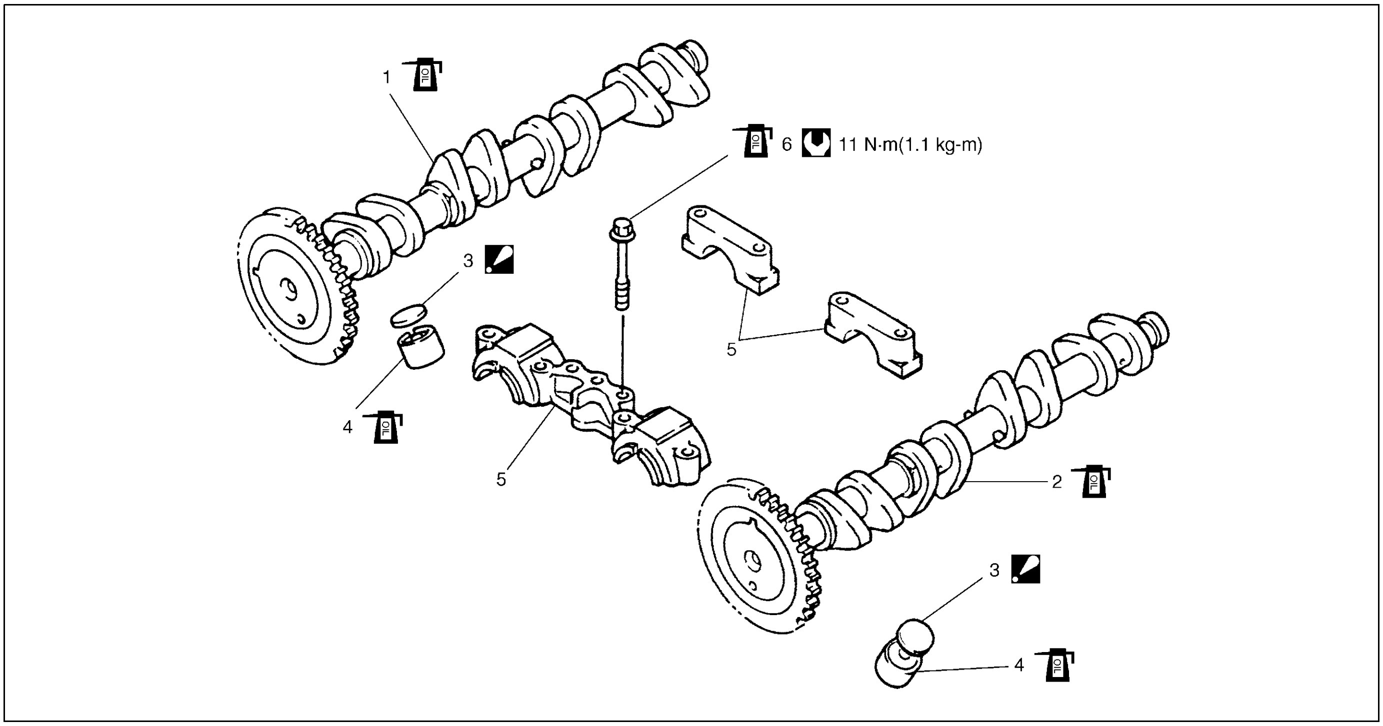
9) Install timing chain tensioner adjuster assembly (1) with a retainer (2).
   Tighten adjuster bolts to specified torque and then remove a retainer from chain tensioner adjuster assembly.

Tightening torque
Timing chain tensioner adjuster bolts
(a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)



10) Apply engine oil to timing chain and then turn crankshaft clockwise by 2 revolutions and check that match marks (1) on intake and exhaust camshaft timing sprockets are in match with notches (2) on cylinder head and key (3) is on upside of crankshaft as shown in figure.
    If each mark of timing chain and each match mark are no matches, adjust each sprocket and timing chain.
11) Install timing chain cover referring to “Timing Chain Cover” in this section.
12) Perform Steps 3) to 8) of “INSTALLATION” of “Timing Chain Cover” in this section.

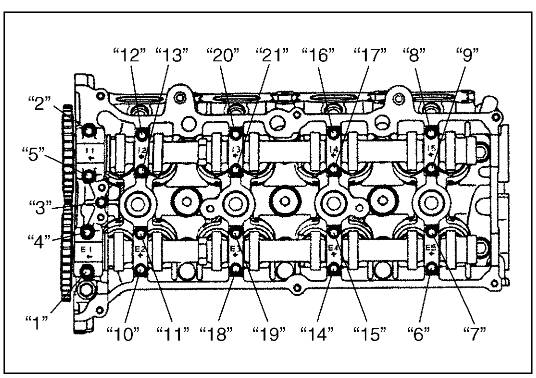
Camshaft, Tappet and Shim



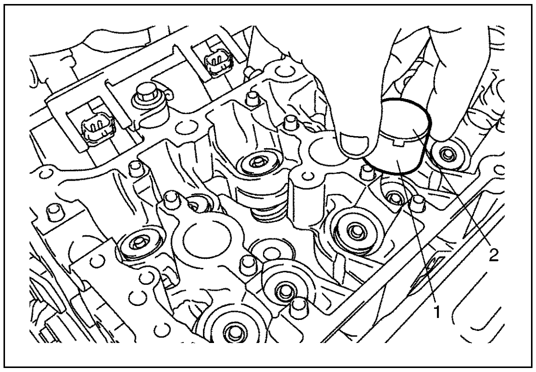
1. Intake camshaft	4. Tappet	Tightening torque
2. Exhaust camshaft	5. Camshaft housing	Apply engine oil to sliding surface of each part.
3. Shim : Shim No. on it faces tappet side.	6. Camshaft housing bolt	

REMOVAL

1) Remove cylinder head cover and oil pan referring to “Cylinder Head Cover” and “Oil Pan and Oil Pump Strainer” in this section.
2) Remove timing chain cover referring to “Timing Chain Cover” in this section.
3) Remove timing chain referring to “Timing Chain and Chain Tensioner” in this section.



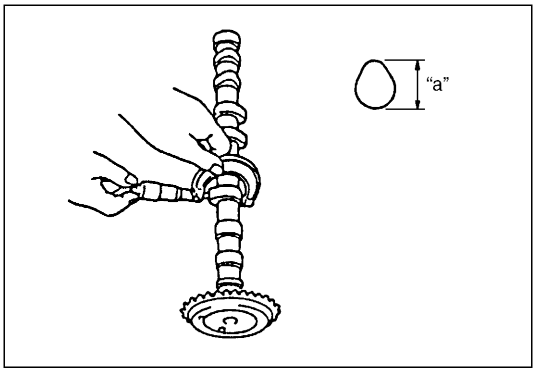
4) Loosen camshaft housing bolts in such order as indicated in figure and remove them.
5) Remove camshaft housings.
6) Remove intake and exhaust camshafts.



7) Remove tappets (1) with shims (2).

INSPECTION

Cam Wear

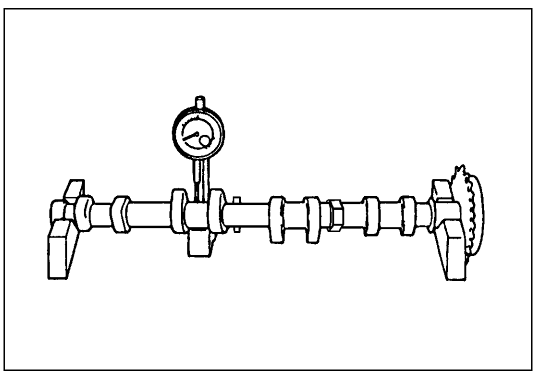


Using a micrometer, measure cam height “a”. If measured height is below its limit, replace camshaft.

Cam height “a” of camshaft

	Standard	Limit
Intake cam	**44.919 – 45.079 mm (1.768 – 1.775 in.)**	**44.80 mm (1.764 in.)**
Exhaust cam	**44.399 – 44.559 mm (1.748 – 1.754 in.)**	**44.28 mm (1.743 in.)**

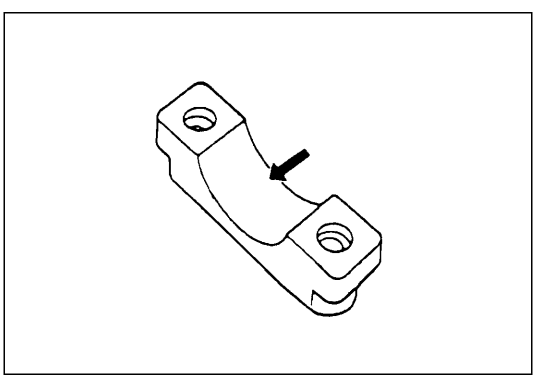
Camshaft Runout



Set camshaft between two “V” blocks, and measure its runout by using a dial gauge.
If measured runout exceeds below limit, replace camshaft.

Camshaft runout limit
0.10 mm (0.0039 in.)

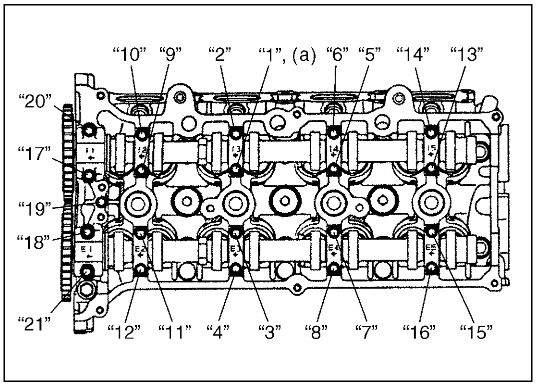
Camshaft Journal Wear



Check camshaft journals and camshaft housings for pitting, scratches, wear or damage.
If any malcondition is found, replace camshaft or cylinder head with housing. Never replace cylinder head without replacing housings.

Check clearance by using gauging plastic. Checking procedure is as follows.

1) Clean housings and camshaft journals.
2) Remove all tappets with shims.
3) Install camshafts to cylinder head.
4) Place a piece of gauging plastic to full width of journal of camshaft (parallel to camshaft).
5) Install camshaft housing.

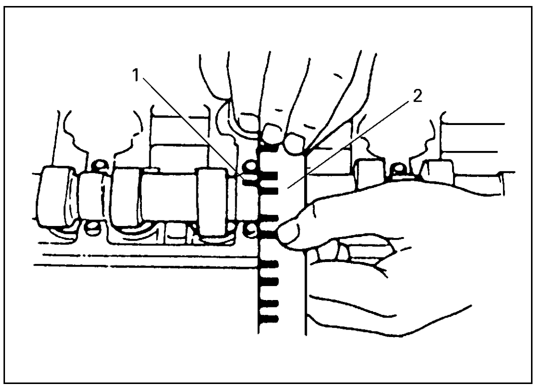


6) Tighten camshaft housing bolts in such order as indicated in figure a little at a time till they are tightened to specified torque.

NOTE:

Do not rotate camshaft while gauging plastic is installed.

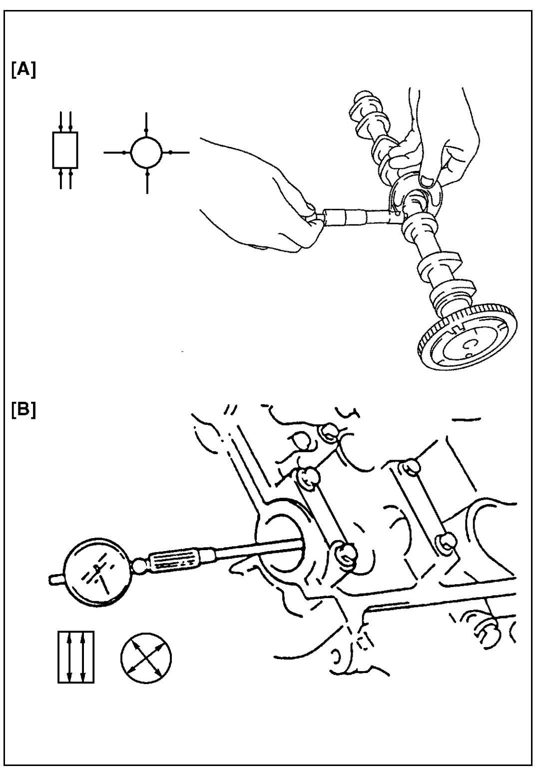
Tightening torque
Camshaft housing bolts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)



7) Remove housing, and using scale (2) on gauging plastic (1) envelop, measure gauging plastic width at its widest point.

Camshaft journal clearance

Standard	Limit
0.045 – 0.087 mm (0.0018 – 0.0034 in.)	**0.12 mm (0.0047 in.)**



If measured camshaft journal clearance exceeds limit, measure journal (housing) bore and outside diameter of camshaft journal. Replace camshaft or cylinder head assembly whichever the difference from specification is greater.

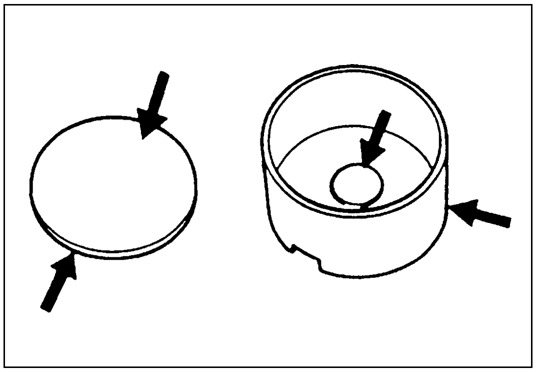
Camshaft journal outside diameter [A]

Item	Standard
No.1	**26.934 – 26.955 mm (1.0604 – 1.0612 in.)**
Other	**22.934 – 22.955 mm (0.9029 – 0.9037 in.)**

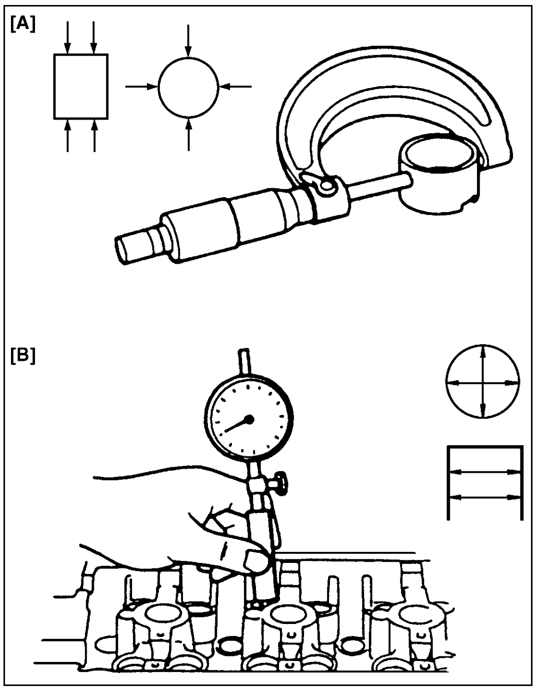
Camshaft journal bore diameter [B]

Item	Standard
No.1	**27.000 – 27.021 mm (1.0630 – 1.0638 in.)**
Other	**23.000 – 23.021 mm (0.9055 – 0.9063 in.)**

Wear of Tappet and Shim



Check tappet and shim for pitting, scratches or damage.
If any malcondition is found, replace.



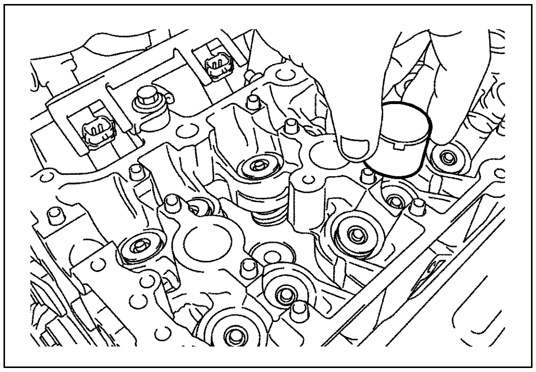
Measure cylinder head bore and tappet outside diameter to determine cylinder head-to-tappet clearance. If clearance exceeds limit, replace tappet or cylinder head.

Cylinder head to tappet clearance
Standard : 0.025 – 0.066 mm (0.0010 – 0.0026 in.)
Limit : 0.15 mm (0.0059 in.)

Tappet outside diameter [A]
Standard : 30.959 – 30.975 mm (1.2189 – 1.2195 in.)

Cylinder head tappet bore [B]
Standard : 31.000 – 31.025 mm (1.2205 – 1.2215 in.)

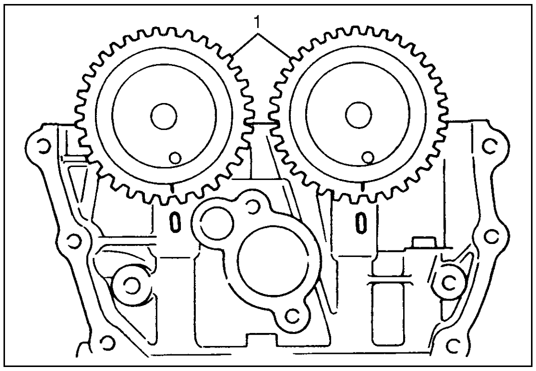
INSTALLATION



1) Install tappets and shims to cylinder head.
   Apply engine oil around tappet and then install it to cylinder head.

NOTE:

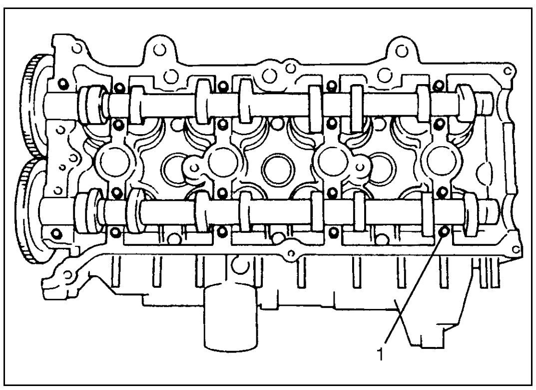
When installing shim, make sure to direct shim No. side toward tappet.



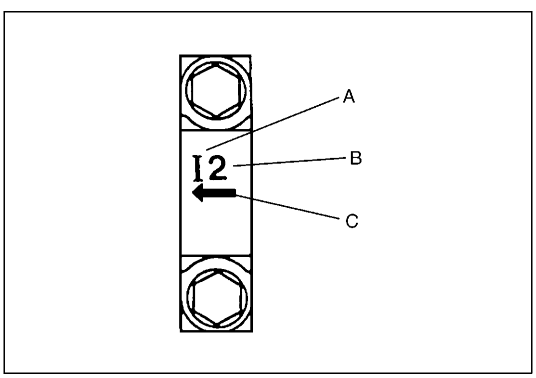
2) Install camshafts (1).
   Apply engine oil to sliding surface of each camshaft and camshaft journal then install them as shown in figure.

NOTE:

Before installing camshafts, turn crankshaft until key position faces upward. Refer to “Timing Chain and Chain Tensioner”.

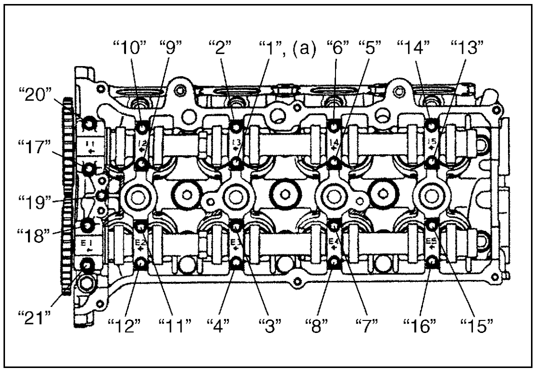


3) Install camshaft housing pins (1) as shown in figure.



4) Check position of camshaft housings.
   Embossed marks are provided on each camshaft housing, indicating position and direction for installation. Install housings as indicated by these marks.

A.	I : Intake side or E : Exhaust side
B.	Position from timing chain side
C.	Pointing to timing chain side

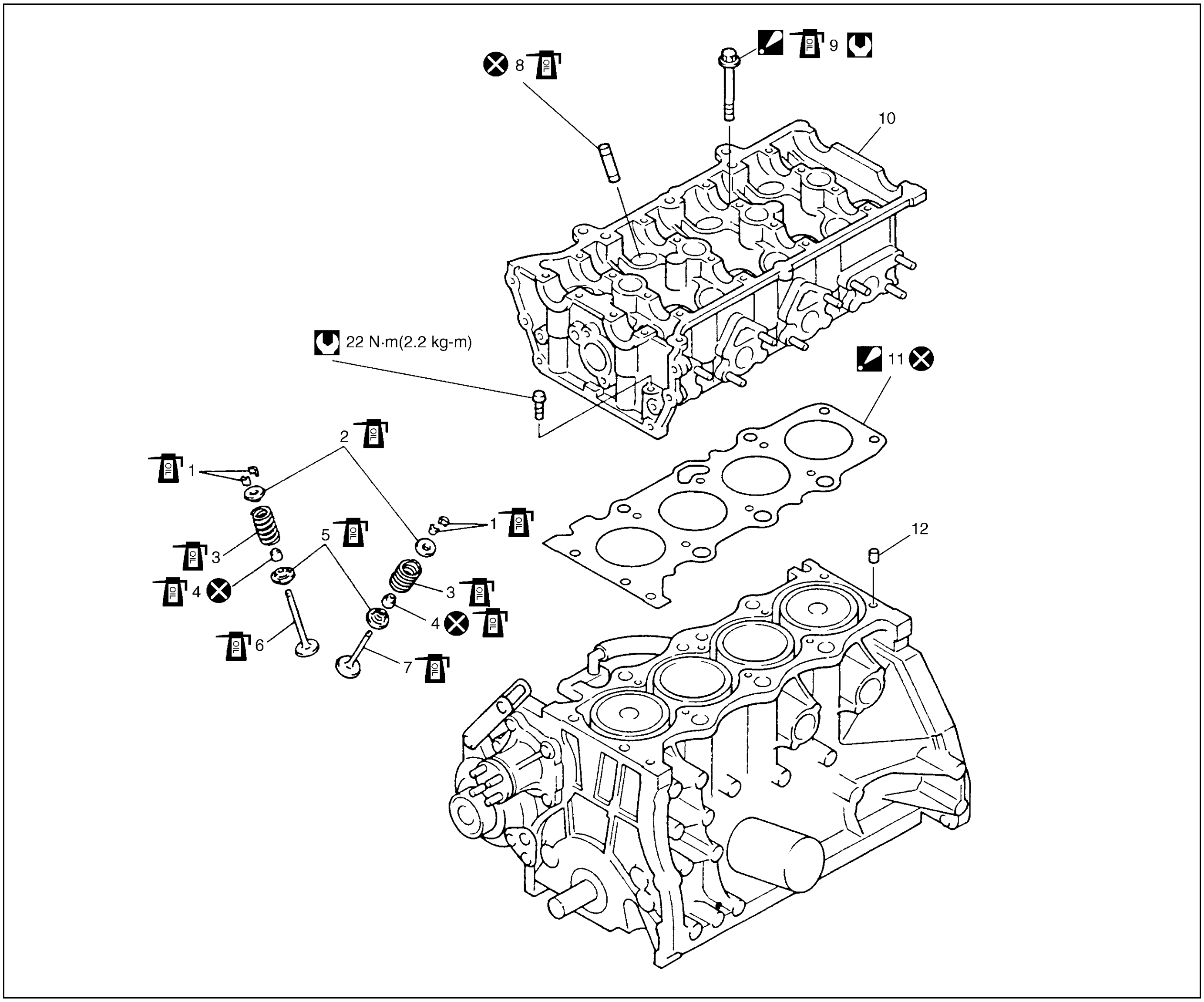


5) After applying engine oil to housing bolts, tighten them temporarily first. Then tighten them by the following numerical order in figure. Tighten a little at a time and evenly among bolts and repeat tightening sequence two or three times before they are tightened to specified torque.

Tightening torque
Camshaft housing bolts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)

6) Install timing chain with crankshaft sprocket referring to "Timing Chain and Chain Tensioner" in this section.
7) Install timing chain cover referring to "Timing Chain Cover" in this section.
8) Check valve lashes referring to "Valve Lash" in this section.
9) Install cylinder head cover and oil pan referring to "Cylinder Head Cover" and "Oil Pan and Oil Pump Strainer" in this section.
10) Install radiator with cooling fan and connect A/T fluid hoses (vehicle with A/T), radiator inlet and outlet hoses referring to "Water Pump Belt and Cooling Fan" and "Radiator" in Section 6B.
11) Adjust generator belt tension referring to "Water Pump Belt Tension" in Section 6B.
12) Adjust A/C compressor and/or P/S pump belt tension (if equipped) referring to "Compressor Drive Belt" in Section 1B or "Power Steering Belt" in Section 3B1.
13) Refill cooling system with coolant, engine with engine oil and A/T with specified A/T fluid (vehicle with A/T).
14) Verify that there is no coolant leakage, oil leakage and A/T fluid leakage (vehicle with A/T) at each connection.

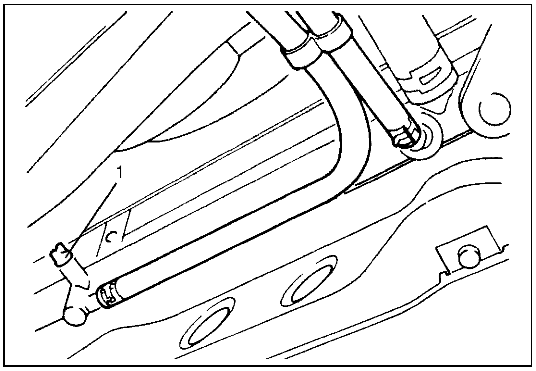
Valves and Cylinder Head



1. Valve cotters	6. Intake valve	11. Cylinder head gasket : "TOP" mark provided on gasket comes to crankshaft pulley side, facing up.
2. Valve spring retainer	7. Exhaust valve	12. Knock pin
3. Valve spring	8. Valve guide	Tightening torque
4. Valve stem seal	9. Cylinder head bolt 1) Tighten all bolts at 40 N·m (4.0 kg-m) 2) Turn all bolts to 60° 3) Then, turn all bolts to 60° once again	Do not reuse.
5. Valve spring seat	10. Cylinder head	Apply engine oil to sliding surface of each part.

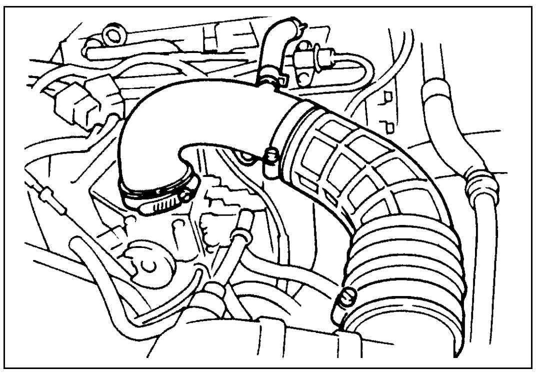
REMOVAL

1) Relieve fuel pressure referring to “Fuel Pressure Relief Procedure” in Section 6.
2) Disconnect negative cable at battery.
3) Drain engine oil.

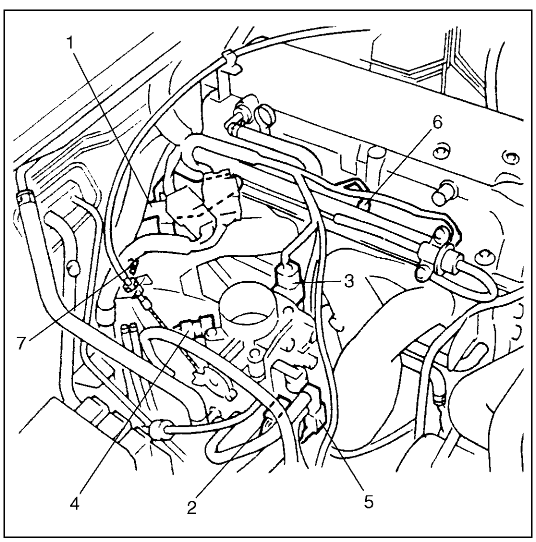


4) Drain coolant by loosening drain plug (1).

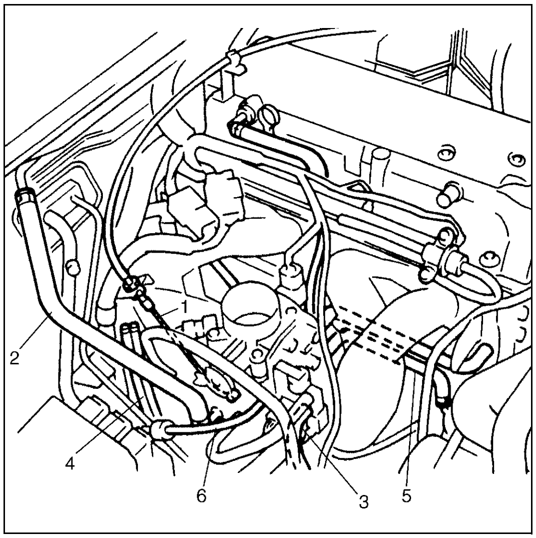
> **WARNING:**
> **To help avoid danger of being burned, do not remove drain plug (1) and radiator cap while engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if plug and cap are taken off too soon.**



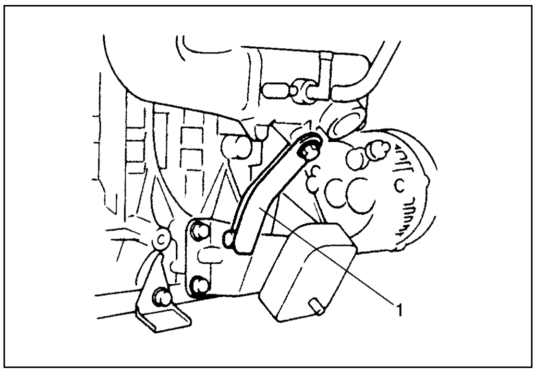
5) Remove air cleaner outlet No.1 and No.2 hoses and breather hose.



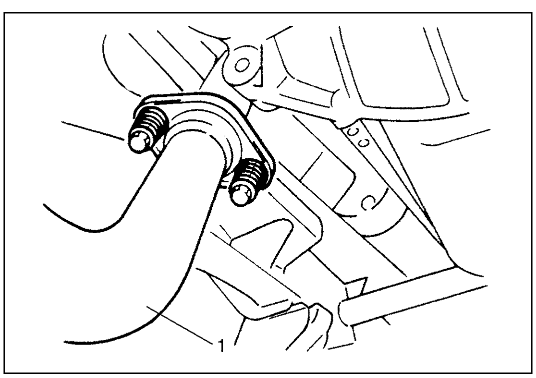
6) Remove intake manifold bracket (1) with main harness from intake manifold.
7) Disconnect the following electric lead wires:
   - EGR valve (if equipped)
   - IAC valve (2)
   - TP sensor (3)
   - MAP sensor (4)
   - CMP sensor
   - ECT sensor
   - EVAP canister purge valve (5)
   - Injectors (6)
   - Ignition coils
   - Heated oxygen sensor
   - Ground terminal (7) from intake manifold
   - Each wire harness clamps
8) Remove heated oxygen sensor bracket from cylinder head and detach heated oxygen sensor coupler from its bracket.



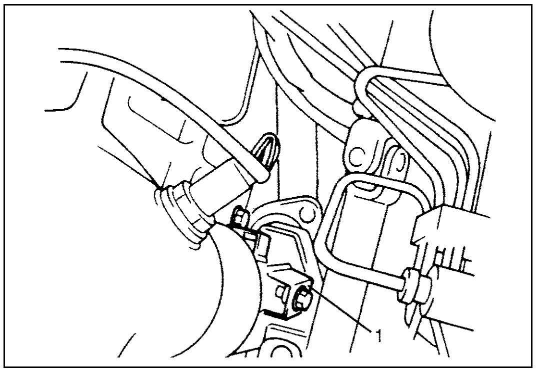
9) Disconnect accelerator cable (1) from throttle body.
10) Disconnect the following hoses:
   - Brake booster hose (2) from intake manifold
   - Canister purge hose (3) from EVAP canister purge valve
   - Fuel feed and return hoses (4) from each pipe
   - Water hose from thermostat case (5)
   - Heater inlet hose from its pipe
   - Vacuum hose (to check valve) (6)
11) Remove canister purge hose bracket from intake manifold.



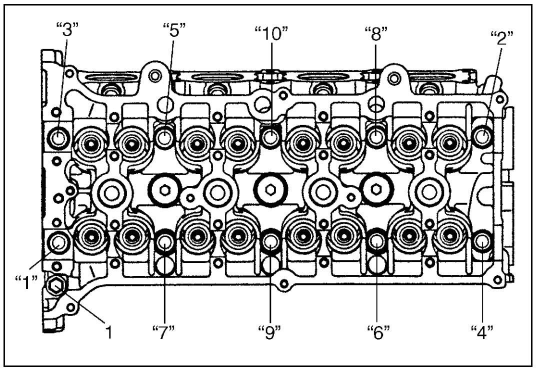
12) Remove intake manifold stiffener (1).
13) Remove oil pan referring to “Oil Pan and Oil Pump Strainer” in this section.
14) Remove cylinder head cover referring to “Cylinder Head Cover” in this section.
15) Remove timing chain cover referring to “Timing Chain Cover” in this section.
16) Remove timing chain referring to “Timing Chain and Chain Tensioner” in this section.
17) Remove intake and exhaust camshafts referring to “Camshaft, Tappet and Shim” in this section.



18) Disconnect exhaust pipe (1) from exhaust manifold.



19) Remove exhaust manifold stiffener (1).



20) Loosen cylinder head bolts in such order as indicated in figure by using a 12 corner socket wrenches and remove them.

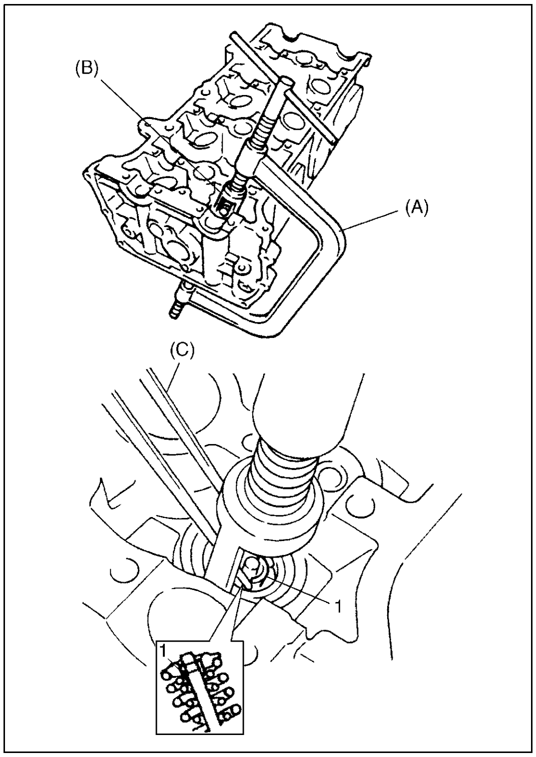
NOTE:

Don’t forget to remove bolt (M8) (1) as shown in figure.

21) Check all around cylinder head for any other parts required to be removed or disconnected and remove or disconnect whatever necessary.
22) Remove cylinder head with intake manifold and exhaust manifold. Use lifting device, if necessary.

DISASSEMBLY

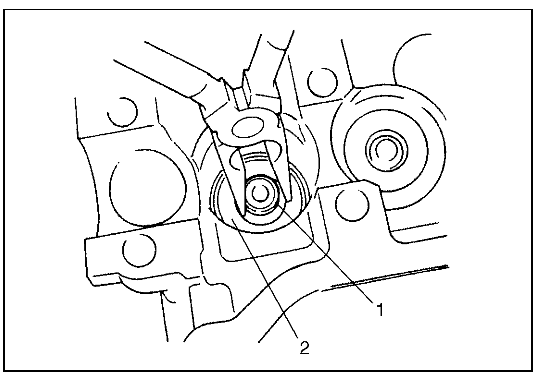
1) For ease in servicing cylinder head, remove intake manifold, injectors and exhaust manifold from cylinder head.



2) Using special tools (Valve lifter), compress valve spring and then remove valve cotters (1) by using special tool (Forceps).

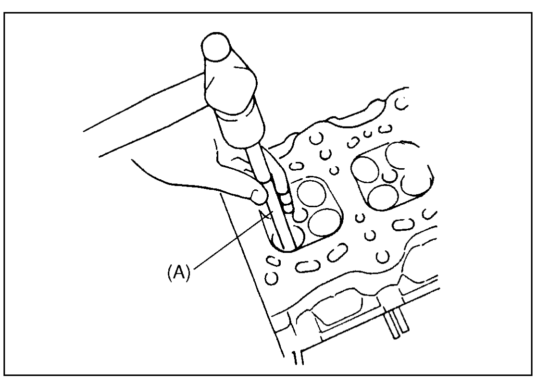
Special tool
(A) : 09916-14510
(B) : 09916-14521
(C) : 09916-84511

3) Release special tools and remove spring retainer and valve spring.
4) Remove valve from combustion chamber side.



5) Remove valve stem seal (1) from valve guide and then valve spring seat (2).

NOTE:
Do not reuse seal once disassembled. Be sure to use new seal when assembling.



6) Using special tool (valve guide remover), drive valve guide out from combustion chamber side to valve spring side.

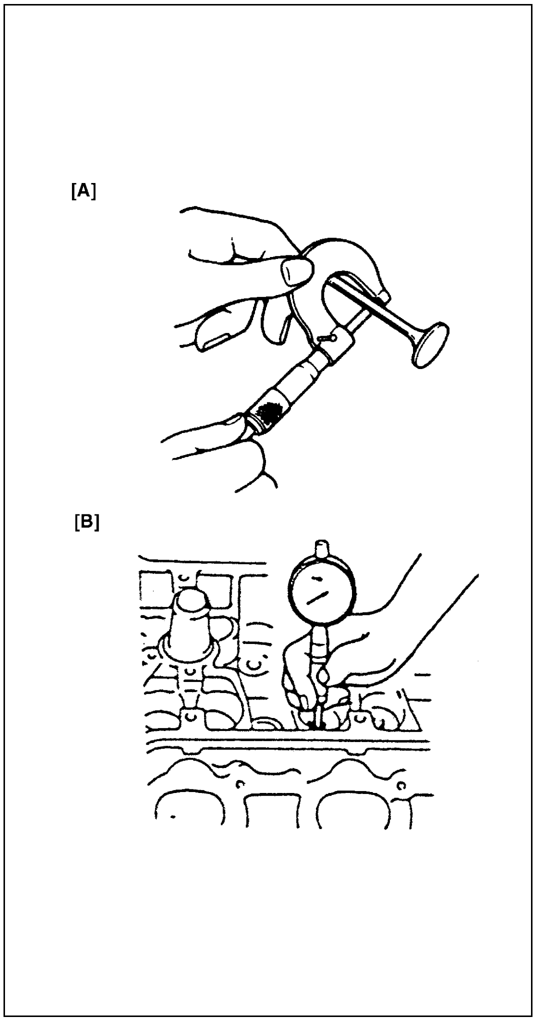
Special tool
(A) : 09916-44910

NOTE:
Do not reuse valve guide once disassembled. Be sure to use new valve guide (Oversize) when assembling.

7) Place disassembled parts except valve stem seal and valve guide in order so that they can be installed in their original position.

INSPECTION

Valve Guides



Using a micrometer and bore gauge, take diameter readings on valve stems and guides to check stem-to-guide clearance. Be sure to take reading at more than one place along the length of each stem and guide.
If clearance exceeds limit, replace valve and valve guide.

Valve stem-to-guide clearance

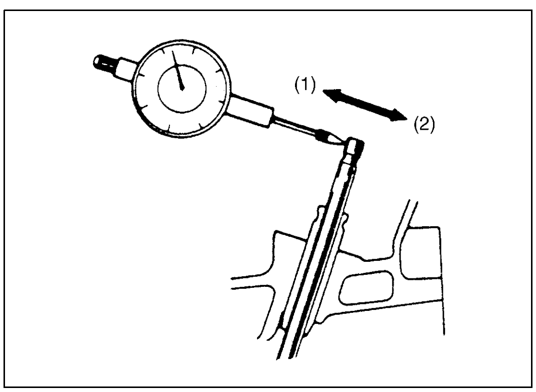
	Standard	Limit
In	0.020 – 0.047 mm (0.0008 – 0.0019 in.)	0.07 mm (0.0028 in.)
Ex	0.045 – 0.072 mm (0.0018 – 0.0028 in.)	0.09 mm (0.0035 in.)

Valve stem diameter [A]

	Standard
In	5.465 – 5.480 mm (0.2152 – 0.2157 in.)
Ex	5.440 – 5.455 mm (0.2142 – 0.2148 in.)

Valve guide bore [B]

	Standard
In and Ex	5.485 – 5.510 mm (0.2159 – 0.2169 in.)

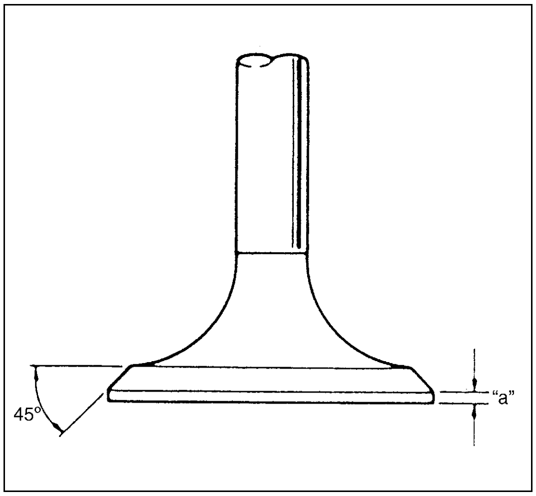


If bore gauge is not available, check end deflection of valve stem with a dial gauge instead.
Move stem end in directions (1) and (2) to measure end deflection.
If deflection exceeds its limit, replace valve stem and valve guide.

Valve stem end deflection limit
In: 0.14 mm (0.006 in.)
Ex: 0.18 mm (0.007 in.)

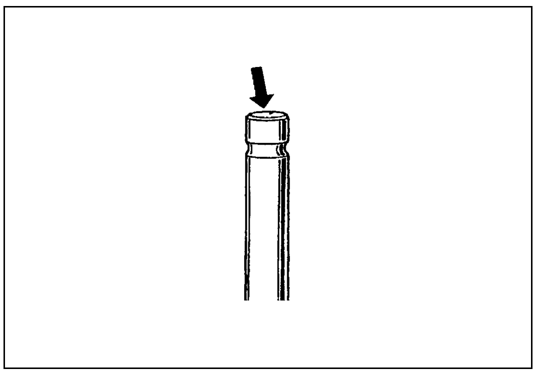
Valves

- Remove all carbon from valves.
- Inspect each valve for wear, burn or distortion at its face and stem end, as necessary, replace it.

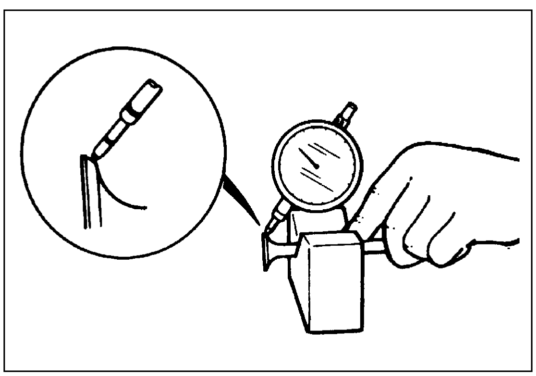


- Measure thickness "a" of valve head. If measured thickness exceeds limit, replace valve.

Valve head thickness "a" (In and Ex)
Standard : 1.22 – 1.55 mm (0.048 – 0.061 in.)
Limit : 0.9 mm (0.035 in.)

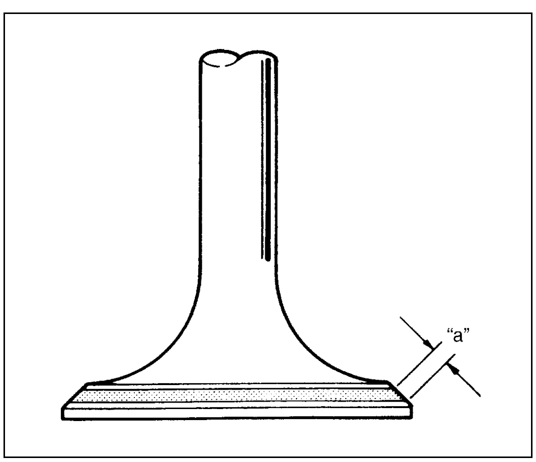


- Inspect valve stem end face for pitting and wear. If pitting or wear is found there, valve stem end may be resurfaced, but not too much to grind off its chamber. When it is worn out too much that its chamber is gone, replace valve.



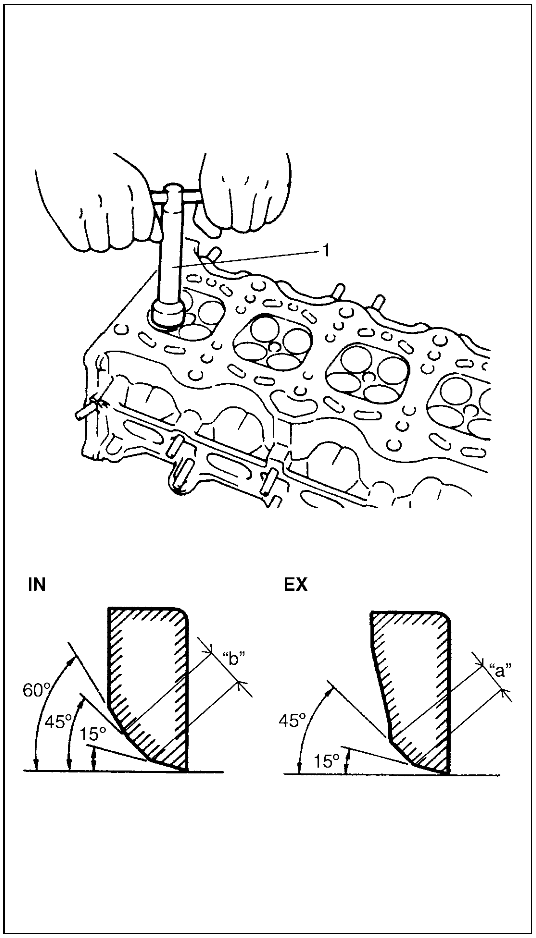
- Check each valve for radial runout with a dial gauge and "V" block. To check runout, rotate valve slowly. If runout exceeds its limit, replace valve.

Limit on valve head radial runout
0.08 mm (0.003 in.)



- Seating contact width:
  Create contact pattern on each valve in the usual manner, i.e. by giving uniform coat of marking compound to valve seat and by rotatingly tapping seat with valve head. Valve lapper (tool used in valve lapping) must be used.
  Pattern produced on seating face of valve must be a continuous ring without any break, and the width of pattern must be within specified range.

Standard seating width "a" revealed by contact pattern on valve face
In and Ex : 1.1 – 1.3 mm (0.0433 – 0.0512 in.)



- Valve seat repair:
  A valve seat not producing a uniform contact with its valve or showing width of seating contact that is out of specified range must be repaired by regrinding or by cutting and regrinding and finished by lapping.

1) EXHAUST VALVE SEAT: Use valve seat cutters (1) to make two cuts as illustrated in figure. Two cutters must be used: the first for making 15° angle, and the second for making 45° angle. The second cut must be made to produce desired seat width.

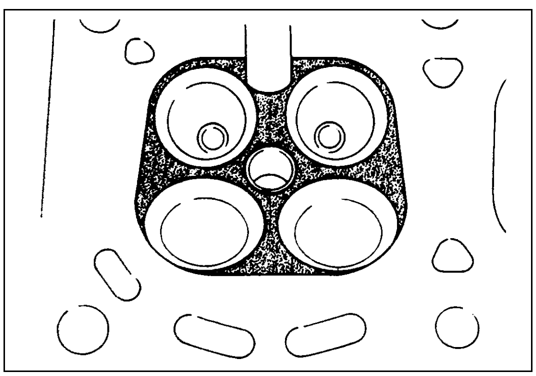
Seat width for exhaust valve seat
"a" : 1.1 – 1.3 mm (0.0433 – 0.0512 in.)

2) INTAKE VALVE SEAT: Use valve seat cutters to make three cuts as illustrated in figure. Three cutters must be used: the 1st for making 15° angle, the 2nd for making 60° angle, and 3rd for making 45° angle. The 3rd cut (45°) must be made to produce desired seat width.

Seat width for intake valve seat
"b" : 1.1 – 1.3 mm (0.0433 – 0.0512 in.)

3) VALVE LAPPING: Lap valve on seat in two steps, first with coarse size lapping compound applied to face and the second with fine-size compound, each time using valve lapper according to usual lapping method.

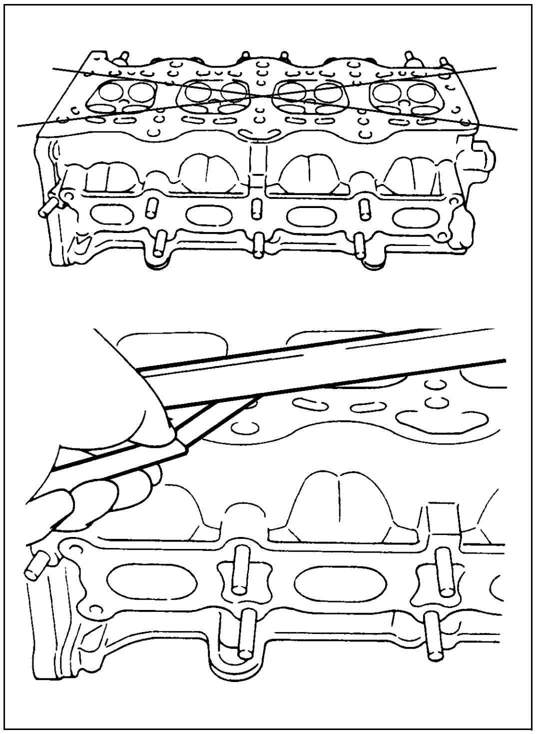
Cylinder Head



- Remove all carbon deposits from combustion chambers.

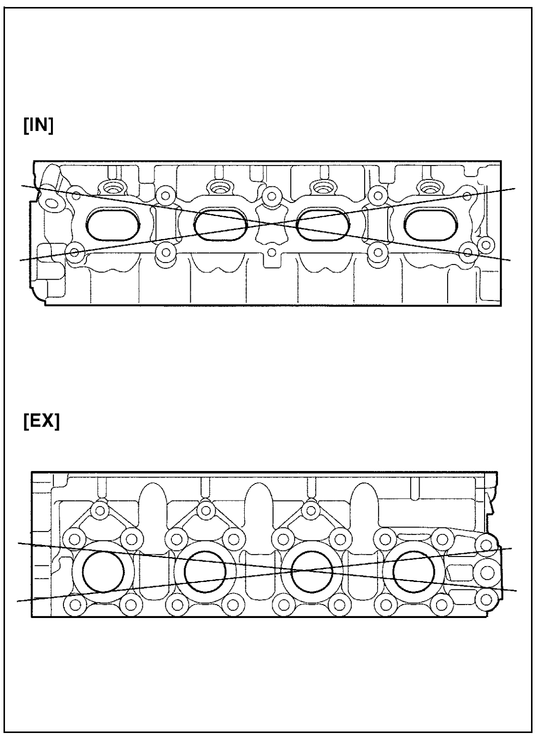
NOTE:

Do not use any sharp-edged tool to scrape off carbon deposits. Be careful not to scuff or nick metal surfaces when decarboning. The same applies to valves and valve seats, too.



- Check cylinder head for cracks on intake and exhaust ports, combustion chambers, and head surface.
  Using a straightedge and thickness gauge, check flatness of gasketed surface at a total of 2 locations. If distortion limit, given below, is exceeded, correct gasketed surface with a surface plate and abrasive paper of about #400 (Waterproof silicon carbide abrasive paper): place abrasive paper on and over surface plate, and rub gasketed surface against paper to grind off high spots. Should this fail to reduce thickness gauge readings to within limit, replace cylinder head.
  Leakage of combustion gases from this gasketed joint is often due to warped gasketed surface: such leakage results in reduced power output.

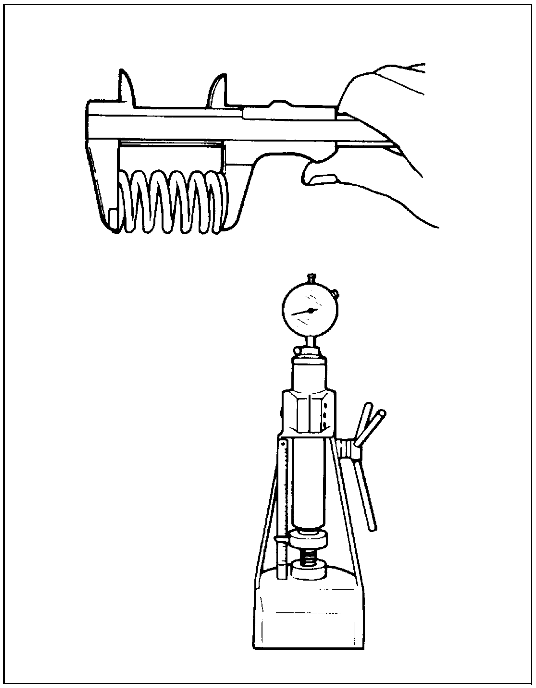
Limit of distortion for surface of cylinder head piston side
0.03 mm (0.001 in.)



- Distortion of manifold seating faces:
  Check seating faces of cylinder head for manifolds, using a straightedge and thickness gauge, in order to determine whether these faces should be corrected or cylinder head replaced.

Limit of distortion for surface of cylinder head intake and exhaust manifolds sides
0.05 mm (0.002 in.)

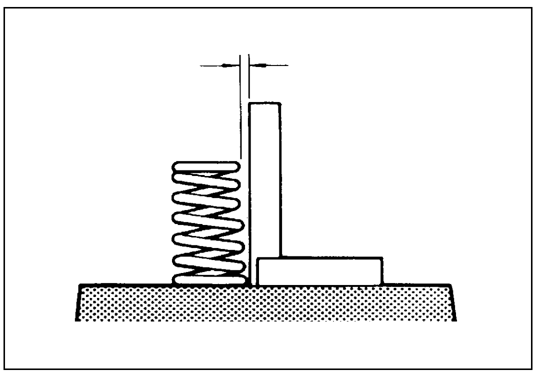
Valve Springs



- Referring to data given below, check to be sure that each spring is in sound condition, free of any evidence of breakage or weakening. Remember, weakened valve springs can cause chatter, not to mention possibility of reducing power output due to gas leakage caused by decreased seating pressure.

Valve spring free length
Standard : 36.83 mm (1.450 in.)
Limit : 35.83 mm (1.410 in.)

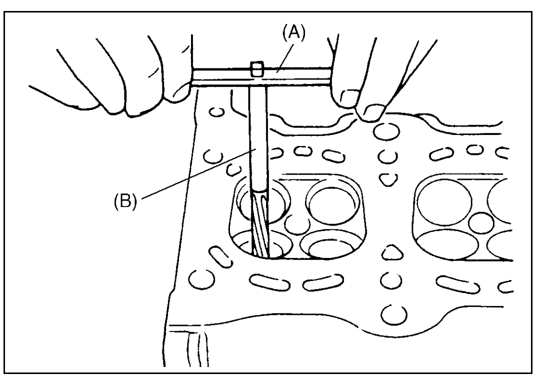
Valve spring preload
Standard : 107 – 125 N (10.7 – 12.5 kg) for 31.5 mm (23.6 – 27.6 lb / 1.240 in.)
Limit : 102 N (10.2 kg) for 31.5 mm (22.9 lb / 1.240 in.)



- Spring skewness:
  Use a square and surface plate to check each spring for skewness in terms of clearance between end of valve spring and square. Valve springs found to exhibit a larger clearance than limit given below must be replaced.

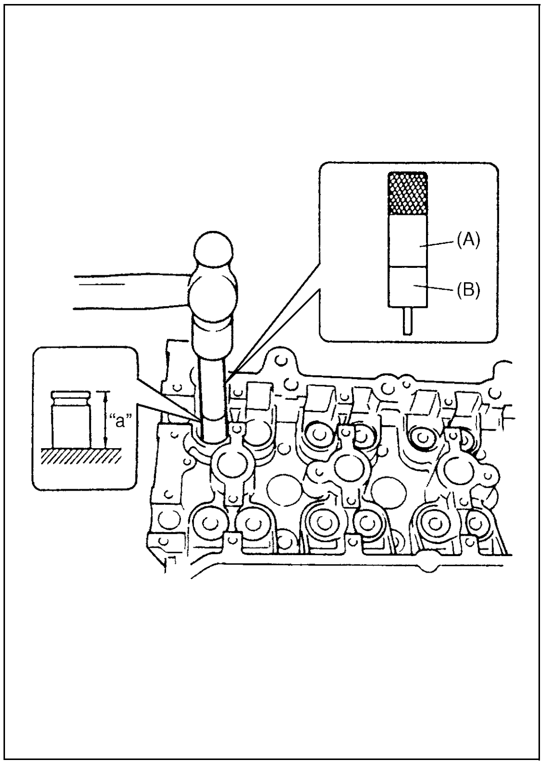
Valve spring skewness
Limit : 1.6 mm (0.063 in.)

ASSEMBLY



1) Before installing valve guide into cylinder head, ream guide hole with special tool (10.5 mm reamer) so as to remove burrs and make it truly round.

Special tool
(A) : 09916-34542
(B) : 09916-37320

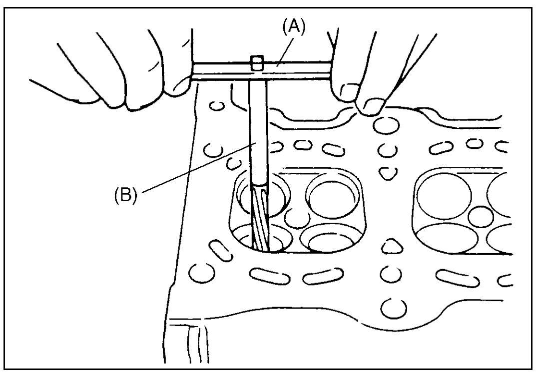


2) Install valve guide to cylinder head.
Heat cylinder head uniformly to a temperature of 80 to 100 °C (176 to 212 °F) so that head will not be distorted, and drive new valve guide into hole with special tools. Drive in new valve guide until special tool (Valve guide installer) contacts cylinder head.
After installing, make sure that valve guide protrudes by specified dimension "a" from cylinder head.

Special tool
(A) : 09916-58210
(B) : 09916-56011

NOTE:
- **Do not reuse once-disassembled valve guide. Make sure to install new valve guide.**
- **Intake and exhaust valve guides are identical.**

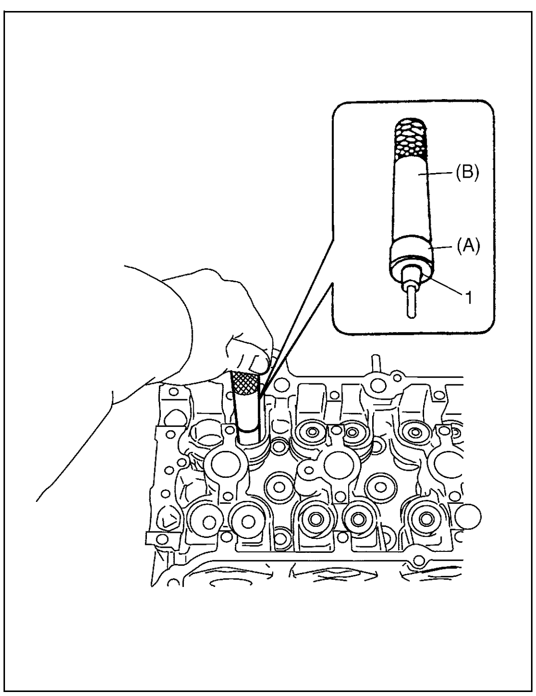
Specification for valve guide protrusion "a"
Intake and exhaust sides
: 11.3 mm (0.44 in.)



3) Ream valve guide bore with special tool (5.5 mm reamer). After reaming, clean bore.

Special tool
(A) : 09916-34542
(B) : 09916-34550

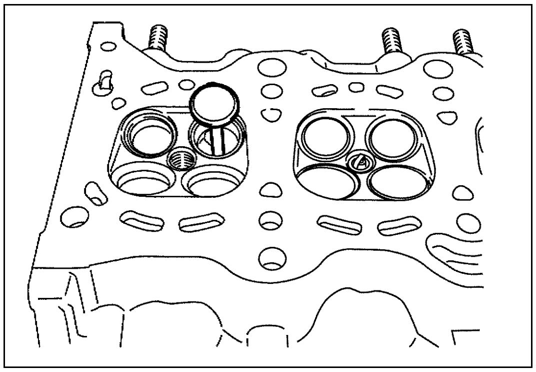
4) Install valve spring seat to cylinder head.



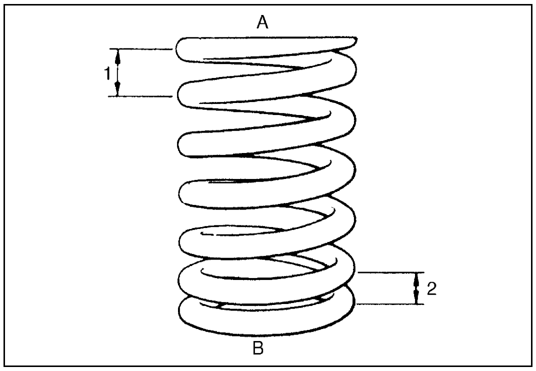
5) Install new valve stem seal (1) to valve guide.
After applying engine oil to seal and spindle of special tool (Valve guide installer handle), fit oil seal to spindle, and then install seal to valve guide by pushing special tool by hand.
After installing, check to be sure that seal is properly fixed to valve guide.

Special tool
(A) : 09917-98221
(B) : 09916-58210

NOTE:
- **Do not reuse once-disassembled seal. Be sure to install new seal.**
- **When installing, do not tap or hit special tool with a hammer or else. Install seal to guide only by pushing special tool by hand. Tapping or hitting special tool may cause damage to seal.**

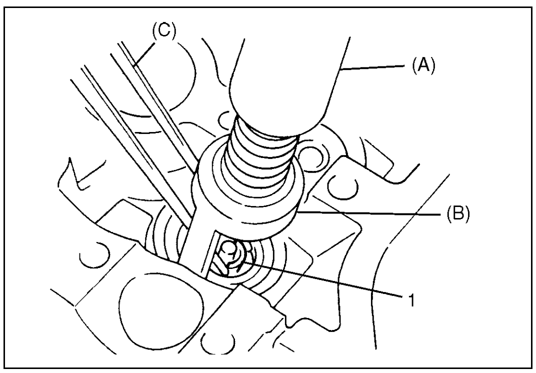


6) Install valve to valve guide
   Before installing valve to valve guide, apply engine oil to stem seal, valve guide bore and valve stem.



7) Install valve spring and spring retainer.
   Each valve spring has top end (large-pitch end (1)) and bottom end (small-pitch end (2)). Be sure to position spring in place with its bottom end (small-pitch end) facing the bottom (valve spring seat side).

A :	Valve spring retainer side
B :	Valve spring seat side



8) Using special tools (Valve lifter), compress valve spring and fit two valve cotters (1) into groove in valve stem.

Special tool
(A) : 09916-14510
(B) : 09916-14521
(C) : 09916-84511

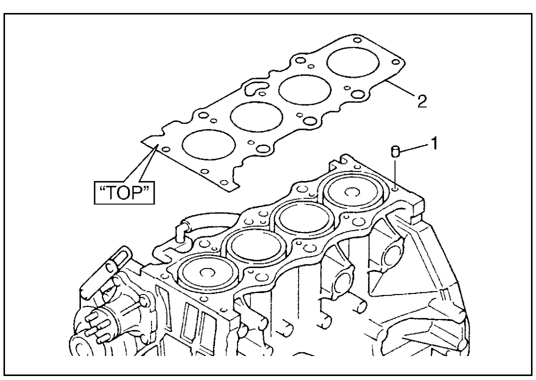
NOTE:

When compressing the valve spring, do not damage inside face of tappet installing hole.

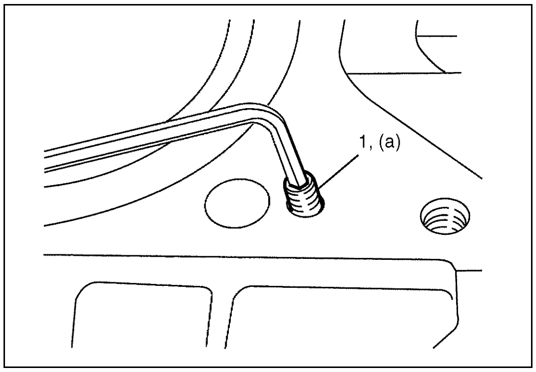
9) Install intake manifold, injectors and exhaust manifold to cylinder head.

INSTALLATION

1) Clean mating surface of cylinder head and cylinder block. Remove oil, old gasket and dust from mating surface.



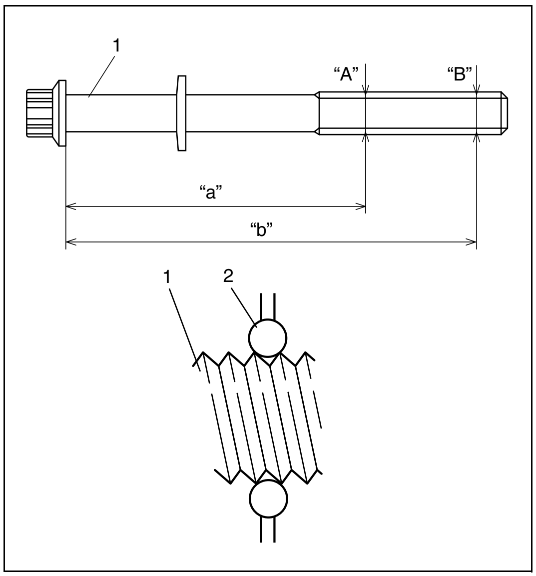
2) Install knock pins (1) to cylinder block.
3) Install new cylinder head gasket (2) to cylinder block."TOP" mark provided on gasket comes to crankshaft pulley side, facing up (toward cylinder head side).



4) Make sure that oil jet (venturi plug) (1) is installed and if it is, that it is not clogged.
   When installing it, be sure to tighten to specified torque.

Tighting torque
Venturi plug (a) : 5 N·m (0.5 kg-m, 3.5 lb-ft)

5) Install cylinder head to cylinder block.
   Apply engine oil to cylinder head bolts and tighten them gradually as follows.

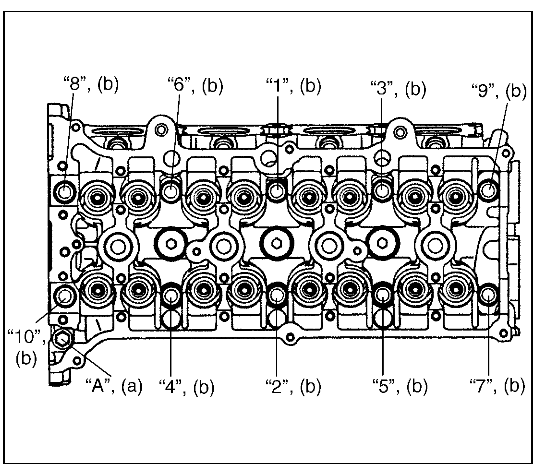


NOTE:

If cylinder head bolts are reused, check thread diameters of them for deformation according to the following and replace them with new ones if thread diameter difference exceeds limit.
Measure each thread diameter of cylinder head bolt (1) at "A" on 83.5 mm (2.81 in.) from seat side of flange bolt and "B" on 115 mm (4.53 in.) from seat side of flange bolt by using a micrometer (2).
Then calculate difference in diameters ("A" – "B").
If it exceeds limit, replace with new one.

Cylinder head bolt diameter measurement points
"a" : 83.5 mm (2.81 in.)
"b" : 115 mm (4.53 in.)

Cylinder head bolt diameter difference (deformation)
Limit ("A" – "B") : 0.1 mm (0.004 in.)



a) Tighten cylinder head bolts ("1" – "10") to 20 N·m (2.0 kg-m, 14.5 lb-ft) according to numerical order as shown by using a 12 corner socket wrenches.
b) In the same manner as in Step a), tighten them to 40 N·m (4.0 kg-m, 29.0 lb-ft).
c) Retighten all bolts 60° according to numerical order in figure.
d) Repeat Step c).
e) Tighten bolt "A" to specified torque.

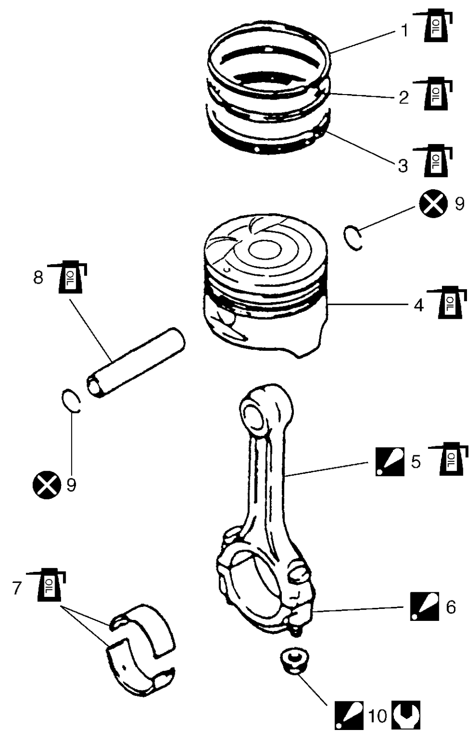
NOTE:

Be sure to tighten M8 bolt ("A") after securing the other bolt.

Tightening torque
Cylinder head bolt for M8 (a) : 22 N·m (2.2 kg-m, 16.0 lb-ft)
Cylinder head bolts for M10
(b) : 40 N·m (4.0 kg-m, 29.0 lb-ft) and extra tightening 60° twice

6) Install exhaust manifold stiffener and exhaust pipe referring to “Exhaust Manifold” in this section.
7) Install camshafts, timing chain and chain cover referring to “Camshaft, Tappet and Shim”, “Timing Chain and Chain Tensioner” and “Timing Chain Cover” in this section.
8) Install cylinder head cover and oil pan referring to “Cylinder Head Cover” and “Oil Pan and Oil Pump Strainer” in this section.
9) Install intake manifold stiffener and connect each hoses and electric lead wires securely.
10) Install air cleaner outlet hoses.
11) Install radiator with cooling fan and connect A/T fluid hoses (vehicle with A/T), radiator inlet and outlet hoses referring to “Water Pump Belt and Cooling Fan” and “Radiator” in Section 6B.
12) Adjust generator belt tension referring to “Water Pump Belt Tension” in Section 6B.
13) Adjust A/C compressor and/or P/S pump belt tension (if equipped) referring to “Compressor Drive Belt” in Section 1B or “Power Steering Belt” in Section 3B1.
14) Adjust accelerator cable play referring to “Accelerator Cable Adjustment” in Section 6E.
15) Check to ensure that all removed parts are back in place. Reinstall any necessary parts which have not been reinstalled.
16) Refill cooling system with coolant, engine with engine oil and A/T with specified A/T fluid (vehicle with A/T).
17) Connect negative cable at battery.
18) Verify that there is no fuel leakage, coolant leakage, oil leakage, A/T fluid leakage (vehicle with A/T) and exhaust gas leakage at each connection.

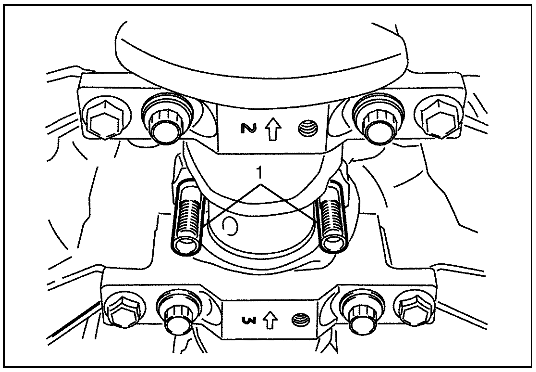
Pistons, Piston Rings, Connecting Rods and Cylinders



	1. Top ring		8.	Piston pin
	2. 2nd ring		9.	Piston pin circlip
	3. Oil ring		10.	Bearing cap nut 1) Tighten all nuts to 15 N·m (1.5 kg-m) 2) Turn all nuts to 45° 3) Then, turn all nuts to 45° once again
	4. Piston			Tightening torque
	5. Connecting rod : Apply engine oil to sliding surface except inner surface of big end, and rod bolts. Make sure rod bolt diameter when reuse it due to plastic deformation tightening. Refer to “Inspection” of “Connecting Rod”.			Apply engine oil to sliding surface of each parts.
	6. Connecting rod bearing cap : Point arrow mark on cap to crankshaft pulley side.			Do not reuse.
	7. Connecting rod bearing			

REMOVAL

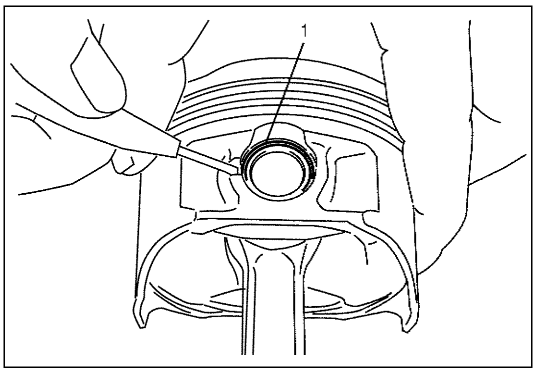
1) Relieve fuel pressure referring to “Fuel Pressure Relief Procedure” in Section 6.
2) Disconnect negative cable at battery.
3) Drain engine oil.
4) Drain coolant.
5) Remove cylinder head referring to “Valves and Cylinder Head” in this section.
6) Mark cylinder number on all pistons, connecting rods and connecting rod caps using silver pencil or quick drying paint.
7) Remove rod bearing caps.



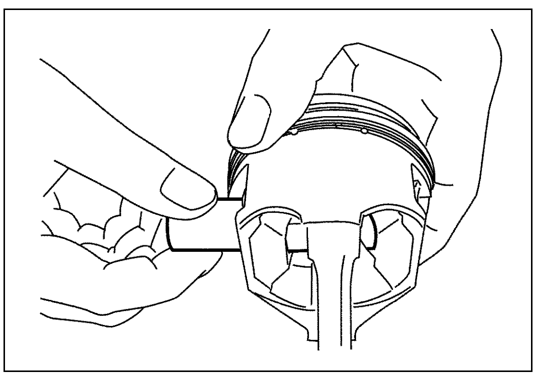
8) Install guide hose (1) over threads of rod bolts.
   This prevents damage to bearing journal and rod bolt threads when removing connecting rod.
9) Decarbon top of cylinder bore before removing piston from cylinder.
10) Push piston and connecting rod assembly out through the top of cylinder bore.

DISASSEMBLY

1) Using piston ring expander, remove two compression rings (Top and 2nd) and oil ring from piston.
2) Remove piston pin from connecting rod.



- Ease out piston pin circlips (1), as shown.



- Force piston pin out.

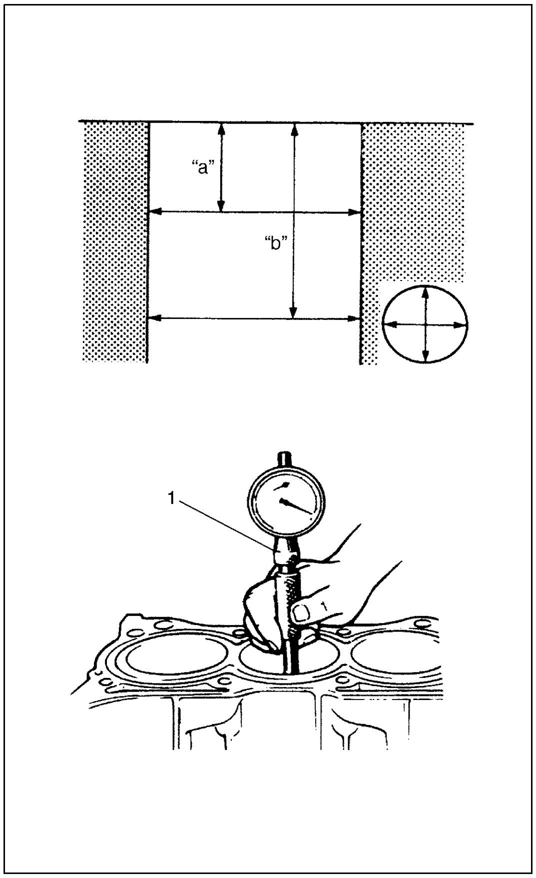
CLEANING

Decarbon piston head and ring grooves, using a suitable tool.

INSPECTION

Cylinder

- Inspect cylinder walls for scratches, roughness or ridges which indicate excessive wear. If cylinder bore is very rough or deeply scratched or ridged, rebore cylinder and use oversize piston.



- Using a cylinder gauge (1), measure cylinder bore in thrust and axial directions at two positions ("a" and "b") as shown in figure.
  If any of the following conditions is noted, rebore cylinder.
1) Cylinder bore dia. exceeds limit.
2) Difference of measurements at two positions exceeds taper limit.
3) Difference between thrust and axial measurements exceeds out-of-round limit.

Limit on cylinder bore diameter
78.114 mm (3.073 in.)

Limit on taper and out-of-round for cylinder
0.10 mm (0.004 in.)

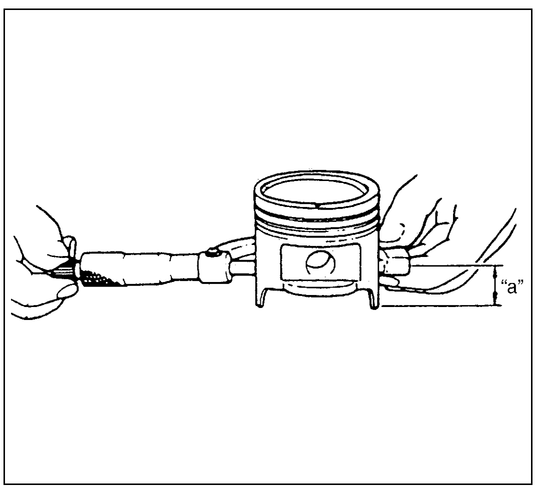
NOTE:

If any one of four cylinders has to be rebored, rebore all four to the same next oversize. This is necessary for the sake of uniformity and balance.

"a" :	50 mm (1.96 in.)
"b" :	95 mm (3.74 in.)

Pistons

- Inspect piston for faults, cracks or other damaged.
  Damaged or faulty piston should be replaced.

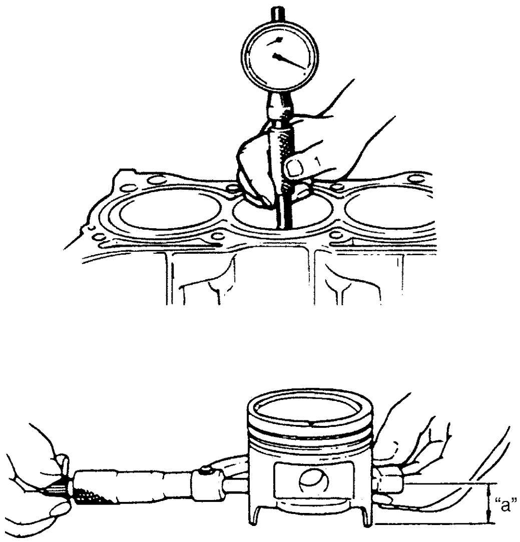


- Piston diameter:
  As indicated in figure, piston diameter should be measured at a position 19.5 mm (0.77 in.) from piston skirt end in the direction perpendicular to piston pin.

Piston diameter specification

Standard size	**77.953 – 77.968 mm (3.0690 – 3.0696 in.)**
Oversize 0.50 mm (0.0196 in.)	**78.453 – 78.468 mm (3.0887 – 3.0893 in.)**

"a" :	19.5 mm (0.77 in.)



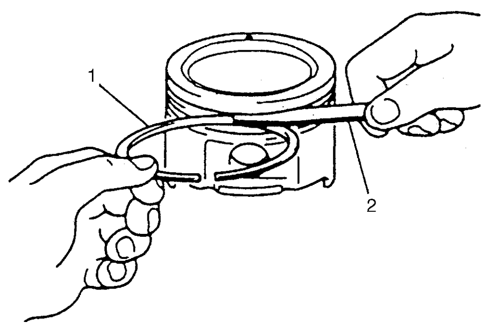
- Piston clearance:
  Measure cylinder bore diameter and piston diameter to find their difference which is piston clearance. Piston clearance should be within specification as given below. If it is out of specification, rebore cylinder and use oversize piston.

Piston clearance
Standard : 0.032 – 0.061 mm (0.0013 – 0.0024 in.)
Limit : 0.161 mm (0.0063 in.)

NOTE:

Cylinder bore diameters used here are measured in thrust direction at two positions.

“a” :	19.5 mm (0.77 in.)

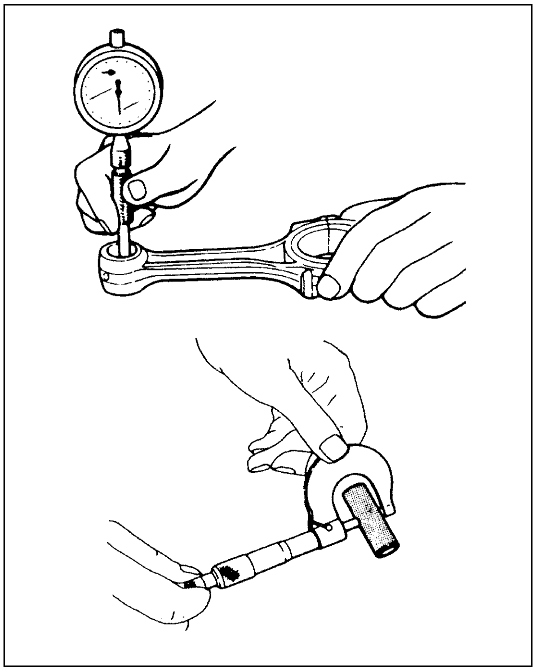


- Ring groove clearance:
  Before checking, piston grooves must be clean, dry and free of carbon deposits.
  Fit new piston ring (1) into piston groove, and measure clearance between ring and ring land by using thickness gauge (2).
  If clearance is out of limit, replace piston.

Ring groove clearance
Top ring
Standard : 0.03 – 0.07 mm (0.0012 – 0.0028 in.)
Limit : 0.12 mm (0.0047 in.)
2nd ring
Standard : 0.02 – 0.06 mm (0.0008 – 0.0024 in.)
Limit : 0.10 mm (0.0039 in.)
Oil ring
Standard : 0.03 – 0.17 mm (0.0012 – 0.0067 in.)

Piston Pin

- Check piston pin, connecting rod small end bore and piston bore for wear or damage, paying particular attention to condition of small end bore bush. If pin, connecting rod small end bore or piston bore is badly worn or damaged, replace pin, connecting rod and/or piston.



- Piston pin clearance:
  Check piston pin clearance in small end and piston. Replace connecting rod and/or piston if its small end is badly worn or damaged or if measured clearance exceeds limit.

Piston pin clearance in connecting rod small end
0.003 – 0.014 mm (0.0001 – 0.0006 in.)

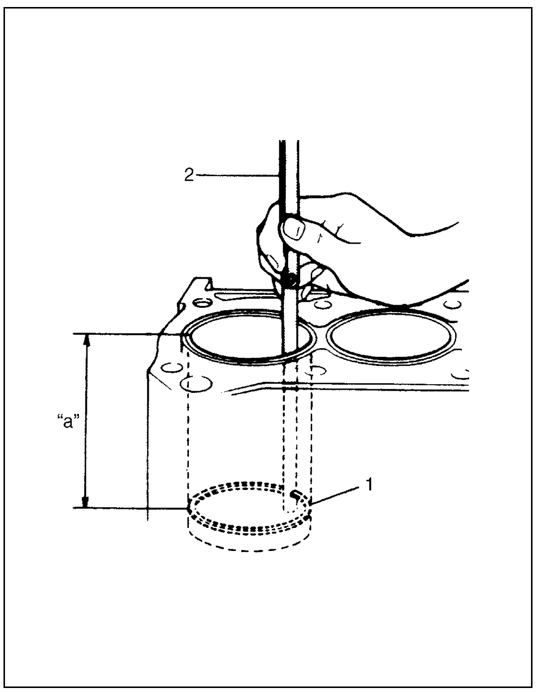
Piston pin clearance in piston
0.006 – 0.017 mm (0.00024 – 0.00067 in.)

Small-end bore for connecting rod
20.003 – 20.011 mm (0.7875 – 0.7878 in.)

Piston pin diameter
19.997 – 20.000 mm (0.7873 – 0.7874 in.)

Piston bore
20.006 – 20.014 mm (0.7876 – 0.7880 in.)

Piston Rings



To measure end gap, insert piston ring (1) into cylinder bore and then measure the gap by using thickness gauge (2).
If measured gap is out of specification, replace ring.

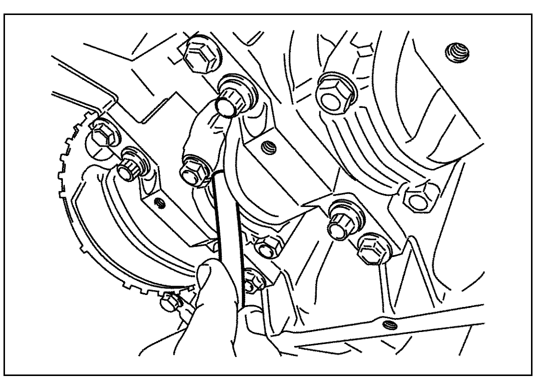
NOTE:
Decarbon and clean top of cylinder bore before inserting piston ring.

Piston ring end gap

Item	Standard	Limit
Top ring	**0.20 – 0.35 mm (0.0079 – 0.0138 in.)**	**0.7 mm (0.0276 in.)**
2nd ring	**0.30 – 0.45 mm (0.0118 – 0.0177 in.)**	**1.0 mm (0.0039 in.)**
Oil ring	**0.20 – 0.70 mm (0.0079 – 0.0276 in.)**	**1.5 mm (0.059 in.)**

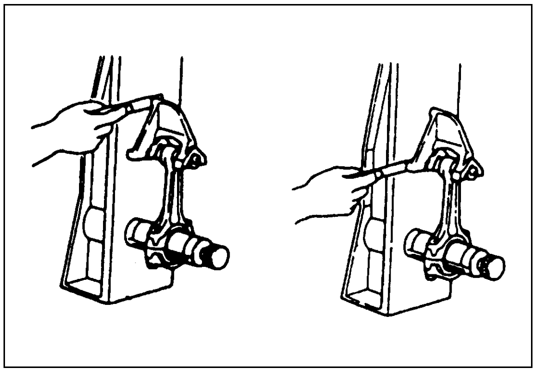
"a" : 120 mm (4.72 in.)

Connecting Rod



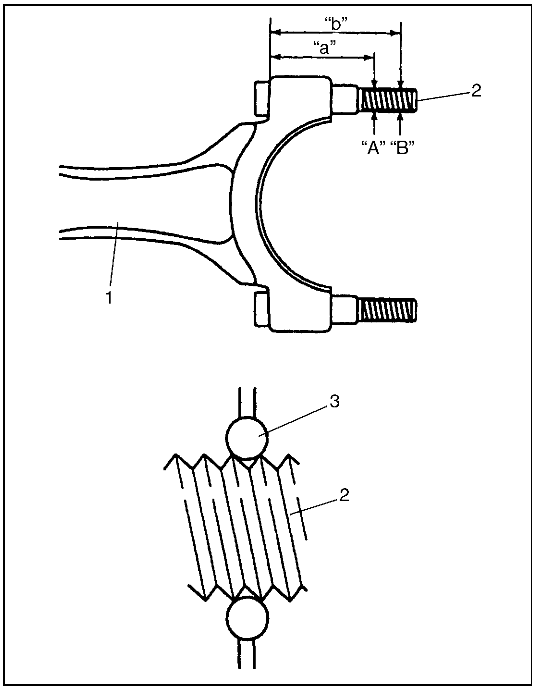
- Big-end side clearance:
  Check big-end of connecting rod for side clearance, with rod fitted and connected to its crank pin in the normal manner. If measured clearance is found to exceed its limit, replace connecting rod.

Side clearance for connecting rod big-end
Standard : 0.25 – 0.40 mm (0.0098 – 0.0157 in.)
Limit : 0.55 mm (0.0217 in.)



- Connecting rod alignment:
  Mount connecting rod on aligner to check it for bow and twist. If limit is exceeded, replace it.

Connecting rod alignment
Limit on bow : 0.05 mm (0.0020 in.)
Limit on twist : 0.10 mm (0.0039 in.)

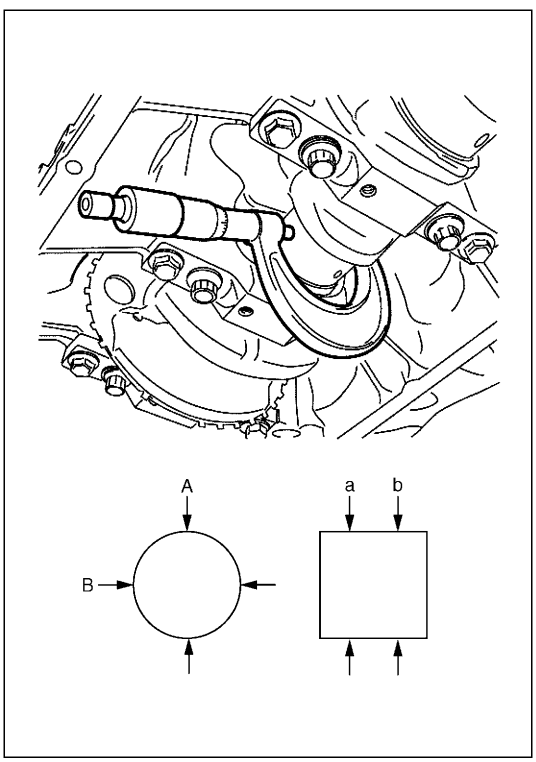


- Connecting rod bolt diameter (Plastic deformation tightening bolt)
  Measure connecting rod (1) bolt (2) for diameter "A" on 32 mm (1.25 in.) from bolt mounting surface and diameter "B" on 40 mm (1.57 in.) from bolt mounting surface by using a micrometer (3).
  Calculate difference in diameters ("A" – "B"). If it exceeds limit, replace connecting rod.

Connecting rod bolt measurement points
"a" : 32 mm (1.25 in.)
"b" : 40 mm (1.57 in.)

Connecting rod bolt diameter difference
Limit ("A" – "B") : 0.1 mm (0.004 in.)

Crank Pin and Connecting Rod Bearings

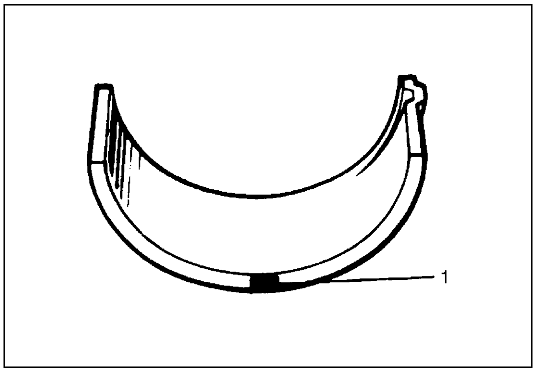


- Inspect crank pin for uneven wear or damage. Measure crank pin for out-of-round or taper with a micrometer. If crank pin is damaged or out-of-round or taper is out of limit, replace crankshaft or regrind crank pin to undersize and use undersize bearing.

Crank pin diameter

Connecting rod bearing size	Crank pin diameter
Standard	41.982 – 42.000 mm (1.6528 – 1.6535 in.)
0.25 mm (0.0098 in.) undersize	41.732 – 41.750 mm (1.6430 – 1.6437 in.)

Out-of-round : A – B
Taper : a – b
Crank pin taper and out-of-round
Limit : 0.01 mm (0.0004 in.)

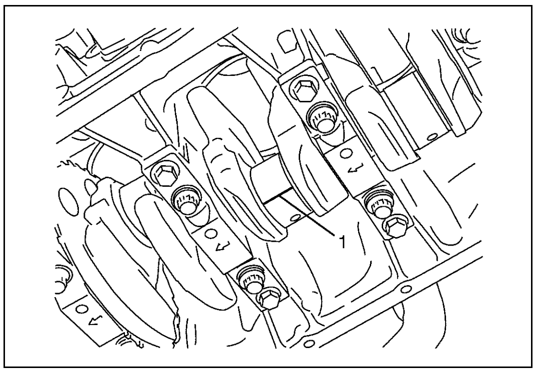


- Rod bearing :
  Inspect bearing shells for signs of fusion, pitting, burn or flaking and observe contact pattern. Bearing shells found in defective condition must be replaced.
  Two kinds of rod bearing are available; standard size bearing and 0.25 mm (0.0098 in.) undersize bearing. For identification of undersize bearing, it is painted red at the position as indicated in figure, undersize bearing thickness is 1.605 – 1.615 mm (0.0632 – 0.0635 in.) at the center of it.

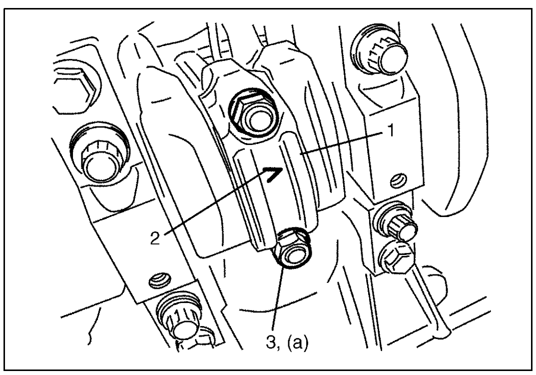
1. Red paint

- Rod bearing clearance:

1) Before checking bearing clearance, clean bearing and crank pin.
2) Install bearing in connecting rod and bearing cap.

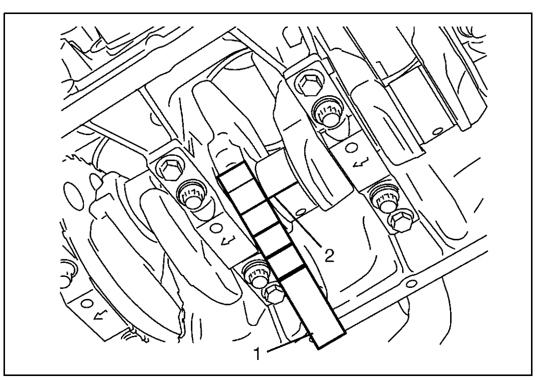


3) Place a piece of gauging plastic (1) to full width of crank pin as contacted by bearing (parallel to crankshaft), avoiding oil hole.



4) Install rod bearing cap (1) to connecting rod.
   When installing cap, be sure to point arrow mark (2) on cap to crankshaft pulley side, as shown in figure. After applying engine oil to rod bolts and tighten cap nuts (3) gradually as follows.
   a) Tighten all cap nuts to 15 N·m (1.5 kg-m, 11.0 lb-ft).
   b) Retighten them to 45°.
   c) Repeat step b).

Tightening torque
Connecting rod bearing cap nuts
(a) : 15 N·m (1.5 kg-m, 11.0 lb-ft) and extra tightening 45° twice



5) Remove cap and using a scale (1) on gauging plastic (2) envelope, measure gauging plastic width at the widest point (clearance).
   If clearance exceeds its limit, use a new standard size bearing and remeasure clearance.

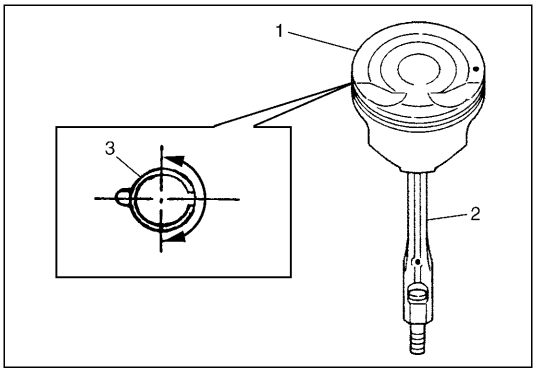
Connecting rod bearing clearance
Standard : 0.029 – 0.047 mm (0.0011 – 0.0019 in.)
Limit : 0.065 mm (0.0026 in.)

6) If clearance can not be brought to within its limit even by using a new standard size bearing, regrind crankpin to undersize and use 0.25 mm undersize bearing.

NOTE:

After checking the rod bearing clearance, make sure to check connecting rod bolt diameter.
Refer to "Inspection" of "Connecting Rod".

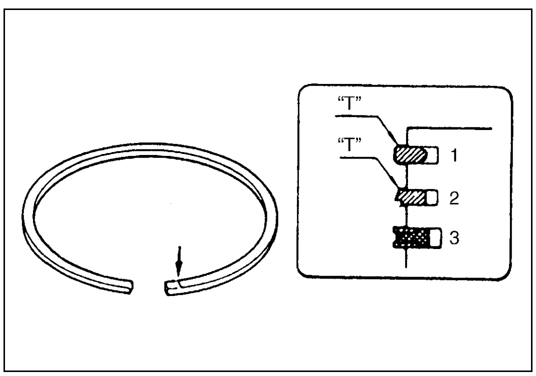
ASSEMBLY



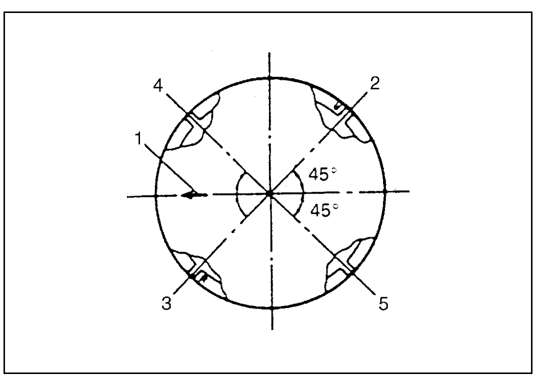
1) Install piston pin to piston (1) and connecting rod (2):
   a) After applying engine oil to piston pin and piston pin holes in piston and connecting rod.
   b) Fit connecting rod as shown in figure.
   c) Insert piston pin to piston and connecting rod.
   d) Install piston pin circlips (3).

NOTE:

Circlip should be installed with its cut part facing as shown in figure. Install so that circlip end gap comes within such range as indicated by arrow.



2) Install piston rings to piston :
   a) As indicated in figure, 1st and 2nd rings have "T" mark respectively. When installing these piston rings to piston, direct marked side of each ring toward top of piston.
   b) 1st ring (1) differs from 2nd ring (2) in thickness, shape and color of surface contacting cylinder wall.
      Distinguish 1st ring from 2nd ring by referring to figure.
   c) When installing oil ring (3) install spacer first and then two rails.



3) After installing three rings (1st, 2nd and oil rings), distribute their end gaps as shown in figure.

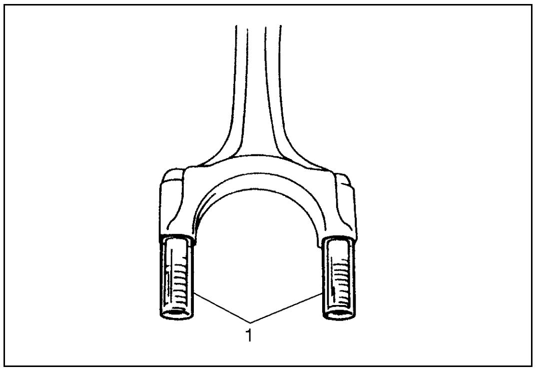
1.	Arrow mark
2.	1st ring end gap
3.	2nd ring end gap and oil ring spacer gap
4.	Oil ring upper rail gap
5.	Oil ring lower rail gap

INSTALLATION

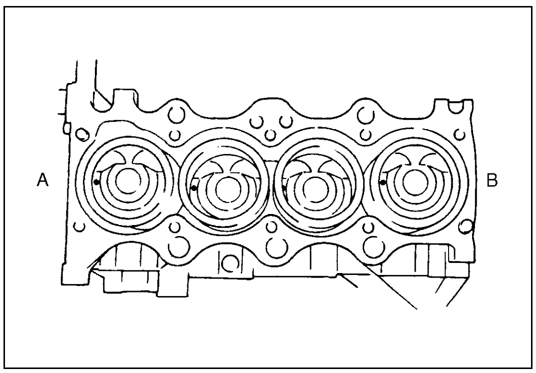
1) Apply engine oil to pistons, rings, cylinder walls, connecting rod bearings and crankpins.

NOTE:

Do not apply oil between connecting rod and bearing or between bearing cap and bearing.

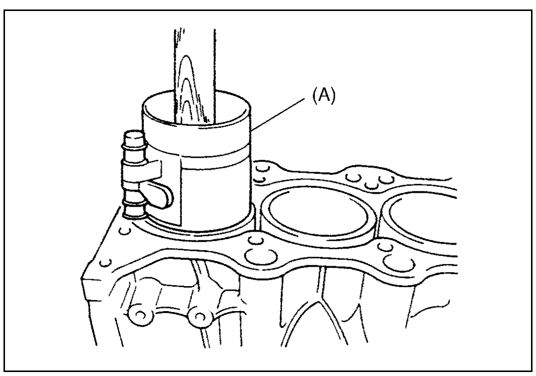


2) Install guide hoses (1) over connecting rod bolts. These guide hoses protect crank pin and threads of rod bolt from damage during installation of connecting rod and piston assembly.



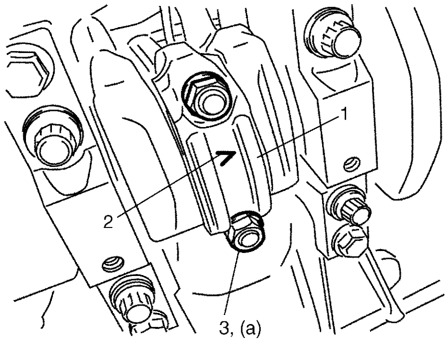
3) When installing piston and connecting rod assembly into cylinder bore, point front mark on piston head to crankshaft pulley side.

A :	Crankshaft pulley side
B :	Flywheel side



4) Install piston and connecting rod assembly into cylinder bore. Use special tool (Piston ring compressor) to compress rings. Guide connecting rod into place on crankshaft. Using a hammer handle, tap piston head to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

Special tool
(A) : 09916-77310



5) Install bearing cap (1):
Point arrow mark (2) on cap to crankshaft pulley side.
After applying oil to rod bolts and tighten cap nuts (3) gradually as follows.

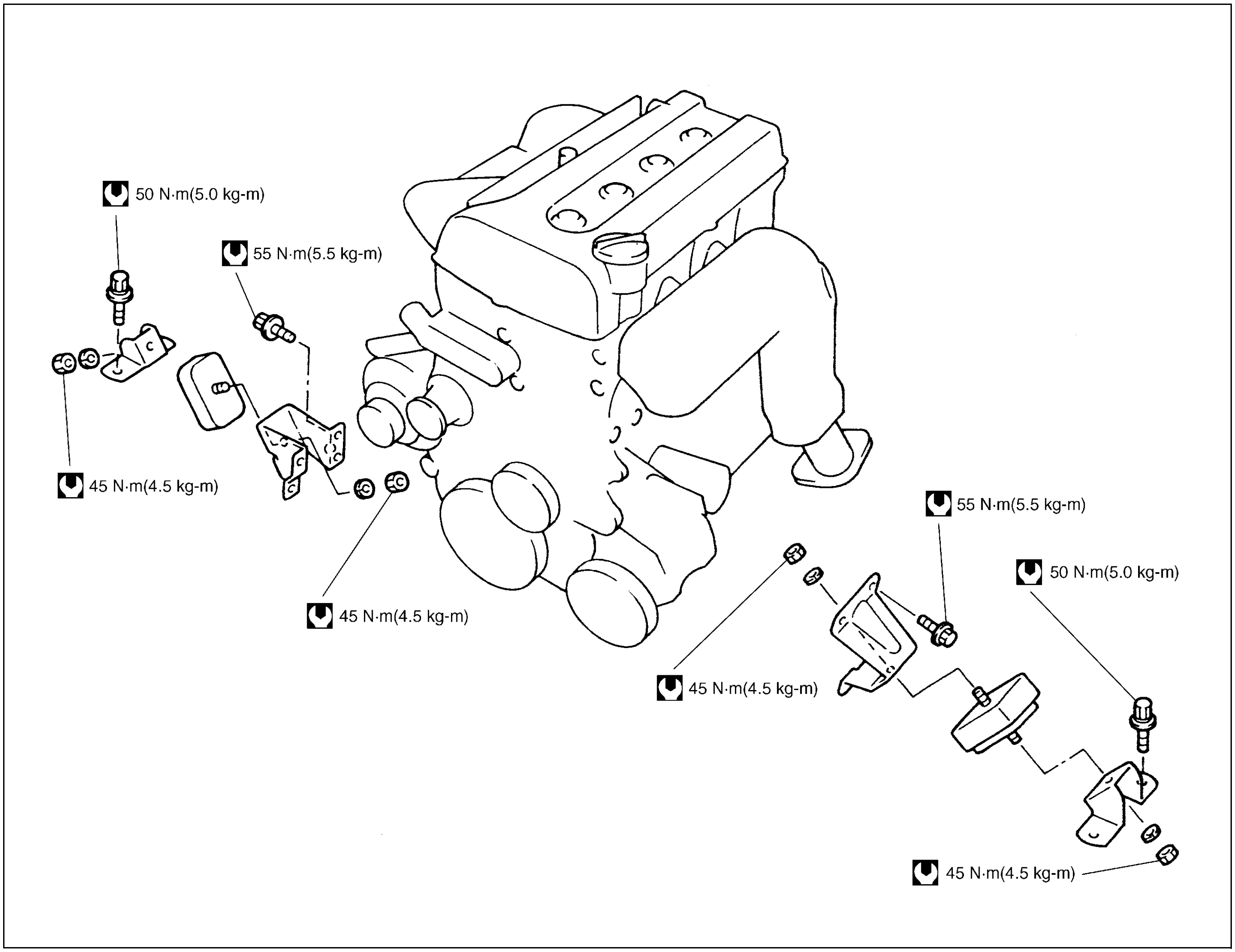
NOTE:
Before installing bearing cap, make sure to check connecting rod bolt diameter.
Refer to “Inspection” of “Connecting Rod” in this section.

a) Tighten all cap nuts to 15 N·m (1.5 kg-m, 11.0 lb-ft).
b) Retighten them to 45°.
c) Repeat Step b).

Tightening torque
Connecting rod bearing cap nuts
(a) : 15 N·m (1.5 kg-m, 11.0 lb-ft) and extra tightening 45° twice.

6) Reverse removal procedure for installation as previously outlined.
7) Adjust generator belt tension referring to “Water Pump Belt Tension” in Section 6B.
8) Adjust A/C compressor and/or P/S pump belt tension (if equipped) referring to “Compressor Drive Belt” in Section 1B or “Power Steering Belt” in Section 3B1.
9) Adjust accelerator cable play referring to “Accelerator Cable Adjustment” in Section 6E.
10) Check to ensure that all removed parts are back in place. Reinstall any necessary parts which have not been reinstalled.
11) Refill cooling system with coolant engine with engine oil and A/T with specified A/T fluid (vehicle with A/T).
12) Connect negative cable at battery.
13) Verify that there is no fuel leakage, coolant leakage, oil leakage, A/T fluid leakage (vehicle with A/T) and exhaust gas leakage at each connection.

Engine Mountings



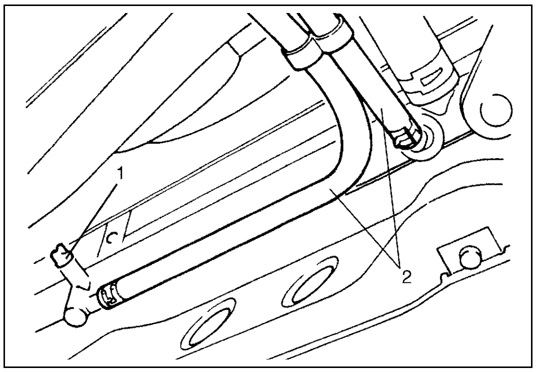
[torque symbol]	Tightening torque

Unit Repair Overhaul

Engine Assembly

REMOVAL

1) Relieve fuel pressure referring to “Fuel Pressure Relief Procedure” in Section 6.
2) Disconnect negative cable at battery.
3) Remove engine hood after disconnecting windshield washer hose.
4) Remove A/C compressor and/or P/S pump belt (if equipped).
5) Remove generator belt.
6) Drain engine oil.

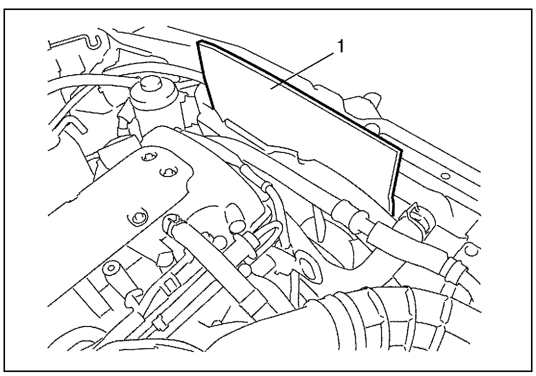


7) Drain coolant.

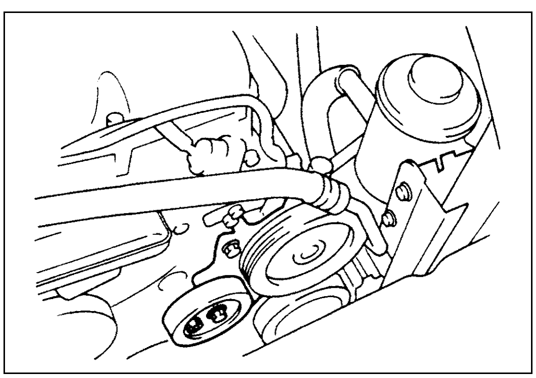
WARNING:

To help avoid danger of being burned, do not remove drain plug (1) and radiator cap while engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if plug and cap are taken off too soon.

8) Disconnect radiator inlet and outlet hoses from each pipe.
9) Disconnect A/T fluid hoses (2) (vehicle with A/T) and release its clamps. Place some container under radiator to receive A/T fluid which will flow out when hose is disconnected.



10) Remove fan shroud upper bolts and install board (1) or the like. This prevents damage to radiator fins when removing and installing radiator.
11) Remove radiator with cooling fan referring to Section 6B. Then remove water pump pulley.



12) With hose connected, detach P/S pump from its bracket (if equipped) referring to “Power Steering Pump” in Section 3B1.

NOTE:

Suspend removed P/S pump at a place where no damage will be caused during removal and installation of engine assembly.

13) If vehicle equipped with A/C compressor, work of right hand steering vehicle differs from its of left hand steering vehicle. Each work is as follows.

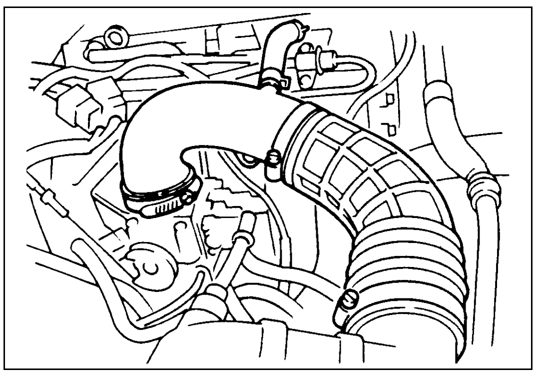
a) For right hand steering vehicle:
   With hose connected, detach A/C compressor from its bracket.

NOTE:

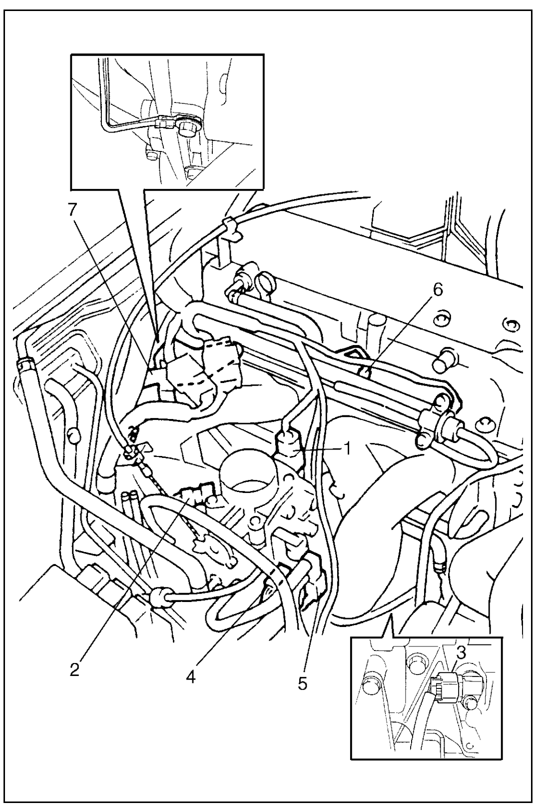
Suspend removed A/C compressor at a place where no damage will be caused during removal and installation of engine assembly.

b) For left hand steering vehicle:
   i) Recover refrigerant from refrigeration system using recovery and recycling equipment.
   ii) Disconnect magnet clutch lead wire.
   iii) Remove suction pipe and disconnect discharge pipe from A/C compressor.
   iv) Remove A/C compressor from its bracket.

When servicing above steps, refer to “Compressor” in Section 1B.

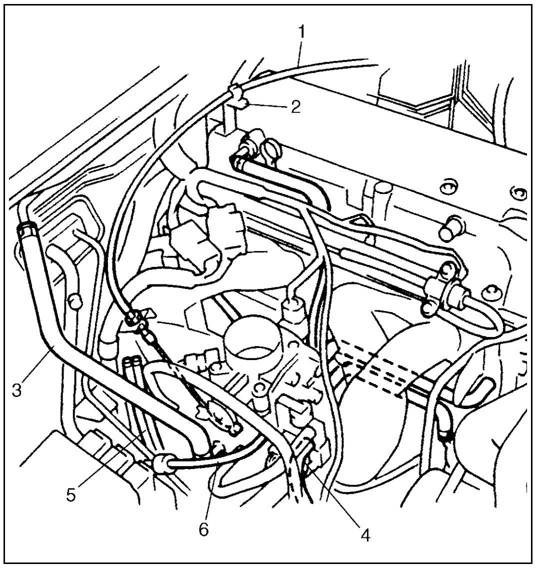


14) Remove air cleaner outlet No.1 and No.2 hoses.

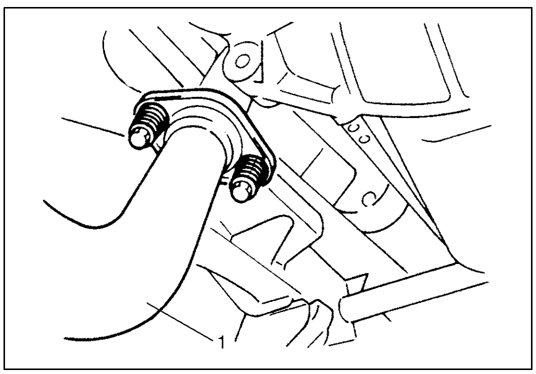


15) Disconnect the following electric lead wires:
   - TP sensor (1)
   - MAP sensor (2)
   - CKP sensor (if equipped) (3)
   - CMP sensor
   - ECT sensor
   - Heated oxygen sensor
   - EGR valve (if equipped)
   - IAC valve (4)
   - EVAP canister purge valve (5)
   - Injectors (6)
   - Ignition coils
   - Generator
   - Starting motor
   - Oil pressure switch
   - Ground terminal from intake manifold and cylinder block
   - Each wire harness clamps
16) Remove intake manifold bracket (7) with main harness from intake manifold.
17) Remove starting motor referring to “Dismounting” in Section 6G.

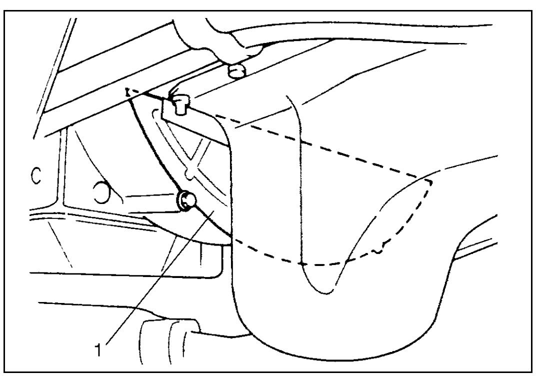
18) Remove heated oxygen sensor bracket from cylinder head and detach No.1 heated oxygen sensor coupler from its bracket.



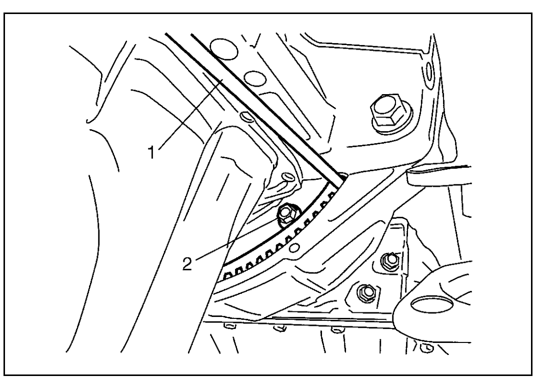
19) Release accelerator cable (1) from clamp (2) (for left hand steering vehicle only) and disconnect accelerator cable from throttle body.
20) Remove canister purge hose bracket from intake manifold.
21) Disconnect the following hoses:
   - Brake booster hose (3) from intake manifold
   - Canister purge hose (4) from EVAP canister purge valve
   - Fuel feed and return hoses (5) from each pipe
   - Heater inlet and outlet hoses from each pipe
   - Vacuum hose (6) (to check valve)



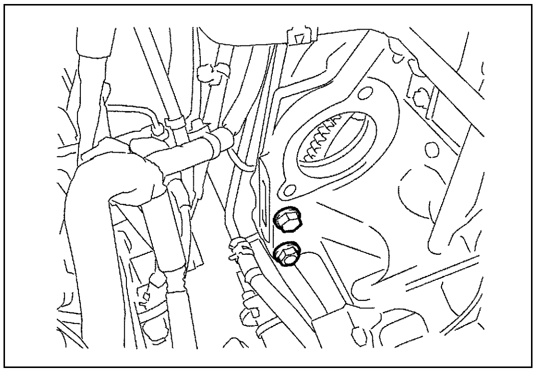
22) Disconnect exhaust pipe (1) from exhaust manifold.



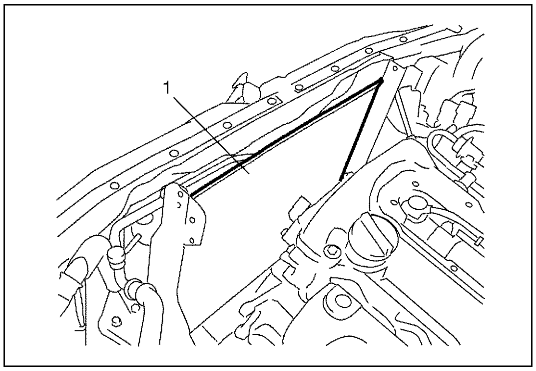
23) Remove clutch housing (torque converter housing for A/T) lower plate (1).



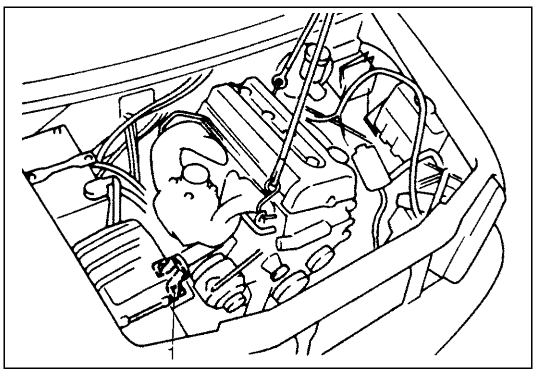
24) With drive plate locked by using a proper size rod (1) or the like, remove torque converter bolts (2) (vehicle with A/T).
25) Support transmission. For A/T vehicle, do not jack under A/T oil pan to support transmission.



26) Remove bolts and nuts fastening cylinder block and transmission.

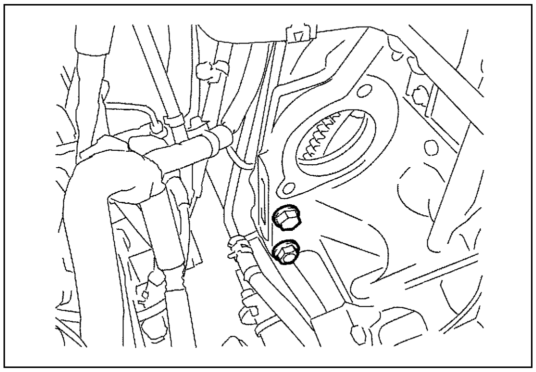


27) Install board (1) or the like on A/C condenser. This prevents damage to condenser fins when lifting and lowering engine assembly.

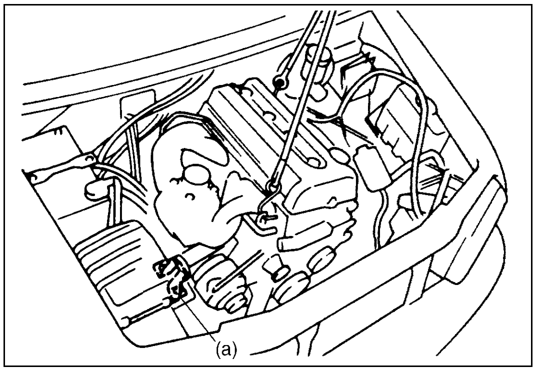


28) Install lifting device.
29) Remove right and left engine mounting bracket bolts (1).
30) Before lifting engine, check to ensure all hoses, electric wires and cables are disconnected from engine.
31) Remove engine assembly from chassis and transmission by lifting a little, sliding toward front side, and then carefully hoist engine assembly.

INSTALLATION

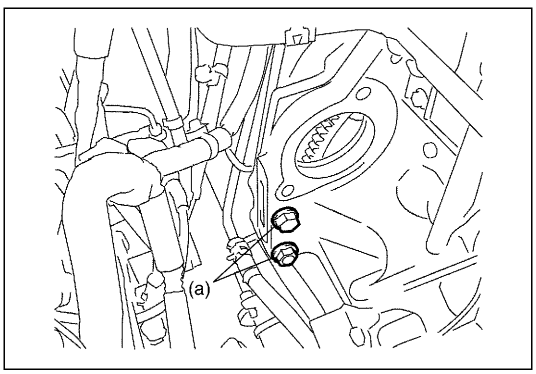


1) Lower engine assembly into engine compartment.
   Connect engine to transmission.
   Hard-tighten bolts and nuts fastening cylinder block and transmission.



2) Tighten right and left engine mounting bracket bolts to specified torque.

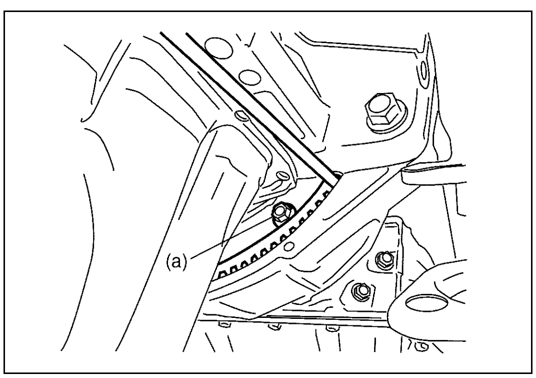
Tightening torque
Engine mounting bracket bolts
(a) : 50 N·m (5.0 kg-m, 36.5 lb-ft)



3) Tighten bolts and nuts fastening cylinder block and transmission to specified torque.

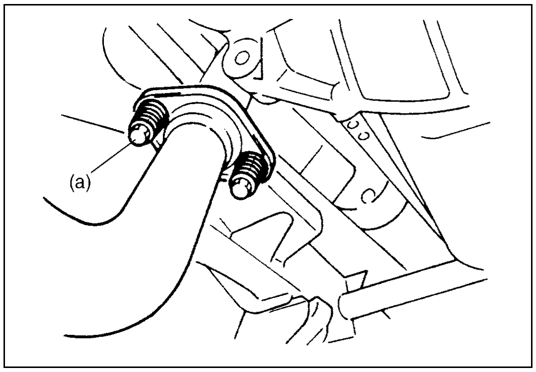
Tightening torque
Vehicle with M/T
Cylinder block and transmission fastening bolts and nuts
(a) : 94 N·m (9.4 kg-m, 68.0 lb-ft)
Vehicle with A/T
Cylinder block and transmission fastening bolts and nuts
(a) : 80 N·m (8.0 kg-m, 58.0 lb-ft)

4) Remove lifting device.



5) Reverse removal procedure for installation, noting the following points.
   - Tighten torque converter bolts to specified torque (vehicle with A/T).

Tightening torque
Torque converter bolts (a) : 20 N·m (2.0 kg-m, 14.5 lb-ft)

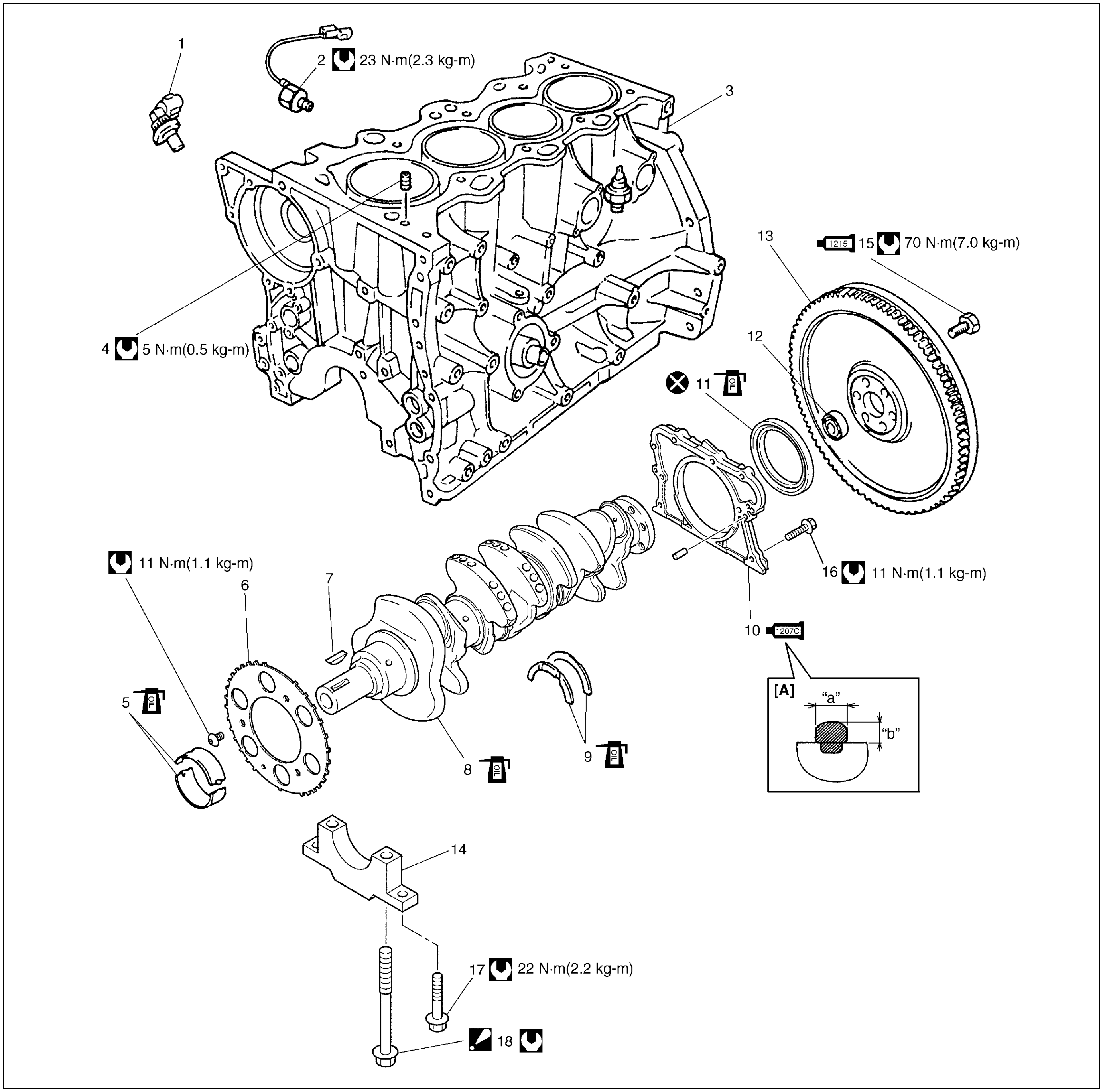


- Install seal ring and exhaust pipe to exhaust manifold. Tighten pipe fasteners to specified torque.

Tightening torque
Exhaust pipe bolts (a) : 50 N·m (5.0 kg-m, 36.5 lb-ft)

6) Reverse disconnected hoses, cables and electric wires for connection.
7) Install air cleaner outlet hoses.
8) Install radiator with cooling fan and connect A/T fluid hoses (vehicle with A/T), radiator inlet and outlet hoses referring to “Water Pump Belt and Cooling Fan” and “Radiator” in Section 6B.
9) Adjust generator belt tension referring to “Water Pump Belt Tension” in Section 6B.
10) Adjust A/C compressor and/or P/S pump belt tension (if equipped) referring to “Compressor Drive Belt” in Section 1B or “Power Steering Belt” in Section 3B1.
11) Adjust accelerator cable play referring to “Accelerator Cable Adjustment” in Section 6E.
12) Check to ensure that all removed parts are back in place. Reinstall any necessary parts which have not been reinstalled.
13) Refill cooling system with coolant engine with engine oil and A/T with specified A/T fluid (vehicle with A/T).
14) Connect negative cable at battery.
15) Verify that there is no fuel leakage, coolant leakage, oil leakage, A/T fluid leakage (vehicle with A/T) and exhaust gas leakage at each connection.

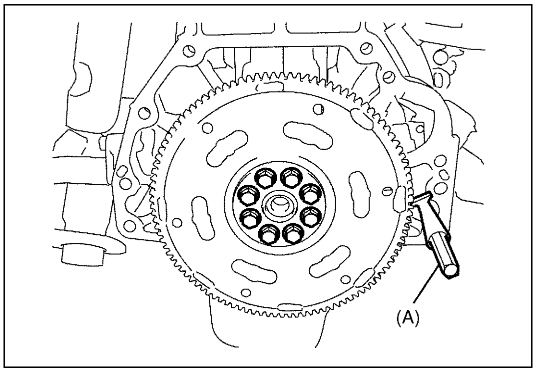
Main Bearings, Crankshaft and Cylinder Block



	Tightening torque	4.	Venturi plug	12.	Input shaft bearing
	Do not reuse.	5.	Main bearing	13.	Flywheel
	Apply engine oil to inside / sliding surface.	6.	Sensor plate	14.	Main bearing cap
"a" :	3 mm (0.12 in.)	7.	Crankshaft timing sprocket key	1215 15.	Flywheel mounting bolt : Apply sealant 99000-31110 to thread part.
"b" :	2 mm (0.08 in.)	8.	Crankshaft	16.	Rear oil seal housing mounting bolt
1.	CKP sensor (if equipped)	9.	Thrust bearing	17.	Main bearing cap No.2 bolt
2.	Knock sensor	1207C 10.	Rear oil seal housing : Apply specified amount [A] of sealant 99000-31150 to mating surface.	18.	Main bearing cap No.1 bolt 1) Tighten all bolts to 50 N·m (5.0 kg-m) 2) Then, turn all bolts to 60°
3.	Cylinder block	11.	Rear oil seal		

REMOVAL

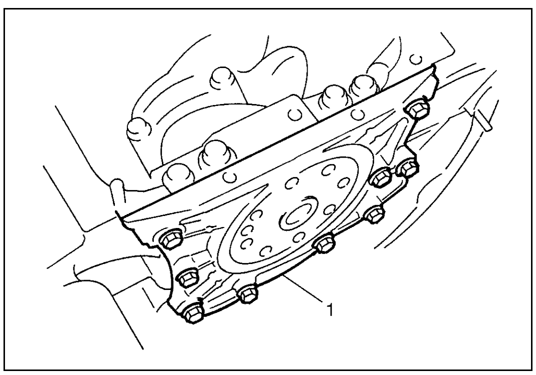
1) Remove engine assembly from vehicle as previously outlined.



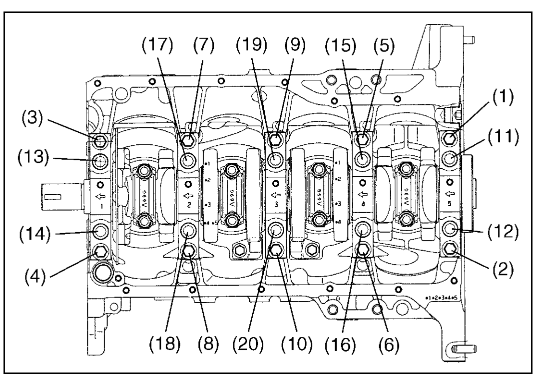
2) Remove clutch cover, clutch disc and flywheel (drive plate for A/T) by using special tool.

Special tool
(A) : 09924-17810

3) Remove the following parts from engine as previously outlined.
   - Oil pan and oil pump strainer
   - Intake manifold and exhaust manifold
   - Cylinder head cover
   - Timing chain cover
   - Timing chain guide, chain tensioner adjuster, chain tensioner, timing chain and crankshaft timing sprocket
   - Camshaft, tappet and shim
   - Cylinder head assembly
   - Piston and connecting rod



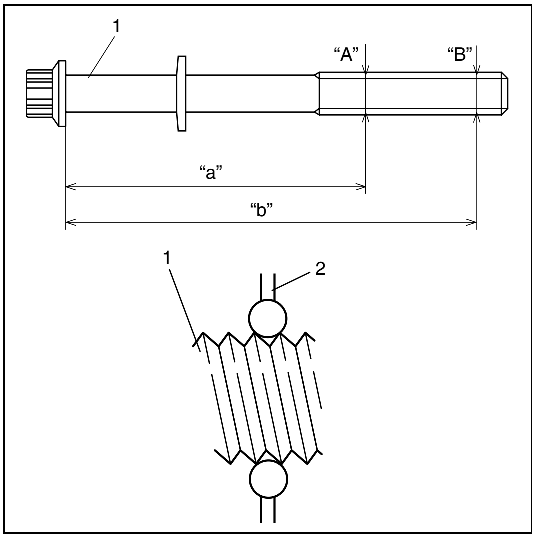
4) Remove rear oil seal housing (1).



5) Loosen bearing cap No.1 and No.2 bolts in such order as indicated in figure and remove them.
6) Remove crankshaft from cylinder block.

INSPECTION

Main bearing cap No.1 bolt



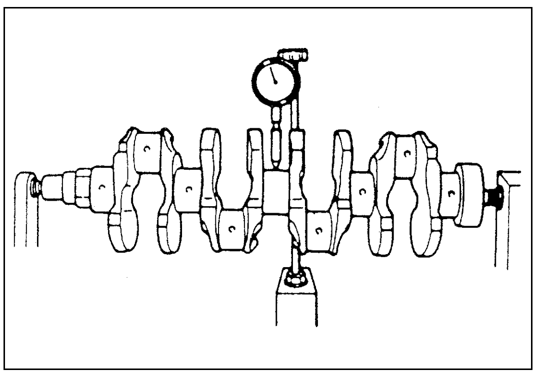
Measure each thread diameter of bearing cap No.1 bolts (1) at "A" on 60 mm (2.36 in.) from seat side of flange bolt and "B" on 90 mm (3.54 in.) from seat side of flange bolt by using a micrometer (2).
Calculate difference in diameters ("A" – "B").
If it exceeds limit, replace with new one.

Bearing cap No.1 bolt diameter measurement points
"a" : 60 mm (2.36 in.)
"b" : 90 mm (3.54 in.)

Bearing cap No.1 bolt diameter difference
Limit ("A" – "B") : 0.2 mm (0.008 in.)

Crankshaft

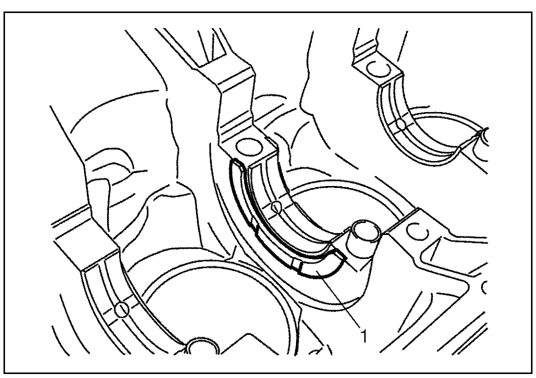
Crankshaft runout



Using a dial gauge, measure runout at center journal. Rotate crankshaft slowly. If runout exceeds its limit, replace crankshaft.

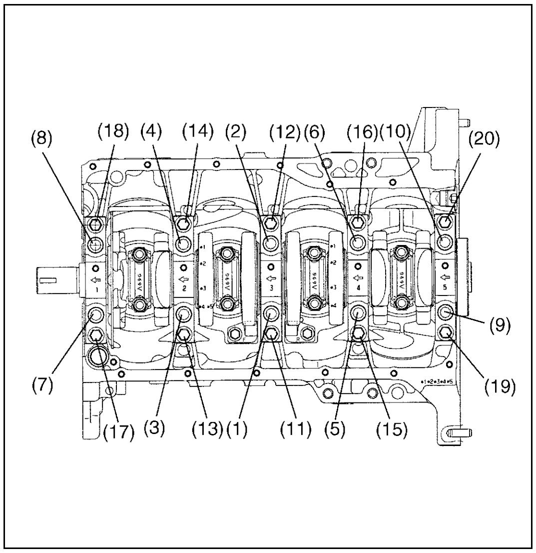
Crankshaft runout
Limit : 0.04 mm (0.0016 in.)

Crankshaft thrust play



Measure this play with crankshaft set in cylinder block in the normal manner, that is with thrust bearing (1) and journal bearing caps installed.

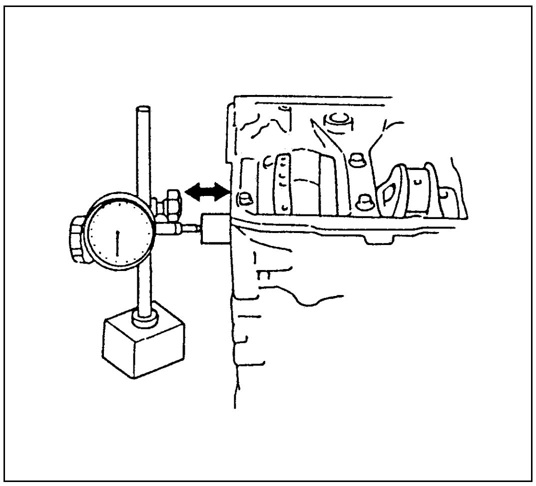
Thickness of crankshaft thrust bearing
Standard : 2.500 mm (0.0984 in.)
Oversize (0.125 mm (0.0049 in.)) : 2.563 mm (0.1009 in.)



Tighten bearing cap No.1 bolts (1) – (10) and No.2 bolts (11) – (20) gradually as follows.

1) Tighten bolts (1) – (10) to 30 N·m (3.0 kg-m, 22.0 lb-ft) according to numerical order in figure.
2) In the same manner as in Step 1), tighten them to 50 N·m (5.0 kg-m, 36.5 lb-ft).
3) In the same manner as in step 1), retighten them to 60°.
4) Tighten bolts (11) – (20) to 22 N·m (2.2 kg-m, 16.0 lb-ft) according to numerical order in figure.

Tightening torque
Crankshaft bearing cap No.1 bolts (1) – (10) :
50 N·m (5.0 kg-m, 36.5 lb-ft) and extra tightening 60°
Crankshaft bearing cap No.2 bolts (11) – (20) :
22 N·m (2.2 kg-m, 16.0 lb-ft)



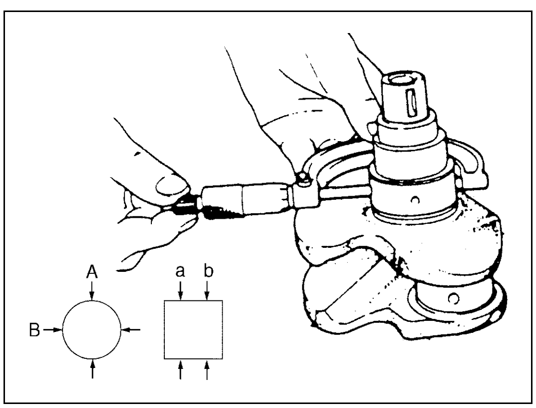
Use a dial gauge to read displacement in axial (thrust) direction of crankshaft.
If its limit is exceeded, replace thrust bearing with new standard one or oversize one to obtain standard thrust play.

Crankshaft thrust play
Standard : 0.11 – 0.31 mm (0.0043 – 0.0122 in.)
Limit : 0.35 mm (0.0138 in.)

NOTE:

After checking the thrust play, check for thread deformation of each bearing cap No.1 bolt according to previous mentioned "Main Bearing Cap No.1 Bolt" once again.

Out-of-round and taper of journals



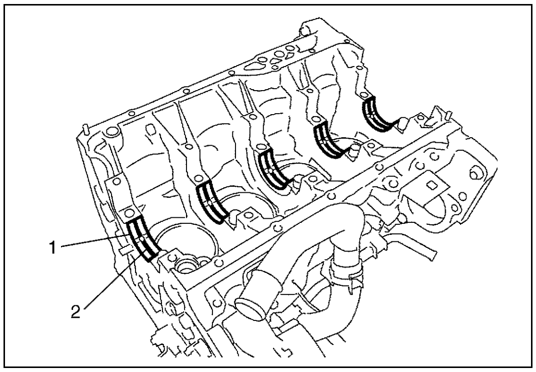
An unevenly worn crankshaft journal shows up as a difference in diameter at a cross section or along its length (or both). This difference, if any, is determined by taking micrometer readings. If any one of journals is badly damaged or if amount of uneven wear in the sense explained above exceeds its limit, regrind or replace crankshaft.

Crankshaft out-of-round and taper
Limit : 0.01 mm (0.0004 in.)
Out-of-round : A – B
Taper : a – b

Main Bearings

General information

- Service main bearings are available in standard size and 0.25 mm (0.0098 in.) undersize, and each of them has 5 kinds of bearings differing in tolerance.



- Upper half of bearing (1) has an oil groove (2) as shown in figure.
  Install this half with oil groove to cylinder block.
- Lower half of bearing does not have an oil groove.

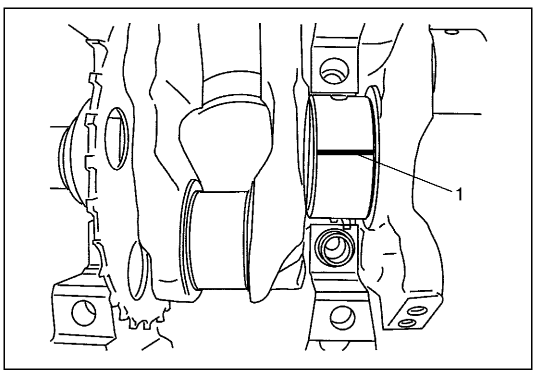
Visual inspection

Check bearings for pitting, scratches, wear or damage.
If any malcondition is found, replace both upper and lower halves.
Do not replace either half without replacing the other half.

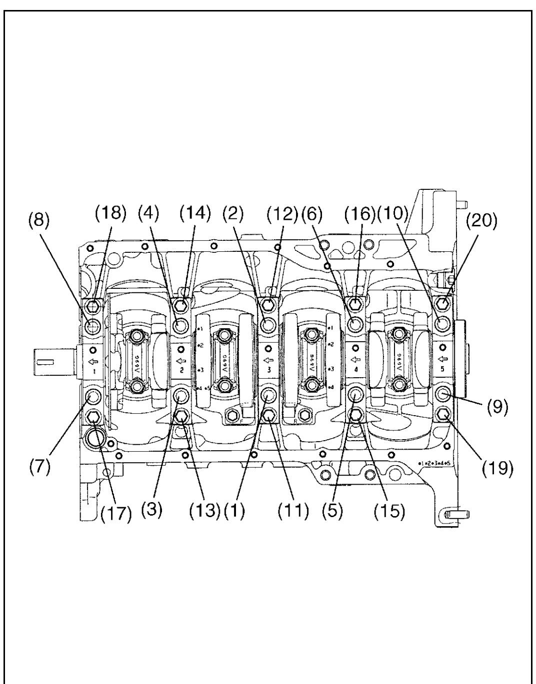
Main bearing clearance

Check clearance by using gauging plastic according to the following procedure.

1) Remove bearing caps.
2) Clean bearings and main journals.



3) Place a piece of gauging plastic (1) the full width of bearing (parallel to crankshaft) on journal, avoiding oil hole.



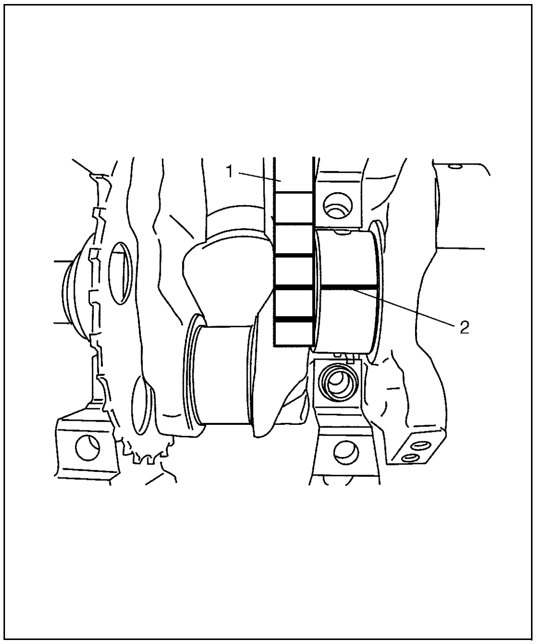
4) Tighten bearing cap No.1 bolts (1) – (10) and No.2 bolts (11) – (20) gradually as follows.
   a) Tighten bolts (1) – (10) to 30 N·m (3.0 kg-m, 22.0 lb-ft) according to numerical order in figure.
   b) In the same manner as in Step a), tighten them to 50 N·m (5.0 kg-m, 36.5 lb-ft).
   c) In the same manner as in step a), retighten them to 60°.
   d) Tighten bolts (11) – (20) to 22 N·m (2.2 kg-m, 16.0 lb-ft) according to numerical order in figure.

Tighting torque

Crankshaft bearing No.1 bolts (1) – (10) :
50 N·m (5.0 kg-m, 36.5 lb-ft) and extra tightening 60°
Crankshaft bearing No.2 bolts (11) – (20) :
22 N·m (2.2 kg-m, 16.0 lb-ft)

NOTE:

Do not rotate crankshaft while gauging plastic is installed.



5) Remove bearing caps and using scale (1) on gauging plastic (2) envelop, measure gauging plastic width at its widest point. If clearance exceeds its limit, replace bearing. Always replace both upper and lower inserts as a unit.
   A new standard bearing may produce proper clearance. If not, it will be necessary to regrind crankshaft journal for use of 0.25 mm undersize bearing.
   After selecting new bearing, recheck clearance.

Main bearing clearance
Standard : 0.025 – 0.045 mm (0.0010 – 0.0018 in.)
Limit : 0.065 mm (0.0026 in.)

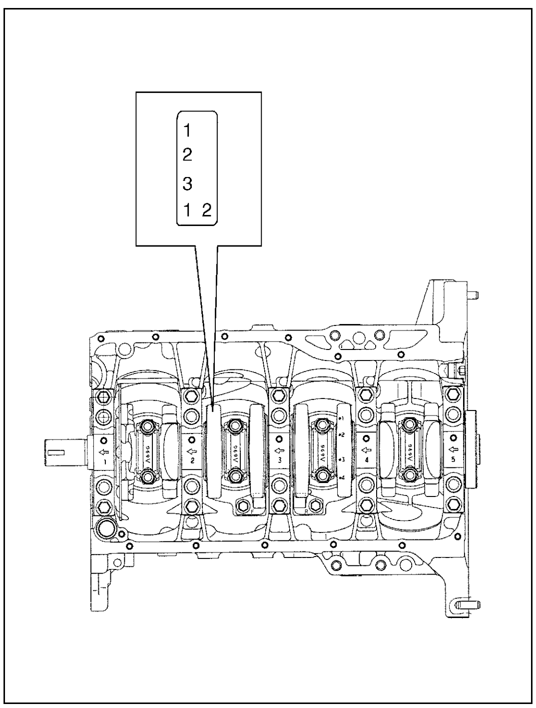
NOTE:

After checking the bearing clearance, check for thread deformation of each bearing cap No.1 bolt according to previous mentioned Step 4) once again.

Selection of main bearings

STANDARD BEARING:

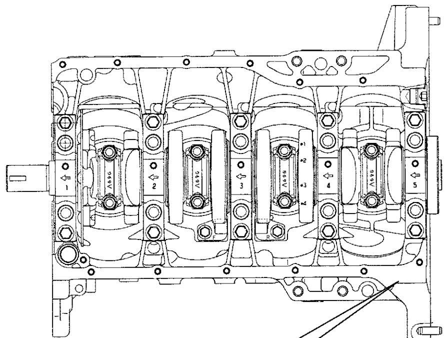
If bearing is in malcondition, or bearing clearance is out of specification, select a new standard bearing according to the following procedure and install it.



1) First check journal diameter. As shown in figure, crank web No.2 has stamped numbers.
   Three kinds of numbers (“1”, “2” and “3”) represent the following journal diameters.
   Stamped numbers on crank web No.2 represent journal diameters marked with an arrow in figure respectively.
   For example, stamped number “1” indicates that corresponding journal diameter is 44.994 – 45.000 mm (1.7714 – 1.7717 in.).

Crankshaft journal diameter

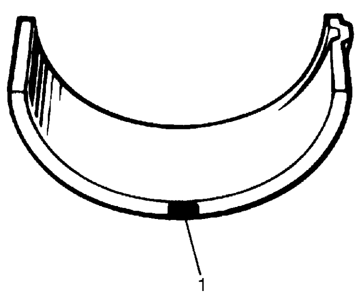
Stamped numbers	Journal diameter
1	**44.994 – 45.000 mm (1.7714 – 1.7717 in.)**
2	**44.988 – 44.994 mm (1.7712 – 1.7714 in.)**
3	**44.982 – 44.988 mm (1.7709 – 1.7712 in.)**



2) Next, check bearing cap bore diameter without bearing. On mating surface of cylinder block, five alphabets are stamped as shown in figure.
Three kinds of alphabets (“A”, “B” and “C”) represent the following cap bore diameters.
Stamped alphabets on cylinder block represent bearing cap bore diameter marked with an arrow in figure respectively. For example, stamped “A” indicates that corresponding bearing cap bore diameter is 49.000 – 49.006 mm (1.9291 – 1.9294 in.).

Crankshaft bearing cap bore

Stamped alphabet	Bearing cap bore diameter (without bearing)
A	49.000 – 49.006 mm (1.9291 – 1.9294 in.)
B	49.006 – 49.012 mm (1.9294 – 1.9296 in.)
C	49.012 – 49.018 mm (1.9296 – 1.9298 in.)



3) There are five kinds of standard bearings differing in thickness. To distinguish them, they are painted in the following colors at the center of bearings.
Each color indicates the following thickness.

Standard size of crankshaft main bearing

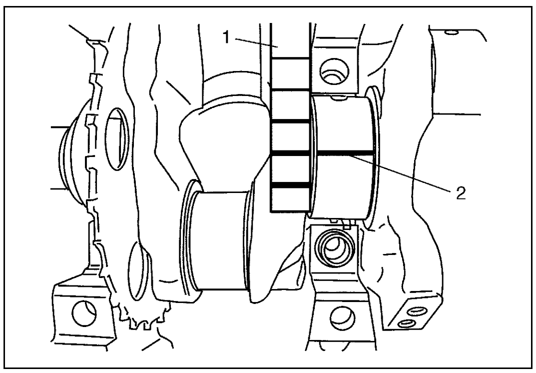
Color painted	Bearing thickness
Pink	1.990 – 1.994 mm (0.0783 – 0.0785 in.)
Purple	1.993 – 1.997 mm (0.0785 – 0.0786 in.)
Brown	1.996 – 2.000 mm (0.0786 – 0.0787 in.)
Green	1.999 – 2.003 mm (0.0787 – 0.0789 in.)
Black	2.002 – 2.006 mm (0.0788 – 0.0790 in.)

1. Paint

4) From number stamped on crank web No.2 and alphabets stamped on cylinder block, determine new standard bearing to be installed to journal, by referring to table shown below.
   For example, if number stamped on crank web No.2 is “1” and alphabet stamped on cylinder block is “B”, install a new standard bearing painted in “Purple” to its journal.

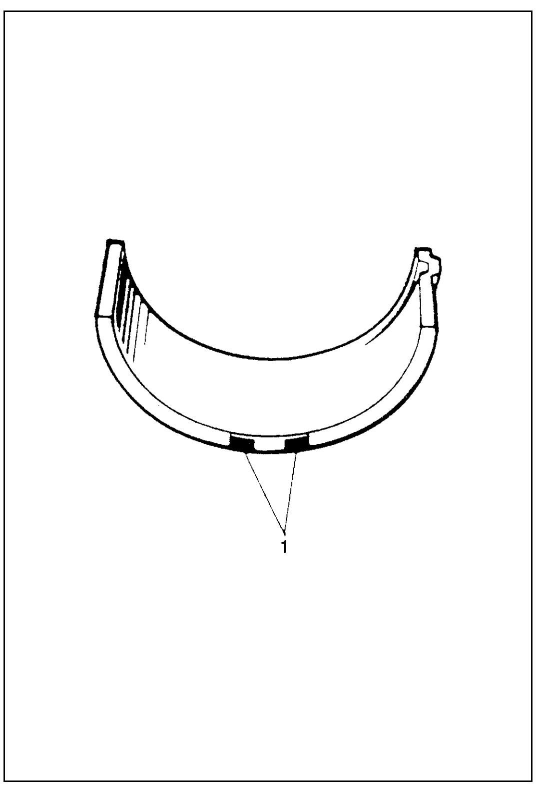
Specification of standard crankshaft main bearing

		Number stamped on crank web No.2 (Journal diameter)		
		1	2	3
Alphabet stamped on cylinder block (Cap bore dia.)	A	Pink	Purple	Brown
	B	Purple	Brown	Green
	C	Brown	Green	Black
		New standard bearing to be installed.		



5) Using scale (1) on gauging plastic (2), check bearing clearance with newly selected standard bearing.
   If clearance still exceeds its limit, use next thicker bearing and recheck clearance.
6) When replacing crankshaft or cylinder block due to any reason, select new standard bearings to be installed by referring to number stamped on new crankshaft or alphabets stamped on new cylinder block.

UNDERSIZE BEARING (0.25 mm):



- 0.25 mm undersize bearing is available, in five kinds varying in thickness.
  To distinguish them, each bearing is painted in the following colors at the center of bearing.
  Each color represents the following thickness.

Undersize of crankshaft main bearing

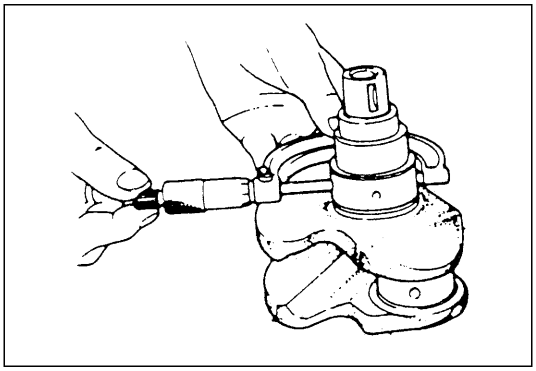
Color painted	Bearing thickness
Red and Pink	2.115 – 2.119 mm (0.0833 – 0.0834 in.)
Red and Purple	2.118 – 2.122 mm (0.0834 – 0.0835 in.)
Red and Brown	2.121 – 2.125 mm (0.0835 – 0.0837 in.)
Red and Green	2.124 – 2.128 mm (0.0836 – 0.0838 in.)
Red and Black	2.127 – 2.131 mm (0.0837 – 0.0839 in.)

1. Paint

- If necessary, regrind crankshaft journal and select undersize bearing to use with it as follows.

a) Regrind journal to the following finished diameter.

Finished diameter
44.732 – 44.750 mm (1.7611 – 1.7618 in.)

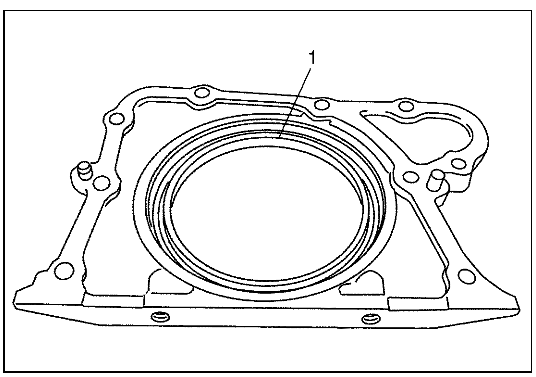


1) Using micrometer, measure reground journal diameter. Measurement should be taken in two directions perpendicular to each other in order to check for out-of-round.
2) Using journal diameter measured above and alphabets stamped on cylinder block, select an undersize bearing by referring to table given below.
   Check bearing clearance with newly selected undersize bearing.

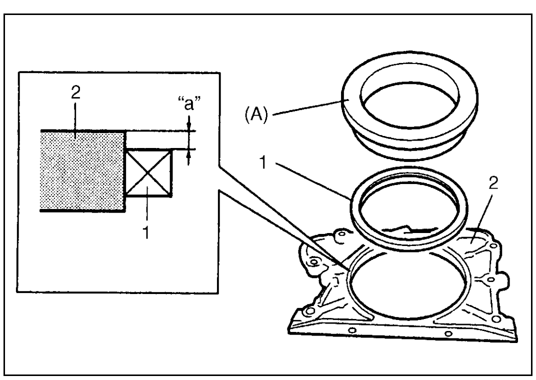
Specification of undersize crankshaft main bearing

		Measured journal diameter		
		44.744 – 44.750 mm (1.7616 – 1.7618 in.)	44.738 – 44.744 mm (1.7613 – 1.7616 in.)	44.732 – 44.738 mm (1.7611 – 1.7613 in.)
Alphabets stamped on cylinder block	A	Red and Pink	Red and Purple	Red and Brown
	B	Red and Purple	Red and Brown	Red and Green
	C	Red and Brown	Red and Green	Red and Black
		Undersize bearing to be installed		

Rear Oil Seal



Carefully inspect oil seal (1) for wear or damage.
If its lip is worn or damaged, replace it.



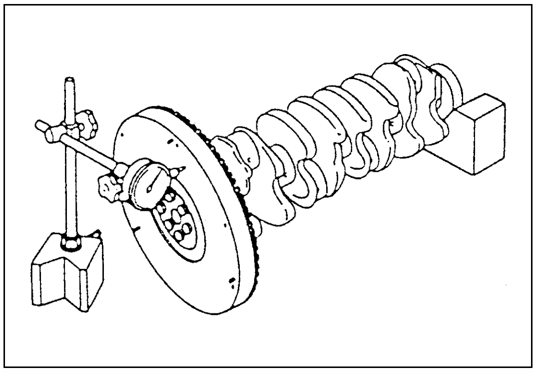
For oil seal installation, press-fit rear oil seal (1) to oil seal housing (2) by using special tool as shown in the figure.

Special tool
(A) : 09911-97820

Crank rear oil seal installing position
“a” : 3 mm (0.12 in.)

Flywheel

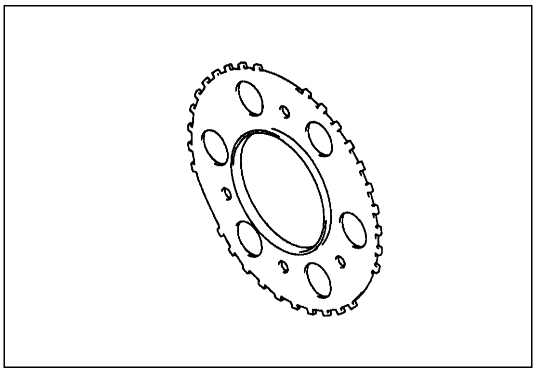
- If ring gear is damaged, cracked or worn, replace flywheel.
- If the surface contacting clutch disc is damaged, or excessively worn, replace flywheel.



- Check flywheel for face runout with a dial gauge.
  If runout exceeds its limit, replace flywheel.

Flywheel runout
Limit : 0.2 mm (0.0079 in.)

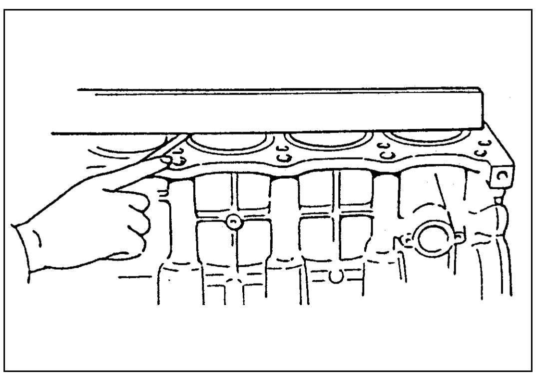
Sensor Plate



- Check sensor plate for crack or damage. If malcondition is found, replace it.

Cylinder Block

Distortion of gasketed surface



- Using straightedge and thickness gauge, check gasketed surface for distortion and, if flatness exceeds its limit, correct it.

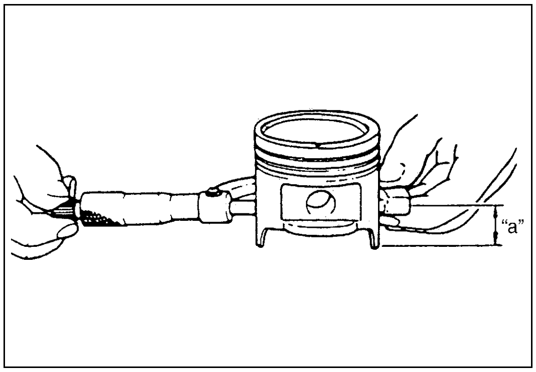
Cylinder block flatness
Limit : 0.05 mm (0.0020 in.)

Honing or reboring cylinders

1) When any cylinder needs reboring, all other cylinders must also be rebored at the same time.
2) Select oversized piston according to amount of cylinder wear.

Oversize piston diameter

Size	Piston diameter
Oversize 0.50	78.453 – 78.468 mm (3.0887 – 3.0893 in.)



3) Using micrometer, measure piston diameter.

Measurement position for piston diameter
"a" : 19.5 mm (0.77 in.)

4) Calculate cylinder bore diameter to be rebored as follows.
   D = A + B – C
   D : Cylinder bore diameter to be rebored.
   A : Piston diameter as measured.
   B : Piston clearance = 0.02 –0.04 mm (0.0008 – 0.0016 in.)
   C : Allowance for honing = 0.02 mm (0.0008 in.)
5) Rebore and hone cylinder to calculated dimension.

NOTE:

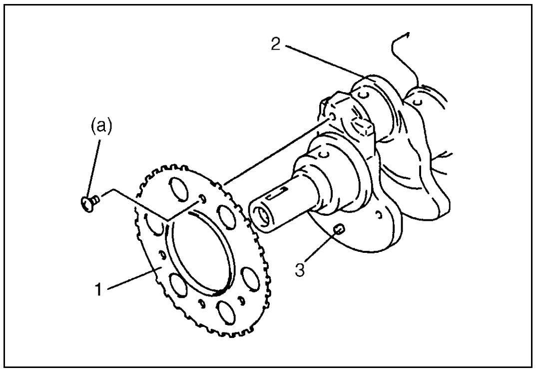
Before reboring, install all main bearing caps in place and tighten to specification to avoid distortion of bearing bores.

6) Measure piston clearance after honing.

INSTALLATION

NOTE:

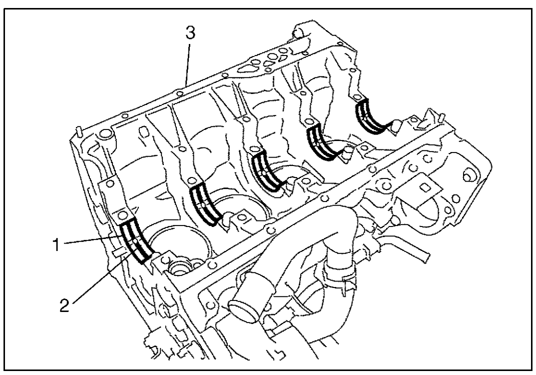
- **All parts to be installed must be perfectly clean.**
- **Be sure to oil crankshaft journals, journal bearings, thrust bearings, crankpins, connecting rod bearings, pistons, piston rings and cylinder bores.**
- **Journal bearings, bearings caps, connecting rods, rod bearings, rod bearing caps, pistons and piston rings are in combination sets. Do not disturb such combination and make sure that each part goes back to where it came from, when installing.**



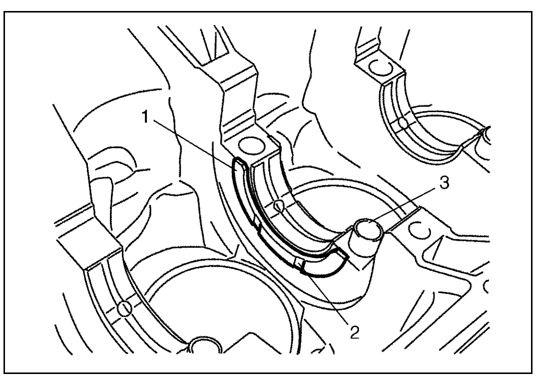
1) Install sensor plate (1) to crankshaft (2) and tighten bolts to specified torque.

NOTE:
When installing sensor plate, align spring pin (3) on crankshaft and hole of sensor plate.

Tightening torque
Sensor plate bolts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)



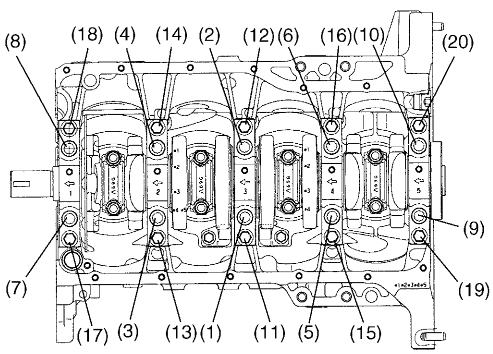
2) Install main bearings to cylinder block.
   Upper half of bearing (1) has an oil groove (2).
   Install it to cylinder block (3), and the other half without oil groove to bearing cap.
   Make sure that two halves are painted in the same color.



3) Install thrust bearings (1) to cylinder block between No.2 and No.3 cylinders. Face oil groove (2) sides to crank webs.
4) Confirm that dowel pins(3) are installed to intake side of each journal.

5) Install crankshaft to cylinder block.

6) Install bearing cap to cylinder block, making sure to point arrow mark (on each cap) to crankshaft pulley side. Fit them sequentially in ascending order, 1, 2, 3, 4 and 5, starting from pulley side.
After applying engine oil to bearing cap No.1 bolts ((1) – (10)) and bearing cap No.2 bolts ((11) – (20)), tighten them gradually as follows.



NOTE:

- **If bearing cap No.1 bolts are reused, check thread diameters of them for deformation according to previous mentioned "Main Bearing Cap No.1 Bolt" and replace them with new ones if thread diameter exceeds limit.**

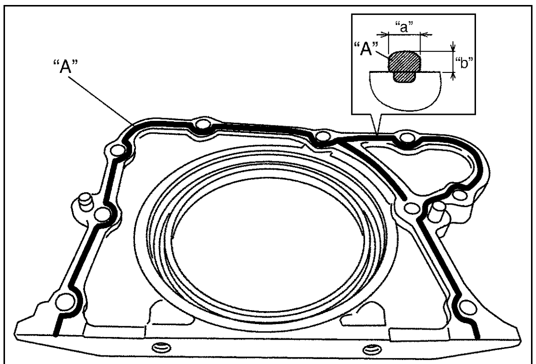
a) Tighten bolts (1) – (10) to 30 N·m (3.0 kg-m, 22.0 lb-ft) according to numerical order as shown by using a 12 corner socket wrenches.
b) In the same manner as in Step a), tighten them to 50 N·m (5.0 kg-m, 36.5 lb-ft).
c) In the same manner as in Step a), retighten them to 60°.
d) Tighten bolts (11) – (20) to 22 N·m (2.2 kg-m, 16.0 lb-ft) according to numerical order as shown.

Tightening torque
Crankshaft bearing cap No.1 bolts (1) – (10)
: 50 N·m (5.0 kg-m, 36.5 lb-ft) and extra tightening 60°
Crankshaft bearing cap No.2 bolts (11) – (20)
: 22 N·m (2.2 kg-m, 16.0 lb-ft)

NOTE:

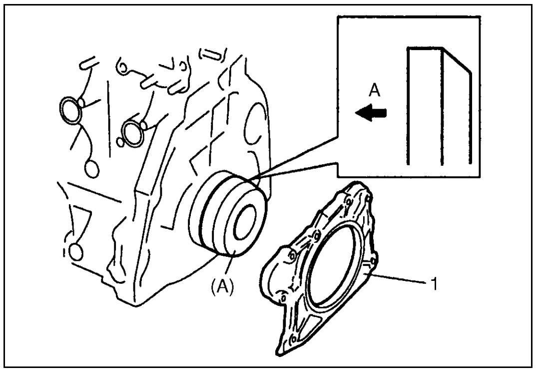
After tightening cap bolts, check to be sure that crankshaft rotates smoothly when turning it by 12 N·m (1.2 kg-m, 9.0 lb-ft) torque or below.

7) Apply sealant to mating surface of rear oil seal housing (1).



"A" : Sealant 99000-31150

Sealant amount for rear oil seal housing
Width "a" : 3 mm, 0.12 in.
Height "b" : 2 mm, 0.08 in.

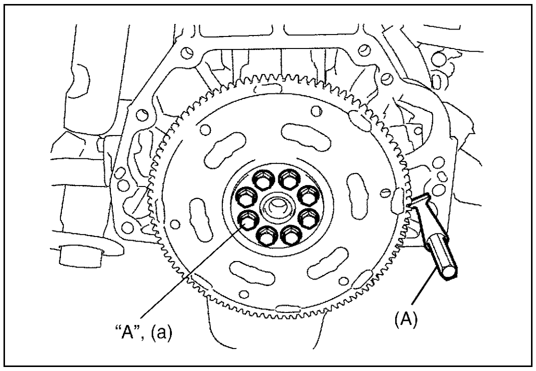


8) Install rear oil seal housing (1) and tighten bolts to specified torque by using special tool.

Special tool
(A) : 09911-97720

Tightening torque
Rear oil seal housing bolts : 11 N·m (1.1 kg-m, 8.0 lb-ft)

A : Crankshaft side



9) Install flywheel (drive plate for A/T).
   Using special tool, lock flywheel or drive plate, and tighten flywheel or drive plate bolts applied with sealant to specification.

"A" : Sealant 1215 99000-31110

Special tool
(A) : 09924-17810

Tightening torque
Flywheel or drive plate bolts
(a) : 70 N·m (7.0 kg-m, 51.0 lb-ft)

10) Install the following parts to engine as previously outlined.
   - Piston and connecting rod
   - Cylinder head assembly
   - Camshaft, tappet and shim
   - Timing chain guide, chain tensioner adjuster, chain tensioner, timing chain and crankshaft timing sprocket
   - Timing chain cover
   - Cylinder head cover
   - Intake manifold and exhaust manifold
   - Oil pan and oil pump strainer
11) Install clutch to flywheel (vehicle with M/T) referring to "Clutch Cover, Clutch Disc, Flywheel and Release Bearing" in Section 7C.
12) Install engine assembly to vehicle referring to "Engine Assembly" in this section.

Required Service Material

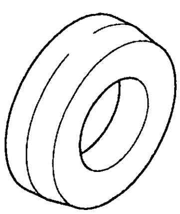
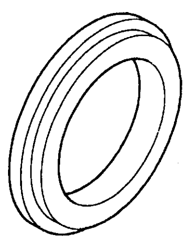
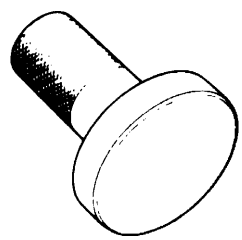
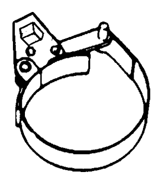
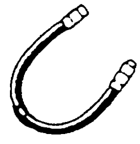
Material	Recommended SUZUKI product (Part Number)	Use
Sealant	SUZUKI BOND NO. 1207C (99000-31150)	• To apply to mating surface of cylinder block and oil pan. • To apply to mating surface of cylinder block and timing chain cover. • To apply to sealing surface of cylinder head cover. • To apply to mating surface to rear oil seal housing.
	SUZUKI BOND NO. 1207B (99000-31140)	• To apply to mating surface of cylinder block, cylinder head and timing chain cover.
	SUZUKI BOND NO. 1215 (99000-31110)	• To flywheel (M/T) or drive plate (A/T) bolts.

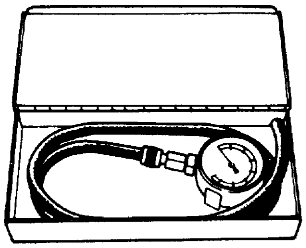
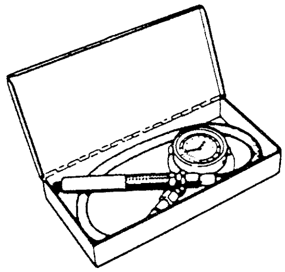
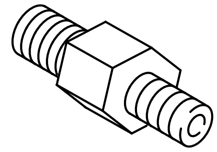
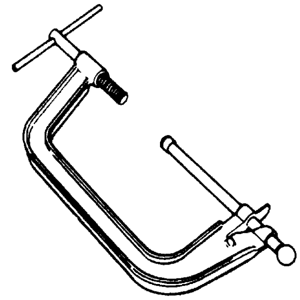
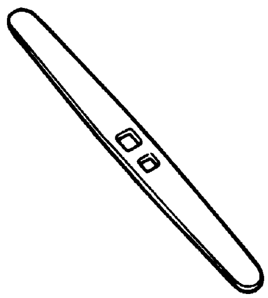
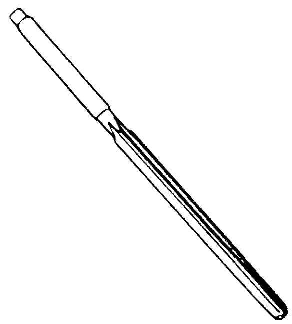
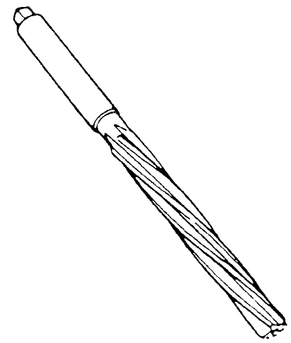
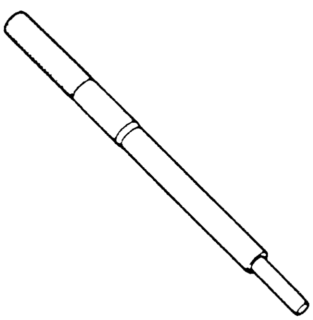
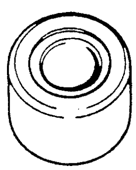
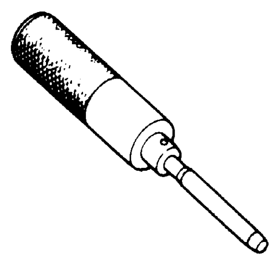
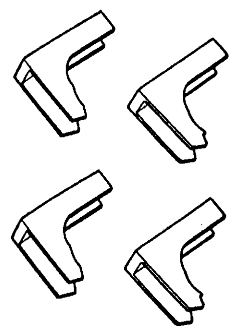
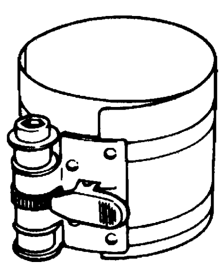
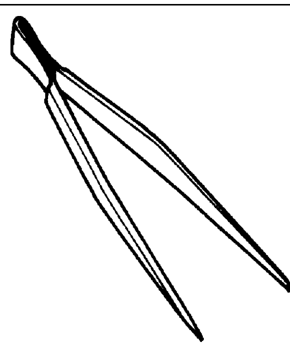
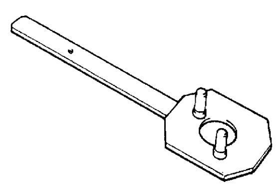
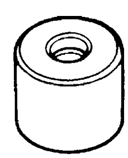
Tightening Torque Specification

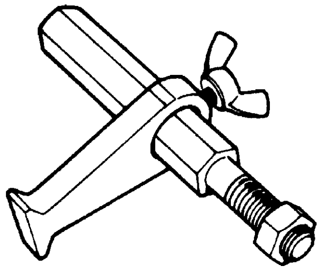
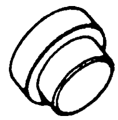
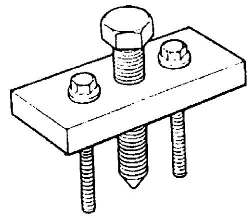
Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
Oil pressure switch	14.0	1.4	10.5
Camshaft housing bolts (for replacement of shim)	8.0	0.8	6.0
Camshaft housing bolts	11.0	1.1	8.0
Cylinder head cover bolts	8.0	0.8	6.0
Intake manifold bolts and nuts	25.0	2.5	18.0
Exhaust manifold bolts and nuts	55.0	5.5	40.0
Exhaust pipe bolts	50.0	5.0	36.5
Exhaust manifold stiffener bolts	50.0	5.0	36.5
Oil pump strainer bolt	11.0	1.1	8.0
Oil pump strainer bracket bolt	11.0	1.1	8.0
Oil pan bolts and nuts	11.0	1.1	8.0
Oil pan drain plug	50.0	5.0	36.5
Timing chain cover bolts and nut	23.0	2.3	17.0
Crankshaft pulley bolt	150.0	15.0	108.5
Oil pump rotor plate bolts	11.0	1.1	8.0
Timing chain No.1 guide bolts	9.0	0.9	6.5
Timing chain tensioner adjuster bolts	11.0	1.1	8.0
Venturi plug	5.0	0.5	3.5
Cylinder head bolt for M8	22.0	2.2	16.0
Cylinder head bolts for M10	a) Tighten 40 N·m b) Turn 60° c) Turn 60°	a) Tighten 4.0 kg-m b) Turn 60° c) Turn 60°	a) Tighten 29.0 lb-ft b) Turn 60° c) Turn 60°
Connecting rod bearing cap nuts	a) Tighten 15 N·m b) Turn 45° c) Turn 45°	a) Tighten 1.5 kg-m b) Turn 45° c) Turn 45°	a) Tighten 11.0 lb-ft b) Turn 45° c) Turn 45°
Engine mounting bolts	50.0	5.0	36.5

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
Crankshaft bearing cap No.1 bolts (for inspection of crankshaft thrust play)	50.0	5.0	36.5
Crankshaft bearing cap No.2 bolts	22.0	2.2	16.0
Sensor plate bolts	11.0	1.1	8.0
Crankshaft bearing cap No.1 bolts	a) Tighten 50 N·m b) Turn 60°	a) Tighten 5.0 kg-m b) Turn 60°	a) Tighten 36.5 lb-ft b) Turn 60°
Rear oil seal housing bolts	11.0	1.1	8.0
Flywheel or drive plate bolts	70.0	7.0	51.0
Torque converter bolts	20.0	2.0	14.5
Timing chain tensioner bolt	22.0	2.2	16.0
Knock sensor	23.0	2.3	16.5
Cylinder block and transmission fastening bolts and nuts (vehicle with M/T)	94.0	9.4	68.0
Cylinder block and transmission fastening bolts and nuts (vehicle with A/T)	80.0	8.0	58.0

Special Tool

 09911-97720 Oil seal guide	 09911-97820 Oil seal installer	 09913-75520 Bearing installer	 09915-47330 Oil filter wrench
 09915-64510-001 Compression gauge	 09915-64510-002 Connector	 09915-64530 Hose	 09915-67010 Attachment

 09915-67310 Vacuum gauge	 09915-77310 Oil pressure gauge	 09915-78211 Oil pressure gauge attachment	 09916-14510 Valve lifter
 09916-14521 Valve lifter attachment	 09916-34542 Reamer handle	 09916-34550 Reamer (5.5 mm)	 09916-37320 Reamer (10.5 mm)
 09916-44910 Valve guide remover	 09916-56011 Valve guide installer attachment	 09916-58210 Valve guide installer han-dle	 09916-67020 Tappet holder
 09916-77310 Piston ring compressor	 09916-84511 Forceps	 09917-68221 Camshaft lock holder	 09917-98221 Valve stem seal installer

		
09924-17810 Flywheel holder	09926-58010 Bearing puller attachment	09944-36011 Steering wheel remover

SECTION 6B

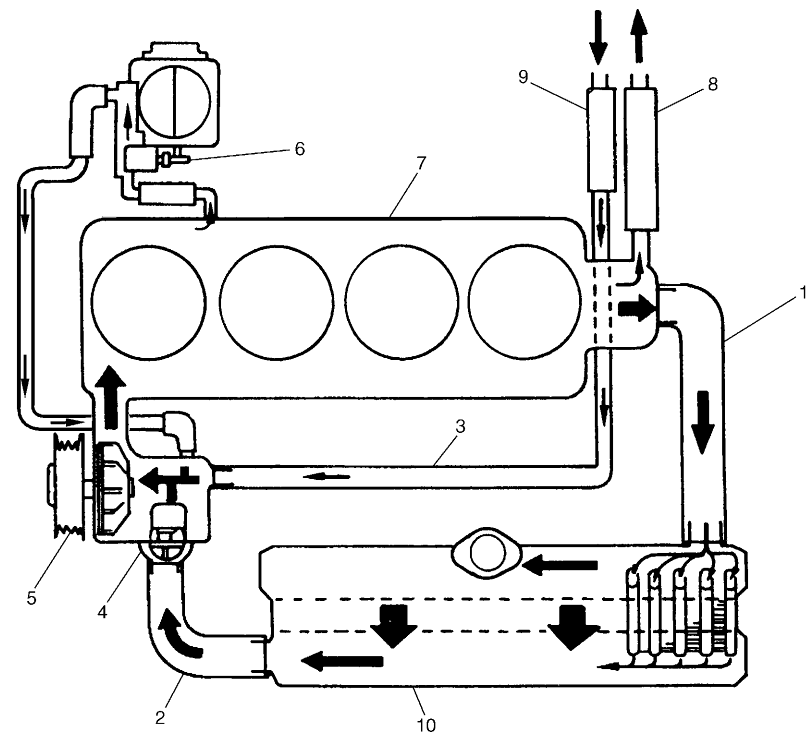
ENGINE COOLING

CONTENTS

General Description

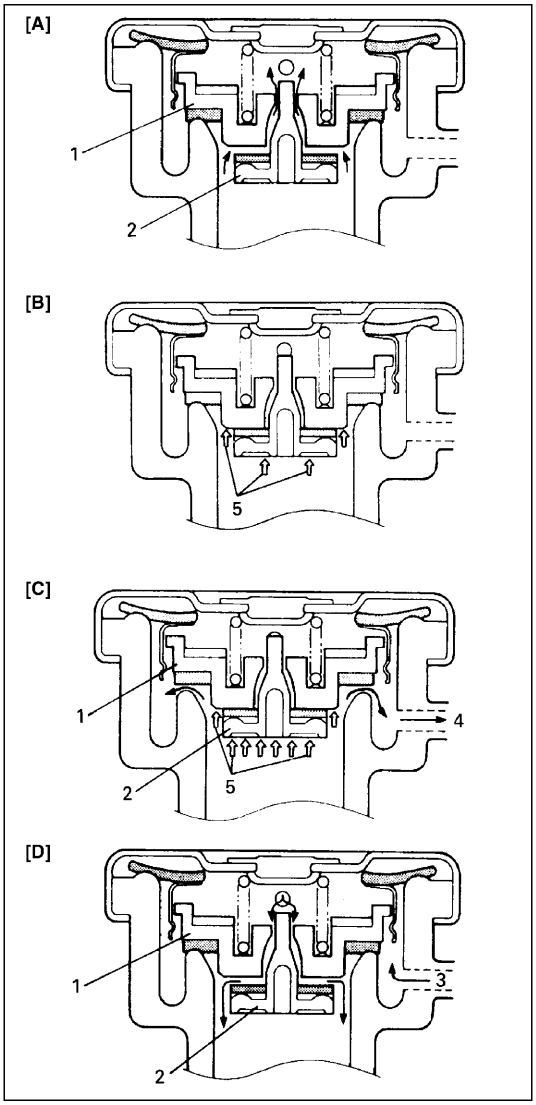
The cooling system consists of the radiator cap, radiator, reservoir, hoses, water pump, cooling fan & clutch, thermostat. The radiator is of tube-and-fin type.

Cooling System Circulation



1. Radiator inlet hose	5. Water pump	9. Heater outlet hose
2. Radiator outlet hose	6. Fast idle control plunger of throttle body	10. Radiator
3. Water inlet pipe	7. Cylinder block/cylinder head	
4. Thermostat	8. Heater inlet hose	

Radiator Cap



A pressure-vent cap is used on the radiator. The cap contains a pressure valve (1) and ventilation valve (2).
The cap has its face marked 1.1, which means that its pressure valve opens at 1.1 kg/cm^2 (15.6 psi, 110 kPa).

NOTE:

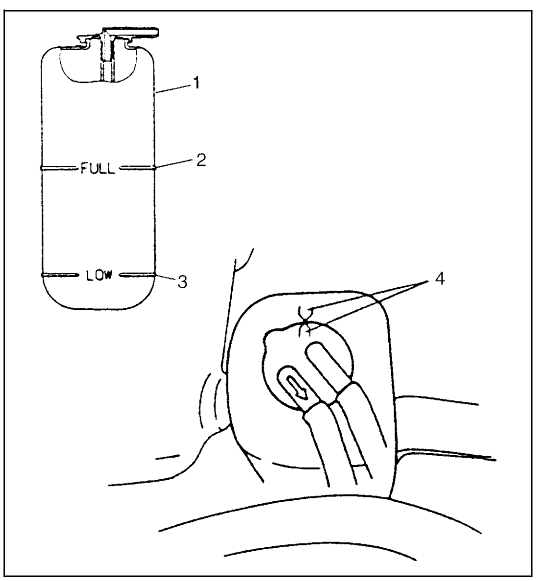
Do not remove radiator cap to check engine coolant level; check coolant visually at the see-through coolant reservoir.
Coolant should be added only to reservoir as necessary.

WARNING:

As long as there is pressure in the cooling system, the temperature can be considerably higher than the boiling temperature of the solution in the radiator without causing the solution to boil. Removal of the radiator cap while engine is hot and pressure is high will cause the solution to boil instantaneously and possibly with explosive force, spewing the solution over engine, fenders and person removing cap. If the solution contains flammable antifreeze such as alcohol (not recommended for use at any time), there is also the possibility or causing a serious fire.

[A]: At air bleed	3. From reservoir
[B]: At valves closed	4. To reservoir
[C]: At pressure relief	5. Pressure in radiator
[D]: At vacuum relief	

Coolant Reservoir

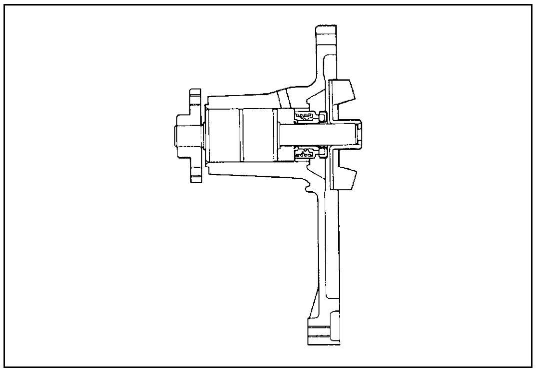


A “see-through” plastic reservoir (1) is connected to the radiator by a hose.
Coolant level should be between “FULL” level mark (2) and “LOW” level mark (3) on the reservoir.
Coolant should be added only to the reservoir as necessary.

NOTE:

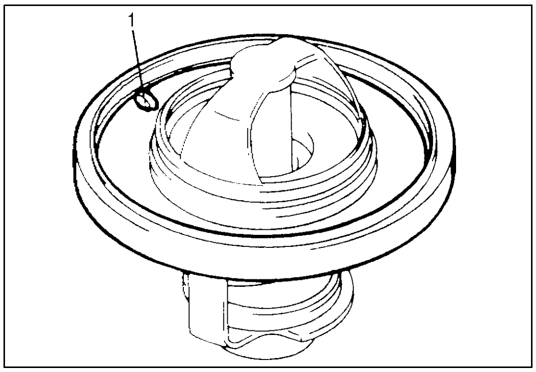
When installing reservoir cap, set arrow marks (4) on the reservoir and cap as the figure.

Water Pump



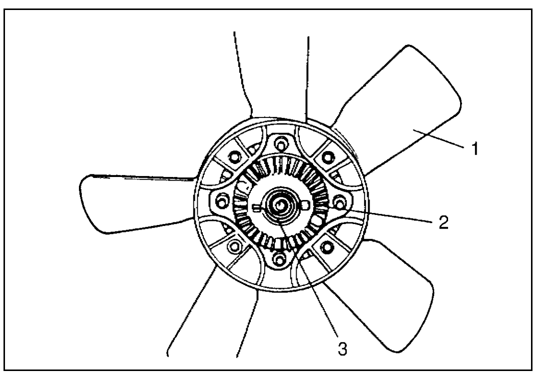
The centrifugal type water pump is used in the cooling system.
The pump impeller is supported by a totally sealed bearing.
The water pump can not be disassembled.

Thermostat



A wax pellet type thermostat is used in the cooling system.
The temperature at which the valve begins to open is stamped on thermostat.
In the top portion of the thermostat, an air bleed valve (1) is provided; this valve is for venting out the gas or air, if any, that is accumulated in the circuit.

Cooling Fan Clutch



Fluid is enclosed in the cooling fan clutch (2) and at its center front, there is a bimetal (3) whose thermal reaction and the engine speed control the cooling fan speed.

NOTE:

Do not disassemble clutch assembly.

WARNING:

Keep hands, tools, and clothing away from engine cooling fan (1) to help prevent personal injury.

Coolant (Water) Temperature Gauge

A water temp. gauge is located at intake manifold.
This gauge activates a temp. meter in the instrument cluster.
When installing, wind sealing tape on gauge thread and tighten it.

Diagnosis

Condition	Possible Cause	Correction
Engine overheats	• Loose or broken water pump belt	Adjust or replace.
	• Not enough coolant	Check coolant level and add as necessary.
	• Faulty thermostat	Replace.
	• Faulty water pump	Replace.
	• Dirty or bent radiator fins	Clean or remedy.
	• Coolant leakage on cooling system	Repair.
	• Defective cooling fan clutch	Check and replace as necessary.
	• Plugged radiator	Check and replace radiator as necessary.
	• Faulty radiator cap	Replace.
	• Maladjusted ignition timing	Check system related parts.
	• Dragging brakes	Adjust brake.
	• Slipping clutch	Adjust or replace.

Maintenance

Coolant

The coolant recovery system is standard. The coolant in the radiator expands with heat, and the overflow is collected in the reservoir.
When the system cools down, the coolant is drawn back into the radiator.
The cooling system has been filled at the factory with a quality coolant that is either 50/50 mixture of water and anti-freeze / anti-corrosion coolant (ethylene glycol antifreeze).
The 50/50 mixture coolant solution provides freezing protection to – 36 °C (– 33 °F).

- Maintain cooling system freeze protection at – 36 °C (– 33 °F) to ensure protection against corrosion and loss of coolant from boiling.
  This should be done even if freezing temperatures are not expected.
- Add ethylene glycol base coolant when coolant has to be added because of coolant loss or to provide added protection against freezing at temperature lower than – 36 °C (– 33 °F).

Anti-freeze proportioning table

Freezing temperature	**°C**	**– 16**	**– 36**
	°F	**3**	**– 33**
Anti-freeze / Anti-corrosion coolant concentration	**%**	**30**	**50**
Ratio of compound to cooling water	**ltr.**	**1.35/3.15**	**2.25/2.25**
	US pt.	**2.85/6.65**	**4.75/4.75**
	Imp pt.	**2.37/5.53**	**3.95/3.95**

Coolant capacity

Engine radiator and heater	**5.2 liters (11.0/9.2 US/Imp. pt.)**
Reservoir	**0.7 liters (1.5/1.2 US/Imp. pt.)**
Total	**5.9 liters (12.5/10.5 US/Imp. pt.)**

NOTE:

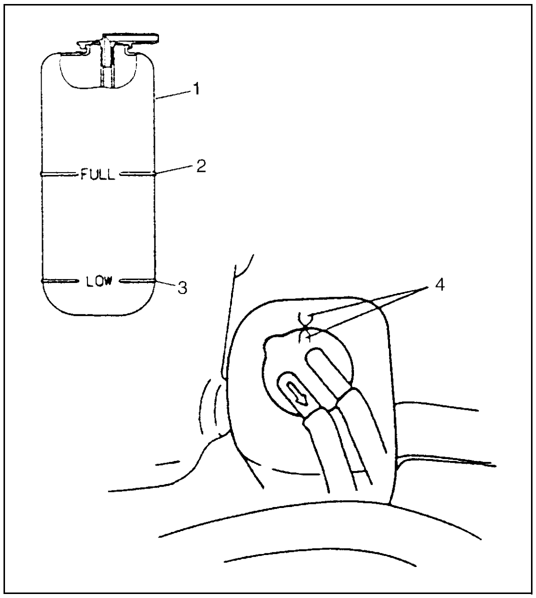
- **Alcohol or methanol base coolant or plain water alone should not be used in cooling system at any time as damage to cooling system could occur.**
- **Even in a market where no freezing temperature is anticipated, mixture of 70% water and 30% ethylene glycol antifreeze (Antifreeze / Anticorrosion coolant) should be used for the purpose of corrosion protection and lubrication.**

Coolant Level

WARNING:
To help avoid danger of being burned:
- **Do not remove reservoir cap while coolant is "boiling", and**
- **Do not remove radiator cap while engine and radiator are still hot.**

Scalding fluid and steam can be blown out under pressure if either cap is taken off too soon.

To check level, look at "see-through" reservoir.
It is not necessary to remove radiator cap to check coolant level.



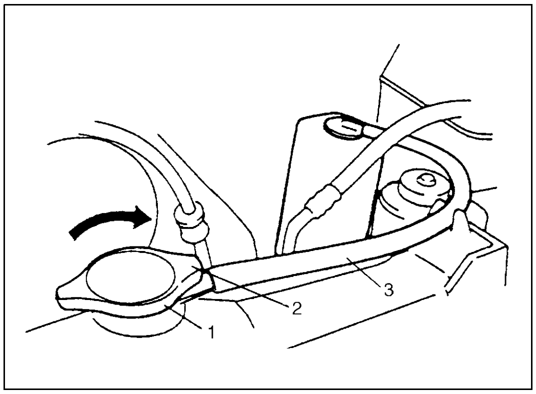
When engine is cool, check coolant level in reservoir (1).
A normal coolant level should be between "FULL" (2) and "LOW" (3) marks on reservoir (1).
If coolant level is below "LOW" mark, remove reservoir cap and add proper coolant to reservoir to bring coolant level up to "FULL" mark. Then, reinstall cap.

NOTE:
- **If proper quality antifreeze is used, there is no need to add extra inhibitors or additives that claim to improve system. They may be harmful to proper operation of system.**
- **When installing reservoir cap, set arrow marks (4) on the reservoir and cap as the figure.**

Cooling System Service

WARNING:
To help avoid danger of being burned, do not remove radiator cap while engine and radiator are still hot.
Scalding fluid and steam can be blown out under pressure if cap is taken off too soon.

Cooling system should be serviced as follows.
1) Check cooling system for leakage or damage.
2) Wash radiator cap and filler neck with clean water by removing radiator cap when engine is cold.
3) Check coolant for proper level and freeze protection.
4) Using a pressure tester, check system and radiator cap for proper pressure holding capacity 1.1 kg/cm^2 (15.6 psi, 110 kPa). If replacement of cap is required, use proper cap specified for this vehicle.



NOTE:

After installing radiator cap (1) to radiator, make sure that its ear (2) is aligned with reservoir hose (3) as shown in figure.
If not, turn cap more to align its ear with hose.

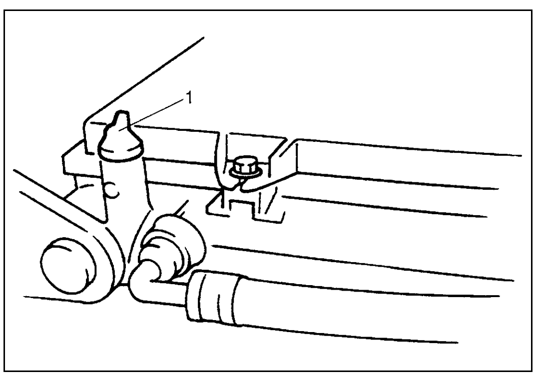
5) Tighten hose clamps and inspect all hoses.
   Replace hoses whenever cracked, swollen or otherwise deteriorated.
6) Clean frontal area of radiator core.

Cooling System Flush and Refill

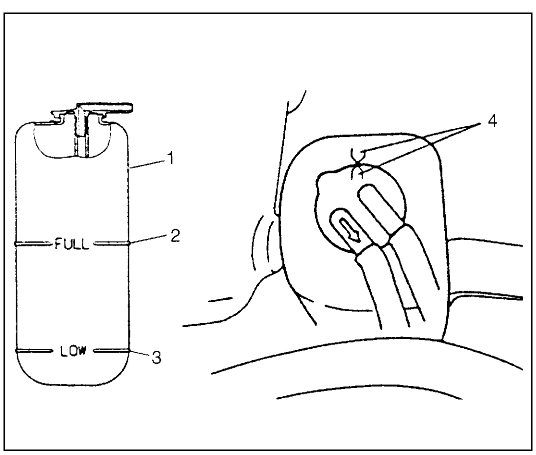
WARNING:

To help avoid danger of being burned, do not remove radiator cap while engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if cap is taken off too soon.

1) Remove radiator cap when engine is cool:
   Turn cap slowly to the left until it reaches a “stop” (Do not press down while turning it).
   Wait until pressure is relieved (indicated by a hissing sound) then press down on cap and continue to turn it to the left.
2) With radiator cap removed, run engine until upper radiator hose is hot (this shows that thermostat is open and coolant is flowing through system).



3) Stop engine and open radiator drain plug (1) to drain coolant.
4) Close drain plug. Add water until system is filled and run engine until upper radiator hose is hot again.
5) Repeat steps 3 and 4 several times until drained liquid is nearly colorless.
6) Drain system and then close radiator drain plug tightly.



7) Disconnect hose from water reservoir (1). Remove reservoir and pour out any fluid. Scrub and clean inside of reservoir with soap and water. Flush it well with clean water and drain. Reinstall reservoir and hose.
8) Add 50/50 mixture of good quality ethylene glycol antifreeze and water to radiator and reservoir.
   Fill radiator to the base of radiator filler neck and reservoir to “FULL” level mark (2). Reinstall reservoir cap setting the arrow marks (4) on the reservoir and cap as the figure.

3. LOW level mark

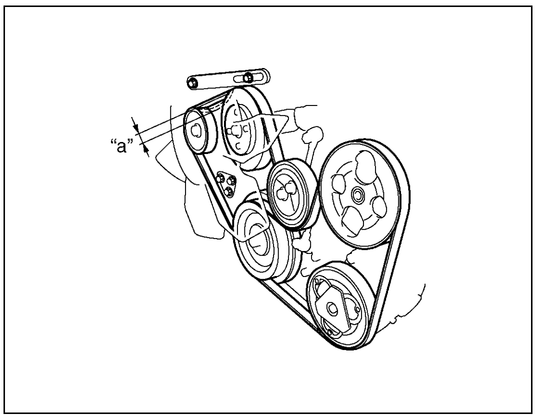
9) Run engine, with radiator cap removed, until radiator upper hose is hot.
10) With engine idling, add coolant to radiator until level reaches the bottom of filler neck. Install radiator cap, making sure that the ear of cap lines up with reservoir hose.

Water Pump Belt Tension

WARNING:

Disconnect negative cable at battery before checking and adjusting belt tension.

1) Inspect belt for cracks, cuts, deformation, wear and cleanliness. If it is necessary to replace belt, refer to “Water Pump Belt and Cooling Fan” in this section.

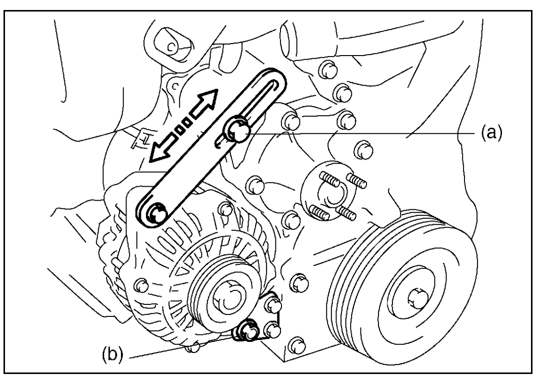


2) Check belt for tension. Belt is in proper tension when it deflects 4.5 to 5.5 mm (0.18 – 0.22 in.) under thumb pressure (about 10 kg or 22 lb.).

Water pump belt tension
“a” : 4.5 – 5.5 mm (0.18 – 0.22 in.) as deflection / 10 kg (22 lbs)

NOTE:

When replacing belt with a new one, adjust belt tension to 3 – 4 mm (0.12 – 0.16 in.).



3) If belt is too tight or too loose, adjust it to proper tension by displacing generator position.
4) Tighten generator adjusting bolt and pivot bolts as specified torque.

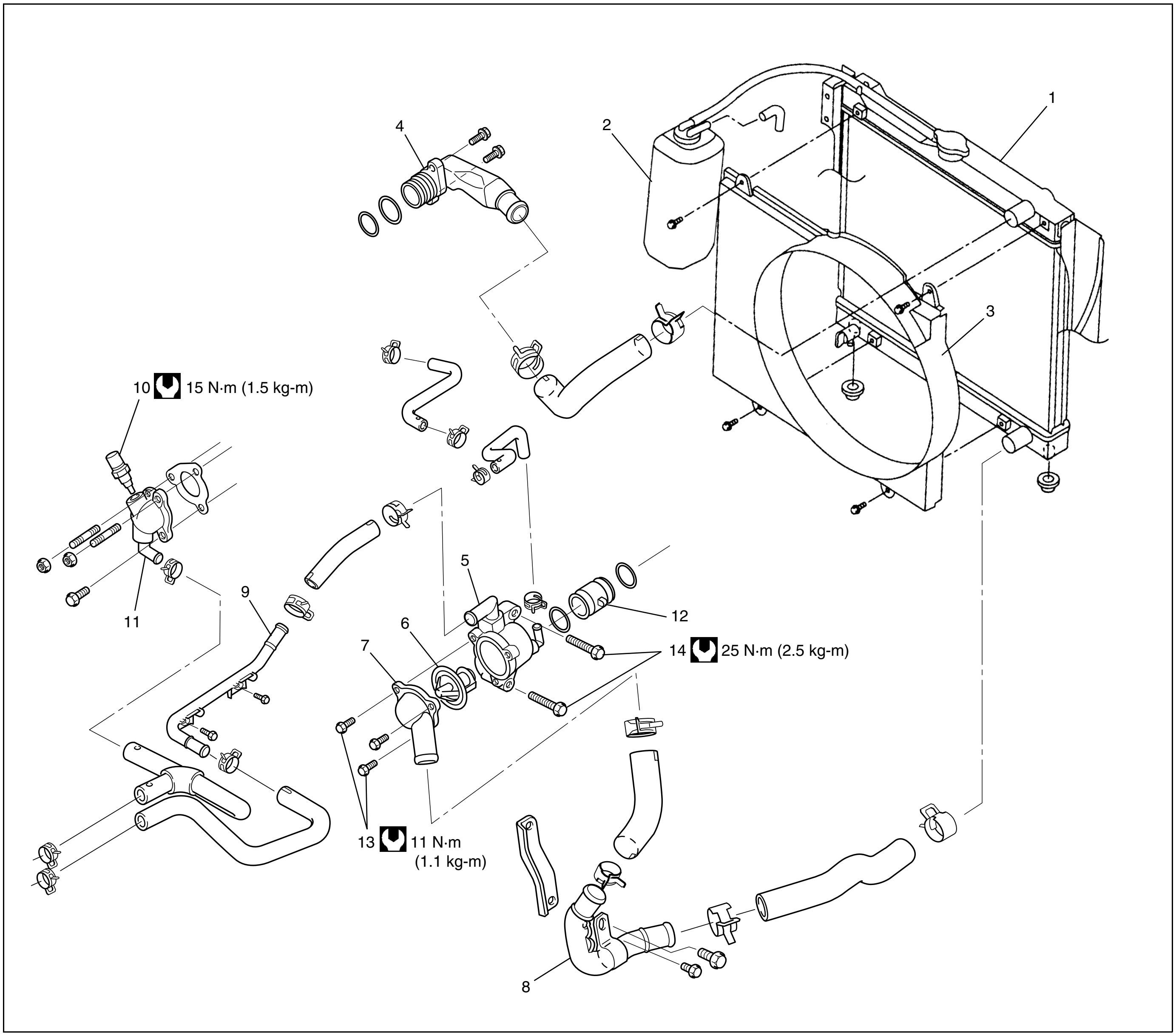
Tightening torque
Generator adjusting bolt (a) : 23 N·m (2.3 kg-m, 17.0 lb-ft)
Generator pivot bolts (b) : 50 N·m (5.0 kg-m, 36.0 lb-ft)

5) Connect negative cable at battery terminal.

On-Vehicle Service

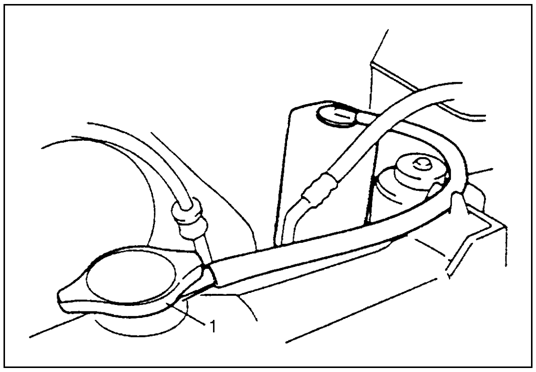
CAUTION:
- **Check to make sure that engine coolant temperature is cold before removing any part of cooling system.**
- **Disconnect negative cable at battery before removing any part.**

Cooling System Component



1. Radiator	6. Thermostat	11. Water outlet cap
2. Reservoir	7. Thermostat cap	12. Thermostat case outlet pipe
3. Cooling fan shroud	8. Radiator outlet pipe	13. Thermostat cap bolt
4. Water outlet pipe	9. Heater pipe	14. Thermostat case bolt
5. Thermostat case	10. ECT sensor	Tightening Torque

Coolant Draining



1) Remove radiator cap (1).
2) Loosen drain plug on radiator to drain coolant.
3) After draining coolant, be sure to tighten drain plug securely.
4) Fill cooling system. Refer to “Coolant” in this section.

Cooling Water Pipes or Hoses

REMOVAL

1) Drain cooling system.
2) To remove water pipes or hoses, loosen screw on each pipe or hose clip and pull hose end off.

INSTALLATION

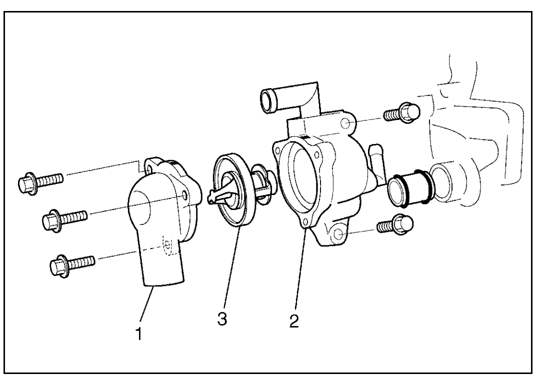
Install removed parts in reverse order of removal procedure, noting the following.

- Tighten each clamp bolt securely.
- Refill cooling system with proper coolant, referring to description on “Coolant” and “Cooling System Flush and Refill” in this section.

Thermostat

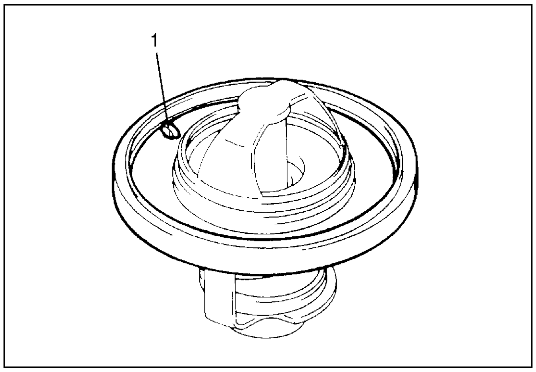
REMOVAL

1) Drain cooling system and tighten drain plug.
2) Remove intake manifold, referring to “Throttle Body and Intake Manifold” in Section 6A1.

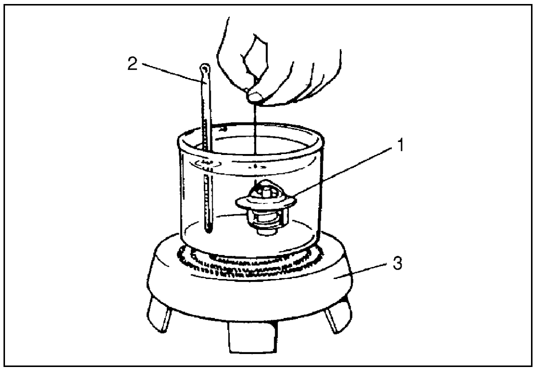


3) Disconnect thermostat cap (1) from thermostat case (2).
4) Remove thermostat (3).

INSPECTION



1) Make sure that air bleed valve (1) of thermostat is clear. Should this valve be clogged, engine would tend to overheat.
2) Check valve seat for some foreign matters being stuck which prevent valve from seating tight.



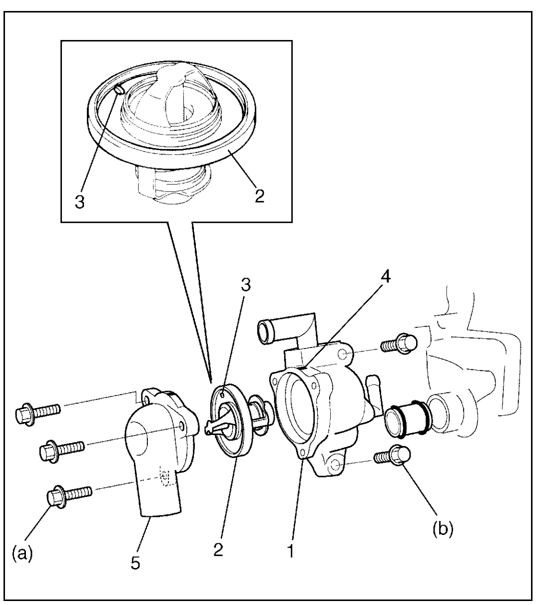
3) Check thermostatic movement of wax pellet as follows:
   a) Immerse thermostat (1) in water, and heat water gradually.
   b) Check that valve starts to open at specification temp.
   c) If valve starts to open at a temperature substantially below or above, thermostat unit should be replaced with a new one.
      Such a unit, if re-used, will bring about overcooling or overheating tendency.

Thermostat functional specification

Temp. at which valve begins to open	**80 – 84 °C (176 – 183 °F)**
Temp. at which valve becomes fully open	**93 – 97 °C (199 – 207 °F)**
Valve lift	**More than 8 mm at 95 °C (203 °F)**

2. Thermometer	
3. Heater	

INSTALLATION



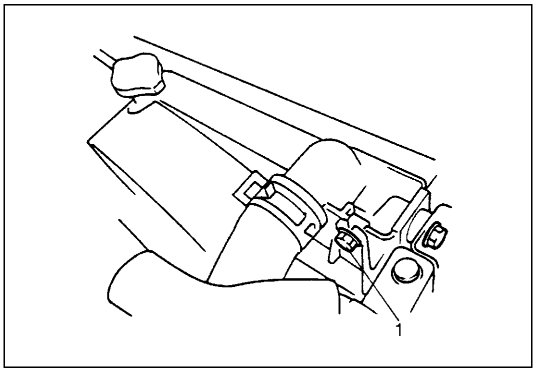
1) When positioning the thermostat (2) on the thermostat case (1), be sure to align its air breather valve (3) with mark (4).
2) Install thermostat cap (5) to thermostat case with align air bleed valve and mark.
   Then, tighten mounting bolts to specified torque.

Tightening torque
Thermostat cap bolts
(a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)
Thermostat case bolts
(b) : 25 N·m (2.5 kg-m, 18.0 lb-ft)

3) Install intake manifold by referring to “Throttle Body and Intake Manifold” in Section 6A1.
4) Fill the cooling system.

Water Pump Belt and Cooling Fan

REMOVAL

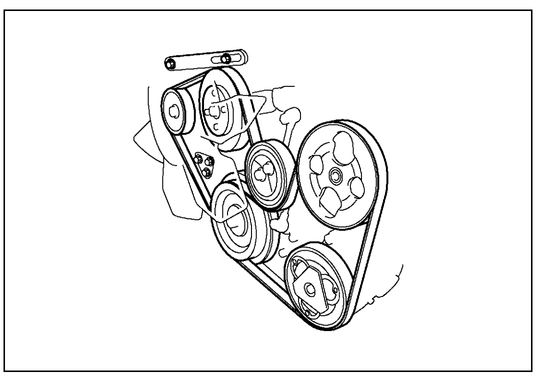


1) Remove radiator shroud securing bolts (1).
2) Remove radiator by referring to “Radiator” in this section.
3) Loosen water pump drive belt tension.
4) Remove cooling fan by removing securing nuts.
   Remove power steering and/or compressor drive belt before removing water pump belt.
5) Remove pump belt.

INSTALLATION

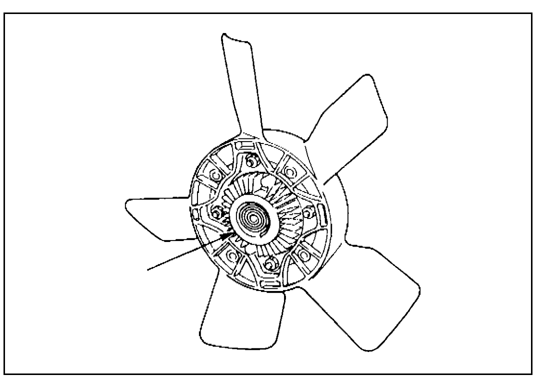
Once cooling fan or water pump belt has been removed, make sure to tighten bolts and nuts securely in reinstallation and adjust pump belt tension to specification. For specified tension, refer to “Water Pump Belt Tension” in this section.

WATER PUMP BELT TENSION INSPECTION



1) Check belt tension. It should be within specification. Refer to “Water Pump Belt Tension” in this section.
2) If tension is out of specification, adjust it.
   For its adjustment, refer to “Water Pump Belt Tension” in this section.
   After adjustment, be sure to tighten bolts.

COOLING FAN CLUTCH INSPECTION

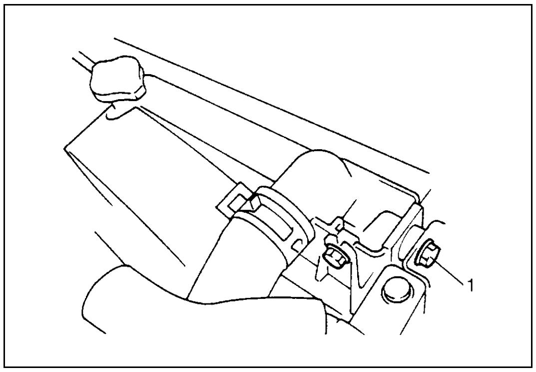


Inspect fluid coupling for oil leakage.
If necessary, replace fan clutch assembly. Do not disassemble clutch assembly.

Radiator

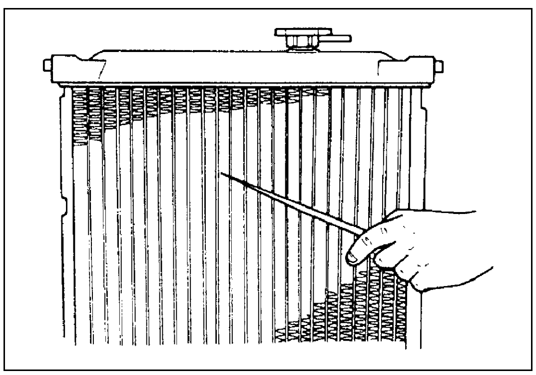
REMOVAL

1) Drain cooling system.
2) Remove radiator shroud.
3) Disconnect water hoses from radiator.
4) With automatic transmission (A/T) vehicle, disconnect additional two fluid hoses from radiator.
   Place some container under radiator to receive A/T fluid which will flow out when hose is disconnected.
5) Install radiator protection board to between radiator and cooling fan.



6) Remove radiator after removing two bolts (1).

INSPECTION



If the water side of the radiator is found excessively rusted or covered with scales, clean it by flushing with the radiator cleaner compound.
This flushing should be carried out at regular intervals for scale or rust formation advances with time even where a recommended type of coolant is used. Periodical flushing will prove more economical.
Inspect the radiator cores and straighten the flattened or bent fins, if any. Clean the cores, removing road grimes and trashes.
Excessive rust or scale formation on the wet side of the radiator lowers the cooling efficiency.
Flattened or bent fins obstruct the flow of air through the core to impede heat dissipation.

Radiator flushing interval recommended
Two years

INSTALLATION

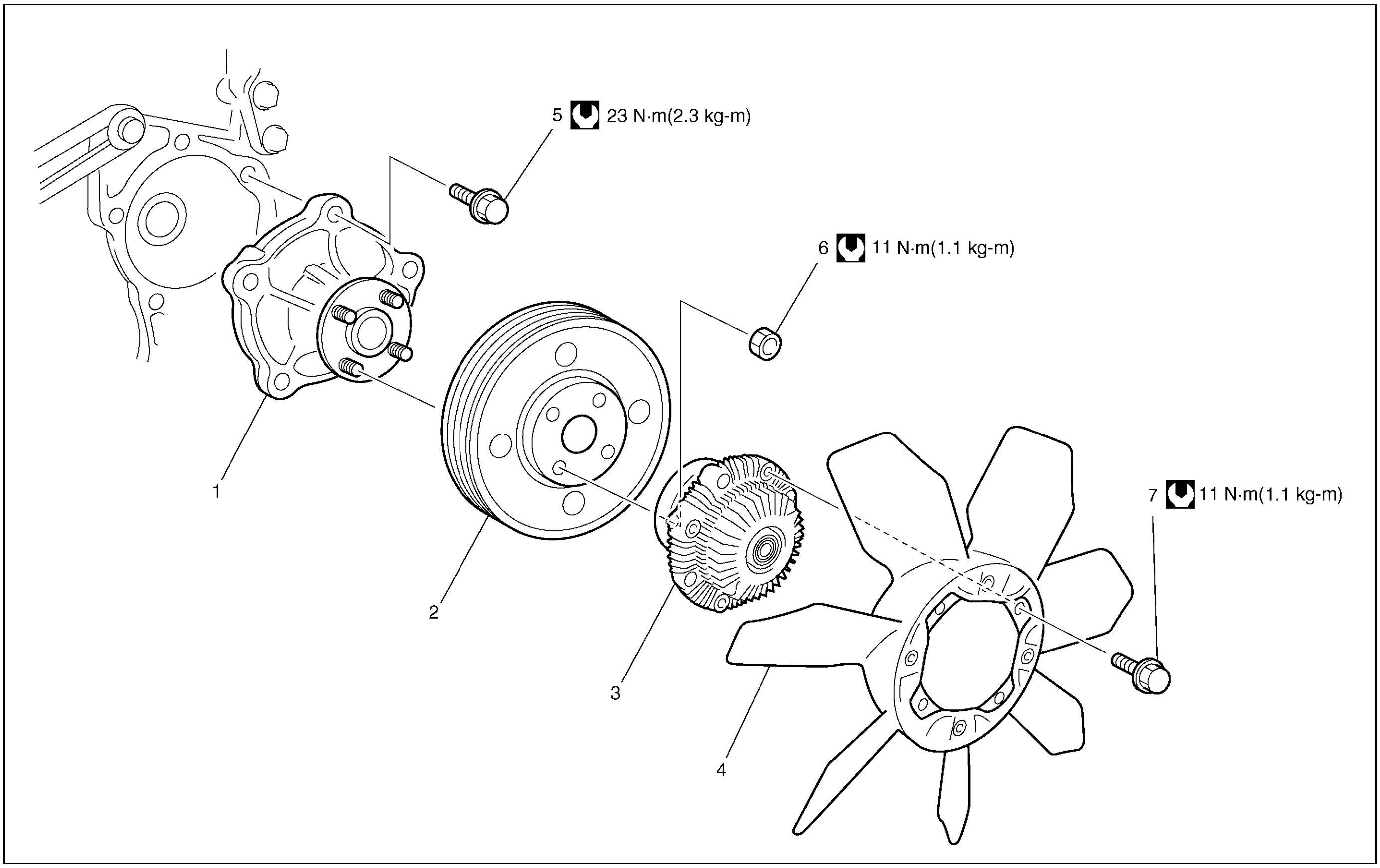
Reverse removal procedures.

NOTE:

- **Refill cooling system with proper coolant referring to “Coolant” and “Cooling System Flush and Refill” in this section.**
- **With automatic transmission vehicle, fill A/T fluid up to specified level. For procedure to check A/T fluid and its level, refer to “Changing Fluid” in Section 7B.**
- **After installation, check each joint for leakage.**

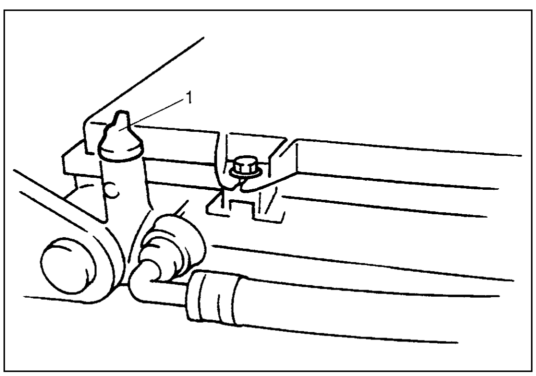
Water Pump

COMPONENTS



1. Water pump	4. Radiator cooling fan	7. Radiator cooling fan mounting bolt
2. Water pump pulley	5. Water pump mounting bolts	Tightening Torque
3. Radiator cooling fan clutch	6. Water pump pulley and fan clutch mounting nuts	

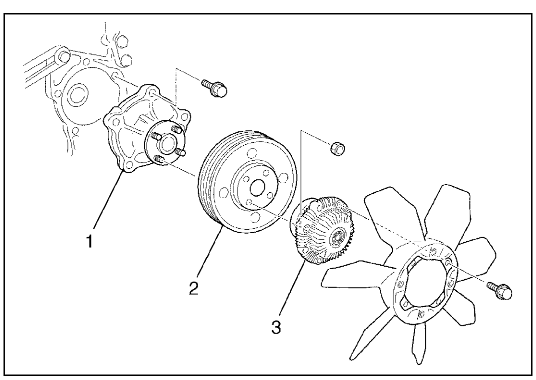
REMOVAL



1) Drain cooling system.
   Refer to Step 6) of “Cooling System Flush and Refill” in this section.

1. Drain plug

2) Remove the radiator shroud.
3) Remove radiator referring to “Radiator” in this section.

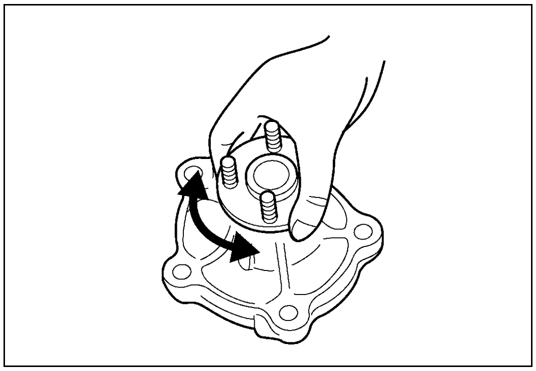


4) Loosen water pump drive belt tension.
   Then remove water pump pulley (2) with fan clutch (3) and pump drive belt.
5) Remove water pump assembly (1).

INSPECTION

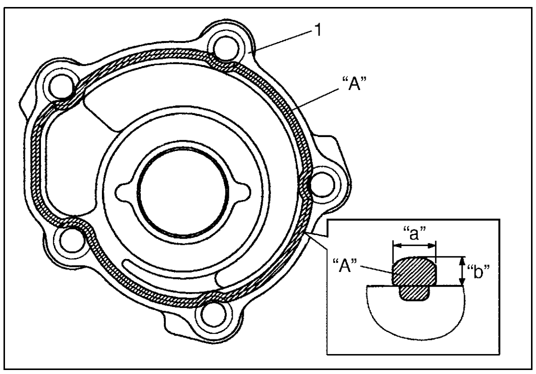
NOTE:

Do not disassemble water pump.
If any repair is required on pump, replace it as assembly.



- Rotate water pump by hand to check for smooth operation.
  If pump does not rotate smoothly or makes an abnormal noise, replace it.

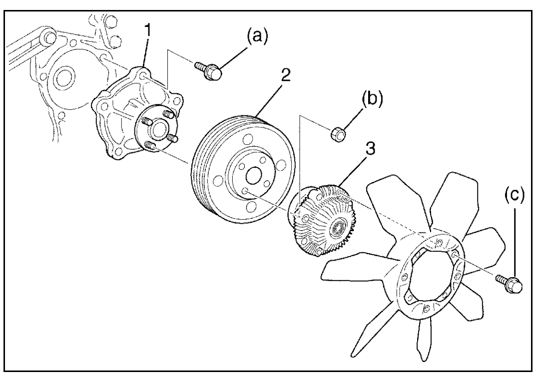
INSTALLATION



1) Apply sealant to water pump (1).

   "A" : Sealant 99000-31150

   Sealant quantity for mating surface of water pump
   Width "a" : 3mm (0.12 in.)
   Height "b" : 2mm (0.08 in.)



2) Install water pump (1) to cylinder block.

   Tightening torque
   Water pump bolts (a) : 23 N·m (2.3 kg-m, 17.0 lb-ft)

3) Install water pump pulley (2) with fan clutch (3).

   Tightening torque
   Water pump pulley nuts (b) : 11 N·m (1.1 kg-m, 8.0 lb-ft)
   Fan clutch bolts (c) : 11 N·m (1.1 kg-m, 8.0 lb-ft)

4) Install water pump drive belt, cooling fan and radiator shroud.
5) Adjust water pump belt tension.
   Refer to "Water Pump Belt Tension" in this section.
6) Connect negative cable at battery.
7) Fill the cooling system.

Required Service Material

Material	Recommended SUZUKI product (Part Number)	Use
Ethylene glycol base coolant (Anti-freeze / Anti-corrosion coolant)	–	Additive to engine cooling system for improving cooling efficiency and for protection against rusting.
Sealant	SUZUKI BOND NO.1207C (99000 – 31150)	To apply to water pump mating surface.

Tightening Torque Specification

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
Water pump bolt	23	2.3	17.0
Thermostat cap bolt	11	1.1	8.0
Thermostat case bolt	25	2.5	18.0
Fun clutch bolt	11	1.1	8.0

SECTION 6C

ENGINE FUEL

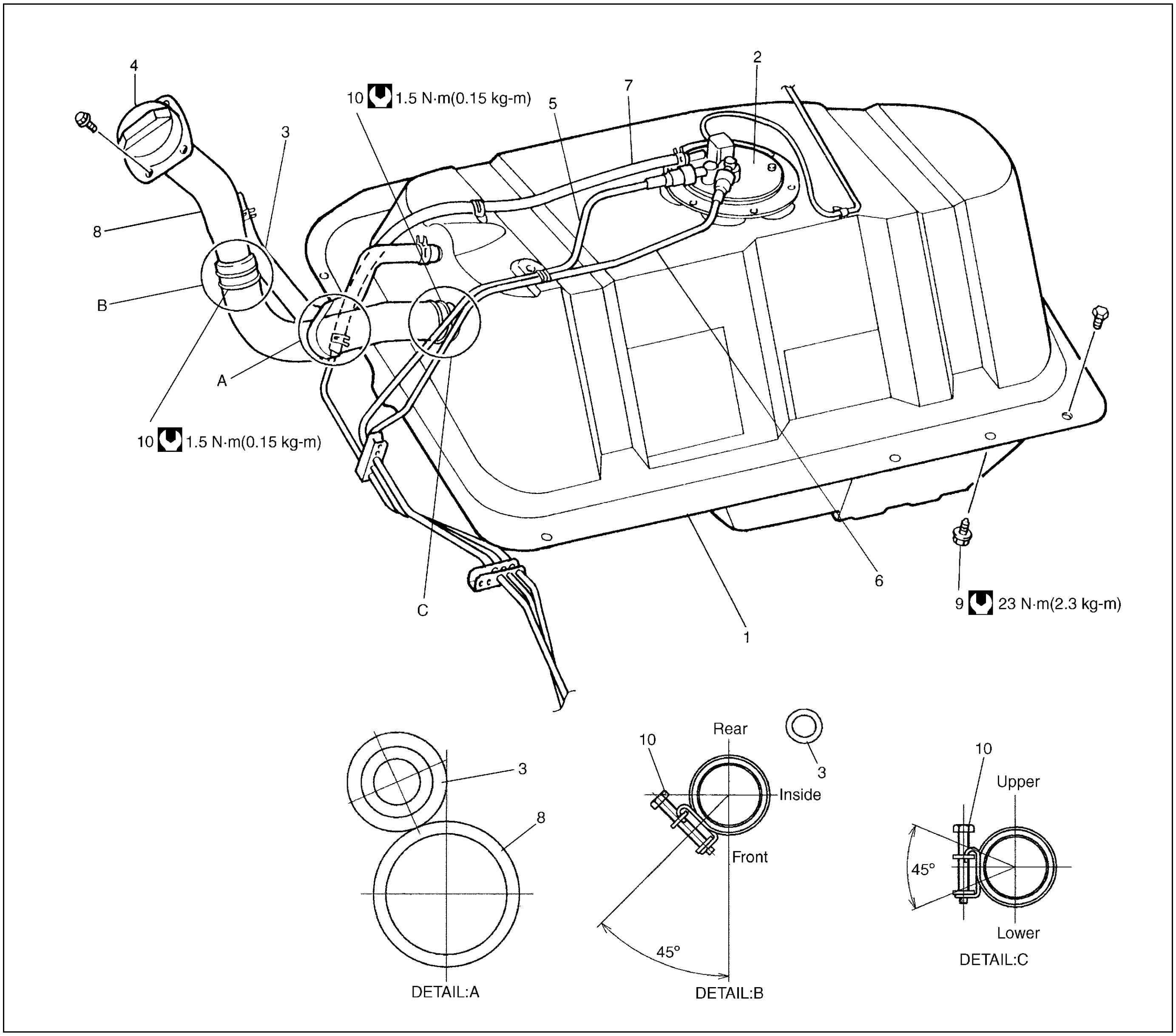
CONTENTS

CAUTION:
For vehicles with a catalytic converter, be sure to use unleaded fuel only. Use of leaded and/or low lead fuel can result in engine damage and reduce the effectiveness of the emission control system.

General Description

Fuel System

The main components of the fuel system are fuel tank, fuel pump assembly with fuel filter and fuel level gauge and fuel cut valve, fuel feed line, fuel return line and fuel vapor line.
For the details of fuel flow and fuel vapor flow, refer to “Fuel Delivery System” and “Emission Control System” in Section 6E.

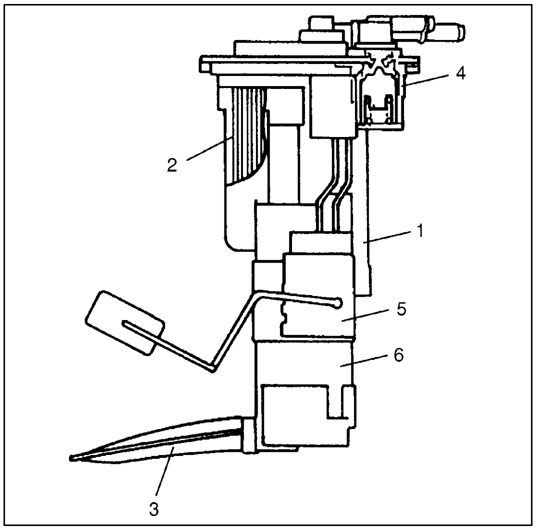


1. Fuel tank	4. Fuel filler cap	7. Fuel vapor line	10. Fuel filler hose clamp
2. Fuel pump assembly	5. Fuel feed line	8. Fuel filler neck	Tightening torque
3. Breather hose	6. Fuel return line	9. Fuel tank mounting bolt	

Fuel Tank

The fuel tank is located under the rear section of the vehicle. The fuel pump assembly is installed in fuel tank. Whenever servicing the fuel pump assembly, the fuel tank must be removed from the vehicle.

Fuel Pump Assembly



The fuel pump assembly (1) consists of fuel pump (6), fuel filter (2), fuel level gauge (5) and fuel cut valve (4).

3. Suction filter

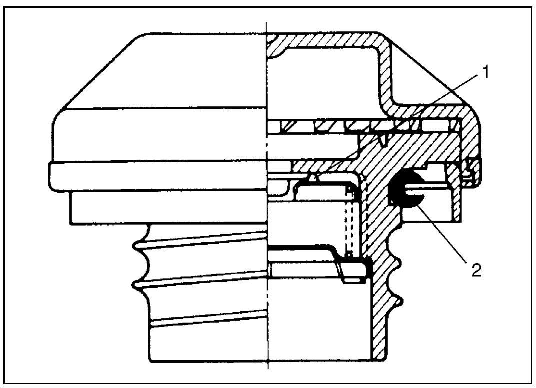
FUEL PUMP

For structure and operation of the fuel pump, refer to “Fuel Delivery System” in Section 6E.

FUEL CUT VALVE

The fuel cut valve consists of a float and a spring. It allows only the fuel vapor to flow into the canister and prevents the fuel from flowing into the canister.

Fuel Filler Cap



The fuel tank filler neck has a vacuum cap.
A ratchet tightening device on the threaded fuel filler cap reduces the chances of incorrect installation, which would prevent sealing fuel vapors.
After the gasket (2) on fuel filler cap and the filler neck flange contact, the ratchet produces a loud clicking noise, indicating the seal has been set.
This cap has a vacuum relief valve (1) inside.
The vacuum relief valve opens to relieve the vacuum created in the fuel tank.

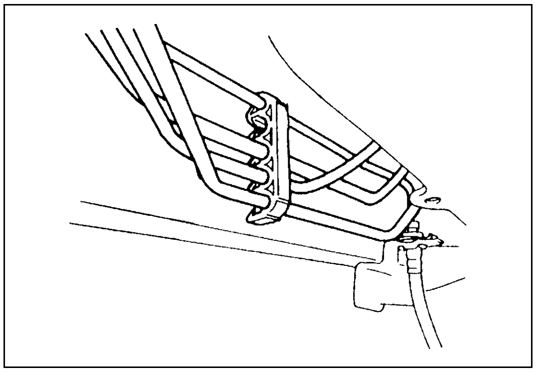
On-Vehicle Service

Before work, refer to “Precaution on Fuel System Service” in Section 6.

Fuel Lines

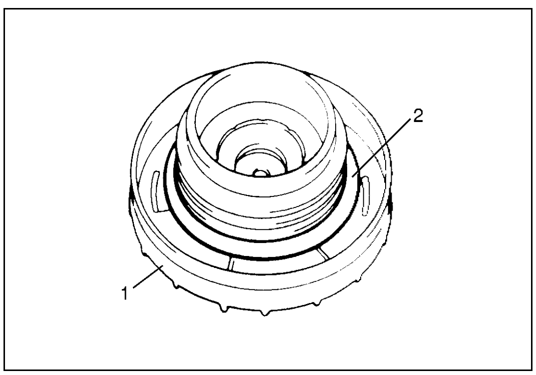
Due to the fact that fuel feed line is under high pressure, use special care when servicing it.

INSPECTION



Visually inspect fuel lines for evidence of fuel leakage, hose crack and deterioration, or damage. Make sure all clamps are secure. Replace parts as needed.

Fuel Filler Cap



Remove cap (1) and check gasket (2) for even filler neck imprint and deterioration or any damage. If gasket is in malcondition, replace cap.

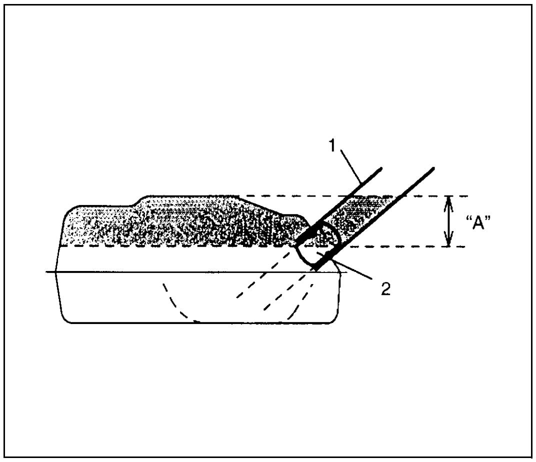
NOTE:
If cap requires replacement, only a cap with the same features should be used. Failure to use correct cap can result in critical malfunction of system.

Fuel Tank

REMOVAL

WARNING:
- **Before starting the following procedure, be sure to observe “Precaution on Fuel System Service” in Section 6.**
- **Keep fuel tank horizontally and stably when removing it. Fuel may come out if tank is tilted. Also, fuel tank may drop and cause personal injury.**

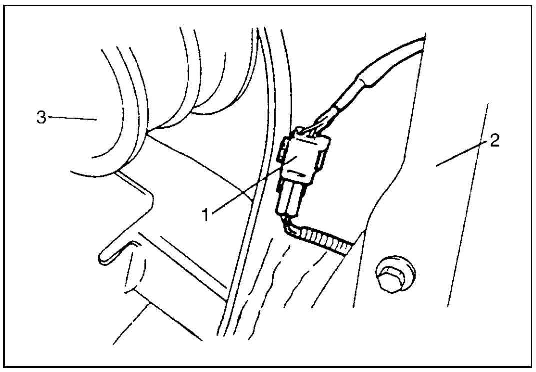
1) Relieve fuel pressure in fuel feed line referring to “Fuel Pressure Relief Procedure” in Section 6.
2) Disconnect negative cable at battery.
3) Remove fuel filler cap.



4) Insert hose of a hand operated pump into fuel filler hose (1) and drain fuel in space "A" in the figure (drain fuel through it till fuel stops).

CAUTION:
Do not force hose of a hand operated pump into fuel tank. Doing so can damage inlet valve (2).

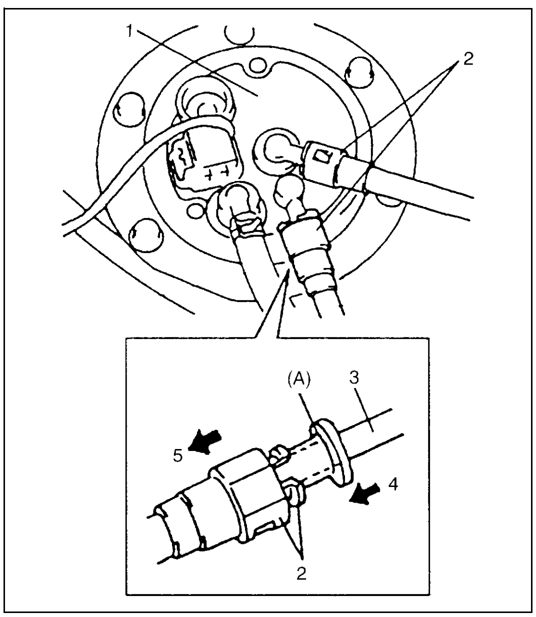
5) Hoist vehicle.
6) Remove exhaust center pipe referring to "Components" in Section 6K and rear propeller shaft referring to "Propeller Shafts" in Section 4B.



7) Disconnect coupler (1) for fuel pump assembly.
The coupler is close by left rear suspension coil spring (3).

2. Fuel tank

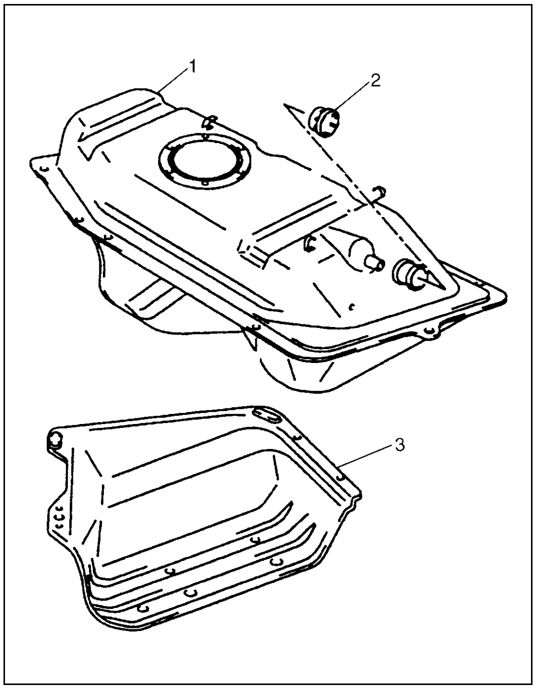
8) Remove fuel tank filler hose protector.
Disconnect filler hose and breather hose from fuel filler neck.
9) Disconnect fuel vapor hose from pipe.
10) With fuel tank supported on a jack, remove fuel tank bolts.



11) Lower fuel tank a little and hold it. Unclamp fuel hoses and disconnect them from fuel pump assembly (1).
When disconnecting joints of fuel feed line and return line from pipe, unlock joint by inserting special tool between pipe (3) and joint lock first.

Special tool
(A) : 09919-47020

2. Quick joint	5. Disconnect joint
4. Insert special tool	



12) Remove fuel tank (1) from vehicle. Remove fuel tank protector (3) and inlet valve (2) as necessary.

FUEL TANK PURGING PROCEDURE

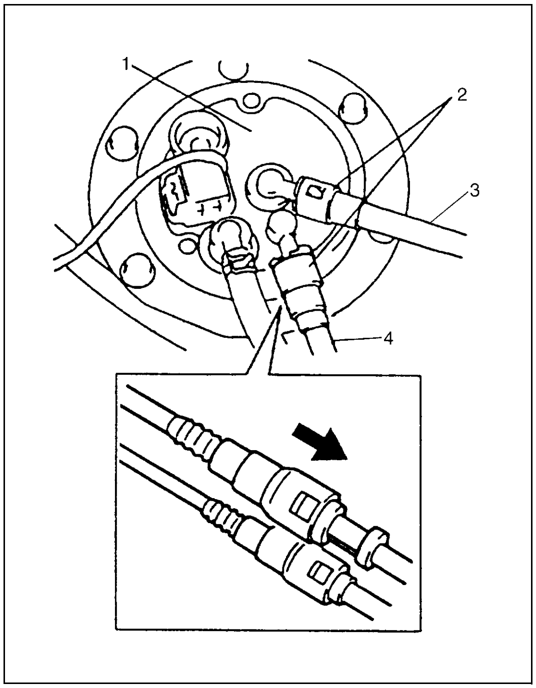
CAUTION:

This purging procedure will not remove all fuel vapor. Do not attempt any repair on tank where heat or flame is required, as an explosion resulting in personal injury could occur.

The following procedure is used for purging the fuel tank.

1) After removing fuel tank, remove all hoses and fuel pump assembly from fuel tank.
2) Drain all remaining fuel from tank.
3) Move tank to flushing area.
4) Fill tank with warm water or tap water, and agitate vigorously and drain. Repeat this washing until inside of tank is clean. Replace tank if its inside is rusty.
5) Completely flush out remaining water after washing.

INSTALLATION



1) Install fuel pump (1) assembly to fuel tank. Refer to “Fuel Pump Assembly” in this section. Install protector to fuel tank.
2) Install inlet valve to fuel tank.
   If deformed or damaged in any other way, replace with a new one.
3) Connect fuel filler and breather hoses to fuel tank and vapor hose to fuel pump assembly. Clamp them securely.
4) Lift up fuel tank on jack.
   Connect fuel feed hose (4) and return hose (3) to pipes as shown in figure and clamp them securely.

CAUTION:
When connecting joint, clean outside surfaces of pipe where joint is to be inserted, push joint into pipe till joint lock clicks and check to ensure that pipes are connected securely, or fuel leak may occur.

2. Quick joint

5) Install fuel tank to vehicle and connect wire harness coupler.
6) Connect fuel filler hose and breather hose to fuel filler neck. Connect fuel vapor hose to pipe. Clamp them securely.
7) Install fuel filler hose protector.

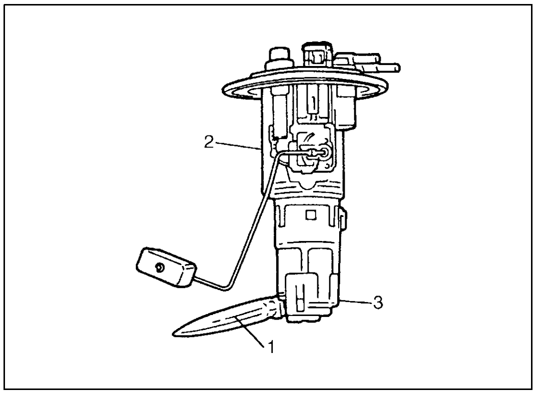
Fuel Pump Assembly

WARNING:
Before starting the following procedure, be sure to observe “Precaution on Fuel System Service” in Section 6.

REMOVAL

1) Remove fuel tank from vehicle. Refer to “Fuel Tank” in this section.
2) Disconnect wire harness coupler and fuel vapor hose from fuel pump assembly.
3) Remove fuel pump assembly from fuel tank by removing bolts.

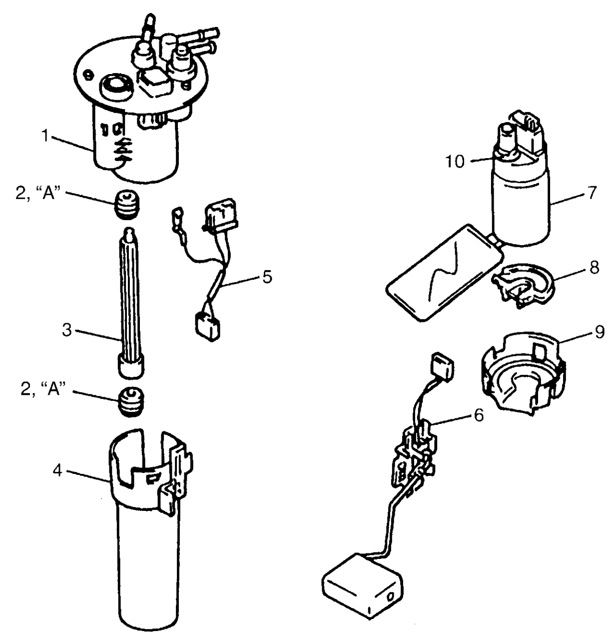
INSPECTION



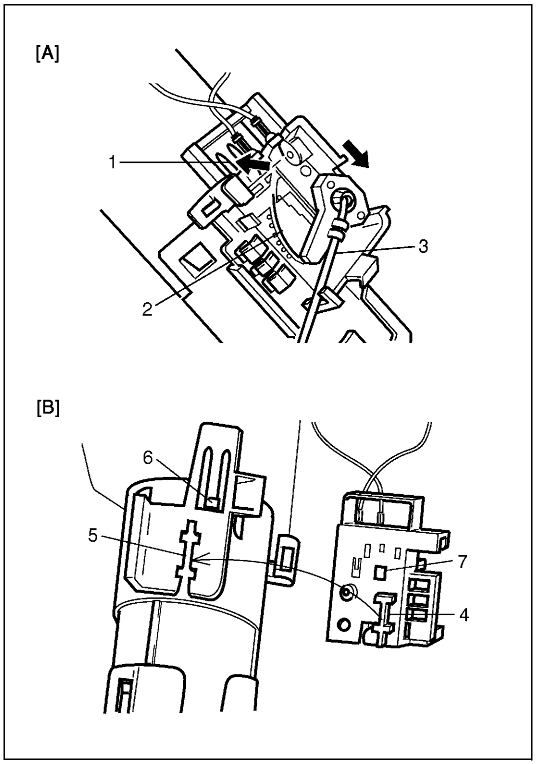
Check fuel pump assembly for damage.
Check fuel suction filter (1) for evidence of dirt and contamination. If present, replace or clean and check for presence of dirt in fuel tank.
For inspection of fuel pump itself, refer to "Table B – 3 Fuel Pressure Check" in Section 6.
For inspection of fuel level gauge, refer to "Fuel Meter / Fuel Gauge Unit" in Section 8.

2.	Fuel filter & bracket assembly
3.	Fuel pump motor & level gauge assembly

DISASSEMBLY / REASSEMBLY



"A" :	Apply oil	4.	Housing	8.	Cushion
1.	Bracket sub assembly (including fuel filter)	5.	Lead wire	9.	Bracket
2.	Grommet	6.	Fuel level gauge	10.	Spacer
3.	Tube	7.	Fuel pump		



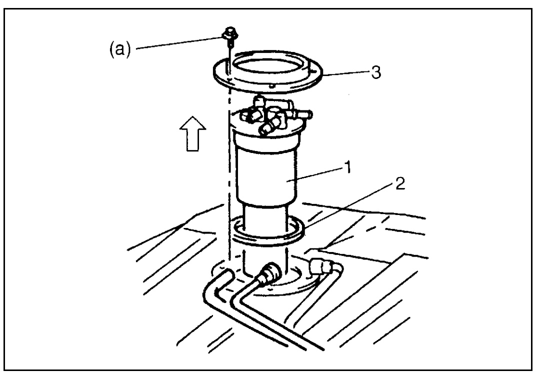
CAUTION:
- **While removing fuel level gauge, do not contact resistor plate (2) or deform arm (3). It may cause fuel level gauge to fail.**
- **When removing grommet from fuel tube or bracket sub assembly, be very careful not to cause damage to grommet installed section (sealed section in bore). Should it be damaged, replace it with new one, or fuel will leak from that part.**

NOTE:
- **When removing fuel level gauge, press snap-fit part (1) and slide it in the arrow direction as shown in figure.**
- **When installing fuel level gauge to housing, fit protrusion (4) of fuel level gauge in groove (5) in housing and slide it up till lug (6) fits in window (7) securely. Refer to figure shown.**

[A] :	Removal
[B] :	Installation

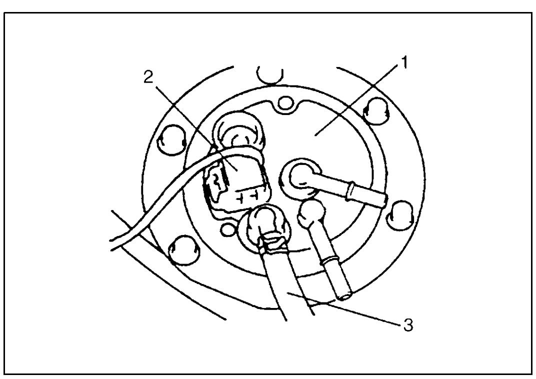
INSTALLATION

1) Clean mating surfaces of fuel pump assembly and fuel tank.



2) Install new gasket (2) and plate (3) to fuel pump assembly (1) then install fuel pump assembly to fuel tank.

Tightening torque
Fuel pump assembly bolts (a) : 10 N·m (1.0 kg-m, 7.5 lb-ft)



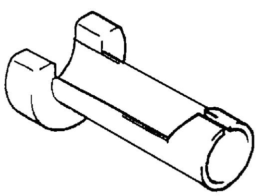
3) Connect wire harness coupler (2) and fuel vapor hose (3) to fuel pump assembly (1).

4) Install fuel tank to vehicle. Refer to “Fuel Tank” in this section.

Tightening Torque Specification

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
Fuel pump assembly bolt	10	1.0	7.5

Special Tool



09919-47020
Quick joint remover

SECTION 6E

ENGINE AND EMISSION CONTROL SYSTEM

WARNING:

For vehicles equipped with Supplemental Restraint (Air Bag) System:

- **Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to "Air Bag System Components and Wiring Location View" under "General Description" in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and "Service Precautions" under "On-Vehicle Service" in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.**
- **Technical service work must be started at least 90 seconds after the ignition switch is turned to the "LOCK" position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).**

NOTE:

Whether following systems (parts) are used in the particular vehicle or not depends on specifications. Be sure to bear this in mind when performing service work.

- **EGR valve**
- **Heated oxygen sensor (s) or CO adjusting resistor**
- **Three way catalytic converter (TWC) and warm up three-way catalytic converter (WU-TWC)**

CONTENTS

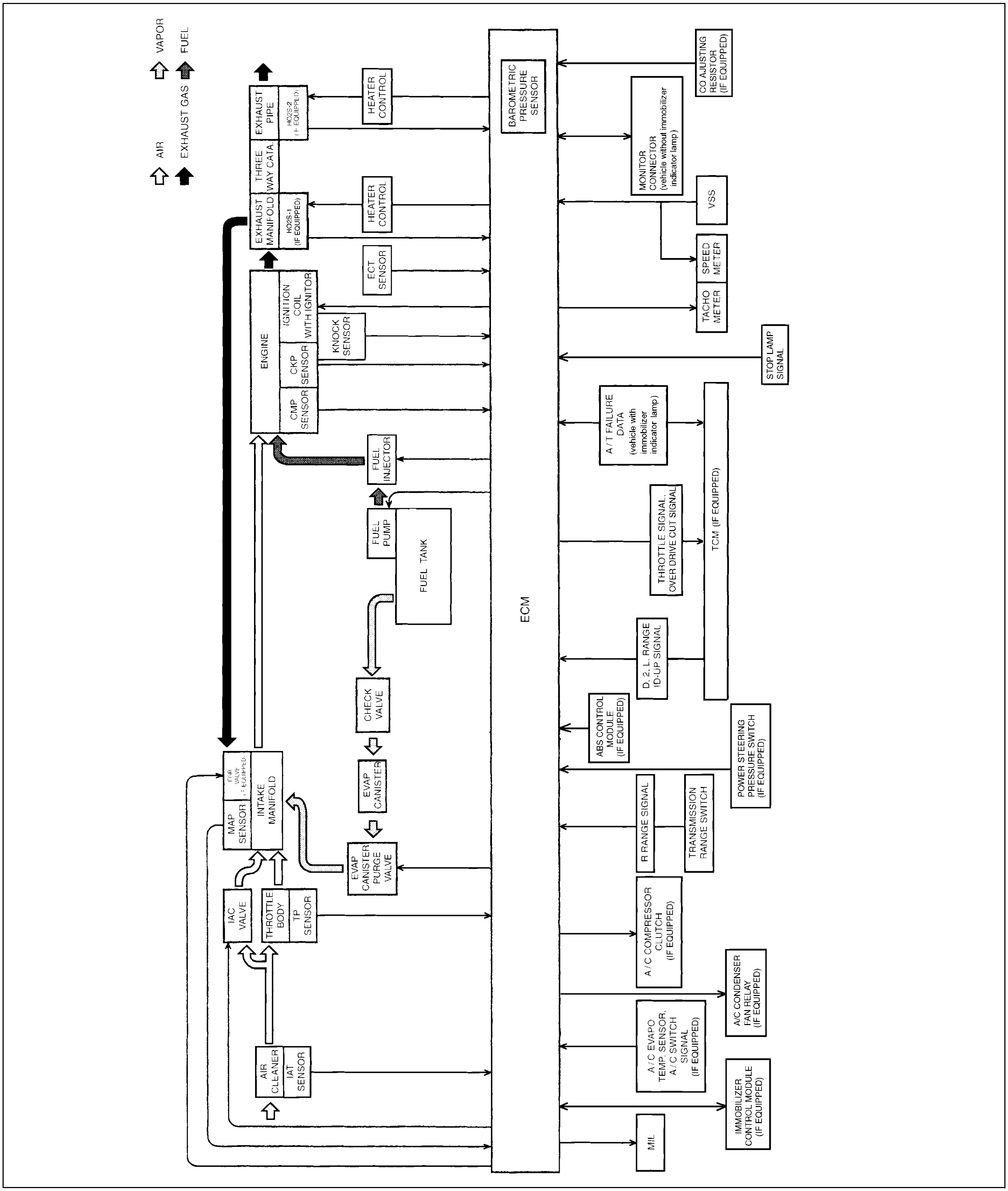
General Description

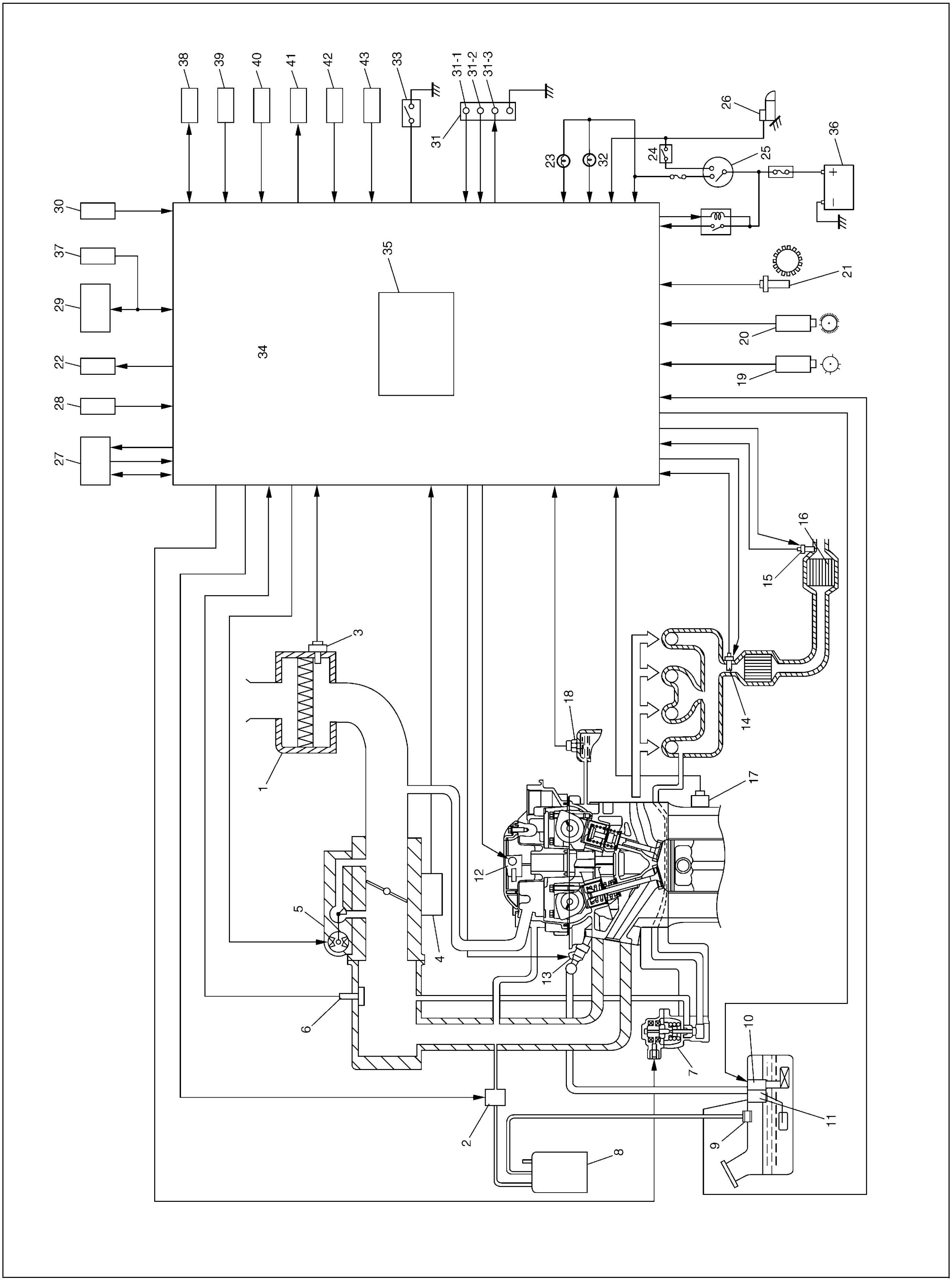
The engine and emission control system is divided into 4 major sub-systems: air intake system, fuel delivery system, electronic control system and emission control system.

Air intake system includes air cleaner, throttle body, IAC valve and intake manifold.

Fuel delivery system includes fuel pump, delivery pipe, fuel pressure regulator, etc. Electronic control system includes ECM, various sensors and controlled devices.

Emission control system includes EGR, EVAP and PCV system.





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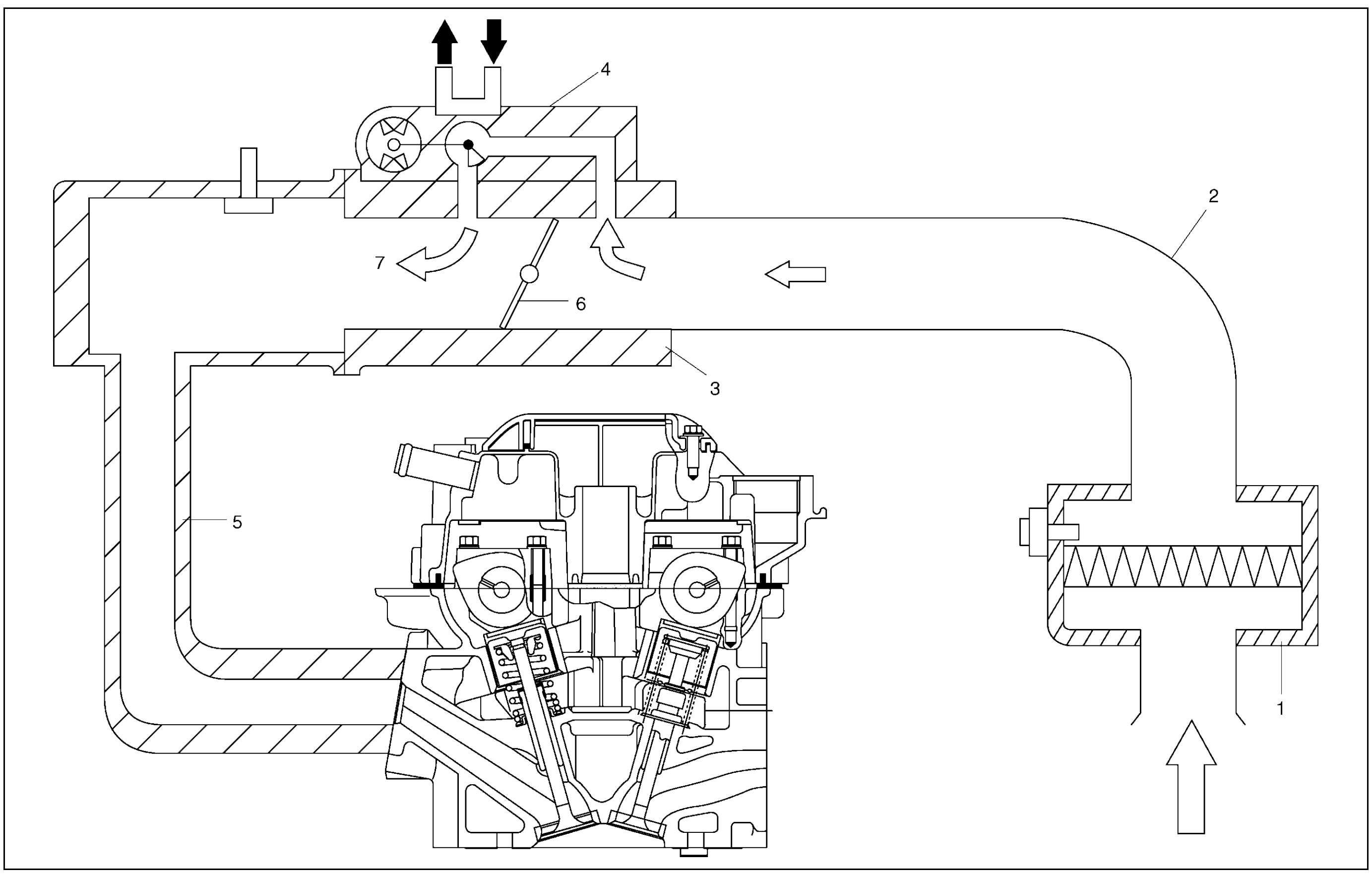
1. Air Cleaner	17. Knock sensor	31-2. Test switch terminal (vehicle w/o immobilizer indicator lamp)
2. EVAP canister purge valve	18. ECT sensor	31-3. Duty output terminal (vehicle w/o immobilizer indicator lamp)
3. IAT sensor	19. CMP sensor	32. Immobilizer indicator lamp (if equipped)
4. TP sensor	20. CKP sensor	33. Stop lamp switch
5. IAC valve	21. VSS	34. ECM
6. MAP sensor	22. A/C condenser fan (if equipped)	35. Barometric pressure sensor (vehicle with immobilizer indicator lamp)
7. EGR valve (if equipped)	23. Malfunction indicator lamp in combination meter	36. Battery
8. EVAP canister	24. Park/Neutral position switch in TR switch (A/T)	37. Immobilizer control module (if equipped)
9. Tank pressure control valve (built-in fuel pump)	25. Ignition switch	38. ABS control module (if equipped)
10. Fuel pump	26. Starter magnetic switch	39. CO adjusting resistor (if equipped)
11. Fuel level sensor	27. TCM (A/T)	40. Power steering pressure switch (if equipped)
12. Ignition coil assembly	28. Transmission range switch (A/T)	41. A/C compressor clutch (if equipped)
13. Fuel injector	29. DLC	42. A/C EVAP TEMP. sensor (if equipped)
14. Heated Oxygen Sensor (HO2S)-1 (if equipped)	30. Electric load	43. A/C switch (if equipped)
15. Heated Oxygen Sensor (HO2S)-2 (if equipped)	31. Monitor connector (if equipped)	
16. Three way catalytic convertor (if equipped)	31-1. Diagnosis switch terminal (vehicle w/o immobilizer indicator lamp)	

Air Intake System

The main components of the air intake system are air cleaner (1), air cleaner outlet hose (2), throttle body (3), idle air control valve (4) and intake manifold (5).

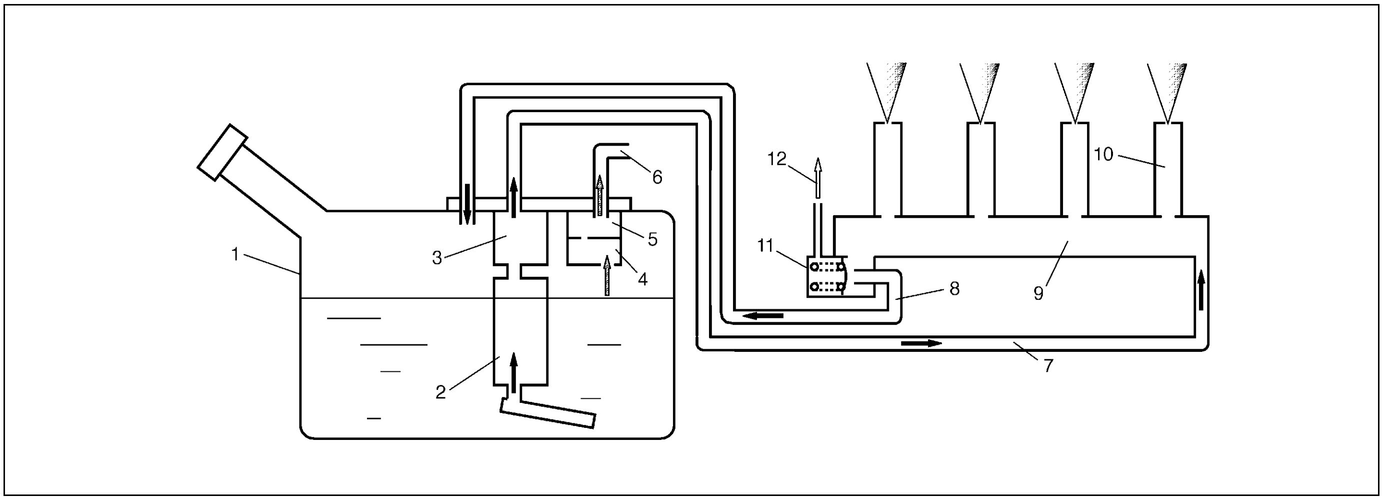
The air (by the amount corresponding to the throttle valve (6) opening and engine speed) is filtered by the air cleaner (1), passes through the throttle body (3), is distributed by the intake manifold (5) and finally drawn into each combustion chamber.

When the idle air control valve (4) is opened according to the signal from ECM, the air (7) bypasses the throttle valve (6) through bypass passage and is finally drawn into the intake manifold (5).



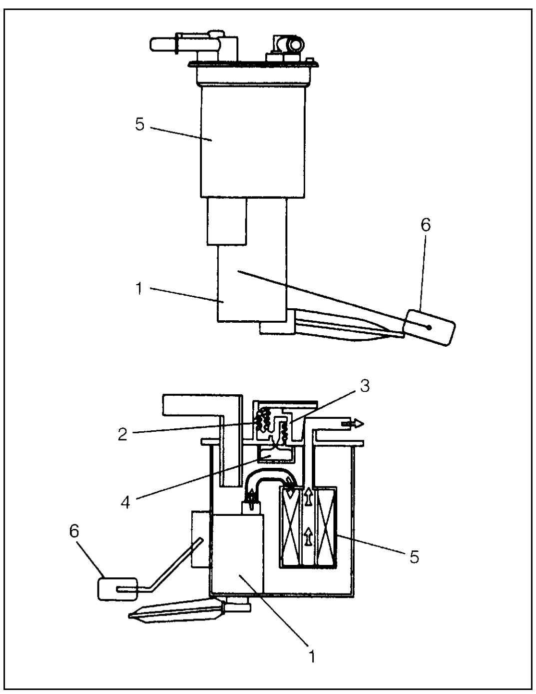
Fuel Delivery System

The fuel delivery system consists of the fuel tank (1), fuel pump (2), fuel filter (3), fuel pressure regulator (11), delivery pipe (9) and fuel injectors (10).
The fuel in the fuel tank is pumped up by the fuel pump, filtered by the fuel filter and fed under pressure to each injector through the delivery pipe.
As the fuel pressure applied to the injector (the fuel pressure in the fuel feed line) is always kept a certain amount higher than the pressure in the intake manifold by the fuel pressure regulator, the fuel is injected into the intake port of the cylinder head when the injector open according to the injection signal from ECM.
The fuel relieved by the fuel pressure regulator returns through the fuel return line (8) to the fuel tank.



4. Fuel cut valve	6. To EVAP canister	12. To intake manifold (vacuum passage)
5. Fuel tank pressure control valve	7. Fuel feed line	

Fuel pump



An in-tank type electric pump has been adopted for the fuel pump (1). Incorporated in the pump assembly are;

- Tank pressure control valve (2) which keeps the pressure in the fuel tank constant, and prevents the fuel from spouting and tank itself from being deformed.
- Relief valve (3) which prevents the pressure in tank from rising excessively.
- Fuel cut valve (4) which closes as the float rises so that the fuel will not enter the canister when the fuel level in the tank rises high depending on the fuel level in the tank and the vehicle tilt angle.

Also, a fuel filter (5) is included and a fuel level gauge (6) is attached.

Electronic Control System

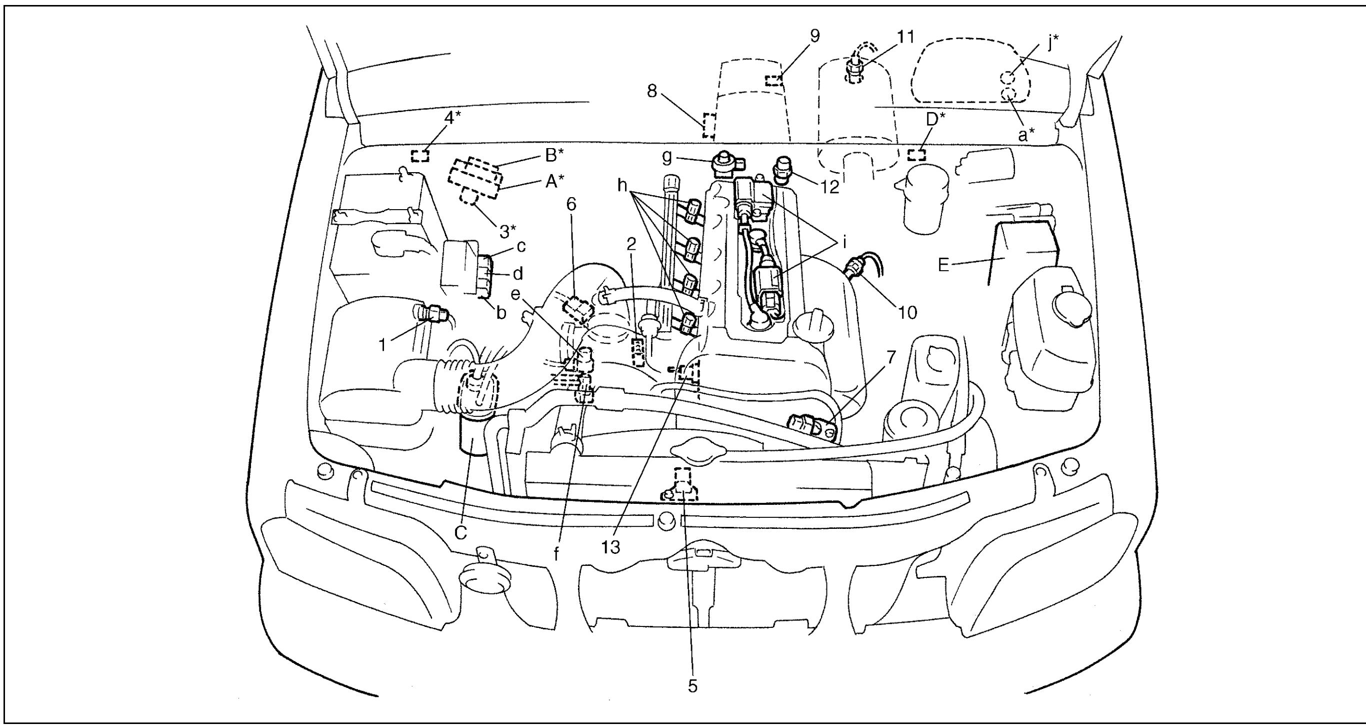
The electronic control system consists of 1) various sensors which detect the state of engine and driving conditions, 2) ECM which controls various devices according to the signals from the sensors and 3) various controlled devices.
Functionally, it is divided into the following sub systems:

- Fuel injection control system
- Idle speed control system
- Fuel pump control system
- A/C control system (if equipped)
- A/C condenser fan control system
- EGR system (if equipped)
- Evaporative emission control system
- Oxygen sensor heater control system
- Ignition control system

Also, with A/T model, ECM sends throttle valve opening signal and over drive cut signal to transmission control module to control A/T.

NOTE:

The figure shows left-hand steering vehicle. For right-hand steering vehicle, parts with (*) are installed at the other side.



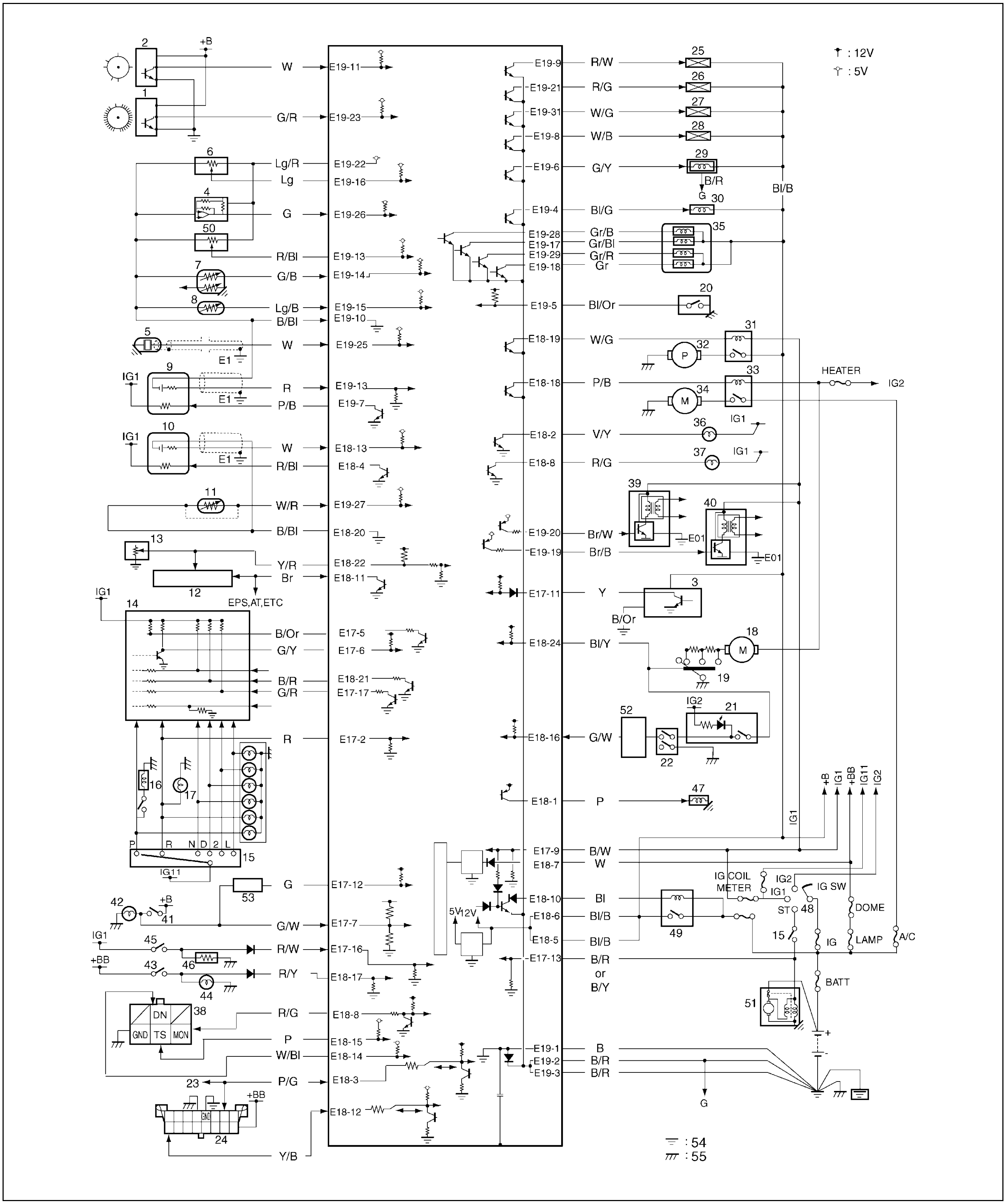
1.	IAT sensor	a :	Immobilizer indicator lamp (if equipped)	A :	ECM
2.	TP sensor	b :	A/C condenser fan motor relay (if equipped)	B :	A/T control module
3.	Monitor connector	c :	Main relay	C :	EVAP canister
4.	CO adjusting resistor (if equipped)	d :	Fuel pump relay	D :	DLC
5.	CKP sensor	e :	IAC valve	E :	ABS control module (if equipped)
6.	MAP sensor	f :	EVAP canister purge valve		
7.	CMP sensor	g :	EGR valve (if equipped)		
8.	Transmission range switch	h :	Fuel injector		
9.	VSS	i :	Ignition coil assemblies		
10.	HO2S-1 (if equipped)	J :	MIL		
11.	HO2S-2 (if equipped)				
12.	ECT sensor				
13.	Knock sensor				

Engine & emission control input / output table

	OUTPUT / INPUT	ELECTRIC CONTROL DEVICE											
		FUEL PUMP RELAY	FUEL INJECTOR	HO2S HEATER	IAC VALVE	IGNITION COIL WITH IGNITER	EGR VALVE (IF EQUIPPED)	EVAP CANISTER PURGE VALVE	A/C COMPRESSOR CLUTCH	A/C CONDENSER FAN RELAY	MIL	MAIN RELAY	TRANSMISSION CONTROL MODULE
SIGNAL FROM SENSOR, SWITCH AND CONTROL MODULE	DIAGNOSIS SWITCH TERMINAL (VEHICLE WITHOUT IMMOBILIZER INDICATOR LAMP)										○		
	BAROMETRIC PRESSURE SENSOR (VEHICLE WITH IMMOBILIZER INDICATOR LAMP)		○		○						○		○
	STOP LAMP SWITCH				○								
	STARTER SWITCH	○	○		○				○		○		
	IGNITION SWITCH	○	○	○	○	○	○	○	○	○		○	○
	LIGHTING SWITCH				○								
	REAR DEFOGGER SWITCH (IF EQUIPPED)				○								
	BLOWER SWITCH				○								
	A/C SWITCH (IF EQUIPPED)				○				○	○			
	A/C EVAPORATOR TEMP. SENSOR (IF EQUIPPED)				○				○				
	VSS				○				○	○	○		○
	HEATED OXYGEN SENSOR-1 (IF EQUIPPED)		○					○			○		
	HEATED OXYGEN SENSOR-2 (IF EQUIPPED)	For detecting deterioration of three way catalytic converter									○		
	IAT SENSOR		○		○	○	○	○	○		○		
	ECT SENSOR		○	○	○	○	○	○	○	○	○		○
	TP SENSOR		○		○	○			○		○		○
	MAP SENSOR		○	○	○	○	○	○	○		○		
	CMP SENSOR	○	○	○	○	○	○	○	○		○		
	CKP SENSOR	○	○	○	○	○	○	○	○		○		
	TEST SWITCH TERMINAL (VEHICLE WITHOUT IMMOBILIZER INDICATOR LAMP)					○							
	KNOCK SENSOR					○					○		

ECM INPUT / OUTPUT CIRCUIT DIAGRAM

For TYPE A (See NOTE)



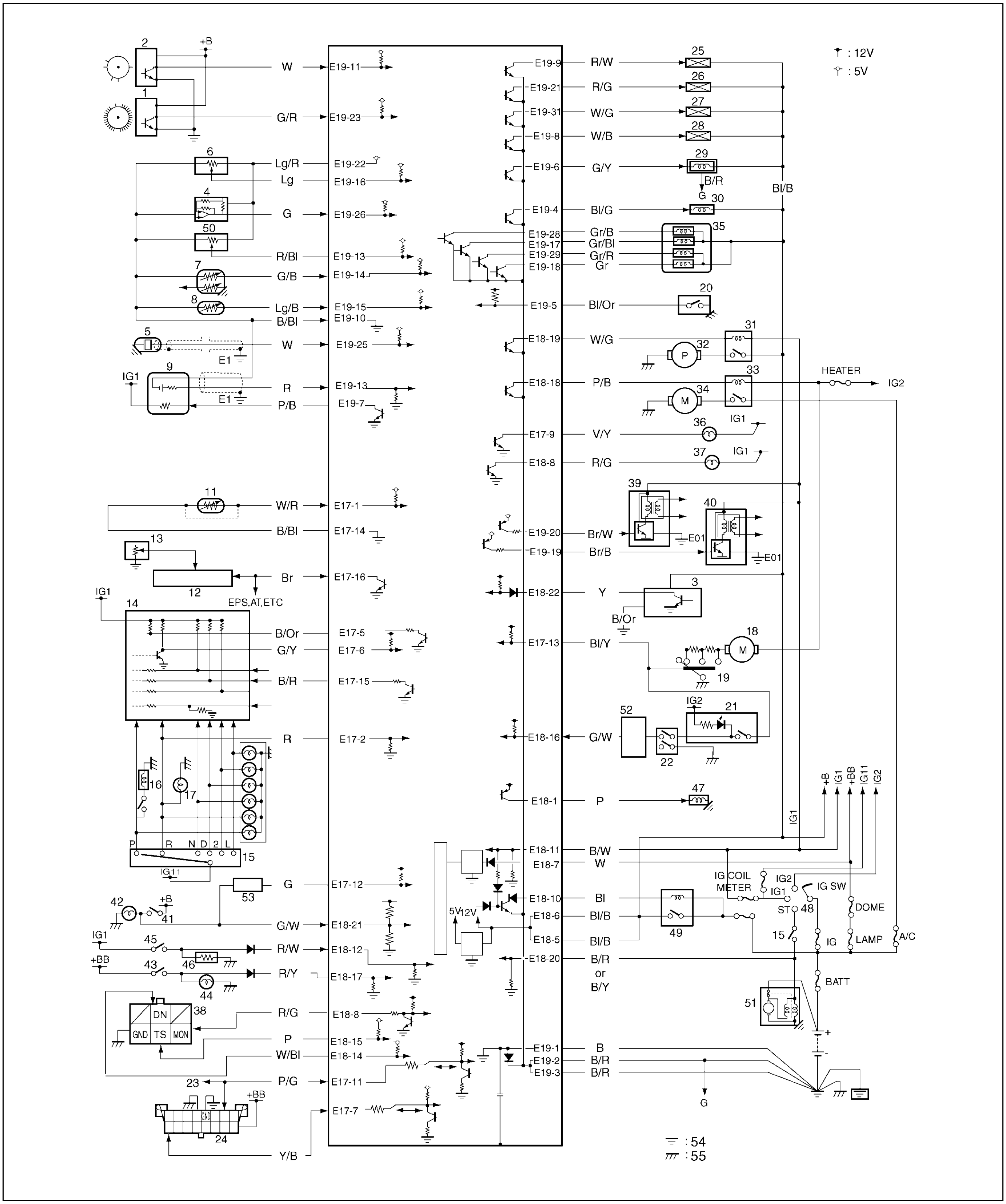
NOTE:

Type A is other than follows.

Type B is left hand steering vehicle equipped with fasten seat belt light and EGR valve or right hand steering vehicle equipped with fasten seat belt light and immobilizer control system.

1. CKP sensor	20. Power steering pressure switch (if equipped)	39. Ignition coil assembly (for No.1 and No.4 spark plugs)
2. CMP sensor	21. A/C switch	40. Ignition coil assembly (for No.2 and No.3 spark plugs)
3. VSS	22. A/C refrigerant pressure switch (if equipped)	41. Stop lamp switch
4. MAP sensor	23. Immobilizer control module (if equipped)	42. Stop lamp
5. Knock sensor	24. Data link connector	43. Lighting switch
6. TP sensor	25. Injector No.1	44. Position lamp
7. ECT sensor	26. Injector No.2	45. Rear defogger switch (if equipped)
8. IAT sensor	27. Injector No.3	46. Rear defogger (if equipped)
9. Heated oxygen sensor-1 (if equipped)	28. Injector No.4	47. A/C compressor clutch (if equipped)
10. Heated oxygen sensor-2 (if equipped)	29. IAC valve	48. Ignition switch
11. A/C evaporator temp. sensor (if equipped)	30. EVAP canister purge valve	49. Main relay
12. Speedometer	31. Fuel pump relay	50. CO adjusting register (if equipped)
13. Fuel level sensor	32. Fuel pump	51. Starting motor
14. TCM (A/T)	33. A/C condenser fan relay (if equipped)	52. 4WD controller (4WD)
15. Transmission range switch (A/T)	34. A/C condenser fan motor (if equipped)	53. ABS control module (if equipped)
16. Shift lock solenoid (A/T, if equipped)	35. EGR valve (if equipped)	54. Engine ground
17. Backup lamp	36. Malfunction indicator lamp	55. Body ground
18. Heater fan motor	37. Immobilizer indicator lamp (if equipped)	
19. Heater fan switch	38. Monitor connector (vehicle without immobilizer indicator lamp)	

For TYPE B (See NOTE)



NOTE:

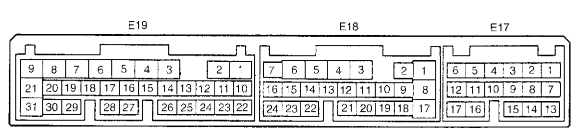
See NOTE in “ECM INPUT / OUTPUT CIRCUIT DIAGRAM” for applicable model.

1. CKP sensor	20. Power steering pressure switch (if equipped)	39. Ignition coil assembly (for No.1 and No.4 spark plugs)
2. CMP sensor	21. A/C switch	40. Ignition coil assembly (for No.2 and No.3 spark plugs)
3. VSS	22. A/C refrigerant pressure switch (if equipped)	41. Stop lamp switch
4. MAP sensor	23. Immobilizer control module (if equipped)	42. Stop lamp
5. Knock sensor	24. Data link connector	43. Lighting switch
6. TP sensor	25. Injector No.1	44. Position lamp
7. ECT sensor	26. Injector No.2	45. Rear defogger switch (if equipped)
8. IAT sensor	27. Injector No.3	46. Rear defogger (if equipped)
9. Heated oxygen sensor-1 (if equipped)	28. Injector No.4	47. A/C compressor clutch (if equipped)
10. Heated oxygen sensor-2 (if equipped)	29. IAC valve	48. Ignition switch
11. A/C evaporator temp. sensor (if equipped)	30. EVAP canister purge valve	49. Main relay
12. Speedometer	31. Fuel pump relay	50. CO adjusting register (if equipped)
13. Fuel level sensor	32. Fuel pump	51. Starting motor
14. TCM (A/T)	33. A/C condenser fan relay (if equipped)	52. 4WD controller (4WD)
15. Transmission range switch (A/T)	34. A/C condenser fan motor (if equipped)	53. ABS control module (if equipped)
16. Shift lock solenoid (A/T, if equipped)	35. EGR valve (if equipped)	54. Engine ground
17. Backup lamp	36. Malfunction indicator lamp	55. Body ground
18. Heater fan motor	37. Immobilizer indicator lamp (if equipped)	
19. Heater fan switch	38. Monitor connector (vehicle without immobilizer indicator lamp)	

ECM TERMINAL ARRANGEMENT TABLE

For TYPE A (See NOTE)

CONNEC-TOR	TERMINAL	WIRE COLOR	CIRCUIT	CONNEC-TOR	TERMINAL	WIRE COLOR	CIRCUIT
E19	1	B	Ground for ECM	E18	7	W	Backup power source
	2	B/R	Ground for drive circuit		8	R/G	Immobilizer indicator lamp (if equipped)
	3	B/R	Ground for drive circuit				Duty output terminal (vehicle without immobilizer indicator lamp)
	4	Bl/G	Canister purge valve		9	–	–
	5	Bl/Or	Power steering pressure switch (if equipped)		10	Bl	Main relay
	6	G/Y	IAC valve		11	Br	Tachometer
	7	P/B	Heater of HO2S-1 (if equipped)		12	Y/B	Data link connector (5 V)
	8	W/B	No.4 fuel injector		13	W	Heated oxygen sensor-2 (if equipped)
	9	R/W	No.1 fuel injector		14	W/Bl	Diagnosis switch terminal (vehicle without immobilizer indicator lamp)
	10	B/Bl	Ground for sensor circuit		15	P	Test switch terminal (vehicle without immobilizer indicator lamp)
	11	W	CMP sensor		16	G/W	A/C SW signal (if equipped)
	12	–	–		17	R/Y	Lighting switch
	13	R R/Bl	Heated oxygen sensor-1 (if equipped) CO adjusting resistor (w/o HO2S)		18	P/B	A/C condenser fan relay (if equipped)
	14	G/B	ECT sensor		19	W/G	Fuel pump relay
	15	Lg/B	IAT sensor		20	B/Bl	Ground for sensor
	16	Lg	TP sensor		21	B/R	Throttle opening signal output for A/T (A/T)
	17	Gr/Bl	EGR valve (stepper motor coil 3, if equipped)		22	Y/R	Fuel level gauge (vehicle with immobilizer indicator lamp)
	18	Gr	EGR valve (stepper motor coil 1, if equipped)		23	–	–
	19	Br/B	IG coil assembly for No.2 and 3 spark plugs		24	Bl/Y	Heater blower switch
	20	Br/W	IG coil assembly for No.1 and 4 spark plugs				
	21	R/G	No.2 fuel injector	E17	1	–	–
	22	Lg/R	Power supply for sensor		2	R	R-range signal (A/T)
	23	G/R	CKP sensor		3	–	–
	24	–	–		4	–	–
	25	W	Knock sensor		5	B/Or	Overdrive cut signal (A/T)
	26	G	MAP sensor		6	G/Y	D-range idle-up signal (A/T)
	27	W/R	A/C evaporator temp. sensor		7	G/W	Stop lamp switch
	28	Gr/B	EGR valve (stepper motor coil 4, if equipped)		8	–	–
	29	Gr/R	EGR valve (stepper motor coil 2, if equipped)		9	B/W	Ignition switch
	30	–	–		10	–	–
	31	W/G	No.3 fuel injector		11	Y	Vehicle speed sensor
					12	G	ABS signal (if equipped)
E18	1	P	A/C compressor clutch (if equipped)		13	B/Y (M/T) B/R (A/T)	Engine start signal
	2	V/Y	Malfunction indicator lamp		14	–	–
	3	P/G	Data link connector (12 V)		15	–	–
	4	R/Bl	Heater of HO2S-2 (if equipped)		16	R/W	Rear defogger switch (if equipped)
	5	Bl/B	Power source		17	G/R	A/T failure signal (A/T) (vehicle with immobilizer indicator lamp)
	6	Bl/B	Power source				

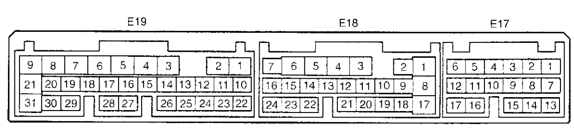


NOTE:

See NOTE in “ECM INPUT / OUTPUT CIRCUIT DIAGRAM” for applicable model.

For TYPE B (See NOTE)

CONNECTOR	TERMINAL	WIRE COLOR	CIRCUIT
E19	1	B	Ground for ECM
	2	B/R	Ground for drive circuit
	3	B/R	Ground for drive circuit
	4	Bl/G	Canister purge valve
	5	Bl/Or	Power steering pressure switch (if equipped)
	6	G/Y	IAC valve
	7	P/B	Heater of HO2S-1 (if equipped)
	8	W/B	No.4 fuel injector
	9	R/W	No.1 fuel injector
	10	B/Bl	Ground for sensor circuit
	11	W	CMP sensor
	12	–	–
	13	R R/Bl	Heated oxygen sensor-1 (if equipped) CO adjusting resistor (w/o HO2S)
	14	G/B	ECT sensor
	15	Lg/B	IAT sensor
	16	Lg	TP sensor
	17	Gr/Bl	EGR valve (stepper motor coil 3, if equipped)
	18	Gr	EGR valve (stepper motor coil 1, if equipped)
	19	Br/B	IG coil assembly for No.2 and 3 spark plugs
	20	Br/W	IG coil assembly for No.1 and 4 spark plugs
	21	R/G	No.2 fuel injector
	22	Lg/R	Power supply for sensor
	23	G/R	CKP sensor
	24	–	–
	25	W	Knock sensor
	26	G	MAP sensor
	27	–	–
	28	Gr/B	EGR valve (stepper motor coil 4, if equipped)
	29	Gr/R	EGR valve (stepper motor coil 2, if equipped)
	30	–	–
	31	W/G	No.3 fuel injector
E18	1	P	A/C compressor clutch (if equipped)
	2	–	–
	3	–	–
	4	R/Bl	Heater of HO2S-2 (if equipped)
	5	Bl/B	Power source
	6	Bl/B	Power source
	7	W	Backup power source
	8	R/G	Immobilizer indicator lamp (if equipped) Duty output terminal (vehicle without immobilizer indicator lamp)
	9	–	–
	10	Bl	Main relay
	11	B/W	Ignition switch
	12	R/W	Rear defogger switch
	13	–	–
	14	W/Bl	Diagnosis switch terminal (vehicle without immobilizer indicator lamp)
	15	P	Test switch terminal (vehicle without immobilizer indicator lamp)
	16	G/W	A/C SW signal (if equipped)
	17	R/Y	Lighting switch
	18	P/B	A/C condenser fan relay (if equipped)
	19	W/G	Fuel pump relay
	20	B/Y (M/T) B/R (A/T)	Engine start signal
	21	G/W	Stop lamp switch
	22	Y	Vehicle speed sensor
	23	–	–
	24	–	–
E17	1	W/R	A/C evaporator temp. sensor
	2	R	R-range signal (A/T)
	3	–	–
	4	–	–
	5	B/Or	Overdrive cut signal (A/T)
	6	G/Y	D-range idle-up signal (A/T)
	7	Y/B	Data link connector
	8	–	–
	9	V/Y	Malfunction indicator lamp
	10	–	–
	11	P/G	Data link connector (12 V)
	12	G	ABS signal (if equipped)
	13	Bl/Y	Heater blower switch
	14	B/Bl	Ground for sensor
	15	B/R	Throttle opening sensor
	16	Br	Tachometer
	17	–	–

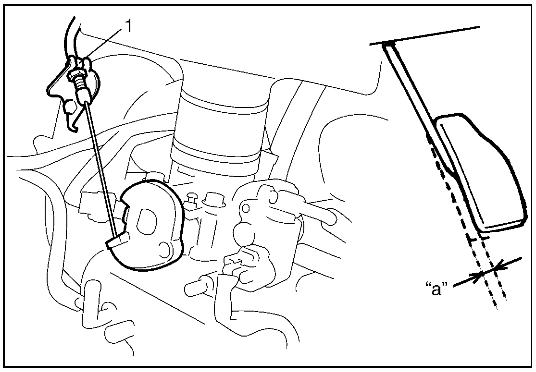


NOTE:

See NOTE in "ECM INPUT / OUTPUT CIRCUIT DIAGRAM" for applicable model.

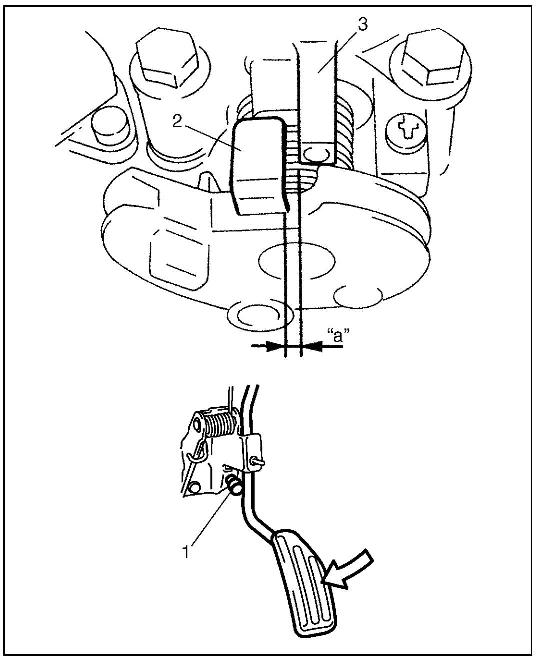
On-Vehicle Service

Accelerator cable adjustment



1) With throttle valve closed, check accelerator pedal play which should be within following specification.
   If measured value is out of specification, adjust it to specification with cable adjusting nut (1).

Accelerator pedal play
"a" : 2 – 7 mm (0.08 – 0.27 in.)



2) With accelerator pedal depressed fully, check clearance between throttle lever (2) and lever stopper (3) (throttle body) which should be within following specification.
   If measured value is out of specification, adjust it to specification by changing height of pedal stopper bolt (1).

Accelerator cable adjustment clearance
(With pedal depressed fully)
"a" : 0.5 – 2.0 mm (0.02 – 0.07 in.)

Idle speed / idle air control (IAC) duty inspection

Before idle speed / IAC duty check, make sure of the following.

- Lead wires and hoses of Electronic Fuel Injection and engine emission control systems are connected securely.
- Accelerator cable has some play, that is, it is not tight.
- Valve lash is checked and adjusted according to maintenance schedule.
- Ignition timing is within specification.
- All accessories (wipers, heater, lights, A/C, etc.) are out of service.
- Air cleaner has been properly installed and is in good condition.
- No abnormal air inhaling from air intake system.

After above items are all confirmed, check idle speed and IAC duty as follows.

NOTE:

Before starting engine, place transmission gear shift lever in "Neutral" (shift selector lever to "P" range for A/T vehicle), and set parking brake and block drive wheels.

1) Connect SUZUKI scan tool to DLC with ignition switch OFF, if it is available.
2) Warm up engine to normal operating temperature.
3) Check engine idle speed and “IAC duty” as follows:
   a) When using SUZUKI scan tool:
      i) Select “Data List” mode on scan tool to check “IAC duty”.

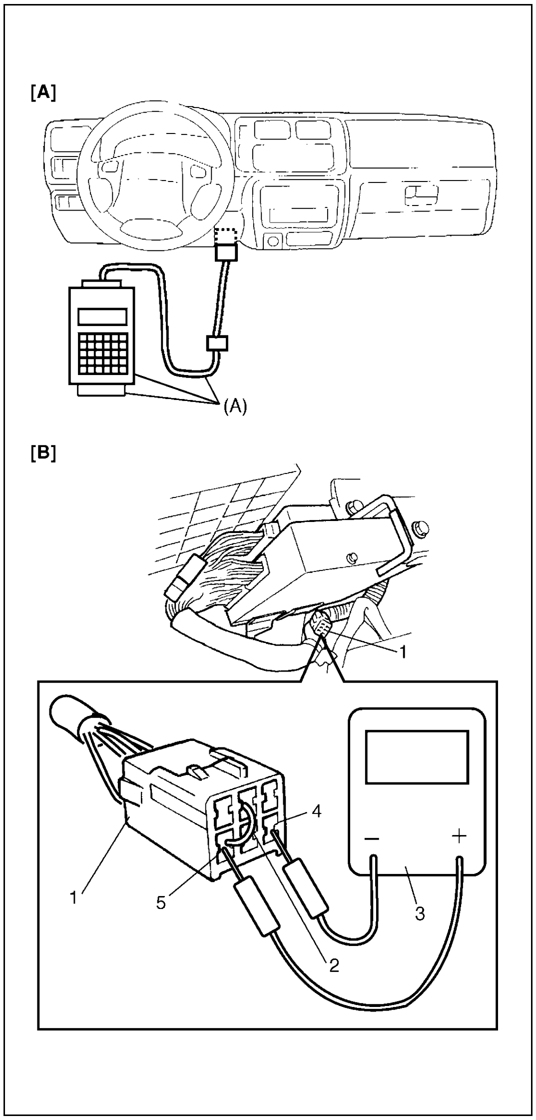
(A) : SUZUKI scan tool

   b) When using duty meter (3) (Vehicle without immobilizer indicator lamp):

NOTE:

IAC duty can be checked using monitor connector only for vehicle not equipped with immobilizer indicator lamp.

      i) Set tachometer.
      ii) Using service wire (2), ground “Diag. switch terminal” in monitor connector (1) and connect duty meter between “Duty output terminal (4)” and “Ground terminal (5)” of monitor connector (1).



[A] :	When using SUZUKI scan tool
[B] :	When using duty meter (Vehicle without immobilizer indicator lamp)

4) If duty and/or idle speed is out of specifications, inspect idle air control system referring to “Diagnostic Flow Table B-4 Idle Air Control System Check” in Section 6.

Engine idle speed and IAC duty

	A/C OFF	A/C ON
M/T vehicle	**700 ± 50 r/min (rpm) 5 – 25 %**	**900 ± 50 r/min (rpm)**
A/T vehicle at P/N range	**750 ± 50 r/min (rpm) 5 – 25 %**	**900 ± 50 r/min (rpm)**

NOTE:

Above duty values are ON duty (low voltage rate) meter indications.

5) Remove service wire from monitor connector.
6) Check that specified engine idle speed is obtained with A/C ON if vehicle is equipped with A/C.
   If not, check A/C ON signal circuit and idle air control system.

Idle mixture inspection / adjustment (vehicle without heated oxygen sensor)

All vehicles not equipped with heated oxygen sensor are shipped with their CO % factory adjusted as follows.

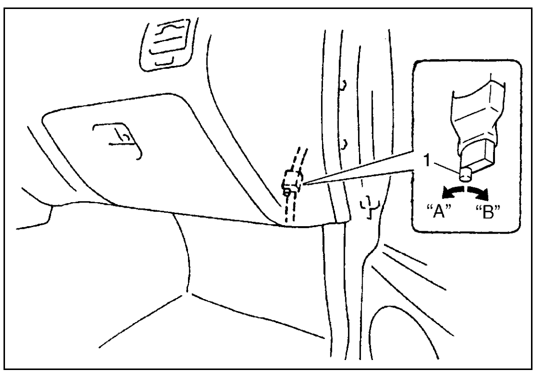
Engine idle mixture (CO %)
0.5 – 1.5 % at specified idle speed

Idle mixture adjustment should never be changed from the original factory setting. However, if during diagnosis, the check indicates idle mixture to be the cause of a driver performance complaint or emission failure, the idle mixture can be adjusted using the following procedures.

NOTE:

For this inspection and adjustment, exhaust gas tester (CO meter) and engine tachometer are necessary.

1) Check idle speed according to “Idle Speed / Idle Air Control (IAC) Duty Inspection” in this section.



2) Using exhaust gas tester, check that idle mixture CO % is within above specification. If it is out of specification, adjust it to specification by turning resistor knob.

NOTE:

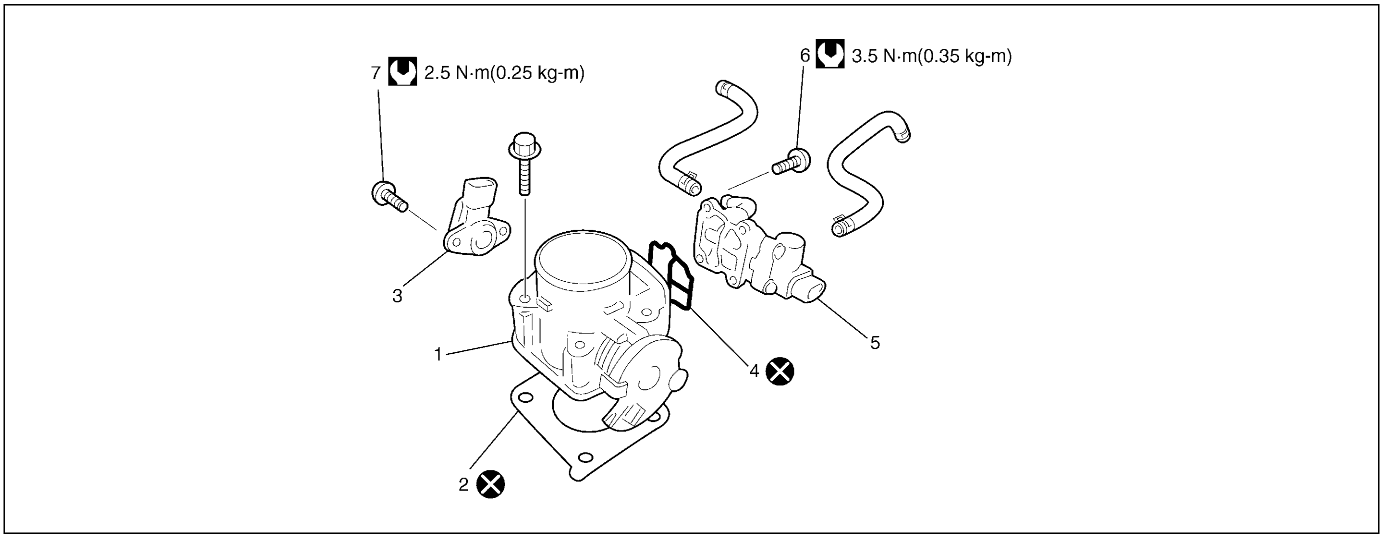
CO adjusting resistor knob to “A” increases CO % (A/F mixture becomes rich) and turning it to “B” decreases CO % (A/F mixture becomes lean).

1. CO adjusting resistor

3) If idle mixture has been adjusted, confirm that idle speed is within specification.

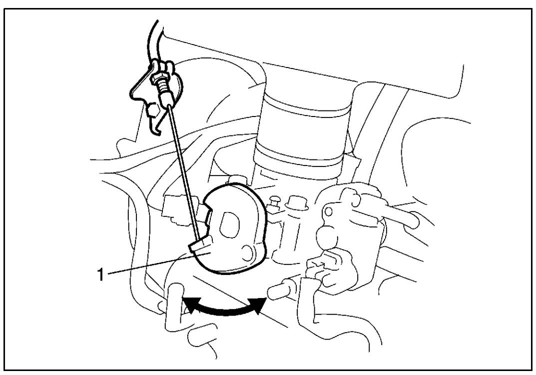
Air Intake System

Throttle body



1. Throttle body	4. Gasket	7. TP sensor screws
2. Throttle body gasket	5. Idle air control valve	Tightening torque
3. TP sensor	6. IAC valve screws	Do not reuse

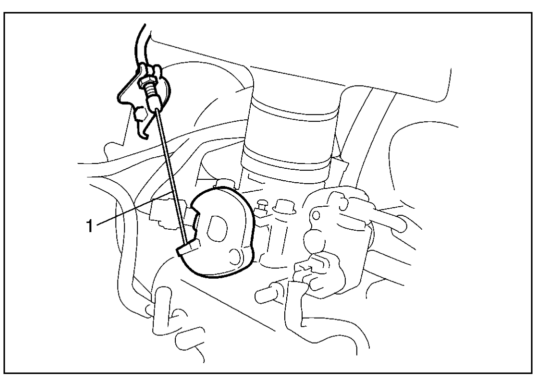
ON-VEHICLE INSPECTION



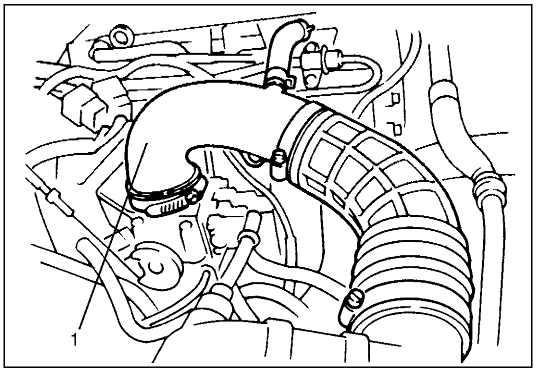
- Check that throttle valve lever (1) moves smoothly.

REMOVAL

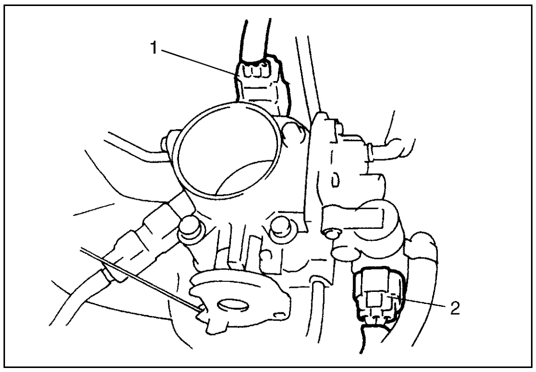
1) Disconnect negative cable at battery.
2) Drain cooling system.



3) Disconnect accelerator cable (1) from throttle valve lever.



4) Disconnect air cleaner outlet NO.2 hose (1) from throttle body.



5) Disconnect electric connector from TP sensor (1) and IAC valve (2).
6) Remove throttle body from intake manifold.
7) Disconnect engine coolant hoses from throttle body.

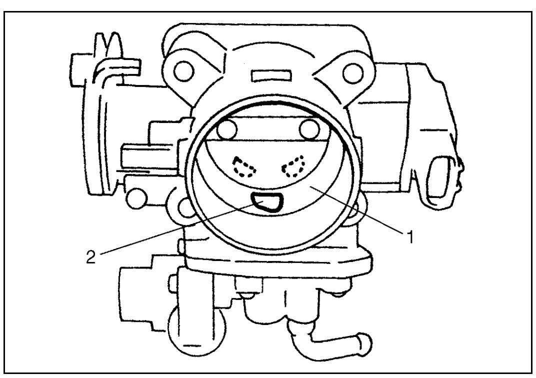
DISASSEMBLY

NOTE:

While disassembling and assembling throttle body, use special care not to deform levers on throttle valve shaft or cause damage to any other parts.

1) Remove TP sensor and IAC valve from throttle body.

CLEANING



Clean throttle body bore (1) and idle air passage (2) by blowing compressed air.

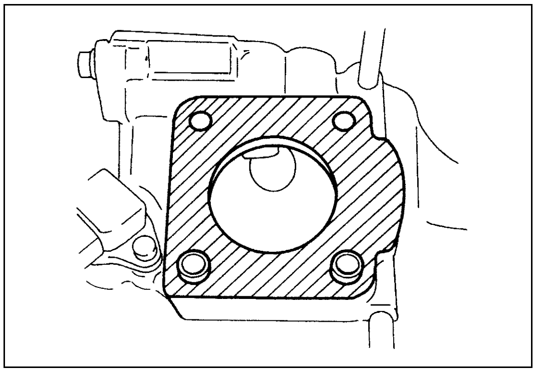
NOTE:

TP sensor, idle air control valve or other components containing rubber must not be placed in a solvent or cleaner bath. A chemical reaction will cause these parts to swell, harden or get distorted.

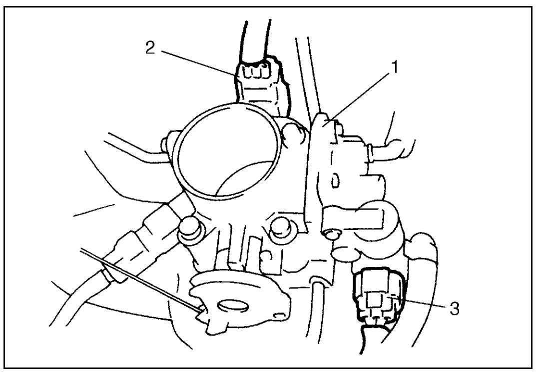
REASSEMBLY

1) Install IAC valve to throttle body referring to “Idle Air Control Valve” in this section.
2) Install TP sensor to throttle body referring to “Throttle Position Sensor” in this section for installation.

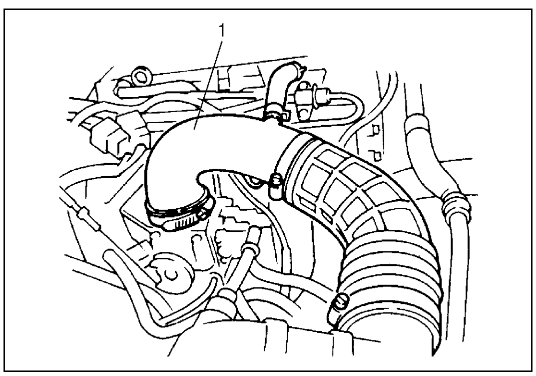
INSTALLATION



1) Clean mating surfaces and install throttle body gasket to intake manifold.
   Use new gasket.



2) Connect engine coolant hoses.
3) Install throttle body (1) to intake manifold.
4) Connect connectors to TP sensor (2) and IAC valve (3) securely.



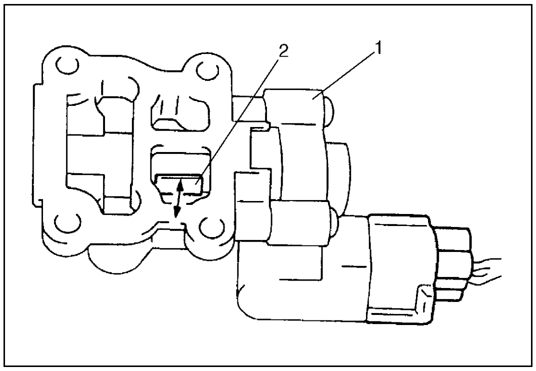
5) Install air cleaner outlet No.2 hose (1) and pipe.
6) Connect accelerator cable and adjust cable play to specification.
7) Refill cooling system.
8) Connect negative cable at battery.

Idle air control valve (IAC valve)

REMOVAL

1) Remove throttle body from intake manifold referring to “Throttle Body” in this section for removal.
2) Remove IAC valve from throttle body.

INSPECTION

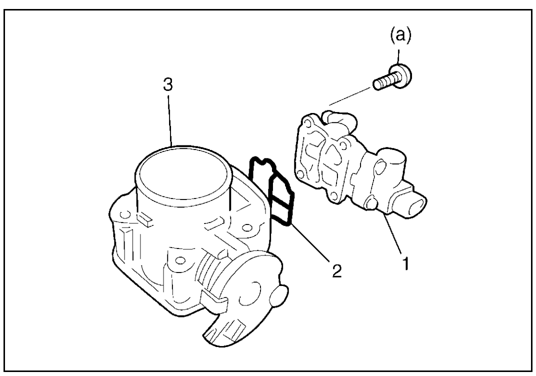


1) Connect each connector to IAC valve (1), TP sensor and IAT sensor.
2) Check that rotary valve (2) of IAC valve opens and closes once and then stops in about 60 ms as soon as ignition switch is turned ON.

NOTE:

- **This check should be performed by two people, one person turns on ignition switch while the other checks valve operation.**
- **As valve operation is momentary, it may be overlooked. To prevent this, perform this operation check 3 times or more continuously.**
  If rotary valve of IAC valve does not operate at all, check wire harness for open and short. If wire harness is in good condition, replace IAC valve and recheck.

INSTALLATION



1) Install new O-ring (2) to IAC valve (1).
2) Install IAC valve (1) to throttle body (3).
   Tighten IAC valve screws to specified torque.

Tightening torque
IAC valve screws (a) : 3.5 N·m (0.35 kg-m, 2.5 lb-ft)

3) Install throttle body to intake manifold referring to “Throttle Body” in this section for installation.

Fuel Delivery System

Fuel pressure inspection

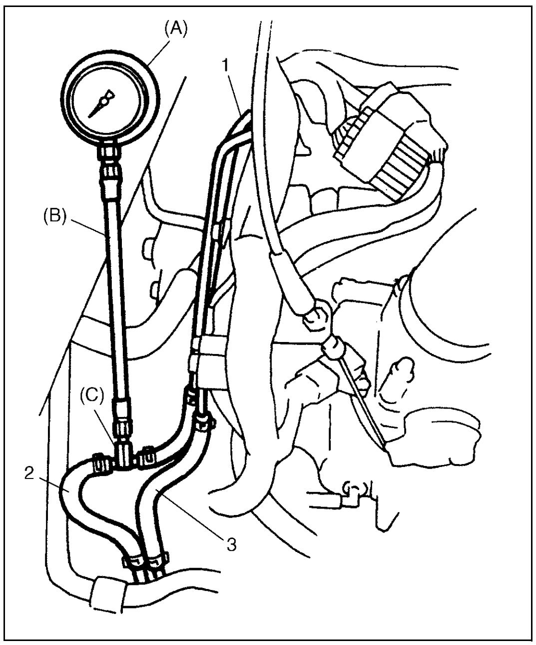
WARNING:

Be sure to perform work in a well-ventilated area and away from any open flames, or there is a risk of a fire breaking out.

1) Relieve fuel pressure in fuel feed line referring to "Fuel Pressure Relief Procedure" in Section 6.
2) Disconnect fuel feed hose from fuel delivery pipe.

CAUTION:

A small amount of fuel may be released when fuel hose is disconnected. Place container under the joint with a shop cloth so that released fuel is caught in container or absorbed in cloth. Place that cloth in an approved container.



3) Connect special tools and hose between fuel delivery pipe (1) and fuel feed hose (2) as shown in figure, and clamp hoses securely to ensure no leaks occur during checking.

Special tool
(A) : 09912-58442
(B) : 09912-58432
(C) : 09912-58490

3. Fuel return pipe

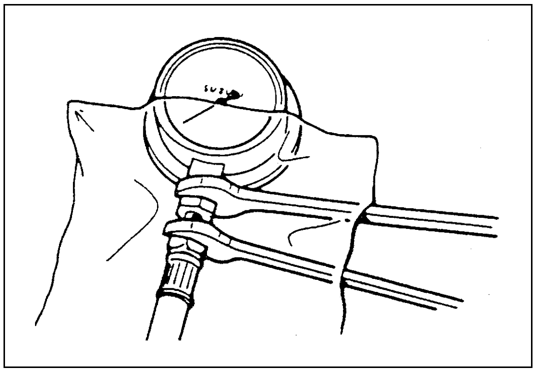
4) Check that battery voltage is above 11 V.

5) Turn ignition switch ON to operate fuel pump and after 2 seconds turn it OFF. Repeat this 3 or 4 times and then check fuel pressure.

Fuel pressure specification

CONDITION	FUEL PRESSURE
With fuel pump operating and engine stopped	**270 – 310 kPa 2.7 – 3.1 kg/cm^2, 38.4 – 44.0 psi**
At specified idle speed	**210 – 260 kPa 2.1 – 2.6 kg/cm^2, 29.8 – 37.0 psi**
With 1 min. after engine (fuel pump) stop (Pressure reduces as time passes)	**over 200 kPa 2.0 kg/cm^2, 28.4 psi**

6) Start engine and warm it up to normal operating temperature.
7) Measure fuel pressure at idling.
   If measured pressure doesn't satisfy specification, refer to "Diagnostic Flow Table B-3" in Section 6 and check each possibly defective part. Replace if found defective.



8) After checking fuel pressure, remove fuel pressure gauge.

> **CAUTION:**
> **As fuel feed line is still under high fuel pressure, make sure to release fuel pressure according to following procedures.**
> - **Place fuel container under joint.**
> - **Cover joint with rag and loosen joint nut slowly to release fuel pressure gradually.**

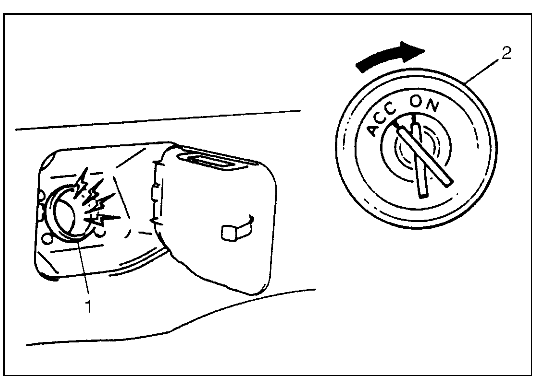
9) Remove special tools from fuel delivery pipe.
10) Connect fuel feed hose to fuel delivery pipe and clamp it securely.
11) With engine "OFF" and ignition switch "ON", check for fuel leaks.

Fuel pump

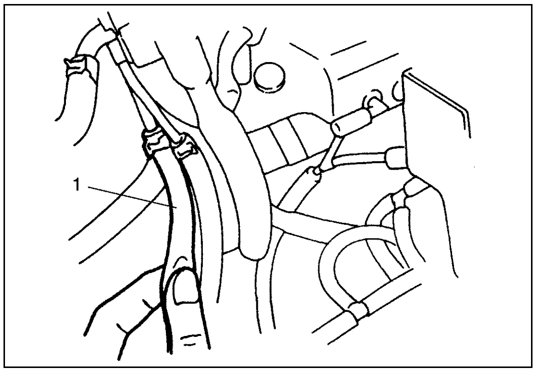
ON-VEHICLE INSPECTION

> **CAUTION:**
> **When fuel filler cap is removed in any procedure, work must be done in a well-ventilated area, keep away from any open flames and without smoking.**

NOTE:
The fuel pressure regulator is the one body with the fuel pump assembly so individual inspection of it is impossible.



1) Remove filler cap and turn ON ignition switch (2). Then fuel pump operating sound should be heard from fuel filler (1) for about 2 seconds and stop. Be sure to reinstall fuel filler cap after checking.
   If above check result is not satisfactory, advance to "Diagnostic Flow Table B-2" in Section 6.
2) Turn OFF ignition switch and leave over 10 minutes as it is.



3) Fuel pressure should be felt at fuel feed hose (1) for 2 seconds after ignition switch ON.
   If fuel pressure is not felt, advance to "Diagnostic Flow Table B-3" in Section 6.

REMOVAL

Remove fuel tank from body according to procedure described in "Fuel Tank" of Section 6C and remove fuel pump from fuel tank.

INSPECTION

Check fuel pump filter for evidence of dirt and contamination. If present, clean and check for presence of dirt in fuel tank.

INSTALLATION

1) Install fuel pump to its bracket.
2) Install fuel pump to fuel tank and then install fuel tank to body according to procedure described in "Fuel Tank" of Section 6C.

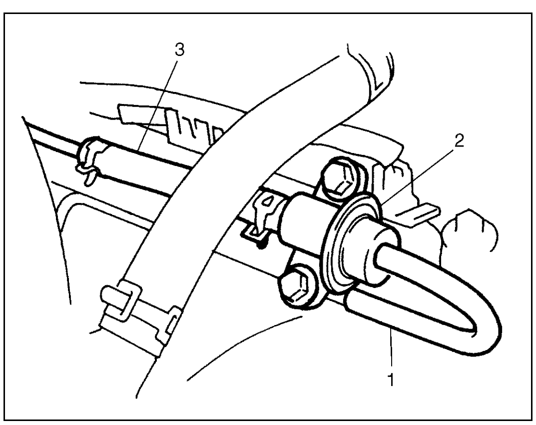
Fuel pressure regulator

ON-VEHICLE INSPECTION

Perform fuel pressure inspection according to procedure described in "Fuel Pressure Inspection" of this section.

REMOVAL

1) Relieve fuel pressure according to procedure described on "Fuel Pressure Relief Procedure" in Section 6.
2) Disconnect battery negative cable from battery.



3) Disconnect vacuum hose (1) from fuel pressure regulator (2).
4) Remove fuel pressure regulator from fuel delivery pipe.

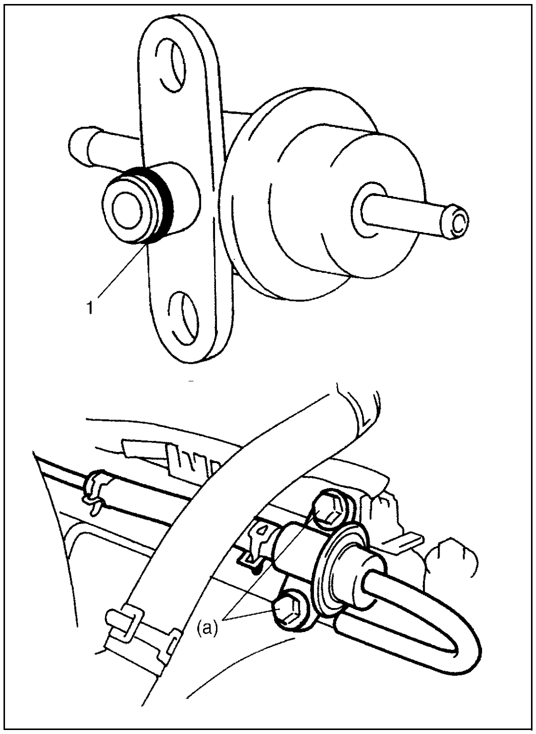
CAUTION:

A small amount of fuel may be released when it is from delivery pipe.
Place a shop cloth under delivery pipe so that released fuel is absorbed in it.

5) Disconnect fuel return hose (3) from fuel pressure regulator.

INSTALLATION

For installation, reverse removal procedure and note following precautions.



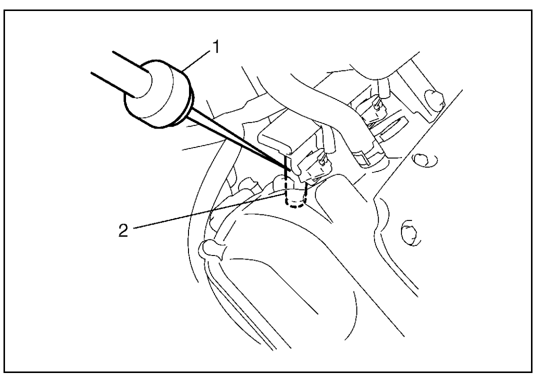
- Use new O-ring (1).
- Apply thin coat of gasoline to O-ring to facilitate installation.
- Tighten fuel pressure regulator bolts to specified torque.

Tightening torque
Fuel pressure regulator bolts
(a) : 10 N·m (1.0 kg-m, 7.5 lb-ft)

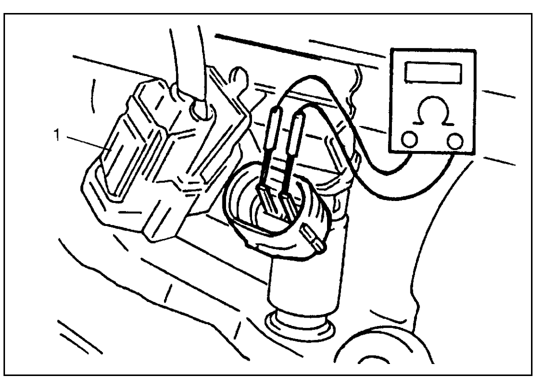
- With engine “OFF” and the ignition switch ON position, check for fuel leaks around fuel line connection.

Fuel injector

ON-VEHICLE INSPECTION



1) Using sound scope (1) or such, check operating sound of injector (2) when engine is running or cranking.
   Cycle of operating sound should vary according to engine speed.
   If no sound or an unusual sound is heard, check injector circuit (wire or connector) or injector (2).



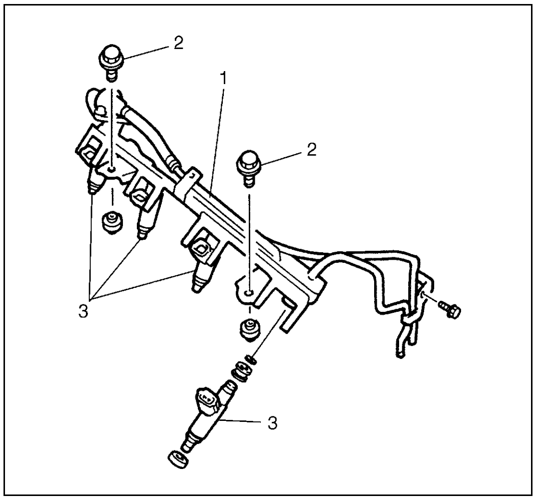
2) Disconnect connector (1) from injector, connect ohmmeter between terminals of injector and check resistance.
   If resistance is out of specification, replace.

Resistance of injector
11.3 – 13.8 Ω at 20 °C, 68 °F

3) Connect connector (1) to injector securely.

REMOVAL

1) Relieve fuel pressure according to procedure described in "Fuel Pressure Relief Procedure" in Section 6.
2) Disconnect battery negative cable at battery.
3) Disconnect fuel injector couplers and release wire harness from clamps.
4) Remove clamp bolt for fuel feed pipe and return pipe.

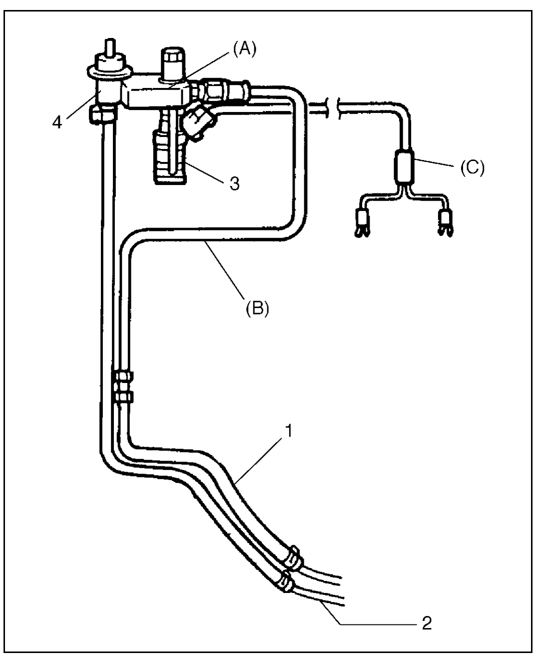


5) Remove fuel delivery pipe bolts (2).
6) Remove fuel injector(s) (3).

CAUTION:
A small amount of fuel may come out after removal of fuel injectors, cover them with shop cloth.

INSPECTION

WARNING:
As fuel is injected in this inspection, perform in a well ventilated area and away from open flames.
Use special care to prevent sparking when connecting and disconnecting test lead to and from battery.



1) Install injector (3) and fuel pressure regulator (4) to special tool (injector checking tool).

Special tool
(A) : 09912-58421

2) Connect special tools (hose and attachment) to fuel feed hose (1) of vehicle.

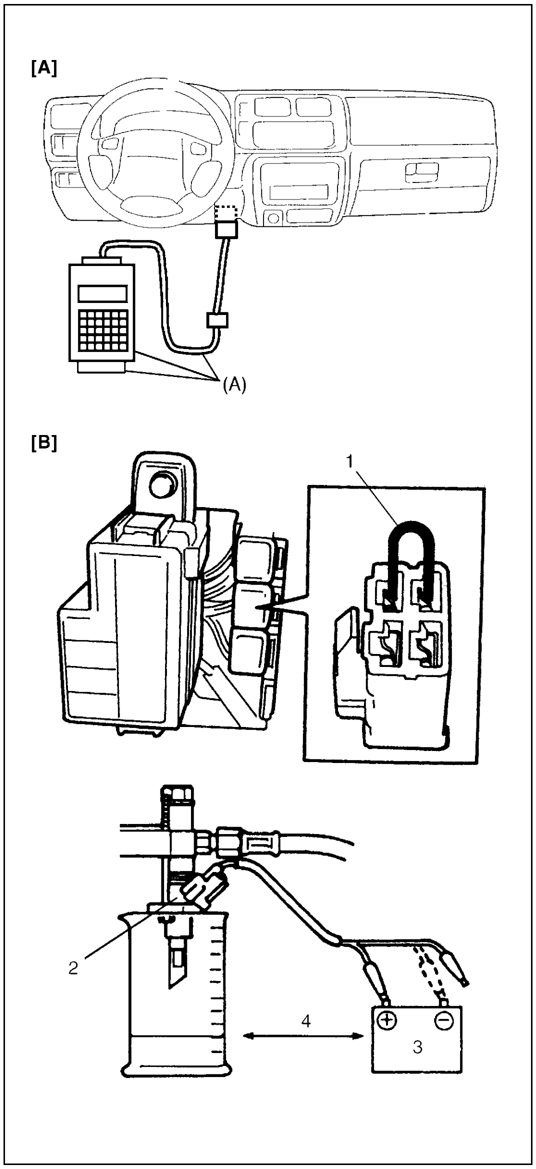
Special tool
(B) : 09912-58432

3) Connect special tool (test lead) to injector.

Special tool
(C) : 09930-88530

2. Fuel return line

4) Install suitable vinyl tube onto injector nozzle to prevent fuel from splashing out when injecting.



5) Put graduated cylinder under injector as shown.
6) Operate fuel pump and apply fuel pressure to injector as follows:
   a) When using SUZUKI scan tool :
      i) Connect SUZUKI scan tool to DLC with ignition switch OFF.
      ii) Turn ignition switch ON, clear DTC and select “MISC TEST” mode on SUZUKI scan tool.
      iii) Turn fuel pump ON by using SUZUKI scan tool.

   (A) : SUZUKI scan tool

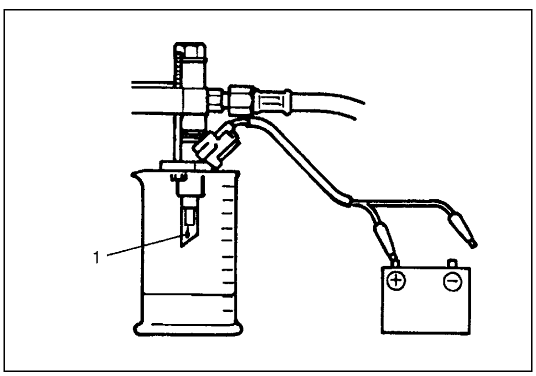
   b) Without using SUZUKI scan tool :
      i) Remove fuel pump relay from connector.
      ii) Connect two terminals of relay connector using service wire (1) as shown in figure.

CAUTION:
Check to make sure that connection is made between correct terminals. Wrong connection can cause damage to ECM, wire harness, etc.

      iii) Turn ignition switch ON.
7) Apply battery voltage (3) to injector (2) for 15 seconds and measure injected fuel volume with graduated cylinder.
   Test each injector two or three times.
   If not within specification, replace injector.

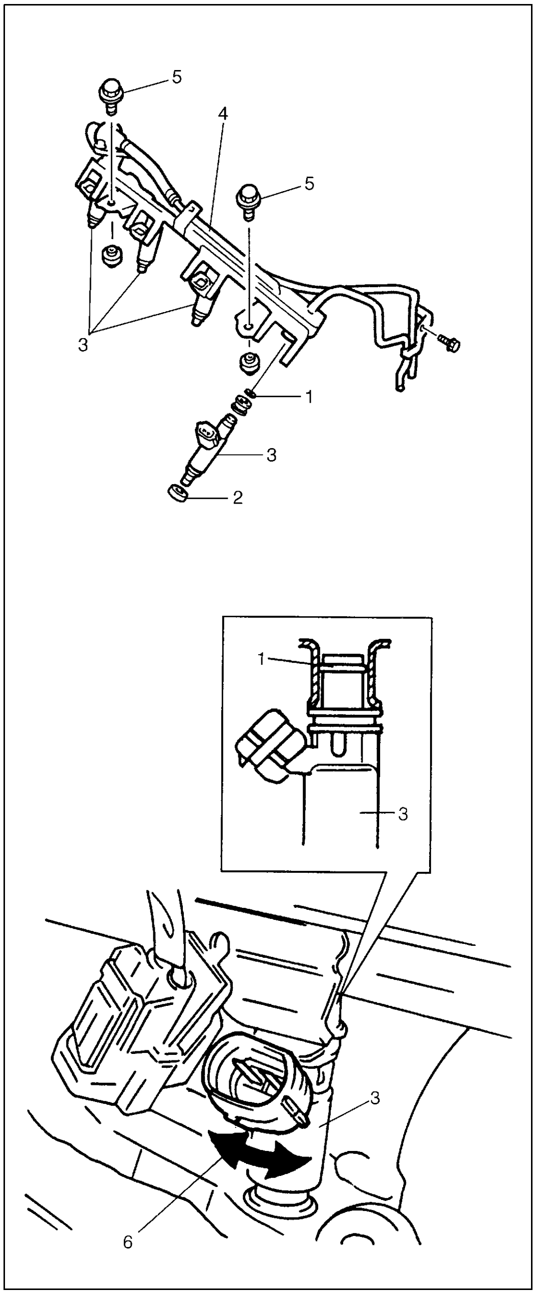
Injected fuel volume
43 – 47 cc/15 sec. (1.45/1.51 – 1.58/1.65 US/Imp. oz/15 sec.)

4.	Keep as far apart as possible
[A] :	When using SUZUKI scan tool
[B] :	Without using SUZUKI scan tool



8) Check fuel leakage from injector nozzle. Do not operate injector for this check (but fuel pump should be at work).
   If fuel leaks (1) more than following specifications, replace.

Fuel leakage (1)
Less than 1 drop/min.



INSTALLATION

For installation, reverse removal procedure and note following precautions.

- Replace injector O-ring (1) with new one using care not to damage it.
- Check if cushion (2) is scored or damaged. If it is, replace with new one.
- Apply thin coat of fuel to O-rings (1) and then install injectors (3) into delivery pipe (4) and intake manifold.
  Make sure that injectors (3) rotate smoothly (6). If not, probable cause is incorrect installation of O-ring (1). Replace O-ring (1) with new one.
- Tighten delivery pipe bolts (5) and make sure that injectors (3) rotate smoothly (6).
- After installation, with engine “OFF” and ignition switch “ON”, check for fuel leaks around fuel line connection.

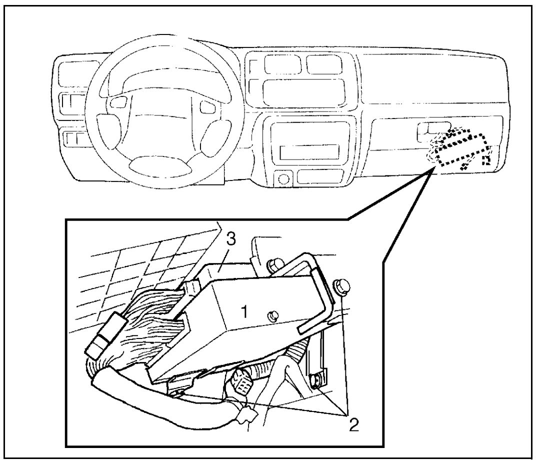
Electronic Control System

Engine control module (ECM)

CAUTION:
As ECM consists of precision parts, be careful not to expose it to excessive shock.

REMOVAL

1) Disconnect battery negative cable at battery.
2) Disable air bag system, refer to "Disabling Air Bag System" in Section 10B if equipped.
3) Remove glove box.



4) Disconnect ECM (1) and TCM (3) (if equipped) connectors.
5) Loosen 2 nuts (2) and remove ECM and TCM (if equipped).

INSTALLATION

1) Reverse removal procedure noting the following:
- Connect connectors to ECM and TCM (if equipped) securely.

Manifold absolute pressure sensor (MAP sensor)

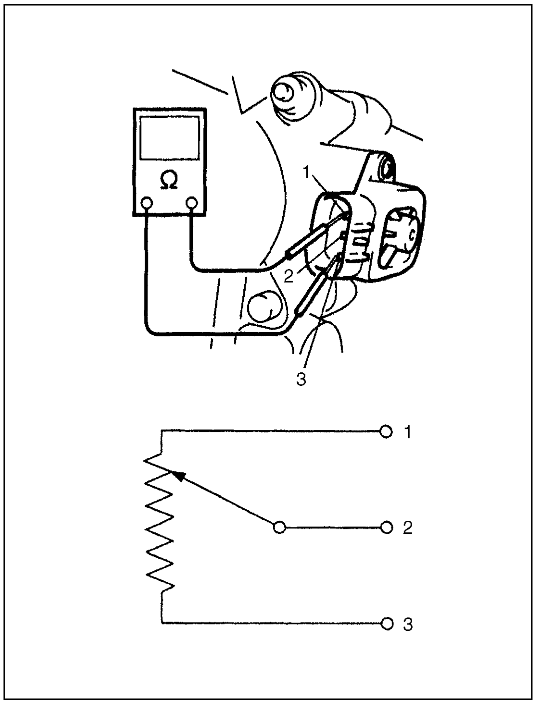
INSPECTION

Check MAP sensor referring to "MAP Sensor Individual Check" in DTC P0105 (No.11) Flow Table of Section 6. If malfunction is found, replace.

Throttle position sensor (TP sensor)

INSPECTION

1) Disconnect negative cable at battery and connector from TP sensor.



2) Using ohmmeter, check resistance between terminals under each condition given in table below.
   If check result is not satisfactory, replace TP sensor.

TP sensor resistance

TERMINALS	RESISTANCE
Between 1 and 3 terminals	4.0 – 6.0 kΩ
Between 2 and 3 terminals	20.0 Ω – 6.0 kΩ, varying according to throttle valve opening.

NOTE:

There should be more than 2 kΩ resistance difference between when throttle valve is at idle position and when it is fully open.

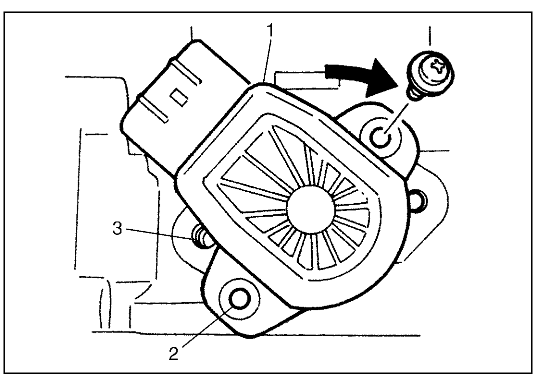
1.	Reference voltage terminal
2.	Output voltage terminal
3.	Ground terminal

3) Connect TP sensor connector securely.
4) Connect negative cable to battery.

REMOVAL

1) Remove throttle body from intake manifold referring to “Throttle Body” in this section for removal.
2) Remove TP sensor from throttle body.

INSTALLATION



1) Install TP sensor (1) to throttle body.
   Fit TP sensor to throttle body in such way that its holes (3) are a little away from TP sensor screw holes (2) and turn TP sensor clockwise so that those holes align.

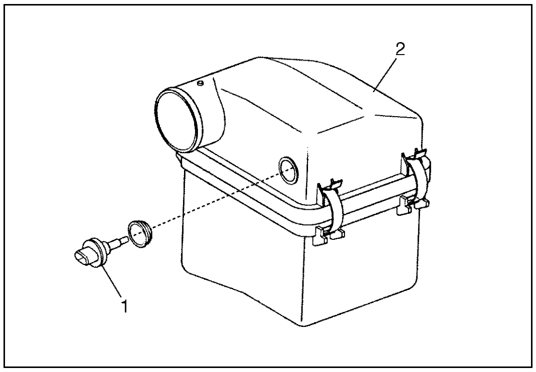
Tightening torque
TP sensor screws (a) : 2.5 N·m (0.25 kg-m, 1.8 lb-ft)

2) Connect connector to TP sensor securely.
3) Connect battery negative cable to battery.

Intake air temperature sensor (IAT sensor)

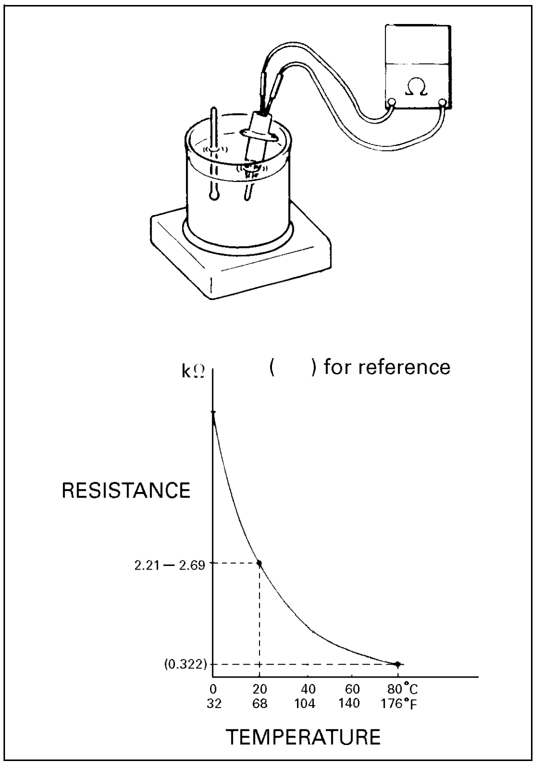
REMOVAL

1) Disconnect battery negative cable at battery.



2) Disconnect connector from IAT sensor (1).
3) Remove IAT sensor (1) from air cleaner case (2).

INSPECTION

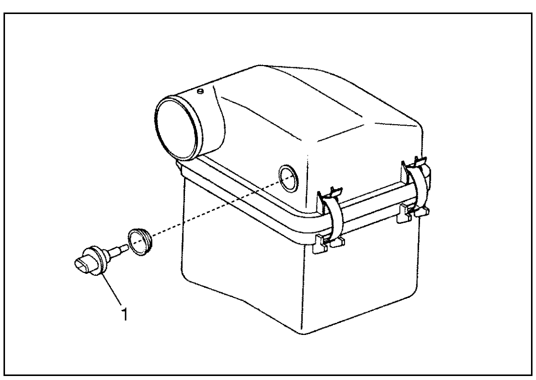


Immerse temperature sensing part of IAT sensor in water (or ice) and measure resistance between sensor terminals while heating water gradually.
If measured resistance doesn't show such characteristic as shown in left figure, replace IAT sensor.

INSTALLATION

Reverse removal procedure noting the following.

- Clean mating surfaces of IAT sensor and air cleaner case.



- Connect IAT sensor connector (1) securely.

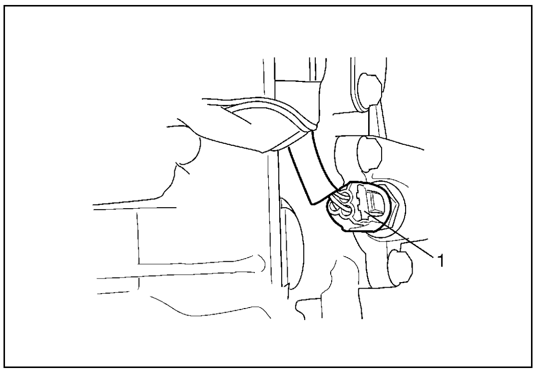
Engine coolant temperature sensor (ECT sensor)

REMOVAL

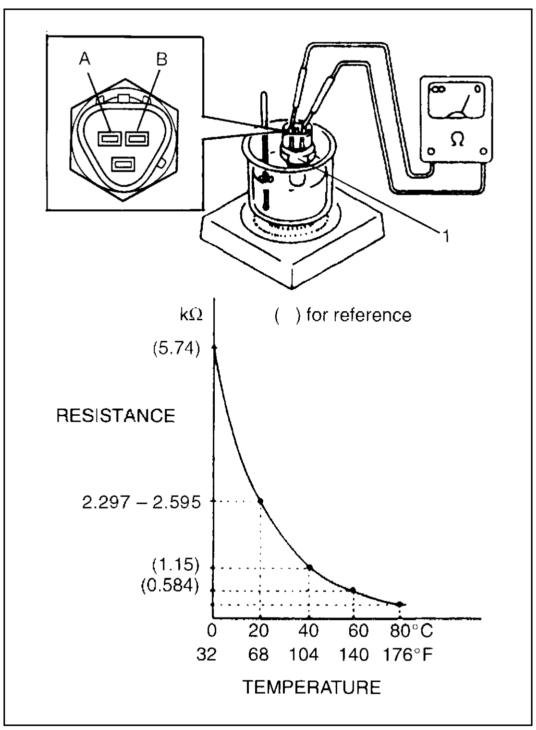
1) Disconnect battery negative cable at battery.
2) Drain coolant referring to Step 6) of “Cooling System Flush and Refill” in Section 6B.

> **WARNING:**
> **To help avoid danger of being burned, do not remove radiator cap while engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if cap is taken off too soon.**

3) Disconnect connector from ECT sensor.
4) Remove ECT sensor (1) from water outlet cap.



INSPECTION

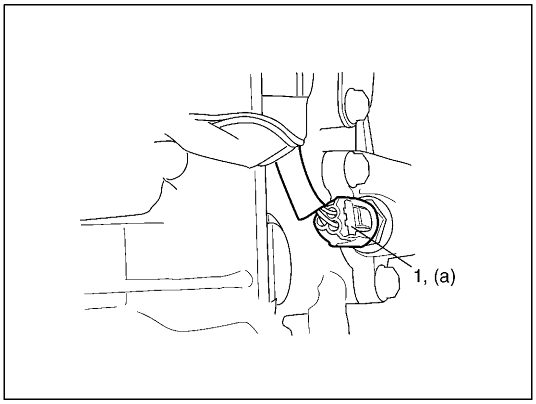


Immerse temperature sensing part of ECT sensor (1) in water (or ice) and measure resistance between terminal “A” and “B” while heating water gradually.
If measured resistance doesn’t show such characteristic as shown in left figure, replace ECT sensor (1).

INSTALLATION

Reverse removal procedure noting the following:

- Clean mating surfaces of ECT sensor (1) and water outlet cap.
- Check O-ring for damage and replace if necessary.



- Tighten ECT sensor (1) to specified torque.

Tightening torque
ECT sensor (a) : 15 N·m (1.5 kg-m, 11.5 lb-ft)

- Connect connector to ECT sensor (1) securely.
- Refill coolant referring to “Cooling System Flush and Refill” in Section 6B.

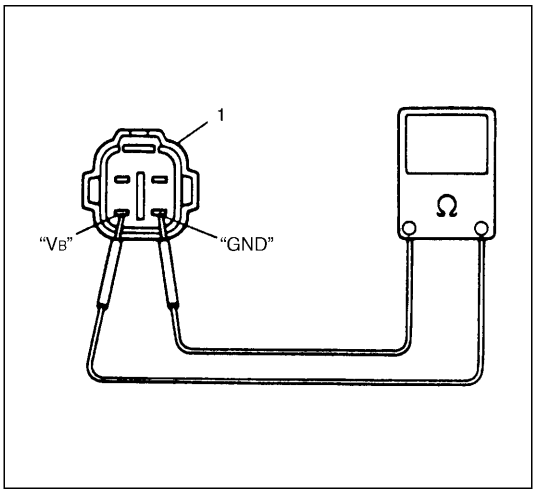
Heated oxygen sensor (Sensor-1 and sensor-2)

OXYGEN SENSOR HEATER INSPECTION

1) Disconnect sensor connector.
2) Using ohmmeter, measure resistance between terminals “V_B” and “GND” of sensor connector.
   If found faulty, replace oxygen sensor.

NOTE:
Temperature of sensor affects resistance value largely. Make sure that sensor heater is at correct temperature.

Resistance of oxygen sensor heater
HO2S-1 : 5.0 – 6.4 Ω at 20 °C, 68 °F
HO2S-2 : 11.7 – 14.3 Ω at 20 °C, 68 °F

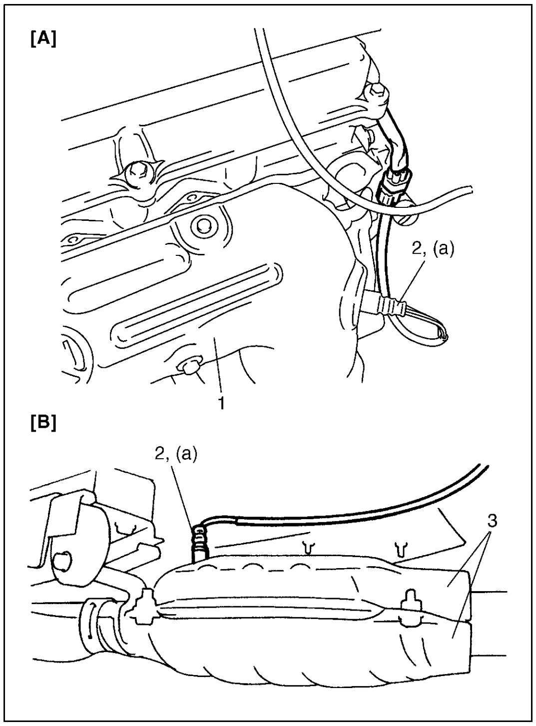


1. Viewed from terminal side

3) Connect sensor connector securely.

REMOVAL

WARNING:
To avoid danger of being burned, do not touch exhaust system when system is hot. Oxygen sensor removal should be performed when system is cool.



1) Disconnect negative cable at battery.
2) For sensor-1, remove exhaust manifold cover (1) and disconnect connector of heated oxygen sensor and release its wire harness from clamps.
3) For sensor-2, disconnect connector of heated oxygen sensor and release its wire harness from clamp. Hoist vehicle and then remove exhaust No.1 pipe covers (3).
4) Remove heated oxygen sensor (2) from exhaust manifold or exhaust No.1 pipe.

[A] :	HO2S-1
[B] :	HO2S-2

INSTALLATION

Reverse removal procedure noting the following.

- Tighten heated oxygen sensor (2) to specified torque.

Tightening torque
Heated oxygen sensor (a) : 45 N·m (4.5 kg-m, 32.5 lb-ft)

- Connect connector of heated oxygen sensor (2) and clamp wire harness securely.
- After installing heated oxygen sensor (2), start engine and check that no exhaust gas leakage exists.

Camshaft position sensor

INSPECTION

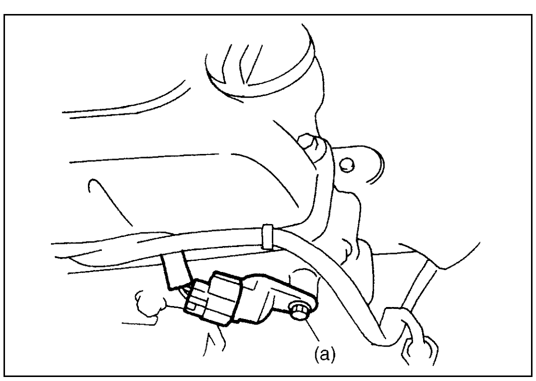
Check camshaft position sensor referring to “DTC P0340 (No. 15) Diag. Flow Table” in Section 6. If malfunction is found, replace.

REMOVAL

1) Disconnect negative cable at battery.
2) Disconnect connector from camshaft position sensor.
3) Remove camshaft position sensor from cylinder head.

INSTALLATION

1) Check that O-ring is free from damage.
2) Check that camshaft position sensor and signal rotor tooth are free from any metal particles and damage.



3) Install camshaft position sensor to sensor case.

Tightening torque
Camshaft position sensor bolt
(a) : 10 N·m (1.0 kg-m, 7.5 lb-ft)

4) Connect connector to it securely.
5) Connect negative cable to battery.

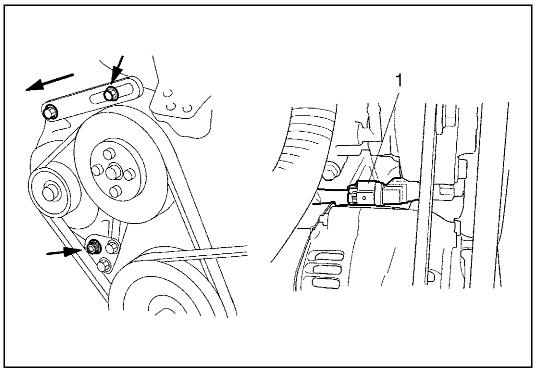
Crankshaft position sensor

INSPECTION

Check crankshaft position sensor referring to step 2 and 6 of “DTC P0335 (No.23) Flow Table” in Section 6. If malfunction is found, replace.

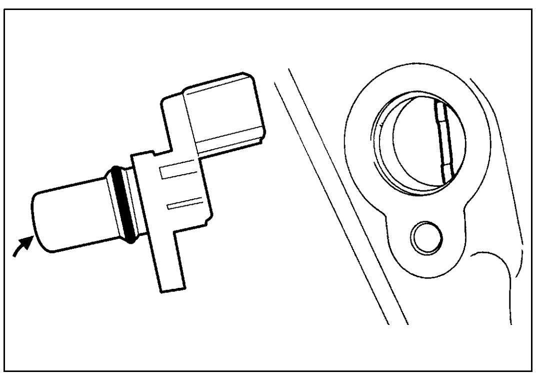
REMOVAL

1) Disconnect negative cable at battery.
2) Remove generator drive belt, loosen pivot bolt and move generator outward.
3) Disconnect connector from crankshaft position sensor.



4) Remove crankshaft position sensor (1) from cylinder block.

INSTALLATION



1) Check to make sure that crankshaft position sensor and pulley tooth is free from any metal particles and damage.
2) Install crankshaft position sensor to cylinder block.
3) Connect connector to it securely.
4) Adjust generator belt tension, refer to “Water Pump Belt Tension” in Section 6B.
5) Connect negative cable to battery.

Vehicle speed sensor (VSS)

INSPECTION

Check vehicle speed sensor referring to step 7 of “DTC P0500 (No.16) Flow Table” in Section 6. If malfunction is found, replace.

Fuel level sensor (GAUGE)

INSPECTION

Refer to “Fuel Meter / Fuel Gauge Unit” in Section 8.

REMOVAL / INSTALLATION

Refer to “Fuel Pump Assembly” in Section 6C.

Knock sensor

INSPECTION

Check knock sensor referring to “DTC P0325 (No.17) Flow Table” in Section 6. If malfunction is found, replace.

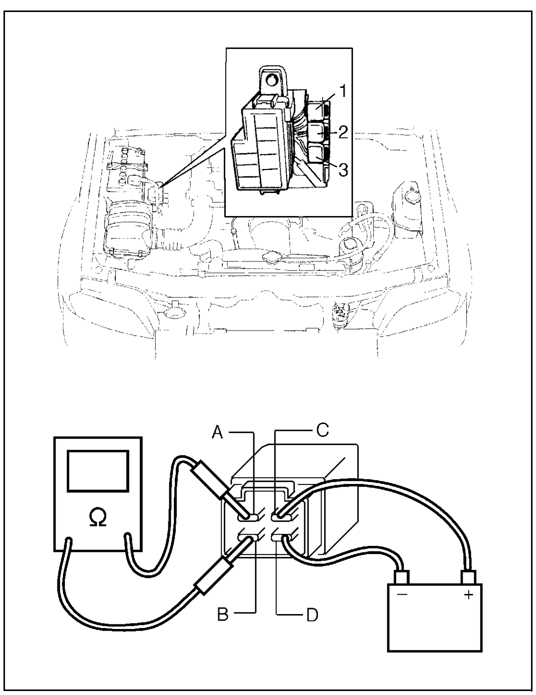
REMOVAL / INSTALLATION

Refer to “Knock Sensor” in Section 6A1.

Main relay, fuel pump relay and A/C condenser fan control relay

INSPECTION

1) Disconnect negative cable at battery.



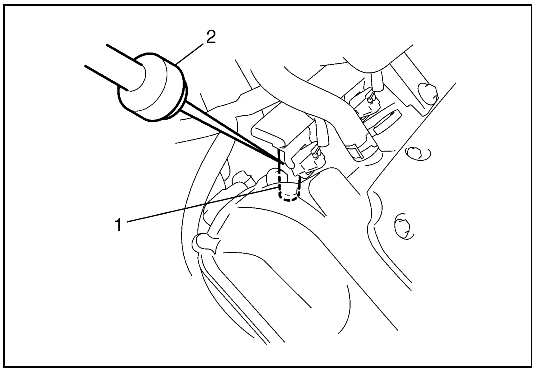
2) Remove main relay (1), fuel pump relay (2) and A/C condenser fan control relay (3) from vehicle.
3) Check that there is no continuity between terminal “A” and “B”. If there is continuity, replace relay.
4) Connect battery positive (+) terminal to terminal “C” of relay.
   Connect battery negative (–) terminal “D” of relay.
   Check continuity between terminal “A” and “B”.
   If there is no continuity when relay is connected to the battery, replace relay.

Fuel cut operation

INSPECTION

NOTE:

Before inspection, check to make sure that gear shift lever is in neutral position (with A/T model, selector lever in "P" range), A/C is OFF and that parking brake lever is pulled all the way up.



1) Warm up engine to normal operating temperature.
2) While listening to sound of injector (1) by using sound scope (2) or such, increase engine speed to higher than 3,000 r/min.
3) Check to make sure that sound to indicate operation of injector stops when throttle valve is closed instantly and it is heard again when engine speed is reduced to less than about 2,000 r/min.

A/C condenser fan control system

SYSTEM INSPECTION

WARNING:

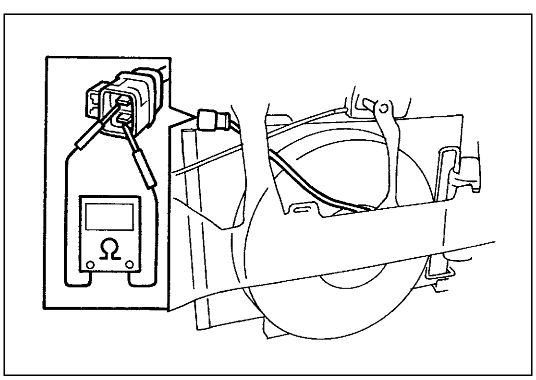
Keep hands, tools, and clothing away from A/C condenser fan to help prevent personal injury. This fan is electric and can come on whether or not the engine is running. The fan can start automatically in response to the ECT sensor with the ignition switch in the "ON" position.

Check system for operation referring to "Flow Table B-7" in Section 6.

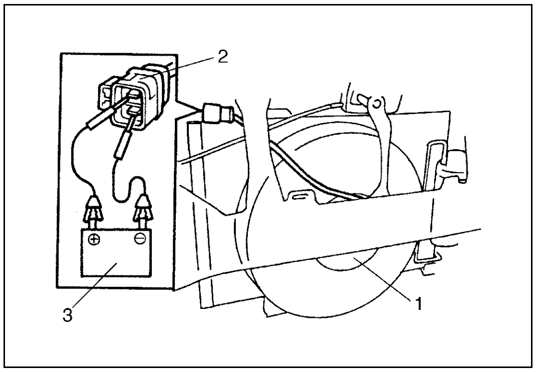
If A/C condenser fan fails to operate properly, check relay, A/C condenser fan and electrical circuit.

A/C condenser fan

INSPECTION



1) Check continuity between each two terminals.
   If there is no continuity, replace A/C condenser fan motor.



2) Connect battery (3) to A/C condenser fan motor coupler (2) as shown in figure, then check that the A/C condenser fan motor (1) operates smoothly.
   If A/C condenser fan motor does not operate smoothly, replace motor.

Reference current data of A/C condenser fan motor
Approx. 6.7 – 8.3 A at 12 V

Output signals of throttle valve opening and engine coolant temp. (Vehicle with A/T only)

THROTTLE VALVE OPENING SIGNAL INSPECTION

Check throttle valve opening (throttle position) signal referring to step 1 of “DTC P1700 (No.32 or 33) Flow Table” in Section 7B.
If check result is not satisfactory, check each wire harness, circuit connections and TP sensor.

ENGINE COOLANT TEMP. SIGNAL INSPECTION

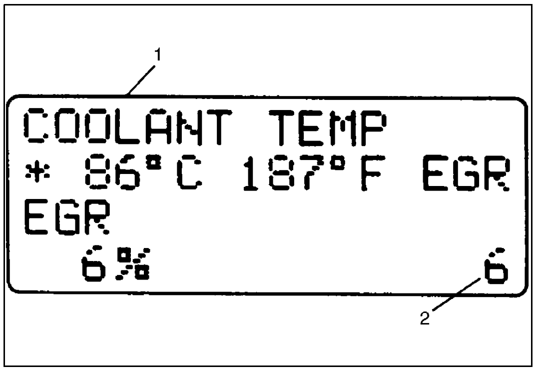
Check engine coolant temp. signal referring to step 1 of “DTC P1709 (No.51) Flow Table” in Section 7B.
If check result is not satisfactory, check each wire harness, circuit connection and ECT sensor.

Emission Control System

EGR system (If equipped)

SYSTEM INSPECTION (USING SUZUKI SCAN TOOL)

1) Connect SUZUKI scan tool to DLC with ignition switch OFF.
2) Turn ignition switch ON and then select “DATA LIST” mode on scan tool.
3) Make sure that vehicle condition is as following.
   - Vehicle speed = 0 km/h (0 KPH)
   - Engine speed ≤ 3000 rpm
4) Clear DTC by using “CLEAR INFO” mode.



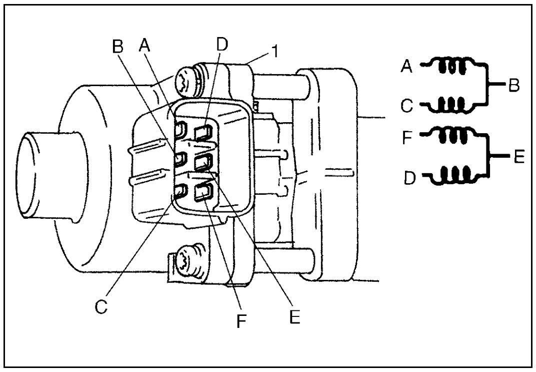
5) With engine idling (without depressing accelerator pedal), open EGR valve by using “STEP EGR” mode in “MISC TEST” menu.
   In this state, according as EGR valve opening increases engine idle speed drops. If not, possible cause is clogged EGR gas passage, stuck or faulty EGR valve, poor performance of ECT sensor or TP sensor or DTC and/or pending DTC is (are) stored in ECM memory.

1. SUZUKI scan tool display
2. EGR valve opening (0: Close, 100: Full Open)

REMOVAL

1) Disconnect negative cable at battery.
2) Disconnect EGR valve connector.
3) Remove EGR pipe.
4) Remove EGR valve and gasket from cylinder head.

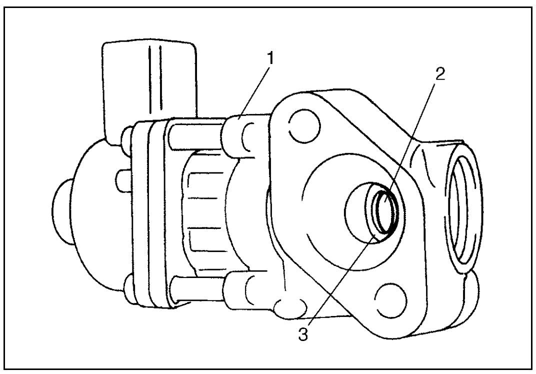
INSPECTION



1) Check resistance between following terminals of EGR valve (1) in each pair.
   If found faulty, replace EGR valve assembly.

EGR valve resistance

Terminal	Standard resistance
A – B C – B F – E D – E	20 – 24 Ω



2) Remove carbon from EGR valve (1) gas passage.

NOTE:

Do not use any sharp-edged tool to remove carbon.
Be careful not to damage or bend EGR valve, valve seat and rod.

3) Inspect valve (2), valve seat (3) and rod for fault, cracks, bend or other damage.
   If found faulty, replace EGR valve assembly.

INSTALLATION

Reverse removal procedure noting following.

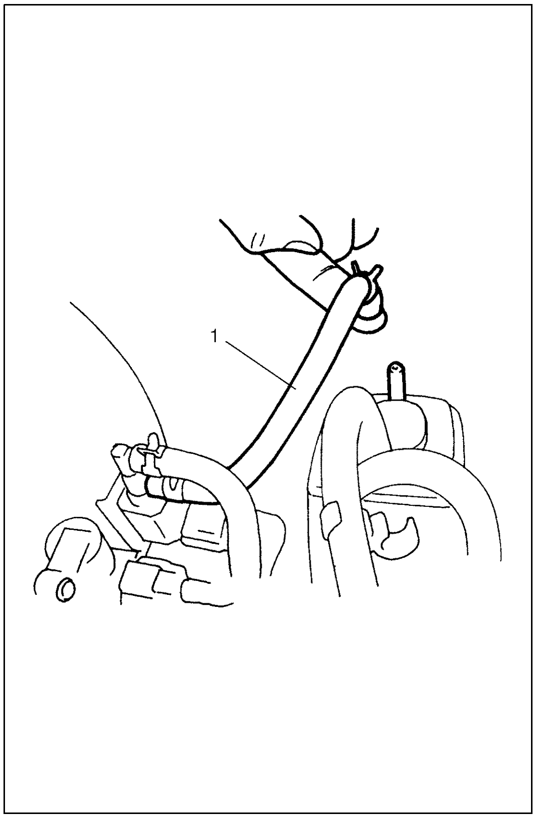
- Clean mating surface of valve and cylinder head.
- Use new gaskets.

Evaporative emission (EVAP) control system

EVAP CANISTER PURGE INSPECTION

NOTE:

Before inspection, check to make sure that gear shift lever is in neutral position (with A/T model, selector lever in “P” range) and that parking brake lever is pulled all the way up.



1) Disconnect purge hose (1) from EVAP canister.
2) Place finger against the end of disconnected hose and check that vacuum is not felt there when engine is cool and running at idle speed.
3) Connect purge hose to EVAP canister and warm up engine to normal operating temperature.
4) Turn ignition switch OFF.
5) Restart engine and run it at 2000 r/min. for 2 min. or more.
6) Disconnect purge hose from EVAP canister.
7) Also check that vacuum is felt when engine is running at 3000 r/min.

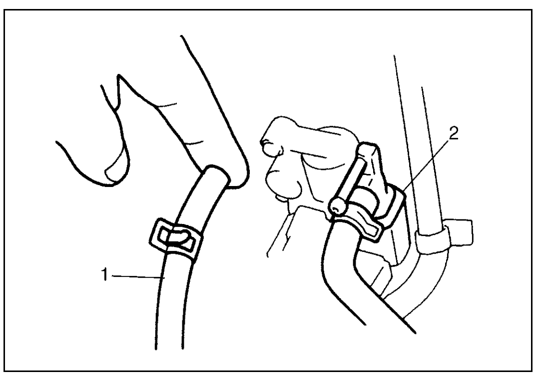
NOTE:

ECM detects a change in the purge fuel vapor concentration and sometimes stops purging for several seconds but this is nothing abnormal.

8) If vacuum is not felt in Step 7), run engine at idle for 8 min. or more and then repeat check in Step 7).

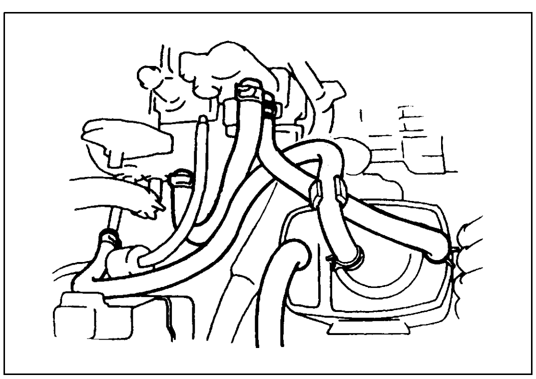
If check result is not satisfactory in Steps 2) and 8), check vacuum passage, hoses, EVAP canister purge valve, wire harness and ECM.

VACUUM PASSAGE INSPECTION



Start engine and run it at idle speed. Disconnect vacuum hose (1) from EVAP canister purge valve (2). With finger placed against hose disconnected, check that vacuum is applied.
If it is not applied, clean vacuum passage by blowing compressed air.

VACUUM HOSE INSPECTION



Check hoses for connection, leakage, clog and deterioration. Replace as necessary.

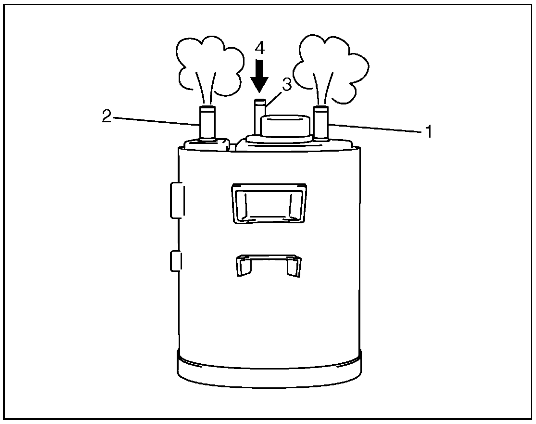
EVAP CANISTER PURGE VALVE INSPECTION

Check EVAP canister purge valve referring to step 2 of “DTC P0443 Flow Table” in Section 6.
If found malfunction, replace.

EVAP CANISTER INSPECTION

WARNING:
DO NOT SUCK nozzles on EVAP canister. Fuel vapor inside EVAP canister is harmful.

1) Check outside of EVAP canister visually.
2) Disconnect vacuum hoses from EVAP canister.



3) Check that there should be no restriction of flow through purge pipe (1) and air pipe (2) when air is blown (4) into tank pipe (3).
   If any faulty condition is found in above inspection replace.

PCV system

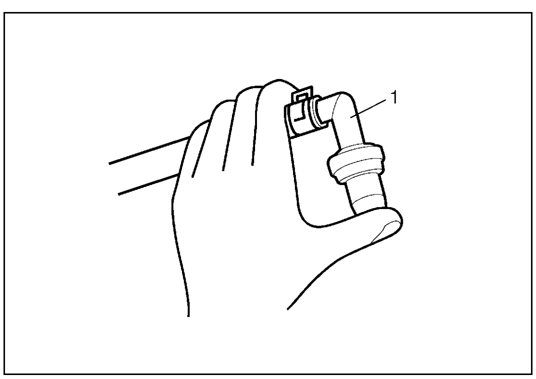
NOTE:
Be sure to check that there is no obstruction in PCV valve or its hoses before checking IAC duty, for obstructed PCV valve or hose hampers its accurate adjustment.

PCV HOSE INSPECTION

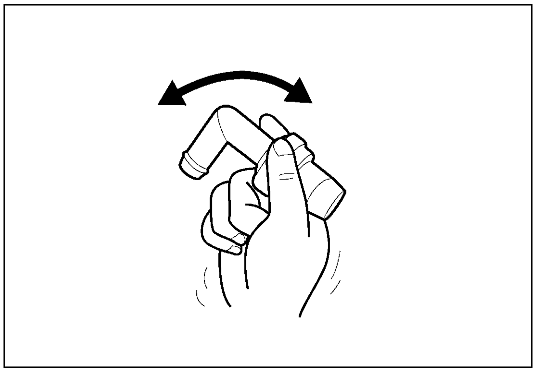
Check hoses for connection, leakage, clog and deterioration.
Replace as necessary.

PCV VALVE INSPECTION

1) Disconnect PCV valve (1) from cylinder head cover and install plug to head cover hole.
2) Run engine at idle.

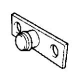
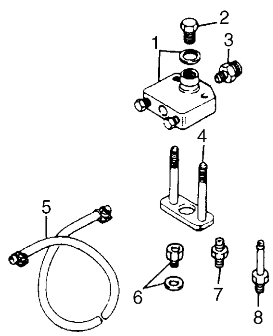
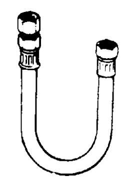
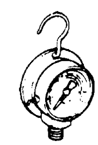
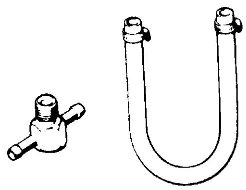
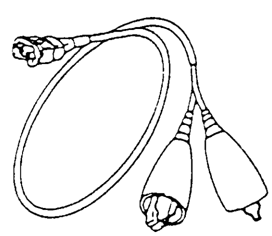
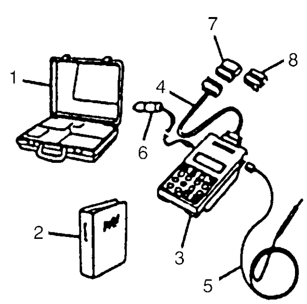
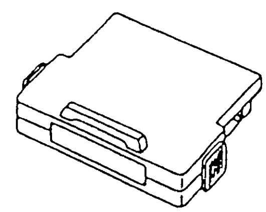


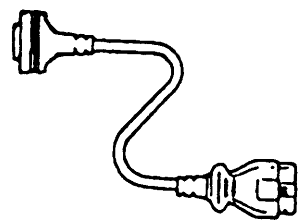
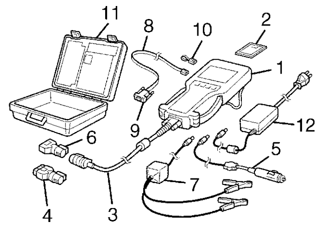
3) Place your finger over end of PCV valve (1) to check for vacuum. If there is no vacuum, check for clogged valve. Replace as necessary.



4) After checking vacuum, stop engine and remove PCV valve (1).
   Shake valve and listen for the rattle of check needle inside the valve. If valve does not the rattle, replace valve.
5) After checking, remove plug and install PCV valve (1).

Special Tools

 09912-57610 Checking tool plate	 09912-58421 Checking tool set (See NOTE “A”.)	 09912-58432 Pressure hose	 09912-58442 Pressure gauge
 09912-58490 3-way joint & hose	 09930-88530 Injector test lead	 09931-76011 SUZUKI scan tool (Tech 1A) kit (See NOTE “B”.)	 Mass storage cartridge

 09931-76030 16/14 pin DLC cable	 Tech 2 kit (SUZUKI scan tool) (See NOTE “C”.)

NOTE:

- **“A”: This kit includes the following items.**
  1. Tool body & washer, 2. Body plug, 3. Body attachment-1, 4. Holder, 5. Return hose & clamp, 6. Body attachment-2 & washer, 7. Hose attachment-1, 8. Hose attachment-2
- **“B”: This kit includes the following items and substitutes for the Tech 2 kit.**
  1. Storage case, 2. Operator’s manual, 3. Tech 1A, 4. DLC cable (14/26 pin, 09931-76040), 5. Test lead / probe, 6. Power source cable, 7. DLC cable adaptor, 8. Self-test adaptor
- **“C”: This kit includes the following items and substitutes for the Tech 1A kit.**
  1. Tech 2, 2. PCMCIA card, 3. DLC cable, 4. SAE 16/19 adapter, 5. Cigarette cable, 6. DLC loopback adapter, 7. Battery power cable, 8. RS232 cable, 9. RS232 adapter, 10. RS232 loopback connector, 11. Storage case, 12. Power supply

Tightening Torque Specifications

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
TP sensor mounting screw	2.5	0.25	1.8
IAC valve screw	3.5	0.35	2.5
ECT sensor	15	1.5	11.5
Heated oxygen sensor-1 and -2	45	4.5	32.5
Camshaft position sensor	10	1.0	7.5
Fuel pressure regulator bolt	10	1.0	7.5

SECTION 6F

IGNITION SYSTEM (ELECTRONIC IGNITION SYSTEM)

WARNING:

For vehicles equipped with Supplemental Restraint (Air Bag) System:

- **Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to "Air Bag System Components and Wiring Location View" under "General Description" in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and "Service Precautions" under "On-Vehicle Service" in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.**
- **Technical service work must be started at least 90 seconds after the ignition switch is turned to the "LOCK" position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).**

CONTENTS

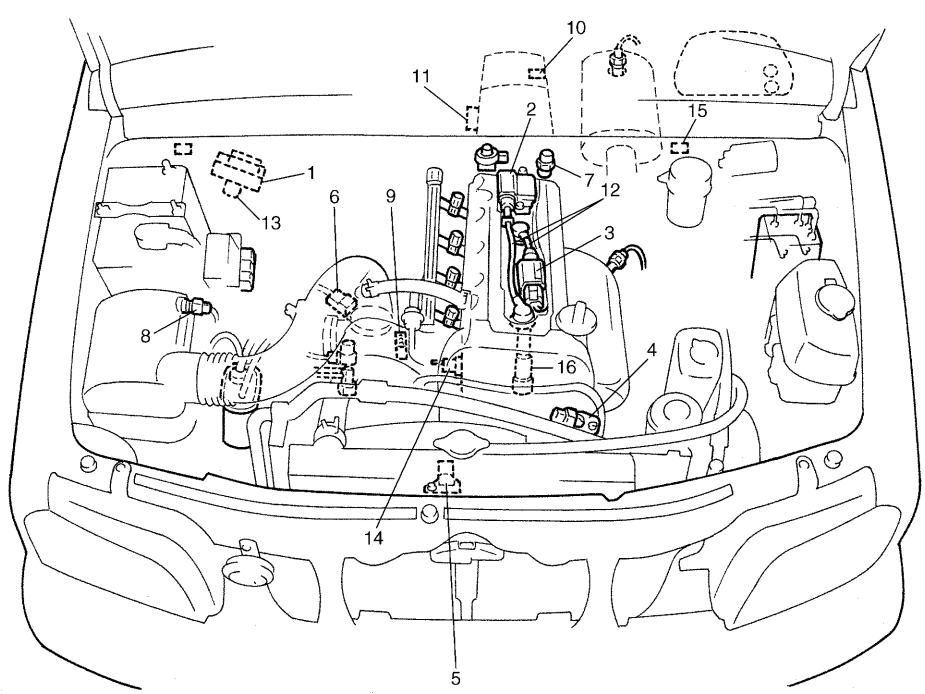
General Description

The ignition system is an electronic (distributorless) ignition system. It consists of the parts as described below and has an electronic ignition control system.

- ECM
  It detects the engine and vehicle conditions through the signals from the sensors, determines the most suitable ignition timing and time for electricity to flow to the primary coil and sends a signal to the ignitor (power unit) in the ignition coil assembly.
- Ignition coil assembly (including an ignitor)
  The ignition coil assembly has a built-in ignitor which turns ON and OFF the current flow to the primary coil according to the signal from ECM. When the current flow to the primary coil is turned OFF, a high voltage is induced in the secondary coil.
- High tension cords and spark plugs.
- CMP sensor (Camshaft position sensor) and CKP sensor (Crankshaft position sensor)
  Using signals from these sensors, ECM identifies the specific cylinder whose piston is in the compression stroke, detects the crank angle and adjust initial ignition timing automatically.
- TP sensor, ECT sensor, MAP sensor and other sensors/switches
  Refer to “Electronic Control System” in Section 6E for details.

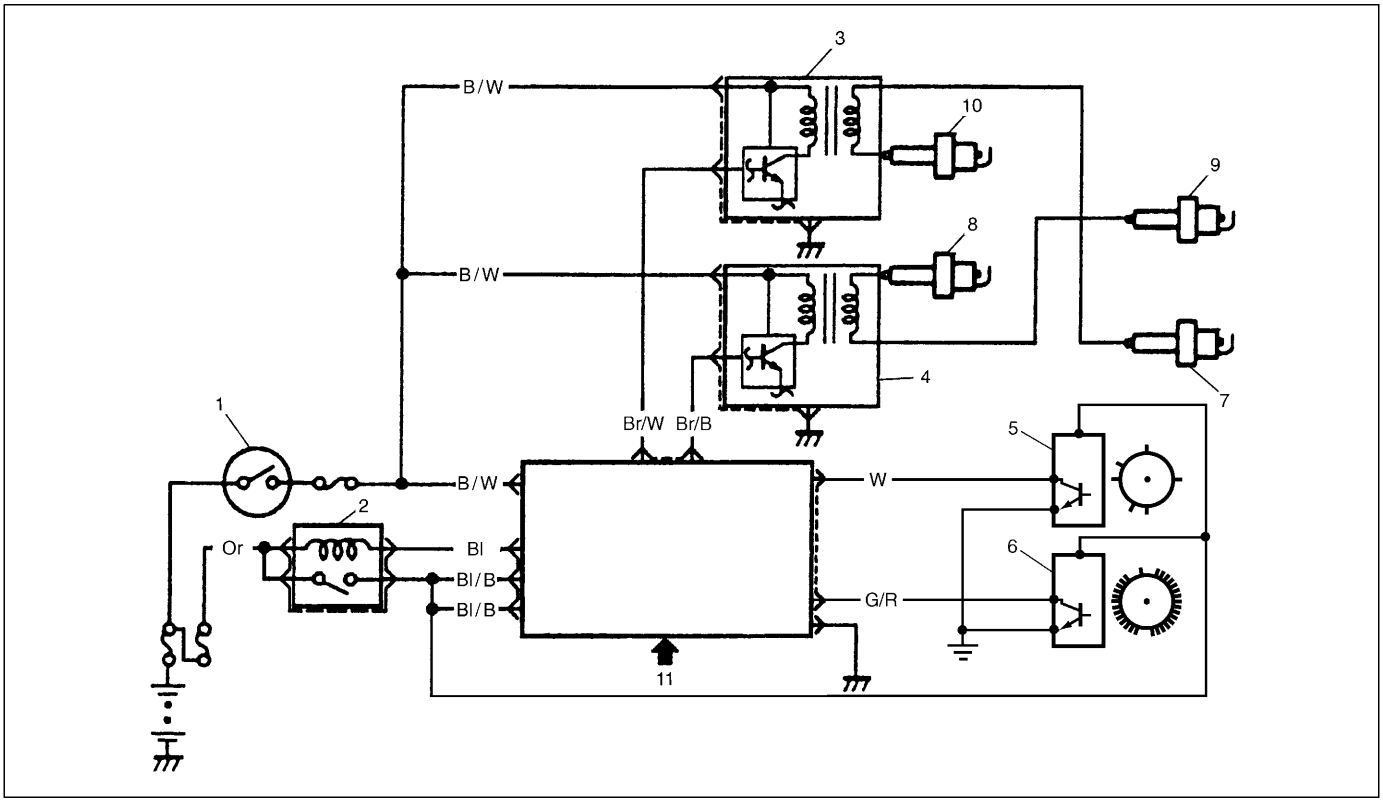
Although this ignition system does not have a distributor, it has two ignition coil assemblies (one is for No.1 and No.4 spark plugs and the other is for No.2 and No.3 spark plugs). When an ignition signal is sent from ECM to the ignitor in the ignition coil assembly for No.1 and No.4 spark plugs, a high voltage is induced in the secondary coil and that passes through the high-tension cords and causes No.1 and No.4 spark plugs to spark simultaneously. Likewise, when an ignition signal is sent to the ignitor in the other ignition coil assembly, No.2 and No.3 spark plugs spark simultaneously.

SYSTEM COMPONENTS



1. ECM	7. ECT sensor	13. Monitor connector
2. Ignition coil assembly for No.1 and No.4 spark plugs	8. IAT sensor	14. Knock sensor
3. Ignition coil assembly for No.2 and No.3 spark plugs	9. TP sensor	15. DLC
4. CMP sensor	10. VSS	16. Spark plugs
5. CKP sensor	11. Transmission range switch (A/T)	
6. MAP sensor	12. High-tension cords	

SYSTEM WIRING DIAGRAM



1. Ignition switch	7. No.1 spark plug
2. Main relay	8. No.2 spark plug
3. Ignition coil assembly for No.1 and No.4 spark plugs	9. No.3 spark plug
4. Ignition coil assembly for No.2 and No.3 spark plugs	10. No.4 spark plug
5. CMP sensor	11. Sensed information (MAP sensor, ECT sensor, IAT sensor, TP sensor, Knock sensor, VSS, Park/Neutral position signal, Electric load signal, Engine start signal, Test switch terminal)
6. CKP sensor	

Diagnosis

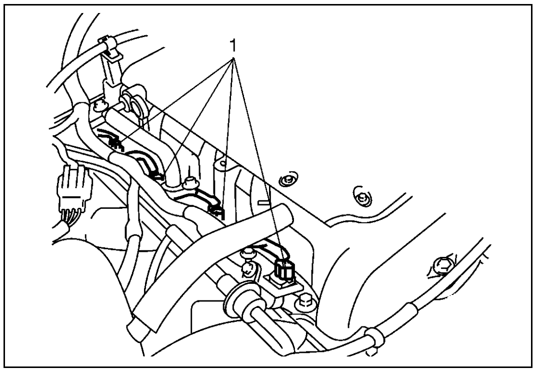
Condition	Possible Cause	Correction
Engine cranks, but will not start or hard to start (No spark)	Blown fuse for ignition coil	Replace.
	Loose connection or disconnection of lead wire or high-tension cord(s)	Connect securely.
	Faulty high-tension cord(s)	Replace.
	Faulty spark plug(s)	Adjust, clean or replace.
	Faulty ignition coil	Replace ignition coil assembly.
	Faulty CKP sensor or CKP sensor plate	Clean, tighten or replace.
	Faulty ECM	Replace.
Poor fuel economy or engine performance	Incorrect ignition timing	Check related sensors and CKP sensor plate.
	Faulty spark plug(s) or high-tension cord(s)	Adjust, clean or replace.
	Faulty ignition coil assembly	Replace.
	Faulty CKP sensor or CKP sensor plate	Clean, tighten or replace.
	Faulty ECM	Replace.

IGNITION SYSTEM DIAGNOSTIC FLOW TABLE

Step	Action	Yes	No
1	Was “Engine Diagnostic Flow Table” in Section 6 performed?	Go to Step 2.	Go to “Engine Diag. Flow Table” in Section 6.
2	Ignition Spark Test 1) Check all spark plugs for condition and type referring to “Spark Plugs” section. 2) If OK, perform ignition spark test, referring to “Ignition Spark Test” section. Is spark emitted from all spark plugs?	Go to Step 11.	Go to Step 3.
3	Diagnostic Trouble Code (DTC) Check Is DTC stored in ECM?	Go to applicable DTC Diag. Flow Table in Section 6.	Go to Step 4.
4	Electrical Connection Check 1) Check ignition coil assemblies and high-tension cords for electrical connection. Are they connected securely?	Go to Step 5.	Connect securely.
5	High-tension Cords Check 1) Check high-tension cord for resistance referring to “High-Tension Cords” section. Is check result satisfactory?	Go to Step 6.	Replace high-tension cord(s).
6	Ignition Coil Assembly Power Supply and Ground Circuit Check 1) Check ignition coil assembly power supply and ground circuits for open and short. Are circuits in good condition?	Go to Step 7.	Repair or replace.
7	Ignition Coil Assembly Check 1) Check ignition coil for resistance referring to “Ignition Coil Assembly” section. Is check result satisfactory?	Go to Step 8.	Replace ignition coil assembly.
8	Crankshaft Position (CKP) Sensor Check 1) Check crankshaft position sensor referring to Step 2 and 6 of “DTC P0335 (No.23) CKP Sensor Circuit Malfunction” in Section 6. Is check result satisfactory?	Go to Step 9.	Tighten CKP sensor bolt, replace CKP sensor or CKP sensor plate.
9	Ignition Trigger Signal Circuit Check 1) Check ignition trigger signal wire for open, short and poor connection. Is circuit in good condition?	Go to Step 10.	Repair or replace.
10	A Known-good Ignition Coil Assembly Substitution 1) Substitute a known-good ignition coil assembly and then repeat Step 2. Is check result of Step 2 satisfactory?	Go to Step 11.	Substitute a known-good ECM and then repeat Step 2.
11	Ignition Timing Check 1) Check initial ignition timing and ignition timing advance referring to “Ignition Timing” section. Is check result satisfactory?	System is in good condition.	Check CKP sensor, CKP sensor plate and input signals related to this system.

On-Vehicle Service

Ignition Spark Test

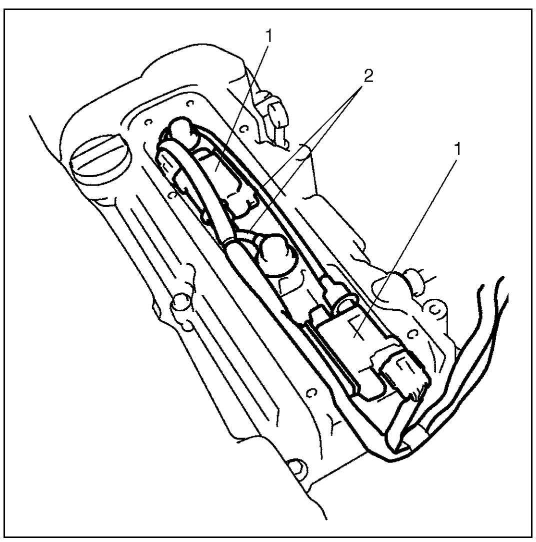


1) Disconnect all injector connectors (1) from injectors.

WARNING:
Without disconnection of injector couplers, combustible gas may come out from spark plug holes during this test and may get ignited in engine room.

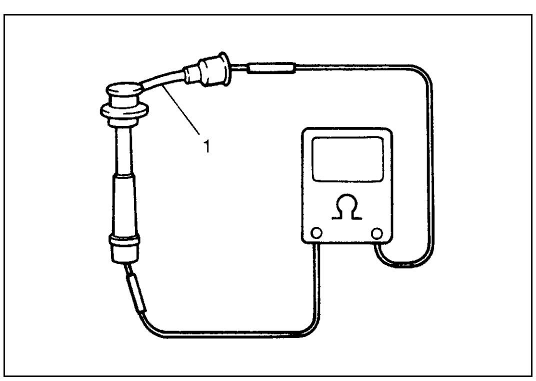
2) Remove cylinder head upper cover.
3) Remove spark plug and check it for condition and type referring to "Spark Plugs" in this section.
4) If OK, connect ignition coil connector to ignition coil assembly and connect spark plug to ignition coil assembly or high-tension cord. Ground spark plug.
5) Crank engine and check if each spark plug sparks.
6) If no spark is emitted, inspect the related parts as described under "Diagnosis" earlier in this section.

High-tension Cords



1) Remove cylinder head upper cover and disconnect high-tension cords (2) from ignition coil assemblies (1) while gripping each cap.
2) Pull out high-tension cords from spark plugs while gripping each cap.

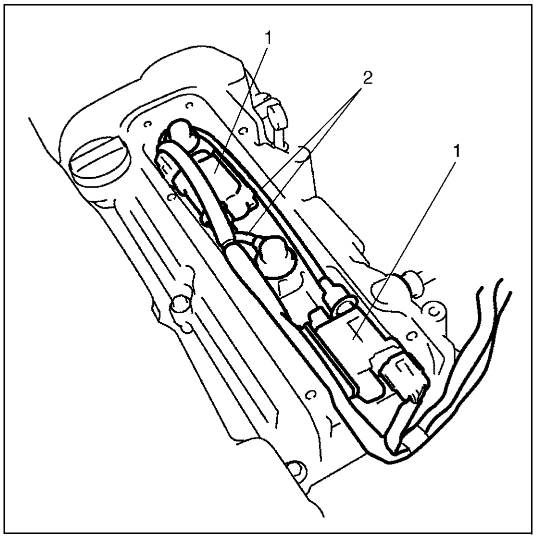
CAUTION:
- **Removal of high-tension cords together with clamps will be recommended so as not to damage their inside wire (resistive conductor).**
- **For the same reason, pull out each connection by gripping cap portion.**



3) Measure resistance of high-tension cord (1) by using ohmmeter.

High-tension cord resistance
4 – 10 kΩ/m (1.2 – 3.0 kΩ/ft)

4) If resistance exceeds specification, replace high-tension cord(s).

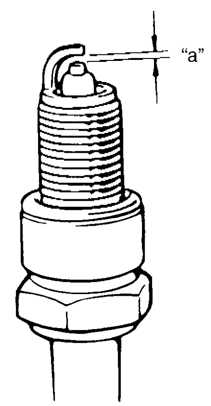


5) Install high-tension cords (2) to spark plugs and ignition coil assemblies (1) while gripping each cap.

CAUTION:
- **Never attempt to use metal conductor high-tension cords as replacing parts.**
- **Insert each cap portion fully when installing high-tension cords.**

Spark Plugs

1) Pull out high-tension cords by gripping their caps and then remove ignition coil assemblies referring to “Ignition Coil Assembly” in this section.
2) Remove spark plugs.
3) Inspect them for:
- Electrode wear
- Carbon deposits
- Insulator damage



4) If any abnormality is found, adjust air gap, clean with spark plug cleaner or replace them with specified new plugs.
For iridium/platinum spark plugs, replace them with new plugs.

Spark plug air gap "a"
1.0 – 1.1 mm (0.040 – 0.043 in.)

Spark plug type
NGK : BKR6E-11, IFR5E11
DENSO : K20PR-U11, SK16PR-A11

NOTE:

NGK IFR5E11 or DENSO SK16PR-A11 is highly recommended for better engine starting performance under – 25°C (– 13°F).

CAUTION:

When servicing the iridium/platinum spark plugs (slender center electrode type plugs), do not touch the center electrode to avoid damage to it. The electrode is not strong enough against mechanical force as it is slender and its material is not mechanically tough.

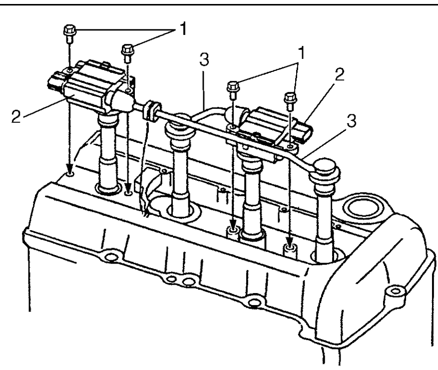
5) Install spark plugs and torque them to specification.

Tightening torque
Spark plug : 25 N·m (2.5 kg-m, 18.0 lb-ft)

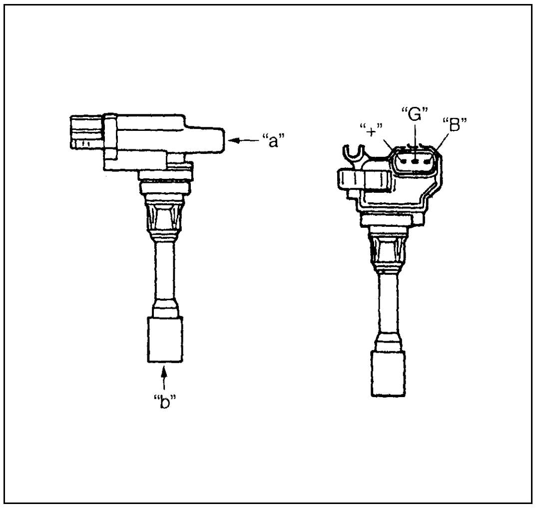
6) Install ignition coil assemblies referring to "Ignition Coil Assembly" in this section.
7) Install high-tension cords securely by gripping their caps.

Ignition Coil Assembly (Including Ignitor)

1) Disconnect negative cable at battery.
2) Remove cylinder head upper cover.
3) Disconnect ignition coil connector.



4) Disconnect high-tension cord (3) from ignition coil assembly (2).
5) Remove ignition coil bolts (1) and then pull out ignition coil assembly.



6) Measure resistance between terminals as follows by using analog type ohmmeter.
   If check result is not satisfactory, replace ignition coil assembly.

   Secondary coil resistance
   "a" – "b" : 7.5 – 14 kΩ (at 20°C, 68°F)

7) Install ignition coil assembly.
8) Tighten ignition coil bolts, and then connect ignition coil coupler.
9) Install high-tension cord to ignition coil assembly while gripping its cap.
10) Install cylinder head upper cover.

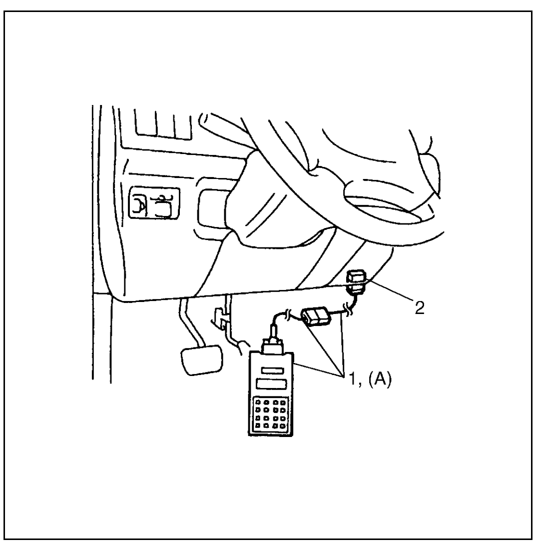
Crankshaft Position Sensor (CKP Sensor)

Refer to "Crankshaft Position Sensor" in Section 6E for removal, inspection and installation.

Ignition Timing

NOTE:
- **Ignition timing is not adjustable. If ignition timing is out of specification, check system related parts.**
- **Before starting engine, place transmission gear shift lever in "Neutral" (shift selector lever to "P" range for A/T model), and set parking brake.**

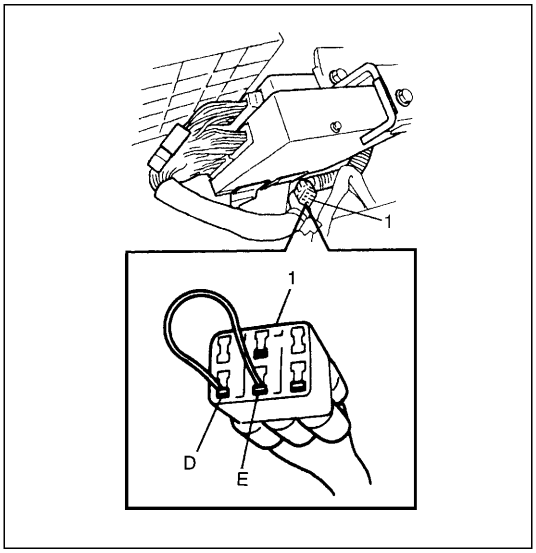
INSPECTION



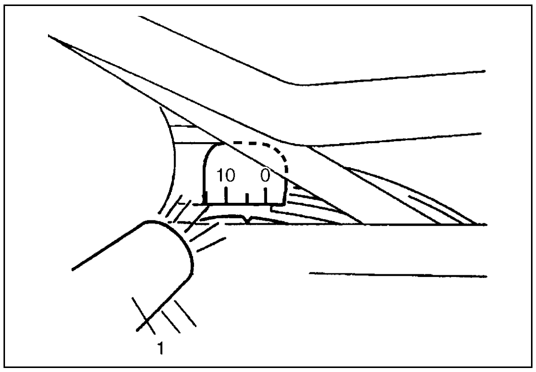
1) When using SUZUKI scan tool (1), connect SUZUKI scan tool to DLC (2) with ignition switch OFF.

   Special tool
   (A) : SUZUKI scan tool

2) Start engine and warm it up to normal operating temperature.
3) Make sure that all of electrical loads except ignition are switched off.
4) Check to be sure that idle speed is within specification.
   (Refer to "Idle Speed/Idle Air Control Duty Inspection" in Section 6E.)



5) Fix ignition timing to initial one as follows.
   a) When using SUZUKI scan tool:
      Select “MISC” mode on SUZUKI scan tool and fix ignition timing to initial one.
   b) Without using SUZUKI scan tool: (vehicle without immobilizer indicator lamp)
      Disconnect scan tool from DLC, and connect D and E terminals of monitor connector (1) or E to body ground by using service wire so that ignition timing is fixed on initial one.



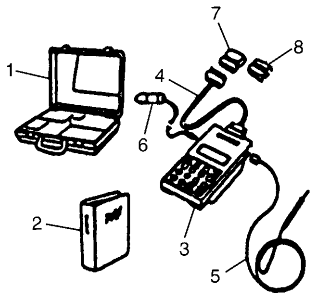
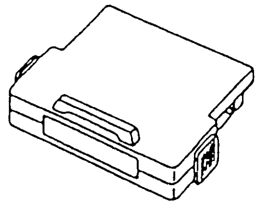
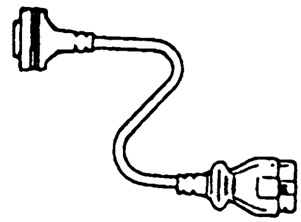
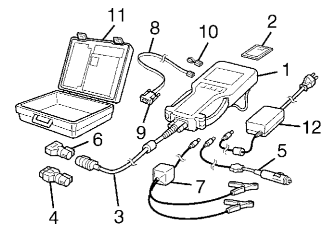
6) Using timing light (1), check that ignition timing is within specification.

Initial ignition timing (test switch terminal grounded or fixed with SUZUKI scan tool)
5 ± 3° BTDC at idle speed

Ignition order
1-3-4-2

7) If ignition timing is out of specification, check the followings:
   - CKP sensor
   - CKP sensor plate
   - TP sensor
   - Test switch signal circuit
   - VSS
   - Timing chain cover installation
8) After checking Initial Ignition Timing, release ignition timing fixation by using SUZUKI scan tool or disconnect service wire from monitor connector.
9) With engine idling (test switch terminal ungrounded, throttle opening at closed position and car stopped), check that ignition timing is about 7°–17° BTDC. (Constant variation within a few degrees from 7°–17° indicates no abnormality but proves operation of electronic timing control system.) Also, check that increasing engine speed advances ignition timing. If above check results are not satisfactory, check CKP sensor, test switch terminal circuit and ECM.

Special Tools

			
09931-76011		09931-76030	
Tech 1A kit (SUZUKI scan tool) (See NOTE “A”.)	Mass storage cartridge for Tech 1A	16/14 pin DLC adapter for Tech 1A	Tech 2 kit (SUZUKI scan tool) (See NOTE “B”.)

NOTE:
- **“A” : This kit includes the following items and substitutes for the Tech 2 kit.**
  1. Storage case, 2. Operator’s manual, 3. Tech 1A, 4. DLC cable (14/26 pin, 09931-76040), 5. Test lead/probe, 6. Power source cable, 7. DLC cable adaptor, 8. Self-test adaptor
- **“B” : This kit includes the following items and substitutes for the Tech 1A kit.**
  1. Tech 2, 2. PCMCIA card, 3. DLC cable, 4. SAE 16/19 adapter, 5. Cigarette cable, 6. DLC loopback adapter, 7. Battery power cable, 8. RS232 cable, 9. RS232 adapter, 10. RS232 loopback connector, 11. Storage case, 12. Power supply

Tightening Torque Specification

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
Spark plug	25	2.5	18.0

SECTION 6G

CRANKING SYSTEM

WARNING:

For vehicles equipped with Supplemental Restraint (Air Bag) System:

- **Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to "Air Bag System Components and Wiring Location View" under "General Description" in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and "Service Precautions" under "On-Vehicle Service" in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.**
- **Technical service work must be started at least 90 seconds after the ignition switch is turned to the "LOCK" position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).**

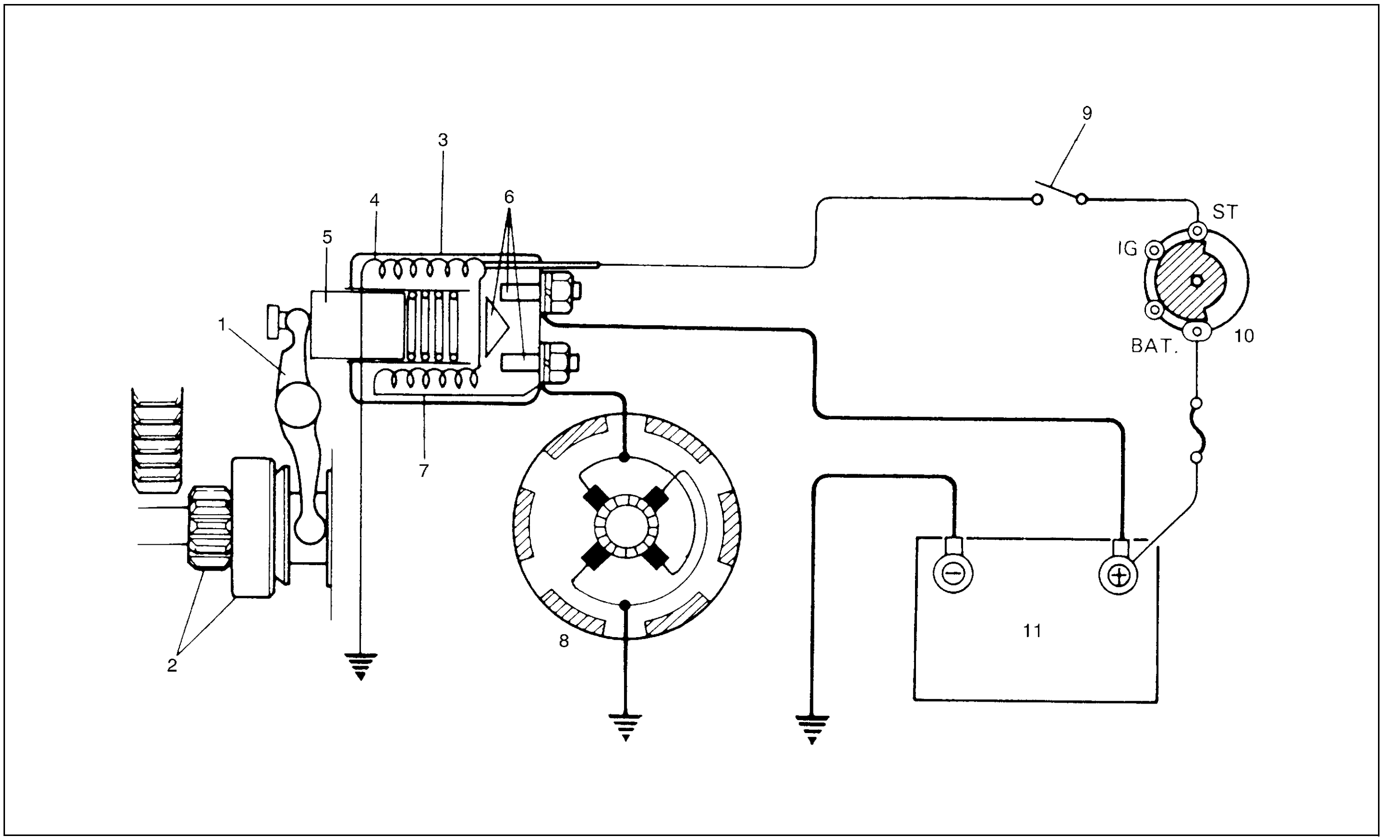
NOTE:

Starting motor varies depending on specifications, etc. Therefore, be sure to check model and specification of vehicle being serviced before replacing parts.

CONTENTS

General Description

Cranking Circuit



1. Pinion drive lever	5. Plunger	9. A/T: Transmission range switch (shift lever switch)
2. Pinion & Over-running clutch	6. Magnetic switch contacts	10. Ignition & Starter switch
3. Magnetic switch	7. Pull-in coil	11. Battery
4. Hold-in coil	8. Starting motor	

Diagnosis

Diagnosis Table

Possible symptoms due to starting system trouble would be as follows:

- Starting motor does not run (or runs slowly)
- Starting motor runs but fails to crank engine
- Abnormal noise is heard

Proper diagnosis must be made to determine exactly where the cause of each trouble lies.....in battery, wiring harness, (including starting motor switch), starting motor or engine.

Do not remove motor just because starting motor does not run. Check following items and narrow down scope of possible causes.

1) Condition of trouble
2) Tightness of battery terminals (including ground cable connection on engine side) and starting motor terminals
3) Discharge of battery
4) Mounting of starting motor

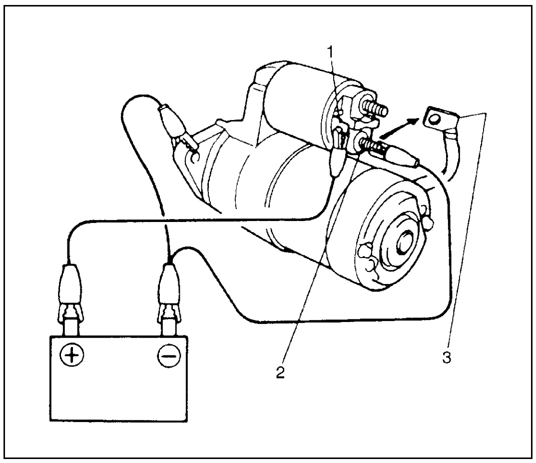
Condition	Possible Cause	Correction
Motor not running (No operating sound of magnetic switch)	Shift lever switch is not in P or N, or not adjusted (A/T)	Shift in P or N, or adjust switch.
	Battery run down	Recharge battery.
	Battery voltage too low due to battery deterioration	Replace battery.
	Poor contact in battery terminal connection	Retighten or replace.
	Loose grounding cable connection	Retighten.
	Fuse set loose or blown off	Tighten or replace.
	Poor contacting action of ignition switch and magnetic switch	Replace.
	Lead wire coupler loose in place	Retighten.
	Open-circuit between ignition switch and magnetic switch	Repair.
	Open-circuit in pull-in coil	Replace magnetic switch.
	Brushes are seating poorly or worn down	Repair or replace.
	Poor sliding of plunger and/or pinion	Repair.
Motor not running (Operating sound of magnetic switch heard)	Battery run down	Recharge battery.
	Battery voltage too low due to battery deterioration	Replace battery.
	Loose battery cable connections	Retighten.
	Burnt main contact point, or poor contacting action of magnetic switch	Replace magnetic switch.
	Brushes are seating poorly or worn down	Repair or replace.
	Weakened brush spring	Replace.
	Burnt commutator	Replace armature.
	Layer short-circuit of armature	Replace.
	Crankshaft rotation obstructed	Repair.
Starting motor running but too slow (small torque) (If battery and wiring are satisfactory, inspect starting motor)	Insufficient contact of magnetic switch main contacts	Replace magnetic switch.
	Layer short-circuit of armature	Replace.
	Disconnected, burnt or worn commutator	Repair commutator or replace armature.
	Worn brushes	Replace brush.
	Weakened brush springs	Replace spring.
	Burnt or abnormally worn end bush	Replace bush.
Starting motor running, but not cranking engine	Worn pinion tip	Replace over-running clutch.
	Poor sliding of over-running clutch	Repair.
	Over-running clutch slipping	Replace over-running clutch.
	Worn teeth of ring gear	Replace flywheel (M/T) or drive plate (A/T).
Noise	Abnormally worn bush	Replace bush.
	Worn pinion or worn teeth of ring gear	Replace pinion or flywheel (M/T) or drive plate (A/T).
	Poor sliding of pinion (failure in return movement)	Repair or replace.
	Worn internal or planetary gear teeth	Replace.
	Lack of oil in each part	Lubricate.

Condition	Possible Cause	Correction
Starting motor does not stop running	Fused contact points of magnetic switch	Replace magnetic switch.
	Short-circuit between turns of magnetic switch coil (layer short-circuit)	Replace magnetic switch.
	Failure of returning action in ignition switch	Replace.

Performance Test

CAUTION:
Each test must be performed within 3 – 5 seconds to avoid coil from burning.

PULL-IN TEST

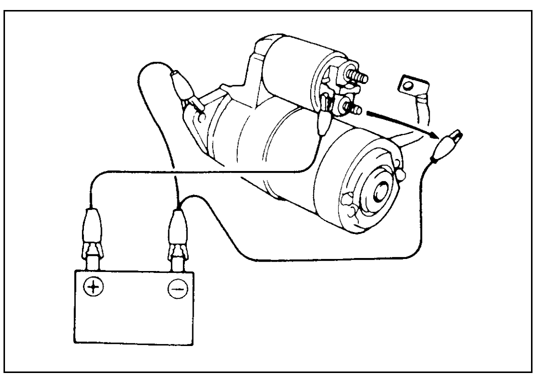


Connect battery to magnetic switch as shown.
Check that plunger and pinion move outward.
If plunger and pinion don't move, replace magnetic switch.

NOTE:
Before testing, disconnect lead wire from terminal M.

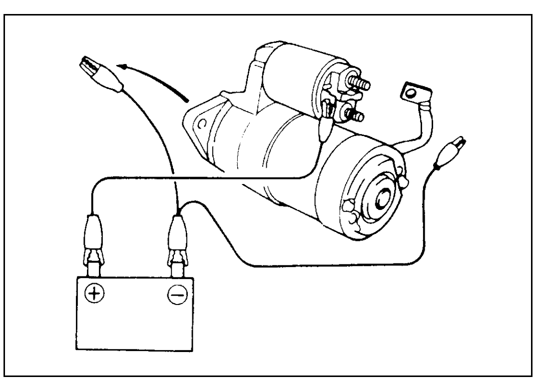
1.	Terminal "S"
2.	Terminal "M"
3.	Lead wire (switch to motor)

HOLD-IN TEST

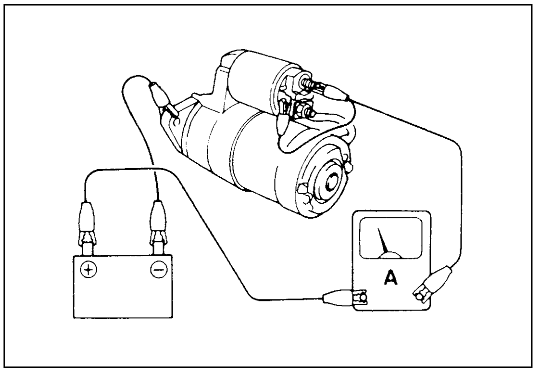


While connected as above with plunger out, disconnect negative lead from terminal "M".
Check that plunger and pinion remain out.
If plunger and pinion return inward, replace magnetic switch.

PLUNGER AND PINION RETURN TEST



Disconnect negative lead from starting motor body.
Check that plunger and pinion return inward.
If plunger and pinion don't return, replace magnetic switch.



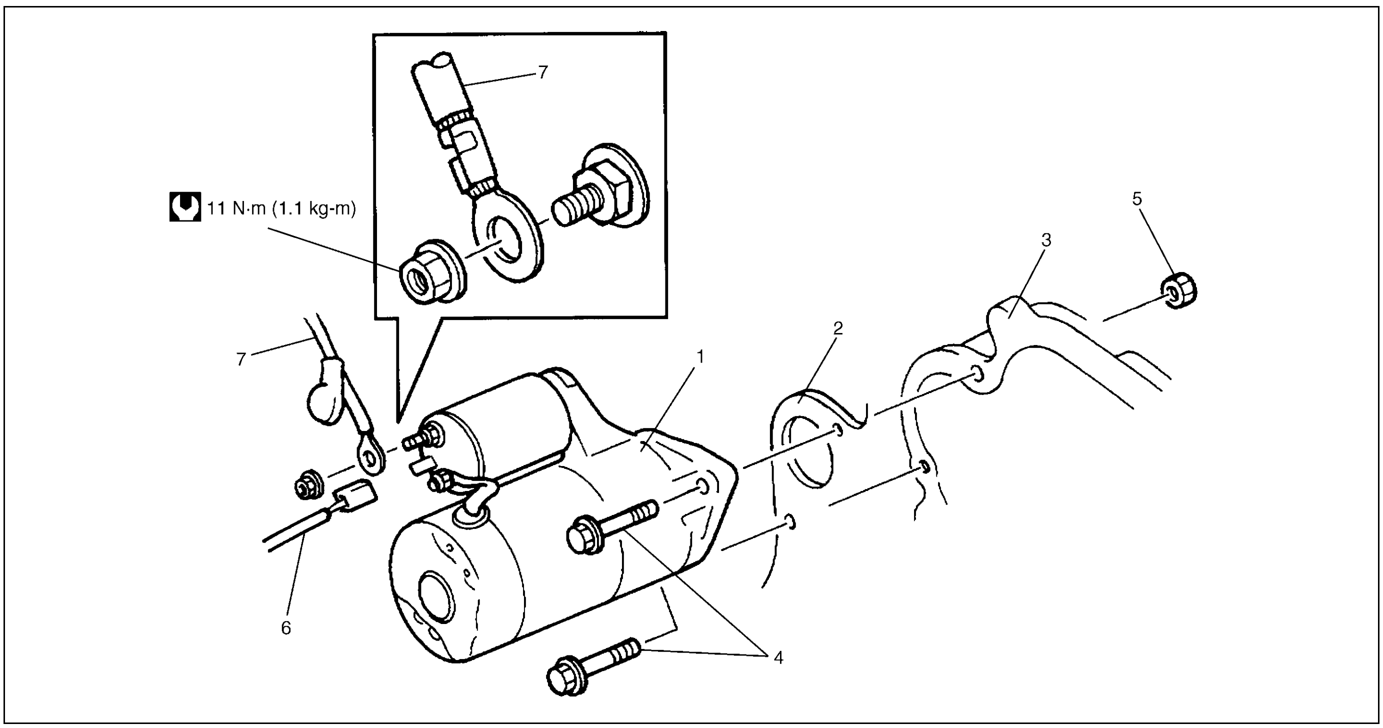
NO-LOAD PERFORMANCE TEST

Connect battery and ammeter to starter as shown.
Check that starter rotates smoothly and steadily with pinion moving out. Check that ammeter indicates specified current.

Specified current (No-load performance test)
: 90 A MAX. at 11 V

On-Vehicle Service

Starting Motor



1. Starting motor	3. Transmission case	5. Starting motor mounting nut	7. Battery cable
2. Clutch housing upper plate	4. Starting motor mounting bolt	6. Magnetic switch lead wire	Tightening Torque

DISMOUNTING

1) Disconnect negative (–) battery lead at battery.
2) Disconnect magnetic switch lead wire (6) and battery cable (7) from starting motor terminals.
3) Remove starting motor mount bolts (4) and nut (5).
4) Remove starting motor (1).

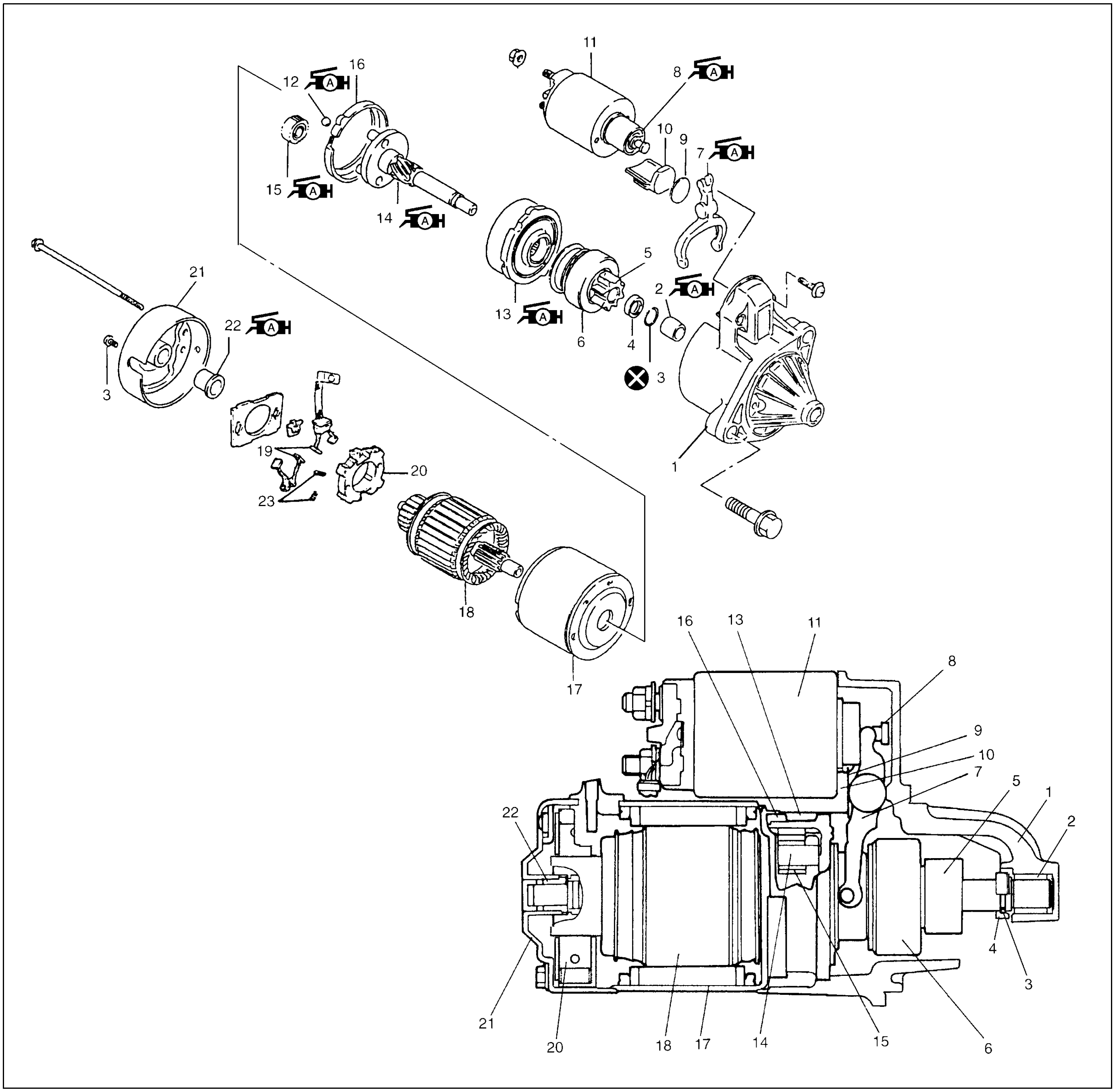
REMOUNTING

Reverse the dismounting procedure.

DISASSEMBLY AND REASSEMBLY

NOTE:

- **Make sure to apply grease before assembly, where are indicated "A" in the figure below.**
- **Spare parts have been lubricated.**



1. Front housing	6. Over-running clutch	11. Magnetic switch	16. Packing	21. Rear bracket
2. Bush	7. Lever	12. Ball	17. Yoke	22. Rear bush
3. Snap ring	8. Plunger	13. Internal gear	18. Armature	23. Brush spring
4. Pinion stop ring	9. Plate	14. Planetary carrier shaft	19. Brush	Apply grease (99000-25010)
5. Pinion gear	10. Seal rubber	15. Planetary gear	20. Brush holder	Do not reuse.

Specifications

<table>
<tr><td colspan="3">Voltage</td><td colspan="2">12 volts</td></tr>
<tr><td colspan="3">Output</td><td>0.9 kW</td><td>1.2 kW</td></tr>
<tr><td colspan="3">Rating</td><td colspan="2">30 seconds</td></tr>
<tr><td colspan="3">Direction of rotation</td><td colspan="2">Clockwise as viewed from pinion side</td></tr>
<tr><td colspan="3">Brush length</td><td>12.3 mm (0.48 in.)</td><td>12.3 mm (0.48 in.)</td></tr>
<tr><td colspan="3">Number of pinion teeth</td><td colspan="2">8</td></tr>
<tr><td colspan="2">Performance</td><td>Condition</td><td colspan="2">Guarantee</td></tr>
<tr><td rowspan="6">Around at
20° C (68 °F)</td><td>No load characteristic</td><td>11.0 V</td><td>90 A maximum
2,800 rpm minimum</td><td>90 A maximum
2,500 rpm minimum</td></tr>
<tr><td rowspan="2">Load characteristic</td><td>8.0 V
200 A</td><td>4.8 N·m (0.48 kg-m,
3.5 lb-ft) minimum
1,260 rpm minimum</td><td>–</td></tr>
<tr><td>7.5 V
300 A</td><td>–</td><td>10.5 N·m (1.05 kg-m,
7.6 lb-ft) minimum
880 rpm minimum</td></tr>
<tr><td rowspan="2">Locked rotor current</td><td>3.5 V</td><td>550 A maximum
12.2 N·m (1.22 kg-m,
8.8 lb-ft) minimum</td><td>–</td></tr>
<tr><td>4.0 V</td><td>–</td><td>760 A maximum
19.5 N·m (1.95 kg-m,
14.1 lb-ft) minimum</td></tr>
<tr><td colspan="2">Magnetic switch operating voltage</td><td colspan="2">8 volts maximum</td></tr>
</table>

SECTION 6H

CHARGING SYSTEM

WARNING:

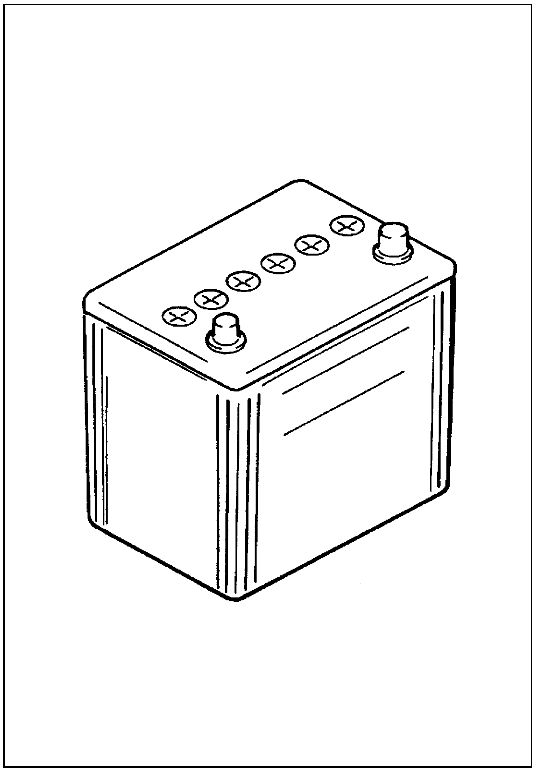
For vehicles equipped with Supplemental Restraint (Air Bag) System

- **Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to "Air Bag System Components and Wiring Location View" under "General Description" in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and "Service Precautions" under "On-Vehicle Service" in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.**
- **Technical service work must be started at least 90 seconds after the ignition switch is turned to the "LOCK" position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).**

CONTENTS

General Description

Battery



The battery has three major functions in the electrical system.

- It is a source of electrical energy for cranking the engine.
- It acts as a voltage stabilizer for the electrical system.
- It can, for a limited time, provide energy when the electrical load exceeds the output of the generator.

CARRIER AND HOLD-DOWN

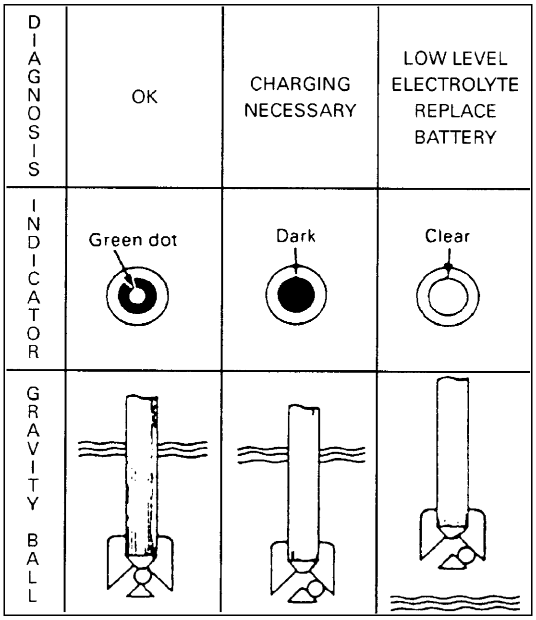
The battery carrier should be in good condition so that it will support the battery securely and keep it level.
Before installing the battery, the battery carrier and hold-down clamp should be clean and free from corrosion and make certain there are no parts in carrier.
To prevent the battery from shaking in its carrier, the hold-down bolts should be tight enough but not over-tightened.

ELECTROLYTE FREEZING

The freezing point of electrolyte depends on its specific gravity. Since freezing may ruin a battery, it should be protected against freezing by keeping it in a fully charged condition. If a battery is frozen accidentally, it should not be charged until it is warmed.

SULFATION

If the battery is allowed to stand for a long period in discharged condition, the lead sulfate becomes converted into a hard, crystalline substance, which will not easily turn back to the active material again during the subsequent recharging. “Sulfation” means the result as well as the process of that reaction.
Such a battery can be revived by very slow charging and may be restored to usable condition but its capacity is lower than before.



BUILT-IN INDICATOR (IF EQUIPPED)

The battery has a built-in temperature compensated indicator in the top of the battery. This indicator is to be used with the following diagnostic procedure. When checking the indicator, make sure that the battery has a clean top. A light may be needed in some poorly-lit areas.

Three types of indication which is available under normal operation are as follows.

- Green Dot
  Battery is sufficiently charged for testing.
- Dark
  Battery must be charged before testing.
  If there is a cranking complaint, battery should be tested as described in Diagnosis section. Charging and electrical systems should also be checked at this time.
- Clear or Light Yellow
  This means that fluid level is below the bottom of hydrometer. Its possible cause is excessive or prolonged charging, a broken case, excessive tipping or normal battery deterioration.
  When the battery is found in such condition, it is possible that high charging voltage is caused by the faulty charging system and therefore, charging and electrical systems need to be checked. If there is a trouble in cranking and its cause lies in the battery, it should be replaced.

CARE OF BATTERY

WARNING:

- **Never expose battery to open flame or electric spark because of battery generate gas which is flammable and explosive.**
- **Do not allow battery fluid to contact eyes, skin, fabrics, or painted surfaces as fluid is a corrosive acid. Flush any contacted area with water immediately and thoroughly.**
- **Batteries should always be kept out of reach of children.**

1) The battery is a very reliable component, but needs periodical attentions.
   - Keep the battery carrier clean.
   - Prevent rust formation on the terminal posts.
   - Keep the electrolyte up to the upper level uniformly in all cells.

When keeping battery on vehicle over a long period of time, follow instructions given below.

- Weekly, start the engine and run it until it reaches normal operating temperature with engine speed of 2,000 to 3,000 rpm. Make sure all electric switches are off before storing the vehicle.
- Recharge the battery twice a month to prevent it from discharging excessively. This is especially important when ambient temperature is low.
  The battery discharges even when it is not used, while vehicles are being stored. Battery electrolyte can freeze and battery case can crack at cold ambient condition if battery is not properly charged.

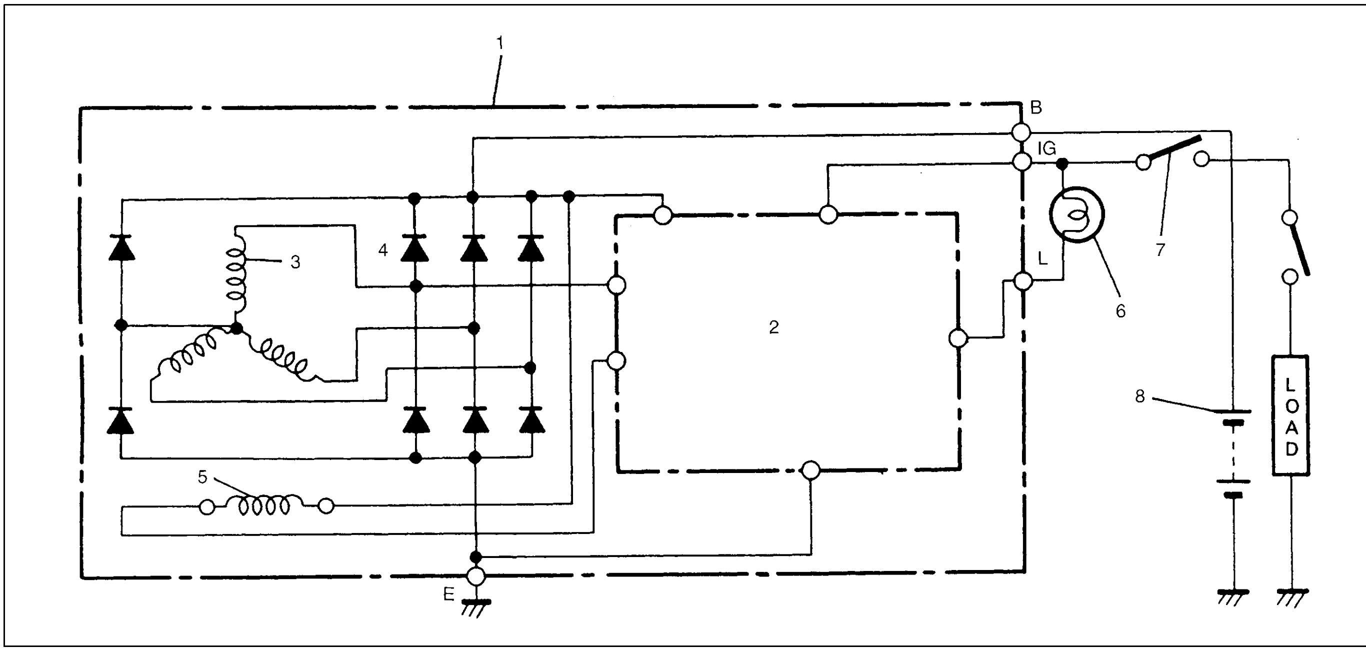
2) Keep the battery cable connections clean.
   The cable connections, particularly at the positive (+) terminal post, tend to become corroded. The product of corrosion, or rust, on the mating faces of conductors resists the flow of current.
   Clean the terminals and fittings periodically to ensure good metal-to-metal contact, and grease the connections after each cleaning to protect them against rusting.
3) Be always in the know as to the state of charge of the battery. The simplest way to tell the state of charge is to carry out a hydrometer test. The hydrometer is an instrument for measuring the specific gravity (S.G.) of the battery electrolyte. The S.G. of the electrolyte is indicative of the state of charge. Refer to “HYDROMETER TEST” in this section.

Generator

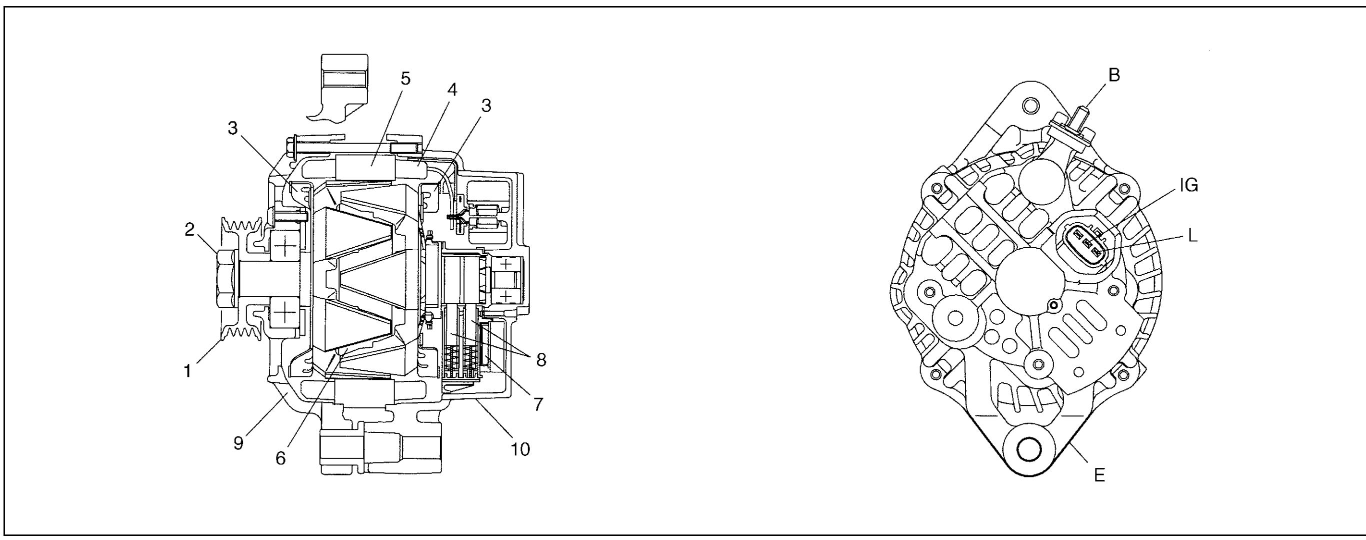
The generator is a small and high performance type with an IC regulator incorporated.
The internal components are connected electrically as shown below figure.

The generator features are as follows:

- Solid state regulator is mounted inside the generator.
- All regulator components are enclosed into a solid mold.
- This unit along with the brush holder assembly is attached to the rear housing.
- The IC regulator uses integrated circuits and controls the voltage produced by the generator, and the voltage setting cannot be adjusted.
- The generator rotor bearings contain enough grease to eliminate the need for periodic lubrication. Two brushes carry current through the two slip rings to the field coil mounted on the rotor, and under normal conditions will provide long period of attention-free service.
- The stator windings are assembled on the inside of a laminated core that forms part of the generator frame.
- A condenser mounted in the rear housing suppresses radio noise.



1. Generator with regulator assembly	3. Stator coil	5. Field coil (rotor coil)	7. Main switch
2. I.C. regulator	4. Diode	6. Charge indicator light	8. Battery



1. Pulley	5. Stator core	9. Front housing	IG: Ignition terminal
2. Pulley nut	6. Field coil	10. Rear housing	L: Lamp terminal
3. Rotor fan	7. Regulator	B: Generator output (Battery terminal)	
4. Stator coil	8. Brush	E: Ground	

Diagnosis

Battery

COMMON CAUSES OF FAILURE

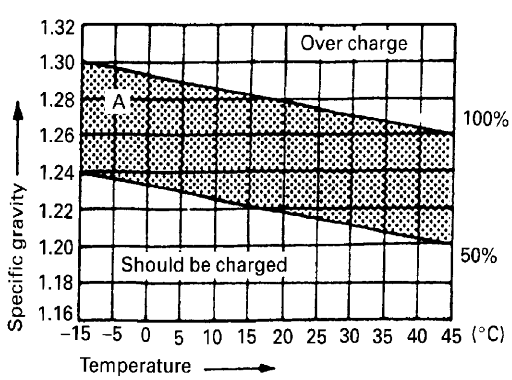
A battery is not designed to last indefinitely; however, with proper care, it will provide many years of service. If the battery performs satisfactorily during test but fails to operate properly for no apparent reason, the followings are some factors that may point to the cause of trouble:

- Accessories left on overnight or for an extended period without the generator operating.
- Slow average driving speeds for short periods.
- Electrical load exceeding generator output particularly with addition of after market equipment.
- Defects in charging system such as high resistance, slipping drive belt, loose generator output terminal, faulty generator or voltage regulator. Refer to “Generator” in this “Diagnosis” section.
- Battery abuse, including failure to keep battery cable terminals clean and tight or loose battery hold down.
- Mechanical problems in electrical system such as shorted or pinched wires.

VISUAL INSPECTION

Check for obvious damage, such as cracked or broken case or cover, that could permit loss of electrolyte. If obvious damage is noted, replace battery. Determine cause of damage and correct as needed.

HYDROMETER TEST



The direct method of checking the battery for state of charge is to carry out a high rate discharge test, which involves a special precise voltmeter and an expensive instrument used in the service shops, but not recommendable to the user of the vehicle.

At 20 °C of battery temperature (electrolyte temperature):

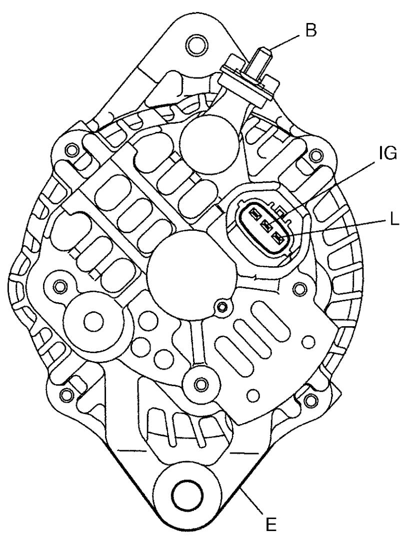
- The battery is in FULLY CHARGED STATE if the electrolyte S.G. is 1.280.
- The battery is in HALF CHARGED STATE if the S.G. is 1.220.
- The battery is in NEARLY DISCHARGED STATE if the S.G. is 1.150 and is in danger of freezing.

As the S.G. varies with the temperature, if battery temperature is not at 20 °C (68 °F), you have to correct your S.G. reading (taken with your hydrometer) to the value at 20 °C (68 °F) and apply the corrected S.G. value to the three-point guide stated value. For the manner of correction, refer to the graph showing the relation between S.G. value and temperature.

How to use the temperature-corrected state-of-charge graph

Suppose your S.G. reading is 1.28 and the battery temperature is –5 °C (23 °F). Locate the intersection of the –5 °C line and the 1.28 S.G. line.
The intersection is within the "A" zone (shaded area in the graph) and that means CHARGED STATE.
To know how much the battery is charged, draw a line parallel to the zone demarcation line and extend it to the right till it meets with the percentage scale. In the present example, the line meets at about 85% point on the percentage scale. Therefore, the battery is charged up to the 85% level.

Generator



CAUTION:
- **Do not mistake polarities of IG terminal and L terminal.**
- **Do not make a short circuit between IG and L terminals. Always connect these terminals through a lamp.**
- **Do not connect any load between L and E.**
- **When connecting a charger or a booster battery to vehicle battery, refer to this section describing battery charging.**

B:	Generator output (Battery terminal)
E:	Ground
IG:	Ignition terminal
L:	Lamp terminal

Trouble in charging system will show up as one or more of following conditions:
1) Faulty indicator lamp operation.
2) An undercharged battery as evidenced by slow cranking or indicator dark.
3) An overcharged battery as evidenced by excessive spewing of electrolyte from vents.

Noise from generator may be caused by a loose drive pulley, loose mounting bolts, worn or dirty bearings, defective diode, or defective stator.

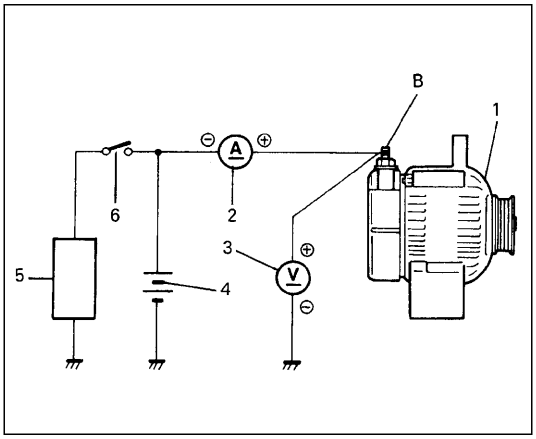
FAULTY INDICATOR LAMP OPERATION

Condition	Possible Cause	Correction
Charge light does not light with ignition ON and engine off	Fuse blown	Check fuse.
	Light burned out	Replace light.
	Wiring connection loose	Tighten loose connection.
	IC regulator or field coil faulty	Check generator.
Charge light does not go out with engine running (battery requires frequent recharging)	Drive belt loose or worn	Adjust or replace drive belt.
	IC regulator or generator faulty	Check charging system.
	Wiring faulty	Repair wiring.

UNDERCHARGED BATTERY

This condition, as evidenced by slow cranking or indicator clear with red dot can be caused by one or more of the following conditions even though indicator lamp may be operating normal.
Following procedure also applies to cars with voltmeter and ammeter.

1) Make sure that undercharged condition has not been caused by accessories left on for extended period of time.
2) Check drive belt for proper tension.
3) If battery defect is suspected, refer to BATTERY section.
4) Inspect wiring for defects. Check all connections for tightness and cleanliness, battery cable connections at battery, starting motor and ignition ground cable.



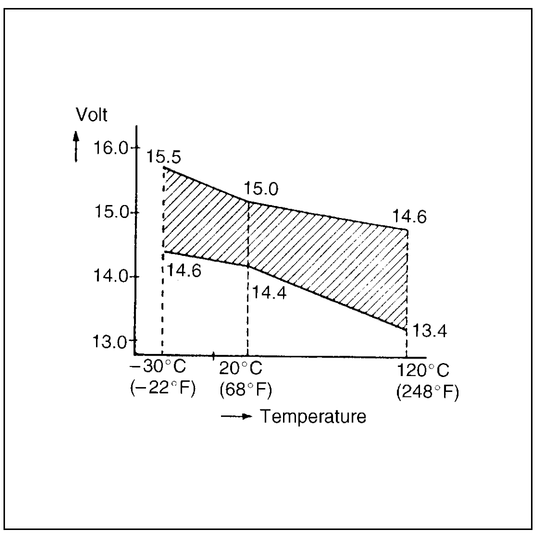
5) Connect voltmeter and ammeter as shown in the figure.

NOTE:
Use fully charged battery.

1.	Generator
2.	Ammeter (between generator (B) terminal and battery (+) terminal)
3.	Voltmeter (between generator (B) terminal and ground)
4.	Battery
5.	Load
6.	Switch

6) Measure current and voltage.

No-load Check



1) Run engine from idling up to 2,000 rpm and read meters.

NOTE:
Turn off switches of all accessories (wiper, heater etc.).

Standard current
10 A maximum
Standard voltage
14.4 – 15.0 V (at 20 °C, 68 °F)

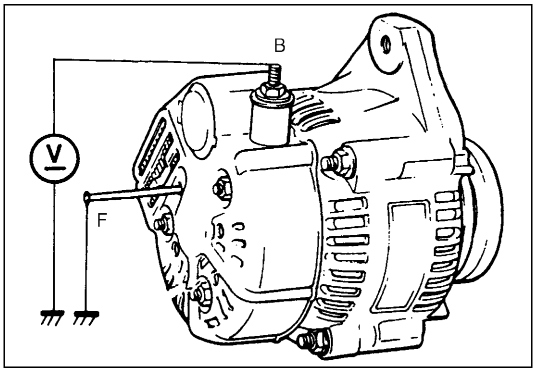
NOTE:
Consideration should be taken that voltage will differ somewhat with regulator case temperature as shown in the graph.

Higher Voltage

If voltage is higher than standard value, check ground of brushes.
If brushes are not grounded, replace IC regulator.

Lower Voltage

If voltage is below or in standard value, increase engine speed up to 2,000 – 2,500 rpm soon after starting engine, and read maximum value on ammeter immediately.
If current is less than 49 A, repair or replace generator.

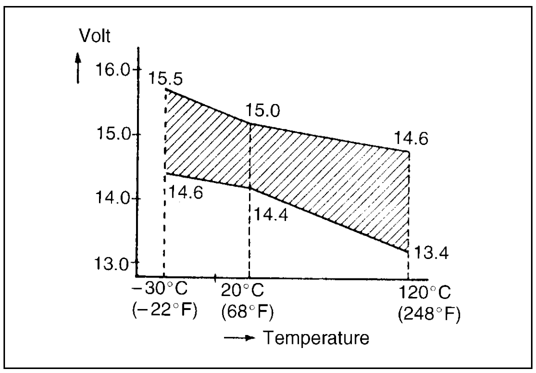


2) Ground F terminal and start engine, then measure voltage at B terminal as shown in left figure.
   - Voltage is higher than standard value
     It is considered that generator itself is good but IC regulator has been damaged, replace IC regulator.
   - Voltage is lower than standard value
     Generator itself has problem, check the generator.

Load Check

1) Run engine at 2,000 rpm and turn on head light and heater motor.
2) Measure current and if it is less than 20 A repair or replace generator.

OVERCHARGED BATTERY



1) To determine battery condition, refer to Battery section.
2) If obvious overcharged condition exists as evidenced by excessive spewing of electrolyte, measure generator B terminal voltage at engine 2,000 rpm.
3) If measured voltage is higher than upper limit value, proceed to disassembly section of generator service.
4) Check ground of brushes. If brushes are not grounded, replace IC regulator. Then check field coil for grounds and shorts, referring to “INSPECTION” section.

On-Vehicle Service

Battery

Jump starting in case of emergency

WITH AUXILIARY (BOOSTER) BATTERY

CAUTION:
If vehicle is manual transmission model and has a catalytic converter, do not push or tow it to start. Damage to its emission system and/or to other parts may result.

Both booster and discharged battery should be treated carefully when using jumper cables. Follow procedure outlined below, being careful not to cause sparks.

WARNING:
- **Departure from these conditions or procedure described below could result in:**
  - **Serious personal injury (particularly to eyes) or property damage from such causes as battery explosion, battery acid, or electrical burns.**
  - **Damage to electronic components of either vehicle.**
- **Remove rings, watches, and other jewelry. Wear approved eye protection.**
- **Be careful so that metal tools or jumper cables do not contact positive battery terminal (or metal in contact with it) and any other metal on vehicle, because a short circuit could occur.**

1) Set parking brake and place automatic transmission in PARK (NEUTRAL on manual transmission). Turn off ignition, turn off lights and all other electrical loads.
2) Check electrolyte level. If it is below low level line, add distilled water.
3) Attach end of one jumper cable to positive terminal of booster battery and the other end of the same cable to positive terminal of discharged battery. (Use 12-volt battery only to jump start engine).
4) Attach one end of the remaining negative cable to negative terminal of booster battery, and the other end to a solid engine ground (such as exhaust manifold) at least 45 cm (18 in.) away from battery of vehicle being started.

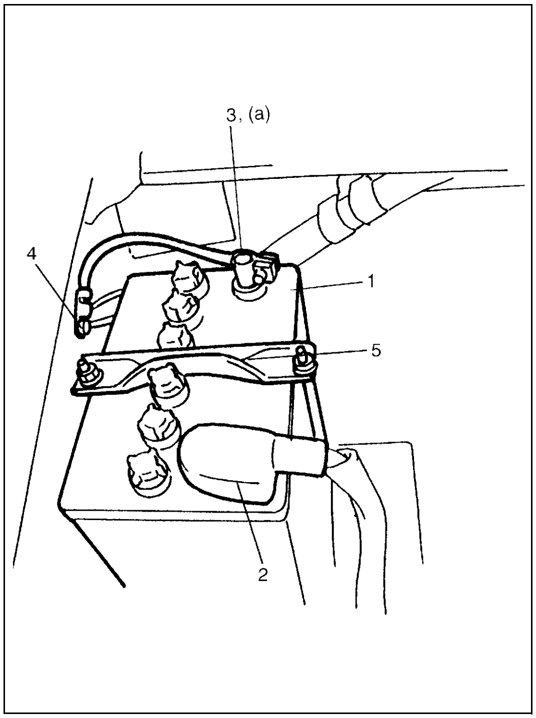
WARNING:
Do not connect negative cable directly to negative terminal of dead battery.

5) Start engine of vehicle with booster battery and turn off electrical accessories. Then start engine of the vehicle with discharged battery.
6) Disconnect jumper cables in the exact reverse order.

WITH CHARGING EQUIPMENT

CAUTION:
When jump starting engine with charging equipment, be sure equipment used is 12-volt and negative ground. Do not use 24-volt charging equipment. Using such equipment can cause serious damage to electrical system or electronic parts.

Dismounting



1) Disconnect negative cable (3).
2) Disconnect positive cable (2).
3) Remove retainer (5).
4) Remove battery (1).

4. Body ground bolt

Handling

When handling battery, following safety precautions should be followed:

- Hydrogen gas is produced by battery. A flame or spark near battery may cause the gas to ignite.
- Battery fluid is highly acidic. Avoid spilling on clothing or other fabric. Any spilled electrolyte should be flushed with large quantity of water and cleaned immediately.

Remounting

1) Reverse removal procedure.
2) Torque battery cables to specification.

NOTE:

Check to be sure that ground cable has enough clearance to hood panel by terminal.

Tightening torque
Body ground bolt (a) : 8.0 N·m (0.8 kg-m, 6.0 lb-ft)

Generator

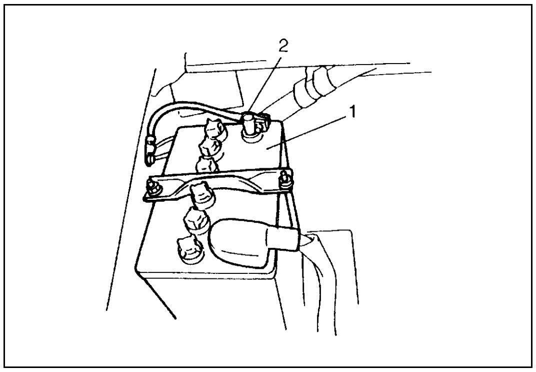
Generator belt

Refer to “Water Pump Belt and Cooling Fan” in Section 6B.

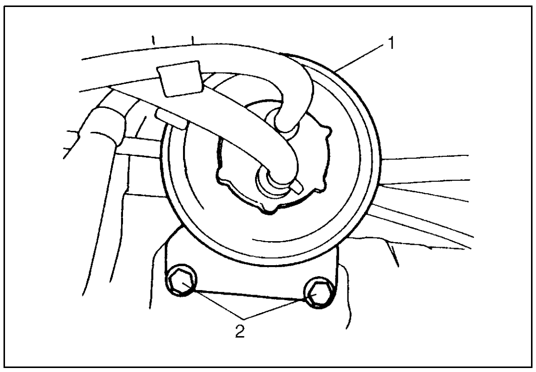
Unit Repair Overhaul

Generator

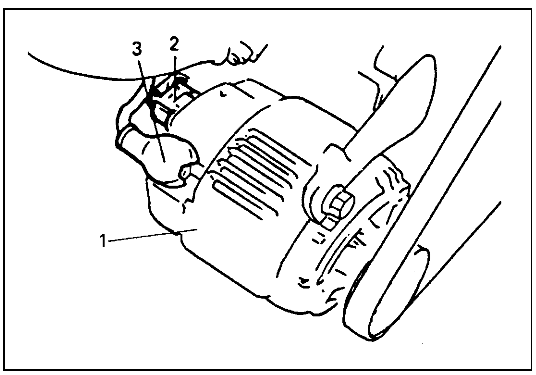
Dismounting



1) Disconnect negative (–) cable (2) at battery (1).

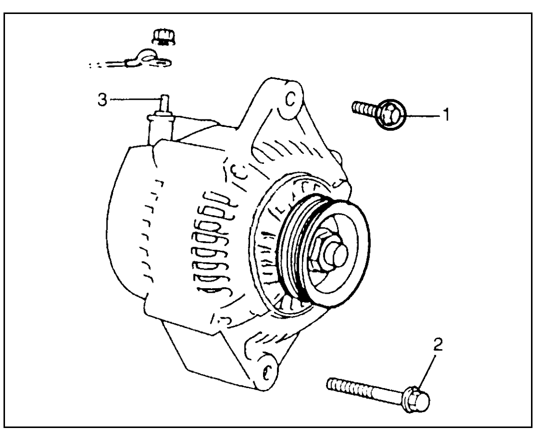


2) Remove bolts (2) and then canister (1) together with its bracket.



3) Disconnect “B” terminal wire (3) and coupler (2) from generator (1).

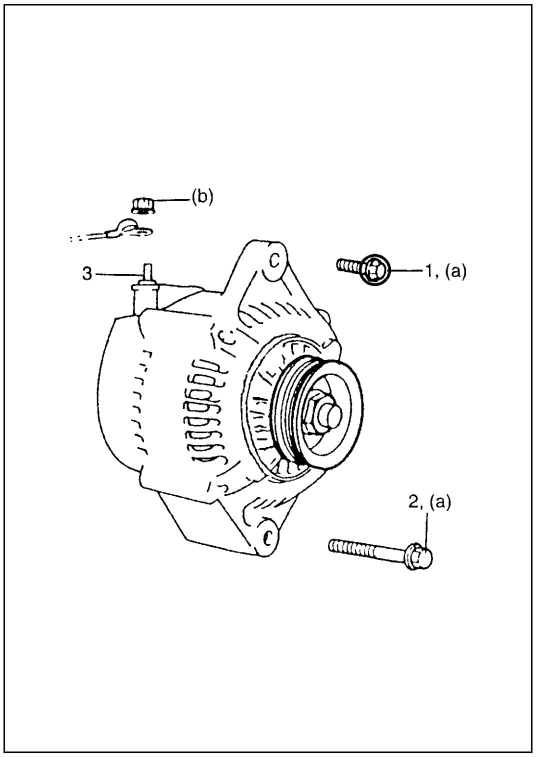
4) Remove generator belt. Refer to “Water Pump Belt and Cooling Fan” in Section 6B.



5) Remove generator.

1.	Generator adjusting bolt
2.	Generator pivot bolt
3.	“B” terminal

Remounting



1) Mount generator on the generator bracket.
2) Tighten generator bolts.

Tightening torque
Generator pivot bolt
(a) : 23 N·m (2.3 kg-m, 16.5 lb-ft)
(b) : 50 N·m (5.0 kg-m, 36.0 lb-ft)

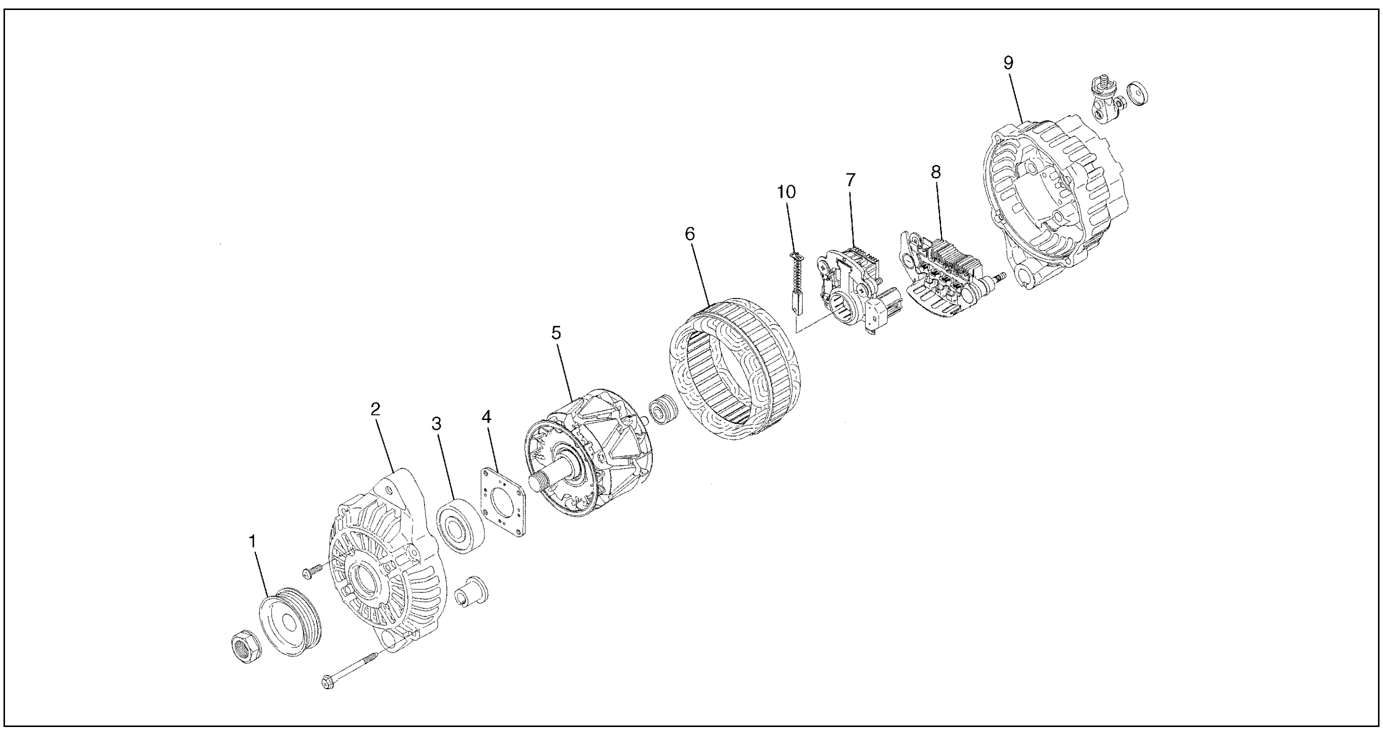
3) Install generator (cooling fan) belt. Refer to “Water Pump Belt and Cooling Fan” in Section 6B.
4) Connect “B” terminal wire (3) and coupler to generator.

Tightening torque
“B” terminal outer nut of generator
(b) : 8.0 N·m (0.8 kg-m, 6.0 lb-ft)

1.	Upper generator bolt (Short)
2.	Lower generator bolt (Long)

5) Install canister.
6) Connect negative (–) cable at battery.

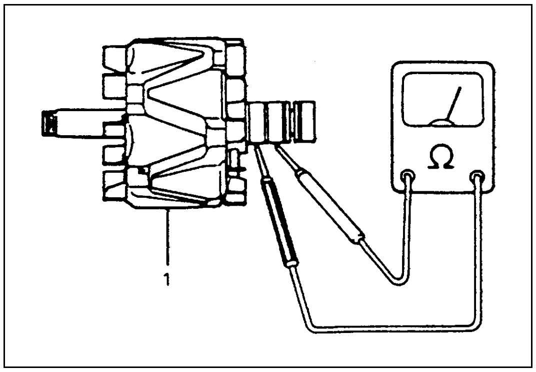
Disassembly and reassembly



1. Pulley	5. Rotor	9. Rear housing
2. Front housing	6. Stator	10. Brush
3. Bearing	7. IC regulator	
4. Retainer	8. Rectifier	

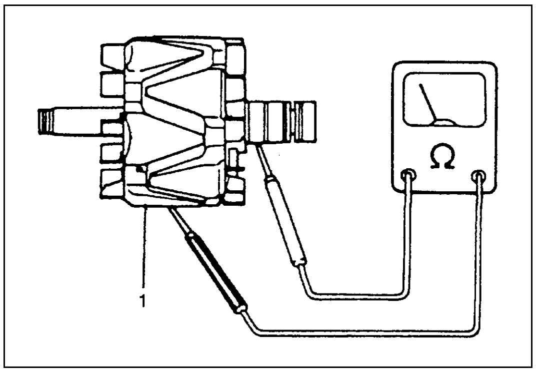
Inspection

Rotor

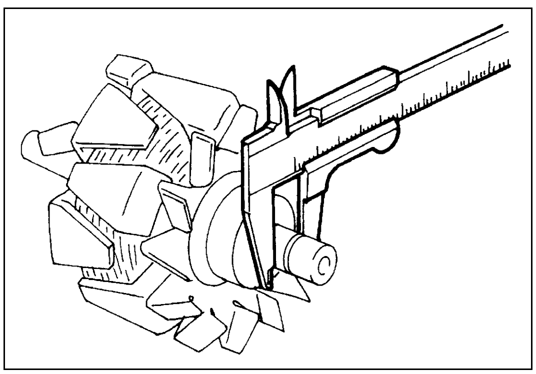


1) Using ohmmeter, check for continuity between slip rings of rotor (1). If there is no continuity, replace rotor.

Standard resistance between slip rings of rotor
1.8 – 2.1 Ω



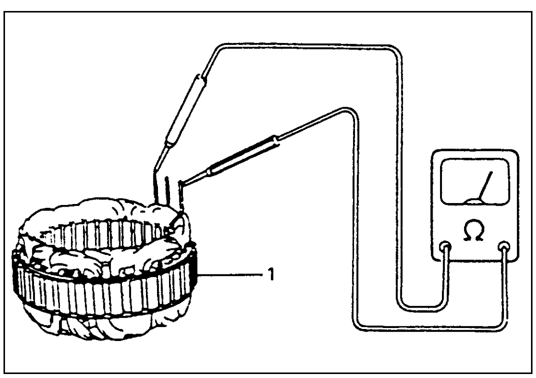
2) Using ohmmeter, check that there is no continuity between slip ring and rotor core. If there is continuity, replace rotor.
3) Check slip rings for roughness or scoring. If rough or scored, replace rotor (1).



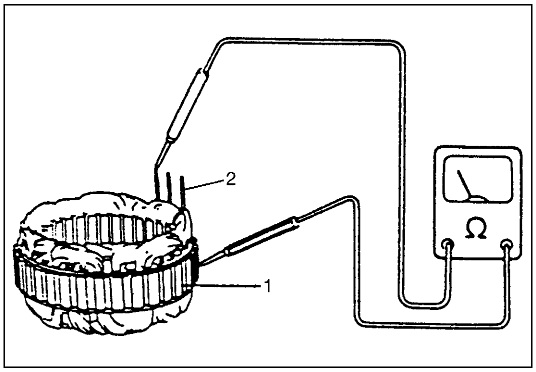
4) Check slip rings for roughness or scoring. If rough or scored, replace rotor.
   Using a vernier caliper, measure the slip ring diameter.
   If the diameter is less than minimum, replace the rotor.

Slip ring diameter
Standard : 14.4 mm (0.567 in.)
Limit : 14.0 mm (0.551 in.)

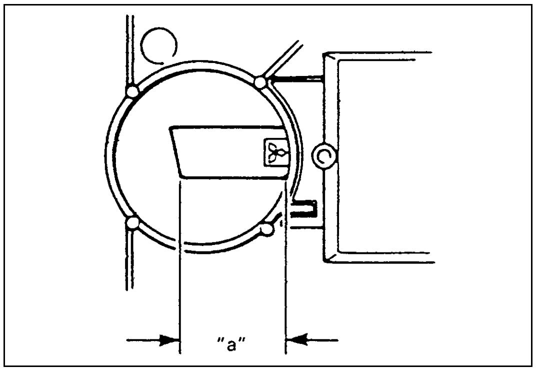
Stator



1) Using ohmmeter, check all leads for continuity.
   If there is no continuity, replace stator (1).



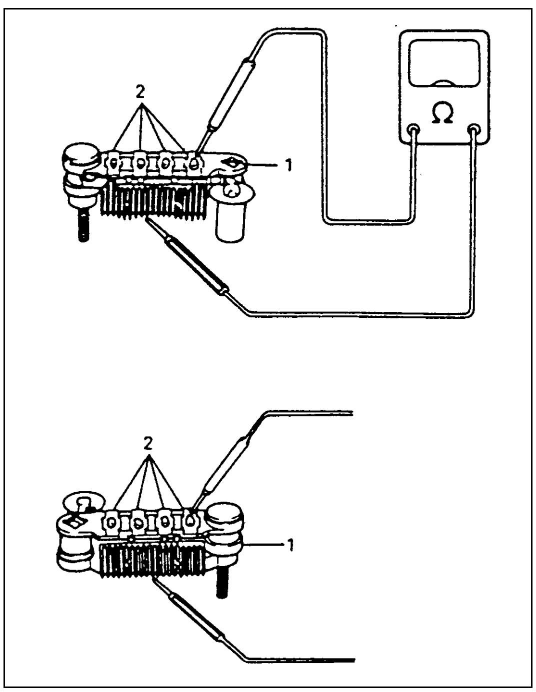
2) Using ohmmeter, check that there is no continuity between coil leads (2) and stator core. If there is continuity, replace stator (1).



Brush and Brush Holder

Check each brush for wear by measuring its length.
If brush is found worn down to service limit, replace brush.

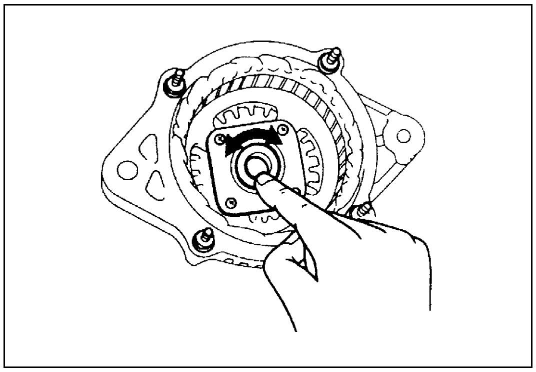
Brush length "a"
Standard : 16 mm (0.63 in.)
Service limit : 2 mm (0.08 in.)



Rectifier

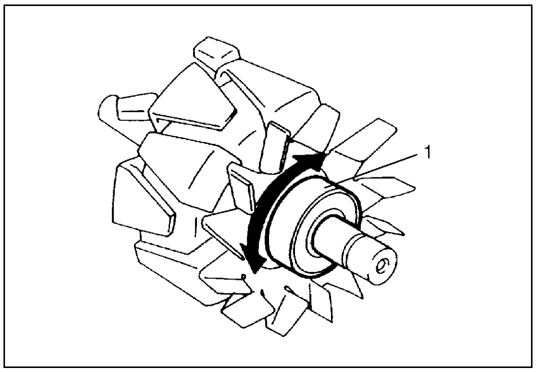
1) Using ohmmeter, check continuity between each of upper and lower rectifier bodies and each diode lead (2).
   Check both directions by reversing probes of ohmmeter and there should be only one-way continuity in each case.
   If check result is not satisfactory, replace rectifier (1).

Drive End Bearing



Check that the bearing is not rough or worn.

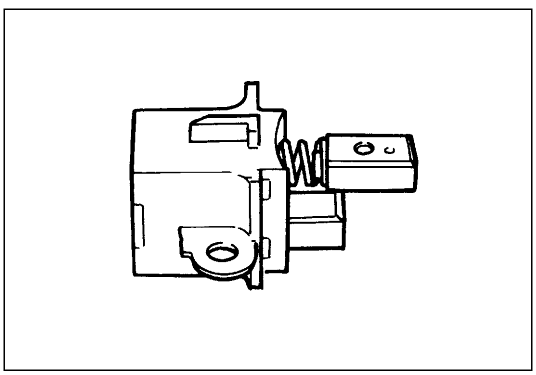
End Housing Bearing



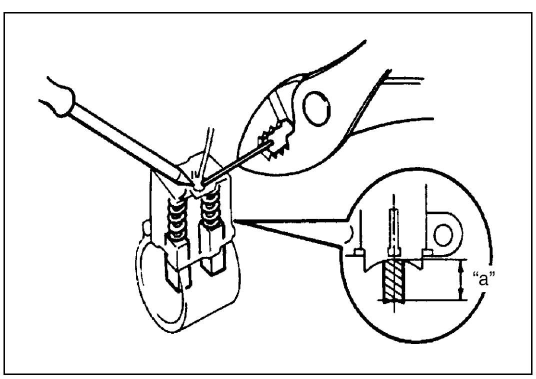
Check that the bearing is not rough or worn.
When removal is necessary, use bearing puller to remove end housing bearing (1).

> **CAUTION:**
> **Be careful not to distort cooling fan blade while applying puller.**

Replace Brush



1) Unsolder and remove the brush and spring.
2) Run the wire of a new brush through the spring and the hole in the brush holder, and insert the spring and brush into the brush holder.



3) Solder the brush wire to the brush holder at specified exposed length.

Exposed brush length
"a" : 10.5 mm (0.413 in.)

4) Check that the brush moves smoothly in the brush holder.
5) Cut off the excess wire.
6) Apply insulation paint to the soldered area.

Specifications

Battery

55B24R TYPE

Rated capacity	36 AH/5HR, 12 Volts
Electrolyte	3.1 L (6.55/5.46 US/Imp pt)
Electrolyte S.G.	1.28 when fully charged at 20 °C (68 °F)

38B20R TYPE

Rated capacity	28 AH/5HR, 12 Volts
Electrolyte	2.1 L (4.44/3.70 US/Imp pt)
Electrolyte S.G.	1.28 when fully charged at 20 °C (68 °F)

Generator

Type	70 A type
Rated voltage	12 V
Nominal output	70 A
Permissible max. speed	18,000 r/min.
No-load speed	1,300 r/min (rpm)
Setting voltage	14.4 to 15.0 V
Permissible ambient temperature	–30 to 90 °C (–22 to 194 °F)
Polarity	Negative ground
Rotation	Clockwise viewed from pulley side

Tightening Torque Specification

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
Body ground bolt	8	0.8	6.0
Generator mounting bolts	23	2.3	16.5
“B” terminal inner nut	4.2	0.42	3.0
“B” terminal outer nut	8	0.8	6.0
Pulley nut	118	11.8	85.5
Rear end frame nuts	4.5	0.45	3.5
Rear end cover nuts			
Rectifier “B” bolt	3.9	0.39	3.0
Stator stud bolts	8.8	0.88	6.5
Drive end bearing plate screws	2.6	0.26	2.0
Rectifier screws	2.0	0.20	1.5
Regulator and brush holder screws			
Terminal plate bolt	3.8	0.38	3.0