SECTION 6

ENGINE GENERAL INFORMATION AND DIAGNOSIS

WARNING:

For vehicles equipped with a 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 "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).**

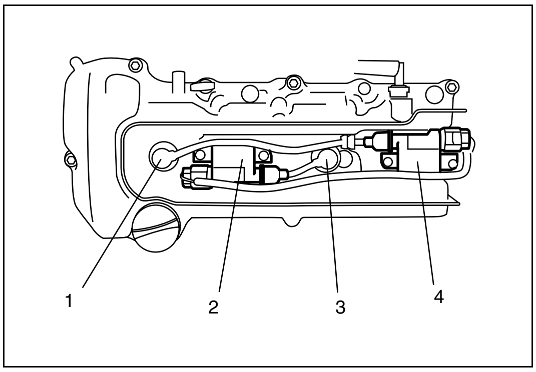
CONTENTS

General 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.

Precaution

Precaution 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.

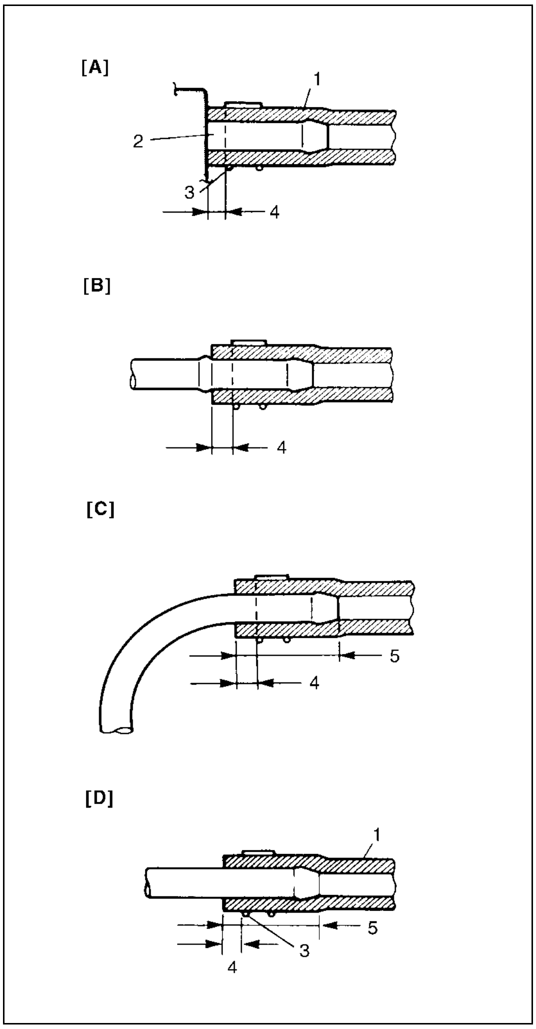
- When raising or supporting engine for any reason, do not use a jack under oil pan. Due to small clearance between oil pan and oil pump strainer, jacking against oil pan may cause it to be bent against strainer resulting in damaged oil pick-up unit.
- It should be kept in mind, while working on engine, 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 pressure regulator) 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.
- When installing injector, fuel feed pipe or lubricate its O-ring with gasoline.

[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 (0.12 – 0.27 in.) from hose end.
5.	20 to 30 mm (0.79 – 1.18 in.)

Fuel pressure relief procedure

CAUTION:

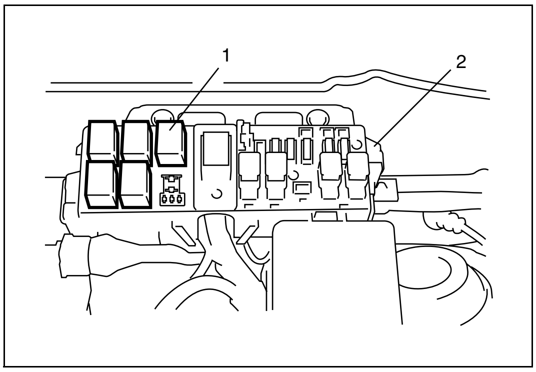
This work must not be done when engine is hot. If done so, it may cause adverse effect to catalyst.

NOTE:

If any service shown below is performed, ECM may detect DTC(s). Therefore, clear DTC(s) by referring to “Diagnostic Trouble Code (DTC) Clearance” in this section in case that DTC(s) is detected after all services are done.

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/fuse box cover.



3) Disconnect fuel pump relay (1) from relay/fuse box (2).
4) Remove fuel filter 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 relay/fuse box (2) and install relay/fuse box cover.

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.

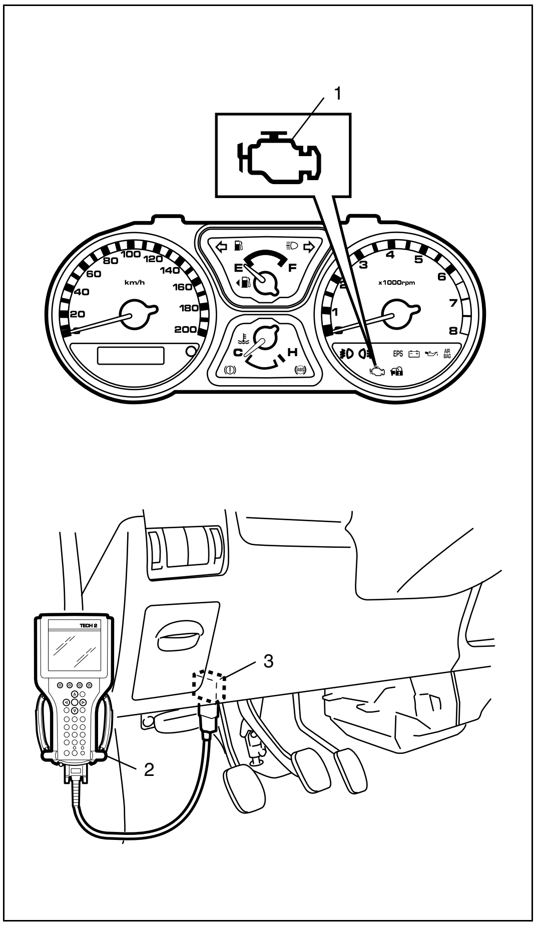
Diagnosis

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 and Emission Control System Check".
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.

On-Board Diagnostic System Description

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 circuit 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 OBD generic scan tool. (Diagnostic information can be accessed by using a scan tool.)

3. Data link connector (DLC)

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 CYCLE DETECTION LOGIC

The malfunction detected in the first driving cycle is stored in ECM memory (in the form of pending DTC) 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

[A]

1.	TROUBLE CODE	P0102	(1st)
2.	COOLANT TEMP.	80 °C	
3.	ENGINE SPEED	750 RPM	
4.	SHORT FT B1	– 0.8 %	
5.	SHORT FT B2	– 0.1 %	
6.	LONG FT B1	– 1.3 %	
7.	LONG FT B2	– 1.5 %	
8.	CALC LOAD	20.5 %	
9.	FUEL SYSTEM B1	CLOSED	
10.	FUEL SYSTEM B2	CLOSED	
11.	MAP	30.6 kPa	
12.	VEHICLE SPEED	0 km/h	

[B]

ECM stores the engine and driving conditions (in the form 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.

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".)

[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	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

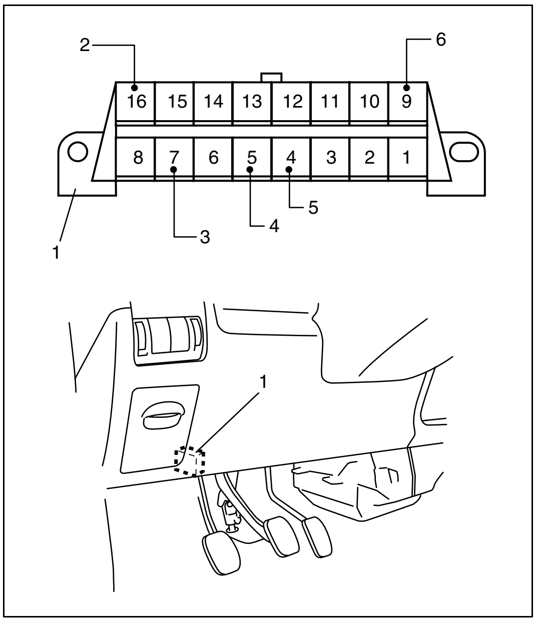
In the 2nd through the 4th frames, the freeze frame data of each malfunction is stored in the order as the malfunction is detected. These data are not updated.
Shown in the table below are examples of how freeze frame data are stored when two or more malfunctions are detected.

			FRAME			
			FRAME 1	FRAME 2	FRAME 3	FRAME 4
			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	P0401 (EGR) detected	Data at P0401 detection	Data at P0401 detection	–	–
	2	P0171 (Fuel system) detection	Data at P0171 detection	Data at P0401 detection	Data at P0171 detection	–
	3	P0300 (Misfire) detected	Data at P0171 detection	Data at P0401 detection	Data at P0171 detection	Data at P0300 detection
	4	P0301 (Misfire) detected	Data at P0171 detection	Data at P0401 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 SAE J1962 in the shape of connector and pin assignment.

OBD serial data line (3) (K line of ISO 9141) is used for Suzuki Scan Tool or OBD generic scan tool to communicate with ECM, 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 + (Unswitched Vehicle Battery Positive)
4.	ECM ground (Signal Ground)
5.	Vehicle body ground (Chassis Ground)

Precaution in Diagnosing Trouble for Engine

- Don't disconnect couplers from ECM, battery cable from 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 OBD 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
  If two or more 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 P0401/P0402 (EGR flow malfunction)
  – DTC P0171/P0172 (Fuel system too lean/too rich) and DTC P0401/P0402 (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 the 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 and Emission Control System Check

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

Step	Action	Yes	No
1	Customer Complaint Analysis 1) Perform customer complaint analysis referring to “1. CUSTOMER COMPLAINT ANALYSIS” in followings. Was customer complaint analysis performed?	Go to Step 2.	Perform customer complaint analysis.
2	Diagnostic Trouble Code (DTC) and Freeze Frame Data Check, Record and Clearance 1) Check for DTC (including pending DTC) referring to the “2. DIAGNOSTIC TROUBLE CODE (DTC)/ FREEZE FRAME DATA CHECK, RECORD AND CLEARANCE” in followings. Is there any DTC(s)?	Print DTC and freeze frame data or write them down and clear them by referring to “Diagnostic Trouble Code (DTC) Clearance” in this section, and go to Step 3.	Go to Step 4.
3	Visual Inspection 1) Perform visual inspection referring to the “3. and 4. VISUAL INSPECTION” in followings. Is there any faulty condition?	Repair or replace malfunction part, and go to Step 11.	Go to Step 5.
4	Visual Inspection 1) Perform visual inspection referring to the “3. and 4. VISUAL INSPECTION” in followings. Is there any faulty condition?		Go to Step 8.
5	Trouble Symptom Confirmation 1) Confirm trouble symptom referring to the “5. TROUBLE SYMPTOM CONFIRMATION” in followings. Is trouble symptom identified?	Go to Step 6.	Go to Step 7.
6	Rechecking and Record of DTC/Freeze Frame Data 1) Recheck for DTC and freeze frame data referring to “Diagnostic Trouble Code (DTC) Check” in this section. Is there any DTC(s)?	Go to Step 9.	Go to Step 8.
7	Rechecking and Record of DTC/Freeze Frame Data 1) Recheck for DTC and freeze frame data referring to “Diagnostic Trouble Code (DTC) Check” in this section. Is there any DTC(s)?		Go to Step 10.
8	Engine Basic Inspection and Engine Symptom Diagnosis 1) Check and repair according to “Engine Basic Inspection” and “Engine Symptom Diagnosis” in this section. Are check and repair complete?	Go to Step 11.	Check and repair malfunction part(s). Go to Step 11.
9	Trouble Shooting for DTC 1) Check and repair according to applicable DTC diag. flow table. Are check and repair complete?		
10	Check for Intermittent Problems 1) Check for intermittent problems referring to “10. CHECK FOR INTERMITTENT PROBLEM” in followings. Is there any faulty condition?	Repair or replace malfunction part(s), and go to Step 11.	Go to Step 11.

Step	Action	Yes	No
11	Final Confirmation Test 1) Clear DTC if any. 2) Perform final confirmation test referring to “11. FINAL CONFIRMATION TEST” in followings. Is there any problem symptom, DTC or abnormal condition?	Go to Step 6.	End.

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 “Diagnostic Trouble Code (DTC) Check” in this section. If DTC is indicated, print it and freeze frame data or write them down and then clear them by referring to “Diagnostic Trouble Code (DTC) Clearance” in this 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 6 and 7.
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.

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” in this 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 Flow Table”.

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

Refer to “Diagnostic Trouble Code (DTC) Check” in this section for checking procedure.

8. ENGINE BASIC INSPECTION AND ENGINE SYMPTOM DIAGNOSIS

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 Symptom Diagnosis” 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. DIAGNOSTIC TROUBLE CODE FLOW TABLE (See each DTC Diag. Flow Table)

Based on the DTC indicated in Step 6 or 7 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:	

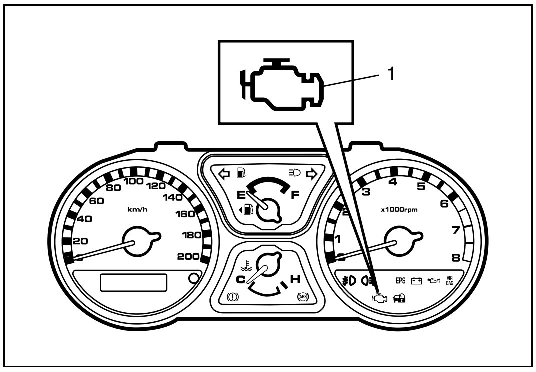
VEHICLE/ENVIRONMENTAL CONDITION WHEN PROBLEM OCCURS	
Environmental Condition	
Weather	☐Fair ☐Cloudy ☐Rain ☐Snow ☐Always ☐Other ________
Temperature	☐Hot ☐Warm ☐Cool ☐Cold (°F/ °C) ☐Always
Frequency	☐Always ☐Sometimes (times/ day, month) ☐Only once ☐Under certain condition
Road	☐Urban ☐Suburb ☐Highway ☐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:

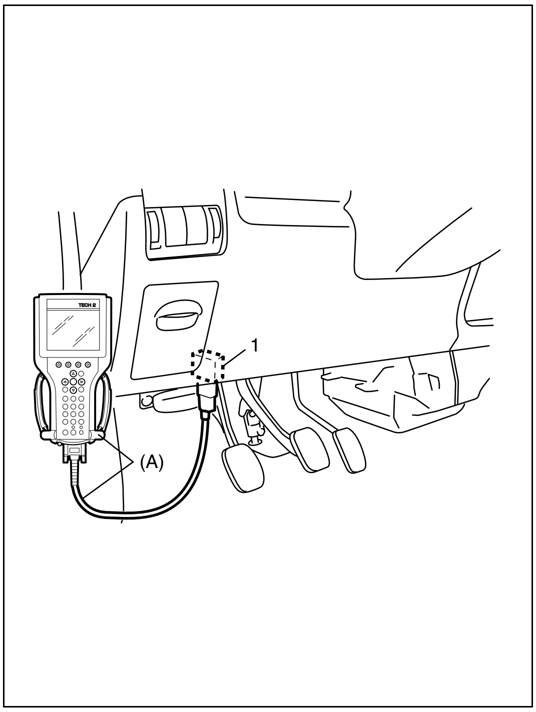
The above form is a standard sample. It should be modified according to conditions characteristic of each market.

Malfunction Indicator Lamp (MIL) Check



1) Turn ON ignition switch (but the engine at stop) and check that MIL (1) lights.
   If MIL does not light up (or MIL dims), go to “Malfunction Indicator Lamp Does Not Come “ON” at Ignition Switch ON (But Engine Stops)” for troubleshooting.
2) Start engine and check that MIL turns OFF.
   If MIL remains ON and no DTC is stored in ECM, go to “Malfunction Indicator Lamp Remains “ON” after Engine Starts” for troubleshooting.

Diagnostic Trouble Code (DTC) Check



1) Prepare OBD generic scan tool or 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.

Diagnostic Trouble Code (DTC) Clearance

1) Connect OBD generic scan tool or Suzuki Scan Tool to data link connector in the same manner as when making this connection for DTC check.
2) Turn ignition switch OFF and then 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 the 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 (see item "WARM-UP CYCLE" of "On-Board Diagnostic System Description" in this section).**

DTC Table

DTC NO.	DETECTING ITEM	DETECTING CONDITION (DTC will set when detecting:)	MIL
P0010	Camshaft position actuator circuit	Actual valve timing fails to become close to target advance level of each function although advance control function or retarding control function is at work.	2 driving cycles
P0011	Camshaft position - timing over-advanced or system performance	Actual valve of advanced valve timing does not reach target value, or valve timing is advanced although ECM command is most retarding.	1 driving cycle
P0012	Camshaft position - timing over-retarded		1 driving cycle
P0031	HO2S heater control circuit low (Sensor–1)	Heater current is lees than specification while heater ON.	2 driving cycles
P0032	HO2S heater control circuit high (Sensor–1)	Heater current is more than specification while heater ON.	2 driving cycles
P0037	HO2S heater control circuit low (Sensor–2)	Heater current is lees than specification while heater ON.	2 driving cycles
P0038	HO2S heater control circuit high (Sensor–2)	Heater current is more than specification while heater ON.	2 driving cycles
P0101	Mass air flow circuit range/ performance	Poor performance of MAF sensor	2 driving cycles
P0102	Mass air flow circuit low input	Low voltage	1 driving cycle
P0103	Mass air flow circuit high input	High voltage	
P0107	Manifold absolute pressure low input	Low voltage (or manifold absolute pressure sensor circuit open or shorted to ground)	1 driving cycle
P0108	Manifold absolute pressure high input	High voltage (or manifold absolute pressure sensor circuit shorted to power circuit)	1 driving cycle
P0112	Intake air temperature sensor circuit low	High temperature – low voltage (or IAT sensor circuit shorted to ground)	1 driving cycle
P0113	Intake air temperature sensor circuit high	Low temperature – high voltage (or IAT sensor circuit open)	
P0117	Engine coolant temperature sensor circuit low	High temperature – low voltage (or ECT sensor circuit shorted to ground)	1 driving cycle
P0118	Engine coolant temperature sensor circuit high	Low temperature – high voltage (or ECT sensor circuit open)	
P0121	Throttle position circuit range/performance	Poor performance of TP sensor	2 driving cycles
P0122	Throttle position circuit low	Low voltage (or TP sensor circuit shorted to ground)	1 driving cycle
P0123	Throttle position circuit high	High voltage (or TP sensor circuit open)	

DTC NO.	DETECTING ITEM	DETECTING CONDITION (DTC will set when detecting:)	MIL
P0131	O2 sensor (HO2S) circuit low voltage (Sensor–1)	Min. output voltage of HO2S–1 higher than specification	2 driving cycles
P0132	O2 sensor (HO2S) circuit high voltage (Sensor–1)	Max. output voltage of HO2S–1 is lower or higher than specification	
P0133	O2 sensor (HO2S) circuit slow response (Sensor–1)	Response time of HO2S–1 output voltage between rich and lean is longer than specification.	
P0134	O2 sensor (HO2S) circuit no activity detected (Sensor–1)	Output voltage of HO2S–1 fails to go above specification. (or HO2S–1 circuit open or short)	2 driving cycles
P0137	O2 sensor (HO2S) circuit low voltage (Sensor–2)	Min. output voltage of HO2S–2 is higher than specification	2 driving cycles
P0138	O2 sensor (HO2S) circuit high voltage (Sensor–2)	Max. output voltage of HO2S–2 is lower or higher than specification	2 driving cycles
P0171	System too lean	Total fuel trim is larger than specification for specified time or longer. (Fuel trim toward rich side is large.)	2 driving cycles
P0172	System too rich	Total fuel trim is smaller than specification for specified time or longer. (Fuel trim toward lean side is large.)	2 driving cycles
P0300	Random misfire detected	Misfire of such level as to cause damage to three way catalyst.	*1 driving cycle
P0301 P0302 P0303 P0304	Cylinder 1 misfire detected Cylinder 2 misfire detected Cylinder 3 misfire detected Cylinder 4 misfire detected	Misfire of such level as to deteriorate emission but not to cause damage to three way catalyst.	2 driving cycles
P0327	Knock sensor circuit low	Knock sensor circuit shorted to ground (low voltage)	1 driving cycle
P0328	Knock sensor circuit high	Knock sensor circuit open (high voltage)	1 driving cycle
P0335	Crankshaft position sensor circuit	No signal during engine running	1 driving cycle
P0340	Camshaft position sensor circuit	No reference signal during engine cranking or pulse number of position signal is out of specification.	
P0401	Exhaust gas recirculation flow insufficient detected	Insufficient EGR flow	2 driving cycles
P0402	Exhaust gas recirculation flow excessive detected	Excessive EGR flow	2 driving cycles
P0403	Exhaust gas recirculation control circuit	Low voltage (or EGR valve stepping motor coil circuit open or shorted to ground)	1 driving cycle
P0420	Catalyst system efficiency below threshold	Output waveforms of HO2S–1 and HO2S–2 are similar.	2 driving cycles
P0443	Evaporative emission system purge control valve circuit	Monitor signal of EVAP canister purge valve is different from command signal (circuit open or shorted to ground)	2 driving cycles
P0462	Fuel level sensor circuit low	Low voltage	2 driving cycles
P0463	Fuel level sensor circuit high	High voltage	2 driving cycles

DTC NO.	DETECTING ITEM	DETECTING CONDITION (DTC will set when detecting:)	MIL
P0480	Fan 1 (Radiator cooling fan) control circuit	Radiator cooling fan relay terminal voltage is low when cooling temp. is lower than specification.	2 driving cycles
P0481	Fan 2 (A/C condenser fan) control circuit	Monitor signal of A/C condenser fan relay is different from command signal.	2 driving cycles
P0500	Vehicle speed sensor	No signal during fuel cut for specified time or longer	2 driving cycles
P0505	Idle air control system	Voltage is out of specification for longer than specified time	1 driving cycle
P0506	Idle air control system RPM lower than expected	Engine idle speed is lower than target speed out of specified value for longer than specified time	2 driving cycles
P0507	Idle air control system RPM higher than expected	Engine idle speed is higher than target speed out of specified value for longer than specified time	2 driving cycles
P0601	Internal control module memory check sum error	Data write error or check sum error	1 driving cycle
P0602	Control module programming error	Data programming error	1 driving cycle
P0616	Starter relay circuit low	Starter signal circuit open (low voltage)	2 driving cycles
P0617	Starter relay circuit high	Starter signal circuit shorted to power supply (high voltage)	2 driving cycles
P1510	ECM backup power supply malfunction	Backup power voltage is out of specification after starting engine.	1 driving cycle
P2227	Barometric pressure circuit range/performance	Difference between barometric pressure sensor value and calculated barometric pressure value is larger than specification.	2 driving cycles
P2228	Barometric pressure circuit low	Barometric pressure sensor circuit shorted to ground.	1 driving cycle
P2229	Barometric pressure circuit high	Barometric pressure sensor circuit open	1 driving cycle
P1620	ECU code not registered	Refer to “DTC Table” in Section 8G.	
P1621	No ECU code transmitted from Immobilizer Control Module	Refer to “DTC Table” in Section 8G.	
P1622	Fault in ECM	Refer to “DTC Table” in Section 8G.	
P1623	ECU code not matched	Refer to “DTC Table” in Section 8G.	

NOTE:

- **1 driving cycle: MIL lights up when DTC is detected while 1 driving cycle.**
- **2 driving cycles: MIL lights up when the same DTC is detected also in the next driving cycle after DTC is detected and stored temporarily in the first driving cycle.**
- ***1 driving cycle:**
  MIL blinks or lights up. Refer to “DTC P0300 Random Misfire Detected / DTC P0301 Cylinder 1 Misfire Detected / DTC P0302 Cylinder 2 Misfire Detected / DTC P0303 Cylinder 3 Misfire Detected / DTC P0304 Cylinder 4 Misfire Detected” for details.

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
P0102	Mass air flow circuit low input	• ECM controls injector drive time (fuel injection volume) according to throttle valve opening (closed throttle position or not). • ECM stops EGR control.
P0103	Mass air flow circuit high input	
P0112	Intake air temperature sensor circuit low	• ECM controls actuators assuming that intake air temperature is 23°C (73.4°F).
P0113	Intake air temperature sensor circuit high	
P0117	Engine coolant temperature circuit low	• ECM controls actuators assuming that engine coolant temperature is 30°C (86°F). • ECM operates radiator fan.
P0118	Engine coolant temperature circuit high	
P0122	Throttle position circuit low input	• ECM controls actuators assuming that throttle opening is about 12.5°.
P0123	Throttle position circuit high input	
P0335	Crankshaft position sensor circuit	• Fix ignition timing. • ECM changes injection control system from sequential injection to simultaneous one.
P0340	Camshaft position sensor circuit	ECM changes injection control system from sequential injection to simultaneous one.
P0500	Vehicle speed sensor	ECM controls actuators assuming vehicle speed is 0 km/h (0 mile/h).
P2227	Barometric pressure sensor performance problem	ECM controls actuators assuming that barometric pressure is 100 kPa (760 mmHg).

Visual Inspection

Visually check following parts and systems.

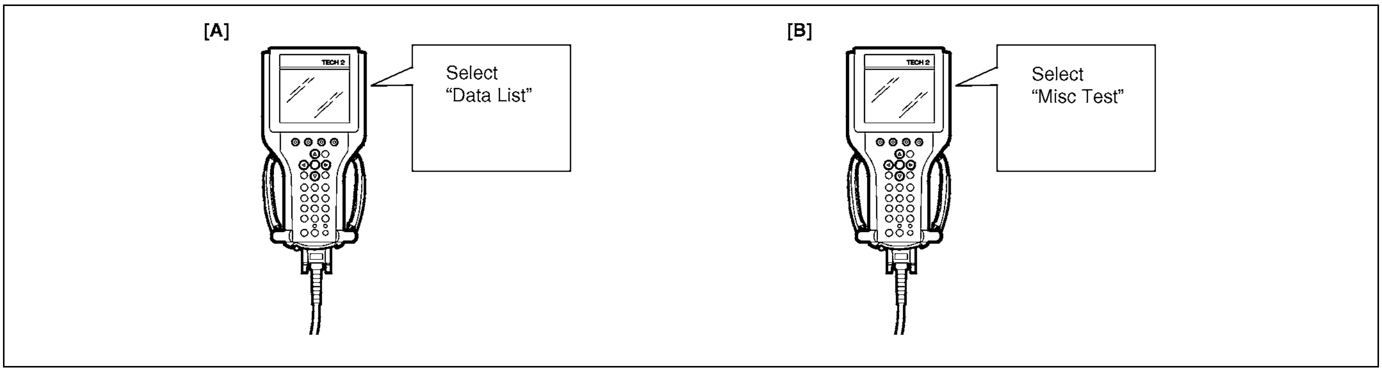
INSPECTION ITEM	REFERRING SECTION
• Engine oil – level, leakage	"Engine Oil and Oil Filter Replacement" in Section 0B.
• Engine coolant – level, leakage	"Engine Coolant Replacement" in Section 0B.
• Fuel – level, leakage	"Fuel Lines and Connections Inspection" in Section 0B.
• Air cleaner element – dirt, clogging	"Fuel Lines and Connections Inspection" in Section 0B.
• Battery – fluid level, corrosion of terminal	
• Water pump belt – tension damage	"Drive Belt Inspection" in Section 0B.
• Throttle cable – play (under warm engine), installation	"Accelerator cable adjustment" in Section 6E1.
• Vacuum hoses of air intake system – disconnection, looseness, deterioration, bend	"Evaporative emission control system inspection" in Section 6E1.
• Connectors of electric wire harness – disconnection, friction	
• Fuses – burning	
• Parts – installation, bolt – looseness	
• Parts – deformation	
• Other parts that can be checked visually	
Also check the following items at engine start, if possible	
• Malfunction indicator lamp – Operation	"Malfunction Indicator Lamp (MIL) Check" in this section.
• Charge warning lamp – Operation	"Charging indicator lamp operation" in Section 6H.
• Engine oil pressure warning lamp – Operation	"Engine Oil Pressure Switch Inspection" in Section 8.
• Engine coolant temp. meter – Operation	"Engine Coolant Temperature (ECT) Gauge Inspection" in Section 8.
• Fuel level meter – Operation	"Fuel Gauge Inspection" in Section 8.
• Tachometer – 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

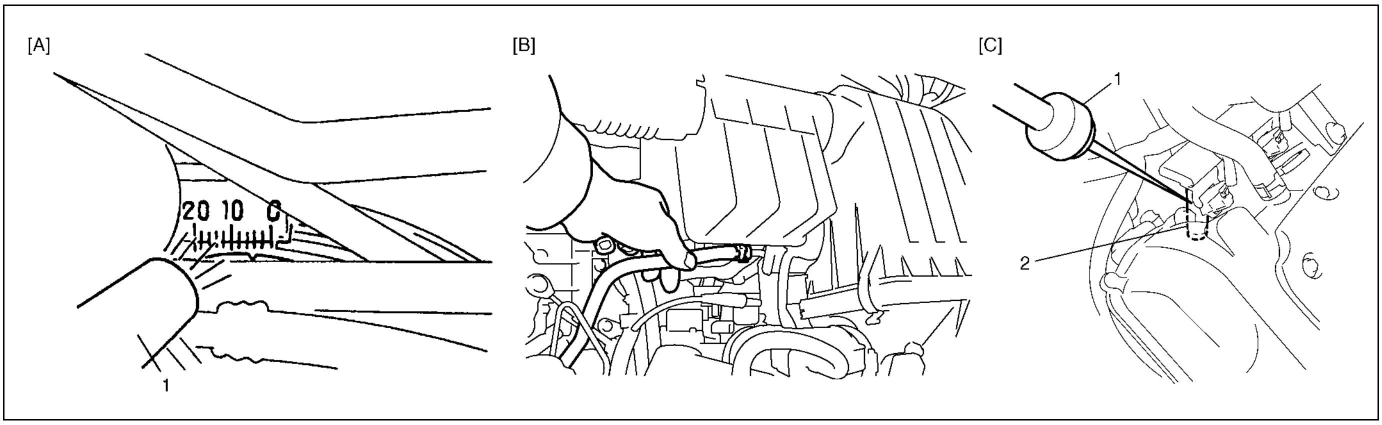
This check is very important for troubleshooting when ECM has detected no DTC and no abnormality has been found in visual inspection.
Follow the flow table carefully.

Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check".
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 7.
5	Check idle speed as follows: 1) Warm up engine to normal operating temp. 2) Shift transmission to neutral position for M/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?	Go to Step 6.	Go to "Engine Symptom Diagnosis".
6	Check ignition timing as follows: 1) Using Suzuki Scan Tool, select "MISC" mode on Suzuki Scan Tool and fix ignition timing to initial one. See Fig. 2. 2) Using timing light (1), check initial ignition timing. See Fig. 3. Is it 5° ± 3° BTDC at specified idle speed?	Go to "Engine Symptom Diagnosis".	Check ignition control related parts referring to "Ignition Timing Inspection" in Section 6F1.
7	Is immobilizer control system equipped?	Go to Step 8.	Go to Step 9.
8	Check immobilizer system malfunction as follows. 1) Check immobilizer indicator lamp for flashing. Is it flashing when ignition switch is turned to ON position?	Go to "DTC Check" in Section 8G.	Go to Step 9.
9	Check fuel supply as follows: 1) Check to make sure that enough fuel is filled in fuel tank. 2) Turn ON ignition switch for 3 seconds and then OFF. Repeat this a few times. See Fig. 4. Is fuel pressure felt from fuel feed hose (4) when ignition switch is turned ON?	Go to Step 11.	Go to Step 10.
10	Check fuel pump for operating. Was fuel pump operating sound heard from fuel filler for about 3 seconds after ignition switch ON and stop?	Go to "Table B-3 Fuel Pressure Check".	Go to "Table B-2 Fuel Pump and Its Circuit Check".
11	Check ignition spark as follows: 1) Disconnect injector couplers. 2) Remove spark plugs and connect them to high-tension cords or ignition coils. 3) Ground spark plugs. 4) Crank engine and check if each spark plug sparks. Is it in good condition?	Go to Step 12.	Go to "Ignition Spark Test" in Section 6F1.

Step	Action	Yes	No
12	Check fuel injector for operation as follows: 1) Install spark plugs and connect injector connectors. 2) Using sound scope (1), check operating sound of each injector (2) when cranking engine. See Fig. 5. Was injector operating sound heard from all injectors?	Go to "Engine Symptom Diagnosis".	Go to "Table B-1 Fuel Injector Circuit Check" in this section.



[A]:	Fig. 1 for Step 5
[B]:	Fig. 2 for Step 6



[A]:	Fig. 3 for Step 6
[B]:	Fig. 4 for Step 9
[C]:	Fig. 5 for Step 12

Engine Symptom Diagnosis

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

Condition	Possible Cause	Reference Item
Hard Starting (Engine cranks OK)	Faulty spark plug	“Spark Plugs Removal and Installation” in Section 6F1.
	Leaky high-tension cord	“High-Tension Cords Removal and Installation” in Section 6F1.
	Loose connection or disconnection of high-tension cords or lead wires	“High-Tension Cords Removal and Installation” in Section 6F1.
	Faulty ignition coil	“Ignition Coil Assembly (Including Ignitor) Inspection” in Section 6F1.
	Dirty or clogged fuel hose or pipe	“Table B-3 Fuel Pressure Check” in this section.
	Malfunctioning fuel pump	“Table B-3 Fuel Pressure Check” in this section.
	Air inhaling from intake manifold gasket or throttle body gasket	
	Faulty idle air control system	“Table B-4 Idle Air Control System Check” in this section.
	Faulty ECT sensor or MAF sensor	“Engine coolant temperature sensor (ECT sensor) inspection” or “Mass air flow (MAF) and intake air temperature (IAT) sensor inspection” in Section 6E1.
	Faulty ECM	
	Low compression	“Compression Check” in Section 6A1.
	Poor spark plug tightening or faulty gasket	“Spark Plugs Removal and Installation” in Section 6F1.
	Compression leak from valve seat	“Valves and Cylinder Head Inspection” in Section 6A1.
	Sticky valve stem	“Valves and Cylinder Head Inspection” in Section 6A1.
	Weak or damaged valve springs	“Valves and Cylinder Head Inspection” in Section 6A1.
	Compression leak at cylinder head gasket	“Valves and Cylinder Head Inspection” in Section 6A1.
	Sticking or damaged piston ring	“Pistons, Piston Rings, Connecting Rods and Cylinders Inspection” in Section 6A1.
	Worn piston, ring or cylinder	“Pistons, Piston Rings, Connecting Rods and Cylinders Inspection” in Section 6A1.
	Malfunctioning PCV valve	“PCV system inspection” in Section 6E1.
	VVT system out of order	“Diagnostic Flow Table B-10” in this section or “Oil control valve inspection” in Section 6E1.

Condition	Possible Cause	Reference Item
Low oil pressure	Improper oil viscosity	"Engine Oil and Oil Filter Replacement" in Section 0B.
	Malfunctioning oil pressure switch	"Engine Oil Pressure Switch Inspection" in Section 8.
	Clogged oil strainer	"Oil Pan and Oil Pump Strainer Removal and Installation" in Section 6A1.
	Functional deterioration of oil pump	"Oil Pan and Oil Pump Strainer Removal and Installation" in Section 6A1.
	Worn oil pump relief valve	"Oil Pan and Oil Pump Strainer Removal and Installation" in Section 6A1.
	Excessive clearance in various sliding parts	
Engine noise Note: Before checking mechanical noise, make sure that: Specified spark plug is used. Specified fuel is used.	Improper valve lash	"Valves and Cylinder Head Inspection" in Section 6A1.
	Worn valve stem and guide	"Valves and Cylinder Head Inspection" in Section 6A1.
	Weak or broken valve spring	"Valves and Cylinder Head Inspection" in Section 6A1.
	Warped or bent valve	"Valves and Cylinder Head Inspection" in Section 6A1.
	Worn piston, ring and cylinder bore	"Pistons, Piston Rings, Connecting Rods and Cylinders Inspection" in Section 6A1.
	Worn rod bearing	"Pistons, Piston Rings, Connecting Rods and Cylinders Inspection" in Section 6A1.
	Worn crank pin	"Pistons, Piston Rings, Connecting Rods and Cylinders Inspection" in Section 6A1.
	Loose connecting rod nuts	"Pistons, Piston Rings, Connecting Rods and Cylinders Inspection" in Section 6A1.
	Low oil pressure	"Low oil pressure" in this table.
	Low oil pressure	"Low oil pressure" in this table.
	Worn bearing	"Main Bearings, Crankshaft and Cylinder Block Inspection" in Section 6A1.
	Worn crankshaft journal	"Main Bearings, Crankshaft and Cylinder Block Inspection" in Section 6A1.
	Loose bearing cap bolts	"Main Bearings, Crankshaft and Cylinder Block Inspection" in Section 6A1.
	Excessive crankshaft thrust play	"Main Bearings, Crankshaft and Cylinder Block Inspection" in Section 6A1.

Condition	Possible Cause	Reference Item
Overheating	Inoperative thermostat	"Thermostat Inspection" in Section 6B.
	Poor water pump performance	"Water Pump Inspection" in Section 6B.
	Clogged or leaky radiator	"Radiator Inspection" in Section 6B.
	Improper engine oil grade	"Engine Oil and Oil Filter Replacement" 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.
	Faulty radiator fan control system	"Table B-7 Radiator Fan Control System Check" in this section.
	Dragging brakes	"Diagnosis Table" in Section 5.
	Slipping clutch	"Diagnosis Table" in Section 7C1.
	Blown cylinder head gasket	"Valves and Cylinder Head Inspection" in Section 6A1.
Poor gasoline mileage	Leaks or loose connection of high-tension cord	"High-Tension Cords Removal and Installation" in Section 6F1.
	Faulty spark plug (improper gap, heavy deposits and burned electrodes, etc.)	"Spark Plugs Removal and Installation" in Section 6F1.
	Malfunctioning EGR valve	"EGR valve inspection" Section 6E1.
	High idle speed	"Improper engine idling or engine fails to idle" in this table.
	Poor performance of TP sensor, ECT sensor or MAF sensor	"Throttle position sensor (TP sensor) on-vehicle inspection", "Engine coolant temperature sensor (ECT sensor) inspection" or "Mass air flow (MAF) and intake air temperature (IAT) sensor inspection" in Section 6E1.
	Faulty fuel injector(s)	"Table B-1 Fuel Injector Circuit Check" in this section.
	Faulty ECM	
	Low Compression	"Low compression" in this table.
	Poor valve seating	"Valves and Cylinder Head Inspection" in Section 6A1.
	Dragging brakes	"Diagnosis Table" in Section 5.
	Slipping clutch	"Diagnosis Table" in Section 7C1.
	Thermostat out of order	"Thermostat Inspection" in Section 6B.
	Improper tire pressure	"Wheel Maintenance" in Section 3F.
	VVT system out of order	"Diagnostic Flow Table B-10" in this section or "Oil control valve inspection" in Section 6E1.

Condition	Possible Cause	Reference Item
Excessive engine oil consumption	Blown cylinder head gasket	"Valves and Cylinder Head Inspection" in Section 6A1.
	Leaky camshaft oil seals	"Camshaft, Tappet and Shim Inspection" in Section 6A1.
	Sticky piston ring	"Pistons, Piston Rings, Connecting Rods and Cylinders Inspection" in Section 6A1.
	Worn piston and cylinder	"Pistons, Piston Rings, Connecting Rods and Cylinders Inspection" in Section 6A1.
	Worn piston ring groove and ring	"Pistons, Piston Rings, Connecting Rods and Cylinders Inspection" in Section 6A1.
	Improper location of piston ring gap	"Pistons, Piston Rings, Connecting Rods and Cylinders Disassembly and Assembly" in Section 6A1.
	Worn or damaged valve stem seal	"Valves and Cylinder Head Disassembly and Assembly" in Section 6A1.
	Worn valve stem	"Valves and Cylinder Head Inspection" in Section 6A1.
Engine hesitates (Momentary lack of response as accelerator is depressed. Can occur at all vehicle speeds. Usually most severe when first trying to make vehicle move, as from a stop sign.)	Spark plug faulty or plug gap out of adjustment	"Spark Plugs Removal and Installation" in Section 6F1.
	Leaky high-tension cord	"High-Tension Cords Removal and Installation" in Section 6F1.
	Fuel pressure out of specification	"Table B-3 Fuel Pressure Check" in this section.
	Malfunctioning EGR valve	"EGR valve inspection" in section 6E1.
	Poor performance of TP sensor, ECT sensor or MAF sensor	"Throttle position sensor (TP sensor) removal and installation", "Engine coolant temperature sensor (ECT sensor) inspection" or "Mass air flow (MAF) and intake air temperature (IAT) sensor inspection" in Section 6E1.
	Faulty fuel injector	"Table B-1 Fuel Injector Circuit Check" in this section.
	Faulty ECM	
	Engine overheating	"Overheating" in this table.
	Low compression	"Low Compression" in this table.
	VVT system out of order	"Diagnostic Flow Table B-10" in this section or "Oil control valve inspection" in Section 6E1.

Condition	Possible Cause	Reference Item
Surge (Engine power variation under steady throttle or cruise. Feels like vehicle speeds up and down with no change in accelerator pedal.)	Leaky or loosely connected high-tension cord	"High-Tension Cords Removal and Installation" in Section 6F1.
	Faulty spark plug (excess carbon deposits, improper gap, and burned electrodes, etc.)	"Spark Plugs Removal and Installation" in Section 6F1.
	Variable fuel pressure	"Table B-3 Fuel Pressure Check" in this section.
	Kinky or damaged fuel hose and lines	
	Faulty fuel pump (clogged fuel filter)	
	Malfunctioning EGR valve	"EGR valve inspection" in Section 6E1.
	Poor performance of MAF sensor	"Mass air flow (MAF) and intake air temperature (IAT) sensor inspection" in Section 6E1.
	Faulty fuel injector	"Table B-1 Fuel Injector Circuit Check" in this section.
	Faulty ECM	
Excessive detonation (Engine makes continuously sharp metallic knocks that change with throttle opening. Sounds like pop corn popping.)	Faulty spark plug	"Spark Plugs Removal and Installation" in Section 6F1.
	Loose connection of high-tension cord	"High-Tension Cords Removal and Installation" in Section 6F1.
	Engine overheating	"Overheating" in this table.
	Clogged fuel filter (faulty fuel pump) or fuel lines	"Table B-1 Fuel Injector Circuit Check" or "Table B-2 Fuel Pump and Its Circuit Check" in this section.
	Air inhaling from intake manifold or throttle body O-ring	
	Malfunctioning EGR valve	"EGR valve inspection" in Section 6E1.
	Poor performance of knock sensor, ECT sensor or MAF sensor	"DTC P0325 Flow Table" in this section, "Engine coolant temperature sensor (ECT sensor) inspection" or "Mass air flow (MAF) and intake air temperature (IAT) sensor inspection" in Section 6E1.
	Faulty fuel injector(s)	"Table B-1 Fuel Injector Circuit Check" in this section.
	Faulty ECM	
	Excessive combustion chamber deposits	"Pistons, Piston Rings, Connecting Rods and Cylinders Components" in Section 6A1.
	VVT system out of order	"Diagnostic Flow Table B-10" in this section or "Oil control valve inspection" in Section 6E1.

Condition	Possible Cause	Reference Item
Engine has no power	Faulty spark plug	"Spark Plugs Removal and Installation" in Section 6F1.
	Faulty ignition coil with ignitor	"Ignition Coil Assembly (Including Ignitor) Inspection" in Section 6F1.
	Leaks, loose connection or disconnection of high-tension cord	"High-Tension Cords Removal and Installation" in Section 6F1.
	Faulty knock sensor	"DTC P0325 Flow Table" in this section.
	Clogged fuel hose or pipe	"Table B-3 Fuel Pressure Check" in this section.
	Malfunctioning fuel pump	"Table B-2 Fuel Pump and Its Circuit Check" in this section.
	Air inhaling from intake manifold gasket or throttle body gasket	
	Engine overheating	"Overheating" in this table.
	Malfunctioning EGR valve	"EGR valve inspection" in Section 6E1.
	Maladjusted accelerator cable play	"Accelerator cable adjustment" in Section 6E1.
	Poor performance of TP sensor, ECT sensor or MAF sensor	"Throttle position sensor (TP sensor) on-vehicle inspection", "Engine coolant temperature sensor (ECT sensor) inspection" or "Mass air flow (MAF) and intake air temperature (IAT) sensor inspection" in Section 6E1.
	Faulty fuel injector(s)	"Table B-1 Fuel Injector Circuit Check" in this section.
	Faulty ECM	
	Dragging brakes	"Diagnosis Table" in Section 5.
	Slipping clutch	"Diagnosis Table" in Section 7C1.
	Low compression	"Compression Check" in Section 6A1.
	VVT system out of order	"Diagnostic Flow Table B-10" in this section or "Oil control valve inspection" in Section 6E1.

Condition	Possible Cause	Reference Item
Improper engine idling or engine fails to idle	Faulty spark plug	"Spark Plugs Removal and Installation" in Section 6F1.
	Leaky or disconnected high-tension cord	"High-Tension Cords Removal and Installation" in Section 6F1.
	Faulty ignition coil with ignitor	"Ignition Coil Assembly (Including Ignitor) Inspection" in Section 6F1.
	Fuel pressure out of specification	"Table B-3 Fuel Pressure Check" in this section.
	Leaky manifold, throttle body, or cylinder head gasket	
	Malfunctioning EGR valve	"EGR valve inspection" in Section 6E1.
	Faulty idle air control system	"Table B-4 Idle Air Control System Check" in this section.
	Faulty evaporative emission control system	"Evaporative emission control system inspection" in Section 6E1.
	Faulty EGR system	"EGR valve inspection" in Section 6E1.
	Faulty fuel injector(s)	"Table B-1 Fuel Injector Circuit Check" in this section.
	Poor performance of ECT sensor, TP sensor or MAF sensor	"Throttle position sensor (TP sensor) removal and installation", "Engine coolant temperature sensor (ECT sensor) inspection" or "Mass air flow (MAF) and intake air temperature (IAT) sensor inspection" in Section 6E1.
	Faulty ECM	
	Loose connection or disconnection of vacuum hoses	
	Malfunctioning PCV valve	"PCV system inspection" in Section 6E1.
	Engine overheating	"Overheating" in this section.
	Low compression	"Compression Check" in Section 6A1.
	VVT system out of order	"Diagnostic Flow Table B-10" in this section or "Oil control valve inspection" in Section 6E1.

Condition	Possible Cause	Reference Item
Excessive hydrocarbon (HC) emission or carbon monoxide (CO)	Faulty spark plug	"Spark Plugs Removal and Installation" in Section 6F1.
	Leaky or disconnected high-tension cord	"High-Tension Cords Removal and Installation" in Section 6F1.
	Faulty ignition coil with ignitor	"Ignition Coil Assembly (Including Ignitor) Inspection" in Section 6F1.
	Low compression	"Compression Check" in Section 6A1.
	Lead contamination of three way catalytic converter	Check for absence of filler neck restrictor.
	Faulty evaporative emission control system	"Evaporative emission control system inspection" in Section 6E1.
	Fuel pressure out of specification	Table B-3 Fuel Pressure Check.
	Closed loop system (A/F feed back compensation) fails • Faulty TP sensor • Poor performance of ECT sensor or MAF sensor	 "Throttle position sensor (TP sensor) on-vehicle inspection" in Section 6E1. "Engine coolant temperature sensor (ECT sensor) inspection" or "Mass air flow (MAF) and intake air temperature (IAT) sensor inspection" in Section 6E1.
	Faulty injector(s)	"Table B-1 Fuel Injector Circuit Check" in this section.
	Faulty ECM	
	Engine not at normal operating temperature	
	Clogged air cleaner	
	Vacuum leaks	
	VVT system out of order	"Diagnostic Flow Table B-10" in this section or "Oil control valve inspection" in Section 6E1.
Excessive nitrogen oxides (NOx) emission	Improper ignition timing	"Ignition Timing Inspection" in Section 6F1.
	Lead contamination of catalytic converter	Check for absence of filler neck restrictor.
	Faulty EGR system	"EGR valve inspection" in Section 6E1.
	Fuel pressure out of specification	"Table B-3 Fuel Pressure Check" in this section.
	Closed loop system (A/F feed back compensation) fails • Faulty TP sensor • Poor performance of ECT sensor or MAF sensor	 "Throttle position sensor (TP sensor) on-vehicle inspection" in Section 6E1. "Engine coolant temperature sensor (ECT sensor) inspection" or "Mass air flow (MAF) and intake air temperature (IAT) sensor inspection" in Section 6E1.
	Faulty injector(s)	"Table B-1 Fuel Injector Circuit Check" in this section.
	Faulty ECM	
	VVT system out of order	"Diagnostic Flow Table B-10" in this section or "Oil control valve inspection" in Section 6E1.

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 table below 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.**
- **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.**

<table>
<tr><th></th><th>SCAN TOOL DATA</th><th colspan="2">VEHICLE CONDITION</th><th>NORMAL CONDITION/
REFERENCE VALUES</th></tr>
<tr><td>✱</td><td>COOLANT TEMP
(ENGINE COOLANT TEMP.)</td><td colspan="2">At specified idle speed after warming up</td><td>80 – 100°C, 176 – 212°F</td></tr>
<tr><td>✱</td><td>INTAKE AIR TEMP</td><td colspan="2">At specified idle speed after warming up</td><td>–5°C (23°F) + environmental temp. to 40°C (104°F) + environmental temp.</td></tr>
<tr><td>✱</td><td>ENGINE SPEED</td><td colspan="2">At idling with no load after warming up</td><td>Desired idle speed
±50 r/min</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">INJ PULSE WIDTH
(FUEL INJECTION PULSE WIDTH)</td><td colspan="2">At specified idle speed with no load after warming up</td><td>2.0 – 4.0 msec.</td></tr>
<tr><td colspan="2">At 2500 r/min with no load after warming up</td><td>2.0 – 3.6 msec.</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">TP SENSOR VOLT
(THROTTLE POSITION SENSOR OUTPUT VOLTAGE)</td><td rowspan="2">Ignition switch ON/ warmed up engine stopped</td><td>Accelerator pedal released</td><td>0.5 – 1.0 V</td></tr>
<tr><td>Accelerator pedal depressed fully</td><td>Less than 4.8 V</td></tr>
<tr><td></td><td>DESIRED IDLE
(DESIRED IDLE SPEED)</td><td colspan="2">At idling with radiator cooling fan stopped and all electrical parts turned OFF after warming up, M/T at neutral</td><td>700 r/min</td></tr>
<tr><td></td><td>IAC FLOW DUTY
(IDLE AIR CONTROL FLOW DUTY)</td><td colspan="2">At idling with no load after warming up</td><td>5 – 55%</td></tr>
<tr><td>✱</td><td>SHORT FT B1
(SHORT TERM FUEL TRIM)</td><td colspan="2">At specified idle speed after warming up</td><td>– 20 – +20%</td></tr>
<tr><td>✱</td><td>LONG FT B1
(LONG TERM FUEL TRIM)</td><td colspan="2">At specified idle speed after warming up</td><td>– 20 – +20%</td></tr>
<tr><td rowspan="2">✱</td><td rowspan="2">MAF
(MASS AIR FLOW RATE)</td><td colspan="2">At specified idle speed with no load after warming up</td><td>1.0 – 4.0 g/s
0.14 – 0.52 lb/min</td></tr>
<tr><td colspan="2">At 2500 r/min with no load after warming up</td><td>4.0 – 12.0 g/s
0.53 – 1.58 lb/min</td></tr>
</table>

	SCAN TOOL DATA	VEHICLE CONDITION		NORMAL CONDITION/ REFERENCE VALUES
✱	CALC LOAD (CALCULATED LOAD VALUE)	At specified idle speed with no load after warming up		10 – 20%
		At 2500 r/min with no load after warming up		10 – 18%
✱	THROTTLE POSITION (ABSOLUTE THROTTLE POSITION)	Ignition switch ON/ warmed up engine stopped	Accelerator pedal released	9 – 19%
			Accelerator pedal depressed fully	70 – 90%
✱	O2S B1 S1 (HEATED OXYGEN SENSOR–1)	At specified idle speed after warming up		0 – 0.95 V
✱	O2S B1 S2 (HEATED OXYGEN SENSOR–2)	When engine is running at 2000 r/min. for 3 min or longer after warming up.		0 – 0.95 V
	FUEL SYSTEM B1 (FUEL SYSTEM STATUS)	At specified idle speed after warming up		CLOSED (closed loop)
	TOTAL FUEL TRIM	At specified idle speed after warming up		– 35 – +35%
✱	MAP (INTAKE MANIFOLD ABSOLUTE PRESSURE)	At specified idle speed with no load after warming up		24 – 38 kPa 180 – 285 mmHg
	BAROMETRIC PRES	–		Display the barometric pressure
	STEP EGR FLOW DUTY	At specified idle speed after warming up		0%
	FUEL CUT	When engine is at fuel cut condition		ON
		Other than fuel cut condition		OFF
	CLOSED THROTTLE POS (CLOSED THROTTLE POSITION)	Throttle valve at idle position		ON
		Throttle valve opens larger than idle position		OFF
	CANIST PRG DUTY (EVAP CANISTER PURGE FLOW DUTY)	At specified idle speed after warming up		0%
✱	IGNITION ADVANCE (IGNITION TIMING ADVANCE FOR NO.1 CYLINDER)	At specified idle speed with no load after warming up		3 – 13° BTDC
	BATTERY VOLTAGE	Ignition switch ON/engine stop		10 – 14 V
	FUEL PUMP	Within 3 seconds after ignition switch ON or engine running		ON
		Engine stop at ignition switch ON		OFF
	ELECTRIC LOAD	Ignition switch ON/Headlight, small light, all turned OFF		OFF
		Ignition switch ON/Headlight, small light, turned ON		ON
	BRAKE SWITCH	Ignition switch ON	Brake pedal is released	OFF
			Brake pedal is depressed	ON
	RADIATOR FAN (RADIATOR FAN CONTROL RELAY)	Ignition switch ON	Engine coolant temp.: Lower than 95°C (203°F)	OFF
			Engine coolant temp.: 97.5°C (208°F) or higher	ON

	SCAN TOOL DATA	VEHICLE CONDITION		NORMAL CONDITION/ REFERENCE VALUES
	BLOWER FAN	Ignition switch ON	Blower fan switch: 2nd speed position or more	ON
			Blower fan switch: under 2nd speed position	OFF
	A/C SWITCH (if equipped with A/C)	Engine running after warming up, A/C not operating		OFF
		Engine running after warming up, A/C operating		ON
	A/C MAG CLUTCH (if equipped with A/C)	Engine running	A/C switch and blower motor switch turned ON	ON
			A/C switch and blower motor switch turned OFF	OFF
	A/C COND FAN (if equipped with A/C)	Engine running	Blower motor switch and A/C switch turned ON	ON
			Blower motor switch and/ or A/C switch turned OFF	OFF
	VVT GAP (TARGET-ACTUAL POSITION)	At specified idle speed after warming up		0 – 3°

SCAN TOOL DATA DEFINITIONS

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

It is detected by engine coolant temp. sensor.

INTAKE AIR TEMP. (°C, °F)

It is detected by intake air temp. sensor.

ENGINE SPEED (rpm)

It is computed by reference pulses from the camshaft position sensor.

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).

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

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

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.

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).

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 means an enrichment correction, and a value less than 0 implies an enleanment correction.

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

It represents total mass of air entering intake manifold which is measured by mass air flow sensor.

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%

THROTTLE POS (ABSOLUTE THROTTLE POSITION, %)

When throttle position sensor is fully closed position, throttle opening is indicated as 0% and 90 – 100% full open position.

O2S SENSOR B1 S1 (HEATED OXYGEN SENSOR–1, V)

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

O2S 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.

FUEL SYSTEM (FUEL SYSTEM STATUS)

Air/fuel ratio feedback loop status displayed as one of the followings.
OPEN: Open loop-has not yet satisfied conditions to go closed loop.
CLOSED: Closed loop-using oxygen sensor(s) as feedback for fuel control.
OPEN-DRIVE COND: Open loop due to driving conditions (Power enrichment, etc.).
OPEN SYS FAULT: Open loop due to detected system fault.
CLOSED-ONE O2S: Closed loop, but fault with at least one oxygen sensor-may be using single oxygen sensor for fuel control.

TOTAL FUEL TRIM B1 (%)

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

MAP (MANIFOLD ABSOLUTE PRESSURE, mmHg, kPa)

This value indicates how much correction is necessary to keep the air/fuel mixture stoichiometrical.
It is detected by manifold absolute pressure sensor.

BAROMETRIC PRESS (kPa, inHg)

This parameter represents a measurement of barometric air pressure and is used for altitude correction of the fuel injection quantity and IAC valve control.

STEP EGR FLOW DUTY (%)

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

FUEL CUT (ON/OFF)

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

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.

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

This parameter indicates valve ON (valve open) time rate within a certain set cycle of EVAP canister purge valve which controls the amount of EVAP purge.

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.

BATTERY VOLTAGE (V)

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

FUEL PUMP (ON/OFF)

ON is displayed when the ECM activates the fuel pump via the fuel pump relay switch.

ELECTRIC LOAD (ON/OFF)

ON: Headlight or small light ON signal inputted.
OFF: Above electric loads all turned OFF.

BRAKE SW (ON/OFF)

This parameter indicates the state of the brake switch.

RADIATOR FAN (RADIATOR FAN CONTROL RELAY, ON/OFF)

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

BLOWER FAN (ON/OFF)

This parameter indicates the state of the blower fan motor switch.

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.

A/C MAG SWITCH (A/C COMPRESSOR RELAY, ON/OFF)

This parameter indicates the state of the A/C switch.

A/C COND FAN (ON/OFF)

This parameter indicates the state of the A/C Condenser Fan control signal.

VVT GAP [TARGET-ACTUAL POSITION] (°)

It is calculated using the formula: target valve timing advance – actual valve timing advance.

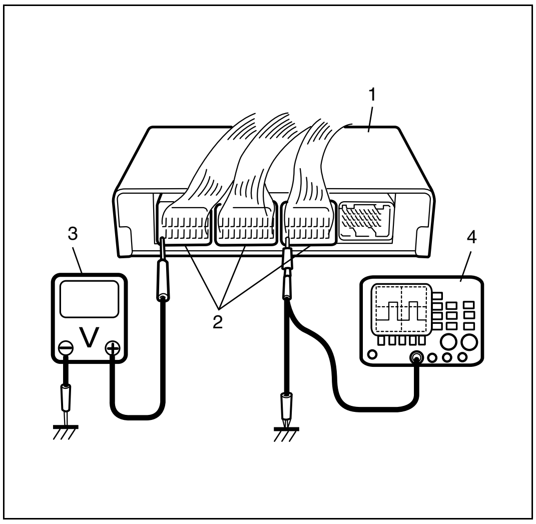
Inspection of ECM and Its Circuits

ECM and its circuits can be checked at ECM wiring couplers by measuring voltage, pulse signal and resistance.

CAUTION:

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

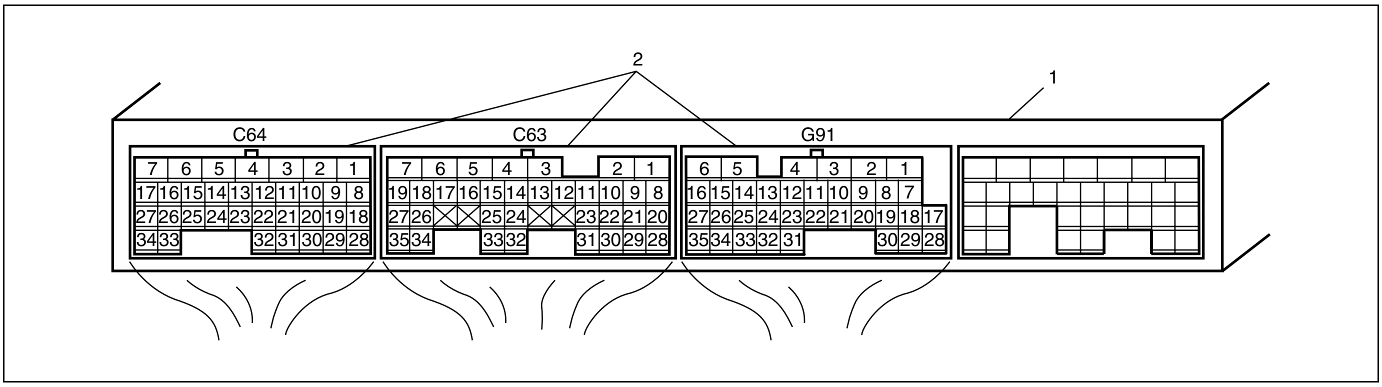
VOLTAGE CHECK



1) Remove ECM (1) from vehicle body referring to “Engine control module (ECM) removal and installation” in Section 6E1.
2) Check voltage and/or pulse signal at each terminal of couplers (2) connected, using voltmeter (3) and oscilloscope (4).

NOTE:

- **As each terminal voltage is affected by the battery voltage, confirm that it is 11 V or more when ignition switch is turned ON.**
- **Voltage with asterisk(*) cannot be measured by voltmeter because it is pulse signal.**
  Check it with oscilloscope if necessary.



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

<table>
<tr><th>TERMINAL NUMBER</th><th>WIRE COLOR</th><th>CIRCUIT</th><th>NORMAL VOLTAGE</th><th>CONDITION</th></tr>
<tr><td>C64-1</td><td>BLK/ORN</td><td>Ground for ECM</td><td>Below 0.3 V</td><td>Ignition switch turned ON</td></tr>
<tr><td>C64-2</td><td>BLK</td><td>Ground for ECM</td><td>Below 0.3 V</td><td>Ignition switch turned ON</td></tr>
<tr><td rowspan="2">C64-3</td><td rowspan="2">RED/BLU</td><td rowspan="2">Heater output of heated oxygen sensor–2</td><td>10 – 14 V</td><td>Ignition switch turned ON</td></tr>
<tr><td>0 – 1 V
(Reference waveform No.1)</td><td>Engine running at idling after vehicle running over 30 km/h, 19ml/h for 5 min.</td></tr>
<tr><td rowspan="2">C64-4</td><td rowspan="2">BLK/WHT</td><td rowspan="2">Heater output of heated oxygen sensor–1</td><td>10 – 14 V</td><td>Ignition switch turned ON</td></tr>
<tr><td>*0 – 2 V
↑↓
13.5 –14.8 V
(Reference waveform No.2 and No.3)</td><td>Engine running at idling with after warming up.
(Output signal is active low duty pulse. Duty ratio varies depending on engine condition.)</td></tr>
<tr><td rowspan="2">C64-5</td><td rowspan="2">GRN/YEL</td><td rowspan="2">A/C condenser fan motor relay No.2 output (if equipped)</td><td>10 – 14 V</td><td>Engine running, engine coolant temperature more than 113°C, 235°F or for about 7 sec. after A/C operated (A/C request signal inputted low voltage).</td></tr>
<tr><td>0 – 1 V</td><td>Engine running, engine coolant temperature under than 110°C, 230°F and after about 7 sec. after A/C operated (A/C request signal inputted low voltage) or A/C OFF.</td></tr>
<tr><td>C64-6</td><td>PNK</td><td>Fuel cost output</td><td>*0 – 2 V
↑↓
13.5 – 14.8 V</td><td>Engine running at idling with after warming up.
(Output signal is 3.33 Hz duty pulse. Duty ratio varies depending on vehicle condition.)</td></tr>
<tr><td>C64-7</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td rowspan="2">C64-8</td><td rowspan="2">RED/YEL</td><td rowspan="2">IAC valve output (stepper motor coil 3)</td><td>0 – 1 V</td><td>Ignition switch turned ON</td></tr>
<tr><td>*0 – 2 V
↑↓
8 – 14 V
(Reference waveform No.4)</td><td>Ignition switch is turned to ST (cranking) position.
(Output signal is active low duty pulse. Pulse generated times depending on vehicle condition)</td></tr>
<tr><td rowspan="2">C64-9</td><td rowspan="2">RED/BLU</td><td rowspan="2">IAC valve output (stepper motor coil 2)</td><td>8 – 14 V</td><td>Ignition switch turned ON</td></tr>
<tr><td>*0 – 2 V
↑↓
8 – 14 V
(Reference waveform No.4)</td><td>Ignition switch is turned to ST (cranking) position.
(Output signal is active low duty pulse. Pulse generated times depending on vehicle condition)</td></tr>
<tr><td rowspan="2">C64-10</td><td rowspan="2">RED/WHT</td><td rowspan="2">IAC valve output (stepper motor coil 1)</td><td>0 – 1 V</td><td>Ignition switch turned ON</td></tr>
<tr><td>*0 – 2 V
↑↓
8 – 14 V
(Reference waveform No.4)</td><td>Ignition switch is turned to ST (cranking) position.
(Output signal is active low duty pulse. Pulse generated times depending on vehicle condition)</td></tr>
</table>

<table>
<tr><th>TERMINAL NUMBER</th><th>WIRE COLOR</th><th>CIRCUIT</th><th>NORMAL VOLTAGE</th><th>CONDITION</th></tr>
<tr><td rowspan="2">C64-11</td><td rowspan="2">PNK/BLK</td><td rowspan="2">A/C compressor relay output (if equipped)</td><td>10 – 14 V</td><td>Engine running, A/C request signal high input</td></tr>
<tr><td>0 – 1 V</td><td>Engine running, A/C request signal low input</td></tr>
<tr><td rowspan="2">C64-12</td><td rowspan="2">PNK</td><td rowspan="2">A/C condenser fan motor relay No.1 output (if equipped)</td><td>10 – 14 V</td><td>Ignition switch turned ON, coolant temperature under 113°C, 235°F or A/C request signal high input</td></tr>
<tr><td>0 – 1 V</td><td>Ignition switch turned ON, coolant temperature more than 110°C, 230°F or A/C request signal low input</td></tr>
<tr><td rowspan="2">C64-13</td><td rowspan="2">BLU/BLK</td><td rowspan="2">EVAP canister purge valve output</td><td>10 – 14 V</td><td>Ignition switch turned ON with engine stop</td></tr>
<tr><td>*0 – 0.6 V
↑↓
10 – 14 V
(Reference waveform No.25)</td><td>Engine running and vehicle running over 40 km/h, 25 ml/h
(Output signal is 10 Hz duty pulse. Duty ratio varies depending on vehicle condition.)</td></tr>
<tr><td rowspan="2">C64-14</td><td rowspan="2">GRN</td><td rowspan="2">Fuel pump relay output</td><td>0 – 2.5 V</td><td>For 3 sec. from the time is ignition switch turned to ON or while engine is running</td></tr>
<tr><td>10 – 14 V</td><td>On and after 3 sec. from the time is ignition switch turned to ON or while engine is stop</td></tr>
<tr><td rowspan="2">C64-15</td><td rowspan="2">BRN/WHT</td><td rowspan="2">Main power supply relay output</td><td>10 – 14 V</td><td>Ignition switch is turned OFF</td></tr>
<tr><td>0 – 2 V</td><td>Ignition switch is turned ON</td></tr>
<tr><td rowspan="2">C64-16</td><td rowspan="2">WHT/RED</td><td rowspan="2">EGR valve (stepper motor coil 3) output</td><td>10 – 14 V</td><td>Ignition switch is turned ON</td></tr>
<tr><td>*0 – 2 V
↑↓
8 – 14 V
(Reference waveform No.5)</td><td>Ignition switch is turned to ST (cranking) position.
(Output signal is active low duty pulse. Pulse generated times depending on vehicle condition)</td></tr>
<tr><td rowspan="2">C64-17</td><td rowspan="2">GRN/RED</td><td rowspan="2">EGR valve (stepper motor coil 1) output</td><td>0 – 2 V</td><td>Ignition switch turned ON</td></tr>
<tr><td>*0 – 2 V
↑↓
8 – 14 V
(Reference waveform No.5)</td><td>Ignition switch is turned to ST (cranking) position.
(Output signal is active low duty pulse. Pulse generated times depending on vehicle condition)</td></tr>
<tr><td>C64-18</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>C64-19</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>C64-20</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>C64-21</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>C64-22</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>C64-23</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>C64-24</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>C64-25</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>C64-26</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>C64-27</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
</table>

TERMINAL NUMBER	WIRE COLOR	CIRCUIT	NORMAL VOLTAGE	CONDITION
C64-28	RED/BLK	IAC valve output (stepper motor coil 4)	8 – 14 V	Ignition switch turned ON
			*0 – 2 V ↑↓ 8 – 14 V (Reference waveform No.4)	Ignition switch is turned to ST (cranking) position. (Output signal is active low duty pulse. Pulse generated times depending vehicle condition)
C64-29	–	–	–	–
C64-30	–	–	–	–
C64-31	GRN/WHT	Ignition coil No.2 and No.3 output	0 – 0.6 V	Ignition switch turned ON
			*0 – 0.6 V ↑↓ 2 – 5 V (Reference waveform No.6)	Engine running (Output signal is active high pulse. Pulse frequency varies depending on engine speed.)
C64-32	GRN/YEL	Ignition coil No.1 and No.4 output	0 – 0.6 V	Ignition switch turned ON
			*0 – 0.6 V ↑↓ 2 – 5 V (Reference waveform No.7)	Engine running (Output signal is active high pulse. Pulse frequency varies depending on engine speed.)
C64-33	BRN/YEL	EGR valve (stepper motor coil 4) output	0 – 2 V	Ignition switch turned ON
			*0 – 2 V ↑↓ 8 – 14 V (Reference waveform No.5)	Ignition switch is turned to ST (cranking) position. (Output signal is active low duty pulse. Pulse generated times depending on vehicle condition)
C64-34	GRN/ORN	EGR valve (stepper motor coil 2) output	10 – 14 V	Ignition switch turned ON
			*0 – 2 V ↑↓ 8 – 14 V (Reference waveform No.5)	Ignition switch is turned to ST (cranking) position. (Output signal is active low duty pulse. Pulse generated times depending on vehicle condition)
C63-1	BLK/ORN	Ground for ECM	Below 0.3 V	Ignition switch turned ON
C63-2	BLU	Oil control valve output	*0 – 0.6 V ↑↓ 13 – 14 V (Reference waveform No.8 and No.9)	Ignition switch turned ON
				While engine running. (Output signal is active low duty pulse. Duty ratio varies depending on vehicle condition)
C63-3	–	–	–	–
C63-4	BLU/ORN	Fuel injector No.4 output	10 – 14 V	Ignition switch turned ON
			*0 – 0.6 V ↑↓ 10 – 14 V (Reference waveform No.10 and No.11)	Engine running (Output signal is active low pulse. Pulse frequency varies depending on engine speed.)

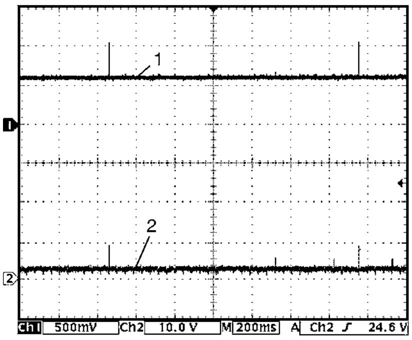
TERMINAL NUMBER	WIRE COLOR	CIRCUIT	NORMAL VOLTAGE	CONDITION
C63-5	BLU/RED	Fuel injector No.3 output	10 – 14 V	Ignition switch turned ON
			*0 – 0.6 V ↑↓ 10 – 14 V (Reference waveform No.10 and No.12)	Engine running (Output signal is active low pulse. Pulse frequency varies depending on engine speed.)
C63-6	BLU/WHT	Fuel injector No.2 output	10 – 14 V	Ignition switch turned ON
			*0 – 0.6 V ↑↓ 10 – 14 V (Reference waveform No.10 and No.13)	Engine running (Output signal is active low pulse. Pulse frequency varies depending on engine speed.)
C63-7	BLU/YEL	Fuel injector No.1 output	10 – 14 V	Ignition switch turned ON
			*0 – 0.6 V ↑↓ 10 – 14 V (Reference waveform No.10 and No.14)	Engine running (Output signal is active low pulse. Pulse frequency varies depending on engine speed.)
C63-8	GRY/RED	Output of 5 V power source for throttle position (TP) sensor	4.5 – 5.5 V	Ignition switch turned ON
C63-9	RED	Knock sensor signal	*2 – 3 V (Reference waveform No.15 and No.16)	Ignition switch turned ON
				Engine running at idling with after warming up
C63-10	RED/YEL	Reference (classified cylinder) signal for CMP sensor	*0 – 0.6 V ↑↓ 4 – 5 V (Reference waveform No.17)	Engine running at idling with after warming up (Sensor signal is pulse. Pulse frequency varies depending on engine speed.) (6 pulses are generated par 1camshaft revolution)
C63-11	WHT	Oxygen signal of heated oxygen sensor–1	0.5 – 1.5 V	Ignition switch turned ON
			*Deflects between over 0.5 V and under 0.45 V (Reference waveform No.2 and No.3)	While engine running at 2,000 r/min. for 1min. or longer after warmed up
C63-12	–	–	–	–
C63-13	–	–	–	–
C63-14	PNK/BLK	Mass air flow (MAF) sensor signal	0.5 – 1.5 V	Ignition switch turned ON and engine stops
			1.3 – 1.8 V (Reference waveform No.18)	When engine running at specified idle speed after warming up

TERMINAL NUMBER	WIRE COLOR	CIRCUIT	NORMAL VOLTAGE	CONDITION
C63-15	RED/WHT	Manifold absolute pressure (MAP) sensor signal	About 4 V (Reference wave-form No.19)	Ignition switch turned ON with baromet-ric pressure at 100kPa, 760mmHg
			0.4 – 1.8 V (Reference wave-form No.20)	While specified idle speed after warming up with barometric pressure at 100kPa, 760mmHg
C63-16	LT GRN	Engine coolant temp. (ECT) sensor signal	3.3 – 3.6 V	Ignition switch turned ON, ECT at 0°C, 32°F
			1.1 – 1.5 V	Ignition switch turned ON, ECT at 50°C, 122°F
			0.3 – 0.45 V	Ignition switch turned ON, ECT at 100°C, 212°F
C63-17	LT GRN/ BLK	Intake air temperature (IAT) sensor signal	3.3 – 3.6 V	Ignition switch turned ON, IAT at 0°C, 32°F
			1.6 – 1.9 V	Ignition switch turned ON, IAT at 40°C, 104°F
			0.6 – 0.8 V	Ignition switch turned ON, IAT at 80°C, 176°F
C63-18	–	–	–	–
C63-19	YEL	Vehicle speed sensor signal	*0 – 1 V ↑↓ 10 – 14 V (Reference wave-form No.21)	Vehicle running. (Sensor signal is pulse. Pulse frequency varies depending on vehicle speed. (8190 pulses are generated par 60 km/ h, 37.5 ml/h)
C63-20	–	–	–	–
C63-21	–	–	–	–
C63-22	–	–	–	–
C63-23	–	–	–	–
C63-24	–	–	–	–
C63-25	–	–	–	–
C63-26	–	–	–	–
C63-27	–	–	–	–
C63-28	ORN	Ground for sensors	Below 0.3 V	Ignition switch turned ON
C63-29	–	–	–	–
C63-30	PNK	CKP sensor signal	0 – 1 V	Ignition switch turned ON
			*4.4 – 4.6 V ↑↓ 0.1 – 0.3 V (Reference wave-form No.17)	Engine running at idling with after warm-ing up. (Sensor signal is pulse. Pulse frequency varies depending on engine speed.) (31(34–4) pulses are generated par 1crankshaft revolution)
C63-31	GRN/YEL	Ground of ECM for shield wire	Below 0.3 V	Ignition switch turned ON
C63-32	–	–	–	–

TERMINAL NUMBER	WIRE COLOR	CIRCUIT	NORMAL VOLTAGE	CONDITION
C63-33	BRN	Oxygen signal of heated oxygen sensor–2	0.5 – 1.5 V	Ignition switch turned ON
			*Deflects between over 0.5 V and under 0.45 V (Reference waveform No.1)	While engine running at 2,000 r/min. for 1min. or longer after vehicle running over 30 km/h, 19 ml/h
C63-34	GRY/BLU	Throttle position (TP) sensor signal	0.5 – 1.0 V	Ignition switch turned ON and throttle valve at idle position with warmed engine
			3.4 – 4.7 V	Ignition switch turned ON and throttle valve at full open position
C63-35	BLK/YEL	Starting motor signal	0 – 1 V	Ignition switch turned ON
			6 – 14 V	While engine cranking
G91-1	PPL/WHT	MIL (Malfunction indicator lamp) output	0 – 2.5 V	Ignition switch turned ON with engine stop
			10 – 14 V	Engine running
G91-2	LT GRN/ BLK	Immobilizer indicator lamp output (if equipped)	10 – 14 V	While engine running
			0 – 1 V	Ignition switch turned ON with engine stop
G91-3	–	–	–	–
G91-4	BRN	Radiator fan motor relay output	10 – 14 V	Ignition switch turned ON, engine coolant temperature under 95°C, 203°F
			0 – 1 V	Ignition switch turned ON, engine coolant temperature more than 97.5°C, 207.5°F
G91-5	BLK/RED	Main power supply	10 – 14 V	Ignition switch turned ON
G91-6	BLK/RED	Main power supply	10 – 14 V	Ignition switch turned ON
G91-7	–	–	–	–
G91-8	–	–	–	–
G91-9	GRN/WHT	Electric load signal for stop lamp	0 – 1 V	Ignition switch turned ON, stop lamp not lighted up
			10 – 14 V	Ignition switch turned ON, stop lamp lighted up
G91-10	YEL	Serial communication line of data link connector 5 V	4 – 6 V	Ignition switch turned ON
G91-11	BLU	Serial communication line of data link connector 12 V	10 – 14 V	Ignition switch turned ON
G91-12	BRN	Engine revolution signal output for tachometer	0 – 0.8 V	Ignition switch turned ON with engine stop
			*0 – 1 V ↑↓ 8 – 14 V (Reference waveform No.22 and No.23)	While engine running. (Output signal is pulse. Pulse frequency varies depending on engine speed.) (2 pulses are generated par 1crankshaft revolution.) (3000 r/min = 100 Hz)

TERMINAL NUMBER	WIRE COLOR	CIRCUIT	NORMAL VOLTAGE	CONDITION
G91-13	YEL	Electric load signal for heater blower motor	10 – 14 V	Ignition switch turned ON, blower fan selector selected at OFF
			0 – 1 V	Ignition switch turned ON, blower fan selector selected at 2nd speed position or more
G91-14	YEL/RED	Fuel level sensor signal	0 – 6 V	Ignition switch turned ON Voltage depends on fuel level
G91-15	WHT/BLK	A/C evaporator outlet air temp. sensor signal (if equipped)	3.3 – 3.8 V	Ignition switch turned ON at A/C evaporator inlet air temperature 0°C (32°F)
			2.5 – 2.9 V	Ignition switch turned ON at A/C evaporator inlet air temperature 15°C (59°F)
			1.9 – 2.3 V	Ignition switch turned ON at A/C evaporator inlet air temperature 25°C (77°F)
G91-16	WHT/RED	Power source for ECM internal memory	10 – 14 V	Ignition switch turned ON and turned OFF
G91-17	–	–	–	–
G91-18	–	–	–	–
G91-19	–	–	–	–
G91-20	–	–	–	–
G91-21	–	–	–	–
G91-22	–	–	–	–
G91-23	–	–	–	–
G91-24	–	–	–	–
G91-25	–	–	–	–
G91-26	–	–	–	–
G91-27	–	–	–	–
G91-28	BLK/WHT	Ignition switch signal	0 – 1 V	Ignition switch turned OFF
			10 – 14 V	Ignition switch turned ON
G91-29	–	–	–	–
G91-30	YEL/GRN	A/C request signal (if equipped)	10 – 14 V (High input)	Ignition switch turned ON, blower fan selector selected OFF position or A/C switch turned OFF or A/C evaporator temp. less than 2.5°C, 36.5°F
			0 – 1 V (Low input)	Ignition switch turned ON, blower fan selector selected other than OFF position and A/C switch turned ON with A/C evaporator temp. more than 4°C, 39.2°F
G91-31	PPL	Vehicle speed sensor signal for speedometer	*0 – 1 V ↑↓ 10 – 14 V (Reference waveform No.21)	Vehicle running. (Sensor signal is pulse. Pulse frequency varies depending on vehicle speed.) (8190 pulses/sec. are generated par 60 km/h, 37.5 ml/h)
G91-32	GRY	ECT sensor signal for combination meter	*0 – 0.6 V ↑↓ 13 – 14 V (Reference waveform No.24)	Ignition switch turned ON (Output signal is 5 Hz active low duty pulse. Duty ratio varies depending on ECT.) ECT –30°C = 10% ON duty ECT 130°C = 90% ON duty

TERMINAL NUMBER	WIRE COLOR	CIRCUIT	NORMAL VOLTAGE	CONDITION
G91-33	RED/YEL	Electric load signal for clearance lamp	0 – 1 V	Ignition switch turned ON, clearance lamp not lighted up
			10 – 14 V	Ignition switch turned ON, clearance lamp lighted up
G91-34	–	–	–	–
G91-35	ORN	Ground for A/C evaporator outlet air temp. sensor (if equipped)	Below 0.3 V	Ignition switch turned ON

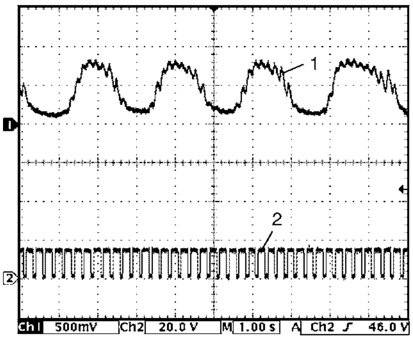


1. Reference waveform No.1

Heated oxygen sensor–2 heater signal at engine idling

Measurement terminal	CH1: C63-33 to C64-1 CH2: C64-3 to C64-1
Oscilloscope setting	CH1: 500 mV/DIV, CH2: 10 V/DIV TIME: 200 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Drive vehicle at 60 km/h (37 mil/h) for 10 min. • Engine at specified idle speed

1.	Heated oxygen sensor–2 signal
2.	Heated oxygen sensor–2 heater signal

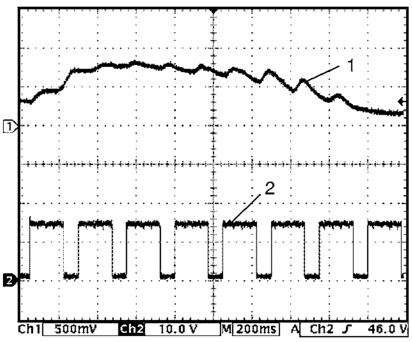


2. Reference waveform No.2

Heated oxygen sensor–1 signal at engine idling

Measurement terminal	CH1: C63-11 to C64-1 CH2: C64-4 to C64-1
Oscilloscope setting	CH1: 500 mV/DIV, CH2: 20 V/DIV TIME: 1 s/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

1.	Heated oxygen sensor–1 signal
2.	Heated oxygen sensor–1 heater signal



3. Reference waveform No.3

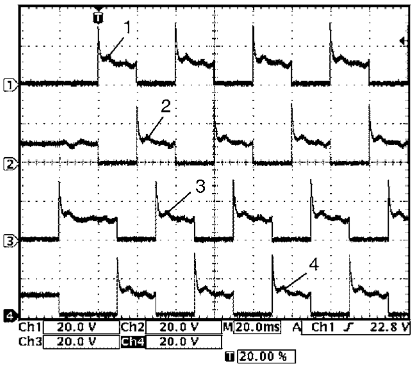
Heated oxygen sensor–1 heater signal at engine idling

Measurement terminal	CH1: C63-11 to C64-1 CH2: C64-4 to C64-1
Oscilloscope setting	CH1: 500 mV/DIV, CH2: 10 V/DIV TIME: 200 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

1.	Heated oxygen sensor–1 signal
2.	Heated oxygen sensor–1 heater signal

4. Reference waveform No.4

IAC valve signal

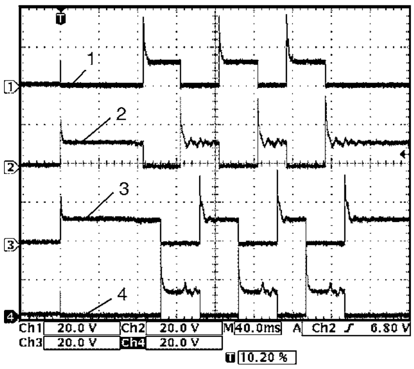


Measurement terminal	CH1: C64-10 to C64-1 CH2: C64-9 to C64-1 CH3: C64-8 to C64-1 CH4: C64-28 to C64-1
Oscilloscope setting	CH1: 20 V/DIV, CH2: 20 V/DIV CH3: 20 V/DIV, CH4: 20 V/DIV TIME: 20 ms/DIV
Measurement condition	Ignition switch turned ON from ST (cranking) position

1.	IAC valve stepper motor coil 1 signal
2.	IAC valve stepper motor coil 2 signal
3.	IAC valve stepper motor coil 3 signal
4.	IAC valve stepper motor coil 4 signal

5. Reference waveform No.5

EGR valve signal

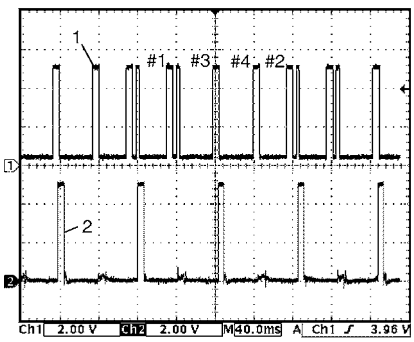


Measurement terminal	CH1: C64-17 to C64-1 CH2: C64-34 to C64-1 CH3: C64-16 to C64-1 CH4: C64-33 to C64-1
Oscilloscope setting	CH1: 20 V/DIV, CH2: 20 V/DIV CH3: 20 V/DIV, CH4: 20 V/DIV TIME: 40 ms/DIV
Measurement condition	At the moment of the ignition switch in turned on

1.	EGR valve stepper motor coil 1 signal
2.	EGR valve stepper motor coil 2 signal
3.	EGR valve stepper motor coil 3 signal
4.	EGR valve stepper motor coil 4 signal

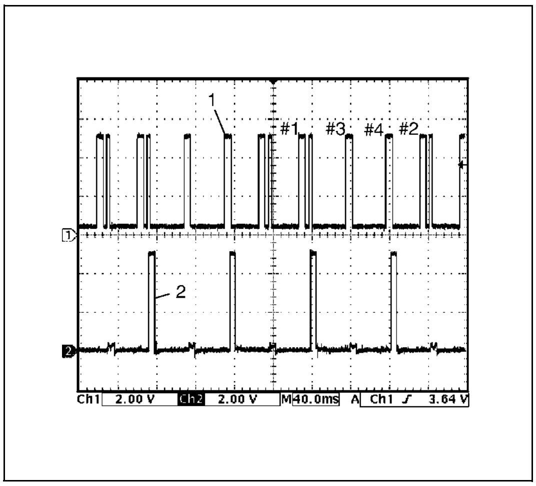
6. Reference waveform No.6

Ignition coil No.2 and No.3 signal at engine idling



Measurement terminal	CH1: C63-10 to C64-1 CH2: C64-31 to C64-1
Oscilloscope setting	CH1: 2 V/DIV, CH2: 2 V/DIV TIME: 40 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

1.	Cylinder reference signal (CMP reference signal)
2.	No.2 and No.3 ignition signal

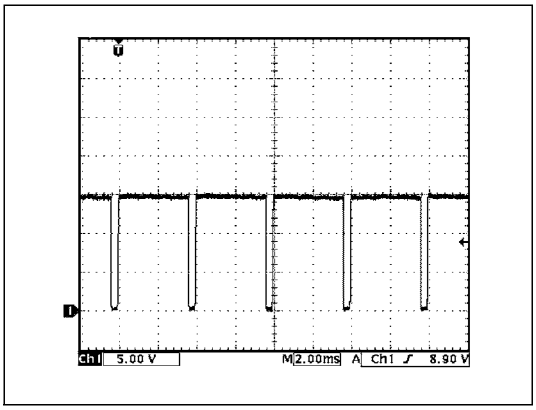


7. Reference waveform No.7

Ignition coil No.1 and No.4 signal at engine idling

Measurement terminal	CH1: C63-10 to C64-1 CH2: C64-32 to C64-1
Oscilloscope setting	CH1: 2 V/DIV, CH2: 2 V/DIV TIME: 40 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

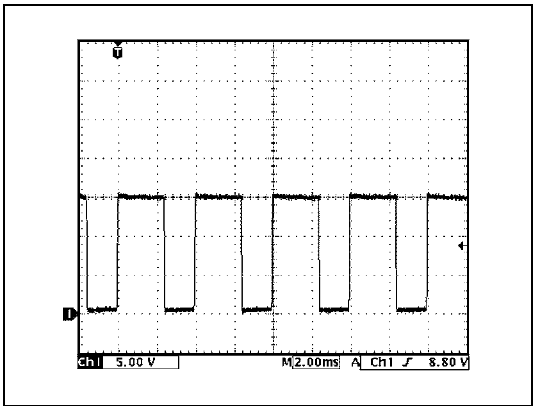
1. Cylinder reference signal (CMP reference signal)
2. No.1 and No.4 ignition signal



8. Reference waveform No.8

Oil control valve signal at engine idling

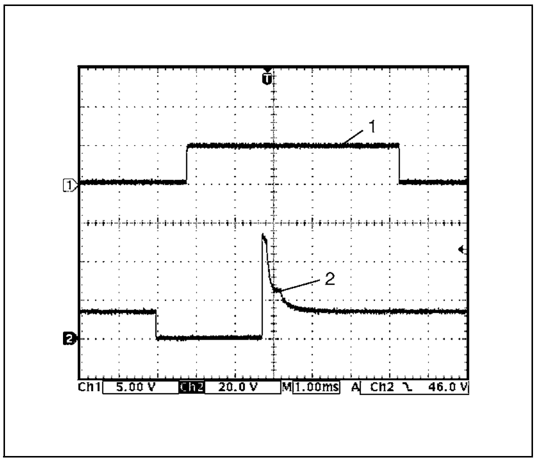
Measurement terminal	CH1: C63-2 to C64-1
Oscilloscope setting	CH1: 5 V/DIV TIME: 2 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed



9. Reference waveform No.9

Oil control valve signal at engine racing

Measurement terminal	CH1: C63-2 to C64-1
Oscilloscope setting	CH1: 5 V/DIV TIME: 2 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at racing

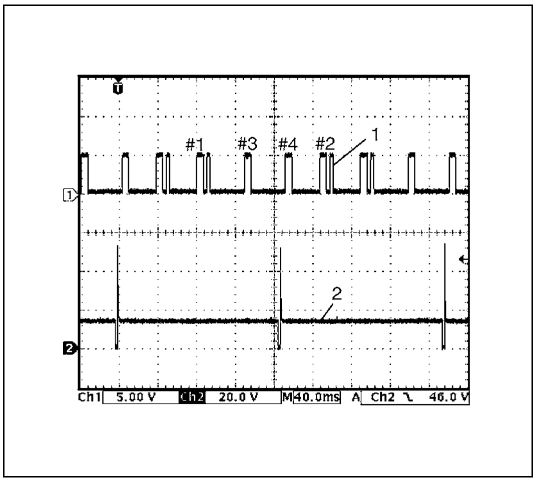


10. Reference waveform No.10

Fuel injector signal at engine idling

Measurement terminal	CH1: C63-10 to C64-1 CH2: C63-6 to C64-1
Oscilloscope setting	CH1: 5 V/DIV, CH2: 20 V/DIV TIME: 1 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

1. Cylinder reference signal (CMP reference signal)
2. Fuel injector signal

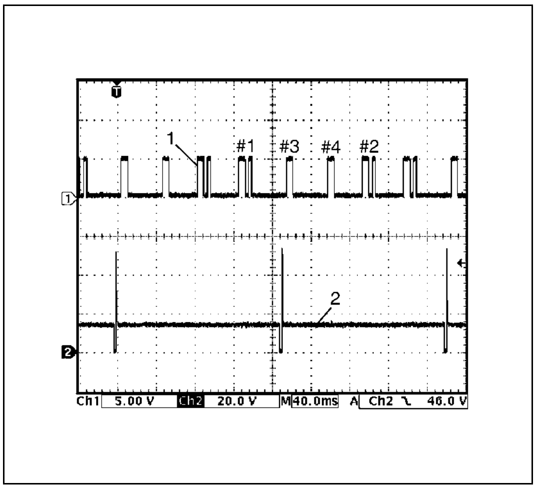


11. Reference waveform No.11

No.4 fuel injector signal at engine idling

Measurement terminal	CH1: C63-10 to C64-1 CH2: C63-4 to C64-1
Oscilloscope setting	CH1: 5 V/DIV, CH2: 20 V/DIV TIME: 40 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

1.	Cylinder reference signal (CMP reference signal)
2.	No.4 fuel injector signal\

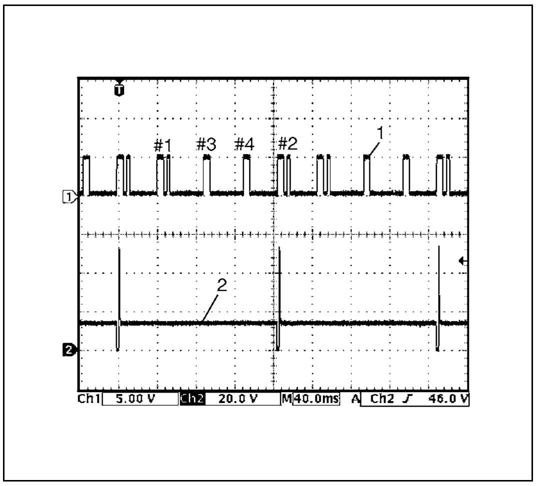


12. Reference waveform No.12

No.3 fuel injector signal at engine idling

Measurement terminal	CH1: C63-10 to C64-1 CH2: C63-5 to C64-1
Oscilloscope setting	CH1: 5 V/DIV, CH2: 20 V/DIV TIME: 40 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

1.	Cylinder reference signal (CMP reference signal)
2.	No.3 fuel injector signal

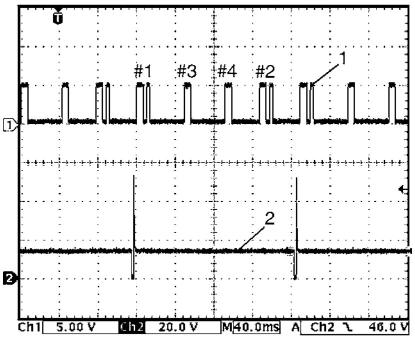


13. Reference waveform No.13

No.2 fuel injector signal at engine idling

Measurement terminal	CH1: C63-10 to C64-1 CH2: C63-6 to C64-1
Oscilloscope setting	CH1: 5 V/DIV, CH2: 20 V/DIV TIME: 40 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

1.	Cylinder reference signal (CMP reference signal)
2.	No.2 fuel injector signal

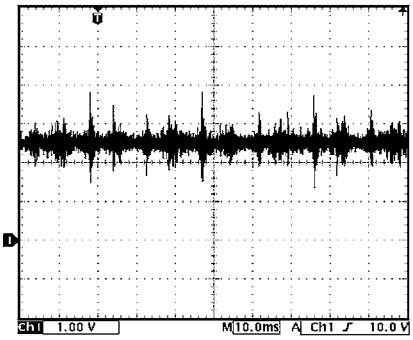


14. Reference waveform No.14

No.1 fuel injector signal at engine idling

Measurement terminal	CH1: C63-10 to C64-1 CH2: C63-7 to C64-1
Oscilloscope setting	CH1: 5 V/DIV, CH2: 20 V/DIV TIME: 40 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

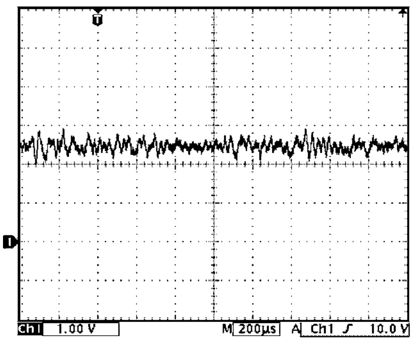
1.	Cylinder reference signal (CMP reference signal)
2.	No.1 fuel injector signal



15. Reference waveform No.15

Knock sensor signal at engine speed 4000 r/min.

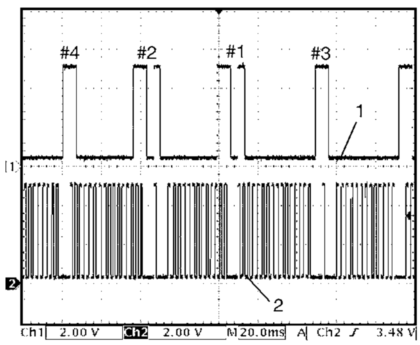
Measurement terminal	CH1: C63-9 to C64-1
Oscilloscope setting	CH1: 1 V/DIV TIME: 10 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Run engine at 4000 r/min.



16. Reference waveform No.16

Knock sensor signal at engine speed 4000 r/min.

Measurement terminal	CH1: C63-9 to C64-1
Oscilloscope setting	CH1: 1 V/DIV TIME: 200 µs/DIV
Measurement condition	• After warmed up to normal operating temperature • Run engine at 4000 r/min.

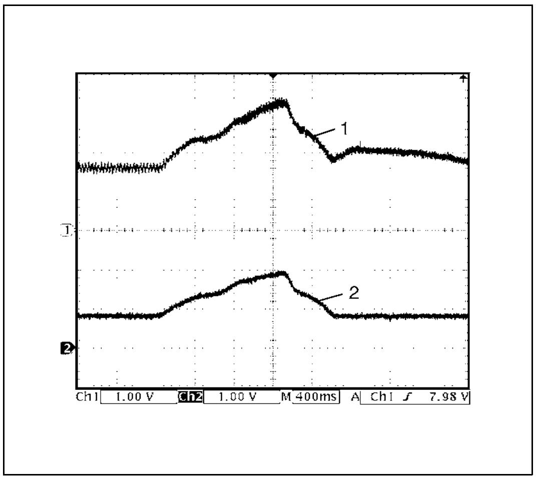


17. Reference waveform No.17

CMP sensor signal at engine idling

Measurement terminal	CH1: C63-10 to C64-1 CH2: C63-30 to C64-1
Oscilloscope setting	CH1: 2 V/DIV, CH2: 2 V/DIV TIME: 20 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

1.	Cylinder reference signal (CMP reference signal)
2.	CKP signal

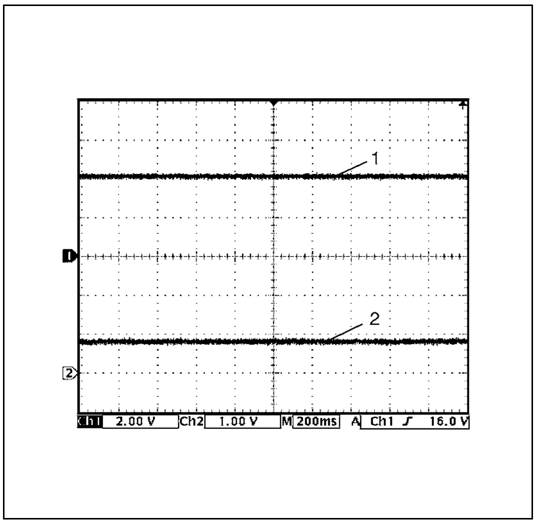


18. Reference waveform No.18

Mass air flow sensor signal at engine racing

Measurement terminal	CH1: C63-14 to C63-28 CH2: C63-34 to C63-28
Oscilloscope setting	CH1: 1 V/DIV, CH2: 1 V/DIV TIME: 400 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine racing

1.	Mass air flow sensor signal
2.	Throttle position sensor signal

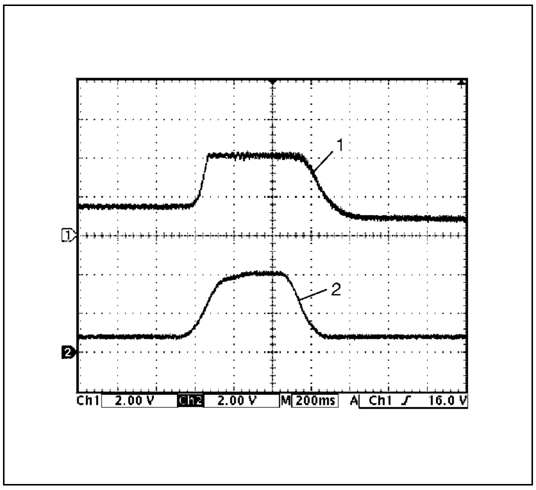


19. Reference waveform No.19

Manifold absolute pressure sensor signal at ignition switch turned ON

Measurement terminal	CH1: C63-15 to C63-28 CH2: C63-34 to C63-28
Oscilloscope setting	CH1: 2 V/DIV, CH2: 2 V/DIV TIME: 200 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Ignition switch turned ON

1.	Manifold absolute pressure sensor signal
2.	Throttle position sensor signal

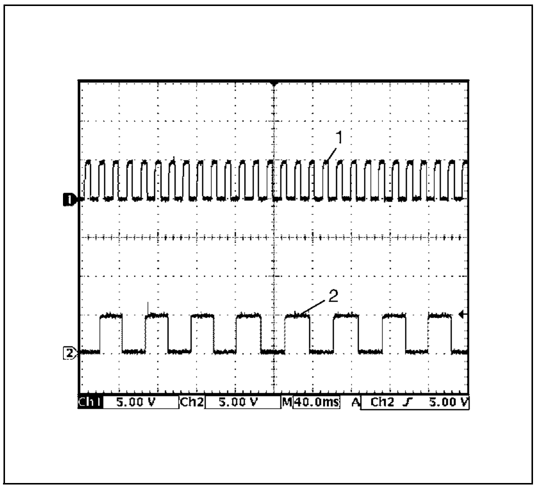


20. Reference waveform No.20

Manifold absolute pressure sensor signal at engine racing

Measurement terminal	CH1: C63-15 to C63-28 CH2: C63-34 to C63-28
Oscilloscope setting	CH1: 2 V/DIV, CH2: 2 V/DIV TIME: 200 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine racing

1.	Manifold absolute pressure sensor signal
2.	Throttle position sensor signal

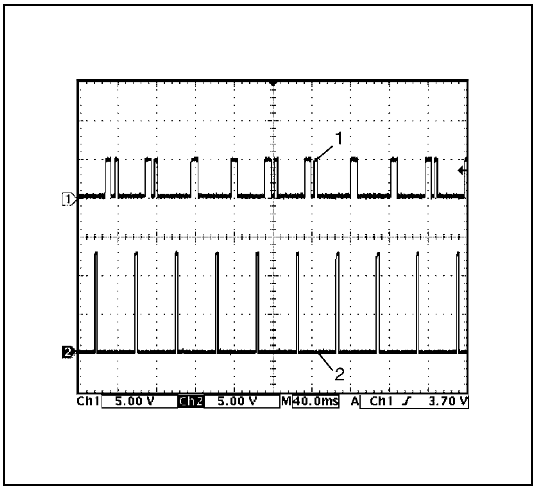


21. Reference waveform No.21

VSS signal at 30 km/h (19 mil/h)

Measurement terminal	CH1: G91-31 to C64-1 CH2: C63-19 to C64-1
Oscilloscope setting	CH1: 5 V/DIV, CH2: 5 V/DIV TIME: 40 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Drive vehicle at 30 km/h (19 mil/h)

1.	VSS signal for speedometer
2.	VSS signal

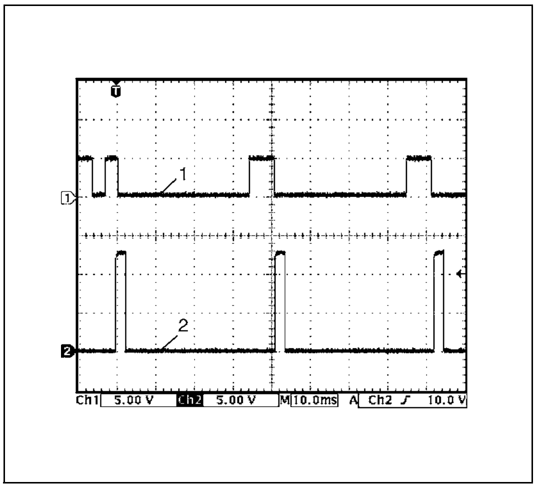


22. Reference waveform No.22

Ignition pulse (engine revolution) signal at engine idling

Measurement terminal	CH1: G63-10 to C64-1 CH2: G91-12 to C64-1
Oscilloscope setting	CH1: 5 V/DIV, CH2: 5 V/DIV TIME: 40 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

1.	Cylinder reference signal (CMP reference signal)
2.	Ignition pulse signal

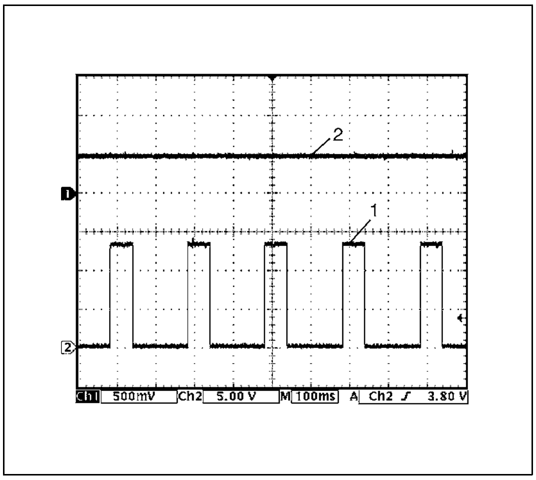


23. Reference waveform No.23

Ignition pulse (engine revolution) signal at engine idling

Measurement terminal	CH1: G63-10 to C64-1 CH2: G91-12 to C64-1
Oscilloscope setting	CH1: 5 V/DIV, CH2: 5 V/DIV TIME: 10 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

1.	Cylinder reference signal (CMP reference signal)
2.	Ignition pulse signal

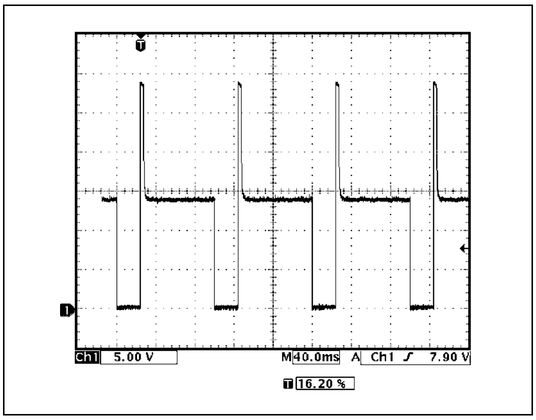


24. Reference waveform No.24

Engine coolant temperature signal at engine idling

Measurement terminal	CH1: C63-16 to C63-28 CH2: G91-32 to C64-1
Oscilloscope setting	CH1: 500 mV/DIV, CH2: 5 V/DIV TIME: 100 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Engine at specified idle speed

1.	Engine coolant temperature signal for combination meter
2.	Engine coolant temperature sensor signal

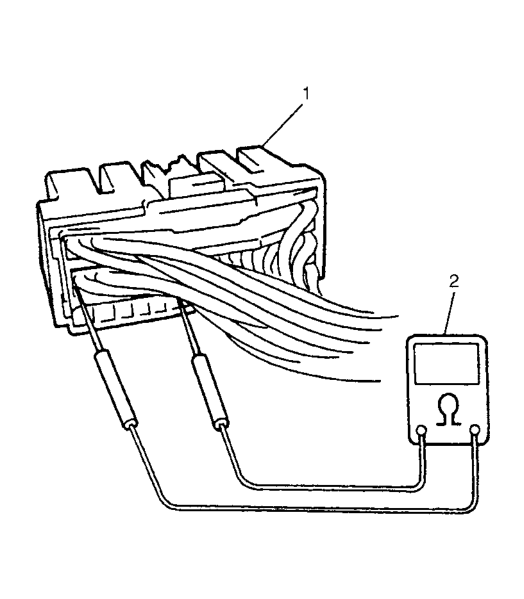


25. Reference waveform No.25

EVAP canister purge valve signal

Measurement terminal	CH1: G64-13 to C64-1
Oscilloscope setting	CH1: 5 V/DIV TIME: 40 ms/DIV
Measurement condition	• After warmed up to normal operating temperature • Drive vehicle at 40 km/h (25 mil/h) or more

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).

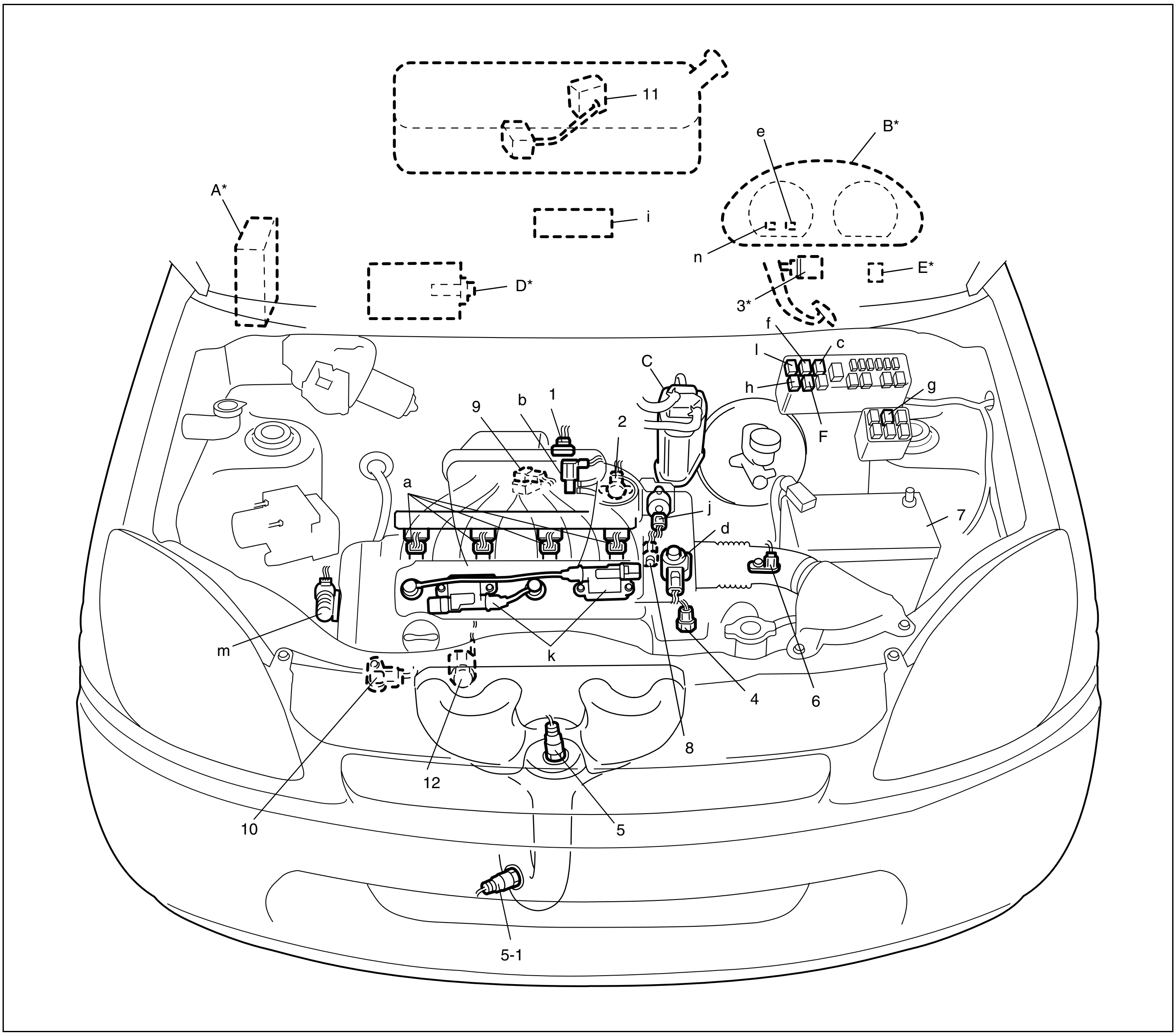
2) Check resistance between each pair of terminals of disconnected couplers as listed in the following table.

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).**

TERMINALS	CIRCUIT	STANDARD RESISTANCE	CONDITION
C64-3 to G91-28	Heater of HO2S–2	4 – 15 Ω	–
G91-4 to G91-5/6	Radiator fan relay	160 – 240 Ω	–
G64-15 to G91-28	Main relay	160 – 240 Ω	Battery disconnected and ignition switch ON
C64-14 to G91-28	Fuel pump relay	160 – 240 Ω	–
C64-5 to G91-5/6	A/C condenser fan relay No.2 (if equipped)	100 – 150 Ω	–
C63-5 to G91-5/6	No.3 fuel injector	10.8 – 18.2 Ω	–
C63-4 to G91-5/6	No.4 fuel injector		
C64-17 to G91-5/6	EGR valve (stepping motor No.1 coil)	20 – 29 Ω	–
C64-13 to G91-5/6	EVAP canister purge valve	28 – 35 Ω	–
C63-6 to G91-5/6	No.2 fuel injector	10.8 – 18.2 Ω	–
C64-34 to G91-5/6	EGR valve (stepping motor No.2 coil)	20 – 31 Ω	–
C64-33 to G91-5/6	EGR valve (stepping motor No.4 coil)		
C64-16 to G91-5/6	EGR valve (stepping motor No.3 coil)		
C64-4 to G91-28	Heater of HO2S–1	2 – 11 Ω	–
C63-7 to G91-5/6	No.1 fuel injector	10.8 – 18.2 Ω	–
C64-10 to G91-5/6	Idle air control valve (stepper motor coil 1)	24 – 35 Ω	–
C64-9 to G91-5/6	Idle air control valve (stepper motor coil 2)	24 – 35 Ω	–
C64-8 to G91-5/6	Idle air control valve (stepper motor coil 3)	24 – 35 Ω	–
C64-28 to G91-5/6	Idle air control valve (stepper motor coil 4)	24 – 35 Ω	–
C64-11 to G91-5/6	A/C compressor relay (if equipped)	160 – 240 Ω	–
C63-2 to G91-5/6	Oil control valve	6 – 15 Ω	–

COMPONENT LOCATION



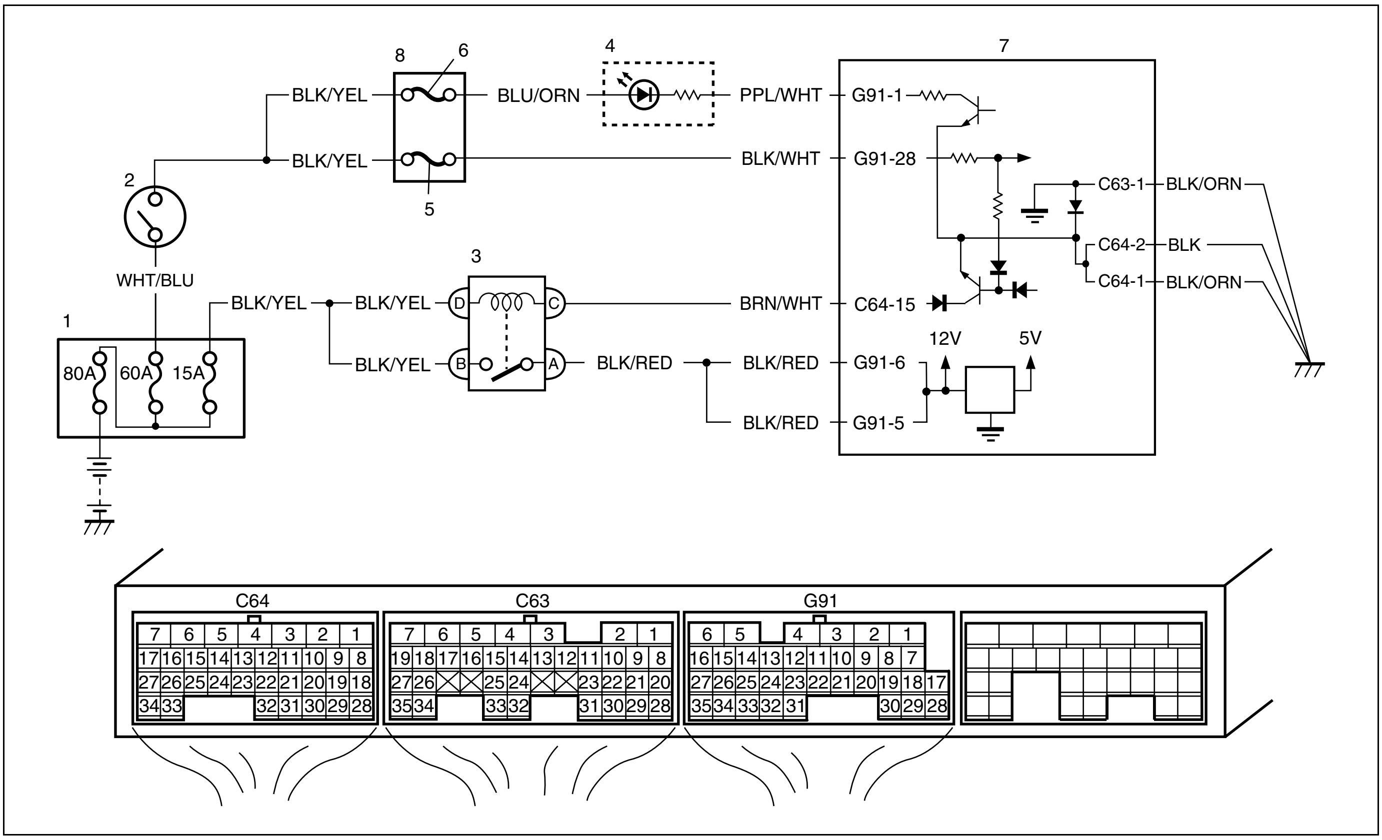
INFORMATION SENSORS	CONTROL DEVICES	OTHERS
1. MAF and IAT sensor	a: Fuel injector	A: ECM
2. TP sensor	b: EVAP canister purge valve	B: Combination meter
3. Stop lamp switch	c: Fuel pump relay	C: EVAP canister
4. ECT sensor	d: EGR valve	D: A/C evaporator inlet air temp. sensor (if equipped)
5. Heated oxygen sensor–1	e: Malfunction indicator lamp	E: Data link connector
5-1. Heated oxygen sensor–2	f: A/C condenser fan relay No.1 (if equipped)	F: A/C compressor relay (if equipped)
6. VSS	g: A/C condenser fan relay No.2 (if equipped)	
7. Battery	h: Radiator fan control relay	
8. CMP sensor	i: Fuel cost meter	
9. MAP sensor	j: IAC valve	
10. CKP sensor	k: Ignition coil assembly (with ignitor)	
11. Fuel level sensor	l: Main relay	
12. Knock sensor	m: Oil control valve	
	n: Immobilizer indicator lamp	

NOTE:

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

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

WIRING DIAGRAM



1. Relay/fuse box	4. Malfunction indicator lamp in combination meter	7. ECM
2. Ignition switch	5. "IG" fuse	8. Circuit fuse box
3. Main relay	6. "METER" fuse	

CIRCUIT DESCRIPTION

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.

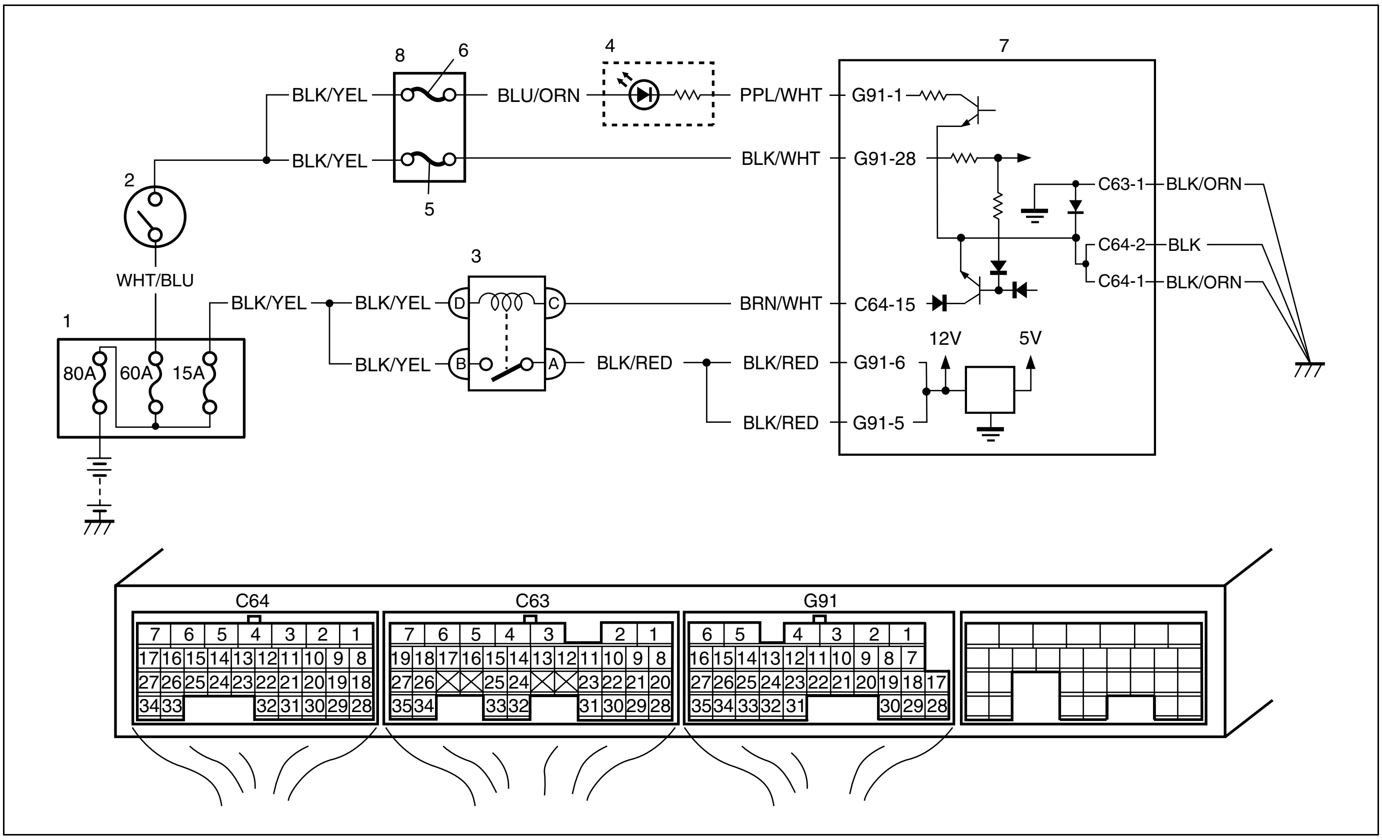
TROUBLESHOOTING

Step	Action	Yes	No
1	MIL Power Supply Check 1) Turn ignition switch to ON position. Do other warning lights come ON?	Go to Step 4.	Go to Step 2.
2	METER Fuse Check 1) Turn ignition switch to OFF position. 2) Check for fuse blow at "METER" fuse. Is "METER" fuse in good condition?	Go to Step 3.	Replace "METER" fuse and check for short.

Step	Action	Yes	No
3	MIL Power Supply Check 1) Disconnect ignition switch connector. 2) Remove "METER" fuse. 3) Measure resistance between "BLK/YEL" wire terminal of ignition switch connector and "BLK/YEL" wire terminal of "METER" fuse connector. Is resistance 1 Ω or less?	Go to Step 4.	"BLK/YEL" wire circuit open or poor connection.
4	MIL Power Supply Check 1) Connect ignition switch connector. 2) Install "METER" fuse. 3) Remove combination meter referring to "Combination Meter Removal and Installation" in Section 8. 4) Check for proper connection to combination meter connector at "BLU/ORN" wire and "PPL/WHT" wire terminals. 5) If OK, then turn ignition switch to ON position and measure voltage between combination meter connector at "BLU/ORN" wire terminal and body ground. Is it 10 – 14 V?	Go to Step 5.	"BLU/ORN" wire circuit open.
5	MIL Circuit Check 1) Turn ignition switch OFF position. 2) Disconnect ECM connector "G91". 3) Check for proper connection to ECM connector at "G91-1" wire terminal. 4) Measure resistance between "PPL/WHT" wire terminal of combination meter connector and "G91-1" wire terminal of ECM connector. Is resistance 1 Ω or less?	Go to Step 6.	"PPL/WHT" wire circuit open.
6	MIL Circuit Check 1) Connect combination meter connectors. 2) Turn ignition switch to ON position. 3) Using service wire, ground "G91-1" terminal wire of disconnected ECM connector. Does MIL turn ON?	Substitute a known-good ECM and recheck.	Replace combination meter.

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

WIRING DIAGRAM



1. Relay/fuse box	4. Malfunction indicator lamp in combination meter	7. ECM
2. Ignition switch	5. “IG” fuse	8. Circuit fuse box
3. Main relay	6. “METER” fuse	

CIRCUIT DESCRIPTION

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.

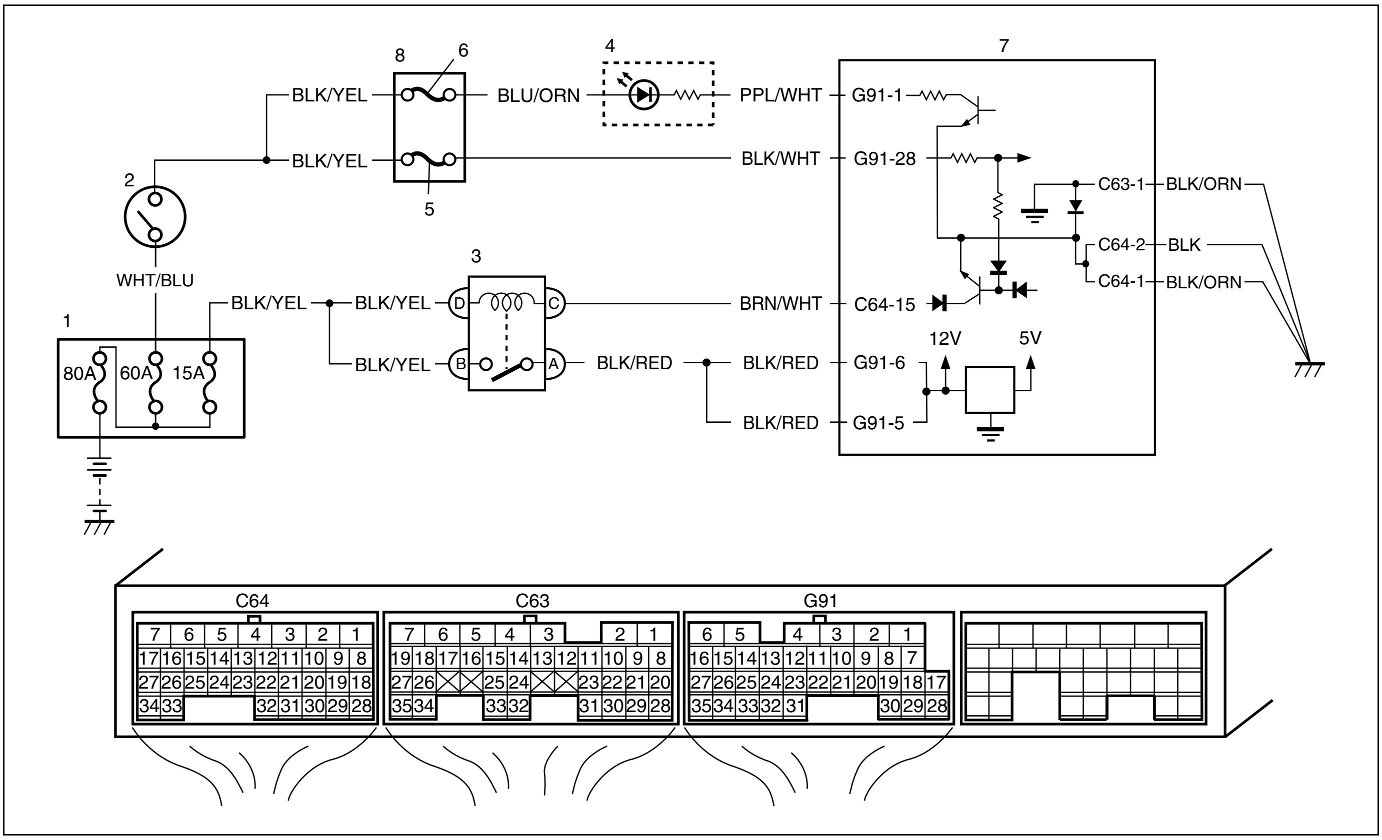
TROUBLESHOOTING

Step	Action	Yes	No
1	DTC Check 1) Check DTC referring to “Diagnostic Trouble Code (DTC) Check” in this section. Is there any DTC(s)?	Go to Step 2 of “Engine and Emission Control System Check” in this section.	Go to Step 2.
2	DTC Check 1) Start engine and recheck DTC while engine running. Is there any DTC(s)?	Go to Step 2 of “Engine and Emission Control System Check” in this section.	Go to Step 3.

Step	Action	Yes	No
3	MIL Circuit Check 1) Turn ignition switch to OFF position. 2) Remove combination meter referring to “Combination Meter Removal and Installation” in Section8. 3) Disconnect connectors from ECM. 4) Measure resistance between “PPL/WHT” wire terminal of combination meter connector and body ground. Is resistance infinity?	Go to Step 4.	“PPL/WHT” wire circuit shorted to ground.
4	MIL Circuit Check 1) Connect connectors to combination meter. Does MIL turn ON at ignition switch turned ON?	Replace combination meter.	Substitute a known-good ECM and recheck.

Table A-3 ECM Power and Ground Circuit Check-MIL Doesn't Light with Ignition Switch ON and Engine Doesn't Start Though It Is Cranked Up

WIRING DIAGRAM



1. Relay/fuse box	4. Malfunction indicator lamp in combination meter	7. ECM
2. Ignition switch	5. "IG" fuse	8. Circuit fuse box
3. Main relay	6. "METER" fuse	

CIRCUIT DESCRIPTION

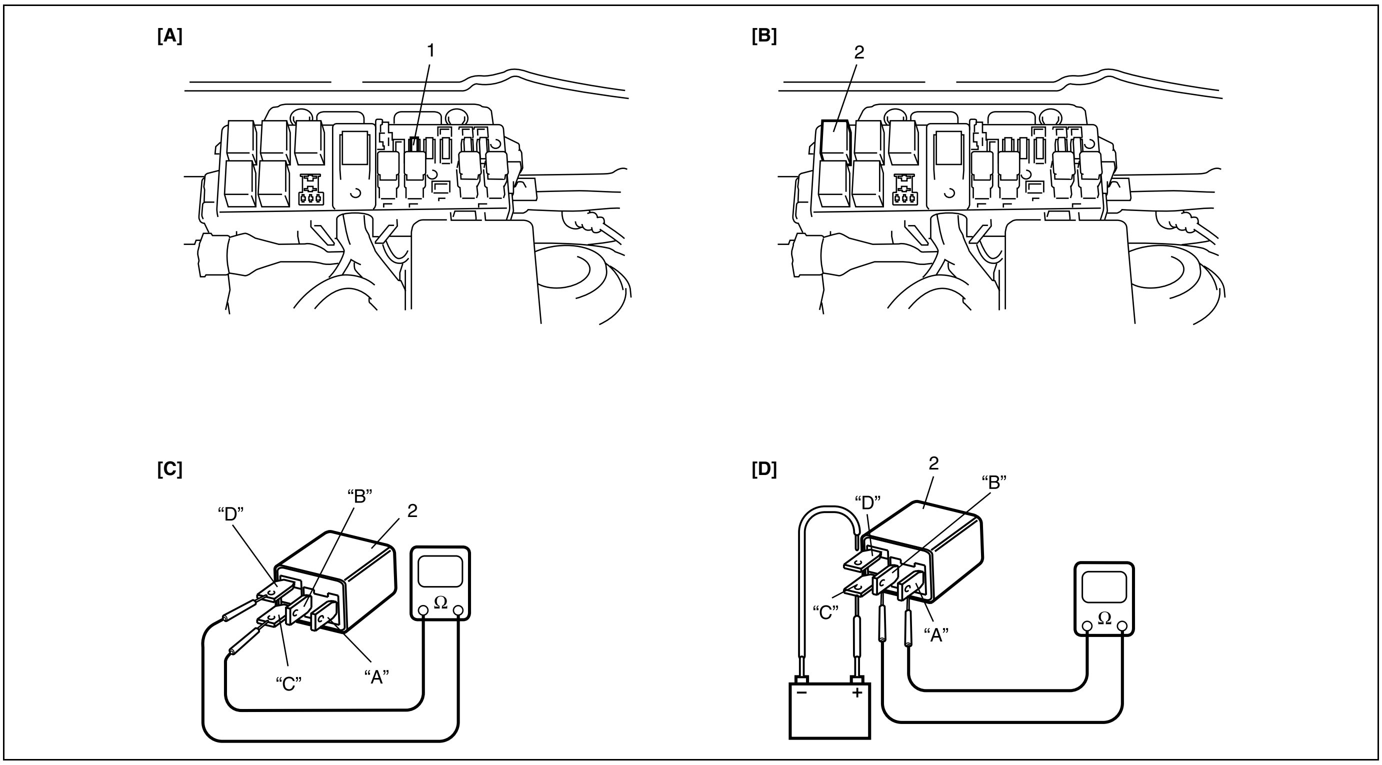
When the ignition switch tuned ON, the main relay turns ON (the contact point closes) and the main power is supplied to ECM.

TROUBLESHOOTING

Step	Action	Yes	No
1	IG Fuse Check 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Check for proper connection to ECM connector at "G91-1", "G91-28", "C64-15", "G91-6", "G91-5", "C63-1", "C64-1" and "C64-2" wire terminals. 3) If OK, check "IG" fuse for fuse blow. Is "IG" fuse in good condition?	Go to Step 2.	Replace fuse and check for short in circuits connected to this fuse.
2	Ignition Signal Check 1) Turn ignition switch to ON position. 2) Measure voltage between "G91-28" wire terminal of ECM connector and body ground. Is voltage 10 – 14 V?	Go to Step 3.	"BLK/WHT" or "BLK/YEL" wire circuit open.

Step	Action	Yes	No
3	Main Relay Circuit Check 1) Turn ignition switch to OFF position. 2) Check for fuse blow at main fuse (15 A). (See Fig. 1.) 3) If OK, measure voltage between “C64-15” wire terminal of ECM connector and body ground. Is voltage 10 – 14 V?	Go to Step 4.	Go to Step 8.
4	Main Relay Circuit Check 1) Remove ECM from vehicle body and connect connectors to ECM. 2) Turn ignition switch to ON position. 3) Measure voltage between “C64-15” wire terminal of ECM connector and body ground. Is voltage 0 – 1 V?	Go to Step 6.	Go to Step 5.
5	ECM Ground Circuit Check 1) Turn ignition switch to OFF position. 2) Disconnect connectors from ECM. 3) Measure resistance between each “C63-1”, “C64-1” and “C64-2” wire terminals of ECM connector and body ground. Is resistance 1 Ω or less?	Substitute a known-good ECM and recheck.	“BLK/ORN” or “BLK” wire open circuit or high resistance circuit.
6	Main Relay Circuit Check 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Using service wire, ground “C64-15” wire terminal of ECM connector and measure voltage between each “G91-5” and “G91-6” wire terminals of ECM connector and body ground. Is voltage 10 – 14 V?	Substitute a known-good ECM and recheck.	Go to Step 7.
7	Main Relay Circuit Check 1) Remove main relay from relay/fuse box. (See Fig. 2.) 2) Check for proper connection to main relay connector at “BLK/YEL” and “BLK/RED” wire terminals. 3) If OK, measure resistance between each “G91-5” and “G91-6” wire terminals of ECM connector and “BLK/RED” wire terminal of main relay connector. Is resistance 1Ω or less?	Go to Step 8.	“BLK/RED” wire open circuit or high resistance circuit.
8	Main Relay Circuit Check 1) Remove main relay from relay/fuse box. 2) Measure voltage between “BLK/YEL” wire terminals of main relay connector and body ground. Is voltage 10 – 14 V?	Go to Step 9.	“BLK/YEL” wire circuit open.

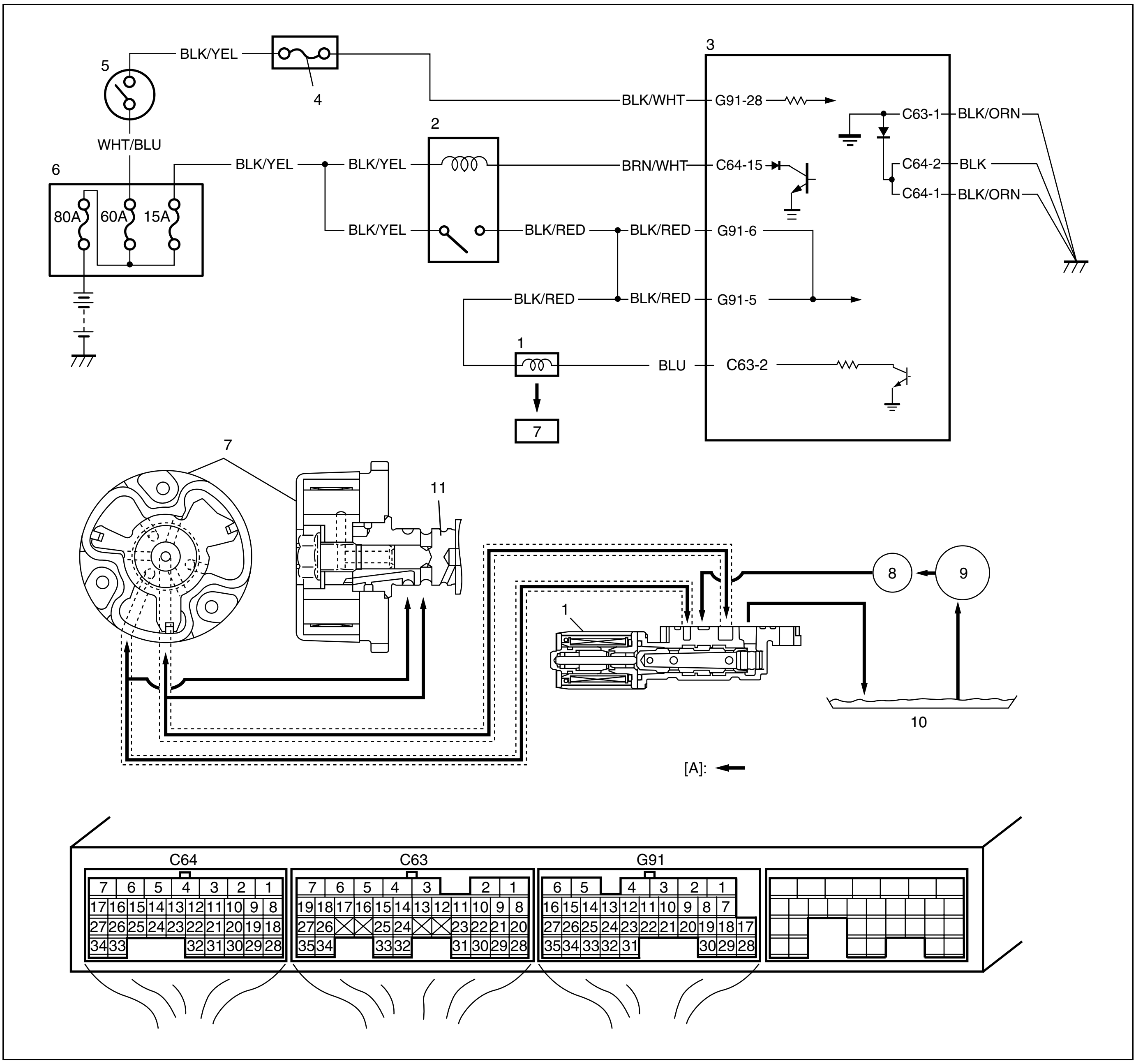
Step	Action	Yes	No
9	Main Relay Check 1) Measure resistance between each two terminals of main relay. (See Fig. 3). Between main relay terminals “A” and “B”: Infinity “C” and “D”: 160 – 240 Ω at 20°C (68°F) 2) Check that there is continuity between terminals “A” and “B” when battery is connected to terminals “C” and “D” (See Fig. 4). Is main relay in good condition?	“BRN/WHT” wire open circuit or high resistance circuit.	Replace main relay.



[A]: Fig. 1 for Step 3	[C]: Fig. 3 for Step 9	1. Main fuse (15 A)
[B]: Fig. 2 for Step 7	[D]: Fig. 4 for Step 9	2. Main relay

DTC P0010 Camshaft Position Actuator Circuit

WIRING DIAGRAM



[A]: Oil flow	3. ECM	6. Relay/fuse box	9. Oil pump
1. Oil control valve	4. “IG” fuse	7. Camshaft timing sprocket	10. Oil pan
2. Main relay	5. Ignition switch	8. Oil filter	11. Intake camshaft

CIRCUIT DESCRIPTION

Actual valve timing fails to become close to target advance level of each function although advance control function or retarded advance control function is at work.

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
Monitor signal of oil control valve is different from command signal. (Circuit open or short) (2 driving cycle detection logic)	• Oil control valve • Oil control valve circuit • ECM

DTC CONFIRMATION PROCEDURE

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.
- **Intake air temperature: –7°C (19.4°F) or higher**
- **Engine coolant temperature: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

1) Clear DTC. Refer to “Diagnostic Trouble Code (DTC) Clearance”.
2) Start engine.
3) Maintain engine speed at 2000 r/min. or higher for 5 seconds.
4) Check DTC. Refer “Diagnostic Trouble Code (DTC) Check”.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Check oil control valve power supply circuit. 1) Turn OFF ignition switch, disconnect connector from oil control valve. 2) Turn ignition switch ON, measure voltage between “BLK/RED” wire terminal of oil control valve connector and engine ground. Is voltage 10 – 14 V?	Go to Step 3.	“BLK/RED” wire open circuit.
3	Check wire circuit. 1) Turn OFF ignition switch, disconnect connectors from ECM. 2) Check for proper connection to “C63-2” wire terminal of ECM connector. 3) If OK, measure resistance between “C63-2” wire terminal of ECM connector and vehicle body ground. Is resistance infinity?	Go to Step 4.	“BLU” wire shorted to ground circuit.
4	Check wire circuit. 1) Turn ignition switch ON, measure voltage between “C63-2” wire terminal of ECM connector and engine ground. Is voltage 0 V?	Go to Step 5.	“BLU” wire shorted to power supply circuit.
5	Check wire circuit. 1) Turn OFF ignition switch, connect connector to oil control valve. 2) Turn ignition switch ON, measure voltage between “C63-2” wire terminal of ECM connector and engine ground. Is voltage 10 – 14 V?	Go to Step 6.	“BLU” wire open circuit.
6	Check oil control valve. 1) Check oil control valve referring to “Oil control valve inspection” in Section 6E1. Is it in good condition?	Go to Step 7.	Replace oil control valve.

Step	Action	Yes	No
7	Check oil control valve control circuit. 1) Check for proper connection to “G91-5” and “G91-6” wire terminals of ECM connector. 2) Turn OFF ignition switch, measure resistance between each “G91-5” and “G91-6” wire terminals of ECM connector and “C63-2” wire terminal of ECM connector. Is resistance 6 – 8.5 Ω at 20°C, 68°F?	Substitute a known-good ECM and recheck.	“BLK/RED” wire and/or “BLU” wire in high resistance circuit.

DTC P0011 Camshaft Position – Timing Over-Advanced or System Performance
DTC P0012 Camshaft Position – Timing Over-Retarded

DESCRIPTION

Actual value of advanced valve timing does not reach target value.
Valve timing is advanced although ECM command is most retarding.

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
Actual valve of advanced valve timing does not reach target value, or valve timing is advanced although ECM command is most retarding. (1 driving cycle detection logic)	• Oil control valve • Oil galleries of timing sprocket • Intake camshaft timing sprocket (VVT actuator)

DTC CONFIRMATION PROCEDURE

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.

- **Intake air temperature: –7°C (19.4°F) or higher**
- **Engine coolant temperature: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2500 m, 8200 ft or less (540 mmHg, 72 kPa or more)**

1) Clear DTC. Refer to “Diagnostic Trouble Code (DTC) Clearance”
2) Start engine and drive vehicle under usual driving condition for 5 minutes or longer until engine is warmed up to normal operating temperature.
3) Stop vehicle.
4) Run engine at idle speed for 1 minute.
5) Start vehicle and increase vehicle speed up to 80 km/h (50 mile/h).
6) Keep vehicle speed at 80 km/h (50 mile/h) for 1 minute or longer at 5th gear position or D range.
7) Decrease vehicle speed gradually.
8) Stop vehicle and ignition switch OFF.
9) Repeat step 4) to 7) one time.
10) Stop vehicle.

Check DTC. Refer to “Diagnostic Trouble Code (DTC) Check” in this section.

TROUBLESHOOTING

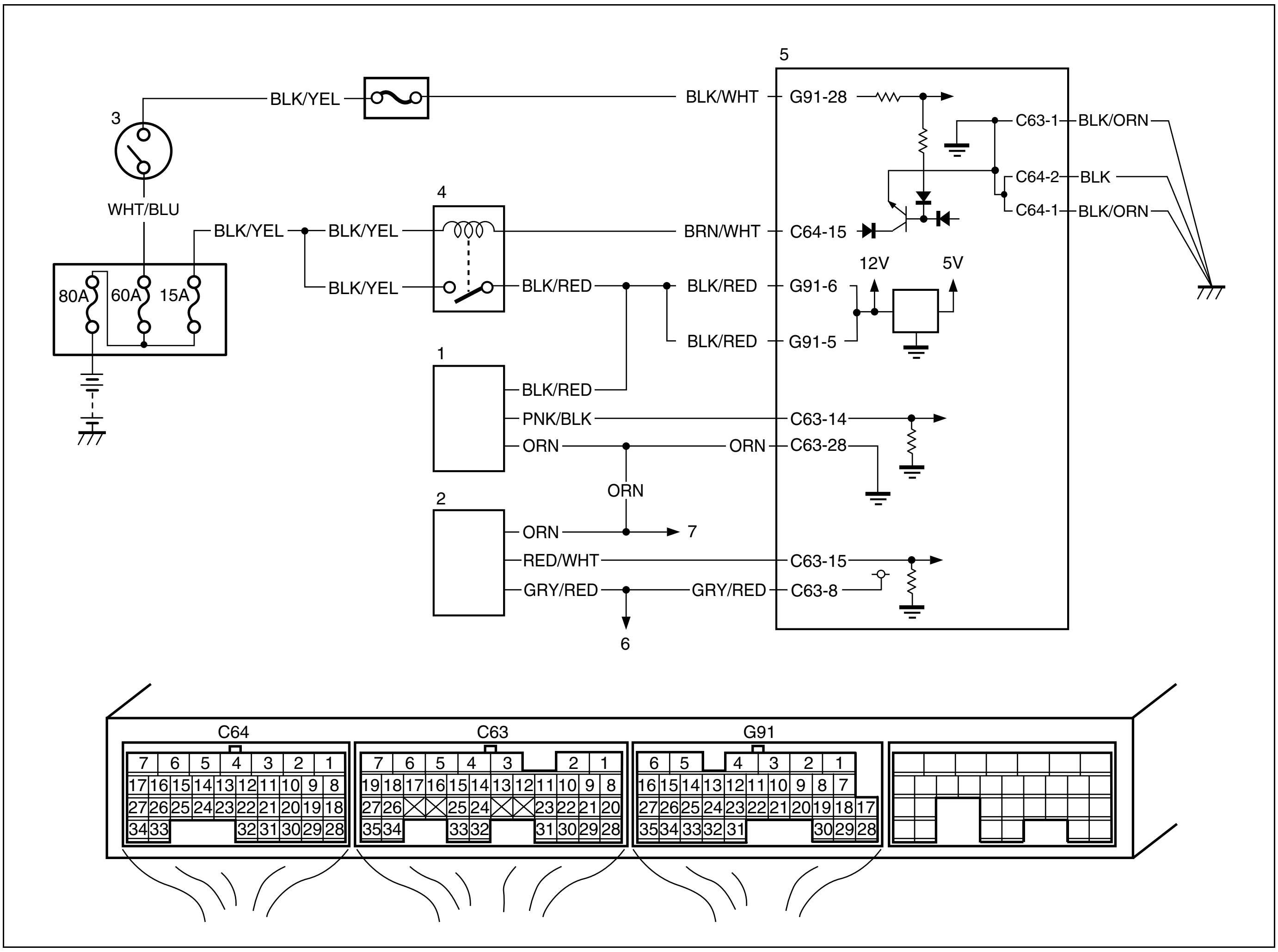
Step	Action	Yes	No
1	Is DTC P0010 detected together?	Go to “DTC P0010 Camshaft Position Actuator Circuit” in this section.	Go to Step 2.
2	Do you have Suzuki Scan Tool?	Go to Step 3.	Go to Step 5.
3	VVT GAP Check 1) With ignition switch turned OFF, connect Suzuki Scan Tool. 2) Start engine and warm up to normal operating temperature. 3) Select menu to DATA LIST. 4) Check that the VVT GAP displayed on Suzuki Scan Tool is 0 – 5°. Is it OK?	Go to Step 4.	Check valve timing referring to “Timing Chain and Chain Tensioner Removal and Installation” in Section 6A1. If OK, go to Step 5.
4	VVT Signal Check 1) Drive vehicle the following condition. • Vehicle speed at 80 km/h (50 mile/h). • Gear position at 5th or D range. 2) Check that the VVT GAP displayed on Suzuki Scan Tool is 0 – 5°. Is it OK?	Substitute a known-good ECM and recheck.	Go to Step 5.
5	Oil Control Circuit Visual Inspection 1) Remove cylinder head cover referring to “Cylinder Head Cover Removal and Installation” in Section 6A1. 2) Check oil pressure leakage from oil control circuit. Is it in good condition?	Go to Step 6.	Repair or replace.
6	Check Oil Control Circuit. 1) Remove oil control valve referring to “Oil control valve” in Section 6A1. 2) Remove oil gallery pipe referring to “Oil gallery pipe” in Section 6A1. 3) Check oil gallery pipe and oil control valve for clog or sludge. Is it in good condition?	Go to Step 7.	Clean oil control valve and oil gallery pipe. Replace oil control valve if a problem is not solved after cleaning oil control valve and oil gallery pipe.
7	Check Oil Control Valve 1) Check oil control valve referring to “Oil control valve inspection” in Section 6E1. Is it in good condition?	Replace camshaft timing sprocket.	Replace oil control valve.

NOTE:

Upon completion of inspection and repair work, perform “DTC Confirmation Procedure” and confirm that the trouble has been corrected.

DTC P0101 Mass Air Flow Circuit Range/Performance

WIRING DIAGRAM



1. MAF and IAT sensor	4. Main relay	7. To other sensors
2. MAP sensor	5. ECM	
3. Ignition switch	6. To TP sensor	

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
Even if the voltage of the throttle position sensor changes, the voltage of the mass air flow sensor does not change normally. (2 driving cycle detection logic)	• Air intake system (clog or leakage) • High resistance in the sensor circuit • MAF sensor • TP sensor • 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 very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 person, a driver and tester, on a level road.**

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.

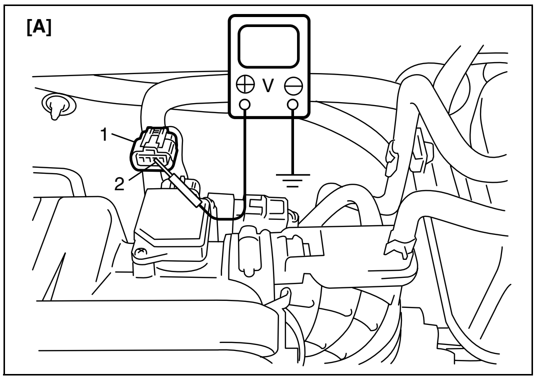
- **Intake air temperature: –7°C (19.4°F) or higher**
- **Engine coolant temperature: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm up to normal operating temperature. (ECT approx. 90 – 95°C, 194 – 203°F)
4) Drive vehicle at 40 km/h (25 mile/h) at 5th gear or D range (engine speed: about 1250 rpm).
5) Increase vehicle speed to 45 km/h (28 mile/h) at 5th gear or D range (engine speed: about 1400 rpm).
6) Release accelerator pedal to decrease vehicle speed till 40 km/h (25 mile/h).
7) Repeat Step 4) to 6) for 5 times.
8) Stop vehicle and check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Visual inspection. Check MAF sensor and air intake system for: 1) Objects which block measuring duct and resistor of MAF sensor. 2) Other air flow which does not pass the MAF sensor. Are there in good condition?	Go to Step 3.	Repair or replace.
3	MAF sensor performance check. 1) With ignition switch turned OFF, install scan tool. 2) Start engine and warm up to normal operation temperature. 3) Check MAF value using scan tool, under the following conditions. **MAF value specification** **Idling: 1.5 – 4.0 g/sec.** **Racing at 2500 r/min: 5.0 – 10.0 g/sec.** Is each value as specified?	Go to Step 11.	Go to Step 4.
4	MAF sensor output voltage check. 1) Check voltage between “C63-14” and “C63-28” wire terminals under the following conditions. **Voltage between “C63-14” and “C63-28” wire terminals of ECM connector** **Ignition switch ON, leaving engine OFF: 0.5 – 1.2 V** **Idling: 1.3 – 1.8 V** Is each value as specified?	Poor “C63-14” or/ and “C63-28” terminal connection. If OK, substitute a known-good ECM and recheck.	Go to Step 5.

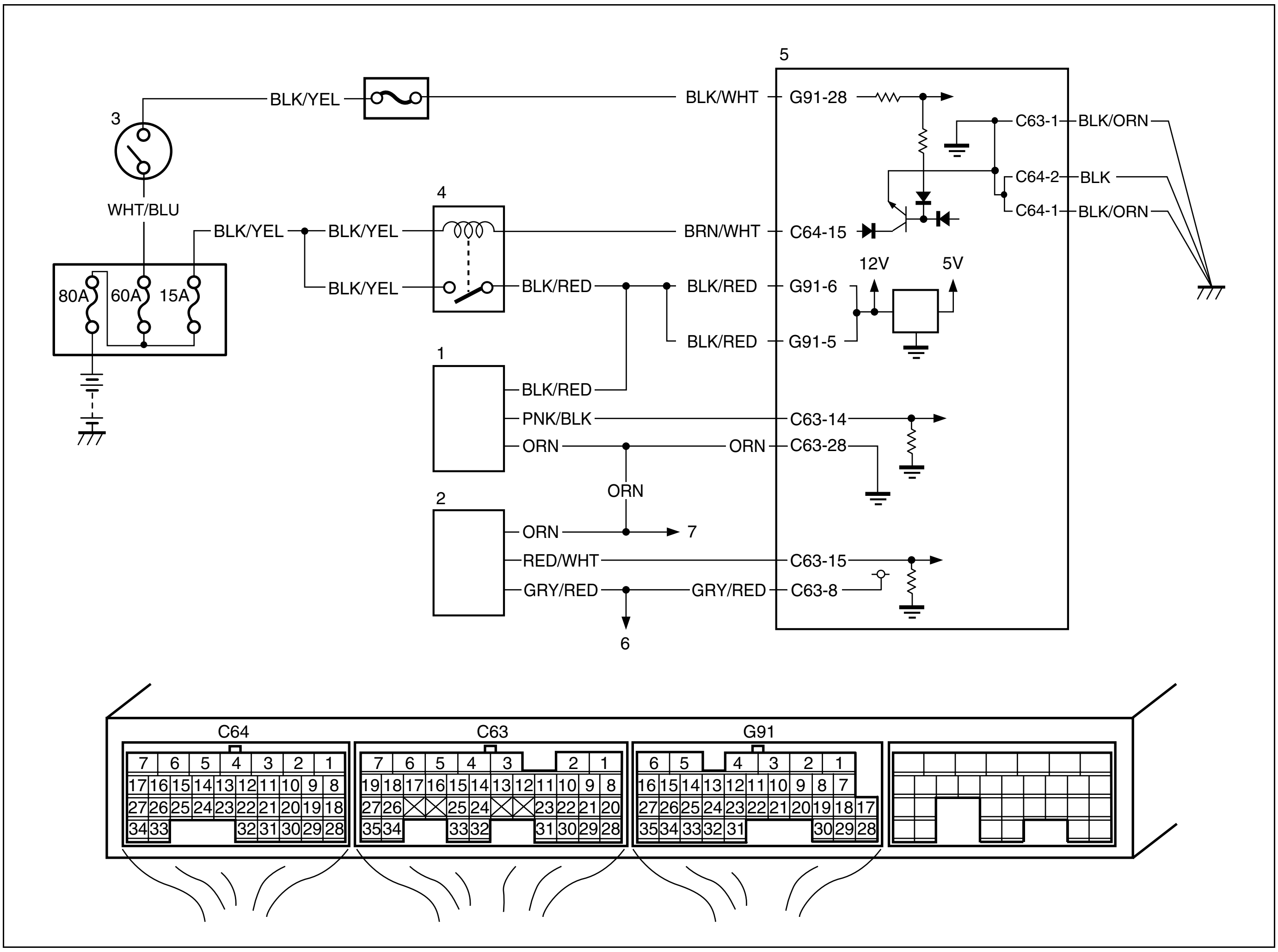
Step	Action	Yes	No
5	Check MAF sensor power supply voltage. 1) Disconnect connector from MAF sensor with ignition switch turned OFF. 2) Turn ON ignition switch, measure voltage between engine ground and "BLK/RED" wire terminal of MAF sensor connector. See Fig. 1. Is voltage 10 – 14 V?	Go to Step 6.	"BLK/RED" wire in open circuit.
6	Check MAF sensor ground circuit. 1) Measure resistance between "ORN" wire terminal of MAF sensor connector and engine ground. Is resistance below 5Ω?	Go to Step 8.	Go to Step 7.
7	Check ground circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and connect connectors to ECM. 3) Measure resistance between "C63-28" wire terminal of ECM connector and vehicle body ground. Is resistance below 5 Ω?	"ORN" wire in open or high resistance circuit.	ECM grounds "C63-1", "C64-1" and/or "C64-2" circuit in open or high resistance. If wires are OK, substitute a known-good ECM and recheck.
8	Check MAF sensor signal circuit. 1) Turn ON ignition switch. 2) Measure voltage between "PNK/BLK" wire terminal of MAF sensor connector and engine ground. Is voltage 0 V?	Go to Step 9.	"PNK/BLK" wire shorted to others circuit.
9	Check MAF sensor signal circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between "PNK/BLK" wire terminal of MAF sensor connector and vehicle body ground. Is resistance infinity?	Go to Step 10.	"PNK/BLK" wire shorted to ground circuit.
10	Check MAF sensor signal circuit. 1) Measure resistance between "PNK/BLK" wire terminal of MAF sensor connector and "C63-14" wire terminal of ECM connector. Is resistance below 3 Ω?	Faulty MAF sensor.	"PNK/BLK" wire in open or high resistance circuit.
11	Is DTC P0121 detected?	Go to "DTC P0121 Throttle Position Sensor Circuit Range / Performance" in this section.	Substitute a known-good ECM and recheck.



[A]:	Fig.1 for Step 5
1.	MAF sensor coupler
2.	“BLK/RED” wire terminal

DTC P0102 Mass Air Flow Circuit Low Input

WIRING DIAGRAM



1. MAF and IAT sensor	4. Main relay	7. To other sensors
2. MAP sensor	5. ECM	
3. Ignition switch	6. To TP sensor	

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
DTC will be set when all of the following conditions are detected for 5 seconds continuously. • Engine is running • Current of MAF sensor output is less than the specified value for the specified time continuously.	• Open or short in MAF sensor circuit • MAF sensor • ECM

DTC CONFIRMATION PROCEDURE

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and run it for 10 sec.
4) Check DTC and pending DTC.

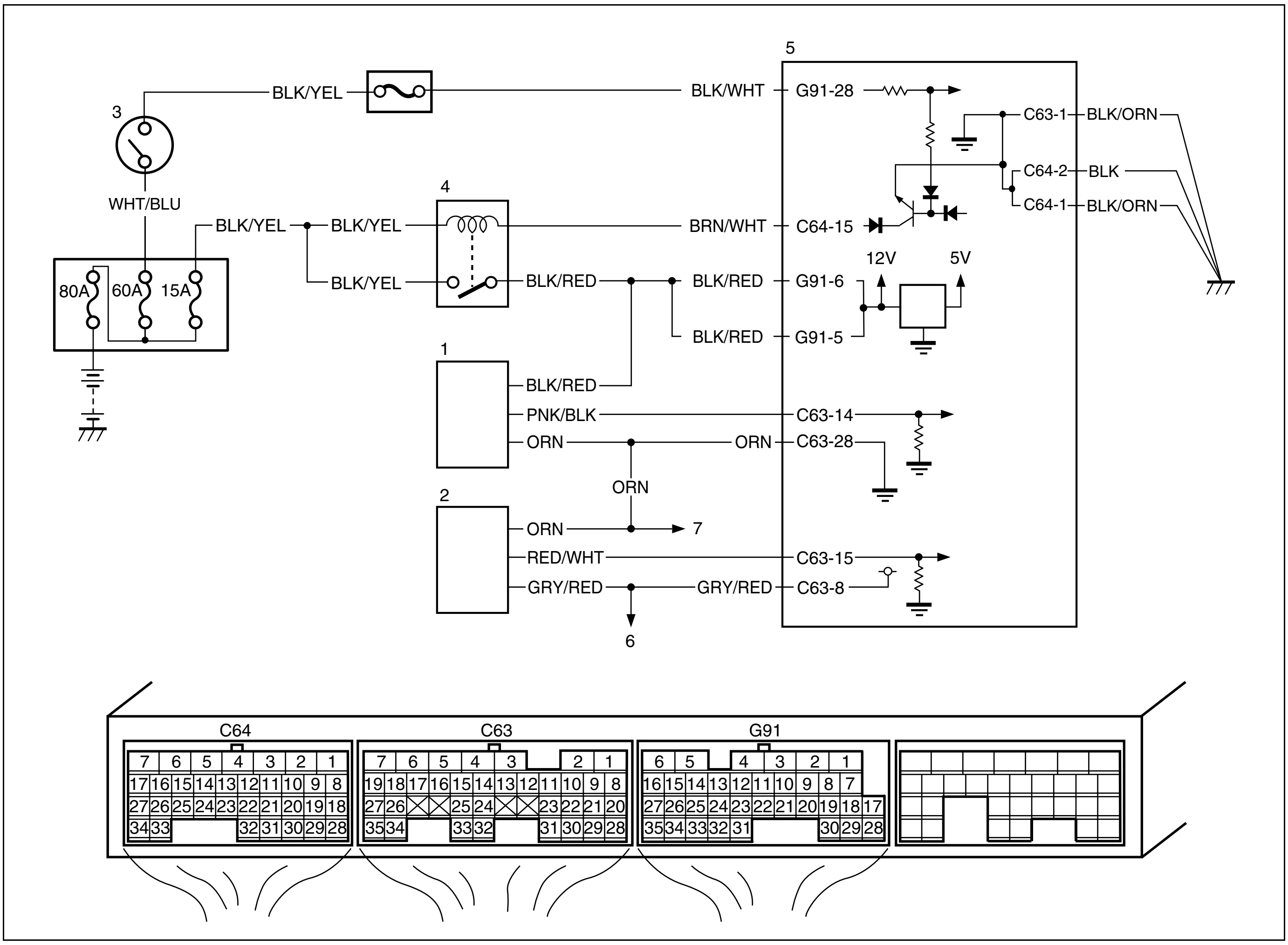
TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	MAF Sensor Check. 1) Connect scan tool to DLC with ignition switch turned OFF. 2) Start engine and check MAF value displayed on scan tool. (Refer to “Scan Tool Data” in this section for normal value.) Is normal value indicated?	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.	Go to Step 3.
3	Check MAF sensor power supply voltage. 1) Disconnect connector from MAF sensor with ignition switch turned OFF. 2) Turn ON ignition switch, measure voltage between engine ground and “BLK/RED” wire terminal of MAF sensor connector. Is voltage 10 – 14 V?	Go to Step 4.	“BLK/RED” wire in open circuit.
4	Check MAF sensor ground circuit. 1) Measure resistance between “ORN” wire terminal of MAF sensor connector and engine ground. Is resistance below 5 Ω?	Go to Step 6.	Go to Step 5.
5	Check ground circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and connect connectors to ECM. 3) Measure resistance between “C63-28” terminal of ECM connector and vehicle body ground. Is resistance below 5 Ω?	“ORN” wire in open or high resistance circuit.	ECM grounds “C63-1”, “C64-1” and/or “C64-2” circuit open or high resistance. If wires are OK, substitute a known-good ECM and recheck.

Step	Action	Yes	No
6	Check MAF sensor signal circuit. 1) Turn ON ignition switch. 2) Measure voltage between “PNK/BLK” wire terminal of MAF sensor connector and engine ground. Is voltage 0 V?	Go to Step 7.	“PNK/BLK” wire shorted to other circuit.
7	Check MAF sensor signal circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between “PNK/BLK” wire terminal of MAF sensor connector and vehicle body ground. Is resistance infinity?	Go to Step 8.	“PNK/BLK” wire shorted to ground circuit.
8	Check MAF sensor signal circuit. 1) Measure resistance between “PNK/BLK” wire terminal of MAF sensor connector and “C63-14” terminal of ECM connector. Is resistance below 3 Ω?	Go to Step 9.	“PNK/BLK” wire in open or high resistance circuit.
9	Check MAF sensor output signal. 1) Connect ECM connectors to MAF sensor and ECM with ignition switch turned OFF. 2) Check voltage between “C63-14” and “C63-28” under the following condition. **Voltage between “C63-14” and “C63-28” of ECM connector at ignition switch ON, leaving engine stop: 0.5 – 1.2 V** **Idling: 1.3 – 1.8 V** Is each value as specified?	Substitute a known-good ECM and recheck.	Faulty MAF and IAT sensor.

DTC P0103 Mass Air Flow Circuit High Input

WIRING DIAGRAM



1. MAF and IAT sensor	4. Main relay	7. To other sensors
2. MAP sensor	5. ECM	
3. Ignition switch	6. To TP sensor	

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
DTC will be set when all of the following conditions are detected for 5 seconds continuously. • Engine is running • After 3 seconds from ignition switch ON, and current of MAF sensor output is more than the specified value for the specified time continuously.	• Open or short in MAF sensor circuit • MAF sensor • ECM

DTC CONFIRMATION PROCEDURE

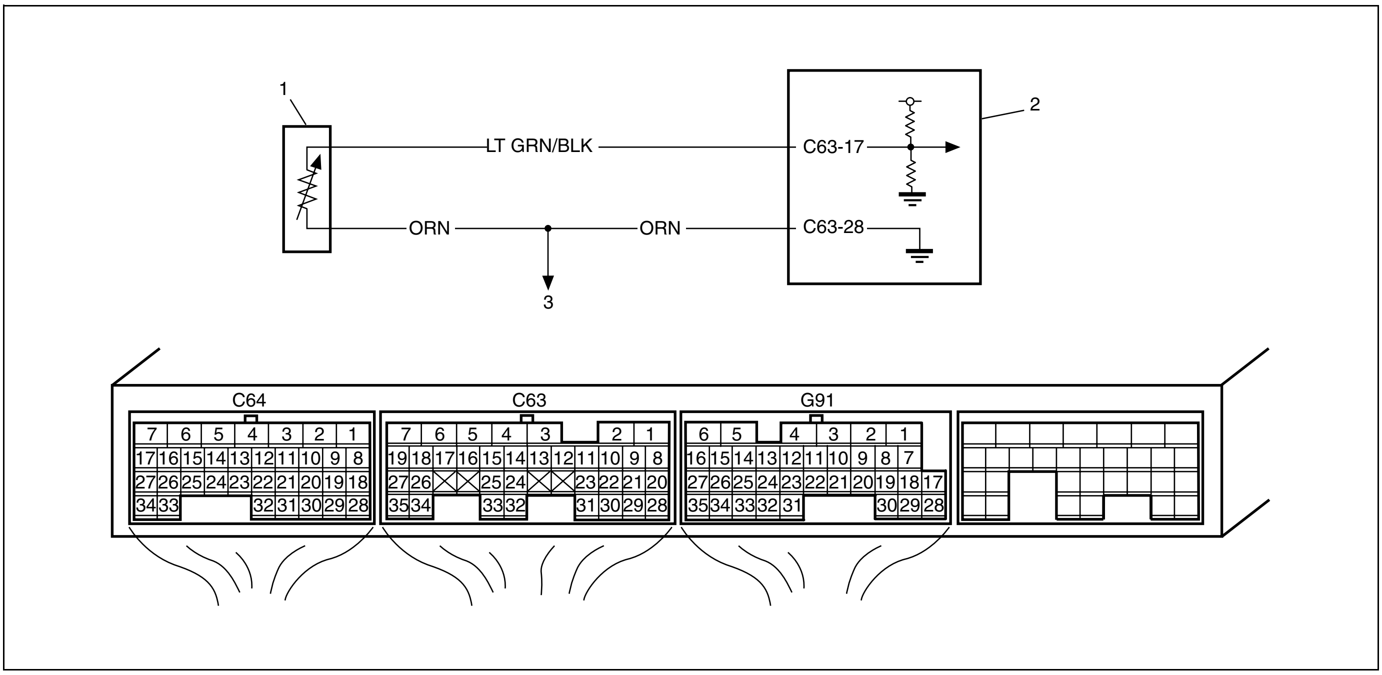
1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and run it for 10 sec.
4) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check" in this section.
2	MAF sensor check. 1) Connect scan tool to DLC with ignition switch turned OFF. 2) Start engine and check MAF value displayed on scan tool. (Refer to "Scan Tool Data" in this section for normal value.) Is normal value indicated?	Intermittent trouble. Check for intermittent referring to "Intermittent and Poor Connection" in Section 0A.	Go to Step 3.
3	Check MAF sensor power supply voltage. 1) Disconnect connector from MAF sensor with ignition switch turned OFF. 2) Turn ON ignition switch, measure voltage between engine ground and "BLK/RED" wire terminal of MAF sensor connector. Is voltage 10 – 14 V?	Go to Step 4.	"BLK/RED" wire in open circuit.
4	Check MAF sensor ground circuit. 1) Measure resistance between "ORN" wire terminal of MAF sensor connector and engine ground. Is resistance below 5 Ω?	Go to Step 6.	Go to Step 5.
5	Check ground circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and connect connectors to ECM. 3) Measure resistance between "C63-28" terminal of ECM connector and vehicle body ground. Is resistance below 5 Ω?	"ORN" wire in open or high resistance circuit.	ECM grounds "C63-1", "C64-1" and/or "C64-2" circuit in open or high resistance. If wires are OK, substitute a known-good ECM and recheck.
6	Check MAF sensor signal circuit. 1) Turn ON ignition switch. 2) Measure voltage between "PNK/BLK" wire terminal of MAF sensor connector and engine ground. Is voltage 0 V?	Go to Step 7.	"PNK/BLK" wire shorted to others circuit.
7	Check MAF sensor output signal 1) Connect connector to MAF sensor with ignition switch turned OFF. 2) Check voltage between "C63-14" and "C63-28" under the following condition. **Voltage between "C63-14" and "C63-28" of ECM connector at ignition switch ON, leaving engine OFF: 0.5 – 1.0 V** **Idling: 1.3 – 1.8 V** Is each value as specified?	Substitute a known-good ECM and recheck.	Faulty MAF and IAT sensor.

DTC P0112 Intake Air Temperature Sensor Circuit Low

WIRING DIAGRAM



1.	MAF and IAT sensor
2.	ECM
3.	To other sensor

DTC DETECTING CONDITION AND TROUBLE AREA

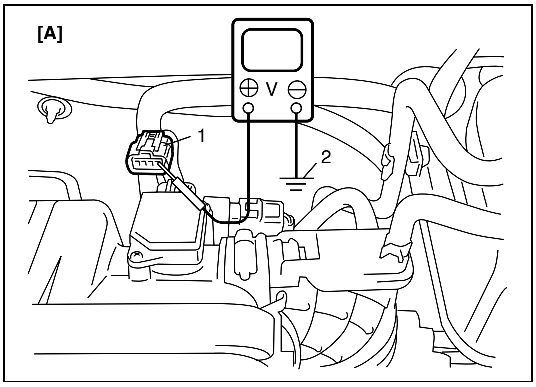
DTC DETECTING CONDITION	TROUBLE AREA
DTC will be set when all of the following conditions are detected for 5 seconds continuously. • Engine is running • Voltage of IAT sensor output is less than the specified value (High intake air temperature (low voltage/low resistance))	• IAT sensor circuit • IAT sensor • ECM

DTC CONFIRMATION PROCEDURE

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and run it for 10 sec.
4) Check DTC and pending DTC.

TROUBLESHOOTING

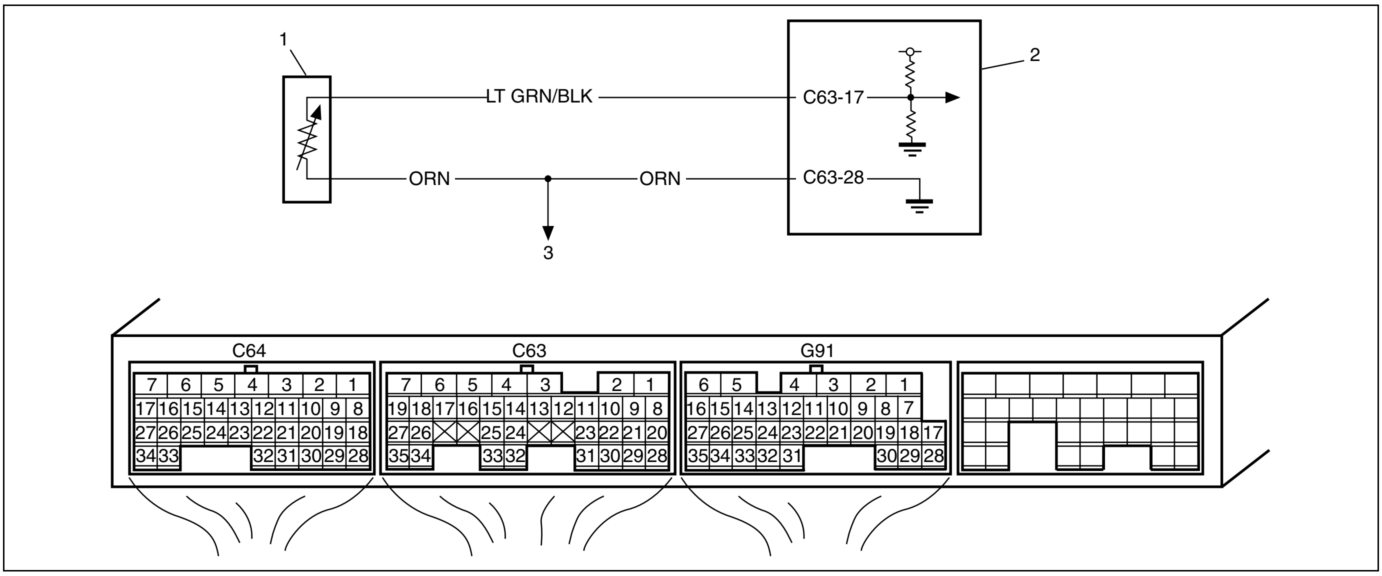
Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	IAT sensor and its circuit check. 1) Connect scan tool with ignition switch turned OFF. 2) Turn ON ignition switch. 3) Check intake air temp. displayed on scan tool. Is 165°C (329°F) indicated?	Go to Step 3.	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.
3	Check ECM voltage. 1) Disconnect connector from IAT sensor with ignition switch turned OFF. 2) Check for proper connection to IAT sensor at “LT GRN/BLK” and “ORN” wire terminals. 3) If OK, then turn ON ignition switch, check voltage between “LT GRN/BLK” wire terminal of IAT sensor connector and vehicle body ground. See Fig. 1. Is voltage about 4 – 6 V?	Go to Step 6.	Go to Step 4.
4	Check IAT circuit insulation. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between “LT GRN/BLK” wire terminal of IAT sensor connector and body ground. Is resistance infinity?	Go to Step 5.	“LT GRN/BLK” wire shorted to ground circuit. If wire are OK, substitute a known-good ECM and recheck.
5	Check IAT short circuit. 1) Turn ON ignition switch. 2) Check voltage between “LT GRN/BLK” wire terminal of IAT sensor connector and vehicle body ground. Is voltage about 0 V?	Go to Step 6.	“LT GRN/BLK” wire shorted to other circuits. If wire are OK, substitute a known-good ECM and recheck.
6	Check IAT sensor according to “Mass air flow (MAF) and intake air temperature (IAT) sensor inspection” in Section 6E1. Is it in good condition?	Substitute a known-good ECM and recheck.	Replace MAF and IAT sensor.



[A]:	Fig.1 for Step 3
1.	Disconnected MAF and IAT sensor connector
2.	Engine ground

DTC P0113 Intake Air Temperature Sensor Circuit High

WIRING DIAGRAM



1.	MAF and IAT sensor
2.	ECM
3.	To other sensor

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
DTC will be set when all of the following conditions are detected for 5 seconds continuously. • Engine is running • Voltage of IAT sensor output is more than the specified value (Low intake air temperature (high voltage/high resistance))	• IAT sensor circuit • IAT sensor • ECM

DTC CONFIRMATION PROCEDURE

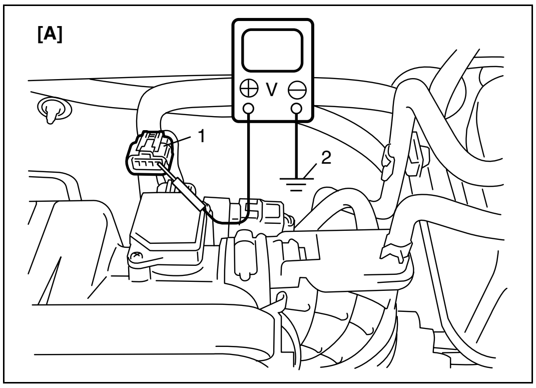
1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and run it for 10 sec.
4) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	IAT sensor and its circuit check. 1) Connect scan tool to DLC with ignition switch turned OFF. 2) Turn ON ignition switch. 3) Check intake air temp. displayed on scan tool. Is –40°C (–40°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 IAT sensor voltage. 1) Disconnect connector from IAT sensor with ignition switch turned OFF. 2) Check for proper connection to IAT sensor at “LT GRN/BLK” and “ORN” wire terminals. 3) If OK, then turn ON ignition switch, check voltage between “LT GRN/BLK” wire terminal of IAT sensor connector and vehicle body ground. See Fig. 1. Is voltage about 4 – 6 V?	Go to Step 7.	Go to Step 4.
4	Check ECM voltage. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and connect connectors to ECM. 3) Check for proper connection of ECM connector at “C63-17” terminal. 4) If OK, then turn ON ignition switch, check voltage between “C63-17” terminal of ECM connector and vehicle body ground. Is voltage about 4 – 6 V?	“LT GRN/BLK” wire open circuit. If wire and connection are OK, go to Step 5.	Go to Step 5.
5	Check wire circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Turn ON ignition switch. 3) Check voltage between “LT GRN/BLK” wire terminal of IAT sensor connector and vehicle body ground. Is voltage about 0 V?	Go to Step 6.	“LT GRN/BLK” wire shorted to other circuits. If wire are OK, substitute a known-good ECM and recheck.
6	Check wire circuit. 1) Measure resistance between “C63-17” terminal of ECM connector and “LT GRN/BLK” wire terminal of IAT sensor connector with ignition switch turned OFF. Is resistance below 5 Ω?	Go to Step 7.	“LT GRN/BLK” wire in high resistance circuit.
7	Check ground circuit. 1) Connect connectors to ECM. 2) Check for proper connection of IAT sensor connector at “ORN” wire terminal. 3) Measure resistance between “ORN” wire terminal of IAT sensor connector and body ground. Is resistance below 5 Ω?	Go to Step 9.	Go to Step 8.
8	Check ground circuit. 1) Measure resistance between “C63-28” terminal of ECM connector and body ground. Is resistance below 5 Ω?	“ORN” wire open circuit or high resistance circuit. Poor “C63-28” connection.	Faulty ECM ground circuit. If circuit are OK, substitute a known-good ECM and recheck.

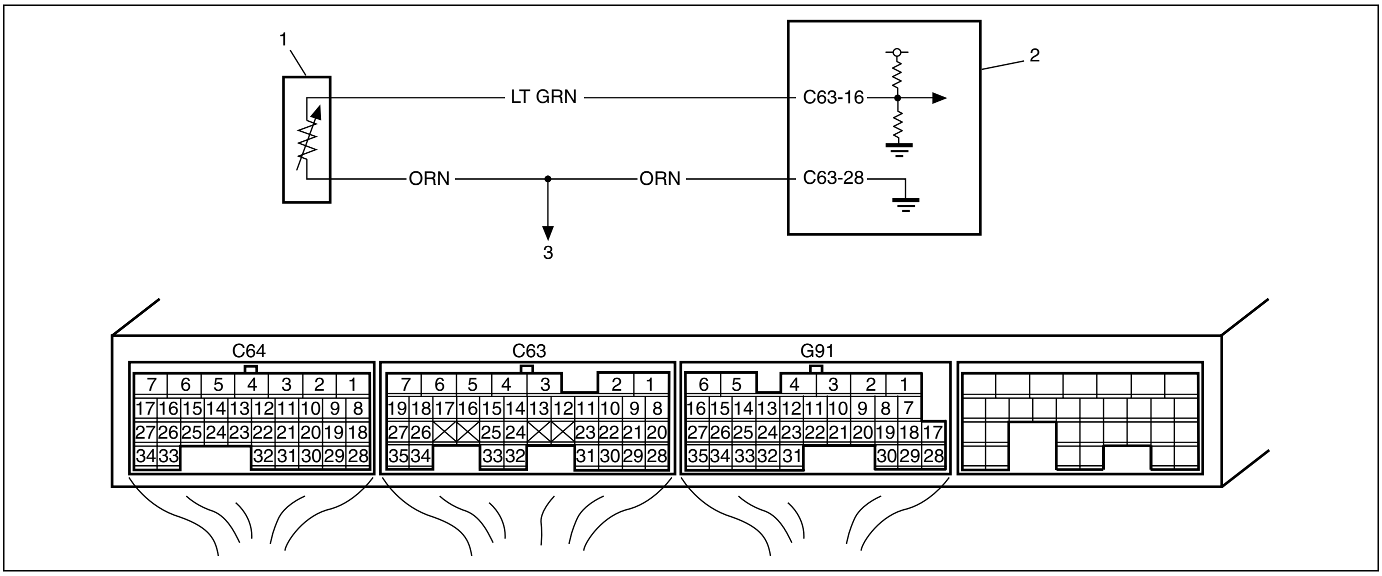
Step	Action	Yes	No
9	Check IAT sensor according to "Mass air flow (MAF) and intake air temperature (IAT) sensor inspection" in Section 6E1. Is it in good condition?	Substitute a known-good ECM and recheck.	Replace MAF and IAT sensor.



[A]:	Fig. 1 for Step 3
1.	Disconnected MAF and IAT sensor connector
2.	Engine ground

DTC P0117 Engine Coolant Temperature Circuit Low

WIRING DIAGRAM



1. ECT sensor	2. ECM	3. To other sensors

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
DTC will be set when all of the following conditions are detected for 5 seconds continuously. • Engine is running • Voltage of ECT sensor output is less than the specified value (High engine coolant temperature (low voltage/low resistance))	• ECT sensor circuit • ECT sensor • ECM

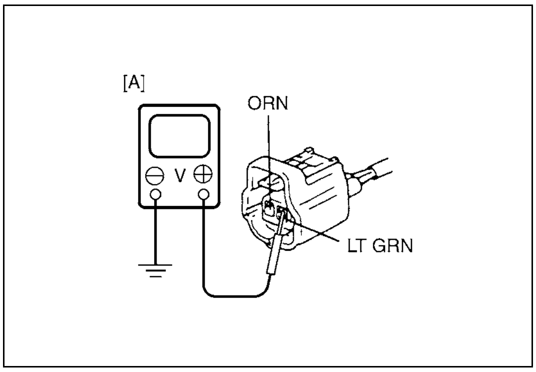
DTC CONFIRMATION PROCEDURE

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and run it for 10 sec. or more.
4) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	ECT sensor and its circuit check. 1) Connect scan tool with ignition switch turned OFF. 2) Turn ignition switch ON. 3) Check engine coolant temp. displayed on scan tool. Is 164°C (327°F) indicated?	Go to Step 3.	Intermittent trouble check for intermittent referring to “Intermittent and Poor Connection” in section 0A.

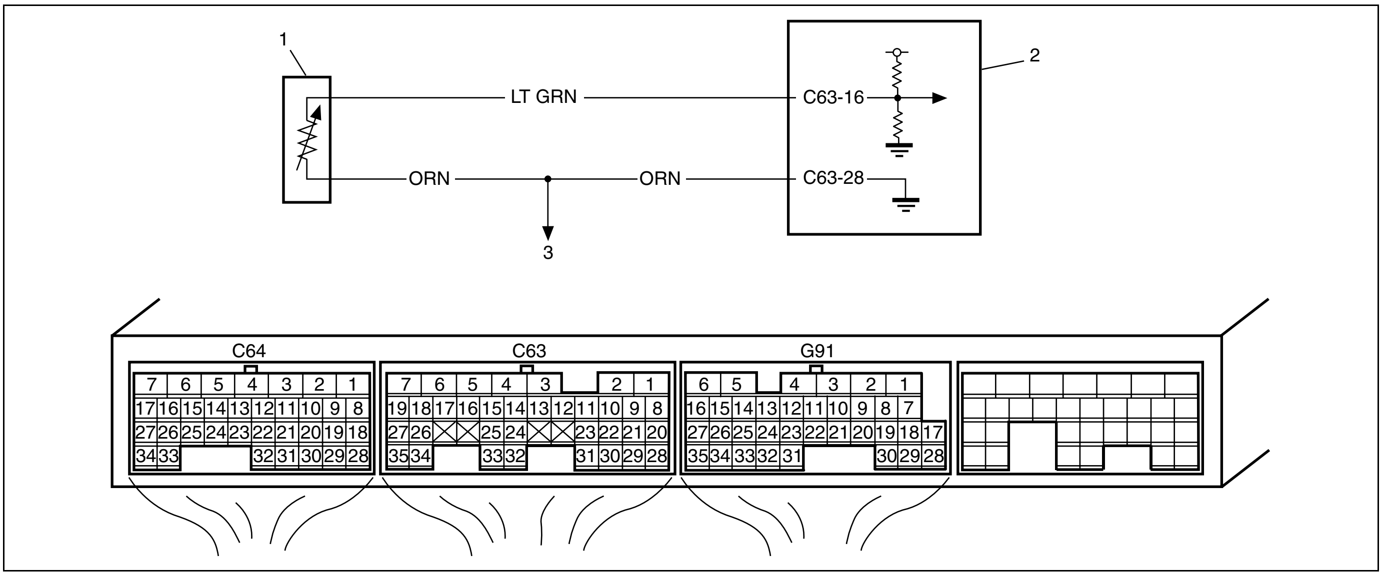
Step	Action	Yes	No
3	Check ECM voltage. 1) Disconnect connector from ECT sensor with ignition switch turned OFF. 2) Check for proper connection to ECT sensor at “LT GRN” and “ORN” wire terminals. 3) If OK, then turn ON ignition switch, check voltage between “LT GRN” wire terminal and vehicle body ground. See Fig. 1. Is voltage about 4 – 6 V?	Got to Step 6.	Go to Step 4.
4	Check ECT sensor circuit insulation. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between “LT GRN” wire terminal of ECT sensor connector and body ground. Is resistance infinity?	Got to Step 5.	“LT GRN” wire shorted to ground circuit. If wire are OK, substitute a known-good ECM and recheck.
5	Check ECT sensor short circuit. 1) Turn ON ignition switch. 2) Check voltage between “LT GRN” wire terminal of ECT sensor connector and vehicle body ground. Is voltage about 0 V?	Got to Step 6.	“LT GRN” wire shorted to other circuits. If wire are OK, substitute a known-good ECM and recheck.
6	Check ECT sensor according to “Engine coolant temperature sensor (ECT sensor) inspection” in Section 6E1. Is it in good condition?	Substitute a known-good ECM and recheck.	Replace ECT sensor.



[A]: Fig. 1 for Step 3

DTC P0118 Engine Coolant Temperature Circuit High

WIRING DIAGRAM



1.	ECT sensor
2.	ECM
3.	To other sensors

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
DTC will be set when all of the following conditions are detected for 5 seconds continuously. • Engine is running • Voltage of ECT sensor output is more than the specified value (Low engine coolant temperature (high voltage/high resistance))	• ECT sensor circuit • ECT sensor • ECM

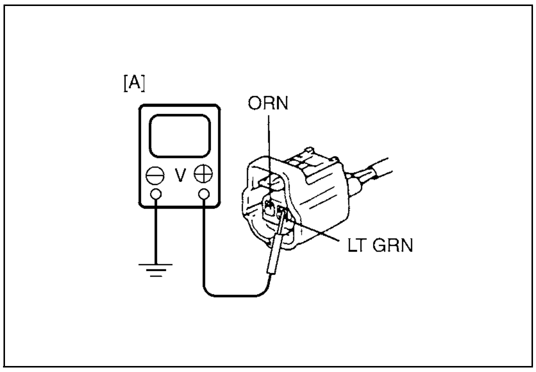
DTC CONFIRMATION PROCEDURE

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and run it for 10 sec. or more.
4) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	ECT sensor and its circuit check. 1) Connect scan tool with ignition switch turned OFF. 2) Turn ignition switch ON. 3) Check engine coolant temp. displayed on scan tool. Is –40°C (–40°F) indicated?	Go to Step 3.	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.
3	Check ECT voltage. 1) Disconnect connector from ECT sensor with ignition switch turned OFF. 2) Check for proper connection to ECT sensor at “LT GRN” and “ORN” wire terminals. 3) If OK, then turn ON ignition switch, check voltage between “LT GRN” wire terminal of ECT sensor connector and vehicle body ground. See Fig. 1. Is voltage about 4 – 6 V?	Go to Step 6.	Go to Step 4.
4	Check ECM voltage. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and connect connectors to ECM. 3) Check for proper connection of ECM connector at “C63-16” terminals. 4) If OK, then turn ON ignition switch, check voltage between “C63-16” wire terminal of ECM connector and vehicle body ground. Is voltage about 4 – 6 V?	“LT GRN” wire open circuit. If wire and connection are OK, go to Step 5.	Go to Step 5.
5	Check ECT sensor harness voltage. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Turn ON ignition switch. 3) Check voltage between “LT GRN” wire terminal of ECT sensor connector and vehicle body ground. Is voltage about 0 V?	Go to Step 6.	“LT GRN” wire shorted to other circuits. If wire are OK, substitute a known-good ECM and recheck.
6	Check ECT sensor harness resistance. 1) Measure resistance between “C63-16” terminal of ECM connector and “LT GRN” wire terminal of ECT sensor connector with ignition switch turn OFF. Is resistance below 5 Ω?	Go to Step 7.	“LT GRN” wire in high resistance circuit.

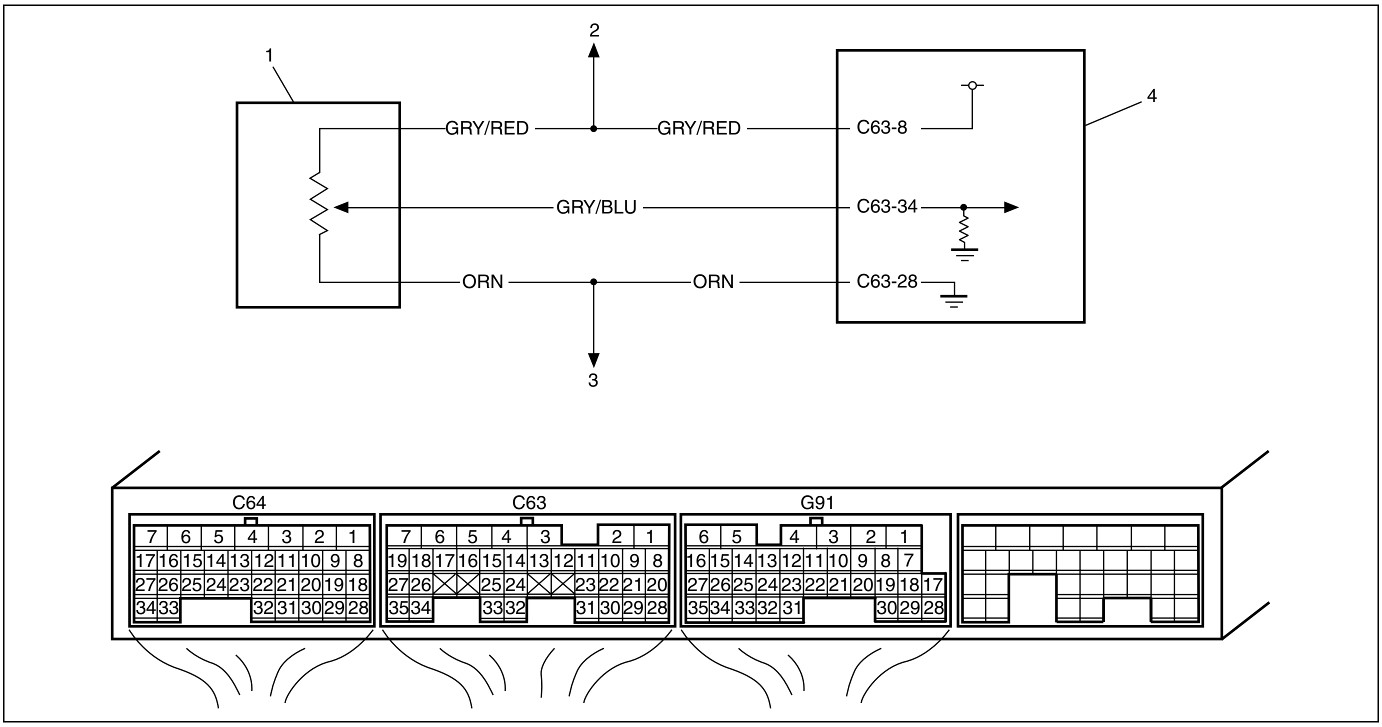
Step	Action	Yes	No
7	Check ECT sensor ground circuit. 1) Connect connectors to ECM. 2) Check for proper connection of ECT sensor connector at “ORN” wire terminal. 3) Measure resistance between “ORN” wire terminal of ECT sensor connector and vehicle body ground. Is resistance below 5 Ω?	Go to Step 9.	Go to Step 8.
8	Check ECT sensor ground circuit. 1) Measure resistance between “C63-28” terminal of ECM connector and vehicle body ground. Is resistance below 5 Ω?	“ORN” wire open circuit or high resistance circuit. Poor “C63-28” connection.	Faulty ECM ground circuit. If circuit are OK, substitute a known-good ECM and recheck.
9	Check ECT sensor according to “Engine coolant temperature sensor (ECT sensor) inspection” in Section 6E1. Is it in good condition?	Substitute a known-good ECM and recheck.	Replace ECT sensor.



[A]: Fig. 1 for Step 3

DTC P0121 Throttle Position Sensor Circuit Range / Performance

WIRING DIAGRAM



1. TP sensor	3. To other sensors
2. To MAP sensor	4. ECM

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
Even if the voltage of the mass air flow sensor changes, the voltage of the throttle position sensor does not change normally. (2 driving cycle detection logic)	• Air intake system • TP sensor • TP sensor circuit • ECM • MAF sensor • Idle air control valve

DTC CONFIRMATION PROCEDURE

WARNING:
- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and 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.**

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.
- **Intake air temp.: –7°C, 19.4°F or higher**
- **Engine coolant temp.: –7°C, 19.4°F or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm up to normal operating temperature.
4) Drive vehicle at 60 km/h (38 mile/h) at 5th gear or D range.
5) Increase vehicle speed to 65 km/h (40 mile/h) at 5th gear or D range.
6) Release accelerator pedal to decrease vehicle speed till 60 km/h (38 mile/h).
7) Repeat Step 4) to 6) for 3 times.
8) Stop vehicle and check DTC and pending DTC.

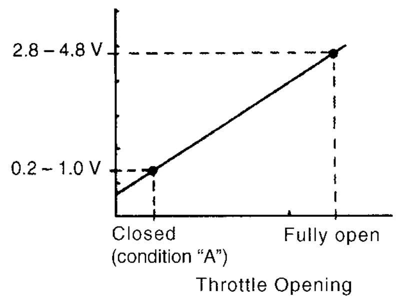
TROUBLESHOOTING

Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check" in this section.
2	Check TP sensor and its circuit. 1) Turn OFF ignition switch and connect Suzuki Scan Tool to DLC. 2) Turn ON ignition switch and check TP sensor output voltage when throttle valve is at idle position and fully opened. See Fig. 1. Does voltage vary within specified value linearly as shown in figure?	Go to Step 11.	Go to Step 3.
3	Check TP sensor voltage. 1) Disconnect connector from TP sensor with ignition switch turned OFF. 2) Check for proper connection to TP sensor connector at "GRY/RED", "GRY/BLU" and "ORN" wire terminals. 3) If OK, then with ignition switch turned ON, check voltage between "GRY/RED" wire terminal of TP sensor connector and body ground. Is voltage about 4 – 6 V?	Go to Step 7.	Go to Step 4.
4	Check ECM voltage. 1) Turn ignition switch to OFF position. 2) Check for proper connection of ECM connector at "C63-8" wire terminal. 3) If OK, disconnect connector from MAP sensor. 4) Turn ON ignition switch, check voltage between "C63-8" wire terminal of ECM connector and body ground. Is voltage about 4 – 6 V?	"GRY/RED" wire open or high resistance circuit. Faulty MAP sensor, check MAP sensor according to "MAP Sensor Individual Check" under "DTC P0108 Manifold Absolute Pressure High Input" in this section. If they are OK, go to Step 5.	Go to Step 5.

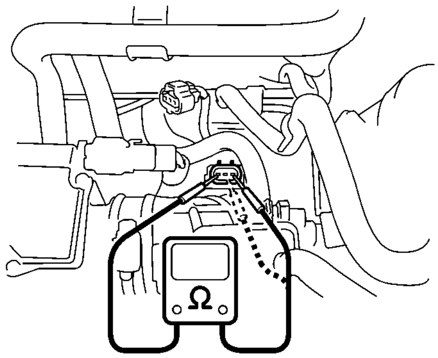
Step	Action	Yes	No
5	Check wire circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between “GRY/RED” wire terminal of ECM connector and body ground and between “GRY/BLU” wire terminal of ECM connector and body ground. Is resistance infinity?	Go to Step 6.	“GRY/RED” and/or “GRY/BLU” wire shorted to ground circuit. If wire are OK, substitute a known-good ECM and recheck.
6	Check wire circuit. 1) Turn ON ignition switch. 2) Check voltage between “GRY/RED” wire terminal of ECM connector and body ground and between “GRY/BLU” wire terminal of ECM connector and body ground. Is voltage about 0 V at each terminal?	Go to Step 7.	“GRY/RED” and/or “GRY/BLU” wire shorted to power circuit. If wire are OK, substitute a known-good ECM and recheck.
7	Check wire circuit. 1) Measure resistance between “C63-34” wire terminal of ECM connector and “GRY/BLU” wire terminal of TP sensor connector with ignition switch turned OFF. Is resistance below 5 Ω?	Go to Step 8.	“GRY/BLU” wire in high resistance circuit.
8	Check ground circuit. 1) Connect connectors to ECM. 2) Check for proper connection of MAP sensor connector at “ORN” wire terminal. 3) Measure resistance between “ORN” wire terminal of MAP sensor connector and body ground. Is resistance below 5 Ω?	Go to Step 10.	Go to Step 9.
9	Check ground circuit. 1) Measure resistance between “C63-28” wire terminal of ECM connector and body ground. Is resistance below 5 Ω?	“ORN” wire open circuit or high resistance circuit. Poor “C63-28” connection.	Faulty ECM ground circuit. If circuit are OK, substitute a known-good ECM and recheck.
10	Check TP sensor. 1) Turn OFF ignition switch. 2) Disconnect TP sensor connector. 3) Check for proper connection to TP sensor at each terminal. 4) If OK, then measure resistance between TP sensor terminals and check if each measured value is as specified. See Fig. 2. **TP sensor resistance** **Between 1 and 3: 4.0 – 6.0 kΩ** **Between 1 and 2: 0.1 – 6.5 kΩ, varying according to throttle valve opening.** Are measured values as specified?	Go to Step 11.	Replace TP sensor.

Step	Action	Yes	No
11	Check MAF sensor for performance. 1) Check MAF sensor performance, referring to “DTC P0101 Mass Air Flow Circuit Range/Performance” in this section. Is it in good condition?	Go to Step 12.	Repair or replace it.
12	Is DTC P0506 or P0507 detected?	Go to applicable DTC diag. flow table.	Go to Step 13.
13	Check idle air control (IAC) valve 1) Check idle air control valve referring to “Idle air control (IAC) valve operation check” in this section. Is it in good condition?	Go to Step 14.	Repair or replace idle air control valve.
14	Check throttle body. 1) Check throttle body for clog or leak. Is it OK?	Substitute a known-good ECM and recheck.	Repair throttle body.

[A]



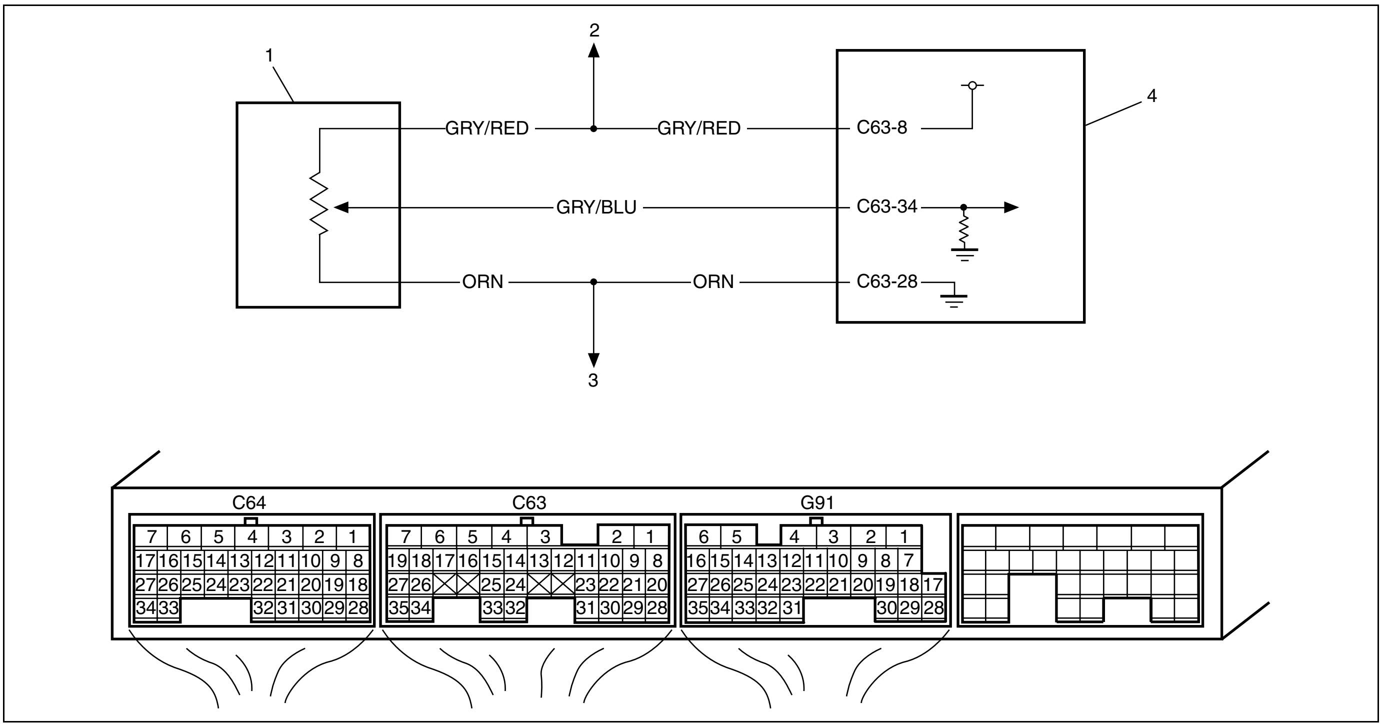
[B]



[A]:	Fig. 1 for Step 2
[B]:	Fig. 2 for Step 10

DTC P0122 Throttle Position Sensor Circuit Low

WIRING DIAGRAM



1. TP sensor	2. To MAP sensor	3. To other sensors	4. ECM

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
DTC will be set when all of the following conditions are detected for 5 seconds continuously. • Engine is running • Voltage of TP sensor output is less than 0.15 V	• TP sensor circuit • TP sensor • ECM

DTC CONFIRMATION PROCEDURE

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and run it for 10 sec. or more.
4) Check DTC and pending DTC.

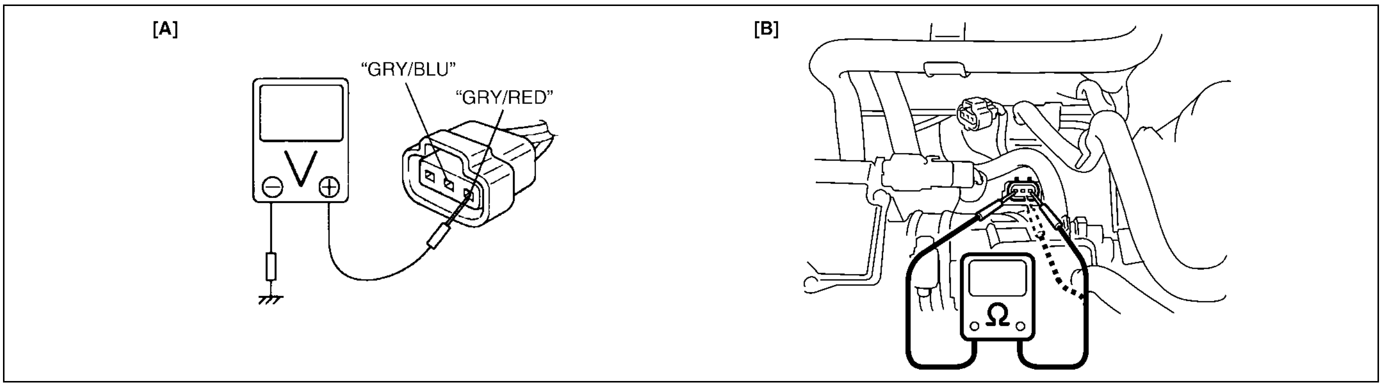
TROUBLESHOOTING

NOTE:

When this DTC and P1700 are stored together, also clear DTC stored in TCM after completion of repair.

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.

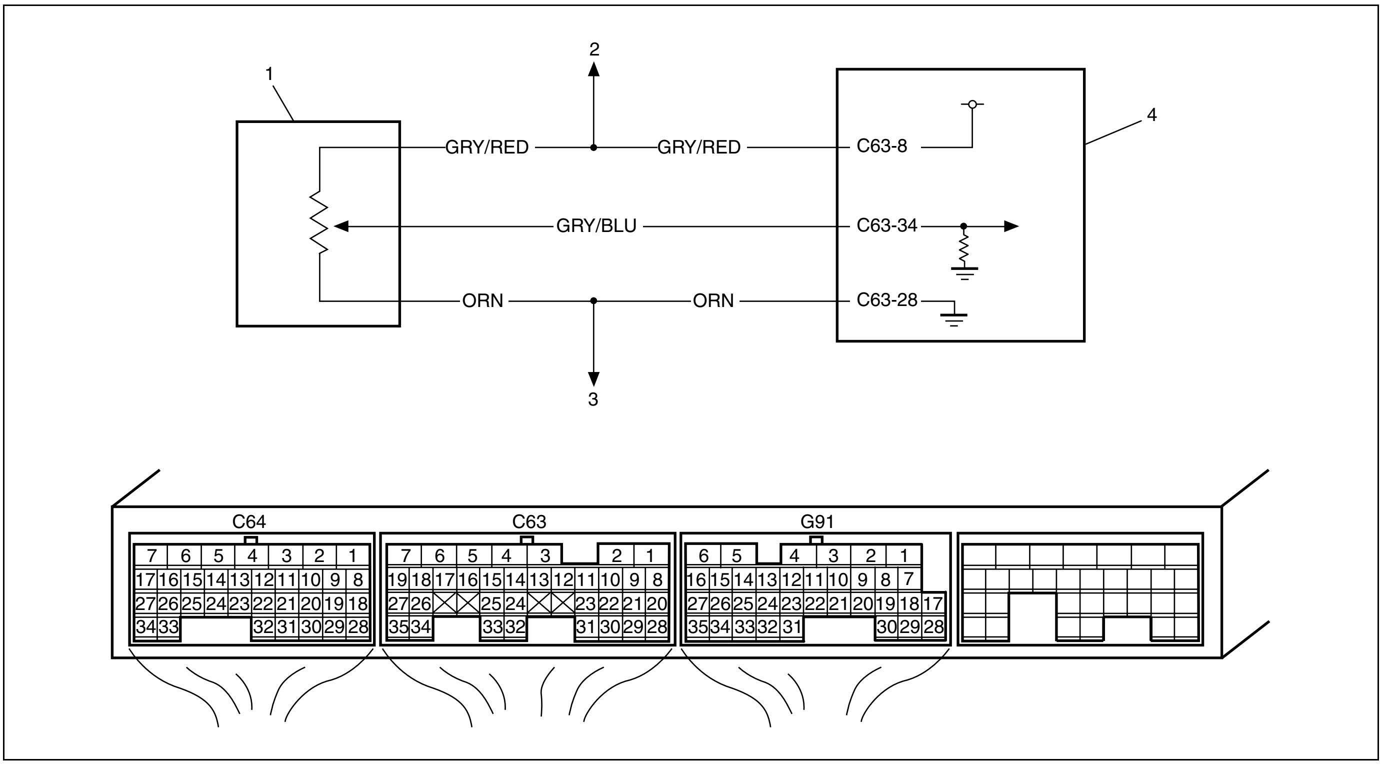
Step	Action	Yes	No
2	Check TP sensor and its circuit. 1) Connect scan tool to DLC with ignition switch turned OFF and then turn ON ignition switch. 2) Check throttle valve opening percentage displayed on scan tool. 3) Check throttle valve opening percentage displayed on scan tool while opening throttle valve from idle position to full open position. Is it displayed 0%?	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 turned OFF. 2) Check for proper connection to TP sensor at “GRY/RED”, “GRY/BLU” and “ORN” wire terminals. 3) If OK, then with ignition switch turned ON, check voltage between “GRY/RED” wire terminal of TP sensor connector and body ground. See Fig. 1. Is voltage about 4 – 6 V at each terminal?	Go to Step 5.	Go to Step 4.
4	Check ECM voltage. 1) Check for proper connection of ECM connector at “C63-8” and “C63-34” wire terminals. 2) If OK, disconnect connector from MAP sensor. 3) Turn ON ignition switch, check voltage between “C63-8” wire terminal of ECM connector and body ground. Is voltage about 4 – 6 V at each terminal?	Check MAP sensor according to “MAP Sensor Individual Check” under “DTC P0108 Manifold Absolute Pressure High Input” in Section 6E1. If they are OK, go to Step 5.	Go to Step 5.
5	Check wire circuit. 1) Disconnect connectors from ECM with ignition switch turn OFF. 2) Check that there is insulation between “GRY/RED” wire terminal of TP sensor connector and body ground and between “GRY/BLU” wire terminal of TP sensor connector and body ground. Is there insulation?	Go to Step 6.	“GRY/RED” and/or “GRY/BLU” wire shorted to ground circuit. If wires are OK, substitute a known-good ECM and recheck.
6	Check TP sensor. 1) Check resistance between terminals of TP sensor. See Fig. 2. **TP sensor resistance** **Between 1 and 3: 4.0 – 6.0 kΩ** **Between 1 and 2: 0.1 – 6.5 kΩ** Are measured values within specifications?	Substitute a known-good ECM and recheck.	Replace TP sensor.



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

DTC P0123 Throttle Position Circuit High Input

WIRING DIAGRAM



1. TP sensor	3. To other sensors
2. To MAP sensor	4. ECM

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
DTC will be set when all of the following conditions are detected for 5 seconds continuously. • Engine is running • Voltage of TP sensor output is more than 4.7 V	• TP sensor circuit • TP sensor • ECM

DTC CONFIRMATION PROCEDURE

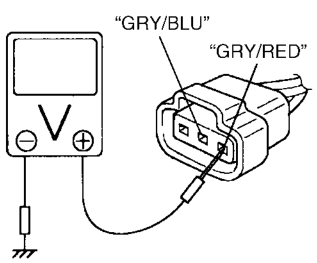
1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and run it for 10 sec. or more.
4) Check DTC and pending DTC.

TROUBLESHOOTING

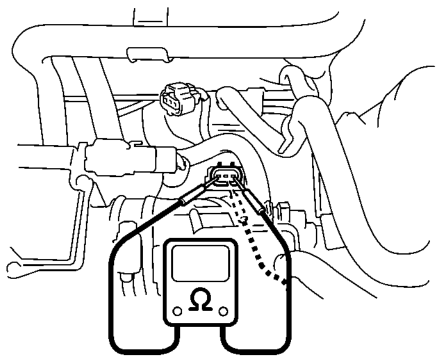
Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check" in this section.
2	Check TP sensor and its circuit. 1) Connect scan tool to DLC with ignition switch turned OFF and then turn ignition switch ON. 2) Check throttle valve opening percentage displayed on scan tool. 3) Check throttle valve opening percentage displayed on scan tool while opening throttle valve from idle position to full open position. Is it displayed 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 turned OFF. 2) Check for proper connection to TP sensor at "GRY/RED", "GRY/BLU" and "ORN" wire terminals. 3) If OK, then with ignition switch turned ON, check voltage between "GRY/RED" wire terminal of TP sensor connector and body ground. See Fig. 1. Is voltage about 4 – 6 V at each terminal?	Go to Step 6.	Go to Step 4.
4	Check ECM voltage. 1) Check for proper connection of connector at "C63-8" and "C63-34" wire terminals. 2) If OK, disconnect connector from MAP sensor. 3) Turn ON ignition switch, check voltage between "C63-8" wire terminal of ECM connector and body ground. Is voltage about 4 – 6 V at each terminal?	"GRY/RED" and/or "GRY/BLU" wire open circuit. Check MAP sensor according to "MAP Sensor Individual Check" under "DTC P0108 Manifold Absolute Pressure High Input" in this section. If they are OK, go to Step 5.	Go to Step 5.

Step	Action	Yes	No
5	Check wire circuit. 1) Disconnect connector from ECM with ignition switch turned OFF. 2) Turn ON ignition switch. 3) Check voltage between “GRY/RED” wire terminal of TP sensor connector and body ground and between “GRY/BLU” wire terminal of TP sensor connector and body ground. Is voltage about 0 V at each terminal?	Go to Step 7.	“GRY/RED” and/or “GRY/BLU” wire shorted to power circuit. If wire are OK, substitute a known-good ECM and recheck.
6	Check wire circuit. 1) Measure resistance between “C63-34” wire terminal of ECM connector and “GRY/BLU” wire terminal of TP sensor connector with ignition switch turned OFF. Is resistance below 5 Ω?	Go to Step 8.	“GRY/BLU” wire open circuit or high resistance circuit.
7	Check ground circuit. 1) Connect connector to ECM. 2) Check for proper connection of MAP sensor at “ORN” wire terminal. 3) Measure resistance between “ORN” wire terminal of MAP sensor connector and body ground. Is resistance below 5 Ω?	Go to Step 9.	Go to Step 8.
8	Check ground circuit. 1) Measure resistance between “C63-28” wire terminal of ECM connector and body ground. Is resistance below 5 Ω?	“ORN” wire open circuit or high resistance circuit. Poor “C63-28” connection.	Faulty ECM ground circuit. If circuit are OK, substitute a known-good ECM and recheck.
9	Check TP sensor. 1) Check resistance between terminals of TP sensor. See Fig. 2. **TP sensor resistance** **Between 1 and 3: 4.0 – 6.0 kΩ** **Between 1 and 2: 0.1 – 6.5 kΩ** Are measured values within specifications?	Substitute a known-good ECM and recheck.	Replace TP sensor.

[A]



[B]

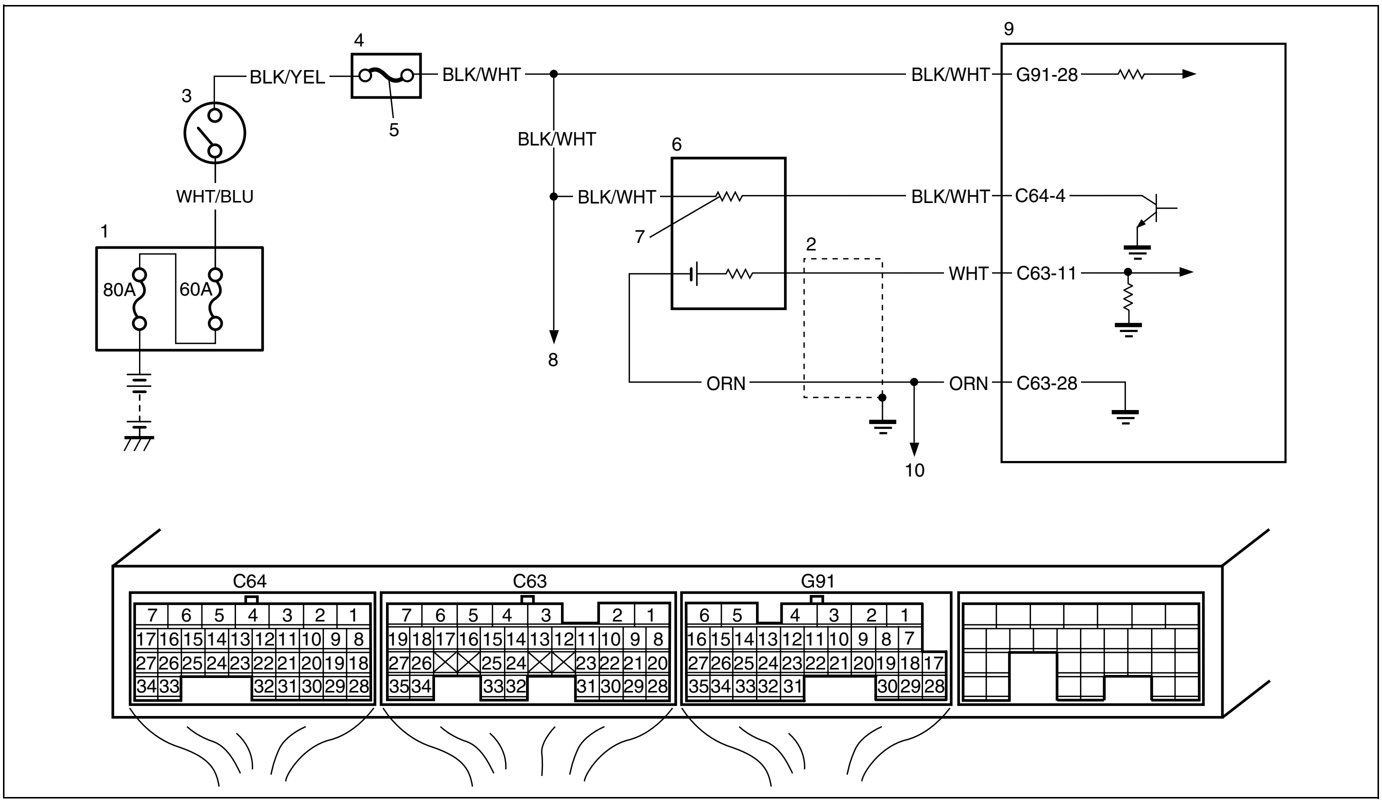


[A]:	Fig. 1 for Step 3
[B]:	Fig. 2 for Step 9

DTC P0131 O2 Sensor (HO2S) Circuit Low Voltage (Sensor-1)

DTC P0132 O2 Sensor (HO2S) Circuit High Voltage (Sensor-1)

WIRING DIAGRAM



1. Relay/fuse box	4. Circuit fuse box	7. Heater	10. To other sensor
2. Shield wire	5. "IG" fuse	8. To HO2S–2 heater	
3. Ignition switch	6. HO2S–1	9. ECM	

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
DTC P0131: • HO2S voltage is higher than 4.5 V even after engine running for specified time continuously from engine start • Maximum HO2S voltage is less than 0.6 V or minimum HO2S voltage is less than 0.3 V (2 driving cycle detection logic) DTC P0132: • HO2S voltage is less than 3.0 V even after engine running for specified time continuously from engine start • Maximum HO2S voltage is 0.74 V or more or minimum HO2S voltage is 0.34 V or more (2 driving cycle detection logic)	• HO2S–1 sensor circuit • HO2S–1 sensor • Fuel system • ECM • Fuel shortage

DTC CONFIRMATION PROCEDURE

WARNING:

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

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.

- **Intake air temp.: –7°C, 19.4°F or higher**
- **Engine coolant temp.: –7°C, 19.4°F or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm up to normal operating temperature.
4) Drive vehicle at 40 mph (60 km/h) or higher. (engine speed: 2500 – 3000 r/min.)
5) Keep above vehicle speed for 6 min. or more. (Throttle valve opening is kept constant in this step.)
6) Release accelerator pedal and with engine brake applied, keep vehicle coasting (with fuel cut for 3 sec. or more) and then stop vehicle.
7) Check DTC and pending DTC.

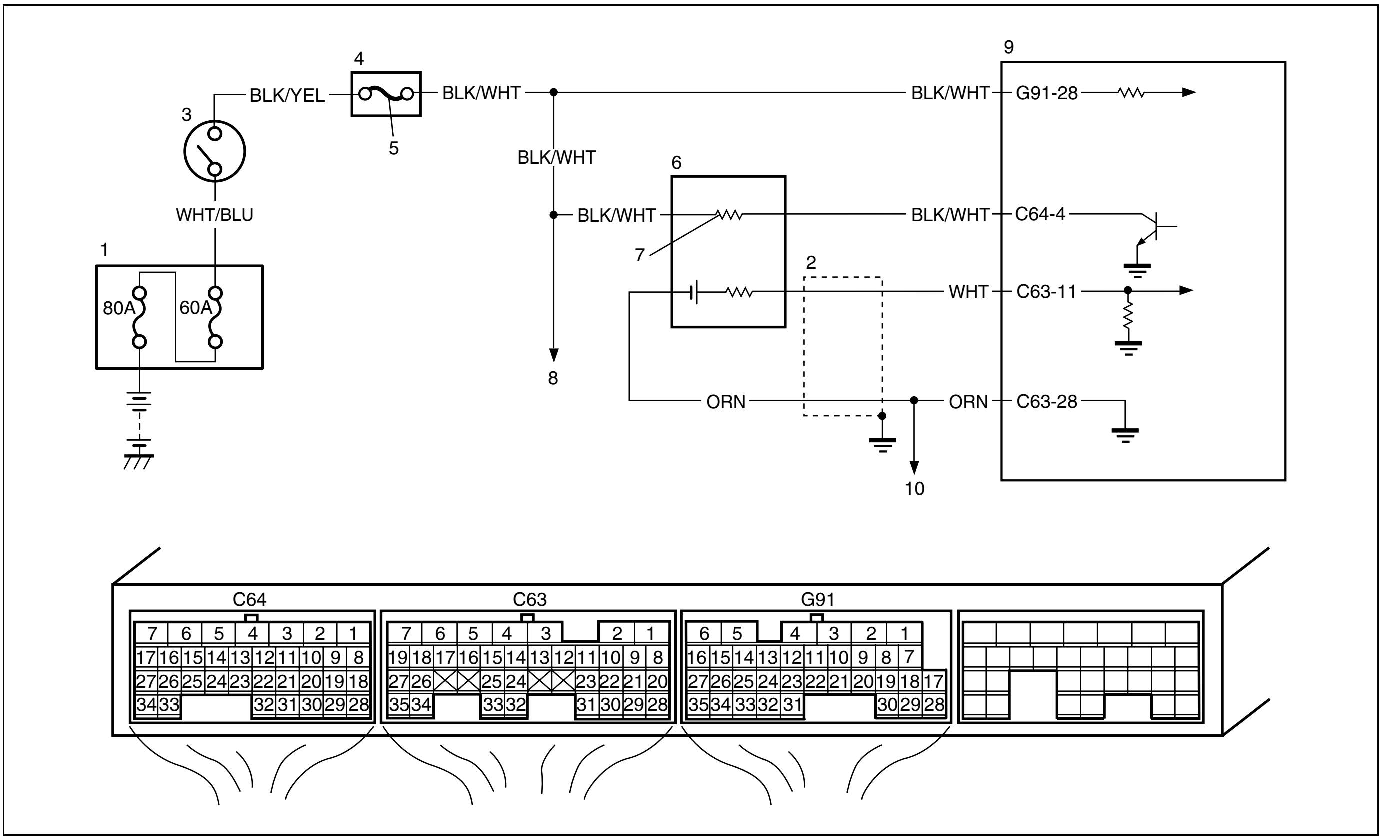
TROUBLESHOOTING

Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check" in this section.
2	Is there DTC(s) other than HO2S–1?	Go to applicable DTC diag. flow table.	Go to Step 3.
3	Check HO2S–1 signal. 1) Connect scan tool to DLC with ignition switch turned OFF. 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 0.74 V repeatedly?	Intermittent trouble. Check for intermittent referring to "Intermittent and Poor Connection" in Section 0A. If they are OK, go to Step 8.	Go to Step 4.
4	Check HO2S–1 sensor ground. 1) Disconnect connector from HO2S–1 sensor with ignition switch turned OFF. 2) Check for proper connection to HO2S–1 sensor connector at "WHT", "ORN" and "BLK/WHT" wire terminals. 3) If wire and connection are OK, check there is continuity between "ORN" wire terminal of HO2S–1 sensor connector and engine ground. Is it continuity?	Go to Step 5.	"ORN" wire open circuit. Poor "C63-28" terminal connection. Faulty ECM ground. If they are OK, substitute a known-good ECM and recheck.

Step	Action	Yes	No
5	Check HO2S–1 sensor ground. 1) With ignition switch turned ON, check voltage between “ORN” wire terminal of HO2S–1 sensor connector and engine ground. Is voltage about 0.1 V or less?	Go to Step 6.	“ORN” wire high resistance circuit. Poor “C63-28” terminal connection. Faulty ECM ground. If they are OK, substitute a known-good ECM and recheck.
6	Check wire circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and connect connectors to ECM. 3) Measure resistance between “WHT” wire terminal of HO2S–1 connector and “C63-11” wire terminal of ECM connector. Is resistance less than 5 Ω?	Go to Step 7.	“WHT” wire high resistance circuit or open circuit. Poor “C63-11” terminal connection. Faulty ECM ground. If they are OK, substitute a known-good ECM and recheck.
7	Check wire circuit. 1) Disconnect connector from ECM with ignition switch turn OFF. 2) Measure resistance between “WHT” wire terminal of HO2S–1 sensor connector and body ground. Is resistance infinity?	Go to Step 8.	“WHT” wire shorted to ground circuit.
8	Check HO2S–1 signal circuit. 1) Measure voltage between “WHT” wire terminal of HO2S–1 connector and vehicle body ground. Is voltage 0 V?	Go to Step 9.	“WHT” wire shorted to others circuit.
9	Check HO2S–1 heater circuit. 1) Check HO2S–1 heater circuit, referring to “DTC P0031 HO2S Heater Control Circuit Low (Sensor-1) DTC P0032 HO2S Heater Control Circuit High (Sensor-1)”. Is circuit in good condition?	Go to Step 10.	Repair or replace it.
10	Check exhaust system. 1) Check exhaust system for exhaust gas leakage. Is it OK?	Go to Step 4 in DTC P0171 and P0172 diagnosis flow table. If it is in good condition, go to Step 11.	Repair exhaust system for leakage.
11	Check air intake system. 1) Check air intake system for clog or leak. Is it OK?	Check HO2S–1 sensor, referring to “Heated oxygen sensor (HO2S-1 and HO2S-2) heater on-vehicle inspection” in Section 6E1. If it in good condition, substitute a known-good ECM and recheck.	Repair or replace.

DTC P0133 O2 Sensor (HO2S) Circuit Slow Response (Sensor-1)

WIRING DIAGRAM



1. Relay/fuse box	4. Circuit fuse box	7. Heater	10. To other sensor
2. Shield wire	5. "IG" fuse	8. To HO2S–2 heater	
3. Ignition switch	6. HO2S–1	9. ECM	

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
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. (2 driving cycle detection logic)	• Heated oxygen sensor–1

DTC CONFIRMATION PROCEDURE

WARNING:

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

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.

- **Intake air temp.: –7°C (19.4°F) or higher**
- **Engine coolant temp.: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

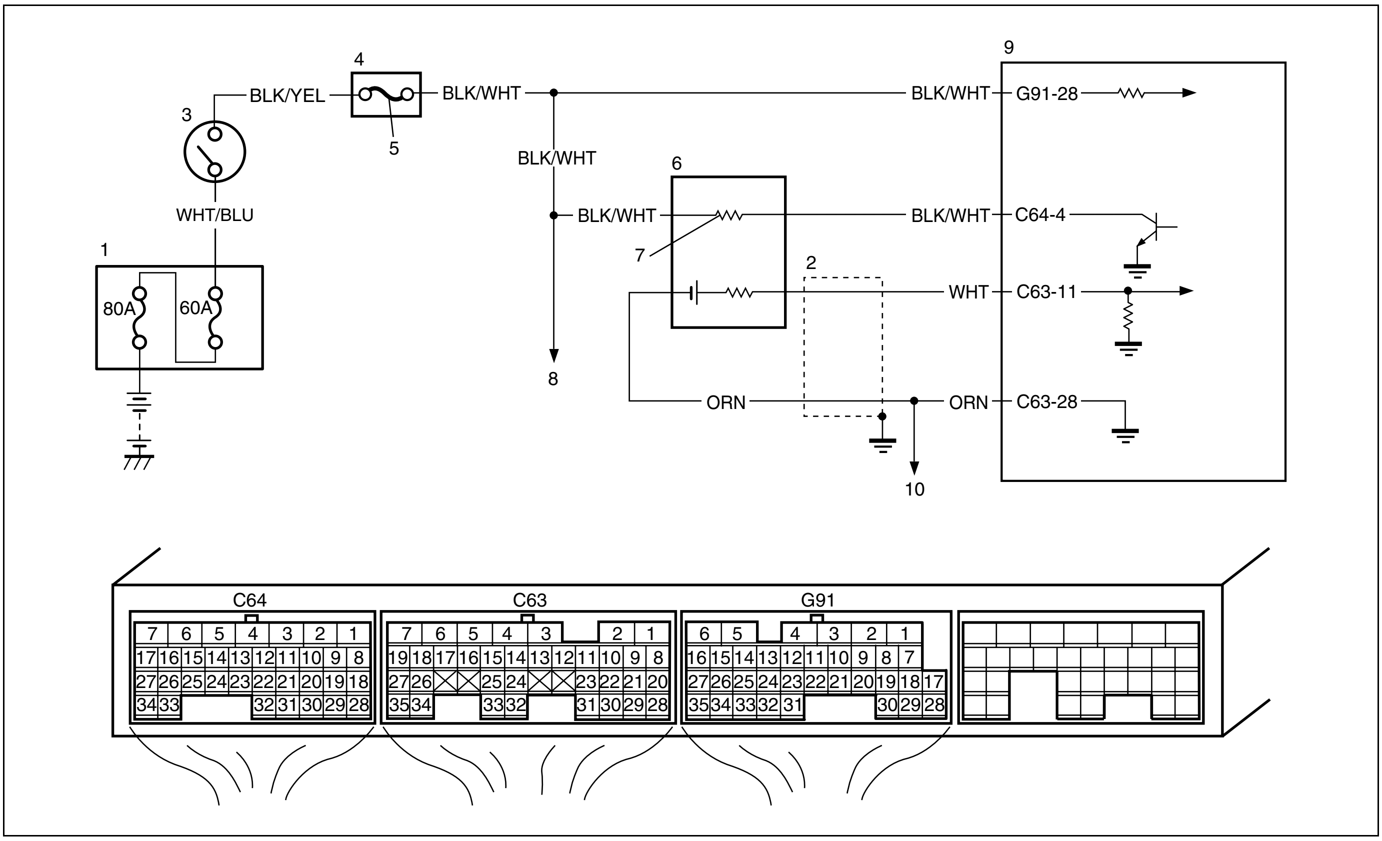
1) Perform step 1) to 6) of DTC P0131/P0132 confirmation procedure.
2) Check if DTC and pending DTC exists by using scan tool. If not, check if oxygen sensor monitoring test has completed by using scan tool. If not in both of above checks (i.e., no DTC and pending DTC and oxygen sensor monitoring test not completed), check vehicle condition (environmental) and repeat step 3) through 6) of DTC P0131/P0132 confirmation procedure.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Is there DTC(s) other than HO2S–1 (DTC P0133)?	Go to applicable DTC diag. flow table.	Replace HO2S–1.

DTC P0134 Heated Oxygen Sensor (HO2S) No Activity Detected (Sensor-1)

WIRING DIAGRAM



1. Relay/fuse box	4. Circuit fuse box	7. Heater	10. To other sensor
2. Shield wire	5. “IG” fuse	8. To HO2S–2 heater	
3. Ignition switch	6. HO2S–1	9. ECM	

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
Maximum HO2S voltage is lower than 0.45 V. (2 driving cycle detection logic)	• HO2S–1 • HO2S–1 circuit • Fuel system • Exhaust gas leakage • ECM • Fuel shortage

DTC CONFIRMATION PROCEDURE

Refer to “DTC P0133 O2 Sensor (HO2S) Circuit Slow Response (Sensor-1)” in this section.

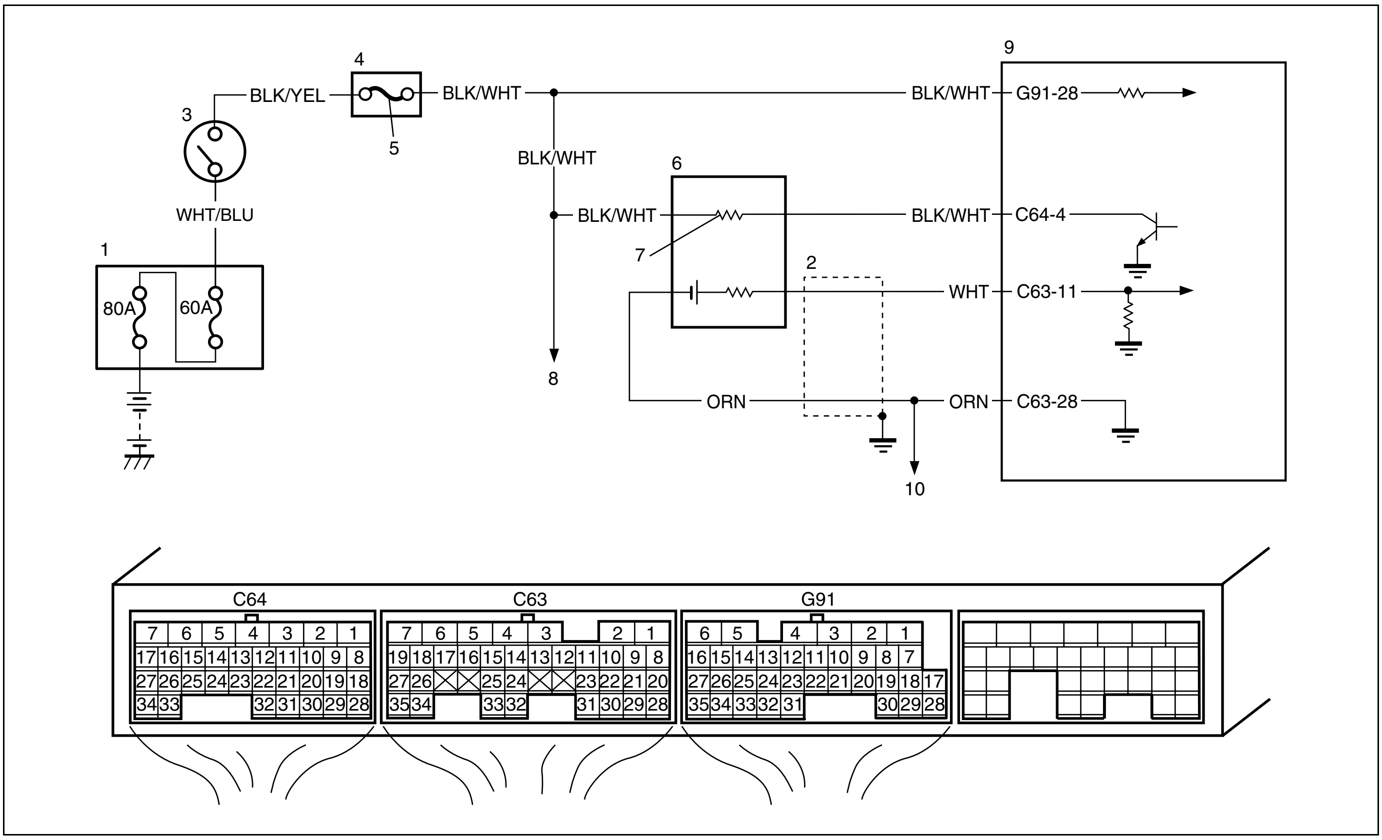
TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	HO2S–1 output voltage check. 1) Connect scan tool to DLC with ignition switch turned OFF. 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 to enrich A/F mixture and take foot off from pedal to enlean) and check HO2S output voltage displayed on scan tool. Is over 0.74 V and below 0.3 V indicated?	Go to Step 4.	Go to Step 3.
3	Check HO2S–1 sensor ground. 1) Disconnect connector from HO2S–1 sensor with ignition switch turned OFF. 2) Check for proper connection to HO2S–1 sensor at “WHT”, “ORN” and “BLK/WHT” wire terminals. 3) If wire and connection are OK, check there is continuity between “ORN” wire terminal of HO2S–1 sensor connector and engine ground. Is it continuity?	Go to Step 4.	“ORN” wire open circuit. Poor “C63-28” terminal connection. Faulty ECM ground. If they are OK, substitute a known-good ECM and recheck.
4	Check HO2S–1 sensor ground. 1) With ignition switch turn ON, check voltage between “ORN” wire terminal of HO2S–1 sensor connector and engine ground. Is voltage about 0.1 V or less?	Go to Step 5.	“ORN” wire high resistance circuit. Poor “C63-28” terminal connection. Faulty ECM ground. If they are OK, substitute a known-good ECM and recheck.

Step	Action	Yes	No
5	Check wire circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and connect connectors to ECM. 3) Measure resistance between “WHT” wire terminal of HO2S–1 harness connector and “C63-11” terminal. Is resistance less than 5 Ω?	Go to Step 6.	“WHT” wire high resistance circuit or open circuit. Poor “C63-11” terminal connection. Faulty ECM ground. If they are OK, substitute a known-good ECM and recheck.
6	Check wire circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between “WHT” wire terminal of HO2S–1 sensor connector and body ground. Is resistance infinity?	Go to Step 7.	“WHT” wire shorted to ground circuit.
7	Check HO2S–1 heater circuit. 1) Check HO2S–1 heater circuit, referring to “DTC P0031 HO2S Heater Control Circuit Low (Sensor-1) DTC P0032 HO2S Heater Control Circuit High (Sensor-1)”. Is result in good condition?	Go to Step 8.	Repair or replace it.
8	Check exhaust system. 1) Check exhaust system for exhaust gas leakage. Is it OK?	Go to Step 4 in DTC P0171 and P0172 diagnosis flow table. If it is in good condition, go to Step 9.	Repair exhaust system for leakage.
9	Check air intake system. 1) Check air intake system for clog or leak. Is it OK?	Check HO2S–1 sensor, referring to “Heated oxygen sensor (HO2S-1 and HO2S-2) heater on-vehicle inspection” in Section 6E1. If it in good condition, substitute a known-good ECM and recheck.	Repair or replace.

DTC P0031 HO2S Heater Control Circuit Low (Sensor-1)
DTC P0032 HO2S Heater Control Circuit High (Sensor-1)

WIRING DIAGRAM



1. Relay/fuse box	4. Circuit fuse box	7. Heater	10. To other sensor
2. Shield wire	5. "IG" fuse	8. To HO2S–2 heater	
3. Ignition switch	6. HO2S–1	9. ECM	

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
Current of HO2S–2 heater is more than specified value or lower than specified value for 3 seconds continuously (2 driving cycle detection logic)	• HO2S–1 heater • HO2S–1 heater circuit • ECM

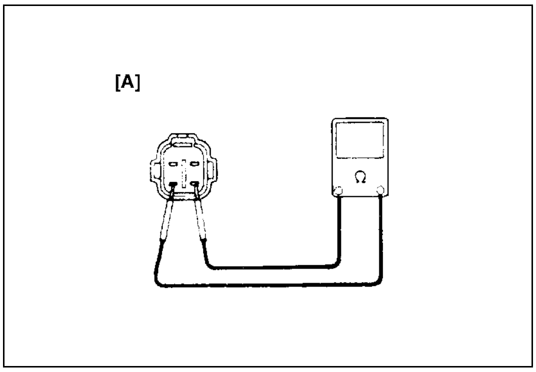
DTC CONFIRMATION PROCEDURE

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm up to normal operating temperature.
4) Run engine at idle speed for 1 min. or more.
5) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check" in this section.
2	Check HO2S–1 heater power circuit. 1) Disconnect connector from HO2S–1 sensor with ignition switch turned OFF. 2) Check for proper connection to HO2S–1 sensor at "BLK/WHT" wire terminals. 3) If wire and connection are OK, measure voltage between "BLK/WHT" wire terminal and engine ground with ignition switch turned ON. Is voltage over 10 V?	Go to Step 3.	"BLK/WHT" wire open circuit or shorted to ground circuit.
3	Check HO2S–1 heater power circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between "BLK/WHT" wire terminal of HO2S–1 connector and "C64-4" terminal wire of ECM connector. Is resistance below 5 Ω?	Go to Step 4.	"BLK/WHT" wire high resistance circuit.
4	Check HO2S–1 heater drive circuit. 1) Measure resistance between "C64-4" wire terminal of ECM connector and vehicle body ground. Is resistance infinity?	Go to Step 5.	"BLK/WHT" wire shorted to ground circuit.
5	Check HO2S–1 heater drive circuit. 1) Turn ON ignition switch. 2) Measure voltage between "C64-4" wire terminal of ECM connector and vehicle body ground. Is voltage 0 V?	Go to Step 6.	"BLK/WHT" wire shorted to power circuit.
6	Check HO2S–1 heater drive circuit. 1) Connect connector to HO2S–1 with ignition switch turned OFF. 2) Turn ON ignition switch. 3) Measure voltage between "C64-4" wire terminal of ECM connector and vehicle body ground with disconnect connector from ECM. Is voltage over 10 V?	Go to Step 7.	"BLK/WHT" wire open circuit.
7	Check heater of sensor–1. 1) Disconnect HO2S–1 coupler with ignition switch turned OFF. 2) Check HO2S–1 heater resistance. See Fig. 1. It is 5.0 – 6.4 Ω at 20°C (68°F)?	Go to Step 8.	Replace HO2S–1.

Step	Action	Yes	No
8	Check HO2S–1 heater power circuit. 1) Disconnect connector from ECM with ignition switch turned OFF. 2) Connect connector to HO2S–1 with ignition switch turned OFF. 3) Measure resistance between “C64-4” wire and “G91-28” wire terminals of ECM connector. It resistance below 12 Ω?	HO2S–1 heater circuit are OK. Substitute a known-good ECM and recheck.	“BLK/WHT” wire high resistance circuit.

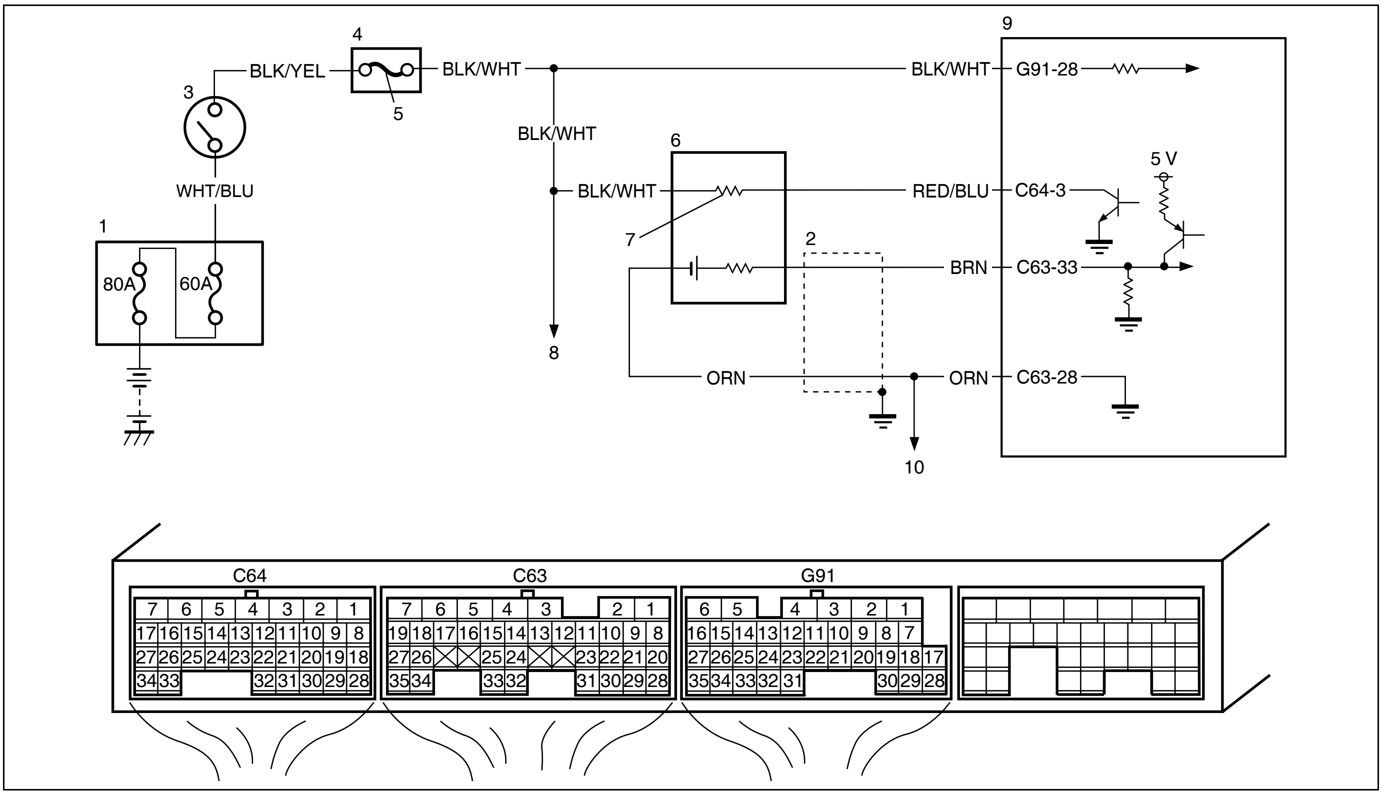


[A]: Fig. 1 for Step 7

DTC P0137 O2 Sensor (HO2S) Circuit Low Voltage (Sensor-2)

DTC P0138 O2 Sensor (HO2S) Circuit High Voltage (Sensor-2)

WIRING DIAGRAM



1. Relay/fuse box	4. Circuit fuse box	7. Heater	10. To other sensor
2. Shield wire	5. “IG” fuse	8. To HO2S–1 heater	
3. Ignition switch	6. HO2S–2	9. ECM	

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
DTC P0137: The voltage of HO2S–2 sensor is more than 4.5 V with HO2S–2 heater ON. DTC P0138: When the minimum voltage of HO2S–2 sensor is more than 0.4 V or the average voltage of the sensor is more than 0.9 V, DTC P0138 is detected after the following driving sequence. 1) Drive the vehicle with the speed of 80 km/h (50 mile/h) at 5th gear or D range. 2) Release the accelerator pedal for more than 4 seconds. 3) Stop the vehicle at the idle state for 6 seconds. (2 driving cycle detection logic)	• HO2S–2 • HO2S–2 circuit • Fuel system • ECM • Fuel shortage

DTC CONFIRMATION PROCEDURE

WARNING:

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

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.

- **Intake air temp.: –7°C, 19.4°F or higher**
- **Engine coolant temp.: –7°C, 19.4°F or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm up to normal operating temperature.
4) Increase vehicle speed to 60 – 80 km/h (37 – 50 mile/h) at 5th gear or D range.
5) Release accelerator pedal and with engine brake applied, keep vehicle coasting (with fuel cut for 4 sec. or more), then stop vehicle and run engine at idle speed for 6 sec. or more.
6) Repeat Step 4).
7) Keep above vehicle speed for 8 min. or more. (Throttle valve opening is kept constant in this Step.)
8) Repeat Step 5).
9) Check DTC and pending DTC.

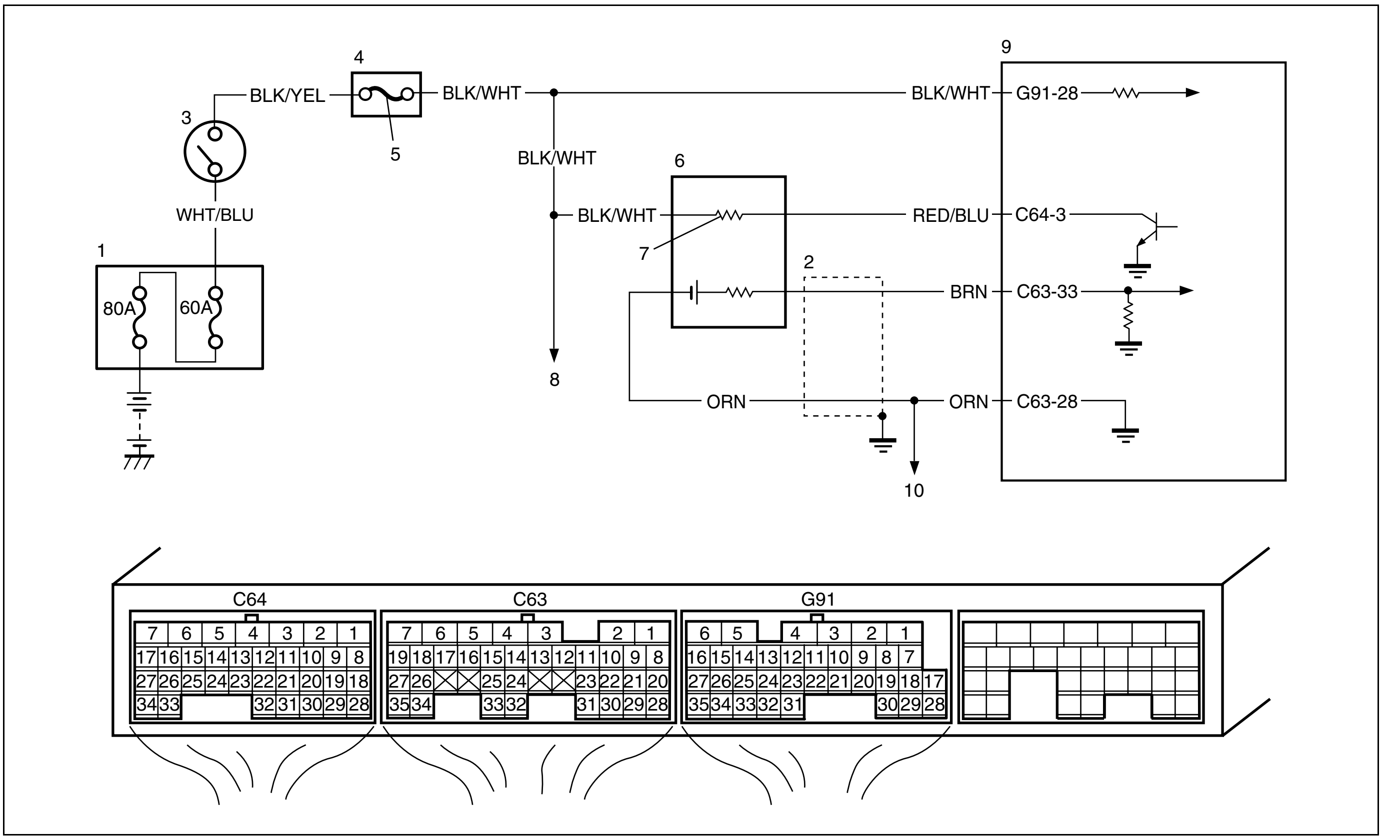
TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Is there DTC(s) other than fuel system (DTC P0171/P0172) and HO2S–2 (DTC P0134)?	Go to applicable DTC diag. flow table.	Go to Step 3.
3	Check HO2S–2 and its circuit. 1) Connect scan tool to DLC with ignition switch turned OFF. 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–2 output voltage indicate deflect between over 0.35 V and below 0.25 V?	Go to DTC P0171 and P0172 diag. flow table (Fuel System Check).	Go to Step 4.
4	Check HO2S–2 sensor ground. 1) Disconnect connector from HO2S–2 sensor with ignition switch turned OFF. 2) Check for proper connection to HO2S–2 sensor connector at “BRN”, “ORN”, “RED/BLU” and “BLK/WHT” wire terminals. 3) If wire and connection are OK, check there is continuity between “ORN” wire terminal of HO2S–2 sensor connector and engine ground. Is it continuity?	Go to Step 5.	“ORN” wire open circuit. Poor “C63-28” terminal connection. Faulty ECM ground. If they are OK, substitute a known-good ECM and recheck.

Step	Action	Yes	No
5	Check HO2S–2 sensor ground. 1) With ignition switch turn ON, check voltage between "ORN" wire terminal of HO2S–2 sensor connector and engine ground. Is voltage about 0.1 V or less?	Go to Step 6.	"ORN" wire high resistance circuit. Poor "C63-28" terminal connection. Faulty ECM ground. If they are OK, substitute a known-good ECM and recheck.
6	Check wire circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and connect connectors to ECM. 3) Measure resistance between "BRN" wire terminal of HO2S–2 sensor connector and "C63-33" wire terminal of ECM connector. Is resistance less than 5 Ω?	Go to Step 7.	"WHT" wire high resistance circuit or open circuit. Poor "C63-33" terminal connection. Faulty ECM ground. If they are OK, substitute a known-good ECM and recheck.
7	Check wire circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between "BRN" wire terminal of HO2S–2 sensor connector and body ground. Is resistance infinity?	Go to Step 8.	"BRN" wire shorted to ground circuit.
8	Check HO2S–2 signal circuit. 1) Measure voltage between "BRN" wire terminal of HO2S–2 sensor connector and vehicle body ground. Is voltage 0 V?	Go to Step 9.	"BRN" wire shorted to others circuit.
9	Check HO2S–2 heater circuit. 1) Check HO2S–2 heater circuit, referring to "DTC P0037 HO2S Heater Control Circuit Low (Sensor-2) DTC P0038 HO2S Heater Control Circuit High (Sensor-2)". Is circuit in good condition?	Go to Step 10.	Repair or replace it.
10	Check exhaust system. 1) Check exhaust system for exhaust gas leakage. Is it OK?	Go to Step 4 in DTC P0171 and P0172 diagnosis flow table. If it is in good condition, go to Step 11.	Repair exhaust system for leakage.
11	Check air intake system. 1) Check air intake system for clog or leak. Is it OK?	Check HO2S–2 sensor, referring to "Heated oxygen sensor (HO2S-1 and HO2S-2) heater on-vehicle inspection" in Section 6E1. If it is in good condition, substitute a known-good ECM and recheck.	Repair or replace.

DTC P0037 HO2S Heater Control Circuit Low (Sensor-2)
DTC P0038 HO2S Heater Control Circuit High (Sensor-2)

WIRING DIAGRAM



1. Relay/fuse box	4. Circuit fuse box	7. Heater	10. To other sensor
2. Shield wire	5. "IG" fuse	8. To HO2S–1 heater	
3. Ignition switch	6. HO2S–2	9. ECM	

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
Current of HO2S–2 heater is more than specified value or less than specified value for 3 seconds continuously (2 driving cycle detection logic)	• HO2S–2 heater • HO2S–2 heater circuit • 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 very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 person, a driver and tester, on a level road.**

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm up to normal operating temperature.
4) Run engine at idle speed for 1 min.
5) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Check HO2S–2 heater power circuit. 1) Disconnect connector from HO2S–2 sensor with ignition switch turned OFF. 2) Check for proper connection to HO2S–2 sensor at “BLK/WHT” and “RED/BLU” wire terminals. 3) If wire and connection are OK, measure voltage between “BLK/WHT” wire terminal of HO2S–2 sensor connector and engine ground with ignition switch turned ON. Is voltage over 10 V?	Go to Step 3.	“BLK/WHT” wire open circuit or shorted to ground circuit.
3	Check HO2S–2 heater power circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between “BLK/WHT” wire terminal of HO2S–2 sensor connector and “G91-28” terminal wire of ECM connector. Is resistance below 5 Ω?	Go to Step 4.	“BLK/WHT” wire high resistance circuit.
4	Check HO2S–2 heater drive circuit. 1) Measure resistance between “RED/BLU” wire terminal of HO2S–2 sensor connector and vehicle body ground. Is resistance infinity?	Go to Step 5.	“RED/BLU” wire shorted to ground circuit.
5	Check HO2S–2 heater drive circuit. 1) Turn ON ignition switch. 2) Measure voltage between “RED/BLU” wire terminal of HO2S–2 sensor connector and vehicle body ground. Is voltage 0 V?	Go to Step 6.	“RED/BLU” wire shorted to power circuit.
6	Check HO2S–2 heater drive circuit. 1) Connect connector to HO2S–2 with ignition switch turned OFF. 2) Turn ON ignition switch. 3) Measure voltage between “C64-3” wire terminal of disconnected ECM connector and vehicle body ground. Is voltage over 10 V?	Go to Step 7.	“RED/BLU” wire open circuit.
7	Check heater of sensor–2. 1) Disconnect HO2S–2 coupler with ignition switch turned OFF. 2) If OK, then check heater resistance. Is it 11.7 – 14.3 Ω at 20°C, 68°F?	Go to Step 8.	Replace HO2S–2.

Step	Action	Yes	No
8	Check HO2S–2 heater power circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Connect connector to HO2S–2 with ignition switch turned OFF. 3) Measure resistance between “C64-3” and “G91-28” wire terminals of ECM connector. Is resistance below 30 Ω?	HO2S–2 heater circuit are OK. Substitute a known-good ECM and recheck.	“RED/BLU” wire high resistance circuit.

DTC P0171 System Too Lean

DTC P0172 System Too Rich

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
P0171: Total fuel trim is higher than 43%. P0172: Total fuel trim is lower than –30%. (2 driving cycle detection logic)	• Vacuum leaks • Exhaust gas leakage • Fuel pressure out of specification • Fuel injector malfunction • Heated oxygen sensor–1 malfunction • MAF sensor malfunction • ECT sensor 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 very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 person, a driver and tester, on a level road.**

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.

- **Intake air temp.: –7°C (19.4°F) or higher**
- **Engine coolant temp.: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm up to normal operating temperature.
4) Operate vehicle within freeze frame data condition as noted for 5 min.
5) Stop vehicle and check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Is there DTC(s) other than “P0171” and “P0172”?	Go to applicable DTC flow table.	Go to Step 3.
3	Check intake system and exhaust system for leakage. Are intake system and exhaust system in good condition?	Go to Step 4.	Repair or replace.
4	Check fuel pressure referring to “Table B-3 Fuel Pressure Check” in this section. Is check result satisfactory?	Go to Step 5.	Repair or replace.
5	Check fuel injectors referring to “Fuel injector inspection” in Section 6E1. Is check result satisfactory?	Go to Step 6.	Faulty injector(s) or its circuit.
6	Check fuel level sensor. Is DTC P0463 displayed?	Go to Step 7.	Faulty fuel level sensor or its circuit.
7	Check MAF sensor referring to Step 2 and 3 of “DTC P0101 Mass Air Flow Circuit Range/Performance”. Is check result satisfactory?	Go to Step 8.	Faulty MAF sensor or its circuit.
8	Check ECT sensor referring to Step 3 and 4 of “DTC P0118 Engine Coolant Temperature Circuit High”. Is check result satisfactory?	Go to Step 9.	Faulty ECT sensor or its circuit.
9	Check HO2S–1 referring to Step 2 of “DTC P0131 O2 Sensor (HO2S) Circuit Low Voltage (Sensor-1)”. Is check result satisfactory?	Substitute a known-good ECM and recheck.	Faulty HO2S–1 or its circuit.

DTC P0300 Random Misfire Detected
DTC P0301 Cylinder 1 Misfire Detected
DTC P0302 Cylinder 2 Misfire Detected
DTC P0303 Cylinder 3 Misfire Detected
DTC P0304 Cylinder 4 Misfire Detected

SYSTEM DESCRIPTION

ECM measure the angle of the crankshaft based on the pulse signal from the CKP sensor and CMP sensor for each cylinder. If it detects a large change in the angle speed of the crankshaft, it concludes occurrence of a misfire. When the number of misfire is counted by ECM beyond the DTC detecting condition, it determine the cylinder where the misfire occurred and output it as DTC.

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
P0300 • Misfire, which causes catalyst to overheat during 200 engine revolutions, is detected at 2 or more cylinders. (MIL flashes as long as this misfire occurs continuously.) or • Misfire, which affects exhaust emission adversely during 1000 engine revolution, is detected at 2 or more cylinders. (2 driving cycle detection logic)	• Ignition system • Fuel injector and its circuit • Fuel pressure • EGR system • Fuel level sensor • Abnormal air drawn in • Engine compression • Valve lash adjuster • Valve timing • Fuel shortage
P0301, P0302, P0303, P0304 • Misfire, which causes catalyst to overheat during 200 engine revolutions, is detected at 1 cylinder. (MIL flashes as long as this misfire occurs continuously.) or • Misfire, which affects exhaust emission adversely during 1000 engine revolution, is detected at 1 cylinder. (2 driving cycle detection logic)	

DTC CONFIRMATION PROCEDURE

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

NOTE:
Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.
- **Intake air temp.: –7°C, 19.4°F or higher**
- **Engine coolant temp.: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Drive vehicle under freeze frame data condition as noted for 1 min. or more.
4) Stop vehicle and check DTC and pending DTC.

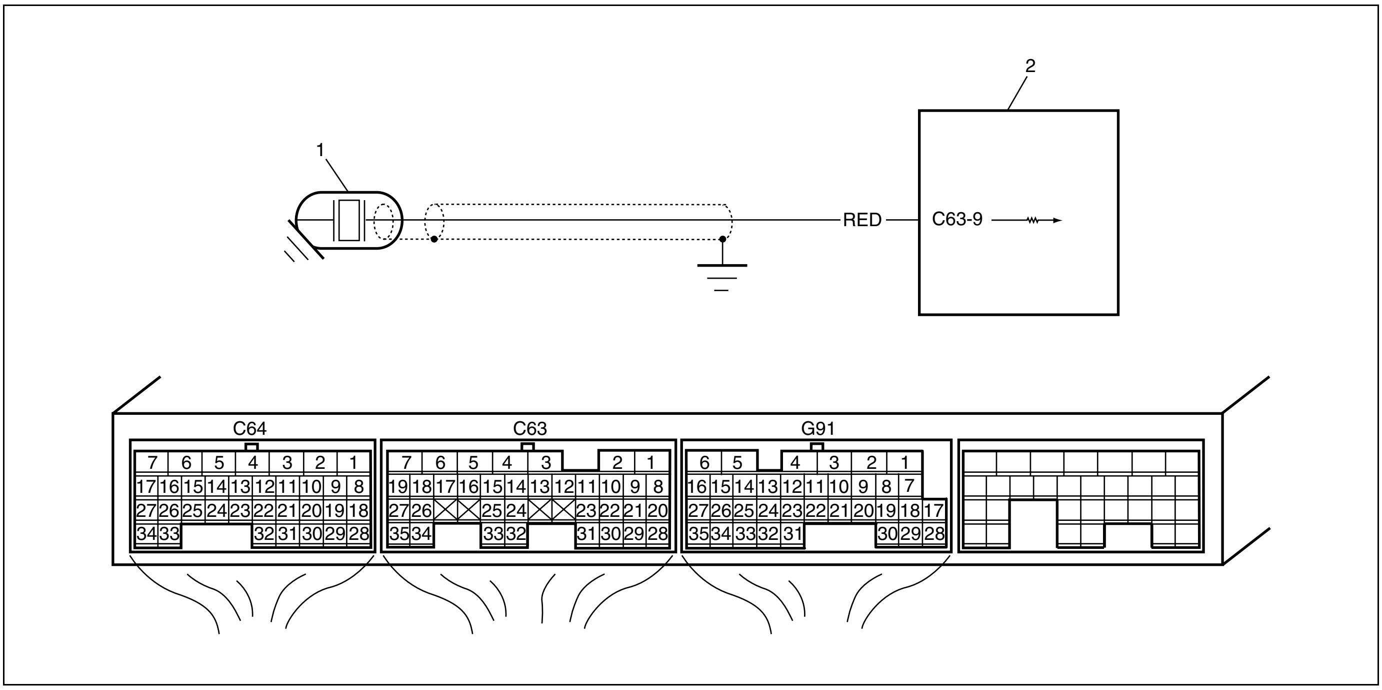
TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Does fuel level meter indicate “E” level (empty)?	Add fuel and recheck.	Go to Step 3.
3	Ignition system inspection. 1) Check spark plug and ignition spark of cylinder where misfire occurs, referring to “Spark Plugs Inspection” and “Ignition Spark Test” in Section 6F1. Is it in good condition?	Go to Step 4.	Faulty ignition coil, wire harness, spark plug or other system parts.
4	Fuel injector circuit check. 1) Using sound scope, check each injector operating sound at engine cranking or idling. Do all injectors make operating sound?	Go to Step 5.	Check coupler connection and wire harness of injector not making operating sound and injector itself. If OK, substitute a known-good ECM and recheck.
5	Fuel pressure inspection. 1) Check fuel pressure referring to “Table B-3 Fuel Pressure Check” in this section. Is check result satisfactory?	Go to Step 6.	Repair or replace.
6	Fuel injector inspection. 1) Check fuel injector(s) referring to “Fuel injector inspection” in Section 6E1. Is check result satisfactory?	Go to Step 7.	Replace.
7	Ignition timing inspection. 1) Check ignition timing referring to “Ignition Timing Inspection” in Section 6F1. Is check result satisfactory?	Go to Step 8.	Check related sensors.
8	EGR system inspection. 1) Check EGR system referring to “EGR valve inspection” in Section 6E1. Is check result satisfactory?	Go to Step 9.	Repair or replace.
9	Fuel level sensor inspection. 1) Check fuel level sensor referring to Step 2 of “DTC P0462 Fuel Level Sensor Circuit Low”. Is check result satisfactory?	Go to Step 10.	Repair or replace.

Step	Action	Yes	No
10	Engine mechanical systems check. Check engine mechanical parts or system which can cause engine rough idle or poor performance. – Engine compression (Refer to “Compression Check” in Section 6A1.) – Valve lash adjustor (Refer to “Valve Lash (Clearance) Inspection” in Section 6A1.) – Valve timing (Refer to “Timing Chain and Chain Tensioner Removal and Installation” in 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.

DTC P0327 Knock Sensor Circuit Low
DTC P0328 Knock Sensor Circuit High

WIRING DIAGRAM



1. Knock sensor	2. ECM

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
DTC will be set when all of the following conditions are detected for 5 seconds continuously. P0327 • Engine is running • Voltage of knock sensor is less than 0.9 V P0328 • Engine is running • Voltage of knock sensor is 4 V or more	• Open or short in knock sensor circuit • Knock sensor • ECM

DTC CONFIRMATION PROCEDURE

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.

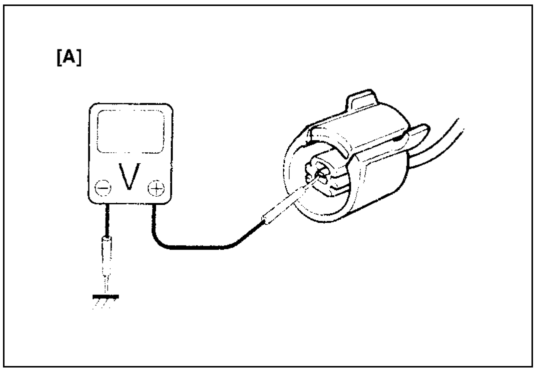
- **Intake air temp.: –7°C (19.4°F) or higher**
- **Engine coolant temp.: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

1) Connect scan tool to DLC with ignition switch turned OFF.
2) Turn ON ignition switch and clear DTC, pending DTC and freeze frame data by using scan tool.
3) Start engine and run it for 10 sec.
4) Check DTC by using scan tool.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Check sensor circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and connect connectors to ECM. 3) Measure voltage between “C63-9” wire terminal of ECM connector and vehicle body ground with engine running. Is voltage within 0.9 – 4 V?	Intermittent trouble. Check for intermittent refer to “Intermittent and Poor Connection” in Section 0A. If OK, substitute a known-good ECM and recheck.	Go to Step 3.
3	Check sensor circuit for open. 1) Disconnect connector from knock sensor with ignition switch turned OFF. 2) Turn ON ignition switch, measure voltage between “RED” wire of knock sensor connector and engine ground. See Fig. 1. Is voltage 4 – 6 V?	Go to Step 6.	Go to Step 4.
4	Check sensor circuit for open. 1) Turn ON ignition switch, measure voltage between “C63-9” wire terminal of ECM connector and engine ground. Is voltage 4 – 6 V?	“RED” wire in open circuit.	Go to Step 5.
5	Check sensor circuit for short. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between “C63-9” terminal of ECM connector and vehicle body ground. Is resistance infinity?	Go to Step 6.	“RED” wire in shorted to ground circuit. If wire is OK, substitute a known-good ECM and recheck.

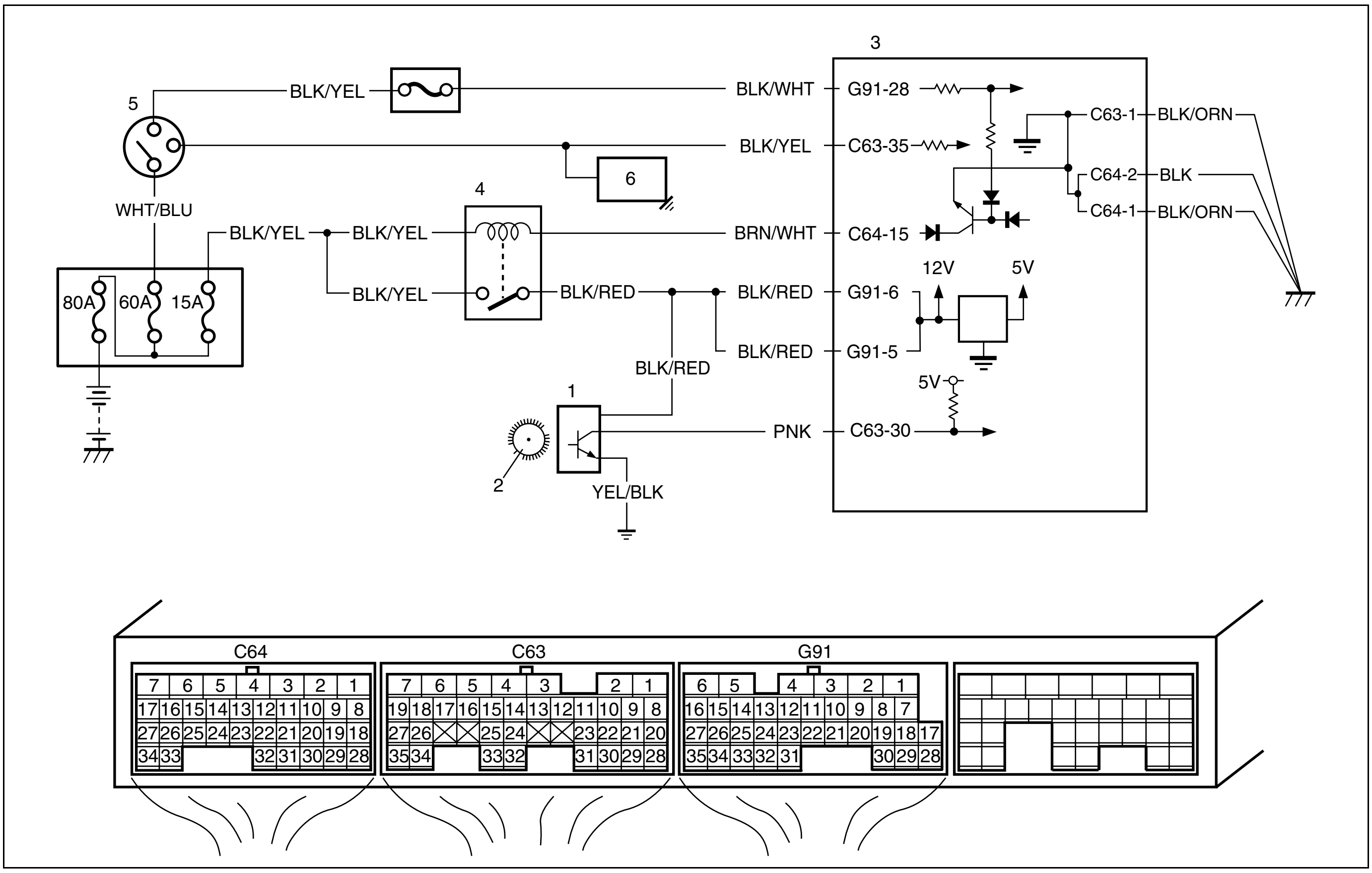
Step	Action	Yes	No
6	Check sensor circuit for short. 1) Turn ON ignition switch, measure voltage between “C63-9” terminal of ECM connector and vehicle body ground. Is voltage 0 V?	Go to Step 7.	“RED” wire in shorted to other circuit.
7	Check sensor circuit for high resistance. 1) Measure resistance between “C63-9” wire terminal of ECM connector and “RED” wire terminal of knock sensor harness connector. Is resistance below 5Ω?	Faulty knock sensor	“RED” wire in high resistance circuit.



[A]: Fig. 1 for Step 3

DTC P0335 Crankshaft Position (CKP) Sensor Circuit

WIRING DIAGRAM



1. CKP sensor	4. Main relay
2. Sensor plate on crankshaft	5. Ignition switch
3. ECM	6. Starting motor

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
No CKP sensor signal for 3 seconds at engine cranking while starting motor signal is inputting	• CKP sensor circuit open or short • Crankshaft timing pulley teeth damaged • CKP sensor malfunction, foreign material being attached or improper installation • ECM • Engine start signal circuit malfunction

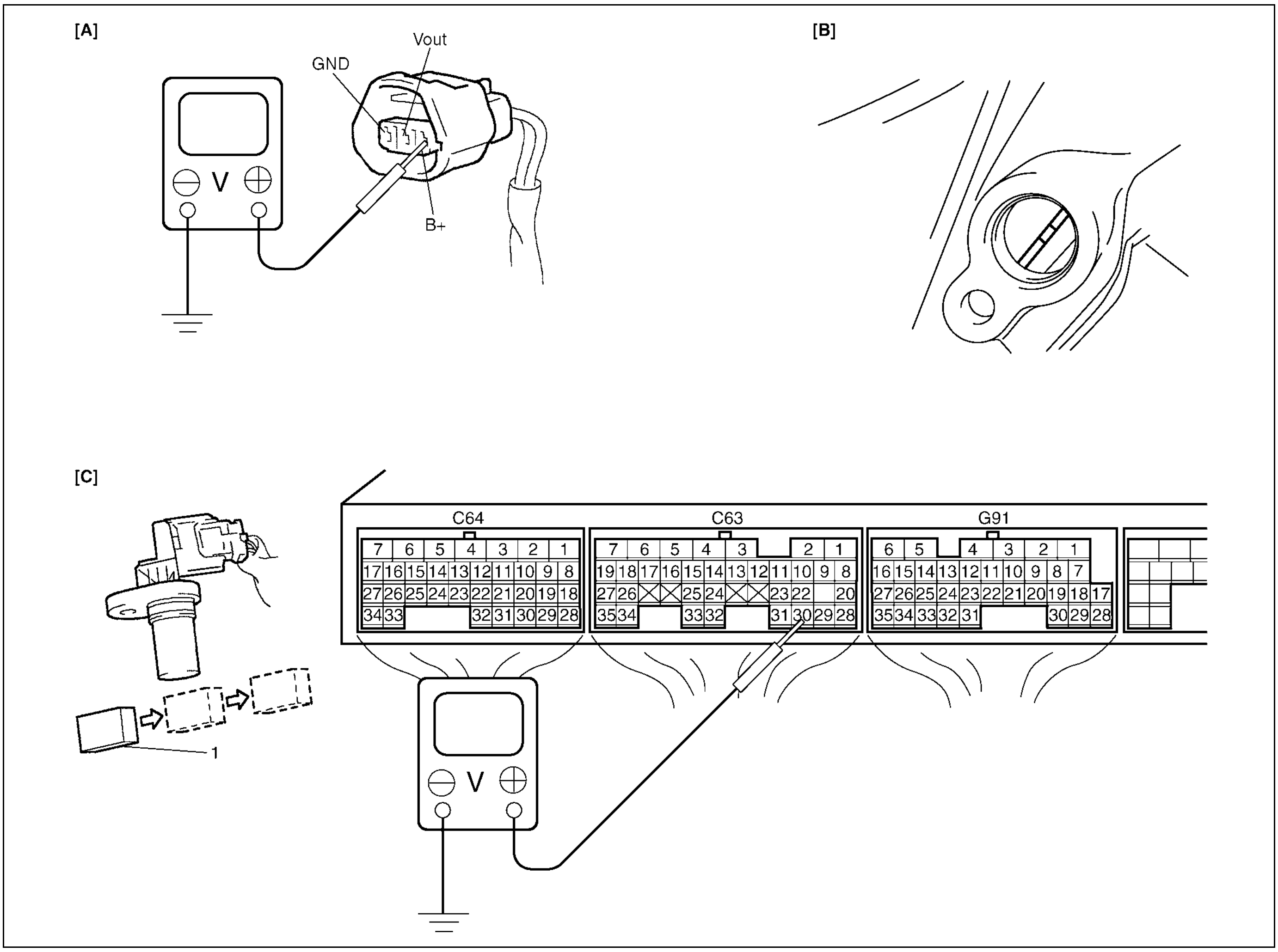
DTC CONFIRMATION PROCEDURE

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Crank engine for 3 – 5 sec.
4) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check" in this section.
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 "BLK/RED", "PNK" and "YEL/BLK" wire terminals. 3) If OK, turn ignition switch ON and check for voltage at "BLK/RED", "PNK" and "YEL/BLK" wire terminals of disconnected CKP sensor connector. See Fig. 1. Terminal "B+": 10 – 14 V Terminal "Vout": 4 – 5 V Terminal "GRD": 0 V Is check result satisfactory?	Go to Step 5.	Go to Step 4.
4	Was terminal "Vout" voltage in Step 3 out of specification?	"PNK" wire open, short or poor connection. If wire and connection are OK, substitute a known-good ECM and recheck.	"BLK/RED" and "YEL/BLK" wire open, short or poor connection.
5	Check Ground Circuit. 1) Turn ignition switch to OFF position. 2) Measure resistance between "YEL/BLK" wire terminal of CKP sensor connector and engine ground. Is resistance below 5 Ω?	Go to Step 6.	"YEL/BLK" wire open or high resistance.
6	Check Engine Start Signal. 1) Check voltage between "C63-35" wire terminal of ECM connector and engine ground with engine cranking. Does it voltage more than 6 V?	Go to Step 7.	"BLK/YEL" wire circuit open, high resistance or shorted to ground. If wire are OK, check starting motor referring to "Starting Motor Inspection" in Section 6G.

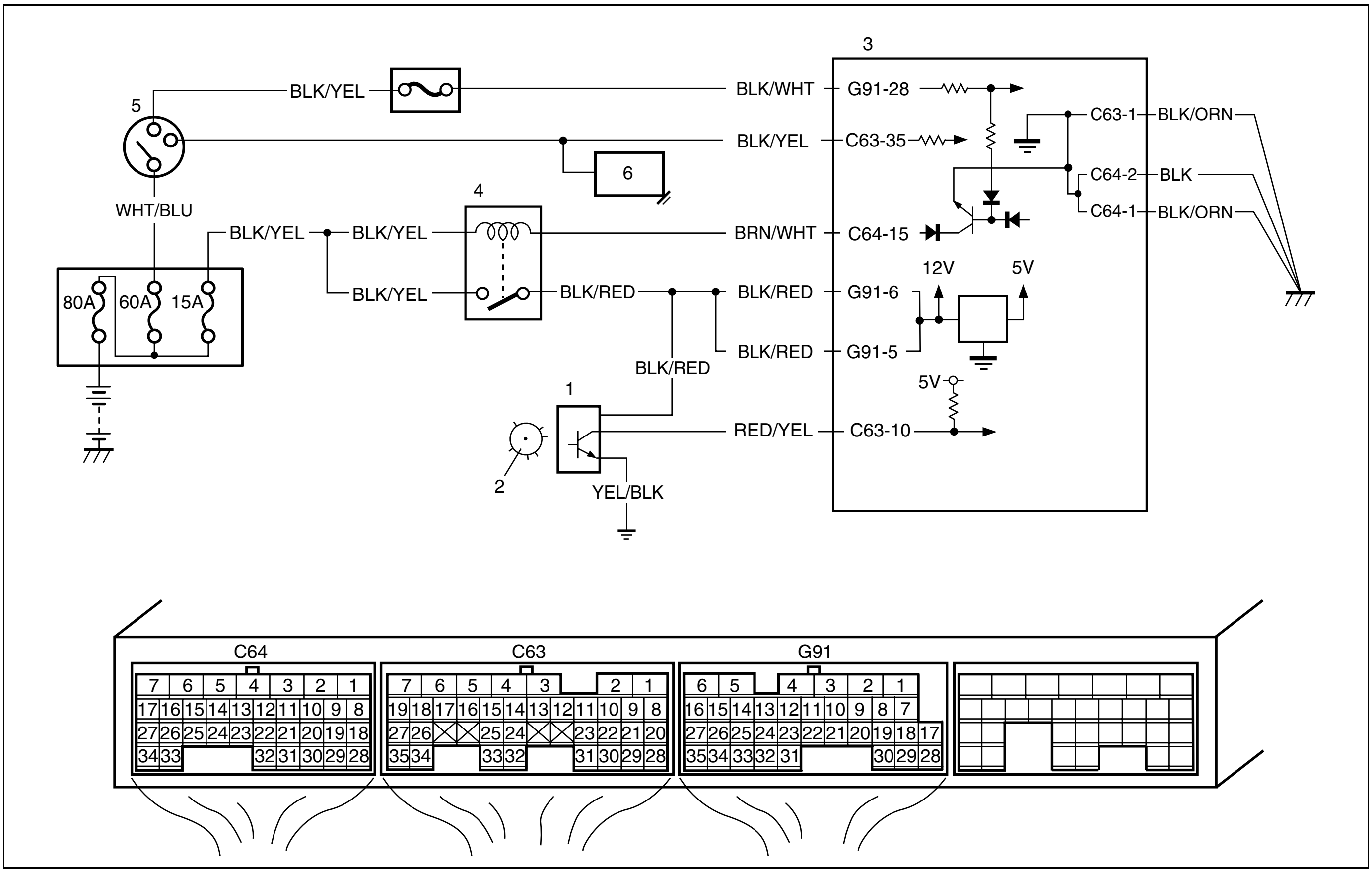
Step	Action	Yes	No
7	Check CKP Sensor. 1) Remove CKP sensor referring to “Crankshaft position sensor (CKP sensor) removal and installation” in Section 6E1. 2) Remove metal particles on end face of CKP sensor, if any. 3) Connect CKP sensor connector. 4) Turn ignition switch to ON position. 5) Check voltage between “C63-30” wire terminal of ECM connector and engine ground by passing magnetic substance (iron) (1) while keeping approx. 1 mm (0.03 in.) gap with respect to end face of CKP sensor. See Fig. 2. Does voltage vary from low (0 – 1 V) to high (4 – 5 V) or from high to low?	Go to Step 8.	Replace CKP sensor.
8	Check signal rotor for the following. See Fig. 3. • 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 signal rotor.



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

DTC P0340 Camshaft Position Sensor Circuit

WIRING DIAGRAM



1. CMP sensor	3. ECM	5. Ignition switch
2. Signal rotor	4. Main relay	6. Starting motor

SYSTEM DESCRIPTION

The CMP sensor located on the transmission side of cylinder head consists of the signal generator (magnetic sensor) and signal rotor (intake camshaft portion).
The signal generator generates Reference signal through slits in the slit plate which turns together with the camshaft.

Reference signal

The CMP sensor generates 6 pulses of signals each of which has a different waveform length while the camshaft makes one full rotation. Refer to “Inspection of ECM and Its Circuits” in this section.
Based on these signals, ECM judges which cylinder piston is in the compression stroke and the engine speed.

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
No CMP sensor signal for 3 seconds at engine cranking while starting motor signal is inputting	• CMP sensor circuit open or short • Signal rotor teeth damaged • CMP sensor malfunction, foreign material being attached or improper installation • ECM • Engine start signal circuit malfunction

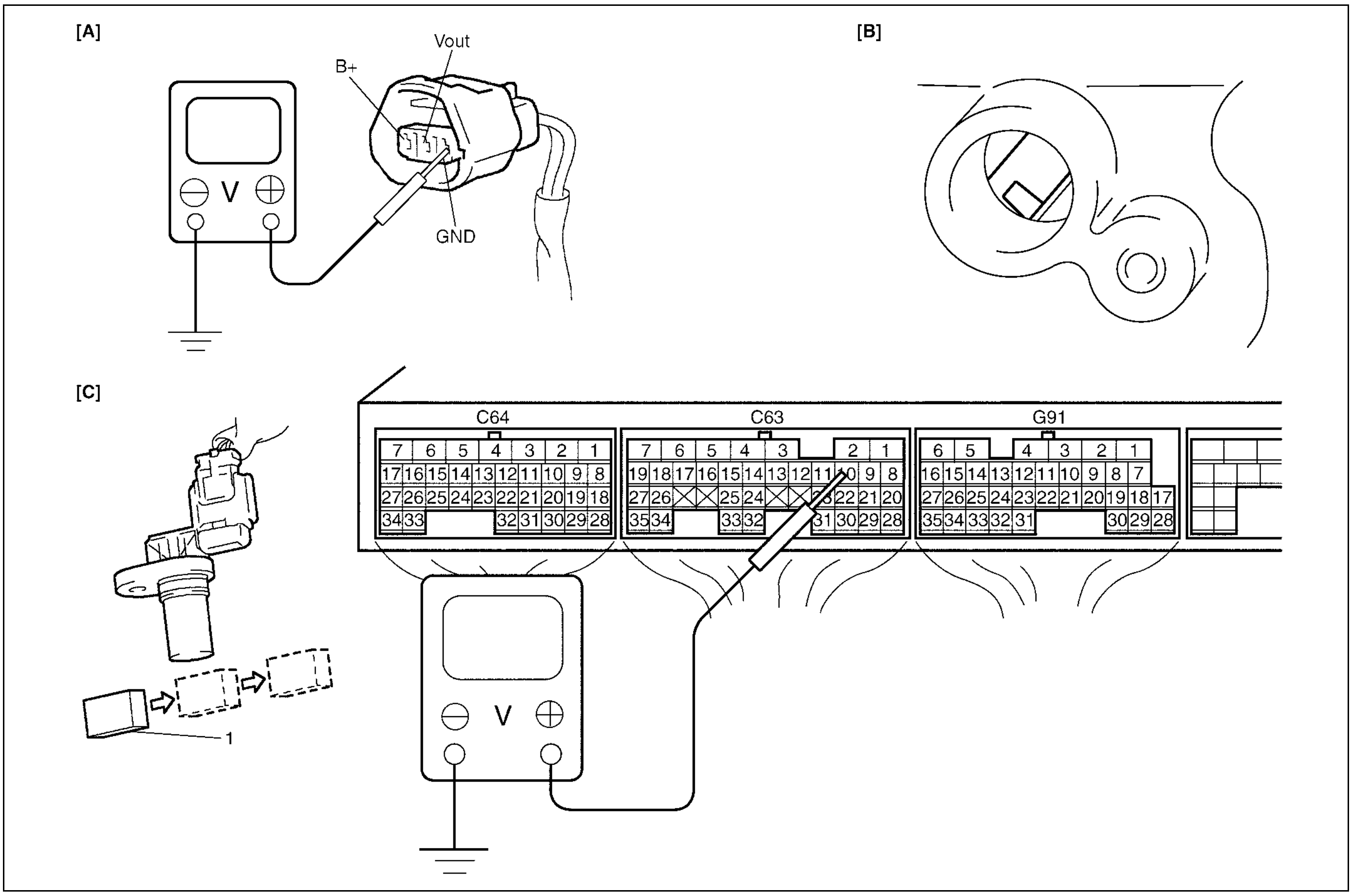
DTC CONFIRMATION PROCEDURE

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Crank engine for 5 sec.
4) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
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 “BLK/RED”, “RED/YEL” and “YEL/BLK” wire terminals. 3) If OK, turn ignition switch ON and check for voltage at “BLK/RED”, “RED/YEL” and “YEL/BLK” wire terminals of disconnected CMP sensor connector. See Fig. 1. Terminal “B+”: 10 – 14 V Terminal “Vout”: 4 – 5 V Terminal “GRD”: 0 V Is check result satisfactory?	Go to Step 5.	Go to Step 4.
4	Was terminal “Vout” voltage in Step 3 out of specification?	“RED/YEL” wire open, short or poor connection. If wire and connection are OK, substitute a known-good ECM and recheck.	“BLK/RED” and “YEL/BLK” wire open, short or poor connection.
5	Check Ground Circuit. 1) Turn ignition switch to OFF position. 2) Check for continuity between “YEL/BLK” wire terminal of CKP sensor connector and engine ground. Is continuity indicated?	Go to Step 6.	“YEL/BLK” wire open or poor connection.
6	Check Engine Start Signal. 1) Check voltage between “C63-35” wire terminal of ECM connector and engine ground with engine cranking. Does it voltage more than 6 V?	Go to Step 7.	“BLK/YEL” wire circuit open or shorted to ground. If wire are OK, check starting motor referring to “Starting Motor Inspection” in Section 6G.

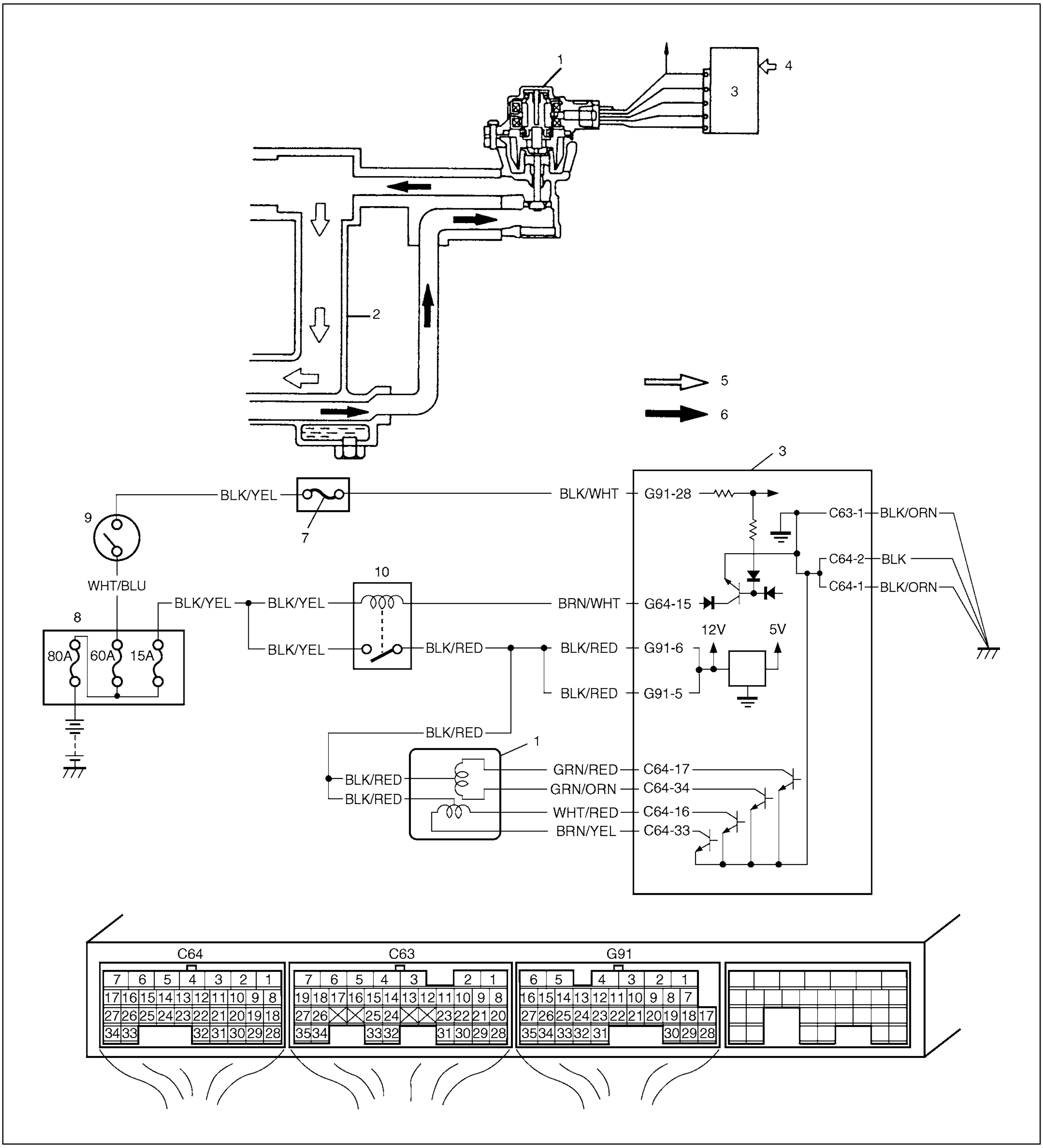
Step	Action	Yes	No
7	Check CMP Sensor. 1) Remove CMP sensor referring to “Camshaft position sensor (CMP sensor) removal and installation” in Section 6E1. 2) Remove metal particles on end face of CMP sensor, if any. 3) Connect CMP sensor connector. 4) Turn ignition switch to ON position. 5) Check voltage between “C63-10” wire terminal of ECM connector and engine ground by passing magnetic substance (iron) (1) while keeping approx. 1 mm (0.03 in.) gap with respect to end face of CMP sensor. See Fig. 2. Does voltage vary from low (0 – 1 V) to high (4 – 5 V) or from high to low?	Go to Step 8.	Replace CMP sensor.
8	Check signal rotor for the following. See Fig. 3. • 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 signal rotor.



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

DTC P0401 Exhaust Gas Recirculation Flow Insufficient Detected
DTC P0402 Exhaust Gas Recirculation Flow Excessive Detected

SYSTEM/WIRING DIAGRAM



1. EGR value	4. Sensed information	7. "IG" fuse	10. Main relay
2. Intake manifold	5. Fresh air	8. Relay/fuse box	
3. ECM	6. Exhaust gas	9. Ignition switch	

DTC DETECTING CONDITION AND TROUBLE AREA (DTC P0401/P0402)

DTC DETECTING CONDITION	TROUBLE AREA
DTC P0401: Difference in intake manifold absolute pressure between opened EGR valve and closed EGR valve is smaller than specified value. DTC P0402: Difference in intake manifold absolute pressure between opened EGR valve and closed EGR valve is larger than specified value. (2 driving cycle detection logic)	• EGR valve • EGR passage • MAP sensor • ECM

DTC CONFIRMATION PROCEDURE (DTC P0401/P0402)

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.**

NOTE:
Check to make sure that following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.
- **Intake air temp.: –7°C (19.4°F) or higher**
- **Engine coolant temp.: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm up to normal operating temperature.
4) Increase engine speed to 3000 rpm in 3rd gear.
5) Release accelerator pedal and with engine brake applied, keep vehicle coasting for 5 sec. or more. (Keep fuel cut condition for 5 sec. or more) If fuel cut condition is not kept for 5 sec. or more, coast down a slope in engine speed 1000 – 3000 rpm for 5 sec. or more.
6) Step vehicle and run engine at idle.
7) Check DTC and pending DTC by using scan tool.

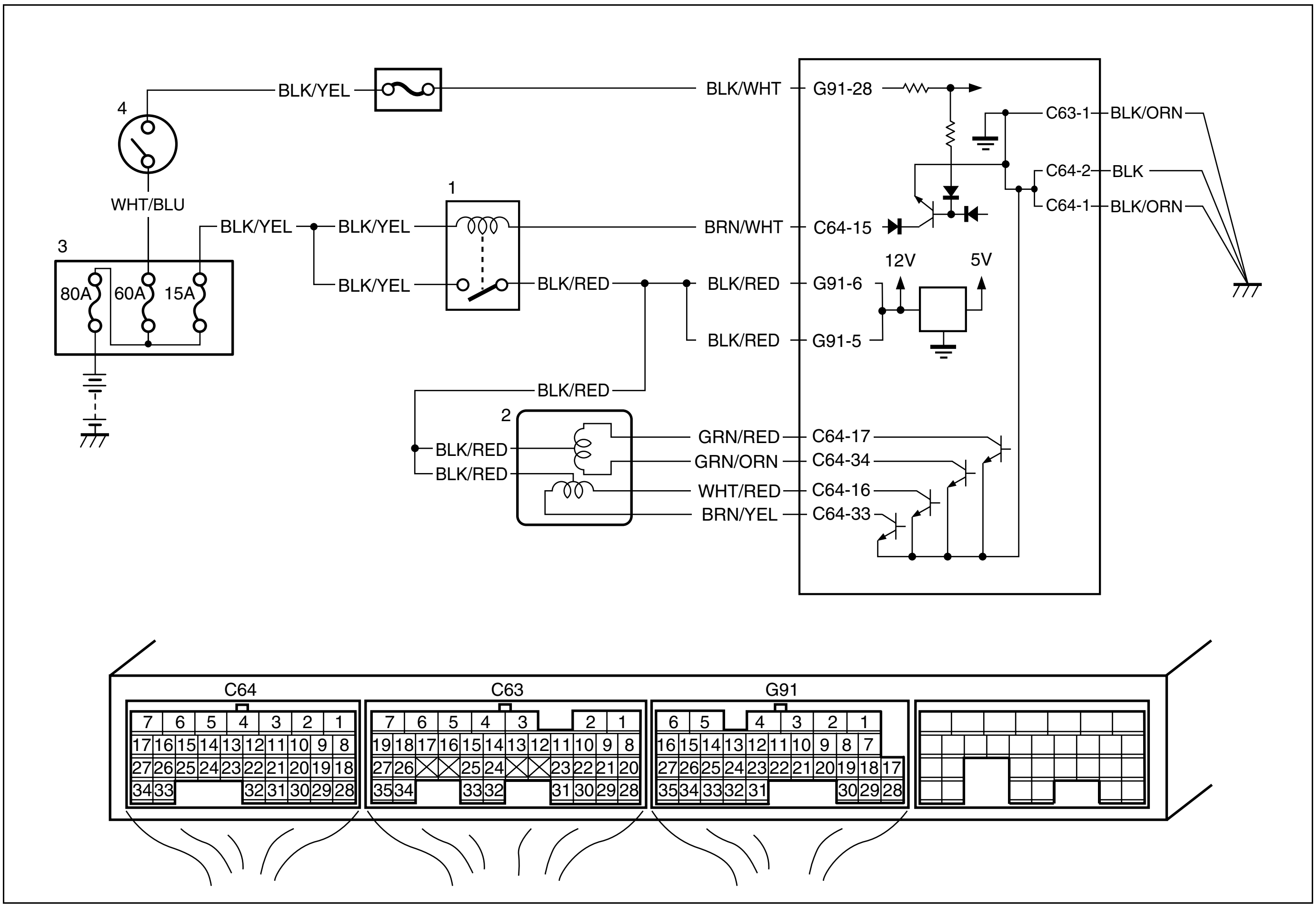
TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check”.
2	EGR valve operation check. 1) With ignition switch turned OFF, install Suzuki Scan Tool. 2) Check EGR system referring to “EGR system inspection” in Section 6E1. Is it in good condition?	Go to Step 3.	Go to Step 4.

Step	Action	Yes	No
3	MAP sensor check. 1) Check MAP sensor for performance referring to "MAP Sensor Individual Check" in "DTC P0108 Manifold Absolute Pressure High Input" Diag. Flow Table. Is check result satisfactory?	Intermittent trouble or faulty ECM Check for intermittent referring to "Intermittent and Poor Connection" in Section 0A.	Repair or replace.
4	EGR valve power supply circuit check. 1) With ignition switch turned OFF, disconnect EGR valve coupler. 2) With ignition switch turned ON, check voltage between "BLK/RED" wire terminal of EGR valve coupler and engine ground. Is each voltage 10 – 14 V?	Go to Step 5.	Faulty "BLK/RED" wire.
5	Check wire circuit. 1) Measure voltage between engine ground and each "GRN/RED", "GRN/ORN", "WHT/RED" and "BRN/YEL" wire terminal of EGR valve connector. Is each voltage 0 V?	Go to Step 6.	Some wire shorted to other circuits. If wires are OK, substitute a known-good ECM and recheck.
6	Check wire circuit. 1) With ignition switch turned OFF, check that there are insulating between engine ground and each "GRN/RED", "GRN/ORN", "WHT/RED" and "BRN/YEL" wire terminal of EGR valve connector. Are there insulating?	Go to Step 7.	Some wire shorted to ground circuit. If wires are OK, substitute a known-good ECM and recheck.
7	EGR valve stepping motor coil circuit check. 1) With ignition switch turned OFF, connect EGR valve coupler and disconnect ECM couplers. 2) Check resistance between "G91-5/6" and "C64-17", "C64-34", "C64-16", "C64-33" wire terminal of ECM connector. Is each resistance 20 – 24Ω at 20°C, 68°F.	Go to Step 8.	Faulty "GRN/RED", "GRN/ORN", "WHT/RED" and "BRN/YEL" wire or EGR valve.
8	Check wire circuit. 1) Measure voltage between engine ground and each "GRN/RED", "GRN/ORN", "WHT/RED" and "BRN/YEL" wire terminal of EGR valve connector. Is each voltage 10 – 14 V?	Some wire in high resistance circuit. If wires are good condition, faulty EGR valve.	Some wire open circuit. If wires are good condition, faulty EGR valve.
9	MAP sensor check: 1) Check MAP sensor for performance referring to "MAP Sensor Individual Check" in "DTC P0108" Diag. Flow Table. Is check result satisfactory?	EGR passage clogged or EGR valve malfunction, If all above are OK, substitute known-good ECM and recheck.	Repair or replace.

DTC P0403 Exhaust Gas Recirculation Control Circuit

WIRING DIAGRAM



1. Main relay	2. EGR valve	3. Relay/fuse box	4. Ignition switch

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
EGR valve output voltage is low although ECM commanded EGR valve to turn OFF. (1 driving cycle detection logic)	• EGR valve circuit open • EGR valve • 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.**

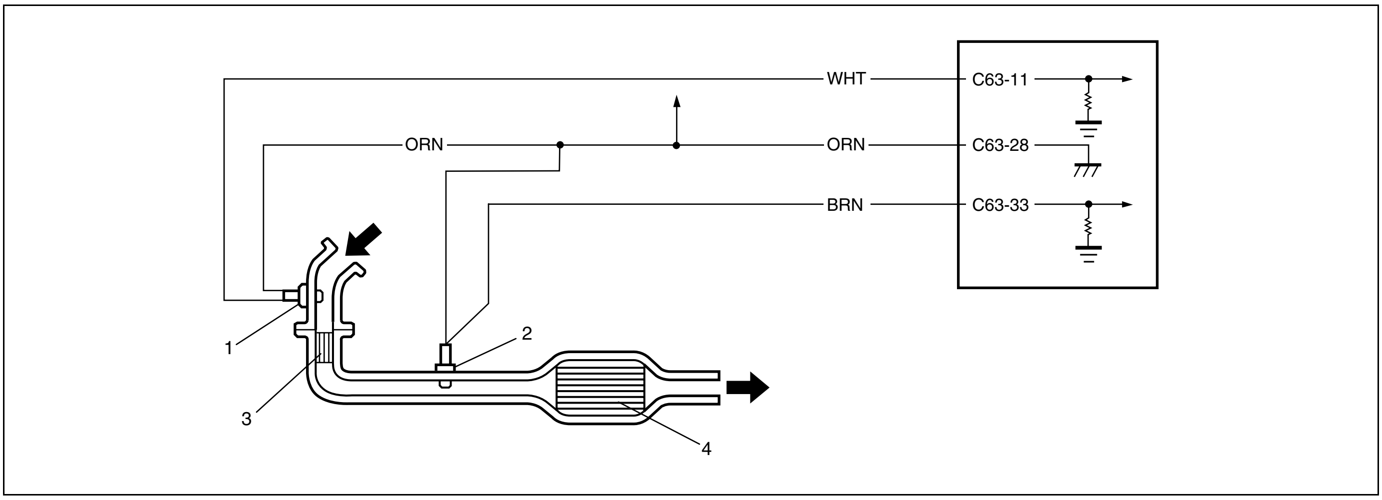
1) With ignition switch turned OFF, connect scan tool to DLC.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm it up to normal operating temperature.
4) Drive vehicle in 2000 – 3500 rpm of engine speed.
5) Keep above vehicle speed for 1 min. (Throttle valve opening is kept constant in this step.)
6) Stop vehicle and check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	EGR valve power supply circuit check. 1) Remove air intake pipe. 2) With ignition switch turned OFF, disconnect EGR valve coupler. 3) With ignition switch turned ON, check voltage between “BLK/RED” wire terminals of EGR valve coupler and body ground. Is check voltage 10 – 14 V?	Go to Step 3.	Faulty “BLK/RED” wire.
3	Check wire circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Turn ON ignition switch. 3) Measure voltage between engine ground and each “GRN/RED”, “GRN/ORN”, “WHT/RED”, “BRN/YEL” wire terminal of EGR valve connector. Is each voltage 0 V?	Go to Step 4.	Some wire shorted to other circuits. If wires are OK, substitute a known-good ECM and recheck.
4	Check wire circuit. 1) With ignition switch turned OFF, measure resistance between engine ground and each GRN/RED”, “GRN/ORN”, “WHT/RED”, “BRN/YEL” wire terminal of EGR valve connector. Is resistance infinity?	Go to Step 5.	Some wire shorted to ground circuit. If wires are OK, substitute a known-good ECM and recheck.
5	EGR valve stepper motor coil circuit check. 1) With ignition switch turned OFF, connect EGR valve coupler. 2) Check resistance between “G91-5/6” and each “C64-17”, “C64-34”, “C64-16”, “C64-33” wire terminal of ECM connector. Is each resistance 20 – 24 Ω at 20°C, 68°F?	Faulty ECM substitute a known-good ECM and recheck.	Go to Step 6.
6	Check wire circuit. 1) Connect connectors to ECM with ignition switch turned OFF. 2) Turn ON ignition switch. 3) Measure voltage between engine ground and each “GRN/RED”, “GRN/ORN”, “WHT/RED”, “BRN/YEL” wire terminal of EGR valve connector. Is each voltage 10 – 14 V?	Some wire in high resistance circuit. If wires are good condition, faulty EGR valve.	Some wire open circuit. If wires are good condition, faulty EGR valve.

DTC P0420 Catalyst System Efficiency Below Threshold

SYSTEM/WIRING DIAGRAM

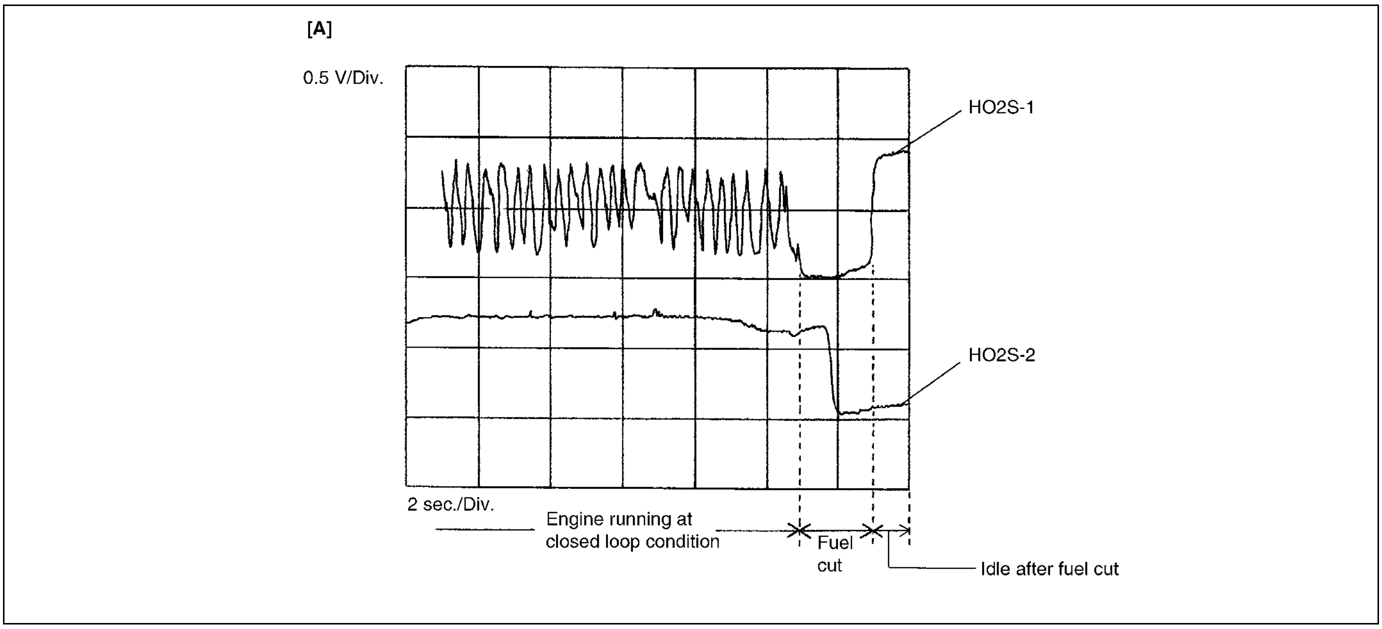


CIRCUIT DESCRIPTION

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

When the catalyst is functioning properly, the variation cycle of HO2S–2 (2) output voltage (oxygen concentration) is slower than that of HO2S–1 (1) output voltage because of the amount of oxygen in the exhaust gas which has been stored in warm up three way catalytic converter (3) and three way catalytic converter (4).

REFERENCE



[A]: Oscilloscope Waveforms

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
• 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 is less than specified value. ✱2 driving cycle detection logic, monitoring once/1 driving	• Exhaust gas leak • Three way catalytic converter 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.**

NOTE:

Check to make sure that following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.
- **Intake air temp.: –7°C (19.4°F) or higher**
- **Engine coolant temp.: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

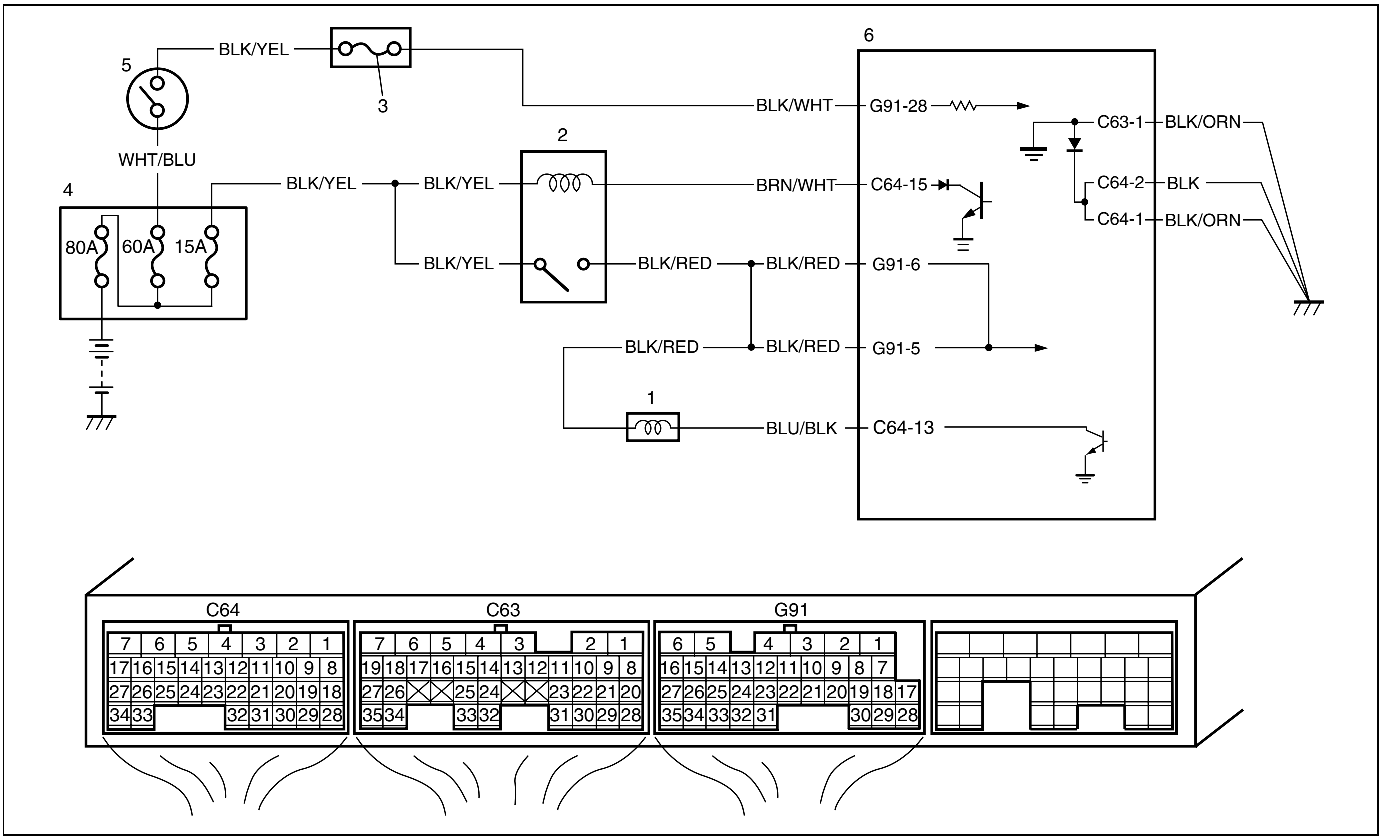
1) Connect scan tool to DLC with ignition switch turned OFF.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Increase vehicle speed to 50 – 60 mph, 80 – 100 km/h. (engine speed: 2500 – 3000 r/min.)
4) Keep above vehicle speed for 10 min. or more (Throttle valve opening is kept constant in this step).
5) Stop vehicle and check if DTC/pending DTC exists using scan tool. If not, check if catalyst monitoring test has completed using scan tool. If not in both of above checks (i.e., no DTC/pending DTC and catalyst monitoring test not completed), check vehicle condition (environmental) and repeat step 3) through 5).

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Exhaust system visual inspection. 1) Check exhaust system for leaks, damage and loose connection. Is it in good condition?	Go to Step 3.	Repair or replace.
3	HO2S–2 output voltage check. 1) Check output voltage of HO2S–2 referring to “DTC P0137 O2 Sensor (HO2S) Circuit Low Voltage (Sensor-2)” or “DTC P0138 O2 Sensor (HO2S) Circuit High Voltage (Sensor-2)”. Is check result satisfactory?	Replace three way catalytic converter.	Check “WHT” and “ORN” wires for open and short, and connections for poor connection. If wires and connections are OK, replace HO2S–2.

DTC P0443 Evaporative Emission System Purge Control Valve Circuit

WIRING DIAGRAM



1. EVAP canister purge valve	3. "IG" fuse	5. Ignition switch
2. Main relay	4. Relay/fuse box	6. ECM

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
Monitor signal of EVAP canister purge valve is different from command signal. (Circuit open or short) (2 driving cycle detection logic)	• EVAP canister purge valve • EVAP canister purge valve circuit • 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) With ignition switch OFF, connect scan tool to DLC.
2) Turn On ignition switch and clear DTC using scan tool.
3) Start engine and run engine at idle speed (600 rpm or more) for 1 minute with all electric loads turned OFF.
4) Check DTC and pending DTC.

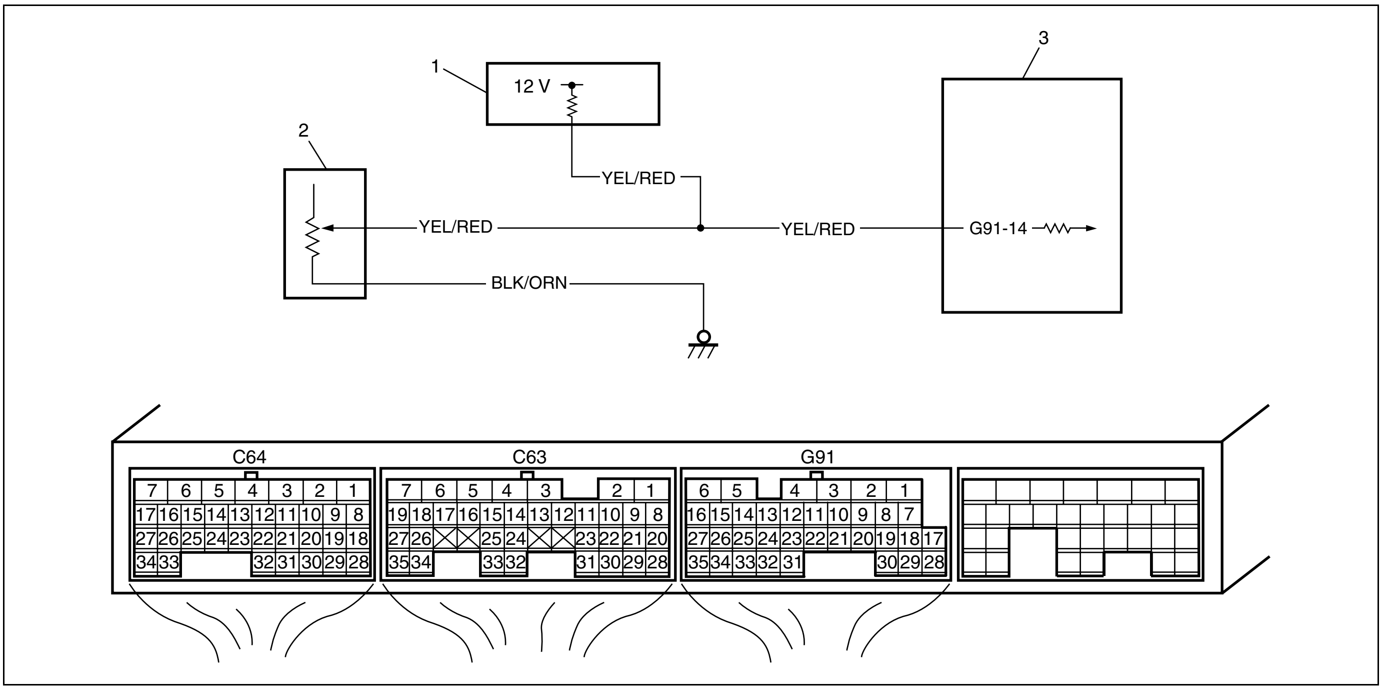
TROUBLESHOOTING

WARNING:
In order to reduce risk of fire and personal injury, this work must be performed in a well ventilated area and away from any open flames such as gas hot water.

Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check".
2	Check EVAP canister purge power supply circuit. 1) Turn OFF ignition switch, disconnect connector from EVAP canister purge valve. 2) Measure voltage between engine ground and "BLK/RED" wire terminal of EVAP canister purge valve connector with ignition switch turned ON. Is it voltage 10 – 14 V?	Go to step 3.	"BLK/RED" wire open circuit.
3	Check wire circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between "C64-13" terminal of ECM connector and vehicle body ground. Is resistance infinity?	Go to Step 4.	"BLU/BLK" wire shorted to ground circuit.
4	Check wire circuit. 1) Measure voltage between "C64-13" terminal of ECM connector and vehicle body ground. Is voltage 0 V?	Go to Step 5.	"BLU/BLK" wire shorted to others circuit.
5	Check wire circuit. 1) Connect connector to purge control valve with ignition switch turned OFF. 2) Remove ECM from vehicle body and then connect connectors to ECM. 3) Turn ON ignition switch, measure voltage between "C64-13" terminal of ECM connector and vehicle body ground. Is it voltage 10-14 V?	Go to Step 6.	"BLU/BLK" wire open circuit.
6	Check EVAP canister purge control valve. 1) Check EVAP canister purge control valve referring to "Evaporative emission control system inspection" in Section 6E1. Is it in good condition?	Go to Step 7.	Faulty EVAP canister purge control valve.
7	Check EVAP canister purge control circuit. 1) With ignition switch turn OFF, measure resistance between "G91-5/6" terminal and "C64-13" terminal of ECM connector. Is resistance below 40 Ω at 20°C, 68°F?	Faulty ECM, substitute a known-good ECM and recheck.	"BLK/RED" and/or "BLU/BLK" wire in high resistance circuit.

DTC P0462 Fuel Level Sensor Circuit Low

WIRING DIAGRAM



1.	Fuel level meter in combination meter
2.	Fuel level sensor (gauge)
3.	ECM

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
• Fuel level sensor voltage is lower than 0.16 V for 5 seconds continuously. (2 driving cycle detection logic)	• “YEL/RED” circuit short • Fuel level sensor malfunction • ECM malfunction • Combination meter malfunction

DTC CONFIRMATION PROCEDURE

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and run it for 30 sec. or more.
4) Check DTC and pending DTC.

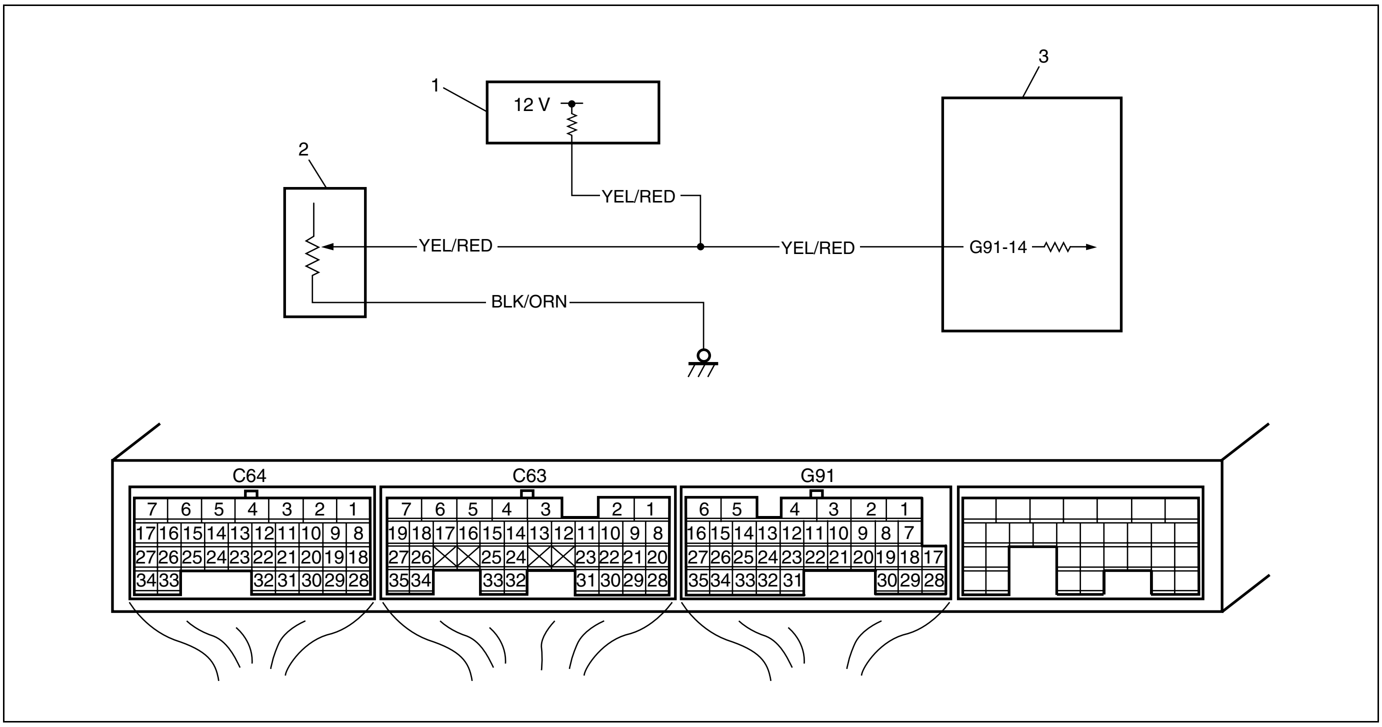
TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Do you have Suzuki Scan Tool?	Go to Step 3.	Go to Step 4.

Step	Action	Yes	No
3	Fuel Level Sensor Output Signal Check with Suzuki Scan Tool 1) Connect Suzuki Scan Tool to DLC with ignition switch turned OFF. 2) Turn ON ignition switch and check fuel level displayed on Suzuki Scan Tool. Is 100% displayed?	Go to Step 5.	Intermittent trouble or faulty ECM. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.
4	Fuel Level Sensor Output Signal Check 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and then connect connectors to ECM. 3) Turn ON ignition switch and measure voltage between “G91-14” wire terminal of ECM connector and vehicle body ground. Is voltage about 3.5 V or less?	Go to Step 5.	Intermittent trouble or faulty ECM. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.
5	Fuel Level Sensor Output Signal Circuit Check 1) Disconnect connectors from combination meter referring to “Combination Meter Removal and Installation” in Section 8C. 2) Remove fuel pump referring to “Fuel Pump Assembly Removal and Installation” in Section 6C. 3) Disconnect connectors from ECM. 4) Measure resistance between “G91-14” wire terminal of ECM connector and vehicle body ground. Is it infinite?	Go to Step 6.	“YEL/RED” wire shorted to ground circuit.
6	Combination Meter Check 1) Check fuel gauge referring to Fuel Gauge Inspection” in Section 8C. Is it in good condition?	Go to Step 7.	Faulty combination meter.
7	Check Fuel Level Sensor 1) Check fuel level sensor referring to “Fuel Level Sensor (Gauge Unit) Inspection” in Section 8C. Is it in good condition?	Substitute a known-good ECM and recheck.	Faulty fuel level sensor.

DTC P0463 Fuel Level Sensor Circuit High

WIRING DIAGRAM



1.	Fuel level meter in combination meter
2.	Fuel level sensor (gauge)
3.	ECM

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
• Fuel level sensor voltage is higher than 7.1 V for 5 seconds continuously. (2 driving cycle detection logic)	• "YEL/RED" or "BLK/ORN" circuit open • Fuel level sensor malfunction • ECM malfunction • Combination meter faulty

DTC CONFIRMATION PROCEDURE

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and run it for 30 sec. or more.
4) Check DTC and pending DTC.

TROUBLESHOOTING

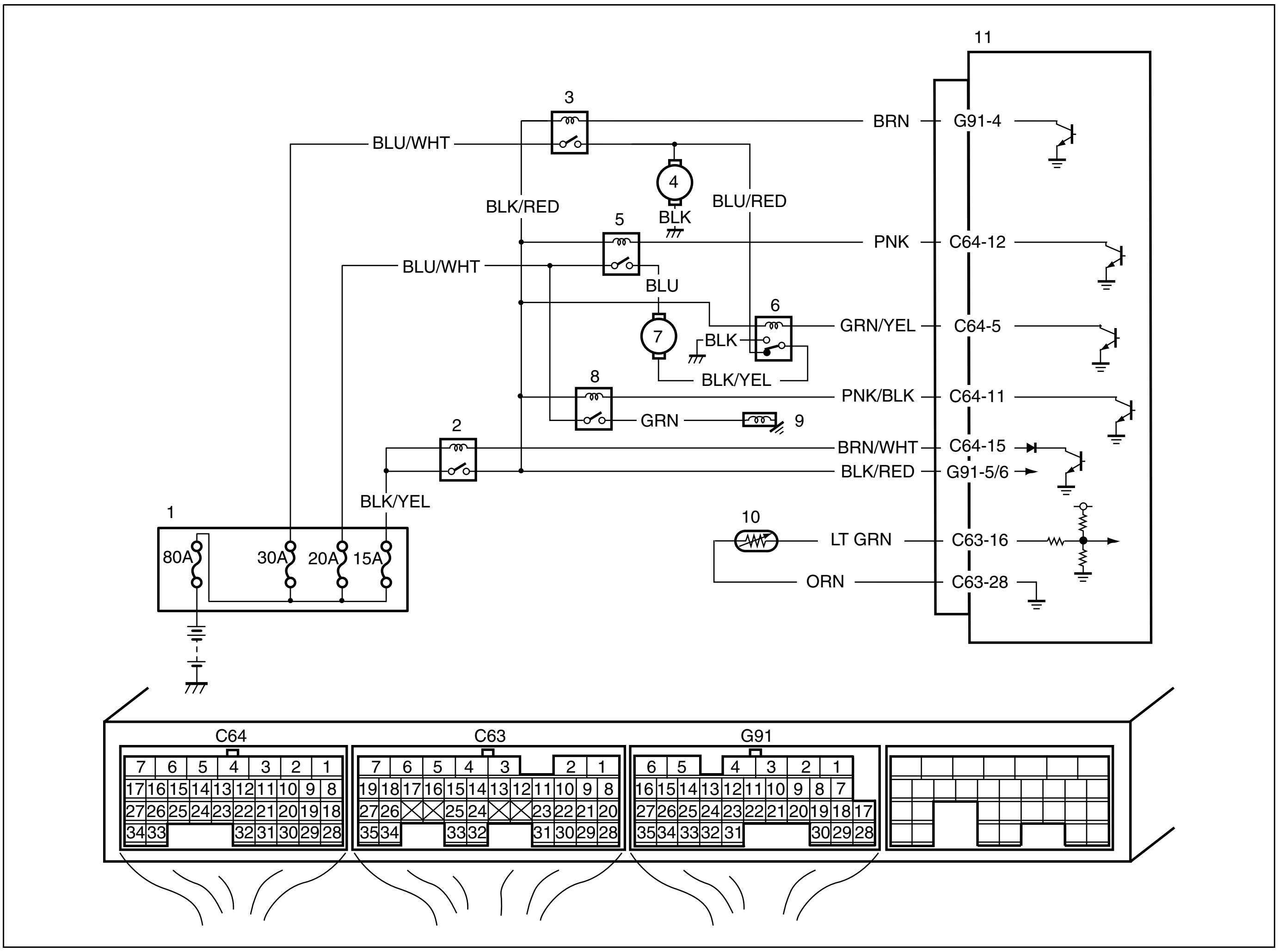
Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check" in this section.
2	Does fuel level meter in combination meter indicate "E" (empty)?	Replenish fuel tank with fuel and go to Step 3.	Go to Step 3.
3	Do you have Suzuki Scan Tool?	Go to Step 4.	Go to Step 5.

Step	Action	Yes	No
4	Fuel Level Sensor Output Signal Check with Suzuki Scan Tool 1) Connect Suzuki Scan Tool to DLC with ignition switch turned OFF. 2) Turn ON ignition switch and check fuel level displayed on Suzuki Scan Tool. Is it 3% or less?	Go to Step 6.	Intermittent trouble or faulty ECM. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.
5	Fuel Level Sensor Output Signal Check 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and then connect connectors to ECM. 3) Turn ON ignition switch and measure voltage between “G91-14” wire terminal of ECM connector and vehicle body ground. Is voltage about 3.5 V or more?	Go to Step 6.	Intermittent trouble or faulty ECM. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.
6	Fuel Level Sensor Circuit Resistance Check 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Check for proper connection to “G91-14” wire terminal of ECM connector. 3) If OK, measure resistance between “G91-14” wire terminal of ECM connector and vehicle body ground. Is resistance below 280 Ω?	Go to Step 7.	Go to Step 9.
7	Fuel Level Sensor Output Signal Circuit Check for Short 1) Disconnect connectors from combination meter referring to “Combination Meter Removal and Installation” in Section 8C. 2) Turn ON ignition switch and measure voltage between “G91-14” wire terminal of ECM connector and vehicle body ground. Is voltage 0 V?	Go to Step 8.	“YEL/RED” wire shorted to power supply circuit.
8	Check ECM Voltage 1) Connect connectors to ECM with ignition switch turned OFF. 2) Turn ON ignition switch and measure voltage between “G91-14” wire terminal of ECM connector and vehicle body ground. Is voltage below 0.1 V?	Faulty combination meter.	Substitute a known-good ECM and recheck.
9	Fuel Level Sensor Output Signal Circuit Check for Open 1) Turn OFF ignition switch and then disconnect combination meter connector referring to “Combination Meter Removal and Installation” in Section 8C. 2) Check for proper connection to “YEL/RED” wire terminal of combination meter connector. 3) If OK, measure resistance between “G91-14” wire terminal of ECM connector and “YEL/RED” wire terminal of combination meter connector. Is resistance below 10 Ω?	Go to Step 10.	“YEL/RED” wire in open or high resistance circuit at between ECM wire terminal and combination meter wire terminal.

Step	Action	Yes	No
10	Fuel Level Sensor Output Signal Circuit Check for Open 1) Remove fuel pump referring to “Fuel Pump Assembly Removal and Installation” in Section 6C. 2) Connect connectors to combination meter. 3) Turn ON ignition switch, measure voltage between “YEL/RED” wire terminal of disconnected fuel pump connector and vehicle body ground. Is voltage 10 – 14 V?	Go to Step 11.	“YEL/RED” wire circuit open.
11	Fuel Level Sensor Ground Circuit Check 1) Turn ignition switch to OFF position. 2) Check for proper connection to “BLK/ORN” wire terminal of fuel pump connector. 3) If OK, measure resistance between “BLK/ORN” wire terminal of fuel pump connector and vehicle body ground. Is resistance below 5 Ω?	Go to Step 12.	“BLK/ORN” wire in open or high resistance circuit.
12	Fuel Level Sensor Circuit Check for High Resistance 1) Check for proper connection to “YEL/RED” wire terminal of fuel pump connector. 2) If OK, measure resistance between “YEL/RED” wire terminal of fuel pump connector and “G91-14” wire terminal of ECM connector. Is resistance below 10 Ω?	Go to Step 13.	“YEL/RED” wire in high resistance circuit.
13	Check Fuel Level Sensor 1) Check fuel level sensor referring to “Fuel Level Sensor (Gauge Unit) Inspection” in Section 8C. Is it in good condition?	Faulty combination meter.	Faulty fuel level sensor.

DTC P0480 Fan 1 (Radiator Cooling Fan) Control Circuit

WIRING DIAGRAM



1. Relay/fuse box	4. Radiator fan motor	7. A/C condenser fan motor	10. ECT sensor
2. Main relay	5. A/C condenser fan relay No.1	8. A/C compressor relay	11. ECM
3. Radiator fan relay	6. A/C condenser fan relay No.2	9. A/C compressor	

CIRCUIT DESCRIPTION

Radiator fan relay is controlled by ECM if ECT is specified value.

When A/C condenser fan motor is running while head light is turned ON and engine is running at below 1500 r/min, radiator fan relay is turned OFF for 2 sec. by ECM.

DTC DETECTING CONDITION	TROUBLE AREA
• Monitor signal of radiator fan relay is different from command signal.	• “BLK/WHT”, “BLK/RED” or “BRN” circuit open or short • Radiator fan relay malfunction • ECM malfunction

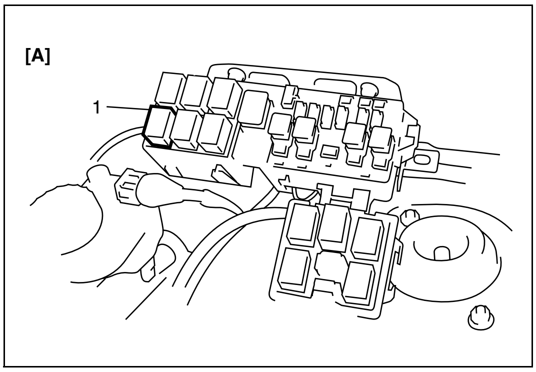
DTC CONFIRMATION PROCEDURE

1) Turn ignition switch turned OFF.
2) Clear DTC with ignition switch ON.
3) Warm up engine until radiator cooling fan starts to operate.
4) Check pending DTC in “ON BOARD TEST” or “PENDING DTC” mode and DTC in “DTC” mode.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Check Relay Circuit 1) Disconnect radiator fan relay from relay/ fuse box with ignition switch turned OFF. (See Fig. 1.) 2) Turn ignition switch to ON position. 3) Measure voltage between “BLK/RED” wire terminal of radiator fan relay connector and engine ground. Is voltage 10 – 14 V?	Go to Step 3.	“BLK/RED” wire in open or high resistance circuit.
3	Check Relay Circuit 1) Turn ignition switch to OFF position. 2) Install radiator fan relay to relay/fuse box. 3) Disconnect connectors from ECM. 4) Remove ECM from vehicle body and then connect connectors to ECM. 5) Turn ignition switch to ON position. 6) Measure voltage between “G91-4” wire terminal of ECM connector and vehicle body ground. Is voltage 10 – 14 V?	Go to Step 4.	Go to Step 6.
4	Check Relay Circuit 1) Turn ignition switch to OFF position. 2) Disconnect connectors from ECM. 3) Remove radiator fan relay from relay/fuse box. 4) Measure voltage between “G91-4” wire terminal of ECM connector and vehicle body ground with ignition switch turned ON. Is voltage 0 V?	Go to Step 5.	“BRN” wire shorted to power circuit.
5	Radiator Fan Control Signal Check 1) Disconnect negative (–) cable at battery. 2) Disconnect connector from ECT sensor. 3) Connect connectors to ECM. 4) Install radiator fan relay to relay/fuse box. 5) Connect negative (–) cable to battery. 6) Measure voltage between “G91-4” wire terminal of ECM connector and vehicle body ground with ignition switch turned ON. Is voltage about 0 V?	System is in good condition.	Substitute a known-good ECM and recheck.

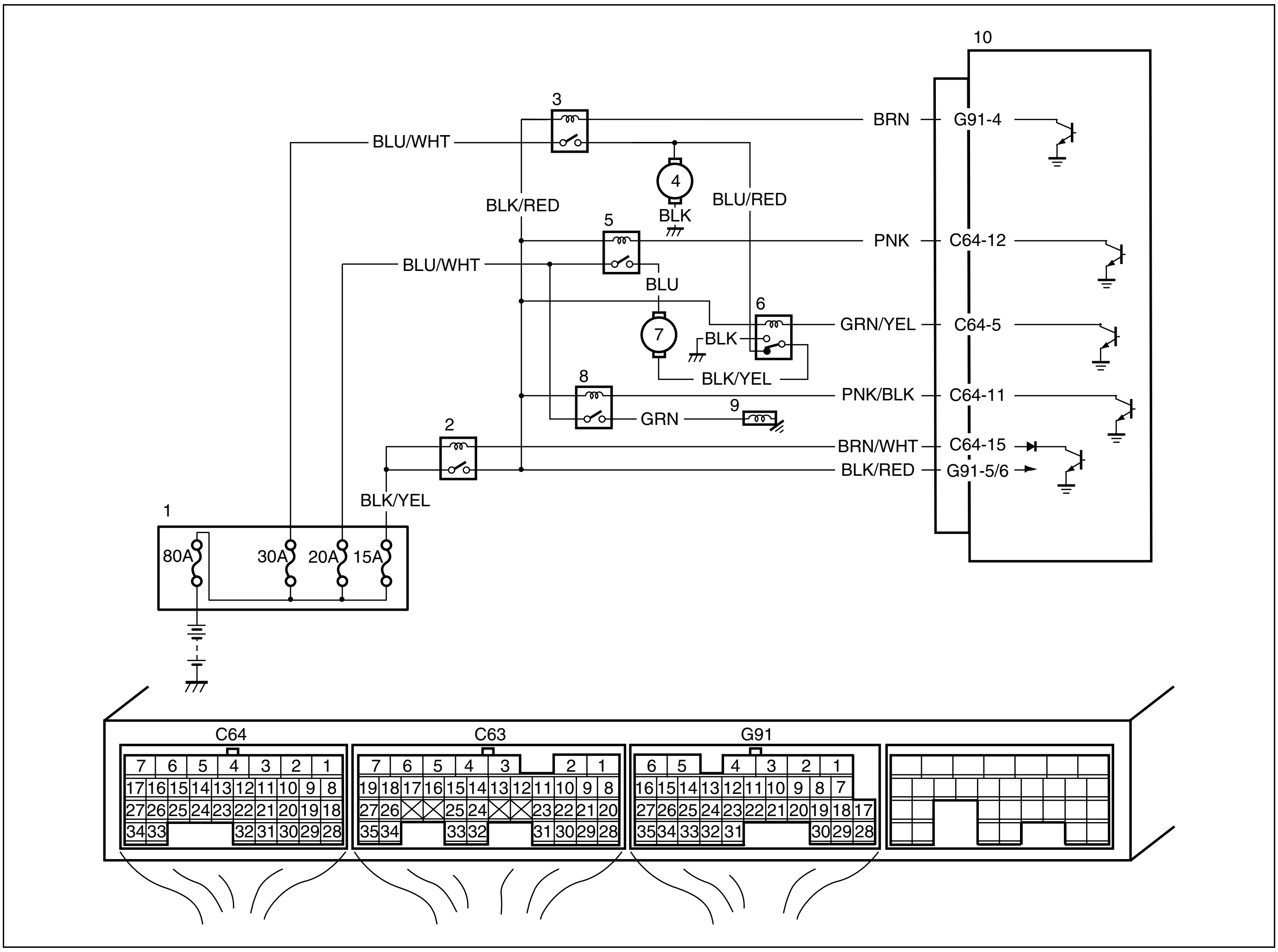
Step	Action	Yes	No
6	Radiator Fan Control Signal Check 1) Turn ignition switch to OFF position. 2) Install radiator fan relay to relay/fuse box. 3) Disconnect connectors from ECM. 4) Measure voltage between “G91-4” wire terminal of ECM connector and vehicle body ground with ignition switch turned ON. Is voltage 10 – 14 V?	Substitute a known-good ECM and recheck.	Go to Step 7.
7	Check Relay Circuit 1) Turn ignition switch to OFF position. 2) Disconnect connectors from ECM. 3) Remove radiator fan relay from relay/fuse box. 4) Check for proper connection to “G91-4” wire terminal of ECM connector and “BRN” wire terminal of radiator fan relay connector. 5) If OK, measure resistance between “G91-4” wire terminal of ECM connector and “BRN” wire terminal of radiator fan relay connector. Is resistance 1 Ω or less?	Go to Step 8.	“BRN” wire in open or high resistance circuit.
8	Check Relay Circuit 1) Measure resistance between “G91-4” wire terminal of ECM connector and vehicle body ground. Is it infinite?	Go to Step 9.	“BRN” wire shorted to ground circuit.
9	Check Radiator Fan Relay 1) Check radiator fan relay referring to “Main relay, fuel pump relay and radiator fan relay inspection” in Section 6E1. Is it in good condition?	System is in good condition. Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.	Replace radiator fan relay.



[A]:	Fig. 1 for Step 2
1.	Radiator fan relay

DTC P0481 Fan 2 (A/C Condenser Fan) Control Circuit

WIRING DIAGRAM



1. Relay/fuse box	4. Radiator fan motor	7. A/C condenser fan motor	10. ECM
2. Main relay	5. A/C condenser fan relay No.1	8. A/C compressor relay	
3. Radiator fan relay	6. A/C condenser fan relay No.2	9. A/C compressor	

CIRCUIT DESCRIPTION

A/C condenser fan motor is turned ON and OFF by its relay which ECM controls.
When A/C condenser fan motor starts is running while head light is turned ON and engine is running at below 1500 r/min, A/C condenser fan relay No.2 and radiator fan relay is turned OFF for 2 sec. by ECM.
Other than above condition, A/C condenser fan relay No.2 is leaving turned ON by ECM.

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
• Monitor signal of A/C condenser fan relay is different from command signal.	• "PNK" or "BLU/WHT" circuit open or short • A/C condenser fan relay malfunction • ECM malfunction

DTC CONFIRMATION PROCEDURE

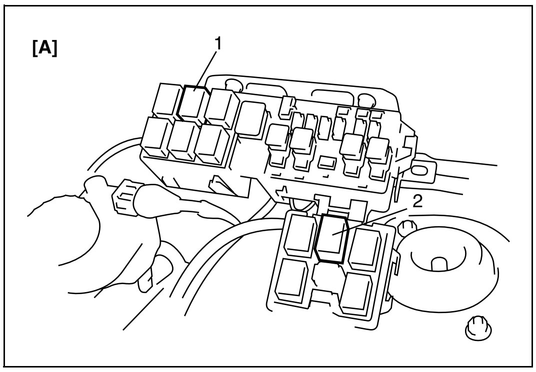
1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm up engine to normal operating temperature.
4) Run engine at idle and turn both A/C switch and heater blower switch ON (turn ON air conditioning) for 3 min. or more.
5) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check" in this section.
2	Check Relay Circuit 1) Disconnect A/C condenser fan relay No.1 from relay/fuse box with ignition switch turned OFF. (See Fig. 1.) 2) Measure voltage between "BLK/RED" wire terminal of A/C condenser fan relay No.1 connector and engine ground with ignition switch turned ON. Is voltage 10 – 14 V?	Go to Step 3.	"BLK/RED" wire in open or high resistance circuit.
3	Check Relay Circuit 1) Disconnect A/C condenser fan relay No.2 from relay box with ignition switch turned OFF. (See Fig. 1.) 2) Measure voltage between "BLK/RED" wire terminal of A/C condenser fan relay No.2 connector and engine ground with ignition switch turned ON. Is voltage 10 – 14 V?	Go to Step 4.	"BLK/RED" wire in open or high resistance circuit.
4	Check Relay Circuit 1) Install A/C condenser fan relay No.1 and No.2 with ignition switch turned OFF. 2) Disconnect connectors from ECM. 3) Remove ECM from vehicle body and then connect connectors to ECM. 4) Measure voltage between each "C64-12" and "C64-5" wire terminal of ECM connector and vehicle body ground with ignition switch turned ON. Is each voltage 10 – 14 V?	Go to Step 5.	Go to Step 7.

Step	Action	Yes	No
5	Check Relay Circuit 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove A/C condenser fan relay No.1 and No.2. 3) Measure voltage between each “C64-12” and “C64-5” wire terminals of ECM connector and vehicle body ground with ignition switch turned ON. Is each voltage 0 V?	Go to Step 6.	“PNK” and “GRN/YEL” wire shorted to power circuit.
6	A/C Condenser Fan Control Signal Check 1) Connect connectors to ECM with ignition switch turned OFF. 2) Install A/C condenser fan relay No.1 and No.2. 3) Operate A/C system after an engine running. 4) Measure voltage between each “C64-12” and “C64-5” wire terminal of ECM connector and vehicle body ground. Is each voltage about 0 V?	System is in good condition.	Substitute a known-good ECM and recheck.
7	Check Relay Circuit 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove A/C condenser fan relay No.1 and No.2. 3) Check for proper connection to “C64-12” and “C64-5” wire terminals of ECM connector, “PNK” wire terminal of A/C condenser fan relay No.1 connector and “GRN/YEL” wire terminal of A/C condenser fan relay No.2 connector. 4) If OK, measure resistance between “C64-12” wire terminal of ECM connector and “PNK” wire terminal of A/C condenser fan relay No.1 connector and “C64-5” wire terminal of ECM connector and “GRN/YEL” wire terminal of A/C condenser fan relay No.2 connector. Is each resistance 1 Ω or less?	Go to Step 8.	“PNK” and “GRN/YEL” wire in open or high resistance circuit.
8	Check Relay Circuit 1) Measure resistance between each “C64-12” and “C64-5” wire terminals of ECM connector and vehicle body ground. Is each resistance infinite?	Go to Step 9.	“PNK” and “GRN/YEL” wire shorted to ground circuit.

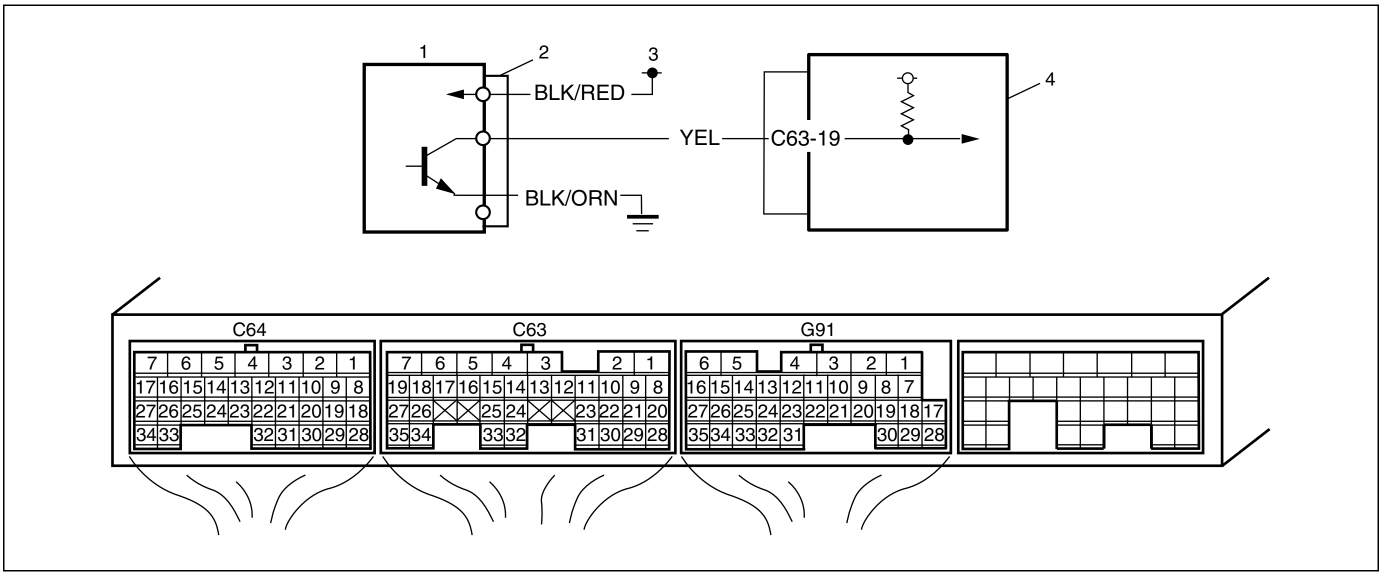
Step	Action	Yes	No
9	Check A/C Condenser Fan Relay No.1 and No.2 1) Check A/C condenser fan relay No.1 and No.2 referring to “Condenser Cooling Fan Relay (No.1 and No.2) Inspection” in Section 1B. Is each relay in good condition?	Go to Step 10.	Replace A/C condenser fan relay No.1 or No.2.
10	A/C Condenser Fan Control Signal Check 1) Connect connectors to ECM. 2) Install A/C condenser fan relay No.1 and No.2. 3) Start engine. 4) Measure voltage between each “C64-12” and “C64-5” wire terminal of ECM connector and vehicle body ground. Is each voltage 10 – 14 V?	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.	Substitute a known-good ECM and recheck.



[A]:	Fig. 1 for Step 2 and Step 3
1.	A/C condenser fan relay No.1
2.	A/C condenser fan relay No.2

DTC P0500 Vehicle Speed Sensor (VSS) Malfunction

WIRING DIAGRAM



1. VSS	3. To main relay
2. VSS connector	4. ECM

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
• Vehicle speed signal is not input while fuel cut at deceleration for 5 seconds continuously.	• “BLK/ORN” circuit open • “YEL” or “BLK/RED” circuit open or short • VSS malfunction • ECM malfunction

DTC CONFIRMATION PROCEDURE

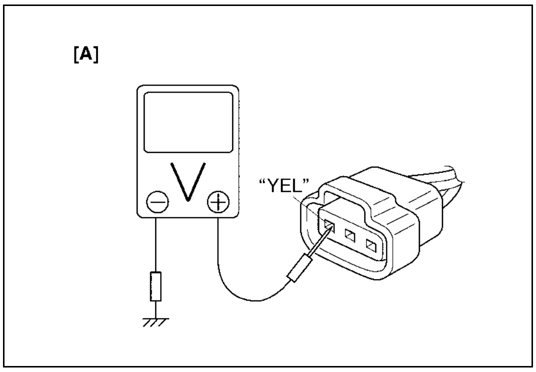
WARNING:
- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester.**

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Warm up engine to normal operating temperature.
4) Increase vehicle speed to 50 mph, 80 km/h.
5) Release accelerator pedal and with engine brake applied, keep vehicle coasting for 6 sec. or more (fuel cut condition for 5 sec. or more) and stop vehicle.
6) Check pending DTC and DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check”.
2	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 3.
3	Check power supply circuit. 1) With OFF ignition switch turned, disconnect connector from VSS. 2) Check proper connection for “BLK/RED”, “BLK/ORN” and “YEL” wire terminal. 3) If wires are OK, turn ON ignition switch, measure voltage between engine ground and “BLK/RED” wire terminal. Is it voltage 10 – 14 V?	Go to Step 4.	“BLK/WHT” wire open circuit.
4	Check ground circuit. 1) Measure resistance between engine body ground and “BLK/ORN” wire terminal with ignition switch turn OFF. Is resistance below 5 Ω?	Go to Step 5.	“BLK/ORN” wire open or high resistance circuit.
5	Check wire circuit. 1) Turn ON ignition switch, measure voltage between engine ground and “YEL” wire terminal at VSS connector. See Fig. 1. Is it voltage 4 – 5 V?	Go to Step 9.	Go to Step 6.
6	Check ECM voltage. 1) Turn ON ignition switch, measure voltage between vehicle body ground and “C63-19” terminal at ECM connector. Is it voltage 4 – 5 V?	“YEL” wire open circuit.	Go to Step 7.
7	Check short circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Turn ON ignition switch, measure voltage between engine ground and “C63-19” terminal. Is it voltage 0 V?	Go to Step 8.	“YEL” wire shorted to power supply circuit.
8	Check short circuit. 1) Measure resistance between engine ground and “C63-19” terminal with ignition switch turned OFF. Is resistance infinity?	Go to Step 9.	“YEL” wire shorted to ground circuit. If wire are OK, substitute a known-good ECM and recheck.

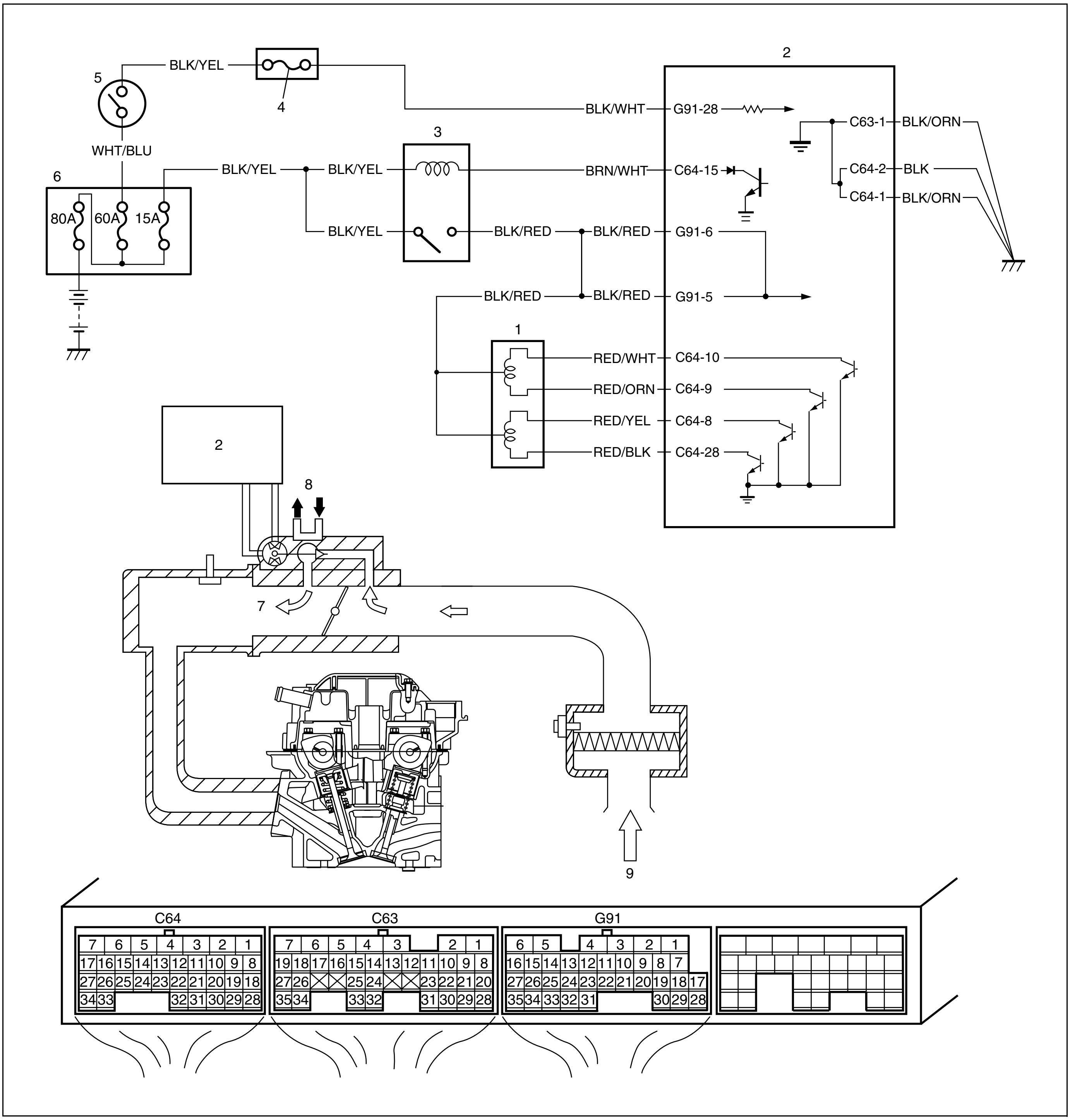
Step	Action	Yes	No
9	Check signal rotor. 1) Remove VSS referring to “Vehicle Speed Sensor (VSS) Removal and Installation” in Section 7A. 2) Visually inspect VSS sensor signal rotor for damage. Was any damage found?	Faulty VSS signal rotor.	Substitute a known-good VSS and recheck.



[A]: Fig. 1 for Step 5

DTC P0505 Idle Air Control System

SYSTEM/WIRING DIAGRAM



1. IAC valve	4. "IG" fuse	7. Bypass air
2. ECM	5. Ignition switch	8. Engine coolant
3. Main relay	6. Relay/fuse box	9. Intake air

DTC DETECTING CONDITION AND TROUBLE AREA (DTC P0505)

DTC DETECTING CONDITION	TROUBLE AREA
• IAC valve signal voltage is out of specification for about 2 sec. or more. • Engine revolution keeps excessively high for engine idling (1 driving cycle detection logic)	• Idle air control valve or its circuit • ECM • Intake air leakage

DTC CONFIRMATION PROCEDURE

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.
Electric load (lighting, heater blower, rear defogger, etc.) and A/C are turned OFF.

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm up to normal operating temperature (80°C – 110°C, 176°F – 230°F).
4) Run engine at idle speed (600 – 1000 r/min.) for 1 min. or more.
5) Check DTC and pending DTC.

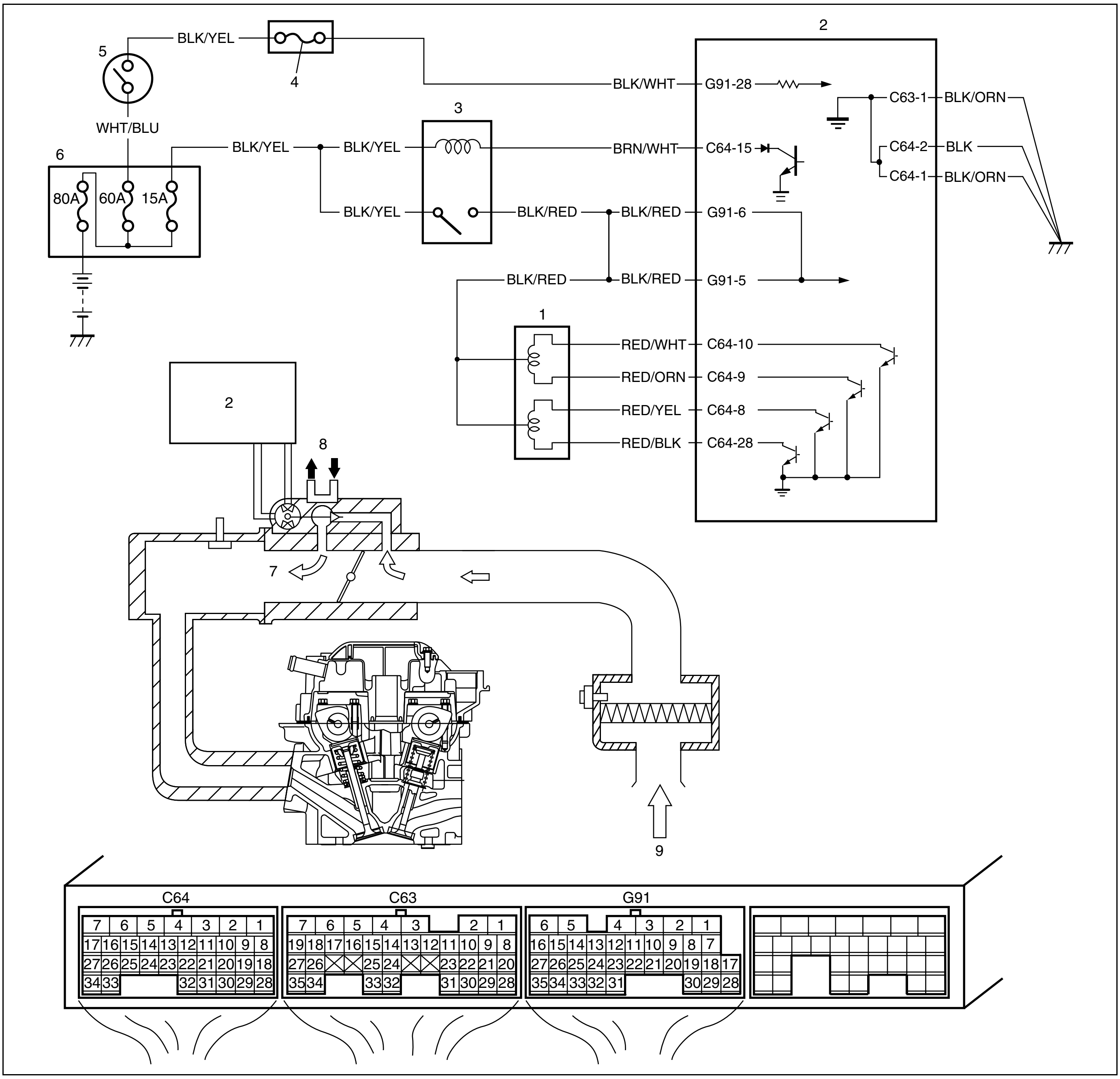
TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Idle Speed Check 1) Check idle speed/idle air control duty referring to “Idle speed/idle air control (IAC) duty inspection” in Section 6E1. Is check result as specified?	Go to Step 3.	Go to Step 4.
3	Idle Air Control Valve Operation Check 1) Check idle air control valve for operation referring to “Idle air control (IAC) valve operation check” in this section. Is check result satisfactory?	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A. If OK, substitute a known-good ECM and recheck.	Go to Step 4.
4	Idle Air Control Valve Circuit Check 1) Disconnect connector from idle air control valve with ignition switch turned OFF. 2) Turn ON ignition switch, measure voltage between “BLK/RED” wire terminals of idle air control valve connector and engine ground. Is voltage 10 – 14 V?	Go to Step 5.	“BLK/RED” wire in open or high resistance circuit.
5	Idle Air Control Valve Check 1) Check idle air control valve for resistance referring to “Idle air control (IAC) valve check” in this section. Is check result satisfactory?	Go to Step 6.	Replace idle air control valve.

Step	Action	Yes	No
6	Idle Air Control Valve Circuit Check 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between "RED/WHT" wire terminal of idle air control valve connector and "C64-10" wire terminal of ECM connector, "RED/ORN" wire terminal of idle air control valve connector and "C64-9" wire terminal of ECM connector, "RED/YEL" wire terminal of idle air control valve connector and "C64-8" wire terminal of ECM connector, "RED/BLK" wire terminal of idle air control valve connector and "C64-28" wire terminal of ECM connector. Are resistance 1 Ω or less?	Go to Step 7.	"RED/WHT", "RED/ORN", "RED/YEL" or "RED/BLK" wire in open or high resistance circuit.
7	Idle Air Control Valve Circuit Check 1) Measure resistance between each "C64-10", "C64-9", "C64-8" and "C64-28" wire terminals of ECM connector and vehicle body ground. Is each resistance infinite?	Go to Step 8.	"RED/WHT", "RED/ORN", "RED/YEL" or "RED/BLK" wire in shorted to ground circuit.
8	Idle Air Control Valve Circuit Check 1) Connect connectors to ECM. 2) Turn ON ignition switch, measure voltage between each "C64-10", "C64-9", "C64-8" and "C64-28" wire terminals of ECM connector and vehicle body ground. Is each voltage 0 V?	Go to Step 9.	"RED/WHT", "RED/ORN", "RED/YEL" or "RED/BLK" wire in shorted to power circuit.
9	ECM Voltage Check 1) Connect connector to idle air control valve with ignition switch turned OFF. 2) Turn ON ignition switch, measure voltage between each "C64-10", "C64-9", "C64-8" and "C64-28" wire terminals of ECM connector and vehicle body ground. • "C64-8" and "C64-10" wire terminals: 0 – 1 V • "C64-9" and "C64-28" wire terminals: 10 – 14 V Are check results satisfactory?	Go to Step 10.	Substitute a known-good ECM and recheck.
10	Make sure if the following conditions are satisfied. • The throttle valve is fully closed. • The air cleaner element is installed properly. Is it in good condition?	Replace idle air control valve.	Repair or replace.

DTC P0506 Idle Air Control System RPM Lower than Expected
DTC P0507 Idle Air Control System RRM Higher than Expected

SYSTEM/WIRING DIAGRAM



1. IAC valve	3. Main relay	5. Ignition switch	7. Bypass air	9. Intake air
2. ECM	4. "IG" fuse	6. Relay/fuse box	8. Engine coolant	

DTC DETECTING CONDITION AND TROUBLE AREA (DTC P0506/P0507)

DTC DETECTING CONDITION	TROUBLE AREA
DTC P0506: Engine idle speed is 100 r/min. or more lower than target idle speed for 20 sec. continuously when vehicle stops and closed throttle position (ON). DTC P0507: Engine idle speed is 200 r/min. or more higher than target idle speed for 20 sec. continuously when vehicle stops and closed throttle position (ON). (2 driving cycle detection logic)	• Idle air control valve or its circuit • Air intake system (clog or leakage) • Engine mechanical • Accessory engine load • ECM • Vehicle speed sensor

DTC CONFIRMATION PROCEDURE

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.

- **Intake air temperature: –7°C (19.4°F) or higher**
- **Engine coolant temperature: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**
- **Transmission gear shift lever is shifted in “Neutral” for M/T**
- **Electric load (lighting, heater blower, rear defogger, etc.) and A/C are turned OFF.**

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and warm up to normal operating temperature (80°C – 110°C, 176°F – 230°F).
4) Run engine at idle speed (600 – 1000 r/min.) for 1 min. or more.
5) Check DTC and pending DTC.

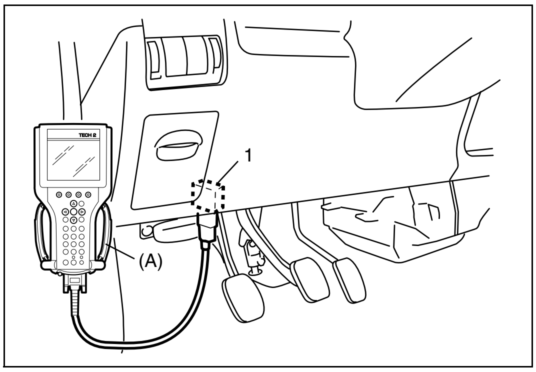
TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	DTC Check Is DTC P0505 displayed?	Go to “DTC P0505 Idle Air Control System” in this section.	Go to Step 3.
3	Idle Speed Check 1) Check idle speed/idle air control duty referring to “Idle speed/idle air control (IAC) duty inspection” in Section 6E1. Is check result as specified?	Go to Step 4.	Go to Step 5.
4	Vehicle Speed Sensor Signal Check Is vehicle speed displayed on scan tool when driving vehicle?	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A. If OK, substitute a known-good ECM and recheck.	Go to “DTC P0500 Vehicle Speed Sensor (VSS) Malfunction” in this section.

Step	Action	Yes	No
5	Air Intake System Check 1) Check air intake system for clog and inhaling. Is check result satisfactory?	Go to Step 6.	Repair or replace.
6	Idle Air Control Valve Operation Check 1) Check idle air control valve for operation referring to “Idle air control (IAC) valve operation check” in this section. Is check result satisfactory?	Go to Step 9.	Go to Step 7.
7	Idle Air Control Valve Circuit Check 1) Disconnect connector from idle air control valve with ignition switch turned OFF. 2) Turn ON ignition switch, measure voltage between “BLK/RED” wire terminals of idle air control valve connector and engine ground. Is voltage 10 – 14 V?	Go to Step 8.	“BLK/RED” wire in open or high resistance circuit.
8	Idle Air Control Valve Check 1) Check idle air control valve for resistance referring to “Idle air control (IAC) valve check” in this section. Is check result satisfactory?	Go to Step 9.	Replace idle air control valve.
9	Idle Air Control System Check 1) Check parts or system which can cause engine low or high idle. • EGR valve malfunction (leakage) • EVAP system malfunction • Accessory engine load • Engine mechanical (engine compression) • Throttle body malfunction • PCV system malfunction • Accelerator cable (get stuck on) • Brake booster malfunction Are they in good condition?	Substitute a known-good ECM and recheck.	Repair or replace.

Idle air control (IAC) valve operation check

USING SUZUKI SCAN TOOL



1) Connect Suzuki Scan Tool to DLC (1) with ignition switch OFF.

Special tool
(A): Suzuki Scan Tool

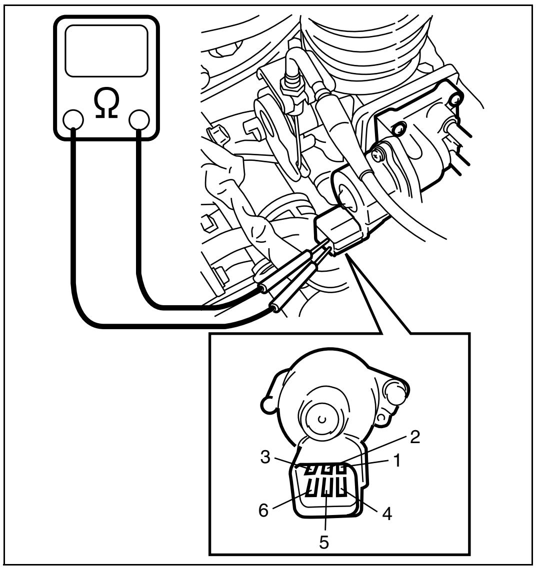
2) Warm up engine to normal operating temperature.
3) Clear DTC and select "MISC TEST" mode on Suzuki Scan Tool.
4) Check that idle speed increases and/or reduces when IAC valve is opened and/or when closed by Suzuki Scan Tool.
   If idle speed does not change, check IAC valve and wire harness.

NOT USING SUZUKI SCAN TOOL

1) Warm up engine to normal operating temperature.
2) Stop engine.
3) Turn ignition switch to ON position.
4) Disconnect IAC valve connector.
5) Start engine.
6) Connect IAC valve connector.
7) Check that idle speed increases and/or reduces when connector is connected to IAC valve.
   If idle speed does not change, check IAC valve and wire harness.

Idle air control (IAC) valve check

1) Disconnect negative cable at battery.
2) Disconnect connector from IAC valve.
3) Check for proper connection to IAC valve at each terminal.

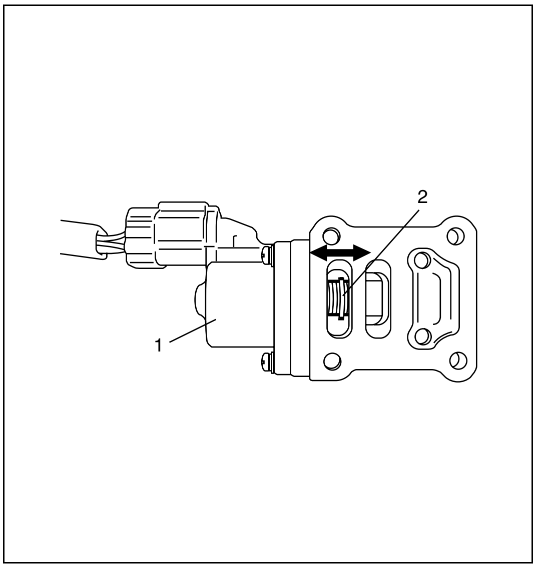


4) Check each coil of IAC valve for resistance.
   If resistance is out of specification, replace IAC valve.

IAC valve resistance specification

Terminals	Resistance
Between "1" and "2"	25.5 – 33.5 Ω (at 20°C, 68°F)
Between "3" and "2"	
Between "4" and "5"	
Between "6" and "5"	

5) Connect connector to IAC valve.
6) Remove IAC valve form throttle body referring to "Idle air control (IAC) valve removal and installation" in Section 6E1.



7) Check that valve (2) of IAC valve (1) opens and closes once and then stops in about 60 ms as soon as ignition switch is turned ON.

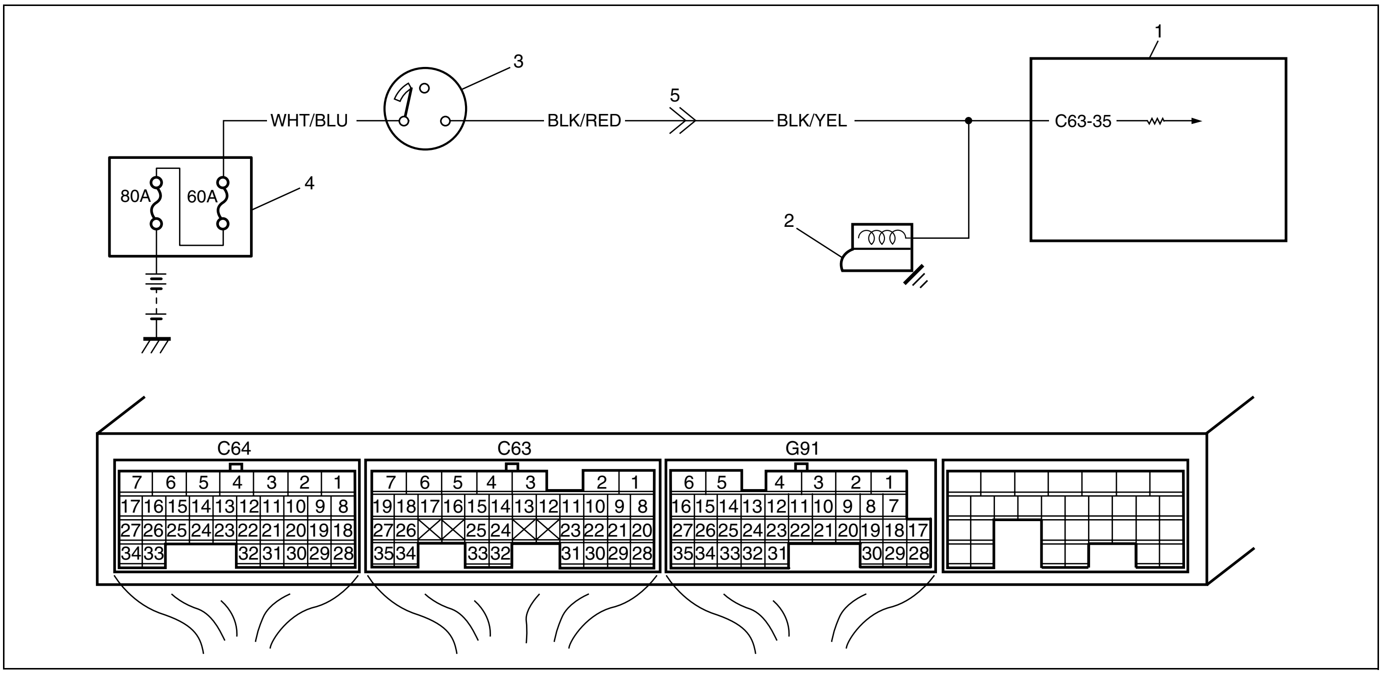
NOTE:

- **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 over-looked. To prevent this operation check 3 times or more continuously.**
  If 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.

8) Install IAC valve to throttle body referring to “Idle air control (IAC) valve removal and installation” in Section 6E1.
9) Connect negative cable at battery.

DTC P0616 Starter Relay Circuit Low

WIRING DIAGRAM



1. ECM	3. Ignition switch	5. Instrument panel harness/engine harness connector
2. Starter motor	4. Relay/fuse box	

DTC DETECTING CONDITION	TROUBLE AREA
Engine starts even though vehicle is at stop and engine starter signal is low voltage. (2 driving cycle detection logic)	• Engine starter signal circuit • ECM

DTC CONFIRMATION PROCEDURE

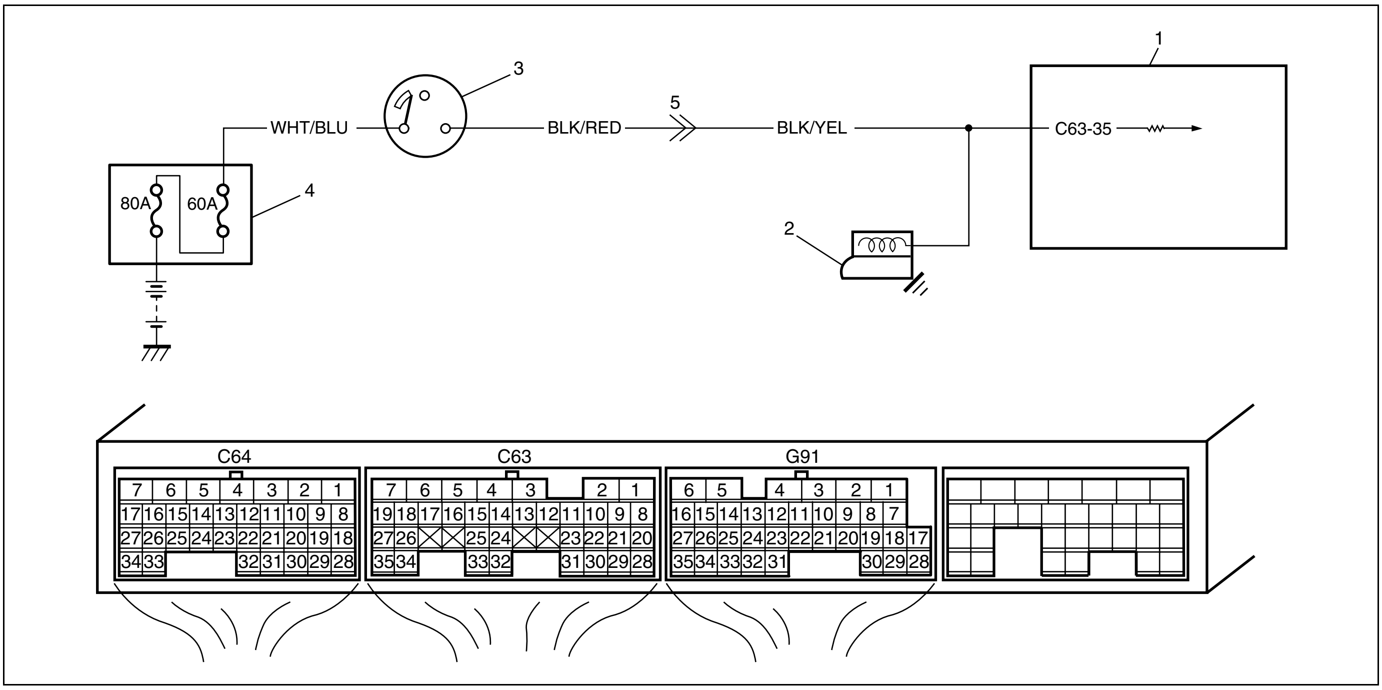
1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine.
4) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check”.
2	Signal circuit check 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and then connect connectors to ECM. 3) Check for voltage at terminal “C63-35”, under the following condition. While engine cranking: 6 – 14 V After starting engine: 0 – 1 V Is voltage as specified?	Poor “C63-35” 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.	“BLK/YEL” wire or “BLK/RED” wire circuit open.

DTC P0617 Starter Relay Circuit High

WIRING DIAGRAM



1. ECM	4. Relay/fuse box
2. Starter motor	5. Instrument panel harness/engine harness connector
3. Ignition switch	

DTC DETECTING CONDITION	TROUBLE AREA
Engine starter signal is high voltage for 180 seconds continuously while engine is running. (2 driving cycle detection logic)	• Engine starter signal circuit • ECM

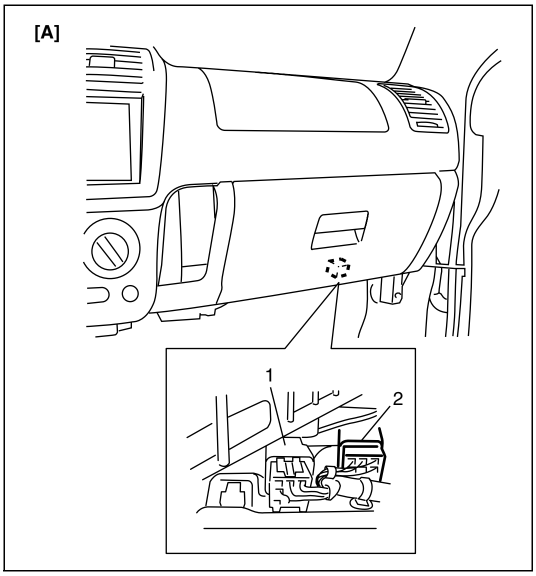
DTC CONFIRMATION PROCEDURE

1) With ignition switch turned OFF, connect scan tool.
2) Turn ON ignition switch and clear DTC using scan tool.
3) Start engine and run it at idle for 3 min. or more.
4) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in this section.
2	Starter Signal Check 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and then connect connectors to ECM. 3) Start engine, check voltage between “C63-35” wire terminal of ECM connector and vehicle body ground. Is voltage 0 – 1 V?	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A. If OK, substitute a known-good ECM and recheck.	Go to Step 3.

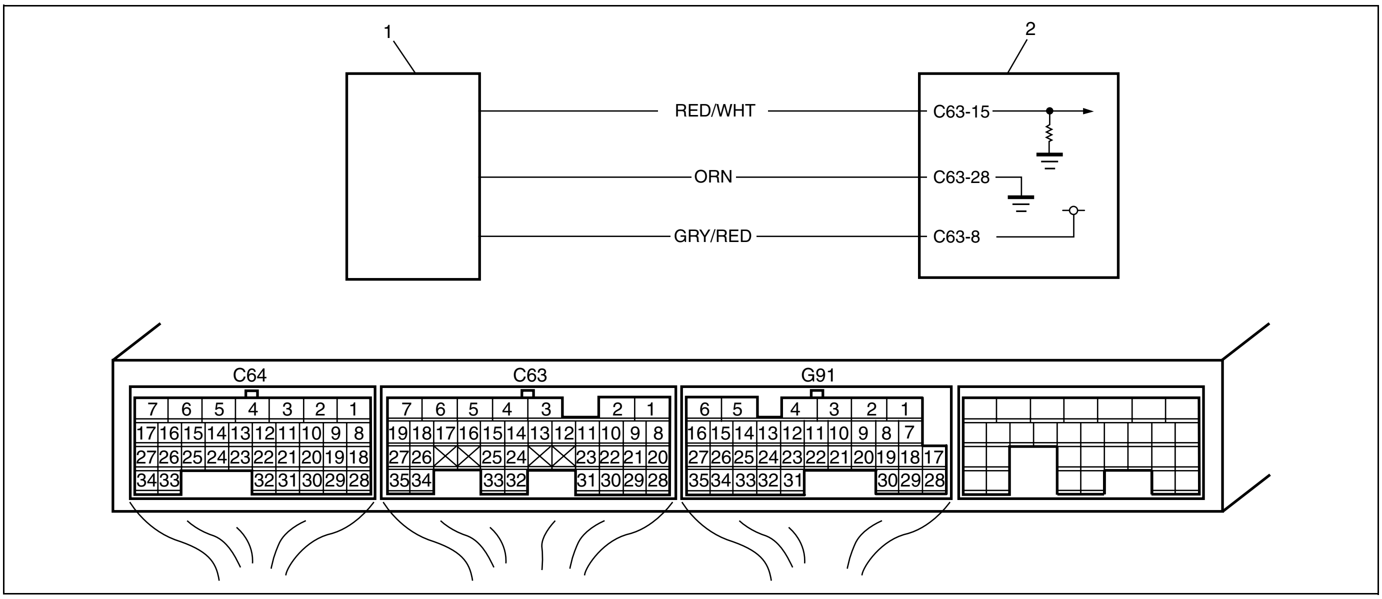
Step	Action	Yes	No
3	Starter Signal Circuit Check 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Turn ON ignition switch, check voltage between “C63-35” wire terminal of ECM connector and vehicle body ground. Is voltage 0 – 1 V?	Substitute a known-good ECM and recheck.	Go to Step 4.
4	Starter Signal Circuit Check 1) Disconnect instrument panel harness/ engine harness connector. (See Fig. 1) 2) Turn ON ignition switch, measure voltage between “BLK/RED” wire terminal of instrument panel harness/engine harness connector and vehicle body ground. Is voltage 0 – 1 V?	“BLK/YEL” wire shorted to power circuit.	Go to Step 5.
5	Ignition Switch Inspection 1) Check ignition switch referring to “Ignition (Main) Switch ON-Vehicle Inspection” in Section 8C. Is it in good condition?	“BLK/RED” wire shorted to power circuit.	Replace ignition switch.



[A]:	Fig. 1 for Step 4
1.	Front wiper intermittent timer
2.	Instrument panel harness/engine harness connector

DTC P0107 Manifold Absolute Pressure Low Input

WIRING DIAGRAM



1. Manifold absolute pressure sensor	2. ECM

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
• Manifold absolute pressure sensor output voltage is lower than 0.2 V for 5 sec. continuously. (2 driving cycle detection logic)	• Manifold absolute pressure sensor circuit • Manifold absolute pressure sensor • Manifold absolute pressure sensor vacuum 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.**

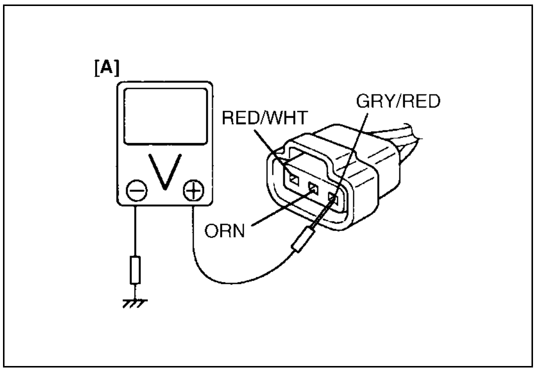
NOTE:
Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.
- **Intake air temperature: –7°C (19.4°F) or higher**
- **Engine coolant temperature: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

1) Connect scan tool to DLC with ignition switch OFF.
2) Turn ON ignition switch and clear DTC using scan tool and warm up engine completely.
3) Drive the vehicle with the speed of 40 km/h (25 mile/h) in the 5th gear or D range, and then accelerate the vehicle for more than 5 seconds by stepping only half of the accelerator pedal.
4) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check".
2	Check MAP sensor and its circuit. 1) Connect scan tool to DLC with ignition switch turned OFF. 2) Turn ignition switch ON. 3) Check intake manifold pressure. Is it 146 kPa (43.1 in.Hg) or 0 kPa (0 in.Hg)?	Go to Step 3.	Intermittent trouble. Check for intermittent referring to "Intermittent and Poor Connection" in Section 0A. If OK, go to Step 9.
3	Check MAP sensor power supply voltage. 1) Disconnect connector from MAP sensor with ignition switch tuned OFF. 2) Check for proper connection of MAP sensor at "GRY/RED", "ORN" and "RED/WHT". 3) Turn ON ignition switch, measure voltage between engine ground and "GRY/RED" wire terminal. See Fig. 1. Is voltage 4 – 5 V?	Go to Step 6.	Go to Step 4.
4	Check MAP sensor power supply voltage. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and then connect connectors to ECM. 3) Turn ON ignition switch, measure voltage between vehicle body ground and "C63-8" terminal. Is voltage 4 – 5 V?	"GRY/RED" wire in open circuit.	Go to Step 5.
5	Check MAP sensor power supply circuit. 1) Disconnect connectors from TP sensor with ignition switch turned OFF. 2) Turn ON ignition switch, measure voltage between vehicle body ground and "C63-8" terminal. Is voltage 4 – 5 V?	Faulty TP sensor.	"GRY/RED" wire shorted to ground or other circuit. If wires are OK, substitute a known-good ECM and recheck.
6	Check MAP sensor ground circuit. 1) Measure resistance between "ORN" wire terminal in MAP sensor harness connector and engine ground. Is resistance below 5Ω?	Go to Step 8.	Go to Step 7.
7	Check ground circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and connect connectors to ECM. 3) Measure resistance between "C63-28" terminal and vehicle body ground. Is resistance below 5Ω?	"ORN" wire in open or high resistance circuit.	ECM grounds "C63-28" and/or "C64-2" circuit in open or high resistance. If wires are OK, substitute a known-good ECM and recheck.

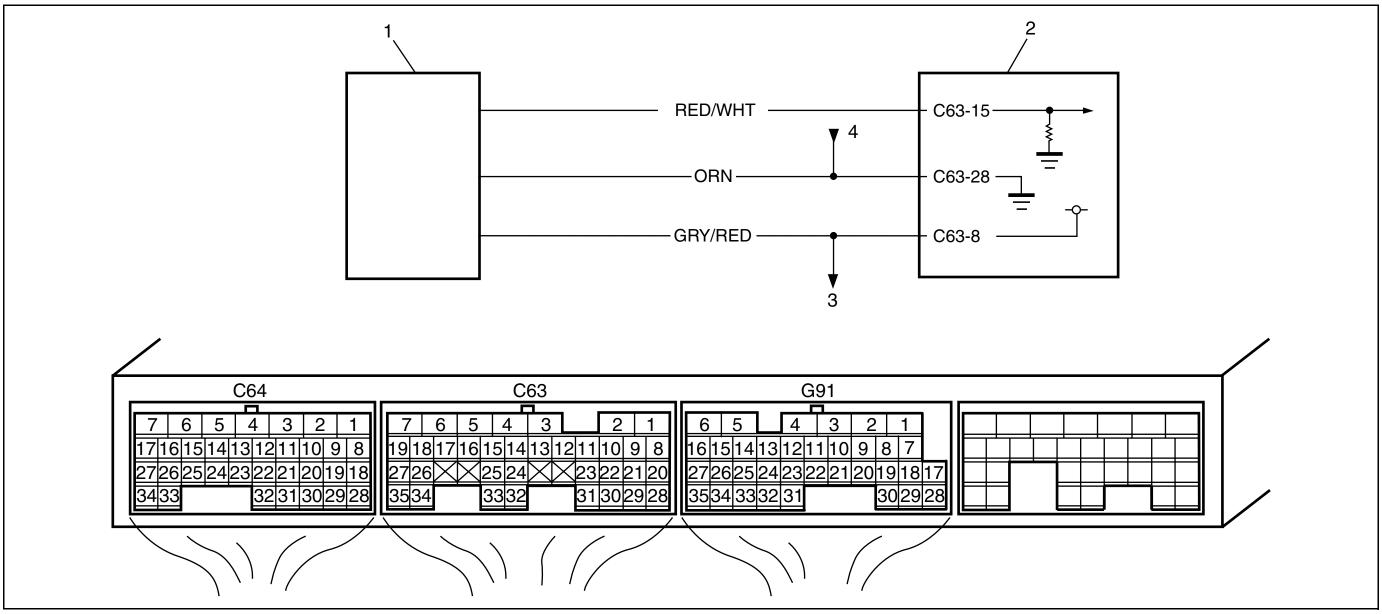
Step	Action	Yes	No
8	Check MAP sensor signal circuit. 1) Turn ON ignition switch. 2) Measure voltage between “RED/WHT” wire terminal in MAP sensor harness connector and engine ground. Is voltage 0 V?	Go to Step 9.	“RED/WHT” wire shorted to other circuit.
9	Check MAP sensor signal circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Measure resistance between “C63-15” terminal and vehicle body ground. Is resistance infinity?	Go to Step 10.	“RED/WHT” wire shorted to ground circuit.
10	Check MAP sensor signal circuit. 1) Measure resistance between “RED/WHT” wire terminal in MAP sensor harness connector and “C63-15” terminal in ECM connector. Is resistance below 5 Ω?	Go to Step 11.	“RED/WHT” wire in open or high resistance circuit.
11	Check MAP sensor output signal. 1) Check MAP sensor according to “MAP Sensor Individual Check” in this section. Is it in good condition?	Substitute a known-good ECM and recheck.	Faulty MAP sensor.



[A]: Fig. 1 for Step 3

DTC P0108 Manifold Absolute Pressure High Input

WIRING DIAGRAM



1. Manifold absolute pressure sensor	3. To TP sensor
2. ECM	4. From other sensors

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
• Manifold absolute pressure sensor output voltage is 4.6 V or higher for 24 sec. continuously. (2 driving cycle detection logic)	• Manifold absolute pressure sensor circuit • Manifold absolute pressure sensor • Manifold absolute pressure sensor vacuum 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.**

NOTE:

Check to make sure that the following conditions are satisfied when using this DTC CONFIRMATION PROCEDURE.

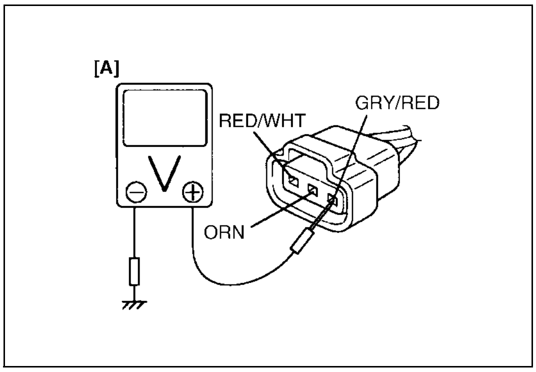
- **Intake air temperature: –7°C (19.4°F) or higher**
- **Engine coolant temperature: –7°C (19.4°F) or higher**
- **Altitude (barometric pressure): 2400 m, 8000 ft or less (560 mmHg, 75 kPa or more)**

1) Connect scan tool to DLC with ignition switch turned OFF.
2) Turn ON ignition switch and clear DTC using scan tool and warm up engine completely.
3) Run engine at idle speed for 1 min.
4) Check DTC and pending DTC.

TROUBLESHOOTING

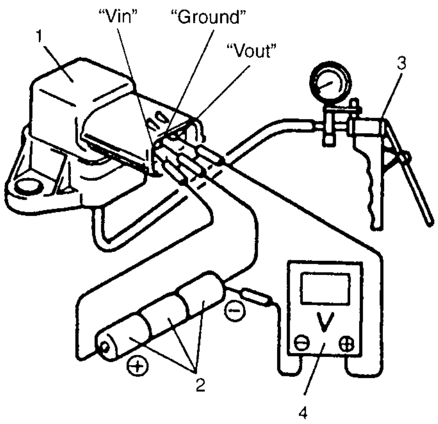
Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” performed?	Go to Step 2.	Go to “Engine and Emission Control System Check”.
2	Check MAP sensor and its circuit. 1) Connect scan tool to DLC with ignition switch OFF. 2) Turn ignition switch ON. 3) Check intake manifold pressure. Is it 146 kPa (43.1 in.Hg) or 0 kPa (0 in.Hg)?	Go to Step 3.	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A. If OK, go to Step 8.
3	Check MAP sensor power supply voltage. 1) Disconnect connector from MAP sensor with ignition switch tuned OFF. 2) Check for proper connection of MAP sensor at “GRY/RED”, “ORN” and “RED/WHT”. 3) Turn ON ignition switch, measure voltage between engine ground and “GRY/RED” wire terminal. See Fig. 1. Is voltage 4 – 5 V?	Go to Step 5.	Go to Step 4.
4	Check MAP sensor power supply voltage. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and then connect connectors to ECM. 3) Turn ON ignition switch, measure voltage between vehicle body ground and “C63-8” terminal. Is voltage 4 – 5 V?	“GRY/RED” wire in open circuit.	“GRY/RED” wire shorted to other circuit. If wires are OK, substitute a known-good ECM and recheck.
5	Check MAP sensor ground circuit. 1) Measure resistance between “ORN” wire terminal in MAP sensor harness connector and engine ground. Is resistance below 5 Ω?	Go to Step 7.	Go to Step 6.
6	Check ground circuit. 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and connect connectors to ECM. 3) Measure resistance between “C63-28” terminal and vehicle body ground. Is resistance below 5 Ω?	“ORN” wire in open or high resistance circuit.	ECM grounds “C63-28” and/or “C64-2” circuit in open or high resistance. If wires are OK, substitute a known-good ECM and recheck.
7	Check MAP sensor signal circuit. 1) Disconnect connectors from ECM with ignition switch turn OFF. 2) Turn ON ignition switch. 3) Measure voltage between “RED/WHT” wire terminal in MAP sensor harness connector and engine ground. Is voltage 0 V?	Go to Step 8.	“RED/WHT” wire shorted to power supply or other circuit.

Step	Action	Yes	No
8	Check MAP sensor output signal. 1) Check MAP sensor according to "MAP Sensor Individual Check" in this section. Is it in good condition?	Substitute a known-good ECM and recheck.	Faulty MAP sensor.



[A]: Fig. 1 for Step 3

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).

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

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

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

4. Digital type voltmeter

DTC P0601 Internal Control Module Memory Check Sum Error
DTC P0602 Control Module Programming Error

SYSTEM DESCRIPTION

Internal control module is installed in ECM.

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
Data write error or check sum error	ECM

DTC CONFIRMATION PROCEDURE

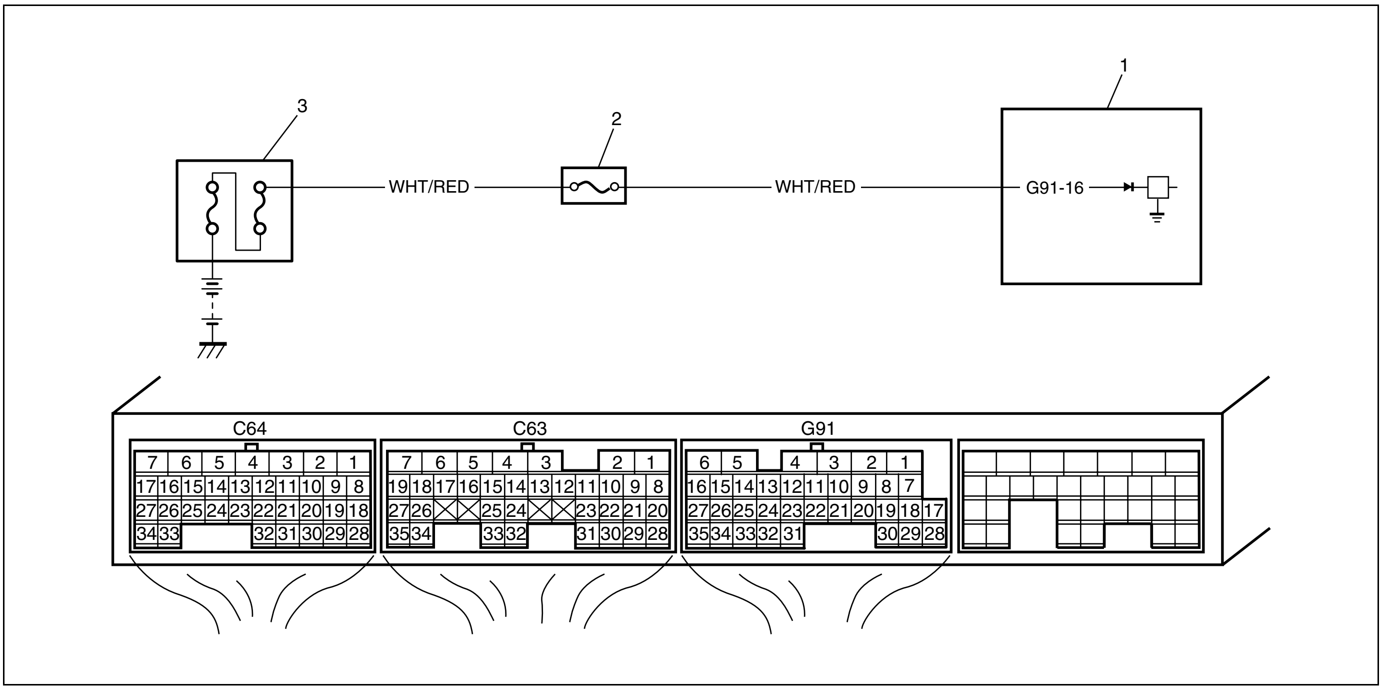
1) Connect scan tool to DLC with ignition switch OFF.
2) Turn ON ignition switch and clear DTC, pending DTC and freeze frame data by using scan tool.
3) Start engine and run it at idle if possible.
4) Check DTC and pending DTC by using scan tool.

TROUBLESHOOTING

Substitute a known-good ECM and recheck.

DTC P1510 ECM Back-up Power Supply Malfunction

WIRING DIAGRAM



1.	ECM
2.	“RADIO DOME” fuse
3.	Relay/fuse box

CIRCUIT DESCRIPTION

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 AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
Back-up circuit voltage is less than 5 V for 5 seconds continuously while engine running.	Battery voltage supply circuit

DTC CONFIRMATION PROCEDURE

1) Connect scan tool to DLC with ignition switch turned OFF.
2) Turn ON ignition switch and clear DTC using scan tool and run engine at idle speed for 1 min.
3) Check DTC and pending DTC.

TROUBLESHOOTING

Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check".
2	Battery voltage supply circuit check 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Remove ECM from vehicle body and then connect connectors to ECM. 3) While engine running, check voltage between "G91-16" and ground. Is voltage 10 – 14 V?	Poor "G91-16" 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.	"RADIO DOME" fuse blown "WHT/RED" circuit open or short.

DTC P2227 Barometric Pressure Circuit Range/Performance
DTC P2228 Barometric Pressure Circuit Low
DTC P2229 Barometric Pressure Circuit High

SYSTEM DESCRIPTION

Barometric pressure sensor is installed in ECM (PCM).

DTC DETECTING CONDITION AND TROUBLE AREA

DTC DETECTING CONDITION	TROUBLE AREA
DTC P2227: While running under conditions described for "DTC Confirmation Procedure", barometric pressure value compared with intake manifold vacuum value in fuel cut state is not as specified. (2 driving cycle detection logic)	• Manifold absolute pressure sensor performance problem • Barometric pressure sensor in ECM
DTC P2228: Barometric pressure signal less than 1.5 V is detected.	• Barometric pressure sensor in ECM
DTC P2229: Barometric pressure signal more than 4.5 V is detected.	

DTC CONFIRMATION PROCEDURE

DTC P2228/P2229

1) Connect scan tool to DLC with ignition switch OFF.
2) Turn ON ignition switch and clear DTC by using scan tool and run engine for 1 min.
3) Check DTC and pending DTC by using scan tool.

DTC P2227

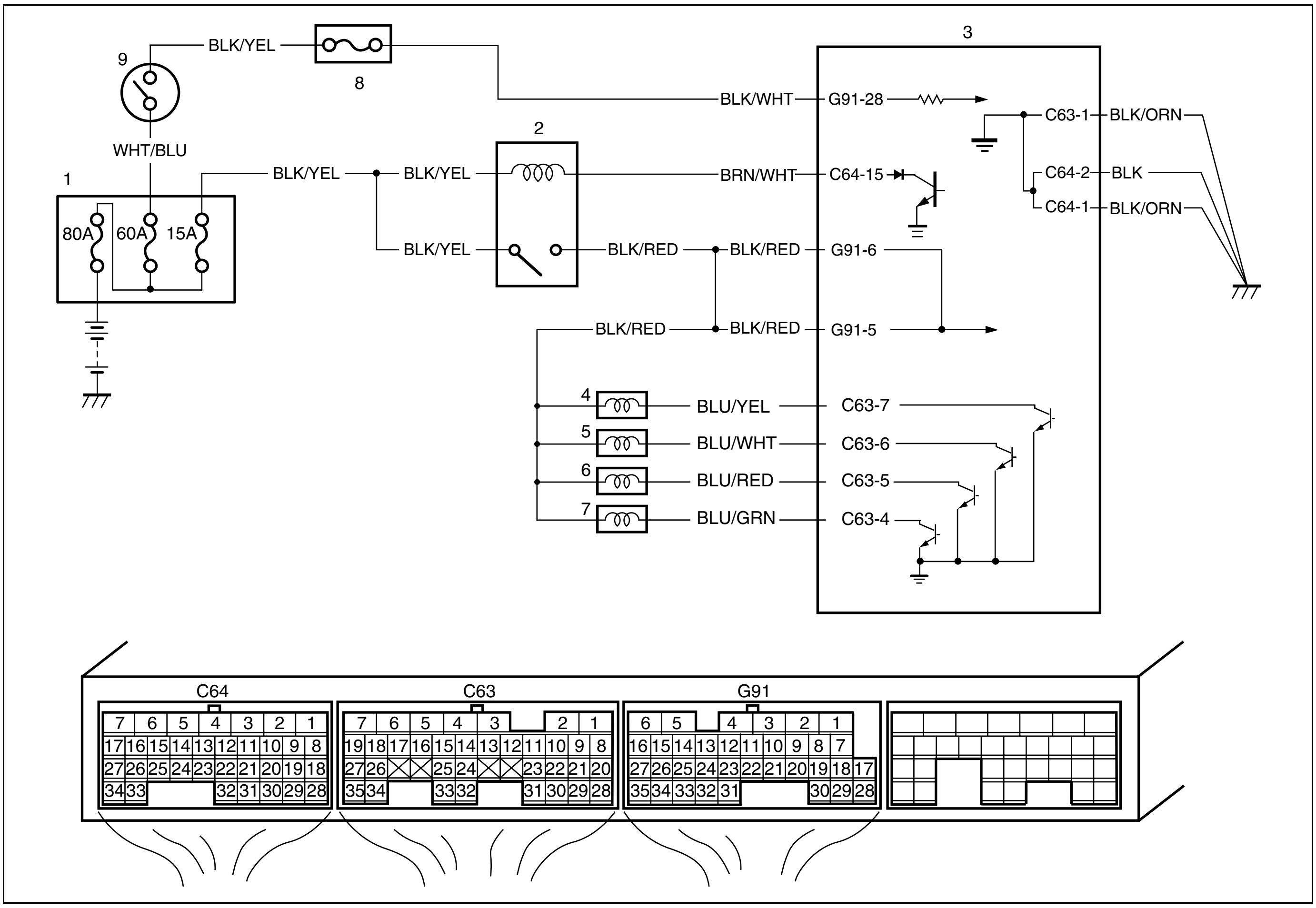
WARNING:
- **When performing a road test, select a place where there is no traffic or possibility of a traffic accident and be very careful during testing to avoid occurrence of an accident.**
- **Road test should be carried out with 2 persons, a driver and a tester, on a level road.**

1) Connect scan tool to DLC with ignition switch OFF.
2) Turn ON ignition switch and clear DTC, pending DTC and freeze frame data by using scan tool and warm up engine to normal operating temperature.
3) Increase engine speed to 3000 rpm in 3rd gear in case of M/T.
4) Release accelerator pedal and with engine brake applied, keep vehicle coasting for 5 sec. or more. (Keep fuel cut condition for 5 sec. or more) If fuel cut condition is not kept for 5 sec. or more, coast down a slope in engine speed 1000 – 3000 rpm for 5 sec. or more.
5) Stop vehicle and run engine at idle.
6) Repeat Steps 3) – 5) 2 times.
7) Check DTC and pending DTC by using scan tool.

DTC TROUBLESHOOTING

Step	Action	Yes	No
1	Was "Engine and Emission Control System Check" performed?	Go to Step 2.	Go to "Engine and Emission Control System Check".
2	Is DTC P2227 set?	Go to Step 3.	Substitute a known-good ECM and recheck.
3	MAP sensor check 1) Check MAP sensor and its circuit referring to "DTC P0107 Manifold Absolute Pressure Low Input" and "DTC P0108 Manifold Absolute Pressure High Input". Is check result satisfactory?	Substitute a known-good ECM and recheck.	MAP sensor or its circuit malfunction.

Table B-1 Fuel Injector Circuit Check

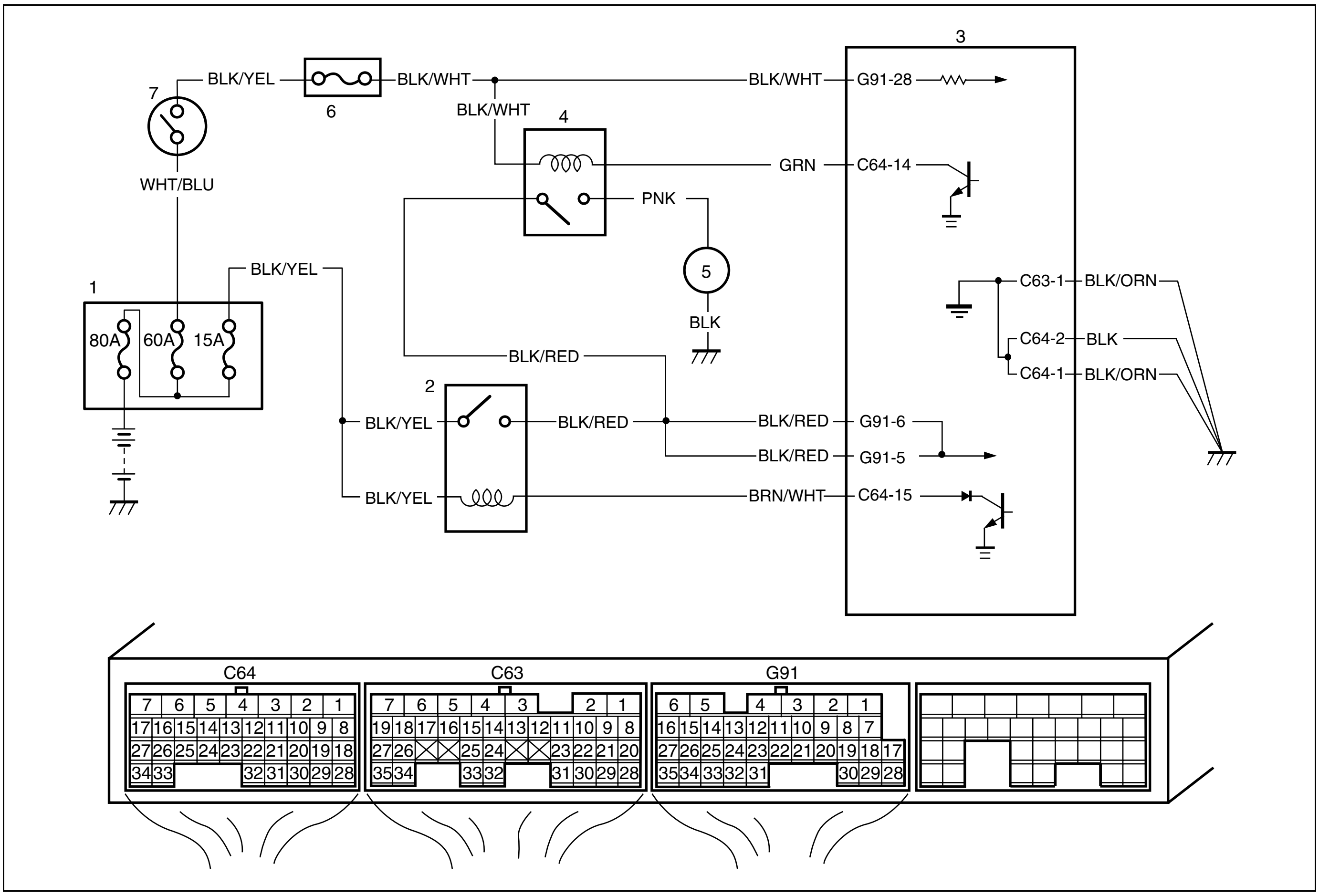


1. Relay/fuse box	4. No.1 injector	7. No.4 injector
2. Main relay	5. No.2 injector	8. "IG" fuse
3. ECM	6. No.3 injector	9. Ignition switch

TROUBLESHOOTING

Step	Action	Yes	No
1	Check each injector for operating sound at engine cranking using sound scope. Do all 4 injector make operating sound?	Fuel injector circuit is in good condition.	Go to Step 2.
2	Check fuel injector resistance. 1) Disconnect connectors from fuel injectors with ignition switch turn OFF. 2) Check for proper connection to fuel injector at each terminals. 3) If OK, check all 4 fuel injectors for resistance, referring to “Fuel injector inspection” in Section 6E1. Are all injectors in good condition?	Go to Step 3.	Faulty fuel injector.
3	Check fuel injector insulation resistance. 1) Check that there is insulating between each fuel injector terminals and engine ground. Is there insulating?	Go to Step 4.	Faulty fuel injector.
4	Check fuel injector power supply. 1) Measure voltage between each “BLK/RED” wire terminal and engine ground with ignition switch turned ON. Is voltage 10 – 14 V?	Go to Step 5.	“BLK/RED” wire in open circuit or shorted to ground circuit. If it is in good condition, go to diag flow table A-3.
5	Check wire circuit. 1) Turn OFF ignition switch. 2) Disconnect connectors from ECM. 3) Measure resistance between each “BLU/YEL”, “BLU/WHT”, “BLU/RED”, “BLU/GRN” wire terminal and vehicle body ground. Is resistance infinity?	Go to Step 6.	“BLU/YEL”, “BLU/WHT”, “BLU/RED”, “BLU/GRN” wire shorted to ground.
6	Check wire circuit. 1) Measure voltage between each “BLU/YEL”, “BLU/WHT”, “BLU/RED”, “BLU/GRN” wire terminal and vehicle body ground with ignition switch turned ON. Is voltage 0 V?	Go to Step 7.	“BLU/YEL”, “BLU/WHT”, “BLU/RED”, “BLU/GRN” wire shorted to power supply circuit.
7	Check fuel injector drive signal. 1) Connect connectors to each fuel injectors and ECM with ignition switch turned OFF. 2) Turn ON ignition switch. 3) Measure voltage “C63-7”, “C63-6”, “C63-5”, “C63-4” terminal and vehicle body ground. Is voltage 10 – 14 V?	Check fuel injector, referring to “Fuel injector inspection” in Section 6E1. If result in good condition, substitute a known-good ECM and recheck.	“BLU/YEL”, “BLU/WHT”, “BLU/RED”, “BLU/GRN” open circuit.

Table B-2 Fuel Pump and Its Circuit Check



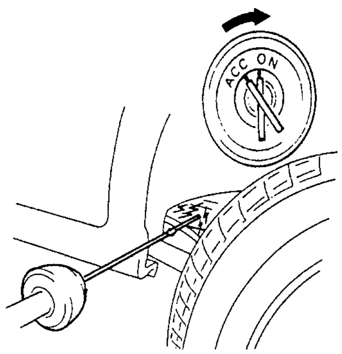
1. Relay/fuse box	4. Fuel pump relay	7. Ignition switch
2. Main relay	5. Fuel pump	
3. ECM	6. "IG" fuse	

TROUBLESHOOTING

Step	Action	Yes	No
1	Check fuel pump control system for operation. See Fig. 1. Is fuel pump heard to operate for 3 sec. after ignition switch ON?	Fuel pump circuit is in good condition.	Go to Step 2.
2	Check fuel pump relay power supply. 1) Disconnect fuel pump relay from relay/fuse box with ignition switch turned OFF. 2) Check for proper connection to fuel pump relay at each terminals. 3) If OK, turn ON ignition switch, measure voltage between "BLK/WHT" wire terminal and engine ground. Is voltage 10 – 14 V?	Go to Step 3.	"BLK/WHT" wire open or shorted to ground circuit.
3	Check fuel pump relay power supply. 1) Turn ON ignition switch, measure voltage between "BLK/RED" wire terminal of fuel pump relay connector and engine ground. Is voltage 10 –14 V?	Go to Step 4.	"BLK/RED" wire open circuit.

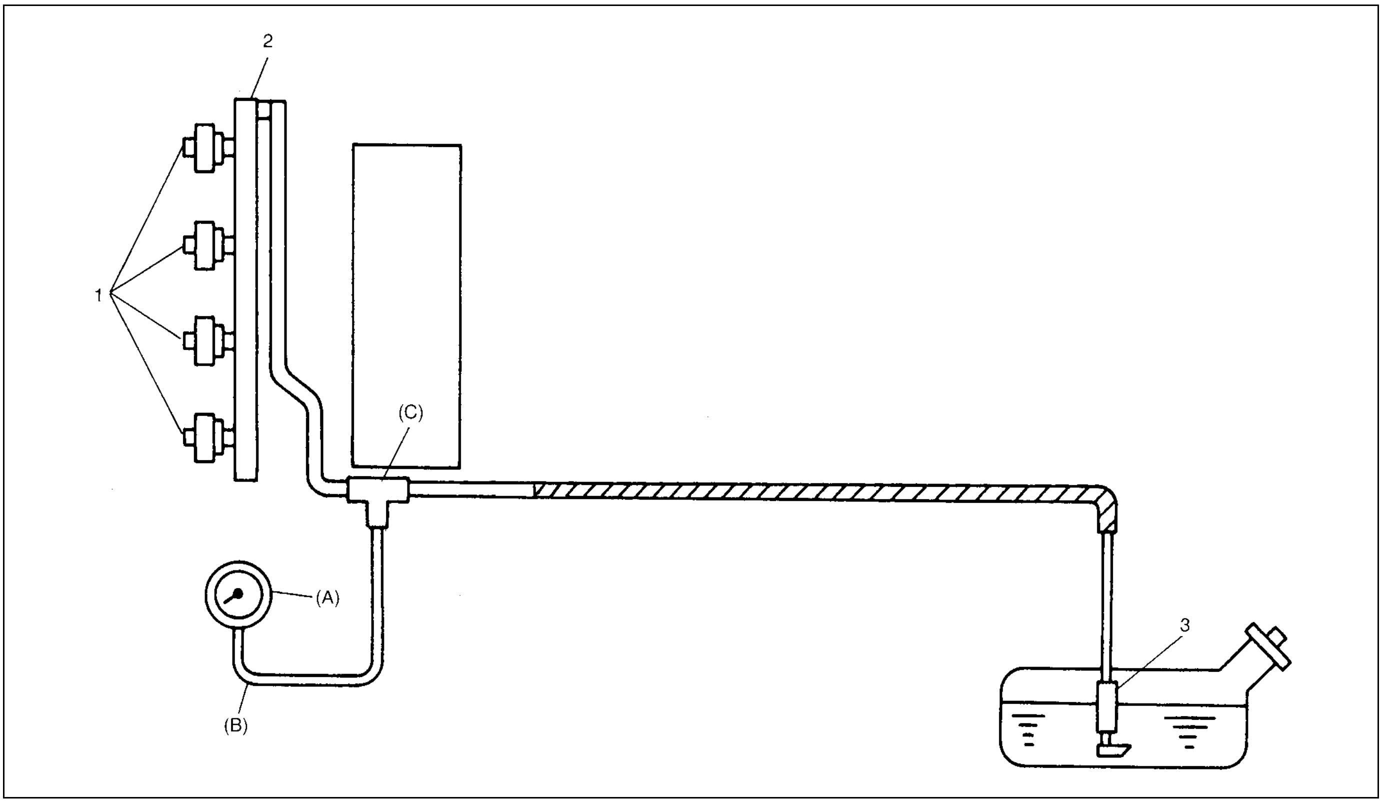
Step	Action	Yes	No
4	Check fuel pump relay. 1) Check fuel pump relay, referring to “Main relay, fuel pump relay and radiator fan relay inspection” in Section 6E1. Is relay in good condition?	Go to Step 5.	Faulty relay.
5	Check fuel pump relay drive signal. 1) Connect fuel pump relay to relay/fuse box. 2) Connect voltmeter between “G64-14” terminal and vehicle body ground. 3) Measure voltage at after 3 second ignition switch turned ON. Is voltage 10 – 14 V?	Go to Step 6.	“BLK/WHT” wire open circuit or shorted to ground circuit.
6	Check fuel pump relay drive signal. 1) Measure voltage at within 3 second after ignition switch turned ON. Is voltage 0 – 1 V?	Go to Step 7.	Substitute a known-good ECM and recheck.
7	Check wire circuit. 1) Turn OFF ignition switch. 2) Detach fuel tank, referring to “Fuel Tank Removal and Installation” in Section 6C. 3) Disconnect connector from fuel pump. 4) Measure resistance between “PNK” wire terminal and vehicle body ground. Is resistance infinity?	Go to Step 8.	“PNK” wire shorted to ground.
8	Check fuel pump circuit. 1) Turn OFF ignition switch. 2) Connect service wire between “G64-14” terminal and vehicle body ground. 3) Turn ON ignition switch, measure voltage between “PNK” terminal at fuel pump connector and vehicle body ground. Is voltage 10 – 14 V?	Go to Step 9.	“PNK” wire open circuit.
9	Check fuel pump circuit. 1) Turn OFF ignition switch. 2) Check that there is continuity between “BLK” terminal at fuel pump connector and vehicle body ground. Is there continuity?	Faulty fuel pump.	“BLK” wire open circuit.

[A]



[A]: Fig. 1 for Step 1

Table B-3 Fuel Pressure Check



1. Injector	3. Fuel filter and fuel pump	B: Hose
2. Delivery pipe	A: Gauge	C: 3-way joint

TROUBLESHOOTING

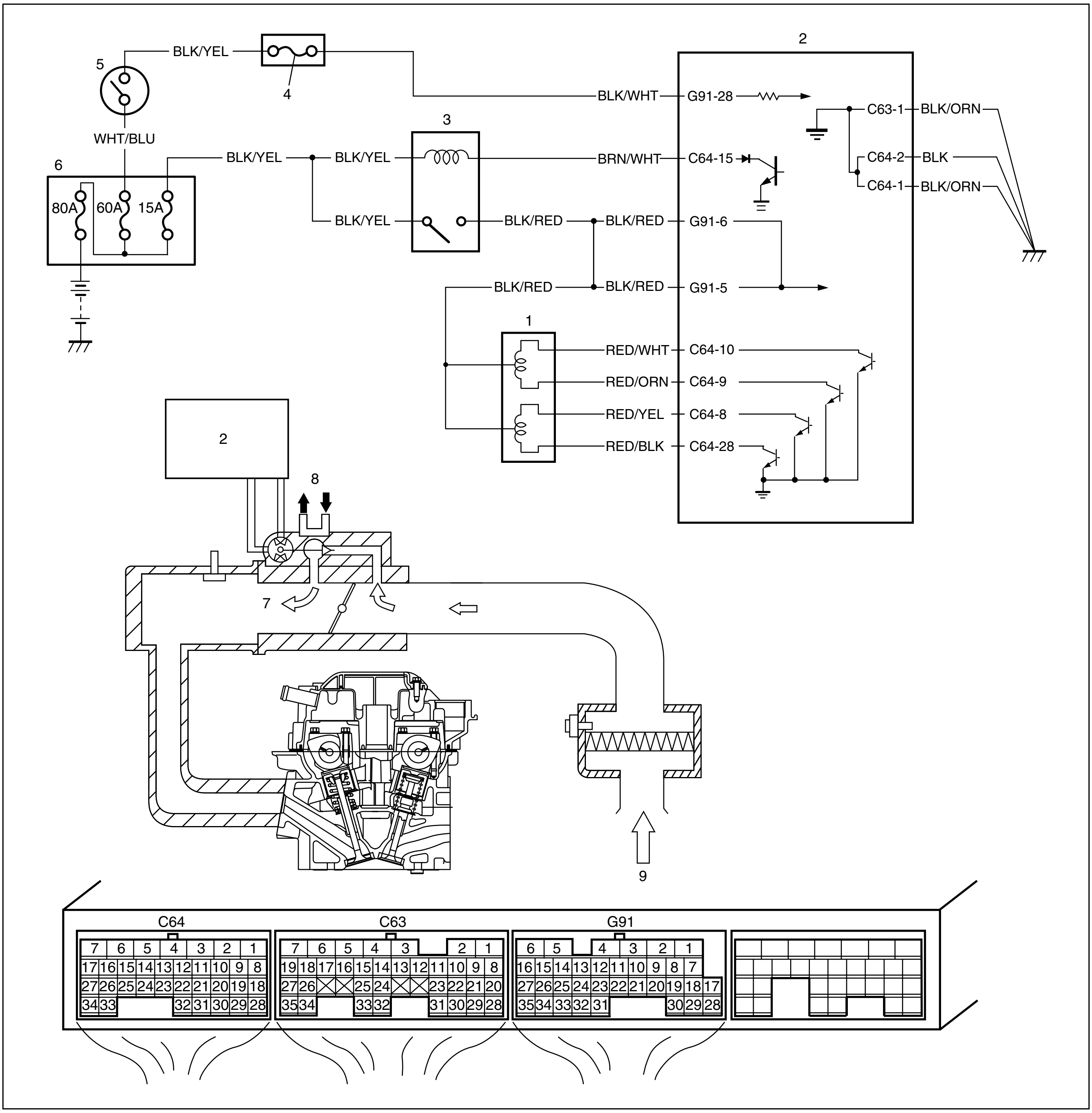
NOTE:

Before using the following table, check to make sure that battery voltage is higher than 11 V. If battery voltage is low, pressure becomes lower than specification even if fuel pump and line are in good condition.

Step	Action	Yes	No
1	Fuel Pressure Check 1) Check fuel pressure referring to “Fuel pressure inspection” under “Fuel Delivery System Description” in Section 6E1. Are they satisfied each condition?	Go to Step 2.	Go to Step 5.
2	Fuel Pressure Check 1) Start engine and warm it up to normal operating temperature. 2) Keep engine speed to 4000 rpm. Does fuel pressure shows the value which is about the same as Step 1?	Go to Step 3.	Go to Step 8.
3	Fuel Line Check 1) Check fuel pipe, fuel hose and joint for fuel leakage. Are they in good condition?	Go to Step 4.	Repair or replace.

Step	Action	Yes	No
4	Fuel Line Check 1) Check fuel pipe, fuel hose and joint for damage or deform. Are they in good condition?	Faulty fuel pressure regulator.	Repair or replace.
5	Was fuel pressure higher than specification in Step 1?	Go to Step 6.	Go to Step 7.
6	Fuel Line Check 1) Check fuel pipe, fuel hose and joint for damage or deform. Are they in good condition?	Faulty fuel pressure regulator.	Repair or replace.
7	Fuel Pump Operating Sound Check 1) Remove fuel filler cap and then turn ON ignition switch. Can you hear operation sound?	Go to Step 8.	Faulty fuel pump.
8	Fuel Line Check 1) Check fuel pipe, fuel hose and joint for damage or deform. Are they in good condition?	Clogged fuel filter, faulty fuel pump, faulty fuel pressure regulator or fuel leakage from hose connection in fuel tank.	Repair or replace.

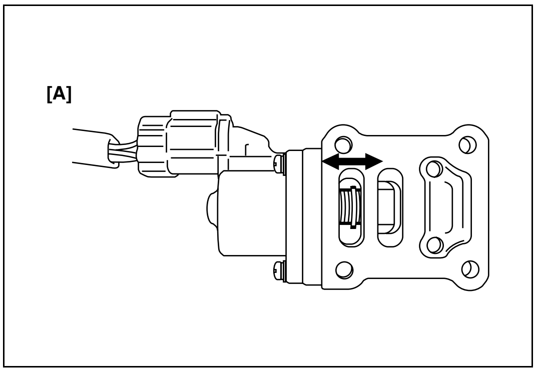
Table B-4 Idle Air Control System Check



1. IAC valve	4. "IG" fuse	7. Bypass air
2. ECM	5. Ignition switch	8. Engine coolant
3. Main relay	6. Relay/fuse box	9. Intake air

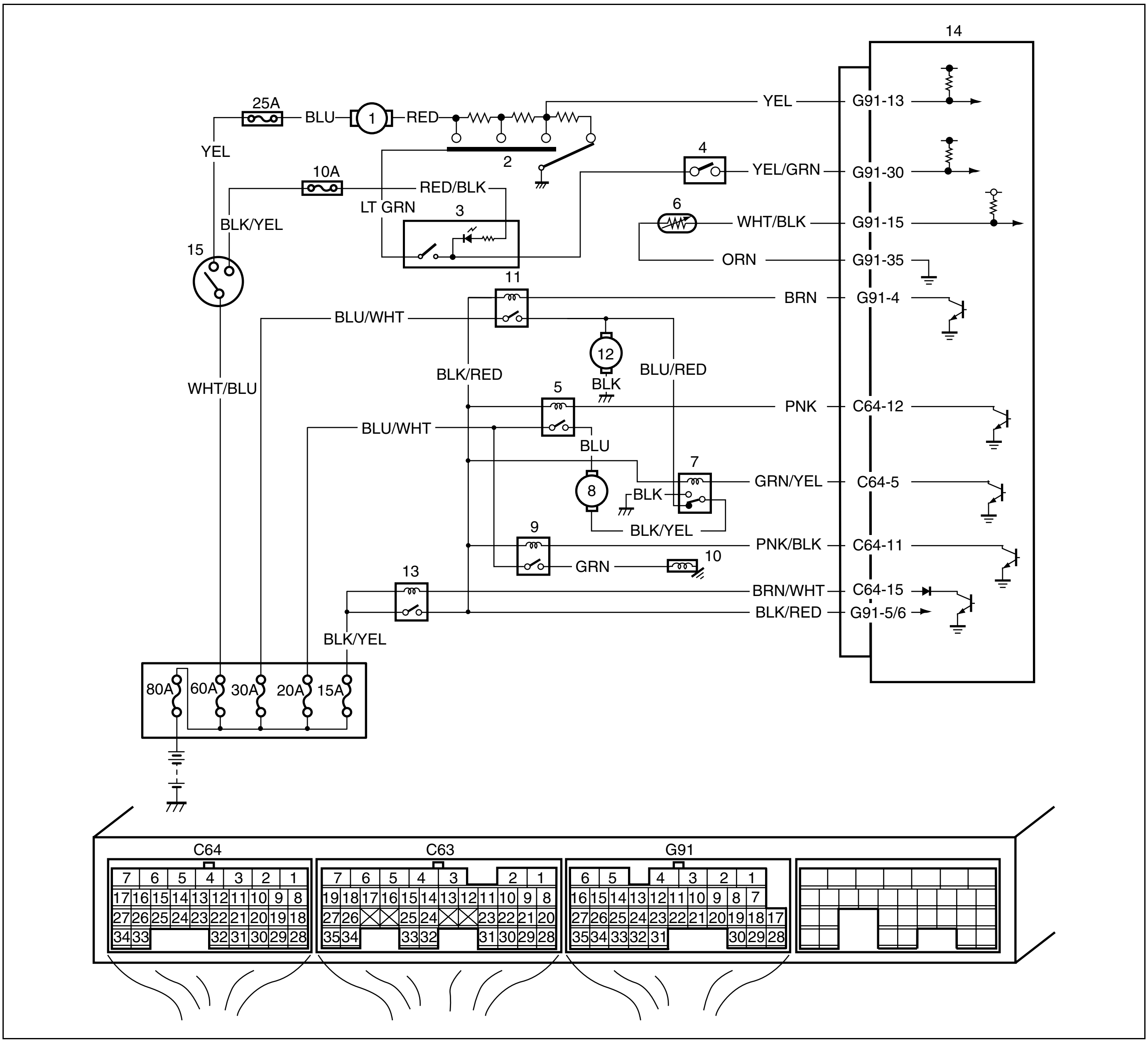
TROUBLESHOOTING

Step	Action	Yes	No
1	Check engine idle speed and IAC duty referring to “Idle speed/idle air control (IAC) duty inspection” in Section 6E1. 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 “Table B-6 Electric Load Signal Circuit Check” Closed throttle position (TP sensor) Stuck to PCV valve.
3	Is engine idle speed kept specified speed even with headlight ON?	System is in good condition.	Go to Step 6.
4	Was idle speed higher than specification in Step 1?	Go to Step 5.	Go to Step 6.
5	Check A/C (input) signal circuit referring to Step 1 of “Table B-5 A/C Signal Circuits Check (Vehicle with A/C)”, if equipped. Is it in good condition?	Go to Step 6.	Repair or replace A/C signal circuit or A/C system.
6	Check Idle Air Control system. 1) Remove IAC valve from throttle body referring to “Idle air control (IAC) valve removal and installation” in Section 6E1. 2) Check IAC valve for operation referring to “Idle air control (IAC) valve inspection” in Section 6E1. See Fig. 1. Is check result satisfactory?	Intermittent trouble or faulty ECM. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A.	Go to Step 7.
7	Check Wire Harness for Open or 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 connectors from ECM. 5) Check for proper connection to ECM at “C64-10”, “C64-9”, “C64-8” and “C64-28” terminals. 6) If OK, check “BLK/RED”, “RED/WHT”, “RED/ORN”, “RED/YEL” and “RED/BLK” circuit for open or short. Are they in good condition?	Replace IAC valve and recheck.	Repair or replace.



[A]: Fig. 1 for Step 6

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



1. Blower fan motor	5. A/C condenser fan relay No.1	9. A/C compressor relay	13. Main relay
2. Blower fan switch	6. A/C evaporator inlet air temp. sensor	10. A/C compressor	14. ECM
3. A/C switch	7. A/C condenser fan relay No.2	11. Radiator fan motor relay	15. Ignition switch
4. A/C pressure switch	8. A/C condenser fan motor	12. Radiator fan motor	

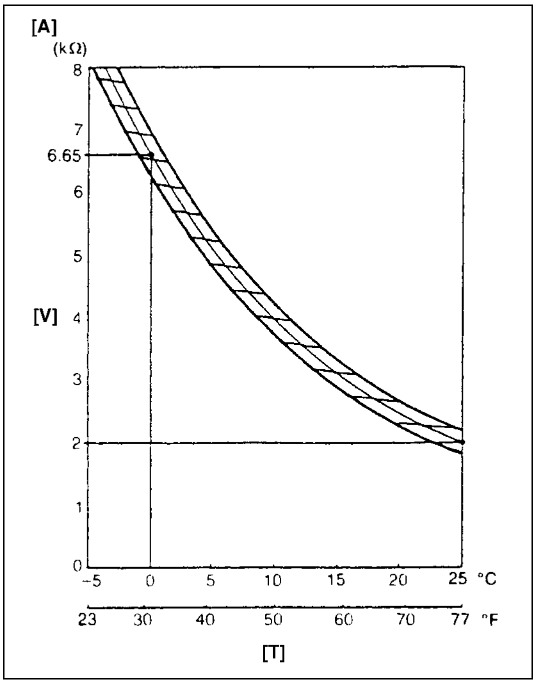
TROUBLESHOOTING

Step	Action	Yes	No
1	Check Evaporator Temp. Sensor 1) Disconnect connectors from ECM with ignition switch turned OFF. 2) Check for proper connection to “G91-15” and “G91-35” wire terminals of ECM connector. 3) If OK, measure resistance between “G91-15” and “G91-35” wire terminals of ECM connector. (See Fig. 1.) At 0°C: 6.3 – 7.0 kΩ At 25°C: 1.8 – 2.2 kΩ Is it within specification?	Go to Step 2.	Faulty A/C evaporator temperature sensor or its circuit.
2	Check A/C signal 1) Measure voltage between “G91-30” wire terminal of ECM connector and vehicle body ground under the following condition. With ignition switch ON and A/C switch OFF: 10 – 14 V With ignition switch ON, A/C and heater blower switch ON: 0 – 1 V Is check result as specified?	Go to Step 3.	A/C and heater blower switch circuit, A/C refrigerant pressure switch or heater controller malfunction.
3	Check A/C signal 1) Connect connectors to ECM with ignition switch turned OFF. 2) Measure voltage between “G91-30” wire terminal of ECM connector and vehicle body ground under the following condition. With ignition switch ON and A/C switch OFF: 10 – 14 V With ignition switch ON, A/C and heater blower switch ON: 0 – 1 V Is check result as specified?	Go to Step 4.	Poor “G91-30” terminal connection. If OK, substitute a known–good ECM and recheck.
4	Check A/C Condenser Fan Control System Is A/C cooling fan started when A/C and heater blower switch turned ON?	Go to Step 8.	Go to Step 5.
5	Check Condenser Fan Control Circuit 1) Check DTC with scan tool. Is DTC P0481 displayed?	Go to “DTC P0481 Fan 2 (A/C Condenser Fan) Control Circuit” in this section.	Go to Step 6.
6	Check Condenser Fan Relay 1) Check A/C condenser fan relay No.1 and No.2 referring to “Condenser Cooling Fan Relay (No.1 and No.2) Inspection” in Section 1B. Are check result satisfactory?	Go to Step 7.	Replace A/C condenser fan relay No.1 and No.2.

Step	Action	Yes	No
7	Check Condenser Fan 1) Check condenser fan referring to "Condenser Cooling Fan Motor On-Vehicle Inspection" in Section 1B. Is check result satisfactory?	A/C condenser fan drive circuit malfunction. If circuit OK, go to Step 8.	Replace A/C condenser fan motor.
8	Check A/C Compressor Control System Is A/C compressor started when A/C and heater blower switch turned ON while engine running?	A/C system is in good condition.	Go to Step 9.
9	Check A/C Compressor Relay Circuit 1) Check voltage between "C64-11" wire terminal of ECM connector and vehicle body ground under the following condition. While engine running and A/C switch OFF: 10 – 14 V While engine running, A/C and heater blower switch ON: 0 – 1 V Are check result satisfactory?	Go to Step 10.	Go to Step 11.
10	Check A/C Compressor Relay 1) Check A/C compressor relay referring to "Compressor Relay Inspection" in Section 1B. Is it in good condition?	Check A/C Compressor referring to "Compressor Relay Inspection" in Section 1B.	Replace A/C compressor relay.
11	Check A/C Compressor Relay Circuit 1) Remove A/C compressor relay with ignition switch turned OFF. 2) Turn ON ignition switch, check voltage between "BLK/RED" wire terminal of A/C compressor relay connector and vehicle body ground. Is voltage 10 –14 V?	Go to Step 12.	"BLK/RED" wire circuit open.
12	Check A/C Compressor Relay 1) Check A/C compressor relay referring to "Compressor Relay Inspection" in Section 1B. Is it in good condition?	"PNK/BLK" wire circuit open. If OK, substitute a known-good ECM and recheck.	Replace A/C compressor relay.

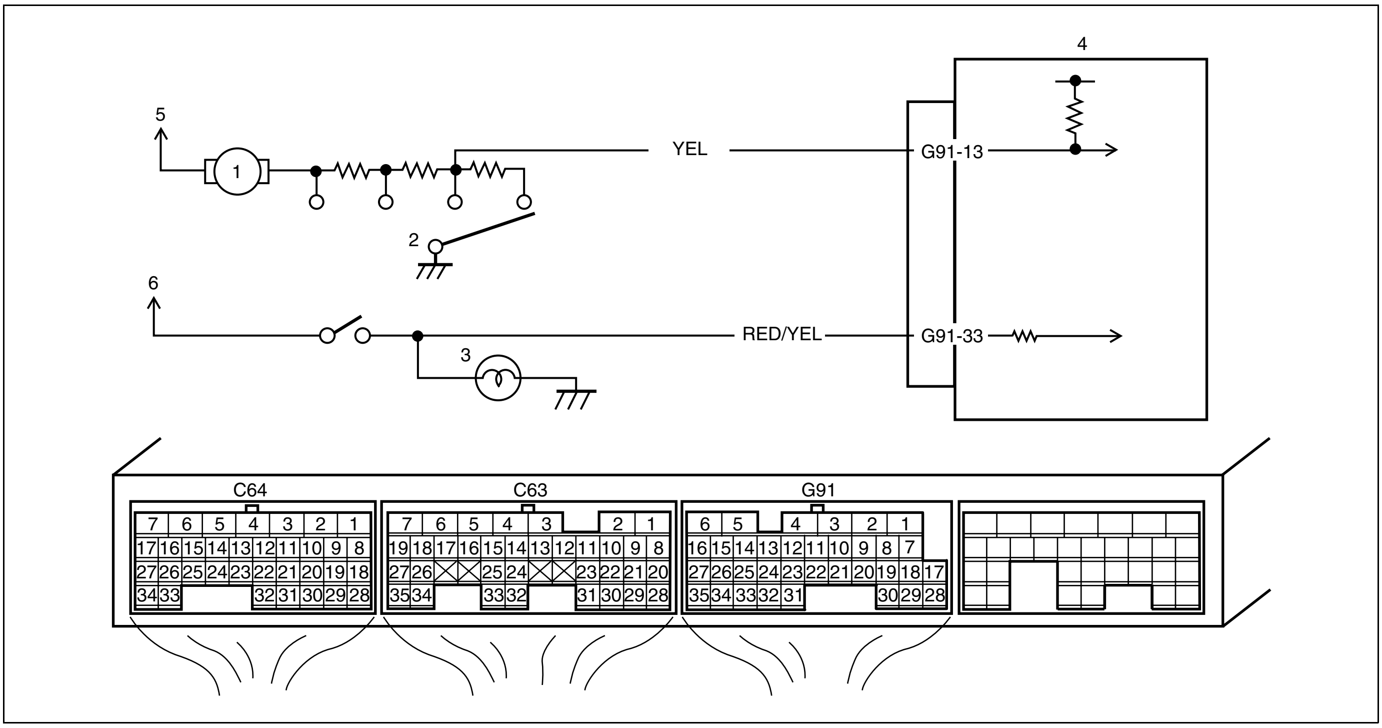
NOTE:

When A/C evaporator thermistor temp. is below 2.5°C (36.5°F), A/C remains OFF (C64-11 terminal voltage becomes 0 – 1 V). This condition is not abnormal.



[A]:	Fig. 1 for Step 1
[V]:	Resistance
[T]:	Temperature

Table B-6 Electric Load Signal Circuit Check



1. Blower fan motor	3. Position lamp	5. To “HEATER” fuse
2. Blower fan switch	4. ECM	6. To “TAIL” fuse

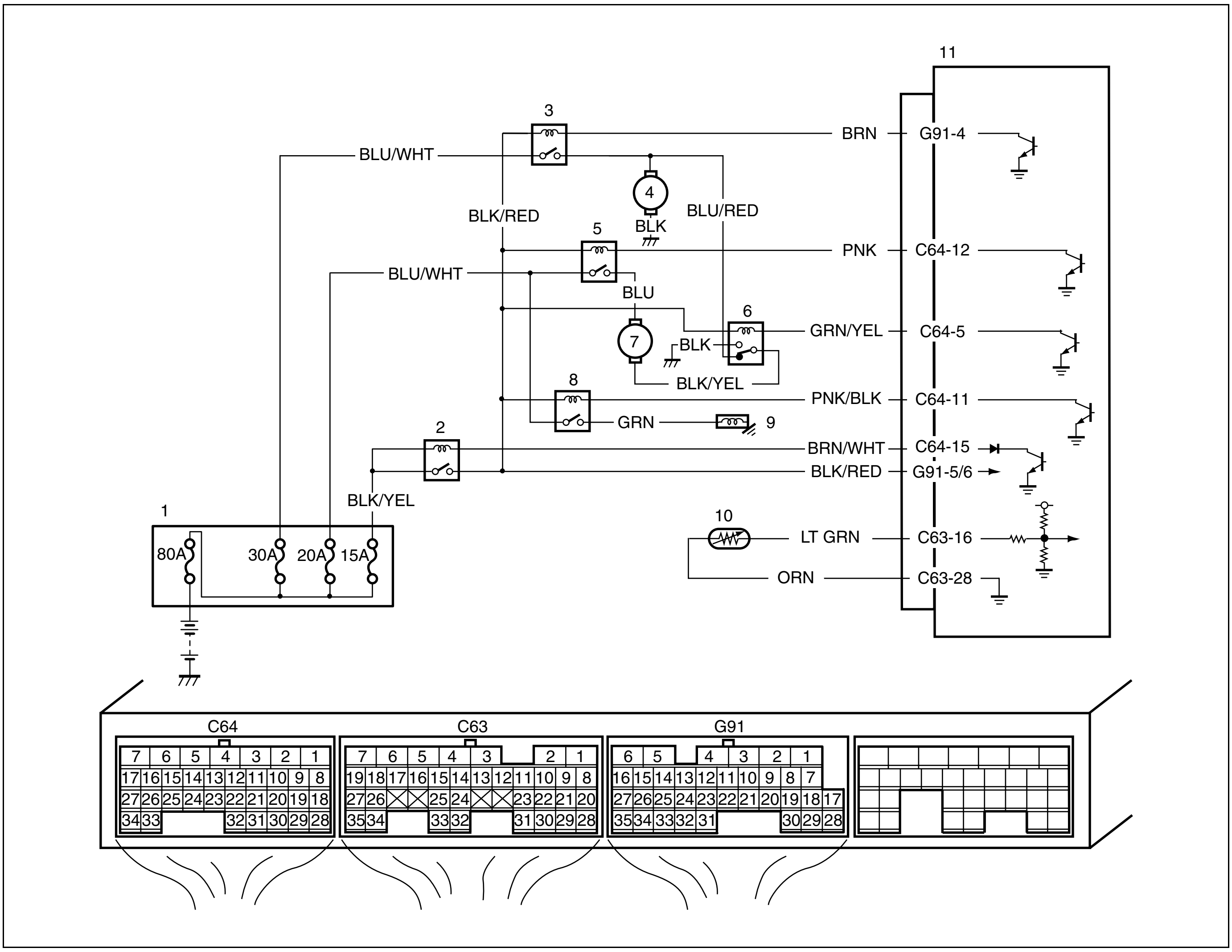
TROUBLESHOOTING

Step	Action	Yes	No
1	Do you have Suzuki Scan Tool?	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. 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.	“YEL” and/or “RED/YEL” 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 “G91-13” and “G91-33” of ECM connector connected, under above each condition. See Table 1. Is each voltage as specified?	Electric load signal circuit is in good condition.	“YEL” and/or “RED/YEL” circuit open or short, electric load diodes malfunction or each electric load circuit malfunction.

Table 1 for Step 2 and 3

		Scan tool or voltmeter		
		SUZUKI SCAN TOOL	VOLTAGE AT G91-33	VOLTAGE AT G91-13
Ignition switch ON, Small light and heater blower fan all turned	OFF	OFF	0 V	10 – 14 V
	ON	ON	10 – 14 V	0 V

Table B-7 Radiator Fan Control System Check



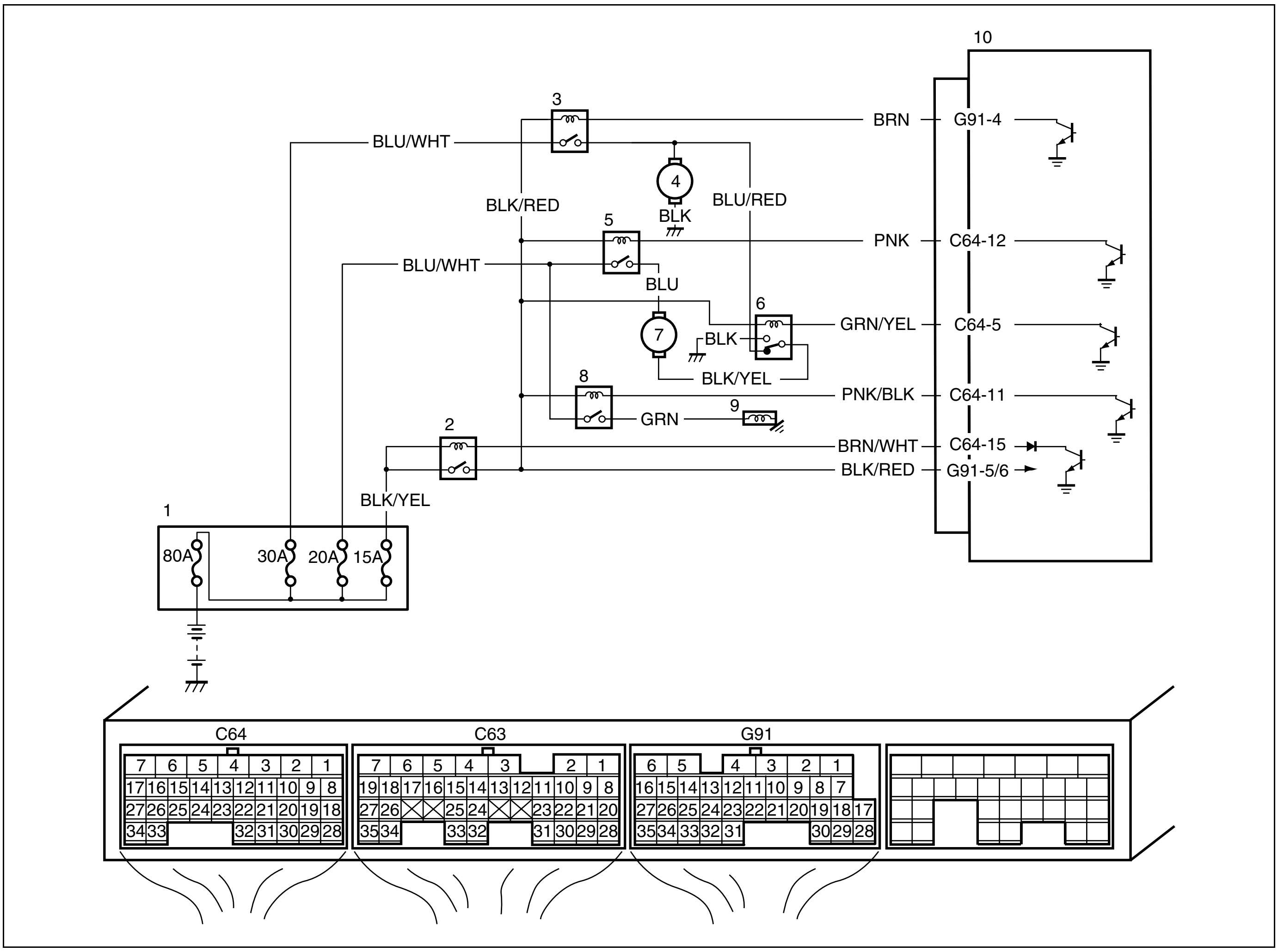
1. Relay/fuse box	5. A/C condenser fan relay No.1	9. A/C compressor
2. Main relay	6. A/C condenser fan relay No.2	10. ECT sensor
3. Radiator fan relay	7. A/C condenser fan motor	11. ECM
4. Radiator fan motor	8. A/C compressor relay	

TROUBLESHOOTING

Step	Action	Yes	No
1	DTC Check Is there DTC(s) ETC sensor circuit (DTC P0117/P0118) and/or radiator fan circuit (DTC P0480) displayed?	Go to corresponding DTC diag. flow table.	Go to Step 2.
2	Radiator Fan Motor Check 1) Disconnect negative cable at battery. 2) Disconnect connector from ECT sensor. 3) Connect negative cable to battery. Does radiator fan motor rotate at ignition switch turned ON?	System is in good condition.	Go to Step 3.

Step	Action	Yes	No
3	Main Fuse Check 1) Turn ignition switch to OFF position. 2) Disconnect connector from ECT sensor. 3) Remove main fuse from relay/fuse box. Is main (30 A) fuse in good condition?	Go to Step 4.	Replace main fuse.
4	Radiator Fan Motor Circuit Check 1) Remove radiator fan relay from relay/fuse box. 2) Measure voltage between “BLU/WHT” wire terminal of radiator fan relay connector and vehicle body ground. Is voltage 10 – 14 V?	Go to Step 5.	“BLU/WHT” wire open or high resistance circuit.
5	Check Radiator Fan Relay 1) Check radiator fan relay referring to “Main relay, fuel pump relay and radiator fan relay inspection” in Section 6E1. Is it in good condition?	Go to Step 6.	Replace radiator fan relay.
6	Radiator Fan Control Circuit Check 1) Disconnect radiator fan motor connector. 2) Measure resistance between “BLU/RED” wire terminal of radiator fan motor connector and “BLU/RED” wire terminal of radiator fan relay connector. Is resistance 1Ω or less?	Go to Step 7.	“BLU/RED” wire circuit open or poor connection.
7	Radiator Fan Control Circuit Check 1) Measure resistance between “BLU/RED” wire terminal of radiator fan motor connector and vehicle body ground. Is it infinite?	Go to Step 8.	“BLU/RED” wire circuit shorted to ground.
8	Radiator Fan Control Circuit Check 1) Turn ON ignition switch. 2) Measure voltage between “BLU/RED” wire terminal of radiator fan motor connector and vehicle body ground. Is voltage 0 V?	Go to Step 9.	“BLU/RED” wire shorted to power circuit.
9	Radiator Fan Control Circuit Check 1) Measure resistance between “BLK” wire terminal of radiator fan motor connector and vehicle body ground. Is resistance 1Ω or less?	Replace radiator fan motor.	“BLK” wire open or high resistance circuit.

Table B-8 A/C Condenser Fan Control System



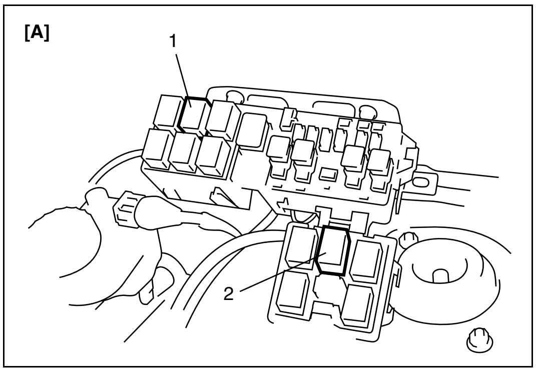
1. Relay/fuse box	5. A/C condenser fan relay No.1	9. A/C compressor
2. Main relay	6. A/C condenser fan relay No.2	10. ECM
3. Radiator fan relay	7. A/C condenser fan motor	
4. Radiator fan motor	8. A/C compressor relay	

TROUBLESHOOTING

Step	Action	Yes	No
1	DTC Check 1) Connect scan tool to DLC with ignition switch turned OFF. 2) Check pending DTC and DTC with scan tool. IS DTC P0480 and/or P0481 displayed?	Go to corresponding DTC diag. Flow table.	Go to Step 2.
2	Check A/C condenser Fan Control System 1) Start engine. 2) Turn ON A/C switch and operate blower fan motor. Is A/C condenser fan motor started?	Go to Step 3.	Go to Step 4.

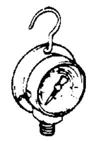
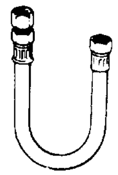
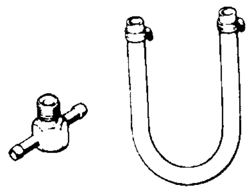
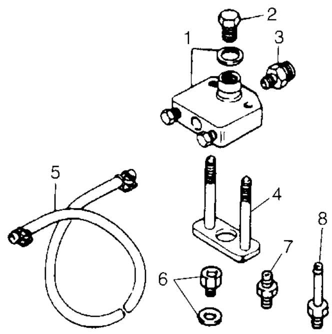
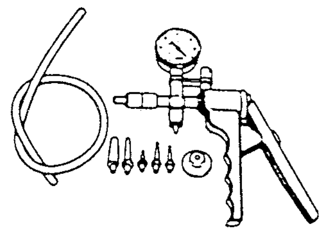
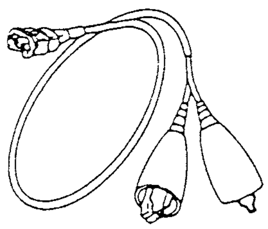
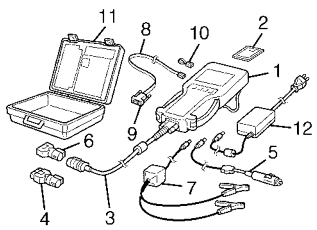
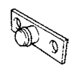
Step	Action	Yes	No
3	Check A/C condenser fan control system. 1) Run engine and warm up it normal operating temperature. 2) Turn ON lighting switch and blower motor switch. 3) Check that A/C condenser fan motor and radiator fan motor operation as follows. • A/C condenser fan motor and radiator fan motor is low speed drive for 2 seconds when A/C switch is ON with engine idling. • A/C condenser fan motor is high speed drive and radiator fan motor is stopped after 2 seconds when A/C switch is ON with engine idling. Is check result satisfactory?	A/C condenser fan control system is in good condition.	Go to Step 6.
4	Check A/C Refrigerant 1) Check amount of A/C refrigerant referring to “Refrigerant charge” in Section 1B. Is it in good condition?	Go to Step 5.	Recharge refrigerant.
5	Check A/C Condenser Fan Relay 1) Check A/C condenser fan relay No.1 and No.2 referring to “Condenser Cooling Fan Relay (No.1 and No.2) Inspection” in Section 1B. Are check result in good condition?	Go to Step 6.	Replace A/C condenser fan relay No.1 or No.2.
6	Check Main Fuse 1) Remove main (20 A) fuse from relay/fuse box. Is it in good condition?	Go to Step 7.	Replace main fuse.
7	Check Wire Circuit 1) Remove A/C condenser fan relay No.1 and No.2 with ignition switch turned OFF. (See Fig. 1.) 2) Turn ON ignition switch, measure voltage between “BLU/WHT” wire terminal of A/C condenser fan relay No.1 connector and vehicle body ground, “BLU/WHT” wire terminal of A/C condenser fan relay No.2 connector and vehicle body ground. Are voltage 10 – 14 V?	Go to Step 8.	“BLU/WHT” wire in open or high resistance circuit.
8	Check Wire Circuit 1) Disconnect A/C condenser fan motor connector with ignition switch turned OFF. 2) Measure resistance between “BLU” wire terminal of A/C condenser fan relay No.1 connector and “BLU” wire terminal of A/C condenser fan motor connector. Is resistance 1Ω or less?	Go to Step 9.	“BLU” wire in open or high resistance circuit.

Step	Action	Yes	No
9	Check Wire Circuit 1) Turn ON ignition switch, measure voltage between “BLU” wire terminal of A/C condenser fan relay No.1 connector and vehicle body ground. Is voltage 0 V?	Go to Step 10.	“BLU” wire shorted to power circuit.
10	Check Wire Circuit 1) Turn OFF ignition switch, measure resistance between “BLU/YEL” wire terminal of A/C condenser fan relay No.2 connector and “BLU/YEL” wire terminal of A/C condenser fan motor connector. Is resistance 1Ω or less?	Go to Step 11.	“BLU/YEL” wire shorted to power circuit.
11	Check Wire Circuit 1) Turn ON ignition switch, measure voltage between “BLU/YEL” wire terminal of A/C condenser fan relay No.2 connector and vehicle body ground. Is voltage 0 V?	Go to Step 12.	“BLU/YEL” wire in open or high resistance circuit.
12	Check Wire Circuit 1) Turn OFF ignition switch, measure resistance between “BLK” wire terminal of A/C condenser fan relay No.2 connector and vehicle body ground. Is resistance 1Ω or less?	Go to Step 13.	“BLK” wire in open or high resistance circuit.
13	Check A/C Condenser Fan Motor 1) Check A/C condenser fan motor operation referring to “Condenser Cooling Fan Motor On-Vehicle Inspection” in Section 1B. Is it in good condition?	Intermittent trouble. Check for intermittent referring to “Intermittent and Poor Connection” in Section 0A. If OK, substitute a known-good ECM and recheck.	Replace A/C condenser fan motor.



[A]:	Fig. 1 for Step 7
1.	A/C condenser relay No.1
2.	A/C condenser relay No.2

Special Tool

			
09912-58442 Pressure gauge	09912-58432 Pressure hose	09912-58490 3-way joint & hose	09912-58421 Checking tool set (See NOTE "A".)
			
09917-47011 Vacuum pump gauge	09930-88530 Injector test lead	Tech 2 kit (Suzuki Scan Tool) (See NOTE "C".)	09912-57610 Checking tool plate

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
- **“C”: This kit includes the following items.**
  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 a Supplemental Restraint (Air Bag) System :

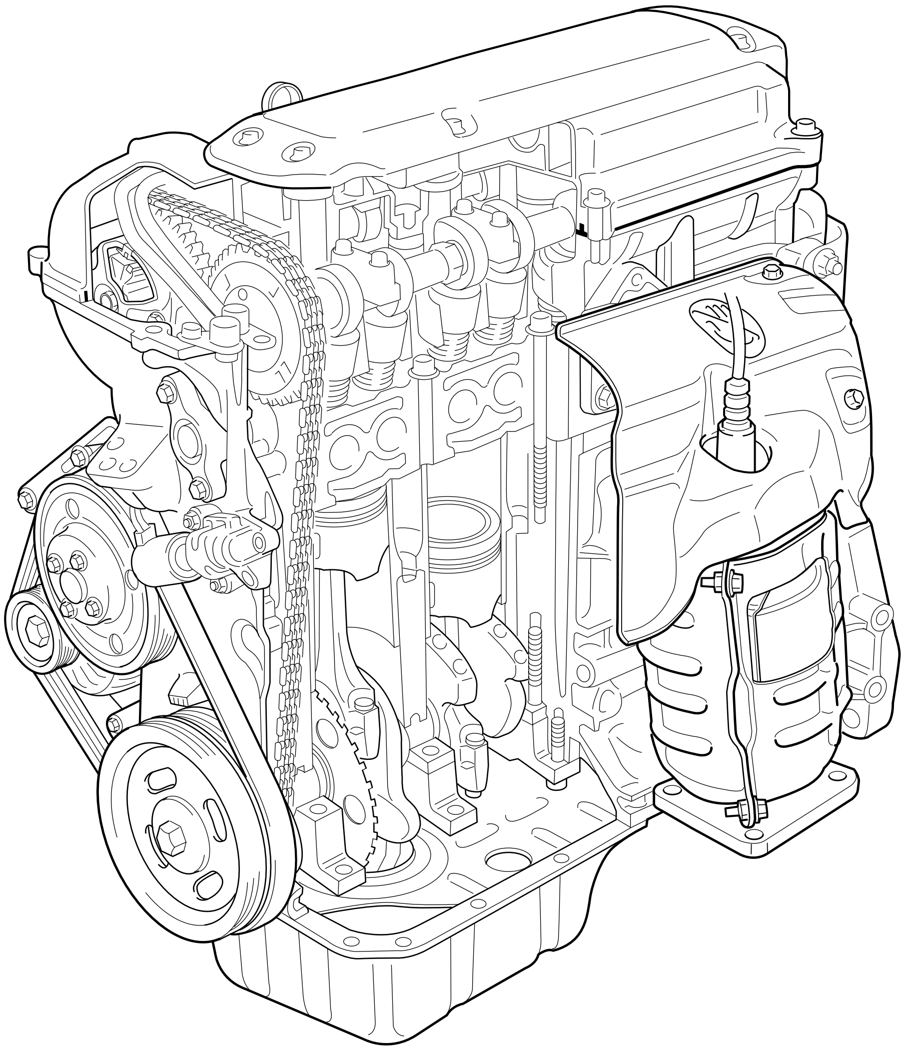
- **Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to "System Components and Wiring Location View" under "General Description" in air bag system section in order to confirm whether you are performing service on or near the air 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 Construction Description

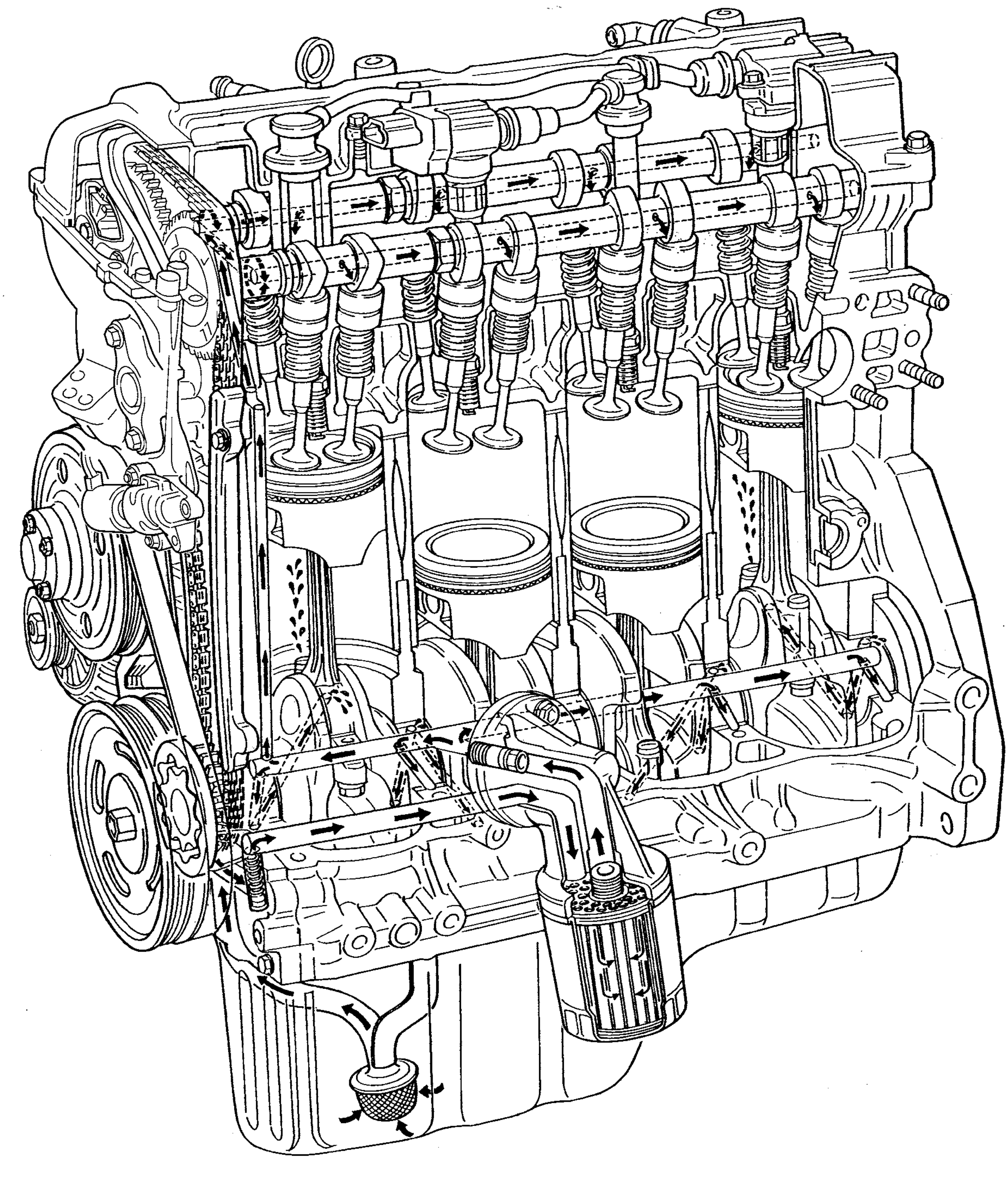
The engine is water-cooled, in line 4 cylinders, 4 stroke cycle gasoline unit with its DOHC (Double overhead camshaft) valve mechanism arranged for “V” type valve configuration and 16 valves (4 valves/one cylinder). The double overhead camshaft is mounted over the cylinder head; it is driven from crankshaft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



Engine Lubrication Description

The oil pump is of a trochoid type, and mounted on 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 390 kPa (3.9 kg/cm^2, 56.6 psi).



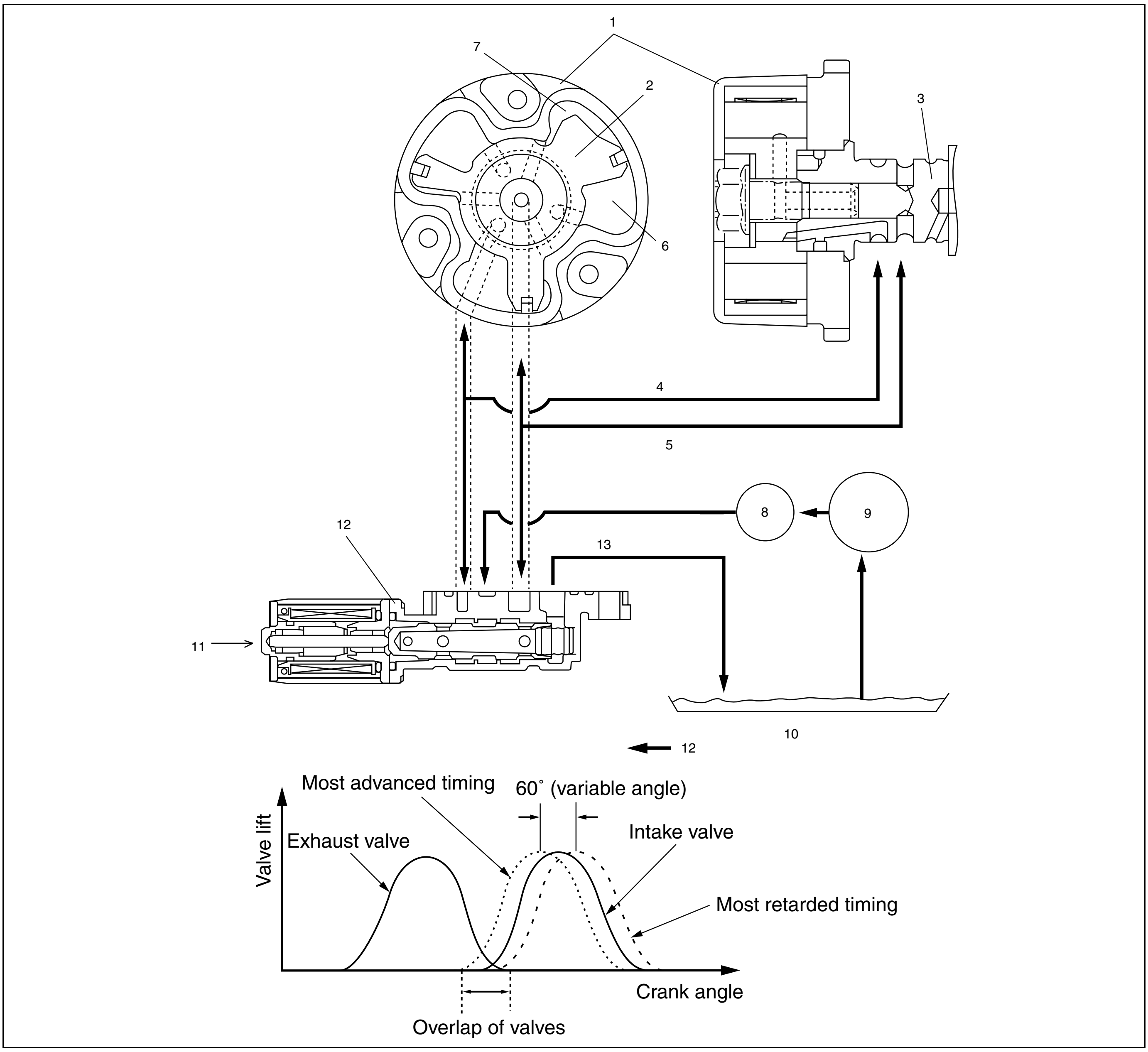
Variable Valve Timing (VVT) System Description

System description

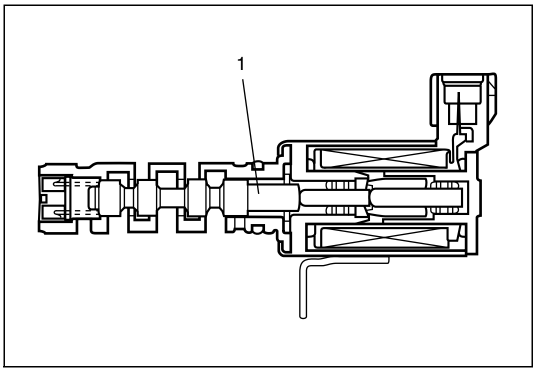
The VVT system is an electronic control system which continuously vary and optimize the intake valve timing in response to the engine operating condition.

The optimized intake valve timing produce such an air intake with high efficiency that both the higher power generation and lower fuel consumption can be attained in the whole engine speed range from low to high. In the area of the average engine load, low emission of nitrogen oxides (NOx) and high fuel efficiency can also be attained by making the valve opening overlap between the intake and exhaust valves longer.

For the brief of the system operation, the intake valve timing is varied by the cam timing sprocket (1) which varies the rotational phase between the intake camshaft (3) and sprocket. The rotor (2) in the cam timing sprocket is actuated by switching or adjusting the hydraulic pressure applied to the chambers for the timing advancing (7) and/or retarding (6). To switch or adjust the hydraulic pressure appropriately, ECM operates the oil control valve (12) with detecting the engine speed, intake air value, throttle opening, engine coolant temperature and camshaft position (angle).

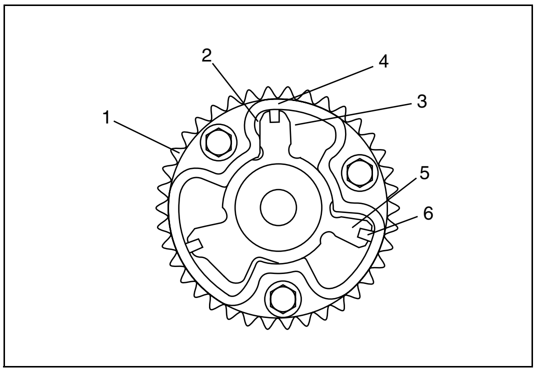


4. Oil passage to chamber for timing retarding	8. Oil filter	10. Oil pan	12. Oil flow
5. Oil passage to chamber for timing advancing	9. Oil pump	11. Control signal from ECM	



Oil control valve

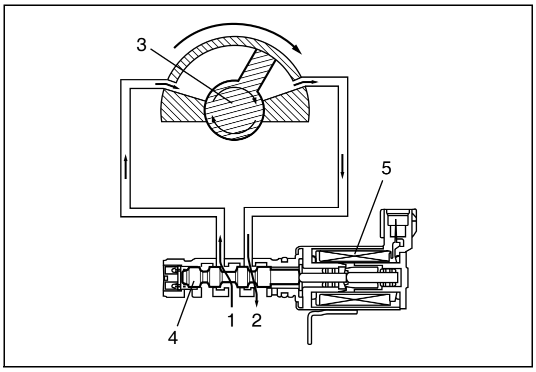
The oil control valve switches and adjusts the hydraulic pressure applied to the cam timing sprocket by moving the spool valve (1) according to the duty pulse signals output from the ECM. By this operation, the intake valve timing is varied continuously. Signals output from the ECM are the duty pulse of about 240 Hz.



Cam timing sprocket

The cam timing sprocket is equipped with the chambers for timing advancing (2) and retarding (3) which are separated by the rotor (5). The rotor rotates receiving the hydraulic pressure applied to both the chambers. The sprocket (1) is installed on the housing (4) and the rotor is secured on the intake camshaft by fastening the bolts. Therefore, the actuation of the rotor makes the phase difference between the sprocket and intake camshaft.

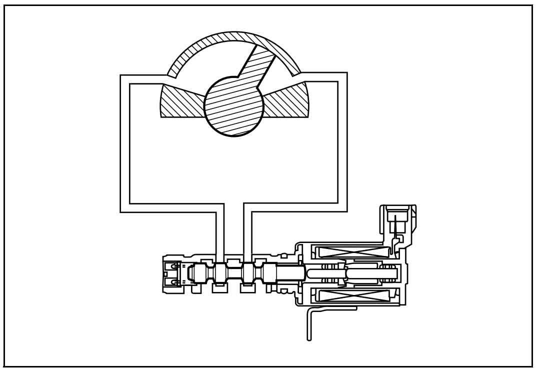
6. Seal



Timing advancing

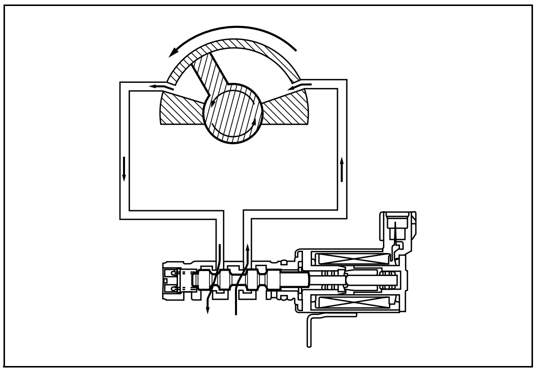
When the duty ratio of the signal output from the ECM is heavy, the spool valve (4) of the oil control valve moves to the left (opposite direction against the coil (5)). By this spool valve movement, the pressurized oil (1) is led into the chambers for timing advancing and the oil in the chambers for timing retarding is drained. This operations actuate the rotor (3) and result in the advanced timing of the intake valve.

2. Drain



Timing holding

When the duty ratio of the signal output from the ECM shows that of holding, the spool valve of the oil control valve is located at hold position. Because this condition generates no oil pressure changes in both chambers, the rotor is fixed at a target position.



Timing retarding

When the duty ratio of the signal output from the ECM is light, the spool valve of the oil control valve moves to the right (head for the coil). By this spool valve movement, the pressurized oil is led into the chambers for timing retarding and the oil in the chambers for timing advancing is drained. This operations actuate the rotor and result in the retarded timing of the intake valve.

Targeted timing varying operation

DRIVING CONDITION	VALVE TIMING	TARGET OF CONTROL	EFFECT
Engine running at idle speed	Most retarded	To shorten the valve opening overlap in order to prevent the exhaust gas counterflow to intake manifold.	Stabilization of the engine rotation at idle speed.
Average engine load range	To the advanced side	To lengthen the valve opening overlap in order to enhance the internal exhaust gas recirculation and reduce the pumping loss.	Improvement of the fuel efficiency. Lowering of the exhaust emission.
Light engine load range	To the retarded side	To shorten the valve opening overlap in order to prevent the exhaust gas counterflow to intake manifold.	Keeping of the engine stability.
Low or average engine speed range with heavy engine load	To the advanced side	To advance the closing timing of the intake valve in order to improve the volumetric efficiency.	Improvement of generating the engine torque at low and average engine speed.
High engine speed range with heavy engine load	To the retarded side	To retard the closing timing of the intake valve in order to improve the volumetric efficiency.	Improvement of generating the engine power.
Low engine coolant temperature	Most retarded	To shorten the valve opening overlap in order to prevent the exhaust gas counterflow to intake manifold and reduce the fuel increasing. To slow the fast idle speed of the engine as a result of stabilizing the engine idling.	Stabilization of the fast idling of the engine. Improvement of the fuel efficiency.
At engine starting and stopping	Most retarded	To shorten the valve opening overlap in order to prevent the exhaust gas counterflow to intake manifold.	Improvement of start ability

Diagnosis

Diagnosis Table

Refer to “Engine Symptom Diagnosis” in Section 6.

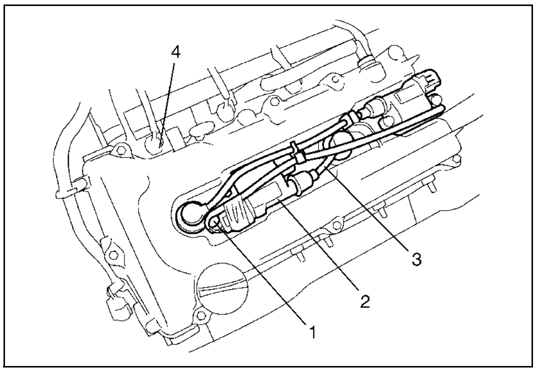
Compression Check

Check compression pressure on all 4 cylinders as follows:

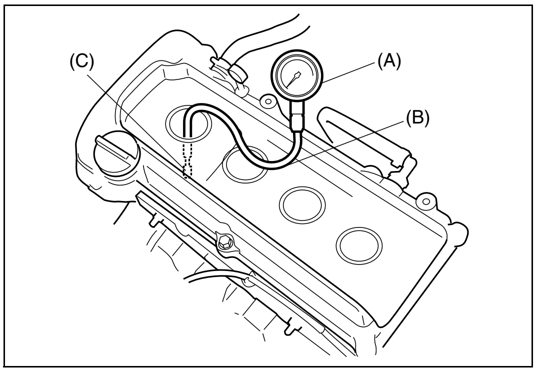
1) Warm up engine to normal operating temperature.
2) Stop engine after warming up.

NOTE:

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

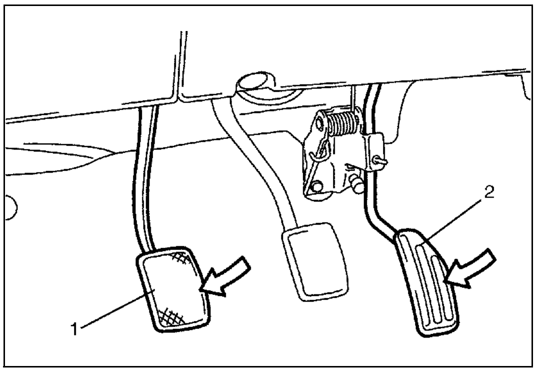


3) Disconnect ignition coil couplers (1).
4) Remove ignition coil assemblies (2) with high-tension cord (3).
5) Remove all spark plugs.
6) Disconnect fuel injector wires (4) at the coupler.



7) Install special tools (compression gauge) into spark plug hole.

Special tool
(A) : 09915-64512
(B) : 09915-64530
(C) : 09915-67010



8) 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.
9) Crank engine with fully charged battery, and read the highest pressure on compression gauge.

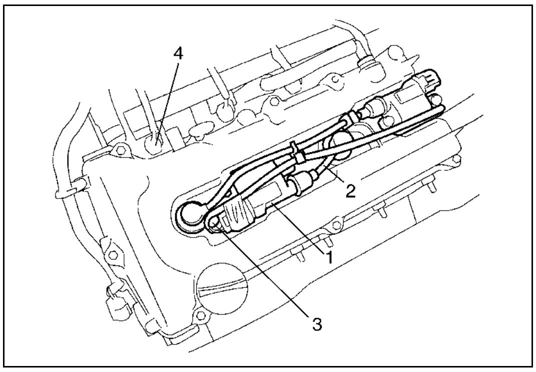
NOTE:

- **For measuring compression pressure, crank engine at least 250 rpm by using fully charged battery.**
- **If measured compression pressure is lower than limit value, check installation condition of special tool. If it is properly installed, possibility is compression pressure leakage from where piston ring or valve contact.**

Compression pressure

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)**

10) Carry out Steps 7) through 9) on each cylinder to obtain 4 readings.



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

Engine Vacuum Check

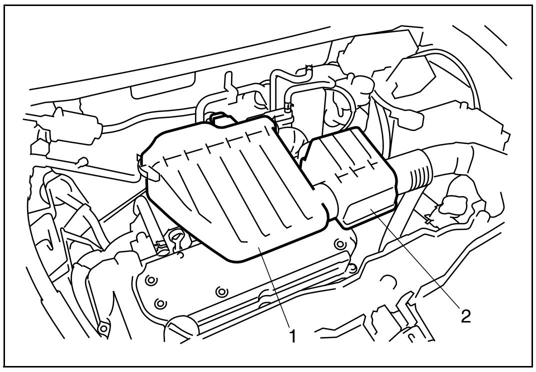
The engine vacuum that develops in the intake line is a good indicator of the condition of the engine. The vacuum checking procedure is as follows :

1) Warm up engine to normal operating temperature.

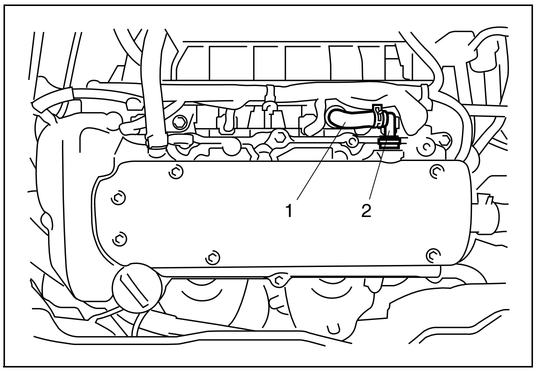
NOTE:

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

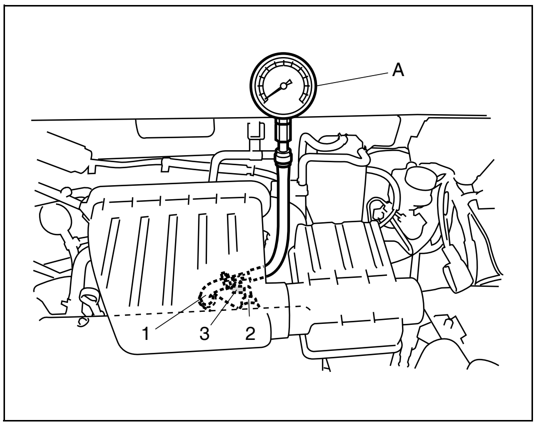
2) Stop engine and turn off the all electric switches.



3) Remove air cleaner case (1) and resonator (2).



4) Remove PCV hose (1) from PCV valve (2).



5) Connect special tool (Vacuum gauge) to PCV hose (1).

Special tool
(A) : 09915-67311

6) Blind PCV valve (2) using tape (3) or the like.
7) Install air cleaner case and resonator.
8) Run engine at specified idle speed and read vacuum gauge. Vacuum should be within specification.

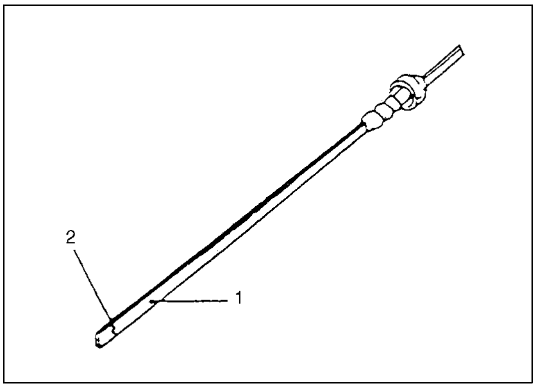
Vacuum specification (at sea level)
59 – 73 kPa (45 – 55 cmHg, 17.7 – 21.6 inHg)
at specified idle speed

9) After checking, disconnect special tool (Vacuum gauge) from PCV valve.
10) Detach blind cap from PCV valve.
11) Install air cleaner case and resonator.

Oil Pressure Check

NOTE:

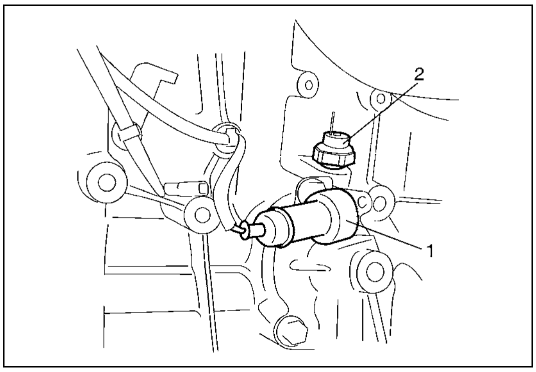
Prior to checking oil pressure, check the following items.



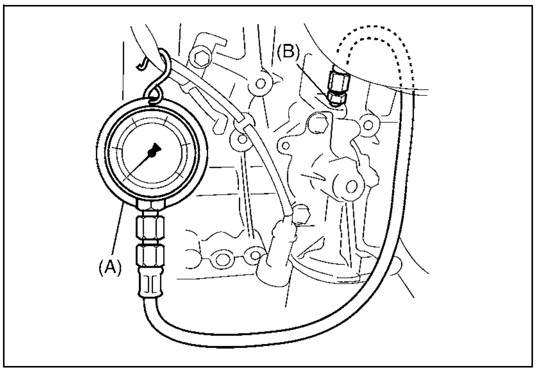
- Oil level in oil pan
  If oil level is low, add oil up to Full level mark (hole) on oil level gauge.
- Oil quality
  If oil is discolored or deteriorated, change it.
  For particular oil to be used, refer to "Engine Oil and Oil Filter Replacement" in Section 0B.

1.	Full level mark (hole)
2.	Low level mark (hole)

- Oil leaks
  If leak is found, repair it.



1) Disconnect oil pressure switch coupler (1).
2) Remove exhaust manifold cover, if necessary.
3) Remove oil pressure switch (2) from cylinder block.



4) Install special tools (Oil pressure gauge) to threaded hole of oil pressure switch.

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

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

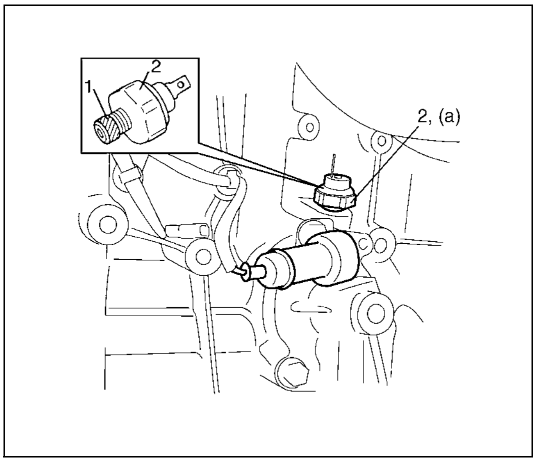
NOTE:

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

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

Oil pressure specification
More than 270 kPa (2.7 kg/cm^2, 39.8 psi) at 4,000 rpm

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



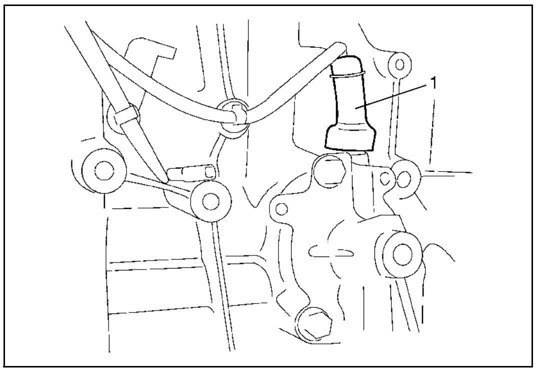
8) Before reinstalling oil pressure switch (2), be sure to wrap its screw threads with sealing tape (1) and tighten switch to specified torque.

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)

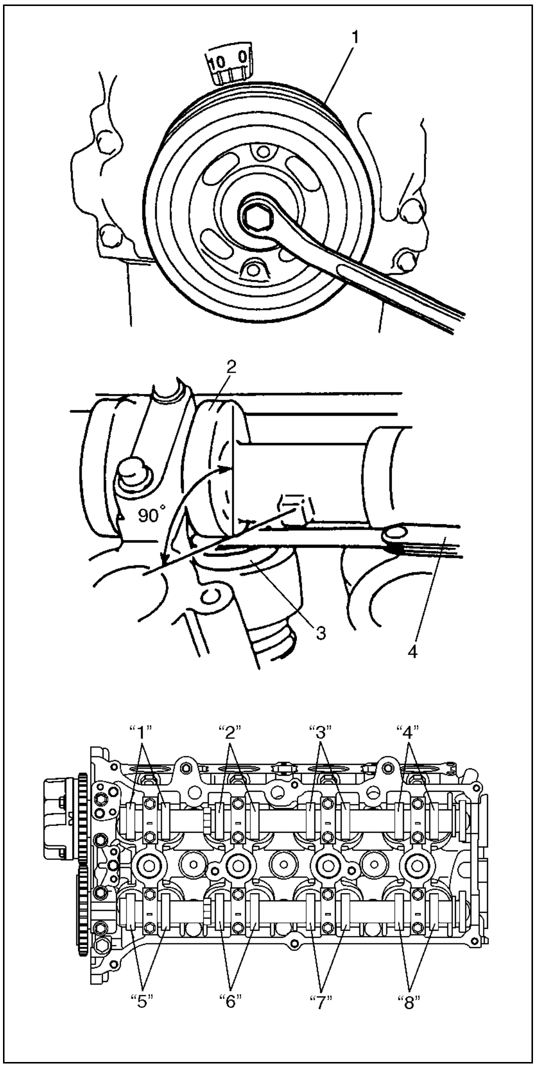
9) Start engine and check oil pressure switch (2) for oil leakage. If oil leakage is found, repair it.



10) Connect oil pressure switch coupler and fit cover (1) firmly.

Valve Lash (Clearance) Inspection

1) Remove negative cable at battery.
2) Remove cylinder head cover referring to “Cylinder Head Cover Removal and Installation” in this section.
3) Remove right side engine under cover, if necessary.



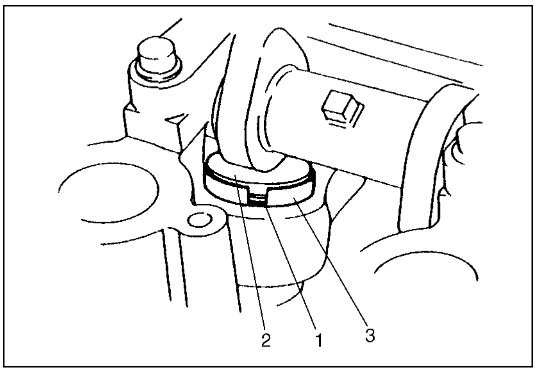
4) Using 17 mm wrench, turn crankshaft pulley (1) clockwise until cam lobes (2) become perpendicular to shim faces (3) at valves “1” and “7” as shown in figure.
5) Check valve lashes with thickness gauge (4) according to the following procedure.
   a) Check valve lashes at valves “1” and “7”.
   b) Turn camshafts by 90° (by turning crankshaft with wrench).
   c) Make sure that cam lobes (2) are perpendicular to shim faces (3) 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”.

If valve lash is out of specification, record valve lash and adjust it to specification referring to “Shim Replacement” in this section.

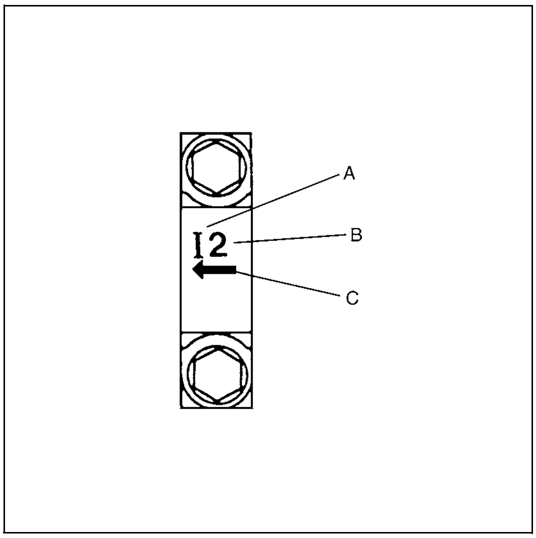
Valve clearance specification

	When cold (Coolant temperature is 15 – 25°C (59 – 77°F))	**When hot (Coolant temperature is 60 – 68°C (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.)**

Shim Replacement



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 down the valve by turning crankshaft to 360°.
3) Hold tappet at that position using special tool as follows.
   a) Remove its housing bolts.

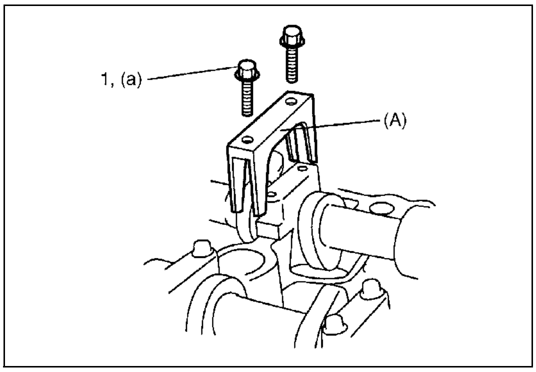


b) Check housing No. and select special tool corresponding to housing No. referring to “the following table”.

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

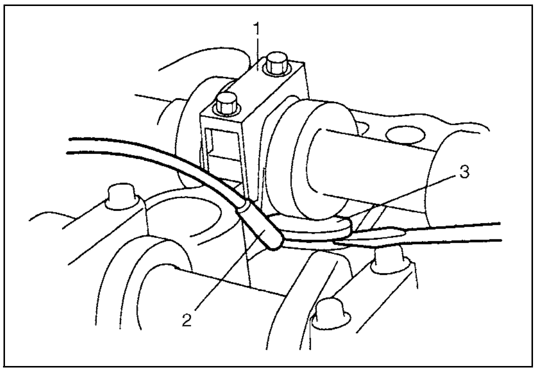
A:	I : Intake side or E : Exhaust side
B:	Position from timing chain side
C:	Pointing to timing chain side



c) Hold down the tappet so as not to contact the shim by installing special tool on camshaft housing with housing bolt (1) tighten housing bolts to specified torque.

Special tool
(A) : 09916-67020 or 09916-67021

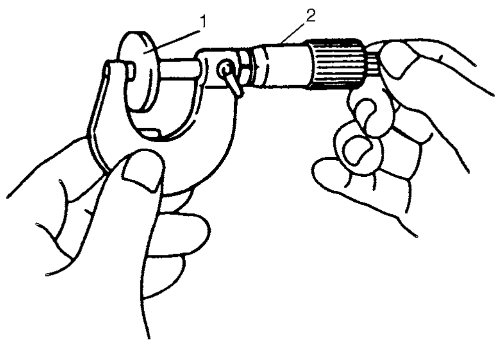
Tightening torque
Camshaft housing bolts (for tightening of special tool)
(a) : 8 N·m (0.8 kg-m, 6.0 lb-ft)



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

WARNING:
Never put in the hand between cam shaft and tappet.

1.	Special tool
2.	Magnet

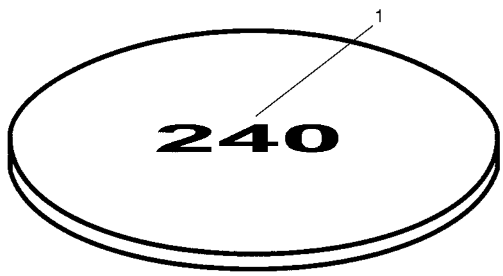


5) Using a micrometer (2), measure the thickness of the removed shim (1), and determine replacement shim by calculating the thickness of new shim with the following formula and table.

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

For 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.)

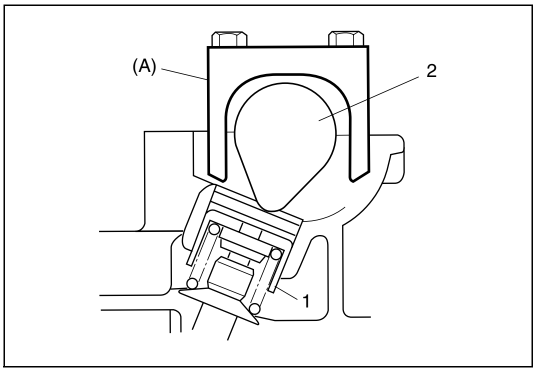


6) Select new shim No. (1) with a thickness as close as possible to calculated value.

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		

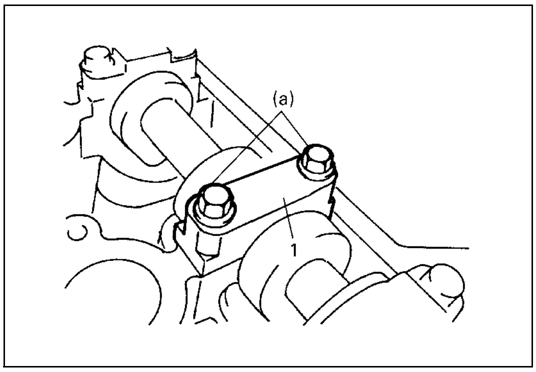
7) Install new shim facing shim No. side with tappet.



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

Special tool
(A) : 09916-67020 or 09916-67021

1.	Tappet
2.	Camshaft



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

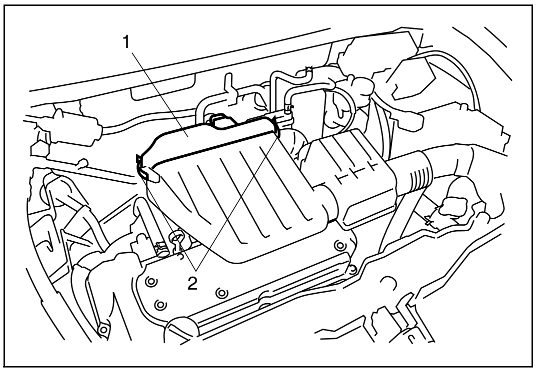
Tightening torque
Camshaft housing bolts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)

10) Check valve clearance again after adjusting it.
11) After checking and adjusting all valves.
12) Install cylinder head cover referring to “Cylinder Head Cover Removal and Installation” in this section.

On-Vehicle Service

Air Cleaner Element Removal and Installation

Removal

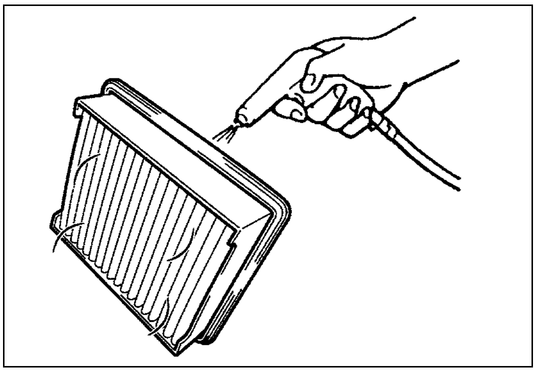


1) Open air cleaner case (1) by unhooking its clamps (2).
2) Remove air cleaner element from case.

Installation

Reverse removal procedure for installation.

Air Cleaner Element Inspection and Cleaning



- Check air cleaner element for dirt. Replace excessively dirty element.
- Blow off dust by compressed air from air outlet side of element.

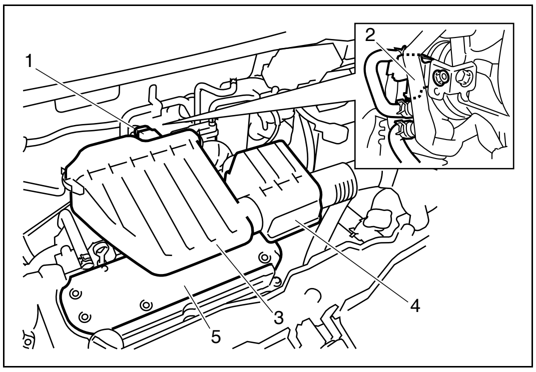
Knock Sensor Removal and Installation

Refer to “Knock sensor removal and installation” in Section 6E1.

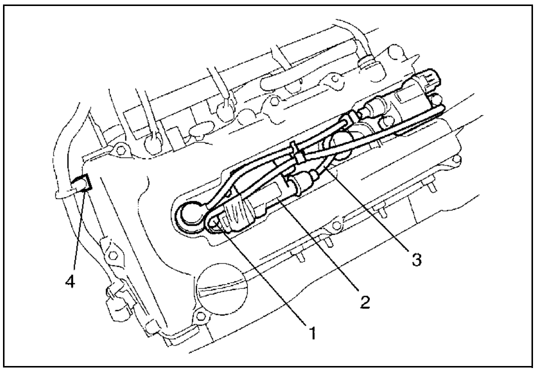
Cylinder Head Cover Removal and Installation

Removal

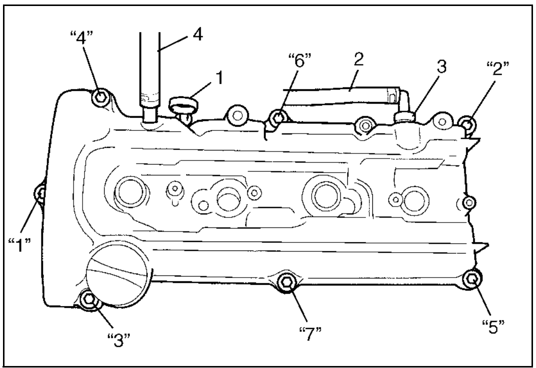
1) Disconnect negative cable at battery.



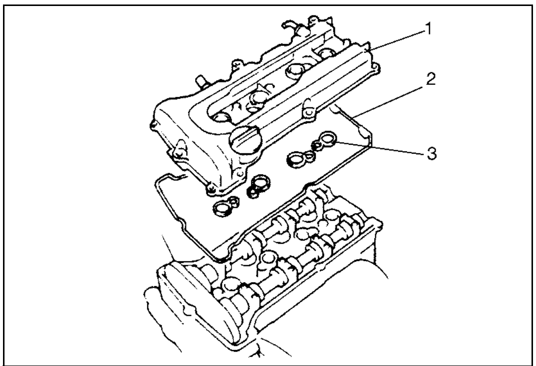
2) Disconnect MAF sensor coupler (1).
3) Remove EVAP canister purge valve (2).
4) Remove air cleaner case (3) and resonator (4).
5) Remove cylinder head upper cover (5).



6) Disconnect ignition coil couplers (1).
7) Remove ignition coil assemblies (2) with high-tension cord (3).
8) Remove wire harness clamp (4) from cylinder head cover.

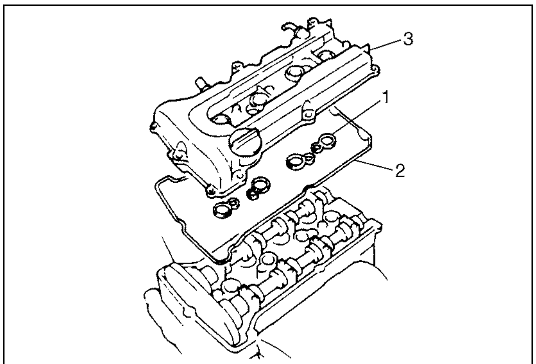


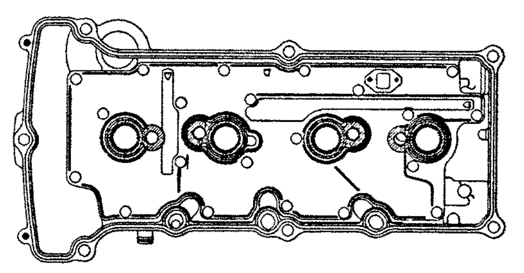
9) Remove oil level gauge (1).
10) Disconnect PCV hose (2) from PCV valve (3) and disconnect breather hose (4) from cylinder head cover.
11) Remove cylinder head cover mounting bolts in such order as indicated in figure.



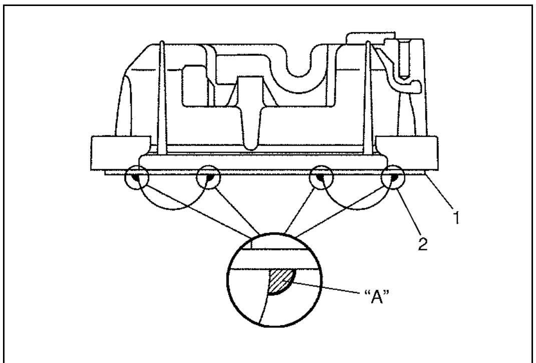
12) Remove cylinder head cover (1) with cylinder head cover gasket (2) and spark plug hole gasket (3).

Installation



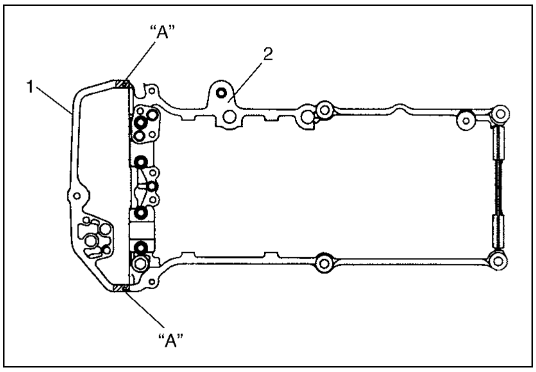


1) Install new spark plug hole gaskets (1) and new cylinder head cover gasket (2) to cylinder head cover (3) as shown in figure.



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 cover gasket (1) sealing surface area (2) as shown.

"A" : Sealant 99000-31250



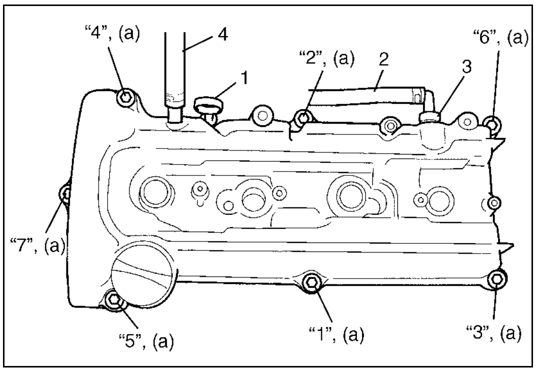
- Timing chain cover (1) and cylinder head (2) mating surface as shown.

"A" : Sealant 99000-31250

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.

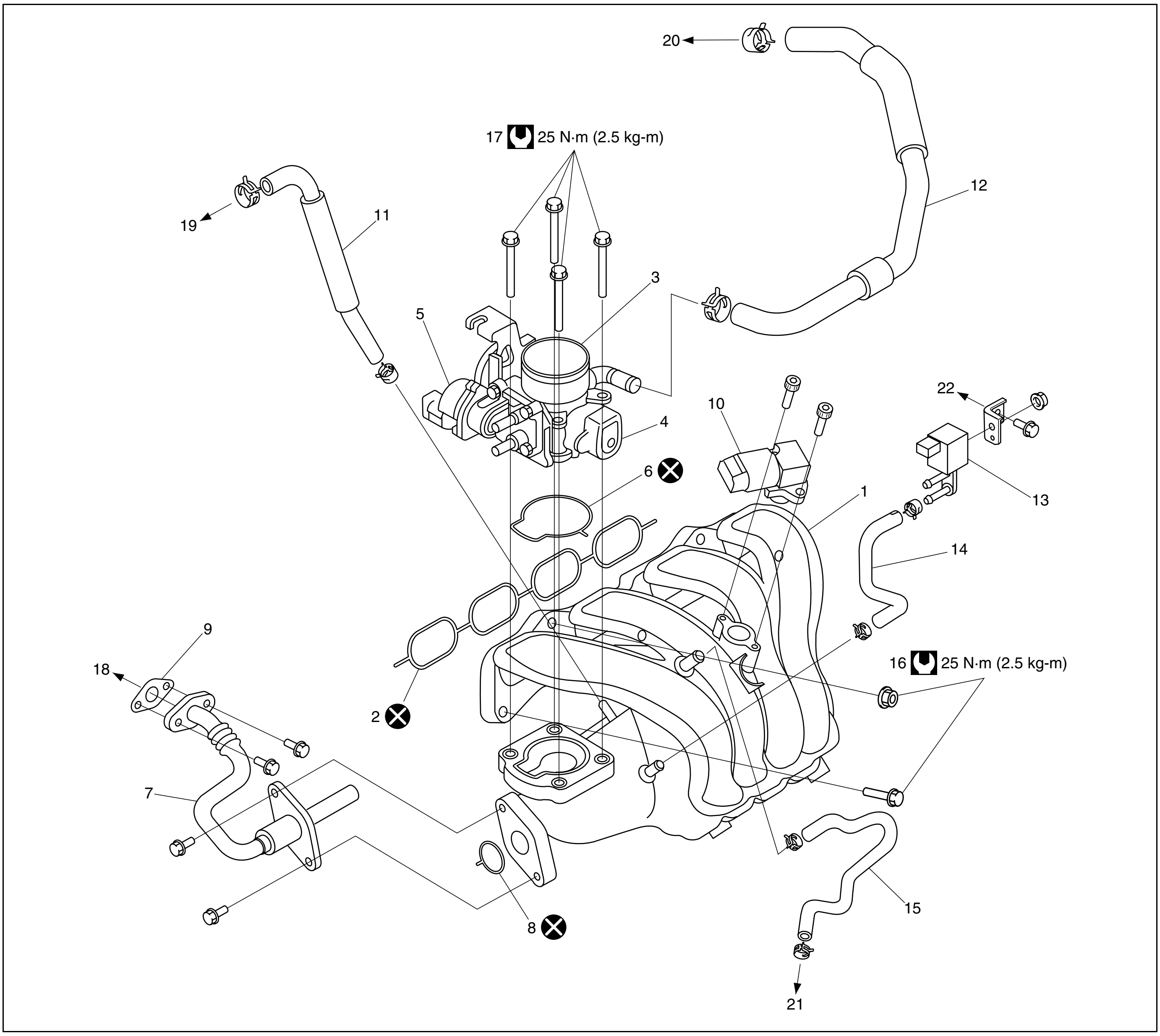


4) Tighten bolts in such order as indicated in figure a little at a time till they are tightened to specified torque.

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

5) Connect PCV hose (2) to PCV valve (1).
6) Connect breather hose (4).
7) Install oil level gauge (3).
8) Install wire harness clamp to cylinder head cover.
9) Install ignition coil assemblies with high-tension cord.
10) Connect ignition coil couplers and clamp harness securely.
11) Install cylinder head upper cover.
12) Install air cleaner case and resonator.
13) Connect negative cable at battery.

Throttle Body and Intake Manifold Components

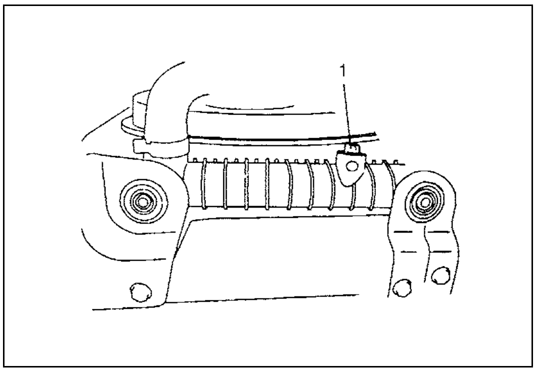


1. Intake manifold	7. EGR pipe	13. EVAP canister purge valve	19. To PCV valve
2. Intake manifold O-Ring	8. O-Ring	14. EVAP canister purge valve hose	20. To cylinder head cover
3. Throttle body	9. Gasket	15. Brake booster hose	21. To brake booster
4. TP sensor	10. MAP sensor	16. Intake manifold mounting bolt and nut	22. To air cleaner case
5. IAC valve	11. PCV valve hose	17. Throttle body mounting bolt	Tightening torque
6. O-Ring	12. Breather hose	18. To EGR valve	Do not reuse.

Throttle Body Removal and Installation

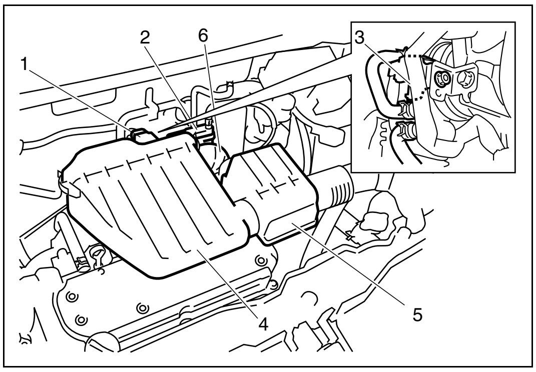
Removal

1) Relieve fuel pressure referring to "Fuel pressure relief procedure" in Section 6.
2) Disconnect negative cable at battery.

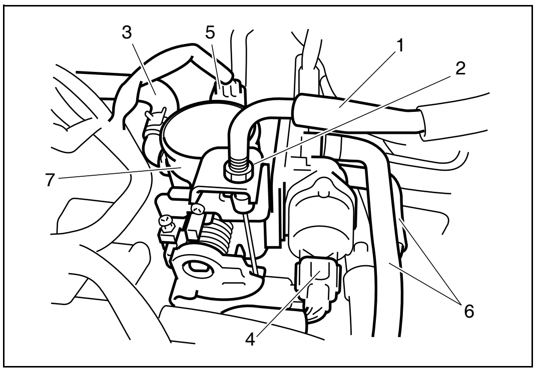


3) Drain coolant by loosening drain plug (1).

> **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) Disconnect MAF sensor coupler (1).
5) Remove EVAP canister purge valve chamber (2) from air cleaner outlet hose.
6) Remove EVAP canister purge valve (3).
7) Remove air cleaner case (4) and resonator (5).
8) Remove air cleaner outlet hose (6).



9) Remove accelerator cable (1) by loosening lock nut (2).
10) Disconnect breather hose (3) and water hoses (6) from throttle body.
11) Disconnect IAC valve coupler (4) and TP sensor coupler (5).
12) Remove throttle body (7) from intake manifold.

Installation

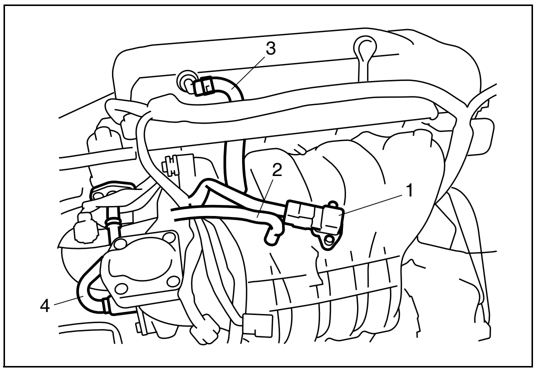
Reverse removal procedure for installation noting the followings.

- Use new throttle body O-ring.
- 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 6E1.
- 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.

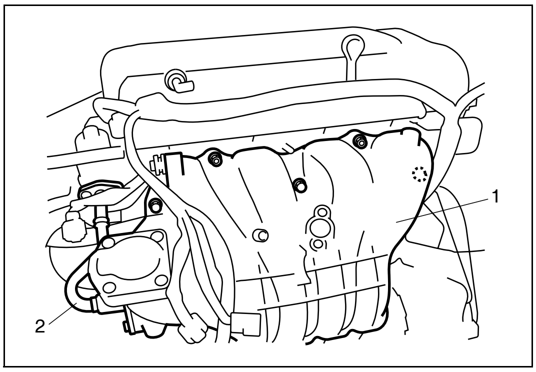
Intake Manifold Removal and Installation

Removal

1) Remove throttle body referring to "Throttle Body Removal and Installation" in this section.



2) Disconnect MAP sensor coupler (1).
3) Disconnect the following hoses :
  - Brake booster hose (2) from cylinder head cover
  - PCV hose (3) from PCV valve
4) Disconnect EGR pipe (4) from EGR valve.

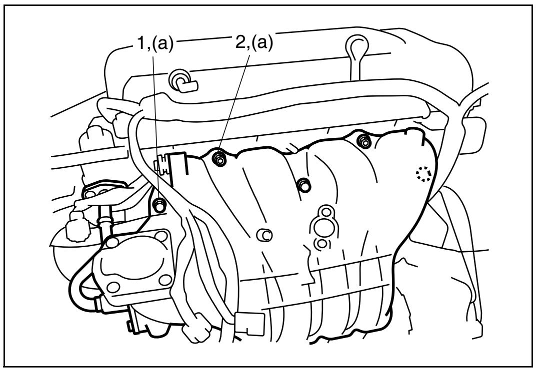


5) Remove intake manifold (1) and EGR pipe (2) from cylinder head, and then remove its gasket and O-ring.

Installation

Reverse removal procedure for installation noting the followings.

- Use new intake manifold O-ring.
- Use new EGR pipe gasket and O-ring.

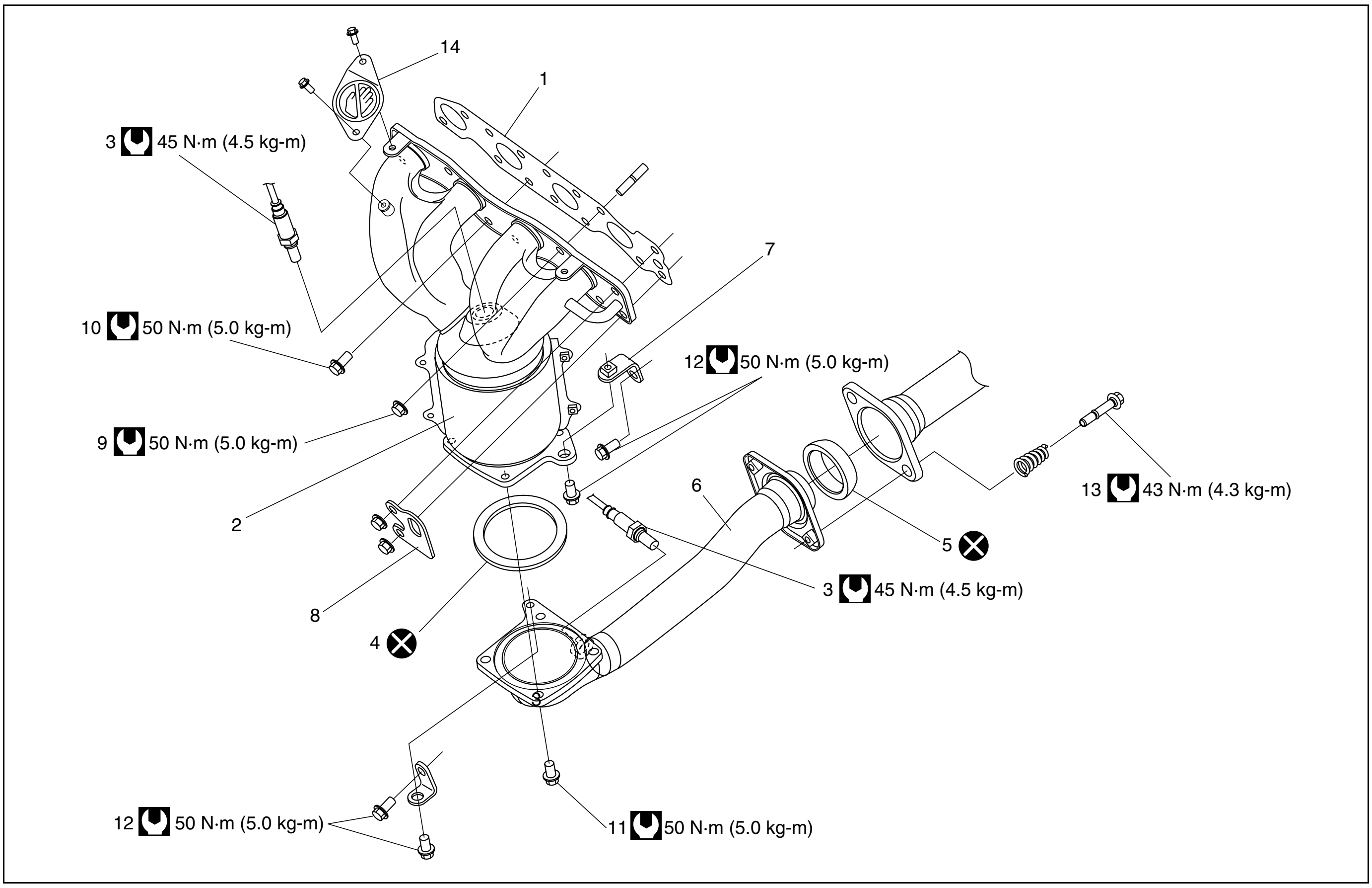


- Tighten bolts (1) and nuts (2) to specified torque.

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 6E1.
- 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 Components



1. Exhaust manifold gasket	7. Exhaust manifold stiffener	13. Exhaust pipe No.2 bolt
2. Exhaust manifold	8. Engine hook	14. Caution plate
3. Exhaust oxygen sensor	9. Exhaust manifold mounting nut	Tightening torque
4. Exhaust pipe gasket	10. Exhaust manifold mounting bolt	Do not reuse.
5. Seal ring No.1	11. Exhaust pipe No.1 bolt	
6. Exhaust No.1 pipe	12. Exhaust manifold stiffener bolt	

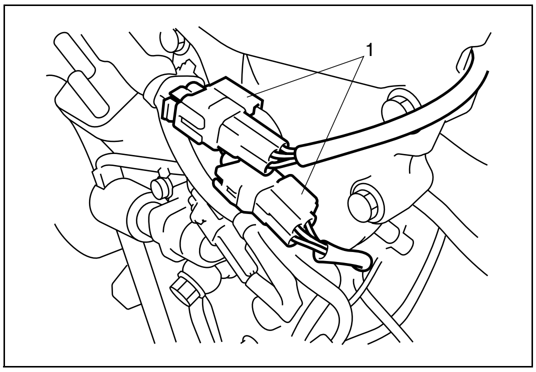
Exhaust Manifold Removal and Installation

WARNING:

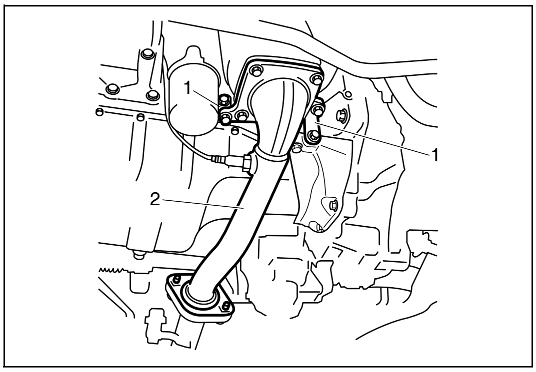
To avoid danger of being burned, do not service exhaust system while it is still hot. Service should be performed after system cools down.

Removal

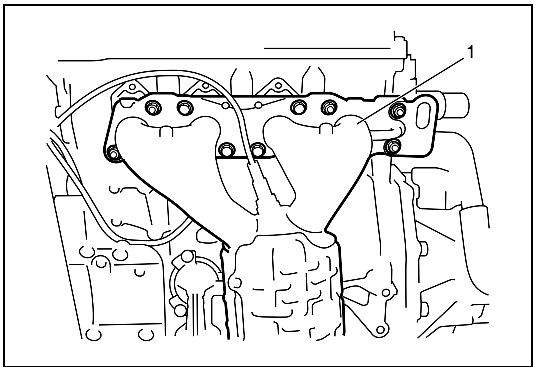
1) Disconnect negative cable at battery.
2) Remove front bumper with front grille referring to “Front Bumper and Rear Bumper Removal and Installation” in Section 9.
3) Remove radiator referring to “Radiator Removal and Installation” in Section 6B for equipped with A/C.
4) With hose connected, detach A/C condenser from vehicle body for equipped with A/C.



5) Disconnect heated oxygen sensor coupler (1) and detach it from its stay.

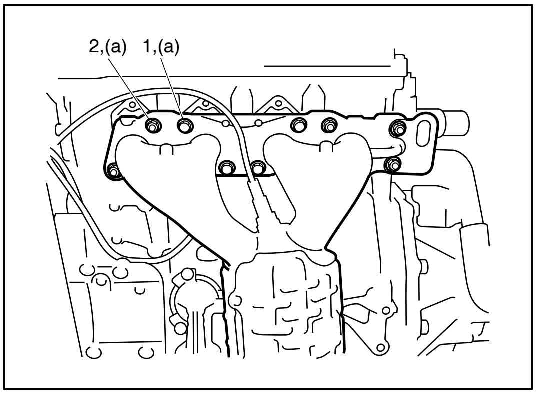


6) Remove exhaust manifold stiffener (1).
7) Disconnect exhaust No.1 pipe (2) from exhaust manifold.



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

Installation

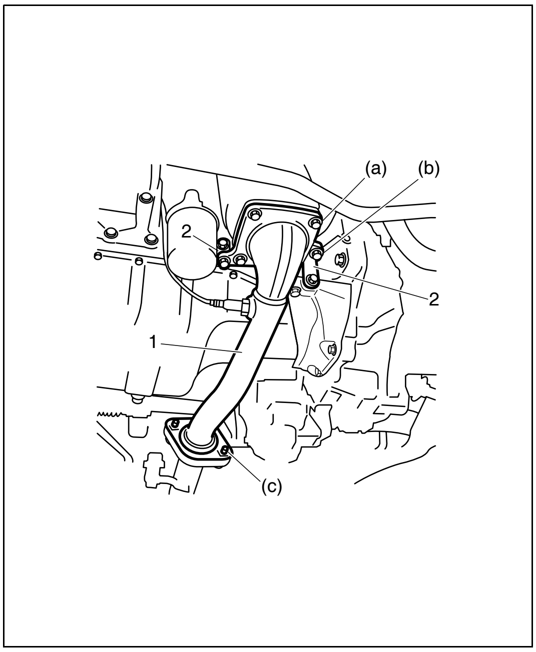


1) Install new gasket to cylinder head.
   Then install exhaust manifold.
   Tighten manifold bolts (1) and nuts (2) to specified torque.

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

NOTE:

The figure on the left varies with specification.



2) Install new seal ring and connect exhaust No.1 pipe (1) to exhaust manifold.
   Tighten pipe fasteners to specified torque.

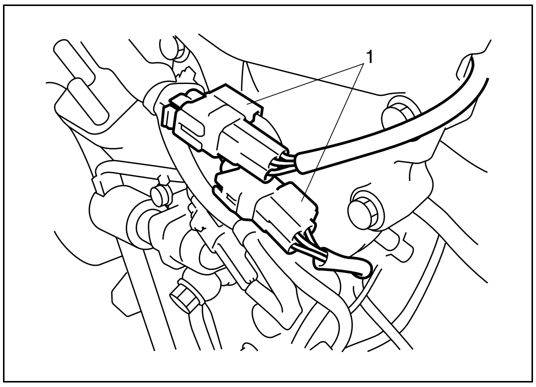
Tightening torque
Exhaust No.1 pipe bolts (a) : 50 N·m (5.0 kg-m, 36.5 lb-ft)

3) Install exhaust manifold stiffener (2).
   Tighten exhaust manifold stiffener bolts to specified torque.

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

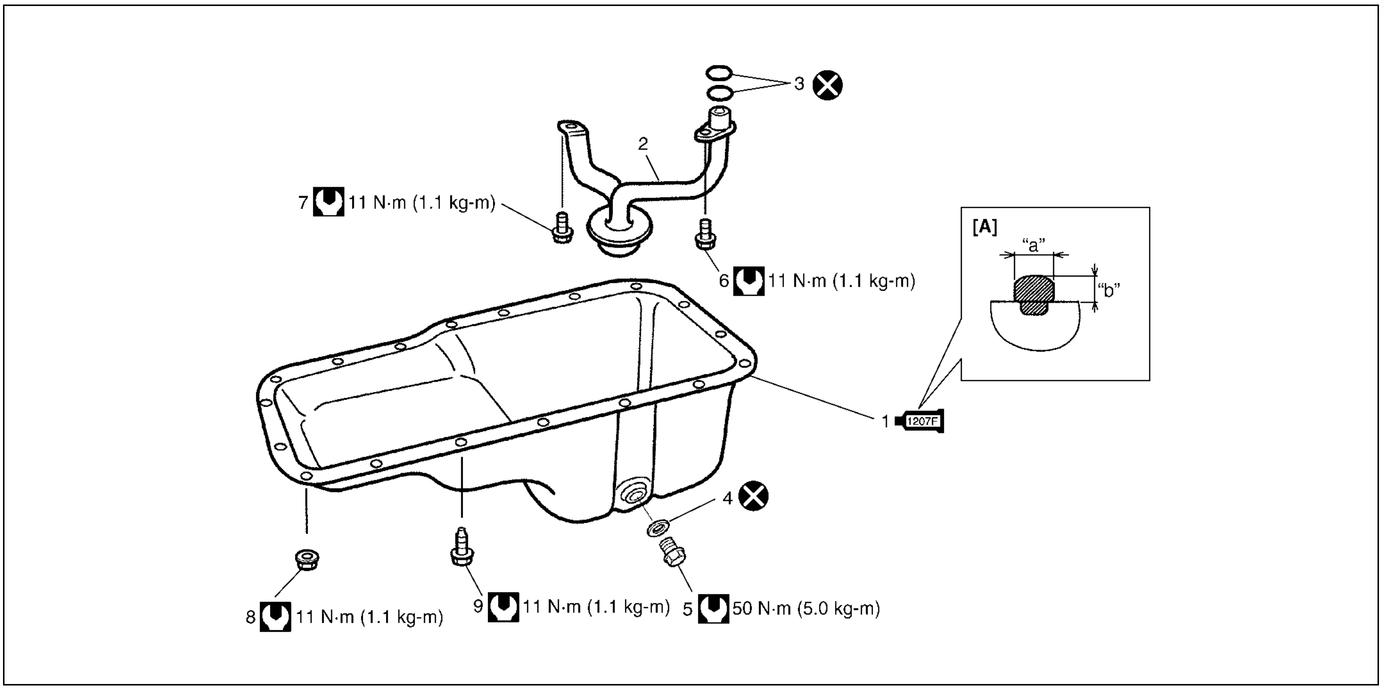
4) Install new seal ring and connect exhaust No.1 pipe (1) to exhaust No.2 pipe.
   Tighten pipe fasteners to specified torque.

Tightening torque
Exhaust No.2 pipe bolts (c) : 43 N·m (4.3 kg-m, 31.5 lb-ft)



5) Connect heated oxygen sensor coupler (1) and fit coupler to bracket securely.
6) Install A/C condenser to vehicle body for equipped with A/C.
7) Install radiator referring to “Radiator Removal and Installation” in Section 6B for equipped with A/C.
8) Install front bumper with front grille by referring to “Front Bumper and Rear Bumper Removal and Installation” in Section 9.
9) Connect negative cable to battery.
10) Check exhaust system for exhaust gas leakage.

Oil Pan and Oil Pump Strainer Components

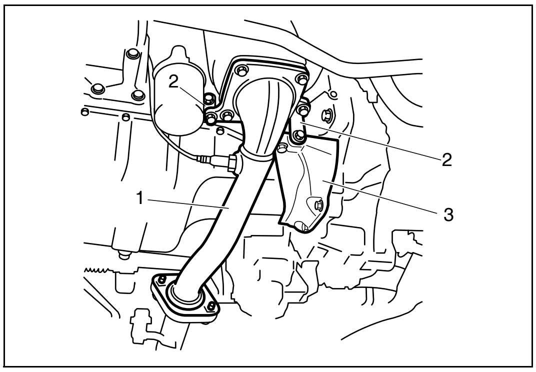


[A] :	Sealant application amount	3. O-ring	8. Oil pan nut
"a" :	3 mm (0.12 in.)	4. Gasket	9. Oil pan bolt
"b" :	2 mm (0.08 in.)	5. Drain plug	Tightening torque
1207F 1.	Oil pan : Apply sealant 99000-31250 to mating surface.	6. Strainer bolt	Do not reuse.
2.	Strainer	7. Bracket bolt	

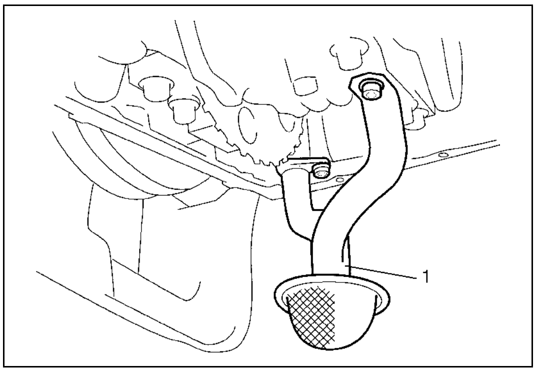
Oil Pan and Oil Pump Strainer Removal and Installation

Removal

1) Remove oil level gauge.
2) Drain engine oil by removing drain plug.

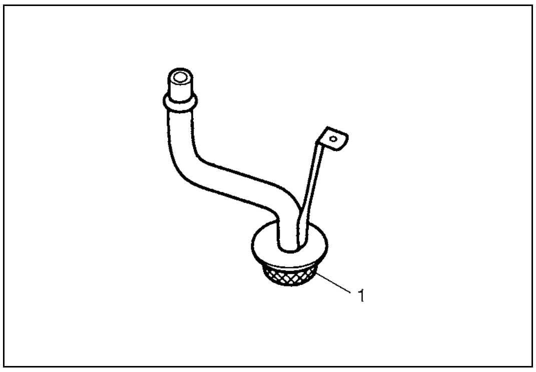


3) Remove exhaust No.1 pipe (1), exhaust manifold stiffener (2) and transaxle stiffener (3).
4) For 2WD vehicle, remove engine rear mounting bracket.
5) For 4WD vehicle, remove transfer referring to "Transfer Dismounting and Mounting" in Section 7D.

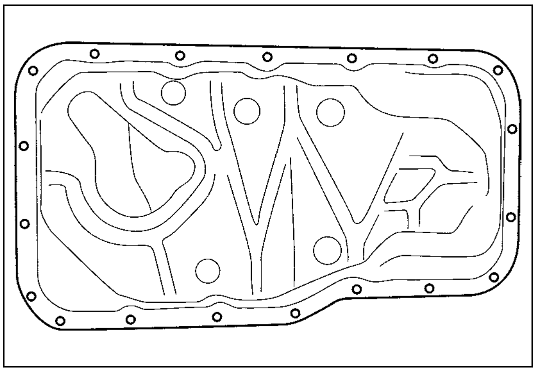


2) Remove oil pan and then oil pump strainer (1) from cylinder block.

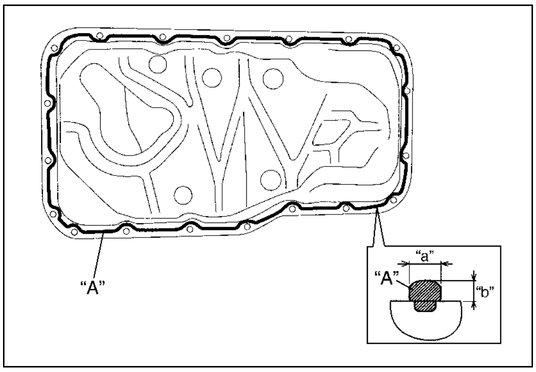
Installation



1) Clean oil pump strainer screen (1).



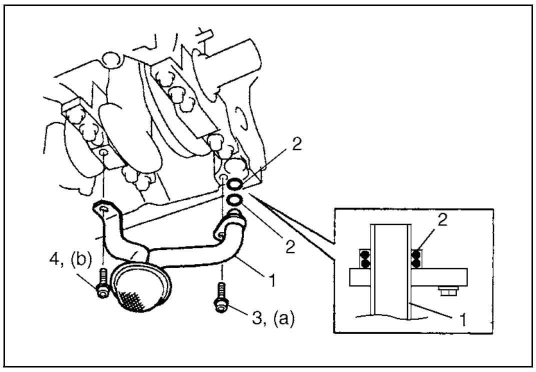
2) Clean sealing surface on oil pan and cylinder block.
   Remove oil, old sealant and dust from sealing surface.



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

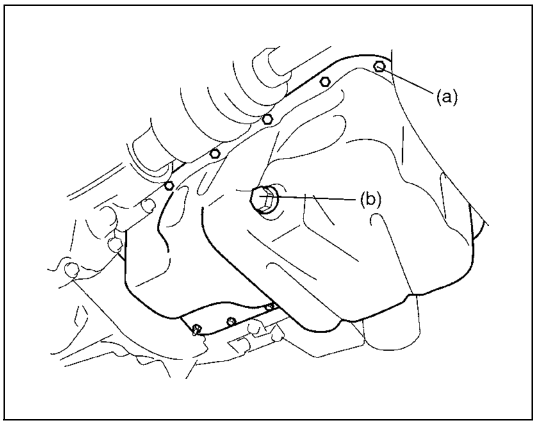
"A" : sealant 99000-31250

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



4) Install new O-rings (2) in the position as shown in figure and install oil pump strainer (1).
   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)



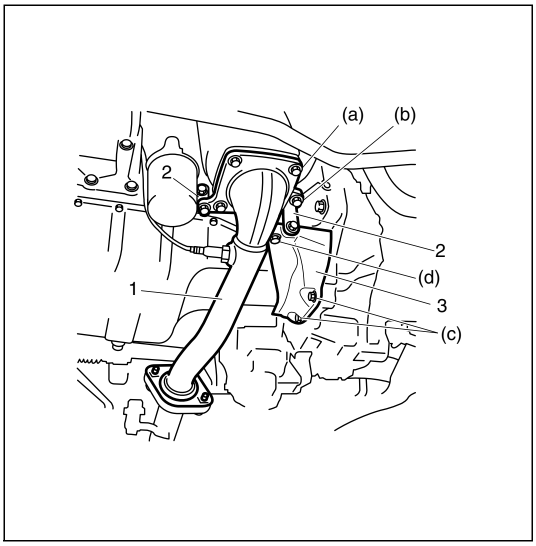
5) After fitting oil pan to cylinder block, run in securing bolts and start tightening at the center :
   move wrench outward, tightening one bolt at a time. Tighten bolts and nuts to specified torque.

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

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

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

7) For 2WD vehicle, install Engine rear mounting bracket.
8) For 4WD vehicle, install transfer referring to “Transfer Dismounting and Mounting” in Section 7D.



9) Install transaxle stiffener (3).
   Tighten transaxle stiffener bolts (c) first and next (d) with specified torque.

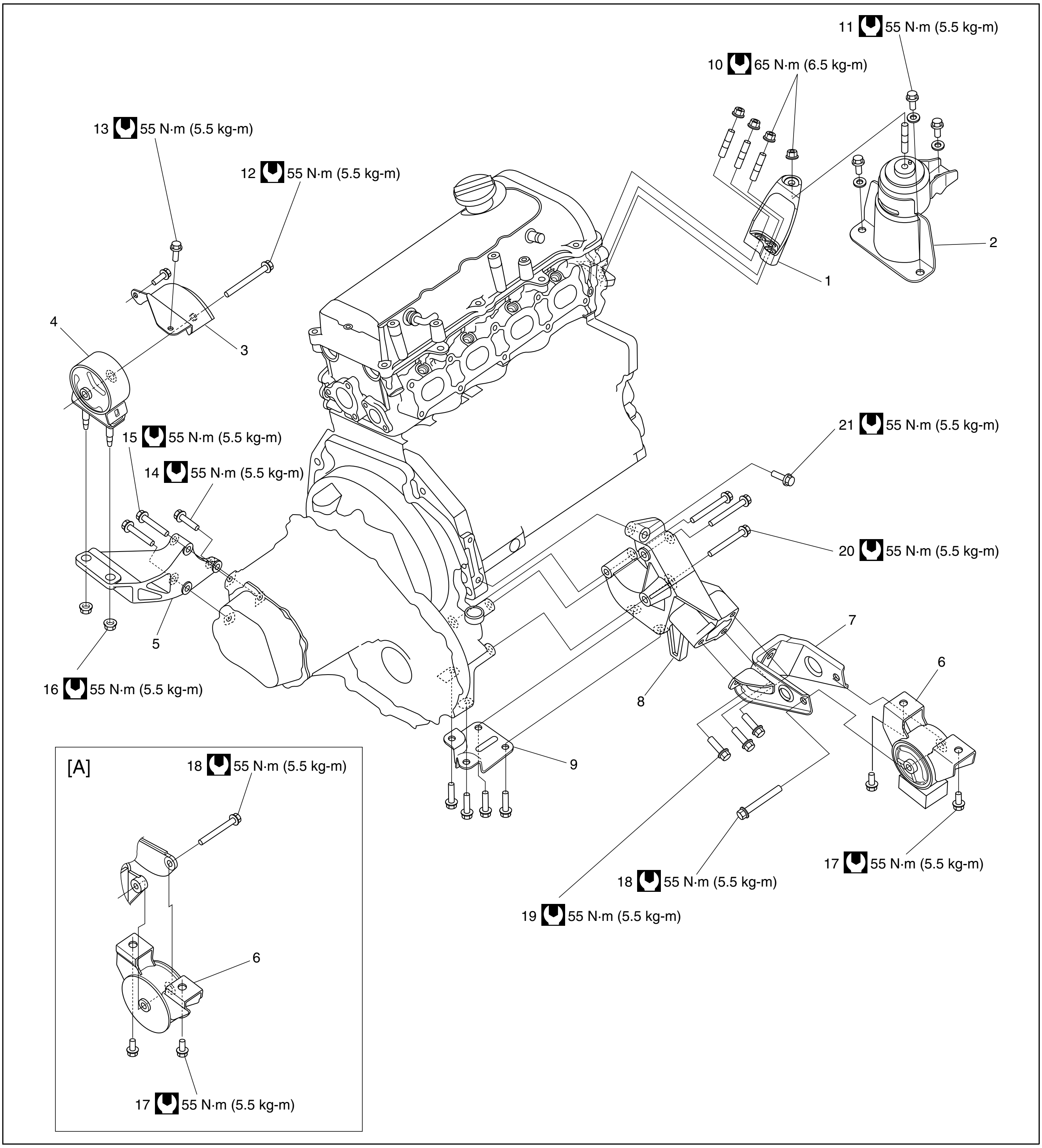
Tightening torque
Transaxle stiffener bolts (c and d) :
50 N·m (5.0 kg-m, 36.5 lb-ft)

10) Install exhaust manifold stiffener (2) and exhaust No.1 pipe (1).
    Tighten bolts to specified torque.

Tightening torque
Exhaust No.1 pipe bolts (a) : 50 N·m (5.0 kg-m, 36.5 lb-ft)
Exhaust manifold stiffener bolts (b) :
50 N·m (5.0 kg-m, 36.5 lb-ft)

11) Install oil level gauge.
12) Refill engine with engine oil referring to “Engine Oil and Oil Filter Replacement” in Section 0B.
13) Verify that there is no engine oil leakage and exhaust gas leakage at each connection.

Engine Mountings Components



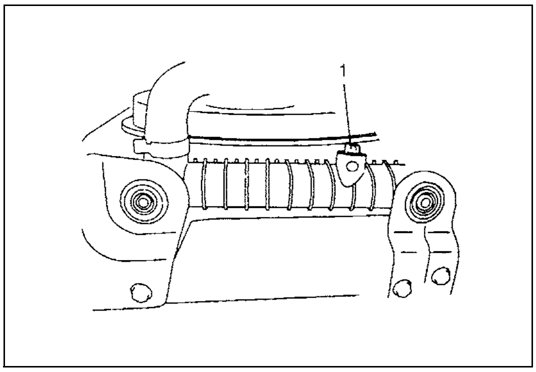
[A] : 4WD MODEL	8. Engine rear mounting No.2 bracket	16. Engine left mounting bracket nut
1. Engine right mounting	9. Engine rear mounting bracket stiffener	17. Engine rear mounting bolt
2. Engine right body side bracket	10. Engine right mounting nut	18. Engine rear mounting bolt
3. Engine left body side bracket	11. Engine right body side bracket bolt	19. Engine rear mounting No.1 bracket bolt
4. Engine left mounting	12. Engine left mounting bolt	20. Engine rear mounting No.2 bracket bolt
5. Engine left mounting bracket	13. Engine left body side bracket bolt	21. Engine rear mounting No.2 bracket bolt
6. Engine rear mounting	14. Engine left mounting bracket bolt (short)	Tightening torque
7. Engine rear mounting No.1 bracket	15. Engine left mounting bracket bolt (long)	

Unit Repair Overhaul

Engine Assembly Removal and Installation

Removal

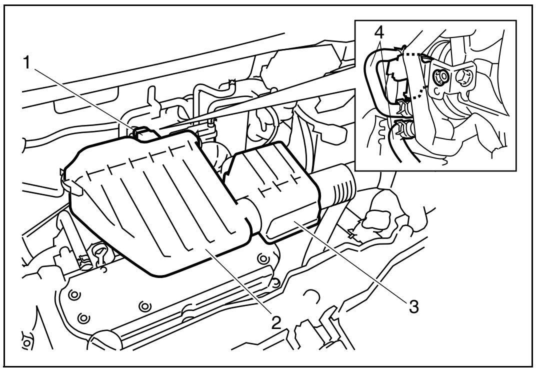
1) Relieve fuel pressure referring to "Fuel pressure relief procedure" in Section 6.
2) Disconnect negative and positive cables at battery.
3) Remove engine hood after disconnecting windshield washer hose.
4) Remove right and left side engine under covers.
5) Remove A/C compressor belt by referring to "Compressor Assembly Removal and Installation" in Section 1B (if equipped).
6) Drain engine oil referring to "Engine Oil and Oil Filter Replacement" in Section 0B.
7) Drain transaxle oil referring to "Manual Transaxle Oil Change" in Section 7A1.
8) Drain transfer oil referring to "Transfer Oil Change" in Section 7D (for 4WD vehicle).



9) Drain coolant by referring to "Cooling System Flush and Refill" in Section 6B.

WARNING:

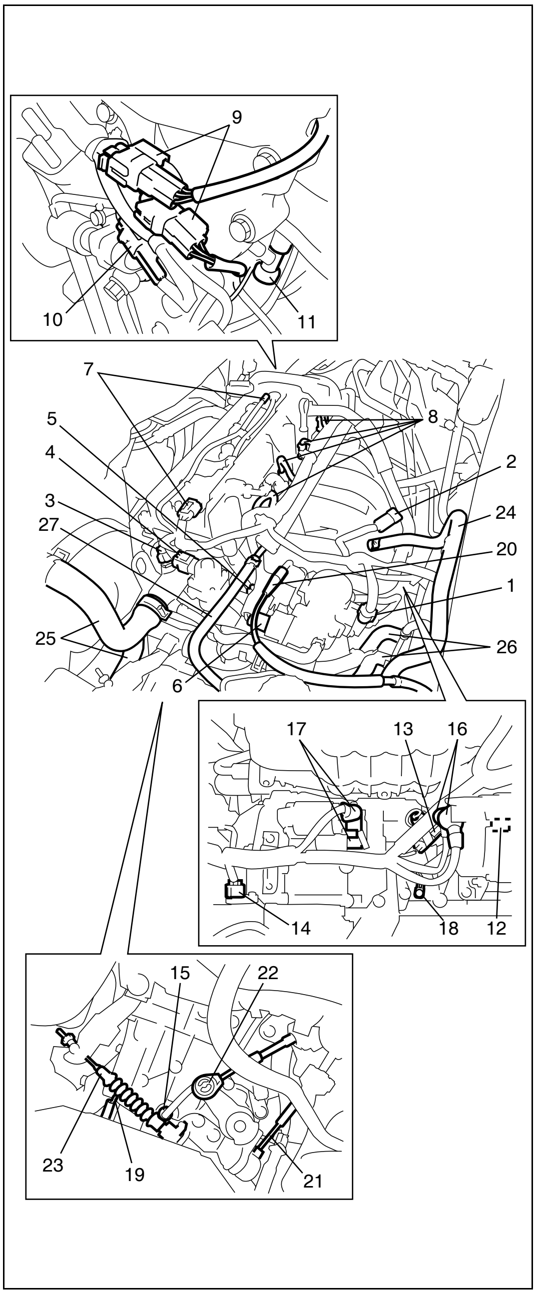
To help avoid danger of being burned, do not remove drain plug (1) and radiator cap while engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if plug and cap are taken off too soon.



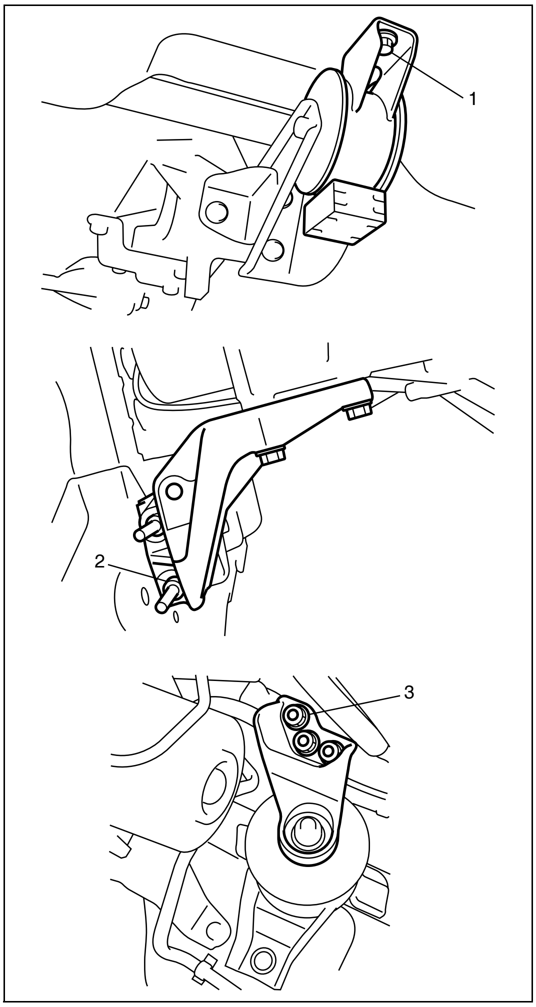
10) Disconnect MAF sensor coupler (1).
11) Remove air cleaner case (2) and resonator (3).
12) Remove canister purge hose (4) from EVAP canister purge valve.
13) With hose connected, detach A/C compressor from its bracket (if equipped).

NOTE:

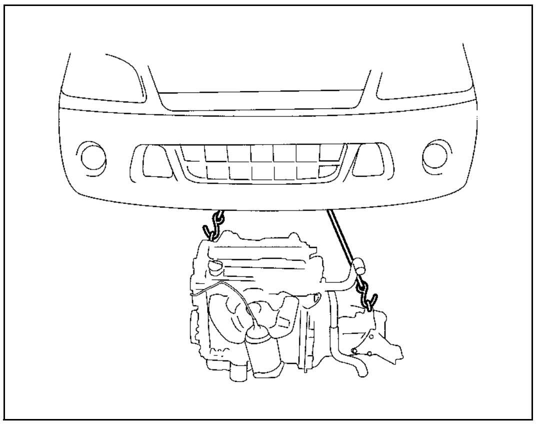
Suspend removed A/C compressor at a place where no damage will be caused during removal and installation of engine assembly.



14) Disconnect the following electric lead wires:
    - TP sensor (1)
    - MAP sensor (2)
    - ECT sensor (3)
    - EGR valve (4)
    - CMP sensor (5)
    - IAC valve (6)
    - Ignition coil assembly (7)
    - Injectors (8)
    - Heated oxygen sensor (9)
    - Oil control valve (10)
    - Engine oil pressure switch (11)
    - CKP sensor (12)
    - Knock sensor (13)
    - VSS (14)
    - Back up light switch (15)
    - Generator (16)
    - Starting motor (17)
    - Ground terminal (18) from cylinder block
    - Battery ground cable (19) from transaxle
    - Magnet clutch switch of A/C compressor (if equipped)
    - Each wire harness clamps
15) Remove fuse box from its bracket.
16) Disconnect the following cables :
    - Accelerator cable (20)
    - Gear select control cable (21)
    - Gear shift control cable (22)
    - Clutch cable (23)
17) Disconnect the following hoses :
    - Brake booster hose (24) from intake manifold
    - Radiator inlet and outlet hoses (25) from each pipe
    - Heater inlet and outlet hoses (26) from each pipe
    - Fuel feed hoses (27) from fuel feed pipe
18) Remove exhaust No.1 pipe referring to “Exhaust Manifold Removal and Installation” in this section.
19) Disconnect right and left drive shaft joints to differential gear referring to “Front Drive Shaft Assembly Removal and Installation” in Section 4A.
    For engine and transaxle removal, it is not necessary to remove drive shafts from steering knuckle.
20) For 4WD vehicle, remove propeller shaft referring to “Propeller Shaft Removal and Installation” in Section 4B.



21) Install lifting device.
22) Remove engine rear mounting bolts (1), engine left mounting bracket nuts (2) and engine right mounting nuts (3).



23) Before removing engine with transaxle from body, recheck to make sure all hoses, electric wires and cables are disconnected from engine and transaxle.
24) Lower engine with transaxle from body.

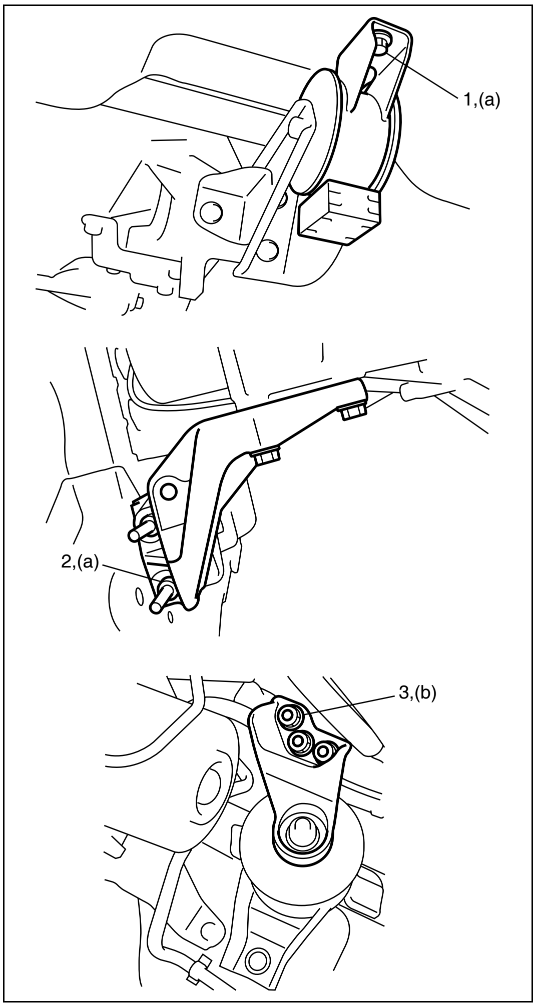
NOTE:

Before lowering engine, to avoid damage to A/C compressor, raise it through clearance made on engine crankshaft pulley side. At this time, use care so that no excessive force is applied to hoses.

25) Disconnect transaxle from engine referring to “Transaxle Unit Dismounting and Remounting” in Section 7A1.
26) Remove clutch cover and clutch disk referring to “Clutch Cover, Clutch Disc and Flywheel Removal and Installation” in Section 7C1.

Installation

1) Install clutch cover and clutch disk referring to “Clutch Cover, Clutch Disc and Flywheel Removal and Installation” in Section 7C1.
2) Connect transaxle to engine referring to “Transaxle Unit Dismounting and Remounting” in Section 7A1.

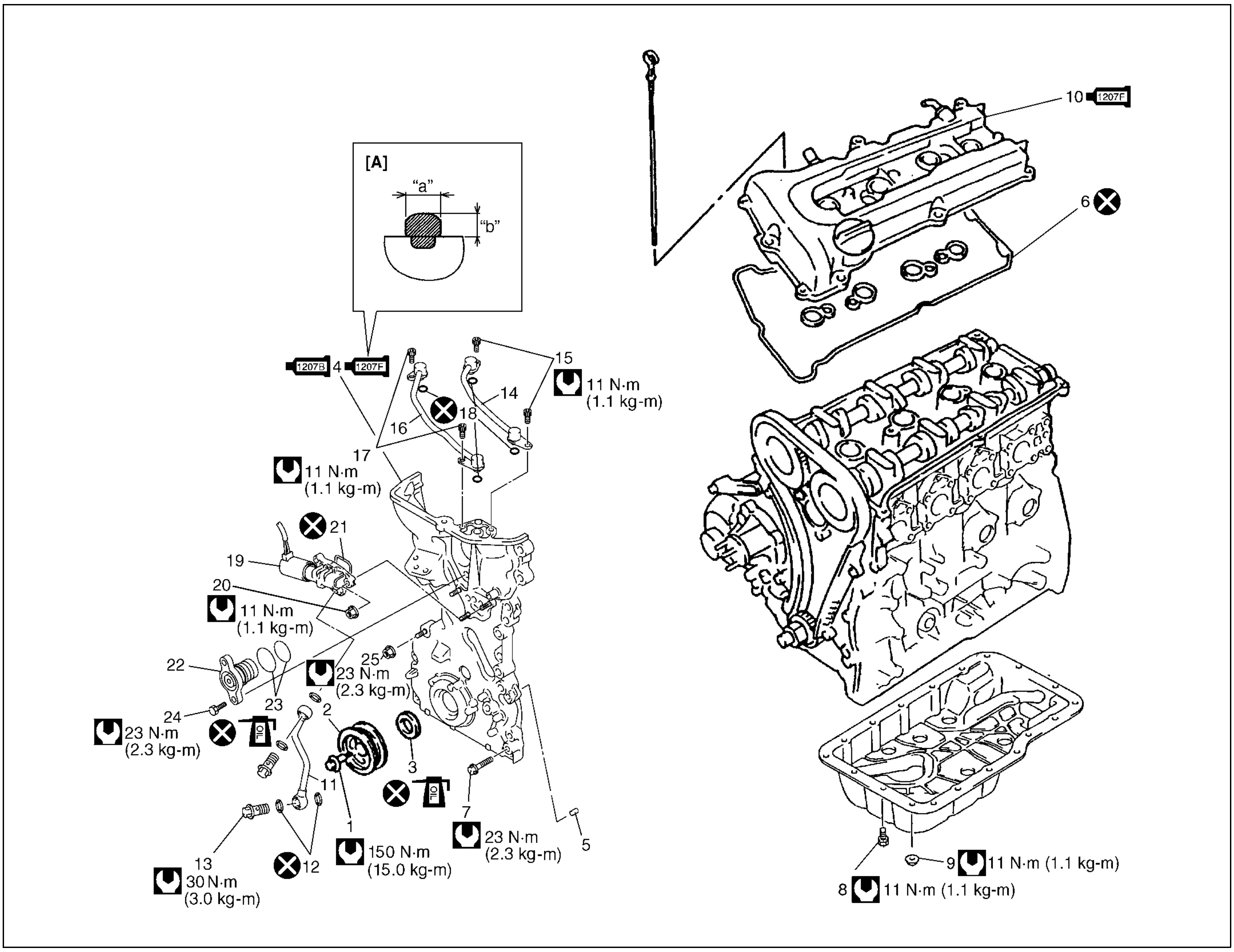


3) Lift engine with transaxle into engine compartment, but do not remove lifting device.
4) Install engine rear mounting bolts (1), engine left mounting bracket nuts (2) and engine right mounting nuts (3).
   Tighten these bolts and nuts to specified torque.

Tightening torque
Engine left mounting bolts
(a) : 55 N·m (5.5 kg-m, 40.0 lb-ft)
Engine right mounting bracket nuts
(b) : 65 N·m (6.5 kg-m, 47.0 lb-ft)

5) Remove lifting device.
6) For 4WD vehicle, install propeller shaft referring to “Propeller Shaft Removal and Installation” in Section 4B.
7) Connect drive shaft joints referring to Section 4A.
8) Install exhaust No.1 pipe referring to “Exhaust Manifold Removal and Installation” in this section.
9) Reverse disconnected hoses, cables and electric wires for connection.
10) Install air cleaner case and resonator.
11) Install A/C compressor to its bracket (if equipped).
12) Adjust A/C compressor belt tension (if equipped) referring to “Compressor Drive Belt Inspection and Adjustment” in Section 1B.
13) Adjust accelerator cable play referring to “Accelerator cable adjustment” in Section 6E1.
14) Check to ensure that all removed parts are back in place. Reinstall any necessary parts which have not been reinstalled.
15) Refill cooling system with coolant referring to “Cooling System Flush and Refill” in Section 6B.
16) Refill engine with engine oil referring to “Engine Oil and Oil Filter Replacement” in Section 0B.
17) Refill transaxle with transaxle oil referring to “Manual Transaxle Oil Change” in Section 7A1.
18) Refill transfer with transfer oil referring to “Transfer Oil Change” in Section 7D (for 4WD vehicle).
19) Connect negative cable at battery.
20) Verify that there is no fuel leakage, coolant leakage, oil leakage and exhaust gas leakage at each connection.

Timing Chain Cover Components



[A]: Sealant application amount	8. Oil pan mounting bolt	18. O ring
"a": 3 mm (0.12 in.)	9. Oil pan mounting nut	19. Oil control valve
"b": 2 mm (0.08 in.)	[1207F] 10. Cylinder head cover : Apply sealant 99000-31250 to the sealing point for timing chain cover mating surface and cylinder head gasket sealing point referring to "Installation" under "Cylinder Head Cover Removal and Installation" in this section.	20. Oil control valve mounting nut
1. Crankshaft pulley bolt	11. Oil gallery pipe No.1	21. O ring
2. Crankshaft pulley	12. Copper washer	22. Cap
[OIL] 3. Oil seal : Apply engine oil to oil seal lip.	13. Oil gallery pipe No.1 bolt	[OIL] 23. O ring
[1207B] [1207F] 4. Timing chain cover : Apply sealant 99000-31140 to the mating surface of cylinder and cylinder head. : Apply sealant 99000-31250 to the mating surface of timing chain cover referring to the figure of Step 1) of "Installation" under "Timing Chain Cover Removal and Installation" in this section.	14. Oil gallery pipe No.2	24. Cap bolt
5. Pin	15. Oil gallery pipe No.2 bolt	25. Timing chain cover mounting nut
6. Cylinder head cover gasket	16. Oil gallery pipe No.3	Tightening torque
7. Timing chain cover mounting bolts	17. Oil gallery pipe No.3 bolt	Do not reuse.

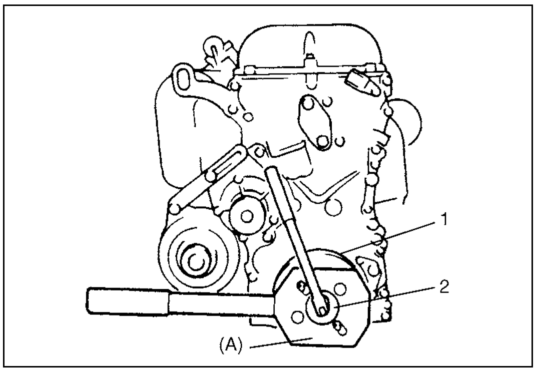
Timing Chain Cover Removal and Installation

Removal

CAUTION:

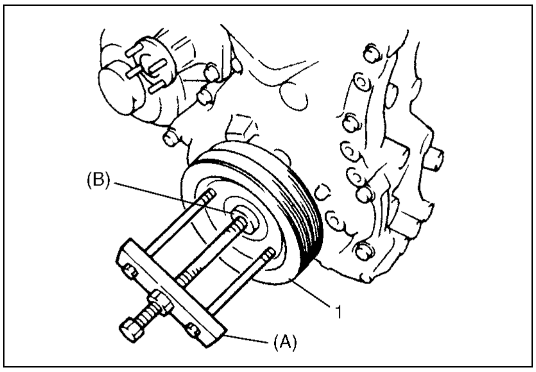
- **Keep working table, tools and hands clean while overhauling.**
- **Use special care to handle aluminum parts so as not to damage them.**
- **Do not expose removed parts to dust. Keep them always clean.**

1) Remove engine assembly from vehicle referring to "Engine Assembly Removal and Installation" in this section.



2) Remove crankshaft pulley bolt (2).
   To lock crankshaft pulley (1), use special tool with it as shown in figure.

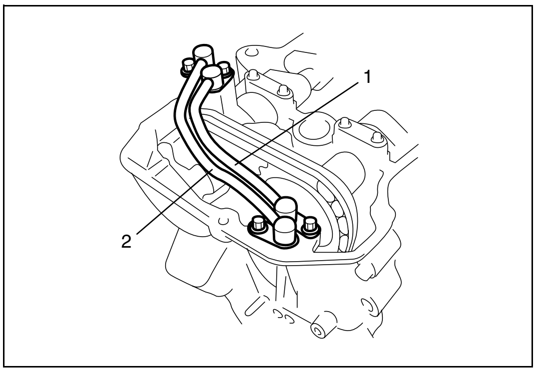
   Special tool
   (A) : 09917-68221



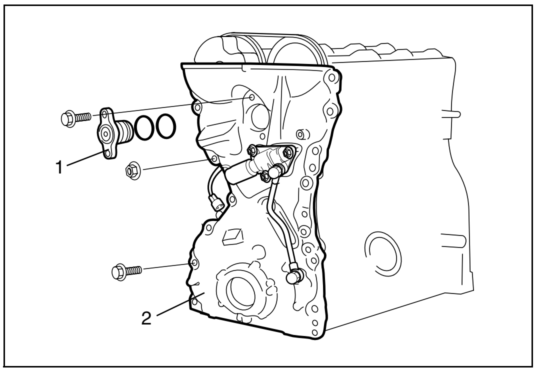
3) Remove crankshaft pulley (1).
   If it is hard to remove, use special tools as shown in figure.

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

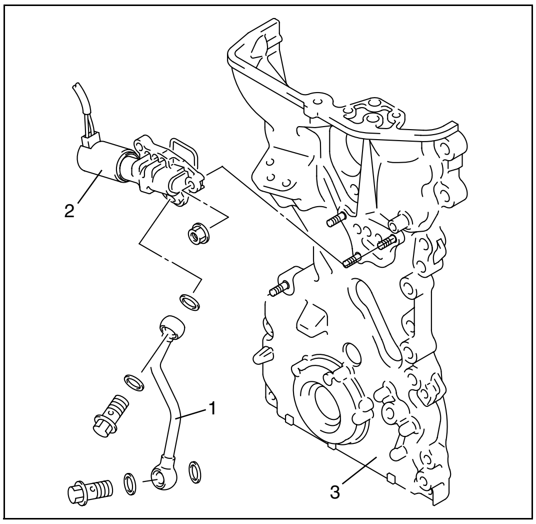
4) Remove cylinder head cover referring to "Cylinder Head Cover Removal and Installation" in this section.
5) Remove oil pan referring to "Oil Pan and Oil Pump Strainer Removal and Installation" in this section.
6) Remove water pump pulley.



7) Remove oil gallery pipes No.2 (1) and No.3 (2).



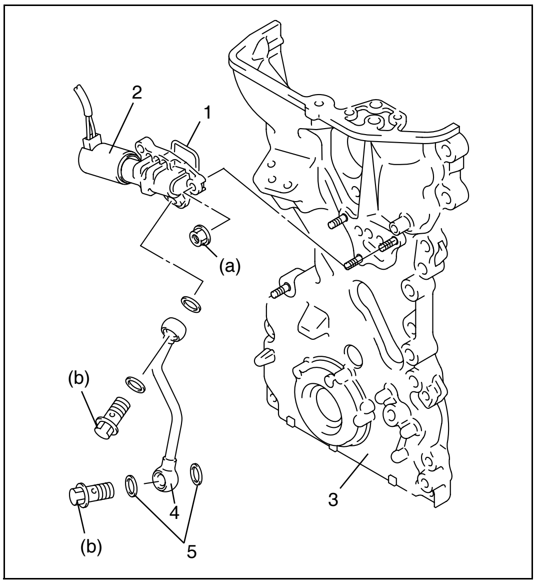
8) Remove cap (1) from timing chain cover (2).
9) Remove timing chain cover.



10) Remove oil gallery pipe No.1 (1) and oil control valve (2) from timing chain cover (3).

Installation

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

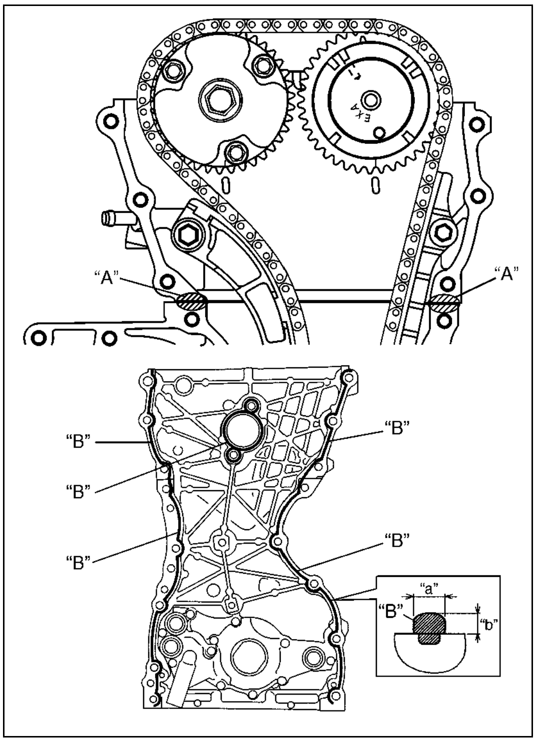


2) Install new O-ring (1) to oil control valve (2).
3) Install oil control valve to timing chain cover (3).
   Tighten nuts to specification.

Tightening torque
Oil control valve mounting nuts
(a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)

4) Install oil gallery pipe No.1 (4) with new copper washers (5) to timing chain cover.
   Tighten bolts to specification.

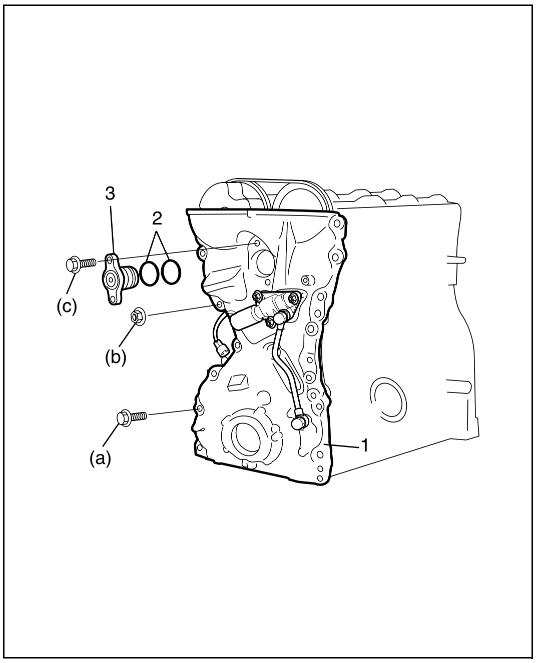
Tightening torque
Oil gallery pipe No.1 bolts
(b) : 30 N·m (3.0 kg-m, 21.5 lb-ft)



5) 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 99000-31250

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



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

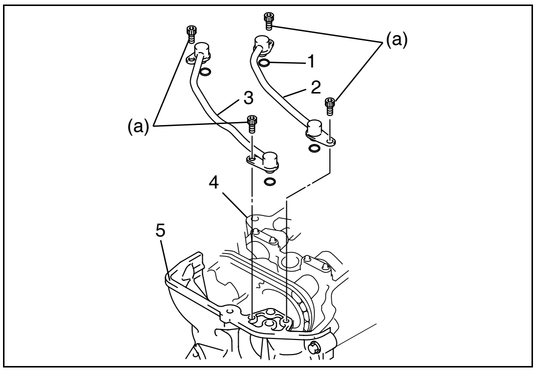
NOTE:

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

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

7) Apply engine oil to new O-rings (2) and install them to cap (3).
8) Install cap (3) to timing chain cover (1).
   Tighten bolts to specified torque.

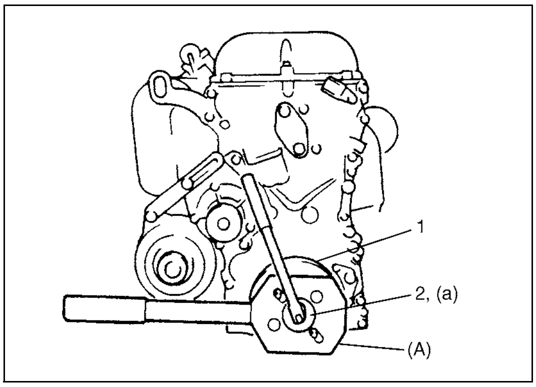
Tightening torque
Cap bolts (c) : 23 N·m (2.3 kg-m, 17.0 lb-ft)



9) Install new O-ring (1) to oil gallery pipes No.2 (2) and No.3 (3).
10) Install oil gallery pipes No.2 and No.3 to cylinder head (4) and timing chain cover (5).
   Tighten bolts to specified torque.

Tightening torque
Oil gallery pipes No.2 and No.3 bolts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)

11) Install water pump pulley.
12) Install cylinder head cover referring to “Cylinder Head Cover Removal and Installation” in this section.
13) Install oil pan referring to “Oil Pan and Oil Pump Strainer Removal and Installation” in this section.



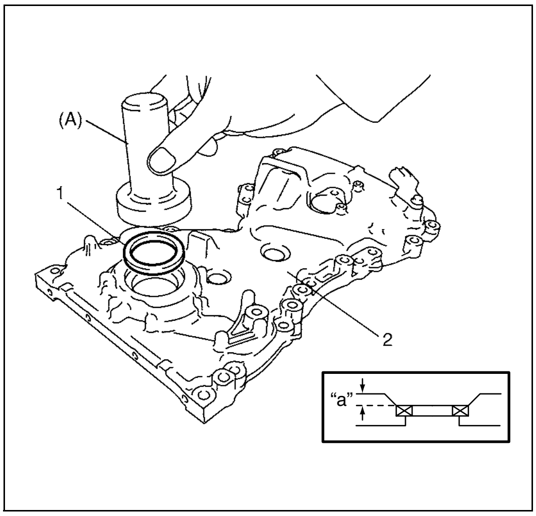
14) Install crankshaft pulley (1). Tighten bolt (2) to specified torque. To lock crankshaft pulley, use special tool with it as shown in the figure.

Special tool
(A) : 09917-68221

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

15) Install engine assembly to vehicle referring to “Engine Assembly Removal and Installation” in this section.

Timing Chain Cover Inspection



Oil seal

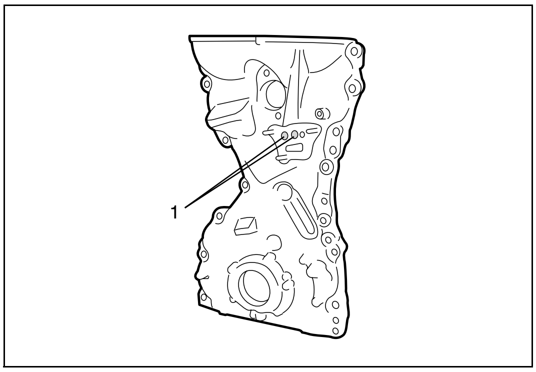
- Check oil seal (1) lip for fault or other damage.
  Replace as necessary.

NOTE:

When installing new oil seal, press fit to timing chain cover (2) by using special tool (Bearing installer) as shown in the figure.

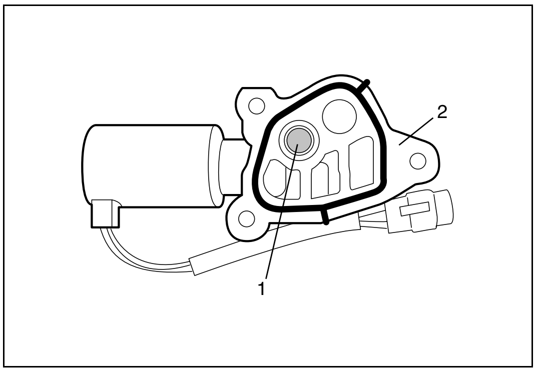
Special tool
(A) : 09913-75810

Drive in dimension
“a” : 1.5 mm (0.06 in.)



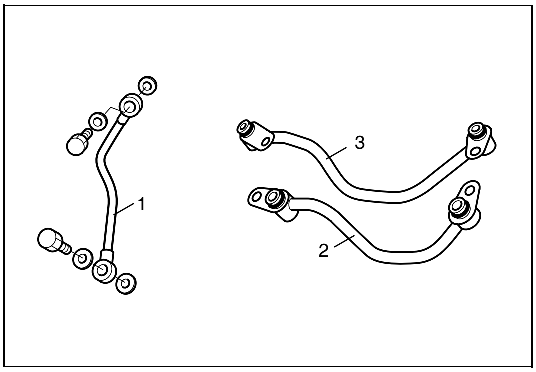
Timing chain cover

Inspect strainer (1) of oil passage for driving intake cam timing sprocket assembly (VVT actuator).
If clog or foreign matter exists, clean strainer.



Oil control valve

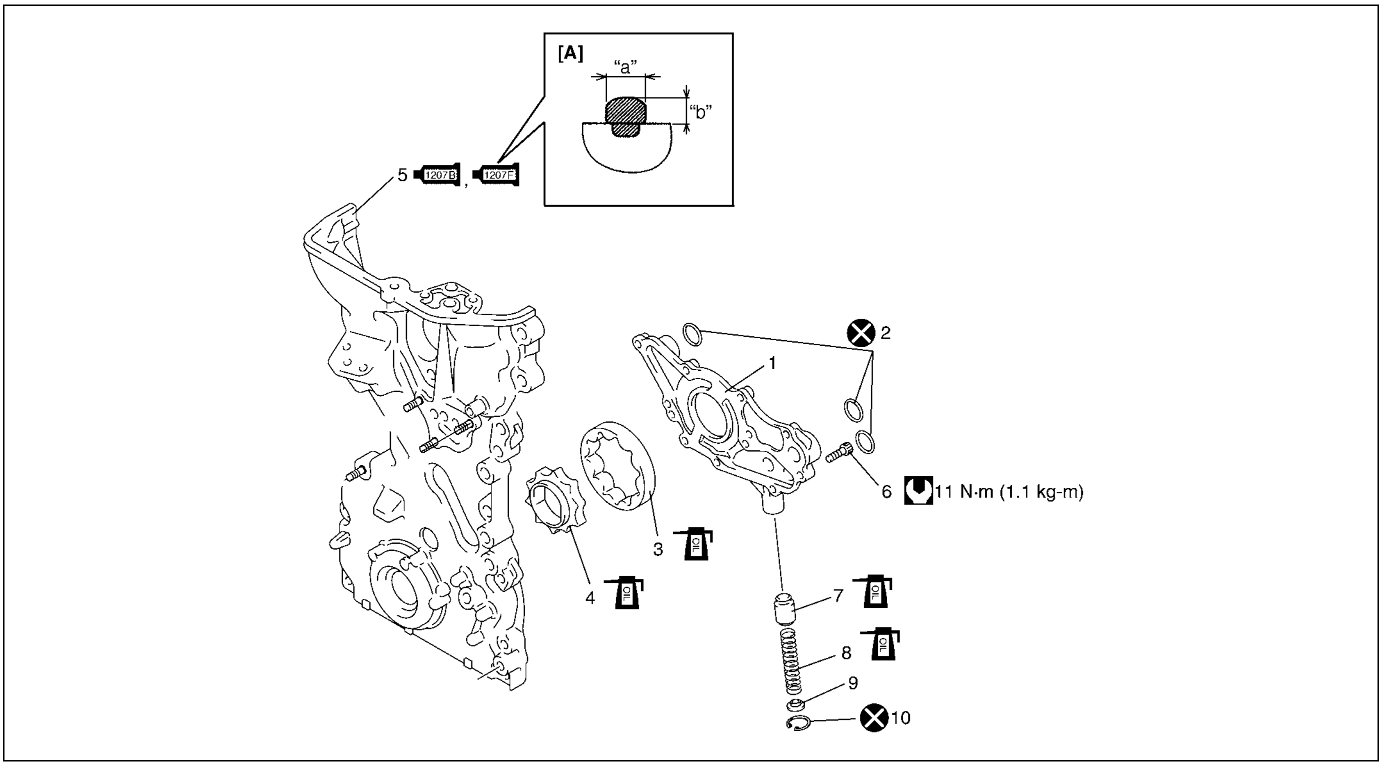
Inspect strainer (1) and mating surface (2) of oil control valve.
Clean oil control valve.



Oil gallery pipe

Inspect oil gallery pipes No.1 (1), No.2 (2) and No.3 (3).
Replace if crack, deformation or clog exists.

Oil Pump Components



[A] : Sealant application amount	4. Inner rotor	10. Circlip
"a" : 3 mm (0.12 in.)	5. Timing chain cover : Apply sealant 99000-31140 to the mating surface of cylinder and cylinder head. : Apply sealant 99000-31250 to mating surface of timing chain cover referring to the figure of Step 4) of "Installation" under "Timing Chain Cover Removal and Installation" in this section.	Tightening torque
"b" : 2 mm (0.08 in.)	6. Rotor plate bolt	Do not reuse.
1. Rotor plate	7. Relief valve	Apply thin coat of engine oil to sliding surface of each parts.
2. O ring	8. Spring	
3. Outer rotor	9. Retainer	

Oil Pump Removal and Installation

Removal

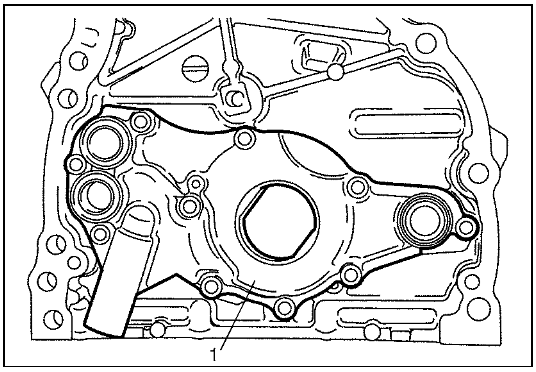
Remove timing chain cover referring to "Timing Chain Cover Removal and Installation" in this section.

Installation

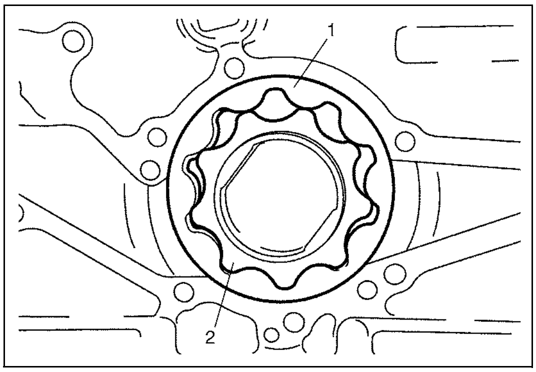
For installation referring to "Timing Chain Cover Removal and Installation" in this section.

Oil Pump Disassembly and Assembly

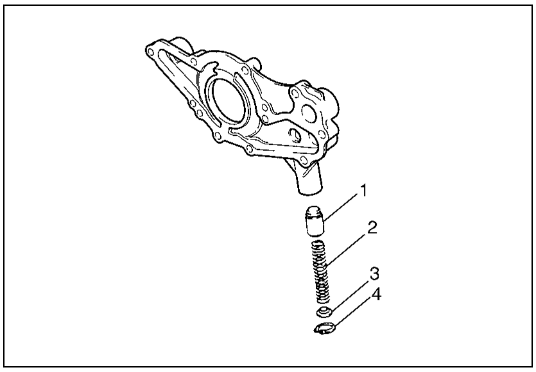
Disassembly



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



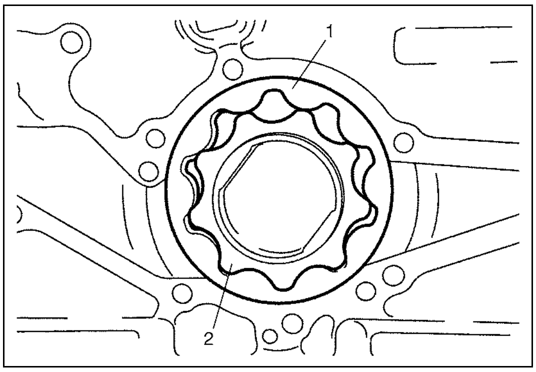
2) Remove outer rotor (1) and inner rotor (2).



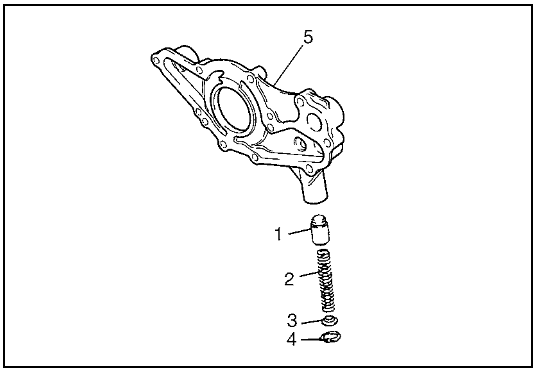
3) Remove relief valve (1), spring (2) and retainer (3) by removing circlip (4).

Assembly

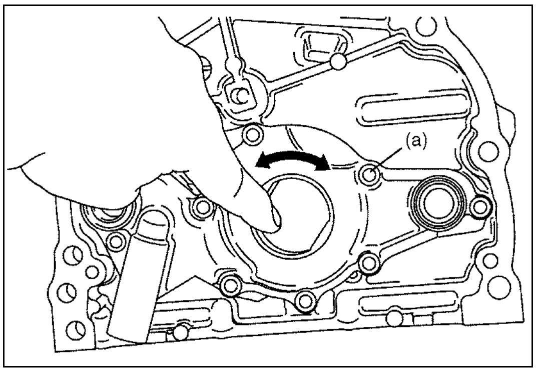
1) Wash, clean and then dry all disassembled parts.
2) Apply thin coat of engine oil to inner and outer rotors, oil seal lip portion, inside surfaces of oil pump case and plate.



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



4) Apply engine oil to relief valve (1) and spring (2), and install them with retainer (3) and new circlip (4) to rotor plate (5).

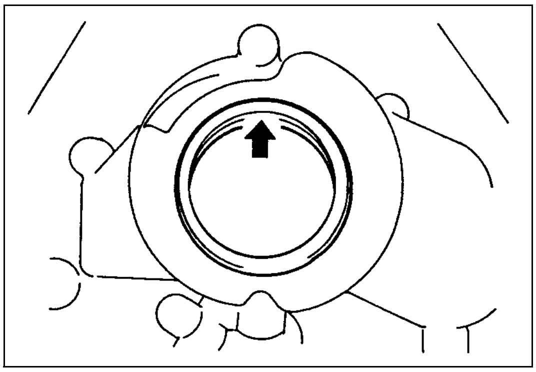


5) Install rotor plate and tighten all bolts to specified torque.
   After installing plate, check to be sure that rotors turn smoothly by hand (0.3 N·m (0.03 kg-m, 0.25 lb-ft) torque or below).

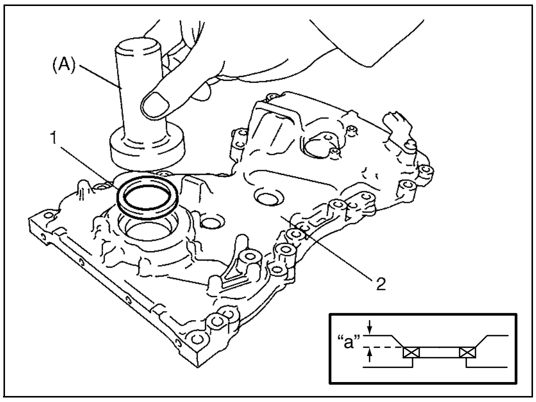
Tightening torque
Oil pump rotor plate bolts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)

Oil Pump Inspection

Oil seal



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



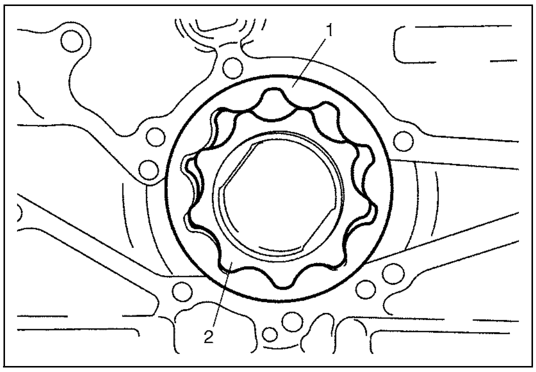
NOTE:

When installing new oil seal (1), press-fit it to oil pump case (2) by using special tool as shown in the figure.

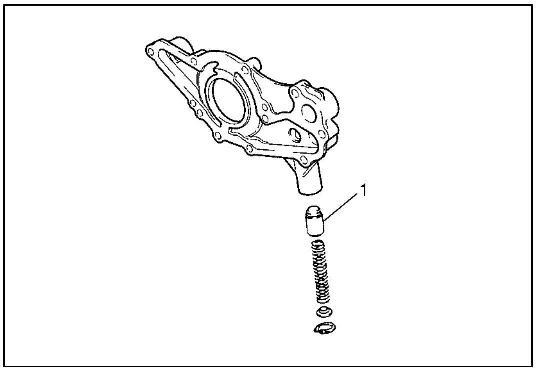
Special tool
(A) : 09913-75810

Drive in dimension
“a” : 1.5 mm (0.06 in.)

Oil pump assembly

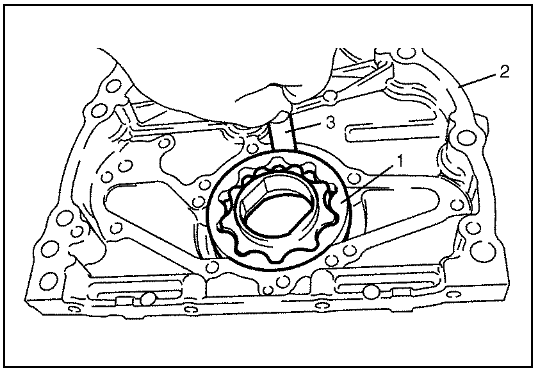


- Check outer (1) and inner rotors (2), rotor plate, and oil pump case for excessive wear or damage.



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

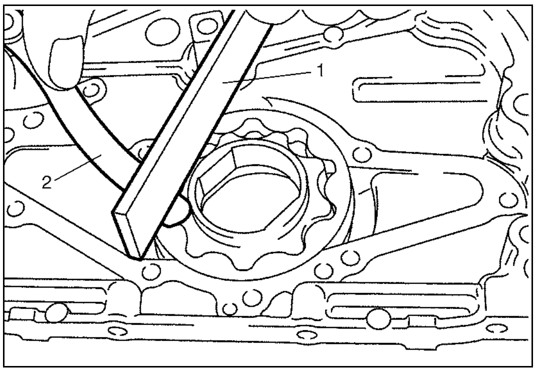
Radial clearance



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

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

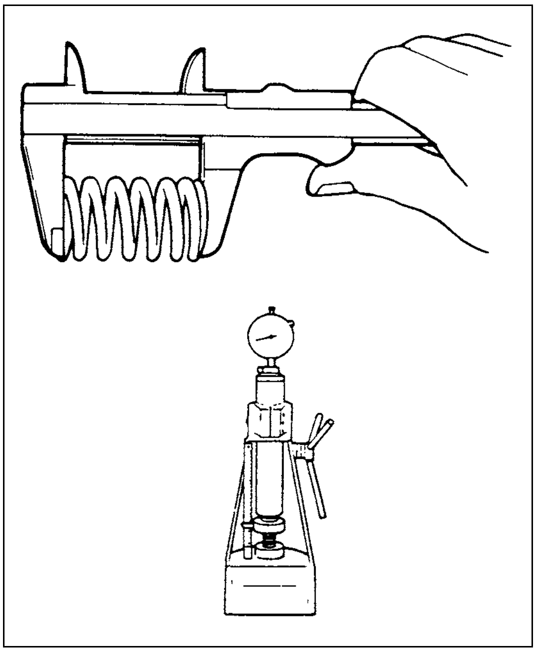
Side clearance



Using straight edge (1) and thickness gauge (2), measure side clearance.
If clearance exceeds its limit, replace oil pump assembly.

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

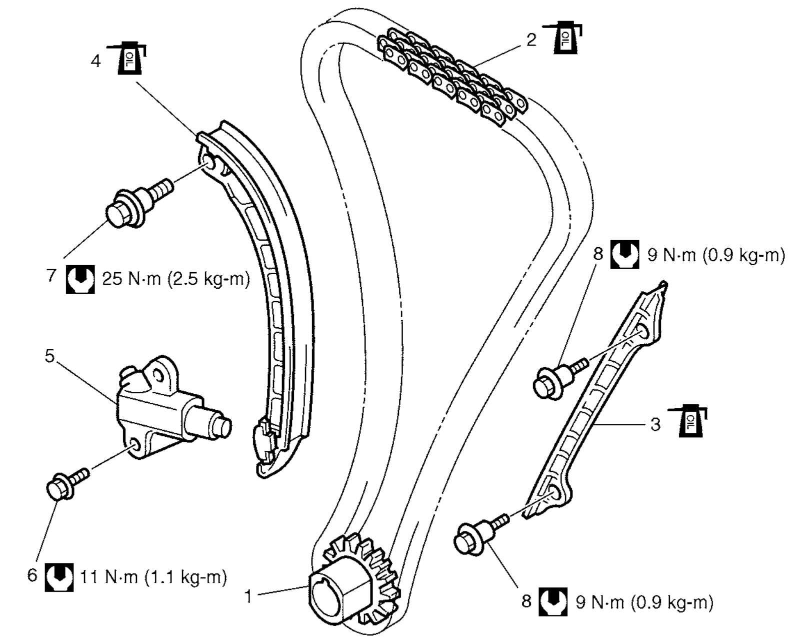
Relief valve spring free length and load



Check relief valve spring free length and load as shown in figure.
If the measured valve spring length is lower than the specification, replace relief valve spring.

	Standard	Limit
Free length	**52.4 mm (2.06 in.)**	**–**
Load at spring length 38.5 mm (1.52 in.)	**77 N (7.7 kgf, 17.0 lb)**	**69 N (6.9 kgf, 15.0 lb)**

Timing Chain and Chain Tensioner Components



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

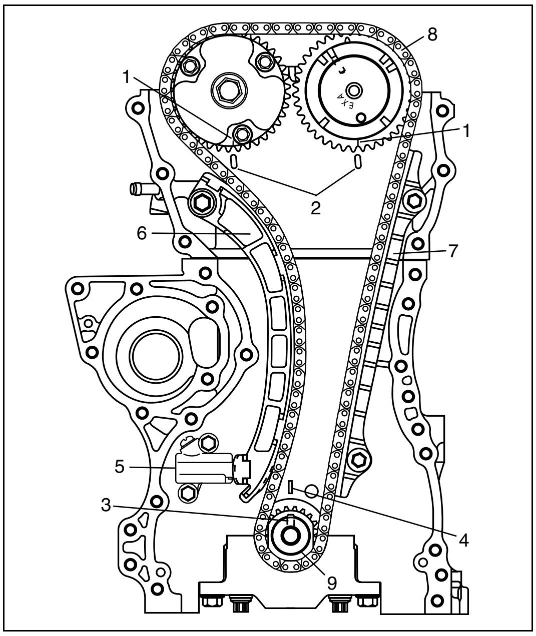
Timing Chain and Chain Tensioner Removal and Installation

Removal

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.

1) Remove timing chain cover referring to “Timing Chain Cover Removal and Installation” in this section.

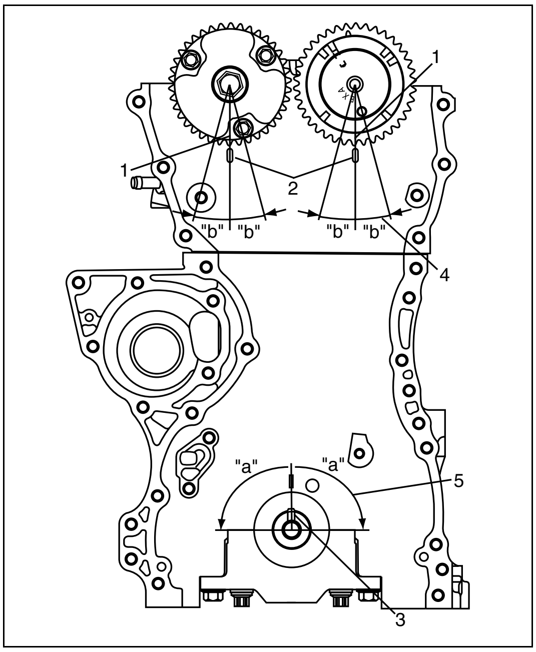


2) By turing crankshaft, align both intake and exhaust camshaft timing sprocket marks (1) with notches (2) of cylinder head respectively and align crank shaft sprocket key (3) with notch of cylinder block (4).
3) Remove timing chain tensioner adjuster assembly (5).
4) Remove timing chain tensioner (6).
5) Remove timing chain No.1 guide (7).
6) Remove timing chain (8) with crankshaft timing sprocket (9)

Installation

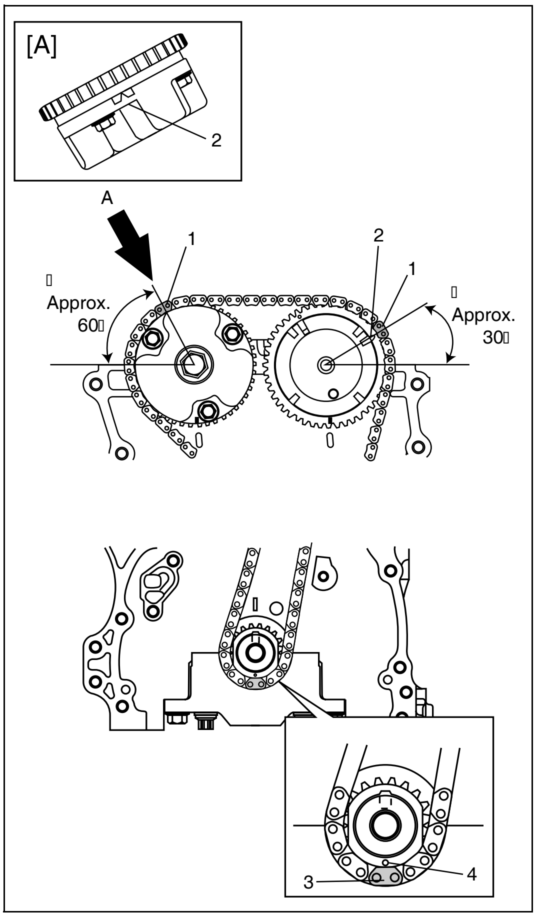
CAUTION:

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.



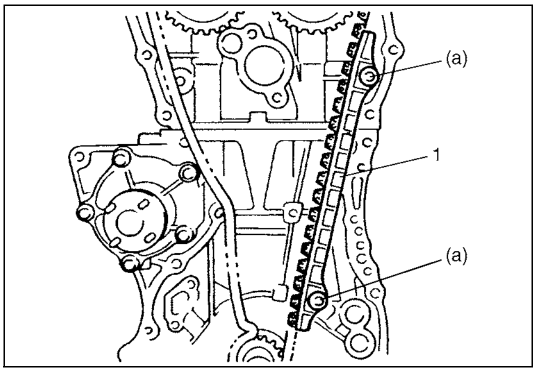
1) Check that match marks (1) on intake and exhaust camshaft timing sprockets are in match with notches (2) on cylinder head as shown in figure.
2) Set key (3) and turn crankshaft to position key on upside of crankshaft.

"a" : 90°	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.
"b" : 15°	5. Crankshaft allowable turning range. By key on crankshaft, within 90° from top on both right and left.



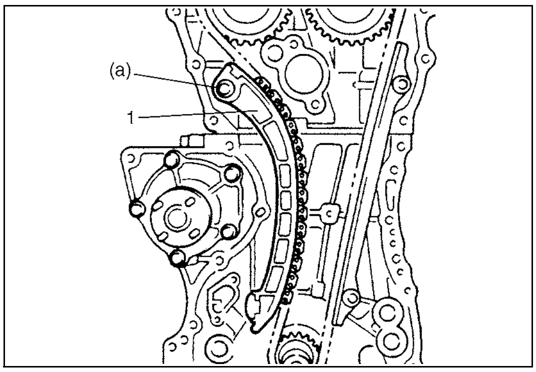
3) Install timing chain by aligning dark blue plate (1) of timing chain and triangle mark (2) on camshaft timing sprocket as shown in figure.
4) Fit crankshaft timing sprocket to timing chain by aligning gold plate (3) of timing chain and circle mark (4) on crankshaft timing sprocket. Then install crankshaft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

[A] : View A



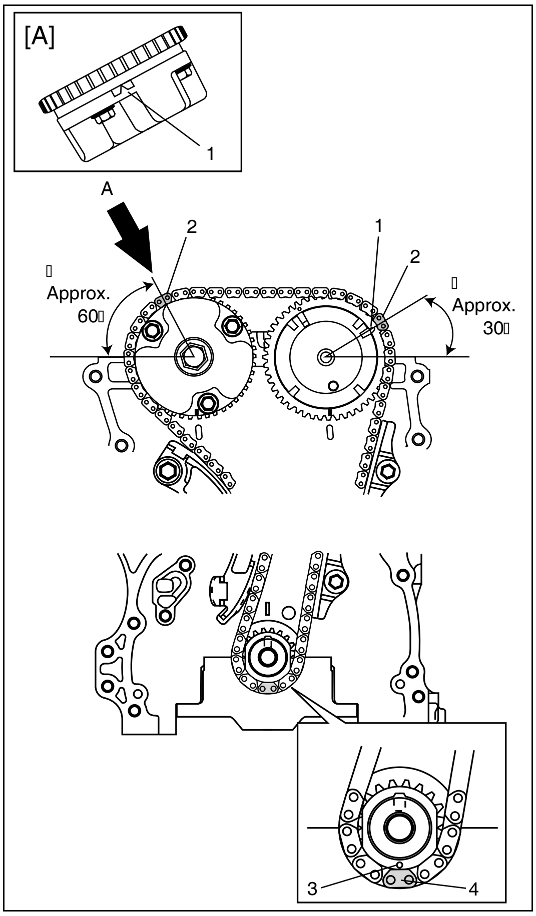
5) Apply engine oil to sliding surface of timing chain No.1 guide (1) and install it as shown in figure.
   Tighten guide bolts to specified torque.

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



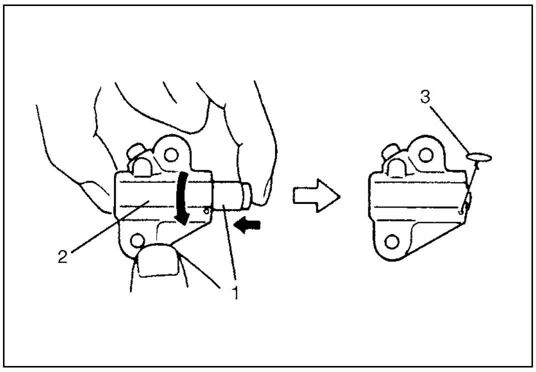
6) Apply engine oil to sliding surface of chain tensioner (1) and install chain tensioner and spacer.
   Tighten tensioner bolt to specified torque

Tightening torque
Timing chain tensioner bolt
(a) : 25 N·m (2.5 kg-m, 18.0 lb-ft)

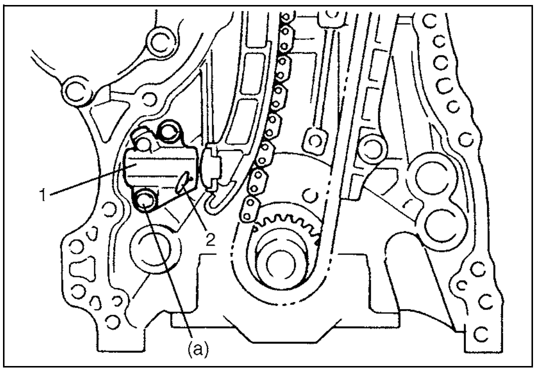


7) Check that match marks (1) on intake and exhaust camshaft timing sprockets are in match with marking of timing chain (2) and match mark on crankshaft timing sprocket (3) are in with marking of timing chain (4).

[A] :	View A

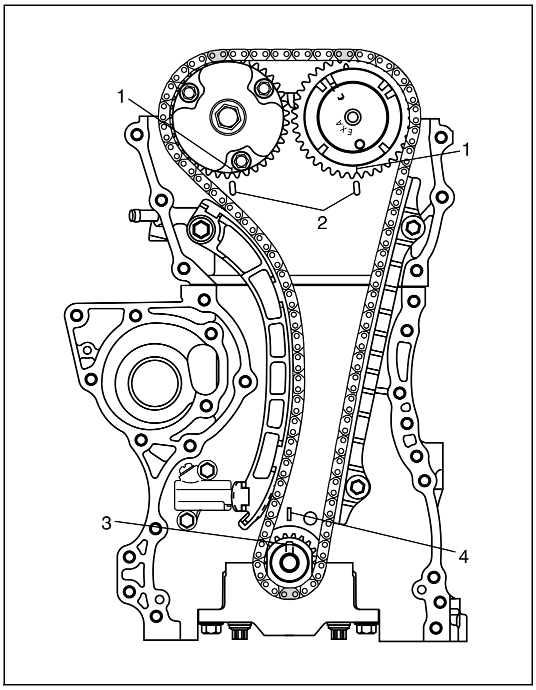


8) Screw in plunger (1) by turning body (2) in arrow direction and install a retainer (3) (wire) to hold plunger in place.



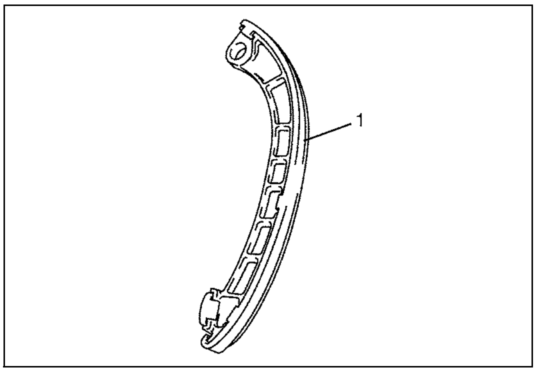
9) Install timing chain tensioner adjuster assembly (1) with a retainer (2).
   Tighten adjuster bolts to specified torque and then remove a retainer from chain tensioner adjuster assembly.

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



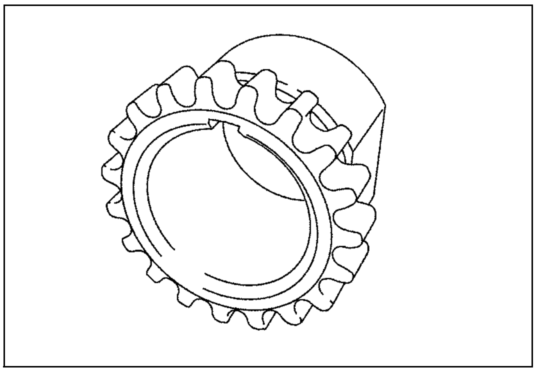
10) Apply engine oil to timing chain and then turn crankshaft clockwise by 2 revolutions and check that match marks (1) on intake and exhaust camshaft timing sprockets are in match with notches (2) on cylinder head and key (3) is in match with notch (4) on cylinder block as shown in figure.
    If each marking chain and each match mark are no matches, adjust each sprockets and timing chain.
11) Install timing chain cover referring to “Timing Chain Cover Removal and Installation” in this section.
12) Perform Steps 3) to 8) of “Installation” of “Timing Chain Cover Removal and Installation” in this section.

Timing Chain and Timing Chain Tensioner Inspection



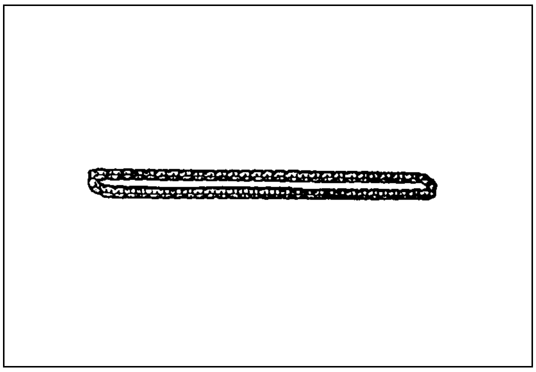
Timing chain tensioner

- Check shoe (1) for wear or damage.



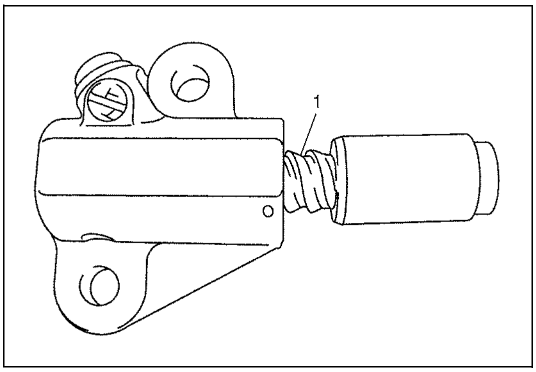
Crankshaft timing sprocket

- Check teeth of sprocket for wear or damage.



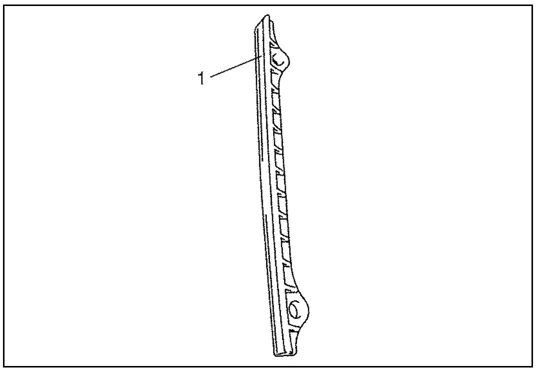
Timing chain

- Check timing chain for wear or damage.



Timing chain tensioner adjuster

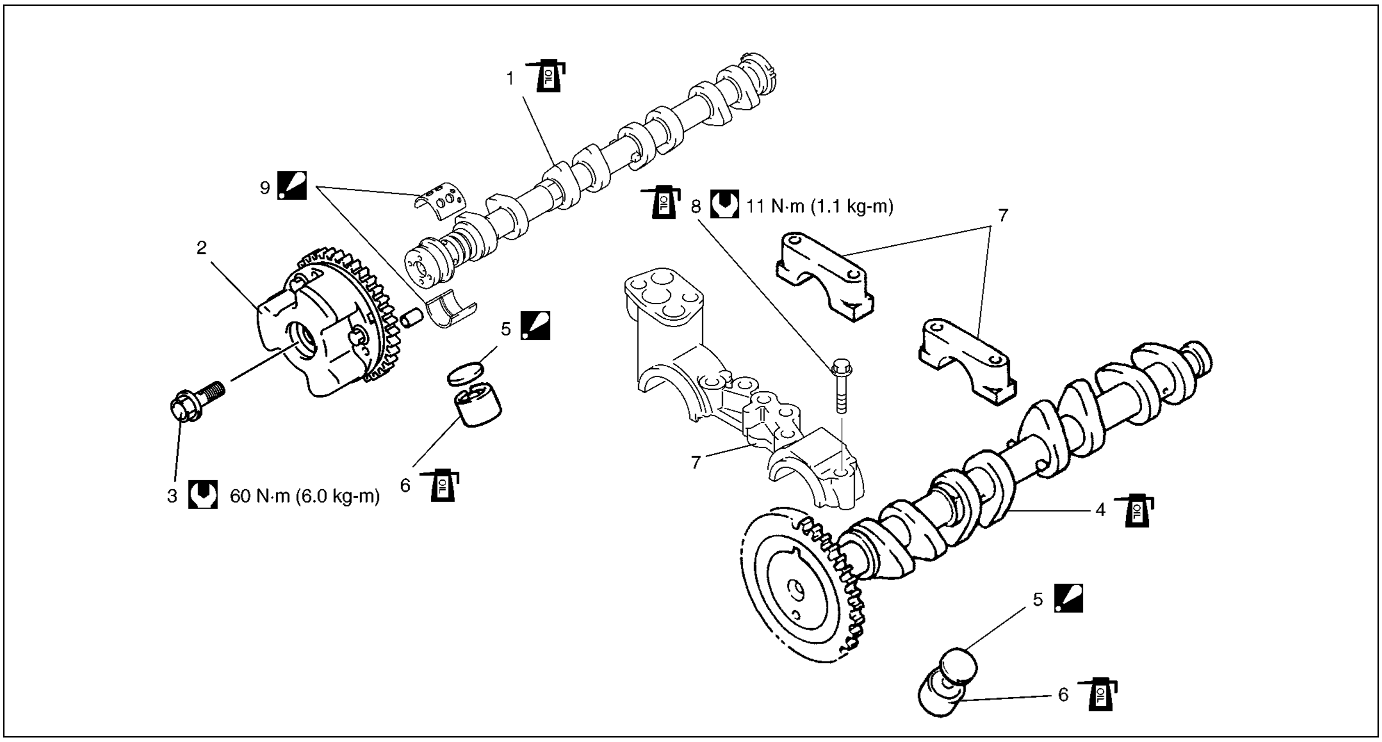
- Check that tooth surface (1) are free from damage.



Timing chain No.1 guide

- Check shoe (1) for wear or damage.

Camshaft, Tappet and Shim Components



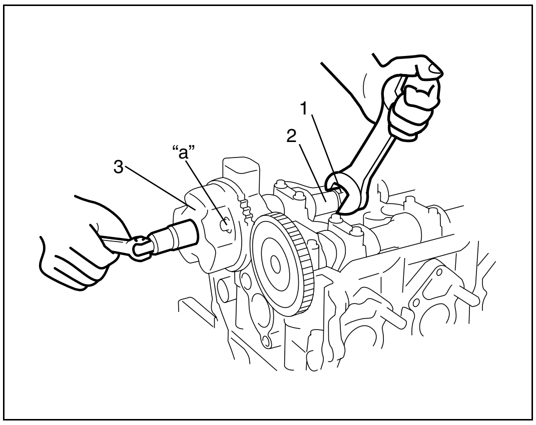
1. Intake camshaft	5. Shim : Shim No. on it faces tappet side.	9. Upper camshaft bearing : Install a bearing half with some holes to upper side of intake camshaft No.1 bearing.
2. Intake camshaft sprocket assembly	6. Tappet	Tightening torque
3. Intake camshaft sprocket bolt	7. Camshaft housing	Apply engine oil to sliding surface of each part.
4. Exhaust camshaft	8. Camshaft housing bolt	

Camshaft, Tappet and Shim Removal and Installation

Removal

CAUTION:
- **Keep working table, tools and hands clean while overhauling.**
- **Use special care to handle aluminum parts so as not to damage them.**
- **Do not expose removed parts to dust. Keep them always clean.**

1) Remove timing chain cover referring to “Timing Chain Cover Removal and Installation” in this section.
2) Remove timing chain referring to “Timing Chain and Chain Tensioner Removal and Installation” in this section.

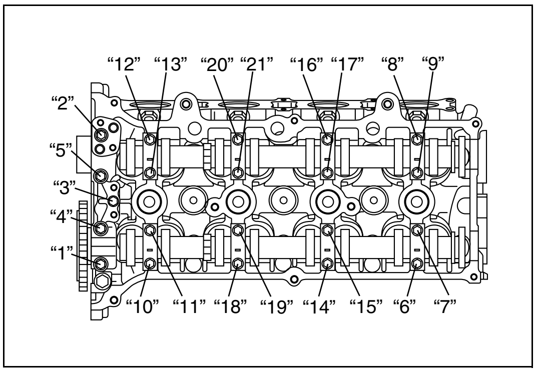


3) With hexagonal section (1) of intake camshaft (2) held stationary with spanner or the like, loosen mounting bolt of intake cam timing sprocket assembly (3) and remove it.

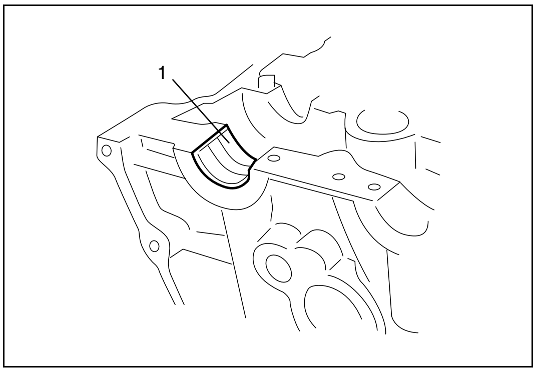
CAUTION:

Never attempt to loosen mounting bolt with intake cam timing sprocket assembly held stationary. Failure to follow this could result in damage to lock pin.

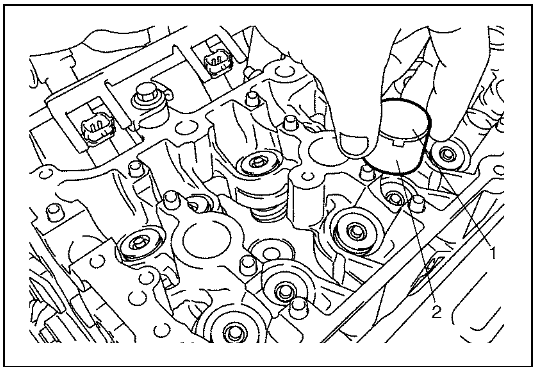
Do not loosen bolt "a" because intake cam timing sprocket assembly is not serviceable.



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.

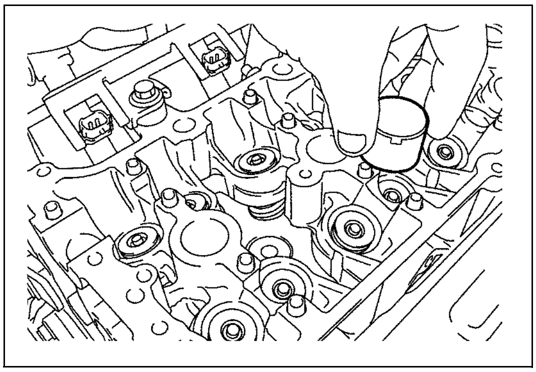


7) Remove camshaft bearing (1).



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

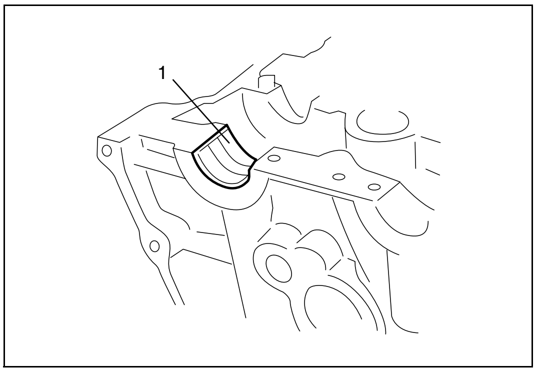
Installation



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

NOTE:

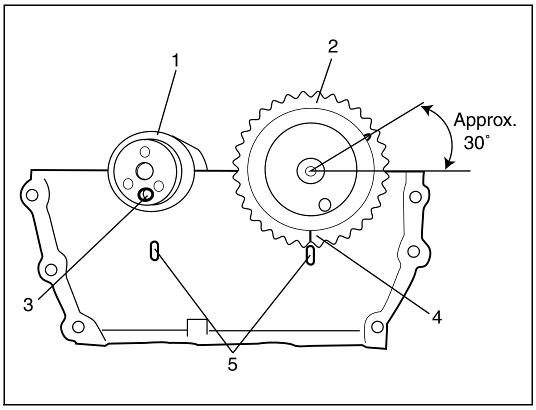
When installing shim, make sure to direct shim No. side toward tappet.



2) Install camshaft bearing (1) to cylinder head.

CAUTION:

Do not apply engine oil to camshaft bearing back.
Only a upper half bearing of intake camshaft bearing No.1 has some holes. Other bearings.

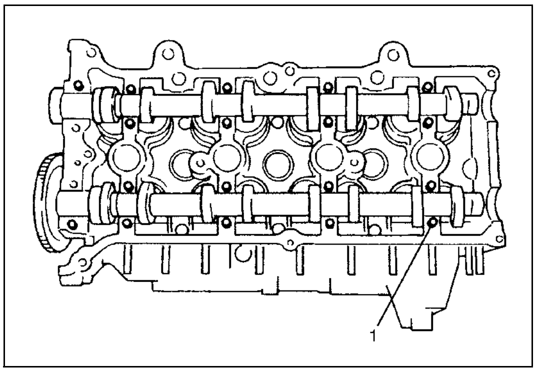


3) Install intake camshaft (1) and exhaust camshaft (2).
   Align knock pin (3) and match mark (4) with notches (5) as shown in the figure.

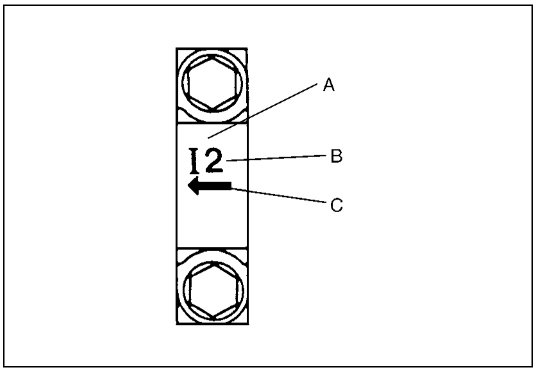
NOTE:

Before installing camshafts, turn crankshaft until key faces upward. Refer to "Timing Chain and Chain Tensioner Components".

4) Apply engine oil to sliding surface of each camshaft and camshaft journal then install them as shown in figure.

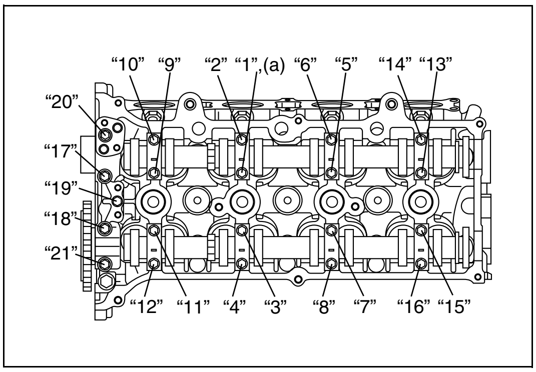


5) Install camshaft housing pins (1) as shown in figure.



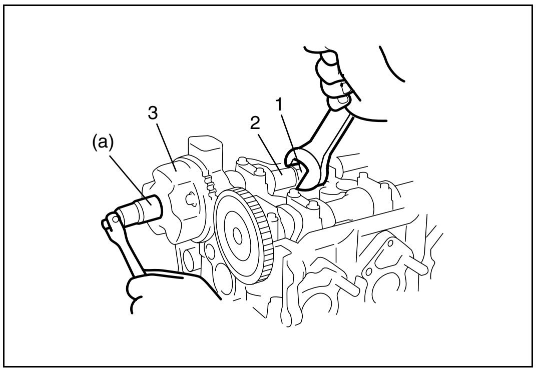
6) Check position of camshaft housings.
   Embossed marks are provided on each camshaft housing, indicating position and direction for installation. Install housings as indicated by these marks.

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



7) After applying engine oil to housing bolts, tighten them temporarily first. Then tighten them by the 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)



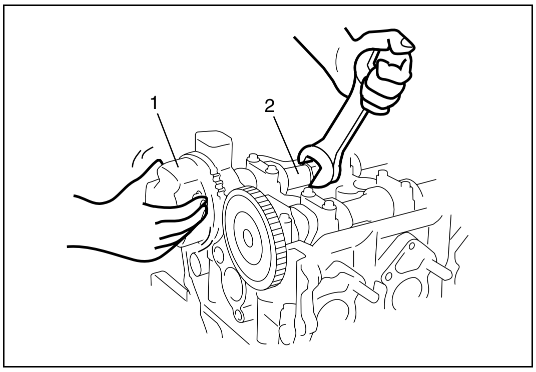
8) With hexagonal section (1) of intake camshaft (2) held stationary with spanner or the like, tighten bolt of intake cam timing sprocket assembly (3) to specification.

Tightening torque
Intake cam timing sprocket bolts
(a) : 60 N·m (6.0 kg-m, 43 lb-ft)

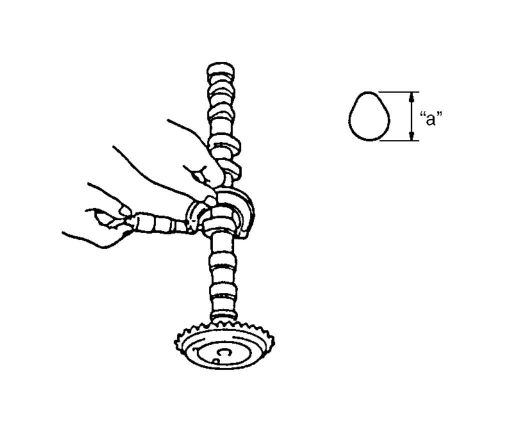
9) Install timing chain with crankshaft sprocket referring to "Timing Chain and Chain Tensioner Removal and Installation" in this section.
10) Install timing chain cover referring to "Timing Chain Cover Removal and Installation" in this section.
11) Check valve lashes as previously outlined.
12) Perform Steps 3) to 8) of "Installation" of "Timing Chain Cover Removal and Installation" in this section.

Camshaft, Tappet and Shim Inspection

Intake cam timing sprocket assembly



Fit intake cam timing sprocket assembly to camshaft (2) and hold hexagonal section of camshaft by using spanner or the like.
Check if sprocket (1) is not turned by hand.
If moved, replace intake cam timing sprocket assembly.

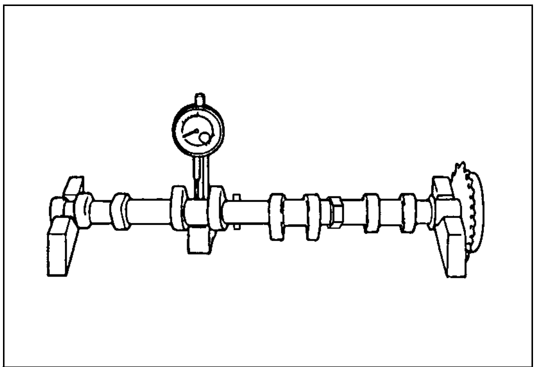


Cam wear

Using a micrometer, measure cam height "a". If measured height underruns its limit, replace camshaft.

Cam height "a" of camshaft

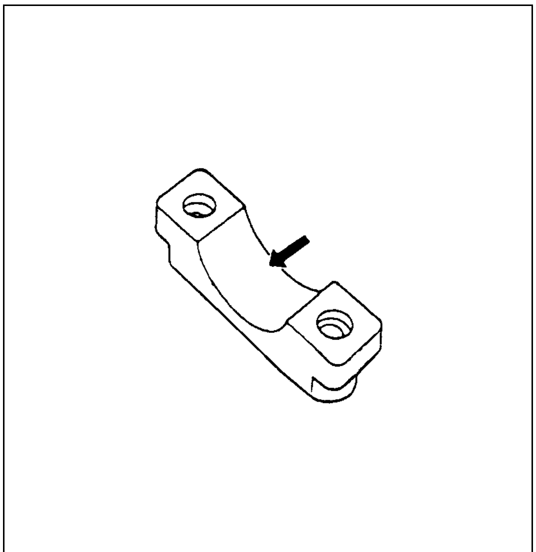
	Standard	Limit
Intake cam	**44.929 – 45.089 mm (1.769 – 1.775 in.)**	**44.80 mm (1.764 in.)**
Exhaust cam	**44.399 – 44.559 mm (1.748 – 1.754 in.)**	**44.28 mm (1.743 in.)**



Camshaft runout

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

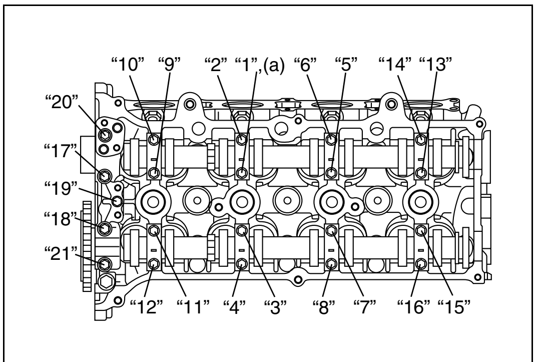
Camshaft runout limit
: 0.10 mm (0.0039 in.)



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 gaging plastic. Checking procedure is as follows.

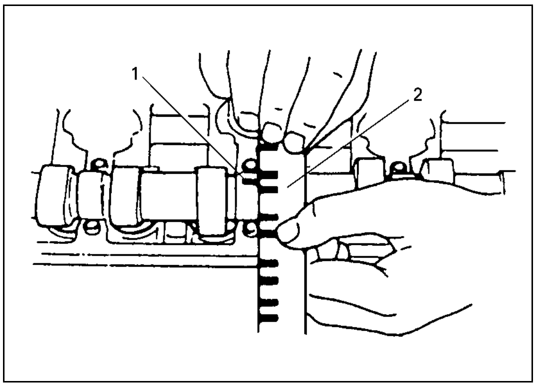
1) Clean housings and camshaft journals.
2) Remove all tappets with shims.
3) Install camshafts to cylinder head.
4) Place a piece of gaging plastic to full width of journal of camshaft (parallel to camshaft).
5) Install camshaft housing.



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 gaging plastic is installed.

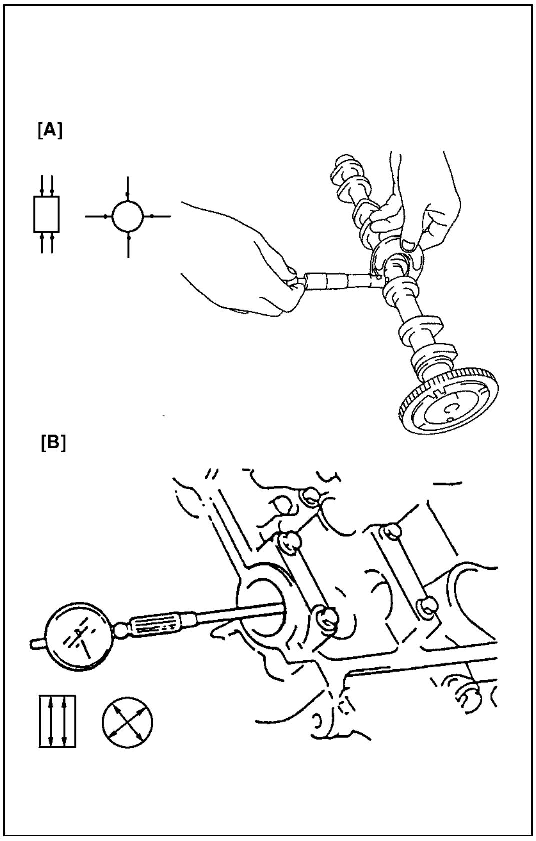
Tightening torque
Camshaft housing bolts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)



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

Camshaft journal clearance

	Standard	Limit
Intake side No.1 housing	0.020 – 0.072 mm (0.0008 – 0.0028 in.)	0.10 mm (0.0039 in.)
Others	0.045 – 0.087 mm (0.0018 – 0.0034 in.)	0.12 mm (0.0047 in.)



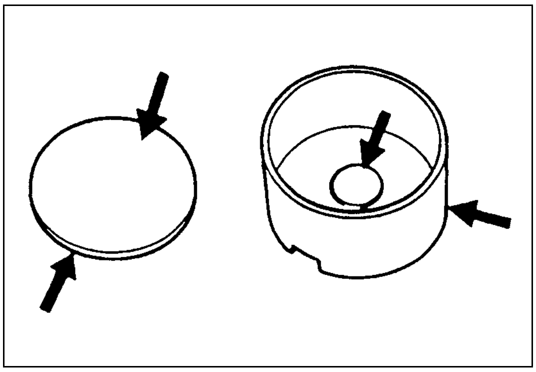
If measured camshaft journal clearance exceeds limit, measure journal (housing) bore and outside diameter of camshaft journal. Replace camshaft or cylinder head assembly whichever the difference from specification is greater.

Camshaft journal diameter [A]

Item	Standard
Intake side No.1 housing	26.940 – 26.955 mm (1.0606 – 1.0612 in.)
Exhaust side No.1 housing	26.934 – 26.955 mm (1.0604 – 1.0612 in.)
Others	22.934 – 22.955 mm (0.9029 – 0.9037 in.)

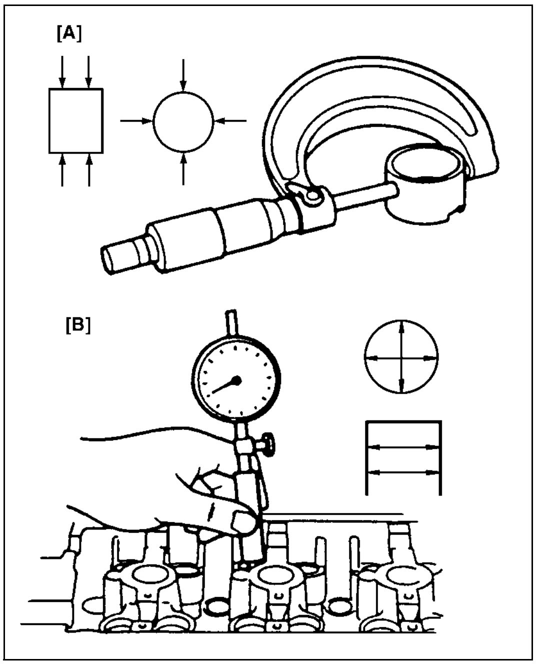
Camshaft journal bearing bore [B]

Item	Standard
Intake side No.1 housing	–
Exhaust side No.1 housing	27.000 – 27.021 mm (1.0630 – 1.0638 in.)
Others	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.



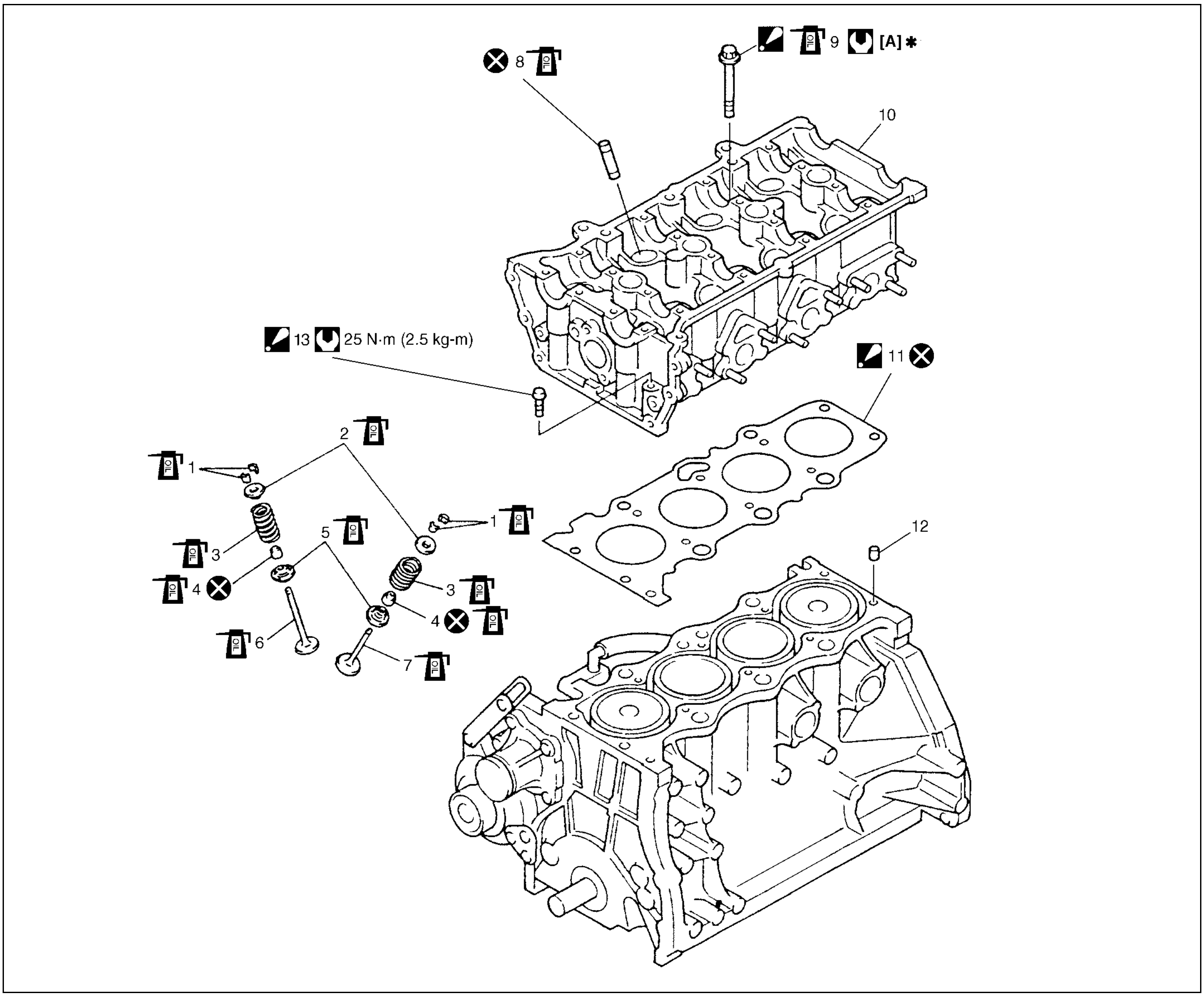
Measure cylinder head bore and tappet outside diameter to determine cylinder head-to-tappet clearance. If clearance exceeds limit, replace tappet or cylinder head.

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.)

Valves and Cylinder Head Components

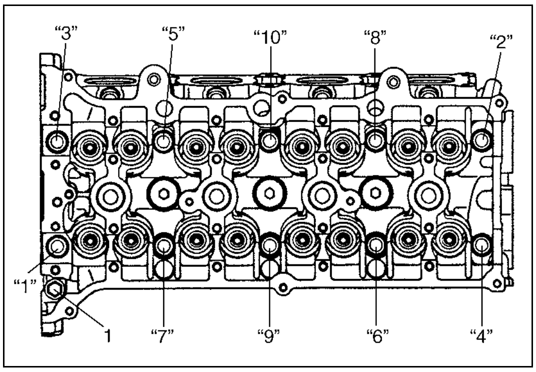


[A]✱ 1) Tighten all bolts at 20 N·m (2.0 kg-m) 2) Tighten all bolts at 40 N·m (4.0 kg-m) 3) Then retighten all bolts by turning through 60° 4) Repeat step 3) again	6. Intake valve	12. Knock pin
1. Valve cotters	7. Exhaust valve	13. Cylinder head bolt (M8) : Be sure to tighten cylinder head bolt (M8) after securing the other cylinder head bolt (M10).
2. Valve spring retainer	8. Valve guide	Tightening torque
3. Valve spring	9. Cylinder head bolt (M10) : Never reuse cylinder head bolts once disassembled it due to plastic deformation tightening. Be sure to use new cylinder head bolts when installing.	Do not reuse.
4. Valve stem seal	10. Cylinder head	Apply engine oil to sliding surface of each part.
5. Valve spring seat	11. Cylinder head gasket : "TOP" mark provided on gasket comes to crankshaft pulley side, facing up.	

Valves and Cylinder Head Removal and Installation

Removal

1) Remove engine assembly from vehicle referring to "Engine Assembly Removal and Installation" in this section.
2) Remove oil pan referring to "Oil Pan and Oil Pump Strainer Removal and Installation" in this section.
3) Remove cylinder head cover referring to "Cylinder Head Cover Removal and Installation" in this section.
4) Remove timing chain cover referring to Steps 2) to 7) of "Removal" in "Timing Chain Cover Removal and Installation" in this section.
5) Remove timing chain referring to Steps 2) to 6) of "Removal" under "Timing Chain Cover Removal and Installation" in this section.
6) Remove intake and exhaust camshafts referring to Steps 3) to 7) of "Removal" under "Camshaft, Tappet and Shim Removal and Installation" in this section.



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

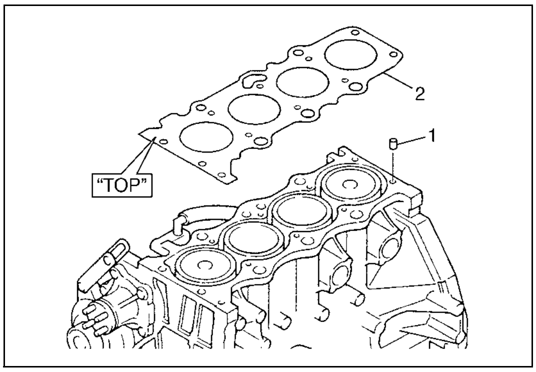
NOTE:

- **Don't forget to remove bolt (M8) (1) as shown in figure.**
- **Never reuse cylinder head bolts once disassembled it due to plastic deformation tightening. Be sure to use new cylinder head bolts when installing.**

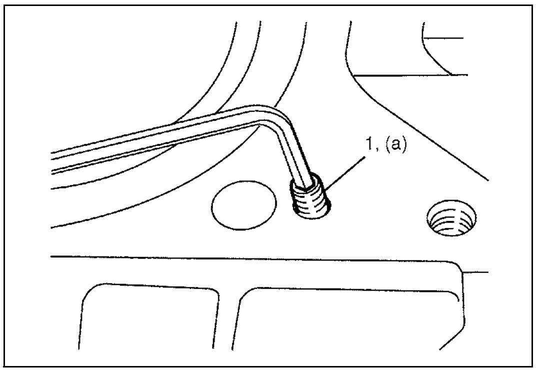
8) Check all around cylinder head for any other parts required to be removed or disconnected and remove or disconnect whatever necessary.
9) Remove exhaust manifold, if necessary, referring to "Exhaust Manifold Removal and Installation" in this section.
10) Remove cylinder head with intake manifold and exhaust manifold. Use lifting device, if necessary.

Installation

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

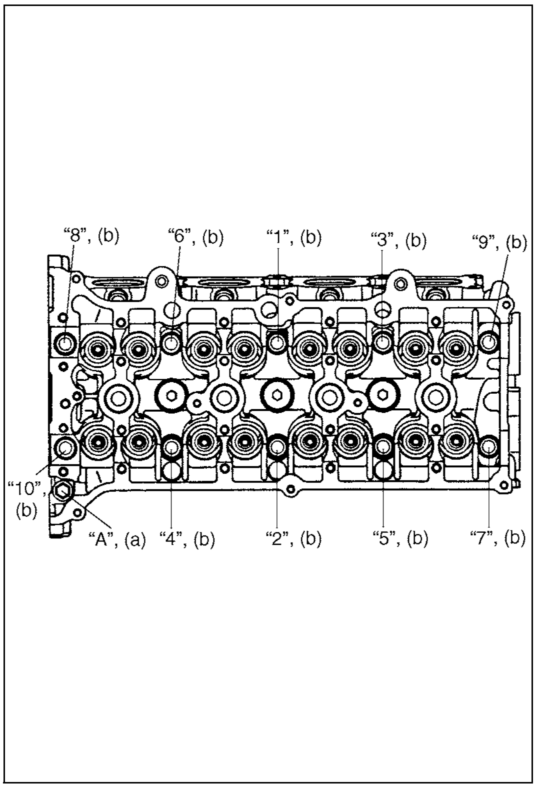


2) Install knock pins (1) to cylinder block.
3) Install new cylinder head gasket (2) to cylinder block. "TOP" mark provided on gasket comes to crankshaft pulley side, facing up (toward cylinder head side).



4) Make sure that oil jet (venturi plug) (1) is not clogged. If it is not installed, install it as specified torque.

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

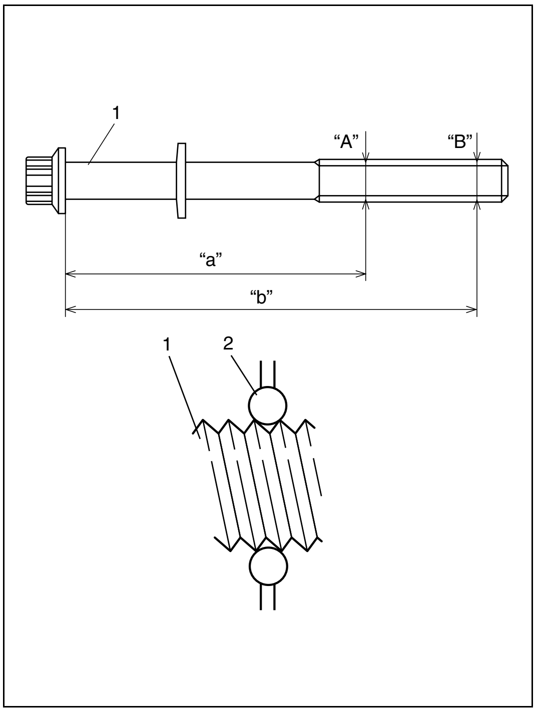


5) Install cylinder head to cylinder block. Apply engine oil to new cylinder head bolts and tighten them gradually as follows.
   a) Tighten cylinder head bolts ("1" – "10") to 20 N·m (2.0 kg-m, 14.5 lb-ft) according to numerical order as shown by using a 12 corner socket wrenches.
   b) In the same manner as in Step a), tighten them to 40 N·m (4.0 kg-m, 29.0 lb-ft).
   c) Turn 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) : 25 N·m (2.5 kg-m, 18.0 lb-ft)
Cylinder head bolts for M10
(b) : 20 N·m (2.0 kg-m, 14.5 lb-ft), 40 N·m (4.0 kg-m, 29.0 lb-ft) and then retighten by turning through 60° twice



NOTE:

If they are reused, check thread diameters of cylinder head bolt (1) for deformation according to the follows and replace them with new ones if thread diameter difference exceeds limit.

Measure each thread diameter of cylinder head bolt (1) at "A" on 83.5mm(2.81in.) from seat side of flange bolt and "B" on 115mm(4.53in.) 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" : 83.5mm (2.81in.)
"b" : 115mm (4.53in.)

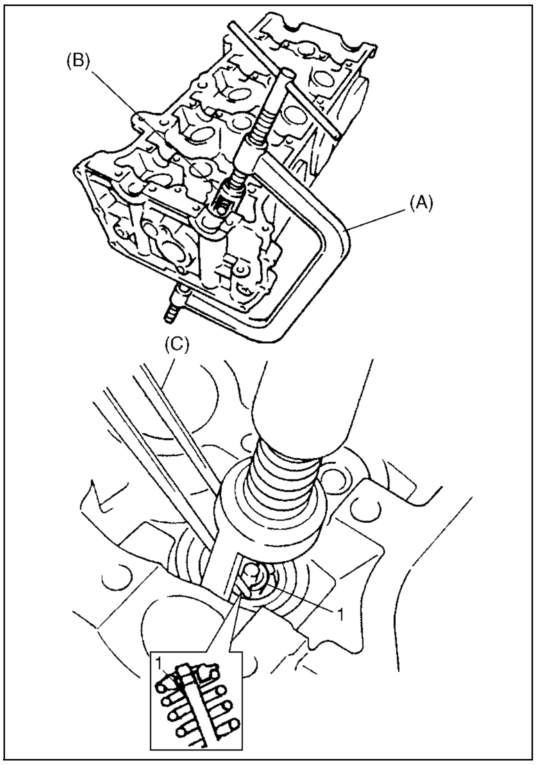
Cylinder head bolt diameter difference (deformation)
Limit ("A" – "B") : 0.1mm (0.004in.)

6) Install camshafts, tappet and shim referring to "Camshaft, Tappet and Shim Removal and Installation" in this section.
7) Install timing chain referring to "Timing Chain and Chain Tensioner Removal and Installation" in this section.
8) Install timing chain cover referring to "Timing Chain and Chain Tensioner Removal and Installation" in this section.
9) Install cylinder head cover referring to "Cylinder Head Cover Removal and Installation" in this section.
10) Install oil pan referring to "Oil Pan and Oil Pump Strainer Removal and Installation" in this section.

Valves and Cylinder Head Disassembly and Assembly

Disassembly

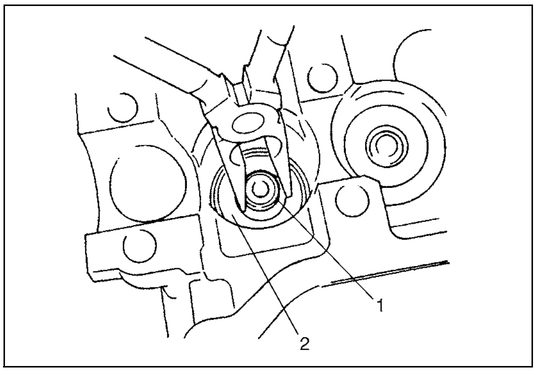
1) For ease in servicing cylinder head, remove intake manifold, injectors and exhaust manifold from cylinder head.



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

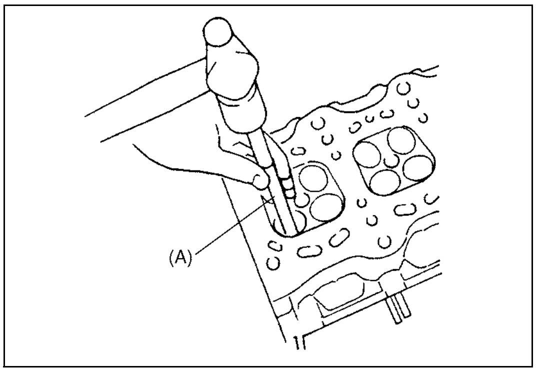
3) Release special tools (valve lifter), and remove spring retainer and valve spring.
4) Remove valve from combustion chamber side.



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

NOTE:

Do not reuse valve stem seal (1) once disassembled. Be sure to use new valve stem seal when assembling.



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

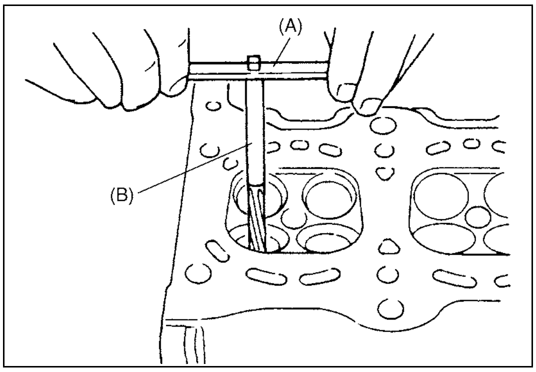
Special tool
(A) : 09916-44910

NOTE:

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

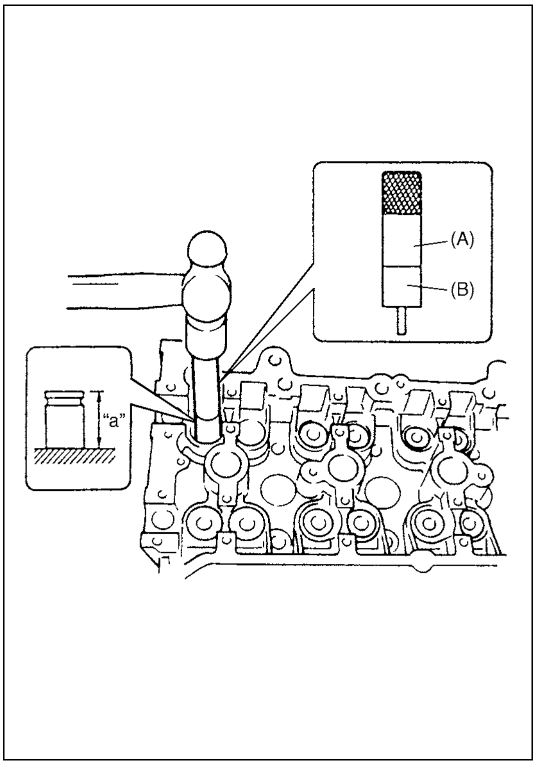
7) Place disassembled parts except valve stem seal and valve guide in order so that they can be installed in their original position.

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

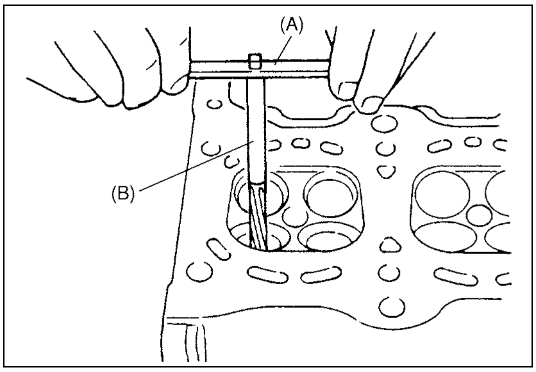


2) Install valve guide to cylinder head.
   Heat cylinder head uniformly to a temperature of 80 to 100 °C (176 to 212 °F) so that head will not be distorted, and drive new valve guide into hole with special tools. Drive in new valve guide until special tool (Valve guide installer) contacts cylinder head.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

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

NOTE:
- **Never reuse once-disassembled valve guide. Make sure to install new valve guide.**
- **Intake and exhaust valve guides are identical.**

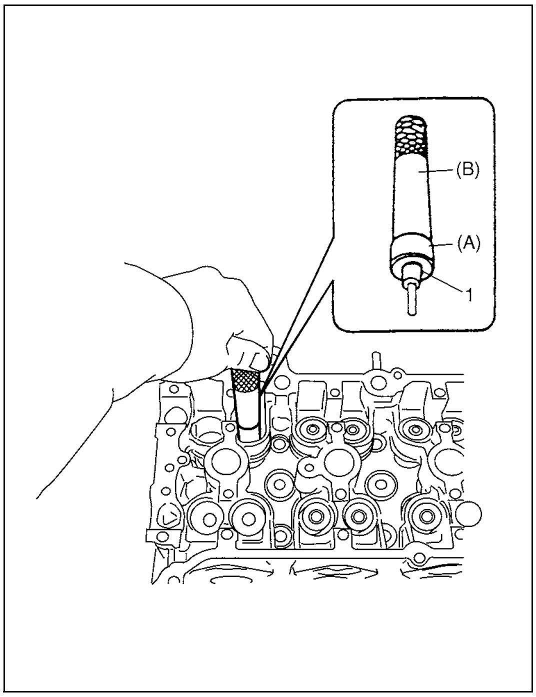
Specification for valve guide protrusion "a"
Intake side : 11.3 mm (0.44 in.)
Exhaust side : 11.3 mm (0.44 in.)



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

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

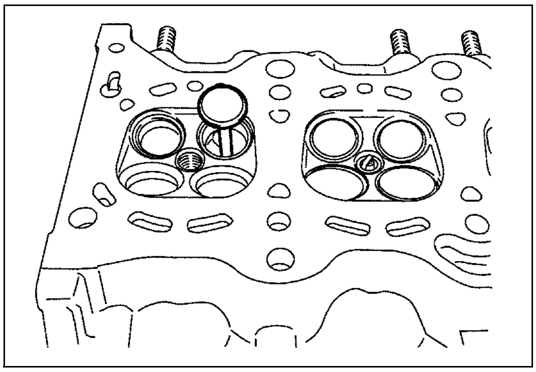
4) Install valve spring seat to cylinder head.



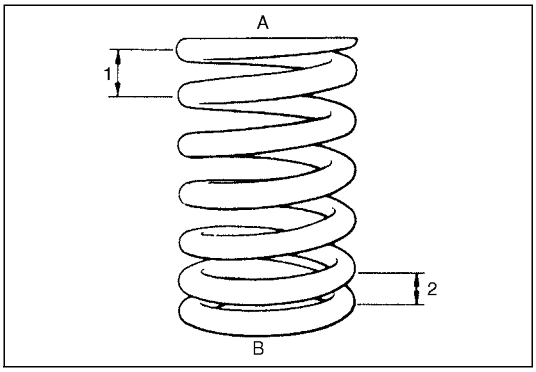
5) Install new valve stem seal (1) to valve guide.
After applying engine oil to seal and spindle of special tool (Valve guide installer handle), fit oil seal to spindle, and then install seal to valve guide by pushing special tool by hand.
After installing, check to be sure that seal is properly fixed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

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

NOTE:
- **Do not reuse once-disassembled seal. Be sure to install new seal.**
- **When installing, never 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.**

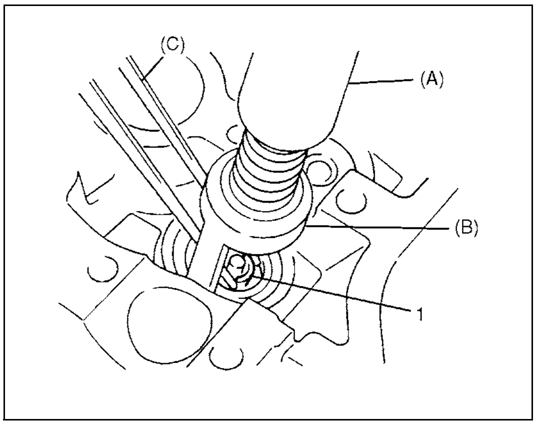


6) Install valve to valve guide.
Before installing valve to valve guide, apply engine oil to stem seal, valve guide bore and valve stem.



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

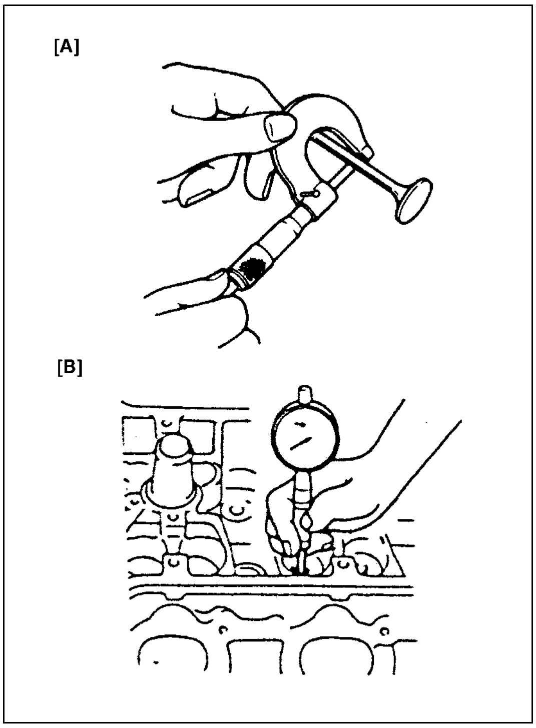
NOTE:
When compressing the valve spring, be carefully to free from damage in inside face of tappet installing hole.

9) Install intake manifold referring to “Intake Manifold Removal and Installation” in this section.
10) Install fuel injectors referring to “Fuel injector removal and installation” in Section 6E1.
11) Install exhaust manifold referring to “Exhaust Manifold Removal and Installation” in this section.

Valves and Cylinder Head Inspection

Valve guides

Valve stem-to-guide clearance



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.

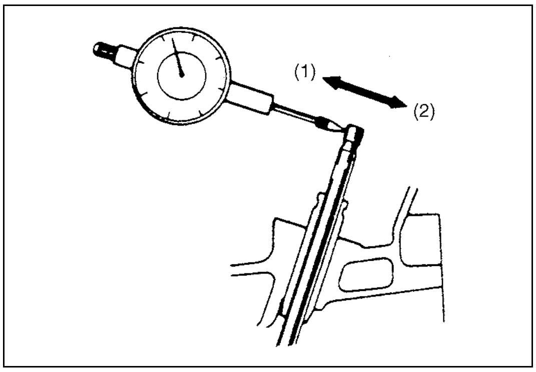
Valve stem-to-guide clearance

Item	Standard	Limit
In	0.020 – 0.047 mm (0.0008 – 0.0018 in.)	0.07 mm (0.0028 in.)
Ex	0.045 – 0.072 mm (0.0017 – 0.0028 in.)	0.09 mm (0.0035 in.)

Valve stem diameter [A] standard
In : 5.465 – 5.480 mm (0.2150 – 0.2157 in.)
Ex : 5.440 – 5.455 mm (0.2142 – 0.2148 in.)

Valve guide bore [B] standard
In and Ex : 5.500 – 5.512 mm (0.2165 – 0.2170 in.)

Valve stem end deflection



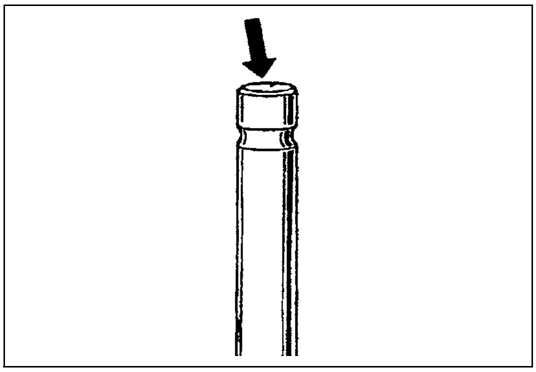
If bore gauge is not available, check end deflection of valve stem with a dial gauge instead.
Move stem end in directions (1) and (2) to measure end deflection.
If deflection exceeds its limit, replace valve stem and valve guide.

Valve stem end deflection limit
In : 0.14 mm (0.005 in.)
Ex : 0.18 mm (0.007 in.)

Valves

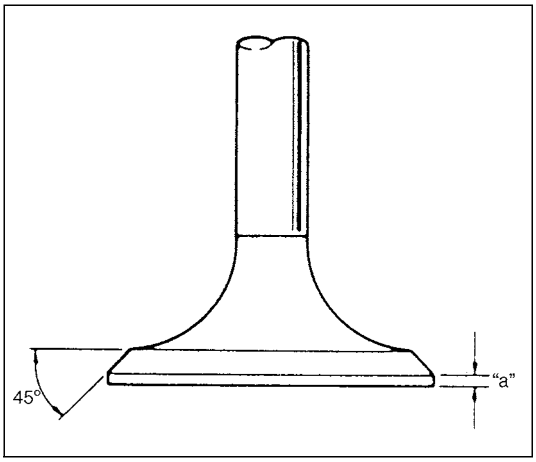
Visual inspection

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



- 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.

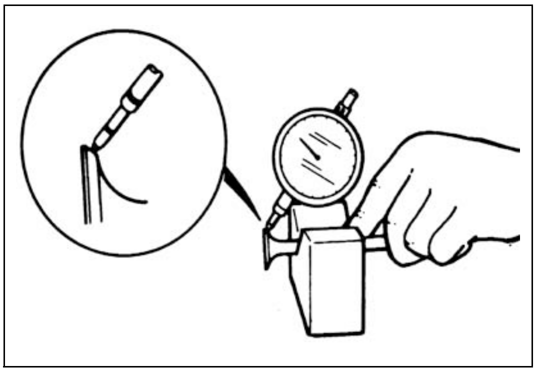
Valve head thickness



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

Valve head thickness "a" (In and Ex)
Standard : 1.25 – 1.55 mm (0.049 – 0.061 in.)
Limit : 0.9 mm (0.035 in.)

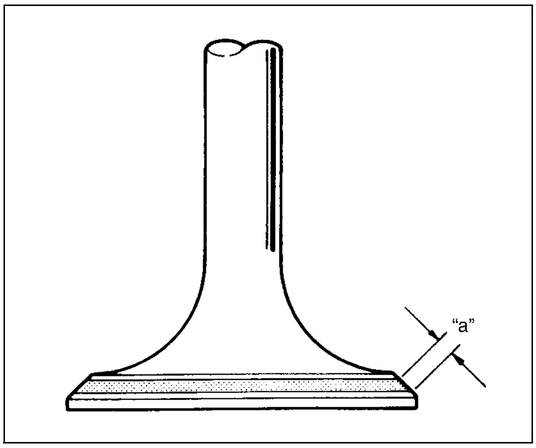
Valve head radial runout



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.)

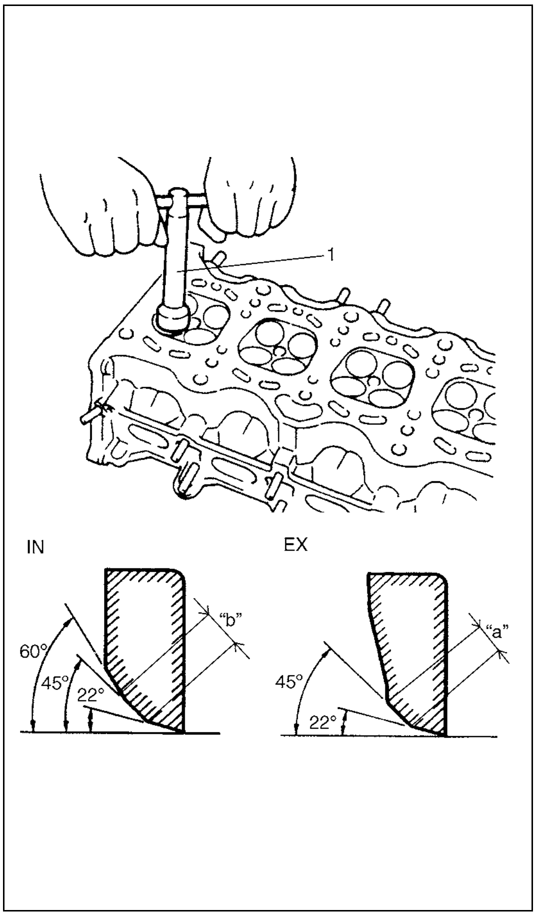
Seating contact width



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 : 1.0 - 1.4 mm (0.0389 - 0.0551 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 22° angle, and the second for making 45° angle. The second cut must be made to produce desired seat width.

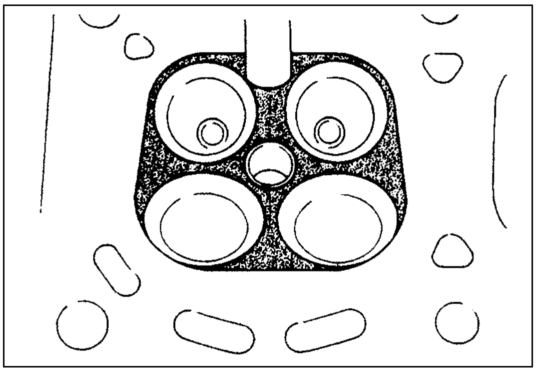
Seat width for exhaust valve seat
"a" : 1.0 – 1.4 mm (0.0389 – 0.0551 in.)

2) INTAKE VALVE SEAT : Use valve seat cutters (1) 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" : 1.0 – 1.4 mm (0.0389 – 0.0551 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.

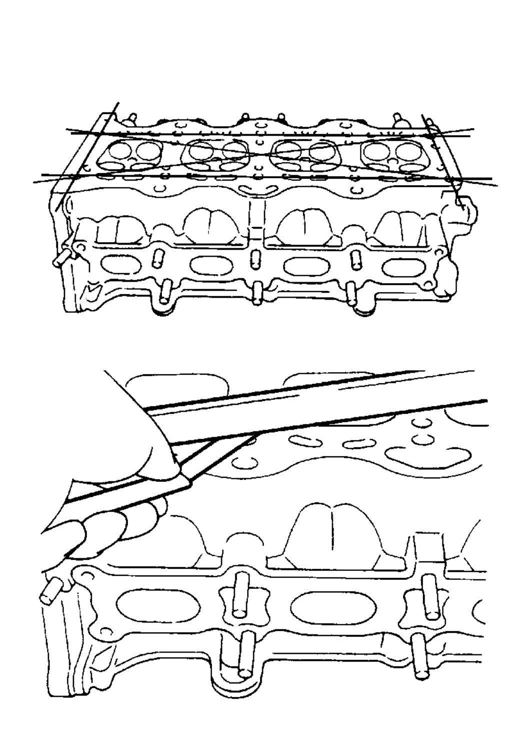
Cylinder head



- Remove all carbon deposits from combustion chambers.

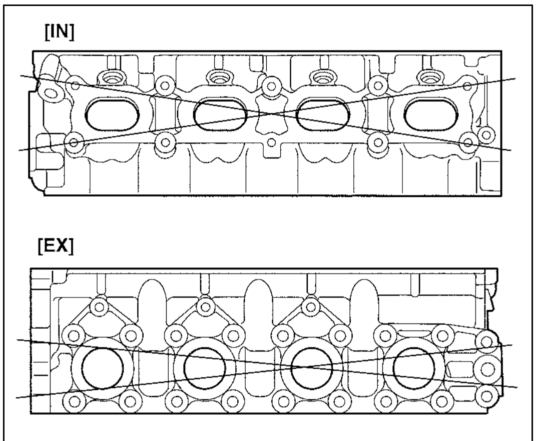
NOTE:

Do not use any sharp-edged tool to scrape off carbon deposits. Be careful not to scuff or nick metal surfaces when decarbonizing. 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 6 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.

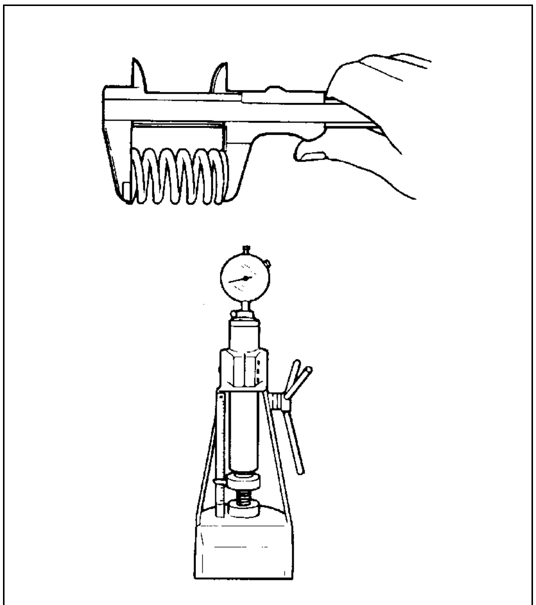
Limit of distortion for cylinder head surface on piston side : 0.03 mm (0.001 in.)



- 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 cylinder head surface on intake and exhaust manifold
0.05 mm (0.002 in.)

Valve springs

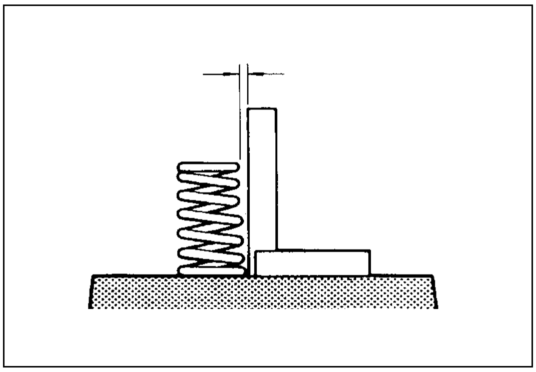


Valve spring free length and preload

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 (1.411 in.)

Valve spring preload
Standard : 107 – 125 N (10.7 – 12.5 kg) for 31.50 mm (23.6 – 27.6 lb/1.240 in.)
Limit : 102 N (10.2 kg) for 31.5 mm (22.5 lb/1.240 in.)

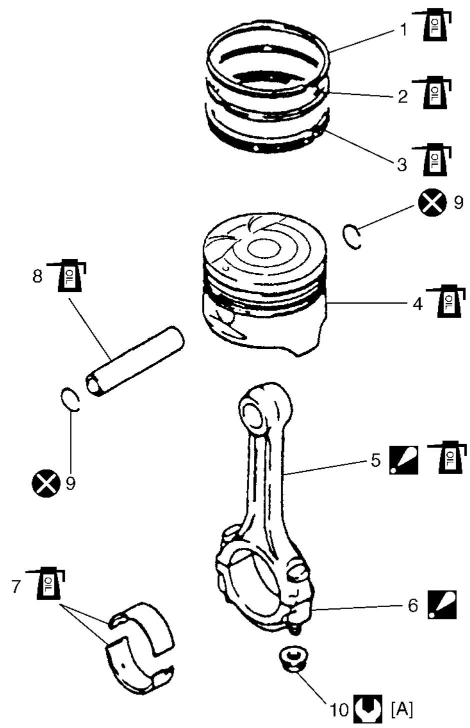


Spring squareness

Use a square and surface plate to check each spring for squareness 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 squareness limit
1.6 mm (0.079 in.)

Pistons, Piston Rings, Connecting Rods and Cylinders Components

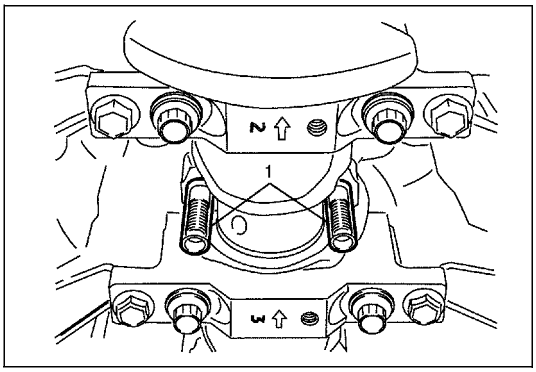


	[A] :	1) Tighten all nuts to 15 N·m (1.5 kg-m) 2) Then retighten all nuts by turning through 45° 3) Repeat step 2) again	7.	Connecting rod bearing
	1.	Top ring	8.	Piston pin
	2.	2nd ring	9.	Piston pin circlip
	3.	Oil ring	10.	Bearing cap nut
	4.	Piston		Tightening torque
	5.	Connecting rod : Apply engine 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”.	OIL	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.

Pistons, Piston Rings, Connecting Rods and Cylinders Removal and Installation

Removal

1) Remove engine assembly from vehicle referring to “Engine Assembly Removal and Installation” in this section.
2) Remove cylinder head referring to “Valves and Cylinder Head Removal and Installation”.
3) Mark cylinder number on all pistons, connecting rods and connecting rod caps using silver pencil or quick drying paint.
4) Remove rod bearing caps.



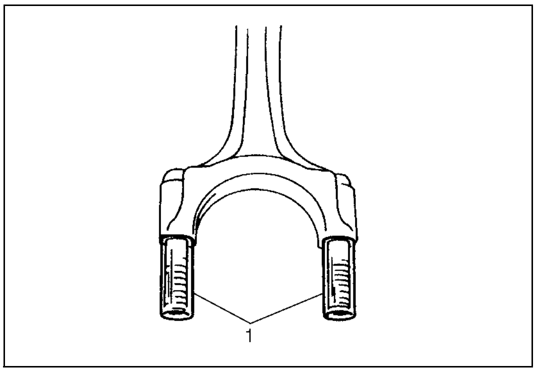
5) Install guide hose (1) over threads of rod bolts.
   This prevents damage to bearing journal and rod bolt threads when removing connecting rod.
6) Decarbonize top of cylinder bore before removing piston from cylinder.
7) Push piston and connecting rod assembly out through the top of cylinder bore.

Installation

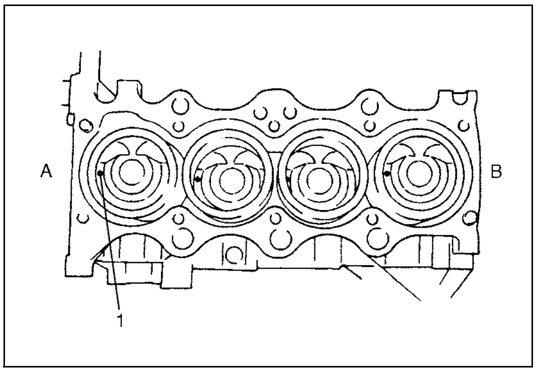
1) Apply engine oil to pistons, rings, cylinder walls, connecting rod bearings and crank pins.

NOTE:

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

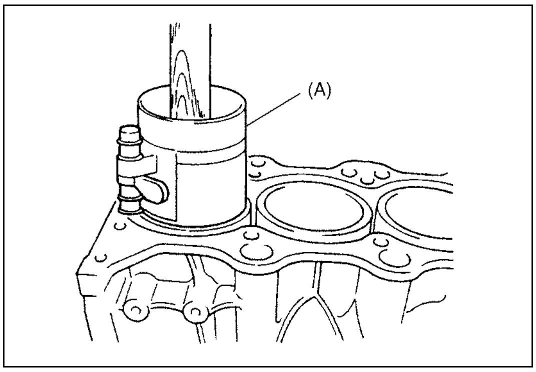


2) Install guide hoses (1) over connecting rod bolts.
   These guide hoses protect crank pin and threads of rod bolt from damage during installation of connecting rod and piston assembly.



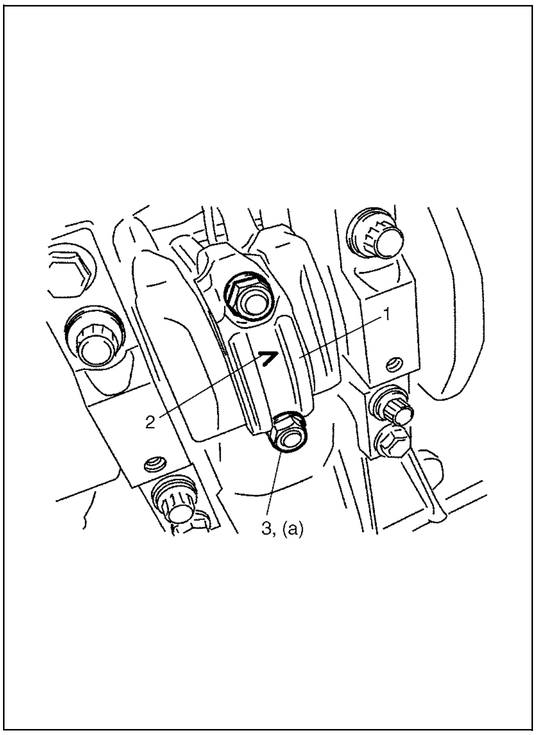
3) When installing piston and connecting rod assembly into cylinder bore, point front mark (1) on piston head to crankshaft pulley side.

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.
   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) once again.

Tightening torque
Connecting rod bearing cap nuts
(a) : 15 N·m (1.5 kg-m, 11.0 lb-ft), and then retighten by turning through 45° twice.

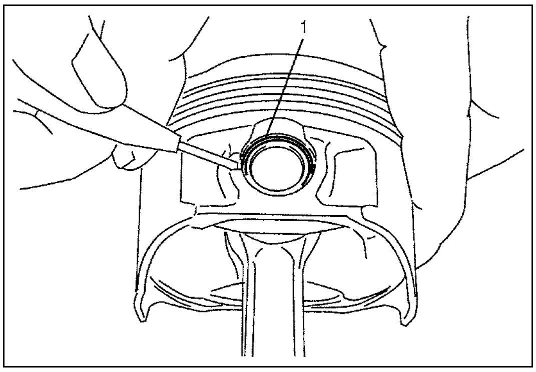
NOTE:
Before installing bearing cap, make sure that checking for connecting rod bolt deformation.
Refer to "Connecting rod" of "Pistons, Piston Rings, Connecting Rods and Cylinders Inspection" in this section.

6) Install cylinder head referring to "Valves and Cylinder Head Removal and Installation" in this section.

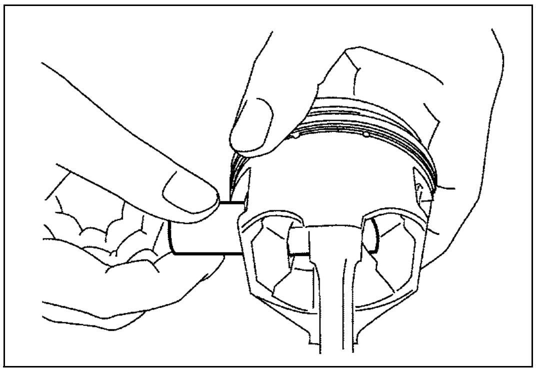
Pistons, Piston Rings, Connecting Rods and Cylinders Disassembly and Assembly

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 as follows.



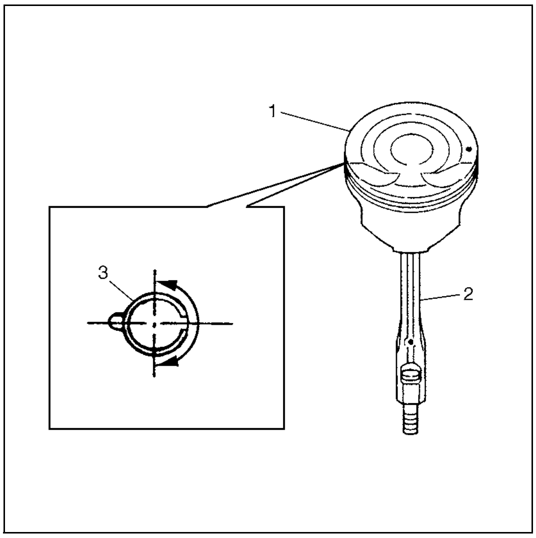
   a) Ease out piston pin circlips (1), as shown.



b) Force piston pin out.

Assembly

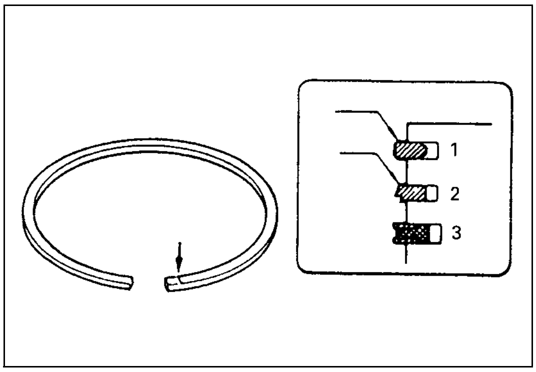
1) Decarbonize piston head and ring grooves using a suitable tool.



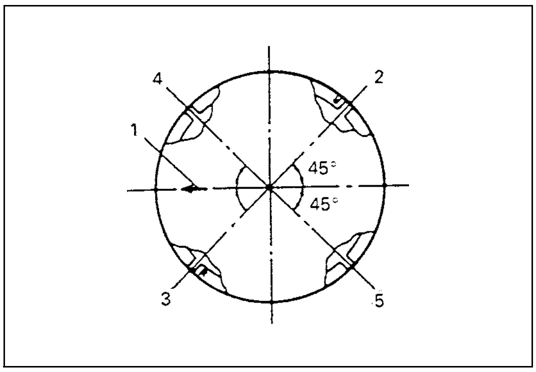
2) Install piston pin to piston (1) and connecting rod (2) :
   a) After applying engine oil to piston pin and piston pin holes in piston and connecting rod.
   b) Fit connecting rod as shown in figure.
   c) Insert piston pin to piston and connecting rod.
   d) Install piston pin circlips (3).

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.



3) 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.



4) 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

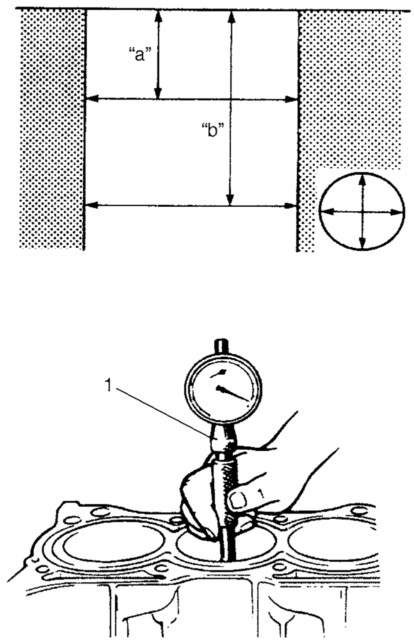
Pistons, Piston Rings, Connecting Rods and Cylinders Inspection

Cylinder

Visual inspection

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.

Cylinder bore diameter, taper and out-of-round



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.

Cylinder bore diameter
Standard : 78.00 – 78.014 mm (3.0709 – 3.0714 in.)
Limit : 78.050 mm (3.073 in.)

Cylinder taper and out-of-round
Limit : 0.10 mm (0.004 in.)

"a" :	50 mm (1.96 in.)
"b" :	100 mm (3.94 in.)

NOTE:

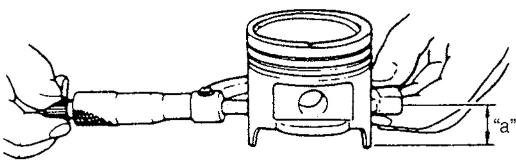
If any one of four cylinders has to be rebored, rebore all four to the same next oversize. This is necessary for the sake of uniformity and balance.

Pistons

Visual inspection

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

Piston diameter

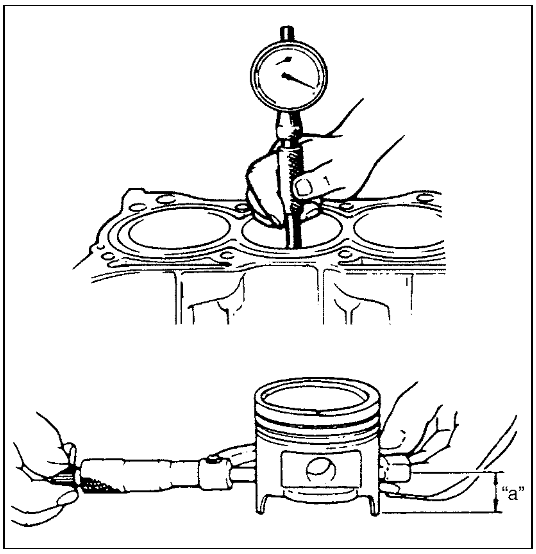


As indicated in figure, piston diameter should be measured at a position 19.5 mm (0.77 in.) from piston skirt end in the direction perpendicular to piston pin.

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

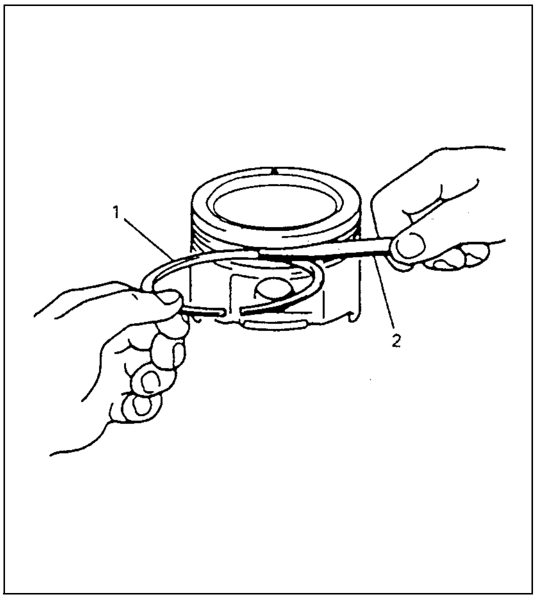
Measure cylinder bore diameter and piston diameter to find their difference which is piston clearance. Piston clearance should be within specification as given below. If it is out of specification, rebore cylinder and use oversize piston.

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

NOTE:

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

"a" : 19.5 mm (0.77 in.)



Ring groove clearance

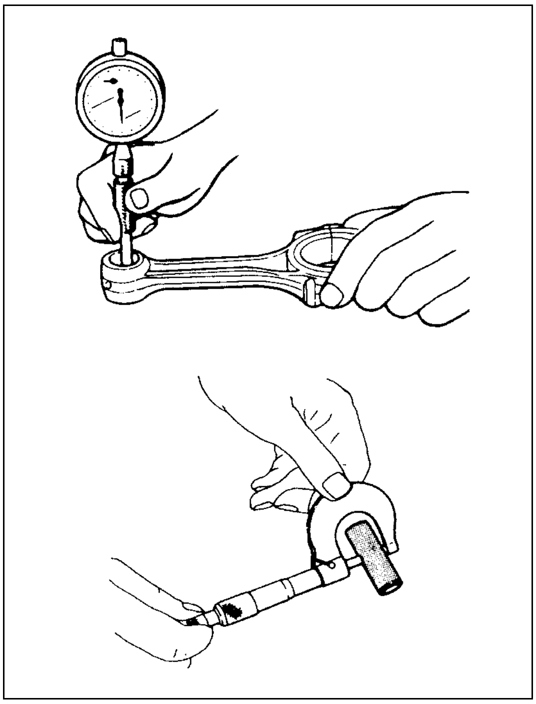
Before checking, piston grooves must be clean, dry and free of carbon deposits.
Fit new piston ring (1) into piston groove, and measure clearance between ring and ring land by using thickness gauge (2). If clearance is out of limit, replace piston.

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

Visual inspection

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.

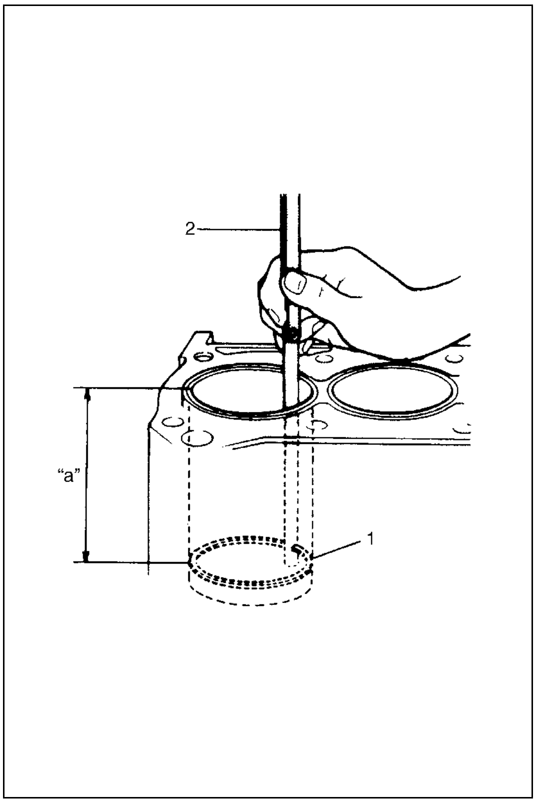
Piston pin clearance in connecting rod small end
Standard : 0.003 – 0.014 mm (0.0001 – 0.0006 in.)
Limit : 0.05 mm (0.0020 in.)

Piston pin clearance in piston
Standard : 0.006 – 0.017 mm (0.00024 – 0.00067 in.)
Limit : 0.05 mm (0.0020 in.)

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

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

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



Piston rings

Piston ring end gap

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

NOTE:

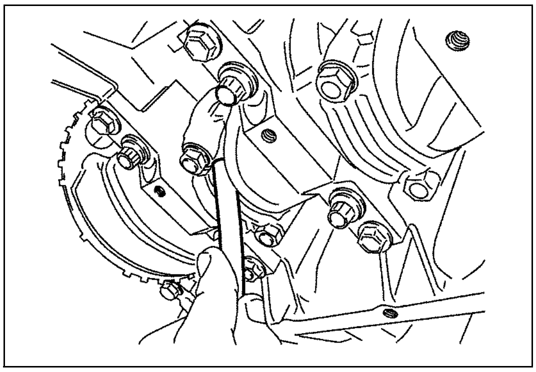
Decarbonize and clean top of cylinder bore before inserting piston ring.

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 (0.0394 in.)
Oil ring	0.20 – 0.70 mm (0.0079 – 0.0276 in.)	1.2 mm (0.0472 in.)

"a" : 120 mm (4.72 in.)

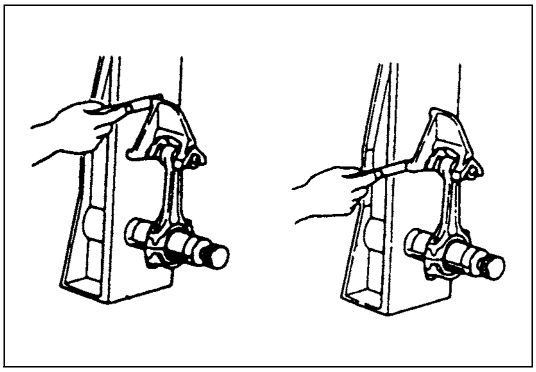
Connecting rod



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.

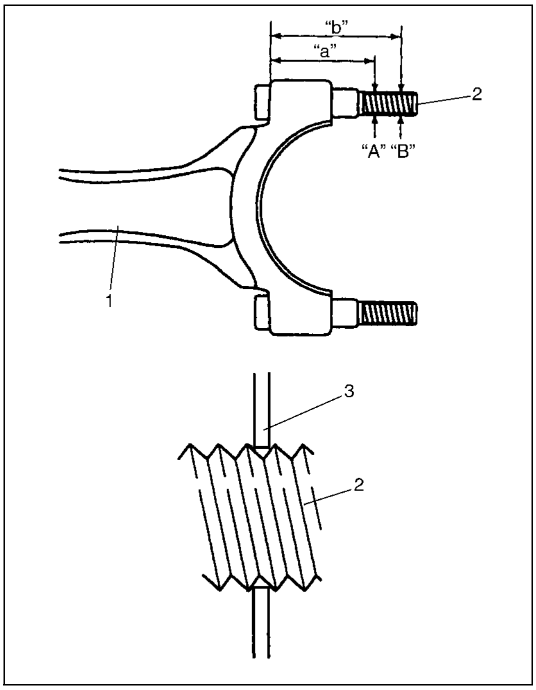
Big-end side clearance
Standard : 0.25 - 0.40 mm (0.0098 - 0.0157 in.)
Limit : 0.55 mm (0.0217 in.)



Connecting rod alignment

Mount connecting rod on aligner to check it for bow and twist. If the measured value exceeds the limit, 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 deformation (Plastic deformation tightening bolt)

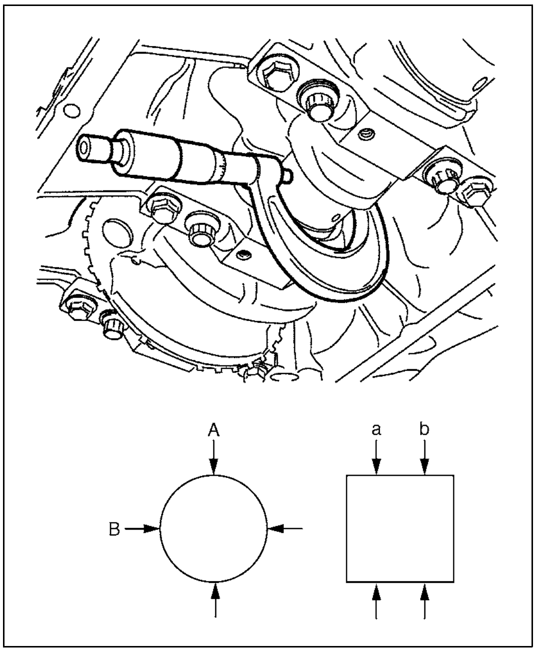
Measure each thread diameter of connecting rod (1) bolt (2) at "A" on 32 mm (1.25 in.) from bolt mounting surface and "B" on 40 mm (1.57 in.) from bolt mounting surface by using a micrometer (3). Calculate difference in diameters ("A" – "B"). If it exceeds limit, replace connecting rod.

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

Crank pin diameter



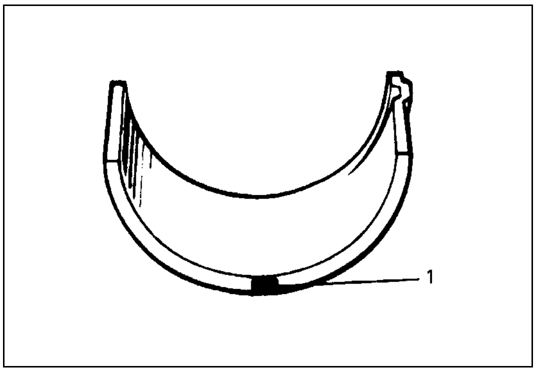
Inspect crank pin for uneven wear or damage. Measure crank pin for out-of-round or taper with a micrometer. If crank pin is damaged or out-of round or taper is out of limit, replace crankshaft or regrind crank pin to undersize and use undersize bearing.

Crank pin diameter

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

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

Connecting rod bearing general information



Service connecting rod bearings are available in standard size and 0.25 mm (0.0098 in.) undersize, and standard size bearing has 5 kinds of bearings differing in tolerance.
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.

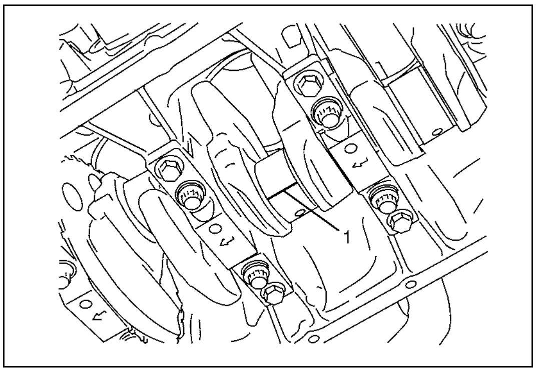
1. Painting

Connecting rod bearing visual inspection

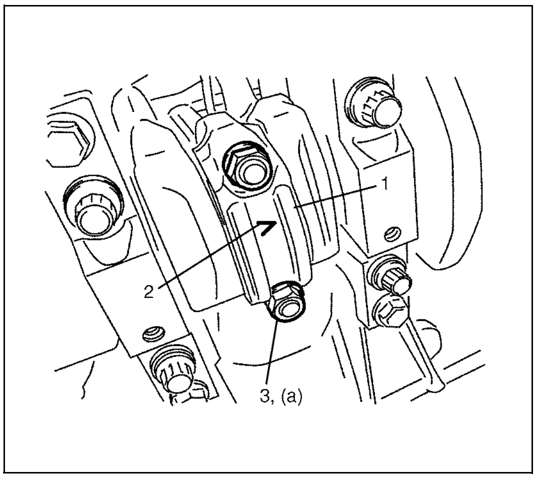
Inspect bearing shells for signs of fusion, pitting, burn or flaking and observe contact pattern. Bearing shells found in defective condition must be replaced.

Connecting rod bearing clearance

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

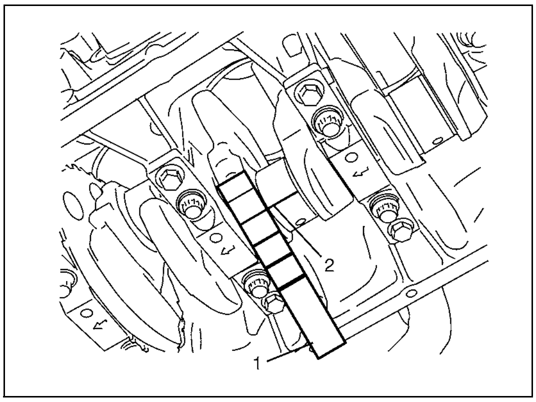


3) Place a piece of gaging plastic (1) to full width of crank pin as contacted by bearing (parallel to crankshaft), avoiding oil hole.



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) once again.

Tightening torque
Connecting rod bearing cap nuts
(a) : 15 N·m (1.5 kg-m, 11.0 lb-ft), and then retighten by turning through 45° twice



5) Remove cap and using a scale (1) on gaging plastic (2) envelope, measure gaging plastic width at the widest point (clearance).
If clearance exceed its limit, use a new standard size bearing referring to “Selection of connecting rod bearings” in this section.
After selecting new bearing, recheck clearance.

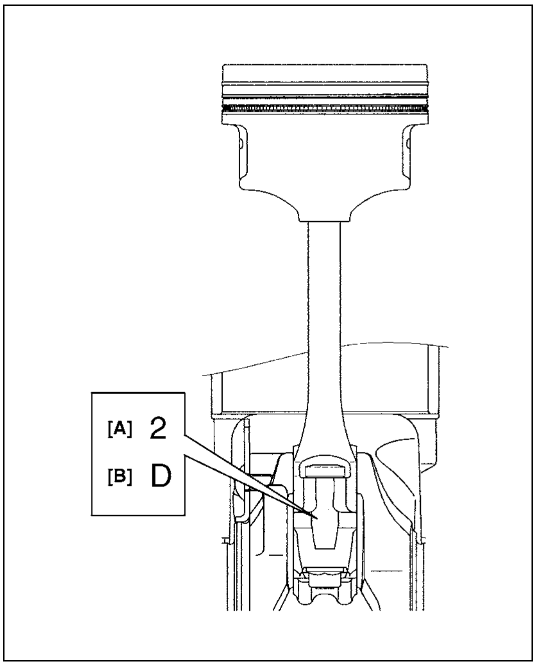
Connecting rod bearing clearance
Standard : 0.029 – 0.047 mm (0.0011 – 0.0018 in.)
Limit : 0.065 mm (0.0026 in.)

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

NOTE:
After checking the rod bearing clearance, make sure that checking for Connecting rod bolt deformation.
Refer to “Connecting rod” of “Pistons, Piston Rings, Connecting Rods and Cylinders Inspection”.

Selection of connecting rod bearings

NOTE:
- **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.**
- **When replacing crankshaft or connecting rod and its bearing due to any reason, select new standard bearings to be installed by referring to numbers stamped on connecting rod and its cap and/or alphabets stamped on crank web of No.3 cylinder.**

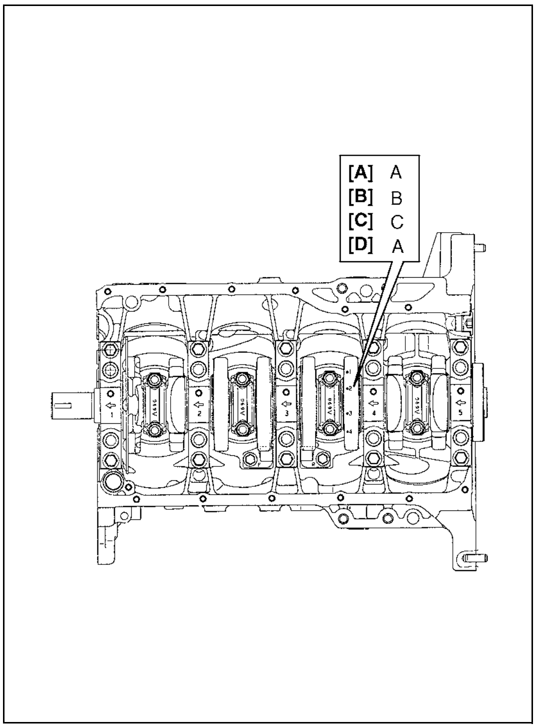


1) Check stamped numbers on connecting rod and its cap as shown.
   Three kinds of numbers ("1", "2" and "3") represent the following connecting rod big end inside diameters.
   For example, stamped number "1" indicates that corresponding connecting rod big end inside diameter is 45.000 – 45.006 mm (1.7717 – 1.7718 in.).

Connecting rod big end inside diameter

Stamped numbers	connecting rod big end inside diameter
1	45.0000 – 45.0060 mm (1.7717 – 1.7718 in.)
2	45.0061 – 45.0120 mm (1.7719 – 1.7721 in.)
3	45.0121 – 45.0180 mm (1.7722 – 1.7723 in.)

[A]:	Weight indication mark
[B]:	Connecting rod big end inside diameter number

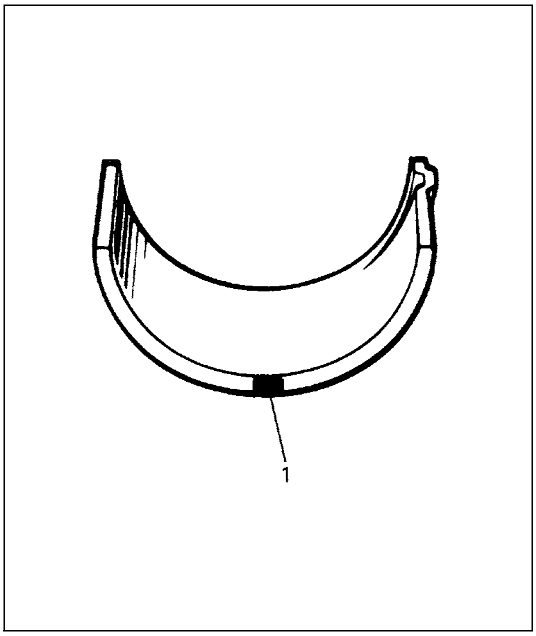


2) Next, check crankshaft pin diameter. On crank web No.3, four alphabets are stamped as shown in figure.
   Three kinds of alphabet ("A", "B" and "C") represent the following crankshaft pin diameter respectively.
   For example, stamped "A" indicates that corresponding crankshaft pin diameter is 41.994 – 42.000 mm (1.6533 – 1.6534 in.).

Crankshaft pin outer diameter

Stamped alphabet	Crankshaft pin diameter
A	41.9940 – 42.0000 mm (1.6533 – 1.6534 in.)
B	41.9880 – 41.9939 mm (1.6531 – 1.6532 in.)
C	41.9820 – 41.9879 mm (1.6529 – 1.6530 in.)

[A]:	Crankshaft pin diameter for No.1 cylinder
[B]:	Crankshaft pin diameter for No.2 cylinder
[C]:	Crankshaft pin diameter for No.3 cylinder
[D]:	Crankshaft pin diameter for No.4 cylinder



3) There are five kinds of standard bearings differing in thickness. To distinguish them, they are painted in the following colors at the position as indicated in figure.
   Each color indicated the following thickness at the center of bearing.

Standard size of connecting rod bearing thickness

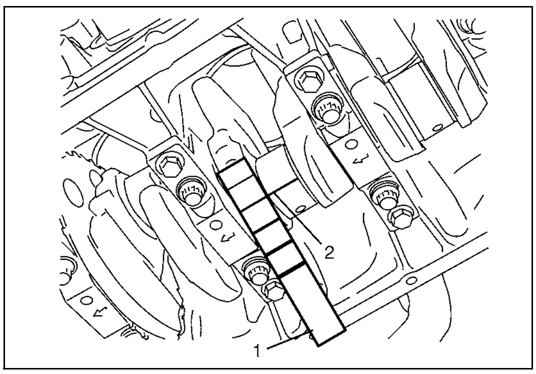
Color painted	Bearing thickness
Blue	1.4991 – 1.5020 mm (0.05902 – 0.05913 in.)
Yellow	1.4961 – 1.4990 mm (0.05890 – 0.05901 in.)
Nothing	1.4931 – 1.4960 mm (0.05878 – 0.05889 in.)
Black	1.4901 – 1.4930 mm (0.05867 – 0.05877 in.)
Green	1.4870 – 1.4900 mm (0.05855 – 0.05866 in.)

1. Paint

4) From number stamped on connecting rod and its cap and alphabets stamped on crank web No.3, determine new standard bearing to be installed to connecting rod big end inside, by referring to table.
   For example, if number stamped on connecting rod and its cap is “1” and alphabet stamped on crank web No.3 is “B”, install a new standard bearing painted in “Black” to its connecting rod big end inside.

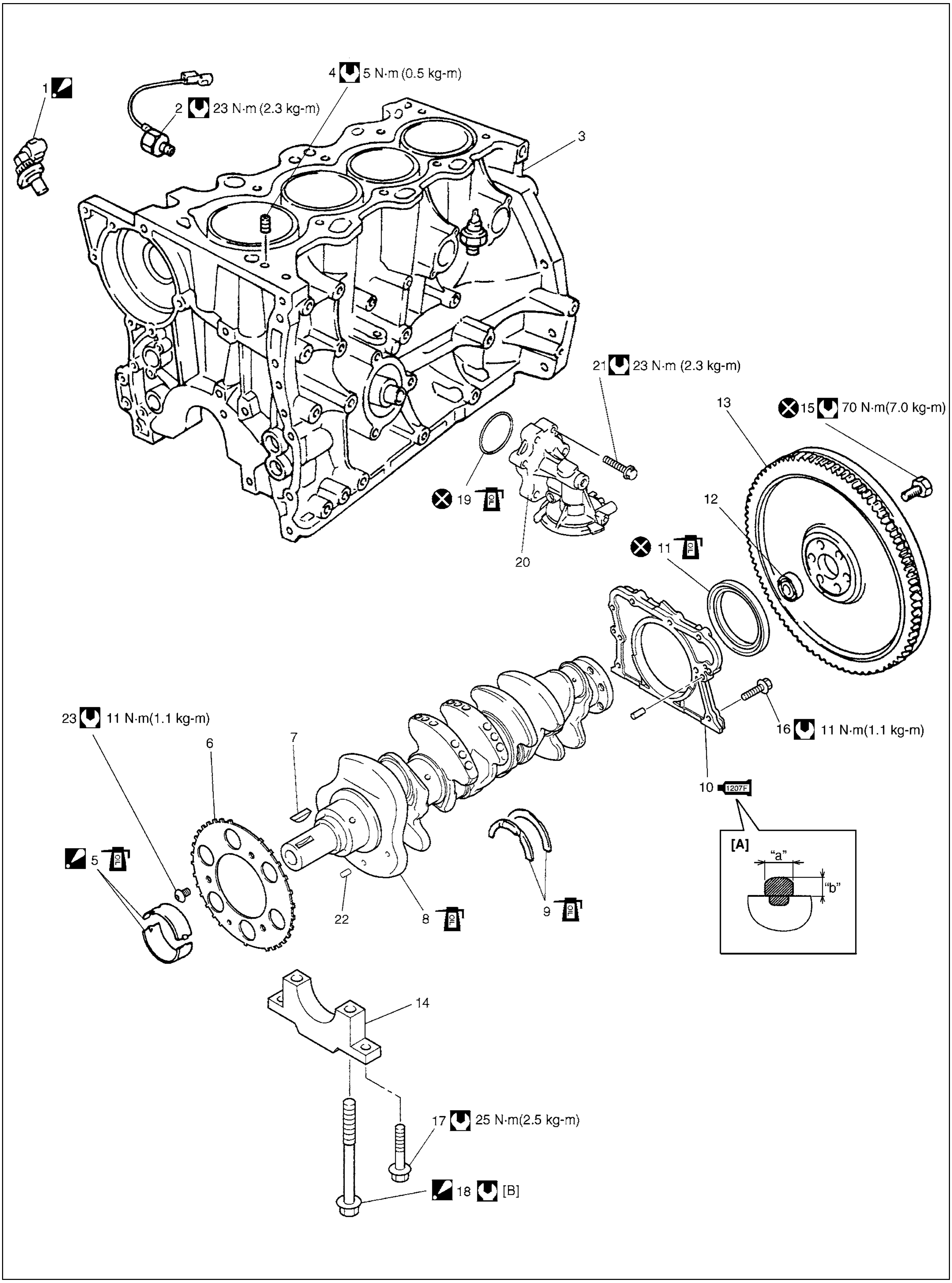
Specification of new standard connecting rod bearing size

		Number stamped on connecting rod and its cap (connecting rod big end inside diameter)		
		1	2	3
Alphabet stamped on crank web No.3 (Crankshaft pin diameter)	A	Green	Black	Nothing
	B	Black	Nothing	Yellow
	C	Nothing	Yellow	Blue
		New standard bearing to be installed.		



5) Using scale (1) on gaging plastic (2), check bearing clearance with newly selected standard bearing.
   If clearance still exceeds its limit, use next thicker bearing and recheck clearance.

Main Bearings, Crankshaft and Cylinder Block Components

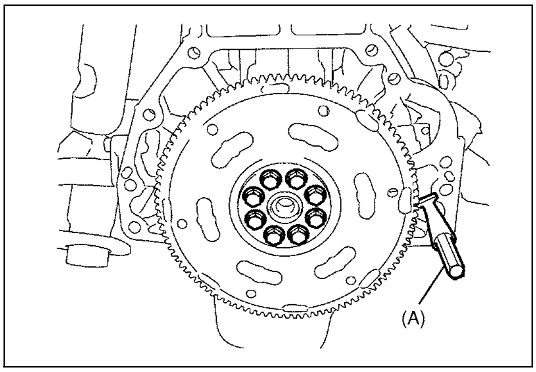


[A] :	Sealant application amount	4.	Venturi plug	14.	Main bearing cap
[B] :	1) Tighten all bolts to 30 N·m (3.0 kg-m) 2) Tighten all bolts to 50 N·m (5.0 kg-m) 3) Then retighten all bolts by turning through 60°	5.	Main bearing : Upper half of bearing has an oil groove	15.	Flywheel mounting bolt
	Tightening torque	6.	Sensor plate	16.	Rear oil seal housing mounting bolt
	Do not reuse.	7.	Crankshaft timing sprocket key	17.	Main bearing cap No.2 bolt
	Apply engine oil to inside / sliding surface.	8.	Crankshaft	18.	Main bearing cap No.1 bolt : Never reuse main bearing cap No.1 bolts once disassembled it due to plastic deformation tightening. Be sure to use new main bearing cap No.1 bolts when installing.
"a" :	3 mm (0.12 in.)	9.	Thrust bearing	19.	O-ring
"b" :	2 mm (0.08 in.)	10.	Rear oil seal housing : Apply sealant 99000-31250 to mating surface.	20.	Oil filter adapter case
1.	CKP sensor (if equipped) : When installing CKP sensor, use new sensor mounting bolt.	11.	Rear oil seal	21.	Oil filter adapter bolt
2.	Knock sensor	12.	Input shaft bearing	22.	Spring pin
3.	Cylinder block	13.	Flywheel	23.	Sensor plate bolt

Main Bearings, Crankshaft and Cylinder Block Removal and Installation

Removal

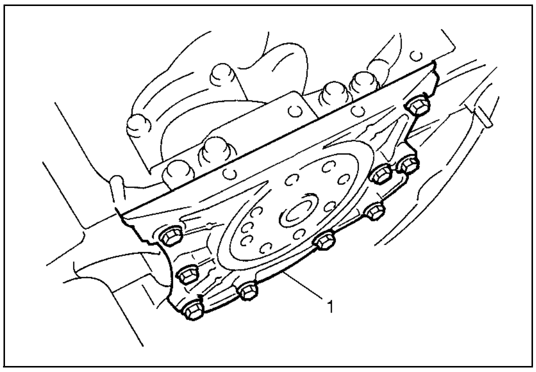
1) Remove engine assembly from vehicle referring to "Engine Assembly Removal and Installation" in this section.



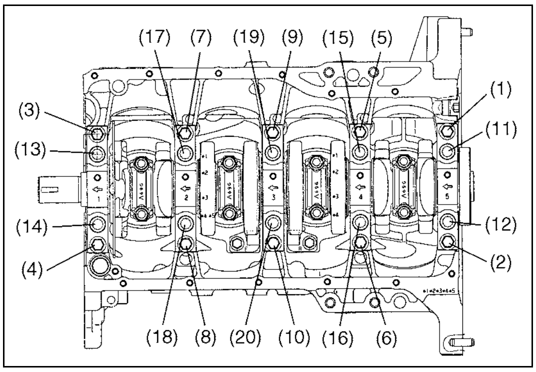
2) Remove clutch cover, clutch disc and flywheel (drive plate for A/T) by using special tool.

Special tool
(A) : 09924-17810

3) Remove piston and connecting rod referring to "Pistons, Piston Rings, Connecting Rods and Cylinders Removal and Installation" in this section.



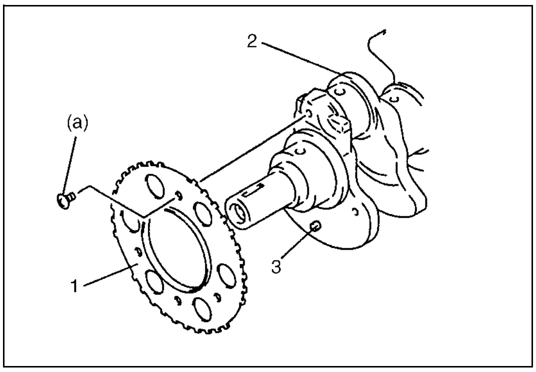
4) Remove rear oil seal housing (1).



5) Loosen main bearing cap No.1 and No.2 bolts in such order as indicated in figure and remove them.
6) Remove crankshaft from cylinder block.

Installation

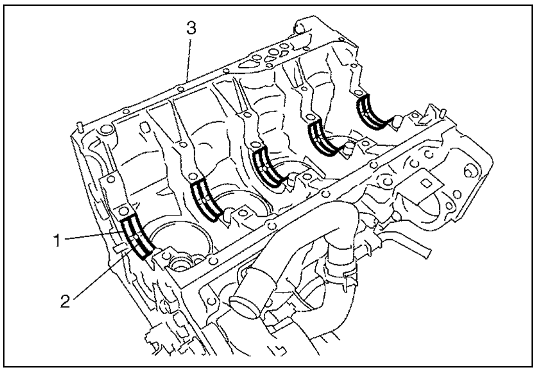
CAUTION:
- **Use new bearing cap No.1 bolts. They are deformed once they are used because they are plastic deformation tightening bolts.**
- **All parts to be installed must be perfectly clean.**
- **Be sure to oil crankshaft journals, journal bearings, thrust bearings, crankpins, connecting rod bearings, 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.**



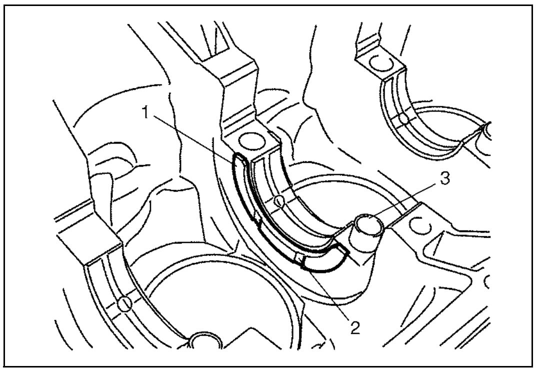
1) Install sensor plate (1) to crankshaft (2) and tighten bolts to specified torque.

NOTE:
When installing sensor plate, align spring pin (3) on crankshaft and hole of sensor plate.

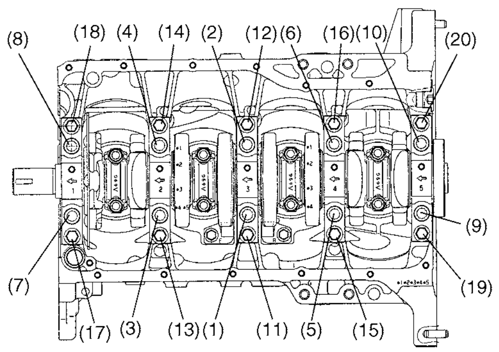
Tightening torque
Sensor plate bolts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)



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.



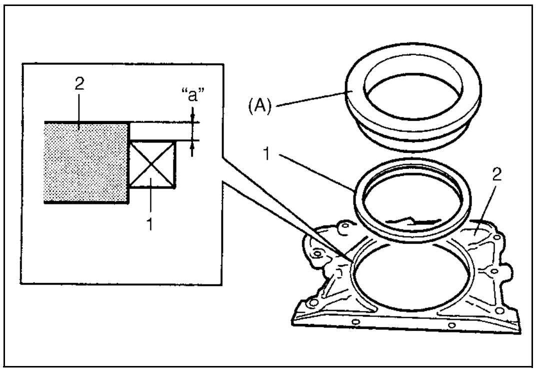
3) Install thrust bearings (1) to cylinder block between No.2 and No.3 cylinders. Face oil groove (2) sides to crank webs.
4) Confirm that dowel pins (3) are installed to intake side of each journal.
5) Install crankshaft to cylinder block.



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 main bearing cap No.1 bolts ((1) – (10)) and main bearing cap No.2 bolts ((11) – (20)), tighten them gradually as follows.
   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 25 N·m (2.5 kg-m, 18.0 lb-ft) according to numerical order as shown.

Tightening torque
Main bearing No.1 bolts (1) – (10)
: 30 N·m (3.0 kg-m, 22.0 lb-ft), 50 N·m (5.0 kg-m, 36.5 lb-ft) and then retighten by turning through 60°
Main bearing No.2 bolts (11) – (20)
: 25 N·m (2.5 kg-m, 18.0 lb-ft)

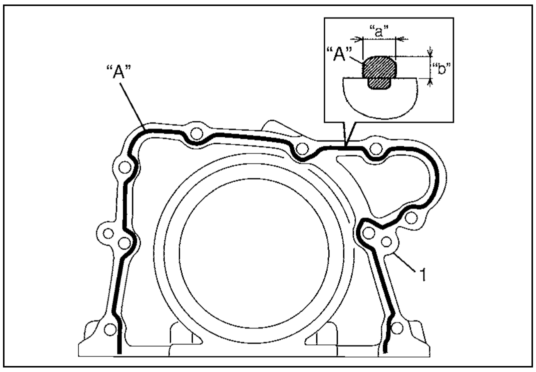
CAUTION:
After tightening cap bolts, check to be sure that crankshaft rotates smoothly when turning it by 12 N·m (1.2 kg-m, 9.0 lb-ft) torque or below.



7) If necessary, 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

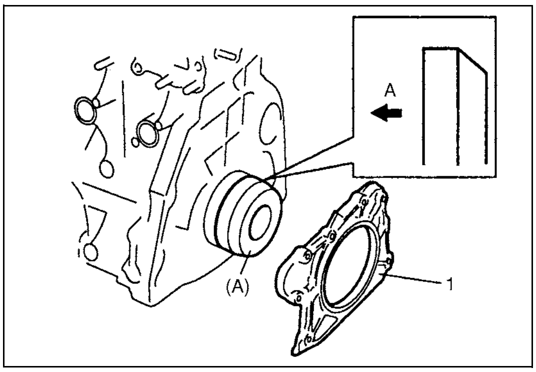
Crank rear oil seal installing position (dimension)
"a" : 3 mm (0.12 in.)



8) Apply sealant to mating surface of rear oil seal housing (1).

"A" : Sealant 99000-31250

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

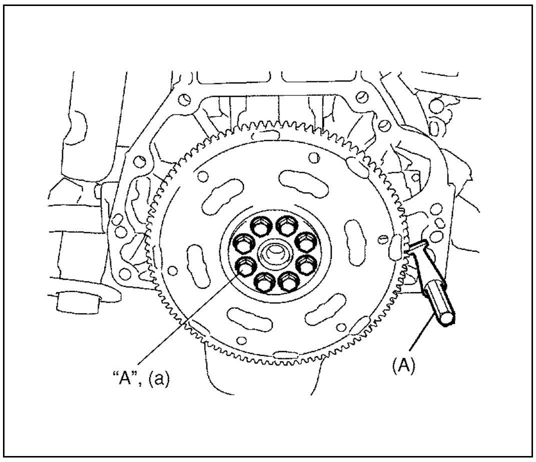


9) Install rear oil seal housing (1) and tighten bolts to specified torque by using special tool.

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



10) Install flywheel ((for M/T) or drive plate (for A/T)).
Using special tool, lock flywheel or drive plate, and tighten flywheel or drive plate bolts to specified torque.

NOTE:
Use new flywheel or drive plate bolts.

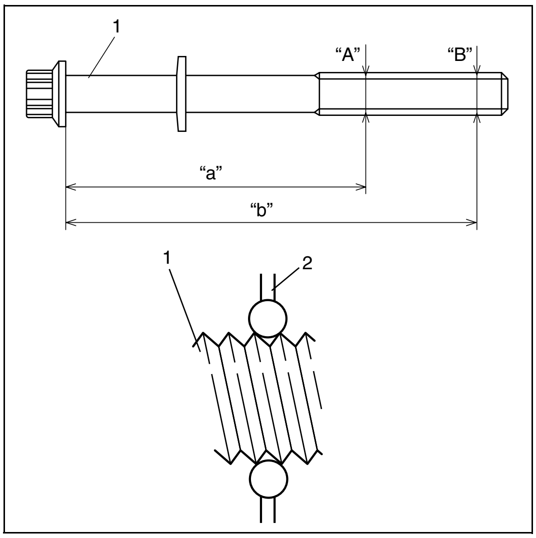
Special tool
(A) : 09924-17810

Tightening torque
Flywheel or drive plate bolts
(a) : 70 N·m (7.0 kg-m, 51.0 lb-ft)

11) Install piston and connecting rod referring to "Pistons, Piston Rings, Connecting Rods and Cylinders Removal and Installation" in this section.
12) Install engine assembly to vehicle referring to "Engine Assembly Removal and Installation" in this section.

Main Bearings, Crankshaft and Cylinder Block Inspection

Main bearing cap No.1 bolt



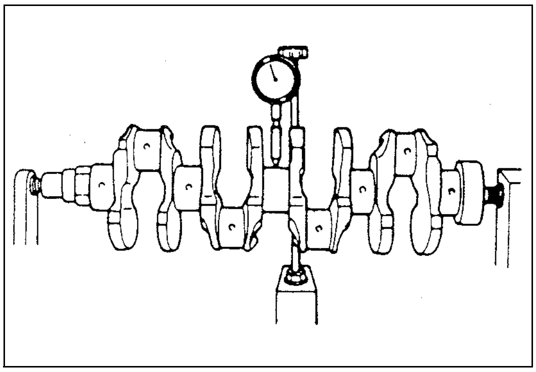
Measure each thread diameter main bearing cap No.1 bolts (1) at "A" on 60mm(2.36in.) from seat side of flange bolt and "B" on 90mm(3.54in.) from seat side of flange bolt by using a micrometer (2).
Calculate difference in diameters ("A" – "B").
If it exceeds limit, replace with new one.

Main bearing cap No.1 bolt diameter measurement points
"a" : 60mm (2.36in.)
"b" : 90mm (3.54in.)

Main bearing cap No.1 bolt diameter difference
Limit ("A" – "B") : 0.2mm (0.008in.)

Crankshaft

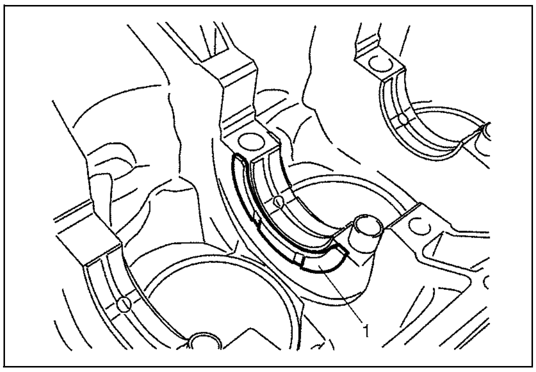
Crankshaft runout



Using a dial gauge, measure runout at center journal. Rotate crankshaft slowly. If runout exceeds its limit, replace crankshaft.

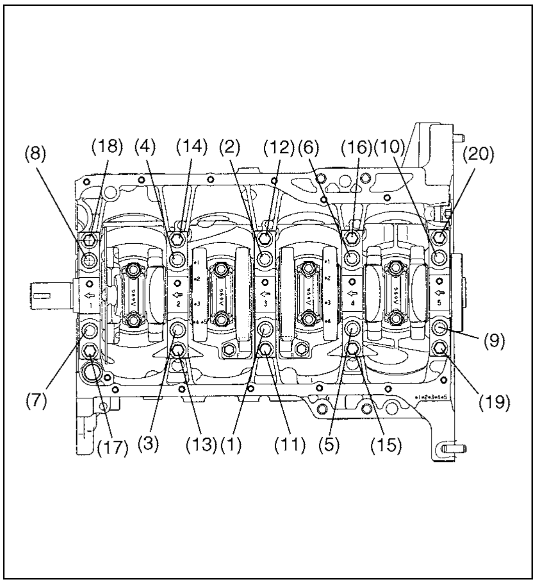
Crankshaft runout
Limit : 0.02 mm (0.0008 in.)

Crankshaft thrust play



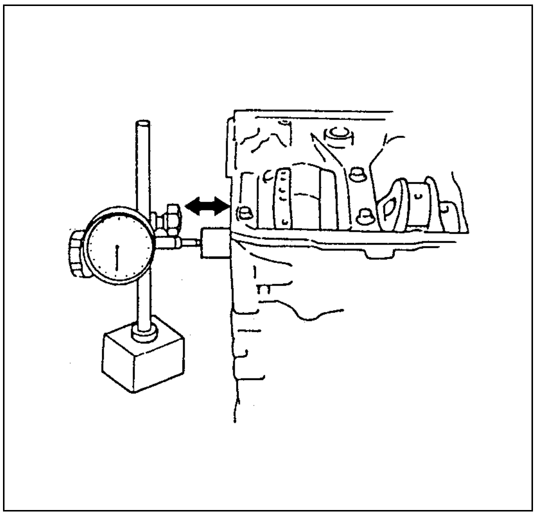
1) Measure this play with crankshaft set in cylinder block in the normal manner, that is with thrust bearing (1) and journal bearing caps installed.

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.)



2) Tighten main bearing cap No.1 bolts (1) – (10) and main bearing cap 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 1), tighten them to 50 N·m (5.0 kg-m, 36.5 lb-ft).
   c) In the same manner as in step 1), retighten them to 60°.
   d) Tighten bolts (11) – (20) to 25 N·m (2.5 kg-m, 18.0 lb-ft) according to numerical order in figure.

Tightening torque
Main bearing cap No.1 bolts (1) – (10) :
30 N·m (3.0 kg-m, 21.5 lb-ft), 50 N·m (5.0 kg-m, 36.5 lb-ft) and then retighten by turning through 60 °
Main bearing cap No.2 bolts (11) – (20) :
25 N·m (2.5 kg-m, 18.0 lb-ft)

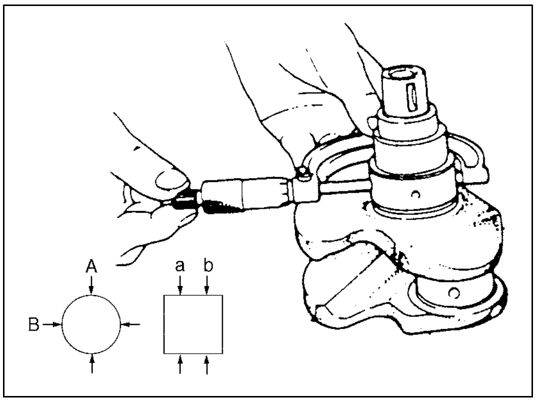


3) Use a dial gauge to read displacement in axial (thrust) direction of crankshaft.
   If its limit is exceeded, replace thrust bearing with new standard one or oversize one to obtain standard thrust play.

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, make sure that thread deformation of each main bearing cap No.1 bolt referring to "Main bearing cap No.1 bolt" in this section.

Out-of-round and taper (uneven wear) of journals



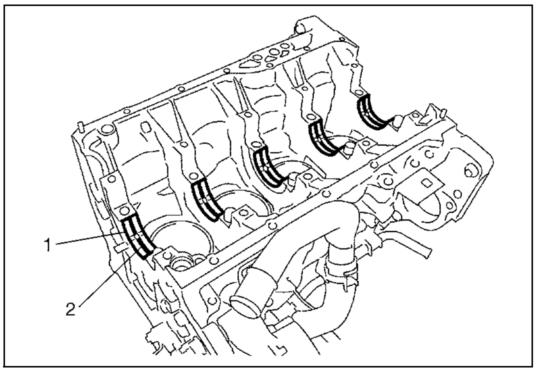
An unevenly worn crankshaft journal shows up as a difference in diameter at a cross section or along its length (or both). This difference, if any, is determined by taking micrometer readings. If any one of journals is badly damaged or if amount of uneven wear in the sense explained below exceeds its 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

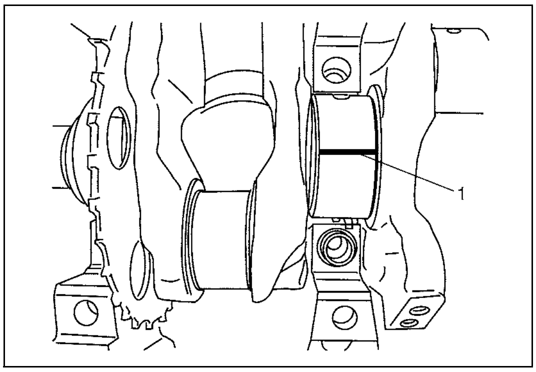
Check bearings for pitting, scratches, wear or damage.
If any malcondition is found, replace both upper and lower halves.
Never replace either half without replacing the other half.

Main bearing clearance

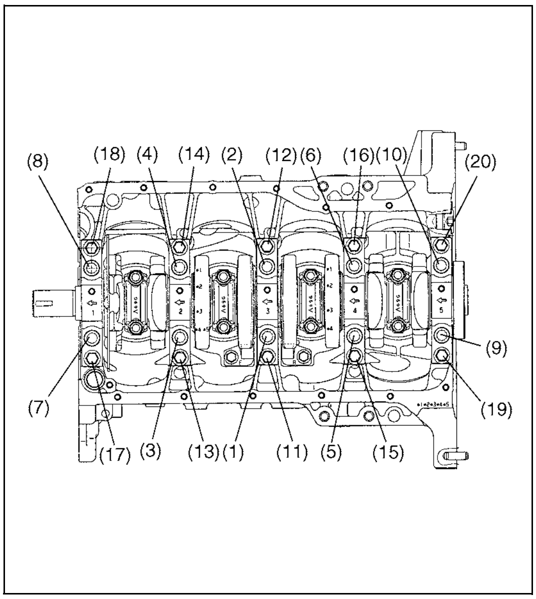
CAUTION:
Do not rotate crankshaft while gaging plastic is installed.

Check clearance by using gaging plastic according to the following procedure.

1) Remove bearing caps.
2) Clean bearings and main journals.

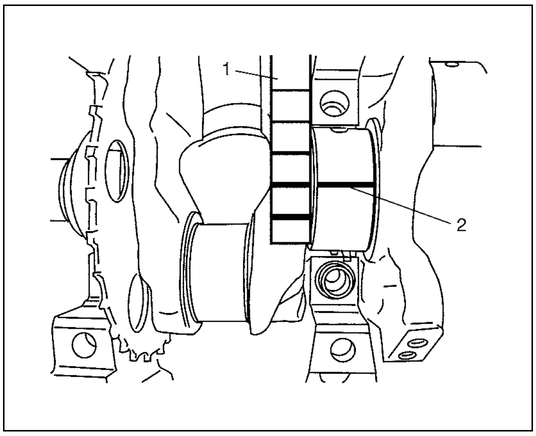


3) Place a piece of gaging plastic (1) the full width of bearing (parallel to crankshaft) on journal, avoiding oil hole.



4) Tighten main bearing cap No.1 bolts (1) – (10) and main bearing No.2 cap 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 25 N·m (2.5 kg-m, 18.0 lb-ft) according to numerical order in figure.

Tightening torque
Main bearing cap No.1 bolts (1) – (10) :
30 N·m (3.0 kg-m, 22.0 lb-ft), 50 N·m (5.0 kg-m, 36.5 lb-ft) and then retighten by turning through 60°
Main bearing cap No.2 bolts (11) – (20) :
25 N·m (2.5 kg-m, 18.0 lb-ft)



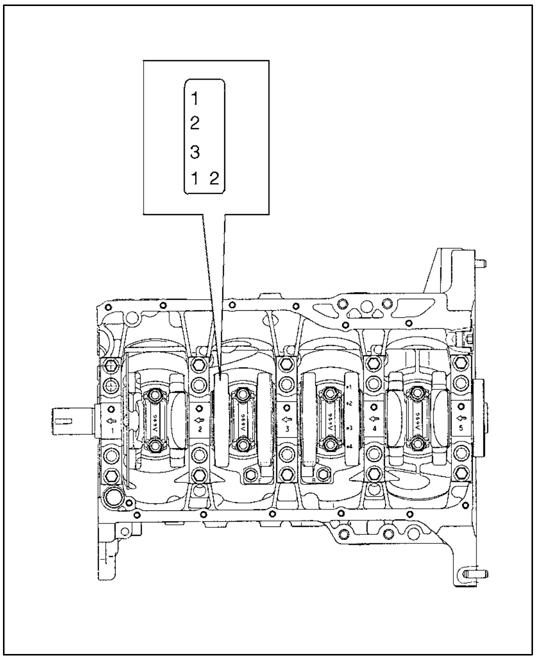
5) Remove bearing caps and using scale (1) on gaging plastic (2) envelop, measure gaging plastic width at its widest point. If clearance exceeds its limit, replace bearing. Always replace both upper and lower inserts as a unit.
   A new standard bearing may produce proper clearance. If not, it will be necessary to regrind crankshaft journal for use of 0.25 mm (0.0098 in.) undersize bearing.
   After selecting new bearing, recheck clearance.

Main bearing clearance
Standard : 0.025 – 0.045 mm (0.0010 – 0.0018 in.)
Limit : 0.058 mm (0.0023 in.)

Selection of main bearings

Standard bearing

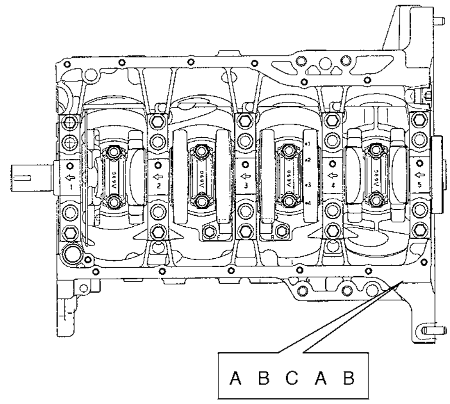
If bearing is in malcondition, or bearing clearance is out of specification, select a new standard bearing according to the following procedure and install it.



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

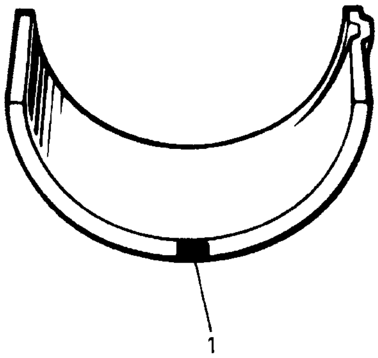
Stamped numbers	Journal diameter
1	**44.994 – 45.000 mm (1.7714 – 1.7717 in.)**
2	**44.988 – 44.994 mm (1.7712 – 1.7714 in.)**
3	**44.982 – 44.988 mm (1.7709 – 1.7712 in.)**



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") or numbers ("1", "2" and "3") represent the following cap bore diameters.
   Stamped alphabets or numbers on cylinder block represent bearing cap bore diameter marked with an arrow in figure respectively. For example, stamped "A" or "1" indicates that corresponding bearing cap bore diameter is 49.000 – 49.006 mm (1.9291 – 1.9294 in.).

Crankshaft bearing cap bore

Stamped alphabet (number)	Bearing cap bore diameter (without bearing)
A (1)	49.000 – 49.006 mm (1.9291 – 1.9294 in.)
B (2)	49.006 – 49.012 mm (1.9294 – 1.9296 in.)
C (3)	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 position as indicated in figure.
   Each color indicated the following thickness at the center of bearing.

Standard size of crankshaft main bearing thickness

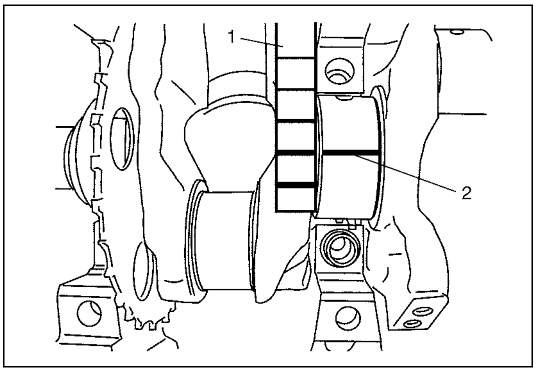
Color painted	Bearing thickness
Pink	1.990 – 1.994 mm (0.0783 – 0.0785 in.)
Purple	1.993 – 1.997 mm (0.0785 – 0.0786 in.)
Brown	1.996 – 2.000 mm (0.0786 – 0.0787 in.)
Green	1.999 – 2.003 mm (0.0787 – 0.0789 in.)
Black	2.002 – 2.006 mm (0.0788 – 0.0790 in.)

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.

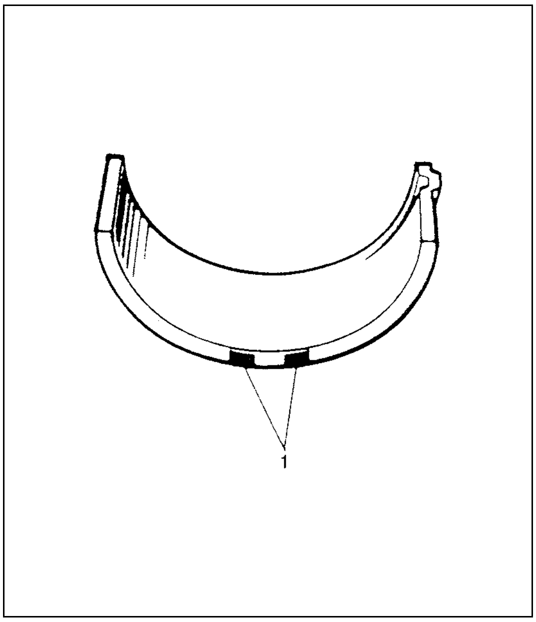
Specification of new standard crankshaft main bearing size

		Number stamped on crank web No.2 (Journal diameter)		
		1	2	3
Alphabet stamped on cylinder block (Cap bore dia.)	A (1)	Pink	Purple	Brown
	B (2)	Purple	Brown	Green
	C (3)	Brown	Green	Black
		New standard bearing to be installed.		



5) Using scale (1) on gaging 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 (0.0098 in.))



- 0.25 mm (0.0098 in.) undersize bearing is available, in five kinds varying in thickness.
  To distinguish them, each bearing is painted in the following colors at such position as indicated in figure.
  Each color represents the following thickness at the center of bearing.

Undersize of crankshaft main bearing thickness

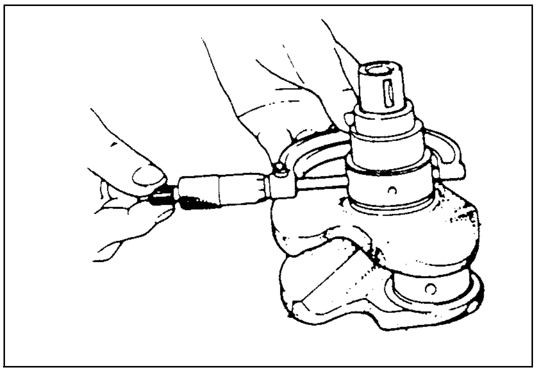
Color painted	Bearing thickness
Red and Pink	2.115 – 2.119 mm (0.0833 – 0.0834 in.)
Red and Purple	2.118 – 2.122 mm (0.0834 – 0.0835 in.)
Red and Brown	2.121 – 2.125 mm (0.0835 – 0.0837 in.)
Red and Green	2.124 – 2.128 mm (0.0836 – 0.0838 in.)
Red and Black	2.127 – 2.131 mm (0.0837 – 0.0839 in.)

1. Paint

- If necessary, regrind crankshaft journal and select undersize bearing to use with it as follows.

1) Regrind journal to the following finished diameter.

Finished diameter
44.732 – 44.750 mm (1.7611 – 1.7618 in.)

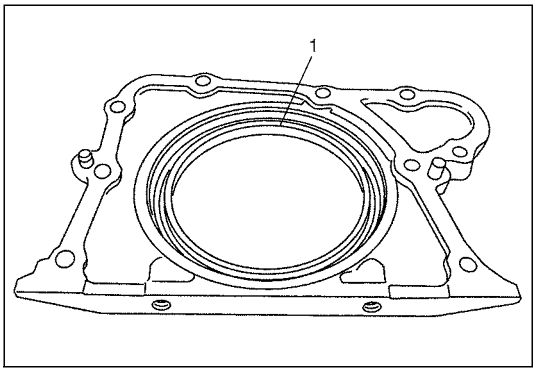


2) Using micrometer, measure reground journal diameter. Measurement should be taken in two directions perpendicular to each other in order to check for out-of-round.
3) Using journal diameter measured above and alphabets stamped on cylinder block, select an undersize bearing by referring to table given below.
   Check bearing clearance with newly selected undersize bearing.

Specification of new standard 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 (1)	Red and Pink	Red and Purple	Red and Brown
	B (2)	Red and Purple	Red and Brown	Red and Green
	C (3)	Red and Brown	Red and Green	Red and Black
		Undersize bearing to be installed		

Rear oil seal



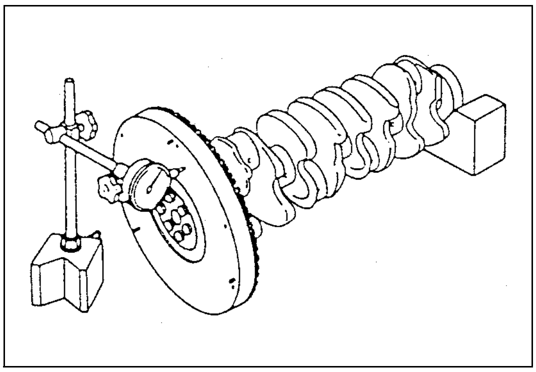
Carefully inspect oil seal (1) for wear or damage.
If its lip is worn or damaged, replace it.

Flywheel

Visual inspection

- If ring gear is damaged, cracked or worn, replace flywheel.
- If the surface contacting clutch disc is damaged, or excessively worn, replace flywheel.

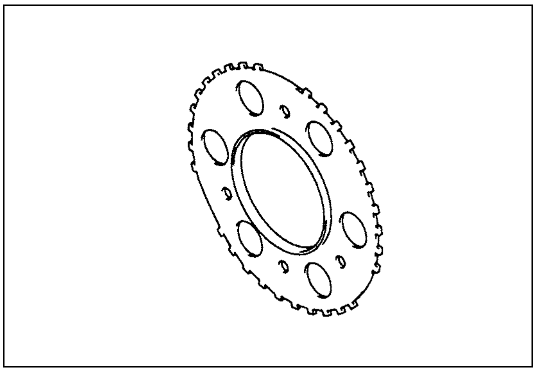
Flywheel face runout



Check flywheel face runout with a dial gauge.
If runout exceeds its limit, replace flywheel.

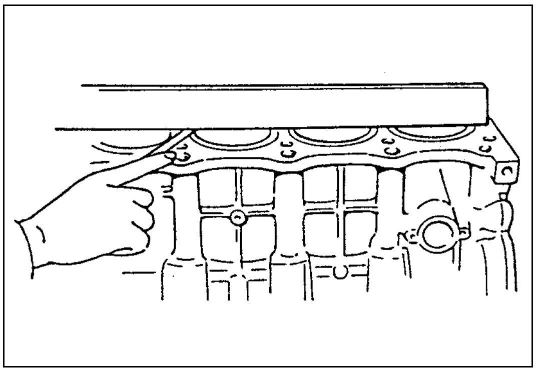
Flywheel face runout
Limit : 0.2 mm (0.0079 in.)

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.

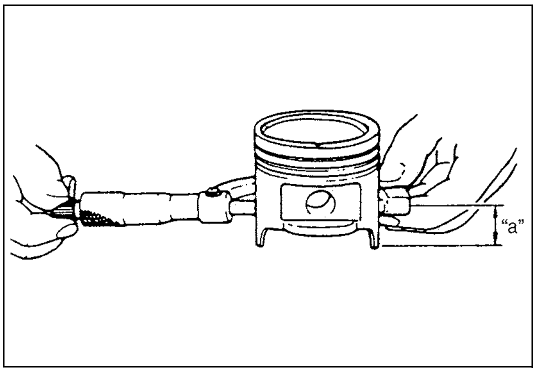
Cylinder block flatness
Limit : 0.03 mm (0.0012 in.)

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) Rebore and hone cylinder to the following dimension.

Cylinder bore diameter to be rebored
Oversize 0.50 : 78.500 – 78.514 mm (3.0906 – 3.0911 in.)

NOTE:

Before reboring, install all main bearing caps in place and tighten to specification to avoid distortion of bearing bores.

5) Measure piston clearance after honing.

Piston clearance : 0.032 – 0.061 mm (0.0013 – 0.0024 in.)

Required Service Material

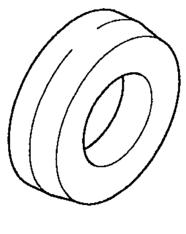
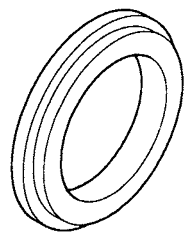
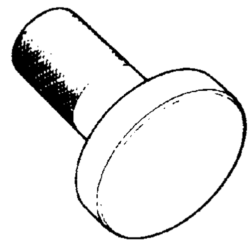
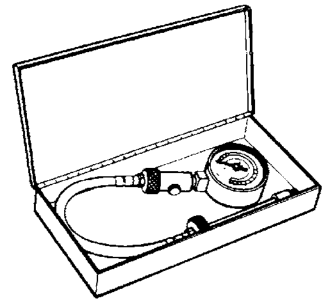
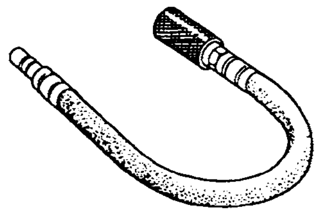
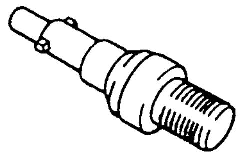
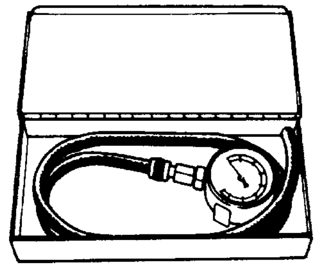
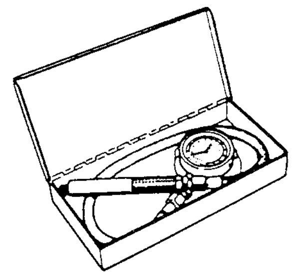
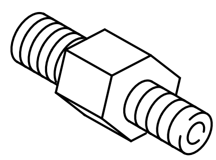
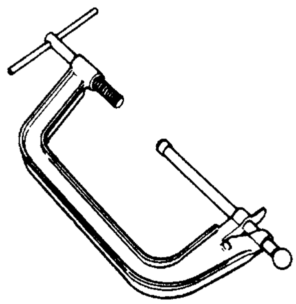
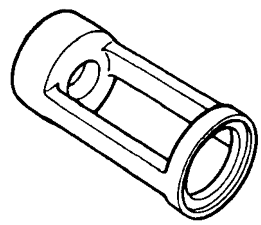
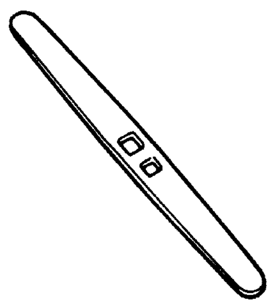
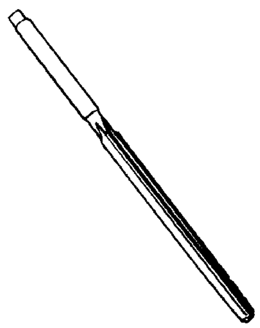
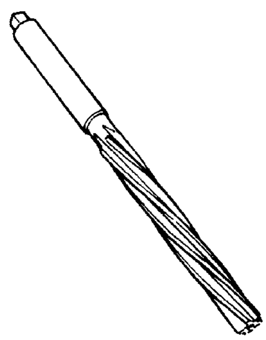
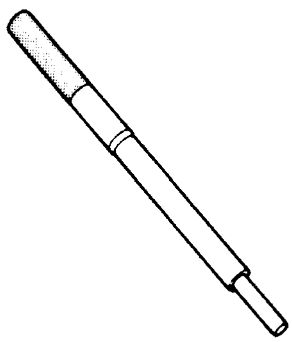
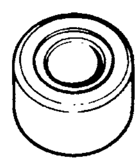
Material	Recommended product (Part Number)	Use
Sealant	Sealant 1207F (99000-31250)	• To apply to mating surfaces of cylinder block and oil pan. • To apply to mating surfaces of cylinder block and timing chain cover. • To apply to sealing surfaces of cylinder head cover. • To apply to mating surfaces to rear oil seal housing.
	Sealant 1207B (99000-31140)	• To apply to mating surface of cylinder block, cylinder head and timing chain cover.
	Sealant 1215 (99000-31110)	• To apply to the thread of the bolt of water outlet pipe.

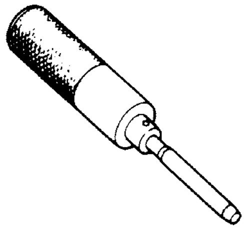
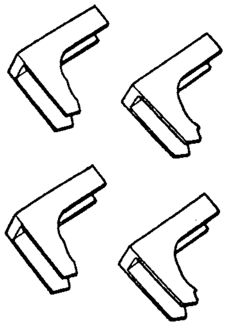
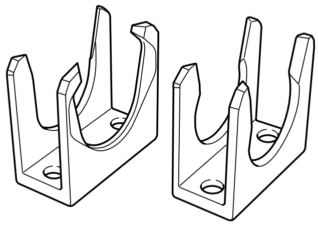
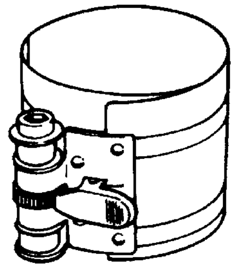
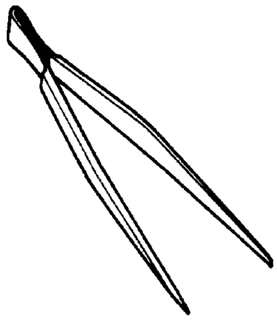
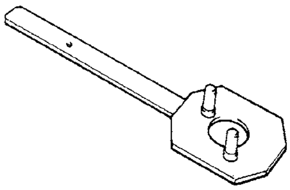
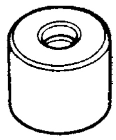
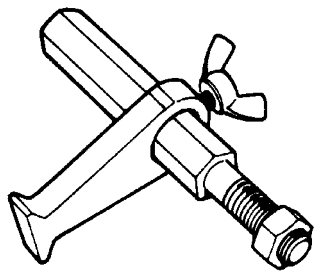
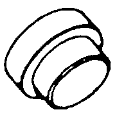
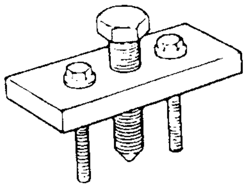
Tightening Torque Specification

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
Oil pressure switch	14	1.4	10.5
Camshaft housing bolts (for replacement of shim)	8	0.8	6.0
Camshaft housing bolts	11	1.1	8.0
Engine cover bolts	8	0.8	6.0
Intake manifold bolts and nuts	25	2.5	18.0
Exhaust manifold bolts and nuts	50	5.0	36.5
Exhaust pipe No.1 bolts	50	5.0	36.5
Exhaust manifold stiffener bolts	50	5.0	36.5
Exhaust pipe No.2 bolts	43	4.3	31.5
Exhaust oxygen sensor	45	4.5	32.5
Oil pump strainer bolt	11	1.1	8.0
Oil pump strainer bracket bolt	11	1.1	8.0
Oil pan bolts and nuts	11	1.1	8.0
Oil pan drain plug bolt	50	5.0	36.5
Timing chain cover bolts	23	2.3	17.0
Crank shaft pulley bolt	150	15.0	108.5
Oil pump rotor plate bolts	11	1.1	8.0
Timing chain No.1 guide bolts	9	0.9	6.5
Timing chain tensioner adjuster bolts	11	1.1	8.0
Venturi plug	5	0.5	3.5
Cylinder head bolt for M8	25	2.5	18.0

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
Cylinder head bolts for M10	a) Tighten 20 N·m b) Tighten 40 N·m c) Retighten by turning through 60° d) Retighten by turning through 60°	a) Tighten 2.0 kg-m b) Tighten 4.0 kg-m c) Retighten by turning through 60° d) Retighten by turning through 60°	a) Tighten 14.5 lb-ft b) Tighten 29.0 lb-ft c) Retighten by turning through 60° d) Retighten by turning through 60°
Connecting rod bearing cap nuts	a) Tighten 15 N·m b) Retighten by turning through 45° c) Retighten by turning through 45°	a) Tighten 1.5 kg-m b) Retighten by turning through 45° c) Retighten by turning through 45°	a) Tighten 11.0 lb-ft b) Retighten by turning through 45° c) Retighten by turning through 45°
Engine mounting bolts for M8	25	2.5	18.0
Engine mounting bolts and nuts for M10	55	5.5	40.0
Engine right mounting nuts	65	6.5	47.0
Main bearing cap No.1 bolts	a) Tighten 30 N·m b) Tighten 50 N·m c) Retighten by turning through 60°	a) Tighten 3.0 kg-m b) Tighten 5.0 kg-m c) Retighten by turning through 60°	a) Tighten 22.0 lb-ft b) Tighten 36.5 lb-ft c) Retighten by turning through 60°
Main bearing cap No.2 bolts	25	2.5	18.0
Sensor plate bolts	11	1.1	8.0
Rear oil seal housing bolts	11	1.1	8.0
Flywheel or drive plate bolts	70	7.0	51.0
Transaxle stiffener bolts	50	5.0	36.5
Timing chain tensioner bolt	25	2.5	18.0
Oil gallery pipe No.1 bolts	30	3.0	21.5
Oil gallery pipe No.2 bolts	11	1.1	8.0
Oil gallery pipe No.3 bolts	11	1.1	8.0
Oil control valve mounting nuts	11	1.1	8.0
Intake camshaft sprocket bolt	60	6.0	43.0

Special Tool

 09911-97720 Oil seal guide	 09911-97820 Oil seal installer	 09913-75810 Bearing installer	 09915-64512 Compression gauge
 09915-64530 Hose	 09915-67010 Attachment	 09915-67311 Vacuum gauge	 09915-77310 Oil pressure gauge
 09915-78211 Oil pressure gauge attach- ment	 09916-14510 Valve lifer	 09916-14521 Valve lifer 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

 09916-58210 Valve guide installer handle	[A]  09916-67020 Tappet holder See NOTE below	[B]  09916-67021 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		

NOTE:

[A] and [B] tools in the above table are interchangeable.

SECTION 6B

ENGINE COOLING

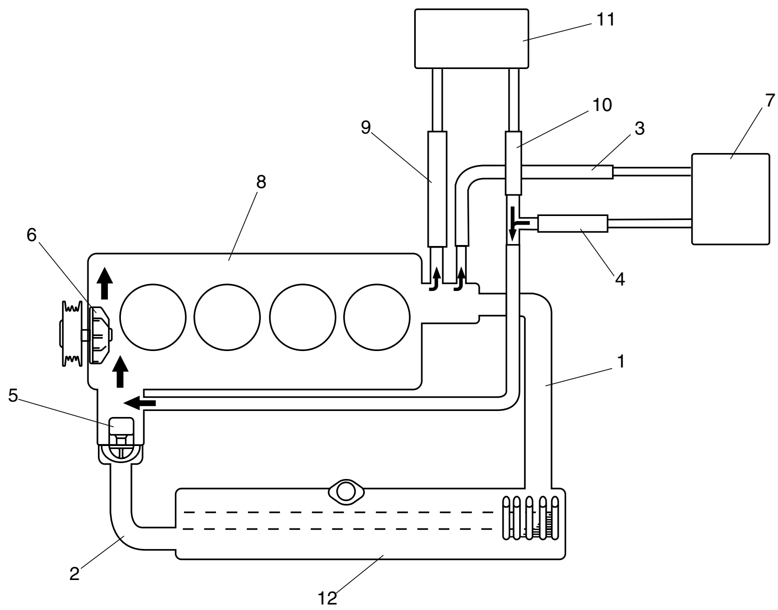
CONTENTS

General Description

The cooling system consists of the radiator cap, radiator, coolant reservoir, hoses, water pump, cooling fan and thermostat. The radiator is tube-and-fin type one.

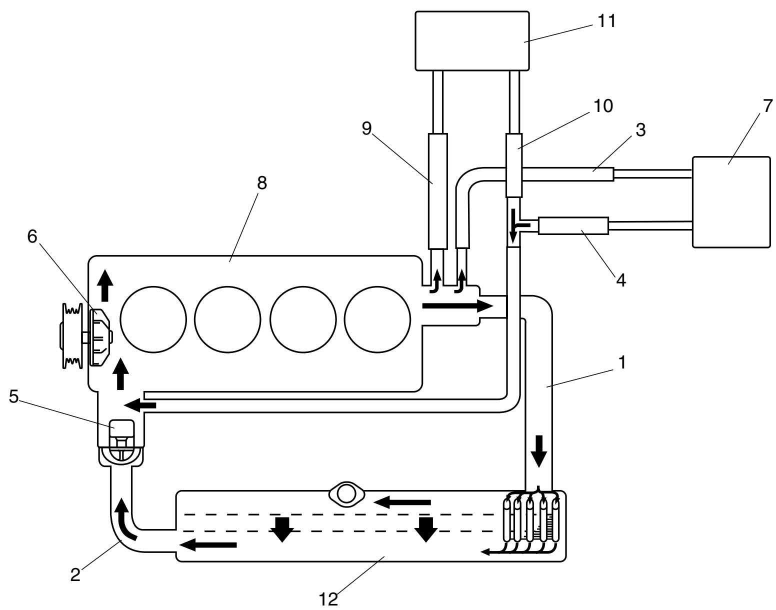
Cooling System Circulation

1) While the engine is warmed up (thermostat closed), coolant circulates as follows.



1. Radiator inlet hose	5. Thermostat	9. Heater core inlet hose
2. Radiator outlet hose	6. Water pump	10. Heater core outlet hose
3. Throttle body inlet hose	7. Throttle body	11. Heater core
4. Throttle body outlet hose	8. Engine	12. Radiator

2) When coolant is warmed up to normal temperature and the thermostat opens, coolant passes through the radiator core to be cooled as follows.



1. Radiator inlet hose	5. Thermostat	9. Heater core inlet hose
2. Radiator outlet hose	6. Water pump	10. Heater core outlet hose
3. Throttle body inlet hose	7. Throttle body	11. Heater core
4. Throttle body outlet hose	8. Engine	12. Radiator

Coolant

The coolant recovery system is standard. The coolant in the radiator expands with heat, and the coolant is overflowed to the reservoir.
When the system cools down, the coolant is drawn back into the radiator.

The cooling system has been filled with a quality coolant that is a 50/50 mixture of water and ethylene glycol antifreeze.

This 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).

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.**
- **Coolant must be mixed with demineraled water or distilled water.**

Anti-freeze proportioning table

		For M/T model	For A/T model
Freezing temperature	°C	–36	–36
	°F	–33	–33
Anti-freeze/Anti-corrosion coolant concentration	%	50	50
Ratio of compound to cooling water	ltr.	2.80/2.80	2.70/2.70
	US pt.	5.92/5.92	5.71/5.71
	Imp pt.	4.93/4.93	4.75/4.75

Coolant capacity

	For M/T model	For A/T model
Engine radiator and heater	5.0 liters (10.00/8.80 US/Imp. pt.)	4.8 liters (10.14/8.45 US/Imp. pt.)
Reservoir	0.6 liters (1.27/1.06 US/Imp. pt.)	0.6 liters (1.27/1.06 US/Imp. pt.)
Total	5.6 liters (11.84/9.86 US/Imp. pt.)	5.4 liters (11.41/9.51 US/Imp. pt.)

Diagnosis

Diagnosis Table

Condition	Possible Cause	Correction
Engine overheats (It is in case that radiator fan operates)	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.
	Clogged radiator	Check and replace radiator as necessary.
	Faulty radiator cap	Replace.
	Improper ignition timing	Adjust.
	Dragging brakes	Adjust brake.
	Slipping clutch	Adjust or replace.
	Poor charge battery	Check and replace as necessary.
	Poor generation generator	Check and repair.
	ECT sensor faulty	Check and replace as necessary.
	Radiator cooling fan relay faulty	Check and replace as necessary.
	ECM faulty	Check and replace as necessary.
	Wiring or grounding faulty	Repair and necessary.
	Equipped with too much electric load part(s)	Dismount.
	Radiator cooling fan motor faulty	Check and replace as necessary.
Engine overheats (It is in case that radiator fan won't operates)	Fuse blown	Check 30A fuse of relay/fuse box and check for short circuit to ground.
	Radiator cooling fan relay	Check and replace as necessary.
	ECT sensor faulty	Check and replace as necessary.
	Radiator cooling fan motor faulty	Check and replace as necessary.
	Wiring or grounding faulty	Repair as necessary
	ECM faulty	Check and replace as necessary.

System Circuit Inspection

Refer to “Table B-7 Radiator Fan Control System Check” in Section 6

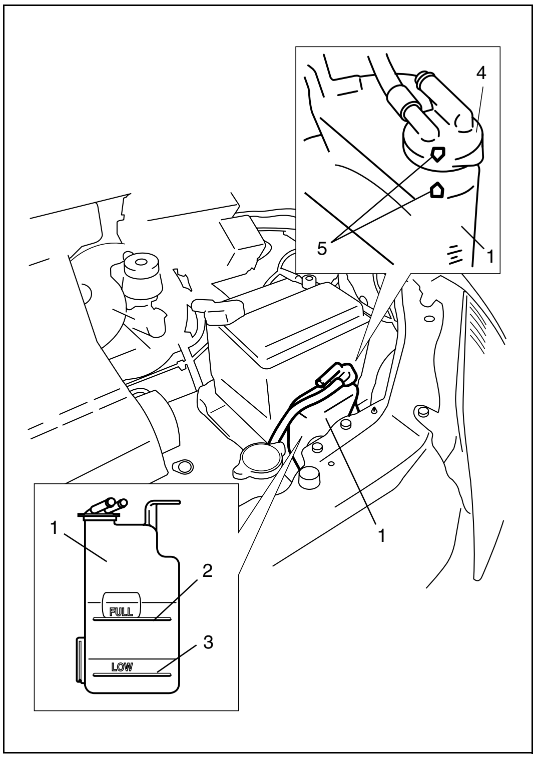
Maintenance

WARNING:
- **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.
- **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 anti-freeze such as alcohol (not recommended for use at any time), there is also the possibility of causing a serious fire.**

Coolant Level Check

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 radiator cap is taken off too soon.

To check level, lift hood and look at "see-through" coolant 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" mark (2) and "LOW" mark (3) on reservoir (1).
If coolant level is below "LOW" mark (3), remove reservoir cap (4) and add proper coolant to reservoir to bring coolant level up to "FULL" mark (2). Then, reinstall cap (4) and align match marks (5) on reservoir and cap (4).

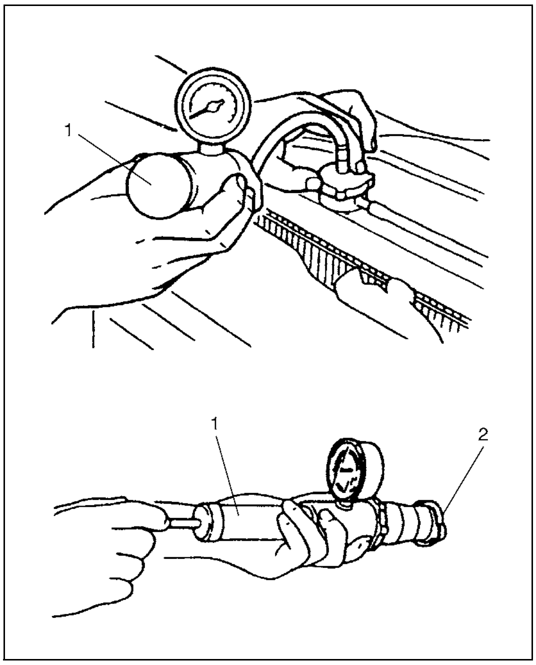
NOTE:
- **If proper quality antifreeze is used, there is no need to add extra inhibitors or additives that claim to improve system.**
  They may be harmful to proper operation of system, and are unnecessary expense.
- **When installing reservoir cap, align arrow marks (5) on reservoir and cap.**

Engine Cooling System Inspection and 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.

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 (1), check system and radiator cap (2) for proper pressure holding capacity.
   If replacement of cap is required, use a proper cap for this vehicle.

Cooling system and radiator cap holding pressure (for inspection)
: 110 kPa (1.1 kg/cm^2, 15.6 psi)

NOTE:

After installing radiator cap to radiator, make sure that the ear of cap lines is parallel to radiator.

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:

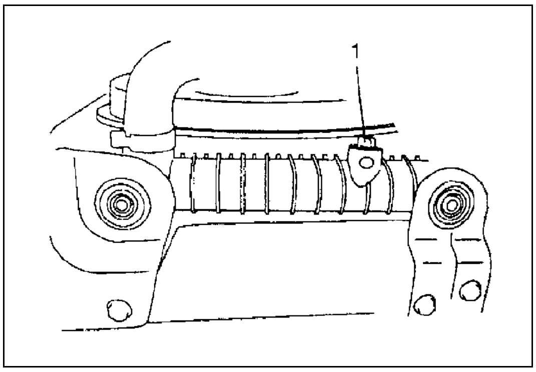
To help avoid danger of being burned, do not remove radiator cap while engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if cap is taken off too soon.

NOTE:

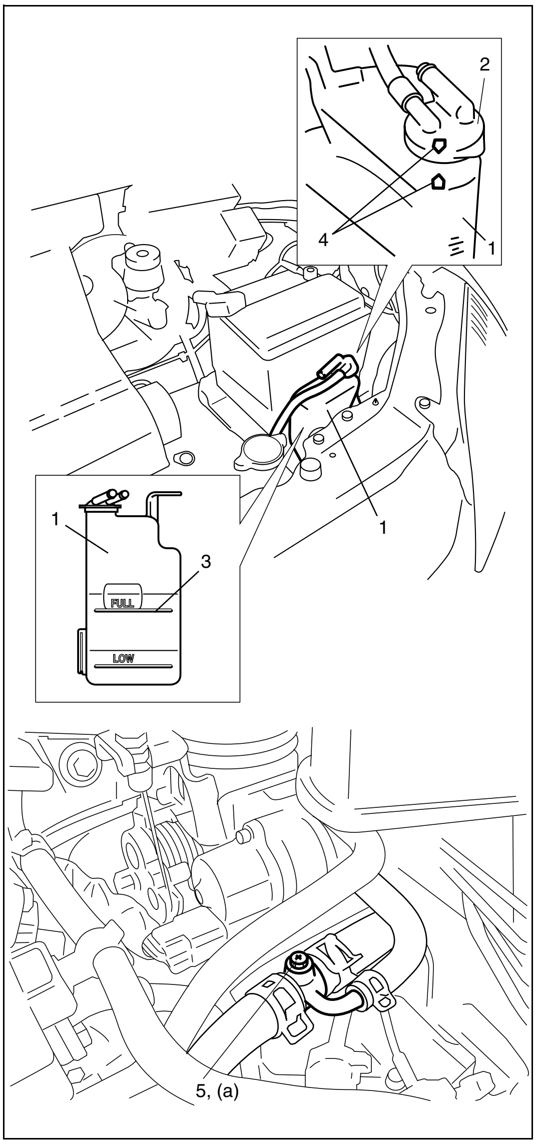
For detail of coolant specification, refer to "Coolant" in this section.

1) Remove radiator cap when engine is cool as follows.
   a) Turn cap counterclockwise slowly until it reaches a "stop". (Do not press down while turning it).
   b) Wait until pressure is relieved (indicated by a hissing sound) then press down on cap and continue to turn it counterclockwise.

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 drain coolant from radiator drain plug (1).
4) Close radiator drain plug (1). 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) Close radiator drain plug (1) tightly.



7) Remove reservoir (1), and remove cap (2) from reservoir (1).
8) Pour out any fluid, scrub and clean inside of reservoir with soap and water.
   Flush it well with clean water and drain. Reinstall reservoir.
9) Fill reservoir with coolant up to “Full” level mark (3).
10) Install reservoir cap (2) and align match marks (4) on reservoir and its cap.
11) Loosen air ventilation bolt (5) one and a half turns.
12) Fill radiator with coolant up to spilling coolant from air ventilation bolt (5).
13) Tighten air ventilation bolt (5) to specified torque.

Tightening torque
Air ventilation bolt (a) : 4.5 N·m (0.45 kg-m, 3.5 lb-ft)

14) Fill radiator with coolant up to bottom of radiator filler neck and install radiator cap, making sure that the ear of cap lines is parallel to radiator.
15) Run engine at idle speed.
16) Loosen air ventilation bolt (5) one and a half turns.
17) Run engine at 2000-3000 rpm, and tighten air ventilation bolt (5) to specified torque after spilling coolant from air ventilation bolt (5).

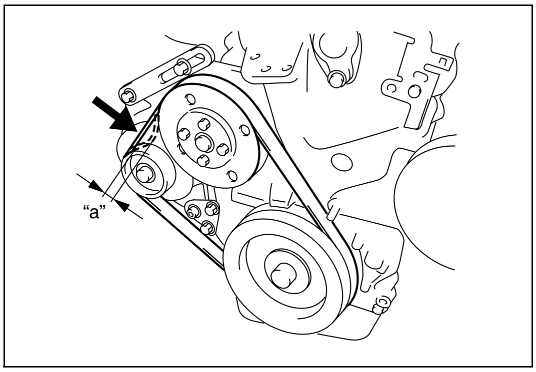
Tightening torque
Air ventilation bolt (a) : 4.5 N·m (0.45 kg-m, 3.5 lb-ft)

18) Run engine until radiator fan motor is operated.
19) Stop engine and wait until engine comes cooled down to help avoid danger of being burned.
20) Add coolant to radiator up to bottom of radiator filler neck, and install radiator cap, making sure that the ear of cap lines is parallel to radiator.
21) Repeat step 15) through 20).
22) Confirm that reservoir coolant level is “Full” level mark (3). If coolant is insufficient, repeat step 9) and 10).

Water Pump/Generator Drive Belt Tension Inspection and Adjustment

WARNING:
- **Disconnect negative cable at battery before checking and adjusting belt tension.**
- **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) Inspect belt for cracks, cuts, deformation, wear and cleanliness. If it is necessary to replace belt, refer to “Water Pump/Generator Drive Belt Removal and Installation” in this section.

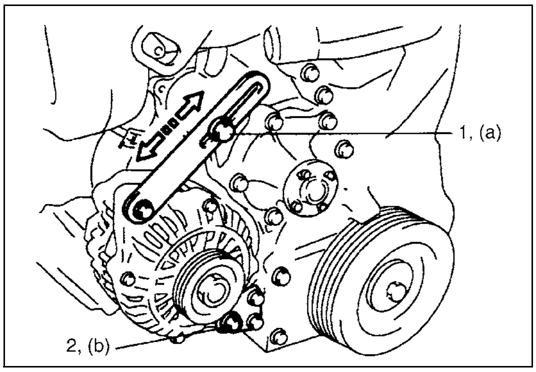


2) Check belt for tension. Belt is in proper tension when it deflects the following specification under thumb pressure (about 10 kg or 22 lb.).

Water pump / generator drive 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 (1) and pivot bolts (2) as specified torque.

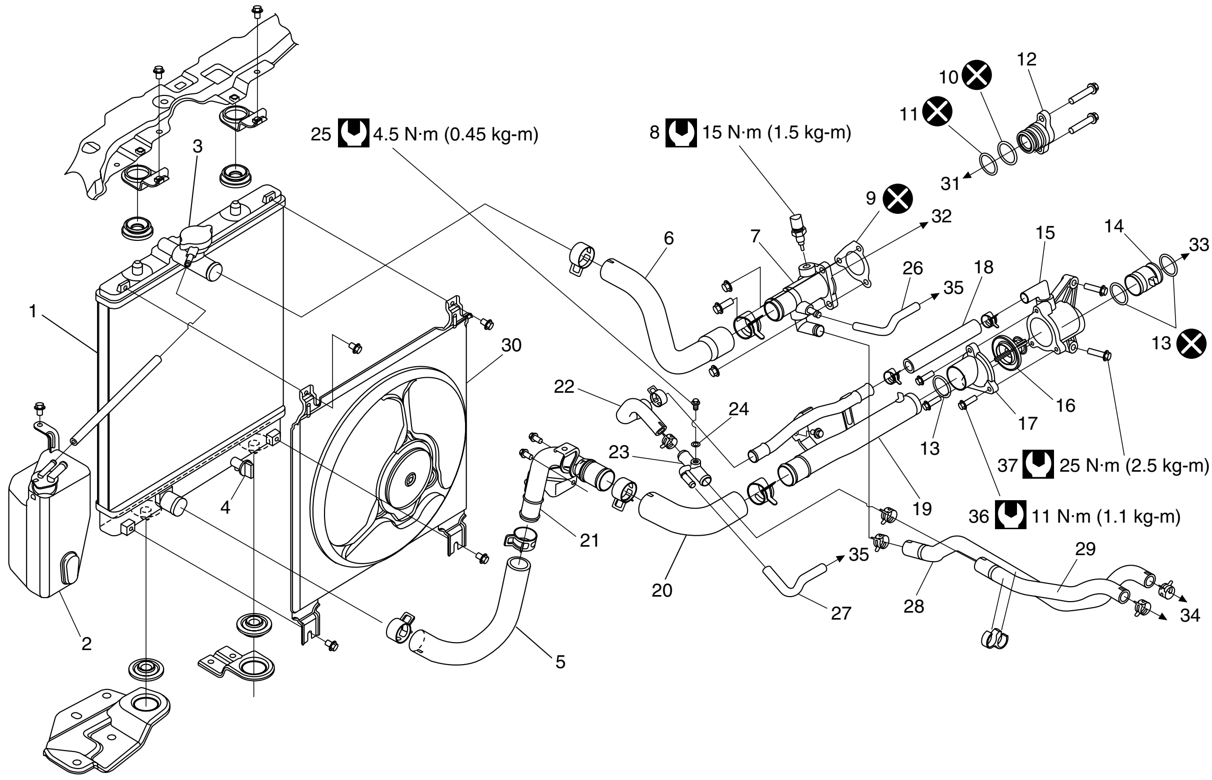
Tightening torque
Generator adjusting bolt (a) : 23 N·m (2.3 kg-m, 17.0 lb-ft)
Generator pivot bolt (b) : 50 N·m (5.0 kg-m, 36.0 lb-ft)

5) Connect negative cable at battery.

On-Vehicle Service

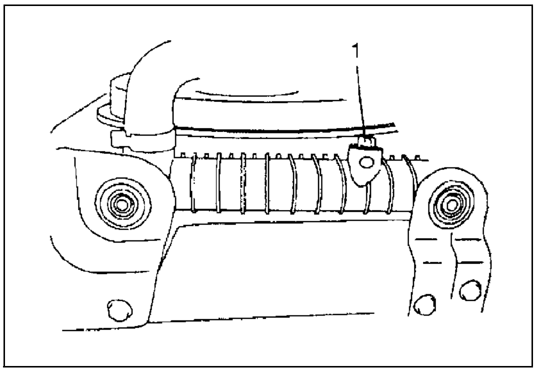
WARNING:
- **Check to make sure that engine coolant temperature is cold before removing any part of cooling system.**
- **Also be sure to disconnect negative cord from battery terminal before removing any part.**

Cooling System Components



1. Radiator	14. Thermostat case water outlet pipe	27. Throttle body outlet hose
2. Reservoir	15. Thermostat case	28. Heater core inlet hose
3. Radiator cap	16. Thermostat	29. Heater core outlet hose
4. Drain plug	17. Thermostat cap	30. Radiator cooling fan assembly
5. Radiator outlet hose	18. Water bypass hose	31. To timing chain cover
6. Radiator inlet hose	19. Water inlet pipe No.1	32. To cylinder head
7. Water outlet cap	20. Water inlet hose	33. To water pump
8. ECT sensor	21. Water inlet pipe No.2	34. To heater core
9. Gasket	22. Heater outlet hose No.2	35. To throttle body
10. Water outlet cap O-ring No.1	23. Heater union	36. Thermostat cap bolt
11. Water outlet cap O-ring No.2	24. Heater union gasket	37. Thermostat case bolt
12. Water outlet plug	25. Air ventilation bolt	Tightening torque
13. O-ring	26. Throttle body inlet hose	Do not reuse.

Cooling System Draining

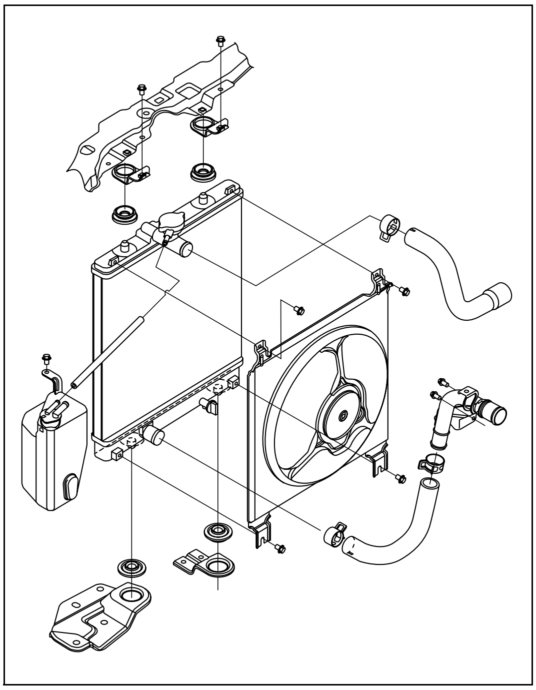


1) Remove radiator cap.
2) Drain coolant from radiator drain plug (1).
3) After draining coolant, be sure to tighten drain plug (1) securely.

Cooling System Refill

Refer to step 7) to 22) of “Cooling System Flush and Refill” in this section.

Cooling Water Pipes or Hoses



Removal

1) Drain coolant referring to “Cooling System Draining” in this section.
2) To remove these pipes or hoses, loosen clamp on each hose and pull hose end off.

Installation

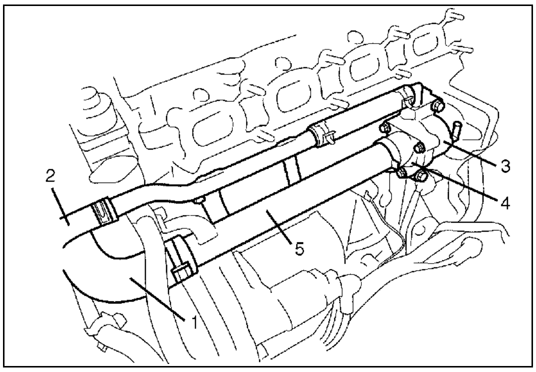
Install removed parts in reverse order of removal procedure, noting the following.

- Tighten each clamp securely.
- Refill cooling system referring to step 7) to 22) of “Cooling System Flush and Refill” in this section.

Thermostat Removal and Installation

Removal

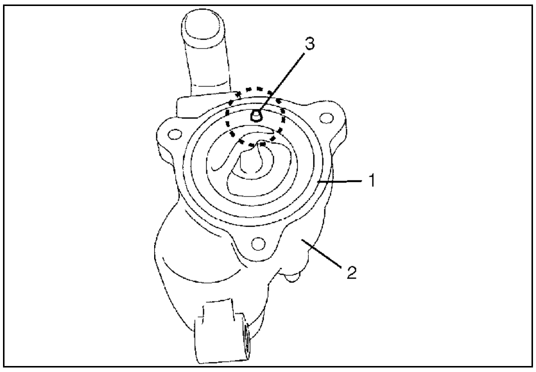
1) Drain coolant referring to “Cooling System Draining” in this section.
2) Remove intake manifold referring to “Intake Manifold Removal and Installation” in Section 6A1.
3) Remove generator referring to “Generator Dismounting and Remounting” in Section 6H.



4) Disconnect water hose (1) and heater hose (2) from each pipe.
5) Remove thermostat case (3) with thermostat cap (4) and water inlet pipe (5).
6) Remove water inlet pipe (5) with thermostat cap (4) from thermostat case.
7) Remove thermostat.

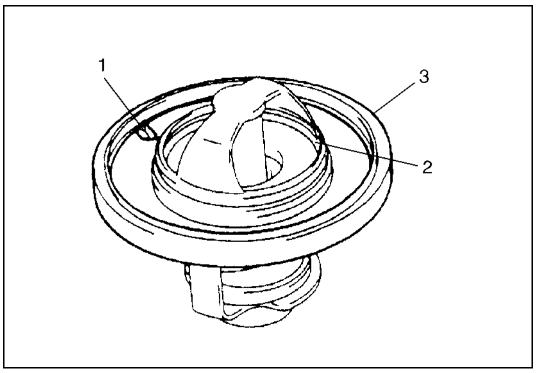
Installation

Reverse removal procedure for installation noting the following points.

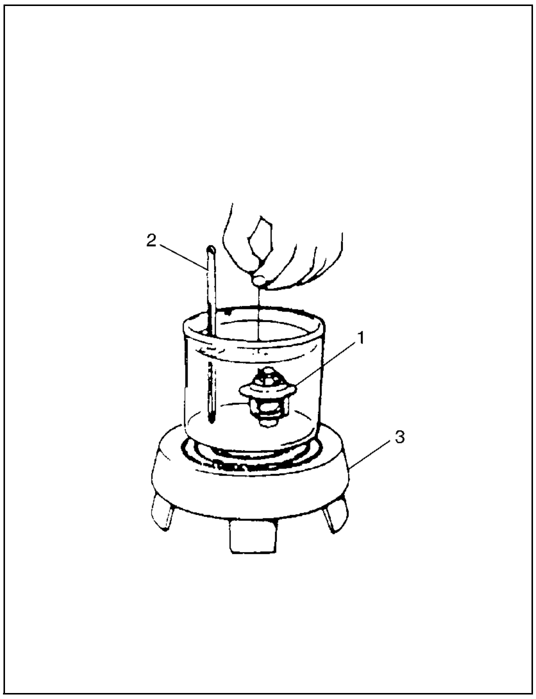


- When positioning thermostat (1) on thermostat case (2), be sure to position it so that air bleed valve (3) comes at position as shown in figure.
- Use new O-rings when installing.
- Adjust water pump belt tension referring to “Water Pump/ Generator Drive Belt Tension Inspection and Adjustment” in this section.
- Adjust A/C compressor belt tension (if equipped) referring to “Compressor Drive Belt Inspection and Adjustment” in Section 1B.
- Refill cooling system referring to step 7) to 22) of “Cooling System Flush and Refill” in this section.
- Verify that there is no coolant leakage at each connection.

Thermostat Inspection



- Make sure that air bleed valve (1) of thermostat is clean. Should this valve be clogged, engine would tend to overheat.
- Check to make sure that valve seat (2) is free from foreign matters which would prevent valve from seating tight.
- Check thermostat seal (3) for breakage, deterioration or any other damage.



- Check thermostatic movement of wax pellet as follows :

a) Immerse thermostat (1) in water, and heat water gradually as shown.
b) Check that valve starts to open at specific temperature.

Temperature at which valve begins to open
: 80 – 84°C (176 – 183°F)
Temperature at which valve become fully open
: 95 – 97°C (203°F)
Valve lift
: More than 8 mm at 95°C (203°F)

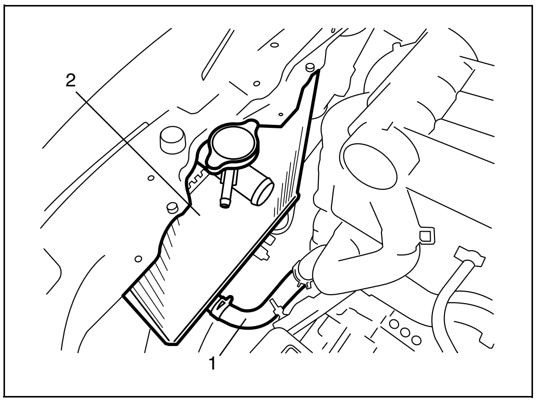
If valve starts to open at a temperature substantially below or above specific temperature, thermostat unit should be replaced with a new one. Such a unit, if reused, will bring about overcooling or overheating tendency.

2. Thermometer
3. Heater

Radiator Removal and Installation

Removal

1) Disconnect negative cable at battery.
2) Drain cooling system referring to “Cooling System Draining” in this section.
3) Remove cooling fan assembly referring to “Radiator Cooling Fan Removal and Installation” in this section.

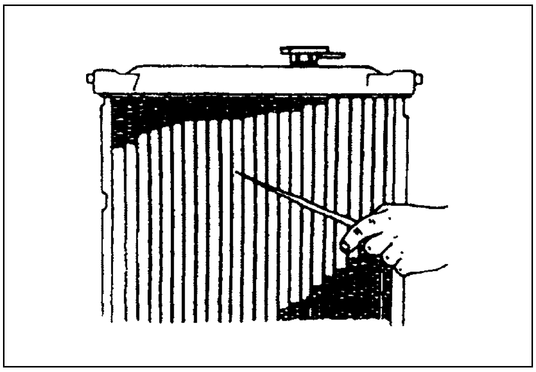


4) Remove radiator outlet hose (1) from radiator (2).
5) Remove radiator (2) from vehicle.

Installation

Reverse removal procedures noting the followings.
- Refill cooling system referring to step 7) to 22) of “Cooling System Flush and Refill” in this section.
- After installation, check each joint for leakage.

Radiator Inspection



Check radiator for leakage or damage. Straighten bent fins, if any.

Radiator Cleaning

Clean frontal area of radiator cores.

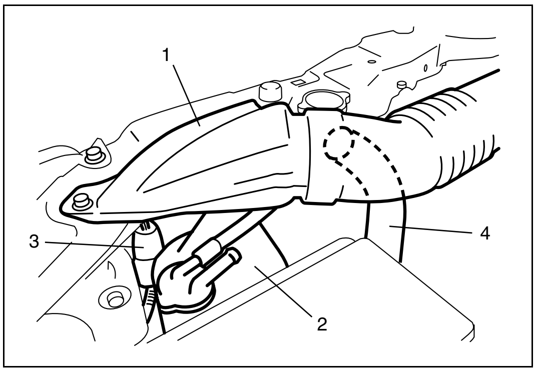
Radiator Cooling Fan Relay Inspection

Refer to “Main relay, fuel pump relay and radiator fan relay inspection” in Section 6E.

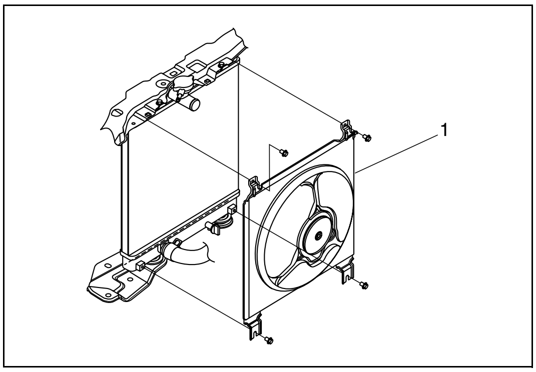
Radiator Cooling Fan Removal and Installation

Removal

1) Disconnect negative cable at battery.
2) Drain coolant referring to “Cooling System Draining” in this section.



3) Remove air cleaner suction pipe (1) and reservoir (2).
4) Disconnect cooling fan motor connector (3).
5) Remove radiator inlet hose (4) from radiator.



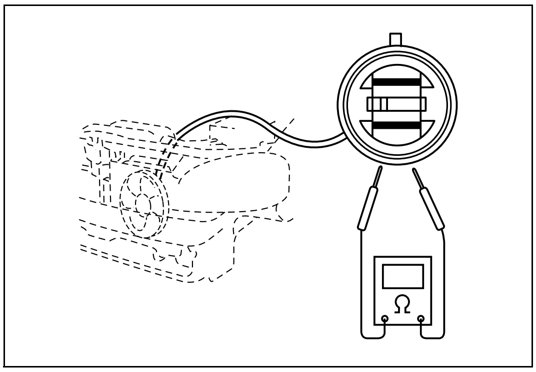
6) Remove radiator cooling fan motor (1) from radiator.

Installation

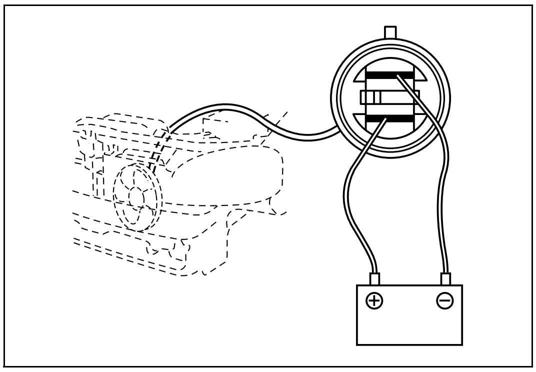
Reverse removal procedure for installation noting the following.

- Refill cooling system referring to step 7) to 18) of "Cooling System Flush and Refill" in this section.
- After installation, verify there is no coolant leakage at each connection.

Radiator Cooling Fan Inspection



1) Check continuity between terminals. If there is no continuity, replace radiator fan motor.



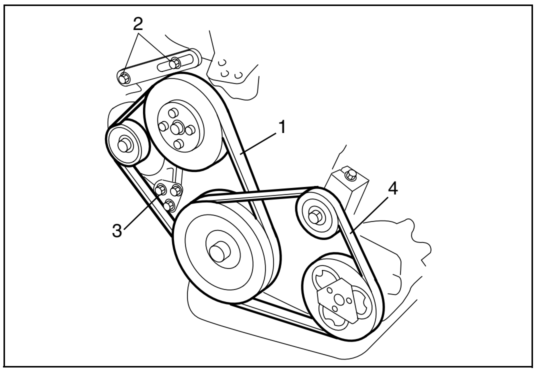
2) Connect battery to radiator fan motor coupler as shown in figure, then check that the radiator fan motor operates smoothly. If radiator fan motor does not operate smoothly, replace motor.

Radiator cooling fan motor specified current at 12 V
10.0 A maximum

Water Pump/Generator Drive Belt Removal and Installation

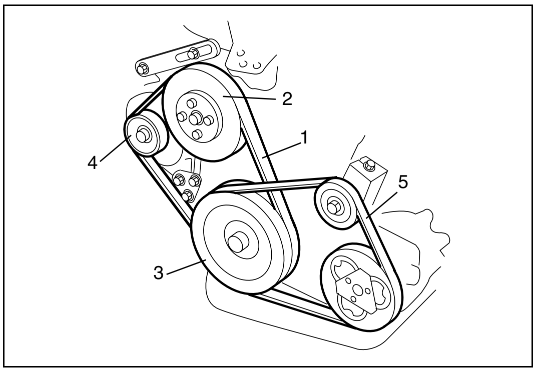
Removal

1) Disconnect negative cable at battery.



2) If vehicle equipped with A/C, remove compressor drive belt (4) before removing water pump belt (1).
   Refer to "Compressor Drive Belt Replacement" in Section 1B.
3) Loosen drive belt adjusting bolt (2) and generator pivot bolt (3).
4) Slacken belt by displacing generator and then remove it.

Installation

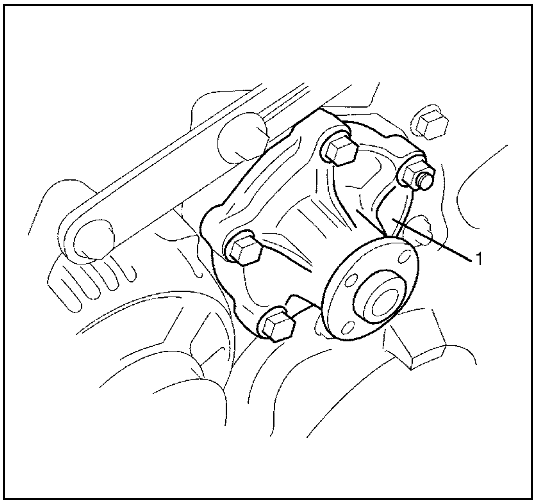


1) Install belt (1) to water pump pulley (2), crankshaft pulley (3) and generator pulley (4).
2) Adjust belt tension by referring to “Water Pump/Generator Drive Belt Tension Inspection and Adjustment” in this section.
3) If vehicle equipped with A/C, install compressor drive belt (5) referring to “Compressor Drive Belt Inspection and Adjustment” in Section 1B.
4) Connect negative cable at battery.

Water Pump Removal and Installation

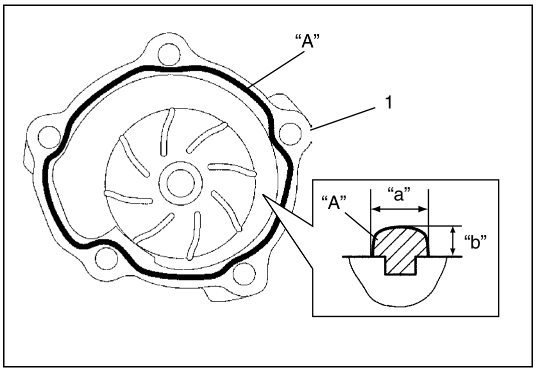
Removal

1) Disconnect negative cable at battery.
2) Drain coolant referring to “Cooling System Draining” in this section.
3) Remove water pump/generator drive belt referring to Water Pump/Generator Drive Belt Removal and Installation” in this section.



4) Remove water pump assembly (1).

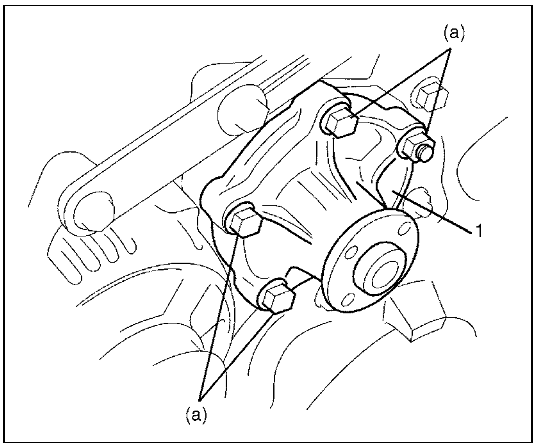
Installation



1) Apply sealant to mating surface of water pump (1) as shown in figure.

“A” : Sealant 99000-31150

Sealant quantity (to mating surface of water pump)
Width “a” : 3 mm (0.12 in.)
Height “b” : 2 mm (0.08 in.)



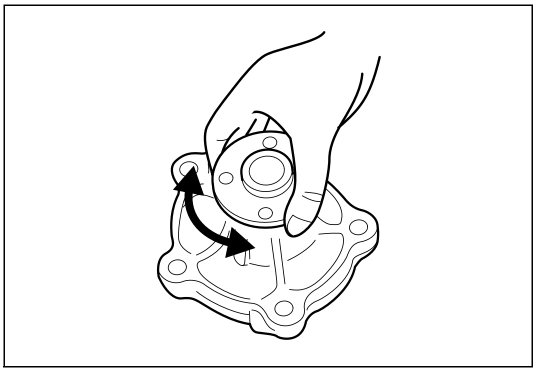
2) Install water pump assembly (1) to cylinder block and tighten bolts and nut to specified torque.

Tightening torque
Water pump bolts and nut (a) : 22 N·m (2.2 kg-m, 16.0 lb-ft)

3) Install water pump pulley.
4) Install water pump/generator drive belt referring to “Water Pump/Generator Drive Belt Removal and Installation” in this Section.
5) Install A/C compressor belt (if equipped) referring to “Compressor Drive Belt Inspection and Adjustment” in Section 1B.
6) Refill cooling system referring to step 7) to 22) of “Cooling System Flush and Refill” in this section.
7) Connect negative cable at battery.
8) Check each part for leakage.

Water Pump Inspection

CAUTION:
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 abnormal noise, replace it.

Engine Coolant Temperature Sensor (ECT Sensor) Removal and Installation

Refer to “Engine coolant temperature sensor (ECT sensor) removal and installation” in Section 6E1.

Engine Coolant Temperature Sensor (ECT Sensor) Inspection

Refer to “Engine coolant temperature sensor (ECT sensor) inspection” in Section 6E1.

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 mating surface of water pump

Tightening Torque Specification

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
ETC sensor	15	1.5	11.0
Air ventilation bolt	4.5	0.45	3.5
Thermostat cap bolts	11	1.1	8.0
Thermostat case bolts	25	2.5	18.0
Generator adjusting bolt	23	2.3	17.0
Generator pivot bolt	50	5.0	36.5
Water pump bolts and Nuts	22	2.2	16.0

SECTION 6C

ENGINE FUEL

WARNING:

For vehicles equipped with a 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 "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).**

CAUTION:

The engine of this vehicle requires the use of 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.

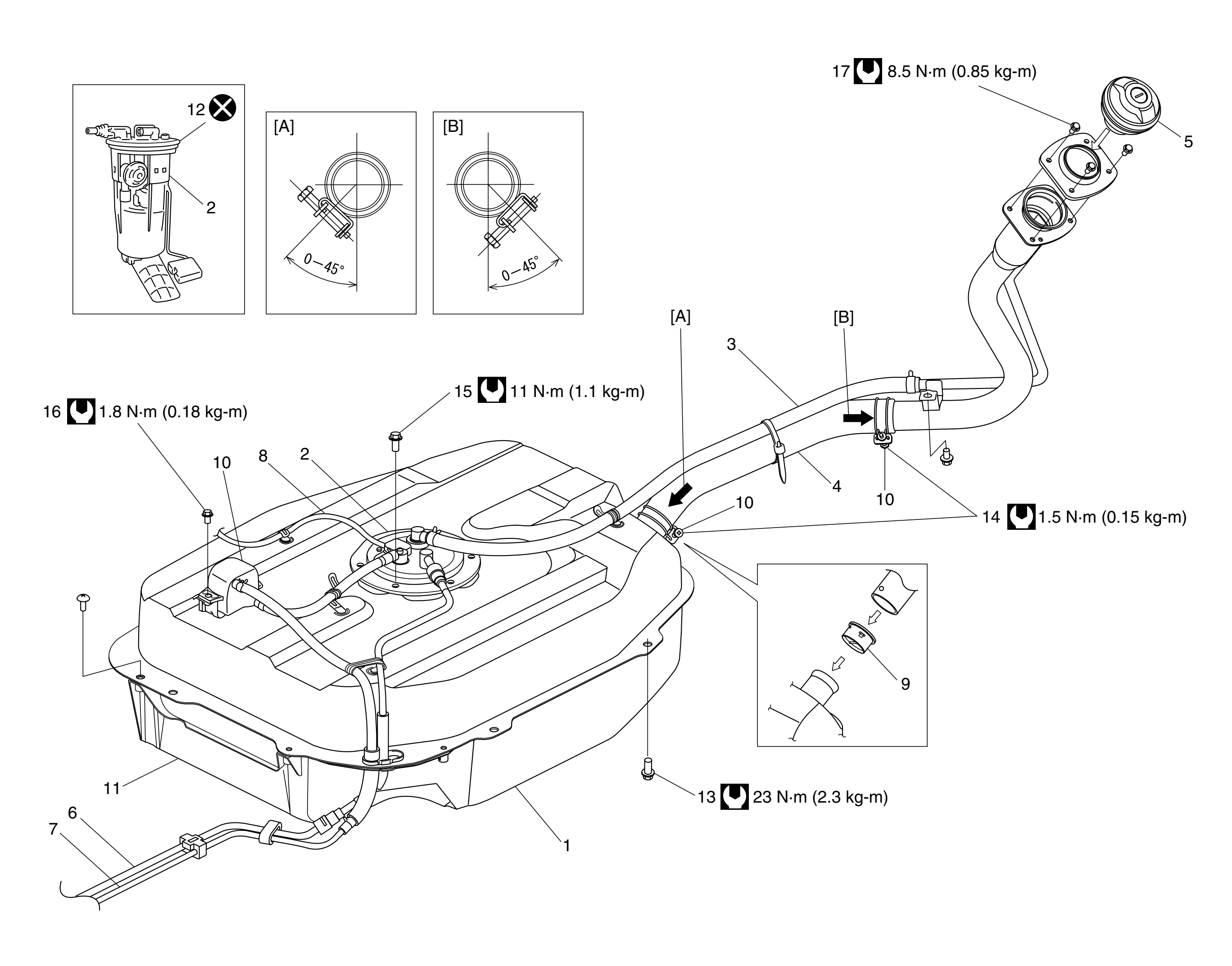
CONTENTS

General Description

The main components of the fuel system are fuel tank, fuel pump assembly (with fuel filter, fuel level gauge, fuel pressure regulator and tank pressure control valve), fuel/vapor separator fuel feed line and fuel vapor line.
For the details of fuel flow and fuel vapor flow, refer to "General Description" in Section 6E1.

On-Vehicle Service

Fuel System Components



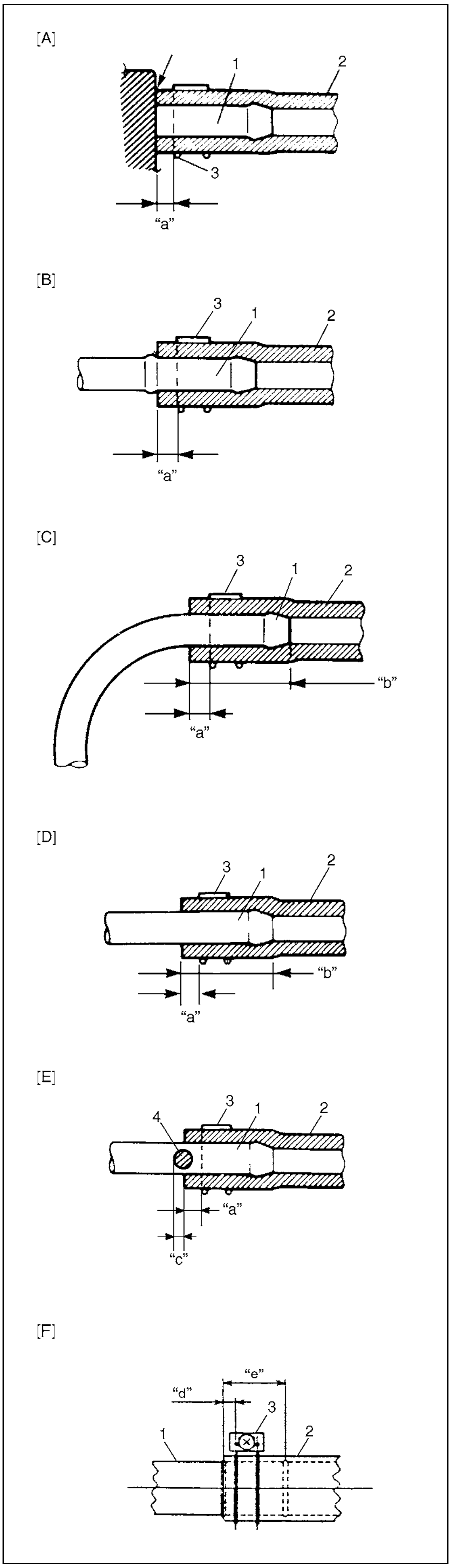
[A] : VIEW: X	4. Fuel tank filler hose	10. Fuel/vapor separator	16. Fuel/vapor separator screw
[B] : VIEW: Y	5. Fuel filler cap	11. Tank cover	17. Fuel filler neck screw
"A" : DOT MARK ON HOSE	6. Fuel feed line	12. Fuel pump gasket	Do not reuse.
1. Fuel tank	7. Fuel vapor line	13. Fuel tank bolt (4 pcs.)	Tightening torque
2. Fuel pump assembly	8. Wire harness for fuel pump	14. Fuel filler hose clamp screw	
3. Breather hose	9. Fuel tank inlet valve	15. Fuel pump bolt (6 pcs.)	

Precautions

WARNING:

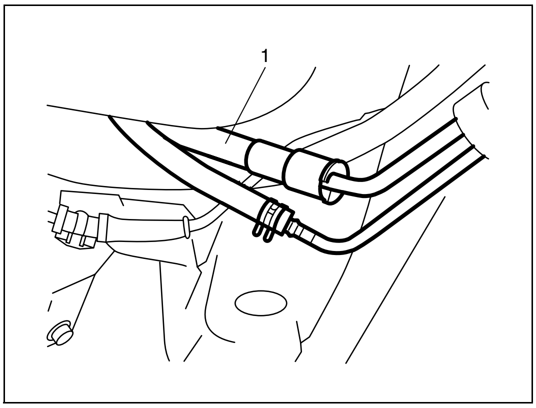
Before attempting service of any type on fuel system, the following should be always observed in order to reduce the risk or fire and personal injury.

- **Disconnect negative cable at battery.**
- **Do not smoke, and place no smoking signs near work area.**
- **Be sure to have CO_2 fire extinguisher handy.**
- **Be sure to perform work in a well-ventilated area and away from any open flames (such as gas hot heater).**
- **Wear safety glasses.**
- **To relieve fuel vapor pressure in fuel tank, remove fuel filler cap from fuel filler neck and then reinstall it.**
- **As fuel feed line 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 relieve fuel pressure "Fuel pressure relief procedure" in Section 6.
- **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. Be sure to put that cloth in an approved container when disconnection is completed.**
- **Note that fuel hose connection varies with each type of pipe. Be sure to connect and clamp each hose correctly referring to the figure.**



[A] :	With short pipe, fit hose as far as it reaches pipe joint as shown.
[B] :	With the following type pipe, fit hose as far as its peripheral projection as shown.
[C] :	With bent pipe, fit hose as far as its bent part as shown or till depth "b".
[D] :	With straight pipe, fit hose till depth "b".
[E] :	With red marked pipe, fit hose end reaches red mark on pipe.
[F] :	For fuel tank filler hose, insert it to spool or welding-bead.
1.	Pipe
2.	Hose
3.	Clamp
4.	Ped mark
"a" :	Clamp securely at a position 3 – 7 mm (0.12 – 0.27 in.) from hose end.
"b" :	20 – 30 mm (0.79 – 1.18 in.)
"c" :	0 – 5 mm (0 – 0.19 in.)
"d" :	5 – 12 mm (0.2 – 0.47 in)
"e" :	40 mm (1.57 in)

Fuel Lines Inspection



CAUTION:

Due to the fact that fuel feed line (1) is under high pressure, use special care when servicing it.

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.

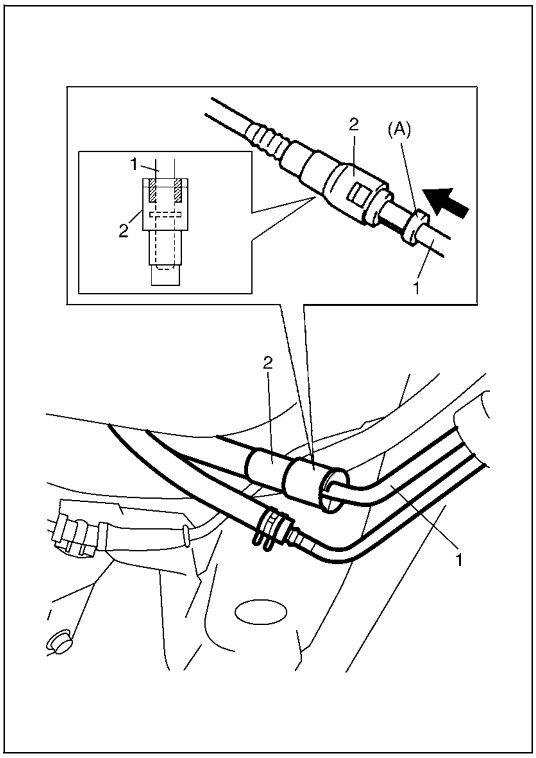
Fuel Pipe Removal and Installation

WARNING:

A small amount of fuel may be released after disconnecting fuel hose. In order to reduce the chance of personal injury, cover hose and pipe to be disconnected with a shop cloth.
Be sure to put that cloth in an approved container when disconnection is completed.

Removal

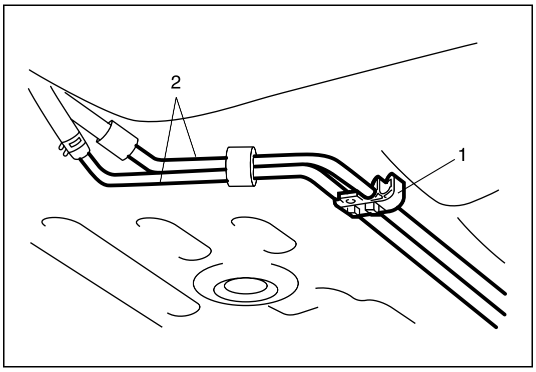
1) Relieve fuel pressure in fuel feed line according to “Fuel pressure relief procedure” in Section 6.
2) Disconnect negative cable at battery.



3) Disconnect fuel pipe joint and fuel hose from fuel pipe at the front and rear of each fuel pipe.
   For quick joint (2), disconnect it as follows :
   a) Remove mud, dust and/or foreign material between pipe (1) and joint by blowing compressed air.
   b) Unlock joint lock by inserting special tool between pipe and joint.

   Special tool
   (A) : 09919-47020

   c) Disconnect joint (2) from pipe (1).



4) Mark the location of clamps (1) on fuel pipes (2), so that the clamps can be reinstalled to where they were.
5) Remove pipes (2) with clamp (1) from vehicle.
6) Remove clamp (1) from pipes (2).

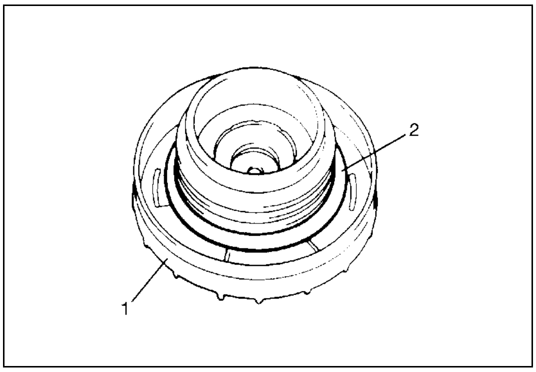
Installation

1) Install clamps to marked location on pipes. If clamp is deformed or its claw is bent or broken, replace it with new one.
2) Install pipes with pipe clamps to vehicle.
3) Connect fuel hoses and pipes to each pipe.

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.

4) With engine OFF, turn ignition switch to ON position and check for fuel leaks.

Fuel Filler Cap Inspection



Remove cap (1), and check gasket for even filler neck imprint, and deterioration or any damage. If gasket (2) is in malcondition, replace cap.

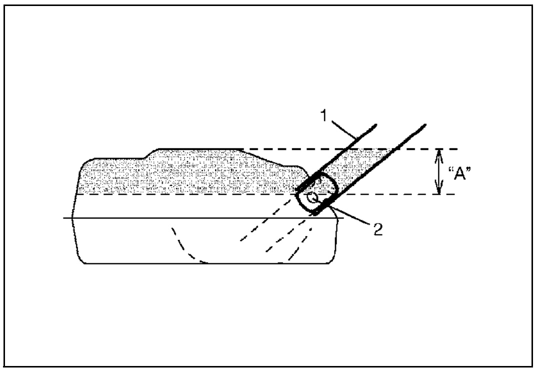
NOTE:
If cap requires replacement, only a cap with the same features should be used. Failure to use correct cap can result in critical malfunction of system.

Fuel Tank Inlet Valve Removal and Installation

WARNING:
Before starting the following procedure, be sure to observe "Precautions" in this section.

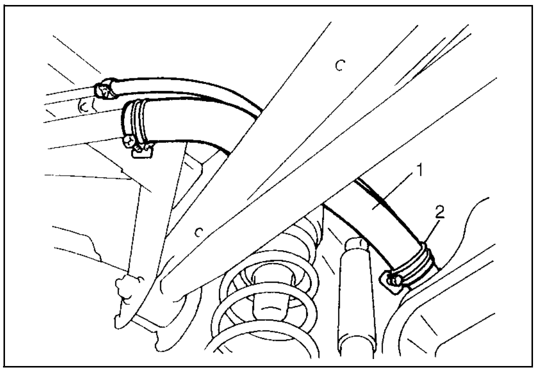
Removal

1) Remove fuel filler cap.

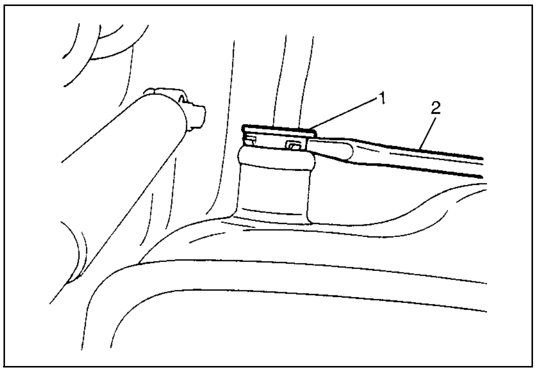


2) Insert hose of a hand operated pump into fuel filler hose (1) and drain fuel in space "A" in the figure.

CAUTION:
Do not force pump hose into fuel tank, or pump hose may damage fuel tank inlet valve (2).



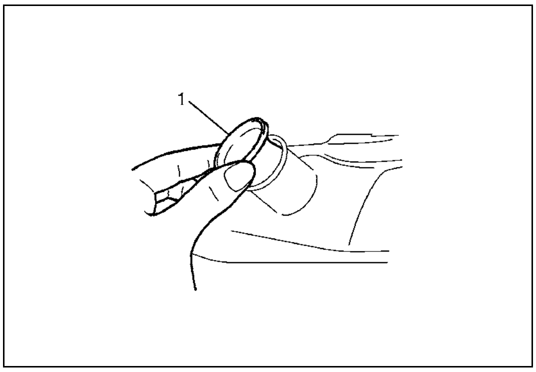
3) Hoist vehicle, and remove clamp (2) and fuel filler hose (1) from fuel tank.



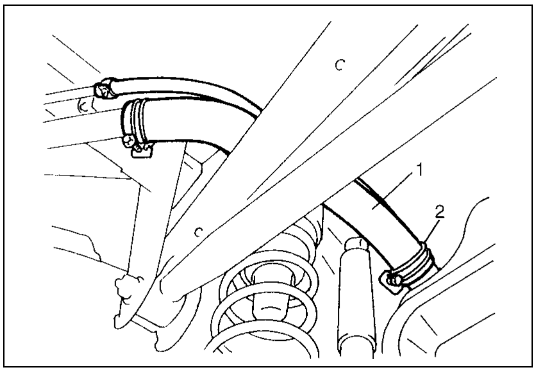
4) Remove fuel tank inlet valve (1) using flat head rod (2) or the like.

CAUTION:
Be careful not to damage fuel tank inlet valve (1) with flat head rod (2) or the like.

Installation

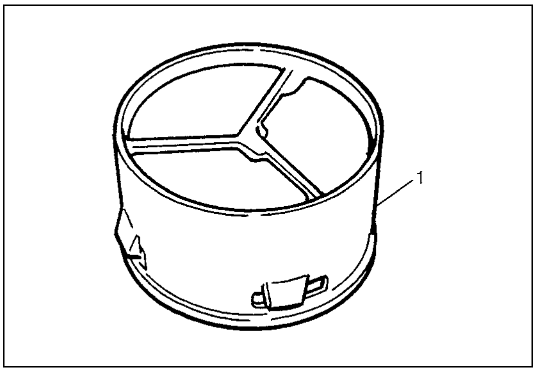


1) Install fuel tank inlet valve (1) to fuel tank.



2) Install fuel filler hose (1) to fuel tank and secure it with clamp (2).
   For proper installation, refer to “Fuel System Components” in this section.
3) Lower vehicle and install fuel filler cap.

Fuel Tank Inlet Valve Inspection



Check fuel tank inlet valve (1) for the following.
- Damage
- Smooth opening and closing

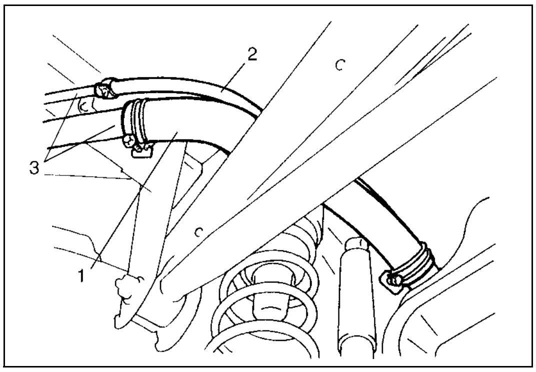
If any damage or malfunction is found, replace.

Fuel Tank Removal and Installation

Removal

WARNING:
- **Before starting the following procedure, be sure to observe “Precautions” in this section.**
- **A small amount of fuel may be released after the fuel hose is disconnected. In order to reduce the chance of personal injury, cover the hose and pipe to be disconnected with a shop cloth. Be sure to put that cloth in an approved container when disconnection is completed.**

1) Relieve fuel pressure in fuel feed line according to “Fuel pressure relief procedure” in Section 6.
2) Disconnect negative cable at battery.
3) Hoist vehicle.

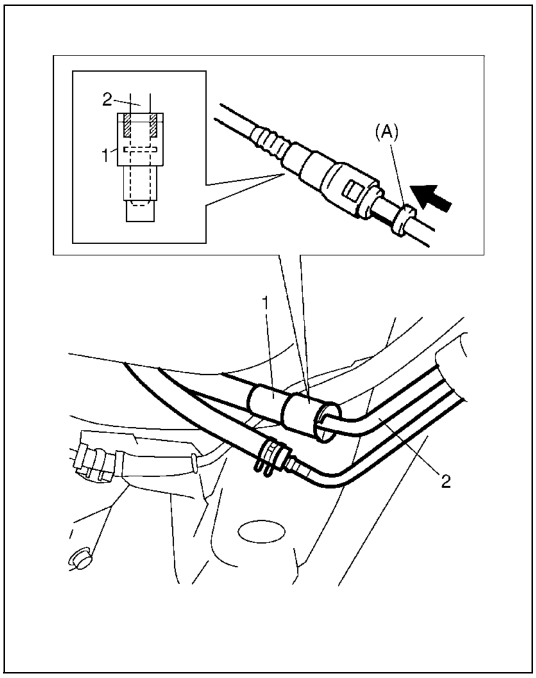


4) Disconnect fuel filler hose (1) and breather hose (2) from filler neck (3).

> **CAUTION:**
> **Never disconnect fuel filler hose (1) from fuel tank inlet. If half or more of fuel is remaining to fuel tank, fuel over flows in this case and come out.**

5) Due to absence of fuel tank drain plug, drain fuel tank by pumping fuel out through fuel tank filler.
   Use hand operated pump device to drain fuel tank.

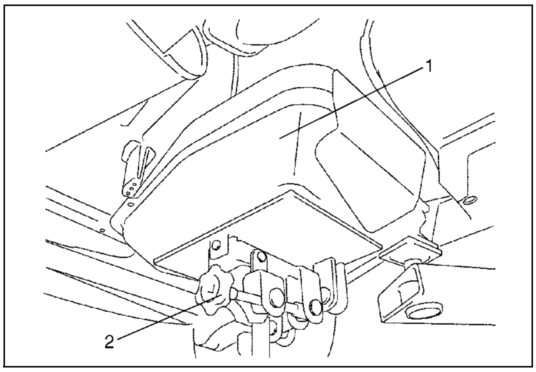
> **CAUTION:**
> - **Do not force pump hose into fuel tank, or pump hose may damage fuel tank inlet valve.**
> - **Never drain or store fuel in an open container due to possibility of fire or explosion.**



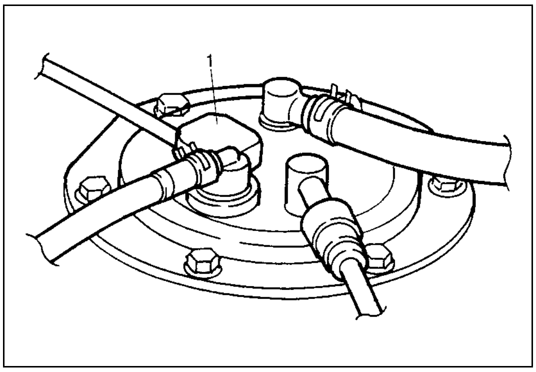
6) Disconnect fuel pipe joint and fuel hoses from pipes.
   For quick joint, disconnect it as follows :
   a) Remove mud, dust and/or foreign material between pipe and joint by blowing compressed air.
   b) Unlock joint (1) lock by inserting special tool between pipe (2) and joint (1).

   Special tool
   (A) : 09919-47020

   c) Disconnect joint from pipe.



7) Support fuel tank (1) with jack (2) and remove its mounting bolts.

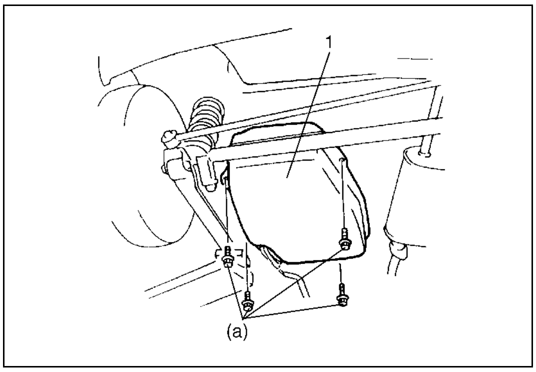


8) Lower fuel tank a little as to disconnect wire harness at connector (1), then remove fuel tank.

Installation

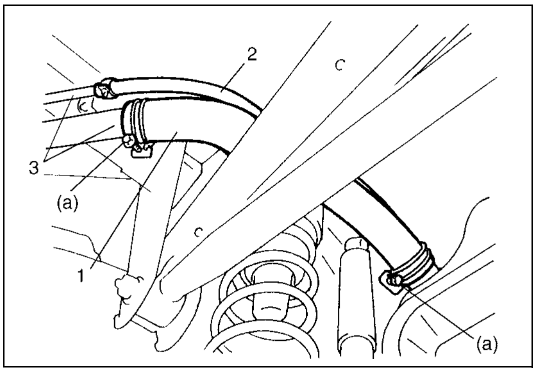
CAUTION:
- **When connecting joint, clean outside surfaces of pipe where joint is to be inserted, push joint into pipe till joint lock clicks and check to ensure that pipes are connected securely, or fuel leak may occur.**
- **Never let the fuel hoses touch the ABS sensor harness (if equipped).**

1) If parts have been removed from fuel tank, install them before installing fuel tank to vehicle.



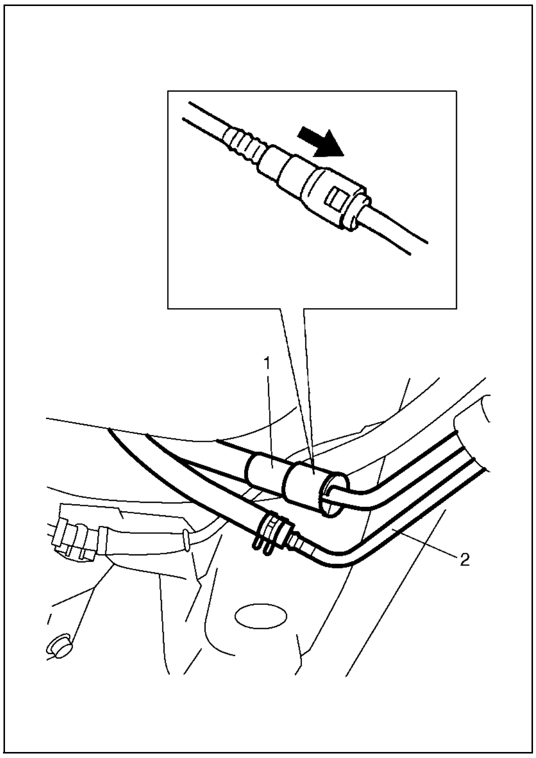
2) Raise fuel tank (1) with jack and connect connector of fuel pump and gauge and clamp wire harness.
3) Install fuel tank (1) to vehicle.

Tightening torque
Fuel tank bolt (a) : 23 N·m (2.3 kg-m, 17.0 lb-ft)



4) Connect fuel filler hose (1) and breather hose (2) to filler neck (3) as shown in figure and clamp them securely.

Tightening torque
Fuel filler hose clamp (a) : 1.5 N·m (0.15 kg-m, 1.0 lb-ft)



5) Connect fuel feed hose (1) and vapor hose (2) to each pipe as shown in figure and clamp them securely.
6) Connect negative cable at battery.
   With engine OFF, turn ignition switch to ON position and check for fuel leaks.

Fuel Tank Inspection

After removing fuel tank, check hoses and pipes connected to fuel tank for leaks, loose connections, deterioration or damage. Also check fuel pump assembly gaskets for leaks, visually inspect fuel tank for leaks and damage.
Replace any damaged or malconditioned parts.

Fuel Tank Purging Procedure

WARNING:

This purging procedure will not remove all fuel vapor.
Do not attempt any repair on tank using heat of flame as an explosion resulting in personal injury could occur.

CAUTION:

Never remain water in fuel tank after washing, or fuel tank inside will get corrosion.

The following procedure are used for purging fuel tank.
1) After removing fuel tank, remove all hoses, pipes and fuel pump assembly from fuel tank.
2) Drain all remaining fuel from tank.
3) Place fuel 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.

Fuel Pump On-Vehicle Inspection

Refer to “Fuel Delivery System” and/or “Fuel pump with pressure regulator on-vehicle inspection” in Section 6E1.

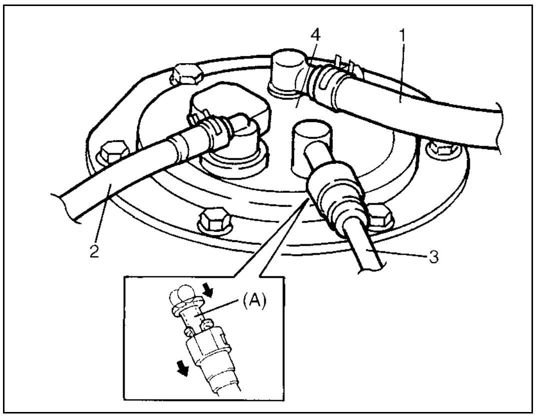
Fuel Pump Assembly Removal and Installation

WARNING:

Before starting the following procedure, be sure to observe “Precautions” in this section.

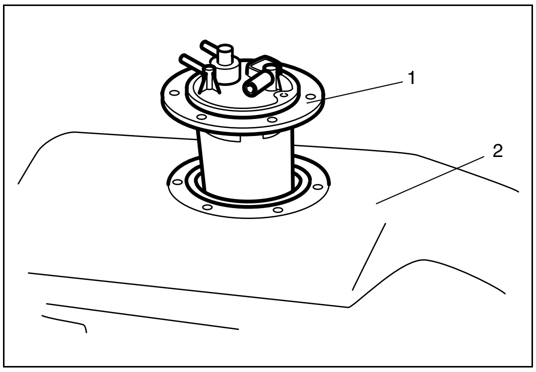
Removal

1) Remove fuel tank from vehicle referring to “Fuel Tank Removal and Installation” in this section.



2) Disconnect fuel breather hose (1), fuel vapor hose (2) and pipes from fuel pump assembly (4).
   When disconnecting joint of fuel feed line (3) from pipe, unlock joint by inserting special tool between pipe and joint lock first.

Special tool
(A) : 09919-47020

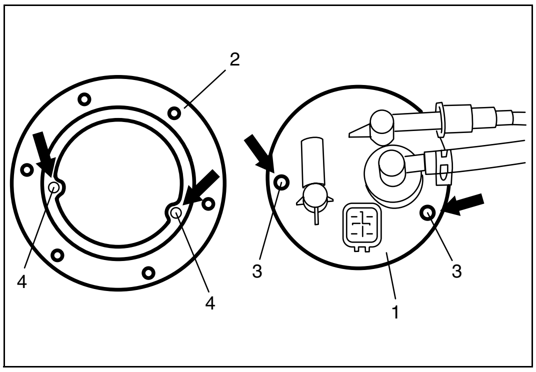


3) Remove fuel pump assembly (1) from fuel tank (2).

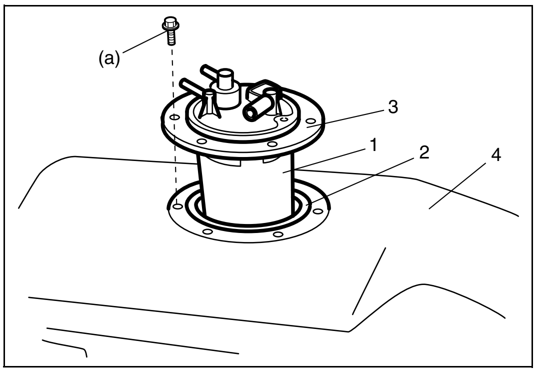
Installation

CAUTION:

When connecting joint, clean outside surface 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.

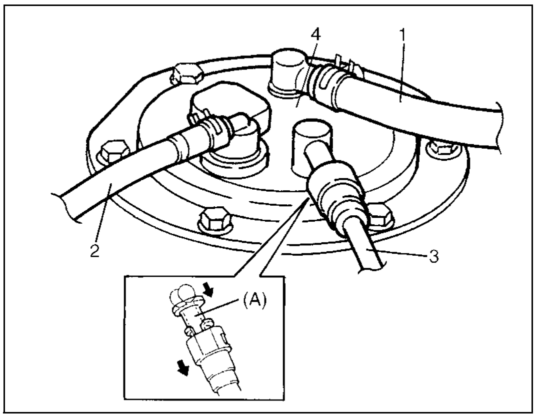


1) Clean mating surfaces of fuel pump assembly (1) and fuel tank.
2) Put plate (2) on fuel pump assembly (1) by matching the protrusion of fuel pump assembly (3) to plate hole (4) as shown.



3) Install new gasket (2) and fuel pump assembly (1) with plate (3) to fuel tank (4).

Tightening torque
Fuel pump assembly bolts (a) : 11 N·m (1.1 kg-m, 8.0 lb-ft)

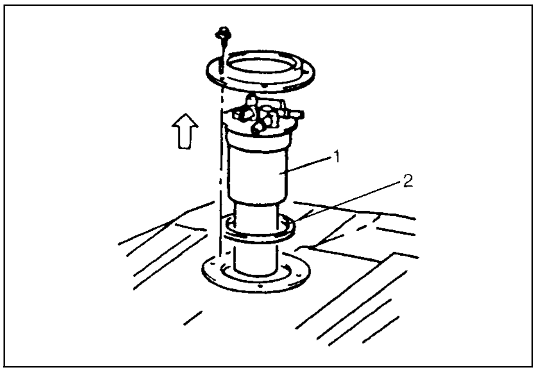


4) Connect fuel breather hose (1), fuel vapor hose (2) and fuel feed line (3) (pipe joint) to fuel pump assembly (4).

5) Install fuel tank (1) to vehicle referring to “Fuel Tank Removal and Installation” in this section.

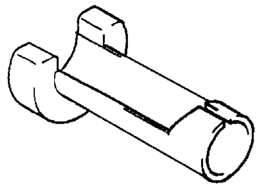
Fuel Pump Inspection

- 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 electrical circuit, refer to “Table B-3 Fuel Pressure Check” in Section 6.
- For inspection of fuel level gauge (2), refer to “Fuel Level Sensor (Gauge Unit) Inspection” in Section 8C.

Special Tool



09919-47020
Quick joint remover

Tightening Torque Specification

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
Fuel tank bolts	23	2.3	17.0
Fuel filler hose clamps	1.5	0.15	1.0
Fuel pump assembly bolts	11	1.1	8.0
Fuel filler neck bolts	8.5	0.85	6.5
Fuel/vapor separator screw	1.8	0.18	1.5

SECTION 6E1

ENGINE AND EMISSION CONTROL SYSTEM

WARNING:

For vehicles equipped with a 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 "System Components and Wiring Location View" under "General Description" in Section 10B 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 Section 10B 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).**

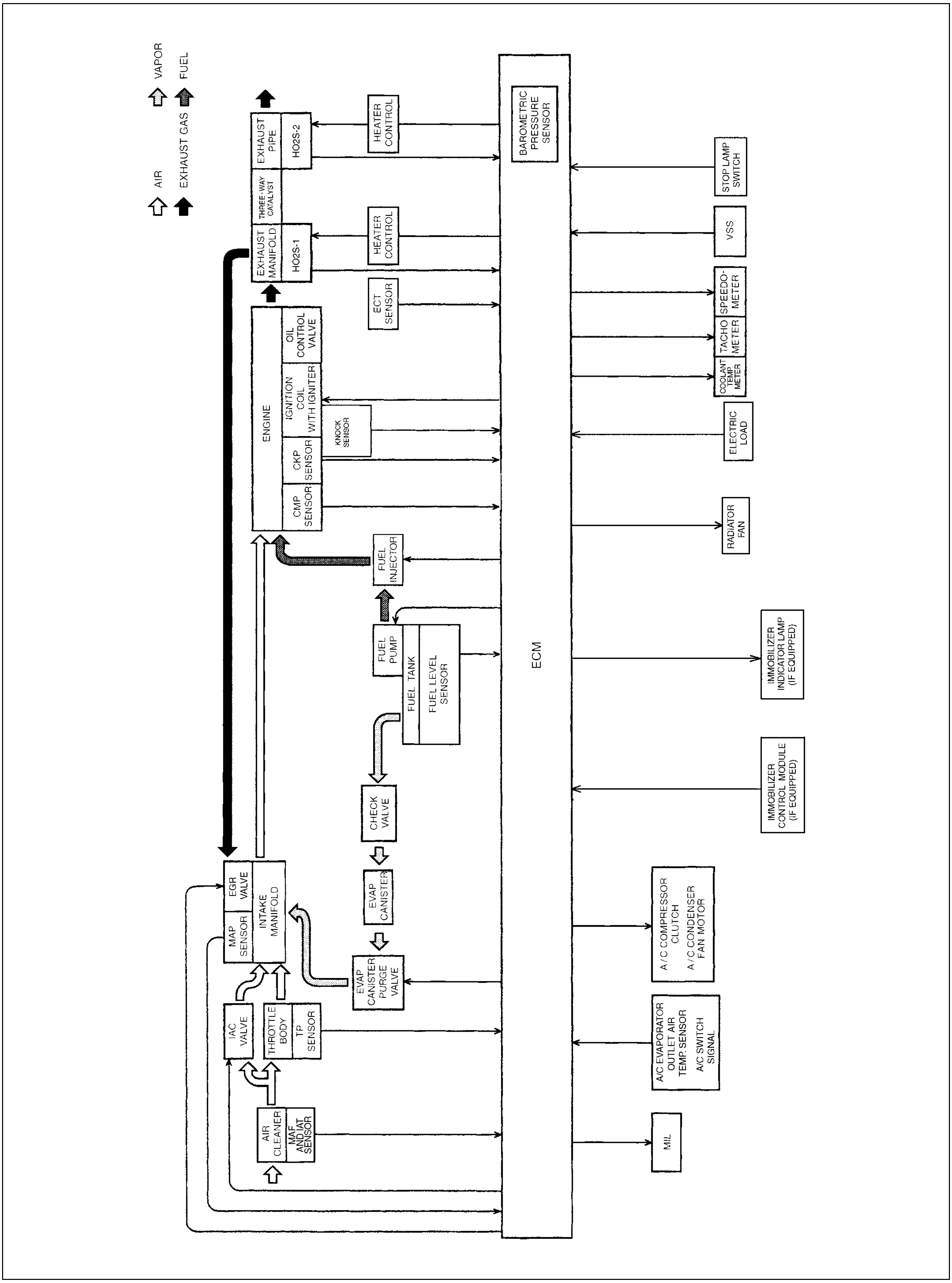
CONTENTS

General Description

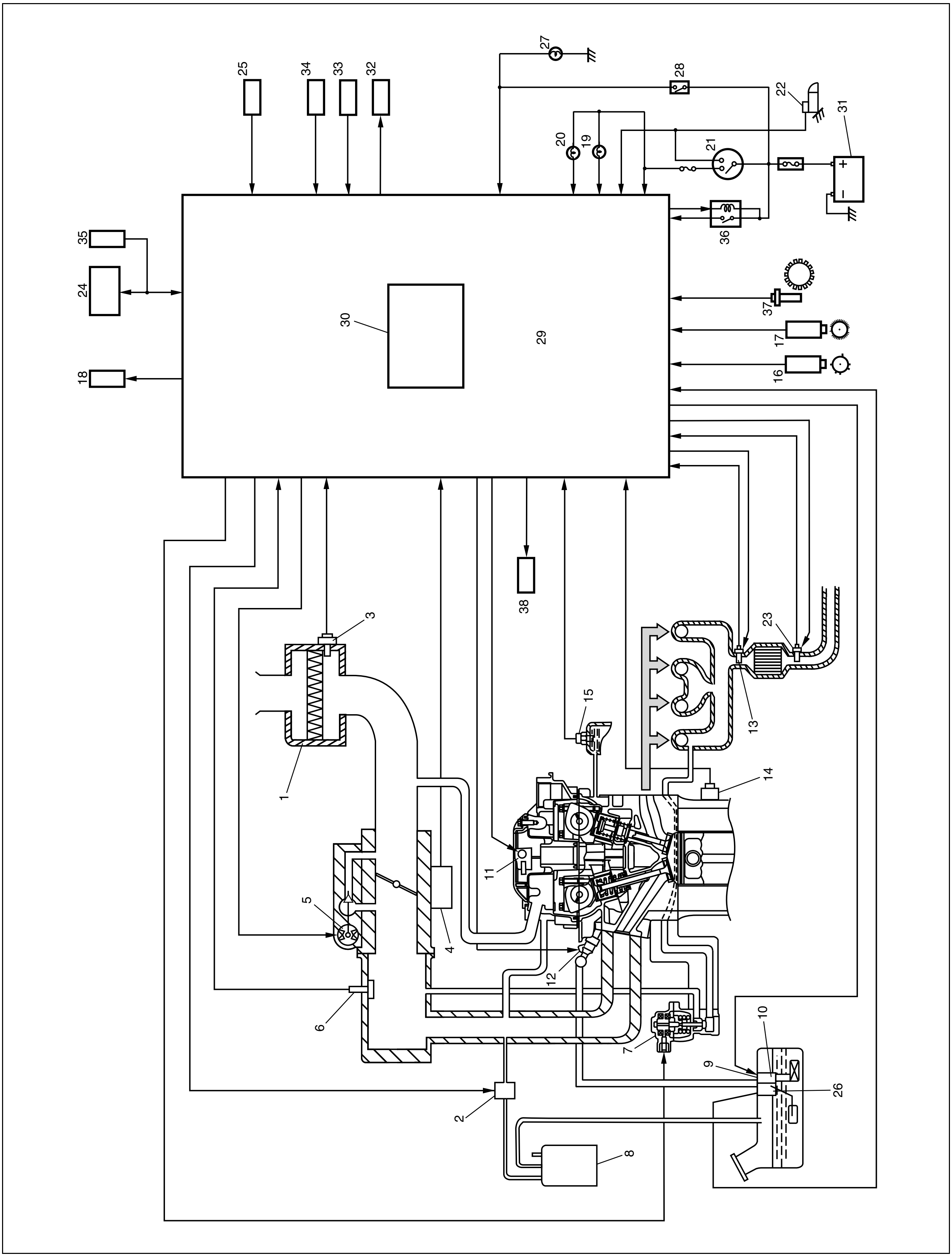
Engine and Emission Control System Construction

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, etc. Electronic control system includes ECM, various sensors and controlled devices.
Emission control system includes EGR, EVAP and PCV system.

ENGINE AND EMISSION CONTROL SYSTEM FLOW DIAGRAM



ENGINE AND EMISSION CONTROL SYSTEM DIAGRAM



1. Air Cleaner	14. Knock sensor	27. Stop lamp
2. EVAP canister purge valve	15. ECT sensor	28. Stop lamp switch
3. MAF and IAT sensor	16. CMP sensor	29. ECM
4. TP sensor	17. CKP sensor	30. Barometric pressure sensor (if equipped)
5. IAC valve	18. Radiator fan	31. Battery
6. MAP sensor	19. Malfunction indicator lamp in combination meter	32. A/C compressor and condenser fan relay (if equipped)
7. EGR valve	20. Immobilizer indicator lamp in combination meter	33. A/C switch (if equipped)
8. EVAP canister	21. Ignition switch	34. A/C evaporator outlet air temp. sensor (if equipped)
9. Tank pressure control valve (built-in fuel pump)	22. Starter magnetic switch	35. Immobilizer control module (if equipped)
10. Fuel pump (with pressure regulator)	23. Heated Oxygen Sensor–2 (HO2S–2)	36. Main relay
11. Ignition coil assembly	24. DLC	37. VSS
12. Fuel injector	25. Electric load	38. Oil control valve
13. Heated Oxygen Sensor–1 (HO2S–1)	26. Fuel level sensor	

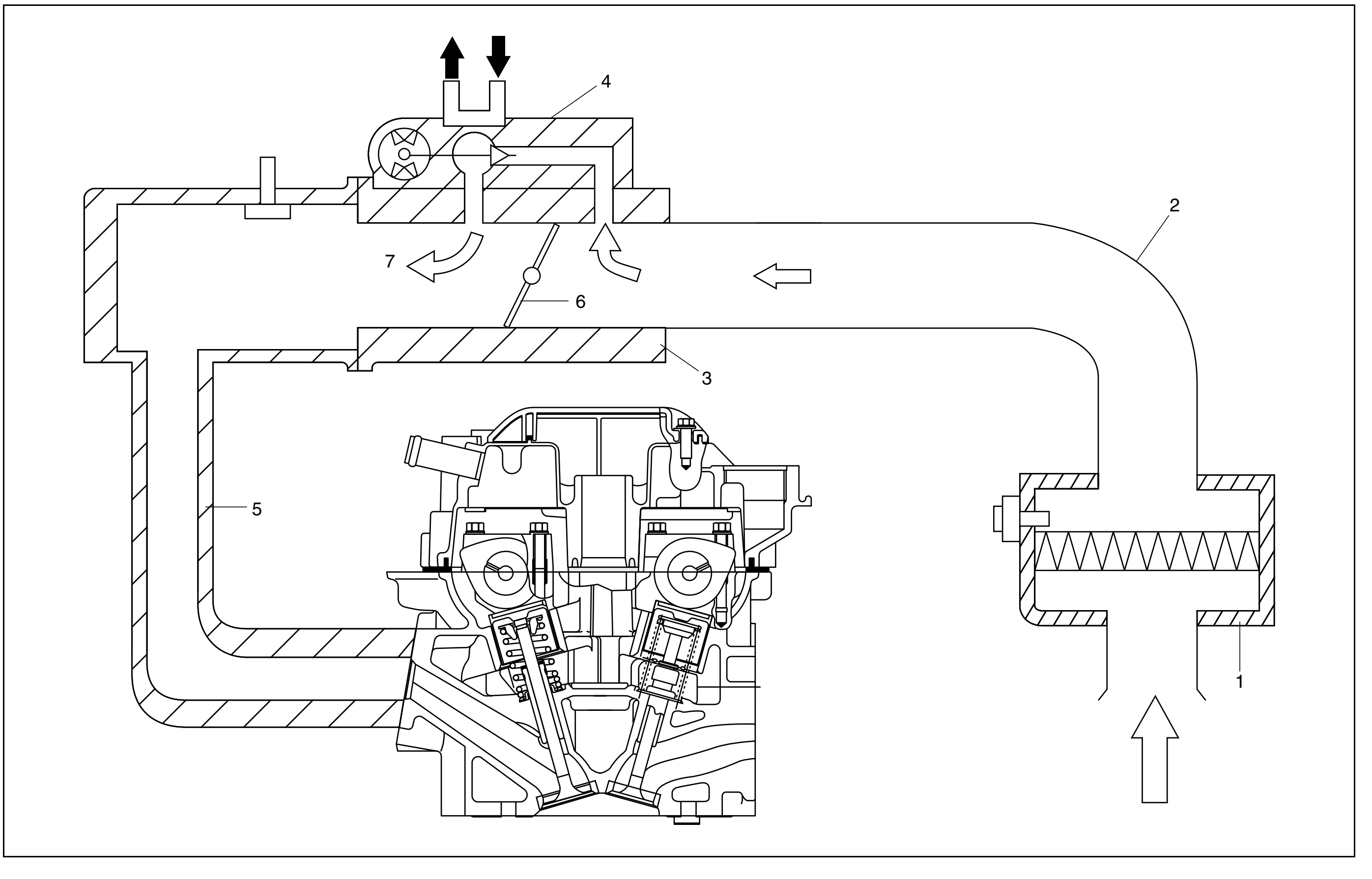
Air Intake System Description

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).

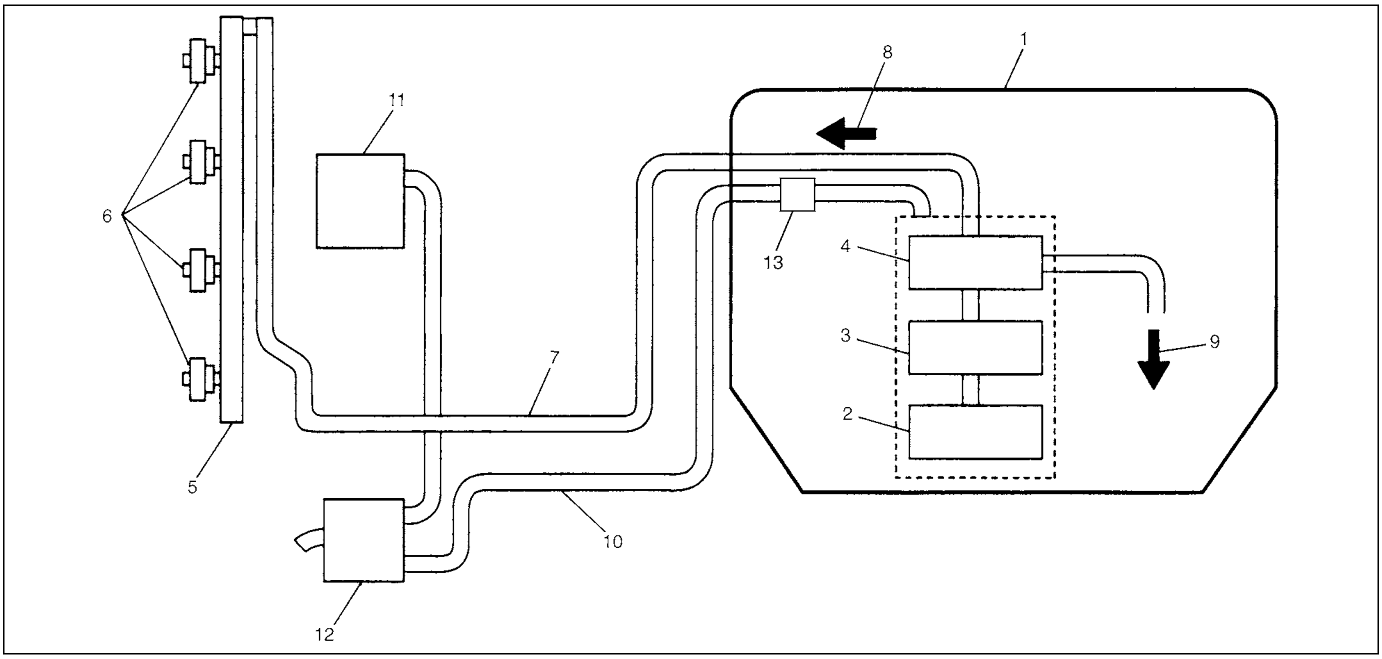
AIR INTAKE SYSTEM DIAGRAM



Fuel Delivery System Description

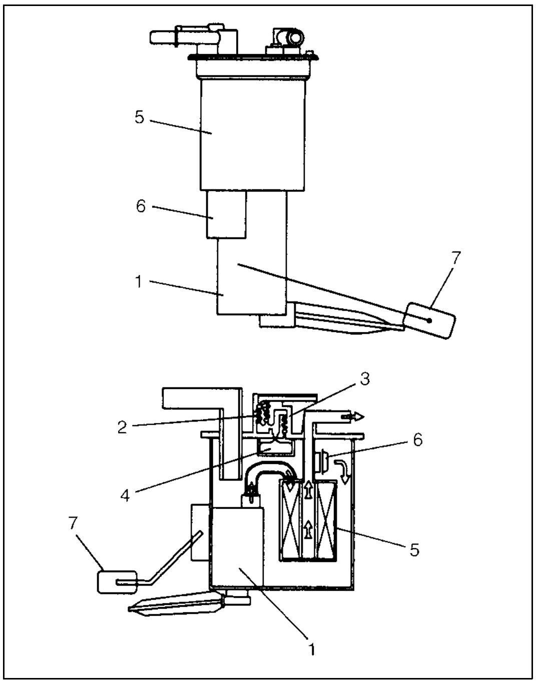
The fuel system consists of fuel tank (1), fuel pump (2) (with built-in fuel filter (3) and fuel pressure regulator (4)), delivery pipe (5), injectors (6) and fuel feed line (7).
The fuel (8) in the fuel tank (1) is pumped up by the fuel pump (2), sent into delivery pipe (5) and injected by the injectors (6).
As the fuel pump assembly is equipped with built-in fuel filter (3) and fuel pressure regulator (4), the fuel (8) is filtered and its pressure is regulated before being sent to the delivery pipe (5).
The excess fuel from fuel pressure regulation process is returned back (9) into the fuel tank.
Also, fuel vapor generated in fuel tank is led through the fuel vapor line (10) into the EVAP canister (12).

FUEL DELIVERY SYSTEM DIAGRAM



11. Intake manifold	13. Fuel vapor separator

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) and a fuel pressure regulator (6) are included and a fuel level gauge (7) is attached.
Addition of the fuel pressure regulator (6) to the fuel pump makes it possible to maintain the fuel pressure at constant level and ECM controls compensation for variation in the intake manifold pressure.

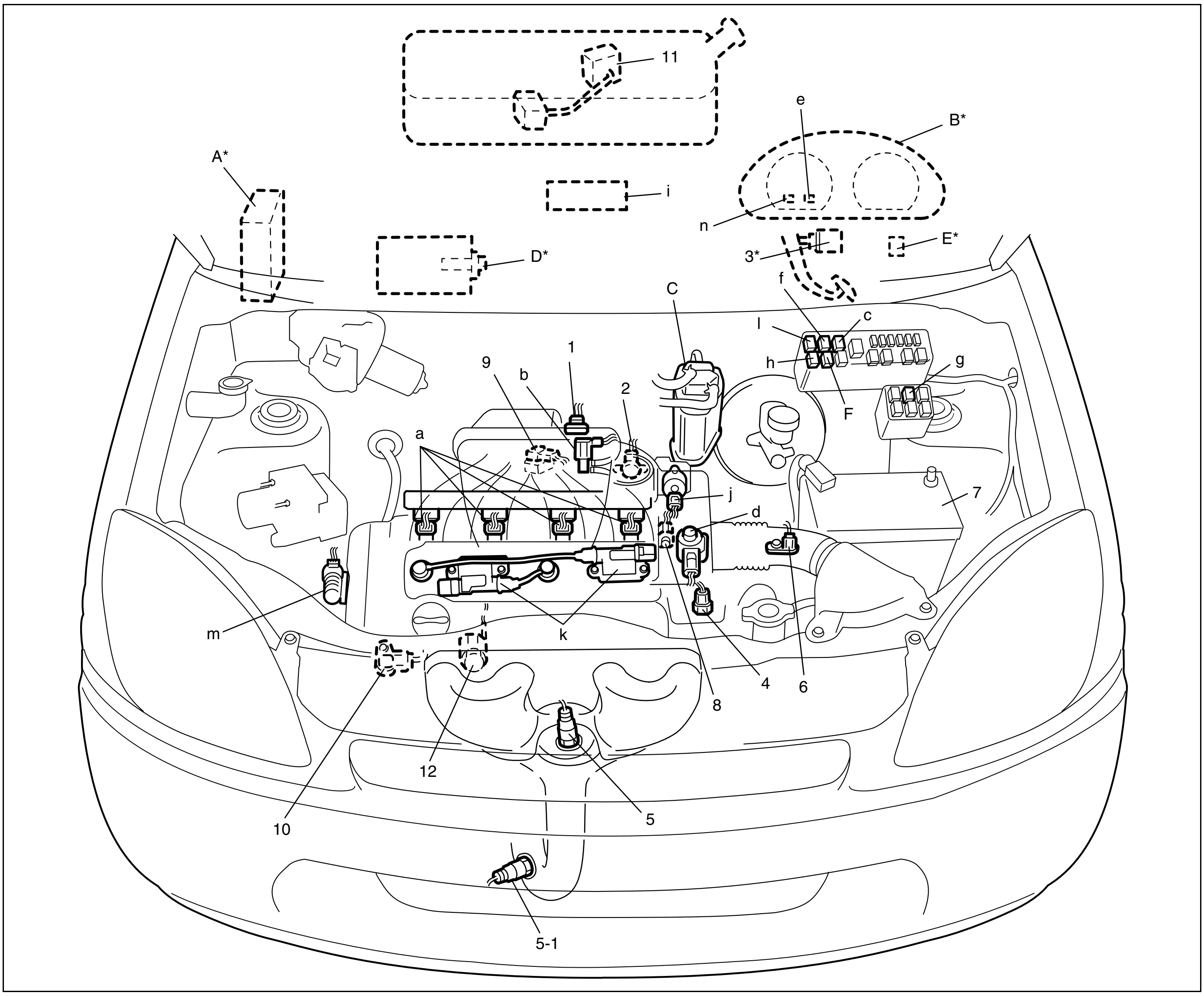
Electronic Control System Description

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 nine sub systems:

- Fuel injection control system
- Idle speed control system
- Fuel pump control system
- A/C control system (if equipped)
- Radiator fan control system
- EGR system
- Evaporative emission control system
- Oxygen sensor heater control system
- Ignition control system

ELECTRONIC CONTROL SYSTEM COMPONENT LOCATION



INFORMATION SENSORS	CONTROL DEVICES	OTHERS
1. MAF and IAT sensor	a: Fuel injector	A: ECM
2. TP sensor	b: EVAP canister purge valve	B: Combination meter
3. Stop lamp switch	c: Fuel pump relay	C: EVAP canister
4. ECT sensor	d: EGR valve	D: A/C evaporator outlet air temp. sensor (if equipped)
5. Heated oxygen sensor–1	e: Malfunction indicator lamp	E: Data link connector
5-1. Heated oxygen sensor–2	f: A/C condenser fan relay No.1 (if equipped)	F: A/C compressor relay (if equipped)
6. VSS	g: A/C condenser fan relay No.2 (if equipped)	
7. Battery	h: Radiator fan relay	
8. CMP sensor	i: Fuel cost meter	
9. MAP sensor	j: IAC valve	
10. CKP sensor	k: Ignition coil assembly (with ignitor)	
11. Fuel level sensor	l: Main relay	
12. Knock sensor	m: Oil control valve	
	n: Immobilizer indicator lamp	

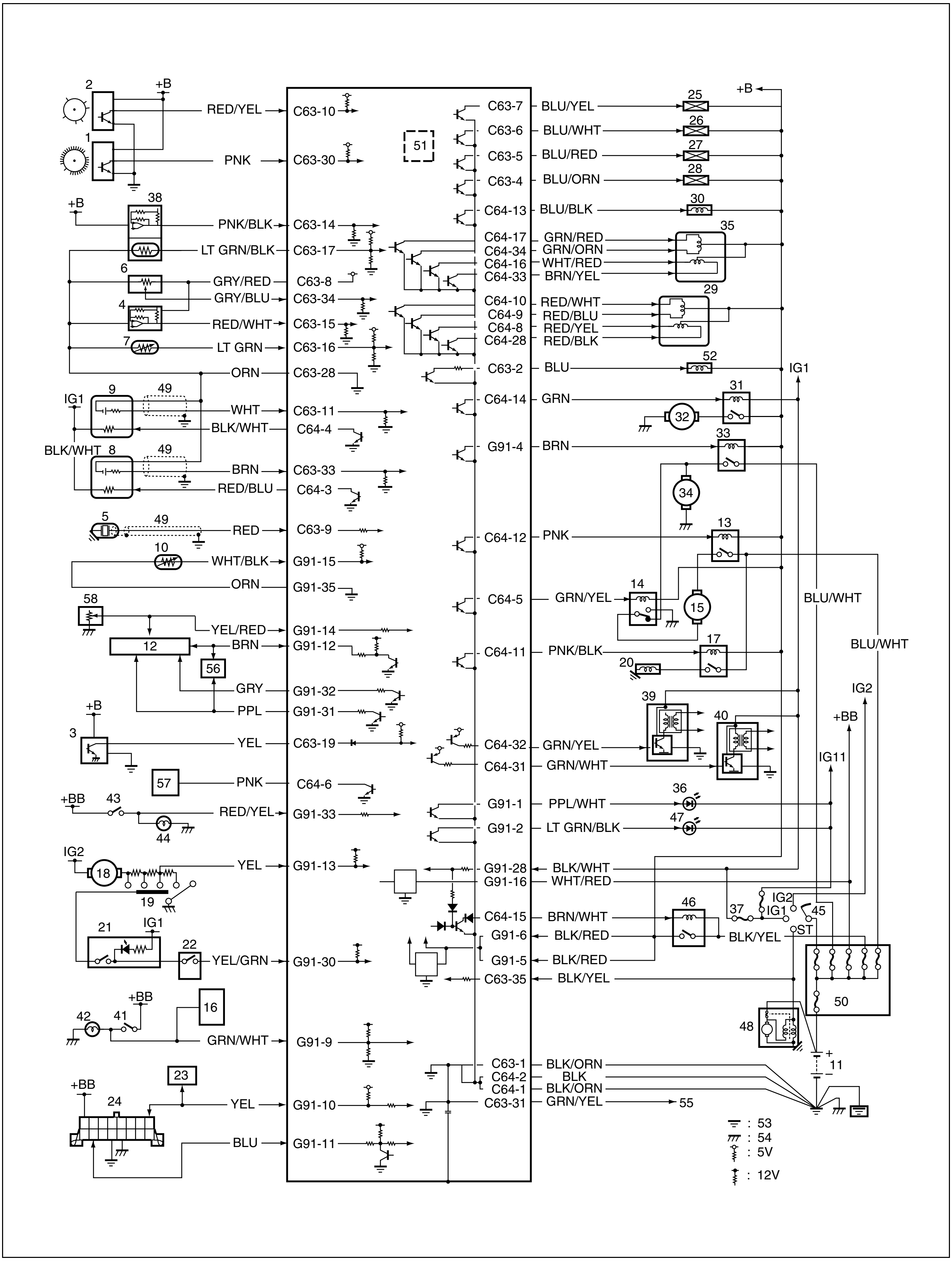
NOTE:

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

ENGINE AND 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	EVAP CANISTER PURGE VALVE	A/C COMPRESSOR AND CONDENSER FAN RELAY	RADIATOR FAN RELAY	MIL	MAIN RELAY	OIL CONTROL VALVE
SIGNAL FROM SENSOR, SWITCH AND CONTROL MODULE	FUEL LEVEL SENSOR	For detecting fuel level											
	BAROMETRIC PRESSURE SENSOR		○		○	○		○			○		
	STOP LAMP SWITCH				○								
	START SWITCH	○	○	○	○		○		○		○		○
	IGNITION SWITCH	○	○	○	○	○	○	○	○	○		○	○
	LIGHTING SWITCH				○								
	BLOWER SWITCH				○				○				
	A/C SWITCH				○			○	○	○			
	A/C EVAP OUTLET AIR TEMP. SENSOR				○				○				
	VSS		○		○		○		○	○	○		○
	HEATED OXYGEN SENSOR-1		○					○			○		
	HEATED OXYGEN SENSOR-2	For detecting deterioration of three way catalytic converter									○		
	MAF SENSOR		○	○	○	○	○	○			○		
	IAT SENSOR		○		○	○	○	○			○		
	ECT SENSOR		○	○	○	○	○	○	○	○	○		○
	TP SENSOR		○		○	○	○	○	○		○		○
	MAP SENSOR		○	○	○	○	○	○	○		○		○
	CMP SENSOR	○	○			○					○		○
	CKP SENSOR	○	○	○	○	○	○	○	○		○		○
	KNOCK SENSOR					○					○		

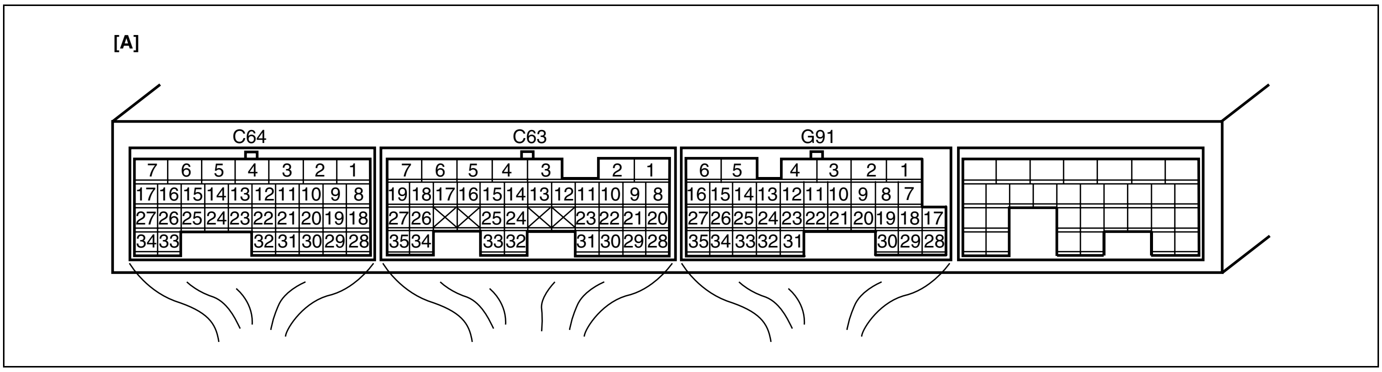
ECM INPUT/OUTPUT CIRCUIT DIAGRAM



1. CKP sensor	21. A/C switch	41. Stop lamp switch
2. CMP sensor	22. A/C pressure switch	42. Stop lamp
3. VSS	23. Immobilizer control module	43. Lighting switch
4. MAP sensor	24. Data link connector	44. Position lamp
5. Knock sensor	25. Injector No.1	45. Ignition switch
6. TP sensor	26. Injector No.2	46. Main relay
7. ECT sensor	27. Injector No.3	47. Immobilizer indicator lamp
8. Heated oxygen sensor–2	28. Injector No.4	48. Starting motor
9. Heated oxygen sensor–1	29. IAC valve	49. Shield wire
10. A/C evaporator outlet air temp. sensor	30. EVAP canister purge valve	50. Main fuse
11. Battery	31. Fuel pump relay	51. Barometric pressure sensor
12. Combination meter	32. Fuel pump	52. Oil control valve
13. A/C condenser fan relay No.1	33. Radiator fan relay	53. Engine ground
14. A/C condenser fan relay No.2	34. Radiator fan motor	54. Body ground
15. A/C condenser fan motor	35. EGR valve	55. Shield ground
16. ABS control module	36. Malfunction indicator lamp	56. EPS control module
17. A/C compressor relay	37. “IG” fuse	57. Fuel cost meter in multi information display
18. Heater fan motor	38. MAF and IAT sensor	58. Fuel level sensor
19. Heater fan switch	39. Ignition coil assembly (for No.1 and No.4 spark plugs)	
20. A/C compressor clutch	40. Ignition coil assembly (for No.2 and No.3 spark plugs)	

ECM TERMINAL ARRANGEMENT TABLE

CON-NECTOR	TERMI-NAL	WIRE COLOR	CIRCUIT
C64	1	BLK/ORN	Ground for ECM
	2	BLK	Ground for ECM
	3	RED/BLU	Heater output of heated oxygen sensor–2
	4	BLK/WHT	Heater output of heated oxygen sensor–1
	5	GRN/YEL	A/C condenser fan motor relay No.2 output (if equipped)
	6	PNK	Fuel cost output
	7	–	–
	8	RED/YEL	IAC valve output (stepper motor coil 3)
	9	RED/BLU	IAC valve output (stepper motor coil 2)
	10	RED/WHT	IAC valve output (stepper motor coil 1)
	11	PNK/BLK	A/C compressor relay output (if equipped)
	12	PNK	A/C condenser fan motor relay No.1 output (if equipped)
	13	BLU/BLK	EVAP canister purge valve output
	14	GRN	Fuel pump relay output
	15	BRN/WHT	Main power supply relay output
	16	WHT/RED	EGR valve (stepper motor coil 3) output
	17	GRN/RED	EGR valve (stepper motor coil 1) output
	18	–	–
	19	–	–
	20	–	–
	21	–	–
	22	–	–
	23	–	–
	24	–	–
	25	–	–
	26	–	–
	27	–	–
	28	RED/BLK	IAC valve output (stepper motor coil 4)
	29	–	–
	30	–	–
	31	GRN/WHT	Ignition coil No.2 and No.3 output
	32	GRN/YEL	Ignition coil No.1 and No.4 output
	33	BRN/YEL	EGR valve (stepper motor coil 4) output
	34	GRN/ORN	EGR valve (stepper motor coil 2) output
C63	1	BLK/ORN	Ground for ECM
	2	BLU	Oil control valve output
	3	–	–
	4	BLU/ORN	Fuel injector No.4 output
	5	BLU/RED	Fuel injector No.3 output
	6	BLU/WHT	Fuel injector No.2 output
	7	BLU/YEL	Fuel injector No.1 output
	8	GRY/RED	Output of 5V power source for throttle position (TP) sensor
	9	RED	Knock sensor signal
	10	RED/YEL	Reference signal for CMP sensor
	11	WHT	Oxygen signal of heated oxygen sensor–1
	12	–	–
	13	–	–
	14	PNK/BLK	Mass air flow (MAF) sensor signal
	15	RED/WHT	Manifold absolute pressure (MAP) sensor signal
	16	LT GRN	Engine coolant temp. (ECT) sensor signal
	17	LT GRN/BLK	Intake air temperature (IAT) sensor signal
	18	–	–
	19	YEL	Vehicle speed sensor signal
	20	–	–
C63	21	–	–
	22	–	–
	23	–	–
	24	–	–
	25	–	–
	26	–	–
	27	–	–
	28	ORN	Ground for sensors
	29	–	–
	30	PNK	CKP sensor signal
	31	GRN/YEL	Ground of ECM for shield wire
	32	–	–
	33	BRN	Oxygen signal of heated oxygen sensor–2
	34	GRY/BLU	Throttle position (TP) sensor signal
	35	BLK/YEL	Starting motor signal
G91	1	PPL/WHT	MIL (Malfunction indicator lamp) output
	2	LT GRN/BLK	Immobilizer indicator lamp output (if equipped)
	3	–	–
	4	BRN	Radiator fan motor relay output
	5	BLK/RED	Main power supply
	6	BLK/RED	Main power supply
	7	–	–
	8	–	–
	9	GRN/WHT	Electric load signal for stop lamp
	10	YEL	Serial communication line of data link connector 5 V
	11	BLU	Serial communication line of data link connector 12 V
	12	BRN	Engine revolution signal output for tachometer
	13	YEL	Electric load signal for heater blower motor
	14	YEL/RED	Fuel level sensor signal
	15	WHT/BLK	A/C evaporator outlet air temp. sensor signal (if equipped)
	16	WHT/RED	Power source for ECM internal memory
	17	–	–
	18	–	–
	19	–	–
	20	–	–
	21	–	–
	22	–	–
	23	–	–
	24	–	–
	25	–	–
	26	–	–
	27	–	–
	28	BLK/WHT	Ignition switch signal
	29	–	–
	30	YEL/GRN	A/C request signal (if equipped)
	31	PPL	Vehicle speed sensor signal for speedometer
	32	GRY	ECT sensor signal for combination meter
	33	RED/YEL	Electric load signal for clearance lamp
	34	–	–
	35	ORN	Ground for A/C evaporator outlet air temp. sensor (if equipped)



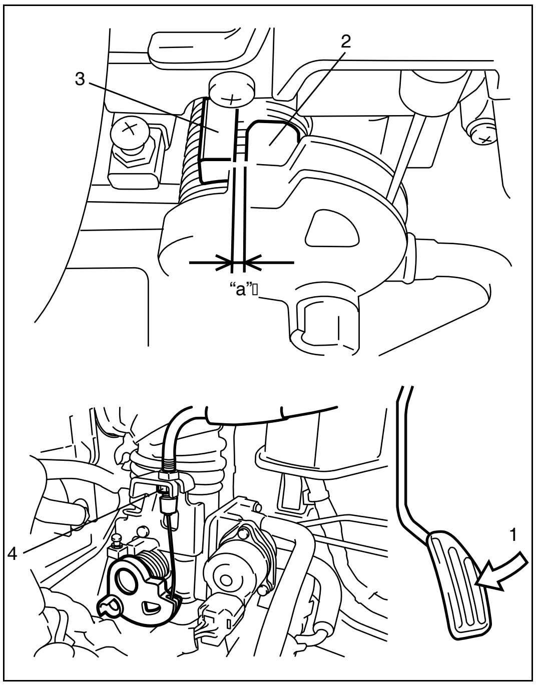
[A]: Terminal arrangement of ECM coupler (viewed from harness side)

NOTE:

For abbreviation of wire color, refer to “Abbreviations and Symbols May be Used in This Manual” in Section 0A.

On-Vehicle Service

Accelerator cable adjustment



With accelerator pedal depressed fully (1), check clearance between throttle lever (2) and lever stopper (3) of throttle body.
If measured value is out of specification, adjust it to specification with cable adjusting nut (4).

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

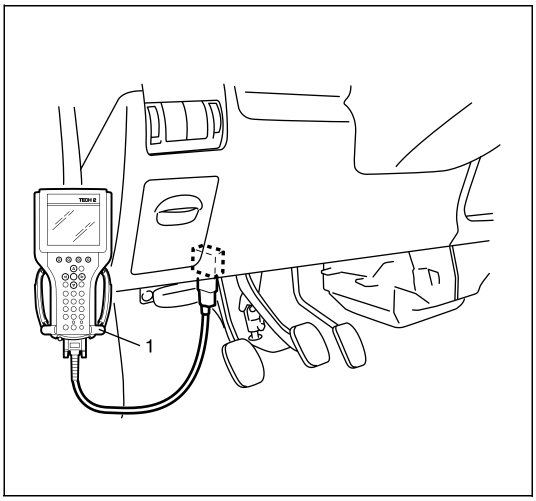
Before idle speed/IAC duty check, make sure of the following.

- 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 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 scan tool (1) to DLC with ignition switch OFF.

2) Warm up engine to normal operating temperature.
3) Check engine idle speed and “IAC duty” by using “Data List” mode on scan tool to check “IAC duty”.
4) If duty and/or idle speed is out of specifications, inspect idle air control system referring to “Table B-4 Idle Air Control System Check” in Section 6.

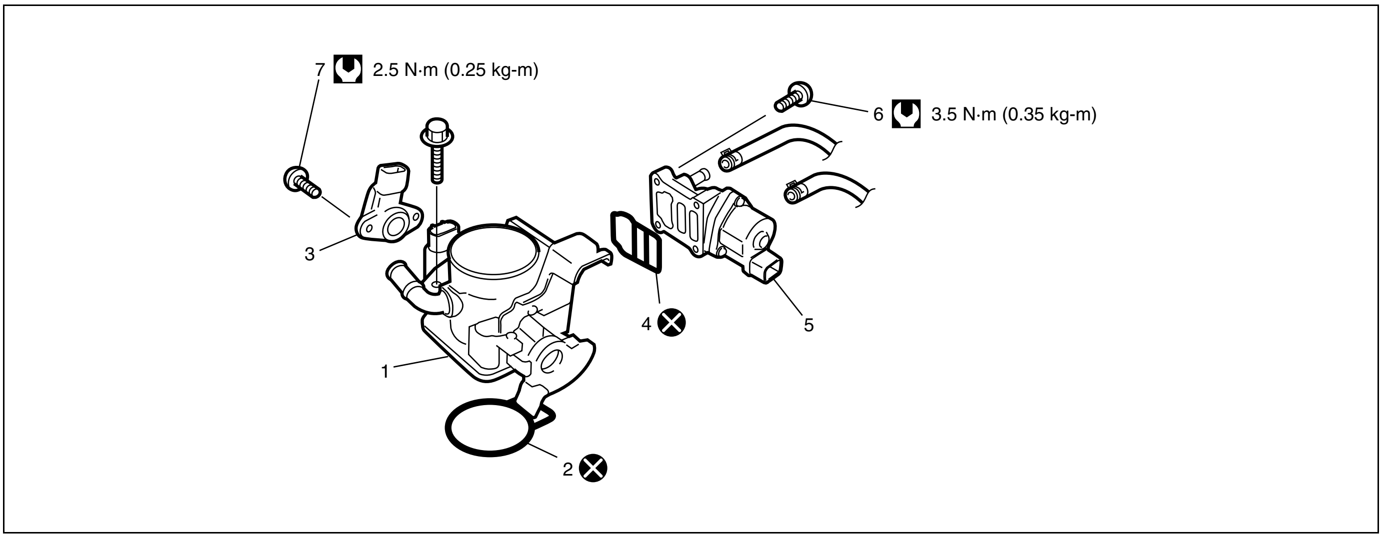
Engine idle speed and IAC duty

A/C OFF	A/C ON
700 ± 50 r/min (rpm) **10 – 55 %**	**850 ± 50 r/min (rpm)**

5) Check that specified engine idle speed is obtained with A/C ON if vehicle is equipped with A/C.
   If not, check A/C request signal circuit and idle air control system.

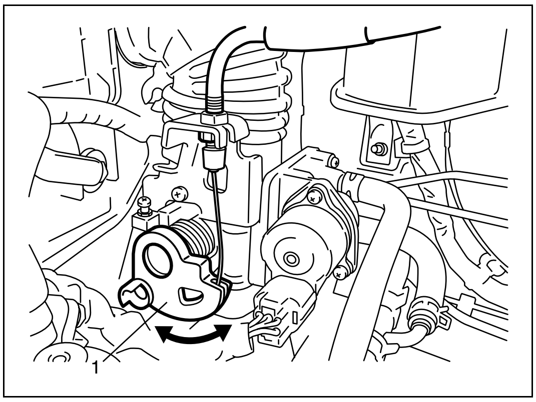
Air Intake System

Throttle body Components



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.

Throttle body on-vehicle inspection

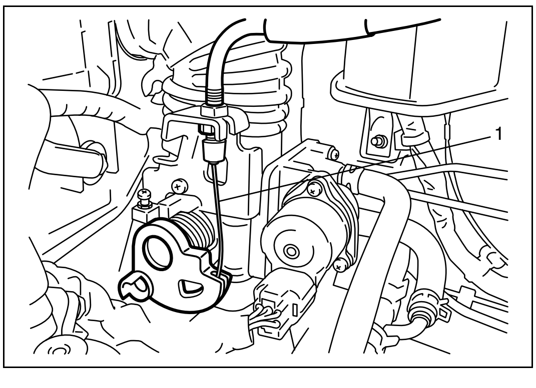


- Check that throttle valve lever (1) moves smoothly.

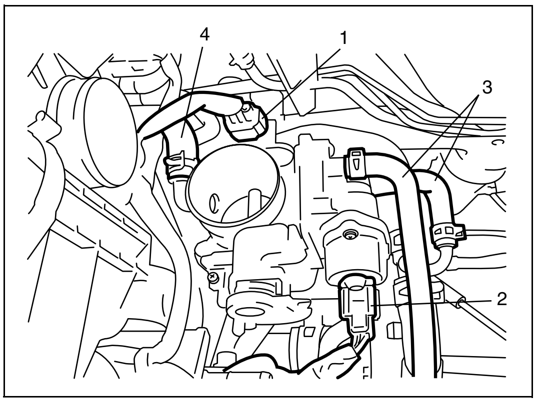
Throttle body removal and installation

REMOVAL

1) Disconnect negative cable at battery.
2) Drain coolant referring to “Cooling System Draining” in Section 6B.



3) Disconnect accelerator cable (1) from throttle body.
4) Detach EVAP canister and purge valve chamber, and remove air cleaner outlet hose.



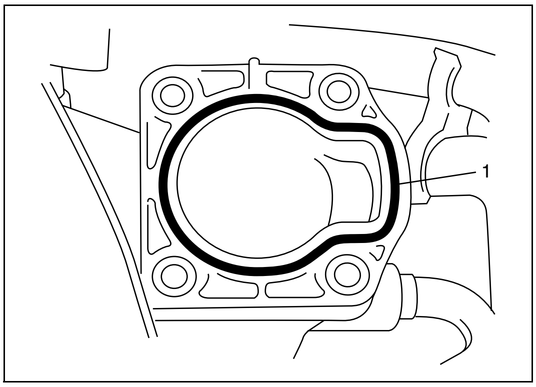
5) Disconnect connectors from TP sensor (1) and IAC valve (2).
6) Disconnect engine coolant hoses (3) and breather hose (4) from throttle body.
7) Remove throttle body from intake manifold.
8) Remove TP sensor and IAC valve from throttle body.

NOTE:

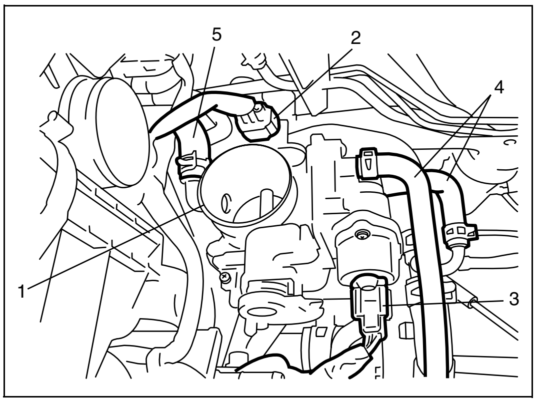
While disassembling and assembling throttle body, use special care not to deform levers on throttle valve shaft or cause damage to any other parts.

INSTALLATION

1) Install IAC valve to throttle body referring to “INSTALLATION” under “Idle air control (IAC) valve removal and installation” in this section.
2) Install TP sensor to throttle body referring to “INSTALLATION” under “Throttle position sensor (TP sensor) removal and installation” in this section.

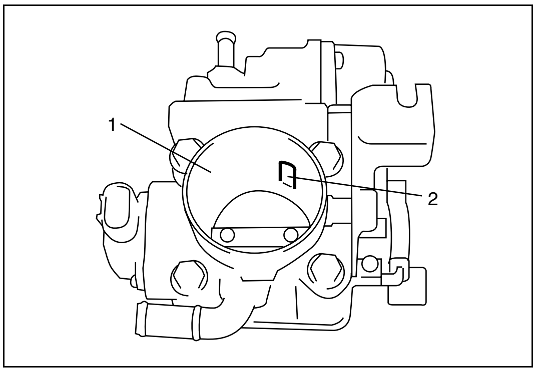


3) Clean mating surfaces and install new throttle body gasket (1) to intake manifold.



4) Install throttle body (1) to intake manifold.
5) Connect connectors to TP sensor (2) and IAC valve (3) securely.
6) Connect engine coolant hoses (4) and breather hose (5).
7) Connect accelerator cable and adjust cable play to specification.
8) Install air cleaner outlet hose, purge valve chamber and EVAP canister.
9) Refill coolant referring to “Cooling System Refill” in Section 6B.
10) Connect negative cable at battery.

Throttle body cleaning



Clean throttle body bore (1) and idle air passage (2) by blowing compressed air.

NOTE:

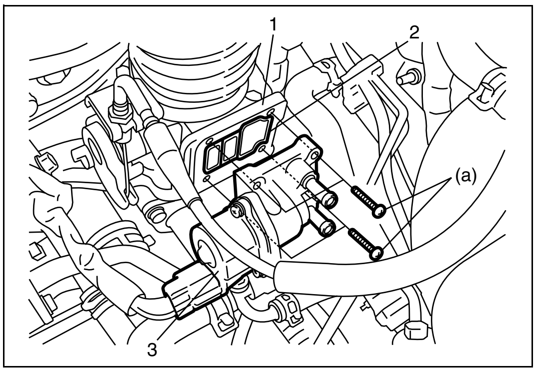
TP sensor, idle air control valve or other components containing rubber must not be placed in a solvent or cleaner bath. A chemical reaction will cause these parts to swell, harden or get distorted.

Idle air control (IAC) valve removal and installation

REMOVAL

1) Detach EVAP canister.
2) Drain coolant referring to “Cooling System Draining” in Section 6B.
3) Disconnect coolant hoses from IAC valve.
4) Remove IAC valve from throttle body.

INSTALLATION



1) Install new gasket (2) to throttle body (1).
2) Install IAC valve (3) to throttle body (1).
   Tighten IAC valve screws to specified torque.

Tightening torque
IAC valve screw (a): 3.5 N·m (0.35 kg-m, 2.5 lb-ft)

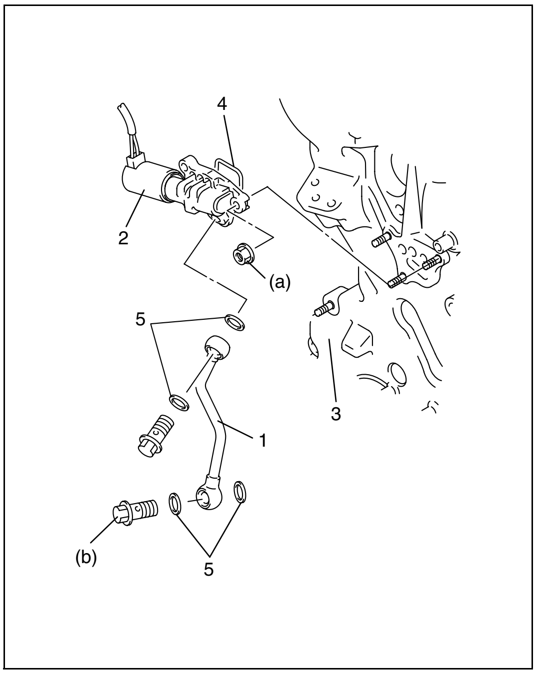
3) Connect coolant hoses to IAC valve.
4) Refill coolant referring to “Cooling System Refill” in Section 6B.
5) Install EVAP canister.

Idle air control (IAC) valve inspection

Refer to “Idle air control (IAC) valve check” under “DTC P0506 Idle Air Control System RPM Lower than Expected DTC P0507 Idle Air Control System RRM Higher than Expected” in Section 6.

Oil control valve removal and installation

REMOVAL



Remove oil gallery pipe No.1 (1) and oil control valve (2) from timing chain cover (3).

INSTALLATION

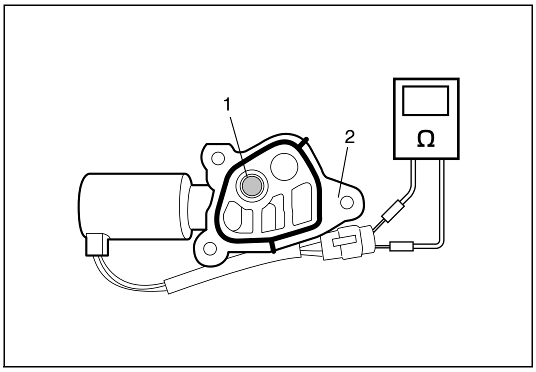
1) Install new O-ring (4) to oil control valve.
2) Install oil control valve to timing chain cover.
   Tighten nuts to specification.

Tightening torque
Oil control valve mounting nuts
(a): 11 N·m (1.1 kg-m, 8.0 lb-ft)

3) Install oil gallery pipe No.1 with new copper washers (5) to timing chain cover.
   Tighten bolts to specification.

Tightening torque
Oil gallery pipe No.1 bolts
(b): 30 N·m (3.0 kg-m, 21.5 lb-ft)

Oil control valve inspection



1) Inspect strainer (1) and mating surface (2) of oil control valve for clog or damage. Clean oil control valve if clog or foreign matter is present on strainer or mating surface of oil control valve.
   Replace oil control valve if its mating surface is damaged.
2) Check resistance between terminals of oil control valve.

Resistance: 6.7 – 7.7 Ω (at 20°C (68°F))

Fuel Delivery System

Fuel pressure inspection

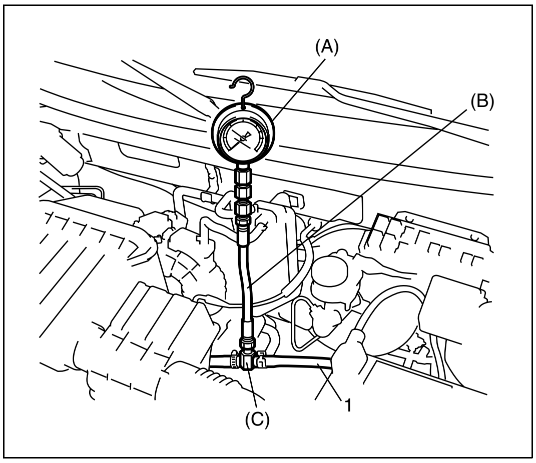
WARNING:

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 and fuel feed hose (1) as shown in figure, and clamp hoses securely to ensure no leaks occur during checking.

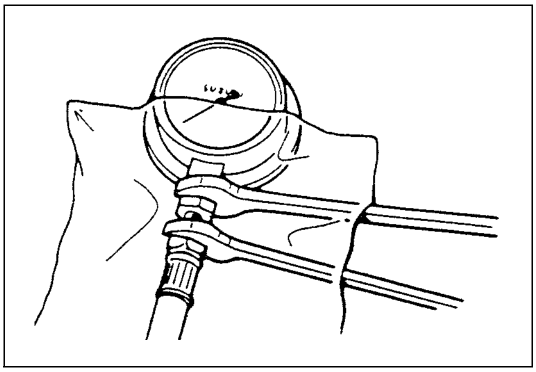
Special tool
(A): 09912-58442
(B): 09912-58432
(C): 09912-58490

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	
With 1 min. after engine (fuel pump) stop (Pressure reduces as time passes)	over 250 kPa (2.5 kg/cm^2, 35.6 psi)

6) Start engine and warm it up to normal operating temperature.
7) Measure fuel pressure at idling.
   If measured pressure does not satisfy specification, refer to “Table B-3 Fuel Pressure Check” in Section 6 and check each possibly defective part. Replace if found defective.



8) After checking fuel pressure, remove fuel pressure gauge.

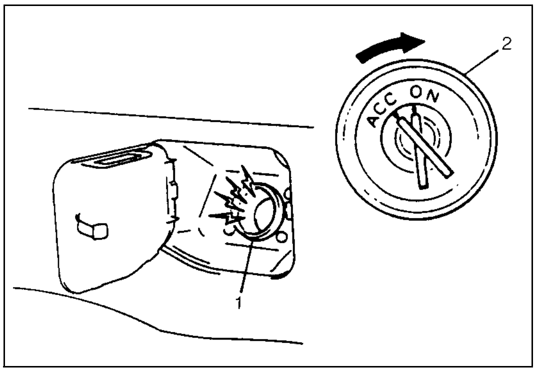
CAUTION:
As fuel feed line is still under high fuel pressure, make sure to release fuel pressure according to following procedures.
- **Place fuel container under joint.**
- **Cover joint with rag and loosen joint nut slowly to release fuel pressure gradually.**

9) Remove special tools from fuel delivery pipe and fuel feed hose.
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 with pressure regulator on-vehicle inspection

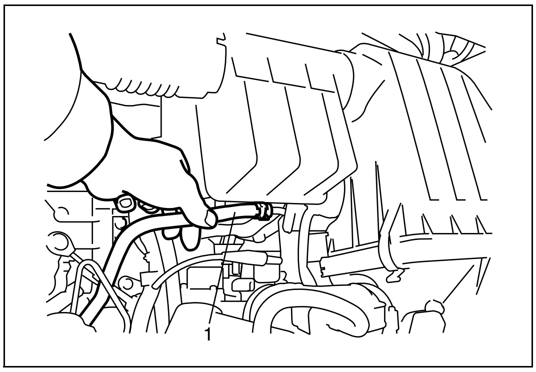
CAUTION:
When fuel filler cap is removed in any procedure, work must be done in a well-ventilated area, keep away from any open flames and without smoking.

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. Then fuel pump operating sound should be heard from fuel filler for about 2 seconds and stop. Be sure to reinstall fuel filler cap after checking.
If above check result is not satisfactory, advance to “Table B-2 Fuel Pump and Its Circuit Check” in Section 6.

1.	Fuel filler
2.	Ignition switch



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 about 2 seconds after ignition switch ON.
If fuel pressure is not felt, advance to “Table B-3 Fuel Pressure Check” in Section 6.

Fuel pump with pressure regulator removal and installation

REMOVAL

Remove fuel tank from body according to procedure described in "Fuel Tank Removal and Installation" of Section 6C and remove fuel pump from fuel tank.

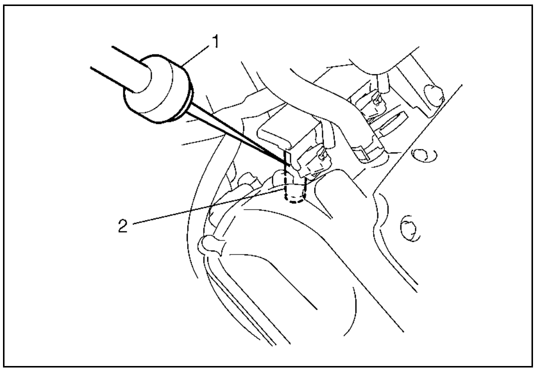
INSTALLATION

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 Removal and Installation" of Section 6C.

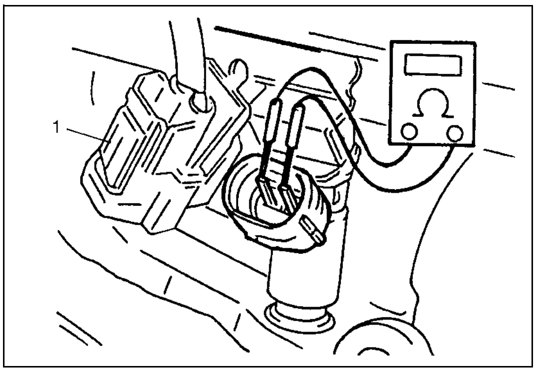
Fuel pump with pressure regulator inspection

Check fuel pump filter for evidence of dirt and contamination. If present, clean and check for presence of dirt in fuel tank.

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 fuel injector
11.3 – 13.8 Ω at 20°C (68°F)

3) Connect connector (1) to injector securely.

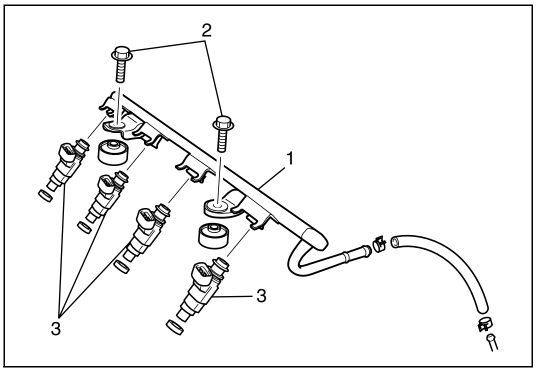
Fuel injector removal and installation

REMOVAL

CAUTION:

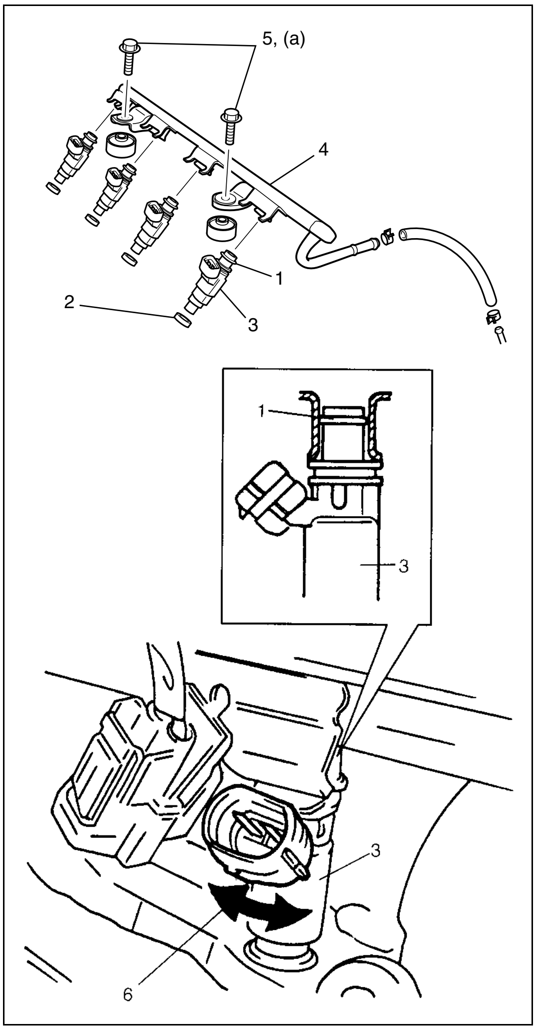
A small amount of fuel may come out after removal of fuel injectors, cover them with shop cloth.

1) Relieve fuel pressure according to procedure described in “Fuel pressure relief procedure” of Section 6.
2) Disconnect battery negative cable at battery.
3) Disconnect MAF and IAT sensor connector, and detach EVAP canister purge valve.
4) Remove air cleaner assembly with air intake pipe.
5) Disconnect fuel injector couplers.



6) Disconnect fuel feed hose from fuel delivery pipe (1).
7) Remove fuel delivery pipe bolts (2).
8) Remove fuel injector(s) (3).

INSTALLATION



For installation, reverse removal procedure and note following precautions.

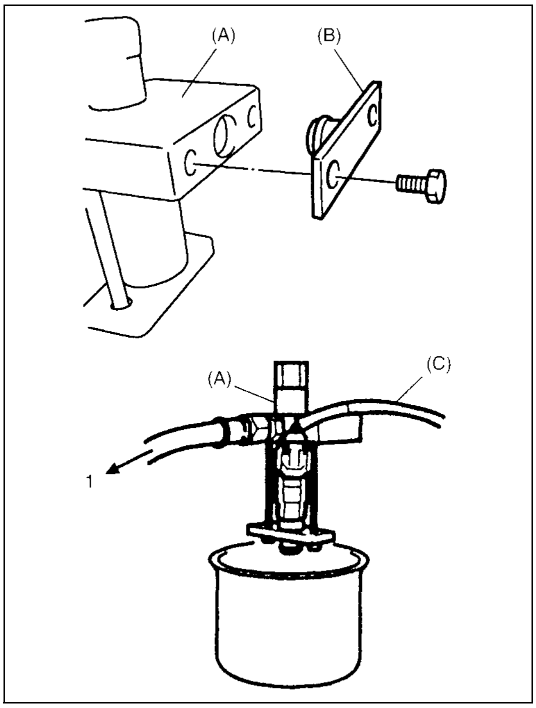
- Replace injector O-ring (1) with new one using care not to damage it.
- Check if cushion (2) is scored or damaged. If it is, replace with new one.
- Apply thin coat of fuel to O-rings (1) and then install injectors (3) into delivery pipe (4) and cylinder head.
  Make sure that injectors (3) rotate 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).

Tightening torque
Delivery pipe bolts (a): 25 N·m (2.5 kg-m, 18.0 lb-ft)

- After installation, with engine "OFF" and ignition switch "ON", check for fuel leaks around fuel line connection.

Fuel injector 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.



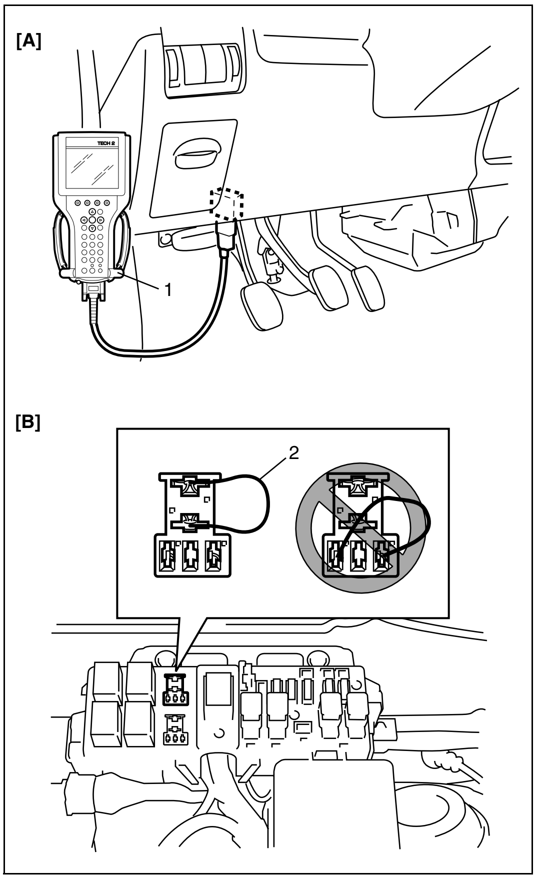
1) Install injector to special tool (injector checking tool).

Special tool
(A): 09912-58421
(B): 09912-57610

2) Connect special tools (hose and attachment) to fuel feed pipe (1) of vehicle.
3) Connect special tool (test lead) to injector.

Special tool
(C): 09930-88530

4) Install suitable vinyl tube onto injector nozzle to prevent fuel from splashing out when injecting.
5) Put graduated cylinder under injector.



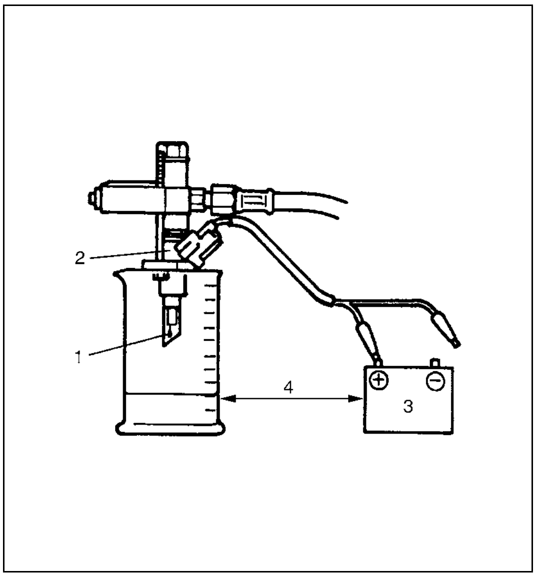
6) Operate fuel pump and apply fuel pressure to injector as follows:
   a) When using scan tool:
      i) Connect scan tool (1) to DLC with ignition switch OFF.
      ii) Turn ignition switch ON, clear DTC and select “MISC TEST” mode on scan tool.
      iii) Turn fuel pump ON by using scan tool.
   b) Without using scan tool:
      i) Remove fuel pump relay from connector.
      ii) Connect two terminals of relay connector using service wire (2) 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.

[A]:	When using Suzuki Scan Tool
[B]:	When not using Suzuki Scan Tool



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.)

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
Less than 1 drop/min.

4. Keep as far apart as possible

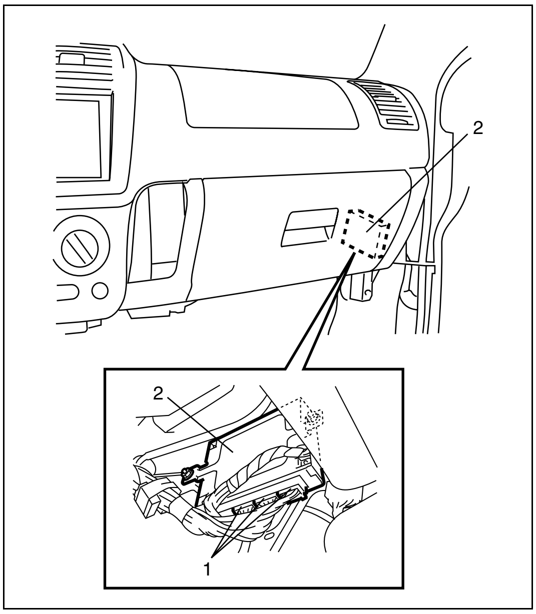
Electronic Control System

Engine control module (ECM) removal and installation

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, referring to “Disabling air bag system” in Section 10B if equipped.



3) Disconnect ECM connectors (1).
4) Remove ECM (2) by removing nuts.

INSTALLATION

Reverse removal procedure noting the following:

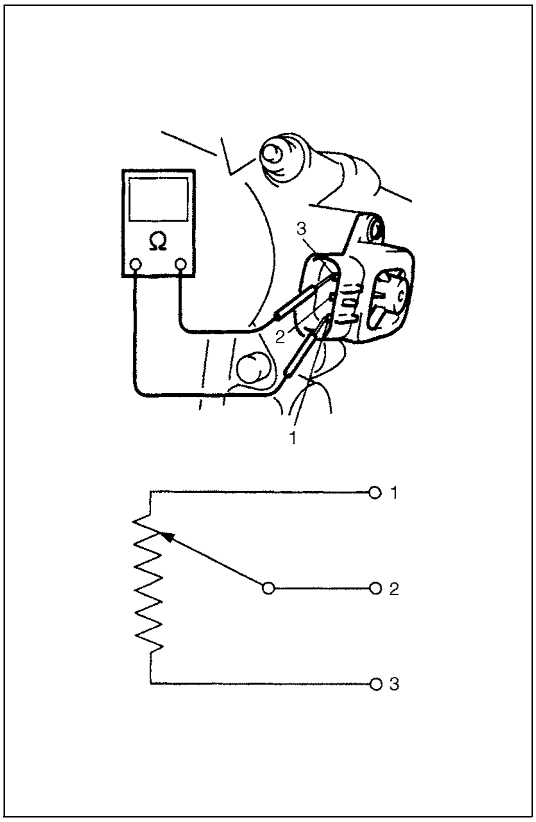
- Connect connectors to ECM securely.

Manifold absolute pressure sensor (MAP sensor) inspection

Check MAP sensor referring to “MAP Sensor Individual Check” under “DTC P0108 Manifold Absolute Pressure High Input” in Section 6. If malfunction is found, replace.

Throttle position sensor (TP sensor) on-vehicle inspection

1) Disconnect negative cable at battery.
2) Detach EVAP canister and purge valve chamber, and remove air cleaner outlet hose.
3) Disconnect TP sensor connector.



4) 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 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.

5) Connect TP sensor connector securely.
6) Connect negative cable to battery.

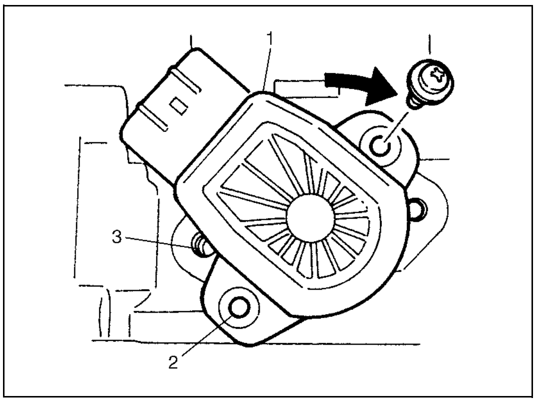
1.	Reference voltage terminal
2.	Output voltage terminal
3.	Ground terminal

Throttle position sensor (TP sensor) removal and installation

REMOVAL

1) Disconnect battery negative cable at battery.
2) Detach EVAP canister and purge valve chamber, and remove air cleaner outlet hose.
3) Disconnect TP sensor connector and 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) as shown in figure and turn TP sensor clockwise so that those holes align.

   Tightening torque
   TP sensor screw (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.

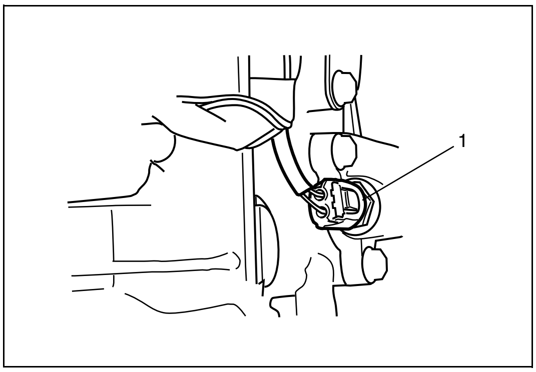
Engine coolant temperature sensor (ECT sensor) removal and installation

REMOVAL

1) Disconnect battery negative cable at battery.
2) Drain coolant referring to “Cooling System Draining” 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.**

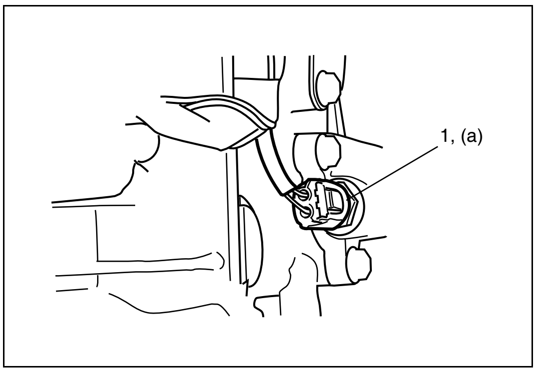
3) Remove air intake pipe.
4) Disconnect connector from ECT sensor.



5) Remove ECT sensor (1) from thermostat case.

INSTALLATION

Reverse removal procedure noting the following:

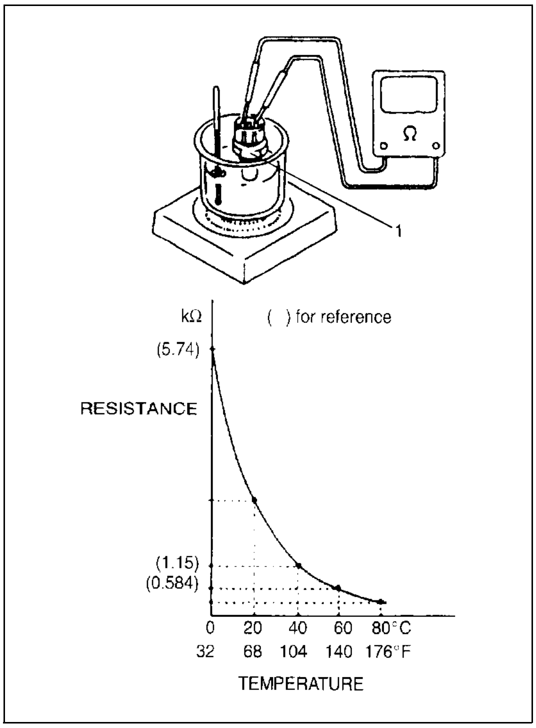


- Clean mating surfaces of ECT sensor (1) and thermostat case.
- Check O-ring for damage and replace if necessary.
- Tighten ECT sensor (1) to specified torque.

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 Refill” in Section 6B.

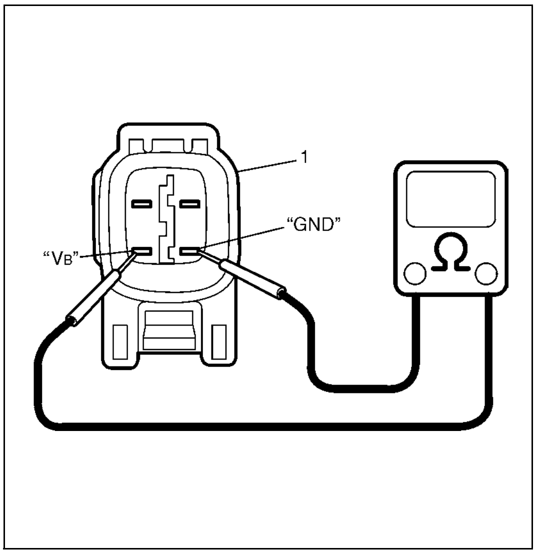
Engine coolant temperature sensor (ECT sensor) inspection



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 does not show such characteristic as shown in the graph, replace ECT sensor (1).

Heated oxygen sensor (HO2S-1 and HO2S-2) heater on-vehicle 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)

3) Connect sensor connector securely.

1. Viewed from terminal side

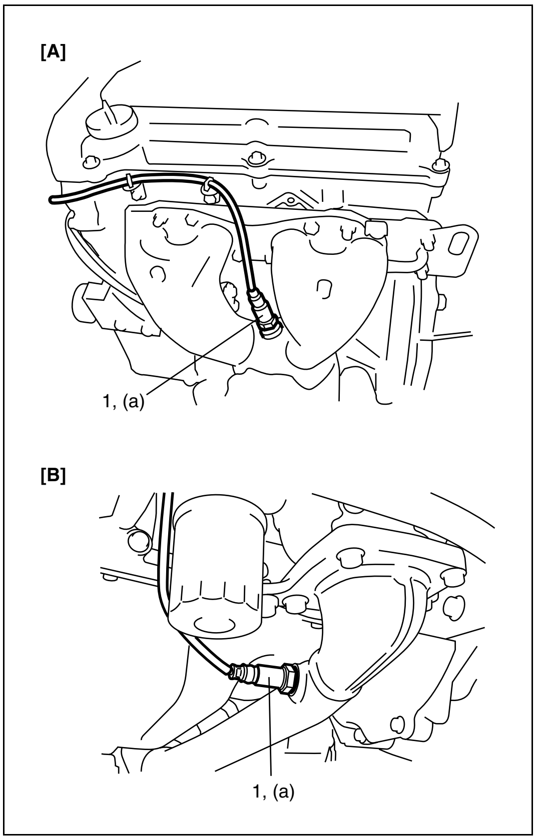
Heated oxygen sensor (HO2S-1 and HO2S-2) removal and installation

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 HO2S–1, disconnect connector of heated oxygen sensor and release its wire harness from clamps.
   a) For vehicle not equipped with A/C, remove front bumper and engine front cover.
   b) For vehicle equipped with A/C, remove exhaust manifold referring to “Exhaust Manifold Removal and Installation” in Section 6A1.
3) For HO2S–2, disconnect connector of heated oxygen sensor and release its wire harness from clamp and hoist vehicle.



4) Remove heated oxygen sensor (1) from exhaust manifold or exhaust pipe.

INSTALLATION

Reverse removal procedure noting the following.

- Tighten heated oxygen sensor (1) to specified torque.

Tightening torque
Heated oxygen sensor (a): 45 N·m (4.5 kg-m, 32.5 lb-ft)

- For equipped with A/C, install exhaust manifold referring to “Exhaust Manifold Removal and Installation” in Section 6A1.
- Connect connector of heated oxygen sensor (1) and clamp wire harness securely.
- After installing heated oxygen sensor (1), start engine and check that no exhaust gas leakage exists.

[A]:	HO2S–1
[B]:	HO2S–2

Camshaft position sensor (CMP sensor) inspection

Check camshaft position sensor referring to “DTC P0340 Camshaft Position Sensor Circuit” in Section 6. If malfunction is found, replace.

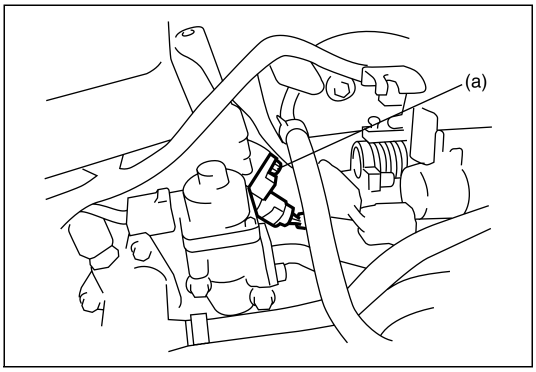
Camshaft position sensor (CMP sensor) removal and installation

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 teeth are free from any metal particles and damage.



3) Install camshaft position sensor to cylinder head.

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.

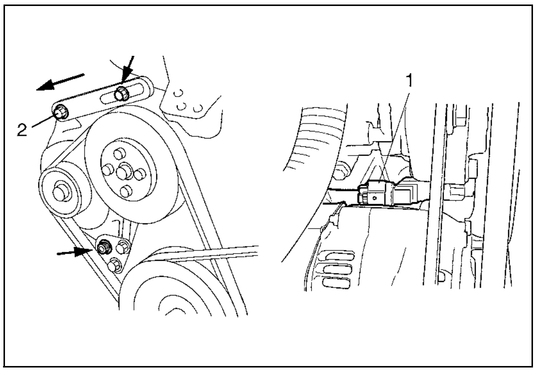
Crankshaft position sensor (CKP sensor) inspection

Check crankshaft position sensor referring to Steps 2 and 7 of "DTC P0335 Crankshaft Position (CKP) Sensor Circuit" in Section 6. If malfunction is found, replace.

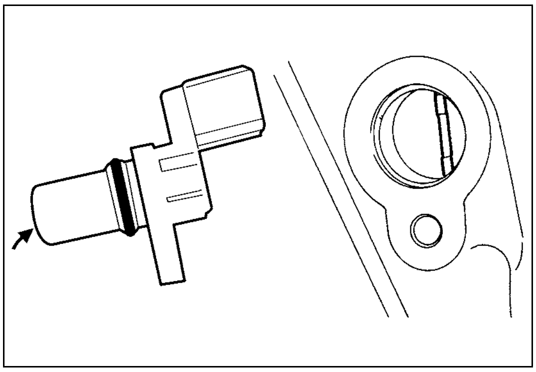
Crankshaft position sensor (CKP sensor) removal and installation

REMOVAL

1) Disconnect negative cable at battery.



2) Remove generator drive belt, loosen pivot bolt (2) and move generator rearward.
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 teeth are 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/Generator Drive Belt Tension Inspection and Adjustment” in Section 6B.
5) Connect negative cable to battery.

Fuel Level Sensor Removal and Installation

Refer to “Fuel Pump Assembly Removal and Installation” in Section 6C.

Fuel Level Sensor Inspection

Refer to “Fuel Level Sensor (Gauge Unit) Inspection” in Section 8.

Vehicle speed sensor (VSS) inspection

Check vehicle speed sensor referring to “DTC P0500 Vehicle Speed Sensor (VSS) Malfunction” in Section 6. If malfunction is found, replace.

Vehicle speed sensor (VSS) removal and installation

Refer to “Vehicle Speed Sensor (VSS) Removal and Installation” in Section 7A.

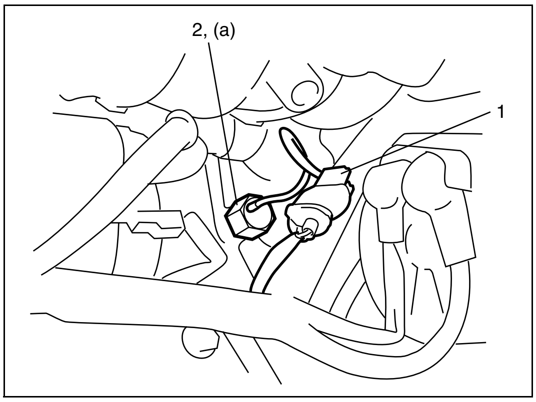
Knock sensor inspection

Check knock sensor referring to “DTC P0327 Knock Sensor Circuit Low DTC P0328 Knock Sensor Circuit High” in Section 6. If malfunction is found, replace.

Knock sensor removal and installation

REMOVAL

1) Disconnect negative cable from battery.
2) Hoist vehicle.



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

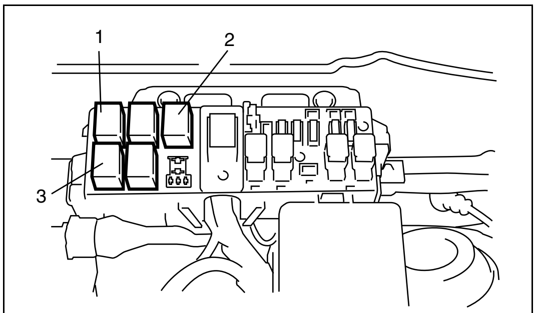
INSTALLATION

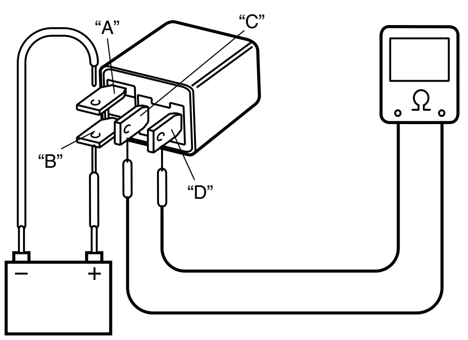
Reverse removal procedure for installation.

Tightening torque
Knock sensor (a): 22 N·m (2.2 kg-m, 16.0 lb-ft)

Main relay, fuel pump relay and radiator fan relay inspection

1) Disconnect negative cable at battery.



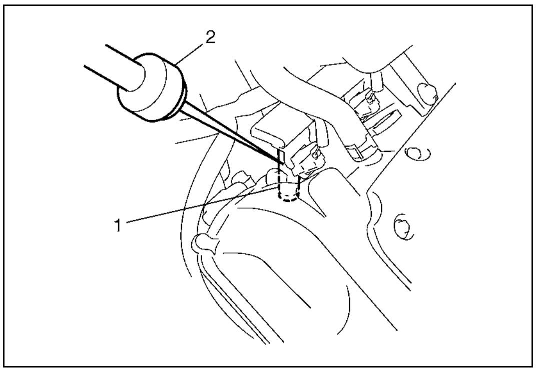


2) Remove main relay (1), fuel pump relay (2) and radiator fan relay (3) from relay/fuse box.
3) Check that there is no continuity between terminal “C” and “D”. If there is continuity, replace relay.
4) Connect battery positive (+) terminal to terminal “B” of relay.
   Connect battery negative (–) terminal “A” of relay.
   Check continuity between terminal “C” and “D”.
   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.

Radiator fan control system inspection

SYSTEM INSPECTION

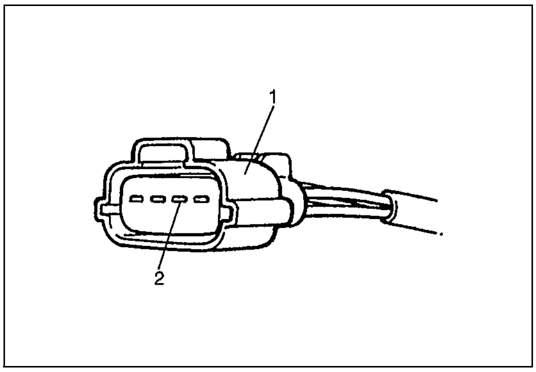
WARNING:

Keep hands, tools, and clothing away from engine cooling 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.

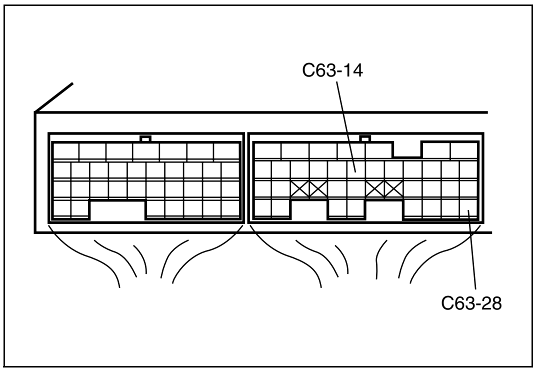
Check system for operation referring to "Table B-7 Radiator Fan Control System Check" in Section 6.
If radiator fan fails to operate properly, check relay, radiator fan and electrical circuit.

Mass air flow (MAF) and intake air temperature (IAT) sensor on-vehicle inspection

1) Remove ECM referring to "Engine control module (ECM) removal and installation" in this section.
2) Connect couplers to ECM.
3) Disconnect MAF and IAT sensor connector.



4) Connect voltmeter to “BLK/RED” wire terminal (2) of MAF and IAT sensor coupler (1) disconnected and ground.
5) Turn ignition switch ON and check that voltage is battery voltage.
   If not, check if wire harness is open or connection is poor.



6) Turn ignition switch OFF and connect coupler to MAF and IAT sensor.
7) Turn ignition switch ON and check MAF signal voltage between “C63-14” terminal and “C63-28” terminal of ECM coupler.

MAF signal voltage of MAF and IAT sensor at ignition switch ON: 0.5 – 1.0 V

1. ECM

8) Start engine and check that voltage is lower than 5 V and it rises as engine speed increases.

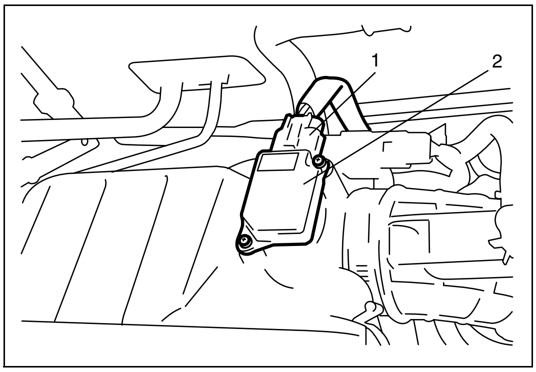
MAF signal reference voltage of MAF and IAT sensor at specified Idle speed: 1.3 – 1.8 V

9) If check result is not as specified above, cause may lie in wire harness, coupler connection, MAF and IAT sensor or ECM.

Mass air flow (MAF) and intake air temperature (IAT) sensor removal and installation

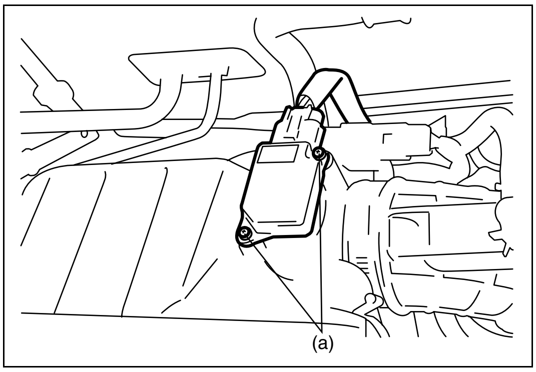
REMOVAL

1) Disconnect negative cable at battery.
2) Disconnect MAF and IAT sensor coupler (1).
3) Remove MAF and IAT sensor (2) from air cleaner assembly.



INSTALLATION

Reverse removal procedure noting the followings.



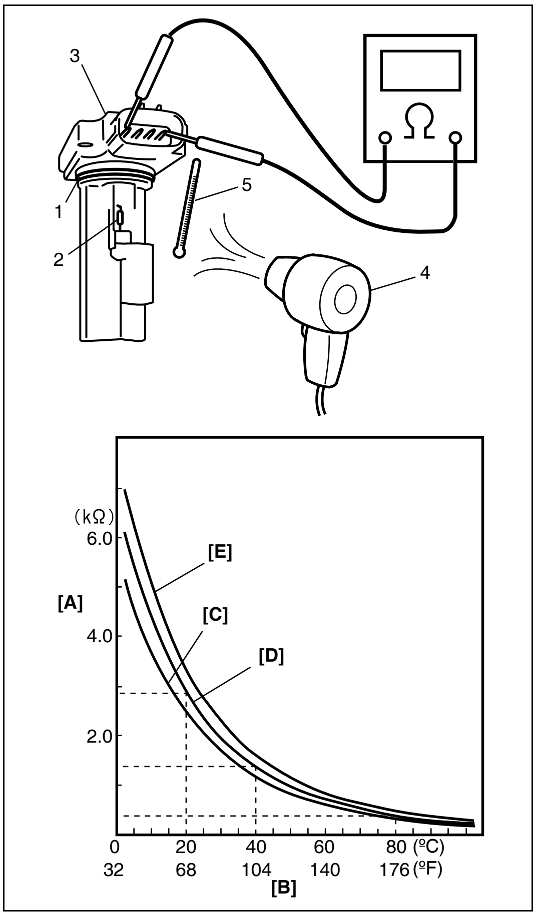
- Tighten MAF and IAT sensor screws to specified torque.

Tightening torque
MAF sensor screw (a): 2.5 N·m (0.25 kg-m, 1.8 lb-ft)

- Connect MAF and IAT sensor coupler securely.

Mass air flow (MAF) and intake air temperature (IAT) sensor inspection

CAUTION:
Do not heat up the MAF and IAT sensor more than 100°C (212°F). Otherwise, the MAF and IAT sensor is damaged.



- Check sensor O-ring (1) for damage and deterioration. Replace as necessary.
- Blow hot air to temperature sensing part (2) of MAF and IAT sensor (3) using hot air drier (4) and measure resistance between sensor terminals while heating air gradually.
  If measured resistance does not show such characteristic as shown, replace MAF and IAT sensor.

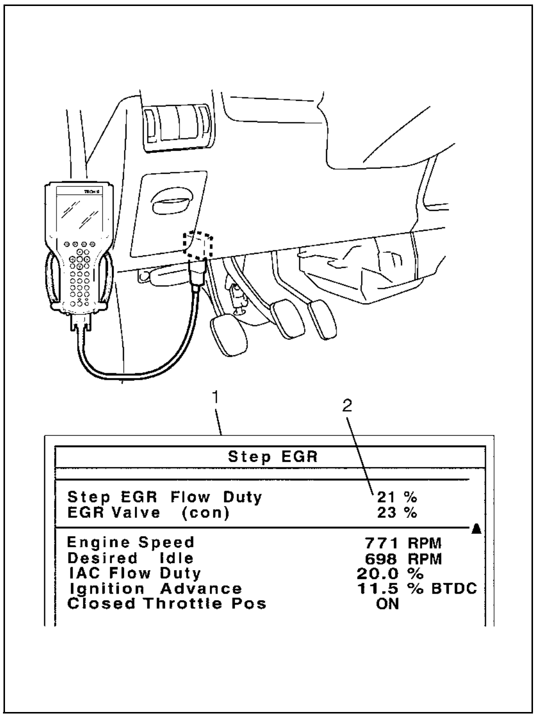
Intake air temperature sensor resistance

Temperature	Resistance
20°C (68°F)	2.33 – 2.97 kΩ
40°C (104°F)	1.08 – 1.47 kΩ
80°C (176°F)	0.309 – 0.432 kΩ

[A]:	Resistance
[B]:	Temperature
[C]:	Lower limit
[D]:	Nominal
[E]:	Upper limit
5.	Temperature gauge

Emission Control System

EGR system inspection



1) Connect Suzuki Scan Tool to data link connector (DLC) with ignition switch turn OFF.
2) Turn ON ignition switch and erase DTC using “CLEAR DTC” in “TROUBLU CODES” menu.
3) Start engine and warm up it to normal operating temperature then select “DTATA LIST” mode on scan tool.
4) Make sure that vehicle condition is as following.
   - Vehicle speed = 0 km/h (0 KPH)
   - Engine speed ≤ 900 rpm
   - Engine coolant temp. ≥ 90°C, 164°F
5) With engine idling (without depressing accelerator pedal), open EGR valve 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.

1.	Suzuki Scan Tool display
2.	EGR valve opening (0: Close, 100: Full Open)

EGR valve removal and installation

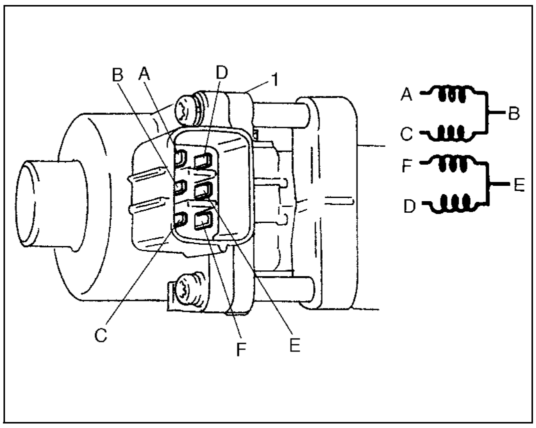
REMOVAL

1) Disconnect negative cable at battery.
2) Remove air intake pipe.
3) Remove EGR pipe.
4) Disconnect EGR valve connector.
5) Remove EGR valve and gasket from cylinder head.

INSTALLATION

Reverse removal procedure noting following.
- Clean mating surface of valve and cylinder head.
- Use new gaskets.

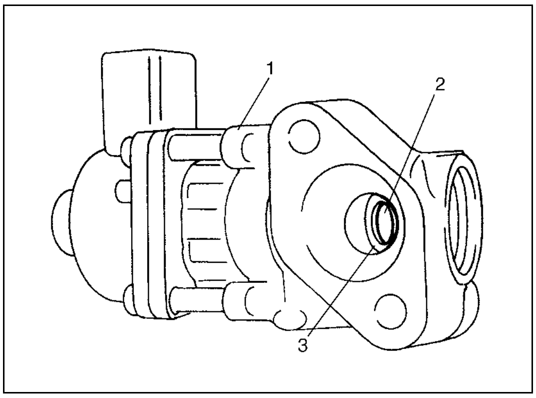
EGR valve inspection



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 gas passage.

NOTE:

Do not use any sharp–edged tool to remove carbon.
Be careful not to damage or bend EGR valve (1), valve seat (3) and rod.

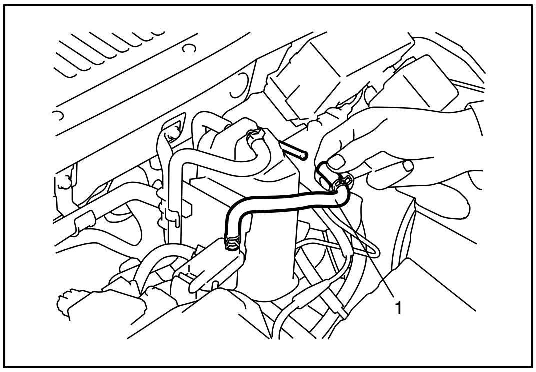
3) Inspect valve (2), valve seat and rod for fault, cracks, bend or other damage.
If found faulty, replace EGR valve assembly.

Evaporative emission control system inspection

EVAP CANISTER PURGE

NOTE:

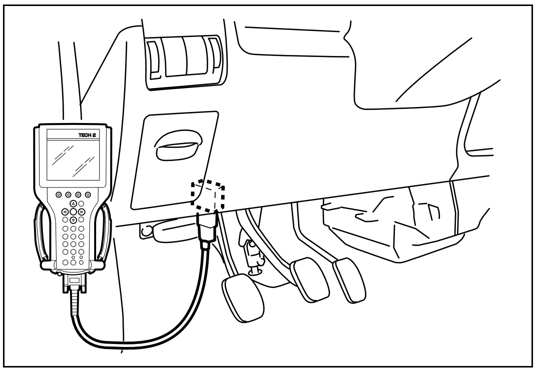
Before inspection, check to make sure that gear shift lever is in neutral position (with A/T model, selector lever in "P" range) and that parking brake lever is pulled all the way up.



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.
If check result is not satisfactory, check EVAP canister purge valve, wire harness and ECM.

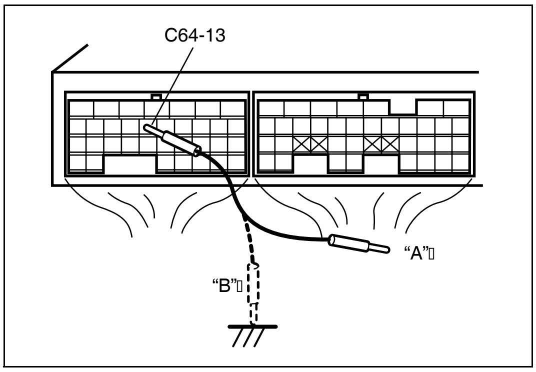
EVAP CANISTER PURGE VALVE and ITS CIRCUIT

1) Prepare to operate EVAP canister purge valve as follows.
   a) When using Suzuki Scan Tool:

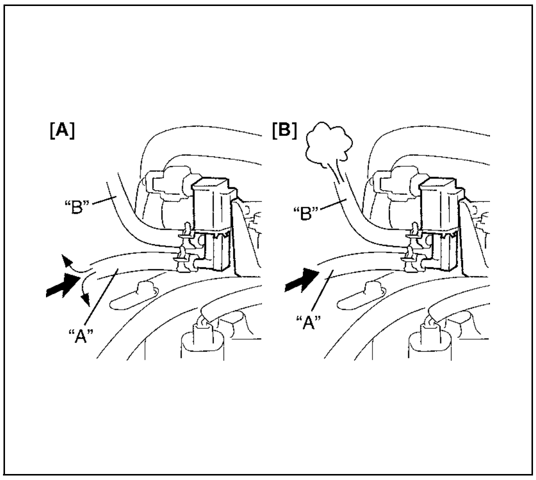


      i) Connect Suzuki Scan Tool to DLC with ignition switch OFF and disconnect purge valve vacuum hoses from intake manifold and purge valve chamber.
      ii) Turn ON ignition switch, clear DTC and select "MISC TEST" mode on Suzuki Scan Tool.

   b) When not using Suzuki Scan Tool:
      i) Disconnect purge valve vacuum hoses from intake manifold and purge valve chamber.



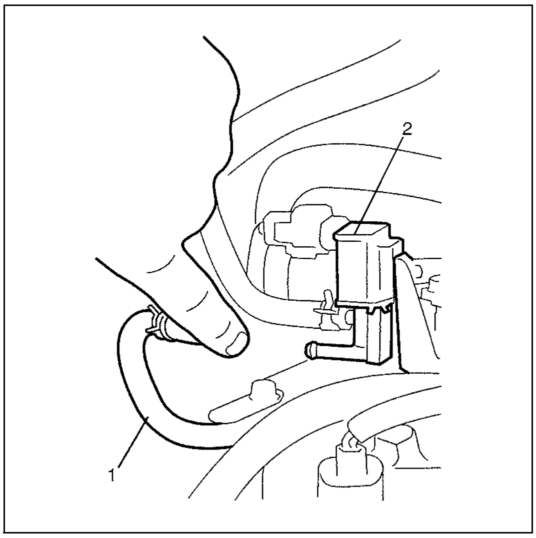
ii) Turn ON ignition switch.
Using service wire, ground C64-13 terminal of ECM connector (valve ON) "B" and unground it (valve OFF) "A".



2) Check purge valve for operation and vacuum passage for clog when valve is switched ON and OFF by using Suzuki Scan Tool or service wire.
If check result is not described, check vacuum hoses, EVAP canister purge valve, wire harness and connections.

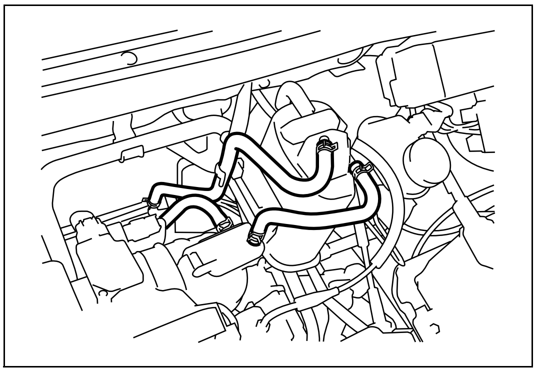
EVAP canister purge valve specification
[A] Valve OFF:
When blowing into hose "A", air should not come out of hose "B".
[B] Valve ON:
When blowing into hose "A", air should come out of hose "B".

VACUUM PASSAGE



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.

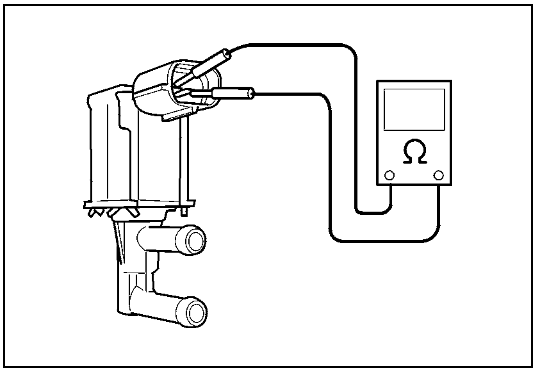
VACUUM HOSE



Check hoses for connection, leakage, clog and deterioration. Replace as necessary.

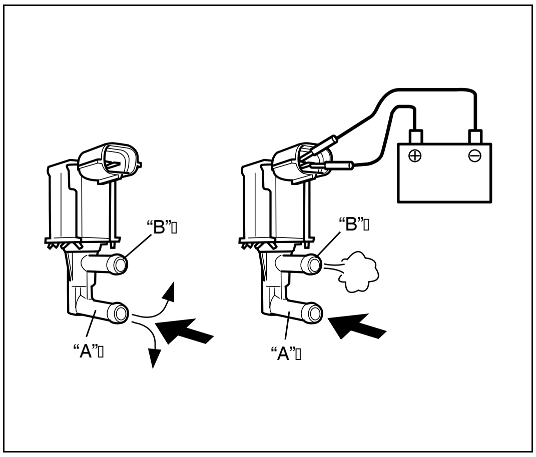
EVAP CANISTER PURGE VALVE

1) With ignition switch OFF, disconnect coupler from canister purge valve.
2) Remove EVAP canister purge valve from air cleaner assembly.



3) Check resistance between two terminals of EVAP canister purge valve.
   If resistance is not as specified, replace.

EVAP canister resistance
30 – 34 Ω at 20°C (68°F)



4) With coupler disconnected, blow into pipe "A". Air should not come out of pipe "B".
5) Connect 12 V-battery to EVAP canister purge valve terminals. In this state, blow pipe "A". Air should come out of pipe "B".
   If check result is not described, replace EVAP canister purge valve.

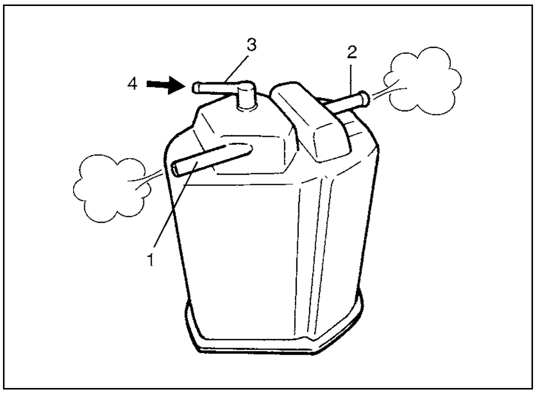
> **WARNING:**
> **Do not suck the air through valve. Fuel vapor inside valve in harmful.**

6) Install EVAP canister purge valve to air cleaner assembly.

EVAP CANISTER

> **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 inspection

NOTE:

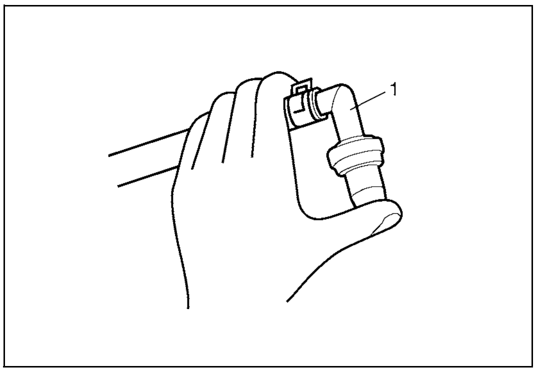
Be sure to check that there is no obstruction in PCV valve or its hoses before checking IAC duty, for obstructed PCV valve or hose hampers its accurate adjustment.

PCV HOSE

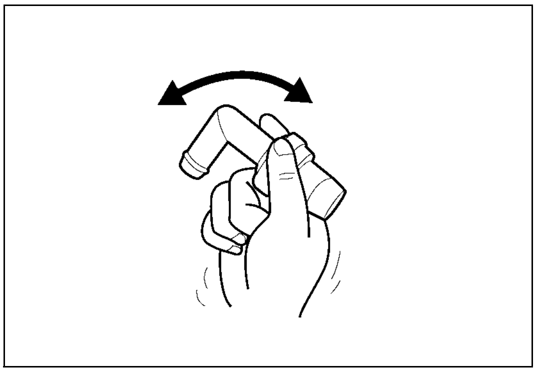
Check hoses for connection, leakage, clog and deterioration.
Replace as necessary.

PCV VALVE

1) Detach air cleaner assembly.
2) Disconnect PCV valve from cylinder head cover and install plug to head cover hole.
3) Install air cleaner assembly temporarily.
4) Run engine at idle.

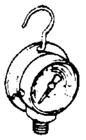
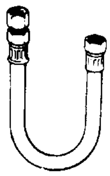
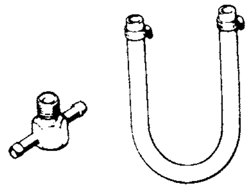
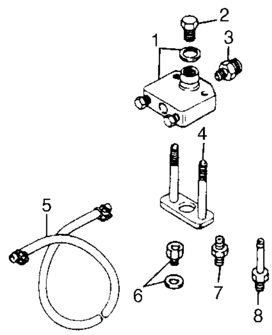
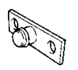
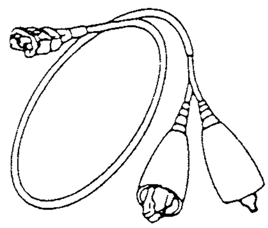


5) Place your finger over end of PCV valve (1) to check for vacuum.
   If there is no vacuum, check for clogged valve. Replace as necessary.



6) After checking vacuum, stop engine and remove PCV valve. Shake valve and listen for the rattle of check needle inside the valve. If valve does not the rattle, replace valve.
7) After checking, remove plug and install PCV valve.
8) Install air cleaner assembly securely.

Special Tool

 09912-58442 Pressure gauge	 09912-58432 Pressure hose	 09912-58490 3-way joint & hose	 09912-58421 Checking tool set (See NOTE "A".)
 09912-57610 Checking tool plate	 09930-88530 Injector test lead	 Tech 2 kit (Suzuki Scan Tool) (See NOTE "B".)	

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.**
  1. Tech 2, 2. PCMCIA card, 3. DLC cable, 4. SAE 16/19 adaptor, 5. Cigarette cable, 6. DLC loopback adaptor, 7. Battery power cable, 8. RS232 cable, 9. RS232 adaptor, 10. RS 232 loopback connector, 11. Storage case, 12. Power supply

Tightening Torque Specification

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	45	4.5	32.5
Camshaft position sensor	10	1.0	7.5
Knock sensor	22	2.2	16.0
Oil control valve mounting nut	11	1.1	8.0
Oil gallery pipe No.1 bolt	30	3.0	21.5
Delivery pipe bolt	25	2.5	18.0
MAF and IAT sensor screw	2.5	0.25	1.8

SECTION 6F1

IGNITION SYSTEM (ELECTRONIC IGNITION SYSTEM)

WARNING:

For vehicles equipped with a 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 “System Components and Wiring Location View” under “General Description” in Section 10B 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 Section 10B 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

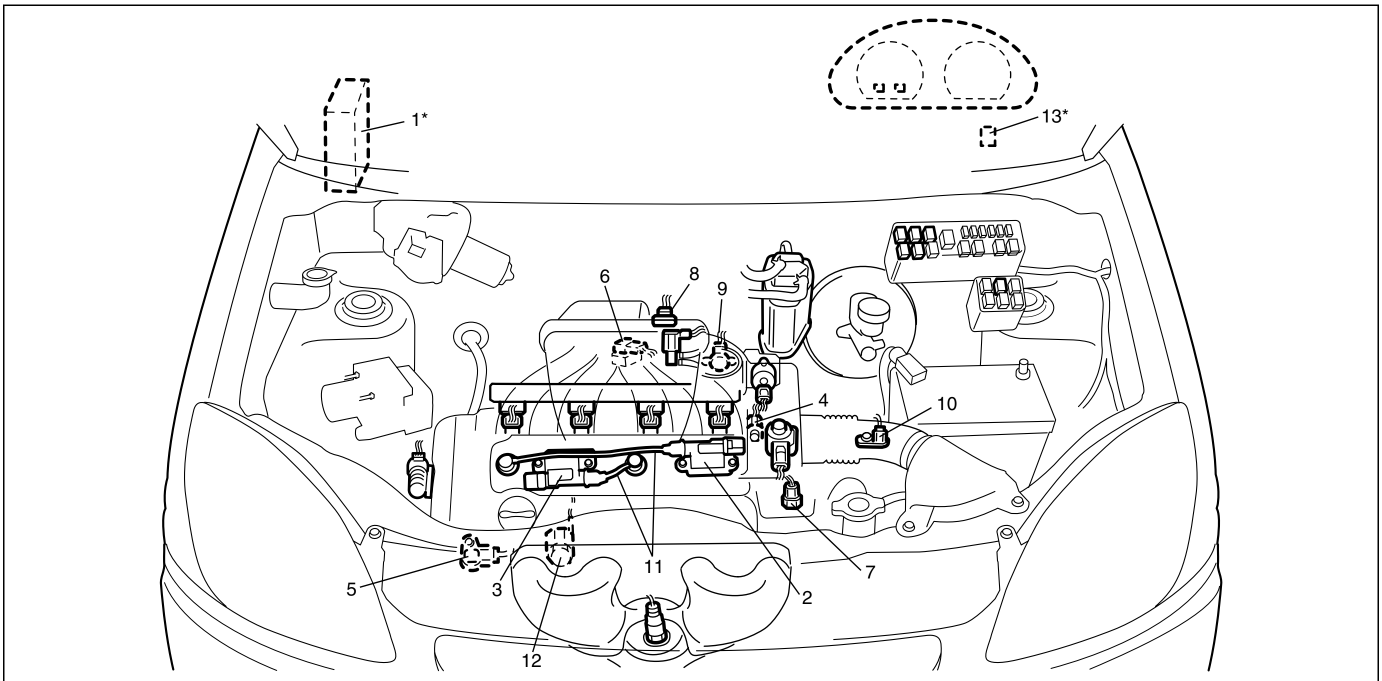
Ignition System Construction

The ignition system is an electronic (distributorless) ignition system. Its consists of the parts as described below.

- 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 igniter)
  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 adjusts initial ignition timing automatically.
- TP sensor, ECT sensor, MAP sensor and other sensors/switches
  Refer to “Electronic Control System Description” in Section 6E1 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.

Ignition System Components Locator Diagram

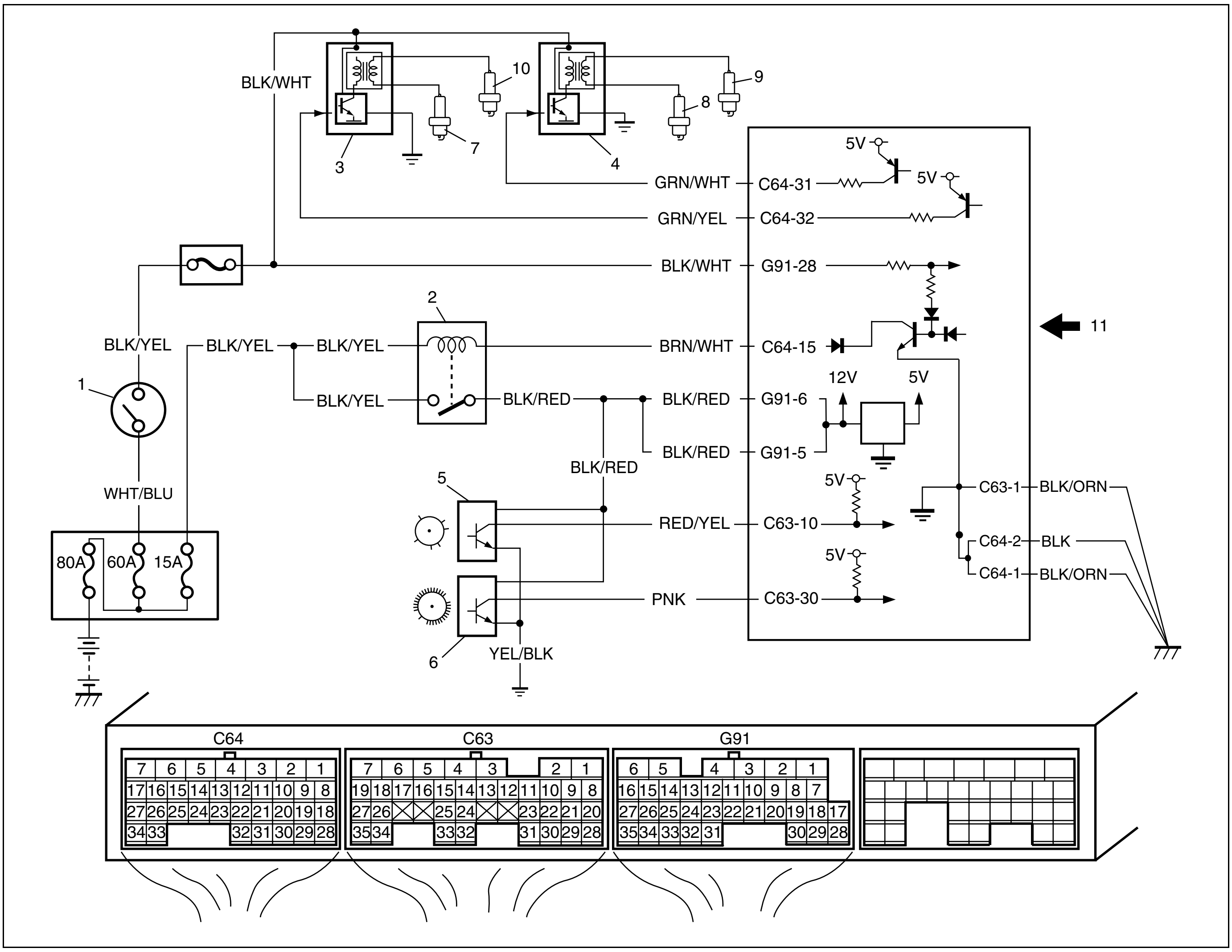


1. ECM	4. CMP sensor	7. ECT sensor	10. VSS	13. Data link connector
2. Ignition coil assembly for No.1 and No.4 spark plugs	5. CKP sensor	8. MAF and IAT sensor	11. High-tension cords	
3. Ignition coil assembly for No.2 and No.3 spark plugs	6. MAP sensor	9. TP sensor	12. Knock sensor	

NOTE:

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

Ignition System Wiring Circuit Diagram



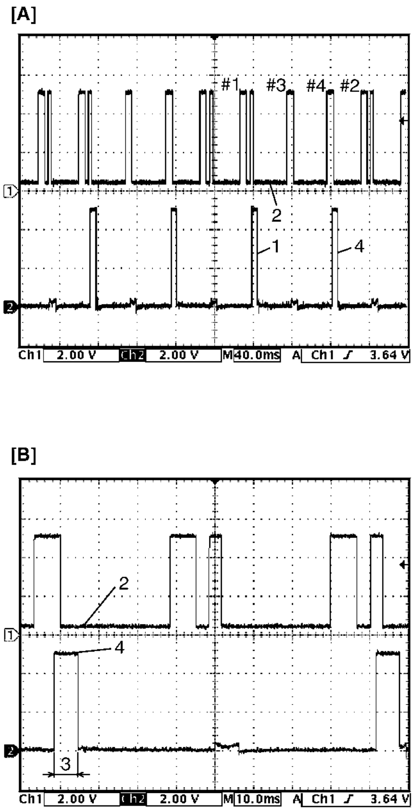
1.	Ignition switch	7.	No.1 spark plug
2.	Main relay	8.	No.2 spark plug
3.	Ignition coil assembly for No.1 and No.4 spark plugs	9.	No.3 spark plug
4.	Ignition coil assembly for No.2 and No.3 spark plugs	10.	No.4 spark plug
5.	CMP sensor	11.	Sensed information (MAP sensor, ECT sensor, MAF and IAT sensor, TP sensor, Knock sensor, VSS, Electric load signal, Engine start signal)
6.	CKP sensor		

Diagnosis

Ignition System Symptom 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 CMP sensor or sensor rotor tooth of camshaft	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 CMP sensor or sensor rotor tooth of camshaft	Clean, tighten or replace.
	Faulty ECM	Replace.

Reference Waveform



Oscilloscope waveforms of CMP sensor and No.1/No.4 ignition trigger signal are as shown in figure when connecting oscilloscope between terminals C63-10 of ECM connectors connected to ECM and ground, and between terminal C64-32 and ground.

Measurement condition for waveform [A]

Measurement terminal	**CH1: C63-10 to C64-1** **CH2: C64-32 to C64-1**
Oscilloscope setting	**CH1: 2 V/DIV, CH2: 2 V/DIV** **TIME: 40 ms/DIV**
Measurement condition	**After warmed up engine to normal operating temperature** **Engine at specified idle speed**

Measurement condition for waveform [B]

Measurement terminal	**CH1: C63-10 to C64-1** **CH2: C64-32 to C64-1**
Oscilloscope setting	**CH1: 2 V/DIV, CH2: 2 V/DIV** **TIME: 10 ms/DIV**
Measurement condition	**After warmed up engine to normal operating temperature** **Engine at specified idle speed**

[A]:	Oscilloscope waveforms at specified idle speed
[B]:	Detail waveforms at specified idle speed
1.	No.1 ignition trigger signal
2.	CMP sensor signal
3.	Primary coil current flow time
4.	No.4 ignition trigger signal

Ignition System Diagnostic Flow Table

Step	Action	Yes	No
1	Was “Engine and Emission Control System Check” in Section 6 performed?	Go to Step 2.	Go to “Engine and Emission Control System Check” in Section 6.
2	Ignition Spark Test 1) Check all spark plugs for condition and type referring to “Spark Plugs Inspection” in this section. 2) If OK, perform ignition spark test, referring to “Ignition Spark Test” in this 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 Table” in Section 6.	Go to Step 4.

Step	Action	Yes	No
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 Inspection” in this 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 (Including Ignitor) Inspection” in this 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, 7 and 8 of “DTC P0335 Crankshaft Position (CKP) Sensor Circuit” 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 Inspection” in this section. Is check result satisfactory?	System is in good condition.	Check CMP sensor, CMP sensor rotor tooth of camshaft, CKP sensor, CKP sensor plate and/or input signals related to this system.

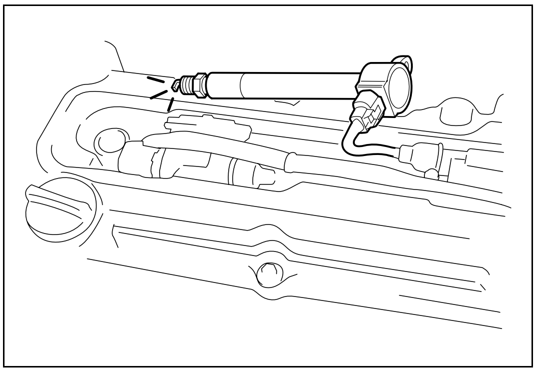
On-Vehicle Service

Ignition Spark Test

1) Remove air cleaner assembly with air intake pipe.
2) Disconnect all injector couplers 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.**

3) Remove spark plug and check it for condition and type referring to “Spark Plugs Removal and Installation” in this section.

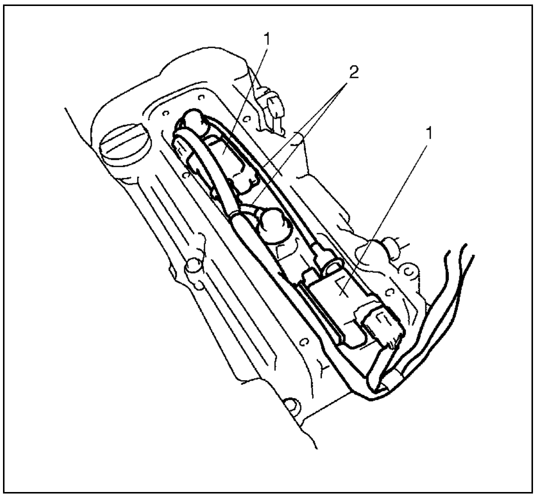


4) If OK, connect ignition coil coupler to ignition coil assembly and connect spark plug to ignition coil assembly or high-tension cord. Ground spark plug.
5) Crank engine and check if each spark plug sparks.
6) If no spark is emitted, inspect the related parts as described under “Ignition System Symptom Diagnosis” in this section.

High-Tension Cords Removal and Installation

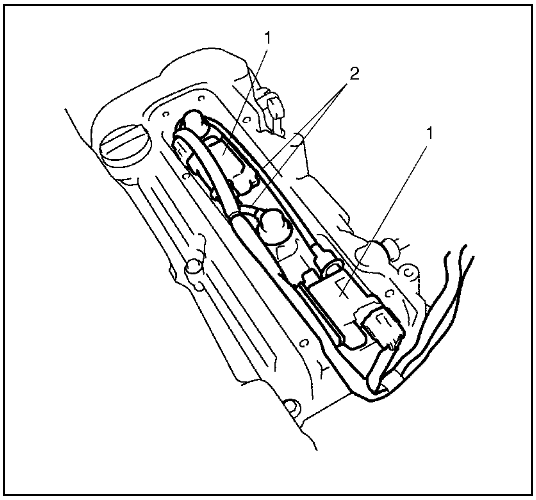
REMOVAL

1) Remove air cleaner assembly with air intake pipe and cylinder head upper cover.



2) Disconnect high-tension cords (2) from ignition coil assemblies (1) while gripping each cap.
3) 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.**



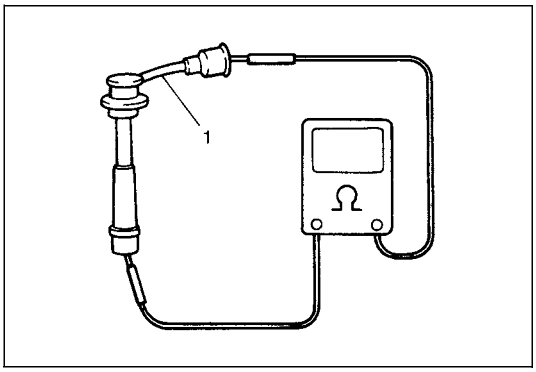
INSTALLATION

1) 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.**

2) Install cylinder head upper cover and air cleaner assembly with air intake pipe.

High-Tension Cords Inspection



Measure resistance of high-tension cord (1) by using ohmmeter. If resistance exceeds specification, replace high-tension cord(s).

No.1 high-tension cord resistance
1.4 – 4.0 kΩ

No.3 high-tension cord resistance
0.6 – 2.0 kΩ

Spark Plugs Removal and Installation

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**
- **Do not clean or adjust gap for the iridium/platinum spark plugs.**

REMOVAL

1) Remove air cleaner assembly with air intake pipe and cylinder head upper cover.
2) Pull out high-tension cords by gripping their caps and then remove ignition coil assemblies referring to “Ignition Coil Assembly (Including Ignitor) Removal and Installation” in this section.
3) Remove spark plugs.

INSTALLATION

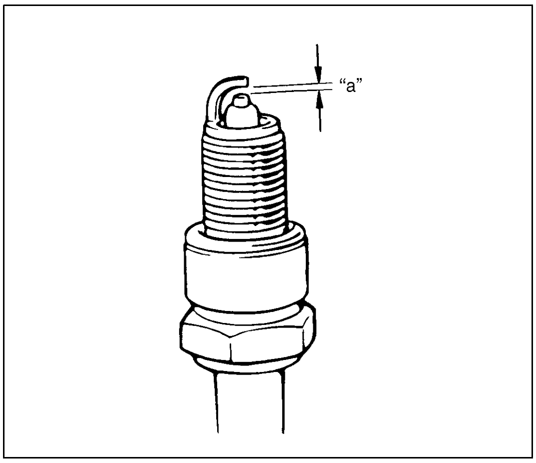
1) Install spark plugs and torque them to specification.

Tightening torque
Spark plug: 25 N·m (2.5 kg-m, 18.0 lb-ft)

2) Install ignition coil assemblies referring to “Ignition Coil Assembly (Including Ignitor) Removal and Installation” in this section.
3) Install high-tension cords securely by gripping their caps.
4) Install cylinder head upper cover and air cleaner assembly with air intake pipe.

Spark Plugs Inspection

- Inspect them for:
  – Electrode wear
  – Carbon deposits
  – Insulator damage



- If any abnormality is found, for spark plug other than iridium/platinum, adjust air gap, clean with spark plug cleaner or replace them with specified new pugs.
  For iridium/platinum spark plugs, replace them with new plugs.

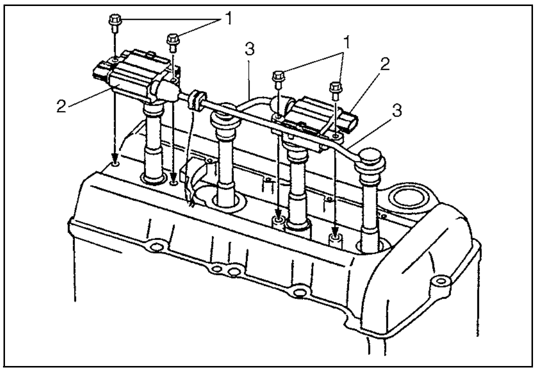
Spark plug air gap
“a”: 1.0 – 1.1 mm (0.040 – 0.043 in.)

Spark plug type
NGK: IFR6J11 (iridium/platinum spark plug)

Ignition Coil Assembly (Including Ignitor) Removal and Installation

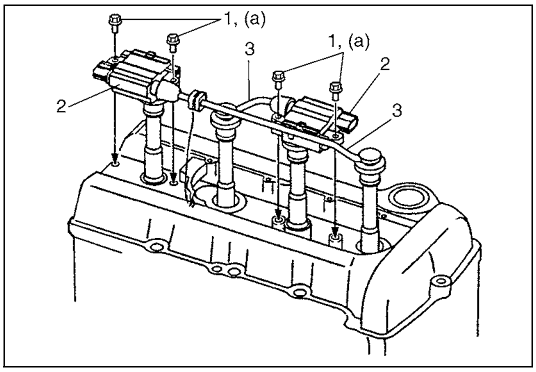
REMOVAL

1) Disconnect negative cable at battery.
2) Remove air cleaner assembly with air intake pipe and cylinder head upper cover.
3) Disconnect ignition coil coupler.



4) Disconnect high-tension cord (3) from ignition coil assembly (2).
5) Remove ignition coil bolts (1) and then pull out ignition coil assembly.

INSTALLATION

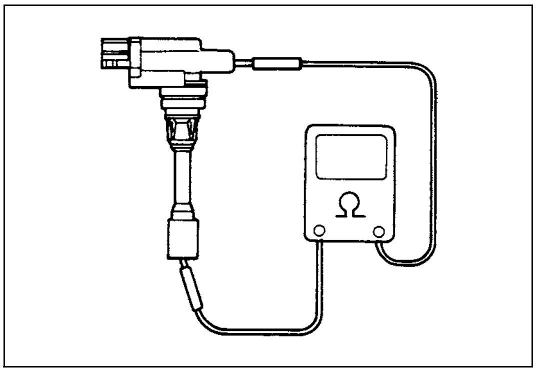


1) Install ignition coil assembly (2).
2) Tighten ignition coil bolts (1) to specified torque, and then connect ignition coil coupler.

Tightening torque
Ignition coil bolt (a): 10 N·m (1.0 kg-m, 7.5 lb-ft)

3) Install high-tension cord (3) to ignition coil assembly while gripping its cap.
4) Install cylinder head upper cover and air cleaner assembly with air intake pipe.
5) Connect negative cable to battery.

Ignition Coil Assembly (Including Ignitor) Inspection



Measure secondary coil for resistance.
If resistance is out of specification, replace ignition coil assembly.

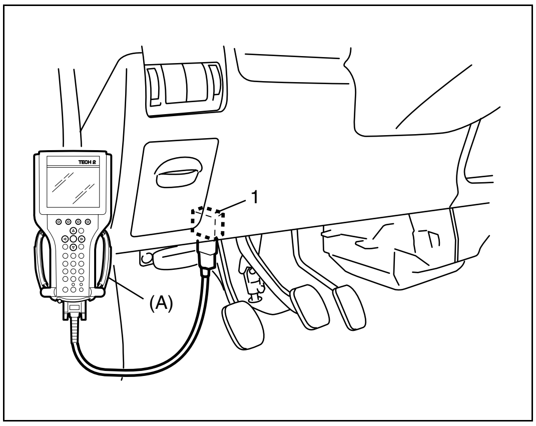
Secondary coil resistance
7.1 – 9.5 kΩ at 20°C, 68°F

Crankshaft Position (CKP) Sensor

Refer to “Crankshaft position sensor (CMP sensor) removal and installation” and “Crankshaft position sensor (CKP sensor) inspection” in Section 6E1 for removal, inspection and installation.

Ignition Timing Inspection

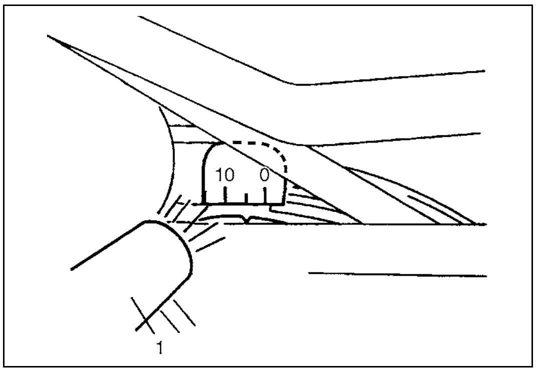
NOTE:
- **Ignition timing is not adjustable. If ignition timing is out of specification, check system related parts.**
- **Before starting engine, place transmission gear shift lever in “Neutral” (shift selector lever to “P” range for A/T model), and set parking brake.**



1) Connect scan tool to DLC (1) 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 referring to “Idle speed/idle air control (IAC) duty inspection” in Section 6E1.
5) Fix ignition timing by using “Fixed Spark” of “Misc Test” mode on scan tool.



6) Set timing light (1) to high-tension cord for No.1 cylinder and check that ignition timing is within specification.

   Initial ignition timing (fixed with 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
   - CMP sensor
   - CMP sensor rotor tooth of camshaft
   - VSS
   - Timing chain cover installation

8) After checking Initial Ignition Timing, release ignition timing fixation by using scan tool.
9) With engine idling (throttle opening at closed position and car stopped), check that ignition timing is about 3° – 13° BTDC. (Constant variation within a few degrees from 3° – 13° 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 and ECM.

Tightening Torque Specification

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
Spark plug	25	2.5	18.0
Ignition coil bolt	10	1.0	7.5

Special Tool

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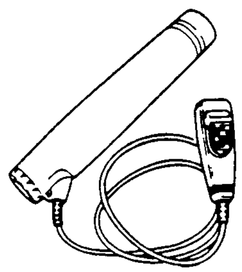
<td>

09930-76420
Timing light (Dry cell type)
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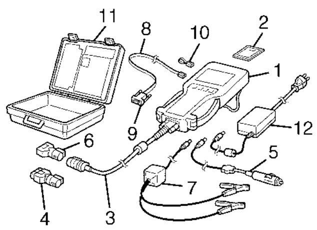

Tech 2 kit (Suzuki Scan Tool) (See NOTE.)
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</table>

NOTE:
This kit includes the following items.
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 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 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).**

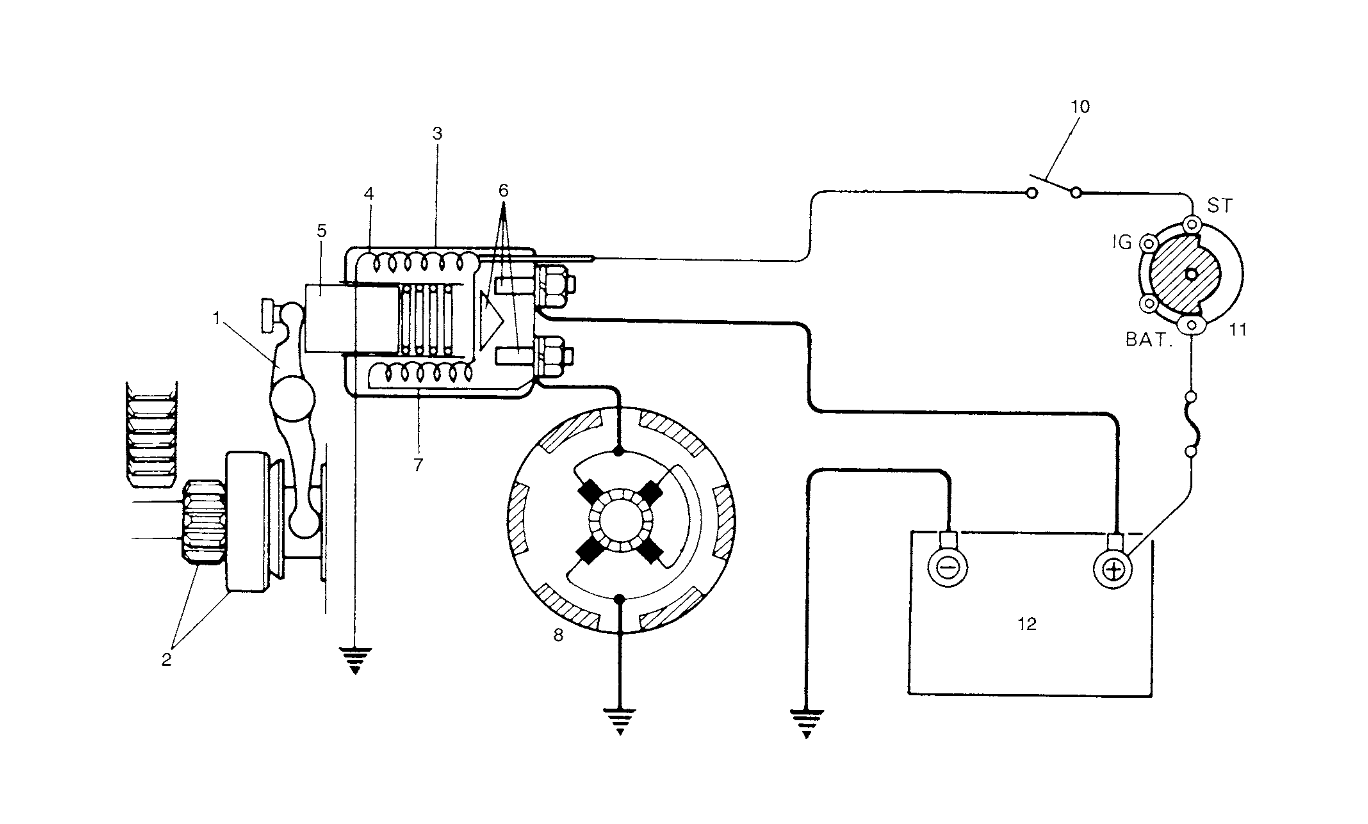
NOTE:

Starting motor varies depending on specifications, etc. Therefore, be sure to check model and specification of the vehicle being serviced before replacing parts.

CONTENTS

General Description

Cranking System Circuit Diagram



1. Pinion drive lever	5. Plunger	9. Blank
2. Pinion & Over-running clutch	6. Magnetic switch contacts	10. A/T: Transmission range switch (shift lever switch)
3. Magnetic switch	7. Pull-in coil	11. Ignition & Starter switch
4. Hold-in coil	8. Starting motor	12. Battery

Diagnosis

Cranking System Symptom Diagnosis

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

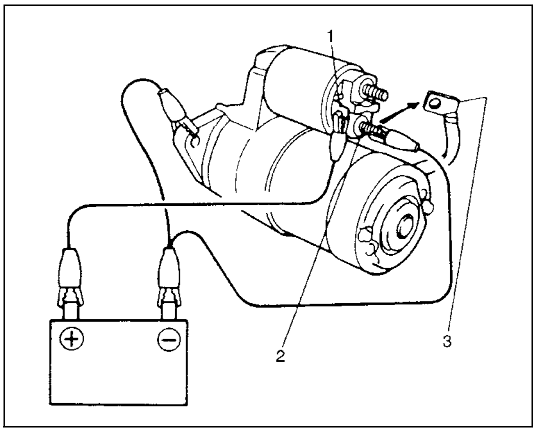
Condition	Possible Cause	Correction
Motor not running (No operating sound of magnetic switch)	Shift lever switch is not in P or N, or not adjusted (A/T)	Shift in P or N, or adjust switch.
	Battery run down	Recharge battery.
	Battery voltage too low due to battery deterioration	Replace battery.
	Poor 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.
Noise	Abnormally worn bush	Replace bush.
	Worn pinion or worn teeth of ring gear	Replace pinion or flywheel.
	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.
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.

Cranking System Test

CAUTION:

Each test must be performed within 3 – 5 seconds to avoid coil from burning.

Pull-in test



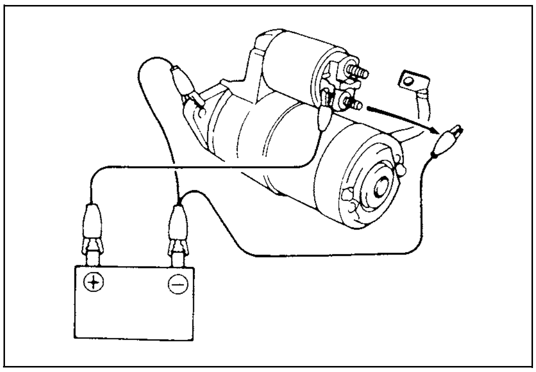
Connect battery to magnetic switch as shown.
Check that plunger and pinion move outward.
If plunger and pinion don't move, replace magnetic switch.

NOTE:

Before testing, disconnect lead wire from terminal M.

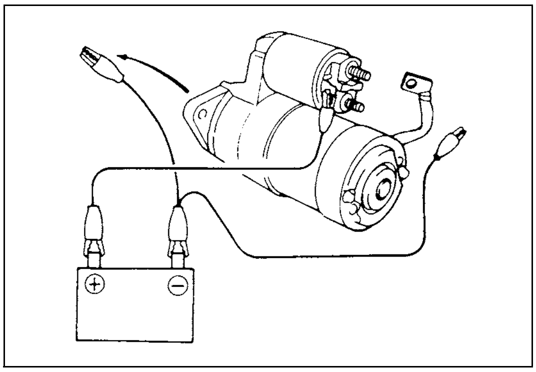
1.	Terminal "S"
2.	Terminal "M"
3.	Lead wire (switch to motor)

Hold-in test



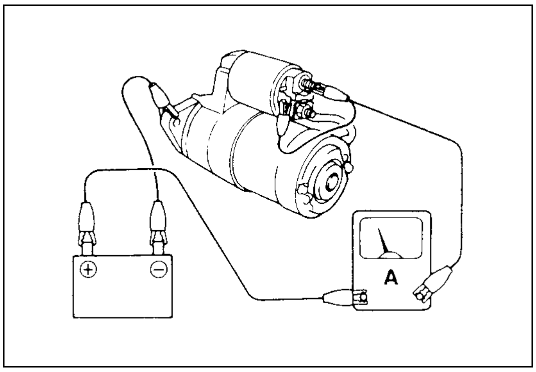
While connected as above with plunger out, disconnect negative lead from terminal "M".
Check that plunger and pinion remain out.
If plunger and pinion return inward, replace magnetic switch.

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

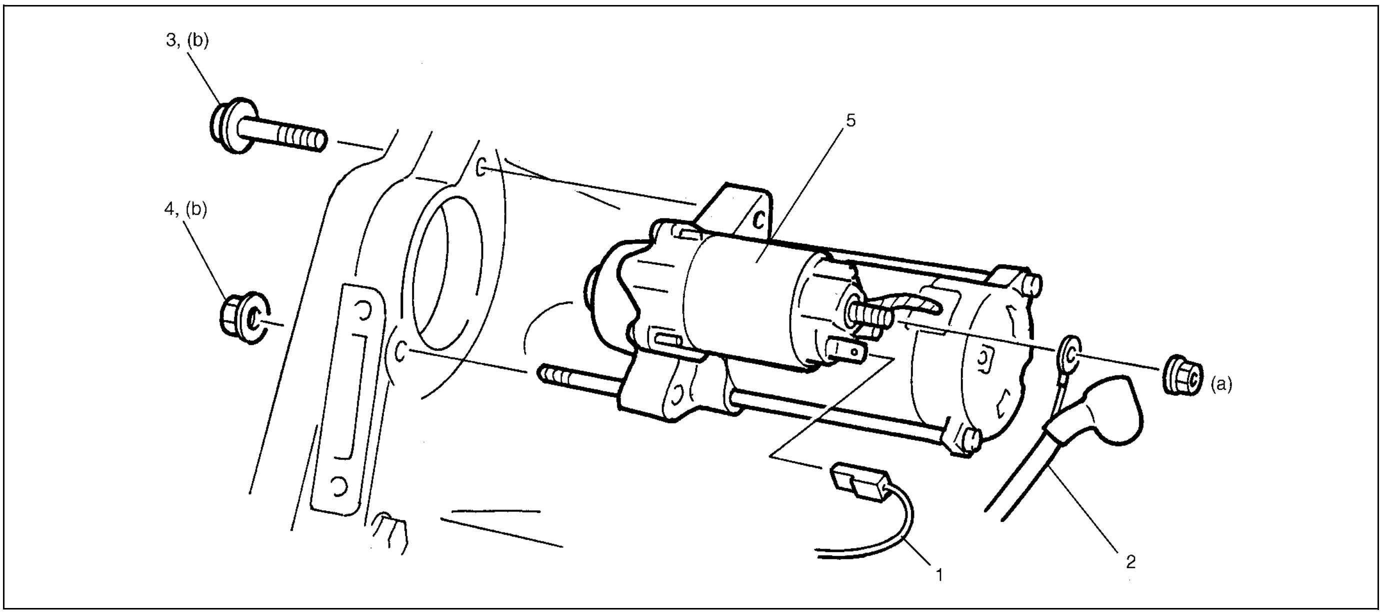


Connect battery and ammeter to starter as shown.
Check that starter rotates smoothly and steadily with pinion moving out. Check that ammeter indicates specified current.

Specified current (No-load performance test)
0.8 kW TYPE: 53 A MAX. at 11.5 V
1.2 kW TYPE: 90 A MAX. at 11 V

ON-Vehicle Service

Starting Motor Dismounting and Remounting



Dismounting

1) Disconnect negative (–) battery lead at battery.
2) Disconnect magnetic switch lead wire (1) and battery cable (2) from starting motor terminals.
3) Remove starting motor mount bolt (3) and nut (4).
4) Remove starting motor (5).

Remounting

Reverse the dismounting procedure.

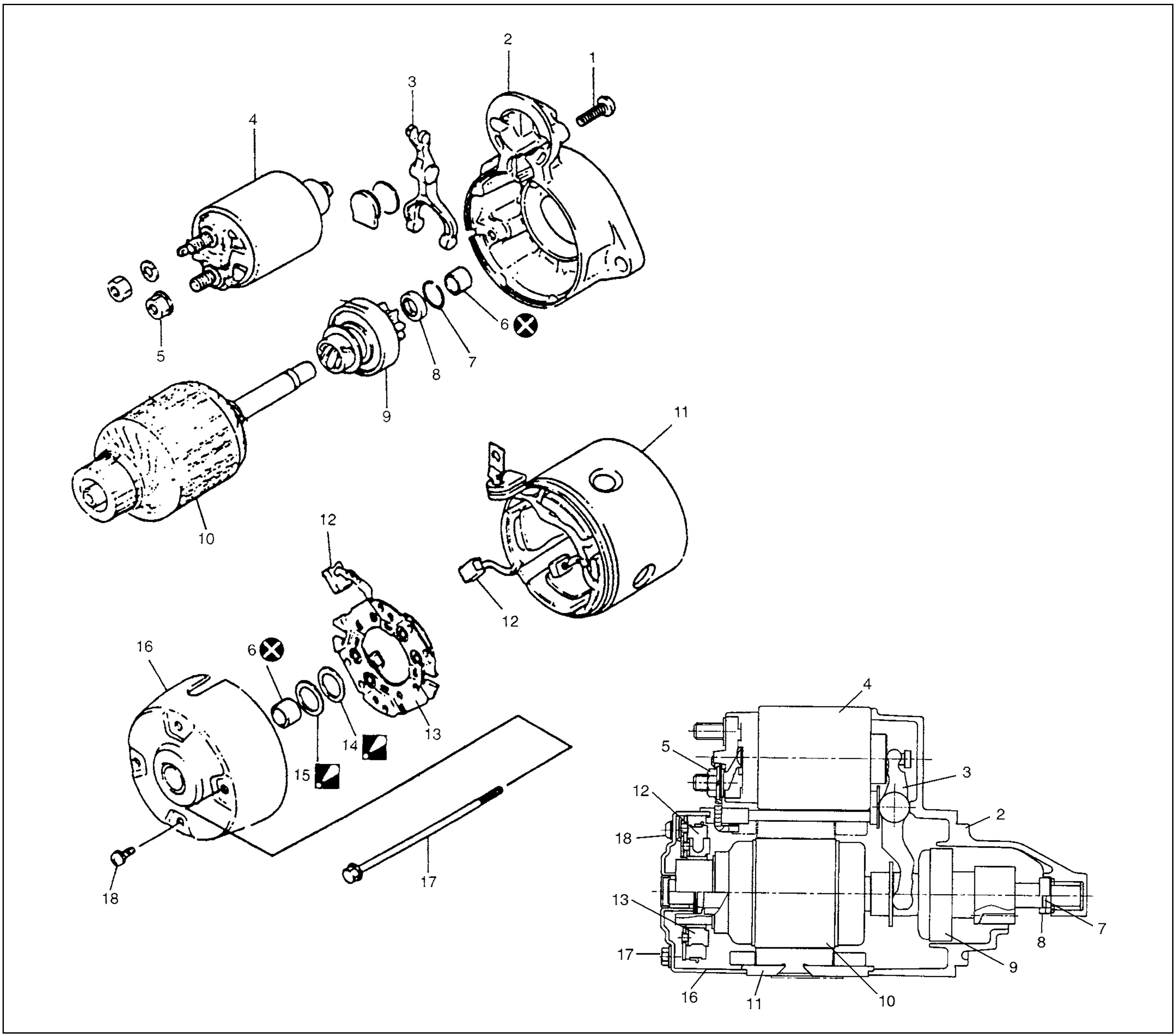
Tightening torque
Starting motor battery cable nut (a): 10 N·m (1.0 kg-m, 7.5 lb-ft)
Starting motor mount bolt and nut (b): 45 N·m (4.5 kg-m, 32.5 lb-ft)

Starting Motor Disassembly and Reassembly

0.8 kW TYPE

NOTE:

Apply grease (99500-25010) to sliding surface of each below part.

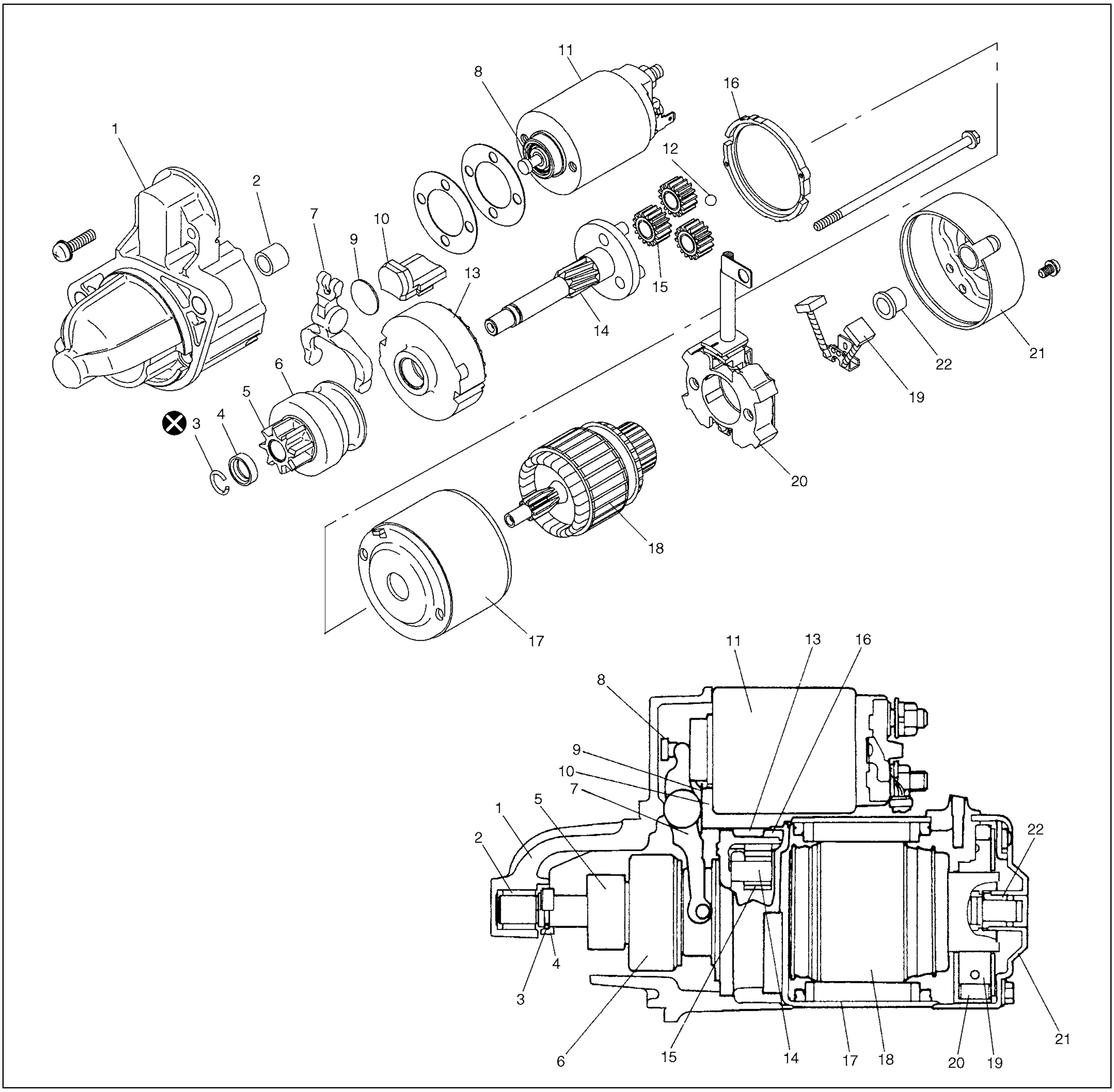


1. Magnetic switch mounting screw	8. Stop ring	15. Armature shaft washer : Thickness 0.5 mm (0.02 in.)
2. Front housing	9. Over-running clutch	16. Rear bracket
3. Pinion driver lever	10. Armature	17. Rear bracket bolt
4. Magnetic switch	11. Starting motor yoke	18. Rear bracket screw
5. Field coil lead nut	12. Brush	Do not reuse.
6. Armature shaft bush	13. Brush holder	
7. Snap ring	14. Armature shaft washer : Thickness 1.8 mm (0.07 in.)	

1.2 kW TYPE

NOTE:

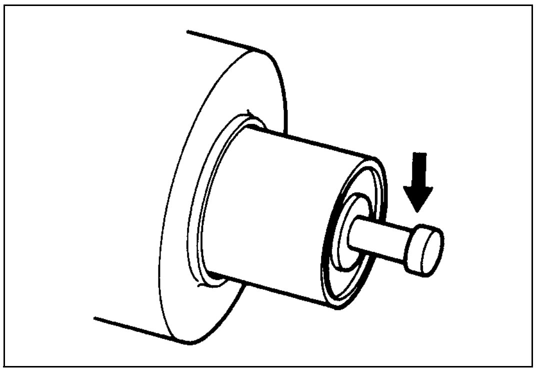
Apply grease (99500-25010) to sliding surface of each below part.



1.	Front housing	7.	Lever	13.	Internal gear	19.	Brush
2.	Bush	8.	Plunger	14.	Planetary carrier shaft	20.	Brush holder
3.	Snap ring	9.	Plate	15.	Planetary gear	21.	Rear bracket
4.	Pinion stop ring	10.	Seal rubber	16.	Packing	22.	Rear bush
5.	Pinion gear	11.	Magnetic switch	17.	Yoke	⊗	Do not reuse.
6.	Over-running clutch	12.	Ball	18.	Armature		

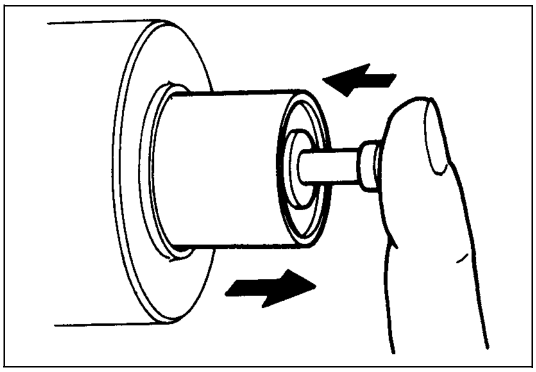
Starting Motor Inspection

PLUNGER



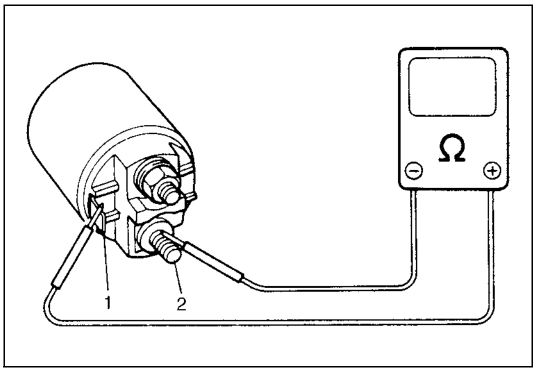
Inspect plunger for wear. Replace if necessary.

MAGNETIC SWITCH



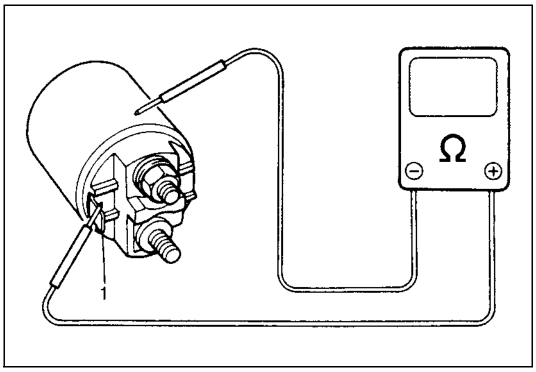
Push in plunger and release it. The plunger should return quickly to its original position. Replace if necessary.

Pull-in Coil Open Circuit Test



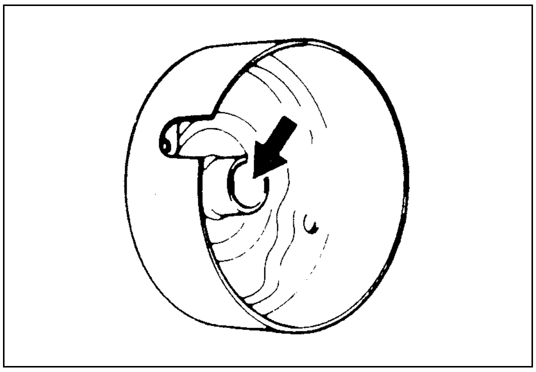
Check for continuity across magnetic switch ‘S’ terminal (1) and ‘M’ terminal (2). If no continuity, coil is open and should be replaced.

Hold-in Coil Open Circuit Test



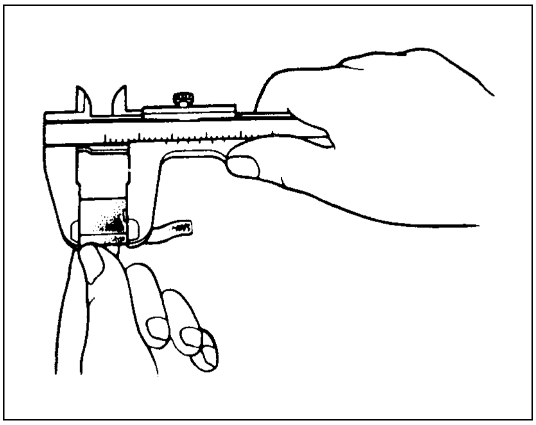
Check for continuity across magnetic switch ‘S’ terminal (1) and coil case. If no continuity, coil is open and should be replaced.

REAR BRACKET BUSH



Inspect bush for wear or damage. Replace if necessary.

BRUSH



- Check brushes for wear.
  Measure length of brushes and if below limit, replace brush.

Brush length

	0.8 kW	1.2 kW
Standard	17.0 mm (0.67 in.)	12.3 mm (0.48 in.)
Limit	11.5 mm (0.45 in.)	7.0 mm (0.28 in.)

- Install brushes to each brush holder and check for smooth movement.

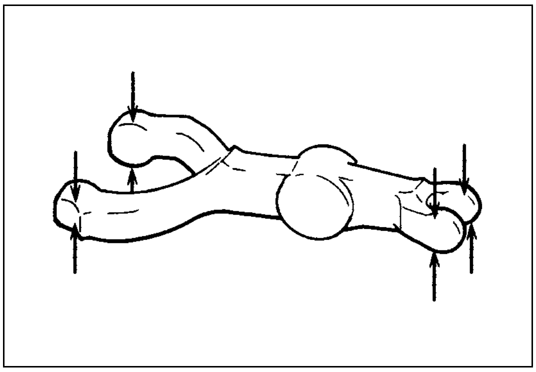
SPRING

Inspect brush springs for wear, damage or other abnormal conditions. Replace if necessary.

Brush spring tension

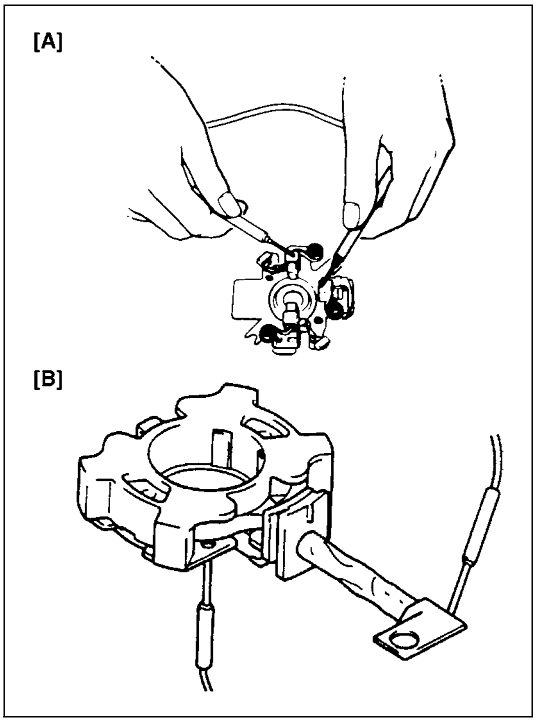
	0.8 kW	1.2 kW
Standard	1.95 kg (4.3 lb)	2.2 kg (4.85 lb)
Limit	0.9 kg (1.98 lb)	0.6 kg (1.32 lb)

DRIVE LEVER



Inspect drive lever for wear. Replace if necessary.

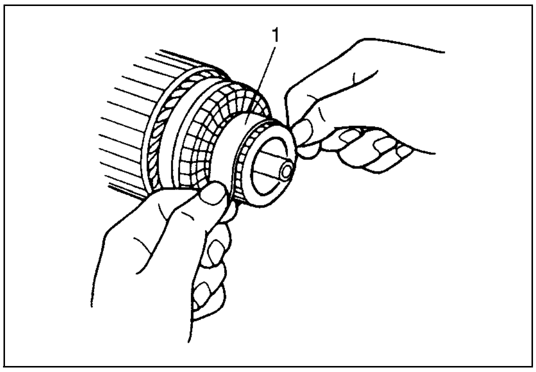
BRUSH HOLDER



- Check movement of brush in brush holder. If brush movement within brush holder is sluggish, check brush holder for distortion and sliding faces for contamination.
  Clean or correct as necessary.
- Check for continuity across insulated brush holder (positive side) and grounded brush holder (negative side).
  If continuity exists, brush holder is grounded due to defective insulation and should be replaced.

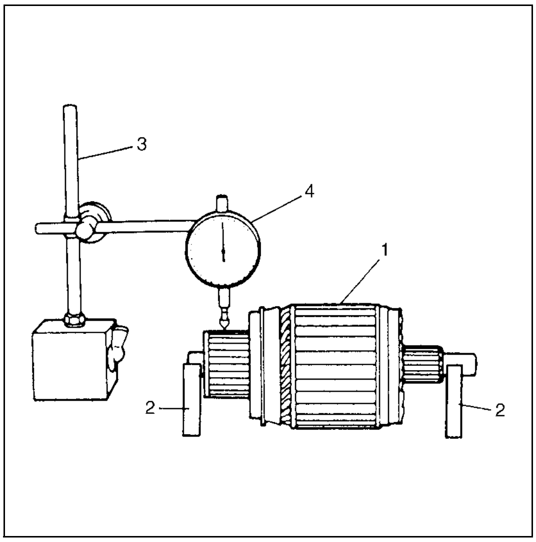
[A]:	0.8 kW
[B]:	1.2 kW

ARMATURE



- Inspect commutator for dirt or burn. Correct with sandpaper or lathe, if necessary.

1. Sandpaper of #300 – 400



- Check commutator for uneven wear with armature supported on V-blocks (2). If deflection of dial gauge (4) pointer exceeds limit, repair or replace.

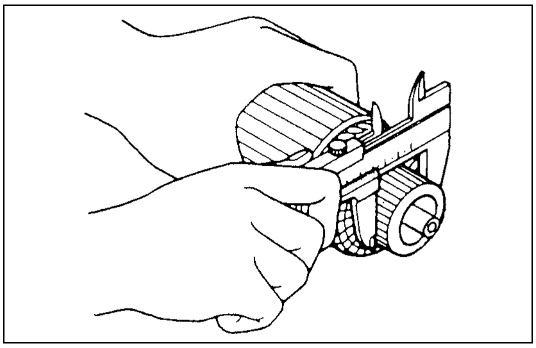
NOTE:

Below specification presupposes that armature is free from bend. Bent armature must be replaced.

Commutator out of round

	0.8 kW and 1.2 kW
Standard	0.05 mm (0.002 in.) or less
Limit	0.4 mm (0.015 in.)

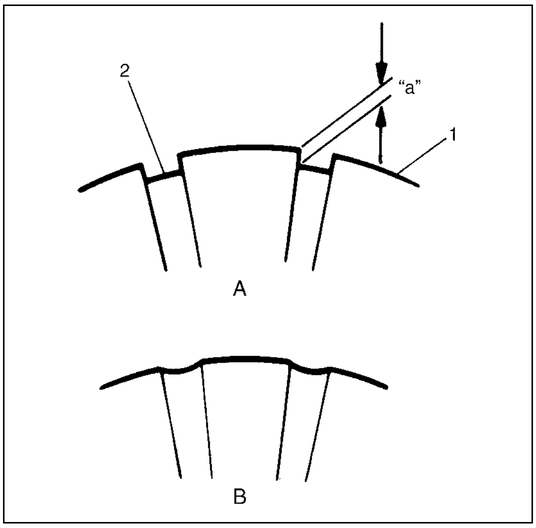
1. Armature
3. Magnetic stand



• Inspect commutator for wear. If diameter is below limit, replace armature.

Commutator outside diameter

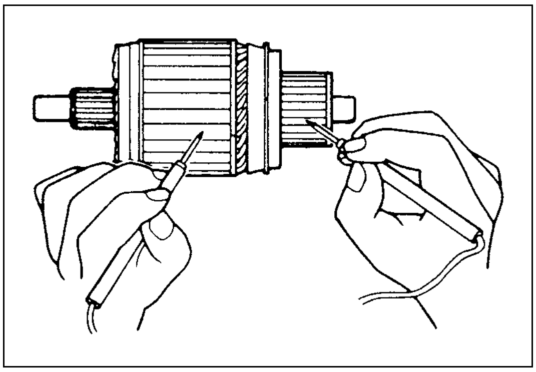
	0.8 kW	1.2 kW
Standard	32.0 mm (1.26 in.)	29.4 mm (1.16 in.)
Limit	31.4 mm (1.24 in.)	28.8 mm (1.13 in.)



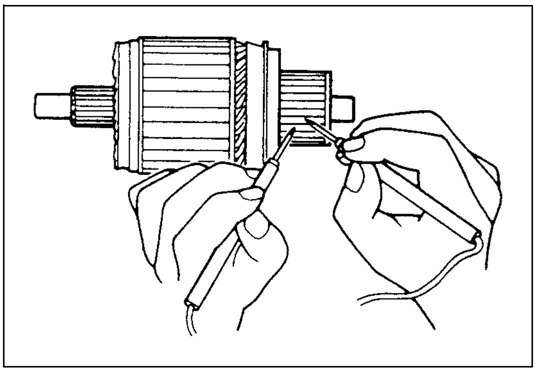
• Inspect commutator for insulator depth. Correct or replace if below limit.

Commutator insulator depth "a"
Standard: 0.4 – 0.6 mm (0.015 – 0.024 in.)
Limit: 0.2 mm (0.008 in.)

A:	Correct
B:	Incorrect
1.	Commutator segment
2.	Insulator



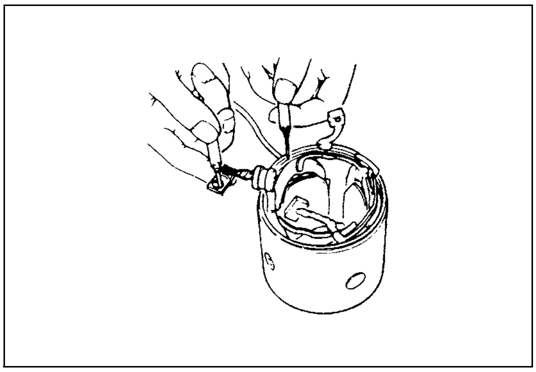
• Check commutator and armature core. If there is continuity, armature is grounded and must be replaced.



• Check for continuity between segments. If there is no continuity at any test point, there is an open circuit and armature must be replaced.

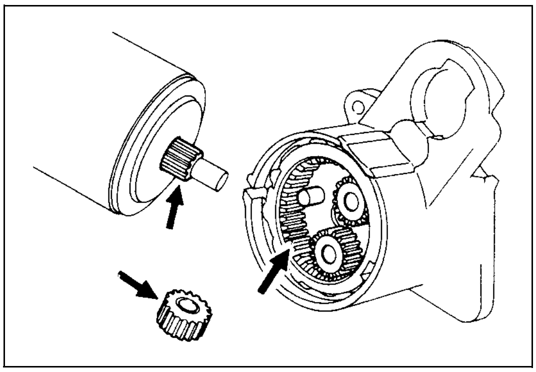
FIELD COIL (0.8 kW TYPE)

Ground Test



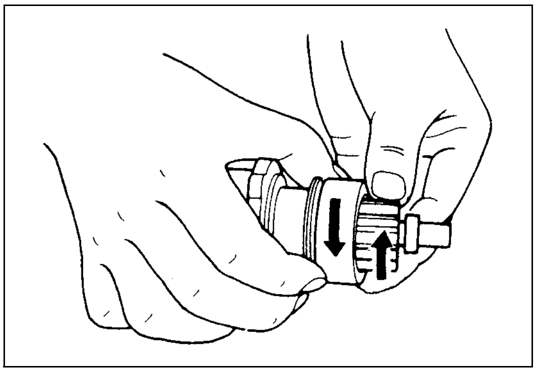
Check continuity between brush and bare surface.
If there is continuity, field windings are grounded.
The yoke assembly must be replaced.

GEARS (1.2 kW TYPE)

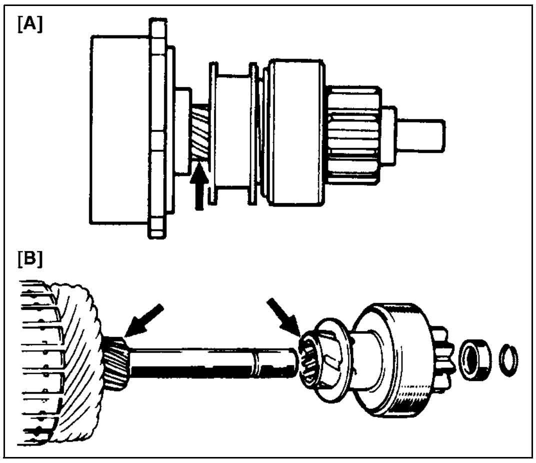


Inspect internal gear and planetary gears for wear, damage or other abnormal conditions. Replace if necessary.

PINION AND OVER-RUNNING CLUTCH

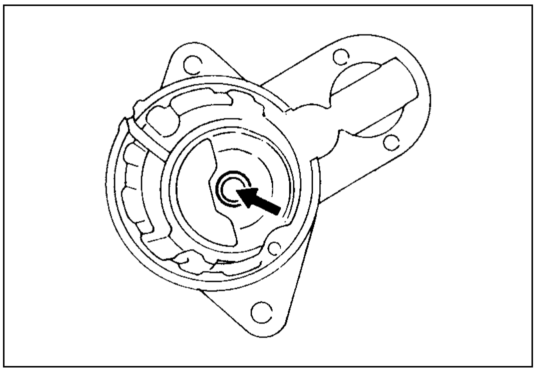


- Inspect pinion for wear, damage or other abnormal conditions.
  Check that clutch locks up when turned in direction of drive and rotates smoothly in reverse direction. Replace if necessary.



- Inspect spline teeth for wear or damage. Replace if necessary.
  Inspect pinion for smooth movement.

[A]:	1.2 kW
[B]:	0.8 kW



FRONT HOUSING NEEDLE BEARING OR BUSH

Inspect bush for wear or damage. Replace if necessary.

Specification

0.8 kW type

<table>
<tr><td colspan="3">Voltage</td><td colspan="2">12 volts</td></tr>
<tr><td colspan="3">Output</td><td colspan="2">0.8 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>Standard: 17.0 mm (0.67 in.)</td><td>Limit: 11.5 mm (0.45 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="4">Around at 20°C (68°F)</td><td>No load characteristic</td><td>11.5 V</td><td colspan="2">53 A maximum
6,000 rpm minimum</td></tr>
<tr><td>Load characteristic</td><td>9 V
150 A</td><td colspan="2">2.8 N·m (0.28 kg-m, 2.0 lb-ft) minimum
2,000 rpm minimum</td></tr>
<tr><td>Locked characteristic</td><td>5 V</td><td colspan="2">360 A maximum
6.86 N·m (0.7 kg-m, 5.1 lb-ft) minimum</td></tr>
<tr><td colspan="2">Magnetic switch operating voltage</td><td colspan="2">8 volts maximum</td></tr>
</table>

1.2 kW type

<table>
<tr><td colspan="3">Voltage</td><td colspan="2">12 volts</td></tr>
<tr><td colspan="3">Output</td><td colspan="2">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>Standard: 12.3 mm (0.48 in.)</td><td>Limit: 7.0 mm (0.27 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="4">Around at 20°C (68°F)</td><td>No load characteristic</td><td>11.0 V</td><td colspan="2">90 A maximum
2,500 rpm minimum</td></tr>
<tr><td>Load characteristic</td><td>7.5 V
300 A</td><td colspan="2">10.5 N·m (1.05 kg-m, 7.59 lb-ft) minimum
880 rpm minimum</td></tr>
<tr><td>Locked characteristic</td><td>4.0 V</td><td colspan="2">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>

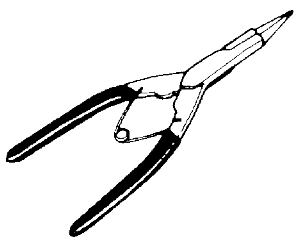
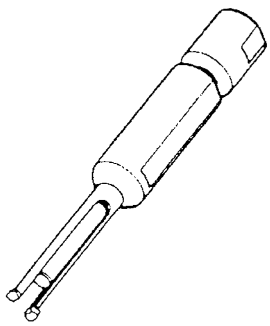
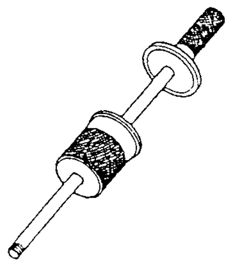
Tightening Torque Specification

Fastening part	Tightening torque		
	N•m	kg-m	lb-ft
Starting motor battery cable nut	10	1.0	7.5
Starting motor mount bolt and nut	45	4.5	32.5

Required Service Material

Material	Recommended SUZUKI product (Part Number)	Use
Lithium grease	SUZUKI SUPER GREASE A (99000-25010)	• Armature shaft (for 0.8 kW) • Over-running clutch (for 0.8 kW) • Armature shaft bushes (for 0.8 kW) • Drive lever (for 0.8 kW) • Front and rear bush (for 1.2 kW) • Plunger (for 1.2 kW) • Pinion drive lever (for 1.2 kW) • Internal gear (for 1.2 kW) • Planetary carrier shaft (for 1.2 kW) • Planetary gear (for 1.2 kW) • Ball (for 1.2 kW)

Special Tools

		
09900-06107 Snap ring pliers (Opening type)	09921-20200 Bearing remover	09930-30102 Sliding shaft

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 "System Components and Wiring Location View" under "General Description" in Section 10B 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 Section 10B 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 Description

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

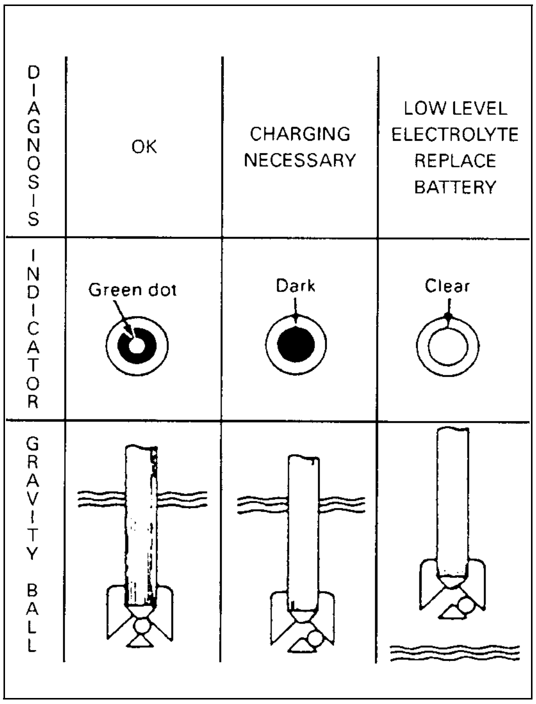
The freezing point of electrolyte depends on its specific gravity. Since freezing may ruin a battery, it should be protected against freezing by keeping it in a fully charged condition. If a battery is frozen accidentally, it should not be charged until it is warmed.

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 at 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 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.**

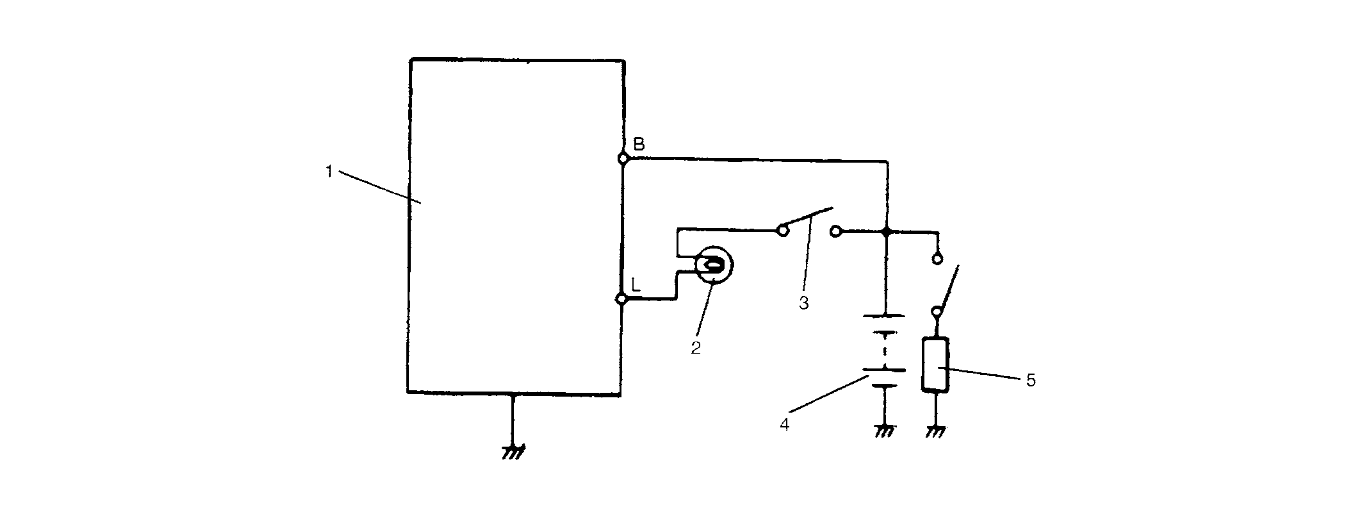
1) The battery is a very reliable component, but needs periodical attentions.
   - Keep the battery carrier clean
   - Prevent rust formation on the terminal posts
   - Keep the electrolyte up to the upper level uniformly in all cells.
   - When keeping battery on vehicle over a long period of time, follow instructions given below.
     – Weekly, start the engine and run it until it reaches normal operating temperature with engine speed of 2000 to 3000 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 Description

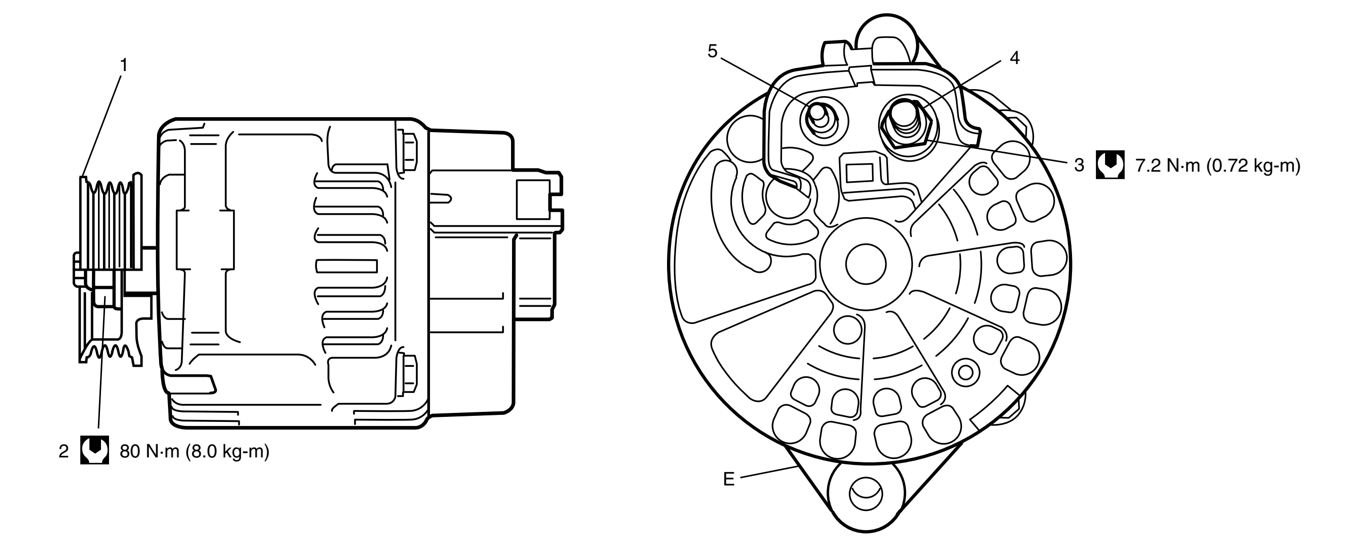
The generator is a small and high performance type with an IC regulator incorporated.
The internal components are connected electrically as shown below figure.

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.



1. Generator with regulator assembly	3. Ignition switch	5. Load
2. Charge indicator light	4. Battery	



1. Pulley	3. “B” terminal inner nut	5. “L” terminal
2. Pulley nut	4. “B” terminal	Tightening torque

Diagnosis

Battery Inspection

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

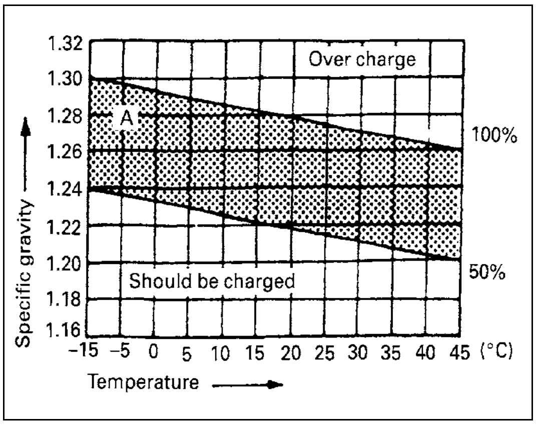
The direct method of checking the battery for state of charge is to carry out a high rate discharge test, which involves a special precise voltmeter and an expensive instrument used in the service shops, but not recommendable to the user of the vehicle.

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 as shown in the figure.



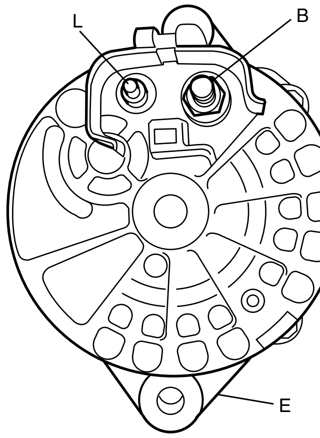
How to use the temperature-corrected state-of-charge graph

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 Symptom Diagnosis



CAUTION:
- **Do not connect any load between L and E.**
- **When connecting charger or booster battery to vehicle battery, refer to "Jump Starting in Case of Emergency" in this section.**

Trouble in charging system will show up as one or more of the 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 loose drive pulley, loose mounting bolts, worn or dirty bearings, defective diode, or defective stator.

B:	Generator output (Battery terminal)
E:	Ground
L:	Lamp terminal

Charging indicator lamp operation

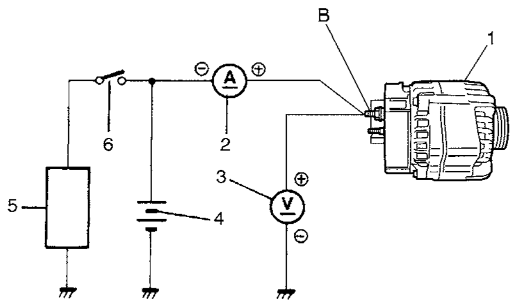
Condition	Possible Cause	Correction
Charge light does not light with ignition ON and engine off	Fuse blown	Check fuse.
	Light burned out	Replace light.
	Wiring connection loose	Tighten loose connection.
	IC regulator or field coil faulty	Check generator.
Charge light does not go out with engine running (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.
Noise from radio	Condenser faulty	Replace IC regulator assembly.

Undercharged battery

This condition, as evidenced by slow cranking or low specific gravity 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.

- Make sure that undercharged condition has not been caused by accessories left on for extended period of time.
- Check drive belt for proper tension.
- If battery defect is suspected, refer to “Battery Description” in this section.
- Inspect wiring for defects. Check all connections for tightness and cleanliness, battery cable connections at battery, starting motor and ignition ground cable.

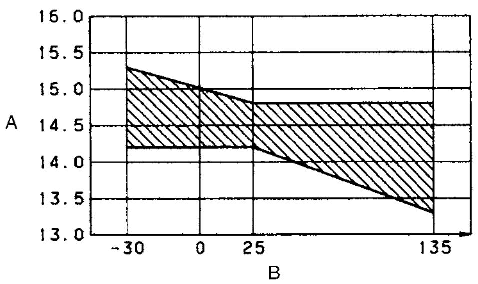
NO-LOAD CHECK



1) 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



2) Run engine from idling up to 2,000 rpm with all accessories turned off and read meters.
   If voltage is higher than standard value, check ground of brushes.
   If brushes are not grounded, replace IC regulator.
   If voltage is lower than standard value, proceed to following check.

Specification for undercharged battery (No-load check)
Current: 10 A
Standard voltage: 14.2 – 14.8 V at 20°C (68°F)

NOTE:
Consideration should be taken that voltage will differ somewhat with regulator case temperature as shown in the figure.

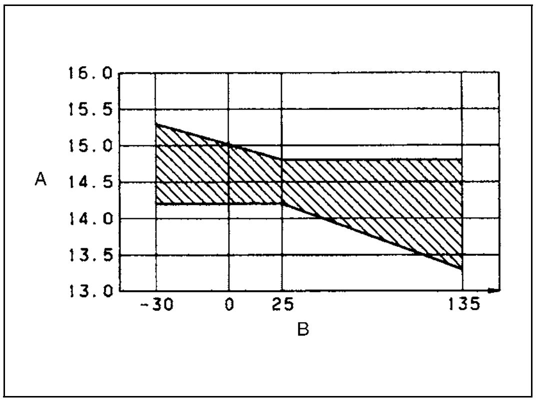
A:	Regulated voltage (V)
B:	Heatsink temperature (°C)

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 Description” in this section.



2) If obvious overcharge 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, disassemble generator.
4) Check ground of brushes. If brushes are not grounded, replace IC regulator. Then check field coil for grounds and shorts.

A:	Regulated voltage (V)
B:	Heatsink temperature (°C)

On-Vehicle Service

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.**

WARNING:

Do not connect negative cable directly to negative terminal of dead battery.

1) Set parking brake and place NEUTRAL on manual transmission (automatic transmission in PARK). 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.
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.

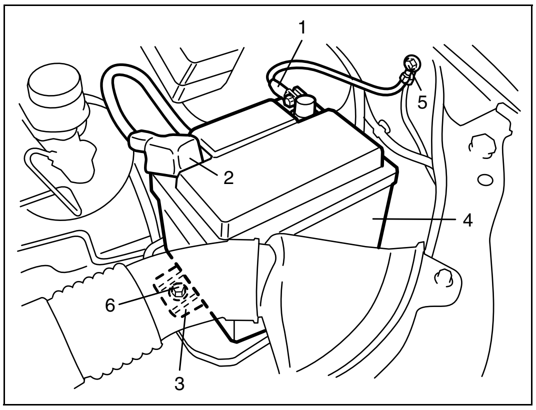
With charging equipment

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.

Battery Dismounting and Remounting

Dismounting



1) Disconnect negative cable (1).
2) Disconnect positive cable (2).
3) Remove retainer (3).
4) Remove battery (4).

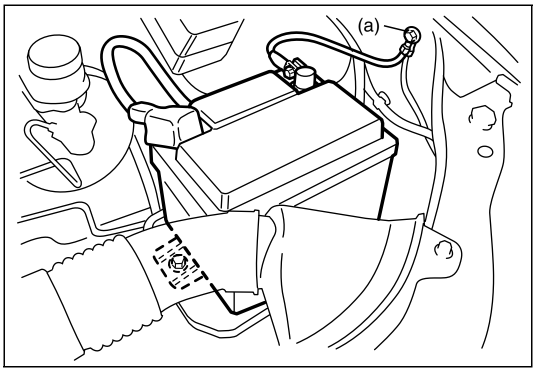
5.	Body ground bolt
6.	Retainer bolt

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:

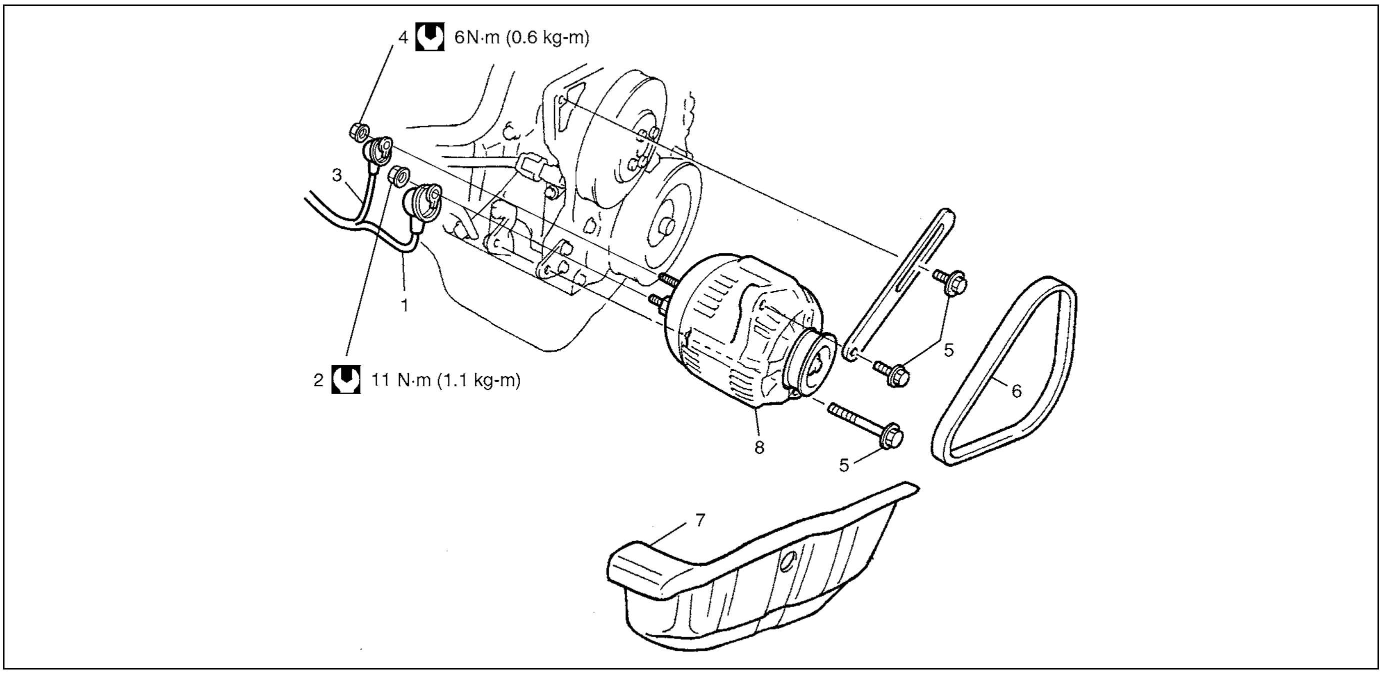
Check to be sure that ground cable has enough clearance to hood panel by terminal.

Tightening torque
Body ground bolt (a): 8.0 N·m (0.8 kg-m, 6.0 lb-ft)

Generator belt Inspection and Adjustment

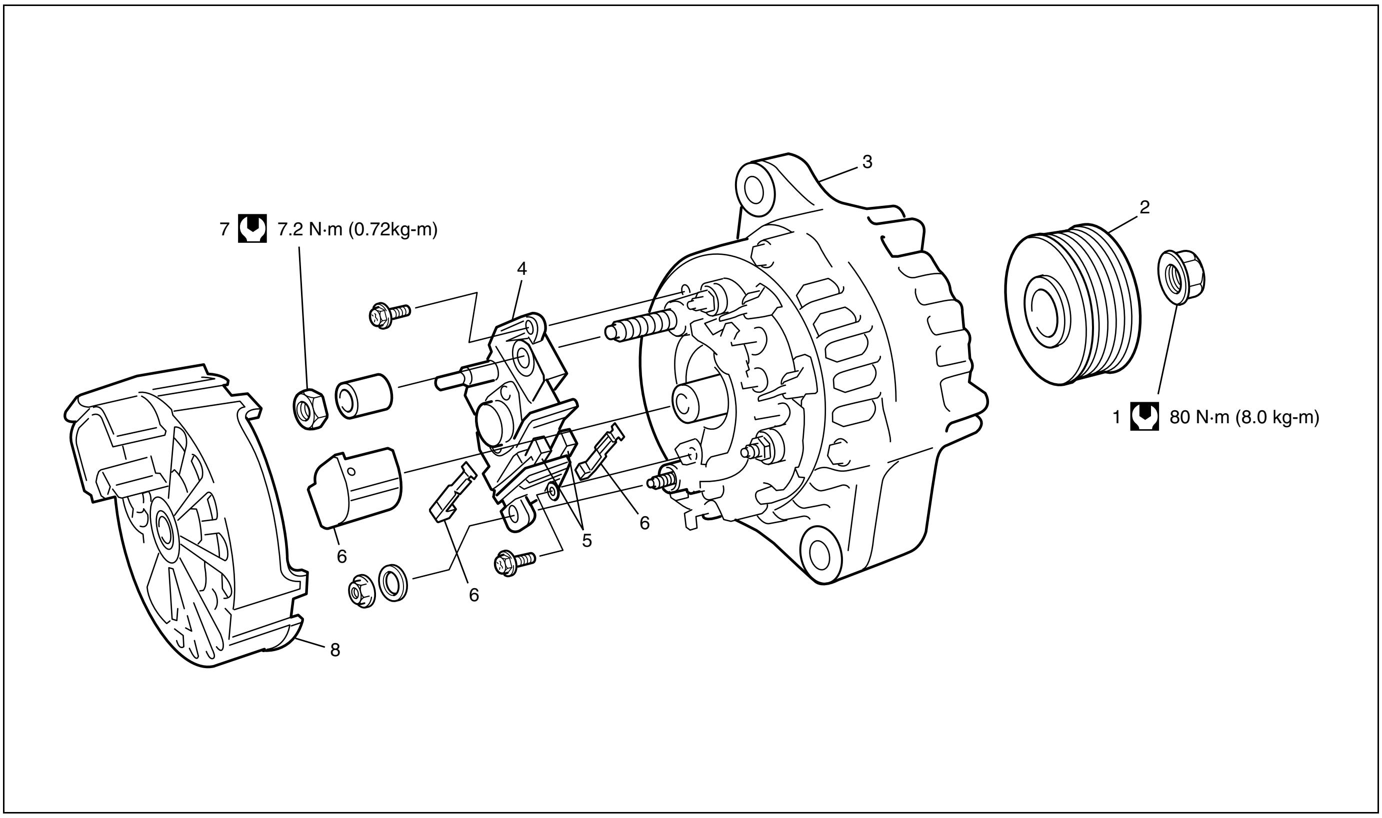
For removal, installation, inspection and adjustment referring to “Water Pump/Generator Drive Belt Tension Inspection and Adjustment” in Section 6B.

Generator Dismounting and Remounting



1. "B" terminal wire	3. "L" terminal wire	5. Generator bolt	7. Splash cover	Tightening torque
2. "B" terminal nut	4. "L" terminal nut	6. Generator belt	8. Generator	

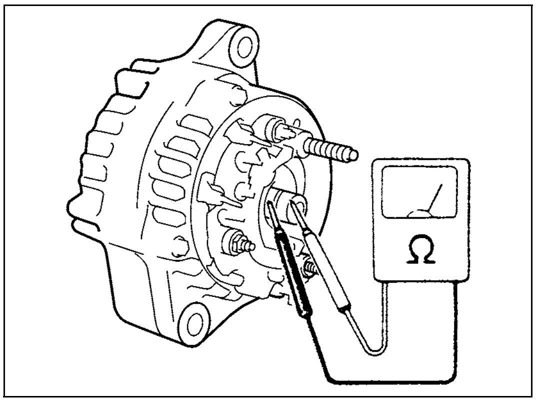
Generator Disassembly and Reassembly



1. Pulley nut	3. Generator assy	5. Brush	7. "B" terminal inner nut	Tightening torque
2. Pulley	4. Brush holder	6. Brush holder cover	8. Rear end cover	

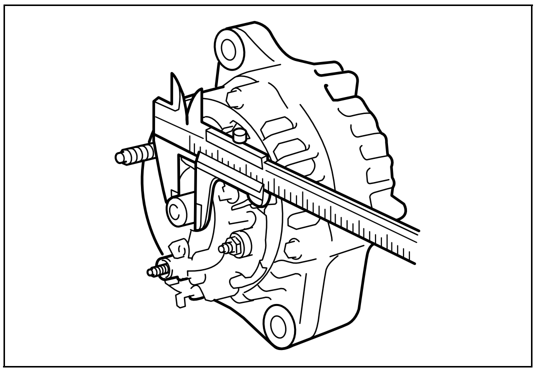
Generator Inspection

ROTOR



1) Using ohmmeter, check for continuity between slip rings of rotor. If there is no continuity, replace rotor.

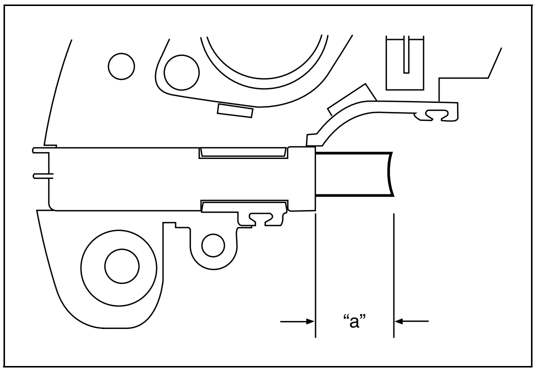
Standard resistance between slip rings of rotor
2.7 – 3.1 Ω at 20°C (68°F)



2) 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: 16.1 – 16.3 mm (0.634 – 0.642 in.)
Limit: 15.0 mm (0.591 in.)

BRUSH



Check each brush for wear by measuring its length as shown. If brush is found worn down to service limit, replace brush.

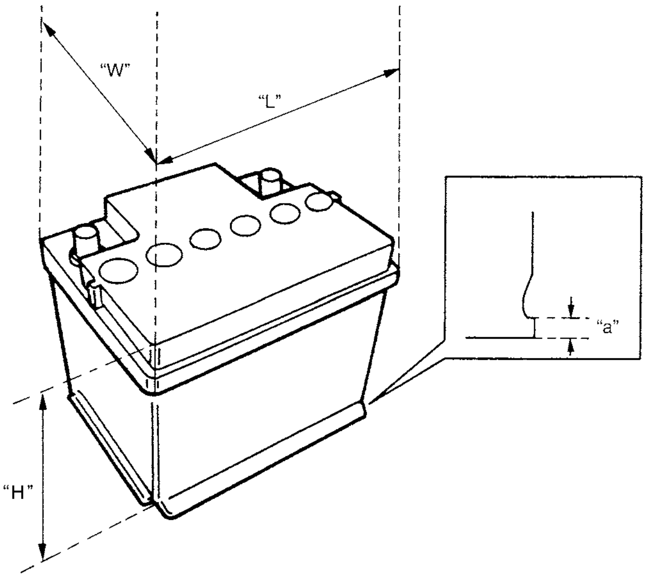
Exposed brush length “a”
Standard: 12.5 mm (0.492 in.)
Limit: 2.5 mm (0.098 in.)

Specification

Battery

NOTE:

The battery used in each vehicle is one of the following two types, depending on specification.

Battery type	CCA 180A	CCA 210A
Nominal output	12 V	
Rated capacity	36 Ah/20 h	44 Ah/20 h
	28 Ah/5 h	36 Ah/5 h
Cold cranking amperes	180 A (DIN)	210 A (DIN)
Electrolyte	3.8 L (8.03/6.69 US/lmp pt)	
Electrolyte specified gravity	1.28 when fully charged at 25°C (77°F)	
Battery dimension		

"L": 209 – 211 mm (8.23 – 8.31 in.)	"H": 172 – 175 mm (6.77 – 6.89 in.)
"W": 173 – 175 mm (6.81 – 6.89 in.)	"a": 10.5 mm (0.41 in.)

Generator

Type	70 A type
Rated voltage	12 V
Nominal output	70 A
Permissible max. speed	18000 r/min.
No-load speed	1230 r/min (rpm)
Setting voltage	14.2 to 14.8 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
“B” terminal inner nut	4.2	0.42	3.0
“B” terminal outer nut	11	1.1	8.0
“L” terminal outer nut	6	0.6	4.5
Pulley nut	111	11.1	80.5