General Description

Engine Cleanliness And Care

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the thousandths of a millimeter (ten thousandths 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 all 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.
- The six cylinders of this engine are identified by numbers; Right side cylinders 1, 3 and 5, Left side cylinders 2, 4 and 6, as counted from crankshaft pulley side to flywheel side.

General Information on Engine Service

The following information on engine service should be noted carefully, as it is important in preventing damage and contributing to reliable engine performance.

- When raising or supporting the engine for any reason, do not use a jack under the oil pan. Due to the small clearance between the oil pan and the oil pump strainer, jacking against the oil pan may cause damage to the oil pick-up unit.
- The 12-volt electrical system is capable of damaging circuits. When performing any work where electrical terminals could possibly be grounded, the ground cable of the battery should be disconnected at the battery.
- Any time the intake air duct or air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material into the cylinder which could cause extensive damage when the engine is started.

Cylinder Block

The cylinder block is made of aluminum die-cast casting for 75°V–type six cylinders. It has a rear plate integrated structure and employs a deep skirt. The cylinder liner is cast and the liner inner diameter and crankshaft journal diameter are classified into grades. The crankshaft is supported by four bearings of which width is different between No.2, No.3 and No.1, No.4; the width of No.3 bearing on the body side is different in order to support the thrust bearing. The bearing cap is made of nodular cast iron and each bearing cap uses four bolts and two side bolts.

Cylinder Head

The cylinder head, made of aluminum alloy casting employs a pent-roof type combustion chamber with a spark plug in the center. The intake and exhaust valves are placed in V-type design. The ports are cross-flow type.

Valve Train

Intake and exhaust camshaft on the both side of banks are driven through an camshaft drive gear by timing belt. The valves are operated by the camshaft and the valve clearance is adjusted to select suitable thickness shim.

Intake Manifold

The intake manifold system is composed of the aluminum cast common chamber and intake manifold attached with six fuel injectors.

Exhaust Manifold

The exhaust manifold is made of nodular cast iron.

Pistons and Connecting Rods

Aluminum pistons are used after selecting the grade that meets the cylinder bore diameter. Each piston has two compression rings and one oil ring. The piston pin made of chromium steel is offset 1mm toward the thrust side, and the thrust pressure of piston to the cylinder wall varies gradually as the piston travels. The connecting rods are made of forged steel. The connecting rod bearings are graded for correct size selection.

Crankshaft and Bearings

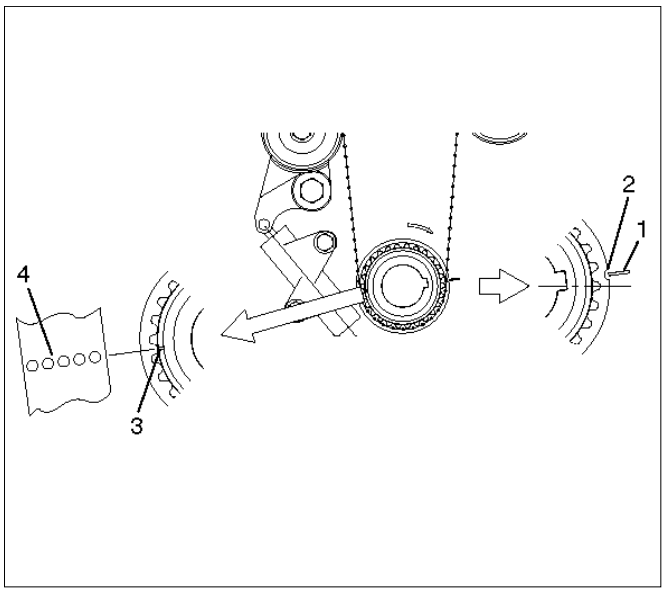
The crankshaft is made of Ductile cast-iron. Pins and journals are graded for correct size selection for their bearing.

Engine Control Module (ECM)

The ECM location is on the common charmber.

Symptom	Possible Cause	Action
Engine overheating	Level of Engine Coolant too low	*Replenish*
	Fan clutch defective	*Replace*
	Thermostat defective	*Replace*
	Engine Coolant pump defective	*Correct or replace*
	Radiator clogged	*Clean or replace*
	Radiator filler cap defective	*Replace*
	Level of oil in engine crankcase too low or wrong engine oil	*Change or replenish*
	Resistance in exhaust system increased	*Clean exhaust system or replace defective parts*
	Throttle Position Sensor adjustment incorrect	*Replace with Throttle Valve ASM*
	Throttle Position Sensor circuit open or shorted	*Correct or replace*
	Cylinder head gasket damaged	*Replace*
Engine overcooling	Thermostat defective	*Replace (Use a thermostat set to open at 82°C (180°F))*
Engine lacks compression	———	*Refer to Hard Start*
Others	Tire inflation pressure abnormal	*Adjust to recommended pressures*
	Brake drag	*Adjust*
	Clutch slipping	*Adjust or replace*
	Level of oil in engine crankcase too high	*Correct level of engine oil*
	EGR valve defective	*Replace*

NOTE: When timing marks are aligned, No.2 piston will be on Top Dead Center.



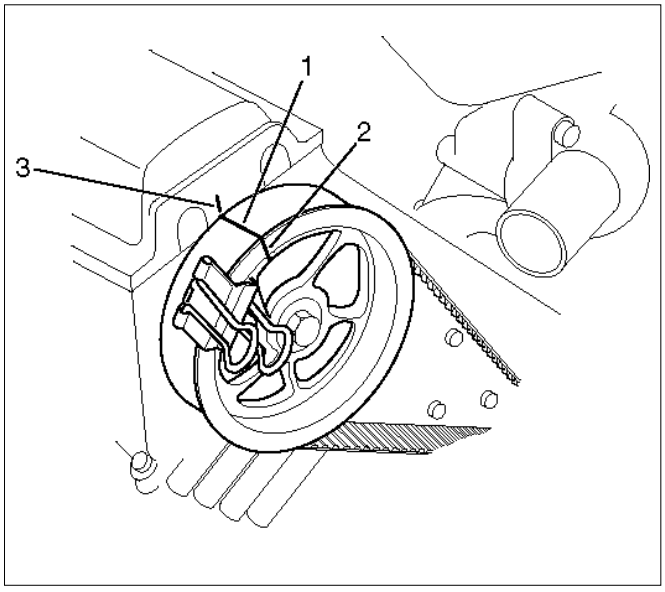
014RW003

Legend

(1) Alignment Mark on Oil Pump
(2) Groove on Crankshaft Timing Pulley
(3) Alignment Mark on Crankshaft Timing Pulley
(4) Alignment Mark on Timing Belt

2. Align the alignment mark on the RH bank camshaft drive gear pulley (2) to the alignment mark of the cylinder head cover RH (3).
3. Align the alignment mark (white line) on the timing belt (1) with alignment mark on the RH bank camshaft drive gear pulley (2) (on the left side as viewed from the front of the vehicle) and put the timing belt on the camshaft drive gear pulley.

   Secure the belt with a double clip or equivalent clip.



014RW00004

Legend

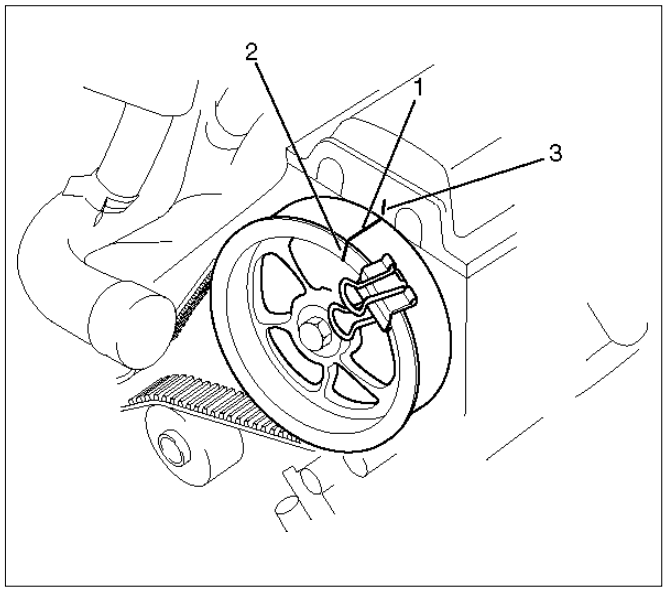
(1) Alignment Mark on Timing Belt (White line).
(2) Alignment Mark on Camshaft Drive Gear Pulley.
(3) Alignemnt Mark on Cylinder Head Cover RH.

4. Align the alignment mark on the LH bank camshaft drive gear pulley (2) to the alignment mark of the cylinder head cover LH (3).
5. Align the alignment mark (white line) on the timing belt (1) with the alignment mark on the LH bank camshaft drive gear pulley (2).

   When aligning the timing marks, use a wrench to turn the camshaft drive gear pulley, then set the timing mark between timing belt and camshaft drive gear pulley and put the timing belt on the camshaft drive gear pulley.

   Secure the belt with a double clip or equivalent clip.

NOTE: It is recommended for easy installation that the belt be secured with a double clip or equivalent clip after it is installed the timing belt to each pulley.



014RW00005

Legend

(1) Alignment Mark on Timing Belt (White line).
(2) Alignment Mark on Camshaft Drive Gear Pulley.
(3) Alignemnt Mark on Cylinder Head Cover LH.

6. Install crankshaft pulley temporarily and tighten center bolt by hand (do not use a wrench).

   Turn the crankshaft pulley clockwise to give some belt slack between the crankshaft timing pulley and the RH bank camshaft drive gear pulley.

Engine Assembly

Removal

P1010068

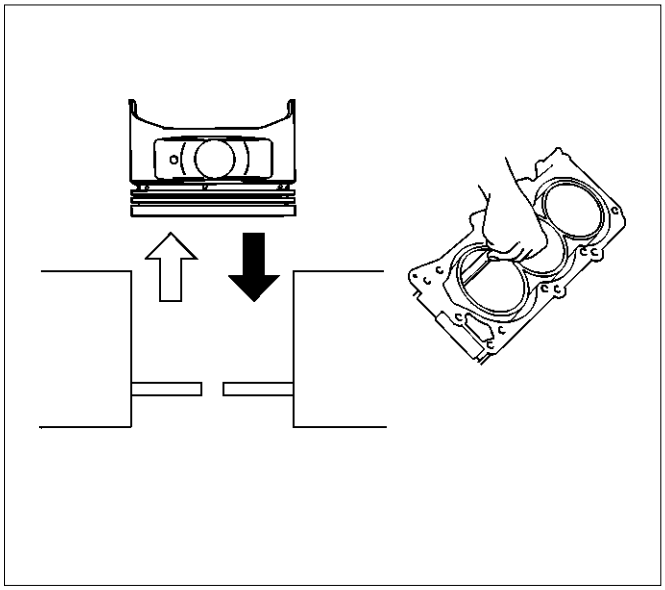
1. Disconnect battery ground and positive cable.
2. Remove battery.
3. Make alignment mark on the engine hood and hinges before removal in order to return the hood to original position exactly.
4. Remove engine hood.
5. Drain radiator coolant.
6. Disconnect accelerator cable and automatic cruise control cable from throttle valve on common chamber.
7. Remove the ECM.
   - Disconnect the two connectors from the ECM.
   - Remove fixing bolts on the common chamber.
   - Remove fixing bolts for ground cable.
8. Disconnect air duct with air cleaner cover.
9. Remove air cleaner assembly.
10. Disconnect canister vacuum hose.
11. Disconnect vacuum booster hose.
12. Disconnect three engine harness connectors.
13. Disconnect harness connector to transmission (left front side of engine compartment), disconnect shift on the fly harness connector from front side of front axle and remove transmission harness bracket from engine left side.
14. Disconnect ground cable between engine and frame.
15. Disconnect bonding cable connector on the back of right dash panel.
16. Disconnect bonding cable terminal on the left bank.
17. Disconnect starter harness connector from starter.
18. Disconnect generator harness connector from generator.
19. Disconnect coolant reserve tank hose from radiator.
20. Remove radiator upper and lower hoses.
21. Remove upper fan shroud.
22. Remove cooling fan assembly four fixing nuts, then the cooling fan assembly.
23. Move drive belt tensioner to loose side using wrench then remove drive belt.
24. Remove power steering pump fixing bolts, then power steering pump. Place the power steering pump along with piping on the body side.
25. Remove air conditioning compressor fixing bolts from bracket and place the compressor along with piping on the body side.
26. Remove four O2 sensor harness connectors (two each bank) from exhaust front pipe.
27. Remove three exhaust pipe fixing nuts from each bank.
28. Remove two exhaust pipe fixing nuts from each exhaust pipe, then move exhaust pipe to rear side of vehicle.
29. Remove flywheel dust covers.
30. Disconnect two heater hoses from engine.
31. Disconnect fuel hose from right side of transmission.

CAUTION: Plug fuel pipe on engine side and fuel hose from fuel tank.

32. Remove transmission assembly. Refer to Transmission section in this manual.
33. Support the engine by engine hoist.
34. Remove two left side engine mount fixing bolts from engine mount on chassis side.
35. Remove two right side engine mount fixing bolts from engine mount on chassis side.
36. Remove engine assembly.

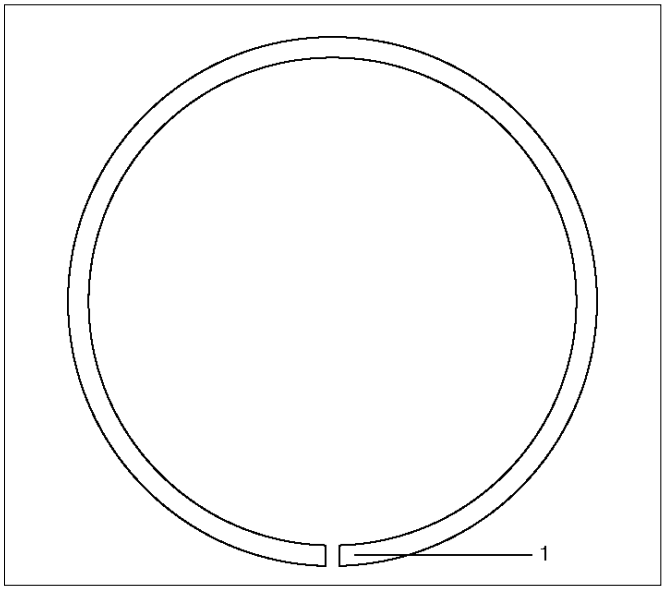
Installation

CAUTION: When assembling the engine and transmission, confirm that dowels have been mounted in the specified positions at the engine side. Also take care that dowel positions are different between the manual transmission and the automatic transmission. Otherweise, the transmission may be damaged.



015RS026

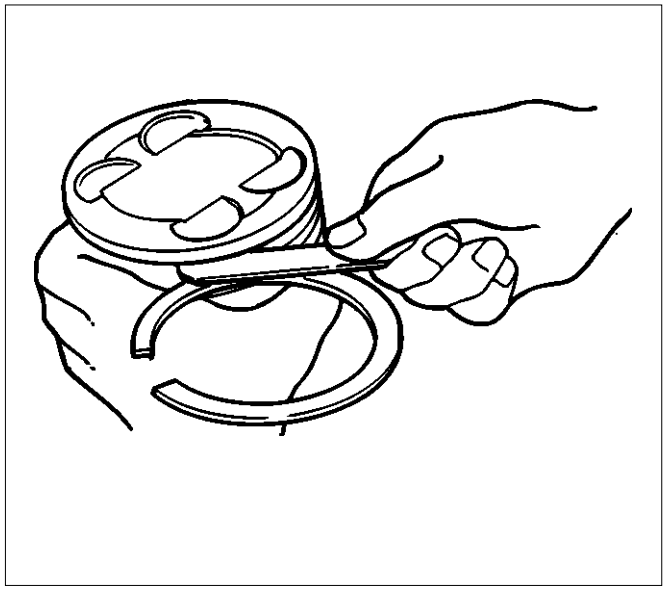
- The No.1 compression ring must be set with direction of origin.
- No.2 compression ring: Positioning mark (1) is painted as shown in the illustration.



015RS027

2. Measure the clearance between the piston ring groove and the piston ring with a feeler gauge. If the piston ring groove / piston ring clearance exceeds the specified limit, the piston must be replaced.

Compression Ring Clearance
Standard : 0.016 mm–0.038 mm
(0.0006 in. –0.0015 in)
Limit : 0.15mm (0.0059 in)



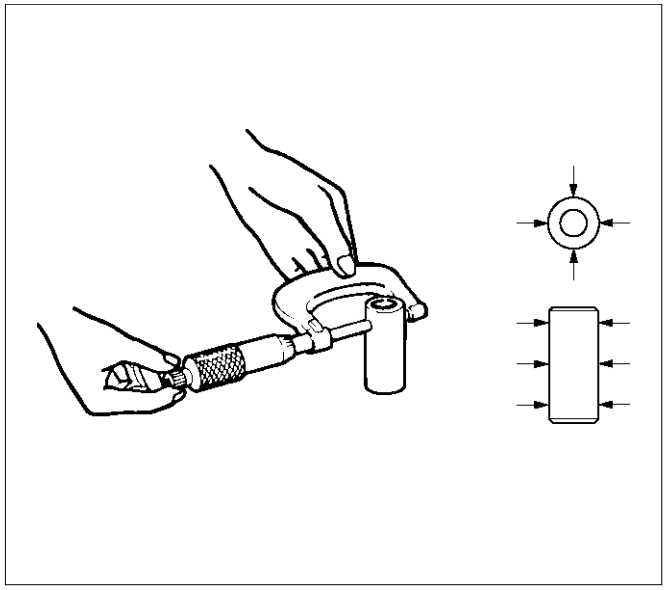
015RS028

Piston Pin (9)

NOTE: Do not reuse the old piston pin.

1. Use a micrometer to measure the new piston pin outside diameter in both directions at three different positions.
2. Measure the inside diameter of the connecting rod small end. If the fitting interference between the small end and pin does not conform to the specified value, the connecting rod must be replaced.

Standard : 0.023 mm–0.038 mm
(0.0009 in–0.0015 in)



015RS029

Draining and Refilling Cooling System

Before draining the cooling system, inspect the system and perform any necessary service to ensure that it is clean, does not leak and is in proper working order. The engine coolant (EC) level should be between the “MIN" and “MAX" lines of reserve tank when the engine is cold. If low, check for leakage and add EC up to the “MAX" line.

There should not be any excessive deposit of rust or scales around the radiator cap or radiator filler hole, and the EC should also be free from oil.

Replace the EC if excessively dirty.

1. Completely drain the cooling system by opening the drain plug at the bottom of the radiator.

P1010064

2. Remove the radiator cap.

WARNING: To avoid the danger of being burned, do not remove the cap while the engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure.

3. Disconnect all hoses from the EC reserve tank.
   Scrub and clean the inside of the reserve tank with soap and water. Flush it well with clean water, then drain it. Install the reserve tank and hoses.
4. Refill the cooling system with the EC using a solution that is 50 percent antifreeze.

Procedure for filling with coolant (in case of full change)

- Make sure that the engine is cool.
- Open radiator cap pour coolant up to filler neck.
- Pour coolant into reservoir tank up to “MAX" line.
- Tighten radiator cap and start the engine. After idling for 2 to 3 minutes, stop the engine and reopen radiator cap. If the water level is lower, replenish.

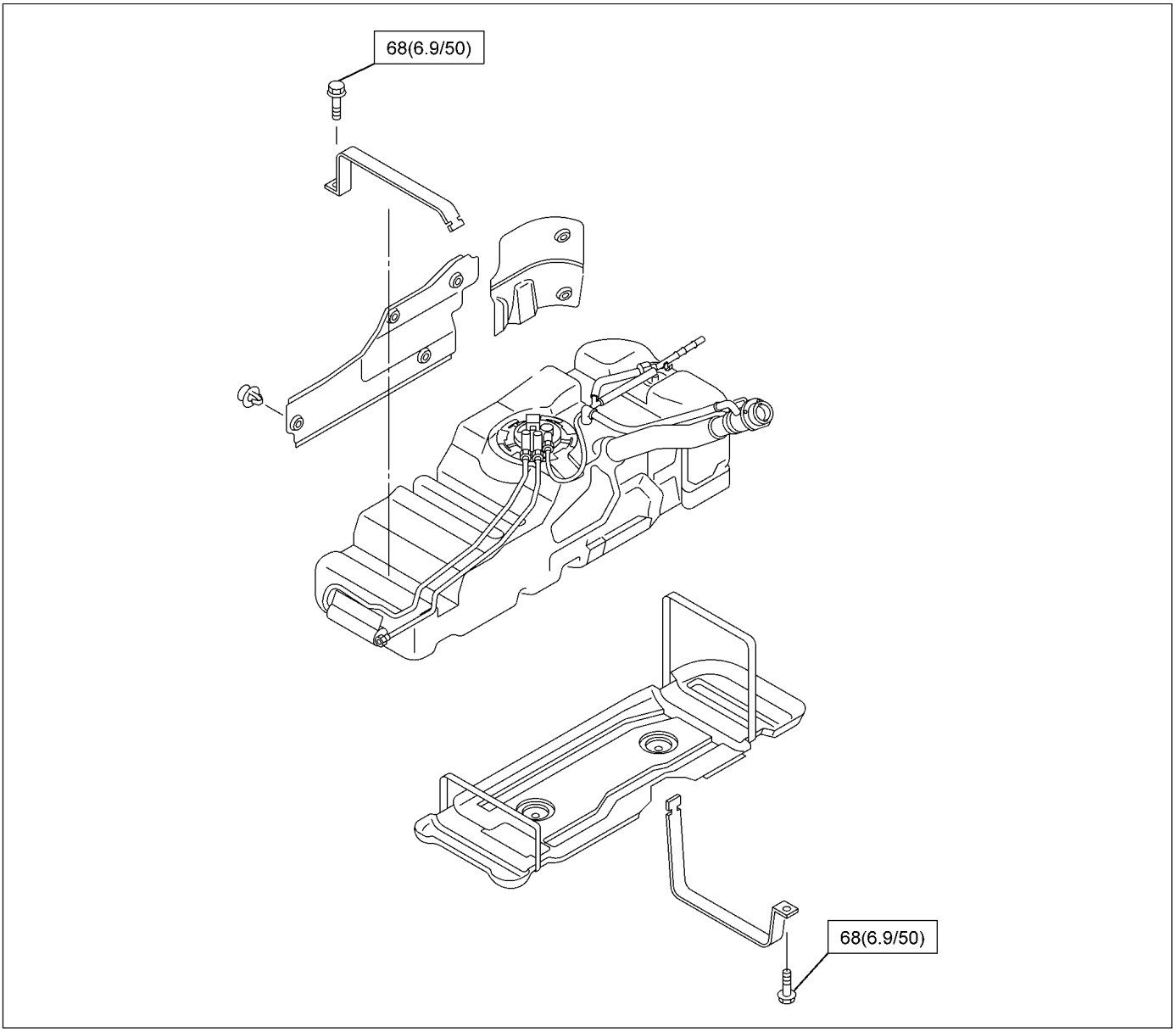
WARNING: When the coolant is heated to a high temperature, be sure not to loosen or remove the radiator cap. Otherwise you might get scalded by not vapor or boiling water. To open the radiator cap, put a piece of thick cloth on the cap and loosen the cap slowly to reduce the pressure when the coolant has become cooler.

- After tightening radiator cap, warm up the engine at about 2000 rpm. Set heater adjustment to the highest temperature position, and let the coolant circulate also into heater water system.
- Check to see the thermostat has opened through the needle position of water thermometer, conduct a 5–minute idling again and stop the engine.
- When the engine has been cooled, check filler neck for water level and replenish if required. Should extreme shortage of coolant is found, check the cooling system and reservoir tank hose for leakage.
- Pour coolant into the reservoir tank up to “MAX" line.

Main Data and Specifications

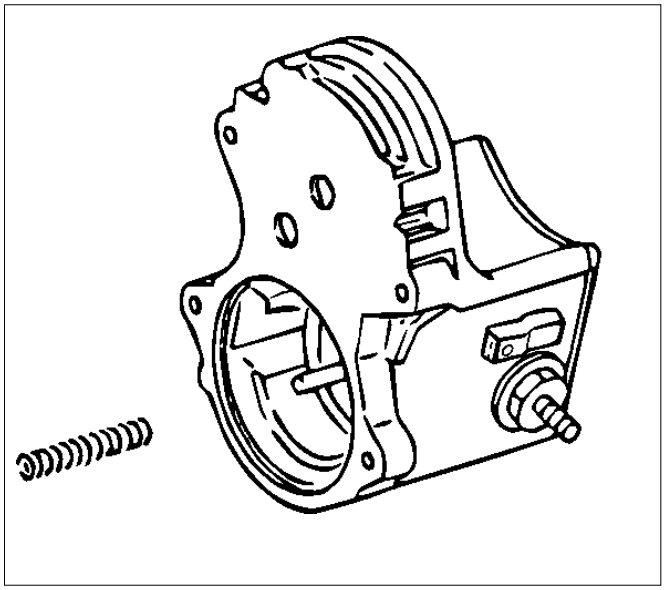
Torque Specification

N·m (kg·m/ lb ft)



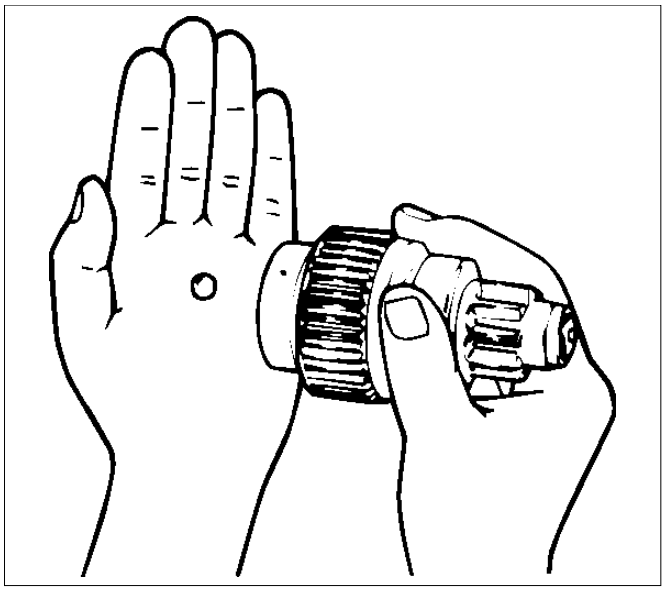
RTW46FMF000601

9. Remove the return spring from the magnetic switch.



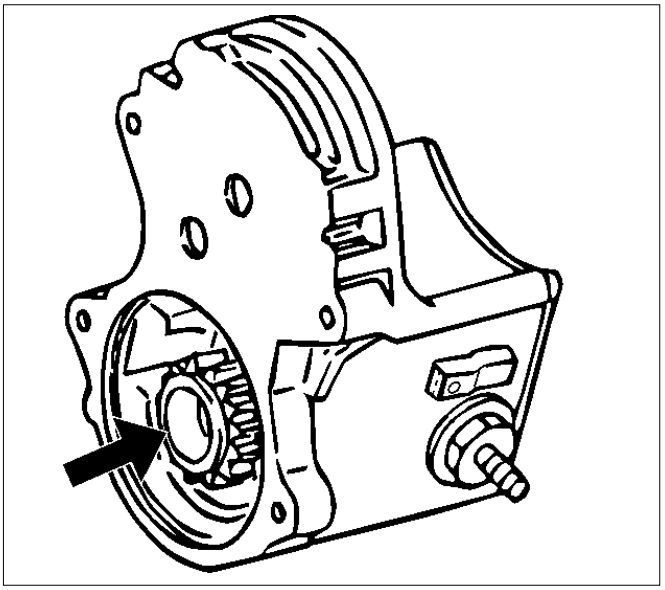
065R100014

10. Remove the steel ball from the overrunning clutch.



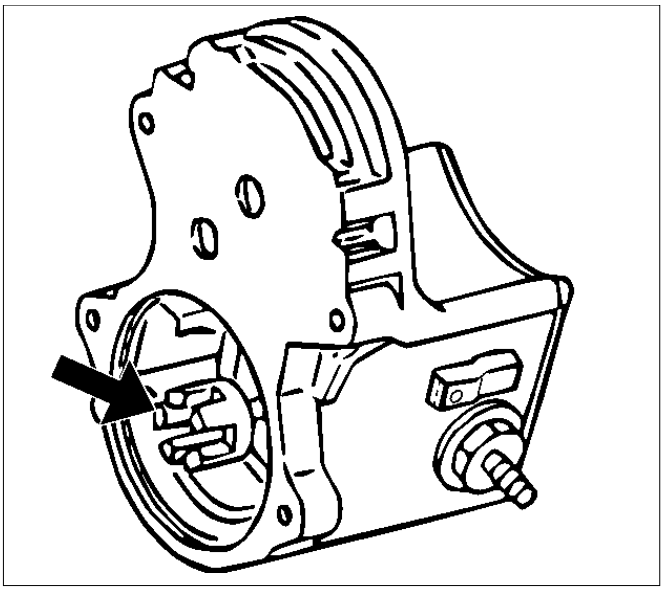
065RY00058

11.Remove the idle pinion from the magnetic switch.



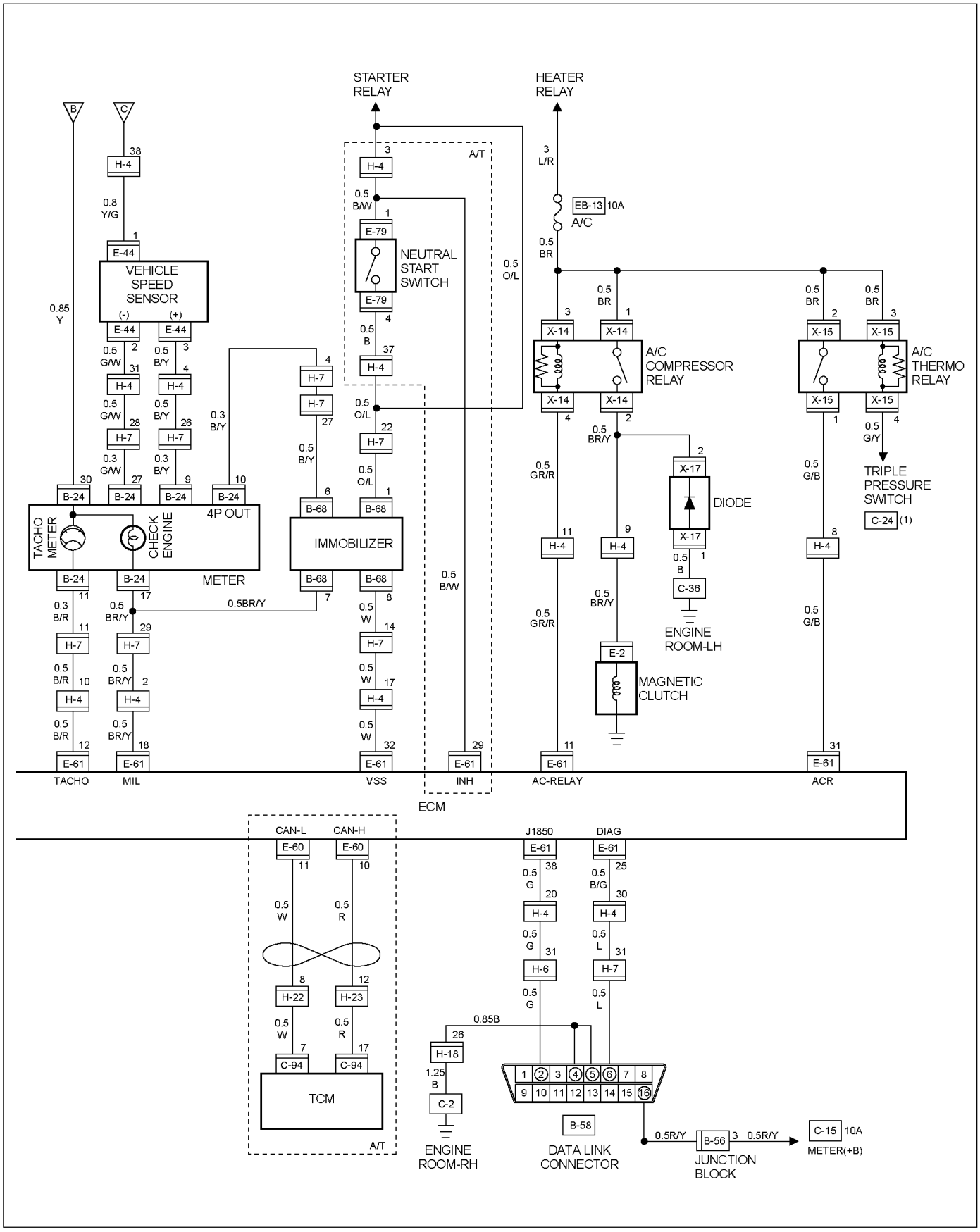
065R100015

12. Remove the retainer from the magnetic switch.



065R100016

13. Remove the magnetic switch.



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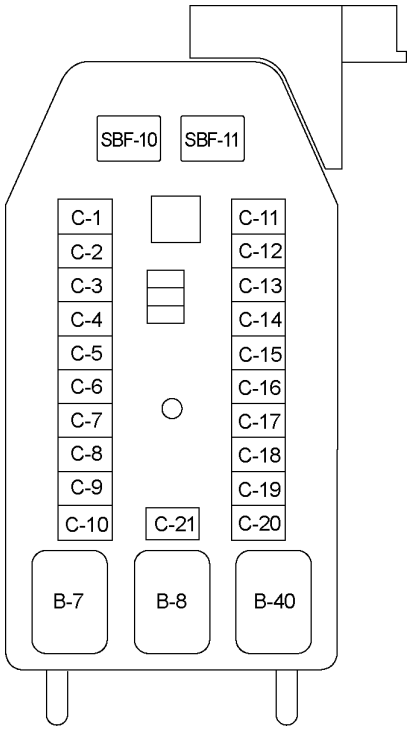
FUSE & RELAY LOCATION (LHD & RHD)

FUSE BOX



RTW46EMF001001

FUSE

NO.	Capacity	Indication on label	NO.	Capacity	Indication on label
C-1	—	—	C-12	15A	CIGER
C-2	10A	ABS	C-13	15A	AUDIO (+B)
C-3	10A	TRAILER	C-14	20A	DOOR LOCK
C-4	15A	BACK UP	C-15	10A	METER (+B)
C-5	15A	METER	C-16	10A	ROOM
C-6	10A	TURN	C-17	10A	ANTI THEFT
C-7	15A	ELEC.IG	C-18	15A	STOP
C-8	15A	ENGINE	C-19	15A	ACC SOCKET
C-9	20A	FRT WIPER	C-20	10A	STARTER
C-10	15A	IG. COIL	C-21	10A	SRS
C-11	10A	AUDIO			

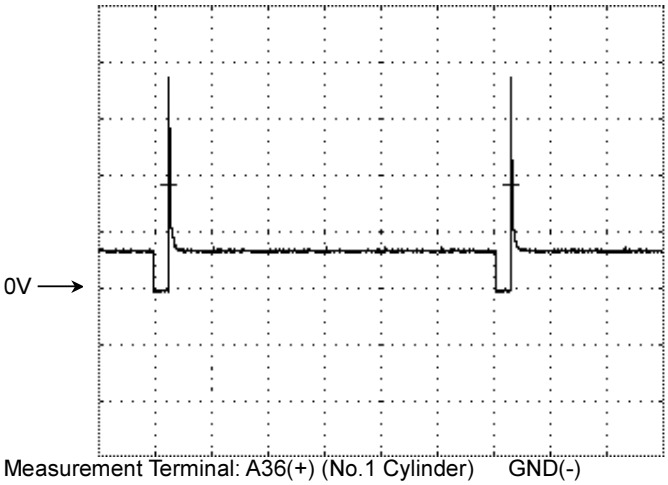
SLOW BLOW FUSE

NO.	Capacity	Indication on label
SBF-10	20A	RR DEF
SBF-11	30A	POWER WINDOW

RELAY

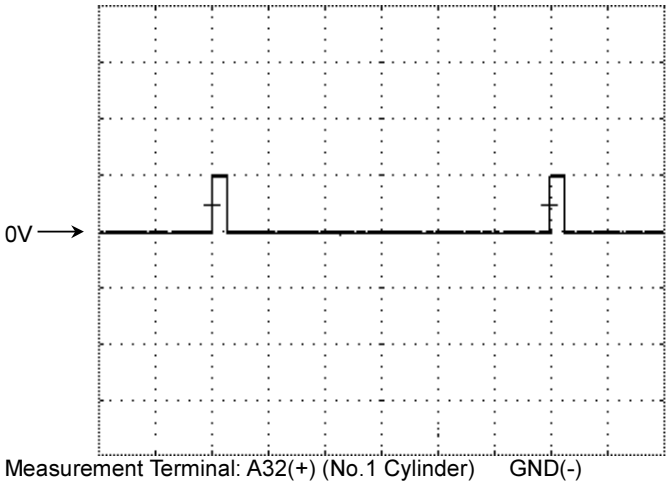
Connector No.	B-7	B-8	B-40
6VE1	REAR DEFOGGER	POWER WINDOW	ACC SOCKET

Injector Control Signal Reference Wave Form



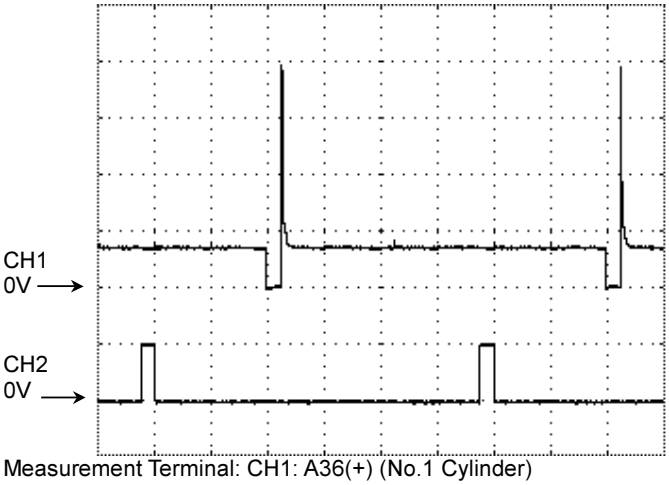
Measurement Terminal: A36(+) (No.1 Cylinder) GND(-)
Measurement Scale: 20V/div 10ms/div
Measurement Condition: Approximately 2000rpm

Ignition Coil Control Signal Reference Wave Form



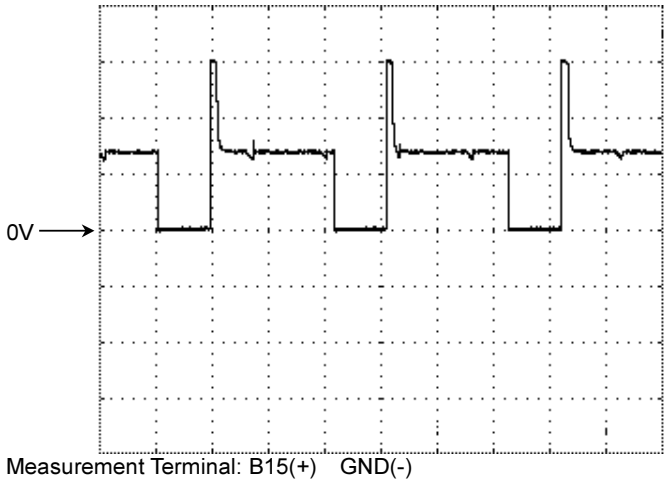
Measurement Terminal: A32(+) (No.1 Cylinder) GND(-)
Measurement Scale: 5V/div 10ms/div
Measurement Condition: Approximately 2000rpm

Injector & Ignition Coil Control Signal Reference Wave Form



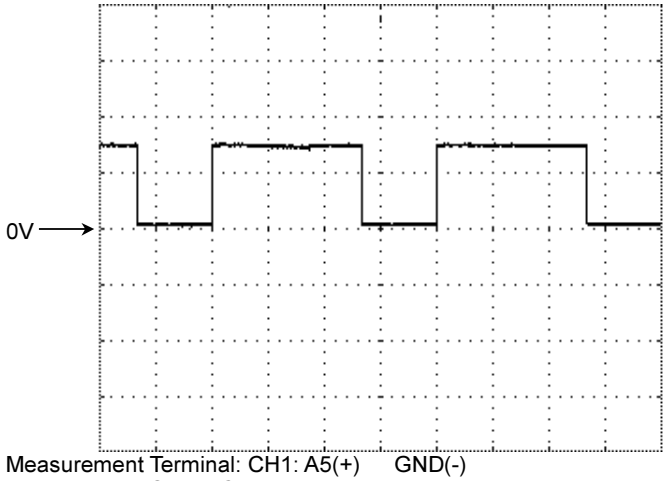
Measurement Terminal: CH1: A36(+) (No.1 Cylinder)
CH2: A32(+) (No.1 Cylinder) GND(-)
Measurement Scale: CH1: 20V/div / CH2: 5V/div 10ms/div
Measurement Condition: Approximately 2000rpm

EVAP Canistor Purge Solenoid Reference Wave Form



Measurement Terminal: B15(+) GND(-)
Measurement Scale: 10V/div 20ms/div
Frequency: Approximately 16Hz

EGR Solenoid Reference Wave Form



Measurement Terminal: CH1: A5(+) GND(-)
Measurement Scale: CH1: 10V/div 2ms/div
Frequency: Approximately 128Hz

What you should do

Step 1: Acquire information

A thorough and comprehensive customer check sheet is critical to intermittent problem diagnosis. You should require this, since it will dictate the diagnostic starting point. The vehicle service history file is another source for accumulating information about the complaint.

Step 2: Analyze the intermittent problem

Analyze the customer check sheet and service history file to determine conditions relevant to the suspect system(s).

Using service manual information, you must identify, trace and locate all electrical circuits related to the malfunctioning system(s). If there is more than one system failure, you should identify, trace and locate areas of commonality shared by the suspect circuits.

Step 3: Simulate the symptom and isolate the problem

Simulate the symptom and isolate the system by reproducing all possible conditions suggested in Step 1 while monitoring suspected circuits/components/ systems to isolate the problem symptom. Begin with the most logical circuit/component.

Isolate the circuit by dividing the suspect system into simpler circuits. Next, confine the problem into a smaller area of the system. Begin at the most logical point (or point of easiest access) and thoroughly check the isolated circuit for the fault, using basic circuit tests.

Hints

You can isolate a circuit by:

- Unplugging connectors or removing a fuse to separate one part of the circuit from another
- If only component fails to operate, begin testing the component
- If a number of components do not operate, begin test at areas of commonality (such as power sources, ground circuits, switches, main connectors or major components)
- Substitute a known good part from the parts department or the vehicle system
- Try the suspect part in a known good vehicle See *Symptom Simulation Tests* on the next page for problem simulation procedures. Refer to service manual sections 6E and 8A for information about intermittent diagnosis. Follow procedures for basic circuit testing in service manual section 8A.

What resources you should use

Whenever appropriate, you should use the following resources to assist in the diagnostic process:

- Service manual
- Bulletins
- Digital multimeter (with a MIN/MAX feature)
- Tech 2 and Tech 2 upload function
- Circuit testing tools (including connector kits/harnesses and jumper wires)
- Experience
- Intermittent problem solving simulation methods
- Customer complaint check sheet

Symptom Simulation Tests

1. Vibration

This method is useful when the customer complaint analysis indicates that the problem occurs when the vehicle/system undergoes some form of vibration.

For connectors and wire harness, slightly shake vertically and horizontally. Inspect the connector joint and body for damage. Also, tapping lightly along a suspected circuit may be helpful.

For parts and sensors, apply slight vibration to the part with a light tap of the finger while monitoring the system for a malfunction.

2. Heat

This method is important when the complaint suggests that the problem occurs in a heated environment. Apply moderate heat to the component with a hair drier or similar tool while monitoring the system for a malfunction.

CAUTION: Care must be take to avoid overheating the component.

3. Water and Moisture

This method may be used when the complaint suggests that the malfunction occurs on a rainy day or under conditions of high humidity. In this case, apply water in a light spray on the vehicle to duplicate the problem.

CAUTION: Care must be take to avoid directly exposing electrical connections to water.

4. Electrical loads

This method involves turning systems ON (such as the blower, lights or rear window defogger) to create a load on the vehicle electrical system at the same time you are monitoring the suspect circuit/component.

SNAPSHOT DISPLAY WITH TIS2000

Procedures for transferring and displaying Tech2 snapshot data by using TIS2000 [Snapshot Upload] function is described below.

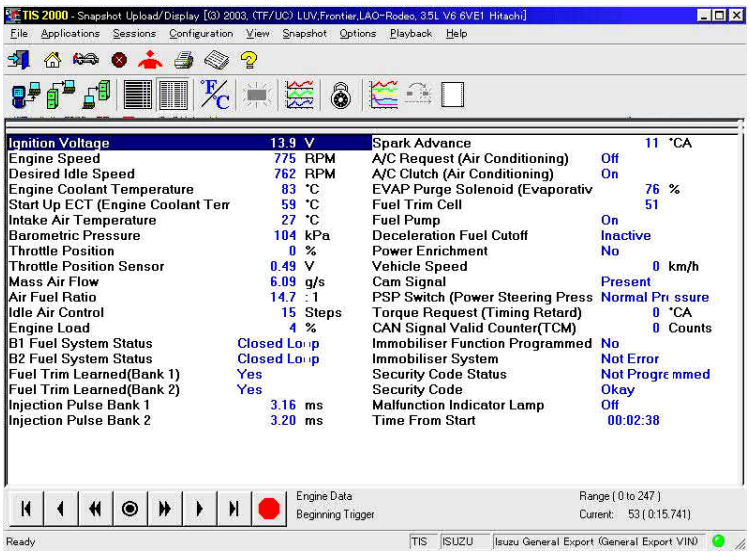
Snapshot data can be displayed with [Snapshot Upload] function included in TIS2000.

By analyzing these data in various methods, trouble conditions can be checked.

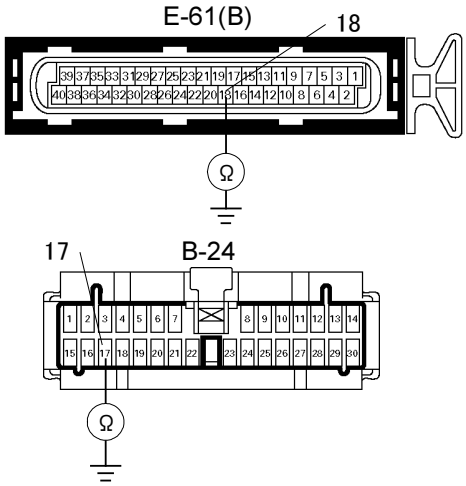
Snapshot data is displayed by executing the three steps below shown:

1. Record the snapshot data, in Tech2.

2. Transfer the snapshot data to PC.



Check Engine Lamp (MIL) “ON" Steady

Step	Action	Value (s)	Yes	No
1	1. Ignition "Off", engine "Off". 2. Disconnect the ECM connector. 3. Ignition "On". Was the "CHECK ENGINE" lamp turned on?	-	Go to *Step 2*	Go to *Step 4*
2	Using the DVM and check the "CHECK ENGINE" lamp circuit. 1. Ignition "Off", engine "Off". 2. Disconnect the meter connector and ECM connector. 3. Check the circuit for short to ground circuit. Was the problem found? 	-	Verify repair	Go to *Step 3*
3	Replace the meter assembly. Is the action complete?	-	Verify repair	-
4	Is the ECM programmed with the latest software release? If not, download the latest software to the ECM using the **"SPS (Service Programming System)"**. Was the problem solved?	-	Verify repair	Go to *Step 5*
5	Replace the ECM. Is the action complete? **IMPORTANT:** The replacement ECM must be programmed. Refer to section of the Service Programming System (SPS) in this manual. Following ECM programming, the Immobilizer system (if equipped) must be linked to the ECM. Refer to section 11 **“Immobilizer System-ECM replacement”** for the ECM/Immobilizer linking procedure.	-	Verify repair	-

An open or short to voltage circuit in the sensor ground circuit between the ECM terminal B39 and splice will cause one or more of following DTCs to be set:

- **P0103 (Flash Code 61): Mass Air Flow Sensor Circuit High Input**
- **P0113 (Flash Code 23): Intake Air Temperature Sensor High Input**
- **P0123 (Flash Code 21): Throttle Position Sensor High Input**
- **P0341(Flash Code 41): Camshaft Position Sensor Circuit Range/Performance**
- **P0342 (Flash Code 41): Camshaft Position Sensor Circuit No Signal**

An open circuit in the sensor power supply circuit between the ECM terminal B27 and splice will cause one or more of following DTCs to be set:

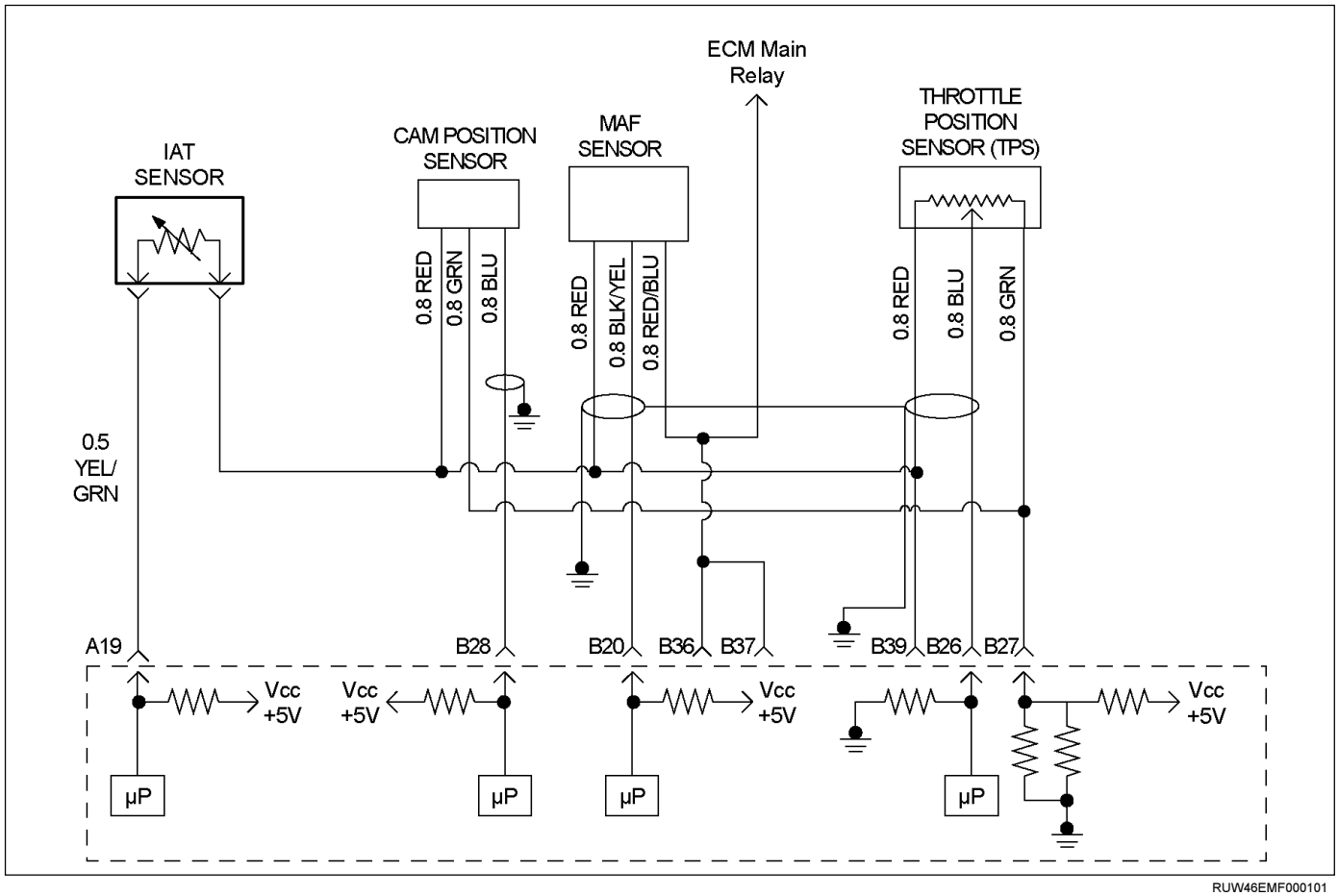
- **P0122 (Flash Code 21): Throttle Position Sensor Low Input**
- **P0342 (Flash Code 41): Camshaft Position Sensor Circuit No Signal**

A short to ground circuit in the sensor power supply circuit between the ECM terminal B27 and splice will cause one or more of following DTCs to be set:

- **P0122 (Flash Code 21): Throttle Position Sensor Low Input**
- **P0336 (Flash Code 29): Crankshaft Position Sensor Circuit Range/Performance (58X)**
- **P0337 (Flash Code 29): Crankshaft Position Sensor Circuit No Signal (58X)**

A short to ground circuit in the sensor signal circuit between the ECM terminal B28 and sensor will cause one of following DTC to be set:

- **P0337 (Flash Code 29): Crankshaft Position Sensor Circuit No Signal (58X)**



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