

# **WORKSHOP MANUAL**

**TF SERIES**

## **GASOLINE ENGINE (C22NE, 22LE, 20LE)**

**SECTION**

**6, 6A, 6B, 6C, 6D, 6E, 6F, 6G, 6H & 6J**



# **ISUZU**

## **THIS MANUAL INCLUDES FOLLOWING SECTIONS**

<b>SECTION</b>	<b>CONTENTS</b>
<b>6</b>	<b>Engine Diagnosis</b>
<b>6A</b>	<b>Engine Mechanical</b>
<b>6B</b>	<b>Engine Cooling</b>
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<b>6D1</b>	<b>Engine Electrical</b>
<b>6D2</b>	<b>Ignition System</b>
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<b>6H</b>	<b>Engine Speed Control System</b>
<b>6J</b>	<b>Induction</b>

## **NOTICE**

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section - OA under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on the latest product information available at the time of publication.

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## SECTION 6

# ENGINE DIAGNOSIS

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# Engine Diagnosis

## Hard Starting

### 1. Starting Motor Does Not Turn Over

#### Trouble Shooting Procedure

Turn on headlights and starter switch.

Condition	Possible cause	Correction
Headlights go out or dim considerably	Battery run down or under charged	Recharge or replace battery
	Terminals poorly connected	Clean battery posts and terminals and connect properly
	Starting motor coil circuit shorted	Overhaul or replace
	Starting motor defective	Overhaul or replace

### 2. Ignition Trouble - Starting Motor Turns Over But Engine Does Not Start

#### Spark Test

Disconnect a high tension cable from any spark plug. Connect the spark plug tester (use commercially available tool), crank the engine, and check if a spark is generated in the spark plug tester. Before cranking the engine, make sure that the spark plug tester is properly grounded. To avoid electrical shock, do not touch the high tension cable while the engine is running.

Condition	Possible cause	Correction
Spark jumps across gap	Spark plug defective	Clean, adjust spark gap or replace
	Ignition timing incorrect	Refer to Ignition System
	Fuel not reaching fuel injector(s) or engine	Refer to item 3 (Trouble in fuel system)
	Valve timing incorrect	Adjust
	Engine lacks compression	Refer to item 4 (Engine lacks compression)
No sparking takes place	Ignition coil disconnected or broken	Connect properly or replace
	Electronic Ignition System with module	Replace
	Poor connections in engine harness	Correct
	Engine Control Module cable disconnected or defective	Correct or replace

**3. Trouble in Fuel System**

Condition	Possible cause	Correction
Starting motor turns over and spark occurs but engine does not start.	Fuel tank empty	Fill
	Water in fuel system	Clean
	Fuel filter clogged	Replace filter
	Fuel pipe clogged	Clean or replace
	Fuel pump defective	Replace
	Fuel pump circuit open	Correct or replace
	Evaporative Emission Control system circuit clogged	Correct or replace
	Multiport Fuel Injection System faulty	Refer to "Electronic Fuel Injection" section

**4. Engine Lacks Compression**

Condition	Possible cause	Correction
Engine lacks compression	Spark plug loosely fitted or spark plug gasket defective	Tighten to specified torque or replace gasket
	Valve timing incorrect	Adjust
	Cylinder head gasket defective	Replace gasket
	Valve incorrectly seated	Lap valve
	Valve stem seized	Replace valve and valve guide
	Valve spring weakened	Replace
	Cylinder or piston rings worn	Overhaul engine
	Piston ring seized	Overhaul engine.

**Engine Compression Test Procedure**

1. Start and run the engine until the engine reaches normal operating temperature.
2. Turn the engine off.
3. Remove all the spark plugs.
4. Remove ignition coil fuse (15A) and disable the ignition system.
5. Remove the fuel pump relay from the relay and fuse box.
6. Engage the starter and check that the cranking speed is approximately 300 rpm.
7. Install cylinder compression gauge into spark plug hole.
8. With the throttle valve opened fully, keep the starter engaged until the compression gauge needle reaches the maximum level. Note the reading.
9. Repeat the test with each cylinder. The pressure difference between the individual cylinders should not exceed 100kPa (14.5 psi).

**6-4 ENGINE DIAGNOSIS (C22NE, 22LE, 20LE)**

**Rough Engine Idling or Engine Stalling**

<b>Condition</b>	<b>Possible cause</b>	<b>Correction</b>
Trouble in fuel injection system	Idle air control valve defective	Replace
	Throttle shutting off incomplete	Correct or replace
	Throttle position sensor circuit open or shorted	Correct or replace
	Fuel injector circuits open or shorted	Correct or replace
	Fuel injectors damaged	Replace
	Fuel pump relay defective	Replace
	Manifold Absolute Pressure Sensor cable disconnected or broken	Correct or replace
	Manifold Absolute Pressure Sensor defective	Replace
	Engine Coolant Temperature Sensor cable disconnected or broken	Correct or replace
	Engine Coolant Temperature Sensor defective	Replace
	Intake Air Temperature sensor cable disconnected or broken	Correct or replace
	Intake Air Temperature sensor defective	Replace
	Knock Sensor (KS) circuits open or shorted	Correct or replace
	KS defective	Replace
	KS Module circuits open or ground	Correct or replace
	KS Module defective	Replace
	Vehicle Speed Sensor circuit open or shorted	Correct or replace
	Vehicle Speed Sensor defective	Replace
Trouble in emission control system	Engine Control Module defective	Replace
	Canister purge solenoid circuit open	Correct
	Canister purge solenoid defective	Replace
	Evaporative Emission Canister Purge control valve defective	Replace
	Trouble in ignition system	Refer to Hard Start Troubleshooting Guide
Others	Engine lacks compression	Refer to Hard Start Troubleshooting Guide
	Valve incorrectly seated	Lap valve
	Air Cleaner Filter clogged	Replace filter element
	Valve timing incorrect	Readjust
	Idle air control valve broken	Replace

**Rough Engine Running**

<b>Condition</b>	<b>Possible cause</b>	<b>Correction</b>
Engine misfires regularly	Ignition coil layer shorted	Replace
	Spark plugs fouling	Clean or install hotter type plug
	Spark plug(s) insulator nose leaking	Replace
	Fuel injector(s) defective	Replace
	Engine control module faulty	Replace
Engine knocks regularly	Spark plugs running too hot	Install colder type spark plugs
	Powertrain control module faulty	Replace
Engine lacks power	Spark plugs fouled	Clean
	Fuel injectors defective	Replace
	Manifold Absolute Pressure (MAP) Sensor or Manifold Absolute Pressure Sensor circuit defective	Correct or replace
	Engine Coolant Temperature Sensor or Engine Coolant Temperature Sensor circuit defective	Correct or replace
	Engine Control Module faulty	Replace
	Intake Air Temperature Sensor or Intake Air Temperature Sensor circuit defective	Correct or replace
	Throttle Position Sensor or Throttle Position Sensor circuit defective	Correct or replace
	Knock Sensor or Knock Sensor circuits defective	Correct or replace
	Knock Sensor Module or Knock Sensor Module circuits defective	Correct or replace



## 6-6 ENGINE DIAGNOSIS (C22NE, 22LE, 20LE)

### Hesitation

Condition	Possible cause	Correction
Hesitation on acceleration	Throttle Position Sensor adjustment incorrect	Replace throttle valve assembly
	Throttle Position Sensor circuit open or shorted	Correct or replace
	Excessive play in accelerator linkage	Adjust or replace
	Manifold Absolute Pressure (MAP) Sensor circuit open or shorted	Correct or replace
	MAP Sensor defective	Replace
	Intake Air Temperature (IAT) Sensor circuit open or shorted	Correct or replace
	Knock Sensor (KS) Circuit open or shorted	Correct or replace
	KS defective	Replace
	KS Module circuits open or shorted	Correct or replace
	KS Module defective	Replace
	IAT Sensor defective	Replace
Hesitation at high speeds (Fuel pressure too low)	Fuel tank strainer clogged	Clean or replace
	Fuel pipe clogged	Clean or replace
	Fuel filter clogged	Replace
	Defective fuel pump system	Check and replace
	Fuel Pressure Control Valve leaking	Replace
Hesitation at high speeds (Fuel injector not working normally)	Power supply or ground circuit for Multiport Fuel Injection System shorted or open	Check and correct or replace
	Cable of Multiport Fuel Injection System disconnected or defective	Correct or replace
Hesitation at high speeds	Engine Control Module defective	Replace
	Throttle Position Sensor circuit open or shorted	Correct or replace
	Throttle Position Sensor defective	Replace
	Engine Coolant Temperature Sensor circuit open or shorted	Correct or replace
	Engine Coolant Temperature Sensor defective	Replace
	MAP Sensor cable open or shorted	Correct or replace
	MAP Sensor defective	Replace
	IAT Sensor circuit open or shorted	Correct or replace
	IAT Sensor defective	Replace
	KS Circuit open or shorted	Correct or replace
	KS defective	Replace
	KS Module circuit open or shorted	Correct or replace
	KS Module defective	Replace
	Throttle valve not wide opened	Check and correct or replace
	Air Cleaner Filter clogged	Replace filter element
Power supply voltage too low	Check and correct or replace	

**Engine Lacks Power**

<b>Condition</b>	<b>Possible cause</b>	<b>Correction</b>
Trouble in fuel system	Fuel Pressure Control Valve not working normally	Replace
	Fuel injector clogged	Clean or replace
	Fuel pipe clogged	Clean
	Fuel filter clogged or fouled	Replace
	Fuel pump drive circuit not working normally	Correct or replace
	Fuel tank not sufficiently breathing due to clogged Evaporative Emission Control System circuit	Clean or replace
	Water in fuel system	Clean
	Inferior quality fuel in fuel system	Use fuel of specified octane rating
	Engine Control Module supplied poor voltage	Correct circuit
	Throttle Position Sensor cable disconnected or broken	Correct or replace
	Throttle Position Sensor defective	Replace
	Manifold Absolute Pressure Sensor not working normally	Replace
	Intake Air Temperature sensor not working normally	Replace
	Engine Coolant Temperature Sensor circuit open or shorted	Correct or replace
	Engine Coolant Temperature Sensor defective	Replace
Engine Control Module defective	Replace	
Trouble in intake or exhaust system	Air Cleaner Filter clogged	Replace filter element
	Air duct kicked or flattened	Correct or replace
Ignition failure	-	Refer to Hard Start Troubleshooting Guide
	Heat range of spark plug inadequate	Install spark plugs of adequate heat range
	Electronic Ignition System with module	Replace

## 6-8 ENGINE DIAGNOSIS (C22NE, 22LE, 20LE)

Condition	Possible cause	Correction
Engine overheating	Level of Engine Coolant too low	Replenish
	Thermo switch or fan motor defective	Replace
	Thermostat defective	Replace
	Engine Coolant pump defective	Correct or replace
	Radiator clogged	Clean or replace
	Radiator filter cap defective	Replace
	Level of oil in engine crankcase too low or wrong oil in engine	Change or replenish
	Resistance in exhaust system increased	Clean exhaust system or replace defective parts
	Throttle Position Sensor adjustment incorrect	Adjust Wide Open Throttle switch setting
	Throttle Position Sensor circuit open or shorted	Correct or replace
	Cylinder head gasket damaged	Replace
	Cooling Fan clutch defective	Replace
	Fan belt slipping	Adjust tension of V-belt or replace V-belt
Engine overcooling	Thermostat defective	Replace (Use a thermostat set to open at 92°C (197.6°F))
Engine lacks compression	-	Refer to Hard Start
Others	Tire inflation pressure abnormal	Adjust to recommend pressures
	Brake drag	Adjust
	Clutch slipping	Adjust or replace
	Level of oil in engine crankcase too high	Correct level of engine oil

### Engine Noisy

Abnormal engine noise often consists of various noises originating in rotating parts, sliding parts and other moving parts of the engine. It is, therefore, advisable to locate the source of noise systematically.

Condition	Possible cause	Correction
Noise from crank journals or from crank bearings (Faulty crank journals and crank bearings usually make dull noise that becomes more evident when accelerating)	Oil clearance increased due to worn crank journals or crank bearings	Replace crank bearings and crankshaft or regrind crankshaft and install the over size bearing
	Crankshaft out of round	Replace crank bearings and crankshaft or regrind crankshaft and install the over size bearing
	Crank bearing seized	Replace crank bearings and crankshaft or regrind crankshaft and install the over size bearing

## Abnormal Noise Due to Hydraulic Lash Adjuster

Should abnormal noise due to the hydraulic lash adjuster trouble be heard immediately after the engine is started, inspect as follows:

Condition	Possible cause	Correction
Abnormal noise is heard	Air contaminated	Bleed
HLA is spongy	Check ball valve broken	Repair
	Safety valve in cylinder head broken	Replace
Valve clearance is not zero	HLA inside stick	Replace HLA assembly

## Troubleshooting Procedure

Short out each spark plug in sequence using insulated spark plug wire removers. Locate cylinder with defective bearing by listening for abnormal noise that stops when spark plug is shorted out.

Condition	Possible cause	Correction
Noise from connecting rods or from connecting rod bearings (Faulty connecting rods or connecting rod bearings usually make an abnormal noise slightly higher than the crank bearing noise, which becomes more evident when engine is accelerated)	Bearing or crankshaft pin worn	Replace connecting rod bearings and crankshaft or regrind crankshaft and install the under size bearing
	Crankpin out of round	Replace connecting rod bearings and crankshaft or regrind crankshaft and install the under size bearing
	Connecting rod bent	Correct or replace
	Connecting rod bearing seized	Replace connecting rod bearings and crankshaft or regrind crankshaft and install the under size bearing

## Troubleshooting Procedure

Abnormal noise stops when the spark plug on the cylinder with defective parts is shorted out.

Condition	Possible cause	Correction
Piston and cylinder (Faulty piston or cylinder usually makes a combined mechanical thumping noise which increases when engine is suddenly accelerated but diminishes gradually as the engine warms up)	Piston clearance increased due to cylinder wear	Replace piston and cylinder body
	Piston seized	Replace piston and cylinder body
	Piston ring broken	Replace piston and cylinder body
	Piston defective	Replace pistons and others

## 6-10 ENGINE DIAGNOSIS (C22NE, 22LE, 20LE)

### Troubleshooting Procedure

Short out each spark plug and listen for change in engine noise.

Condition	Possible cause	Correction
Piston pin noise (Piston makes noise each time it goes up and down)	Piston pin or piston pin hole worn	Replace piston, piston pin and connecting rod assy

### Troubleshooting Procedure

The slapping sound stops when spark plug on bad cylinder is shorted out.

Condition	Possible cause	Correction
Timing belt noise	Timing belt tension is incorrect	Replace pusher or adjust the tension pulley or replace timing belt
	Tensioner bearing defective	Replace
	Timing belt defective	Replace
	Timing wheels defective	Replace
Valve noise	Timing belt comes in contact with timing cover	Replace timing belt and timing cover
	Valve and valve guide seized	Replace valve and valve guide
	Valve spring broken	Replace
Crankshaft noise	Valve seat off-positioned	Correct
	Crankshaft end play excessive (noise occurs when clutch is engaged)	Replace thrust bearing
Engine knocking	Preignition due to use of spark plugs of inadequate heat range	Install Spark Plugs of adequate heat range
	Fuel too low in octane rating	Replace fuel
	Wide Open Throttle enrichment system failure	Refer to Section 6E
	Selection of transmission gear incorrect	Caution operator or incorrect gear selection
Others	Engine overheating	Refer to "Engine Lacks Power"
	Water pump defective	Replace
	V-belt slipping	Adjust tension of V-belt or replace V-belt

**Abnormal Combustion**

Condition	Possible cause	Correction
Trouble in fuel injection system	Fuel pressure control valve defective	Replace
	Fuel filter clogged	Replace
	Fuel pump clogged	Clean or replace
	Fuel tank or fuel pipe clogged	Clean or replace
	Fuel injector clogged	Clean or replace
	Fuel pump relay defective	Replace
	Power supply cable for fuel pump loosely connected or defective	Reconnect, correct or replace
	Manifold Absolute Pressure Sensor circuit open or shorted	Correct or replace
	Manifold Absolute Pressure Sensor defective	Replace
	Engine Coolant Temperature (ECT) Sensor circuit open or shorted	Correct or replace
	ECT Sensor defective	Replace
	Throttle Position Sensor adjustment incorrect	Reconnect
	Throttle Position Sensor defective	Replace
	Throttle Position Sensor connector loosely connected	Reconnect
	Vehicle Speed Sensor cable loosely connected or defective	Correct or replace
	Vehicle Speed Sensor loosely fixed	Fix tightly
Vehicle Speed Sensor in wrong contact or defective	Replace	
Engine Control Module cable loosely connected or defective	Correct or replace	
Trouble in emission control system	Heated Oxygen Sensor circuit open (If applicable)	Correct or replace
	Heated Oxygen Sensor defective (If applicable)	Replace
	Signal vacuum hose loosely fitted or defective	Correct or replace
	ECT Sensor circuit open or shorted	Correct or replace
	ECT Sensor defective	Replace
	Evaporative Emission Control system (If applicable)	Refer to Section 6E
Trouble in ignition system	-	Refer to "Engine Lacks Power"
Trouble in cylinder head parts	Carbon deposits in combustion chamber	Remove carbon
	Carbon deposit on valve, valve seat and valve guide	Remove carbon

**6-12 ENGINE DIAGNOSIS (C22NE, 22LE, 20LE)**

**Engine Oil Consumption Excessive**

<b>Condition</b>	<b>Possible cause</b>	<b>Correction</b>
Oil leaking	Oil pan drain plug loose	Retighten or replace gasket
	Oil pan setting bolts loosened	Retighten
	Oil pan gasket broken	Replace gasket
	Front cover retaining bolts loose or gasket broken	Retighten or replace gasket
	Head cover retaining bolts loose or gasket broken	Retighten or replace gasket
	Oil filter adapter cracked	Replace
	Oil filter attaching bolt loose or rubber gasket broken	Retighten or replace oil filter
	Crankshaft front or rear oil seal defective	Replace oil seal
	Oil pressure unit loose or broken	Retighten or replace
	Blow-by gas hose broken	Replace hose
	Engine/Transmission coupling area	Replace oil seal
Oil leaking into combustion chambers due to poor seal in valve system	Valve stem oil seal defective	Replace
	Valve stem or valve guide worn	Replace valve and valve guide
Oil leaking into combustion chambers due to poor seal in cylinder parts	Cylinders and pistons worn excessively	Rebore cylinder and replace pistons and others
	Piston ring gaps incorrectly positioned	Correct
	Piston rings set with wrong side up	Correct
	Piston rings sticking	Rebore cylinder and replace pistons and others
	Piston ring and ring groove worn	Replace pistons and others
	Return ports in oil rings clogged	Clean piston and replace rings
Crank case ventilation, Positive Crankcase Ventilation System malfunctioning	Positive Crankcase Ventilation Hose clogged	Clean
Others	Improper oil viscosity	Use oil of recommended S.A.E. viscosity
	Continuous high speed driving and or severe usage such as trailer towing	Continuous high speed operation and or severe usage will normally cause increased oil consumption

### Fuel Consumption Excessive

Condition	Possible cause	Correction
Trouble in fuel system	Mixture too rich or too lean due to trouble in fuel injection system	Refer to "Abnormal Combustion"
	Fuel cut function does not act	Refer to "Abnormal Combustion"
Trouble in ignition system	Misfiring or abnormal combustion due to trouble in ignition system	Refer to Hard Start or Abnormal Combustion Troubleshooting Guide
Others	Engine idle speed too high	Reset Idle Air Control Valve
	Returning of accelerator control sluggish	Correct
	Fuel system leakage	Correct or replace
	Clutch slipping	Correct
	Brake drag	Correct
	Selection of transmission gear incorrect	Caution operator of incorrect gear selection

### Oil Problems

Condition	Possible cause	Correction
Oil pressure too low	Wrong oil in use	Replace with correct engine oil
	Relief valve sticking	Replace
	Oil pump not operating properly	Correct or replace
	Oil pump strainer clogged	Clean or replace strainer
	Oil pump worn	Replace
	Oil pressure gauge defective	Correct or replace
	Crankshaft bearing or connecting rod bearing worn	Replace
Oil contamination	Wrong oil in use	Replace with new engine oil
	Oil filter clogged	Replace oil filter
	Cylinder head gasket damage	Replace gasket
	Burned gases leaking	Replace piston and piston rings or rebore cylinders
Oil not reaching valve system	Oil passage in cylinder head or cylinder body clogged	Clean or correct

### Engine Oil Pressure Check

1. Check for dirt, gasoline or water in the engine oil.
  - a. Check the viscosity of the oil.
  - b. Change the oil if the viscosity is outside the specified standard.
  - c. Refer to the "Maintenance and Lubrication" section of this manual.
2. Check the engine oil level.  
 The level should fall somewhere between the "ADD" and the "FULL" marks on the oil level dipstick.  
 If the oil level does not reach the "ADD" mark on the oil level dipstick, engine oil must be added.
3. Remove the oil pressure unit.
4. Install an oil pressure gauge.
5. Start the engine and allow the engine to reach normal operating temperature (About 80°C).
6. Measure the oil pressure.  
**Oil pressure should be:  
 150 kPa(21.8 psi) at idle speed.**
7. Stop the engine.
8. Remove the oil pressure gauge
9. Install the oil pressure unit.
10. Start the engine and check for leaks.



### Malfunction Indicator Lamp

The instrument panel "CHECK ENGINE" Malfunction Indicator lamp (MIL) illuminates by self diagnostic system when the system checks the starting of engine, or senses malfunctions.

Condition	Possible cause	Correction
"CHECK ENGINE" MIL does not illuminate at the starting of engine	Bulb defective	Replace
	MIL circuit open	Correct or replace
	Command signal circuit to operate self diagnostic system shorted	Correct or replace
	Engine Control Module (ECM) cable loosely connected, disconnected or defective	Correct or replace
	ECM defective	Replace
"CHECK ENGINE" MIL illuminates, and stays on	Deterioration heated oxygen sensor of internal element	Replace
	Heated oxygen sensor connector terminal improper contact (If applicable)	Reconnect properly
	Heated oxygen sensor lead wire shorted (If applicable)	Correct
	Heated oxygen sensor circuit open (If applicable)	Correct or replace
	Deterioration engine coolant temperature sensor of internal element	Replace
	Engine coolant temperature sensor connector terminal improper contact	Reconnect properly
	Engine coolant temperature sensor lead wire shorted	Correct
	Engine coolant temperature sensor circuit open	Correct or replace
	Throttle position sensor open or shorted circuits	Correct or replace
	Deterioration of crankshaft position sensor	Replace
	Crankshaft position sensor circuit open or shorted	Correct or replace
	Vehicle speed sensor circuit open	Correct or replace
	Manifold absolute pressure sensor circuit open or shorted	Correct or replace
	Intake air temperature sensor circuit open or shorted	Correct or replace
	Fuel injector circuit open or shorted	Correct or replace
	ECM driver transistor defective	Replace EPROM or ECM
	Malfunctioning of ECM RAM (Random Access Memory) or Malfunctioning of ECM PROM (Programmed Read Only Memory)	Replace EPROM or ECM

## SECTION 6A

# ENGINE MECHANICAL

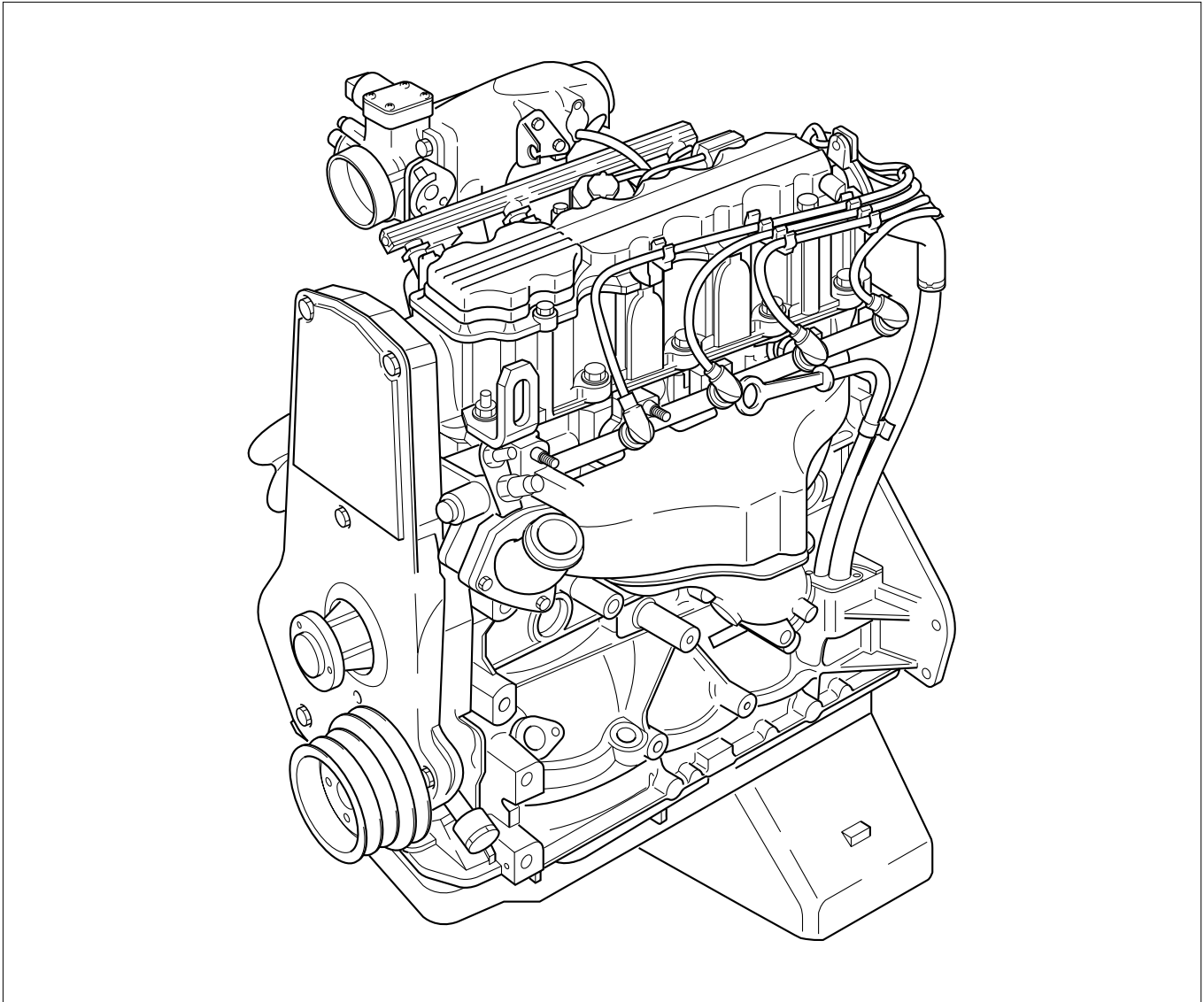
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## GENERAL DESCRIPTION



### 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 surfaced 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 four cylinders of this engine are identified by numbers; cylinders 1, 2, 3 and 4, as counted from crankshaft pulley.

### 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 cast iron. The crankshaft is supported by five bearings. The bearing cap is made of nodular cast iron.

## **Cylinder Head**

The cylinder head is made of aluminum alloy casting with a spark plug in the center.

## **Valve Train**

Valve system is a single over head camshaft.  
The valves clearance adjustment are hydraulic.  
Hydraulic valve lifter adjustment, no adjustment necessary.

## **Intake Manifold**

The intake manifold is made of aluminum alloy.

## **Exhaust Manifold**

The exhaust manifold is made of high Si-Mo nodular iron.

## **Pistons and Connecting Rods**

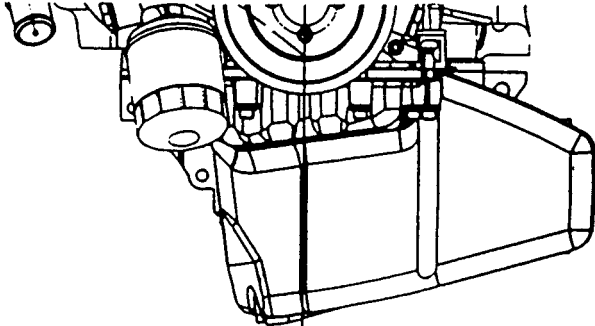
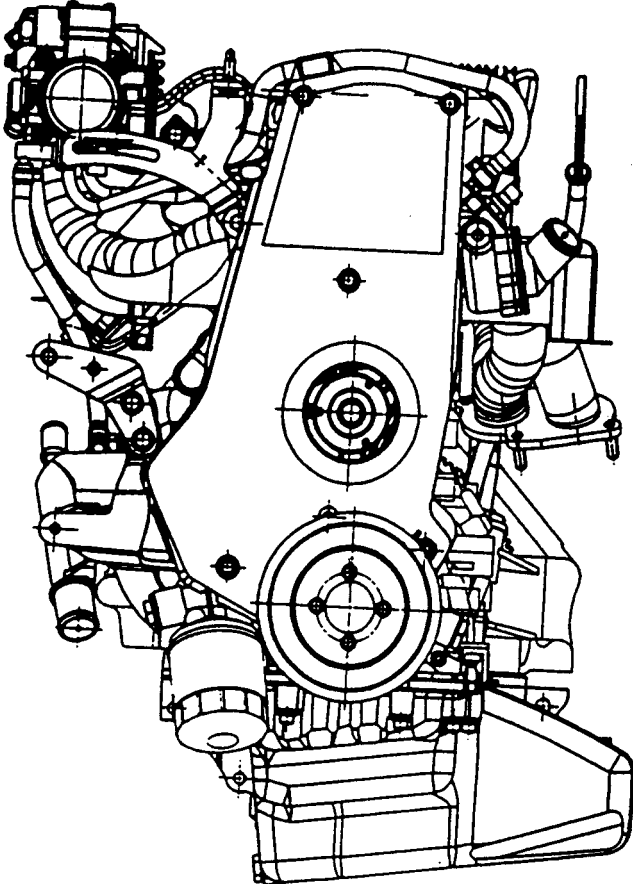
Aluminum pistons are used after selecting the grade that meets the cylinder bore diameter. Each piston has two compression rings and one oil ring. The piston pin is made of cast hardened steel. The connecting rod bearings are made of modular cast iron. The connecting rod bearings are made of steel backed with tri-metal babbitt metal.

## **Crankshaft and Bearings**

The crank shaft is made of modular cast iron. Pins and journal are graded for correct size selection for their bearing.

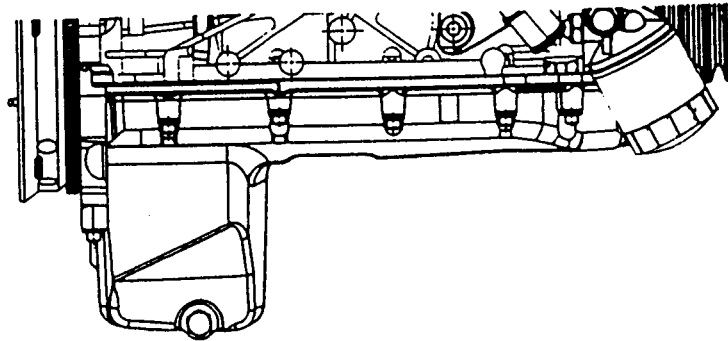
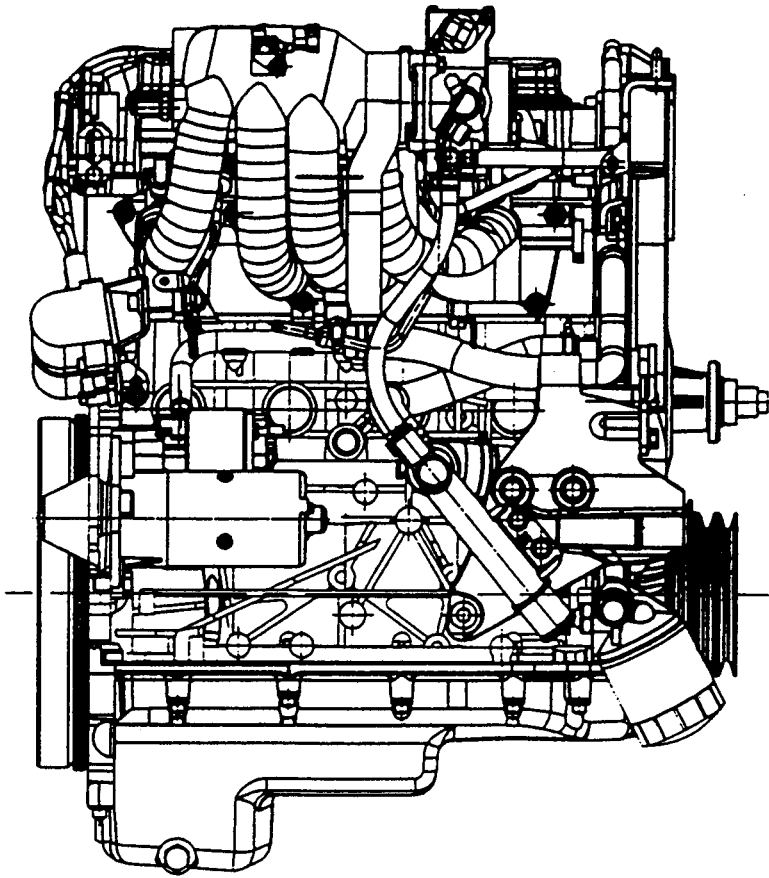
# ENGINE PICTORIAL

## Front View



“4WD OIL PAN”

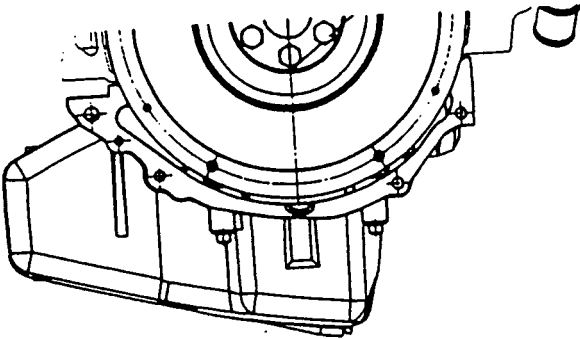
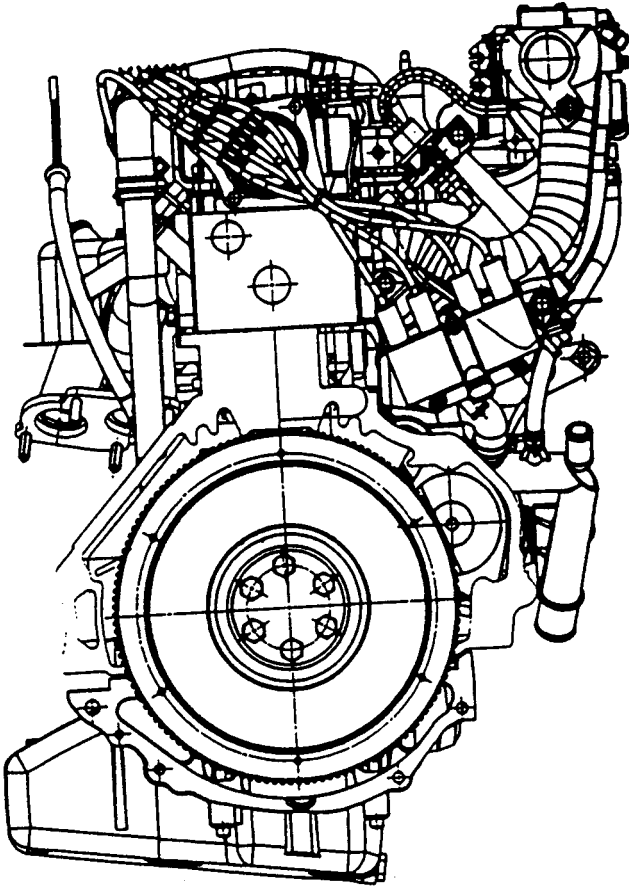
## Inlet Side View



"4WD OIL PAN"

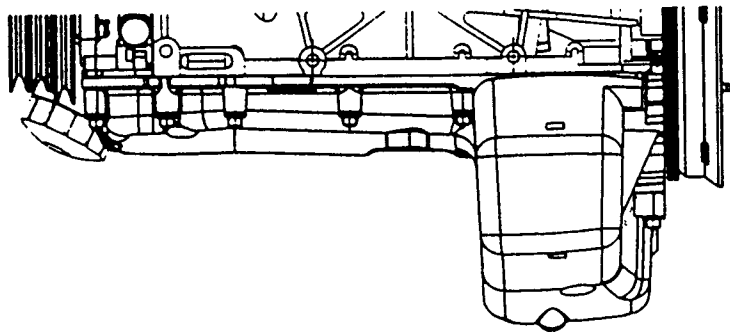
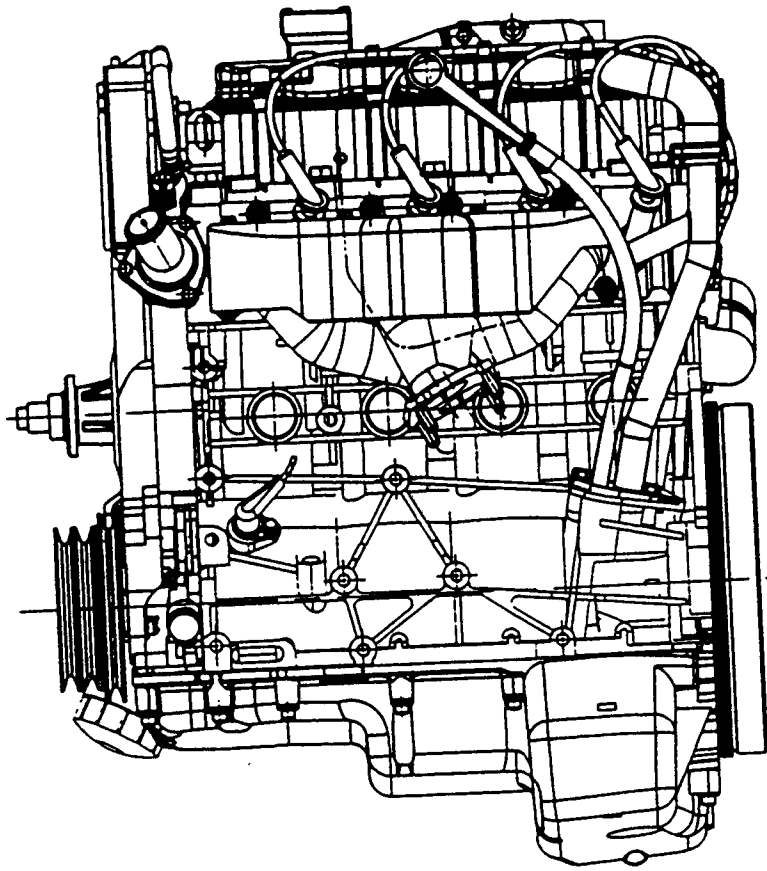


# Rear View



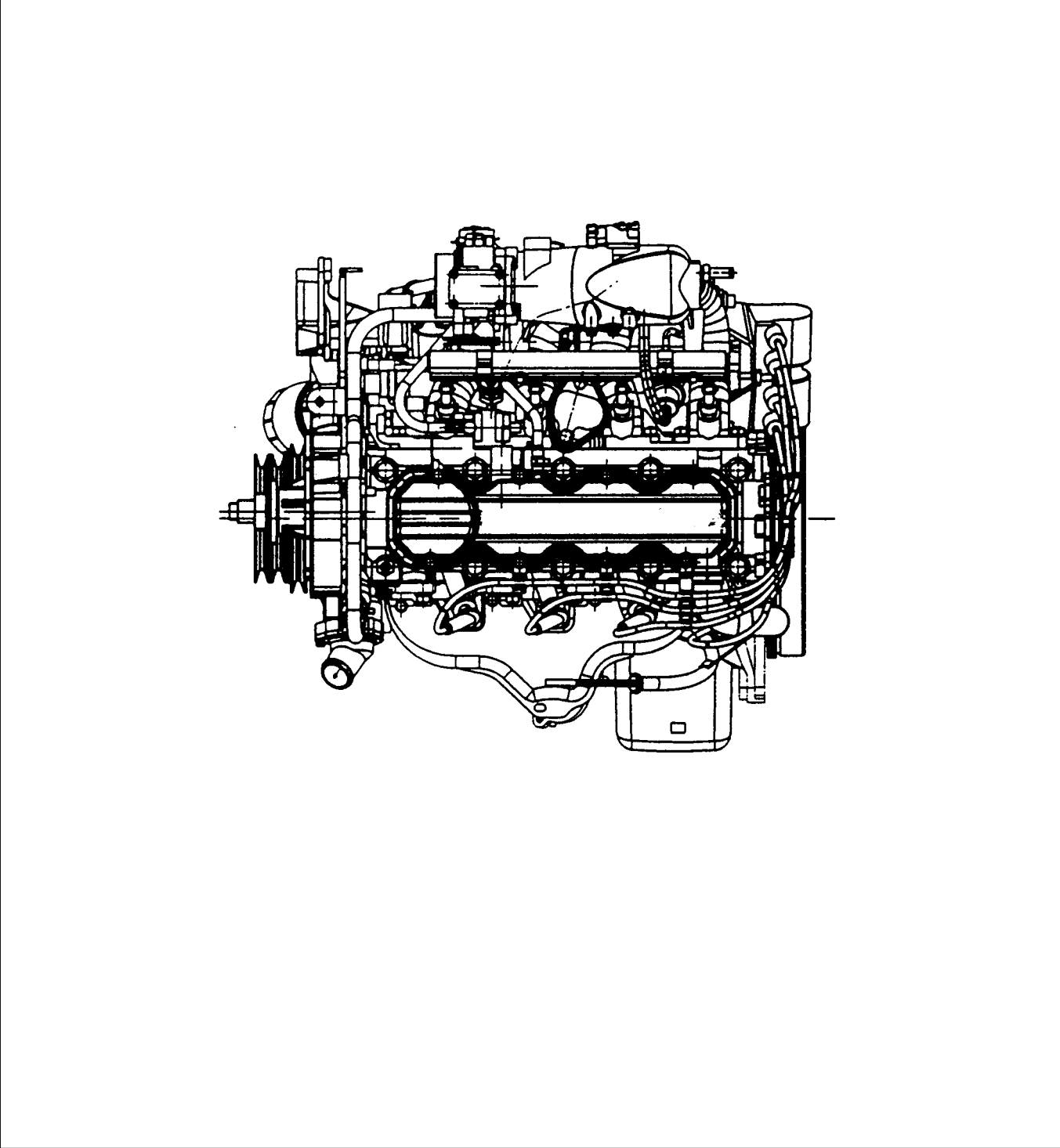
"4WD OIL PAN"

## Exhaust Side View



"4WD OIL PAN"

# Top View



## Main Data and Specifications

Engine - General	C22NE	22LE	20LE
Engine type	Four-cycle, water cooled cross-flow with single over head camshaft Micro-computer control, fuel injection		
Combustion chamber type (Volume)	Hemispherical (43.3cm <sup>3</sup> )	<--	<--
Timing train system	Belt drive	<--	<--
No.of cylinders-bore × stroke mm (in)	4-86.0×94.6 (3.39×3.72)	<--	4-86.0×94.6 (3.39×3.72)
Bore Spacing (C/L to C/L)		93.0 mm	
Firing Order	1-3-4-2	<--	<--
Bore×Stroke	86.0×94.6mm		86.0×86.0
Total piston displacement cm <sup>3</sup> (in <sup>3</sup> )	2,198 (134.39)		1,998 (122.16)
Combustion Chamber Volume		43.3 cm	
No.of piston ring	compression ring : 2 ,oil ring :1		
Compression pressure kg/cm <sup>2</sup> (psi/pa)		17.8 (253/1746)	
Ignition timing (BTDC)	No adjustment		
Idling speed :rpm (WO/AC,W/AC) Acoff		825	
Valve clearances (At cold)			
Intake mm (in)	0 (0) (Hydraulic valve lash adjustment)		
Exhaust mm (in)	0 (0) ( " )		
Intake valves			
Open at (BTDC) deg	29	<--	<--
Close at (ABDC) deg	65	<--	<--
Exhaust valves			
Open at (BBDC) deg	66	<--	<--
Close at (ATDC) deg	29	<--	<--
Ignition system	Fully transistorized battery ignition		
Distributor type	Not applicable, Electronic Spark Timing control		
Distributor advance type	Not applicable, Electronic Spark Timing control		
Spark plug type	RN9YC4		
Spark plug gap mm (in)	1.0--1.1 (0.039--0.043)		
Lubrication system			
Lubricating method	Fully flow pressure circulation		
Special engine oil (API grade)	SE,SF,SG or SH grade		
Oil pressure kg/cm <sup>2</sup> (psi/Pa) rpm	1.5 (21.3/147)/825 (SAE 10W-30/API SE grade) engine oil after warm-up		
Oil pump type	Gear		
Oil filter type	Cartridge full flow		
Oil capacity lit. (US/UK gal.)	with Oil Filter change 4.5litres without Oil Filter change 4.25 (1.07/0.93) litres		
Cooling system			
Radiator type	Corrugated fin with reserve tank		
Coolant capacity lit. (US/UK gal.)	2.3 (0.66/0.55)	←	←
Water pump type	Centrifugal	←	←
Thermostat	Wax pellet with jiggle hole		
Fuel system	Electronically controlled Multi Port Fuel Injection System		
Fuel pump type	Electric		

**6A-12 ENGINE MECHANICAL (C22NE, 22LE, 20LE)**

Engine - General	C22NE	22LE	20LE
Fuel pressure kg/cm <sup>2</sup> (psi/Pa)	3.4 (48.4/334)	<--	<--
Fuel filter type	Cartridge paper element		
Air cleaner type	Dry paper element	<--	<--
Battery Type/V-Ax No. of units	50D20L (STD)		34B19L 46B24L
Alternator			
Capacity V-A(W)	12-70 (840)	<--	<--
Starter			
Output V-kW	1.2-1.4	<--	<--
Exhaust system CO Adjustment	(1) Applicable to Open Loop System (Not equipped H2OS) (2) Not applicable to Closed Loop System (Equipped H2OS)		
Compression Ratio (with Tolerance)	9.2:1±0.3	8.6:1±0.3	8.8:1±0.3
Cylinder Head Material	Aluminum Alloy (gravity cast)		
Cylinder Block Material	Cast Iron		
No.of Mounting Points (including trans.)	3		
Engine Installation Angles-Longitudinal	3° 30'		
-Lateral	7° 50' (towards exhaust side)		
Overall Dimensions (L × W × H):			
- TF (2.2Litre/2WD)	610×550×744 mm		
- TF (2.2Litre/4WD)	610×550×708 mm		
- TF (2.0Litre/2WD)	610×550×734 mm		
Engine Weight - TF (2.2Liter/Man)	136kg		
- TF (2.0Liter/Man)	134kg		
Camshaft Type	SOHC		
No.of Valves per Cylinder - Inlet	1		
- Exhaust	1		
Spark Plug Location	Side		
Port Arrangement	Cross Flow		
Working Principle	Spark Ignition 4-stroke		

<b>Valve System</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Actuation Type	Direct-acting Inverted Bucked Tappet		
Valve Clearance Adjustment	Hydraulic		
Valve Rotor Type	None		
Inlet-Valve Material	Chromium Alloyed Steel		
-Seat Insert Material	Sintered Iron		
Exhaust-Valve Material	Head:Cr-Mn-Ni Alloyed		
-Seat Insert Material	Shaft:Cr-Si Alloyed&Cr plated		
Valve Spring Material	Sintered Iron		
Valve Guide Material	GME 06 100-C1		
Valve Seal Type	QS 13 MR 00		
	Lip		

<b>Water Pump</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Type	Centrifugal		
Drive-Material&Type	HNBR Toothed-belt		
Bearing Type	Double Row Ball		
Shaft Seal Type	Mechanical Ceramic		

<b>Thermostat-Coolant</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Type	Bypass		

<b>Oil Pump &amp; Filter</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Type	Gear Pump		
Location	Front of Engine		
Drive	Direct Crankshaft Driven		
Filter Type	Full Flow with Bypass for blocked filter		

<b>Oil&amp;Oil Reservoir</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Reservoir-Description&Location	1-piece below Engine		
Reservoir Material	Aluminium Alloy (pressure cast)		
Replacement Oil Fill Volume			
-With Filter change	4500 cm <sup>3</sup>		
-without Filter change	4250 cm <sup>3</sup>		
Recommended Oil-Run-in	10W/30SG		
-Service (above-18°C)	10W/40SG		
-Service (below-18°C)	5W/30SG		
Oil Classification	API&CCMC		

<b>Ignition Components</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Spark Plugs	Conventional		
Type	Electronic Spark Control		
No.of Coils&Type	2 Solid State		
Coil Location	Engine-mounted		
Ignition Lead Type	Inductive (hi-resistance)		

**6A-14 ENGINE MECHANICAL (C22NE, 22LE, 20LE)**

<b>Crankshaft</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Material	Nodular Cast Iron		
Bearing subjected to End Thrust	Guide Bearing NO.3		
Main Bearing-Material&Type	Steel Backed Tri-metal Babbitt		
Front Seal-Diameter&Type	35.0mm Lip Seal		
Rear seal-Diameter&Type	90.0mm Micro-lip Seal		
Crankshaft Balancing	Individually Balanced		
No.of Counterweights	8		

<b>Camshaft</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Location	Overhead(Cylinder Head)		
Material	Chilled Cast Iron		
Bearing Material	Aluminium		
No.of Bearings	HNB 5		
Camshaft Drive-Material&Type			

<b>Pistons</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Material	Aluminium Alloy		
Finish & Type	Tin-coated Strutless		

<b>Piston Rings</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Function (top to bottom) -Ring 1	Compression Ring		
-Ring 2	Compression Ring		
-Ring 3	Oil Ring		
Description-Ring 1	Rectangular		
-Ring 2	Taper Face		
-Ring 3	3-piece (2 Scrapers&1 Expander)		
Material-Ring 1	Molybdenum Inlay Nodular Cast Iron		
-Ring 2	Cast Iron (individually cast)		
-Ring 3	Steel		

<b>Piston Pins</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Material	Case Hardened Steel		
Retention	Locked in Rod		
Bearing	Machined in Piston Pin Boss		

<b>Connecting Rod</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Material	Nodular Cast Iron		
Bearing-Material&Type	Steel Backed Tri-metal Babbitt		

<b>Inlet Manifold</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Material	Aluminium Alloy		

<b>Exhaust Manifold</b>	<b>C22NE</b>	<b>22LE</b>	<b>20LE</b>
Description	Dual Take-down		
Material	High Si-Mo Nodular Iron		

## Engine Specification Matrix for destination

99 HEC FOR TF MODEL: VEHICLE MODEL TFR/S (141)	2.2L			
Major Description	AUSTRALIA NEW ZEALAND	CHILE GUATEMALA  COSTA RICA	COLOMBIA	
VEHICLE TYPE	4x2	4x2	4x4	4x2
VEHICLE IDENT. CODE	TA	TC	TD	TC
ENGINE TYPE	C22NE	<--	<--	<--
FUEL CONTROL SYSYTEM	OPEN LOOP	CLOSED LOOP		CLOSED LOOP
COMPRESSION RATIO	9.2:1	<--	<--	<--
FUEL OCTANE(ROD)	91RON	85RON		85RON
FUEL TYPE	UN-LEADED	UN-LEADED		UN-LEADED
HO2	NO	YES	YES	YES
EVAP CANISTER	YES	YES	YES	YES
PURGE CONTROL SOLENOID	YES	YES	YES	YES
CHECK & RELIEF VALVE	YES	YES	YES	YES
ECM	YES	YES	YES	YES
EXHAUST SYSTEM				
FRONT PIPE				
SILENCER				
TWC	YES	YES	YES	YES
CO ADJUSTMENT	YES	NO	NO	NO
	Refer to 6A-78	Refer to 6A-78		Refer to 6A-78



**6A-16 ENGINE MECHANICAL (C22NE, 22LE, 20LE)**

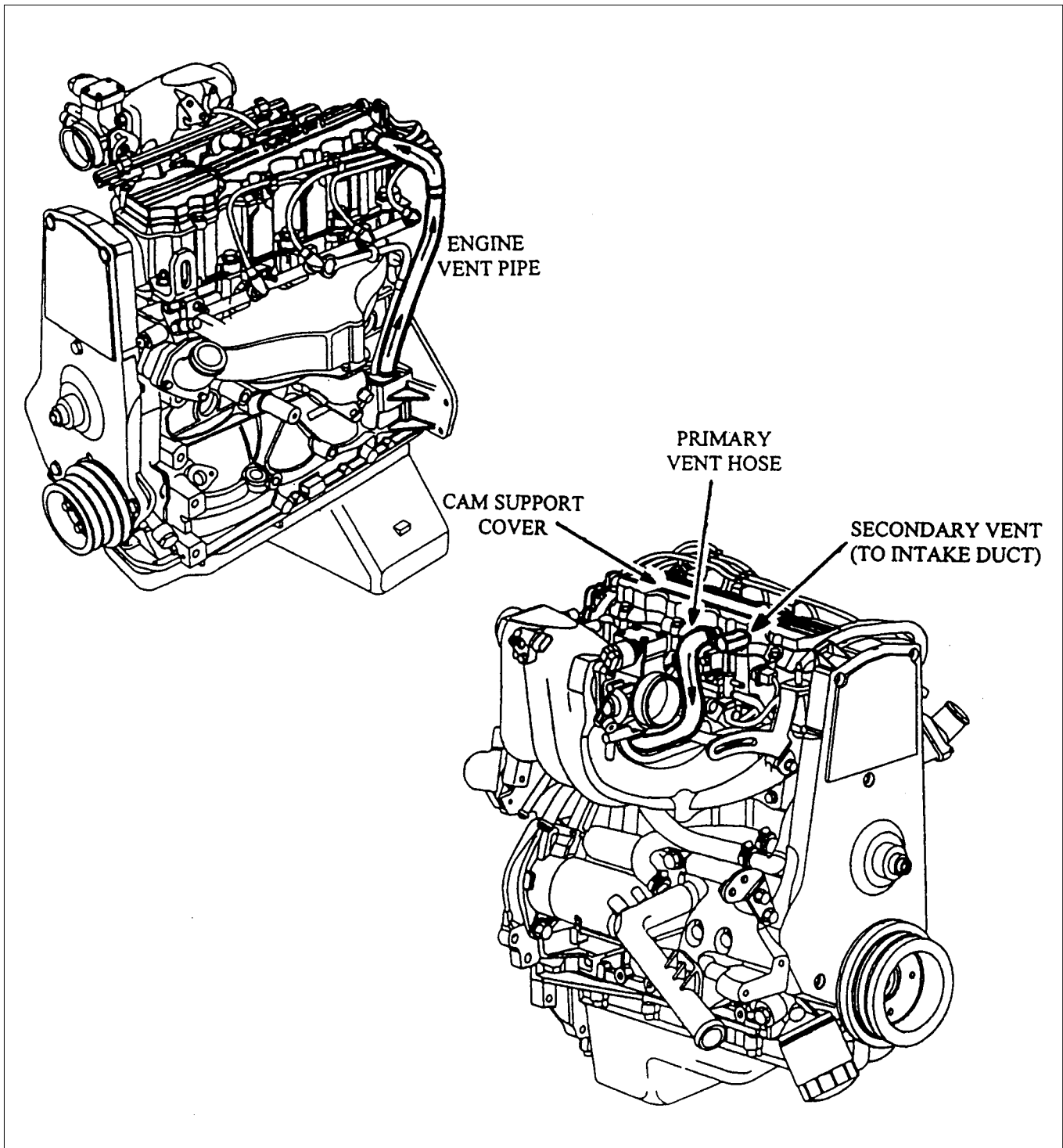
99 HEC FOR TF MODEL: VEHICLE MODEL TFR/S(141)	2.2L				
	COLOMBIA	SOUTH AFRICA			EQUADOR
VEHICLE TYPE	4x4	4x2	4x4	4x4	4x2
VEHICLE IDENT. CODE	TN	TN	TN	TN	TT
ENGINE TYPE	<--	<--		<--	22LE
FUEL CONTROL SYSYTEM	CLOSED LOOP	OPEN LOOP	OPEN LOOP	CLOSED LOOP	OPEN LOOP
COMPRESSION RATIO	<--	<--	<--	<--	80RON
FUEL OCTANE(ROD)	85RON	91RON	91RON	85RON	80RON
FUEL TYPE	UN-LEADED	LEADED	LEADED	LEADED	LEADED
		UN-LEADED	UN-LEADED	LN-LEADED	UN-LEADED
HO2	YES	NO	NO	NO	NO
EVAP CANISTER	YES	YES	NO	NO	YES
PURGE CONTROL SOLENOID	YES	NO	YES	YES	YES
CHECK RELIEF VALVE	YES	NO	NO	NO	YES
ECM	YES	YES	YES	YES	YES
EXHAUST SYSTEM					
FRONT PIPE					
SILENCER					
TWC	YES	NO	NO	YES	NO
CO ADJUSTMENT	NO	YES	YES	NO	YES
	Refer to 6A-78	Refer to 6A-78		Refer to 6A-78	Refer to 6A-78

**ENGINE MECHANICAL (C22NE, 22LE, 20LE) 6A-17**

<b>99 HEC FOR TF MODEL:</b> VEHICLE MODEL TFR/S (141)	<b>2.2L</b>			<b>2.0L</b>
	EQUADOR	CHILE, GULF, KENYA, EGYPT CHINA, NIGERIA, PHILIPPINE		SOUTH AFRICA
VEHICLE TYPE	4x4	4x2	4x4	4x2
VEHICLE IDENT. CODE	TT	TT	TU	TP
ENGINE TYPE	22LE	<--		20LE
FUEL CONTROL SYSYTEM	OPEN LOOP	OPEN LOOP	OPEN LOOP	OPEN LOOP
COMPRESSION RATIO	8.6:1	<--		8.8:1
FUEL OCTANE(ROD)	80RON	80RON	80RON	91RON
FUEL TYPE	LEADED	LEADED	LEADED	LEADED
	<--	<--	<--	<--
HO2	NO	NO	NO	NO
EVAP CANISTER	YES	YES	YES	NO
PURGE CONTROL SOLENOID	YES	YES (*)	YES (*)	NO
CHECK RELIEF VALVE	YES	YES (*)	YES (*)	NO
ECM	YES	YES	YES	YES
EXHAUST SYSTEM				
FRONT PIPE				
SILENCER				
TWC	NO	NO	NO	NO
CD ADJUSTMENT	YES	YES	YES	YES
	Refer to 6A-78	Refer to 6A-78		Refer to 6A-78

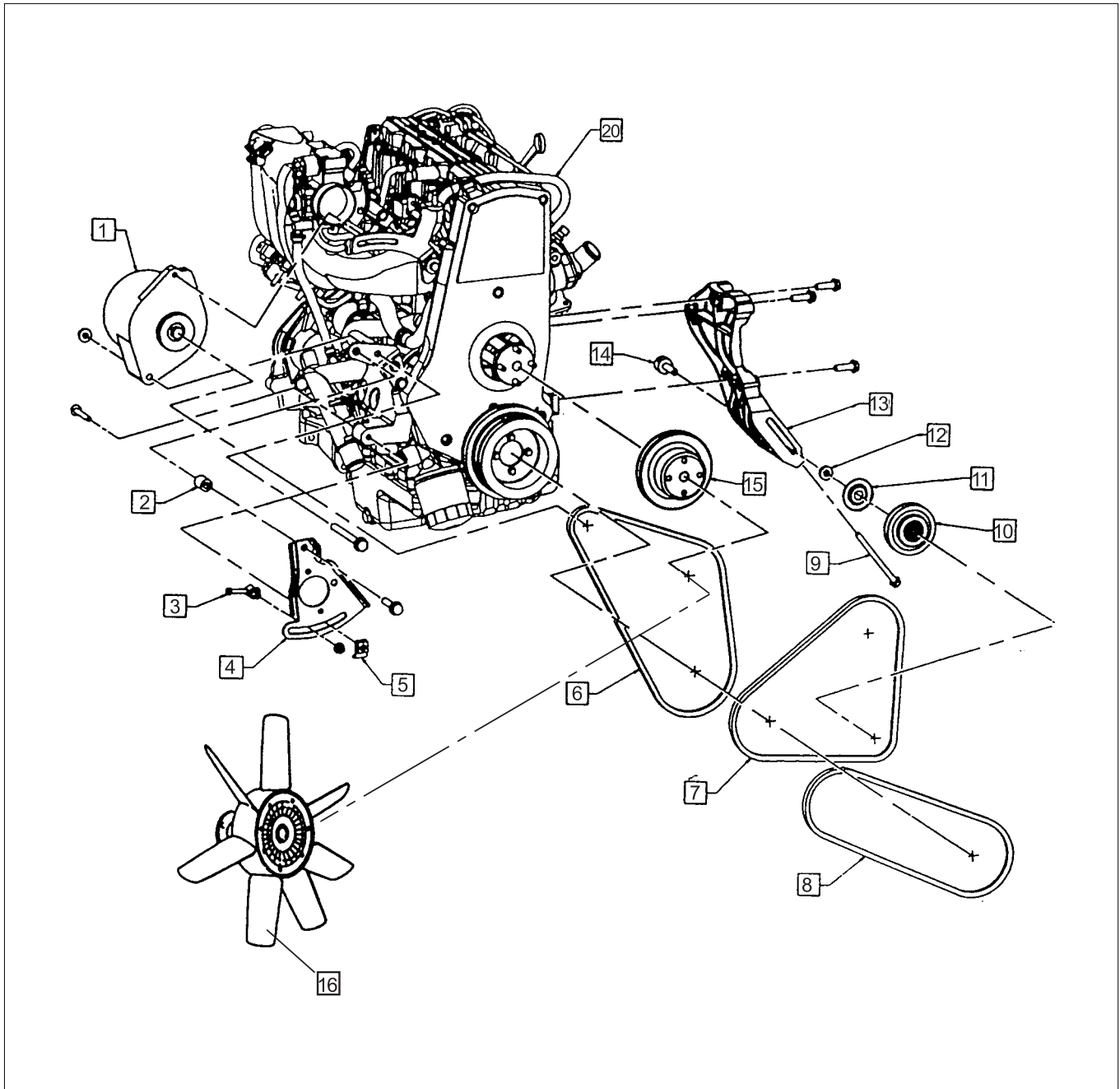
NOTE: (\*) for Chile and Gulf

## CRANKCASE VENTILATION SYSTEM



The Engine Ventilation System passes crankcase vapours, via the Engine Vent Pipe, to the Cam Support Cover, where separation of oil and exhaust gases occur. The oil drains into the Cylinder Head, via the Camshaft Support. The gases pass through the Primary and Secondary Vent Hoses to the intake system, and are consumed during the combustion process.

## ENGINE ASSEMBLY & LOOSE PARTS



### Loose Parts

- 1 Alternator
- 2 P/S Pivot Spacer
- 3 P/S Adjusting Screw
- 4 P/S Adjusting Plate
- 5 P/S Adjusting Nut
- 6 Alternator & Fan Drive Belt
- 7 A/C Compressor Drive Belt
- 8 P/S Pump Drive Belt
- 9 Tensioner Bolt

- 10 Tensioner Pulley
- 11 Pulley Dust Shield Cover
- 12 Pulley Spacer
- 13 A/C Compressor Bracket
- 14 Pulley Bolt
- 15 Fan Pulley
- 16 Cooling Fan

### Engine Assembly

- 20 C22NE, 22LE, 20LE

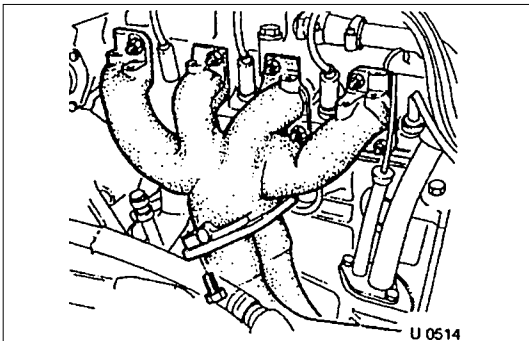
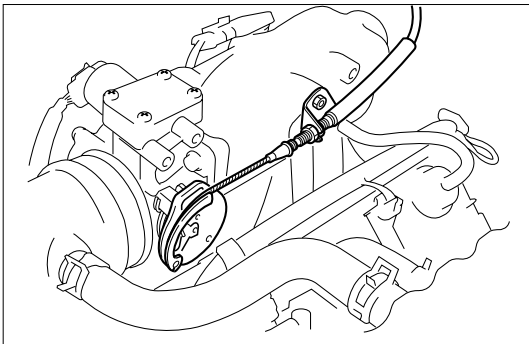
## OPERATIONS ON ENGINE AGGREGATES

### Engine Damping Blocks (Engine Without Transmission)

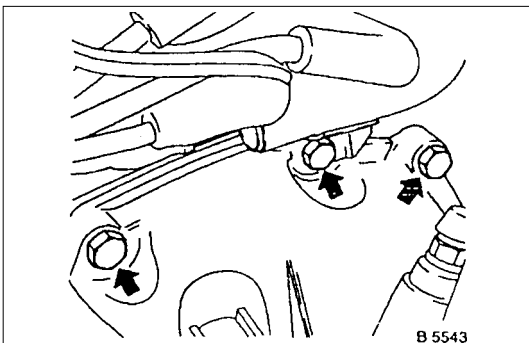


#### Removal

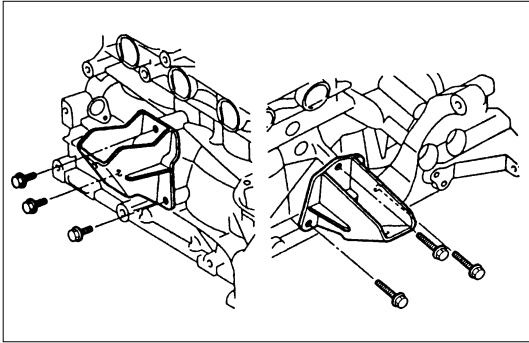
1. Remove bonnet.
2. Remove radiator.
3. Remove air inlet hose.
4. Remove power steering pump drive belt and power steering pump from engine.
5. Remove all cable connections, hoses and lines from engine.
6. Remove accelerator cable from inlet pipe.



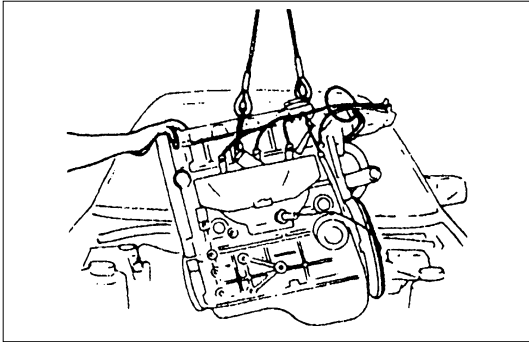
7. Remove exhaust pipe from manifold.



8. Remove lower nine bolts and transmission from engine block.
9. Remove clutch slave cylinder and allow to hang free.
10. Remove starter from engine block.



11. Remove upper bolts of left and right engine mounting from damping blocks.
12. Raise engine slightly.
13. Remove lower bolts of left and right damping blocks.
14. Remove damping blocks.



Attach engine to cable, support transmission with car jack and remove upper transmission fastening bolt.

Press off engine from transmission and lift out of engine compartment.



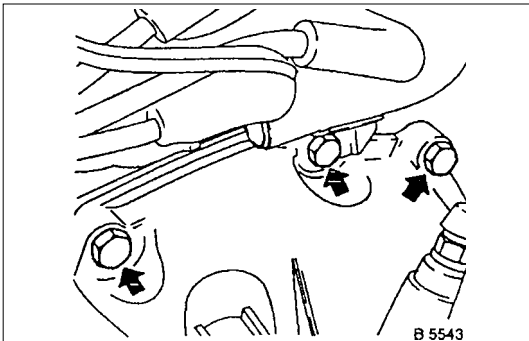
### Installation

Lower engine into engine compartment and insert guide bushings on cylinder block into transmission.



### Tighten (Torque)

Transmission to cylinder block (M10) -45 N·m (4.6 kgf·m)  
 Transmission to cylinder block (M12) -60 N·m (6.1 kgf·m)



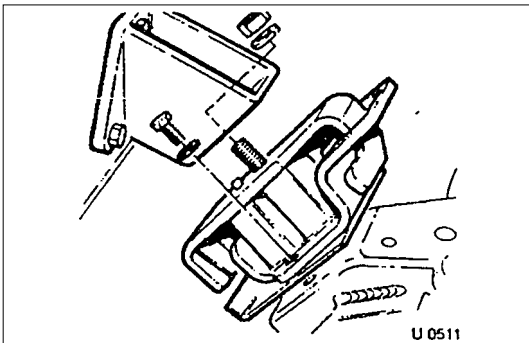
### Installation

1. Install engine to vehicle and transmission.
2. Install clutch slave cylinder.



### Tighten (Torque)

Transmission to engine block bolts - 76 N·m (7.6 kgf·m)

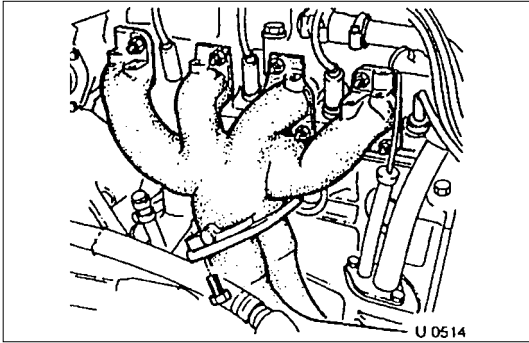


3. Install left engine damping block to sidemember.
4. Install left and right engine damping blocks to engine brackets.

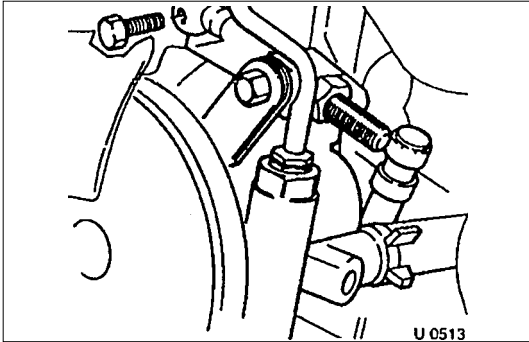


### Tighten (Torque)

Engine damper block to sidemembr - 52 N·m (5.3 kgf·m)  
 Engine damper block to engine bracket - 85 N·m (8.6 kgf·m)



5. Install exhaust pipe to manifold.

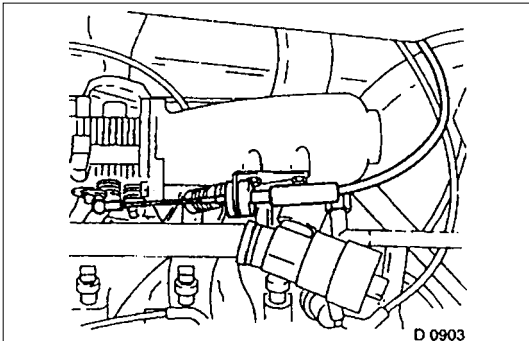


6. Install power steering pump and V-belt.



### Adjust

Adjust power steering pump V-belt tension according to the corresponding operation.



### Installation

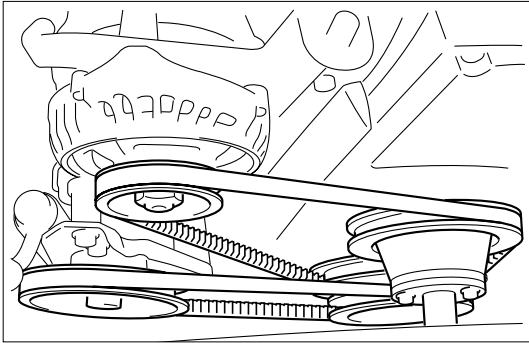
7. Install radiator according to the corresponding operation.
8. Install air inlet hose.
9. Install all electrical cable connections, hoses and lines to engine.
10. Install accelerator cable from inlet pipe.
11. Install bonnet.



### Inspection

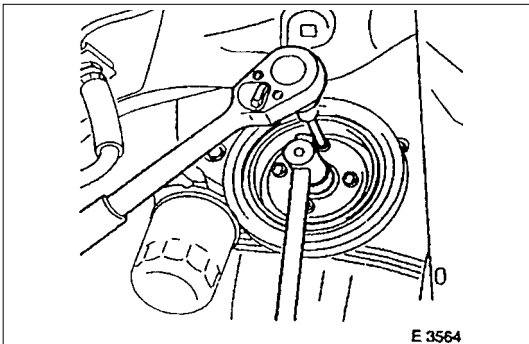
1. Check engine oil level.
2. Fill up cooling system and bleed according to the corresponding operation.

## Toothed Belt and Timing Check

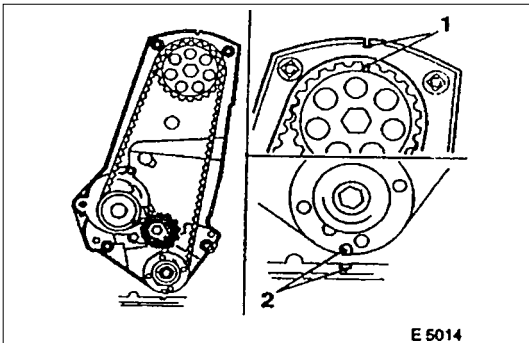


### Removal

1. Remove the belts on the bracket for alternator.
2. Remove the fan.
3. Remove the V-belt for power steering.
4. Remove the V-belt for A/C.
5. Remove the fan belt.
6. Remove the fan shroud.

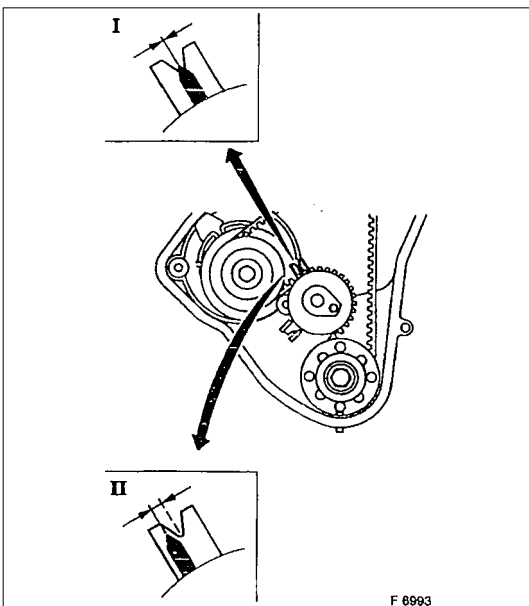


7. Remove the crankshaft pulley while counterholding on the fastening bolt of toothed belt drive gear.
8. Remove the toothed belt from cover.



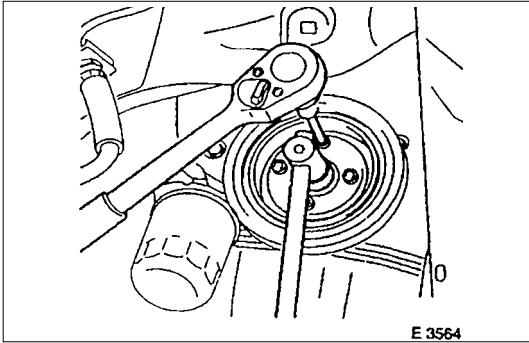
### Inspection

1. Turn the crankshaft in the engine rotational direction mark(2) so that the notch (1) on the camshaft gear aligns with the mark on toothed belt rear cover.
2. Check the timing belt for worn, cracks or oil adhesion.



3. Check that the cast on the water pump aligns with the counterpart on cylinder block (arrowed).
4. The tension of a toothed belt is correctly adjusted when the pointer and the center of the notch are aligned(I). The tension of a run-in toothed belt (regardless of mileage covered) is correctly adjusted when the pointer is positioned approx. 4mm (0.16 in.) to the left of the center of the notch(2).  
Check the condition of the run-in toothed belt for suitability for reuse. Only toothed belts of the toothed belt tension rollers must be replaced and the source of oil contamination must be eliminated.





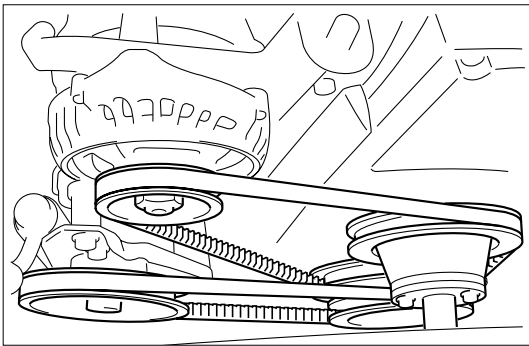
## Installation

1. Install the toothed belt to the cover.
2. Install the crankshaft pulley while counterholding on the fastening bolt of toothed belt drive gear.
3. Install the fan shroud.



## Tighten(Torque)

Crankshaft pulley bolts - 20 N.m (2.1 kgf.m)



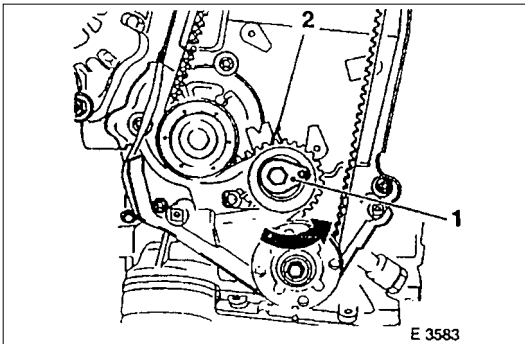
4. Install the fan belt
5. Install the V-belt for A/C.
6. Install the V-belt for power steering.
7. Install the fan.
8. Install the belts on the bracket for alternator.

## Toothed Belt Tension, Adjust (Engines with toothed belt tension roller)



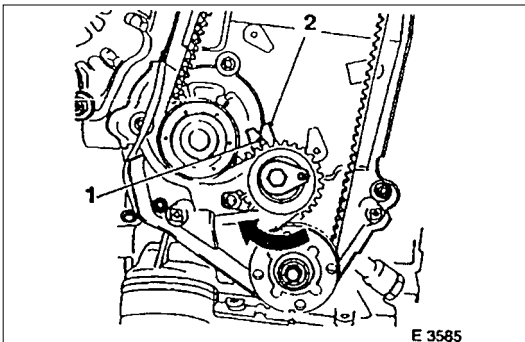
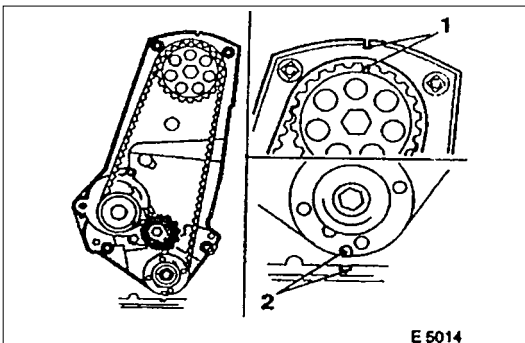
### Removal

Refer to 6A-23. Toothed Belt and Timing check and removal steps.



### Adjust

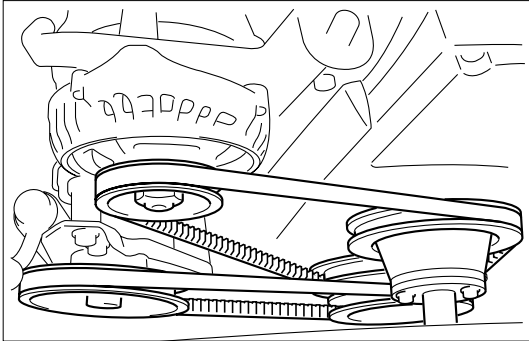
1. Loosen the fastening bolt of the toothed belt tension roller.
2. Turn the toothed belt tension roller at adjustment eccentric(1) in the direction of arrow (counterclockwise), until pointer (2) comes to the right stop.
3. If necessary tighten the fastening bolt of toothed belt tension roller.
4. Rotate the crankshaft twice ( $720^\circ$ ) in the engine rotational direction until marks (2) and (1) align again.
5. Turn the eccentric in the direction of arrow (clockwise) until pointer (1) and notch (2) are positioned to suit age of toothed belt.
6. Rotate the crankshaft twice ( $720^\circ$ ) in the engine rotational direction again and correct adjustment if necessary.



### Installation

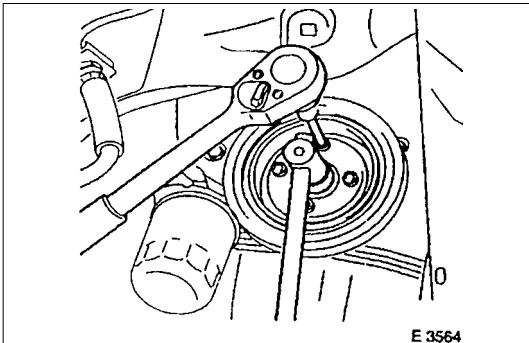
Refer to 6A-24 Toothed Belt and Timing check and installation steps.

## Toothed Belt, Replace (Engine with toothed belt tension roller)



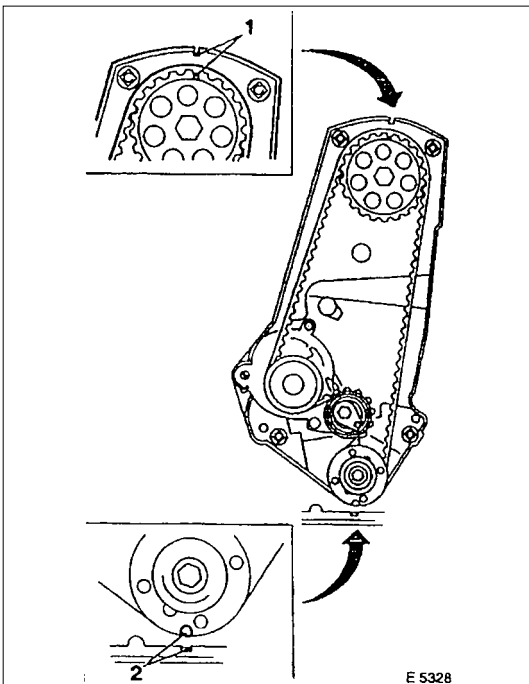
### Removal

1. Remove the belts on the bracket for alternator.
2. Remove the fan.
3. Remove the V-belt for power steering.
4. Remove the V-belt for A/C.
5. Remove the fan belt.
6. Remove the fan shroud.



E 3564

7. Remove the crankshaft pulley while counterholding on the fastening bolt of toothed belt drive gear.
8. Remove the toothed belt from cover.



E 5328

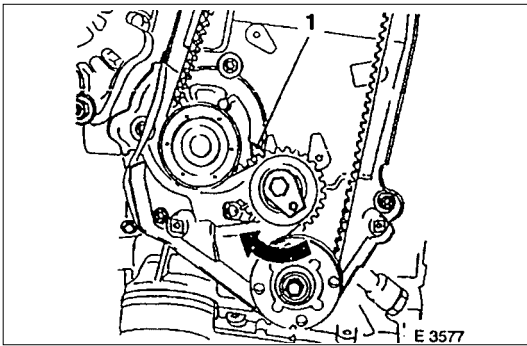


### Adjust

Turn the crankshaft in the engine rotational direction to mark(2).

Align markings on toothed belt and on toothed belt rear cover. Simultaneously, notch (1) on camshaft gear must align with the mark on toothed belt rear cover.

Turn the crankshaft slowly and smoothly.



### Adjust

Loosen the fastening bolt of the toothed belt tension roller and turn the adjustment eccentric in the direction of arrow (clockwise) until pointer (1) comes to the left stop. Remove the toothed belt.



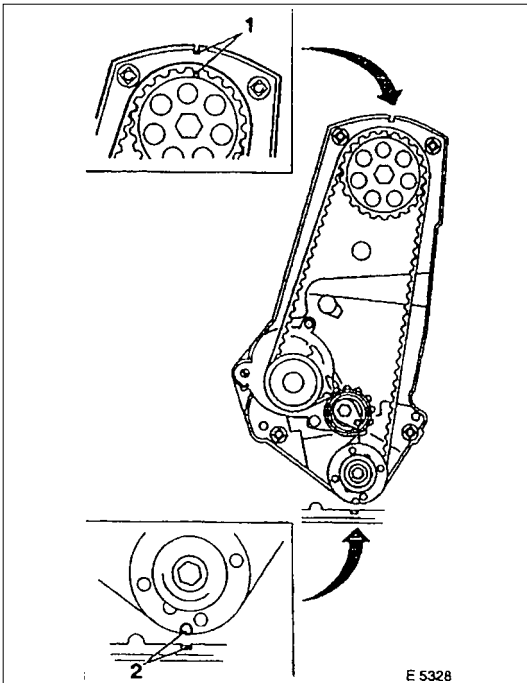
### Installation

1. Install a new toothed belt while keeping tension side taut.



### Adjust

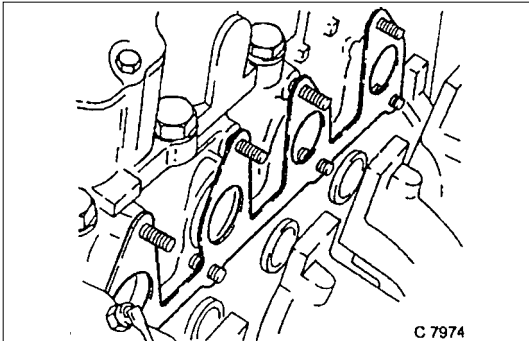
Toothed belt tension - see operation "Toothed Belt Tension".



2. Install the toothed belt to the cover.
3. Install the crankshaft pulley while counterholding on the fastening bolt of toothed belt drive gear.
4. Install the fan shroud.
5. Install the fan belt.
6. Install the V-belt for A/C.
7. Install the V-belt for power steering.
8. Install the fan.
9. Install the belts to the bracket for alternator.

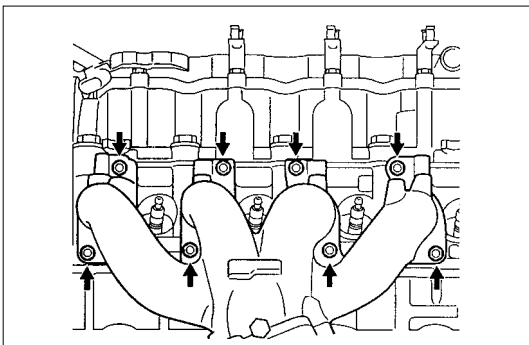
# OPERATIONS ON INSTALLED ENGINE

## SEALING OPERATIONS



### Gasket, Exhaust Manifold, Cylinder Head Removal

1. Remove front exhaust pipe from exhaust manifold.
2. Remove exhaust manifold heat shield.
3. Remove exhaust manifold retaining nut.
4. Remove exhaust manifold from cylinder head.



### Clean

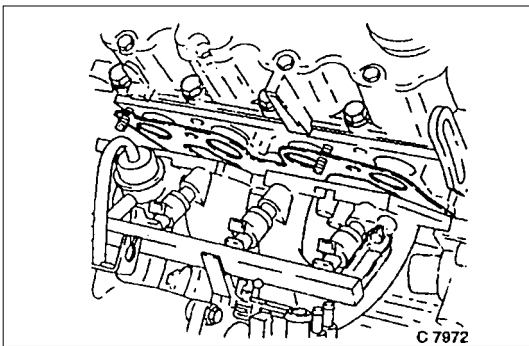
Sealing surfaces.



### Tighten (Torque)

Exhaust manifold to cylinder head - 22 N·m (2.2 kgf·m)

Front exhaust pipe to exhaust manifold - 25 N·m (2.6 kgf·m)



### Gasket, Intake Manifold, Cylinder Head Removal

1. Remove air intake hose.
2. Remove drive belt for alternator.
3. Remove bolt clamping bracket for alternator from intake manifold.
4. Remove intake manifold from cylinder head.



### Clean

Sealing surfaces



### Tighten (Torque)

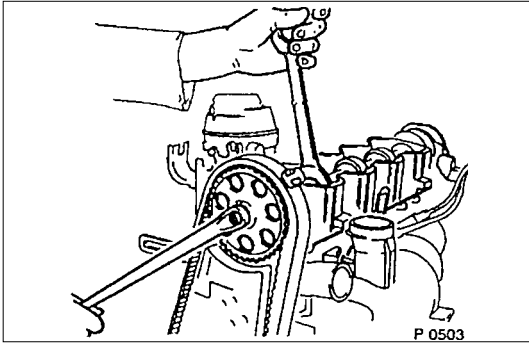
Intake manifold to cylinder head - 22 N·m (2.2 kgf·m)

Clamping bracket for alternator to intake manifold - 25 N·m (2.5 kgf·m)



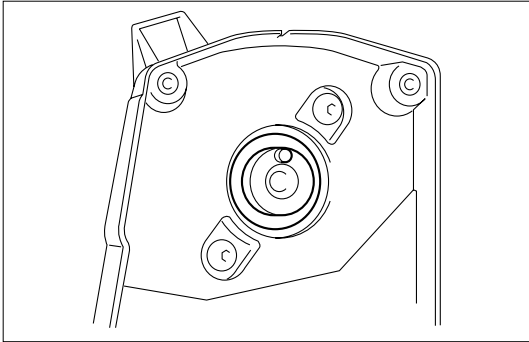
### Installation

1. Install V-belt according to the corresponding operation.
2. Install air intake hose.



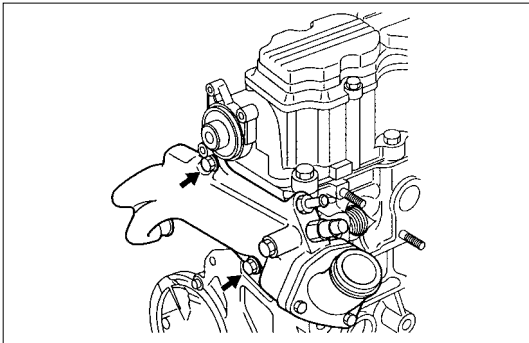
## Seal Ring, Camshaft Housing, Timing Side Removal

1. Remove front toothed belt cover toothed belt from camshaft timing gear according to the corresponding operation.
2. Remove camshaft housing cover and camshaft timing gear.
3. Remove sealing ring by making hole in middle of ring, turning in self-tapping screw and edging out.



## Installation

1. Install sealing ring by using 5-8840-0451-0 with camshaft sprocket bolt and washer.
2. Install coat seal lips of shaft seal ring slightly.



## Seal Ring, Thermostat Housing, Cylinder Head Removal

1. Open radiator drain tap and collect coolant.
2. Remove toothed belt rear cover and toothed belt according to the corresponding operation.
3. Remove camshaft housing cover.
4. Remove camshaft timing gear by counterholding camshaft with a flat spanner.
5. Remove cable from temperature sensor.
6. Remove upper inner hex bolts of rear toothed belt cover.
7. Turn rear toothed belt cover to one side.
8. Remove thermostat housing.
9. Remove sealing ring from cylinder head.



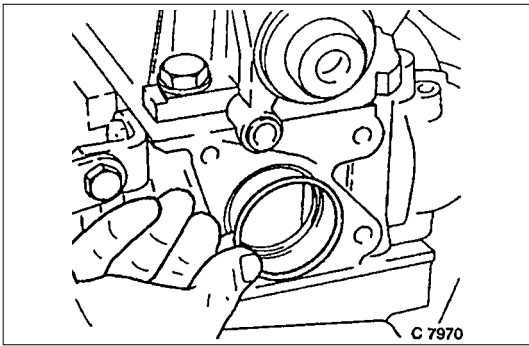
## Clean

Sealing surfaces in cylinder head and thermostat housing.

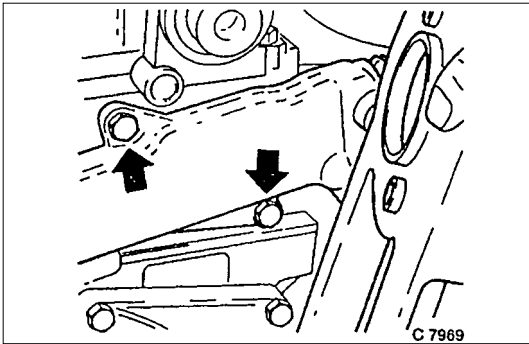


## Installation

1. Install sealing ring in recess of cylinder head.

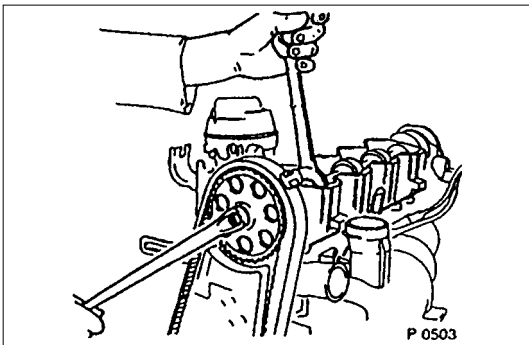


2. Install cable to temperature sensor.
3. Install upper bolts of rear toothed belt rear cover.
4. Install camshaft timing gear then check timing according to the corresponding operation.
5. Install camshaft housing cover.
6. Install toothed belt and front cover.
7. Fill up and bleed cooling system according to the corresponding operation.



### Tighten (Torque)

Thermostat housing to cylinder head - 15 N-m/1.5 kgf-m.

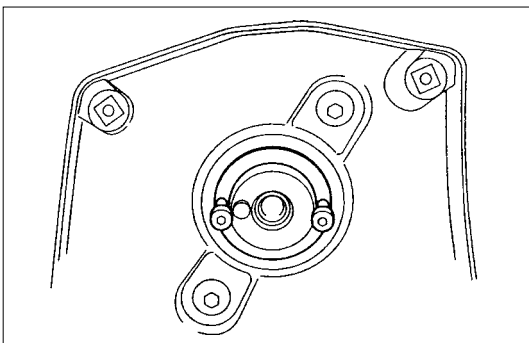


### Seal Ring - Front Camshaft Housing, Replace Removal

Mark running direction of toothed belt.

Remove toothed belt-see operation "Toothed Belt, Replace".

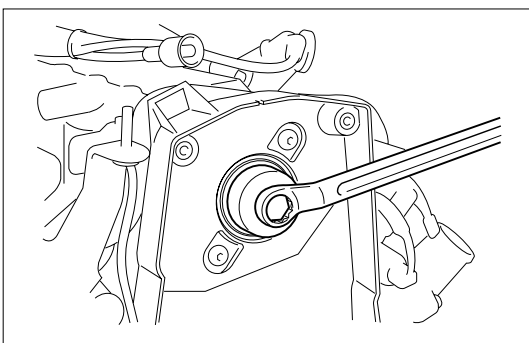
Camshaft housing cover, camshaft pulley-counterhold on hex of camshaft.



### Removal

Screw self-tapping screw into seal ring.

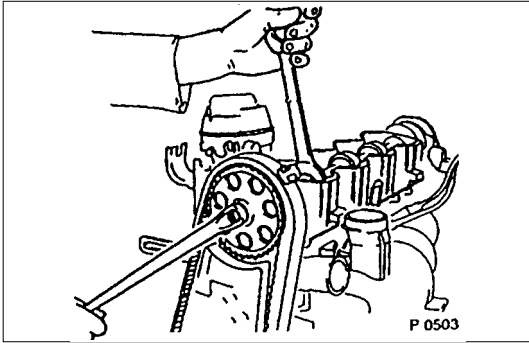
Edge out seal ring.



### Installation

Lightly coat sealing lip of seal ring with protective grease.

Install seal ring with 5-8840-0451-0 into camshaft housing-use screw and washer of camshaft pulley.



### Installation

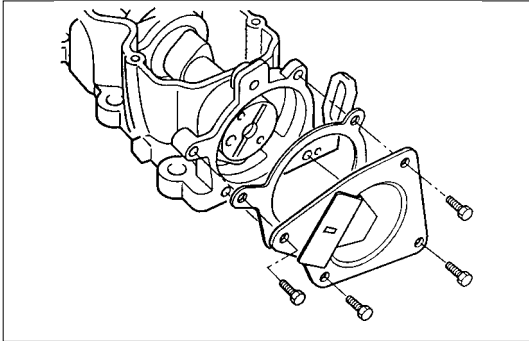
Camshaft pulley-counterhold at hex head of camshaft, camshaft housing cover.

Toothed belt-see operation "Toothed Belt, Replace".  
Note operating erection of toothed belt.



### Tighten (Torque)

Camshaft pulley to camshaft-45 N·m (3.7 kgf·m)

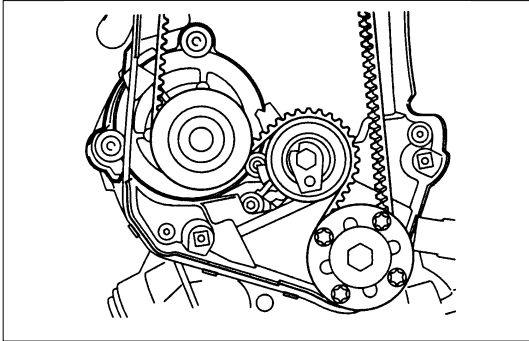


### Tighten (Torque)

Camshaft housing cover to cover to housing-8 N·m (0.8 kgf·m)

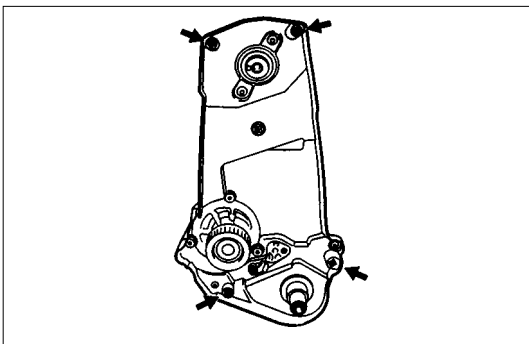
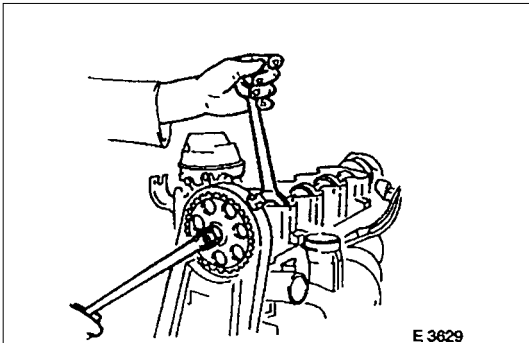
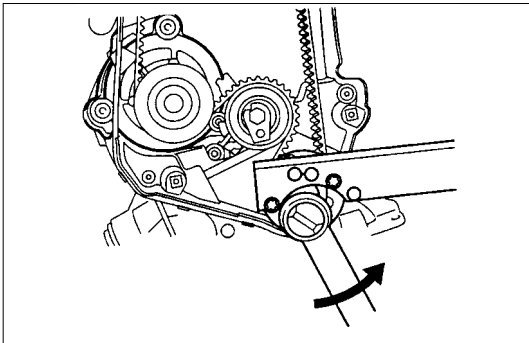


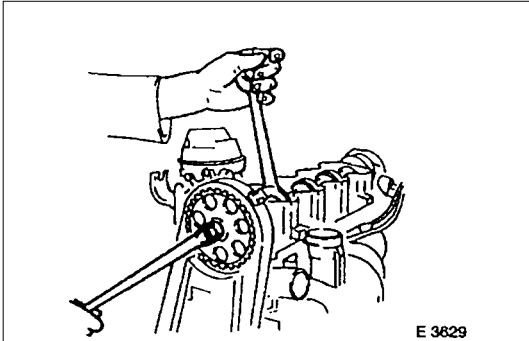
## Toothed Belt Rear Cover (Engine with toothed belt tension roller)



### Removal

1. Mark operating direction of toothed belt.
2. Remove toothed belt according to the operation "Toothed Belt".
3. Remove toothed belt tension roller according to the operation "Toothed Belt Tension Roller".
4. Remove fastening bolt while counterholding with 5-8840-2598-0 (Holding wrench).
5. Remove toothed belt drive gear while counterholding with 5-8840-2598-0 (Holding wrench).
6. Remove camshaft housing cover.
7. Remove camshaft pulley while counterholding at hex head of camshaft.
8. Remove toothed belt rear cover (arrows) from oil pump and camshaft housing.





### Installation

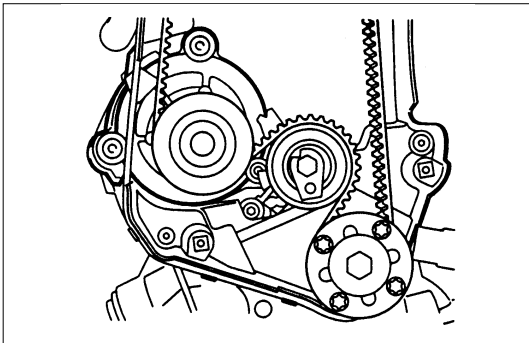
1. Install toothed belt rear cover.
2. Install camshaft pulley while counterholding at camshaft hex head.
3. Install camshaft housing cover.

### Tighten (Torque)

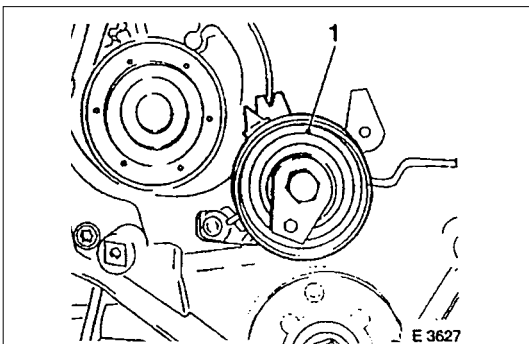
Toothed belt rear cover to oil pump and camshaft housing - 6 N·m/4 lbf ft.

Camshaft housing cover to housing - 6 N·m (0.6 kgf·m).

Camshaft pulley to camshaft - 45 N·m (4.6 kgf·m).



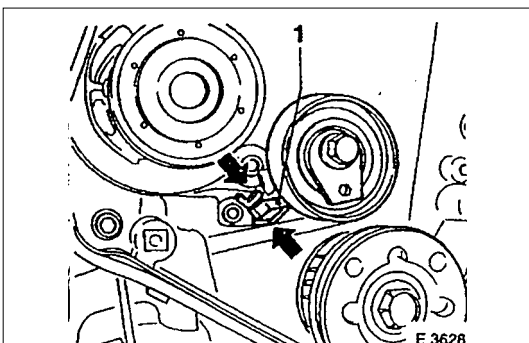
4. Install toothed belt drive gear to crankshaft - 130 N·m (13.3 kgf·m).
5. Install toothed belt according to the operation "Toothed Belt".



### Toothed Belt Tension Roller

#### Removal

1. Mark operating direction of toothed belt.
2. Remove toothed belt according to the operation "Toothed Belt".
3. Remove toothed belt tension roller (1) from oil pump.



#### Installation

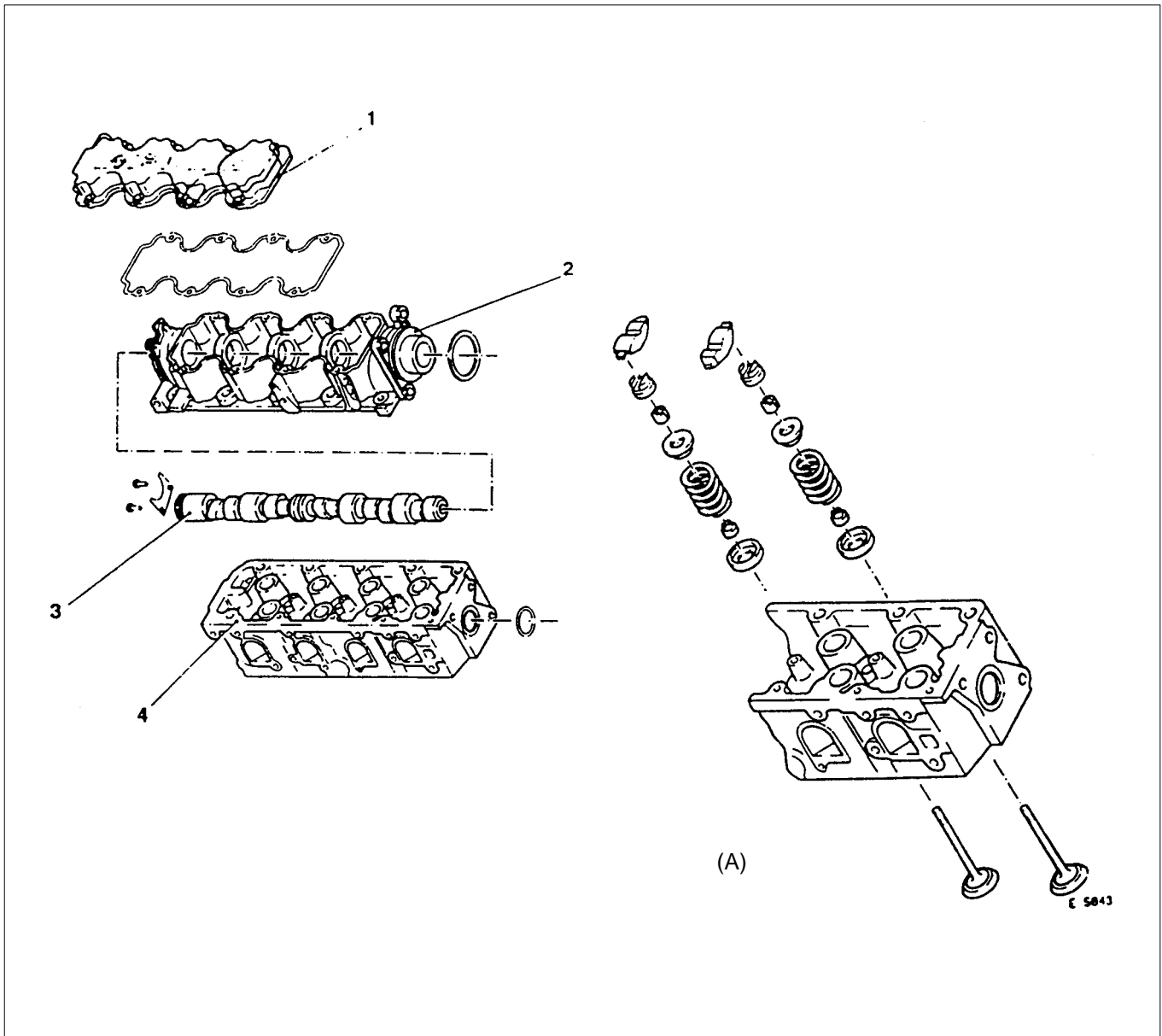
1. Install toothed belt tension roller and make sure that the locking lever (1) engages in the guide lugs (arrowed) on the oil pump housing.
2. Install toothed belt according to the operation "Toothed Belt" with paying attention to the operating direction of toothed belt.

### Tighten (Torque)

Toothed belt tension roller to oil pump - 25 N·m (2.5 kgf·m)

# COMPONENT PARTS

## CYLINDER HEAD

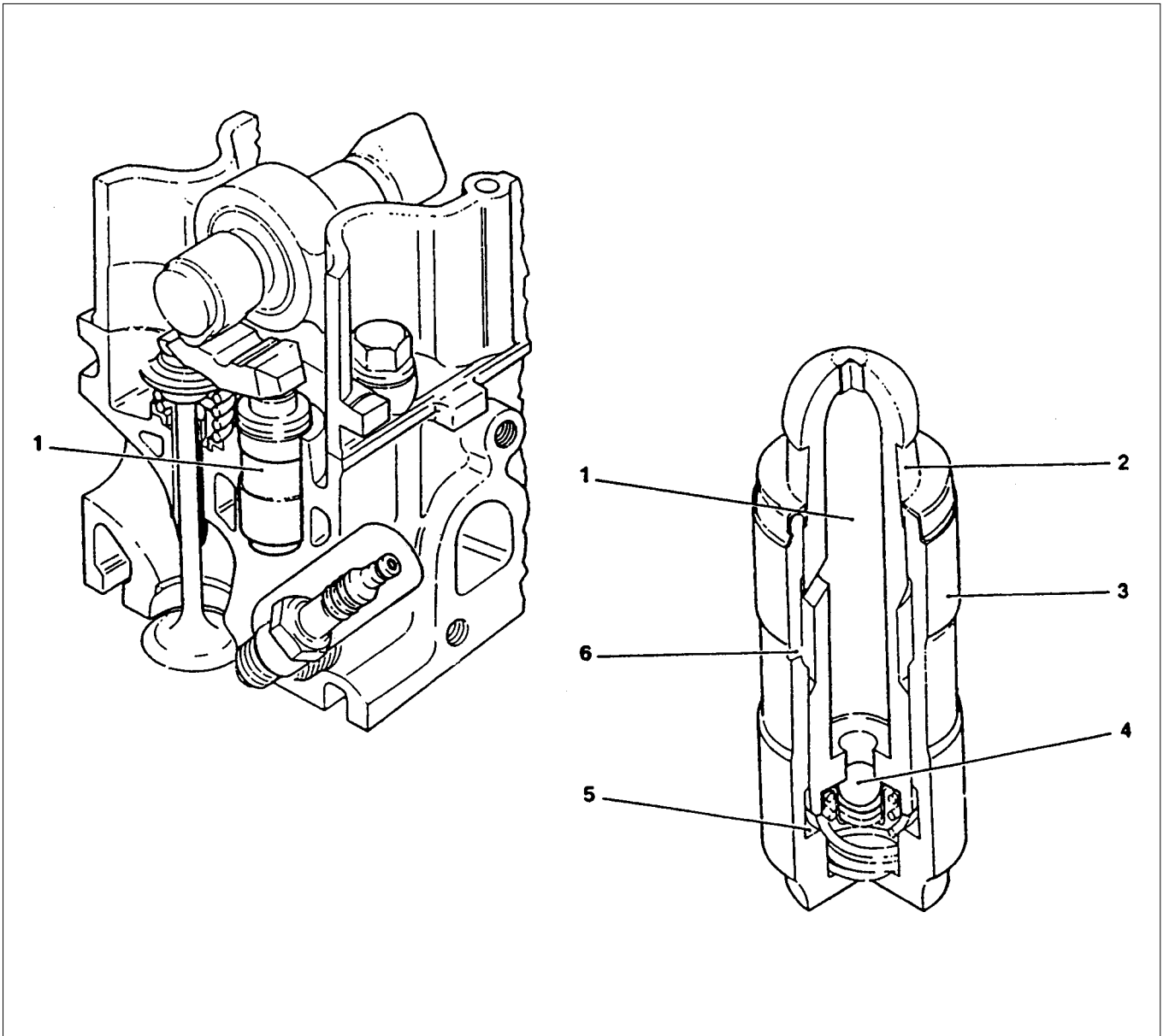


- 1. Camshaft Housing Cover
- 2. Camshaft Housing
- 3. Camshaft
- 4. Cylinder Head

(A) Valve Drive

€ 5843

## HYDRAULIC VALVE LIFTER

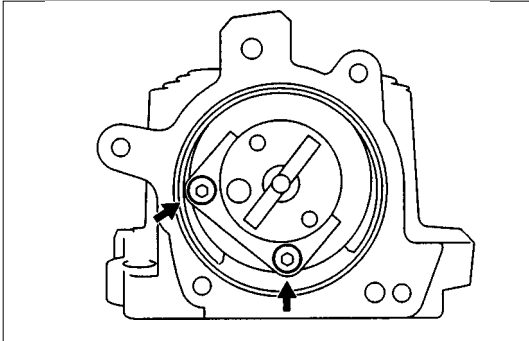


1. Hydraulic Valve Lifter

1. Oil reservoir
2. Piston with ball head (moving)
3. Pressure Cylinder (fixed)
4. Check ball
5. Pressure chamber
6. Oil feed

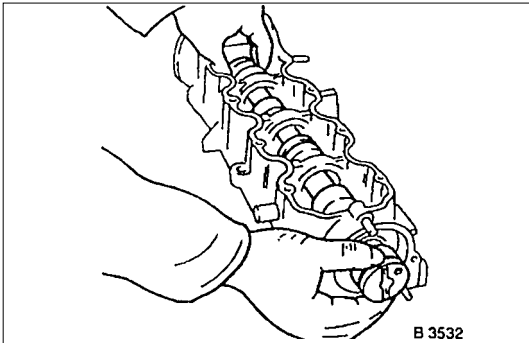
# OPERATIONS ON CYLINDER HEAD AND CAMSHAFT HOUSING

## Camshaft



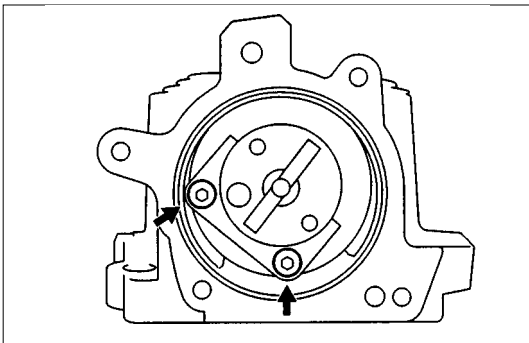
### Removal

1. Remove cylinder head according to the corresponding operation.
2. Remove camshaft housing from cylinder head and lay housing on base provided
3. Remove rear sealing gasket and plate camshaft housing with taking care not to damage housing.
4. Remove thrust plate.
5. Remove camshaft.
6. Remove front sealing gasket and plate from camshaft housing with taking care not to damage housing.



### Inspection

All parts.



### Installation

1. Install camshaft.
2. Coat sliding surfaces with molybdenum disulphate paste.



### Tighten (Torque)

Thrust plate for camshaft housing - 8 N·m (0.8 kgf·m)

## Camshaft Housing, Removal and Installation

See operation Camshaft

### Cylinder Head



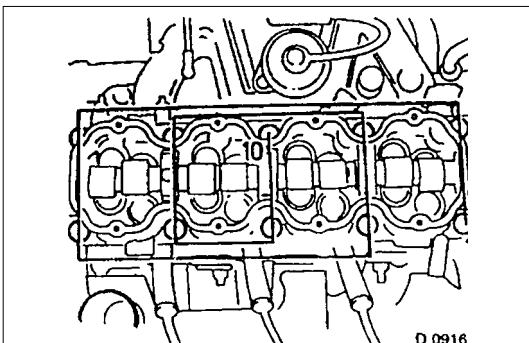
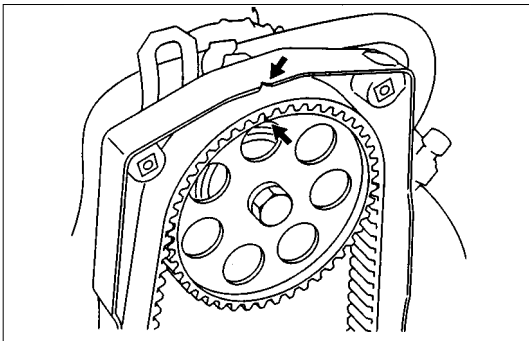
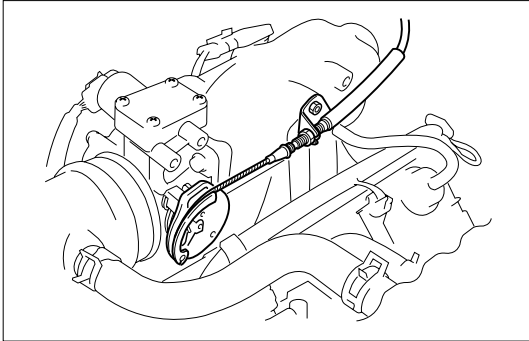
### Important!

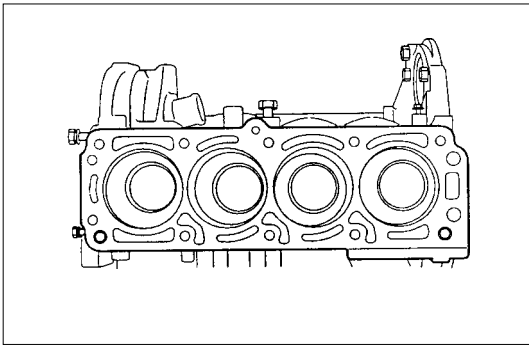
Remove cylinder head only from cold engine (room temperature).



### Removal

1. Remove ground cable from battery.
2. Open radiator drain tap and collect coolant.
3. Remove air intake hose.
4. Remove all cable connections, hoses and lines to the cylinder head.
5. Remove accelerator cable on the throttle valve.
6. Remove V-belt for alternator.
7. Remove front toothed belt cover according to the corresponding operation.
8. Bring piston of 1st cylinder to TDC and mark the position.
9. Remove camshaft housing cover.
10. Remove camshaft timing gear after releasing tension on toothed belt.
11. Remove upper bolts of rear toothed belt cover.
12. Remove exhaust pipe from exhaust manifold.
13. Remove cylinder head after loosening bolts from outside inwards (at first quarter turn then half turn) in a spiral pattern.
14. Remove camshaft housing from cylinder head.
15. Remove rocker arm, pressure parts and hydraulic valve lifter adjuster.





### Clean

All sealing surfaces, drill holes in cylinder head bolts.

Check cylinder block and cylinder head for plane surface according to the corresponding operations.



### Installation

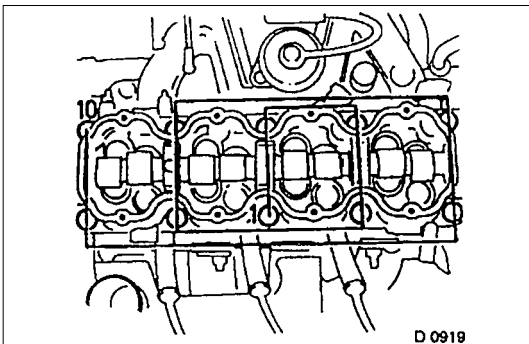
1. Install cylinder head sealing with marking "OBEN/TOP" facing upwards and to right side of engine.
2. Install cylinder head on cylinder block.
3. Install hydraulic valve lash adjuster, pressure parts and rocker arm - molybdenum disulphate paste.
4. Install camshaft housing-Sealing Compound TB-1207C or equivalent.



### Important!

Use new cylinder head bolts.

Screw in bolts until they rest on cover.

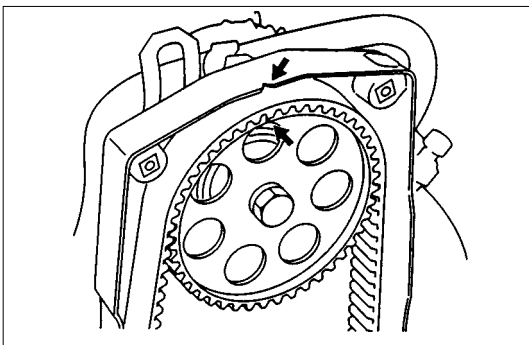


### Torque - Angle Method

Cylinder head to cylinder block - 25 N·m (2.5 kgf·m)

Further turn angle 90°+90°+ 90°.

Tighten cylinder head bolts from inside outwards. In four stages in a spiral pattern.

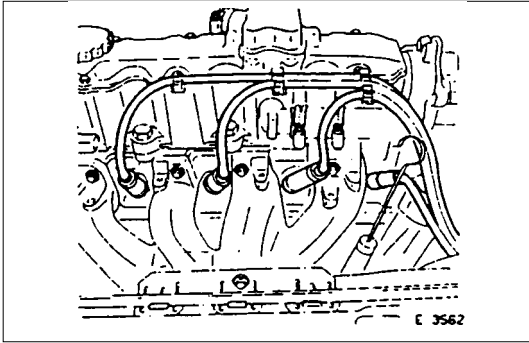


### Tighten (Torque)

Camshaft timing gear to camshaft - 45 N·m (4.6 kgf·m)

5. Install rear toothed belt cover onto camshaft housing.
6. Install toothed belt and apply tension according to the corresponding operation.

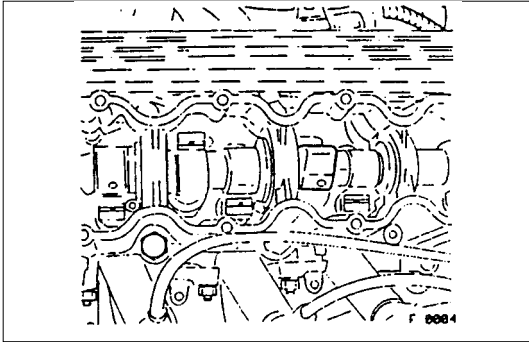
7. Install camshaft housing cover and front toothed belt cover.
8. Install cable connections, all hoses and lines onto cylinder head.
9. Adjust accelerator cable for free of play.
10. Install V-belt according to the corresponding operation.
11. Install air intake hose.
12. Install front exhaust pipe.
13. Install ground cable onto battery.
14. Fill up cooling system and bleed according to the corresponding operation.



## Hydraulic Valve Lifters, Replace

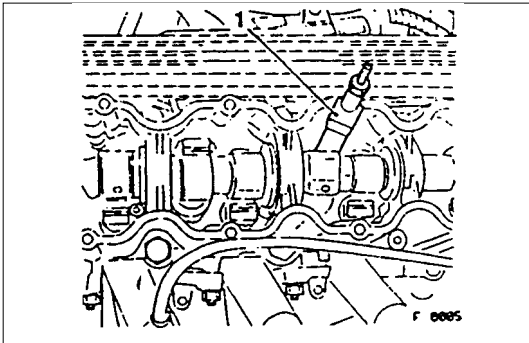
### Removal

1. Remove the spark plug connectors and spark plugs.
2. Remove the camshaft housing cover.



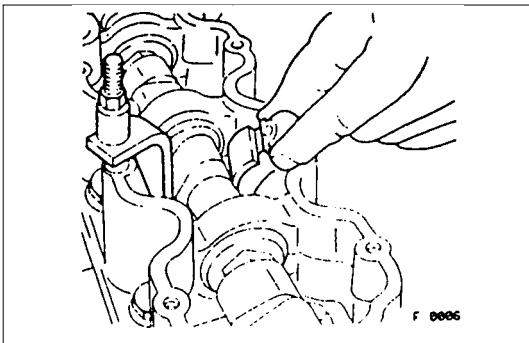
### Removal

3. Turn the crankshaft at fastening bolt of toothed belt drive gear in the direction of the engine rotation until the cam of hydraulic valve lifter being replaced stands vertically.



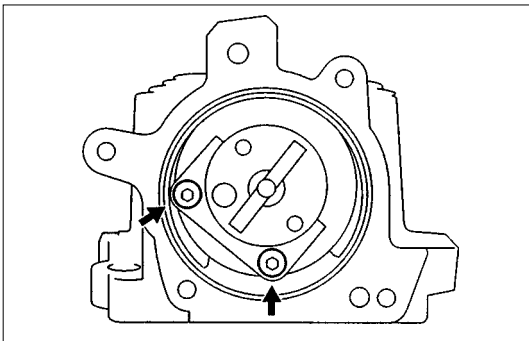
### Removal

4. Apply 5-8840-0457-0 to the camshaft housing, valve spring cap and tension valve spring.



### Removal

5. Remove the cam follower from camshaft housing.  
Note thrust pieces.
6. Remove hydraulic valve lifter from camshaft housing.

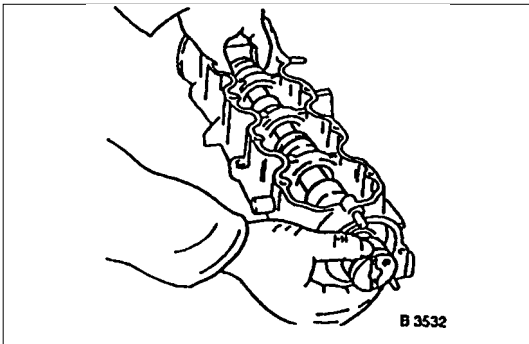


## Camshaft Housing, Replace

### Removal

Cylinder head-see operation "Cylinder Head. Remove and Install".

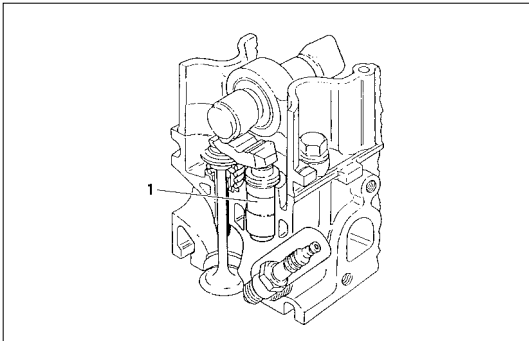




### Inspection

All parts, if necessary replace.

When replacing camshaft, always replace all cam followers.



### Installation

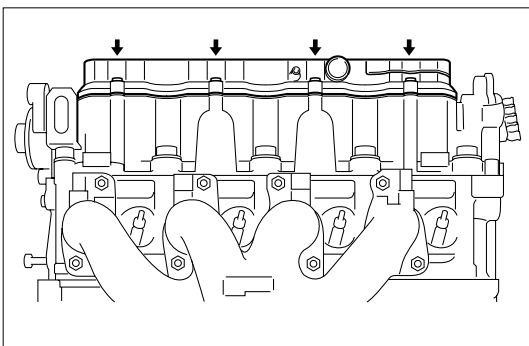
Insert hydraulic valve lifter (1) in camshaft housing.

Coat sliding surfaces of rocker arm with Mcs, Paste and insert in camshaft housing.

### Adjust

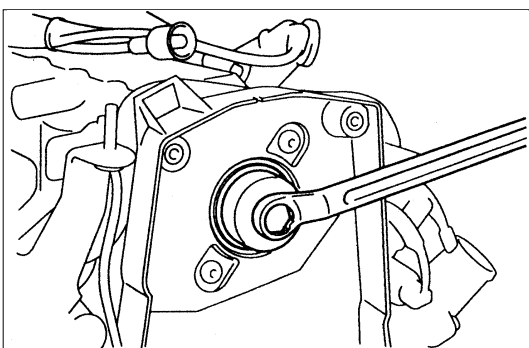
Adjustment of the hydraulic valve lifters is not required.

Pretension is provided by the design.



### Installation

1. Remove 5-8840-0457-0 and install the camshaft housing cover.
2. Insert the spark plug connectors.



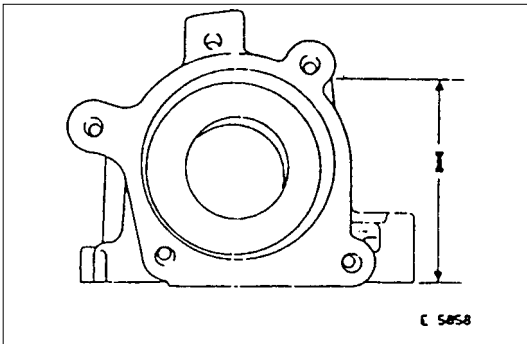
### Tighten (Torque)

Guide plate to camshaft housing.

Insert camshaft with MoS<sub>2</sub> paste.

### Installation

1. Install the front seal ring in camshaft housing with 5-8840-0451-0.
2. Install the camshaft housing rear cover.
3. Install the cylinder head.



## Camshaft Housing, Check for Plane Surface

### Clean

Sealing surfaces.



### Inspection

Check length and width of sealing surface for deformation and diagnosis for warpage and use straight edge feeler gauge.



### Measure

Height of camshaft housing (sealing surface to sealing surface).

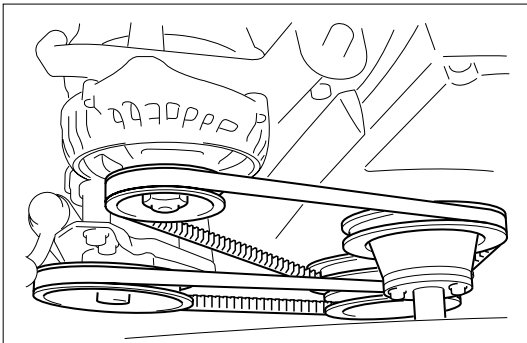
Dimension I: (74.0 mm)

## Cylinder Head, Removal and Installation



### Important

Only remove cylinder head with engine cold (room temperature).



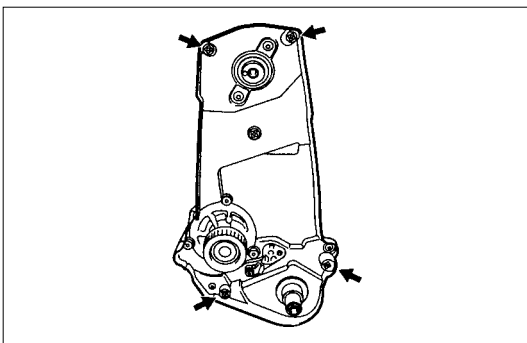
### Removal

1. Remove the alternator, power steering and V-belts.



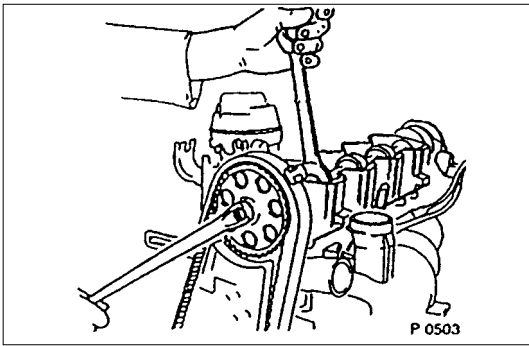
### Removal

2. Loosen the fastening bolts from alternator.
3. Loosen the lower alternator fastening bolt by swinging the alternator to the rear.



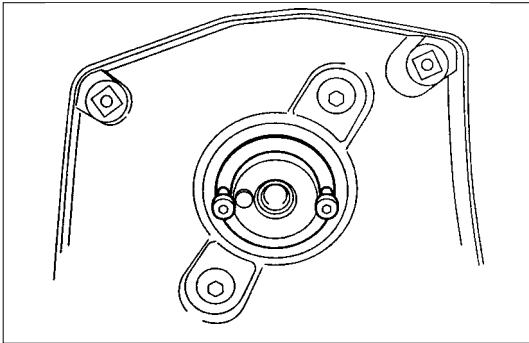
### Removal

4. Remove the front toothed belt cover.
5. Remove the toothed belt from camshaft pulley.  
See operation "Timing Check and Adjust".



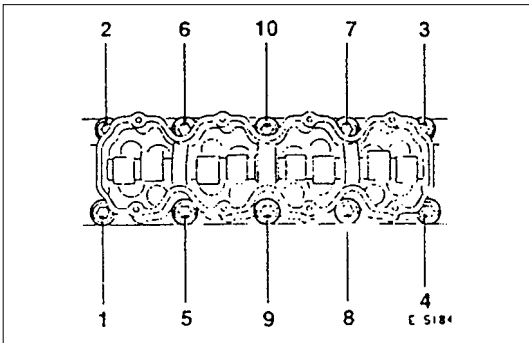
### Removal

- Remove the camshaft housing cover and camshaft pulley by counter-holding at the hex head of camshaft.



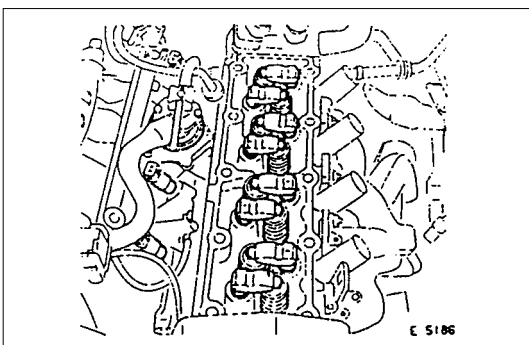
### Removal

- Remove the fastening bolts from camshaft housing.



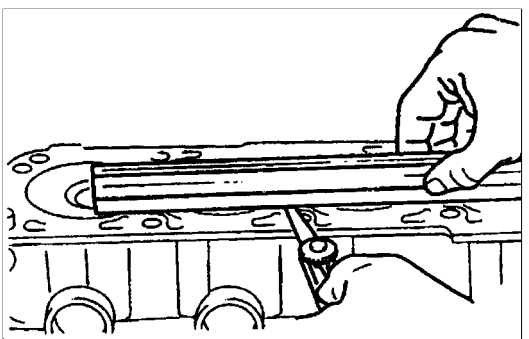
### Removal

- Remove the exhaust pipe from exhaust manifold.
- Loosen the cylinder head bolts spirally from the outside inwards (first 1/4, then 1/2 revolution).



### Removal

- Remove the camshaft housing from cylinder head.
- Remove the cam followers, thrust pieces and hydraulic valve lifters.  
Note the allocation.
- Remove the cylinder head.



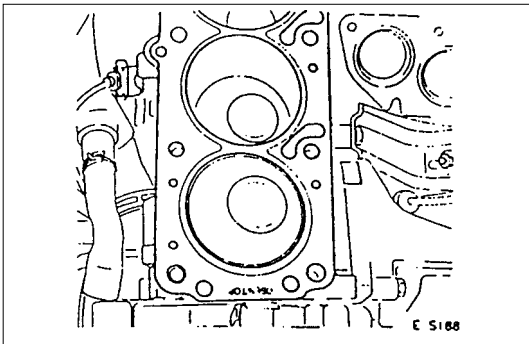
### Clean

Sealing surfaces, bores and threads of cylinder head bolts.



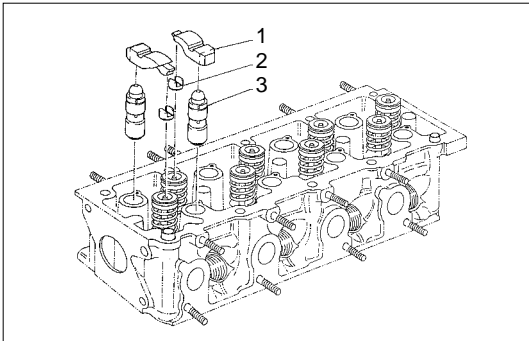
### Inspection

Check cylinder head and cylinder block for plane Surface-see operations "Cylinder Head, Check for Plane Surface" and "Cylinder Block, Check for Plane Surface."



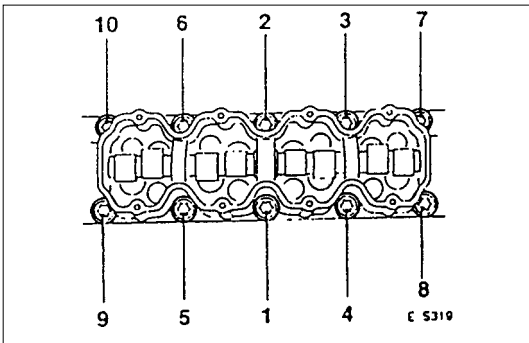
**Installation**

1. Install the cylinder head gasket.  
Mark "OBEN/TOP" on top and turn it towards timing side of engine.
2. Place cylinder head on cylinder block.



**Installation**

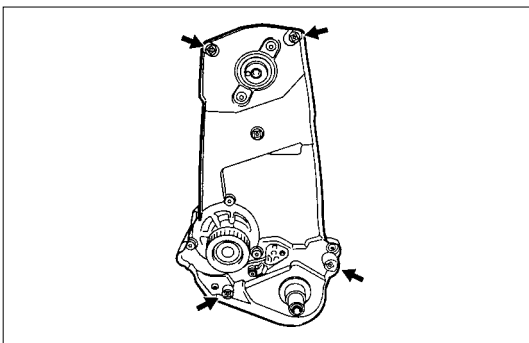
1. Insert the hydraulic valve lifters (3), thrust pieces (2) and cam followers (1) with MoS2 paste.  
Note allocation.
2. Apply a bead of Sealing Compound TB1207C to sealing surface of cylinder head.
3. Install the camshaft housing on cylinder head.



**Torque-Angle Method**

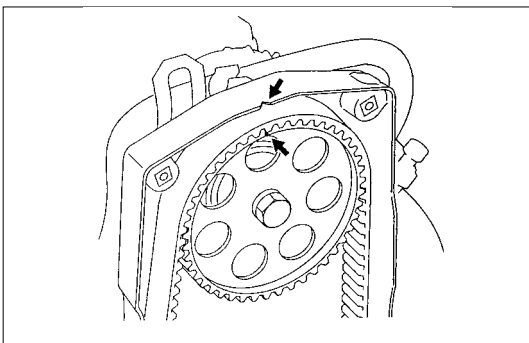
Cylinder head and camshaft housing with new cylinder head bolts to cylinder block.

Cylinder head bolts in sequence shown.



**Installation**

1. Install the rear toothed belt cover to camshaft housing.
2. Install the camshaft pulley to camshaft.
3. Install the camshaft housing cover to housing.



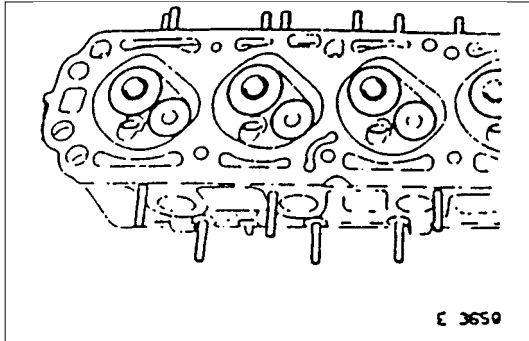
**Installation**

1. Install the toothed belt on camshaft pulley.  
See operation "Timing Adjust".
2. Install the front toothed belt cover.



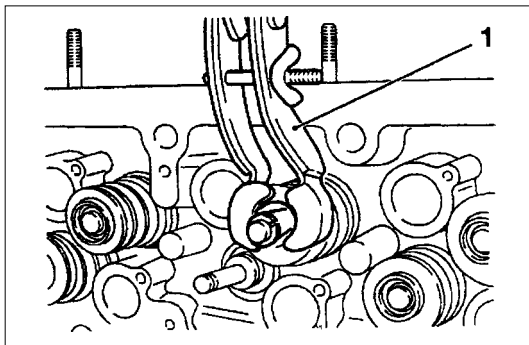
### Installation

1. Install the fastening bolts.
2. Loosen the lower alternator fastening bolt.
3. Install the alternator, power steering and V-belts.



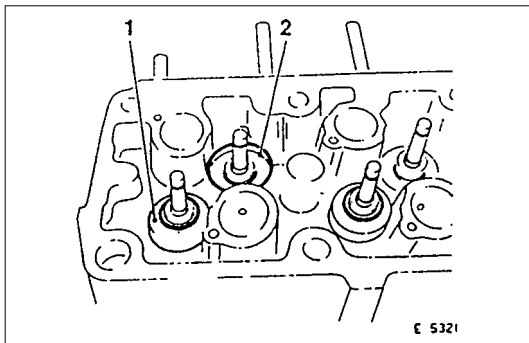
### Cylinder Head, Disassemble and Assemble Removal

1. Remove the hydraulic valve lifters.  
Lay aside in installation positions.
2. Remove the spark plugs, exhaust manifold and intake manifold from cylinder head.



### Removal

1. Mark valves.
2. Remove the tension valve springs with 5-8840-2594-0 (1).
3. Remove valve keepers, valve spring cap and valve spring.



### Removal

1. Remove the valve and valve stem seal.
2. Remove the valve spacer ring (1-exhaust) and valve spring seat (2-intake).
3. Remove valve from cylinder head.



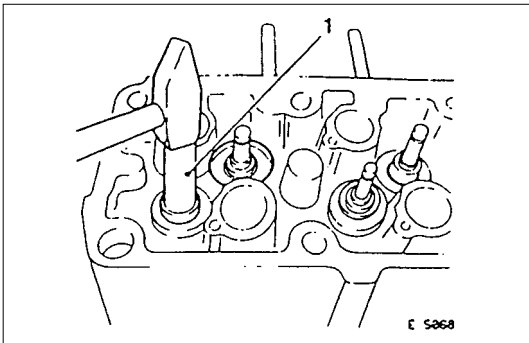
### Clean

Sealing surfaces.



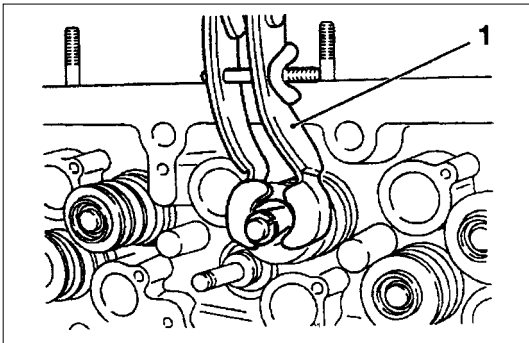
### Inspection

Sealing surfaces for plane surface, guides, sliding and bearing points for wear-see operation "Cylinder Head. Overhaul".



### Installation

1. Coat the valves with engine oil and insert in cylinder head.
2. Install the valve spacer ring or valve rotator(exhaust) and valve spring seal(intake).
3. Push the accompanying assembly sleeve onto valve stem and coat with engine oil.
4. Insert a new valve stem seal with 5-8840-2601-0 (1).
5. Drive the valve stem seal carefully in to stop with light hammer blow.



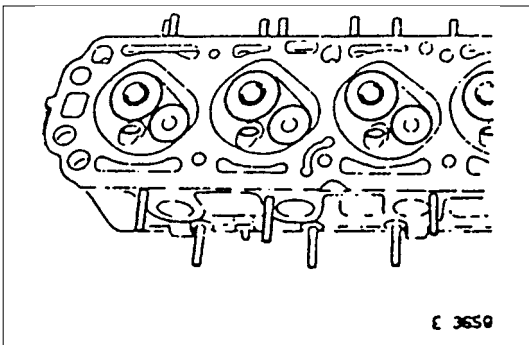
### Installation

1. Install the valve springs and valve spring caps.
2. Install the tension valve springs with 5-8840-2594-0 (1), valve keeper.



### Important!

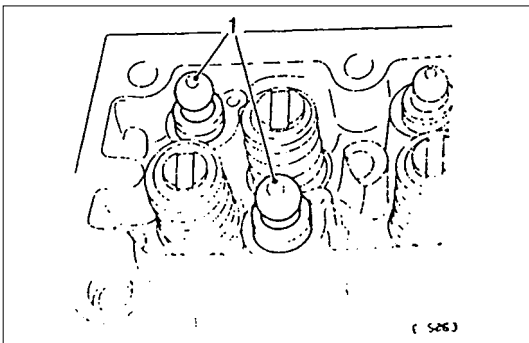
Note markings made on valves.



### Tighten (Torque)

Exhaust manifold and intake manifold with new gaskets to cylinder head.

Thermostat housing with new seal ring to cylinder head:



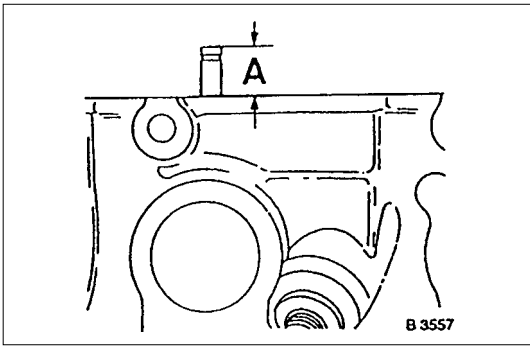
### Tighten (Torque)

Spark plugs with spark plug wrench to cylinder head.



### Installation

1. Coat hydraulic valves lifters (1) with oil.
2. Insert them in cylinder head.  
Note installation position.



### Valve, Grind

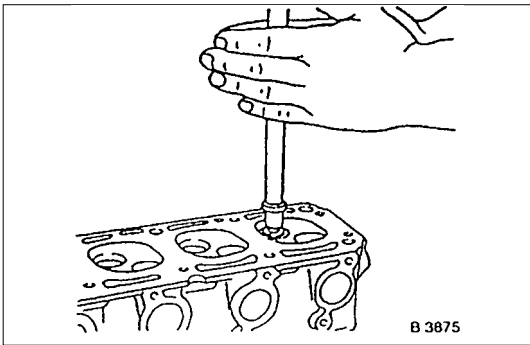
Valves can be reused once or twice after regrinding-only if there are no crater-like burns on the valve cone. Excessive grinding can cause the upper valve head edge to become too thin.

#### ⚠ Important!

Valve stem protection must not exceed dimension "A"-use 5-8840-2596-0.

Do not regrind valve stem ends.

For all valve reworking note that angle of valve head is 44° and the valve seat 45°-see also "Technical Data".



### Valve, Grind In

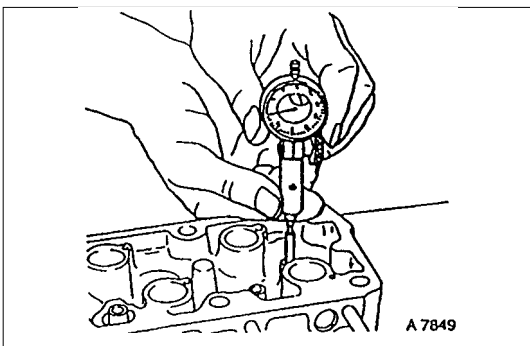
Grind-In the valve to improve valve seating. Grind-In by rhythmically lifting valves and turning uniformly. Use commercially available grinding tool.

#### ⚠ Important!

Use only fine-grained pastes for grinding. Lubricate valve stem before grinding in.

#### 🧼 Clean

After grinding, carefully clean valve and valve seat.



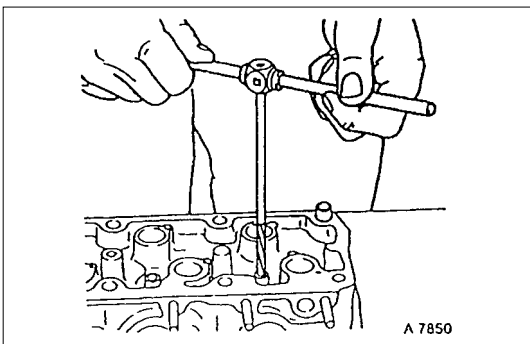
### Valve Guide, Ream

#### 📏 Measure

Diameter of valve guide-dial gauge and internal measuring instrument.

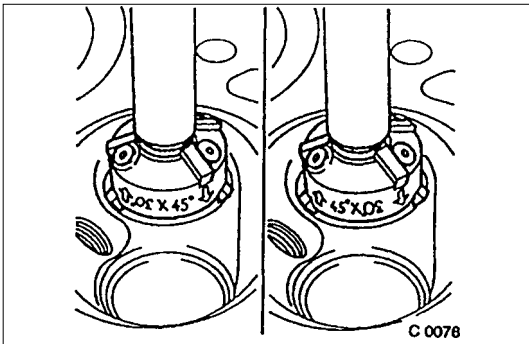
#### ⚠ Important!

Valve oversizes are available ex-works. Oversize identification, on the valve guide and on the valve stem end with the following specified identification figures/letters-see also "Technical Data".



Size	Identification Mark		
	Production	Customer Service	Reamer
Normal	none	K	
0.075 mm	1	K1	
0.150mm	2	K2	

Ream valve guide from the upper side of the cylinder head to the next oversize (use 5-8840-2599-0). After reaming, cross out identification mark and stamp in new identification mark.



### Valve Seating, Mill

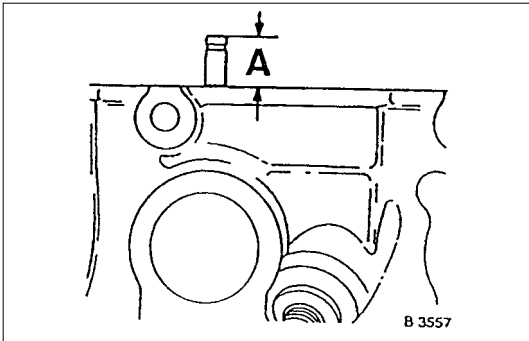
Place cylinder head on block of wood.  
Inlet and exhaust, Guide Drift and Valve Seat Cutter 5-8840-2593-0.

Valve seat-45°, side face, upper correction-30°, side face (arrows on cutter).

Valve seat width:

Inlet-1.0 to 1.5 mm/0.04 to 0.06 in.

Exhaust-1.7 to 2.2 mm/0.072 to 0.088 in.



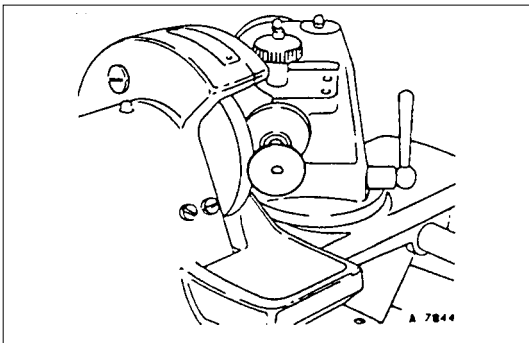
### Inspection

Valve stem projection-use 5-8840-2596-0.



### Important

If dimension "A" is exceeded, use new valves.  
Check valve stem projection again. If dimension "A" is exceeded, replace cylinder head.



### Cylinder Head, Overhaul

Cylinder head disassembled.



### Valve, Grind

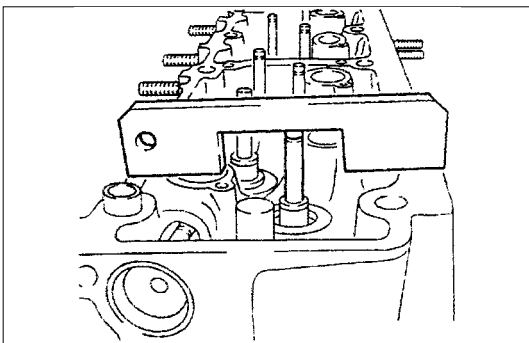
### Important!

Ensure that there are no crater-like burns on the valve cone.

Regrinding possible once or twice.

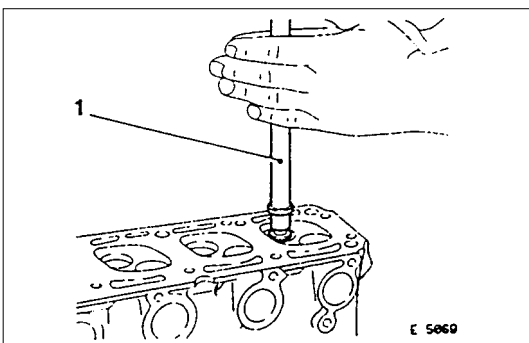
Grinding of valve stem end is not permitted.

Angle at valve head-44°



### Inspection

Check valve stem projection as shown 5-8840-2596-0

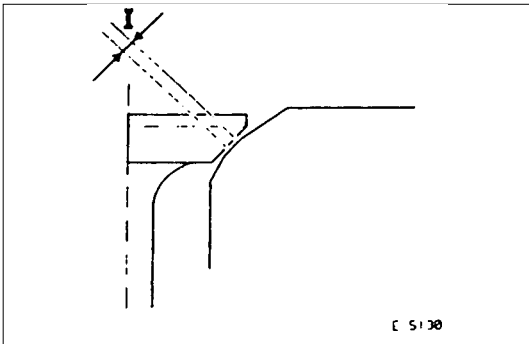


### Valve, Grind in

Lubricate valve stem, use fine-graining grinding paste.

Lift up valve from seat rhythmically using valve grinding tool (1)- for distribution of grinding paste.





### Inspection

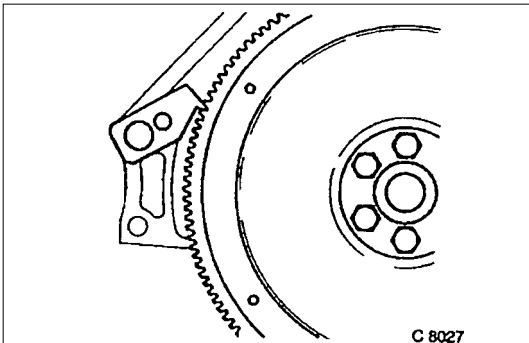
Check contact pattern (I) on valve seat and in cylinder head.



### Clean

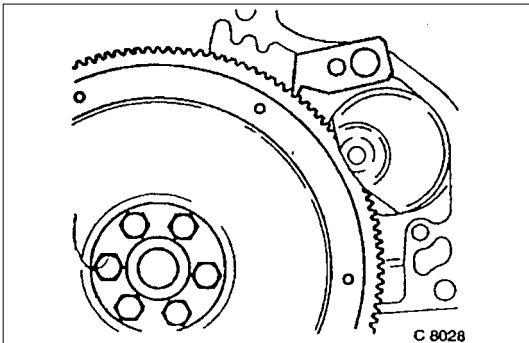
Valves, valve guides, cylinder head.

## Flywheel



### Removal

1. Remove transmission and clutch.
2. Remove flywheel while locking with 5-88400-446-0.



### Torque - Angle Method

Flywheel to crankshaft - 65 Nm/6.5 kgf-m.+30° to 45°



### Important!

Use new bolts.  
Do not apply grease to the thread.

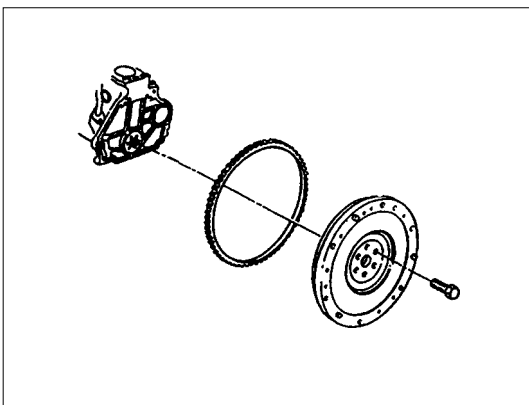


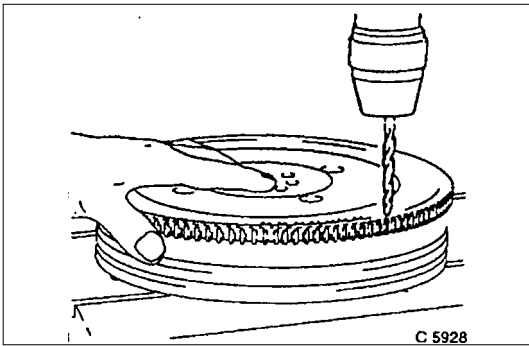
### Installation

1. Install clutch and transmission.

## Component Parts

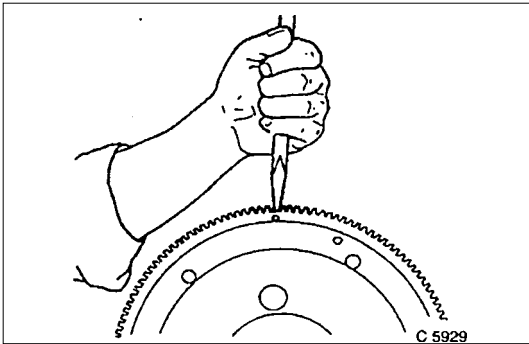
Flywheel and Ring gear. (Manual Transmission)



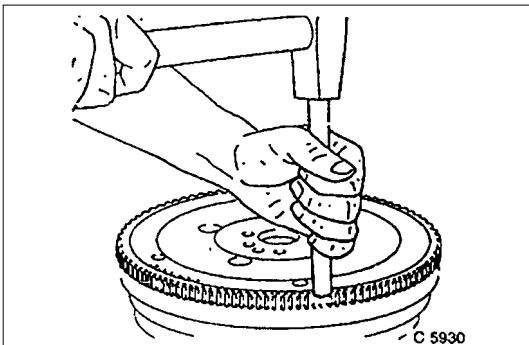


## Starter Ring Gear (Manual Transmission) Removal

1. Remove flywheel according to the corresponding operation.
2. Drill starter ring gear underneath tooth gap approx. 8mm/0.30in. deep with 8mm/0.25in. diameter drill.

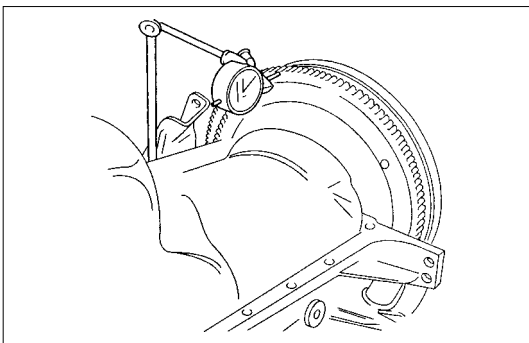


3. Separate starter ring gear with chisel on the drilling point.



## Installation

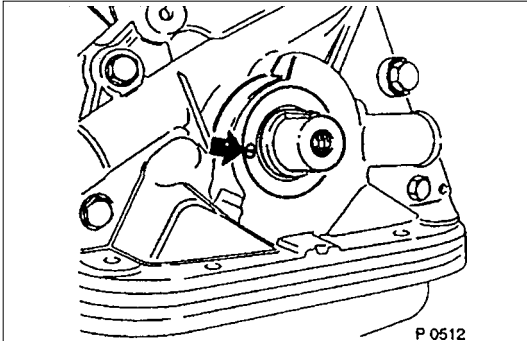
1. Install starter ring gear with inner chamfered edge to flywheel.
2. Heat starter ring gear evenly to 180°C /356°F to 230°C /446°F (yellow paint mark)
3. Install flywheel according to the corresponding operation.



## Inspection

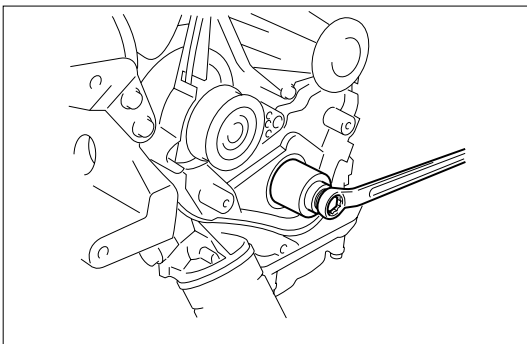
Lateral run-out of starter ring gear - max. 0.5mm/0.02in.

## Seal Ring, Crankshaft (Oil Pump Housing)



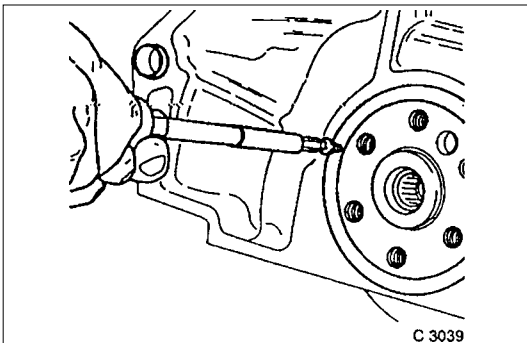
### ↔ Removal

1. Remove toothed belt rear cover according to the corresponding operation.
2. Remove sealing ring by making hole in middle of ring, turning in self-tapping screw and edging out.



### ↔ Installation

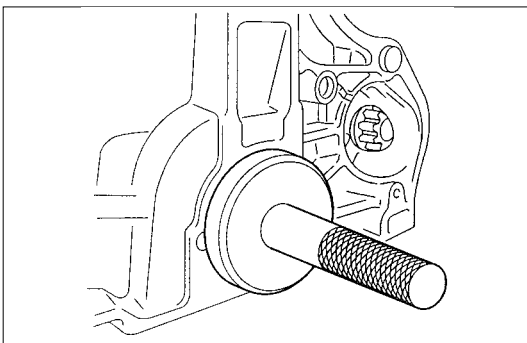
1. Install the protective sleeve to the crankshaft.
2. Coat the sealing lip with protective grease.
3. Install the sealing ring.
4. Install the sealing ring using 5-8840-0455-0.
5. Install the rear toothed belt cover and toothed belt according to the corresponding operations.
6. Replace the sealing ring with a new one.
7. Tighten the belt to the crankshaft.



### ↔ Removal

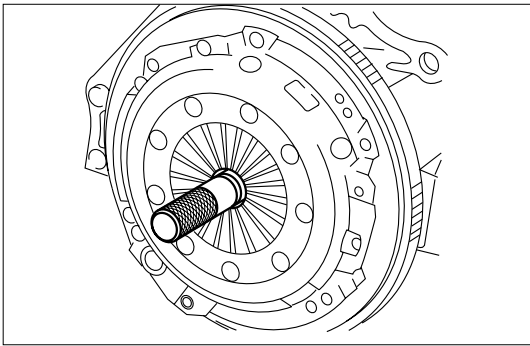
## Seal Ring, Crankshaft Rear

1. Remove transmission and clutch.
2. Remove flywheel or flex plate according to the corresponding operations.
3. Make hole in middle of sealing ring, turn in self-tapping screw and edge out.



### ↔ Installation

1. Install protective sleeve.
2. Coat sealing lip with Protective Grease.
3. Install sealing ring using 5-8840-0459-0 and 5-8840-2597-0.
4. Install flywheel, clutch and transmission.



### Reassembly

Reassemble clutch assembly.



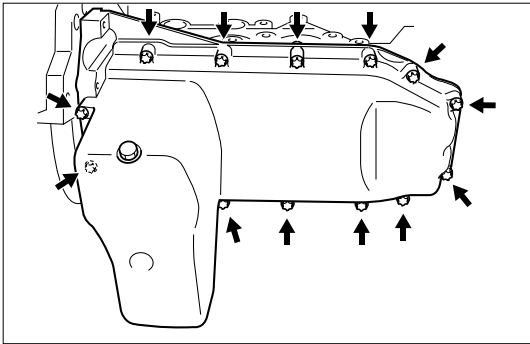
### Disassembly

Disassemble clutch assembly to flywheel using 5-8840-2634-0



### Torque Angle-Method

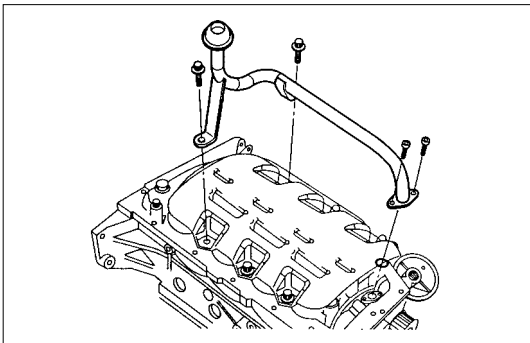
Clutch assembly to flywheel-17.6Nm/1.8 kgf·m.



### Gasket, Oil Pan

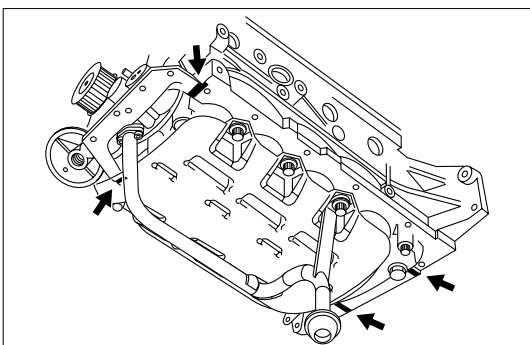
#### Removal

1. Loosen fixing bolts.
2. Remove oil pan from oil pump and cylinder block.



### Clean

Sealing surfaces.



### Installation

1. Apply a bead of Sealing Compound, TB120TC or equivalent to joint of oil pump.
2. Install baffle plate, or reuse baffle plate with valcanized gasket.



### Caution

Baffle plates with valcanized gasket can be retrofitted without difficulty - replace baffle plate with gasket.

3. Install oil intake pipe to oil pump and oil intake pipe bracket to cylinder block.
4. Install oil pan and new gasket to cylinder block and insert bolts with Locking Compound 15 10 177 (90 167 347). Maximum assembly time including torque check is 10 min.



### **Tighten (Torque)**

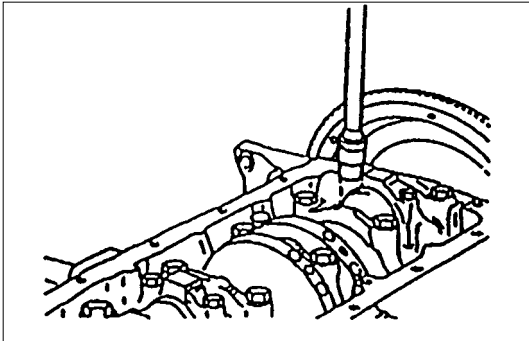
Oil intake pipe to oil pump -8N·m (0.8 kgf·m)

Oil intake pipe bracket to cylinder block - 6 N·m (0.6 kgf·m)

Oil pan to cylinder block - 8 N·m (0.8 kgf·m) with vulcanized gasket - 15 N·m (1.5 kgf·m)

# OPERATIONS ON CRANK DRIVE

## Con-Rod Bearing



### ↔ Removal

1. Remove oil pan according to the corresponding operation.
2. Remove con-rod bearing cap and con-rod bearing after marking both sides.

### 🧼 Clean

Con-rod journal, con-rod bearing cap

### ↔ Installation

1. Install new bearing shafts lightly coated with engine oil.
2. Install con-rod bearing cap.

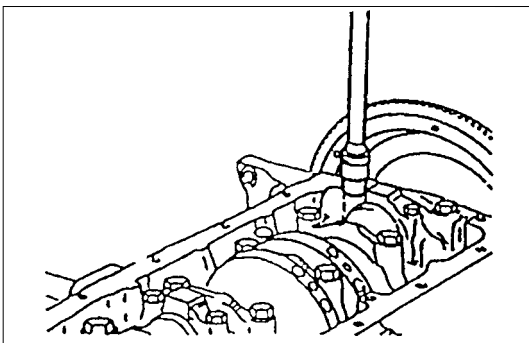
### ⚠ Torque-Angle Method

Con-rod bearing cap to con-rod - 35N·m (3.5 kgf·m) +45° to 60°

### ⚠ Important!

Use new bolts.

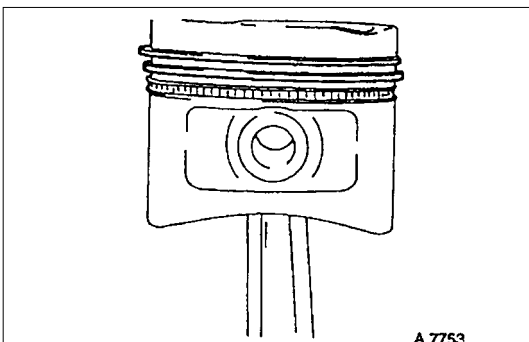
3. Install oil pan according to the corresponding operation.



## Piston with Con-Rod

### ↔ Removal

1. Remove cylinder head and oil pan according to the corresponding operations.
2. Remove piston with con-rod after marking con-rod bearing cap.



### 👁 Inspection

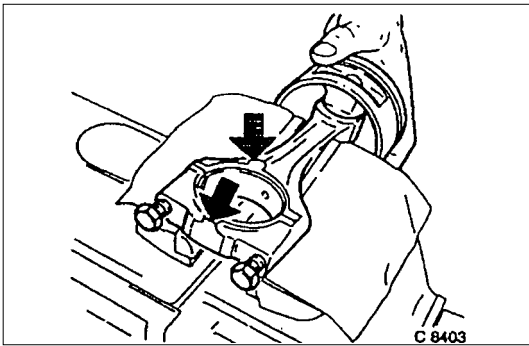
Remove and install all parts, if applicable.

### ⚠ Important!

Ring gap offset:

Piston rings - 180°.

Oil scraper rings - 25 to 50 mm/1 to 2 in. from gap of intermediate ring to the left and to the right.



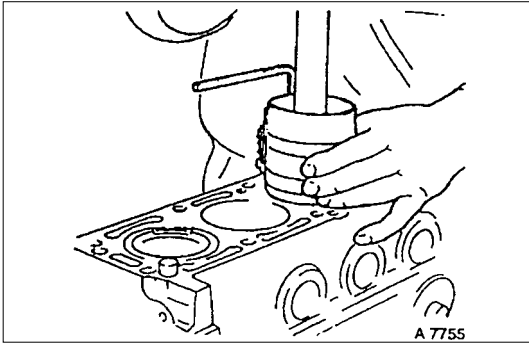
### Installation

1. Install piston with con-rod by inserting with engine oil.
2. Coat piston rings with engine oil and compress with piston ring compressor.

### Important!

Installation position:

Arrow / notch on piston head on timing side of engine  
Beads on con-rod on clutch side



### Torque-Angle Method

Piston to cylinder block.

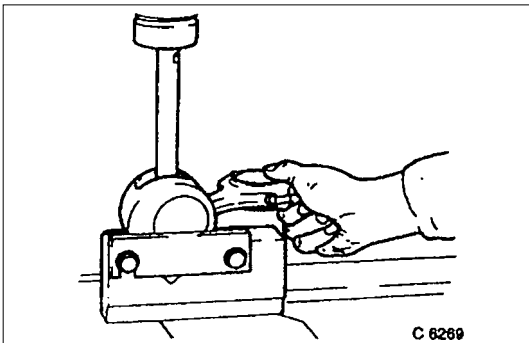
Con-rod bearing cap to con-rod-35N·m (3.5 kgf·m) +45° to 60°

### Important!

Use new bolts.

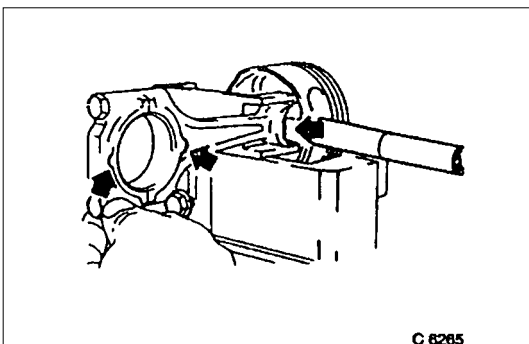
### Installation

1. Install oil pan and cylinder head according to the corresponding operations.
2. Install sealing Gasket or replace if damaged.
3. Install camshaft housing to cylinder head.
4. Install cylinder head according to the corresponding operation.



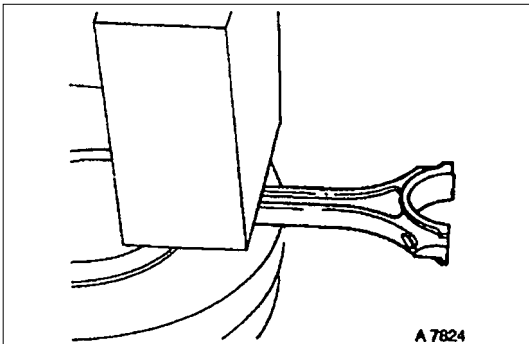
### Con-Rod Removal

1. Remove piston with con-rod according to the corresponding operation.
2. Disassemble con-rod piston assembly by pressing out piston pin, using 5-8840-0468-0.

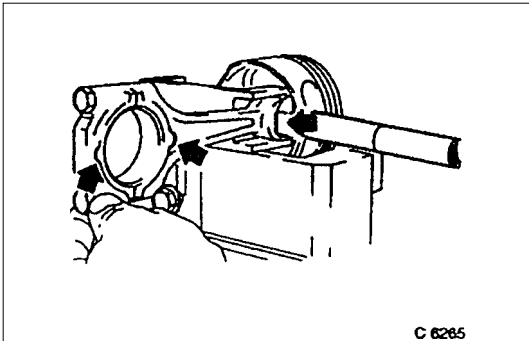


### Installation

1. Slide guide drift (5-8840-0468-0) in horizontal position through piston and con-rod as far as side plate stops.
2. Tighten bolts evenly so that the piston rests flush on the rear plate.
3. Remove centre piece from guide drift and insert piston bolts (lubricated) into guide drift.



4. Heat a new con-rod to 280°C in the oil bath.
5. Install the con-rod to the piston and insert the piston pin.



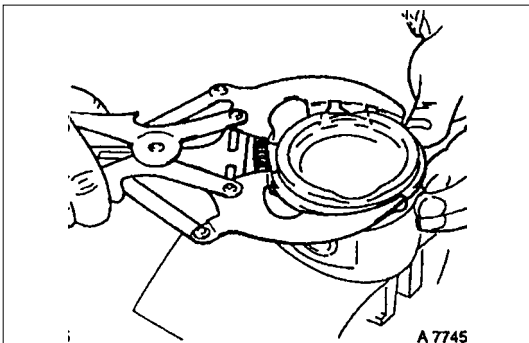
### ⚠ Important!

Since the con-rods have no weight balancing studs, re-working is not possible.

Exchange con-rods in sets only.

Installation position, beads on con-rod point to the flattening on the piston pin eye.

Firmly seated piston pin cannot be pushed in. Carry out installation quickly.



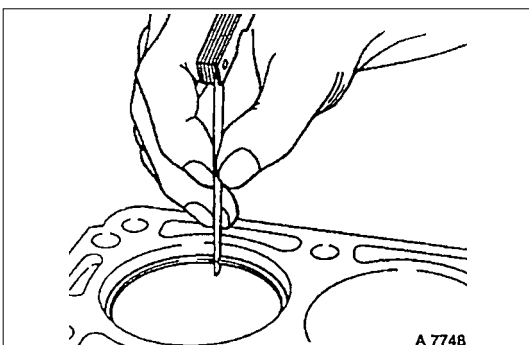
### Piston Rings

#### ↔ Removal

1. Remove piston with con-rod according to the corresponding operation.
2. Remove piston rings using commercially available ring installer or piston ring clamp pliers.

#### 🧼 Clean

Piston ring grooves - ground piece of old piston ring

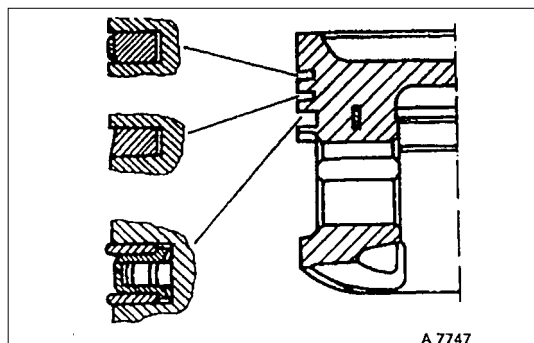


#### 👁 Inspection

Piston ring gap

For piston ring sizes, permissible piston ring gaps - see "Technical Data"



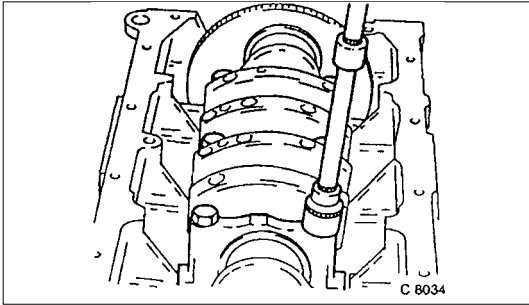


## Installation

1. Install oil scraper ring.
2. Offset ring gaps of steel band rings each 25 to 50 mm/1 to 2in. to the left or right of the intermediate ring gap.
3. Install piston rings.
4. Offset ring gaps by approx. 180°.
5. Install second piston ring with identification mark "TOP" facing upwards.
6. Install piston with con-rod according to the corresponding operation.

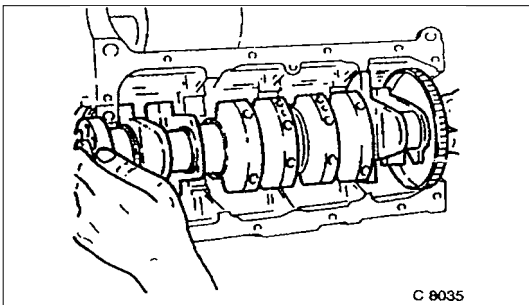
# OPERATIONS ON REMOVED ENGINE

## Crankshaft



### ⇔ Removal

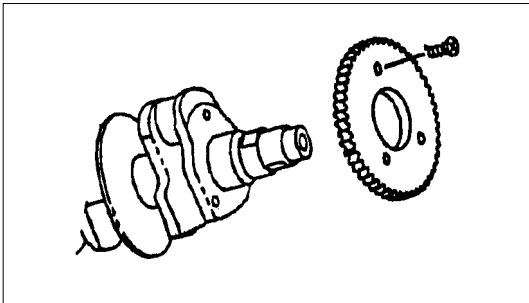
1. Mount the engine on an engine overhaul stand with appropriate adapters.
2. Remove the aggregates, flywheel/drive disc, oil pan, and oil pump according to the corresponding operation.
3. Mark the con-rod bearing cover.
4. Remove the crankshaft bearing cover.
5. Remove the crankshaft from cylinder block.



### 🔍 Inspection

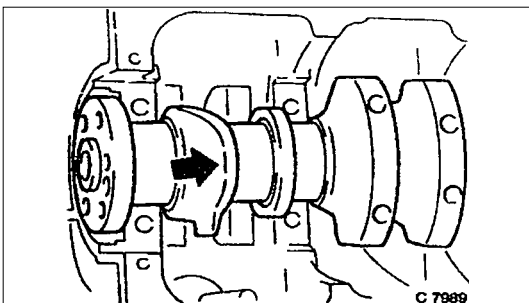
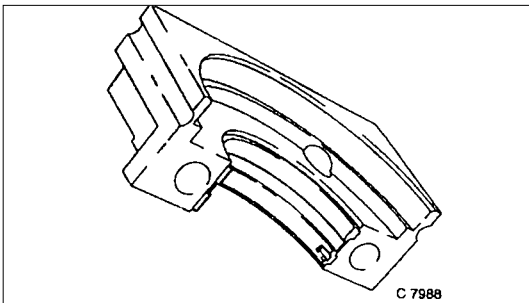
Remove and install all parts if necessary

Crankshaft pulse pickup sensor rotor inspection and repair.  
Inspect the crankshaft pulse pickup sensor rotor for excessive wear and damage.  
Replace the crankshaft pulse pickup rotor if the inspection results exceed wear and damage limits.



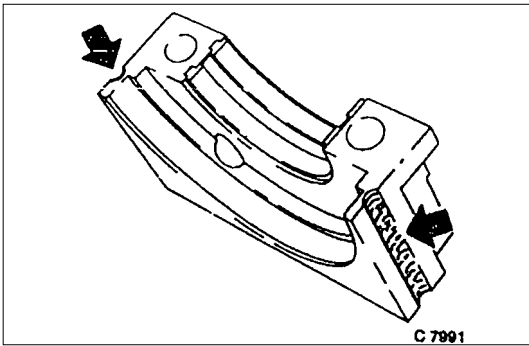
### ⇔ Installation

1. Install the crankshaft pulse pickup sensor.  
Torque: 13N·m (1.3 kgf·m)
2. Install new bearing shells into the cylinder block and bearing cover.
3. Coat the bearing shafts with engine oil.  
For oversizes-see "Technical Data"
4. Install a new crankshaft into the cylinder block.



### Note

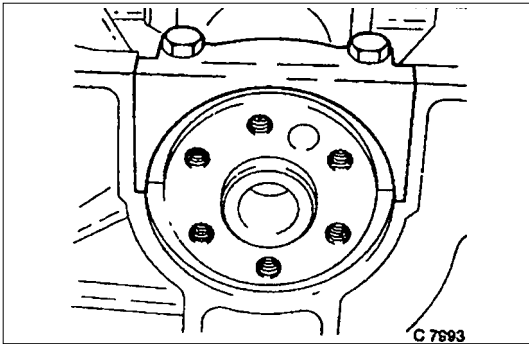
The sealing of the crankshaft can be corrected with light blows with a rubber hammer on the crank arm (arrowed).



5. Apply a bead of sealant (TB-1207C or equivalent) in the grooves of both bearing shells

**! Important!**

After installation of bearing cover, press in sealing compound again from above, until compound emerges at the joints.



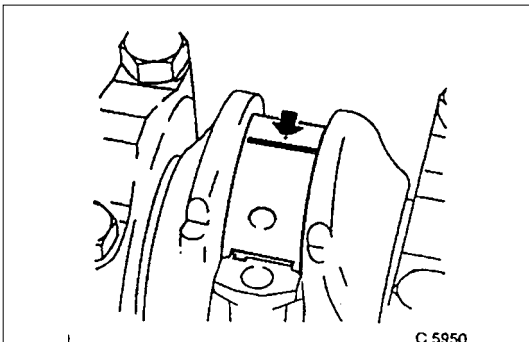
**⚙ Torque - Angle Method**

Bearing cover to cylinder block - 50 N·m (5.1 kgf·m) +40° to 50°  
Con-rod bearing cover to con-rod - 35 N·m (3.5 kgf·m) +45° to 60°

60°

Use new bolts.

6. Install oil pump, oil pan, rear crankshaft sealing, flywheel/drive plate, and aggregates according to the corresponding operations.



**👁 Inspection**

Bearing play - bearing cover removed

**📏 Measure**

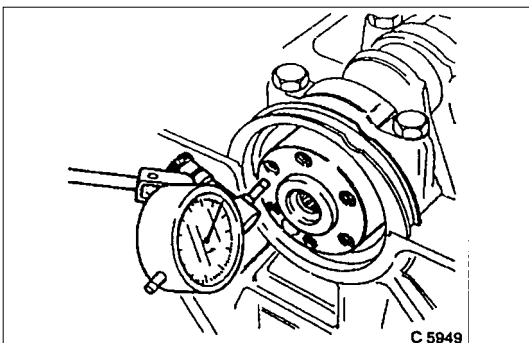
With "Plastigage" (ductile plastic threads)

Cut threads to length of bearing width and lay axially between crankshaft journal and bearing shell (arrowed).

Install bearing cover with correct torque.

**! Important!**

Grease crankshaft journal and lubricate bearing shell slightly so that the thread does not tear when the bearing cover is moved

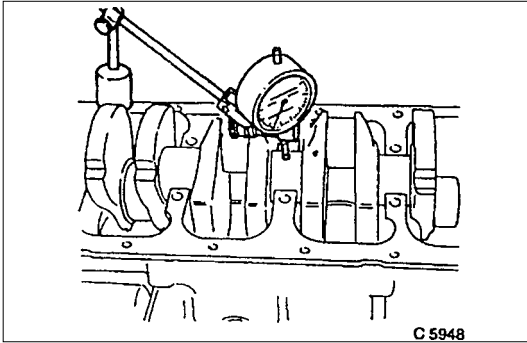


**👁 Crankshaft Inspection**

End play when bearing shells are installed.

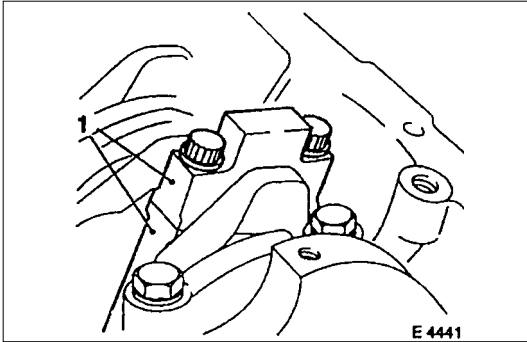
Front end contact surfaces of flywheel/flexible plate.

Permissible end play - see "Technical Data "



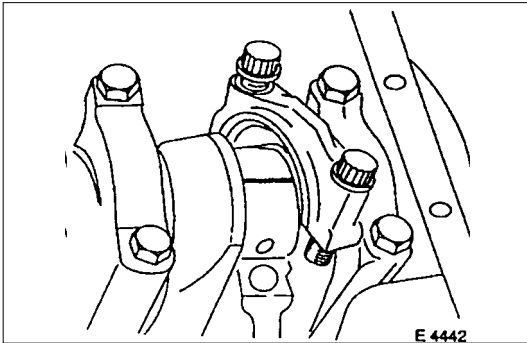
## Inspection

Out-of-round (run-out)-middle bearing shell removed when mounting on front and rear bearing.  
Permissible out-of-round - see "Technical Data"



## Bearing Free Play Measurement

Two methods for measuring bearing free play are described - 1. Plastigage method and 2. micrometer and gauge method. The two procedures are suitable for measuring both con-rod and main bearing free play. For both methods ensure con-rod and main bearing caps are identified (1) prior to removal as they are machine matched.



## 1. Plastigage Method

### Removal

1. Remove bearing cap and shell.
2. Lightly coat journals and bearings with engine oil to prevent Plastigage from tearing when cap is removed.

### Installation

1. Lay a length of Plastigage across width of crank pin and fit bearing cap and shell using old bolts at this stage.

## Important!

Do not allow crankshaft to rotate.

## Torque - Angle Method

Main bearing cap bolt - 60 N·m (6.1 kgf·m) +40° + to 50°.  
Con-rod bearing cap bolts - 35 N·m (3.6 kgf·m) +45°.

### Removal

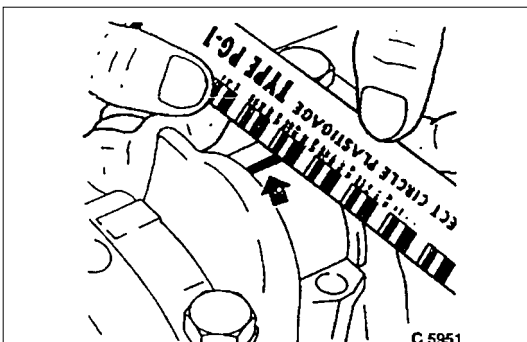
1. Remove bearing cap and shell.

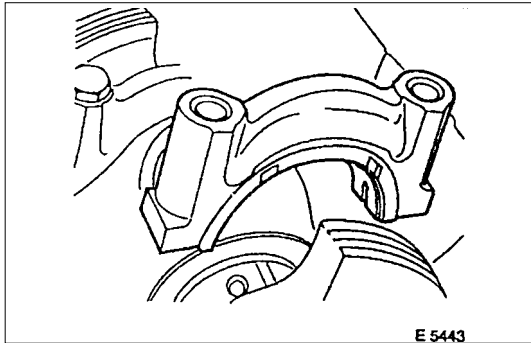
### Measure

Width of Plastigage - use scale supplied with Plastigage.

If con-rod bearing clearance exceeds 0.031mm/0.001in or main journal bearing clearance exceeds 0.04mm/0.02in. - check crankshaft journal diameters - see corresponding operation.

Replace bearing if crankshaft is within specification - see "Technical Data"





### Clean

Plastigage from journals.

Lightly coat journals and bearings with engine oil.



### Installation

Install bearing cap and shell using new bolts.



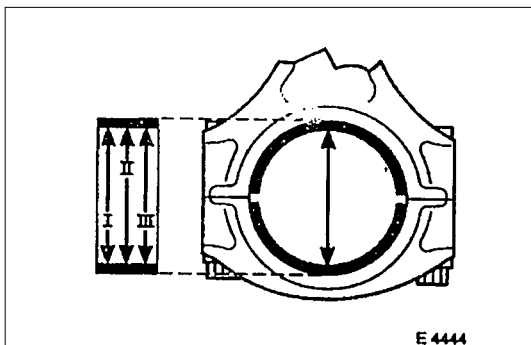
### Torque - Angle Method

Main bearing cap bolt - 60 N·m (6.1 kgf·m) +40° to 50°.

Con-rod bearing cap bolts - 35 N·m (3.9 kgf·m) +45°.

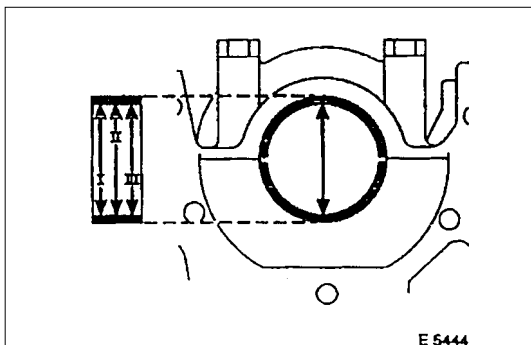
## 2. Micrometer and gauge method.

Crankshaft removed.



### Installation

1. Install caps and bearing shells to con-rods and cylinder block.



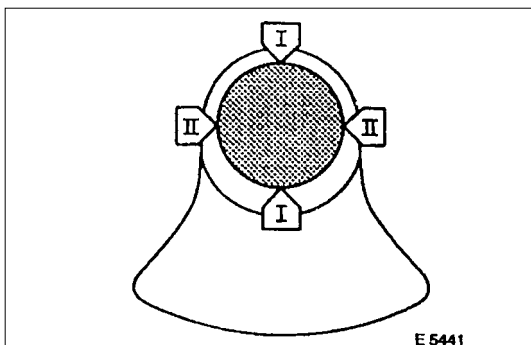
### Measure

Con-rod and main bearing diameters at three points I, II, III (arrowed).

Divide the sum of the three measurements by three to obtain a mean diameter.

The top illustration shows con-rod measuring points.

The second illustration shows main bearing measuring points.



### Measure

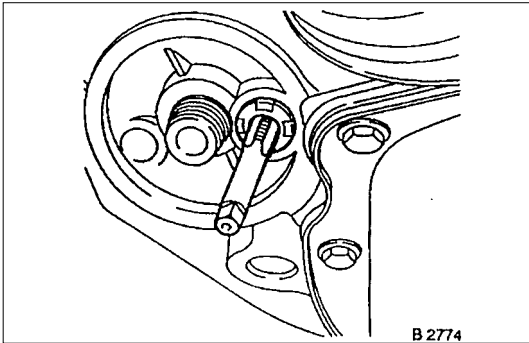
Crankshaft main and con-rod bearing journals at points I and II. Divide the sum of both measurements to obtain a mean diameter.

Crankshaft must be replaced if mean diameter of main or con-rod journals is below specified limit - see "Technical Data".

If crankshaft is serviceable subtract crankshaft mean journal diameters from corresponding shell bearing mean diameters to determine bearing clearance.

Permissible main bearing clearance - 0.015 to 0.04mm/0.0006 to 0.002in.

Permissible con-rod bearing clearance - 0.006 to 0.031mm/0.002 to 0.001in.



### Bypass Valve



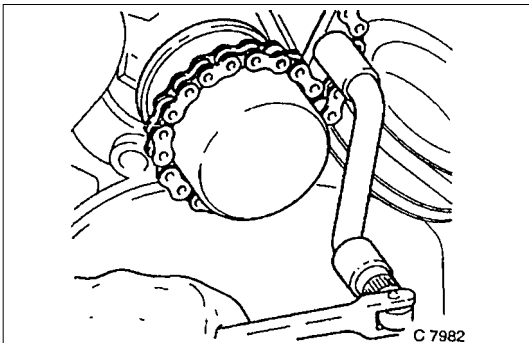
#### Removal

1. Remove oil filter.
2. Remove bypass valve by cutting thread in locking disc with M 10 tap (3rd stage), turning in M 10 bolt and taking out bypass valve from seating.



#### Installation

1. Install bypass valve using drift (diameter approx. 15mm/0.6in.).



### Oil Filter



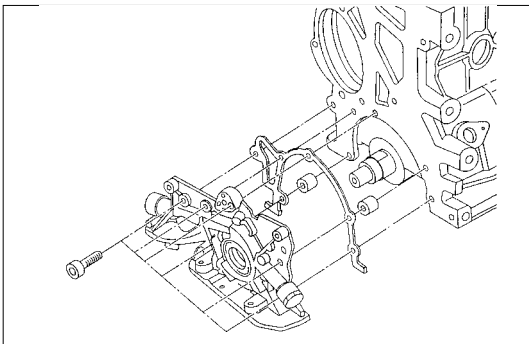
#### Removal

1. Remove oil filter using commercially available tool.



#### Installation

1. Install oil filter by hand and oil seal ring.
2. Fill up engine oil while preventing overflow.

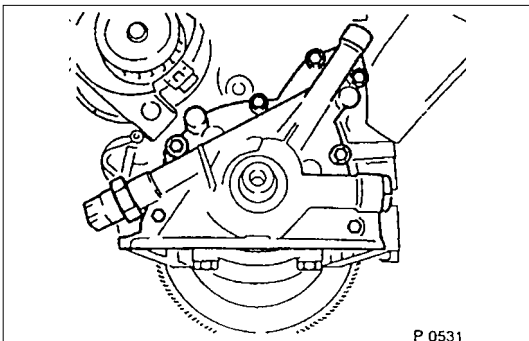


### Oil Pump



#### Removal

1. Remove rear toothed belt cover, and oil pan according to the corresponding operations.
2. Remove oil filter, wiring plug from oil pressure switch, oil pump from cylinder block, and oil pressure switch from oil pump.



### Clean

Sealing surfaces



#### Installation

1. Install oil pressure switch to oil pump, oil pump to cylinder block, oil pan, wiring plug, oil filter and toothed belt cover.



### Tighten (Torque)

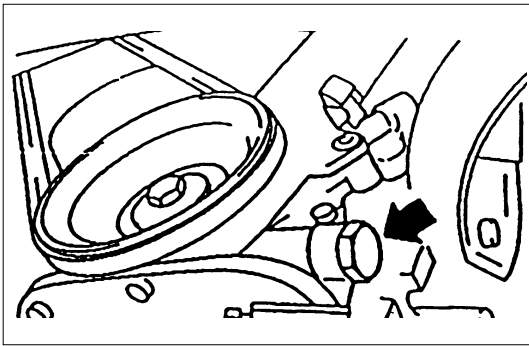
Oil pressure switch to oil pump - 30 N·m (3.2 kgf·m)

Oil pump to cylinder block - 6 N·m (0.6 kgf·m)

Oil intake pipe to oil pump - 8 N·m (0.8 kgf·m)

Intake pipe bracket to cylinder block - 8 N·m (0.8 kgf·m)

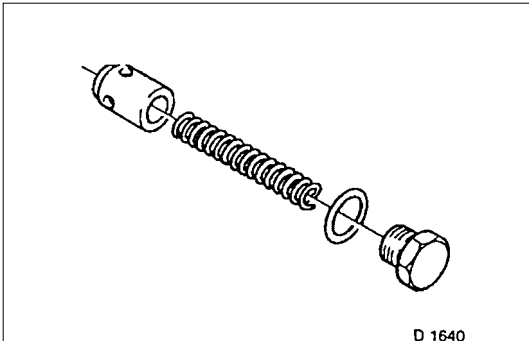
\*Insert bolts with Locktite (Refer to General Description Recommended Liquid Gasket)



### Oil Pump Safety Valve

#### Removal

1. Remove closure plug.
2. Remove seal ring.
3. Remove spring.
4. Remove piston.



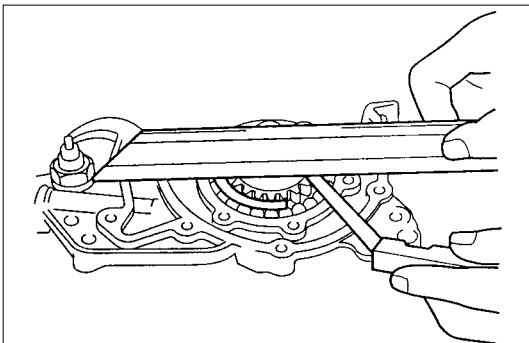
#### Installation

1. Install piston (observe installation position).
2. Install spring.
3. Install seal ring.
4. Install closure plug.



#### Tighten (Torque)

Closure plug - 30 N·m (3.0 kgf·m)



### Oil Pump (Overhaul)

#### Removal

1. Remove oil pump according to the corresponding operation.
2. Remove oil cover and pressure control valve.



#### Inspect

Clearance between gear pair and housing upper edge - see "Technical Data".

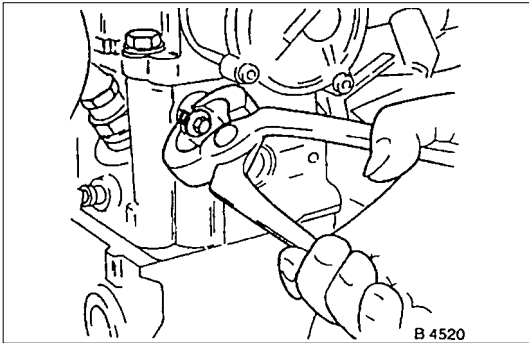
Check housing, cover and pressure control valve.



#### Installation

1. Install pump cover with Sealing Compound 15 03 166 (90 094 714).
2. Install oil pump safety valve according to the corresponding operation.
3. Install oil pump according to the corresponding operation.

# OPERATIONS ON OIL CIRCULATION



## Cylinder Head Safety Valve

### Removal

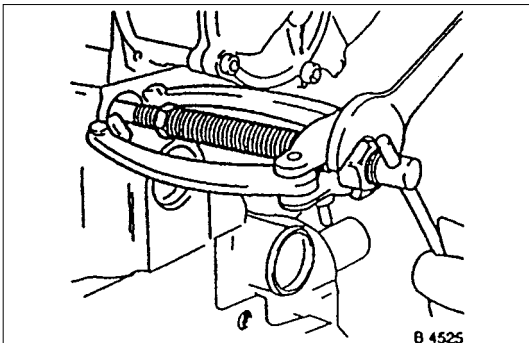
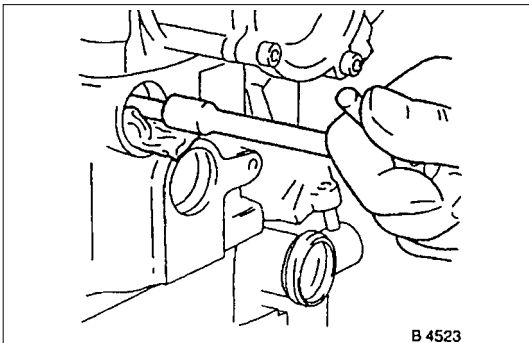
1. Remove cylinder head according to the corresponding operation.
2. Make hole in core plugs with pointed drift, turn in self tapping screw and edge out.



### Important!

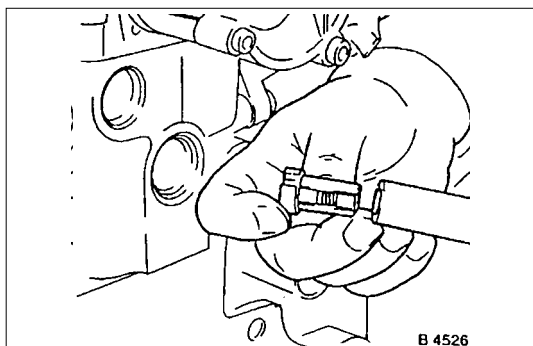
Cover oil duct in cylinder head with piece of cloth.

3. Pull out valve retainer, using commercially available tool.
4. Remove ball and spring.
5. Cut three threads in the ball seating with M 10 tap (3rd stage).
6. Coat tap with grease.



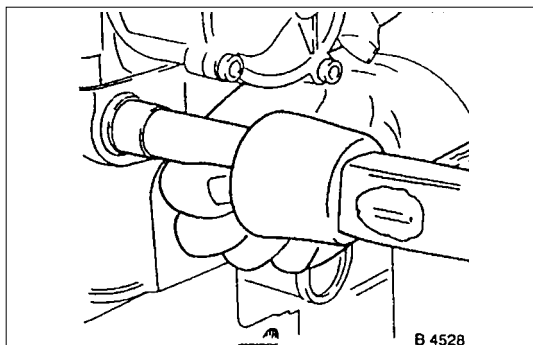
7. Remove ball seating from cylinder head with commercially available tool.  
Do not damage cylinder head.





## Installation

1. Install new pressure valve into cylinder head - with suitable pipe until stop.

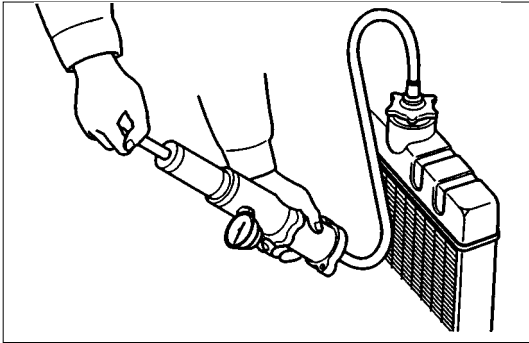


2. Install core hole plugs into cylinder head - with suitable pipe to end of chamfer.

## OPERATIONS ON COOLING SYSTEM

### ⚠ Caution!

Before working with the cooling system, be sure to confirm that the temperature of the engine is cooled down.  
Failure to observe this may cause burn.



### Cooling System, Check for Leaks

#### ↔ Installation

1. Install commercially available coolant checking instrument onto compensation tank (Refer to section 6B; Engine cooling).
2. Check coolant level.

#### 👁 Inspection

Use 5-8840-0277-0 tester & 5-8840-2603-0 adaptor.

### Cooling System, Fill Up and Bleed

#### ⚠ Important!

Radiator and heater core are made from aluminium.  
To avoid corrosion, use only anti-freeze with corrosion protection.

### Replace Coolant

1. Confirm the engine is cold enough.
2. Open the radiator cap, pour coolant to the filler neck level and close the cap.
3. Pour coolant into the reservoir until MAX line is reached.
4. Start the engine, run 2 ~ 3 minutes at idling speed and switch off the engine.
5. Refill coolant if the coolant level is lowered.



### **Important!**

Do not loosen or open the radiator cap when coolant is hot. Doing so may cause hot water or steam to splash out, resulting in burn. When opening the radiator cap, be sure to confirm the coolant is cold. Cover a thick cloth over the cap and loosen it slowly to reduce pressure, then open the cap.

6. Close the radiator cap firmly and run the engine at approx. 2000 rpm. In addition, set the heater temperature adjuster to the max position to circulate coolant in the heater conduit system.
7. Confirm that the temperature gauge reads half or more of full scale and that the thermostat is activated. Then continue idling 5 minutes more and switch off the engine, and allow it to cool.
8. After the engine cools down, check the coolant level and refill it if necessary. When the level is lowered extremely, check the coolant conduit system and reservoir hose for leak.
9. Pour coolant into the reservoir to MAX level.

### **Refill Coolant**



### **Important!**

After closing the cooling system, let engine run warm until thermostat opens (coolant approx. 92°C/197.6F)



### **Inspection**

Coolant level

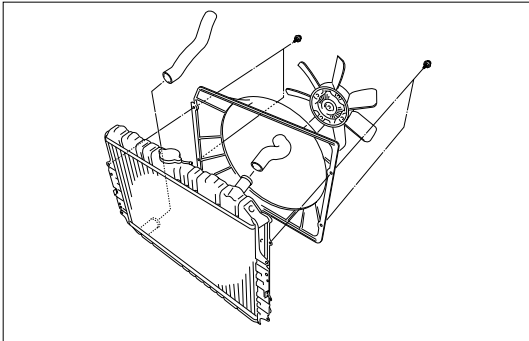
Allow engine to cool. If necessary, refill coolant.

Check that cooling system self-bleeds during engine warming-up phase.

### **Ignition Timing, Check No Adjustment**

# ENGINE EXTERNAL PARTS

## Radiator

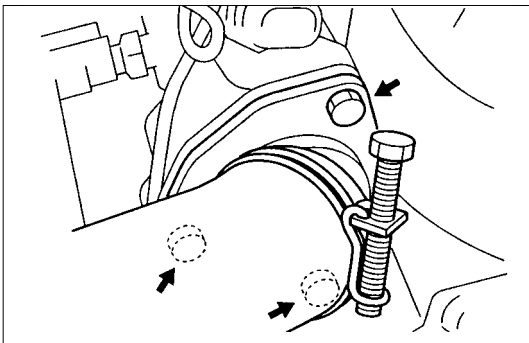


### ↔ Removal

1. Remove the upper hose and lower hose.
2. Remove all V-belts.
3. Remove the cooling fan.
4. Remove the fan guide.
5. Remove the radiator.

### → Installation

1. Install the radiator.
2. Install the fan guide.
3. Install the cooling fan.
4. Install all V-belts.
5. Install the lower and upper hose.



## Thermostat

### ↔ Removal

1. Remove water outlet nozzles with thermostat from thermostat housing.
2. Remove coolant hose and collect coolant.

### ⚠ Important!

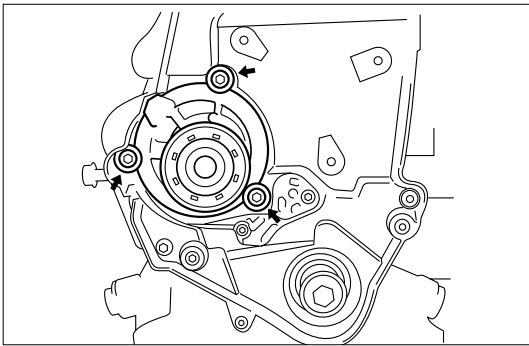
Remove and Install thermostat only together with water outlet nozzles.

### 🔍 Tighten (Torque)

Water outlet nozzles to thermostat housing - 8 N·m (0.8 kgf·m)

### → Installation

1. Install coolant hose.
2. Fill cooling system and bleed according to the corresponding operation.



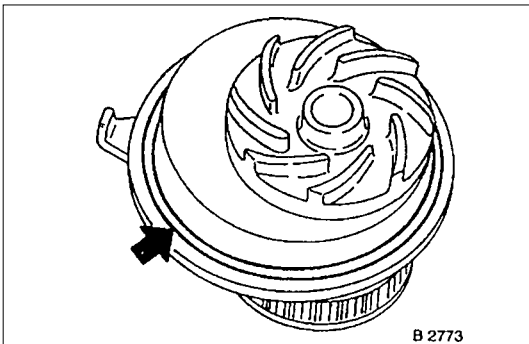
## Water Pump

### ↔ Removal

1. Remove lower hose band from pipe band and collect coolant.
2. Remove front toothed belt cover according to the corresponding operation.
3. Remove water pump from cylinder block after releasing tension on toothed belt.

### 🧼 Clean

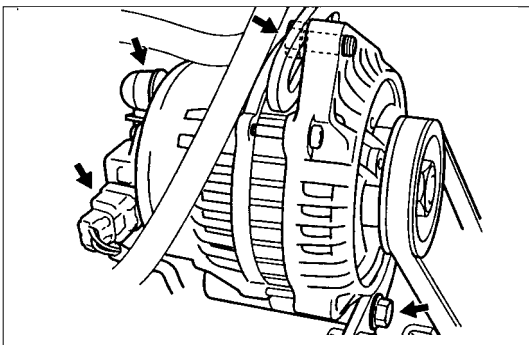
Sealing surfaces



## Coating sealing surfaces with Silicone Grease

### → Installation

1. Install water pump to cylinder block with new rubber O-ring.
2. Apply tension to toothed belt according to the corresponding operation.
3. Install coolant hoses.
4. Fill cooling system and bleed according to the corresponding operation.



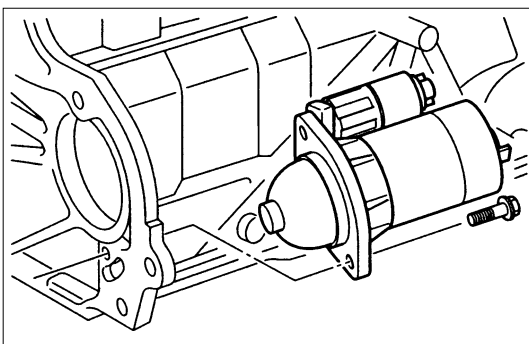
## Alternator

### ↔ Removal

1. Remove ground cable from battery.
2. Remove cable connection from alternator and V-belt.
3. Remove alternator from retaining strap and lower fastening.

### → Installation

1. Install alternator by tightening firmly by hand.
2. Install V-belt and apply tension according to the corresponding operation.
3. Install cable connections to alternator.
4. Install ground cable to battery.



## Starter

### ↔ Removal

1. Remove cable connections from starter.
2. Remove upper bolt of transmission side.
3. Remove lower bolt of engine side.



## Tighten (Torque)

Starter to cylinder block:

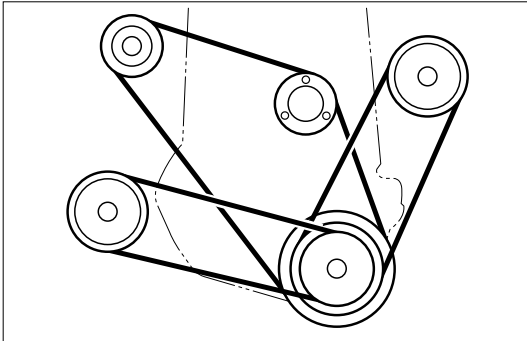
Engine side - 45 N·m (4.6 kgf·m)

Transmission side - 75 N·m (7.6 kgf·m)

Starter support to cylinder block - 25 N·m (2.5 kgf·m)

Re-connect cables.

## V-belt Tension of Alternator



### Measure

Measure V-belt tension of alternator.

Permitted values for new V-belt are approx. 311-489N (31-50 kgf).

Note:

V-belt to deflection as loaded with 10kg : 8-12mm.



### Adjust

Adjust V-belt tension by loosening clamping bracket and lower alternator bracket and moving alternator.



## Tighten (Torque)

Clamping bracket to alternator - 25 N·m (2.6 kgf·m)

Lower alternator bracket - 25 N·m (2.6 kgf·m)

## V-Belt Tension of Power Steering Pump



### Measure

Measure V-belt tension of power steering pump. Permitted values for new belt are approx. 578-712N (59-73 kgf) and 534-667N (54-68 kgf) for used belt.

Note:

V-belt to deflection as loaded with 10kg : 8-12mm.



### Adjust

Adjust V-belt tension by loosening clamping bolt, lower pump bracket, and adjusting nuts and moving steering pump.



## Tighten (Torque)

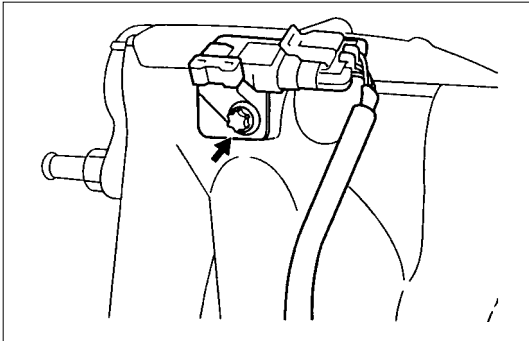
Adjusting nuts - 18 N·m (1.8 kgf·m)

Clamping bolt - 25 N·m (2.6 kgf·m)

Lower pump bracket - 26 N·m (2.6 kgf·m)

# FUEL INJECTION SYSTEM

## MAP SENSOR

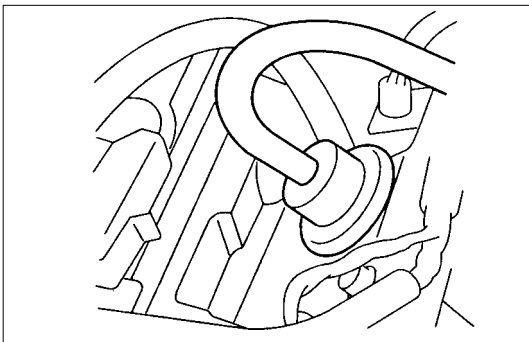


### ↔ Removal

1. Disconnect the battery cable.
2. Disconnect the electrical connector from the sensor.
3. Remove the mounting bolts securing the sensor to the manifold.
4. Remove the sensor from the intake manifold.

### ↔ Installation

1. Push MAP sensor into the manifold.
2. Install the mounting bolts and tighten them.
3. Connect electrical connector.
4. Connect the battery cable.



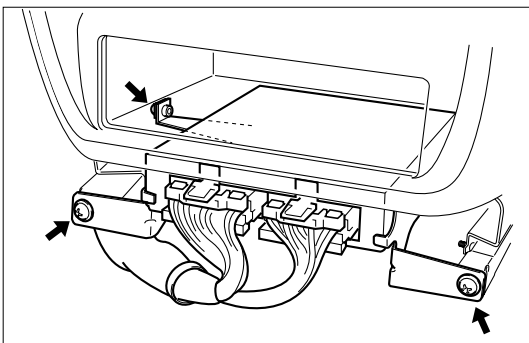
## Pressure Regulator

### ↔ Removal

1. Remove vacuum hose.
2. Remove fuel hoses.
3. Remove pressure regulator.

### ↔ Installation

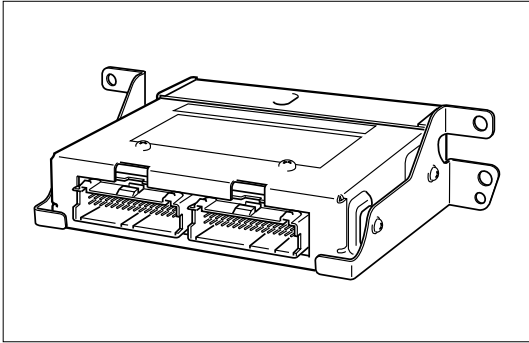
1. Install pressure regulator.
2. Install fuel hoses.
3. Install vacuum hoses.



## ECM (Engine Control Module)

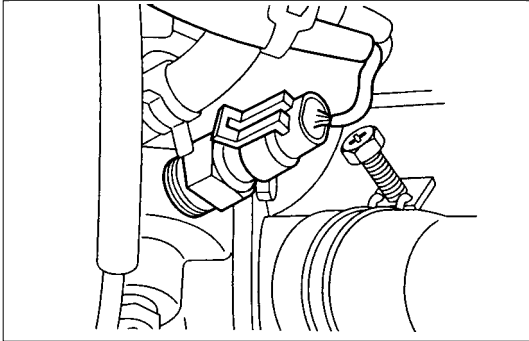
### ↔ Removal

1. Remove the center console assembly.
2. Remove the ECM cover.
3. Remove 3 screws for the bracket.
4. Pull ECM out.
5. Disconnect the connectors.



### Installation

1. Connect the connectors.
2. Install ECM to the proper position.
3. Tighten 4 screws to the bracket.
4. Install the ECM cover.
5. Install the center console assembly.



### ECT

#### Removal

1. Remove wiring harness plug and coolant temperature sensor.



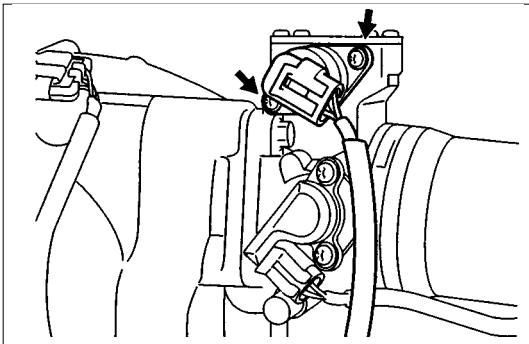
#### Tighten (Torque)

- Temperature sensor to intake pipe - 10 N·m (1.0 kgf·m)  
 Wiring harness plug to temperature sensor



#### Inspection

Coolant level



### Idle Air Control (IAC) Valve

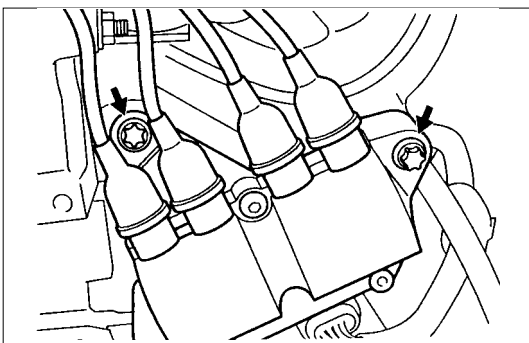
#### Removal

1. Remove wiring harness plug, hose clamps and idle speed adjuster.



#### Installation

1. Install idle speed adjuster, hose clamps and wiring harness plug.



### Ignition Coil

#### Removal

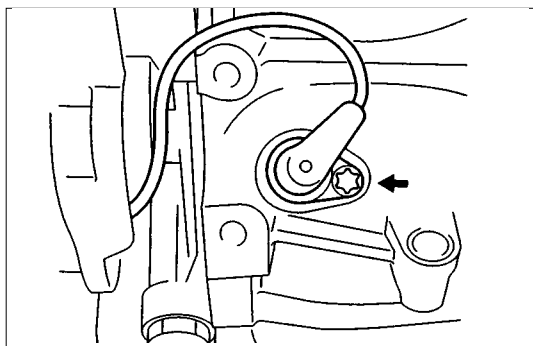
1. Remove 2 bolts, plug and ignition coil.



#### Installation

1. Install ignition coil, plug and bolts.





### Crank Position Sensor



#### Removal

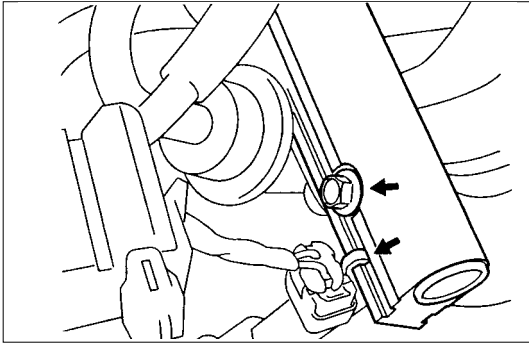
1. Remove crank position sensor.



#### Installation

1. Install crank position sensor.

## FUEL INJECTOR



### ↔ Removal

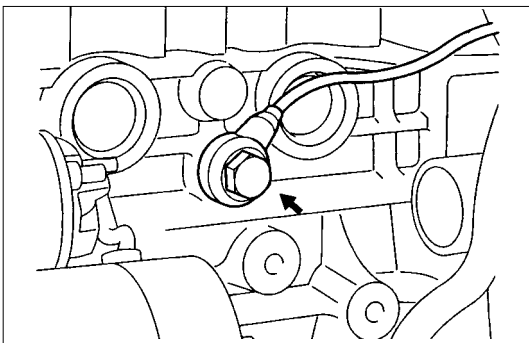
**Caution:** To reduce the risk of fire and personal injury, it is necessary to relieve the fuel system pressure before servicing the fuel system components.

**Caution:** After relieving the fuel system pressure, a small amount of fuel may be released when servicing fuel lines or connections. Reduce the chance of personal injury by covering the fuel line fitting with a shop towel before disconnecting the fittings. The towel will absorb any fuel that may leak out. When the disconnect is completed, place the towel in an approved container.

1. Depressurize the fuel system.
2. Disconnect the fuel inlet.
3. Disconnect the fuel return line.
4. Remove the fuel rail from the intake manifold.
5. Remove the fuel injector from the fuel rail by disengaging claws.

### → Installation

1. Install the fuel injector to the fuel rail by engaging claws.
2. Install the fuel rail to the intake manifold.
3. Connect the fuel return line firmly.
4. Connect the fuel supply line firmly.

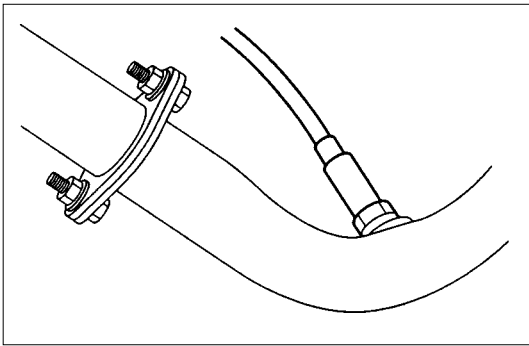


### ↔ Knock sensor Removal

1. Remove fixing bolts.
2. Disconnect the connector at the other side.

### ⊗ Tighten (Torque)

Oxygen sensor in exhaust pipe - 30N·m (3.2 kgf·m)  
When re-using, insert oxygen sensor.



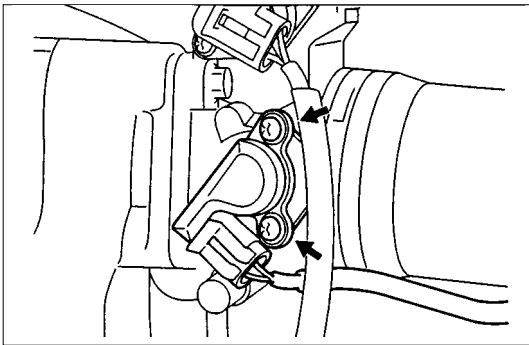
### Oxygen Sensor (If applicable) Removal

1. Remove wiring harness plug.
2. Remove oxygen sensor from the front exhaust pipe.



### Tighten (Torque)

Oxygen sensor in exhaust pipe - 30 N·m (3.1 kgf·m)



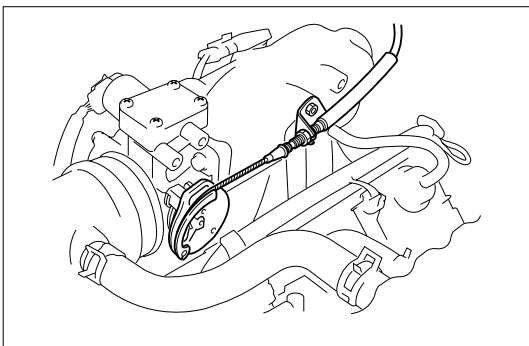
### Throttle Valve Position Sensor Removal

1. Remove wiring harness connector.
2. Remove throttle valve position sensor.



### Installation

1. Install throttle valve position sensor.
2. Install wiring harness connector.



### Accelerator Pedal and Cable Removal

1. Remove pad stopper from pedal stop bolt.



### Measure

Dimension "A":

RD=15mm ± 0.5mm/0.59in. ± 0.02in.

LD=14mm ± 0.5mm/0.55in. ± 0.02in.



### Installation

1. Install pad stopper.

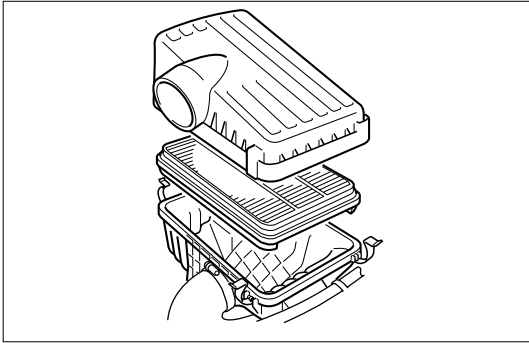


### Inspection

Ensure that accelerator pedal is fully in idle position and accelerator level at engine is in closed position.

Pull outer sleeve of accelerator cable towards pedal and check that clip on sleeve is in slot nearest to grommet.

Reposition clip if necessary, and check that full throttle and idle positions are obtained at engine lever.



## Air Cleaner Filter



### Removal

1. Remove positive ventilation hose connector.
2. Remove intake air temperature sensor.
3. Remove mass air flow sensor.
4. Remove air cleaner duct assembly.
5. Remove air cleaner element.



### Inspection

Check the air cleaner filter for damage or dust clogging. Replace if it is damaged, or clean if it is clogged.



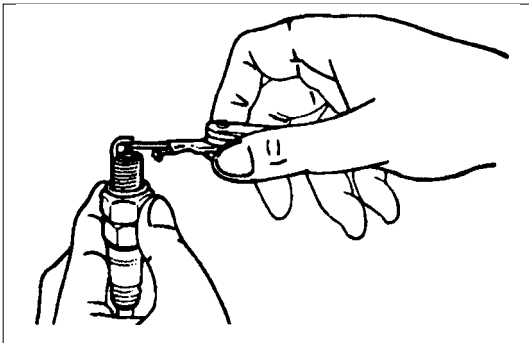
### Cleaning Method

Tap the air cleaner filter gently so as not to damage the paper filter, or clean the element by blowing with compressed air of about 490 kPa (71 psi) from the clean side if it is extremely dirty.



### Installation

1. Install air cleaner element.
2. Attach the air cleaner duct cover to the body completely, then clamp it with the clip.
3. Install mass air flow sensor.
4. Install mass air temperature sensor.
5. Install positive crankcase ventilation hose connector.



## Spark Plug Thread

### Recondition

Ream thread and recut using commercially available spark plug thread drill (observe manufacturer's instructions).



### Removal

Remove thread bush on spark plug. (dimensions (A) = 17mm/0.67in.)



### Tighten (Torque)

Spark plug with thread bush into cylinder head - 25N·m (2.5 kgf·m) - use

# TECHNICAL DATA

## SOHC Gasoline Engine C22NE/22LE/20LE

### Engine Oil Viscosity

The following engine oils can be used:

A = single-grade oils

B = multigrade oils

C = easy run oils

depending on the outside temperature.

### Engine Oil Quality

It is important that the following API and CCMC classes are used:

Engines	Single and multigrade oils	Easy run oils
Petrol	API-SF/CC, SF/CD, SG/CC, SG/CD, CCMC/G4	API-SF/CC, SF/CD, SG/CD CCMC-G5/PD2

### Important!

CD engine oils designed by manufacturers specially for diesel engines are not suitable for petrol engines, unless a sufficient performance class for petrol engines (e.g. API-SF/CCMC-G4) is also indicated.

### Disposal.

Observe the relevant national regulations when disposing of used oil.

### Engine Oil Filling Quantities

Initial filling (litres)	Filling quantity with filter change* (litres)	MIN to MAX (litres)
4.25	4.5	1.00

\*Up to mark "MAX" on oil dipstick

### Oil Pump

Backlash	0.1 to 0.2mm
Gaps in gears opposite housing	0.03 to 0.1mm
Oil pressure at idle speed	Engine at operating temperature (>70°C oil and approx. 80°C coolant) 150 kPa/1.5 bar
Oil drain plug	M14 × 1.5

## Cooling System

Radiator

Type: Cross-flow

Radiator core surface in cm<sup>2</sup>: 2000

Cooling system capacity (in litres): 7.2

## Anti-freeze Mixture

Anti-freeze Mixture

Required Quantity (in litres)	Up to-10°C Quantity in litres		Up to-20°C Quantity in litres		Up to-30°C Quantity in litres		Up to-40°C Quantity of litres	
	Water (80%)	Anti- Freeze (20%)	Water (66%)	Anti- Freeze (34%)	Water (56%)	Anti- Freeze (44%)	Water (48%)	Anti- Freeze (52%)
7.2	5.7	1.5	4.7	2.5	4.0	3.2	3.4	3.8

## Cooling System (continued)

Fan

Type: Visco Clutch Fan

Number of blades: 5

Distribution of blades: asymmetric

Diameter mm

## Radiator cap

Boiling point: 123°C

Opening pressure kPa (bar): 120 to 135 (1.20 to 1.35)

## Thermostat

Start of opening: 92°C

Fully opened: 107°C

Type: Bypassed

## Idle Speeds, CO Content, Ignition Adjustment

Applicable System	Idle speed in min <sup>-1</sup> (rpm) Manual	CO content in vol. %	Ignition timing in CA BTDC (adjustment ensues at idle speed, ignition marks must align) with TDC sensor measuring instrument:
Closed Loop System	825	* < 0.4	*** 8 to 12
Open Loop System	825	** 1.0 <sup>+0.2</sup> <sub>-0.5</sub>	*** 8 to 12

Note) \* CO content adjustment not applicable.

\*\* CO content adjustment refer to 6E1-93

\*\*\* Ignition timing adjustment not possible.

## Adjustment Values/Checking Values

Valve clearance		
Inlet		Hydraulic valve lash adjustment
Outlet		No adjustment necessary
Spark plugs - electrode gap		1.0 ~ 1.1 mm
Compression		The difference in compression between the individual cylinders in the engine must not exceed 100 kPa (1 bar).
Pressure loss		The pressure loss of an engine in perfect condition per cylinder is not more than max. 25%

## Cylinder Head

### Cylinder Head Gasket

Thickness - installed	mm	1.15 to 1.30
-----------------------	----	--------------

### Valve seat width at cylinder head

inlet	mm	1.0 to 1.5
outlet	mm	1.7 to 2.2

Valve stem play inlet	mm	0.018 to 0.052
outlet	mm	0.038 to 0.072

### Permissible valve stem to cone runout

inlet	mm	0.03
outlet	mm	0.33

### Overall height of cylinder head

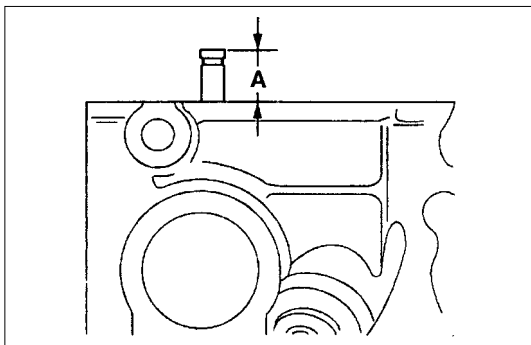
(Sealing surface to sealing surface)	mm	96.00 ± 0.25
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### Installation height

inlet and outlet valves	mm	17.85 to 18.25
dimension "A"		Distance Gauge 5-8840-2596-0

Installation height valve guide	mm	83.50 to 83.80
---------------------------------	----	----------------

Sealing surface peak-to-valley height	mm	max. 0.025
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## Cylinder Head (continued)

### Valve System

Valve lifter valve play compensator  
(hydraulic)

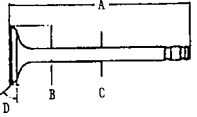
Valve rotators  
(inlet or outlet) outlet

Valve play  
(warm or cold) inlet mm 0  
outlet mm 0



## Cylinder Head (continued)

### Valve Dimensions

	C 20 NE							D
	A in mm		B in mm	C(diameter in mm) and identification mark				
	1)	2)		Normal K	Oversize K1 0.075	Oversize K2 0.150	Oversize A 0.250	
<b>Inlet valve</b>	104.2	103.8	41.8	7.012 6.998	7.087 7.073	7.162 7.148	7.262 7.248	44°
<b>Outlet valve</b>	104.0	103.6	36.5	6.992 6.978	7.087 7.053	7.142 7.128	7.242 7.228	44°
<b>Valve stem bore</b>	-			7.050 7.030	7.125 7.105	7.200 7.180	7.300 7.280	-

1) Production

2) Customer service

The P and A department only supplies valves with a length of 103.8mm (inlet valve) and 103.6mm (outlet valve) only

### Camshaft

Identification letter		J
Colour code	Normal size	-
	0.1mm undersize	violet
Radial runout	mm	0.03
End play	mm	0.09 to 0.21
Cam lift	Inlet and outlet valve	mm 6.67

### Grinding Dimension for Camshaft Bearing Position

Bearing	Bearing journal diameter in mm		Diameter in housing	
	normal	-0.1mm	normal	-0.1mm
1	42.470	42.370	42.525	42.500
	42.455	42.355	42.425	42.400
2	42.720	42.620	42.775	42.675
	42.705	42.605	42.750	42.650
3	42.970	42.870	43.025	42.925
	42.955	42.855	43.000	42.900
4	43.220	43.120	43.275	43.175
	43.205	43.105	43.250	43.150
5	43.470	43.370	43.525	43.425
	43.455	43.355	43.500	43.400

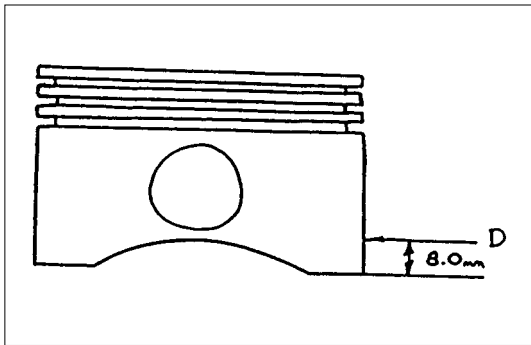
## Crankshaft, Cylinder Block Cylinder Grinding and Piston dimensions

### Cylinder Grinding and Piston Dimensions

	Size	Cylinder bore dia. in mm		Cylinder to Crankshaft housing co-efficient	Related piston dia. in mm		Piston head co-efficient
		over	to		over	to	
<b>Production</b>	1	85.97*	85.89	8	85.95	85.96	8
	2	85.98	85.99	99	85.96	85.97	99
		85.99	86.00	00	85.97	85.98	00
		86.00	86.01	01	85.98	85.99	01
		86.01	86.02	02	85.99	86.00	02
<b>Customer service</b>	Oversize 0.5mm	8.46	86.47	7+0.5	86.44	86.45	7+0.5

Piston diameter must be measured at the position "D".

\*inclusive



### Crankshaft, Cylinder Block (continued) Cylinder Bore

Rebore cylinder Permissible oversize to 0.5mm (see parts microfiche)

After reboring, invalidate original crankcase housing coefficient and drive in new oversize coefficient

Permissible out-of-round: 0.013mm  
Permissible taper: 0.013mm  
Measure out-of-round in bore at 4 different heights

Piston projection above upper edge of cylinder block  
0.40mm

Piston Type Recessed pistons

Clearance For short-blocks and cylinder blocks with complete pistons, the clearance is 0.02 to 0.04mm

For replacement (oversize), depending on available pistons, a clearance of 0.02 to 0.04mm is permissible

## Crankshaft, Cylinder Block (continued)

### Piston Rings

Square ring	Height	mm	1.5
Tapered ring	Height	mm	1.5
Oil scraper	Height	mm	3
Ring gap offset			180°

Note that the upper steel band ring gap is offset 25 to 50mm to the left and the lower 25 to 50mm to the right opposite the intermediate ring gap.

### Piston Pin

Length		mm	61.5
Diameter		mm	21
Type			Shrunk into con-rod
Play		mm	
	in piston		0.011 to 0.014
	in con-rod		none
Installation			When installing piston pins, heat con-rods to approx. 280°C in oil bath. This temperature should under no circumstances be exceeded.

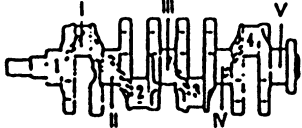
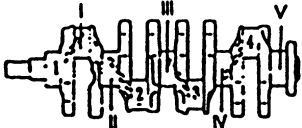
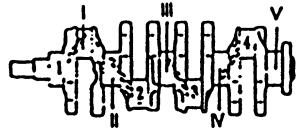
## Crankshaft, Cylinder Block (continued)

The permissible weight variation of con-rods without piston and bearing shell inside an engine is 8 g.

As the con-rods do not have balancing studs, reworking is not possible.

Con-rods can only be replaced in sets.

## Crankshaft, Cylinder Block (continued) Crankshaft Grinding Dimensions

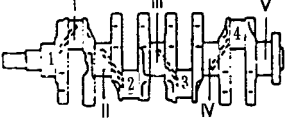
	Crankshaft journal I, II, IV, V Diameter mm	Guide bearing III Widtht mm	Con-rod journal 1 to 4 Diameter   Width mm   mm		Con-rod width mm
	Normal size				
Bearing journal and colour code	from 57.9820 green to 57.9885 > 57.9885 brown to 57.9950	25.900 25.850	48.988 48.970	26.580 26.460	26.390 26.338
Bearing shell identification mark Colour code and embossed Identification mark	Crankshaft bearing I, II, IV, V	Guide bearing III	Con-rod bearing 1 to 4		
	brown-662N green-663N	brown-655N green-658N			
	Crankshaft journal I, II, IV, V Diameter mm	Guide bearing III Widtht mm	Con-rod journal 1 to 4 Diameter   Width mm   mm		Con-rod width mm
	0.25mm Undersize for Production and Customer Service				
Bearing journal and colour code	from 57.7320 green/ to 57.7385 blue > 57.7385 brown/ to 57.7450 blue	26.100 26.050	48.738 48.720		26.580 26.460
Bearing shell identification mark Colour code and embossed Identification mark	Crankshaft bearing I, II, IV, V	Guide bearing III	Con-rod bearing 1 to 4		
	brown/blue-664 A green/blue-655 A	brown/blue-657 A green/blue-658 A			
	Crankshaft journal I, II, IV, V Diameter mm	Guide bearing III Widtht mm	Con-rod journal 1 to 4 Diameter   Width mm   mm		Con-rod width mm
	0.50mm Undersize Customer Service				
Bearing journal and colour code	from 57.4820 green/ to 57.4885 blue > 57.4885 brown/ to 57.4950 blue	26.300 26.250	48.488 48.470		26.580 26.460
Bearing shell identification mark Colour code and embossed Identification mark	Crankshaft bearing I, II, IV, V	Guide bearing III	Con-rod bearing 1 to 4		
	brown/white-666 B green/white-667 B	brown/blue-659 B green/blue-660 B			

### Piston Pins

Dimensions		
Length	mm	61.5
Diameter	mm	21
Type		Shank-fit in con-rod
Clearance		
In piston	mm	0.011 to 0.014
In con-rod	mm	0
Installation		See operation "Con-rod, Replace"

## Con-rod

Permissible, weight variation of con-rods without pistons and bearing shells within an engine 8 g.
As the con-rods have no counterweights, re-working is not possible. Con-rods must be replaced only as a set.

Crankshaft Grinding Dimensions					
	Crankshaft bearing journals I, II, III, IV, V	Guide bearings III	Con-Rod bearing journals 1 to 4		Con-rod
	diameter in mm/colour code	width in mm	diameter in mm	width in mm	width in mm
Standard Size for Production and Service					
	from 57.974 white to 57.981	<u>26.002</u> 25.950	<u>48.988</u> 48.970	<u>26.580</u> 26.450	<u>26.390</u> 26.338
	over 57.981 green to 57.988				
	over 57.988 brown to 57.995				

## Crankshaft, Cylinder Block (continued)

Crankshaft and con-rod journal	Permissible out-of-round: 0.04mm
Out-of-round	Permissible variation of middle crankshaft bearing journal when seating shaft into cylinder block: 0.03mm
Permissible end play	0.05 to 0.152mm
Permissible main bearing play	Bearing I to V: 0.015 to 0.04mm
Permissible con-rod play	0.006 to 0.031mm
Permissible con-rod and play	0.07 to 0.24mm

## Crankshaft, Cylinder Block (continued)

Flywheel

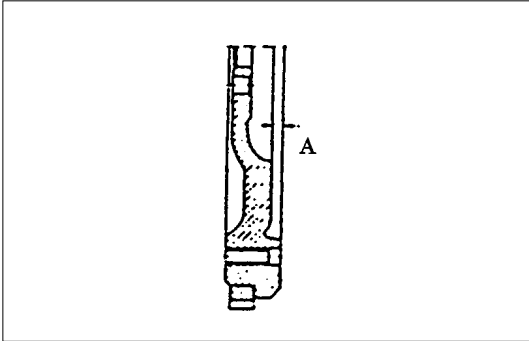
Starter ring gear Before fitting, heat ring gear to 180°C - 230°C

Lateral run-out Permissible lateral run-out of installed starter ring gear to flywheel: 0.5mm

Precision turning Permissible removal of material in clutch disc lining surface area: 0.3mm

In order to achieve the functional relationship again after removal of material, the same removal of material must take place on the fore part of the flywheel (contact for clutch assembly)

Dimension A: 2.1 to 2.2mm



## Recommended Torque Values

	N·m (kgf·m)		
Bearing cover to cylinder block .....	60 <sup>1)</sup>	6.1	+40° to 50°
Bracket for alternator to cylinder block .....	40	4.1	
Bracket for engine damping block to transmission .....	60 <sup>2)</sup>	6.1	
Bracket for engine damping block to engine block .....	60	6.1	
Bracket for pump/compressor to engine block .....	40	4.1	
Camshaft housing cover to housing .....	8	0.8	
Camshaft timing gear to camshaft .....	45	4.6	
Clamping bracket for alternator to intake manifold .....	25	2.5	
Clamping bracket to alternator .....	25	2.5	
Con-rod bearing cap to con-rod .....	35 <sup>1)</sup>	3.5	+45° to 60°
Crankshaft pulley bolts .....	20	2.0	
Cylinder head to cylinder block .....	25 <sup>1)2)</sup>	2.5	+90° +90°
	+90°		
Engine damping block to engine bracket .....	8.5	8.7	
Engine damping block to side member .....	52 <sup>1)</sup>	5.3	
Exhaust manifold to cylinder head .....	22	2.2	

1) Use new bolts

2) Use new locking plates

## Recommended Torque Values

	N·m (kgf·m)			
Flywheel to crankshaft .....	65 <sup>1)</sup>	6.6	+30° to 45°	
Front exhaust pipe to exhaust manifold .....	25	2.5		
Guide sleeve for pressure bearing to transmission .....	22	2.2		
Intake manifold to cylinder head .....	22	2.2		
Lower alternator bracket .....	25	2.5		
Oil drain plug to oil pan .....	45	4.6		
Oil intake pipe bracket to cylinder block .....	6 <sup>2)</sup>	0.6		
Oil intake pipe to oil pump .....	8	0.8		
Oil pan to cylinder block .....	8 <sup>2)3)</sup>	0.8		
Oil pan to cylinder block (vulcanized gasket) .....	15 <sup>2)3)</sup>	1.5		
Oil pressure switch to oil pump .....	30	3.2		
Pump for power steering (ribbed V-belt) to engine block .....	30	3.2		
Spark plugs in cylinder head .....	25	2.5		
Starter support to cylinder block .....	25	2.5		
Starter to cylinder block - engine side .....	45	4.6		
Starter to cylinder block - transmission side .....	75	7.6		
Thermostat housing to cylinder head .....	15	1.5		
Toothed belt drive gear to crankshaft .....	130 <sup>1)</sup>	13.3		
Toothed belt front cover .....	4	0.4		
Toothed belt rear cover .....	6	0.6		
Toothed belt tension roller to oil pump .....	25	2.5		
Transmission to engine block	{	(M10) .....	45	4.6
		(M12) .....	76	7.7
		(M12) .....	60	6.1
Water pump to cylinder block .....	25	2.5		

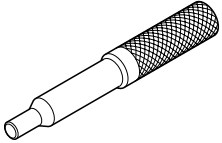
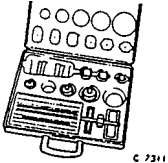
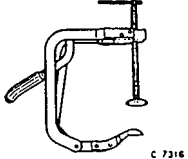
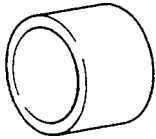
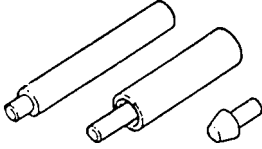
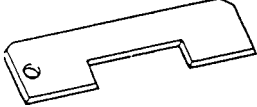
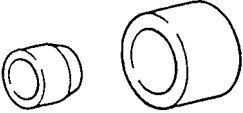
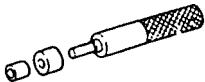

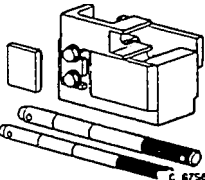
1) Use new bolts

2) Use Locking Compound

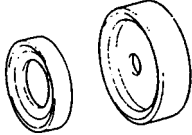
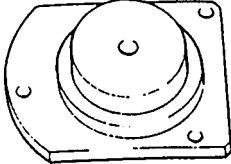
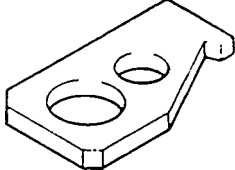


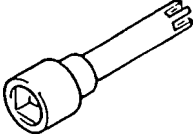
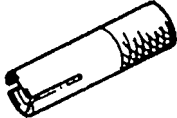
3) Maximum installation time - 10 minutes



## SPECIAL SERVICE TOOLS

ITEM NO.	ILLUSTRATION	PART NO.	PART NAME
		5-8840-2634-0	Aligner
		5-8840-2593-0	Cutter set
		5-8840-2594-0	Spring Compressor
		5-8840-0451-0	Installer
		5-8840-0452-0	Remover / Installer
		5-8840-2596-0	Distance Gauge
		5-8840-0455-0	Assembly Sleeves
		5-8840-2597-0	Installer
		5-8840-0457-0	Remover / Installer
		5-8840-0468-0	Remover / Installer

**ENGINE MECHANICAL (C22NE, 22LE, 20LE) 6A-89**

ITEM NO.	ILLUSTRATION	PART NO.	PART NAME
		5-8840-0459-0	Installer
		5-8840-0460-0	Installer
		5-8840-0446-0	Flywheel Holder
		5-8840-2598-0	Holding Wrench
		5-8840-2599-0	Reamer Set
		5-8840-2600-0	Socket Wrench
		5-8840-2601-0	Installer

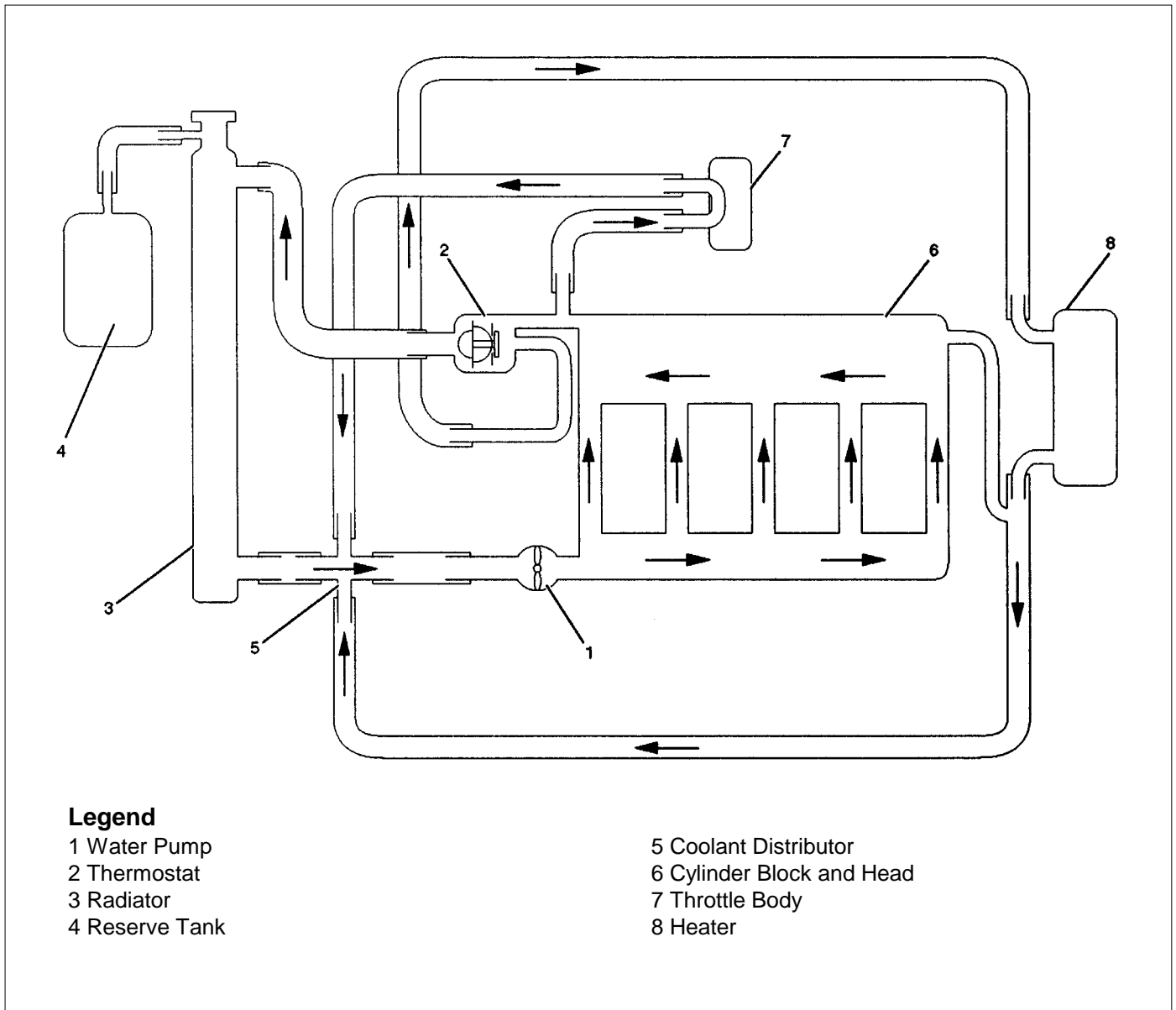
# SECTION 6B

## ENGINE COOLING

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## General Description



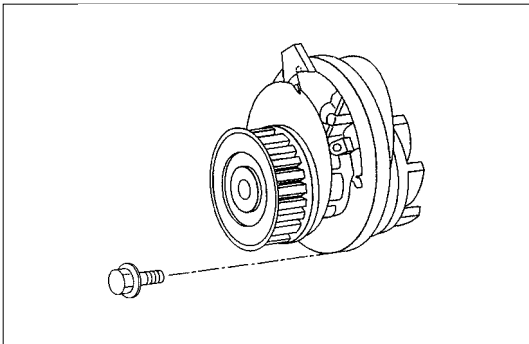
The Cooling System is a pressurized type, where the water pump, which is cambelt driven, forces the circulation of the coolant through the cylinder block and head. The thermostat regulates the flow of coolant between the radiator and the bypass circuit. The heater is part of the bypass circuit. The throttle body pre-heat is a separate circuit which is not regulated by the thermostat. An oil cooler may be fitted as part of this circuit.

## Service Precaution



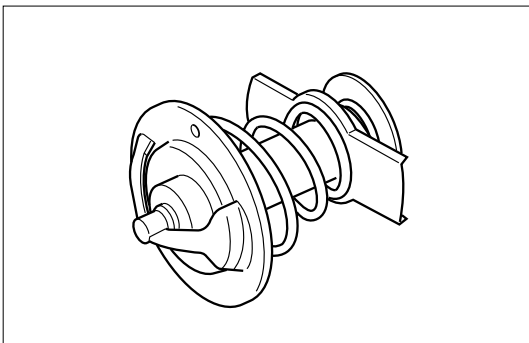
### CAUTION:

Always use the correct fastener in the proper location. When you replace a fastener, use **ONLY** the exact part number for that application. ISUZU will call out those fasteners that require a replacement after removal. ISUZU will also call out the fasteners that require thread lockers or thread sealant. **UNLESS OTHERWISE SPECIFIED**, do not use supplemental coatings (Paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and the joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.



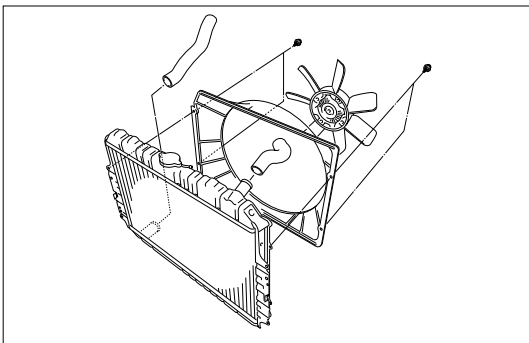
## Water pump

The water pump is centrifugal type and is driven by timing belt.



## Thermostat

The thermostat is a bypass type and is a wax pellet type with a air hole (1).



## Radiator

The radiator is a flow type with corrugated fins.

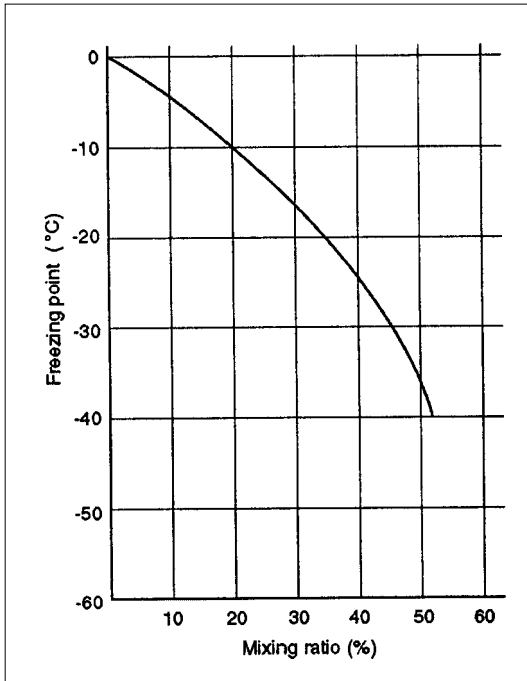
### Antifreeze Solution

- Relation between Mixing ratio and Freezing temperature of the engine coolant varies with the ratio of antifreeze solution in water. Proper mixing ratio can be determined by referring to the chart. Supplemental inhibitors or additives claiming to increase cooling capability that have not been specifically approved by Isuzu are not recommended for addition to the cooling system.
- Calculating mixing ratio  
Mixing ratio

$$= \frac{\text{Antifreeze solution (Lit/gal.)}}{\text{Antifreeze solution (Lit/gal.)} + \text{Water (Lit/gal.)}}$$

NOTE: Antifreeze solution + Water = Total cooling system capacity.

- **Total Cooling System Capacity**  
5.7Lit



- Mixing ratio  
Check the specific gravity of engine coolant in the cooling system temperature ranges from 0°C to 50°C using a suction type hydrometer, then determine the density of the engine coolant by referring to the table.

NOTE:

1. Even in the areas where the atmospheric temperature is higher than 0°C, be sure not to use antifreeze solution at a mixing ratio lower than 20% so that the inside of the engine may not be corroded.
2. If antifreeze solution is used at a mixing ratio higher than 60%, the specific heat of the coolant falls and the engine may be overheated. Moreover, antifreeze performance drop and the coolant may be frozen. The density of the solution must be adjusted as occasion calls.

Antifreeze solution lower than 20% may not have sufficient anticorrosive performance, and therefore, please never fail to adjust as occasion demands within the range of 20% to 60%.

## Diagnosis Engine Cooling Trouble

Condition	Possible cause	Correction
Engine overheating	Low Engine Coolant level	Replenish
	Thermo mater unit faulty	Replace
	Faulty thermostat	Replace
	Faulty Engine Coolant temperature sensor	Repair or replace
	Clogged radiator	Clean or replace
	Faulty radiator cap	Replace
	Low engine oil level or use of improper engine oil	Replenish or change oil
	Clogged exhaust system	Clean exhaust system or replace faulty parts
	Faulty Throttle Position sensor	Replace throttle valve assembly
	Open or shorted Throttle Position sensor circuit	Repair or replace
	Damaged cylinder head gasket	Replace
	Loosen V-belt tension	Adjust belt tension or replace.
	Collapsed hoses	Replace
Faulty Fan clutch	Replace	
Engine overcooling	Faulty thermostat	Replace
Engine slow to warm-up	Faulty thermostat	Replace
	Thermo unit faulty	Replace

## 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.
2. Remove the radiator cap.



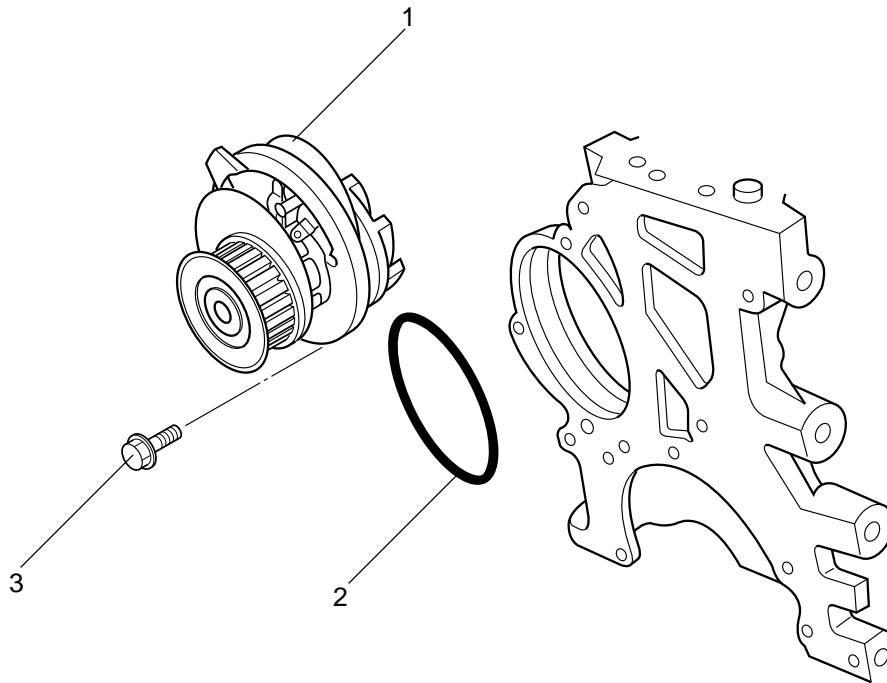
**WARNING: TO AVOID THE DANGER OF BEING BURNED, DO NOT REMOVE THE CAP WHILE THE ENGINE AND RADIATOR ARE STILL HOT. SCALDING FLUID AND STEAM CAN BE BLOWN OUT UNDER PRESSURE.**

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 at least 50 percent antifreeze but no more than 70 percent antifreeze.
4. Refill the cooling system with the EC using a solution that is at least 50 percent antifreeze but no more than 70 percent antifreeze.
5. Fill the radiator to the base of the filler neck.  
Fill the EC reserve tank to "MAX" line when the engine is cold.
6. Block the drive wheels and firmly apply the parking brake. Shift an automatic transmission to "P" (Park) or a manual transmission to neutral.
7. Remove the radiator cap. Start the engine and warm it up at 2,500 - 3,000 rpm for about 30 minutes.
8. When the air comes out from the radiator filler neck and the EC level has gone down, replenish with the EC. Repeat this procedure until the EC level does not go down. Then stop the engine and install the radiator cap. Let the engine cool down.
9. After the engine has cooled, replenish with EC up to the "MAX" line of the reserve tank.
10. Start the engine. With the engine running at 3,000 rpm, make sure there is no running water sound from the heater core (behind the center console).
11. If the running water sound is heard, repeat steps 8 to 10.



# Water Pump

## Water Pump and Associated Parts



### Legend

1 Water Pump Assembly

2 O-Ring

3 Bolt



### Removal

1. Disconnect battery ground cable.
2. Drain coolant.
3. Radiator hose (on inlet pipe side).
4. Remove timing belt, refer to "Timing Belt" in this manual.
5. Remove water pump assembly.



### Inspection

Make necessary repair and parts replacement if extreme wear or damage is found during inspection. Should any of the following problems occur, the entire water pump assembly must be replaced:

- Crack in the water pump body
- EC leakage from the seal unit

- Play or abnormal noise in the bearing
- Cracks or corrosion in the impeller



### Installation

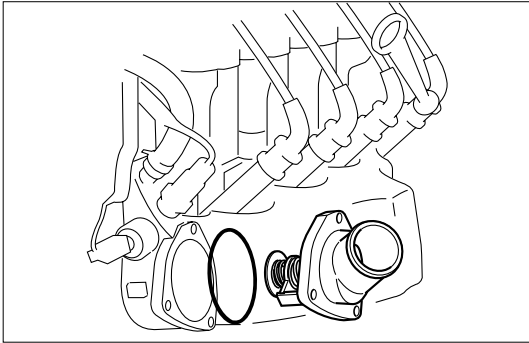
1. Before installing water pump, coat sealing surface with silicon grease.
2. Install water pump assembly and tighten bolts to the specified torque.



**Torque: 25 N·m (2.5 kgf.m)**

3. Timing belt
  - Install timing belt, refer to timing belt installation step in "Timing Belt" in this manual.
4. Connect radiator hose and replenish EC.
5. Connect battery ground cable.

## Thermostat



### ↔ Removal

1. Disconnect battery ground cable.
2. Drain engine coolant from the radiator and engine.
3. Disconnect radiator hose from the inlet pipe.
4. Remove thermostat housing.
5. Remove thermostat from thermostat housing.



### Inspection

Suspend the thermostat in a water-filled container using thin wire. Place a thermometer next to the thermostat. Do not directly heat the thermostat. Gradually increase the water temperature. Stir the water so that the entire water is same temperature. Confirm the temperature when the valve first begins to open.

**Valve opening temperature 92°C (197.6°F)**

Confirm the temperature when the valve is fully opened.

**Valve full open temperature 107°C(224.6°F)**

Make necessary repair and parts replacement if extreme wear or damage is found during inspection.

### ↔ Installation

1. Before installing thermostat, coat sealing surface with silicon grease.
2. Install O-ring.
3. Install thermostat housing and tighten bolts to the specified torque.



**Torque: 15 N·m (1.5 kgf.m)**

4. Installation rubber hose.
5. Replenish engine coolant (EC).
6. Start engine and check for EC leakage.

## Fan Clutch with Cooling Fan



### Inspection and Repair

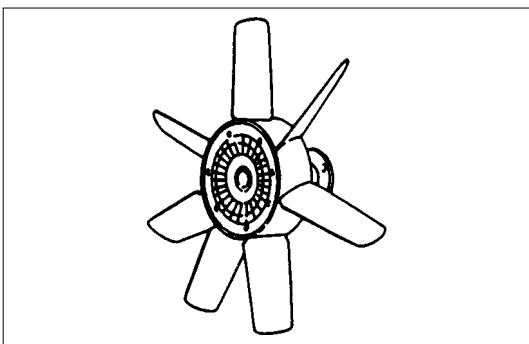
Make necessary correction or parts replacement if wear, damage or any other abnormal condition are found through inspection.



Visually inspect for damage, leak (silicon grease) or other abnormal conditions.

#### 1. Inspection (on-vehicle)

- 1) Turn the fan clutch by hand when in a low temperature condition before starting the engine, and confirm that it can be turned readily.
- 2) Start the engine to warm it up until the temperature at the fan clutch portion gets to around 80°C. Then stop the engine and confirm that the fan clutch can be turned with considerable effort (clutch torque) when turned by hand.



If the fan clutch rotates more readily, however, this indicates that the silicon grease is leaking internally. Replace the fan clutch with a new one.

**2. Inspection (in unit)**

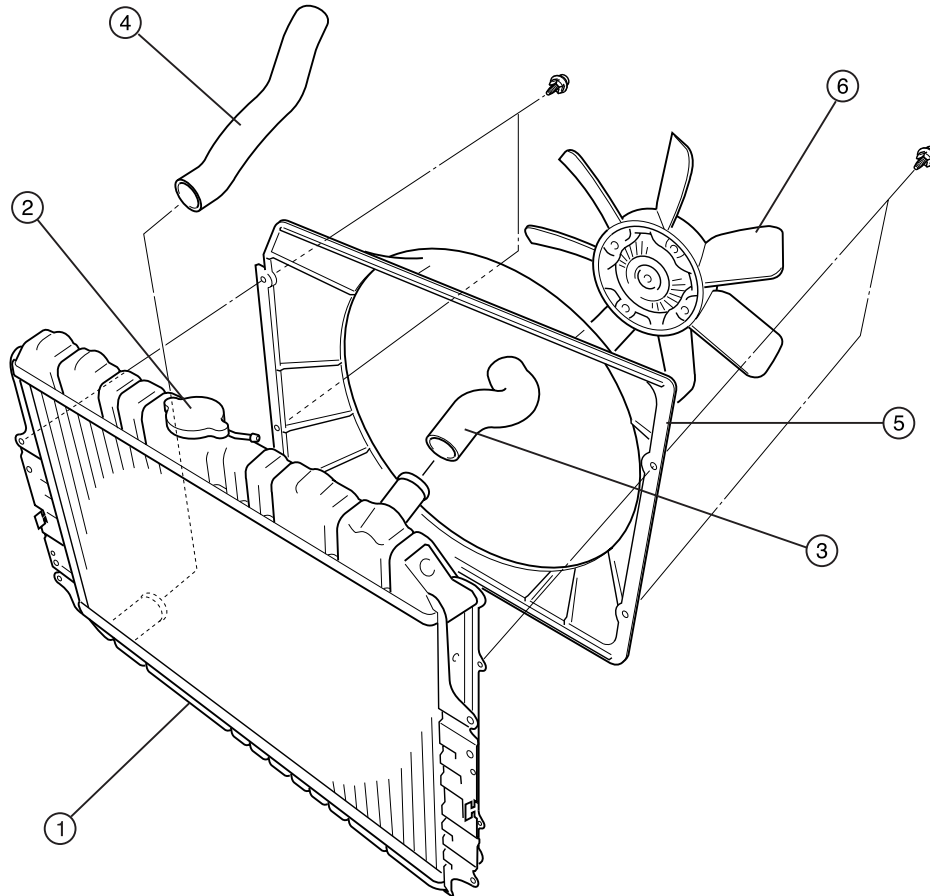
Warm up the bimetal of the fan clutch by using the heat gun until the temperature gets to about 80°C when measured with the thermistor. Then confirm that the fan clutch can be turned with considerable effort (clutch torque).

If the fan clutch rotates more readily at this time, this indicates that the silicon grease is leaking internally.

Replace the fan clutch with a new one.

# Radiator

## Radiator and Associated Parts



### Legend

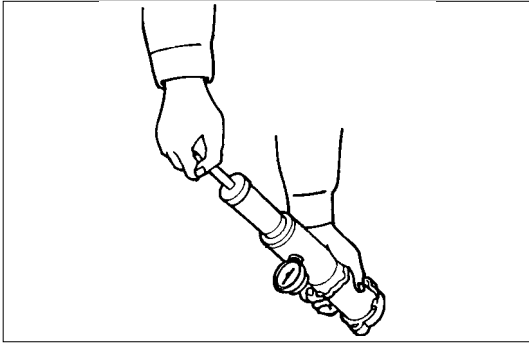
- 1 Radiator
- 2 Radiator Cap
- 3 Radiator Upper Hose

- 4 Radiator Lower Hose
- 5 Cooling Fan Shroud
- 6 Cooling Fan



### Removal

1. Disconnect battery ground cable.
2. Loosen a drain plug to drain engine coolant (EC).
3. Disconnect radiator inlet hose and outlet hose.
4. Disconnect the reserve tank hose from radiator.
5. Lift out the radiator assembly, taking care not to damage the radiator core.



## Inspection

### Radiator Cap

Measure the valve opening pressure of the pressurizing valve with a radiator filler cap tester.

Replace the cap if the valve opening pressure is outside the standard range.

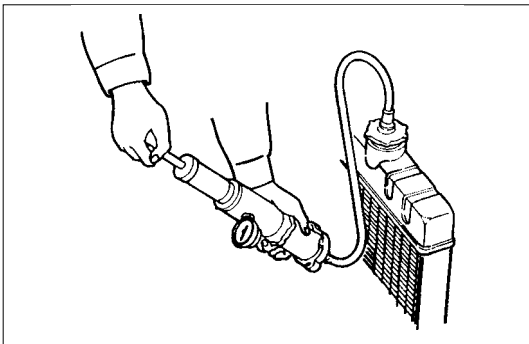
**Valve opening pressure kPa (psi) 88.3 - 1117.7  
(13.5 - 17.8)**

Cap tester: 5-8840-0277-0

Adapter: 5-8840-2603-0

Check the condition of the vacuum valve in the center of the valve seat side of the cap. If considerable rust or dirt is found, or if the valve seat cannot be moved by hand, clean or replace the cap.

**Valve opening vacuum kPa (psi) 1.9 - 4.9  
(0.28 - 0.71)**



### Radiator Core

1. A bent fin may result in reduced ventilation and overheating may occur. All bent fins must be straightened. Pay close attention to the base of the fin when it is being straightened.
2. Remove all dust, bugs and other foreign material.

### Flushing the Radiator

Thoroughly wash the inside of the radiator and the engine coolant passages with cold water and mild detergent. Remove all sign of scale and rust.

### Cooling System Leakage Check

Use a radiator cap tester to force air into the radiator through the filler neck at the specified pressure of 196 kPa (28.5 psi) with a cap tester:

- Leakage from the radiator
- Leakage from the coolant pump
- Leakage from the water hoses
- Check the rubber hoses for swelling.

Cap tester: 5-8840-0277-0

Adapter: 5-8840-2603-0



## Installation

1. Install radiator assembly, taking care not to damage the radiator core.
2. Install the radiator assembly.
3. Connect reserve tank hose.
4. Connect radiator inlet hose and outlet hose.
5. Pour engine coolant up to filler neck of radiator, and up to MAX mark of reserve tank.

Important operation (in case of 100% engine coolant change) procedure for filling with engine coolant.

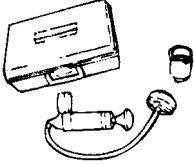
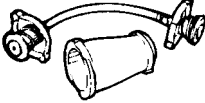
- Remove radiator cap.
- Fill with engine coolant (EC) to the radiator filler neck.
- Fill with EC to the "MAX" line on the reservoir tank.
- Start the engine with the radiator cap removed and bring to operating temperature by running engine at 2,500 - 3,000 rpm for 30 minutes.
- By EC temperature gauge reading make sure that the thermostat is open.
- If air bubbles come up to the radiator filler neck, replenish with EC. Repeat until the EC level does not drop any further. Install the radiator cap and stop the engine.
- Replenish EC to the "MAX" line on the reservoir tank and leave as it is until the engine gets cool.
- After the engine gets cool, start the engine and make sure there is no water running noise heard from the heater core while the engine runs at 3000 rpm.
- Should water running noise be heard, repeat the same procedure from the beginning.

## Main Data and Specifications

### General Specifications

Cooling system	Engine Coolant forced circulation
Radiator	Tube type corrugated (2 tube in row)
Heat radiation capacity	59.100 kcal/h
Heat radiation area	10.915
Radiator front area	0.228
Radiator dry (weight)	66.6N, 6.9kg
Radiator cap valve opening pressure	88.3 - 117.7kpa
Engine coolant capacity	2.3L
Engine coolant pump	Centrifugal type
Thermostat	Bypass type
Engine coolant total capacity	5.7lit

### SPECIAL SERVICE TOOL

ITEM NO.	ILLUSTRATION	PART NO.	PART NAME
1	 <small>901RW072</small>	5-8840-0277-0	Tester; radiator cap
2	 <small>901RW073</small>	5-8840-2603-0	Adapter; radiator cap



# SECTION 6C

## ENGINE FUEL

### CONTENTS

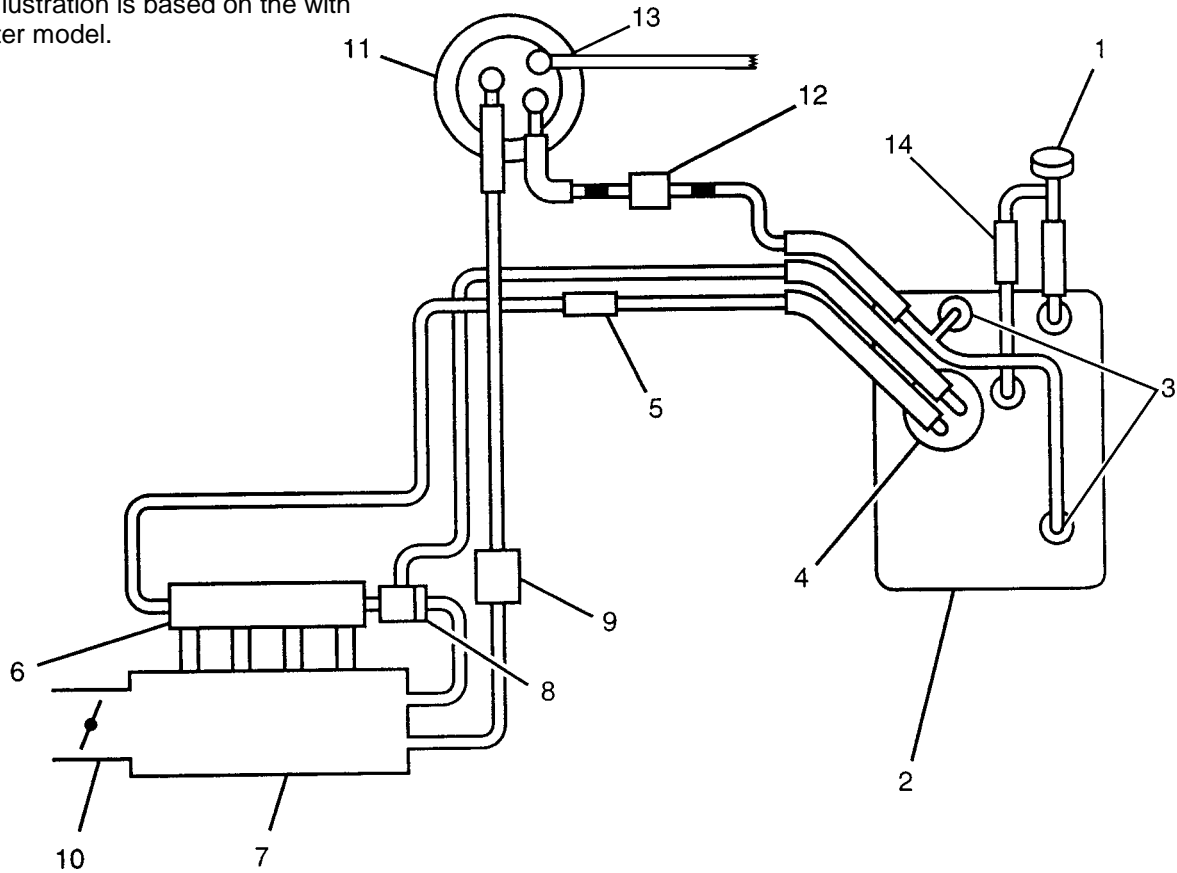
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**Main Data and Specifications ..... 6C-17**

## General Description

This illustration is based on the with canister model.



### Legend

- |                    |                               |
|--------------------|-------------------------------|
| 1 Filter Cap       | 8 Fuel Pressure Control Valve |
| 2 Fuel Tank        | 9 Duty Solenoid Valve         |
| 3 Rollover Valve * | 10 Throttle Valve             |
| 4 Fuel Pump        | 11 Canister *                 |
| 5 Fuel Filter      | 12 Check and Relief Valve *   |
| 6 Fuel Rail        | 13.Drain hose *               |
| 7 Intake Manifold  | 14.2 Way Valve **             |

\* Applicable to EVAP Emission Control System

\*\* Not applicable to EVAP Emission Control System

When working on the fuel system, there are several things to keep in mind:

- Any time the fuel system is being worked on, disconnect the negative battery cable except for those tests where battery voltage is required.
- Always keep a dry chemical (Class B) fire extinguisher near the work area.
- Replace all pipes with the same pipe and fittings that were removed.
- Clean and inspect "O" rings. Replace if required.
- Always relieve the line pressure before servicing any fuel system components.
- Do not attempt repairs on the fuel system until you have read the instructions and checked the pictures relating to that repair.
- Adhere to all Notices and Cautions.

All gasoline engines are designed to use only unleaded gasoline. Unleaded gasoline must be used for proper emission control system operation.

Its use will also minimize spark plug fouling and extend engine oil life. Using leaded gasoline can damage the emission control system and could result in loss of emission warranty coverage.

All cars are equipped with an Evaporative Emission Control System. The purpose of the system is to minimize the escape of fuel vapors to the atmosphere.

### Service Precaution



#### CAUTION:

**Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. ISUZU will call out those fasteners that require a replacement after removal. ISUZU will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (Paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and the joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.**

## Fuel Metering

Engine Control Module (ECM) is in complete control of this fuel delivery system during normal driving conditions.

The intake manifold function, like that of a diesel, is used only to let air into the engine. The fuel is injected by separate injectors that are mounted over the intake manifold.

The Manifold Absolute Pressure (MAP) sensor measures the changes in the intake manifold pressure which result from engine load and speed changes, which the MAP sensor converts to a voltage output.

This sensor generates the voltage to change corresponding to the flow of the air drawn into the engine.

The changing voltage is transformed into an electric signal and provided to the ECM.

With receipt of the signals sent from the MAP sensor, Intake Air Temperature sensor and others, the ECM determines an appropriate fuel injection pulse width feeding such information to the fuel injector valves to effect an appropriate air/fuel ratio. The Multiport Fuel Injection system utilizes an injection system where the injectors turn on at every crankshaft revolution. The ECM controls the injector on time so that the correct amount of fuel is metered depending on driving conditions.

Two interchangeable "O" rings are used on the injector that must be replaced when the injectors are removed.

The fuel rail is attached to the top of the intake manifold and supplies fuel to all the injectors.

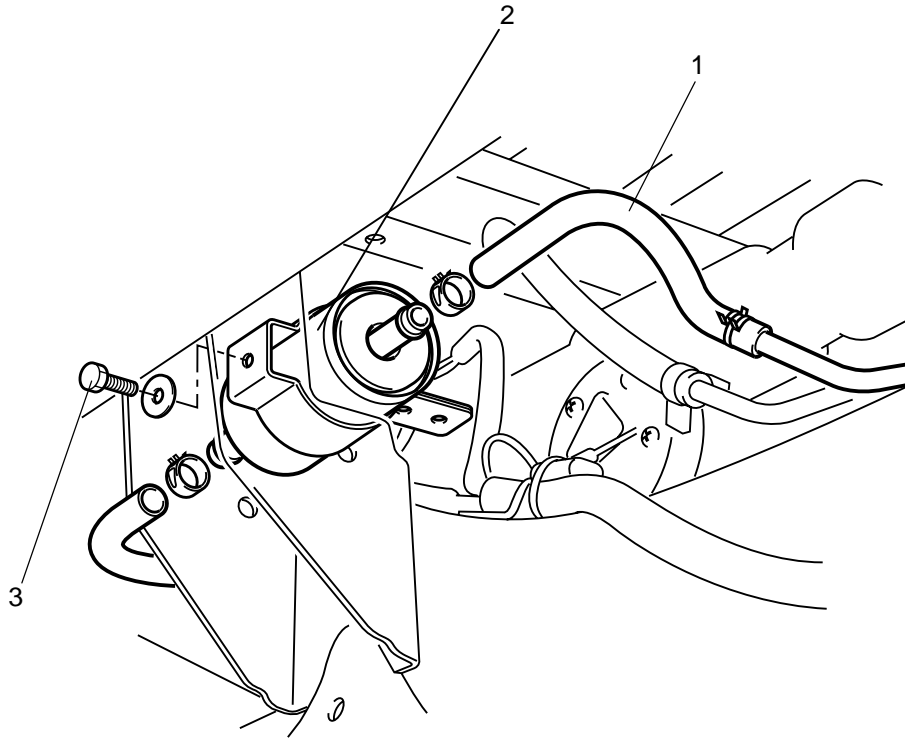
Fuel is recirculated through the rail continually while the engine is running. This removes air and vapors from the fuel as well as keeping the fuel cool during hot weather operation.

The fuel pressure control valve that is mounted on the fuel rail maintains a pressure differential across the injectors under all operating conditions. It is accomplished by controlling the amount of fuel that is recirculated back to the fuel tank based on engine demand.

See Section "Driveability and Emission" for more information and diagnosis.

## Fuel Filter

### Fuel Filter and Associated Parts



#### Legend

- 1 Fuel Hose
- 2 Fuel Filter

3 Fixing bolt



#### Removal



**CAUTION:** When repair to the fuel system has been completed, start engine and check the fuel system for loose connections or leakage. For the fuel system diagnosis, see Section "Driveability and Emissions".

1. Disconnect battery ground cable.
2. Remove fuel filler cap.
3. Loosen the fixing bolt and disconnect fuel hoses (1).
4. Remove fuel filter (2).



### Inspection

1. Replace the fuel filter if the fuel leaks from fuel filter body or if the fuel filter body itself is damaged.
2. Replace the filter if it is clogged with dirt or sediment.
3. Check the drain and if it is clogged with dust, clean it out with air.



### Installation

1. Install the fuel filter in the proper direction.
2. Install fuel filter holder fixing bolt.
3. Connect fuel hoses on engine side and fuel tank side.
4. Install fuel filler cap
5. Connect the battery ground cable.



### Inspection

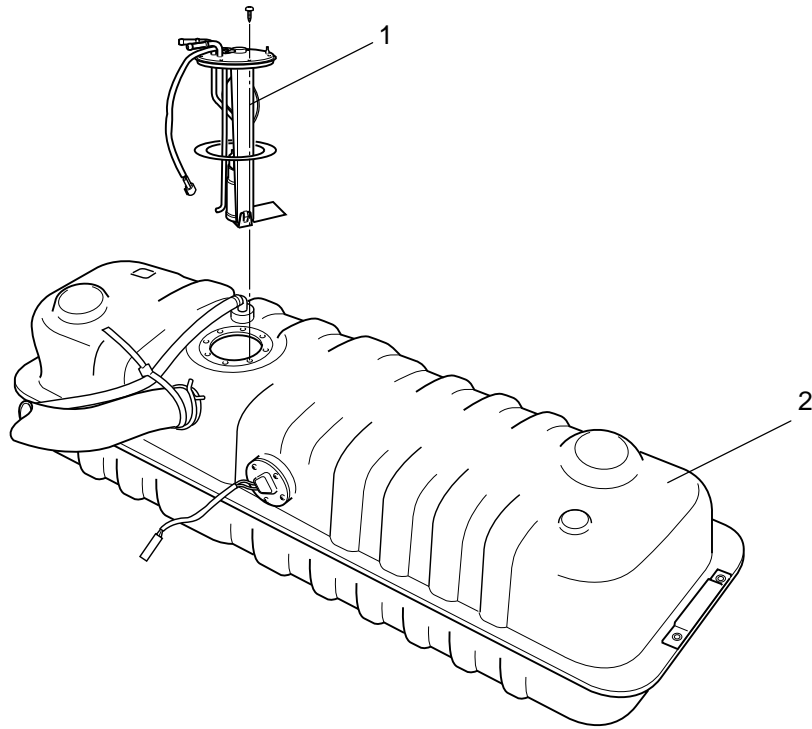
After installation, start engine and check for fuel leak age.

### In-Tank Fuel Filter

The filter is located on the lower end of the fuel pickup tube in the fuel tank. It prevents dirt from entering the fuel pipe and also stops water unless the filter is completely submerged in the water. It is a self cleaning type, not requiring scheduled maintenance. Excess water and sediment in the tank restricts fuel supply to the engine, resulting in engine stop. In such a case, the tank must be cleaned thoroughly.

# Fuel Pump

## Fuel Pump and Associated Parts



### Legend

- 1 Fuel Pump and Sender Assembly
- 2 Fuel Tank Assembly



### Removal

**CAUTION:** When repair to the fuel system has been completed, start engine and check the fuel system for loose connection or leakage. For the fuel system diagnosis, see Section "Driceability and Emission".

1. Disconnect battery ground cable.
2. Loosen fuel filler cap.
3. Support underneath of the fuel tank assembly (2) with a lifter.
4. Remove fuel tank assembly (2). Refer to "Fuel Tank Removal" in this section.
5. Remove fuel pump and sender (FPAS) assembly (1) fixing snapping and remove the FPAS assembly.



## NOTE:

- After removing pump assembly (1), cover fuel tank to prevent any dust entering.
- Remove the fuel pump lock.

**Installation**

1. Install FPAS assembly (1).
2. Install fuel tank assembly (2). Refer to "Fuel Tank Installation".
3. Fill the tank with fuel and tighten fuel filler cap.
4. Connect battery ground cable.

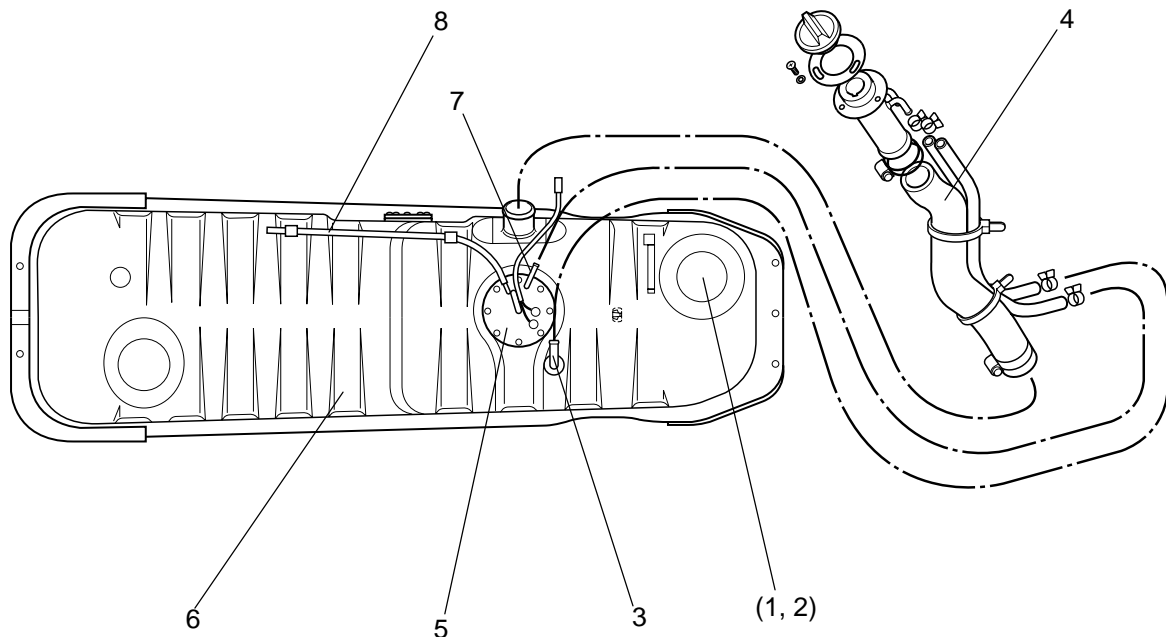
**Fuel Pump Relay****General Description**

In order to control the FPAS operation, the FPAS relay is provided. When the starter switch is turned to "ON" position, the FPAS relay operates the FPAS for 2 seconds.

When it is turned to "START" position, the Engine Control Module receives the reference pulse from the Ignition Control Module and it operates the relay, again causing the FPAS to feed fuel.

## Fuel Tank

### Fuel Tank and Associated Parts



#### Legend

- 1 Roll Over&Float Valve (If applicable)
- 2 Hose; Evaporative Fuel (If applicable)
- 3 Hose; Air Breather
- 4 Hose; Fuel Filler

- 5 Fuel Pump and Sender Assembly
- 6 Fuel Tank Assembly
- 7 Hose; Fuel Delivery
- 8 Hose; Fuel Return



#### Removal



**CAUTION:** When repair to the fuel system has been completed, start engine and check the fuel system for loose connection or leakage. For the fuel system diagnosis, see Section "Driveability and Emission".

1. Disconnect battery ground cable.
2. Loosen fuel filler cap.
3. Support underneath of the fuel tank protector with a lifter.
4. Disconnect evaporative fuel hose at the canister.
5. Disconnect fuel delivery hose and fuel return hose near the fuel filter.

**NOTE:** Plug both ends of the fuel hoses to prevent fuel leakage.

6. Disconnect air breather hose (3) and fuel filler hose (4) at the fuel filler neck.

NOTE: Cover fuel hose to prevent any dust entering.

7. Remove the four fuel tank assembly fixing bolts at four corners of the tank.

8. Let down the tank and disconnect the wiring connectors and the emission hose at the emission port on the fuel pump and sending assembly (5).

9. Remove fuel tank assembly along with protectors.

10. Remove roll over&float valve (1) along with the evaporative fuel hose and pipe (2).

11. Remove fuel pump and sender assembly (5) by removing the snap ring along with the fuel hoses (7, 8).

12. Remove tank protector by removing the fixing bolts.



## Installation

1. Install protectors and tighten the fixing bolts to the specified torque.

**Torque; 68 N·m (6.9 kgf.m)**

2. Install fuel pump and sender assembly by fitting in the snap ring.

3. Install roll over&float valve (1).

4. Lift up fuel tank assembly and connect the emission hose to the emission port and the wiring connectors on the fuel pump and sending assembly (5).

5. Install fuel tank assembly along with protectors and tighten the four fixing bolts to the specified torque.

**Torque: 68 N·m (6.9 kgf.m)**

6. Connect fuel filler hose (4) and air breather hose (3), and clip them firmly.

7. Connect fuel delivery hose (7) and fuel return hose (8), and clip them firmly.

8. Connect evaporative fuel hose (2).

9. Tighten fuel filler cap.

10. Connect battery ground cable.

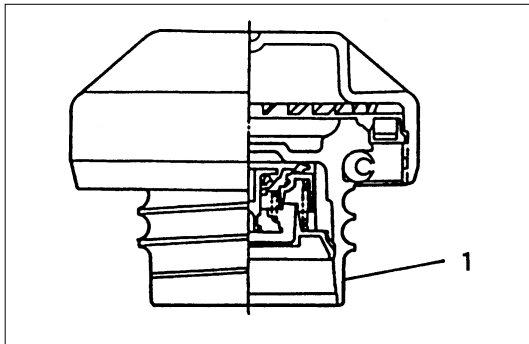
## Fuel Gage Unit



### Removal and Installation



As for removal and installation of the Fuel Gauge Unit, refer to "Fuel Tank" of this section 6C as the fuel gauge unit is combined with the fuel pump and sender assembly.



## Fuel Filler Cap

### General Description

Fuel filler cap includes vacuum valve.

In case any high vacuum happen in tank, the valve works to adjust the pressure to prevent the tank from being damaged.

### Legend

1 Fuel Filler Cap

### Inspection



Check the seal ring in the filler cap for presence of any abnormality and for seal condition.

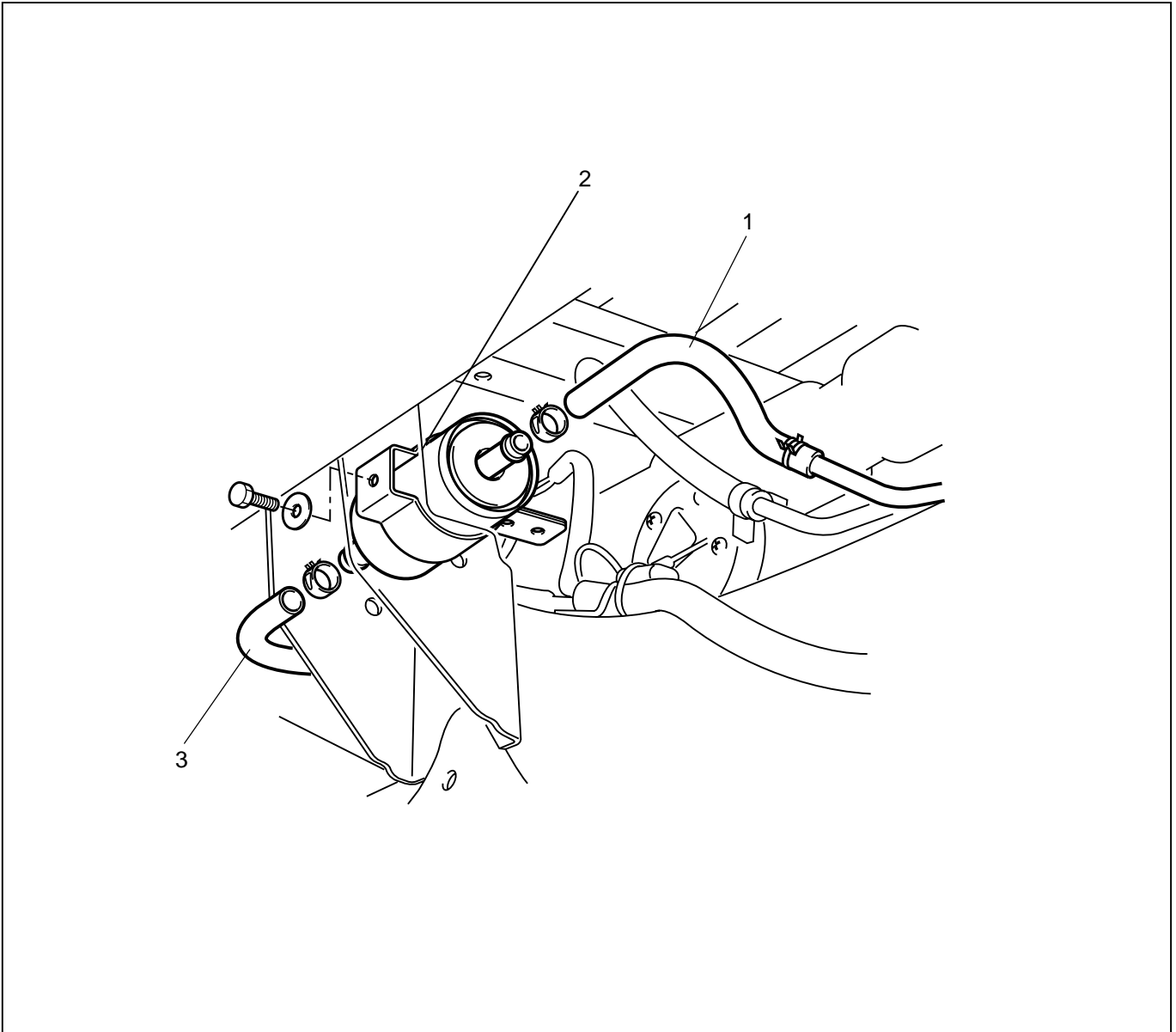
Replace the filler cap, if abnormal.

**CAUTION: The fuel filler cap valve has characteristics.**

**A defective valve, no valve at all or a valve with the wrong characteristics will do a lot of harm to engine operating characteristics; be sure to use the same fuel filler cap as installed in this vehicle.**

## Fuel Filter

### ↔ ↔ Removal and Installation



#### ↔ Removal

1. Inlet and outlet fuel hose
2. Fuel filter

#### ↔ Installation

2. Fuel filter
1. Inlet and outlet fuel hose



### Important Operations - Removal



#### 1. Inlet and Outlet Fuel Hose

Use a rag to prevent the fuel from flowing from the fuel hoses.

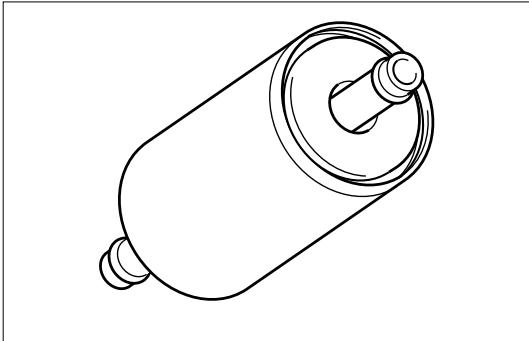
**NOTE:**

**Immediately plug the fuel hoses.**

**Do not work in close proximity to sparks or an open flame.**



### Important Operations - Installation



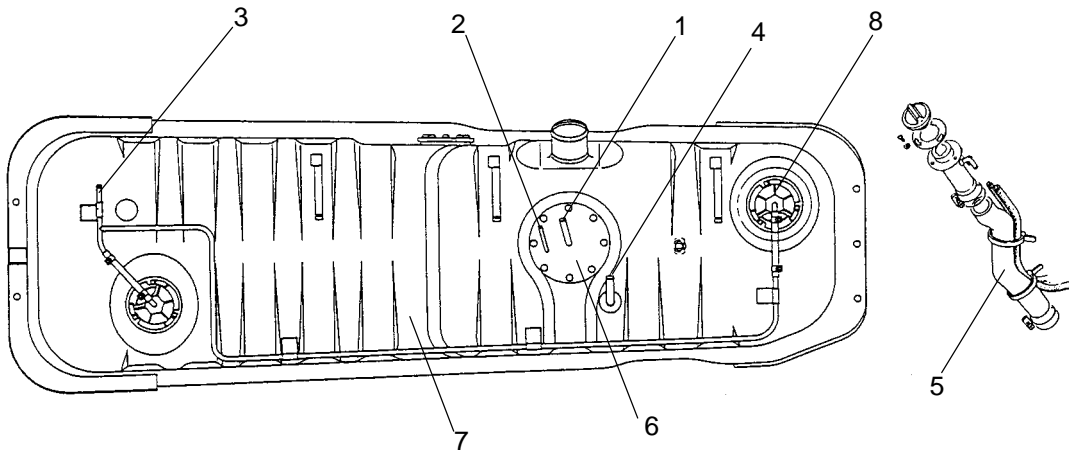
#### 1. Fuel Filter

- 1) Install the fuel filter to the fuel pump in the direction indicated by the arrow stamped on the side of the fuel filter.
- 2) Start the engine.  
Check for fuel leakage from the fuel hose joints.

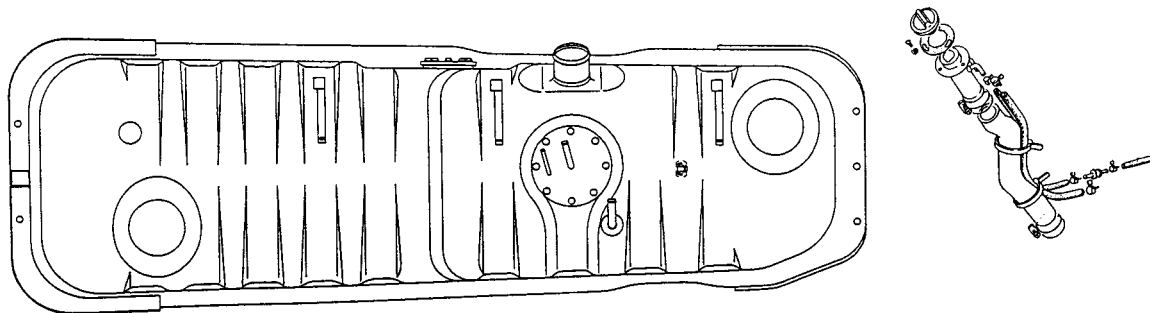
## Fuel Tank

### ↔ ↔ Removal and Installation

WITH CANISTER APPLICABLE TO ROLLOVER VALVE



WITH CANISTER & ROLLOVER VALVE



### ↔ Removal

1. Fuel hose (Delivery)
2. Fuel hose(Return)
3. Evapo fuel hose
4. Breather hose
5. Fuel filler hose
6. Fuel Pump
7. Fuel tank
8. Roll over valve

### ↔ Installation

To install, follow the removal steps in the reverse order.



## Removal

### Preparation

- Disconnect battery ground cable
  - Loosen fuel filler cap
  - Drain fuel
- Tighten drain plug to the specified torque after drain fuel.



---

N·m (kgf·m)

20 (2.0)

---

### NOTE:

**Cover fuel hose with waste to prevent any dust entering.**



## Installation

### 7. Fuel Tank

- Tighten fuel tank bolt



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N·m (kgf·m)

26.5 (2.7)

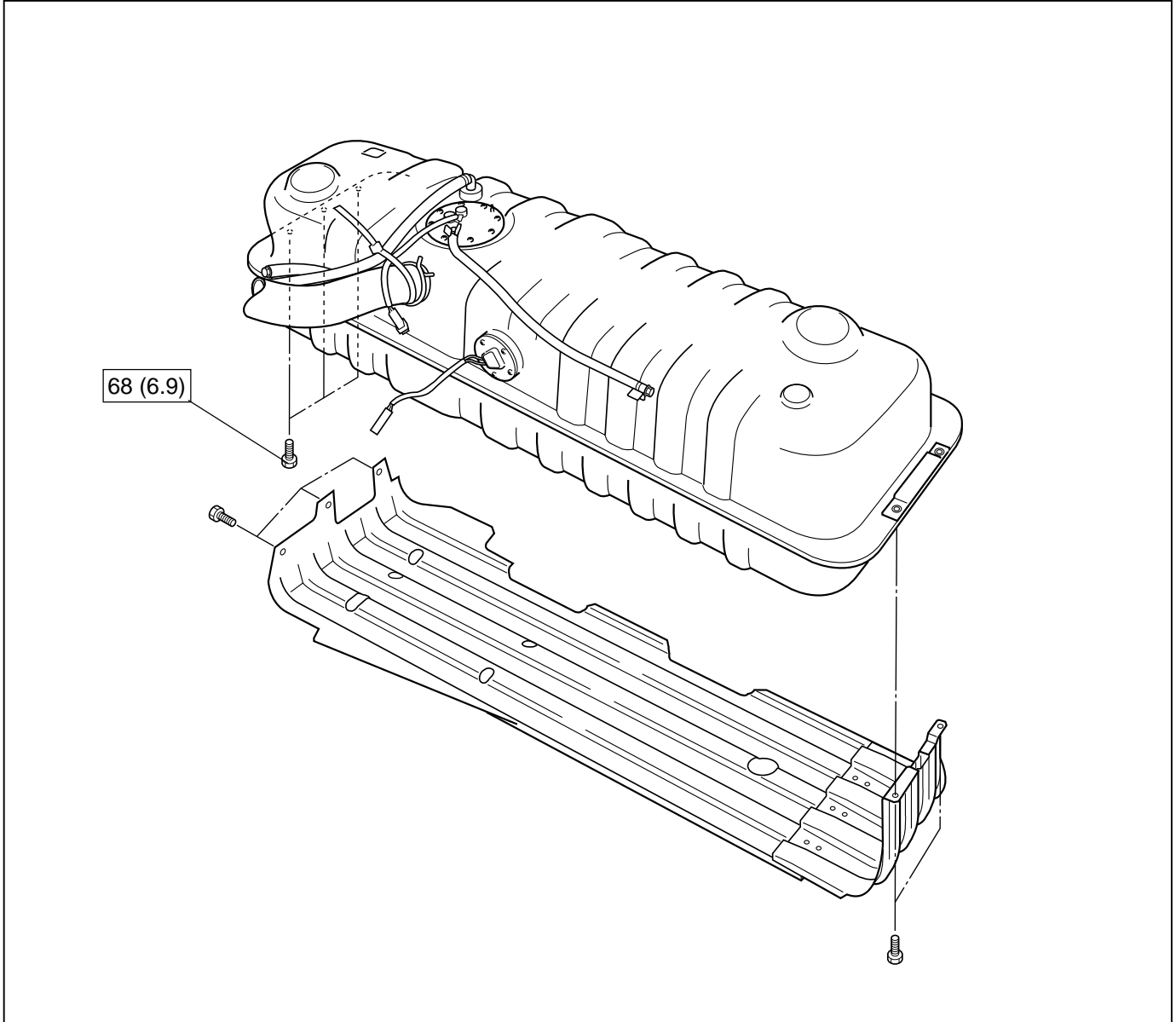
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# Main Data and Specifications

## Torque Specification

N·m (kgf·m)



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# SECTION 6D1

## ENGINE ELECTRICAL

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	PAGE
Battery .....	6D1- 2
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Battery Charging .....	6D1- 4
Jump Starting .....	6D1- 4
Removal .....	6D1- 6
Installation .....	6D1- 6
Main Data and Specifications .....	6D1- 6

## Battery

### General Description

There are six battery fluid caps on top of the battery.

These are covered by a paper label.

The battery is completely sealed except for the six small vent holes on the side. These vent holes permit the escape of small amounts of gas generated by the battery.

This type of battery has the following advantages over conventional batteries:

1. There is no need to add water during the entire service life of the battery.
2. The battery protects itself against overcharging.  
The battery will refuse to accept an extensive charge.  
(A conventional battery will accept an excessive charge, resulting in gassing and loss of battery fluid.)
3. The battery is much less vulnerable to self discharge than a conventional type battery.

### Service Precaution



#### **CAUTION:**

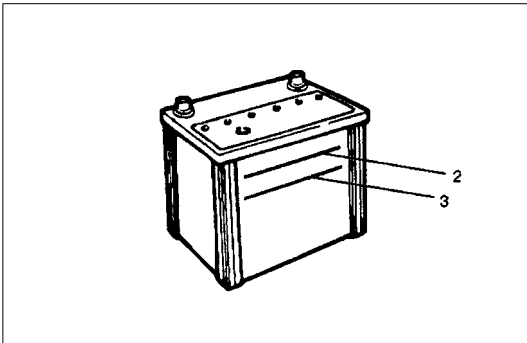
**Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. ISUZU will call out those fasteners that require a replacement after removal. ISUZU will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (Paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and the joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.**

## Diagnosis

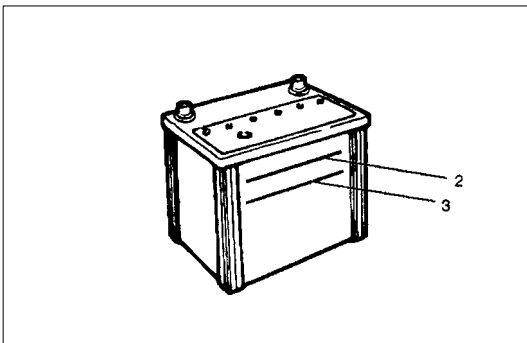
### 1. Visual Inspection

Inspect the battery for obvious physical damage, such as a cracked or broken case, which would permit electrolyte loss. Replace the battery if obvious physical damage is discovered during inspection.

Check for any other physical damage and correct it as necessary.



### 2. Hydrometer Check



### 3. Fluid Level Check

The fluid level should be between the upper level line (2) and lower level line (3) on side of battery.

- a. CORRECT FLUID LEVEL - Charge the battery.
- b. BELOW LOWER LEVEL - Replace battery.

### 4. Voltage Check

1. Put voltmeter test leads to battery terminals.
  - a. VOLTAGE IS 12.4V OR ABOVE - Go to Step 5.
  - b. VOLTAGE IS UNDER 12.4V - Go to procedure (2) below.
2. Determine fast charge amperage from specification. (See Main Data and Specifications in this section).  
Fast charge battery for 30 minutes at amperage rate no higher than specified value.  
Take voltage and amperage readings after charge.
  - a. VOLTAGE IS ABOVE 16V AT BELOW 1/3 OF AMPERAGE RATE - Replace battery.
  - b. VOLTAGE IS ABOVE 16V AT ABOVE 1/3 OF AMPERAGE RATE - Drop charging voltage to 15V and charge for 10 - 15 hours. Then go to Step 5.
  - c. VOLTAGE IS BETWEEN 12V AND 16V - Continue charging at the same rate for an additional 3-1/2 hours. Then go to Step 5.
  - d. VOLTAGE BELOW 12V - Replace Battery.

## Battery Charging

Observe the following safety precautions when charging the battery:

1. Never attempt to charge the battery when the fluid level is below the lower level line on the side of the battery. In this case, the battery must be replaced.
2. Pay close attention to the battery during charging procedure.

Battery charging should be discontinued or the rate of charge reduced if the battery feels hot to the touch.

battery charging should be discontinued or the rate of charge reduced if the battery begins to gas or spew electrolyte from the vent holes.

3. In order to more easily view the hydrometer blue dot or ring, it may be necessary to jiggle or tilt the battery.
4. Battery temperature can have a great effect on battery charging capacity.
5. The sealed battery used on this vehicle may be either quick charged or slow charged in the same manner as other batteries.

Whichever method you decide to use, be sure that you completely charge the battery. Never partially charge the battery.

## Jump Starting

### Jump Starting with an Auxiliary (Booster) Battery

**CAUTION: Never push or tow the vehicle in an attempt to start it. Serious damage to the emission system as well as other vehicle parts will result.**

**Treat both the discharged battery and the booster battery with great care when using jumper cables.**

**Carefully follow the jump starting procedure, being careful at all times to avoid sparking.**

**WARNING: FAILURE TO CAREFULLY FOLLOW THE JUMP STARTING PROCEDURE COULD RESULT IN THE FOLLOWING:**

1. Serious personal injury, particularly to your eyes.
2. Property damage from a battery explosion, battery acid, or an electrical fire.
3. Damage to the electronic components of one or both vehicles particularly.

Never expose the battery to an open flame or electrical spark.

Gas generated by the battery may catch fire or explode.

Remove any rings, watches, or other jewelry before working around the battery. Protect your eyes by wearing an approved set of goggles.

Never allow battery fluid to come in contact with your eyes or skin.

Never allow battery fluid to come in contact with fabrics or painted surfaces.

Battery fluid is a highly corrosive acid.

Should battery fluid come in contact with your eyes, skin, fabric, or a painted surface, immediately and thoroughly rinse the affected area with clean tap water.

Never allow metal tools or jumper cables to come in contact with the positive battery terminal, or any other metal surface of the vehicle. This will protect against a short circuit.

Always keep batteries out of reach of young children.

## Jump Starting Procedure

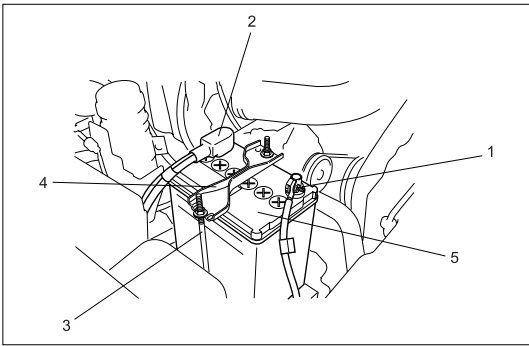
1. Set the vehicle parking brake.  
If the vehicle is equipped with an automatic transmission, place the selector level in the "PARK" position.  
If the vehicle is equipped with a manual transmission place the shift lever in the "NEUTRAL" position.  
Turn "OFF" the ignition.  
Turn "OFF" all lights and any other accessory requiring electrical power.
2. Look at the built-in hydrometer.  
If the indication area of the built-in hydrometer is completely clear, do not try to jump start.
3. Attach the end of one jumper cable to the positive terminal of the booster battery.  
Attach the other end of the same cable to the positive terminal of the discharged battery.  
Do not allow the vehicles to touch each other. This will cause a ground connection, effectively neutralizing the charging procedure.  
Be sure that the booster battery has a 12 volt rating.
4. Attach one end of the remaining cable to the negative terminal of the booster battery.  
Attach the other end of the same cable to a solid engine ground (such as the air conditioning compressor bracket or the generator mounting bracket) of the vehicle with the discharged battery.  
The ground connection must be at least 450 mm (18 in.) from the battery of the vehicle whose battery is being charged.



**WARNING: NEVER ATTACH THE END OF THE JUMPER CABLE DIRECTLY TO THE NEGATIVE TERMINAL OF THE DEAD BATTERY.**

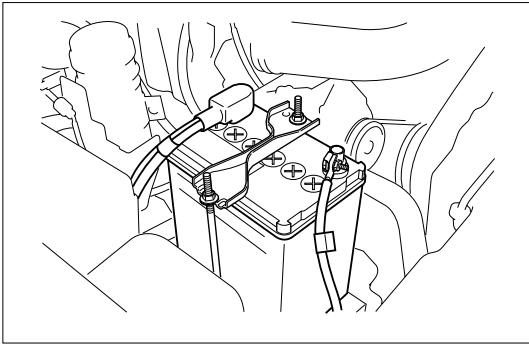
5. Start the engine of the vehicle with the good battery.  
Make sure that all unnecessary electrical accessories have been turned "OFF".
6. Start the engine of the vehicle with the dead battery.
7. To remove the jumper cables, follow the above directions in reverse order.  
Be sure to first disconnect the negative cable from the vehicle with the discharged battery.

## 6D1-6 ENGINE ELECTRICAL



### Removal

1. Remove negative cable (1).
2. Remove positive cable (2).
3. Remove retainer screw and rods (3).
4. Remove retainer (4).
5. Remove battery (5).



### Installation

1. Install battery.
  2. Install retainer.
  3. Install retainer screw and rods.
- NOTE: Make sure that the rod is hooked on the body side.
4. Install positive cable.
  5. Install negative cable.

## Main Data and Specifications

### General Specifications

Model (JIS)	34B19L	46B19L	50D20L
Voltage (V)	12	12	12
Cold Cranking Performance (Amp)	272	325	306
Reserve Capacity (Min)	49	71	78

## SECTION 6D2

# IGNITION SYSTEM

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## General Description

Ignition is done by the Ignition Module that fires. Since the cylinder on exhaust stroke requires less energy to fire its spark plug, energy from the ignition coils can be utilized to fire the mating cylinder on compression stroke. A notch in the timing disc on the crankshaft activates the crank angle sensor which then sends information such as firing order and starting timing of ignition coil to the ECM. By receiving signals such as crank position, engine speed, water temperature and Manifold Absolute Pressure (MAP), the ECM controls the ignition timing.

## Service Precaution

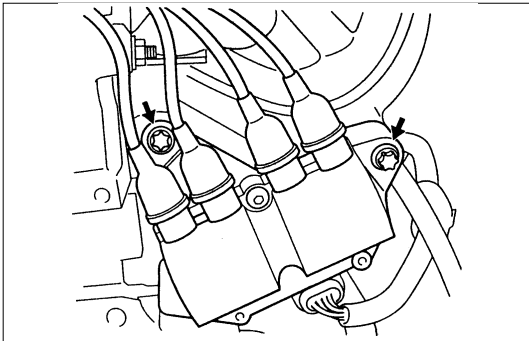


### CAUTION:

Always use the correct fastener in the proper location. When you replace a fastener, use **ONLY** the exact part number for that application. ISUZU will call out those fasteners that require a replacement after removal. ISUZU will also call out the fasteners that require thread lockers or thread sealant. **UNLESS OTHERWISE SPECIFIED**, do not use supplemental coatings (Paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and the joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.

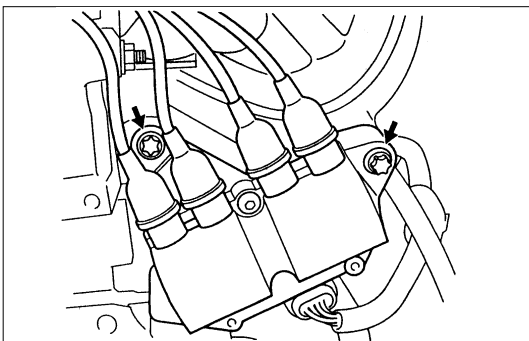
## Diagnosis

Refer to Section Drivability and Emissions for the diagnosis to electronic ignition system (EI system).



### Removal

1. Disconnect battery ground cable.
2. Ignition coil connector.
3. Removal ignition coil.



### Installation

1. Install the ignition coil.  
Connect ignition coil connector and ignition coil, then tighten bolt to the specified torque.  
**Torque: 20 N·m (2.0 kgf.m)**
2. Connect battery ground cable.

## Spark Plug



### Removal

1. Remove spark plugs.



### Inspection and Repair

The spark plug affects entire engine performance and therefore its inspection is very important.

- Check electrode and insulator for presence of cracks, and replace if any.
- Check electrode for wear, and replace if necessary.
- Check gasket for damage, and replace if necessary.
- Measure insulation resistance with an ohmmeter, and replace if faulty.
- Adjust spark plug gap to 1.0 - 1.1 mm (0.027 in) - 0.8 mm (0.031 in).
- Check fuel and electrical systems if spark plug is extremely dirty.
- Use spark plugs having low heat value (hot type plug) if fuel and electrical systems are normal.
- Use spark plugs having high heat value (cold type plug) if insulator and electrode are extremely burned.

### Sooty Spark Plugs

Much deposit of carbon or oil on the electrode and insulator of spark plug reduces the engine performance.

#### Possible causes:

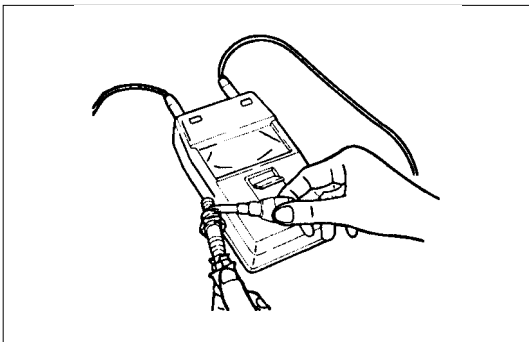
- Too rich mixture
- Presence of oil in combustion chamber
- Incorrectly adjusted spark plug gap

### Burning Electrodes

This fault is characterized by scorched or heavily oxidized electrode or blistered insulator nose.

#### Possible causes:

- Too lean mixture
- Improper heat value



### Measuring Insulation Resistance

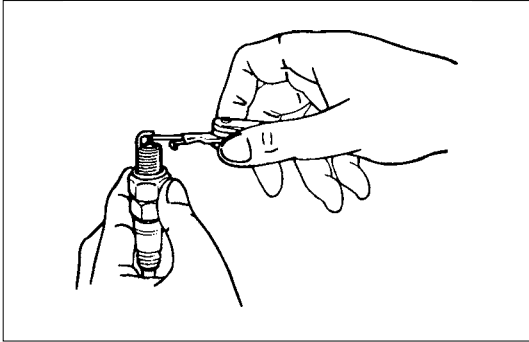
- Measure insulation resistance using a 500 volt megaohm meter.
- Replace spark plugs if measured value is out of standard.

**Insulation resistance: 50 M $\Omega$  or more**



### Cleaning Spark Plugs

- Clean spark plugs with a spark plug cleaner.
- Raise the ground electrode to an angle of 45 to 60 degrees. if electrode is wet, dry it before cleaning.
- After spark plug is thoroughly cleaned, check insulator for presence of cracks.

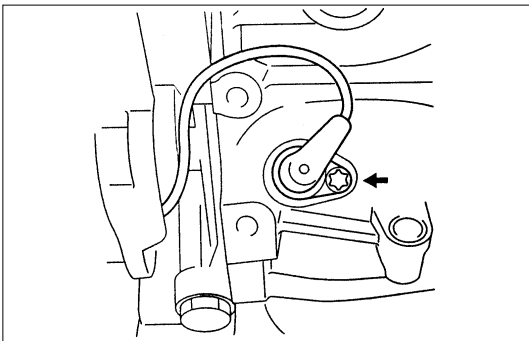


- Clean threads and metal body with a wire brush.
- File the electrode tip if electrode is extremely worn.
- Bend the ground electrode to adjust the spark plug gap.



### Installation

1. Spark plugs
  - Tighten spark plugs to the specified torque.  
**Torque: 25 N·m (2.5 kgf·m)**



### Crankshaft Angle Sensor



#### Removal

1. Disconnect battery ground cable
2. Wiring connector from crankshaft angle sensor.
3. Remove crankshaft angle sensor from cylinder block.



#### Installation

1. Install crankshaft angle sensor into the cylinder block.  
Before installation, apply small amount of engine oil to the O-ring.  
**Torque: 6 N·m (0.6 kgf·m)**
2. Reconnect wiring connector to crankshaft angle sensor.

**Main Data and Specifications**  
**General Specifications**

<b>Ignition System</b>	
Ignition Form	Electronic Ignition System (EI system) with Crankshaft angle Sensor
<b>Spark Plug</b>	
Type	Electronic Spark Control
No. of Coils and Type	2 Solid State
Coil Location	Engine-mounted
Torque	20 N.m (2.0 kgf.m)

## SECTION 6D3

# STARTING AND CHARGING SYSTEM

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## Starting System

### General Description

#### Cranking Circuit

The cranking system consists of a battery, starter, starter switch, starter relay, etc. These main components are connected.

#### Starter

The cranking system employs a magnetic type reduction starter in which the motor shaft is also used as a pinion shaft. When the starter switch is turned on, the contacts of magnetic switch are closed, and the armature rotates. At the same time, the plunger is attracted, and the pinion is pushed forward by the shift lever to mesh with the ring gear.

Then, the ring gear runs to start the engine. When the engine starts and the starter switch is turned off, the plunger returns, the pinion is disengaged from the ring gear, and the armature stops rotation. When the engine speed is higher than the pinion, the pinion idles, so that the armature is not driven.

### Service Precaution

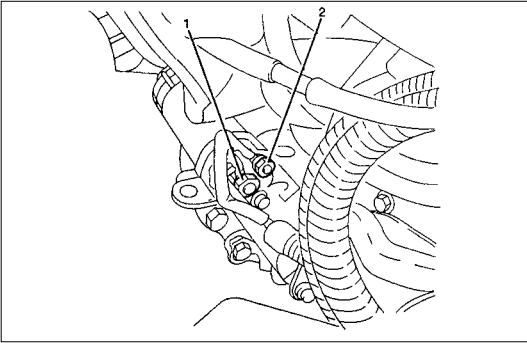


#### CAUTION:

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### Diagnosis

Condition	Possible cause	Correction
Starter does not run	Charging failure	Repair charging system
	Battery Failure	Replace Battery
	Terminal connection failure	Repair or replace terminal connector and/or wiring harness
	Starter switch failure	Repair or replace starter switch
	Starter failure	Repair or replace starter

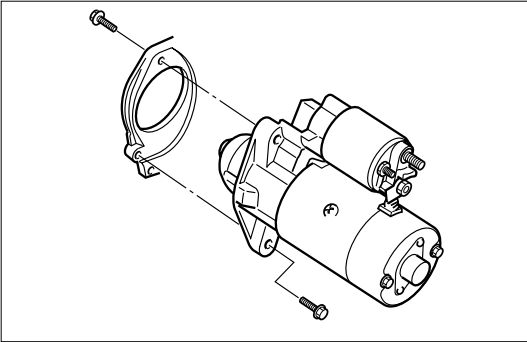


## Starter

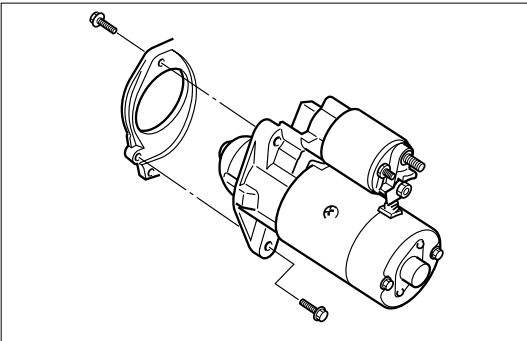


### Removal

1. Battery ground cable.
2. Remove harness connectors (1) and (2).



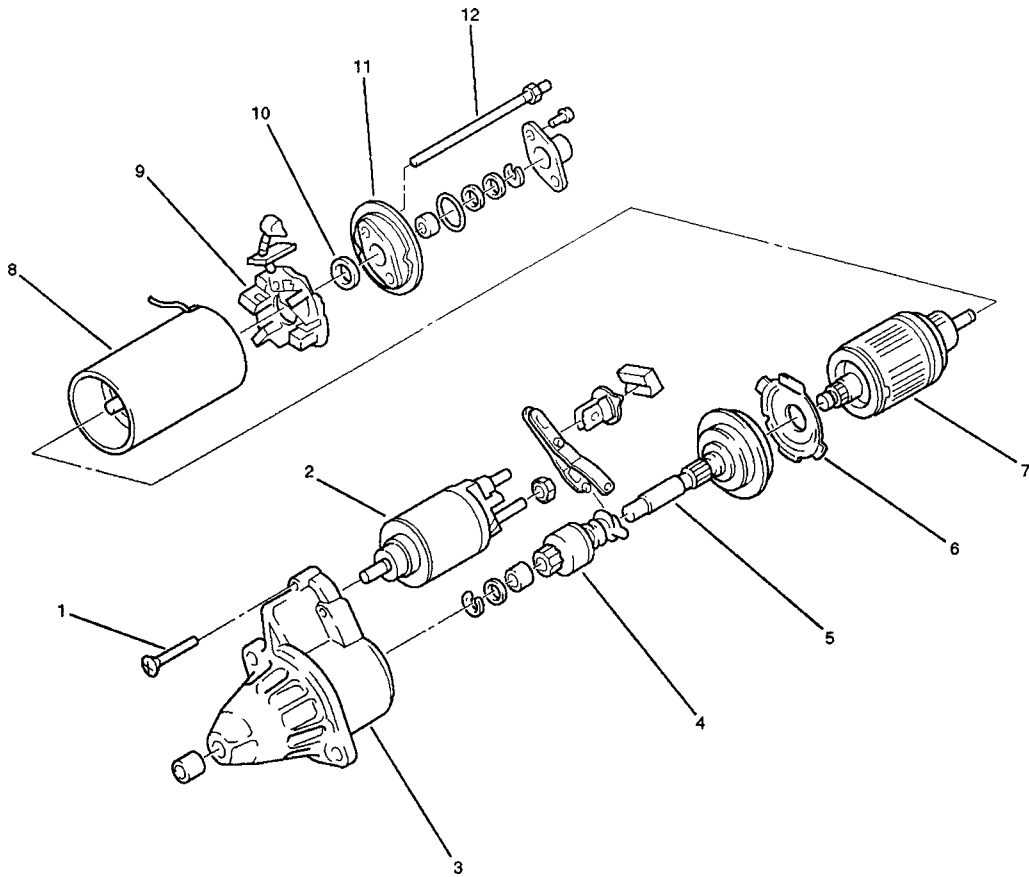
3. Remove bolts from starter.



### Installation

1. Install starter assembly.
2. Install mounting bolts and tighten bolts to specified torque.  
**Torque: 25 N·m (2.5 kgf.m)**
3. Connect harness.
4. Reconnect the battery ground cable.

## Disassembled View

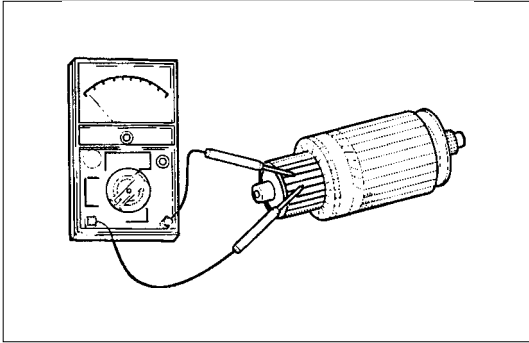


### Legend

- 1 Bolt
- 2 Magnetic Switch
- 3 Gear Case
- 4 Piston
- 5 Piston Shaft
- 6 Center Bracket

- 7 Armature
- 8 Yoke Assembly
- 9 Brush and Brush Holder
- 10 Washer
- 11 Rear Cover
- 12 Through Bolt



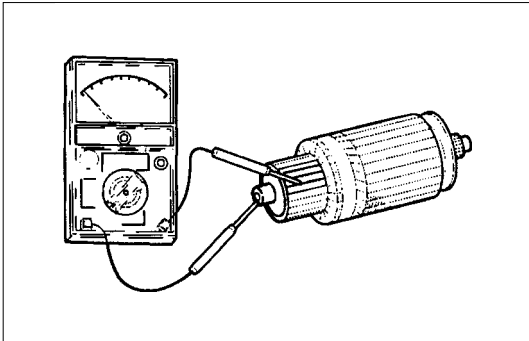


### Inspection and Repair

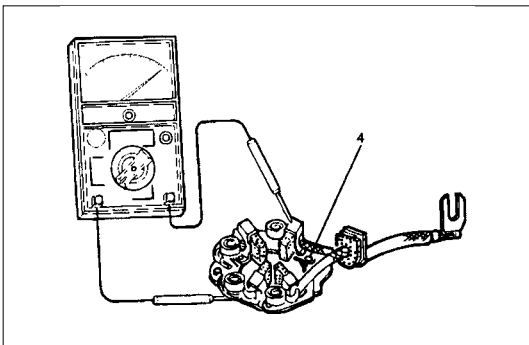
Repair or replace necessary parts if extreme wear or damage is found during inspection.

#### Armature

Check for continuity between commutator and segment. Replace commutator if there is no continuity (i.e., disconnected).



Check for continuity between commutator and shaft. Also, check for continuity between commutator and armature core, armature core and shaft. Replace commutator if there is continuity (i.e., internally grounded).

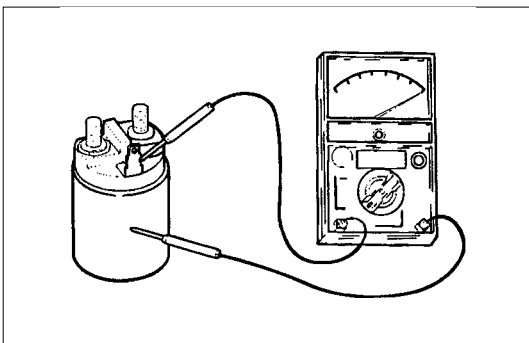


#### Brush

Measure the length of brush. Replace with a new one, if it is below the limit.

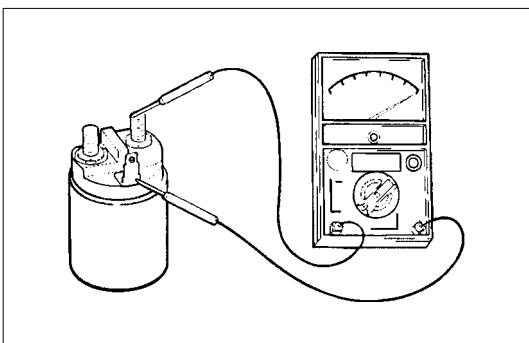
#### Brush Holder

Check for continuity between brush holder (+) (4) and base (-). Replace, if there is continuity (i.e., insulation is broken).



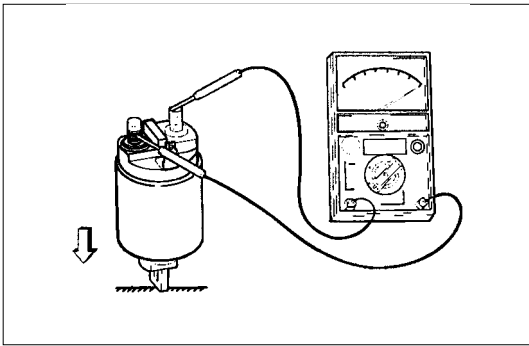
#### Magnetic Switch

Check for continuity of shunt coil between terminals S and M. Replace, if there is no continuity (i.e., coil is disconnected).



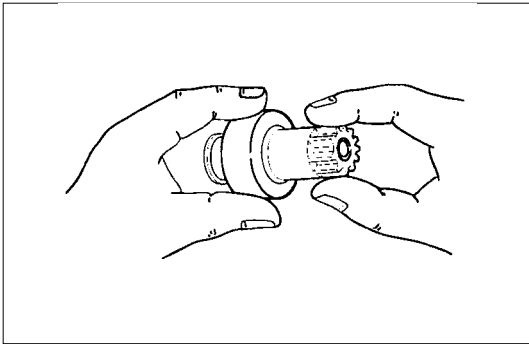
#### Continuity of Series Coil

Check for continuity between terminals S and M. Replace, if there is no continuity (i.e., coil is disconnected).



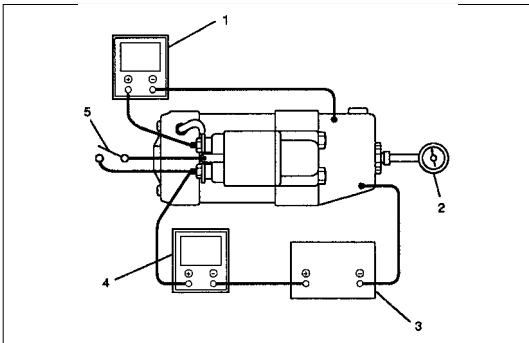
### Continuity of Contacts

With the plunger faced downward, push down the magnetic switch. In this state, check for continuity between terminals B and M. Replace, if there is no continuity (i.e., contacts are faulty).



### Pinion

Check if the pinion rotates smoothly in drive direction by hand, or if it is locked when it is rotated in reverse. If not, replace the pinion.



### Characteristic Test

For easily confirming the characteristics, conduct the no-load test as follows:

Rating as short as 30 seconds requires rapid testing.

Fix the starter on the test bench, and wire as shown in illustration. When the switch is closed, the current flows and the starter runs under no load. At this time, measure current, voltage and speed to check if they satisfy the standard.

### Legend

- 1 Volt Meter
- 2 Revolution Indicator
- 3 Battery
- 4 Ammeter
- 5 Switch

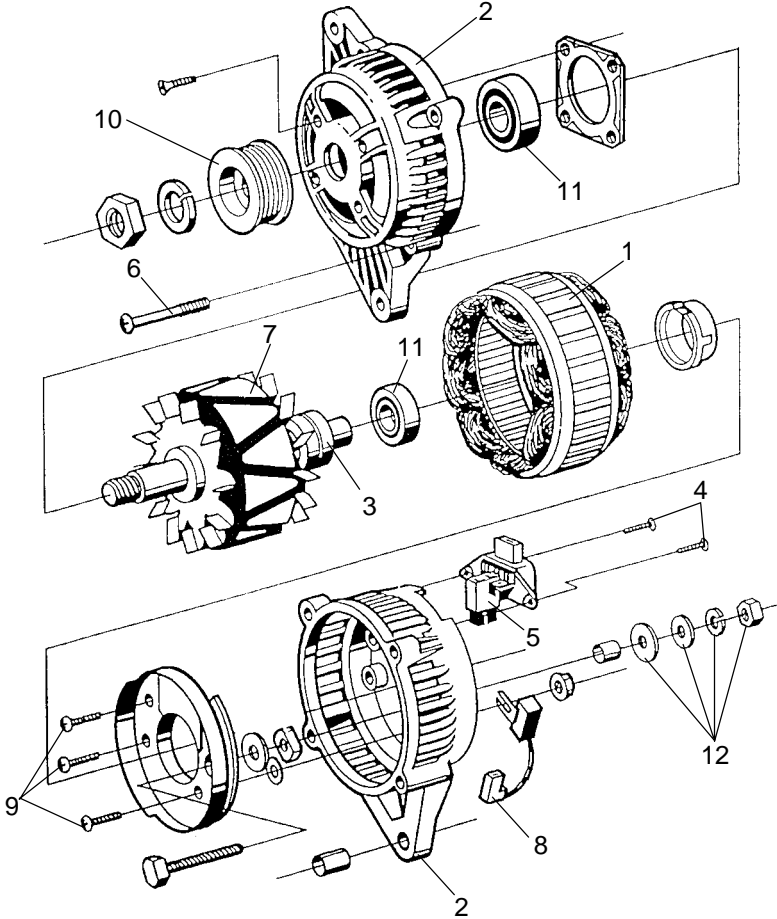
# Charging System

## General Description

The charging system is an IC integral regulator charging system and its main components are connected as shown in illustration.

The regulator is a solid state type and it is mounted along with the brush holder assembly inside the generator installed on the rear end cover.

The generator does not require particular maintenance such as voltage adjustment. The rectifier connected to the stator coil has eight diodes to transform AC voltage into DC voltage. This DC voltage is connected to the output terminal of generator.



**Legend**

- 1 Stator assembly
- 2 Housing
- 3 Slipring
- 4 Screws (2)
- 5 Regulator
- 6 Bolt (4)
- 7 Rectifier assembly
- 8 Retaining assembly
- 9 B+ terminal nut and washer
- 10 Pulley
- 11 Rotor assembly
- 12 Ball bearing

## General On-Vehicle Inspection

The operating condition of charging system is indicated by the charge warning lamp. The warning lamp comes on when the starter switch is turned to "ON" position. The charging system operates normally if the lamp goes off when the engine starts. If the warning lamp shows abnormality or if undercharged or overcharged battery condition is suspected, perform diagnosis by checking the charging system as follows:

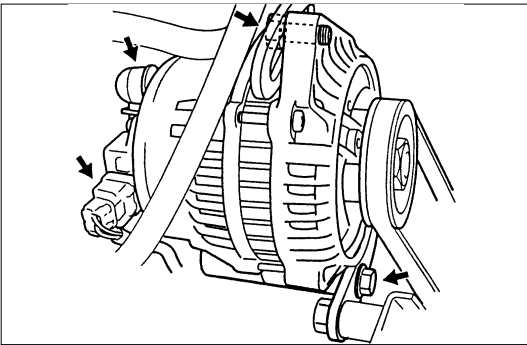
1. Check visually the belt and wiring connector.
2. With the engine stopped, turn the stator switch to "ON" position and observe the warning lamp.

If lamp does not come on:

Disconnect wiring connector from generator, and ground the terminal "L" on connector side.

If lamp comes on:

Repair or replace the generator.



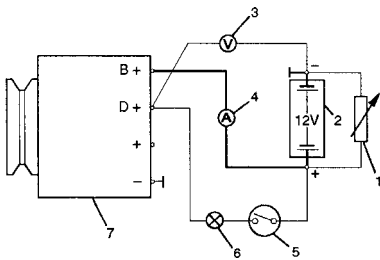
## Generator



### Removal

1. Disconnect battery ground cable.
2. Move drive belt tensioner to loose side using wrench then remove drive belt.
3. Disconnect terminal "B" wiring connector and connector.
4. Remove generator assembly.

### Generator Power and Circuit Diagram

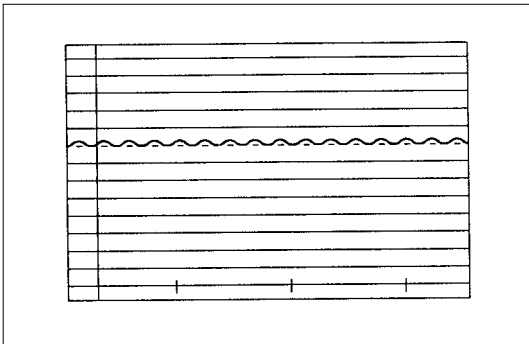


### Inspection

#### Legend

- 1 Load resistor, set parallel to battery
- 2 Battery
- 3 Voltmeter
- 4 Ammeter
- 5 Ignition Lock
- 6 Charge Telltale
- 7 Generator

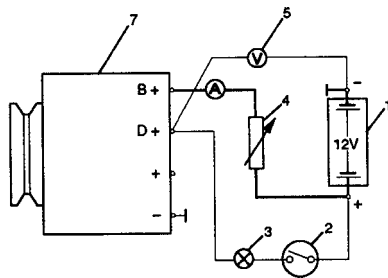
1. Disconnect battery.
2. Close off connecting cable from alternator terminal "B+".
3. Set ammeter (measuring range 100A) in disconnected line.
4. Connect controllable load resistor to battery terminal.
5. Set resistor in front of connection to "O"; connect first to battery, then to resistor.
6. Connect tachometer.
7. Connect oscilloscope according to manufacturer's instructions.
8. Connect battery.
9. Start engine and read off resulting current at various engine speeds.



### Generator Power

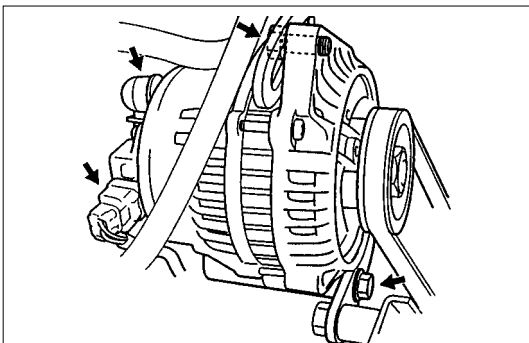
1. Adjust load resistor, if the required load currents are not attained.
2. The shape of the voltage curves on oscilloscope curve should be regular.
3. Test value: 5 to 7A.
4. If the required minimum current intensity is not attained, or if the oscilloscope picture shows variations, the alternator should be overhauled.

### Regulated Voltage Circuit Diagram



### Legend

- 1 Battery
- 2 Ignition Lock
- 3 Charge Telltale
- 4 Resistor, for attainment of load current with the battery set in series
- 5 Voltmeter
- 6 Ammeter
- 7 Generator



### Installation

1. Install generator assembly and bring generator assembly to the position to be installed.
2. Install generator assembly and tighten to the specified torque.

#### Torque:

**Long bolt: 35 N.m (3.6 kgf.m)**

**Short bolt: 20 N.m (2.0 kgf.m)**

3. Connect wiring harness connector.
4. Move drive belt tensioner to loose side using wrench, then install drive belt to normal position.
5. Reconnect battery ground cable.

The generator has four external connections; the "B+" lead to battery positive, "L" lead to the warning lamp circuit(max. 2 watts), "S" lead to battery positive terminal for battery sensing and an earth connection.

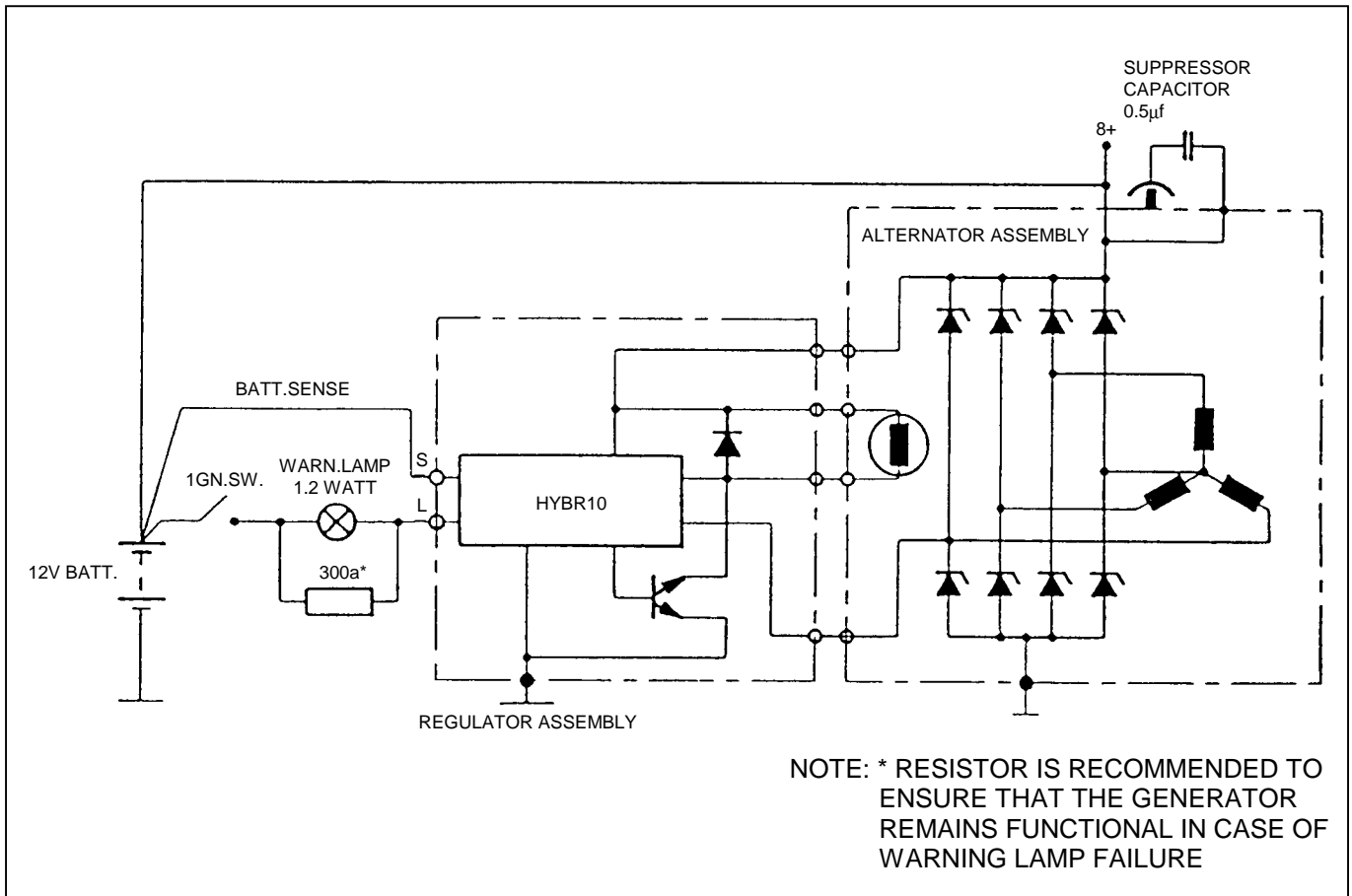
**Explanation of type inscription**

Example:KC-A--> 14V 50-90A.

- K = Code for Stator OD(126mm OD).
- C = Compact Generator.
- A = Ausland (countries other than Germany)
- > = Direction of rotation(clockwise).
- 14V = Generator Operating Voltage.
- 50A = Stabilised output at 25 C at 1800 RPM./13.5 Volts.
- 90A = Stabilised output at 25 C at 1800 RPM./13.5 Volts.

**Generator Connctions.**

- B+ : Battery Main Connection (battery positive)
- S : Battery Sense Connection(battery positive)
- L : Waring lamp(via warning lamp to Ignition switch)





## Warning

Do not reverse S and L connections as this will destroy the warning lamp circuit of the regulator.  
Ensure good electrical contact between generator earth and battery negative,

## Operation

With the Ignition switch turned "ON", current is supplied via the warning lamp to the "L" terminal of the regulator. Base current is fed to T15 causing it to turn on, current then flows from B+ through the rotor winding via the regulator brushes and the collector emitter junction of T15 to earth completing the circuit. The current in the rotor causes a magnetic field between adjacent poles to be created, this field is rotated and cuts the windings of the stator at right angles inducing a voltage into them.

As the speed is increased this induced voltage increases and results in current being rectified in the 3 phase diode bridge and supplied as DC to the B+ output and hence to the battery.

When the voltage at the B+ terminal of the battery reaches around 14.2 volts, this voltage is monitored by the "S" lead and turns the regulator Hybrid base current to T15 OFF removing rotor current, resulting in a decrease in output voltage to below the regulating voltage, T15 base current turns ON and the whole cycle is repeated very rapidly.

D38 protects T15 and the regulator against the back voltage developed across the rotor winding when T15 turns OFF.

The new generated EP regulators incorporate current limiting in the warning lamp circuit.

## Backup Regulation

The EP regulator will limit the output voltage to a safe level should either the main B+ cable or the battery sense wire become decoupled, the output voltage will be slightly above the normal setting(1-3 volts).

## Start up phase

When the Ignition switch is turned on and the engine is not running, the current to the rotor is reduced by switching it on and off at a 50% duty cycle, the frequency is approximately 4 KHz and may be audible at times.

This is quite normal, once the engine is started normal regulation commences.



## Warning lamp failure

Should the warning lamp fail, the generator will self excite by deriving a small current from the phase connection allowing the voltage to build up to regulating level.

Note: no field current will flow when the engine is cranking.

### Diagnosis

The EP regulator incorporates diagnostics which will illuminate the warning lamp as a result of fault conditions in the generator and external circuitry.

These conditions include:

1. An open circuit in the regulator battery sensing wire (S Terminal)
2. An open circuit or excessive voltage drop in the B+ cable.
3. An open circuit in the generator phase connection.
4. Overcharging of the battery.
5. Regulator output stage short circuit.
6. Open circuit rotor.

The regulator compares the voltage at B+ with the voltage at the "S" terminal connected to battery positive. If the voltage differential exceeds a predetermined threshold, the regulator will operate in backup mode to limit the output voltage to a safe level. The warning lamp will remain illuminated as long as these conditions prevail.

Sources of high resistance which will trigger the warning lamp are:

- a. Poor contact in wiring harness connectors.
- b. Poor contact between rectifier and regulator.
- c. High resistance in fusible link assembly.



#### Caution:

**When bench testing the generator it is important that the warning lamp wattage of 2 watts is not exceeded.**

**Reversal of the "S" and "L" on the regulator will damage the regulator.**

**The correct plug for the regulator is a 9 122 067 011 for the Bosch type and for the Shinagawa connector the number is X02FW.**

See appendix 1 for diagnostic matrix.

Before testing or disassembling the generator please observe the following points.

1. When testing the diodes with AC type testers the RMS. Voltage output must not exceed 12.0 volts, it is recommended that the stator should be disconnected during this test.
2. Where zener power diodes are used, the breakdown voltage should be tested to ensure all diodes have the same zener voltage.
3. Insulation tests on the rotor and stator should use a voltage not exceeding 110v for a series test lamp. The rectifier must be disconnected from the stator prior to testing.
4. When carrying out repairs to the charging system always disconnect the battery negative first, and reconnect it last.



5. During current output tests please make sure that the ammeter is securely connected into the charge circuit.
6. Some battery powered timing lights can produce high transient voltages when connected or disconnected. Only disconnect or connect timing lights when the engine is switched off.
7. Make sure the warning lamp circuit is functioning normally before commencing tests.
8. Battery isolation switches must only be operated when the engine is stopped.
9. To protect the charging system when using 240 volt chargers it is recommended that the battery is disconnected whilst charging.
10. Due to the very low resistance value of the stator winding it may not be possible to obtain accurate readings without special equipment.
11. 12 volts must never be connected to the "L" terminal of the regulator as this will damage the lamp driver circuit.
12. No loads apart from the warning lamp can be connected to the "L" terminal. The "W" terminal is provided for this purpose.



### Disassembly

1. Mark the relative positions of the end housings in relation to the stator assembly to aid reassembly. Use a permanent marking pen do not use centre punched as this can cause misalignment of the housings.
2. Remove the EP regulator from the slipping end housing by removing the two screws. Tilt the regulator slightly from the plug connector until the regulator clears the housing, then lift clear.
3. Remove the four through bolts.
4. Carefully remove the stator assembly along with the slipping end housing taking care not to put strain on the stator wires.
5. To disconnect the stator from the rectifier assembly, grasp the stator wires close to the wire loop with a pair of long nosed pliers, heat the joint with a soldering iron, when the point becomes plastic apply a slight twisting motion to the wires, then pull upwards to release the wires. Remove the stator.

This procedure opens the wire loop to release the stator connections easily.
6. To remove the rectifier remove the three retaining screw and the B+ terminal nut and washers.

Note: the B+ bolt and the positive heatsink retaining screw are fitted with mica insulating washers. These must be discarded and replaced with new washers and heatsink compound.

7. To remove the pulley, mount an 8mm Allen key in the vice with the short end upwards, place a 24mm ring spanner on the pulley nut, position the internal hexagon of the rotor shaft onto the Allen key, loosen the nut and remove the pulley.

Note: the pulley has an integral boss which locks up against the bearing, therefore no thrust collar is provided.

8. Removing the rotor assembly. Remove the four retaining screws from the drive end housing, withdraw the rotor complete with the bearing.

Note: the rotor must not be pressed from the drive end housing using a press as the bearing retaining plate and drive end housing will be damaged or distorted. Parts removed in this way must be replaced if the integrity of the generator is to be maintained.

9. Remove the drive end bearing from the rotor shaft using a chuck type pulser, take care not to distort the fan assembly during this process.
10. Remove the slipring end bearing using the same method as in 9.



### Clean

Thoroughly clean all components except the rotor and stator with an approved cleaning agent. Ensure that all traces of oil and dirt are removed. If an abrasive cleaner is used to remove scale and paint from the housings take care not to abrade the bearing and mounting spigot surfaces. The rotor and stator must be cleaned with compressed air only, the use of solvents could cause damage to the insulating materials.



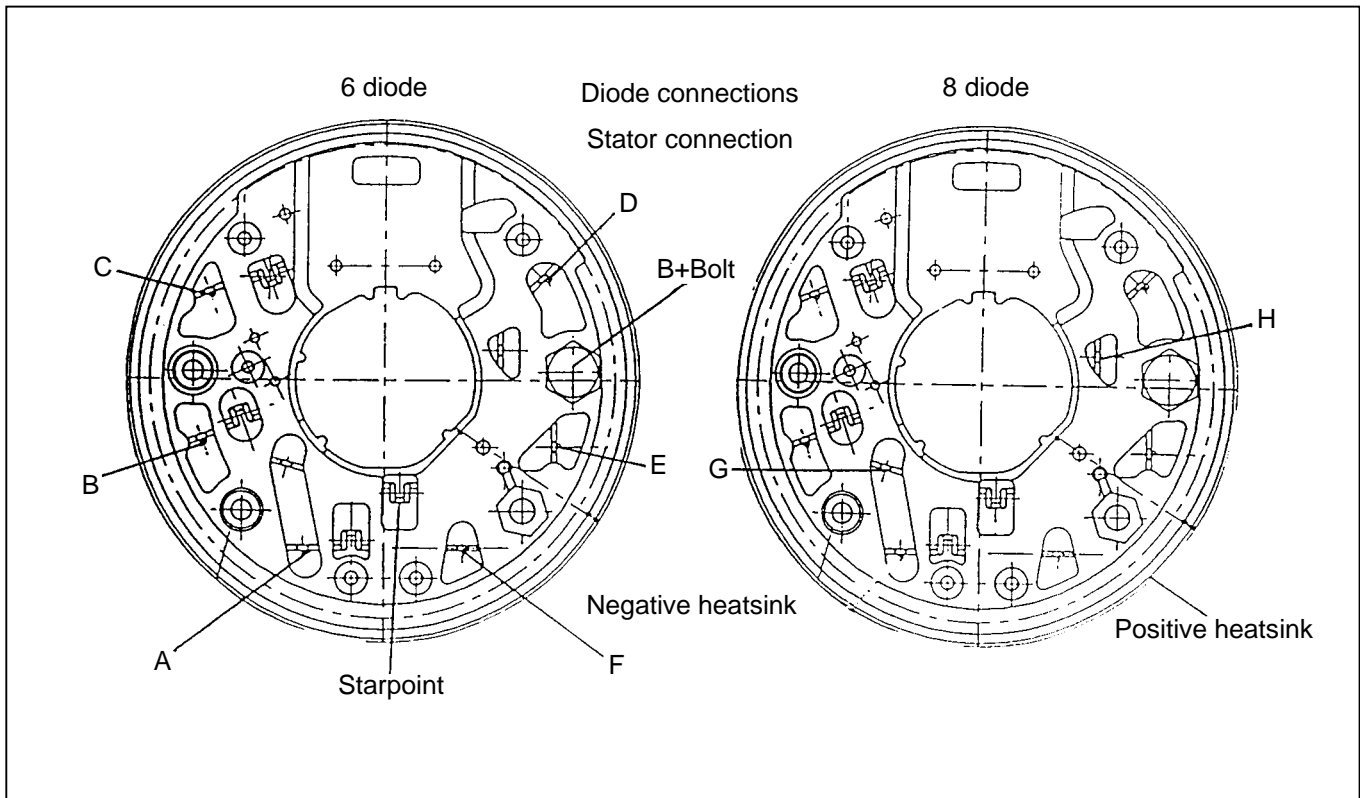
### Inspection

#### 1. Rectifier assembly

The following test equipment is required.

The rectifier assembly is not repairable and must be replaced if a faulty diode is detected during inspection.

- (a) A diode tester where the DC output at the test probes does not exceed 14 volts or in the case of AC testers 12 volts RMS. This is to ensure that when inspecting rectifiers fitted with zener power diodes the forward and reverse checks are complete and are not masked by the diode turning on due to the zener breakdown voltage.
- (b) A zener diode tester with a DC output in excess of 30 volts, the tester should also incorporate internal current limiting set to 5 Ma. to prevent high currents during inspection.
- (c) Diodes can be destroyed during service due to high temperature and overload, open circuits are usually a result of excessive voltage.



**1.1 Power Diodes.**

Apply the negative test probe of the diode tester or a multimeter with a diode test feature to the positive heatsink and the positive probe alternatevely to A,B,C, a low resistance reading, or the forward voltage drop across the diode should be obtained. Reverse the test probes, a high resistance reading or a higher reverse voltage should be obtained.

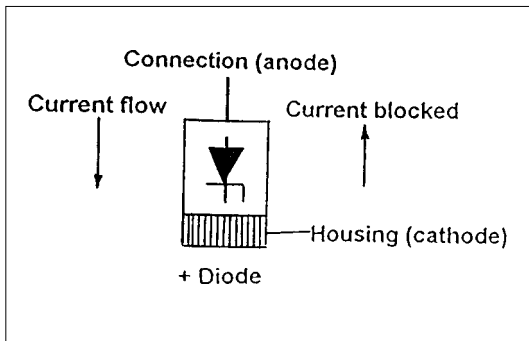
Now connect the positive test probe to the negative heatsink and the negative alternatively to D,E,F, a low resistance or forward voltage drop across the diode should be obtained. Reverse the test probes, a high resistance reading or a higher reverse voltage should be obtained.

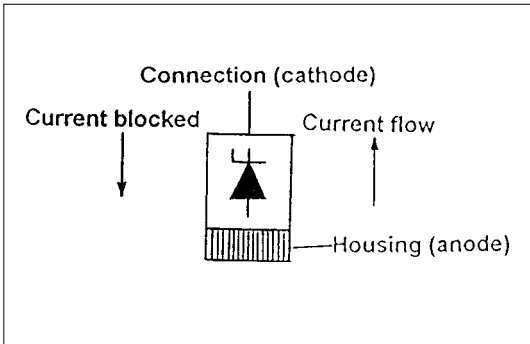
For 8 diode rectifier plates tests for G and H should be included. When the reverse voltage test is done the applied voltage should be less than 14 volts DC or 12 volts RMS for AC testers.

**1.2 Zener Diode**

The basic tests in 1.1 should be undertaken first before the diode zener voltage is tested. Diodes are grouped together according to their zener voltag i.e. all diodes within a rectifier must have the same zener voltage.

Connect the test probes as for the reverse test listed above i.e. reverse biased apply the test voltage form the zener diode tester (current limited to 5ma) and read to zener breakdown voltage this should be a steady reading and not increase with increased voltage from the tester.

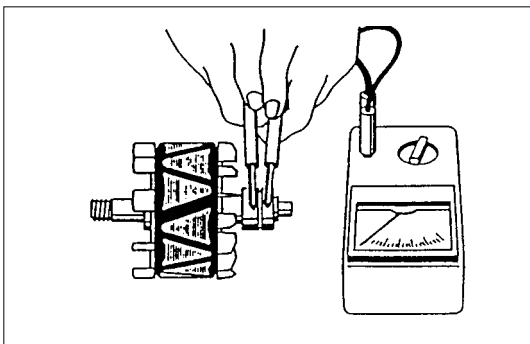




Readings for Zener diode groups 011 to 042

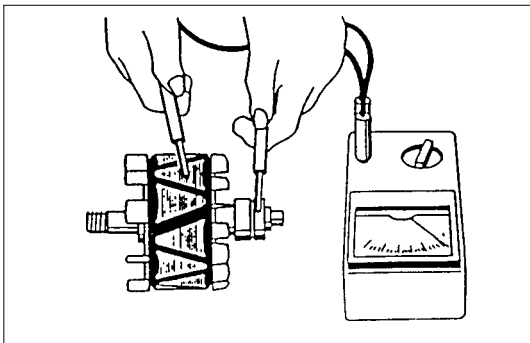
Zener voltage at 5Ma.	Positive diode	Negative diode	Forward current Rating
17.8v-19.2v	011	012	25A
18.8v-20.2v	013	014	25A
19.8v-21.2v	015	016	25A
20.8v-22.2v	017	018	25A
21.8v-23.2v	019	020	25A
22.8v-24.2v	021	022	25A
17.8v-19.2v	031	032	35A
18.8v-20.2v	033	034	35A
19.8v-21.2v	035	036	35A
20.8v-22.2v	037	038	35A
21.8v-23.2v	039	040	35A
22.8v-24.2v	041	042	35A

Note: Diode number is stamped on the rear of the diode.



**2. Stator**

Inspect the stator insulation resistance to ground with an insulation tester or a series test lamp up to 110 volts. The insulation resistance must be greater than 1 megohm. The winding resistance is measured between phases using a low reading ohmmeter designed for this purpose, the values are given at the rear of this instruction.



**3. Rotor**

Inspect the rotor for insulation resistance to ground using an insulation tester or a series test lamp up to 110 volts. The insulation resistance must be greater than 1 megohm. Measure the rotor resistance between the sliprings using an ohmmeter or apply 12 volts across the sliprings and measure the rotor current flow, then divide 12 by the measured current, the results is the rotor resistance in ohms. values are given at the rear of this instruction.

If the sliprings are worn or out of round they must be re machined to a minimum diameter of 26.7 mm and should have a runout not exceeding 0.060mm. If the slipring is below these limits it must be replaced with a new one.



**Warning; extreme care must be exercised when machining the slipring as it is possible for the turning tool to foul the fan.**

#### 4. Replacing the brushes (inbuilt regulator)

Check the brushes for length, this is measured from the brush holder to the end of the brush along its centre line. Also inspect for any sideways wear. If worn replace both brushes. The minimum length is 3.8mm. Inspect the brush springs for signs of corrosion or loss of tension or uneven tension.

Replacing the brushes, using a soldering iron apply heat to the soldered joints on the rear of the brush holder of the regulator, using a small lever prise up the retaining tabs to release the brush lead and spring. Thread the new brush lead up the brush holder along with the spring, pull the lead through the tabs until the brush is protruding 12mm from the holder. Bend down the tabs and solder the brush lead taking care not to allow the solder to run up the lead which will reduce flexibility. Use 60/40 resin cored solder.

#### 5. Ball bearing

Please note the bearings used in this KCA generator are a high tolerance type, only fully sealed bearings of the same specification are to be used as replacements. It is recommended that the bearings be replaced during the reconditioning process to restore the unit to original specification.

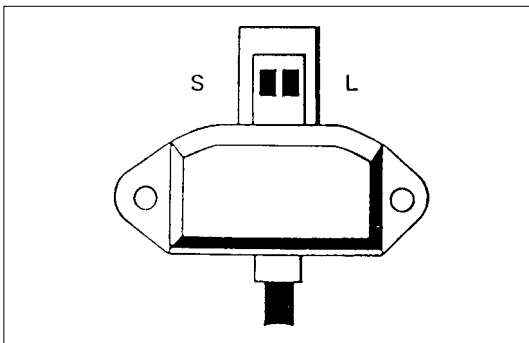
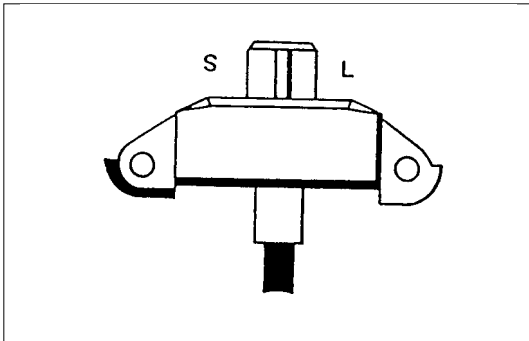
#### 6. Regulator

The regulator can only be tested when fitted into an alternator.



**Warning: do not reverse "S" and "L" connections or put 12 volt supply to "L" terminal, this connection must not be used as a supply source other than to supply the requirements of the warning lamp 2(watts). Such action will destroy the regulator warning lamp circuit.**

For test voltages refer to Generator output testing section. See also additional information on regulator function earlier in this instruction.





## Reassembly Generator

- (a) Press new bearing onto slipping end of the rotor taking care to apply the force to the bearing inner race only, otherwise the bearing will be noisy and its life will be shortened.
- (b) Fit a new bearing to the drive end housing, fit the bearing plate, and four retaining screws, press the rotor into the bearing, using a support tool to take the thrust against the bearing inner.  
The support is fitted from the pulley side of the bearing. In this way the thrust is not taken by the drive end housing.
- (c) To fit pulley, mount an 8mm Allen key in the vice with the short end upwards, place a 24mm ring spanner on the shaft nut, position the internal hexagon of the rotor shaft onto the Allen key, tighten the nut to the required torque (See torque chart)
- (d) Inspect the bearing support ring for signs of damage, if in doubt replace the ring by pressing it into the housing by hand, do not use excessive force.
- (e) To refit the rectifier, fit new mica washers to the positive heatsink B+ bolt and retaining screw each washer must have heatsink compound applied to both surfaces before fitting.  
Fit the three retaining screws to the rectifier then install into slipping end housing. Tighten the B+ bolt to the required torque.
- (f) To refit the stator, make sure the spigot surface are clean and free from damage, fit the stator into the slipping end housing noting the correct lead connection positioning. Fit the stator leads into the wire loops in the rectifier. Using a pair of pliers squeeze the loop to retain the stator lead prior to soldering. Repeat for each lead in turn, solder the leads into position using 60/40 resin cored solder. Make sure the leads will be clear of the internal fan when the rotor is assembled into the stator.
- (g) Carefully install the rotor into the stator/slipping end housing assembly, noting the alignment of the housings and through bolt holes. Fit the through bolts making sure the stator is seated correctly, tighten the through bolts to the correct torque setting (uneven torque can produce magnetic noise levels above normal).
- (h) Fitting the regulator. Compress the brushes into the brush holder by hand, slip the regulator through the opening in the rear of the slipping end housing until the brushes come in contact with the slipping. Press the regulator towards the slipping until the holes are aligned then fit the retaining screws and tighten.



## Inspection

### Generator

Before any in field testing can be undertaken it is important that the battery's conditions is established and the terminals are clean and tight.

Check the condition of the generator drive belt and ensure that it is adjusted in accordance with the engine manufacturer's recommendations.

Battery conditions:

Note: This assessment may be difficult with maintenance free assemblies.

Test the specific gravity of the individual cells the readings should be within 10 points of each other, it is recommended that the average SG should be 1.260 or higher.

A load test should be carried out to determine the ability of the battery to supply and accept current. This is a good indicator as to the general condition of the battery.

A load equal to the normal starting current should be placed across the battery, the duration of this load test should not exceed 10 seconds, during this time the terminal voltage across the battery should not drop below 9.6 volts. Observe each cell for signs of excessive gas liberation, usual an indication of cell failure.

If the battery test is clear proceed with the Generator tests as follows.

Care should be taken when making the following connections. It is recommended that the battery negative terminal be disconnected before the test meters are connected, and reconnecting the negative terminal when the meters are inserted into the circuit under test. The warning lamp in the D+ circuit should not exceed 2 watts.

### Regulating voltage test on the vehicle.

Connect a voltmeter to the generator, the positive lead to the B+ terminal and the negative lead to the generator casing. Select the voltage range to suit the system, i.e. 20v for 12 volt systems or 40v for 24 volt systems. Connect an ammeter in series with the main output cable from the B+ terminal on the generator, the range selected must be capable of reading the maximum output from the generator.

Note the voltmeter reading before starting the engine. This reading should increase when the engine is running indicating generator output, start the engine and increase the engine speed until the generator is running at 4000 rpm, switch on vehicle loads of 5-10 A is indicated on the ammeter, the voltmeter should read 14.0-14.2 v for a 12 volt system, for a 24 volt system the readings should be 5-10 A and 27.7-28.5 volts.

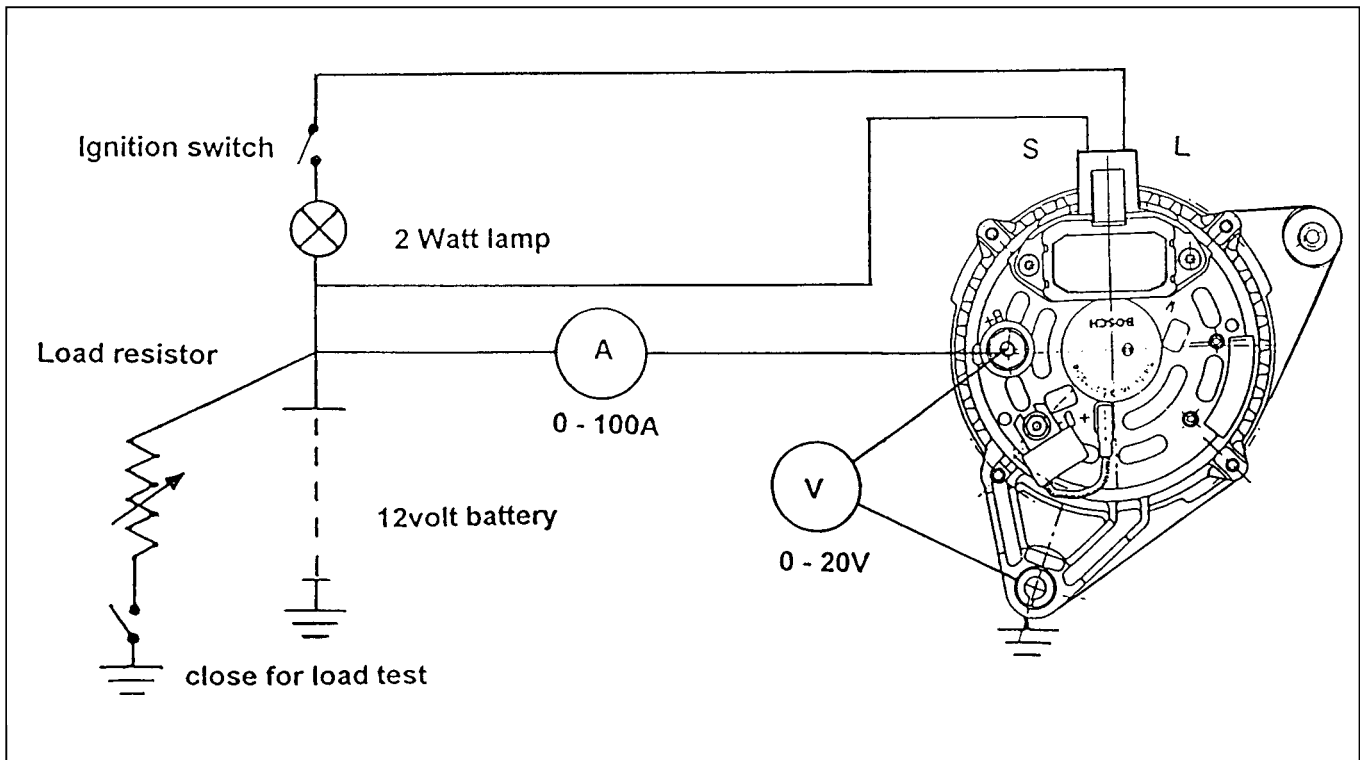
### Load regulation test

Increase the engine speed until the generator is running at 6000 rpm, increase the load to 90% of full output a decrease in the regulating voltage should not exceed 0.50 volts for 12 v and 0.70 v for 24 v regulators of the readings obtained in the previous test. If so, the regulator is defective.

### Generator output test at full load

Increase engine speed until the alternator is running at 6000 rpm, switch on electrical loads until the generator voltage drops to 13.5 volts for 12 v systems and 26 volts for 24 v systems, full output should be obtained under these conditions. It may be necessary to adjust engine speed to maintain alternator speed. If sufficient electrical loads are not available a carbon pile resistance can be connected across the battery and adjusted until maximum output is obtained.

Keep the time for this test to a minimum to avoid undue heating and high engine speeds.





**Technical Data**

			(mm)
Brush wear	-	Minimum Length	3.8
Sliprings	-	Minimum Diameter	26.7
Sliprings	-	Trueness	<0.06
Pole claws	-	Trueness	<0.05(93.25±0.05)

Torque

			N.m(kgf.m)
Pulley retaining nut		54-68(5.5-6.9)	
Capacitor retaining screw		2.7-3.8(0.3-0.4)	
Capacitor whiz nut		1.5-2.2(0.1-0.2)	
B+ terminal nut M8		7.5-8.5(0.8-0.9)	
B+ terminal rectifier nut		6.0-7.5(0.6-0.8)	
Regulator retaining screw		1.6-2.3(0.1-0.2)	
Rectifier retaining screw		1.6-2.3(0.1-0.2)	
Bearing retaining plate screw		2.1-3.0(0.2-0.3)	
Through bolt		3.8-5.5(0.4-0.6)	

Winding resistance(between phases)

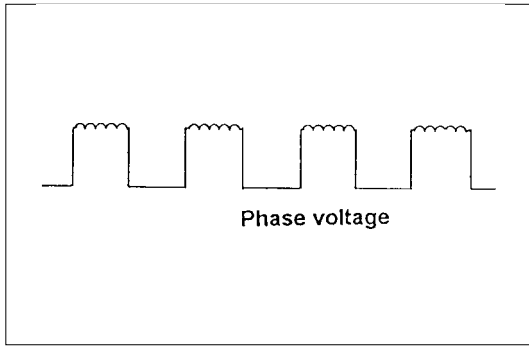
				(Ω)
		Stator	Rotor	
70 Amp generator	0.086+10%	2.6±0.13		
85 Amp generator	0.058+10%	2.6±0.13		
90 Amp generator	0.056+10%	2.6±0.13		

Warning lamp fault indication

Fault running	Generator not running Ignition ON	Generator Ignition ON
Generator out cable O/C	ON	ON
Battery "S" cable O/C	ON	ON
Battery overcharged	ON	ON
Positive diode short	OFF	ON
Negative diode short	ON	ON
Positive diode open	ON	OFF
Negative diode open	ON	OFF
Phase voltage sensing cable open circuit	ON	ON
Power transistor shorted	ON	ON
Warning lamp driver O/C	OFF	OFF

## 6D3-22 STARTING AND CHARGING SYSTEM

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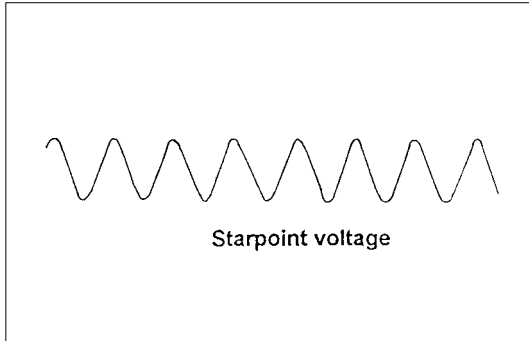
Output wave forms for phase and startpoint connections.

Note; the average of these two waveforms are identical from no load to 100% output of rated load.

Voltage phase = Voltage startpoint

6.9v@ rated output 7.2v@ Zero output

Note: The phase frequency is one third of the startpoint frequency.



# SECTION 6E

## DRIVEABILITY AND EMISSIONS

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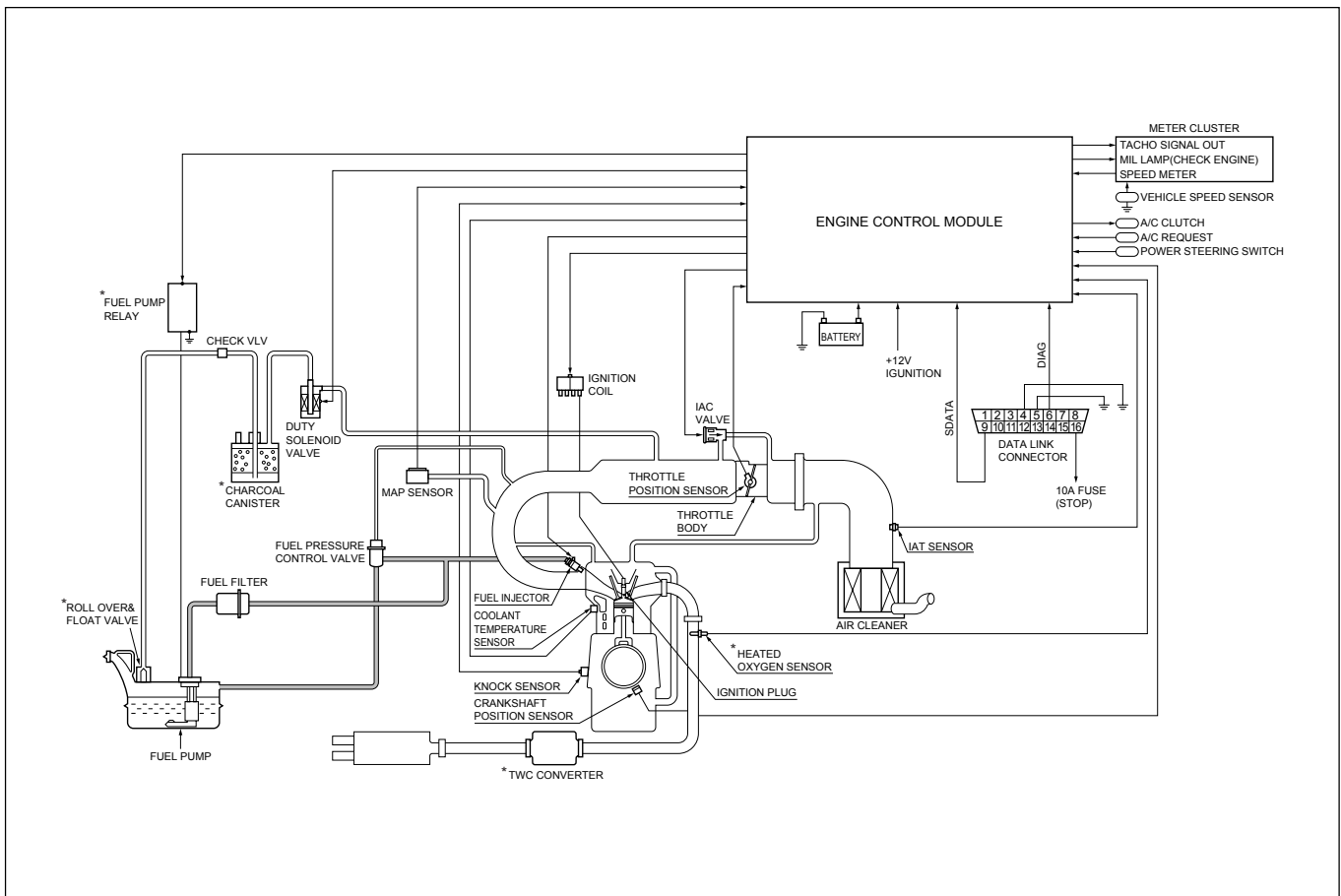
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# SPECIFICATIONS

## Tightening Specifications

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Crankshaft Position Sensor Mounting Bolt	9	-	78
Engine Coolant Temperature Sensor	30	22	-
Fuel Pressure Regulator Attaching Screw	6.5	-	60
Fuel Rail Bolts	7	-	75
Heated Oxygen Sensor (If applicable)	5	40	-
Spark Plugs	25	18	-
Throttle Body Mounting Bolts	13	-	120
VSS Retaining Bolt	13	-	120
Intake Manifold to Cylinder Head	22	16	-

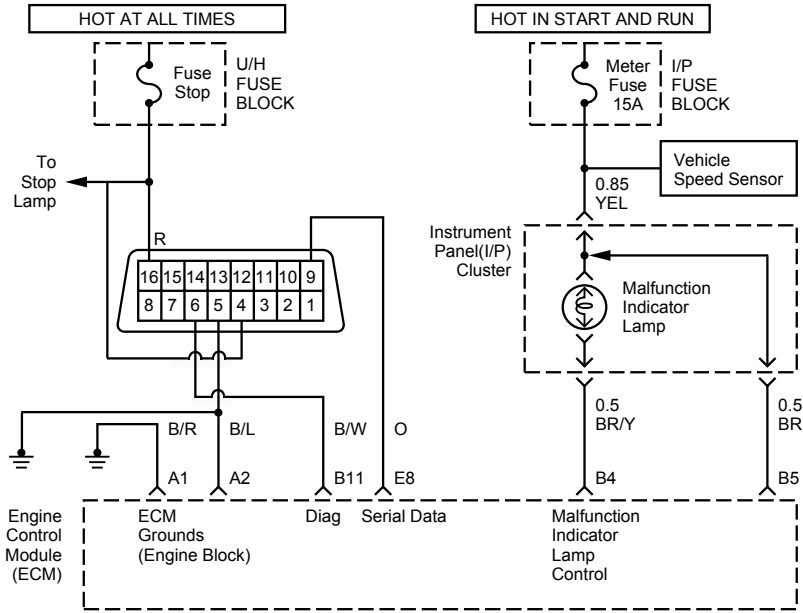
## EMISSION CONTROL SYSTEM SCHEMATICS



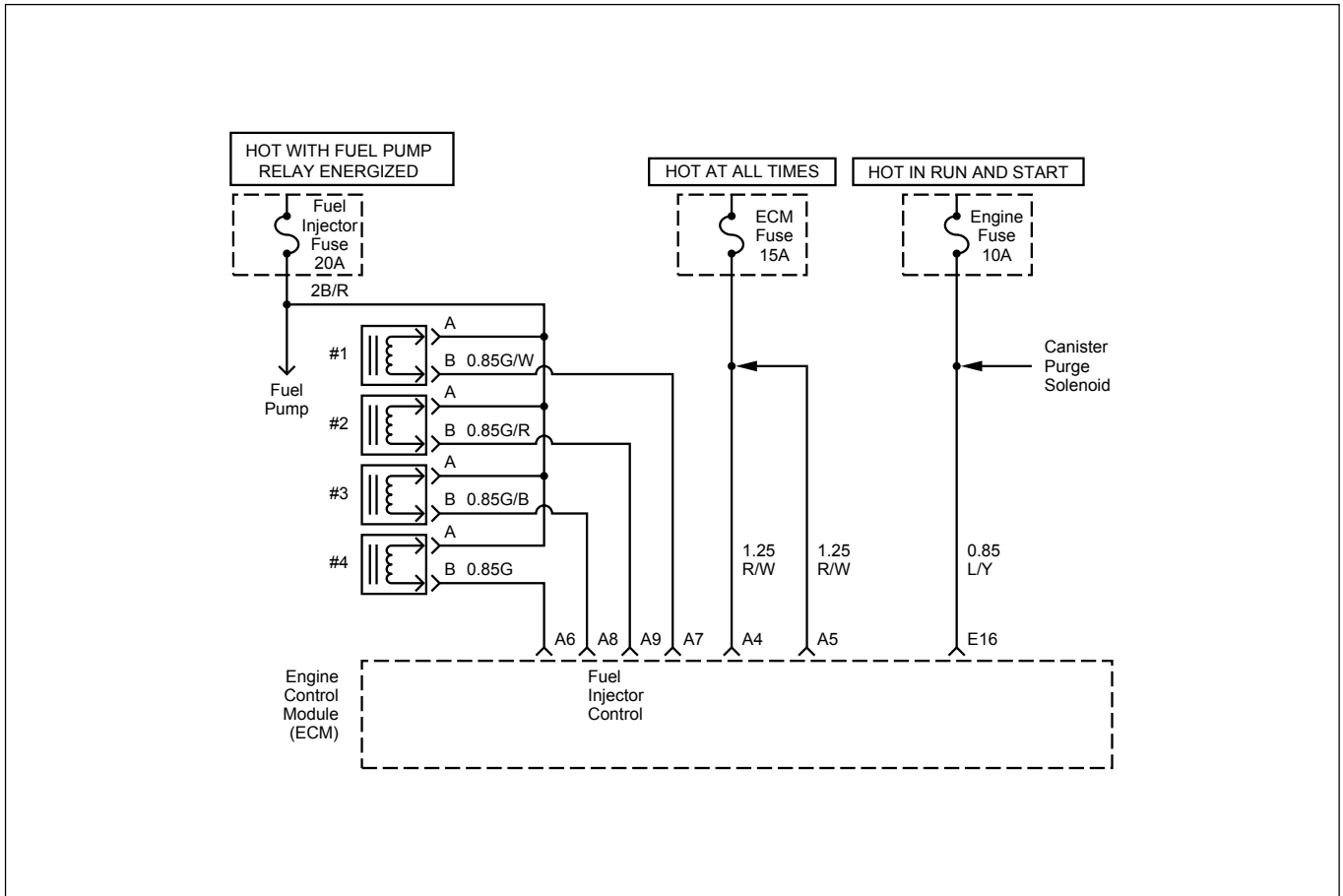
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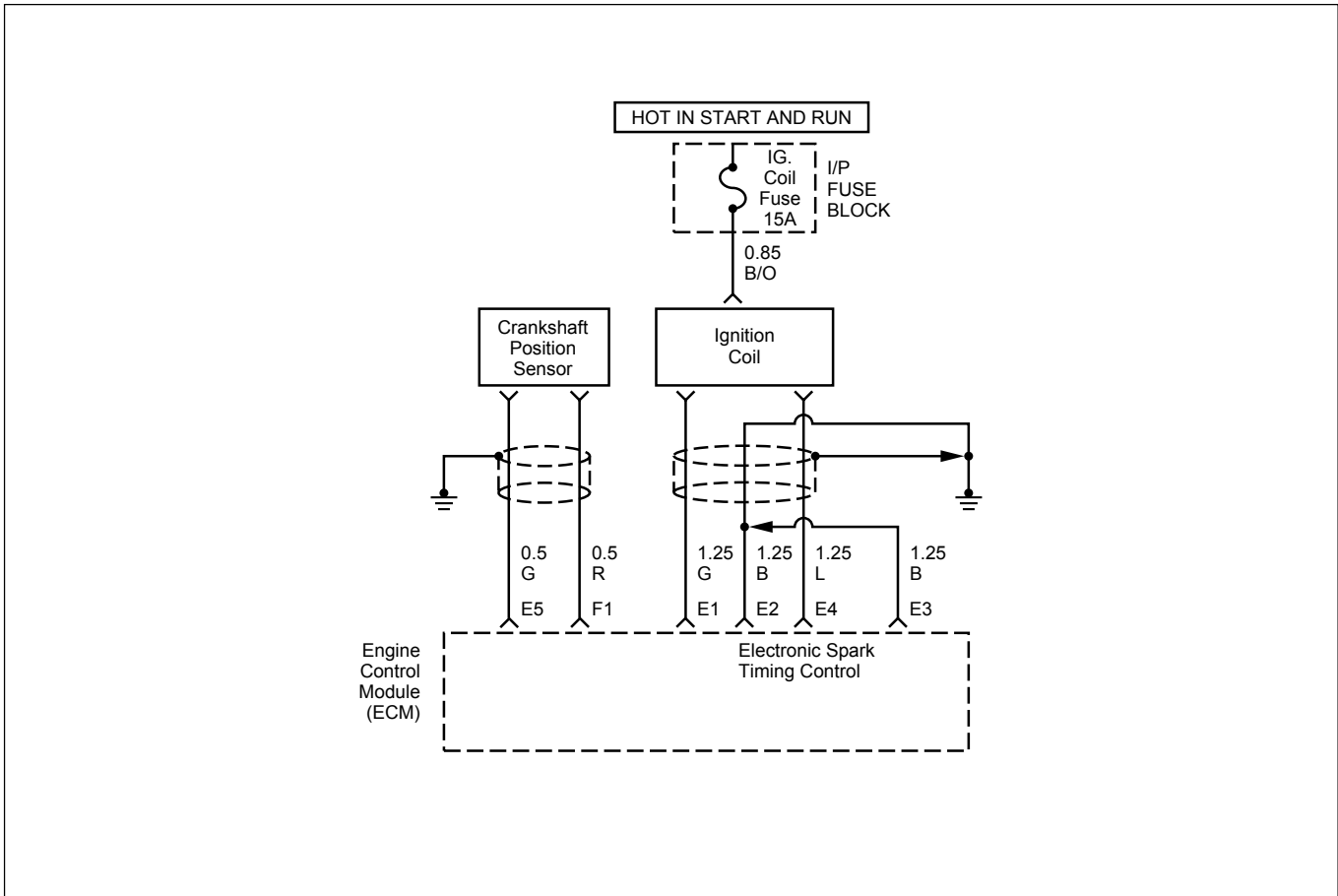
\* If equipped.

# DIAGRAMS AND SCHEMATICS

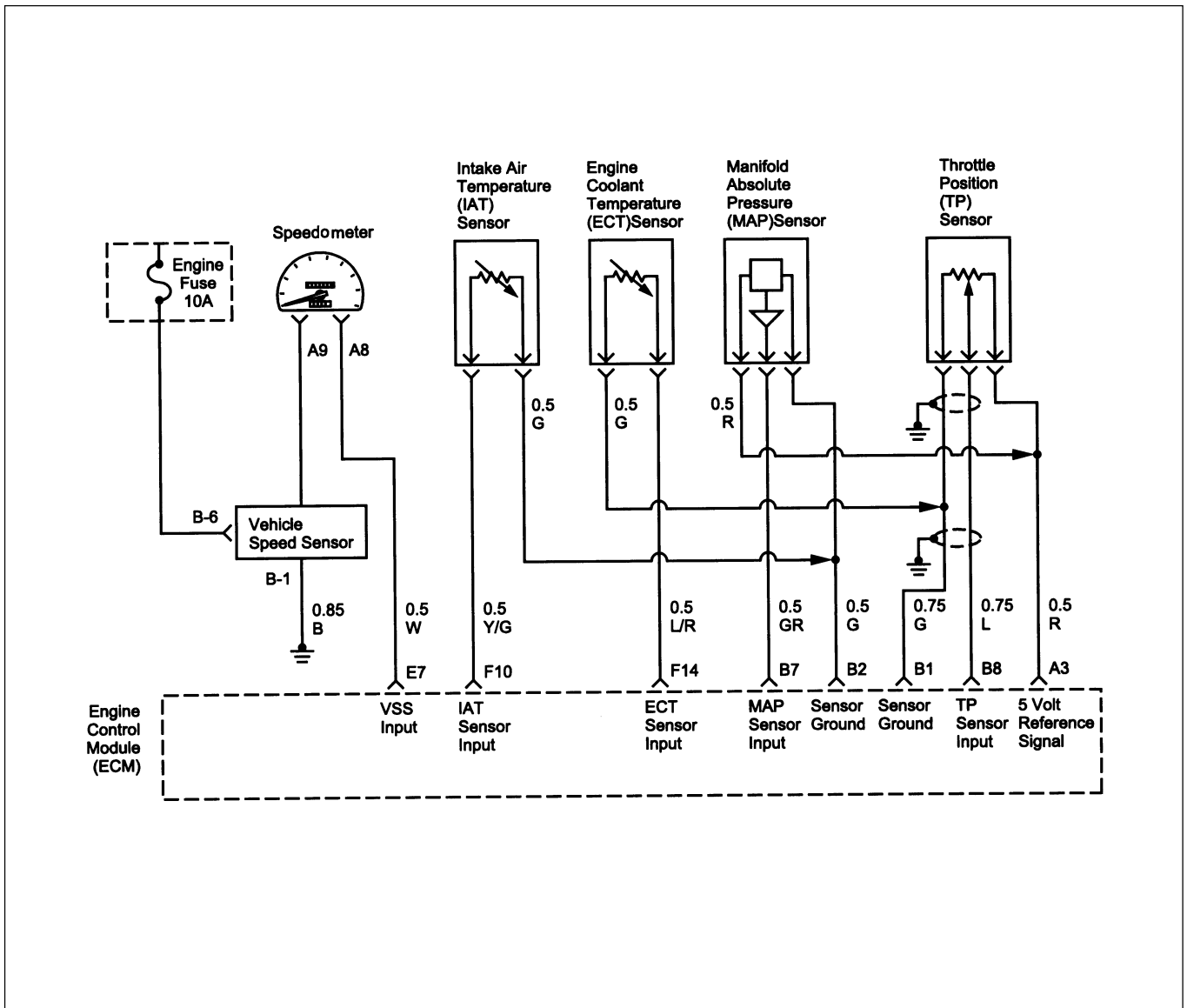


6E1-26 DRIVEABILITY AND EMISSIONS

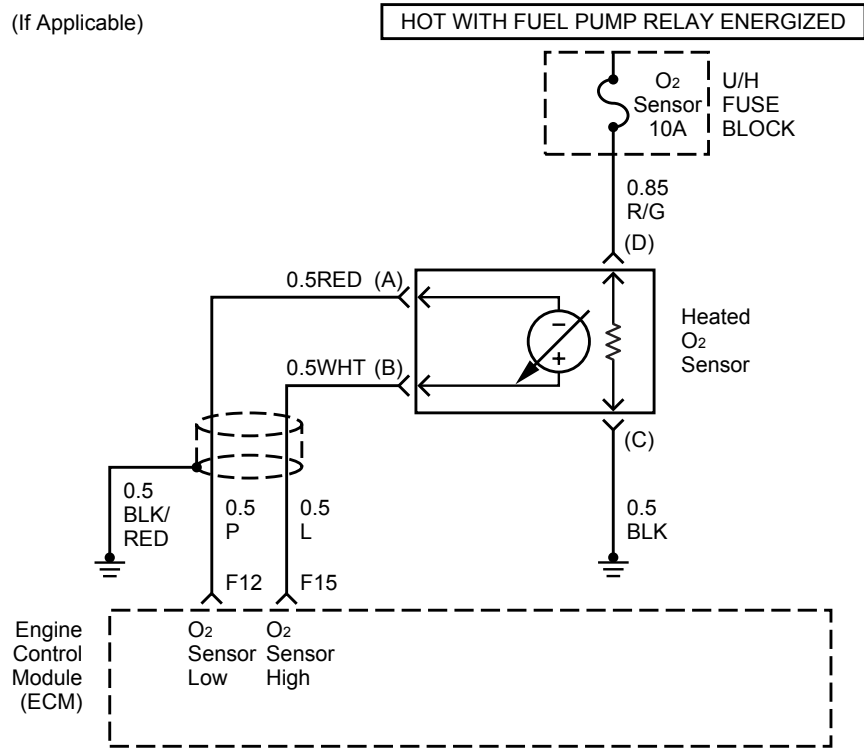




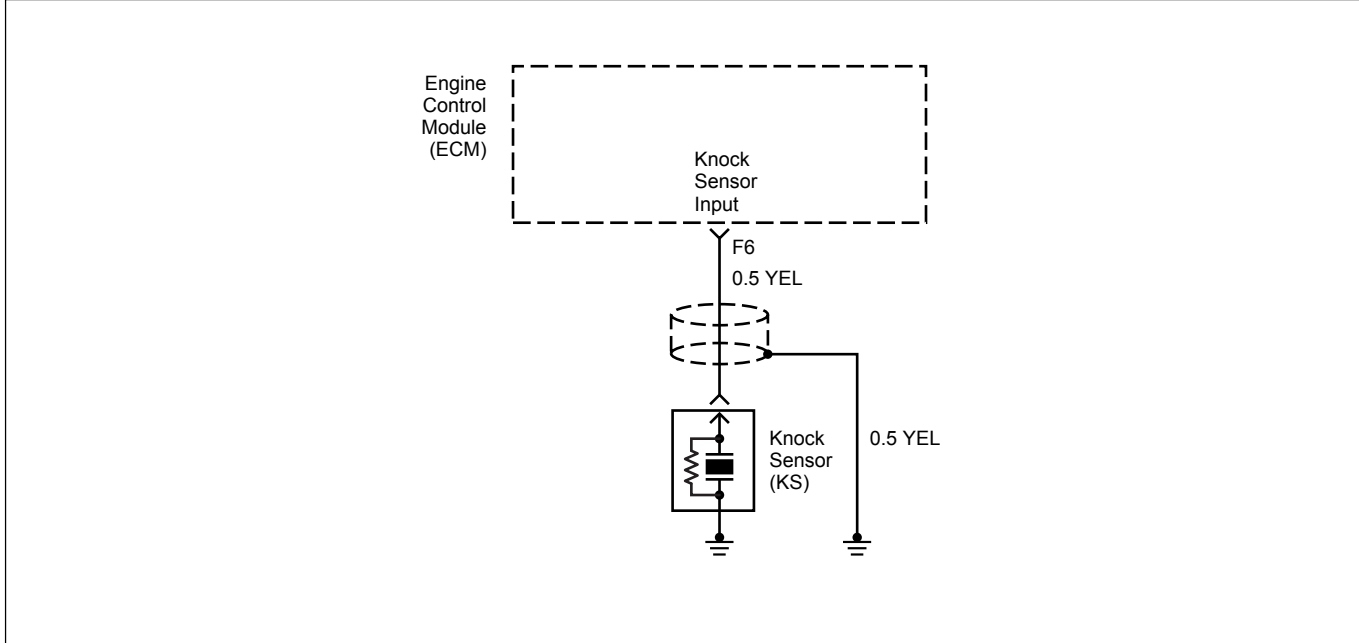
6E1-28 DRIVEABILITY AND EMISSIONS



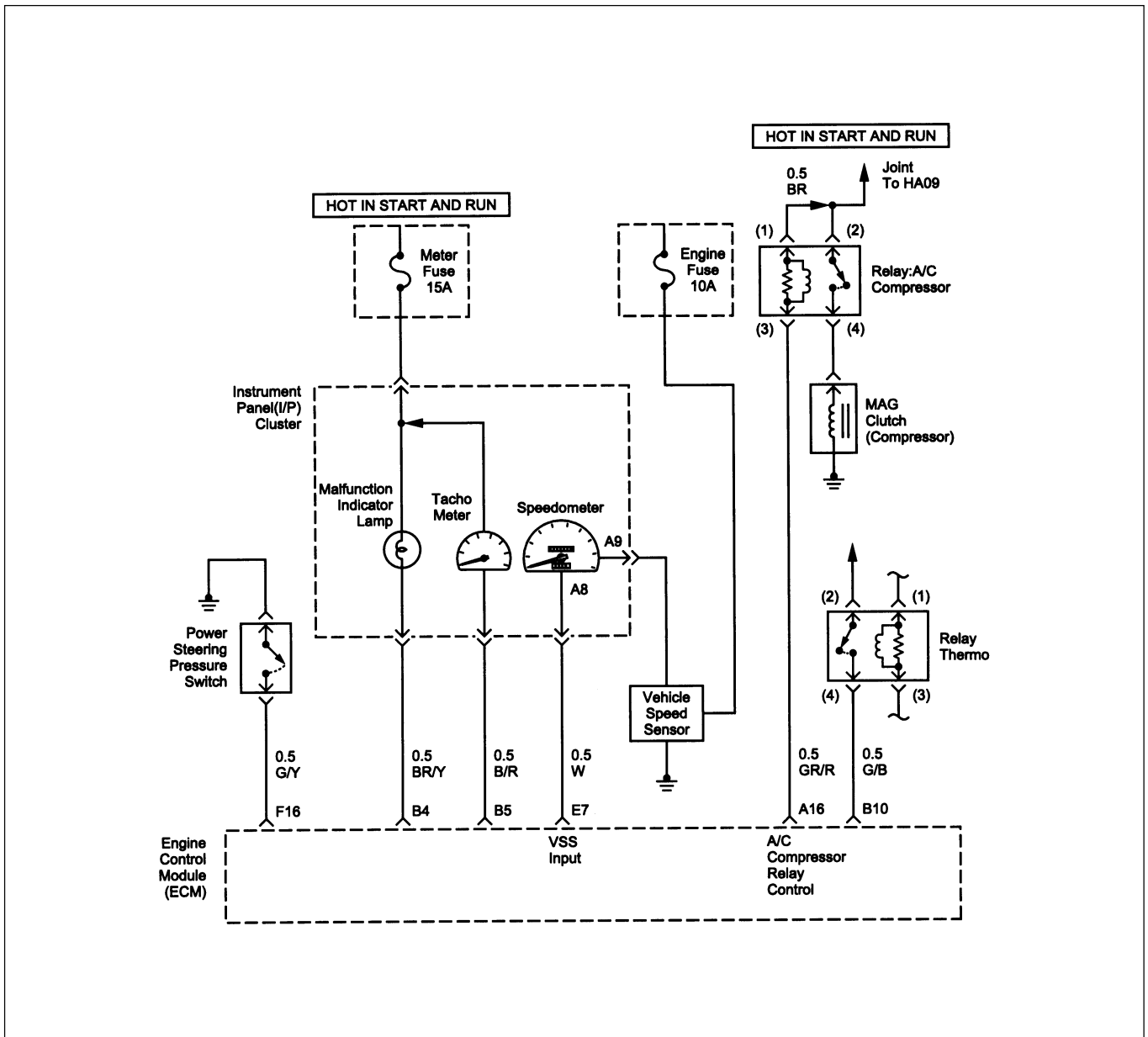
(If Applicable)



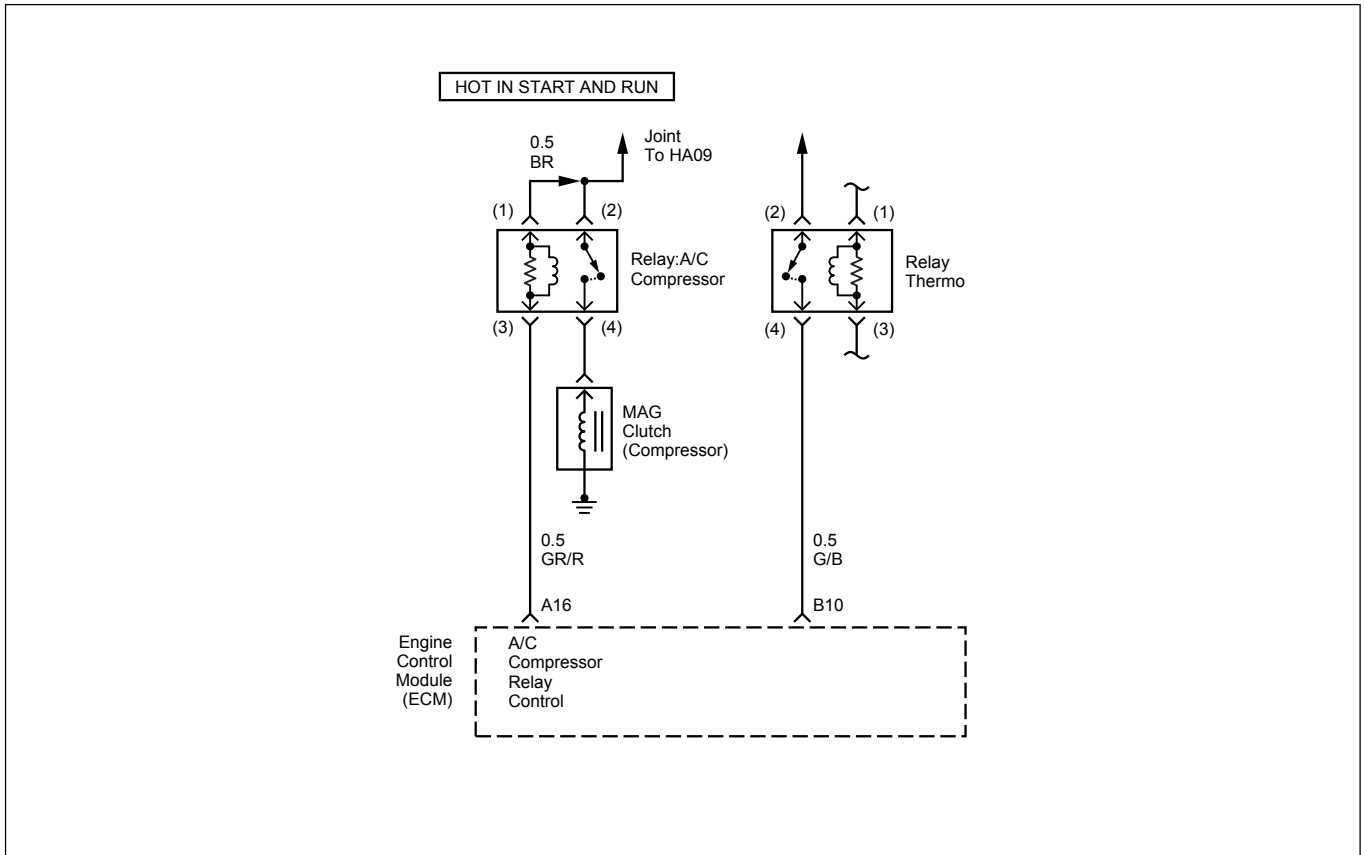
6E1-30 DRIVEABILITY AND EMISSIONS

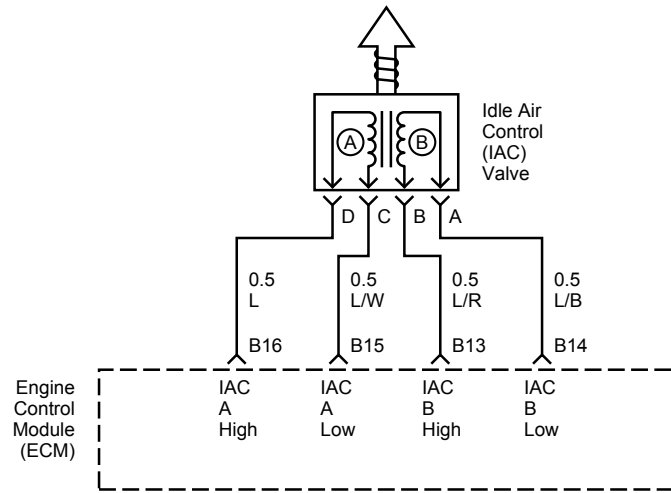






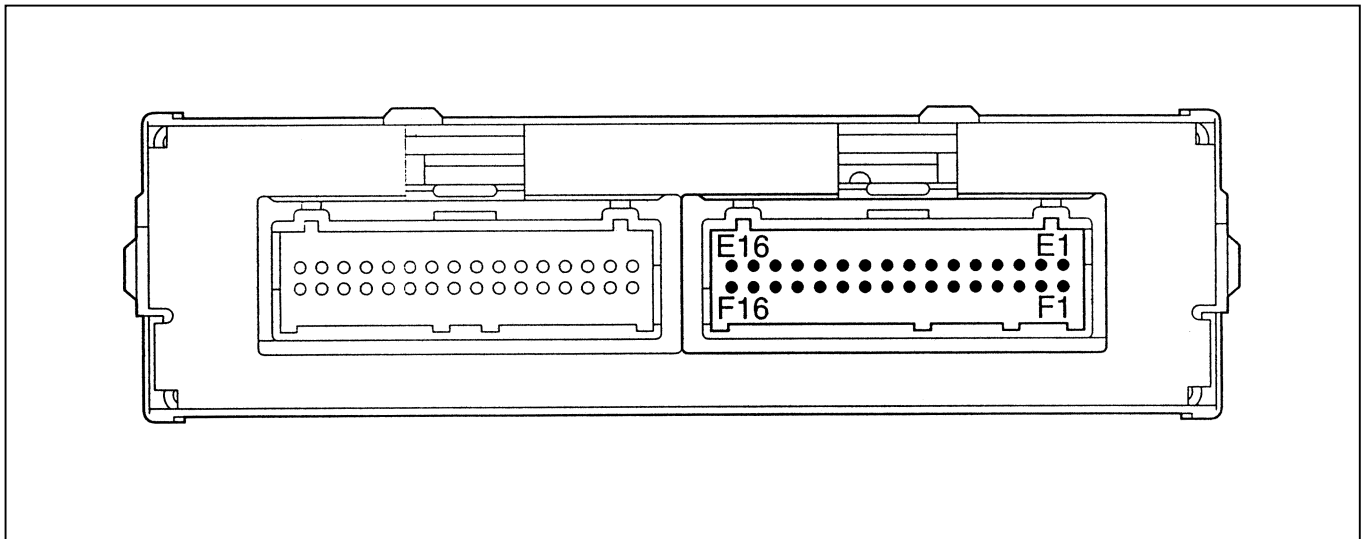
6E1-32 DRIVEABILITY AND EMISSIONS





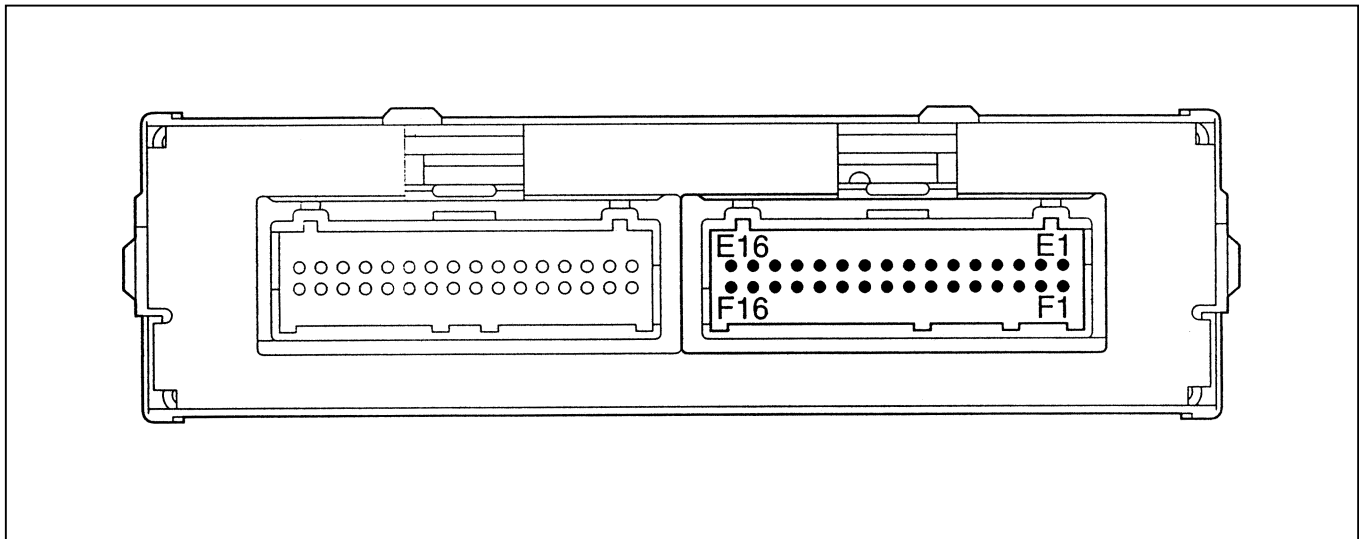


## ECM Pinout Table, 32-Pin Blue Connector-Row "J1"



PIN	PIN Function	Wire Color	IGN ON	ENG RUN	Refer To
E1	Electronic Spark Timing Coil Driver A	G	12V	14V	-
E2	Coil Ground A	B	0V	0V	-
E3	Coil Ground B	B	0V	0V	-
E4	Electronic Spark Timing Coil Driver B	L	12V	14V	-
E5	Crank Position Sensor High	G	1V	1V	General Description and Operation, Crank Position Sensor
E6	Not Used	-	-	-	-
E7	Vss Input	W	9V	11V	Chassis Electrical
E8	Serial Data	R	5V	5V	Serial Data
E9	Not Used	-	-	-	-
E10	Not Used	-	-	-	-
E11	Not Used	-	-	-	-
E12	Not Used	-	-	-	-
E13	Not Used	-	-	-	-
E14	Not Used	-	-	-	-
E15	Not Used	-	-	-	-
E16	Ignition Feed	B/Y	12V	14V	General Description and Operation

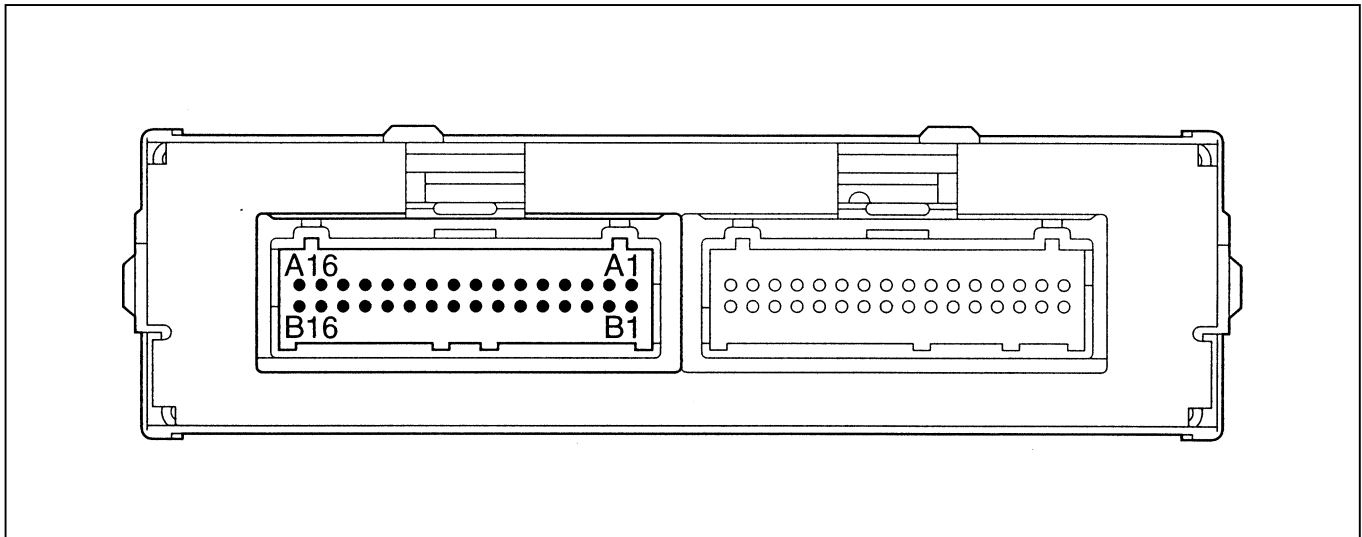
ECM Pinout Table, 32-Pin Blue Connector-Row "J1"



PIN	PIN Function	Wire Color	IGN ON	ENG RUN	Refer To
F1	Crankshaft Position Sensor Low	R	1V	1V	General Description and Operation, Crankshaft Position Sensor
F2	Not Used	-	-	-	-
F3	Not Used	-	-	-	-
F4	Not Used	-	-	-	-
F5	Not Used	-	-	-	-
F6	Knock Sensor Input	Y	0V	0V	General Description and Operation, Knock Sensor
F7	Not Used	-	-	-	-
F8	Not Used	-	-	-	-
F9	Not Used	-	-	-	-
F10	Intake Air Temperature Sensor	Y/G	2V	2V	General Description and Operation, IAT
F11	Not Used	-	-	-	-
F12	Heated O <sub>2</sub> Sensor Low (If applicable)	-	-	-	General Description and Operation, Heated O <sub>2</sub> Sensor
F13	Not Used	-	-	-	-
F14	Engine Coolant Temperature	L/R	2V (0V=151°C)	3V (5V=-40°C)	General Description and Operation, Engine Coolant Temperature Sensor
F15	Heated O <sub>2</sub> Sensor (If applicable)	L	1.0V	0V	General Description and Operation, Heated O <sub>2</sub> Sensor
F16	Power Steering Pressure Switch Input	G/Y	12V	14V	General Description and Operation, PSP

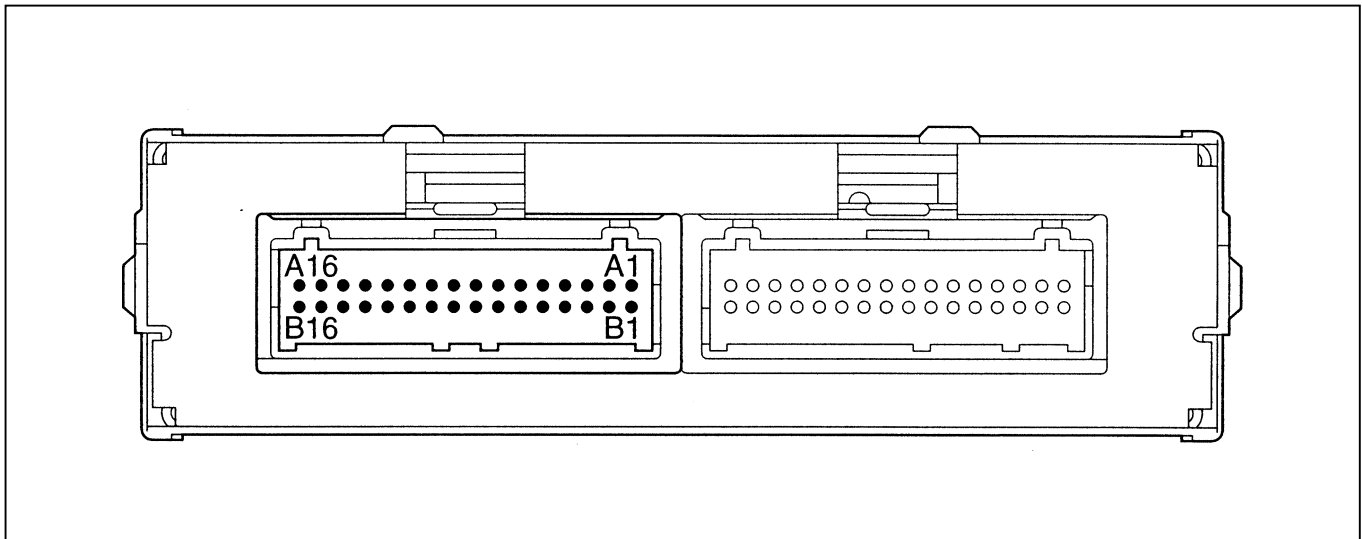
## ECM PINOUTS

ECM Pinout Table, 32-Pin Red Connector-Row "J2"



PIN	PIN Function	Wire Color	IGN ON	ENG RUN	Refer To
A1	Power Ground A	B/R	0.0V	0V	Appropriate Sensor
A2	Sensor Ground B	B/L	0.0V	0V	Appropriate Sensor
A3	5 Volt Reference Signal	R	5.0V	5V	Appropriate Sensor
A4	Battery Feed	R/W	12V	14V	Chassis Electrical
A5	Battery	R/W	12V	14V	Chassis Electrical
A6	Injector #4 Cyl	G	0V	14V	General Description and Operation, Fuel Injector
A7	Injector #1 Cyl	G/W	0V	14V	General Description and Operation, Fuel Injector
A8	Injector #3 Cyl	G/B	0V	14V	General Description and Operation, Fuel Injector
A9	Inject #2 Cyl	G/R	0V	14V	General Description and Operation, Fuel Injector
A10	Not Used	-	-	-	-
A11	Not Used	-	-	-	-
A12	Not Used	-	-	-	-
A13	Fuel Pump Relay	G/W	12V	0V	On-Vehicle Service Fuel Pump Relay
A14	Charcoal Canister Purge Solenoid Valve (If applicable)	R/L	12V	14V	-
A15	Not Used	-	-	-	-
A16	A/C Clutch	W/R	0V	0V	-

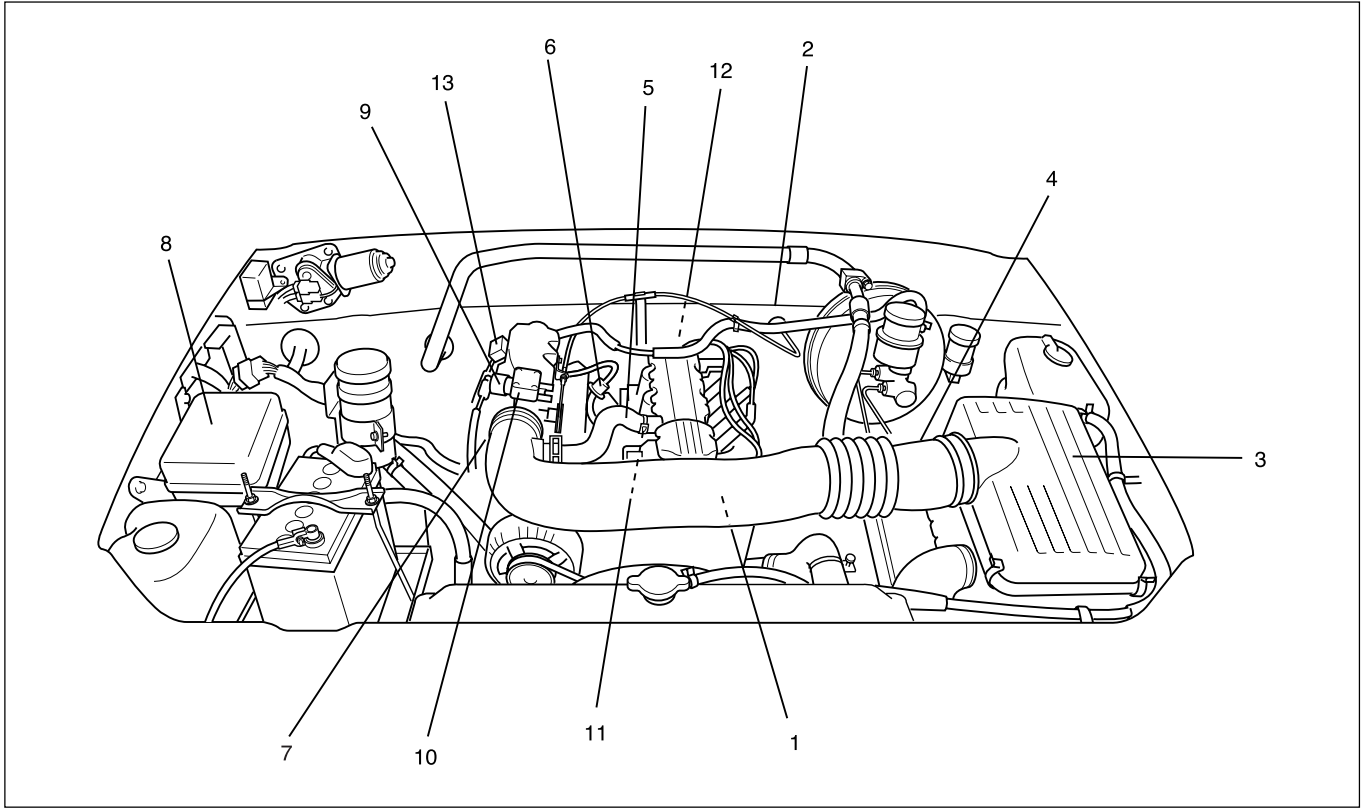
**ECM Pinout Table, 32-Pin Red Connector-Row "J2"**



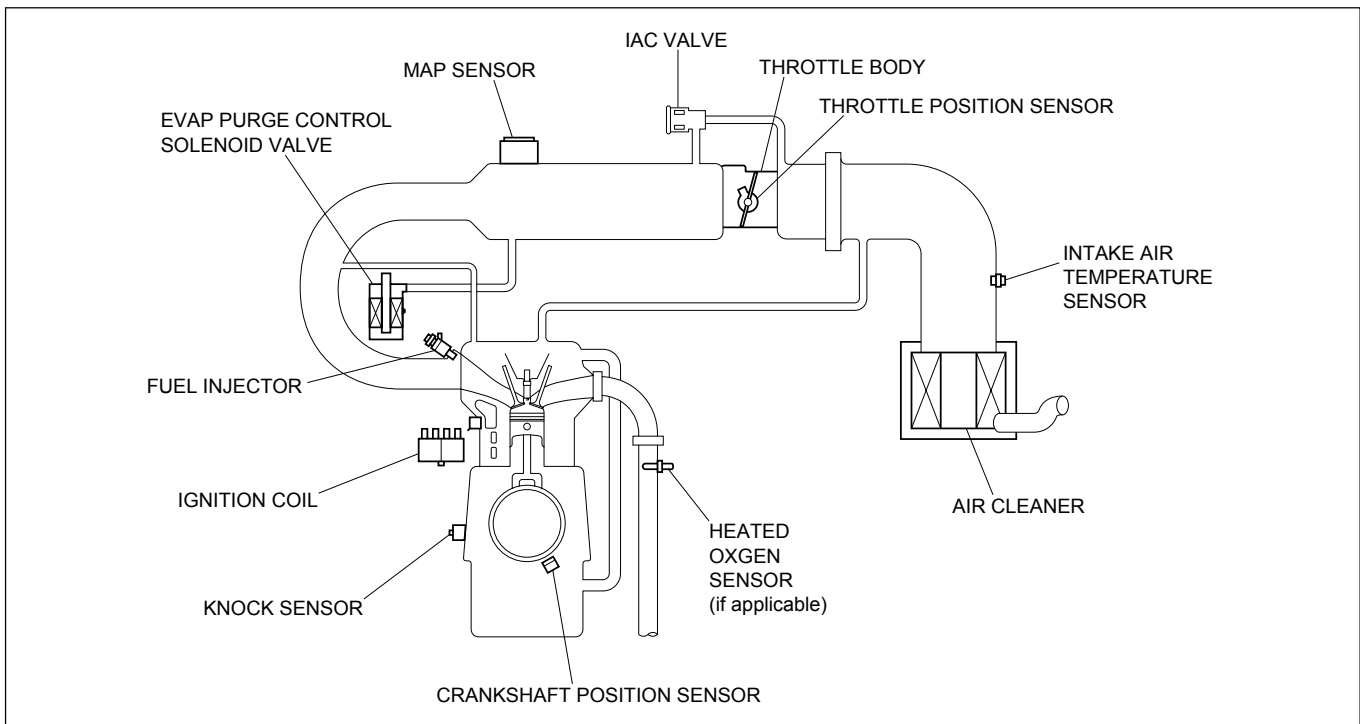
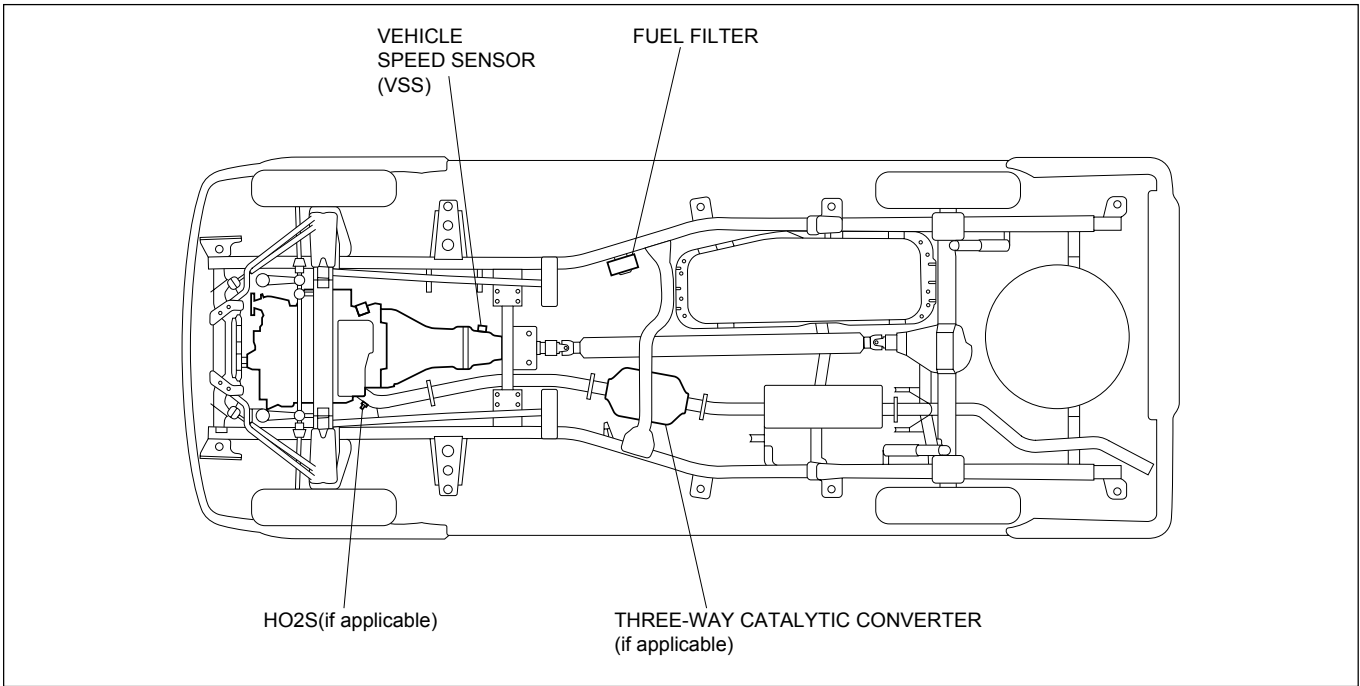
PIN	PIN Function	Wire Clotr	IGN ON	ENG RUN	Rdfer To
B1	TPS 5 Volt Reference Signal A	G	0V	0V	Appropriate Sensor
B2	TPS 5 Volt Reference Signal B	G	0V	0V	Appropriate Sensor
B3	Not Used	-	-	-	-
B4	Check Engine Lamp	R/Y	0V	14V	Chassis Electrical
B5	Tacho-meter Signal	B/R	12V	8-10V	General Description and Operation
B6	Not Used	-	-	-	-
B7	Map Input	W	5.0V (0V=10kpa)	1.0V (5V=104kpa)	General Description and Operation, Manifold Absolute Sensor
B8	Throttle Position Sensor	B	1.0V	1.0V	General Description and Operation, TPS
B9	Not Used	-	-	-	-
B10	A/C Request Signal	G/B	0V	0V	-
B11	DLC (Digital Input)	B/W	12V	14V	Diagnosis, Serial Data
B12	Not Used	-	-	-	-
B13	IAC "B" High	L/R	1V	1V	General Description and Operation, IAC
B14	IAC "B" Low	L/B	11V	13V	General Description and Operation, IAC
B15	IAC "A" Low	L/W	1V	1V	General Description and Operation, IAC
B16	IAC "A" High	L	11V	13V	General Description and Operation, IAC



# COMPONENT LOCATOR



**6E1-40 DRIVEABILITY AND EMISSIONS**



### Engine Component Locator Table

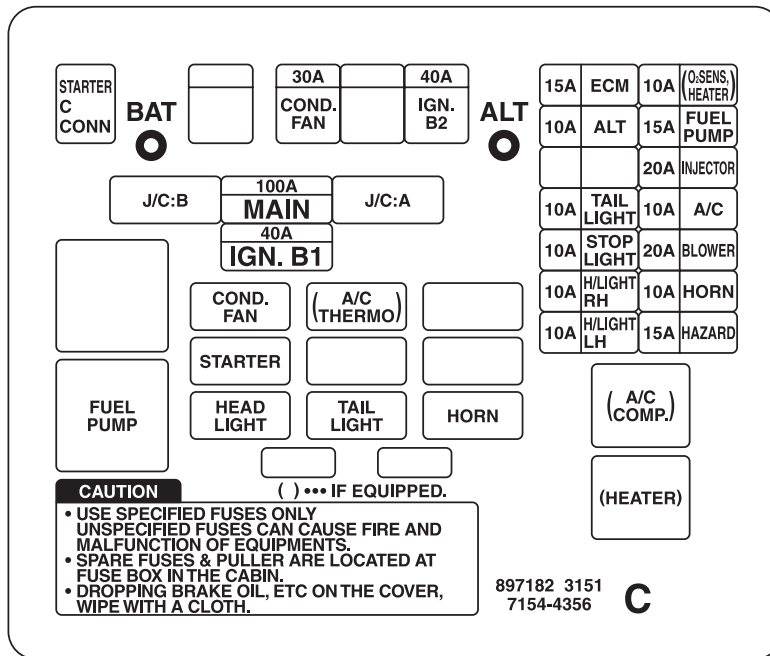
Number	Name	Location
1	Engine Coolant Temperature (ECT) Sensor	Front of engine, next to the thermostat housing
2	Heated Oxygen Sensor (HO2S)	On the exhaust pipe, left side of engine, immediately behind the exhaust manifold
3	Air Cleaner	Left front the engine bay
4	Intake Air Temperature (IAT) Sensor	On the intake air duct near the air cleaner
5	Positive Crankcase Ventilation (PCV) Port	On the right front corner of the valve cover
6	Fuel Pressure Regulator	On the rear end of the fuel rail
7	Throttle Body	Between the intake air duct and the intake manifold
8	Fuse/Relay Box	Along the inside of the right fender
9	Throttle Position (TP) Sensor	On the front of the throttle body
10	Idle Air Control (IAC) Valve	Under the TP sensor
11	EVAP Canister Purge Control Solenoid	On the intake manifold
12	Ignition Coil	Above the starter motor
13	Manifold Absolute Pressure (MAP) Sensor	Bolted to the front edge of the intake manifold, under the fuel rail
*14	EVAP Canister	On the left side Tire house
*15	Check and Relief valve	On the canister hold brace

\* If applicable

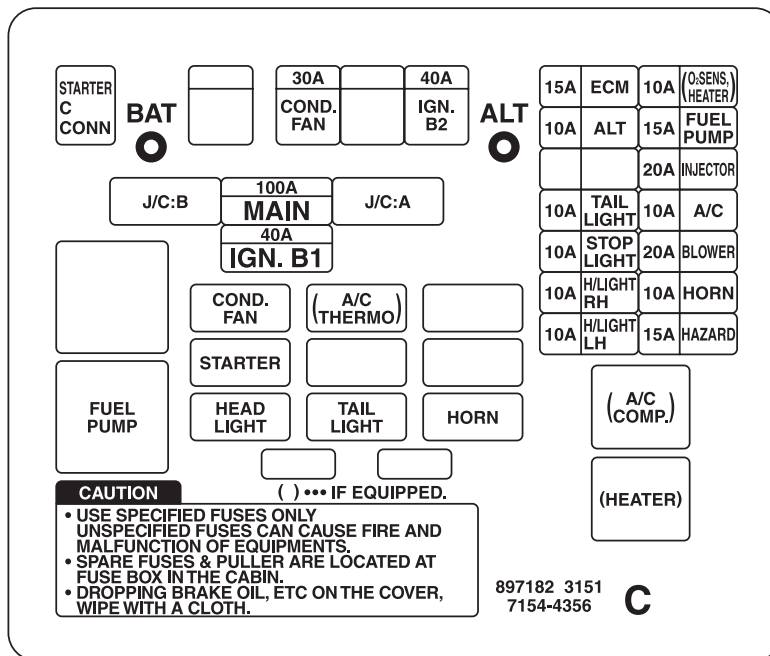
### Undercarriage Component Locator Table

Name	Location
Fuel Pump Assembly	Installed in the top of the fuel tank
EVAP Purge Control Solenoid Valve	At the right rear of the engine
Vehicle Speed Sensor (VSS)	Protrudes from the right side of the transmission housing, rear the output shaft
Crankshaft Position (CKP) Sensor	Lower left hand front of engine, behind power steering pump bracket

## UNDERHOOD (U/H) FUSE AND RELAY PANEL



## INSTRUMENT PANEL (I/P) FUSE BLOCK



# DIAGNOSIS

## STRATEGY-BASED DIAGNOSTICS

### STRATEGY-BASED DIAGNOSTICS

The strategy-based diagnostic is a uniform approach to repair all Electrical/Electronic (E/E) systems. The diagnostic flow can always be used to resolve an E/E system problem and is a starting point when repairs are necessary. The following steps will instruct the technician how to proceed with a diagnosis:

1. Verify the customer complaint.
  - To verify the customer complaint, the technician should know the normal operation of the system.
2. Perform preliminary checks.
  - Conduct a thorough visual inspection.
  - Review the service history.
  - Detect unusual sounds or odors.
  - Gather diagnostic trouble code information to achieve an effective repair.
3. Check bulletins and other service information.
  - This includes videos, newsletters, etc.
4. Refer to service info (manual) system check(s).
  - “System checks” contain information on a system that may not be supported by one or more DTCs. System checks verify proper operation of the system. This will lead the technician in an organized approach to diagnostics.
5. Refer to service diagnostics.

### DTC STORED

Follow the designated DTC chart exactly to make an effective repair.

### NO DTC

Select the symptom from the symptom tables. Follow the diagnostic paths or suggestions to complete the repair. You may refer to the applicable component/system check in the system checks.

### NO MATCHING SYMPTOM

1. Analyze the complaint.
2. Develop a plan for diagnostics.
3. Utilize the wiring diagrams and the theory of operation.

Call technical assistance for similar cases where repair history may be available. Combine technician knowledge with efficient use of the available service information.

### INTERMITTENTS

Conditions that are not always present are called intermittents. To resolve intermittents, perform the following steps:

1. Observe DTCs and DTC modes
2. Evaluate the symptoms and the conditions described by the customer.
3. Use a check sheet or other method to identify the circuit or electrical system component.
4. Follow the suggestions for intermittent diagnosis found in the service documentation.

Most Scan Tools, such as the Tech 2 and the 5-8840-2392-0, have data-capturing capabilities that can assist in detecting intermittents.

### NO TROUBLE FOUND

This condition exists when the vehicle is found to operate normally. The condition described by the customer may be normal. Verify the customer complaint against another vehicle that is operating normally. The condition may be intermittent. Verify the complaint under the conditions described by the customer before releasing the vehicle.

1. Re-examine the complaint.
 

When the complaint cannot be successfully found or isolated, a re-evaluation is necessary. The complaint should be re-verified and could be intermittent as defined in *Intermittents*, or could be normal.
2. Repair and verify.
 

After isolating the cause, the repairs should be made. Validate for proper operation and verify that the symptom has been corrected. This may involve road testing or other methods to verify that the complaint has been resolved under the following conditions:

- Conditions noted by the customer.
- If a DTC was diagnosed, verify a repair by duplicating conditions present when the DTC was set as noted in the customer complaint.

### VERIFYING VEHICLE REPAIR

Verification of the vehicle repair will be more comprehensive for vehicles with OBD system diagnostics. Following a repair, the technician should perform the following steps:

Important: Follow the steps below when you verify repairs on OBD systems. Failure to follow these steps could result in unnecessary repairs.

1. Review and record the customer complaint for the DTC which has been diagnosed.
2. Clear the DTC(s).
3. Operate the vehicle within conditions noted in the customer complaint.
4. Monitor the DTC status information for the specific DTC which has been diagnosed until the diagnostic test associated with that DTC runs.

## GENERAL SERVICE INFORMATION

### OBD SERVICEABILITY ISSUES

#### Fuel Quality

Fuel quality is not a new issue for the automotive industry. The Reid Vapor Pressure of the fuel can also create problems in the fuel system, especially during the spring and fall months when severe ambient temperature swings occur. A high Reid Vapor Pressure could show up as a rich DTC due to excessive canister loading. High vapor pressures generated in the fuel tank can also affect the Evaporative Emission diagnostic as well.

Using fuel with the wrong octane rating for your vehicle may cause driveability problems. Many of the major fuel companies advertise that using "premium" gasoline will improve the performance of your vehicle. Most premium fuels use alcohol to increase the octane rating of the fuel. Although alcohol-enhanced fuels may raise the octane rating, the fuel's ability to turn into vapor in cold temperatures deteriorates. This may affect the starting ability and cold driveability of the engine.

Low fuel levels can lead to fuel starvation, lean engine operation, and eventually engine misfire.

#### Non-OEM Parts

All of the OBD diagnostics have been calibrated to run with OEM parts. Small leaks in the exhaust system

near the heated oxygen sensor can also cause the MIL ("Check Engine" lamp) to turn on.

Aftermarket electronics, such as cellular phones, stereos, and anti-theft devices, may radiate EMI into the control system if they are improperly installed. This may cause a false sensor reading and turn on the MIL ("Check Engine" lamp).

#### Poor Vehicle Maintenance

The sensitivity of OBD diagnostics will cause the MIL ("Check Engine" lamp) to turn ON if the vehicle is not maintained properly. Restricted air filters, fuel filters, and crankcase deposits due to lack of oil changes or improper oil viscosity can trigger actual vehicle faults. Poor vehicle maintenance can not be classified as a "non-vehicle fault", but with the sensitivity of OBD diagnostics, vehicle maintenance schedules must be more closely followed.

#### Related System Faults

Many of the OBD system diagnostics will not run if the ECM detects a fault on a related system or component. One example would be that if the ECM detected a Evap. Purge Solenoid fault, The diagnosis on the Oxygen Sensor (If applicable) would be suspended until the Evap. Purge Solenoid repaired. If this happened, the customer may have to make two trips to the dealership in order to repair the vehicle.

### MAINTENANCE SCHEDULE

Refer to the *Maintenance Schedule*.

### VISUAL/PHYSICAL ENGINE COMPARTMENT INSPECTION

Perform a careful visual and physical engine compartment inspection when performing any diagnostic procedure or diagnosing the cause of an emission test failure. This can often lead to repairing a problem without further steps. Use the following guidelines when performing a visual/physical inspection:

- Inspect all vacuum hoses for punches, cuts, disconnects, and correct routing.
- Inspect hoses that are difficult to see behind other components.
- Inspect all wires in the engine compartment for proper connections, burned or chafed spots, pinched wires, contact with sharp edges or contact with hot exhaust manifolds or pipes.

## BASIC KNOWLEDGE OF TOOLS REQUIRED

**Notice:** Lack of basic knowledge of this powertrain when performing diagnostic procedures could result in an incorrect diagnosis or damage to powertrain components. Do not attempt to diagnose a powertrain problem without this basic knowledge.

A basic understanding of hand tools is necessary to effectively use this section of the Service Manual.

## SERIAL DATA COMMUNICATIONS

This vehicle utilizes the serial data communication system. Each bit of information can have one of two lengths: long or short. This allows vehicle wiring to be reduced by transmitting and receiving multiple signals over a single wire. The messages carried on serial data streams are also prioritized. If two messages attempt to establish communications on the data line at the same time, only the message with higher priority will continue. The device with the lower priority message must wait. For more information on this system of coding, refer to *Decimal/ Binary/ Hexadecimal Conversions*. On this vehicle the Scan Tool displays the actual values for vehicle parameters. It will not be necessary to perform any conversions from coded values to actual values.

# ON-BOARD DIAGNOSTIC (OBD)

## ON-BOARD DIAGNOSTIC TESTS

Miscellaneous Test:

A miscellaneous test is a kind of the On-Board Diagnostics.

Using a tech 2, the miscellaneous test can be conducted, followings are brief description about the miscellaneous tests.

To perform the miscellaneous test, allows the displayed menu on the tech 2. Sub-menu of miscellaneous test are as follows.

- Check powertrain lamp:  
This test allows to turn on and off the powertrain warning lamp in the instrument cluster.

- Fuel Pump:  
Fuel pump test allows to turn on and off the fuel pump.  
If turned off while the engine is running, the engine will stall.
- A/C Clutch:  
The A/C Clutch test allows to turn on and off the airconditioning.
- Canister Purge Control Solenoid Valve:  
This function takes control of the canister purge control solenoid valve.  
The on command represents a 100% pwm, the off command a 0% pwm.
- IAC (Idle Air Control) System:
  - RPM control  
This function allows the user to slew the desired RPM via increments of 25 RPM with a minimum of 600 RPM and a maximum of 2000 RPM.  
The start value will be at 1150 RPM.
  - IAC Control  
This function allows the user to slew the IAC via increments of 25 steps with a minimum of 0 steps and a maximum of 250 steps.  
The start value will be at idle steps.
  - IAC Reset  
The user will have the ability to perform an IAC reset.  
Each keypress will actuate the command to reset.
- Fuel Trim Reset:  
This function allows the user to command the ECM to perform an Long Term Fuel Trim reset, also known as a Block Learn Memory reset.  
Each keypress will actuate the command to reset.
- Fueling Mode:  
This function provides the user with the ability to enable or disable closed loop fuel control.
- Air Fuel Ratio:  
This function allows the user to slew the control state of the A/F ratio within a minimum of 11.7:1 and a maximum of 17.7:1.  
The test starts at an A/F ratio of 14.7 : 1.  
The incremental control is 0.5 steps per keypress.

## COMPREHENSIVE COMPONENT MONITOR DIAGNOSTIC OPERATION

Comprehensive component monitoring diagnostics are involved to monitor emissions-related input and output engine components.

### Input Components:

Input components are monitored for circuit continuity and out-of-range values. This includes rationality checking. Rationality checking refers to indicating a fault when the signal from a sensor does not seem reasonable, i.e. Throttle Position (TP) sensor that indicates high throttle position at low engine loads or MAP voltage). Input components may include, but are not limited to the following sensors:

- Vehicle Speed Sensor (VSS)
- Crankshaft Position (CKP) sensor
- Throttle Position (TP) sensor
- Engine Coolant Temperature (ECT) sensor
- Intake Air Temperature Sensor (IAT)
- Manifold Absolute Pressure (MAP) sensor

In addition to the circuit continuity and rationality check the ECT sensor is monitored for its ability to achieve a steady state temperature to enable “Closed Loop” fuel control (If applicable).

### Output Components:

Output components are diagnosed for proper response to control module commands. Components where functional monitoring is not feasible will be monitored for circuit continuity and out-of-range values if applicable.

Output components to be monitored include, but are not limited to the following circuit:

- Idle Air Control (IAC) Motor
- EVAP Canister Purge Valve Solenoid
- A/C relays
- VSS output
- MIL control

Refer to *ECM and Sensors in General Descriptions*.

### Passive and Active Diagnostic Tests

A passive test is a diagnostic test which simply monitors a vehicle system or component. Conversely, an active test, actually takes some sort of action when performing diagnostic functions, often in response to a failed passive test.

### Intrusive Diagnostic Tests

This is any on-board test run by the Diagnostic Management System which may have an effect on vehicle performance or emission levels.

### Warm-Up Cycle

A warm-up cycle means that engine at temperature must reach a minimum of 70°C(160°F) and rise at least 22°C(40°F) over the course of a trip.

## COMMON OBD TERMS

### Diagnostic For Closed Loop System:

When used as a noun, the word diagnostic refers to any on-board test run by the vehicle's Diagnostic Management System. A diagnostic is simply a test run on a system or component to determine if the system or component is operating according to specification.

### For Closed Loop System:

There are many diagnostics, shown in the following list:

- Oxygen sensors
- Oxygen sensor heaters

### Enable Criteria

The term “enable criteria” is engineering language for the conditions necessary for a given diagnostic test to run. Each diagnostic has a specific list of conditions which must be met before the diagnostic will run. “Enable criteria” is another way of saying “conditions required” .

The enable criteria for each diagnostic is listed on the first page of the DTC description under the heading “Conditions for Setting the DTC” . Enable criteria varies with each diagnostic, and typically includes, but is not limited to the following items:

- engine speed
- vehicle speed
- ECT
- MAP
- IAT
- TP
- high canister purge (If applicable)
- A/C ON

### Trip

Technically, a trip is a key on-run-key off cycle in which all the enable criteria for a given diagnostic are met, allowing the diagnostic to run. Unfortunately, this concept is not quite that simple. A trip is official when all the enable criteria for a given diagnostic are met. But because the enable criteria vary from one diagnostic to another, the definition of trip varies as well. Some diagnostics are run when the vehicle is at operating temperature, some when the vehicle first start up; some require that the vehicle be cruising at a steady highway speed, some run only when the vehicle is at idle. Some run only immediately following a cold engine start-up.

A trip then, is defined as a key on-run-key off cycle in which the vehicle was operated in such a way as to



satisfy the enabled criteria for a given diagnostic, and this diagnostic will consider this cycle to be one trip. However, another diagnostic with a different set of enable criteria (which were not met) during this driving event, would not consider it a trip. No trip will occur for that particular diagnostic until the vehicle is driven in such a way as to meet all the enable criteria

## THE DIAGNOSTIC EXECUTIVE

The Diagnostic Executive is a unique segment of software which is designed to coordinate and prioritize the diagnostic procedures as well as define the protocol for recording and displaying their results. The main responsibilities of the Diagnostic Executive are listed as follows:

- Commanding the MIL("Check Engine" lamp) ON and OFF
- DTC logging and clearing
- Current status information ON each diagnostic

The Diagnostic Executive records DTCs and turns ON the MIL when emission-related faults occur. It can also turn OFF the MIL if the conditions cease which caused the DTC to set.

### Diagnostic Information

The diagnostic charts and functional checks are designed to locate a faulty circuit or component through a process of logical decisions. The charts are prepared with the requirement that the vehicle functioned correctly at the time of assembly and that there are not multiple faults present.

There is a continuous self-diagnosis on certain control functions. This diagnostic capability is complimented by the diagnostic procedures contained in this manual. The language of communicating the source of the malfunction is a system of diagnostic trouble codes. When a malfunction is detected by the control module, a diagnostic trouble code is set and the Malfunction Indicator Lamp (MIL)("Check Engine" lamp) is illuminated.

### Malfunction Indicator Lamp (MIL)

The Malfunction Indicator Lamp (MIL) looks the same as the MIL you are already familiar with ("Check Engine" lamp).

Basically, the MIL is turned ON when the ECM detects a DTC.

### Extinguishing the MIL

The MIL ("Check Engine" lamp) is on the instrument panel and has the following functions:

- It informs the driver that a fault that affects vehicle emission levels has occurred and that the vehicle should be taken for service as soon as possible.
- As a bulb and system check, the MIL will come on with the key on and the engine not running. When the engine is started, the MIL will turn OFF.
- When the MIL remains on while the engine is running, or when a malfunction is suspected due to a driveability or emissions problem, a Powertrain On-Board Diagnostic (OBD) System Check must be performed. The procedures for these checks are given in On-Board Diagnostic (OBD) System Check. These checks will expose faults which may not be detected if other diagnostics are performed first.

Once the ECM determines that a fault(s) has been rectified then the MIL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

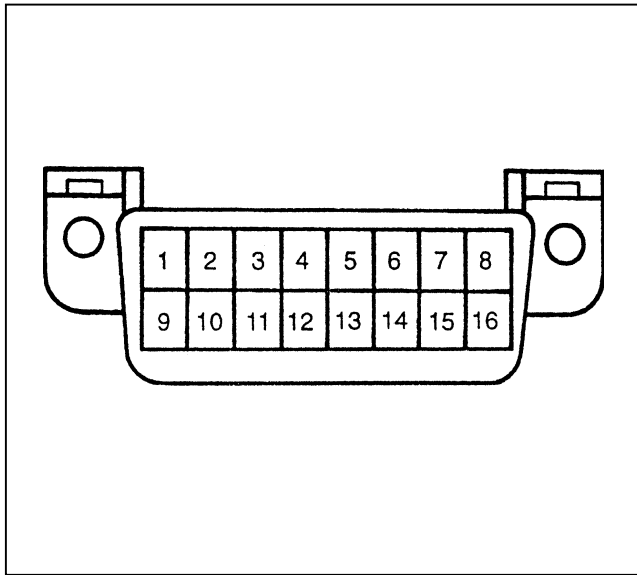
1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

*Refer to clearing Diagnostic Trouble Code*

### Data Link Connector (DLC)

The Provision for communicating with the control module is the Data Link Connector (DLC). It is located at the lower left of the instrument panel behind a small square cover. The DLC is used to connect to a Scan Tool. Some common uses of the Scan Tool are listed below:

- Identifying stored Diagnostic Trouble Codes (DTCs)
- Clearing DTCs
- Performing output control tests
- Reading serial data



### Reading Flash Diagnostic Trouble Codes

The provision for communicating with the Engine Control Module (ECM) is the Data Link Connector (DLC). The DLC is located behind the lower front instrument panel. It is used in the assembly plant to receive information in checking that the engine is operating properly before it leaves the plant.

The diagnostic trouble code(s) (DTCs) stored in the ECM's memory can be read either through a handheld diagnostic scanner plugged into the DLC or by counting the number of flashes of the "Check Engine" Malfunction Indicator Lamp (MIL) when the diagnostic test terminal of the DLC is grounded. The DLC terminal "6" (diagnostic request) is pulled "Low" (grounded) by jumpering to DLC terminal "5", which is a ground wire.

This will signal the ECM that you want to "flash" DTC(s), if any are present. Once terminals "5" and "6" have been connected, the ignition switch must be moved to the "ON" position, with the engine not running. At this point, the "Check Engine" MIL should flash DTC12 three times consecutively.

This would be the following flash, sequence: "flash, pause, flash-flash, long pause, flash, pause, flash-flash, long pause, flash, pause, flash-flash". DTC12 indicates that the ECM's diagnostic system is operating. If DTC12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the appropriate diagnostic chart in DRIVEABILITY AND EMISSIONS.

Following the output of DTC12, the "Check Engine" MIL will indicate a DTC three times if a DTC is present, or it will simply continue to output DTC12. If

more than one DTC three has been stored in the ECM's memory, the DTC(s) will be output from the lowest to the highest, with each DTC being displayed three times.

### Reading Diagnostic Trouble Codes Using a TECH 2

The procedure for reading diagnostic trouble code(s) is to use a diagnostic Tech 2. When reading DTC(s), follow instructions supplied by Tech 2 manufacturer.

### Clearing Diagnostic Trouble Codes

**IMPORTANT:** Do not clear DTCs unless directed to do so by the service information provided for each diagnostic procedure.

If the fault that caused the DTC to be stored into memory has been corrected, the Diagnostic Executive will begin to count the "warm-up" cycles with no further faults detected, the DTC will automatically be cleared from the ECM memory.

To clear Diagnostic Trouble Codes (DTCs), use the Tech 2 "clear DTCs" or "clear information" function. When clearing DTCs follow instructions supplied by the Tech 2 manufacturer.

When a Tech 2 is not available, DTCs can also be cleared by disconnecting *one* of the following sources for at least thirty (30) seconds.

NOTE: To prevent system damage, the ignition key must be "OFF" when disconnecting or reconnecting battery power.

- The power source to the control module. Examples: fuse, pigtail at battery ECM connectors etc.
- The negative battery cable. (Disconnecting the negative battery cable will result in the loss of other on-board memory data, such as preset radio tuning).

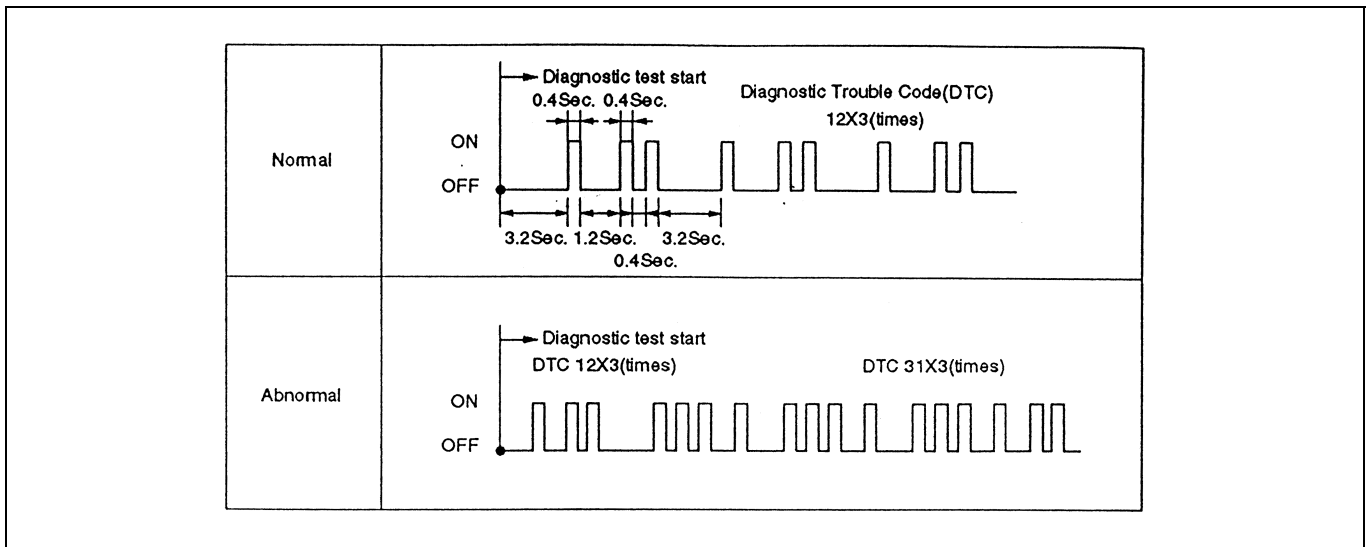
### On-Board Diagnosis (Self-Diagnosis)

1. The Engine Control Module (ECM) conducts a self-test of most of the wiring and components in the system each time the key is turned to ON, and can detect faults in the system while the key is ON. If a fault is detected, the ECM will store a trouble code in memory and flash the CHECK ENGINE indicator to alert the driver.
2. The Diagnostic Trouble Codes (DTC) can be displayed by shorting together terminals and of the

Data Link Connector (DLC) located behind front console.

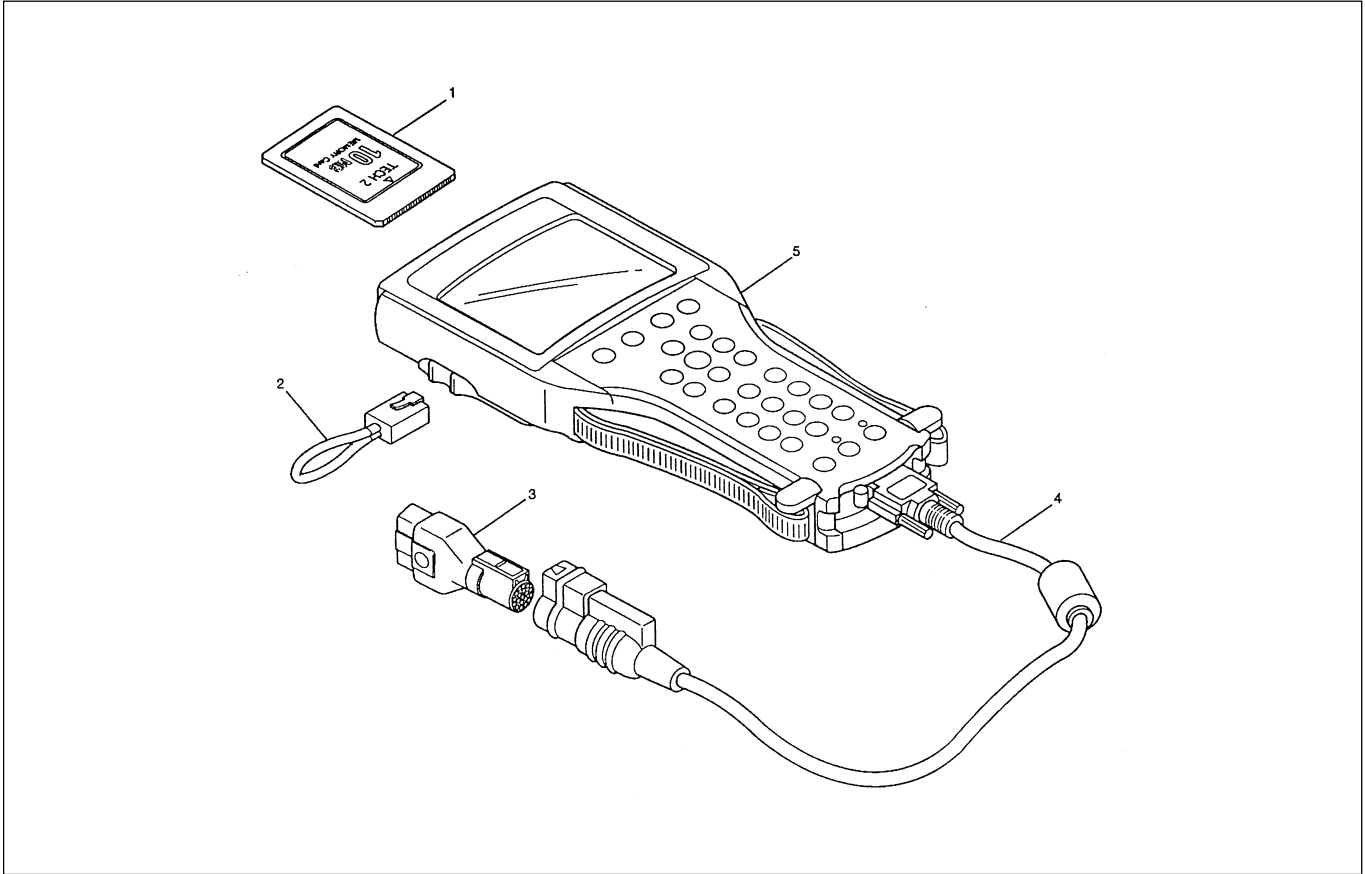
The CHECK ENGINE indicator will flash DTC 12 three times, followed by any DTC. If several DTC are stored, each DTC will be displayed three times. The DTC will be displayed in numerical order. The DTC display will continue as long as the DLC is shorted.

Some DTC can cause other DTC to be stored, It is important to diagnose and repair the lowest numbered DTC first before going on to the higher numbered DTC.



## Tech 2 Scan Tool

From 98 MY, Isuzu dealer service departments are recommended to use Tech 2. Please refer to Tech 2 user guide.



### Legend

(1) PCMCIA Card

(2) RS 232 Loop Back Connector

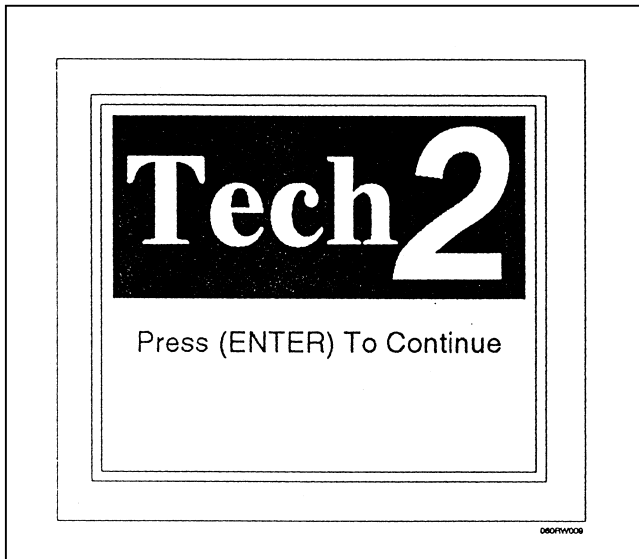
(3) SAE 16/19 Adaptor

(4) DLC Cable

(5) Tech-2

### Getting Started

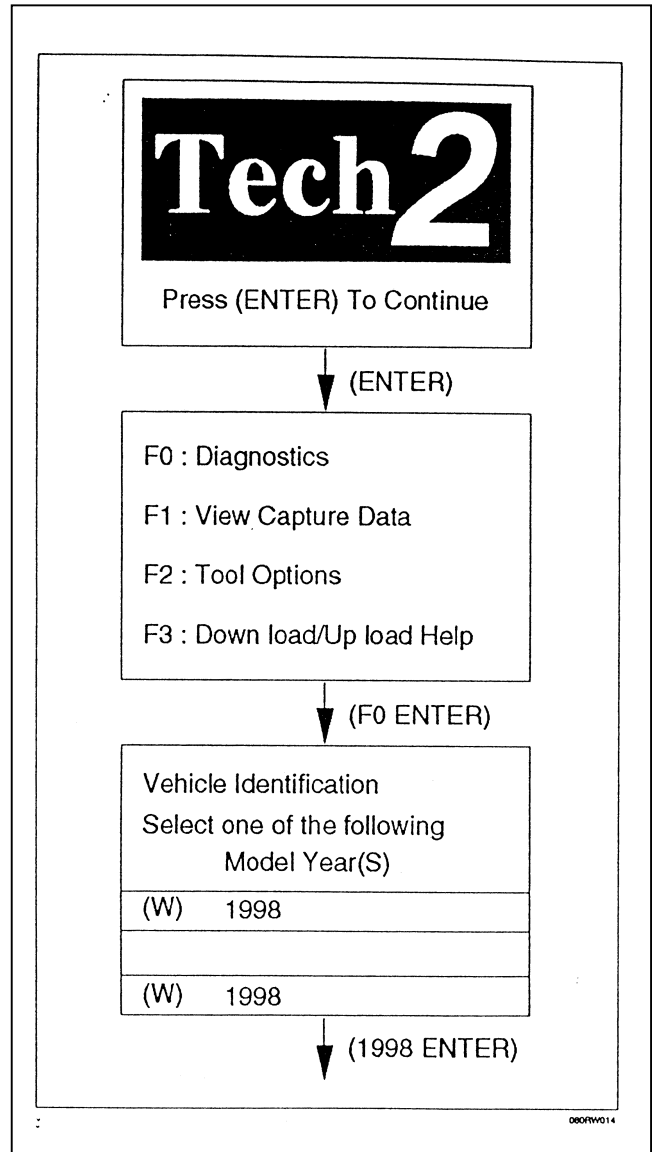
- Before operating the Isuzu PCMCIA card with the Tech 2, the following steps must be performed:
  1. The Isuzu 98 System PCMCIA card (1) inserts into the Tech 2 (5)
  2. Connect the SAE 16/19 adapter (3) to the DLC cable (4).
  3. Connect the DLC cable to the Tech 2 (5)
  4. Make sure the vehicle ignition is off.
  5. Connect the Tech 2 SAE 16/19 adapter to the vehicle DLC.
  6. The vehicle ignition turns on.
  7. Verify the Tech 2 power up display.

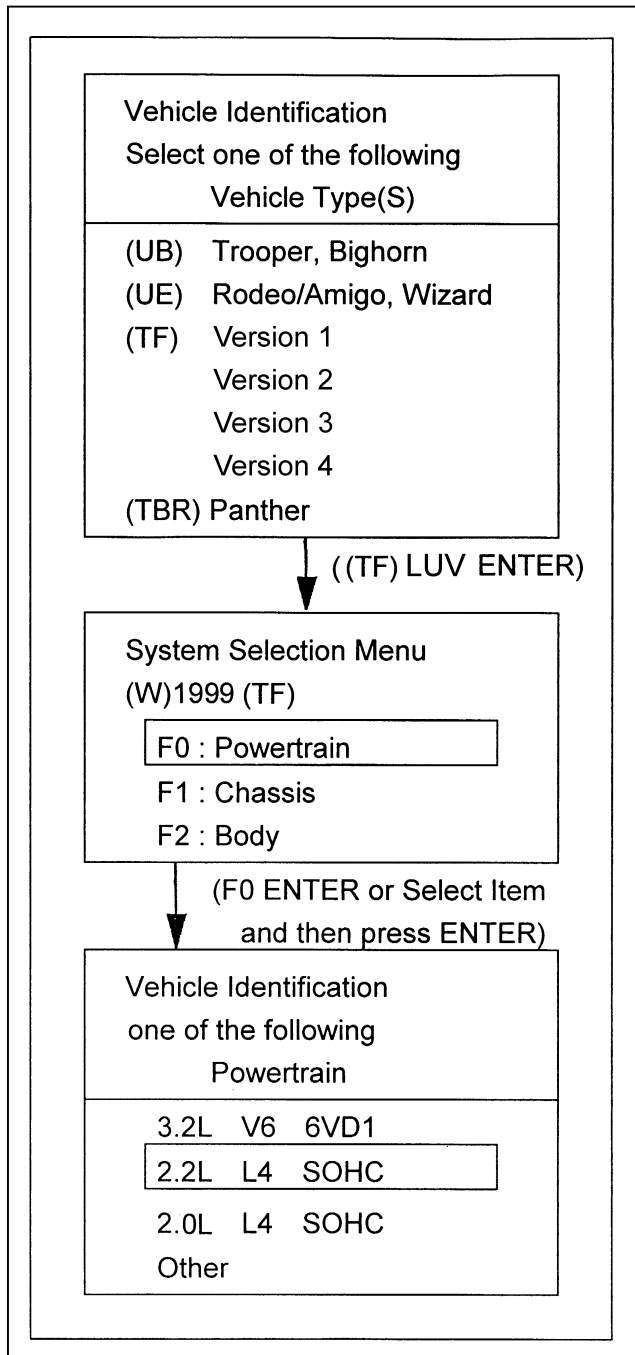


NOTE: The RS232 Loop back connector is only to use for diagnosis of Tech 2 and refer to user guide of the Tech 2.

### Operating Procedure

The power up screen is displayed when you power up the tester with the Isuzu systems PCMCIA card. Follow the operating procedure below.





**Menu**

- The following table shows, the Tech 2 menu structure.

F0: Diagnostic Trouble Codes F0: Read DTC Info Ordered By Priority F1: Clear DTC Information
F1: Data Display F0: Engine Data F2: O2 Sensor Data
F2: Snapshot F3: Miscellaneous Tests F0: Engine Check Light F1: Relays F1: A/C Relay F2: Fuel Pump Relay *F3: Low Fan Replay *F4: High Fan Replay F2: Canister Purge Solenoid F3: IAC System F1: RPM Control F2: IAC Control F3: IAC Reset F4: Fuel System F1: Fuel Trim Reset F2: Fueling Mode F7: Air Fuel Ratio

Note : \*F3 & F4 not applicable to TF models

Note: Selection Table

Applicable Version	Engine Displacement	Compression Ratio	Fuel Octane No. (RON)	Destination *Shows w/canister for EVAP. Emission control
Version 1	2.2L	8.6	80 Leaded/Un-Leaded	*Ecuador, *Gulf, China, Egypt, Kenya, Nigeria and Philippine
Version 2	2.2L	9.2	85 Leaded/Un-Leaded	Chile, Colombia, Guatemala and Costa Rica
Version 3	2.2L	9.2	91 Un-Leaded	*Australia, *New Zealand and South Africa
Version 4	2.0L	8.8	91 Leaded/Un-Leaded	South Africa

## VERIFYING VEHICLE REPAIR

Verification of vehicle repair will be more comprehensive for vehicles with OBD system diagnostics. Following a repair, the technician should perform the following steps:

1. Review and record the customer complaint for the DTC which has been diagnosed.
2. Clear DTC(s).
3. Operate the vehicle within conditions noted in the customer complaint.
4. Monitor the DTC status information for the specific DTC which has been diagnosed until the diagnostic test associated with that DTC runs.

*Following these steps are very important in verifying repairs on OBD systems. Failure to follow these steps could result in unnecessary repairs.*

## READING DIAGNOSTIC TROUBLE CODES USING A SCAN TOOL

The procedure for reading diagnostic trouble code(s) is to use a diagnostic Scan Tool. When reading DTC(s), follow instructions supplied by tool manufacturer.

### Clearing Diagnostic Trouble Codes

**Important:** Do not clear DTCs unless directed to do so by the service information provided for each diagnostic procedure.

If the fault that caused the DTC to be stored into memory has been corrected, the Diagnostic Executive will begin to count the “warm-up” cycles with no further faults detected, the DTC will automatically be cleared from the ECM memory.

To clear Diagnostic Trouble Codes (DTCs), use the diagnostic Scan Tool “clear DTCs” or “clear information” function. When clearing DTCs follow instructions supplied by the tool manufacturer.

When a Scan Tool is not available, DTCs can also be cleared by disconnecting one of the following sources for at least thirty (30) seconds.

**Notice:** To prevent system damage, the ignition key must be OFF when disconnecting or reconnecting battery power.

- The power source to the control module. Examples: fuse, pigtail at battery ECM connectors etc.
- The negative battery cable. (Disconnecting the negative battery cable will result in the loss of other on-board memory data, such as preset radio tuning).

## DTC MODES

There are 2 options available in the Scan Tool DTC mode to display the enhanced information available. After selecting DTC, the following menu appears:

- DTC Info
- Clear DTC Info

The following is a brief description of each of the sub menus in DTC Info and Specific DTC. The order in which they appear here is alphabetical and not necessarily the way they will appear on the Scan Tool.

### DTC Information Mode

Use the DTC info mode to search for a stored DTC. Refer to “Diagnostic Trouble Codes” list.

### Clear DTC Information

The command for clearing DTC’s performs a complete reset of the ECM.

## PRIMARY SYSTEM-BASED DIAGNOSTICS

### PRIMARY SYSTEM-BASED DIAGNOSTICS

There are primary system-based diagnostics which evaluate system operation and its effect on vehicle emissions. The primary system-based diagnostics are listed below with a brief description of the diagnostic function:

### FUEL CONTROL HEATED OXYGEN SENSORS (IF APPLICABLE)

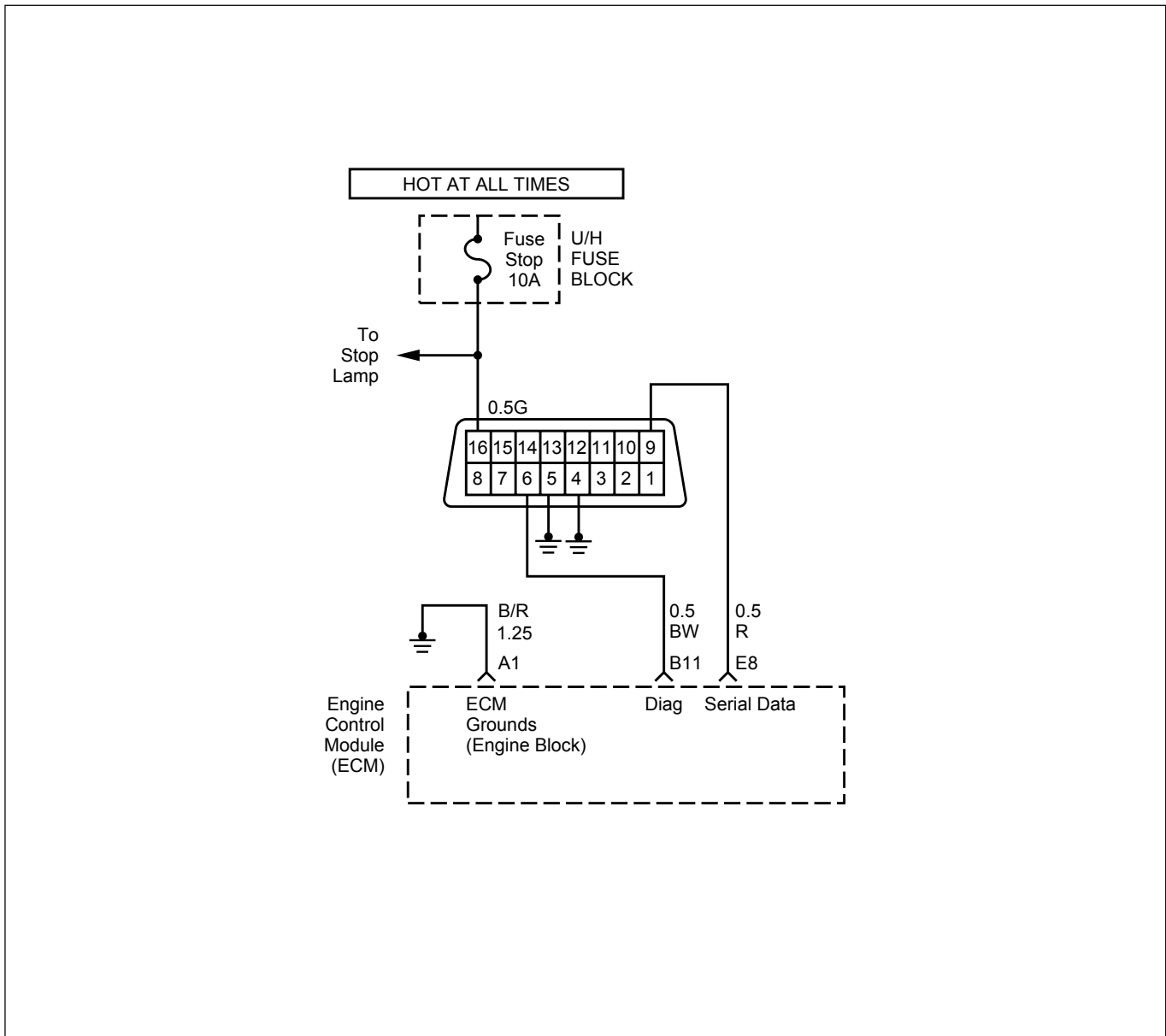
The main function of the fuel control heated oxygen sensors is to provide the control module with exhaust stream oxygen content information to allow proper fueling and maintain emissions within mandated levels. After it reaches operating temperature, the sensor will generate a voltage, inversely proportional to the amount of oxygen present in the exhaust gases. The control module uses the signal voltage from the fuel control heated oxygen sensors while in “Closed Loop” to adjust fuel injector pulse width. While in “Closed Loop”, the ECM can adjust fuel delivery to maintain an air/fuel ratio which allows the best combination of emission control and driveability. The fuel control heated oxygen sensors are also used to determine catalyst efficiency.

### HO2S HEATER

Heated oxygen sensors are used to minimize the amount of time required for “Closed Loop” fuel control to begin operation and to allow accurate catalyst monitoring. The oxygen sensor heater greatly decreases the amount of time required for fuel control sensor (HO2S) to become active.



## ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK



### Circuit Description

The on-board diagnostic system check is the starting point for any driveability complaint diagnosis. Before using this procedure, perform a careful visual/physical check of the ECM and engine grounds for cleanliness and tightness.

The on-board diagnostic system check is an organized approach to identifying a problem created by an electronic engine control system malfunction.

### Diagnostic Aids

An intermittent may be caused by a poor connection, rubbed-through wire insulation or a wire broken inside the insulation. Check for poor connections or a damaged harness. Inspect the ECM harness and

connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection, and damaged harness.

### Test Description

Number(s) below refer to the step number(s) on the Diagnostic Chart:

1. The MIL ("Check Engine" lamp) should be ON steady with the ignition ON/engine OFF. If not, isolate the malfunction in the MIL circuit.
2. Checks the serial data circuit and ensures that the ECM is able to transmit serial data.

## 6E1-56 DRIVEABILITY AND EMISSIONS

3. This test ensures that the ECM is capable of controlling the MIL and the MIL driver circuit is not shorted to ground.
4. If the engine will not start, the *Cranks But Will Not Run* chart should be used to diagnose the condition.
7. A Scan Tool parameter which is not within the typical range may help to isolate the area which is causing the problem.

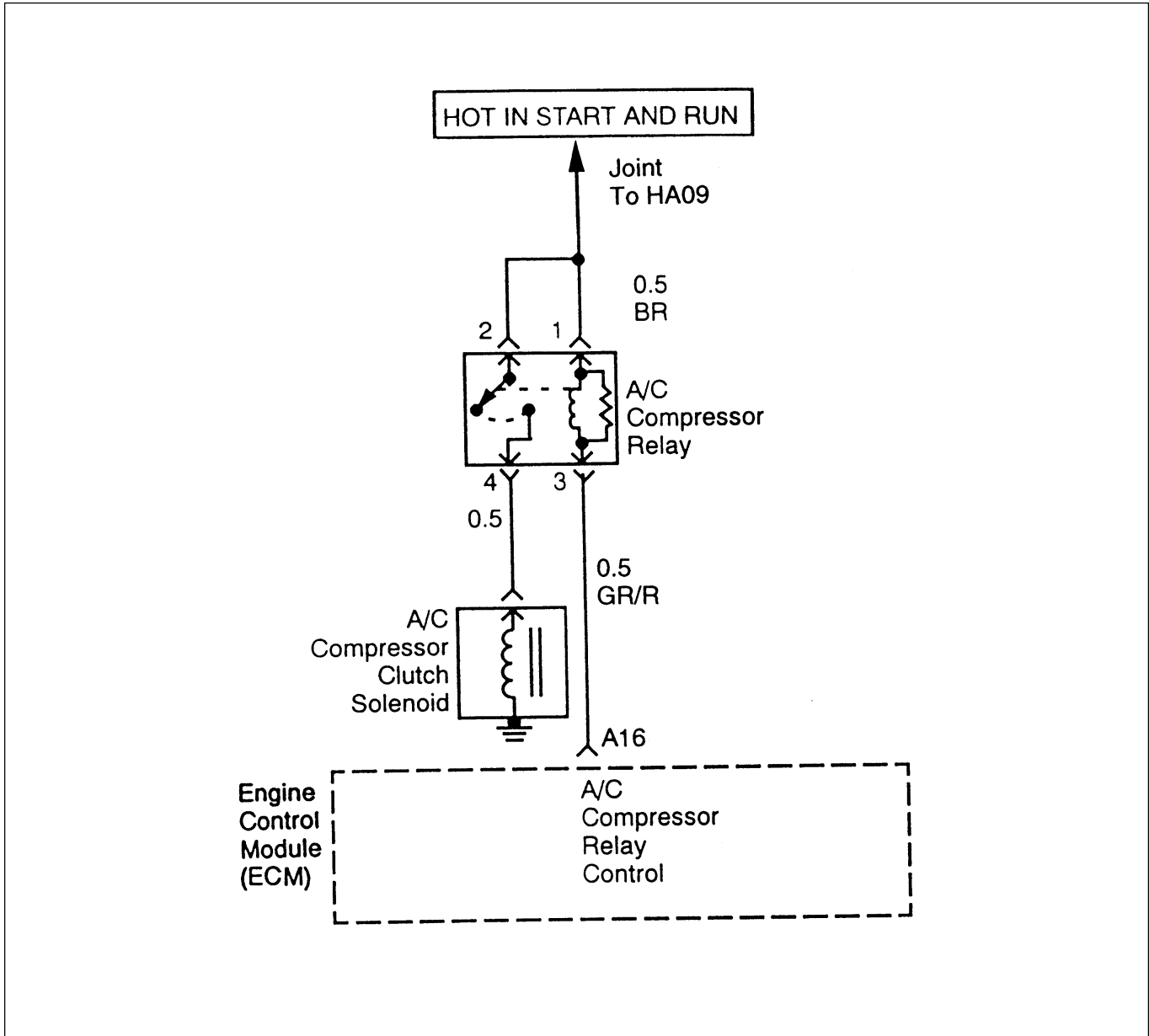
### On-Board Diagnostic (OBD) System Check

Step	Action	Value(s)	Yes	No
1	1. Ignition ON engine OFF. 2. Observe the malfunction indicator lamp (MIL or "Check Engine" lamp). Is the MIL ("Check Engine" lamp) ON?	-	Go to Step 2	Go to No MIL
2	1. Ignition OFF. 2. Install a Scan Tool. 3. Ignition ON. 4. Attempt to display ECM engine data with the Scan Tool. Does the Scan Tool display ECM data?	-	Go to Step 3	Go to Step 8
3	1. Using the Scan Tool output tests function, select MIL dash lamp control and command the MIL OFF. 2. Observe the MIL. Did the MIL turn OFF?	-	Go to Step 4	Go to MIL("Check Engine" Lamp) On Steady
4	Attempt to start the engine. Did the engine start and continue to run?	-	Go to Step 5	Go to Cranks But Will Not Run
5	Select "Display DTCs" with the Scan Tool. Are any DTCs stored?	-	Go to Step 6	Go to Step 7
6	Are two or more of the following DTCs stored? • 14 • 21 • 22 • 33 • 34 • 69	-	Go to "Multiple ECM Information Sensor DTCs Set"	Go to applicable DTC table
7	Compare ECM data values displayed on the Scan Tool to the typical engine scan data values. Are the displayed values normal or close to the typical values?	-	Go to Step 8	Refer to indicated Component System Checks
8	1. Ignition OFF, disconnect the ECM. 2. Ignition ON, engine OFF. 3. Check the serial data circuit for an open, short to ground, or short to voltage. Also, check the DLC ignition feed circuit for an open or short to ground and the DLC ground circuits for an open. 4. If a problem is found, repair as necessary. Was a problem found?	-	Go to Step 2	Go to Step 9

**On-Board Diagnostic (OBD) System Check (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
9	1. Refer to <i>Engine Control Module (ECM) in On-Vehicle Service</i> . 2. Attempt to display ECM data with the Scan Tool. Does the Scan Tool display ECM engine data?	-	Go to <i>Step 2</i>	Go to <i>Step 10</i>
10	Replace the EPROM or ECM. Note) Refer to 6E1-243	-	Verify Repair	-





## A/C CLUTCH CONTROL CIRCUIT DIAGNOSIS

### Circuit Description

When air conditioning and blower fan are selected, and if the system has a sufficient refrigerant charge, a 12-volt signal is supplied to the A/C request input of the engine control module (ECM). The A/C request signal may be temporarily canceled during system operation by the electronic thermostat in the evaporator case. The electronic thermostat may intermittently remove the control circuit ground for the A/C thermostat relay to prevent the evaporator from forming ice. When the A/C request signal is received by the ECM, the ECM supplies a ground from the compressor clutch relay if the engine operating

conditions are within acceptable ranges. With the A/C compressor relay energized, battery voltage is supplied to the compressor clutch coil.

The ECM will enable the compressor clutch to engage whenever A/C has been selected with the engine running, unless any of the following conditions are present:

- The throttle is greater than 95%.
- The engine speed is greater than 6000 RPM.
- The engine coolant temperature (ECT) is greater than 122°C(252°F).
- Fan switch is OFF.
- A/C request switch is OFF.

## 6E1-60 DRIVEABILITY AND EMISSIONS

- Thermo switch (FRT) is OFF.
- Pressure switch is OFF.
- Ignition switch is OFF.

### Diagnostic Aids

To diagnose an intermittent fault, check for the following conditions:

- Poor connection at the ECM-Inspect harness connections for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness-Inspect the wiring harness for damage; shorts to Ground, shorts to Battery Voltage, and Open circuits. If the harness appears

to be OK, observe the A/C clutch while moving connectors and wiring harnesses related to the A/C. A sudden clutch malfunction will indicate the source of the intermittent fault.

### A/C Clutch Diagnosis

This chart should be used for diagnosing the electrical portion of the A/C compressor clutch circuit. A Scan Tool will be used in diagnosing the system. The Scan Tool has the ability to read the A/C request input to the ECM. The Scan Tool can display when the ECM has commanded the A/C clutch ON. The Scan Tool should have the ability to override the A/C request signal and energize the A/C compressor relay.

### A/C Clutch Control Circuit Diagnosis

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	<ol style="list-style-type: none"> <li>1. Ignition ON, Engine OFF.</li> <li>2. Review and record the customer complaint.</li> <li>3. Operate the vehicle within the customer complaint conditions as noted.</li> <li>4. Using the Scan Tool, monitor "DTC" info for DTC 87 or 88.</li> </ol>	-	<i>Refer to Diagnostic Aids</i>	<i>Go to step 3</i>
3	<ol style="list-style-type: none"> <li>1. Ignition OFF.</li> <li>2. Remove the A/C Compressor Clutch Relay from the Underhood Electrical Center.</li> <li>3. Ignition ON, Engine OFF.</li> <li>4. Using a Digital Voltmeter (DVM), check for voltage on the Fused pins of the A/C Compressor Clutch Relay connector.</li> </ol> <p>Does the DVM read the following value?</p>	12 Volts	<i>Go to Step 5</i>	<i>Go to Step 4</i>
4	<p>Check the suspect circuit(s) between the A/C Compressor Clutch Relay connector and the Fuse for the following conditions:</p> <ul style="list-style-type: none"> <li>• A short to ground</li> <li>• An open circuit</li> <li>• A short to voltage</li> </ul> <p>Was the problem found?</p>	-	<i>Verify Repair</i>	-

**A/C Clutch Control Circuit Diagnosis (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
5	1. Ignition OFF. 2. Disconnect the Engine Control Module (ECM) connectors from the ECM. 3. Check the A/C Compressor Clutch Relay control circuit between the ECM and Underhood Electrical Center for the following conditions: <ul style="list-style-type: none"> <li>• A Short to ground</li> <li>• An open circuit</li> <li>• A short to voltage</li> </ul> Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 6</i>
6	1. Reinstall the A/C Compressor Clutch Relay. 2. Using a fused jumper, ground the A/C Compressor Clutch Relay control circuit at the ECM connector. 3. Ignition ON, Engine OFF. Does the A/C Compressor turn ON?	-	<i>Go to Step 9</i>	<i>Go to Step 7</i>
7	1. Ignition OFF. 2. Check the A/C Compressor Clutch circuit between the A/C Compressor Clutch Relay and A/C Compressor Clutch for the following conditions: <ul style="list-style-type: none"> <li>• A Short to ground</li> <li>• An open circuit</li> <li>• A short to voltage</li> </ul> Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 8</i>
8	Replace the A/C Compressor Clutch Relay. Is the action complete?	-	<i>Verify Repair</i>	-
9	Replace the EPROM or ECM.      Note) Refer to 6E1-243	-	-	-

## ELECTRONIC IGNITION SYSTEM DIAGNOSIS

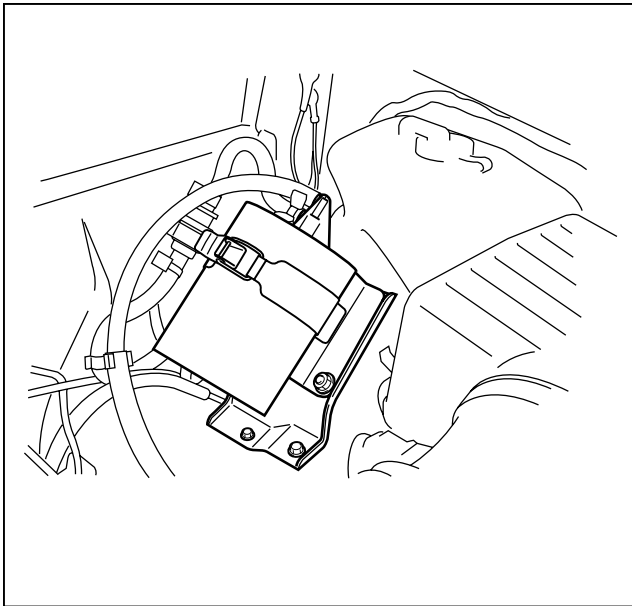
If the engine cranks but will not run or immediately stalls, the Engine Cranks But Will Not Start chart must be used to determine if the failure is in the ignition system or the fuel system. If DTC19, or DTC18 is set, the appropriate diagnostic trouble code chart must be used for diagnosis.

If a misfire is being experienced refer to the *Symptoms* section for diagnosis.

## EVAP CANISTER PURGE CONTROL SOLENOID (IF APPLICABLE)

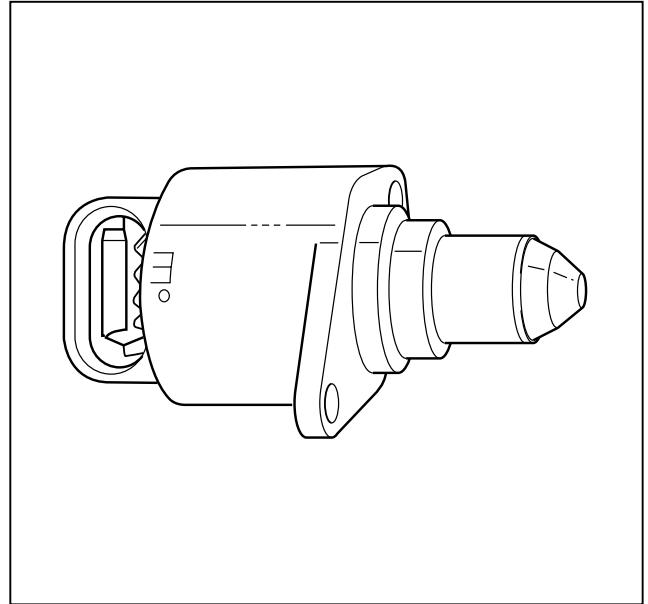
A continuous purge condition with no purge commanded by the ECM will set a DTC62. Refer to the DTC charts for further information.

## VISUAL CHECK OF THE EVAPORATIVE EMISSION CANISTER (IF APPLICABLE)



- If the canister is cracked or damaged, replace the canister.
- If fuel is leaking from the canister, replace the canister and check hoses and hose routing.

## IDLE AIR CONTROL (IAC) VALVE



The Scan Tool displays the IAC pintle position in counts. A count of “0” indicates the ECM is commanding the IAC pintle to be driven all the way into a fully-seated position. This is usually caused by a vacuum leak.

The higher the number of counts, the more air is being commanded to bypass the throttle blade. Refer to *IAC System Check* in order to diagnose the IAC system. Refer to *Rough, Unstable, or Incorrect Idle, Stalling in Symptoms* for other possible causes of idle problems.

## FUEL SYSTEM PRESSURE TEST

A fuel system pressure test is part of several of the diagnostic charts and symptom checks. To perform this test, refer to *Fuel System Diagnosis*.



## FUEL METERING SYSTEM CHECK

Some failures of the fuel metering system will result in an “Engine Cranks But Will Not Run” symptom. If this condition exists, refer to *the Cranks But Will Not Run* chart. This chart will determine if the problem is caused by the ignition system, the ECM, or the fuel pump electrical circuit.

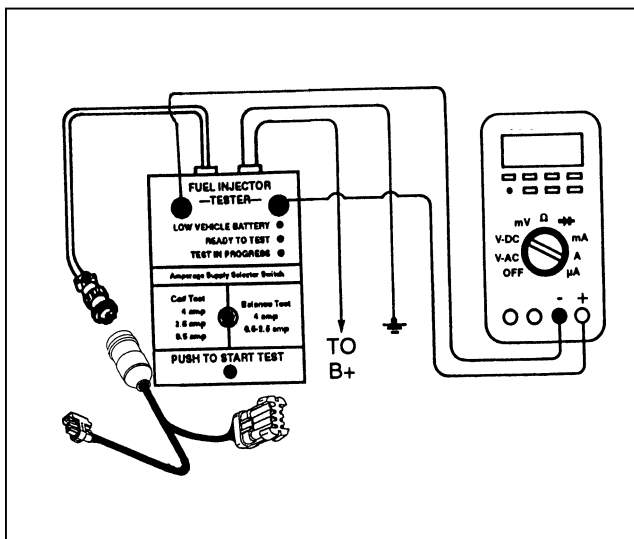
Refer to *Fuel System Electrical Test* for the fuel system wiring schematic.

If there is a fuel delivery problem, refer to *Fuel System Diagnosis*, which diagnoses the fuel injectors, the fuel pressure regulator, and the fuel pump.

### Followings are applicable to the vehicles with closed Loop System:

If a malfunction occurs in the fuel metering system, it usually results in either a rich HO2S signal or a lean HO2S signal. This condition is indicated by the HO2S voltage, which causes the ECM to change the fuel calculation (fuel injector pulse width) based on the HO2S reading. Changes made to the fuel calculation will be indicated by a change in the long term fuel trim values which can be monitored with a Scan Tool. Ideal long term fuel trim values are around 0%; for a lean HO2S signal, the ECM will add fuel, resulting in a fuel trim value above 0%. Some variations in fuel trim values are normal because all engines are not exactly the same. If the evaporative emission canister purge is O2 status may be rich condition. O2 status indicates the lean condition, refer to *DTC44* for items which can cause a lean HO2S signal.

## FUEL INJECTOR COIL TEST PROCEDURE AND FUEL INJECTOR BALANCE TEST PROCEDURE



## Test Description

Number(s) below refer to the step number(s) on the Diagnostic Chart:

- Relieve the fuel pressure by connecting 5-8840-0378-0 T-Joint to the fuel pressure connection on the fuel rail.

**Caution:** In order to reduce the risk of fire and personal injury, wrap a shop towel around the fuel pressure connection. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

Place the fuel pressure gauge bleed hose in an approved gasoline container.

With the ignition switch OFF open the valve on the fuel pressure gauge.

- Record the lowest voltage displayed by the DVM after the first second of the test. (During the first second, voltage displayed by the DVM may be inaccurate due to the initial current surge.)

Injector Specifications:

Resistance Ohms	Voltage Specification at 10°C-35°C (50°F-95°F)
11.8-12.6	5.7-6.6

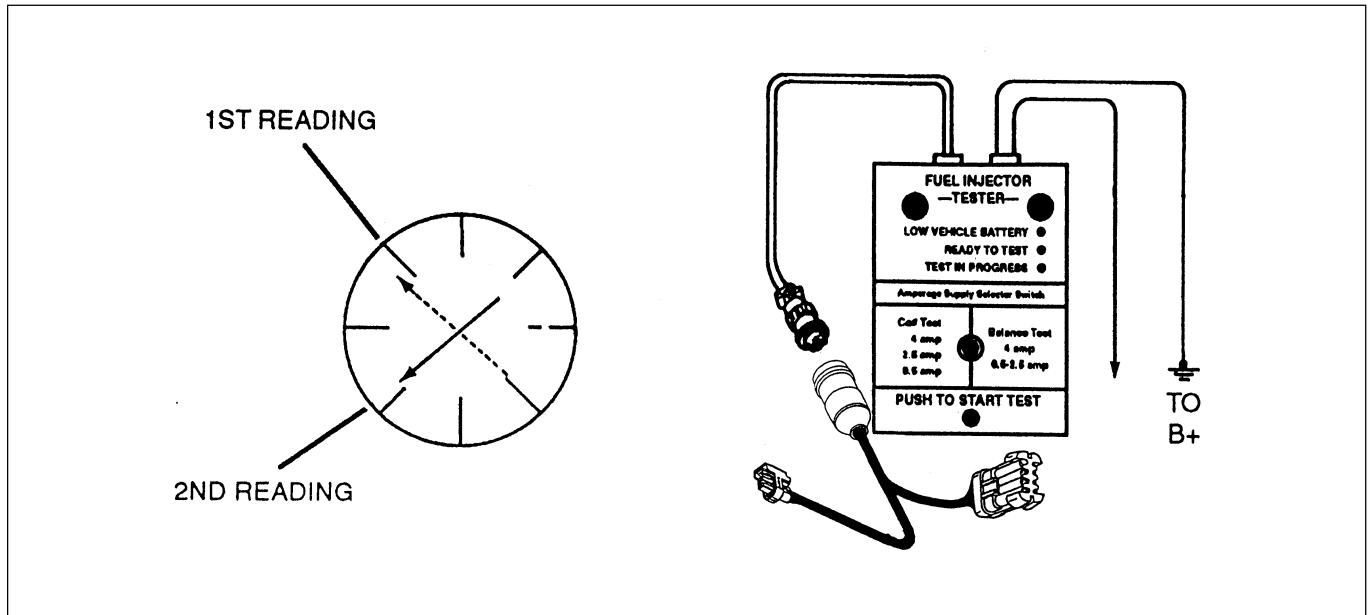
- The voltage displayed by the DVM should be within the specified range.
- The voltage displayed by the DVM may increase throughout the test as the fuel injector windings warm and the resistance of the fuel injector windings changes.
- An erratic voltage reading (large fluctuations in voltage that do not stabilize) indicates an intermittent connection within the fuel injector.

- Injector Specifications:

Highest Acceptable Voltage Reading Above/Below 35°C/10°C (95°F/50°F)	Acceptable Subtracted Value
9.5Volts	0.6Volt

- The Fuel Injector Balance Test portion of this chart (Step 7 through Step 11) checks the mechanical (fuel delivery) portion of the fuel injector. An engine cooldown period of 10 minutes is necessary in order to avoid irregular fuel pressure readings due to “Hot Soak” fuel boiling.

**Injector Coil Test Procedure (Steps 1-6) and Injector Balance Test Procedure (Steps 7-11)**



CYLINDER				
	1	2	3	4
1st Reading (1)	296kPa (43psi)	296kPa (43psi)	296kPa (43psi)	296kPa (43psi)
2nd Reading (2)	205kPa (29psi)	205kPa (29psi)	196kPa (28psi)	274kPa (39psi)
Amount of Drop (1st Reading-2nd Reading)	91kPa (14psi)	91kPa (14psi)	100kPa (15psi)	22kPa (4psi)
Av. Drop = 166kPa/24psi ±10kPa/1.5psi = 156 – 176kPa or 22.5 – 25.5psi	Faulty, Lean (Too Little Fuel Drop)	Faulty, Lean (Too Little Fuel Drop)	Faulty, Lean (Too Little Fuel Drop)	Faulty, Lean (Too Little Fuel Drop)

**NOTE: These figures are examples only.**

### Injector Coil Test Procedure (Steps 1-6) and Injector Balance Test Procedure (Steps 7-11)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	<p>1. Turn the engine OFF.</p> <p><b>Notice:</b> In order to prevent flooding of a single cylinder and possible engine damage, relieve the fuel pressure before performing the fuel injector coil test procedure.</p> <p>2. Relieve the fuel pressure. Refer to Test Description Number 2.</p> <p>3. Connect the 5-8840-2618-0 Fuel Injector Tester to B+ and ground, and to the 5-8840-2589-0 Injector Adapter Cable.</p> <p>4. Remove the harness connector of the Fuel Injector and connect the 5-8840-2589-0 Injector Adapter Cable for F/I check.</p> <p>5. Set the amperage supply selector switch on the fuel injector tester to the "Coil Test" 0.5 amp position.</p> <p>6. Connect the leads from the 5-8840-2392-0 Digital Voltmeter (DVM) to the fuel injector tester. Refer to the illustrations associated with the test description.</p> <p>7. Set the DVM to the tenths scale (0.0).</p> <p>8. Observe the engine coolant temperature.</p> <p>Is the engine coolant temperature within the specified values?</p>	10°C (50°F) to 35°C (95°F)	<i>Go to Step 3</i>	<i>Go to Step 5</i>
3	<p>1. Set the injector adapter cable to injector #1.</p> <p>2. Press the "Push to Start Test" button on the fuel injector tester.</p> <p>3. Observe the voltage reading on the DVM.</p> <p><b>Important:</b> The voltage reading may rise during the test.</p> <p>4. Record the lowest voltage observed after the first second of the test.</p> <p>5. Set the injector adapter cable to the next injector and repeat steps 2, 3, and 4.</p> <p>Did any fuel injector have an erratic voltage reading (large fluctuations in voltage that did not stabilize) or a voltage reading outside of the specified values?</p>	5.7-6.6V	<i>Go to Step 4</i>	<i>Go to Step 7</i>
4	Replace the faulty fuel injector(S). Refer to <i>Fuel Injector</i> . Is the action complete?	-	<i>Go to Step 7</i>	-

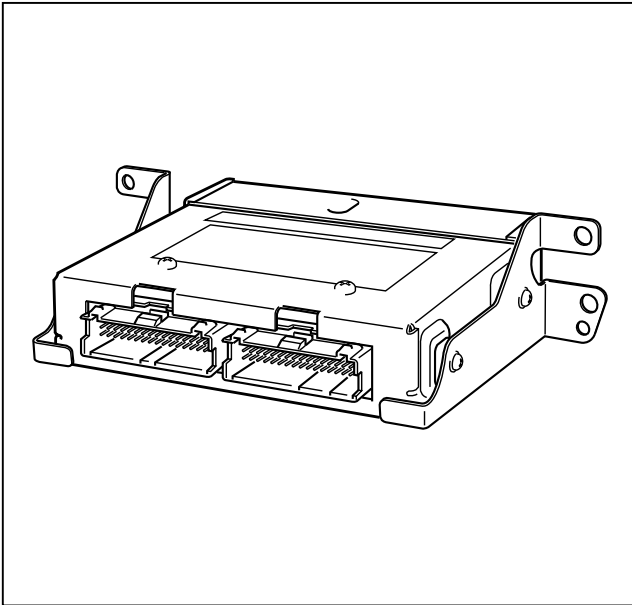
**Injector Coil Test Procedure (Steps 1-6) and  
Injector Balance Test Procedure (Steps 7-11) (Cont'd)**

Step	Action	Value(s)	Yes	No
5	<ol style="list-style-type: none"> <li>1. Set the Injector Adapter Cable to injector #1.</li> <li>2. Press the "Push to Start Test" button on the fuel injector tester.</li> <li>3. Observe the voltage reading on the DVM.</li> </ol> <p><b>Important:</b> The voltage reading may rise during the test.</p> <ol style="list-style-type: none"> <li>4. Record the lowest voltage observed after the first second of the test.</li> <li>5. Set the Injector Adapter Cable to the next injector and repeat steps 2, 3, and 4.</li> </ol> <p>Did any fuel injector have an erratic voltage reading (large fluctuations in voltage that did not stabilize) or a voltage reading above the specified value?</p>	9.5V	<i>Go to Step 4</i>	<i>Go to Step 6</i>
6	<ol style="list-style-type: none"> <li>1. Identify the highest voltage reading recorded (other than those above 9.5V).</li> <li>2. Subtract the voltage reading of each injector from the highest voltage selected in step 1. Repeat until you have a subtracted value for each injector.</li> </ol> <p>For any injector, is the subtracted value in step 2 greater than the specified value?</p>	0.6V	<i>Go to Step 4</i>	<i>Go to Step 7</i>
7	<p><b>Caution: In order to reduce the risk of fire and personal injury, wrap a shop towel around the fuel pressure connection. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the Towel in an approved container when the connection of the fuel pressure gauge is complete.</b></p> <ol style="list-style-type: none"> <li>1. Connect the 5-8840-0378-0 Fuel Pressure Gauge to the fuel pressure test port.</li> <li>2. Energize the fuel pump using the Scan Tool.</li> <li>3. Place the bleed hose of the fuel pressure gauge into an approved gasoline container.</li> <li>4. Bleed the air out of the fuel pressure gauge.</li> <li>5. With the fuel pump running, observe the reading on the fuel pressure gauge.</li> </ol> <p>Is the fuel pressure within the specified values?</p>	296kPa- 376kPa (43-55psi)	<i>Go to Step 8</i>	<i>Go to Fuel System Diagnosis</i>
8	<p>Turn the fuel pump OFF.</p> <p>Does the fuel pressure remain constant?</p>	-	<i>Go to Step 9</i>	<i>Go to Fuel System Diagnosis</i>

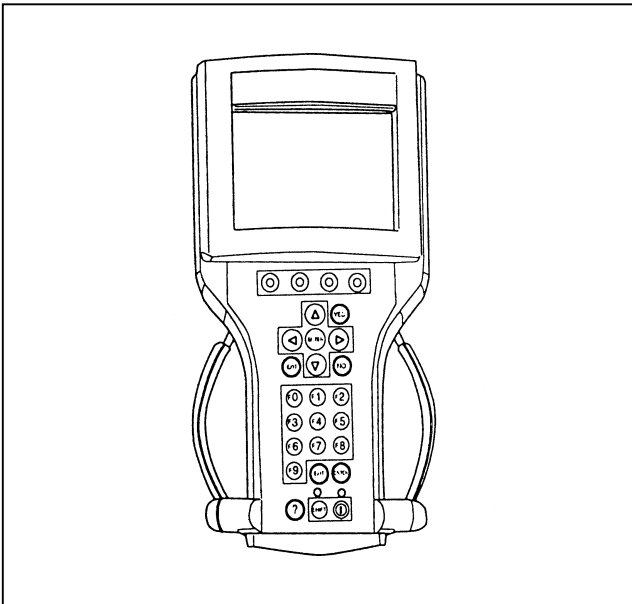
**Injector Coil Test Procedure (Steps 1-6) and  
Injector Balance Test Procedure (Steps 7-11) (Cont'd)**

Step	Action	Value(s)	Yes	No
9	<ol style="list-style-type: none"> <li>1. Connect the 5-8840-0378-0 Fuel Injector Tester and 5-8840-2589-0 Injector Adapter Cable to the fuel injector harness connector.</li> <li>2. Set the amperage supply selector switch on the fuel injector tester to the "Balance Test" 0.5-2.5 amp position.</li> <li>3. Using the Scan Tool turn the fuel pump ON then OFF in order to pressurize the fuel system.</li> <li>4. Record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure stabilizes. This is the first pressure reading.</li> <li>5. Energize the fuel injector by depressing the "Push to Start Test" button on the fuel injector tester.</li> <li>6. Record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure gauge needle has stopped moving. This is the second pressure reading.</li> <li>7. Repeat steps 1 through 6 for each fuel injector.</li> <li>8. Subtract the second pressure reading from the first pressure reading for one fuel injector. The result is the pressure drop value.</li> <li>9. Obtain a pressure drop value for each fuel injector.</li> <li>10. Add all of the individual pressure drop values. This is the total pressure drop.</li> <li>11. Divide the total pressure drop by the number of fuel injectors. This is the average pressure drop.</li> </ol> <p>Does any fuel injector have a pressure drop value that is either higher than the average pressure drop or lower than the average pressure drop by the specified value?</p>	10kPa (1.5psi)	Go to Step 10	Go to OBD System Check
10	<p>Re-test any fuel injector that does not meet the specification. Refer to the procedure in step 11.</p> <p><b>Notice:</b> Do not repeat any portion of this test before running the engine in order to prevent the engine from flooding.</p> <p>Does any fuel injector still have a pressure drop value that is either higher than the average pressure drop or lower than the average pressure drop by the specified value?</p>	10kPa (1.5psi)	Go to Step 11	Go to Symptoms
11	<ol style="list-style-type: none"> <li>1. Replace the faulty fuel injector(s). Refer to <i>Fuel Injector</i>.</li> <li>2. Disconnect the 5-8840-2589-0 Injector Adapter Cable for F/I check and re-connect the original F/I check connector.</li> </ol> <p>Is the action complete?</p>	-	Verify repair	-

## ENGINE CONTROL MODULE (ECM) DIAGNOSIS



To read and clear diagnostic trouble codes, use a Scan Tool.



**Important:** Use of a Scan Tool is recommended to clear diagnostic trouble codes from the ECM memory. Diagnostic trouble codes can also be cleared by turning the ignition OFF and disconnecting the battery power from the ECM for 30 seconds. Turning off the ignition and disconnecting the battery power from the ECM will cause all diagnostic information in the ECM memory to be cleared. Therefore, all the diagnostic tests will have to be re-run.

Since the ECM can have a failure which may affect only one circuit, following the diagnostic procedures in this section will determine which circuit has a problem and where it is.

If a diagnostic chart indicates that the ECM connections or the ECM is the cause of a problem, and the EPROM or ECM is replaced, but this does not correct the problem, one of the following may be the reason:

- There is a problem with the ECM terminal connections. The terminals may have to be removed from the connector in order to check them properly.
- The problem is intermittent. This means that the problem is not present at the time the system is being checked. In this case, refer to the Symptoms portion of the manual and make a careful physical inspection of all components and wiring associated with the affected system.
- There is a shorted solenoid, relay coil, or harness. Solenoids and relays are turned ON and OFF by the ECM using internal electronic switches called drivers. A shorted solenoid, relay coil, or harness will not damage the ECM but will cause the solenoid or relay to be inoperative.

## MULTIPLE ECM INFORMATION SENSOR DTCs SET

### Circuit Description

The engine control module (ECM) monitors various sensors to determine the engine operating conditions. The ECM controls fuel delivery, spark advance, and emission control device operation based on the sensor inputs.

The ECM provides a sensor ground to all of the sensors. The ECM applies 5 volts through a pull-up resistor, and determines the status of the following sensors by monitoring the voltage present between the 5-volt supply and the resistor:

- The throttle position (TP) sensor
  - The manifold absolute pressure (MAP) sensor
- The ECM provides the following sensors with a 5-volt reference and a sensor ground signal:
- Intake Air Temp Sensor (IAT).
  - Engine Coolant Temp Sensor (ECT).
  - Manifold Absolute Pressure Sensor (MAP).
  - Throttle Position Sensor (TPS).

The ECM monitors the separate feedback signals from these sensors in order to determine their operating status.

**Diagnostic Aids**

**Important:** Be sure to inspect ECM and engine grounds for being secure and clean.

A short to voltage in one of the sensor input circuits may cause one or more of the following DTCs to be set:

- 21/33

**Important:** If a sensor input circuit has been shorted to voltage, ensure that the sensor is not damaged. A damaged sensor will continue to indicate a high or low voltage after the affected circuit has been repaired. If the sensor has been damaged, replace it.

A short to ground in the circuit between ECM and sensors will cause one or more of the following DTCs to be set:

- 14/22
- 34/69

Check for the following conditions:

- **Poor connection at ECM.** Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and a poor terminal-to-wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness is not damaged, observe an affected sensor's displayed value on the Scan Tool with the ignition ON and the engine OFF while you move the connectors and the wiring harnesses related to the following sensors:
  - IAT
  - ECT
  - TPS
  - MAP

**Multiple ECM Information Sensor DTCs Set**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	Go to Step 2	Go to OBD System Check
2	1. Turn the ignition OFF disconnect the ECM. 2. Turn the ignition ON check the 5 volt reference circuits for the following conditions: <ul style="list-style-type: none"> <li>• A poor connection at the ECM.</li> <li>• An open between the ECM connector and the splice.</li> <li>• A short to ground.</li> <li>• A short to voltage.</li> </ul> Is there an open or short?	-	Go to Step 3	Go to Step 4
3	Repair the open or short. Is the action complete?	-	Verify repair	-
4	Check the sensor ground circuit for the following conditions: <ul style="list-style-type: none"> <li>• A poor connection at the ECM or the affected sensors.</li> <li>• An open between the ECM connector and the affected sensors.</li> </ul> Is there an open or a poor connection?	-	Go to Step 5	Go to Step 6
5	Repair the open or the poor connection. Is the action complete?	-	Verify repair	-

## Multiple ECM Information Sensor DTCs Set (Cont'd)

Step	Action	Value(s)	Yes	No
6	Measure the voltage between the MAP sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0V	<i>Go to Step 7</i>	<i>Go to Step 10</i>
7	Measure the voltage between the TP sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0V	<i>Go to Step 8</i>	<i>Go to Step 11</i>
8	Measure the voltage between the IAT sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0V	<i>Go to Step 9</i>	<i>Go to Step 12</i>
9	Measure the voltage between the ECT sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0V	<i>Go to Step 14</i>	<i>Go to Step 13</i>
10	Locate and repair the short to voltage in the MAP sensor signal circuit. Is the action complete?	-	<i>Verify repair</i>	-
11	Locate and repair the short to voltage in the TP sensor signal circuit. Is the action complete?	-	<i>Verify repair</i>	-
12	Locate and repair the short to voltage in the IAT sensor signal circuit. Is the action complete?	-	<i>Verify repair</i>	-
13	Locate and repair the short to voltage in the ECT sensor signal circuit. Is the action complete?	-	<i>Verify repair</i>	-
14	Replace the EPPROM or ECM. Note) Refer to 6E1-243	-	<i>Go to OBD System Check</i>	-



## ENGINE SCAN TOOL DATA DEFINITIONS AND RANGES

**A/C CLUTCH - Scan Tool Displays ON or OFF -** Indicates whether the ECM has commanded the A/C clutch ON. Used in A/C system diagnostics.

**A/C REQUEST - Scan Tool Displays NO or OFF -** Indicates the state of the A/C request input circuit from the HVAC controls. The ECM uses the A/C request signal to determine whether A/C compressor operation is being requested.

**AIR/FUEL RATIO - Scan Tool Range 0-0:1-25.5:1 -** Air/fuel ratio indicates the ECM commanded value. In "Closed Loop", the air/fuel ratio should normally be displayed around "14.2-14.7". A lower air/fuel ratio indicates a richer commanded mixture, which may be seen during power enrichment or TWC (If applicable) protection modes. A higher air/fuel ratio indicates a leaner commanded mixture. This can be seen during deceleration fuel mode.

**BARO kPa - Scan Tool Range 10-105 -** The barometric pressure reading is determined from the MAP sensor signal monitored during key up and wide open throttle (WOT) conditions. The barometric pressure is used to compensate for altitude differences and is normally displayed around "61-104" depending on altitude and barometric pressure.

**DECELERATION FUEL CUT OFF - YES or NO- Scan Tool Displays - "ACTIVE" displayed indicates that the ECM has detected conditions appropriate to operate in deceleration fuel mode. The ECM will command the deceleration fuel mode when it detects a closed throttle position while the vehicle is traveling over 20 mph. While in the deceleration fuel mode, the ECM will decrease the amount of fuel delivered by entering "Open Loop" and decreasing the injector pulse width.**

**DESIRED IDLE - Scan Tool Range 0-3187 RPM -** The idle speed that the ECM is commanding. The ECM will compensate for various engine loads based on engine coolant temperature, to keep the engine at the desired speed.

**ECT TEMP. - (Engine Coolant Temperature) Scan Tool Range -40°C to 151°C (-40°F to 304°F) -** The engine coolant temperature (ECT) is mounted in the coolant stream and sends engine temperature information to the ECM. The ECM applies 5 volts to the ECT sensor circuit. The sensor is a thermistor which changes internal resistance as the temperature changes. When the sensor is cold (high resistance),

the ECM monitors a high signal voltage and interprets that as a cold engine. As the sensor warms (decreasing resistance), the voltage signal will decrease and the ECM will interpret the lower voltage as a warm engine.

**TIME FROM START - Scan Tool Range 00:00:00-99:99:99 Hrs:Min:Sec -** Indicates the time elapsed since the engine was started. If the engine is stopped, engine run time will be reset to 00:00:00.

**ENGINE SPEED - Range 0-9999 RPM -** Engine speed is computed by the ECM from the 58X reference input. It should remain close to desired idle under various engine loads with engine idling.

**EVAP PURGE PWM (If applicable) - Scan Tool Range 0%-100% -** Represents the ECM commanded PWM duty cycle of the EVAP purge solenoid valve. "0%" displayed indicates no purge; "100%" displayed indicates full purge.

**FUEL PUMP RELAY - Scan Tool Displays ON or OFF -** Indicates the ECM commanded state of the fuel pump relay driver circuit.

**02 BLM CELL NUMBER (If applicable)- Scan Tool Range 0-21 -** The 02 BLM cell is dependent upon engine speed and MAP sensor readings. A plot of RPM vs. MAP is divided into 22 cells. 02 BLM cell indicates which cell is currently active.

**B1 HO2S BANK 1 (If applicable)- Scan Tool Range 0-1000 mV -** Represents the fuel control exhaust oxygen sensor output voltage. Should fluctuate constantly within a range between 10 mV (lean exhaust) and 1000 mV (rich exhaust) while operating in "Closed Loop".

**B1 HO2S READY BANK 1 (If applicable)- Scan Tool Displays YES or NO -** Indicates the status of the exhaust oxygen sensor. The Scan Tool will indicate that the exhaust oxygen sensor is ready when the ECM detects a fluctuating HO2S voltage sufficient to allow "Closed Loop" operation. This will not occur unless the exhaust sensor is warmed up.

**IAC CONTROL STEP - Scan Tool Range 0-255 steps -** Displays the commanded position of the idle air control pintle in counts. A larger number of counts means that more air is being commanded through the idle air passage. Idle air control should respond fairly quickly to changes in engine load to maintain desired idle RPM.

**IAT (INTAKE AIR TEMPERATURE) - Scan Tool Range -40°C to 151°C (-40°F to 304°F) -** The ECM converts the resistance of the intake air temperature sensor to degrees. Intake air temperature (IAT) is

used by the ECM to adjust fuel delivery and spark timing according to incoming air density.

**BATTERY - Scan Tool Range 0-25.5 Volts** - This represents the system voltage measured by the ECM at its ignition feed.

**INJ. PULSE WIDTH - Scan Tool Range 0-1000 msec.** - Indicates the amount of time the ECM is commanding each injector ON during each engine cycle. A longer injector pulse width will cause more fuel to be delivered. Injector pulse width should increase with increased engine load.

**FUELING MODE (If applicable) - Scan Tool Displays OPEN or CLOSED** - "CLOSED" indicates that the ECM is controlling fuel delivery according to oxygen sensor voltage. In "OPEN" the ECM ignores the oxygen sensor voltage and bases the amount of fuel to be delivered on TP sensor, and engine coolant, sensor inputs only.

**MAP - Scan Tool Range 10-105 kPa (0.00-4.97 Volts)** - The manifold absolute pressure (MAP) sensor measures the change in the intake manifold pressure from engine load, and speed changes. As intake manifold pressure increases, intake vacuum decreases, resulting in a higher MAP sensor voltage and kPa reading. The MAP sensor signal is used to monitor intake manifold pressure changes to update the BARO reading, and as an enabling factor for several of the diagnostics.

**CEL-CHECK ENGINE LIGHT - Scan Tool Displays ON or OFF** - Indicates the ECM commanded state of the malfunction indicator lamp ("Check Engine Lamp").

**02 STATUS (If applicable) - Scan Tool Displays RICH or LEAN** - Indicates whether oxygen sensor voltage is above a 600 mV threshold voltage ("RICH") or below a 3000 mV threshold voltage ("LEAN"). Should change constantly while in "Closed Loop", indicating that the ECM is controlling the air/fuel mixture properly.

**ELECTRIC SPARK CONTROL - Scan Tool Range – 64°CA to 64°CA** - Displays the amount of spark advance being commanded by the ECM on the IC circuit.

**THROTTLE POSITION - Scan Tool Range 0%-100%** - TP (throttle position) angle is computed by the ECM from the TP sensor voltage. TP angle should display "0%" at idle and "100%" at wide open throttle.

**TPS SIGNAL - Scan Tool Range 0.00-5.00 Volts** - The voltage being monitored by the ECM on the TP sensor signal circuit.

## TYPICAL SCAN DATA VALUES

Use the Typical Scan Data Values Table only after the On- Board Diagnostic System Check has been completed, no DTC(s) were noted, and you have determined that the on-board diagnostics are functioning properly. Scan Tool values from a properly-running engine may be used for comparison with the engine you are diagnosing. The typical scan data values represent values that would be seen on a normally-running engine.

**Notice:** A Scan Tool that displays faulty data should not be used, and the problem should be reported to the Scan Tool manufacturer. Use of a faulty Scan Tool can result in misdiagnosis and unnecessary replacement of parts.

Only the parameters listed below are referred to in this service manual for use in diagnosis. For further information on using the Scan Tool to diagnose the ECM and related sensors, refer to the applicable reference section listed below. If all values are within the typical range described below, refer to the *Symptoms* section for diagnosis.

### Test Conditions

Engine running, lower radiator hose hot, transmission in park or neutral, "Closed Loop" (If applicable), accessories OFF, brake not applied and air conditioning OFF.

## 2.2L/2.0L L-4 Engine

Scan Tool Parameter	Data List	Units Displayed	Typical Data Values (IDLE)	Typical Data Values (2500 RPM)	Refer To
A/C Clutch	Engine	On/Off	Off	Off	General Description and Operation, A/C Clutch Circuit Operation
A/C Request	Engine	No/Off	Off	Off	General Description and Operation, A/C Request Signal
Air/Fuel Ratio (If applicable)	Engine	Ratio: _to 1	14.6:1	14.6:1	General Description and Operation, Fuel System Metering Purpose
BARO kPa	Engine	kPa	103 (depends on altitude and barometric)	103 (depends on altitude and barometric)	General Description and Operation
Broadcast Code 'PROM' Identification	Engine	5 Figures	Depends on latest level of engine software and calibration. Review Technical Service Bulletins for most current level.	Depends on latest level of engine software and calibration. Review Technical Service Bulletins for most current level.	-
Decel Fuel Mode	Engine	Active/Inactive	Inactive	Inactive	General Description and Operation, Deceleration Mode
Desired Idle	Engine	RPM	825	-	General Description and Operation, Idle Air Control (IAC) Valve
ECT (Engine Coolant Temp)	Engine	Degrees C, Degrees F	80-100°C (176-212°F)	80-100°C (176-212°F)	General Description and Operation, Engine Coolant Temperature (ECT) Sensor
Time From Start	Engine	Hrs:Min:Sec	Varies. Resets at each engine start.	Varies. Resets at each engine start.	-
Engine Speed	Engine	RPM	Within -50 to +100 of "Desired Idle"	Actual engine speed	-
EVAP Purge PWM (If applicable)	Engine	Percent	0%	0%	Diagnosis, EVAP Emission Canister Purge Valve Check
Fuel Pump	Engine	On/Off	On	On	Engine Fuel

## 2.2L/2.0 L-4 Engine (Cont'd)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Values (IDLE)	Typical Data Values (2500 RPM)	Refer To
O2 BLM Cell Number (If applicable)	Engine	Cell number	20	5	Diagnosis, Fuel Trim Cell Diagnostic Weights
HO2S (If applicable) (millivolts)	Engine	Millivolts	160-800 changing quickly	160-800, always changing quickly	General Description and Operation, Fuel Control HO2S
HO2S (If applicable) (ready/not ready)	Specific Eng: HO2S	Ready/Not Ready	Ready	Ready	General Description and Operation, Fuel Control HO2S; DTC: DTC13
IAT (Intake Air Temp)	Engine	Degrees C, Degrees F	0-100°C, (32°F-212°F) depends on underhood	0-80°C, depends (32°F-176°F) on underhood	General Description and Operation, Intake Air Temperature (IAT) Sensor
Battery	Engine	Volts	14	34	General Description and Operation, Electronic Ignition System
Inj. Pulse	Engine	Milliseconds	1.8-1.9	1.4-1.5	General Description, Fuel Metering, Fuel Injector
Fueling Mode (If applicable)	Engine	Open/Closed	Closed	Closed	General Description and Operation, Fuel Metering System; DTCs: DTC13
MAP kPa (Manifold Absolute Pressure)	Engine	Kilopascals	37	29	General Description and Operation, Manifold Absolute Pressure (MAP) Sensor; DTCs: DTC33/34
CEL	Engine	On/Off	Off	Off	On-Board Diagnostic System Check

## 2.2L/2.0L L-4 Engine (Cont'd)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Values (IDLE)	Typical Data Values (2500 RPM)	Refer To
PSP Switch (Power Steering Pressure)	Engine	ON/OFF	-	-	Power Steering Gear and Pump, General Description, Pressure Switch
O2 STATUS (If applicable)	Engine	Rich/Lean	Always changing	Always changing	General Description and Operation, Fuel Control HO2S
Electric spark control	Engine	Degrees Before Top Dead Center	14	34	General Description and Operation, Electronic Ignition System
TP (Throttle Position)	Engine	Degrees open	0	5	General Description and Operation, Throttle Position (TP) Sensor; DTCs: DTC 21/22
TP Sensor (Throttle Position)	Engine	Volts	0.80	1.02	General Description and Operation, Throttle Position (TP) Sensor; DTCs: DTC 21/22
Vehicle Speed	Engine	km/h	0	0	

### General Description (Evaporative (EVAP) Emission System) (IF APPLICABLE)

#### EVAP Emission Control System Purpose

The basic Evaporative Emission (EVAP) Control System used on all vehicle is the charcoal canister storage method. This method transfers fuel vapor from the fuel tank to an activated carbon (charcoal) storage device (canister) to hold the vapors when the vehicle is not operating. When the engine is running, the fuel vapor is purged from the carbon element by intake air flow and consumed in the normal combustion process.

#### Vapor Canister

Gasoline vapors from the fuel tank flow into the tube labeled tank. Any liquid fuel goes into a reservoir in the bottom of the canister to protect the integrity of the carbon bed. These vapors are absorbed into the carbon. The canister is purged when the engine is running or commanded by Engine Control Module (ECM). Ambient air is allowed into the canister through the air tube in the top. The air mixes with the vapor and the mixture is drawn into the intake manifold.

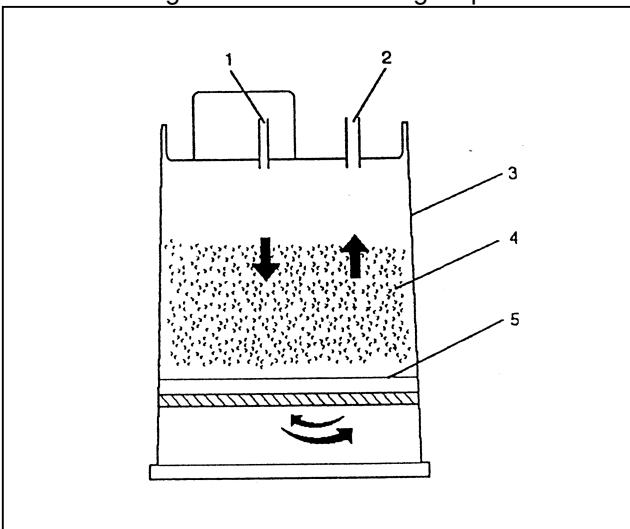
### Evap Control System

The solenoid used with this canister uses Vacuum Switch Valve to control purge. The ECM opens and closes the solenoid to control purge.

The ECM operates a Normally Closed (N/C) solenoid valve which controls the vacuum to purge the charcoal canister. Under cold engine or idle conditions, the solenoid is not energized by the ECM, which blocks vacuum to purge the canister.

The ECM energizes the solenoid valve and allows purge when:

- Engine is warm above 69°C (156°F)
- After the engine has been running a specified time.



### Legend

- (1) Vapor from Fuel Tank
- (2) Evaporate Emission Canister Purge Vacuum
- (3) Canister Body
- (4) Carbon
- (5) Filter
- (6) Grid
- (7) Air Flow During Purge

- Throttle position is above 7% throttle position sensor.

### Results of Incorrect Operation

Poor idle, stalling and poor driveability can be caused by:

- Inoperative purge solenoid.
- Damaged canister.
- Hoses split, cracked and/or not connected to the proper tubes.

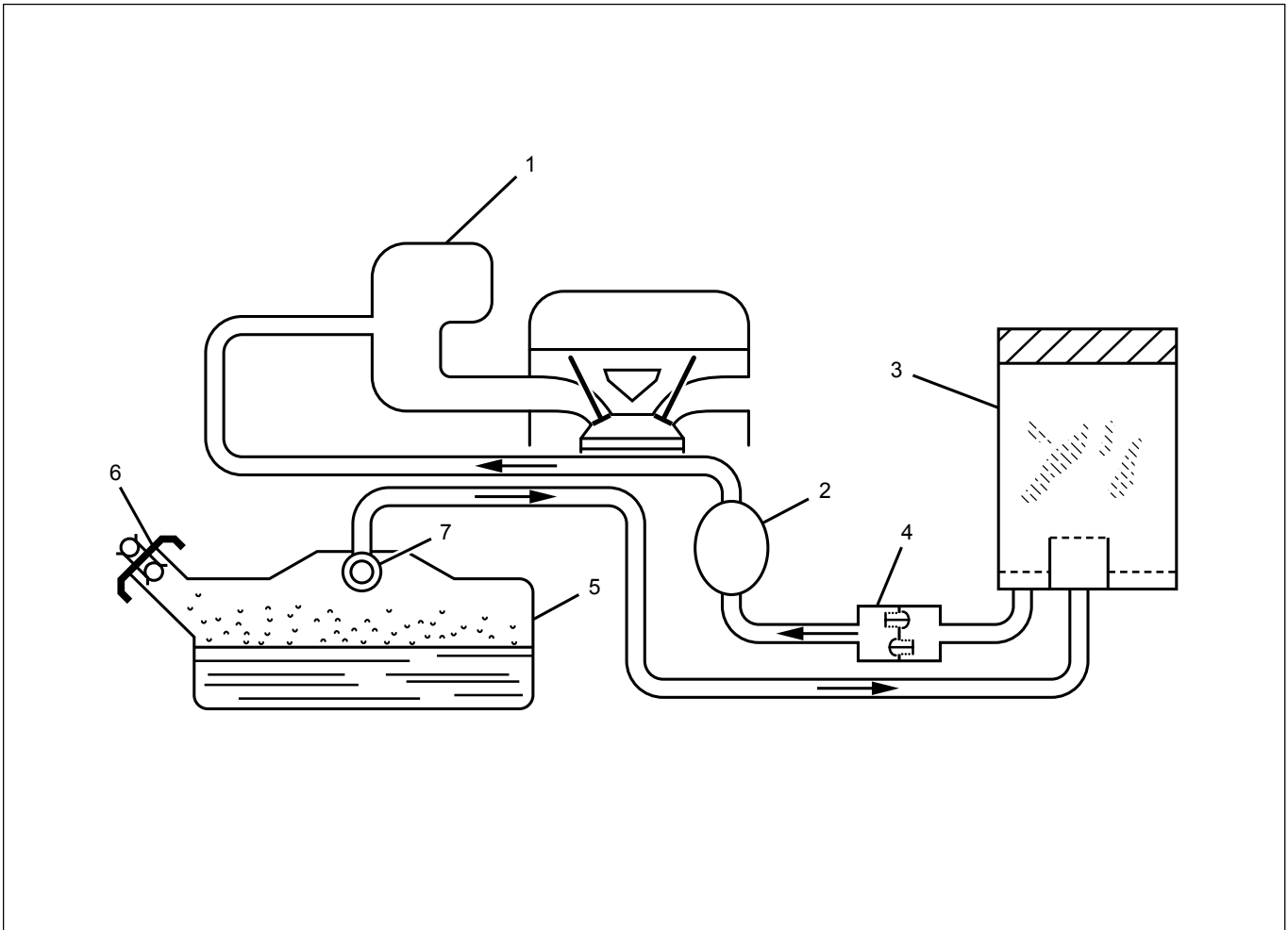
Evidence of fuel loss or fuel vapor odor can be caused by:

- Liquid fuel leaking from fuel lines, or fuel pump.
- Cracked or damaged canister.
- Disconnected, misrouted, kinked, deteriorated or damaged vapor hoses, or control hoses.

If the solenoid is always open, the canister can purge to the intake manifold at all times. This can allow extra fuel at idle or during warm-up, which can cause rough or unstable idle, or too rich operation.

If the solenoid is always closed, the canister can become over-loaded, resulting in fuel odor.

**Diagnosis**



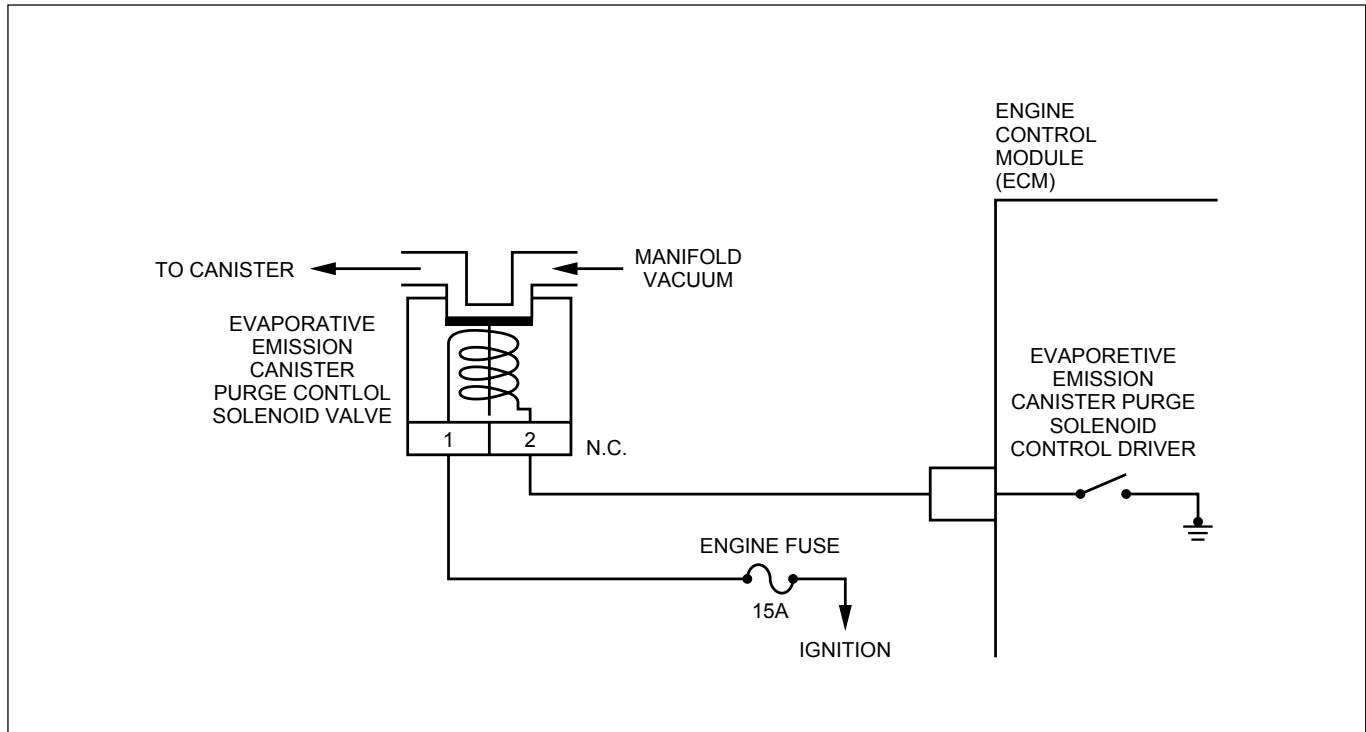
**Legend**

- (1) Intake Manifold
- (2) Fuel Vapor Purge Control Solenoid
- (3) Fuel Vapor Canister
- (4) Check and Relief valve
- (5) Fuel Tank
- (6) Pressure/ Vacuum Vented
- (7) Rollover Valve

**Visual Check of Canister**

Cracked or damaged, replace canister.

## Evaporative Emission Canister Purge Control Solenoid Valve Check (If applicable)



### Circuit Description:

The EVAP canister purge is controlled by a solenoid valve that allows the manifold vacuum to purge the canister. The engine control module (ECM) supplies a ground to energize the solenoid valve (purge on). The EVAP purge solenoid control is pulse-width modulated (PWM) (turned on and off several times a second). The duty cycle (pulse width) is determined by engine operating conditions including load, throttle position, coolant temperature and ambient temperature. The duty cycle is calculated by the ECM. The output is commanded when the appropriate conditions have been met. These conditions are:

- The engine is fully warmed up.
- The engine has been running for a specified time.
- The IAT reading is above 10°C (50°F).

The EVAP purge vacuum switch is a normally closed switch positioned in the purge line between the canister and the EVAP purge control solenoid valve.

A continuous purge condition with no purge commanded by the ECM will set a DTC62.

Poor idle, stalling and poor driveability can be caused by:

- A malfunctioning purge solenoid.
- A damaged canister.
- Hoses that are split, cracked, or not connected properly.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Check to see if the solenoid is opened or closed. The solenoid is normally de-energized in this step, so it should be closed.
2. Check to determine if solenoid was open due to electrical CKT problem or defective solenoid.
3. Completes functional check by grounding test terminal. This should normally energize the solenoid opening the valve which should allow the vacuum to drop (purge "ON").

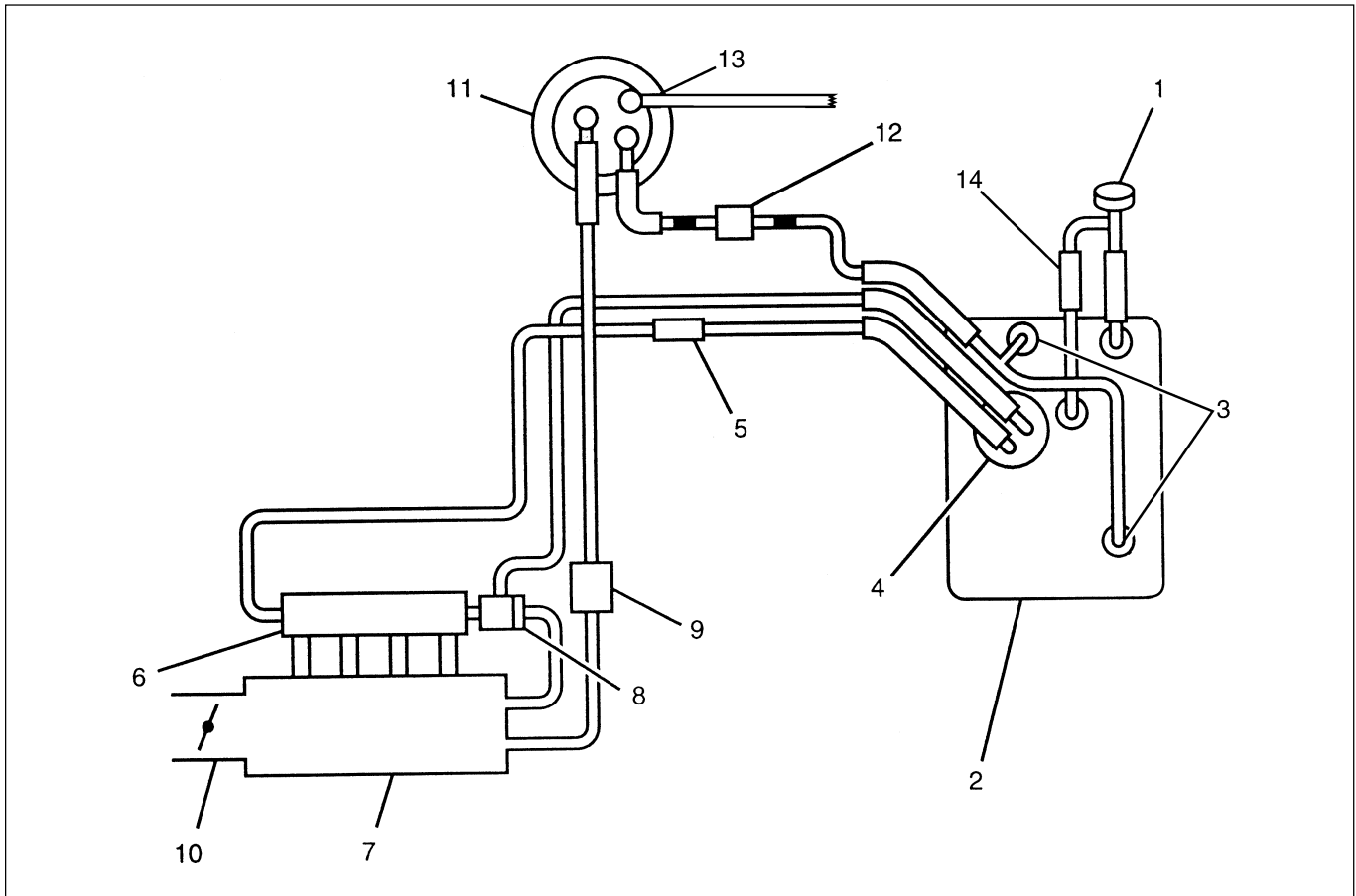
### Diagnostic Aids:

Make a visual check of vacuum hose(s). Check throttle body for possible cracked, or plugged vacuum block.

Malfunction indicator lamp for possible mechanical problem.



**General Description**



**Legend**

- |                    |  |
|--------------------|--|
| (1) Filler Cap     | (7) Intake Manifold                                    |
| (2) Fuel Tank      | (8) Fuel Pressure Regulator                            |
| (3) Rollover Valve | (9) Duty Solenoid Valve (Evap. Purge Control Solenoid) |
| (4) Fuel Pump      | (10) Throttle Valve                                    |
| (5) Fuel Filter    | (11) Canister  |
| (6) Fuel Rail      | (12) Check and Relief Valve                            |
|                    | (13) Drain Hose  |
|                    | (14) 2 Way Valve                                       |

### ECM Diagnostic Trouble Codes

The following table lists the diagnostic trouble codes supported a Tech 2 and to flash. If any DTCs not listed here are displayed by a Tech 2, the Tech 2 data may

be faulty; notify the Tech 2 manufacturer of any DTCs displayed that are not included in the following table.

#### ECM Diagnostic Trouble Codes

DTC using a Tech 2	Flash DTC	Description	Illuminate MIL
22	22	Throttle position low	yes
21	21	Throttle position high	yes
13	13	Oxygen sensor not ready (If applicable)	yes
44	44	Oxygen sensor too lean (If applicable)	yes
45	45	Oxygen sensor rich too long (If applicable)	yes
14	14	Coolant High	yes
15	15	Coolant Low	yes
16	16	Knock sensor disconnected circuit open	yes
18	18	Digital Signal to Noise Enhancement Filter failure	yes
19	19	58X signal incorrect	yes
24	24	Vehicle Speed Sensor fault	yes
33	33	Manifold Absolute Pressure Sensor too high	yes
34	34	MAP too low	yes
49	49	Batt voltage too high	yes
69	69	Intake Air Temp. Sensor too high	yes
71	71	IAT too low	yes
17	17	Injector malf	yes
41	41	Coil Driver B short to battery	yes
42	42	Coil Driver A short to battery	yes
63	63	Coil Driver B short to ground	yes
64	64	Coil Driver A short to ground	yes
35	35	Idle Air Control Value error	yes
56	56	Check Engine Lamp low error	yes
57	57	Check Engine Lamp high error	yes
61	61	Charcoal Canister Purge low error (If applicable)	yes
62	62	CCP Solenoid high error (If applicable)	yes
87	87	AC Clutch relay low error	yes
88	88	AC Clutch relay high error	yes
93	93	Quad Driver Sub Module error	yes
51	51	EPROM error	yes
55	55	EEPROM error	yes
91	91	Tacho out low error	yes
92	92	Tacho out high error	yes
29	29	Fuel Pump relay shorted to ground	yes
32	32	Fuel Pump relay shorted to battery	yes

## SYMPTOM DIAGNOSIS

### PRELIMINARY CHECKS

Before using this section, perform the "On-Board Diagnostic (OBD) System Check" and verify all of the following items:

- The engine control module (ECM) and malfunction indicator lamp (MIL) (Check Engine lamp) are operating correctly.
- There are no Diagnostic Trouble Code(s) stored.
- Scan Tool data is within normal operating range. Refer to *Typical Scan Data Values*.
- Verify the customer complaint and locate the correct symptom in the table of contents. Perform the procedure included in the symptom chart.

### VISUAL/PHYSICAL CHECK

Several of the symptom procedures call for a careful visual/physical check. This can lead to correcting a problem without further checks and can save valuable time. This check should include the following items:

- ECM grounds for cleanliness, tightness and proper location.
- Vacuum hoses for splits, kinks, and proper connections, shown on the "Emission Control System Schematics". Check thoroughly for any type of leak or restriction.
- Air intake ducts for collapsed or damaged areas.
- Air leaks at throttle body mounting area, manifold absolute pressure (MAP) sensor and intake manifold sealing surfaces.
- Ignition wires for cracking, hardness, and carbon tracking.
- Wiring for proper connections, pinches and cuts.

### INTERMITTENT

**Important:** An intermittent problem may or may not turn on the malfunction indicator lamp (MIL) or store a Diagnostic Trouble Code. DO NOT use the Diagnostic Trouble Code (Diagnostic Trouble Code) charts for intermittent problems. The fault must be present to locate the problem.

Most intermittent problems are caused by faulty electrical connections or wiring. Perform a careful visual/physical check for the following conditions.

- Poor mating of the connector halves or a terminal not fully seated in the connector (backed out).
- Improperly formed or damaged terminal.
- All connector terminals in the problem circuit should be carefully checked for proper contact tension.
- Poor terminal-to-wire connection. This requires removing the terminal from the connector body to check.
- Ignition coil shorted to ground and arcing at ignition wires or plugs.
- MIL (Check Engine lamp) wire to ECM shorted to ground.
- Poor ECM grounds. Refer to the ECM wiring diagrams.

Road test the vehicle with a 5-8840-2392-0 Digital Multimeter connected to a suspected circuit. An abnormal voltage when the malfunction occurs is a good indication that there is a fault in the circuit being monitored.

Use a Scan Tool to help detect intermittent conditions. The Scan Tools have several features that can be used to locate an intermittent condition. Use the following features to find intermittent faults:

To check for loss of diagnostic code memory, disconnect the MAP sensor and idle the engine until the MIL (Check Engine lamp) comes on. Diagnostic Trouble Code 34 should be stored and kept in memory when the ignition is turned "OFF." If not, the ECM is faulty. When this test is completed, make sure that you clear the Diagnostic Trouble Code 34 from memory.

Check for improper installation of electrical options such as lights, cellular phones, etc. Check all wires from the ECM to the ignition control module for poor connections.

Check for an open diode across the A/C compressor clutch and check for other open diodes (refer to wiring diagrams in *Electrical Diagnosis*).

If problem has not been found, refer to *ECM Connector Symptom* tables.

### Hard Start Symptom

Step	Action	Value(s)	Yes	No
DEFINITION: Engine cranks, but does not start for a long time. Does eventually run, or may start but immediately stalls.				
1	Was the On-Board Diagnostic (OBD) System Check performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Perform a bulletin search. 2. If a bulletin that addresses the symptom is found, correct the condition as instructed in the bulletin. Was a bulletin found that addresses the symptom?	-	<i>Verify Repair</i>	<i>Go to Step 3</i>
3	Was a visual/physical check performed?	-	<i>Go to Step 4</i>	<i>Go to Visual/Physical Check</i>
4	Check engine coolant temperature (ECT) sensor for shift in value. 1. After 8 hours with the hood up and the engine not running, connect the Scan Tool. 2. Ignition ON, engine not running. 3. Using the Scan Tool, compare Engine Coolant Temperature to Intake Air Temperature. Are ECT and IAT within the specified value of each other?	$\pm 5^{\circ}\text{C}$ ( $\pm 9^{\circ}\text{F}$ )	<i>Go to Step 8</i>	<i>Go to Step 5</i>
5	1. Using a Scan Tool, display the engine coolant temperature and note the value. 2. Check the resistance of the engine coolant temperature sensor. 3. Refer to <i>Temperature vs. Resistance chart in Diagnostic Trouble Code 14</i> for resistance specifications. Is the actual resistance near the resistance value in the chart for the temperature that was noted?	-	<i>Go to Step 7</i>	<i>Go to Step 6</i>
6	Replace the ECT sensor. Is the action complete?	-	<i>Verify repair</i>	-
7	Located and repair high resistance or connection in the ECT signal circuit or the ECT signal circuit or the ECM sensor ground.	-	<i>Verify repair</i>	-
8	Check for a faulty, plugged, or incorrectly installed PCV hoses. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	Visually/Physically inspect the secondary ignition wires. Check for the following conditions: <ul style="list-style-type: none"> <li>• Verify that all ignition wire resistance are less than the specified value.</li> <li>• Verify that ignition wires are correctly routed to eliminate cross-firing.</li> <li>• Verify that ignition wires are not arcing to ground.</li> </ul> Spraying the secondary ignition wires with a light mist of water may help locate an intermittent problem. Was a problem found?	#1 cyl. 4.7k $\Omega$ #2 cyl. 3.9k $\Omega$ #3 cyl. 3.4k $\Omega$ #4 cyl. 3.1k $\Omega$	<i>Verify repair</i>	<i>Go to Step 10</i>

### Hard Start Symptom (Cont'd)

Step	Action	Value(s)	Yes	No
10	Check for proper ignition voltage output with a spark tester (Use commercially available tool). Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
11	1. Remove the spark plugs and check for gas or oil fouling cracks, wear, improper gap, burned electrodes, heavy deposits, or improper heat range. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 12</i>
12	Check for a loose ignition control module ground. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 13</i>
13	1. Check the ignition coil secondary resistance. 2. Replace the coil if it is greater than the specified resistance. Did the coil require replacement?	2.5 k $\Omega$	<i>Verify repair</i>	<i>Go to Step 14</i>
14	Check IAC operation. Perform the procedure in the diagnostic chart <i>Diagnostic Trouble Code 35</i> , Step 6. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 15</i>
15	Check for water or alcohol contaminated fuel. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 16</i>
16	Perform the procedure in Fuel System Pressure Test to determine if there is a problem with fuel delivery. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 17</i>
17	Check for the following engine mechanical problems (refer to <i>Engine Mechanical</i> ): <ul style="list-style-type: none"> <li>• Low compression</li> <li>• Leaking cylinder head gaskets</li> <li>• Worn camshaft</li> <li>• Camshaft drive belt slipped or stripped</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 18</i>
18	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>• Visual/physical inspection</li> <li>• Scan Tool data</li> <li>• All electrical connections within a suspected circuit and/or system</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Contact Technical Assistance</i>

### Surges and/or Chuggles Symptom

Step	Action	Value(s)	Yes	No
DEFINITION: Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal.				
1	Was the <i>On-Board Diagnostic (OBD) System Check</i> performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Perform a bulletin search. 2. If a bulletin that addresses the symptom is found, correct the condition as instructed in the bulletin. Was a bulletin found that addresses the symptom?	-	<i>Verify Repair</i>	<i>Go to Step 3</i>
3	Was a visual/physical check performed?	-	<i>Go to Step 4</i>	<i>Go to Visual/Physical Check</i>
4	Be sure that the driver understands A/C compressor operation as explained in the owner's manual. Inform the customer how the A/C clutch operate. Is the customer experiencing a normal condition?	-	<i>System OK</i>	<i>Go to Step 5</i>
5	Check the fuel control Heated Oxygen Sensor (HO2S) (If applicable). When monitored on the Scan Tool, the HO2S should respond quickly to different throttle positions. If it doesn't check for silicon or other contaminants from fuel or use of improper RTV sealant. The sensors may have a white powdery coating. Silicon contamination sends a rich exhaust signal which causes the ECM to command an excessively lean air/fuel mixture. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	Check the fuel pressure. Refer to <i>Fuel System Pressure Test</i> . Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	Monitor "O2 Status" on the Scan Tool (If applicable). Is "O2 Status" in the (rich condition)?	-	<i>Go to Step 8</i>	<i>Go to Step 9</i>
8	Check items that can cause the engine to run rich. Refer to <i>Diagnostic Aids in Diagnostic Trouble Code 45</i> (If applicable). Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
9	Check items that can cause the engine to run lean. Refer to <i>Diagnostic Aids in Diagnostic Trouble Code 44</i> (If applicable). Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
10	Check for proper ignition voltage output with the spark tester (Use commercially available tool). Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
11	Check for a loose ignition control module ground. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 12</i>

## Surges and/or Chuggles Symptom (Cont'd)

Step	Action	Value(s)	Yes	No
12	<p>Visually/Physically inspect the secondary ignition wires. Check for the following conditions.</p> <ul style="list-style-type: none"> <li>• Verify that all ignition wire resistance are less than the specified value.</li> <li>• Verify that ignition wires are correctly routed to eliminate cross-firing.</li> <li>• Verify that ignition wires are not arcing to ground.</li> </ul> <p>Spraying the secondary ignition wires with a light mist of water may help locate an intermittent problem.</p> <p>Was a problem found?</p>	<p>#1 cyl. 4.7k<math>\Omega</math>  #2 cyl. 3.9k<math>\Omega</math>  #3 cyl. 3.4k<math>\Omega</math>  #4 cyl. 3.1k<math>\Omega</math></p>	Verify repair	Go to Step 13
13	<ol style="list-style-type: none"> <li>1. Check ignition coil secondary resistance.</li> <li>2. Replace the coil if it is greater than the specified resistance.</li> </ol> <p>Did the coil require replacement?</p>	2.5 k $\Omega$	Verify repair	Go to Step 14
14	<ol style="list-style-type: none"> <li>1. Remove the spark plugs and check for gas or oil fouling cracks, wear, improper gap, burned electrodes, heavy deposits or improper heat range.</li> <li>2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs.</li> </ol> <p>Was a problem found?</p>	-	Verify repair	Go to Step 15
15	<ol style="list-style-type: none"> <li>1. Check the injector connectors.</li> <li>2. If any of the connectors are connected at an improper cylinder, correct as necessary.</li> </ol> <p>Was a problem found?</p>	-	Verify repair	Go to Step 16
16	<p>Check the ECM grounds to verify that they are clean and tight. Refer to the ECM wiring diagrams in <i>Electrical Diagnosis</i>.</p> <p>Was a problem found?</p>	-	Verify repair	Go to Step 17
17	<p>Visually/Physically check the vacuum hoses for splits, kinks and proper connections and proper connections and routing as shown on the "Emission Control System Schematics".</p> <p>Was a problem found?</p>	-	Verify repair	Go to Step 18
18	<p>Check the exhaust system for a possible restriction:</p> <ul style="list-style-type: none"> <li>• Damaged or collapsed pipes</li> <li>• Internal muffler failure</li> </ul>	-	Verify repair	Go to Step 19
19	<ol style="list-style-type: none"> <li>1. Review all the diagnostic procedures within this table.</li> <li>2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>• Visual/physical inspection.</li> <li>• Scan Tool data.</li> <li>• All electrical connections within a suspected circuit and/or system.</li> </ul> </li> </ol> <p>Was a problem found?</p>	-	Verify repair	Contact Technical Assistance

### Lack of Power, Sluggish or Spongy Symptom

Step	Action	Value(s)	Yes	No
DEFINITION: Engine delivers less than expected power. Little or no increase in speed when accelerator pedal is pushed down part-way.				
1	Was the <i>On-Board Diagnostic (OBD) System Check</i> performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Perform a bulletin search. 2. If a bulletin that addresses the symptom is found, correct the condition as instructed in the bulletin. Was a bulletin found that addresses the symptom?	-	<i>Verify Repair</i>	<i>Go to Step 3</i>
3	Was a visual/physical check performed?	-	<i>Go to Step 4</i>	<i>Go to Visual/Physical Check</i>
4	1. Remove and check the air filter element for dirt or restrictions. Refer to <i>Air Intake System in On-Vehicle Service</i> . 2. Replace the air filter element if necessary. Was a repair required?	-	<i>Verify repair</i>	<i>Go to Step 5</i>
5	Check for proper ignition voltage output with the spark tester (Use commercially available tool). Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	1. Remove the spark plugs and check for gas or oil fouling, cracks, wear, improper gap, burned electrodes, heavy deposits or improper heat range. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	Check the fuel pressure. Refer to <i>Fuel System Pressure Test</i> . Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 8</i>
8	Check for water or alcohol contaminated fuel. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	Check the ECM grounds to verify that they are clean and tight. Refer to the ECM wiring diagrams in <i>Electrical Diagnosis</i> . Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
10	Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> <li>• Damaged or collapsed pipes</li> <li>• Internal muffler failure</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>



### Lack of Power, Sluggish or Spongy Symptom (Cont'd)

Step	Action	Value(s)	Yes	No
11	Check for the following engine mechanical problems: <ul style="list-style-type: none"> <li>• Low compression</li> <li>• Leaking cylinder head gasket</li> <li>• Worn or incorrect camshaft</li> <li>• Loose timing belt</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 12</i>
12	1. Review all the diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>• Visual/physical inspection.</li> <li>• Scan Tool data.</li> <li>• All electrical connections within a suspected circuit and/or system.</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Contact Technical Assistance</i>

### Detonation/Spark Knock Symptom

Step	Action	Value(s)	Yes	No
DEFINITION: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.				
1	Was the <i>On-Board Diagnostic (OBD) System Check</i> performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Perform a bulletin search. 2. If a bulletin that addresses the symptom is found, correct the condition as instructed in the bulletin. Was a bulletin found that addresses the symptom?	-	<i>Verify Repair</i>	<i>Go to Step 3</i>
3	Was a visual/physical check performed?	-	<i>Go to Step 4</i>	<i>Go to Visual/Physical Check</i>
4	1. If scan tool readings are normal (refer to <i>Typical Scan Values</i> ) and there are no engine mechanical faults, fill the fuel tank with a known quality gasoline that has a minimum octane rating <i>Showing on the applicable specification list</i> . 2. Re-evaluate the vehicle performance. Is detonation present?	-	<i>Go to Step 5</i>	<i>Verify Repair</i>
5	1. Check for obvious overheating problems: <ul style="list-style-type: none"> <li>• Low engine coolant.</li> <li>• Restricted air flow to radiator, or restricted water flow through radiator.</li> <li>• Incorrect coolant solution. It should be a 50/50 mix of approved antifreeze/water.</li> </ul> 2. If a problem is found, repair as necessary. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	Check fuel pressure. Refer to <i>Fuel System Pressure Test</i> . Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	Check items that can cause the engine to run lean. Refer to <i>Diagnostic Aids in Diagnostic Trouble Code 44</i> (if applicable). Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 8</i>
8	Check spark plugs for proper heat range. Refer to <i>General Information</i> . Were incorrect spark plugs installed?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	1. Remove excessive carbon buildup with a top engine cleaner. Refer to instructions on the top engine cleaner can. 2. Re-evaluate vehicle performance. Is detonation still present?	-	<i>Go to Step 10</i>	<i>Verify repair</i>
10	Check for an engine mechanical problem. Perform a cylinder compression check. Refer to <i>Engine Mechanical</i> . Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 11</i>

**Detonation/Spark Knock Symptom (Cont'd)**

Step	Action	Value(s)	Yes	No
11	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>• Visual/physical inspection.</li> <li>• Scan tool data.</li> <li>• All electrical connections within a suspected circuit and/or system.</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Contact Technical Assistance</i>

**Rough, Unstable, or Incorrect Idle, Stalling Symptom (For Open Loop System)**

Step	Action	Value(s)	Yes	No
DEFINITION: Engine runs unevenly at idle. If severe, the engine or vehicle may shake. Engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.				
1	Was the <i>On-Board Diagnostic (OBD) System Check</i> performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Perform a bulletin search. 2. If a bulletin that addresses the symptom is found, correct the condition as instructed in the bulletin. Was a bulletin found that addresses the symptom?	-	<i>Verify Repair</i>	<i>Go to Step 3</i>
3	Was a visual/physical check performed, including the rotor, ignition coil and secondary ignition wires?	-	<i>Go to Step 4</i>	<i>Go to Visual/Physical Check</i>
4	1. Check for incorrect idle speed. Ensure that the following conditions are present. <ul style="list-style-type: none"> <li>• Engine fully warm.</li> <li>• Accessories are OFF.</li> </ul> 2. Using a Scan Tool, monitor IAC position. Is the IAC position within the specified values?	Between 8 and 50 counts	<i>Go to Step 7</i>	<i>Go to Step 5</i>
5	1. Visually/Physically inspect for the following conditions: <ul style="list-style-type: none"> <li>• Restricted air intake system. Check for a restricted air filter element, or foreign objects blocking the air intake system.</li> <li>• Check for objects blocking the IAC passage or throttle bore, excessive deposits in the IAC passage and on the IAC pintle, and excessive deposits in the throttle bore and on the throttle plate.</li> <li>• Check for a condition that causes a large vacuum leak, such as an incorrectly installed or faulty crankcase ventilation hose/brake booster hose.</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	Using a Scan Tool, monitor TP angle with the engine idling. Is the TP angle at the specified value and steady?	0%	<i>Go to Step 7</i>	<i>Refer to Diagnostic Trouble Code 21 for further diagnosis</i>
7	Check for proper ignition voltage output with the spark tester (Use commercially available tool). Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 8</i>
8	1. Remove the spark plugs and check for gas or oil fouling cracks, wear, improper gap, burned electrodes, heavy deposits or improper heat range 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 9</i>

**Rough, Unstable, or Incorrect Idle, Stalling Symptom (For Open Loop System)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
9	Check for a loose ignition coil ground. Refer to Electrical Ignition System. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
10	Check the items that can cause the engine to run lean. Refer to Idle CO Concentration Check and Adjustment. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
11	Check the injector connections, if any of the injectors are connected to an incorrect cylinder, correct as necessary. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 12</i>
12	Perform the injector Coil/Balance Test. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 13</i>
13	Check the following engine mechanical problems: Low compression Leaking cylinder head gasket Worn or incorrect camshaft Sticking or leaking valves Broken valve springs Camshaft drive belt slipped or stripped Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 14</i>
14	1. Check for faulty motor mounts. Refer to Engine Mechanical for inspection of mounts. 2. If a problem is found, repair as necessary. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 15</i>
15	1. Review all the diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: Visual/ Physical inspection Scan tool data All electrical connections within a suspected circuit and/or system Was a problem found?	-	<i>Verify repair</i>	Contact Technical Assistance

### Rough, Unstable, or incorrect Idle, Stalling Symptom (For Closed Loop System)

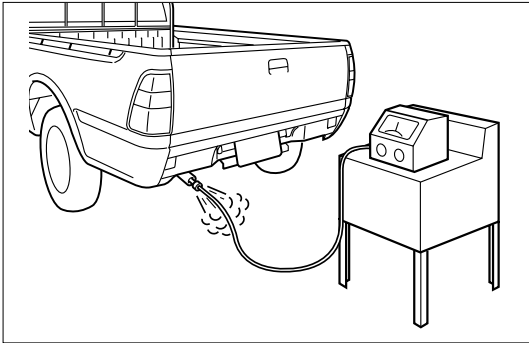
Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Read the "Caution" above. 2. Relieve the fuel system pressure and install the fuel pump pressure gauge to the test fitting. 3. Use a scan tool to command the fuel pump ON. Is there an immediate pressure build-up which indicates the pump is running?	-	<i>Go to Step 3</i>	<i>Go to Step 4</i>
3	1. Verify that the pump is not running by removing the fuel filler cap and listening. 2. Command the pump ON with the scan tool. Did the pump turn OFF after 2 seconds?	-	Test completed	<i>Go to Step 12</i>
4	1. Ignition OFF. 2. Remove the fuel pump relay. 3. Using a test light connected to ground, probe the battery feed to the relay. Did the light illuminate?	-	<i>Go to Step 6</i>	<i>Go to Step 5</i>
5	Repair short or open battery feed to fuel pump relay. Is the action complete?	-	<i>Verify repair</i>	-
6	1. Connect a test light between the two wires that connect to the fuel pump relay pull-in coil. 2. Ignition ON. Did the test light illuminate for 2 seconds and then turn off?	-	<i>Go to Step 12</i>	<i>Go to Step 7</i>
7	1. With a test light connected to battery (-), probe the fuel pump relay connector at the wire which runs from the relay pull-in coil to the ECM. 2. Ignition ON. Did the test light illuminate for 2 seconds and then turn off?	-	<i>Go to Step 8</i>	<i>Go to Step 9</i>
8	Locate and repair open in the fuel pump relay ground circuit. Is the action complete?	-	<i>Verify repair</i>	-
9	Check for short or open between the ECM and the fuel pump relay. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
10	1. Check the fuel pump relay circuit for a poor terminal connection at the ECM. 2. If a problem is found, replace terminal as necessary. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
11	Replace the ECM. <b>Important:</b> The replacement ECM must be programmed. Refer to <i>On-Vehicle Service in Powertrain Control Module</i> and <i>Sensors</i> for procedures. Is the action complete?	-	<i>Verify repair</i>	-

**Rough, Unstable, or incorrect Idle, Stalling Symptom (For Closed Loop System)**

Step	Action	Value(s)	Yes	No
12	1. Reconnect the fuel pump relay. 2. Disconnect the fuel pump electrical connector at the fuel tank. 3. Using a test light connected to ground, probe the fuel pump feed wire (harness side). 4. Command the fuel pump ON with a scan tool. Did the light illuminate for 2 seconds?	-	<i>Go to Step 15</i>	<i>Go to Step 13</i>
13	1. Honk the horn to verify that horn relay is functioning. 2. Substitute the horn relay for the fuel pump relay. 3. Leave the test light connected as in step 12. 4. Command the fuel pump ON with the scan tool. Did the test light illuminate for 2 seconds when the fuel pump was commanded ON?	-	<i>Go to Step 17</i>	<i>Go to Step 14</i>
14	1. Re-connect the horn relay in its proper location. 2. Check for a short circuit, blown fuse or open circuit between the relay and the fuel tank. Is the action complete?	-	<i>Verify repair</i>	-
15	1. with the fuel pump electrical connector at the fuel tank disconnected, connect a test light between the feed wire and the ground wire (harness side). 2. Command the fuel pump ON with a scan tool. Did the test light illuminate for 2 seconds.	-	<i>Go to Step 18</i>	<i>Go to Step 16</i>
16	Repair the open circuit in the fuel pump ground wire. Is the action complete?	-	<i>Verify repair</i>	-
17	1. Re-connect the horn relay in its proper location. 2. Replace the fuel pump relay. Is the action complete?	-	<i>Verify repair</i>	-
18	Replace the fuel pump. Is the action complete?	-	<i>Verify repair</i>	-

## Idle CO Concentration Check and adjustment

1. Before starting adjusting work, check and confirm the following conditions.  
 Normal engine operating temperature.  
 All accessories switched off.  
 Throttle valve closed.  
 Transmission in neutral.
2. Before starting adjusting work, step on accelerator pedal a few times and do racing up to 3000rpm.
3. After taking foot off accelerator pedal, short out pins #5 + #6 of ALDL Connector(Fixed under center console panel) short.  
 (When you do this, Check Engine Lamp will blink, and engine rpm will rise to 100 to 1600rpm)
4. In this condition, connect CO meter with Tail Pig and check CO value(%).

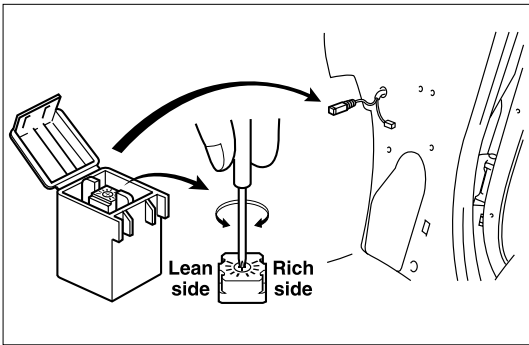


5. If CO value is within the range shown below, leave as it is. If it is out of range, adjust it by turning the screw of CO Adjuster.  
 (After adjusting, confirm that CO value becomes stable.)

Note: After adjusting work is finished, apply the liquid gasket to the CO adjuster screw. And after that, all conditions to restore to former state.

Regulated range of CO concentration value:

$$1.0 \begin{matrix} +0.2 \\ -0.5 \end{matrix}$$





### Poor Fuel Economy Symptom

Step	Action	Value(s)	Yes	No
DEFINITION: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.				
1	Was the <i>On-Board Diagnostic (OBD) System Check</i> performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Perform a bulletin search. 2. If a bulletin that addresses the symptom is found, correct the condition as instructed in the bulletin. Was a bulletin found that addresses the symptom?	-	<i>Verify Repair</i>	<i>Go to Step 3</i>
3	Was a visual/physical check performed?	-	<i>Go to Step 4</i>	<i>Go to Visual/Physical Check</i>
4	Check owner's driving habits. <ul style="list-style-type: none"> <li>• Is the A/C On full time (defroster mode ON)?</li> <li>• Are tires at the correct pressure?</li> <li>• Are excessively heavy loads being carried?</li> <li>• Is acceleration too much, too often?</li> </ul>	-	<i>Go to Step 5</i>	<i>Go to Step 6</i>
5	Review the items in Step 4 with the customer and advise as necessary. Is the action complete?	-	<i>System OK</i>	-
6	1. Visually/Physically check: Vacuum hoses for splits, kinks, and improper connections and routing as shown on the "Emission Control System schematics". Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	Remove and check the air filter element for dirt or for restrictions. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 8</i>
8	1. Remove the spark plugs and check for gas or oil fouling cracks, wear, improper gap, burned electrodes of heavy deposits. 2. Is spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	Check for low engine coolant level. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
10	Check for an incorrect or faulty engine thermostat. Refer to <i>Engine Cooling</i> . Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
11	Check for low engine compression. Refer to <i>Engine Mechanical</i> . Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 12</i>

### Poor Fuel Economy Symptom (Cont'd)

Step	Action	Value(s)	Yes	No
12	Check for proper calibration of the speedometer. Does the speed indicated on the speedometer closely match the vehicle speed displayed on the Scan Tool?	-	<i>Go to Step 14</i>	<i>Go to Step 13</i>
13	Diagnose and repair the inaccurate speedometer condition as necessary. Refer to <i>Vehicle Speed Sensor in Electrical Diagnosis</i> .	-	<i>Verify repair</i>	-
14	Check the air intake system and the crankcase for air leaks. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 15</i>
15	1. Review all the diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>• Visual/physical inspection</li> <li>• Scan tool data</li> <li>• All electrical connections within a suspected circuit and/or system</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 16</i>
16	Perform the procedure in <i>Fuel System Pressure Test</i> . Was the fuel pressure normal?	-	<i>Contact Technical Assistance</i>	<i>Verify repair</i>

### Dieseling, Run-On Symptom

Step	Action	Value(s)	Yes	No
DEFINITION: Engine continues to run after key is turned OFF, but runs very rough. If engine runs smoothly, check the ignition switch and adjustment.				
1	Was the <i>On-Board Diagnostic (OBD) System Check</i> performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Perform a bulletin search. 2. If a bulletin that addresses the symptom is found, correct the condition as instructed in the bulletin. Was a bulletin found that addresses the symptom?	-	<i>Verify repair</i>	<i>Go to Step 3</i>
3	Was a visual/physical check performed?	-	<i>Go to Step 4</i>	<i>Go to Visual/Physical Check</i>
4	1. Check for a short between B+ and the ignition feed circuit. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 5</i>
5	1. Review all the diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>• Visual/physical inspection.</li> <li>• Scan Tool data.</li> <li>• All electrical connections within a suspected circuit and/or system.</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Contact Technical Assistance</i>

### Backfire Symptom

Step	Action	Value(s)	Yes	No
DEFINITION: Fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.				
1	Was the <i>On-Board Diagnostic (OBD) System Check</i> performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Perform a bulletin search. 2. If a bulletin that addresses the symptom is found, correct the condition as instructed in the bulletin. Was a bulletin found that addresses the symptom?	-	<i>Verify repair</i>	<i>Go to Step 3</i>
3	Was a visual/physical check performed?	-	<i>Go to Step 4</i>	<i>Go to Visual/Physical Check</i>
4	Check for proper ignition voltage output with the spark tester (Use commercially available tool). Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 5</i>
5	1. Remove the spark plugs and check for gas or oil fouling cracks, wear, improper gap, burned electrodes of heavy deposits. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	1. Visually/Physically inspect the secondary ignition wires. Check for the following conditions: • Verify that all ignition wire resistance are less than the specified value. • Verify that ignition wires are correctly routed to eliminate cross-firing. • Verify that ignition wires are not arcing to ground. Spraying the secondary ignition wires with a light mist of water may help locate an intermittent problem. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	Check for an intermittent ignition system malfunction: • Intermittent CKP 58X signal. • Intermittent ignition feed circuit or sensor ground circuit to the crankshaft position sensor. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 8</i>
8	Refer to <i>Fuel System Diagnosis</i> to determine if there is a problem with fuel delivery. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	Check for the following engine mechanical problems: • Low compression • Leaking cylinder head gasket • Worn or incorrect camshaft • Incorrect valve timing • Sticking or leaking valves • Camshaft drive belt slipped or stripped. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>

**Backfire Symptom (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
10	Check the intake and exhaust manifold(s) for casting flash. Refer to <i>Engine Mechanical</i> . Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
11	1. Review all the diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>• Visual/physical inspection.</li> <li>• Scan Tool data.</li> <li>• All electrical connections within a suspected circuit and/or system.</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Contact Technical Assistance</i>

**Cuts Out, Misses Symptom**

Step	Action	Value(s)	Yes	No
DEFINITION: Steady pulsation or jerking that follows engine speed; usually more pronounced as engine load increases.				
1	Was the <i>On-Board Diagnostic (OBD) System Check</i> performed?	-	Go to Step 2	Go to OBD System Check
2	1. Perform a bulletin search. 2. If a bulletin that addresses the symptom is found, correct the condition as instructed in the bulletin. Was a bulletin found that addresses the symptom?	-	Verify Repair	Go to Step 3
3	Was a visual/physical check performed?	-	Go to Step 4	Go to Visual/Physical Check
4	Check the ECM grounds to verify that they are clean and tight. Refer to the <i>ECM wiring diagrams in Electrical Diagnosis</i> . Was a problem found?	-	Verify repair	Go to Step 5
5	Monitor "O2 Status" on the Scan Tool. Is the "O2 Status" in the rich condition (If applicable) ?		Go to Step 6	Go to Step 7
6	Check items that can cause the engine to run rich. Refer to "Diagnostic Aids" in <i>Diagnostic Trouble Code 45</i> (If applicable). Was a problem found?	-	Verify repair	Go to Step 9
7	Is the "O2 Status" significantly in the lean condition (If applicable)?	-	Go to Step 8	Go to Step 9
8	Check items that can cause the engine to run lean. Refer to <i>Diagnostic Aids in Diagnostic Trouble Code 44</i> (If applicable). Was a problem found?	-	Verify repair	Go to Step 9
9	1. Check for incorrect idle speed. Ensure that the following conditions are present: <ul style="list-style-type: none"> <li>• Engine fully warm.</li> <li>• Accessories are OFF.</li> </ul> 2. Using a Scan Tool, monitor the IAC position. Is the IAC position within the specified values?	Between 5 and 50 counts	Go to Step 11	Go to Step 10

## Cuts Out, Misses Symptom (Cont'd)

Step	Action	Value(s)	Yes	No
10	<p>1. Visually/Physically inspect for the following conditions:</p> <ul style="list-style-type: none"> <li>• Restricted air intake system. Check for a restricted air filter element, or foreign objects blocking the air intake system.</li> <li>• Check for objects blocking the IAC passage or throttle bore, excessive deposits in the IAC passage and on the IAC pintle, and excessive deposits in the throttle bore and on the throttle plate.</li> <li>• Check for a condition that causes a large vacuum leak, such as an incorrectly installed or faulty crankcase ventilation hoses or brake booster hose disconnected.</li> </ul> <p>Was a problem found?</p>	-	Verify repair	Go to Step 11
11	<p>1. Check the injector connections. If any of the injectors are connected to an incorrect cylinder, correct as necessary.</p> <p>Was a problem found?</p>	-	Verify repair	Go to Step 12
12	<p>1. Perform the <i>Injector Coil/Balance Test</i>.</p> <p>Was a problem found?</p>	-	Verify repair	Go to Step 13
13	<p>1. Check for fuel in the pressure regulator vacuum hose.</p> <p>2. If fuel is present, replace the fuel pressure regulator assembly.</p> <p>Was a problem found?</p>	-	Verify repair	Go to Step 14
14	<p>Check for proper ignition voltage output with the spark tester (Use commercially available tool).</p> <p>Was a problem found?</p>	-	Verify repair	Go to Step 15
15	<p>1. Remove spark plugs and check for gas or oil fouling cracks, wear, improper gap, burned electrodes or heavy deposits.</p> <p>2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs.</p> <p>Was a problem found?</p>	-	Verify repair	Go to Step 16
16	<p>Check for a loose ignition control module ground.</p> <p>Was a problem found?</p>	-	Verify repair	Go to Step 17
17	<p>Using a Scan Tool, monitor the TP angle with the engine idling.</p> <p>Is the TP angle at the specified value and steady?</p>	0%	Go to Step 18	Refer to Diagnostic Trouble Code 21 for further diagnosis
18	<p>Check the PCV passage for proper operation.</p> <p>Was a problem found?</p>	-	Verify repair	Go to Step 19

**Cuts Out, Misses Symptom (Cont'd)**

Step	Action	Value(s)	Yes	No
19	Check the following engine mechanical problems: <ul style="list-style-type: none"> <li>• Low compression</li> <li>• Leaking cylinder head gasket</li> <li>• Worn or incorrect camshaft</li> <li>• Sticking or leaking valves</li> <li>• Valve timing</li> <li>• Broken valve springs</li> <li>• Camshaft drive belt slipped or stripped.</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 20</i>
20	Check for faulty motor mounts. Refer to <i>Engine Mechanical</i> for inspection of mounts. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 21</i>
21	1. Review all the diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>• Visual/physical inspection.</li> <li>• Scan Tool data.</li> <li>• All electrical connections within a suspected circuit and/or system.</li> </ul> Was a problem found?	-	<i>Verify repair</i>	<i>Contact Technical Assistance</i>



### Hesitation, Sag, Stumble Symptom

Step	Action	Value(s)	Yes	No
DEFINITION: Momentary lack of response as the accelerator is pushed down. Can occur at any vehicle speed. Usually most pronounced when first trying to make the vehicle move, as from a stop sign. May cause the engine to stall if severe enough.				
1	Was the <i>On-Board Diagnostic (OBD) System Check</i> performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Perform a bulletin search. 2. If a bulletin that addresses the symptom is found, correct the condition as instructed in the bulletin. Was a bulletin found that addresses the symptom?	-	<i>Verify Repair</i>	<i>Go to Step 3</i>
3	Was a visual/physical check performed?	-	<i>Go to Step 4</i>	<i>Go to Visual/Physical Check</i>
4	1. Check the fuel control heated oxygen sensor (If applicable). The HO <sub>2</sub> S should respond quickly to different throttle positions. If it doesn't, check for silicon or other contaminants from fuel or use of improper RTV sealant. The sensors may have a white powdery coating. Silicon contamination sends a rich exhaust signal which causes the ECM to command an excessively lean air/fuel mixture. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 5</i>
5	Check the fuel pressure. Refer to <i>Fuel System Pressure Test</i> . Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	Observe the "TP angle" display on the Scan Tool while slowly increasing throttle pedal. Does the TP angle display steadily increase from 0% at closed throttle to 100% at WOT?	-	<i>Go to Step 7</i>	<i>Go to Step 13</i>
7	Monitor "Long Term Fuel Trim" on the Scan Tool. Is the "Long Term Fuel Trim" in the negative range (rich condition)?	-	<i>Go to Step 8</i>	<i>Go to Step 9</i>
8	Check items that can cause the engine to run rich. Refer to <i>Diagnostic Aids in Diagnostic Trouble Code 45</i> (If applicable). Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
9	Check items that can cause the engine to run lean. Refer to <i>Diagnostic Aids in Diagnostic Trouble Code 44</i> (If applicable). Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
10	Check for proper ignition voltage output with spark tester (Use commercially available tool). Refer to <i>Electronic Ignition System</i> for the procedure. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 11</i>

**Hesitation, Sag, Stumble Symptom (Cont'd)**

Step	Action	Value(s)	Yes	No
11	Check for a loose ignition control module ground. Was a problem found?	-	Verify repair	Go to Step 12
12	Visually/Physically inspect the secondary ignition wires. Check for the following conditions. <ul style="list-style-type: none"> <li>• Verify that all ignition wire resistance are less than the specified value.</li> <li>• Value that ignition wires are correctly routed to eliminate cross-firing.</li> <li>• Verify that ignition wires are not arcing to ground. Spraying the secondary ignition wires with a light mist of water may help locate an intermittent problem.</li> </ul> Was a problem found?	#1 cyl. 4.7kΩ #2 cyl. 3.9kΩ #3 cyl. 3.4kΩ #4 cyl. 3.1kΩ	Verify repair	Go to Step 14
13	Replace the TP sensor.	-	Verify repair	-
14	1. Check the ignition coil secondary resistance. 2. Replace the coil if it is greater than the specified value. Was a problem found?	2.5 kΩ	Verify repair	Go to Step 15
15	1. Remove the spark plugs and check for gas or oil fouling cracks, wear, improper gap, burned electrodes of heavy deposits. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	-	Verify repair	Go to Step 16
16	Check the ECM grounds to verify that they are clean and tight. Refer to the ECM wiring diagrams in <i>Electrical Diagnosis</i> . Was a problem found?	-	Verify repair	Go to Step 17
17	Visually/Physically check the vacuum hoses for splits, kinks and proper connections and proper connections and routing as shown on the "Emission Control System Schematics". Was a problem found?	-	Verify repair	Go to Step 18
18	1. Review all the diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>• Visual/physical inspection.</li> <li>• Scan Tool data.</li> <li>• All electrical connections within a suspected circuit and/or system.</li> </ul> 3. If a problem is found, repair as necessary. Was a problem found?	-	Verify repair	Contact Technical Assistance

## DEFAULT MATRIX TABLE

### SERVICE PROCEDURE DEFAULT STRATEGY

A referral strategy has been established to assist the technician with additional information when the cause of the failure cannot be determined. If no problem is found after performing diagnostics, then refer to the default matrix table for further diagnostic information.

### Default Matrix Table

Strategy Based Diagnostic Charts	Initial Diagnosis	Default Section(s)
On-Board Diagnostic (OBD) System Check	Vehicle does not enter diagnostics.	Chassis Electrical
On-Board Diagnostic (OBD) System Check	Vehicle enters diagnostics and communicates with the Scan Tool. MIL is ON in diagnostics. Engine does not start and run.	Ignition System Check
On-Board Diagnostic (OBD) System Check	Engine starts and runs, no ECM codes set. Customer complains of vibration.	-
ECM Power and Ground Check	On-Board Diagnostic (OBD) System Check.	Chassis Electrical
ECM Power and Ground Check	On-Board Diagnostic (OBD) System Check. ECM power and ground circuits OK. Data link voltage incorrect.	Chassis Electrical
Symptoms	Initial Diagnosis	Default Section(s)
Intermittens	1. On-board diagnostic (OBD) system check. 2. Careful visual/physical inspections.	Chassis Electrical
Hard Starts	1. OBD system check. 2. Sensors (ECT, MAP, TP); MAP output chart. 3. Fuel system electrical test, fuel system diagnosis. 4. Ignition system. 5. IAC system check.	Engine Mechanical, Ignition System Check, Exhaust System Diagnosis
Surges and/or Chuggles	1. OBD system check. 2. Heated oxygen sensors (If applicable). 3. Fuel system diagnosis. 4. Ignition system.	Calibration ID "Broadcast Code" /Service Bulletins, Ignition System Check, Generator Output, Exhaust System Diagnosis

### Default Matrix Table (Cont'd)

Strategy Based Diagnostic Charts	Initial Diagnosis	Default Section(s)
Lack of Power, Sluggish or Spongy	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Fuel system diagnosis.</li> <li>3. Ignition system.</li> </ol>	Refer to Exhaust System in Engine Exhaust, Calibration ID/Service Bulletins
Detonation/Spark Knock	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Fuel system diagnosis.</li> <li>3. Ignition system.</li> </ol>	Cooling System, Ignition System Check, Calibration ID/Service Bulletins
Hesitation, Sag, Stumble	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. TP.</li> <li>3. MAP output check.</li> <li>4. Fuel system diagnosis.</li> <li>5. Fuel injector and fuel injector balance test.</li> <li>6. EVAP emission canister purge control solenoid valve (If applicable).</li> <li>7. Ignition system.</li> </ol>	Generator Output Voltage (refer to Chassis Electrical), Calibration ID/Service Bulletins, Ignition System Check
Cuts Out, Misses	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Cylinder balance test.</li> </ol>	Ignition System Check
Rough, Unstable, or Incorrect Idle, Stalling	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Fuel injector and fuel injector balance test.</li> <li>3. EVAP emission canister purge control solenoid valve check (If applicable).</li> <li>4. Ignition system.</li> <li>5. IAC operation.</li> </ol>	MAP Output Check, Throttle Linkage, IAC System Check, A/C Clutch Control Circuit Diagnosis, Crankcase Ventilation System, Calibration ID/Service Bulletins, Generator Output Voltage (refer to Chassis Electrical), Exhaust Diagnosis
Poor Fuel Economy	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Careful visual/physical inspection.</li> <li>3. Ignition system.</li> <li>4. Cooling system.</li> </ol>	Exhaust System (refer to Engine Exhaust)
Engine Cranks But Will Not Run	<ol style="list-style-type: none"> <li>1. OBD system check.</li> </ol>	Fuel System Electrical Diagnosis, Fuel System Diagnosis, Fuel Injector and Fuel Injector Balance Test.
Excessive Exhaust Emissions or Odors	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Emission test.</li> <li>3. Cooling system.</li> <li>4. Fuel system diagnosis.</li> <li>5. Fuel injector and fuel injector balance test.</li> <li>6. EVAP emission canister purge control solenoid valve (If applicable).</li> <li>7. Crankcase ventilation system.</li> <li>8. Ignition system.</li> <li>9. MAP output check.</li> </ol>	Exhaust Diagnosis, Calibration ID/Service Bulletins
Dieseling, Run-On	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Careful visual/physical inspection.</li> <li>3. Fuel system diagnosis.</li> </ol>	-

**Default Matrix Table (Cont'd)**

<b>Strategy Based Diagnostic Charts</b>	<b>Initial Diagnosis</b>	<b>Default Section(s)</b>
Backfire	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Ignition system.</li> <li>3. Fuel system diagnosis.</li> <li>4. Fuel injector and fuel injector balance test.</li> </ol>	Exhaust System Diagnosis, Intake Casting Flash, Ignition System Check
Misfire	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Ignition system.</li> <li>3. Fuel system diagnosis.</li> <li>4. Fuel injector and fuel injector balance test.</li> </ol>	Vibrations, Transmission, Driveshaft and Axle
Catalyst Monitor	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Careful visual/physical inspection.</li> <li>3. Heated oxygen sensors. (If applicable)</li> </ol>	Exhaust System
Fuel Trim	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Careful visual/physical inspection.</li> <li>3. Fuel system diagnosis.</li> <li>4. Heated oxygen sensors. (If applicable)</li> </ol>	Exhaust System Intake Air System
Evaporative Emissions (If applicable)	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Careful visual/physical inspection.</li> <li>3. Fuel system diagnosis.</li> </ol>	-
Heated Oxygen Sensors (If applicable)	<ol style="list-style-type: none"> <li>1. OBD system check.</li> <li>2. Careful visual/physical inspection.</li> </ol>	Exhaust System

## ENGINE CRANKS BUT WILL NOT RUN

### Circuit Description

The electronic ignition system uses a dual coil method of spark distribution. In this type of ignition system, the engine control module (ECM) triggers the correct driver inside the ECM, which then triggers the correct ignition timing based on the 58X signal received from the crankshaft position sensor (CKP). The spark plug connected to the coil fires when the coil driver opens the ground circuit for the coil's primary circuit.

During crank, the ECM monitors the CKP 58X signal. The CKP signal is used to determine which cylinder will fire first. After the CKP 58X signal has been processed by the ECM, the four injectors are divided into two groups, one is composed of #1 and #4 cylinders, the other group, #2 and #3 cylinders.

58X signal is processed by ECM and it issues the following command to each group at every turn of the crankshaft.

To jet a half amount of the fuel required for a single combustion stroke to each cylinder.

### Diagnostic Aids

An intermittent problem may be caused by a poor connection, rubbed-through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness - Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection, and damaged harness.
- Faulty engine coolant temperature sensor - Using a scan tool, compare engine coolant temperature with intake air temperature on a completely cool engine. Engine coolant temperature should be within 10°C of intake air temperature. If not, replace the ECT sensor.

### Engine Cranks But Will Not Run

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	Use the Scan Tool and check for any DTC's. Are any DTC's stored?	-	<i>Go to Applicable DTC Table</i>	<i>Go to Step 3</i>
3	Check the 15A ignition coil fuse, the 15A engine device fuse, and the 15A ECM fuse. Was a fuse blown?	-	<i>Go to Step 4</i>	<i>Go to Step 5</i>
4	Check for a short to ground and replace the fuse. Is the action complete?	-	<i>Verify repair</i>	-
5	1. Ignition ON 2. Use a grounded test lamp to verify that B+ is available at the ignition coil fuse, the engine device fuse, and the ECM fuse. 3. Was B+ available at the fuses?	-	<i>Go to Step 7</i>	<i>Go to Step 6</i>
6	Repair the open ignition feed circuit.	-	<i>Go to Fuel System Electrical Test</i>	<i>Go to Fuel System Diagnosis</i>

### Engine Cranks But Will Not Run (Cont'd)

Step	Action	Value(s)	Yes	No
7	1. Disconnect the ignition secondary wire at the No.1. 2. Install a spark tester (Use commercially available tool) at the end of the disconnected ignition coil. 3. Clip the spark tester (Use commercially available tool) to a good ground (not near the battery). 4. Observe the spark tester while the engine is cranking. Was a crisp blue spark observed? (Only one or two sparks followed by no result is considered the same as "No Spark." )	-	<i>Go to Step 16</i>	<i>Go to Step 8</i>
8	1. Disconnect the ignition coil harness connector. 2. Check for an open or short circuit between the ignition coil and the ECM? Was a problem found?	-	<i>Go to Step 9</i>	<i>Go to Step 10</i>
9	Repair the faulty circuit.	-	<i>Verify repair</i>	-
10	1. Ignition ON. 2. Using a Digital Voltmeter (DVM) check the ignition wire coil at the ignition coil harness connector? Was the voltage equal to the specified value?	B+	<i>Go to Step 12</i>	<i>Go to Step 11</i>
11	Repair the open circuit.	-	<i>Verify repair</i>	-
12	1. Ignition OFF. 2. With DVM, check for an open in the ground wire at the ignition coil harness connector. Was the ground wire OK?	-	<i>Go to Step 14</i>	<i>Go to Step 13</i>
13	Repair the faulty wire.	-	<i>Verify Repair</i>	-
14	Replace the ignition coil, verify the repair. Attempt to start the engine. Is there still a problem?	-	<i>Go to Step 15</i>	<i>Verify repair</i>
15	Replace the EPROM or ECM.	-	<i>Verify repair</i>	-
16	Use an ohmmeter to check the ignition coil primary winding resistance. Was the primary winding resistance approximately equal to the specified value?	0.8-18 $\Omega$	<i>Go to Step 17</i>	<i>Go to Step 18</i>
17	Use an ohmmeter to check the ignition coil secondary winding resistance. Was the secondary winding resistance near around the to the specified value?	2.5k $\Omega$	<i>Go to Step 19</i>	<i>Go to Step 18</i>
18	Replace the ignition coil.	-	<i>Verify repair</i>	-
19	Test the resistance of the coil-to-spark plug secondary ignition wire. Was the resistance greater than the specified value?	#1 cyl. 4.7k $\Omega$ #2 cyl. 3.9k $\Omega$ #3 cyl. 3.4k $\Omega$ #4 cyl. 3.1k $\Omega$	<i>Go to Step 20</i>	<i>Go to Step 21</i>
20	Replace the coil-to-spark plug secondary ignition wire and any other secondary wires which exceed the specified value. Is there still a problem?	#1 cyl. 4.7k $\Omega$ #2 cyl. 3.9k $\Omega$ #3 cyl. 3.4k $\Omega$ #4 cyl. 3.1k $\Omega$	<i>Go to Step 21</i>	<i>Verify repair</i>

### Engine Cranks But Will Not Run (Cont'd)

Step	Action	Value(s)	Yes	No
21	1. Remove the spark plugs from all cylinders. 2. Visually inspect the spark plug electrodes. 3. Replace any spark plugs with loose or missing electrodes or cracked insulators. Did your inspection reveal any spark plugs exhibiting excessing fouling?	-	. <i>Correct the fouling condition</i>	<i>Go to Step 33</i>
22	Verify repair. Attempt to start the engine. Is there still a problem?	-	<i>Go to Step 23</i>	<i>Go to Step 22</i>
23	1. Ignition OFF install a fuel pressure gauge at the test fitting on the fuel supply line in the engine compartment. <b>Caution:</b> Use a shop cloth to absorb any fuel leakage while making the connection. 2. Check the engine and observe the fuel pressure. Is the fuel pressure within the specified values, and does it hold steady for 2 seconds?	285-375 kPa (43-55 psi)	<i>Go to Step 25</i>	<i>Go to Step 24</i>
24	Is any fuel pressure indicated?	-	<i>Go to Fuel System Electrical Test</i>	<i>Go to Fuel System Diagnosis</i>
25	1. Install switch box Injector Adaptor Cable 5-8840-2589-0 and Fuel Injector Tester 5-8840-2618-0 to the injector connector. 2. Activate an injector. Did the fuel pressure drop when the injector was activated?	-	<i>Go to Step 26</i>	<i>Go to Fuel System Diagnosis</i>
26	Pressurize the fuel system using the ignition ON and switch the injector connector to test pressure drop for each injector. Was there a pressure drop when each injector was activated?	-	<i>Go to Step 27</i>	<i>Go to Fuel System Diagnosis</i>
27	1. Remove all SST and re-assemble the all connectors and fuel hoses to original position. 2. Crank the engine. Does the engine start smoothly?	-	<i>Go to Step 33</i>	<i>Go to Step 28</i>
28	1. Raise the vehicle and disconnect the CKP sensor harness. 2. Ignition ON. 3. With a test light to ground, probe the CKP ignition feed harness terminal. Did the light illuminate?	-	<i>Go to Step 29</i>	<i>Go to Step 30</i>
29	1. Ignition ON. 2. At the CKP harness connector, connect a test lamp between the ignition and ground terminals. Did the lamp illuminate?	-	<i>Go to Step 31</i>	<i>Go to Step 32</i>



### Engine Cranks But Will Not Run (Cont'd)

Step	Action	Value(s)	Yes	No
30	Check the CKP High circuit between the sensor and the ECM for a short to ground or open circuit. Was a problem found?	-	<i>Verify Repair</i>	<i>Go to Step 33</i>
31	Replace the CKP position sensor. Is there still a problem?	-	<i>Go to Step 34</i>	-
32	Check the CKP Low circuit between the sensor and the ECM for: an open circuit, a short to ground, or short to voltage. Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 33</i>
33	Replace the EPROM or ECM. Note) Refer to 6E-243	-	<i>Verify Repair</i>	-
34	1. Test the fuel for contamination. 2. If a problem is found, clean the fuel system and correct the contaminated fuel condition as necessary. Replace the fuel filter and replace any injectors that are not delivering fuel (see Injector Balance Test). Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 35</i>
35	Refer to <i>Engine Mechanical Diagnosis</i> to diagnose the following conditions: <ul style="list-style-type: none"> <li>• Slipped camshaft drive belt.</li> <li>• Leaking or sticky valves or rings.</li> <li>• Excessive valve deposits.</li> <li>• Loose or worn rocker arms.</li> <li>• Weak valve springs.</li> <li>• Leaking head gasket.</li> </ul> Is the action complete?	-	<i>Verify repair</i>	-





**Test Description**

Number(s) below refer to the step number(s) on the Diagnostic Chart.

- 2. If the fuel pump is operating but incorrect pressure is noted, the fuel pump wiring is OK and the “Fuel System Pressure Test” chart should be used for diagnosis.

**⚠ Caution: To reduce the risk of fire and personal injury:**

- ***It is necessary to relieve fuel system pressure before connecting a fuel pressure gauge. Refer to Fuel Pressure Relief Procedure, below.***
- ***A small amount of fuel may be released when disconnecting the fuel lines. Cover fuel line fittings with a shop towel before disconnecting, to catch any fuel that may leak out. Place the towel in an approved container when the disconnect is completed.***

**Fuel Pressure Relief Procedure**

1. Remove the fuel cap.
2. Remove the fuel pump relay from the underhood relay center.
3. Start the engine and allow it to stall.
4. Crank the engine for an additional 3 seconds.

**Fuel Pressure Gauge Installation**

1. Remove the shoulder fitting cap.
2. Install fuel pressure gauge 5-8840-0378-0 to the fuel feed line located in front of and above the right side valve cover.
3. Reinstall the fuel pump relay.

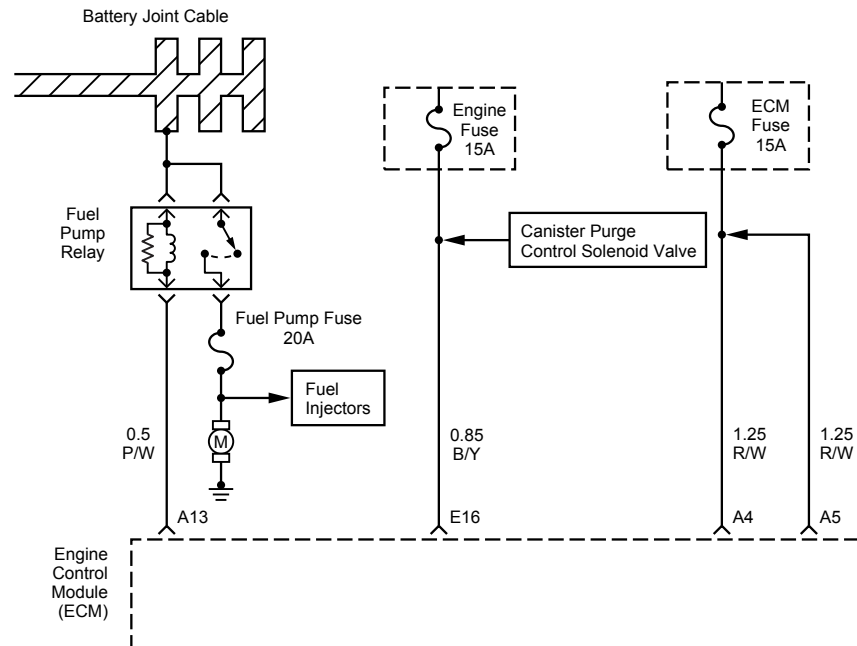
**Fuel System Electrical Test**

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic (OBD) System Check” performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Turn Ignition “ON”. 2. Install Scan Tool 3. Command Fuel Pump “ON”. Did the Fuel Pump turn on?	-	<i>Go to Fuel System Diagnosis</i>	<i>Go to Step 3</i>
3	1. Ignition OFF. 2. Remove the fuel pump relay. 3. Using a test light connected to ground, probe the battery feed to the relay. Did the light illuminate?	-	<i>Go to Step 5</i>	<i>Go to Step 4</i>
4	Repair short or open battery feed to fuel pump relay. Is the action complete?	-	<i>Verify repair</i>	-
5	1. Connect a test light between the two wires that connect to the fuel pump relay pull-in coil. 2. Ignition ON. Did the test light illuminate for 2 seconds and then turn off?	-	<i>Go to Step 11</i>	<i>Go to Step 6</i>
6	1. With a test light connected to battery (-), probe the fuel pump relay connector at the wire which runs from the relay pull-in coil to the ECM. 2. Ignition ON. Did the test light illuminate for 2 seconds and then turn off?	-	<i>Go to Step 7</i>	<i>Go to Step 8</i>

**Fuel System Electrical Test (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
7	Locate and repair open in the fuel pump relay ground circuit. Is the action complete?	-	<i>Verify repair</i>	-
8	Check for short or open between the ECM and the fuel pump relay. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	1. Check the fuel pump relay circuit for a poor terminal connection at the ECM. 2. If a problem is found, replace terminal as necessary. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
10	Replace the EPROM or ECM. Is the action complete?                      Note) Refer to 6E1-243.	-	<i>Verify repair</i>	-
11	1. Reconnect the fuel pump relay. 2. Disconnect the fuel pump electrical connector at the fuel tank 3. Using a test light connected to ground, probe the fuel pump feed wire (harness side). 4. Command the fuel pump ON with a scan tool. Did the light illuminate for 2 seconds?	-	<i>Go to Step 14</i>	<i>Go to Step 12</i>
12	1. Honk the horn to verify that the horn relay is functioning. 2. Substitute the horn relay for the fuel pump relay. 3. Leave the test light connected as in step 12. 4. Command the fuel pump ON with the scan tool. Did the test light illuminate for 2 seconds when the fuel pump was commanded ON?	-	<i>Go to Step 16</i>	<i>Go to Step 13</i>
13	1. Re-connect the horn relay in its proper location. 2. Check for a short circuit, blown fuse or open circuit between the relay and the fuel tank. Is the action complete?	-	<i>Verify repair</i>	-
14	1. With the fuel pump electrical connector at the fuel tank disconnected, connect a test light between the feed wire and the ground wire (harness side). 2. Command the fuel pump ON with a scan tool. Did the test light illuminate for 2 seconds?	-	<i>Go to Step 17</i>	<i>Go to Step 15</i>
15	Repair the open circuit in the fuel pump ground wire. Is the action complete?	-	<i>Verify repair</i>	-
16	1. Re-connect the horn relay in its proper location. 2. Replace the fuel pump relay. Is the action complete?	-	<i>Verify repair</i>	-
17	Replace the fuel pump. Is the action complete?	-	<i>Verify repair</i>	-





## FUEL SYSTEM DIAGNOSIS

### Circuit Description

When the ignition switch is turned ON, the engine control module (ECM) will turn ON the in-tank fuel pump. The in-tank fuel pump will remain ON as long as the engine is cranking or running and the ECM is receiving 58X crankshaft position pulses. If there are no 58X crankshaft position pulses, the ECM will turn the in-tank fuel pump OFF 2 seconds after the ignition switch is turned ON or 2 seconds after the engine stops running.

The in-tank fuel pump is an electric pump within an integral reservoir. The in-tank fuel pump supplies fuel through an in-line fuel filter to the fuel rail assembly.

The fuel pump is designed to provide fuel at a pressure above the pressure needed by the fuel injectors. A fuel pressure regulator, attached to the fuel rail, keeps the fuel available to the fuel injectors at a regulated pressure. Unused fuel is returned to the fuel tank by a separate fuel return line.

### Test Description

Number(s) below refer to the step number(s) on the Diagnostic Chart.

2. Connect the fuel pressure gauge to the fuel feed line as shown in the fuel system illustration. Wrap a shop towel around the fuel pressure connection in order to absorb any fuel leakage that may

occur when installing the fuel pressure gauge. With the ignition switch ON and the fuel pump running, the fuel pressure indicated by the fuel pressure gauge should be 283-376 kPa (41-55 psi). This pressure is controlled by the amount of pressure the spring inside the fuel pressure regulator can provide.

3. A fuel system that cannot maintain a constant fuel pressure has a leak in one or more of the following areas:
  - The fuel pump check valve.
  - The fuel pump flex line.
  - The valve or valve seat within the fuel pressure regulator.
  - The fuel injector(s).
4. Fuel pressure that drops off during acceleration, cruise, or hard cornering may cause a lean condition. A lean condition can cause a loss of power, surging, or misfire. A lean condition can be diagnosed using a Tech 2 Scan Tool.

**Following are applicable to the vehicle with closed Loop System:**

If an extremely lean condition occurs, the oxygen sensor(s) will stop toggling. The oxygen sensor output voltage(s) will drop below 500 mV. Also, the fuel injector pulse width will increase.

**! Important:** Make sure the fuel system is not operating in the "Fuel Cut-Off Mode."

When the engine is at idle, the manifold pressure is low (high vacuum). This low pressure (high vacuum) is applied to the fuel pressure regulator diaphragm. The low pressure (high vacuum) will offset the pressure being applied to the fuel pressure regulator diaphragm by the spring inside the fuel pressure regulator. When this happens, the result is lower fuel pressure. The fuel pressure at idle will vary slightly as the barometric pressure changes, but the fuel pressure at idle should always be less than the fuel pressure noted in step 2 with the engine OFF.

16. Check the spark plug associated with a particular fuel injector for fouling or saturation in order to determine if that particular fuel injector is leaking. If checking the spark plug associated with a particular fuel injector for fouling or saturation does not determine that a particular fuel injector is leaking, use the following procedure:
  - Remove the fuel rail, but leave the fuel lines and injectors connected to the fuel rail. Refer to *Fuel Rail Assembly in On-Vehicle Service*.

- Lift the fuel rail just enough to leave the fuel injector nozzles in the fuel injector ports.

**! Caution:** *In order to reduce the risk of fire and personal injury that may result from fuel spraying on the engine, verify that the fuel rail is positioned over the fuel injector ports and verify that the fuel injector retaining clips are intact.*

- **Pressurize the fuel system by connecting a 20 amp fused jumper between B+ and the fuel pump relay connector.**
- **Visually and physically inspect the fuel injector nozzles for leaks.**

17. A rich condition may result from the fuel pressure being above 376 kPa (55 psi). A rich condition may cause a 45 to set. Driveability conditions associated with rich conditions can include hard starting (followed by black smoke) and a strong sulfur smell in the exhaust.

20. This test determines if the high fuel pressure is due to a restricted fuel return line or if the high fuel pressure is due to a faulty fuel pressure regulator.

21. A lean condition may result from fuel pressure below 333 kPa (48 psi). A lean condition may cause a 44 to set. Driveability conditions associated with lean conditions can include hard starting (when the engine is cold), hesitation, poor driveability, lack of power, surging, and misfiring.

22. Restricting the fuel return line causes the fuel pressure to rise above the regulated fuel pressure. Command the fuel pump ON with the scan tool. The fuel pressure should rise above 376 kPa (55 psi) as the fuel return line becomes partially closed.

**Notice:** Do not allow the fuel pressure to exceed 414 kPa (60 psi). Fuel pressure in excess of 414 kPa (60 psi) may damage the fuel pressure regulator.

**! Caution:** *To reduce the risk of fire and personal injury:*

- **It is necessary to relieve fuel system pressure before connecting a fuel pressure gauge. Refer to Fuel Pressure Relief Procedure, below.**
- **A small amount of fuel may be released when disconnecting the fuel lines. Cover fuel line fittings with a shop towel before disconnecting, to catch any fuel that may leak out. Place the towel in an approved container when the disconnect is completed.**



**Fuel Pressure Relief Procedure**

1. Remove the fuel cap.
2. Located on the intake manifold which is at the top right part of the engine.
3. Start the engine and allow it to stall.
4. Crank the engine for an additional 3 seconds.

**Fuel Pressure Gauge Installation**

1. Remove the shoulder fitting cap.
2. Install fuel pressure gauge 5-8840-0378-0 to the fuel feed line located on the upper right side of the engine.
3. Reinstall the fuel pump relay.

**Fuel System Diagnosis**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Turn the ignition OFF. 2. Turn the air conditioning system OFF. 3. Relieve fuel system pressure and install the fuel pressure gauge. 4. Turn the ignition ON. <b>Note:</b> The fuel pump will run for approximately 2 seconds. Use the Scan Tool to command the fuel pump ON. 5. Observe the fuel pressure indicated by the fuel pressure gauge with the fuel pump running. Is the fuel pressure within the specified limits?	283-376 kPa (41-55 psi)	<i>Go to Step 3</i>	<i>Go to Step 17</i>
3	Does the fuel pressure indicated by the fuel pressure gauge remain constant? <b>Note:</b> The fuel pressure will drop when the fuel pump stops running, then it should stabilize and remain constant.	-	<i>Go to Step 4</i>	<i>Go to Step 12</i>
4	1. When the vehicle is at normal operating temperature, turn the ignition ON to build fuel pressure and observe the measurement on the gauge. 2. Start the engine and observe the fuel pressure gauge. Did the reading drop by the amount specified after the engine was started?	21-105 kPa (3-15 psi)	<i>Go to Step 5</i>	<i>Go to Step 9</i>
5	Is fuel pressure dropping off during acceleration, cruise, or hard cornering?	-	<i>Go to Step 6</i>	<i>Check for improper fuel</i>
6	Visually and physically inspect the following items for a restriction: • The in-pipe fuel filter. • The fuel feed line. Was a restriction found?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	Remove the fuel tank and visually and physically inspect the following items: • The fuel pump strainer for a restriction. • The fuel line for a leak. • Verify that the correct fuel pump is in the vehicle. Was a problem found in any of these areas?	-	<i>Verify repair</i>	<i>Go to Step 8</i>

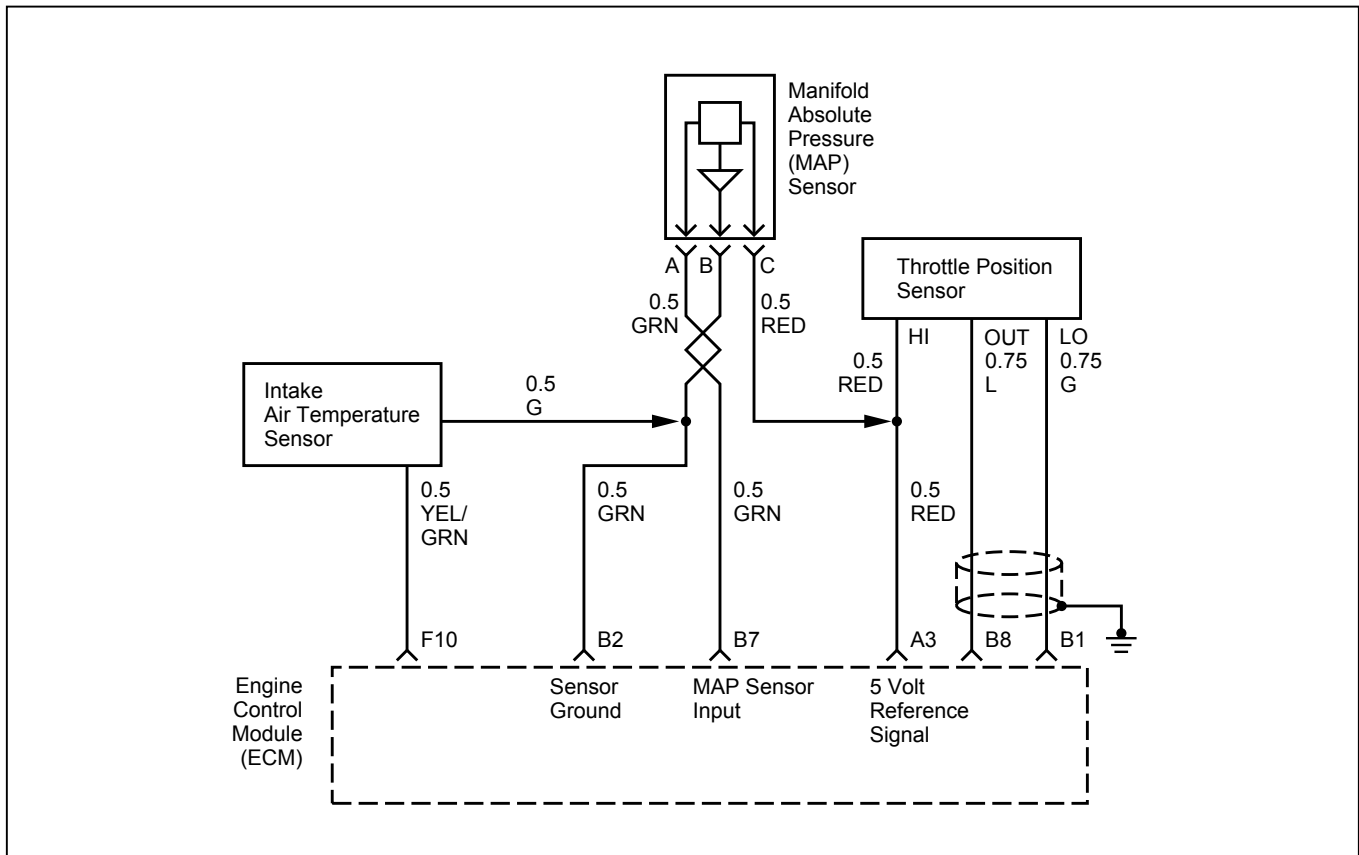
## Fuel System Diagnosis (Cont'd)

Step	Action	Value(s)	Yes	No
8	Replace the fuel pump. Is the action complete?	-	Verify repair	-
9	1. Disconnect the vacuum hose from the fuel pressure regulator. 2. With the engine idling, apply 12-14 inches of vacuum to the fuel pressure regulator. Does the fuel pressure indicated by the fuel pressure gauge drop by the amount specified?	21-105 kPa (3-15 psi)	Go to Step 10	Go to Step 11
10	Locate and repair the loss of vacuum to the fuel pressure regulator. Is the action complete?	-	Verify repair	-
11	Replace the fuel pressure regulator. Is the action complete?	-	Verify repair	-
12	1. Run the fuel pump with the Scan Tool. 2. After pressure has built up, turn off the pump and clamp the supply hose shut with suitable locking pliers. Does the fuel pressure indicated by the fuel pressure gauge remain constant?	-	Go to Step 13	Go to Step 15
13	Visually inspect the fuel supply line and repair any leaks. Was a problem found?	-	Verify repair	Go to Step 14
14	Remove the fuel tank and inspect for leaky hose or in-tank fuel line. Was a problem found?	-	Verify repair	Go to Step 8
15	1. If the pliers are still clamped to the fuel supply hose, remove the locking pliers. 2. With suitable locking pliers, clamp the fuel return line to prevent fuel from returning to the fuel tank. 3. Run the fuel pump with the Scan Tool. 4. After pressure has built up, remove power to the pump. Does the fuel pressure indicated by the fuel pressure gauge remain constant?	-	Go to Step 11	Go to Step 16
16	Locate and replace any leaking fuel injector(s). Is the action complete?	-	Verify repair	-
17	Is the fuel pressure indicated by the fuel pressure gauge above the specified limit?	376 kPa (55 psi)	Go to Step 18	Go to Step 21
18	1. Relieve the fuel pressure. Refer to the <i>Fuel Pressure Relief</i> . 2. Disconnect the fuel return line from the fuel rail. 3. Attach a length of flexible hose to the fuel rail return outlet passage. 4. Place the open end of the flexible hose into an approved gasoline container. 5. Run the fuel pump with the Scan Tool. 6. Observe the fuel pressure indicated by the fuel pressure gauge with the fuel pump running. Is the fuel pressure within the specified limits?	290-376 kPa (42-55 psi)	Go to Step 19	Go to Step 20

### Fuel System Diagnosis (Cont'd)

Step	Action	Value(s)	Yes	No
19	Locate and correct the restriction in the fuel return line. Is the action complete?	-	<i>Verify repair</i>	-
20	Visually and physically inspect the fuel rail outlet passages for a restriction. Was a restriction found?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
21	Is the fuel pressure indicated by the fuel pressure gauge above the specified value?	0 kPa (0 psi)	<i>Go to Step 22</i>	<i>Go to Step 23</i>
22	1. Command the fuel pump ON with the Scan Tool. 2. Using suitable pliers which will not damage the fuel hose, gradually apply pressure with the pliers to pinch the flexible fuel return hose closed. Does the fuel pressure indicated by the fuel pressure gauge rise above the first specified value? <b>Caution: Do not let the fuel pressure exceed the second specified value.</b>	376 kPa (55 psi)  414 kPa (60 psi)	<i>Go to Step 11</i>	<i>Go to Step 7</i>
23	1. Command the fuel pump ON with the Scan Tool. 2. Remove the fuel filler cap and listen for the sound of the fuel pump running. 3. Turn the pump off. Was the fuel pump running?	-	<i>Go to Step 7</i>	<i>Go to Fuel System Electrical Test Chart</i>





## MANIFOLD ABSOLUTE PRESSURE (MAP) OUTPUT CHECK

### Circuit Description

The manifold absolute pressure (MAP) sensor measures the changes in the intake MAP which result from engine load (intake manifold vacuum) and engine speed changes; and converts these into a voltage output. The engine control module (ECM) sends a 5-volt reference voltage to the MAP sensor. As the MAP changes, the output voltage of the sensor also changes. By monitoring the sensor output voltage, the ECM knows the MAP. A lower pressure (low voltage) output voltage will be about 1-2 volts at idle. Higher pressure (high voltage) output voltage will be about 4-4.8 volts at wide open throttle. The MAP sensor is also used, under certain conditions, to measure barometric pressure, allowing the ECM to make adjustments for different altitudes.

### Test Description

**Important:** Be sure to use the same diagnostic test equipment for all measurements.

The number(s) below refer to the step number(s) on the Diagnostic Chart.

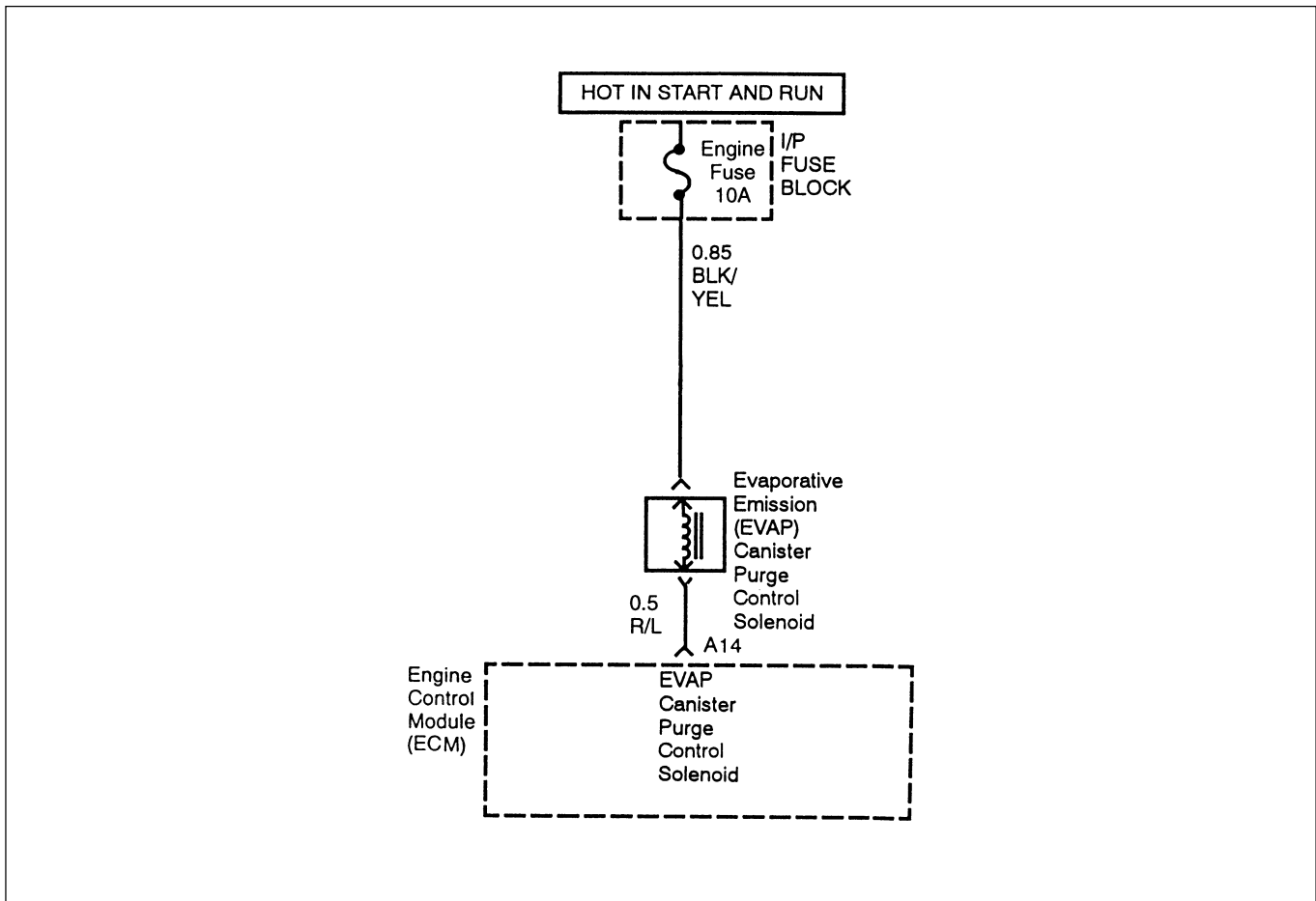
1. When you compare the Scan Tool readings to a known good vehicle, it is important to compare vehicles that use MAP sensors that have the same part number.
2. Applying 34 kPa (10 Hg) vacuum to the MAP sensor should cause the voltage to be 1.5-2.1 volts less than the voltage at step 1. Upon applying vacuum to the sensor, the change in voltage should be instantaneous. A slow voltage change indicates a faulty sensor.
3. Check the vacuum hose to the sensor for leaking or restriction. Be sure that no other vacuum devices are connected to the MAP hose.

**Important:** Make sure the electrical connector remains securely fastened.

4. Disconnect the sensor from the bracket. Twist the sensor with your hand to check for an intermittent connection. Output changes greater than 0.10 volt indicate a bad sensor.

### Manifold Absolute Pressure (MAP) Output Check

Step	Action	Value(s)	Yes	No
1	1. Turn the ignition OFF and leave it OFF for 15 seconds. 2. Ignition ON. Do not crank engine. 3. The Scan Tool should indicate a manifold absolute pressure (MAP) sensor voltage. 4. Compare this scan reading to the scan reading of a known good vehicle obtained using the exact same procedure as in Steps 1-4. Is the voltage reading the same +/-0.40 volt?	-	<i>Go to Step 2</i>	<i>Go to Step 5</i>
2	1. Disconnect the MAP sensor and plug the hole on the intake manifold. 2. Using an adequate rubber hose, connect a hand vacuum pump to the MAP sensor. 3. Check for the following condition: <ul style="list-style-type: none"> <li>• MAP port sealing rubber damaged or split?</li> <li>• Intake vacuum leaks at;</li> <li>• Vacuum leaks at throttle body;</li> </ul> If a problem is found, repair as necessary. Was a problem found? 4. Start the engine. 5. Apply 34 kPa (10 Hg) of vacuum and note the voltage change. Is the voltage change 1.5-2.1 volts less than step 1?	-	<i>Go to Step 3</i>	<i>Go to Step 4</i>
3	No trouble found. Check the sensor seal rubber (color : orange) for leakage or restriction. Does the hose supply vacuum to the MAP sensor only?	-	<i>Go to Step 5</i>	<i>Go to Step 4</i>
4	Repair the seal rubber (color : orange) to ensure the hose supplies vacuum to the MAP sensor only Is the action complete?	-	<i>Verify repair</i>	-
5	Check the sensor connection. Is the sensor connection good?	-	<i>Go to Step 6</i>	<i>Go to Step 7</i>
6	Replace the sensor. Refer to <i>On-Vehicle Service, MAP Sensor</i> . Is the action complete?	-	<i>Verify repair</i>	-
7	Repair the poor connection. Is the action complete?	-	<i>Verify repair</i>	-



## EVAPORATIVE EMISSIONS (EVAP)

### CANISTER PURGE CONTROL SOLENOID VALVE CHECK (IF APPLICABLE)

#### Circuit Description

Canister purge is controlled by a solenoid valve that allows manifold vacuum to purge the canister. The engine control module (ECM) supplies a ground to energize the solenoid valve (purge ON). The EVAP (purge solenoid control is turned ON time) is determined by engine operating conditions including load, throttle position, coolant temperature and ambient temperature. The duty cycle is calculated by the ECM and the purge solenoid is enabled when the appropriate conditions have been met:

- The engine run time after start is more than 60 seconds.
- The engine coolant temperature is above 30°C (86°F).
- The fuel control system is operating in the “Closed-Loop” mode (If applicable).

#### Diagnostic Aids

- Make a visual check of vacuum hoses.
- Check the throttle body for possible cracked or plugged vacuum block.
- Check the malfunction indicator lamp for a possible mechanical problem.

#### Test Description

The number(s) below refer to the step number(s) on the Diagnostic Chart.

1. Check to see if the solenoid is open or closed. The solenoid is normally de-energized in this step, so it should be closed.
2. This step checks to determine if the solenoid was open due to an electrical circuit problem or a defective solenoid.
3. This should normally energize the solenoid, opening the valve and allowing the vacuum to drop (Purge ON).

### Evaporative Emissions (EVAP) Canister Purge Valve Solenoid Check

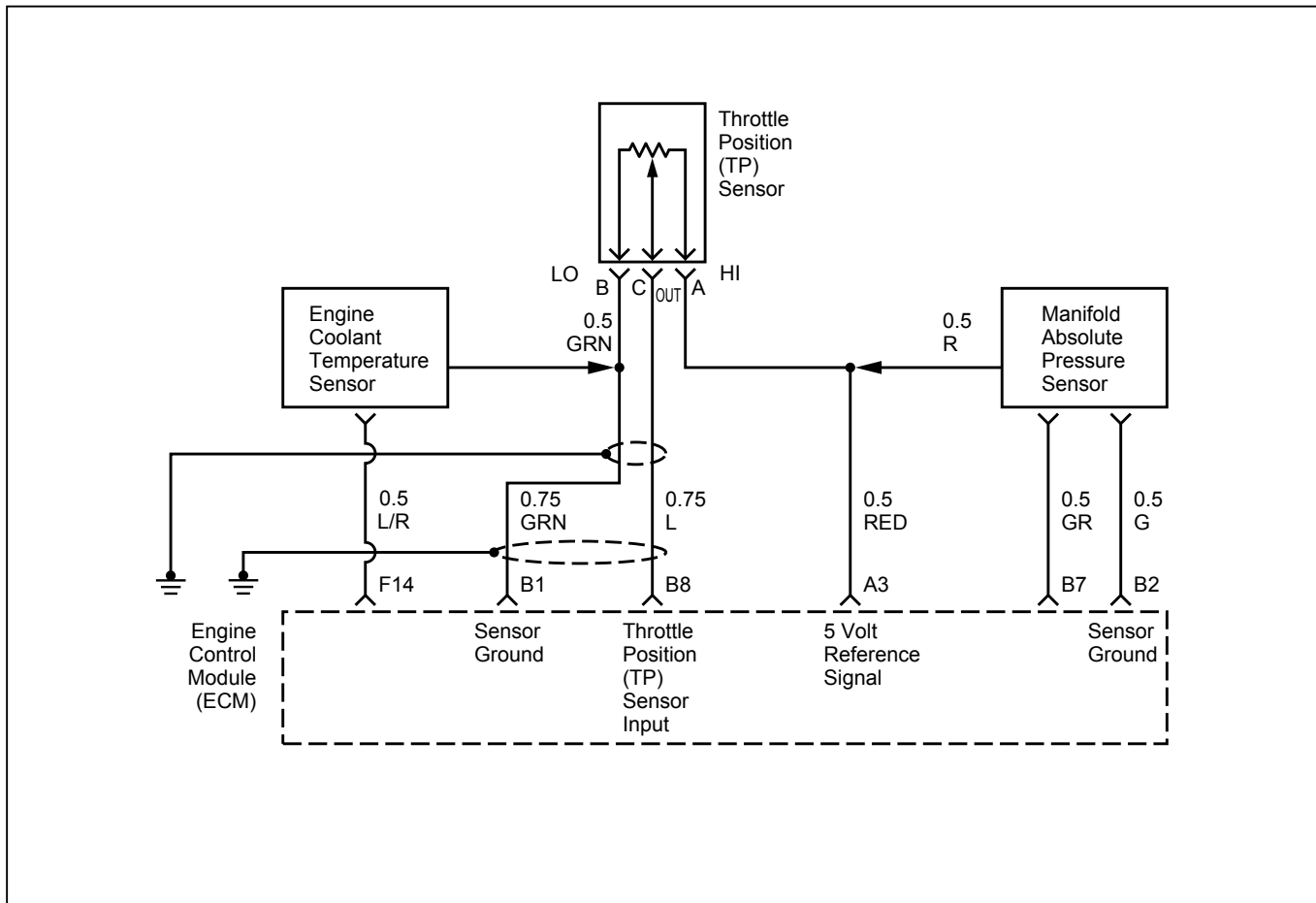
Step	Action	Value(s)	Yes	No
1	1. Ignition OFF. 2. Ignition ON, engine OFF. 3. At the intake manifold, disconnect the hose that goes to the pump solenoid. 4. Using a hand vacuum purge with an attached vacuum gauge 5-8840-0279-0, apply vacuum (10" Hg or 34 kPa) to the solenoid. Does the solenoid hold vacuum?	-	<i>Go to Step 3</i>	<i>Go to Step 2</i>
2	1. Disconnect the solenoid electrical connector. 2. As in Step 1, apply vacuum (10" Hg or 34 kPa) to the solenoid. Does the solenoid hold vacuum?	-	<i>Go to Step 4</i>	<i>Go to Step 7</i>
3	1. At the intake manifold, put a cap over the vacuum port where the hose was disconnected for testing. This is to prevent a vacuum leak when the engine is started. 2. Ignition OFF. 3. Install the scan tool. 4. Apply vacuum to the purge control solenoid with the hand vacuum pump. 5. Start the engine, run at 2500 RPM. 6. Using the Scan Tool command the purge control solenoid ON. Did the vacuum drop when the purge was turned on?	-	<i>Go to Step 8</i>	<i>Go to Step 9</i>
4	Check for a short to ground or open in the wire between the solenoid and the ECM. Is there a problem?	-	<i>Go to Step 5</i>	<i>Go to Step 6</i>
5	Repair the faulty wire. Is the action complete?	-	<i>Verify repair</i>	-
6	Replace the EPROM or ECM. Note) Refer to 6E1-243.	-	<i>Verify repair</i>	-
7	Replace the faulty purge control solenoid. Refer to <i>On-Vehicle Service, EVAP Canister Purge Solenoid</i> . Is the action complete?	-	<i>Verify repair</i>	-
8	1. Turn the ignition OFF. 2. Verify the purge hose nipple is not plugged.	-	<i>No problem found in the EVAP emission canister purge valve check.</i>	<i>Refer to Diagnostic Aids</i>
9	1. Turn the Ignition OFF. 2. Disconnect the solenoid's electrical connector. 3. Connect a test lamp between the harness terminals. 4. Turn the ignition ON. Does the test lamp light?	-	<i>Go to Step 7</i>	<i>Go to Step 10</i>



**Evaporative Emissions (EVAP) Canister Purge Valve Solenoid Check (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
10	Probe each terminal of the solenoid valve electrical connector with a test lamp to ground. Does the test lamp light on both terminals?	-	<i>Go to Step 11</i>	<i>Go to Step 12</i>
11	Repair the short to voltage in the wire between the solenoid and the ECM. Is the action complete?	-	<i>Verify repair</i>	-
12	Does the ignition feed terminals light the test lamp?	-	<i>Go to Step 13</i>	<i>Go to Step 14</i>
13	Check for an open in the wire between the purge control solenoid and the ECM. Was there an open circuit?	-	<i>Go to Step 15</i>	<i>Go to Step 6</i>
14	Repair the open in the ignition feed wire. Is the action complete?	-	<i>Verify repair</i>	-
15	Repair the open wire. Is the action complete?	-	<i>Verify repair</i>	-





## THROTTLE POSITION (TP) SENSOR CIRCUIT RANGE/PERFORMANCE PROBLEM

### Circuit Description

The throttle position (TP) sensor circuit provides a voltage signal that changes relative to throttle blade angle. The signal voltage will vary from about 0.25 volts at closed throttle to about 4.75 volts at wide open throttle (WOT).

The Throttle Position (TP) signal is used by the engine control module (ECM) for fuel control and most of the ECM-controlled outputs. The ECM monitors throttle position and compares actual throttle positions from the TP sensor to a predicted TP value calculated from engine speed.

### Diagnostic Aids

Check for the following conditions:

- Skewed MAP signal or faulty MAP sensor-An incorrect MAP signal may cause the ECM to incorrectly calculate the predicted TP sensor value during high engine load situations. Check for an unusually low MAP reading.
- Poor connection at ECM-Inspect harness connectors for backed-out terminals, improper mating, broken lock, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged Harness-Inspect the wiring harness for damage: An open Circuit, shorts to Ground, or shorts to Battery Positive. If the harness appears to be OK, observe the TP display on the Scan Tool while moving connectors and wiring harnesses related to the sensor. A change in the display will indicate the location of the fault.

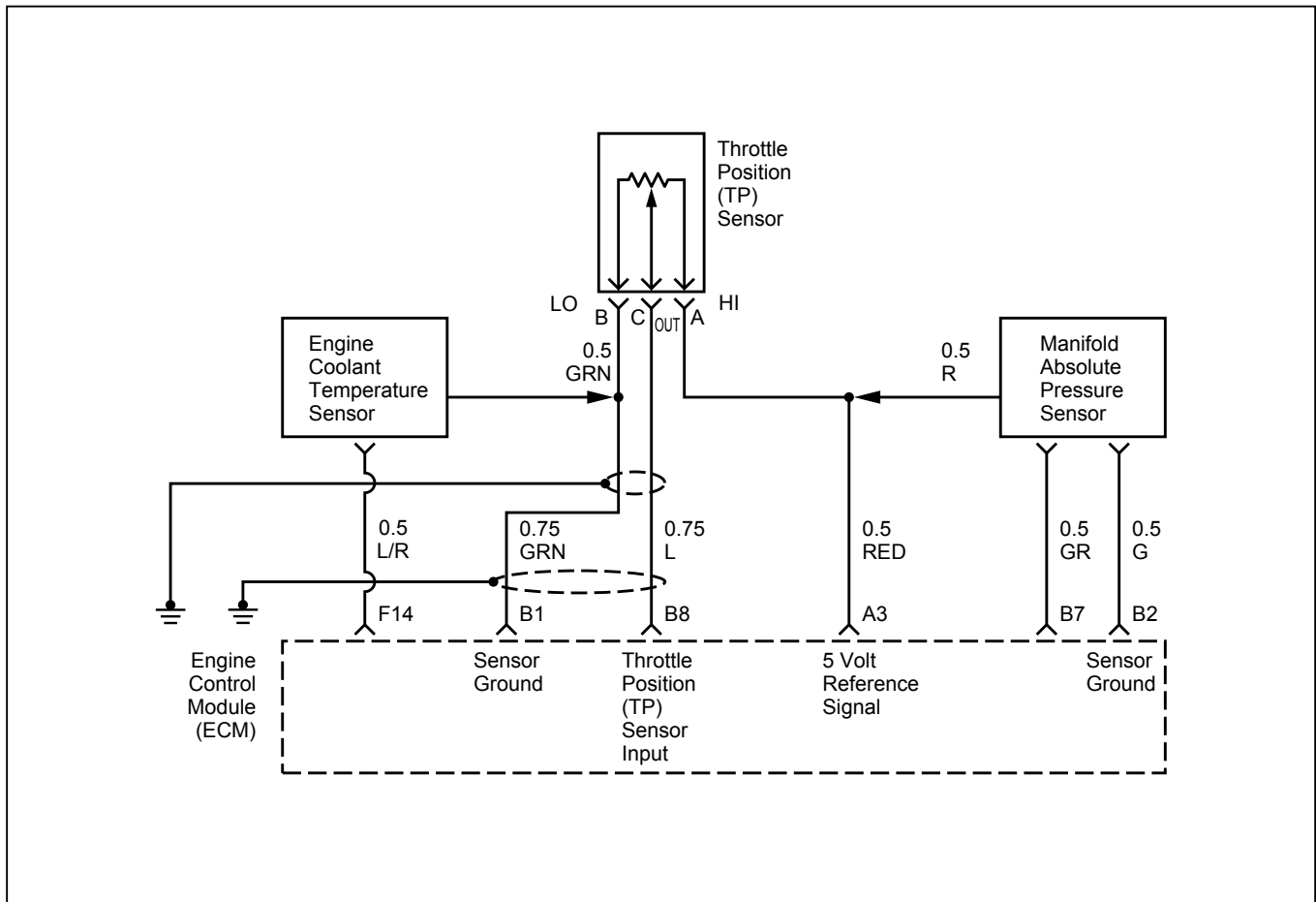
### TP Sensor Circuit Range/Performance Problem

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check " performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition ON, engine OFF. 2. Monitor the TP value on the Scan Tool While moving the throttle between 0% and 100%. Does the TP value on the Scan Tool move smoothly from 0% (0.25 volts) to 100% (4.75 volts)?	-	<i>Go to Step 3</i>	<i>Go to Step 10</i>
3	1. Ignition OFF. 2. Disconnect the Throttle Position (TP) Sensor electrical connector, located on the RH side of the Throttle body. 3. Start the engine, and monitor the TP value with the Scan Tool. Does the TP value on the Scan Tool hold steadily within the given range?	0-0.25 volts 0%	<i>Go to Step 5</i>	<i>Go to Step 4</i>
4	Check the TP sensor signal circuit, between the TP sensor and the Engine Control Module (ECM), for a short to voltage. Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 11</i>
5	Check the TP sensor signal circuit, between the TP sensor and the ECM, the following conditions: <ul style="list-style-type: none"> <li>• A short to ground</li> <li>• An open circuit</li> </ul> Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 6</i>
6	Check the 5 Volt signal circuit between the TP sensor and the ECM, for the following conditions: <ul style="list-style-type: none"> <li>• An Open Circuit</li> <li>• A short to ground</li> <li>• A short to voltage</li> </ul> Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 7</i>
7	1. Ignition OFF. 2. Place a fused jumper between the TP sensor circuit and the 5 volt signal circuit both at the wiring harness TP sensor connector. 3. Ignition ON, engine OFF. 4. Observe the TP value displayed on the Scan Tool. Does the Scan Tool read the following value?	about 5 volts 100%	<i>Go to Step 8</i>	<i>Go to Step 11</i>
8	Check the TP sensor ground circuit, between the TP sensor and the ECM, for the following conditions: <ul style="list-style-type: none"> <li>• An Open Circuit</li> <li>• A short to ground</li> <li>• A short to voltage</li> </ul> Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 9</i>

### TP Sensor Circuit Range/Performance Problem (Cont'd)

Step	Action	Value(s)	Yes	No
9	1. Ignition OFF. 2. Place a Digital Multimeter (DVM), set to measure voltage between the ground circuit and the 5 volt signal circuit, both at the wiring harness' TP sensor connector. 3. Ignition ON, engine OFF. Does the DVM indicate the following value?	about 5 volts	<i>Go to Step 10</i>	<i>Go to Step 11</i>
10	Replace the TP sensor. Verify repair.	-	-	-
11	Replace the EPROM or ECM. Note) Refer to 6E1-243.	-	-	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 22) THROTTLE POSITION (TP) SENSOR CIRCUIT LOW INPUT

### Circuit Description

The throttle position (Throttle Position) sensor circuit provides a voltage signal that changes relative to throttle blade angle. The signal voltage will vary from below 1 volt at closed throttle to about 4 volts at wide open throttle (WOT).

The Throttle Position signal is used by the engine control module (ECM) for fuel control and most of the ECM-controlled outputs. If the ECM detects a low impedance short to ground in the Throttle Position sensor or circuit, then a code 22 will set.

### Conditions for Setting the DTC

- Throttle Position sensor signal voltage is less than 0.19 volt.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- The ECM will use a default throttle position based on RPM.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

Check for the following conditions:

- Poor connection at ECM - Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.

- Damaged harness - Inspect the wiring harness for damage. If the harness appears to be OK, observe the throttle position display on the Scan Tool while moving connectors and wiring harnesses related to the throttle Position sensor. A change in the display will indicate the location of the fault.

**DTC (Flash DTC = 22)  
Throttle Position (TP) Sensor Circuit Low Input**

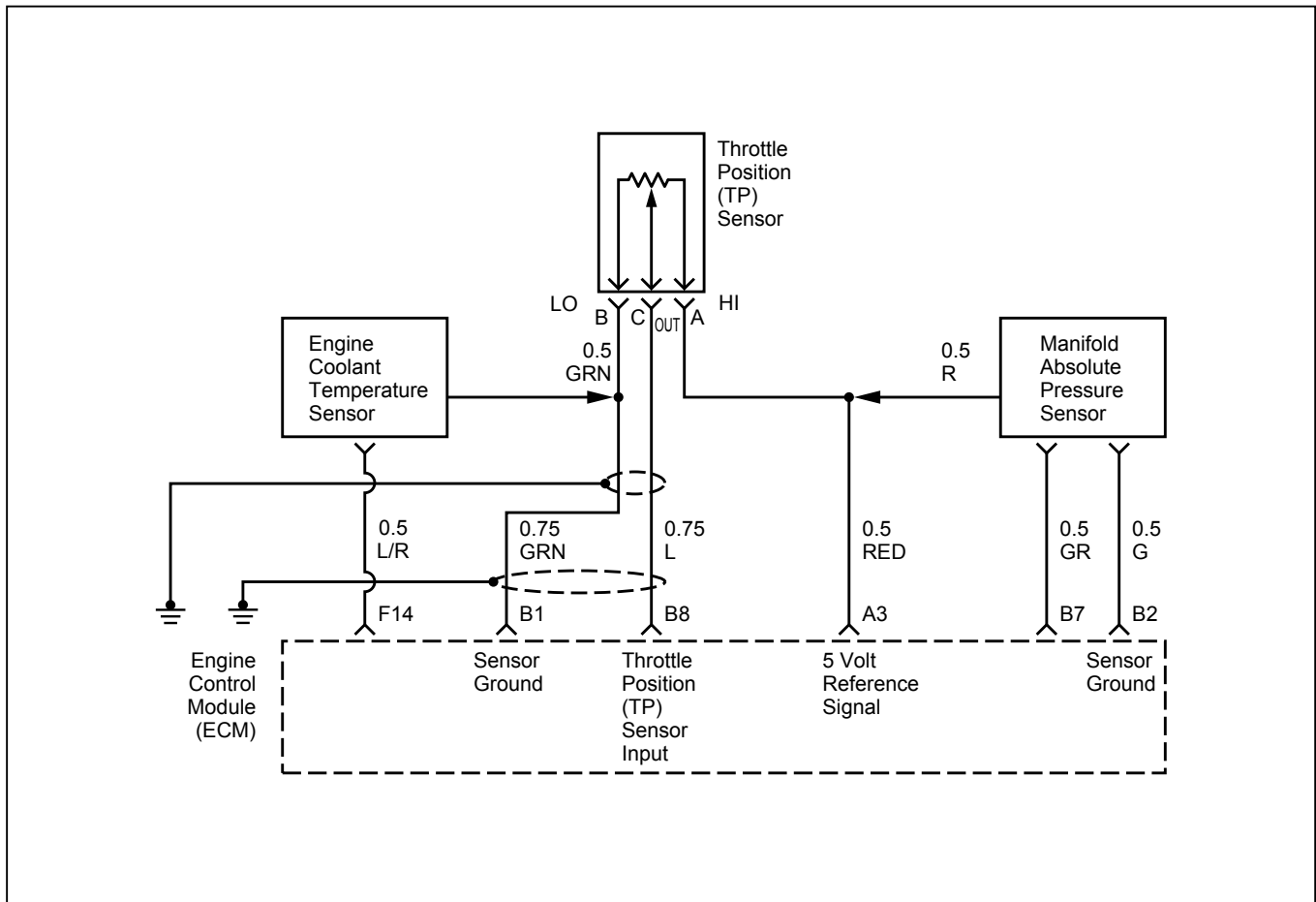
Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition ON, engine OFF. 2. With the throttle closed, observe the "Throttle Position Sensor" display on the Scan Tool. is the "Throttle Position Sensor" below the specified value?	0.19V	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	1. Ignition ON engine OFF. 2. Using a Scan Tool, monitor info for Diagnostic Trouble Code 22. Does the Scan Tool indicate Diagnostic Trouble Code 22 failed?	-	<i>Go to Step 4</i>	<i>Refer to Diagnostic Aids</i>
4	1. Ignition OFF. 2. Disconnect the Throttle Position sensor electrical connector. 3. Jumper the 5 volt reference circuit and the Throttle Position signal together at the Throttle Position sensor harness connector. 4. Ignition ON. Observe the "Throttle Position Sensor" value displayed on the Scan Tool. Is the "Throttle Position Sensor" at the specified value?	5V	<i>Go to Step 10</i>	<i>Go to Step 5</i>
5	1. Disconnect jumper. 2. Connect a test light between B+ and the Throttle Position sensor signal circuit at the Throttle Position sensor harness connector. Observe the "Throttle Position Sensor" value displayed on the Scan Tool. Is the "Throttle Position Sensor" at the specified value?	5V	<i>Go to Step 6</i>	<i>Go to Step 8</i>



**DTC (Flash DTC = 22)**  
**Throttle Position (TP) Sensor Circuit Low Input (Cont'd)**

Step	Action	Value(s)	Yes	No
6	1. Ignition OFF. 2. Disconnect the ECM and check the 5 volt reference circuit for an open or short to ground. 3. If the 5 volt reference circuit is open or shorted to ground, repair it as necessary. Was the 5 volt reference circuit open or shorted to ground?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	Check the 5 volt reference circuit for a poor connection at the ECM and replace the terminal if necessary. Did the terminal require replacement?	-	<i>Verify repair</i>	<i>Go to Step 12</i>
8	1. Ignition OFF. 2. Disconnect the ECM, and check the Throttle Position signal circuit for an open, short to ground, or short to the sensor ground circuit. 3. If the Throttle Position sensor signal circuit is open or shorted to ground, repair it as necessary. Was the Throttle Position signal circuit open or shorted to ground?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	Check the Throttle Position sensor signal circuit for a poor connection at the ECM and replace the terminal if necessary. Did the terminal require replacement?	-	<i>Verify repair</i>	<i>Go to Step 12</i>
10	Check the Throttle Position sensor signal circuit for a poor connection at the Throttle Position sensor and replace the terminal if necessary. Did the terminal require replacement?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
11	Replace the Throttle Position sensor. Is the action complete?	-	<i>Verify repair</i>	-
12	Replace the EPROM or ECM. Is the action complete? <span style="float: right;">Note) Refer to 6E1-243.</span>	-	<i>Verify repair</i>	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 21) THROTTLE POSITION (TP) SENSOR CIRCUIT HIGH INPUT

### Circuit Description

The throttle position (TP) sensor circuit provides a voltage signal that changes relative to throttle blade angle. The signal voltage will vary from below 1 volt at closed throttle to about 4 volts at wide open throttle (WOT).

The throttle Position signal is used by the engine control module (ECM) for fuel control and most of the PCM-controlled outputs. If the ECM detects a low impedance short to battery in the Throttle Position sensor or circuit, then a code 21 will set.

### Conditions for setting the DTC

- Throttle Position Sensor signal is greater than 4.69 volts.
- Engine revolution is less than 3000rpm and manifold vacuum is less than 85kpa.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- The ECM will use a default throttle position based on RPM. Conditions for Clearing the MIL/DTC

### Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM - Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness - Inspect the wiring harness for damage. If the harness appears to be OK, observe the Throttle Position sensor display on the Scan Tool while moving connectors and wiring harnesses related to the throttle Position sensor. A change in the display will indicate the location of the fault.

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- Faulty Throttle Position sensor - With the ignition key ON engine OFF observe the Throttle Position sensor display on the Scan Tool while slowly depressing the accelerator to wide open throttle. If a voltage over 4.88 volts is seen at any point in normal accelerator travel, replace the Throttle Position sensor.

### Test Description

Number(s) below refer to the step number(s) on the Diagnostic Chart.

7. Components that share the Throttle Position sensor 5 volt reference circuit include the following device:

- Engine Coolant Temperature Sensor
- MAP Sensor

Disconnect the component while observing the Throttle Position sensor display on the Scan Tool. If the reading changes drastically when this component is disconnected, replace the component that affected the reading.

### DTC (Flash DTC = 21)

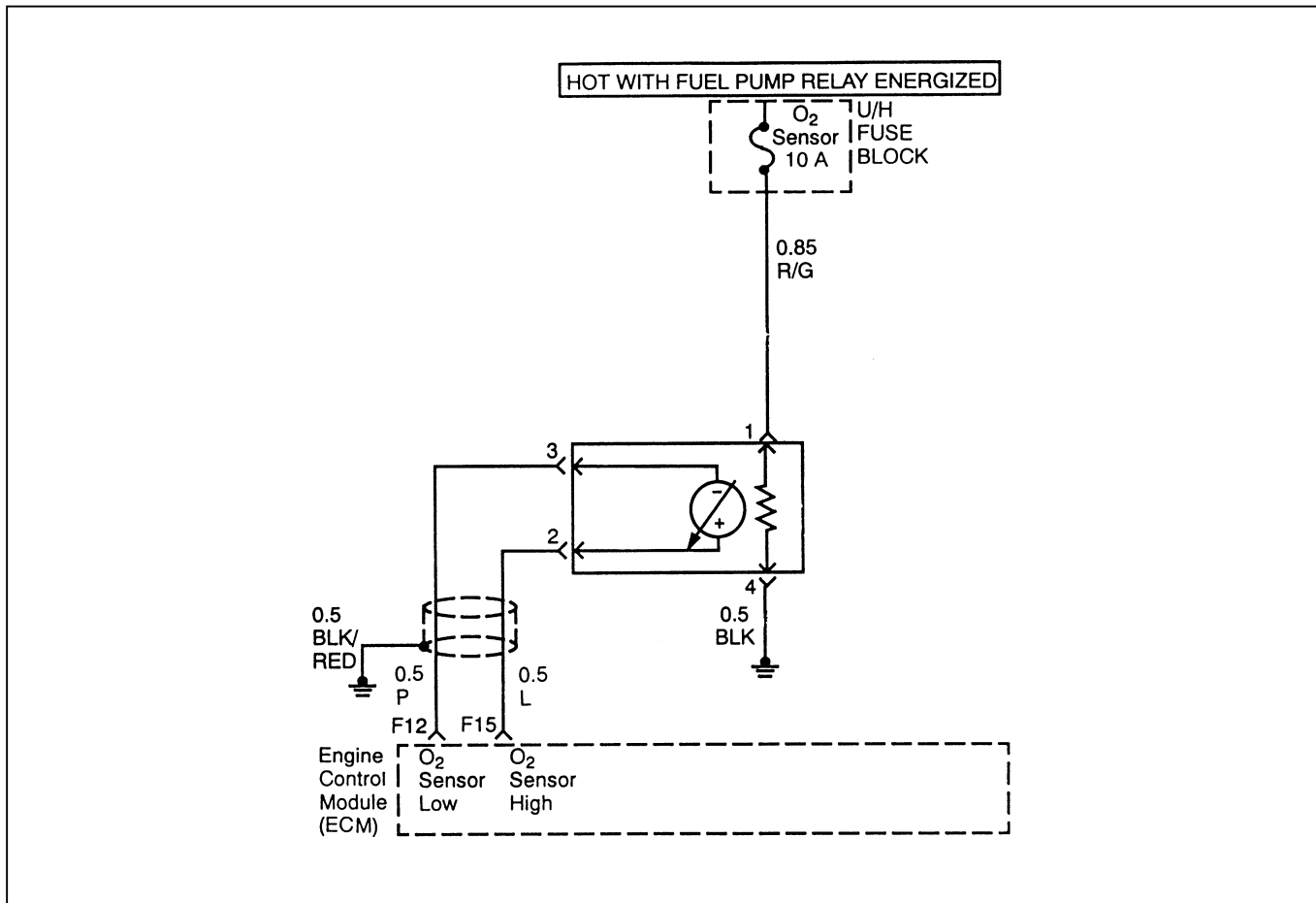
#### Throttle Position (TP) Sensor Circuit High Input

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition ON, engine OFF. 2. With the throttle closed, observe the "Throttle Position Sensor" values displayed on the Scan Tool. Is the "Throttle Position Sensor" above the specified value?	4.78V	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	1. Ignition ON, engine OFF. 2. Using a Scan Tool, monitor info for Diagnostic Trouble Code 21. Does the Scan Tool indicate Diagnostic Trouble Code 21 failed.	-	<i>Go to Step 4</i>	<i>Refer to Diagnostic Aids</i>
4	1. Disconnect the Throttle Position sensor electrical connector. 2. Observe the "Throttle Position Sensor" values displayed on the Scan Tool. Is the "Throttle Position Sensor" near the specified value?	0V	<i>Go to Step 5</i>	<i>Go to Step 6</i>
5	Probe the sensor ground circuit at the Throttle Position sensor harness connector with a test light connected to B+. Is the test light ON?	-	<i>Go to Step 7</i>	<i>Go to Step 10</i>

**DTC (Flash DTC = 21)**  
**Throttle Position (TP) Sensor Circuit High Input (Cont'd)**

Step	Action	Value(s)	Yes	No
6	1. Ignition OFF disconnect the ECM. 2. Ignition ON, engine OFF. 3. Check for a short to voltage on the Throttle Position sensor signal circuit. 4. If the Throttle Position sensor signal circuit is shorted, repair it as necessary. Was the Throttle Position sensor signal circuit shorted?	-	<i>Verify repair</i>	<i>Go to Step 12</i>
7	1. Ignition ON. 2. Monitor the "Throttle Position Sensor" Scan Tool display while disconnecting each of the components that share the 5 volt reference circuit (one at a time). 3. If the "Throttle Position Sensor" values displayed changes, replace the component that caused the display to change when disconnected. Does disconnecting any of these components cause the "Throttle Position Sensor" values displayed to change?	-	<i>Verify repair</i>	<i>Go to Step 8</i>
8	1. Ignition OFF disconnect the ECM. 2. Ignition ON, engine OFF. 3. Check for a short to B+ on the 5 volt reference circuit. 4. If the 5 volt reference circuit is shorted, repair it as necessary. Was the 5 volt reference circuit shorted?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	Check for poor electrical connections at the Throttle Position Sensor and replace terminals if necessary. Did any terminals require replacement?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
10	1. Ignition OFF. 2. Disconnect the ECM, and check for an open sensor ground circuit to the Throttle Position Sensor. 3. If a problem is found, repair it as necessary. Was the sensor ground circuit to the Throttle Position Sensor open?	-	<i>Verify repair</i>	<i>Go to Step 12</i>
11	Replace the Throttle Position Sensor. Is the action complete?	-	<i>Verify repair</i>	-
12	Replace the EPROM or ECM. Is the action complete? <span style="float: right;">Note) Refer to 6E1-243.</span>	-	<i>Verify repair</i>	-





### DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 13) O2 SENSOR CIRCUIT NOT READY DETECTED (IF APPLICABLE)

#### Circuit Description

- The engine control module (ECM) supplies a bias voltage of about 450mV between the heated oxygen sensor (HO2S) high and low circuits. When measured with a 10 megaohm digital voltmeter, this may display as low as 320mV. The oxygen sensor varies the voltage within a range of about 900mV when the exhaust is rich, down through about 60mV when exhaust is lean. The ECM constantly monitors the HO2S signal during "Closed Loop" operation and compensates for a rich or lean condition by decreasing or increasing injector pulse width as necessary. This code determines whether the oxygen sensor is ready for use as a feedback for fuel control system. Then the DTC 13 will set.

#### Conditions for Setting the DTC

- Engine run time is longer than 60 seconds.

All the above conditions are met and the following condition is met:

- HO2S signal voltage remains between 343mV and 540mV.
- Throttle angle is greater than 5%.
- ECT greater than 70°C.

#### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the second time the fault is detected.
- "Open Loop" fuel control will be in effect.

#### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

- They are cleared by disconnecting the Battery for more than 30 seconds.
- A service tool such as Tech 2 is used to clear them.
- Ten consecutive starts without logging a fault.

**Diagnostic Aids**

Check for the following conditions:

- Poor connection or damaged harness - Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection, and damaged harness.
- Faulty HO2S heater or heater circuit - With the ignition ON engine OFF after a cool down period, the HO2S voltage displayed on the Scan Tool is normally 455-460mV. A reading over 1000mV indicates a signal line shorted to voltage. A reading under 5mV indicates a signal line shorted to ground or signal lines shorted together. Disconnect the

HO2S and connect a test light between the HO2S battery feed and heater ground circuits. If the test light does not light for 2 seconds when the ignition is turned on, repair the open battery feed or sensor ground circuit as necessary. If the test light lights and the HO2S signal and low circuits are OK, replace the HO2S.

- Intermittent test - With the ignition ON monitor the HO2S signal voltage while moving the wiring harness and related connectors. If the fault is induced, the HO2S signal voltage will change. This may help isolate the location of the malfunction.

**DTC (Flash DTC = 13)  
O2 Sensor Circuit Not Ready**

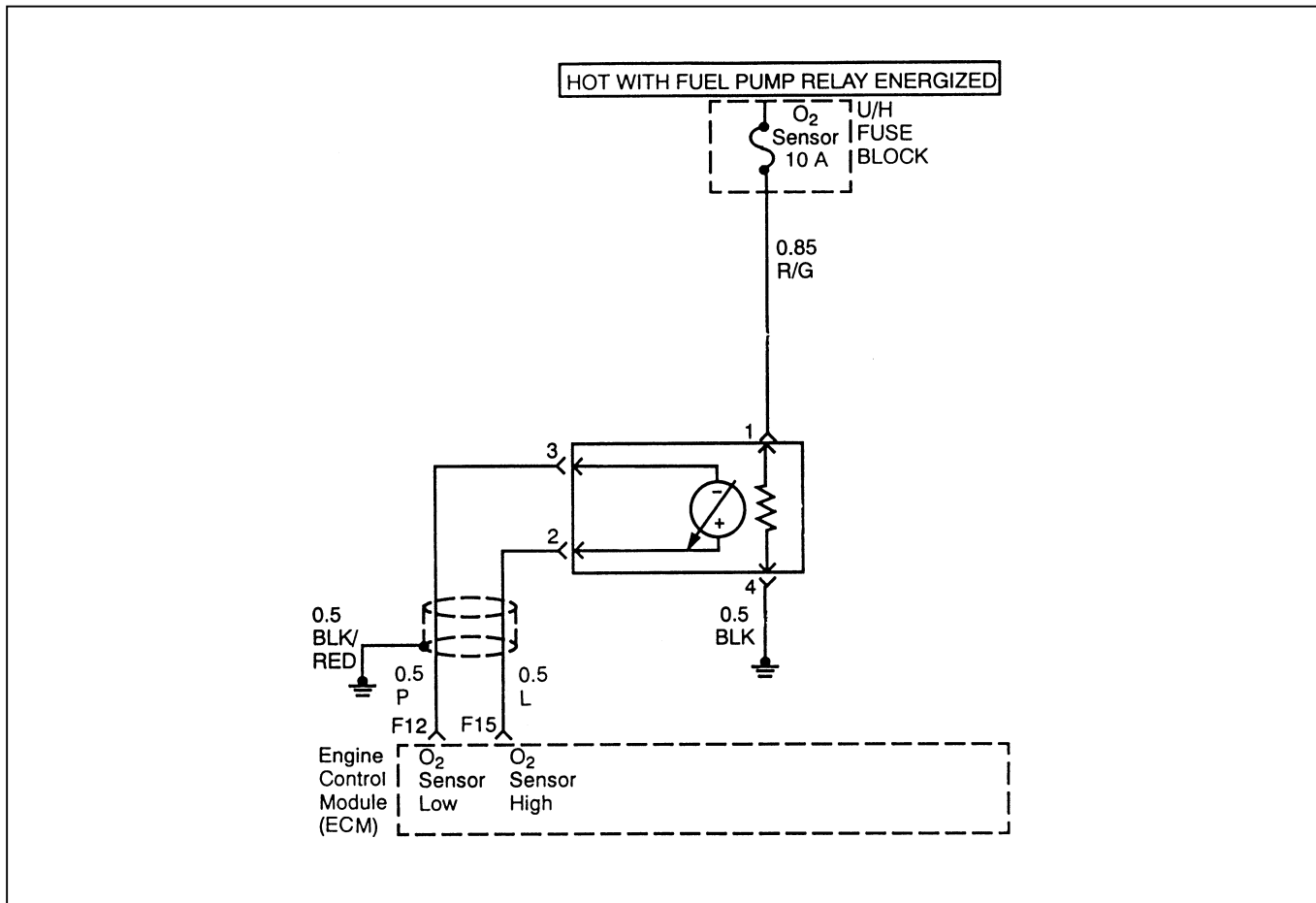
Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Install the Scan Tool. 2. Run the engine at operating temperature. 3. Operate the engine above 1200 RPM for three minutes. Does the Scan Tool indicate HO2S voltage varying outside the specified values?	400-500mV	<i>Go to Step 3</i>	<i>Go to Step 4</i>
3	1. Ignition ON, engine OFF. 2. Using a Scan Tool, monitor info for Diagnostic Trouble Code 13. 3. Note the test result. Does the Scan Tool indicate Diagnostic Trouble Code 13 failed this ignition?	-	<i>Go to Step 4</i>	<i>Refer to Diagnostic Aids</i>
4	Check for a damaged harness. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 5</i>
5	Check for poor HO2S high and low circuit terminal connections at the HO2S harness connector and replace terminal(s) if necessary. Did any terminals require replacement?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	Check for poor HO2S high and low circuit terminal connections at the ECM and replace terminals if necessary. Did any terminals require replacement?	-	<i>Verify repair</i>	<i>Go to Step 7</i>



**DTC (Flash DTC = 13)**  
**O2 Sensor Circuit Not Ready (Cont'd)**

Step	Action	Value(s)	Yes	No
7	1. Ignition OFF. 2. With the ECM disconnected, check continuity of the HO2S high circuit. 3. If the HO2S high circuit measures over 0.5 ohms, repair open or poor connection as necessary. Was a HO2S high circuit problem found and corrected?	-	<i>Verify repair</i>	<i>Go to Step 8</i>
8	1. Ignition OFF. 2. With the ECM disconnected, check continuity of the HO2S low circuit. 3. If the HO2S low circuit measures over 5 ohms, repair open or poor connection as necessary. Was a HO2S low circuit problem found and corrected?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	1. Ignition ON, engine OFF. 2. Disconnect HO2S and jumper the HO2S high and low circuits (ECM side) to ground. 3. Using a Scan Tool, monitor HO2S voltage. Is HO2S voltage approximately equal to the specified value?	10mV	<i>Go to Step 10</i>	<i>Go to Step 11</i>
10	Replace HO2S. Is the action complete?	-	<i>Verify repair</i>	-
11	Replace the EPROM or ECM.    Note) Refer to 6E1-243. Is the action complete?	-	<i>Verify repair</i>	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 44) O2 SENSOR TOO LEAN (IF APPLICABLE)

### Circuit Description

The engine control module (ECM) supplies a bias voltage of about 450mV between the heated oxygen sensor (HO2S) signal and low circuits. When measured with a 10 megaohm digital voltmeter, this may display as low as 350mV. The oxygen sensor varies the voltage within a range of about 900mV when the exhaust is rich, down through about 60mV when exhaust is lean. The ECM constantly monitors the HO2S signal during "Closed Loop" operation and compensates for a rich or lean condition by decreasing or increasing injector pulse width as necessary. If the HO2S voltage remains excessively low for an extended period of time.

This code detects a lean oxygen sensor reading.

### Conditions for Setting the DTC

- Engine run time is longer than 60sec.
- Engine coolant temperature is above 70 °C(158°F).
- Throttle angle is greater than 5%.

All above conditions met and the following condition is met:

- HO2S signal voltage remains less than 274mV.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- "Open Loop" fuel control will be in effect.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

Check for the following conditions:

- Heated oxygen sensor wiring - The sensor pigtail may be routed incorrectly and contacting the exhaust system.
- Poor ECM to engine block ground.
- Fuel pressure - The system will go lean if pressure is too low. The ECM can compensate for some decrease. However, if fuel pressure is too low, a diagnostic Trouble Code 44 may be set. Refer to *Fuel System Diagnosis*.
- Lean injector(s) - Perform "Injector Balance Test."
- Vacuum leaks - Check for disconnected or damaged vacuum hoses and for vacuum leaks at the intake manifold, throttle body, and PCV system.

- Exhaust leaks - An exhaust leak may cause outside air to be pulled into the exhaust gas stream past the HO2S, causing the system to appear lean. Check for exhaust leaks that may cause a false lean condition to be indicated.
- Fuel contamination - Water, even in small amounts, can be delivered to the fuel injectors. The water can cause a lean exhaust to be indicated, Excessive alcohol in the fuel can also cause this condition. Refer to *Fuel System Diagnosis* for the procedure to check for fuel contamination.

If none of the above conditions are present, replace the affected HO2S.

**DTC (Flash DTC = 44)  
O2 Sensor Too Lean**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Install the Scan Tool. 2. Run the engine at operating temperature. 3. Operate the vehicle within the parameters specified under "Conditions for Setting the Diagnostic Trouble Code" criteria included in Diagnostic Support. 4. Using a Scan Tool, monitor HO2S voltage. Does the HO2S voltage remain below the specified value?	300mV	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	1. Ignition ON, engine OFF. 2. Using a Scan Tool, monitor info for Diagnostic Trouble Code 44.	-	<i>Go to Step 4</i>	<i>Refer to Diagnostic Aids</i>
4	1. Turn the ignition OFF. 2. Disconnect the ECM. 3. Check the HO2S high and low circuits for a short to ground or a short to the heater ground circuit. Are the HO2S signal circuits shorted to ground?	-	<i>Go to Step 5</i>	<i>Go to Step 6</i>
5	Repair the HO2S signal circuit. Is the action complete?	-	<i>Verify repair</i>	-
6	1. Turn the ignition OFF HO2S and ECM disconnected. 2. Check for continuity between the high and low signal circuits. Was there continuity between the high and low circuits?	-	<i>Go to Step 7</i>	<i>Go to Step 8</i>
7	Repair the short between the high and low circuits. Is the action complete?	-	<i>Verify repair</i>	-

**DTC (Flash DTC = 44)**  
**O2 Sensor Too Lean (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
8	1. Ignition OFF. 2. Reconnect the ECM, leave the sensor disconnected. 3. Ignition ON. Does the Scan Tool indicate HO2S voltage near the specified value?	430-450mV	<i>Refer to Diagnostic Aids</i>	<i>Go to Step 9</i>
9	Replace the EPROM or ECM. Is the action complete?      Note) Refer to 6E1-243.	-	<i>Verify repair</i>	-





**Diagnostic Aids**

Check the following items:

- Fuel pressure - The system will go rich if pressure is too high. The ECM can compensate for some increase. However, if fuel pressure is too high, a Diagnostic Trouble Code 45 may be set. Refer to *Fuel System Diagnosis*.
- Perform "Injector Balance Test" - Refer to *Fuel System Diagnosis*.
- Check the EVAP canister for fuel saturation - If full of fuel, check canister control and hoses. Refer to *Evaporative (EVAP) Emission Control System*.
- Check for a leak in the fuel pressure regulator diaphragm by checking the vacuum line to toe regulator for the presence of fuel.

- An intermittent TP sensor output will cause the system to go rich due to a false indication of the engine accelerating.
- Silicon contamination of the HO2S can also cause a high HO2S voltage to be indicated. This condition is indicated by a powdery white deposit on the portion of the HO2S exposed to the exhaust stream. If contamination is noticed, replace the affected HO2S.
- Operate the vehicle while monitoring the HO2S voltage with a Scan Tool. If the HO2S voltage is limited within a range between 300mV to 600mV, check the HO2S high and low circuit wiring and associated terminal connections. If the wiring and connections are OK, replace the HO2S.

**DTC (Flash DTC = 45)  
O2 Sensor Too Rich**

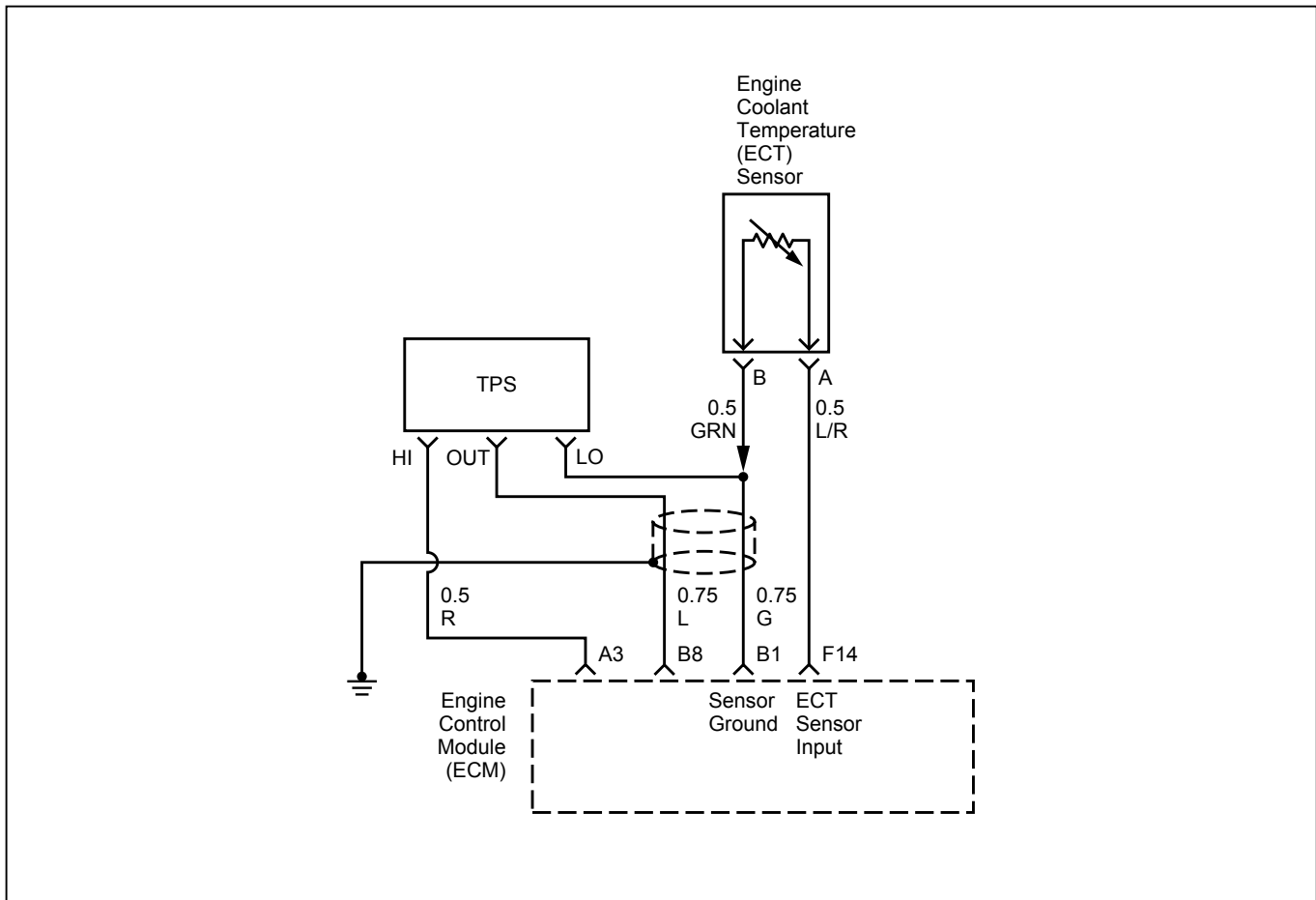
Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Install the Scan Tool. 2. Run the engine at operating temperature. 3. Operate the vehicle within parameters specified under "Conditions for Setting the Diagnostic Trouble Code". 4. Using a Scan Tool, monitor HO2S voltage. Does the HO2S voltage remain above the specified value?	952 mV (500mV in deceleration fuel cutoff mode)	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	1. Ignition ON. 2. Using a Scan Tool, monitor info for Diagnostic Trouble Code 45. 3. Does the Scan Tool indicate Diagnostic Trouble Code 45.	-	<i>Refer to Diagnostic Aids</i>	<i>Go to Step 4</i>
4	1. Ignition OFF. 2. Disconnect HO2S. 3. Ignition ON. 4. At HO2S connector (ECM side) use a DVM to measure voltages at the high and low signal terminals. Are the voltages in the specified range?	5-14V	<i>Go to Step 5</i>	<i>Go to Step 6</i>
5	Repair short to voltage in signal circuit.	-	<i>Verify repair</i>	-
6	1. Ignition OFF. 2. Disconnect the ECM connector. 3. Check for damage to the ECM pins and terminals. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 7</i>



**DTC (Flash DTC = 45)**  
**02 Sensor Too Rich (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
7	1. Ignition ON, engine OFF. 2. Disconnect HO2S and jumper the HO2S high and low circuits (ECM side) to ground. 3. Using a Scan Tool, monitor HO2S voltage. Is HO2S voltage below the specified value?	10mV	<i>Go to Step 8</i>	<i>Go to Step 9</i>
8	Replace HO2S. Is the action complete?	-	<i>Verify repair</i>	-
9	Replace the EPROM or ECM. Is the action complete?                      Note) Refer to 6E1-243.	-	<i>Verify repair</i>	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 14) ENGINE COOLANT TEMPERATURE (ECT) SENSOR CIRCUIT HIGH INPUT

### Circuit Description

The engine coolant temperature (ECT) sensor is a thermistor mounted in the engine coolant stream. The engine control module (ECM) applies a voltage (about 5 volts) through a pull-up resistor to the ECT signal circuit. When the engine coolant is cold, the sensor (thermistor) resistance is high, therefore the ECM will measure a high signal voltage. As the engine coolant warms, the sensor resistance becomes lower, and the ECT signal voltage measured at the ECM drops. With a fully warmed up engine, the ECT signal voltage should measure about 1.5 to 2.0 volts. If the ECM detect a continuous open in the ECT sensor or circuit, then a code 14 will set.

### Conditions for Setting the DTC

- Engine running time is longer than 10secs.
- The ECT sensor signal indicates an engine coolant temperature greater than 140°C (284°F).

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) fault is detected.
- The ECM will substitute the ECT reading with a default engine coolant temperature value. The default value is based on start-up intake air temperature and running time.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

Check for the following conditions:

- Poor connection at ECM - Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness - Inspect the wiring harness for damage, If the harness appears to be OK, observe the ECT display on the Scan Tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.

**Test Description**

Number(s) below refer to the step number(s) on the Diagnostic Chart.

2. Verifies that the fault is present.
3. Refer to the "Temperature vs. Resistance Value" table. The table may be used to test the ECT sensor at various temperatures to evaluate the possibility of a "shifted" sensor that may be stored

above or below a certain temperature. If this is the case, replace the ECT sensor. If the ECT sensor appears to be OK, the fault is intermittent; refer to *Diagnostic Aids*.

**Engine Coolant Temperature Sensor**

°C	°F	OHMS
Temperature vs. Resistance Values (approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

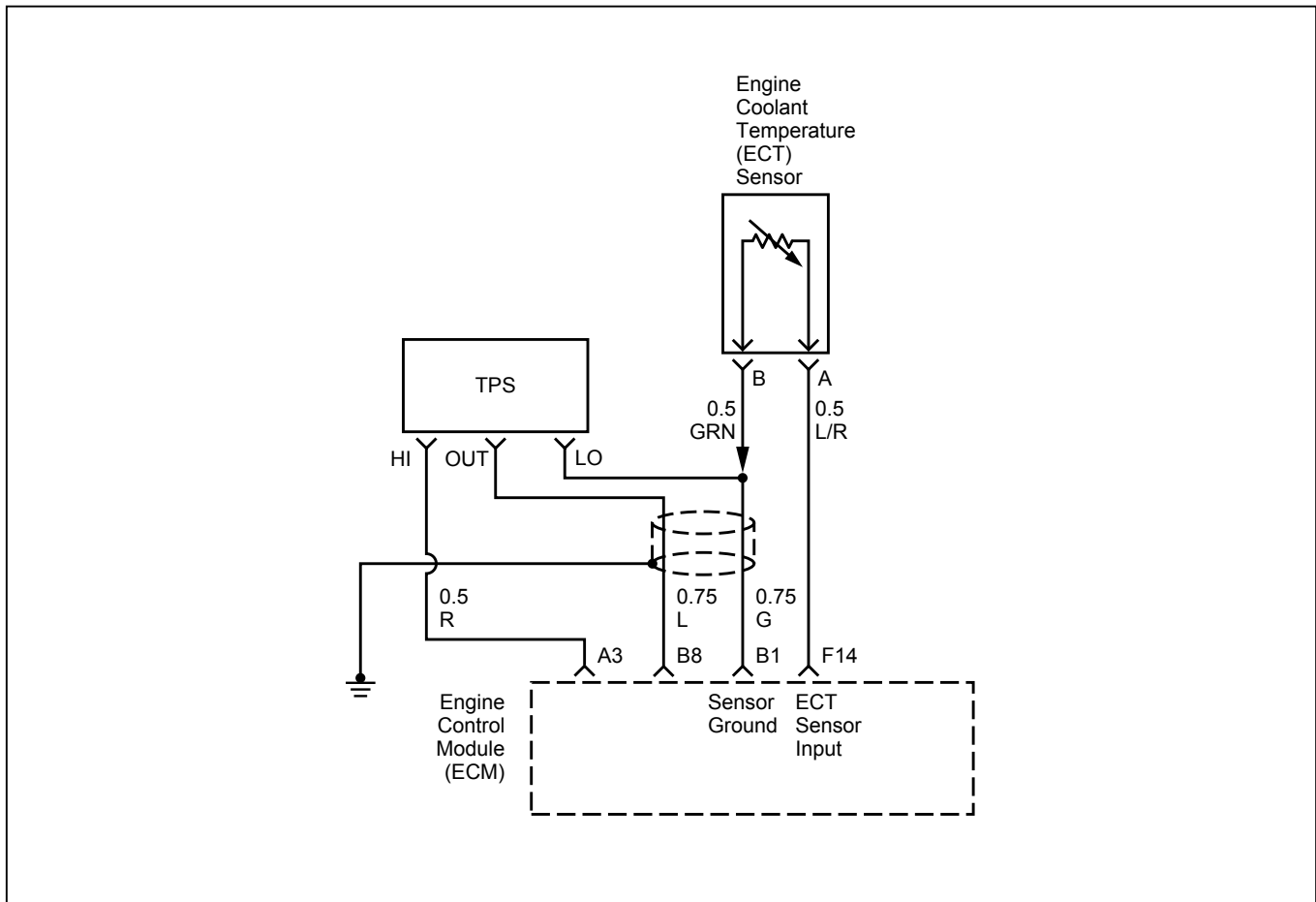
**DTC (Flash DTC = 14)  
ECT Sensor Circuit High Input**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition ON engine OFF 2. Observe the "Eng Coolant Temp" displayed on the Scan Tool. Is the "Eng Coolant Temp" below the specified value?	-35°C (-31°F)	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	1. Ignition ON engine OFF. 2. Using a Scan Tool, monitor the info for Diagnostic Trouble Code 14. Does the Scan Tool indicate Diagnostic Trouble Code 14.	-	<i>Refer to Test Description</i>	<i>Refer to Diagnostic Aids</i>
4	1. Disconnect the ECT sensor electrical connector. 2. Jumper the ECT signal circuit and the sensor ground circuit together at the ECT sensor harness connector. 3. Observe the "Eng Coolant Temp" displayed on the Scan Tool. Is the "Eng Coolant Temp" at the specified value?	140°C (284°F)	<i>Go to Step 6</i>	<i>Go to Step 5</i>

**DTC (Flash DTC = 14)**  
**ECT Sensor Circuit High Input (Cont'd)**

Step	Action	Value(s)	Yes	No
5	1. Jumper the ECT signal circuit at the ECT sensor harness connector to chassis ground. 2. Observe the "Eng Coolant Temp" displayed on the Scan Tool. Is the "Eng Coolant Temp" at the specified value?	140°C (284°F)	<i>Go to Step 7</i>	<i>Go to Step 6</i>
6	Check for poor connections at the ECT sensor and replace terminals if necessary. Did any terminals require replacement?	-	<i>Verify repair</i>	<i>Go to Step 8</i>
7	1. Ignition OFF. 2. Disconnect the ECM, and check the ECT sensor ground circuit for an Short to ground. 3. If the ECT sensor ground circuit is Short to ground, repair it as necessary. Was the ECT sensor ground circuit Short to ground?	-	<i>Verify repair</i>	<i>Go to Step 8</i>
8	Check for a poor sensor ground or ECT signal circuit terminal connection at the ECM and replace terminal(s) if necessary. Did any of the terminal need to be replaced?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	Replace the ECT sensor. Is the action complete?	-	<i>Verify repair</i>	-
10	Replace the EPROM or ECM. Is the action complete?                      Note) Refer to 6E1-243.	-	<i>Verify repair</i>	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 15) ENGINE COOLANT TEMPERATURE (ECT) SENSOR CIRCUIT LOW INPUT

### Circuit Description

The ECT sensor is a thermistor mounted in the engine coolant stream. The engine control module (ECM) applies a voltage (about 5 volts) through a pull-up resistor to the ECT signal circuit. When the engine coolant is cold, the sensor (thermistor) resistance is high, therefore the ECM will measure a high signal voltage. As the engine coolant warms, the sensor resistance becomes lower, and the ECT signal voltage measured at the ECM drops. With a fully warmed-up engine, the ECT signal voltage should measure about 1.5 to 2.0 volts.

### Conditions for Setting the DTC

- Engine running time is longer than 30 secs.
- The ECT sensor signal indicates an engine coolant temperature less than  $-35^{\circ}\text{C}$  ( $-31^{\circ}\text{F}$ ).

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- The ECM will substitute the ECT reading with a default engine coolant temperature value. The default value is based on start-up intake air temperature and running time.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

Check for the following conditions:

- Poor connection at ECM - Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness - Inspect the wiring harness for damage, If the harness appears to be OK, observe the ECT display on the Scan Tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.

**Test Description**

Number(s) below refer to the step number(s) on the Diagnostic Chart.

2. Verifies that the fault is present.
3. Refer to the "Temperature vs. Resistance Value" table. The table may be used to test the ECT sensor at various temperatures to evaluate the possibility of a "shifted" sensor that may be stored

above or below a certain temperature. If this is the case, replace the ECT sensor. If the ECT sensor appears to be OK, the fault is intermittent; refer to *Diagnostic Aids*.

**Engine Coolant Temperature Sensor**

°C	°F	OHMS
Temperature vs. Resistance Values (approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

**DTC (Flash DTC = 15)**

**Engine Coolant Temperature (ECT) Sensor Circuit Low Input**

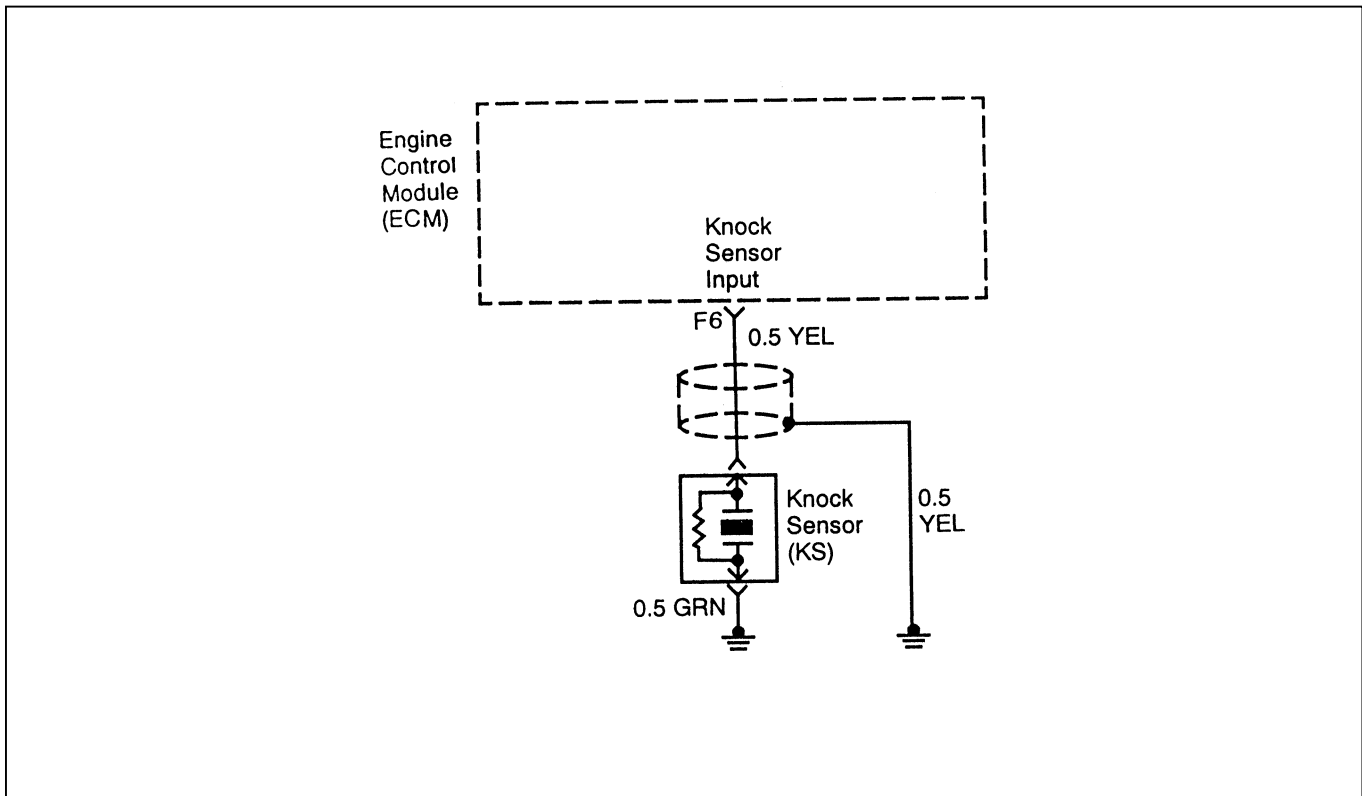
Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition ON, engine OFF 2. Observe the "Eng Coolant Temp" displayed on the Scan Tool. Is the "Eng Coolant Temp" below the specified value?	140°C (284°F)	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	1. Ignition ON, engine OFF. 2. Using a Scan Tool, monitor info for Diagnostic Trouble Code 15. Does the Scan Tool indicate Diagnostic Trouble Code 15?	-	<i>Go to Step 4</i>	<i>Refer to Diagnostic Aids</i>
4	1. Disconnect the ECT sensor electrical connector. 2. Observe the "Eng Coolant Temp" displayed on the Scan Tool. Is the "Eng Coolant Temp" at the specified value?	-35°C (-31°F)	<i>Go to Step 6</i>	<i>Go to Step 5</i>



**DTC (Flash DTC = 15)**  
**Engine Coolant Temperature (ECT) Sensor Circuit Low Input (Cont'd)**

Step	Action	Value(s)	Yes	No
5	1. Ignition OFF. 2. Disconnect the ECM and check the ECT circuit for a an open or a short to battery in the sensor circuit. 3. If the ECT circuit is short to battery or open, repair it as necessary. Was the ECT signal circuit shorted to ground?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
6	Replace the ECT sensor. Is the action complete?	-	<i>Verify repair</i>	-
7	Replace the EPROM or ECM. Is the action complete?                      Note) Refer to 6E1-243.	-	<i>Verify repair</i>	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 16) KNOCK SENSOR (KS) DISCONNECTED MALFUNCTION

### Circuit Description

The knock sensor (KS) system is used to detect engine detonation. The knock sensor produced an AC voltage signal. The knock sensor sends this signal to the ECM. The amplitude and the frequency of the AC voltage signal depends upon the knock level being detected. The ECM will then retard the spark timing based on the signals from the Knock Sensor.

This code detects a disconnected knock sensor. Then a DTC 16 will set.

### Conditions for Setting the DTC

- Electronic and spark control enabled.
- Engine running.
- ECM powered up.
- Engine speed is greater than 2400rpm.

All the above mentioned conditions are met.

### Action Taken When the DTC Sets

- The Malfunction Indicator Lamp (MIL) will illuminate the fault is detected.
- The ECM will use a calculated spark retard value in order to minimize the knock during the conditions when the knock is likely to occur. The calculated value will vary based on the engine speed and load.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

Correct any abnormal engine noise before using the diagnostic table.

Check for an open ignition feed circuit.

### Test Description

Number(s) below refer to the step number(s) on the Diagnostic Table.

2. If the conditions for the test as described above are met, a Diagnostic Trouble Code 16 will set and MIL will illuminate.
4. If the engine has an internal knock or audible noise that causes a knocking type noise on the engine

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block, the knock sensor may be responding to the noise.

6. Any circuitry, that is suspected as causing the complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals,

poor terminal to wiring connections or physical damage to the wiring harness.

8. Checking the internal resistance of the knock sensor verifies if the knock sensor or the wiring to the knock sensor is OK.

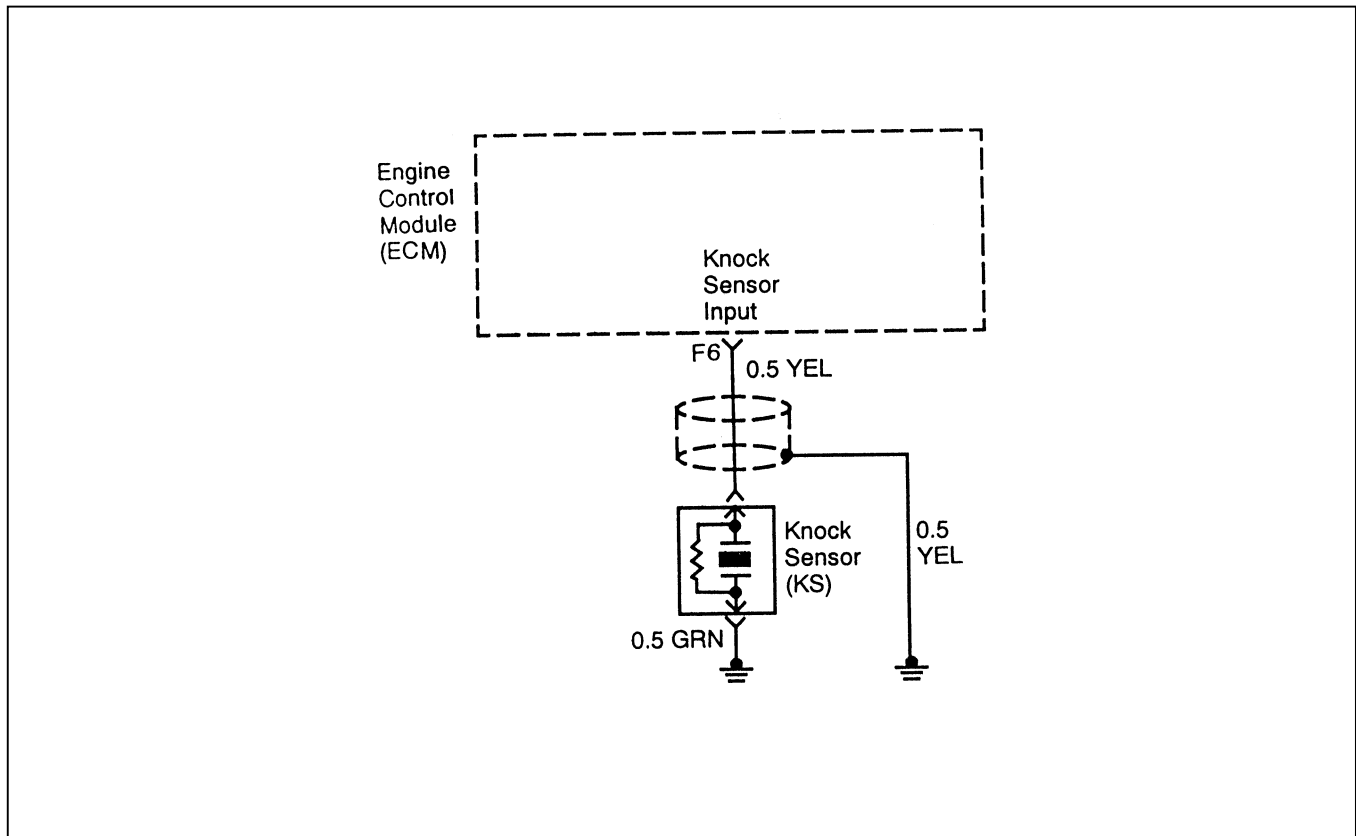
### DTC (Flash DTC = 16) KS Sensor Disconnected Malfunction

Step	Action	Value(s)	Yes	No
1	Was the Powertrain On-Board Diagnostic (OBD) System Check performed?	-	<i>Go to Step 2</i>	<i>Go to Powertrain OBD System Check</i>
2	1. Start the engine. 2. Install a Scan Tool. 3. Clear the Diagnostic Trouble Codes. 4. Run the engine at slightly more than 10% throttle angle. Does the Malfunction Indicator Lamp (MIL) illuminate?	-	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	1. Turn the ignition Switch ON, with engine OFF. Does the Malfunction Indicator Lamp (MIL) illuminate?	-	<i>Go to Step 4</i>	<i>Go to Step 12</i>
4	Listen to the engine while raising and lowering the engine speed. Is a knock or audible noise present?	-	<i>Go to Step 5</i>	<i>Go to Step 6</i>
5	Repair the mechanical engine problem or a loose bracket or component. Is the action complete?	-	<i>Go to Step 12</i>	-
6	Check for a poor connection at the ECM connector, Knock sensor signal circuit and repair as necessary. Was a repair necessary?	-	<i>Go to Step 12</i>	<i>Go to Step 7</i>
7	Replace the EPROM or ECM. Is the action complete?                      Note) Refer to 6E1-243.	-	<i>Go to Step 12</i>	-
8	1. Turn the ignition switch OFF. 2. Disconnect the ECM connectors at the ECM. 3. With a Digital Voltmeter (DVM) connected to ground, measure the resistance of the knock sensor through the knock sensor signal circuit. Is the measured value within the specified value?	95K-105K OHMS	<i>Go to Step 6</i>	<i>Go to Step 9</i>
9	Check the knock sensor electrical connector for a poor connection and repair as necessary. Was a repair necessary?	-	<i>Go to Step 12</i>	<i>Go to Step 10</i>
10	Check the knock sensor signal circuit for an open or a short to ground or to voltage and repair as necessary. Was a repair necessary?	-	<i>Go to Step 12</i>	<i>Go to Step 11</i>
11	Replace the Knock Sensor(KS). Is the action complete?	-	<i>Go to Step 12</i>	-

**DTC (Flash DTC = 16)**  
**KS Sensor Disconnected Malfunction (Cont'd)**

Step	Action	Value(s)	Yes	No
12	1. Using the Scan Tool, clear the Diagnostic Trouble Codes. 2. Start the engine and idle at normal operating temperature. 3. Operate the vehicle within the conditions for setting this Diagnostic Trouble Code as specified in the supporting text. Does the Scan Tool indicate that this diagnostic has ran and passed?	-	<i>Go to Step 13</i>	<i>Go to Step 2</i>
13	Check is any additional Diagnostic Trouble Codes are set. Are any Diagnostic Trouble Codes displayed that have not been diagnosed?	-	<i>Go to applicable Diagnostic Trouble Code table</i>	<i>System OK</i>





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 18) DIGITALLY CONTROLLED SIGNAL TO NOISE ENHANCEMENT FILTER FAILURE

### Circuit Description

The knock sensor (KS) system is used to detect engine detonation. The knock sensor produced an AC voltage signal. The knock sensor sends this signal to the ECM. The amplitude and the frequency of the AC voltage signal depends upon the knock level being detected. The ECM will then retard the spark timing based on the signals from the Knock Sensor.

This code detects a digitally controlled signal to noise enhancement filter failure. Then the DTC 18 will set.

### Conditions for Setting the DTC

- ECM powered up, Engine running, Electronic spark control enabled and Engine rpm is greater than 96 rpm.
- Malfunction 16 is not triggered.

### Action Taken When the DTC Sets

- The Malfunction Indicator Lamp (MIL) will illuminate the second time the fault is detected.
- The ECM will use a calculated spark retard value in order to minimize the knock during the conditions when the knock is likely to occur. The calculated value will vary based on the engine speed and load.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

Correct any abnormal engine noise before using the diagnostic table.

Check for an open ignition feed circuit.

### Test Description

Number(s) below refer to the step number(s) on the Diagnostic Table.

2. If the conditions for the test as described above are met, a Diagnostic Trouble Code 18 will set and MIL will illuminate.

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5. Any circuitry, that is suspected as causing the complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.

9. If the KS module was previously replaced and the Diagnostic Trouble Code resets, a malfunctioning ECM is indicated.

**DTC (Flash DTC = 18)**

**Digitally Controlled Signal To Noise Enhancement Filter Failure**

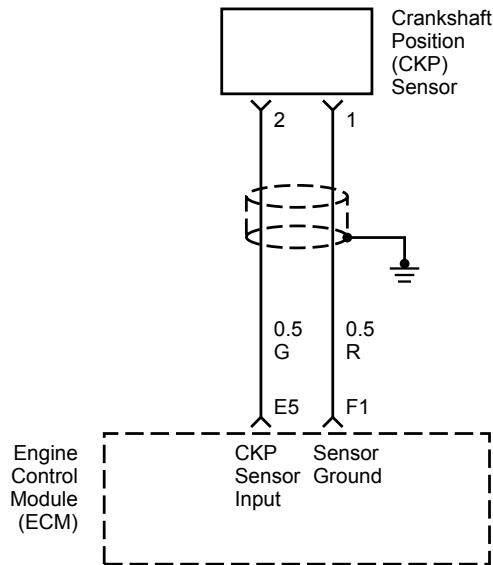
<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
1	Was the On-Board Diagnostic(OBD) System Check performed?	-	<i>Go to Step2</i>	<i>Go to Powertrain OBD System Check</i>
2	1. Operate the engine within the conditions specified in the diagnostic support Conditions for Setting the Diagnostic Trouble Code. 2. Using a Scan Tool, monitor the Specific DTC information for DTC 18. 3. Observe the test results. Does the Scan Tool indicate the DTC 18.	-	<i>Go to Step 3</i>	<i>Go to Diagnostic Aids</i>
3	1. Turn ON the ignition with the engine leaving OFF. 2. Disconnect the KS electrical connector. 3. Using a Digital Voltmeter (DVM), measure the voltage between the KS signal circuit at the knock sensor harness connectors and ground. Is the voltage at the specified value?	Approx.5.0V	<i>Go to Step 4</i>	<i>Go to Step 7</i>
4	Measure the resistance of the KS sensor by connecting the between the KS sensor terminal and the engine block. Is the resistance of the KS sensor near the specified value?	100K OHMS	<i>Go to Step 5</i>	<i>Go to Step 8</i>
5	1. Check the KS signal circuit for a poor terminal connection at the knock sensor. 2. If a problem is found, repair as necessary. Refer to <i>Wiring Repairs in Engine Electrical</i> . Was a problem found?	-	<i>Go to Step 6</i>	<i>Go to Step 8</i>



**DTC (Flash DTC = 18)**  
**Digitally Controlled Signal To Noise Enhancement Filter Failure (Cont'd)**

Step	Action	Value(s)	Yes	No
6	1. Re-Connect the KS Sensor in order to monitor the voltage between the KS sensor terminal and the engine ground. 2. Tap on the engine lift bracket, near the KS Sensor, while observing the signal indicated on the Scan Tool. Is any signal indicated on the while tapping on the engine lift bracket?	-	<i>Go to Step 10</i>	<i>Go to Step 7</i>
7	1. Turn OFF the ignition. 2. Disconnect the ECM. 3. Turn ON the ignition. 4. Check the KS signal circuit between the ECM and the KS sensor connector for an open, a short to voltage, or a short to ground. 5. If a wiring problem is found, repair as necessary. Was a problem found?	-	<i>Go to Step 10</i>	<i>Go to Step 9</i>
8	Replace the KS Sensor. Refer to <i>Knock Sensor</i> . Is action complete?	-	<i>Go to Step 10</i>	-
9	Replace the EPROM or ECM. Note) Refer to 6E1-243. Is the action complete?	-	<i>Go to Step 10</i>	-
10	1. Using the Scan Tool, select the DTC and the Clear Info. 2. Start the Engine. 3. Idle at the normal operating temperature. 4. Select Specific DTC. 5. Enter the DTC number which was set. 6. Operate the vehicle within the conditions for setting this DTC as specified in the supporting text. Does the Scan Tool indicate that this diagnostic ran and passed?	-	<i>Go to Step 11</i>	<i>Go to Step 2</i>
11	Using the Scan Tool, select the Capture Info and the Review Info. Are any DTC displayed that have not been diagnosed?	-	<i>Go to the applicable Diagnostic Trouble Code table</i>	<i>System OK</i>





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 19) CRANKSHAFT POSITION (CKP) SENSOR SIGNAL INCORRECT

### Circuit Description

The 58X reference signal is produced by the crankshaft position (CKP) sensor. During one crankshaft revolution, 58 crankshaft pulses will be produced. The engine control module (ECM) uses the 58X reference signal to calculate engine RPM and crankshaft position. The ECM constantly monitors the number of pulses on the 58X reference circuit. If the ECM receives an incorrect number of pulses on the 58X reference circuit, Diagnostic Trouble Code 19 will set.

### Conditions for Setting the DTC

- Engine is running.
- Number of revolutions with pulses not equal to 58 is greater than 20.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) after the fault is detected.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

An intermittent may be caused by a poor connection, rubbed-through wire insulation or a wire broken inside the insulation. Check for:

- Poor connection - Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.

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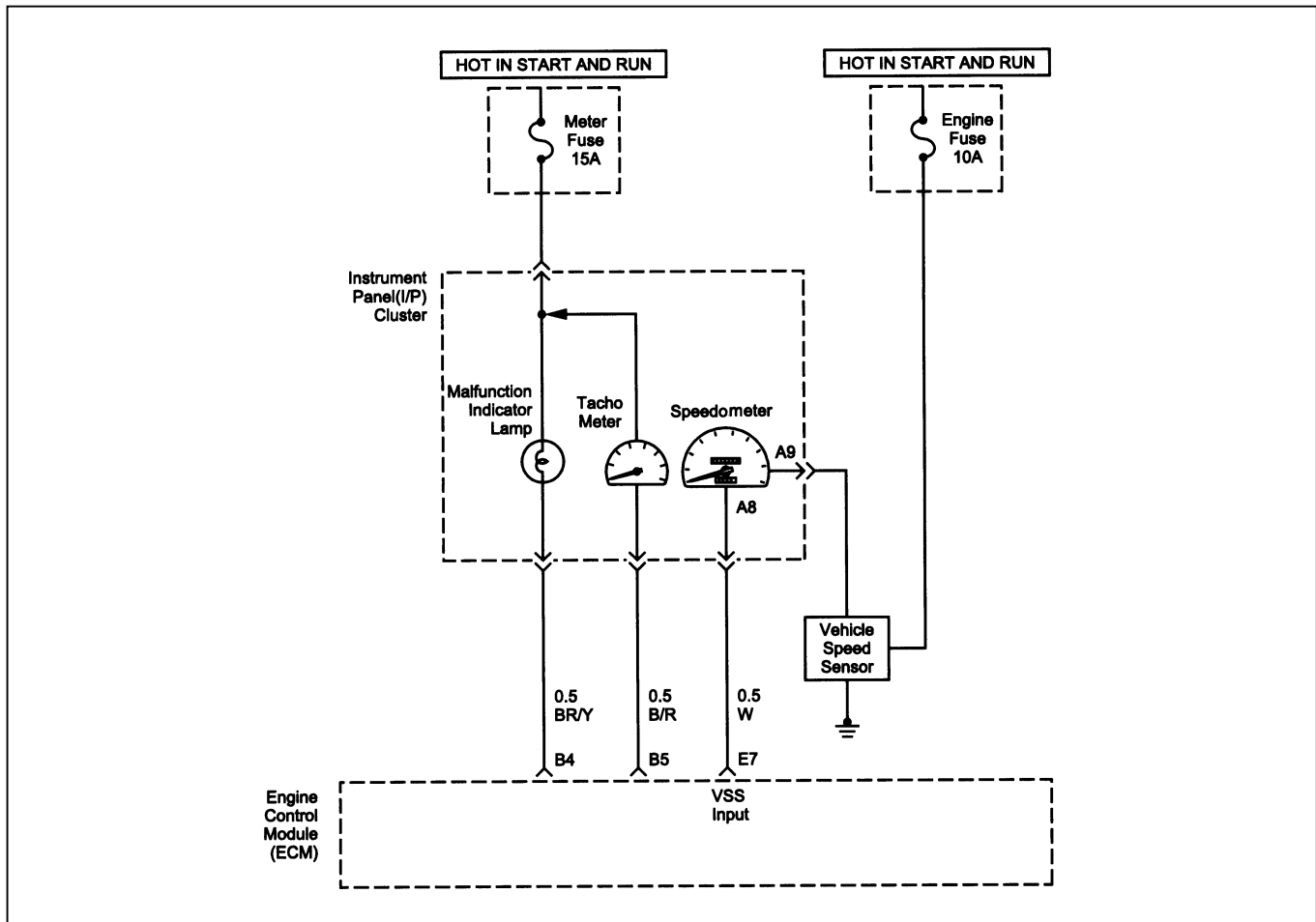
- Damaged harness - Inspect the wiring harness for damage; shorts to Ground, shorts to Battery Positive, and Open circuits. If the harness appears to be OK, disconnect the ECM, turn the ignition on and observe a voltmeter connected to the 58X reference circuit at the ECM harness connector

while moving connectors and wiring harnesses related to the ECM. A change in voltage will indicate the location of the fault.

- This code detects an incorrect 58X signal caused by intermittent failures.

### DTC (Flash DTC = 19) Crankshaft Position (CKP) Sensor Signal Incorrect

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	Go to Step 2	Go to OBD System Check
2	Attempt to start the engine. Does the engine start?	-	Go to Step 3	Refer to Engine Cranks But Will Not Run chart
3	1. Clear Diagnostic Trouble Code 19. 2. Start the engine and idle for 1 minute. 3. Observe Diagnostic Trouble Codes. Is Diagnostic Trouble Code 18 set?	-	Go to Step 4	Refer to Diagnostic Aids
4	1. Disconnect the ECM and CKP sensor. 2. Check for an open or a short to ground in the 58X reference circuit between the CKP sensor connector and the ECM harness connector. 3. If a problem is found, repair as necessary. Was a problem found?	-	Verify repair	Go to Step 5
5	1. Reconnect the ECM and CKP sensor. 2. Connect a Digital Voltmeter (DVM) to measure voltage on the 58X reference circuit at the ECM connector. 3. Observe the voltage while cranking the engine. Is the voltage near the specified value?	2.5V	Go to Step 8	Go to Step 6
6	Check the connections at the CKP sensor and replace the terminals if necessary. Did any terminals require replacement?	-	Verify repair	Go to Step 7
7	Replace the CKP sensor. Is the action complete?	-	Verify repair	-
8	Check connections at the ECM and replace the terminals if necessary. Did any terminals require replacement?	-	Verify repair	Go to Step 9
9	Replace the EPROM or ECM. Is the action complete?                      Note) Refer to 6E1-243.	-	Verify repair	-



## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 24) VEHICLE SPEED SENSOR (VSS) FAULT

### Circuit Description

The vehicle speed sensor has a magnet rotated by the transmission output shaft. Attached to the sensor is a hall effect circuit that interacts with the magnetic field created by the rotating magnet. A 12-volt operating supply for the speed sensor hall circuit is supplied from the meter fuse. The VSS pulses to ground the 5-volt signal sent from the engine control module (ECM) on the reference circuit. The ECM interprets vehicle speed by the number of pulses to ground per second on the reference circuit. Then a DTC 24 will set.

### Conditions for Setting the DTC

- Vehicle speed is less than 3 km/h.
- Engine is running.
- MAP is less than 24kPa.
- Throttle closed and in Drive.
- Engine Speed is between 2000 RPM and 5000 RPM.

- Following malfunctions are not set: DTC 21, 22, 33, 34 are not set.

When the above conditions are met, one of the following tests will run:

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the fault is detected.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

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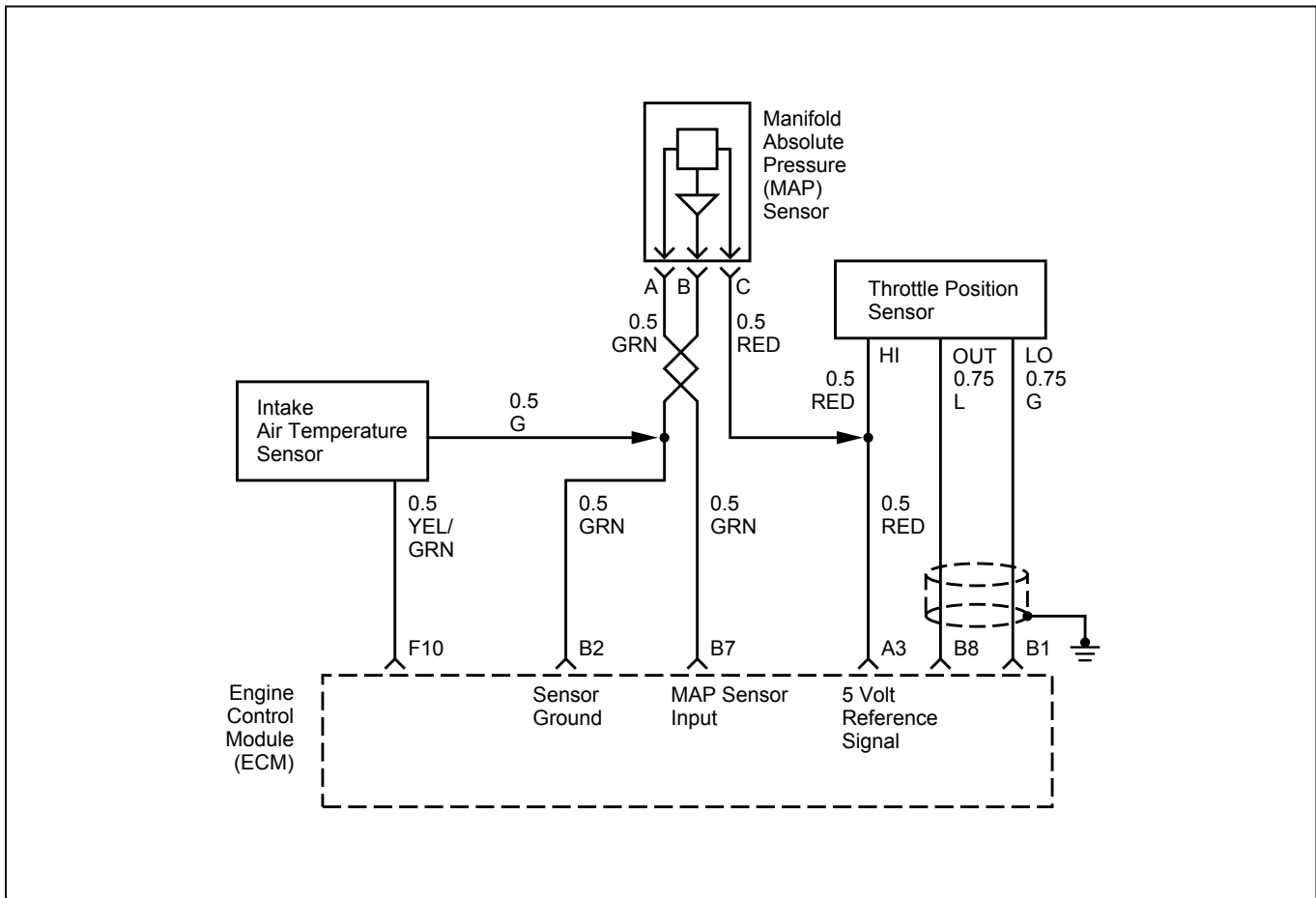
### Diagnostic Aids

- Poor connection at the ECM: Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.

- Damaged harness: Inspect the wiring harness to the Speedometer, Tachometer and check Engine Lamp for an intermittent open or intermittent short circuit.

### DTC (Flash DTC = 24) Vehicle Speed Sensor (VSS) Fault

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition OFF. 2. Disconnect the VSS connector. 3. Using a test light to battery +, probe the connector ground wire. Did the light illuminate?	-	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	Repair the open in the sensor ground circuit.	-	<i>Verify repair</i>	-
4	1. Ignition ON. 2. Using a Digital Voltmeter (DVM), measure at the VSS connector between ground and voltage supply. Was the measurement near the specified value?	Battery voltage	<i>Go to Step 6</i>	<i>Go to Step 5</i>
5	Repair the open or short to ground in the sensor circuit.	-	<i>Verify repair</i>	-
6	1. Ignition OFF. 2. Check the white wire between the VSS sensor connector and the ECM for the following conditions: <ul style="list-style-type: none"> <li>An open circuit</li> <li>A short to ground</li> </ul> Was the faulty condition located?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
7	Using a DVM, measure the resistance between the VSS sensor body and transmission case (ground). Is the resistance above the specified value?	10K OHMS	<i>Verify repair</i>	<i>Go to Step 9</i>
8	1. Remove the VSS from the transmission case. 2. Visually inspect the VSS for damage. Does the VSS appear to be OK?	-	<i>Verify repair</i>	-
9	Replace the VSS	-	<i>Verify repair</i>	-
10	Replace the EPROM or ECM. Verify repair. <span style="float: right;">Note) Refer to 6E1-243.</span>	-	<i>Verify repair</i>	-



### DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 33) MANIFOLD ABSOLUTE PRESSURE (MAP) TOO HIGH

#### Circuit Description

The manifold absolute pressure (MAP) sensor responds to changes in intake manifold pressure. The MAP sensor signal voltage to the engine control module (ECM) varies from below 2 volts at idle (low manifold pressure) to above 4 volts with the ignition ON, engine not running or at wide-open throttle (high manifold pressure).

A "speed density" method of determining engine load is used. This is calculated using inputs from the MAP sensor, the CKP Sensor, and the Intake Air Temperature (IAT) sensor. The MAP sensor is the main sensor used in this calculation, and measuring engine load is its main function. The ECM monitors the MAP signals for voltages outside the normal range of the MAP sensor. This code defects a short to MAP signal voltage in the MAP sensor circuit. Diagnostic Trouble Code 33 will be set.

#### Conditions for Setting the DTC

- No TP sensor Diagnostic Trouble Codes 21 or 22 present.

- Engine is running.
- Not in power enrich mode.
- Throttle Position Sensor value is less than 1%.
- Altitude Compensated Manifold Absolute Pressure is greater than 95kpa.

#### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).

#### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

Check for the following conditions:

- Poor connection at ECM - Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.

- Damaged harness - Inspect the wiring harness for damage, shorts to Ground, shorts to Battery positive, and Open circuits. If the harness appears to be OK, observe the MAP display on the Scan Tool while moving connectors and wiring harnesses related to the sensor. A change in the display will indicate the location of the fault.

**DTC (Flash DTC = 33)  
Manifold Absolute Pressure (MAP) Too High**

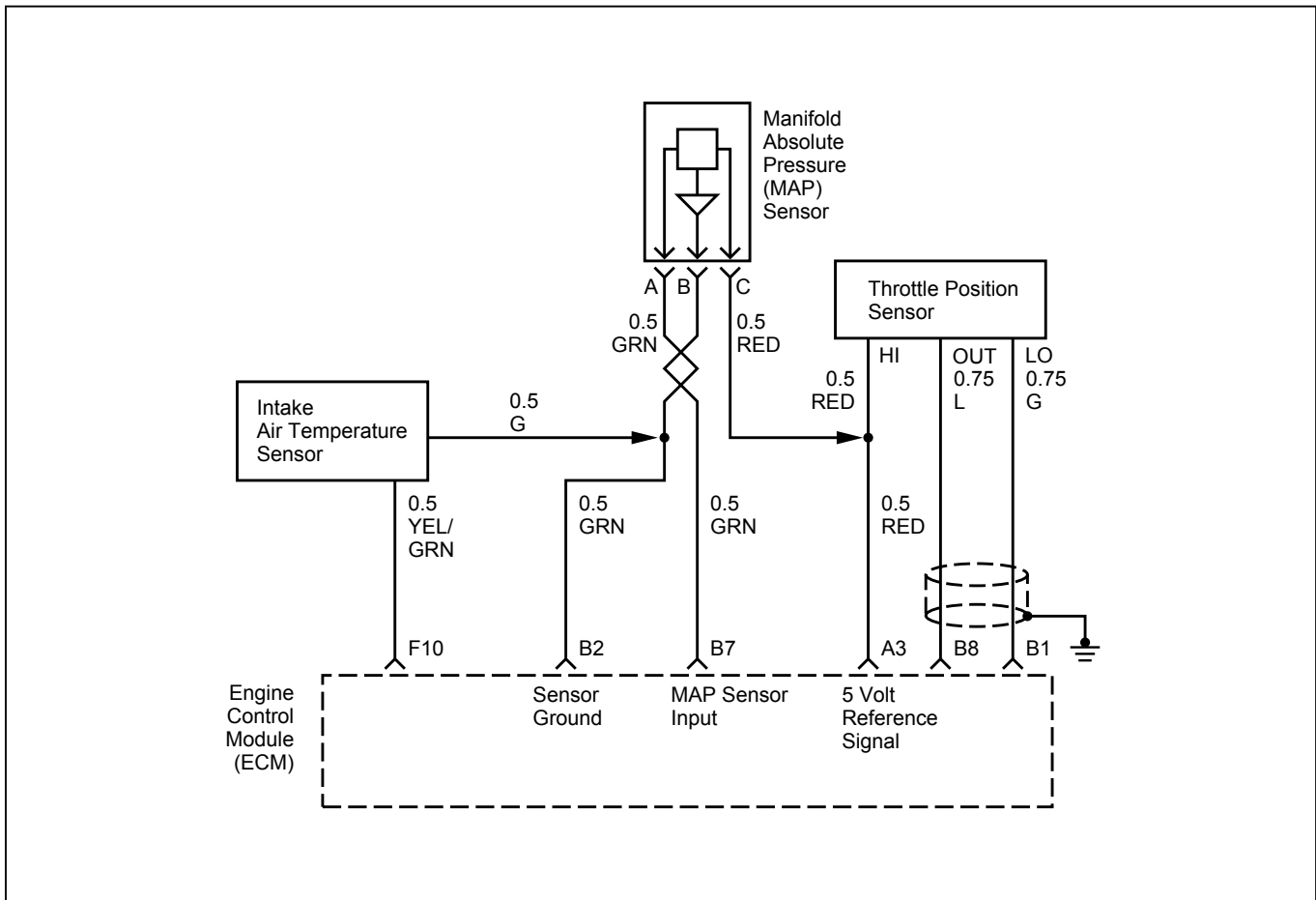
Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. If the engine idle is rough, unstable or incorrect, repair the idle problem before using this chart. Refer to <i>Symptoms</i> section. 2. With the engine idling, note the MAP value on the Scan Tool. Is the MAP reading above the specified value?	About 4V 90 kPa	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	1. Ignition ON engine OFF. 2. Using the Scan Tool, monitor info for Diagnostic Trouble Code 33. Does the Scan Tool indicate Diagnostic Trouble Code 33 failed?	-	<i>Go to Step 4</i>	<i>Refer to Diagnostic Aids</i>
4	1. Ignition OFF. 2. Disconnect the MAP sensor electrical connector. 3. Ignition ON. 4. Observe the MAP value displayed on the Scan Tool. Is the MAP value near the specified value?	0V 10.3 Kpa	<i>Go to Step 5</i>	<i>Go to Step 6</i>
5	Check the MAP sensor signal circuit, between the MAP sensor and the Engine control Module (ECM), for a short to voltage. Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 12</i>
6	Check the MAP sensor signal circuit, between the MAP sensor and the ECM for the following conditions: • A short to ground • An open circuit Was the problem found?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	Check the 5 volt signal circuit, between the MAP sensor and the ECM for the following conditions: • A short to ground • An open circuit • A short to voltage Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 8</i>



**DTC (Flash DTC = 33)**  
**Manifold Absolute Pressure (MAP) Too High (Cont'd)**

Step	Action	Value(s)	Yes	No
8	1. Ignition OFF. 2. Place a fused jumper between the MAP sensor circuit and the 5 volt signal circuit, both at the wiring harness' MAP sensor connector. 3. Ignition ON, Engine OFF. 4. Observe the MAP value displayed on the Scan Tool. Does the Scan Tool read the following value?	5 Volts 104 kPa	<i>Go to Step 9</i>	<i>Go to Step 12</i>
9	Check the MAP sensor ground circuit, between the MAP sensor and the ECM, for the following conditions: <ul style="list-style-type: none"> <li>• A short to ground</li> <li>• An open circuit</li> <li>• A short to voltage</li> </ul> Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 10</i>
10	1. Ignition OFF. 2. Place a Digital Multimeter (DVM), set to measure voltage between the ground circuit and the 5 volt signal circuit, both at the wiring harness' MAP sensor connector. 3. Ignition ON, Engine OFF. Does the DVM read the following value?	5 Volts	<i>Go to Step 11</i>	<i>Go to Step 12</i>
11	Replace the MAP Sensor. Verify Repair.	-	-	-
12	Replace the EPROM or ECM. Verify Repair. <p style="text-align: right;">Note) Refer to 6E1-243.</p>	-	-	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 34) MANIFOLD ABSOLUTE PRESSURE (MAP) TOO LOW

### Circuit Description

The manifold absolute pressure (MAP) sensor responds to changes in intake manifold pressure. The MAP sensor signal voltage to the engine control module (ECM) varies from below 2 volts at idle (low manifold pressure) to above 4 volts with the ignition ON engine not running or at wide-open throttle (high manifold pressure).

A "speed density" method of determining engine load is used. This is calculated using inputs from the MAP sensor, the CKP Sensor, and the Intake Air Temperature (IAT) sensor. The MAP sensor is the main sensor used in this calculation, and measuring engine load is its main function. The ECM monitors the MAP signals for voltages outside the normal range (10-104 kpa) of the MAP sensor. If the ECM detects a MAP signal voltage that is excessively low, Diagnostic Trouble Code 34 will be set.

### Conditions for Setting the DTC

- Manifold Absolute Pressure is less than 14 kpa and one of following condition is met the DTC will set.

Condition A:

- Malfunction 21 not present and rpm is less than 1050.

Or,

Condition B:

- Malfunction 21 not present and rpm is greater than 1050 and TP opening is greater than 18.75% and ignition ON.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

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1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM - Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness - Inspect the wiring harness for damage, shorts to Ground, shorts to Battery positive, and Open circuits. If the harness appears to be OK, observe the MAP display on the Scan Tool while moving connectors and wiring harnesses related to the sensor. A change in the display will indicate the location of the fault.
- A faulty 5 volt reference circuit could also set a TP Sensor Diagnostic Trouble Code because the two sensors share the same 5 volt reference pin at the ECM.

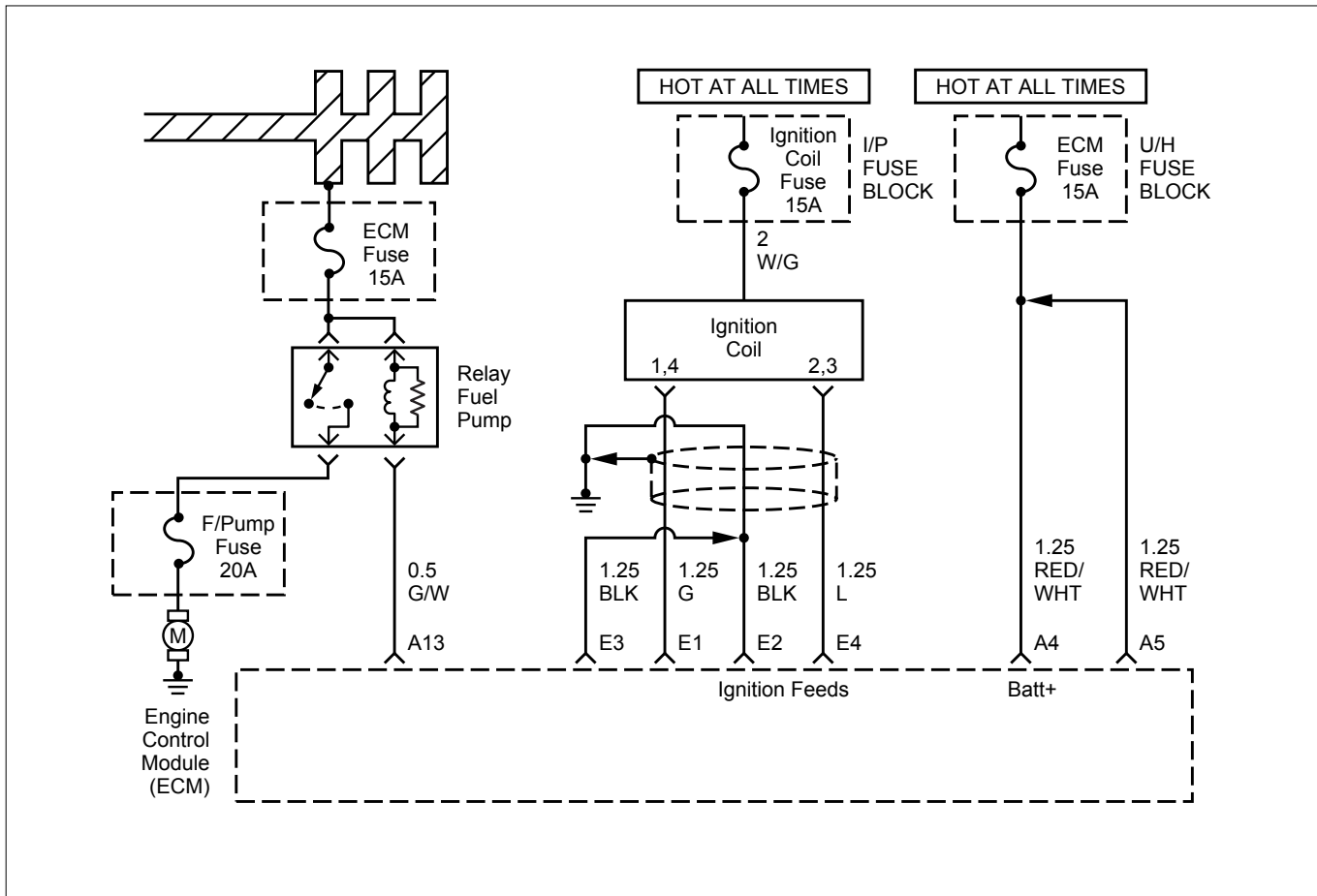
### DTC (Flash DTC = 34) Manifold Absolute Pressure (MAP) Too Low

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition ON engine OFF. 2. With the throttle closed, observe the MAP value displayed on the Scan Tool. Is the MAP value near the specified value?	0V 10.3 kPa at sea level	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	1. Ignition ON, engine OFF. 2. Using a Scan Tool, monitor info for Diagnostic Trouble Code 34. Does the Scan Tool indicate Diagnostic Trouble Code 34 failed?	-	<i>Go to Step 4</i>	<i>Refer to Diagnostic Aids</i>
4	1. Ignition OFF. 2. Disconnect the MAP sensor electrical connector. 3. Jumper the 5 volt reference circuit and the MAP signal together at the MAP sensor harness connector. 4. Ignition ON. 5. Observe the MAP value displayed on the Scan Tool. Is the MAP value near the specified value?	5V 104 kPa	<i>Go to Step 10</i>	<i>Go to Step 5</i>
5	1. Disconnect the jumper. 2. Connect a test light between B+ and the MAP sensor signal circuit at the MAP sensor harness connector. 3. Observe the MAP value displayed on the Scan Tool. Is the MAP value near the specified value?	5V 104 kPa	<i>Go to Step 6</i>	<i>Go to Step 8</i>

**DTC (Flash DTC = 34)**  
**Manifold Absolute Pressure (MAP) Too Low (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
6	1. Ignition OFF. 2. Disconnect the ECM and check the 5 volt reference circuit for an open or short to ground. 3. If the 5 volt reference circuit is open or shorted to ground, repair it as necessary. Was the 5 volt reference circuit open or shorted to ground?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	Check the 5 volt reference circuit for a poor connection at the ECM and replace the terminal if necessary. Did the terminal require replacement?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
8	1. Ignition OFF. 2. Disconnect the ECM, and check the MAP signal circuit for an open, short to ground, or short to the sensor ground circuit. 3. If the MAP sensor signal circuit is open or shorted to ground, repair it as necessary. Was the MAP signal circuit open or shorted to ground?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	Check the MAP sensor signal circuit for a poor connection at the ECM and the MAP sensor; replace the terminal if necessary. Did the terminal require replacement?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
10	Replace the MAP sensor. Is the action complete?	-	<i>Verify repair</i>	-
11	Replace the EPROM or ECM.      Note) Refer to 6E1-243. Is the action complete?	-	<i>Verify repair</i>	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 49) SYSTEM VOLTAGE HIGH

### Circuit Description

The engine control module (ECM) monitors the system voltage on the ignition feed terminal to the ECM. A system voltage Diagnostic Trouble Code will set whenever the voltage is above a calibrated value.

This malfunction detects an over-voltage condition in the battery voltage circuit.

### Conditions for Setting the DTC

- Engine is running.
- Battery Voltage is greater than 17.2V.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) for the first time the malfunction is detected.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

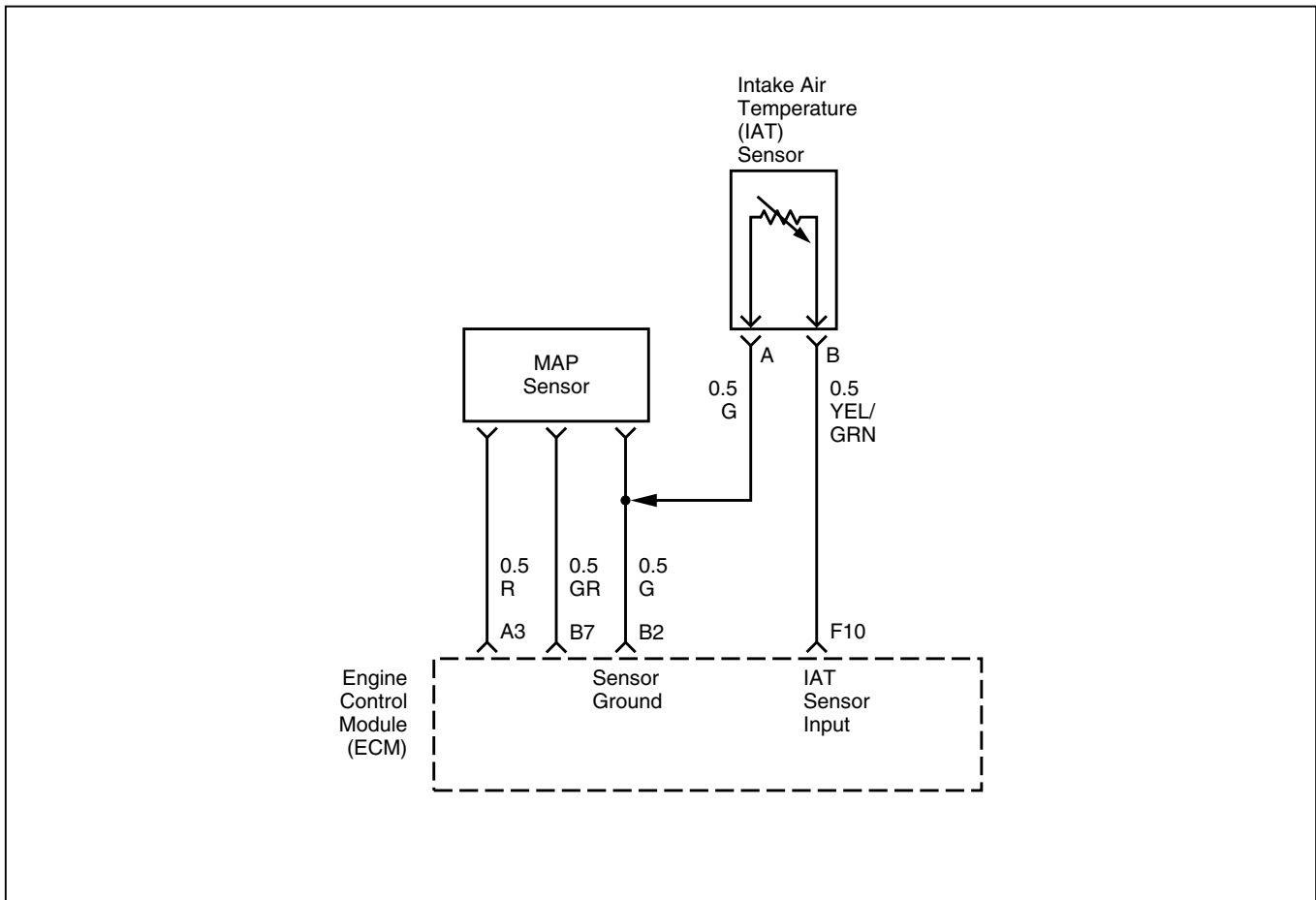
### Diagnostic Aids

- Check for a faulty charging system components.

**DTC (Flash DTC = 49)  
System Voltage High**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition OFF, engine OFF. 2. Using a Digital Voltmeter (DVM), measure the battery voltage at the battery. Is the battery voltage greater than the specified value?	16V	Go to Step 3	Go to Step 4.
3	1. Charge the battery and clean the battery terminals. 2. Clean the battery ground cable connection if corrosion is indicated. Is the battery voltage greater than the specified value?	16V	Replace battery	Go to Step 4
4	1. Turn OFF all the accessories. 2. Install the Scan Tool. 3. Select the ignition voltage parameter on the data list. 4. Start the engine and raise the engine speed to 2000 RPM. Is it the voltage above the specified value?	16V	Go to Step 5	Go to Step 6
5	Replace or repair the generator (see <i>Charging System</i> ). Is a malfunction present?	-	Verify Repair	-
6	Replace the EPROM or ECM. Is the action complete? <span style="float: right;">Note) Refer to 6E1-243.</span>	-	Verify Repair	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 69) INTAKE AIR TEMPERATURE (IAT) SENSOR TOO HIGH

### Circuit Description

The intake air temperature (IAT) sensor is a thermistor which measures the temperature of the air entering the engine. The engine control module (ECM) applies 5 volts through a pull-up resistor to the IAT sensor. When the intake air is cold, the sensor resistance is high and the ECM will monitor a high signal voltage on the IAT signal circuit. If the intake air is warm, the sensor resistance is lower, causing the ECM to monitor a lower voltage. Diagnostic Trouble Code 69 will set when the ECM detects an excessively high signal voltage on the intake air temperature sensor signal circuit.

### Conditions for Setting the DTC

- The engine is running.
  - IAT sensor temperature is greater than 140 deg.C.
- The above conditions are met.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- The ECM will use a default IAT value based on ECM inputs and engine run time.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM - Inspect harness connectors for backed-out terminals, improper

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mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.

- Damaged harness - Inspect the wiring harness for damage, shorts to Ground, shorts to Battery Positive, and Open Circuits. If the harness appears to be OK, observe the IAT display on the Scan Tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.

If Diagnostic Trouble Code 69 cannot be duplicated, the information included in the Failure Records data can be useful in determining vehicle mileage since the Diagnostic Trouble Code was last set.

### Test Description

Number(s) below refer to the step number(s) on the Diagnostic Chart.

2. Verifies that the fault is present.
3. If Diagnostic Trouble Code 69 can be repeated only by duplicating the Failure Records conditions, refer to the "Temperature vs. Resistance Values" table. The table may be used to test the IAT sensor

at various temperatures to evaluate the possibility of a "shifted" sensor that may be open above or below a certain temperature. If this is the case, replace the IAT sensor. If the IAT sensor appears to be OK, the fault is intermittent; refer to *Diagnostic Aids*.

### Intake Air Temperature Sensor

°C	°F	OHMS
Temperature vs. Resistance Values (approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

### DTC (Flash DTC = 69)

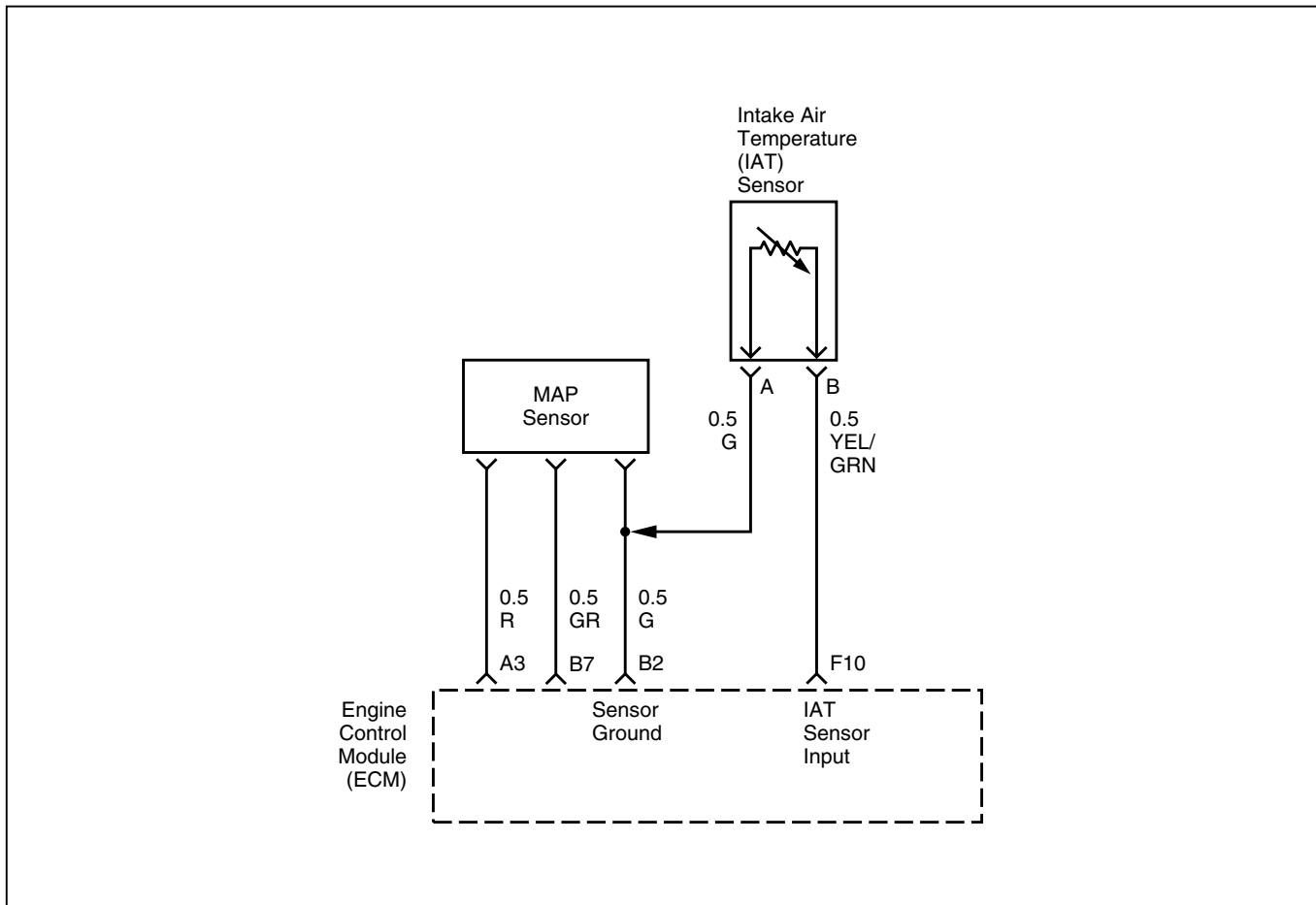
#### Intake Air Temperature (IAT) Sensor Too High

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	Ignition ON, engine OFF Observe the "Intake Air Temp" values displayed on the Scan Tool. Is the "Intake Air Temp" values below the specified value?	5V -36°C (-32.8°F)	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	1. Ignition ON, engine OFF. 2. Using a Scan Tool, monitor info for Diagnostic Trouble Code 69. Does the Scan Tool indicate Diagnostic Trouble Code 69 failed?	-	<i>Refer to Test Description</i>	<i>Refer to Diagnostic Aids</i>
4	1. Ignition OFF. 2. Disconnect the IAT sensor electrical connector. 3. Jumper the IAT signal circuit and the sensor ground circuit together at the IAT sensor harness connector. 4. Ignition ON. 5. Observe the "Intake Air Temp" values displayed on the Scan Tool. Is the "Intake Air Tempe" values at the specified value?	0V 140°C (284°F)	<i>Go to Step 6</i>	<i>Go to Step 5</i>

**DTC (Flash DTC = 69)**  
**Intake Air Temperature (IAT) Sensor Too High (cont'd)**

Step	Action	Value(s)	Yes	No
5	1. Jumper the IAT signal circuit at the IAT sensor harness connector to chassis ground. 2. Observe the "Intake Air Temp" display on the Scan Tool. Is the "Intake Air Tempe" at the specified value?	0V 140°C (284°F)	<i>Go to Step 7</i>	<i>Go to Step 8</i>
6	Check for poor connections at the IAT sensor and replace terminals if necessary. Did any terminals require replacement?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
7	1. Ignition OFF. 2. Disconnect the ECM, and check the IAT sensor ground circuit for an open. 3. If the IAT sensor ground circuit is open, repair it as necessary. Was the IAT sensor ground circuit open?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
8	1. Ignition OFF. 2. Disconnect the ECM, and check the IAT signal circuit for an open. 3. If the IAT sensor signal circuit is open, repair it as necessary. Was the IAT signal circuit open?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	Check for a poor sensor ground or IAT signal circuit terminal connection at the ECM and replace terminal(s) if necessary. Did any of the terminal need to be replaced?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
10	Replace the IAT sensor. Is the action complete?	-	<i>Verify repair</i>	-
11	Replace the EPROM or ECM. Is the action complete?                      Note) Refer to 6E1-243.	-	<i>Verify repair</i>	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 71) INTAKE AIR TEMPERATURE (IAT) SENSOR TOO LOW

### Circuit Description

The intake air temperature (IAT) sensor is a thermistor which measures the temperature of the air entering the engine. The engine control module (ECM) applies 5 volts through a pull-up resistor to the IAT sensor. When the intake air is cold, the sensor resistance is high and the ECM will monitor a high signal voltage on the IAT signal circuit. If the intake air is warm, the sensor resistance is lower, causing the ECM to monitor a lower voltage. Diagnostic Trouble Code 71 will set when the ECM detects an excessively low signal voltage (short to ground) on the intake air temperature sensor signal circuit.

### Conditions for Setting the DTC

- The engine has been running for over 2 minutes.
- IAT sensor temperature is less than  $-36$  degC.

The above conditions are met.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).
- The ECM will use a default IAT value based on PCM inputs and engine run time.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

Check for the following conditions:

- Poor connection at ECM - Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness - Inspect the wiring harness for damage, shorts to ground, shorts to battery, and open circuits. If the harness appears to be OK, observe the IAT display on the Scan Tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.

If Diagnostic Trouble Code 71 cannot be duplicated, the information included in the Failure Records data can be useful in determining vehicle mileage since the Diagnostic Trouble Code was last set.

**Test Description**

Number(s) below refer to the step number(s) on the Diagnostic Chart:

2. Verifies that the fault is present.
3. If Diagnostic Trouble Code 71 can be repeated only by duplicating the Failure Records condition,

refer to the *Temperature vs. Resistance Value* table. The table may be used to test the IAT sensor at various temperatures to evaluate the possibility of a "shifted" sensor that may be stored above or below a certain temperature. If this is the case, replace the IAT sensor. If the IAT sensor appears to be OK, the fault is intermittent; refer to *Diagnostic Aids*.

**Intake Air Temperature Sensor**

°C	°F	OHMS
Temperature vs. Resistance Values (approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

**DTC (Flash DTC = 71)**

**Intake Air Temperature (IAT) Sensor Too Low**

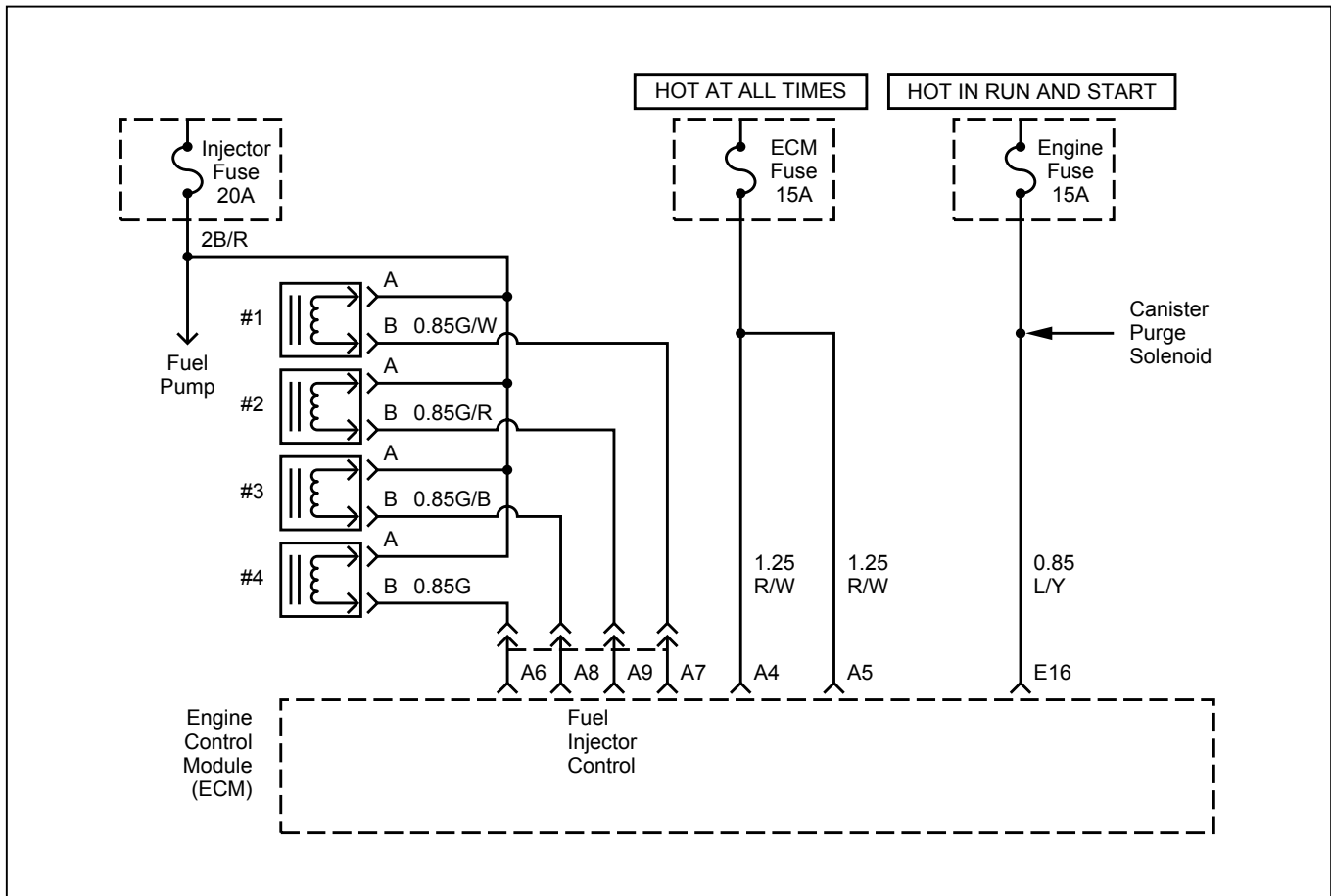
Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition ON, engine OFF 2. Using a Scan Tool, monitor the intake air temperature (IAT). Is the intake air temperature greater then the specified value?	140°C (284°F)	<i>Go to Step 4</i>	<i>Go to Step 3</i>
3	1. Ignition ON, engine OFF Review and record Scan Tool Failure Records data. 2. Using a Scan Tool, monitor the info for Diagnostic Trouble Code 71. Does the Scan Tool indicate Diagnostic Trouble Code 71?	-	<i>Refer to Test Description</i>	<i>Refer to Diagnostic Aids</i>

**DTC (Flash DTC = 71)**  
**Intake Air Temperature (IAT) Sensor Too Low (Cont'd)**

Step	Action	Value(s)	Yes	No
4	1. Ignition OFF. 2. Disconnect the IAT sensor electrical connector. 3. Ignition ON. 4. Observe the intake air temperature on the Scan Tool. Is the intake air temperature below the specified value?	-36°C (-32.8°F)	<i>Go to Step 6</i>	<i>Go to Step 5</i>
5	1. Ignition OFF. 2. Disconnect the PCM electrical connectors. 3. Check the IAT sensor signal circuit for a short to ground. Is the IAT sensor signal circuit shorted to ground?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
6	Replace the IAT sensor. Is the action complete?	-	<i>Verify repair</i>	-
7	Replace the EPROM or ECM. Note) Refer to 6E1-243. Is the action complete?	-	<i>Verify repair</i>	-







**DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 17)  
INJECTOR CIRCUIT MALFUNCTION**

**Circuit Description**

The engine control module (ECM) has 2 injector driver circuits. Each controls 2 injectors as a one group. When a driver circuit is grounded by the ECM, the injector is activated. The ECM monitors the current in each driver circuit. The ECM measures a voltage drop through a fixed resistor and controls it. The voltage on each driver is monitored to detect a fault. If the voltage is not what the ECM expects to monitor on the circuit, a Diagnostic Trouble Code is set. This Diagnostic Trouble Code is also set if an injector driver is shorted to voltage. This code an injectors short to ground, battery or a disconnected injector, then a DTC 17 will be set.

**Conditions for Setting the DTC**

- The actual output voltage of injector driver is opposite to the expected state thus setting injector feedback line low.

- Fuel pump relay is commanded on and Fuel pump relay is not shorted to battery and battery voltage is greater than 9 volts.

**Action Taken When the DTC Sets**

- The ECM will illuminate the malfunction indicator lamp (MIL).
- "Open Loop" fuel control will be in effect.

**Conditions for Clearing the MIL/DTC**

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

An injector driver circuit that is open or shorted to voltage will cause a Diagnostic Trouble Code 17 to

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set. It will also cause a misfire due to an inoperative injector.

Long term and short term fuel trims that are excessively high or low are a good indication that an injector is faulty. Use Fuel Injector Coil Test Procedure to check for faulty injectors.

### Test Description

The number(s) below refer to the step number(s) on the Diagnostic Chart.

3. This step determines if Diagnostic Trouble Code 17 is the result of a hard failure or an intermittent condition.

4. This steps tests the harness wiring and ECM control of the injectors.

6. Because the test light was ON steady, voltage to the injector is OK, but the driver circuit is grounded at all times. This step determines if the circuit is shorted to ground or the ECM is faulty.

8. Because the test light was OFF steady, the injector driver circuit is shorted to voltage.

10. Normal injector resistance is slightly more than if tested directly at the injector because it includes resistance of the harness wires. The normal value is about 13.5Ω.

### DTC (Flash DTC = 17)

#### Injector Circuit Malfunction

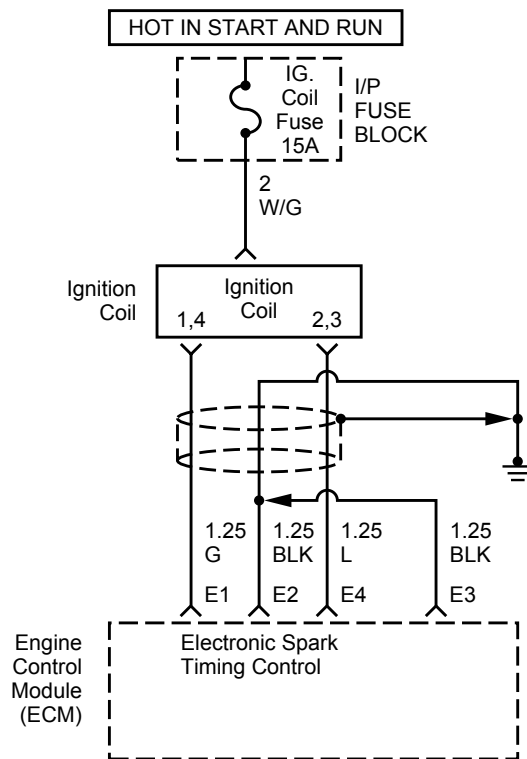
(Repeat Following Steps for each injector if necessary)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	Go to Step 2	Go to OBD System Check
2	Will the engine start?	-	Go to Step 3	Cranks But Will Not Run Chart
3	1. Install the Scan Tool. 2. Idle the engine for one minute. Does the Diagnostic Trouble Code 17 Set?	-	Go to Step 4	Go to Diagnostic Aids
4	1. Ignition off. 2. Disconnect the injector connector of No.1 Cyl. And then start the engine to check the injector working condition. 3. Repeat above steps on all injectors. 4. If the injector and injector driver circuit is normal condition, the engine becomes rough running. Does the engine running condition change?	-	Go to OBD System Check	Go to Step 5

**DTC (Flash DTC = 17)**  
**Injector Circuit Malfunction (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
5	Does the engine Idle Condition change? Note the detected faulty injector.	-	<i>Go to Step 6</i>	<i>Go to Step 8</i>
6	1. Ignition off. 2. Disconnect the ECM connector for the affected injectors. 3. With a test light (commercial available) connected to B+, probe the affected applicable injector circuit. Does the test light illuminate?	-	<i>Go to Step 7</i>	<i>Go to Step 8</i>
7	Repair short to ground in the injector driver circuit. Is the action complete?	-	<i>Verify Repair</i>	-
8	Re-connect the ECM connector. 1. Disconnect the injector test connector. 2. Ignition ON. 3. Use a test light (commercial available) connected to ground to probe the injector connector terminal. 4. Only the Ign+ terminal should illuminate the test high. Besides the Ign+, did any other terminal illuminate the test light?	-	<i>Go to Step 9</i>	<i>Go to Step 10</i>
9	Repair the short to voltage in the injector driver circuit.	-	<i>Verify Repair</i>	<i>Go to Step 10</i>
10	1. Ignition OFF. 2. Disconnect the ECM connector. 3. Clip one lead of an ohmmeter to the ignition pin on the harness side ECM connector. 4. Touch the other lead to the another pin in that connector. Instead of normal injector resistance, did the ohmmeter indicate an open circuit?	-	<i>Go to Step 11</i>	<i>Go to Step 12</i>
11	Repair the open circuit or open injector.	-	<i>Verify Repair</i>	<i>Go to Step 12</i>
12	Replace the *EPROM or ECM. Note) *Refer to 6E1-243.	-	<i>Verify repair</i>	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 41) IGNITION COIL DRIVER "B" SHORT TO BATTERY

### Circuit Description

The ignition control circuit in ECM provides a zero volt or a 5 volt signal to the ignition coil driver. The normal circuit voltage is zero volts. When the coil driver receives the 5 volt signal from the ignition control circuit, it provides a ground path for the B+ voltage supplied to the ignition primary coil. When the ECM turns off the 5 volts to the module, the module will remove the ground path of the ignition primary coils; causing the magnetic field produces a voltage in the secondary coils which fires the spark plug.

The circuit between the coil driver and the ignition control circuit is monitored for a short to battery on the Electronic Spark Timing B/coil driver B line. When the ECM detects a problem in the ignition control circuit, it will set DTC 41.

### Conditions for Setting the DTC

- Fault feedback line generates an interrupt on start of dwell.

- No Electronic Spark Timing activation requested by serial data.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

Check for the following conditions:

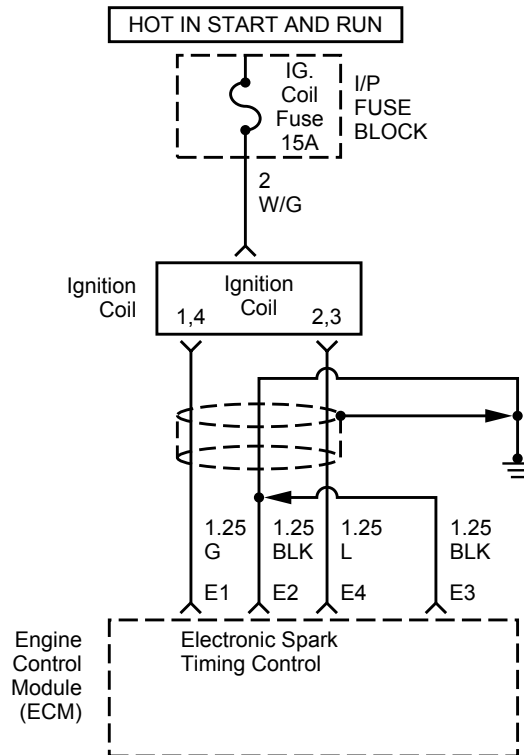
- Poor connection at the ECM - Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections.
- Damaged harness - Inspect the wiring harness for damage; Open circuits, shorts to ground, or shorts

to Voltage. If the harness appears to be OK, observe the Scan Tool display related to DTC 41 while moving the connector and wiring related to the ignition system. A change in the display will indicate the location of the fault.

- This code detects a short to battery on the Electronic Spark Timing B/Coil Driver B (#2, #3 cyl.) line.

**DTC (Flash DTC = 41)  
Ignition Coil Driver "B" Short To Battery**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	Check for a faulty connection or damaged terminals at the ignition coil. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 3</i>
3	Check for a faulty connection or damaged terminals at the ECM connector. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 4</i>
4	1. Ignition OFF. 2. Disconnect the ignition coil. 3. Check the ignition coil circuit for a short to battery. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 5</i>
5	Check for a short circuit between the ignition coil and the ECM. If a problem is found, repair the wire harness. Is there still a problem?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	Replace the ignition control module. Verify repair. Is there still a problem?	-	<i>Go to Step 8</i>	-
7	Replace the EPROM or ECM. Is the repair complete? <span style="float: right;">Note) Refer to 6E1-243.</span>	-	<i>Verify repair</i>	-



## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 42) IGNITION COIL DRIVER "A" SHORT TO BATTERY

### Circuit Description

The ignition control circuit in ECM provides a zero volt or a 5 volt signal to the ignition coil driver. The normal circuit voltage is zero volts. When the module receives the 5 volt signal from the ignition control circuit, it provides a ground path for the B+ voltage supplied to the ignition primary coil. When the ECM turns off the 5 volts to the module, the module will remove the ground path of the ignition primary coils; causing the magnetic field produces a voltage in the secondary coils which fires the spark plug.

The circuit between the coil driver and the ignition control circuit is monitored for a short to battery on the Electronic Spark Timing A/coil driver A line. When the ECM detects a problem in the ignition control circuit, it will set DTC 42.

### Conditions for Setting the DTC

- Fault feedback line generates an interrupt on start of dwell.

- No Electronic Spark Timing requested by serial data.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

Check for the following conditions:

- Poor connection at the ECM - Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or

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damaged terminals, and poor terminal-to-wire connections.

- Damaged harness - Inspect the wiring harness for damage; Open circuits, shorts to ground, or shorts to Voltage. If the harness appears to be OK, observe the Scan Tool display related to DTC 42 while moving the connector and wiring related to the

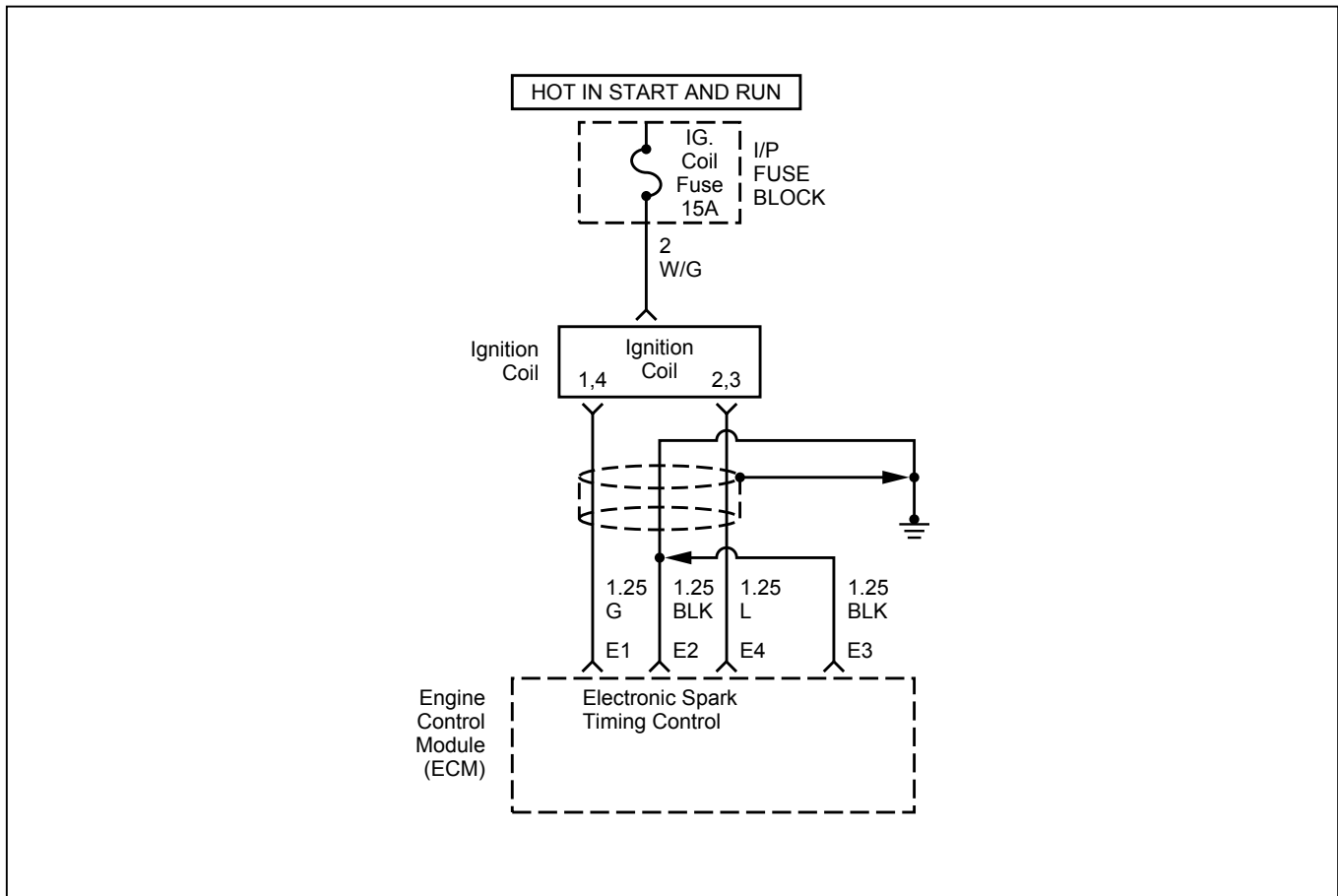
ignition system. A change in the display will indicate the location of the fault.

- This code detects a short to battery on the Electronic Spark Timing A/Coil Driver A (#1, #4 cyl.) line.

### DTC (Flash DTC = 42) Ignition Coil Driver "A" Short To Battery

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	Check for a faulty connection or damaged terminals at the ignition coil. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 3</i>
3	Check for a faulty connection or damaged terminals at the ECM connector. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 4</i>
4	1. Ignition OFF. 2. Disconnect the ignition coil. 3. Check the ignition coil circuit for a short to battery. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 5</i>
5	Check for a short circuit between the ignition coil and the ECM. If a problem is found, repair the wire harness. Is there still a problem?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	Replace the ignition control module. Verify repair. Is there still a problem?	-	-	<i>Go to Step 7</i>
7	Replace the EPROM or ECM. Is the repair complete? <span style="float: right;">Note) Refer to 6E1-243.</span>	-	<i>Verify repair</i>	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 63) IGNITION COIL DRIVER "B" SHORT TO GROUND

### Circuit Description

The ignition control circuit provides a zero volt or a 5 volt signal to the ignition coil driver. The normal circuit voltage is zero volts. When the module receives the 5 volt signal from the engine control module (ECM), it provides a ground path for the B+ voltage supplied to the ignition primary coil. When the ECM turns off the 5 volts to the module, the module will remove the ground path of the ignition primary coils; causing the magnetic field produces a voltage in the secondary coils which fires the spark plug.

The circuit between the ECM and the ignition control module is monitored for a short to ground on the Electronic Spark Timing B/coil driver B line. When the ECM detects a problem in the ignition control circuit, it will set DTC 63.

### Conditions for Setting the DTC

- Fault feedback line generates an interrupt on end of dwell.

- No Electronic Spark Timing activation requested by serial data.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

Check for the following conditions:

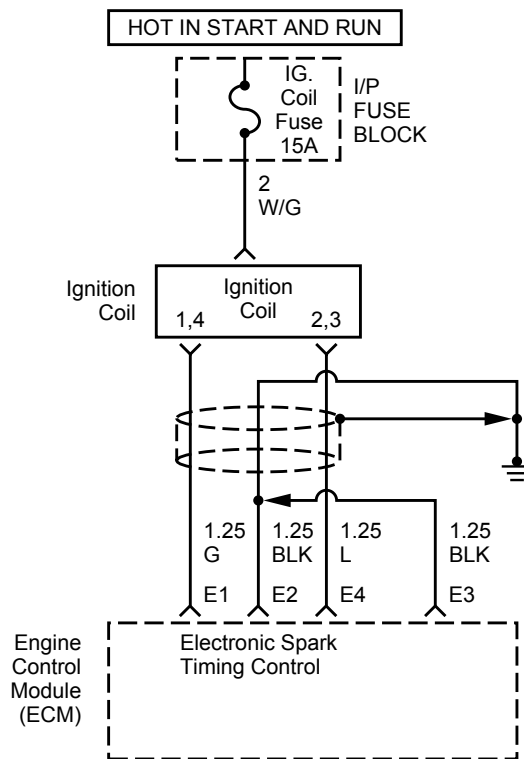
- Poor connection at the ECM - Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections.
- Damaged harness - Inspect the wiring harness for damage; Open circuits, shorts to ground, or shorts

to Voltage. If the harness appears to be OK, observe the Scan Tool display related to DTC 63 while moving the connector and wiring related to the ignition system. A change in the display will indicate the location of the fault.

- This code detects a short to ground on the Electronic Spark Timing B/coil Driver B(#2, #3 cyl.) line.

**DTC (Flash DTC = 63)  
Ignition Coil Driver "B" Short To Ground**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	Check for a faulty connection or damaged terminals at the ignition control module. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 3</i>
3	Check for a faulty connection or damaged terminals at the ECM connector. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 4</i>
4	Check for an open circuit between the ignition coil and ECM. If a problem is found, repair the wire harness. Is there still a problem?	-	<i>Verify repair</i>	<i>Go to Step 5</i>
5	Check for an short to ground between the ignition coil and battery +. If a problem is found, repair the wire harness. Is there still a problem?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	1. Ignition OFF. 2. Disconnect the ignition coil. 3. Check for an open circuit in the ignition coil. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 5</i>
7	Replace the ignition coil. Verify repair. Is there still a problem?	-	<i>Go to Step 8</i>	-
8	Replace the EPROM or ECM. Is the repair complete? <span style="float: right;">Note) Refer to 6E1-243.</span>	-	<i>Verify repair</i>	-



## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 64) IGNITION COIL DRIVER "A" SHORT TO GROUND

### Circuit Description

The ignition control circuit in ECM provides a zero volt or a 5 volt signal to the ignition coil driver. The normal circuit voltage is zero volts. When the coil driver receives the 5 volt signal from the ignition control circuit, it provides a ground path for the B+ voltage supplied to the ignition primary coil. When the ECM turns off the 5 volts to the module, the module will remove the ground path of the ignition primary coils; causing the magnetic field produces a voltage in the secondary coils which fires the spark plug.

The circuit between the coil driver and the ignition control circuit is monitored for a short to ground on the Electronic Spark Timing A/coil drive A line. When the ECM detects a problem in the ignition control circuit, it will set DTC 64.

### Conditions for Setting the DTC

- Fault feedback line generates an interrupt on end of dwell.

- No Electronic Spark Timing activation requested by serial data.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

Check for the following conditions:

- Poor connection at the ECM - Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or

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damaged terminals, and poor terminal-to-wire connections.

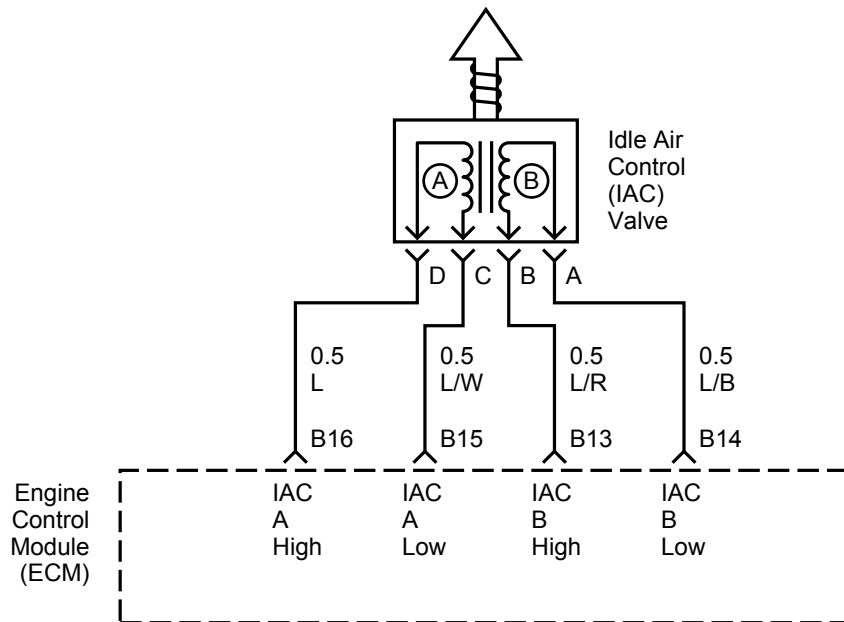
- Damaged harness - Inspect the wiring harness for damage; Open circuits, shorts to ground, or shorts to Voltage. If the harness appears to be OK, observe the Scan Tool display related to DTC 64 while moving the connector and wiring related to the

ignition system. A change in the display will indicate the location of the fault.

- This code detects a short to ground on the Electronic Spark Timing A/Coil Driver A (#1, #4 cyl.) line.

### DTC (Flash DTC = 64) Ignition Coil Driver "A" Short To Ground

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	Check for a faulty connection or damaged terminals at the ignition control module. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 3</i>
3	Check for a faulty connection or damaged terminals at the ECM connector. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 4</i>
4	Check for an open circuit between the ignition coil and ECM. If a problem is found, repair the wire harness. Is there still a problem?	-	<i>Verify repair</i>	<i>Go to Step 5</i>
5	Check for a short to ground between the ignition coil and battery +. If a problem is found, repair the wire harness. Is there still a problem?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	1. Ignition OFF. 2. Disconnect the ignition coil. 3. Check the ignition control circuit for a short to voltage. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	Replace the ignition control module. Verify repair. Is there still a problem?	-	<i>Go to Step 8</i>	-
8	Replace the EPROM or ECM. Is the repair complete? <span style="float: right;">Note) Refer to 6E1-243.</span>	-	<i>Verify repair</i>	-



## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 35) IDLE AIR CONTROL (IAC) ERROR

### Circuit Description

The engine control module (ECM) controls engine idle speed with the idle air control (IAC) valve. To increase idle speed, the ECM retracts the IAC valve pintle away from its seat, allowing more air to bypass the throttle bore. To decrease idle speed, it extends the IAC valve pintle towards its seat, reducing bypass air flow. A Scan Tool will read the ECM commands to the IAC valve in counts. Higher counts indicate more air bypass (higher idle). Lower counts indicate less air is allowed to bypass (lower idle).

This malfunction detects an error in the IAC control logic, then DTC 35 will set.

### Conditions for setting the DTC

- Engine rpm error is greater than 175 rpm.
  - No DTC 21, 22 and 24 present.
- And,
- Engine desired rpm is not fixed by tester.
  - IAC movement is not inhibited by low or high battery voltage.
- And,
- IAC normal closed loop is enabled.
  - Coolant of lesets are decayed to 0.

### Action Taken when the DTC sets

- The ECM will illuminate the malfunction indicator lamp (MIL).

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

A slow, unstable, or fast idle may be caused by a non-IAC system problem that cannot be overcome by the IAC valve. Out of control range IAC Scan Tool counts will be above 60 if idle is too low, and zero counts if idle is too high. The following checks should be made to repair a non-IAC system problem:

- Vacuum leak (high idle) - If idle is too high, stop the engine. Fully extend (low) IAC with the IAC motor analyzer 5-8840-2312-0. Start the engine. If idle speed is above 825 RPM, locate and correct the vacuum leak, including the PCV system. Check for binding of the throttle blade or linkage.

#### Following are applicable to the vehicle with closed Loop System.

- Throttle body - Remove the IAC valve and inspect the bore for foreign material.
- IAC valve electrical connections - IAC valve connections should be carefully checked for proper contact.
- PCV hose - An incorrect or faulty hose may result in an incorrect idle speed. Refer to *Diagnosis, Rough Idle, Stalling*. If intermittent poor driveability or idle symptoms are resolved by disconnecting the IAC, carefully recheck the connections and valve terminal resistance, or replace the IAC.
- Lean heated oxygen sensor signal (high air/fuel ratio) - The idle speed may be too high or too low. Engine speed may vary up and down, and disconnecting the IAC valve does not help. Diagnostic trouble code 44 may be set. Scan Tool oxygen (O<sub>2</sub>) voltage will be less than 27 mV (2.74 V). Check for low regulated fuel pressure, water in fuel, or a restricted injector.

- Rich heated oxygen sensor signal (low air/fuel ratio) - The idle speed will be too low. Scan Tool IAC counts will usually be above 80. The system is obviously rich and may exhibit black smoke in the exhaust.
- Scan Tool O<sub>2</sub> voltage will be fixed at about 750 mV (0.75 V). Check for high fuel pressure, or a leaking or sticking injector. A silicon-contaminated heated oxygen sensor will show an O<sub>2</sub> voltage slow to respond on the Scan Tool.

### Test Description

Number(s) below refer to the step number(s) on the Diagnostic Chart.

1. The IAC motor analyzer 5-8840-2312-0 is used to extend and retract the IAC valve. Valve movement is verified by an engine speed change. If no change in engine speed occurs, the valve can be resettled when removed from the throttle body.
2. This step checks the quality of the IAC movement in step 1. Between 700 revolutions per minute (RPM) and about 1500 RPM, the engine speed should change smoothly with each flash of the tester light in both extend and retract. If the IAC valve is retracted beyond the control range (about 1500 RPM), it may take many flashes to extend the IAC valve before engine speed will begin to drop. This is normal on certain engines. Fully extending the IAC may cause engine stall. This may be normal.
6. Steps 1 and 2 verified the proper IAC valve operation. This step checks the IAC circuits. Each lamp on the noid light should flash red and green while the IAC valve is cycled. While the sequence of color is not important, if either light is OFF or does not flash red and green, check the circuits for faults, beginning with poor terminal contacts.

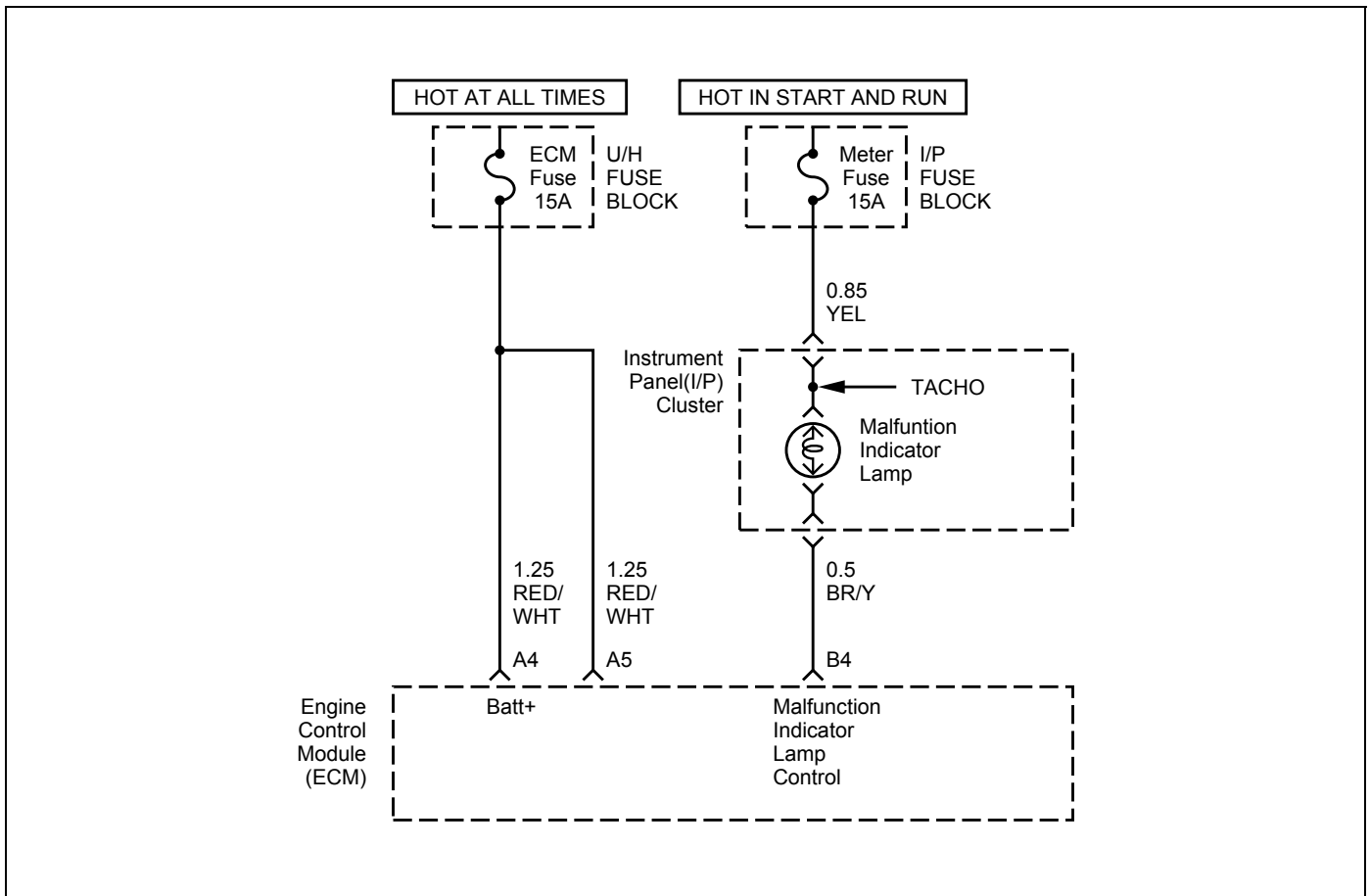
**DTC (Flash DTC = 35)**  
**Idle Air Control (IAC) Error**

Step	Action	Value(s)	Yes	No
1	1. Ignition OFF.. 2. Connect the IAC motor analyzer 5-8840-2312-0 to the IAC valve. 3. Set the parking brake. 4. Block the wheels. 5. Turn the air conditioning OFF. 6. Idle the engine in Park (A/T) or Neutral (M/T). 7. Install the scan tool. Display the RPM. 8. Use the IAC motor analyzer 5-8840-2312-0 to extend and retract the IAC valve. 9. The engine speed should decrease and increase as the IAC is cycled. Does the RPM change?	-	<i>Go to Step 2</i>	<i>Go to Step 3</i>
2	RPM should change smoothly with each flash of the IAC motor analyzer 5-8840-2312-0 light. Does the RPM change within the range specified?	700-1500 RPM	<i>Go to Step 6</i>	<i>Go to Step 3</i>
3	Check the IAC passages. Are the IAC passages blocked?	-	<i>Go to Step 4</i>	<i>Go to Step 5</i>
4	Clear any obstruction from the IAC passages. Is the action complete?	-	<i>Verify repair</i>	-
5	Replace the IAC. Refer to <i>On-Vehicle Service, Idle Air Control Valve</i> . Is the action complete?	-	<i>Verify repair</i>	-
6	1. Install the appropriate IAC noid light from 5-8840-2312-0 into the powertrain control module harness. 2. Cycle the IAC motor analyzer 5-8840-2312-0 and observe the noid lights. 3. Both the lights should cycle red and green, but never OFF, as the RPM is changed over its range. Do the noid lights cycle red and green?	-	<i>Go to Step 7</i>	<i>Go to Step 8</i>
7	1. Use the other connector on the IAC motor analyzer 5-8840-2312-0 pigtail. 2. Check the resistance across the IAC coils. Measure the resistance between terminal A and terminal B. 3. Measure the resistance between terminal C and terminal D. Is the resistance within the specified range?	40-80 ohms	<i>Go to Step 9</i>	<i>Go to Step 10</i>

**DTC (Flash DTC = 35)**  
**Idle Air Control (IAC) Error (Cont'd)**

Step	Action	Value(s)	Yes	No
8	<p>If the circuits did not test green and red, check the following:</p> <ul style="list-style-type: none"> <li>• Faulty connector terminal contacts.</li> <li>• Open circuits, including connections.</li> <li>• Circuits shorted to ground or voltage.</li> <li>• Faulty engine control module connector(s) or engine control module.</li> </ul> <p>Are repairs necessary?</p>	-	<i>Go to Step 13</i>	-
9	<p>1. Check the resistance between the IAC terminal B and terminal C.</p> <p>2. Check the resistance between the IAC terminal A and terminal D.</p> <p>Is the resistance infinite?</p>	-	<i>Go to Step 11</i>	<i>Go to Step 12</i>
10	<p>Replace the IAC. Refer to <i>On-Vehicle Service, Idle Air Control Valve</i>.</p> <p>Is the action complete?</p>	-	<i>Go to Step 7</i>	-
11	<p>Check the IAC valve and circuit.</p> <p>Are the IAC valve and circuit OK?</p>	-	<i>Refer to Diagnostic Aids</i>	<i>Go to Step 12</i>
12	<p>Replace the IAC. Refer to <i>On-Vehicle Service, Idle Air Control Valve</i>.</p> <p>Is the action complete?</p>	-	<i>Go to Step 9</i>	-
13	<p>Repair or replace the faulty component(s).</p> <p>Is the action complete?</p>	-	<i>Go to Step 6</i>	-





## DIAGNOSTIC TROUBLE CODE (DTC) 56 (Flash DTC = 56) CHECK ENGINE LAMP LOW ERROR

### Circuit Description

The "Check Engine" lamp (MIL) should always be illuminated and steady with the ignition ON and the engine stopped. Battery feed Voltage is supplied to the MIL bulb through the meter fuse. The engine control module (ECM) turns the MIL ON by grounding the MIL driver circuit.

### Conditions for setting the DTC

- This code detects a low impedance short to ground on an open contact on the MIL output.
- Driver feedback information shows a low state at its operation even when commanded high.

### Action Taken when the DTC sets

- The MIL will not turn ON.

### Conditions for Clearing the DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

An intermittent MIL may be caused by a poor connection, rubbed-through wire insulation, or a wire broken inside the insulation. Check for the following items:

- Inspect the ECM harness and connections for improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection, and damaged harness.
- If the engine runs OK, check for a faulty light bulb, an open in the MIL driver circuit, or an open in the instrument cluster ignition feed.
- If the engine cranks but will not run, check for an open ECM ignition or battery feed, or a poor ECM to engine ground.

**Test Description**

Number(s) below refer to the step number(s) on the Diagnostic Chart.

2. A “No MIL” condition accompanied by a no-start condition suggests a faulty ECM ignition feed or battery feed circuit.
9. Using a test light connected to B+, probe each of the ECM ground terminals to ensure that a good ground is present. Refer to *ECM Terminal End View* for terminal locations of the ECM ground circuits.

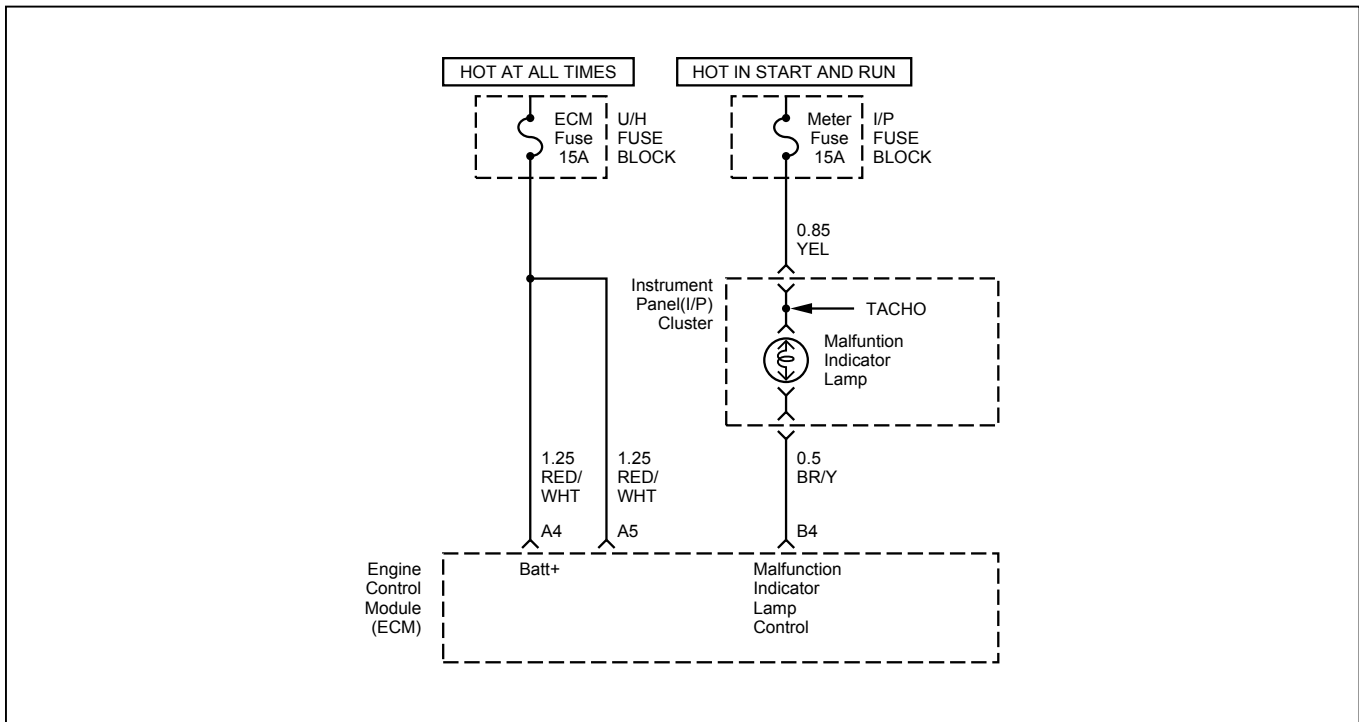
**DTC (Flash DTC = 56)  
Check Engine Lamp Low Error**

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic (OBD) System Check” performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	Attempt to start the engine. Does the engine start?	-	<i>Go to Step 3</i>	<i>Go to Step 6</i>
3	Check the meter fuse for the instrument cluster turn, back and gauge. Is the fuse OK?	-	<i>Go to Step 4</i>	<i>Go to Step 16</i>
5	1. Ignition OFF. 2. Disconnect the ECM. 3. Jumper the MIL driver circuit at the ECM connector to ground. 4. Ignition ON. Is the MIL ON?	-	<i>Go to Step 10</i>	<i>Go to Step 11</i>
6	Check the ECM ignition feed and battery feed fuses (15A Ignition fuse and 15A ECM fuse). Are both fuses OK?	-	<i>Go to Step 8</i>	<i>Go to Step 15</i>
8	Probe the battery feed circuit at the ECM harness connector with a test light to ground. Is the test light ON?	-	<i>Go to Step 9</i>	<i>Go to Step 14</i>
9	Check for a faulty ECM ground connection. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
10	Check for damaged terminals at the ECM. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 17</i>
11	Check for an open MIL driver circuit between the ECM and the MIL. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 18</i>

**DTC (Flash DTC = 56)**  
**Check Engine Lamp Low Error (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
14	Locate and repair the open ECM battery feed circuit. Is the action complete?	-	<i>Verify repair</i>	-
15	Locate and repair the short to ground in the ECM battery feed circuit. Is the action complete?	-	<i>Verify repair</i>	-
16	Locate and repair the short to ground in the MIL feed circuit to the instrument cluster, and replace the fuse. Is the action complete?	-	<i>Verify repair</i>	-
17	Replace the EPROM or ECM. Note) Refer to 6E1-243.	-	<i>Verify repair</i>	-
18	Check the MIL driver circuit for a poor connection at the instrument panel connector. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Instrument Panel in Electrical Diagnosis</i>





## DIAGNOSTIC TROUBLE CODE (DTC) 57 (Flash DTC = 57) CHECK ENGINE LAMP HIGH ERROR

### Circuit Description

The malfunction indicator lamp (MIL) should always be illuminated and steady with the ignition ON and the engine stopped. Battery feed voltage is supplied directly to the MIL indicator. The engine control module (ECM) turns the MIL ON by grounding the MIL driver circuit.

### Conditions for setting the DTC

- This code detects a low impedance short to battery on the MIL output.
- Driver feedback information shows a low state at its operation even when commanded high.

### Action Taken when the DTC sets

- The MIL will stay ON.

### Conditions for Clearing the DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

An intermittent may be caused by a poor connection, rubbed-through wire insulation, or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness - Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection, and damaged harness.

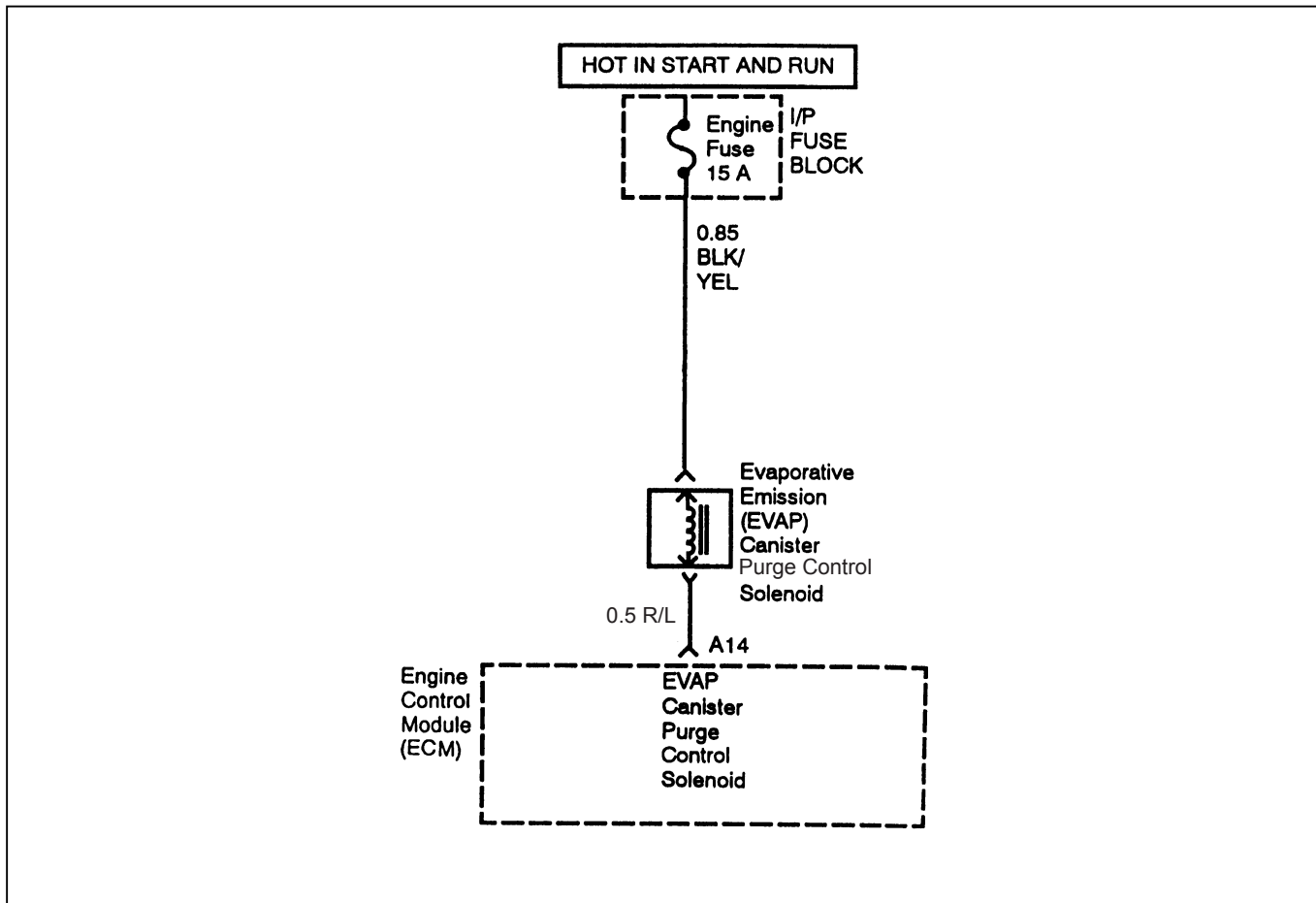
**Test Description**

Number(s) below refer to the step number(s) on the Diagnostic Chart.

2. If the MIL does not remain ON when the ECM is disconnected, the MIL driver wiring is not faulty.
3. If the MIL driver circuit is OK, the instrument panel cluster is faulty.

**DTC (Flash DTC = 57)  
Check Engine Lamp High Error**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition OFF, disconnect ECM. 2. Ignition ON, observe the MIL. Is the MIL ON?	-	<i>Go to Step 3</i>	<i>Go to Step 5</i>
3	1. Ignition OFF, disconnect the instrument panel cluster. 2. Check the MIL driver circuit between the ECM and the instrument panel cluster for a short to battery. 3. If a problem is found, repair as necessary. Was the MIL driver circuit shorted to battery?	-	<i>Go to OBD System Check</i>	<i>Go to Step 4</i>
4	Replace the instrument panel cluster. Is the action complete?	-	<i>Go to OBD System Check</i>	-
5	1. Ignition OFF, reconnect the ECM. 2. Refer to <i>On-Vehicle Service in Engine Control Module and Sensors</i> for procedures. 3. Using the scan tool output controls function, select MIL dash lamp control and command the MIL OFF. Did the MIL turn OFF?	-	<i>Go to OBD System Check</i>	<i>Go to Step 6</i>
6	Replace the EPROM or ECM. Note) Refer to 6E1-243.	-	<i>Go to OBD System Check</i>	-



**DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 61)  
EVAPORATIVE EMISSION (EVAP) CONTROL SYSTEM  
CANISTER PURGE CONTROL VALVE CIRCUIT LOW ERROR (IF APPLICABLE)**

### Circuit Description

The engine control Module (ECM) controls the Evaporative Emission (EVAP) Canister Purge control Solenoid Valve through the use of a control (ground) circuit. If the ECM commands the Purge solenoid to maximum duty cycle (100%) but the voltage remains High (12 volts); or, if the ECM commands the Purge solenoid to high duty cycle (100%) but the voltage remains low (0 volts), this malfunction detects a low impedance short to ground or open contact on the canister purge solenoid output. Then DTC 61 will set.

### Conditions for Setting the DTC

- Driver feedback information shows a low state at its operation even when commanded high.

### Action Taken When the DTC Sets

- The ECM will illuminate the Malfunction Indicator Lamp (MIL).

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

- Poor connections, or a damaged harness - Inspect the harness connectors for: backed-out terminals, improper mating or damaged terminals. Also check for open circuits, shorts to ground, and shorts to voltage.

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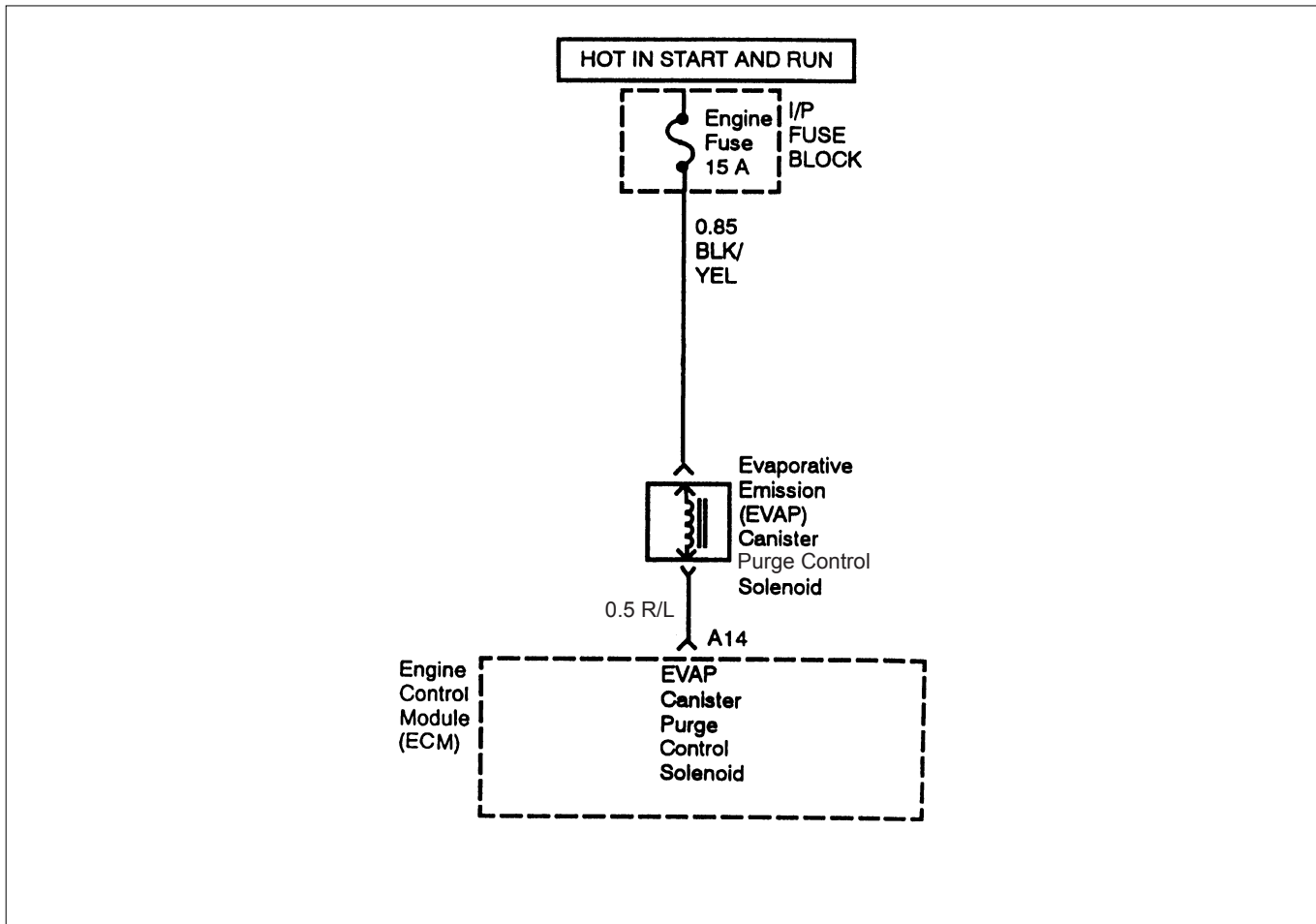
- This malfunction detects a low impedance short to ground or open contact on the purge control solenoid output.

### DTC (Flash DTC = 61)

### Evaporative Emission (EVAP) Control System Canister Purge Control Valve Circuit Low Error

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition ON, Engine OFF. 2. Using the Scan Tool, monitor info for Diagnostic Trouble Code 61. Does the Scan Tool indicate DTC 61.	-	Refer to Diagnostic Aids	Go to Step 3
3	1. Ignition OFF. 2. Disconnect the EVAP Canister Purge Control Solenoid from the wiring harness connector from the EVAP Canister Purge Control Solenoid. 3. Ignition ON, Engine OFF. 4. Using a Digital Voltmeter (DVM), check for voltage on the "Engine IG." Fuse pin of the EVAP Canister Purge Control Solenoid wiring harness connector. Does the DVM read the following value?	12 Volts	Go to Step 5	Go to Step 4
4	Check the suspect circuit between the EVAP Canister Purge Control Solenoid connector and the "Engine IG." Fuse for the following conditions: <ul style="list-style-type: none"> <li>• A short to ground</li> <li>• An open circuit</li> <li>• A short to voltage</li> </ul> Was the problem found?	-	Verify repair	-
5	Using a DVM, check the resistance of the EVAP Canister Purge Control Solenoid. Does the DVM read the following value?	less than 5 ohms	Go to Step 6	Go to Step 7
6	Replace the EVAP Canister Purge Control Solenoid. Verify repair.	-	-	-
7	Replace the EPROM or ECM. Note) Refer to 6E1-243.	-	-	-





**DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 62)  
EVAPORATIVE EMISSION (EVAP) CONTROL SYSTEM  
CANISTER PURGE CONTROL VALVE CIRCUIT HIGH ERROR (IF APPLICABLE)**

### Circuit Description

The engine control Module (ECM) controls the Evaporative Emission (EVAP) Canister Purge Solenoid Valve through the use of a control (ground) circuit. If the ECM commands the Purge solenoid to maximum duty cycle (100%) but the voltage remains High (12 volts); or, if the ECM commands the Purge solenoid to minimum duty cycle (0%) but the voltage remains high (12 volts), this malfunction detects a high impedance short to ground or open contact on the canister purge solenoid output. Then DTC 62 will set.

### Conditions for Setting the DTC

- Driver feedback information shows a high state at its operation even when commanded low.

### Action Taken When the DTC Sets

- The ECM will illuminate the Malfunction Indicator Lamp (MIL).

### Conditions for Clearing the MIL/DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

- Poor connections, or a damaged harness - Inspect the harness connectors for: backed-out terminals, improper mating or damaged terminals. Also check

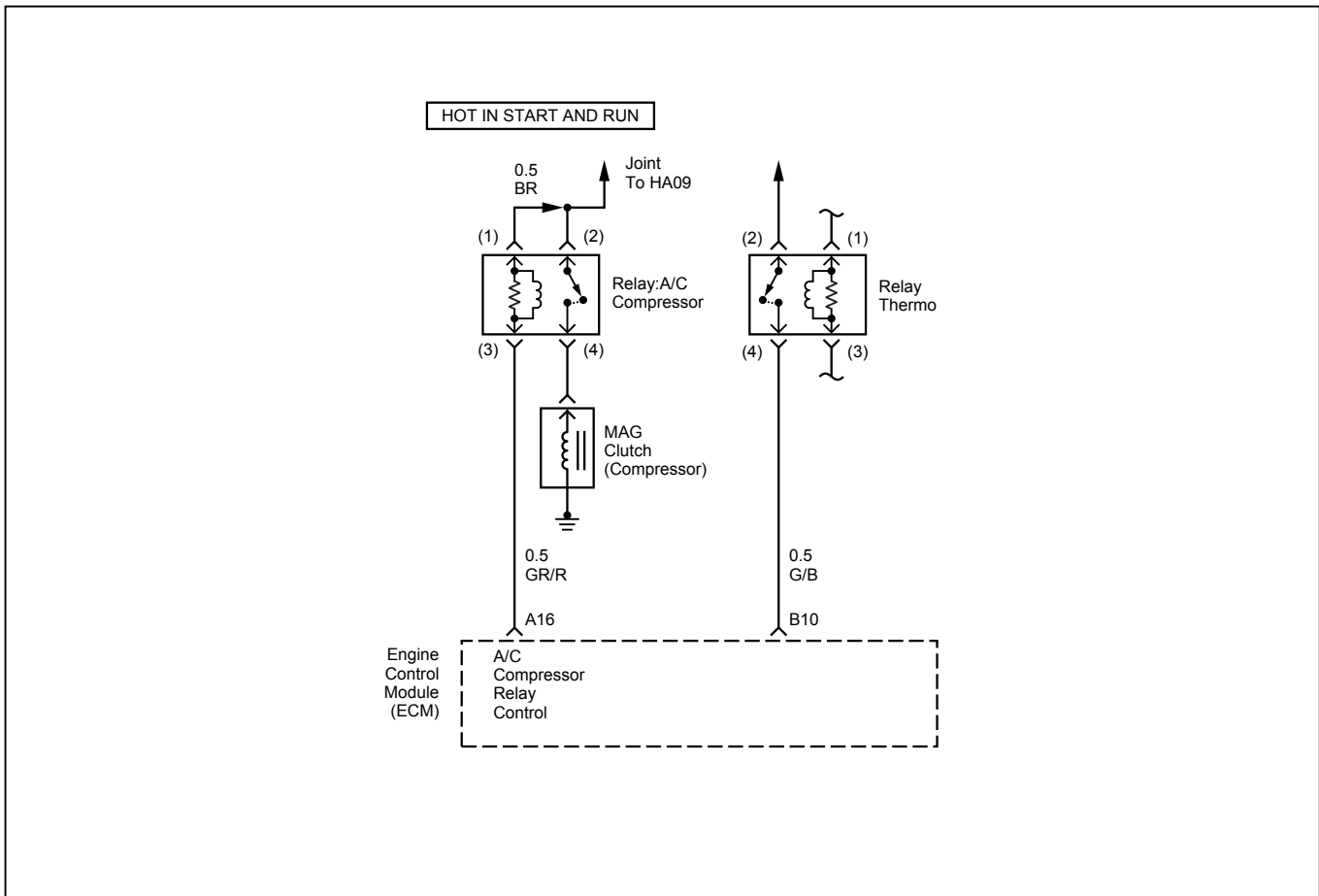
**6E1-216 DRIVEABILITY AND EMISSIONS**

for open circuits, shorts to ground, and shorts to voltage.

- This malfunction detects a high impedance short to ground or open contact on the purge control solenoid output.

**DTC (Flash DTC = 62)****Evaporative Emission (EVAP) Control System Canister Purge Control Valve Circuit High Error**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition ON, Engine OFF. 2. Using the Scan Tool, monitor info for Diagnostic Trouble Code 62. Does the Scan Tool indicate DTC 62.	-	<i>Refer to Diagnostic Aids</i>	<i>Go to Step 3</i>
3	1. Ignition OFF. 2. Disconnect the EVAP Canister Purge Control Solenoid from the wiring harness connector from the EVAP Canister Purge Control Solenoid. Using a DVM, check the resistance of the EVAP Canister Purge Control Solenoid. Does the DVM read the following value?	less than 5 ohms	<i>Go to Step 4</i>	<i>Go to Step 5</i>
4	1. Ignition OFF. 2. Disconnect the engine Control Module (ECM) connectors from the ECM. 3. Check the EVAP Canister Purge Control Solenoid control circuit between the ECM and EVAP Canister Purge Control Solenoid for the following conditions: <ul style="list-style-type: none"> <li>• A short to ground</li> <li>• An open circuit</li> <li>• A short to voltage</li> </ul> Was the problem found?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
5	Replace the EVAP Canister Purge Control Solenoid. Verify repair.	-	-	-
6	Replace the EPROM or ECM. Note) Refer to 6E1-243.	-	-	-



## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 87) A/C COMPRESSOR CLUTCH RELAY LOW ERROR

### Circuit Description

The engine control module (ECM) controls the A/C Compressor Clutch Solenoid through the use of a relay and a control (ground) circuit. This malfunction detects a low impedance short to ground or open contact on the A/C clutch relay output, then DTC 87 will set.

### Conditions for Setting the DTC

- Driver feedback information shows a low state at its operation even when commanded high.

### Action Taken When the DTC Sets

- The ECM will illuminate Malfunction Indicator lamp (MIL).

### Conditions for Clearing the DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

- This malfunction detects a low impedance short to ground or open contact on the AC clutch relay output.

To diagnose an intermittent fault, check for the following conditions:

- Poor connection at the ECM-Inspect harness connections for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.

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- Damaged harness-Inspect the wiring harness for damage; shorts to Ground, shorts to Battery Voltage, and Open circuits. If the harness appears to be OK, observe the A/C clutch while moving connectors and wiring harnesses related to the A/C. A sudden clutch malfunction will indicate the source of the intermittent fault.

### A/C Clutch Diagnosis

This chart should be used for diagnosing the electrical portion of the A/C compressor clutch circuit. A Scan Tool will be used in diagnosing the system. The Scan Tool has the ability to read the A/C request input to the ECM. The Scan Tool can display when the ECM has commanded the A/C clutch ON. The Scan Tool should have the ability to override the A/C request signal and energize the A/C compressor relay.

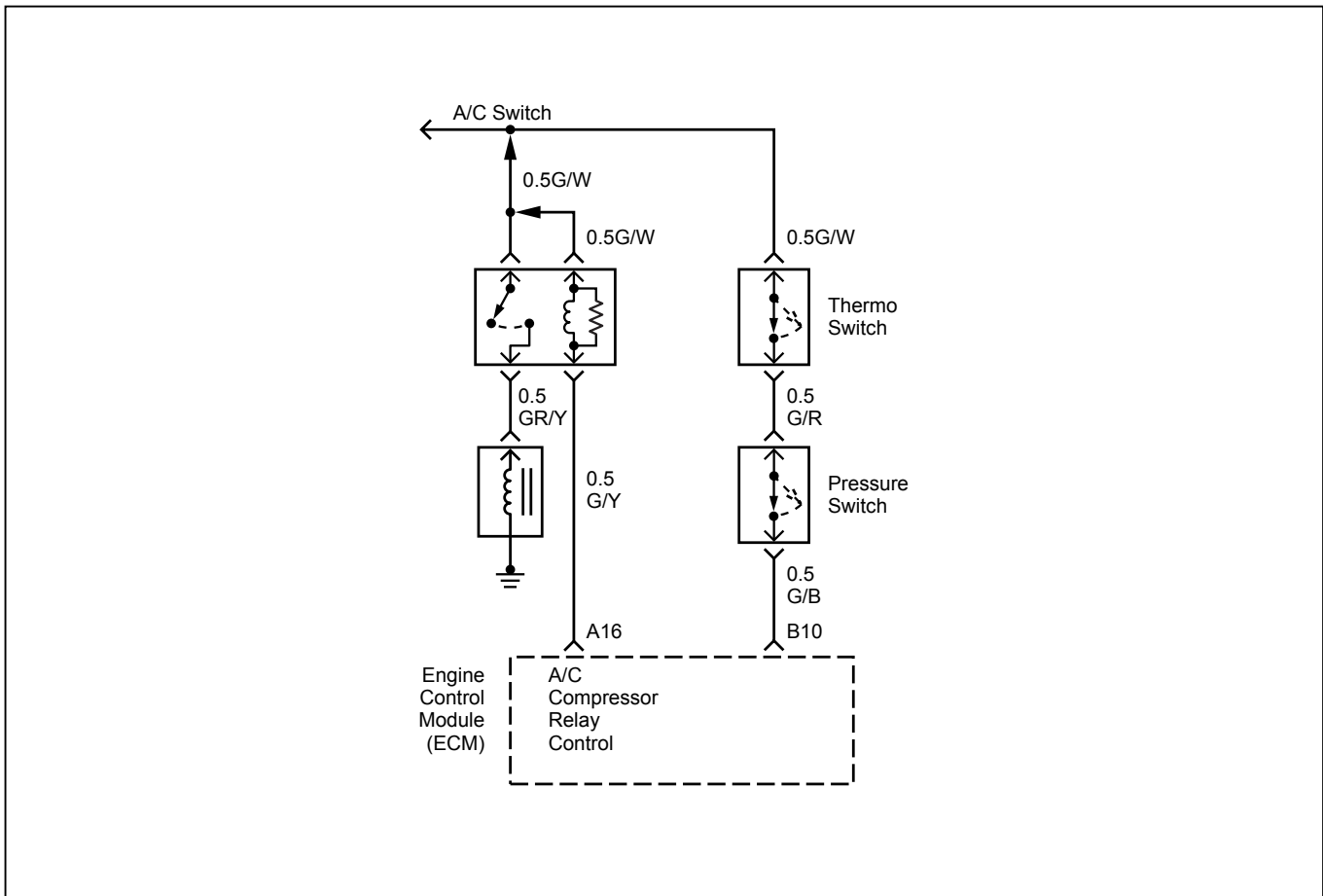
### DTC (Flash DTC = 87) A/C Compressor Clutch Relay Low Error

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition ON, engine OFF. 2. Using the Scan Tool, monitor info for DTC 87. Does the Scan Tool indicate DTC 87?	-	<i>Refer to Diagnostic Aids</i>	<i>Go to Step 3</i>
3	1. Ignition OFF. 2. Check for an open circuit at the pressure switch and thermo switch. And also check for an open circuit at the wire harness between pressure switch and the ECM, pressure switch and thermo switch, thermo switch and the Fuse. Repair it necessary.	-	<i>Verify Repair</i>	<i>Go to Step 4</i>
4	1. Remove the A/C Compressor Clutch Relay from the Underhood Electrical Center. 2. Ignition ON, engine OFF. 3. Using a Digital Voltmeter (DVM), check for voltage on the Fused pins of the A/C Compressor Clutch Relay connector. Does the DVM read the following value?	12 Volts	<i>Go to Step 6</i>	<i>Go to Step 5</i>
5	Check the suspect circuit(s) between the A/C Compressor Clutch Relay connector and the Fuse for the following conditions: • A short to ground • An open circuit Was the problem found?	-	<i>Verify Repair</i>	-
6	1. Ignition OFF. 2. Disconnect the Engine Control Module (ECM) connectors from the ECM. 3. Check the A/C Compressor Clutch Relay control circuit between the ECM and Underhood Electrical Center for the following conditions: • A short to ground • An open circuit Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 7</i>

**DTC (Flash DTC = 87)**  
**A/C Compressor Clutch Relay Low Error (Cont'd)**

Step	Action	Value(s)	Yes	No
7	1. Reinstall the A/C Compressor Clutch Relay. 2. Using a fused jumper, ground the A/C Compressor Clutch Relay control circuit at the ECM connector. 3. Ignition ON, Engine OFF. Does the A/C Compressor turn ON?	-	<i>Go to Step 10</i>	<i>Go to Step 8</i>
8	1. Ignition OFF. 2. Check the A/C Compressor Clutch circuit between the A/C Compressor Clutch Relay and A/C Compressor Clutch for the following conditions: <ul style="list-style-type: none"> <li>• A short to ground</li> <li>• An open circuit</li> </ul> Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 9</i>
9	Replace the A/C Compressor Clutch Relay. Is the action complete?	-	<i>Verify Repair</i>	-
10	Replace the EPROM or ECM. Varyfy Repair <span style="float: right;">Note) Refer to 6E1-243.</span>	-	-	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 88) A/C COMPRESSOR CLUTCH RELAY HIGH ERROR

### Circuit Description

The engine control module (ECM) controls the A/C Compressor Clutch Solenoid through the use of a relay and a control (ground) circuit. This malfunction detects a low impedance short to ground or open contact on the A/C clutch relay output, then DTC 88 will set.

### Conditions for Setting the DTC

- Driver feedback information shows a high state at its operation even when commanded low.

### Action Taken When the DTC Sets

- The ECM will illuminate Malfunction Indicator lamp (MIL).

### Conditions for Clearing the DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

- This malfunction detects a low impedance short to battery on the AC clutch relay output.

To diagnose an intermittent fault, check for the following conditions:

- Poor connection at the ECM-Inspect harness connections for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness-Inspect the wiring harness for damage; shorts to Battery Voltage, and Open circuits. If the harness appears to be OK, observe the A/C clutch while moving connectors and wiring harnesses related to the A/C. A sudden clutch

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malfunction will indicate the source of the intermittent fault.

Tool has the ability to read the A/C request input to the ECM. The Scan Tool can display when the ECM has commanded the A/C clutch ON. The Scan Tool should have the ability to override the A/C request signal and energize the A/C compressor relay.

**A/C Clutch Diagnosis**

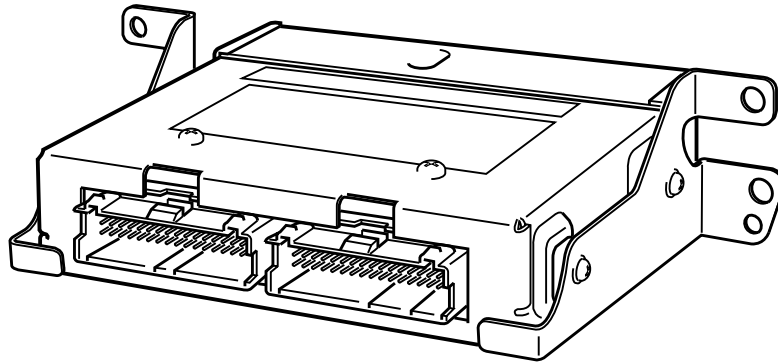
This chart should be used for diagnosing the electrical portion of the A/C compressor clutch circuit. A Scan Tool will be used in diagnosing the system. The Scan

**DTC (Flash DTC = 88)  
A/C Compressor Clutch Relay High Error**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition ON, engine OFF. 2. Using the Scan Tool, monitor info for DTC 88. Does the Scan Tool indicate DTC 88?	-	<i>Refer to Diagnostic Aids</i>	<i>Go to Step 3</i>
3	1. Ignition OFF. 2. Remove the A/C Compressor Clutch Relay from the Underhood Electrical Center. 3. Ignition ON, engine OFF. 4. Using a Digital Voltmeter (DVM), check for voltage on the Fused pins of the A/C Compressor Clutch Relay connector. Does the DVM read the following value?	12 Volts	<i>Go to Step 4</i>	<i>Go to Step 5</i>
4	1. Ignition OFF. 2. Disconnect the Engine Control Module (ECM) connectors from the ECM. 3. Check the A/C Compressor Clutch Relay control circuit between the ECM and Underhood Electrical Center for the following conditions: • A short to battery Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 5</i>
5	1. Reinstall the A/C Compressor Clutch Relay. 2. Using a fused jumper, ground the A/C Compressor Clutch Relay control circuit at the ECM connector. 3. Ignition ON, Engine OFF. Does the A/C Compressor turn ON?	-	<i>Go to Step 8</i>	<i>Go to Step 6</i>
6	1. Ignition OFF. 2. Check the A/C Compressor Clutch circuit between the A/C Compressor Clutch Relay and A/C Compressor Clutch for the following conditions: • A short to battery Was the problem found?	-	<i>Verify Repair</i>	<i>Go to Step 7</i>
7	Replace the A/C Compressor Clutch Relay. Is the action complete?	-	<i>Verify Repair</i>	-
8	Replace the EPROM or ECM. Verify Repair	-	-	-

Note) Refer to 6E1-243.





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 93) QUAD DRIVER SUB MODULE

### Circuit Description

Quad Driver Sub Module (QDSM) are used by the engine control module (ECM) to turn ON many of the current-driven devices that are needed to control various engine and transmission functions. Each QDSM is capable of controlling up to 4 separate outputs by applying ground to the device which the ECM is commanding ON.

QDSMs have the capability of diagnosing each output circuit individually. DTC 93 set indicates an improper voltage level has been detected on a QDSM output.

This DTC detects a short to battery or Open Load or Short to ground at the QDSM output, then DTC P93 will set.

### Conditions for Setting the DTC

- If fault line from the QDSM is detected low.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).

### Conditions for Clearing the DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM - Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness - Inspect the wiring harness for damage. If the harness appears to be OK, disconnect the ECM, turn the ignition ON and

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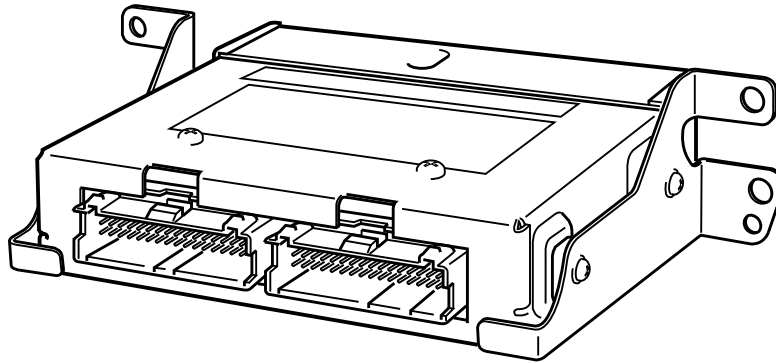
observe a voltmeter connected to the MIL driver circuit at the ECM harness connector while moving connectors and rewiring harnesses relates to the MIL. A change in voltage will indicate the location of the fault.

This malfunction detects a:

Short to battery or Open Load or Short to ground at QDSM output.

### DTC (Flash DTC = 93) Quad Driver Sub Module

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	Replace the EPROM or ECM. Note) Refer to 6E1-243. Is the action complete?	-	<i>Verify Repair</i>	-



### **DIAGNOSTIC TROUBLE CODE DTC (Flash DTC=51) ELECTRICALLY PROGRAMMABLE READ-ONLY MEMORY (EPROM) ERROR**

#### **Circuit Description**

The Engine control module (ECM) used in this vehicle utilizes an electrically programmable read- only memory (EPROM). The EPROM contains program ID- Calibration variable.

This malfunction checks the integrity of the EPROM (ECM will not run), then DTC 51 will set.

#### **Conditions for Setting the DTC**

- If calculated check sum is not equal to the stored check sum.

#### **Action Taken When the DTC Sets**

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the malfunction is detected.

#### **Conditions for Clearing the MIL/DTC**

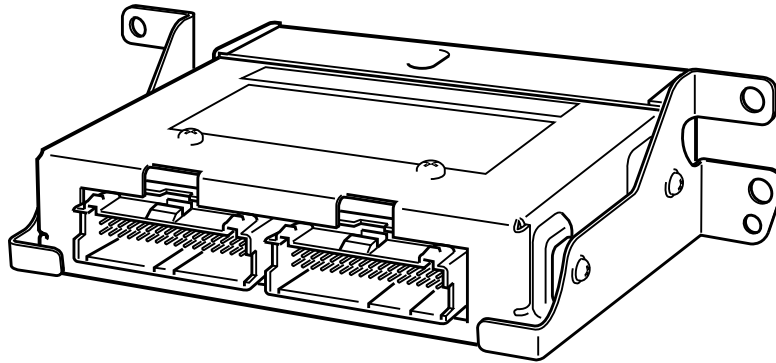
- Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory. Any fault codes will remain in ECM memory until -
  1. They are cleared by disconnecting the Battery for more than 30 seconds.
  2. A service tool such as Tech 2 is used to clear them.
  3. Ten consecutive starts without logging a fault.

#### **Diagnostic Aids**

- Diagnostic Trouble Code 51 indicates that the ECM will not run. The only possible repair is the EPROM or ECM replacement.

**DTC (Flash DTC = 51)**  
**Electrically Programmable Read-Only Memory (EPROM) Error**

<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to step 2</i>	Go to OBD System Check
Refer to Service Bulletins. Is there still a problem?	-	<i>Go to step 3</i>	Verify Repair
Replace the EPROM or ECM. Is the action complete? <span style="float: right;">Note) Refer to 6E1-243.</span>		<i>Verify Repair</i>	-



### DIAGNOSTIC TROUBLE CODE DTC (Flash DTC = 55)

## ELECTRICALLY ERASABLE PROGRAMMABLE READ-ONLY MEMORY (EEPROM) ERROR

### Circuit Description

The Engine control module (ECM) used in this vehicle utilizes an electrically erasable programmable read-only memory (EEPROM). The EEPROM contains program information and the calibrations required for engine, diagnostics operation.

This malfunction checks the integrity of microprocessor config register located in the EEPROM (ECM will not run), then DTC 55 will set.

### Conditions for Setting the DTC

- The ECM detects an internal program fault.

### Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the malfunction is detected.

### Conditions for Clearing the MIL/DTC

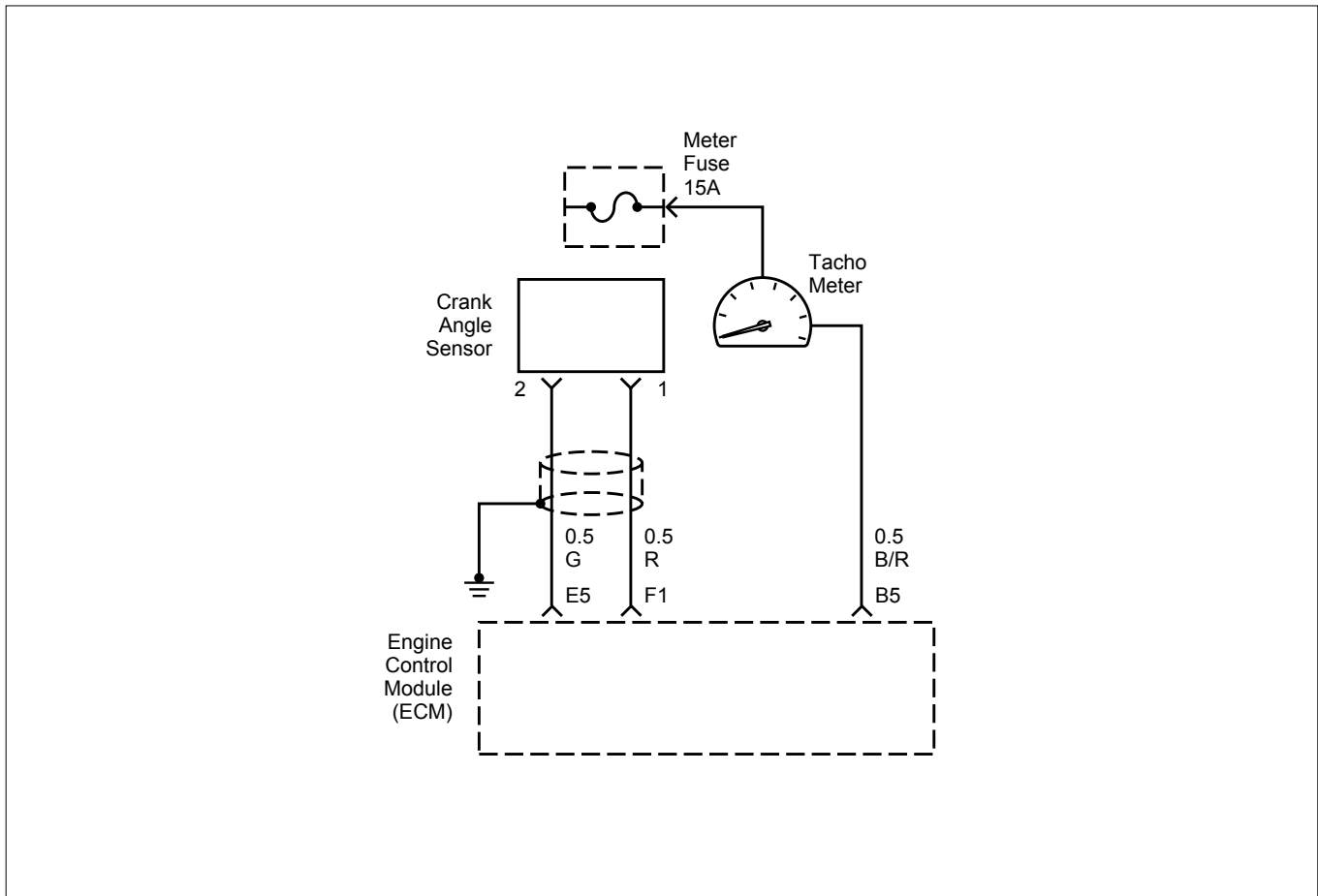
- Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory. Any fault codes will remain in ECM memory until -
  1. They are cleared by disconnecting the Battery for more than 30 seconds.
  2. A service tool such as Tech 2 is used to clear them.
  3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

- Diagnostic Trouble Code 55 indicates that ECM will not run. The only possible repair is the EPROM or ECM replacement.

**DTC (Flash DTC = 55)**  
**Electrically Erasable Programmable Read-Only Memory Error**

<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to step 2</i>	Go to OBD System Check
Refer to Service Bulletins. Is there still a problem?	-	<i>Go to step 3</i>	Verify Repair
Replace the EPROM or ECM. Is the action complete? <span style="float: right;">Note) Refer to 6E1-243.</span>		<i>Verify Repair</i>	-



## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 91) TACHO OUT LOW ERROR

### Circuit Description

Based on the information from the Crank Position Sensor (CKP), X58 reference signal is generated at each rotation of the crankshaft.

Engine Control Module (ECM) converts X58 reference signal into rectangle wave and delivers it as output signal to drive the pulse motor of the crankshaft.

When the wave length of the output signal is long, the tacho meter indicates the engine speed is low, and vice versa.

This malfunction detects a low impedance short to ground or open contact on the Tacho output, the Diagnostic Trouble Code 91 will be set.

### Conditions for Setting the DTC

- Driver feedback information shows a low state at its operation even when commanded low.

### Action Taken When the DTC Sets

- The ECM will turn ON the Malfunction Indicator Lamp

### Conditions for Clearing the DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

- Poor connections or a damaged harness - Inspect the harness connections for: backed out terminals, improp, mating or damaged terminals. Also check for open circuit, short to ground, and short to voltage.

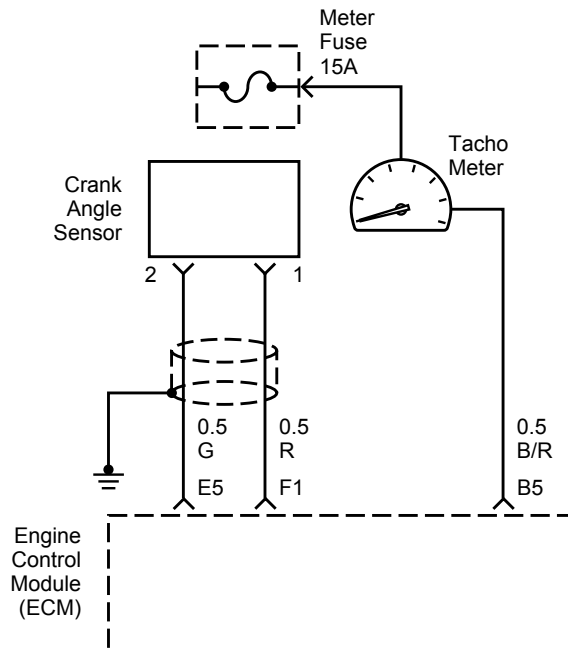
**6E1-230 DRIVEABILITY AND EMISSIONS**

- This malfunction detects a low impedance short to ground or open contact on the ECM out put circuit.

**DTC (Flash DTC = 91)  
Tacho Out Low Error**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition OFF. 2. Check for a faulty connection or damaged terminals at the ECM connector. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 3</i>
3	Check for a faulty connection or damaged terminals at the ECM connector. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 4</i>
4	1. Check for an open or short to ground in the circuit between the meter cluster connector and the ECM connector. If a problem is found, repair as necessary.	-	<i>Verify repair</i>	<i>Go to Step 5</i>
5	1. Check for an open circuit between the meter cluster connector and the ground. If a problem is found, repair as necessary.	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	1. Check for an open circuit between the meter cluster and battery feed. If a problem is found, repair as necessary.	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	1. Disconnect the meter cluster Panel. 2. Check the tacho meter circuit for an open. Was a problem found?	-	<i>Go to Step 5</i>	<i>Go to Step 9</i>
8	1. Disconnect the ECM and CKP sensor. 2. Check for an open in the 58X reference circuit between the connector and the ECM harness connector. 3. If a problem is found, repair as necessary. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 9</i>
9	1. Reconnect the ECM and CKP sensor. 2. Connect a Digital Voltmeter (DVM) to measure voltage on the 58X reference circuit at the ECM connector. 3. Observe the voltage while cranking the engine. Is the voltage near the specified value?	2.5V	<i>Go to Step 12</i>	<i>Go to Step 10</i>
10	Check the connections at the CKP sensor and replace the terminals if necessary. Did any terminals require replacement?	-	<i>Verify repair</i>	<i>Go to Step 11</i>
11	Replace the CKP sensor. Is the action complete?	-	<i>Verify repair</i>	-
12	Check connections at the ECM and replace the terminals if necessary. Did any terminals require replacement?	-	<i>Verify repair</i>	<i>Go to Step 13</i>
13	Replace the EPROM or ECM. Is the action complete?      Note) Refer to 6E1-243.	-	<i>Verify repair</i>	-





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC =92) TACHO OUT HIGH ERROR

### Circuit Description

Based on the information from the Crank Position Sensor (CKP), X58 reference signal is generated at each rotation of the crankshaft.

Engine Control Module (ECM) converts X58 reference signal into rectangular wave and delivers it as output signal to drive the pulse motor of the crankshaft.

When the wave length of the output signal is long, the tacho meter indicates the engine speed is low, and vice versa.

This malfunction detects a low impedance short to battery or on the Tacho output, then Diagnostic Trouble Code 92 will be set.

### Conditions for Setting the DTC

- Driver feedback information shows a low state at its operation even when commanded low.

### Action Taken When the DTC Sets

- The ECM will turn ON the Malfunction Indicator Lamp

### Conditions for Clearing the DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

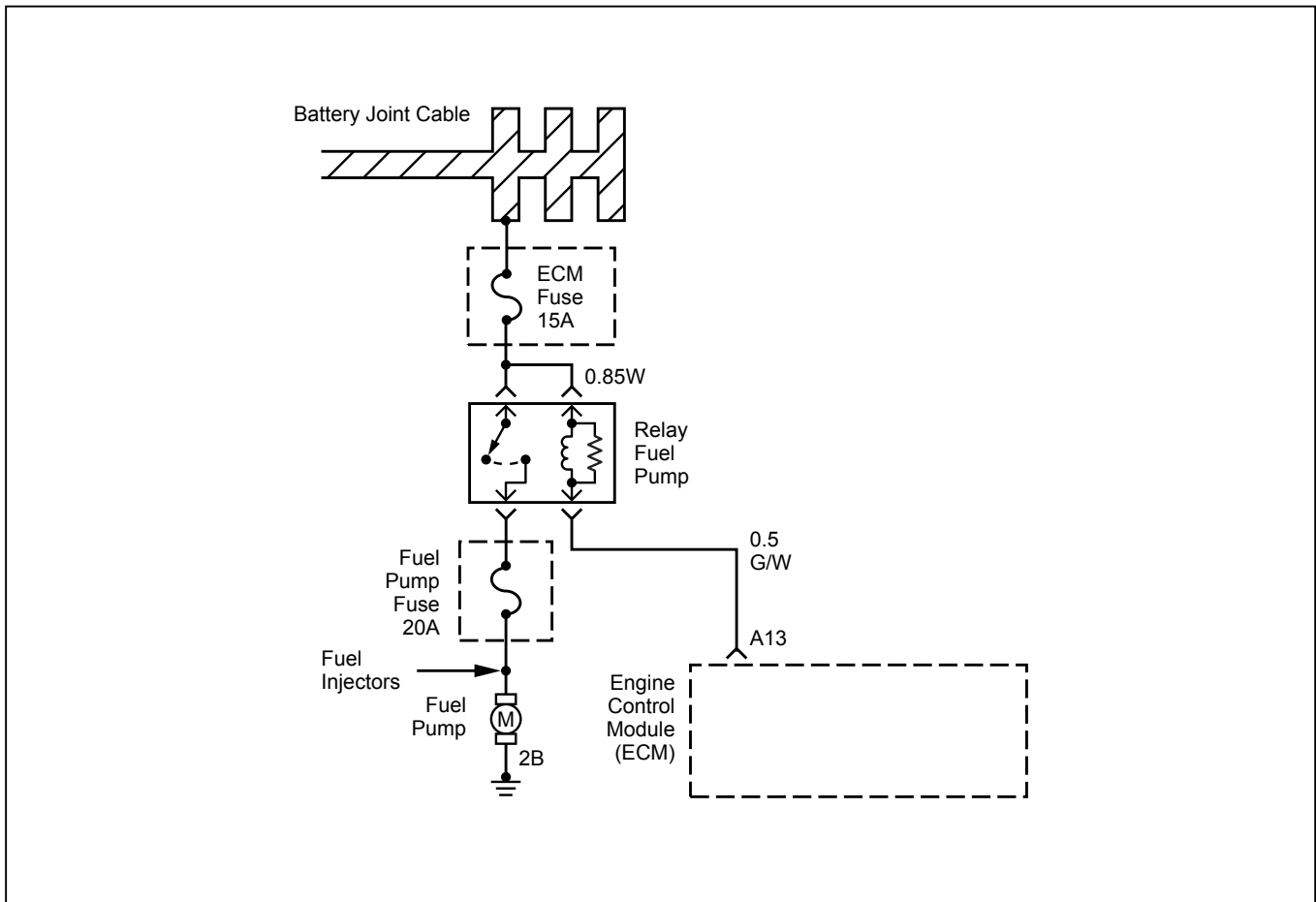
1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

### Diagnostic Aids

- Poor connections or a damaged harness - Inspect the harness connections for: backed out terminals, improp, mating or damaged terminals. Also check for open circuit, and short to battery.

**DTC (Flash DTC = 92)**  
**Tacho Out High Error**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition OFF. 2. Check for a faulty connection or damaged terminals at the tacho meter connector. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 3</i>
3	Check for a faulty connection or damaged terminals at the ECM connector. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 4</i>
4	Check for a short circuit between the meter cluster connector and the ECM. If a problem is found, repair the wire harness. Is there still a problem?	-	<i>Verify repair</i>	<i>Go to Step 5</i>
5	1. Disconnect the ECM. 2. Check the ignition control circuit for a short to voltage. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 6</i>
6	Replace the meter cluster. Verify repair. Is there still a problem?	-	<i>Go to Step 8</i>	<i>Refer to CKP Sensor Signal Incorrect</i>
7	1. Disconnect the ECM and CKP sensor. 2. Check for a short to ground in the 58X reference circuit between the CKP sensor connector and the ECM harness connector. 3. If a problem is found, repair as necessary. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 8</i>
8	1. Reconnect the ECM and CKP sensor. 2. Connect a Digital Voltmeter (DVM) to measure voltage on the 58X reference circuit at the ECM connector. 3. Observe the voltage while cranking the engine. Is the voltage near the specified value?	2.5V	<i>Go to Step 11</i>	<i>Go to Step 9</i>
9	Check the connections at the CKP sensor and replace the terminals if necessary. Did any terminals require replacement?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
10	Replace the CKP sensor. Is the action complete?	-	<i>Verify repair</i>	-
11	Check connections at the ECM and replace the terminals if necessary. Did any terminals require replacement?	-	<i>Verify repair</i>	<i>Go to Step 12</i>
12	Replace the EPROM or ECM. Is the action complete? <span style="float: right;">Note) Refer to 6E1-243.</span>	-	<i>Verify repair</i>	-



## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 29) FUEL PUMP RELAY SHORTED TO GROUND

### Circuit Description

When the ignition switch is first turned ON, the engine control module (ECM) energizes the fuel pump relay which applies power to the in-tank fuel pump. The fuel pump relay will remain ON as long as the engine is running or cranking and the ECM is receiving 58X crankshaft position pulses. If no 58X crankshaft position pulses are present, the ECM de-energizes the fuel pump relay within 2 seconds after the ignition is turned ON or the engine is stopped.

The fuel pump delivers fuel to the fuel rail and injectors, then to the fuel pressure regulator. The fuel pressure regulator controls fuel pressure by allowing excess fuel to be returned to the fuel tank. With the engine stopped and ignition ON, the fuel pump can be turned ON by using a command by the scan tool.

This code detects a fuel pump relay short to ground or disconnected.

### Conditions for Setting the DTC

- ECM has commanded Fuel Pump relay to be de-energized.
- Feedback information shows relay is still energized or, an open contact is present.

**Action Taken When the DTC sets**

- The ECM will turn ON the Malfunction Indicator Lamp.

**Conditions for Clearing the DTC**

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

An intermittent may be caused by a poor connection, rubbed-through wire insulation, or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness - Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection, and damaged harness.
- This malfunction detects a fuel pump relay short to ground or disconnection.

**Test Description**

Number(s) below refer to the step number(s) on the Diagnostic Chart.

2. If the fuel pump is operating but incorrect pressure is noted, the fuel pump wiring is OK and the “Fuel System Pressure Test” chart should be used for diagnosis.

**⚠ Caution: To reduce the risk of fire and personal injury:**

- *It is necessary to relieve fuel system pressure before connecting a fuel pressure gauge. Refer to Fuel Pressure Relief Procedure, below.*
- *A small amount of fuel may be released when disconnecting the fuel lines. Cover fuel line fittings with a shop towel before disconnecting, to catch any fuel that may leak out. Place the towel in an approved container when the disconnect is completed.*

**Fuel Pressure Relief Procedure**

1. Remove the fuel cap.
2. Remove the fuel pump relay from the underhood relay center.
3. Start the engine and allow it to stall.
4. Crank the engine for an additional 3 seconds.

**⚠ Fuel Pressure Gauge Installation**

1. Remove the shoulder fitting cap.
2. Install fuel pressure gauge 5-8840-0378-0 to the fuel feed line located in front of and above the right side valve cover.
3. Reinstall the fuel pump relay.

**DTC (Flash DTC = 29)  
Fuel Pump Relay Shorted To Ground**

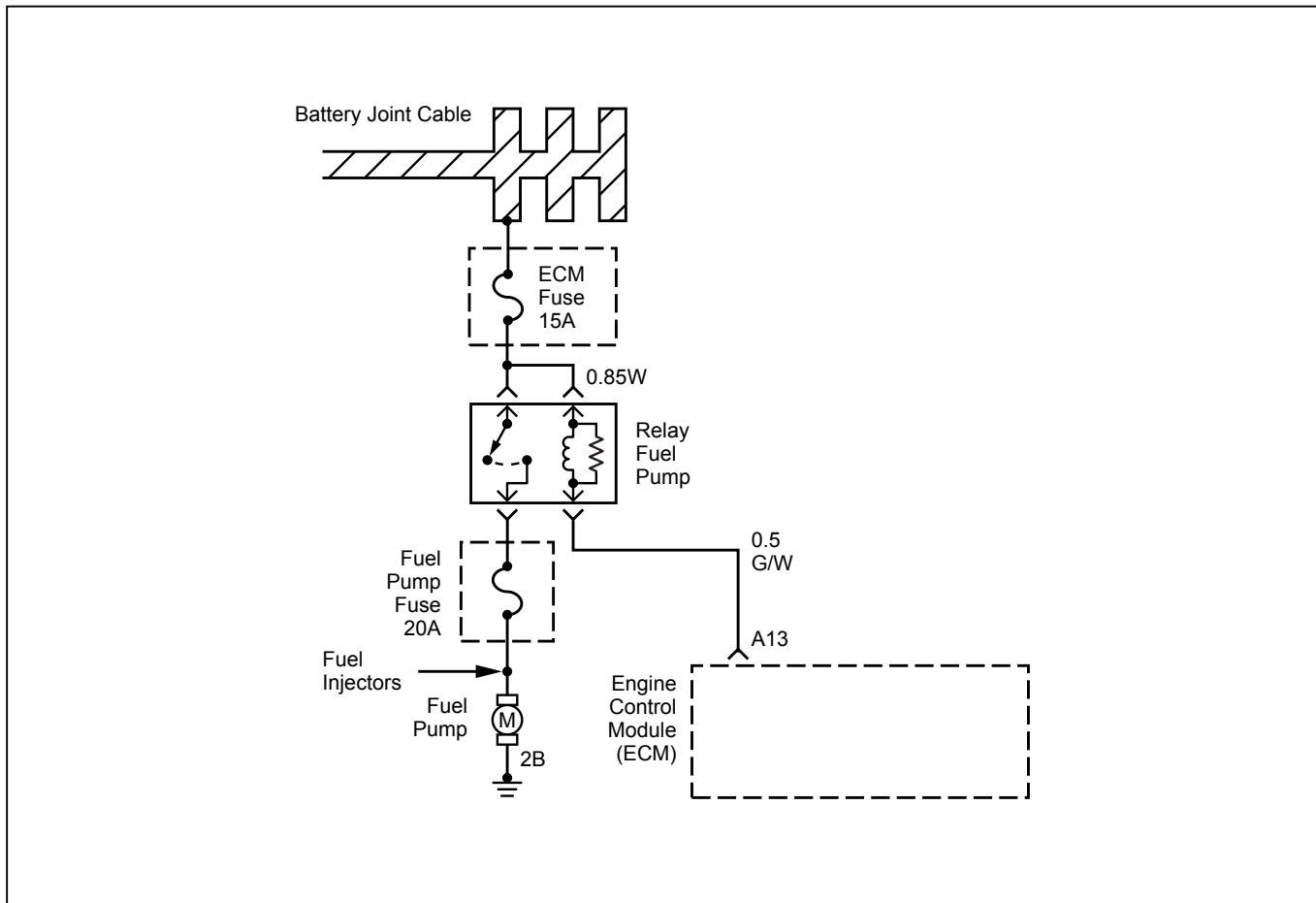
Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic (OBD) System Check” performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Read the “Caution” above. 2. Relieve the fuel system pressure and install the fuel pump pressure gauge to the test fitting. 3. Use a scan tool to command the fuel pump ON. Is there an immediate pressure build-up which indicates the pump is running?	-	<i>Go to Step 3</i>	<i>Go to Step 4</i>

**DTC (Flash DTC = 29)**  
**Fuel Pump Relay Shorted To Ground (Cont'd)**

Step	Action	Value(s)	Yes	No
3	<ol style="list-style-type: none"> <li>1. Verify that the pump is not running by removing the fuel filler cap and listening.</li> <li>2. Check the fuel pump relay connector is loosely fitting or disconnected. Repair it necessary.</li> <li>3. Command the pump ON with the scan tool.</li> </ol> Did the pump turn OFF after 2 seconds?	-	<i>Test completed</i>	<i>Go to Step 4</i>
4	<ol style="list-style-type: none"> <li>1. Ignition OFF.</li> <li>2. Remove the fuel pump relay.</li> <li>3. Connect a test light between the two wires that connect to the fuel pump relay pull-in coil.</li> <li>4. Ignition ON.</li> </ol> Did the test light illuminate for 2 seconds and then turn off?	-	<i>Go to Step 9</i>	<i>Go to Step 5</i>
5	<ol style="list-style-type: none"> <li>1. With a test light connected to battery (-), probe the fuel pump relay connector at the wire which runs from the relay pull-in coil to the ECM.</li> <li>2. Ignition ON.</li> </ol> Did the test light illuminate for 2 seconds and then turn off?	-	<i>Go to Step 6</i>	<i>Go to Step 7</i>
6	Check for short to ground between the ECM and the fuel pump relay. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 7</i>
7	<ol style="list-style-type: none"> <li>1. Check the fuel pump relay circuit for a poor terminal connection at the ECM.</li> <li>2. If a problem is found, replace terminal as necessary.</li> </ol> Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 8</i>
8	Replace the EPROM or ECM. Is the action complete?      Note) Refer to 6E1-243.	-	<i>Verify repair</i>	-
9	<ol style="list-style-type: none"> <li>1. Honk the horn to verify that the horn relay is functioning.</li> <li>2. Substitute the horn relay for the fuel pump relay.</li> <li>3. Leave the test light connected as in step 12.</li> <li>4. Command the fuel pump ON with the scan tool.</li> </ol> Did the test light illuminate for 2 seconds when the fuel pump was commanded ON?	-	<i>Go to Step 13</i>	<i>Go to Step 10</i>
10	<ol style="list-style-type: none"> <li>1. Re-connect the horn relay in its proper location.</li> <li>2. Check for a short circuit, blown fuse or open circuit between the relay and the fuel tank.</li> </ol> Is the action complete?	-	<i>Verify repair</i>	-
11	<ol style="list-style-type: none"> <li>1. With the fuel pump electrical connector at the fuel tank disconnected, connect a test light between the feed wire and the ground wire (harness side).</li> <li>2. Command the fuel pump ON with a scan tool.</li> </ol> Did the test light illuminate for 2 seconds?	-	<i>Go to Step 14</i>	<i>Go to Step 12</i>

**DTC (Flash DTC = 29)**  
**Fuel Pump Relay Shorted To Ground (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
12	Repair the open circuit in the fuel pump ground wire. Is the action complete?	-	<i>Verify repair</i>	-
13	1. Re-connect the horn relay in its proper location. 2. Replace the fuel pump relay. Is the action complete?	-	<i>Verify repair</i>	-
14	Replace the fuel pump. Is the action complete?	-	<i>Verify repair</i>	-



## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC = 32) FUEL PUMP RELAY SHORTED TO BATTERY

### Circuit Description

When the ignition switch is first turned ON, the engine control module (ECM) energizes the fuel pump relay which applies power to the in-tank fuel pump. The fuel pump relay will remain ON as long as the engine is running or cranking and the ECM is receiving 58X crankshaft position pulses. If no 58X crankshaft position pulses are present, the ECM de-energizes the fuel pump relay within 2 seconds after the ignition is turned ON or the engine is stopped.

The fuel pump delivers fuel to the fuel rail and injectors, then to the fuel pressure regulator. The fuel pressure regulator controls fuel pressure by allowing excess fuel to be returned to the fuel tank. With the engine stopped and ignition ON, the fuel pump can be turned ON by using a command by the scan tool.

This code detects a fuel pump relay short to battery.

### Conditions for Setting the DTC

- ECM has commanded Fuel Pump relay to be energized.
- Feedback information shows relay is still de-energized.

### Action Taken When the DTC sets

- The ECM will turn ON the Malfunction Indicator Lamp.

### Conditions for Clearing the DTC

Once the ECM determines that a fault(s) has been rectified then the CEL will switch OFF, although the fault code will remain in the ECM memory.

Any fault codes will remain in ECM memory until -

1. They are cleared by disconnecting the Battery for more than 30 seconds.
2. A service tool such as Tech 2 is used to clear them.
3. Ten consecutive starts without logging a fault.

**Diagnostic Aids**

An intermittent may be caused by a poor connection, rubbed-through wire insulation, or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness - Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection, and damaged harness.
- Fuel pump relay short to battery.

**Test Description**

Number(s) below refer to the step number(s) on the Diagnostic Chart.

2. If the fuel pump is operating but incorrect pressure is noted, the fuel pump wiring is OK and the “Fuel System Pressure Test” chart should be used for diagnosis.

**⚠ Caution:** To reduce the risk of fire and personal injury:

- *It is necessary to relieve fuel system pressure before connecting a fuel pressure gauge. Refer to Fuel Pressure Relief Procedure, below.*
- *A small amount of fuel may be released when disconnecting the fuel lines. Cover fuel line fittings with a shop towel before disconnecting, to catch any fuel that may leak out. Place the towel in an approved container when the disconnect is completed.*

**Fuel Pressure Relief Procedure**

1. Remove the fuel cap.
2. Remove the fuel pump relay from the underhood relay center.
3. Start the engine and allow it to stall.
4. Crank the engine for an additional 3 seconds.

**⚠ Fuel Pressure Gauge Installation**

1. Remove the shoulder fitting cap.
2. Install fuel pressure gauge 5-8840-0378-0 to the fuel feed line located in front of and above the right side valve cover.
3. Reinstall the fuel pump relay.

**DTC (Flash DTC = 32)  
Fuel Pump Relay Shorted To Battery**

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic (OBD) System Check” performed?	-	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Read the “Caution” above. 2. Relieve the fuel system pressure and install the fuel pump pressure gauge to the test fitting. 3. Use a scan tool to command the fuel pump ON. Is there an immediate pressure build-up which indicates the pump is running?	-	<i>Go to Step 3</i>	<i>Go to Step 4</i>
3	1. Verify that the pump is not running by removing the fuel filler cap and listening. 2. Command the pump ON with the scan tool. Did the pump turn OFF after 2 seconds?	-	<i>Test completed</i>	<i>Go to Step 12</i>
4	1. Ignition OFF. 2. Remove the fuel pump relay. 3. Using a test light connected to ground, probe the battery feed to the relay. Did the light illuminate?	-	<i>Go to Step 6</i>	<i>Go to Step 5</i>

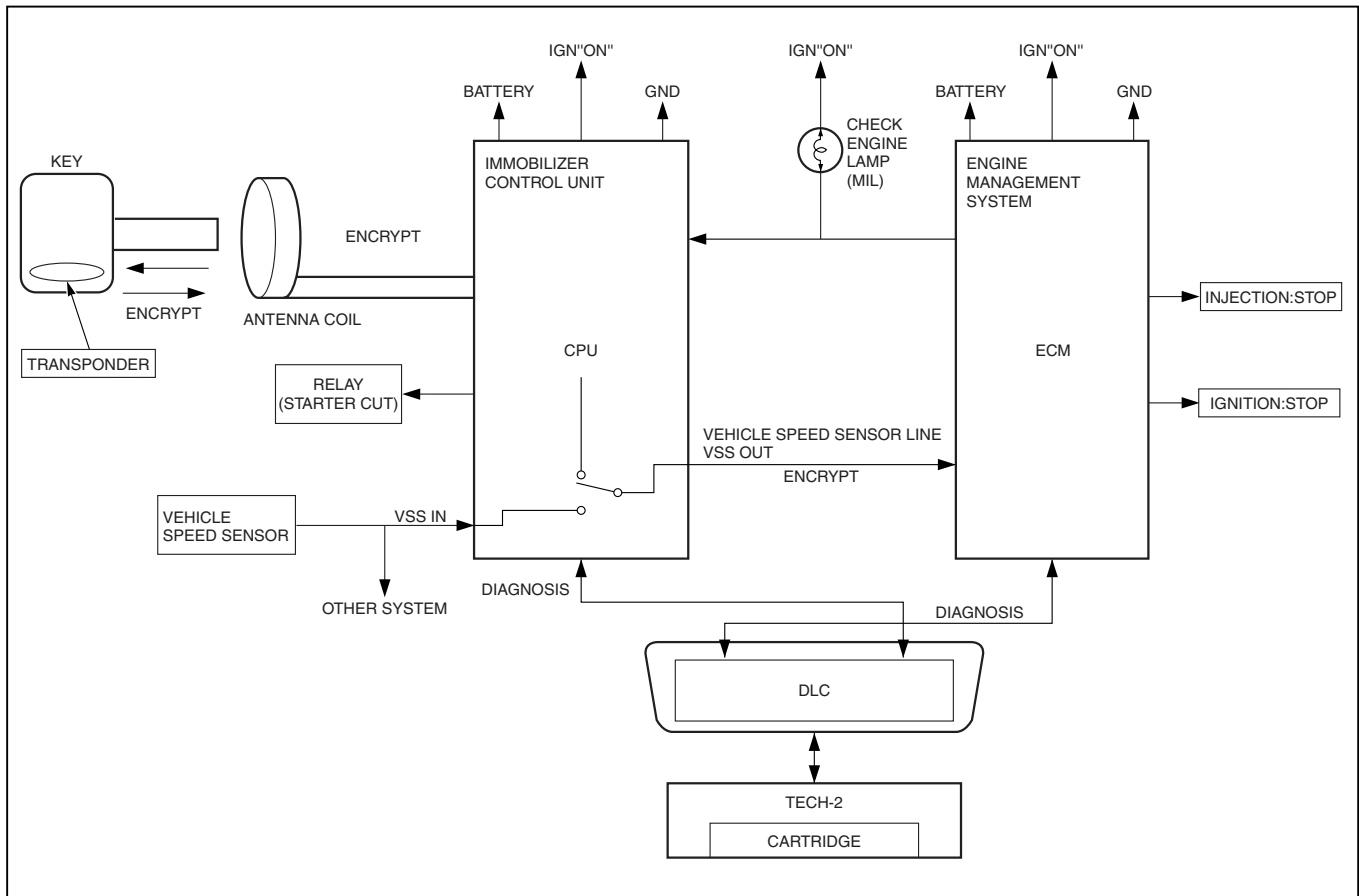


**DTC (Flash DTC = 32)**  
**Fuel Pump Relay Shorted To Battery (Cont'd)**

Step	Action	Value(s)	Yes	No
5	Repair short or open battery feed to fuel pump relay. Is the action complete?	-	<i>Verify repair</i>	-
6	1. Connect a test light between the two wires that connect to the fuel pump relay pull-in coil. 2. Ignition ON. Did the test light illuminate for 2 seconds and then turn off?	-	<i>Go to Step 12</i>	<i>Go to Step 7</i>
7	1. With a test light connected to battery (-), probe the fuel pump relay connector at the wire which runs from the relay pull-in coil to the ECM. 2. Ignition ON. Did the test light illuminate for 2 seconds and then turn off?	-	<i>Go to Step 8</i>	<i>Go to Step 9</i>
8	Locate and repair open in the fuel pump relay ground circuit. Is the action complete?	-	<i>Verify repair</i>	-
9	1. Check for short or open between the battery and the fuel pump relay. 2. Check the fuel pump relay circuit for a poor terminal connection at the ECM. 3. If a problem is found, replace terminal as necessary. Was a problem found?	-	<i>Verify repair</i>	<i>Go to Step 10</i>
10	Replace the EPROM or ECM. Is the action complete?      Note) Refer to 6E1-243.	-	<i>Verify repair</i>	-
11	1. Reconnect the fuel pump relay. 2. Disconnect the fuel pump electrical connector at the fuel tank 3. Using a test light connected to ground, probe the fuel pump feed wire (harness side). 4. Command the fuel pump ON with a scan tool. Did the light illuminate for 2 seconds?	-	<i>Go to Step 14</i>	<i>Go to Step 12</i>
12	1. Honk the horn to verify that the horn relay is functioning. 2. Substitute the horn relay for the fuel pump relay. 3. Leave the test light connected as in step 11. 4. Command the fuel pump ON with the scan tool. Did the test light illuminate for 2 seconds when the fuel pump was commanded ON?	-	<i>Go to Step 16</i>	<i>Go to Step 13</i>
13	1. Re-connect the horn relay in its proper location. 2. Check for a short circuit, blown fuse or open circuit between the relay and the fuel tank. Is the action complete?	-	<i>Verify repair</i>	-

**DTC (Flash DTC = 32)**  
**Fuel Pump Relay Shorted To Battery (Cont'd)**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
14	1. With the fuel pump electrical connector at the fuel tank disconnected, connect a test light between the feed wire and the ground wire (harness side). 2. Command the fuel pump ON with a scan tool. Did the test light illuminate for 2 seconds?	-	<i>Go to Step 17</i>	<i>Go to Step 15</i>
15	Repair the open circuit in the fuel pump ground wire. Is the action complete?	-	<i>Verify repair</i>	-
16	1. Re-connect the horn relay in its proper location. 2. Replace the fuel pump relay. Is the action complete?	-	<i>Verify repair</i>	-
17	Replace the fuel pump. Is the action complete?	-	<i>Verify repair</i>	-



## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC=83) RECEIVED RESPONSE WAS NOT CORRECT

### Circuit Description

The ECM decides whether that is an abnormality in the immobilizer control system. DTC 83 is recorded by the ECM when received response was not correct.

### Condition for Setting the DTC

- Received response was not correct.

### Action Taken When the DTC Sets

- Flashing the MIL.
- The engine does not start.

### Condition for Clearing the MIL/DTC

- Use clear DTC information with Tech2. (Refer to the immobilizer workshop manual.) (ISUZU TF Immobilizer system)

### Diagnostic Aids

Check for the following conditions:

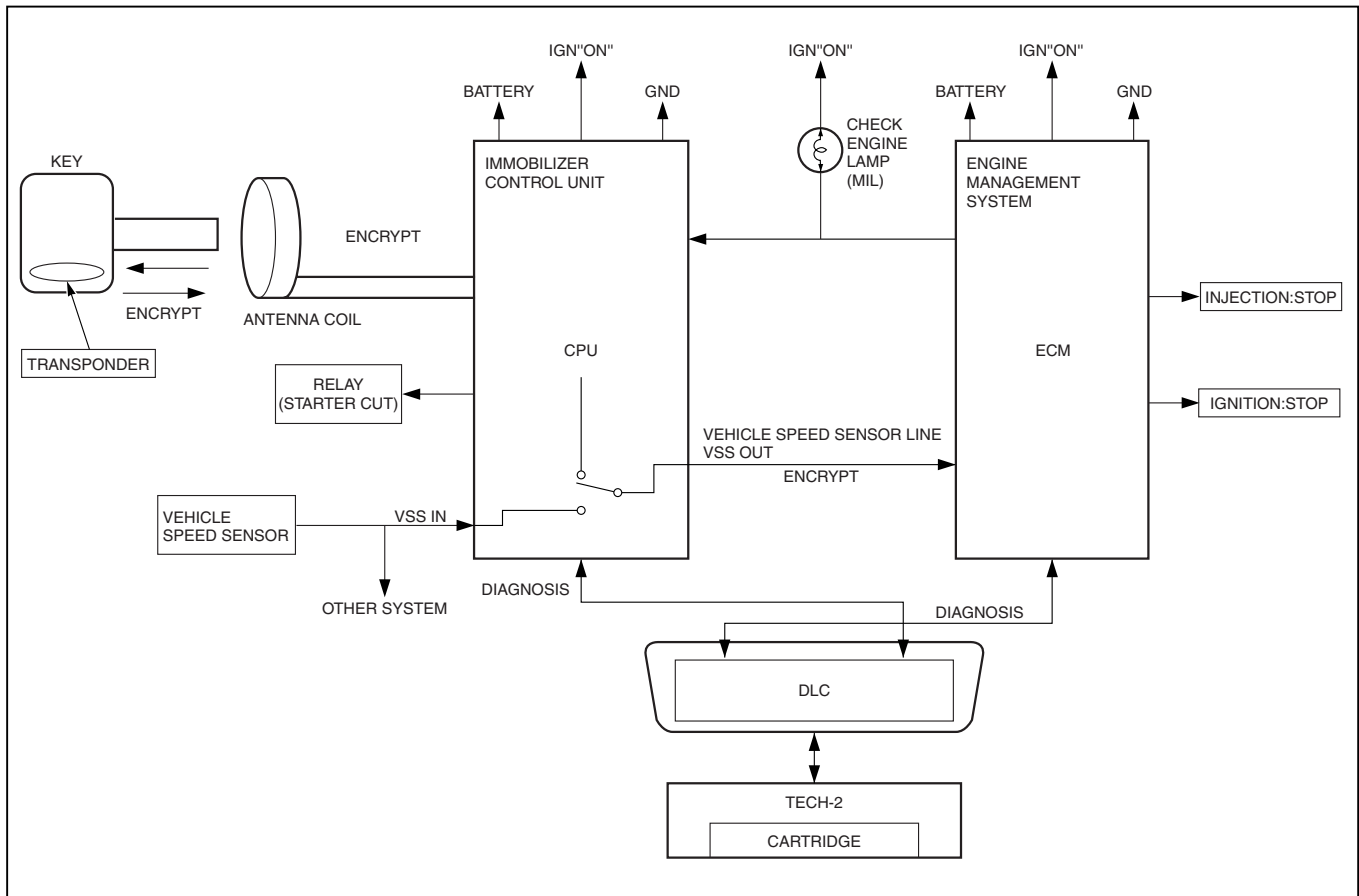
- Poor connection at ECM and Immobilizer-Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed

or damaged terminals, and poor terminal to wire connection.

- Damaged harness-Inspect the wiring harness for damage, If the harness appears to be OK, disconnect the ECM and Immobilizer, turn the ignition "ON" and observe a voltmeter connected to the suspect driver circuit at the ECM and Immobilizer harness connector while moving connectors and wiring harnesses relates to the MIL. A change in voltage will indicate the location of the fault.

**DTC (Flash DTC=83)  
Received Response Was Not Correct**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
1	Was the "On-Board Diagnostic (OBD) system Check" performed?	-	Go to <i>Step 2</i>	Go to <i>OBD system check</i>
2	Replace the ECM. <b>IMPORTANT:</b> The replacement ECM must be programmed. Refer to On-Vehicle Service in Engine Control Module and Sensors for procedures and Immobilizer system workshop manual. And also refer to latest Service Bulletin. Check to see if the Latest software is released or not. And then Down Load the LATEST PROGRAMMED SOFTWARE to the replacement ECM. Is the action complete?	-	Verify repair	-



## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC=84) NO RESPONSE FROM IMMOBILIZER

### Circuit Description

The ECM decides whether that is an abnormality in the immobilizer control system. DTC 84 is recorded by the ECM when no response from immobilizer.

### Condition for Setting the DTC

- No response from immobilizer.

### Action Taken When the DTC sets

- Flashing the MIL.
- The Engine does not start.

### Condition for Clearing the MIL/DTC

- Use clear DTC information with Tech2. (Refer to the immobilizer workshop manual.) (ISUZU TF Immobilizer system)

### Diagnostic Aids

Check for the following conditions:

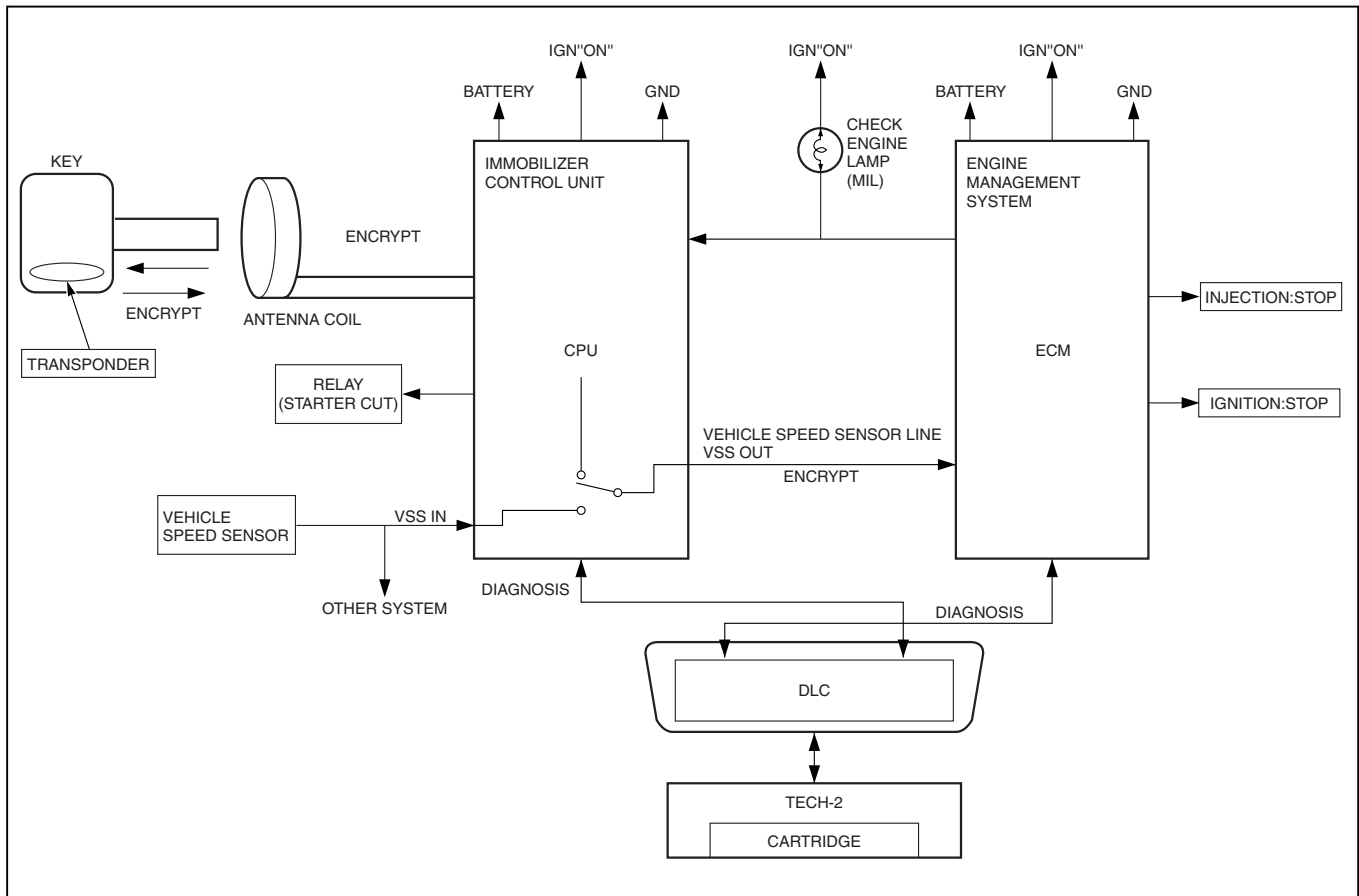
- Poor connection at ECM and Immobilizer-Inspect harness connectors for backed out terminals,

improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.

- Damaged harness? Inspect the wiring harness for damage, If the harness appears to be OK, disconnect the ECM and Immobilizer, turn the ignition "ON" and observe a voltmeter connected to the suspect driver circuit at the ECM and Immobilizer harness connector while moving connectors and wiring harnesses relates to the MIL. A change in voltage will indicate the location of the fault.

**DTC (Flash DTC=84)  
No Response From Immobilizer**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) system Check" performed?	-	Go to <i>Step 2</i>	Go to <i>OBD system check</i>
2	Using the Tech2 system selection menu, select Body function. Does the Tech2 indicate DTC B****?	-	Refer to " <i>Immobilizer workshop manual</i> "	Go to <i>Step 3</i>
3	Does the Tech2 indicate DTC 84?	-	Go to <i>Step 4</i>	Refer to <i>Diagnostic Aids</i>
4	1. Check the Circuit for Immobilizer system. 2. Disconnect the VEHICLE SPEED SENSOR LINE VSS OUT harness. 3. Check for open or short to ground in the wire between the ECM and IMMOBILIZER CONTROL UNIT by DMM. If a problem found, repair as necessary. Was a problem found?	-	Verify repair	Go to <i>Step 5</i>
5	Replace the ECM. <b>IMPORTANT:</b> The replacement ECM must be programmed. Refer to On-Vehicle Service in Engine Control Module and Sensors for procedures and Immobilizer system workshop manual. And also refer to latest Service Bulletin. Check to see if the Latest software is released or not. And then Down Load the LATEST PROGRAMMED SOFTWARE to the replacement ECM. Is the action complete?	-	Verify repair	-



## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC=85) SECURITY CODE & SECURITY KEY NOT PROGRAMMED

### Circuit Description

The ECM decides whether that is an abnormality in the immobilizer control system. DTC 85 is recorded by the ECM when security code & secret key not programmed.

### Condition for Setting the DTC

- Security code & secret key not programmed.

### Action Taken When the DTC Sets

- Flashing the MIL.
- The engine does not start.

### Condition for Clearing the MIL/DTC

- Use clear DTC information with Tech2. (Refer to the immobilizer workshop manual.) (ISUZU TF Immobilizer system)

### Diagnostic Aids

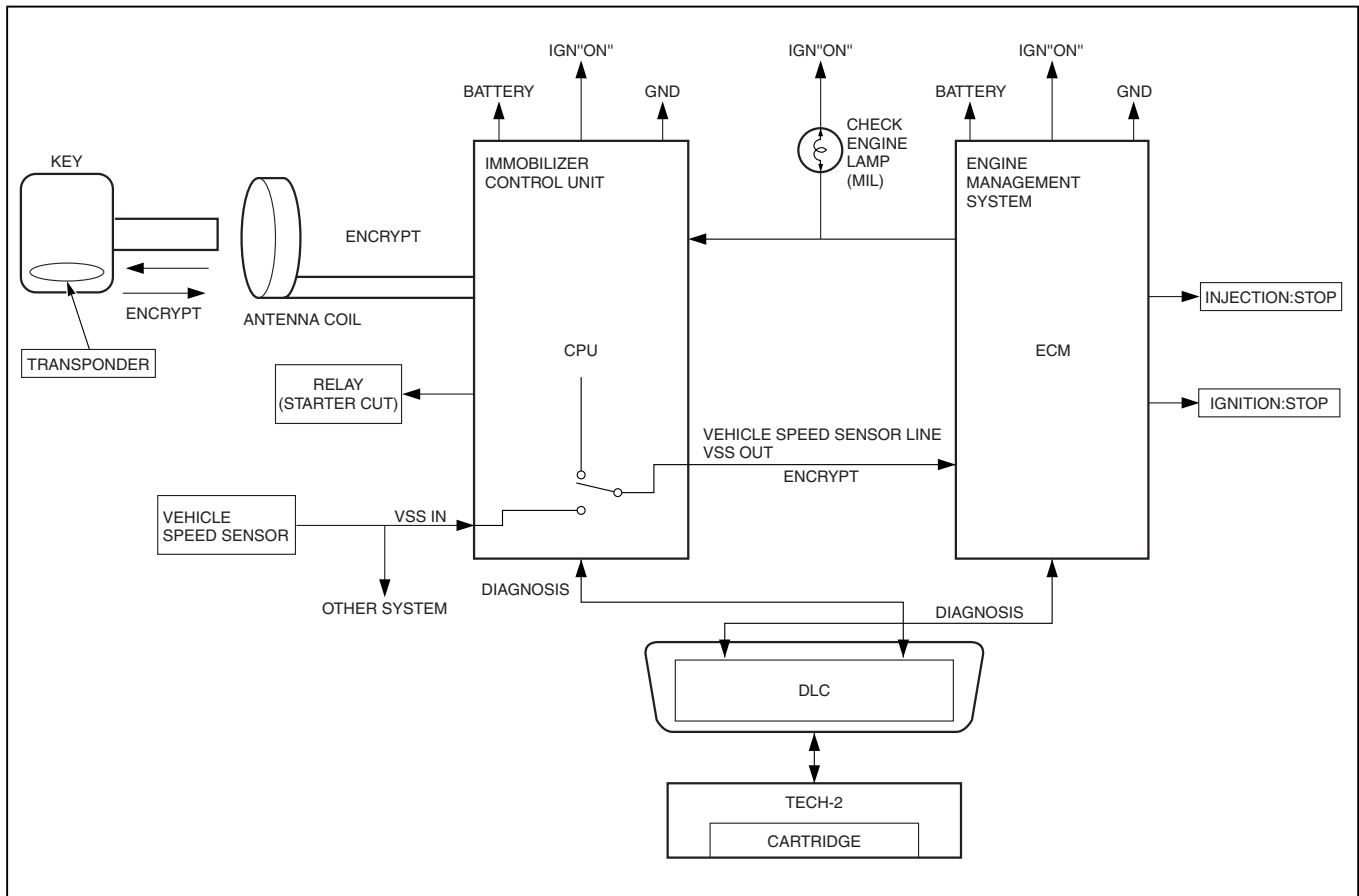
Check for the following conditions:

- Poor connection at ECM and Immobilizer-Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness?Inspect the wiring harness for damage, If the harness appears to be OK, disconnect the ECM and Immobilizer, turn the ignition "ON" and observe a voltmeter connected to the suspect driver circuit at the ECM and Immobilizer harness connector while moving connectors and wiring harnesses relates to the MIL. A change in voltage will indicate the location of the fault.

**DTC (Flash DTC=85)  
Security Code & Secret Key Not Programmed**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
1	Was the "On-Board Diagnostic (OBD) system Check" performed?	-	Go to <i>Step 2</i>	Go to <i>OBD system check</i>
2	Using the Tech2 system selection menu, select Body function. Does the Tech2 indicate DTC B****?	-	Refer to " <i>Immobilizer workshop manual</i> "	Go to <i>Step 3</i>
3	<b>IMPORTANT:</b> The replacement ECM must be programmed. Refer to On-Vehicle Service in Engine Control Module and Sensors for procedures and Immobilizer system workshop manual. And also refer to latest Service Bulletin. Check to see if the Latest software is released or not. And then Down Load the LATEST PROGRAMMED SOFTWARE to the replacement ECM. Is the action complete?	-	Go to <i>Step 4</i>	-
4	Does the Tech2 indicate DTC 85?	-	Go to <i>Step 3</i>	Verify repair.





## DIAGNOSTIC TROUBLE CODE (DTC) (Flash DTC=86) RECEIVED INCORRECT SECURITY CODE

### Circuit Description

The ECM decides whether that is an abnormality in the immobilizer control system. DTC 86 is recorded by the ECM when received incorrect security code.

### Condition for Setting the DTC

- Received incorrect security code.

### Action Taken When the DTC Sets

- Flashing the MIL.
- The engine does not start.

### In case replacement ECM, Action Taken

#### When the DTC Sets

- Flashing the MIL.

### Condition for Clearing the MIL/DTC

- Use clear DTC information with Tech2. (Refer to the immobilizer workshop manual.) (ISUZU TF Immobilizer system)

### Diagnostic Aids

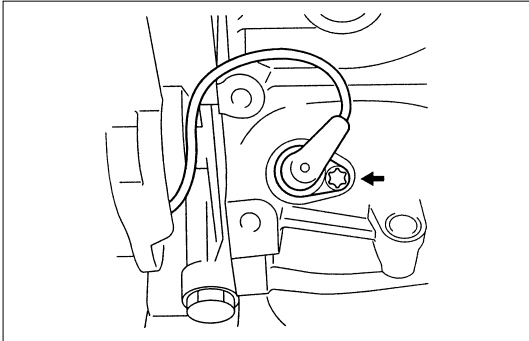
Check for the following conditions:

- Poor connection at ECM and Immobilizer-Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness?Inspect the wiring harness for damage, If the harness appears to be OK, disconnect the ECM and Immobilizer, turn the ignition "ON" and observe a voltmeter connected to the suspect driver circuit at the ECM and Immobilizer harness connector while moving connectors and wiring harnesses relates to the MIL. A change in voltage will indicate the location of the fault.

**DTC (Flash DTC=86)**  
**Received Incorrect Security Code**

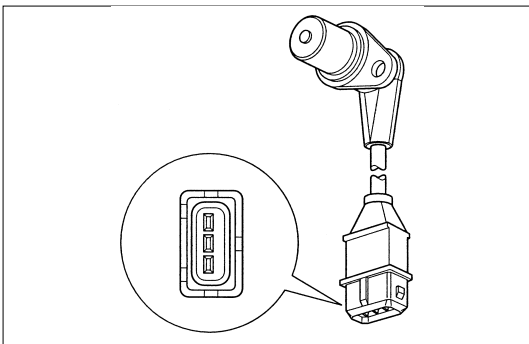
<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
1	Was the "On-Board Diagnostic (OBD) system Check" performed?	-	Go to <i>Step 2</i>	Go to <i>OBD system check</i>
2	Recheck the security code. Is the action complete?	-	Verify repair	-

## ON-VEHICLE SERVICE PROCEDURE ECM AND SENSORS



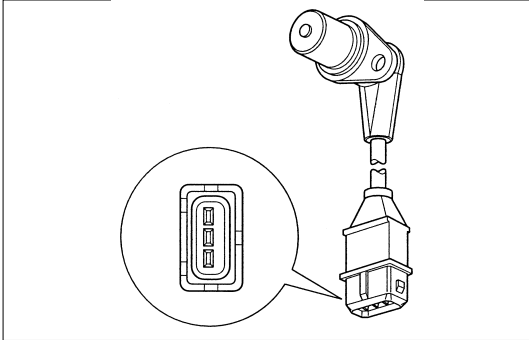
### CRANKSHAFT POSITION (CKP) SENSOR Removal

1. Disconnect the negative battery cable.
2. Remove the drive belt. Refer to Engine Mechanical Section.
3. Remove the A/C compressor from engine. Refer to *Engine Mechanical Section*.



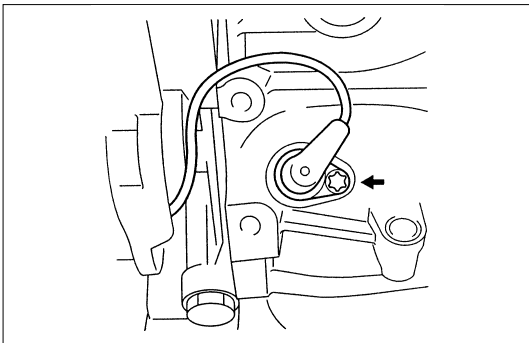
4. Disconnect electrical connector from the sensor.
5. Remove the retaining bolt and sensor from the engine block.

**Note:** Use caution to avoid any hot oil that might drip out.



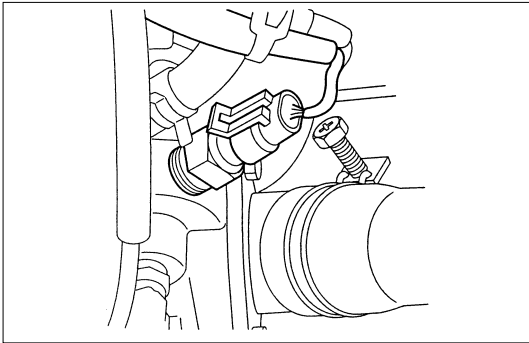
### Installation

1. Install the crank shaft position sensor to its position.
2. Install and tighten the mounting bolt. Refer to *Engine Mechanical Section*.



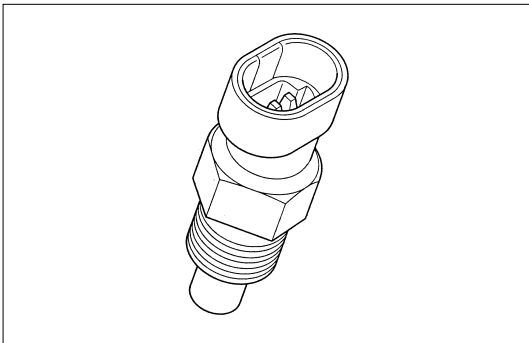
3. Reinstall the A/C compressor to the engine.
4. Reinstall the accessory drive belt.
5. Connect the negative battery cable.

## ENGINE COOLANT TEMPERATURE (ECT) SENSOR



### Removal

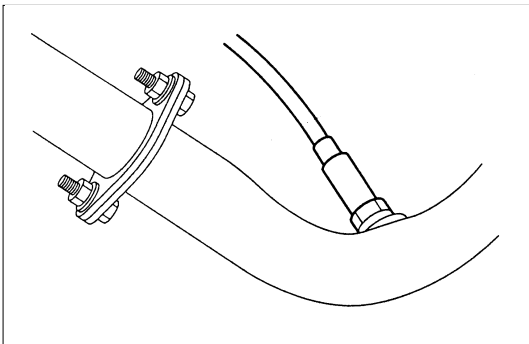
1. Disconnect the negative battery cable.
2. Drain enough engine coolant so that the coolant level will be below the ECT sensor.
3. Remove electrical connector from the sensor located on the thermostat housing.
4. Unscrew the sensor from the thermostat housing.



### Installation

1. Install the sensor into the thermostat housing. Do not over tighten.
2. Connect electrical connector.
3. Add engine coolant to required level. Refer to *Engine Cooling System Section*.
4. Connect the negative battery cable.

## HEATED OXYGEN SENSOR (HO<sub>2</sub>S) (If applicable)



### Removal

1. Disconnect the negative battery cable.
2. The sensor is mounted on the exhaust pipe ahead of the catalytic converter.
3. Disconnect pig tail electrical connector.



**Important:** The pigtail is permanently attached to the sensor. Be careful not to pull the wires out.

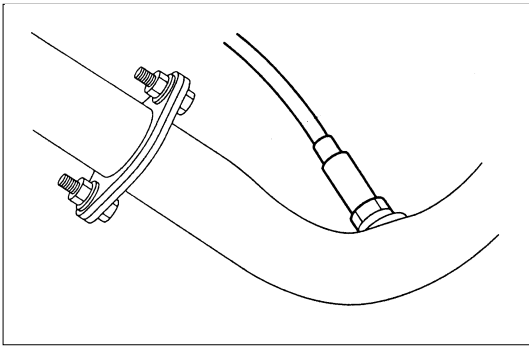
4. Unscrew sensor from the exhaust pipe. Because of the expansion and contraction of the metal in the exhaust system over time, this may be difficult if the engine temperature is below 48 degree C.



### Inspection

**Note:** The sensor is identical. Inspect each in the same way.

1. Inspect the pigtail and the electrical connector for grease, dirt, corrosion and bare wire or worn insulation.
2. Inspect the louvered end of the sensor for grease, dirt, excessive carbon build up or other contaminants.

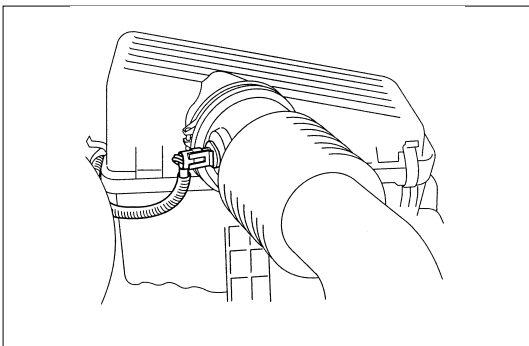


## Installation

**Note:** If HO2S is reinstalled after removal.

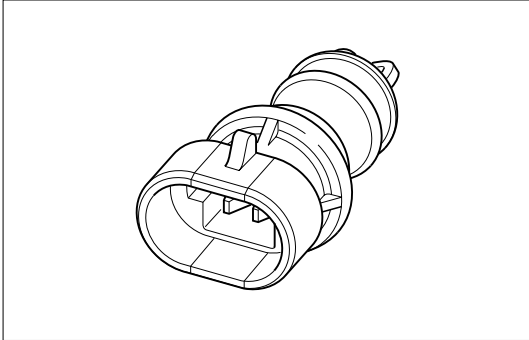
1. Install HO2S on the exhaust pipe.
2. Tighten the sensor to 55 Nm(7.6kgf·m).
3. Connect the pigtail to the wiring harness.
4. Connect the negative battery cable.

## INTAKE AIR TEMPERATURE (IAT) SENSOR

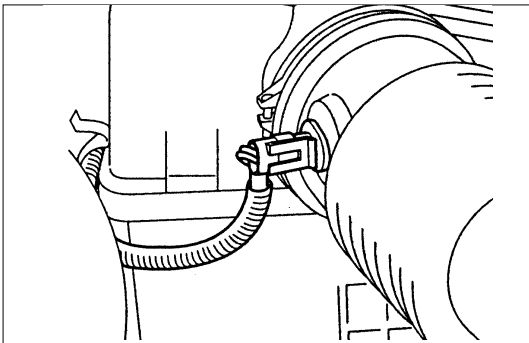


## Removal

1. Disconnect the negative battery cable.
2. The IAT sensor is located in the intake air duct between the air filter and the throttle body.



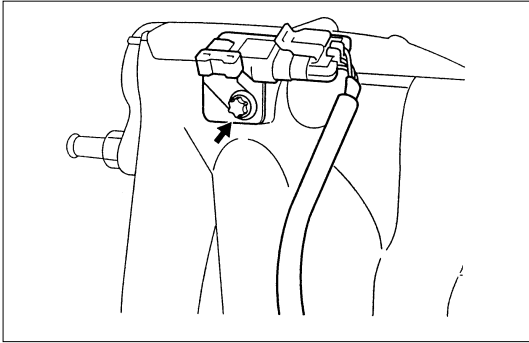
3. Disconnect the electrical connector from the sensor.
4. Remove the sensor from intake air duct by using a rocking motion while pulling the sensor.



## Installation

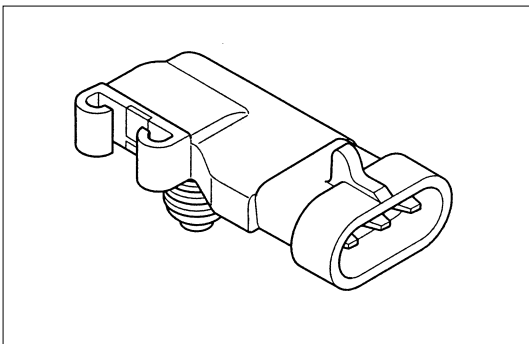
1. Install the IAT sensor into intake air duct. Make sure the sensor is pushed all the way into the intake air duct.
2. Connect electrical connector.
3. Connect the negative battery cable.

## MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR



### Removal

1. Disconnect the negative battery cable.
2. Disconnect the electrical connector from the sensor. (The MAP sensor is located on the intake manifold behind throttle body.)
3. Connect electrical connector.
4. Connect the negative battery cable.



### Installation

1. Push MAP sensor into the manifold. Make sure the sensor is pushed always into its position.
2. Install a mounting bolts and tighten.
3. Remove a mounting bolt securing the sensor to the manifold.
4. Remove the sensor from the intake manifold using rocking motion while pulling the sensor.

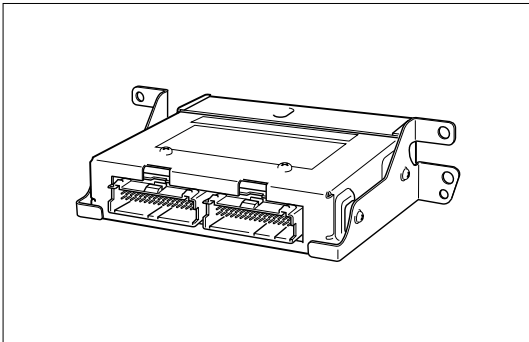
## MALFUNCTION INDICATOR LAMP (MIL)

Refer to Instrument Panel Removal Procedure.

## ENGINE CONTROL MODULE (ECM)

### Electrostatic Discharge (ESD) Damage

Electronic components used in the control system are often designed to carry very low voltage. Electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 volts of static electricity can cause damage to some electronic components. By comparison, it takes as much as 4000 volts for a person to even feel the zap of a static discharge. There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a car seat. Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charge of the same polarity are drained off leaving the person highly charged with opposite polarity. Static charge can cause damage, therefore, it is important to use care when handling and testing electronic components.

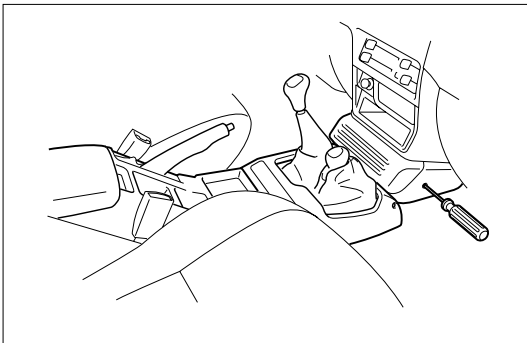


**Notice:** To prevent possible Electrostatic Discharge damage, follow these guidelines:

- Do not touch the control module connector pins or soldered components on the control module circuit board.
- Do not open the replacement part package until the part is ready to be installed.
- Before removing the parts from the package, ground the package to a known good ground on the vehicle.
- If the parts been handled while sliding across the seat, or while sitting from standing position, or walking a distance, touch a known good ground before installing the parts.

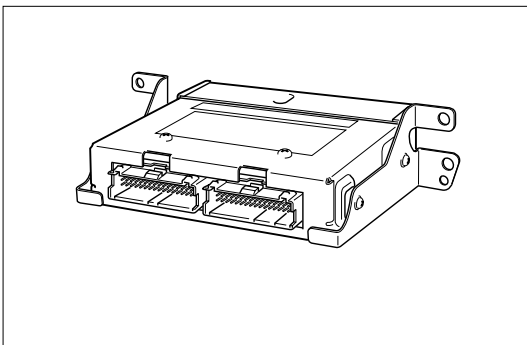
**Notice:** To prevent internal ECM damage, the ignition must be OFF position in order to disconnect or reconnect power to the ECM (for example: battery cable, pig-tail, ECM fuse, jumper cable, etc.).

## ENGINE CONTROL MODULE (ECM)



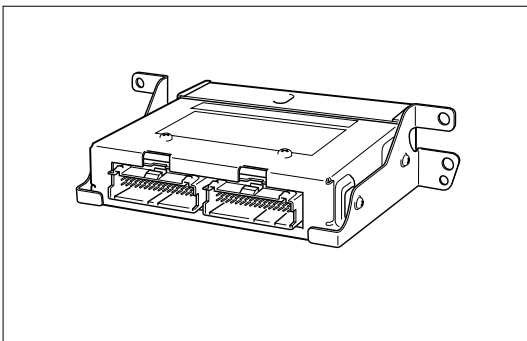
### Removal

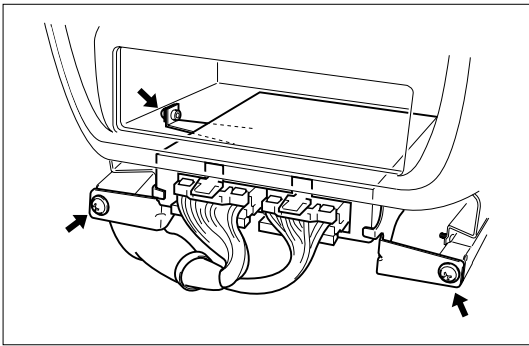
1. The ECM cover is located at the Instrument panel lower center cover assembly.
2. Remove the center cover assembly.
3. Remove the three screws.
4. Pull out the ECM.
5. Disconnect both red and tan connectors.
6. Remove the four screws located on both sides and then remove the brackets from the ECM.



### Installation

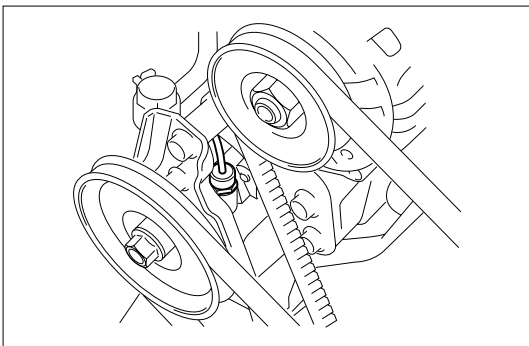
1. Attach the brackets to both sides of the ECM main body by securely tightening the screws.





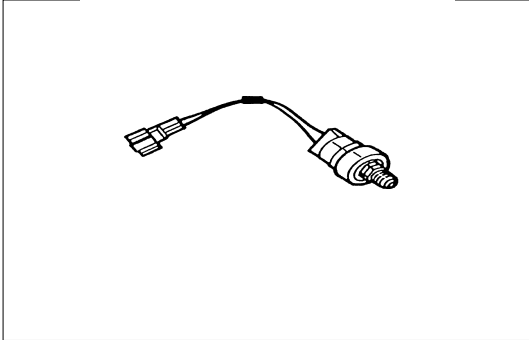
2. Connect both red and tan connectors.
3. Replace the ECM to the original position by tightening the screws.
4. Attach the center cover assembly.

## POWER STEERING PRESSURE (PSP) SWITCH



### ↔ Removal

1. Disconnect the battery negative cable.
2. Disconnect the PSP switch pigtail from the wiring harness.

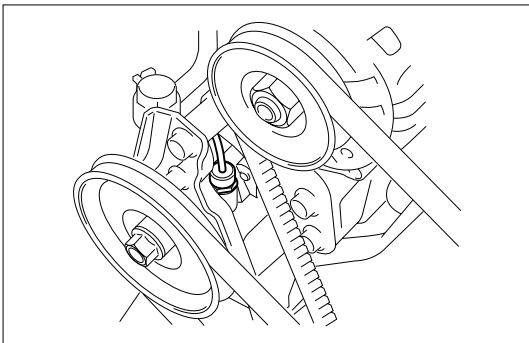


**Important:** The pigtail is permanently attached to the switch. Do not attempt to remove the wire from the switch.



**Important:** Have container ready to catch the power steering fluid that leaks out of the line when the switch is removed.

3. Unscrew the PSP switch from the power steering pump.

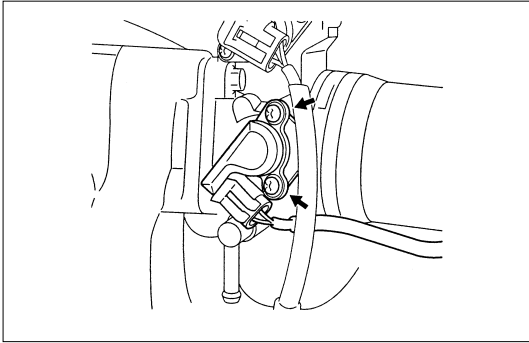


### ↔ Installation

1. Install the PSP switch into the power steering pump.
2. Connect electrical connector.
3. Ensure power steering fluid level and no leakage. Add power steering fluid if necessary. *Refer to Power Steering Section.*
4. Connect the negative battery cable.



## THROTTLE POSITION SENSOR (TPS)



### Removal

1. Disconnect the negative battery cable.
2. Disconnect the TPS electrical connector.
3. Remove the two screws and TP sensor from the throttle body.

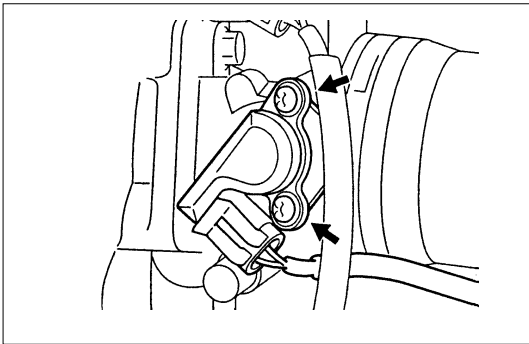
**Notice:** Do not clean the TP sensor by soaking it in solvent. The sensor will be damaged as a result.



### Function Check

Use a Scan Tool to check the TP sensor output voltage at closed throttle.

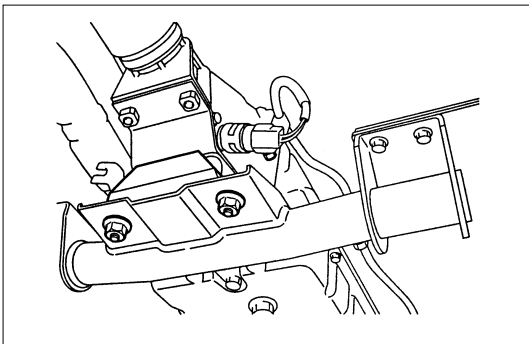
- The voltage should be under 0.25 volts.
- If the reading is greater than 0.25 volts, check the throttle shaft to see if it is binding. Check that the throttle cable is properly adjusted, also. *Refer to Throttle Cable Adjustment.*
- If the throttle shaft is not binding and the throttle cable is properly adjusted, install a new TP sensor.



### Installation

1. Install the TP sensor on the throttle body with two screws.
2. Connect the electrical connector.
3. Connect the negative battery cable.

## VEHICLE SPEED SENSOR (VSS)

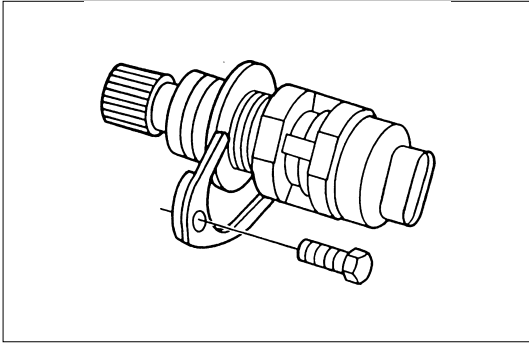


### Removal

1. Disconnect the negative battery cable.
2. VSS is located on the right side of the transmission case just ahead of the rear propeller shaft. Disconnect the VSS electrical connector.
3. Remove the bolt and the VSS from the transmission case by wiggling it slightly and pulling it straight out.

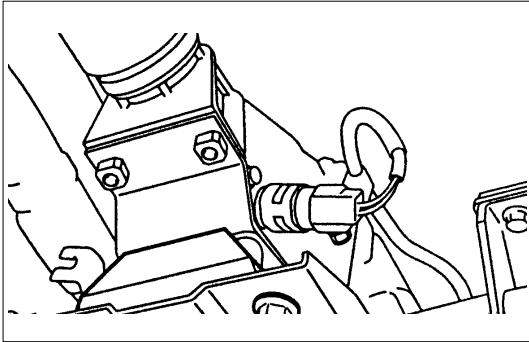


**Important:** Have a container ready to catch any fluid that leaks out when the VSS is removed from the transfer case.



### Inspection

1. Inspect the electrical connector for signs of corrosion or warping. Replace the VSS if the electrical connector is corroded or warped.
2. Inspect the VSS driven gear for chips, breaks, or worn condition. Replace the VSS if the driven gear is chipped, broken or worn.
3. Inspect the O-ring for wear, nicks, tears, or looseness. Replace the O-ring if necessary.

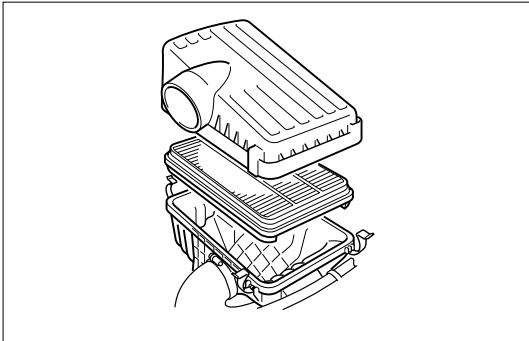


### Installation

1. Install the VSS in the transmission case with the notch for the connector facing the rear.
2. Secure the VSS with mounting bolt. Tighten the bolt to 16 N·m (17kgf·m).
3. Connect electrical connector to the VSS.
4. Check the transmission oil level. Add oil if necessary.
5. Connect the negative battery cable.

# AIR INDUCTION SYSTEM

## AIR FILTER



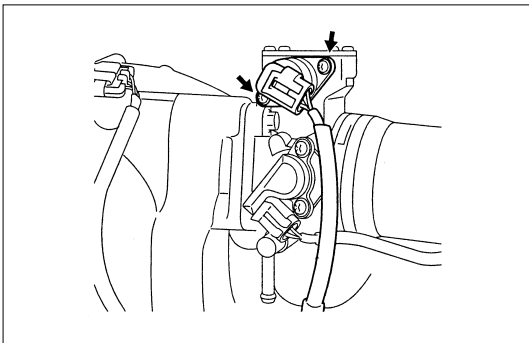
### ↔ Removal

1. Disconnect electrical connector at the IAT sensor.
2. Release the four latches securing the lid to the air cleaner housing.
3. Remove the air cleaner lid.
4. Remove the air filter element.

### ↔ Installation

1. Install the air filter element in the air cleaner housing.
2. Install the air cleaner lids.
3. Secure the three latches, holding the lid on the air cleaner housing.
4. Connect the electrical connector to the IAT sensor.

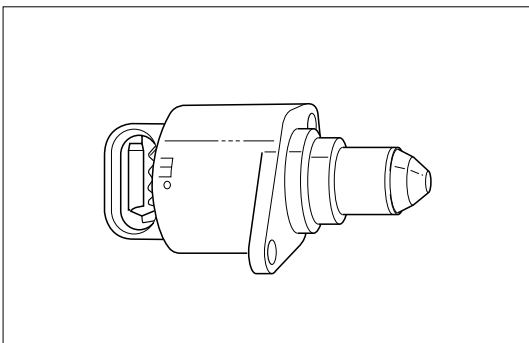
## IDLE AIR CONTROL (IAC) VALVE



### ↔ Removal

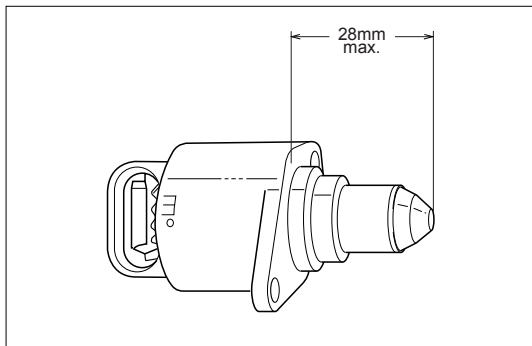
1. Disconnect the negative battery cable.
2. Disconnect the IAC electrical connector.
3. Remove the two screws and IAC valve from the throttle body.

**Notice:** Do not clean the IAC valve by soaking it in solvent. The valve will be damaged as a result.



### 🔧 Cleaning and Inspection

- Clean the IAC valve O-ring sealing surface, pintle valve seat and air passage.
- Use carburetor cleaner and a parts cleaning brush to remove carbon deposit. Do not use a cleaner that contain methyl ethyl ketone. This is an extremely strong solvent and not necessary for this type of deposit.
- Shiny spots on the pintle are normal and do not indicate misalignment or a bent pintle shaft.
- Inspect the IAC valve O-ring for cuts, cracks or distortion. Replace the O-ring if damaged.



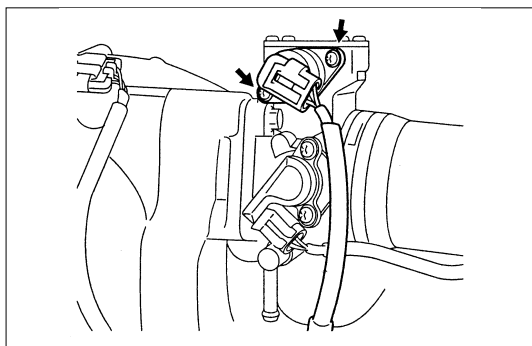
## Measurement

- In order to install a new IAC valve, measure the distance between the tip of the pintle and the mounting flange. If that measurement is 28 mm or less, the valve needs no adjustment. If the measurement is greater than 28 mm, apply finger pressure and retract the valve. The force required to retract the pintle on a new valve will not damage the valve, shaft or pintle.

**Notice:** Do not push or pull on the IAC valve pintle on IAC valve that has been in service. The force required to move the pintle may damage it.



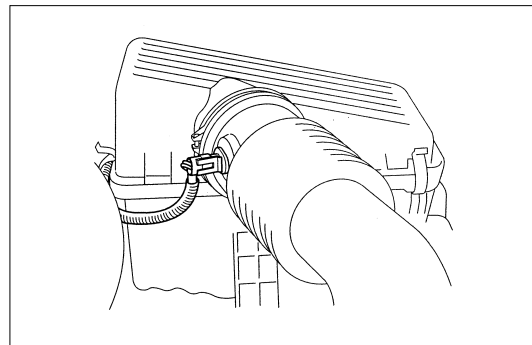
**Important:** Use an identical replacement part in order to replace a valve. IAC valve pintle shape and diameter are designed for the specific application.



## Installation

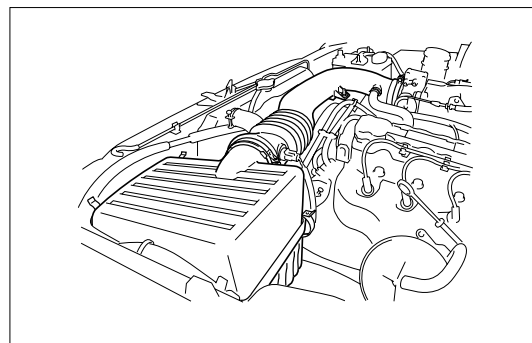
- Install IAC valve on the throttle valve body with the two screws. Tighten the screws to 1 N·m (1.2kgf·m).
- Connect electrical connector to IAC valve.
- Connect the negative battery cable.

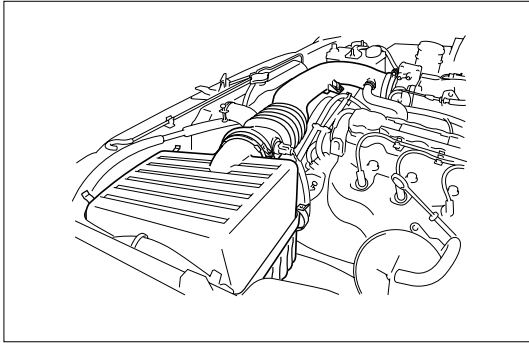
## INTAKE AIR DUCT



## Removal

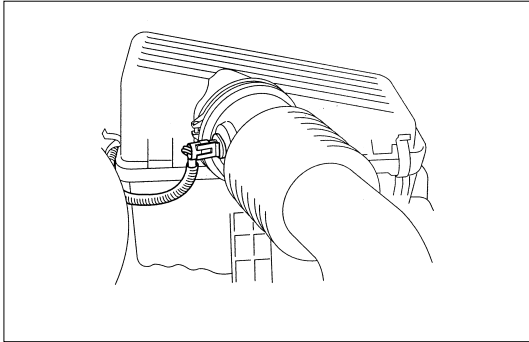
- Disconnect the negative battery cable.
- Disconnect electrical connector at IAT sensor.
- Remove the IAT sensor if necessary. *Refer to Intake Air Temperature Sensor Removal.*
- Loosen retaining clamps at the throttle body and at the air filter box.
- Disconnect brake booster vacuum hose at intake manifold and at brake booster.
- Remove retaining nut at the intake air duct bracket at top of valve cover.
- Disconnect the intake air duct from the throttle body and at the air filter box.





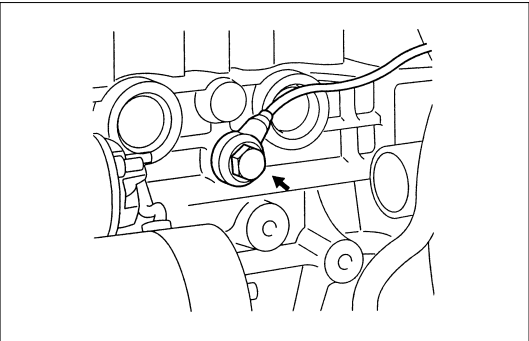
## Installation

1. Connect the intake air duct at the throttle body and at the air filter box. Make sure retaining hole is inserted to the intake air duct bracket.
2. Tighten retaining clamp at the throttle body and at the air filter box.
3. Install a nut to the intake air duct bracket and tighten.
4. Connect brake booster vacuum hose to intake manifold and to brake booster and secure them with clamps.
5. Install IAT sensor if necessary. Refer to Intake Air Temperature Sensor Installation.
6. Connect electrical connector at IAT sensor.
7. Connect the negative battery cable.



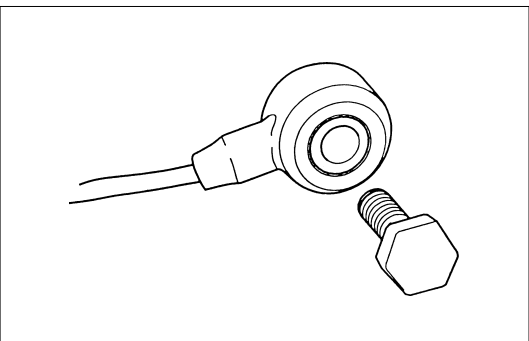
**Important:** Use an identical replacement part in order to replace a valve. IAC valve pintle shape and diameter are designed for the specific application.

## KNOCK SENSOR



## Removal

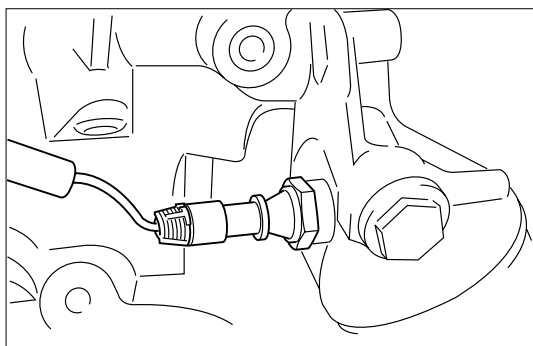
1. Disconnect the negative battery cable.
2. Disconnect pig tail electrical connector at near the top of generator.
3. Unscrew retaining bolt from Knock Sensor located on the passenger side of engine block just front of starter.
4. Remove Knock Sensor with retaining bolt.



## Installation

1. Install Knock Sensor with retaining bolt. Tighten the screws to 20N·m (2.0kgf·m).
2. Connect pigtail electrical connector.
3. Connect battery negative cable.

## OIL PRESSURE SWITCH



### Removal

1. Disconnect battery negative cable.
2. Disconnect electrical connector at Oil Pressure Switch.
3. Unscrew Oil Pressure Switch from Oil Filter Mounting Housing.

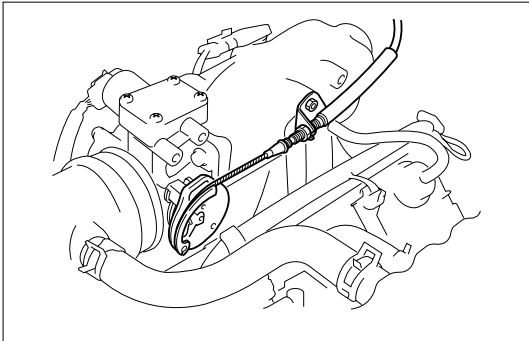


### Installation

1. Install Oil Pressure Switch into Oil Filter Mounting Housing and tighten. Tighten the screws to 30 -50Nm (3.1 -5.1kgf.m).
2. Connect electrical connector.
3. Connect battery negative cable.

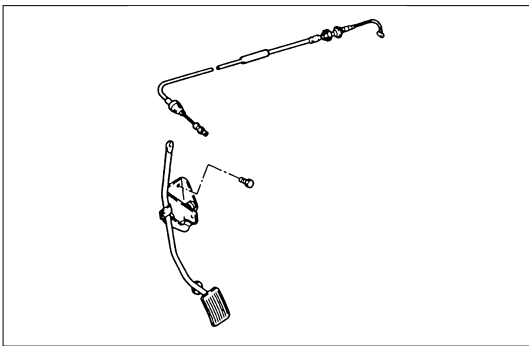
# FUEL METERING SYSTEM

## ACCELERATOR CABLE ASSEMBLY



### ⇨ Removal

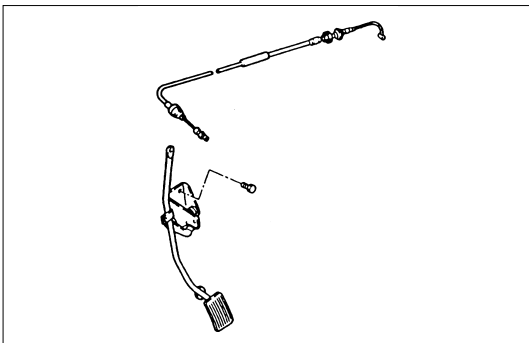
1. Loosen the adjusting nut on the cable bracket mounting on the throttle body.
2. Remove the cable clip from holding bracket.
3. Remove accelerator control cable (on the throttle valve end).
4. Remove the accelerator control cable (on the accelerator pedal end).
5. Remove the grommet.
6. Remove the accelerator control cable.



### Ⓛ Inspection

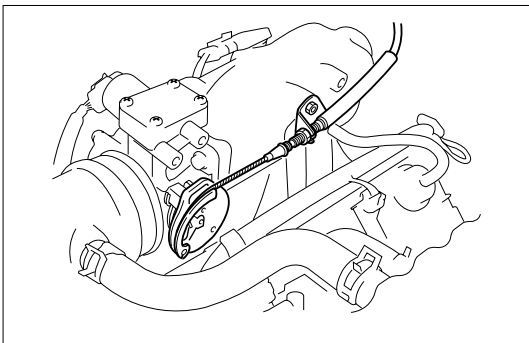
Check the following items, and replace the control cable if any abnormality is found:

- The control cable should move smoothly.
- The control cable should not be bent or kinked.
- The control cable should be free of damage and corrosion.

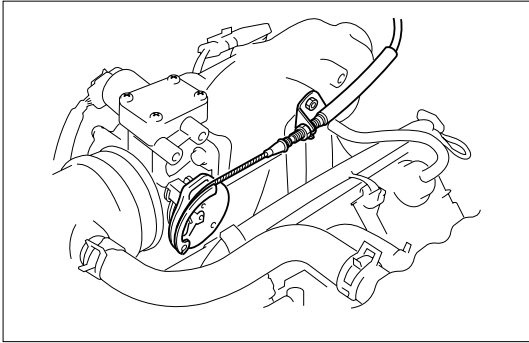


### ⇨ Installation

1. Install the accelerator control cable.
2. Install the grommet.
3. Install the accelerator control cable on the accelerator pedal.
4. Install the accelerator control cable on the throttle valve.
5. Install the cable clip to the holding bracket.
6. Adjust the accelerator cable. *Refer to Accelerator Cable Adjustment Section.*

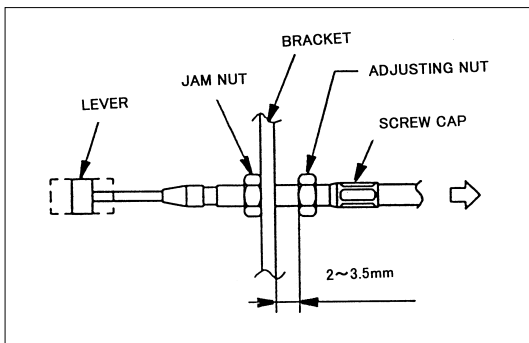


## ACCELERATOR CABLE ADJUSTMENT



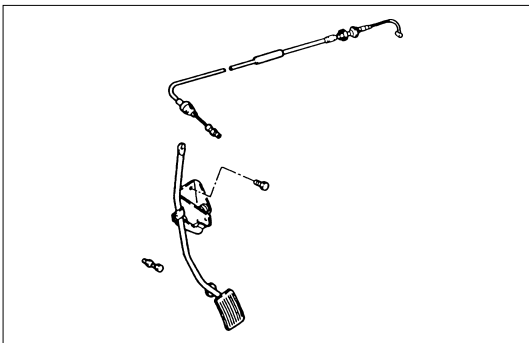
### Adjustment

1. Loosen the adjusting nut.
2. Loosen the jam nut.
3. Pull the outer cable while fully closing the throttle valve.
4. Tighten the adjusting nut.
5. Tighten the jam nut.
6. Loosen the adjusting nut and adjust clearance between adjusting nut and bracket to 2~3.5mm.
7. Tighten the jam nut again.
8. Manually operate valve.



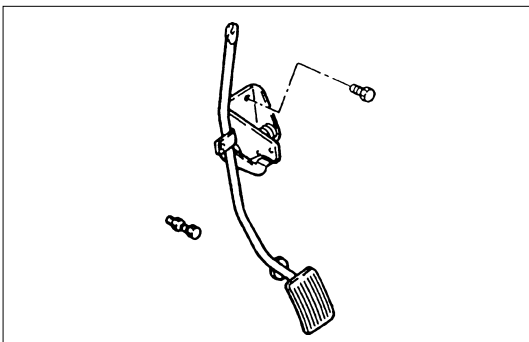
**Important:** The valve lever must return up to the stopper screw. If the valve lever does not reach the stopper screw, repeat the procedure again from Step 1.

## ACCELERATOR PEDAL REPLACEMENT



### Removal

1. Disconnect the accelerator pedal control cable from the accelerator pedal assembly.
2. Remove the two screws retaining the accelerator pedal to the bulkhead.
3. Remove the accelerator pedal from the bulkhead.

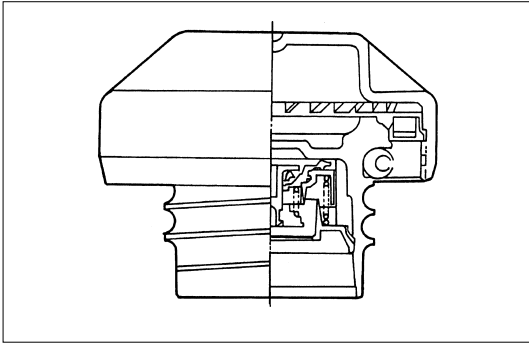


### Installation

1. Install the accelerator pedal assembly to the bulkhead with two screws.
2. Connect the accelerator control cable to the accelerator pedal assembly.
3. Adjust accelerator cable if necessary. *Refer to Accelerator Control Cable Adjustment Section.*



## FUEL FILLER CAP



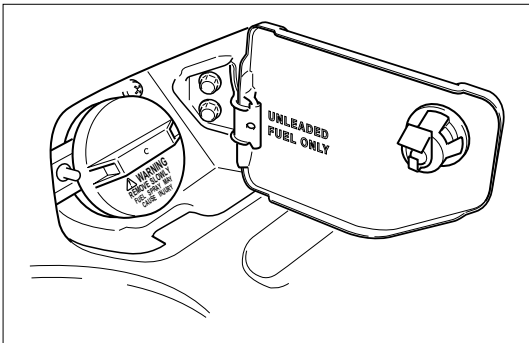
The Fuel Filler Cap includes a vacuum valve. If high vacuum occurs in the fuel tank, the vacuum valve works to adjust the pressure in order to prevent damage to the tank.



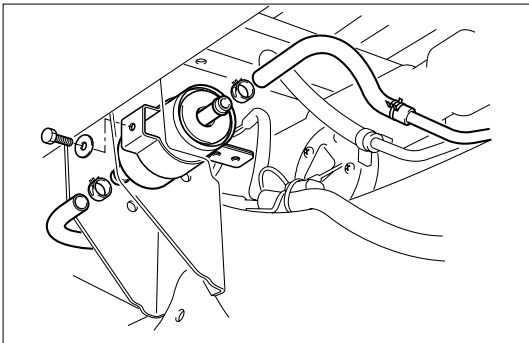
### Inspection

**Notice:** Replace the fuel filler cap with the same type of filler cap that was originally installed on the vehicle.

- Check the seal ring in the filler cap for any abnormality and for seal condition.
- Replace the filler cap if any abnormality is found.

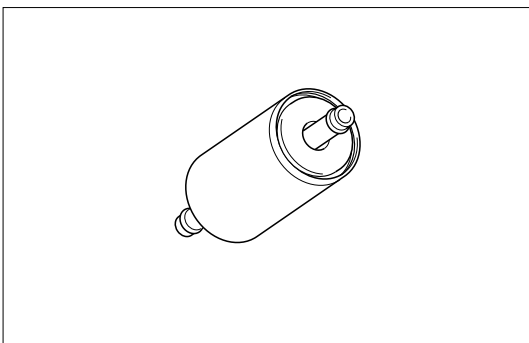


## FUEL FILTER



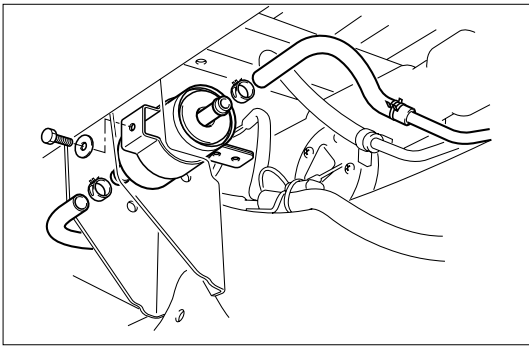
### Removal

1. Disconnect the negative battery cable.
2. Remove the fuel filler cap.
3. Disconnect the fuel line from the fuel filter on the engine side.
4. Disconnect the fuel line from the fuel filter on the fuel tank side.
5. Remove the bolt on the fuel filter holder.
6. Remove the fuel filter.



### Inspection

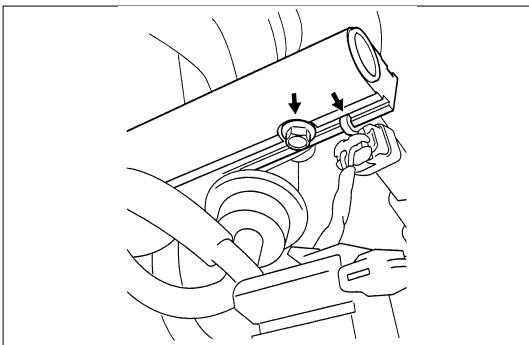
1. Replace the fuel filter when the following occur:
  - Fuel leaks from the fuel filter body
  - The fuel filter body is damaged
  - The fuel filter is clogged with dirt or sediment
2. If the drain hole is clogged with dust, clean the drain hole with air.



## Installation

1. Install the fuel filter in the correct direction.
2. Install the bolt on the fuel filter holder.
3. Connect the fuel line on the engine side.
4. Connect the fuel line on the fuel tank side.
5. Install the fuel filler cap.
6. Connect the negative battery cable.

## FUEL INJECTORS



## Removal

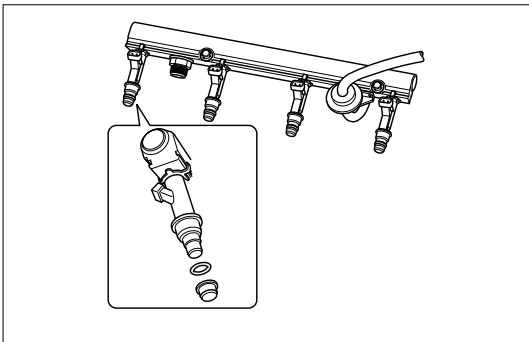
**Notice:** If the fuel injectors are leaking, the engine oil may be contaminated with fuel. Check the oil for signs of contamination and change the oil and filter if necessary.

**Notice:** Use care in removing the fuel injector in order to prevent damage to the fuel injector al connector pins or fuel injector nozzles. The fuel injector is an al component and should not be immersed in any type of cleaner as this may damage the fuel injector.



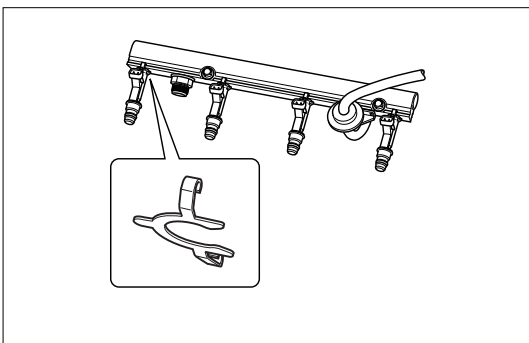
**Important:** Fuel injectors are serviced as complete assembly only.

1. Disconnect the negative battery cable.
2. Disconnect al connector from fuel injector.
3. Remove the fuel rail. *Refer to Fuel Rail Removal Procedure.*
4. Remove the fuel injector retainer clip.
5. Remove the fuel injector assembly from fuel rail.
6. Remove O-ring from the fuel injector.
7. Remove O-ring backup from fuel injector.



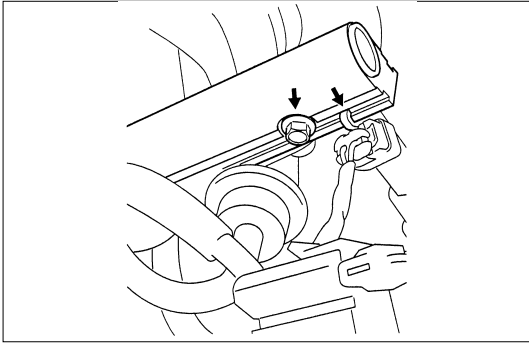
## Inspection

1. Inspect O-ring for crack, damage or leaks.
2. Replace worn or damaged O-ring.
3. Lubricate the new O-rings with engine oil before installation.



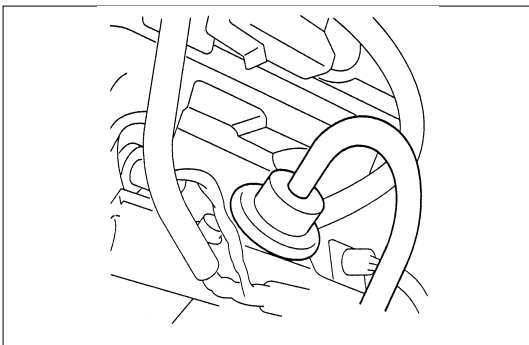
## Installation

1. Lubricate the new O-ring with engine oil.
2. Install the O-ring backup on the fuel injector.
3. Install new O-ring on the fuel injector.
4. Install all four injector on the fuel rail.
5. Use new injector retainer clip to retain the injetor to the fuel rail.
6. Coat the end of the fuel injector with engine oil.



7. Install fuel rail assembly. Tighten the nuts to 19 N·m (1.9 kgf·m). Refer to *Fuel Rail Installation Procedure*.  
Tighten the flare nut to 27 - 33 N·m (2.8 - 3.4 kgf·m).
8. Connect the negative battery cable.

## FUEL PRESSURE REGULATOR



### Removal



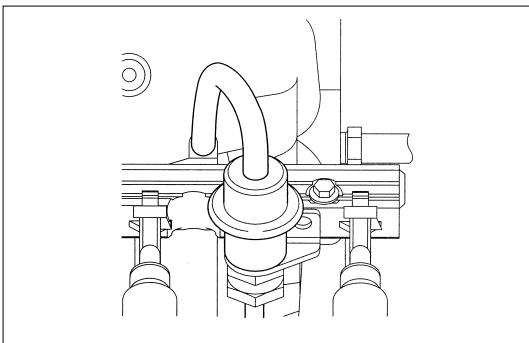
**Caution:** To reduce the risk of fire and personal injury, it is necessary to relieve the fuel system pressure before servicing the fuel system components.



**Caution:** After relieving the fuel system pressure, a small amount of fuel may be released when servicing fuel lines or connections. Reduce the chance of personal injury by covering the fuel line fitting with a shop towel before disconnecting the fittings. The towel will absorb any fuel that may leak out. When the disconnect is completed, place the towel in an approved container.

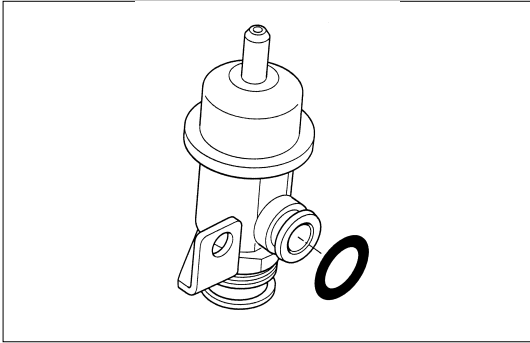
**Notice:** Compressed air must never be used to test or clean a fuel pressure regulator, as damage to the fuel pressure regulator may occur.

**Notice:** To prevent damage to the fuel pressure regulator, do not immerse the pressure regulator in solvent.

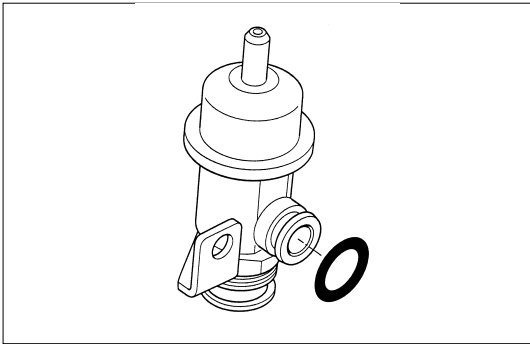


### Removal

1. Depressurize the fuel system. Refer to *Fuel Pressure Relief Procedure*.
2. Disconnect the negative battery cable.
3. Remove the fuel pump relay.
4. Disconnect the vacuum line from fuel pressure regulator.

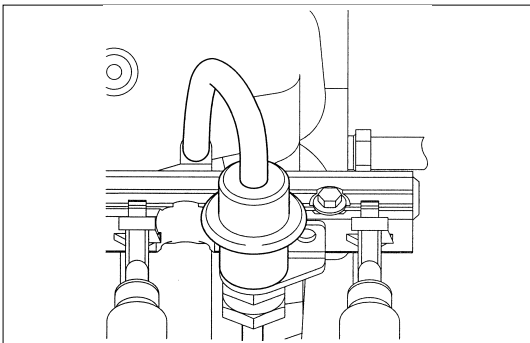


5. Remove the fuel pressure regulator retaining screw.
6. Remove the fuel pressure regulator from fuel rail.

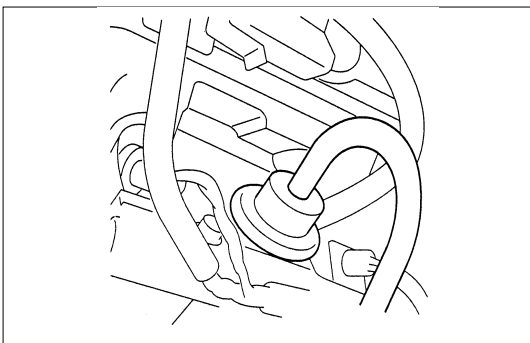


**↔** Installation

1. Insert the fuel pressure regulator into the fuel rail.

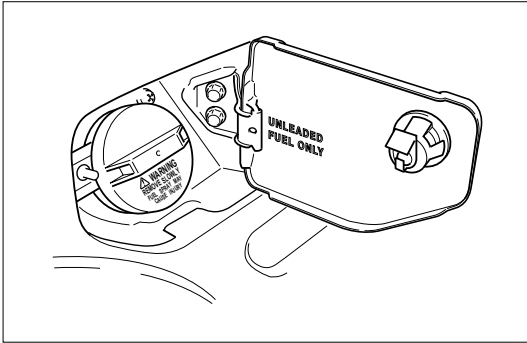


2. Install the fuel pressure regulator retaining bracket and tighten with a screw.
3. Connect vacuum line onto the fuel pressure regulator.



4. Install the fuel pump relay.
5. Connect the negative battery cable.
6. Crank the engine until it starts. Cranking the engine may take longer than usual due to trapped air in the fuel line.
7. Tighten the flare nut to 27 - 33 N·m (2.8 - 3.4 kgf·m).

## FUEL PRESSURE RELIEF

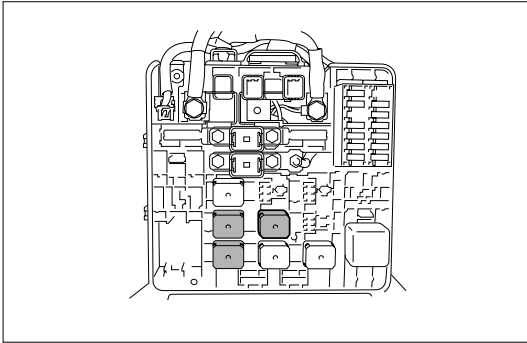


**Caution:** To reduce the risk of fire and personal injury, it is necessary to relieve the fuel system pressure before servicing the fuel system components.



**Caution:** After relieving the fuel system pressure, a small amount of fuel may be released when servicing fuel lines or connections. Reduce the chance of personal injury by covering the fuel line fitting with a short towel before disconnecting the fittings. The towel will absorb any fuel that may leak out. When the disconnect is completed, place the towel in an approved container.

1. Remove the fuel filler cap.
2. Remove the fuel pump relay from the underhood relay box.
3. Start the engine and allow it to stall.
4. Crank the engine for about 30 seconds.
5. Disconnect the negative battery cable.

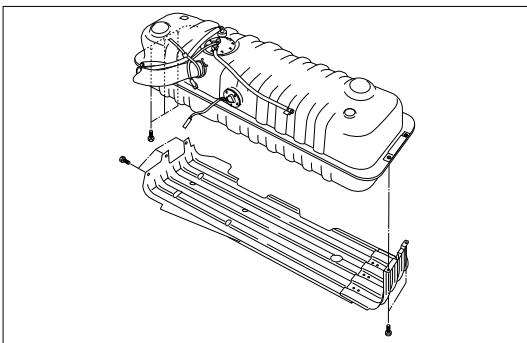
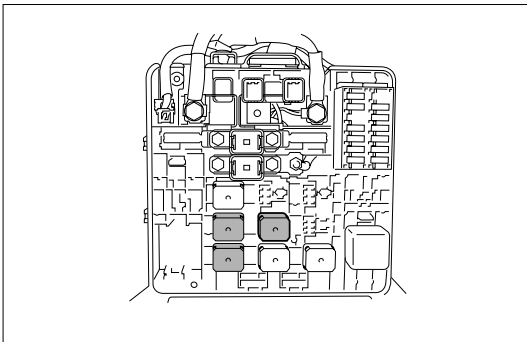


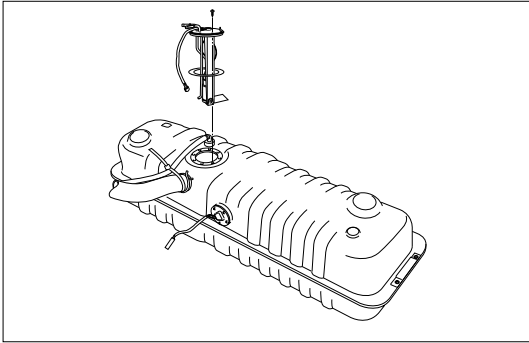
## FUEL PUMP ASSEMBLY



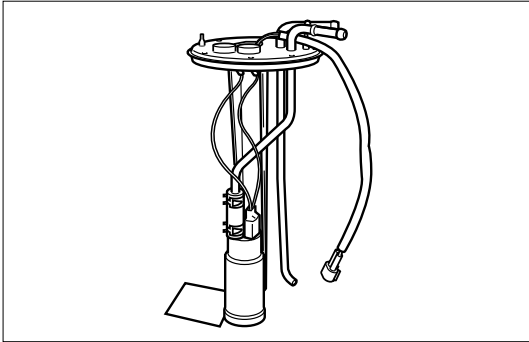
### Removal

1. Disconnect the negative battery cable.
2. Drain all fuel from fuel tank from filler neck.
3. Remove the fuel pump relay from the fuse and relay box at right side of engine room.
4. Remove fuel tank. Refer to *Fuel Tank Removal Procedure*.
5. Using commercially available tool, loosen the screws on the fuel pump and remove the fuel pump from the fuel tank.



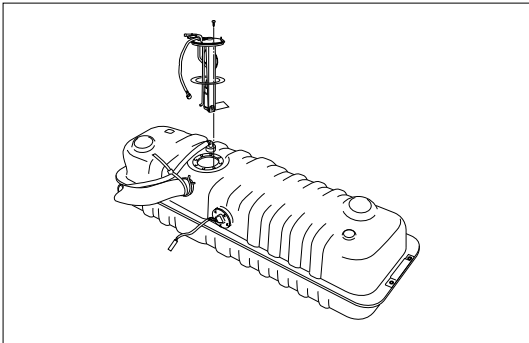


6. Lift fuel pump to remove from fuel tank.



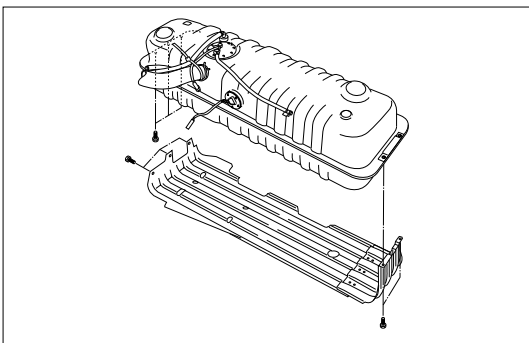
### Inspection

Inspect in-tank fuel filter for tears, damage or evidence of dirt debris or water in the fuel. If any of these conditions exist, replace the in-tank fuel filter.



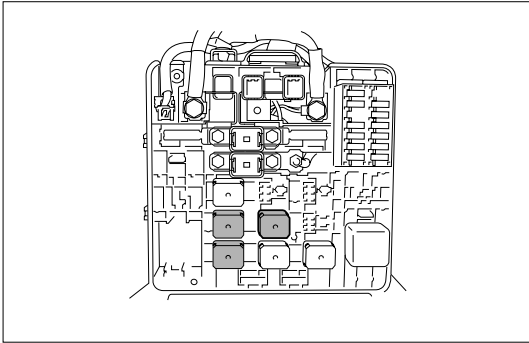
### Installation

1. Insert the fuel pump assembly into fuel tank and place them in their position.
2. Using commercially available tool, tighten the screws to the fuel pump assembly into the fuel tank.



3. Install the fuel tank. *Refer to Fuel Tank Installation Procedure.*
4. Install the fuel pump relay.
5. Connect the negative battery cable.

## FUEL PUMP RELAY



### Removal

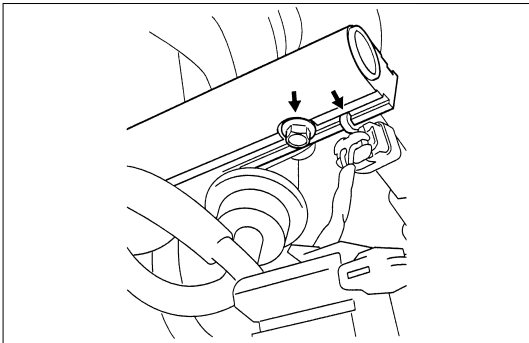
1. Remove the fuse and relay box cover located right side of engine room.
2. Determine correct relay by referring to the diagram on the cover.
3. Insert a small screwdriver or use thumb pressure to release the retainer of the relay.
4. Pull the relay straight up and out of the fuse and relay box.



### Installation

1. Insert the relay into the correct place in the fuse and relay box with the catch slot aligned to retainer.
2. Press down until the catch of retainer engages.
3. Install fuse and relay box cover.

## FUEL RAIL ASSEMBLY



### Removal

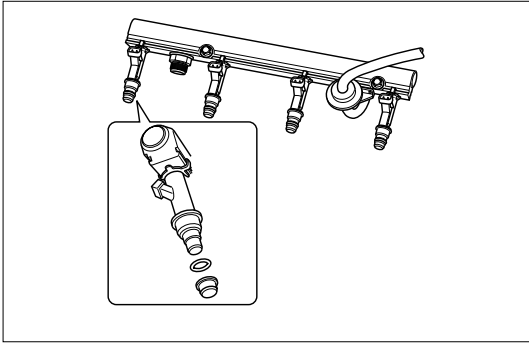
#### Notice:

- Use care when removing the fuel rail assembly in order to prevent damage to the injector al connector terminal and the injector spray tips.
- Fitting should be capped and holes plugged during servicing to prevent dirt and other contaminants from entering open lines and passage.

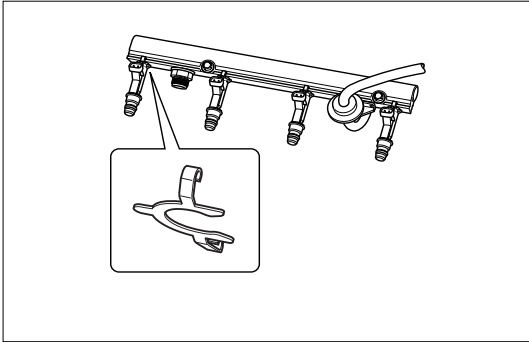


**Important:** An eight-digit identification number is stamped on side of the fuel injector. Refer to this number when you service the fuel rail or when a replacement part is required.

1. Disconnect 4 injector connectors.
2. Lift side-clip up on the fuel rail.
3. Disconnect fuel pressure regulator hose.
4. Disconnect wiring harness from the bands on the fuel rail.
5. Remove the intake pipe.
6. Loosen flare nut.
  - A Lift up the injectors carefully to separate them from intake manifold.
  - B Lift up the fuel rail with injectors as assembly. Do not separate the fuel injectors from fuel rail.
  - C If an injector become separated from fuel rail, injector backup O-ring and injector retainer clip must be replaced.
  - D Drain residual fuel from fuel rail into an approved container.

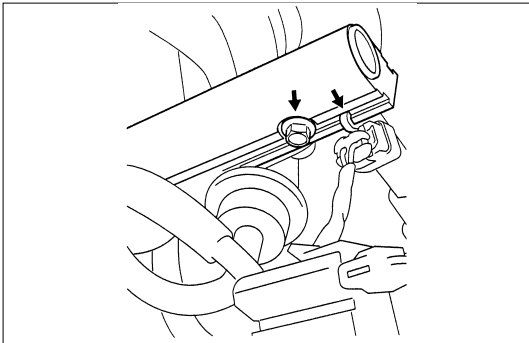


7. If removal of fuel pressure regulator is necessary, *Refer to Fuel Pressure Regulator Removal Procedure.*
8. If removal of fuel injector is necessary, *Refer to Fuel Injectors Removal Procedure.*



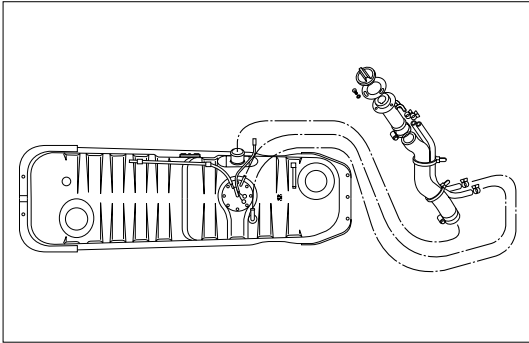
**↔↔ Installation**

1. Install the fuel injectors if necessary. Refer to Fuel Injector Installation Procedure.
2. Install the fuel pressure regulator if necessary. *Refer to Fuel Pressure Regulator Installation Procedure.*
3. Place the fuel injector rail assembly on the manifold and insert the injectors into each port by pushing fuel rail.
4. Install two fuel rail retaining bolts. Tighten fuel rail retaining bolt to 19 N·m (1.9kgf·m)
5. Place wiring harness in its place and secure it with two nuts.
6. Connect all connector to each fuel injector.
7. Connect the fuel supply line securely. Do not over tighten.
8. Connect the fuel return line securely. Do not over tighten.
9. Connect the negative battery cable.
10. Crank the engine until it starts. Cranking the engine may take longer than usual due to trapped air in the fuel system. Check for leak. If fuel leak is observed, stop engine immediately. Before correcting fuel leak, be sure to depressurize system again.



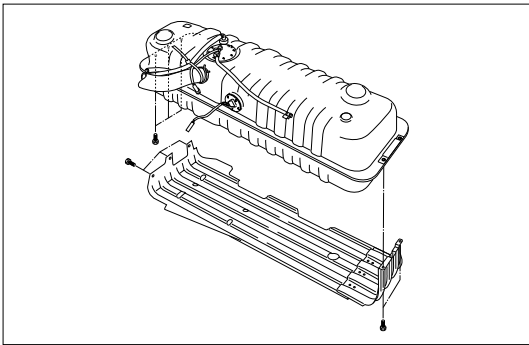
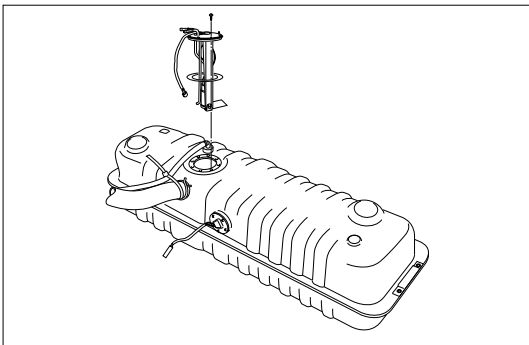


## FUEL TANK

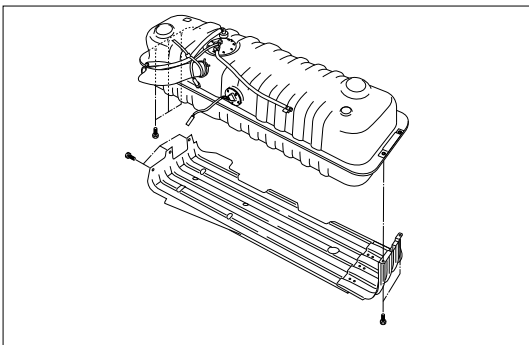


### Removal

1. Disconnect the negative battery cable.
2. Remove fuel filler cap.
3. Drain the fuel from fuel filler neck.
4. Disconnect the fuel filler hose at the fuel tank.
5. Disconnect the air breather hose at the fuel tank.
6. Disconnect the evaporator hose at the fuel tank.
7. Hold entire fuel tank at the bottom with stands.
8. Disconnect fuel supply lines and fuel return line at near the fuel filter inside of body frame.
9. Remove fixing bolts holding fuel tank to the frame.
10. Lower tank assembly from the vehicle a little to make access space on top.
11. Disconnect connectors at fuel pump.

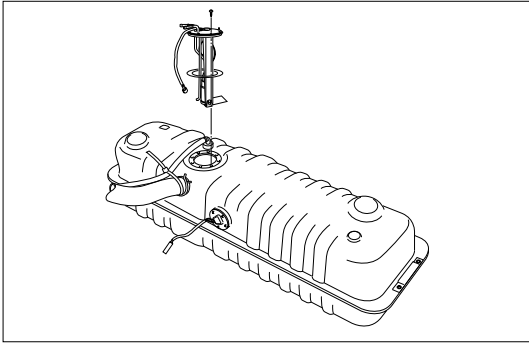


12. Remove pump tank assembly from the vehicle.
13. Remove the tank under guard to the tank.
14. Remove the tank from the guard.

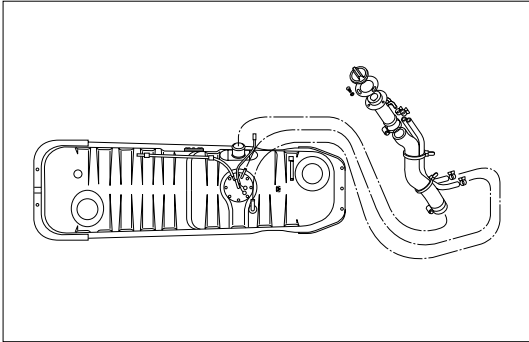


### Installation

1. Secure fuel tank into under guard with retaining bolts, if necessary.
2. Place the fuel tank assembly onto stands.
3. Lift the fuel tank assembly near the position.
4. Connect connectors at fuel pump.
5. Lift the fuel pump to its position and secure it with mounting bolts. Make sure that all hoses and fuel lines are out of way between the fuel tank and the fuel tank bracket. Tighten the fuel tank retaining bolts to 36 N·m (3.7kgf·m).

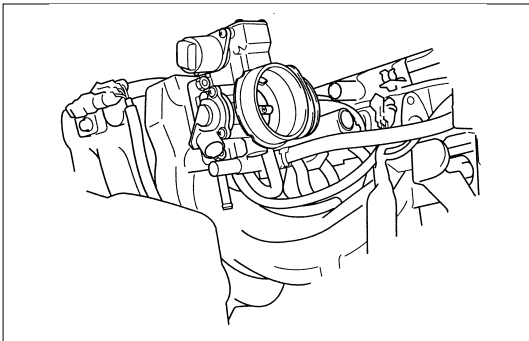


6. Connect fuel supply and return lines.
7. Connect the fuel filler hose, the air breather hose and EVAP hose onto fuel tank and secure them with clamps.



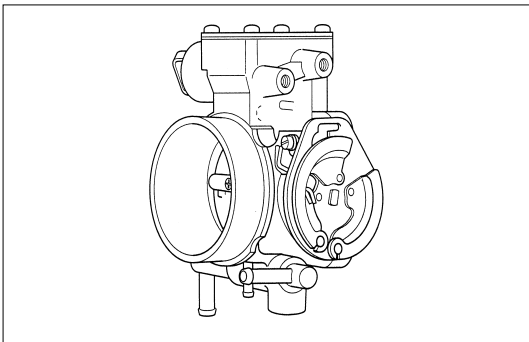
8. Pour fuel into fuel tank.
9. Install fuel filler cap securely.
10. Connect the battery negative cable.

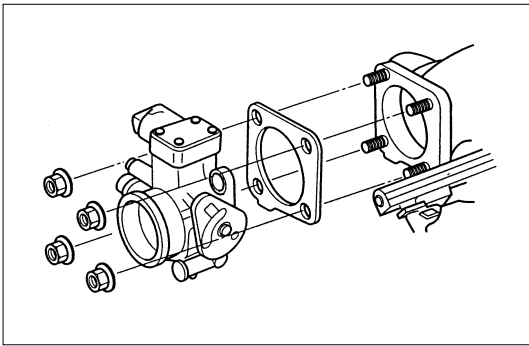
## THROTTLE BODY (TB)



### Removal

1. Disconnect the negative battery cable.
2. Drain the cooling system. *Refer to Cooling System.*
3. Remove the air intake duct. *Refer to Air Intake Duct Removal Procedure.*
4. Remove the accelerator cable from throttle. *Refer to Accelerator Cable Assembly Removal Procedure.*
5. Disconnect the air connectors from the throttle position sensor and the idle air control valve solenoid.
6. Disconnect all vacuum hoses below air horn.
7. Disconnect coolant lines.
8. Remove the mounting nuts retaining the throttle body to the intake manifold.
9. Remove the throttle body from the intake manifold.





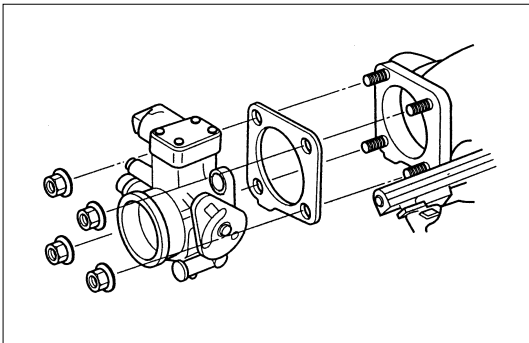
10. Remove the gaskets from the intake manifolds.
11. Remove the IAC. Refer to *Idle Air Control Valve Solenoid Removal Procedure*.
12. Remove TPS. Refer to *Throttle Position Sensor Removal Procedure*.



### Inspection

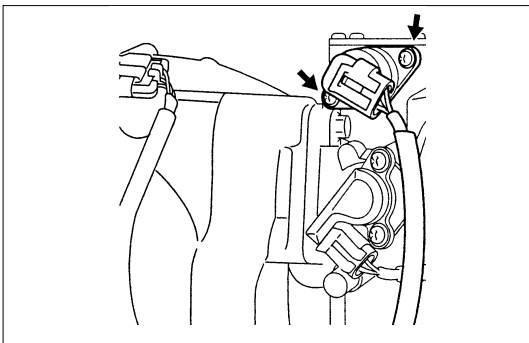
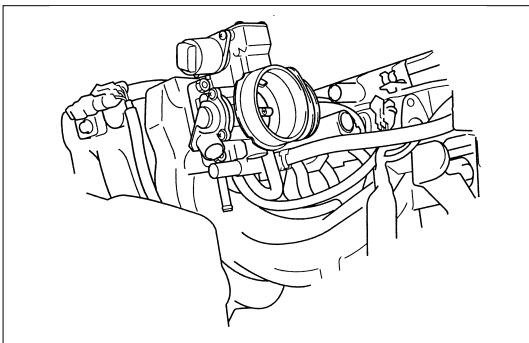
**Notice:** Do not use solvent of any type when you clean the gasket surfaces on the intake manifold and the throttle body assembly. The gasket surface and the throttle body assembly may be damaged as results.

1. If the throttle body gasket needs to be released, remove any gasket material that may be stuck to the mating surfaces of the manifold.
2. Do not leave any scratches in the aluminum casting.



### Installation

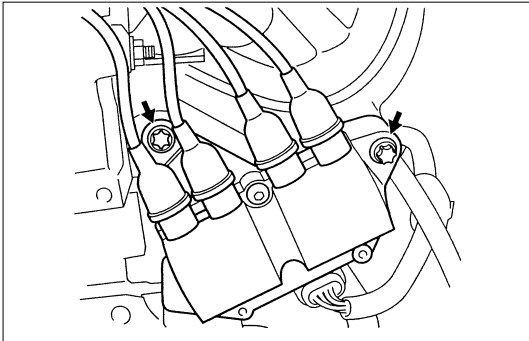
1. Install IAC valve onto the throttle body. Refer to IAC valve Installation Procedure.
2. Install TPS onto the throttle body if necessary. Refer to TPS Installation Procedure.
3. Place the gasket then the throttle body on the manifold.
4. Install four mounting bolts. Tighten the throttle body mounting bolt to 13.5 N·m (1.4kgf·m).
5. Connect coolant line and secure them with clamps.
6. Connect all vacuum hoses and secure them with clamps if necessary.
7. Install accelerator control cable bracket onto the throttle body.
8. Connect accelerator control cable to throttle plate.



9. Connect all connector at IAC valve and TPS.
10. Install the air intake duct. Refer to *Air Intake Duct Installation Procedure*.
11. Fill the cooling system with required coolant. Refer to *Engine Cooling System*.
12. Connect the negative battery cable.

# ELECTRONIC IGNITION SYSTEM

## IGNITION COIL



### ↔ Removal

1. Disconnect the negative battery cable.
2. Disconnect the all connector from the ignition control module.
3. Remove the three attaching screws.
4. Remove the ignition control module from the engine block.

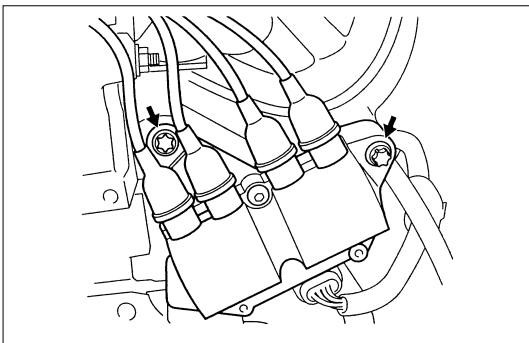
### ↔ Installation

1. Fasten the module to the engine block with three screws.
2. Reconnect the all connector.
3. Reconnect the negative battery terminal

## IGNITION COIL

### ↔ Removal

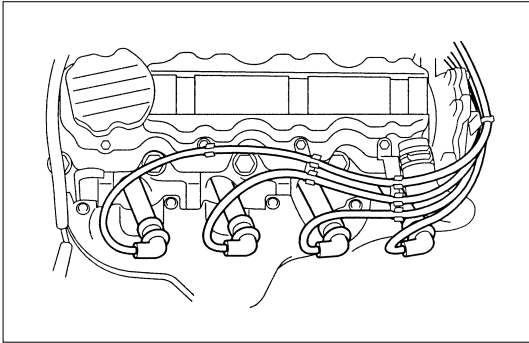
1. Disconnect the negative battery cable.
2. Disconnect all four spark plug cables from the coil.
3. Disconnect al connector from the ignition coil.
4. Remove three mounting bolts from the ignition coil.
5. Remove the ignition coil from the bracket.



### ↔ Installation

1. Install the ignition coil onto the bracket with three mounting bolts.
2. Connect al connector at the ignition coil.
3. Connect spark plug cable to the ignition coil.
4. Connect the negative battery cable.

## SPARK PLUGS



Type: RN9YC4

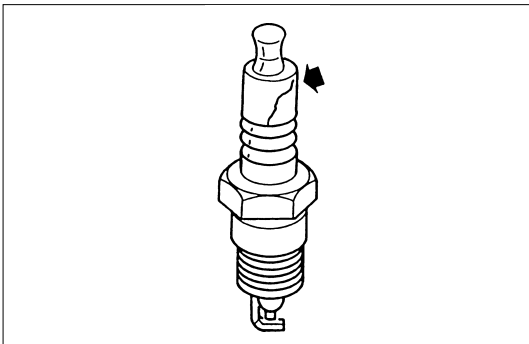
Spark Gap: 1.0-1.1 mm (0.039" - 0.043")

Spark Plug Torque: 25N·m (2.5kgf·m)



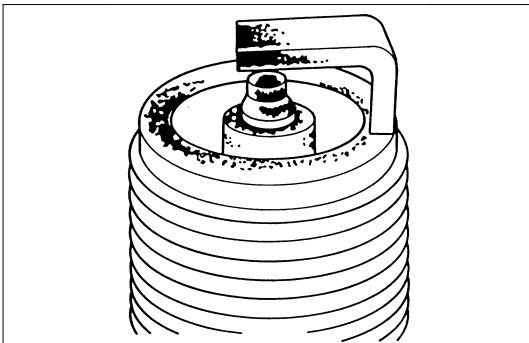
### Removal

1. Disconnect the negative battery cable.
2. Remove the spark plug cable.
3. Remove the spark plug.



### Inspection

1. Check the insulator for cracks. Replace the spark plug if cracks are present.
2. Check the electrode condition and replace the spark plug if necessary.



If the spark plug electrodes and insulators are fouled with carbon or oil, the engine will not operate efficiently.

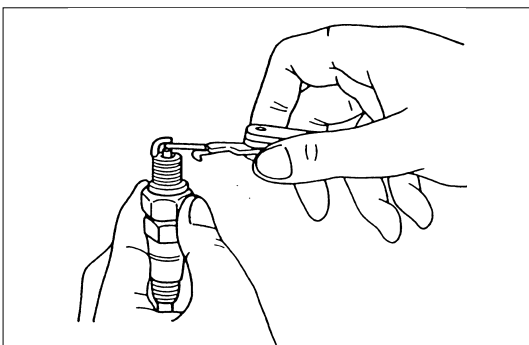
There are a number of possible causes:

- Fuel mixture is too rich.
- Oil in the combustion chamber.
- The spark plug gap is not set correctly.

If spark plug fouling is excessive, check the fuel and ai system for possible causes of trouble. If fuel and ai system are normal, install spark plugs of a higher heat range which have the same physical dimensions as the original equipment spark plugs.

The following symptoms are characteristics of spark plugs that are running too hot:

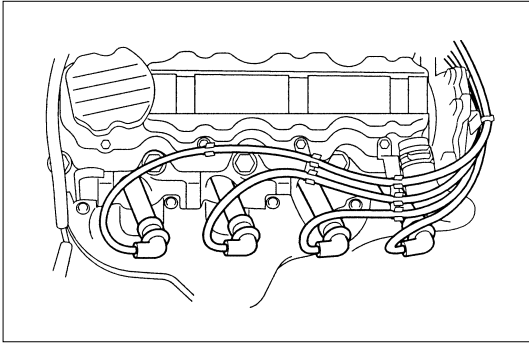
- Fuel mixture is too lean.
- Heat range is incorrect.



If vehicle usage does not conform to normal driving conditions, a more suitable spark plug may be substituted.

If fuel and ai system are normal, in most cases of this sort, the problem can be corrected by using a colder type spark plug with the same physical dimensions as the original equipment spark plug.

3. Check the gaskets for damage and replace if necessary.
4. Measure the spark plug gap. The specification is 1.0 to 1.1mm (0.039 to 0.043").
5. Adjust the spark gap by bending the grounded electrode.



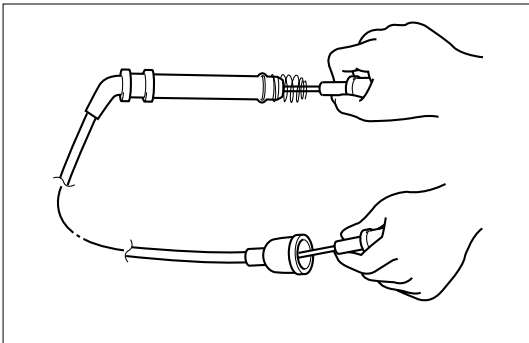
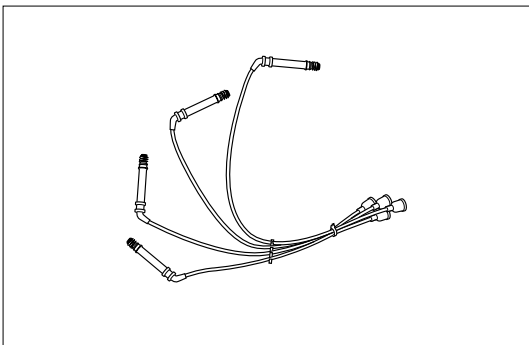
## Installation

1. Tighten the spark plug to the 25N·m (2.5kgf·m).
2. Push the spark plug cable in until it snaps in.

## SPARK PLUG CABLES

The cable contains a synthetic conductor which is easily damaged. Never stretch or kink the cable. Disconnect the cable from spark plug and the ignition coil.

The original equipment cables and the ignition coil are marked to show correct location of the cables. If spark plug cables or the ignition coil are replaced previously, before cables are removed from the ignition coil, mark the cables and the coil so they can be reconnected in the same position.



## Inspection

**Notice:** Never puncture the spark plug cable's insulation with a needle or the pointed end of a probe into the cable. An increase in resistance would be created which would cause the cable to become defective.

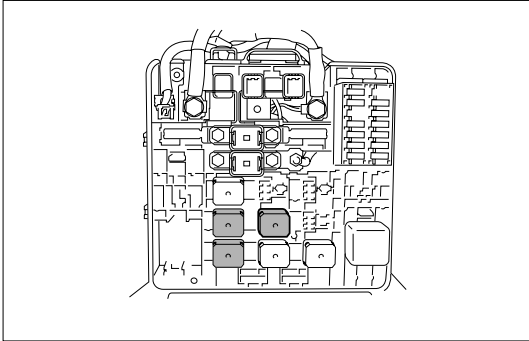
1. If the cable has broken or cracked insulation, it must be replaced.
2. If the terminals are corroded or loose, the cable must be replaced.
3. Check that the cable resistance does not exceed #1 cyl. 4.7 k $\Omega$ , #2 cyl. 3.9 k $\Omega$ , #3 cyl. 3.4k $\Omega$  and #4 cyl. 3.1k $\Omega$ .

# EMISSIONS

## CATALYTIC CONVERTER (IF APPLICABLE)

Refer to *Engine Exhaust*.

## AIR CONDITIONING RELAY



### ↔ Removal

1. Remove the fuse and relay box cover at right side of engine room.
2. Refer to the diagram on the cover to determine which is the correct relay.
3. Insert small screwdriver or use thumb pressure to release the retainer of the relay.
4. Pull the relay straight up and out of the fuse and relay box.

### ↔ Installation

1. Insert the relay into the correct place in the fuse and relay box with the catch slot aligned to retainer.
2. Press down until the catch of retainer engages.
3. Install fuse and relay box cover.

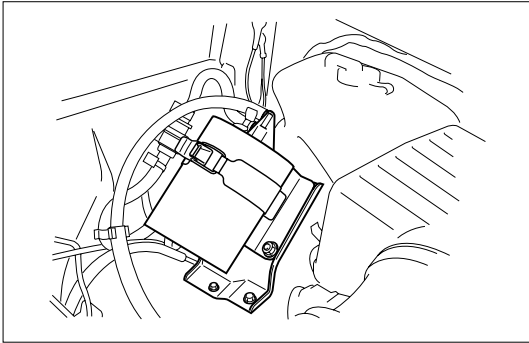
### ⏏ IGNITION TIMING ADJUSTMENT

There is no timing adjustment. The timing signal is furnished by the CKP, ECM control the ignition timing.

## EVAP CANISTER HOSES (IF APPLICABLE)

To see the routing of the EVAP canister hoses, refer to *Emission Control System schematics*.

## EVAP CANISTER (IF APPLICABLE)



### ↔ Removal

1. Disconnect all hoses.
2. Remove EVAP canister.

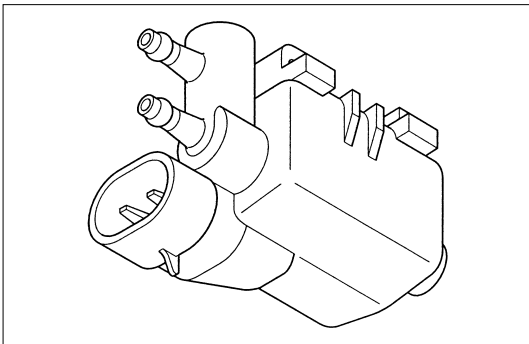
### 👁 Inspection

1. Inspect the hoses for cracks, damage and leaks.
2. Inspect the canister for damages.

### ↔ Installation

1. Install EVAP canister.
2. Connect all hoses and secure them with clamps.

## EVAP CANISTER PURGE VALVE SOLENOID (IF APPLICABLE)



### ↔ Removal

1. Disconnect the negative battery cable.
2. Disconnect all connector from EVAP purge solenoid located on the intake manifold.
3. Disconnect the vacuum hoses from the solenoid.
4. Slide EVAP purge solenoid out from the bracket.

### ↔ Installation

1. Insert EVAP purge solenoid valve onto the bracket.
2. Install the bracket on the intake manifold.
3. Connect vacuum hoses and all connector at the purge valve.



# WIRING AND CONNECTORS

## WIRING HARNESS SERVICE

The control module harness electrically connects the control module to the various solenoids, switches and sensors in the vehicle engine compartment and passenger compartment. Replace wire harnesses with the proper part number replacement.

Because of the low amperage and voltage levels utilized in electric control systems, it is essential that all wiring in environmentally exposed areas be repaired with crimp and seal splice sleeves.

The following wire harness repair information is intended as a general guideline only. Refer to *Chassis Electrical* for all wire harness repair procedures.

## ECM CONNECTORS AND TERMINALS



### Removal

1. Remove the connector terminal retainer.
2. Push the wire connected to the affected terminal through the connector face so that the terminal is exposed.
3. Service the terminal as necessary.



### Installation

1. Bend the tab on the connector to allow the terminal to be pulled into position within the connector.
2. Pull carefully on the wire to install the connector terminal retainer.

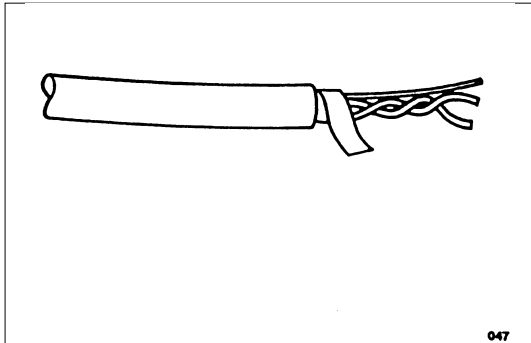
## CONNECTORS AND TERMINALS

Use care when probing a connector and when replacing terminals. It is possible to short between opposite terminals. Damage to components could result. Always use jumper wires between connectors for circuit checking. NEVER probe through Weather-Pack seals. Use an appropriate connector test adapter kit which contains an assortment of flexible connectors used to probe terminals during diagnosis. Use an appropriate fuse remover and test tool for removing a fuse and to adapt the fuse holder to a meter for diagnosis.

Open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor, or in the wiring harness, may temporarily correct the open circuit. Intermittent problems may also be caused by oxidized or loose connections.

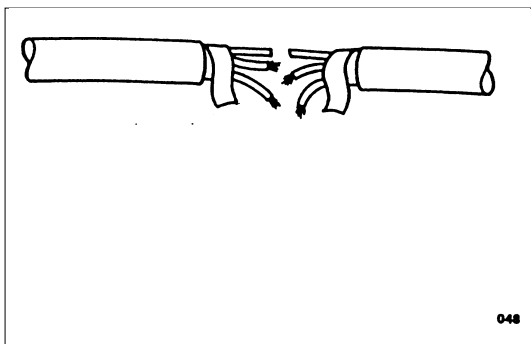
Be certain of the type of connector/terminal before making any connector or terminal repair. Weather-Pack and Com-Pack III terminals look similar, but are serviced differently.

## WIRE HARNESS REPAIR: TWISTED SHIELDED CABLE

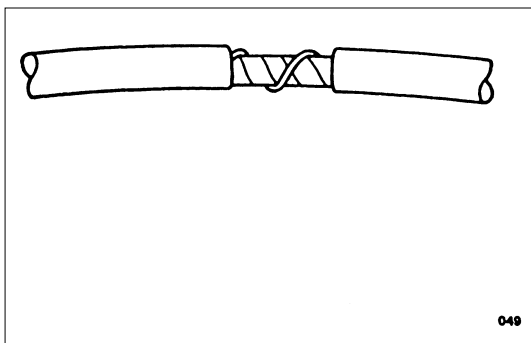


### Removal

1. Remove the outer jacket.
2. Unwrap the aluminum/mylar tape. Do not remove the mylar.

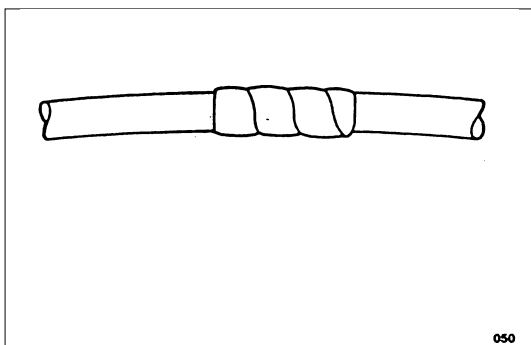


3. Untwist the conductors.
4. Strip the insulation as necessary.



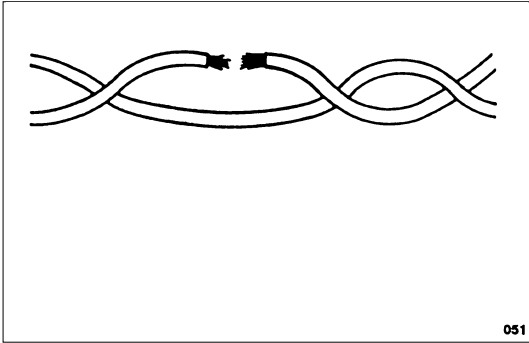
### Installation

1. Splice the wires using splice clips and rosin core solder.
2. Wrap each splice to insulate.
3. Wrap the splice with mylar and with the drain (uninsulated) wire.



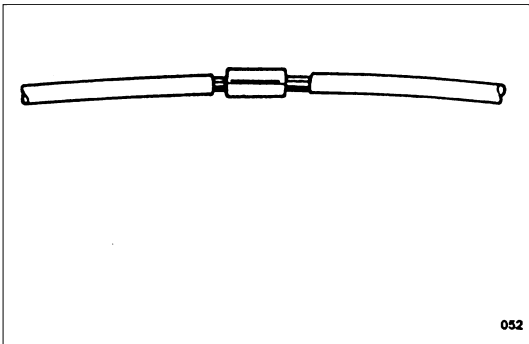
4. Tape over the whole bundle to secure.

## TWISTED LEADS



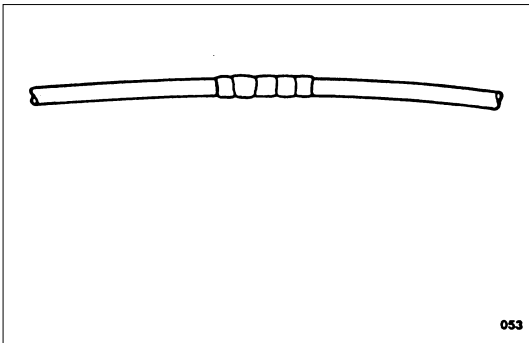
### Removal

1. Locate the damaged wire.
2. Remove the insulation as required.

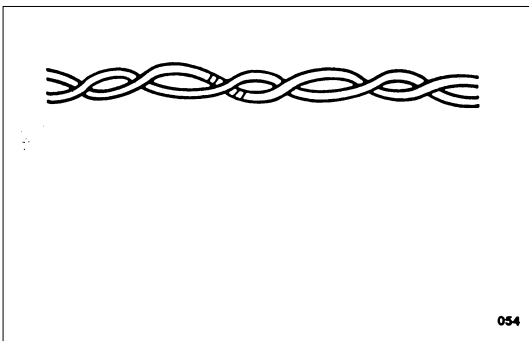


### Installation

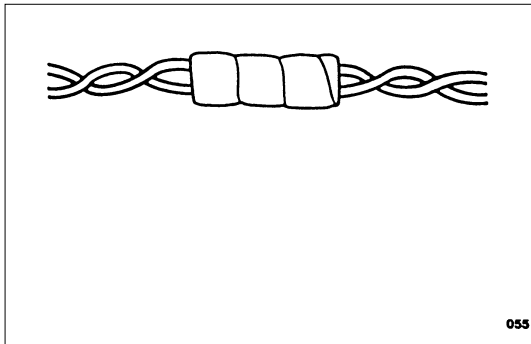
1. Use splice clips and rosin core solder in order to splice the two wires together.



2. Cover the splice with tape in order to insulate it from the other wires.



3. Twist the wires as they were before starting this procedure.

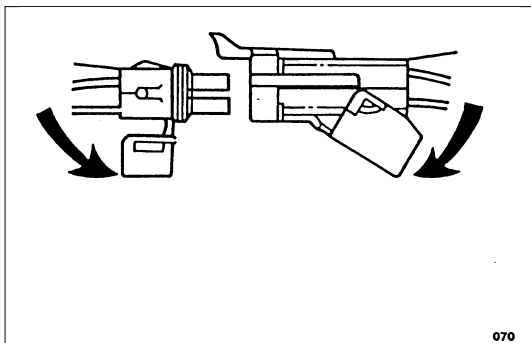


4. Tape the wires with electrical tape.

## WEATHER-PACK CONNECTOR

### Tools Required

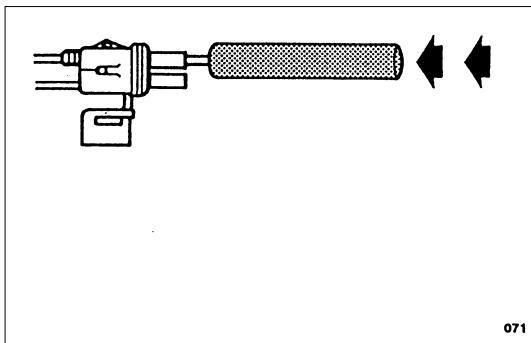
5-8840-0388-0 Weather-Pack II Terminal Remover



### ↔ Removal

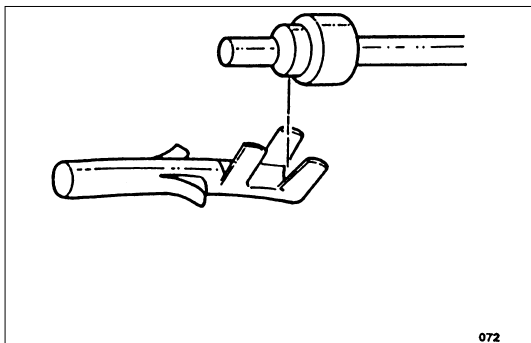
A Weather-Pack connector can be identified by a rubber seal at the rear of the connector. This engine room connector protects against moisture and dirt, which could form oxidation and deposits on the terminals. This protection is important, because of the low voltage and the low amperage found in the electronic systems.

1. Open the secondary lock hinge on the connector.

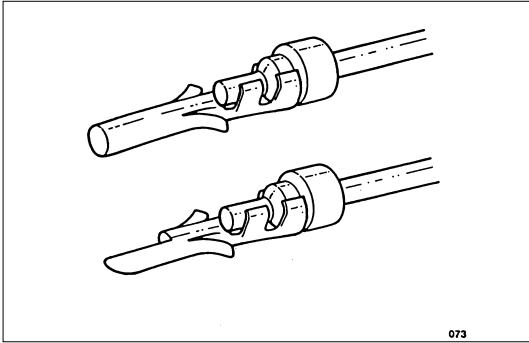


2. Use tool 5-8840-0388-0 or the equivalent to remove the pin and the sleeve terminals. Push on 5-8840-0388-0 to release.

**Notice:** Do not use an ordinary pick or the terminal may be bent or deformed. Unlike standard blade terminals, these terminals cannot be straightened after they have been improperly bent.



3. Cut the wire immediately behind the cable seal.

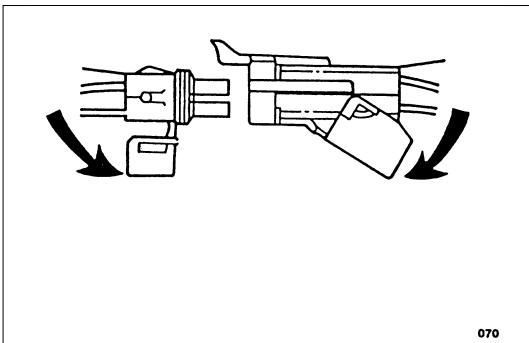


## Installation

Make certain the connectors are properly seated and all of the sealing rings are in place when you reconnect the leads. The secondary lock hinge provides a backup locking feature for the connector. The secondary lock hinge is used for added reliability. This flap should retain the terminals even if the small terminal lock tangs are not positioned properly.

Do not replace the Weather-Pack connections with standard connections. Read the instructions provided with the Weather-Pack connector and terminal packages.

1. Replace the terminal.
2. Slip the new seal onto the wire.
3. Strip 5mm (0.2") of insulation from the wire.
4. Crimp the terminal over the wire and the seal.
5. Push the terminal and the connector to engage the locking tangs.
6. Close the secondary locking hinge.



## COM-PACK III

The Com-Pack III terminal looks similar to some Weather-Pack terminals. This terminal is not sealed and is used where resistance to the environment is not required. Use the standard method when repairing a terminal. Do not use the Weather-Pack terminal tool 5-8840-0388-0 or equivalent. These will damage the terminals.

## METRI-PACK

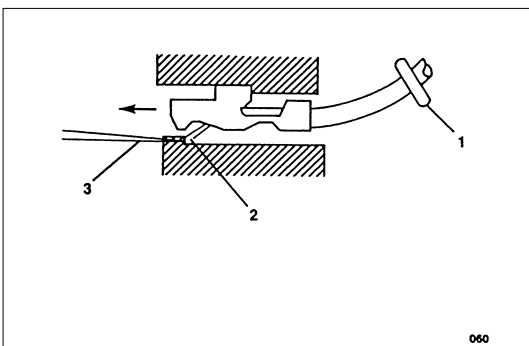
### Tools Required

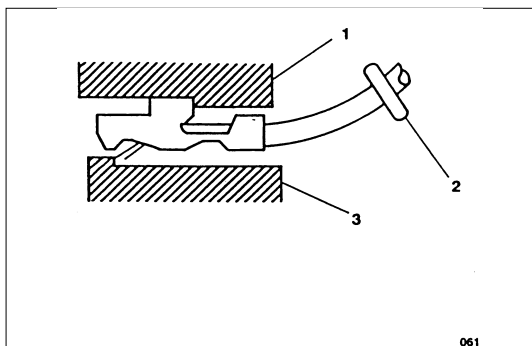
5-8840-0632-0 Terminal Remover

### Removal

Some connectors use terminals called Metri-Pack Series 150. These may be used at the engine coolant temperature (ECT) sensor.

1. Slide the seal (1) back on the wire.
2. Insert the 5-8840-0632-0 tool or equivalent (3) in order to release the terminal locking tang (2).
3. Push the wire and the terminal out through the connector. If you reuse the terminal, reshape the locking tang.





## Installation

Metri-Pack terminals are also referred to as "pull-to-seat" terminals.

1. In order to install a terminal on a wire, the wire must be inserted through the seal (2) and through the connector (3).
2. The terminal (1) is then crimped onto the wire.
3. Then the terminal is pulled back into the connector to seat it in place.

## GENERAL DESCRIPTION

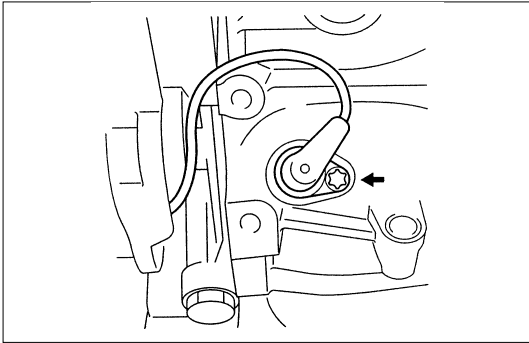
### ECM AND SENSORS

#### 58X REFERENCE ECM INPUT

The engine control module (ECM) uses this signal from the crankshaft position (CKP) sensor to calculate engine RPM and crankshaft position at all engine speeds. The ECM also uses the pulses on this circuit to initiate injector pulses. If the ECM receives a number of pulses other than the expected amount, DTC 19, will set. The engine will not start and run without using the 58X reference signal.

#### A/C REQUEST SIGNAL

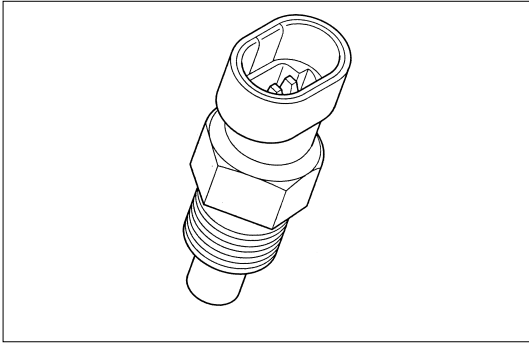
This signal tells the ECM when the A/C mode is selected at the A/C control switch. The ECM uses this signal to adjust the idle speed before turning ON the A/C clutch. The A/C compressor will be inoperative if this signal is not available to the ECM. Refer to *A/C Clutch Circuit Diagnosis* for A/C wiring diagrams and diagnosis for the A/C electrical system.



#### CRANKSHAFT POSITION (CKP) SENSOR

The crankshaft position (CKP) sensor provides a signal used by the engine control module (ECM) to calculate the ignition sequence and ECM uses this signal as a trigger for fuel injection timing and spark timing. The CKP sensor initiates the 58X reference pulses which the ECM uses to calculate RPM and crankshaft position.

Refer to *Electronic Ignition System* for additional information.

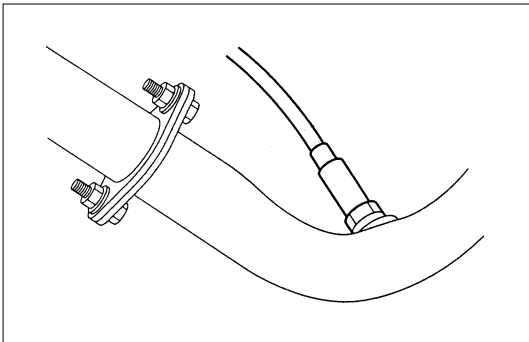


## ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The engine coolant temperature (ECT) sensor is a thermistor (a resistor which changes value based on temperature) mounted in the engine coolant stream. Low coolant temperature produces a high resistance of about 100,000 ohms at  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ). High temperature causes a low resistance of about 70 ohms at  $130^{\circ}\text{C}$  ( $266^{\circ}\text{F}$ ).

The ECM supplies a 5-volt signal to the ECT sensor through resistors internal to the ECM and then measures the voltage after the internal resistor. This signal voltage will be high when the engine is cold and low when the engine is hot. By measuring the voltage, the ECM calculates the engine coolant temperature. Engine coolant temperature affects most of the systems that the ECM controls.

The Scan Tool displays engine coolant temperature in degrees. After engine start-up, the temperature should rise steadily to about  $92^{\circ}\text{C}$  ( $197^{\circ}\text{F}$ ). It then stabilizes when the thermostat opens. If the engine has not been run for several hours (overnight), the engine coolant temperature and intake air temperature displays should be close to each other. A hard fault in the engine coolant sensor circuit will set DTC 14 or 15.



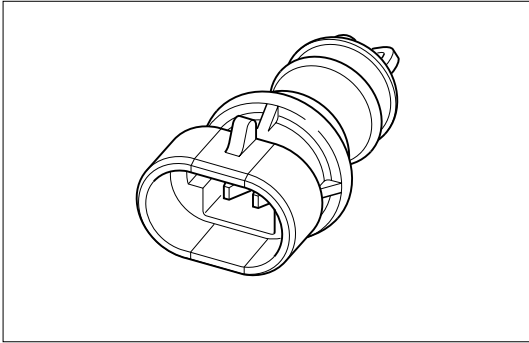
## FUEL CONTROL HEATED OXYGEN SENSOR (IF APPLICABLE)

The fuel control heated oxygen sensor is mounted in the exhaust stream where it can monitor the oxygen content of the exhaust gas. The oxygen present in the exhaust gas reacts with the sensor to produce a voltage output. This voltage should constantly fluctuate from approximately 60mV to 900mV. The heated oxygen sensor voltage can be monitored with a Scan Tool. By monitoring the voltage output of the oxygen sensor, the ECM calculates the pulse width command for the injectors to produce the proper combustion chamber mixture.

- Low HO2S voltage is a lean mixture which will result in a rich command to compensate.
- High HO2S voltage is a rich mixture which will result in a lean command to compensate.

When HO2S is not ready for use as a feedback for fuel control system, Diagnostic Trouble Code 13 will be set and the scan tool will display a voltage between 340mv and 540mv.

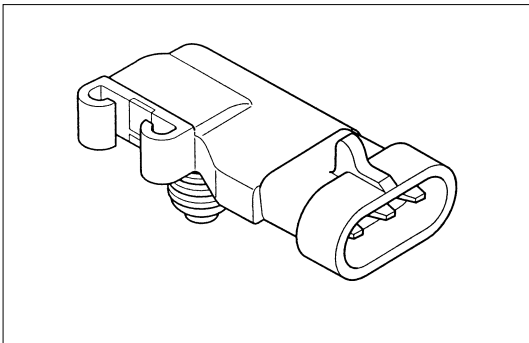




## INTAKE AIR TEMPERATURE (IAT) SENSOR

The intake air temperature (IAT) sensor is a thermistor which changes its resistance based on the temperature of air entering the engine. Low temperature produces a high resistance of about 100,000 ohms at  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ). High temperature causes low resistance of about 70 ohms at  $130^{\circ}\text{C}$  ( $266^{\circ}\text{F}$ ). The ECM supplies a 5-volt signal to the sensor through a resistor internal to the ECM, and then monitors the signal voltage. The voltage will be high when the incoming air is cold. The voltage will be low when the incoming air is hot. By measuring the voltage, the ECM calculates the incoming air temperature. The IAT sensor signal is used to adjust spark timing according to the incoming air density.

The Scan Tool displays the temperature of the air entering the engine. The temperature should read close to the ambient air temperature when the engine is cold and rise as underhood temperature increases. If the engine has not been run for several hours (overnight), the IAT sensor temperature and engine coolant temperature should read close to each other. A failure in the IAT sensor circuit will set DTC 69 or DTC 71.



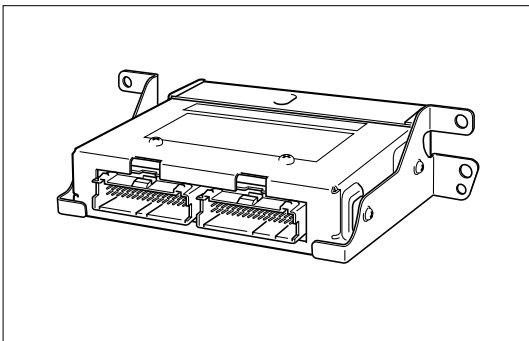
## MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The MAP sensor responds to changes in intake manifold pressure (vacuum). The MAP sensor signal voltage to the ECM varies from below 2 volts at idle (high vacuum) to above 4 volts with the ignition ON, engine not running or at wide-open throttle (low vacuum).

The MAP sensor is used to determine the following.

- Engine vacuum level for other diagnostics.
- Barometric pressure (BARO).

If the ECM detects a voltage that is lower than the possible range of the MAP sensor, DTC 34 will be set. A signal voltage higher than the possible range of the sensor will DTC 33.



## ENGINE CONTROL MODULE (ECM)

The engine control module (ECM) is located in the passenger compartment at the Instrument panel lower center cover assembly. The ECM controls the following:

- Fuel metering system.
- Ignition timing.
- On-board diagnostics for electrical functions.

The ECM constantly observes the information from various sensors. The ECM controls the systems that affect vehicle performance. The ECM performs the diagnostic function of the system. It can recognize operational problems, alert the driver through the Check Engine lamp, and store diagnostic trouble codes (DTCs). DTCs identify the problem areas to aid the technician in making repairs.

## ECM FUNCTION

The ECM supplies either 5 or 12 volts to power various sensors or switches. The power is supplied through resistors in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, a digital voltmeter with at least 10 megohms input impedance is required to ensure accurate voltage readings. Tool 5-8840-2392-0 meets this requirement. The ECM controls output circuits such as the injectors, IAC, etc., by controlling the ground or the power feed circuit through transistors or through either of the following two devices:

- Output Driver Module (ODM)
- Quad Driver Module (QDM)

## ECM COMPONENTS

The ECM is designed to maintain exhaust emission levels to government mandated standards while providing excellent driveability and fuel efficiency. The ECM monitors numerous engine and vehicle functions via electronic sensors such as the throttle position sensor (TPS), heated oxygen sensor (HO2S) if applicable, and vehicle speed sensor (VSS). The ECM also controls certain engine operations through the following:

- Fuel injector control
- Ignition control module
- Evaporative emission (EVAP) purge
- A/C clutch control

## ECM VOLTAGE DESCRIPTION

The ECM supplies a buffered voltage to various switches and sensors. It can do this because resistors in the ECM which are so high in value that a test light may not illuminate when connected to the circuit. An ordinary shop voltmeter may not give an accurate reading because the voltmeter input impedance is too low. Use a 10-megohm input impedance digital voltmeter (such as 5-8840-2392-0) to assure accurate voltage readings.

The input/output devices in the ECM include analog-to-digital converters, signal buffers, counters, and special drivers. The ECM controls most components with electronic switches which complete a ground circuit when turned "ON." These switches are arranged in groups of 4, called a quad driver module (QDM), which can independently control up to 4 output.

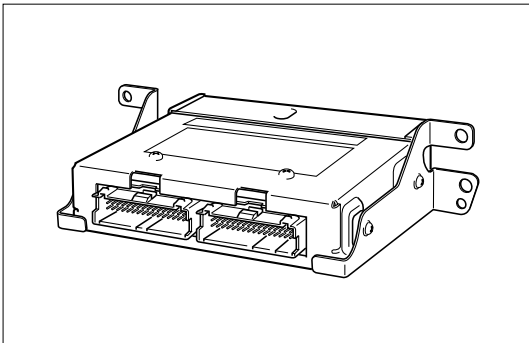
## ECM INPUTS/OUTPUTS

### Inputs - Operating Conditions Read

- Air Conditioning Compressor Clutch ON or OFF
- Engine Coolant Temperature
- Crankshaft Position
- Exhaust Oxygen Content (If equipped)
- Manifold Absolute Pressure
- Battery Voltage
- Throttle Position
- Knock
- Vehicle Speed
- Fuel Pump Voltage
- Power Steering Pressure
- Intake Air Temperature

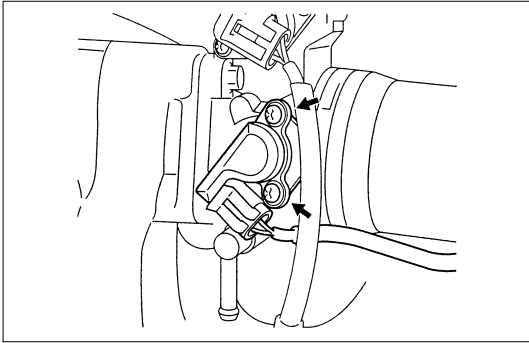
### Outputs - Systems Controlled

- EVAP Canister Purge Control Solenoid Valve
- Ignition Control
- Fuel Injector Control
- Idle Air Control
- Electric Fuel Pump Relay
- Air Conditioning Compressor Clutch Relay
- Diagnostics
  - OBD Malfunction Indicator Lamp (Check Engine lamp)
  - Data Link Connector (DLC)
  - Data Output
- Tachometer Signal



## ECM SERVICE PRECAUTIONS

The ECM is designed to withstand normal current draws associated with vehicle operation. Avoid overloading any circuit. When testing for opens and shorts, do not ground or apply voltage to any of the ECM's circuits unless instructed to do so. These circuits should only be tested using digital voltmeter 5-8840-2392-0. The ECM should remain connected to the ECM or to a recommended breakout box.

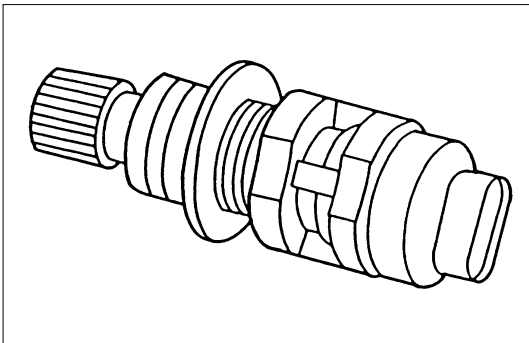


## THROTTLE POSITION SENSOR (TPS)

The throttle position sensor (TPS) is a potentiometer connected to the throttle shaft on the throttle body. The ECM monitors the voltage on the signal line and calculates throttle position. As the throttle valve angle is changed (accelerator pedal moved), the TPS signal also changes. At a closed throttle position, the output of the TPS is about 0.25 Volts. As the throttle valve opens, the output increases so that at wide open throttle (WOT), the output voltage should be about 4.75 volts.

The ECM calculates fuel delivery based on throttle valve angle and manifold pressure for fuel delivery under the most circumstances. A broken or loose TPS may cause intermittent bursts of fuel from an injector and unstable idle because the ECM thinks the throttle is moving. A hard failure in the TPS 5-volt reference or signal circuits will set either a DTC21 or 22. If ECM detects a low impedance short to ground in the TPS circuit, Diagnostic Trouble code 22 will be set.

If ECM detects a low impedance short to battery in the TPS circuit, Diagnostic Trouble Code 21 will be set.



## VEHICLE SPEED SENSOR (VSS)

The ECM determines the speed of the vehicle by converting a pulsing voltage signal from the vehicle speed sensor (VSS) into km per hour. The ECM uses this signal to operate the speedometer.

## USE OF CIRCUIT TESTING TOOLS

Do not use a test light to diagnose the electric electrical system unless specifically instructed by the diagnostic procedures. Use Connector Test Adapter Kit 5-8840-0385-0 whenever diagnostic procedures call for probing connectors.

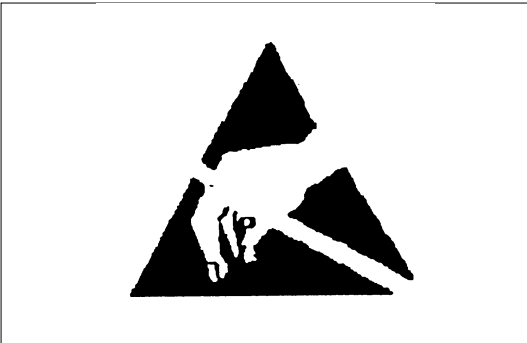
## AFTERMARKET ELECTRICAL AND VACUUM EQUIPMENT

Aftermarket (add-on) electrical and vacuum equipment is defined as any equipment which connects to the vehicle's electrical or vacuum systems that is installed on a vehicle after it leaves the factory. No allowances have been made in the vehicle design for this type of equipment.

**Notice:** No add-on vacuum equipment should be added to this vehicle.

**Notice:** Add-on electrical equipment must only be connected to the vehicle's electrical system at the battery (power and ground).

Add-on electrical equipment, even when installed to these guidelines, may still cause the electric system to malfunction. This may also include equipment not connected to the vehicle electrical system such as portable telephones and radios. Therefore, the first step in diagnosing any electric problem is to eliminate all aftermarket electrical equipment from the vehicle. After this is done, if the problem still exists, it may be diagnosed in the normal manner.



## ELECTROSTATIC DISCHARGE DAMAGE

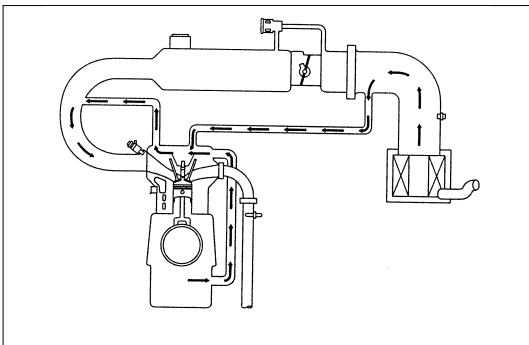
Electronic components used in the ECM are often designed to carry very low voltage. Electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 volts of static electricity can cause damage to some electronic components. By comparison, it takes as much as 4000 volts for a person to feel even the zap of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and induction.

- An example of charging by friction is a person sliding across a vehicle seat.
- Charge by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off leaving the person highly charged with the opposite polarity. Static charges can cause damage, therefore it is important to use care when handling and testing electronic components.

**Notice:** To prevent possible electrostatic discharge damage, follow these guidelines:

- Do not touch the ECM connector pins or soldered components on the ECM circuit board.
- Do not touch any electronic module component leads.
- Do not open the replacement part package until the part is ready to be installed.
- Before removing the part from the package, ground the package to a known good ground on the vehicle.
- If the part has been handled while sliding across the seat, while sitting down from a standing position, or while walking a distance, touch a known good ground before installing the part.



## AIR INDUCTION

### AIR INDUCTION SYSTEM

The air induction system filters contaminants from the outside air, and directs the progress of the air as it is drawn into the engine. A remote-mounted air cleaner prevents dirt and debris in the air from entering the engine. The air duct assembly routes filtered air to the throttle body. Air enters the engine by the following steps:

1. Through the throttle body.
2. Into the intake manifold.
3. Through the cylinder head intake ports.
4. Into the cylinders.

## FUEL METERING

### ACCELERATION MODE

The ECM provides extra fuel when it detects a rapid increase in the throttle position and the air flow.

### ACCELERATOR CONTROLS

the accelerator control system is a cable-type system with specific linkage adjustments.  
Refer to *Cable Adjustment*.

## BATTERY VOLTAGE CORRECTION MODE

When battery voltage is low, the ECM will compensate for the weak spark by increasing the following:

- The amount of fuel delivered.
- The idle RPM.

## CLEAR FLOOD MODE

Clear a flooded engine by pushing the accelerator pedal down all the way. The ECM then de-energizes the fuel injectors. The ECM holds the fuel injectors de-energized as long as the throttle remains above 75% and the engine speed is below 800 RPM. If the throttle position becomes less than 75%, the ECM again begins to pulse the injectors ON and OFF, allowing fuel into the cylinders.

## DECELERATION FUEL CUTOFF (DFCO) MODE

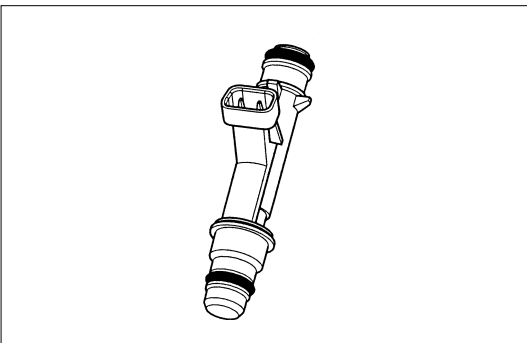
The ECM reduces the amount of fuel injected when it detects a decrease in the throttle position and the air flow. When deceleration is very fast, the ECM may cut off fuel completely. Until enable conditions meet the engine revolution less 1000 rpm or manifold absolute pressure less than 10 kpa.

## ENGINE SPEED/VEHICLE SPEED/ FUEL DISABLE MODE

The ECM monitors engine speed. It turns off the fuel injectors when the engine speed increases above 6000 RPM. The fuel injectors are turned back on when engine speed decreases below 3500 RPM.

## FUEL CUTOFF MODE

No fuel is delivered by the fuel injectors when the ignition is OFF. This prevents engine run-on. In addition, the ECM suspends fuel delivery if no reference pulses are detected (engine not running) to prevent engine flooding.



## FUEL INJECTOR

The group fuel injection fuel injector is a solenoid-operated device controlled by the ECM. The ECM energizes the solenoid, which opens a valve to allow fuel delivery. The fuel is injected under pressure in a conical spray pattern at the opening of the intake valve. Excess fuel not used by the injectors passes through the fuel pressure regulator before being returned to the fuel tank.

A fuel injector which is stuck partly open will cause a loss of fuel pressure after engine shut down, causing long crank times.

## FUEL METERING SYSTEM COMPONENTS

The fuel metering system is made up of the following parts:

- The fuel injectors.
- The throttle body.
- The fuel rail.
- The fuel pressure regulator.
- The ECM.
- The crankshaft position (CKP) sensor.
- The idle air control (IAC) valve.
- The fuel pump.
- The fuel pump relay.

### Basic System Operation

The fuel metering system starts with the fuel in the fuel tank. An electric fuel pump, located in the fuel tank, pumps fuel to the fuel rail through an in-line fuel filter. The pump is designed to provide fuel at a pressure above the pressure needed by the injectors. A fuel pressure regulator in the fuel rail keeps fuel available to the fuel injectors at a constant pressure. A return line delivers unused fuel back to the fuel tank. Refer to *Section 6C* for further information on the fuel tank, line filter, and fuel pipes.

## FUEL METERING SYSTEM PURPOSE

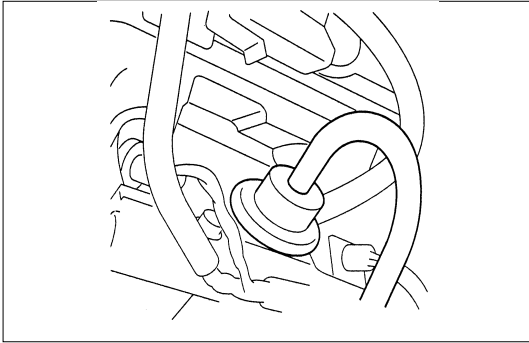
The basic function of the air/fuel metering system is to control the air/fuel delivery to the engine. Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each intake valve.

### Following are applicable to the vehicle with closed Loop System:

The ECM monitors signals from several sensors in order to determine the fuel needs of the engine. Fuel is delivered under one of several conditions called "modes." All modes are controlled by the ECM.

The main control sensor is the heated oxygen sensor (HO2S) located in the exhaust system. The HO2S tells the ECM how much oxygen is in the exhaust gas. The ECM changes the air/fuel ratio to the engine by controlling the amount of time that the fuel injector is ON. The best mixture to minimize exhaust emissions is 14.7 parts of air to 1 part of gasoline by weight, which allows the catalytic converter to operate most efficiently. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "closed loop" system.





## FUEL PRESSURE REGULATOR

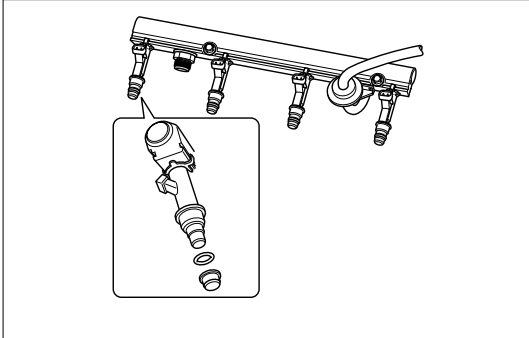
The fuel pressure regulator is a diaphragm-operated relief valve mounted on the fuel rail with fuel pump pressure on one side and manifold pressure on the other side. The fuel pressure regulator maintains the fuel pressure available to the injector at three times barometric pressure adjusted for engine load. It may be serviced separately.

If the pressure is too low, poor performance and a DTC 44, will be the result. If the pressure is too high, a DTC 45 will be the result. Refer to *Fuel System Diagnosis* for information on diagnosing fuel pressure conditions.

## FUEL PUMP ELECTRICAL CIRCUIT

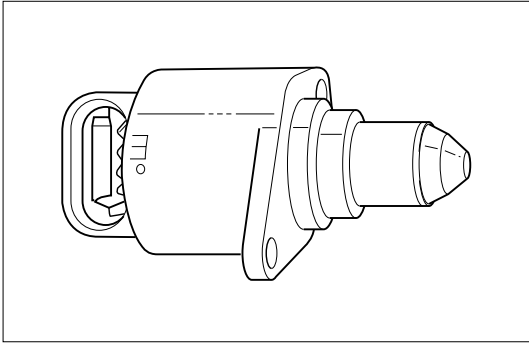
When the key is first turned ON, the ECM energizes the fuel pump relay for two seconds to build up the fuel pressure quickly. If the engine is not started within two seconds, the ECM shuts the fuel pump off and waits until the engine is cranked. When the engine is cranked and the 58X crankshaft position signal has been detected by the ECM, the ECM supplies 12 volts to the fuel pump relay to energize the electric in-tank fuel pump.

An inoperative fuel pump will cause a "no-start" condition. A fuel pump which does not provide enough pressure will result in poor performance.



## FUEL RAIL

The fuel rail is mounted to the top of the engine and distributes fuel to the individual injectors. Fuel is delivered to the fuel inlet tube of the fuel rail by the fuel lines. The fuel goes through the fuel rail to the fuel pressure regulator. The fuel pressure regulator maintains a constant fuel pressure at the injectors. Remaining fuel is then returned to the fuel tank.



## IDLE AIR CONTROL (IAC) VALVE

The purpose of the idle air control (IAC) valve is to control engine idle speed, while preventing stalls due to changes in engine load. The IAC valve, mounted in the throttle body, controls bypass air around the throttle plate. By moving the conical valve (pintle) in (to decrease air flow) or out (to increase air flow), a controlled amount of air can move around the throttle plate. If the RPM is too low, the ECM will retract the IAC pintle, resulting in more air moving past the throttle plate to increase the RPM. If the RPM is too high, the ECM will extend the IAC pintle, allowing less air to move past the throttle plate, decreasing the RPM.

The IAC pintle valve moves in small steps called counts. During idle, the proper position of the IAC pintle is calculated by the ECM based on battery voltage, coolant temperature, engine load, and engine RPM. If the RPM drops below a specified value, and the throttle plate is closed, the ECM senses a near-stall condition. The ECM will then calculate a new IAC pintle valve position to prevent stalls.

If the IAC valve is disconnected and reconnected with the engine running, the idle RPM will be wrong. In this case, the IAC must be reset. The IAC resets when the key is cycled on ON then OFF. When servicing the IAC, it should only be disconnected or connected with the ignition OFF.

The position of the IAC pintle valve affects engine start-up and the idle characteristics of the vehicle. When the ECM detects the 175 rpm higher engine revolution than desires engine rpm, this malfunction detects an error in the IAC control logic. Diagnostic Trouble code 35 will be set.

## RUN MODE (APPLICABLE TO CLOSED LOOP SYSTEMS)

The run mode has the following two conditions:

- Open loop
- Closed loop

When the engine is first started, the system is in "open loop" operation. In "Open Loop," the ECM ignores the signal from the heated oxygen sensor (HO2S). It calculates the air/fuel ratio based on inputs from the TP, ECT, and MAP sensors. The system remains in "Open Loop" until the following conditions are met:

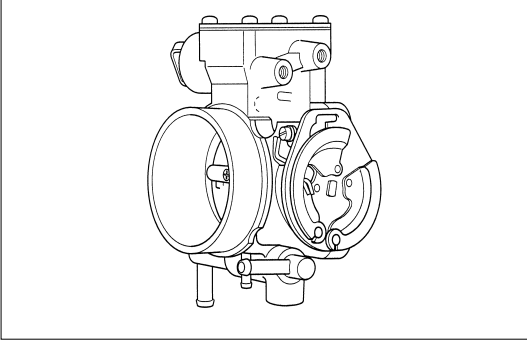
- The HO2S has a varying voltage output showing that it is hot enough to operate properly (this depends on temperature).
- The ECT has reached a specified temperature.
- A specific amount of time has elapsed since starting the engine.
- Engine speed has been greater than a specified RPM since start-up.

The specific values for the above conditions vary with different engines and are stored in the programmable read only memory (PROM). When these conditions are met, the system enters "closed loop" operation. In "closed loop," the ECM calculates the air/fuel ratio (injector on-time) based on the signal from the HO2S. This allows the air/fuel ratio to stay very close to 14.7:1.

## STARTING MODE

When the ignition is first turned ON, the ECM energizes the fuel pump relay for two seconds to allow the fuel pump to build up pressure. The ECM then checks the engine coolant temperature (ECT) sensor and the throttle position (TP) sensor to determine the proper air/fuel ratio for starting.

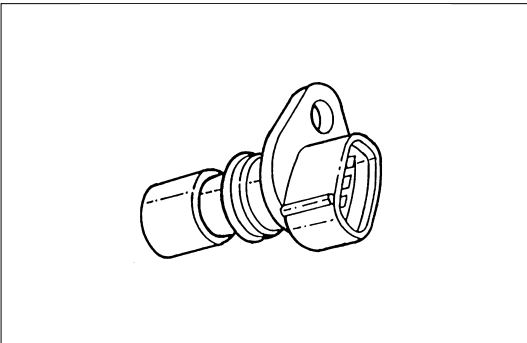
The ECM controls the amount of fuel delivered in the starting mode by adjusting how long the fuel injectors are energized by pulsing the injectors for very short times.



## THROTTLE BODY UNIT

The throttle body has a throttle plate to control the amount of air delivered to the engine. The TP sensor and IAC valve are also mounted on the throttle body.

Vacuum ports located behind the throttle plate provide the vacuum signals needed by various components. Engine coolant is directed through a coolant cavity in the throttle body to warm the throttle valve and to prevent icing.



## ELECTRONIC IGNITION SYSTEM

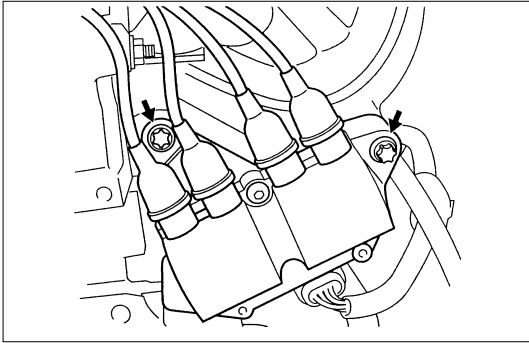
### CRANKSHAFT POSITION (CKP) SENSOR

The crankshaft position (CKP) sensor provides a signal used by the engine control module (ECM) to calculate the ignition sequence. The sensor initiates the 58X reference pulses which the ECM uses to calculate RPM and crankshaft position. Refer to *Electronic Ignition System* for additional information.

## ELECTRONIC IGNITION

The electronic ignition system controls fuel combustion by providing a spark to ignite the compressed air/fuel mixture at the correct time. To provide optimum engine performance, fuel economy, and control of exhaust emissions, the ECM controls the spark advance of the ignition system. Electronic ignition has the following advantages over a mechanical distributor system:

- No moving parts.
- Less maintenance.
- Remote mounting capability.
- No mechanical load on the engine.
- More coil cool down time between firing events.
- Elimination of mechanical timing adjustments.
- Increased available ignition coil saturation time.



## IGNITION COILS

The all engines use 2 ignition coils, 1 per 2 cylinders. A two-wire connector provides a 12-volt primary supply through the 15-amp ignition coil fuse.

## IGNITION CONTROL

The ignition control (IC) spark timing is the ECM's method of controlling the spark advance and the ignition dwell. The IC spark advance and the ignition dwell are calculated by the ECM using the following inputs:

- Engine speed.
- Crankshaft position (58X reference).
- Engine coolant temperature (ECT) sensor.
- Throttle position (TP) sensor.
- Vehicle speed (vehicle speed sensor).
- ECM and ignition system supply voltage.

## IGNITION CONTROL ECM OUTPUT

Ignition Coil works to generate only the secondary voltage be receiving the primary voltage from ECM.

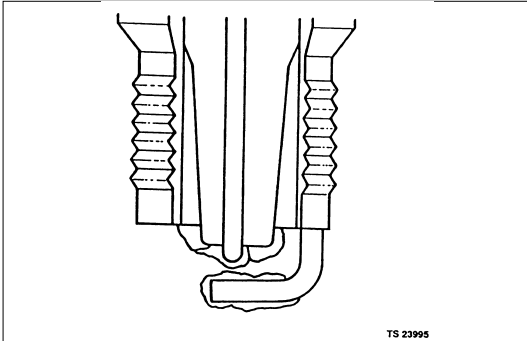
The primary voltage is generated at the coil driver located in the ECM. The coil driver generate the primary voltage based on the X58 signal. In accordance with the X58 signal, ignition coil driver determines the adequate ignition timing and also cylinder number to ignite.

Ignition timing is determined the Coolant Temp., Intake Air Temp., Engine Speed, Engine Load, knock Sensor Signal, etc.

## ENGINE CONTROL MODULE (ECM)

The ECM is responsible for maintaining proper spark and fuel injection timing for all driving conditions. To provide optimum driveability and emissions, the ECM monitors the input signals from the following components in order to calculate spark timing:

- Engine coolant temperature (ECT) sensor.
- Intake air temperature (IAT) sensor.
- Throttle position sensor (TPS).
- Vehicle speed sensor (VSS).
- Crankshaft position (CKP) sensor.



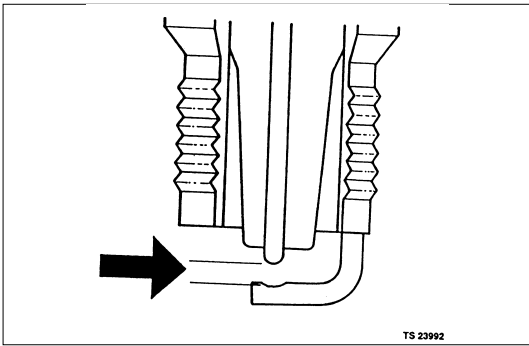
## SPARK PLUG

Although worn or dirty spark plugs may give satisfactory operation at idling speed, they frequently fail at higher engine speeds. Faulty spark plugs may cause poor fuel economy, power loss, loss of speed, hard starting and generally poor engine performance. Follow the scheduled maintenance service recommendations to ensure satisfactory spark plug performance. Refer to *Maintenance and Lubrication*.

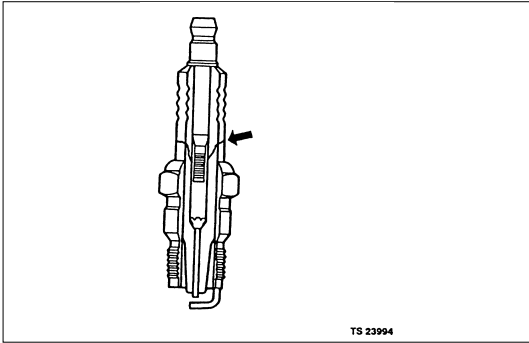
Normal spark plug operation will result in brown to grayish-tan deposits appearing on the insulator portion of the spark plug. A small amount of red-brown, yellow, and white powdery material may also be present on the insulator tip around the center electrode. These deposits are normal combustion by-products of fuels and lubricating oils with additives. Some electrode wear will also occur. Engines which are not running properly are often referred to as "misfiring." This means the ignition spark is not igniting the air/fuel mixture at the proper time. While other ignition and fuel system causes must also be considered, possible causes include ignition system conditions which allow the spark voltage to reach ground in some other manner than by jumping across the air gap at the tip of the spark plug, leaving the air/fuel mixture unburned. Misfiring may also occur when the tip of the spark plug becomes overheated and ignites the mixture before the spark jumps. This is referred to as "pre-ignition."

Spark plugs may also misfire due to fouling, excessive gap, or a cracked or broken insulator. If misfiring occurs before the recommended replacement interval, locate and correct the cause.

Carbon fouling of the spark plug is indicated by dry, black carbon (soot) deposits on the portion of the spark plug in the cylinder. Excessive idling and slow speeds under light engine loads can keep the spark plug temperatures so low that these deposits are not burned off. Very rich fuel mixtures or poor ignition system output may also be the cause. Refer to *DTC 45*. Oil fouling of the spark plug is indicated by wet oily deposits on the portion of the spark plug in the cylinder, usually with little electrode wear. This may be caused by oil during break-in of new or newly overhauled engines. Deposit fouling of the spark plug occurs when the normal red-brown, yellow or white deposits of combustion by-products become sufficient to cause misfiring. In some cases, these deposits may melt and form a shiny glaze on the insulator around the center electrode. If the fouling is found in only one or two cylinders, valve stem clearances or intake valve seals may be allowing excess lubricating oil to enter the cylinder, particularly if the deposits are heavier on the side of the spark plug facing the intake valve.

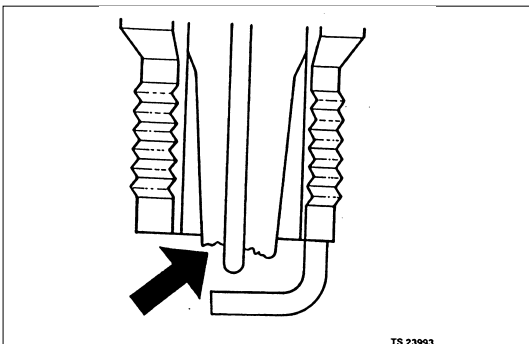


Excessive gap means that the air space between the center and the side electrodes at the bottom of the spark plug is too wide for consistent firing. This may be due to improper gap adjustment or to excessive wear of the electrode during use. A check of the gap size and comparison to the gap specified for the vehicle in Maintenance and Lubrication will tell if the gap is too wide. A spark plug gap that is too small may cause an unstable idle condition. Excessive gap wear can be an indication of continuous operation at high speeds or with engine loads, causing the spark to run too hot. Another possible cause is an excessively lean fuel mixture.



Low or high spark plug installation torque or improper seating can result in the spark plug running too hot and can cause excessive center electrode wear. The plug and the cylinder head seats must be in good contact for proper heat transfer and spark plug cooling. Dirty or damaged threads in the head or on the spark plug can keep it from seating even though the proper torque is applied. Once spark plugs are properly seated, tighten them to the torque shown in the Specifications Table. Low torque may result in poor contact of the seats due to a loose spark plug. Over tightening may cause the spark plug shell to be stretched and will result in poor contact between the seats. In extreme cases, exhaust blow-by and damage beyond simple gap wear may occur.

Cracked or broken insulators may be the result of improper installation, damage during spark plug re-gapping, or heat shock to the insulator material. Upper insulators can be broken when a poorly fitting tool is used during installation or removal, when the spark plug is hit from the outside, or is dropped on a hard surface. Cracks in the upper insulator may be inside the shell and not visible. Also, the breakage may not cause problems until oil or moisture penetrates the crack later.



A broken or cracked lower insulator tip (around the center electrode) may result from damage during re-gapping or from "heat shock" (spark plug suddenly operating too hot).

- Damage during re-gapping can happen if the gapping tool is pushed against the center electrode or the insulator around it, causing the insulator to crack. When re-gapping a spark plug, make the adjustment by bending only the ground side terminal, keeping the tool clear of other parts.
- "Heat shock" breakage in the lower insulator tip generally occurs during several engine operating conditions (high speeds or heavy loading) and may be caused by over-advanced timing or low grade fuels. Heat shock refers to a rapid increase in the tip temperature that causes the insulator material to crack.

Spark plugs with less than the recommended amount of service can sometimes be cleaned and re-gapped, then returned to service. However, if there is any doubt about the serviceability of a spark plug, replace it. Spark plugs with cracked or broken insulators should always be replaced.

## A/C CLUTCH DIAGNOSIS

### A/C CLUTCH CIRCUIT OPERATION

A 12-volt signal is supplied to the A/C request input of the ECM when the A/C is selected through the A/C control switch. The A/C compressor clutch relay is controlled through the ECM. This allows the ECM to modify the idle air control position prior to the A/C clutch engagement for better idle quality. If the engine operating conditions are within their specified calibrated acceptable ranges, the ECM will enable the A/C compressor relay. This is done by providing a ground path for the A/C relay coil within the ECM. When the A/C compressor relay is enabled, battery voltage is supplied to the compressor relay is enabled, battery voltage is supplied to the compressor clutch coil.

The ECM will enable the A/C compressor clutch whenever the engine is running and the A/C has been requested. The ECM will not enable the A/C compressor clutch if any of the following conditions are met:

- The engine speed is greater than 6000 RPM.
- The ECT is greater than 122°C (251°F).
- The throttle is more than 95% open.

### A/C CLUTCH CIRCUIT PURPOSE

The A/C compressor operation is controlled by the engine control module (ECM) for the following reasons:

- It improves idle quality during compressor clutch engagement.
- It improves wide open throttle (WOT) performance.
- It provides A/C compressor protection from operation with incorrect refrigerant pressures.

The A/C electrical system consists of the following components:

- The A/C control switch.
- The A/C refrigerant pressure switches.
- The A/C compressor clutch.
- The A/C compressor clutch relay.
- The ECM.

### A/C REQUEST SIGNAL

This signal tells the ECM when the A/C mode is selected at the A/C control switch. The ECM uses this input to adjust the idle speed before turning on the A/C clutch. The A/C compressor will be inoperative if this signal is not available to the ECM. Refer to *A/C Clutch Circuit Diagnosis* for A/C wiring diagrams and diagnosis for the A/C electrical system.

## EVAPORATIVE EMISSION (EVAP) SYSTEM (IF APPLICABLE)

### EVAP EMISSION CONTROL SYSTEM PURPOSE

The basic evaporative emission (EVAP) control system used on all vehicles is the charcoal canister storage method. Gasoline vapors from the fuel tank flow into the canister through the inlet labeled "TANK." These vapors are absorbed into the activated carbon (charcoal) storage device (canister) in order to hold the vapors when the vehicle is not operating. The canister is purged by ECM control when the engine coolant temperature is over 60°C (140°F), the IAT reading is over 10°C (50°F), and the engine has been running. Air is drawn into canister through the air inlet grid. The air mixes with the vapor and the mixture is drawn into the intake manifold.

### EVAP EMISSION CONTROL SYSTEM OPERATION

The EVAP canister purge is controlled by a solenoid valve that allows the manifold vacuum to purge the canister. The engine control module (ECM) supplies a ground to energize the solenoid valve (purge on). The EVAP purge solenoid control is pulse-width modulated (PWM) (turned on and off several times a second). The duty cycle (pulse width) is determined by engine operating conditions including load, throttle position, coolant temperature and ambient temperature. The duty cycle is calculated by the ECM. The output is commanded when the appropriate conditions have been met. These conditions are:

- The engine is fully warmed up.
- The engine has been running for a specified time.
- The IAT reading is above 10°C (50°F).
- A continuous purge condition with no purge commanded by the ECM will set a DTC 62.
- Purge/Vacuum Hoses. Made of rubber compounds, these hoses route the gasoline fumes from their sources to the canister and from the canister to the intake air flow.
- EVAP Canister. Mounted on a bracket ahead of the fuel tank, the canister stores fuel vapors until the ECM determined that engine conditions are right for them to be removed and burned.

Poor idle, stalling and Poor driveability can be caused by:

- A malfunctioning purge solenoid.
- A damaged canister.
- Hoses that are split, cracked, or not connected properly.



## SYSTEM FAULT DETECTION

The EVAP leak detection strategy is based on applying vacuum to the EVAP system and monitoring vacuum decay. At an appropriate time, the EVAP purge solenoid is turned "ON," allowing the engine vacuum to draw a small vacuum on the entire evaporative emission system.

After the desired vacuum level has been achieved, the EVAP purge solenoid is turned "OFF," sealing the system. A leak is detected by monitoring for a decrease in vacuum level over a given time period, all other variables remaining constant.

If the desired vacuum level cannot be achieved in the test described above, a large leak or a faulty EVAP purge control solenoid valve is indicated.

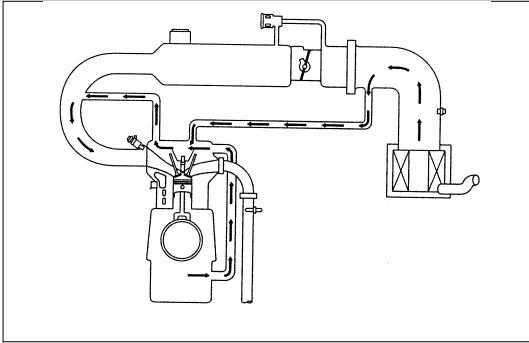
Leaks can be caused by the following conditions:

- Missing or faulty fuel cap
- Disconnected, damaged, pinched, or blocked EVAP purge line
- Disconnected, damaged, pinched, or blocked fuel tank vapor line
- Disconnected or faulty EVAP purge control solenoid valve
- Open ignition feed circuit to the purge solenoid
- Damaged EVAP canister
- Leaking fuel sender assembly O-ring
- Leaking fuel tank or fuel filler neck

The ECM supplies a ground to energize the purge control solenoid valve (purge "ON" ). The EVAP purge control is PWM, or turned "ON" and "OFF," several times a second. The duty cycle (pulse width) is determined by engine operating conditions including load, throttle position, coolant temperature and ambient temperature. The duty cycle is calculated by the ECM and the output is commanded when the appropriate conditions have been met.

The system checks for conditions that cause the EVAP system to purge continuously by commanding the EVAP purge solenoid "OFF", EVAP purge PWM "0%". If fuel tank vacuum level increases during the test, a continuous purge flow condition is indicated. This can be caused by the following conditions:

- EVAP purge solenoid leaking
- EVAP purge and engine vacuum lines switched at the EVAP purge control solenoid valve
- EVAP purge control solenoid valve driver circuit grounded



## POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM

### CRANKCASE VENTILATION SYSTEM PURPOSE

The crankcase ventilation system is used to consume crankcase vapors in the combustion process instead of venting them to the atmosphere. Fresh air from the throttle body is supplied to the crankcase and mixed with blow-by gases. This mixture is then passed through the positive crankcase ventilation (PCV) port into the intake manifold.

While the engine is running, exhaust gases and small amounts of the fuel/air mixture escape past the piston rings and enter the crankcase. These gases are mixed with clean air entering through a tube from the air intake duct.

During normal, part-throttle operation, the system is designed to allow crankcase gases to flow through the PCV hose into the intake manifold to be consumed by normal combustion.

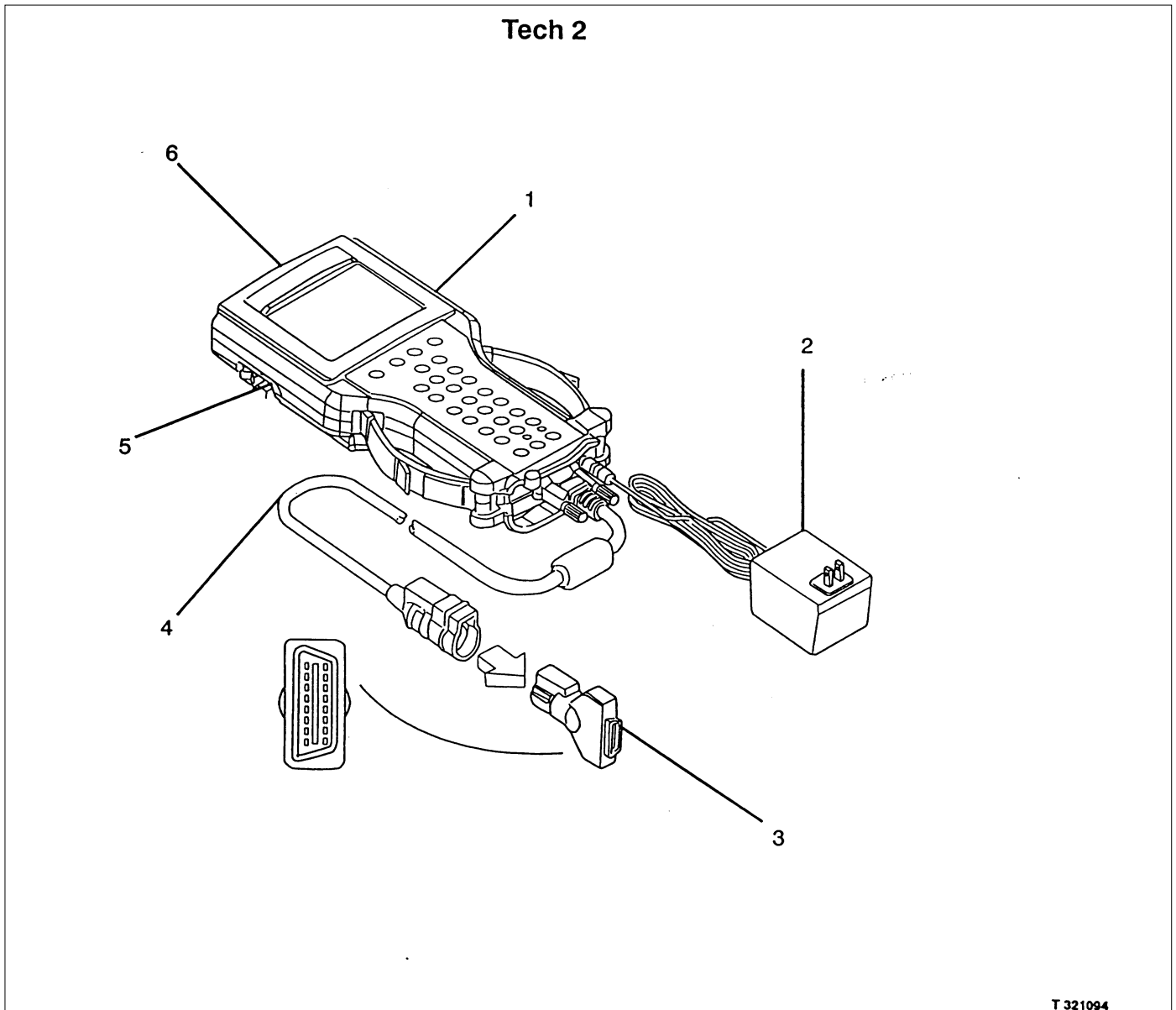
A plugged positive crankcase ventilation port or PCV hose may cause the following conditions:

- Rough idle.
- Stalling or slow idle speed.
- Oil leaks.
- Sludge in the engine.

A leaking PCV hose would cause:

- Rough idle.
- Stalling.
- High idle speed.

## SPECIAL SERVICE TOOLS

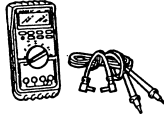

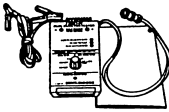

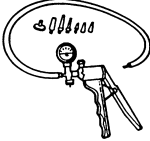


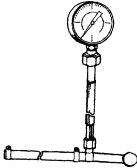



T 321094



### Legend

- |  |                                 |
|--|---------------------------------|
| (1) Tech 2 Scan Tool                   | (4) Tech 2 DLC Interface Cable  |
| (2) Tech 2 AC/DC Power Adapter         | (5) Tech 2 RS232 Connector Port |
| (3) Tech 2 OBD DLC Interface Connector | (6) Tech 2 10 Meg Memory Card   |

## SPECIAL SERVICE TOOLS (Cont'd)

ITEM NO.	ILLUSTRATION	PART NO.	PART NAME
	 <p style="text-align: center; font-size: small;">TS 22300</p>	5-8840-2392-0	High Impedance Multimeter (Digital Voltmeter -DVM)
	 <p style="text-align: center; font-size: small;">TS 24069</p>	5-8840-2312-0	IAC Motor Analyzer
	 <p style="text-align: center; font-size: small;">T-321099</p>	5-8840-2618-0	Fuel Injector Tester
	 <p style="text-align: center; font-size: small;">TS 23369</p>	5-8840-0385-0	Connector Test AdapterKit
	 <p style="text-align: center; font-size: small;">TS 23367</p>	5-8840-0279-0	Vacuum Pump with Gauge
	 <p style="text-align: center; font-size: small;">100</p>	5-8840-0632-0	Terminal Remover
	 <p style="text-align: center; font-size: small;">101</p>	5-8840-0388-0	Weather Pack Terminal Remover
		5-8840-0378-0	Pressure Gauge
	 <p style="text-align: center; font-size: small;">TS 30010</p>	5-8840-2607-0	EVAP Pressure/Purge Diagnostic Station

## SPECIAL SERVICE TOOLS (Cont'd)

ITEM NO.	ILLUSTRATION	PART NO.	PART NAME
		5-8840-2608-0	Ultrasonic Leak Detector
		5-8840-2589-0	Injector Adapter Cable

- <sup>1</sup> 5-8840-2608-0 EVAP Pressure/Purge Diagnostic Station is a multipurpose tool which is used to perform several diagnostic procedures for enhanced emission testing. The station will accommodate a nitrogen gas filled cylinder which is used to pressurize the vehicle EVAP system for a leakdown test and leak location test when a vehicle is repaired for leakage in the enhanced evaporative emission control system. It also has two additional gauges (one in inches of mercury and one in inches of water) which are used to measure both source vacuum and EVAP canister purge vacuum to verify correct operation and vapor flow within the canister purge circuit.
- <sup>2</sup> 5-8840-2608-0 Ultrasonic Leak Detector is a microprocessor-based device used to detect leaks in the enhanced evaporative emission control system. The evaporative system is pressurized to 30 inches of water using the 5-8840-2608-0 EVAP Pressure/Purge Diagnostic System. Small leaks in the EVAP system will emit sound at a high frequency undetectable by a human ear but detectable with the 5-8840-2608-0. The technician traces along the evaporative system and can pinpoint leaks due to corroded lines, cracked hoses, or a damaged EVAP component. The detector includes a high quality set of headphones to block out surrounding shop noise and the LED sensitivity meter allows a visual reference for locating leaks in conjunction with the audio output heard through the headphones. Powered by (1) nine volt battery.

# SECTION 6F

## ENGINE EXHAUST

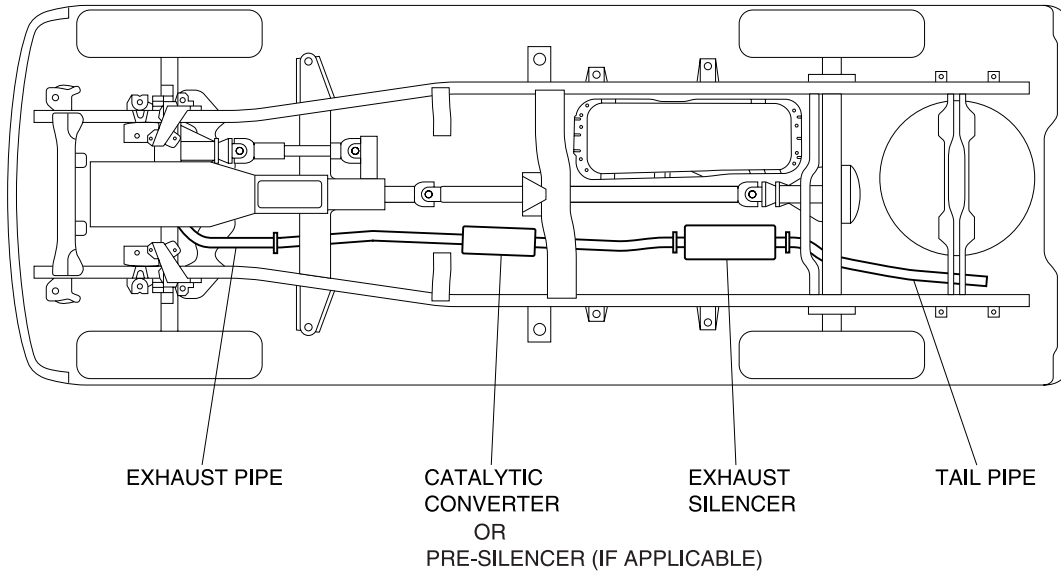
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## General Description

This illustration is based on the 4×4 with TWC model.





When inspecting or replacing exhaust system components, make sure there is adequate clearance from all points on the underbody to prevent overheating the floor pan and possible damage to the passenger compartment insulation and trim materials.

Check complete exhaust system and nearby body areas and rear compartment lid for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections or other deterioration which could permit exhaust fumes to seep into the rear compartment or passenger compartment. Dust or water in the rear compartment may be an indication of a problem in one of these areas. Any faulty areas should be corrected immediately.

### Hangars

Various types of hangers are used to support exhaust system(s). These include conventional rubber straps, rubber rings, and rubber blocks.

The installation of exhaust system supports is very important, as improperly installed supports can cause annoying vibrations which can be difficult to diagnose.

### Three Way Catalytic Converter (If applicable)

The three way catalytic converter is an emission control device added to the exhaust system to reduce pollutants from the exhaust gas stream.



**CAUTION: The catalytic converter requires the use of unleaded fuel only.**

Periodic maintenance of the exhaust system is not required. If the vehicle is raised for other service, it is advisable to check the condition of the complete exhaust system.

A dual bed monolith catalytic converter is used in combination with three way catalytic converter.

Catalytic Types:

Three way (Reduction/Oxidation) catalyst

The catalyst coating on the three way (reduction) converter contains platinum and rhodium which lowers the levels of nitrous oxide (NO<sub>x</sub>) as well as hydrocarbons (HC) and carbon monoxide (Co).

### Gasket

The gasket must be replaced whenever a new exhaust pipe, muffler or catalytic converter is installed.

## Service Precaution

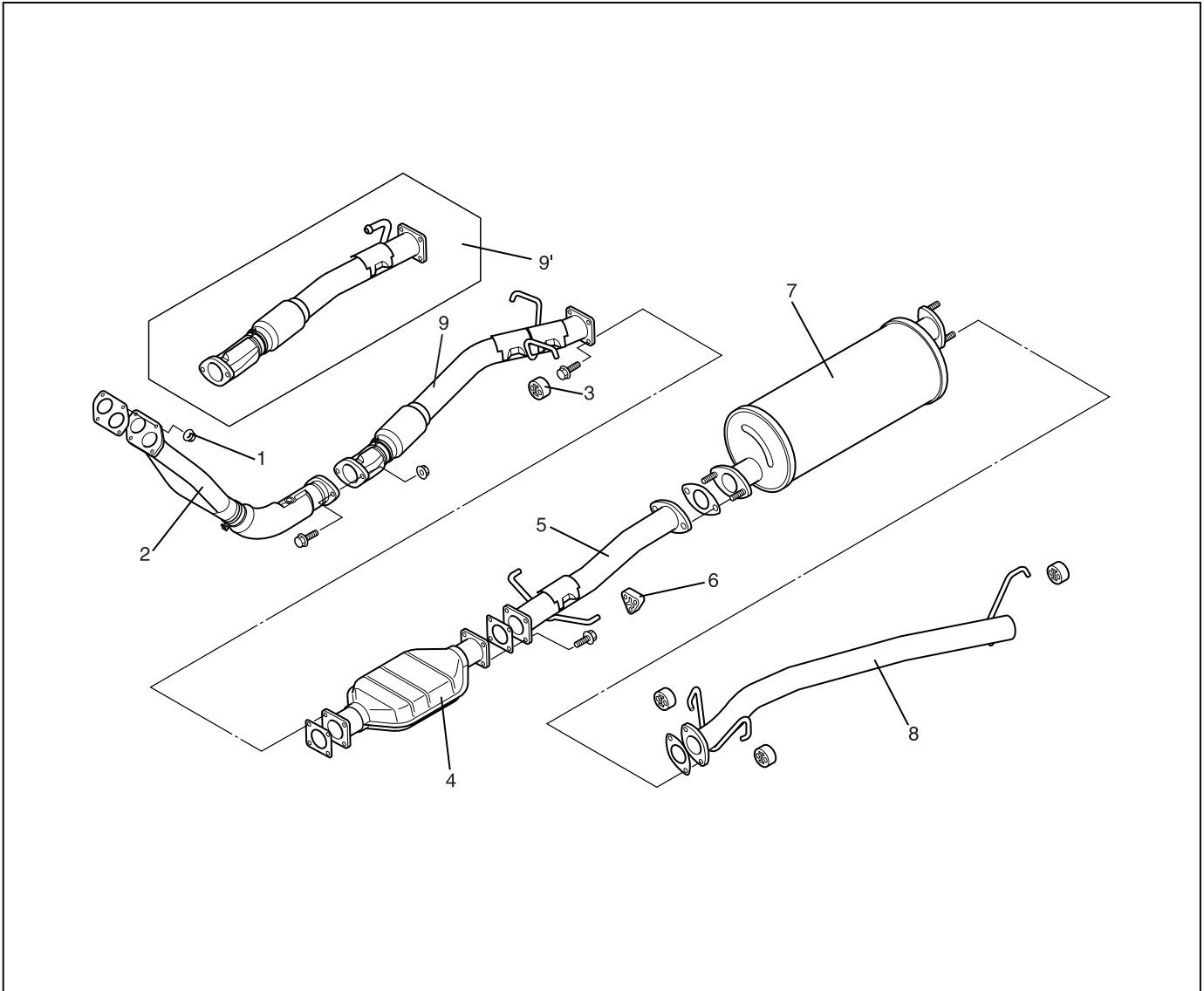


### CAUTION:

Always use the correct fastener in the proper location. When you replace a fastener, use **ONLY** the exact part number for that application. ISUZU will call out those fasteners that require a replacement after removal. ISUZU will also call out the fasteners that require thread lockers or thread sealant. **UNLESS OTHERWISE SPECIFIED**, do not use supplemental coatings (Paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and the joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.

## Exhaust Pipe

### Exhaust Pipe and Associated parts



#### ↔ Removal

1. Front exhaust pipe flange nut and gasket
2. Front exhaust pipe
3. Center exhaust pipe damper rubber
4. Catalytic converter
5. Center exhaust pipe
6. Rear exhaust pipe damper rubber
7. Exhaust silencer with rear exhaust pipe
8. Rear exhaust pipe
9. Mid pipe (for 4x4)
- 9'. Mid pipe (for 4x2)

#### → Installation

To install, follow the removal steps in the reverse order.

**Important - Installation****1. Front Exhaust Pipe Flange Nut**

Connect the exhaust pipe to the exhaust manifold.

Front exhaust pipe to manifold nut.

Torque



N·m (kgf·m)

28 (2.9)

**Inspection**

Make the necessary adjustments, and part replacements if excessive wear or damage is discovered during inspection.

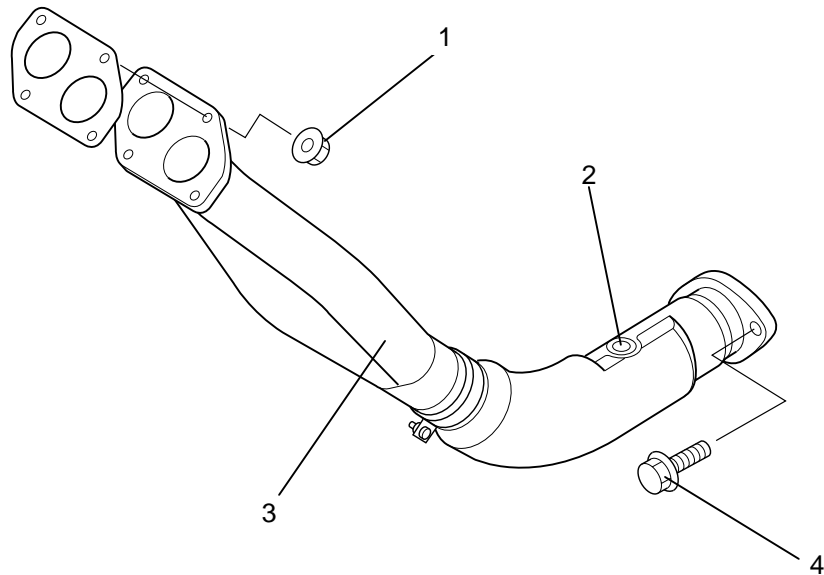
- 1. Front Exhaust Pipe**
- 2. Center Exhaust Pipe and Catalytic Converter Flange Nut**
- 3. Exhaust Pipe Damper Rubber**
- 4. Exhaust Silencer with Rear Exhaust Pipe**

Check the pipes for corrosion, cracking, damage or misalignment and repair if required.

Check the damper rubber for deterioration or damage and repair if required.

## Front Exhaust Pipe

### Front Exhaust Pipe and Associated Parts



#### Legend

1 Front Exhaust Pipe Fixing Nuts  
2 O<sub>2</sub> Sensor (If applicable)

3 Front Exhaust Pipe  
4 Front Exhaust Pipe Fixing Bolts and Nuts



#### Removal

1. Disconnect battery ground cable.
2. Raise the vehicle and support with suitable safety stands.
3. Disconnect O<sub>2</sub> sensor harness connector and remove front side O<sub>2</sub> sensor (2). (If applicable)
4. Remove front exhaust pipe fixing bolts and nuts (4).
5. Remove front exhaust pipe fixing four stud nuts from exhaust manifold (1).
6. Remove front exhaust pipe (3)



## Installation

1. Install front exhaust pipe (3) and tighten four stud nuts.



**Torque:**

**Stud Nuts: 28 N·m (2.9 kgf·m)**

**Nuts: 43 N·m (4.4 kgf·m)**

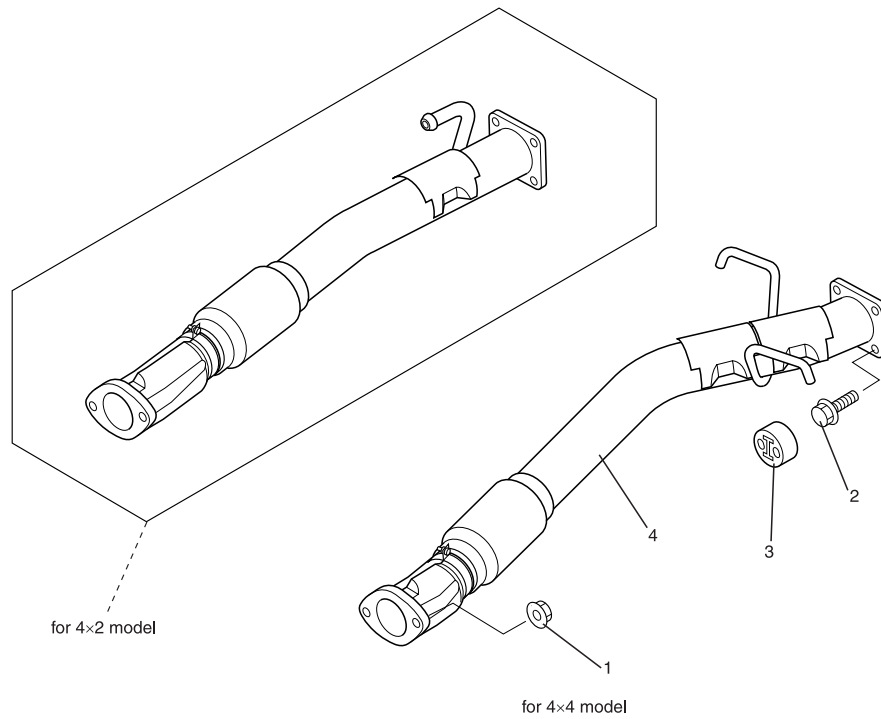
2. Tighten front side O<sub>2</sub> sensor and reconnect O<sub>2</sub> sensor harness connector. (If applicable)



**Torque:55 N·m (5.6 kgf·m)**

## Mid Pipe

### Mid Pipe and Associated Parts



### Legend

1. Front Exhaust Pipe Fixing Bolts and Nuts
2. Mid Pipe Fixing Bolts
3. Mid Exhaust Pipe Mounting Rubber
4. Mid Pipe



### Removal

1. Disconnect battery ground cable.
2. Raise the vehicle and support with suitable safety stands.
3. Remove front exhaust pipe fixing bolts and nuts (1).
4. Remove mid pipe fixing four stud nuts from Catalytic Converter.
5. Remove mid pipe (4)



## Installation

1. Install center exhaust pipe (4) and tighten four fixing bolts (2) and two bolts and nuts (1) to the specified torque:



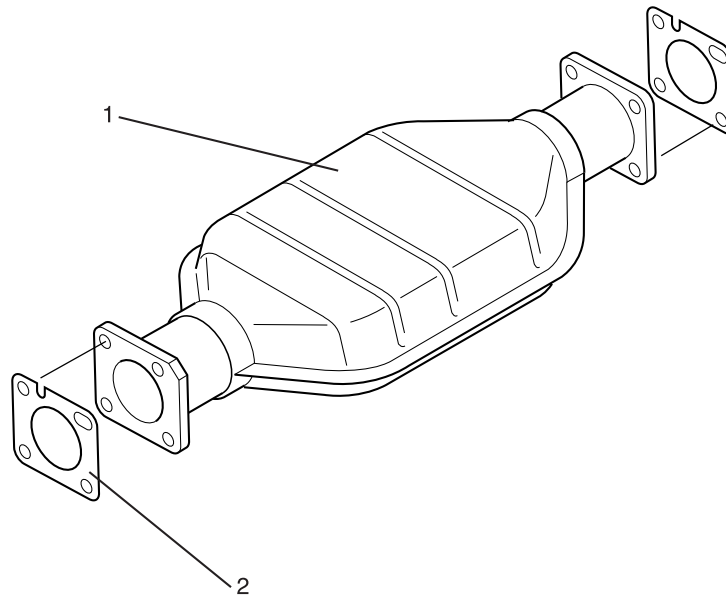
### **Torque:**

**Fixing bolts: 43 N·m (4.4 kgf·m)**

**Bolts: 43 N·m**



## Catalytic Converter (If applicable) Catalytic Converter and Associated Parts



### Legend

- 1. Catalytic Converter
- 2. Grakets

### ↔ Removal

1. Disconnect battery ground cable.
2. Raise the vehicle and support with suitable safety stands.
3. Remove center exhaust pipe fixing bolts.
4. Remove exhaust silencer fixing bolts.
5. Remove catalytic converter (1).

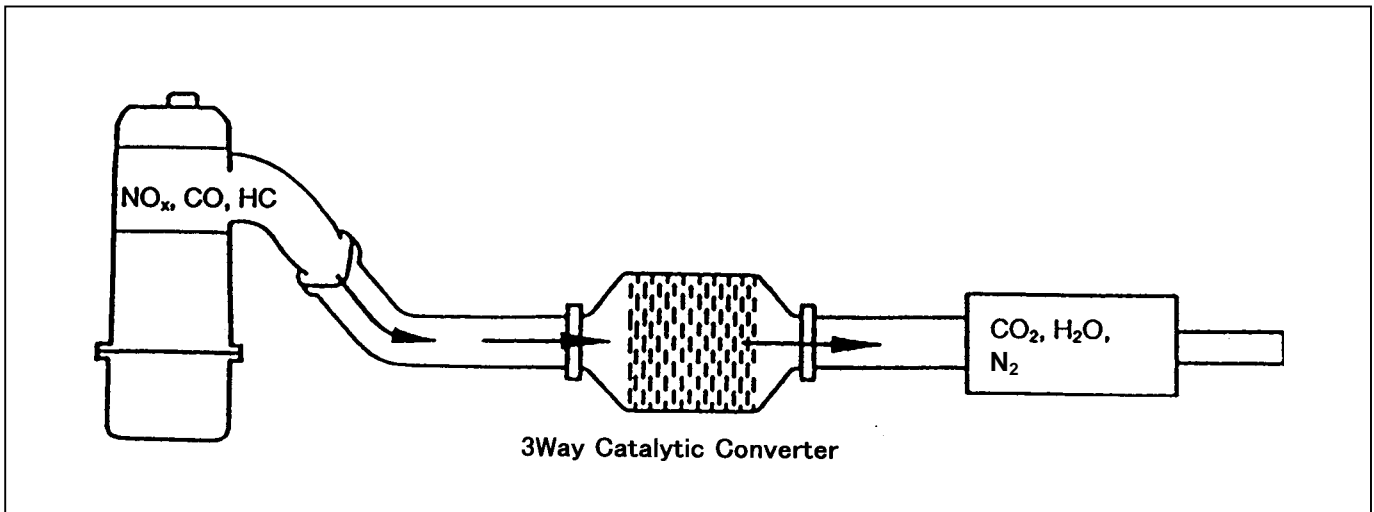
### ↔ Installation

1. Install Catalytic Converter (1) and tighten four exhaust silencer fixing bolts and center exhaust pipe fixing bolts to the specified torque:

**Torque:**

**Fixing bolts: 43 N·m (4.4 kgf·m)**

## 3 WAY CATALYTIC CONVERTER SYSTEM (If applicable)

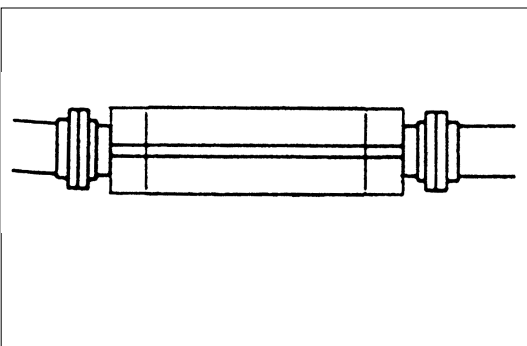


### Inspection

Make the necessary adjustments, and part replacements if excessive or damage is discovered during inspection.

### Exhaust Pipe Assembly

1. Check connections for looseness or damage.
2. Check clamps for weakness, crack, or damage.



### Catalytic Converter

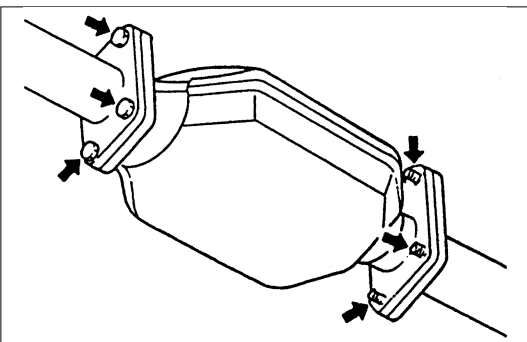
Check for dents or damage.

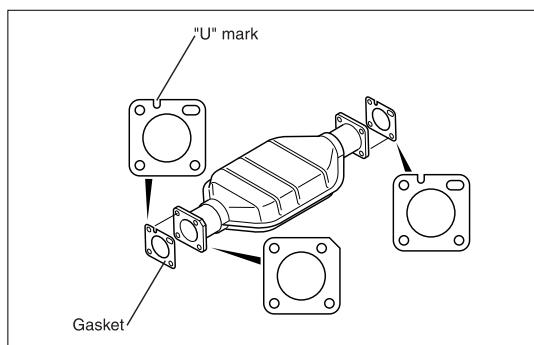
If any part of the converter is damaged or dented, repair or replace it.



### Removal

1. Jack up the vehicle.
2. Check that the converter is cool.
3. Remove the bolts at the front and rear of the converter.
4. Remove the converter and gaskets.





### Installation

1. Place new gaskets on the converter front and rear pipes, and connect the converter to the exhaust pipes.

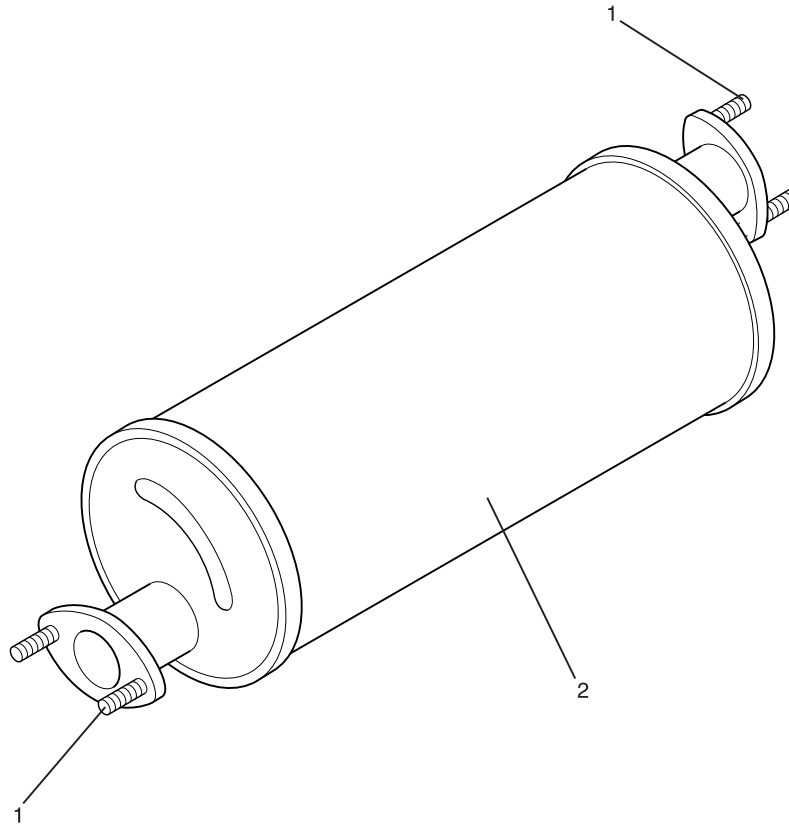
**Note:**

**When placing new gaskets, check that "U" mark on the gasket is upside.**

2. Tighten the bolts with the specified torque.
3. Reinstall the bracket bolts and tighten them.

## Exhaust Silencer

### Exhaust Silencer and Associated Parts



#### Legend

1. Exhaust Silencer Fixing Bolts
2. Exhaust Silencer



#### Removal

1. Disconnect battery ground cable.
2. Raise the vehicle and support with suitable safety stands.
3. Remove four exhaust silencer fixing bolts (1) and two rear exhaust pipe fixing bolts and nuts (2) then disconnect rear exhaust silencer from rear exhaust pipe
4. Remove exhaust silencer mounting rubbers from chassis side then remove exhaust silencer.



## Installation

1. Install the exhaust silencer and tighten two bolts and nuts (2) on rear exhaust pipe to specified torque then tighten four bolts (1) on Catalytic Converter to specified torque.

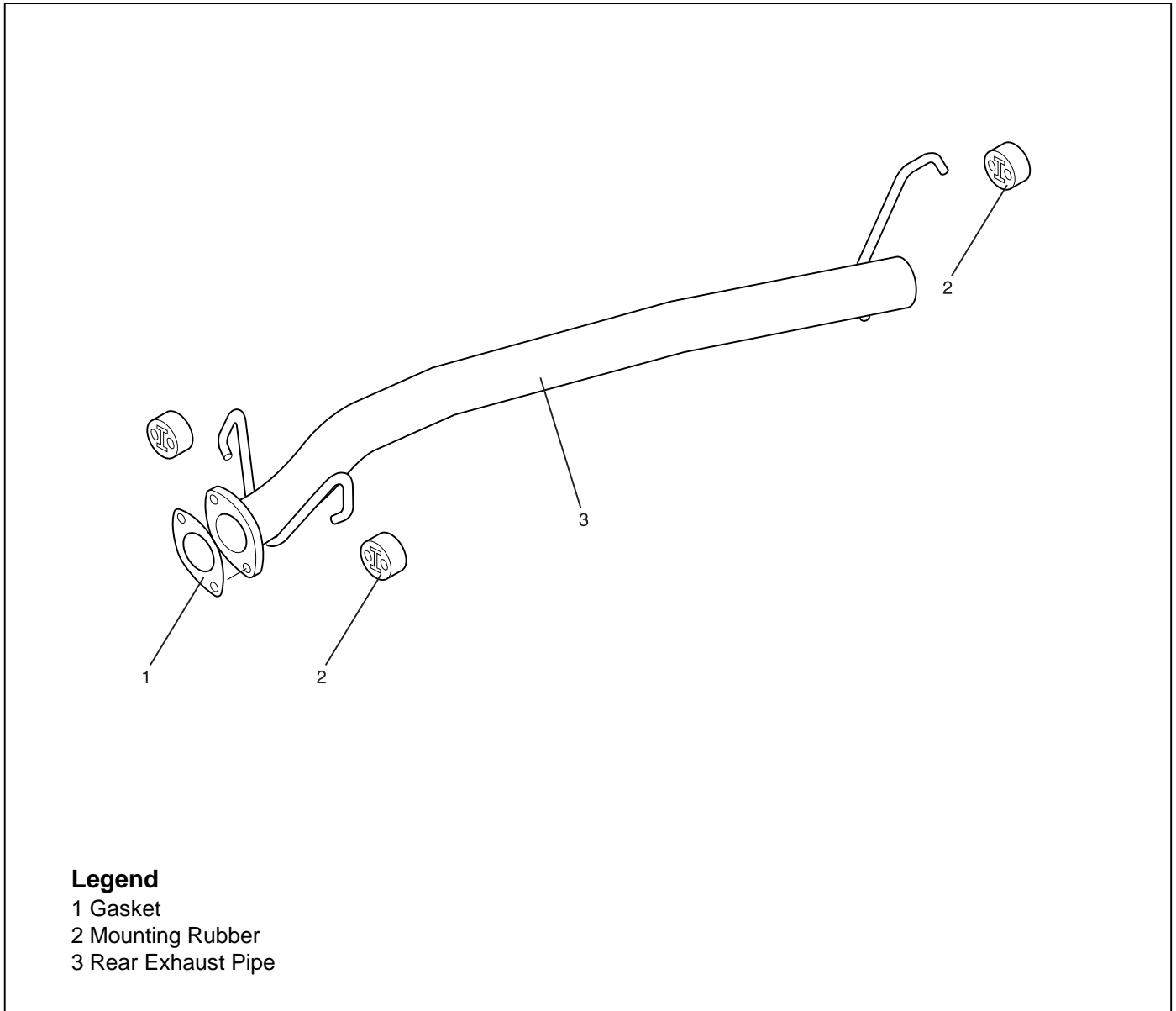


**Torque:**

**Bolts: 43 N·m (4.4 kgf·m)**

## Rear Exhaust pipe

### Rear Exhaust pipe and Associated Parts



#### ↔ Removal

1. Disconnect battery ground cable
2. Raise the vehicle and support with suitable safety stands.
3. Remove rear exhaust pipe fixing bolts and nuts, then disconnect rear exhaust pipe (3) from exhaust silencer.
4. Remove mounting rubber (2).
5. Remove rear exhaust pipe (3).



**Installation**

1. Install the mounting rubber (2).
2. Install the exhaust pipe (3) and tighten two bolts and nuts on exhaust silencer to specified torque.



**Torque:**

**Nuts: 43 N.m (4.4 kgf.m)**

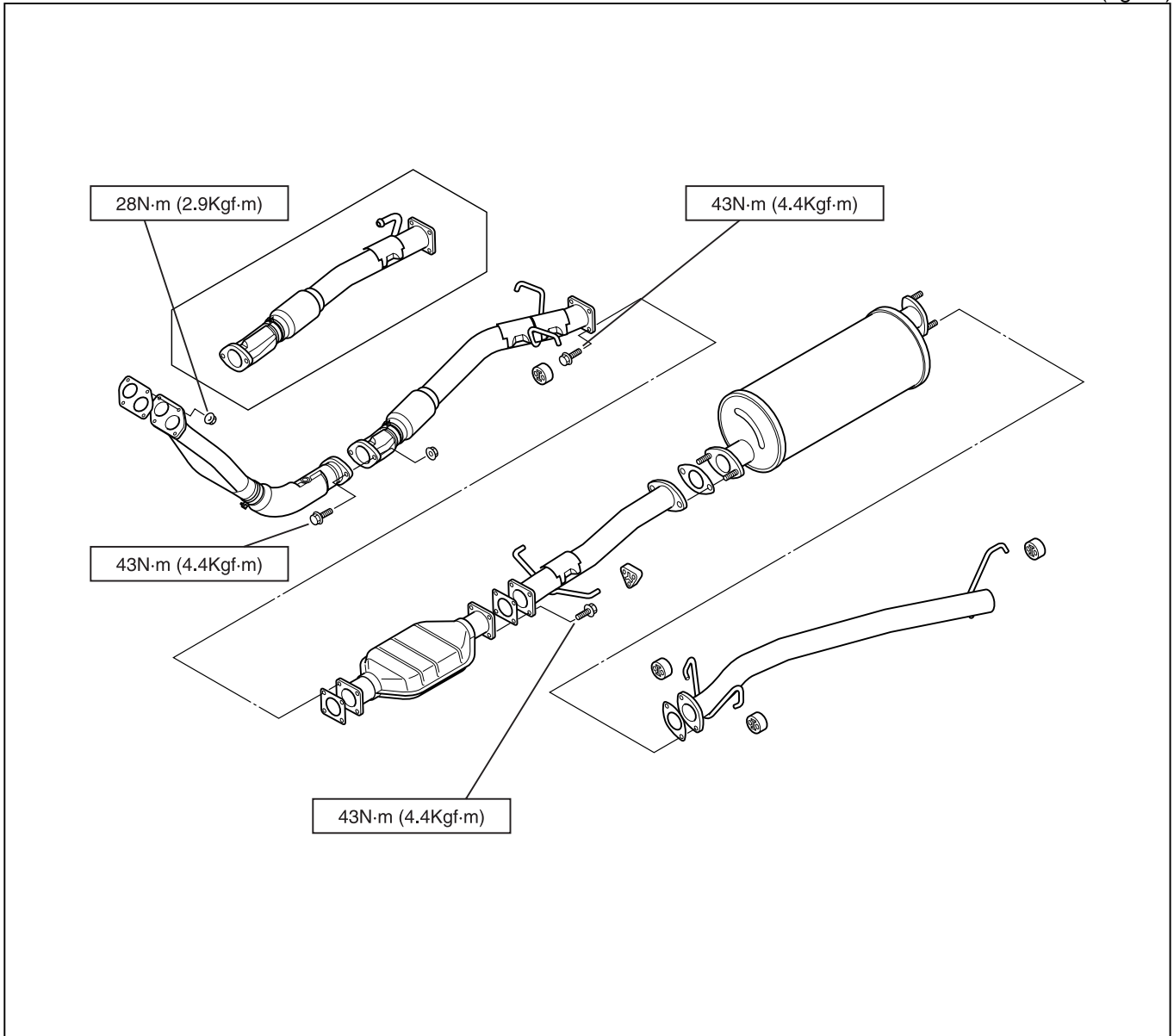
**Main Data and Specifications**

Exhaust system		
Pipe outside diameter X thickness		
Front pipe	mm(in)	} 42.7 X 1.5 (1.8X0.059)<Flange> { 54.0 X 1.5 (2.0 X 0.059)
Middle pipe	mm(in)	
Rear pipe	mm(in)	50.8 X 1.5 (2.0 X 0.059)
Silencer		
Type		Circular section-shell construction of triple skin and end plates, internal construction of baffles and perforated tubes.
Inside diameter	mm (in)	Approximately 180 (7.09)
Length	mm (in)	Approximately 525 (20.67)
Mounting		
Number of suspension points		4
Type		Rubber
Catalytic converter type		Three way Catalytic Converter

# Main Data and Specifications

## Torque Specification

N·m (kgf·m)





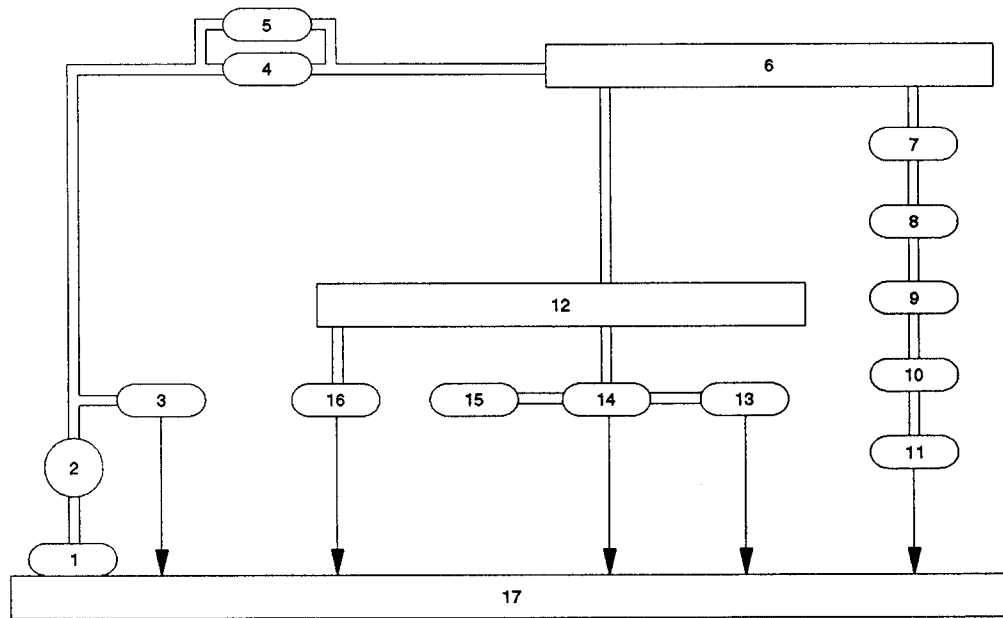
# SECTION 6G

## ENGINE LUBRICATION

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Inspection and Repair.....	6G- 7
Reassembly .....	6G- 7

## General Description



### Legend

- 1 Oil Strainer
- 2 Oil Pump
- 3 Relief Valve
- 4 Oil Filter
- 5 Safety Valve
- 6 Oil Gallery
- 7 Crankshaft Bearing
- 8 Crankshaft

- 9 Connecting Rod Bearing
- 10 Connecting Rod
- 11 Piston
- 12 Oil Gallery; Cylinder Head
- 13 Camshaft
- 14 Camshaft Journal
- 15 HLV
- 16 Check relief valve
- 17 Oil Pan

A gear-type oil pump is directly driven by the crankshaft and draws oil from the oil pan, via the suction pipe. It then passes the pressurized oil through a full-flow disposable oil filter, to the main oil gallery in the cylinder block. An oil pump pressure relief valve and oil filter bypass valve are incorporated in the system.

From the main oil gallery in the cylinder block, the cylinder head and crankshaft main bearings are supplied with oil. The camshaft bearings and hydraulic tappets are supplied through the main feed galleries in the cylinder head. Vent valves allow air to be expelled from the oil galleries in the cylinder head. The balance shaft journals are directly fed from the crankshaft main bearings. The connecting rod bearings are fed via passages in the crankshaft. The oil returns to the oil pan via passages in the cylinder block.

## Service Precaution

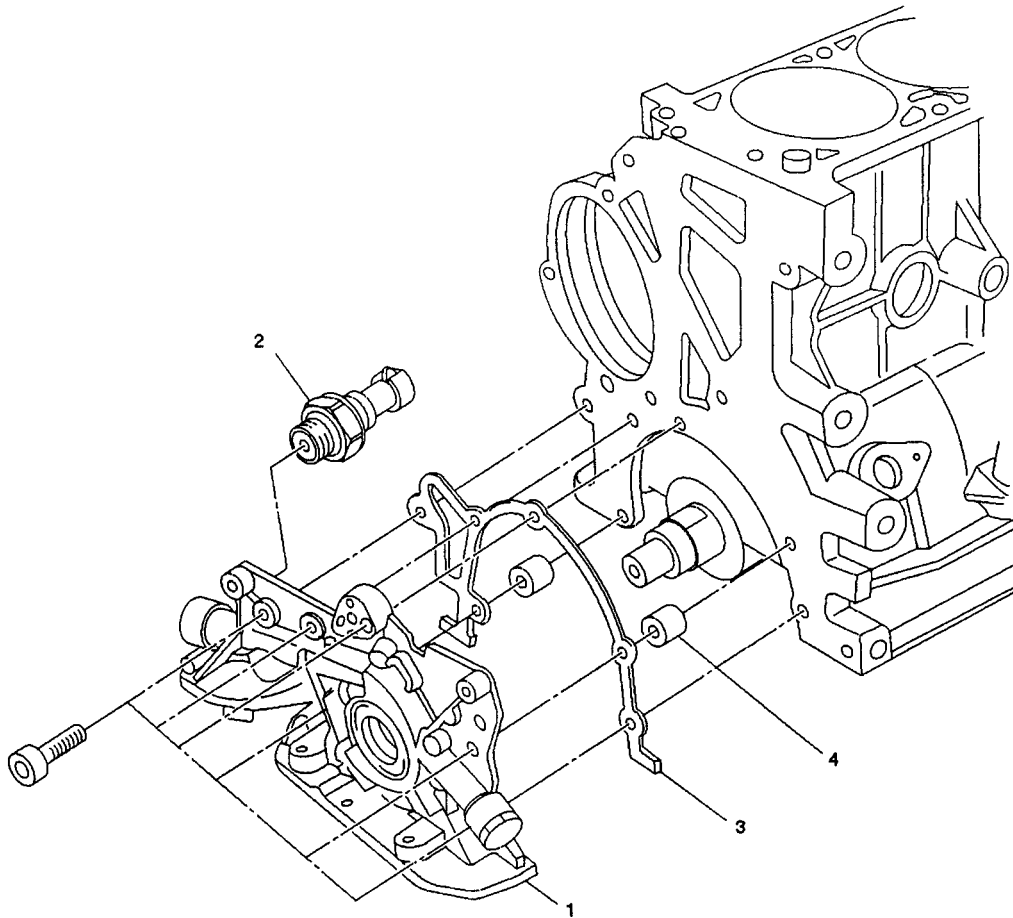


### CAUTION:

Always use the correct fastener in the proper location. When you replace a fastener, use **ONLY** the exact part number for that application. ISUZU will call out those fasteners that require a replacement after removal. ISUZU will also call out the fasteners that require thread lockers or thread sealant. **UNLESS OTHERWISE SPECIFIED**, do not use supplemental coatings (Paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and the joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.

## Oil Pump

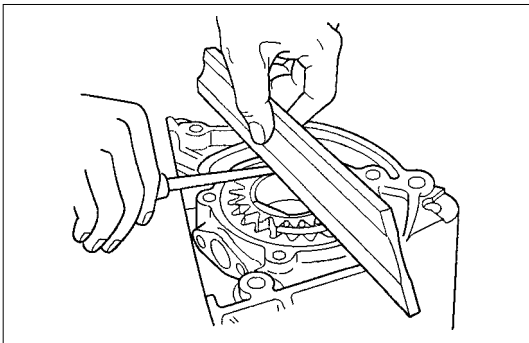
### Oil Pump and Associated Parts



#### Legend

1 Oil Pump Assembly  
2 Oil Pressure Switch

3 Gasket  
4 Sleeve



#### Disassembly

1. Remove crankshaft timing pulley.
2. Remove oil pan.
3. Remove oil strainer.
4. Remove oil pump assembly.
5. Remove oil pressure switch.
6. Remove gasket.
7. Remove sleeve.



## Inspection and Repair

**CAUTION:** Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.

### Body and Gears

The pump assembly must be replaced if one or more of the conditions below is discovered during inspection:

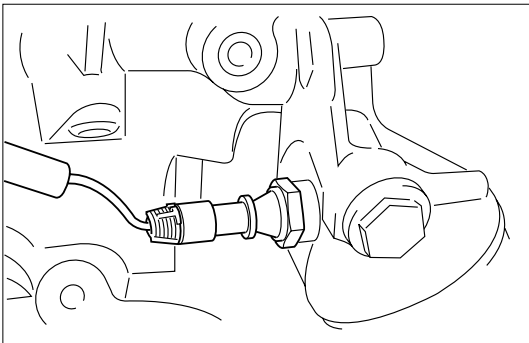
Indentation of gear pair - Use feeler strip and straight edge.

**Dimension: 0.03 mm to 0.10 mm**

**(0.0012 to 0.0039 in)**

### Oil Strainer

Check the oil strainer for cracking and scoring. If cracking and scoring are found, the oil strainer must be replaced.



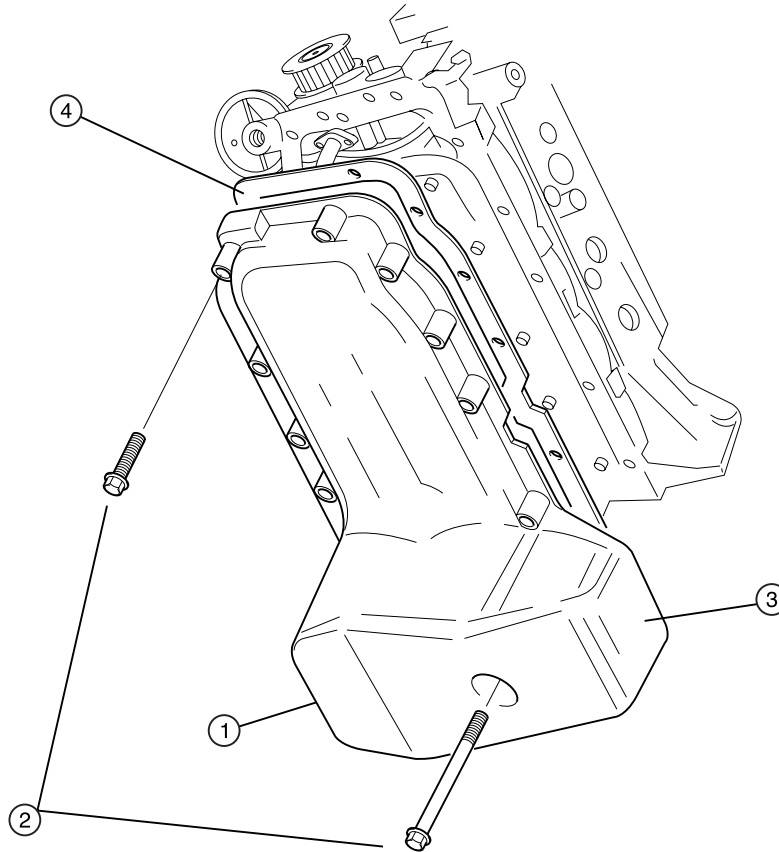
## Reassembly

1. Install oil pressure switch to the oil pump.  
**Torque: 40 N·m (4.1 kgf.m)**
2. Install the oil pump with the sleeve and the gasket.  
**Torque: 6 N·m (0.6 kgf.m)**
3. Install oil strainer.  
**Torque: 8 N·m (0.8 kgf.m)**
4. Install the oil pan  
**Tighten the bolts:**  
**15 N·m (1.5 kgf.m)**
5. Install crankshaft timing pulley.  
**Tighten the bolts:**  
**20 N·m (2.0 kgf.m)**



## Oil Pan

### Oil Pan and Associated Parts



#### Legend

- 1 Drain Plug
- 2 Bolts
- 3. Oil Pan

4 Oil Pan Gasket

#### ⚠ Important

#### ⚡ Disassembly

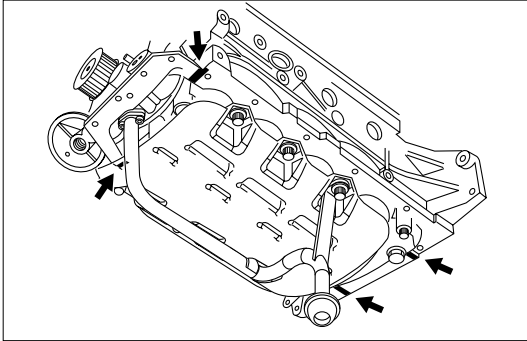
1. Loosen a drain plug to drain oil.
2. Remove engine hood.
3. Remove engine rear mounting.
4. Remove transmission assembly.
5. Remove engine front mounting.
6. Raise the vehicle and support with switch stands, and then remove engine.
7. Remove oil pan.



### Inspection and Repair



**CAUTION:** Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.



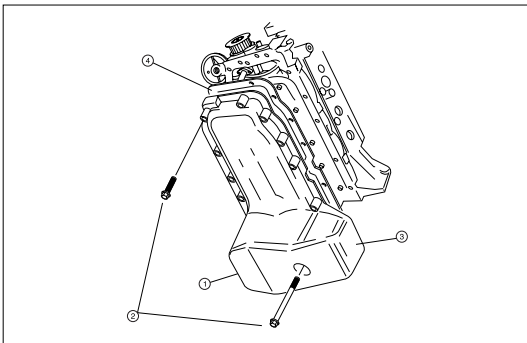
### Reassembly

To install follows the disassembly steps in the reverse order.



### Important

Sealer - Apply silicon into groove in oil pan lugs prior to fitment of oil pan to block, remove excess sealer after oil pan is bolted to block.



### Torque

Bolts - Tighten bolts to the specified torque.

Torque : 15 N·m (1.5 kgf·m)

Engine oil - Refill engine oil to the oil pan.

(Lit)

Without filter change	4.40
With filter change	4.70

## SECTION 6H

# ENGINE SPEED CONTROL SYSTEM

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Adjustment .....	6H- 3

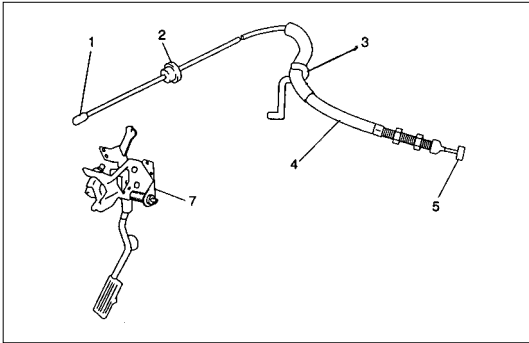


## Service Precaution



### CAUTION:

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## Accelerator Pedal Control Cable

### Removal

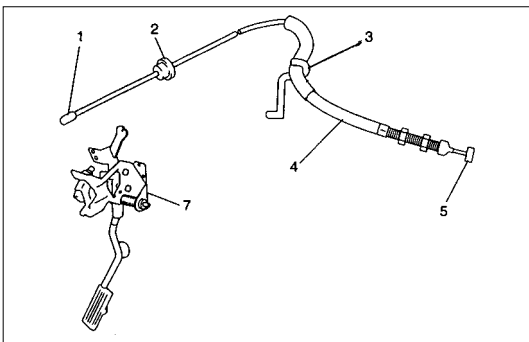
1. Loosen the adjust nut on the cable bracket mounted.
2. Remove cable clip (3).
3. Disconnect accelerator pedal (AP) control cable (5). (on throttle valve side)
4. Disconnect AP control cable (1). (on AP pedal (7) side)
5. Remove grommet (2).
6. Remove AP control cable (4).



### Inspection

Check the following items, and replace the control cable if any abnormality is found:

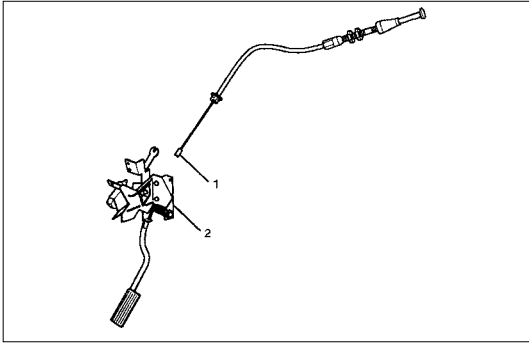
- The control cable should move smoothly.
- The control cable should not be bent or kinked.
- The control cable should be free of damage and corrosion.



### Installation

1. Install AP control cable (4).
2. Install grommet (2).
3. Connect AP control cable (1). (on AP (7) side)
4. Connect AP control cable (5). (on throttle valve side)
5. Install cable clip (3).
6. Install adjusting nut.
7. Confirm the free play of throttle valve control valve.

**Free Play: 3 to 8 mm (0.117 to 0.312 in)**



## Accelerator Pedal

### Accelerator Pedal and Associated Parts

#### Legend

- 1 Accelerator Pedal Control Cable
- 2 Accelerator Pedal Assembly



#### Removal

1. Accelerator pedal control cable (1).
2. Accelerator pedal assembly (2).



#### Installation

1. Accelerator pedal assembly (2).
2. Accelerator pedal control cable (1).



#### Adjustment

##### Manual Transmission:

- Rotate counterclockwise to loosen the locked nut and screw the stopper bolt in sufficiently.
- Fully depress the pedal and hold it there by hand. Next, rotate the stopper bolt until it hits the stopper of pedal bracket. Then, lock the stopper bolt there.

# SECTION 6J INDUCTION

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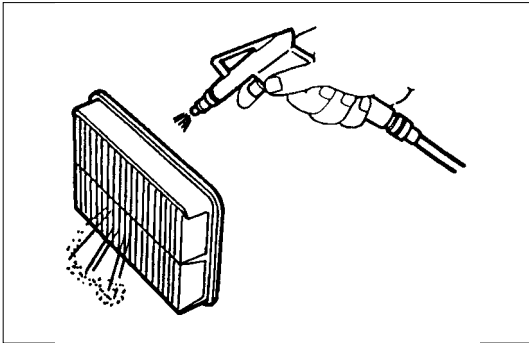
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## Service Precaution



### CAUTION:

Always use the correct fastener in the proper location. When you replace a fastener, use **ONLY** the exact part number for that application. ISUZU will call out those fasteners that require a replacement after removal. ISUZU will also call out the fasteners that require thread lockers or thread sealant. **UNLESS OTHERWISE SPECIFIED**, do not use supplemental coatings (Paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and the joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.



## Air Cleaner Filter



### Removal

1. Remove positive ventilation hose connector.
2. Remove intake air temperature sensor.
3. Remove mass air flow sensor.
4. Remove air cleaner duct assembly.
5. Remove air cleaner element.



### Inspection

Check the air cleaner filter for damage or dust clogging. Replace if it is damaged, or clean if it is clogged.



### Cleaning Method

Tap the air cleaner filter gently so as not to damage the paper filter, or clean the element by blowing with compressed air of about 490 kPa (71 psi) from the clean side if it is extremely dirty.



### Installation

1. Install air cleaner element.
2. Attach the air cleaner duct cover to the body completely, then clamp it with the clip.
3. Install mass air flow sensor.
4. Install mass air temperature sensor.
5. Install positive crankcase ventilation hose connector.

## **TFHEC-WE-981**

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA, Canada, Europe and Thailand.

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