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ISUZU COMMERCIAL TRUCK FORWARD TILTMASTER

SERVICE MANUAL 6HK1-TC ENGINE

1998-2001 FSR, FTR, FVR
2000-2001 FRR
2000-2001 WT5500

FORWARD

This service manual contains diagnosis, on-vehicle service, wiring diagrams, and component unit repair for 6HK1-TC engine. (1998 – 2001 FSR, FTR, FVR & 2000 – 2001 FRR (WT5500)/ENGINE).

Keep this manual in a handy place for ready reference. If properly used, it will enable the technician to serve the owners of these vehicles.

CAUTION:

This service manual is intended for use by professional, qualified technicians.
Attempting repairs or service without the appropriate training, tools, and equipment could cause injury to you or others and damage to your vehicle that may cause it not to operate properly.
These vehicle contain parts dimensioned in the metric system as well as in the customary system. Some fasteners are metric and are very close in dimension to familiar customary fasteners in the inch system. It is important to note that, during any vehicle maintenance procedures, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. (Numbers on the heads of metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings.) Mismatched or incorrect fasteners can result in vehicle damage or malfunction, or possibly personal injury. Therefore, fasteners removed from the vehicle should be saved for re-use in the same location whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original. For information and assistance, see you Authorized dealer.

CAUTION

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed.

Proper service and repair are important to the safety of the service technician and the safe, reliable operation of all motor vehicles. If a part replacement is necessary, the part must be replaced with one of the same part number or with a part of the same quality. Do not use and incorrect or a replacement part of lesser quality.

The service procedures recommended and described in this service manual are effective methods of performing service and repair. Some of these procedures require the use of tools specially designed for the purpose.

Accordingly, anyone who intends to use a replacement part, service procedure or tool, which is not recommended by the vehicle manufacturer, must first determine that neither technician safety nor the safe operation of the vehicle will be jeopardized by the replacement part, service procedure or tool selected.

It is important to note that this manual contains various **Cautions** and **Notices** that must be carefully observed in order to reduce the risk of personal injury during service or repair, or the possibility that improper service or repair may damage the vehicle or render it unsafe. It is also important to understand that these `Cautions' and `Notices' are not exhaustive, because it is impossible to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

SERVICE MANUAL

6HK1-TC ENGINE FOR 1998-2001 FSR, FTR, FVR & 2000-2001 FRR 2000-2001 WT5500

Any reference to brand names in this manual is intended merely as an example of types of lubricants, tools, materials, etc., recommended for use. In all cases, an equivalent may be used.

All information, illustrations, and specifications contained in this manual are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

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SECTION 6

ENGINE

CONTENTS

SECTION 6A6

DIESEL ENGINE ON-VEHICLE SERVICE

NOTICE: *Always use the correct fastener in the correct 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.*

CONTENTS

GENERAL DESCRIPTION

The ISUZU model 6HK1-TC engine is used in the vehicle covered in this manual. The engine is an in-line six cylinder, four stroke, water cooled, direct fuel injection, turbocharged diesel. The charge air cooler is the air to air heat exchange system using a corrugated-fin heat exchanger installed in front of the radiator.

The forged crankshaft is supported by seven precision insert main bearings. The crankshaft thrust washer is located at the number seven crankshaft main bearing.

The connecting rods have precision insert type crankshaft (big end) bearings. The piston pins are retained by snap rings. The pistons have three compression rings and one oil control ring. The pistons are cooled by oil jets. Dry liners are used. The liners have been phosphated (P-Mn method), both inside and outside for long life.

The camshaft is supported by four plain bearings, and is gear driven. Motion is transferred to the overhead valves by shaft type roller valve rocker arms.

The cylinder head may be rebuilt with new valve guides and seats. Refer to "Engine Overhaul" in SECTION 6A6B.

For further information on engine overhaul of the 7.8L, refer to SECTION 6A6B.

For information about the turbocharger, refer to SECTION 6J.

ENGINE IDENTIFICATION

The engine used in this vehicle is the 7.8L (475 CID).

The engine identification number is on the front right hand side (passenger) of the cylinder block. For further information, refer to SECTION 0A.

ENGINE LUBRICATION

A gear type oil pump is used. The engine is equipped with both full flow and bypass filters. An oil cooler is provided to help control oil temperatures. Major moving parts are supplied with oil from a large oil gallery in the cylinder block.

ON-VEHICLE SERVICE

VALVE ROCKER ARM COVER

Remove or Disconnect (Figure 1)

1. Tilt the cab.
2. Negative battery cables. Refer to SECTION 6D1.
3. Air inlet pipes. Refer to SECTION 6J.
4. Valve rocker arm cover with gasket.

NOTICE: Do not pry on the valve rocker arm cover. Damage to the sealing surfaces may result.

Clean

- Oil and grease from the sealing surfaces on the cylinder head and the valve rocker arm cover.

Install or Connect (Figure 1)

1. Valve rocker arm cover and the gasket to the cylinder head.
2. Valve rocker arm bolts.

Tighten

- Valve rocker arm cover bolts to 13.N·m (113 lb. in.).

3. Air inlet pipes.
4. Negative battery cables.
5. Lower the cab.

VALVE ROCKER ARM AND CAMSHAFT

Remove or Disconnect (Figure 2)

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Air inlet pipes. Refer to SECTION 6J.
4. Valve rocker arm cover. Refer to "Valve Rocker Arm Cover" in this section.
5. Connector both on the top of injectors and from engine harness.
6. Harness assembly.
7. Loosen all the valve adjusters, but do not remove.
8. Loosen the valve rocker arm shaft bracket bolts evenly, starting from the outer bolts moving to the inner bolts.

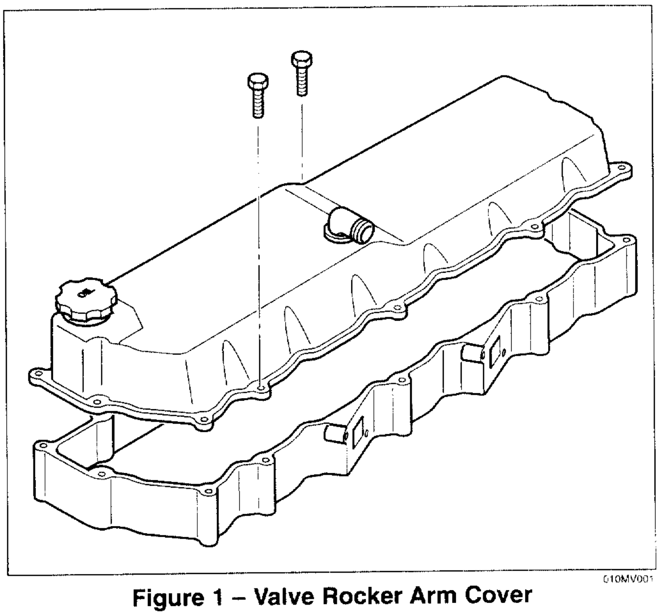


Figure 1 – Valve Rocker Arm Cover

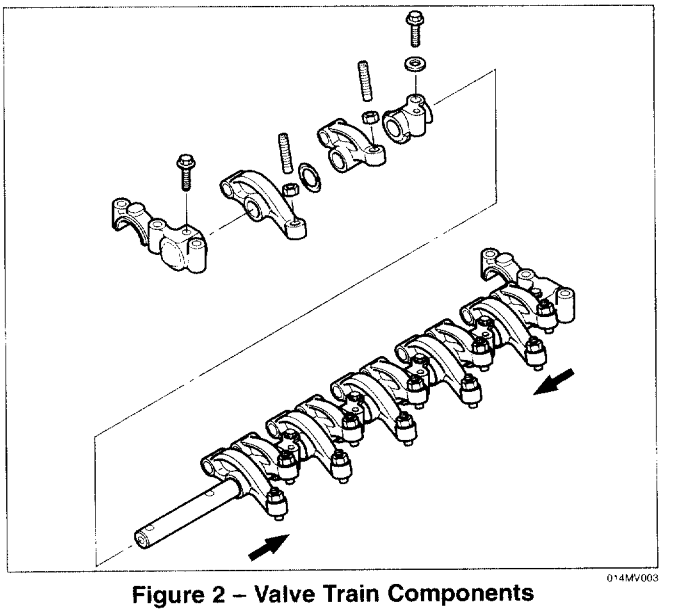


Figure 2 – Valve Train Components

Important

- Do not remove the rocker arm shaft bracket bolts from the valve rocker arm shaft assembly until the assembly is removed from the vehicle. Place on a work bench before disassembling.

9. Valve rocker arm shaft assembly.
10. Loosen camshaft bearing cap nuts evenly, starting from the outer nut moving to the inner nut.
11. Camshaft assembly.

Important

- Store used components in order so they can be reassembled in the same location.

Disassemble

- Rocker arm shaft bracket bolts, front camshaft bracket, valve rocker arm, valve rocker arm spring, valve rocker arm shaft bracket, and the rear camshaft bracket from the valve rocker arm shaft.

Clean

- Oil and dirt from the valve rocker arm assembly with approved cleaners.

Inspect

- All the valve rocker arm components for excessive scoring and wear. Replace if necessary.

Measure

- Valve rocker arm. Refer to SECTION 6A6B for valve rocker arm specifications.

Install or Connect (Figures 3 and 6)

1. Camshaft to the cylinder head.
2. Camshaft bearing caps to the cylinder head.

Important

- Camshaft bearing caps must be installed in facing front mark to engine front.

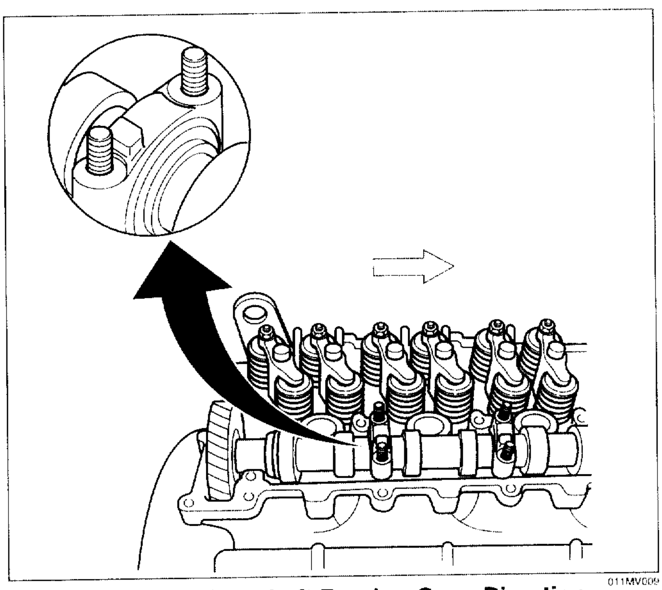


Figure 3 – Camshaft Bearing Caps Direction

3. Tighten camshaft bearing cap to 27 N·m (20 lb·ft).

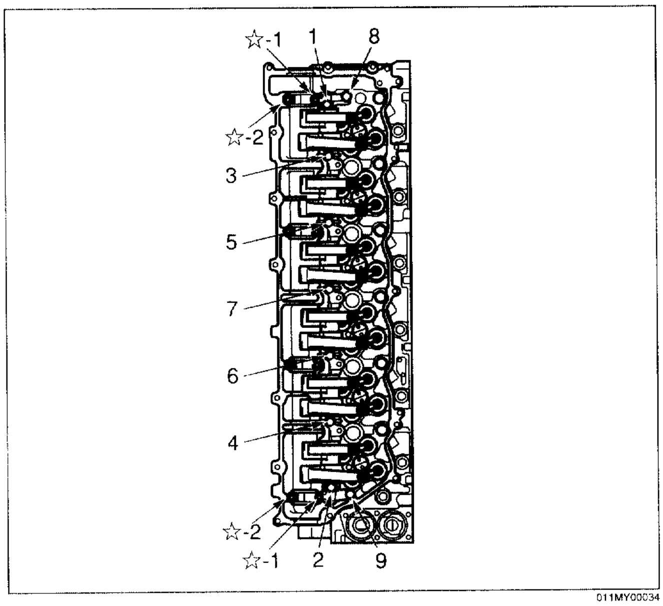


Figure 4 – Rocker Arm Shaft Bracket Tightening Sequence

4. Tighten the valve rocker arm bolts.

Important

- Loosen the valve adjustment bolts completely.
- Tightening sequence must be strictly observed to avoid rocker arm shaft damage due to possible excessive bending.

Tighten (Figure 4)

- First of all tighten star mark 1 nut then tighten star mark 2 nut.
- After tighten star mark 1 and 2, tighten rocker arm shaft bracket bolts in sequence.
  - — Star mark nut 1 and 2 to 27 N·m (20 lb·ft)
  - — Bolts 1 through 7 to 56 N·m (41 lb·ft).
  - — Bolts 8 and 9 to 27 N·m (20 lb·ft).

Adjust

- Refer to SECTION 6A6B for the "Valve Rocker Arm Adjustment" procedure.

5. Apply the sealant to lower surface of lower case and put on the cylinder head.

Tighten

- Bolts 19 N·m (14 lb·ft)

6. Harness assembly.

Tighten

- Bolt 21 N·m (16 lb·ft)

7. Tighten connector nuts to injector
   - Nut 1.4 N·m (12 lb·in)
8. Connect harness connector.
9. Valve rocker arm cover and the gasket to the cylinder head.
10. Valve rocker arm cover bolts.

Tighten

- Valve rocker arm cover bolts to 13 N·m (113 lb·in).

11. Air inlet pipes.
12. Negative battery cables.
13. Lower the cab.

VALVE STEM SEAL AND VALVE SPRING

Tools Required:
J36022 Air Adapter
J43267 Valve Stem Seal Installer
J43263 Valve Spring Compressor

Remove or Disconnect (Figures 5 through 7)

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Air inlet pipes. Refer to SECTION 6J.
4. Valve rocker arm cover. Refer to "Valve Rocker Arm Cover" in this section.
5. Valve rocker arm shaft assembly. Refer to "Valve Rocker Arm" in this section.
6. Valve bridge.
7. Glow plugs.
8. Valve keys.
   A. Install J36022 adapter at the glow plug hole into the cylinder head.
   B. Apply compressed air to hold the valves in place.
   C. Install J43263 to the cylinder head and compress the valve spring.
   D. Remove the valve keys.
   E. Carefully release the valve spring tension.
9. Valve spring retainers.
10. Inner and outer valve springs.
11. Valve spring seats.
12. Valve stem seals.

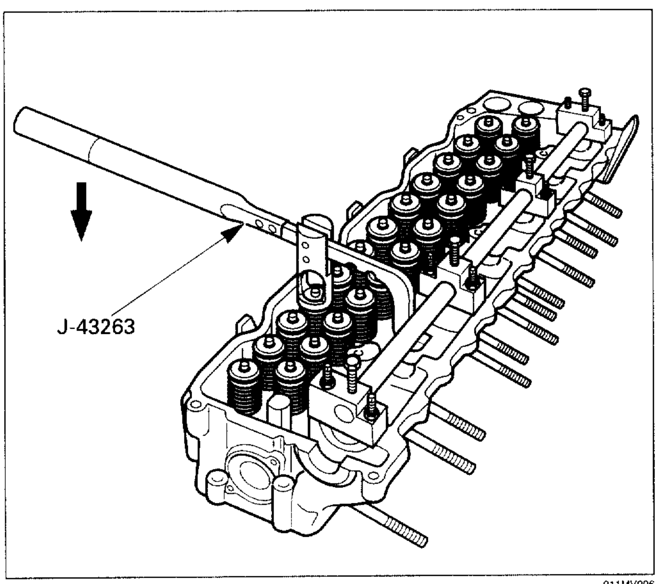


Figure 5 – Compressing the Valve Spring

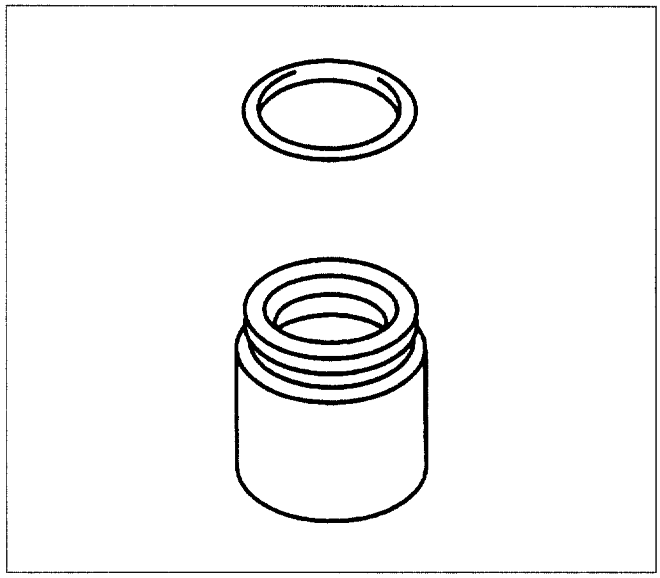


Figure 6 – Valve Seal

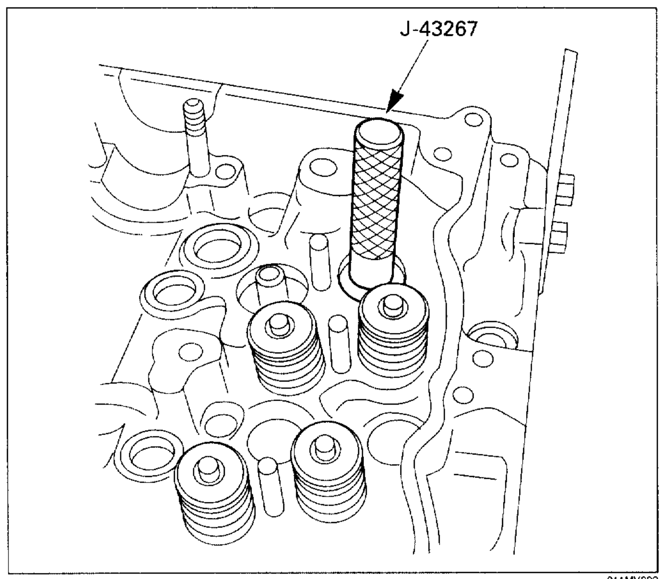


Figure 7 – Installing the Valve Seal

Install or Connect (Figures 5 through 7)

- Lubricate the new valve stem seals with clean engine oil.
- Valve stem seals using J43267.

1. Valve stem seals.
2. Valve spring seats.
3. Inner and outer valve springs.
4. Valve spring retainers.
   A. With compressed air applied to the cylinder, compress the valve spring using J43263.
   B. Install the valve keys.
   C. Carefully release the valve spring tension. Make sure the valve keys stay in place.
   D. Remove J43263.
   E. Remove J36022.
5. Valve bridge.
6. Glow plugs.
7. Valve rocker arm assembly. Refer to "Valve Rocker Arm" in this section.
8. Valve rocker arm cover.

9. Air inlet pipes.
10. Negative battery cables.
11. Lower the cab.

INTAKE MANIFOLD

Remove or Disconnect (Figures 8 and 9)

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Air inlet pipes and brackets. Refer to SECTION 6J.
4. Coolant over flow hose bracket from the intake manifold. Refer to SECTION 6B.

Important

- Do not bend the fuel injector lines in any shape or form to ease the removal of the intake manifold.

5. Fuel lines from the fuel common rail to the fuel injector. Refer to SECTION 6C2.
6. Fuel lines from supply pump to fuel common rail.

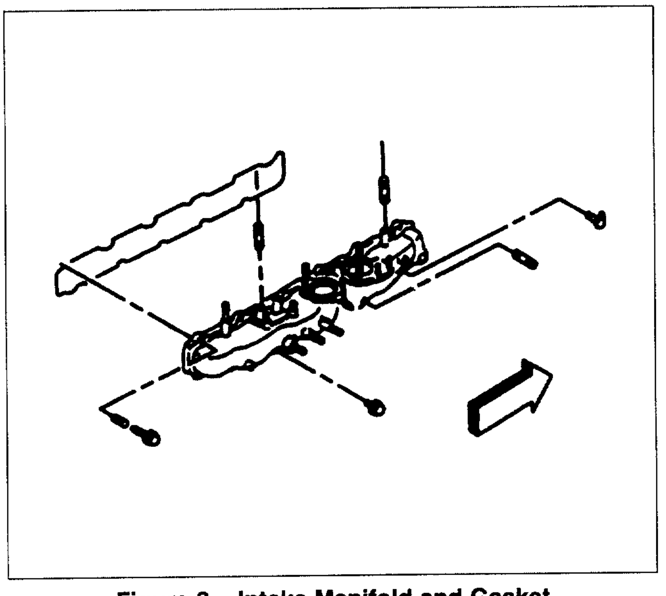


Figure 8 – Intake Manifold and Gasket

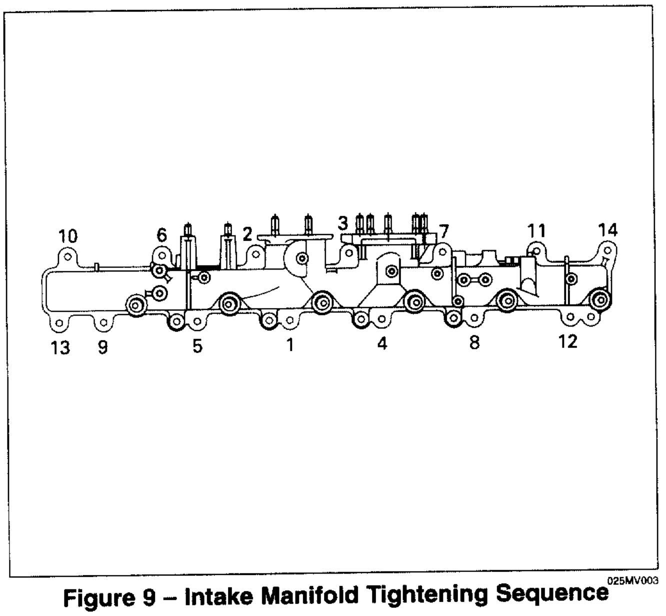


Figure 9 – Intake Manifold Tightening Sequence

7. Fuel injector return line from the fuel injector, fuel common rail and the fuel supply pump. Refer to SECTION 6C2.
8. Fuel filter and the bracket from the intake manifold. Refer to SECTION 6C2.
9. Intake manifold bolts.
10. Intake manifold and the gasket.

Inspect

- Intake manifold for cracks or damage to the gasket mating surfaces.

Install or Connect (Figures 8 and 9)

1. Intake manifold and gasket to the cylinder head.
2. Intake manifold bolts and nuts.
3. Fuel common rail.

Tighten

- Intake manifold bolts to 15 N·m (130 lb. in.).

4. Fuel lines from the supply pump to the fuel common rail.
5. Fuel lines from the common rail the fuel injector.
6. Fuel injector return line from fuel injector, fuel common rail and the fuel supply pump.
7. Fuel filter and the bracket to the intake manifold.
8. Fuel lines to the fuel filter and to the fuel supply pump.
9. Negative battery cables.
10. Lower the cab.

EXHAUST MANIFOLD

Remove or Disconnect (Figure 10)

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Turbocharger assembly. Refer to SECTION 6J.
4. Exhaust heat shield.
5. Exhaust manifold nuts, bolts, washers, and the spacers.
6. Exhaust manifold and the gasket.

Inspect

- Exhaust manifold for cracks or damage.

Measure

- Use a straight edge to check the flatness of the exhaust manifold. If a gap of 0.4 mm (0.015 in.) or more exists, replace the exhaust manifold.

Install or Connect (Figure)

1. Exhaust gasket and the exhaust manifold.
2. Exhaust manifold bolts, washers, spacers and the nuts.

Tighten

- Exhaust manifold bolts and nuts to 34 N·m (25 lb. ft).

3. Exhaust manifold heat shield.
4. Turbocharger assembly.
5. Negative battery cables.
6. Lower the cab.

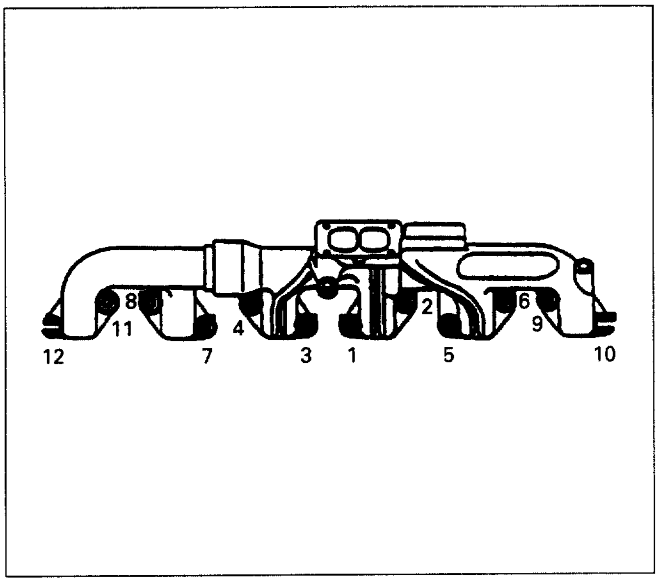


Figure 10 – Exhaust Manifold

CYLINDER HEAD

Remove or Disconnect (Figures 11 through 14)

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Drain the cooling system. Refer to SECTION 6B.
4. Air inlet pipes. Refer to SECTION 6J.
5. Turbocharger assembly. Refer to SECTION 6J.
6. Intake manifold assembly. Refer to "Intake Manifold" in this section.
7. Exhaust manifold assembly. Refer to "Exhaust Manifold" in this section.
8. Heat shield and bracket.
9. Valve rocker arm cover. Refer to "Valve Rocker Arm Cover" in this section.
10. Valve rocker arm and camshaft from the cylinder head. Refer to "Valve rocker arm and camshaft" in this section.
11. Fuel injector nozzles. Refer to SECTION 6C2.
12. Coolant line from the air compressor to the cylinder head.
13. Glow plugs. Refer to SECTION 6D6.
14. Air compressor line bracket from the rear of the cylinder head. Refer to SECTION 5J.
15. Cylinder head bolts from the cylinder head.
16. Cylinder head and the gasket from the engine.

Clean

- Carbon deposits from the combustion chambers.
- All traces of the old cylinder head gasket from the cylinder head and the engine block.
- Cylinder head bolt threads using a wire brush
- Metal chips and dirt from the threads in the cylinder block.

Inspect

- Cylinder head for cracks or damaged parts.
- Threaded parts for wear or damage.

Measure

- Use a straight edge to check the flatness of the cylinder head. If the cylinder head has more than 0.2 mm (0.0078 in.) gap between the straight edge and the surface of the cylinder head, replace the cylinder head. Refer to SECTION 6A6B.

Install or Connect (Figures 10 through 14)

1. Cylinder head and the gasket to the engine block.
   - Apply sealant to the rear corners of the cylinder block.
   - Install the cylinder head gasket with the part number facing up.
2. Cylinder head bolts to the cylinder head.

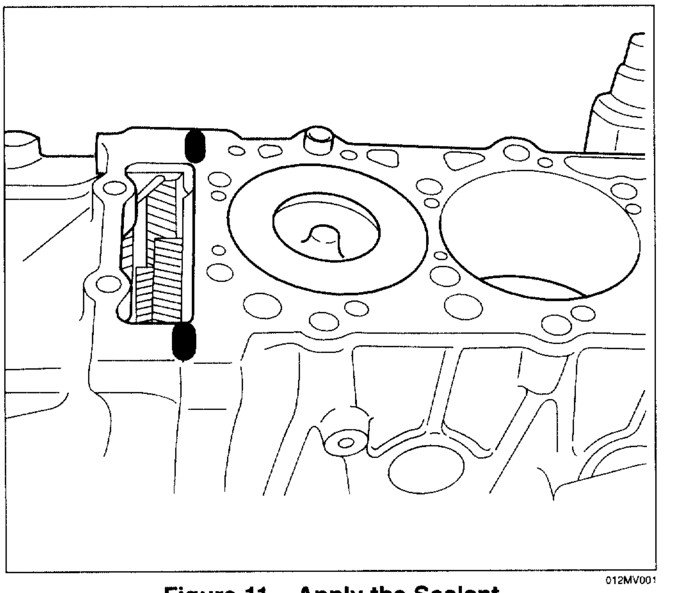


Figure 11 – Apply the Sealant

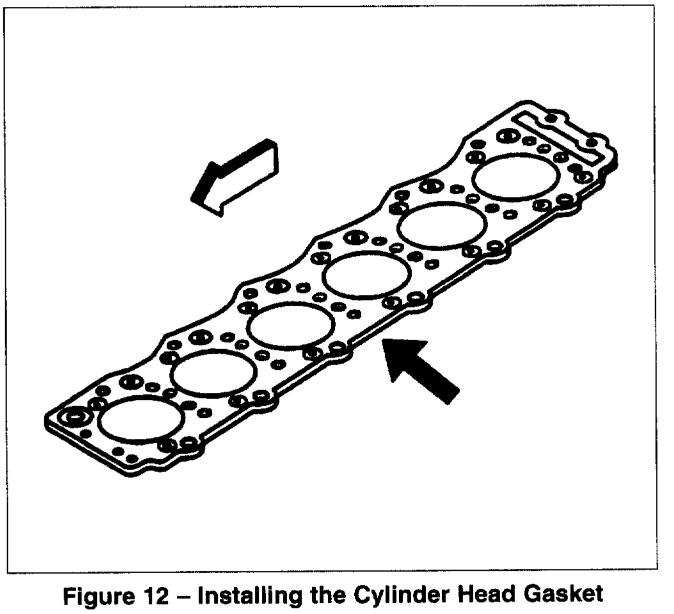


Figure 12 – Installing the Cylinder Head Gasket

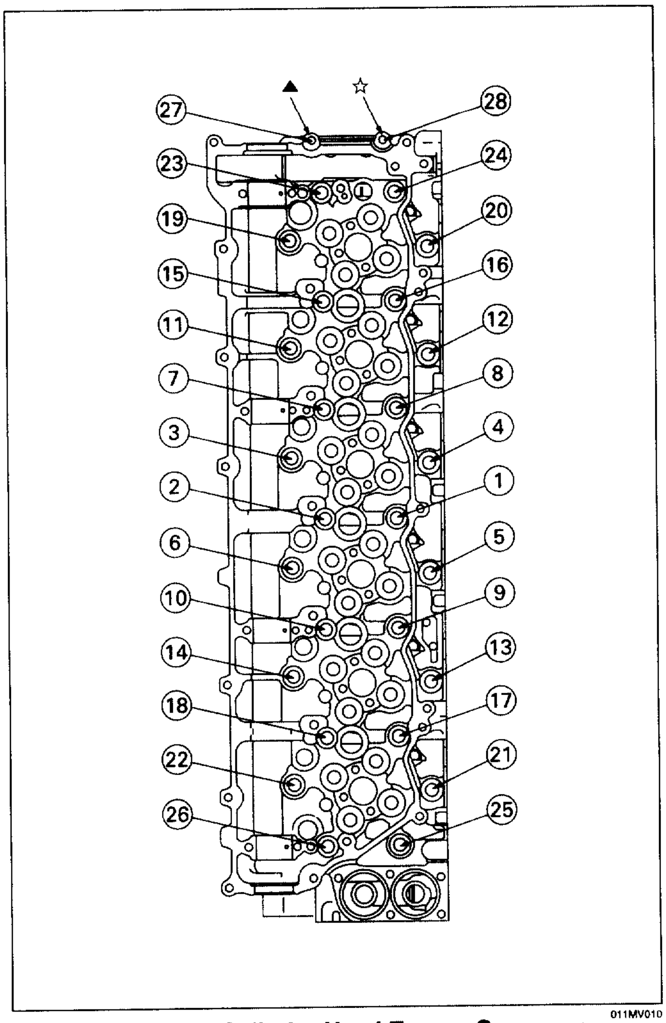


Figure 13 – Cylinder Head Torque Sequence

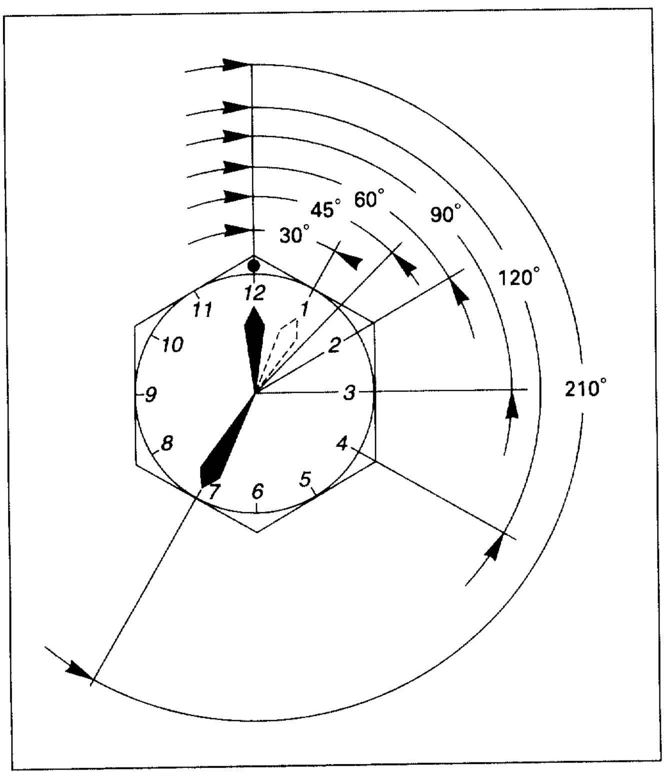


Figure 14 – Final Torque Step

Tighten

- Cylinder head bolts in the following steps.

For M14 Bolts

- Apply molybdenum disulfide grease to thread and contact surface of washer.
- Tighten cylinder head bolt and follow the tightening order 1 to 26.
  - — 98 N·m (72 lb·ft.).
  - — 147 N·m (108 lb·ft.).
  - — Turn all the cylinder head bolts an additional 45 degree.

For M10 Bolts

- Apply engine oil to threads and follow the tightening order number 27 to 28.
  - — 39 N·m (28 lb·ft.)

3. Camshaft and valve rocker arm to the cylinder head. Refer to "Valve rocker arm and Camshaft" in this section.
4. Valve rocker arm cover.
5. Coolant line from the air compressor to the cylinder head.
6. Air compressor lines and the bracket to the rear of the cylinder head.
7. Glow plugs.
8. Fuel injector nozzles.
9. Valve rocker arm cover.
10. Exhaust manifold. Refer to "Exhaust Manifold" in this section.
11. Intake manifold. Refer to "Intake Manifold"" in this section.
12. Turbocharger assembly. Refer to SECTION 6J.
13. Air inlet pipes.
14. Negative battery cables.
15. Lower the cab.

Important

- Check the cylinder head bolts faulty, and its using limit is six times. If a problem is found, replace as necessary.

CYLINDER HEAD REPAIR

- Refer to SECTION 6A6B for cylinder head repair.

CRANKSHAFT BALANCER (EXTERNAL) FRONT COVER AND FRONT COVER OIL SEAL

Tools Required:

J.39046 Crankshaft Balancer (External) Remover and Installer
J41220 Oil Slinger Remover
J41221 Oil Seal Installer

Remove or Disconnect (Figures 15 through 16)

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Drive belts. Refer to SECTION 6B.
4. Crankshaft balancer bolts and washers from the crankshaft balancer.
5. Crankshaft balancer bolt and the washer.
6. Crankshaft balancer from the crankshaft.
7. Front cover seal.
   - Carefully pry out the seal with a screw driver. Do not damage the front cover.
8. Front cover bolts.
9. Front cover.

Important

- Oil slinger must be replaced if the front cover oil seal has been removed.
- Install J41220 and remove the oil slinger.

Install or Connect (Figures 17 through 20)

1. Oil slinger.
   - Install J41221.
     A. Apply clean engine oil to the oil slinger.
     B. Insert the oil slinger into the adapter.
     C. Install the oil slinger sleeve to the adapter, and tighten the center bolt until the sleeve comes in contact with the adapter and stops.
     D. After pressing in the oil slinger, make sure that the distance between the crankshaft end surface and the oil slinger is, 11.5 ± 0.15 mm (0.453 ± 0.006 in.).
        - Check the measurement at several different points.
2. Apply the sealant on the cylinder block then install the front cover.
3. Front cover bolts.

Tighten

- Bolts to 19 N·m (14 lb·ft).

4. Front cover seal.
   - Install J41221.
     A. Apply clean engine oil to the oil seal.
     B. Insert the oil seal into the adapter.
     C. Install the oil seal to the adapter, and tighten the center bolt until the sleeve comes in contact with the adapter and stops.
     D. After pressing in the oil seal, make sure that the distance between the crankshaft end surface and the oil seal is 8.5 ± 0.15 mm (0.335 ± 0.005 in.).
     - Check the measurement at several different points.

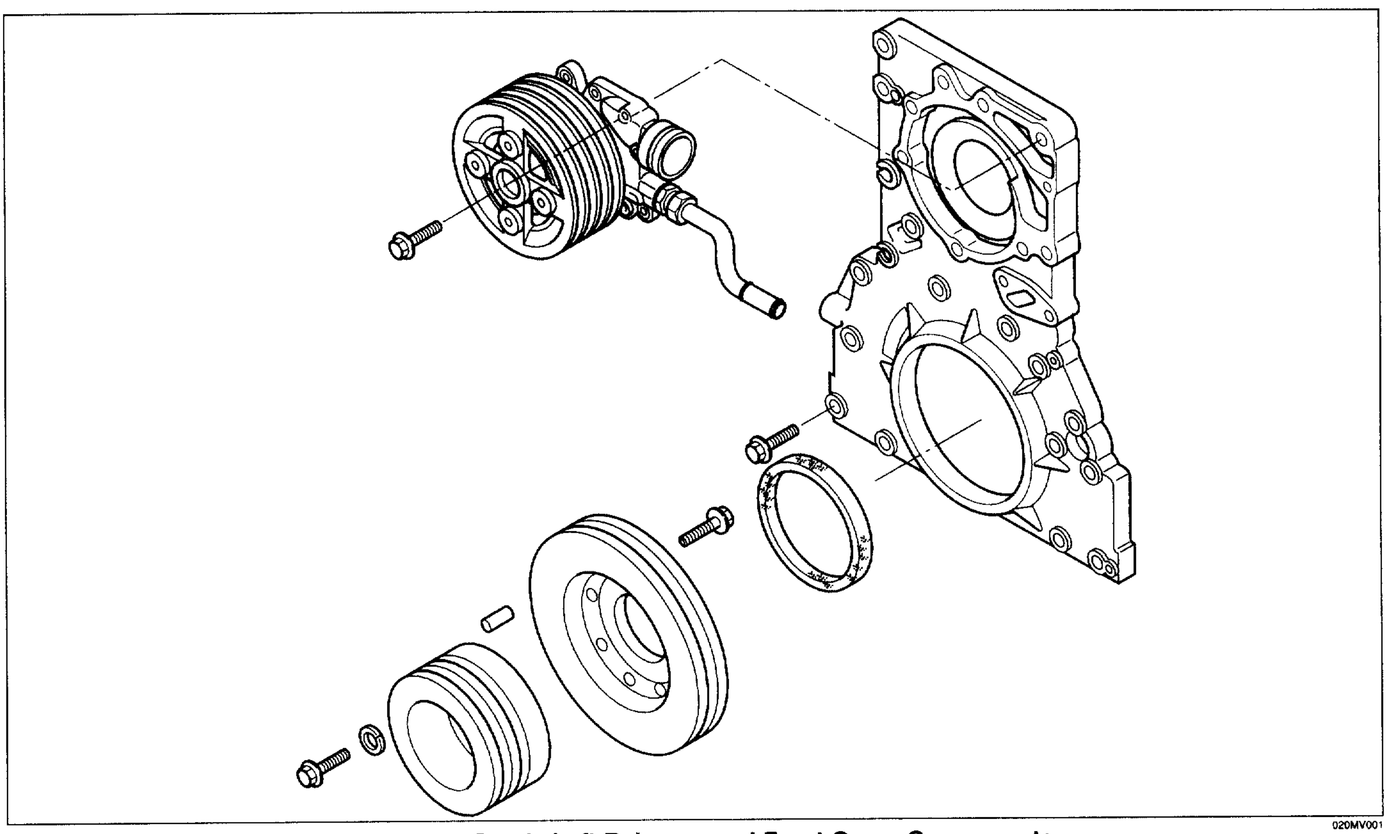


Figure 15 – Crankshaft Balancer and Front Cover Components

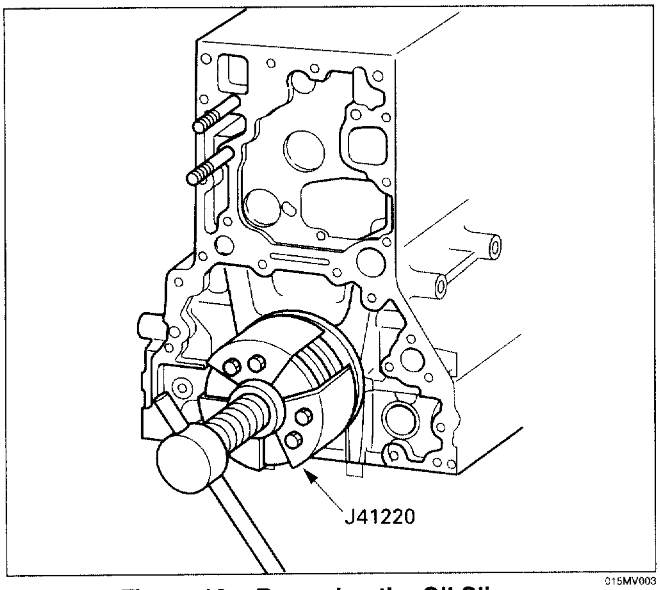


Figure 16 – Removing the Oil Slinger

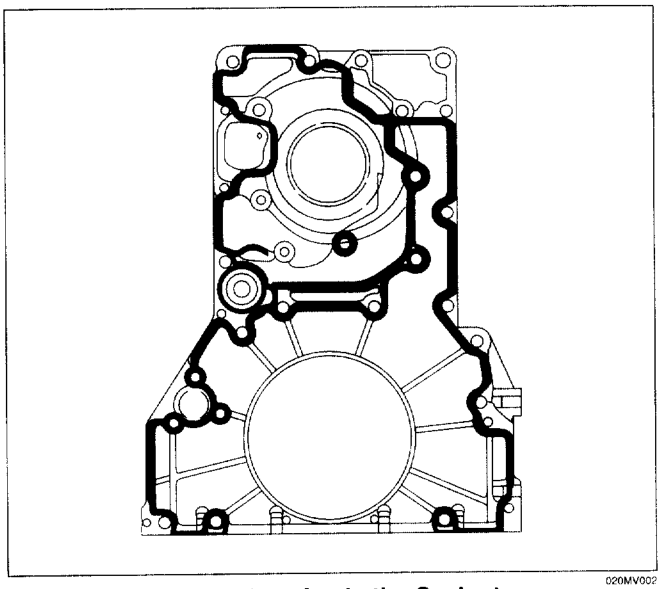


Figure 17 – Apply the Sealant

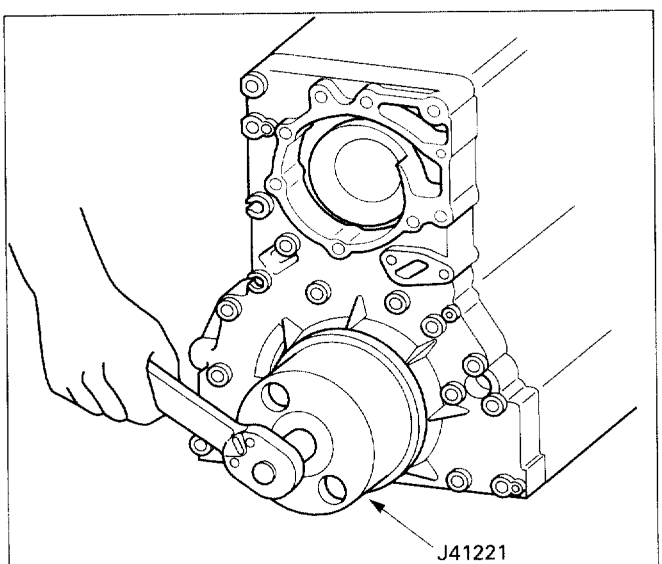


Figure 18 – Install Oil Seal and Slinger

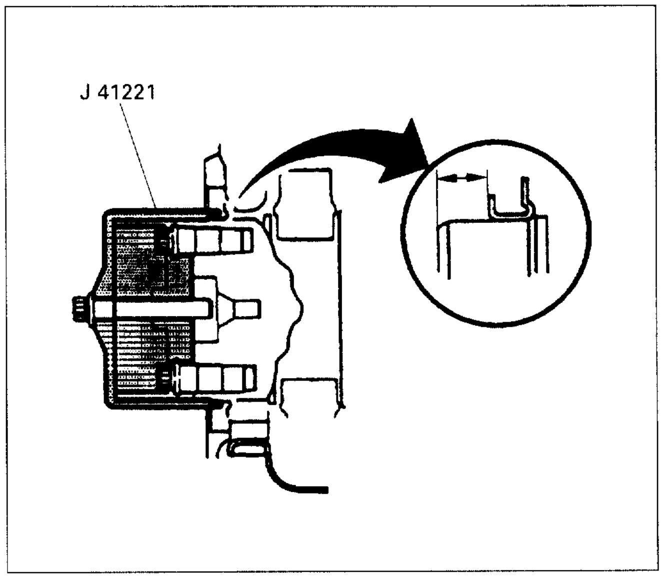


Figure 19 – Checking the Slinger Clearance

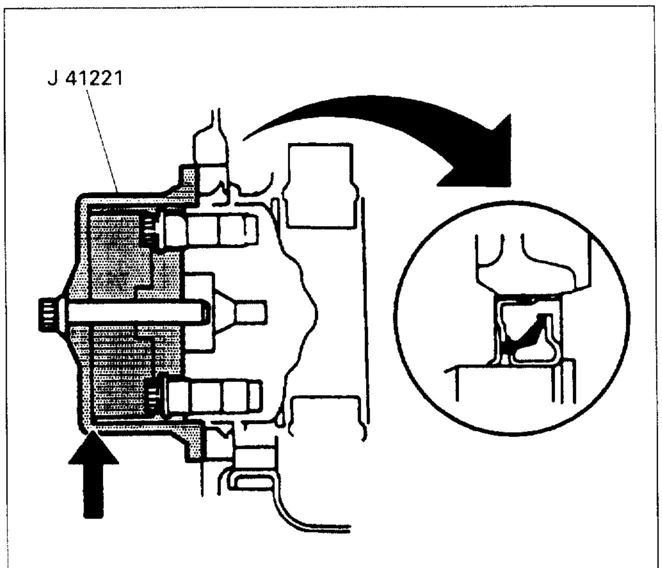


Figure 20 – Checking the Seal Clearance

Inspect

- Crankshaft balancer for excessive wear or damage.
- Crankshaft balancer for silicone leakage. If leakage appears, replace the crankshaft balancer.

5. Crankshaft balancer, bolts and washers.

Tighten

- Crankshaft balancer bolts and nuts to 48 N·m (35 lb·ft).

6. Crankshaft balancer to the crankshaft.
7. Crankshaft balancer bolt and washer to the crankshaft.

Tighten

- Crankshaft balancer bolt and washer to 200 N·m (148 lb·ft).

8. Drive belts.
9. Negative battery cables.
10. Lower the cab.

OIL PAN

Remove or Disconnect

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
   - Drain the crankcase.
3. Engine oil level indicator.
4. Bolts from the oil pan.
5. Oil pan.

Clean

- Sealant from the oil pan and the engine block.
- Sludge and dirt from the inside of the oil pan.
- All mating surfaces must be free of oil and dirt.

Install or Connect (Figures 21 through 23)

1. Apply sealant to the oil pan.
2. Apply sealant to the four corners of the cylinder block.
   - Apply a bead of silicone sealant approx. 2 mm (0.08 in.) thick and approx. 3 mm (0.12 in.) wide (Three Bond No. 1207C).
3. Bolts to the oil pan.

Tighten

- Oil pan bolts to 24 N·m (17 lb·ft.)

4. Engine oil level indicator.
5. Negative battery cables.
6. Lower the cab.
   - Fill the crankcase with the proper grade and quantity of engine oil. Refer to SECTION 0B.

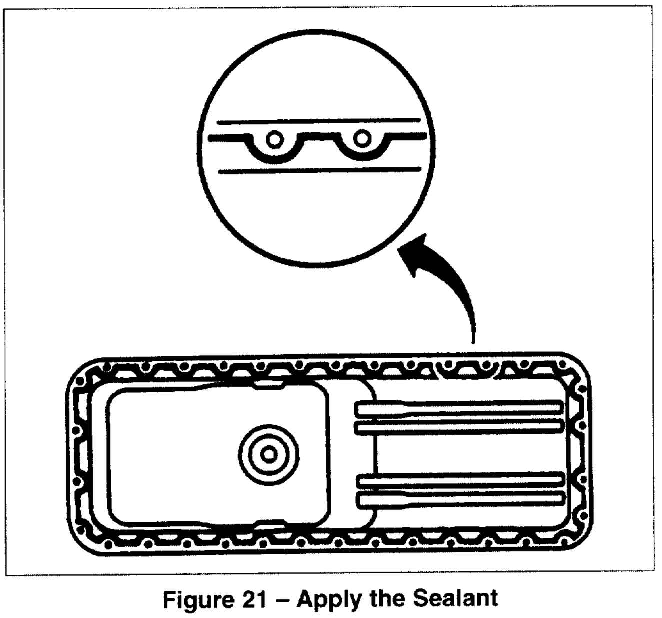
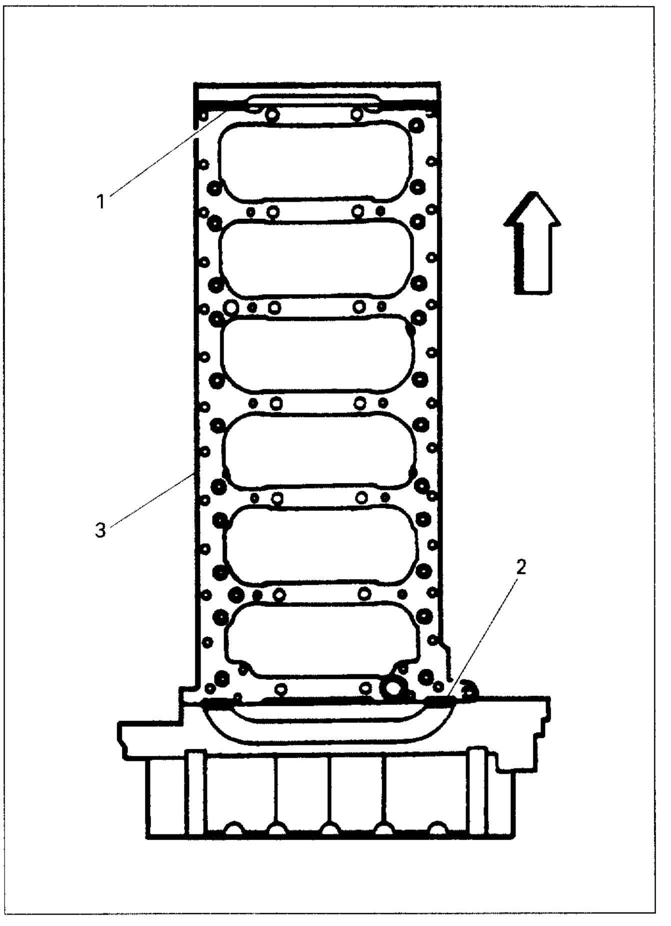


Figure 21 – Apply the Sealant



Legend
(1) Applying the Sealant at the Front Corners
(2) Applying the Sealant at the Rear Corners
(3) Cylinder Block

Figure 22 – Applying the Sealant

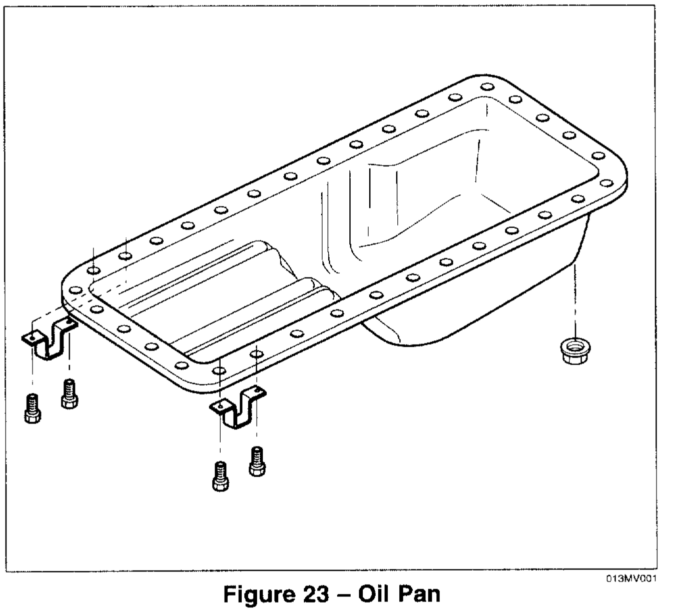


Figure 23 – Oil Pan

OIL PUMP

- For further information, refer to SECTION 6A6B.

OIL PUMP REPAIR

- For further information, refer to SECTION 6A6B.

CRANKSHAFT REAR OIL SEAL

Tools Required:
J41220 Oil Slinger Remover
J41221 Oil Seal Installer

Remove or Disconnect (Figure 24)

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Raise the vehicle.
   - Support the engine with a suitable stand.
4. Transmission assembly. Refer to SECTION 7A6 for automatic transmission, or SECTION 7B for manual transmission.
5. Flywheel or clutch. Refer to SECTION 7C.
6. Oil slinger and the rear crankshaft oil seal.
   - Install J41220 and remove the oil slinger and oil seal.

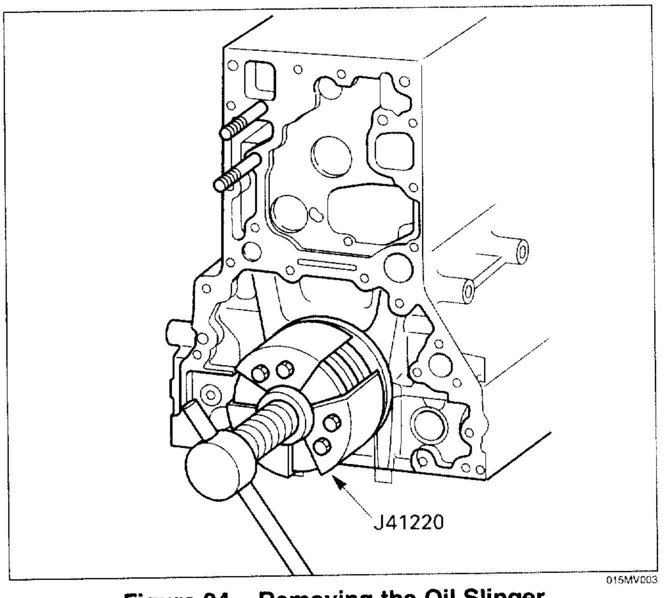


Figure 24 – Removing the Oil Slinger

Important

- Crankshaft rear oil slinger is gray. Front cover oil slinger is black.

Install or Connect (Figure 25 through 28)

1. Oil slinger.
   - Install J41221.
     A. Do not apply engine oil to the oil slinger inside surface.
     B. Insert the oil slinger into the adapter.
     C. Install the oil slinger sleeve to the adapter, and tighten the center bolt until the sleeve comes in contact with the adapter and stops.
     D. After pressing in the oil slinger, make sure that the distance between the crankshaft end surface and the oil slinger is (1) 10.5 ± 0.15 mm (0.413 ± 0.006 in.).
     - Check the measurement at several different points.

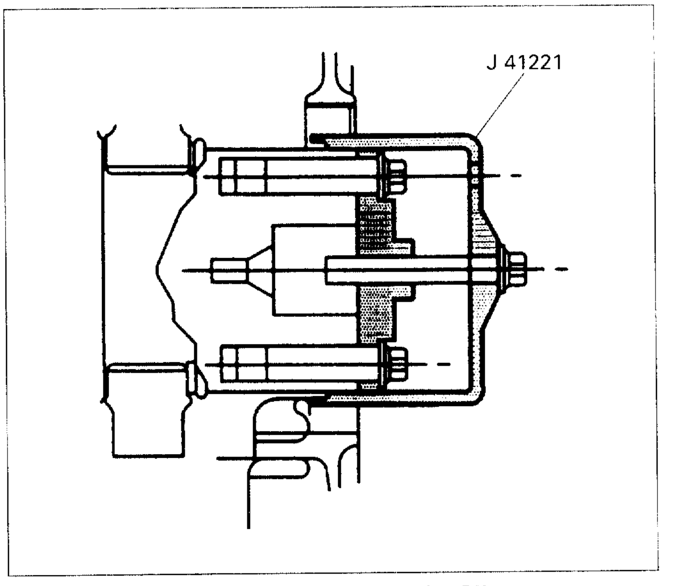
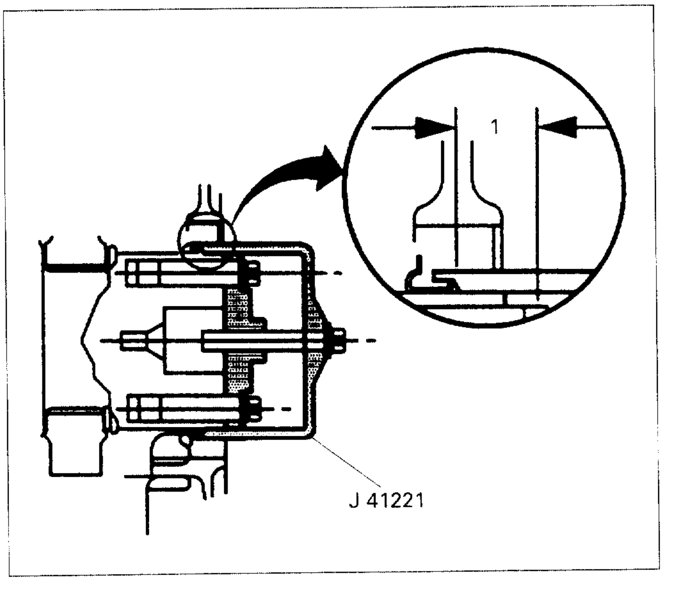


Figure 25 – Installing the Oil Slinger



Legend
(1) Measuring the Depth
Figure 26 – Measuring the Installed Depth

2. Crankshaft rear seal.
   - Install J41221.
     A. Apply clean engine oil to the oil seal lip. Do not apply engine oil to outside surface.
     B. Insert the oil seal adapter.
     C. Install the oil seal to the adapter, and tighten the center bolt until the sleeve comes in contact with the adapter and stops.

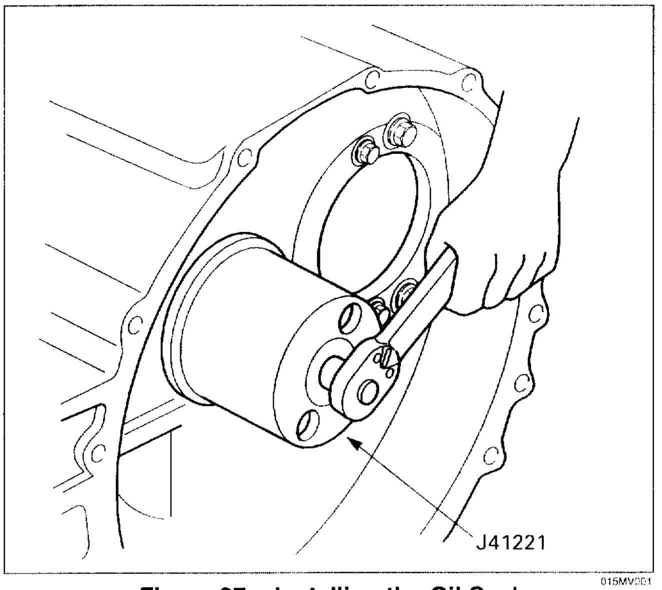
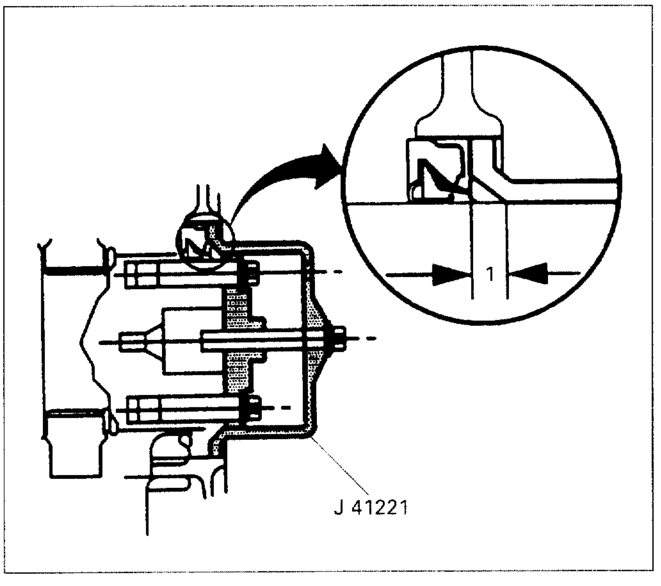


Figure 27 – Installing the Oil Seal



Legend
(1) Measuring the Depth

Figure 28 – Measuring the Installed Depth

D. After pressing in the oil seal, make sure that the distance between the crankshaft end surface and the oil seal is (1) 7.5 ± 0.15 mm (0.295 ± 0.006 in.).
   - Check the measurement at several different points.

3. Flywheel or clutch. Refer to SECTION 7C.
4. Transmission assembly.
   - Remove engine support.
5. Lower the vehicle.
6. Negative battery cables.
7. Lower the cab.

CAMSHAFT

Tools Required:
J 22888-D Crankshaft Sprocket Puller

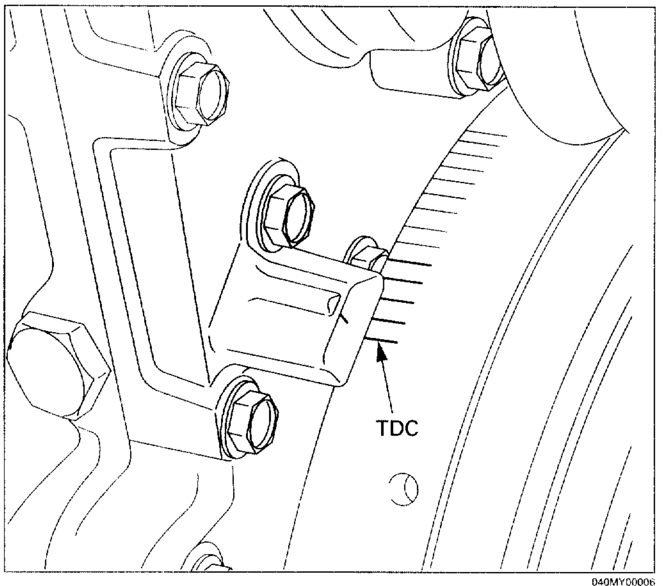


Figure 29 – Timing Marks

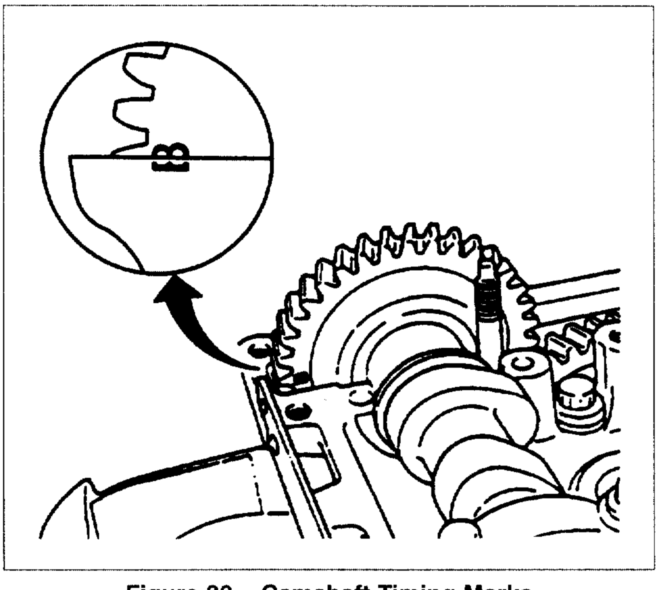


Figure 30 – Camshaft Timing Marks

Remove or Disconnect (Figures 29 through 34)

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Glow plugs. Refer to SECTION 6D6.
4. Valve rocker arm cover. Refer to "Valve Rocker Arm Cover" in this section.
5. Rotate the engine to top dead center and align the timing marks on the camshaft (B).
6. Both connector on the injector and from engine harness.
7. Harness assembly.
8. Loosen the valve rocker arm adjusters, but do not remove them.
9. Loosen the valve rocker arm shaft bracket bolts evenly, starting from the outside bolts moving to the inner bolts.
10. Valve rocker arm assembly.
11. Loosen camshaft bearing cap nuts evenly starting from the outer nut moving to the inner nut.
12. Camshaft assembly with gear.

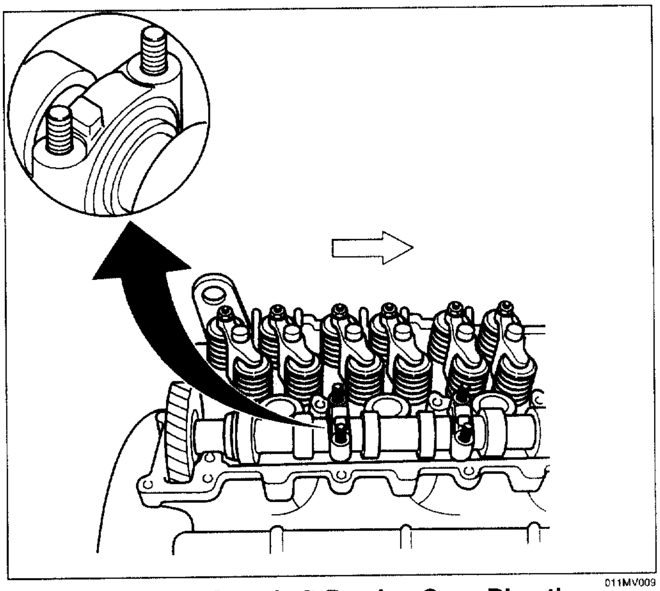


Figure 31 – Camshaft Bearing Caps Direction

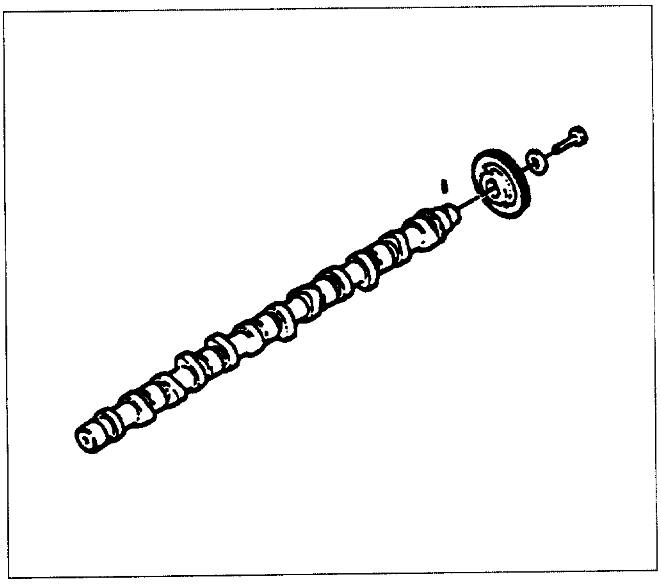


Figure 32 – Camshaft and Components

Important

- Do not remove the rocker arm shaft bracket bolts from the valve rocker arm shaft assembly.

13. Gear from the camshaft.
    - Install J22888-D on gear.
    - Remove the gear.

Clean

- Camshaft gear bore and keyway.

Inspect

- Camshaft for excessive wear on the lobes and the bearing surfaces.
- Camshaft gear for chips or broken teeth.

Measure

- Camshaft
- Refer to SECTION 6A6B in this manual for the camshaft specifications.

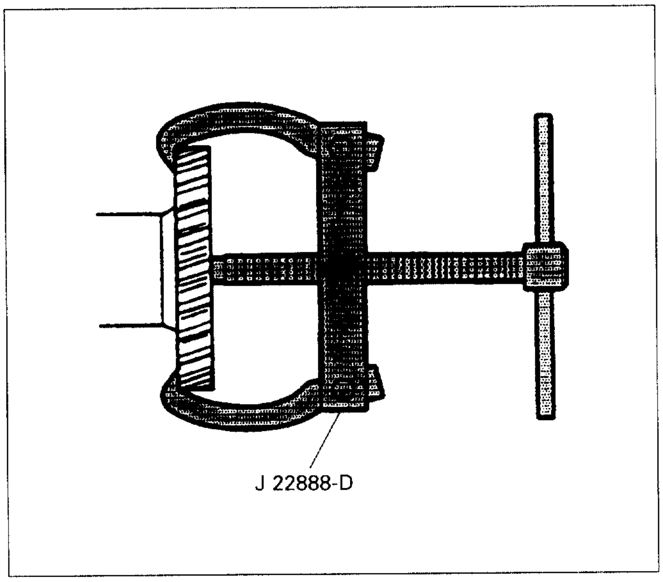


Figure 33 – Removing the Camshaft Gear

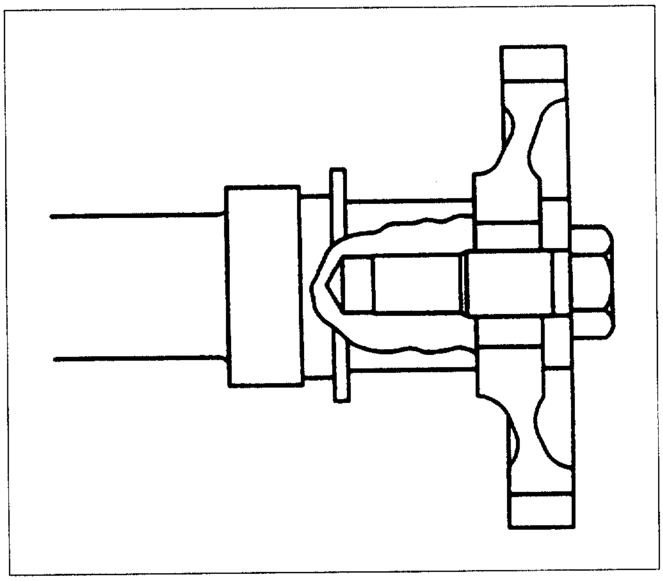


Figure 34 – Installing the Camshaft Gear

Install or Connect (Figures 31 and 34)

1. Gear to the camshaft.
2. Bolt to the camshaft.

Tighten

- Camshaft gear bolt to 142 N·m (105 lb·ft).

3. Camshaft and bearing cap to the cylinder head. Refer to "Valve Rocker Arm and Camshaft" in this section.
4. Valve rocker arm assembly to the cylinder head. Refer to "Valve Rocker Arm and Camshaft" in this section.

Adjust

- Valve Rocker Arms.
- Refer to SECTION 6A6B, for the valve rocker arm adjustment procedure.

5. Valve rocker arm cover and gasket to the cylinder head.
6. Valve rocker arm cover bolts.

Tighten

- Valve rocker arm cover bolts to 13 N·m (113 lb·in).

7. Glow plugs.
8. Negative battery cables.
9. Lower the cab.

CONNECTING ROD AND PISTON

1. Remove the engine assembly. Refer to "Engine" in this section.
2. Refer to "Engine Overhaul" in SECTION 6A6B.

CRANKSHAFT MAIN BEARING

1. Remove the engine. Refer to "Engine" in this section.
2. Refer to "Engine Overhaul" in SECTION 6A6B.

CRANKSHAFT

1. Remove the engine. Refer to "Engine" in this section.
2. Refer to "Engine Overhaul" in SECTION 6A6B.

FLYWHEEL

Remove or Disconnect (Figure 35)

1. Negative battery cables. Refer to SECTION 6D1.
2. Raise the vehicle.
3. Transmission assembly. Refer to SECTION 7A6 for automatic transmission, or SECTION 7B for manual transmission.
4. Clutch assembly, (if equipped). Refer to SECTION 7C.
5. Bolts and spacer.
6. Flywheel assembly. Refer to SECTION 7A.

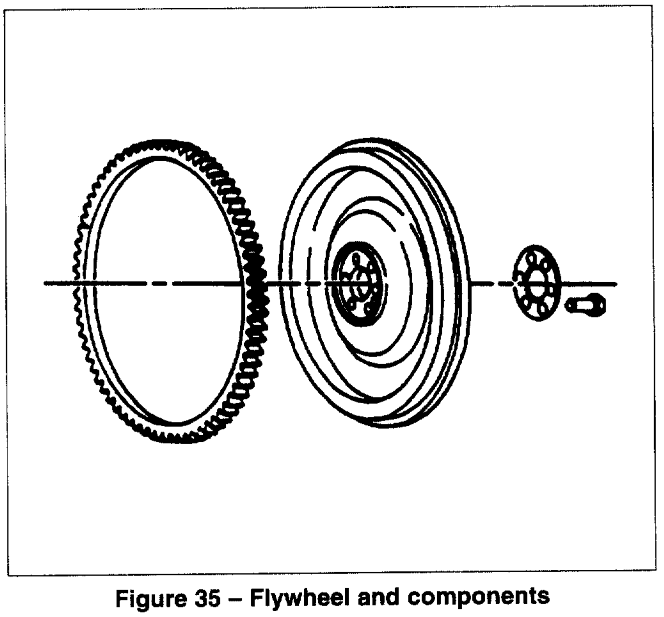


Figure 35 – Flywheel and components

Inspect

- Flywheel for burning, scoring, warping or excessive wear.
- Flywheel ring gear for worn or broken teeth.

FLYWHEEL RING GEAR

Remove or Disconnect (Figure 35)

1. Use a torch to heat the flywheel ring gear evenly.

NOTICE: ***Never heat the flywheel ring gear to red hot. This will change its metal structure and could cause damage to the ring gear or flywheel***

2. Drive the flywheel ring gear off with a hammer and a drift.
3. Heat the flywheel ring gear evenly to allow the ring gear fit on the flywheel. Do not allow the temperature exceed 120 deg C (250 deg F).
4. Ring gear to the flywheel, as soon as it is heated (Figure 36).

Install or Connect (Figure 35)

1. Flywheel to the crankshaft.
2. Bolts and spacer to the flywheel, (apply a small amount of molybdenum to the bolts). Refer to SECTION 7A, for the proper bolt tightening sequence.
3. Clutch to the flywheel.
4. Transmission assembly to the engine.
5. Lower the vehicle.
6. Negative battery cables.

ENGINE MOUNTS

Cushion-type mountings are used at both the front and the rear of the engine.

INSPECTING ENGINE MOUNTS

NOTICE: ***Broken or deteriorated mounts can cause misalignment and eventually destroy certain drive train components. Also, when a single mount breaks, the remaining mountings are subjected to abnormally high stresses, which may lead to early wear and breakage.***

Engine mounts should be inspected periodically and replaced if any damaged or deteriorated mounts are found.

Check the engine mounting brackets for cracks or elongated bolt holes. Replace the brackets if necessary. Check the mounting fasteners for the correct torque. Refer to "Specifications" at the end of this section. Inspect the rubber parts for deterioration and replace if needed.

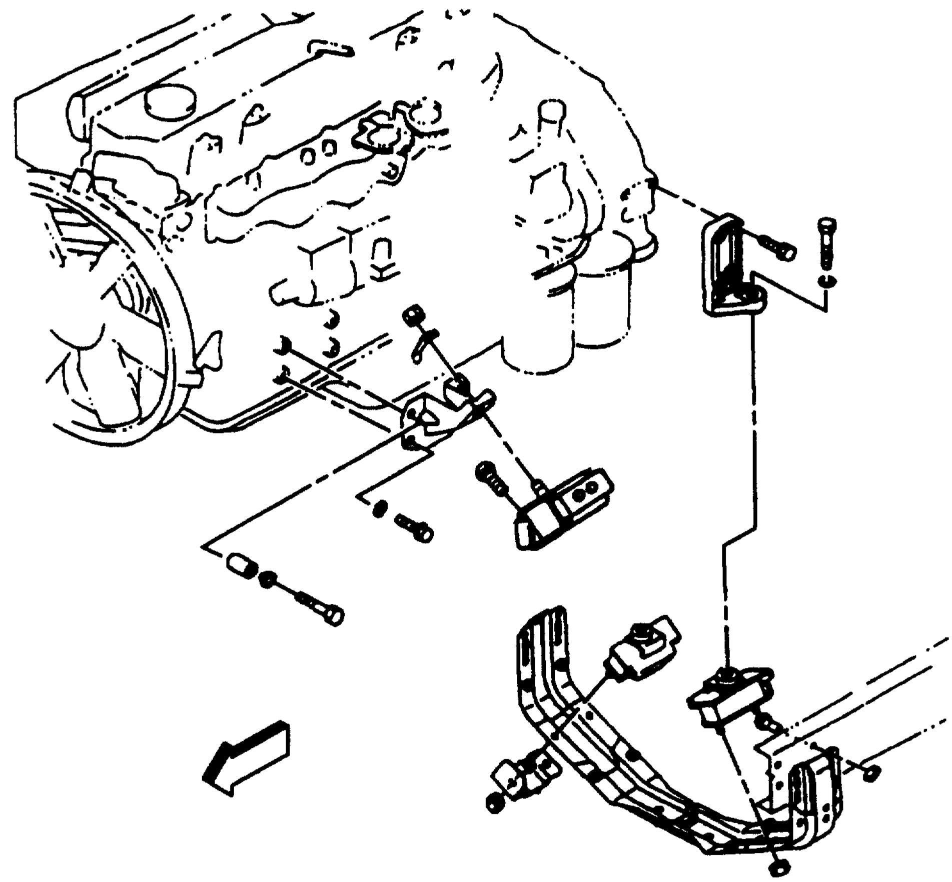


Figure 36 – Engine Mounts

FRONT ENGINE MOUNT

Remove or Disconnect (Figure 36)

NOTICE: ***When the raising or supporting the engine, do not use a jack under the oil pan, any sheet metal, or crankshaft pulley. Jacking against these parts may cause damage.***

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Engine mounting nuts and washers from the mounting bracket to the front mount.

NOTICE: ***When supporting the engine to replace a mount, raise the engine only to the height required to provide clearance for the mount removal. It may be necessary to drain the cooling system and disconnect hoses to avoid damage when the engine is raised. Be careful that control linkage and wiring are not damaged from raising the engine. When replacing a single front mount, both mounts should be detached before attempting to raise the engine. Failure to do this will place excessive stress on the attached mounts when the engine is raised.***

4. Bolts and nuts from the frame to the front mounts.
5. Raise the front of the engine.
   - Provide lifting equipment to safely support and raise the front of engine as required.
   - Raise the engine enough to permit removal of the mounting cushions.
6. Remove the front mounting cushion, spacers, washers as required.
7. Mounting bracket bolts and washers (if used).
8. Mount the front bracket to the engine, (if necessary).

Important

- Any vehicle components held in place by the engine mounting fasteners must be supported before the fasteners are removed.

Install or Connect

1. Mounting bracket to the engine, (if necessary).

   Tighten

   - Mount bracket bolt to 78.5 N·m (58 lb·ft).
2. Mounting bracket bolts and washers.

   Tighten

   - Mounting bolts and nuts to 64 N·m (47 lb·ft).

3. Front engine mounts to the bracket, (install nuts and washers to hold them in place).
4. Lower the engine.
5. Mounting bolts to the frame.

Tighten

- Mounting nuts to 83 N·m (61 lb·ft).
- Mounting bolts to 36 N·m (27 lb·ft).

6. Negative battery cables.
7. Lower the cab.

REAR ENGINE MOUNT

Remove or Disconnect (Figure 36)

1. Through bolts and the washers from both of the rear engine mount brackets.

NOTICE: ***When supporting the engine to replace a mount, raise the engine only to the height required to provide clearance for the mount removal. It may be necessary to drain the cooling system and disconnect hoses to avoid damage when the engine is raised. Be careful that control linkage and wiring are not damaged from raising the engine. When replacing a single front mount, both mounts should be detached before attempting to raise the engine. Failure to do this will place excessive stress on the attached mounts when the engine is raised.***

2. Raise the engine.
3. Rear mounting bolts and nuts.
4. Rear engine mounts from the mounting brackets.
5. Nuts and washers from the rear mounts.
6. Rear mounts from the frame rail.

Install or Connect

1. Rear mounts to the frame rail.
2. Nuts, bolts, and washers to the rear mounts and tighten.

Tighten

- Bolts and nuts to 108 N·m (80 lb·ft).

3. Rear mounting brackets to the engine.

Tighten

- Rear mount bracket bolt to 75.5 N·m (56 lb·ft).

4. Lower the engine.
5. Through bolts to the rear mounts.
6. Tighten through bolts.

Tighten

- Bolts to 294 N·m (217 lb·ft).

ENGINE

NOTICE: ***If the engine is damaged internally and a new engine assembly is installed in the vehicle, make sure all foreign material is completely flushed out of the cooling system. The oil cooler system should also be flushed out (if equipped). Failure to rid the oil or cooler system of debris can result in engine damage to the replacement engine.***

The procedure required to replace an engine varies according to the optional equipment, and available shop facilities. The following procedure is intended only as a guide for performing the work. The technician must determine what additional work is needed.

It is important to note "CAUTIONS" and "NOTICES" against the use of some specific service methods that can harm personnel, damage the vehicle or make it unsafe. A technician who uses a service procedure or tools which are not recommended must be thoroughly satisfied that neither the safety of personnel, nor safety of the vehicle will be jeopardized by the service method selected.

NOTICE: ***On some vehicles it may be necessary to support the transmission as the engine is removed to prevent the transmission from falling, causing damage to the unit.***

Remove or Disconnect (Figure 36)

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Drain the cooling system. Refer to SECTION 6B.

CAUTION: If the vehicle is equipped with air conditioning, removal of refrigerant line must be done by trained personnel. Injuries can result from improper procedures.

4. Air conditioning compressor. Refer to SECTION 1B.
5. Air inlet pipes. Refer to SECTION 6J.
6. Air intake housing from the cab bridge.
7. Coolant reservoir, hose and bracket. Refer to SECTION 6B.
8. Cab bridge support. Refer to SECTION 10B.
9. Engine oil level indicator tube.
10. Power steering pump from the engine, (lay to the side). Refer to SECTION 3B.
11. Air compressor and lines, (if equipped). Refer to SECTION 5J.
12. Radiator and charge air cooler assemblies. Refer to SECTION 6B.
13. Radiator and heater hoses. Refer to SECTION 6B.
14. Engine electrical harness from the retainers and the brackets.
15. Engine electrical harness from all the electrical connectors.
16. All ground straps from the engine to the frame.
17. Engine stop and throttle cables. Refer to SECTION 6C2.
18. Fuel line and connectors from the fuel supply pump. Refer to SECTION 6C2.

Important

- Cap the fuel line and the fittings to prevent the fuel from leaking and dirt from entering the fuel system.

19. Engine tachometer drive cable.
20. Engine brake rod, (if equipped).
21. Raise the vehicle.
22. Exhaust pipe from the turbocharger. Refer to SECTION 6J.
23. Exhaust pipe from the muffler. Refer to SECTION 6F.
24. Starter assembly. Refer to SECTION 6D2C.
25. Torque converter bolts from the torque converter, (if equipped). Refer to SECTION 7A.
26. Lower the vehicle.
27. Support the transmission.
    - Use a suitable support.
28. Attach suitable overhead hoist.
29. Front engine mounting bolts.
30. Bolts from the transmission to the engine.
31. Engine from the transmission assembly. Refer to SECTION 7A6 for automatic transmission, or SECTION 7B for manual transmission.
32. Engine from the vehicle.

Install or Connect (Figure 36)

1. Engine to the transmission assembly.
2. Engine to the engine mounts.
3. Bolts from the transmission to the engine.
4. Engine mount through bolts.

Tighten

- Through bolts to 245 N·m (180 lb·ft).

5. Front engine mount bolts.

Tighten

- Mount bolts to 36 N·m (27 lb·ft).

6. Remove the overhead hoist.
7. Raise the vehicle.
8. Torque converter bolts to the torque converter.
9. Starter assembly.
10. Exhaust from the muffler to the turbocharger.
11. Turbocharger to the exhaust.
12. Lower the vehicle.
13. Engine stop and throttle cables.
14. Engine brake rod.
15. Engine tachometer drive cable.
16. Fuels line and connectors to the fuel supply pump.
17. Ground straps to the frame and the engine.
18. Engine electrical harness to all the connectors.
19. Engine electrical harness to the retainers and the brackets.
20. Radiator, charge air cooler and the air conditioning condenser assembly.
21. Radiator and heater hoses to the engine.
22. Air compressor and the lines.
23. Power steering pump.
24. Air conditioning compressor to the mounting bracket.
25. Engine oil level indicator tube.
26. Cab bridge.
27. Coolant reservoir, hose and the bracket.
28. Air intake housing to the cab bridge.
29. Air inlet pipes.
30. Negative battery cables.
31. Lower the cab.
32. Fill the engine cooling system with the proper type and quantity of coolant. Refer to SECTION 6B and 0B.
33. Fill the engine crankcase with the proper grade and quantity of engine oil. Refer to SECTION 0B.
34. Charge the A/C system, refer to SECTION 1B.

Important

- **Check all fluid levels before starting engine.**

THREAD REPAIR

General purpose thread repair kits are available commercially. Damaged threads may be reconditioned by drilling out, rethreading, and installing a suitable thread insert. Refer to "Engine Overhaul" in SECTION 6A6B for further information.

SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS

MODEL	6HK1-TC
Type	Inline 6, 4 stroke
Induction	Turbocharged Combustion
Combustion	Direct Injection
Bore	115 mm (4.5276 in.)
Stroke	125 mm (4.9213 in.)
Displacement	7.8L (475.1 Cu. In.)
Compression Ratio	16.8:1
Firing Order	1-5-3-6-2-4
Valve Clearance, Cold (Intake and Exhaust)	0.4 mm (0.16 in.)
Full Flow Oil Filter	Cartridge Type
Oil Capacity	14.0L (14.79 Qts) *
Oil Pressure (Minimum at an Idle)	100 kPa (14 psi)
Compression at 200 RPM (Production)	3240 kPa (469 psi)
Compression at 200 RPM (Service Limit)	2157 kPa (313 psi)
Difference between each cylinder	Less than 196 kPa (28 psi)
* Includes full flow filter, which should be changed at each oil change.	

FASTENER TIGHTENING SPECIFICATIONS

Application	N·m	Lb Ft	Lb In.
Camshaft Bearing Cap Nut	27	20	—
Camshaft Gear Bolt	142	105	—
Camshaft Thrust Bracket Bolt (No. 1, and No. 7)	27.5	20	—
Charge Air Pipe Bolt	37	7	—
Connecting Rod Bolt (Apply Molybdenum disulfide grease)			
First Stage	39	29	—
Second Stage	plus 60 deg	plus 60 deg	—
Third Stage	plus 30 deg	plus 30 deg	—
Crankshaft Balancer Bolt and Washer	200	148	—
Crankshaft Pulley Bolt and Washer	48	35	—
Cylinder Body Lower Crankcase (M10)	37	27	—
Cylinder Body Lower Crankcase (M14) (Apply Molybdenum disulfide grease)			
First Stage	98	72	—
Second Stage	132	98	—
Third Stage	plus 45 deg	plus 45 deg	—
Cylinder Head Bolt (M14) (Apply Molybdenum disulfide grease)			
First Stage	98	72	—
Second Stage	147	108	—
Third Stage	plus 30 to 60 deg	plus 30 to 60 deg	—
Cylinder Head Bolt (M10)	39	28	—
Engine Mounting Bolt to the Frame	36	27	—
Engine Mounting Nut to the Frame	83	61	—
Engine Mount Through Bolt	294	217	—
Exhaust Manifold Nut and Bolt	34	25	—
Exhaust Pipe Adapter to the Exhaust Manifold	52	38	—

Application	N·m	Lb Ft	Lb In.
Flywheel Bolt First Stage Second Stage Third Stage	 78 plus 60 deg plus 75 deg	 58 plus 60 deg plus 75 deg	 — — —
Front Cover Bolt	19	14	—
Front Engine Mount Bolt	64	47	—
Glow Plug	25	18	—
Idle Gear A Bolt (Apply Molybdenum disulfide grease)	29 + 75 deg	21 + 75 deg	—
Idle Gear A Shaft Bolt	26.5	20	—
Idle Gear B Bolt	95	70	—
Idle Gear B Shaft Bolt	31.4	23	—
Idle Gear C Bolt	95	70	—
Intake Manifold Bolt	15	—	130
Oil Cooler Bolt	19	14	—
Oil Jet Bolt	21	15	—
Oil Pan Bolt	24	17	—
Oil Pump Body Bolt	24	17	—
Oil Strainer Tube Bolt (M8)	24	17	—
Oil Strainer Tube Bolt (M10)	48	5	—
Rear Engine Mounting Nut and Bolt to the Frame	108	80	—
Thermostat Housing Bolt to the Cylinder Head	19	14	—
Turbocharger Drain Line Bolt (to Block)	8	13	—
Turbocharger Drain Line Bolt (to Turbocharger)	27	20	—
Turbocharger Feed Line Bolt (to Block)	18	13	—
Turbocharger Feed Line Bolt (to Turbocharger)	18	13	—
Turbocharger to Exhaust Manifold Nut	52	38	—
Valve Rocker Arm Cover Bolt	13	—	113
Valve Rocker Arm Shaft Support Bolt (M8)	27	20	—
Valve Rocker Arm Shaft Support Bolt (M10)	56	41	—
Water Outlet Bolt (M8)	19	14	—
Water Pump Bolt and Nut	19	14	—
Water by Pass Duct Bolt (M16)	103	76	—

SPECIAL TOOLS

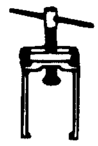
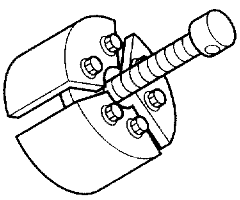
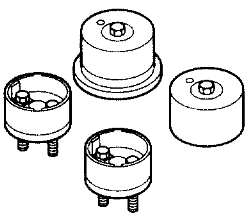
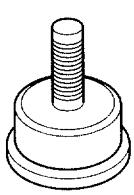
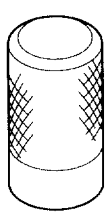
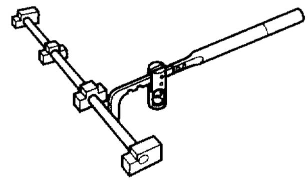
ILLUSTRATION	TOOL NO. TOOL NAME
 901LX078	**J22888-D** D Gear Puller
 89439-68580	**J41220** Slinger Remover
 89439-68560	**J41221** Oil Seal Remover and Installer
 89439-68190	**J41222** Crankshaft Gear Installer
 58840-26250	**J43267** Valve Stem Seal Installer

ILLUSTRATION	TOOL NO. TOOL NAME
 58840-26210	**J43263** Valve Spring Compressor

SECTION 6A6B

DIESEL ENGINE OVERHAUL

NOTICE: *Always use the correct fastener in the correct 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.*

CONTENTS

CONTENTS (cont'd)

GENERAL DESCRIPTION

The ISUZU model 6HK1-TC engine is used in vehicles covered by this manual. The engine is an in line six cylinder, four stroke, water cooled, direct fuel injection, turbocharged diesel. The charge air cooleris the air to air heat exchange system using a corrugated-fin heat exchanger installed in front of the radiator.

The forged crankshaft is supported by seven precision insert main bearings. The crankshaft thrust washer is located at the number seven crankshaft main bearing.

The connecting rods have precision insert type crankshaft (big end) bearings. The piston pins are retained by snap rings. The pistons have three compression rings and one oil control ring. The pistons are cooled by oil jets. The 6HK1-TC diesel uses dry cylinder liners. The liners have been phosphated (P- Mn method), both inside and outside for long life.

The camshaft is supported by seven plain bearings. The camshaft is gear driven. Motion is transferred to the overhead valves by shaft type roller valve rocker arms.

The cylinder head may be rebuilt, with new valve guides and seats.

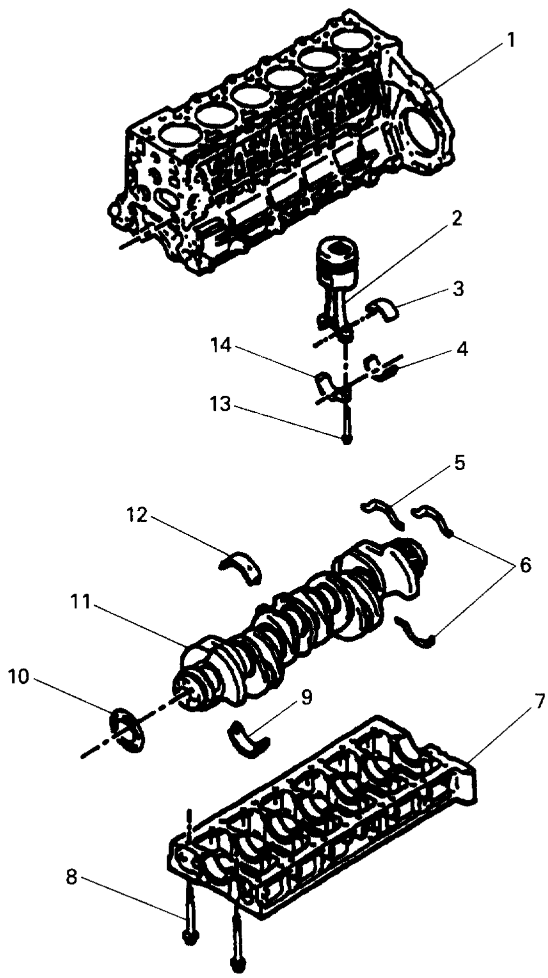
ENGINE IDENTIFICATION

The engine used in this vehicle is a 7.8L (475 CID).

The engine identification number is on the front right hand side (passenger) of the cylinder block. For further information, refer to "GENERAL INFORMATION" in SECTION 0A.

ENGINE LUBRICATION

A gear type oil pump is used. The engine is equipped with both full flow filter. An oil cooler is provided to help control oil temperatures. Major moving parts are supplied with oil from a larger oil gallery in the cylinder block.



(1) Cylinder Block
(2) Piston and Connecting Rod
(3) Upper Connecting Rod Bearing
(4) Lower Connecting Rod Bearing
(5) Thrust Washer
(6) Thrust Washer
(7) Lower Crankcase
(8) Crankshaft Bolt
(9) Lower Crankshaft Main Bearing
(10) Oil Slinger
(11) Crankshaft
(12) Upper Crankshaft Main Bearing
(13) Connecting Rod Bolt
(14) Connecting Rod Cap

Figure 1 — Cylinder Block and Components

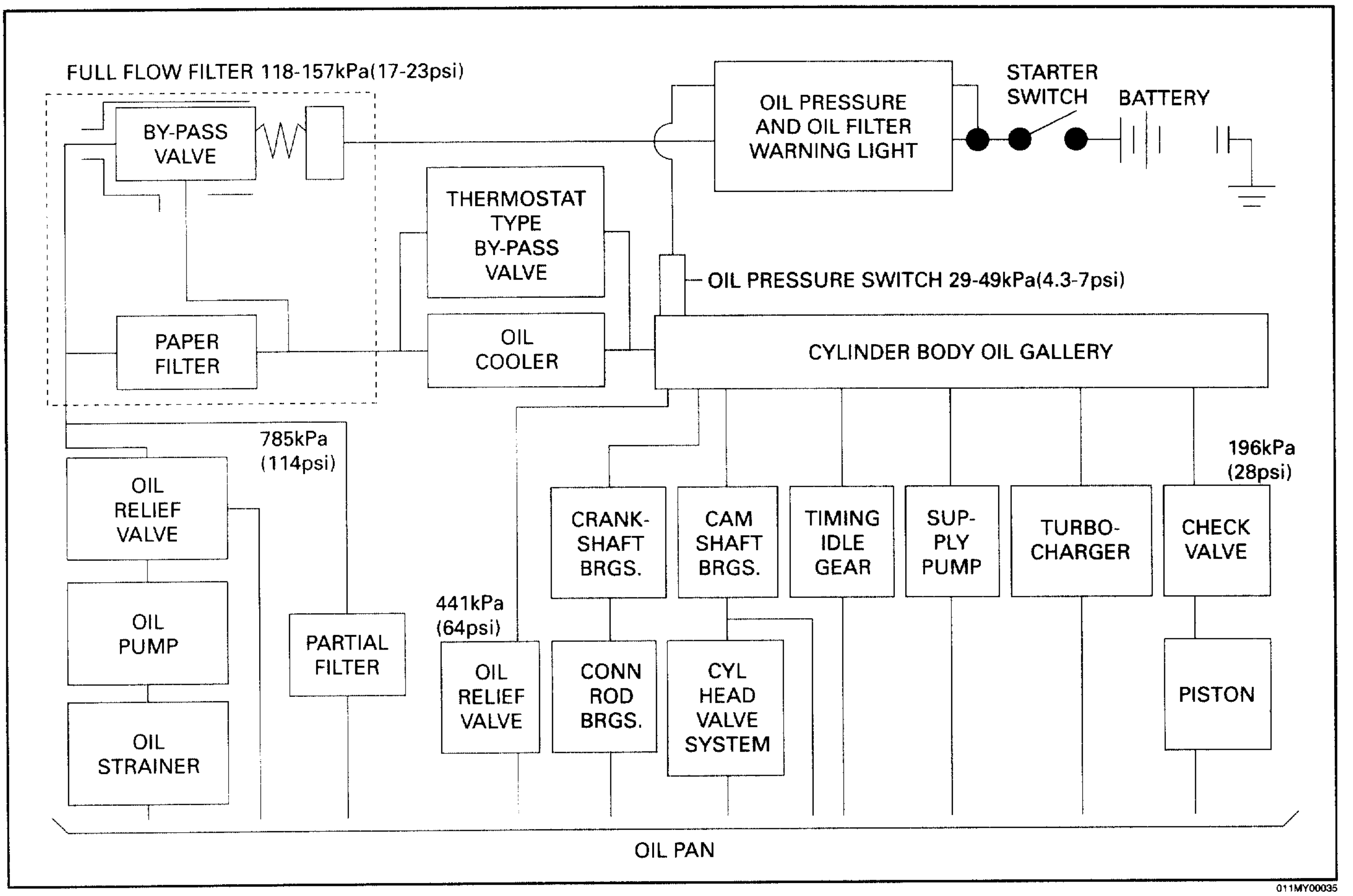


Figure 2 — Lubrication System

DISASSEMBLY OF THE ENGINE

TOOLS AND SHOP EQUIPMENT

A clean well-lit work area should be available. Other necessary equipment includes: a suitable parts cleaning tank, compressed air supply, trays to keep parts and fasteners organized, and an adequate set of hand tools.

An approved engine repair stand will aid the technician and help to prevent personal injury or damage to the engine components.

Special tools are listed and illustrated throughout this section. A complete listing is at the end of this section. These tools (or their equivalents) are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these tools will also minimize possible damage to engine components.

Some precision measuring tools are required for inspection of certain critical components. Torque wrenches are necessary for the correct assembly of various parts.

ACCESSORY REMOVAL

This manual takes into consideration that the engine accessories have been removed. These accessories may include one or more of the following:

- Power Steering Pump
- Air Conditioning Compressor
- Generator
- Air Compressor (for air brakes)
- Starter Motor
- Hydraulic Pump (for hydraulic brakes)
- Drive Belts
- Engine Cooling Fans and Clutch

Diagrams of emissions and vacuum hose routings, wiring harness routing, accessory drive belts layout, etc., should be made before removing accessories.

CLEANING

NOTICE: ***Clean the engine only when it is cold, and never when the engine is running. Spraying or pouring water or other fluids on the engine when it is warm or hot, or when it is running, can cause serious damage to the engine and its components.***

Remove the engine accessories before cleaning to provide better access to the engine exterior surfaces. Cover all openings to the engine, after any engine control units such as, air inlet pipes, glow plugs, turbocharger etc., have been removed. Methods used to clean the engine will depend on what is available. Steam cleaning, pressure washing, or solvent cleaning are some of the acceptable methods. Allow the engine to dry before beginning any of the repair work. It is important that the engine be as clean as possible to prevent dirt from entering critical areas during disassembly.

DRAINING THE ENGINE

Remove or Disconnect

1. Oil pan drain plug.
2. Oil filter.
   - Allow the oil to drain into the proper container.
3. Coolant drain plugs from the engine block.
   - Allow the coolant to drain into the proper container.

Install or Connect

1. Oil drain plug to the oil pan.
2. Coolant drain plugs to the engine block.

FLYWHEEL REMOVAL

For service of the flywheel, refer to SECTION 7A6.

INTAKE MANIFOLD REMOVAL

Remove or Disconnect

1. Fuel injection lines from the fuel injectors.
2. Fuel lines from the fuel filter to the fuel supply pump.
3. Fuel injector return lines from fuel injectors.
4. Coolant pipe and bracket.
5. Fuel line from fuel supply pump to fuel common rail.
6. Fuel common rail.
7. Intake manifold bolts
8. Intake manifold with the gasket.

EXHAUST MANIFOLD REMOVAL

Remove or Disconnect

1. Turbocharger drain pipe with gasket.
2. Oil feed pipe.
3. Turbocharger assembly. Refer to SECTION 6J.
4. Front exhaust pipe.
5. Exhaust manifold nuts, bolts, washers and the spacers.
6. Exhaust manifold with the gasket.

GLOW PLUG REMOVAL

Remove or Disconnect

1. Glow plugs from the cylinder head. Refer to SECTION 6D6.

FUEL SUPPLY PUMP REMOVAL

Remove or Disconnect

1. Fuel supply pump from the engine. Refer to SECTION 6C2.

THERMOSTAT HOUSING/THERMOSTAT REMOVAL

Remove or Disconnect

1. Bolts from the thermostat housing.
2. Thermostat housing from the cylinder head.
3. Both thermostats and the gasket from the cylinder head.

VALVE ROCKER ARM COVER REMOVAL

Remove or Disconnect

1. Bolts from the valve rocker arm cover.
2. Valve cover and gasket from the cylinder head.

NOTICE: Do not pry on the valve rocker arm cover. Damage to the sealing surfaces may result.

VALVE ROCKER ARM ASSEMBLY AND CAMSHAFT ASSEMBLY REMOVAL

Remove or Disconnect

1. Both connector on the top of injectors and from engine harness.
2. Harness assembly.
3. Lower case.
4. Loosen all the valve adjusters, but do not remove.
5. Loosen the valve rocker arm shaft bracket bolts evenly, starting from the outer bolts moving to the inner bolts.

   Important

   - Do not remove the rocker arm shaft bracket bolts from the valve rocker arm shaft assembly until the assembly has been removed from the engine.
6. Valve rocker arm assembly.
7. Loosen camshaft bearing cap nuts evenly, starting from the outer nut moving to the inner nut.
8. Camshaft assembly.

CYLINDER HEAD ASSEMBLY REMOVAL

Remove or Disconnect

1. Cylinder head from the cylinder block.

WATER PUMP REMOVAL

Remove or Disconnect

1. Bolts from the water duct.
2. Water duct and O-ring from the water pump.
3. Bolts from the water pump.
4. Water pump assembly with the gaskets.

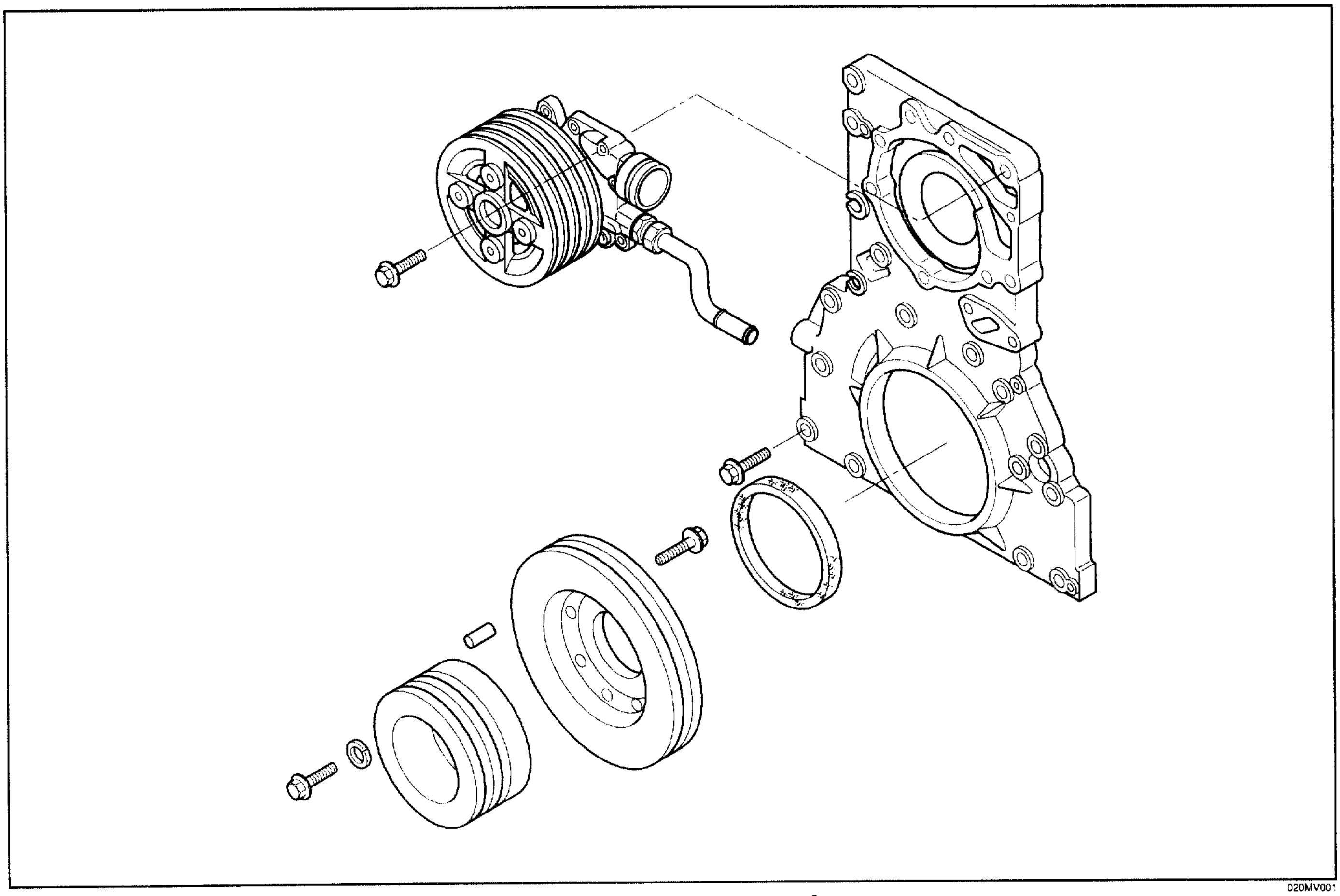


Figure 3 — Crankshaft Balancer and Components

CRANKSHAFT BALANCER REMOVAL

Remove or Disconnect (Figure 3)

1. Bolts and washers from the crankshaft pulley.
2. Crankshaft pulley from the crankshaft.
3. Bolt and washer from the crankshaft.
4. Crankshaft balancer from the crankshaft.

FRONT COVER REMOVAL

Remove or Disconnect (Figure 3)

1. Bolts and washers from the front cover.
2. Front cover from the engine.
3. Seal and gasket from the front cover.

OIL PAN REMOVAL

Remove or Disconnect (Figure 4)

1. Engine oil level indicator.
2. Bolts, nuts and the washers from the oil pan.
3. Oil pan and the gasket from the engine block.

FLYWHEEL HOUSING REMOVAL

Remove or Disconnect

1. NE sensor.
2. Flywheel
3. Cover drive gear power steering pump.
4. Drive gear power steering pump.
5. Bolts from the flywheel housing.
6. Flywheel housing from the engine.

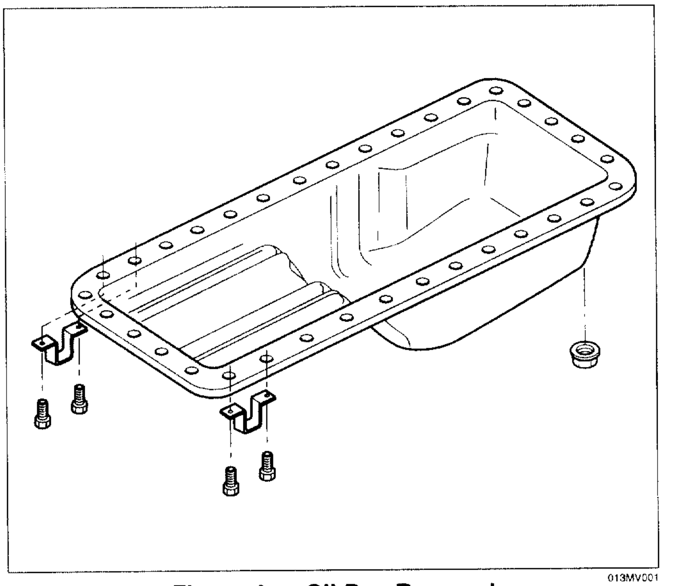


Figure 4 — Oil Pan Removal

OIL PUMP REMOVAL

Remove or Disconnect

1. Oil pick up tube and the O-ring.
2. Oil slinger from the crankshaft.

Important

- Do not damage the crankshaft when removing the oil slinger.

3. Idler gears with the shafts from the cylinder block.
4. Oil pump with the drive gear from the cylinder block.

PISTON AND CONNECTING ROD REMOVAL

Remove or Disconnect (Figure 5)

1. Bolts from the connecting rod.
2. Piston and connecting rod from the cylinder.

Important

- The connecting rods and caps are marked from the factory so they can be returned to the proper cylinder. Replacement connecting rods and caps are not marked. They must be marked after installation.

CYLINDER LINER REMOVAL

Remove or Disconnect (Figure 6)

1. Rotate the crankshaft so the journal is just below TDC.
2. Cylinder liner from the block, using wooden or plastic hammer.

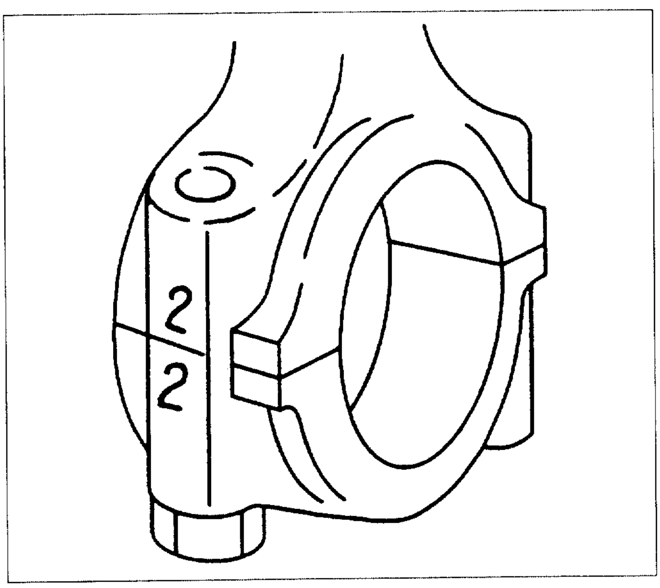


Figure 5 — Connecting Rod Markings

CRANKSHAFT REMOVAL

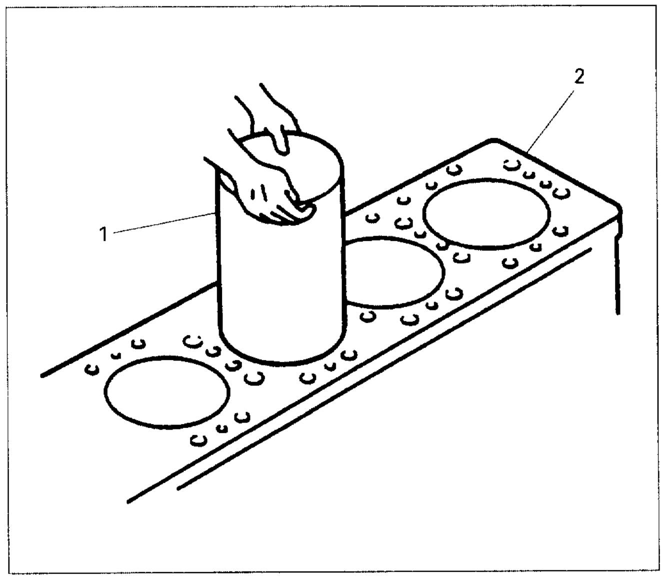
Remove or Disconnect (Figure 1)

1. Loosen the lower crankcase body bolts (marked M14) evenly.
2. Loosen the lower crankcase bolts (marked M10) evenly from the outer bolts to the inner.
3. Crankshaft from the lower crankcase cylinder block.
4. Crankshaft main bearings and thrust washers from the lower crankcase.

OIL JET REMOVAL

Remove or Disconnect (Figure 7)

1. Bolt from the cylinder block.
2. Oil jet and washers from the cylinder block.



Legend
(1) Cylinder Liner
(2) Cylinder Block

Figure 6 — Cylinder Liner Removal

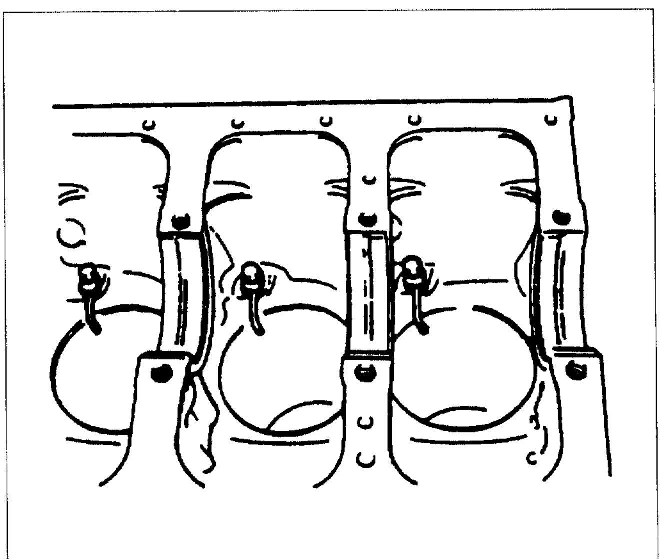


Figure 7 – Oil Jet Removal

CLEANING, INSPECTION, AND REPAIR

You will need a solvent tank large enough to hold the larger engine parts, along with various bristle brushes and a gasket scraper. A source of compressed air will be helpful in the cleaning operations.

Precision measuring tools will be required for the inspection procedure. These include: micrometers, cylinder bore gauge, feeler gauge, dial indicators sets, etc. It is very important that the inspection work be performed with the proper method and tools. The rebuilt engine cannot be expected to perform properly. If any of the parts are worn beyond their serviceable limits.

ENGINE BLOCK

The cylinder block needs to be inspected thoroughly to determine if it is reusable. Before the cylinder block inspection can be performed, it should be stripped of all coolant plugs and oil gallery plugs. To prevent dirt from being stuck into the oil bypass valves, they must be removed before the cylinder block can be cleaned.

OIL FILTER AND CYLINDER BLOCK PLUG REMOVAL

Remove or Disconnect (Figure 8)

1. Oil pipe.
2. Oil filter assembly.
3. Cup plugs and the block heater (if equipped).
4. Oil gallery plugs (if equipped).

CYLINDER BLOCK CLEANING

Clean

1. Block into the solvent.
2. Gasket from the sealing surfaces.
   - Use only the proper cleaning solvent when removing old gasket material.
3. Blow compressed air through all oil passages. Wear protective safety glasses and gloves.
4. Scale deposits from the coolant passages.
5. Crankshaft.

CYLINDER BLOCK INSPECTION

Inspect

1. Cylinder block for cracks and wear.
   - Coolant jackets
   - Crankshaft bearing webs
   - Engine mounting bosses
   - Thrust washer mating surfaces on cylinder block and lower crankcase.

Measure (Figure 9 through 11)

2. Cylinder block for warpage.
   - Use a straight edge and a feeler gauge to measure the four sides and the two diagonals of the cylinder block. If the measured values exceed the 0.2 mm (0.008 in.)., the cylinder block must be replaced.
3. Crankshaft bearing bores (cylinder block and lower crankcase).
4. Use an inside micrometer and measure the crankshaft bearing inside diameter.
   - Subtract the crankshaft main bearing journal diameter from the crankshaft main bearing inside diameter to obtain the proper clearances.
   - No. 4 crankshaft main bearing journal: 81.875 to 81.895 mm.(3.2234 to 3.2242 in.).
     — Production: 0.093 to 0.124 mm (0.0037 to 0.0049 in.).
     — Service Limit: 0.14 mm (0.0055 in.).
   - All other crankshaft main bearing journals:
     — Production: 0.063 to 0.094 mm (0.0025 to 0.0037 in.).
     — Service Limit: 0.14 mm (0.0055 in.).

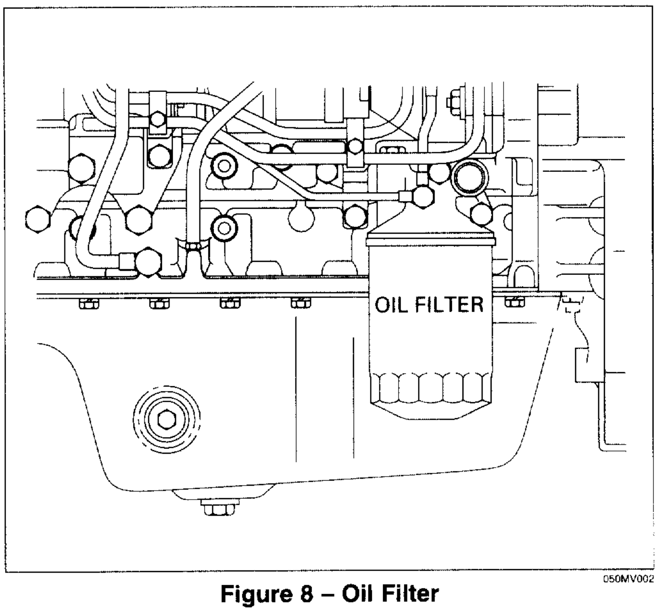


Figure 8 – Oil Filter

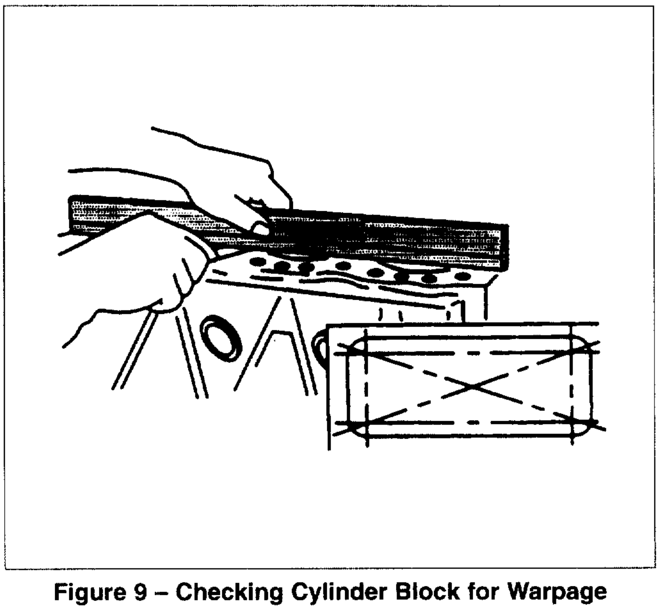


Figure 9 – Checking Cylinder Block for Warpage

CRANKSHAFT INSPECTION

Tools Required:
J22888-D Gear Puller
J41222 Timing Gear Installer

Inspect

1. Crankshaft.
   - Crankshaft for cracks
   - Crankshaft main bearing surfaces
   - Crankshaft thrust washer surfaces for excessive wear
   - Crankshaft timing gear for chipped or broken teeth

Measure (Figures 11 through 14)

1. Crankshaft main bearing journals.
   - No. 4 crankshaft main bearing journal: 81.875 to 81.895 mm.(3.2234 to 3.2242 in.).
   - All other crankshaft main bearing journals: 81.905 to 81.925 mm.(3.2246 to 3.2254 in.).
2. Crankshaft for run out.
   - Mount the crankshaft between centers or on V blocks and check.
   - Run out should not exceed 0.45 mm (0.0177 in.).
3. Crankshaft connecting rod journals at two different points on the journal.
   - Connecting rod bearings journals should be: 72.902 to 72.922 mm (2.8702 to 2.8709 in.).
   - If the crankshaft does not meet specifications, it should be replaced.

Important

- Replace the crankshaft or the main bearing inserts or both, to obtain the proper clearances.

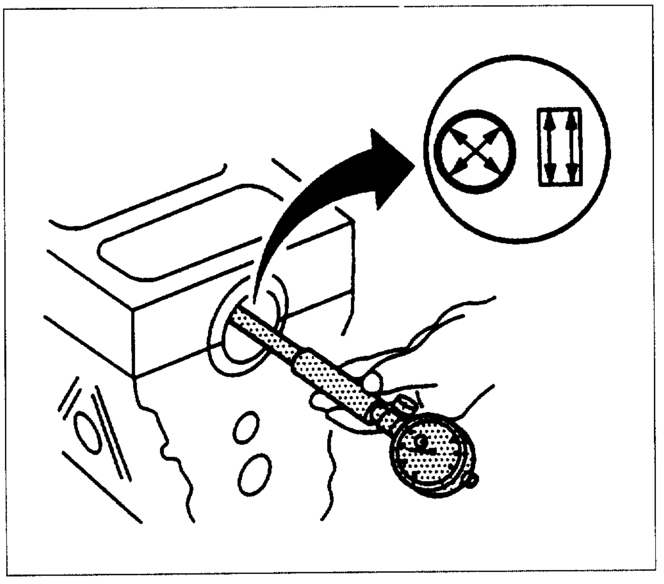


Figure 10 – Measuring Crankshaft Journal Inside Diameter

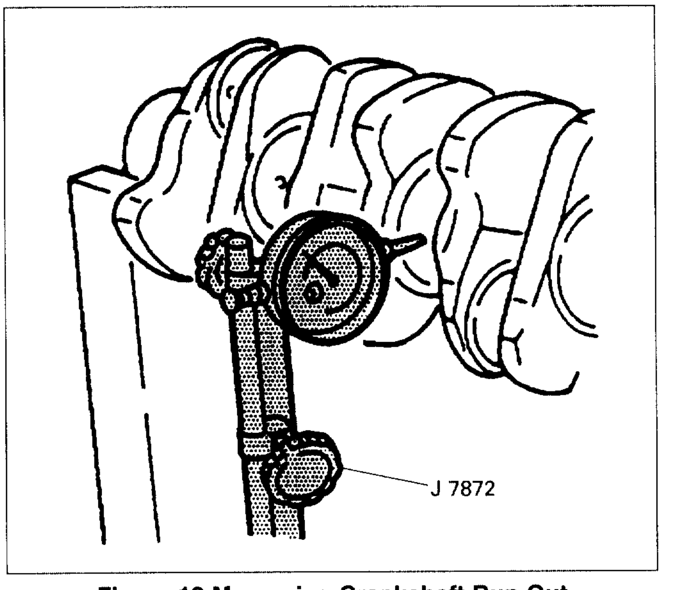


Figure 12 Measuring Crankshaft Run Out

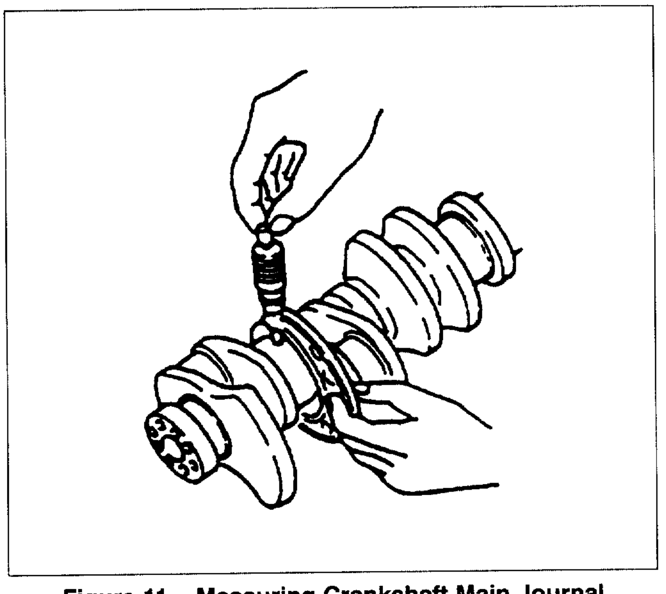


Figure 11 – Measuring Crankshaft Main Journal

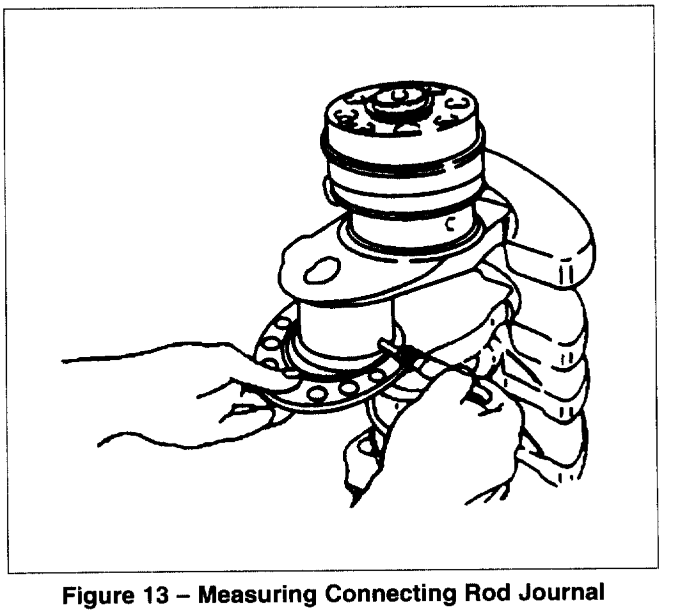


Figure 13 – Measuring Connecting Rod Journal

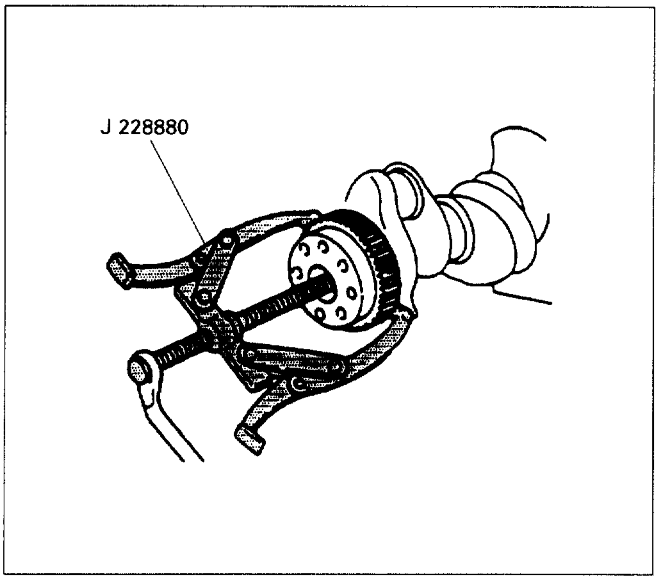


Figure 14 – Crankshaft Timing Gear Removal

CRANKSHAFT TIMING GEAR INSPECTION AND REPLACEMENT

Tools Required:
J22880 Gear Puller
J41222 Gear Installer

Remove or Disconnect (Figure 14)

1. Install tool J22880 on the crankshaft timing gear.
2. Crankshaft timing gear from the crankshaft.

Install or Connect (Figure 15)

1. Crankshaft timing gear to the crankshaft.
2. With tool J41222, install crankshaft timing gear on the crankshaft.

Important

- When installing crankshaft timing gear, make sure that the timing mark is facing away from the cylinder block.

OIL PUMP INSPECTION AND REPAIR

Disassembly and Inspection (Figure 16 through 20)

1. Driven gear and shaft from the oil pump body.
2. Cotter pin from the oil pump.
3. Oil relief valve from the oil pump.
4. Oil pump drive gear.
   - Use a gear puller to remove the oil pump drive gear.
5. Drive gear.

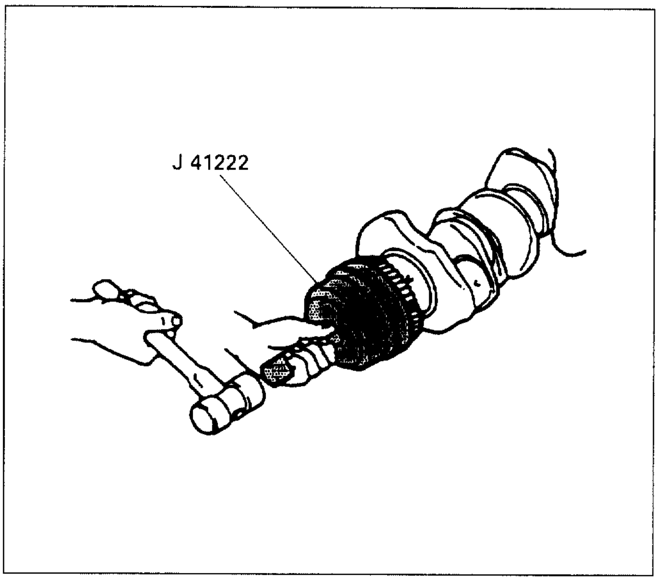


Figure 15 – Crankshaft Timing Gear Installation

Clean

- Clean all parts in solvent.
- Blow the parts dry with compressed air. Wear protective safety glasses and gloves.

Inspect

- Oil pump body for cracks or damage.
- Gears for pitting and wear.

Measure

- Gear tooth to wall clearance.
- Clearance must not exceed 0.3 mm (0.012 in.).
- Gear end clearance.
- Clearance must not exceed 0.2 mm (0.08 in.).

Important

- If the clearances are excessive, replace the oil pump as an assembly.

Measure

- For drive gear shaft and oil pump body clearance.
- Use a micrometer to measure the drive gear shafts.
- The measurement should be: 15.9 mm (0.626 in.).
- Use an inside micrometer to measure the oil pump body inside diameter.
- Use an inside micrometer to measure the cylinder block body bushing for the oil pump.
- If the clearance between the gear shaft and the oil pump body or the cylinder block bushing exceeds. 0.2 mm (0.008 in.)., both the oil pump and or the cylinder block bushing may have to be replaced.

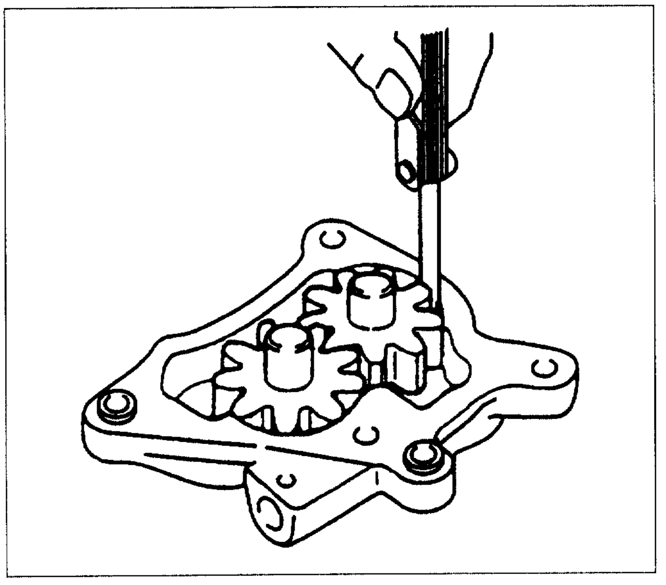


Figure 16 – Measuring Gear to Wall Clearance

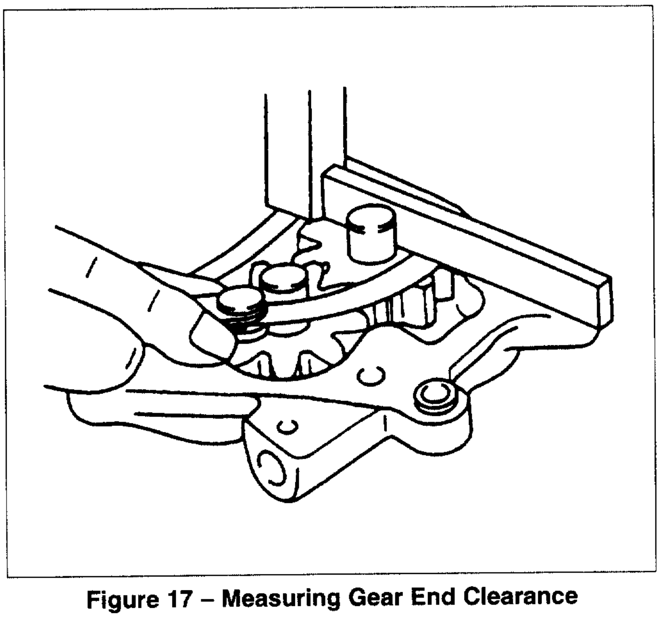
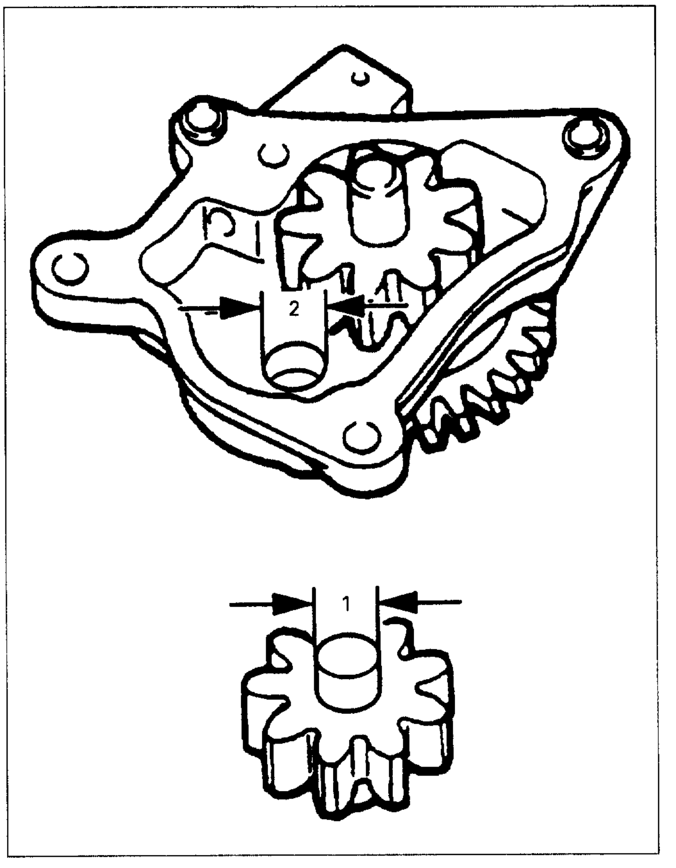
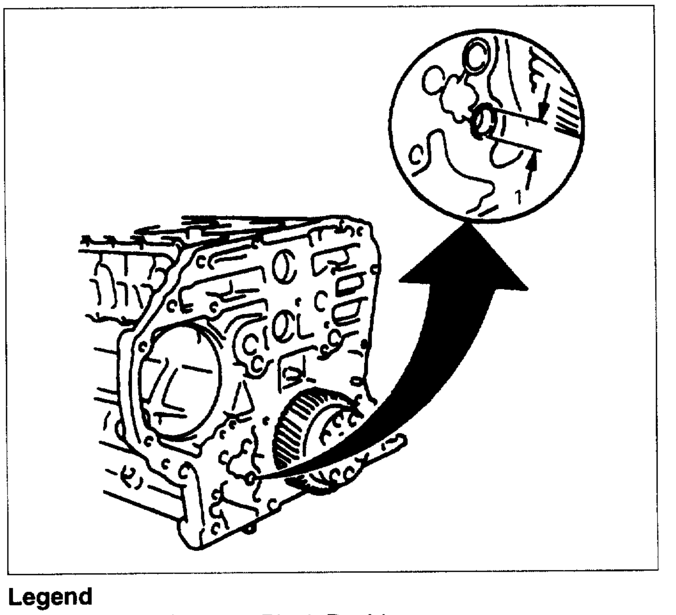


Figure 17 – Measuring Gear End Clearance



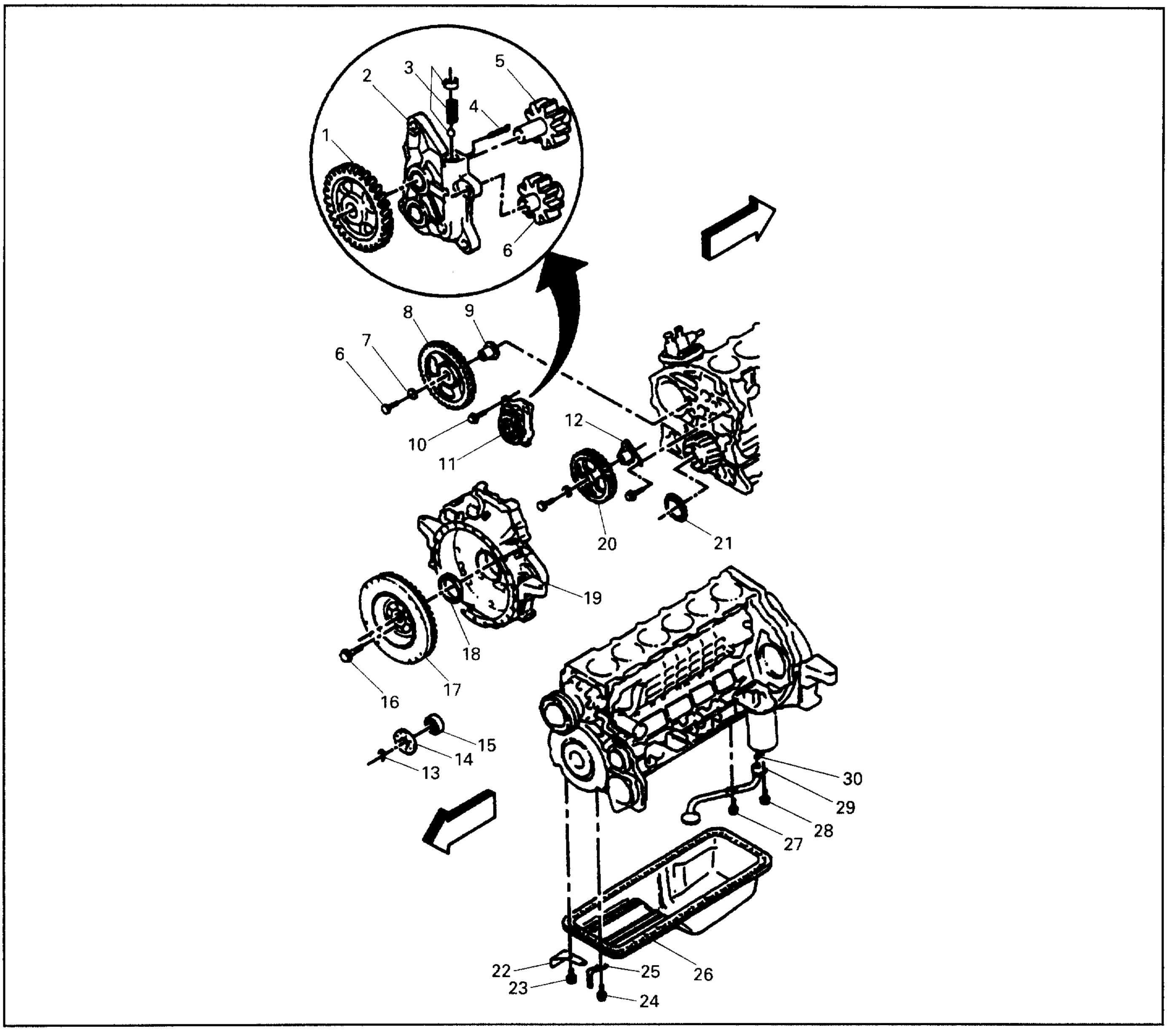
Legend
(1) Drive Gear Shaft
(2) Driven Gear Bushing

Figure 18 — Oil Pump Body Clearance



Legend
(1) Oil Pump Cylinder Block Bushing

Figure 19 — Cylinder Block Oil Pump Bushing Clearance



Legend

(1) Oil Pump Drive Gear
(2) Oil Pump Body
(3) Oil Pump Relief Valve Assembly
(4) Cotter Pin
(5) Drive Gear
(6) Driven Gear and Shaft
(7) Washer
(8) Idler Gear A
(9) Idler Gear Shaft
(10) Oil Pump Mounting Bolt
(11) Oil Pump Assembly
(12) Idler Gear B Shaft
(13) Snap Ring for Pilot Bearing
(14) Spacer
(15) Pilot Bearing
(16) Crankshaft Bolt
(17) Flywheel
(18) Crankshaft Rear Oil Seal
(19) Flywheel Housing
(20) Idler Gear B
(21) Oil Slinger
(22) Bracket
(23) Bolt
(24) Bolt
(25) Bracket
(26) Oil Pan
(27) Bolt for Oil Pick Up Tube
(28) Bolt for Oil Pick Up Tube
(29) Oil Pick Up Tube
(30) O-ring for Oil Pick Up Tube

Figure 20 — Oil Pump and Components

Reassemble (Figure 20)

1. Apply clean engine oil to the drive gear (5).
2. Install the oil pump drive gear to the drive gear (5).
   - When installing the drive gear (1), make sure that the large hub side of the gear is facing away from the oil pump body (2).
   - Use a bench press to press the drive gear on to the drive gear shaft.
3. Oil relief valve assembly (3) into the oil pump body (2).
4. Cotter pin (4) to the oil pump body (2).
5. Apply clean engine oil to the drive gear and drive gear shaft.
6. Driven gear and shaft (6) to the oil pump body (2).

IDLER GEAR INSPECTION AND REPLACEMENT

Tools Required:
J7872 Dial Indicator With Magnetic Base
J26900 Micrometer

Measure (Figures 21 and 22)

1. Idler gear end play.
   - If the measurement is greater than 0.2 mm (0.008 in.)., the idler gear and or hub should be replaced.
2. Idler gear backlash.
   - With dial indicator J7872, rest the plunger on the teeth of the idler gear. Zero the gauge and rock the idler gear back and forth to read the gear backlash. If the reading is more than 0.3 mm (0.012 in.)., replace the worn gear or gears.

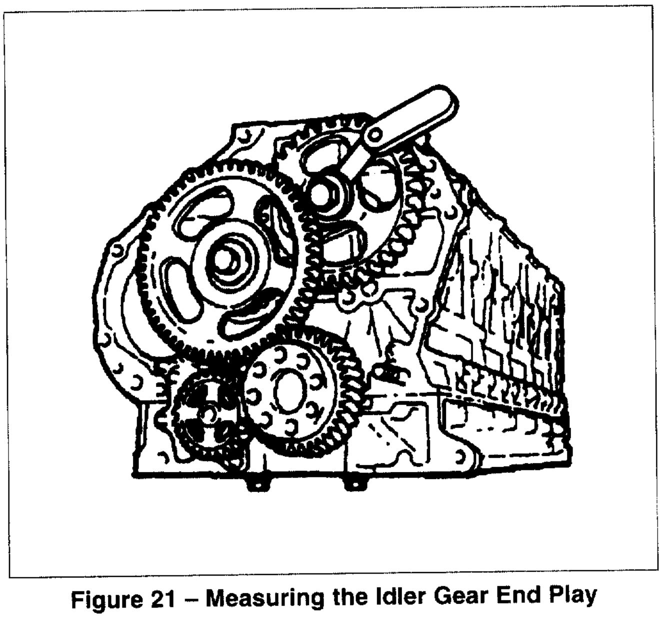


Figure 21 – Measuring the Idler Gear End Play

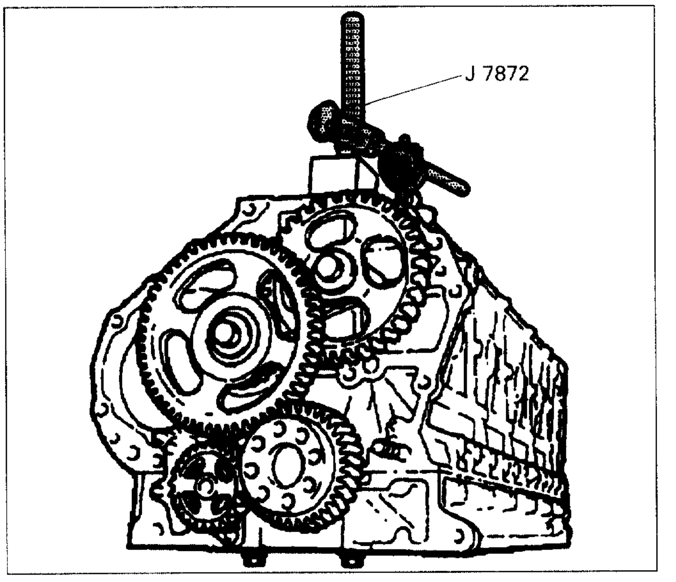


Figure 22 – Measuring the Idler Gear Backlash

Disassemble (Figures 23 and 24)

1. Rotate the crankshaft until the timing marks are aligned.
2. Bolt and washer from the idler gear.
3. Idler gear from the hub.
4. Mounting bolts from the hub.
5. Hub from the cylinder block.

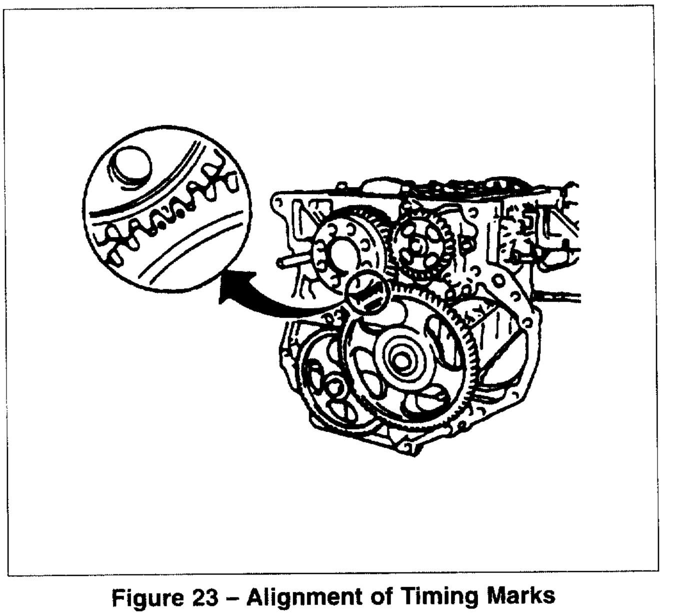


Figure 23 – Alignment of Timing Marks

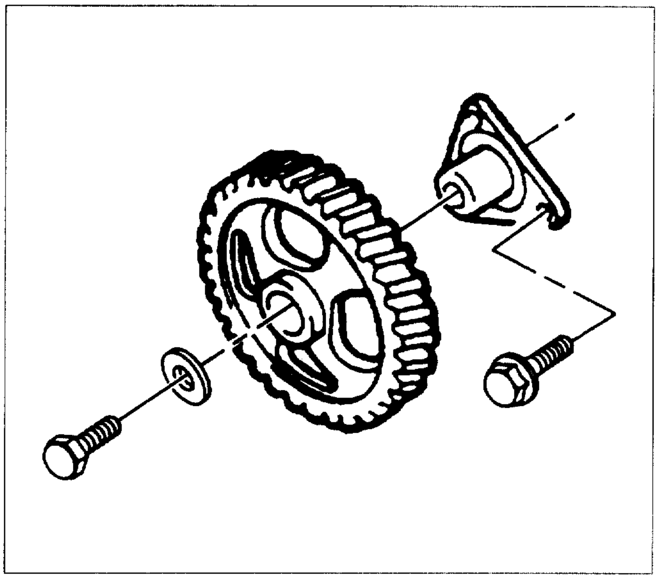


Figure 24 – Idler Gear and Hub

Inspect

- Gear teeth for chips or excessive wear.
- Gear bushing for scoring or damage.
- Hub for scoring or damage.

Measure (Figures 25 and 26)

- Measure the idler gear hub with tool J26900 .
- Measure the idler gear bushing inside diameter, using an inside diameter micrometer.
- Subtract the hub outside diameter from the idler gear bushing inside diameter to obtain the hub to idler gear bushing clearance.
  - Production clearance is: 0.02 to 0.062 mm (0.00078 to 0.0024 in.).
  - Service limit: 0.2 mm (0.0079 in.).
- If the clearance is excessive, replace the hub or gear as required. The bushing is not available separately.

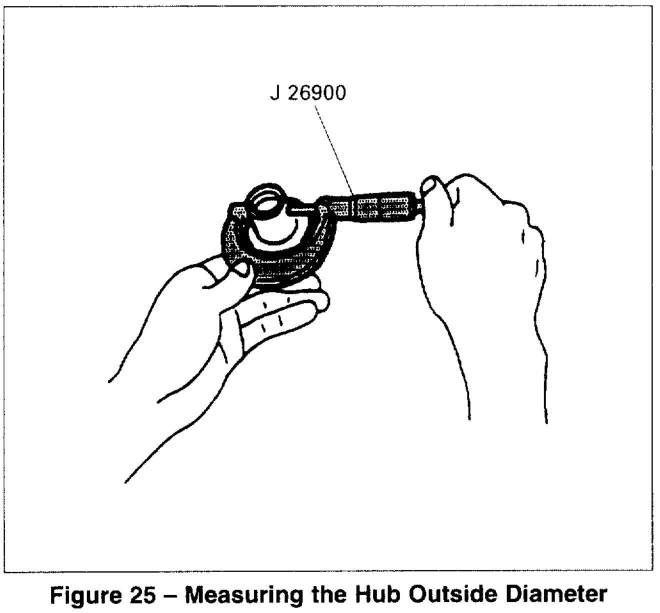


Figure 25 – Measuring the Hub Outside Diameter

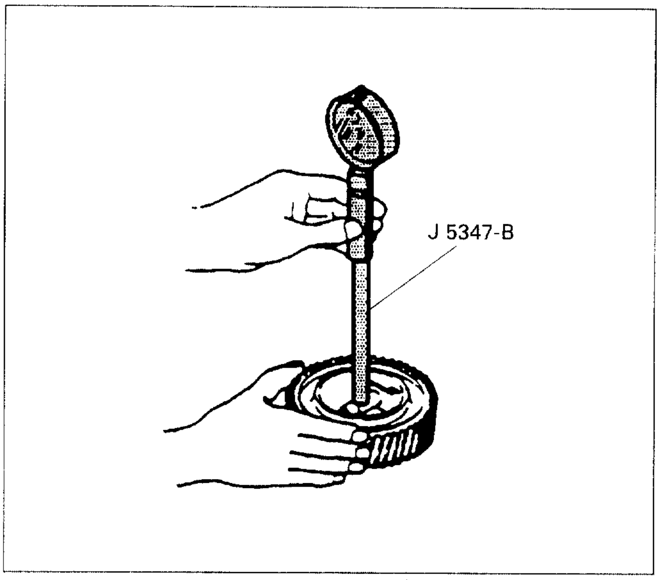


Figure 26 – Measuring Idler Gear Inside Diameter

PISTON, CONNECTING ROD AND CYLINDER LINER ASSEMBLIES

Remove or Disconnect (Figures 27 through 32)

1. Piston rings from the piston.
2. Snap rings from the piston pin.
3. Piston pin from the piston.
   - Heat the piston if necessary to aid in the piston pin removal. Do not drive the piston pin out.

Clean

- Piston and rings in cleaning solvent. Do not use a wire brush on the piston, damage may occur.
- Piston ring grooves with a ring groove cleaning tool.

Inspect

- Pistons for cracks and scoring.
- Liner for scratches, cracks, and scoring.

Measure

- Piston ring groove clearance.
  - First groove: 0.080 to 0.115 mm (0.0031 to 0.0045 in.).
  - Service limit: 0.2 mm (0.0787 in.).
  - Second and third grooves: 0.05 mm to 0.08 mm (0.0019 to 0.0031 in.).
  - Service limit: 0.15 mm (0.0059 in.).
  - Oil control ring: 0.030 to 0.07 mm (0.0012 to 0.0028 in.).
  - Service limit: 0.15 mm (0.0059 in.).
- Piston ring end gap (Figure 29).
- Insert piston assembly into the cylinder liner, 195 mm (7.67 in.). below the top of the cylinder liner.
- Piston ring gap:
  - First compression ring 0.18 to 0.28 mm (0.0071 to 0.0110 in.).
  - Service limit 1.2 mm (0.0472 in.).

- — Second and third compression rings 0.35 to 0.5 mm (0.01378 to 0.01958 in.).
- — Service limit 1.2 mm (0.0472 in.).
- — Oil control ring 0.15 to 0.35 mm (0.0059 to 0.0138 in.).
- — Service limit 1.2 mm (0.0472 in.).
- Piston pin bore inside diameter measurement.
  - — 40.004 to 40.012 mm (1.5750 to 1.5752 in.).
- Piston pin to the piston clearance. Measure the piston pin at three different points.
  - — 39.995 to 40.000 mm (1.5746 to 1.5748 in.).
- Replace piston pin, if it is less than the specification.
- Subtract the piston pin diameter from the piston pin bore reading.
- Proper clearance 0.004 to 0.017 mm (0.0002 to 0.0007 in.).

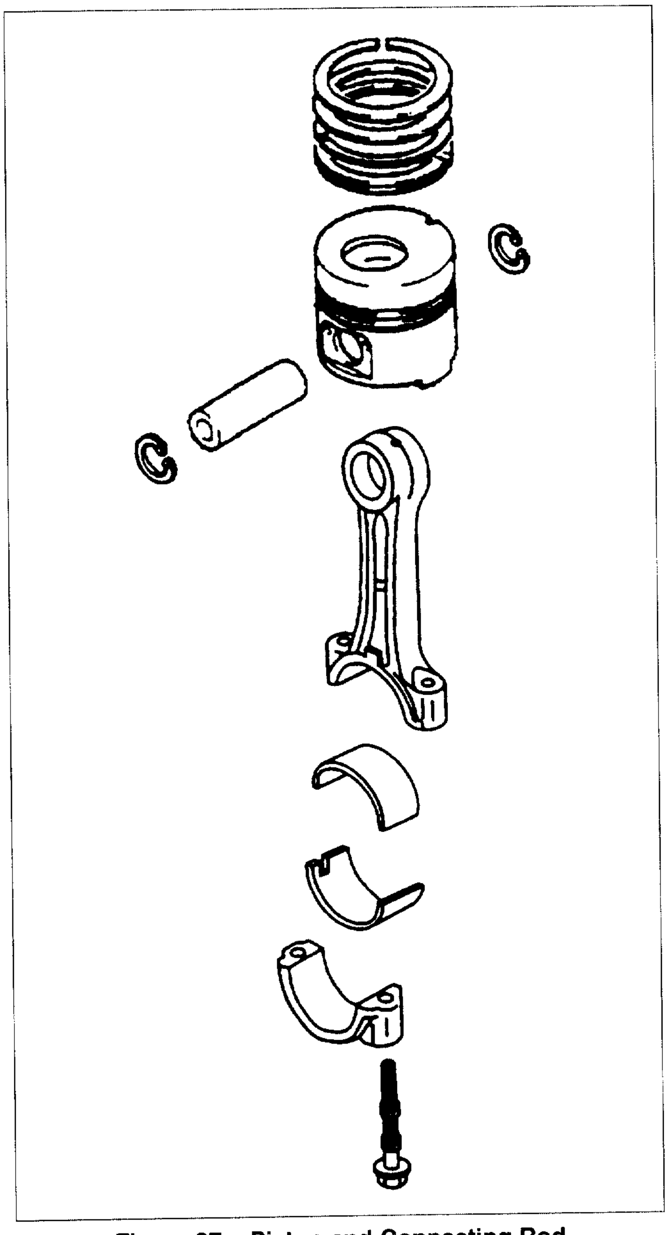


Figure 27 – Piston and Connecting Rod Components

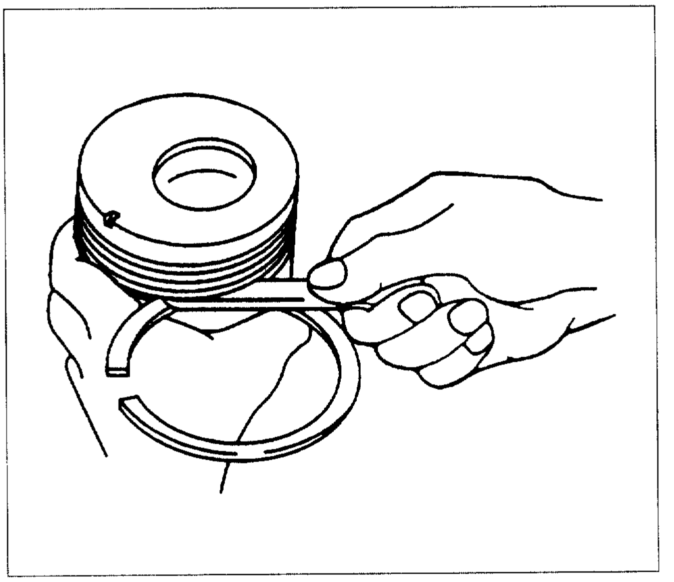


Figure 28 – Measuring Piston Ring Groove Clearance

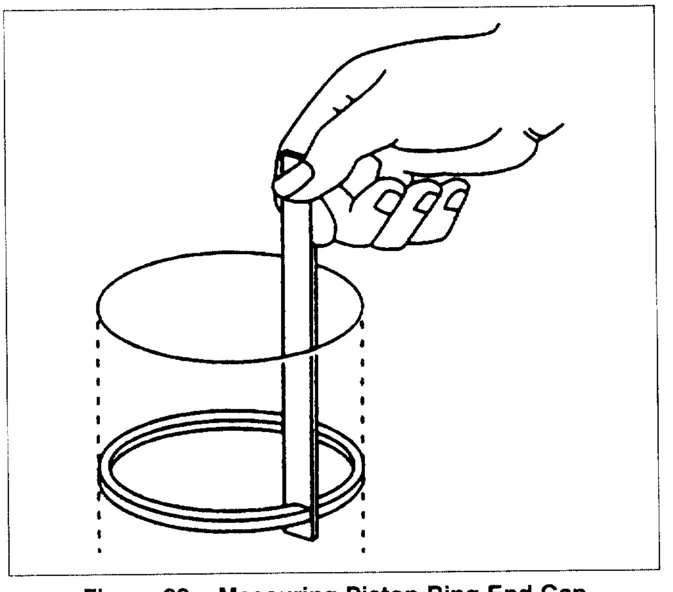


Figure 29 – Measuring Piston Ring End Gap

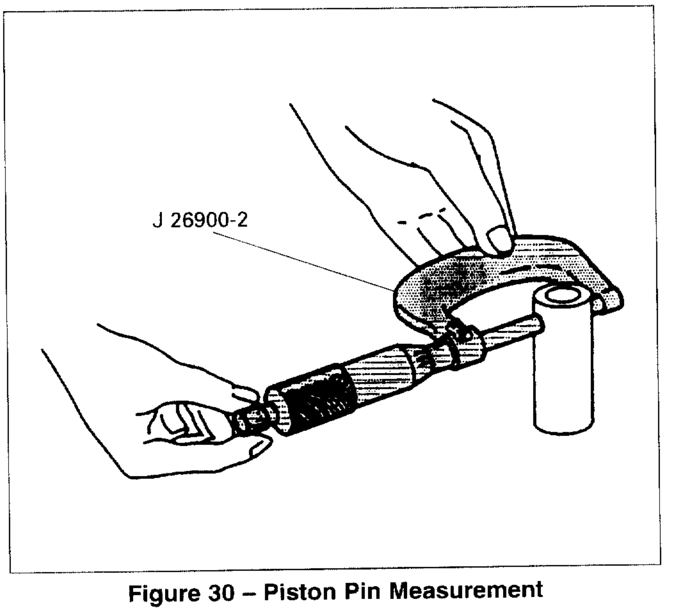
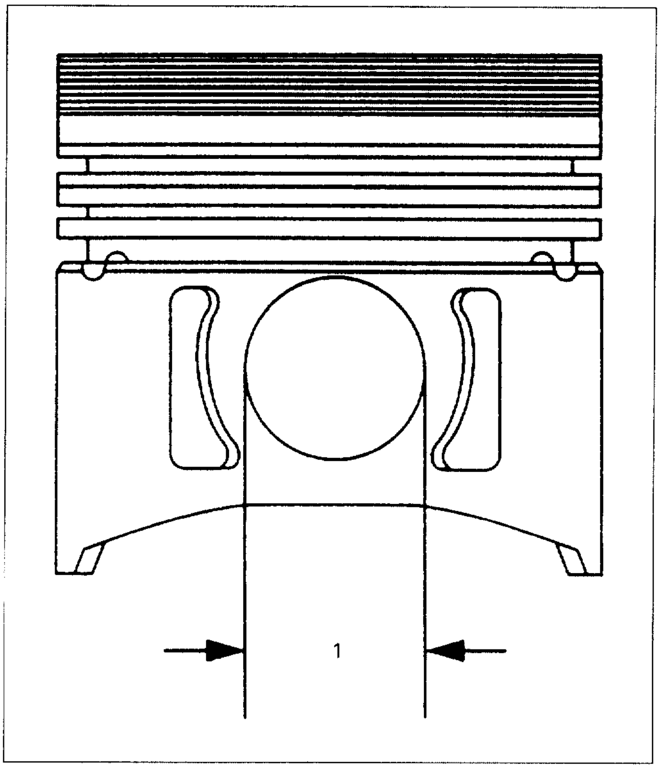


Figure 30 – Piston Pin Measurement



Legend

(1) Piston Pin Bore Measurement

Figure 31 — Measuring the Piston Pin Bore

PISTON SELECTION

Measure (Figures 32 and 33)

1. Cylinder liner outside diameter.
   - Place the bore gauge 20 mm (0.79 in.)., below the gasket surface.
   - Replace the cylinder liner if not with in specifications.
     — Grade 1: 117.981 to 117.990 mm (4.6449 to 4.6453 in.).
     — Grade 2: 117.991 to 118.000 mm (4.6453 to 4.6457 in.).
     — Grade 3: 118.001 to 118.010 mm (4.6457 to 4.64619 in.).
   - When replace the cylinder liner from service part liner, select liner grade 1X for factory liner grade 1 and 2, liner grade 3X for factory liner grade 3.
     The cylinder liner bore diameter grade have not grade for service part liner.
2. Piston diameter.
   - Place the micrometer 82 mm (3.23 in.). below the piston crown, at a right angle to the piston pin bore.
     — Grade A: 114.970 to 114.979 mm (4.5264 to 4.5267 in.).
     — Grade B: 114.980 to 114.989 mm (4.5268 to 4.5271 in.).
     — Grade C: 114.990 to 115.000 mm (4.5272 to 4.5276 in.).
   - There are three different sizes of pistons to be installed from factory. The size grades are referred to as: "A", "B" and "C".
   - The size grade letter is stamped on the piston crown. The engine may come with any combination of piston sizes.
   - Replace the piston, the piston grade have not stamped for service part piston.
   - Pistons are supplied either as part of the cylinder liner set, or separately.
   - When replacing the cylinder liner, also replace the piston. When replacing a piston separately, be sure that the piston to cylinder liner clearance is within factory specifications.
   - Separately supplied pistons have no stamp grade mark.
3. Piston to cylinder liner clearance.
   - Subtract the piston diameter from the cylinder liner bore diameter.
   - Correct clearance is 0.122 to 0.159 mm (0.0048 to 0.0063 in.).
   - If the clearance is correct, the piston and the cylinder liner are acceptable for further use.
   - If the clearance is incorrect, try a new piston.

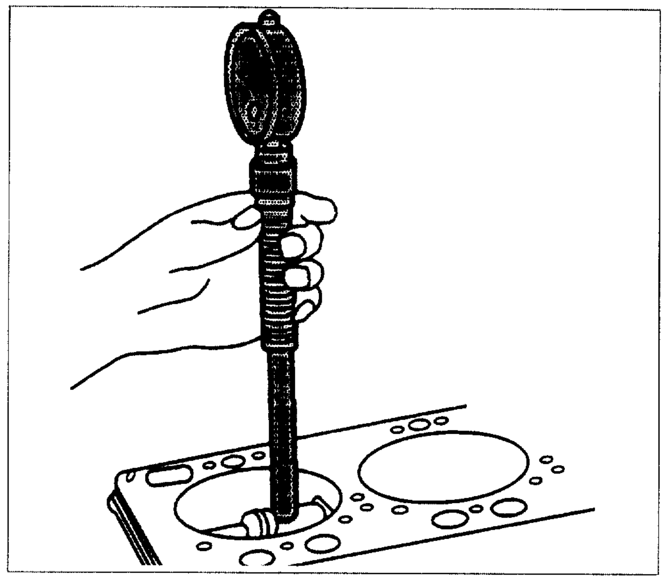


Figure 32 – Measuring the Cylinder Liner Bore

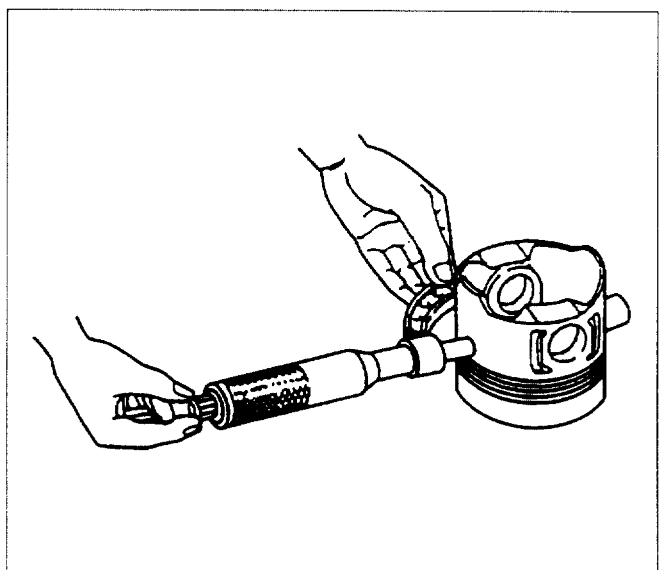


Figure 33 – Measuring the Piston

- If the clearance cannot be brought within factory specifications by the use of new piston, the cylinder liner must be replaced. There are no "oversize" pistons available.

Important

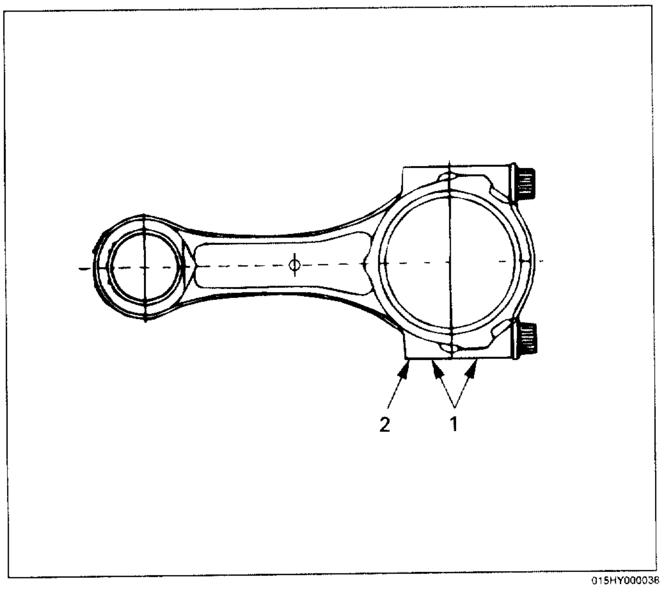
- Never attempt to hone the cylinder liner. Honing may damage the chrome finish on the liners surface.

CONNECTING ROD BEARING SELECTION

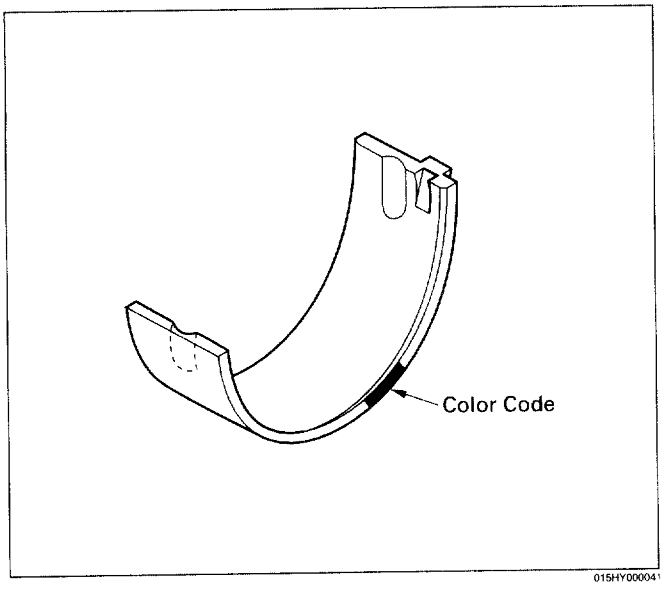
Refer to the following table when installing or replacing the connecting rod bearings.

Pay close attention to the grade mark (2) on the big end of the connecting rod.

Do not confuse the grade mark on the big end of connecting rod with the alignment cylinder No. mark (1).



015HY000036



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CONNECTING ROD BEARING COMBINATION

mm (in)

Connecting Rod Big End Grade Mark	Connecting Rod Bearing Color Code	Oil Clearance
A	Green	0.037 – 0.077 (0.0015 – 0.0030)
B	Yellow	

INSPECTING THE CONNECTING ROD

Clean

- Clean all parts in solvent.
- Blow the parts dry with compressed air. Wear protective safety glasses and gloves.

Inspect (Figure 34)

- Connecting rods and connecting rod caps for cracks, damage, etc.
- Piston pin bushing for scoring.
- Connecting rod bearing insert for scoring.
- Connecting rod bearing insert tension. Moderate finger pressure should be needed to push the bearing insert into place.
- Connecting rod journal on the crankshaft for scoring or other damage.

Measure (Figures 31, 34 and 36)

- Piston pin to the piston clearance. Measure the piston pin at three different points.
- Replace the piston pin if the piston pin is less than 39.95 mm (1.5728 in.).
- Piston pin bushing inside diameter.
- The correct diameter is: 40.012 to 40.022 mm (1.5753 to 1.5767 in.).

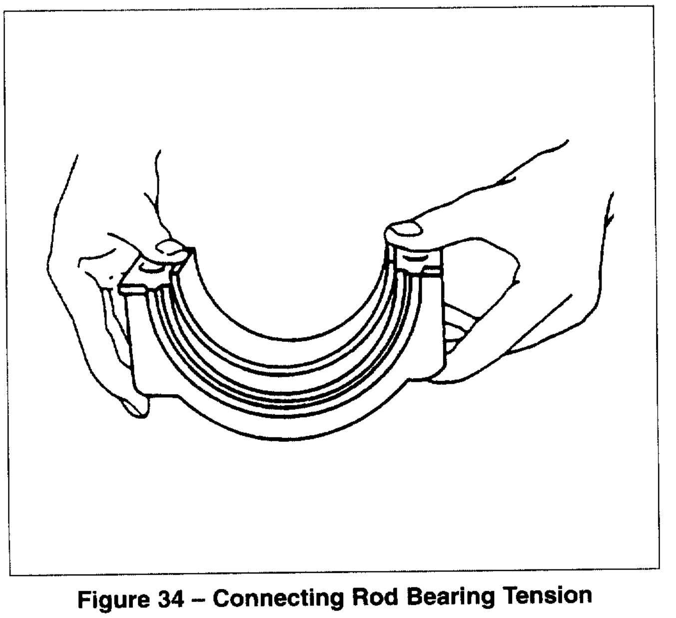


Figure 34 – Connecting Rod Bearing Tension

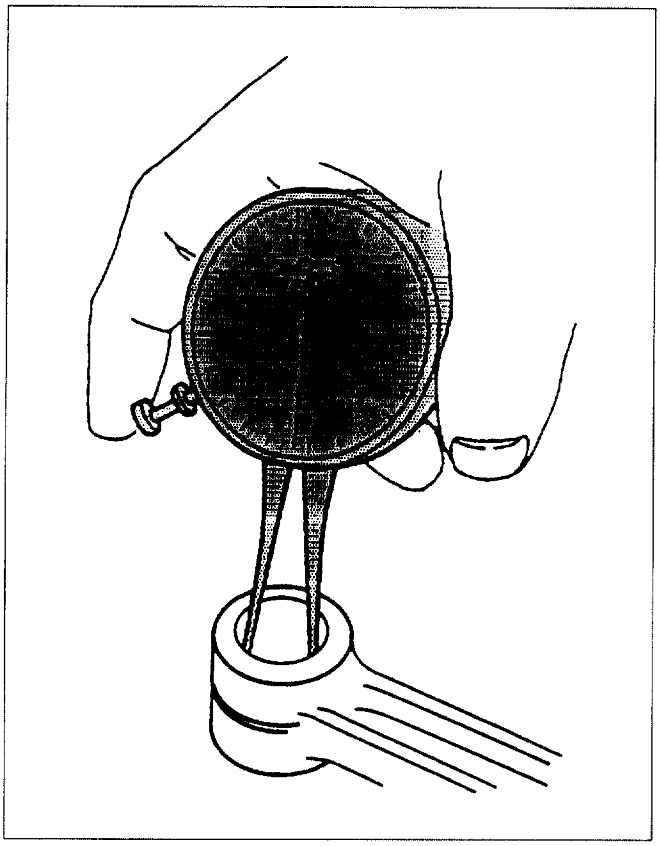


Figure 35 – Measuring Piston Pin Bushing Inside Diameter

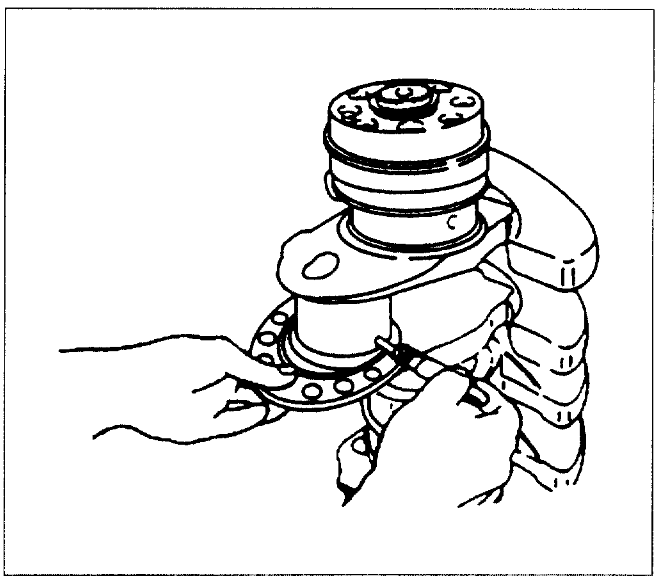


Figure 36 – Measuring the Connecting Rod Journal

- Piston pin to piston pin bushing clearance is as follows.
  - — Clearance: 0.012 to 0.027 mm (0.0005 to 0.0011 in.).
  - — Service limit: 0.05 mm (0.002 in.).
- Subtract the piston pin diameter from the piston pin bushing inside diameter.
- Connecting rod journal diameter, measure at two different points.
  - — Measurements should be: 72.902 to 72.922 mm (2.8701 to 2.8709 in.).

Important

- Undersize bearing are not available. If the crankshaft is worn, replaced it.

Measure

- Connecting rod bearing clearances can be measured by using the plastic gauge method.

Install or Connect (Figures 37 and 38)

1. Apply a piece of plastic gauge the width of the connecting rod bearing journal.
2. Connecting rod bearing inserts to the connecting rod and the connecting rod cap.
   - Apply a small amount of molybdenum grease to the bolts.

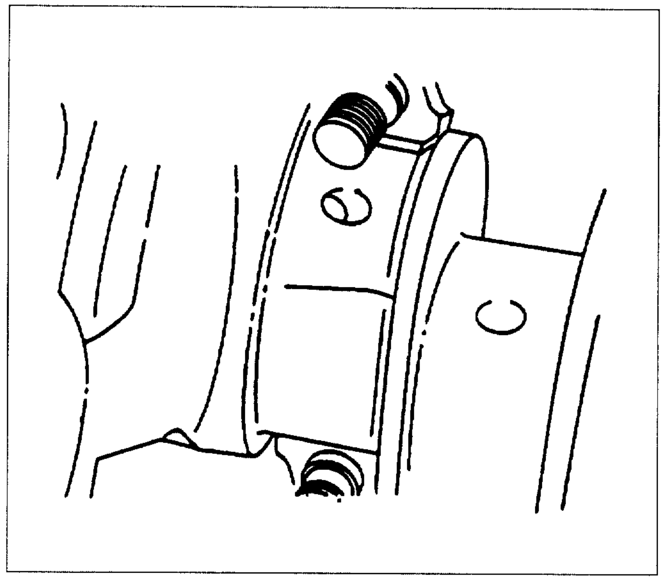


Figure 37 – Installing the Plastic Gauge

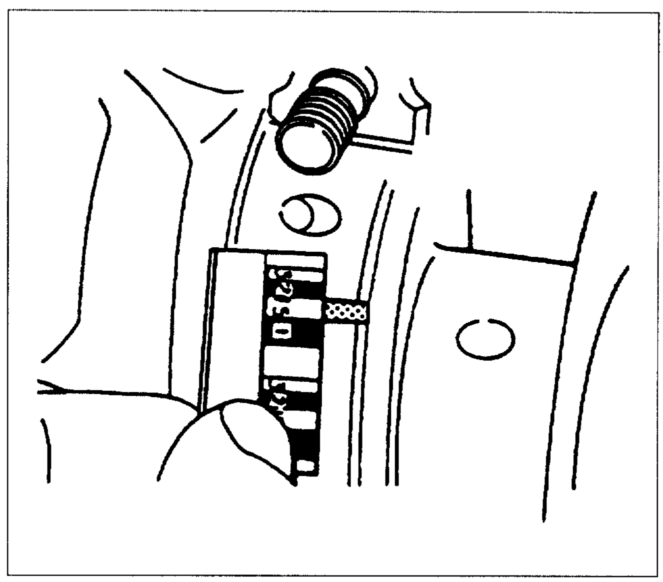


Figure 38 – Measuring the Plastic Gauge

3. Tighten the connecting rod bolts.

Tighten

- Bolts to 39 N·m (29 lb. ft.). Then tighten an additional 60 degrees and then 30 degrees.

Remove or Disconnect (Figure 38)

1. Remove the connecting rod cap from the crankshaft.
2. Measure the plastic gauge.

Important

- **Do not remove the plastic gauge from the crankshaft journal until the clearance measurement is finished.**

Measure

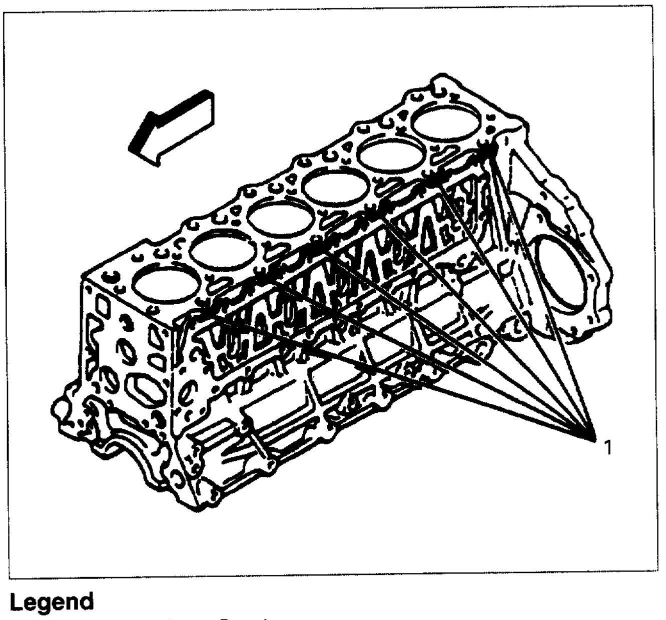
- Check the connecting rod bearing clearances.
- If the clearances are within factory specifications, the connecting rod bearings are satisfaction.
- Remove the plastic gauge.
- If the clearances are not within factory specifications, replace the connecting rod bearing inserts as a set (upper and lower inserts).
- Repeat the procedure.
- If connecting rod bearings still are not within factory specifications, replace the crankshaft.

CYLINDER LINER SELECTION

The cylinder body upper left side has been stamped during production to indicate the correct cylinder liner. The cylinder liner grade (1, 2, or 3) is indicated by this stamp.

Replacement cylinder liners have their grade (1X or 3X) stamped on the outside of the cylinder liner.

Select the 1X grade of replacement cylinder liners as marked 1 and 2 on the upper left side of the cylinder body, or 3X grade of replacement cylinder liners as marked 3 on the upper left side of the cylinder body.



Legend

(1) Cylinder Liner Grades

Figure 39 — Cylinder Liner Grademark

Measure

- Cylinder body bore to cylinder liner outside diameter clearance.
- Standard clearance: 0.011 to 0.029 mm (0.0004 to 0.0011 in.).

Important

- Clearance refers to the gap between the larger cylinder body bore and the smaller cylinder liner outside diameter.

CYLINDER HEAD AND VALVE TRAIN COMPONENTS

VALVE TRAIN COMPONENTS

Remove or Disconnect (Figure 40)

1. Valve rocker arm shaft assembly from the cylinder head.

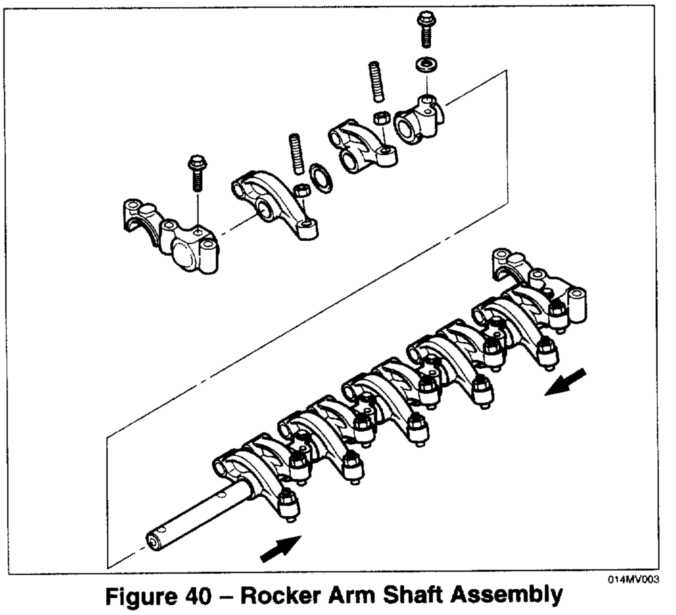


Figure 40 – Rocker Arm Shaft Assembly

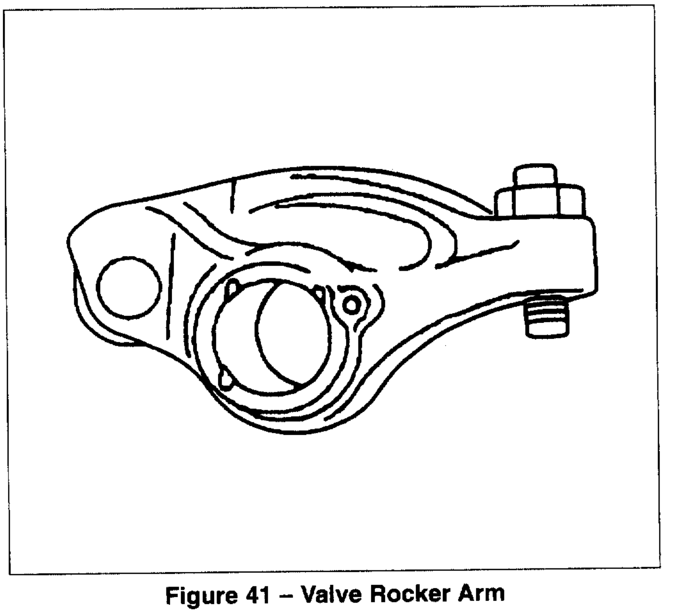


Figure 41 – Valve Rocker Arm

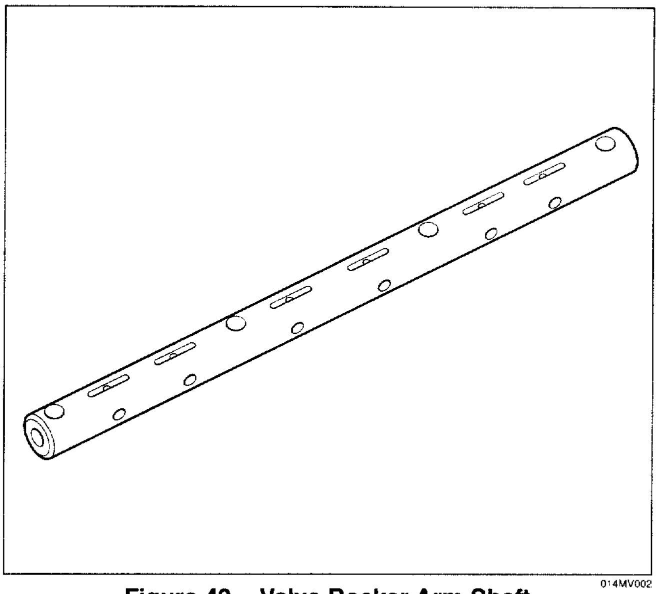


Figure 42 – Valve Rocker Arm Shaft

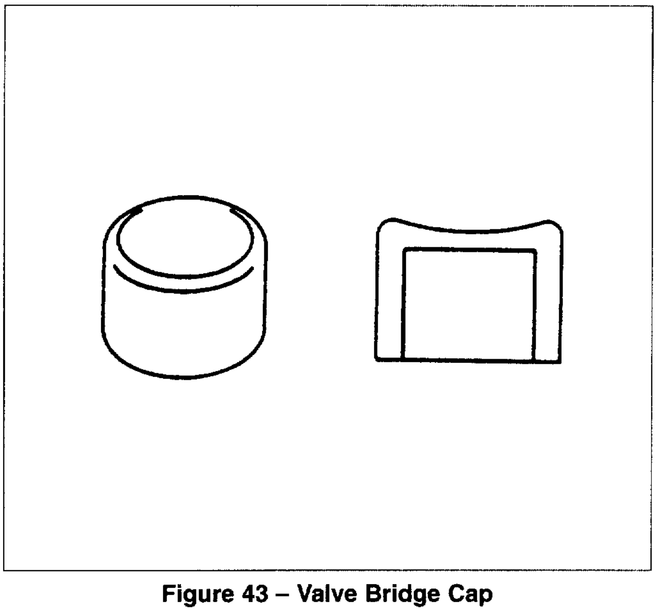


Figure 43 – Valve Bridge Cap

Disassemble

- Valve rocker arm shaft assembly.

Clean

- Clean all parts with cleaning solvent.
- Use compressed air to blow dry the parts. Wear safety eye glasses and gloves.

Inspect (Figures 41 through 43)

- Camshaft retaining brackets for cracks or damage.
- Valve rocker arm shaft for scoring or wear.
- Valve rocker arm inside diameter for scoring or wear.
- Valve rocker arm and the valve bridge cap contact area for pitting and excessive wear.

Measure

- Valve rocker arm inside diameter.
  - Production diameter is: 22.010 to 22.035 mm (0.8665 to 0.8675 in.).
  - Service limit: 22.15 mm (0.872 in.). Replace the part if the measurement is greater than the specification.
- Valve rocker arm shaft.
  - Production diameter: 21.979 to 22.0 mm (0.8653 to 0.8661 in.).
  - Service limit: 21.85 mm (0.8602 in.). Replace the part if the measurement is less than the specifications.
- Subtract the valve rocker arm shaft diameter from the valve rocker arm diameter to obtain the valve rocker arm clearance.
  - Production clearance: 0.010 to 0.056 mm (0.0004 to 0.0022 in.).
  - Service limit: 0.2 mm (0.0079 in.). Replace the part if the measurement is greater than the specification.
- With a pocket scale (ruler) across the top of the valve cap, measure the distance from the bottom of the scale (ruler) to the bottom of the valve cap. If the measurement is greater than 0.1 mm (0.004 in.)., replace the valve cap.

CAMSHAFT INSPECTION

Inspect

- Camshaft lobes and bearing journals for pitting, abnormal or excessive wear.
- Camshaft gear for chipped or broken teeth.

Measure (Figures 44 through 46)

- Camshaft journals at two different points.
  - Production diameter: 39.950 to 39.975 mm (1.5728 to 1.5738 in.).
  - Service limit: 39.85 mm (1.569 in.).

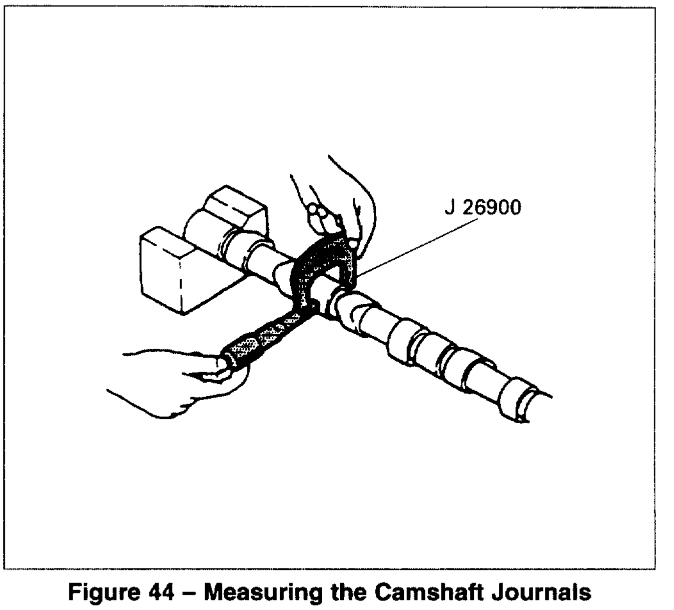


Figure 44 – Measuring the Camshaft Journals

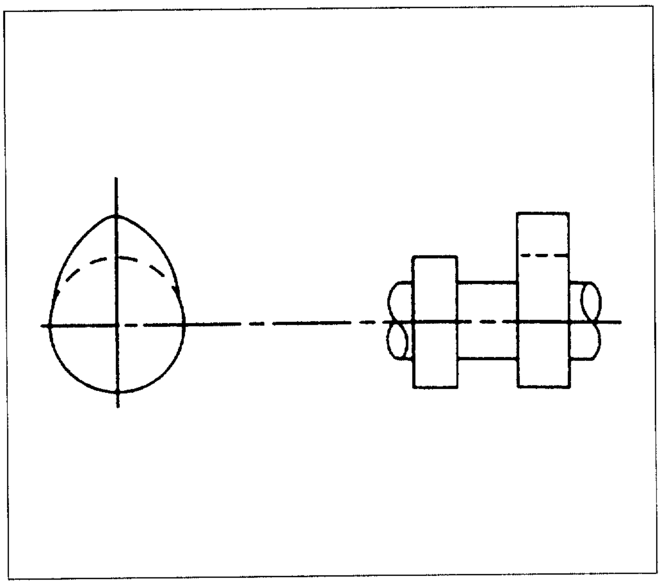


Figure 45 – Measuring the Camshaft Lobes

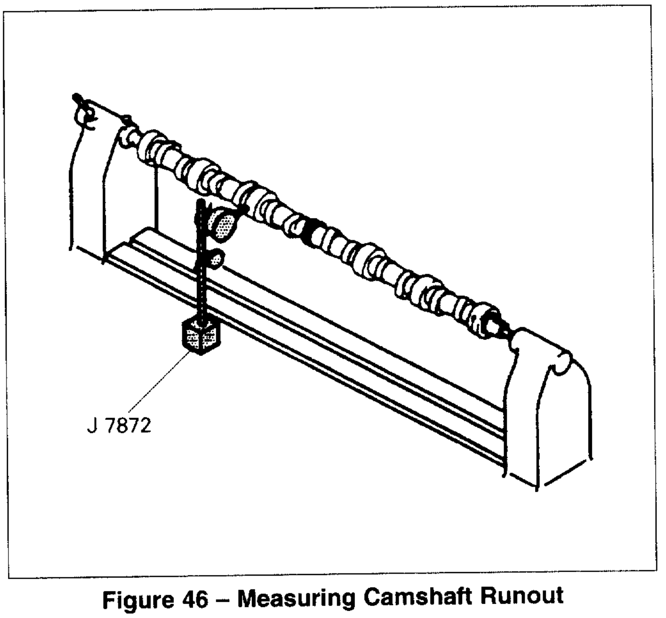


Figure 46 – Measuring Camshaft Runout

- Camshaft bearing inside diameter. The correct measurement is 40.0 to 40.04 mm (1.575 to 1.576 in.).
- Camshaft journal to camshaft bearing clearance.
  - Subtract the camshaft bearing journal diameter, from the camshaft inside diameter.
  - Production clearance: 0.025 to 0.09 mm (0.001 to 0.004 in.).
  - Service limit: 0.15 mm (0.006 in.).
- Camshaft lobe height.
  - Camshaft lobe height should be: 52.851 mm (2.0807 in.) for intake and 54.541 mm (2.1473 in.) for exhaust. Replace the camshaft if the measurement height is below 52.017 mm (2.0500 in.) for intake, 53.761 mm (2.1166 in.) for exhaust.
- Camshaft for runout.
- If the measurement is greater than 0.05 mm (0.0020 in.)., replace the camshaft.

CYLINDER HEAD CLEANING, INSPECTION AND REPAIR

Remove or Disconnect (Figure 47)

1. Remove the valve springs.

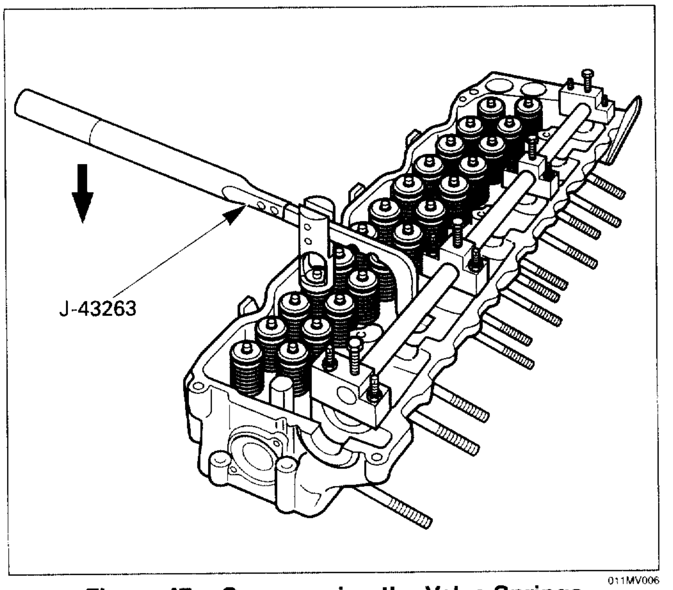


Figure 47 – Compressing the Valve Springs

Inspect

- Carbon from all of the valve ports and combustion chambers.
- Valve guide and bore of dirt and carbon.
- Valve stems and heads.

Important

- Do not use a wire wheel.
- Remove traces of the old gaskets from the cylinder head.

Inspect

- Cylinder head for cracks or damaged threaded holes.
- Cylinder head gasket mating surfaces for damage.
- Valves for damage.
- Valve seats for damage.

Measure (Figures 48 through 53)

- Cylinder head for flatness.
- Check in six different directions. If the cylinder head is distorted more than 0.2 mm (0.0078 in.)., replace the cylinder head.

Important

- **Do not resurface the cylinder head.***

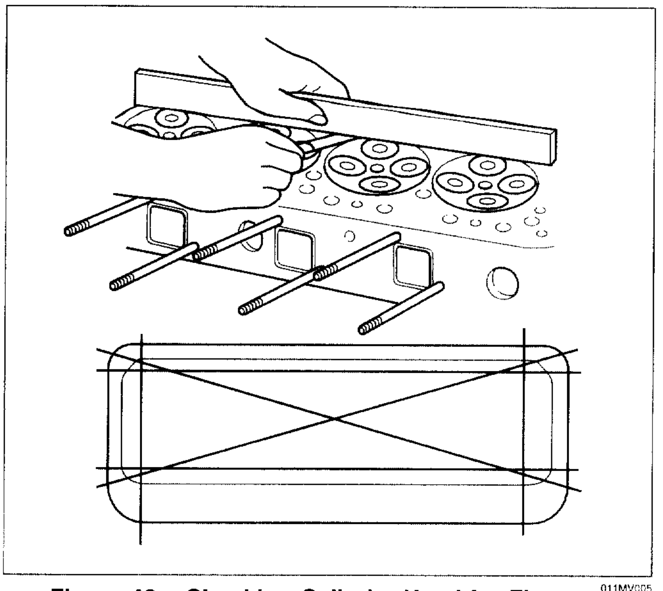


Figure 48 – Checking Cylinder Head for Flatness

2. Valve installed depth.
   - If the measurement is more than 2.5 mm (0.098 in.). for the intake valve and 2.8 mm (0.110 in.). for the exhaust valve, replace the valve or the valve seat as required.

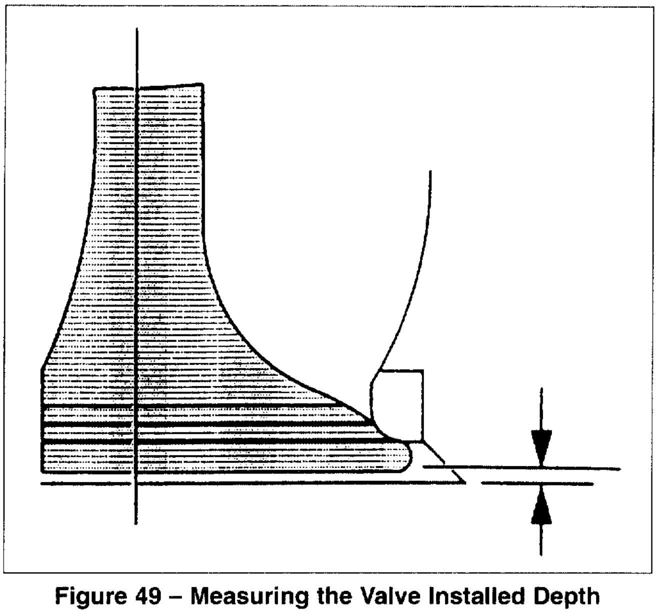


Figure 49 – Measuring the Valve Installed Depth

3. Valve stem diameter.
   - Production specification for the intake valve: 7.946 to 7.961 mm (0.3128 to 0.3134 in.).
   - Service limit: 7.88 mm (0.3102 in.).
   - Production specification for the exhaust valve: 7.921 to 7.936 mm (0.3118 to 0.3124 in.).
   - Service limit: 7.88 mm (0.3102 in.).

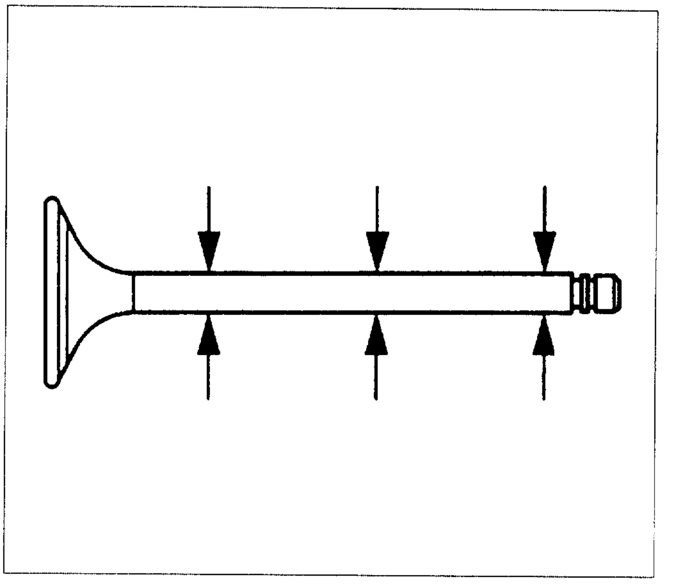


Figure 50 – Measuring the Valve Stem Diameter

4. Valve guide inside diameter.
5. Valve guide to valve stem clearance.
6. Locate the dial indicator so that the plunger is 10 mm (0.39370 in.). above the valve guide.

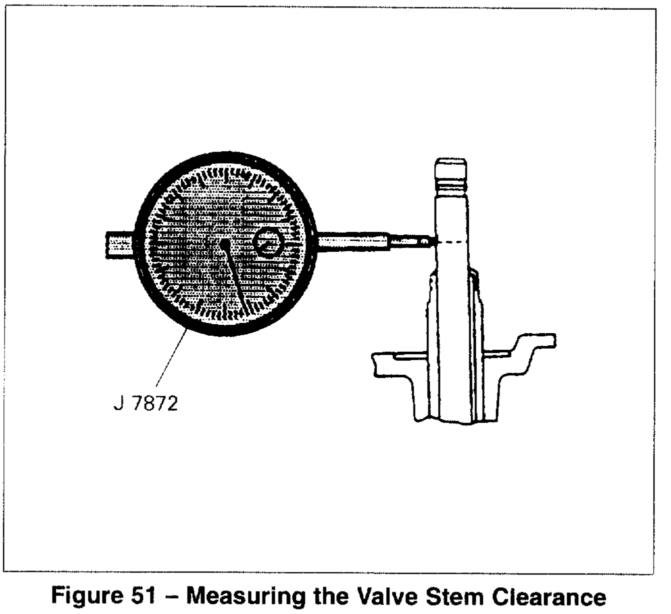


Figure 51 – Measuring the Valve Stem Clearance

7. Hold the valve on its seat.
8. Move the valve stem from side to side to obtain the clearance reading.
   - Production specification for the intake valve guide: 0.04 to 0.07 mm (0.0016 to 0.0028 in.).
   - Service limit: 0.2 mm (0.0079 in.).
   - Production specification for the exhaust valve guide: 0.06 to 0.1 mm (0.0024 to 0.0039 in.).
   - Service limit: 0.25 mm (0.0098 in.).
9. Valve spring length.
   - Production specification for intake valve spring: 65.9 mm (2.5945 in.).
   - Service limit: 64.8 mm (2.5512 in.).
   - Production specification for exhaust spring: 68.1 mm (2.6811 in.).
   - Service limit: 66.9 mm (2.6339 in.).

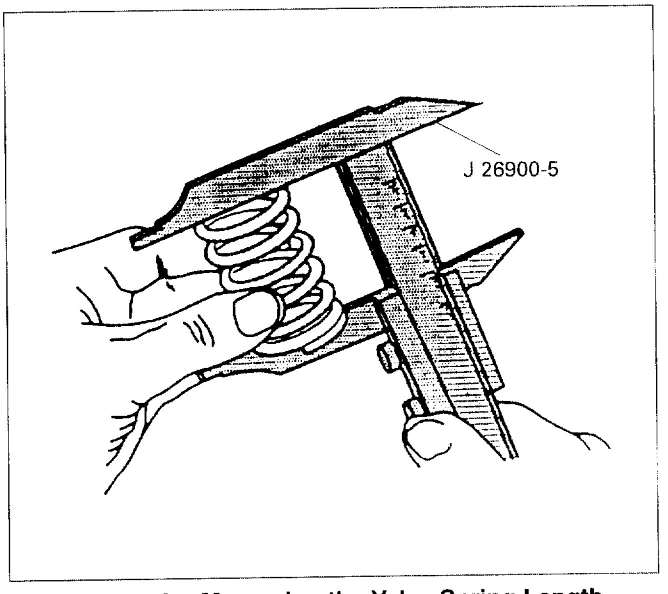


Figure 52 – Measuring the Valve Spring Length

10. Valve spring tension.
    - Compress the valve springs to the specified height.
      — Specified height 46 mm (1.8110 in.). length.
      — Intake Production: 348.1 N (78.3 lb.).
      — Service Limit: 296 N (67 lb.).
      — Exhaust Production: 382.5 N (86 lb.).
      — Service Limit: 325 N (73 lb.).
    - If valve springs are not within factory specifications, replace the valve springs.

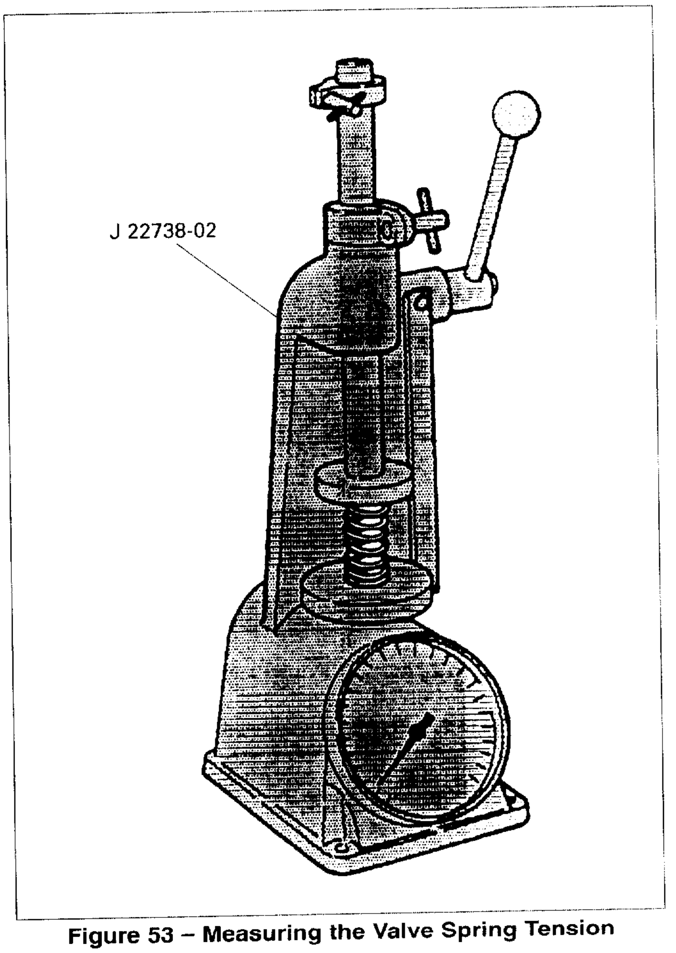


Figure 53 – Measuring the Valve Spring Tension

VALVE SEAT

Reconditioning of the valve seats is very important because the seating of the valves must be precise in order for the engine to deliver the power and the performance it was designed to produce.

Another important factor is the cooling of the valve head. Good contact between each valve and its seat in the cylinder head is a must to insure that the heat in the valve head will be properly dispersed.

Several different types of equipment are available for grinding of the valve seats. The recommendations of the equipment manufacturer should be carefully followed to attain the proper results.

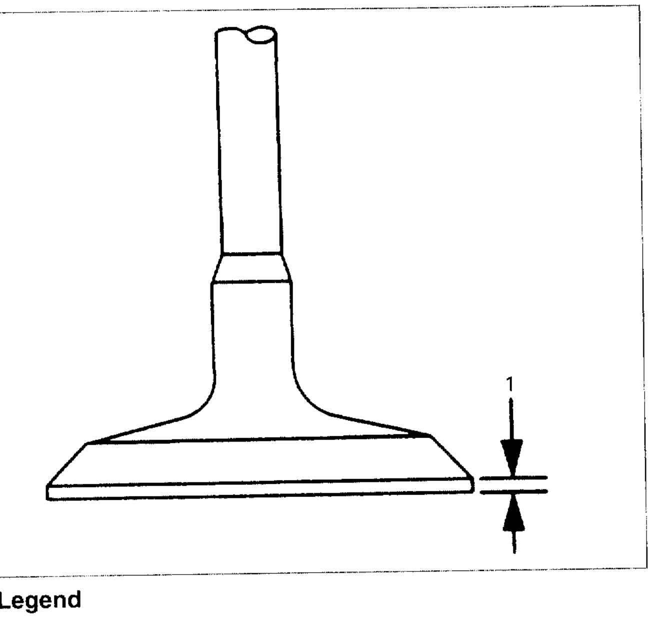
Regardless of what type of equipment is being used, it is necessary that the valve guide bores are clear of carbon or dirt to ensure the proper centering of the pilot in the valve guide. The correct seat angle is 89 degrees and 45 minutes for exhaust, 119 degrees and 45 minutes for intake.

If too much material is removed from the valve seat, the valve install depth may become too excessive. If this is the case, the valve seat must be replaced.

Valves that are pitted, should be replaced to the new part. Valve stems which show excessive wear, or valves that are warped, should be replaced.

Measure

1. Valve margin thickness.
   - Measurement for intake valves: 1.71 mm (0.0673 in.).
   - Measurement for exhaust valves: 1.75 mm (0.0689 in.).
2. Valve face angle.
   - Face angle for the intake valve: 60 degrees.
   - Face angle for the exhaust valve: 45 degrees.



Legend
(1) Valve Margin

Figure 54 — Valve Margin Thickness

VALVE GUIDE REPLACEMENT

Tools Required:
J43272 Valve Guide Remover and Installer

Remove or Disconnect (Figure 55)

1. Place the cylinder head on wooden blocks with combustion chamber facing up.
2. Drive valve guide out with tool J43272.

Clean

- Clean the valve guide bore in the cylinder head.

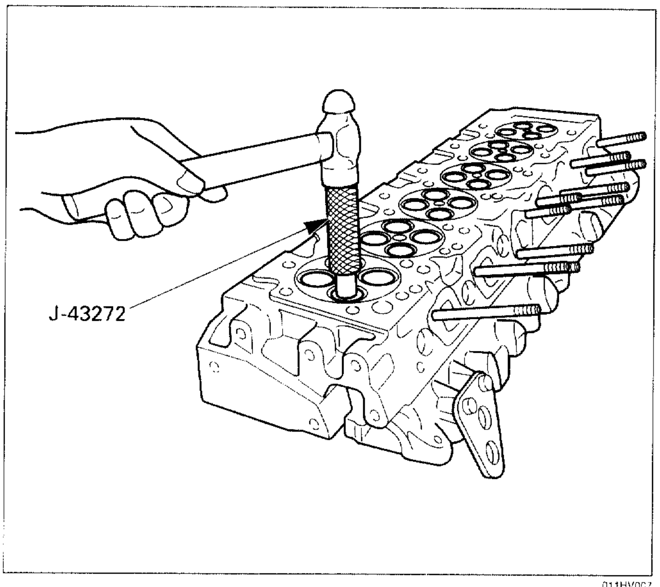


Figure 55 – Removing the Valve Guide

Install or Connect (Figure 56)

1. Install new valve guide with tool J43272, Valve Guide Installer.
   - Measure the distance from the top of the valve guide to the cylinder head surface.
     — 19 mm (0.7480 in.).
   - Tool J43272 is supplied with a installer designed to install the valve guide to the proper depth.

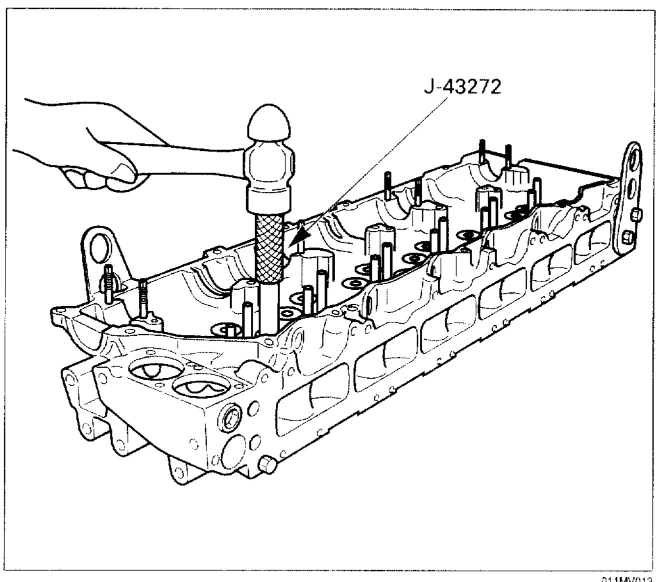


Figure 56 – Installing the Valve Guide

VALVE SEAT REPLACEMENT

Remove or Disconnect (Figure 55)

1. Grind the valve seat (intake and exhaust) until the seat measures (1) 0.5 to 1 mm (0.0196 to 0.04 in.). thick.
2. Remove the valve seat with a pry tool.

Clean

- Thoroughly clean the valve seat counter bore in the cylinder head before installing new seat.

Install or Connect (Figure 49)

1. Press the new valve seat into the cylinder head.
2. Grind valve seat.

Important

- When a new valve seat and new valve are used together, the installed depth should be 0.65 to 1.1 mm (0.0255 to 0.0433 in.). The installed depth should not be any greater than 2.5 mm (0.098 in.). for the intake valve, and 2.8 mm (0.110 in.). for the exhaust valve.

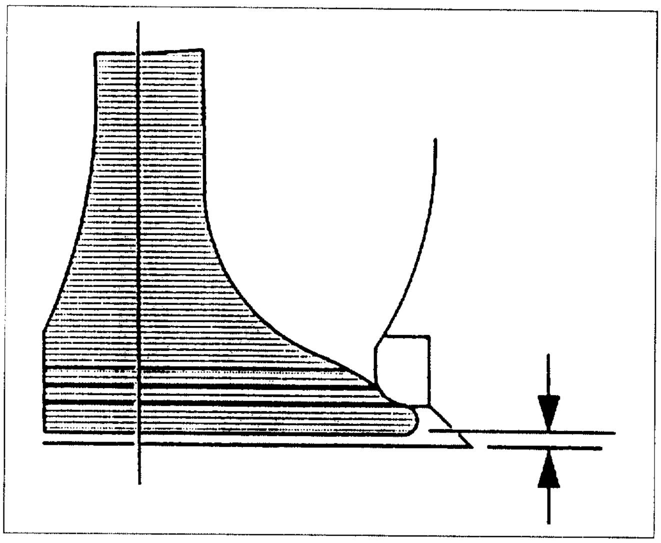


Figure 57 — Valve Installed Depth

VALVE LAPPING

The valves should be lapped just before the final assembly to assure a good valve seal.

1. Apply Prussian blue dye or equivalent to the valve seat.
2. Insert the valve into the proper port.
3. Rotate the valve lightly, then remove.
4. Inspect the valve face.

Measure

- The valve seat width will be indicated by the mark on the valve face.

5. Measure the valve seat width.
   - Intake valve should be: 3.2 mm (0.1260 in.).
   - Exhaust valve should be: 2.8 mm (0.1102 in.).

Important

- Contact area should be centered on the valve face. If not, check the condition of the valve seat and repair as needed.

6. Repeat steps 1 through 5 on the remaining valves.

Clean

- Clean all the Prussian blue dye from the valves and the valve seats.

7. Apply a medium valve lapping compound to the valve.
8. Lap the valve until a light gray ring appears all the way around the valve face.
9. Thoroughly clean all the valve lapping compound from the valve and valve seat.
10. Repeat this procedure on the remaining valve and valve seats.

INSTALLING THE VALVE SEALS

Tools Required:
J43267 Valve Seal Installer

Install or Connect (Figures 58 and 59)

1. Lubricate the valve stem seal with clean engine oil.
2. Install valve stem seal using tool J43267.

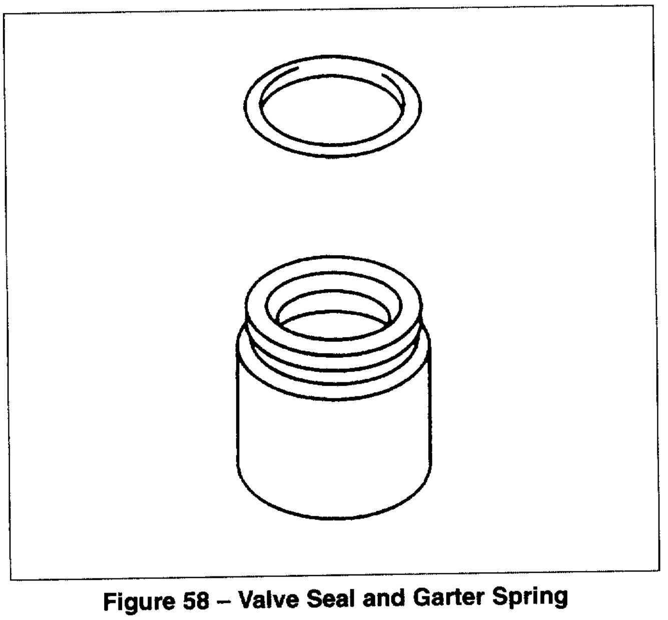


Figure 58 – Valve Seal and Garter Spring

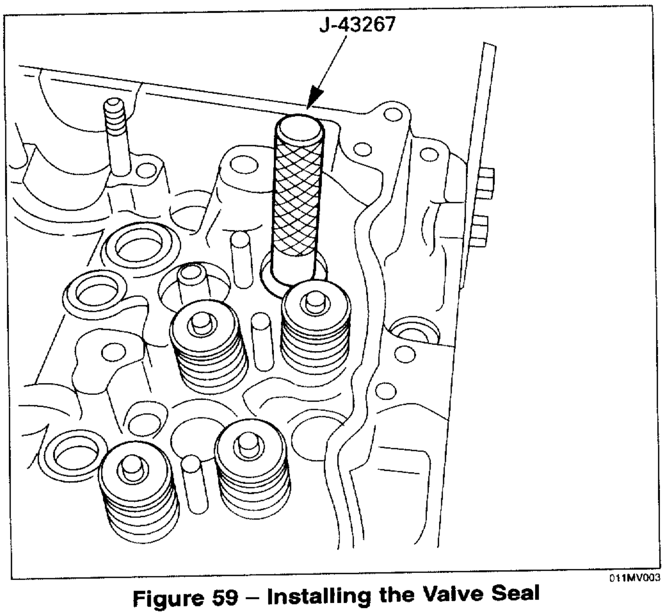


Figure 59 – Installing the Valve Seal

INJECTION NOZZLE SLEEVE REPLACEMENT

Tools Required:
J43265 Remover: Nozzle Sleeve
J43266 Installer: Nozzle Sleeve

Remove or Disconnect (Figure 60)

1. Place the cylinder head on wooden block with combustion chamber facing up.
2. Remove the injection nozzle sleeve with tool J43265.

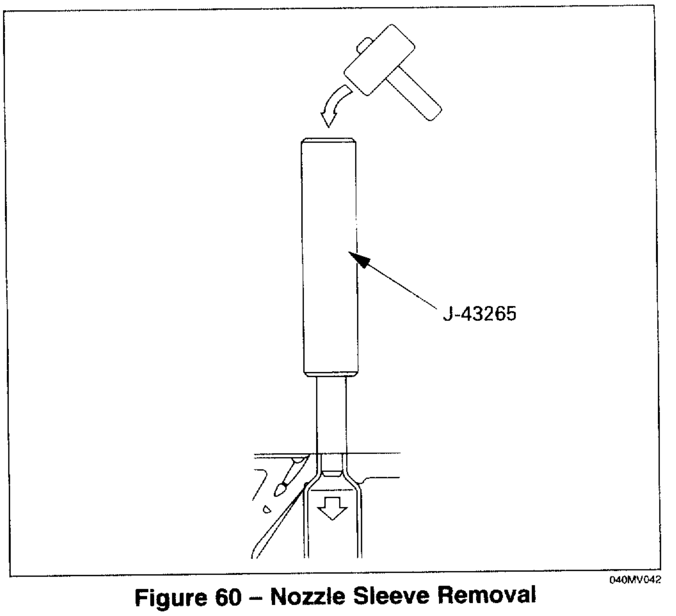


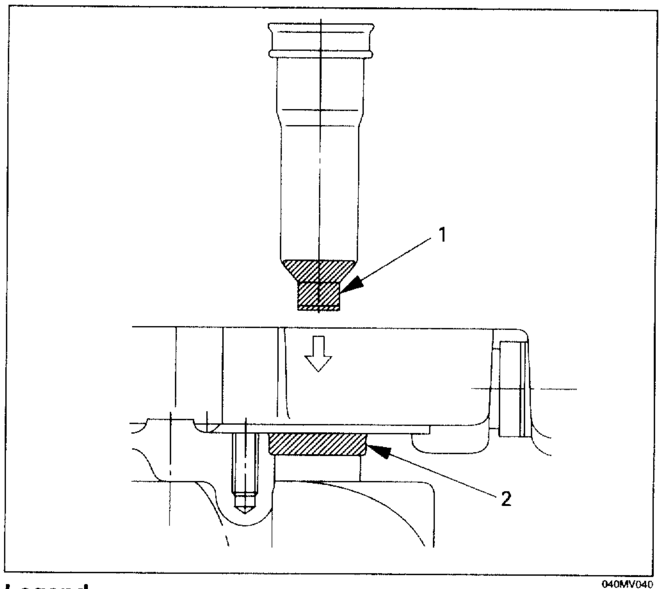
Figure 60 – Nozzle Sleeve Removal

Clean

- Clean the injection nozzle sleeve bore in the cylinder head.

Install or Connect (Figures 61 and 62)

1. Install the O-ring to the new injection nozzle sleeve.
2. Apply sealant (LOCKTITE No. TL290) to new injection nozzle sleeve (1) and apply engine oil to cylinder head nozzle sleeve bore (2) as shown in the illustration.
3. Insert the injection nozzle sleeve to cylinder head.
4. Use injection nozzle clamp bolt to clamp the injection nozzle sleeve with tool J43266.
5. Put ball bearing (Outside diameter 9.525 mm (3.8 in.) into the injection nozzle sleeve and set too J43266.
6. Strike out the ball bearing by tool J43266.



Legend

(1) Sealant (LOCKTITE No. TL290) on Injection Nozzle Sleeve.
(2) Engine oil on Cylinder Head Nozzle Sleeve Bore.

Figure 61 – Apply Sealant to Nozzle Sleeve

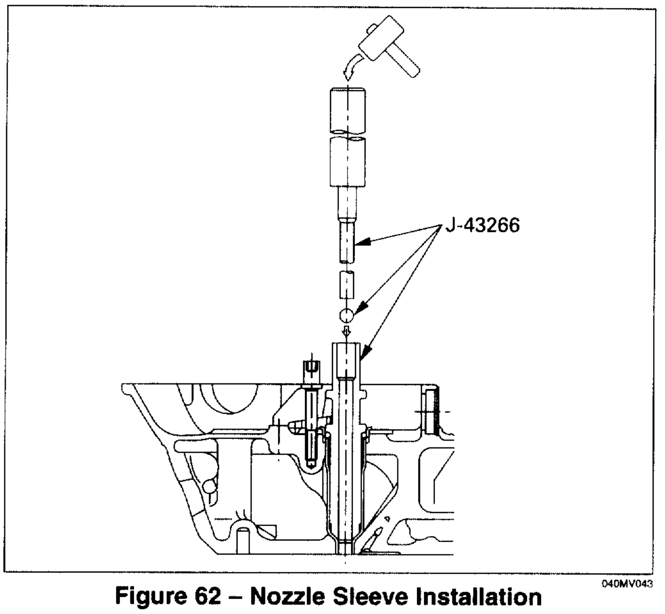


Figure 62 – Nozzle Sleeve Installation

ASSEMBLING THE CYLINDER HEAD

Tools Required:
J8062 Valve Spring Compressor

Install or Connect (Figure 63)

1. Apply clean engine oil to the valve stem.
2. Insert the valve into the proper port.
3. Valve spring seats to the cylinder head.
4. Valve spring with retainer.

Important

- Painted part of the valve springs (close spaced) coils must be toward the cylinder head.

5. Compress the valve springs, using J8062.
6. Apply a small amount of grease on the end of the valve stem.
   - Apply a small amount of grease to the end of the valve stem. This will help retain the valves keys in position while releasing tool J8062.
7. Valve keys to the valve stem.
8. Slowly release valve spring compressing tool J8062.

Important

- Make sure that the valve keys are installed properly before proceeding to the next set of valves.

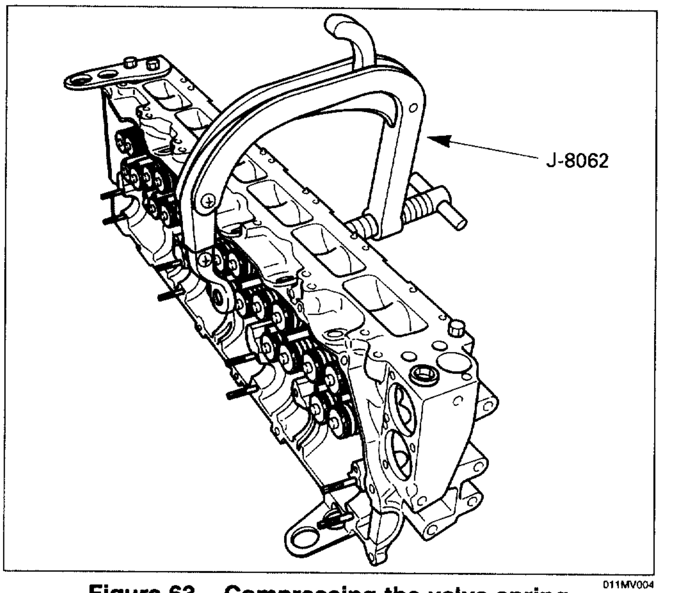


Figure 63 – Compressing the valve spring

ASSEMBLY OF THE ENGINE

OIL JET INSTALLATION

Install or Connect (Figure 64)

1. Bolt and washers to the oil jet.
2. Oil jet to the cylinder block.
3. Tighten the oil jet.

Tighten

- Bolts to 21 N·m (15 lb. ft.).

Important

- Failure to install the oil jets to the cylinder block will cause loss of oil pressure and possible engine damage.

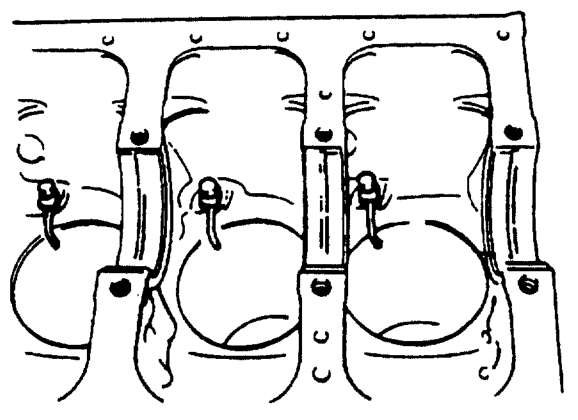


Figure 64 – Installation of the Oil Jets

OIL FILTER INSTALLATION

Install or Connect (Figure 8)

1. Oil filter bracket and gasket to the cylinder block .
2. Bolts to the oil filter bracket.
3. Tighten oil filter bracket bolts.

Tighten

- Bolts to 38 N·m (28 lb. ft.).

4. Install the oil filter.
   - Fill filter with oil before installing it to the bracket.

CRANKSHAFT INSTALLATION

CRANKSHAFT BEARING SELECTION

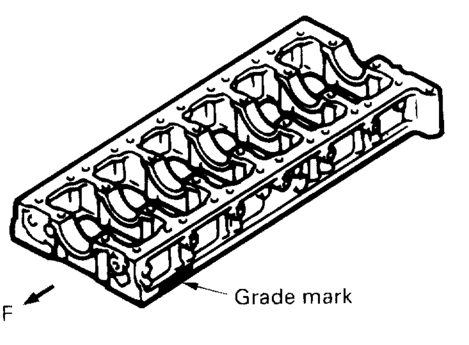
Refer to the following table when replacing the crankshaft and/or the crankshaft bearing.

Crankshaft bearing selection is based on the measured diameters of the crankshaft journals and the bearing housing.

Match the crankshaft bearing housing grade marks and the crankshaft journal grade marks in the table below to determine the correct crankshaft bearing size.

CRANKSHAFT BEARING INSERT GRADE MARK POSITION

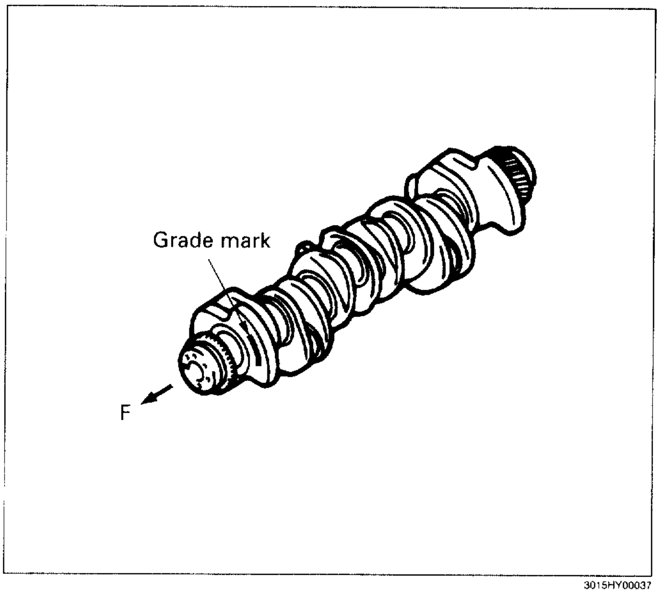
The crankshaft bearing housing grade marks (1 or 2) are stamped collectively for all cylinders on the underside of the left front portion of the crankcase.

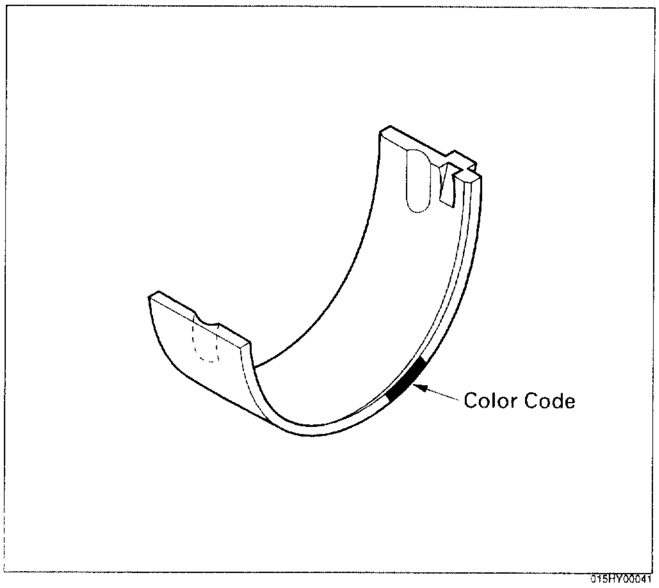


CRANKSHAFT JOURNAL GRADE MARK POSITION

The crankshaft journal grade marks (1 or 2) are stamped collectively for all cylinders on the front side of the crankshaft No. 1 balancer.

The clearance between the crankshaft journal and the bearing must be the same for each position after installation of the crankshaft and the crankshaft bearings.





CRANKSHAFT BEARING COMBINATION

Bearing Housing Grade Mark	Crankshaft Journal Grade Mark	Crankshaft Bearing Color Code
1	1	Green
1	2	Pink
2	1	Yellow
2	2	Green

OIL CLEARANCE

mm (in)

Crankshaft Main Bearing No. 4 (center)	0.093 – 0.124 (0.0037 – 0.0049)
Crankshaft Main Bearing (except No. 4)	0.063 – 0.094 (0.0025 – 0.0037)

Install or Connect (Figures 65 through 68)

1. Upper crankshaft main bearing inserts into the cylinder block.
   - Upper crankshaft main bearing inserts have the oil holes and grooves in them.
   - Make sure that the bearing inserts fit correctly into the cylinder block.
2. Crankshaft into the cylinder block.
3. Upper thrust washer into the cylinder block.
   - Upper thrust washer does not have a locating tab. It must be rolled into the cylinder block.
   - New thrust washers must be used if the crankshaft end play measurement at disassembly was excessive.
4. Lower crankshaft bearing inserts into the lower crankcase housing.
   - Lower crankshaft bearing inserts are plain and have no grooves in them.
   - Make sure that the bearing inserts fit correctly into the cylinder block.

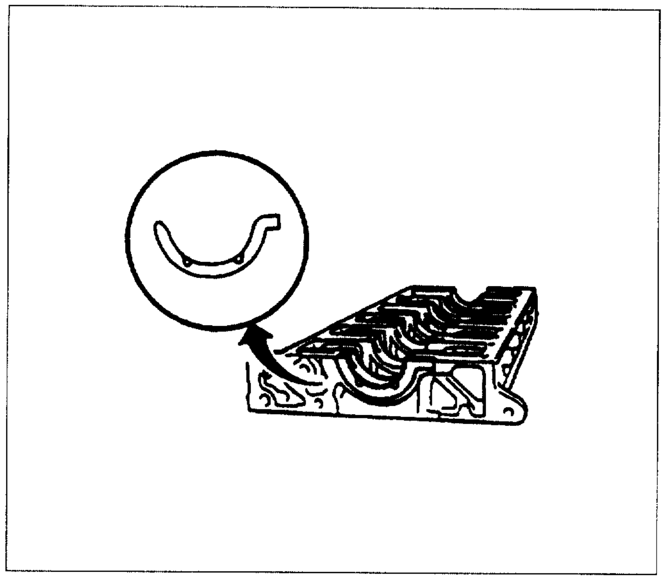


Figure 65 – Lower Thrust Washer Installation

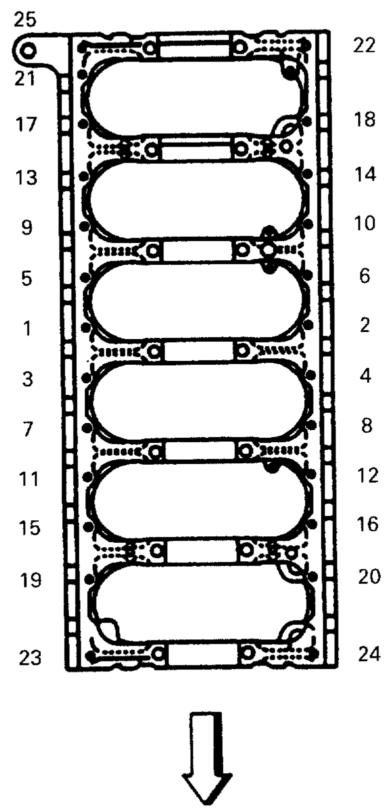


Figure 66 – Cylinder Block to Lower Crankcase Bolt Tightening Sequence

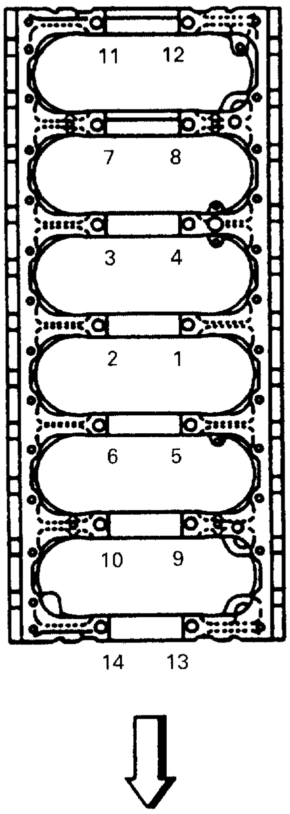


Figure 67 – Lower Crankcase Bolt Tightening Sequence

Install or Connect

1. Apply clean engine oil to the crankshaft main bearing and inserts.
2. Crankshaft into the cylinder block.
3. Apply sealant to sealing surface of lower crankcase.
4. Lower thrust washer half to the lower crankcase housing, with the grooves facing inward.
5. Apply a small amount of molybdenum grease to the bolts. (M14 Bolts only)
6. Bolts to the lower crankcase housing.
7. Tighten the bolts.
   - The head of the bolt will be marked 14.

   Tighten

   - Tighten bolts in steps:
     - — 98 N·m (73 lb. ft.).
     - — 132 N·m (98 lb. ft.).
     - — turn an additional 45 degrees.
8. Bolts (marked M10) to the crankcase.
   - Bolts evenly in sequence to 37 N·m (27 lb. ft.).
9. Rotate the crankshaft.
   - The crankshaft should rotate freely.
   - If the crankshaft does not rotate freely, loosen the lower crankcase housing bolts (marked M10), until the tight crankshaft main bearing is located.

Tighten

- Burrs on the crankshaft bores.
- Foreign matter between the cylinder block and lower crankcase housing.
- Faulty crankshaft main bearing insert.
- Repair as necessary.

Measure (Figure 68)

- Crankshaft for end play.
- Tap the crankshaft on the flywheel end with a brass hammer to force it forward.
- Insert a feeler gauge between the lower thrust washer half and the crankshaft.
- Production end play is 0.15 to 0.33 mm. (0.005 to 0.012 in.). The service limit is 0.4 mm. (0.0157 in.).

Important

- Check the lower crankcase bolts faulty, and its using limit is six times.
  If a problem is found, replace as necessary.

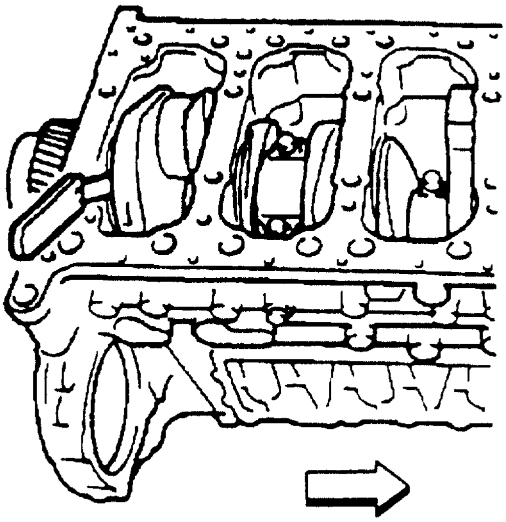


Figure 68 – Measuring Crankshaft End Play

FRONT COVER INSTALLATION

Tools Required:
J39046 Crankshaft Balancer (External) Remover and Installer
J41220 Oil Slinger Remover
J41221 Oil Seal Installer

Install or Connect (Figures 69 through 72)

1. Apply RTV sealant (Three Bond 1207C or equivalent) to the front cover.
2. Front cover to the cylinder block.
3. Bolts to the front cover.
4. Tighten the front cover bolts.

Tighten

- Bolts to 19 N·m (14 lb. ft.).

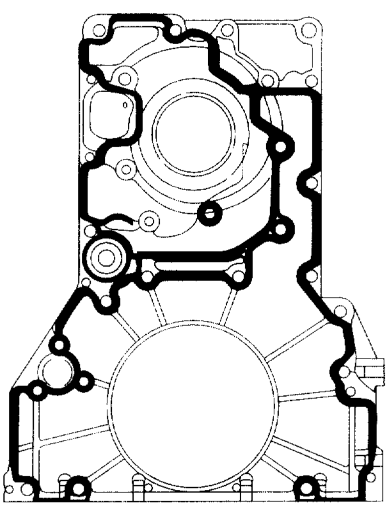


Figure 69 – Apply the Sealant

5. Oil slinger.
   - Install J41221.
     A. Apply clean engine oil to the oil slinger.
     B. Insert the oil slinger into the adapter.
     C. Install the oil slinger sleeve to the adapter, and tighten the center bolt until the sleeve comes in contact with the adapter and stops.
     D. After pressing in the oil slinger, make sure that the distance between the crankshaft end surface and the oil slinger is 11.5 ± 0.15 mm (0.453 ± 0.006 in.).
        - Check the measurement at several different points.

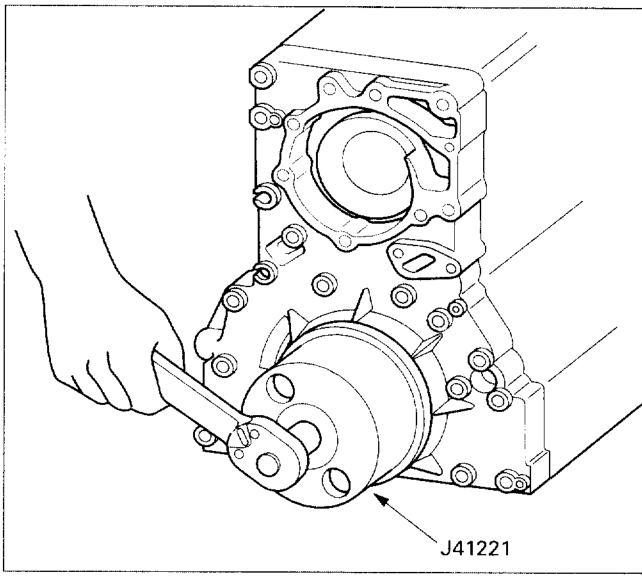


Figure 70 – Install the Oil Slinger and Oil Seal

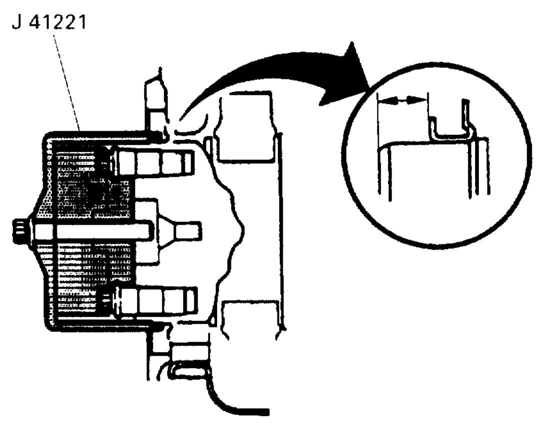


Figure 71 – Checking the Clearance

- Install J41221.
  - A. Apply clean engine oil to the oil seal.
  - B. Insert the oil seal into the adapter.
  - C. Install the oil seal to the adapter, and tighten the center bolt until the sleeve comes in contact with the adapter and stops.
  - D. After pressing in the oil seal, make sure that the distance between the crankshaft end surface and the oil slinger is 8.5 ± 0.15 mm (0.335 ± 0.006 in.).
    - Check the measurement at several different points.

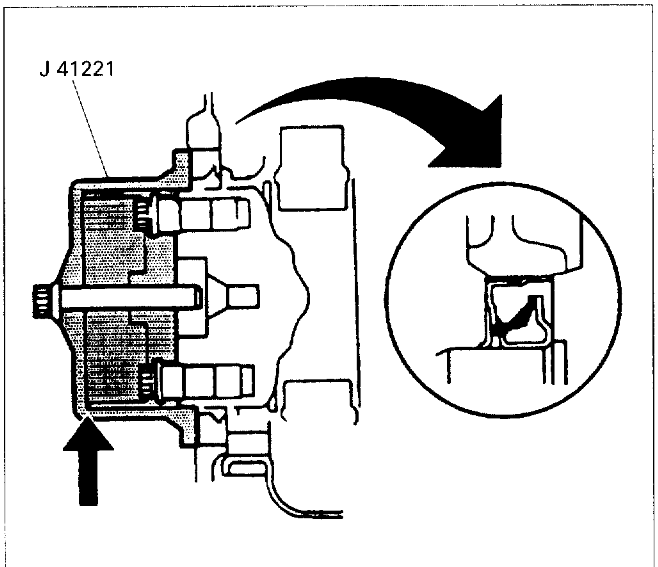


Figure 72 – Checking the Seal Clearance

Inspect

- Crankshaft balancer for excessive wear or damage.
- Crankshaft balancer for silicone leakage. If leakage appears, replace the crankshaft balancer.

6. Crankshaft balancer bolts, washers and the crankshaft balancer.

Tighten

- Bolts and nuts to 48 N·m (35 lb. ft.).

7. Crankshaft balancer to the crankshaft.
8. Crankshaft balancer bolt and washer to the crankshaft.

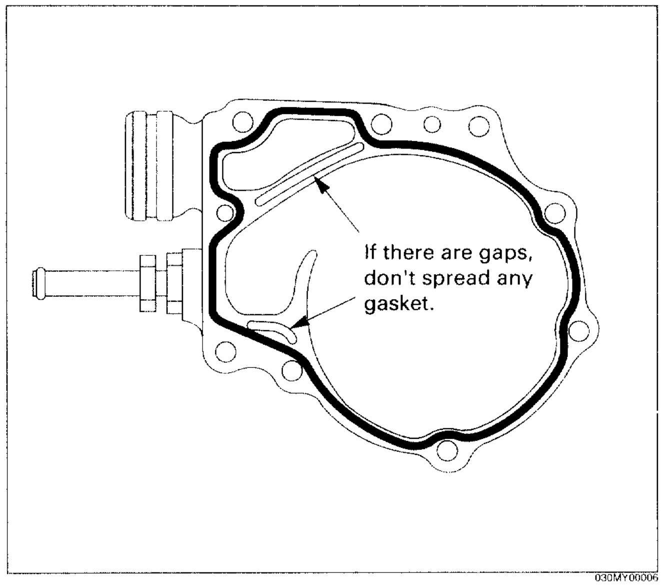
Tighten

- Crankshaft balancer bolt and washer to 200 N·m (148 lb. ft.).

WATER PUMP INSTALLATION

Install or Connect

1. Apply liquid gasket on the water pump assembly.
   - Bead width : 2 – 3 mm (0.079 – 0.181 in.).
     Liquid gasket type : THREE BOND No. 1207C



NOTE: Attach the water pump assembly within 15 min after sealant application.

2. Water pump bolts to the cylinder block.
3. Tighten the water pump bolts.

Tighten

- Bolts (M10) to 36 N·m (28 lb·ft).
- Bolts and nuts (M8) to 19 N·m (14 lb·ft).

4. Water duct and the O-ring to the cylinder head and the water pump.
   - Apply a small amount of liquid soap on the O-ring for easier installation.
5. Bolts to the water duct.

Tighten

- Water duct to
  - — Bolts marked M8 to 19 N·m (14 lb·ft).
  - — Bolts marked M16 to 103 N·m (76 lb·ft).

CYLINDER LINER INSTALLATION

Install or Connect

1. Clean cylinder liners and bores with solvent.
2. Blow dry the cylinder liners with compressed air. Wear protective safety glasses and gloves.

Important

- All foreign material must be carefully removed from the cylinder liner and from the cylinder bore, before the cylinder liner installation.

3. Apply clean engine oil to outside cylinder liner.
4. Cylinder liner into the cylinder block.

Important

- The installation of the cylinder liner retaining bolt and washer will prevent the cylinder liners from moving or falling free, if the engine is being moved or rotated on the engine stand.

5. Cylinder liner retaining bolts and washers.
   - Cylinder liner retaining bolt.
     — Size and pitch: M14-2 mm.
     — Length: 30 mm (1.181 in.).
   - Cylinder liner retainer washer.
     — Thickness: 3 to 5 mm (0.118 to 0.197 in.).
     — Outside diameter: 40 mm (1.575 in.).

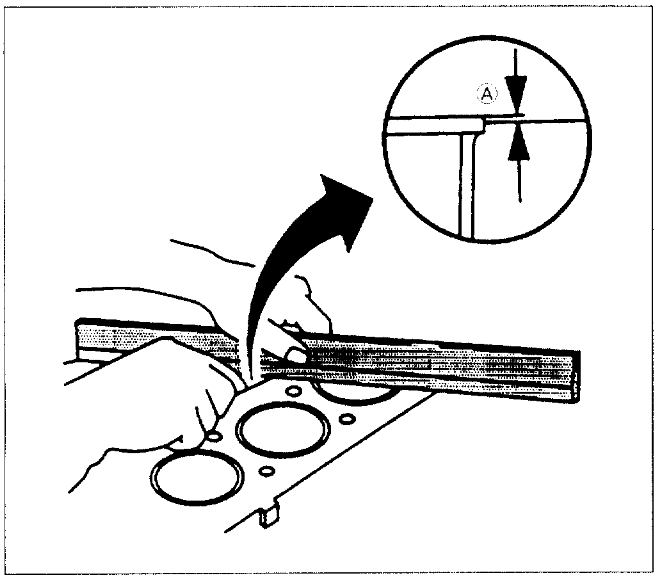
Important

- Remove the cylinder liner retaining bolt and washer when installing the piston assembly. Reinstall the retaining bolt and the washer, after the piston assembly has been installed.
- Leave the retaining bolt and the washer in place and do not remove until the installation of the cylinder head assembly.

6. Measure the amount of the cylinder liner projection (A).

Measure

- Use a straight edge and feeler gauge, as shown in (Figure 73). If properly installed, the cylinder liner should project 0.06 to 0.1 mm (0.0024 to 0.0039 in.). above the gasket mating surface of the cylinder head.
- The difference in the cylinder liner projection height between any two adjacent cylinders, must not exceed 0.03 mm (0.0012 in.).



Legend
(A) Measured Projection
Figure 73 — Measuring the Cylinder Liner Projection

7. Recheck the piston to cylinder liner clearance.

PISTON AND CONNECTING ROD INSTALLATION

Tools Required:
J8037 Piston Ring Compressor

Install or Connect (Figures 74 through 77)

1. Piston to the connecting rod.
   - Position the piston assembly, so the mark on the crown of the piston and the mark on connecting rod are facing opposite.
2. Separate the connecting rod and the connecting rod bearing cap.
3. Piston rings to the piston assembly.
   - Install the piston rings with marks facing up .

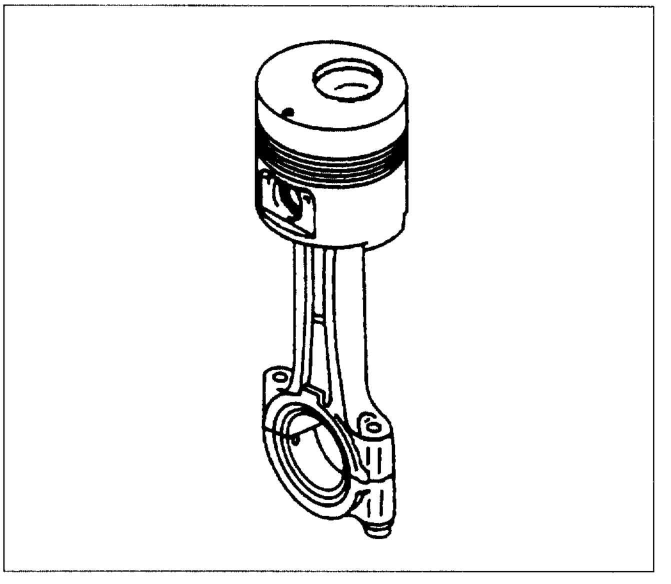


Figure 74 – Piston and Connecting Rod Alignment

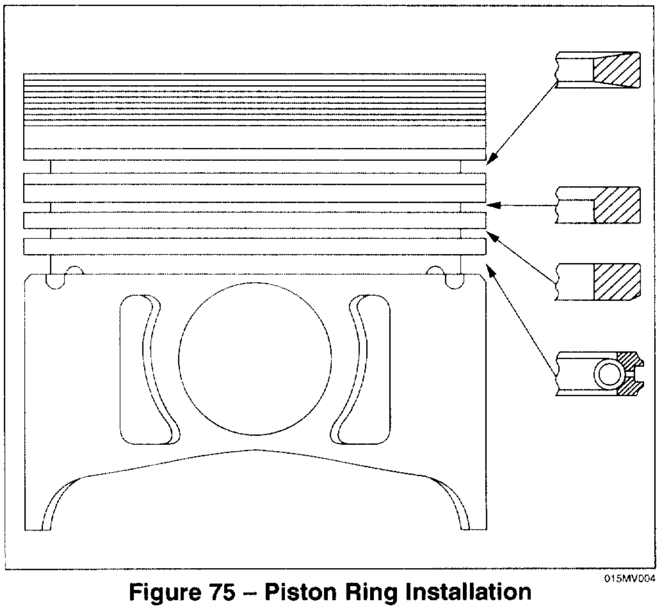


Figure 75 – Piston Ring Installation

- Stagger the piston rings, so the piston ring gaps are 45 degrees apart.

4. Rotate the crankshaft so that the connecting rod journal being worked on is at the bottom of the compression stroke.
5. Apply clean engine oil to the piston assembly.
6. Install tool J8037 piston ring compressor to the piston assembly

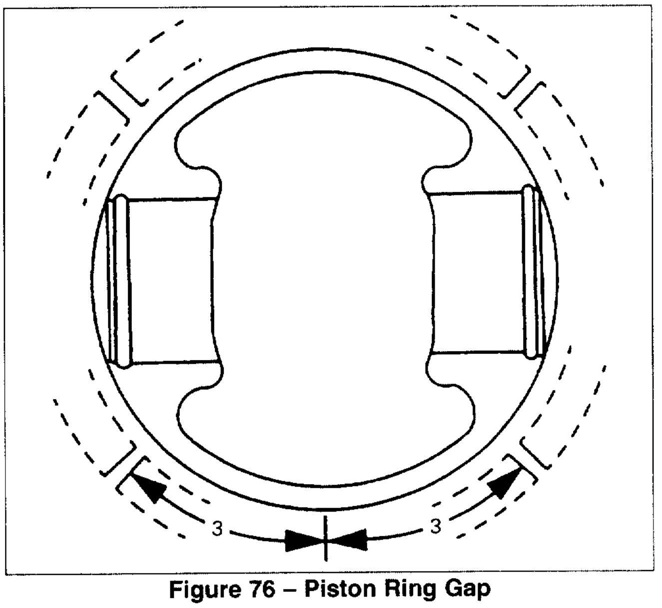


Figure 76 – Piston Ring Gap

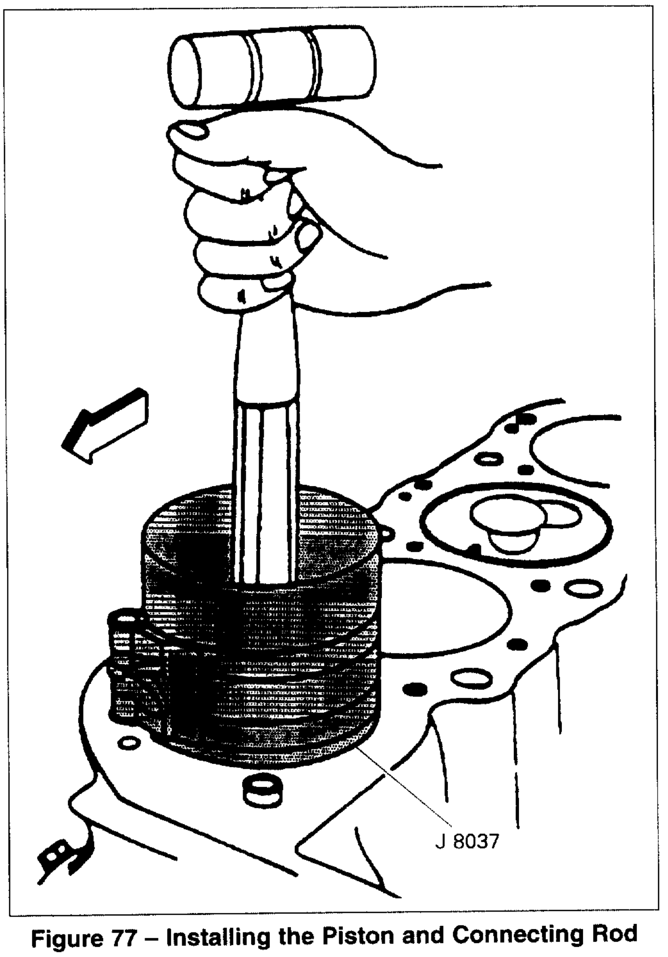


Figure 77 – Installing the Piston and Connecting Rod

7. With a hammer handle, use light blows to tap the piston down into its bore.
   - Hold the ring compressor against the cylinder block until all the piston rings have entered the cylinder bore.
   - From underneath the cylinder block, guide the connecting rod so that it does not come in contact with the connecting rod journal, and damage it.
8. Install the connecting rod bearing insert into the connecting rod and the connecting rod bearing cap.
9. Connecting rod cap to the connecting rod.
10. Bolts to the connecting rod.
11. Tighten the bolts.

Tighten

- Apply a small amount of molybdenum grease to connecting rod bolt.
- Tighten in three steps.
  - — First Step: 39 N·m (29 lb. ft.).
  - — Second Step: Turn both bolts 60 degrees.
  - — Third Step: Then turn both bolts an additional 30 degrees.

12. Rotate the engine.
   - A slight, but even effort will be needed to rotate the engine.
   - If the effort to rotate the engine is uneven or extremely hard, slightly loosen the connecting rod bolts one at a time and rotate the engine to locate the cause and repair as needed.

OIL PUMP INSTALLATION

Tools Required:
J41220 Oil Slinger Remover
J41221 Oil Seal installer

Install or Connect (Figures 78 through 85)

1. Idler gear shaft to the cylinder block.
2. Apply clean engine oil to the bushing inside the cylinder block.
3. Apply RTV sealant (Three Bond 1141E or equivalent) to the edge of the oil pump.

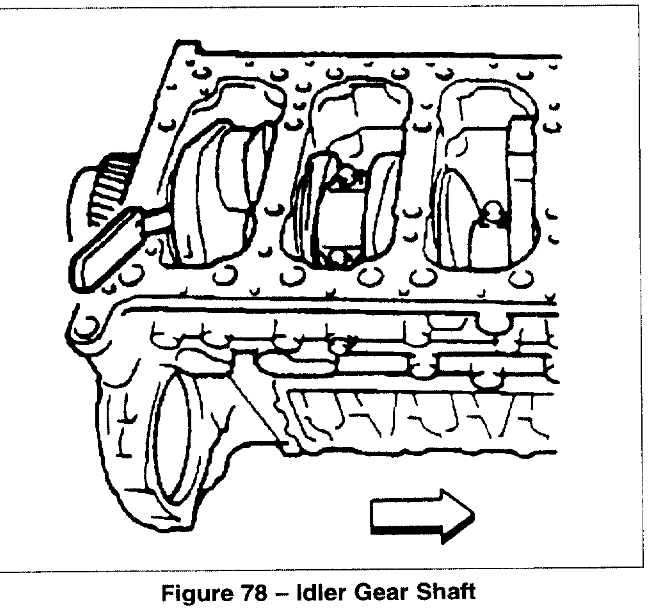


Figure 78 – Idler Gear Shaft

Important

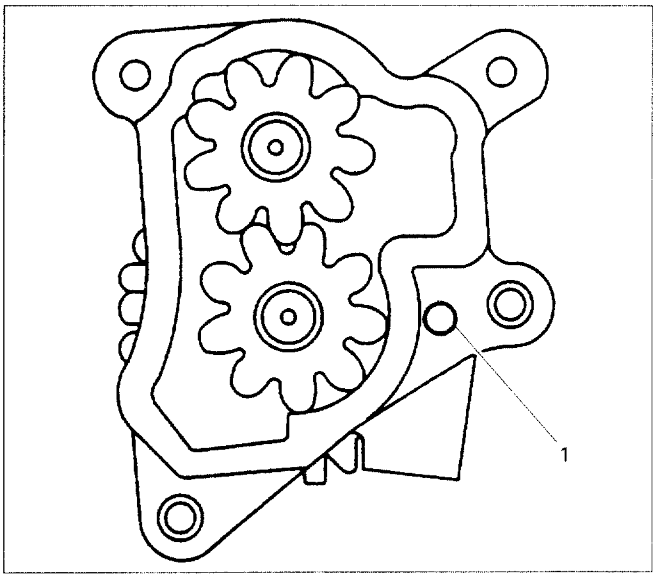
- Do not apply sealant over hole (1), refer to. This will restrict the flow of oil into the cylinder block.

4. Oil pump to the cylinder block.
5. Bolts to the oil pump.
6. Tighten the oil pump bolts.

Tighten

- Bolts to 24 N·m (17 lb. ft.).

7. Idler gear to the idler gear shaft.



Legend
(1) Oil Hole

Figure 79 — Applying Sealant to the Oil Pump

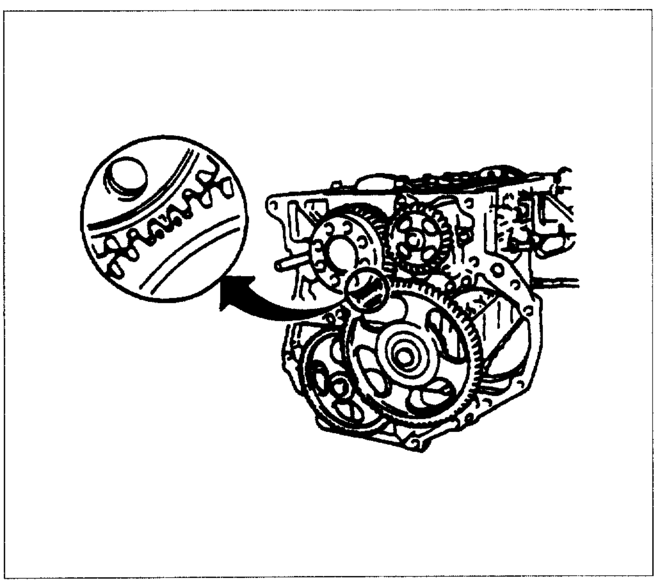


Figure 80 – Aligning the Timing Marks

8. Rotate crankshaft so that number 1 piston is on top dead center.
9. Align the crankshaft gear mark L and the idler gear (A) mark 0.
10. Tighten the idler gear (A) bolt.
    - Idler gear shaft oil port must be facing the cylinder block.

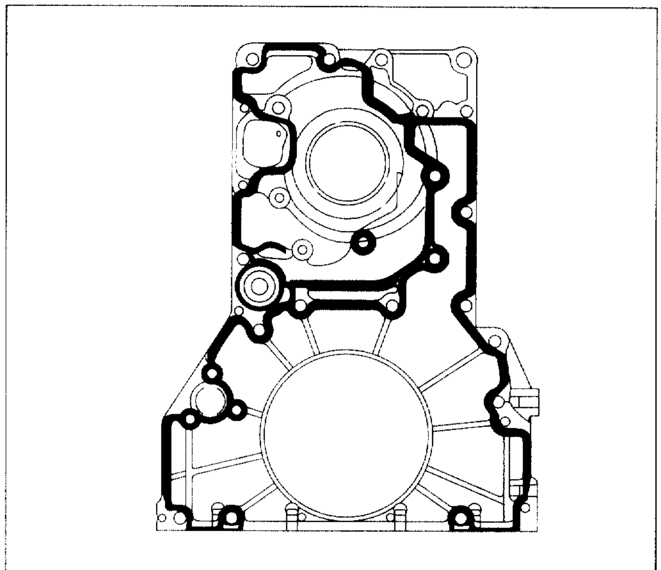


Figure 81 – Applying Sealant to the Flywheel Housing

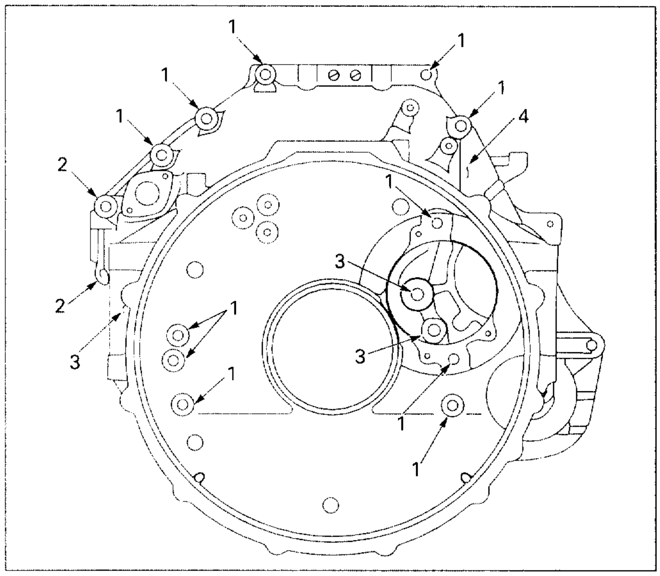


Figure 82 – Flywheel Housing Bolt Tightening Sequence

Tighten

- Apply molybdenum grease to bolts
- Tighten in two steps
  — First stage 29 N·m (21 lb. ft.)
  — Second stage 75 degrees

11. Apply RTV sealant (Three Bond 1141E or equivalent) to the flywheel housing fitting surfaces.
12. Flywheel housing to the cylinder block.
13. Bolts to the cylinder block.
14. Tighten the bolts.

Tighten

- Bolt marked 1, to 92 N·m (71 lb. ft.).
- Bolt marked 2, to 73 N·m (54 lb. ft.).
- Bolt marked 3, to 118 N·m (87 lb. ft.).
- Bolt marked 4, to 86 N·m (64 lb. ft.).

15. Oil slinger to crankshaft.
    A. Apply clean engine oil to the oil slinger.
    B. Insert the oil slinger into the adapter.
    C. Install the oil slinger sleeve to the adapter.
16. After pressing in the oil slinger, make sure that the distance between the crankshaft end surface and the oil slinger is (1) 10.5 ± 0.15 mm (0.413 ± 0.006 in.).
    A. Check the measurement at several different points.

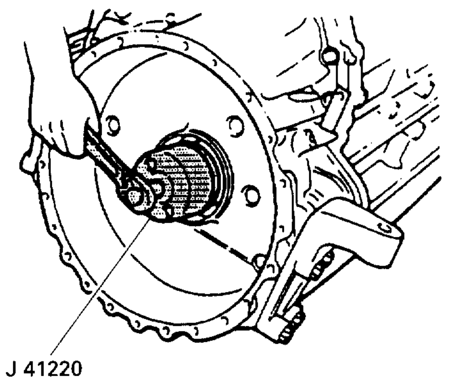
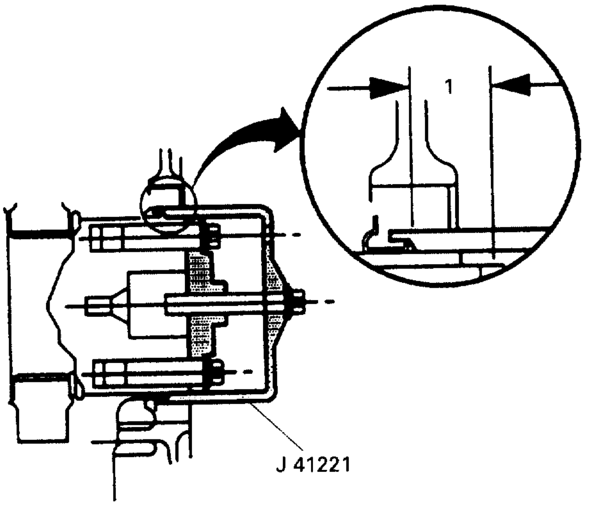


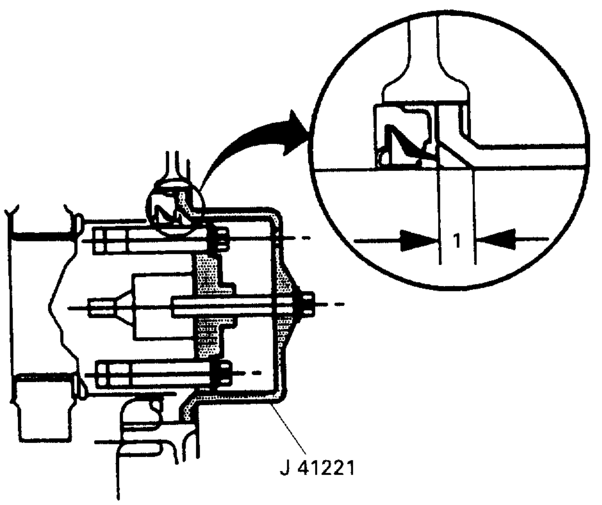
Figure 83 – Oil Slinger to the Crankshaft



Legend
(1) Measurement of the Oil Slinger

Figure 84 — Oil Slinger Installation

17. Crankshaft rear seal.
    - Install J41221.
    A. Apply clean engine oil to the oil seal.
    B. Insert the oil seal adapter.
    C. Install the oil seal to the adapter, and tighten the center bolt until the sleeve comes in contact with the adapter and stops.
    D. After pressing in the oil seal, make sure that the distance between the crankshaft end surface and the oil slinger is (1) 7.5 ± 0.15 mm (0.295 ± 0.006 in.).
    - Check the measurement at several different points.



Legend
(1) Measure Depth

Figure 85 — Oil Seal Installation

18. Flywheel to the crankshaft. Refer to SECTION 7A6.
19. Oil pump pick up tube and O-ring.
20. Bolts to the oil pump pick up tube.
21. Bolts.

Tighten

- Bolt marked M8, to 24 N·m (17 lb.ft.).
- Bolt marked M10, to 48 N·m (35 lb. ft.).

OIL PAN INSTALLATION

1. Refer to SECTION 6A6, for the installation of the oil pan.

CYLINDER HEAD INSTALLATION

Install or Connect (Figure 86 through 89)

1. Remove the cylinder liner retaining bolts and washers.
2. Apply RTV sealant (Three Bond 1207C or equivalent) to the rear corners of the cylinder block.
3. Install the cylinder head gasket with part number facing up.
4. Cylinder head bolts to the cylinder head.

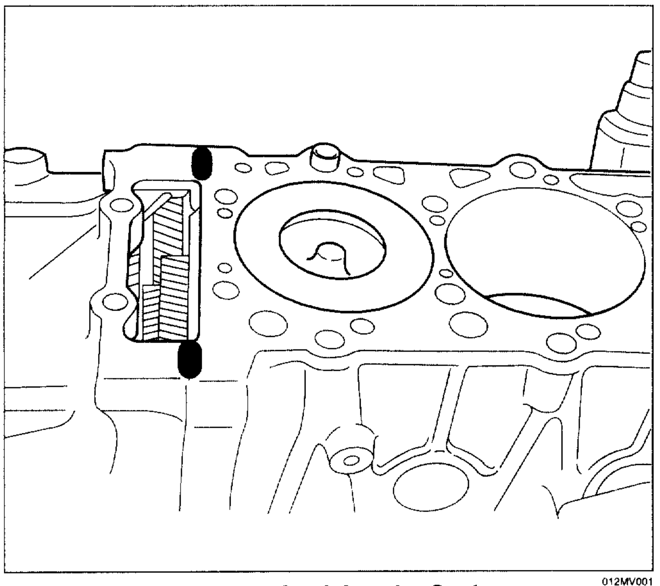


Figure 86 – Applying the Sealant

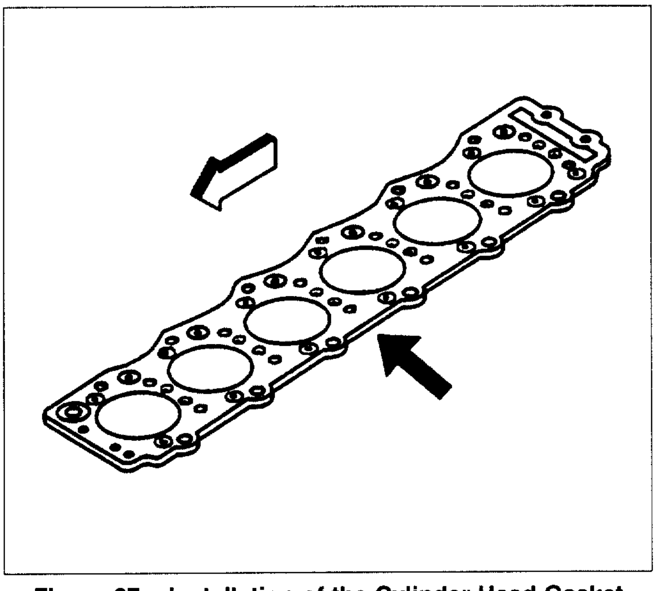


Figure 87 – Installation of the Cylinder Head Gasket

Tighten

- Apply a small amount of molybdenum grease to the M14 bolts.
- Cylinder head bolts in the following steps .
  - — 98 N·m (72 lb. ft.).
  - — 147 N·m (108 lb. ft.).
  - — Turn all the cylinder head bolts an additional 45 degrees.
- Apply clean engine oil to M10 bolts
  Tighten them to order number 27 to 28.
  - — 38 N·m (28 lb. ft.)

5. Install both of the thermostats.
6. Thermostat housing with gasket.
7. Thermostat housing bolts to the cylinder block.
8. Tighten thermostat housing bolts.

Tighten

- Bolts to 19 N·m (14 lb. ft.).

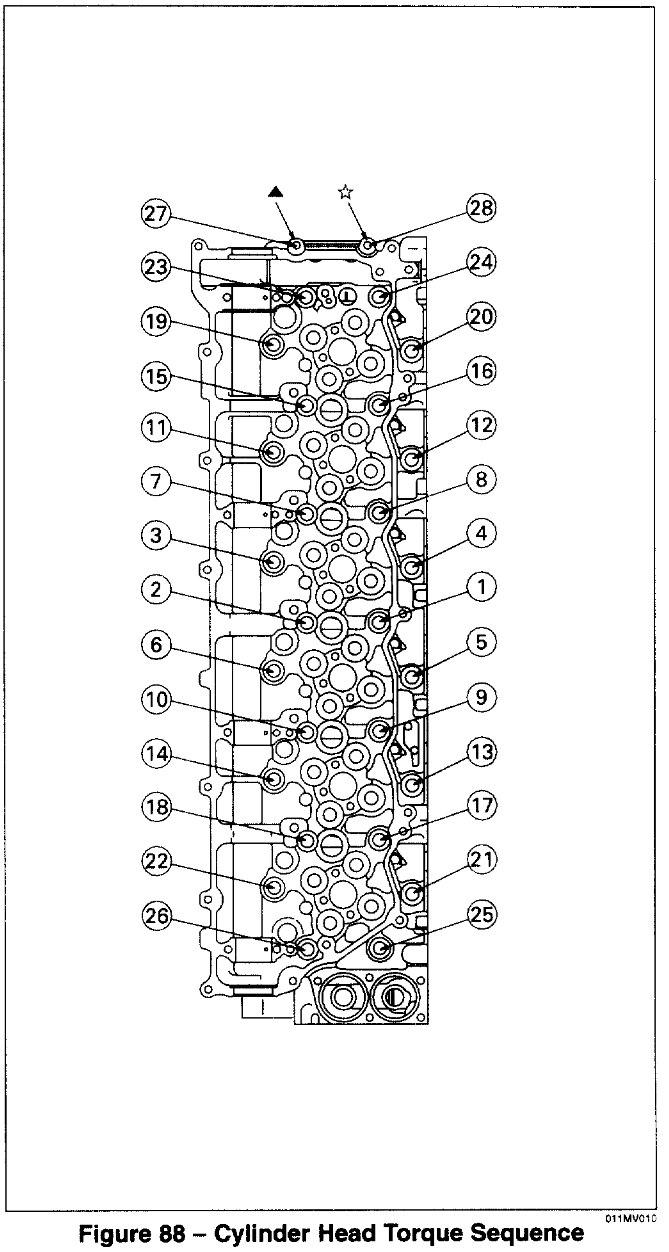


Figure 88 – Cylinder Head Torque Sequence

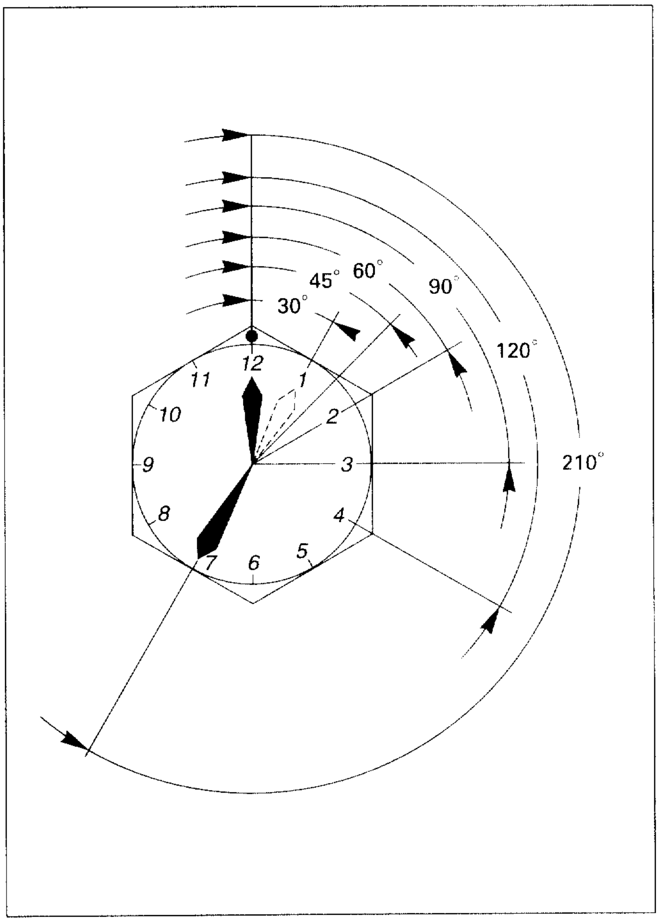


Figure 89 – Final Torque Step

CAMSHAFT INSTALLATION

Install or Connect (Figures 90 and 91)

1. Apply clean engine oil to the camshaft bearing surfaces.
2. Camshaft and the drive gear to the cylinder head.

Important

- When installing the camshaft, make sure that the timing marks are in the proper alignment.

3. Bearing caps to the cylinder head.
   - When installing camshaft bearing caps, make sure that the bearing caps are in numerical sequence.
4. Camshaft bearing cap bolts to the cylinder head.
5. Camshaft bearing cap bolts.

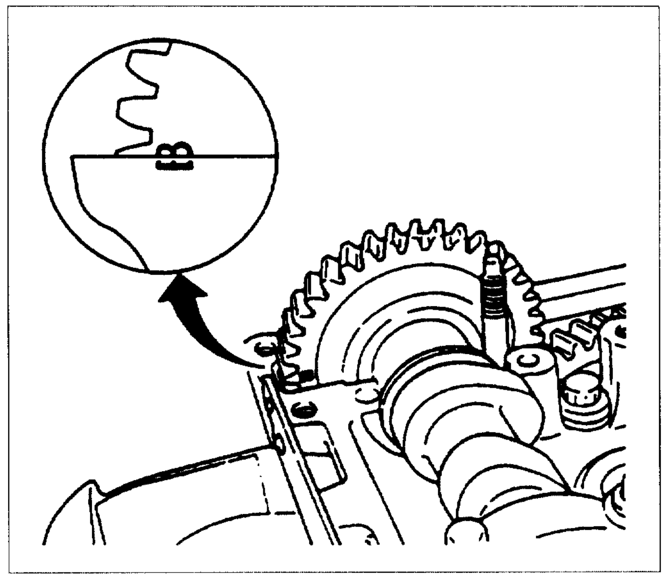


Figure 90 – Camshaft Timing Marks

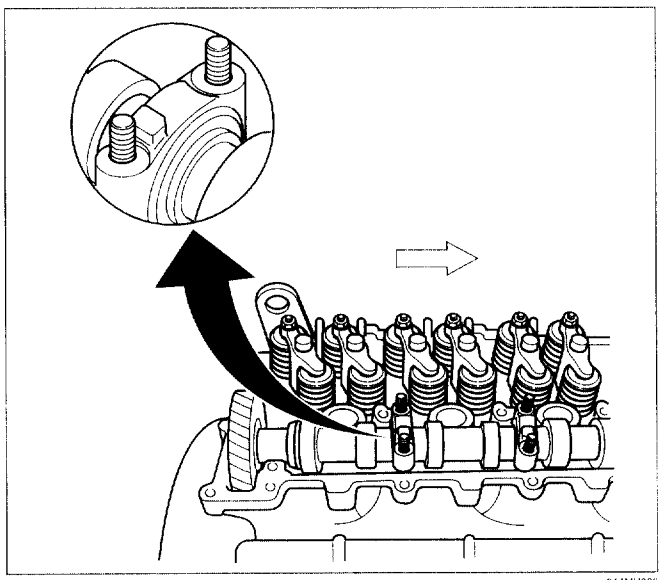


Figure 91 – Camshaft Bearing Caps

Important

- Loosen the valve adjustment bolts completely.
- Tightening sequence must be strictly observed to avoid rocker arm shaft damage due to possible excessive bending.

Tighten

- Bolts to 27 N·m (20 lb. ft.).

VALVE TRAIN INSTALLATION

Install or Connect

1. Valve rocker arm shaft to the cylinder head.
2. Valve rocker arm bolts to the cylinder head.

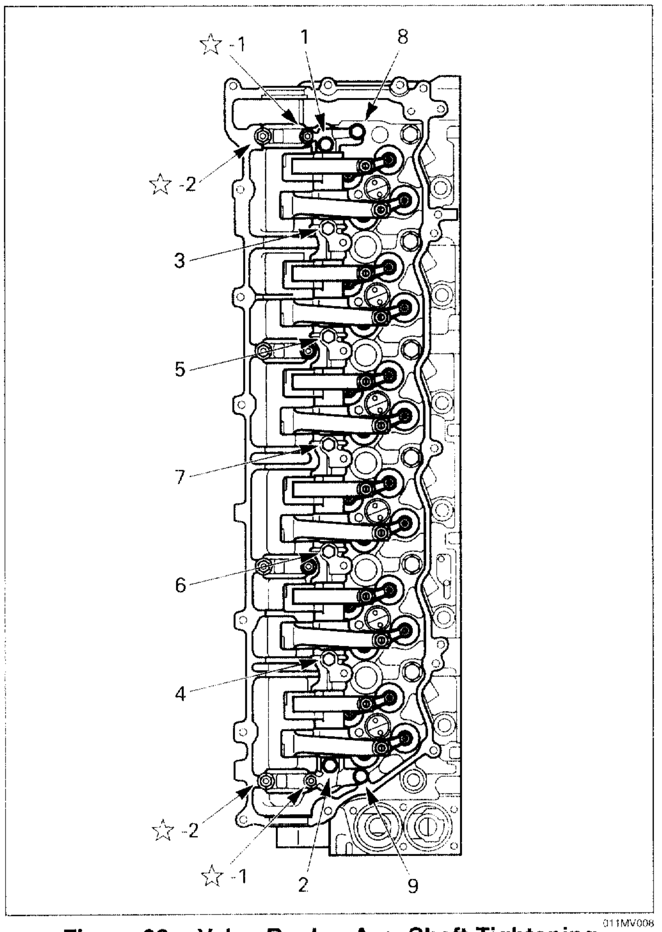


Figure 92 – Valve Rocker Arm Shaft Tightening Sequence

3. Tighten the valve rocker arm bolts.

Tighten

- First of all tighten star mark 1 nut then tighten star mark 2 nut.
- After tighten star mark 1 and 2, tighten rocker arm shaft braket bolts in sequence.
  — Star mark nut 1 and 2 to 27 N·m (20 lb.ft.)
  — Bolts 1 through 7 to 56 N·m (41 lb. ft.)
  — Bolts 8 and 9 to 27 N·m (20 lb. ft.)

VALVE ADJUSTMENT

Adjust (Figures 93 through 96)

1. Rotate the engine so that the timing marks on the front cover and the crankshaft balancer are aligned. Number 1 cylinder should be at TDC.
2. Before adjust the valve clearance, loose adjustment screw both on the rocker arm and the valve bridge.
3. Adjust all the valves clearances to 0.4 mm (0.016 in.).
   - Insert a feeler gauge between the rocker arm and the cap of valve bridge and adjust by turning the adjusitng screw on the rocker arm until there is a slight drag on the feeler gauge. Tighten the lock nut securely.
   - With a feeler gauge inserted, screw in the adjusting screw on the bridge gradually until it touches to the end of the valve stem, and make sure that the movement of the feeler gauge becomes hard.

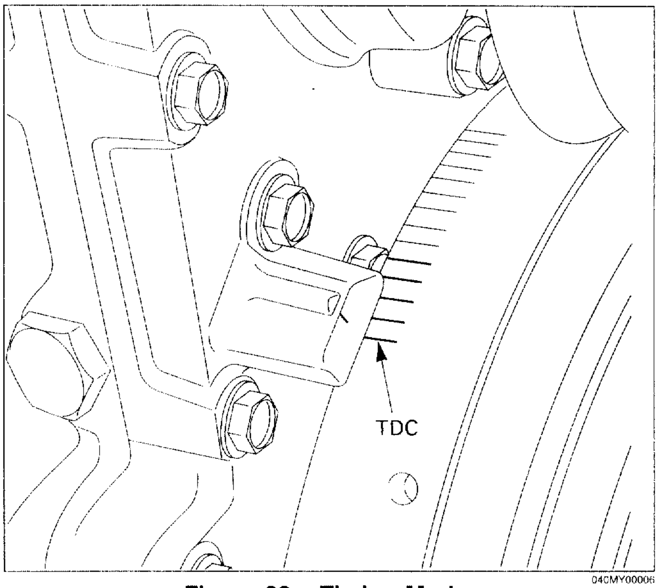


Figure 93 – Timing Marks

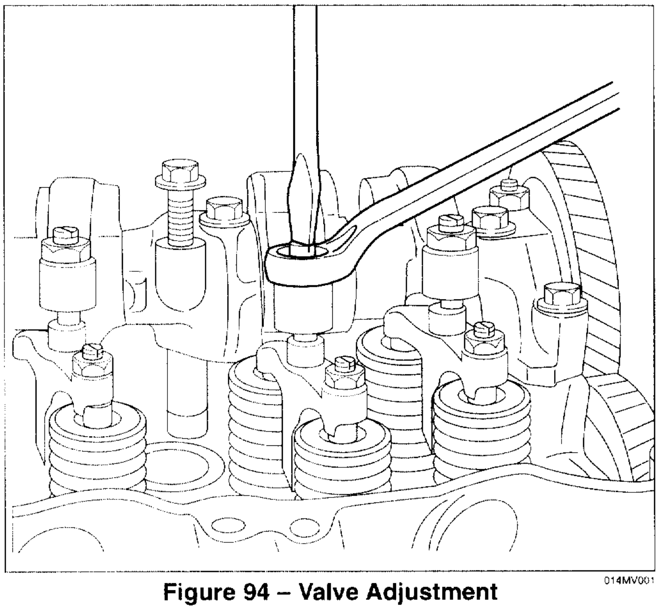


Figure 94 – Valve Adjustment

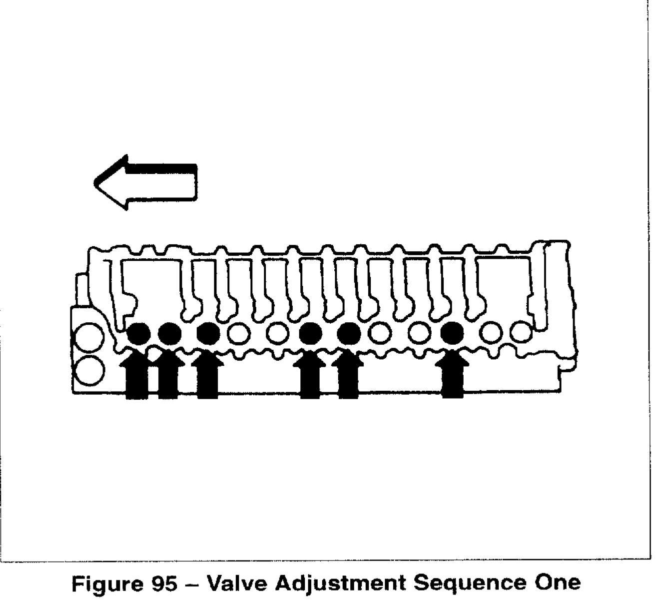


Figure 95 – Valve Adjustment Sequence One

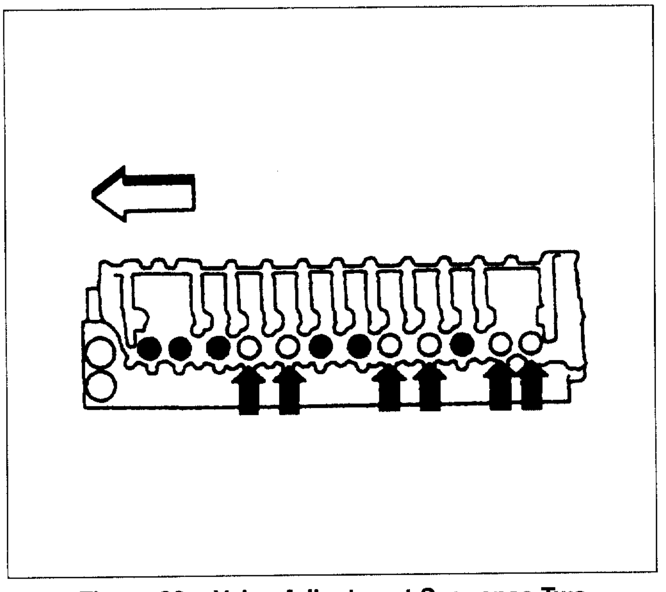


Figure 96 – Valve Adjustment Sequence Two

- In this condition, the opposite end of the bridge is raised. Readjust by loosening the adjusting screw on the bridge until there is a slight drag on the feeler gauge and tighten the lock nut securely.
- Adjust the intake valves on cylinders 1, 2, 4.
- Adjust the exhaust valves on cylinders 1, 3, 5.

3. Tighten adjusting lock nut.

Tighten

- Adjusting lock nut to 22 N·m (16 lb. ft.).

4. Rotate the engine one full turn so that the timing marks on the crankshaft balancer and the front cover are in alignment again.
5. Adjust all the valve clearances to 0.4 mm (0.016 in.).

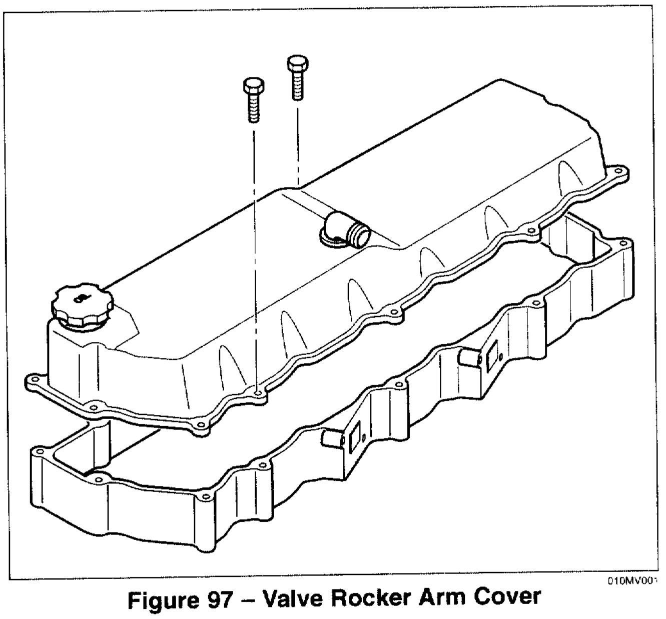


Figure 97 – Valve Rocker Arm Cover

- Insert a feeler gauge between the rocker arm and the cap of valve bridge and adjust by turning the adjusitng screw on the rocker arm until there is a slight drag on the feeler gauge. Tighten the lock nut securely.
- With a feeler gauge inserted, screw in the adjusting screw on the bridge gradually until it touches to the end of the valve stem, and make sure that the movement of the feeler gauge becomes hard.
- In this condition, the opposite end of the bridge is raised. Readjust by loosening the adjusting screw on the bridge until there is a slight drag on the feeler gauge and tighten the lock nut securely.
- Adjust the intake valves on cylinders 3, 5, 6 .
- Adjust the exhaust valves on cylinders 2, 4, 6.

6. Tighten adjusting lock nut.

Tighten

- Adjusting lock nut to 22 N·m (16 lb. ft.).

7. Recheck all the valve clearances and readjust if necessary.
8. Valve rocker arm cover and gasket to the cylinder head.
9. Valve rocker cover bolts to the cylinder head.
10. Tighten valve rocker arm cover bolts.

Tighten

- Valve rocker arm cover bolts to 13 N·m (113 lb. in.).
- Tighten center bolts first, then the outer bolts.

INTAKE MANIFOLD INSTALLATION

Install or Connect (Figures 98 and 99)

1. Intake manifold and gasket to the cylinder head.
2. Nuts and bolts to the intake manifold.
3. Tighten the nuts and bolts in sequence.

Tighten

- Nuts and bolts to 13 N·m (113 lb. in.).

EXHAUST MANIFOLD INSTALLATION

Install or Connect (Figure 100)

1. Exhaust manifold and gasket to the cylinder head.
2. Exhaust manifold nuts, bolts, washers and the spacers (Figure 100).

Tighten

- Nuts and bolts to 34 N·m (25 lb. ft.).

3. Turbocharger to the exhaust manifold. Refer to SECTION 6J.

GLOW PLUG INSTALLATION

For service of the glow plugs, refer to SECTION 6D6.

FUEL INJECTORS AND FUEL SUPPLY PUMP INSTALLATION

For service of the fuel injectors and the fuel supply pump, refer to SECTION 6C2.

FLYWHEEL INSTALLATION

For service of the flywheel, refer to SECTION 7A6.

ENGINE ACCESSORY INSTALLATION

- Refer to the proper for the following accessories:
  - Power Steering Pump.
  - Air Conditioning Compressor.
  - Generator.
  - Air compressor (for air brakes).
  - Starter Motor.
  - Hydraulic Pump (for normal brakes).
  - Drive Belts
  - Engine Cooling Fans and Clutch.

INSTALL THE ENGINE

For service of the engine, refer to SECTION 6A6.

THREAD REPAIR

General purpose thread repair kits are available commercially. Damaged threads may be reconditioned by drilling out, rethreading, and installing a suitable thread insert.

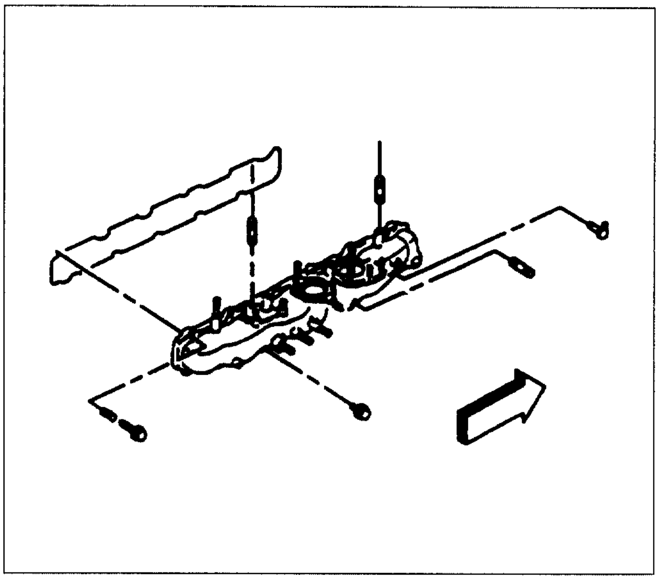


Figure 98 – Intake mamifold and Gasket

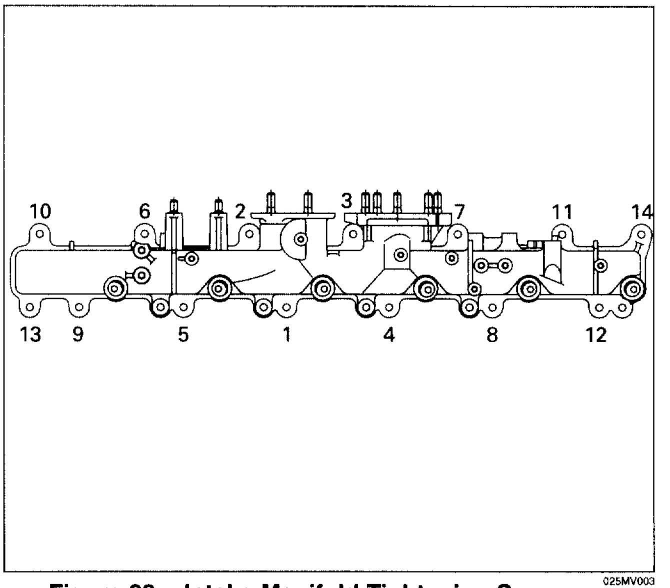


Figure 99 – Intake Manifold Tightening Sequence

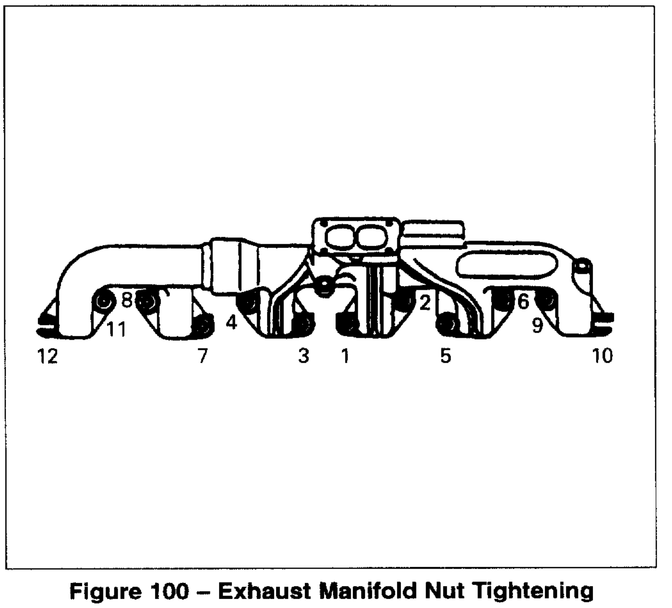


Figure 100 – Exhaust Manifold Nut Tightening Sequence

SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS

MODEL	6HK1-TC
Type	Inline 6, 4 stroke
Induction	Turbocharged
Combustion Chamber Type	Direct Injection
Bore	115 mm (4.5276")
Stroke	125 mm (4.9213")
Displacement	7.786 L (475 Cu.")
Compression Ratio	16.8:1
Firing Order	1-5-3-6-2-4
Valve Clearance, Cold	0.4 mm (0.16")
Full Flow Oil Filter	Cartridge Type
Oil Capacity	14.0L (14.79 Qts) *
Oil Pressure (Minimum at Idle)	Approximately 100 kPa (14 psi).
Compression Pressure at 200 RPM	
Production	3240 kPa (469 psi)
Service Limit	2157 kPa (313 psi)
Difference between each cylinder	Less than 196 kPa (28 psi)
* Includes full flow filter, which should be changed at each oil change.	

ENGINE SPECIFICATIONS

Item		Production	Service Limit
CAMSHAFT			
Camshaft Bearing Inside Diameter		40.0 to 40.04 mm (1.5748 to 1.5764")	40.19 mm (1.58228")
Camshaft Lobe Height	IN	52.851 mm (2.0807")	52.071 mm (2.0500")
	EXH	54.541 mm (2.1473")	53.761 mm (2.1166")
Camshaft Run-Out		–	0.05 mm (0.0020")
Journal Diameter		39.950 to 39.975 mm (1.57283 to 1.57382")	39.85 mm (1.5689")
Journal to Bearing Clearance		0.025 to 0.09 mm (0.0010 to 0.0035")	0.15 to (0.00590")
CONNECTING ROD			
Distortion (per 100 mm).		0.05 mm (0.0020") or less	0.2 mm (0.0079")
Piston Pin Bushing Inside Diameter		40.012 to 40 022 mm (1.5753 to 1.5757")	—
Piston Pin to Connecting Rod Bushing Clearance		0.012 to 0.027 mm (0.0005 to 0.0011")	0.05 mm (0.0020")
CRANKSHAFT AND CONNECTING ROD BEARINGS			
Available Undersize Connecting Rod Bearings		none	none
Connecting Rod Bearing Clearance		0.037 to 0.076 mm (0.00146 to 0.00299")	0.100 mm (0.00394")
Connecting Rod Journal Diameter		72.902 to 72.922 mm (2.8702 to 2.8709")	—
Available Crankshaft Undersize Main Bearings		none	none
CRANKSHAFT			
Crankshaft Main Bearing No. 4 (center) Crearance		0.093 to 0.124 mm (0.0037 to 0.0049")	0.14 mm (0.0055")

Item	Production	Service Limit
Crankshaft Main Bearings (except No. 4) Crearance	0.063 to 0.094 mm (0.0025 to 0.0037")	0.14 mm (0.0055")
Crankshaft End Play	0.15 to 0.33 mm (0.0059 to 0.0130")	0.4 mm (0.0157")
Crankshaft Run-out	0.06 mm (0.0024") or less	0.4 mm (0.0157")
CYLINDER HEAD		
Head Gasket Surface Distortion	0.05 mm (0.002") or less	0.2 mm (0.0079")
CYLINDER LINER		
Cylinder Liner Grade 1X for Service Part (Outside Diameter)	117.990 to 118.000 mm (4.6453 to 4.6457")	—
Cylinder Liner Grade 3X for Service Part (Outside Diameter)	118.001 to 118.010 mm (4.6457 to 4.6461")	—
Cylinder Liner Service Part Inside Diameter (Grade not available)	115.031 to 115.050 mm (4.5288 to 4.5295")	—
Cylinder Block Bore and Cylinder Liner Outside Diameter Clearance	0.011 to 0.029 mm (0.0004 to 0.0011")	—
Projection Above Cylinder Block Gasket Surface	0.06 to 0.1 mm (0.0236 to 0.0039")	—
OIL PUMP		
Drive Gear and Drive Gear Shaft Interference	0.015 to 0.044 mm (0.0006 to 0.0017")	—
Gear and Body Clearance	0.064 to 0.109 mm (0.0025 to 0.0043")	0.2 mm (0.0079")
Gear Shaft and Pump Body or Bushing Clearance	0.04 to 0.07 mm (0.0016 to 0.0028")	0.2 mm (0.0079")
Gear Shaft Outside Diameter	15.989 to 16.0 mm (0.6249 to 0.6299")	15.9 mm (0.6260")
Gear Tooth and Cover Inner Wall Clearance	0.125 to 0.221 mm (0.0049 to 0.0087")	0.3 mm (0.0118")
PISTON DIAMETER		
Service Part Size Grade is not available	114.970 to 115.000 mm (4.5264 to 4.5276")	—
Clearance between Piston and Liner	0.122 to 0.159 mm (0.0048 to 0.0063")	—
PISTON RING END GAP		
First Compression Ring	0.18 to 0.28 mm (0.0071 to 0.0110")	1.5 mm (0.0590")
Second and Third Compression Ring	0.35 to 0.5 mm (0.01378 to 0.01958")	1.5 mm (0.0590")
Oil Control Ring	0.15 to 0.35 mm (0.0059 to 0.0138")	1.5 mm (0.0590")
PISTON RING TO GROOVE CLEARANCE		
1st Compression Ring	0.09 to 0.13 mm (0.0035 to 0.0051")	0.2 mm (0.0079")
2nd and 3rd Compression Ring	0.03 to 0.07 mm (0.0012 to 0.0028")	0.15 mm (0.0059")
Oil Control Ring	0.030 to 0.07 mm (0.0012 to 0.0028")	0.15 mm (0.0059")
Piston Pin Diameter	39.995 mm (1.5746")	—
Piston Pin Hole Diameter in the Piston	40.004 to 40.012 mm (1.5750 to 1.5752")	—
Piston Pin to Piston Clearance	0.009 to 0.017 mm (0.0004 to 0.0007")	0.05 mm (0.002")

Item	Production	Service Limit
TIMING GEARS.*		
Idler Gear Backlash	0.1 to 0.17 mm (0.0039 to 0.0067")	0.3 mm (0.0118")
Idler Gear end Play Gear "A" and "B"	0.08 to 0.155 mm (0.0031 to 0.00610")	0.2 mm (0.0079")
Gear "C"	0.09 to 0.154 mm (0.0035 to 0.0061")	0.2 mm (0.0079")
VALVE GUIDES AND SEATS		
Minimum Valve Margin Thickness	—	—
Intake	1.71 mm (0.0673")	1.3 mm (0.0512")
Exhaust	1.75 mm (0.0689")	1.25 mm (0.0492")
Valve Face Angle : Intake	60 degrees	—
Valve Face Angle : Exhaust	45 degrees	—
VALVE GUIDE TO VALVE STEM CLEARANCE		
Intake	0.039 to 0.071 mm (0.0015 to 0.0028")	0.2 mm (0.0079")
Exhaust	0.064 to 0.096 mm (0.0025 to 0.0038")	0.25 mm (0.0098")
VALVE INSTALLED DEPTH		
Intake	1 mm (0.0394")	2.5 mm (0.0984")
Exhaust	1.3 mm (0.0512")	2.8 mm (0.1102")
VALVE STEM DIAMETER		
Intake	7.946 to 7.961 mm (0.3128 to 0.3134")	7.80 mm (0.3071")
Exhaust	7.921 to 7.936 mm (0.3118 to 0.3124")	7.77 mm (0.3059")
VALVE SEAT WIDTH		
Intake	3.2 mm (0.1260")	—
Exhaust	2.8 mm (0.1102")	—
VALVE SPRINGS		
FREE LENGTH		
Intake	65.9 mm (2.5945")	64.8 mm (2.5512")
Exhaust	68.1 mm (2.6811")	66.9 mm (2.6339")
INCLINATION		
Intake	2.5 mm (0.0984") or less	2.9 mm (0.1142")
Exhaustr	2.5 mm (0.0984") or less	3.0 mm (0.1181")
TENSION (At 46.0 mm [1.8110"] length)		
Intake	348.1 N (78.3 lb.).	296 N (69 lb.).
Exhaust	382.5 N (86 lb.).	325 N (73 lb.).
VALVE TRAIN		
Valve Rocker Arm Inside Diameter	22.01 to 22.035 mm (0.8665 to 0.8675")	22.15 mm (0.8720")
Valve Rocker Arm to Shaft Clearance	0.01 to 0.056 mm (0.0004 to 0.0022")	0.2 mm (0.0079")
Valve Rocker Arm to Shaft Diameter	21.979 to 22.0 mm (0.8653 to 0.8661")	21.85 mm (0.8602")

FASTENER TIGHTENING SPECIFICATIONS

Application	N·m	Lb Ft	Lb In.
Camshaft Bearing Cap	27	20	—
Camshaft Gear Bolt	142	105	—
Rocker Arm Shaft Bracket Nuts (Star mark 1 to 2)	27	20	—
Rocker Arm Shaft Bracket Bolts (8 to 9)	27	20	—
Rocket Arm Shaft Bracket Bolts (1 through 7)	56	41	—
Charge Air Pipe Bolt	37	27	—
Connecting Rod Bolt First Stage Second Stage Third Stage	 39 plus 60 degrees plus 30 degrees	 29 plus 60 degrees plus 30 degrees	 — — —
Crankshaft Balancer Bolt and Washer	200	148	—
Crankshaft Pulley Bolt and Washer	48	35	—
Cylinder Body Lower Crankcase (M10)	37	27	—
Cylinder Lower Crankcase (M14) Apply molybdenum grease First Stage Second Stage Third Stage	 98 132 plus 30 to 60 degrees	 72 98 plus 30 to 60 degrees	 — — —
Cylinder Head Bolt (M14) Apply molybdenum grease First Stage Second Stage Third Stage	 98 147 plus 30 to 60 degrees	 72 108 plus 30 to 60 degrees	 — — —
Cylinder Head Bolt (M10) Apply engine oil	38	28	—
Engine Mounting Bolt to the Frame	36	26	—
Engine Mounting Nut to the Frame	83	61	—
Engine Mount Through Bolt	294	217	—
Exhaust Manifold Nut	34	25	—
Exhaust Pipe Adapter to the Exhaust Manifold	52	38	—
Flywheel Bolt Apply molybdenum grease First Stage Second Stage Third Stage	 78 plus 60 degrees plus 60 degrees	 58 plus 60 degrees plus 60 degrees	 — — —
Front Cover Bolt	19	4	—
Front Engine Mount Bolt	79	57	—
Idler Gear Bolt (Idler A) Apply molybdenum grease First stage Second stage	 29 plus 75 degrees	 21 plus 75 degrees	 — —
Idler Gear Bolt (Idler B)	95	70	—
Idler Gear Shaft Bolt (Idler B)	31	23	—
Intake Manifold Bolt	13	—	113
Oil Cooler Bolt	19	14	—
Oil Filter Bracket Bolt	38	28	—
Oil Jet Bolt	21	15	—
Oil Pan Bolt	24	17	—
Oil Pump Body Bolt	24	17	—
Oil Strainer Tube Bolt (M8)	24	17	—
Oil Strainer Tube Bolt (M10)	48	35	—
Rear Engine Mounting Nut and bolt to the Frame	108	80	—
Thermostat Housing Bolt to the Cylinder Head	19	14	—
Turbocharger Drain Line Bolt (to Block)	18	13	—
Turbocharger Drain Line Bolt (to Turbocharger)	27	20	—

Application	N·m	Lb Ft	Lb In.
Turbocharger Feed Line Bolt (to Block)	18	13	—
Turbocharger Feed Line Bolt (to Turbocharger)	18	13	—
Turbocharger to Exhaust Manifold Nut	52	38	—
Valve Rocker Arm Cover Bolt	13	—	113
Water Outlet Bolt (M8)	19	14	—
Water Pump Bolt (M16)	103	76	—

SPECIAL TOOLS

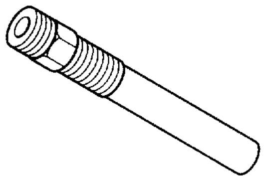
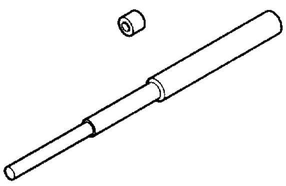
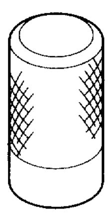
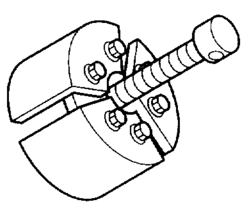
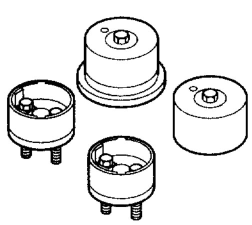
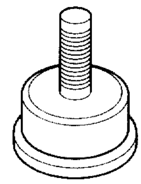
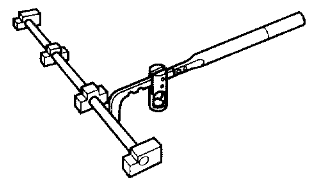
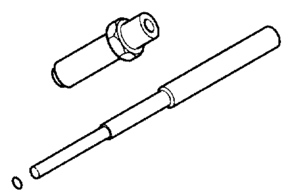
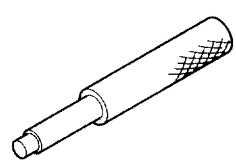
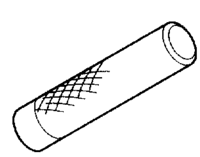
ILLUSTRATION	TOOL NO. TOOL NAME
 58840-26220	**J43264** Compression Gauge Adapter
 58840-26280	**J43272** Valve Guide Remover and Installer
 58840-26250	**J43267** Valve Stem Seal Installer
 89439-68580	**J41220** Slinger Remover
 89439-68560	**J41221** Oil Seal Remover and Installer

ILLUSTRATION	TOOL NO. TOOL NAME
 89439-68190	**J41222** Crankshaft Gear Installer
 58840-26210	**J43263** Valve Spring Compressor
 58840-26240	**J43266** Nozzle Sleeve Installer
 58840-26230	**J43265** Nozzle Sleeve Remover
 58840-26260	**J43268** Guide Bridge Installer

SECTION 6B1B

WATER PUMP OVERHAUL

NOTICE: *Always use the correct fastener in the correct 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.*

CONTENTS

DISASSEMBLY

Disassemble (Figures 1 through 5)

1. Impeller using a suitable puller.
2. Pulley using a suitable puller.
3. Dust thrower.
4. Snap ring using snap ring pliers.
5. Spindle, bearing and spacer using a plastic hammer to lightly tap the spindle free.
6. Front seal.
7. Seal unit using a arbor press and a suitable remover.
8. Bearings and spacer from the spindle using an arbor press.

INSPECTION AND REPAIR

Replace or repair any component that has wear, damage or any other abnormal condition found through inspection.

Inspect (Figures 1 and 6)

- For proper fit of the shaft to pulley center to pulley.
- Housing for cracks or burrs.
- Shaft for cracks, burrs or pitting. Replace as necessary.

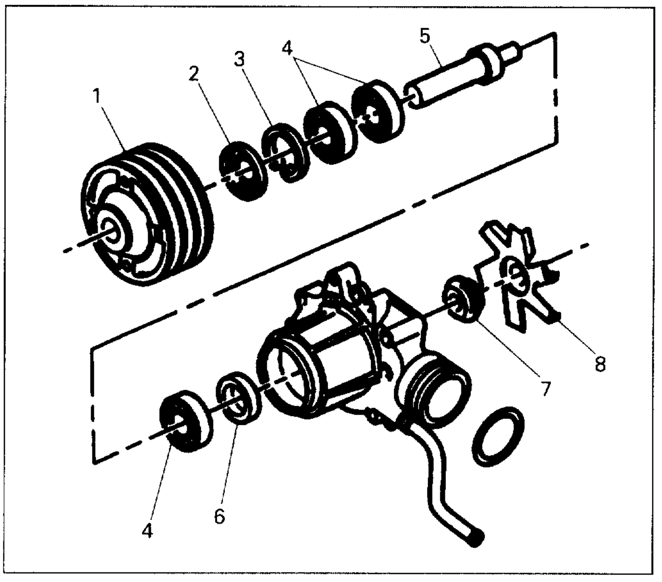
PUMP SPINDLE INTERFERENCES

Interference	mm	in.
Shaft to Pulley Center	0.048 – 0.078	0.0019 – 0.0031
Shaft to Impeller	0.027 – 0.120	0.0011 – 0.0047

ASSEMBLY

Assemble (Figures 7 through 12)

1. Bearings and spacer onto the spindle.
2. Spindle, bearings and spacer to housing using an arbor press and a suitable installer.
3. Prior to installing the front seal, perform the following:
   A. Apply multipurpose type grease to the lip seal.
   B. Apply engine oil to the lip seals outer circumference.
   C. Position the seal so that the lip of the seal is facing forward.
4. Front seal.
5. Snap ring using snap ring pliers.
6. Dust thrower.



Legend
(1) Pulley
(2) Dust Thrower
(3) Snap ring
(4) Bearings and Spacer
(5) Spindle
(6) Front Seal
(7) Seal Unit
(8) Impeller

Figure 1 – Water Pump Component

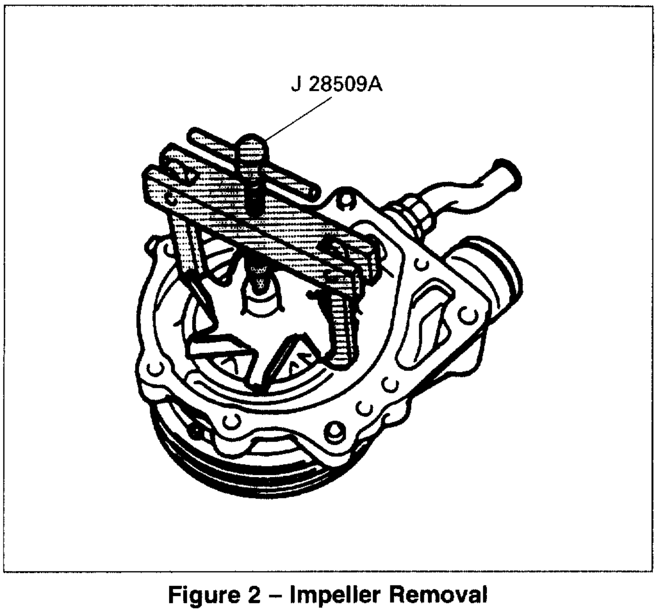


Figure 2 – Impeller Removal

7. Pulley using a bench press.

CAUTION: To protect the bearings and housing during this procedure, the press must contact the impeller side of the pump shaft and the pulley.

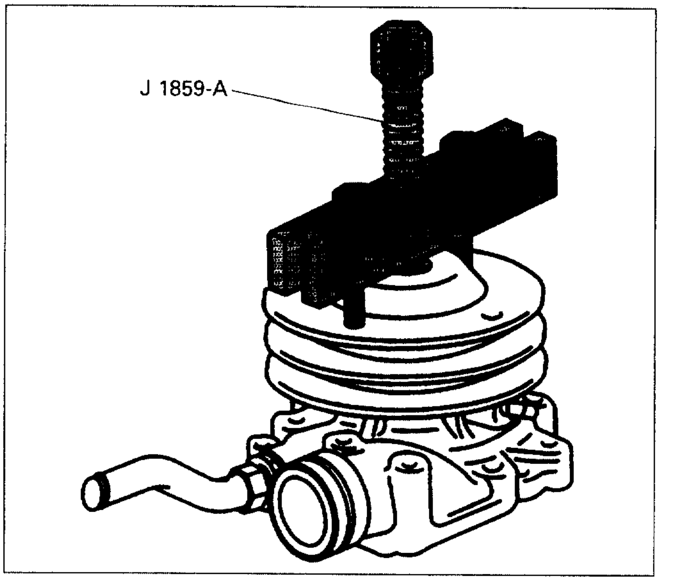


Figure 3 – Pulley Removal

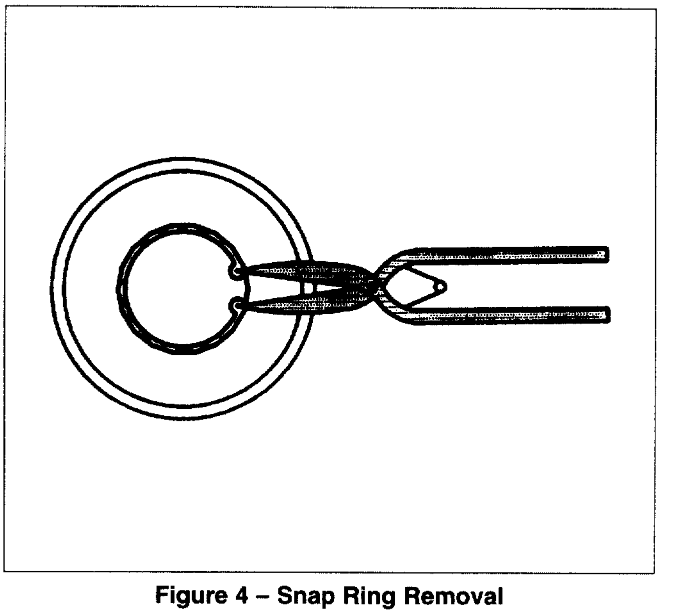


Figure 4 – Snap Ring Removal

8. Apply a thin coat of liquid gasket (Three Bond 1207C or equivalent) to the seal unit before installing.
9. Seal unit to the housing.

Measure

- Install seal unit to specified height using a bench press and installer.
- Seal height 11.0 – 11.6 mm (0.433 – 0.457 in.)

CAUTION: To protect the bearings and housing during this procedure, the press must contact the impeller and the pulley.

10. Impeller to the shaft using bench press, until the impeller bottoms out against the shaft.

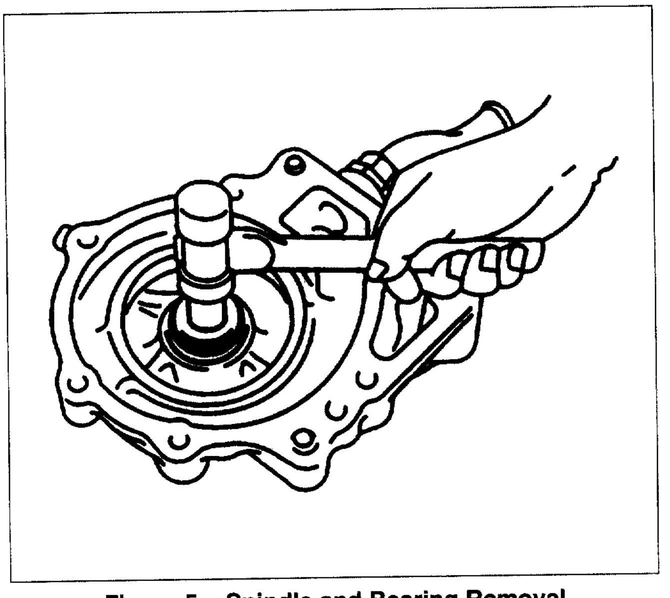


Figure 5 – Spindle and Bearing Removal

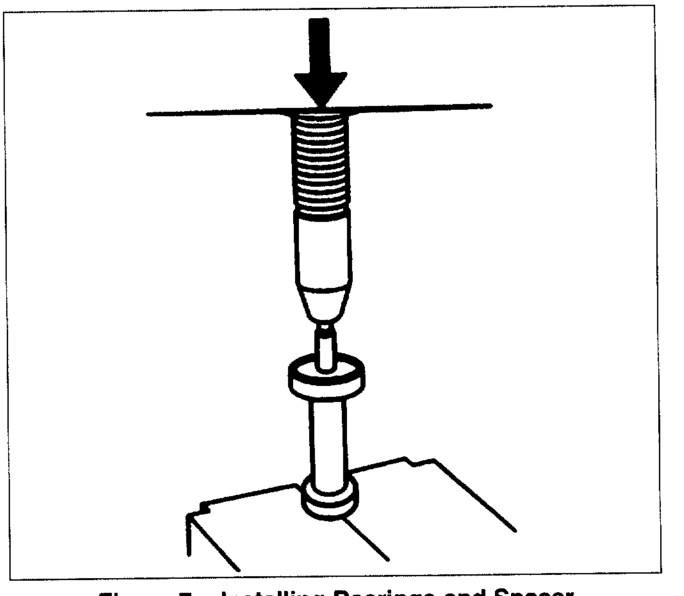


Figure 7 – Installing Bearings and Spacer

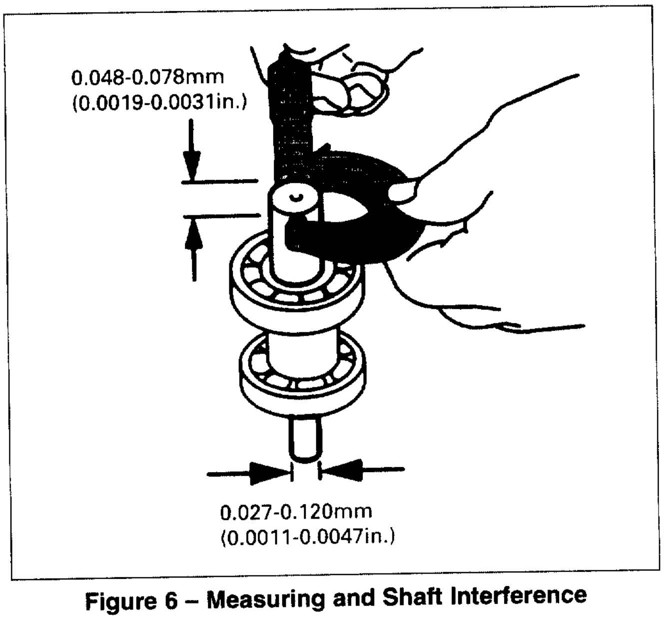


Figure 6 – Measuring and Shaft Interference

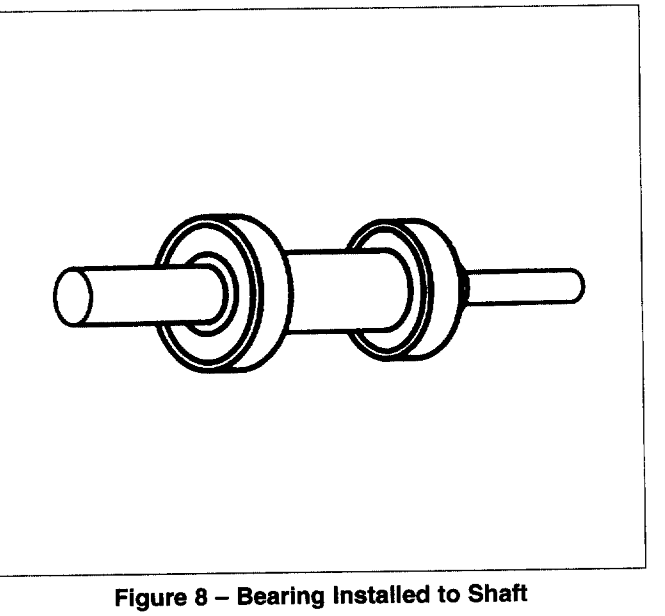


Figure 8 – Bearing Installed to Shaft

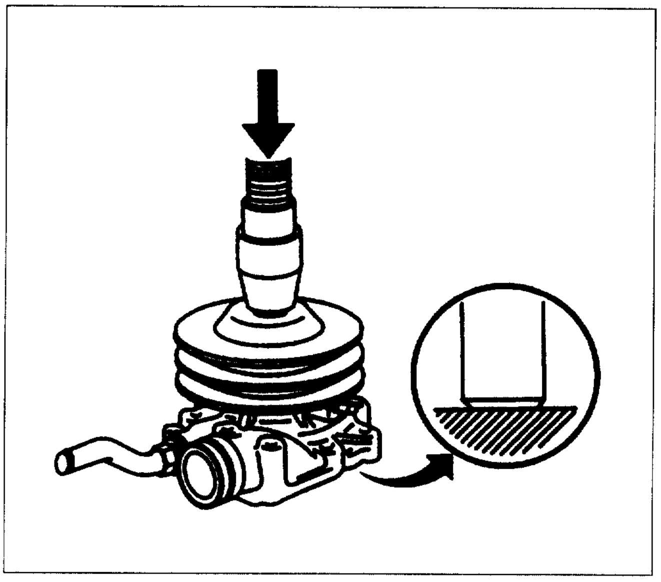


Figure 9 – Pulley Installation

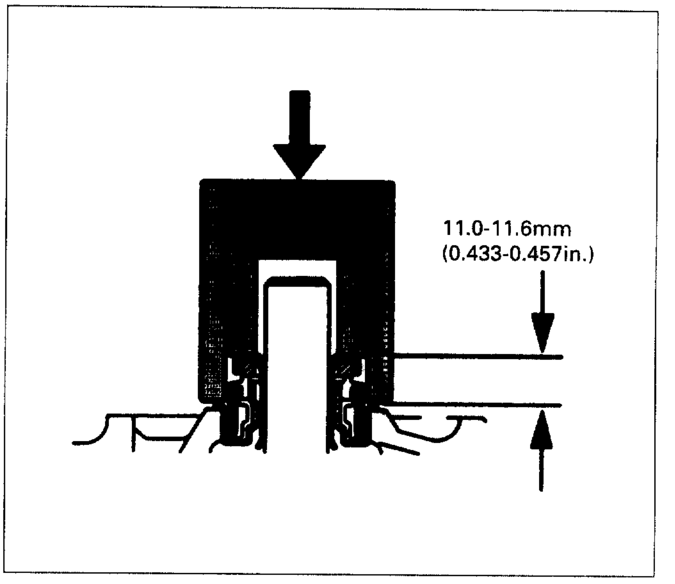


Figure 11 – Installing the Seal Unit

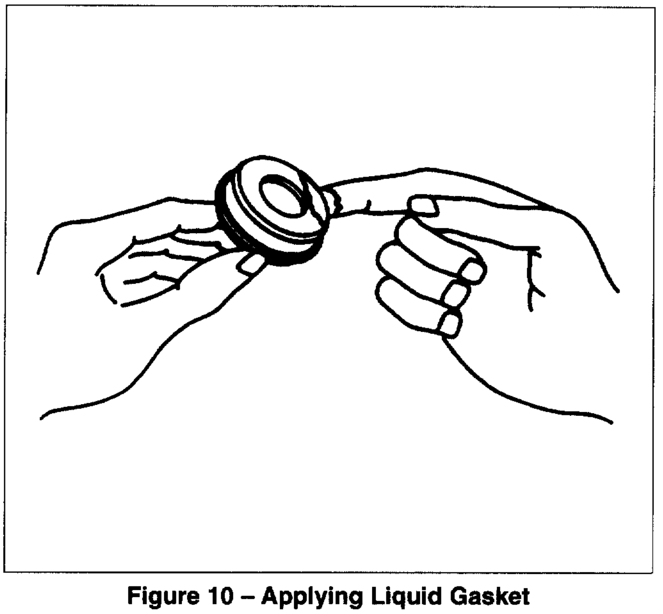


Figure 10 – Applying Liquid Gasket

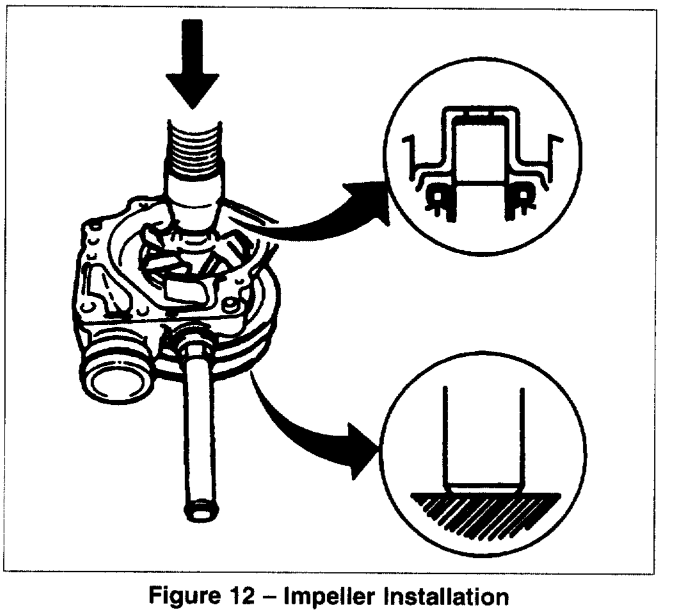


Figure 12 – Impeller Installation

SPECIFICATIONS

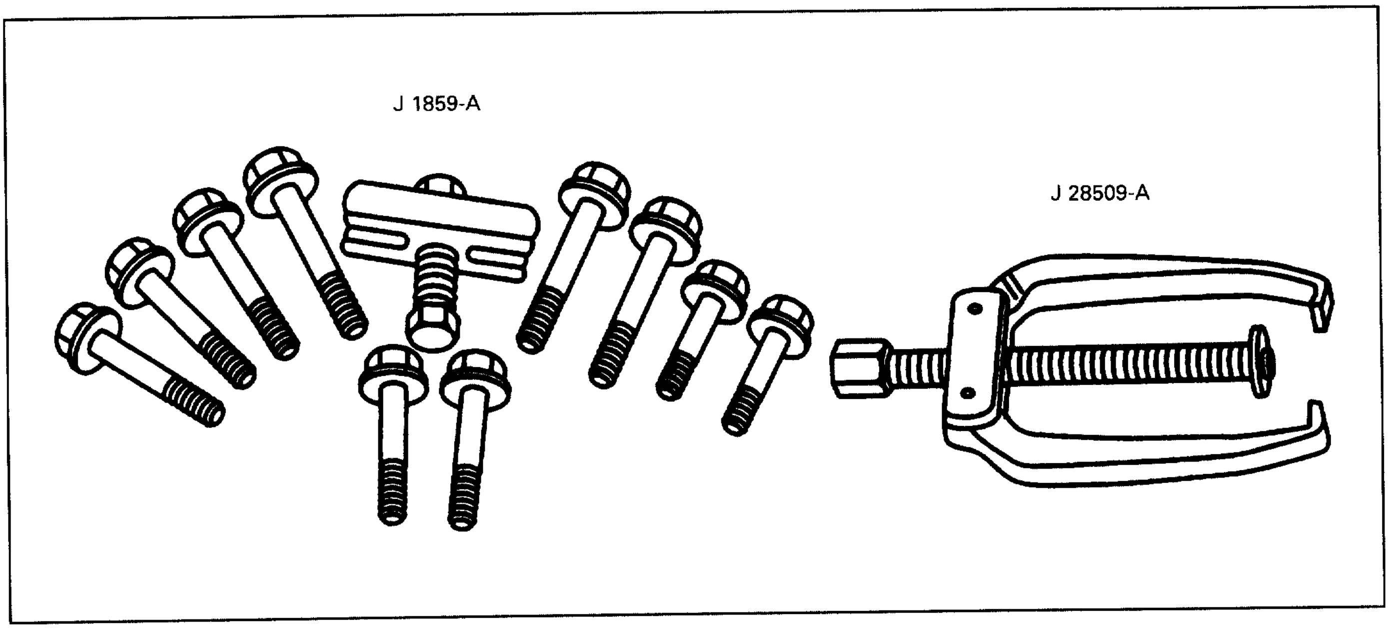
PUMP SPINDLE INTERFERENCES

Interference	mm	in.
Shaft to Pulley Center	0.048 – 0.078	0.0019 – 0.0031
Shaft to Impeller	0.027 – 0.120	0.0011 – 0.0047

SEAL INSTALLATION HEIGHT

Seal Unit Installation	mm	in.
Seal Height	11.0 – 11.6	0.433 – 0.457

SPECIAL TOOLS



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SECTION 6C

FUEL SYSTEM

For information regarding fuel systems, refer to the appropriate Diesel Fuel Injection, Engine Emission and Electrical Diagnosis Service Manual.

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SECTION 6C2

DIESEL FUEL INJECTION

NOTICE: *Always use the correct fastener in the correct 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.*

CONTENTS

GENERAL DESCRIPTION

COMMON RAIL SYSTEM

This section covers the electronically controlled fuel injection system for 6HK1 diesel engine.

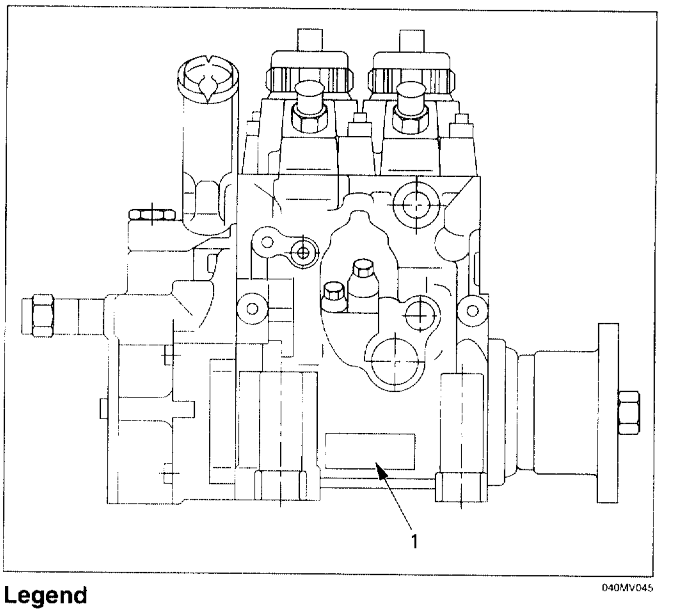
The 6HK1 (7.8L) diesel engine fuel system consists of the following.

- Fuel tank
- Fuel hoses and lines
- Water separator
- Fuel filter
- Fuel feed pump
- Fuel supply pump
- Fuel common rail
- Steel lines
- Six fuel injectors with solenoid valve

The fuel supply pump, fuel common rail and the fuel injectors are made by DENSO.

If an internal problem occurs in the fuel supply pump, the fuel supply pump must be removed from the engine and serviced by an authorized DENSO dealer. Do not open the fuel supply pump and injector assembly, or the warranty is void.

The fuel supply pump has an identification tag (1) attached to the fuel supply pump body (Figure 1).



Legend
(1) Identification Tag

Figure 1 – Identification Tag Location

SYSTEM OUTLINE

The COMMON RAIL SYSTEM detects engine conditions (engine speed, accelerator pedal angle, coolant temperature, etc.) by means of its sensors and generally control fuel injection amount, timing, and pressure by means of its microcomputer, thereby making the engine run in the best condition.

Further, the system performs the self-diagnosis/ lighting function to diagnose main components and, if abnormality found, worn the driver, the failsafe function to stop the engine depending on the parts to which trouble has occurred, and the backup function to switch over the control method to enable the vehicle to run continuously.

SYSTEM COMPOSITION

The system can be functionally divided into two systems, fuel and control.

(1) Fuel System

The high pressure fuel generated by supply pump is distributed to each cylinder. The solenoid valve in the injector opens and closes the nozzle needle valve, thereby controlling the start and end of fuel injection.

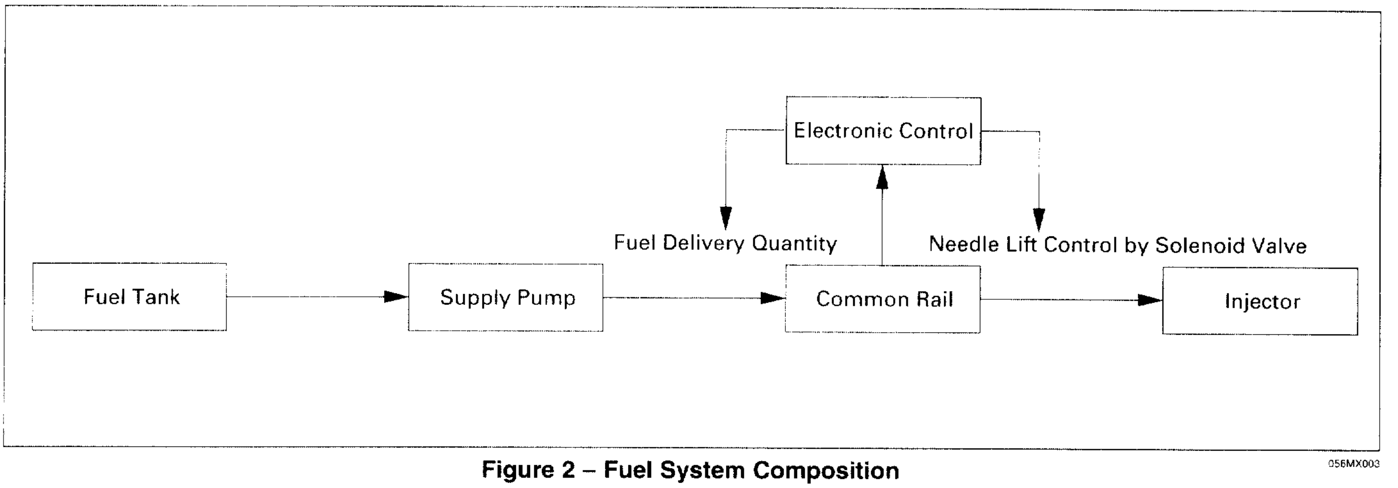


Figure 2 – Fuel System Composition

(2) Control System

ECM is used to compute and control from the signals received from the sensors installed to the engine and vehicle the timing and time for passing current to the injector so that the optimum quantity of fuel can be injected at the optimum timing.

The control system mainly comprises sensors, computer, and actuator.

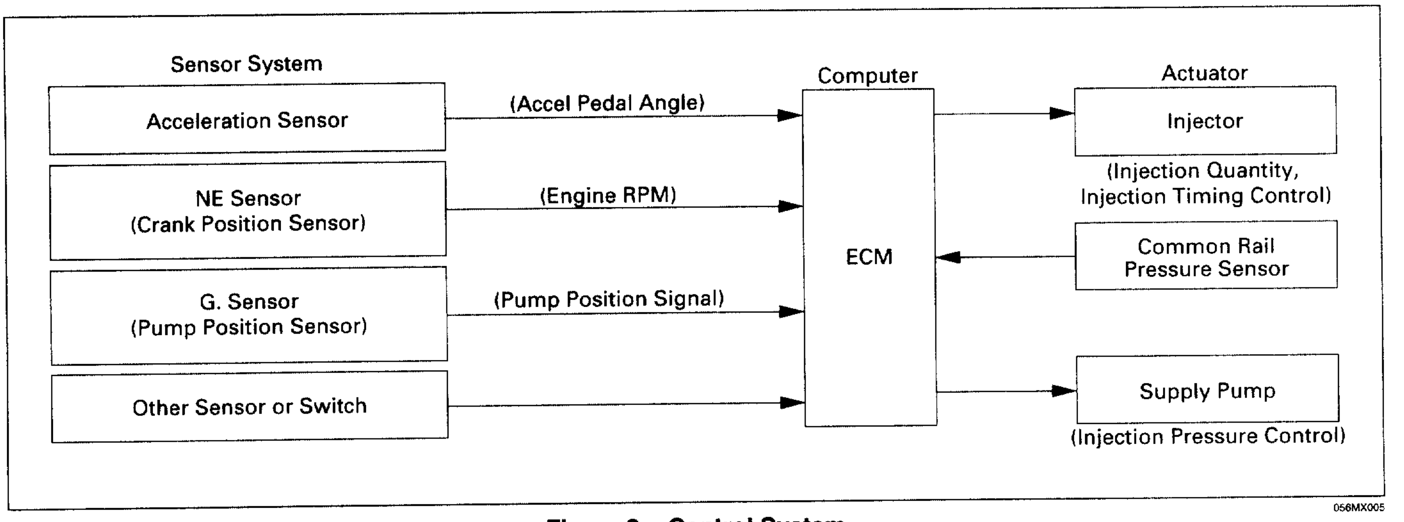


Figure 3 – Control System

(2) System Construction

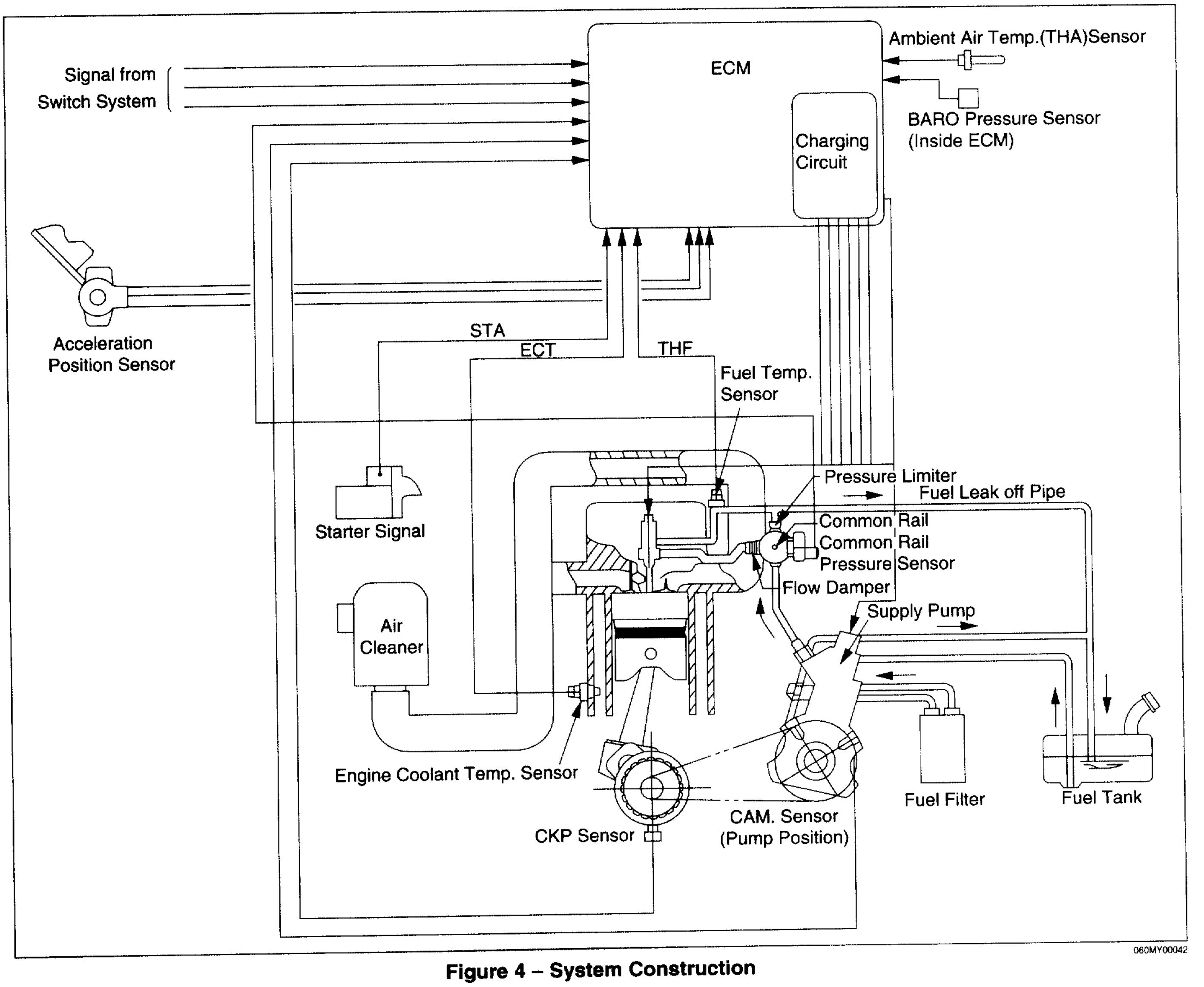


Figure 4 – System Construction

SYSTEM DESCRIPTION AND OPERATION

The COMMON RAIL SYSTEM consists of an supply pump, common rail, injector, ECM and sensors.

The supply pump generates the fuel pressure in the common rail. Fuel pressure is controlled depending on the fuel amount discharged from the supply pump. The fuel discharge amount is controlled by means of PCV provided in the supply pump which is opened/closed in response to electric signals from ECM.

The common rail receives and distributes the fuel pressure made by the supply pump to each cylinder. Fuel pressure is detected by means of a common rail pressure sensor installed to the common rail and is feedback controlled so that the instructed pressure value set according to engine speed and load can agree with an actual pressure value.

The fuel pressure in the common rail is applied through the injection pipe of each cylinder to the nozzle side and control chamber of the injector.

The injector controls injection amount and time by switching on and off a TWV (Two Way Valve). When the TWV is switched on (to carry current), the fuel circuit is changed over to such a status that the high pressure fuel in the control chamber may flow out through and outlet orifice. Owing to nozzle valve opening force caused by the nozzle side of high pressure fuel, the needle valve is lifted to start fuel injection. When the TWV is switched off (to cut current), the fuel circuit is changed over to such a status that the high pressure fuel is flowed back through the inlet orifice into the control chamber.

Therefore, the needle valve comes down to stop fuel injection.

Thus, fuel injection time can be electronically controlled by TWV switching on and fuel injecting amount, by TWV switching off.

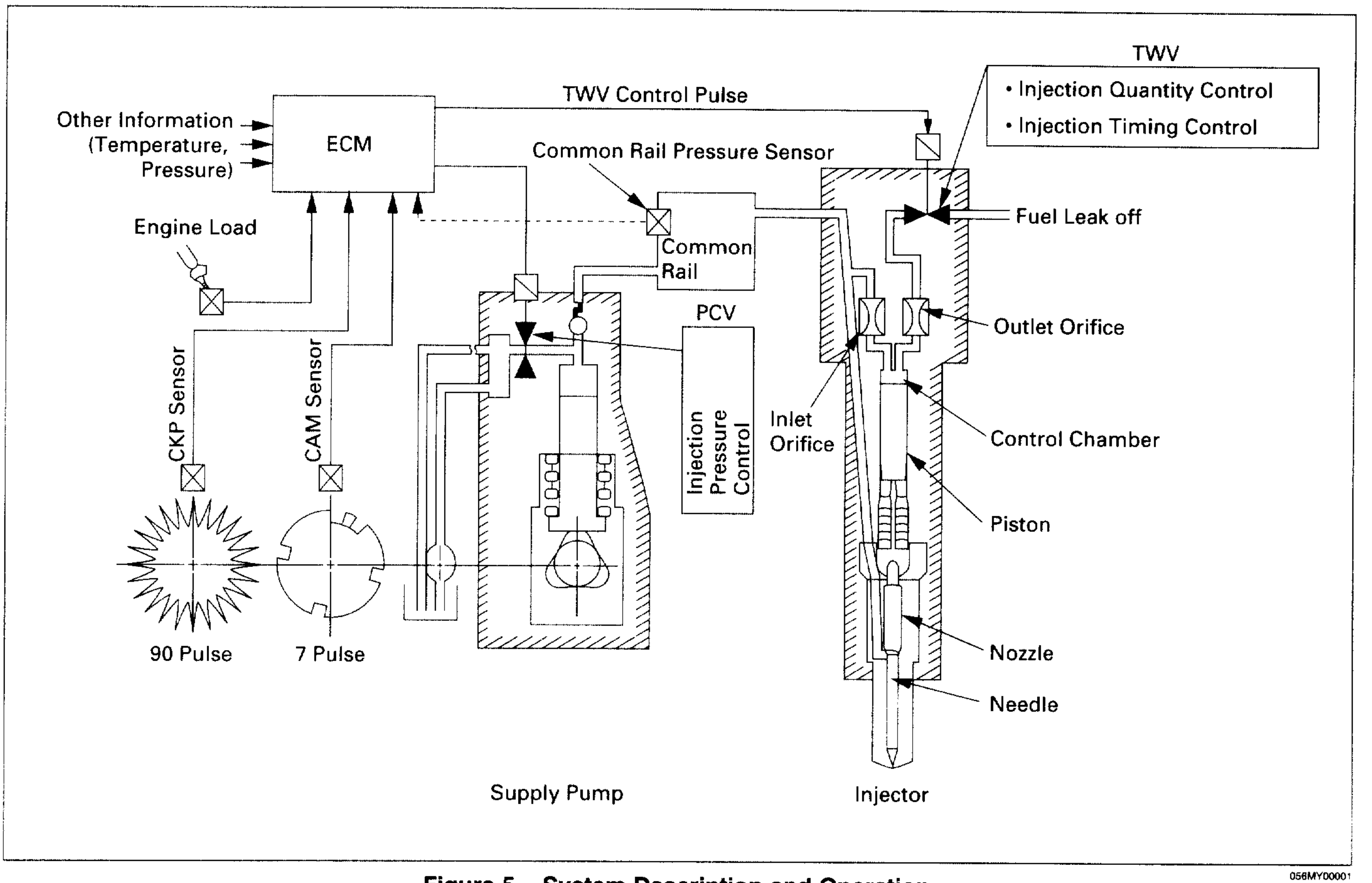


Figure 5 – System Description and Operation

VARIOUS CONTROLS

In comparison with the mechanical governor or timer used in the conventional type supply pump, fuel injection amount/timing can be controlled further properly.

ECM computes from signals coming from the sensors installed to engine and vehicle and controls the time point and length for carrying current to the injector so that the optimum injection can be performed at the optimum timing.

(1) Fuel Pilot Injection Control Function

This is a function to control either fuel pilot injection or not.

(2) Fuel Injection Amount Control Function

This is a function to control fuel injection based on signals from engine speed and accelerator opening sensors so that the optimum injection amount can be obtained. A substitute for the conventional mechanical governor.

(3) Fuel Injection Timing Control Function

This is a function to obtain the optimum injection timing from engine speed and fuel injection amount. A substitute for the conventional timer.

(4) Fuel Injection Pressure Control Function (Common Rail Pressure Control Function)

This is a function to measure fuel pressure with the common rail sensor and feed back the measurement to ECM thereby to control the discharge amount of the pump.

Pressure feedback control is carried out so that the optimum value (instructed value) set according to engine speed and fuel injection amount can be reached

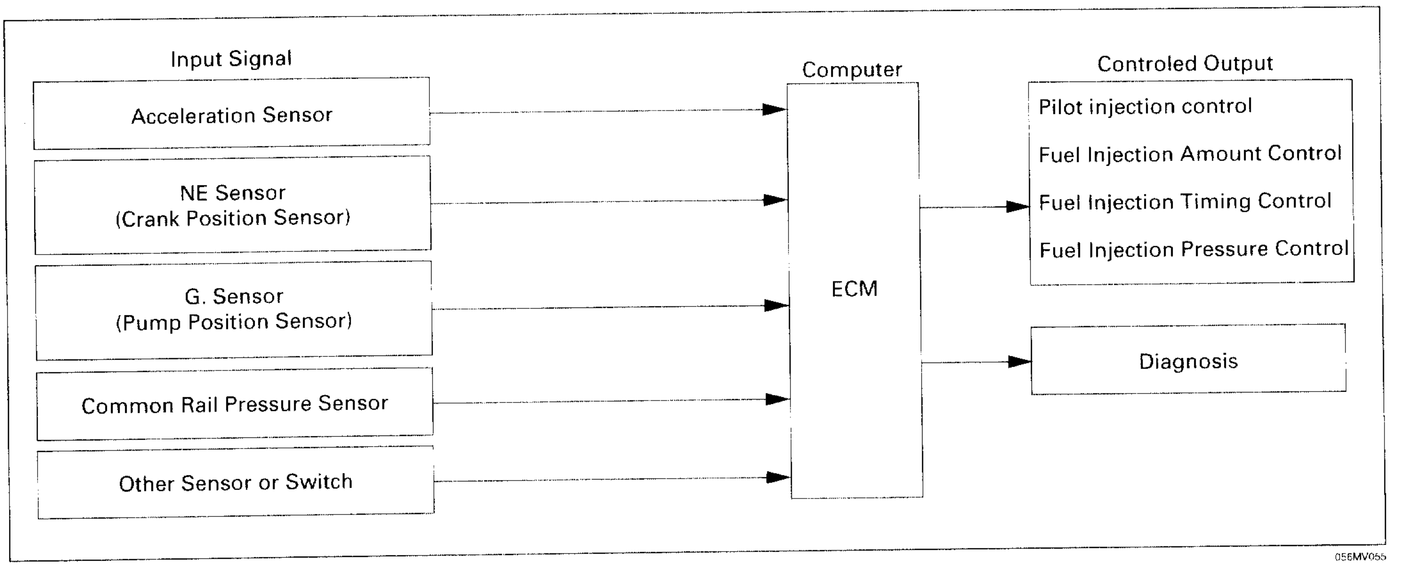


Figure 6 – Control System

FUEL INJECTION RATE CONTROL

(1) Main Injection

Same as the conventional system.

(2) Pilot Injection

This is a small amount of injection conducted prior to the conventional fuel injection (main injection).
Injection rate is increased as there is a rising tide of high pressure injection. But a time lag from fuel injection to combustion start (ignition delay) cannot be shortened over a certain value. As a result the fuel injected could be increased till ignition to cause instantaneous explosive combustion which would in turn increase NOx and noise. Pilot injection puts down an initial injection rate to the irreducible minimum to lessen the explosive combustion so that NOx and noise can be reduced.

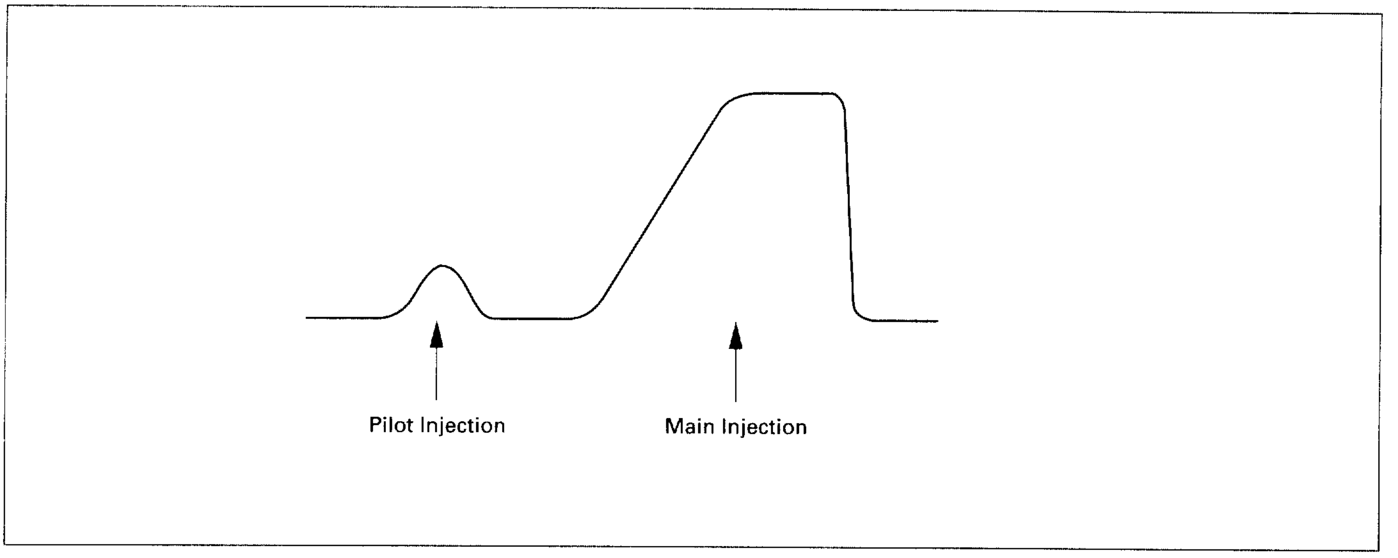


Figure 7 – Pilot Injection

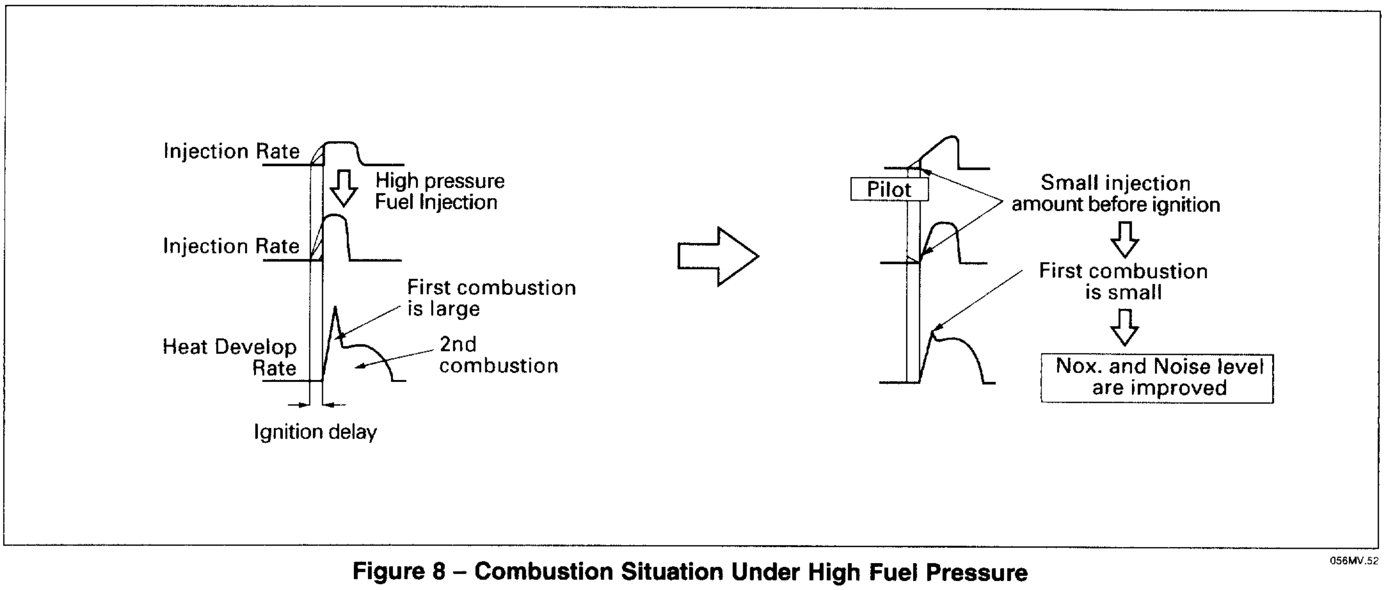


Figure 8 – Combustion Situation Under High Fuel Pressure

(3) Split Injection

This means two or more small amount fuel injections to be conducted prior to the conventional fuel injection (main injection) for increase engine start under cold weather.

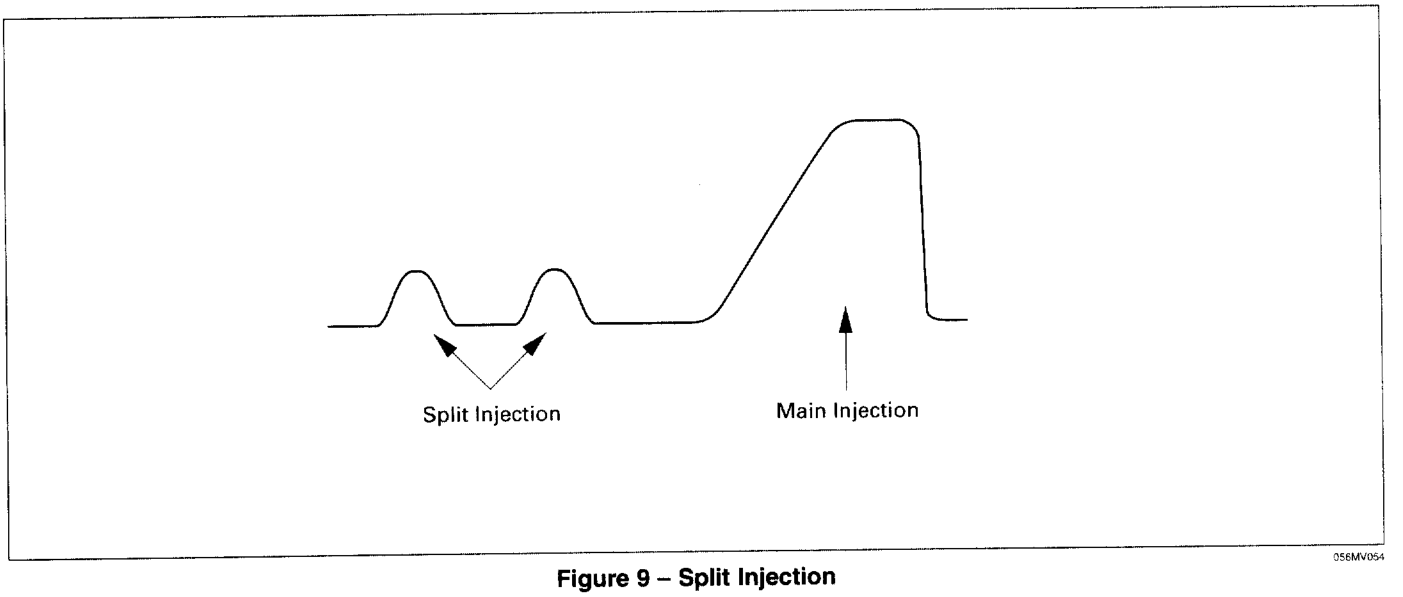


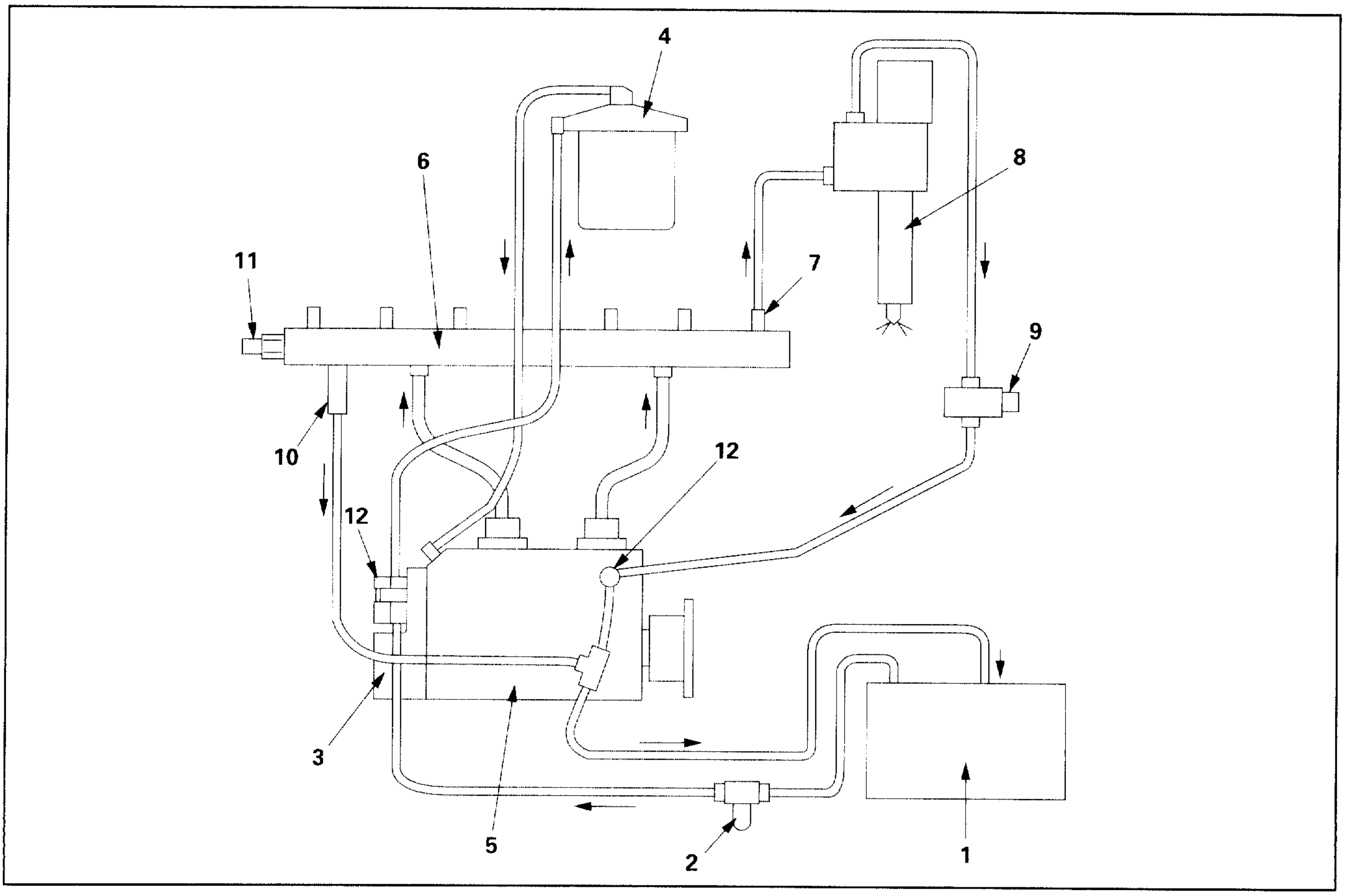
Figure 9 – Split Injection

FUEL INJECTION SYSTEM

SYSTEM OPERATION

Fuel is drawn through the fuel pre-filter (2) by the fuel feed feed pump (3), refer to (Figure 10). The fuel feed pumps the fuel into the fuel filter (4) and then into the fuel supply pump (5). The fuel supply pump then pressurizes and supplies the fuel to fuel common rail.

The pressured fuel distributes through the fuel injectors line to the fuel injectors (8). The high pressure fuel enters the fuel injector and forces the needle off its seat, same time the fuel enters the control room of fuel injectors. The fuel injection timing is controlled by ECM. The ECM command to open the fuel return line of solenoid valve on top of the injector, then the fuel is forced out of the fuel injector into the cylinder.

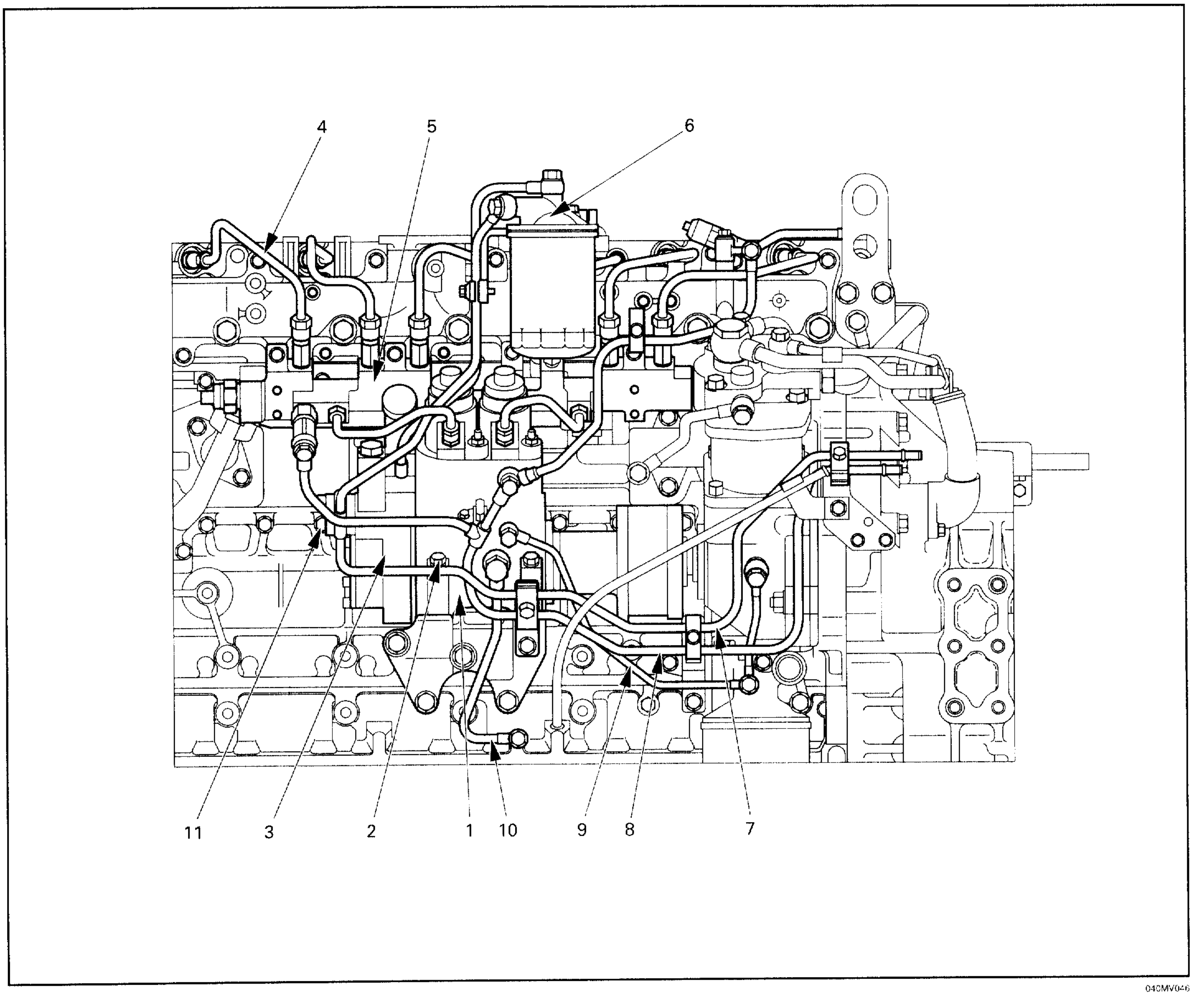


Legend

(1) Fuel Tank
(2) Fuel Pre-Filter
(3) Fuel Feed Pump
(4) Fuel Filter
(5) Supply Pump
(6) Fuel Common Rail
(7) Fuel Flow Dumper
(8) Injector Assembly
(9) Fuel Temperature Sensor
(10) Fuel Pressure Limiter
(11) Fuel Pressure Sensor
(12) Overflow Valve

Figure 10 — Fuel System Schematic

ON VEHICLE SERVICE



Legend

(1) Fuel Supply Pump
(2) Bolt
(3) Fuel Transfer Pump
(4) Injection Pipe
(5) Common Rail
(6) Fuel Filter
(7) Fuel Feed Pipe
(8) Fuel Return Pipe
(9) Oil Feed Pipe
(10) Oil Return Pipe
(11) Fuel Return Overflow Pipe

Figure 11 — Location of Fuel System

FUEL SUPPLY PUMP

Removal

1. Tilt the cab.
2. Disconnect the negative battery cable.
3. Disconnect PCV harness connector.
4. Disconnect G sensor harness connector.
5. Remove clamp bolts from the fuel feed pipe (7), fuel return pipe (8) and fuel supply pipe to fuel filter.
6. Remove fuel feed pipe (7).
7. Remove fuel return pipe (8).
8. Remove oil feed pipe.
9. Remove oil return pipe.
10. Remove two fuel supply pipes between supply pump and common rail.
11. Disconnect coupling fixing bolts.
12. Remove fuel supply pump fixing bolts.
13. Remove fuel supply pump assembly.

Installation

1. Turn crankshaft until the TDC mark is aligned with the pointer. Make sure the No. 1 cylinder is at TDC on the compression stroke.

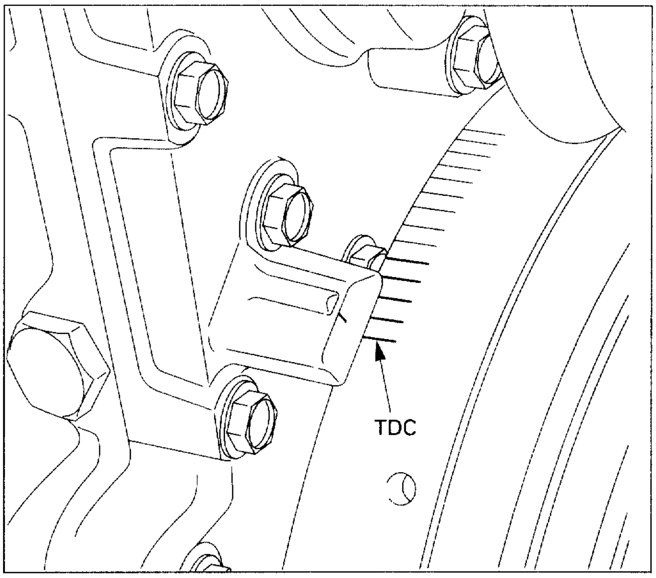


Figure 12 – TDC Mark

2. Confirm that the "S" or "–" mark on the air compressor coupler is aligned with the pointer on the air compressor body. If not, the crankshaft is not on No. 1 compression stroke and must be rotated one turn.
3. Align alignment mark between supply pump coupler and supply pump housing.

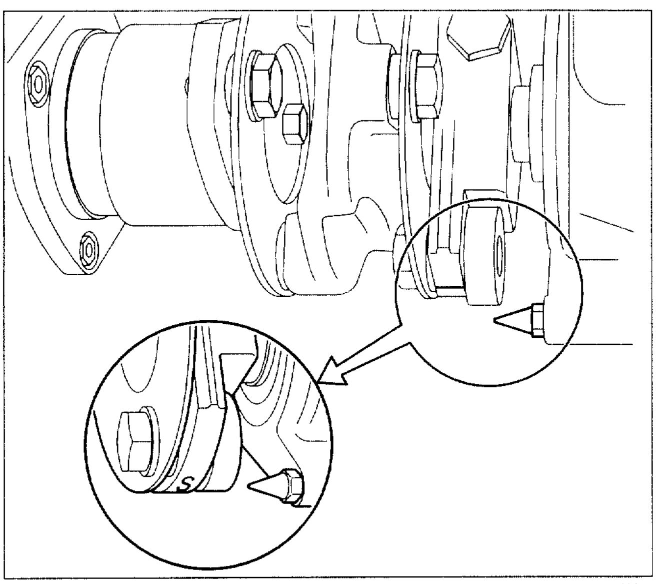


Figure 13-1 – Supply Pump Pointer ("S" mark)

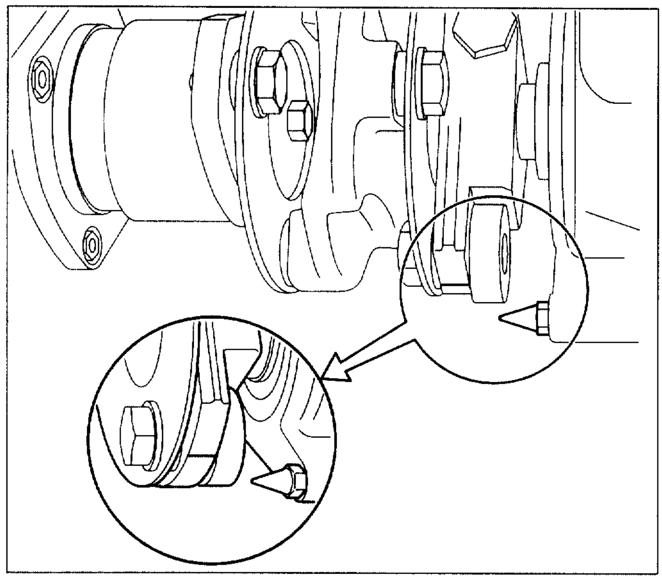
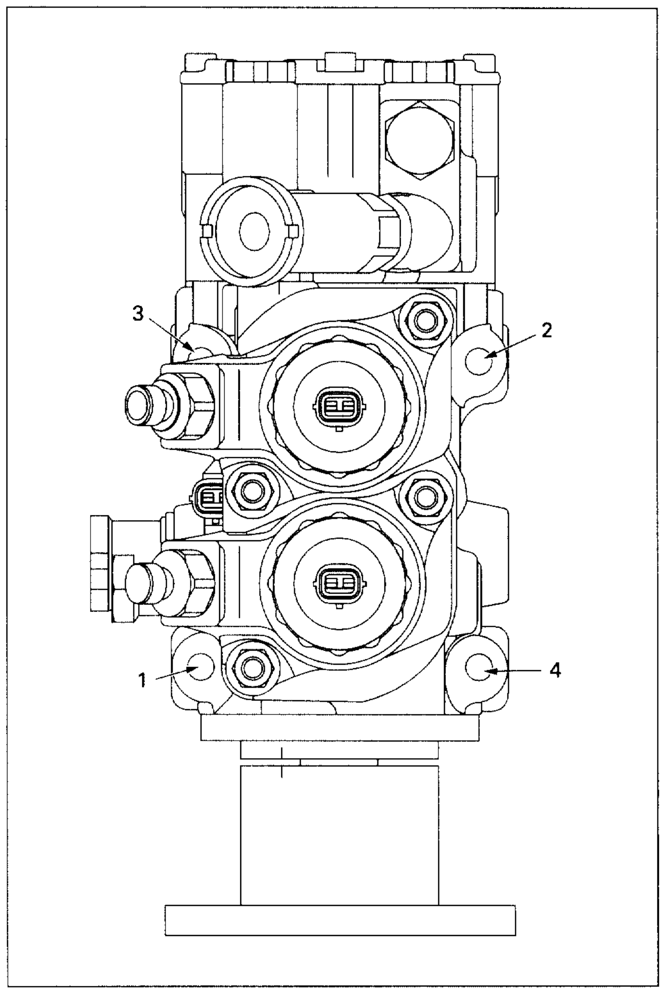


Figure 13-2 – Supply Pump Pointer ("–" mark)

4. Install supply pump assembly onto the pump bracket.
5. Tighten supply pump fixing bolts to the specified torque.
   Torque : 25 N·m (18 lb·ft)



Legend

The number indicate to tighten order.

Figure 14 – Supply Pump Fixing Sequence

6. Tighten coupling bolts to the specified torque.
   Bolt 1: 91 N·m (66 lb·ft)
   Bolt 2: 61 N·m (46 lb·ft)
   Bolt 3: 60 N·m (45 lb·ft)

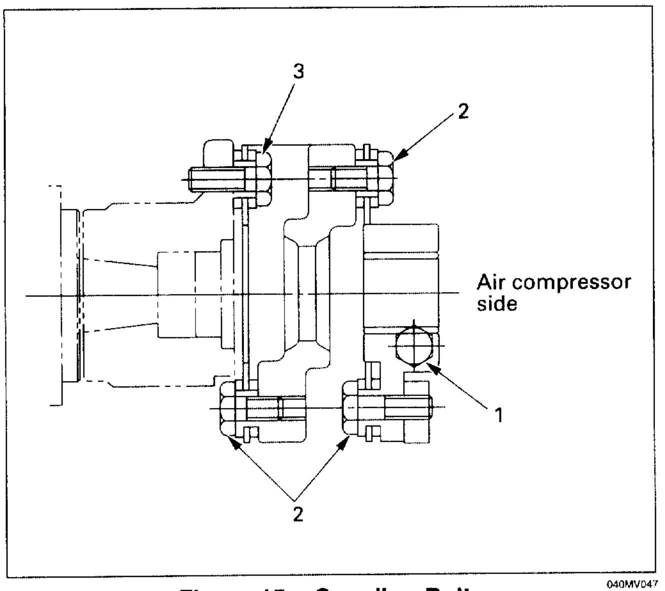


Figure 15 – Coupling Bolts

7. Install two fuel supply pipes between supply pump and commonrail.
8 Install oil return pipe.
9. Install oil feed pipe.
10. Install fuel return pipe.
11. Install fuel feed pipe.

Caution: When install fuel feed pipe on the fuel feed pump, must use special gasket between feed pipe eye (on the relief valve) and return pipe eye (short return pipe). If use other gasket it will cause not start engine.

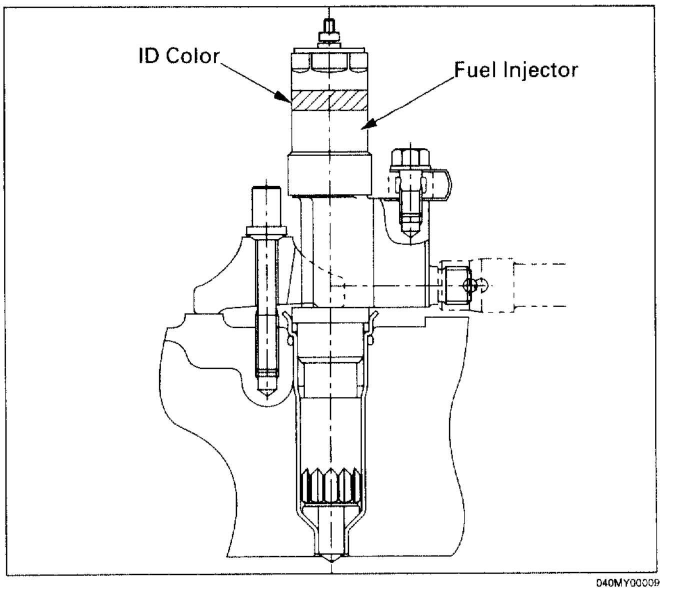
12. Tighten clamp bolts with clamp.
    Torque : 6 N·m (52 lb·in)
13. Reconnect G sensor harness connector.
14. Reconnect PCV harness connector.
15. Reconnect negative battery cable.
16. Down cab and lock.

FUEL INJECTOR

Injector Grade Mark

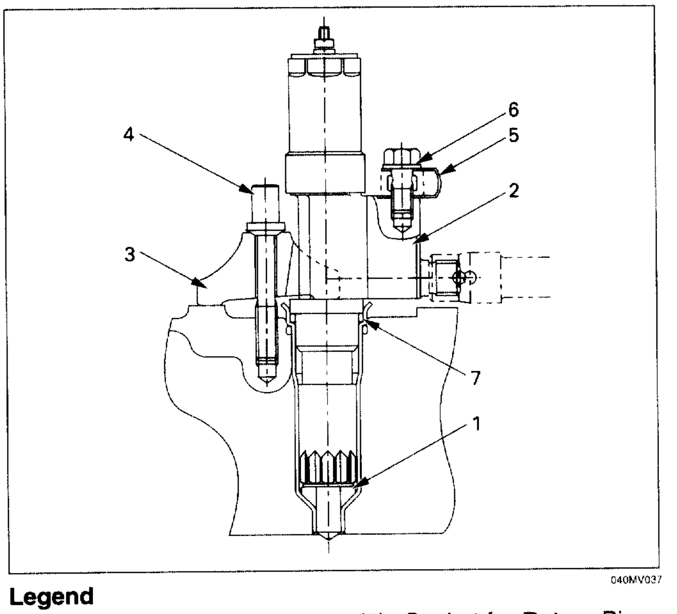
- Refer to the following table for the injector grade mark

Grade	Color	Fuel Rate (mm^3/st)	Remarks
A	Yellow	114 – 121	For Assembling factory
A	Blue	117 – 124	For Assembling factory
Service Part	Not Color	117 – 121	For Workshop



Removal

1. Tilt cab.
2. Disconnect the negative battery cable.
3. Disconnect two TWV harness connector at outside of lower case (Under the valve rocker arm cover).
4. Remove injection pipes between injector and supply pump.
5. Remove valve rocker arm cover.
6. Disconnect TWV harness connector from inside of lower case joint connector.
7. Loosen terminal nuts for TWV harness on the top of injector and remove TWV harness.
8. Remove TWV harness assembly from top of rocker arm assembly.
9. Loosen injector clamp bolt then remove injector assembly.



Legend
(1) Injector Gasket
(2) Injector Assembly
(3) Injector Clamp
(4) Clamp Bolt
(5) Gasket for Return Pipe
(6) Eye Bolt
(7) Injector Sleeve

Figure 16 – Fuel Injector

Installation

1. Standing put injector clamp on the valve spring seat as shown in the illustration.

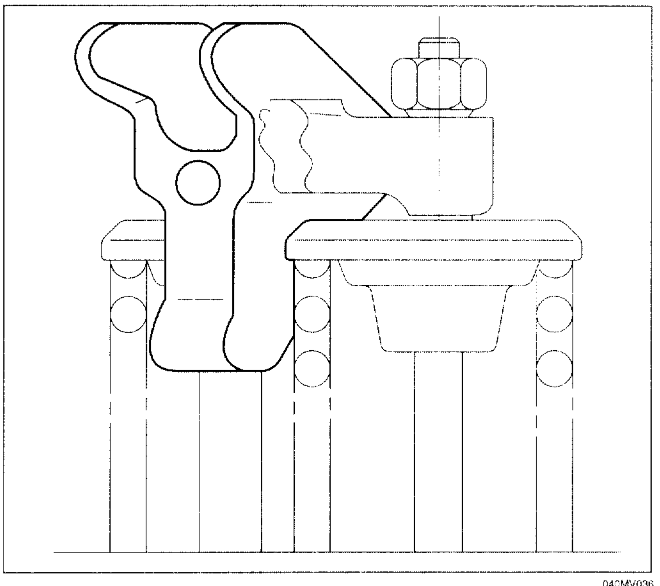


Figure 17 – Fuel Injector Clamp

2. When injector assembly comes installation portion, the injector clamp putting on the injector then install the injector assembly together with clamp into injector sleeve hole.
3. Temporary tighten injection pipe to injector.
4. Apply molybdenum disulfide grease to clamp bolt, tighten injector clamp bolt to specified torque.
   Torque : 31 N·m (22 lb·ft)
5. Tighten injection pipe to the specified torque.
   Torque : 44 N·m (33 lb·ft)
6. Install fuel return pipe, tighten eye bolt to the specified torque.
   Torque : 12 N·m (106 lb·in)

Note:

1. ***Be confirm that tightening torque of injection pipe (Item 5 above) and fuel return pipe eye bolt (Item 6 above) after tighten them for prevent to dilute of engine oil.***
2. ***Make sure that the gasket for return pipe (5) not ride on the injector body when tighten eye bolt. (The correct direction shown in the Figure 16).***

7. Install TWV harness assembly, tighten fixing bolt to specified torque.
   Torque : 22 N·m (16 lb·ft)
8. Install TWV harness to TWV terminals, tighten fixing nut to the specified torque.
   Torque : 2 N·m (17.7 lb·in)

Note: Do not over tight TWV terminal nuts.

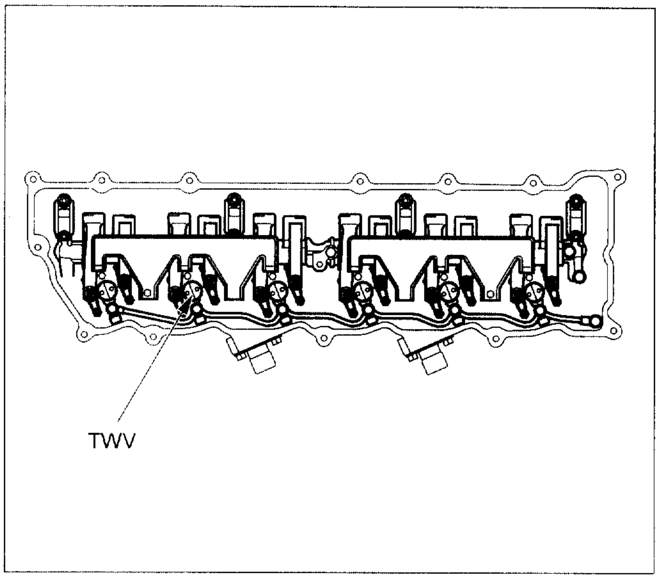


Figure 18 – TWV

9. Reconnect TWV harness to lower case joint connector.
10. Install valve rocker arm cover to tighten to the specified torque.
    Torque : 13 N·m (113 lb·in)
11. Reconnect two TWV harness connector at outside of lower case.
12. Reconnect the negative battery cable.
13. Down cab.

Bleeding Fuel System

Note: The injector assembly must be replaced only assembly.
When the fuel system is opened to the atmosphere, it must be bleed to remove all the air. Air in the fuel system will cause a no start or poor engine performance.

1. Loosen the primer pump knob (1, Figure 19) on the fuel supply pump.

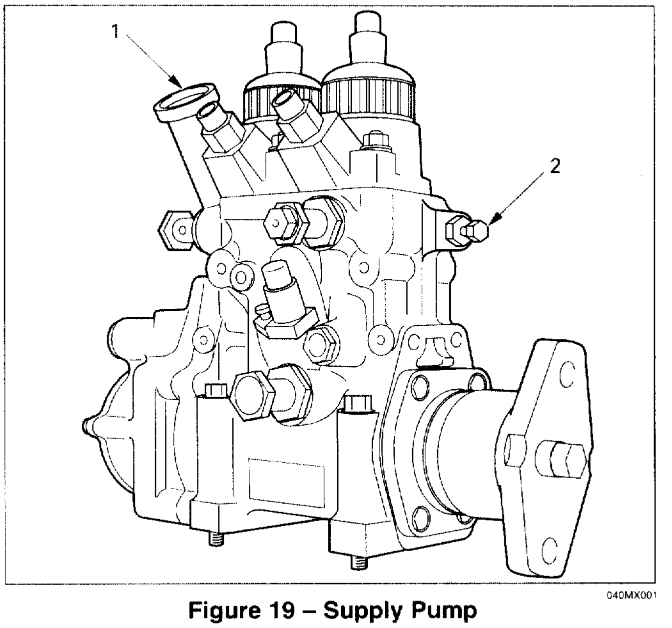


Figure 19 – Supply Pump

2. Loosen the fuel feed line eye bolt (1, Figure 20) on the fuel filter.

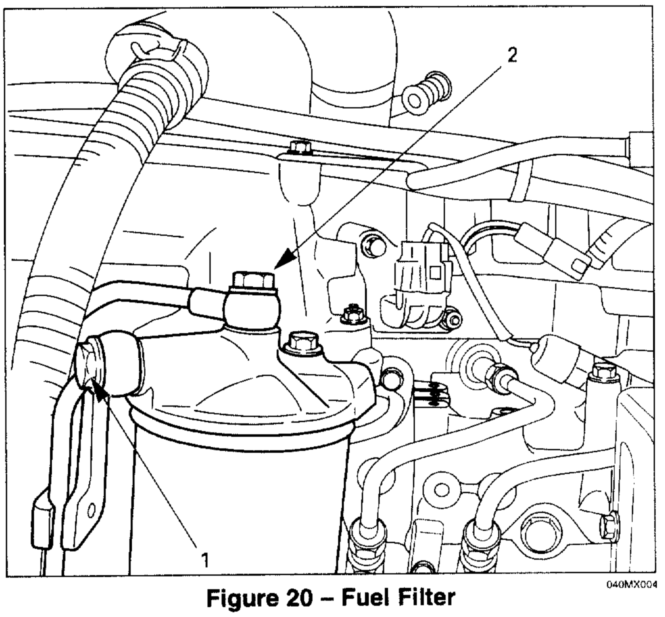


Figure 20 – Fuel Filter

3. Pump the primer pump (1, Figure 19), until a solid stream of fuel comes from the fuel filter feed line eye bolt (1, Figure 20).
4. Tighten the fuel filter eye bolt.
   Torque : 41 N·m (30 lb·ft)
5. Loosen the fuel feed line eye bolt (2, Figure 20) on the fuel filter.
6. Pump the primer pump (1, Figure 19), until a solid stream of fuel comes from the fuel feed line eye bolt (2, Figure 20).
7. Tighten the fuel filter eye bolt (2, Figure 20).
   Torque : 41 N·m (30 lb·ft)
8. Loosen the air bleeding plug (2, Figure 19) on the supply pump.
9. Pump the primer pump (1, Figure 19), until a solid stream of fuel comes from the air bleeding plug (2, Figure 19).
10. Tighten the air bleeding plug.
    Torque : 6 N·m (52 lb·in)
11. Pump the primer pump 60 times.
12. Starter switch "ON" but do not be started engine, turn on the engine idling adjust switch to idling downward until 5 minutes.
13. Pump the primer pump 60 times during step 12.
14. Engine start.
    If the engine does not start, repeat air bleeding procedure form step 1.

Important tightening torque for fuel injection system

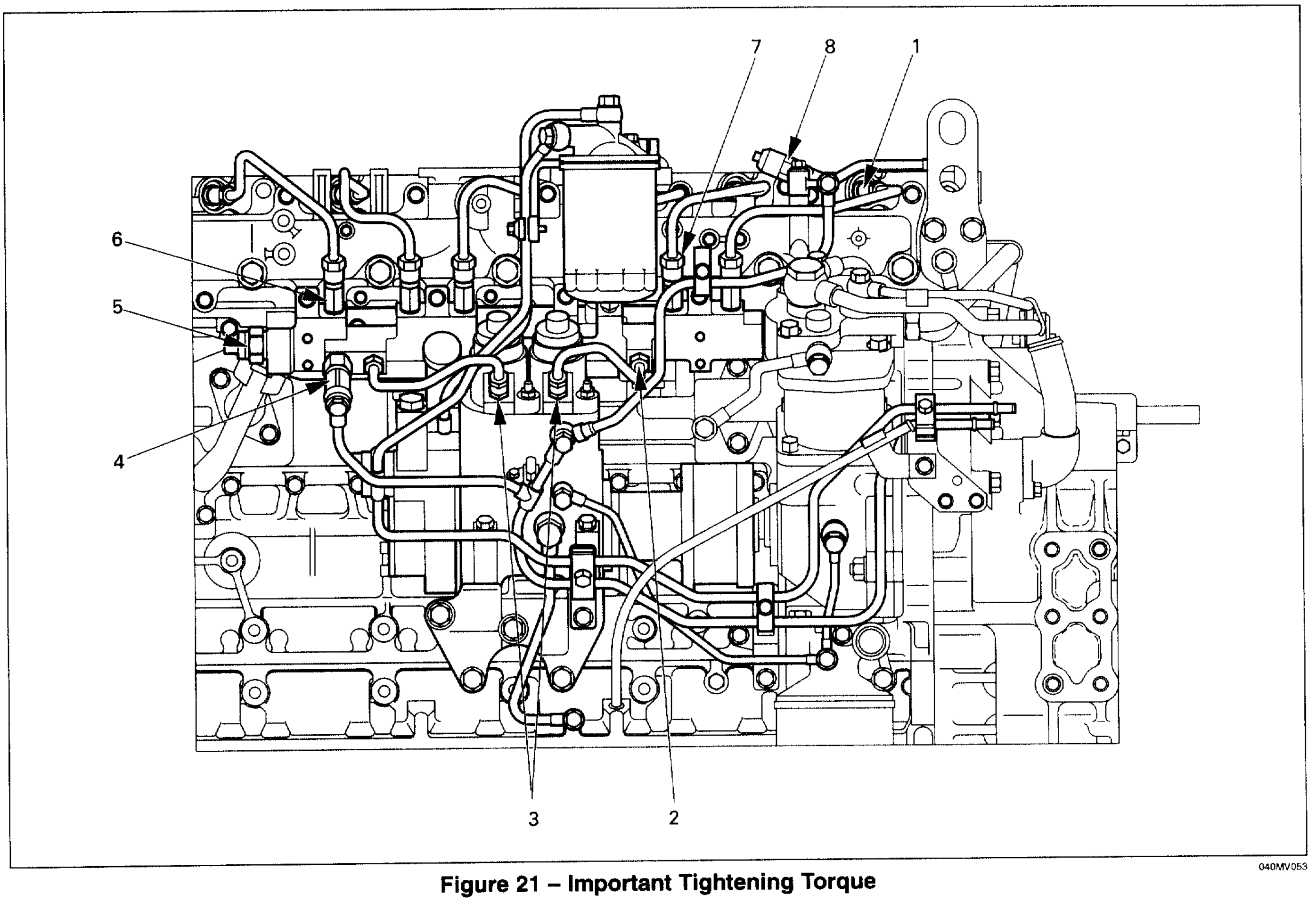


Figure 21 – Important Tightening Torque

Tightening torque

1. Injection pipe sleeve nut, injector side (6 places).
   Torque : 44 N·m (33 lb·ft)
2. High pressure fuel pipe sleeve nut, common rail side (2 places).
   Torque : 54 N·m (40 lb·ft)
3. High pressure fuel pipe sleeve nut, supply pump side (2 places).
   Torque : 44 N·m (33 lb·ft)
4. Fuel pressure limiter.
   Torque : 68.6 N·m (50.6 lb·ft)
5. Common rail pressure sensor.
   Torque : 68.6 N·m (50.6 lb·ft)
6. Flow damper (6 places)
   Torque : 98 N·m (72 lb·ft)
7. Injection pipe sleeve nut, common rail side (6 places)
   Torque : 44 N·m (33 lb·ft)
8. Fuel temperature sensor.
   Torque : 20 N·m (14.5 lb·ft)
9. Fuel return pipe eye bolt, top of injector (7 places)
   Torque : 12 N·m (106 lb·in)

SPECIFICATIONS

Fastener Tightening Specifications

Application	N·m	lb·ft	lb·in
Fuel supply pump bracket to cylinder block	50	37	
Fuel supply pump to pump bracket	25	18	
Fuel supply pump coupling bolt 1	91	66	
Fuel supply pump coupling bolt 2	61	46	
Fuel supply pump coupling bolt 3	60	45	
Fuel pipe clamp bolt	6		52
Fuel injector fixing bolt	31	22	
Fuel injection pipe sleeve nut	44	33	
Fuel return pipe eye bolt	12		106
TWV harness assembly fixing bolt	22	16	
TWV harness terminal nut	2		17
Flow damper	98	72	
Pressure limiter	68.6	50.6	
Common rail pressure sensor	68.6	50.6	
Fuel filter eye bolt	14	10	
Air bleeding plug on supply pump	6		52

BLANK

SECTION 6D6

DIESEL ELECTRICAL

NOTICE: *Always use the correct fastener in the correct 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.*

CONTENTS

GENERAL DESCRIPTION

GLOW PLUGS

Diesel engines relay on the heat of compression to initiate combustion. Cold engine start-ups may require extra engine cranking time to create the necessary heat to ignite the diesel fuel. One of the devices available to aid in cold starting the diesel engine are glow plugs. Six glow plugs are used to preheat the combustion chambers as an aid to starting (Figure 1). The glow plugs (Figure 2) are 10.5 volt heaters, operated at 12 volts, when the engine control switch is turned to the "H" position. This provides a pre-heat feature to the combustion chamber and improves cold engine start ups.

NOTICE: ***Never manually spray starting aid fluids into the air intake where the fluid may come in contact with the heater element. This could result in an explosion and/or fire.***

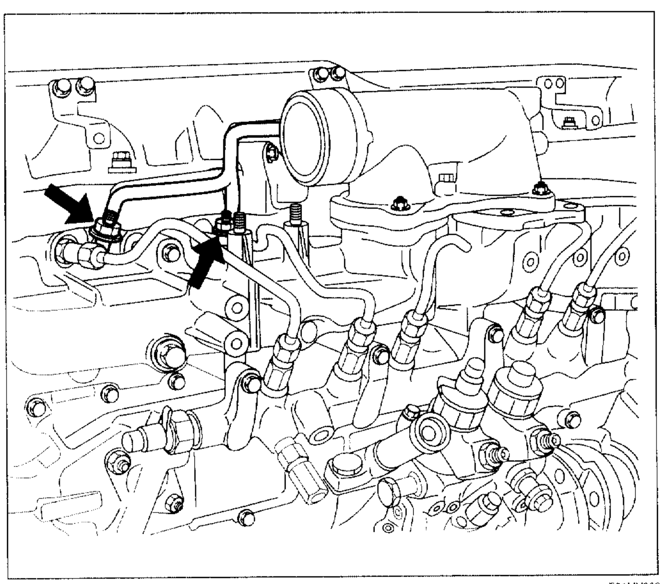


Figure 1 – Glow Plugs

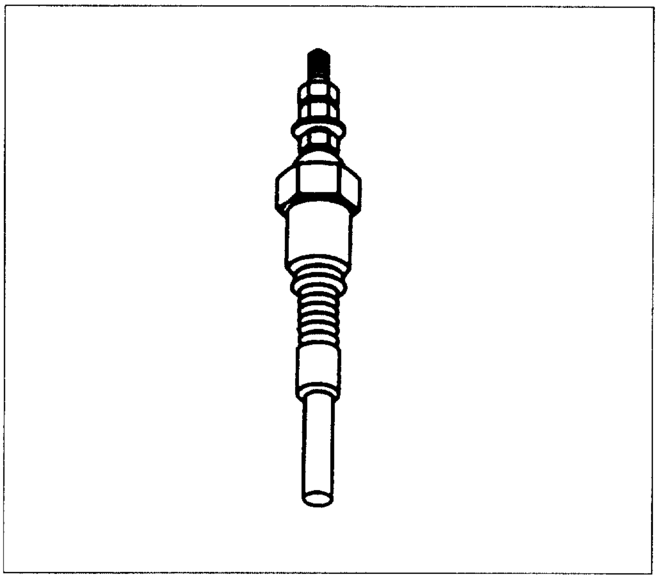


Figure 2 – Glow Plug

STARTING PROCEDURE

To initiate the glow plug operation, these starting procedures should be followed.

1. Turn the engine control switch to the "H" position. Wait until suitable time (according to atmospheric temperature) before cranking the engine.
2. Turn the engine control switch to the "START" position, and release the switch when the engine starts.
3. If the engine does not start after 15 seconds of cranking, repeat steps 1 through 3 until the engine starts.

GLOW PLUG OPERATION

When the engine control switch is turned to the "H" position, current flows through the glow plug relay, and to the glow plugs, heating the glow plugs to 800°C (1472°F). When the ambient temperature is about 0°C (32°F), the glow plugs will take 20 to 25 seconds to heat.

DIAGNOSIS

GLOW PLUG RELAY CHECK

Tools Required:

J 39200 Digital Multimeter

Test the relay circuit for voltage with the relay removed. Use a voltmeter and check for system voltage at cavities B and 30. Cavity 30 is hot at all times. Cavity B is energized by the engine control switch.

Use an ohmmeter to test cavities A and 31. Cavity A is the ground side for the relay. Cavity 31 is the load side (glow plugs) of the relay.

The relay's load side can be checked for high resistance with an ohmmeter. The reading should be 0.1 ohms or less. If the resistance is higher, replace the relay.

GLOW PLUG CHECK

Tools Required:

J 39200 Digital Multimeter

J 35590 Inductive Current Clamp

The glow plugs can be tested in two ways:

1. Take an amperage draw test with an inductive pick-up lead at each glow plug. The rated amp draw should be 6.0 – 7.5 amps per glow plug. Or install the inductive current clamp around the glow plug power supply wire, take the systems current draw reading and divide the reading by the number of glow plugs in the system.
2. A continuity check can also be made with an ohmmeter between the glow plug lead and ground, with the buss bars removed (Figure 3). If no continuity exists, the glow plug will not heat and should be replaced.

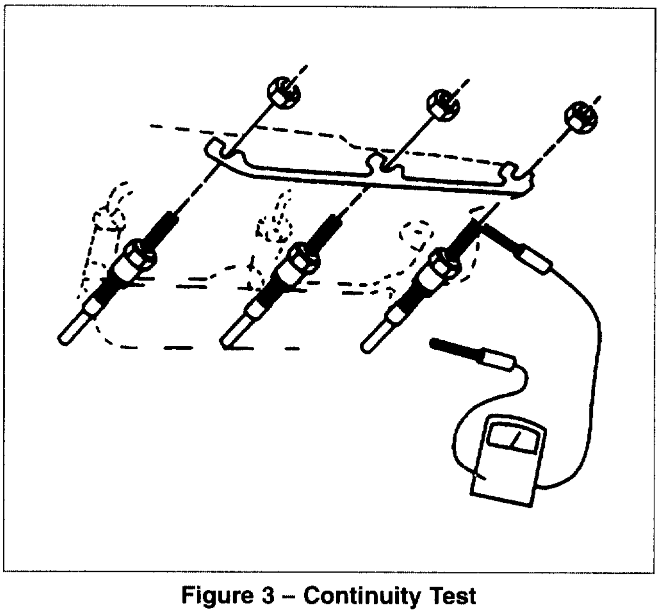


Figure 3 – Continuity Test

BUSS BAR CHECK

Tools Required:

J 39200 Digital Multimeter

J 35590 Inductive Current Clamp

Test for voltage at the buss bars with a voltmeter. Disconnect the negative battery cable and also disconnect the glow plug power supply wire from the buss bar (Figure 4). Connect the voltmeter positive lead to the glow plug power supply wire and the negative lead of the voltmeter to ground. Reconnect the negative battery cable. Turn the engine control switch to the "H" position. The reading should be over 10.5 volts.

A continuity check can be made with an ohmmeter between the buss bar and to the top of each glow plug. The reading should be 0.1 ohm or less. If not, check the glow plug nut contact to the buss bars. If the buss bars are corroded, clean them or replace them as necessary.

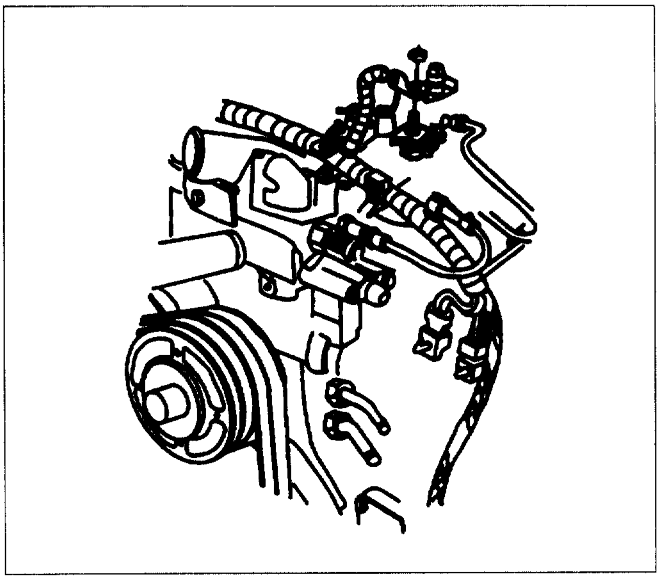


Figure 4 – Glow Plug Power Supply Wire

ON-VEHICLE SERVICE

GLOW PLUG RELAY

Remove or Disconnect

1. Negative battery cable. Refer to "Battery" in SECTION 6D1.
2. Console on the passenger side of instrument panel.
3. Glow plug relay.

Install or Connect

1. Glow plug relay
2. Console on the passenger side of instrument panel.
3. Negative battery cable.

GLOW PLUGS

Remove or Disconnect (Figures 1, 2 and 4)

1. Tilt the cab. Refer to "Cab Tilting" in SECTION 0A.
2. Negative battery cable. Refer to "Battery" in SECTION 6D1.
3. Glow plug power supply wire.
4. Glow plug buss bar.
5. Glow plug(s) from the cylinder head.

Install or Connect (Figures 1, 2 and 4)

1. Glow plug(s) to the cylinder head.

Tighten

- Glow plugs to cylinder head to 25 N·m (18 lb.ft.).

2. Glow plug buss bar.

Tighten

- Glow plugs to buss bar nut to 2 N·m (17 lb.in.).

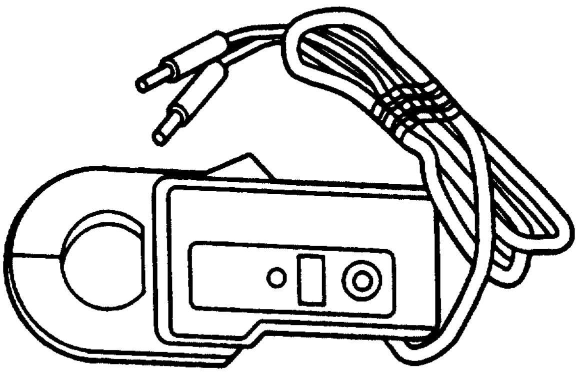
3. Glow plug power supply wire.
4. Negative battery cable.
5. Lower the cab.

SPECIFICATIONS

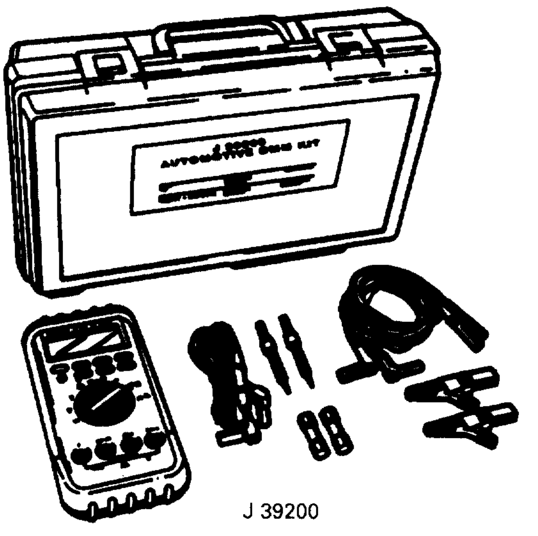
FASTENER TIGHTENING SPECIFICATIONS

Application	N·m	lb·ft	lb·in
Battery Top Post Terminal Nut	17	13	—
Buss Bar to Glow Plug Nut	2	—	17
Glow Plug to Cylinder Head	25	18	—

SPECIAL TOOLS



J 35590



J 39200

SECTION 6E

ENGINE EMISSION AND ELECTRICAL DIAGNOSIS

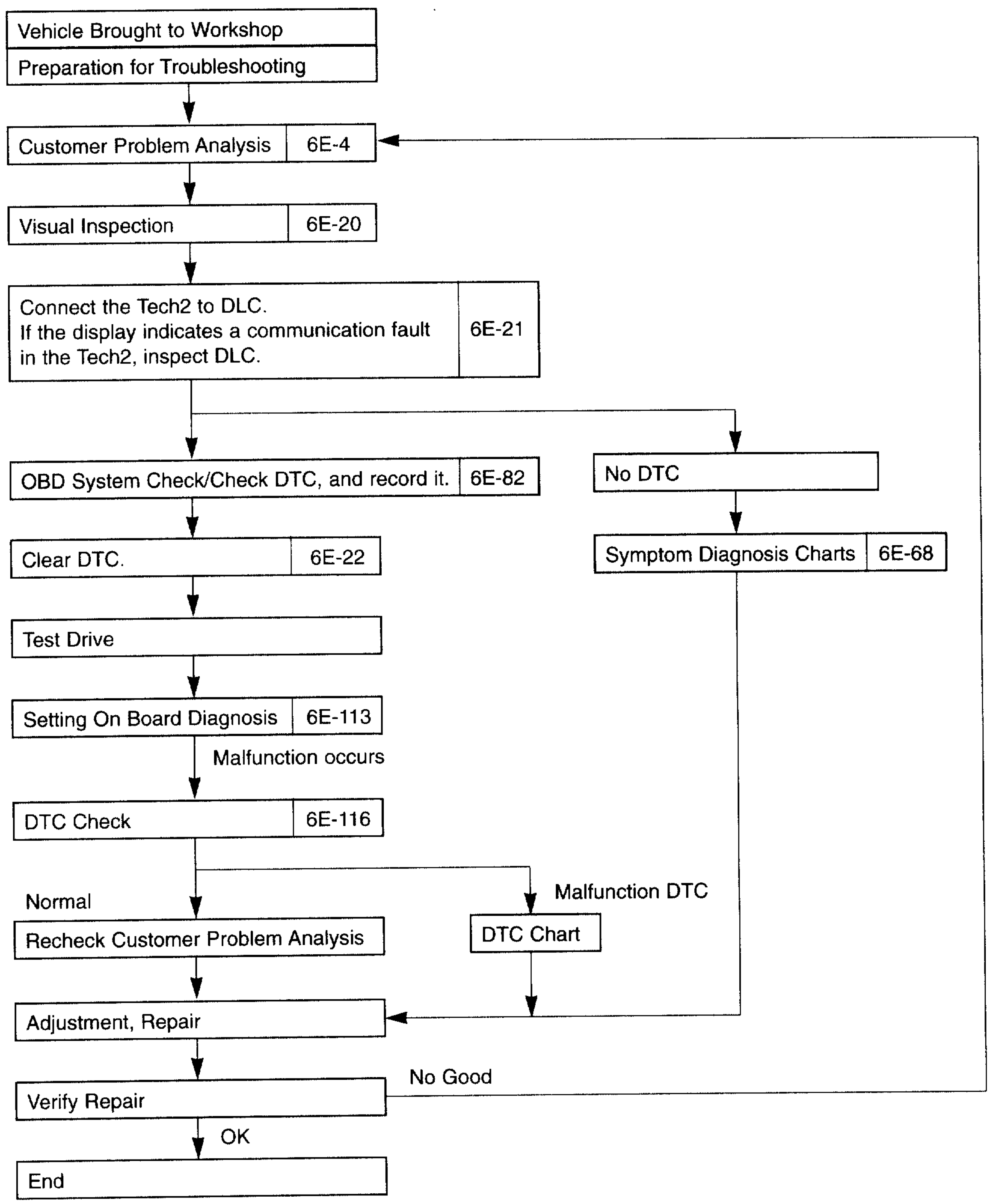
NOTICE: *Always use the correct fastener in the correct location. When you replace a fastener, use ONLY the exact part number for that application. ISUZU will call out those fasteners that require a replacement after removal. ISUZU will also call out the fasteners that require thread lockers or thread 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.*

CONTENTS

GENERAL DESCRIPTION

HOW TO PROCEED WITH TROUBLESHOOTING

Troubleshoot in accordance with the procedure on the following page.
Title side numbers are titles of pages in this manual with the page number indicated in the bottom portion. See the indicated pages for detailed explanations.



CUSTOMER PROBLEM ANALYSIS CHECK

ENGINE CONTROL SYSTEM Check Sheet

Inspector's Name ______________________

Customer's Name		Model and Model Year	
Driver's Name		Frame No	
Date Vehicle Brought in		Engine Model	
License No.		Odometer Reading	km miles

Problem symptoms	☐ Engine does not Start	☐ Engine does not crank ☐ No initial combustion ☐ No complete combustion
	☐ Difficult to Start	☐ Engine cranks slowly ☐ Other ______
	☐ Poor Idling	☐ Idling rpm is abnormal ☐ High (rpm) ☐ Low (rpm) ☐ Rough idling ☐ Other ______
	☐ Poor Driveability	☐ Hesitation ☐ Surging ☐ Other ______
	☐ Engine Stall	☐ Soon after starting ☐ After accelerator pedal depressed ☐ After accelerator pedal released ☐ During A/C operation ☐ Shifting from N to D ☐ Other ______
	☐ Others	

Dates Problem Occurred		
Problem Frequency		☐ Constant ☐ Sometimes (times per day/month) ☐ Once only ☐ Other ______
Condition When Problem Occurs	Weather	☐ Fine ☐ Cloudy ☐ Rainy ☐ Snowly ☐ Various/Other ______
	Outdoor Temperature	☐ Hot ☐ Warm ☐ Cool ☐ Cold (approx. ______ °F/ ______ °C)
	Place	☐ Highway ☐ Suburbs ☐ Inner city ☐ Uphill ☐ Downhill ☐ Rough road ☐ Other ______
	Engine Temperature	☐ Cold ☐ Warming up ☐ After warming up ☐ Any temperature ☐ Other ______
	Engine Operation	☐ Starting ☐ Just after starting (min.) ☐ Idling ☐ Racing ☐ Driving ☐ Constant speed ☐ Acceleration ☐ Deceleration ☐ A/C switch ON/OFF ☐ Other ______

Condition of MIL		☐ Remains on ☐ Sometimes light up ☐ Does not light up
DTC Inspection	Normal Mode (Precheck)	☐ Normal ☐ Malfunction code(s) (code)
	Check Mode	☐ Normal ☐ Malfunction code(s) (code)

FUEL SYSTEM OUTLINE

SYSTEM OUTLINE

This system also provides the following functions:

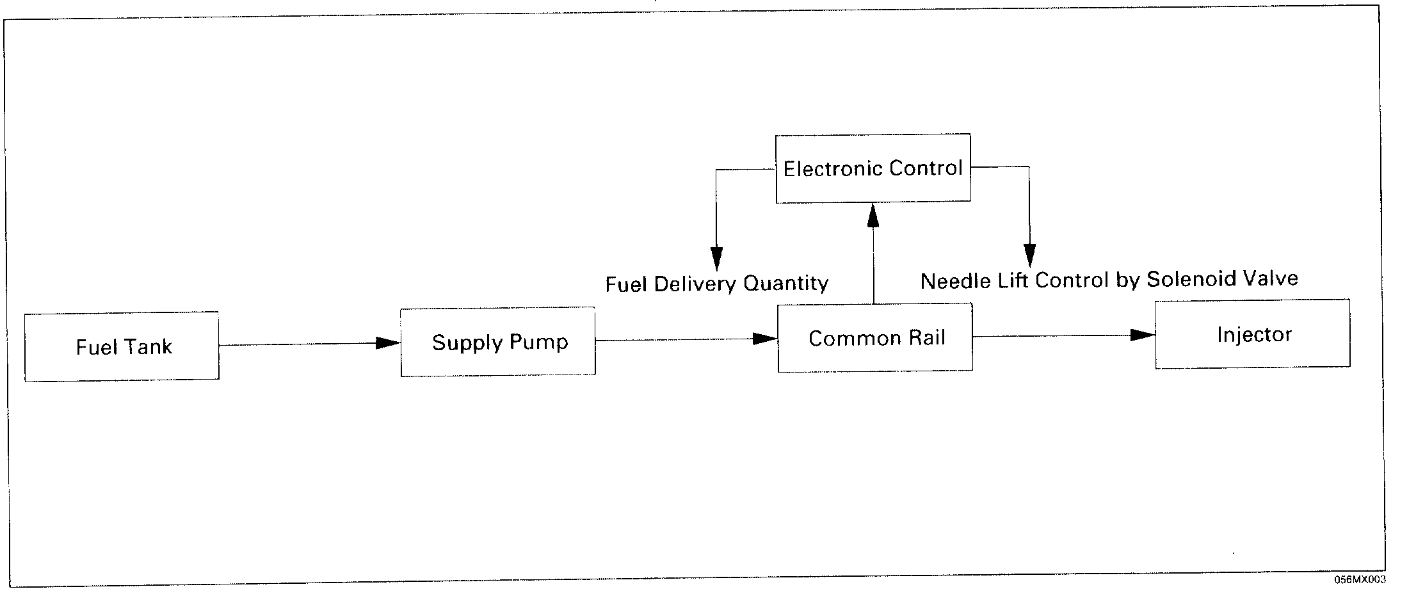
- A self-diagnosis and alarm function that uses a computer to diagnose the system's major components and to alert the driver in case of a problem.
- A fail-safe function to stop the engine, depending upon the location of the problem.
- A backup function to change the fuel regulation method, thus enabling the vehicle to continue operating.

SYSTEM CONFIGURATION

Divided by function, the system can be classified according to the fuel system and the control system.

1. Fuel System

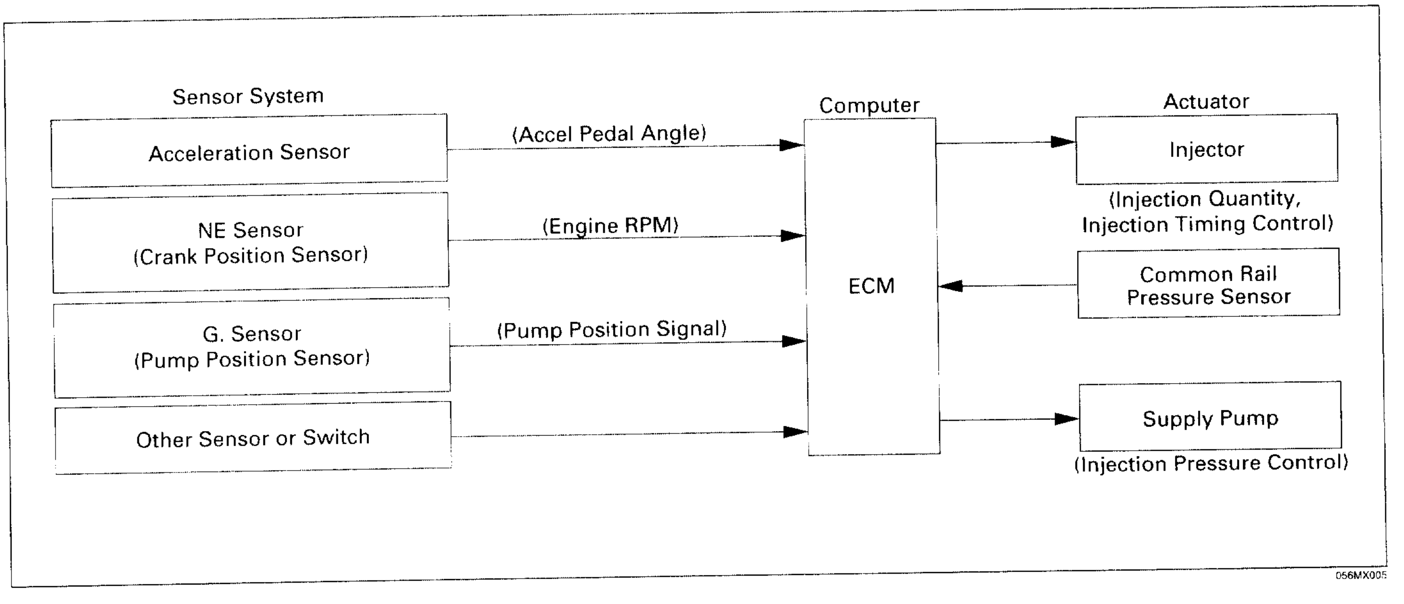
The high-pressure fuel that is generated by the supply pump is distributed to the cylinders by way of a common rail. Then, the electromagnetic valves in the injectors open and close the nozzle needle valve to control the starting and ending of the injection of fuel.



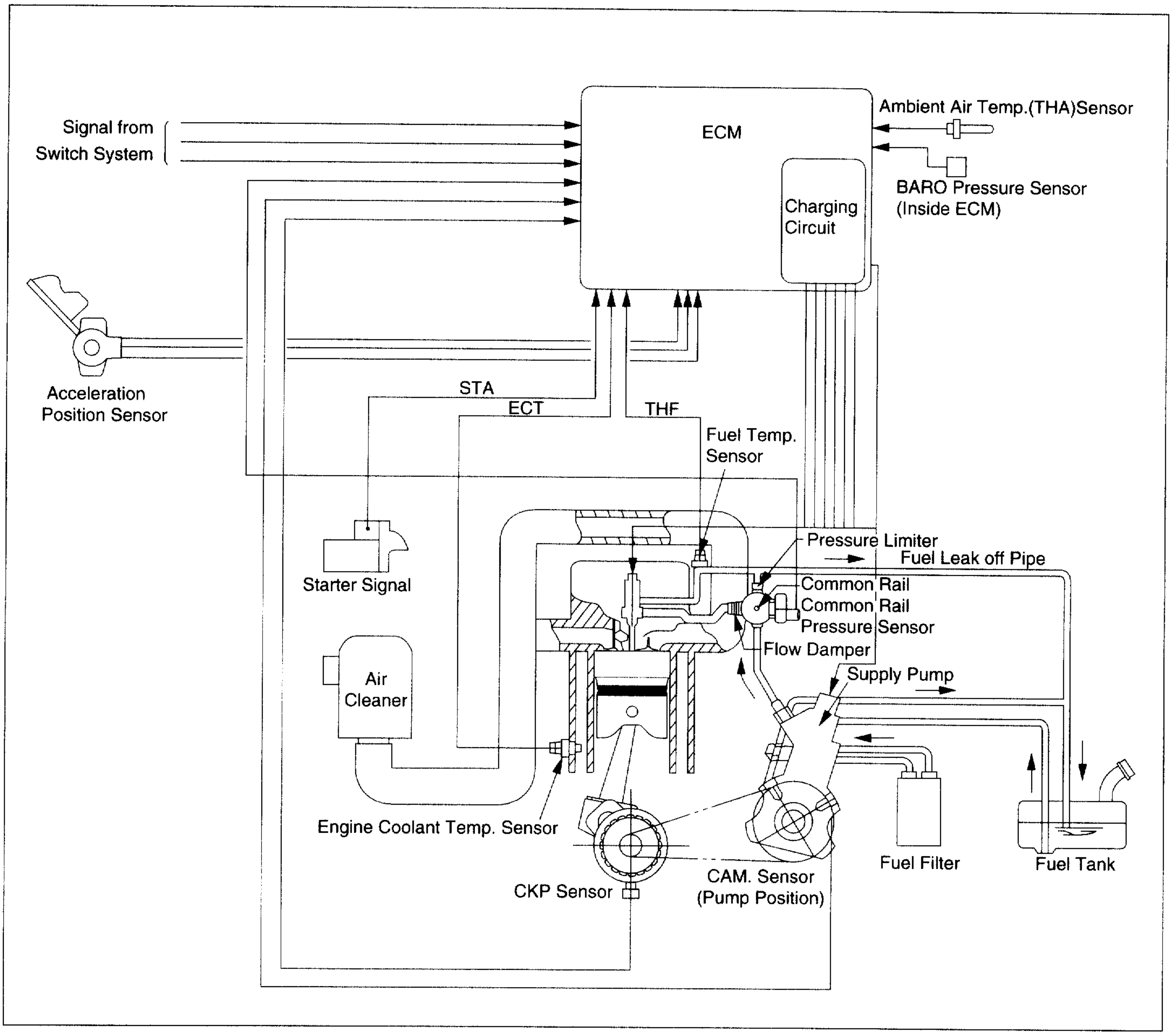
2. Control System

Based on the signals received from various sensors that are mounted on the enigne and on the vehicle, theECU controls the timing of the current and the length of time that the current is applied to the injectors, thus ensuring that an optimal amount of fuel is injected at an optimal time.

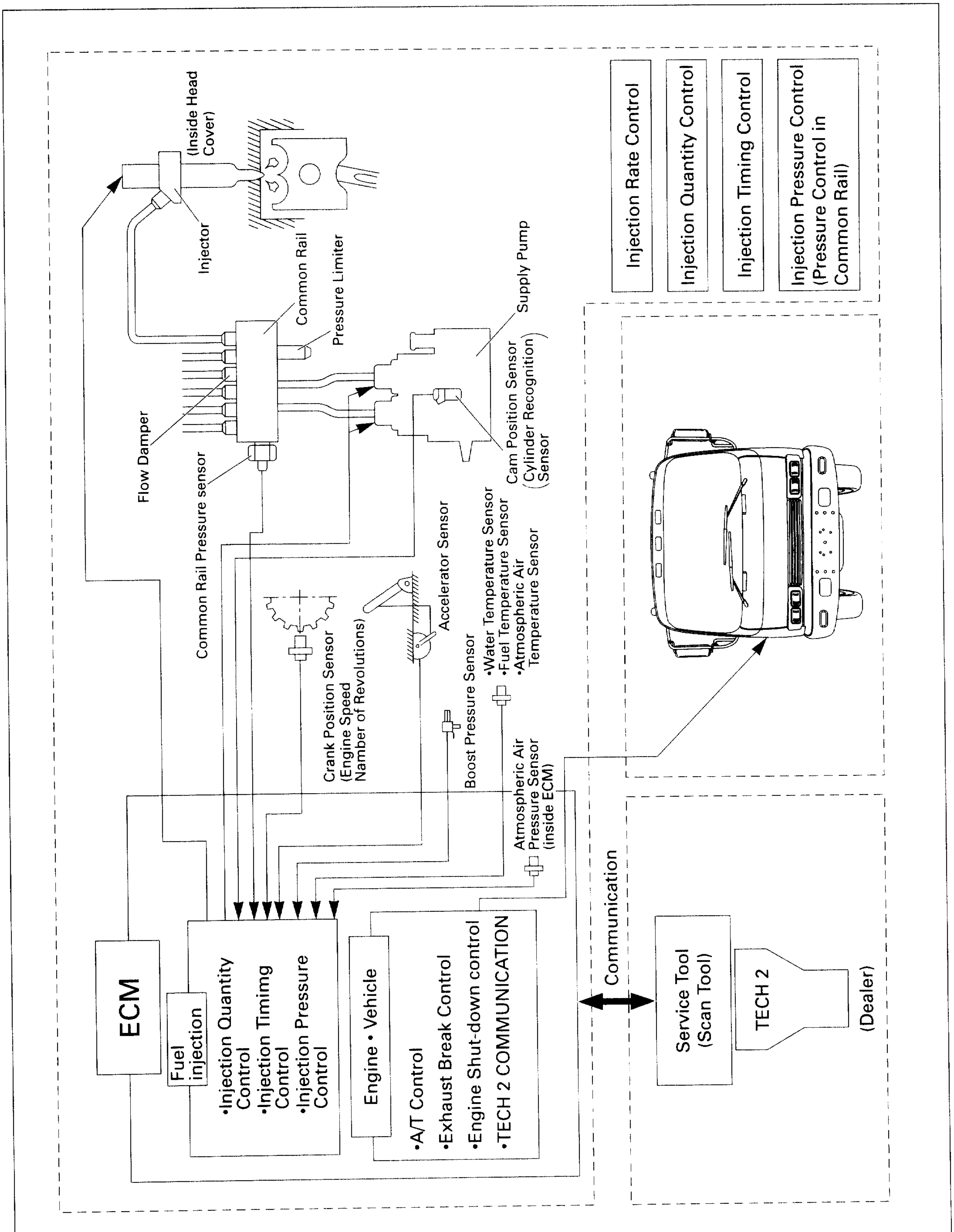
The control system can be broadly classified according to the following electronic components: sensors, computers, and actuators.



3. System Configuration [1]



4. System Configuration [2]



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CONSTRUCTION AND OPERATION OF THE SYSTEM

The COMMON RAIL SYSTEM consists of a supply pump, common rail, injector, ECM and sensors.

The supply pump generates the fuel pressure in the common rail. Fuel pressure is controlled depending on the fuel amount discharged from the supply pump. The fuel discharge amount is controlled by means of PCV provided in the supply pump which is opened/closed in response to electric signals from ECM.

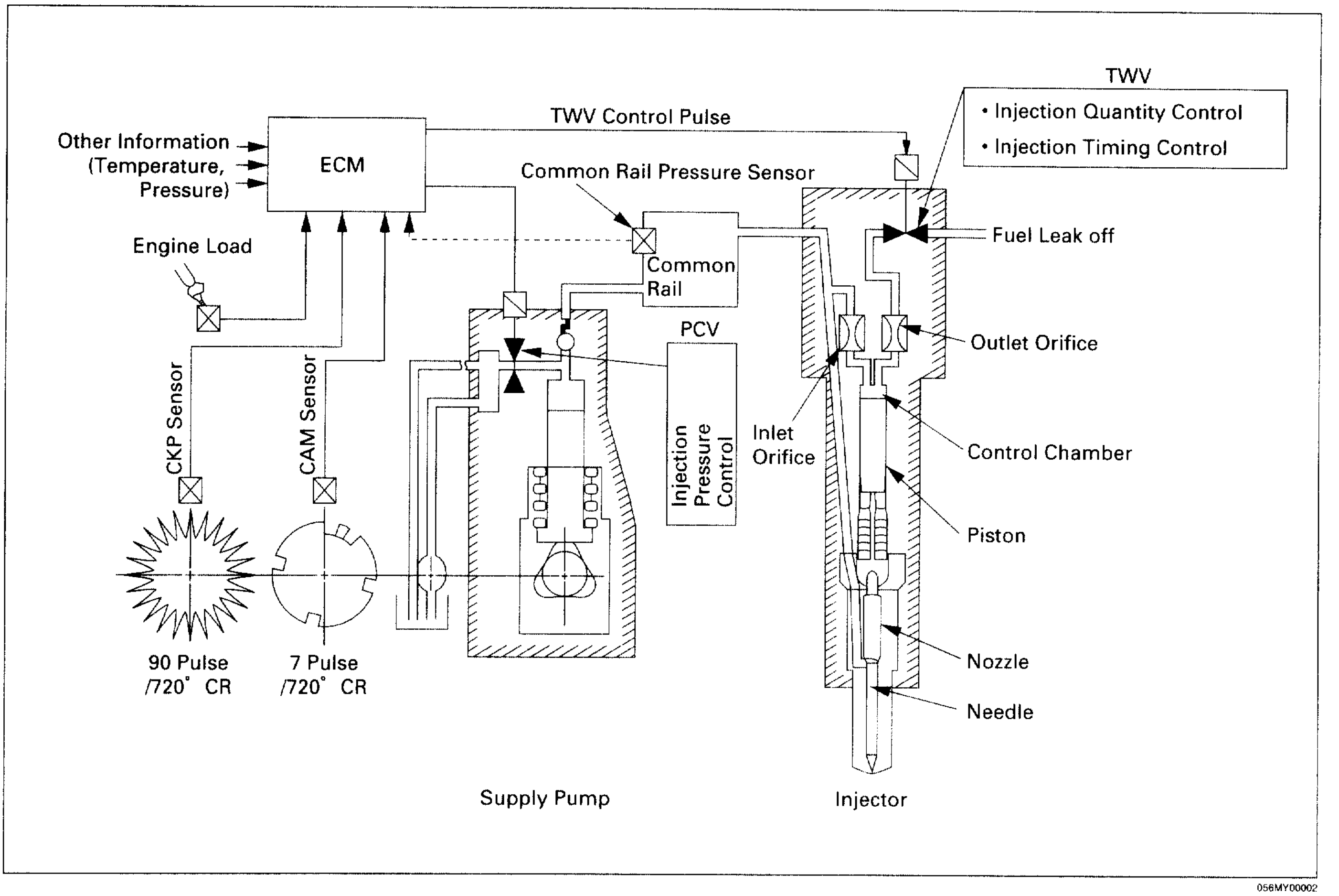
The common rail receives and distributes the fuel pressure made by the supply pump to each cylinder. Fuel pressure is detected by means of a common rail pressure sensor installed to the common rail and is feedback controlled so that the instructed pressure value set according to engine speed and load can agree with an actual pressure value.

The fuel pressure in the common rail is applied through the injection pipe of each cylinder to the nozzle side and control chamber of the injector.

The injector controls injection amount and time by switching on and off a TWV (Two Way Valve). When the TWV is switched on (to carry current), the fuel circuit is changed over to such a status that the high pressure fuel in the control chamber may flow out through and outlet orifice. Owing to nozzle valve opening force caused by the nozzle side of high pressure fuel, the needle valve is lifted to start fuel injection. When the TWV is switched off (to cut current), the fuel circuit is changed over to such a status that the high pressure fuel is flowed back through the inlet orifice into the control chamber.

Therefore, the needle valve comes down to stop fuel injection.

Thus, fuel injection time can be electronically controlled by TWV switching on and fuel injecting amount, by TWV switching off.



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CONSTRUCTION AND OPERATION OF SUPPLY PUMP

SUPPLY PUMP

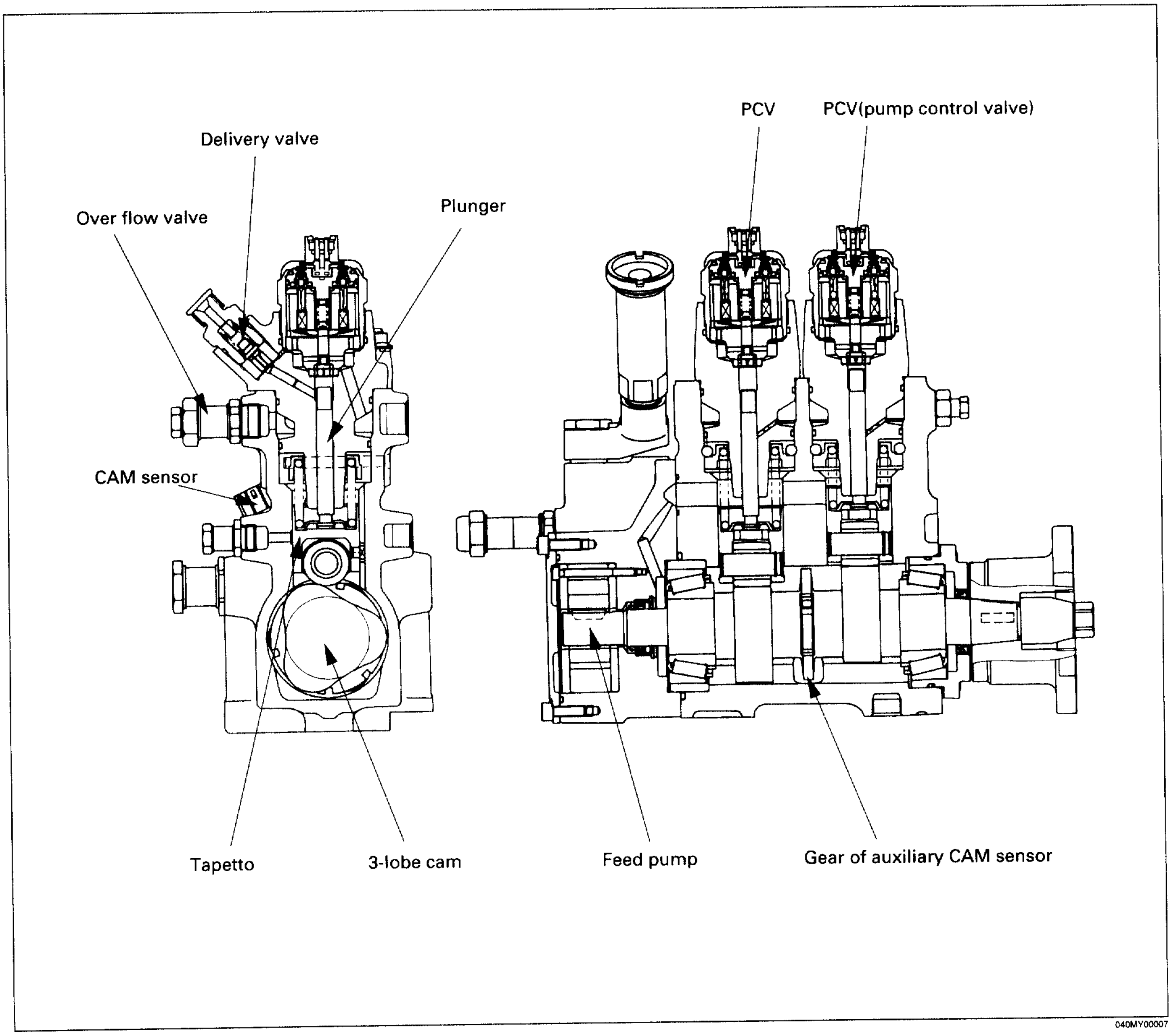
1. Outline

The function of the supply pump is to regulate the fuel discharge volume, thus generating the internal fuel pressure in the common rail.

2. Construction

The supply pump consists of a feed pump, which is similar to that of the conventional inline pump, and the PCVs (pump control valves), which are provided at each cylinder, to regulate the fuel discharge volume.

The supply pump uses a three-lobe cam to reduce the number of cylinders the pump must provide to one-third of the cylinders in the engine (e.g., a two-cylinder pump for an six-cylinder engine). Furthermore, a smooth and stable common rail pressure can be obtained because the frequency that the fuel is pumped to the common rail is the same as the frequency of injection.



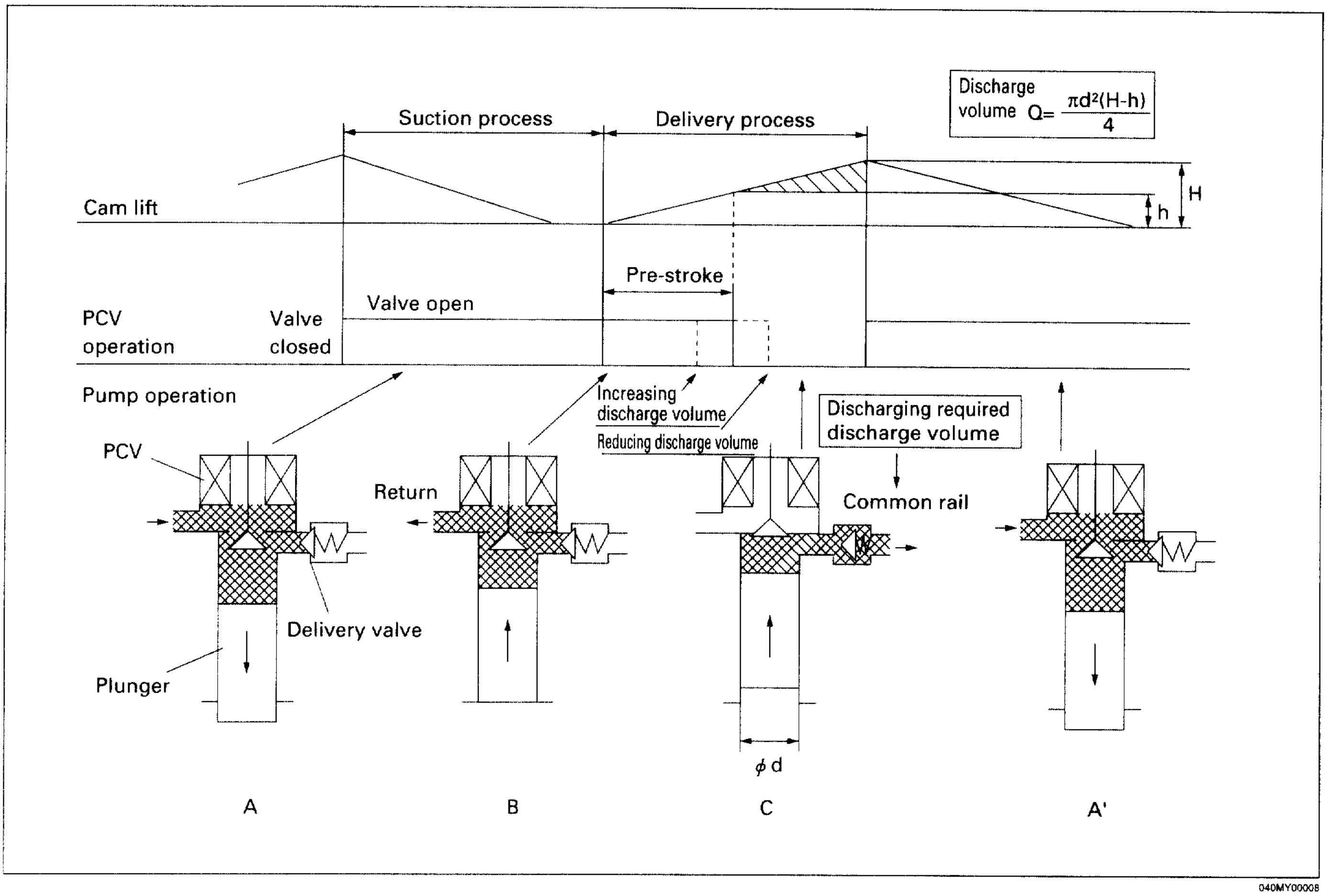
3. Operation

A The PCV remains open during the plunger's downward stroke, allowing the low-pressure fuel to be drawn into the plunger chamber by way of the PVC.

B Even after the plunger begins its upward stroke, if the valve remains open because current is not applied to the PCV, the fuel that was drawn in returns via the PCV, without becoming pressurized.

C When current is applied to the PCV in order to close the valve at the timing that accommodates the required discharge volume, the return passage closes, causing the pressure in the plunger chamber to rise.
Accordingly, the fuel passe through the delivery valve (check valve) to the common rail. As a result, the amount of fuel that corresponds with the lifting of the plunger after the PCV closes becomes the discharge volume, and varying the timing of the closing of the PCV (plunger pre-stroke) causes the discharge volume to vary, thus regulating the common rail pressure.

A' After surpassing the cam's maximum lift, the plunger begins its downward stroke, causing the plunger chamber pressure to decrease. At this time, the delivery valve closes, thus stopping the pumping of the fuel. In addition, because the current to the PCV valve is stopped, the PCV opens, allowing the low-pressure fuel to be drawn into the plunger chamber. Thus, the pump assumes the condition given in "A".



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WORKING ON ELECTRICAL ITEMS

The emission and electrical control system operates on a twelve volt power supply with negative ground polarity. Each wire in the vehicle is of a specific size and has an identifying colored insulation.

These colors are indicated in wiring diagrams and will help in tracing circuits and making proper connections. Wire size is determined by load capacity and circuit length. Some wires are grouped together and taped. Such a grouping of wires is called a harness.

The harness use a split corrugated tube to protect the wires from the elements. Each circuit consists of the following:

- Power source – The battery and the alternator.
- Wires – To carry electrical current through the circuit.
- Fuses – To protect the circuit against current overload.
- Relays – To protect voltage drop between the battery and the circuit parts and to protect the switch points against burning.
- Switches – To open and close the circuit.
- Load – Any device, such as a light or a motor, which converts the electrical current into useful work.
- Ground – To allow the current to flow back to the power source.

In this manual, such electrical device is classified by system. For major parts shown on the circuit based on the circuit diagram for each system, inspection and removal and installation procedures are detailed.

NOTES FOR WORKING ON ELECTRICAL ITEMS

BATTERY CABLE

Disconnecting the Battery Cable

1) All switches should be in the "OFF" position.
2) Disconnect the battery ground cable.
3) Disconnect the battery positive cable.

CAUTION:
It is important that the battery ground cable be disconnected first.
Disconnecting the battery positive cable first can result in a short circuit.

Connecting the Battery Cable

Follow the disconnecting procedure in the reverse order.

CAUTION:
Clean the battery terminal and apply a light coat of grease to prevent terminal corrosion.

Connecting Handling

Disconnecting The Connectors

Some connectors have a tang lock to hold the connectors together during vehicle operation.

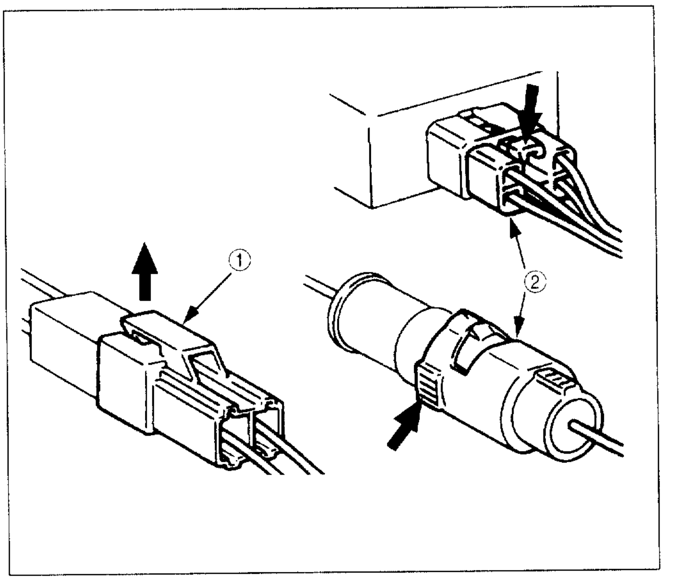
Some tang locks are released by pulling them towards you ①.

Other tang locks are released by pressing them forward ②.

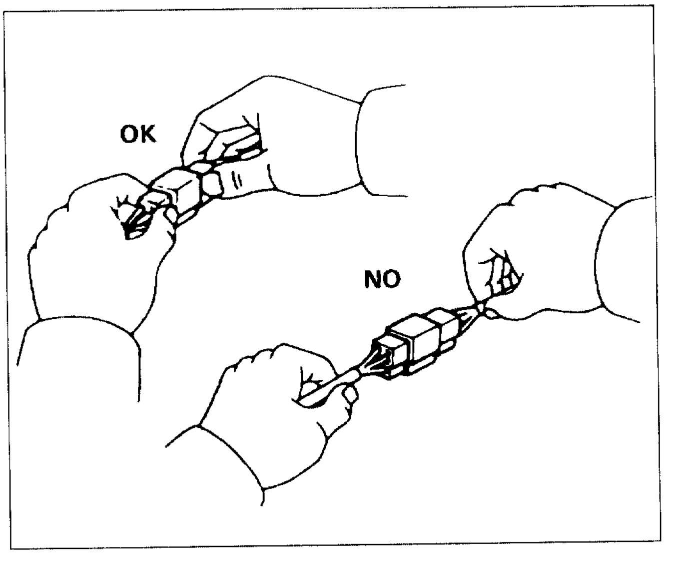
Determine which type of tang lock is on the connector being handled.

Firmly grasp both sides (male and female) of the connector.

Release the tang lock and carefully pull the two halves of the connector apart.

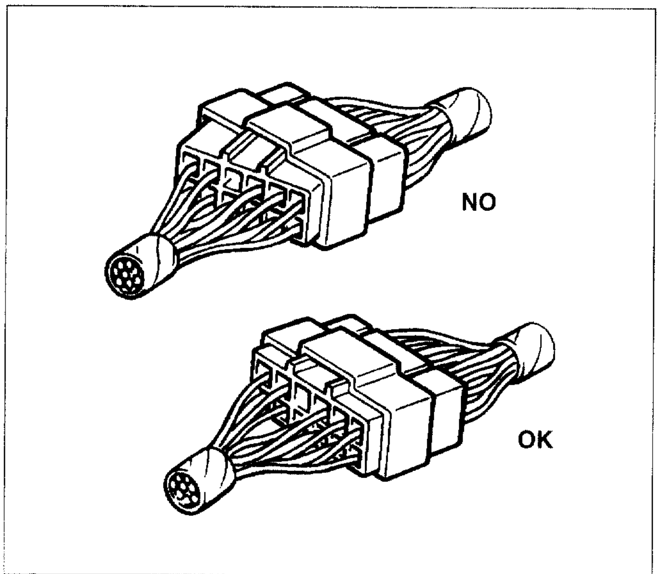


Never pull on the wires to separate the connectors. This will result in wire breakage.



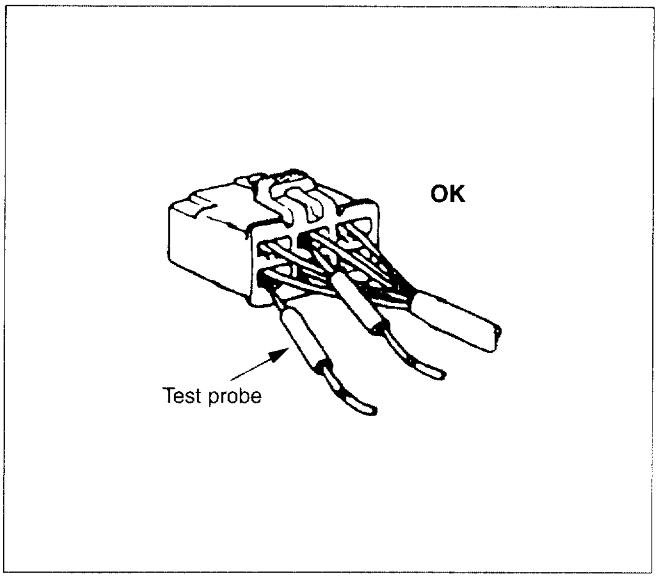
Connecting the Connector

Firmly grasp both sides (male and female) or the connector. Be sure that the connector pins and pin holes match. Be sure that both sides of the connector are aligned with each other. Firmly but carefully push the two sides of the connector together until a distinct click is heard.

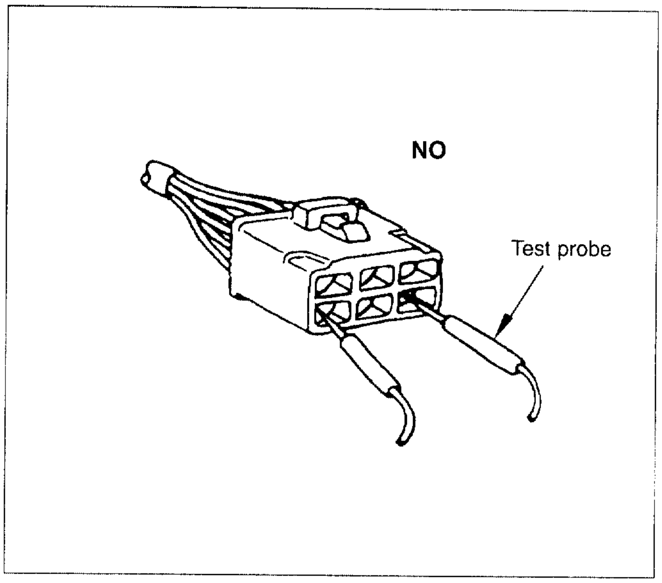


Connector Inspection

Use a circuit tester to check the connector for continuity. Insert the test probes from the connector wire side.

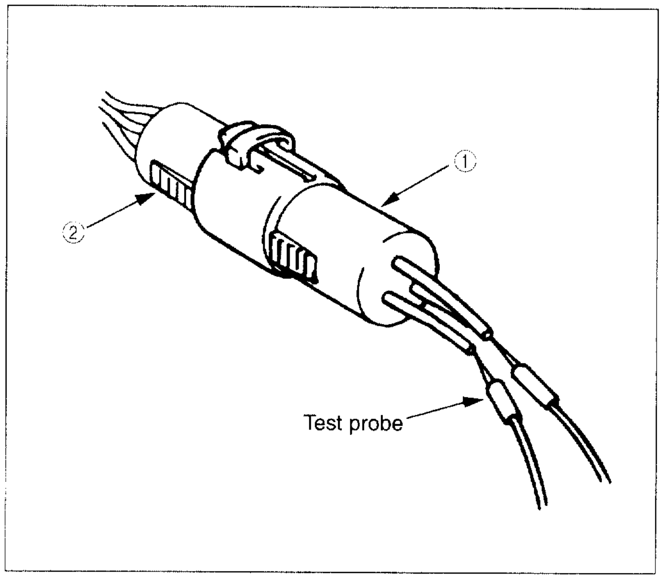


Never insert the circuit tester test probes into the connector open end to test the continuity. Broken or open connector terminals will result.



Waterproof Connector Inspection

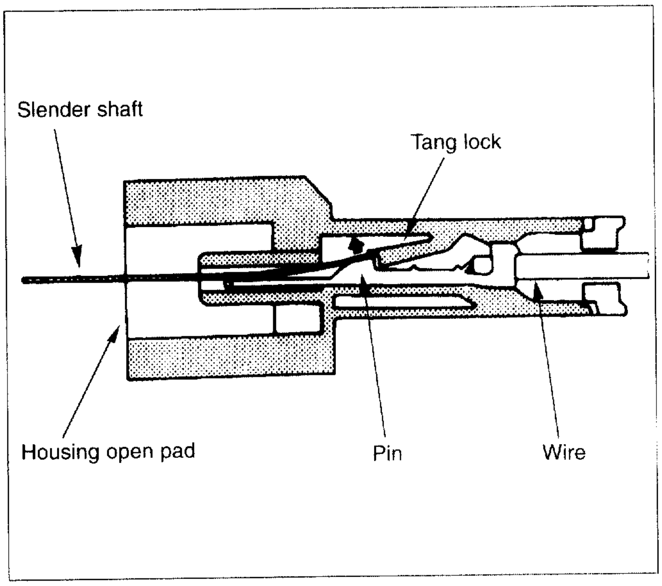
It is not possible to insert the test probes into the connector wire side of a waterproof connector. Prick the insulation on the wires with a straight pin. Connect the test probes to the straight pin to check for connector continuity. Use one side of a connector (1) with its wires cut to make the test. Connect the test connector (2) to the connector to be tested. Connect the test probes to the cut wires to check the connector continuity.



Connector Pin Removal

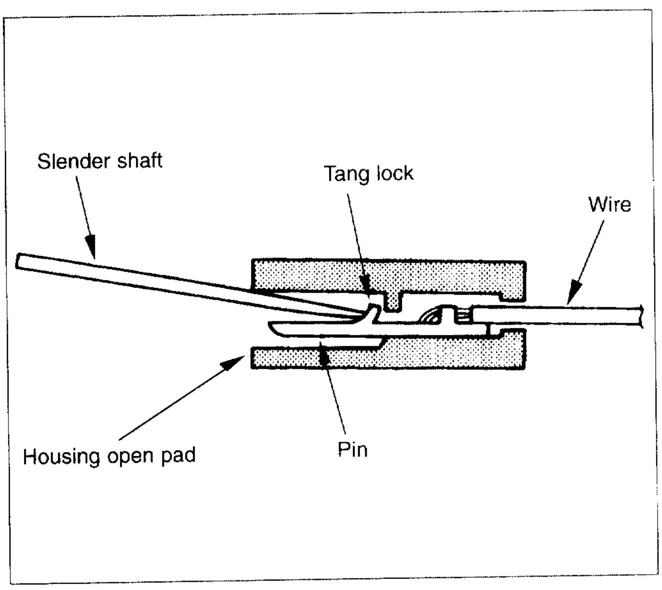
Connecting Housing Tang Lock Type

1) Insert a slender shaft into the connector housing open end.
2) Push the tang lock up (in the direction of the arrow in the illustration). Pull the wire with pin free from the wire side of the connector.



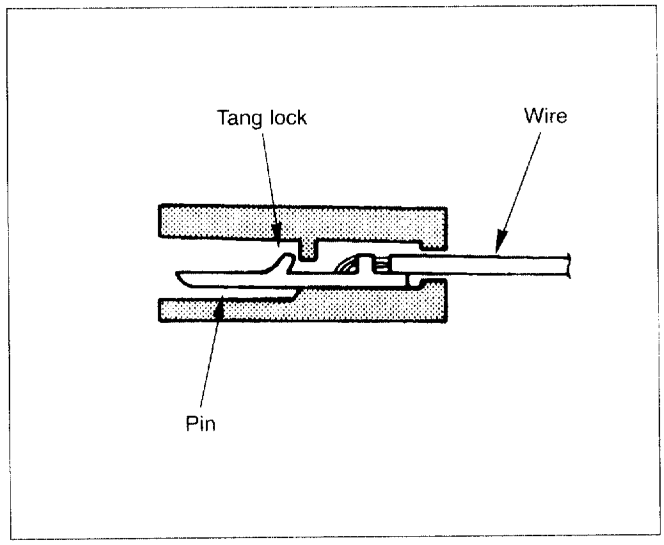
Pin Tang Lock Type

1) Insert a slender shaft into the Connector housing open end.
2) Push the tang lock flat (toward the wire side of the connector). Pull the wire with pin free from the wire side of the connector.



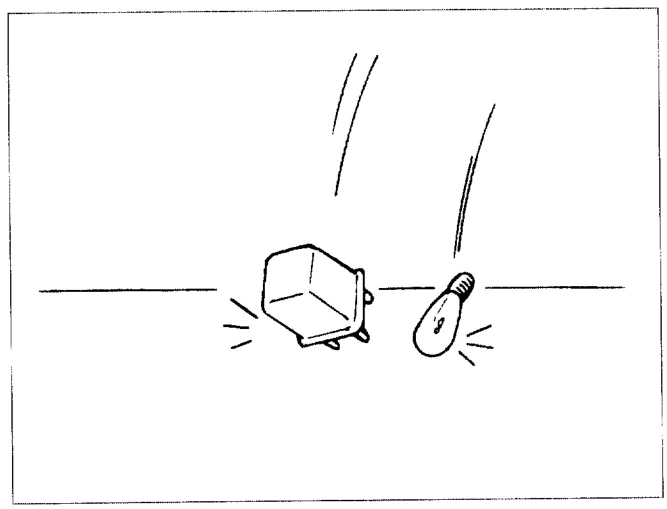
Connector Pin Insertion

1) Check that the tang lock is fully up.
2) Insert the pin from the connector wire side. Push the pin in until the tang lock closes firmly.
3) Gently pull on the wires to make sure that the connector pin is firmly set in place.



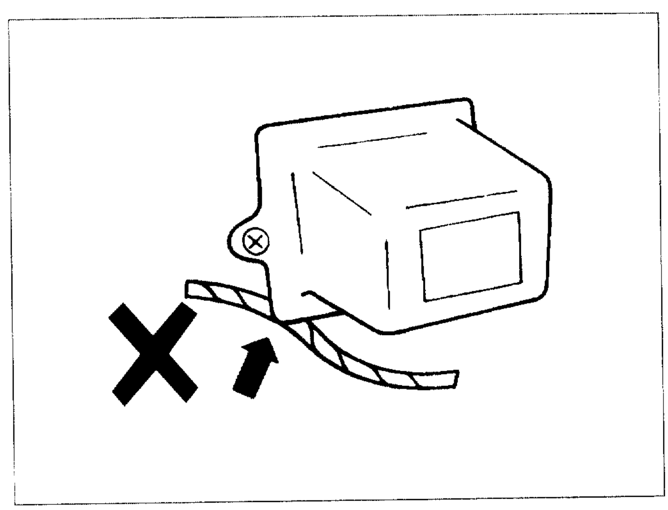
Parts Handling

Be careful when handling electrical parts. They should not be dropped or thrown, because short circuit or other damage may result.



Cable Harness

When installing the parts, be careful not to pinch or wedge the wiring harness.
All electrical connections must be kept clean and tight.



SPLICING WIRE

1. **Open the Harness**

   If the harness is taped, remove the tape. To avoid wire insulation damage, use a sewing "seam ripper" (available from sewing supply stores) to cut open the harness.

   If the harness has a block plastic conduit, simply pull out the desired wire.

2. **Cut the wire**

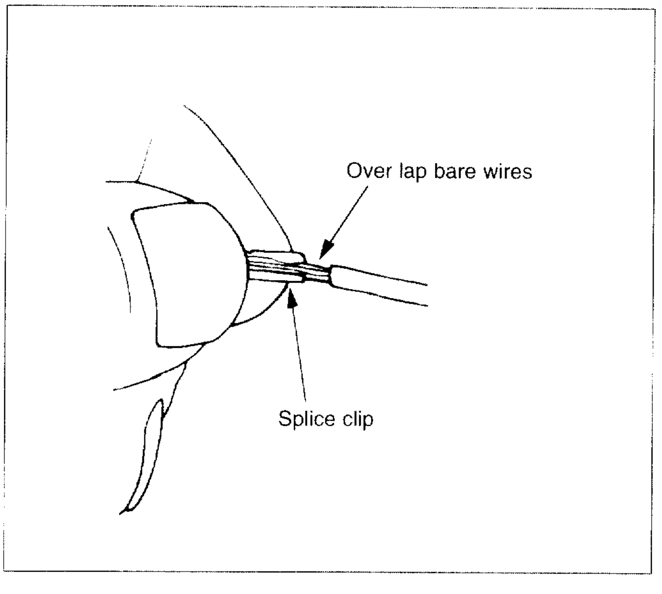
   Begin by cutting as little wire off the harness as possible. You may need the extra length of wire later if you decide to cut more wire off to change the location of a splice. You may have to adjust splice locations to make certain that each splice is at least 1-1/2 in (40 mm) away from other splices, harness branches, or connectors.

3. **Strip the insulation**

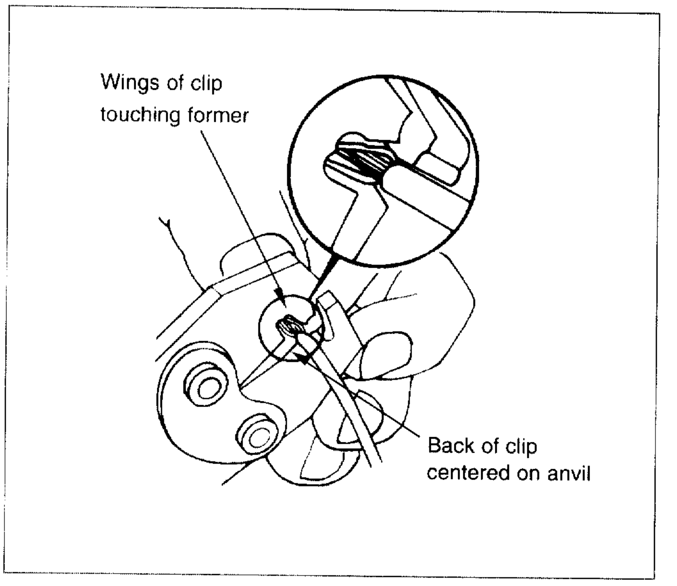
   When replacing a wire, use a wire of the same size as the original wire. Check the striped wire for nicks or cut stands. If the wire is damaged, repeat the procedure on a new section of wire. The two stripped wire ends should be equal in length.

4. **Crimp the Wires**

   Select the proper clip to secure the splice. To determine the proper clip size for the wire being spliced, follow the directions included with you clips. Select the correct anvil on the crimper. (On most crimpers your choice is limited to either a small or large anvil.) Overlap the two stripped wire ends and hold them between your thumb and forefinger. Then, center the splice clip under the stripped wires and hold it in place.



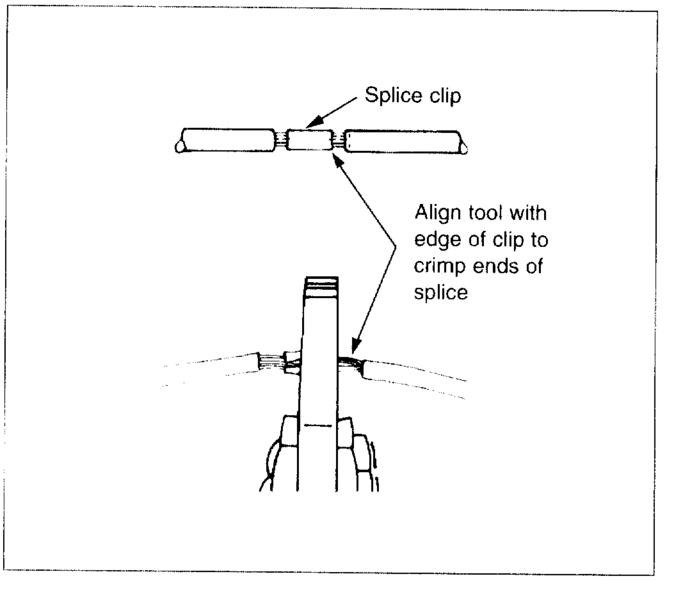
- Open the crimping tool to its full width and rest one handle on a firm flat surface.
- Center the back of the splice clip on the proper anvil and close the crimping tool to the point where the back of the splice clip touches the wings of the clip.
- Make sure that the clip and wires are still in the correct position. Then, apply steady pressure until the crimping tool closes.



Before crimping the ends of the clip, be sure that:

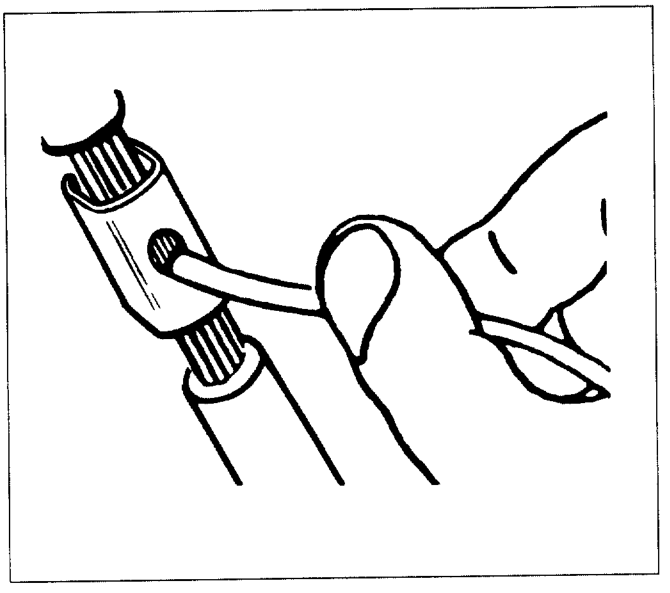
- The wires extend beyond the clip in each direction.
- No stands of wire are cut loose, and
- No insulation is caught under the clip.

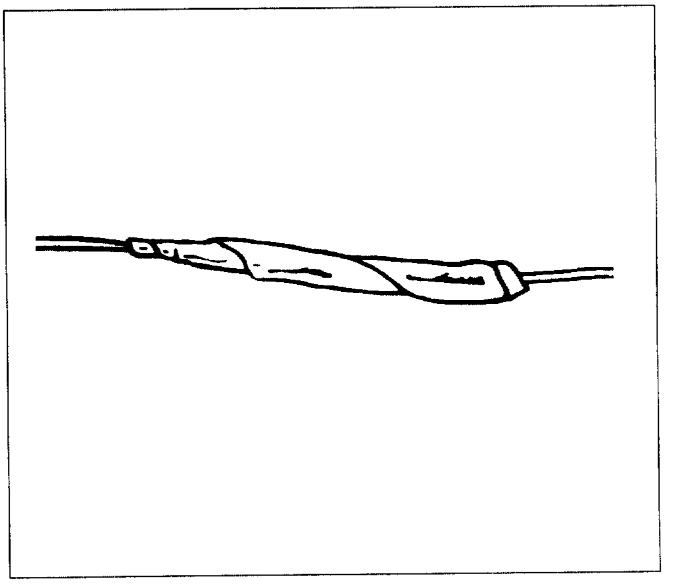
Crimp the splice again, once on each end. Do not let the crimping tool extend beyond the edge of the clip or you may damage or nick the wires.



5. **Solder**

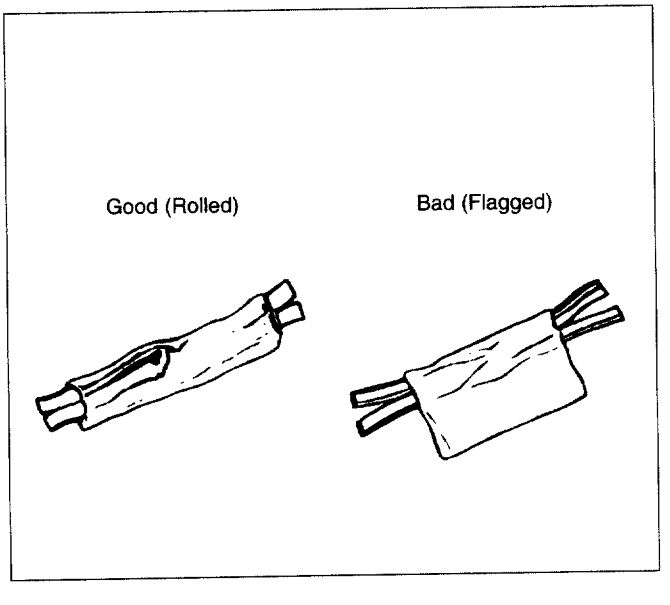
   Apply 60/40 rosin core colder to the opening in the back of the clip. Follow the manufacturer's instructions for the solder equipment you are using.





6. **Tape the Splice**

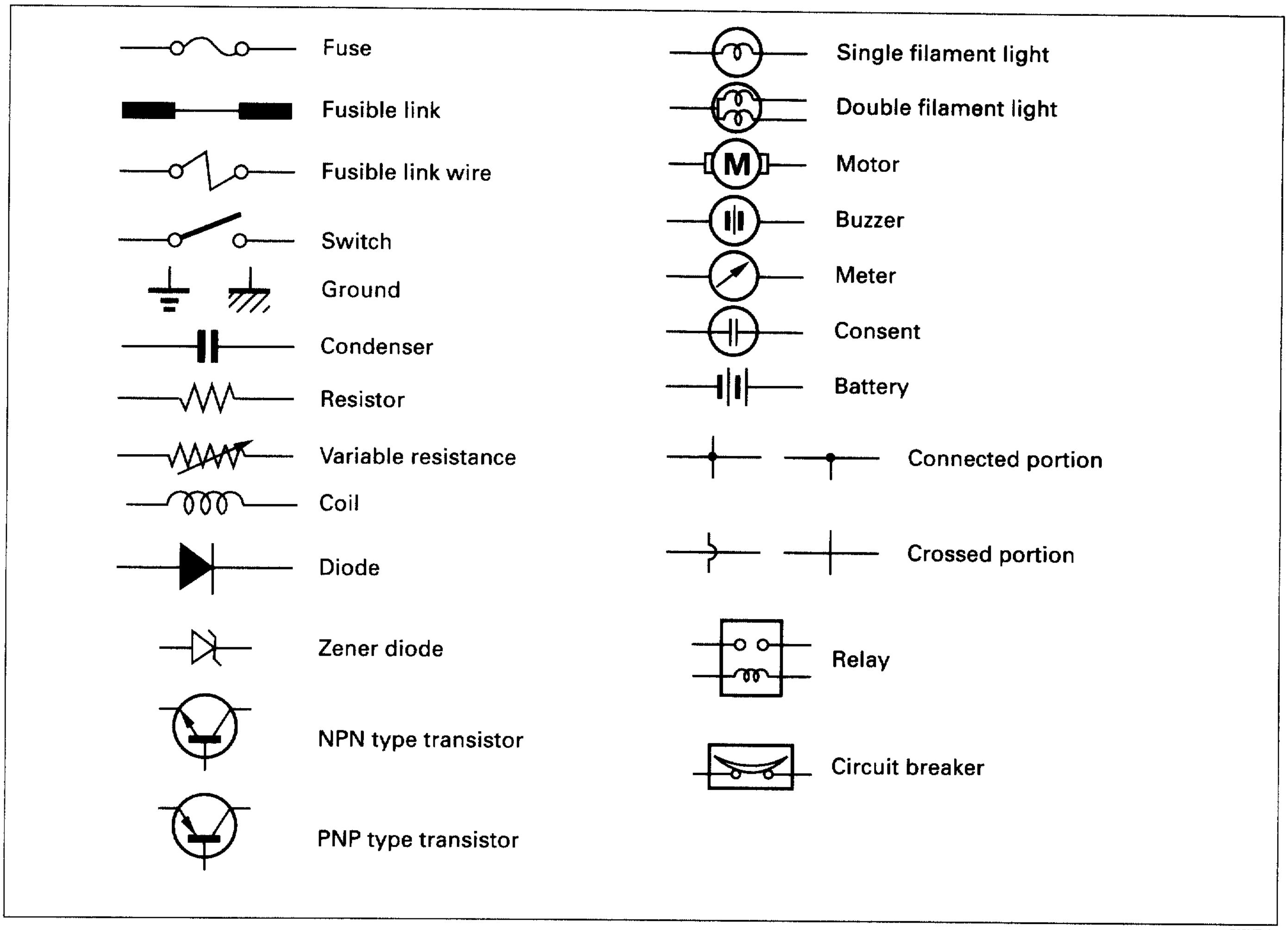
Center and roll the splicing tape. The tape should cover the entire splice. Roll on enough tape to duplicate the thickness of the insulation on the existing wires. Do not flag the tape. Flagged tape may not provide enough insulation, and the flagged ends will tangle with the other wires in the harness.



If the wire does not belong in a conduit or other harness covering, tape the wire again. Use a winding motion to cover the first piece of tape.

SYMBOLS AND ABBREVIATIONS

Symbols



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Abbreviations

ABBREVIATION	MEANING
A	ANALOG
AAT	AMBIENT AIR TEMPERATURE
A/C	AIR CONDITIONER
A/D	ANALOG/DIGITAL
ACT	ACTUATOR
APP	ACCELERATOR PEDAL POSITION
A/T	AUTOMATIC TRANSMISSION
BARO	ATMOSPHERIC PRESSURE
BATT	BATTERY
CAM	PUMP POSITION/CAM POSITION
CKP	CRANKSHAFT POSITION
CONN	CONNECTOR
CSS	COMBINED CHARGING SYSTEM
C/U	CONTROL UNIT
D	DIGITAL
DC	DIRECT CURRENT
D/CONN	DIAGNOSIS CONNECTOR
DTC	DIAGNOSTIC TROUBLE CODE
EC	ELECTRICAL CONTROL GOVERNOR
ECM	ENGINE CONTROL MODULE
ECT	ENGINE COOLANT TEMPERATURE
EH	ELECTRICAL AND HYDRAULIC TIMER
EXH	EXHAUST
FCCB	FUEL CONSUMPTION OF CYLINDER BALANCE
FRT	FRONT
FT	FUEL TEMPERATURE
GND	GROUND (BODY EARTH)
IN	INLET, INTAKE
ISC	IDLE SPEED CONTROL
LH	LEFT HAND (SIDE)
LHD	LEFT HAND DRIVE
MAG	MAGNETIC
ME/CONN	MEMORY ERASER CONNECTOR
MIL	MALFUNCTION INDICATOR LAMP
M/V	MAGNETIC VALVE
N	NEUTRAL (TRANSMISSION GEAR)
N-TDC	NUMBERS TOP DEAD CENTER
NR	NOISE REDUCER

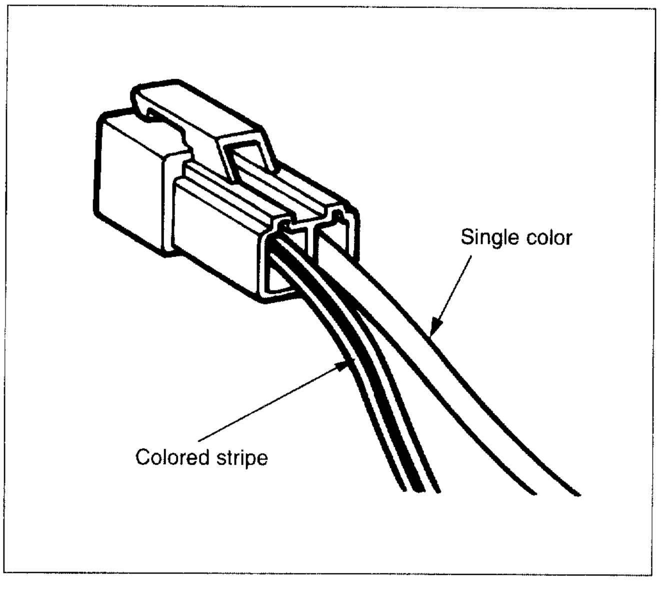
ABBREVIATION	MEANING
OFF	TURN OFF (SWITCH/LAMP)
ON	TURN ON (SWITCH/LAMP)
OPT	OPTION
P BOOST	BOOST PRESSURE
P/BRAKE	PARKING BRAKE
PC SENSOR	COMMON RAIL PRESSURE SENSOR
PCV	PRESSURE CONTROL VALVE
PGND	POWER GROUND (TO BODY EARTH)
PIN	PIN or TERMINAL
P/L	PRESSURE LIMITER
PRESS	PRESSURE
P/T	POWER TRAIN
Q ADJUSTMENT	INJECTION QUANTITY ADJUSTMENT
RH	RIGHT HAND (SIDE)
RHD	RIGHT HAND DRIVE
R/L	RELAY
RR	REAR
SIG	SIGNAL
SS	SPEED SENSOR
SS C/U	SPEED SENSOR CONTROL UNIT
STA	STARTER
STD	STANDARD
SW	SWITCH
THA	AMBIENT AIR TEMPERATURE
THF	FUEL TEMPERATURE
TICS	TIMING AND INJECTION RATE CONTROL SYSTEM
TWV	INJECTOR (TWO WAY VALVE)
VCC	POWER SOURCE
W/G	WASTEGATE
W/L	WARNING LAMP

PARTS FOR ELECTRICAL CIRCUIT

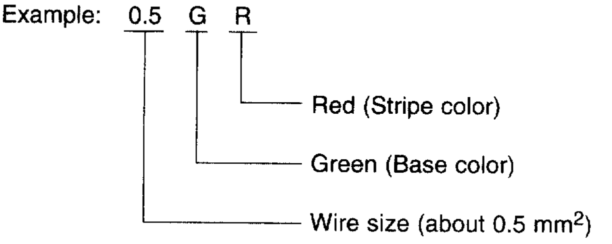
Wiring

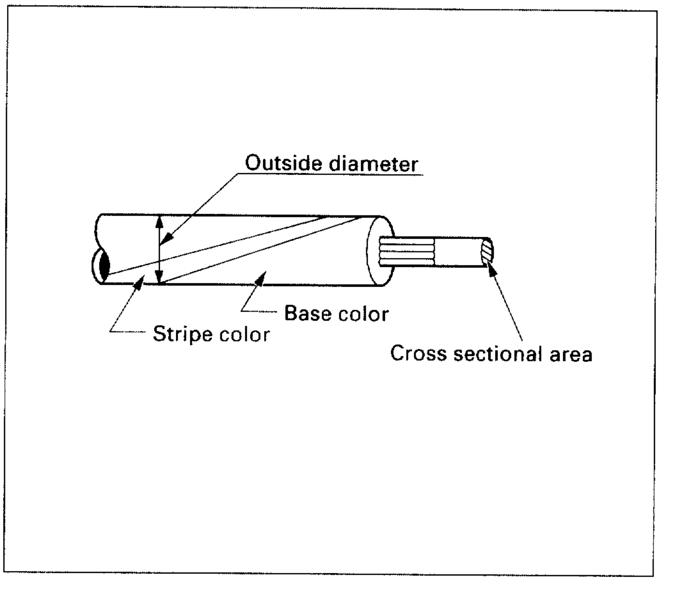
Wire Color

All wires have color-coded insulation.



Wires belonging to a system's main harness will have a single color. Wires belonging to a system's sub circuits will have a colored stripe. Striped wires use the following code to show wire size and colors.





Abbreviations are used to indicate wire color within a circuit diagram.
Refer to the following table.

Wire Color Coding

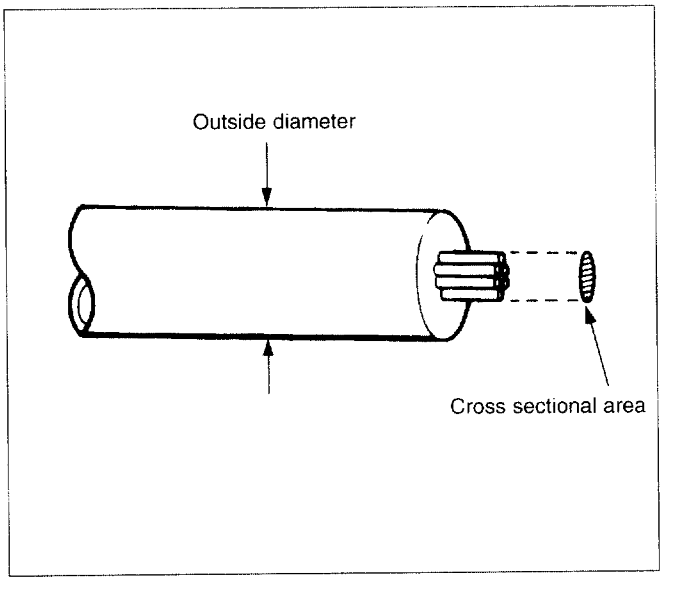
Color-coding	Meaning	Color-coding	Meaning
B	Black	Br	Brown
W	White	Lg	Light green
R	Red	Gr	Gray
G	Green	P	Pink
Y	Yellow	Sb	Sky blue
L	Blue	V	Violet
O	Orange	—	—

Stripe Color Coding

Color coding	Base color	Stripe color
LB	Blue	Black
OB	Orange	Black
PB	Pink	Black
PG	Pink	Green
PL	Pink	Blue
RY	Red	Yellow
VR	Violet	Red
VW	Violet	White
YB	Yellow	Black
YB	Yellow	Green
YV	Yellow	Violet

Wire Size

The size of wire, used in a circuit is determined by the amount of current (amperage), the length of the circuit, and the voltage drop allowed. The following wire size and load capacity, shown below, are specified by SAE.



Nominal size	Cross sectional area (mm^2)	Outside diameter (mm)	Allowable current (A)
0.3	0.372	1.8	9
0.5	0.563	2.0	12
0.85	0.885	2.2	16
1.25	1.287	2.5	21
2	2.091	2.9	28
3	3.296	3.6	37.5
5	5.227	4.4	53
8	7.952	5.5	67
15	13.36	7.0	75
20	20.61	8.2	97

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 information (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 history DTCs, 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 tool, such as the Tech II 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.

General Service Information

OBD Serviceability Issues

The list of non-vehicle faults that could affect the performance of the OBD system has been compiled. These non-vehicle faults vary from environmental conditions to the quality of fuel used.

The illumination of the MIL ("Check Engine Soon" lamp) due to a non-vehicle fault could lead to misdiagnosis of the vehicle, increased warranty expense and customer dissatisfaction. The following list of non-vehicle faults does not include every possible fault and may not apply equally to all product lines.

Poor Vehicle Maintenance

The sensitivity of OBD diagnostics will cause the MIL 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 that were not previously monitored prior to OBD. 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.

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:

- Inspection all vacuum hoses for punches, cuts, disconnects, and correct routing.
- Inspect hoses that are difficult to see behind other components.

- Inspect all wires in e 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

NOTE: 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.

On-Board Diagnostic (OBD)

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

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.

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 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 following:

- Commanding the MIL ("Check Engine Soon" lamp) on and off
- DTC logging and clearing
- Current status information on each diagnostic
- System Status

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 complemented 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) is illuminated.

Malfunction Indicator Lamp (MIL)

The Malfunction Indicator Lamp (MIL) looks the same as the MIL you are already familiar with ("Check Engine Soon" lamp). However, OBD requires that the it illuminate under a strict set of guide lines.

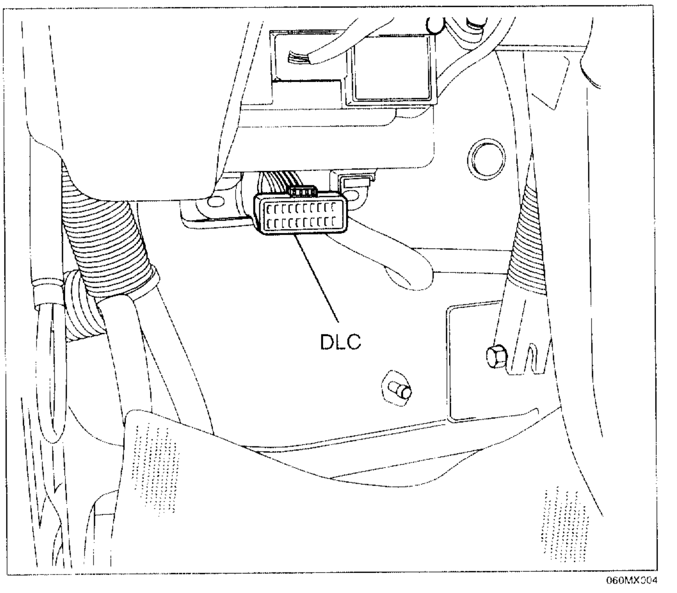
Basically, the MIL is turned on when the ECM detects a DTC that will impact the vehicle emissions and performance.

Extinguishing the MIL

Connect the memory clear switch one to two second then disconnect the memory clear switch.

Data Link Connector (DLC)

The provision for communication 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.



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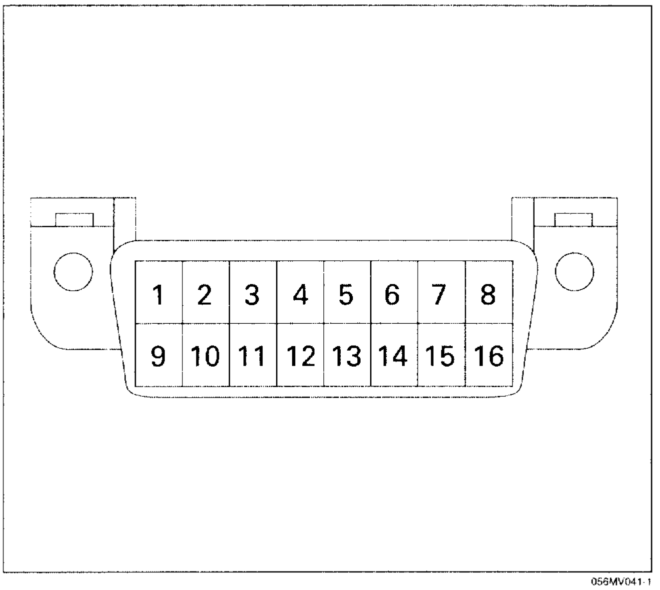
The DLC is used to connect to a scan tool. Some common uses of the scan tool are listed below:

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



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Decimal/Binary/Hexadecimal Conversions

All scan tool manufacturer will display a variety of vehicle information which will aid in repairing the vehicle. Some scan tools will display encoded messages which will aid in determining the nature of the concern. The method of encoding involves the use of a two additional numbering systems: Binary and Hexadecimal.

The binary number system has a base of two numbers. Each digit is either a 0 or a 1. A binary number is an eight digit number and is read from right to left. Each digit has a position number with the farthest right being the 0 position and the farthest left being the 7 position. The 0 position, when displayed by a 1, indicates 1 in decimal. Each position to the left is double the previous position and added to any other position values marked as a 1.

A hexadecimal system is composed of 16 different alpha numeric characters. The alpha numeric characters used are numbers 0 through 9 and letters A through F. The hexadecimal system is the most natural and common approach for scan tool manufacturers to display data represented by binary numbers and digital code.

Verifying Vehicle Repair

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

1. Review and record the Fail Records for the DTC which has been diagnosed.
2. Clear DTC(s).
3. Operate the vehicle within conditions noted in the Fail Records.
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 Tech 2 or Other Scan Tool

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

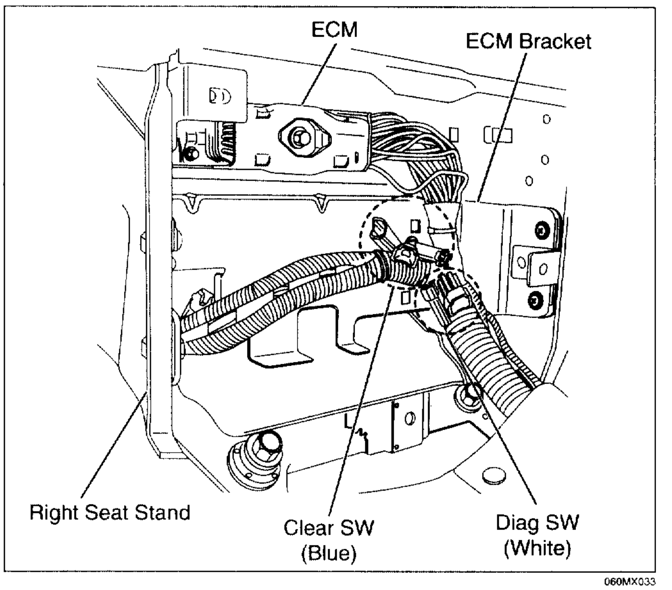
Clearing Diagnostic Trouble Codes

IMPORTANT: Do not clear DTCs unless directed to do so by the service information provided for each diagnostic procedure. When DTCs are cleared, the Failure Record data which may help diagnose an intermittent fault will also be erased from memory.

To clear Diagnostic Trouble Codes (DTCs), use the diagnostic scan tool "clear DTC 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 connect the memory clear switch one to two second then disconnect the memory clear switch.

Vehicle Type: FRR



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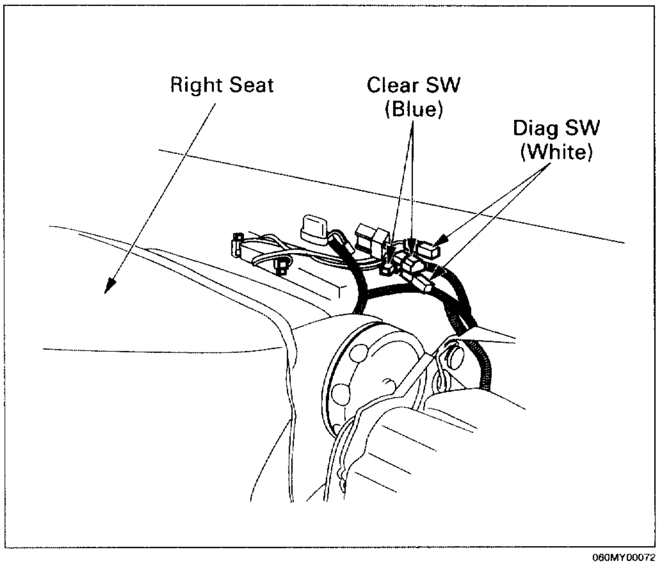
Vehicle Type: FSR, FTR, FVR



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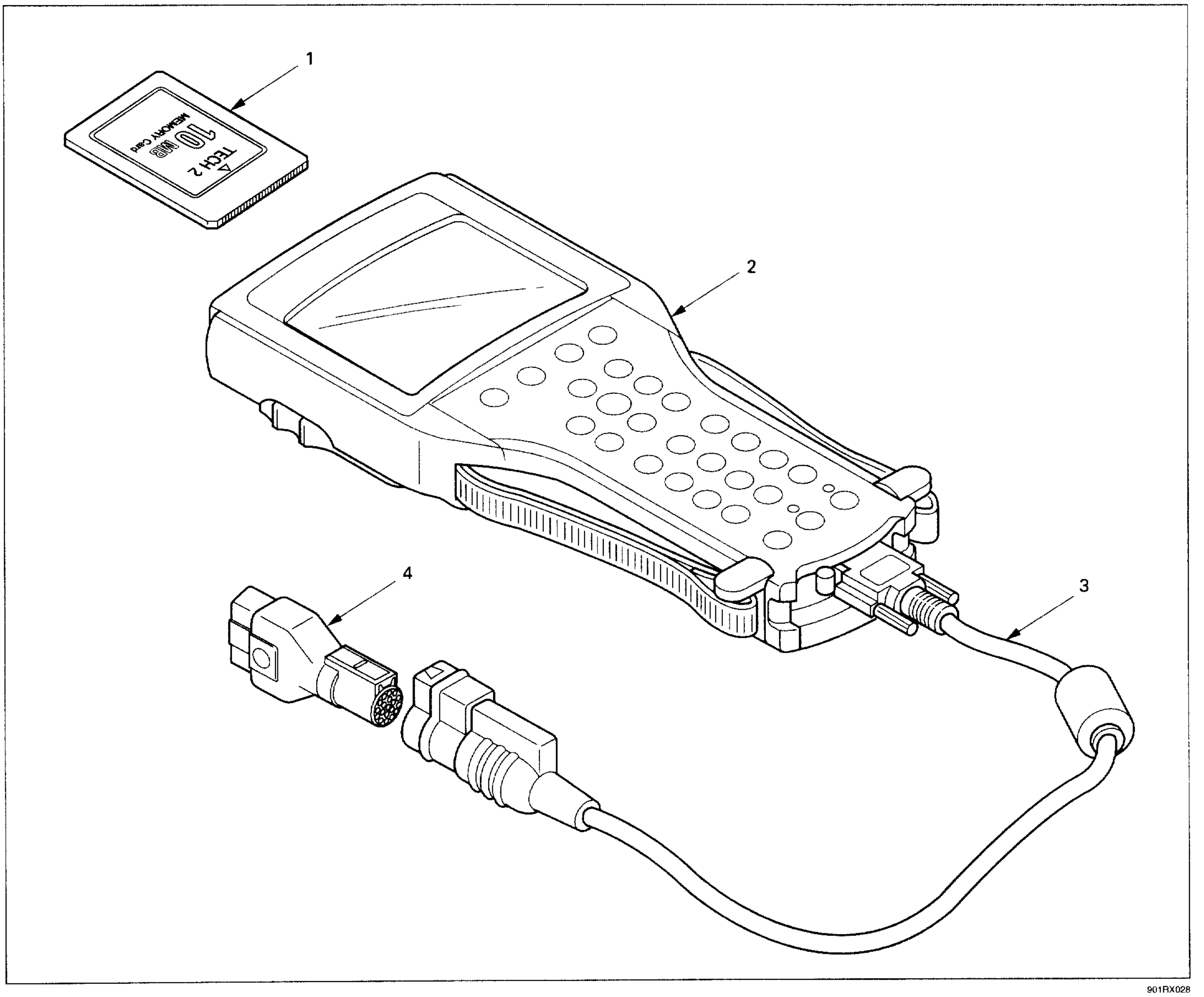
Tech 2 Scan Tool

From 98 MY, Isuzu Dealer service departments are recommended to use Tech 2. Refer to Tech 2 scan tool user guide.



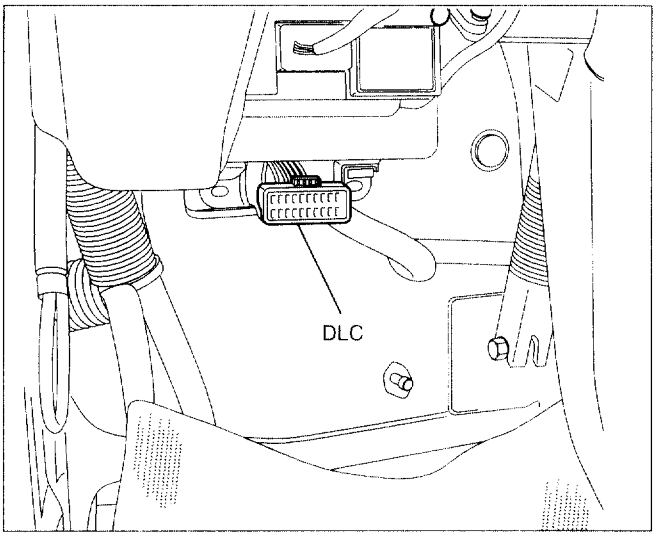
Legend
(1) PCMCIA Card
(2) Tech-2
(3) DLC Cable
(4) SAE 16/19 Adapter

Tech 2 Features

1 Tech 2 is a 12 volt system. Do not apply 24 volt.
2. After connecting and/or installing, the Vehicle Communications Interface (VCI) module, PCMCIA card and DLC connector to the Tech 2, connect the tool to the vehicle DLC.
3. Make sure the Tech 2 is powered OFF when removing or installing the PCMCIA card.
4. The PCMCIA card has a capacity of 10 Megabytes which is 10 times greater than the memory of the Tech 1 Mass Storage Cartridge.
5. The Tech 2 has the capability of two snapshots.
6. The PCMCIA card is sensitive to magnetism and static electricity, so care should be taken in the handling of the card.
7. The Tech 2 can plot a graph when replaying a snapshot.
8. Always return to the Main Menu by pressing the EXIT key several times before shutting down.
9. To clear Diagnostic Trouble Codes (DTCs), open Application Menu and press “F1: Clear DTC Info”.

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 (2).
  2. Connect the SAE 16/19 adapter (4) to the DLC cable (3).
  3. Connect the DLC cable to the Tech 2 (2).
  4. Make sure the vehicle starter key is off.
  5. Connect the Tech 2 SAE 16/19 adapter to the vehicle DLC.



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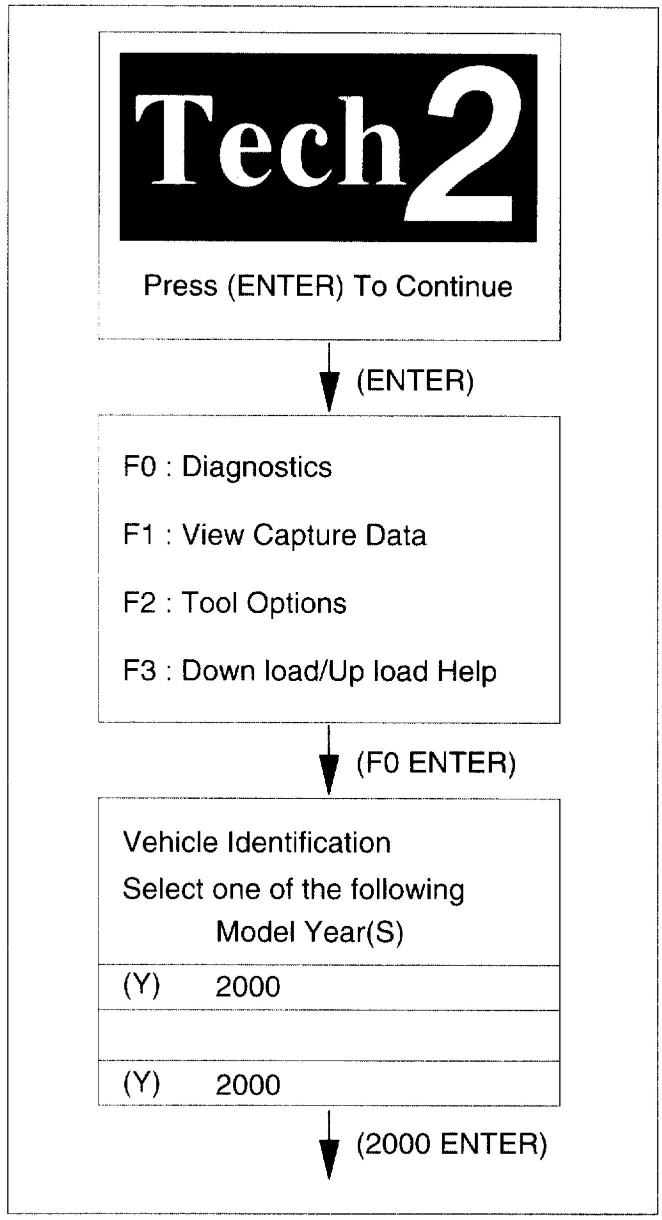
6. The vehicle starter switch turns on.
7. Verify the Tech 2 power up display.

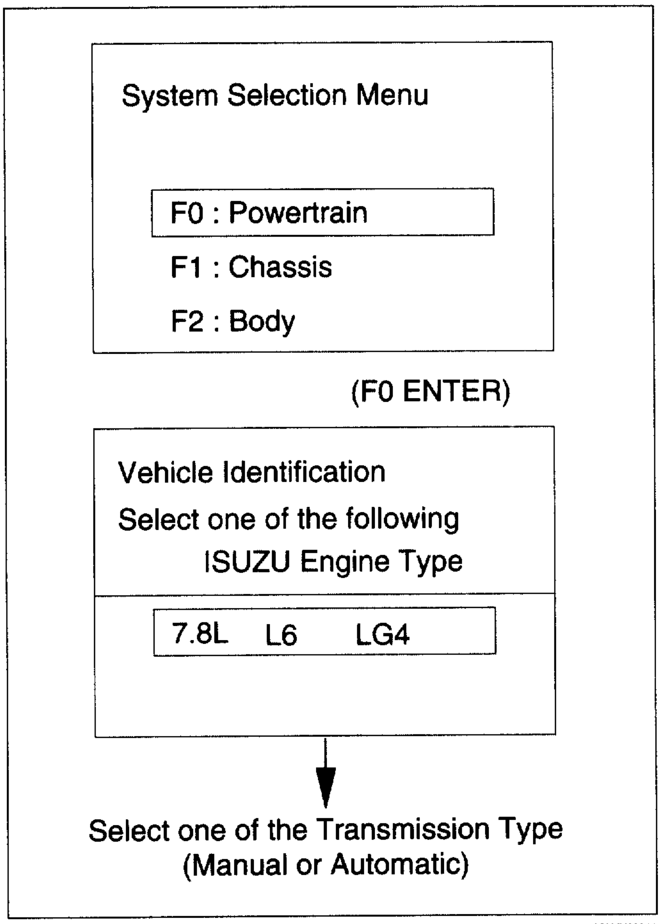
012RW105

Operating Procedure (For example)

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



060RY027



060MY00044

Menu

- The following table shows, which functions are used the available equipment versions.

F0: Diagnostic Trouble Codes F0: DTC Information F0: Engine F1: History F1: Clear DTC Information
F1: Data Display F0: Engine Data 1 F1: Engine Data 2 F2: Engine Data 3 F3: Engine Data 4 F4: Engine Data 5 F5: Engine Data 6
F2: Special Functions F0: Engine Output Controls F1: Fuel System F2: Capture & Restore Fuel Rate Data
F3: Snapshot
F4: ID Information

DTC

On OBD has two options available in the Tech 2 DTC mode to display the enhanced information available. A description of the new modes, DTC Info and Clear DTC Information. After selecting DTC, the following menu appears:

- DTC Info
- Clear DTC Information

DTC Information Mode

Use the DTC info mode to search for store DTC information. There are two choices. The service manual may instruct the technician to test for DTCs in a certain manner. Always follow published service procedures.

To get a complete description of any status, press the "Enter" key before pressing the desired F-key. For example, pressing "Enter" then an F-key will display a definition of the abbreviated scan tool status.

Engine

This selection will display all DTCs that have failed during the present ignition cycle.

History

This selection will display only DTCs that are stored in the ECM's history memory. It will not display Type B DTCs that have not requested the MIL. It will display all type A DTCs that have requested the MIL and have failed within the last 40 warm-up cycles.

Clear DTC Information

To clear Diagnostic Trouble Codes (DTCs), use the diagnostic scan tool "clear DTC information" function.

Tech2 Data Display

Use the Tech 2 Data Values 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. Tech 2 values from a properly-running engine may be used for comparison with the engine you are diagnosing. The Tech 2 data values represent values that would be seen on a normally-running engine.

Engine Data 1

(For example)

F0; ENGINE DATA 1

Engine Speed	610~620	RPM
APP Angle	0	%
Boost Pressure	0	Kpa
BARO	100	Kpa
ECT	176	°F
Ambient Air Temperature	60	°F
Fuel Temperature	113	°F
Battery Voltage	14.5	Volts

Select Items | DTC | Quick Snapshot | More

060MY00053

Engine Data 2

(For example)

F1; ENGINE DATA 2

Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
APP Angle	0	%
ECT	176	°F
Fuel Temperature	113	°F
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	25.0	Mpa
Main Injection Timing	–1.5	°
Basic Fuel Rate	1.1	mm^3
Final Fuel Rate	5.0	mm^3
PCV Close Intrerval	178	°
Battery Voltage	14.5	Volts
Exhaust Brake Switch		OFF
Engine Stop Switch		OFF
Diagnostic Switch		OFF
Clutch Switch		OFF
Starter Switch		OFF

Select Items | DTC | Quick Snapshot | More

060MY00054

Engine Data 3

(For example)

F2; ENGINE DATA 3

Engine Speed	610~620	RPM
Actual Rail Pressure	25.0	Kpa
Basic Fuel Rate	1.1	mm^3
Final Fuel Rate	5.0	mm^3
Fuel Rate at Start	0	mm^3
Fuel Rate at Maximum Speed	249.6	mm^3
Fuel Rate Correction	3	mm^3
ISC Fuel Rate Correction	7	mm^3
ISC Fuel Rate Proportion	0	mm^3
ISC Fuel Rate Intergral	4	mm^3
Sprit Fuel Rate	20	mm^3
Balancing Rate Cylinder 1	0	mm^3
Balancing Rate Cylinder 2	0	mm^3
Balancing Rate Cylinder 3	0	mm^3
Balancing Rate Cylinder 4	0	mm^3
Balancing Rate Cylinder 5	0	mm^3
Balancing Rate Cylinder 6	0	mm^3
Injection Control Mode		Normal Control

Select Items | DTC | Quick Snapshot | More

060MY00055

Engine Data 4

(For example)

F3; ENGINE DATA 4

Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
APP Angle	0	%
ECT	176	°F
Main Injection Timing	–1.5	°
Fuel Temperature	113	°F
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	25.0	Mpa
PCV ON Time	4.38	ms
Flow Limiter 1	0	
Flow Limiter 2	0	
Flow Limiter 3	0	
Flow Limiter 4	0	
Flow Limiter 5	0	
Flow Limiter 6	0	
Pump Control Mode		Normal Control
Injection Control Mode		Normal Control

Select Items | DTC | Quick Snapshot | More

060MY00054

Engine Data 5

(For example)

F4; ENGINE DATA 5

Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
ECT	176	°F
APP Angle	0	%
APP sensor	1.34	Volts
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	25.5	Mpa
Main Injection Timing	–1.5	°
PCV ON Time	4.38	ms
PCV Close Interval	177.5	°
Basic PCV ON Time	188.5	°
Battery Voltage	14.5	Volts
Fuel Temperature	113	°F
Maximum Fuel Temperature	180	°F
Injection Control Mode		Normal Control
Pump Control Mode		Normal Control
Overheat Number of Time	0	
Over Speed Number of Time	0	

Select Items | DTC | Quick Snapshot | More

060MY00057

Engine Data 6

(For example)

F5; ENGINE DATA 6

APP Angle	0	%
Engine Speed	610~620	RPM
Actual Rail Pressure	25.0	Mpa
Fuel Temperature	113	°F
Main Injection Timing	–1.5	°
Main Injection Intreval	0.7	ms
Pilot Injection Intreval	0.55	ms
Split Injection Intreval	0.72	ms
End of Split Injection	650	RPM
PC Valve On Time	4.38	ms
PC Valve Feed back	–7.3	°
PC Valve On Time Length	102.3	°
PC Valve Delay Time	3.3	ms
Crank Signal Present	Yes	
Injection Pump Signal Present	Yes	
Cylinder Balance Mode	Yes	
Engine Start Mode	No	
Engine Running	Yes	

Select Items | DTC | Quick Snapshot | More

060MY00058

Special Functions

This special functions of three menus:

Special Functions

F0 : Engine Output Controls

F1 : Fuel System

F2 : Capture & Restore Fuel Rate Data

060MX025

Engine Output Controls

This engine output controls of two menus:

Special Functions

F0 : Engine Output Controls

F1 : Fuel System

F2 : Capture & Restore Fuel Rate Data

060MX027

Engine Output Controls

F0 : Exhaust Brake Control

F1 : Reset Counters

060MX026

F0: Exhaust Brake Control

This test is conducted to check Exhaust Brake SW for proper operation.

Exhaust Brake Control

Commanded State : None

Engine Data 2

Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
APP Angle	0	%
ECT	176	°F
Fuel Temperature	113	°F
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	25.0	Mpa
Main Injection Timing	—1.5	°
Basic Fuel Rate	1.1	mm^3
Final Fuel Rate	5.0	mm^3
PCV Close Intrerval	178	°
Battery Voltage	14.5	Volts
Exhaust Brake Switch		OFF
Engine Stop Switch		OFF
Diagnostic Switch		OFF
Clutch Switch		OFF
Starter Switch		OFF

Select Items | DTC | Quick Snapshot | More

060MY00059

F1: Reset Counters

Reset Counters

ENGINE DATA 5

Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
ECT	176	°F
APP Angle	0	%
APP sensor	1.34	Volts
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	180	Mpa
Main Injection Timing	1.5	
PCV ON Time	4.38	ms
PCV Close Interval	177.5	°
Basic PCV ON Time	188.5	°
Battery Voltage	14.5	Volts
Fuel Temperature	113	°F
Maximum Fuel Temperature	180	°F
Injection Control Mode		Normal Control
Pump Control Mode		Normal Control
Overheat Number of Time	0	
Over Speed Number of Time	0	

Select Items | DTC | Quick Snapshot | More

060MY00060

Fuel System Test

Special Functions

F0 : Engine Output Controls

F1 : Fuel System

F2 : Capture & Restore Fuel Rate Data

060MX028

This test consists of six menus -

Cylinder Power Balance
RPM Control
Pilot Injector Stop
Fuel Pressure Control
Injection Timing
Injection Stop

In these tests, Tech 2 sends operating signals to the systems to confirm their operations thereby to judge the normality of electric circuit.

To judge intermittent trouble,

Fuel System

F0 : Cylinder Power Balance

F1 : RPM Control

F2 : Pilot Injector Stop

F3 : Fuel Pressure Control

F4 : Injection Timing

F5 : Injection Stop

060MX010

Cylinder Power Balance Test

Tech 2 must be used for this test.

Test Procedure:

1. Connect Tech 2 to the vehicle DLC.
2. Run the Engine at idle.
3. Select F1: Fuel System in the Application Menu.

Special Functions

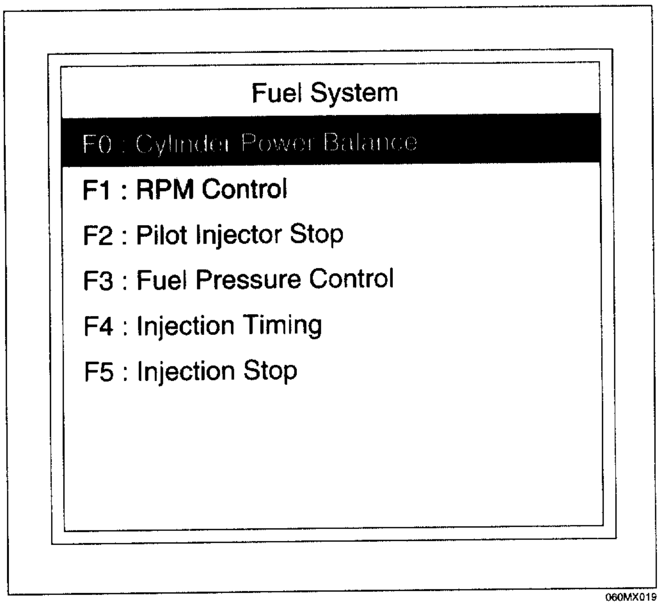
F0 : Engine Output Controls

F1 : Fuel System

F2 : Capture & Restore Fuel Rate Data

060MX028

4. Select F0: Cylinder Power Balance Test in the Fuel System.



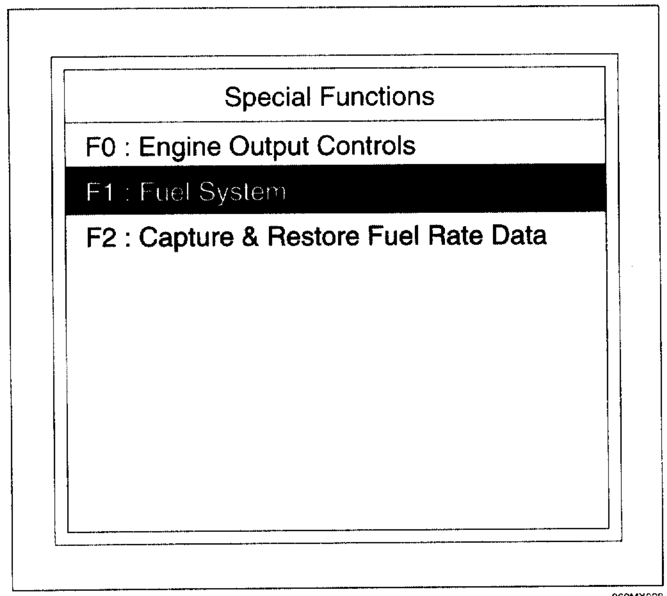
060MX019

RPM Control System Test

Tech 2 must be used for this test.

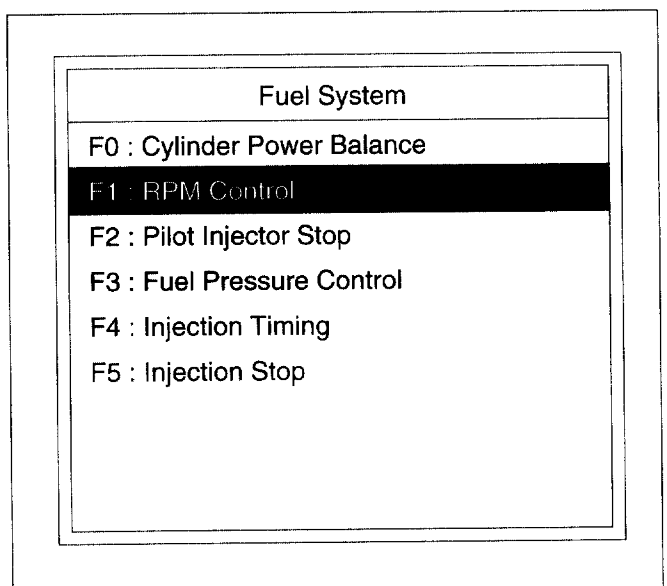
Test Procedure:

1. Connect Tech 2 to the vehicle DLC.
2. Run the Engine at idle.
3. Select F1: Fuel System in the Application Menu.



060MX028

4. Select F1: RPM Control Test in the Fuel System.



060MX020

Pilot Injector Stop Test

This test is conducted to check Pilot Injector operation for proper operation.

Tech 2 must be used for this test.

Test Procedure:

1. Connect Tech 2 to the vehicle DLC.
2. Run the Engine at idle.
3. Select F1: Fuel System in the Application Menu.

Special Functions

F0 : Engine Output Controls

F1 : Fuel System

F2 : Capture & Restore Fuel Rate Data

020MX028

4. Select F2: Pilot Injector Stop in the Fuel system.

Fuel System

F0 : Cylinder Power Balance

F1 : RPM Control

F2 : Pilot Injector Stop

F3 : Fuel Pressure Control

F4 : Injection Timing

F5 : Injection Stop

060MX018

5. Push "Stop" soft key.

Pilot Injector Stop

Commanded State : None

Engine Data 3

Engine Speed	610 620	RPM
Actual Rail Pressure	25.0	Kpa
Basic Fuel Rate	1.1	mm^3
Final Fuel Rate	5.0	mm^3
Fuel Rate at Start	0	mm^3
Fuel Rate at Maximum Speed	249.6	mm^3
Fuel Rate Correction	3	mm^3
ISC Fuel Rate Correction	7	mm^3
ISC Fuel Rate Proportion	0	mm^3
ISC Fuel Rate Intergral	4	mm^3
Sprit Fuel Rate	20	mm^3
Balancing Rate Cylinder 1	0	mm^3
Balancing Rate Cylinder 2	0	mm^3
Balancing Rate Cylinder 3	0	mm^3
Balancing Rate Cylinder 4	0	mm^3
Balancing Rate Cylinder 5	0	mm^3
Balancing Rate Cylinder 6	0	mm^3
Injection Control Mode		Normal Control

Select Items | Stop | Quick Snapshot | More

060MY00061

6. If the engine R.P.M. changes, the Pilot Injector is normal.

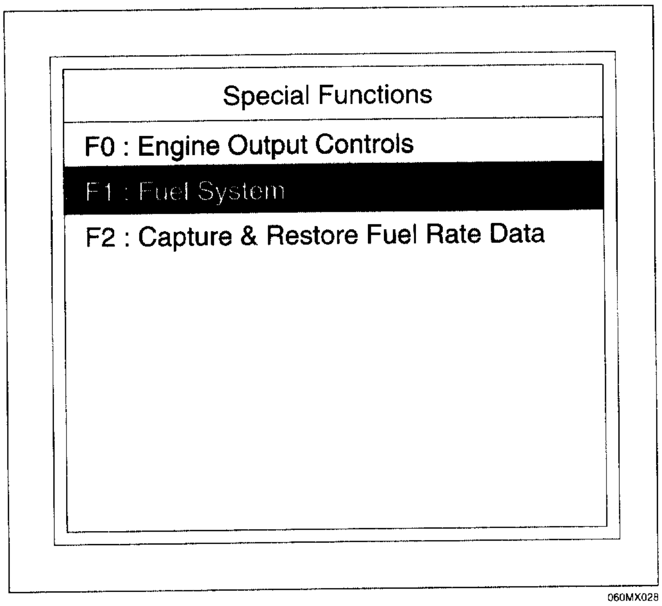
Fuel Pressure Control Test

This test is conducted to check Fuel Pressure Control system for its working.

Tech 2 must be used for this test.

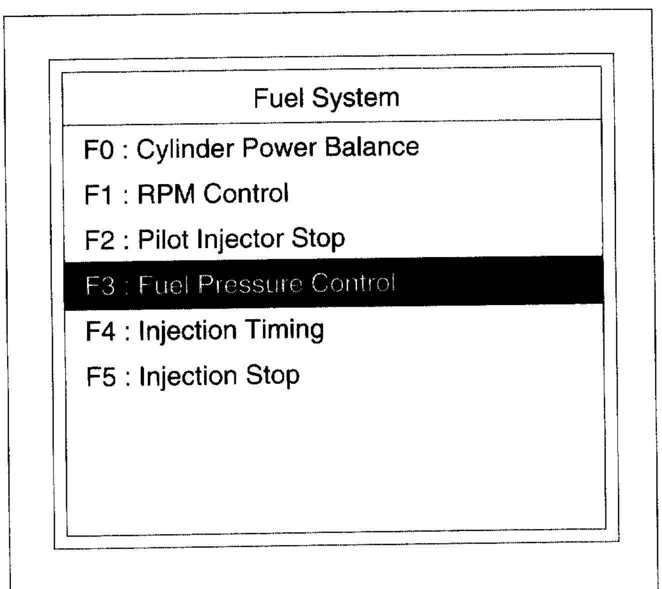
Test Procedure:

1. Connect Tech 2 to the vehicle DLC.
2. Run the Engine at idle.
3. Select F1: Fuel System in the Application Menu.



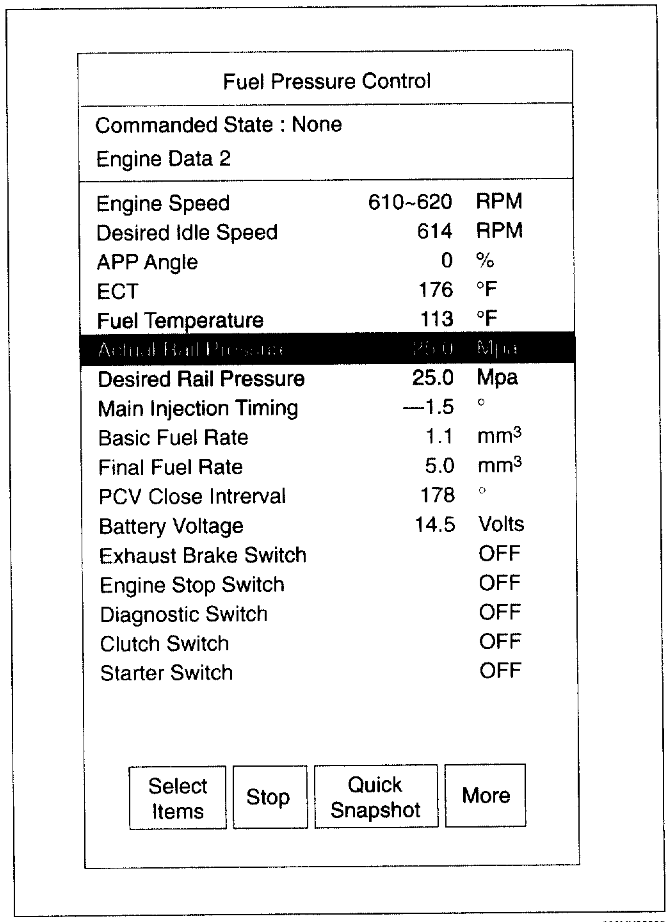
060MX028

4. Select F3: Fuel Pressure Control Test in the Fuel System.



060MX017

5. Push "Start" soft key.



060MY00062

6. Control Fuel Pressure and check data list.
7. If the data list changes, the Fuel Pressure Control System is normal.

Injection Timing

Tech 2 must be used for this test.

Test Procedure:

1. Connect Tech 2 to the vehicle DLC.
2. Run the Engine at idle.
3. Select F1: Fuel System in the Application Menu.

Special Functions
F0 : Engine Output Controls
F1 : Fuel System
F2 : Capture & Restore Fuel Rate Data

060MX028

4. Select F4: Injection Timing.

Fuel System
F0 : Cylinder Power Balance
F1 : RPM Control
F2 : Pilot Injector Stop
F3 : Fuel Pressure Control
F4 : Injection Timing
F5 : Injection Stop

060MX015

Injection Timing

Commanded State : None

Engine Data 2

Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
APP Angle	0	%
ECT	176	°F
Fuel Temperature	113	°F
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	25.0	Mpa
Main Injection Timing	1.5	
Basic Fuel Rate	1.1	mm^3
Final Fuel Rate	5.0	mm^3
PCV Close Intrerval	178	°
Battery Voltage	14.5	Volts
Exhaust Brake Switch		OFF
Engine Stop Switch		OFF
Diagnostic Switch		OFF
Clutch Switch		OFF
Starter Switch		OFF

Select Items | DTC | Quick Snapshot | More

060MY00063

Injection Stop

Tech 2 must be used for this test.

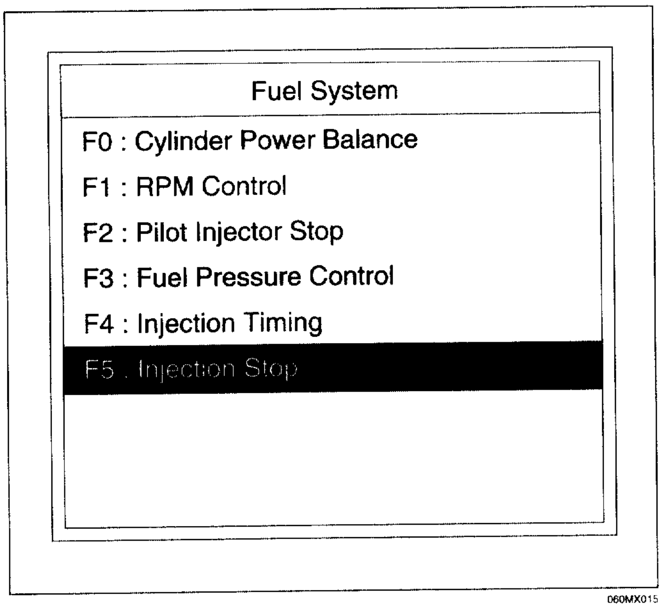
Test Procedure:

1. Connect Tech 2 to the vehicle DLC.
2. Run the Engine at idle.
3. Select F1: Fuel System in the Application Menu.

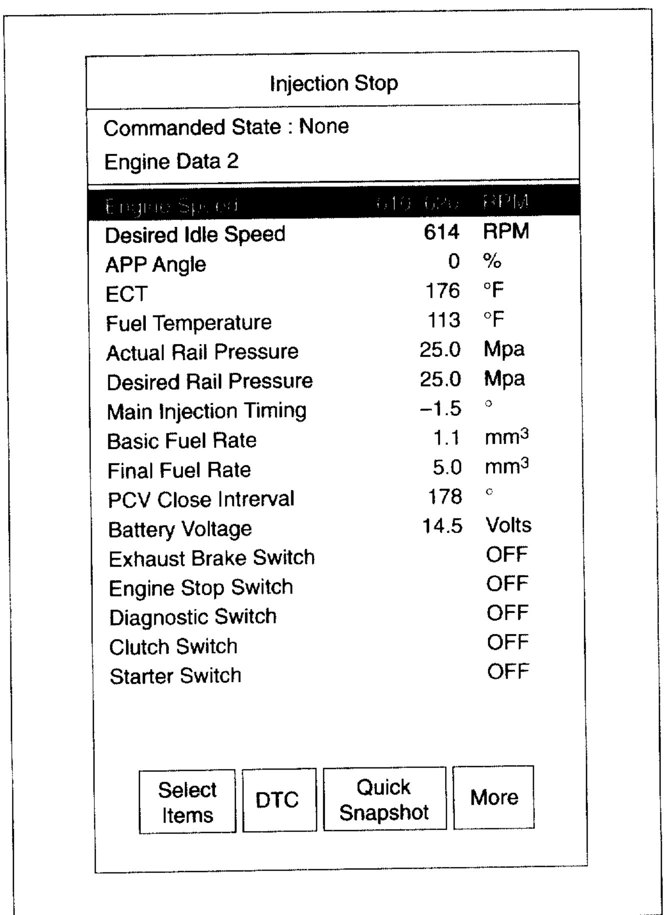
Special Functions
F0 : Engine Output Controls
F1 : Fuel System
F2 : Capture & Restore Fuel Rate Data

060MX028

4. Select F5: Injection Stop in the Fuel System.



060MX015



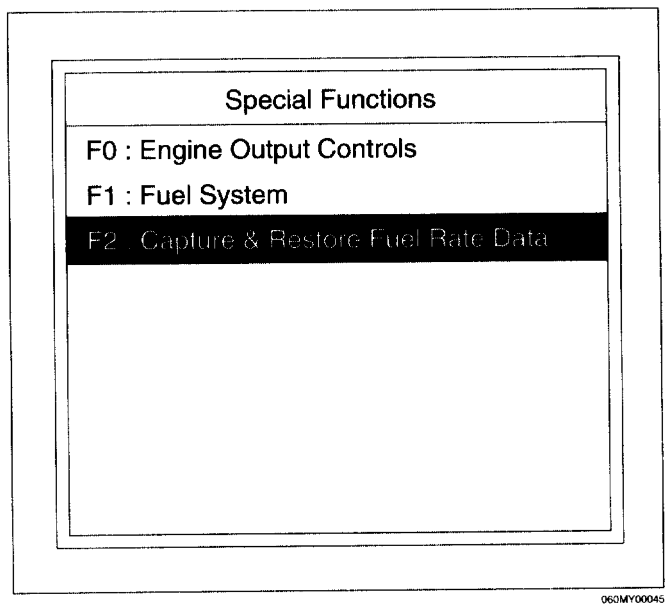
060MY00064

Capture & Restore Fuel Rate Data

IMPORTANT; The replacement ECM must be stored the capture fuel rate data by Tech 2.

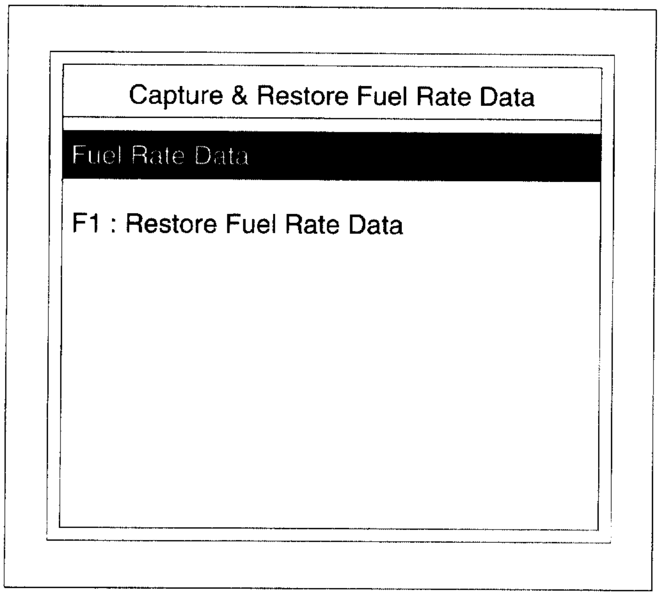
ECM Replace procedure

1. Ignition "ON", Engine "OFF".
2. Tech2 "ON".
3. Push "ENTER" key, when the "Tech2" appeared display screen.
4. Operate "△" or "▽" key, put on the hi-light bar to the "F0: Diagnostic".
5. Operate "△" or "▽" key, put on the hi-light bar to the "(Y) 2000", and push "ENTER" key.
6. Select "ISUZU", and push "ENTER"/
7. Select "F0: Power Train" and push "ENTER".
8. Select "7.8L L6 LG4" by operating "△" or "▽" key.
9. Select "Automatic".
10. Select "F2: Special Functions" by operating "△" or "▽" key, and push "ENTER" key.
11. Select "F2: Capture & Restore . . . . ." by operating "△" or "▽" key, and push "ENTER" key.



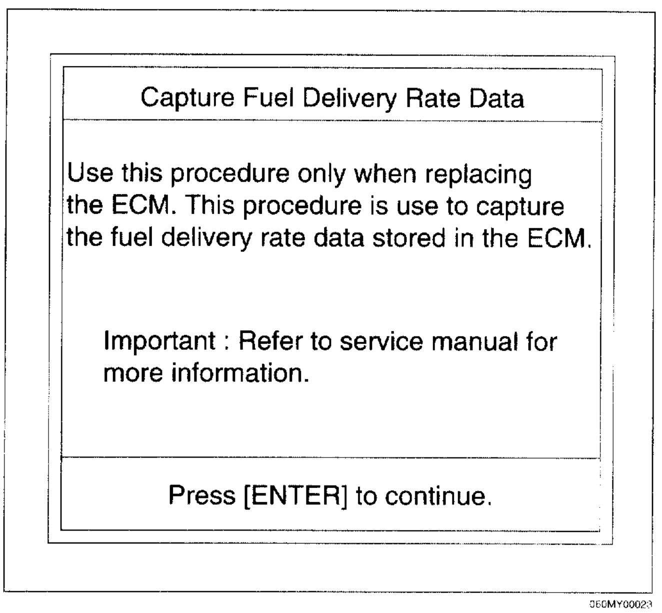
060MY00045

12. Select "F0: Capture Fuel Rate . . . . ." by operating "△" or "▽" key, and push "ENTER" key.



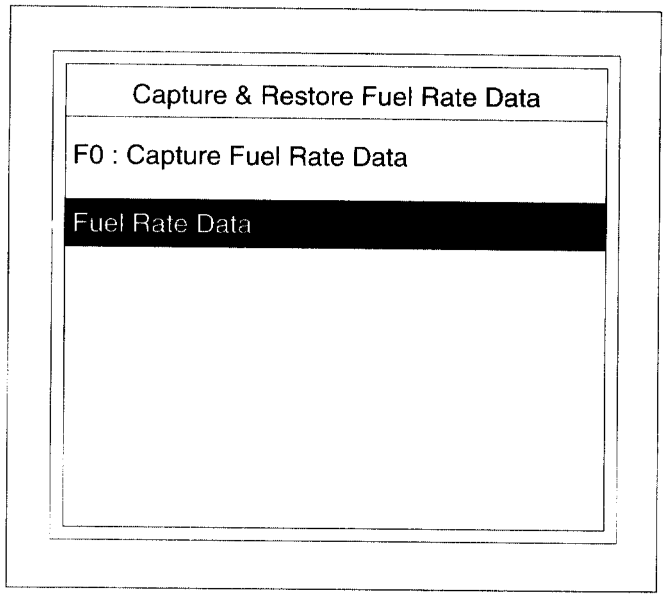
060MX014

13. The message will be appeared on the Display Screen, and push "ENTER" key few times.
When the Up Load was successfully, the message "Fuel Delivery" rate data capture complete.



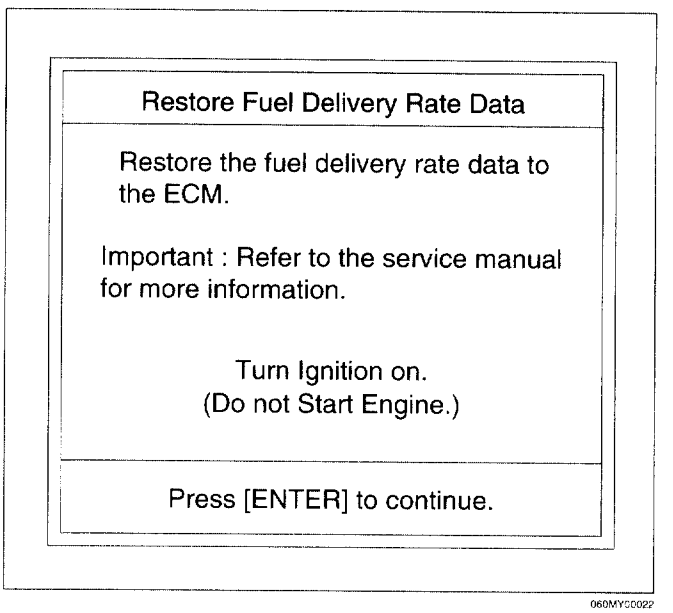
060MY00023

14. Tech2 "OFF" after this message appeared.
15. Ignition "OFF"
16. Replace the ECM.
17. Ignition "ON". Tech2 "ON".
18. Repeat from Item 3 to 11 (This procedure).
19. Select "F1: Restore Fuel Rate . . . . ." by operating "△" or "▽" key, and push "ENTER" key.



060MX013

20. Push "ENTER" key following message few times, when some message will be appeared.



060MY00022

When the "Fuel delivery rate data storage complete was appeared, the procedure was successfully completed". At this moment the "Self Diagnosis Lamp" will be turned off.

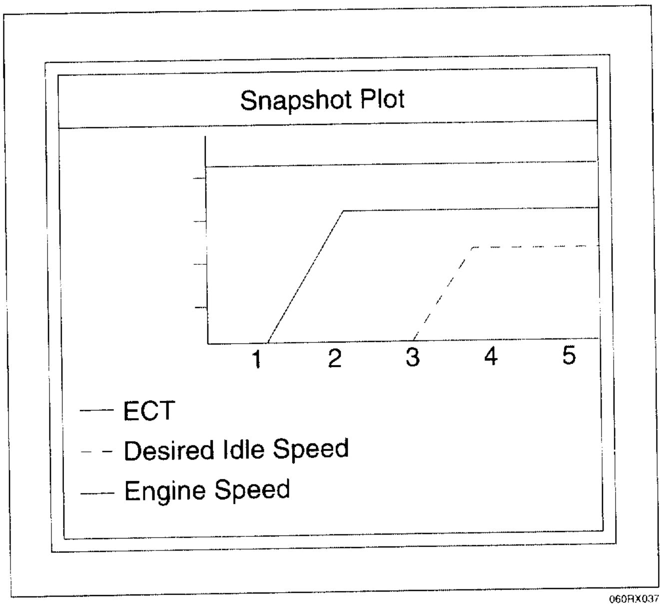
NOTE: Unfortunately if you have failed, return to the initial menu screen by operating the "ENTER" key and repeat again.

There is a possibility to be appeared some information in relation to failure.

Also in this case, by operating "EXIT" key, return to the initial menu screen and then repeat from first step.

Plotting Snapshot Graph

This test selects several necessary items from the data list to plot graphs and makes data comparison on a long term basis. It is an effective test particularly in emission related evaluations.



For trouble diagnosis, you can collect graphic data (snapshot) directly from the vehicle. You can replay the snapshot data as needed. Therefore, accurate diagnosis is possible, even though the vehicle is not available.

Plotting Graph Flow Chart (Plotting graph after obtaining vehicle information)

Procedure Based on Data Display

After confirming FLOW "MAIN MENU DIAGNOSIS" -ID, select "DATA DISPLAY" from APPLICATION MENU.

After display of vehicle data, select "QUICK SNAPSHOT" lower part of the monitor screen.

After lapse of some time, push "EXIT" button.

Procedure Based on Trigger Type Decision

After confirming FLOW "MAIN MENU DIAGNOSIS" -ID, select "SNAP SHOT" from APPLICATION MENU.

Select when the items have been displayed.

After display of snapshot option, decide on a trigger type, and select "RECORD SNAPSHOT", under screen.

If (STANDBY) blinks, upper right of screen, select "TRIGGER", under screen.

Confirm the trigger type.

If "CONTINUE" is displayed under screen after the screen is changed, select.

If "PLOT" is displayed under screen, select "PLOT".

When changed to the item selecting screen, push the enter key in accordance with the items up to three items, and select "ACCEPT", under screen.

The graph is displayed on teh screen.

060RX085

Flow Chart for Snapshot Replay (Plotting Graph)

Press the enter-key in initial display.

Select "VIEW CAPTURE DATA"

If snapshot option is displayed, decide on a trigger type, and slect “REVIEW DATA” under screen.

When the data triggered by vehicle is displayed, select the data.
(Plural display of data depending on the number of times of triggering.)

data is displayed on the screen.
To see the graph, select “PLOT” under screen.

Changed to the item selection screen, push the enter key up to three times, and select “ACCEPT” under screen.

The graph is displayed on the screen.

060RX040

System Parts Description

Supply Pump

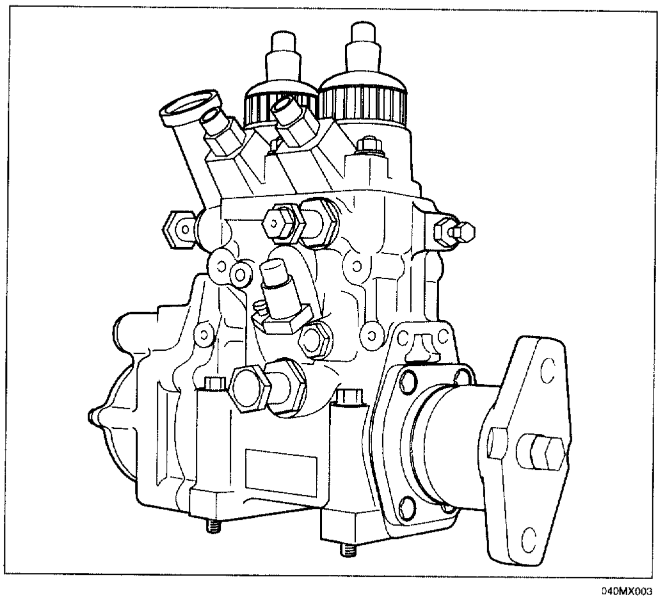
The supply pump is comprised of pump proper, feed pump, and coupling.

Engine output goes to idle gear, air compressor, and drive gear and is transmitted through coupling to the camshaft of supply pump.

Plunger is lubricated and cooled with fuel, be sure not to use any fuel other than specified one.

Supply Pump Unit

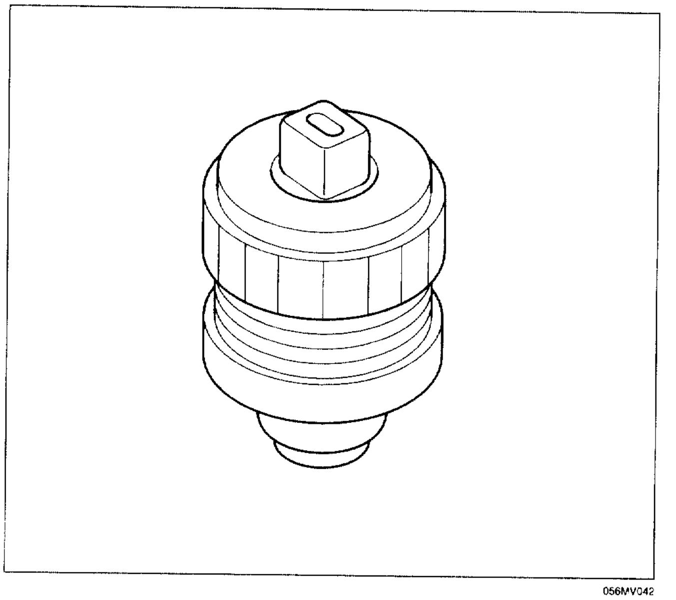
The supply pump unit comprises the same feed system as is used in the conventional duplex pump and two cylinders each having a pressure control valve (PCV). Using triple action cam has reduced the number of pump cylinders required to one third of the number of engine cylinders (2 cyl. pump in case of 6 cyl. engine). Further, the number of times of feeding to common rail is equal to that of injection, giving smooth, stable common rail pressure.



040MX003

Pressure Control Valve (PCV)

PCV is used to adjust supply pump discharge amount so as to adjust common rail pressure. Discharge amount from the supply pump to the common rail is determined by continuity timing to PCV.

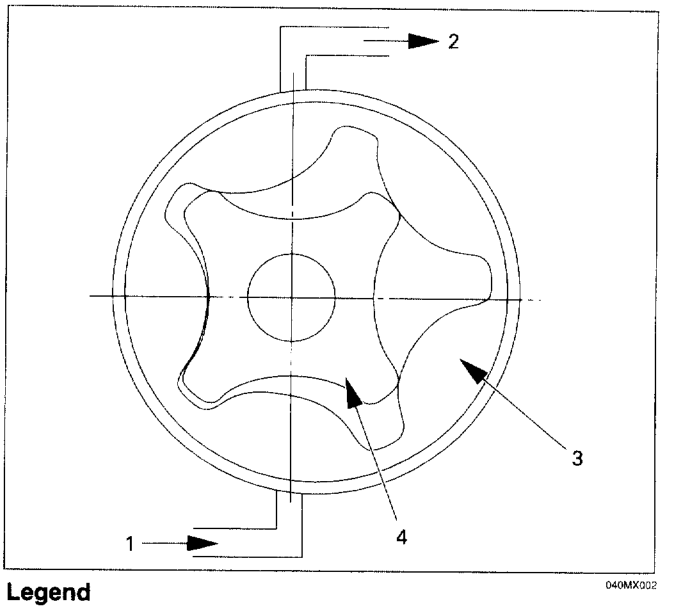


056MV042

NOTE: Do not remove from fuel supply pump.

Feed Pump

The feed pump built in the supply pump to fuel pump up and supply fuel through fuel filter into the supply pump unit. Feed pump inside rotor is driven by supply pump camshaft. When the inside rotor starts to rotate, outside rotor also rotate together with inside rotor. The outside rotor has more one teeth number than inside rotor, therefore, inside rotor tooth sliding on the face of inside tooth in the outside rotor during them rotating. The fuel hold clearance of between outside rotor and inside rotor tooth then fuel is pressed to be pushed out of discharge port.



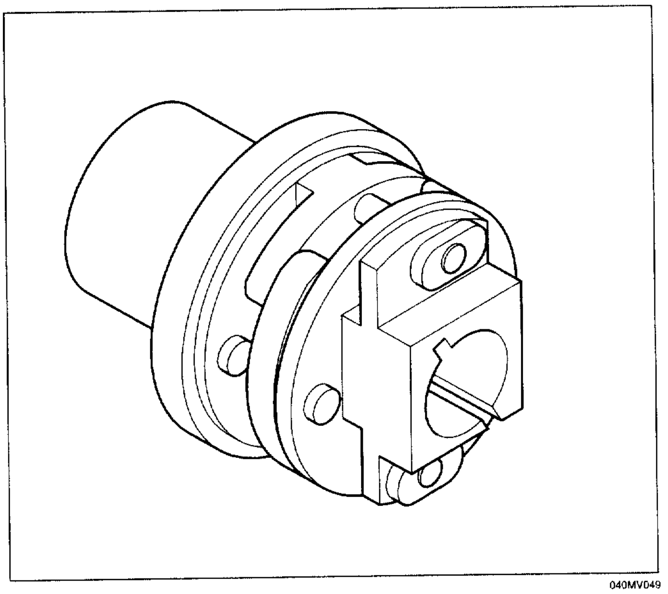
040MX002

Legend

(1) From fuel tank
(2) To fuel filter
(3) Outside rotor
(4) Inside rotor

Coupling

The coupling is a laminated type, serving to transmit the driving torque from the engine side to the camshaft of the supply pump.



040MV049

Pump Position Sensor (CAM Sensor)

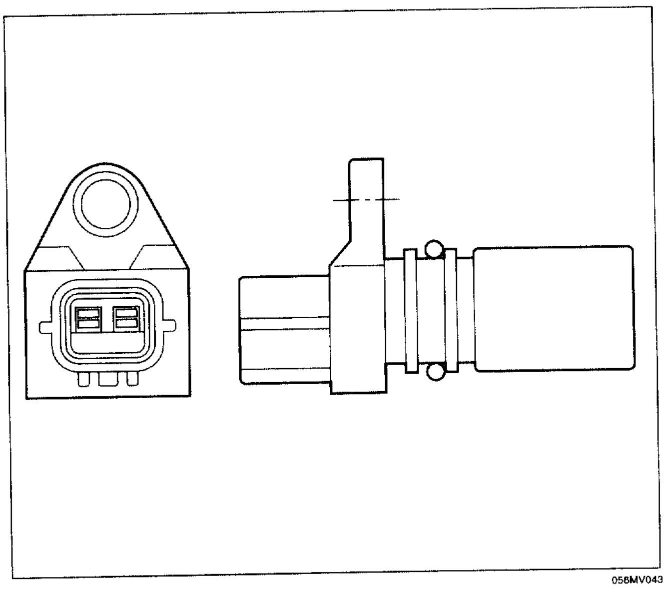
CAM sensor is installed at the side of the supply pump, serving to distinguish the cylinders of the engine and back up the detection of engine speed (in case of CKP sensor trouble).

This CAM sensor comprises the same parts as in CKP sensor, but the number of turns of its coil is different from that of CKP sensor and installed to the supply pump.

With the engine started, the pulser notches in the middle of the supply pump camshaft cut off intermittently the magnetic field made by the sensor magnet, thereby generating alternating current.

The pulser notches are made every 60° of camshaft (every 120° of crank angle) and there is a surplus tooth.

Therefore, seven pulses are outputted per one rotation of camshaft (2 rotations of the engine). The pulse outputted by the surplus tooth is recognized as engine number 1 cylinder reference pulse.



056MV043

Common Rail

The common rail is installed to intake manifold, equipped with flow damper, pressure limiter, and common rail pressure sensor.

The common rail unit has a common fuel passage, fuel passage holes, and installing threaded holes. The common fuel passage is a through hole made in the common rail unit. The common rail pressure sensor is installed at the left end of the hole.

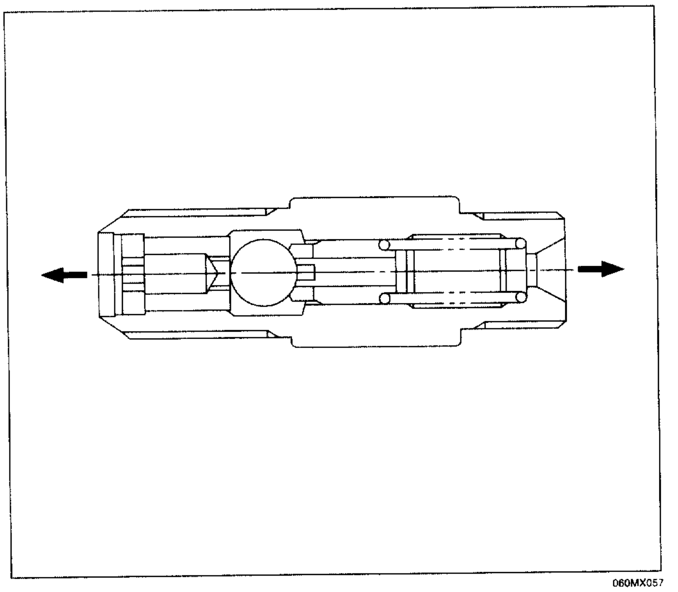
Flow Damper

The flow damper comprises a piston, ball, spring seat, and spring.

The flow damper is used to damp the pressure pulsating in the common rail and the injection pipe.

During driving the flow of fuel makes the piston, ball, and spring seat move a little to the injector side and float.

Should too much fuel pass the flow damper, the ball moves further toward the injector until the ball comes into contact with the seat surface of the flow damper unit, thereby shutting the fuel passages.

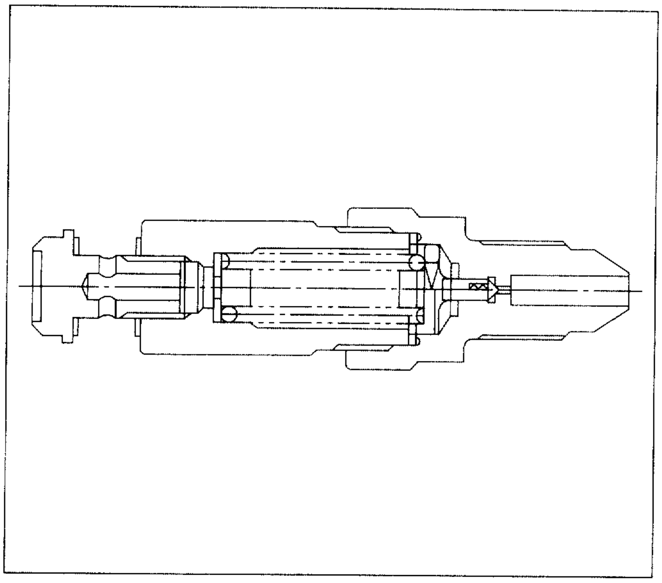


060MX057

NOTE: Do not remove from common rail.

Pressure Limiter

The pressure limiter opens when abnormally high pressure is generated, releasing the pressure. When the common rail pressure reaches approx. 140 MPa (1,420 kg/cm^2), the pressure limiter is actuated (opens), and when the pressure drops to approx. 30 MPa (310 kg/cm^2) later, it works to maintain the pressure, thereby enabling continuous running.



NOTE: Do not remove from common rail.

Common Rail Pressure Sensor

The common rail pressure sensor, installed at left end of the common rail, serving to detect fuel pressure. It is a semiconductor type pressure sensor utilizing silicon's property that the electric resistance of pressurized silicone is varied.

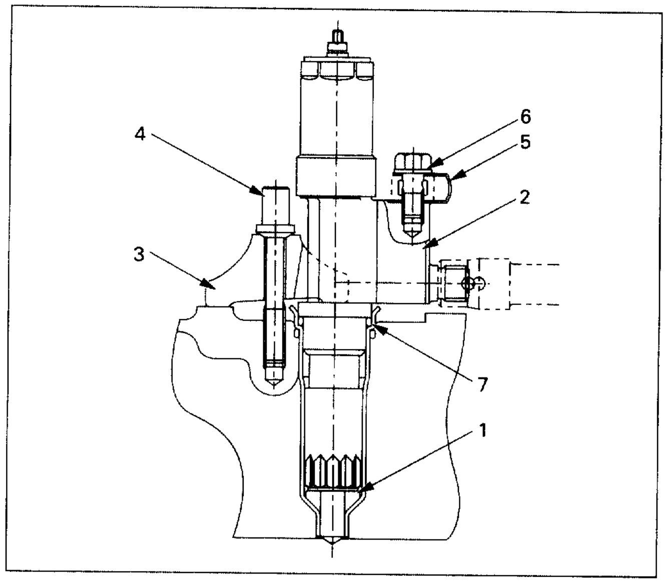
Further, a special gasket is used at the connection part with the common rail body so as to seal high pressure fuel.

Injector

The injector comprises a two-way solenoid valve, hydraulic piston, and nozzle. The solenoid valve controls the injection amount, injection timing, and injection rate of fuel by controlling the pressure in the control chamber.

The nozzle is a multihole type with a injection starting pressure (valve opening pressure) of 8.7 MPa (85 kg/cm^2).

The injection body is clamped. The cylinder head injection part is provided with an O-ring by which the entry of engine oil into the injector hole of the cylinder head is prevented.



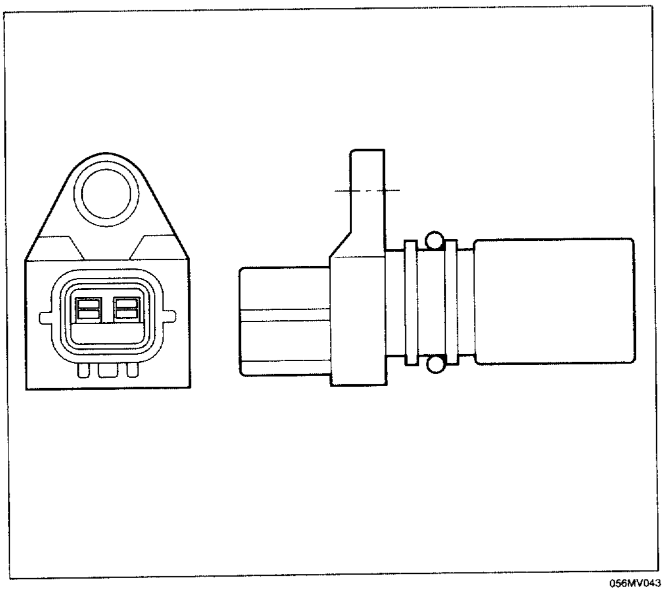
Legend

(1) Injector gasket
(2) Injector assembly
(3) Injector clamp
(4) Clamp bolt
(5) Fuel return pipe
(6) Eye bolt
(7) Injector sleeve

Crank Position Sensor (CKP Sensor)

This sensor comprises a permanent magnet, coil, and iron core and is installed to the flywheel housing. With the engine started, the signal holes made on the outer periphery of the flywheel cut off intermittently the magnetic field made by the magnet, thereby generating AC in the coil.

The signal holes on the flywheel are provided every 7.5°, but 3 point is holeless. 90 pulses are outputted per 2 rotations of the engine. By this signal, engine speed and 7.5°-based crank angle can be detected.

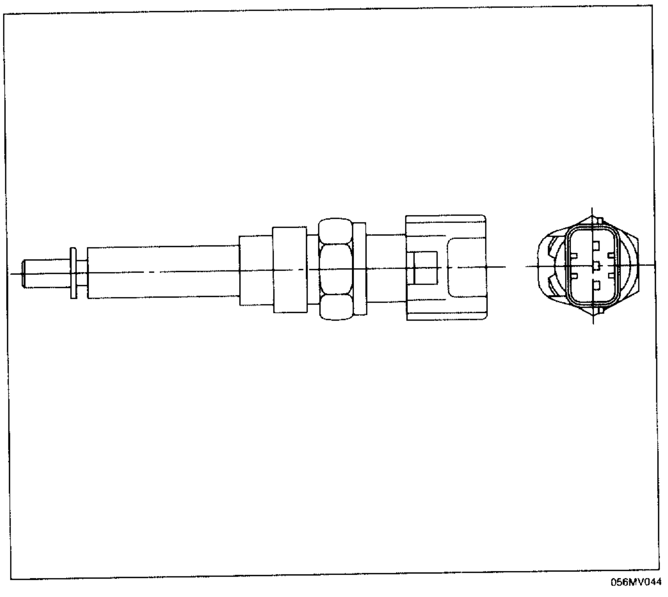


056MV043

ECT Sensor

This sensor is a thermister type installed on the thermostat case. Change in coolant temperature as a resistance change signal is sent to ECM to optimize fuel injection control.

ECM applies voltage to the thermister and detects from the voltage divided between in ECM and thermister resistance values.

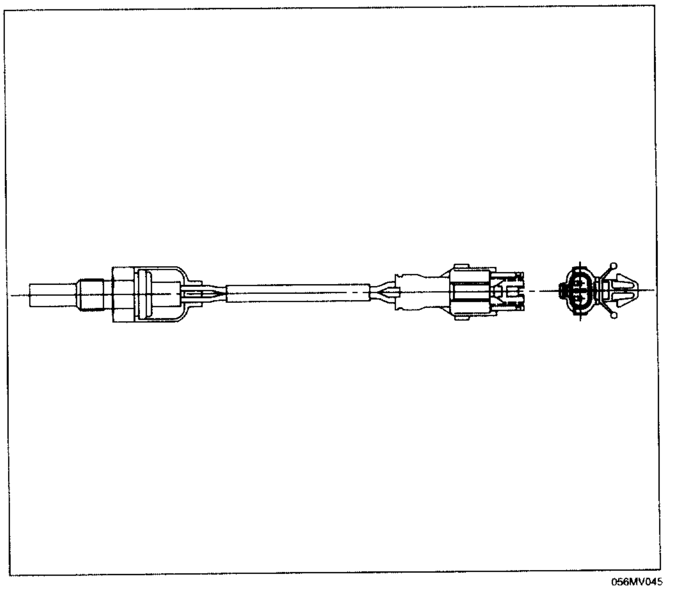


056MV044

FT Sensor (THF)

The FT sensor is a thermister type installed in the casing provided in the fuel return (from the injector) circuit.

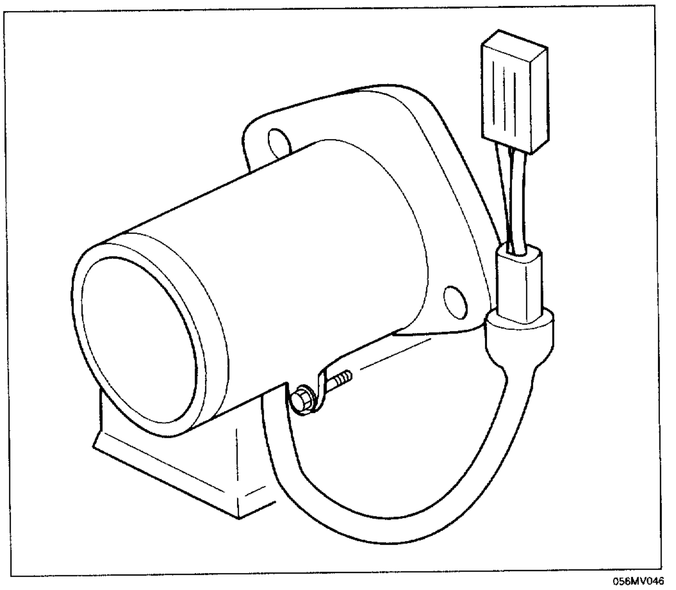
Change in fuel temperature is changed into a resistance change signal and sent to ECM for optimization of fuel injection control.



056MV045

Accelerator Sensor

This sensor is a hole IC type substituting electric signals for accelerator pedaling amount to be sent to ECM. It is installed to accelerator pedal bracket assembly.

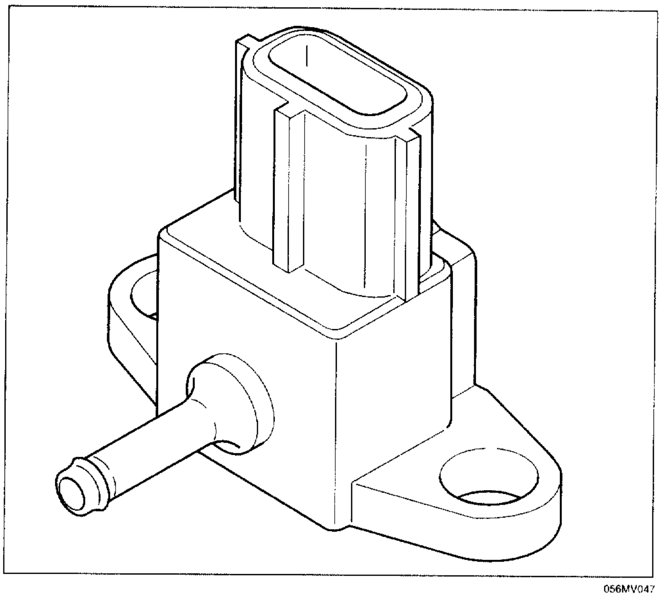


056MV046

Boost Sensor

The boost sensor is fixed on the cab back frame and is connected to rear portion of inlet manifold by vacuum hose.

The boost sensor generates voltage according to air aspiration pressure and generation voltage is input to ECM for boost sensor signal.



056MV047

Ambient Air Temperature Sensor (THA)

The Ambient Air TEMP. Sensor is located inside of cab front panel.

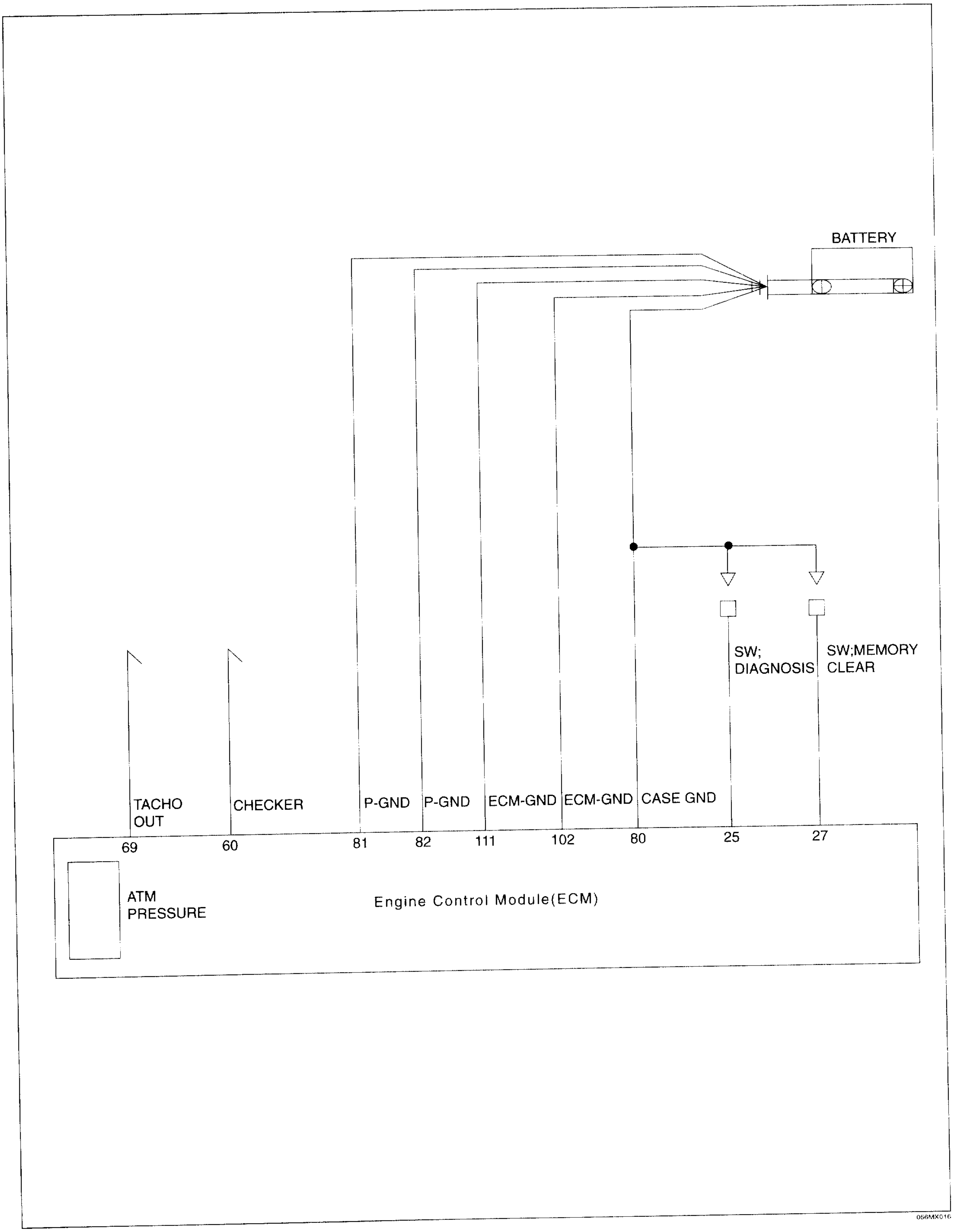
The atmosphere temperature is changed into a resistance change signal and sent to ECM for optimization of fuel injection control.

BARO Sensor (BARO Pressure)

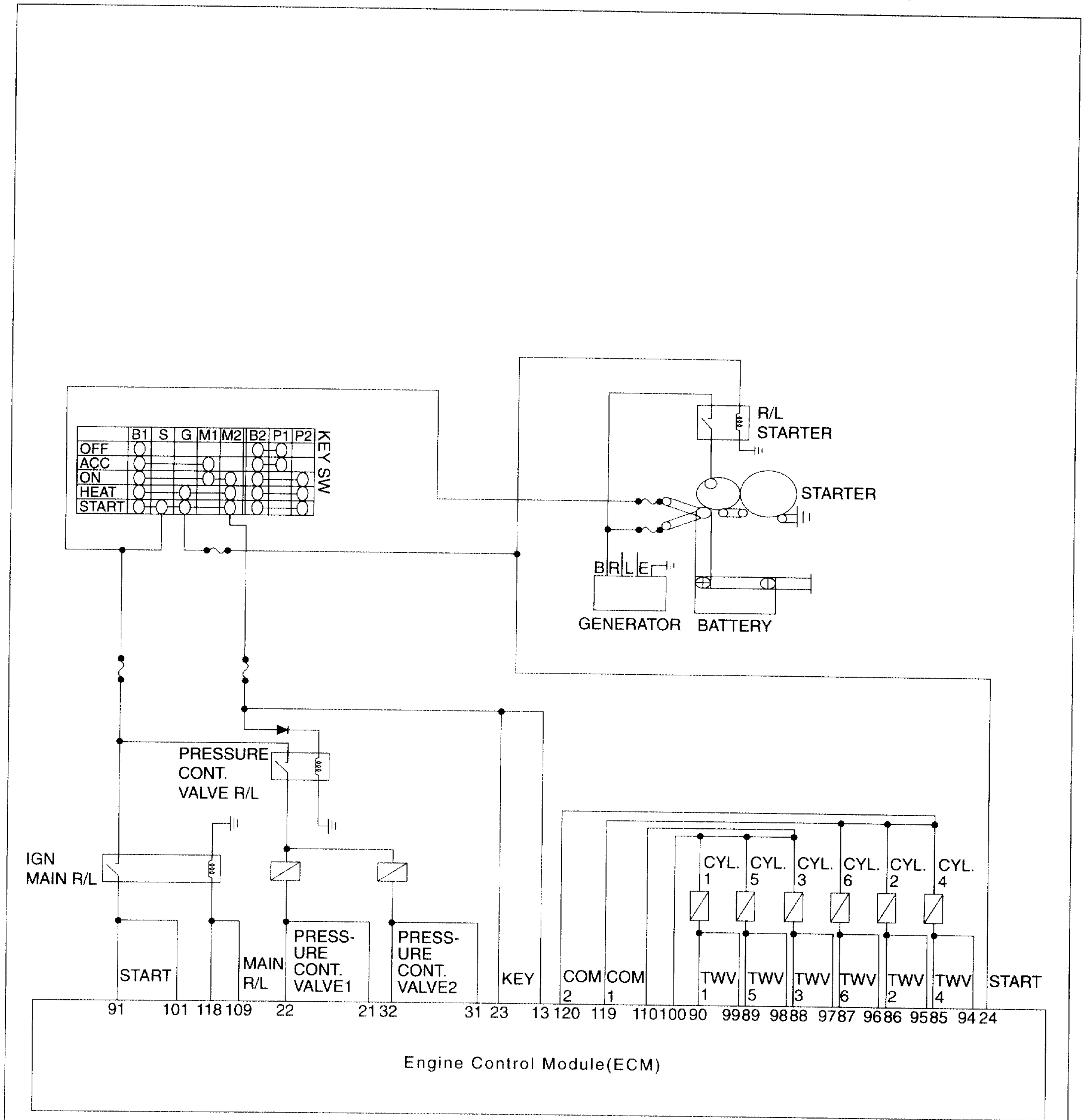
BARO Pressure sensor is located in the ECM.

The BARO pressure sensor signal send to the ECM for optimization of fuel injection control under vehicle operation heigh.

ECM System Wiring Diagram (1 of 4)



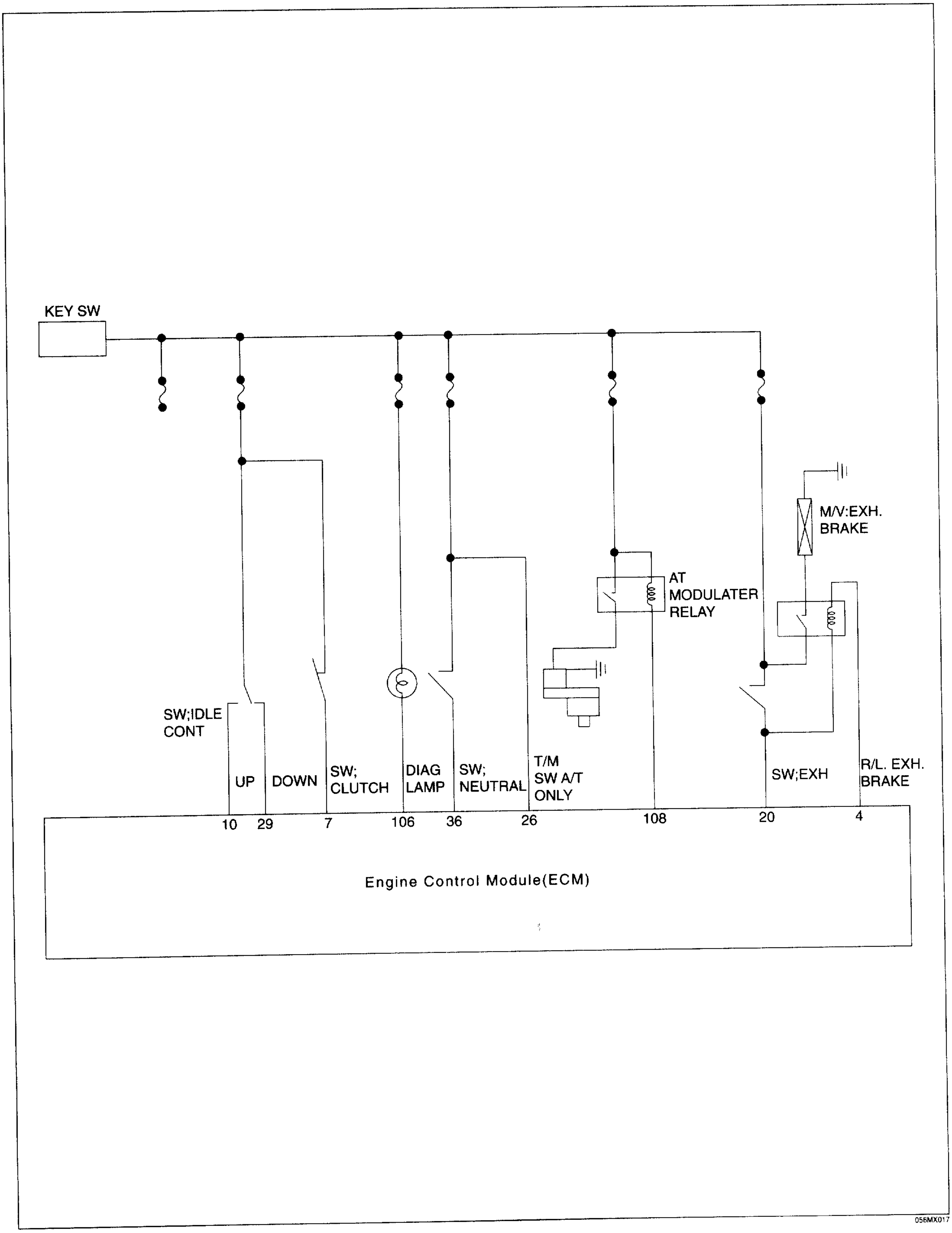
ECM System Wiring Diagram (2 of 4)



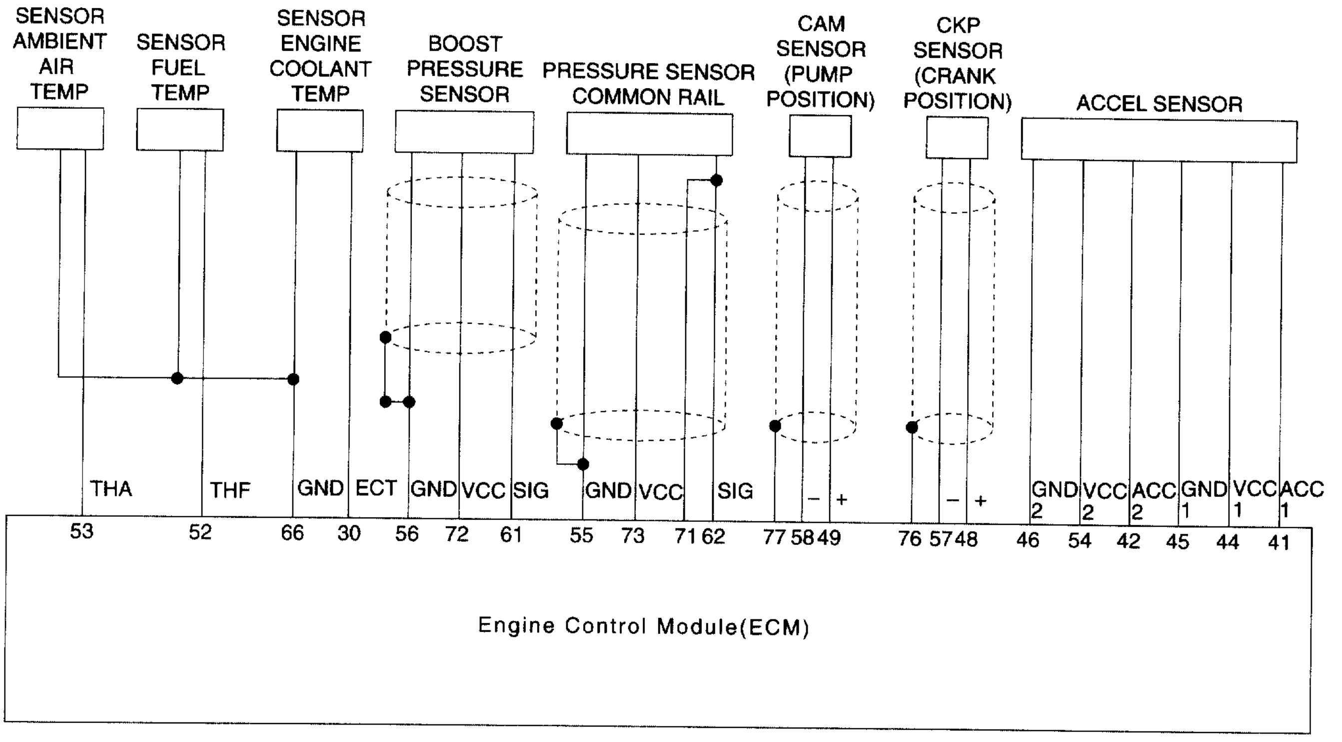
(TWV=Injector)

060MY00069

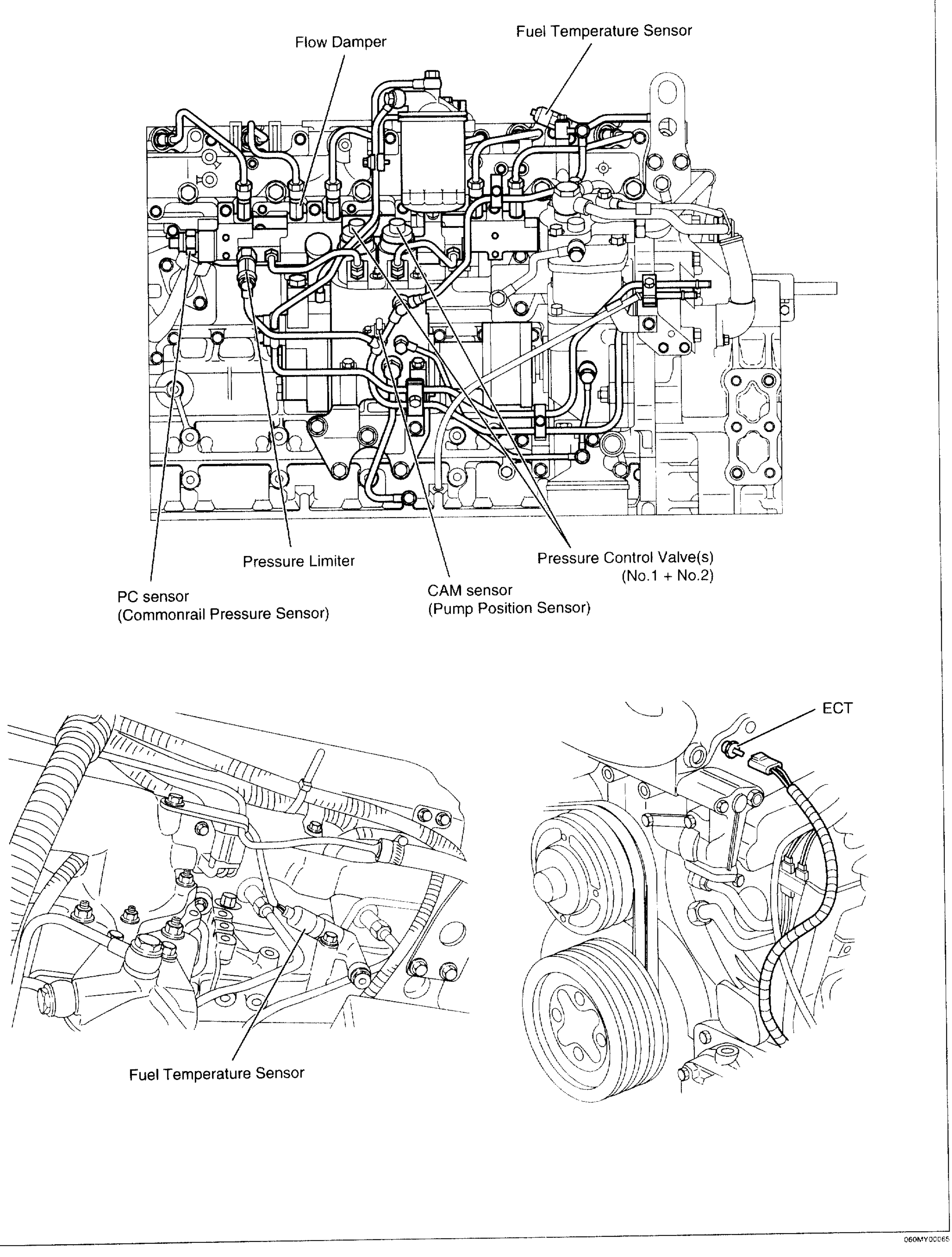
ECM System Wiring Diagram (3 of 4)



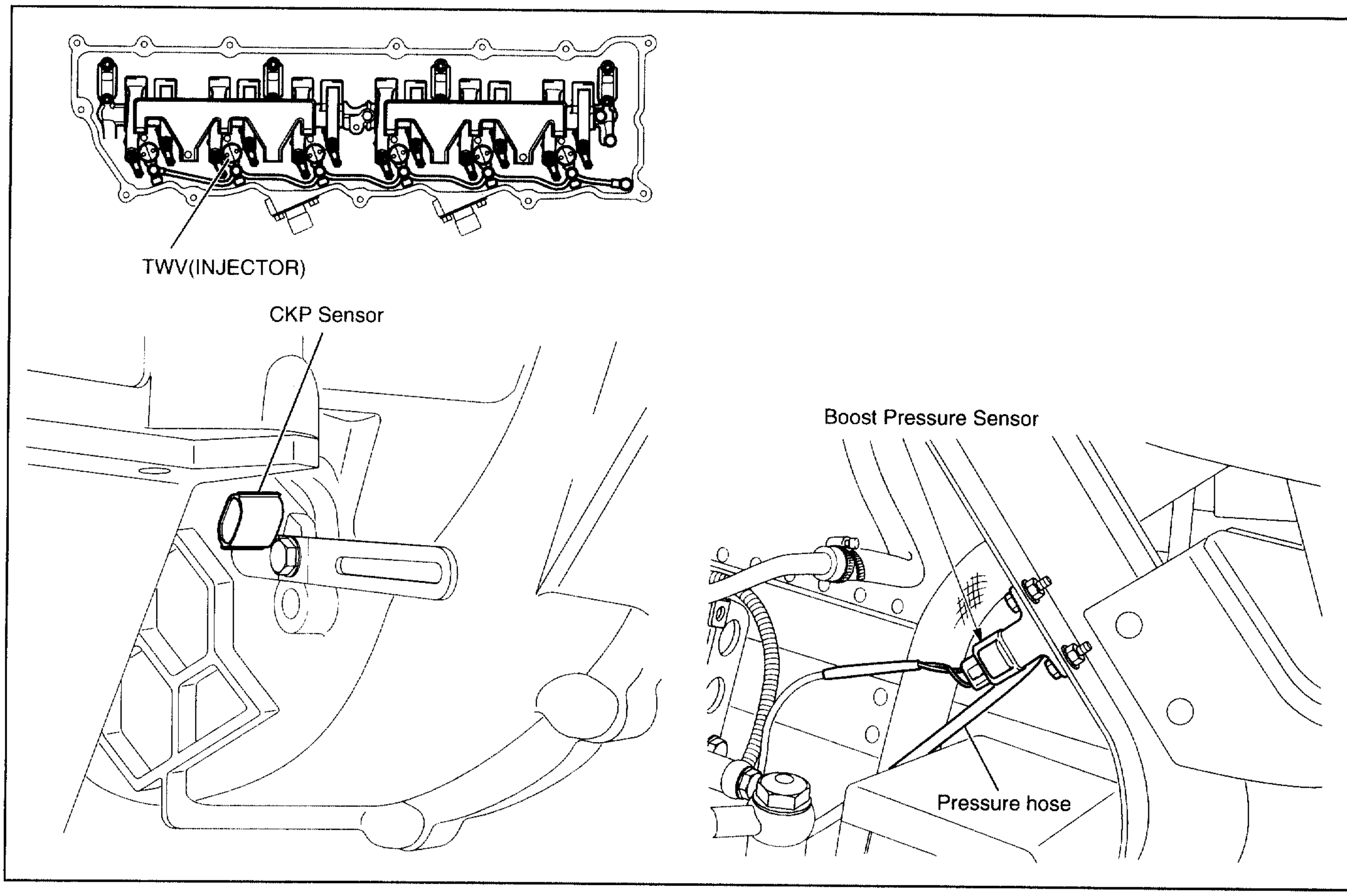
ECM System Wiring Diagram (4 of 4)



Location of Sensor and Switch

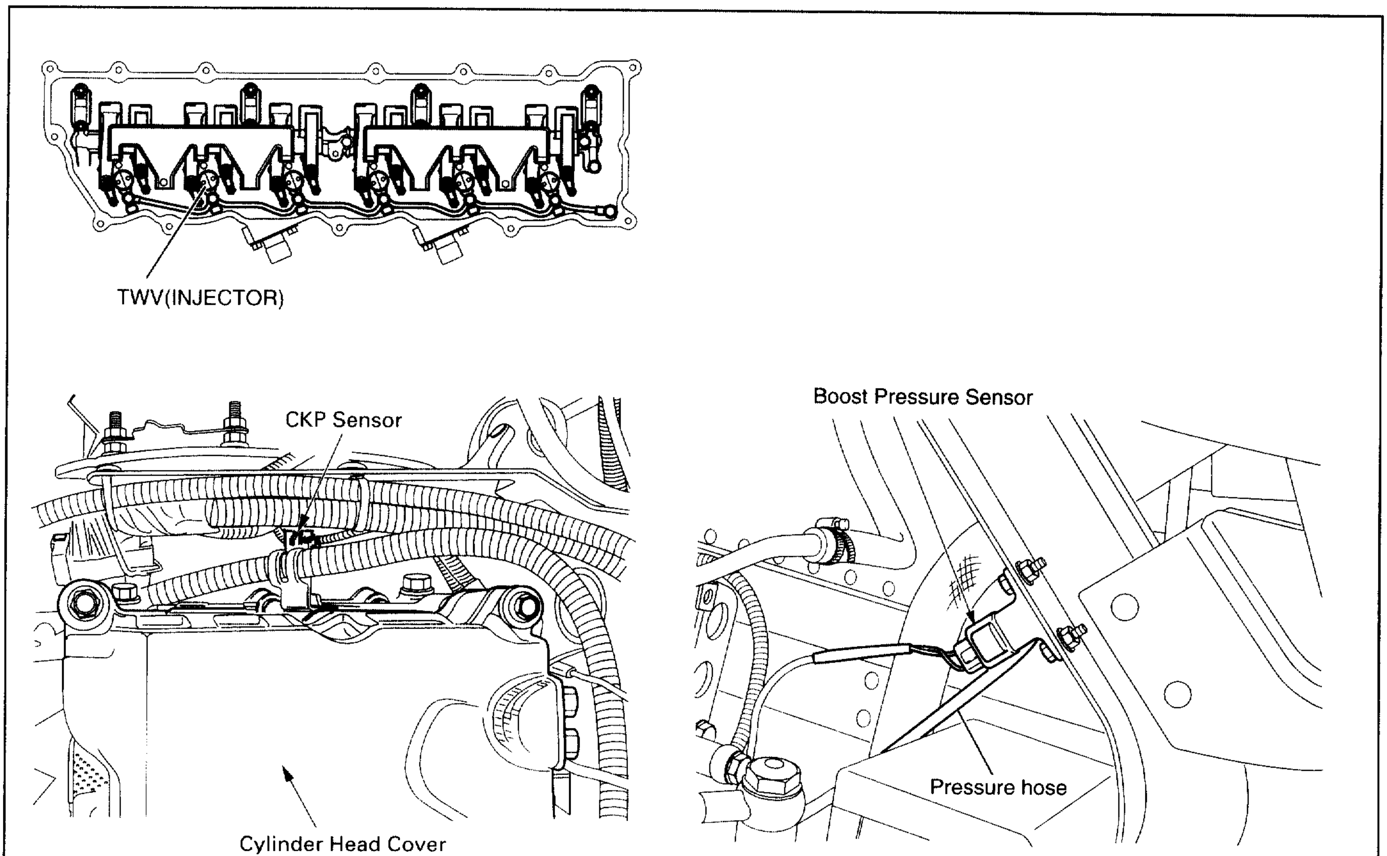


Transmission Type: M/T



060MX091

Transmission Type: A/T



060MY00060

Location of the DLC (Data Link Connector)

The DLC is located under the inner part of left side instrument panel (Driver side).

Location of the memory clear switch

The memory clear switch is located under the passenger seat and the switch is blue color one pin connector.

Location of the PCV relay and MAIN relay

Both relay are located on upper portion of stand seat bracket (The ECM built in inside) in the cab.

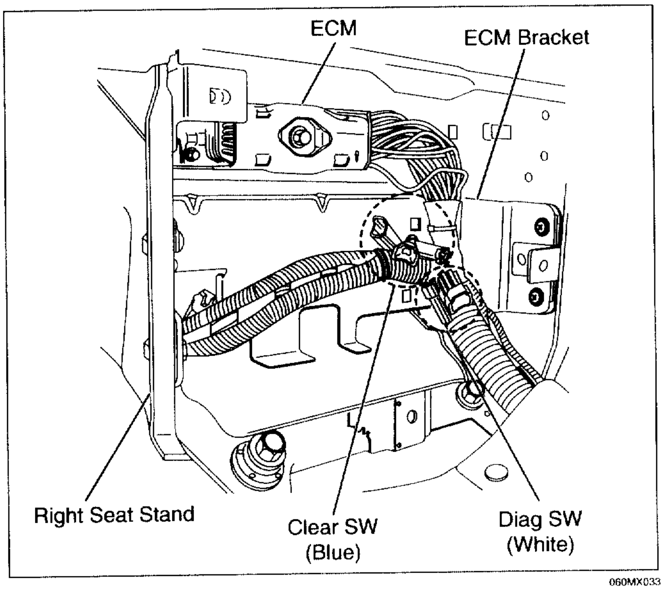
Location of the AAT (Ambient Air temperature) sensor

The AAT sensor is located center of front on the dashpanel.

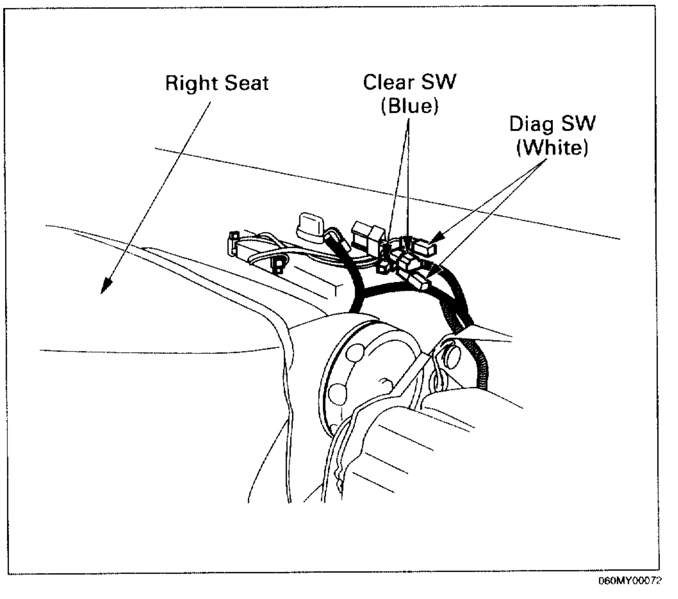
Location of the diagnosis switch

The diagnosis switch is located under the passenger seat and the switch is white color one pin connector.

Vehicle type: FRR

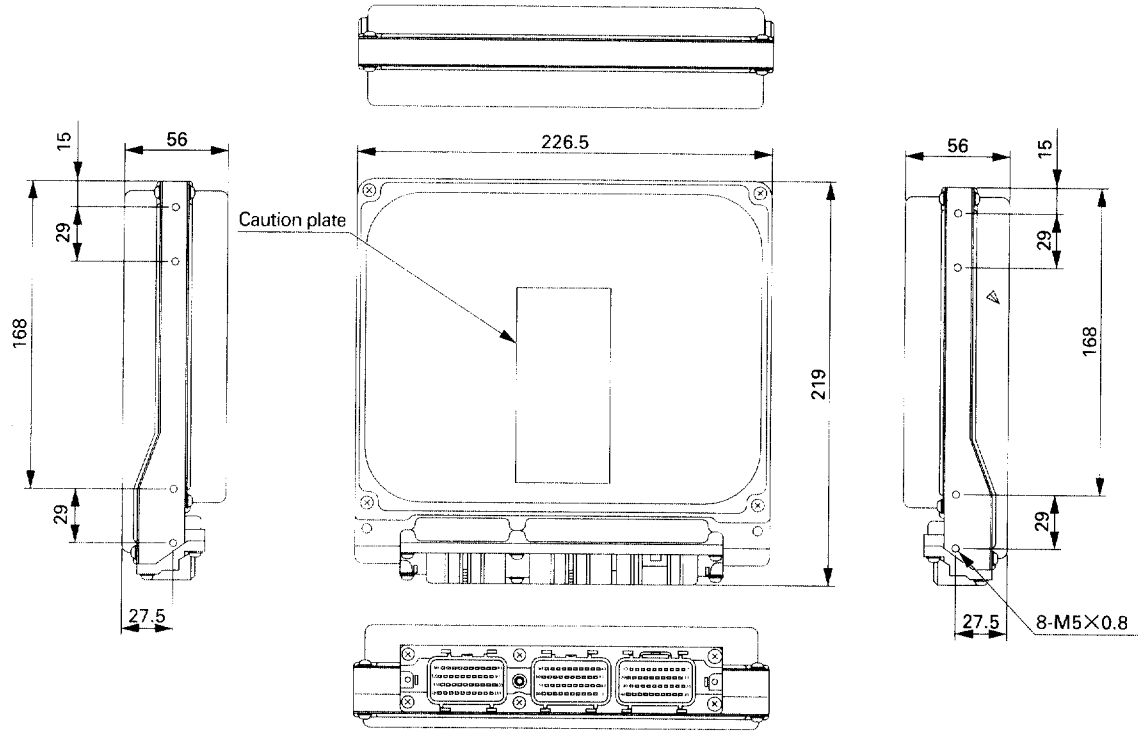


Vehicle type: FSR, FTR, FVR



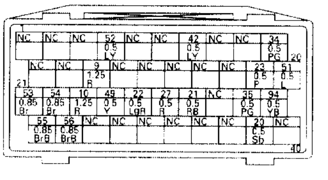
Engine Control Module (ECM)

Appearance of ECM



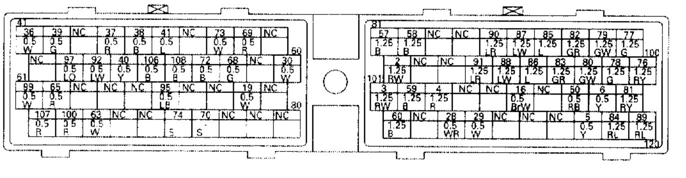
056MV030

Detail of 40 pin connector for Engine harness



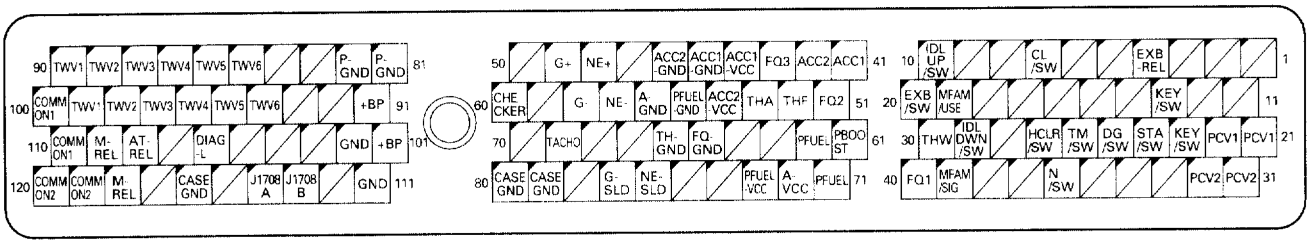
056MV021

Detail of 80 pin connector for Engine harness



056MV020

Chart of ECM INPUT/OUTPUT



Connector Pin Assignment

Connector	Connector Pin number	Connector pin assignment: Abbreviations	Connector pin assignment: Assigned name
40 pin connector	1	——	Not used
	2	——	Not used
	3	——	Not used
	4	EXB–REL	Exhaust brake relay
	5	——	Not used
	6	——	Not used
	7	CL/SW	Clutch switch
	8	——	Not used
	9	——	Not used
	10	IDLUP/SW	Idling up switch
	11	——	Not used
	12	——	Not used
	13	KEY/SW	Key switch
	14	——	Not used
	15	——	Not used
	16	——	Not used
	17	——	Not used
	18	——	Not used
	19	——	Not used
	20	EXB/SW	Exhaust brake switch
	21	PCV1	Pressure control valve 1
	22	PCV1	Pressure control valve 1
	23	KEY/SW	Key switch
	24	STA/SW	Starter switch
	25	DG/SW	Diagnosis switch
	26	TM/SW	Transmission judgment switch
	27	MCLR/SW	Memory clear switch
	28	——	Not used
	29	IDLDWN/SW	Idling down switch
	30	THW (ECT)	Engine coolant temperature sensor
	31	PCV2	Pressure control valve 2
	32	PCV2	Pressure control valve 2

Connector	Connector Pin number	Connector pin assignment	
		Abbreviations	Assigned name
40 pin connector	33	——	Not used
	34	——	Not used
	35	——	Not used
	36	N/SW	Neutral switch
	37	——	Not used
	38	——	Not used
	39	——	Not used
	40	——	Not used
80 pin connector	41	ACC1	Acceleration sensor 1
	42	ACC2	Acceleration sensor 2
	43	——	Not used
	44	ACC1–VCC	Acceleration sensor 1 power source
	45	ACC1–GND	Acceleration sensor 1 ground
	46	ACC2–GND	Acceleration sensor 2 ground
	47	——	Not used
	48	CKP+	Crank position sensor positive
	49	CAM+	Pump position sensor positive
	50	——	Not used
	51	——	Not used
	52	THF	Fuel temperature sensor
	53	THA	Ambient Air temperature sensor
	54	ACC2–VCC	Acceleration sensor 2 power source
	55	PFUEL–GND	Common rail pressure sensor ground
	56	A–GND	Sensor system ground
	57	CKP–	Crank position sensor negative
	58	CAM–	Pump position sensor negative
	59	——	Not used
	60	CHECKER	Indication output (DLC)
	61	PBOOST	Turbocharger Boost pressure sensor
	62	PFUEL	Common rail pressure sensor
	63	——	Not used
	64	——	Not used
	65	FQ–GND	Fuel quantity adjustment resistance common ground
	66	TH–GND	Temperature sensor ground
	67	——	Not used
	68	——	Not used
	69	TACHO	Tachometer output
	70	——	Not used
	71	PFUEL	Common rail pressure sensor
	72	A–VCC	Sensor system power source

Connector	Connector Pin number	Connector pin assignment	
		Abbreviations	Assigned name
80 pin connector	73	PFUEL–VCC	Common rail pressure sensor power source
	74	——	Not used
	75	——	Not used
	76	CKP–SLD	Crank position sensor sealed
	77	CAM–SLD	Pump position sensor sealed
	78	——	Not used
	79	——	Not used
	80	CASE–GND	Common 1
	81	P–GND	Power ground
	82	P–GND	Power ground
	83	——	Not used
	84	——	Not used
	85	TWV4	Two way valve 4
	86	TWV2	Two way valve 2
	87	TWV6	Two way valve 6
	88	TWV3	Two way valve 3
	89	TWV5	Two way valve 5
	90	TWV1	Two way valve 1
	91	+BP	Battery positive (Main relay)
	92	——	Not used
	93	——	Not used
	94	TWV4	Two way valve 4
	95	TWV2	Two way valve 2
	96	TWV6	Two way valve 6
	97	TWV3	Two way valve 3
	98	TWV5	Two way valve 5
	99	TWV1	Two way valve 1
	100	COMMON1	Common 1
	101	+BP	Battery positive (Main relay)
	102	GND	ECM ground
	103	——	Not used
	104	——	Not used
	105	——	Not used
	106	DIAG–L	Diagnostic lamp
	107	——	Not used
	108	AT–REL	Automatic transmission relay
	109	M–REL	Main relay
	110	COMMON1	Common 1
	111	GND	ECM ground
	112	——	Not used

Connector	Connector Pin number	Connector pin assignment	
		Abbreviations	Assigned name
80 pin connector	113	——	Not used
	114	——	Not used
	115	——	Not used
	116	——	Not used
	117	——	Not used
	118	M–REL	Main relay
	119	COMMON2	Common 2
	120	COMMON2	Common 2

Method to confirm the self-diagnosis code (dealer mode)

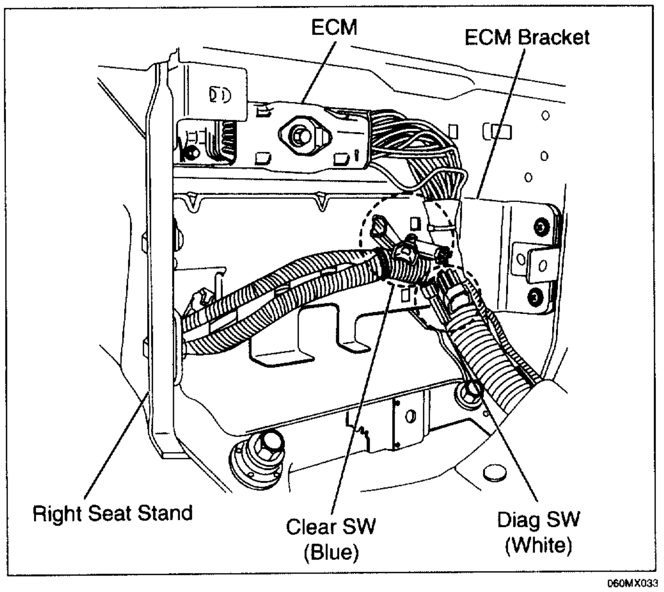
The self-diagnosis code can be read from the flashing of the indicator lamp (service engine soon).

Operation:

When the diagnosis connector mentioned below is connected, the indicator lamp will start flashing. The self-diagnosis code can be read from the flashing of the indicator lamp.

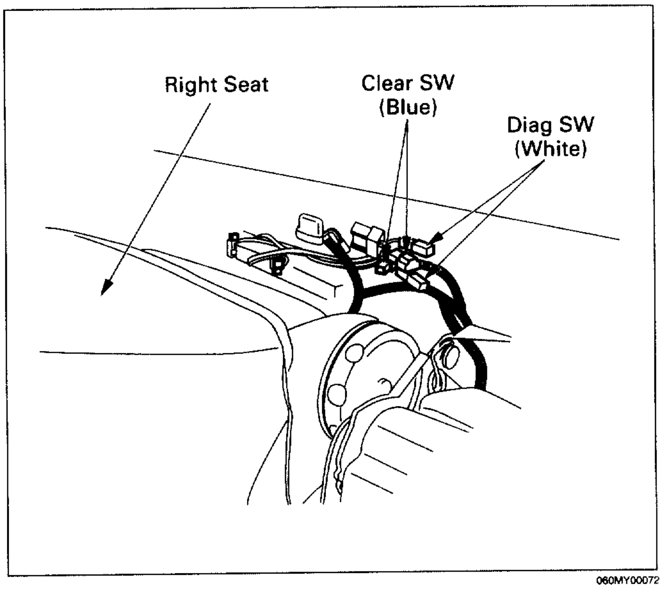
As to the method to read the self-diagnosis code, please refer to the 'How to Read the flashing of the indicator lamp' as mentioned later.

Vehicle type: FRR



060MX033

Vehicle type: FSR, FTR, FVR

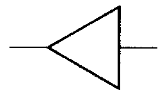
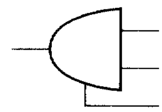
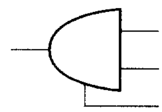


060MY00072

Diagnostic Indication

Contents of diagnostic indication

In accordance with the conditions of Diagnostic switch, the diagnostic lamp indications are changed over as follows:

Control mode	Diag. lamp indicator	Condition
User Mode	ON	 Diagnostic switch "OFF" (Open) 056MV023
Dealer Mode 1	DTC indication of current trouble only	 Diagnostic switch "ON" (GND shorted) No engine stall For 1 sec. or more 056MV024
Dealer Mode 2	DTC indication of current and past troubles	 Diagnostic switch "ON" (GND shorted) Engine stall For 1 sec. or more 056MV025

- Mode changeover between User mode, Dealer mode 1 and Dealer mode 2 is made immediately.
- Mode changeover between Dealer mode 1 and Dealer mode 2 is made after a round of DTC output.

Priority of indications

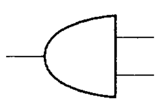
Lamp control by user mode, Dealer mode 1 and 2 > Lamp check control.

Diagnostic lamp patterns in User mode

Pattern 1 .... Lighted all the time
Pattern 2 .... Lighted after 20 sec. continuation of engine speed lower than 700 rpm.
Pattern 3 .... Light goes out.

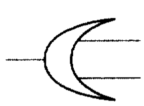
* Lighting condition of pattern 2

(1) Lighted by pattern 2 diagnostic.



056MV026

(2) Not lighted by pattern 2 diagnostic.



056MV027

Diagnostic code outputting in dealer mode

DTC indication is restarted after 2.4 sec. of light out.
The number of times of lighting/going out corresponding to the numeral in each figure are repeated.

Item	Light on time (Sec.)	Light out time (Sec.)
Figure of 100	0.3	0.6
Figure of 10	1.2	0.6
Figure of 1	0.3	0.6
Code intervals	—	2.4

Note: ***Tolerance of difference between light on and light out time is +0.3 to –0.1.***

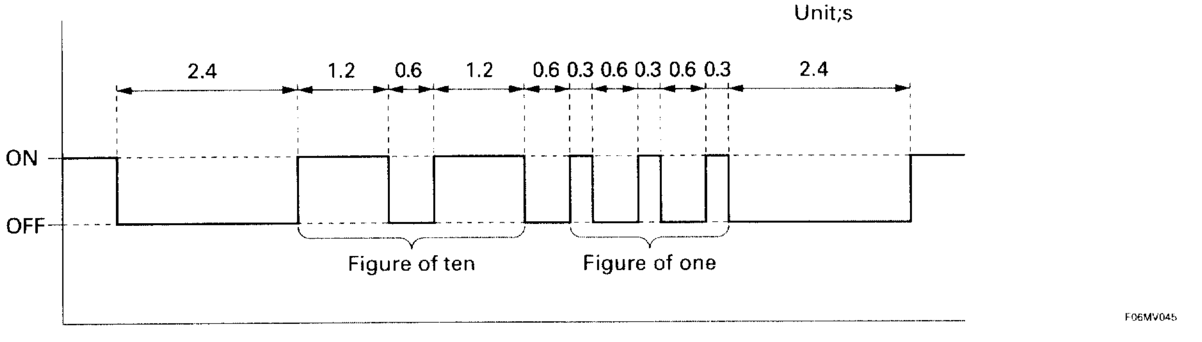
How to read flashing of the indicator lamp

The three-digit self-diagnosis code flashes starting from hundred's figure, while the two-digit self-diagnosis code flashes starting from ten's figure to indicate the self-diagnosis code.
Please read the self-diagnosis code from the flashing.
If the plural self-diagnosis codes are indicated, the same sefl-diagnosis code is flashed repeatedly in steps of three times. Please read it correctly.

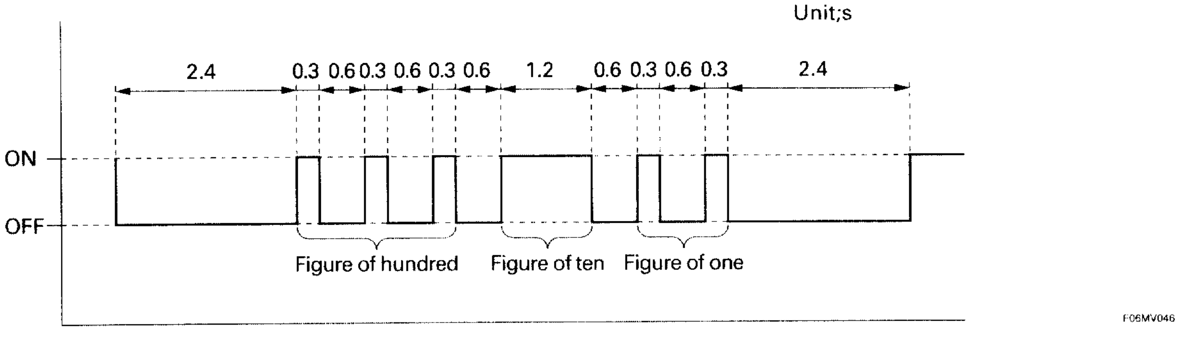
- DTC outputting is done in decreasingly order of DTC number.
- Indication is changed over on completion of output DTC indication.
- DTC indicator is stopped with diagnostic switch being off.
- When there is no DTC output, "1" is outputted in normal DTC code.
- After indicating 3 times pear 1 DTC, shift is conducted to the next DTC. (After making a round, the indications are repeated again.)
- In case of the same diagnostic code, it is used 1 DTC (3 times indication.)

Example Diagnosis Trouble Code Output

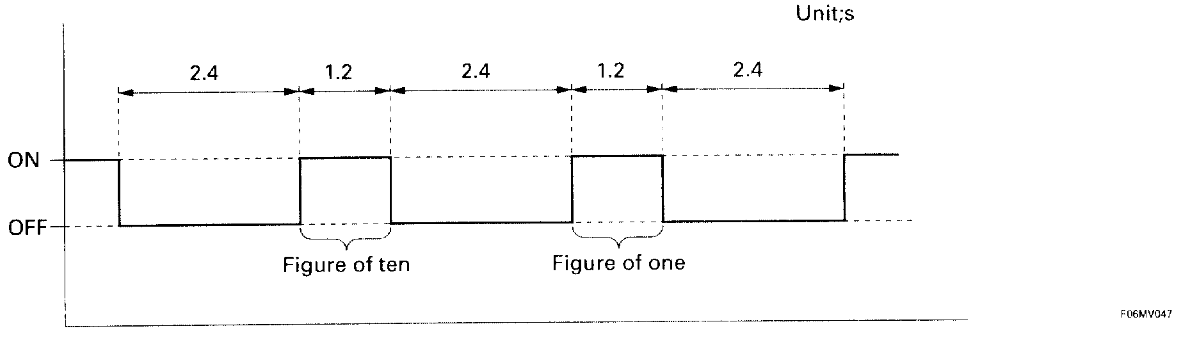
(For example) In case of indicate two digits figure "DTC23"



(For example) In case of indicate three digits figure "DTC312"

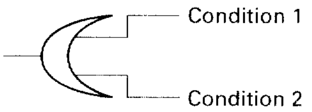


(For example) In case of indicate two digits figure "DTC10"



Clearing method of diagnosis trouble code

Under the following condition, the diagnosis code memorized in EEPROM is cleared.



Condition 1:

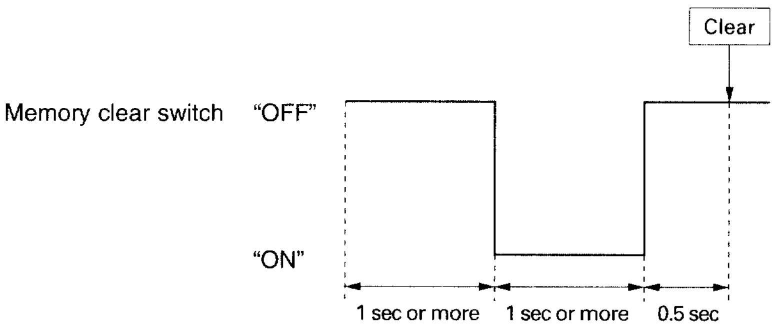
Memory clear switch "OFF" continues 1 sec. or more.

↓

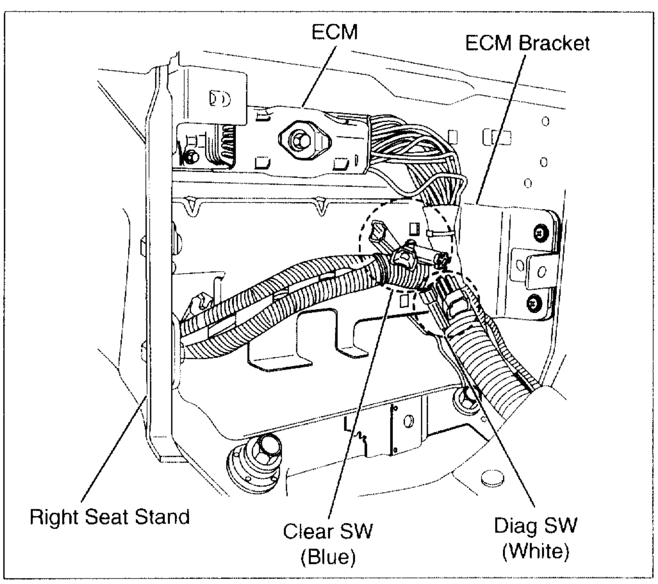
Memory clear switch "ON" continues 1 sec. or more.

↓

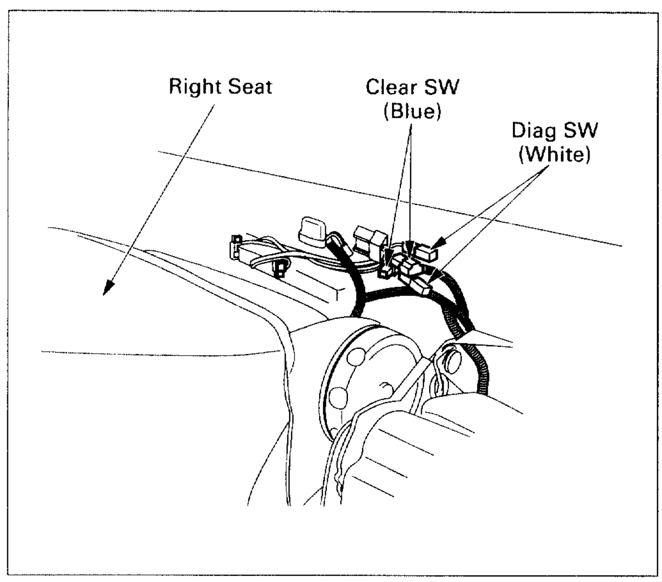
Memory clear switch "OFF" continues 0.5 sec. or more.



Vehicle type: FRR



Vehicle type: FSR, FTR, FVR



Condition 2:

EEPROM data does not match its mirror data.

Typical Scan Data Values

Use the Typical 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 e seen on a normally-running engine.

NOTE: 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.

Scan Tool Parameter	Data List	Units Displayed	Engine Scan Tool Data List Values (Idle)
Engine Speed	Engine	RPM	630 ± 15 (∗1)
Desired Idle Speed	Engine	RPM	630 ± 15(∗1)
App Angle	Engine	%	0
APP Sensor	Engine	Volts	1.34
ECT Engine Coolant Temp.	Engine	°C (°F)	Less than 90 (194)
Fuel Temperature	Engine	°C (°F)	36 ~ 43 (96.8 ~ 109.4)
Maximum Fuel Temperature	Engine	°C (°F)	Less than 100 (212)
Boost Pressure Sensor	Engine	kPa	–2 ~ 2
Actual Fuel Rail	Engine	MPa	25 ~ 26
Desired Rail Pressure	Engine	MPa	25.5
BARO	Engine	kPa	98 ~ 102
Battery Voltage	Engine	Volts	14 ~ 15 V
Starter Switch	Engine	ON/OFF	ON
Neutral Switch	Engine	ON/OFF	ON
Clutch Switch	Engine	ON/OFF	OFF
Exhaust Brake Switch	Engine	ON/OFF	OFF
Engine Stop Switch	Engine	ON/OFF	OFF
Diagnostic Switch	Engine	ON/OFF	OFF
Main Injection Timing	Engine	deg	–1.5 ~ –2.0
Over Speed Number of Times	Engine		0
Overheat Number of Times	Engine		0
Flow Limiter 1	Engine		0
Flow Limiter 2	Engine		0
Flow Limiter 3	Engine		0
Flow Limiter 4	Engine		0
Flow Limiter 5	Engine		0
Flow Limiter 6	Engine	mm^3	0
Balancing Rate Cyl. 1	Engine	mm	–5 ~ 5
Balancing Rate Cyl. 2	Engine	mm	–5 ~ 5
Balancing Rate Cyl. 3	Engine	mm	–5 ~ 5
Balancing Rate Cyl. 4	Engine	mm	–5 ~ 5
Balancing Rate Cyl. 5	Engine	mm	–5 ~ 5
Balancing Rate Cyl. 6	Engine	mm	–5 ~ 5
Final Fuel Rate	Engine	mm^3	5.0
Fuel Rate at Start	Engine	mm^3	0

Scan Tool Parameter	Data List	Units Displayed	Engine Scan Tool Data List Values (Idle)
Fuel Rate at Max Speed	Engine	mm^3	249.6
Sprit Fuel Rate	Engine	mm^3	20
Crank Signal Present	Engine	Yes/No	Yes
Injection Pump Signal Present	Engine	Yes/No	Yes
Cylinder Balance Mode	Engine	Yes/No	Yes
Injection Control Mode	Engine	Control stop/Normal	NORMAL INJ.
Pump Control Mode	Engine	Control stop/Normal	NORMAL
Engine Start Mode	Engine	Yes/No	No
Engine Running	Engine	Yes/No	Yes

NOTE:

(*1) Make sure the desired idle speed and actual idle speed in the data list on the Tech2.
When the engine is at idle, the desired idle speed is applied lower creation by ECM, the result is displayed 614 rpm.
When the actual idle speed is displayed about 614 rpm, the result is normal at idle.

Engine Data Definitions

Data Display Engine 1

Engine Speed	Engine speed is computed by the ECM from the CKP sensor. It should remain close to desired idle under various engine loads with engine idling.
APP Angle	APP angle is computed by the ECM from APP sensor voltages. This should display 0% at idle and 100% at wide open throttle.
Boost Pressure Sensor	The boost pressure sensor measures the change in intake manifold pressure from the engine load.
BARO	The barometric pressure is used to compensate for altitude difference. The BARO is mounted in the ECM.
ECT	The ECT is displayed engine coolant temperature. The ECM applies 5 volts to the ECT circuit. The sensor is a thermistor which changes internal resistance as temperature changes When the sensor is cold (high resistance), the ECM monitors a high signal voltage and interprets that as a cold engine.
Ambient Air Temp.	The ambient air temp. is displayed ambient air temperature. The ECM applies 5 volts to the ambient air temperature sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes.
Fuel Temperature	5 volts to the fuel temperature sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes.
Battery Voltage	This represents the system voltage measure by the ECM at ignition feed.

Data Display Engine 2

Engine Speed	Engine speed is computed by the ECM from the CKP sensor. It should remain close to desired idle under various engine loads with engine idling.
Desired Idle Speed	The desired 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.
APP Angle	APP angle is computed by the ECM from APP sensor voltages. This should display 0% at idle and 100% at wide open throttle.
ECT	The ECT is displayed engine coolant temperature. The ECM applies 5 volts to the ECT circuit. The sensor is a thermistor which changes internal resistance as temperature changes. When the sensor is cold (high resistance), the ECM monitors a high signal voltage and interprets that as a cold engine.
Fuel Temperature	5 volts to the fuel temperature sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes.
Actual Rail Pressure	This is displayed current rail pressure. The ECM will compensate for rail pressure to desired rail pressure.
Desired Rail Pressure	The desired rail pressure that the ECM is commanding. The ECM will compensate for rail pressure on APP angle.
Main Injection Timing	The main injection timing that the ECM is commanding. The ECM will compensate for main injection timing by APP angle and various sensor signals.
Basic Fuel Rate	The basic fuel rate that the ECM is commanding. The ECM will compute for the basic fuel rate by various sensor signals.
Final Fuel Rate	This is displayed current fuel rate. The ECM will compensate for fuel rate to basic fuel rate.
PC Valve Close Interval	This is displayed the PC valve operation interval. The ECM will compute for the PC valve operation by various sensor signals.

Battery Voltage	This represents the system voltage measured by the ECM at ignition feed.
Exhaust Brake Switch	This is displayed operating status for the exhaust brake switch.
Engine Stop Switch	This is displayed operating status for the engine stop switch.
Diagnostic Switch	This is displayed operating status for the diagnostic switch.
Neutral Switch (Automatic Only)	This is displayed operating status for the neutral switch.
Clutch Switch (Manual Only)	This is displayed operating status for the clutch switch.
Starter Switch	This is displayed operating status for the engine starter switch.

Data Display Engine 3

Engine speed	Engine speed is computed by the ECM from the CKP sensor. It should remain close to desired idle under various engine loads with engine idling.
Actual Rail Pressure	This is displayed current rail pressure. The ECM will compensate for rail pressure to desired rail pressure.
Basic Fuel Rate	The basic fuel rate that the ECM is commanding. The ECM will compute for the basic fuel rate by various sensor signals.
Final Fuel Rate	This is displayed current fuel rate. The ECM will compensate for fuel rate to basic fuel rate.
Fuel Rate at Start	This is displayed fuel rate at engine start.
Fuel Rate at Maximum Speed	This is displayed fuel rate at engine maximum speed in this ignition.
Fuel Rate Correction	This is displayed fuel rate correction. The ECM will compensate for fuel rate by APP sensor angle and various sensor signals.
ISC Fuel Rate Correction	This is displayed fuel rate correction for the engine idling. The ECM will compensate for fuel rate by various sensor signals.
ISC Fuel Rate Proportional	This is displayed fuel rate correction for the engine idling. The ECM will compensate for fuel rate by various sensor signals.
ISC Fuel Rate Integral	This is displayed integral fuel rate for the engine idling. The ECM will compensate for fuel rate by various sensor signals.
Split Fuel Rate	This is displayed split fuel rate.
Balancing Rate Cyl. 1	This is displayed fuel rate at engine idling. The ECM will compensate for cylinder balancing fuel rate by various sensor signals.
Balancing Rate Cyl. 2	This is displayed fuel rate at engine idling. The ECM will compensate for cylinder balancing fuel rate by various sensor signals.
Balancing Rate Cyl. 3	This is displayed fuel rate at engine idling. The ECM will compensate for cylinder balancing fuel rate by various sensor signals.
Balancing Rate Cyl. 4	This is displayed fuel rate at engine idling. The ECM will compensate for cylinder balancing fuel rate by various sensor signals.
Balancing Rate Cyl. 5	This is displayed fuel rate at engine idling. The ECM will compensate for cylinder balancing fuel rate by various sensor signals.
Balancing Rate Cyl. 6	This is displayed fuel rate at engine idling. The ECM will compensate for cylinder balancing fuel rate by various sensor signals.
Injection Control Mode	This is displayed control mode for fuel injection.

Data Display Engine 4

Engine speed	Engine speed is computed by the ECM from the CKP sensor. It should remain close to desired idle under various engine loads with engine idling.
Desired Idle Speed	The desired 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.
APP Angle	APP angle is computed by the ECM from APP sensor voltages. This should display 0% at idle and 100% at wide open throttle.
ECT	The ECT is displayed engine coolant temperature. The ECM applies 5 volts to the ECT circuit. The sensor is a thermistor which changes internal resistance as temperature changes. When the sensor is cold (high resistance), the ECM monitors a high signal voltage and interprets that as a cold engine.
Main Injection Timing	The main injection timing that the ECM is commanding. The ECM will compensate for main injection timing by APP angle and various sensor signals.
Fuel Temperature	5 volts to the fuel temperature sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes.
Actual Rail Pressure	This is displayed current rail pressure. The ECM will compensate for rail pressure to desired rail pressure.
Desired Rail Pressure	The desired rail pressure that the ECM is commanding. The ECM will compensate for rail pressure on APP angle.
PC Valve On Time	This is displayed the PC valve On time. The ECM will compute for PC valve operating by various sensor signals.
Flow Limiter 1	This is displayed operation times for the flow damper. The ECM will operate the flow damper by various sensor signals.
Flow Limiter 2	This is displayed operation times for the flow damper. The ECM will operate the flow damper by various sensor signals.
Flow Limiter 3	This is displayed operation times for the flow damper. The ECM will operate the flow damper by various sensor signals.
Flow Limiter 4	This is displayed operation times for the flow damper. The ECM will operate the flow damper by various sensor signals.
Flow Limiter 5	This is displayed operation times for the flow damper. The ECM will operate the flow damper by various sensor signals.
Flow Limiter 6	This is displayed operation times for the flow damper. The ECM will operate the flow damper by various sensor signals.
Pump Control Mode	This is displayed mode the fuel pump control. Operate the flow damper by various sensor signals.
Injection Control Mode	This is displayed control mode for fuel injection.

Data Display Engine 5

Engine speed	Engine speed is computed by the ECM from the CKP sensor. It should remain close to desired idle under various engine loads with engine idling.
Desired Idle Speed	The desired 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	The ECT is displayed engine coolant temperature. The ECM applies 5 volts to the ECT circuit. The sensor is a thermistor which changes internal resistance as temperature changes. When the sensor is cold (high resistance), the ECM monitors a high signal voltage and interprets that as a cold engine.
APP Angle	APP angle is computed by the ECM from APP sensor voltages. This should display 0% at idle and 100% at wide open throttle.
APP Sensor	The voltage being monitored by the ECM on the APP sensor signal circuit.
Actual Rail Pressure	This is displayed current rail pressure. The ECM will compensate for rail pressure to desired rail pressure.
Desired Rail Pressure	The desired rail pressure that the ECM is commanding. The ECM will compensate for rail pressure on APP angle.
Main Injection Timing	The main injection timing that the ECM is commanding. The ECM will compensate for main injection timing by APP angle and various sensor signals.
PC Valve On Time	This is displayed the PC valve On time. The ECM will compute for PC valve operating by various sensor signals.
PC Valve Close Interval	This is displayed the PC valve operation interval. The ECM will compute for the PC valve operation by various sensor signals.
Basic PC Valve On Time	The basic PC valve On time that the ECM is commanding. The ECM will compute for the basic PC valve On time by various sensor signals.
Battery Voltage	This represents the system voltage measure by the ECM at ignition feed.
Fuel Temperature	5 volts to the fuel temperature sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes.
Maximum Fuel Temperature	ECM applies 5 volts to the fuel temperature sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes.
Injection Control Mode	This is displayed control mode for fuel injection.
Pump Control Mode	This is displayed mode the fuel pump control. Operate the flow damper by various sensor signals.
Overheat Number of Times	This is displayed times for engine overheat.
Over Speed Number of Times	This is displayed times for engine over speed.

Data Display Engine 6

APP Angle	APP angle is computed by the ECM from APP sensor voltages. This should display 0% at idle and 100% at wide open throttle.
Engine speed	Engine speed is computed by the ECM from the CKP sensor. It should remain close to desired idle under various engine loads with engine idling.
Actual Rail Pressure	This is displayed current rail pressure. The ECM will compensate for rail pressure to desired rail pressure.
Fuel Temperature	5 volts to the fuel temperature sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes.
Main Injection Timing	The main injection timing that the ECM is commanding. The ECM will compensate for main injection timing by APP angle and various sensor signals.
Main Injection Interval	The main injection interval that the ECM is commanding. The ECM will compensate for main injection interval by APP angle and various sensor signals.
Pilot Injection Interval	This is displayed the pilot injection interval. The ECM will compute for the pilot injection interval by various sensor signals.
Split Injection Interval	This is displayed the split injection interval. The ECM will compute for the split injection interval by various sensor signals.
End of Split Injection	This is displayed the engine speed for end of split injection interval in this ignition.
PC Valve On Time	This is displayed the PC valve On time. The ECM will compute for PC valve operating by various sensor signals.
PC Valve On Feedback	ECM will compute for PC valve operating by various sensor signals.
PC Valve On Length	This is displayed the PC valve ON length. The ECM will compute for PC valve operating by various sensor signals.
PC Valve Delay Time	This is displayed the PC valve delay time.
Crank Signal Present	This is displayed input signal status by the CKP sensor.
Injection Pump Signal Present	This is displayed input signal status by the CMP sensor.
Cylinder Balance Mode	This is displayed cylinder balance mode by the ECM.
Engine Start Mode	This is displayed engine start mode by the ECM.
Engine Running	This is displayed engine running mode by the ECM.

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 DTC(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 CHECK

Several of the symptom procedures call for a careful visual 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, as shown on the "Vehicle Emission Control Information" label. Check thoroughly for any type of leak or restriction.
- Air intake ducts for collapsed or damaged areas.
- Ignition component for cracking, hardness, and carbon tracking.
- Wiring for proper connections, pinches and cuts.

INTERMITTENTS

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 (DTC) 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.

Road test the vehicle with a J 39200 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 monitors.

Use a scan tool to help detect intermittent conditions.

COMMON RAIL SYSTEM & SYMPTOM DIAGNOSIS MENU:

- Engine hard starting
- Engine stall
- Engine will not start and run
- Rough engine idling
- Engine hunting
- Surging, hesitation
- High idle engine speed
- Excessive white or blue smoke
- Excessive black smoke
- Lack of power
- Air bleed error
- Fuel leakage
- Tachometer output error
- Exhaust brake error

The possibility DTCs with symptom diagnosis

Description	DTC(s)
Engine hard starting	14, 15, 118, 158, 159, 227, 23
Engine stall	35, 227, 417
Engine will not start and run (Refer to common rail system check)	14, 15, 421, 217, 218, 247, 248, 271, 272, 273, 274, 275, 276, 158, 159, 115, 245, 417
Rough engine idling (Refer to common rail system check)	14, 15, 35, 115, 118, 151, 158, 159, 217, 218, 245, 247, 248, 261, 262, 263, 264, 265, 266, 271, 272, 273, 274, 275, 276, 421, 23
Engine hunting	115, 118, 151, 245
Surging, Hesitation	211
High idle engine speed/ Engine starts but will not accelerate	24, 35, 217, 218, 226, 227, 245, 247, 248
Engine run steady (Refer to common rail system check)	416
Excessive White or Blue Smoke	71, 118, 151, 22
Excessive Black Smoke	34, 115, 217, 218, 226, 245, 247, 248, 32, 42, 65
Lack of Power	24, 32, 34, 35, 42, 65,115, 118, 158, 159, 217, 218, 226, 245, 247, 248, 261, 262, 263, 264, 265, 266, 271, 272, 273, 274, 275, 276
Tachometer Output Error	14, 15

Hard Start Symptom

STEP	ACTION	VALUE	YES	NO
1	**DEFINITION:** Engine cranks, but does not start for a long time. Does eventually run, or may start but immediately stalls. Was the "On-Board Diagnostic (OBD) System Check" 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	Following below the DTCs stored: DTC 14, 15, 23, 118, 158, 159, 227	—	Go to applicable DTC table	Go to step 5
5	Check the fuel leakage on the high fuel pressure line. If the fuel leakage is found, repair as necessary. Was the fuel leakage found?	—	Verify repair	Go to step 6
6	1. Check for water-or alcohol-contaminated fuel. 2. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Go to step 7
7	1. Check the battery voltage. 2. If a problem is found, repair as necessary Was a problem found?	—	Verify repair	Go to step 8
8	1. Check for the following engine mechanical problems (Refer to Engine Mechanical): • Low compression • Leaking cylinder head gaskets • Worn or incorrect camshaft • Camshaft drive belt slipped or stripped 2. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Go to step 9
9	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: • Visual/physical inspection • Tech2 data • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Contact Technical Assistance

Engine Stall

STEP	ACTION	VALUE	YES	NO
1	**DEFINITION:** Engine cranks, but does not start. Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Was battery within specification?	More than 8V	System OK	Go to step 3
3	Check charging circuit and/or generator condition. Were they operate properly?	—	Go to step 4	Repair/replace problem part
4	Following below the DTCs stored: DTC 35, 227, 417	—	Go to applicable DTC table	Go to step 5
5	Was fuel used within specification?	See owner's manual	Go to step 6	Replace fuel with recommend specification
6	Did you find to contamination of diesel with gasoline, etc?	—	Replace fuel	Go to step 7
7	Did you find any leakage on the fuel pump, injection pipe etc.?	—	Repair problem part	Go to step 8
8	Had you bleed air from fuel line?	—	Go to step 9	Bleed air from fuel line
9	Was the air filter full of debris or other contaminants?	—	Repair/replace problem part	Go to step 10
10	Was fuel pre filter restricted?	—	Go to step 11	Repair/replace problem part
11	Was gauze filter restricted? (The gauze filter is fixed in suction eye bolt on the supply pump)	—	Go to step 12	Clean gauze filter or replace it.
12	Was fuel main filter normal condition? (Clog breakage etc.)	—	System OK	Replace fuel filter element

Engine Hunting

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) system check" performed?	—	Go to step 2	Go to OBD System Check
2	Is engine oil used within specification viscosity?	See owner's manual	Go to step 3	Replace engine oil
3	Did you find dilution of engine oil?	—	Replace engine oil and repair cause of dilution.	Go to step 4
4	Is fuel used within recommendation specification?	See owner's manual	Go to setp 5	Replace fuel with recommend specification.
5	Did you find gasoline contaminated with fuel?	—	Replace fuel	Go to step 6
6	Did you find any breakage on the fuel pump, injection pipe etc.?	—	Repair/replace problem part.	Go to step 7
7	Are fuel filters (prefilter, gauze filter and fuel main filter) normal condition? (The gauze filter is fixed in suction eye bolt on the supply pump.)	—	Go to step 8	Clean/replace problem fuel filter
8	Is air filter normal condition?	—	Go to step 9	Repair/replace problem part
9	Did you done bleeding air from fuel line? Refer to bleeding fuel system on section 6C2 in this manual.	—	Go to step 10	Bleed air from fuel line
10	Following below the DTCs stored: DTC 115, 118, 151, 245	—	Go to applicable DTC table	Go to step 11
11	Check injection balance each for cylinder. Was injection balance of the normal?	—	System OK	Go to step 12
12	Check activity flow damper and/or fuel pipe condition. Did you find any problem on the above part?	—	Replace problem part.	Replace supply pump assembly.

Surging, Hesitation

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) system check" performed?	—	Go to step 2	Go to OBD System Check
2	Is engine oil used within specified viscosity?	See owner's manual	Go to step 2	Replace engine oil
3	Is the engine oil diluted?	—	Replace engine oil and repair cause of dilution.	Go to step 3
4	Is correct fuel used?	See owner's manual	Go to step 4	Replace fuel with recommend specification
5	Is the fuel contaminated with gasoline?	—	Replace fuel	Go to step 5
6	Did you find any damage on the fuel pump, injection pipe etc.?	—	Repair/replace problem part.	Go to step 6
7	Are fuel filters (prefilter, gauze filter and fuel main filter) normal condition? (The gauze filter is fixed in suction eye bolt on the supply pump)	—	Go to step 7	Clean/replace problem fuel filter
8	Is air filter normal condition?	—	Go to step 8	Repair/replace problem part
9	Have you bleed air from fuel line?	—	Go to step 9	Bleed air from fuel line
10	Following below the DTCs stored: DTC 211	—	Go to applicable DTC table	Go to step 11
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: • Visual/physical inspection • Tech2 data • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Contact Technical Assistance

High Idle Engine Speed/Engine Starts But Will Not Accelerate

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) system check" performed?	—	Go to step 2	Go to OBD System Check
2	Following below the DTCs stored: DTC 24, 35, 217, 218, 226, 227, 245, 247, 248	—	Go to applicable DTC table	Go to step 3
3	Check accelerator pedal condition. Was a problem found?	—	Repair or Replace Go to step 1	Replace ECM

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Excessive White or Blue Smoke

STEP	ACTION	VALUE	YES	NO
1	Was engine oil used within specified viscosity?	See owner's manual	Go to step 2	Replace engine oil.
2	Was fuel used within recommended specification? **NOTE: Low cetane number fuel is used, may caused white smoke.**	See owner's manual	Go to step 3	Replace fuel with recommend specification
3	Has gasoline contaminated the fuel?	—	Replace fuel	Go to step 4
4	Bleed air from the fuel lines?	—	Go to step 5	Bleed air from fuel line
5	Following below the DTCs stored: DTC 22, 71, 118, 151		Go to applicable DTC table	Go to step 6
6	Check the mechanical fuel injection timing. Was the problem found?	—	Repair to fuel injection timing	Go to step 7
7	Was compression normal?	More than 2157 kPa (313 psi)	Go to step 8	Repair/replace problem portion (Piston ring, valve stem seal etc.)
8	Was oil entering down turbocharger oil seal? (Blue smoke)	—	Replace oil seal	Go to step 9
9	Was oil entering down piston ring? (Blue smoke)	—	Replace piston ring	Go to step 10
10	Was oil entering down valve stem? (Blue smoke)	— —	Replace valve stem seal	Go to step 1

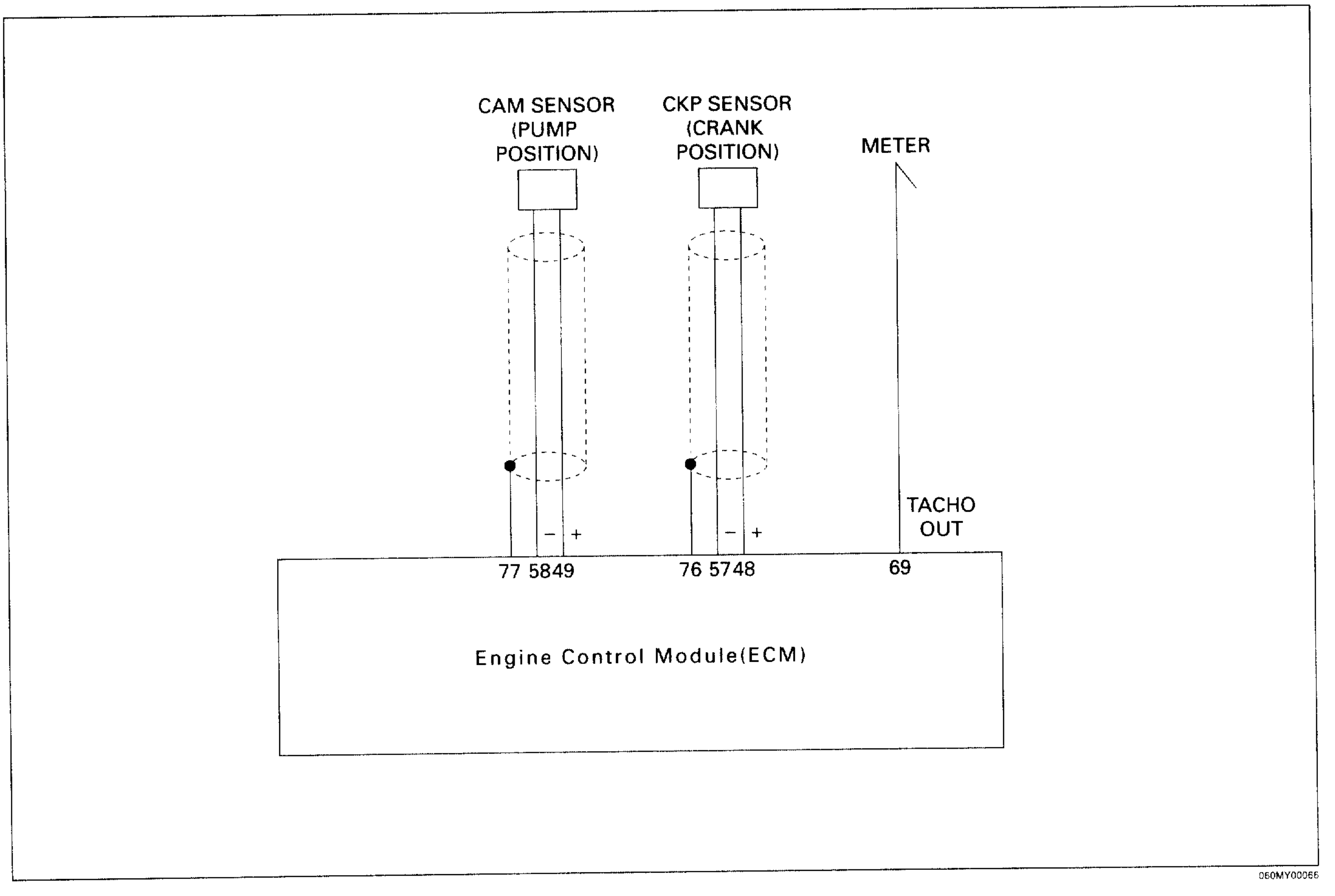
Excessive Black Smoke

STEP	ACTION	VALUE	YES	NO
1	Was engine oil used within specified viscosity?	See owner's manual	Go to step 2	Replace engine oil
2	Was fuel used within recommended specification?	See owner's manual	Go to step 3	Replace fuel with recommend specification
3	Following below the DTCs stored: DTC 32, 34, 42, 65, 115, 217, 218, 226, 245, 247, 248	—	Go to applicable DTC table	Go to step4
4	Check the mechanical fuel injection timing. Was the problem found:	—	Repair to fuel injection timing	Go to step 5
5	Was compression normal?	More than 2157 kpa (313 psi)	Go to step 6	Repair/replace problem portion (Piston ring, value stem seal etc.)
6	Was there a restriction in the exhaust system? (Include exhaust brake system, option on M/T only)	—	Go to step 7	Repair/replace problem portion.
7	Did turbocharger operate properly?	—	Go to step 8	Repair/replace turbocharger
8	Was carbon build up on the tip of the injector?	—	Replace injector assembly	Go to step 9
9	Was there carbon build up or damage to piston or cylinder?	—	Repair/replace problem portion.	System OK

Lack of Power

STEP	ACTION	VALUE	YES	NO
1	**DEFINITION:** Engine delivers less than expected power. Little or no increase in speed when accelerator pedal is pushed down part-way. Was the "On-Board Diagnostic (OBD) System Check" performed ?		Go to step 2	Go to OBD System Check
2	Following below the DTCs stored: "Refer to "The possibility DTCs with symptom diagnosis".	—	Go to applicable DTD table	Go to step 3
3	1. Ignition "OFF". 2. Install Tech2. 3. Ignition "ON", engine is running. 4. Attempt to engine data with the Tech2. 5. Observe actual rail pressure on the engine data. 6. Operate on acceleration pedal at 2500 – 3000 rpm on engine speed, and observe the actual rail pressure. Did the actual rail pressure have a pressure reading above the specified value?	120 MPa	Go to step 4	Go to step 5
4	Replace the common rail ASM. (Replace the pressure limiter) Was the action complete?	—	Go to step 5	—
5	Is oil level OK?	—	Go to step 6	Readjust oil level
6	Is engine oil used within specified viscosity?	—	Go to step 7	Replace engine oil
7	Check the below the filters: Air filter element Oil filter element Fuel filter element Fuel gauze filter (Supply pump)	—	Go to step 8	Clean or replace filter element
8	Is air intake system clogged?	—	Take out foreign material	Go to step 9
9	"Did you find any damage on the fuel pump," "injection pump, etc.?"	—	Repair or replace problem part	Go to step 10
10	Is exhaust brake system OK? (Option on M/T only)	—	Repair or replace problem part	Go to step 11
11	Is engine static timing correct?	—	System OK	Readjust correct timing

TACHOMETER OUTPUT ERROR (No available DTC)



Circuit Description

When CKP sensor and CAM sensor instable (DTC not indicated), tachometer output becomes abnormal. If vehicle running performance is adversely affected, repair the abnormality first.

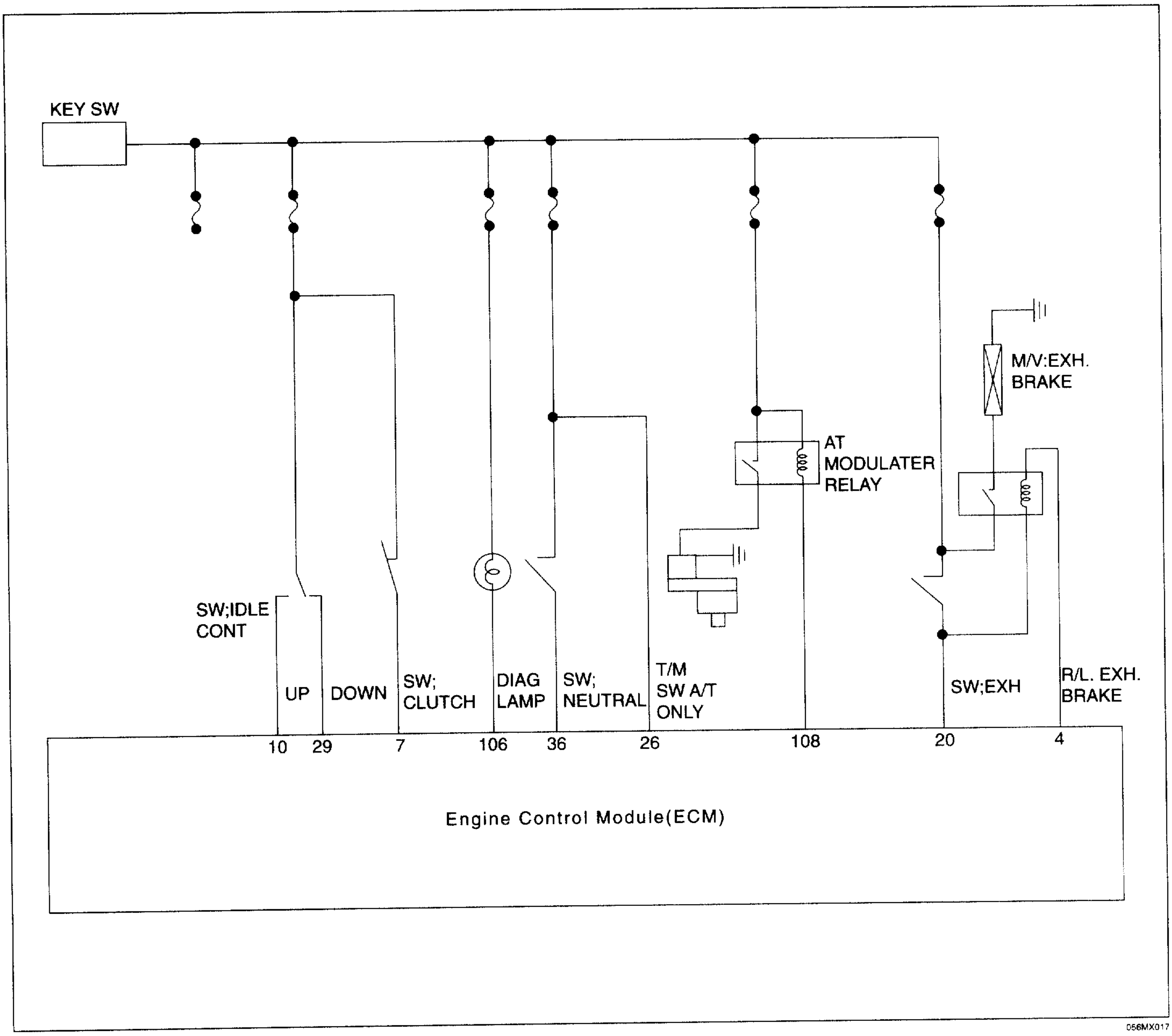
Unless CKP sensor and CAM sensor signal both normal, tachometer output not produced.

- ECM delivers shortwave of 17.5 pulse (0 – 5V) per a rotation to tachometer.
- Tachometer do not produce output at 230 rpm or less.
- If checking by voltage, digital multimeter reads around 2.5V under engine idling, and 5V or 0V for output abnormality.

Tachometer Output Error (No available DTC)

STEP	ACTION	VALUE	YES	NO
1	Did tachometer output error appear without CKP sensor error and CAM sensor error indication during engine in operation? Note: **When CKP sensor and CAM sensor instable (DTC not indicated), tachometer output become abnormal.** **If vehicle running performance adversely affected, repair the abnormality first.** **Unless CKP sensor and CAM sensor signal both normal, tachometer output is not produced.**	—	Go to step 2	• While engine running, CKP sensor NG: Indication abnormal. CAM sensor NG: can be indicated. • After key "OFF", it either CKP sensor or CAM sensor damaged, indication became abnormal.
2	Measure waveform between pin number 69 (TACH) and pin number 102 (ECM–GND) at ECM side. Did the pulse appear?	184Hz	Replace tachometer and/or repair tachometer wire harness.	Go to step 3
3	1. Disconnect connector tachometer side or intermediate connector. (Disconnect tachometer) 2. Measure waveform same as step 2. Did appear the pulse?	184Hz	System OK	Replace ECM
	Note: • **ECM delivers shortwave of 17.5 pulse (0 – 5V) per a rotation to tachometer.** • **Tachometer does not produce output at 230 rpm or less.** • **If checking by voltage, digital multimeter reads around 2.5V under engine idling, and 5V or 0V for output abnormality.**			

EXHAUST BRAKE ERROR (No DTC set) (Option on M/T only)



Exhaust Brake Error (No DTC set) (Option on M/T only)

STEP	ACTION	VALUE	YES	NO
1	Did exhaust brake relay turn "ON" and turn "OFF"?	—	—	Go to step 2
2	Did you find DTC 0024?	—	Repair DTC 0024 first	Go to step 3
3	Measure voltage following points during acceleration "OFF" at ECM ACC1 or ECM ACC2. • Between pin number 41 (ACC1) and pin number 45 (ACC1–GND). • Between pin number 42 (ACC2) and pin number 46 (ACC2–GND). Was voltage within value?	1.4V or less	Go to step 5	Go to step 4
4	Check brake pedal linkage lever condition and/or check sensor adjustment. Was a problem found?	—	Replace Exh R/L	Repair/ readjustment
5	Measure voltage between pin number 20 (EXB/SW) and pin number 111 (GND) during key switch "ON", exhaust brake switch "ON" at ECM side connector. Was voltage within value?	12V	Go to step 6	Replace exhaust brake switch or repair wire harness.
6	Measure voltage between pin number 7 (CL/SW) and pin number 111 (GND) during key switch "ON" and clutch pedal not depressed at ECM side connector. Was voltage within value?	12V	Go to step 7	Replace clutch switch or repair wire harness.
7	1. Remove exhaust brake relay unit from relay connector. 2. Make connection relay unit to battery. Did relay operate?	—	Go to step 8	Replace Exh R/L
8	Install all parts and harness. Use scan tool test mode to check exhaust brake relay activation when key switch "ON" but engine does not run. Did trouble continue?	—	Replace ECM	System OK

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

COMMON RAIL SYSTEM DIAGNOSTIC CHECK

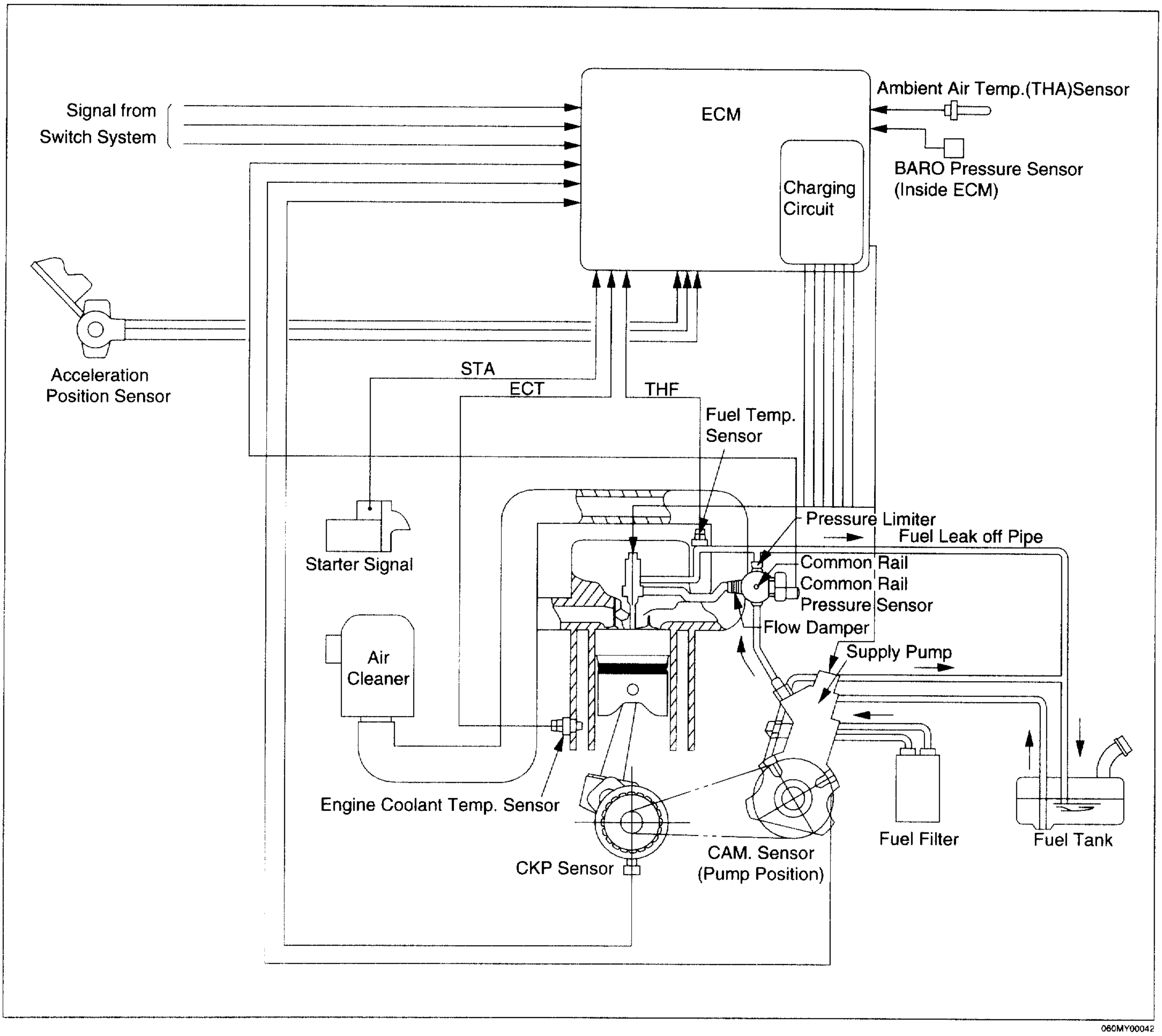
Caution taken in inspecting

(1) In inspecting the OBD system, write down self-diagnosis code to be indicated. (especially, when multiple self-diagnosis codes are indicated.)

(2) Before eliminating the indicated self-diagnosis codes by a memory clear switch, doubly inspect abnormal places as indicated in self-diagnosis code.
(Self-diagnosis code means 'Warning.' Make sure to inspect abnormal section.)

System check diagnostic charts	Possible Conditions
OBD System check	DTC261 to 266, (226, 227), 35, Scan tool (Air bleed, Flow damper, Common rail)
No MIL	Power supply, Ground, Lamp, ECM
MIL will not flash	Power supply, Ground, Lamp, ECM
Engine will not start	DTC 417 (Starter SW)
Check fuel injection and Timing relation (Engine OFF)	DTC 14, 15 (CKP, CAM sensor)
Check supply pump (Engine OFF)	DTC 421, 217, 218, 247, 248 (PCV)
Check injector (Engine OFF)	DTC 271 to 276, 158, 159 (Injector)
Check fuel pressure in common rail (Engine OFF)	DTC 115, 245, Supply pump
System operation check	Air cleaner, Engine oil, Idle control SW
Check fuel injection and Timing relation (Engine running)	DTC 14, 15 (CKP, CAM sensor)
Check supply pump (Engine running)	DTC 421, 217, 218, 247, 248, 226, 227 (PCV, Relay)
Check fuel pressure in common rail (Engine running)	DTC 118, 151 (24), 115, 245 (Common rail, PC)
Check injector [Flow damper/Fuel leak] (Engine running)	DTC 271 to 276, 158, 159 (Injector)
Check fuel system	DTC 226, 227, 118, 151 (Common rail, Fuel line)
Multiple DTCs stored	Common ground, Common power supply

OBD SYSTEM CHECK DIAGNOSIS CHART



Circuit Description

The Common rail system comprises fuel pump, pump control valve (PCV), common rail, two way valve (TWV), injection, flow dumper, pressure limiter, common rail pressure sensor, CAM sensor (Pump Positin), crank position sensor (CKP sensor) and etc.

This system will be clean emission. Because it make high presser fuel.

The fuel press at the fuel pump is send the common rail. PCV is regulated pressure in common rail.

The flow dumper will absorb pressure change in common rail. When Common rail pressure will be maximum, the pressure limiter will open.

Injector is inject fuel into a combustion chamber. And Fuel injection is controlled TWV. This timing is regulated ECM at CAM and CKP sensor.

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

OBD System Check Diagnosis Chart

Test Description

1. This is ECM check. Check warning lamp. When the lamp turn on keeping, it is series trouble.
2. This is self diagnosis of ECM. Connect diagnosis switch.
5. Engine idling will fined condition of the common rail system.
7. This check is Tech2 and ECM. Ignore engine date in this check.
9. ECM system error (DTC35) don't detect other DTCs.

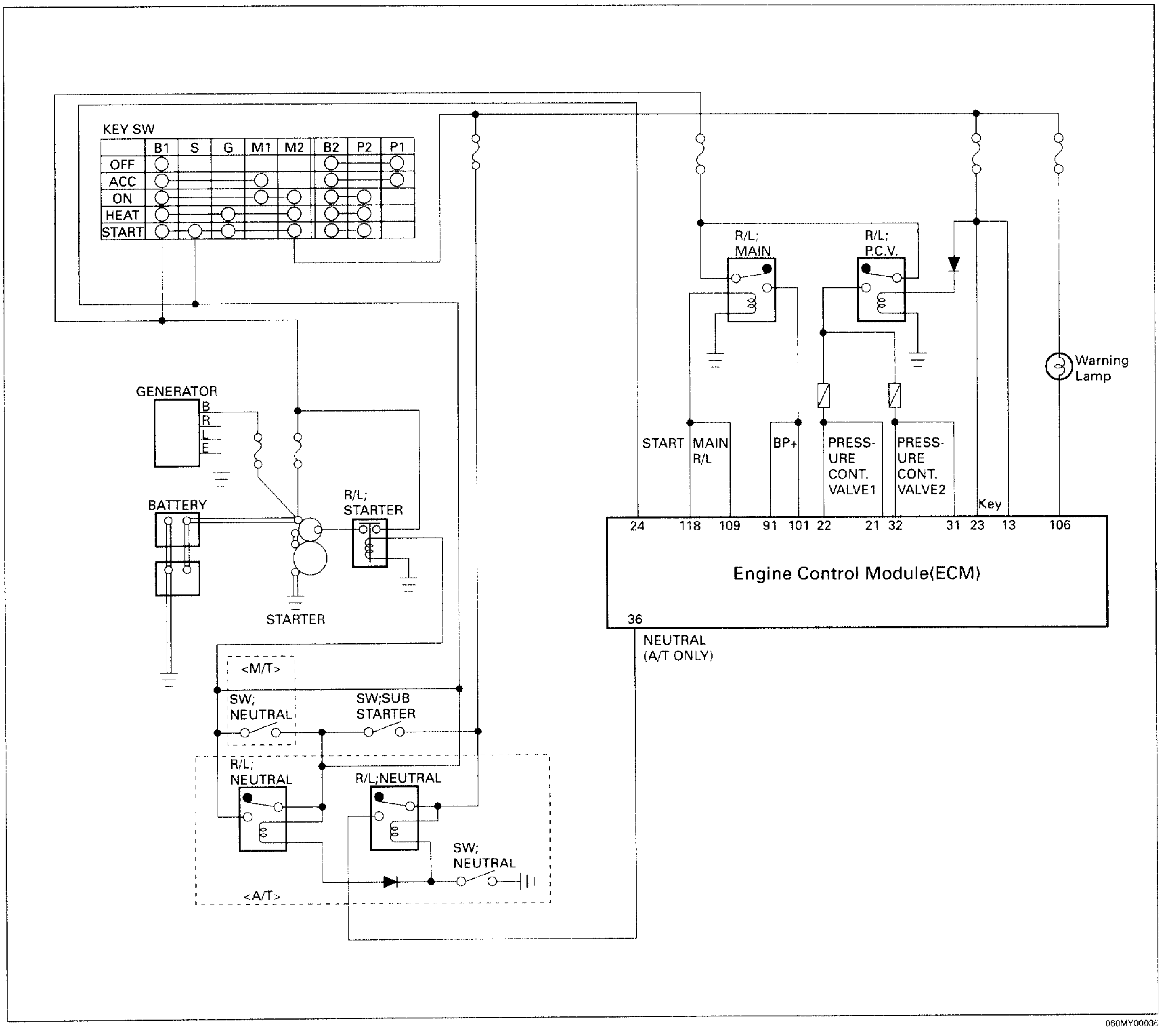
STEP	ACTION	VALUE	YES	NO
1	1. Ignition "OFF". 2. Ignition "ON", engine "OFF". 3. Check MIL lamp "ON" Did the MIL lamp stay "ON" for five seconds, then turn "OFF"?	5 sec.	Go to step 2	Go to "No MIL" Diagnosis chart
2	Connect the Diagnostic switch. Did the MIL flash?	—	Go to step 3	Go to "Will Not Flash" Diagnosis chart
3	Ignition "ON",engine "ON" Did the engine start and run?	—	Go to step 4	Go to "Engine will not start" Diagnosis chart
4	Engine "ON" Was "Check system operation check" performed?	—	Go to step 5	Go to "System operation check" Diagnosis chart
5	Was "Check the fuel system check" performed?	—	Go to step 6	Go to "Check the Fuel system" Diagnosis chart
6	1. Ignition "OFF". 2. Connect the scan tool. 3. Ignition "ON". Was the power supply "ON" and engine data indicated on the Scan tool ?	—	Go to step 7	Go to step 11
7	Check engine data at the scan tool data. Did the engine data normally?	—	Verify repair Go to step 8	Go to step 10
8	Check DTCs stored and record. If DTC "35" was stored, replace ECM as necessary. Was the ECM replaced?	—	Verify repair Go to step 1	Go to step 9
9	1. Engine "ON" 2. Check DTCs stored and record . Was DTC stored?	—	More 2 stored: Go to "Multiple DTCs stored" One stored: Go to "Applicable DTC table"	System OK

OBD System Check Diagnosis Chart (Cont.)

STEP	ACTION	VALUE	YES	NO
10	1. Probe applicable parts for an open to ground and short to voltage 2. Probe a sensor simple substance. If a problem was found, repair as necessary. Did the problem found ?	—	Verify repair Go to step 6	Intermittent Problem, Verify "Customer problem analysis check" Go to step 6
11	Probe DLC circuit for an open or close to ground and short to voltage. If a problem was found, repair as necessary. Did the problem found ?	—	Verify repair Go to step 6	Go to step 12
12	1. Check the program on the scan tool. 2. Check the scan tool. If a ploblem was found, repair or replace as necessary. Was a problem found ?	—	Verify repair Go to step 6	Go to step 13
13	Replace ECM.	—	Go to step 6	—

***IMPORTANT:* The replacement ECM must be restored the capture fuel rate data by Tech 2.**
Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

NO MIL DIAGNOSIS CHART



Circuit Description

The Common rail system comprises fuel pump, pump control valve (PCV), common rail, two way valve (TWV), injection, flow dumper, pressure limiter, common rail pressure sensor, CAM sensor (Pump Position), crank position sensor (CKP sensor) and etc.

This system will be clean emission. Because it make high presser fuel.

The fuel press at the fuel pump is send the common rail. PCV is regulated pressure in common rail.

The flow dumper will absorb pressure change in common rail. When Common rail pressure will be maximum, the pressure limiter will open.

Injector is inject fuel into a combustion chamber. And Fuel injection is controlled TWV. This timing is regulated ECM at CAM and CKP sensor.

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

No MIL Diagnosis Chart

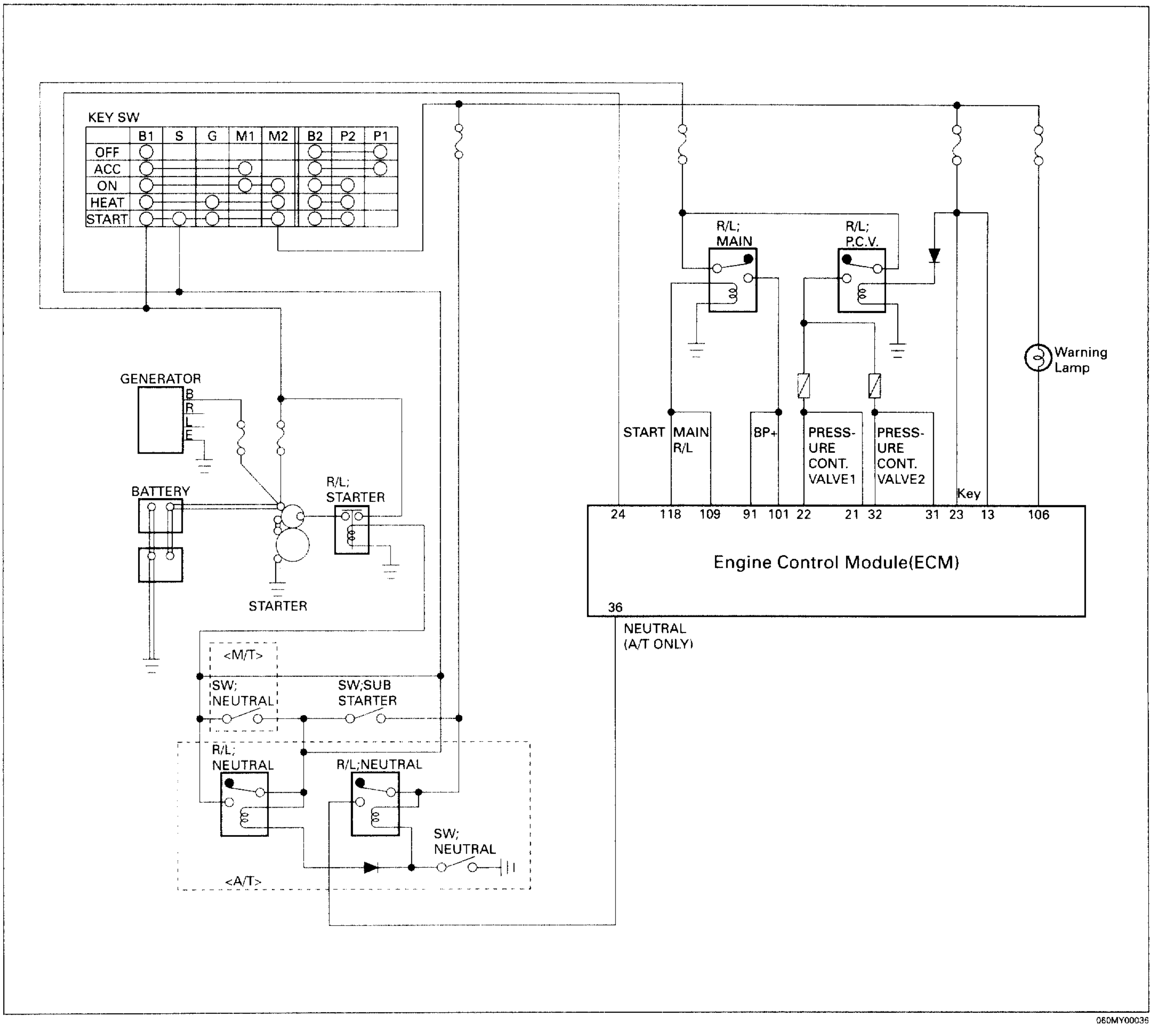
STEP	ACTION	VALUE	YES	NO
1	Was the MIL "OFF" steady?	—	Go to step 2	—
2	1. Ignition "ON", engine "OFF". 2. Check following fuses. (Main, PCV, Warning lamp, meter) If a problem was found, replace the fuse. Was a problem found ?	—	Verify repair	Go to step 3
3	1. Ignition "OFF". 2. Disconnect following fuses. (Main, PCV, Warning lamp, meter) 3. Probe circuits for an open or short. If a problem was found, repair as necessary. Was a problem found ?	—	Verify repair Go to "OBD system check" Diagnosis chart	Go to step 4
4	Check power supply circuit at fuses. If a problem was found, repair as necessary. Was a problem found ?	—	Go to "OBD system check" Diagnosis chart	Go to step 5
5	1. Ignition "ON" . 2. Check voltage at fuse. If a problem was found, repair as necessary. Was a problem found ?	—	Go to "OBD system check" Diagnosis chart Verify repair	Go to step 6
6	1. Ignition "OFF". 2. Check main relay. If a problem was found, replace a relay. Was a problem found ?	—	Verify repair Go to "OBD system check" Diagnosis chart	Go to step 7
7	1. Ignition "OFF". 2. Disconnect main relay. 3. Disconnect following fuses. • Main, PCV, Warning lamp, meter 3. Probe flowing point for an open to ground and short to voltage. • Between fuse and main relay • Between main relay and ECU If a problem was found, repair as necessary. Was a problem found?	—	Verify repair Go to "OBD system check" Diagnosis chart	Go to step 8
8	Check ground circuit. Probe following ground circuit. • ECM case • Power supply for the ECM If a problem was found, repair as necessary. Was a problem found ?	—	Verify repair Go to "OBD system check" Diagnosis chart	Go to step 9
9	Check a bulb for Warning lamp. If a problem was found, replace a bulb. Was a problem found ?	—	Verify repair Go to "OBD system check" Diagnosis chart	Go to step 10
10	1. Probe for an open or short between meter and ECM." If a problem was found, repair as necessary Was a problem found ?	—	Verify repair Go to "OBD system check" Diagnosis chart	Go to step 11

No MIL Diagnosis Chart (Cont.)

STEP	ACTION	VALUE	YES	NO
11	1. Probe for an open or short between meter and fuse. If a problem was found, replace ECM. Was a problem replace the ECM ?	—	Verify repair Go to "OBD system check" Diagnosis chart	Go to step 12
12	1. Ignition "ON", engine "OFF". 2. Check warning lamp "ON". Was the MIL "ON" for five seconds, then time "OFF"?	—	Verify repair Go to "OBD system check" Diagnosis chart	Go to step 13
13	1. Ignition "OFF" 2. Repair or replace meter assembly. Was the meter repaired/replaced?	—	Verify repair Go to "OBD system check" Diagnosis chart	—

***IMPORTANT:** The replacement ECM must be restored the capture fuel rate data by Tech 2.*
Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

MIL WILL NOT FLASH DIAGNOSIS CHART



Circuit Description

It comprises diagnosis switch, ECM, fuses, relays, bulb, battery and etc.

There is Warning lamp on the instrument panel. Diagnosis switch prepare under side of the passenger sheet.

This is check, when self diagnosis isn't operation.

Diagnosis switch connect. If the warning lamp isn't turned on, Excite this checking circuit.

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

Test Description

1 This is lamp check. When ground circuit was abnormal, it isn't flashing.

3 This check is meter circuit .

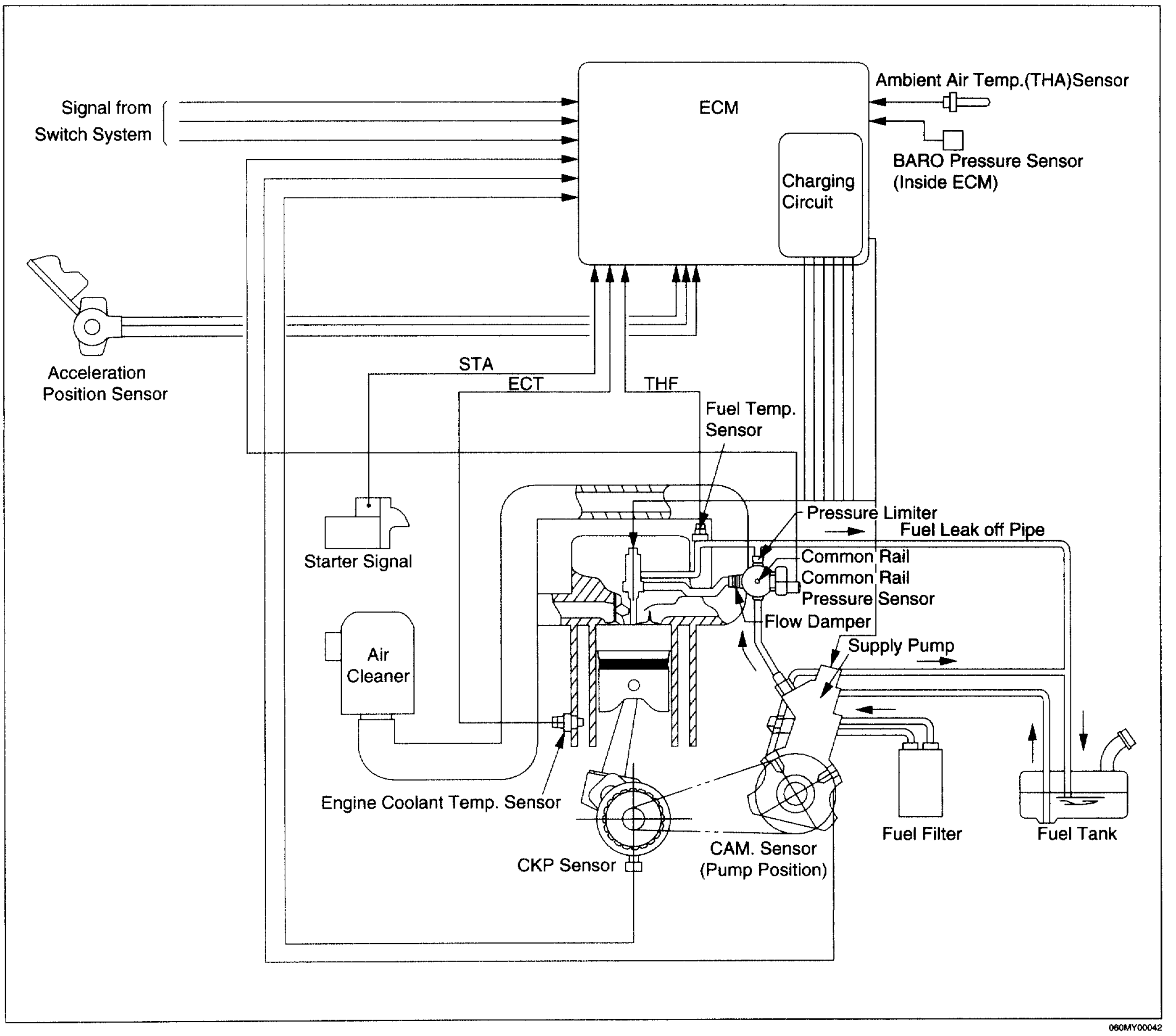
5 This is ground check. Probe any circuits.

MIL Will Not Flash Diagnosis Chart

STEP	ACTION	VALUE	YES	NO
1	1. Diag switch "OFF". 2. Ignition "OFF". 3. Disconnect ECM. 4. Ignition "ON". 5. Check MIL. Is MIL "ON" for 5 seconds, then turn "OFF"?	5 sec.	Go to OBD System check	Go to step 2
2	1. Ignition "OFF". 2. Probe lamp circuit between lamp and ECM for an open or short. If a problem was found, repair as necessary. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 3
3	1. Ignition "ON". 2. If NO lamp, repair meter and fuse. If a problem was found, repair as necessary. Was a problem found?	—	Verify repair Go to OBD System check	Go to step 4
4	1. Ignition "OFF". 2. Connect ECM. 3. Ignition "ON". 4. Diag switch "ON". 5. Check to see if MIL lamp is flashing. Is the MIL lamp flashing?	—	Go to step 5	Go to step 7
5	1. Ignition "OFF". 2. Check following circuit for open or short. • Between ECU and diag switch • Between diag switch and GND If a problem was found, repair diag switch circuit. Was a problem found?	—	Verify repair Go to OBD System check	Go to step 6
6	1. Ignition "ON". 2. Diag switch "ON". 3. Check to see if MIL lamp is flashing. Is the MIL lamp flashing?	—	Replace ECM Verify repair Go to OBD System check	Go to step 7
7	1. Check DTCs Was a DTC displayed?	—	Go to specific DTC Diagnosis chart	Go to OBD System check

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

ENGINE WILL NOT START DIAGNOSIS CHART



Circuit Description

Fuel system comprises fuel, fuel filter, starter switch, injectors, supply pump, sensors, ECM and etc.

There are any causes. It is fuel quality, fuel filter, and other. Refer to any section.

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

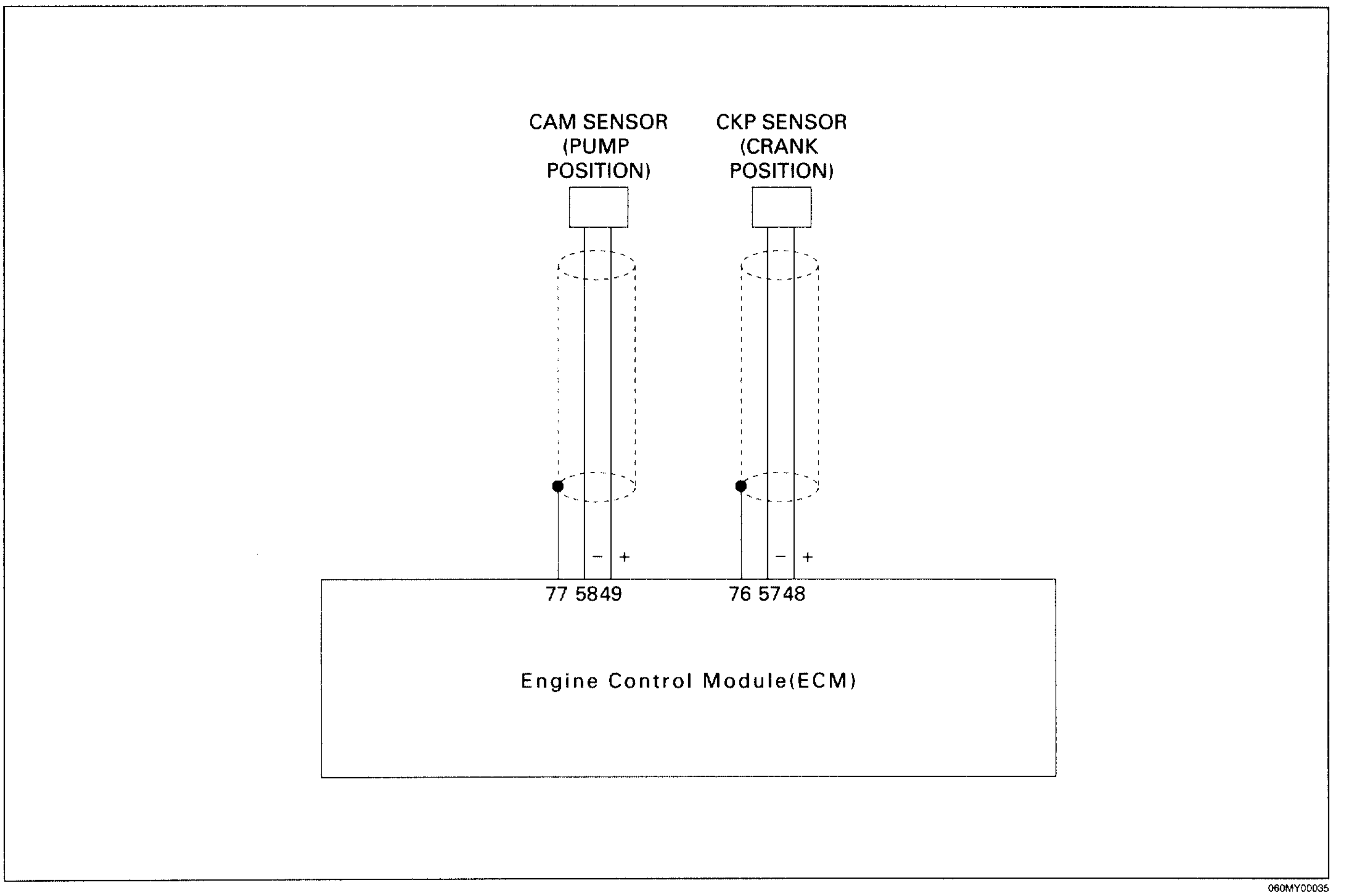
Test Description

5. Check the fuel injection timing relations.
6. Check the supply pump.
7. Check the Injectors.
8. Check the fuel pressure.

Engine Will Not Start Diagnosis Chart

STEP	ACTION	VALUE	YES	NO
1	1. Check vehicle condition. 2. Chack quantity of fuel in fuel tank. If the fuel is low in the fuel tank, add the fuel in the tank. Was a problem found?	—	Verify repair Go to OBD System check	Go to step 2
2	1. Check for water or - contaminated fuel. 2. If a problem is found, repair as necessary. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 3
3	Check the fuel filter. If a problem was found, repair as necessary. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 4
4	1. Perform air bleed. Bleed air from fuel system. 2. Ignition "ON", engine "ON". Did the engine start and run?	—	Verify repair Go to OBD System check	Go step 5
5	Was the "Fuel injection and timing relation (engine off)" check performed?	—	Go to step 6	Go to "Fuel Injection and Timing Relation (engine off)" Diagnosis chart
6	Was the "Check supply pump (engine off)" check performed?	—	Go to step 7	Go to "Check supply pump (engine off)" Diagnosis chart
7	Was the "Check Injectors (engine off)" check performed?	—	Go to step 8	Go to "Check Injectors (engine off)" Diagnosis chart
8	Was the "Check the fuel pressure in common rail (engine off)" check performed?	—	Go to step 9	Go to "Check the fuel pressure (engine off)" Diagnosis chart
9	Refer to Engine Mechanical Diagnosis to diagnose the following conditions: • Faulty or incorrect camshaft drive dears • Leaking or sticky valves or rings • Excessive valve deposits • Weak valve springs • Incorrect valve timing • Leaking head gasket Was a problem found?	—	Verify repair Go to OBD System check	Go to step 4

CHECK FUEL INJECTION AND TIMING RELATION (ENGINE OFF) DIAGNOSIS CHART



Circuit Description

It comprises crank position sensor (CKP sensor), Pump position sensor (CAM position), supply pump, ECM and etc. CKP sensor is sensing speed of engine crank. CAM sensor is sensing speed of 3-rob cam. It send each of signal to ECM.

An engine don't start sometimes. One of causes, there is this trouble. Injection timing is serious.

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

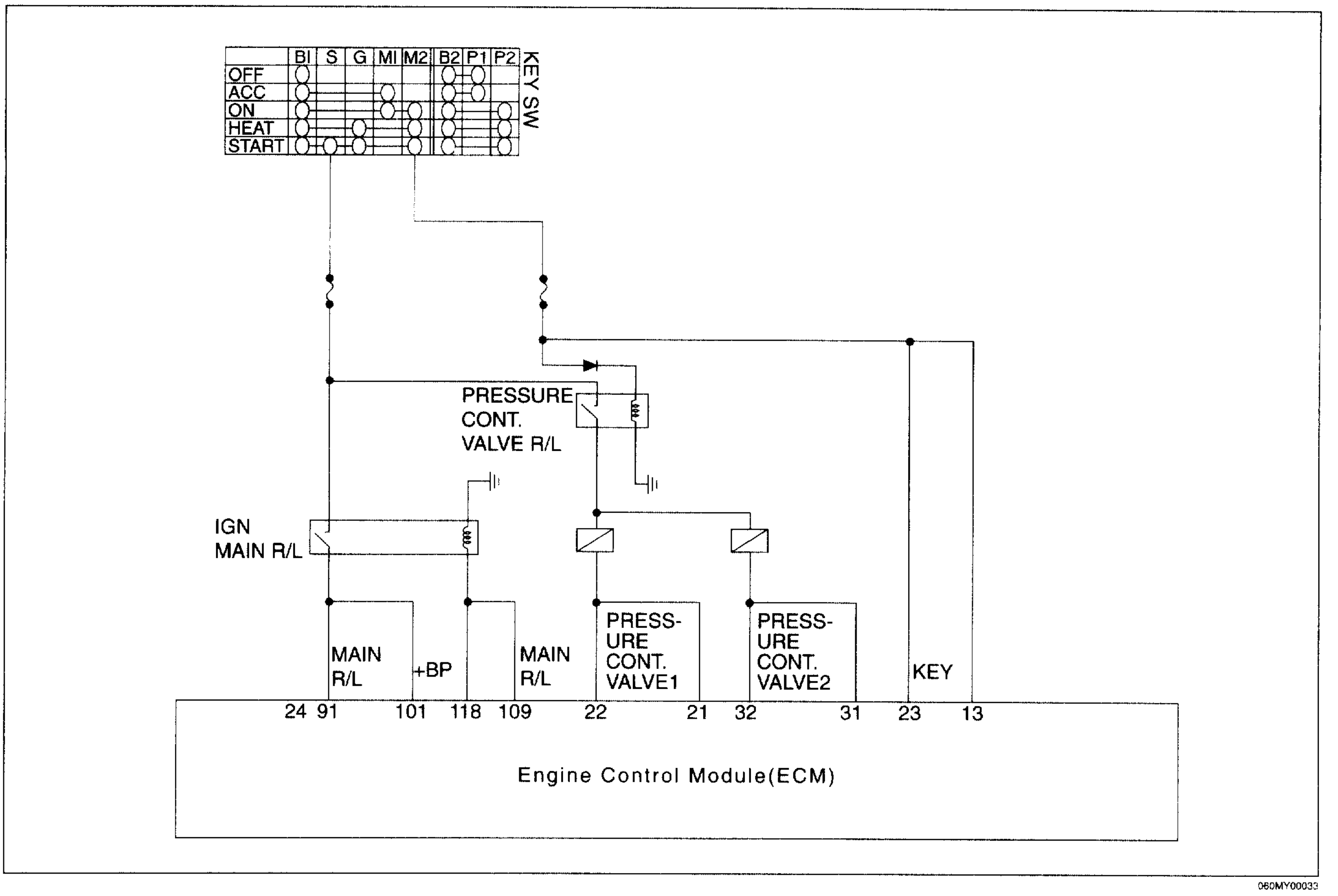
Test Description

1. Check fuel injection timing. There are two timing marks. One is marked on the crank case, another one is marked coupling at the supply pump. If timing mark don't adjust, injection timing will be shift.
2. It is possibility the sensor don't take a voltage and the engine won't run.
3. It is possibility the sensor is broken.

Check Fuel Injection And Timing Relation (Engine OFF) Diagnosis Chart

STEP	ACTION	VALUE	YES	NO
1	Check fuel injection timing. Refer to the timing mark in 6A and 6B sections. If timing was in correct adjust as necessary. Was a problem found?	—	Verify repair Go to OBD System check	Go to step 2
2	Check the installation condition for CKP sensor and CAM sensor. If the installation condition of the sensors is abnormal, repair as necessary. Was a problem found?	—	Verify repair Go to OBD System check	Go to step 3
3	Check the CKP sensor and CAM sensor performance. Probe resistance between the terminal of the sensor and the other terminal. If a problem was found, repair as necessary. Was a problem found? **NOTE:When CAM-Sensor is replaced, the supply pump assembly must be replaced.**	CKP sensor 109 – 143Ω (about 20°C) CAM sensor 1850 – 2450Ω (about 20°C)	Verify repair Go to OBD System check	Go to step 4
4	Check the sensor resistance. Probe resistance between each of the terminals of the sensor and the sensor body. If a problem was found, repair as necessary. Was a problem found? **NOTE:When CAM-Sensor is replaced, the supply pump assembly must be replaced.**	∞ Ω	Verify repair Go to OBD System check	Go to step 5
5	1. Disconnect the harness from ECM. 2. Probe the circuit between ECM and the sensor for an open or short. If a problem was found, repair as necessary. Was a problem found?	—	Verify repair Go to OBD System check	Go to step 6
6	Ignition "ON", engine "ON" Did the engine start and run?	—	Verify repair Go to OBD System check	Return to "Engine Will Not Start" Diagnosis chart

CHECK SUPPLY PUMP (ENGINE OFF) DIAGNOSIS CHART



Circuit Description

It comprises fuses, relays, supply pump, goesfilter and etc. Goesfilter is fuel filter.

It conform supply pump operating. When it broke, fuel don't supply at injectors. According to engine won't start.

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

Test Description

10 This check is mechanical check.

11 PCV1 harness and PCV2 harness don't connect conversely. Because injection timing different PCV1 and PCV2.

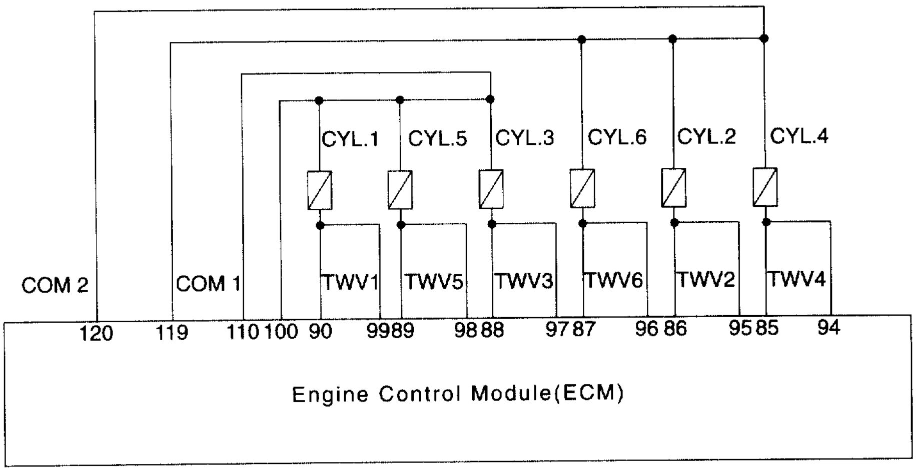
Check Supply Pump (Engine OFF) Diagnosis Chart

STEP	ACTION	VALUE	YES	NO
1	Check following fuses. • Main, PCV fuses If a blown fuse was found, replace as necessary. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 2
2	1. Disconnect following fuses and relays. • Main, PCV fuses 2. Probe the power supply circuit for an open or short. • Main, PCV circuit If a problem was found, repair as necessary. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 3
3	Probe a circuit between the relays and fuses for an open or short. If a problem was found, repair as necessary. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 4
4	Check the pump relays. • Main, PCV relays If a problem was found, replace as necessary. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 5
5	Probe a circuit between the pump relay and PCV for an open to ground and short to voltage. If a problem was found, repair as necessary. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 6
6	1. Disconnect the harness from ECM. 2. Probe a circuit between ECM and PCV for an open or short. If a problem was found, repair as necessary. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 7
7	Probe resistance between the terminal of the PCV and the other terminal. If a problem was found, replace the supply pump ASM. Was a problem found ?	0.9 – 1.2Ω	Verify repair Go to OBD System check	Go to step 8
8	Probe resistance between the each terminals of the PCV and the supply pump body. If a problem was found, replace the supply pump assembly. Was a problem found ?	∞ Ω	Verify repair Go to OBD System check	Go to step 9
9	1. Check the supply pump. 2. Be worked the priming pump and the check following points. • A different working noise from the pump • Raised fuel to the fuel filter • Working (smoothly of the priming pump) If a problem was found, replace the supply pump assembly. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 10
10	1. Remove the pipe between the fuel filter and the supply pump. 2. Check the gauze filter If a problem was found, clean up the filter. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 11

Check Supply Pump (Engine OFF) Diagnosis Chart (Cont.)

STEP	ACTION	VALUE	YES	NO
11	1. Reconnect all pump harness connectors. 2. Check for proper connection. Make sure not to switch the connectors between PCV1 and PCV2. If a problem was found, wake proper connections. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 12
12	1. Perform air bleeding procedure from fuel system. 2. Ignition “ON”, engine “ON”. Did the engine start and run?	—	Verify repair Go to OBD System check	Go to “Engine Will Not Start and Run” Diagnosis chart

CHECK INJECTOR (ENGINE OFF) DIAGNOSIS CHART



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Circuit Description

It comprises circuit of injector, injector, ECM and etc.

There are two way valves (TWV) in injector. TWVs control fuel supply at injectors.

That possibility is high. The circuit is broken. And It is careful, if air be mixed fuel, you can bleed air.

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

Test Description

3 This check is injector assemblies. Because injectors driving circuit was normally.

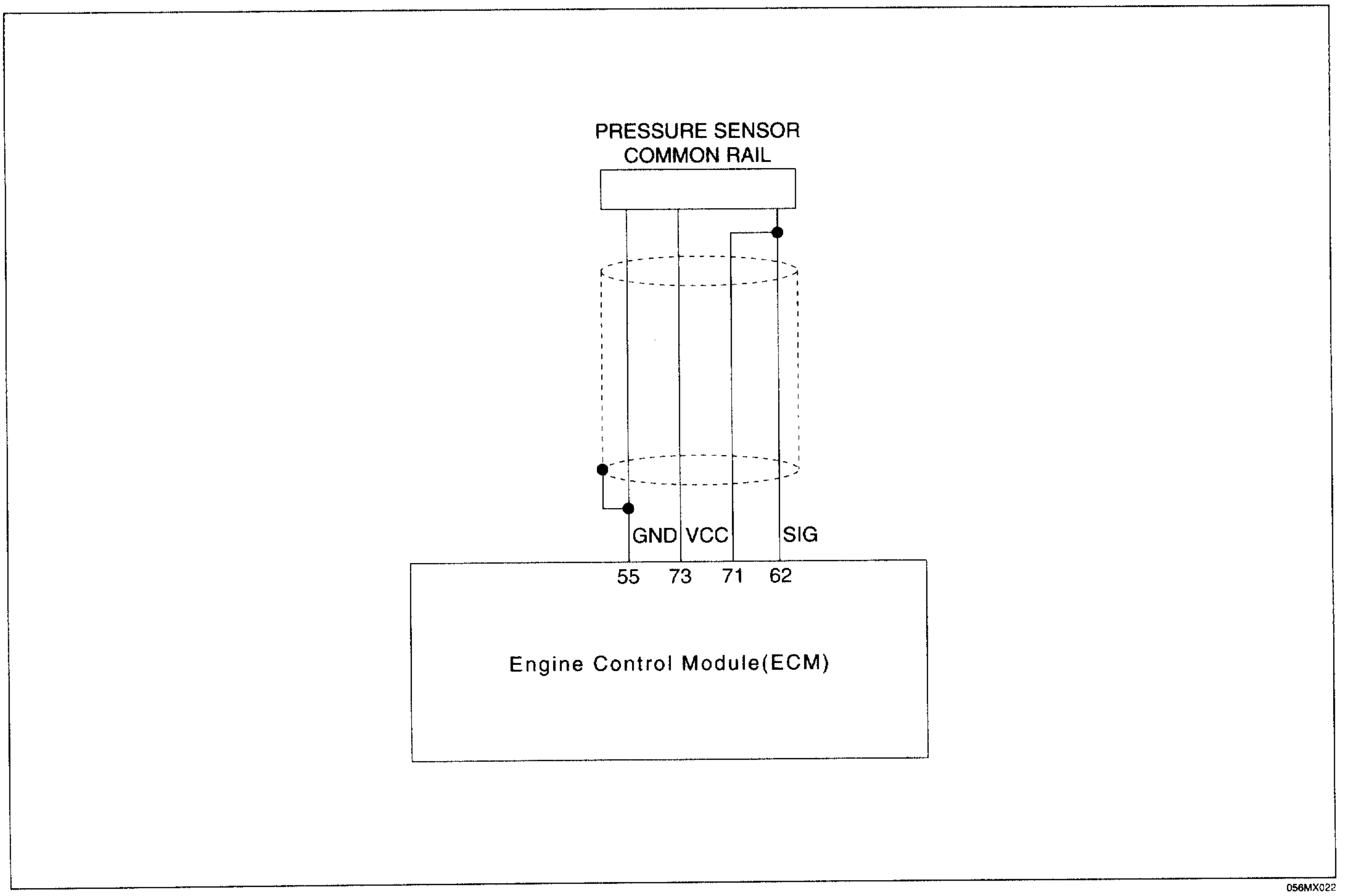
4 Air bleed operating will teach us the injectors is normal.

Check Injector (Engine OFF) Diagnosis Chart

STEP	ACTION	VALUE	YES	NO
1	1. Disconnect following: • The harnesses of ECM • The injector connector of the cylinder block. 2. Probe the circuit for an open or short. If a problem was found, repair as necessary. Was a problem found ?	—	Verify repair Go to OBD System check	Go to step 2
2	1. Probe the Injector circuit at the connector of engine block. 2. Probe the common circuit and TWV circuit for an open or short. (Refer to circuit diagram) If a problem was found, repair as necessary. Was a problem repair ?	Resistance 0.3 – 1.3 Ω	Go to step 3	Go to step 4
3	1. Remove the engine head cover. 2. Disconnect the harness from the injectors. 3. Probe the injector harness for an open or short. 4. Repair circuit as necessary. 5. Probe resistance between the each terminals and between the terminals and injector body. If a problem was found, replace injectors. Was a problem found ?	0.3 – 1.3/∞ Ω (between each terminal/injector body)	Verify repair Go to OBD System check	Go to step 4
4	1. Reconnect all the harnesses. 2. Bleed Fuel system. 3. Ignition “ON”, engine “ON”. Did the engine start and run?	—	Verify repair Go to OBD System check	Go to step 5
5	1. Ignition “OFF”, engine “OFF”. 2. Replace the ECM. 3. Ignition “ON”, engine “ON”. Did the engine start and run?	—	Verify repair Go to OBD System check	Go to “Engine Will Not Start” Diagnosis chart

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2.
Refer to “Capture and Restore Fuel Rate Data” of “Tech 2 Scan Tool” in this manual.

CHECK FUEL PRESSURE IN COMMON RAIL (ENGINE OFF) DIAGNOSIS CHART



Circuit Description

It comprises common rail pressure sensor, priming pump on the supply pump, ECM and etc.

The common pressure sensor is sensing pressure of common rail. It send signal to ECM.

This case, supply pump is working but fuel pressure is poorer than usual. According to Fuel supply isn't enough. Common rail pressure sensor is gauged pressure in common rail.

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

Test Description

2 It conform the ECM operation.

4 Residual pressure depend time after engine stopped.

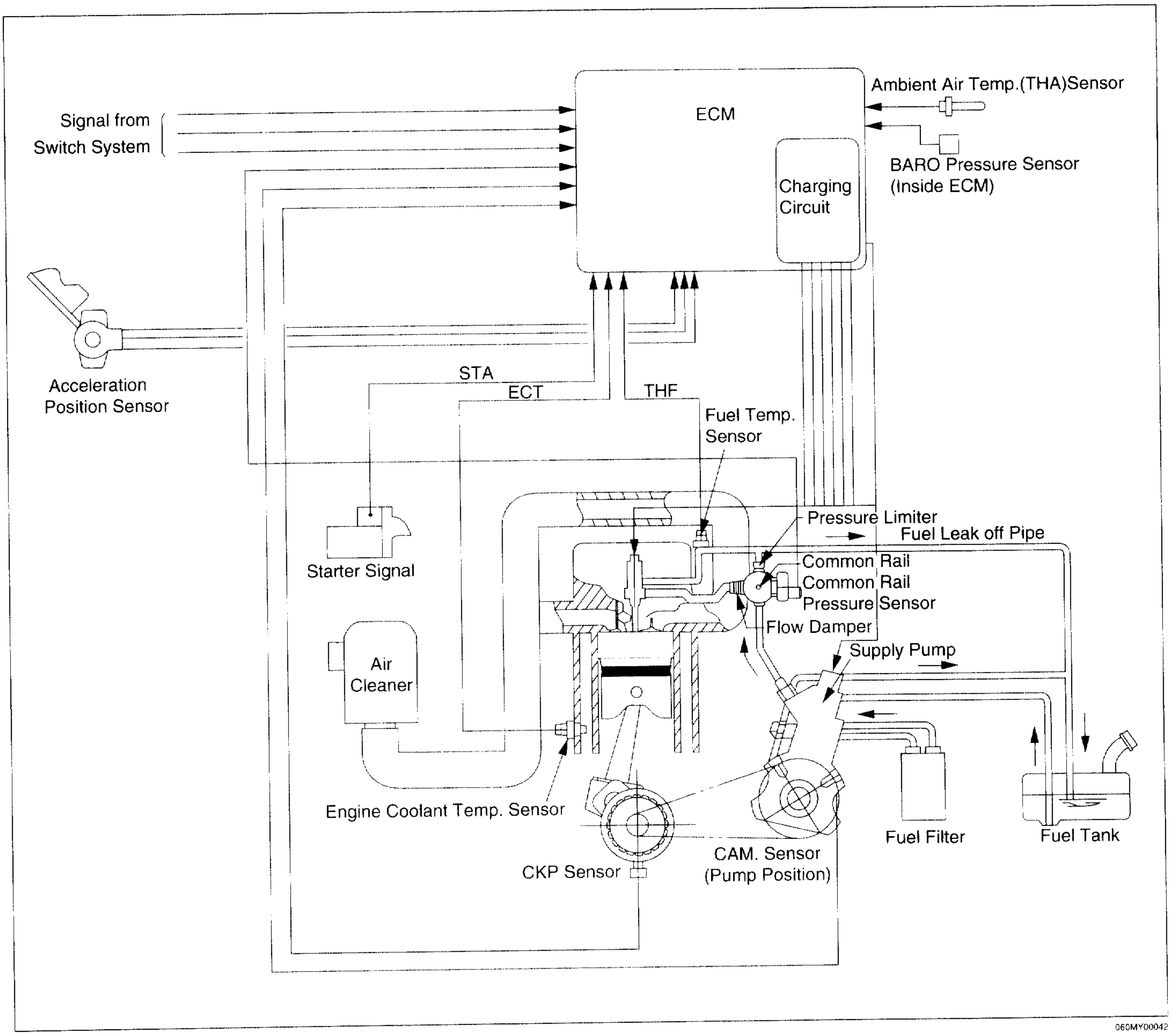
6 It conform fuel line, it is between priming pump to common rail. If fuel don't send common rail, air will be mixed the fuel.

Check Fuel Pressure in Common Rail (Engine Off) Diagnosis Chart

STEP	ACTION	VALUE	YES	NO
1	1. Disconnect the harness from ECM. 2. Probe the circuit between the ECM and fuel pressure sensor for an open or short. If a problem was found, repair as necessary. Was a problem repair ?	—	Verify repair Go to OBD System check	Go to step 2
2	1. Reconnect harness to ECM. 2. Ignition "ON" 3. Probe for voltage on the sensor side and the harness terminal from ECM Was voltage within specified value?	5V	Go to step 4	Go to step 3
3	Replace ECM. Was the action complete ?	—	Go to step 4	Go to step 3
4	1. Ignition "OFF". 2. Reconnect the harness at the pressure sensor. 3. Connect the scan tool. 4. Ignition "ON". Check "Rail Pressure in common Rail" in Section "ENGINE DATA", using the scan tool. **NOTE: When Engine stopped, there is residual pressure.** Is the pressure in the specified range?	0 – 1.5 MPa	Go to step 5	Go to step 6
5	1. Replace the fuel pressure sensor. (Replace the common rail) 2. Bleed fuel system. Was the action complete ?	—	Go to step 4	—
6	1. Operate the priming pump. 2. Check "Actual Pressure in common Rail" in Section "ENGINE DATA", using the scan tool. Was the pressure reading raised while the priming pump was operated?	—	Go to step 7	Go to step 5
7	1. Ignition "ON", Engine "ON" Did the engine start and run?	—	Verify repair Go to OBD System check	Go to "Engine Will Not Start and Run" Diagnosis chart

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

SYSTEM OPERATION CHECK DIAGNOSIS CHART



Circuit Description

It comprises fuel system, air cleaner, engine oil, engine, clutch, transmission, and etc.

It conform idling revolution. If it is abnormal, it conform air cleaner, engine oil.

And refer to each of sections.

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

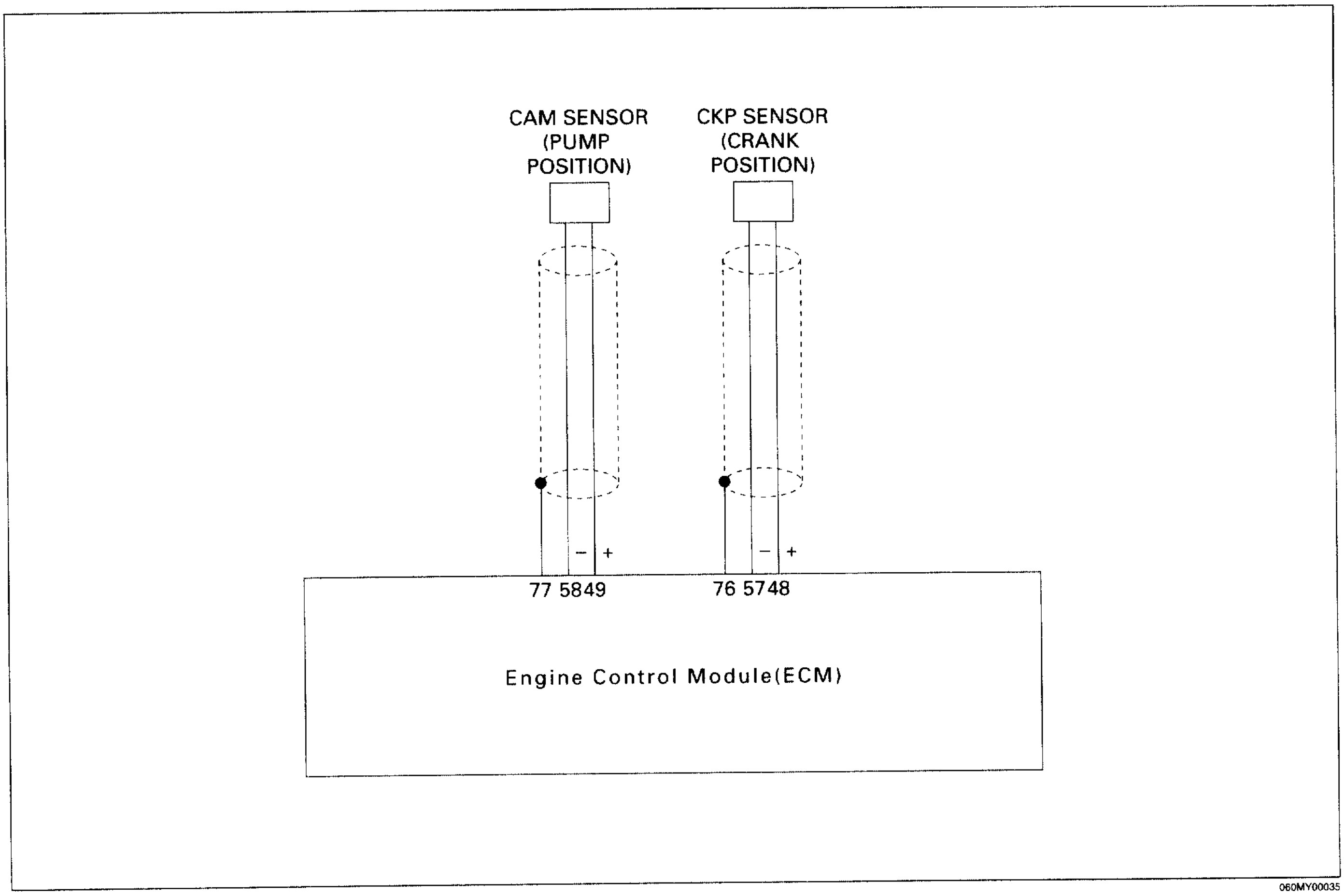
Test Description

3
- Check the Fuel Injection and Timing Relation.
- Check the supply pump.
- Check the fuel pressure in a common rail.
- Check the Injector .

System Operation Check Diagnosis Chart

STEP	ACTION	VALUE	YES	NO
1	Check the air cleaner element. If a problem was found, clean or replace air cleaner element. Was a problem found?	—	Clean or Replace Go to OBD System check	Go to step 2
2	Check the engine oil. If a problem was found, change engine oil. Was a problem found?	—	Change Oil. Go to OBD System check	Go to step 3
3	Check following diagnostic charts. • Check Fuel Injection and Timing Relation (engine running) • Check supply pump (engine running) • Check fuel pressure in common rail (engine running) • Check Injector (engine running) Did you check the listed Diagnosis charts?	—	Go to step 4	Check Appropriate Diagnosis chart
4	Check the manual idle control switch circuit for an open or short. If a problem was found, repair or replace as necessary. Was a problem found ?	—	Repair or Replace. Go to OBD System check	Go to step 5
5	1. Check for the following engine mechanical items. Refer to 6A section in this manual. • Low compression • Sticking or leaking valves • Worn camshaft lobe(s) • Camshaft gear damage. • Incorrect valve timing • Worn rocker arms • Broken valve springs 2. If a problem is found, repair as necessary. Was a problem found?	—	Repair or Replace. Go to OBD System check	Go to step 6
6	Bleed the fuel system. Was the fuel system bleed ?	—	Verify repair Go to OBD System check	Bleed the Fuel system

CHECK FUEL INJECTION AND TIMING RELATION (ENGINE RUNNING) DIAGNOSIS CHART



Circuit Description

It comprises crank position sensor (CKP sensor), Pump position sensor (CAM sensor), supply pump and etc.

CKP sensor is sensing speed of engine crank. CAM sensor is sensing speed of 3-rob cam (There is it in priming pump). It send each of signal to ECM.

An engine idling is abnormal sometimes. One of causes, there is bad condition of sensors.

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

Test Description

1 It is sensor check. The indication will be clear normal signals from it.

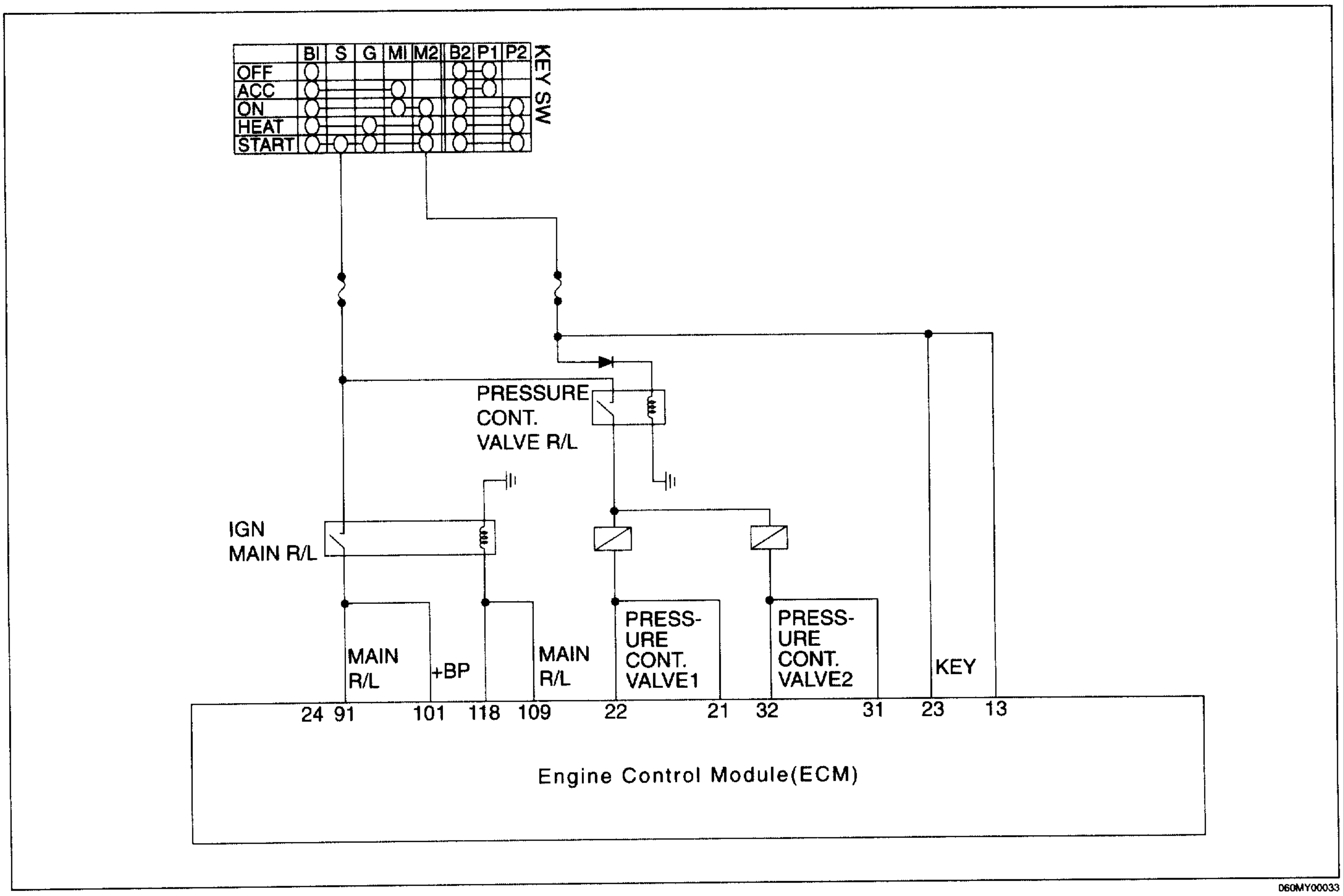
2 Instration condition have a influence sensors signals.

4 When The indication was flashing, it is influence signal noise and missing.

Check Fuel Injection and Timing Relation (Engine Running) Diagnosis Chart

STEP	ACTION	VALUE	YES	NO
1	Check following engine data on the scan tool. • crank position • pump position Did scan tool indicate "YES"?	—	Go to step 6	Go to step 2
2	1. Check installation condition for CKP sensor and CAM sensor. 2. If the installation condition of the sensors is abnormal, repair as necessary. If a problem was found, repair as necessary. Was a problem found?	—	Verify Repair Go to step 6	Go to step 3
3	1. Disconnect harnesses of the ECM. 2. Disconnect harnesses of the sensors. 3. Probe resistance between the each terminals of the sensors and the ECM. If a problem was found, repair as necessary. Was a problem found?	—	Verify Repair Go to step 6	Go to step 4
4	Check following engine data on the scan tool. • crank position • pump position Did scan tool indicate "YES"?	—	Go to step 6	Go to step 5
5	• CKP Sensor 1. Check flywheel. 2. Clean up 3. If a problem was found, repair or replace as necessary. • CAM Sensor 1.Replace supply pump. Did you check the CKP and CAM sensors ?	—	Go to step 6	Check the CKP and CAM sensors
6	Check idling condition. Is Engine idling normal ?	—	Verify repair	Go to "System operation check" Diagnosis chart

CHECK SUPPLY PUMP (ENGINE RUNNING) DIAGNOSIS CHART



Circuit Description

It comprises fuses, relays, supply pump, goesfilter and etc.This case, It conform stopped supply pump. There are two PCV. When One PCV is stopped, Engine will run steady. Because another one is working. Fuel supply to injector. If it broke, it will be stop engine.

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

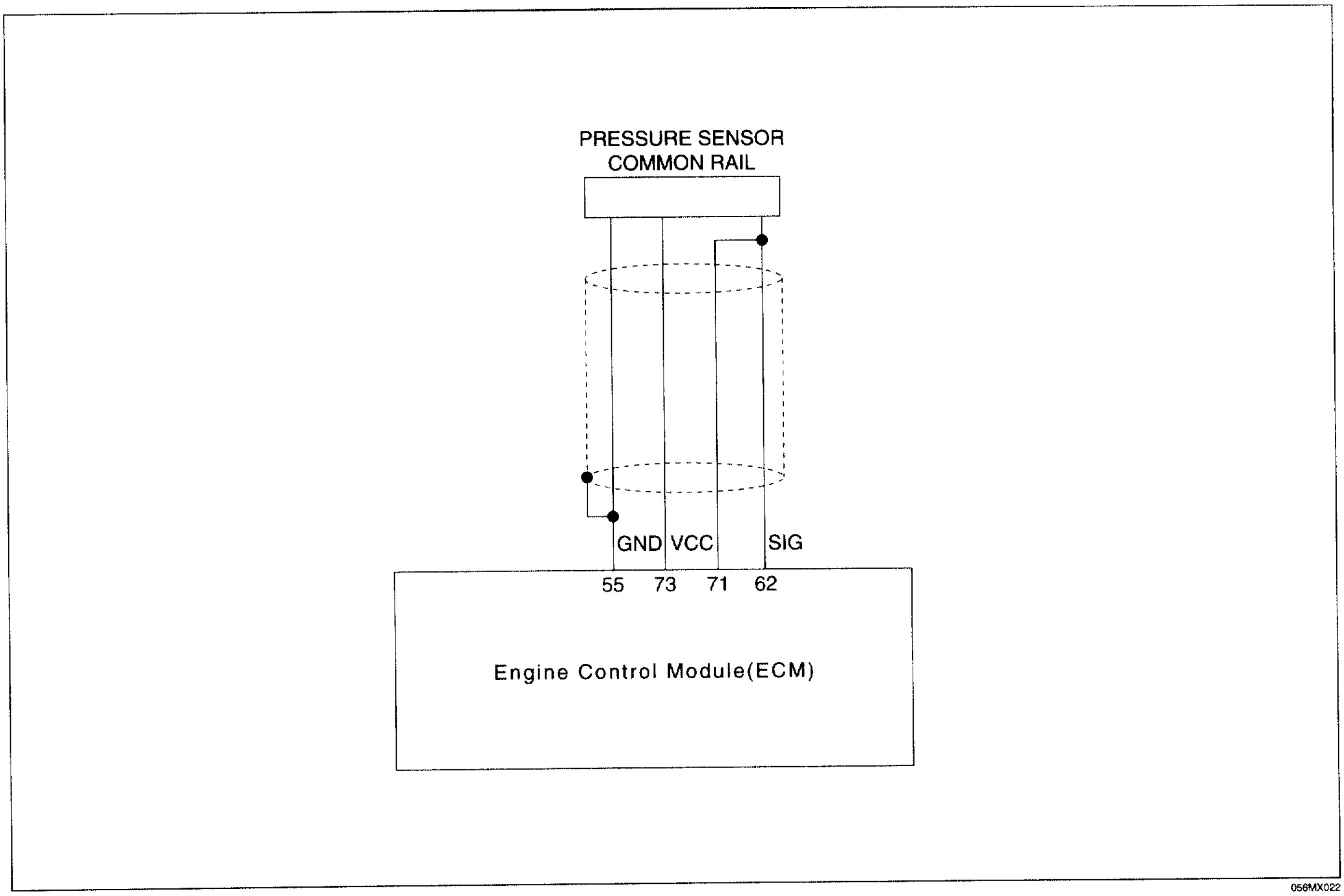
Test Description

1 It will be clear, which is broken PCV1 or PCV2. It is disconnected harness from PCV1. If PCV2 was broken, Fuel supply will be stopped. The engine won't run.

Check Supply Pump (Engine Running) Diagnosis Chart

STEP	ACTION	VALUE	YES	NO
1	1. Engine "ON". 2. Tilt up the CAB on the vehicle. 3. Disconnect the harness from the PCV1. If the engine didn't run, replace supply pump. Was a problem found?	—	Verify Repair Go to OBD System check	Go to step 2
2	1. Reconnect the harness at the PCV1. 2. Disconnect the harness from the PCV2. If the engine didn't run, replace supply pump. Was a problem found?	—	Verify Repair Go to OBD System check	Go to step 3
3	1. Reconnect the harness at the PCV2. 2. Check the idle condition of engine. Is the engine idling Normal ?	—	Go to OBD System check	Go to "System Operation check" Diagnosis chart

CHECK FUEL PRESSURE IN COMMON RAIL (ENGINE RUNNING) DIAGNOSIS CHART



Circuit Description

The common pressure sensor is sensing pressure of common rail. It send signal to ECM.

This case, supply pump is working but fuel pressure is poorer than usual. According to Fuel supply isn't enough. Common rail pressure sensor is gauged pressure in common rail.

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 damagedharness. Inspect the ECM harness and connector forimproper mating, broken locks, improperly formed ordamaged terminals, poor terminal-to-wire connection,and damaged harness.

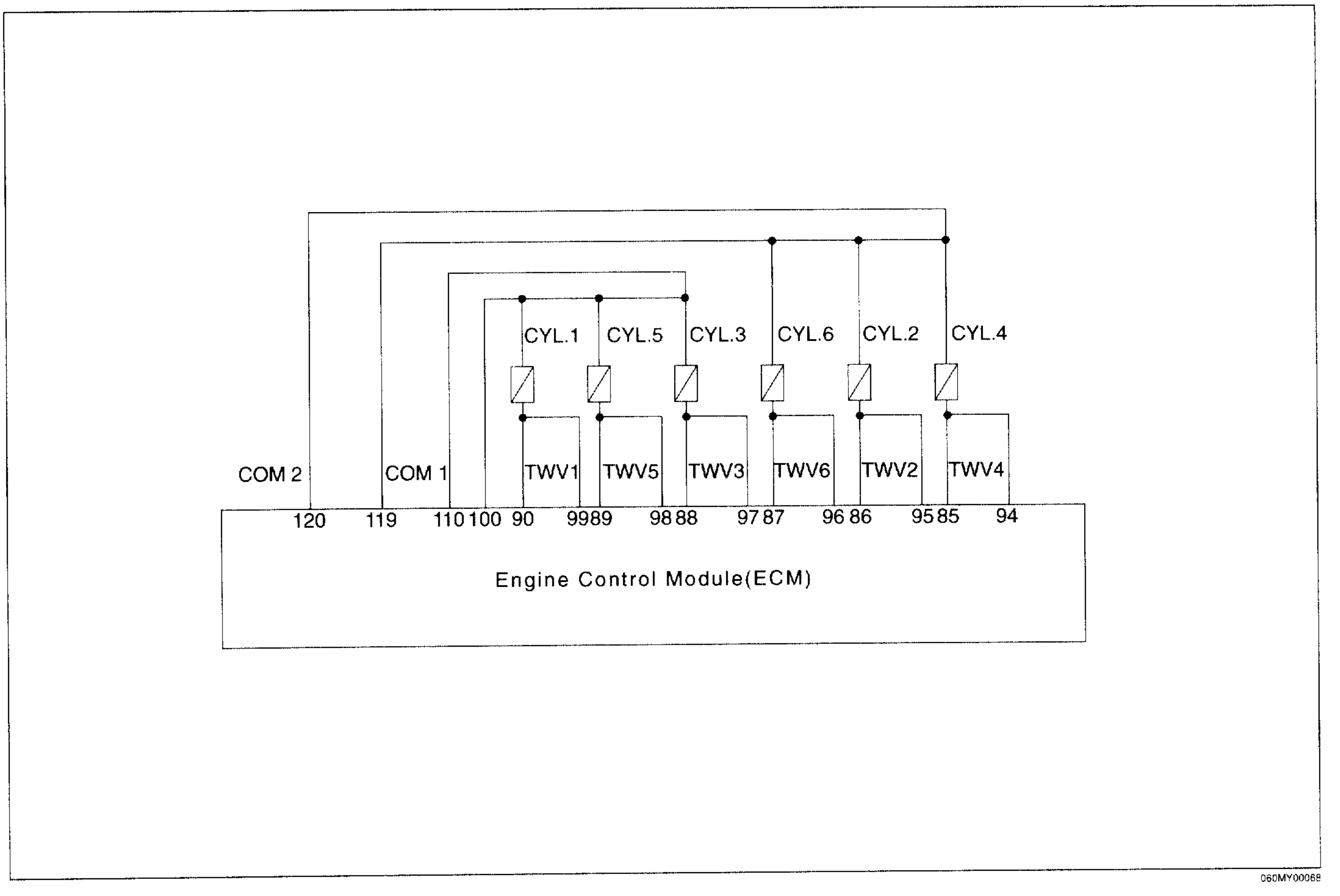
Test Description

1 It is control check. If real rail pressure is nearly purpose pressure then it is normal.

Check Fuel Pressure in Common Rail (Engine Running) Diagnosis Chart

STEP	ACTION	VALUE	YES	NO
1	1. Using a scan tool output tests (Function tests), select "common rail pressure control test". If actual rail pressure didn't follow the desired rail pressure, replace a common pressure sensor. (Common rail) Was a problem found	—	Go to step 2	Go to step 3
2	1. Test the common rail pressure control a scan tool. 2. Select "Data list". 3. Read common rail pressure on the "Data list" with the scan tool. 4. Check the value when the accelerator is opened slowly. If actual rail pressure didn't follow the desired rail pressure, replace a common pressure sensor. (Common rail) Was a problem found ?	—	Verify Repair Go to OBD System check	Go to step 3
3	Check idling condition. Is the engine idling normally ?	—	Verify Repair Go to OBD System check	Go to "System Operation check" Diagnosis chart

CHECK INJECTOR (ENGINE RUNNING) DIAGNOSIS CHART



Circuit Description

It comprises circuit of injector, injector, ECM and etc.

The injector of either one stops. It must be clear broken injector, it need Tech2.

Tech2 is stopped each of injector. Working noise will teach us problem of injector.

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

Test Description

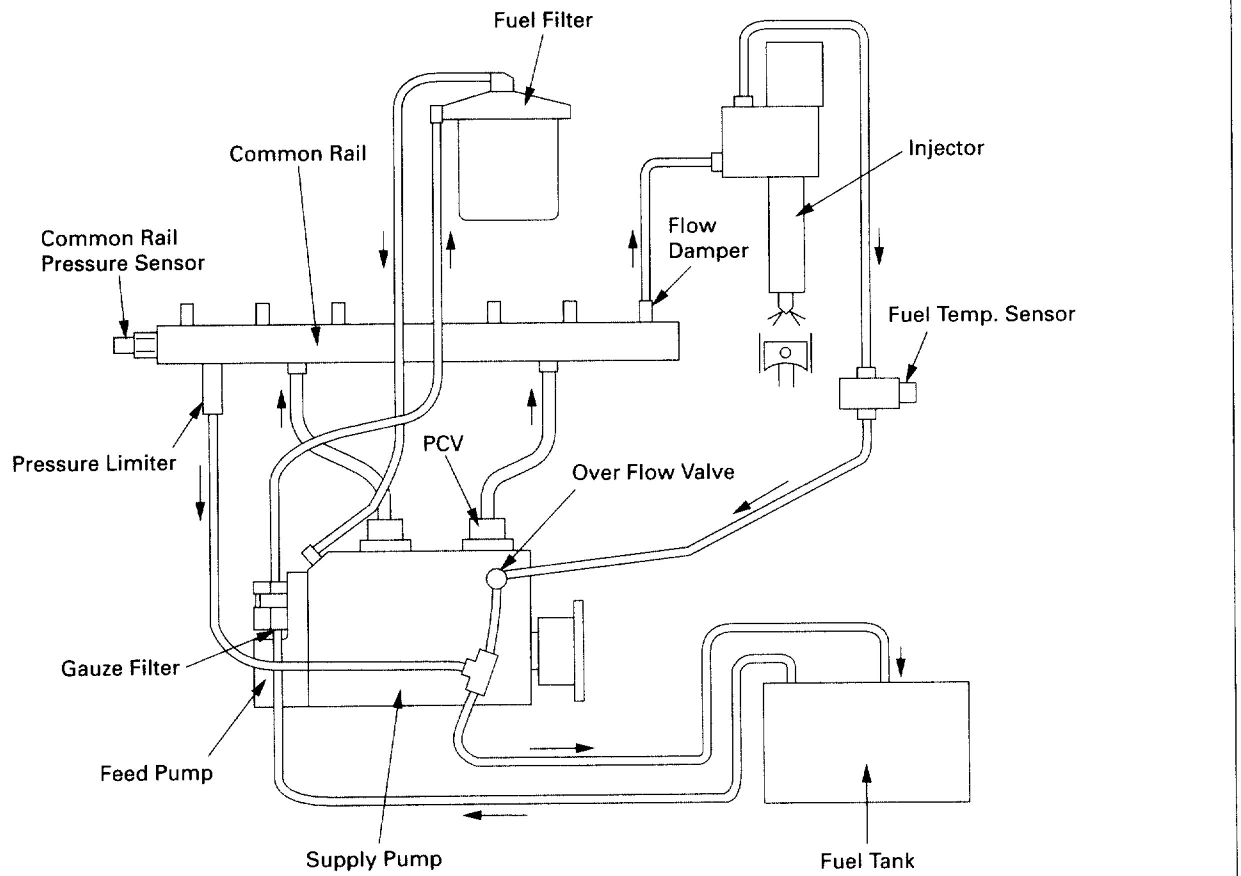
1. It conform broken injector. if one injector stopped each, the working noize and RPM drop will be change. Because all cylinder will be working. When the working noize don't change, some injectors will broke.
2. This system is adopted pilot injection. it will be improved idling stability, combustion and etc.

Check Injector (Engine Running) Diagnosis Chart

STEP	ACTION	VALUE	YES	NO
1	1. Using a scan tool output tests (Function tests), select the "Injection balance test (Injector stop test of each cylinder)" and command each "Injector stop". 2. Check working noize of the engine and RPM drop. Did working noize and RPM change at all cylinders?	—	Go to step 3	Go to step 2
2	1. Engine "OFF". 2. Replace a injector of a cylinder with no change in the working noize and RPM drop. 3. Engine "ON" Was the action completed?	—	Go to step 1	Complete action
3	1. Select "Pilot injection stop test" with the scan tool. 2. Check working noize of the engine and RPM drop. If the working noize of engine and RPM drop changed, replace ECM. Was the action completed?	—	Go to step 4	Complete action
4	Check idling condition. Was the Engine idling normally?	—	Verify repair Go to OBD system check	Go to "System operation check" Diagnosis chart

IMPORTANT: ***The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.***

CHECK FUEL SYSTEM DIAGNOSIS CHART



Circuit Description

It conform leak of fuel. Accelerating of Engine raise fuel pressure and it will be leaks more. Overlook it.

It comprises following pipes and etc.

- Between injectors to common rail.
- Between common rail to supply pump.
- Between supply pump to fuel filter.
- Between fuel filter to fuel tank.
- Between pressure limiter to fuel tank.

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

Test Description

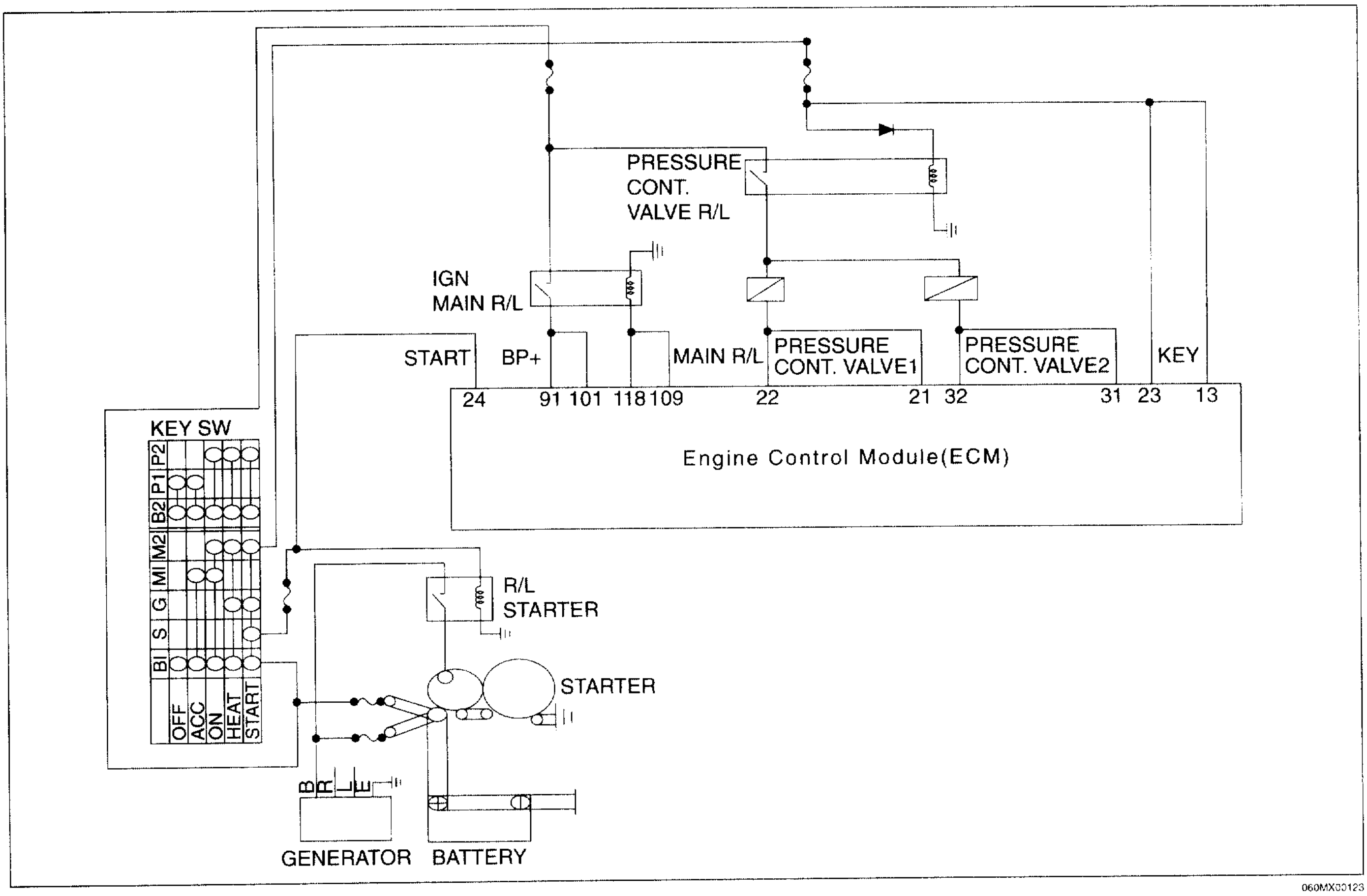
1 Accelerating of Engine raise fuel pressure and it will be leaks more. Overlook it.

Check Fuel System Diagnosis Chart

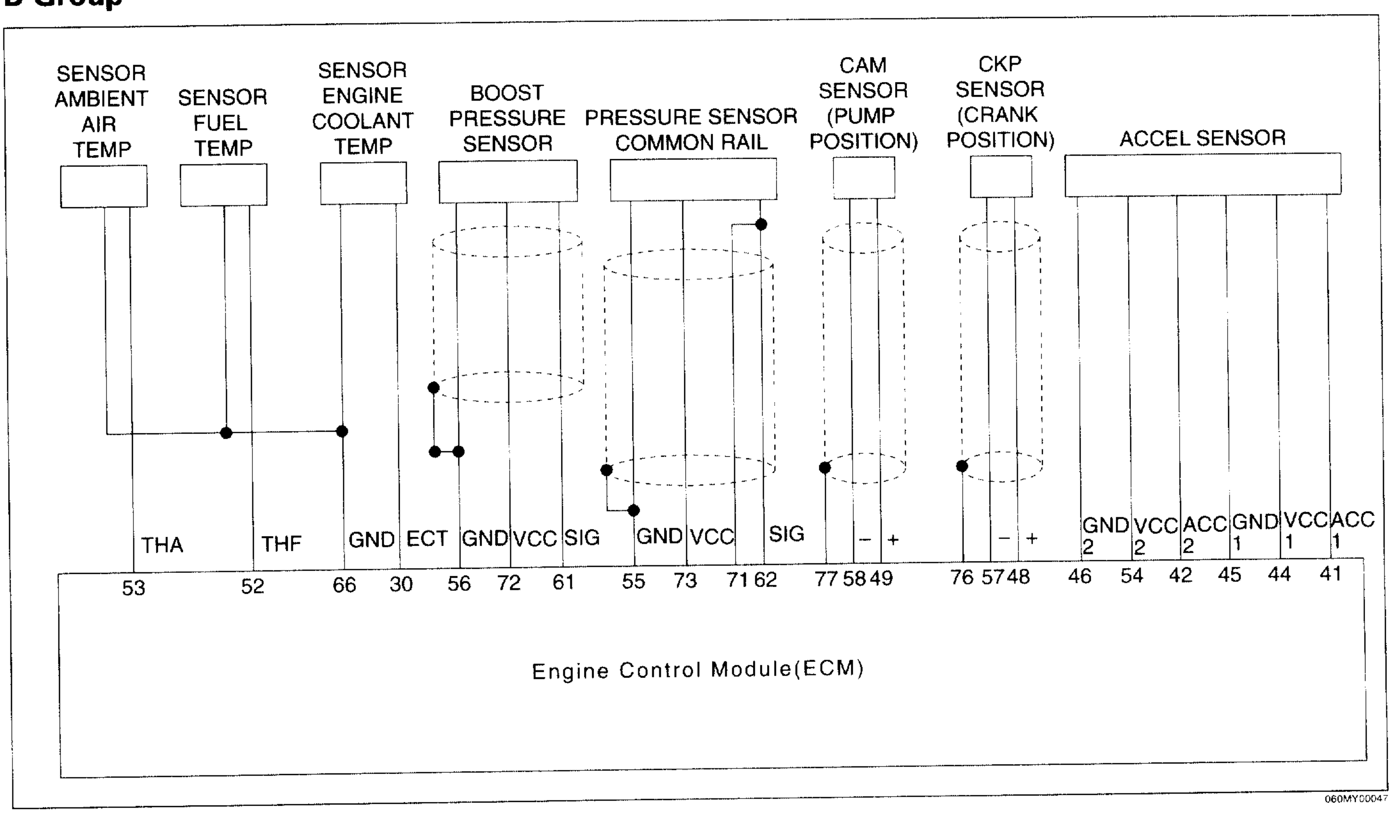
STEP	ACTION	VALUE	YES	NO
1	1. Engine "ON". 2. Acclerate the engine revolution until 3,000 rpm is reached. **NOTE: Don't over-rev. the engine.** 3. Check no "Flow Damper Data" on data list with the scan tool. Did flow damper no count?	—	System OK	Go to step 2
2	1. Ignition "OFF". 2. Check the fuel high pressure pipe with operated flow damper. 3. Check for leak at injector piping. If the pipe has a leak, repair as necessary. Did you the problem repair?	—	Go to step 3	Repair or Replace
3	Check the balancing fuel rate "Engine data" with the scan tool. If a problem was found, repair as necessary. Was a problem found?	–5 – 5	Verify repair Go to OBD system check	Go to step 4
4	Replace the injection. Was a action complete?	—	Verify repair Go to OBD system check	—

MULTIPLE DTCS STORED DIAGNOSIS CHART

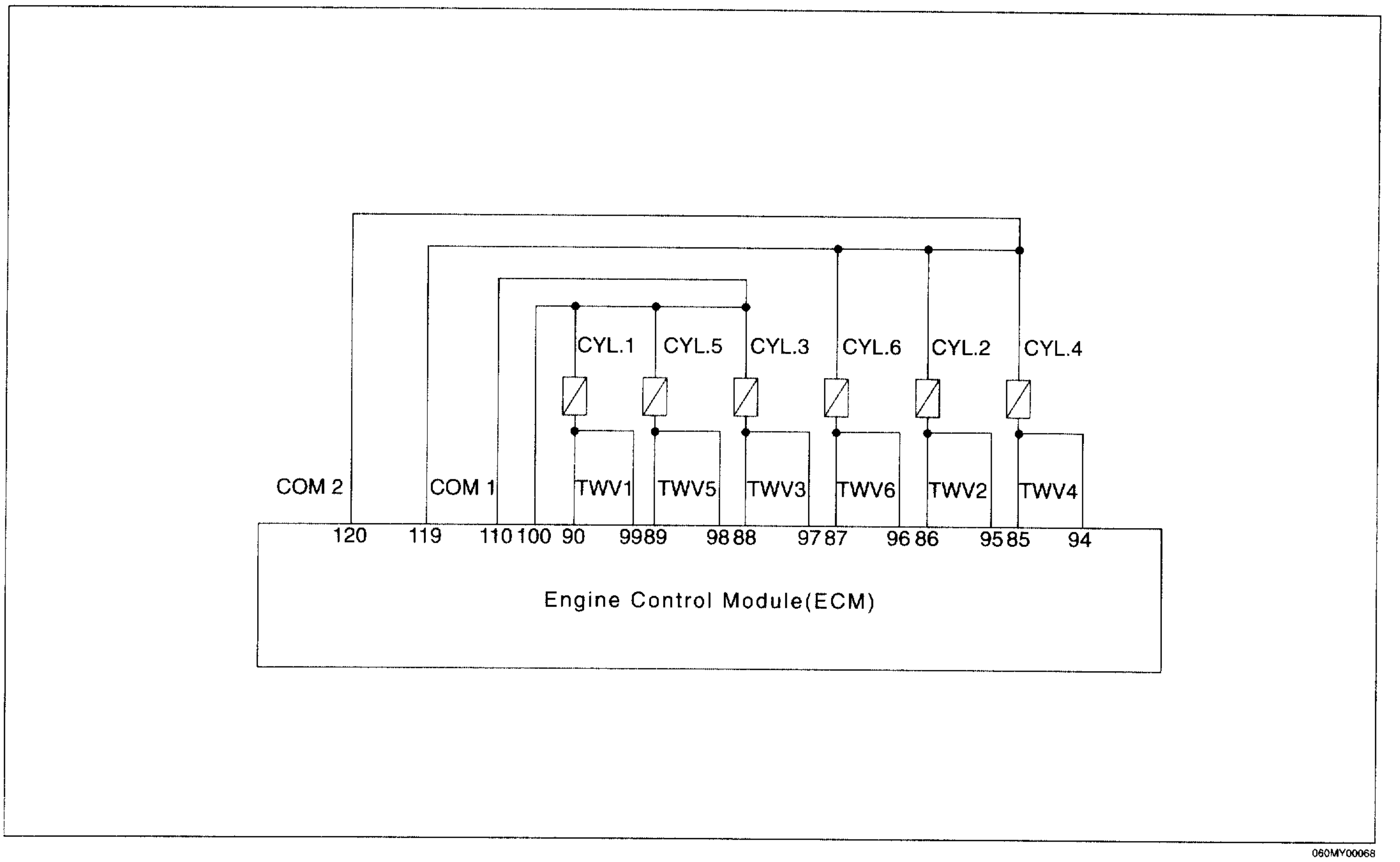
A Group



B Group



C Group



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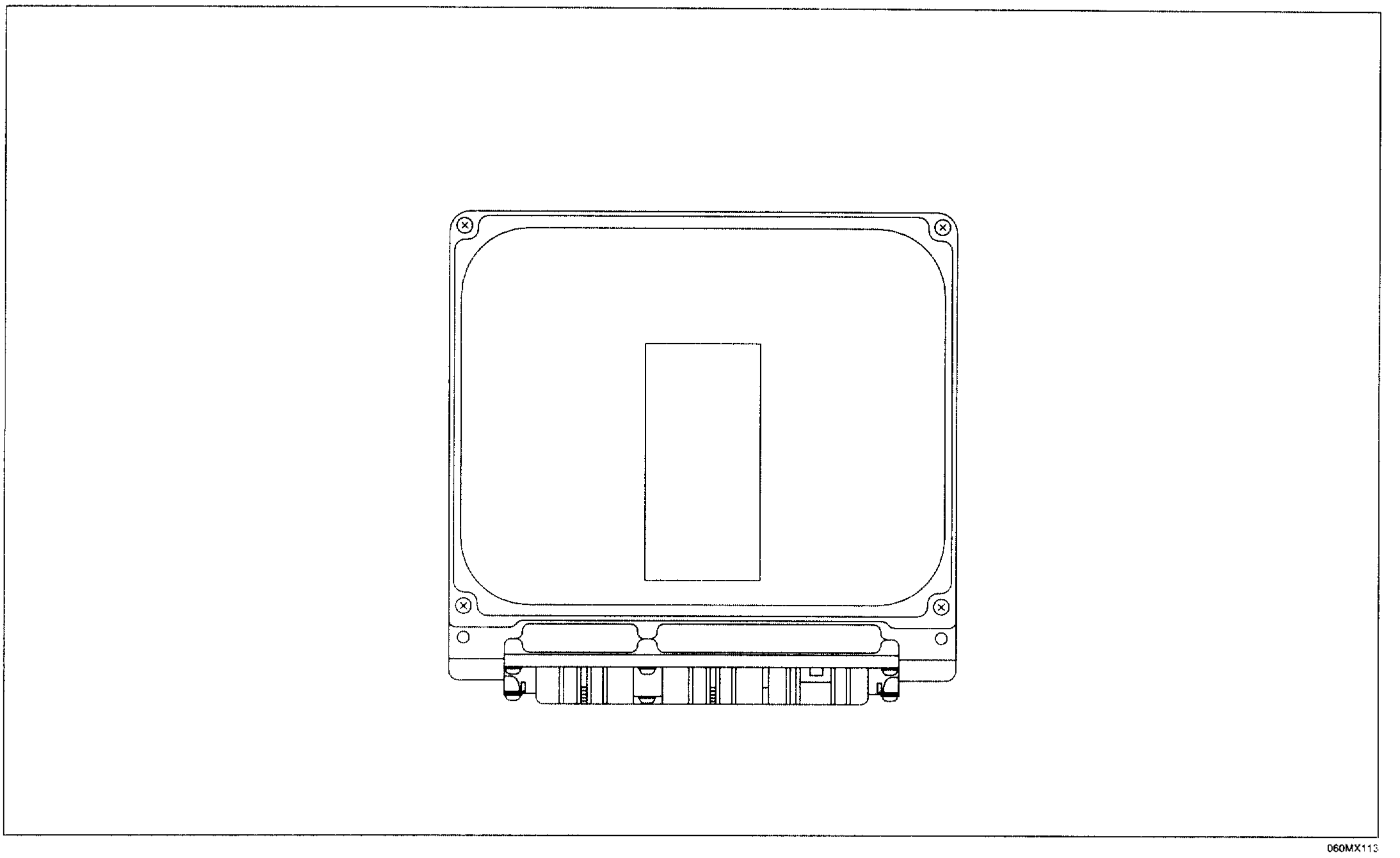
D Group



060MX113

Circuit Description

The Engine Control module(ECM) monitors varlous sensors to determines the engine operating conditions.

The ECM provides a sensor ground to all of the sensors.The ECM applies varlous sensors for a power supply.

Multiple DTCs will set when the ECM detects a problem on conmmon use for the sensors ground or power supply.

If the multiple DTCs set,check the conmmon circuit for sensors ground or power supply as necessary.

The following group to be set for circuit.

A group: Power Supply Circuit
B group: Varlous Sensors and Injectors
C group: Varlous Sensors and Injectors
D group: Internal Circuit for ECM, Signal Cicuit for ECM

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

Test Description

Number below refer to the step number on the diagnosic chart.

1 If the multiple DTCs set,check the conmmon circuit for sensors ground or power supply as necessary, set ,refer to the DTC Chart.

A group: 217, 218, 247, 248, 416, 417, 421, 22, 23, 24
B group: 14, 15, 32,42, 65, 115, 118, 151, 211, 245
C group: 158, 159, 271, 272, 273, 274, 275, 276
D group: 34, 35, 71

STEP	ACTION	VALUE	YES	NO
1	Was the "OBD" problem ?	—	Go to step 2	Go to OBD system check
2	1. Check DTC and inspect group of each DTCs. 2. Locate circuit diagram of problem group. 3. Ignition "OFF". 4. Disconect connector from ECM. 5. Disconect sensor harness connection for DTC . 6. Probe each circuit for an open or short (Check harness side, sensor side and ECM side) 7. Probe power and ground circuit for an open or short (Check harness side, sensor side and ECM side) If a problem was found, repair as necessary Was a problem found?		Verify repair Go to OBD system check	Go to step 3
2	Probe the affected sensor If a problem was found, repair as necessary Was a problem found?	—	Verify repair Go to OBD system check	Go to step 4
3	Probe following ground circuit • ECM case • Sensor If a problem was found, repair as necessary Was a problem found?	—	Verify repair Go to OBD system check	Go to step 5
4	Replace ECM Was ECM replaced?	—	Verify repair Go to OBD system check	Replace ECM

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

ECM Diagnosis Trouble Codes

The following table lists the diagnosis trouble codes supported by this vehicle application. If any DTCs not listed here are displayed by a scan tool, the scan tool data may be faulty; notify the scan tool manufacture of any DTCs displayed that are not included in the following table.

ECM Diagnostic Trouble Codes

DTC	Description	Illuminate MIL	Refer to	Fail safe	Symptom
14	Pump Position Sensor Error (CAM sensor)	2	Check Fuel Injection Timing Relations, DTC table	• When Crank Position sensor is normal, backs up by Crank Position sensor • When both failure, injection stops.	Accuracy of fuel injection timing growing worth, Engine reverse rotation identification impossible, Pump Control Valve (PCV) control position shift, Engine hard starting
15	Crank Position Sensor Error (CKP sensor)	2	Check Fuel Injection Timing Relations, DTC table	• When Pump Position sensor is normal, backs up by Pump Position sensor • When both failure, injection stops.	No tachometer output signal, Accuracy of fuel injection timing growing worth, Engine reverse rotation identification impossible, Pump Control Valve (PCV) control position shift, Engine hard starting, Fuel consumption cylinder balance (FCCB) impossible, Sprit fuel injection impossible, Taken in error of common rail pressure
22	Ambient Air Temperature Sensor Error	3	Multi trouble stored (Ground circuit), DTC table	At starting: THA = –20°C Other = 80°C	White smoke in cold weather
23	Engine Coolant Temperature Sensor Error	3	Multi trouble stored (Ground circuit), DTC table	Starting: Based on –20°C Other: Based on 80°C	Engine hared starting in cold weather Idle unstable in cold weather, White smoke in cold weather
24	1. Accelerator Sensor Error 1 2. Accelerator Sensor Error 2 3. Accelerator Sensor 1 Intermediate Voltage Hold Trouble 4. Accelerator Sensor 2 Intermediate Trouble	1	DTC table"	Item 1, 2, 3 and 4:When one sensor is normal, backup bynormal sensor. When both sensor are faulty accel. is fixed at 20%, however using an injection map for ASC mode.	Lack of power, PTO engage impossible, Accelerator position sensor output signal error, Idle speed error.
32	Boost Pressure Sensor Error	3	Multi trouble stored (Ground circuit), DTC table	Based on relative pressure of 0 kPa. Injection amount map is used for a fail safe mode.	Lack of power, PTO abnormal (common used power source)

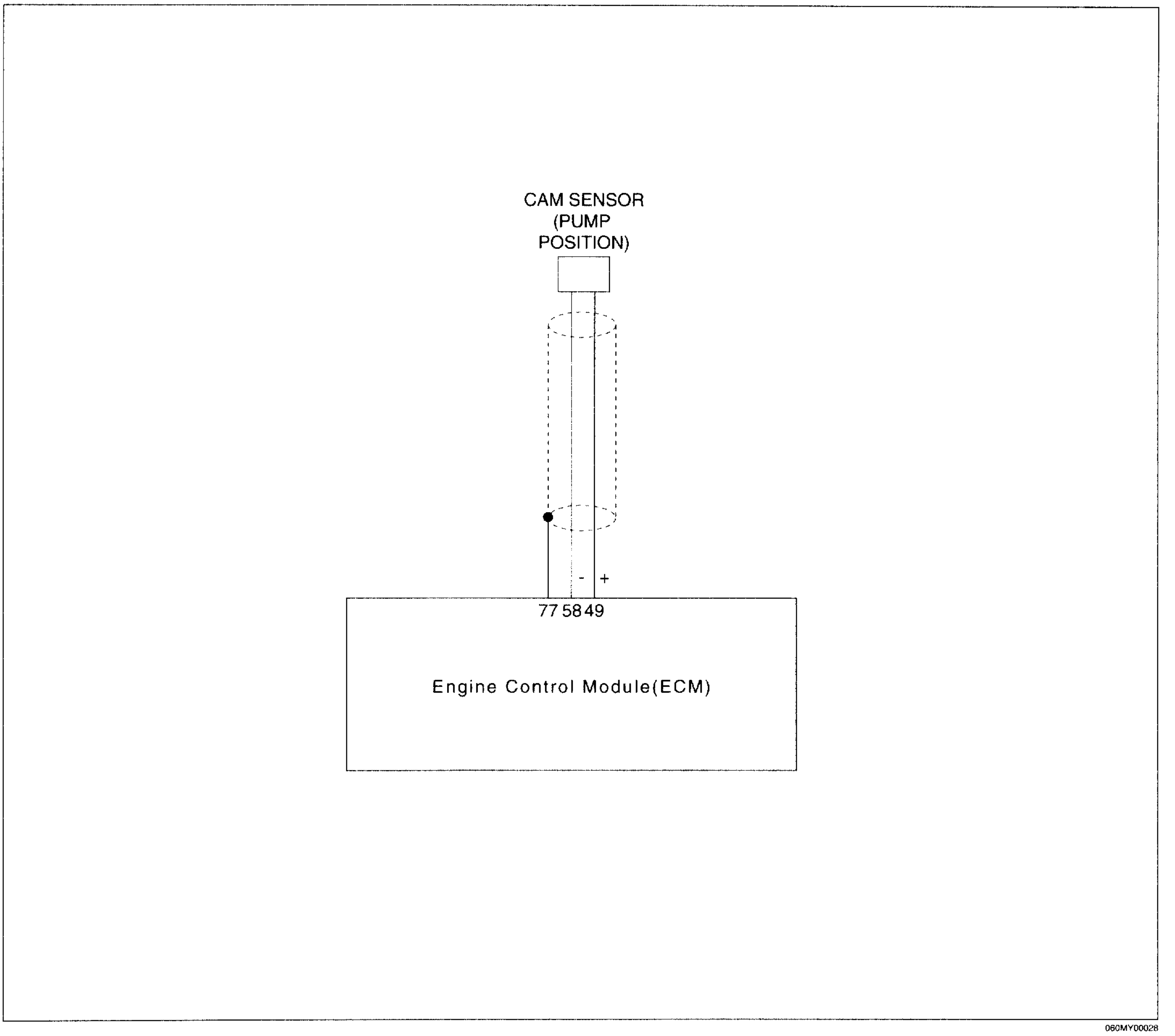
DTC	Description	Illuminate MIL	Refer to	Fail safe	Symptom
34	Fuel Rate Data Error (No History Recorded)	1	DTC table, Scan tool operation	Q (Fuel Rate Data) adjustment data No.8 selected	Lack of power, Black smoke, Poor fuel economy
35	A/D Conversion Error (ECM inside trouble)	1	System check, DTC table	Analog sensor abnormality decision stops and fail safe mode	Lack of power, Rough engine idling, Engine stall
	CPU Monitoring IC Error (ECM inside trouble)			–	
	Charging Circuit Error			Charging stops, driveable by constant current only, and injection amount limited to 80 mm 3 /st.	
42	High Boost Pressure Abnormal	3	DTC table	Injection amount map is used as a fail safe mode.	Lack of power, PTO abnormal (common used power source)
65	Low Boost Pressure Abnormal	3	DTC table	–	Lack of power, PTO abnormal (common used power source)
71	BARO Sensor Error	3	DTC table	Based on the atmospheric pressure of 100 kPa.	Injection timing abnormal, White smoke, Boost compensation don't work
115	Common Rail Pressure Sensor Output Fixed	1	Check fuel pressure in a common rail, DTC table	Same as DTC P245	Lack of power, Black smoke, Both of fuel pressure and engine hunting, PTO engage impossible
118	1. Abnormal Common Rail Pressure (Control System 1st Stage)	1	Check fuel pressure in a common rail, DTC table	Same as DTC P245	Lack of power, White smoke, Both of fuel pressure and engine hunting , PTO engage impossible, Engine heard starting , Fuel leak
	2. Abnormal Common Rail Pressure (Control System 2nd Stage)				
151	Abnormal Common Rail Pressure (Pump Over Pressure Supply)	1	Check fuel pressure in a common rail, DTC table	Same as DTC P245	Lack of power, White smoke, Both of fuel pressure and engine hunting , PTO engage impossible
158	TWV Driving System B+ Shorted	1	Check Injector, DTC table	• Constant current control by common 1 or common 2 whichever normal (Abnormal system separated) • Injection amount limit 80 mm 3 /st or 0 boost flat.	Rough engine idling, Lack of power, Engine heard starting
159	TWV Driving System Ground Shorted	1	Check Injector, DTC table	• Constant current control by common 1 or common 2 whichever normal (Abnormal system separated) • Injection amount limit 80 mm 3 /st or 0 boost flat.	Rough engine idling, Lack of power, Engine heard starting

DTC	Description	Illuminate MIL	Refer to	Fail safe	Symptom
211	Fuel Temperature Sensor Error	3	Multi trouble stored (Ground circuit), DTC table	Backup control by water temperature sensor Starting: Based on –20°C Other: Based on 80°C	Common rail pressure guard (PC guard) impossible in high fuel temperature
217	Coil or Harness for PCV1 are Shorted	1	Check supply pump, DTC table	Abnormally high driving voltage generated PCV off, the target pressure limited to 60 MPa or less.	Lack of power, Black smoke
218	Coil or Harness for PCV2 are Shorted	1	Check supply pump, DTC table	Abnormally high driving voltage generated PCV off, the target pressure limited to 60 MPa or less.	Lack of power, Black smoke
226	Supply pump does not Supply Pressure and/or Pressure Limiter Activated	1	System check, Check supply pump, Check fuel system, DTC table	• Injection amount limit is 60 mm 3 /st. • Target common rail pressure is lower than 25 MPa.	Lack of power, Black smoke
227	Supply pump does not Supply Pressure (Fuel Leakage)	1	System check, Check supply pump, Check fuel system, DTC table	• Fuel injection value lower than 60 mm 3 /st. • Common rail pressure lower than 25 MPa. • Time required for running into backup is varied with the difference common rail pressure against target pressure.	Engine stall, Engine hard starting
245	Abnormal Common Rail Pressure (PC Sensor System)	1	Check fuel pressure in a common rail, DTC table”	Limits are set to common rail pressure open loop control, common rail pressure and injection amount. Common rail pressure: 60 MPa Injection amount: 50 mm 3 /st	Lack of power, Black smoke, Both of fuel pressure and engine hunting , PTO engage impossible
247	PCV1 Coil or Harness Disconnect or Ground Shorted	1	Check supply pump, DTC table	Common rail pressure is limited to 60 Mpa or less.	Lack of power, Black smoke
248	PCV2 Coil or Harness Disconnect or Ground Shorted	1	Check supply pump, DTC table	Common rail pressure is limited to 60 Mpa or less.	Lack of power, Black smoke
261	Damper is Activated for Cylinder No. 1 Flow Damper Activated	3	System check, DTC table	Cylinder injection stops	Rough engine idling, Lack of power, Fuel leakage
262	Damper is Activated for Cylinder No. 2 Flow Damper Activated	3	System check, DTC table	Cylinder injection stops	Rough engine idling, Lack of power, Fuel leakage
263	Damper is Activated for Cylinder No. 3 Flow Damper Activated	3	System check, DTC table	Cylinder injection stops	Rough engine idling, Lack of power, Fuel leakage
264	Damper is Activated for Cylinder No. 4 Flow Damper Activated	3	System check, DTC table	Cylinder injection stops	Rough engine idling, Lack of power, Fuel leakage

DTC	Description	Illuminate MIL	Refer to	Fail safe	Symptom
265	Damper is Activated for Cylinder No. 5 Flow Damper Activated	3	System check, DTC table	Cylinder injection stops	Rough engine idling, Lack of power, Fuel leakage
266	Damper is Activated for Cylinder No. 6 Flow Damper Activated	3	System check, DTC table	Cylinder injection stops	Rough engine idling, Lack of power, Fuel leakage
271	Open Circuit on Cylinder No. 1 at TWV side	1	Check Injector, DTC table	Injection amount limited to 80 mm 3 /st and boost becomes 0.	Rough engine idling, Lack of power
272	Open Circuit on Cylinder No. 2 at TWV side	1	Check Injector, DTC table	Injection amount limited to 80 mm 3 /st and boost becomes 0.	Rough engine idling, Lack of power
273	Open Circuit on Cylinder No. 3 at TWV side	1	Check Injector, DTC table	Injection amount limited to 80 mm 3 /st and boost becomes 0.	Rough engine idling, Lack of power
274	Open Circuit on Cylinder No. 4 at TWV side	1	Check Injector, DTC table	Injection amount limited to 80 mm 3 /st and boost becomes 0.	Rough engine idling, Lack of power
275	Open Circuit on Cylinder No. 5 at TWV side	1	Check Injector, DTC table	Injection amount limited to 80 mm 3 /st and boost becomes 0.	Rough engine idling, Lack of power
276	Open Circuit on Cylinder No. 6 at TWV side	1	Check Injector, DTC table	Injection amount limited to 80 mm 3 /st and boost becomes 0.	Rough engine idling, Lack of power
416	Main Relay System Error (No History Record)	2	Engine run steady, DTC table	Only diagnostic lamp (Flashing lamp) can be lighted by key current.	Battery consume, The system will not turn off
417	Starter Switch Abnormal	3	Engine Not Run, DTC table	—	Startup additional fuel injection don't work, Engine reverse rotation identification impossible, Air breathing impossible, Stator motor erroneous functioning
421	PCV Relay System Error	1	Check supply pump, DTC table	Only diagnostic code memory.	Bad battery consume, Pump control valve(PCV) relay burned out or failed
543	Over Speed Condition	3	DTC table	Fuel injection stop. Fuel pressure feed stop.	Stored DTC in ECM

Illuminate MIL
1 Turn on lamp is starter switch ON.
2 Turn on lamp after engine is running more than 20 second.
3 Not turn on lamp.

DTC 0014 Pump Position Sensor Error (CAM sensor)



Circuit Description

CAM sensor is installed at the side of the supply pump, serving to distinguish the cylinders of the engine and back up the detection of engine speed (in case of CKP sensor trouble).

This CAM sensor comprises the same parts as in CKP sensor, but the number of turns of its coil is different from that of CKP sensor and installed to the supply pump.

With the engine started, the pulser notches in the middle of the supply pump camshaft cut off intermittently the magnetic field made by the sensor magnet, thereby generating alternating current.

The pulser notches are made every 60° of camshaft (every 120° of crank angle) and there is a surplus tooth.

Therefore, seven pulses are outputted per one rotation of camshaft (2 rotations of the engine). The pulse outputted by the surplus tooth is recognized as engine number 1 cylinder reference pulse.

Diagnostic Trouble Code 0014 will set when the ECM detects a no signal for open circuit or sensor damage on the CAM sensor signal circuit.

Conditions for Setting the DTC

- CKP sensor pulse (Crank position, 450 times of pulse input) is normal, there is no CAM sensor pulse input.
- When CAM sensor pulse is inputted over specified cycles.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- When CKP sensor (pump position) is normal, backs up by CKP sensor.
- When both fail, injection stops.

DTC 0014 Pump Position Sensor Error (CAM sensor)

Conditions for Clearing the MIL/DTC

DTC 0014 can be cleared by using the "Clear Info" by Tech 2 or using by the Diag Clear Switch.

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 injection pump signal present display on the scan tool while moving connectors and wiring harnesses related to the CAM sensor. A change in the display will indicate the location of the fault.

F5; ENGINE DATA 6

APP Angle	0	%
Engine Speed	610~620	RPM
Actual Rail Pressure	25.0	Mpa
Fuel Temperature	113	°F
Main Injection Timing	–1.5	°
Main Injection Intrerval	0.7	ms
Pilot Injection Intrerval	0.55	ms
Split Injection Intrerval	0.72	ms
End of Split Injection	650	RPM
PC Valve On Time	4.38	ms
PC Valve Feed back	–7.3	°
PC Valve On Time Length	102.3	°
PC Valve Delay Time	3.3	ms
Crank Signal Present	Yes	
Injection Pump Signal Present	Yes	
Cylinder Balance Mode	Yes	
Engine Start Mode	No	
Engine Running	Yes	

Select Items	DTC	Quick Snapshot	More

060MY00058

- White smoke in case of racing.
- Poor output of tachometer (CAM failure during drive is outputted till engine stop).

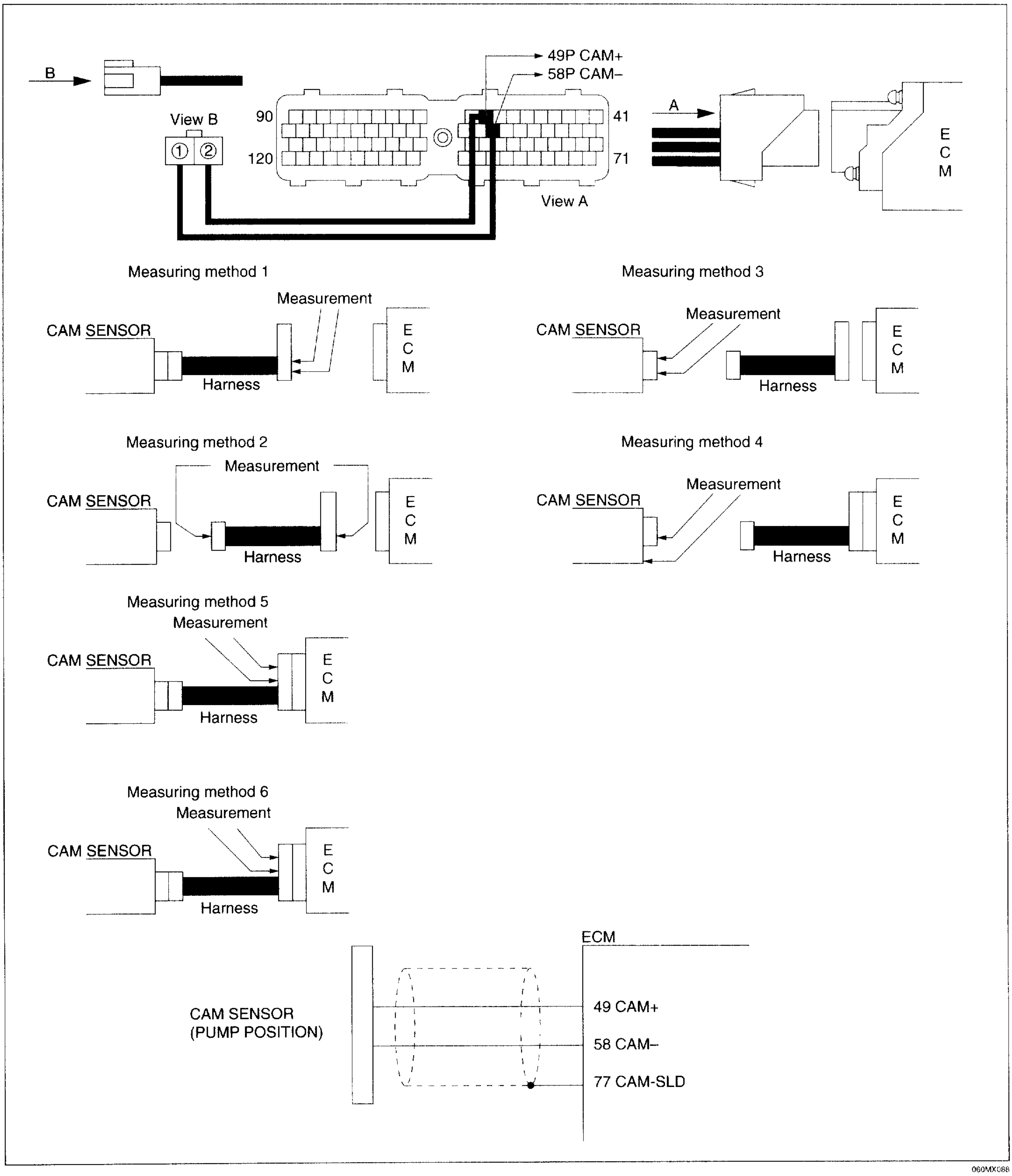
DTC 0014 Pump Position Sensor Error (CAM sensor)

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does DTC 0014 display after engine starting at 700 rpm or less.	—	Go to step 3	—
3 3	1. Key switch OFF. 2. Disconnect ECM connector. 3. Measure resistance between pin number 49 (CAM+) and pin number 58 (CAM–) on the CAM sensor harness. (Measuring method 1) Is resistance within the value?	1850Ω to 2450Ω	Go to step 7	Go to step 4
4	1. Disconnect CAM sensor harness. 2. Measure resistance between pin number 49 (CAM+) and pin number 2 (CAM sensor terminal 1 side) and between pin number 58 (CAM–) and pin number 1 (CAM sensor terminal 2 side). (Measuring method 2) Is resistance within the value?	Less than 2Ω	Go to step 5	Repair harness then Go to step 9
5	Measure resistance in between terminals on the CAM sensor. (Measuring method 3) Is resistance within the value?	1850Ω to 2450Ω	Go to step 6	Replace CAM sensor then Go to step 9
6	Measure shortage between CAM sensor terminal and CAM sensor body. (Measuring method 4) Is resistance within the value?	More than 10MΩ	Go to step 9	Replace CAM sensor then Go to step 9
7	1. Reconnect ECM connector and check DTC. 2. Measure CAM sensor output voltage while engine is running. 3. Observe CAM sensor output voltage waveform (Measuring method 5) by oscilloscope. Is voltage within the value?	More than 0.4V/260 rpm More than 3.4V/2600 rpm	Go to step 8	Replace supply pump assembly then Go to step 8
8	Check DTC indication. Is DTC 0014 displayed?	—	Replace ECM then Go to step 9	Double check for connector cable etc. contact incomplete. Go to step 9
9	Recheck DTC indication. Is DTC 0014 displayed?	—	Go back step 3	System OK

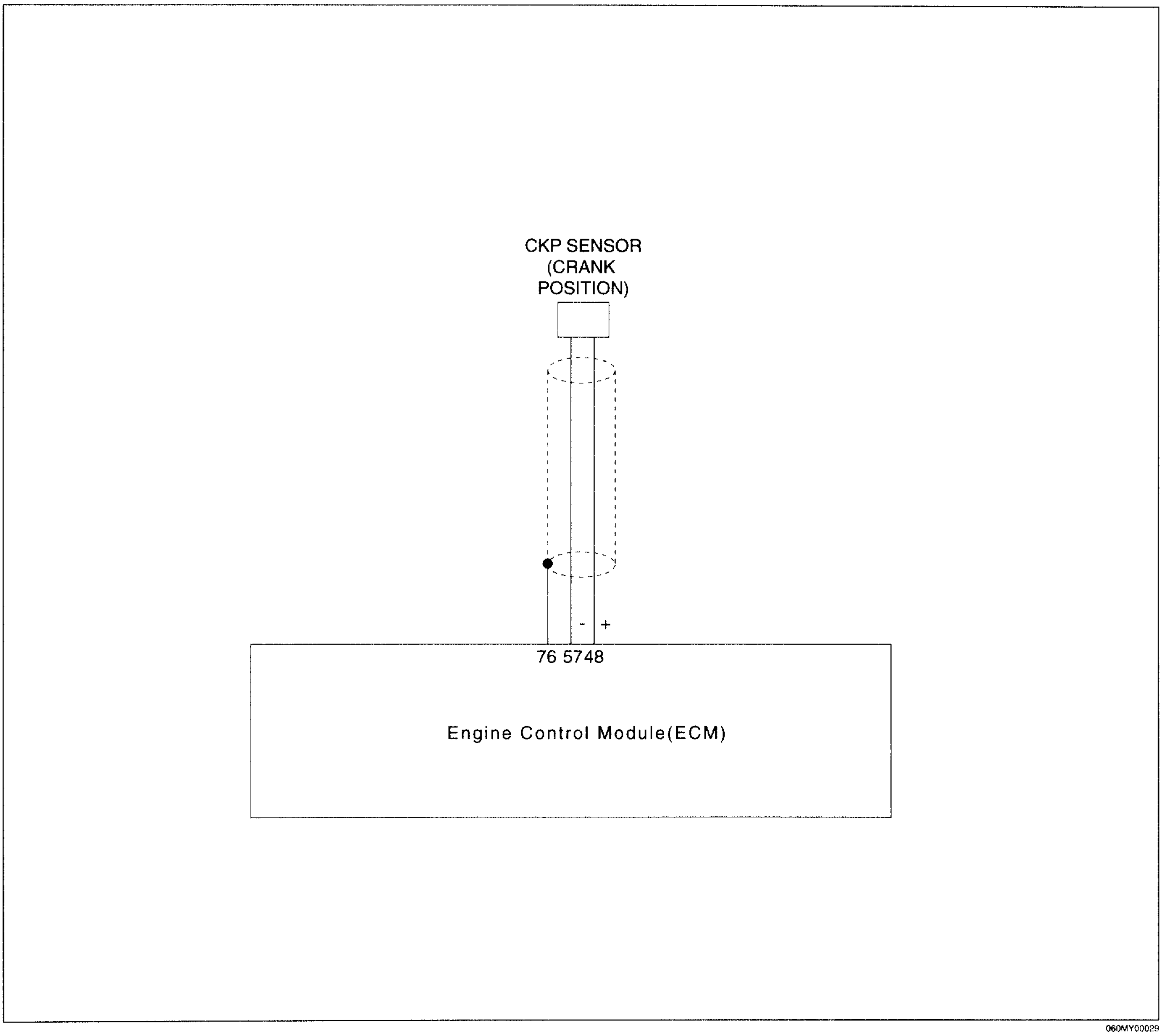
	Note:
	• **As compared with CAM sensor, CKP sensor is difficult to detect trouble because its influence is smaller.**
	• **An Intermittent condition can be caused by the following**
	  • **Poor connections**
	  • **Rubbed through wire insulation**
	• **There are two countermeasure for CAM sensor error, one is CAM sensor replacement and the other is supply pump replacement.**			

***IMPORTANT:** The replacement ECM must be restored the capture fuel rate data by Tech 2.*
Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Pump Position Sensor Error (CAM sensor)



DTC 0015 Crank Position Sensor Error (CKP sensor)



Circuit Description

This sensor comprises a permanent magnet, coil, and iron core and is installed to the flywheel housing. With the engine started, the signal holes made on the outer periphery of the flywheel cut off intermittently the magnetic field made by the magnet, thereby generating AC in the coil.

The signal holes on the flywheel are provided every 7.5°, but 3 point is holeless. Therefore, the signal holes total 45. 90 pulses are outputted per 2 rotations of the engine. By this signal, engine speed and 7.5°-based crank angle can be detected.

Diagnostic Trouble Code 0015 will set when the ECM detects a no signal for open circuit or sensor damage on the CKP sensor signal circuit.

Conditions for Setting the DTC

- When CAM sensor pulse (pump position, 40 times of pulse input) is normal (engine ON) there is no CKP pulse input nor 1 sec. or more.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- When the CKP sensor fails, the engine will run off of the pump position/CAM sensor.
- When both failure, injection stops.

Conditions for Clearing the MIL/DTC

DTC 0015 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

DTC 0015 Crank Position Sensor Error (CKP sensor)

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 crank signal present display on the scan tool while moving connectors and wiring harnesses related to the CKP sensor. A change in the display will indicate the location of the fault.

F5; ENGINE DATA 6

APP Angle	0	%
Engine Speed	610~620	RPM
Actual Rail Pressure	25.0	Mpa
Fuel Temperature	113	°F
Main Injection Timing	–1.5	°
Main Injection Intrerval	0.7	ms
Pilot Injection Intrerval	0.55	ms
Split Injection Intrerval	0.72	ms
End of Split Injection	650	RPM
PC Valve On Time	4.38	ms
PC Valve Feed back	–7.3	°
PC Valve On Time Length	102.3	°
PC Valve Delay Time	3.3	ms
Crank Signal Present	Yes	
Injection Pump Signal Present	Yes	
Cylinder Balance Mode	Yes	
Engine Start Mode	No	
Engine Running	Yes	

Select Items	DTC	Quick Snapshot	More

060MY00058

- White smoke in case of racing.
- Poor output of tachometer (CKP failure during drive is outputted till engine stop).
- Unstable idling (FCCB stops)

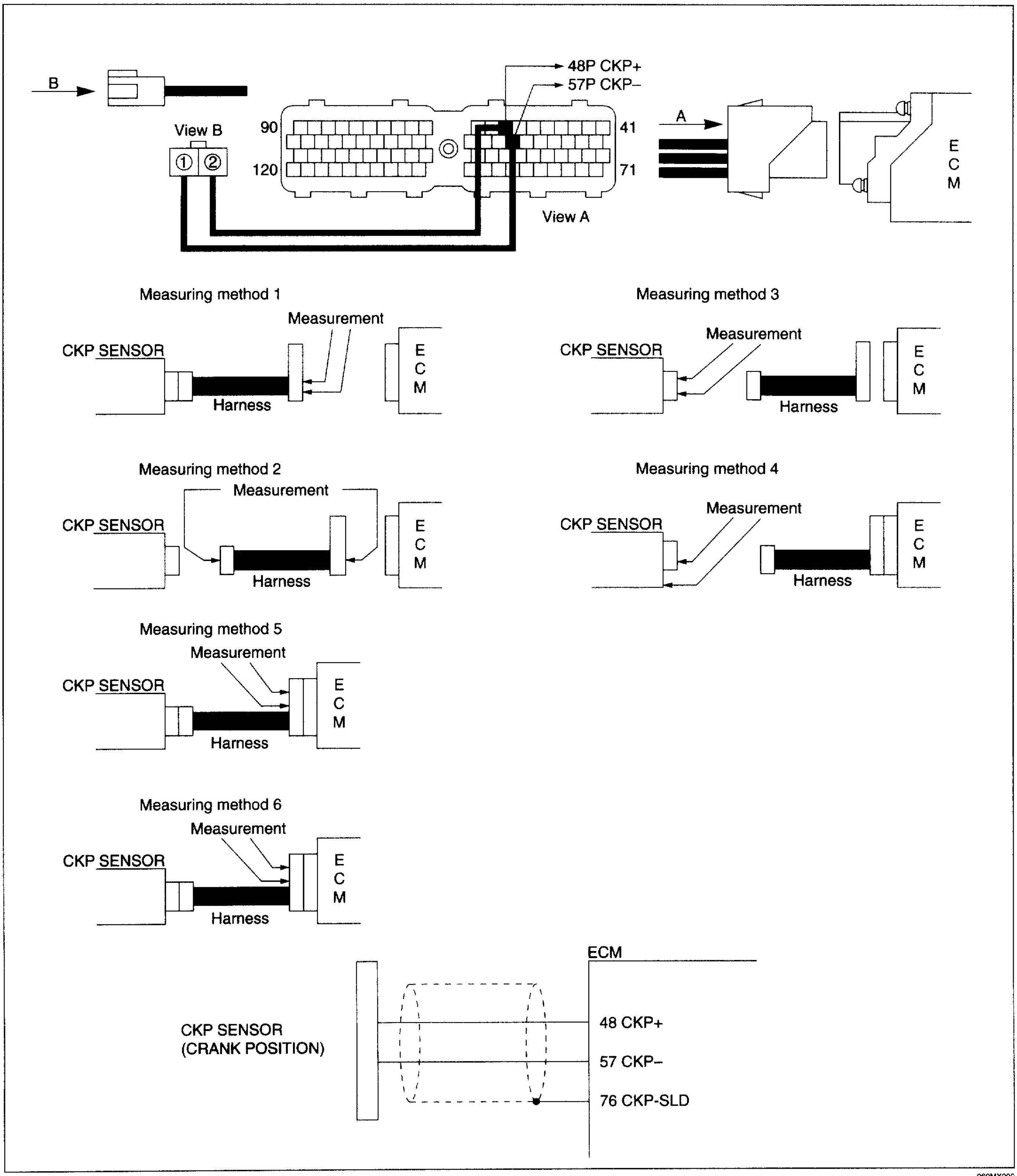
DTC 0015 Crank Position Sensor Error (CKP sensor)

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does DTC 0015 display after engine starting at 700 rpm or less.	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect ECM connector. 3. Measure the resistance between pin number 48 (CKP+) and pin number 57 (CKP–) on the CKP sensor harness. (Measuring method 1)	109Ω to 143Ω	Go to step 7	Go to step 4
4	1. Disconnect CKP sensor connector. 2. Measure the resistance between pin number 48 (CKP+) and CKP sensor pin number 2. 3. Measure the resistance between pin number 57 (CKP–) and CKP sensor pin number 1. (Measuring method 2) Is resistance within the value?	Less than 2Ω	Go to step 5	Repair CKP sensor harness then Go to step 10
5	Measure CKP sensor unit resistance. (Measuring method 3) Is resistance within the value?	109Ω to 143Ω	Go to step 6	Replace CKP sensor then Go to step 10
6	Measure resistance between CKP sensor terminal (+, –) and CKP sensor body. (Insulation shortage check) (Measuring method 4) Is resistance within the value?	10MΩ or more	Go to step 10	Replace CKP sensor then Go to step 10
7	Check CKP sensor for fitness and/or looseness. Is a problem found?	—	Go to step 8	Adjustment then Go to step 10
8	Check CKP sensor for damage. Is there damage on CKP sensor?	—	Replace CKP sensor	Go to step 9
9	1. Clear all DTCs. 2. Check DTC indication. Is DTC 0015 displayed.	—	Replace ECM Go to step 10	Double check for connector cable etc. contact incomplete Go to step 9
10	Check for DTCs. Is DTC 0015 displayed?	—	Go back step 3	System OK
	Note: **1. If scan tool is used, intermittent trouble can be detected by CKP sensor active flag.** **2. If CKP sensor signal is completely lost, tachometer output is not produced (When NG in the midway, use CAM sensor to produce output).** **3. Under CAM sensor operation, diesel knocking and/or white smoke may often occur due to racing.**			

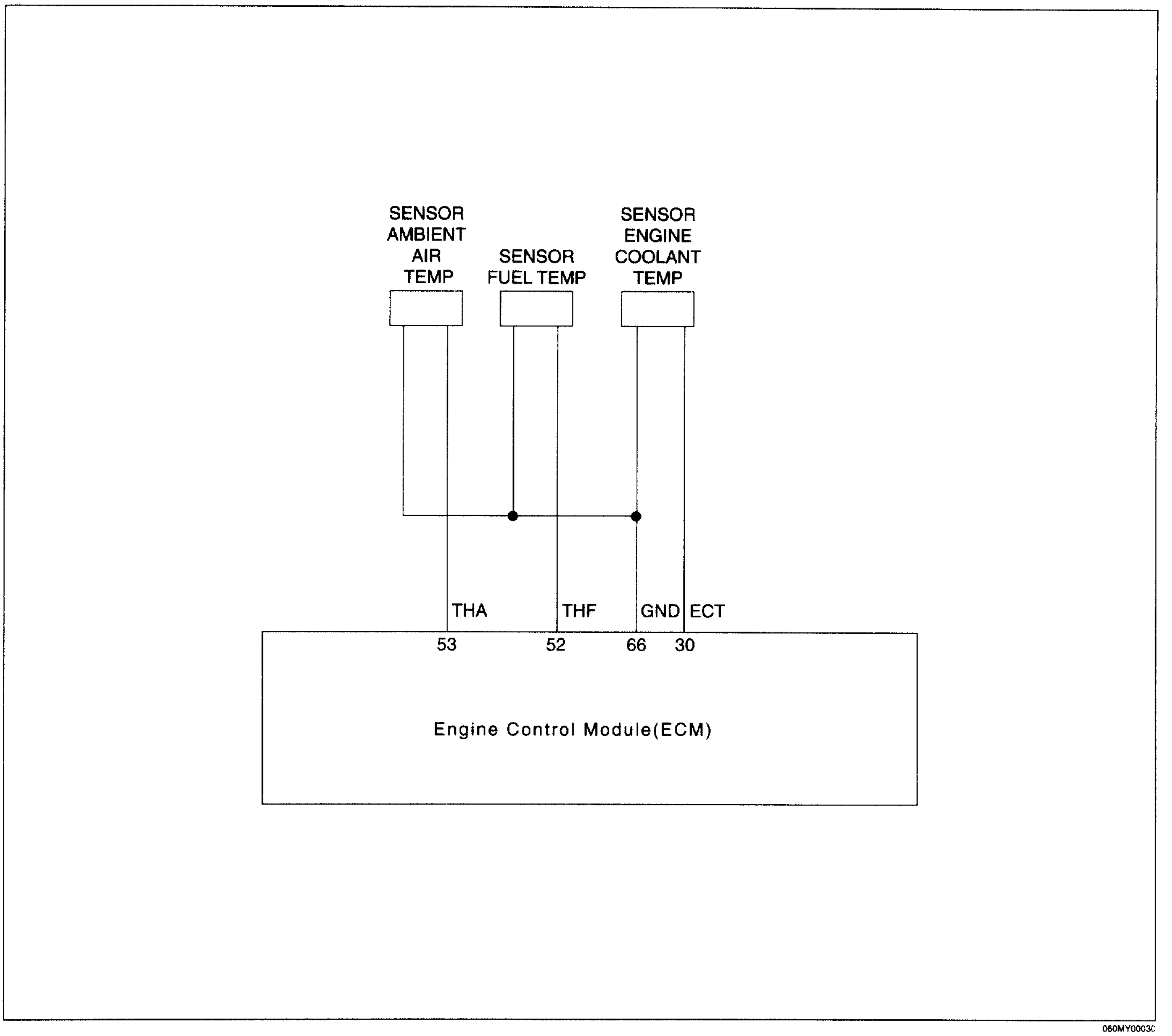
IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

NOTE: Air gap value is 0.9 to 1.2 mm between CKP sensor and flywheel. (Not adjustable)

Crank Position Sensor Error (CKP sensor)



DTC 0022 Ambient Air Temperature Sensor Error



Circuit Description

The Ambient Air Temperature Sensor (THA) is located inside of cab front panel.

The THA is changed into a resistance change signal and sent to ECM for optimization of fuel injection control.

Diagnostic Trouble Code 0022 will set when the ECM detects abnormal signal for open circuit or sensor damage on the sensor signal circuit.

Conditions for Setting the DTC

- THA sensor voltage exceeding 4.95V or lower than 0.1V continues 1 sec. or more.

Action Taken When the DTC Sets

Starting:
THA = –4°F (–20°C)
Other = 176°F (80°C)

Conditions for Clearing the MIL/DTC

DTC 0022 can be cleared by using the “Clear Info” by scan tool or using by the Diag Clear Switch.

DTC 0022 Ambient Air Temperature Sensor Error

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 Ambient Air Temperature display on the scan tool while moving connectors and wiring harnesses related to the THA sensor. A change in the Ambient Air Temperature display will indicate the location of the fault.

F0; ENGINE DATA 1

Engine Speed	610~620	RPM
APP Angle	0	%
Boost Pressure	0	Kpa
BARO	100	Kpa
ECT	176	°F
Ambient Air Temperature	60	°F
Fuel Temperature	113	°F
Battery Voltage	14.5	Volts

Select Items	DTC	Quick Snapshot	More

060MY00053

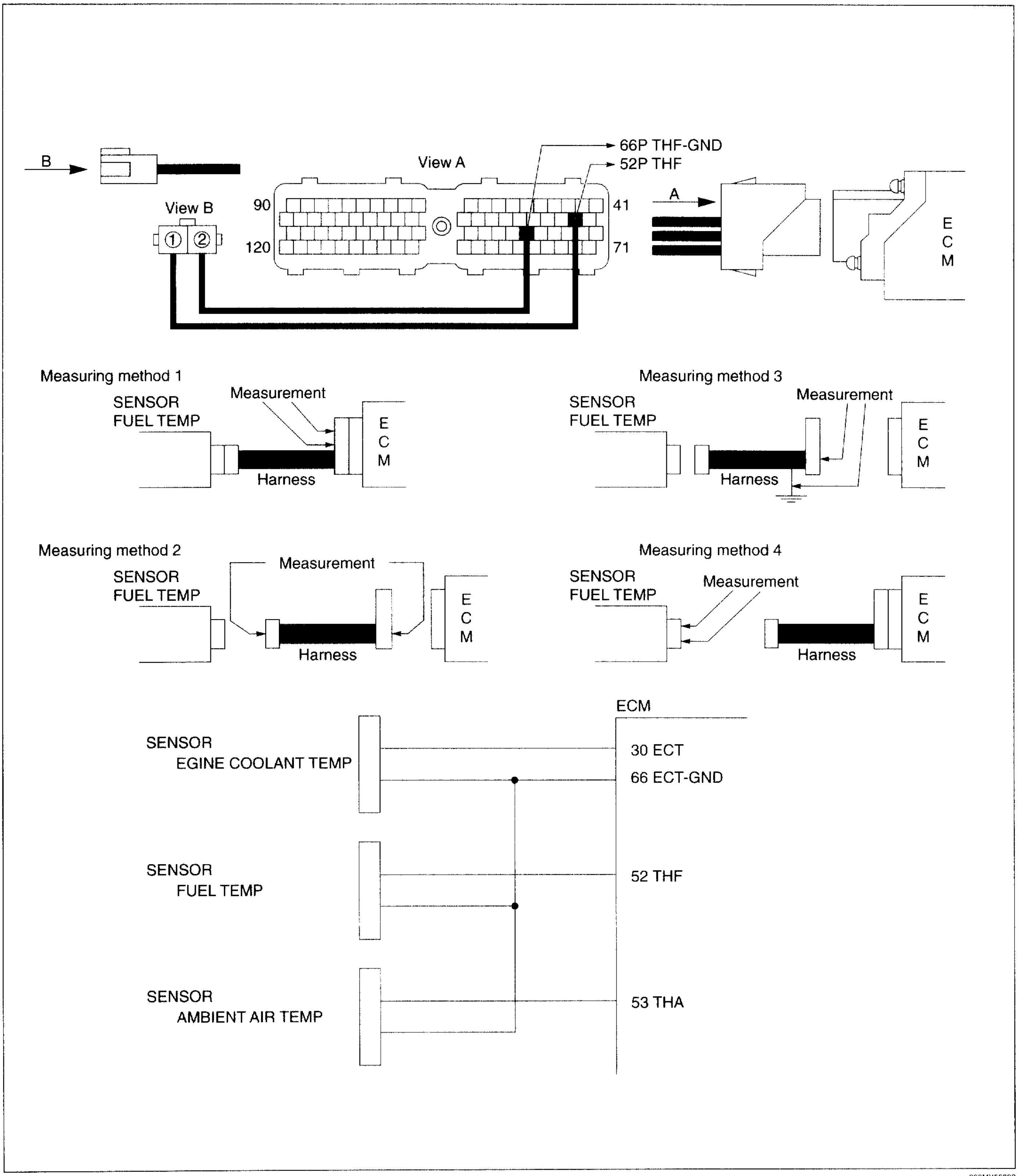
- White smoke at the engine stgarting in cold districts.

DTC 0022 Ambient Air Temperature Sensor Error

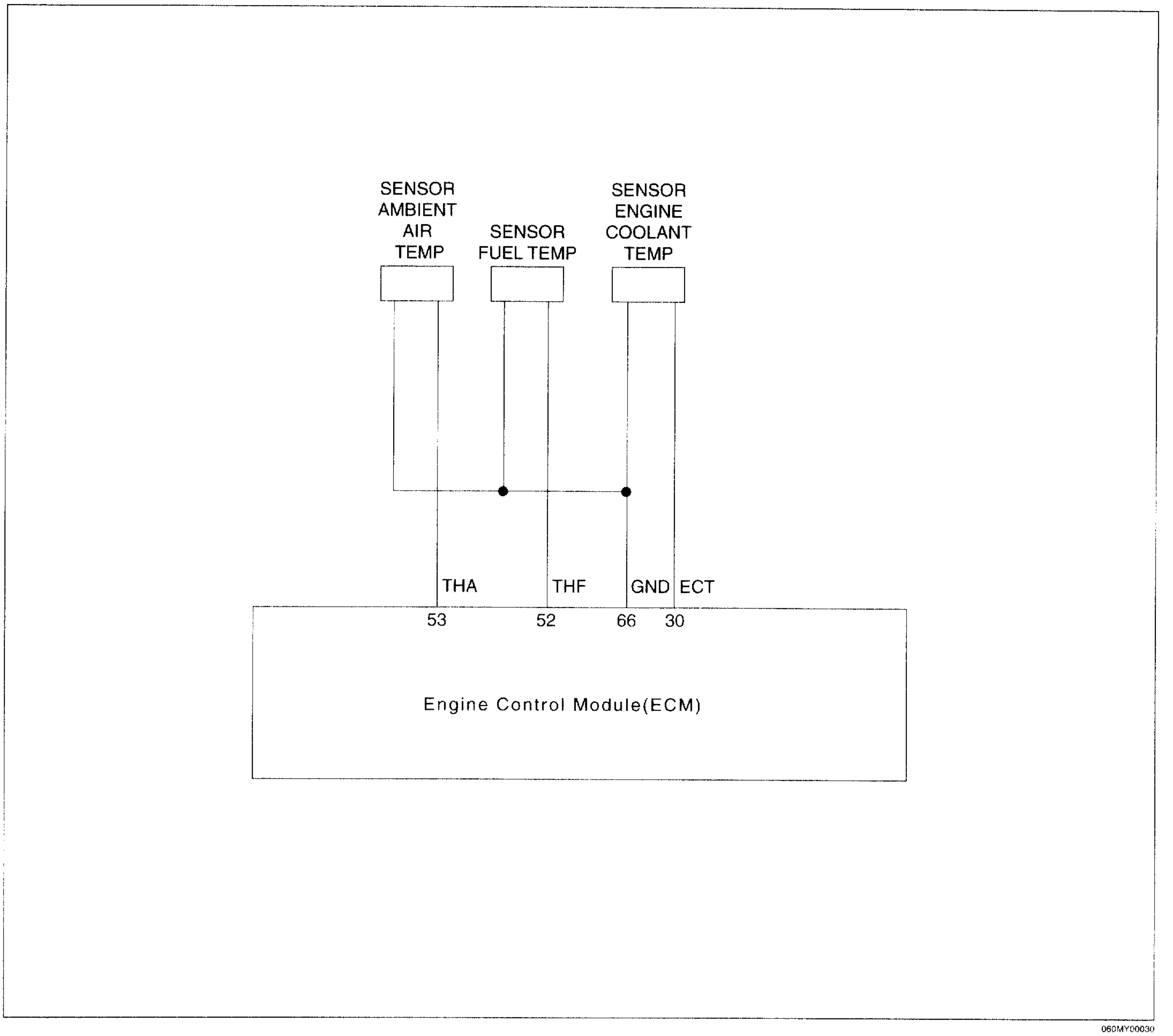
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does display DTC 0022 while key switch "ON" or engine in operating?	—	Go to step 3	—
3	Measure the voltage between pin number 53 (THA) and pin number 66 (AA–GND) at ECM side. (Measuring method 1) Is there voltage beyond compass from value? (2.9V when air temp. about 20°C)	0.1V to 4.8V	Go to step 5	Go to step 4
4	Check incomplete connection connector on the THA sensor harness. Is there incomplete connection?	—	Repair THA sensor harness	System OK
5	Is there abnormal high or low atmospheric temperature at atmospheric temperature sensor fixing area (Displayed by scan tool)?	Fixed 176°F (80°C)	Repair problem portion	Go to step 6
6	1. Key switch "OFF". 2. Disconnect THA sensor harness. 3. Measure resistance following points. (Measuring method 2) • Between pin number 53 (THA) at ECM side and pin number 1 at THA sensor side on the THA sensor harness. • Between pin number 66 (AA–GND) at ECM side and pin number 2 at THA sensor side on the THA sensor harness. Is resistance within value?	2Ω or less	Go to step 7	Repair disconnect THA sensor harness.
7	Measure resistance between pin number 53 (THA) and GND on the THA sensor harness. Is resistance within value?	10MΩ or more	Go to step 8	Repair/replace THA sensor harness. Then go to step 10
8	Measure resistance THA sensor unit. Is resistance within value? Resistance of THA sensor unit Atmospheric temperature (°C) / Resistance (kΩ): 20 — About 3.8 (2.9V) 40 — 1.6 (1.9V) 60 — 0.8 (1.1V) 80 — 0.4 (0.7V)	See table left	Go to step 9	Replace THA sensor assembly. Then go to step 10
9	1. Reconnect THA sensor harness to ECM and THA sensor. 2. Clear DTC. Is display DTC 0022?	—	Replace ECM assembly then Go to step 10	System OK
10	Clear DTC. Is display DTC 0022?	—	Go back to step 3	System OK
	Note: Sometimes it indicate DTC 0022 at abnormal low atmospheric temperature (Less than minus 40°C).			

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Ambient Air Temperature Sensor Error



DTC 0023 Engine Coolant Temperature Sensor Error



Circuit Description

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 less, 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 circit, then a code 0023 will set.

Conditions for Setting the DTC

- Water temperature sensor voltage exceeding 4.8V or lower than 0.1V continues for 1 sec.
  (4.8V = –50°C, 0.1V = 110°C)

Action Taken When the DTC Sets

- Starting: Based on –4°F (–20°C)
- Other: Based on 176°F (80°C)

Conditions for Clearing the MIL/DTC

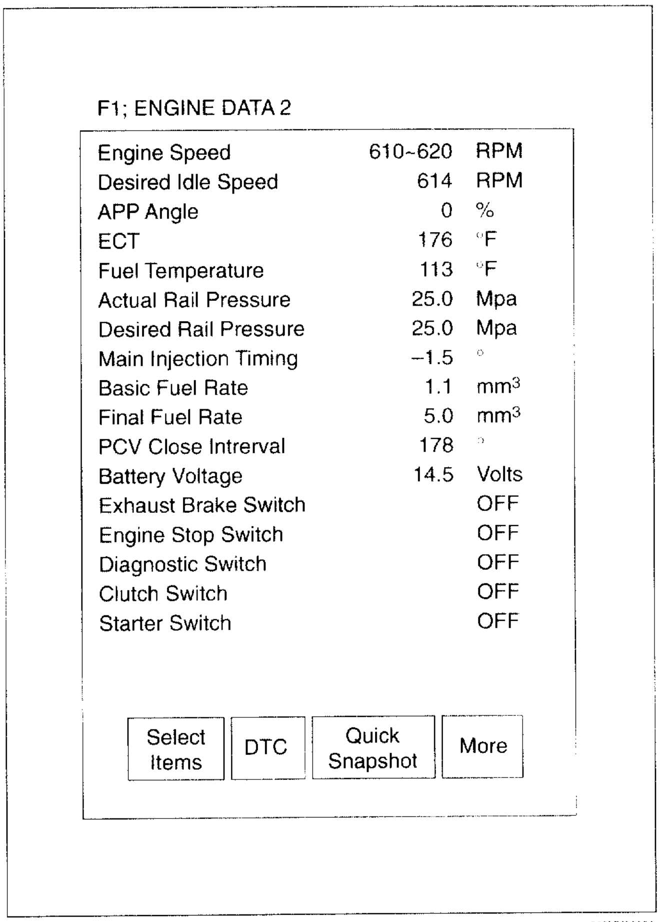
DTC 0023 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

DTC 0023 Engine Coolant Temperature Sensor Error

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 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.



F1; ENGINE DATA 2

Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
APP Angle	0	%
ECT	176	°F
Fuel Temperature	113	°F
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	25.0	Mpa
Main Injection Timing	–1.5	°
Basic Fuel Rate	1.1	mm^3
Final Fuel Rate	5.0	mm^3
PCV Close Intrerval	178	°
Battery Voltage	14.5	Volts
Exhaust Brake Switch		OFF
Engine Stop Switch		OFF
Diagnostic Switch		OFF
Clutch Switch		OFF
Starter Switch		OFF

Select Items | DTC | Quick Snapshot | More

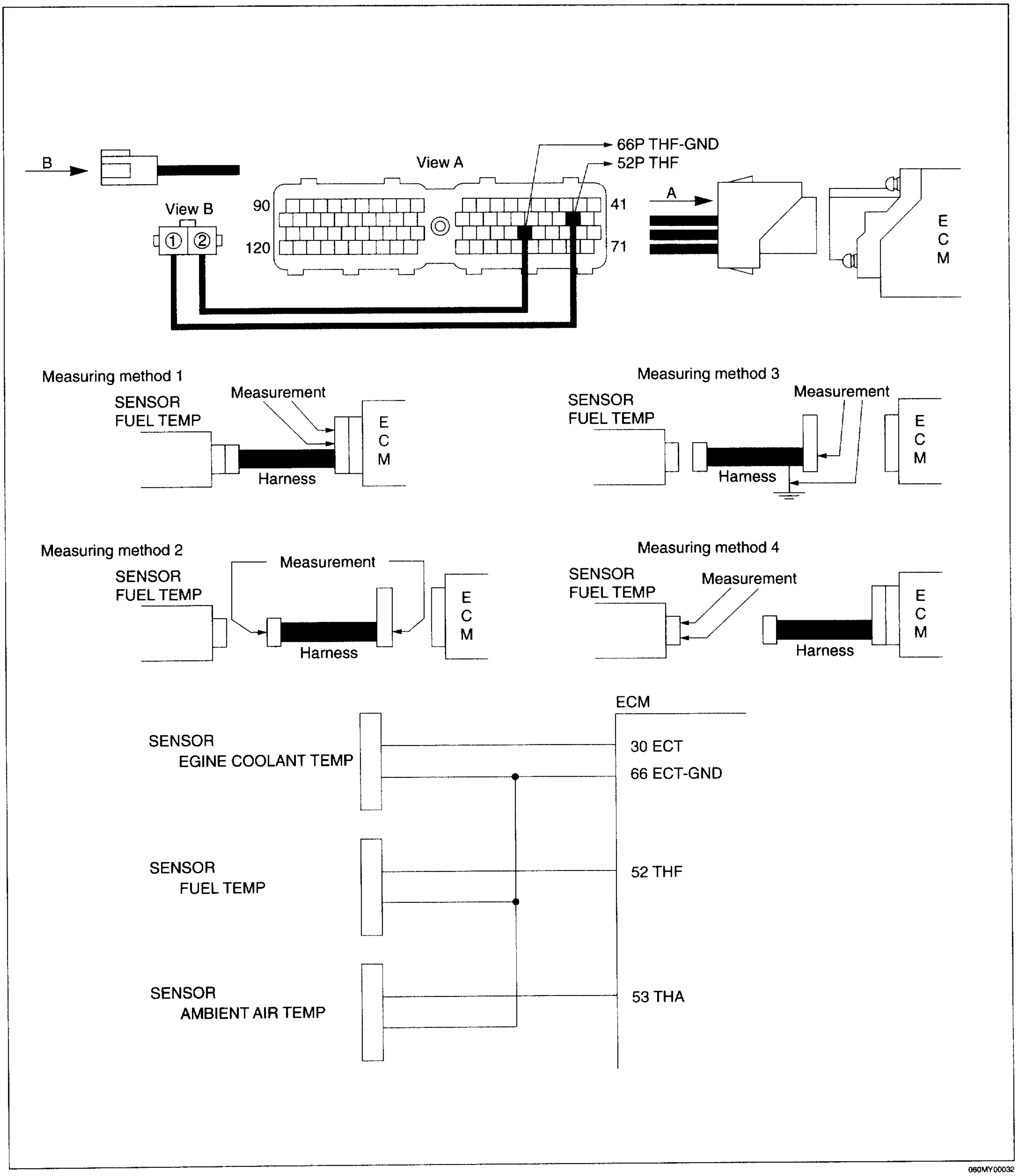
- Smoke observe when started after warming up.
- Excessive white smoke when started in cold weather.

DTC 0023 Engine Coolant Temperature Sensor Error

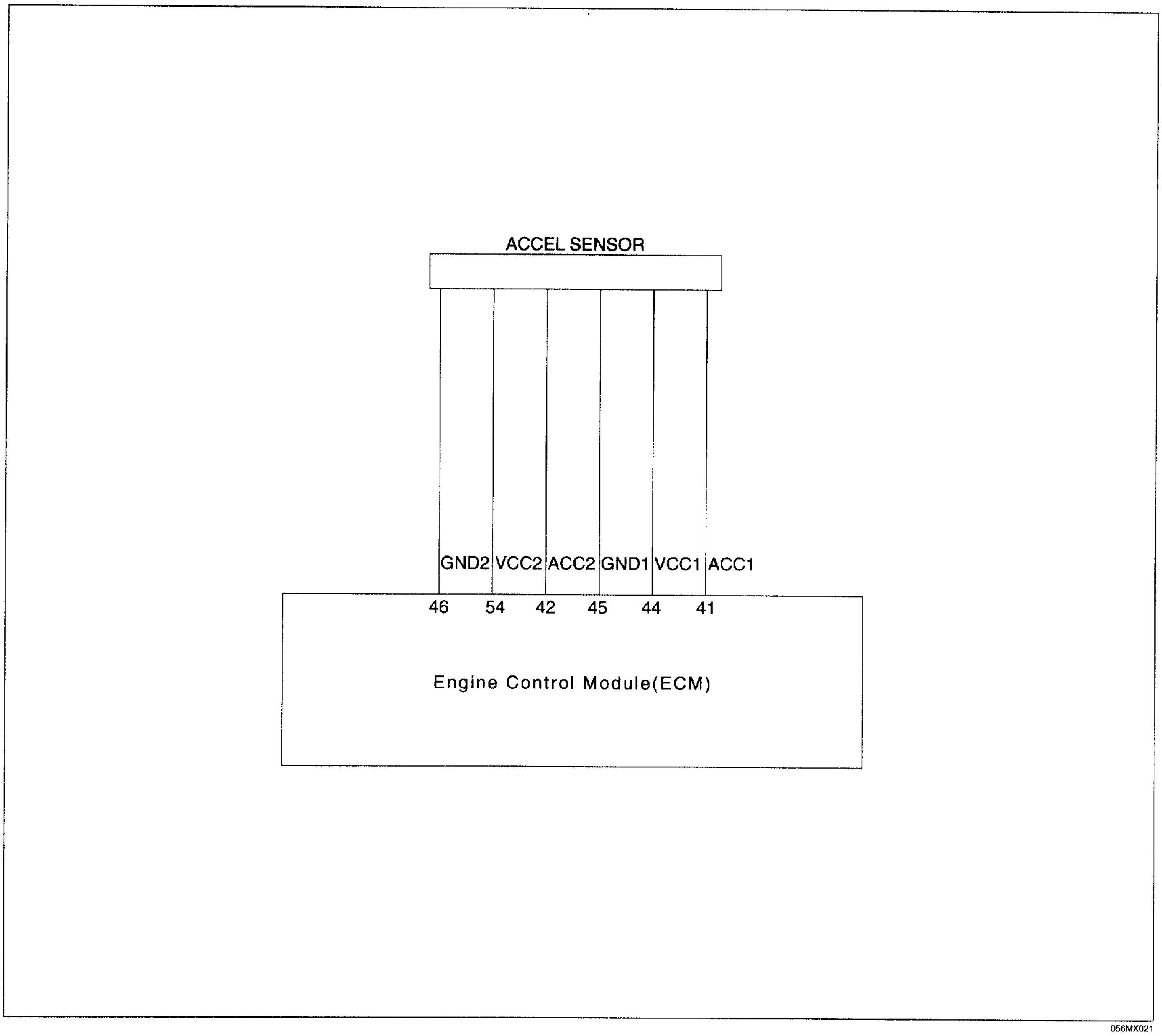
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does display DTC 0023 when key switch "ON" or engine in operation?	—	Go to step 3	—
3	Measure the voltage between pin number 30 (ECT) and pin number 66 at ECM side while key switch "ON" and engine in operation. (Measuring method 1) Is voltage outside specified value? (0.65V when water temp. about 80°C) **Note: When voltage abnormally high e.g. 12V, may be short circuited with B+ line.**	0.1V to 4.8V	Go to step 5	Go to step 4
4	Check intermittent incomplete connection in between connector and ECT sensor harness or temporally overheating of engine. Is there a problem?	—	Go to step 5	Go to step 6
5	Repair/replace engine cooling system such as radiator, fan and thermostat etc. Did you complete?	—	Go to step 3	Complete Then go to step 10
6	1. Key switch "OFF". 2. Disconnect connector from ECM and ECT sensor. 3. Measure resistance following points. (Measuring method 2) • Between pin number 30 (ECT) at ECM side and pin number 1 at sensor side. • Between pin number 66 at ECM side and pin number 3 at sensor side. Is resistance within value?	2Ω or less	Go to step 7	Repair/replace to ECT sensor harness
7	Measure the resistance between pin number 30 (ECT) and GND on the ECT sensor harness. Is resistance within value?	10MΩ or more	Go to step 8	Repair/replace to ECT sensor harness
8	Measure the resistance ECT sensor unit. Is resistance normal value? Resistance for ECT sensor unit Water temperature (°C) / Resistance (kΩ): 20 / About 2.7 (2.5V) 40 / 1.3 (1.6V) 60 / 0.6 (0.9V) 80 / 0.4 (0.65V)	See table left	Go to step 9	Replace ECT sensor
9	1. Reconnect ECT sensor harness connector to both ECM and ECT sensor. 2. Clear DTC. Is DTC 0023 displayed?	—	Replace ECM assembly. Then go to step 10	System OK
10	Clear all DTCs. Is DTC 0023 displayed?	—	Go back to step 3	System OK
	Note: Water temperature GND is common. If disconnected or short circuited, all sensors become erroneous. (Water, atmospheric and fuel temperature)			

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Engine Coolant Temperature Sensor Error



DTC 0024 Accelerator Pedal Position Sensor Error 1 and 2 (Trouble for accelerator sensor intermediate hold)



Circuit Description

This sensor is a hole IC type substituting electric signals for accelerator pedaling amount to be sent to ECM. It is installed to accelerator pedal bracket assembly.

The Accel Position (AP) signal is used by the engine control module (ECM) for fuel control and most of the ECM – controlled outputs. The ECM monitors accel position. If the ECM detects an out-of-range condition, then a DTC code 0024 will set.

Conditions for Setting the DTC

Item 1. Accelerator
Sensor Error 1

Item 2. Accelerator
Sensor Error 2

Item 3. Accelerator
Sensor 1
Intermediate throttle position voltage hold steady.

Item 4. Accelerator
Sensor 2
Intermediate voltage hold trouble.

- Item 1 and 2: Accel voltage exceeding 4.8V or lower than 0.5V continues 1 sec. or more.
- Item 3 and 4: Difference between previous value and current value is lower than 0.05 V (stationary), difference from the other sensor voltage exceeding 0.2V and no individual abnormality detected by sensor 1 and 2 continues.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Item 1, 2, 3 and 4: When one sensor is normal, backup by normal sensor.
- When both sensor are faulty accel. is fixed at 20%, however using an injection map for ASC mode.

DTC 0024 Accelerator Pedal Position Sensor Error 1 and 2 (Trouble for accelerator sensor intermediate hold)

Conditions for Clearing the MIL/DTC

DTC 0024 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

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 APP sensor display on the scan tool while moving connectors and wiring harnesses related to the AP sensor. A change in the APP sensor display will indicate the location of the fault.

F4; ENGINE DATA 5

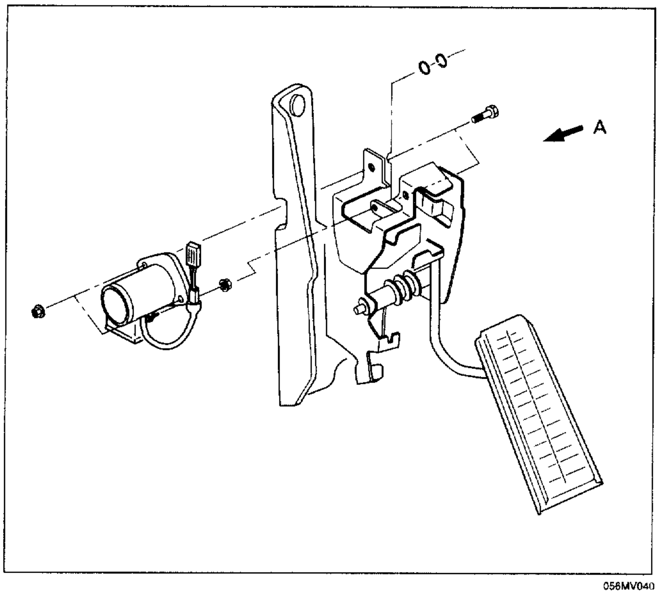
Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
ECT	176	°F
APP Angle	0	%
APP sensor	1.34	Volts
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	25.5	Mpa
Main Injection Timing	–1.5	°
PCV ON Time	4.38	ms
PCV Close Interval	177.5	°
Basic PCV ON Time	188.5	°
Battery Voltage	14.5	Volts
Fuel Temperature	113	°F
Maximum Fuel Temperature	180	°F
Injection Control Mode		Normal Control
Pump Control Mode		Normal Control
Overheat Number of Time	0	
Over Speed Number of Time	0	

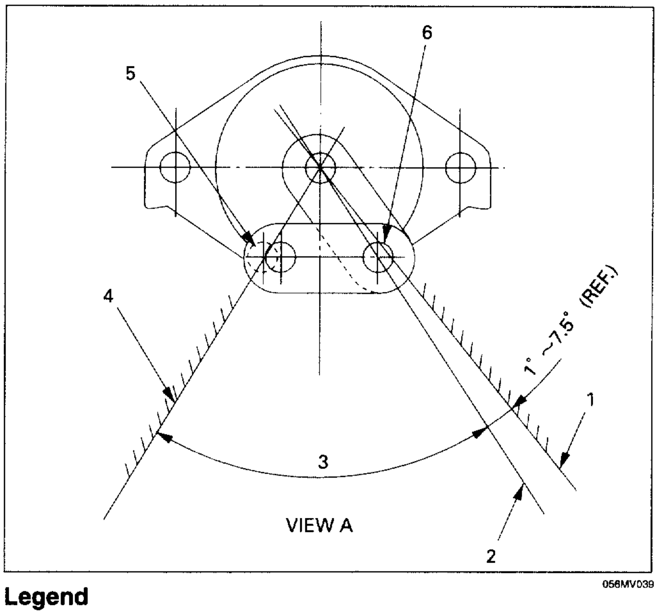
Select Items | DTC | Quick Snapshot | More

060MY00057

- Poor throttle response.
- No accel. response.
- 1200 rpm fixed.

Procedure Acceleration Sensor Adjustment





Legend

(1) Pedal Initial Position
(2) Sensor Set Position
(3) Sensor Travel (Deg.)
(4) Pedal Full Position
(5) Pedal Full Stroke Position
(6) Idling Side Sensor Set Position

Idling side adjustment

Set acceleration sensor output voltage 1.00 ± 0.05 volts at sensor set position (6).

Full Stroke side adjustment

Confirm sensor output voltage more than 3.49 volts when the pedal is AT wide open throttle (5).

DTC 0024 Accelerator Pedal Position Sensor Error 1 and 2 (Trouble for accelerator sensor intermediate hold)

Note: The accelerator sensor is element type and non contact type, thus, when doing judgment to supplying voltage.

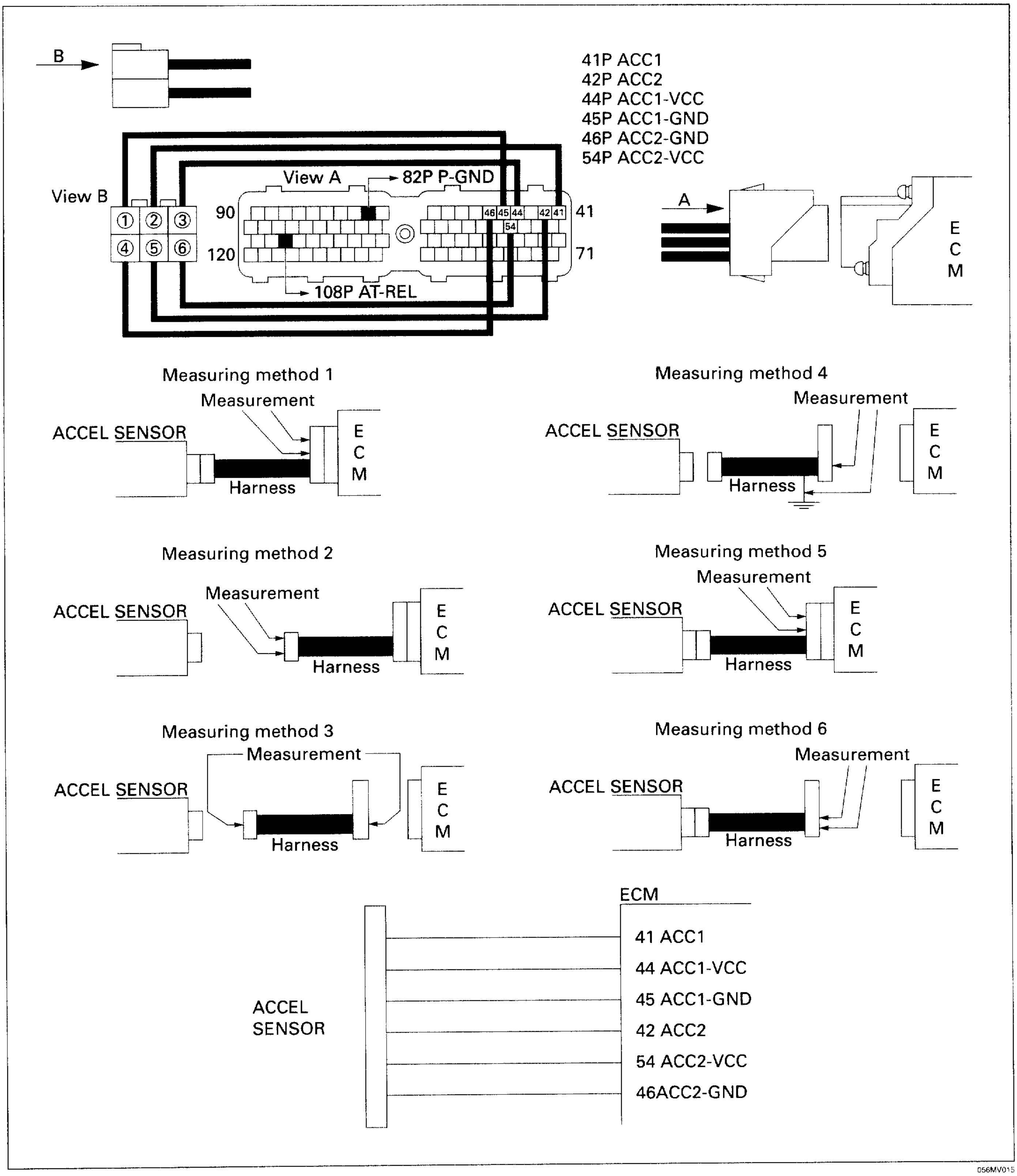
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does DTC 0024 display while key switch "ON" or engine operating?	—	Go to step 3	—
3	Measure voltage following points. (Measuring method 1) • Between pin number 41 (ACC1) and pin number 45 (ACC1–GND) at ECM side. • Between pin number 42 (ACC2) and pin number 46 (ACC2–GND) at ECM side. Is there voltage outside the specified value?	At idling 0.95V to 1.05V At full around 4.5V (Max)	Go to step 5	Go to step 4
4	1. Repair poor connection on accelerator sensor harness. 2. Readjust accelerator sensor in the idle position. Was a repair performed?	—	Go to step 14	Repair/readjust harness or accelerator sensor.
5	Measure voltage between pin number 41 (ACC1) and pin number 42 (ACC2) at engine idle position.	0.2V or less	Go to step 7	Accelerator sensor intermediate hold error. Go to step 6
6	Does accelerator sensor voltage change when the accelerator pedal is depressed?	—	System OK	Readjust accelerator sensor. Then Go to step 14
7	Measure voltage between pin number 41 (ACC1) and pin number 42 (ACC2) at ECM side when accelerator pedal from idle to wide open throttle. (Measuring method 1) Is voltage within value?	0.2V or less	Go to step 8	Repair accel. sensor harness connection condition or replace accelerator sensor. Then Go to step 16
8	1. Key switch "OFF". 2. Disconnect the accelerator sensor side connector. 3. Key switch "ON". 4. Measure voltage following point at ECM side. (Measuring method 2) • Between pin number 44 (ACC1–VCC) and pin number 45 (ACC1–GND). • Between pin number 54 (ACC2–VCC) and pin number 46 (ACC2–GND). Is voltage within value?	4V to 6V	Go to step 12	Go to step 9
9	1. Disconnect accelerator sensor harness from both ECM and sensor. 2. Measure resistance following points on the accelerator sensor harness. (Measuring method 3) • Between pin number 44 (ACC1–VCC) ECM side and pin number 4 sensor side. • Between pin number 45 (ACC1–GND) ECM side and pin number 6 sensor side. • Between pin number 54 (ACC2–VCC) ECM side and pin number 1 sensor side. • Between pin number 46 (ACC2–GND) ECM side and pin number 3 sensor side. Is resistance within value?	2Ω or less	Go to step 10	Repair/replace accelerator sensor harness. Then go to step 16

DTC 0024 Accelerator Pedal Position Sensor Error 1 and 2 (Trouble for accelerator sensor intermediate hold)

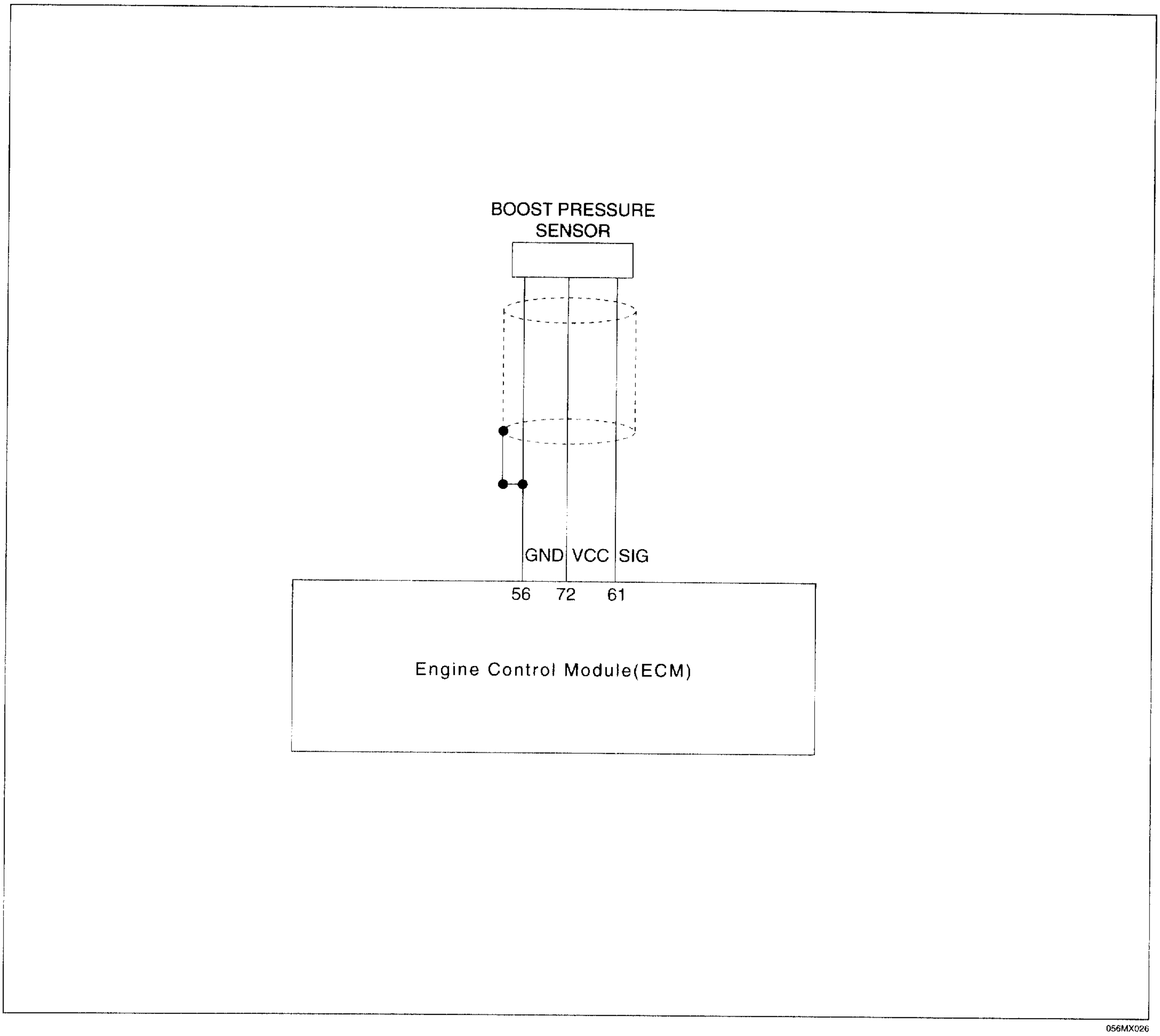
STEP	ACTION	VALUE	YES	NO
10	Measure resistance following points on the accelerator sensor harness. (Measuring method 4) • Between pin number 44 (ACC1–VCC) and GND. • Between pin number 54 (ACC2–VCC) and GND. Is resistance within value?	10MΩ or more	Go to step 11	Repair/replace accelerator sensor harness. Then go to step 16
11	1. Reconnect connector of accelerator sensor harness to ECM. 2. Key switch "ON". 3. Measure voltage at the following point at ECM side. (Measuring method 2) • Between pin number 44 (ACC1–VCC) and pin number 45 (ACC1–GND). • Between pin number 54 (ACC2–VCC) and pin number 46 (ACC2–GND). Is voltage within value?	4V to 6V	Replace accelerator sensor Then to go step 16	Replace ECM assembly. Then go to step 16
12	1. Disconnect connector from both ECM and accelerator sensor. 2. Key switch "OFF" condition. 3. Measure resistance following points. (Measuring method 3) • Between pin number 41 (ACC1) at ECM side and pin number 5 at accelerator sensor side on the accelerator sensor harness. • Between pin number 42 (ACC2) at ECM side and pin number 2 at accelerator sensor side on the accelerator sensor harness. Is resistance within value?	2Ω or less	Go to step 13	Repair/replace accelerator sensor harness. Then to go step 16
13	Measure resistance following point. (Measuring method 4) • Between pin number 41 (ACC1) and GND. • Between pin number 42 (ACC2) and GND. Is resistance within value?	10MΩ or more	Go to step 14	Repair/replace accelerator sensor harness.
14	Reconnect accelerator sensor harness to both ECM and accelerator sensor. Is lamp DTC 0024 displayed?	—	Replace accelerator sensor. Then go to step 15	System OK
15	Clear all DTCs. Is DTC 0024 displayed?	—	Replace ECM assembly	System OK
16	Clear to memoried DTC. Is DTC 0024 displayed?	—	Go back to step 3	System OK
	Note: After replacing the APP it is necessary to set voltage at idle position. (See page 6E-138 for procedure)			

***IMPORTANT:** The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.*

Accelerator Sensor Error 1 and 2 (Trouble for accelerator sensor intermediate hold)



DTC 0032 Boost Pressure Sensor Error



Circuit Description

The boost sensor is fixed on the cab back frame and is connected to rear portion of intake manifold by vacuum hose.

The boost sensor generates voltage according to air aspiration pressure and generation voltage is input to ECM for boost sensor signal.

The ECM monitors the boost pressure sensor signals for voltage outside the normal range of the boost pressure sensor. If the ECM detects a boost pressure sensor signal voltage that is excessively low, Diagnostic Trouble Code 0032 will be set.

Conditions for Setting the DTC

(1)
- When engine stalls and relative boost pressure is higher than 20 kPa continues for 1 sec. or more.

(2)
- Relative boost pressure lower than the –32 kPa continues for 1 sec. or more.

(3)
- If the ECM detects a higher boost sensor signal that continues for 10 sec. or more, a DTC 0042 will be set.

Action Taken When the DTC Sets

- (1), (2) left: Based on relative pressure of 0 kPa.
- (3) left: Injection amount map is used for a fail safe mode.

Conditions for Clearing the MIL/DTC

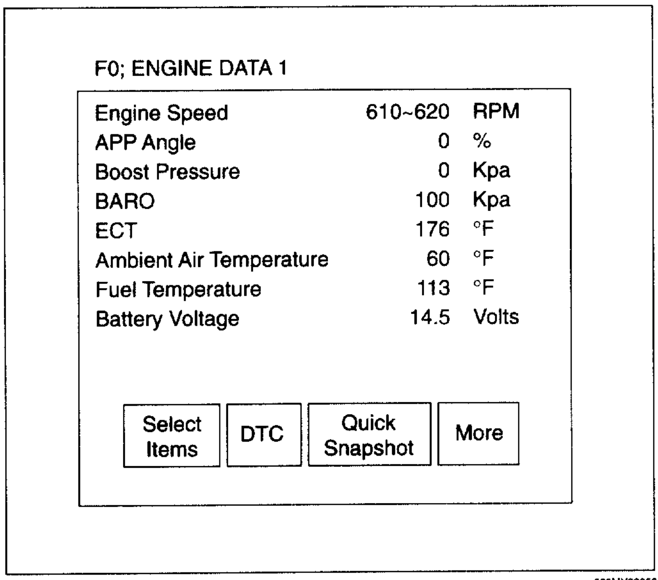
DTC 0032 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

DTC 0032 Boost Pressure Sensor Error

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 Boost Pressure display on the scan tool while moving connectors and wiring harnesses related to the Boost Pressure sensor. A change in the Boost Pressure display will indicate the location of the fault.



060MY00053

- Lack of power due to injection limitation.

DTC 0032 Boost Pressure Sensor Error

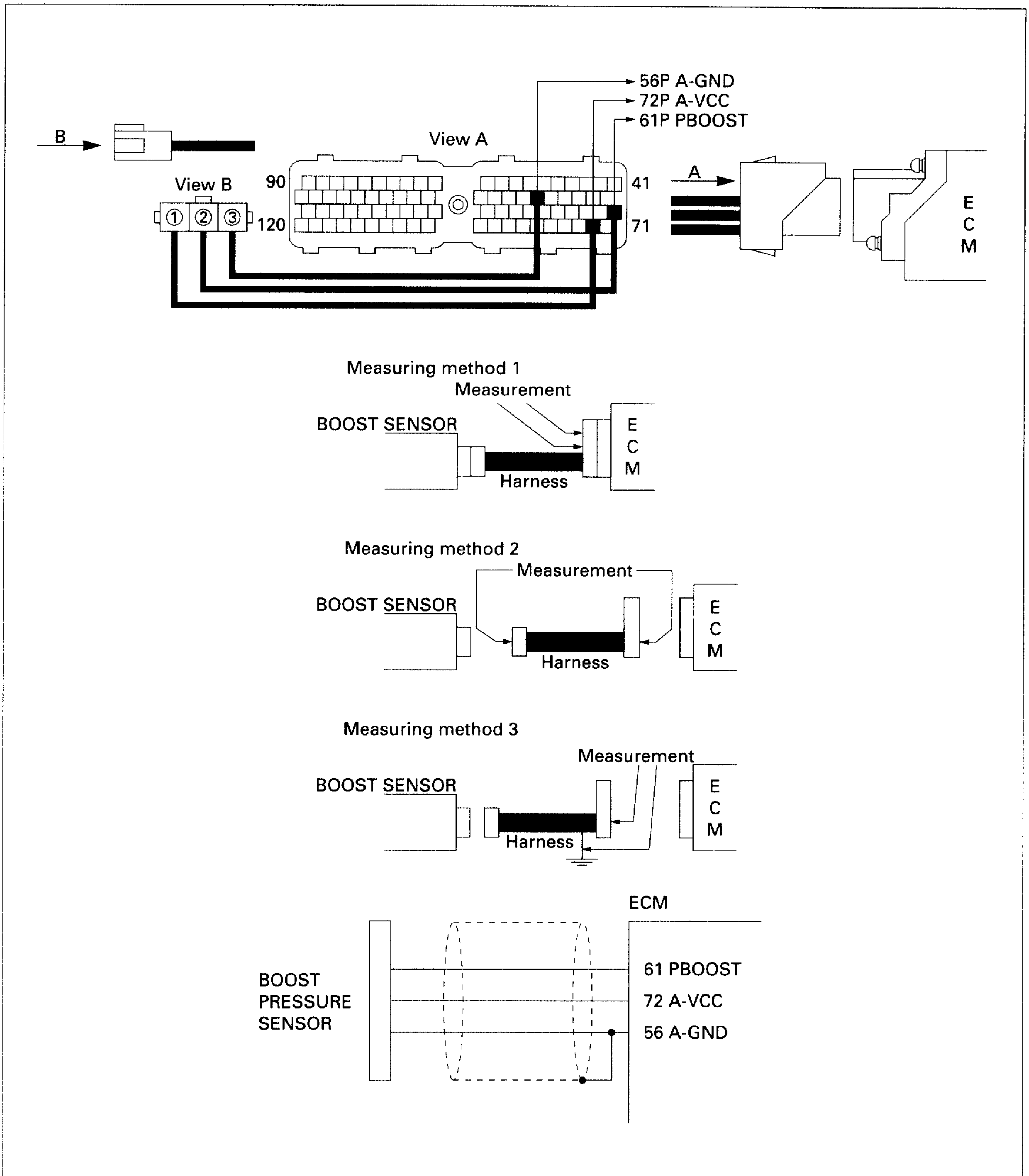
<table>
<tr><th>STEP</th><th>ACTION</th><th>VALUE</th><th>YES</th><th>NO</th></tr>
<tr><td>1</td><td>Was the "On-Board Diagnostic (OBD) System Check" performed?</td><td>—</td><td>Go to step 2</td><td>Go to OBD System Check</td></tr>
<tr><td>2</td><td>Does DTC 0032 display, while key switch "ON" or engine in operation?</td><td>—</td><td>Go to step 3</td><td>—</td></tr>
<tr><td>3</td><td>1. Key switch "ON".
2. Measure voltage between pin number 61 for boost sensor and pin number 56 for A–GND at ECM side connector. (Measuring method 1)
Is voltage within value?</td><td>About 1.3V</td><td>Go to step 7</td><td>Go to step 4</td></tr>
<tr><td>4</td><td>Measure voltage between pin number 72 for A–VCC and pin number 56 for A–GND at ECM side connector. (Measuring method 1)
Is voltage within value?</td><td>4.75V
to
5.25V</td><td>Go to step 6</td><td>Go to step 5</td></tr>
<tr><td rowspan="2">5</td><td>1. Key switch "OFF".
2. Disconnect boost sensor harness connector from sensor and ECM.
3. Measure resistance of the following points on the boost sensor harness. (Measuring method 2)
• Between pin number 72 (A–VCC) at ECM side connector and pin number 1 at sensor side.
• Between pin number 56 (A–GND) at ECM side connector and pin number 3 at sensor side.</td><td>2Ω or less</td><td rowspan="2">Replace boost sensor. Then go to step 10</td><td rowspan="2">Repair boost pressure sensor harness.</td></tr>
<tr><td>• Between pin number 72 (A–VCC) and GND.
• Between pin number 56 (A–GND) and GND.</td><td>10MΩ or more</td></tr>
<tr><td rowspan="2">6</td><td>1. Key switch "OFF"
2. Disconnect boost sensor harness connector from sensor and ECM.
3. Measure resistance of the following points on the boost sensor harness. (Measuring method 2)
• Between pin number 61 (P BOOST) of ECM and pin number 3 (SENSOR).
• Between pin number 56 (A–GND) and pin number 2 (SENSOR).</td><td>2Ω or less</td><td rowspan="2">Replace boost sensor or ECM assembly. Then go to step 10</td><td rowspan="2">Repair boost pressure sensor harness.</td></tr>
<tr><td>• Between pin number 61 (P BOOST) of ECM and GND.
• Between pin number 56 (A–GND) and GND.</td><td>10MΩ or more</td></tr>
<tr><td>7</td><td>1. Connect pressure gauge to boost pressure sensor.
2. Supply pressure.
Is voltage created to meet boost pressure?</td><td><table><tr><th>Pressure (kPa)</th><th>Voltage (V)</th></tr><tr><td>0</td><td>1.029</td></tr><tr><td>50</td><td>1.75</td></tr><tr><td>162</td><td>3.43</td></tr></table></td><td>Go to step 8</td><td>Replace boost sensor</td></tr>
<tr><td>8</td><td>1. Connect all connectors.
2. Start engine.
3. Operate the vehicle several times.
Are there any boost pressure abnormally and/or any leakage?</td><td>—</td><td>Go to step 9</td><td>Go to step 10</td></tr>
<tr><td>9</td><td>Check turbocharger condition, waste gate opening pressure and/or piping.
Is turbocharger and/or piping OK?</td><td></td><td>System OK</td><td>Repair piping and/or Replace turbocharger</td></tr>
</table>

DTC 0032 Boost Pressure Sensor Error

STEP	ACTION	VALUE	YES	NO
10	Clear all DTCs. Is DTC 0032?	—	Replace ECM assembly. Then go to step 11	System OK
11	Clear the DTCs. Is DTC 0032 still displayed? **Note: High boost also abnormal.**	—	Replace ECM. Go to step 11	System OK
	Caution: The actual measuring output voltage of boost sensor will be drifted due to if power source voltage of boost sensor comes down.			

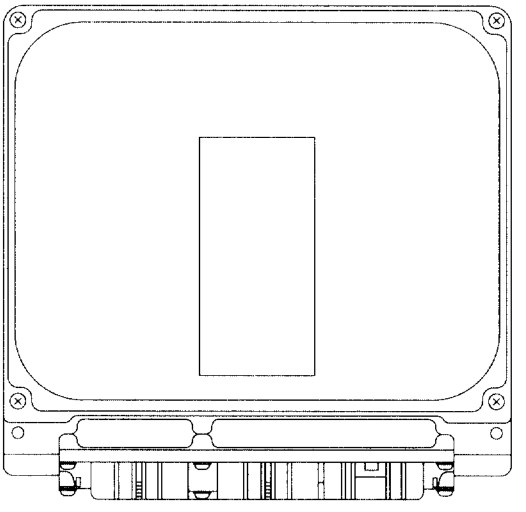
IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2.
Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Boost Pressure Sensor Error



056MV012

DTC 0034 Fuel Rate Data Error (No history recorded)



060MX113

Compare to Fuel rate data (Q-data) chart on the cylinder head to the Fuel rate data (Q-data) on scan tool.

Conditions for Setting the DTC

- EEPROM is not written to continues 0.2 sec.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Fuel rate data No. 8 selected (correction "0").

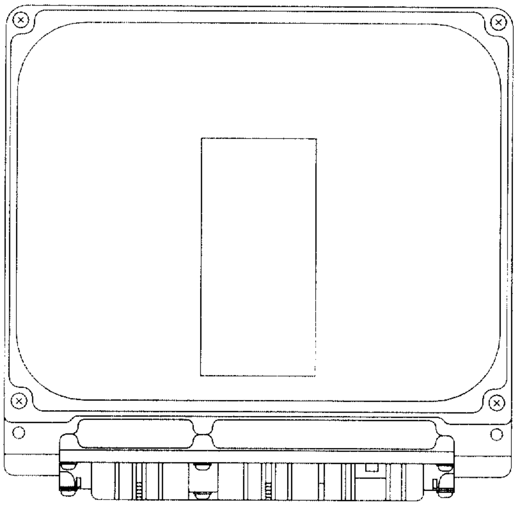
Conditions for Clearing the MIL/DTC

DTC 0034 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

Refer to "Capture and Restore Fuel Rate Data" of "Scan Tool Scan Tool" in this manual.

STEP	ACTION	VALUE	YES	NO
1	Does DTC 0034 display when key switch "ON"	—	Go to step 2	—
2	Assume that fuel rate data may not be written to ECM after replaced ECM assembly. Is the Fuel Rate data listed on the scan tool?	—	Check scan tool connection and/or ECM connection. Then go to step 4	Go to step 3
3	Write fuel rate data to ECM using scan tool. Does DTC 0034 display after writing the fuel rate data?	—	Same as step 2	System OK
4	Does DTC 0034 display when ignition switch "ON"?	—	Go back to step 2	System OK
	Note: • **When ECM assembly replaced, scan tool is required.** • **Make sure that lamp is lighted when DTC 0034 code is set.** • **When ECM replaced, down load fuel rate number from the old ECM, and then input it into new ECM by scan tool.** • **If step 2 and/or 4 are intermittents, call ISUZU Tech Line staff.**			

DTC 0035 Analog Digital Conversion Error, CPU Monitoring IC Error and Charging Circuit Error



060MX113

Circuit Description

The ECM supplies either 5 or 12 volts to power various sensors or switches. The power is supplied through resistances 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. The ECM controls output circuits such as the injectors, ISC, 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)

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 and 7, called either a surface-mounted quad driver module (QDM), which can independently control up to 4 output terminals, or QDMs which can independently control up to 7 outputs. Not all outputs are always used.

Conditions for Setting the DTC

A/D Conversion Error

- CPU A/D conversion is not completed and CPU is normal.

CPU Monitoring IC Error (ECM inside trouble)

- B+ voltage higher than 10V after 2 sec. from resetting, starter switch off continues for 300 ms, timer pulse time abnormal continues over 50 times.

Charging Circuit Error

- Charging voltage abnormal and battery voltage higher than 10V, except on over speed.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.

A/D Conversion Error (ECM inside trouble)

- Analog sensor abnormal and runs in backup mode.

Charging Circuit Error (ECM inside trouble)

- Charging stops, driveable by constant current only, and injection amount limited to 80 mm^3/st.

DTC 0035 Analog Digital Conversion Error, CPU Monitoring IC Error and Charging Circuit Error

Conditions for Clearing the MIL/DTC

DTC 0035 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

Diagnostic Aids

Check for the following conditions:

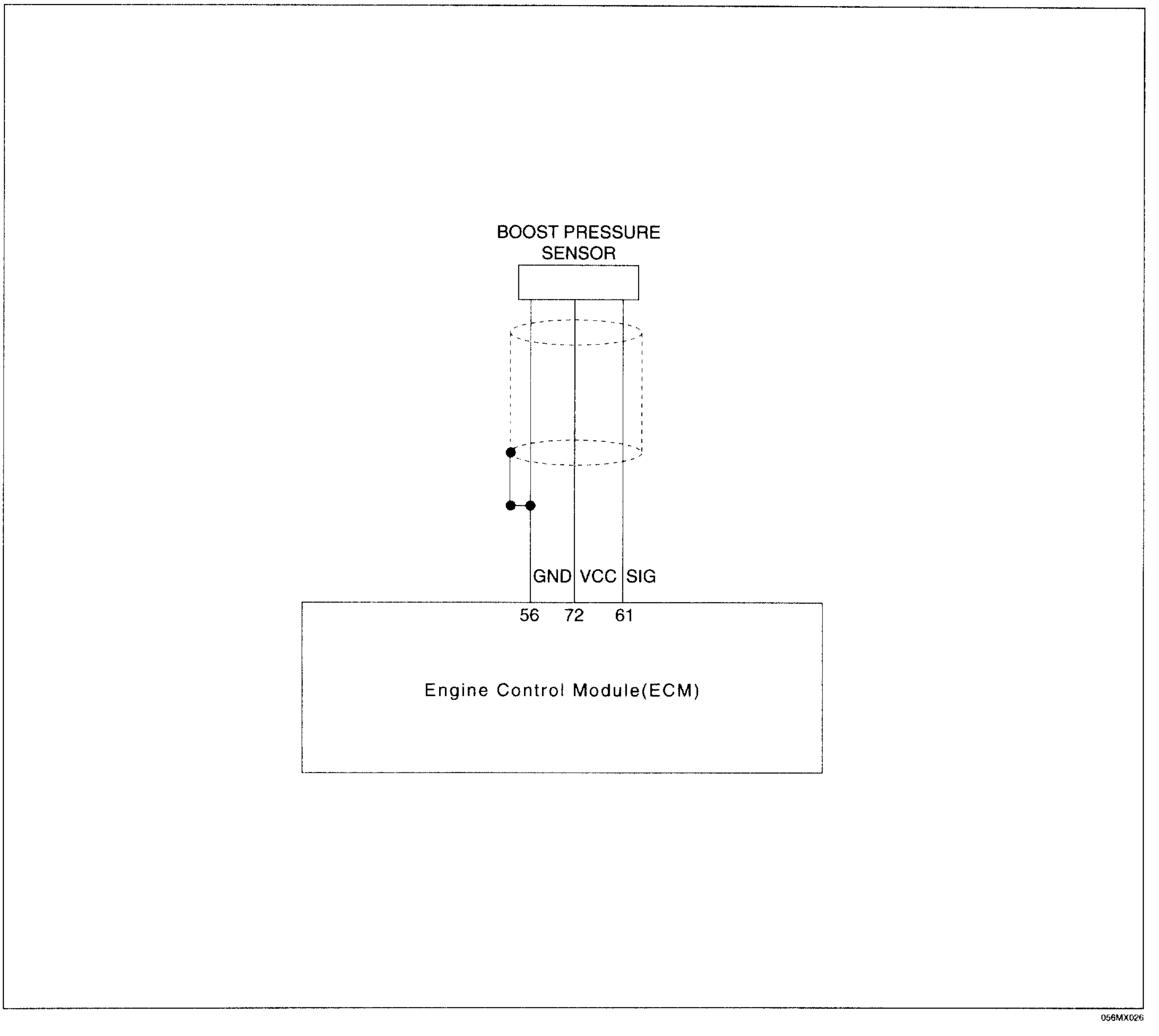
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.

A/D Conversion Error (ECM inside trouble)	Runs poorly ECM in backup mode.
CPU Monitoring IC Error (ECM inside trouble)	Engine will not start and run.
Charging Circuit Error (ECM inside trouble)	Lack of power. and increasing smoke.

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does DTC 0035 display when key switch "ON" or engine is running?	—	Go to step 3	—
3	Clear to the DTCs. Is DTC 0035 displayed?	—	Go to step 5	Go to step 4
4	Check radio wave interference (Is there wireless transmitter near the vehicle?), temporary incomplete contact at harness connector, noise due to harness GND floating or ECM connector GND incomplete connection. Is there any problem?	—	Repair problem. Then go to step 6	System OK
5	Check the GND for a incomplete connection at ECM connector. Is DTC 0035 displayed again?	—	Replace ECM assembly. Then go to step 6	System OK
6	Clear to the DTCs. Is DTC 0035 displayed. **Note: This trouble is circuit problem within ECM. If no problem in power supply or GND, but DTC will not clear, replace ECM.**	—	System OK	Go back to step 3

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

DTC 0042, 0032 High Boost Pressure Abnormal



Circuit Description

The boost sensor is fixed on the cab back frame and is connected to rear portion of inlet manifold by vacuum hose.

The boost sensor generates voltage according to air aspiration pressure and the generated voltage is input to ECM for boost sensor signal.

If the ECM detects a boost sensor signal voltage that is excessively high, Diagnostic Trouble Codes 0042, 0032 will be set.

Conditions for Setting the DTC

- No engine stall, abnormal boost pressure (boost pressure sensor normal condition) and high boost pressure abnormal area continues for 0.5 sec. or more.

Action Taken When the DTC Sets

- Injection amount map is used as a fail safe mode.

Conditions for Clearing the MIL/DTC

DTC 0042 or 0032 can be cleared by using the “Clear Info” by scan tool or using by the Diag Clear Switch.

DTC 0042, 0032 High Boost Pressure Abnormal

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 Boost Pressure display on the scan tool while moving connectors and wiring harnesses related to the Boost Pressure sensor. A change in the display will indicate the location of the fault.

F0; ENGINE DATA 1

Engine Speed	610~620	RPM
APP Angle	0	%
Boost Pressure	0	Kpa
BARO	100	Kpa
ECT	176	°F
Ambient Air Temperature	60	°F
Fuel Temperature	113	°F
Battery Voltage	14.5	Volts

Select Items | DTC | Quick Snapshot | More

060MY00053

- Lack of engine power etc.

DTC 0042, 0032 High Boost Pressure Abnormal

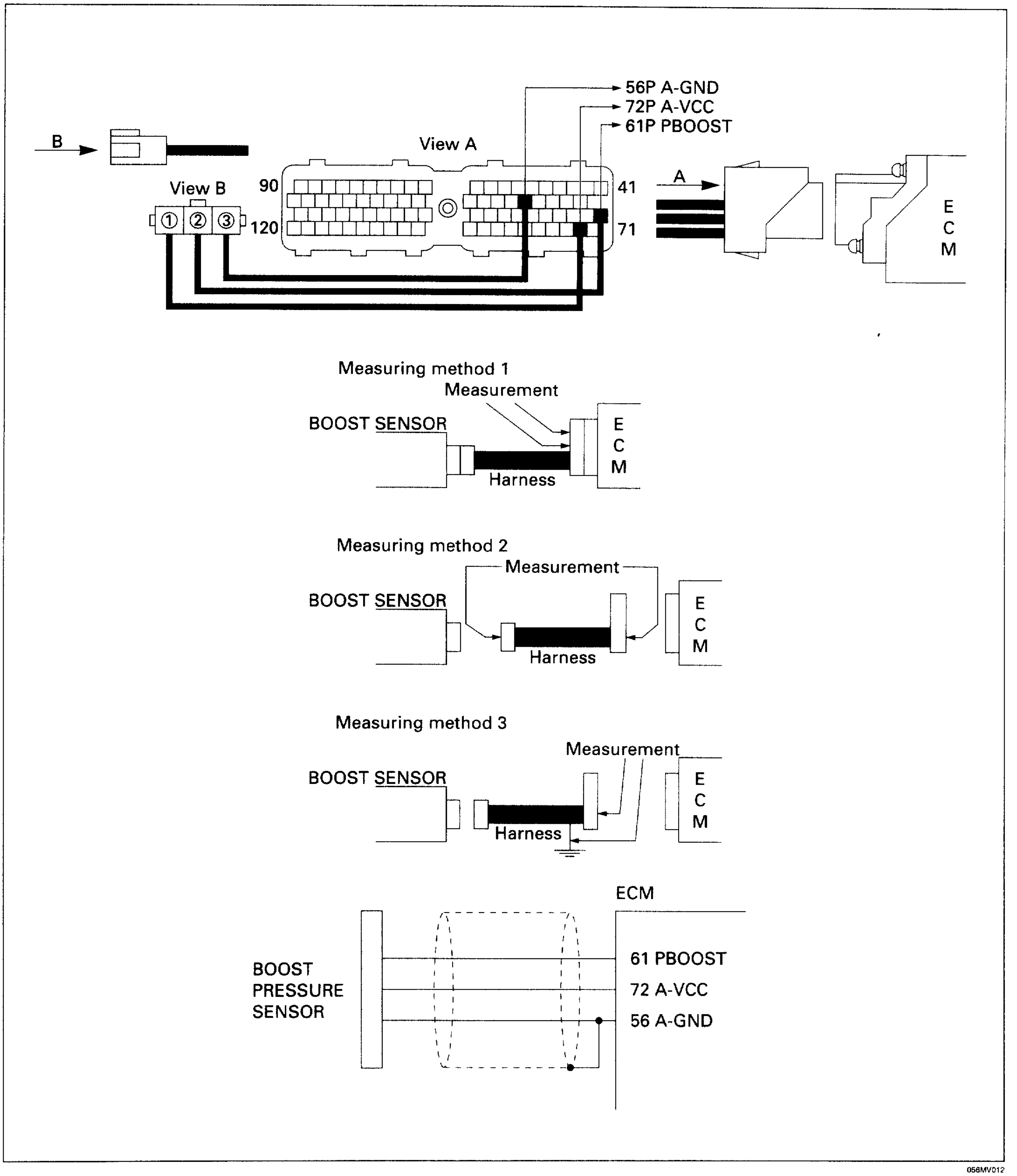
<table>
<tr><th>STEP</th><th>ACTION</th><th>VALUE</th><th>YES</th><th>NO</th></tr>
<tr><td>1</td><td>Was the "On-Board Diagnostic (OBD) System Check" performed?</td><td>—</td><td>Go to step 2</td><td>Go to OBD System Check</td></tr>
<tr><td>2</td><td>Does DTC 0042 or DTC 0032 display while key switch "ON" or engine in operation?
Note: When atmospheric pressure sensor abnormal, PATM is calculated at 100 kPa.</td><td>—</td><td>Go to step 3</td><td>—</td></tr>
<tr><td>3</td><td>1. Connect pressure gauge and pressure supply to boost sensor.
2. Measure voltage between pin number 61 (P BOOST) and pin number 56 (A–GND) at ECM side. (Show Measuring method 1)
Does voltage indicate a normal value according to boost pressure?

Normal value (When VCC = 5V)
<table><tr><th>Boost pressure</th><th>Sensor voltage</th></tr><tr><td>80 kPa</td><td>About 0.7V
(Negative pressure)</td></tr><tr><td>Atmospheric release</td><td>1.0V</td></tr><tr><td>169 kPa</td><td>2.0V</td></tr></table></td><td>Normal value see table left</td><td>Go to step 4</td><td>Replace boost sensor and/or repair piping</td></tr>
<tr><td>4</td><td>Do you find leakage from piping and/or any problem on turbocharger?</td><td>—</td><td>Repair or replace abnormal portion.</td><td>Go to step 5</td></tr>
<tr><td>5</td><td>Drive vehicle to check the following.
Does actual boost pressure and voltage with in specifications?

Specifications (When PATM = 100 kPa)
<table><tr><td>Voltage</td><td>3.4 V or more</td></tr><tr><td>Boost pressure</td><td>162 kPa or more</td></tr><tr><td>CKP</td><td>About 2,000 rpm</td></tr><tr><td>Acceleration</td><td>100%</td></tr></table></td><td>Guide line value see table at left</td><td>Go to step 6</td><td>Repair/replace turbocharger and/or wastegate piping. Refer to Section 6J in this manual. Then go to step 6</td></tr>
<tr><td>6</td><td>Clear the DTCs.
Does DTC 0042 or DTC 0032 display?</td><td>—</td><td>Replace ECM. Then go to step 7</td><td>System OK</td></tr>
<tr><td>7</td><td>Clear the DTCs.
Does DTC 0042 or DTC 0032 still display?</td><td>—</td><td>Go back to step 3</td><td>System OK</td></tr>
<tr><td></td><td colspan="4">Caution: The actual measuring output voltage of boost sensor will be drifted due to if power source voltage of boost sensor comes down.</td></tr>
</table>

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

High Boost Pressure Abnormal



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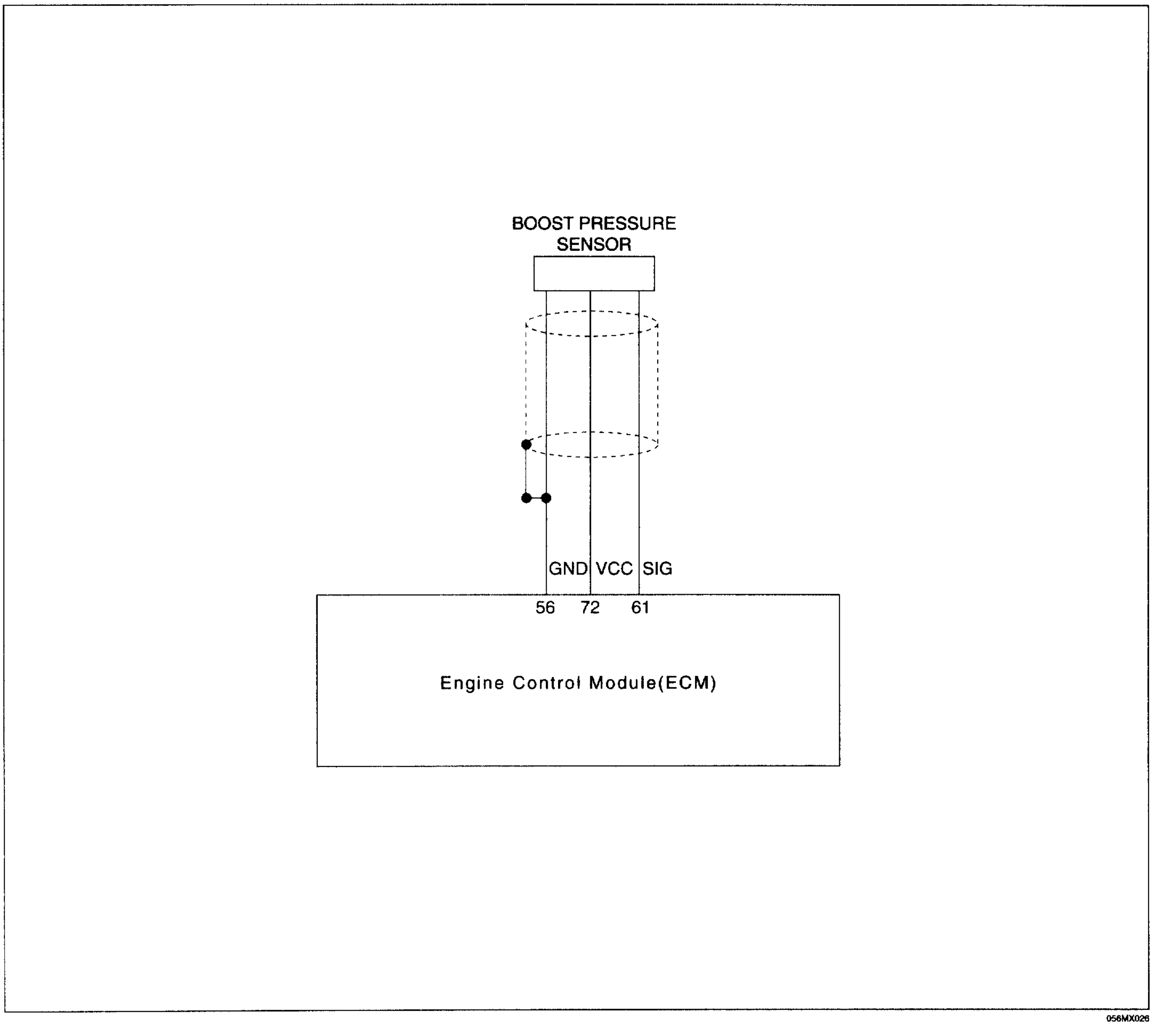
DTC 0065 Low Boost Pressure Abnormal



Circuit Description

The boost pressure sensor is located on the cab back frame and is connected to rear portion of inlet manifold by vacuum hose.

The boost pressure sensor generates a voltage according to air aspiration pressure and the generated voltage is input to ECM for boost sensor signal.

If the ECM detects a boost pressure sensor signal voltage that is excessively low, Diagnostic Trouble Codes 0065 will be set.

Conditions for Setting the DTC

- No engine stall, abnormal boost pressure not in the boost pressure sensor, accelerator open more than 80% and low boost pressure continues for 25 sec. or more.

Conditions for Clearing the MIL/DTC

DTC 0065 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

DTC 0065 Low Boost Pressure Abnormal

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 Boost Pressure display on the scan tool while moving connectors and wiring harnesses related to the Boost Pressure sensor. A change in the display will indicate the location of the fault.

F0; ENGINE DATA 1

Engine Speed	610~620	RPM
APP Angle	0	%
Boost Pressure	0	Kpa
BARO	100	Kpa
ECT	176	°F
Ambient Air Temperature	60	°F
Fuel Temperature	113	°F
Battery Voltage	14.5	Volts

Select Items | DTC | Quick Snapshot | More

060MY00051

- Lack of engine power etc.

DTC 0065 Low Boost Pressure Abnormal

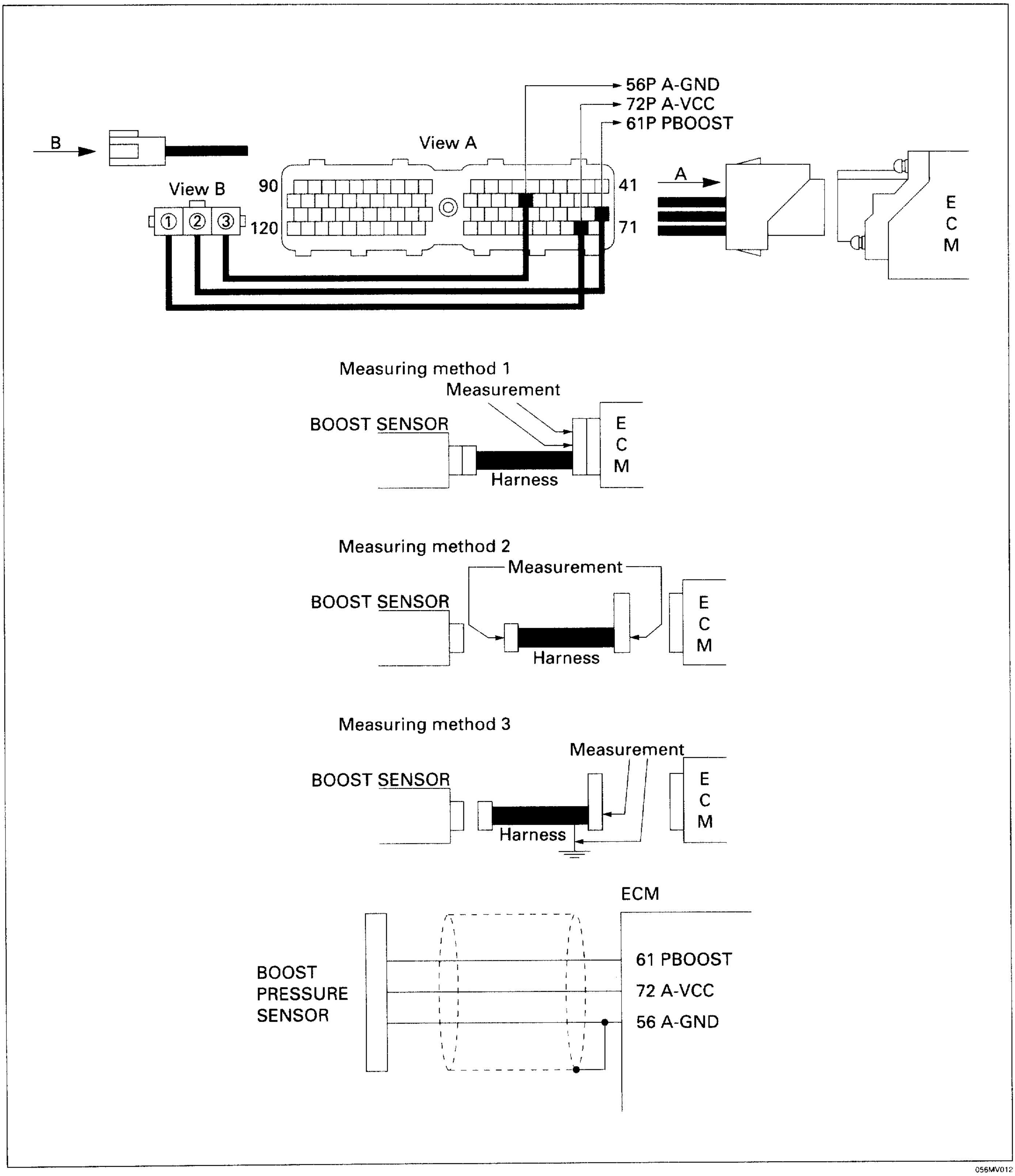
<table>
<tr><th>STEP</th><th>ACTION</th><th>VALUE</th><th>YES</th><th>NO</th></tr>
<tr><td>1</td><td>Was the “On-Board Diagnostic (OBD) System Check” performed?</td><td>—</td><td>Go to step 2</td><td>Go to OBD System Check</td></tr>
<tr><td>2</td><td>Does DTC 0065 display, while key switch “ON” or engine in operation?</td><td>—</td><td>Go to step 3</td><td>—</td></tr>
<tr><td>3</td><td>1. Connect pressure gauge and pressure supply to hose of boost sensor side.
2. Key switch “ON”.
3. Measure voltage between pin number 61 (P BOOST) and pin number 56 (A–GND) at ECM side. (Measuring method 1)
Does voltage indicate normal value according to boost pressure?

Normal value (When VCC = 5V)
<table>
<tr><th>Boost pressure</th><th>Sensor voltage</th></tr>
<tr><td>80 kPa</td><td>About 0.7V
(Negative pressure)</td></tr>
<tr><td>Atmospheric release</td><td>1.0V</td></tr>
<tr><td>169 kPa</td><td>2.0V</td></tr>
</table></td><td>Normal value see table left</td><td>Go to step 4</td><td>Replace boost sensor or repair/replace boost sensor harness.</td></tr>
<tr><td>4</td><td>Is there leakage from piping and/or any problem on turbocharger?</td><td>—</td><td>Repair or replace abnormal portion.</td><td>Go to step 5</td></tr>
<tr><td>5</td><td>Make vehicle actually drive to check as following.
Does actual boost pressure and voltage indicate guide line value? (at acceleration 80% or more opened)

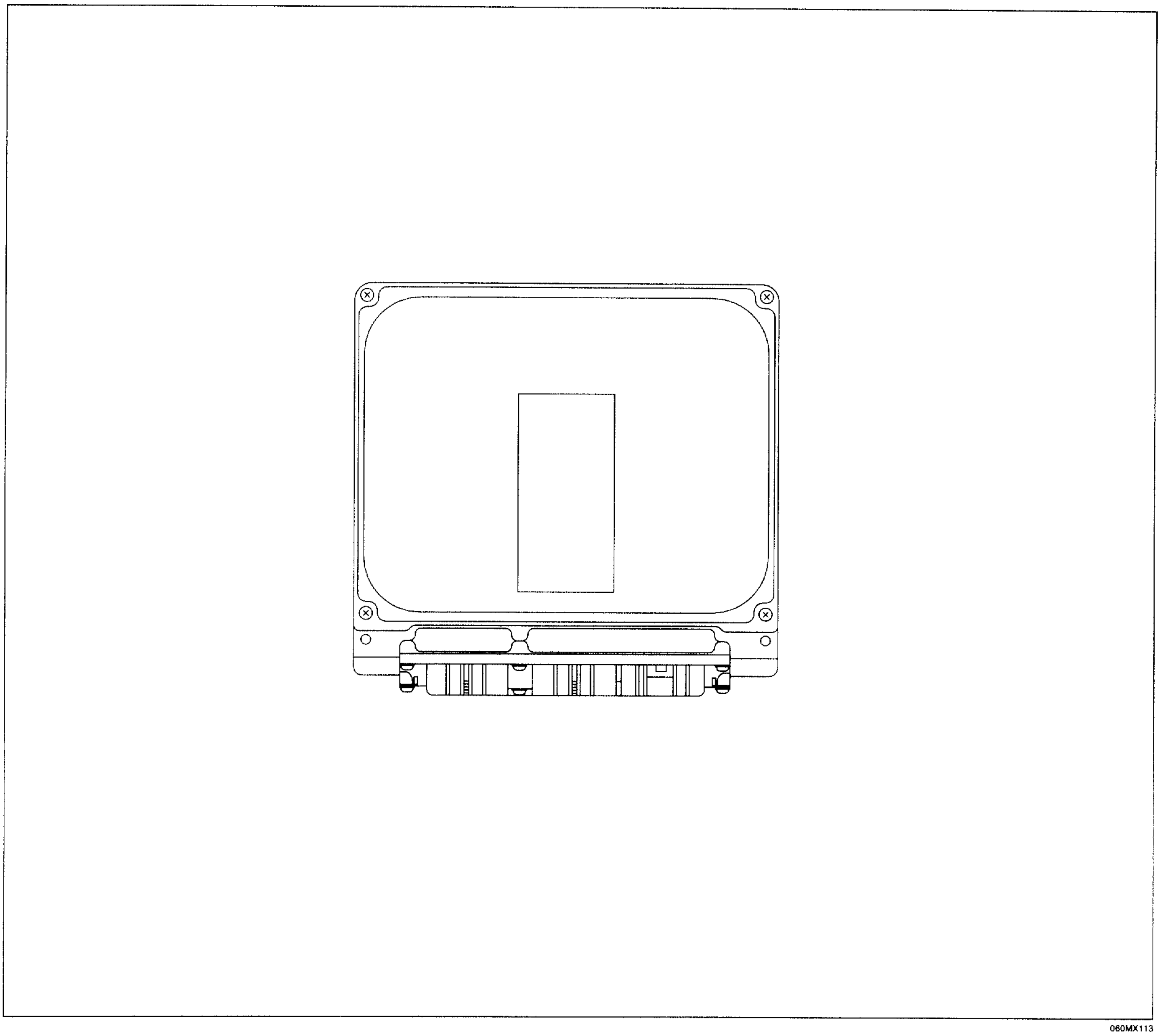
Guide line value (When PATM = 100 kPa)
<table>
<tr><td>Voltage</td><td>2.0 V or less</td></tr>
<tr><td>Boost pressure</td><td>70 kPa or less</td></tr>
<tr><td>CKP</td><td>2,000 rpm</td></tr>
<tr><td>Acceleration</td><td>100%</td></tr>
</table></td><td>Guide line value see table left</td><td>Go to step 6</td><td>Replace boost sensor and/or repair turbocharger. Refer to section 6J in this manual then go to step 6</td></tr>
<tr><td>6</td><td>IClear the DTCs.
Does DTC 0065 still display?</td><td>—</td><td>Replace ECM assembly. Then go to step 7</td><td>System OK</td></tr>
<tr><td>8</td><td>Clear the DTCs.
Does DTC 0065 still display?</td><td>—</td><td>Go back to step 3</td><td>System OK</td></tr>
<tr><td></td><td colspan="4">Caution: The actual measuring output voltage of boost sensor will be drifted due to if power source voltage of boost sensor comes down.</td></tr>
</table>

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2.
Refer to “Capture and Restore Fuel Rate Data” of “Tech 2 Scan Tool” in this manual.

Low Boost Pressure Abnormal



DTC 0071 BARO Sensor Error



060MX113

Circuit Description

The Atmospheric pressure sensor is installed in the ECM.

If the ECM detects a signal voltage that is excessively low or high, Diagnostic Trouble Code 0071 will be set.

Conditions for Setting the DTC

- Atmospheric pressure sensor voltage exceeding 4.7V and lower than 1.9V and continues 1 sec. or more.

Action Taken When the DTC Sets

- Based on the atmospheric pressure of 100 kPa.

Conditions for Clearing the MIL/DTC

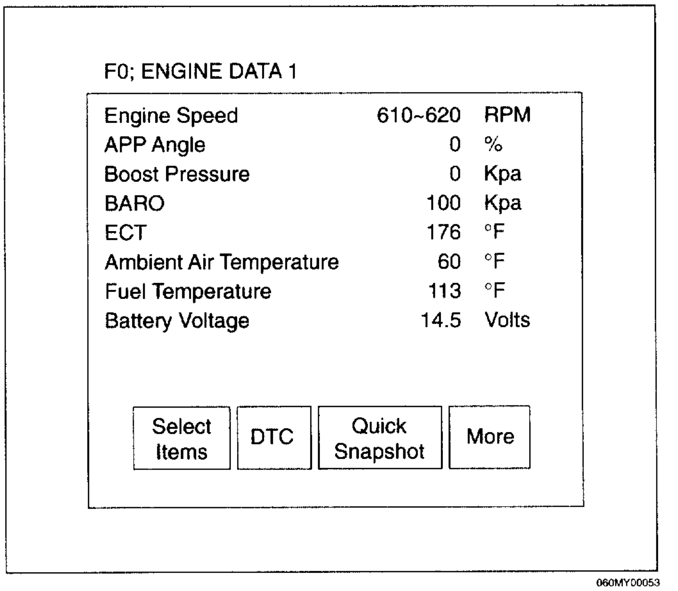
DTC 0071 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

DTC 0071 BARO Sensor Error

Diagnostic Aids

Check for the following conditions:

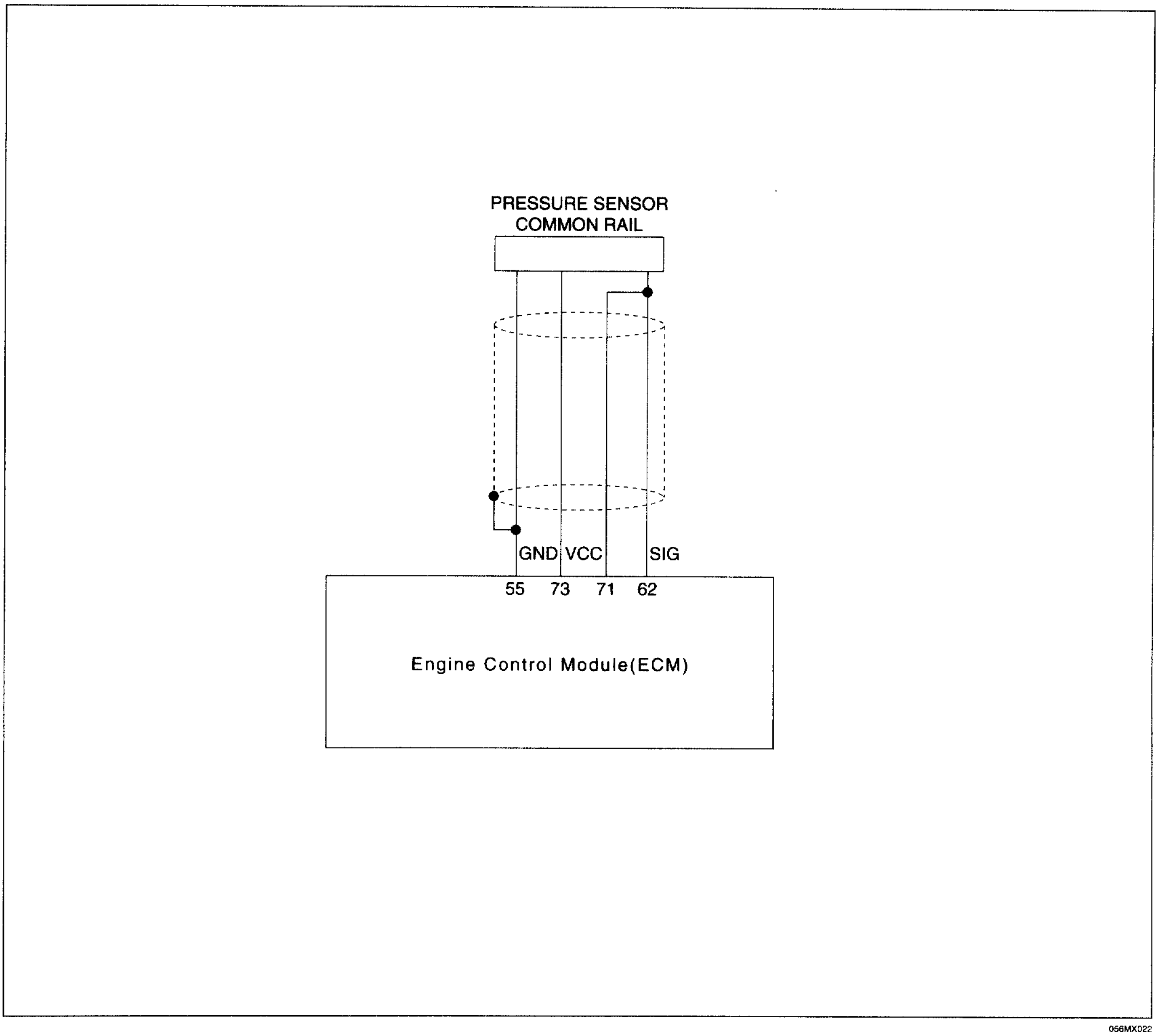
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness – Inspect the wiring harness for damage, shorts to ground, shorts to battery and open circuits. If the harness appears to be OK, observe the display on the scan tool while moving connectors and wiring harnesses related to the BARO sensor. A change in the BARO display will indicate the location of the fault.



STEP	ACTION	VALUE	YES	NO
1	Does DTC 0071 display while key switch "ON" and engine running?	—	Go to step 2	—
2	Does display DTC 0071 again after memory is cleared?	—	Replace ECM assembly. Then go to step 3.	Erroneous diagnosis due to electrical noise or intermittent problem.
3	Clear the DTCs. Does DTC 0071 display?	—	Go back to step 2	System OK
	Note: BARO sensor is inside ECM.			

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

DTC 0115 Common Rail Pressure Sensor Output Fixed



Circuit Description

The common rail is installed to intake manifold, equipped with flow damper, pressure limiter, and common rail pressure sensor.

The common rail unit has a common fuel passage, fuel passage holes, and installing threaded holes. The common fuel passage is a through hole made in the common rail unit. The common rail pressure sensor is installed at the left end of the hole.

The ECM monitors the Rail Pressure signals for voltage outside the normal range of the Rail Pressure sensor. If the ECM detects a Rail Pressure signal voltage that is excessively abnormal, Diagnostic Trouble Code 0115 will be set.

Conditions for Setting the DTC

- Excessive difference between the current and previous valves of common rail pressure, difference from the target value being greater than 10 MPa, common rail pressure being greater than 10 MPa does not set DTC 0245.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Limits are set to common rail pressure open loop control, common rail pressure and injection amount.
- Common rail pressure: 60 MPa maximum Injection amount is limited for 50 mm^3/st.

DTC 0115 Common Rail Pressure Sensor Output Fixed

Conditions for Clearing the MIL/DTC

DTC 0115 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

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 Rail pressure display on the scan tool while moving connectors and wiring harnesses related to the Rail pressure sensor. A change in the Rail pressure display will indicate the location of the fault.

F3; ENGINE DATA 4

Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
APP Angle	0	%
ECT	176	°F
Main Injection Timing	–1.5	°
Fuel Temperature	113	°F
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	25.0	Mpa
PCV ON Time	4.38	ms
Flow Limiter 1	0	
Flow Limiter 2	0	
Flow Limiter 3	0	
Flow Limiter 4	0	
Flow Limiter 5	0	
Flow Limiter 6	0	
Pump Control Mode		Normal Control
Injection Control Mode		Normal Control

Select Items	DTC	Quick Snapshot	More

060MY00056

DTC 0115 Common Rail Pressure Sensor Output Fixed

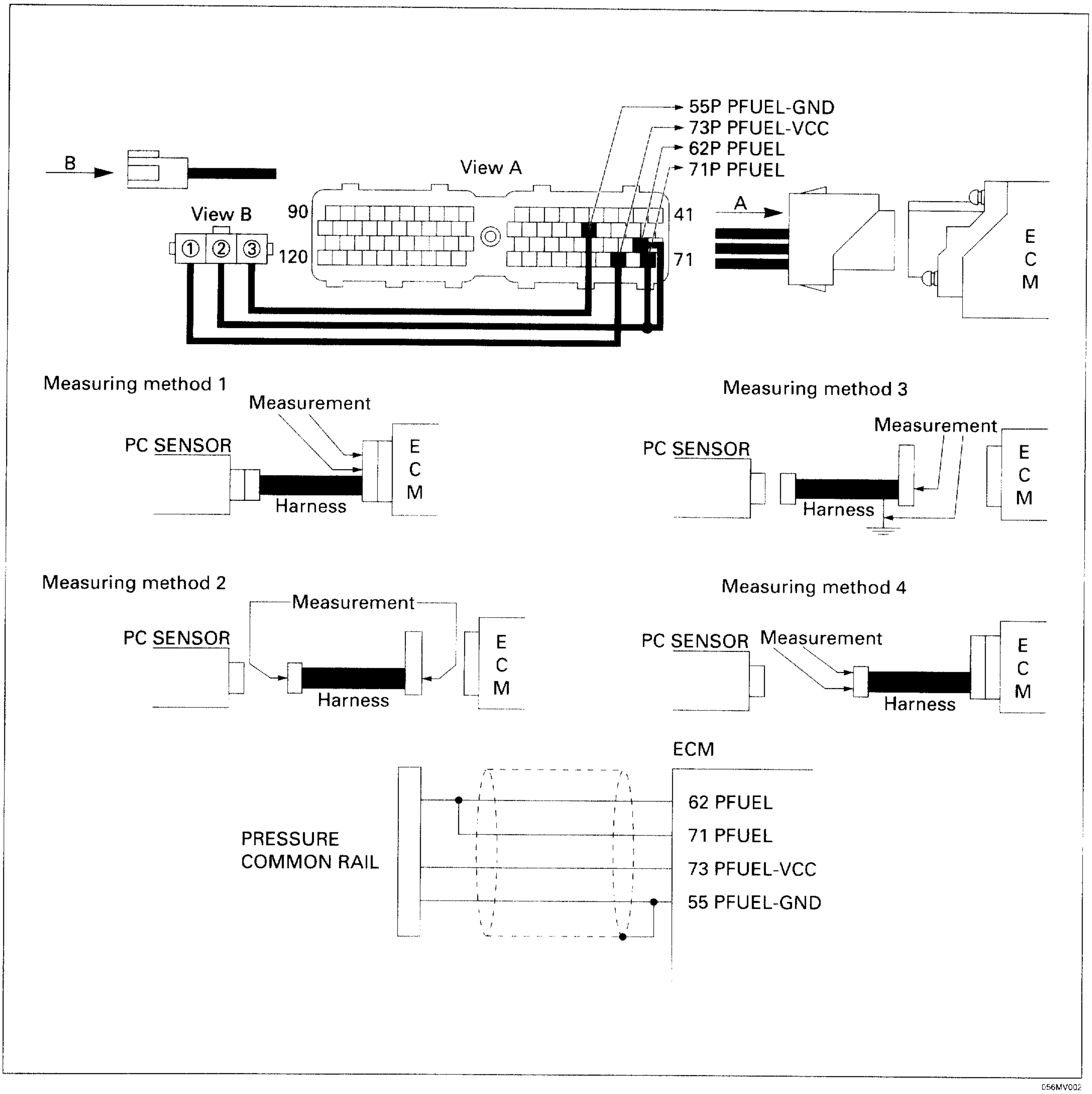
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does DTC 0115 display while engine running on when key switch "ON"?	—	Go to step 3	—
3	1. Key switch "ON". 2. Measure the voltage between pin number 62 and 71 (PFUEL) on ECM side connector and pin number 55 (PFUEL – GND) (Measuring method 1) Is voltage within value? (At idling and fuel pressure 25 MPa, the voltage about 1.4V)	0.9V to 1.1V	Go to step 5	Go to step 4
4	1. Key switch "OFF". 2. Disconnect PC sensor harness from both PC sensor side and ECM side. 3. Measure resistance as below. (List measurement method number) • Between pin number 71 (PFUEL) at ECM side and pin number 2 at PC sensor side. • Between pin number 62 (PFUEL) at ECM side and pin number 2 at PC sensor side. • Between pin number 55 (PFUEL – GND) at ECM side and pin number 3 at PC sensor side. (Measuring method 2)	2Ω or less	Replace PC sensor or ECM assembly then Go to step 11	Repair or replace PC sensor harness then Go to step 11
5	1. Reconnect PC sensor harness. 2. Start the engine. 3. Measure the voltage between pin number 62 and 71 (PFUEL) at ECM side and pin number 55 (PFUEL – GND) at ECM side. (Measuring method 1) Measure voltage while the engine is idling and at varying engine RPMs using the accelerator pedal. Does voltage change?	No change	Go to step 7	Go to step 6
6	Clear to DTC code. Does DTC 0115 display?	—	Replace ECM assembly then Go to step 11	Correct to incomplete contact of connector then Go to step 11
7	1. KEY switch "OFF". 2. Disconnect connector from both ECM and PC sensor. 3. Measure the resistance as below. (List measurement method number) • Between pin number 71 (PFUEL) at ECM side connector and pin number 2 at sensor side. • Between pin number 62 (PFUEL) at ECM side connector and pin number 2 sensor side. • Between pin number 55 (PFUEL – GND) at ECM side connector and pin number 3 sensor side. Is resistance within the value?	2Ω or less	Go to step 8	Repair the PC sensor harness then Go to step 11
8	Measure the resistance between pin number 71 and 62 (PFUEL) at ECM side connector and GND on PC sensor harness. (List measurement method number) Is resistance within value?	10MΩ or more	Go to step 9	Repair the PC sensor harness then Go to step 11

DTC 0115 Common Rail Pressure Sensor Output Fixed

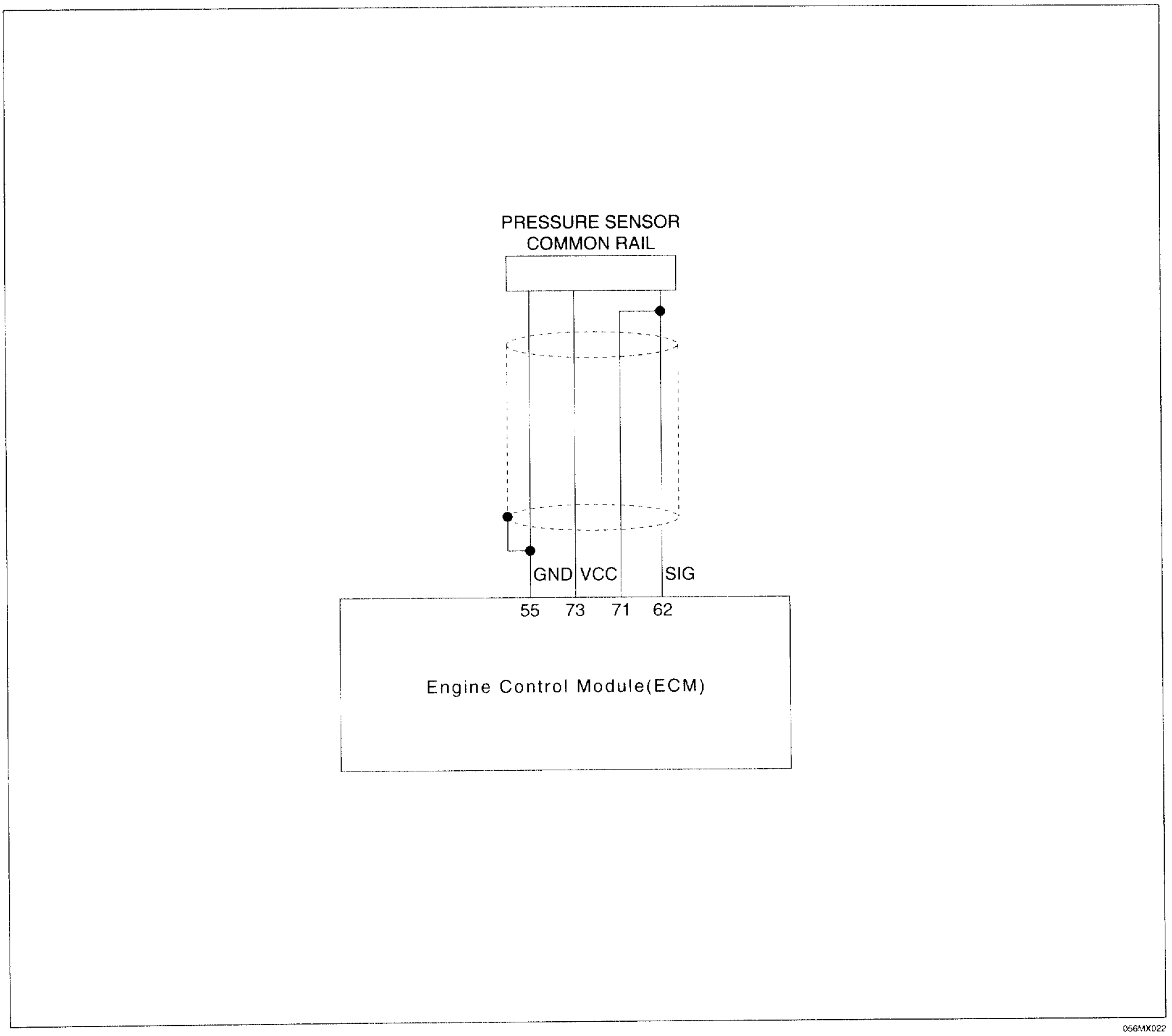
STEP	ACTION	VALUE	YES	NO
9	1. Reconnect all connectors such as PC sensor harness, etc. 2. Clear DTC code. Does DTC 0115 display?	—	Go to step 10	Correct to incomplete contact of connector, then Go to step 11
10	Start engine and race accelerator several times. Does DTC 0115 display?	—	Replace PC sensor or ECM assembly then Go to step 11	System OK
11	Clear DTC. Does DTC 0115 display?	—	Go back to step 3	System OK
	Note: Sometimes it display DTC 0261 to DTC 0266 are set due to PC sensor failure.			

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Common Rail Pressure Sensor Output Fixed



DTC 0118 Common Rail Pressure Abnormal (Control system) 1st and 2nd Stage



Circuit Description

The Common rail is installed to intake manifold, equipped with flow damper, pressure limiter, and common rail pressure sensor.

The common rail pressure sensor, installed at left end of the common rail, serving the detect fuel pressure. It is a semiconductor type pressure sensor utilizing silicon's property that the electric resistance of pressurized silicone is varied.

The ECM monitors the Rail Pressure signals for voltage outside the normal range of the Rail Pressure sensor. If the ECM detects a Rail Pressure signal voltage that is excessively low, Diagnostic Trouble Code 0118 will be set.

Conditions for Setting the DTC

Common Rail Pressure 1st Stage

- No DTC 0245 and common rail pressure over 127 MPa continues for 0.2 sec.

Common Rail Pressure 2nd Stage

- No DTC 0245 and common rail pressure over 130 MPa continues for 0.2 sec.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.

Common Rail Pressure 1st Stage

- Limits are set to common rail pressure open loop control, common rail pressure and injection amount.
- Common rail pressure: 60 MPa maximum Injection amount is limited for 50 mm^3/st.

Common Rail Pressure 2nd Stage

Injection stop and pressure feed stop.

DTC 0118 Common Rail Pressure Abnormal (Control system) 1st and 2nd Stage

Conditions for Clearing the MIL/DTC

DTC 0118 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

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 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.

F3; ENGINE DATA 4

Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
APP Angle	0	%
ECT	176	°F
Main Injection Timing	–1.5	°
Fuel Temperature	113	°F
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	25.0	Mpa
PCV ON Time	4.38	ms
Flow Limiter 1	0	
Flow Limiter 2	0	
Flow Limiter 3	0	
Flow Limiter 4	0	
Flow Limiter 5	0	
Flow Limiter 6	0	
Pump Control Mode		Normal Control
Injection Control Mode		Normal Control

Select Items	DTC	Quick Snapshot	More

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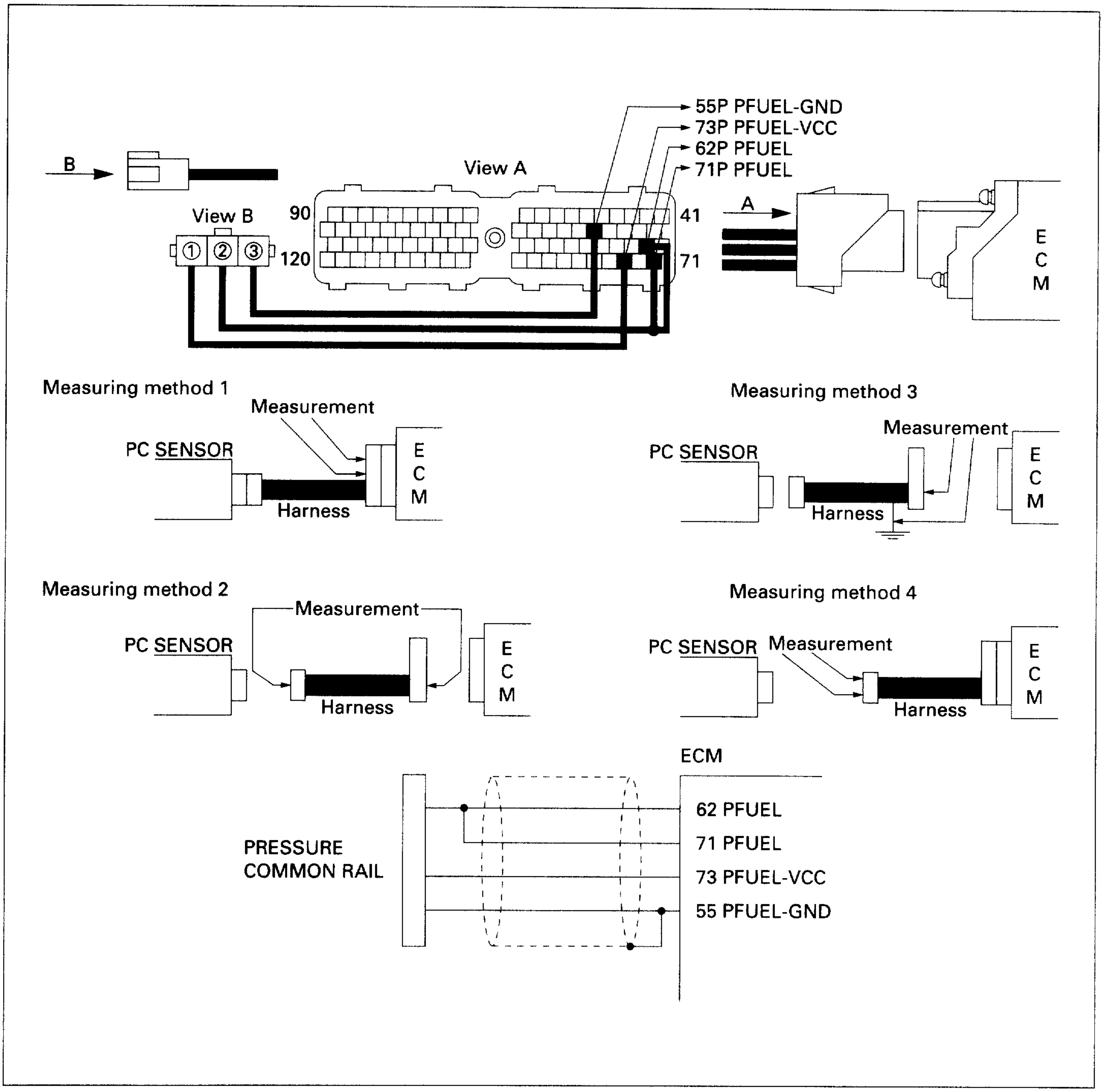
DTC 0118 Common Rail Pressure Abnormal (Control system) 1st and 2nd Stage

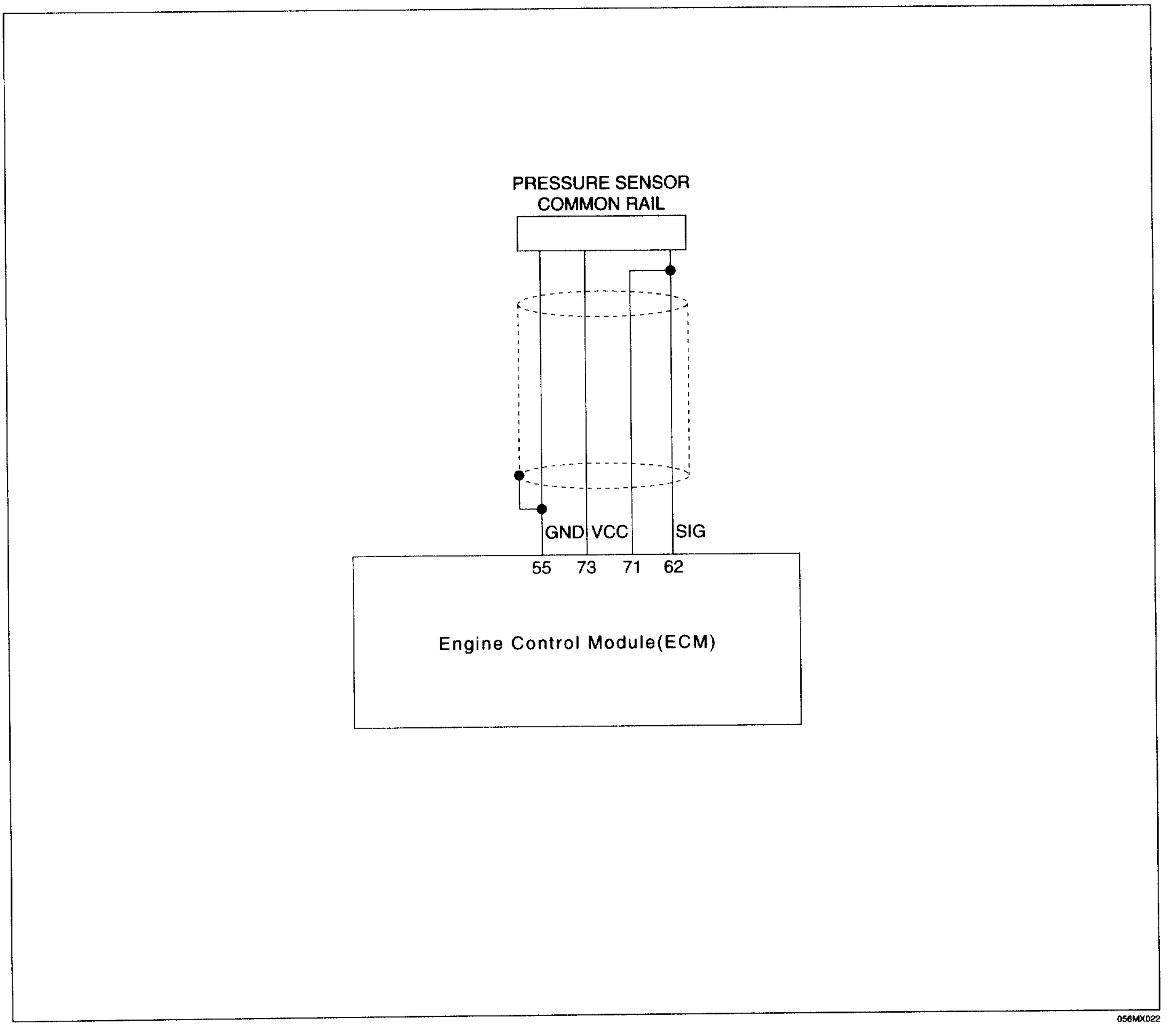
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does DTC 0118 display?	—	Go to step 3	—
3	Measure the voltage while key switch "ON" as follow. (Measuring method 1) Between pin number 62 and 71 (PFUEL) and pin number 55 (PFUEL – GND) at ECM side.	3.4V or more (at 125 Mpa)	Go to step 7	Go to step 4
4	1. Clear the memory. 2. Engine start. Does DTC 0151 or 0118 display? **Note: If you want to start engine, disconnect PC sensor connector (Make open loop circuit).**	—	Go to step 5	Repair incomplete connection on the connector Go to step 10
5	Is PC sensor voltage more than 3.4V when key "ON"?	3.4V or more	Replace PC sensor. Then go to step 6	Go back to step 4
6	Does DTC 0118 display?	—	Go to step 5	System OK
7	1. Disconnect PC sensor harness from both PC sensor and ECM. 2. Measure the resistance following points. (Measuring method 2) • Between pin number 71 and 62 (PFUEL) at ECM side and pin number 2 at PC sensor side on the PC sensor harness. • Between pin number 55 (PFUEL – GND) at ECM side and pin number 3 at PC sensor side on the PC sensor harness. Is resistance within value?	2Ω or less	Go to step 8	Repair/replace PC sensor harness. Then go to step 10
8	Measure resistance between pin number 62 and 72 (PFUEL) at ECM side and GND on the PC sensor harness. (Measuring method 3) Is resistance within value?	10MΩ or more	Replace PC sensor. Then go to step 9	Replace PC sensor harness then go to step 9
9	Reconnect all connectors. Does DTC 0118 display?	—	Replace ECM assembly. Then go to step 10	System OK
10	Does DTC 0118 display?	—	Go back to step 3	System OK

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Common Rail Pressure Abnormal (Control system) 1st and 2nd Stage



DTC 0151 Common Rail Pressure Abnormal (Pump over pressure supply)



Circuit Description

The Common rail is installed on the intake manifold, equipped with flow damper, pressure limiter, and common rail pressure sensor.

The common rail unit has a common fuel passage and fuel passage holes. The comon fuel passage is a through hole made in the common rail unit. The common rail pressure sensor is installed at the left end of the unit.

The ECM monitors the Rail Pressure signals for voltage outside the normal range (10 – 104 kPa) of the Rail Pressure sensor. If the ECM detects a Rail Pressure signal voltage that is excessively low, Diagnostic Trouble Code 0151 will be set.

Conditions for Setting the DTC

- CKP sensor normal, pump normal mode, battery voltage ≥ 8V, pump revolution is 450 rpm or more.
- Water temperature 60°C or more.
  PCV open timing constant, no DTC 0245 and 0115, and common rail pressure continues to be greater than target plus 10 MPa.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Limits are set to common rail pressure open loop control, common rail pressure and injection amount.
- Common rail pressure: 60 MPa maximum Injection amount is limited for 50 mm^3/st.

Conditions for Clearing the MIL/DTC

DTC 0151 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

DTC 0151 Common Rail Pressure Abnormal (Pump over pressure supply)

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 Rail pressure display on the scan tool while moving connectors and wiring harnesses related to the Rail pressure sensor. A change in the Rail pressure display will indicate the location of the fault.

F3; ENGINE DATA 4

Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
APP Angle	0	%
ECT	176	°F
Main Injection Timing	–1.5	°
Fuel Temperature	113	°F
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	25.0	Mpa
PCV ON Time	4.38	ms
Flow Limiter 1	0	
Flow Limiter 2	0	
Flow Limiter 3	0	
Flow Limiter 4	0	
Flow Limiter 5	0	
Flow Limiter 6	0	
Pump Control Mode		Normal Control
Injection Control Mode		Normal Control

Select Items	DTC	Quick Snapshot	More

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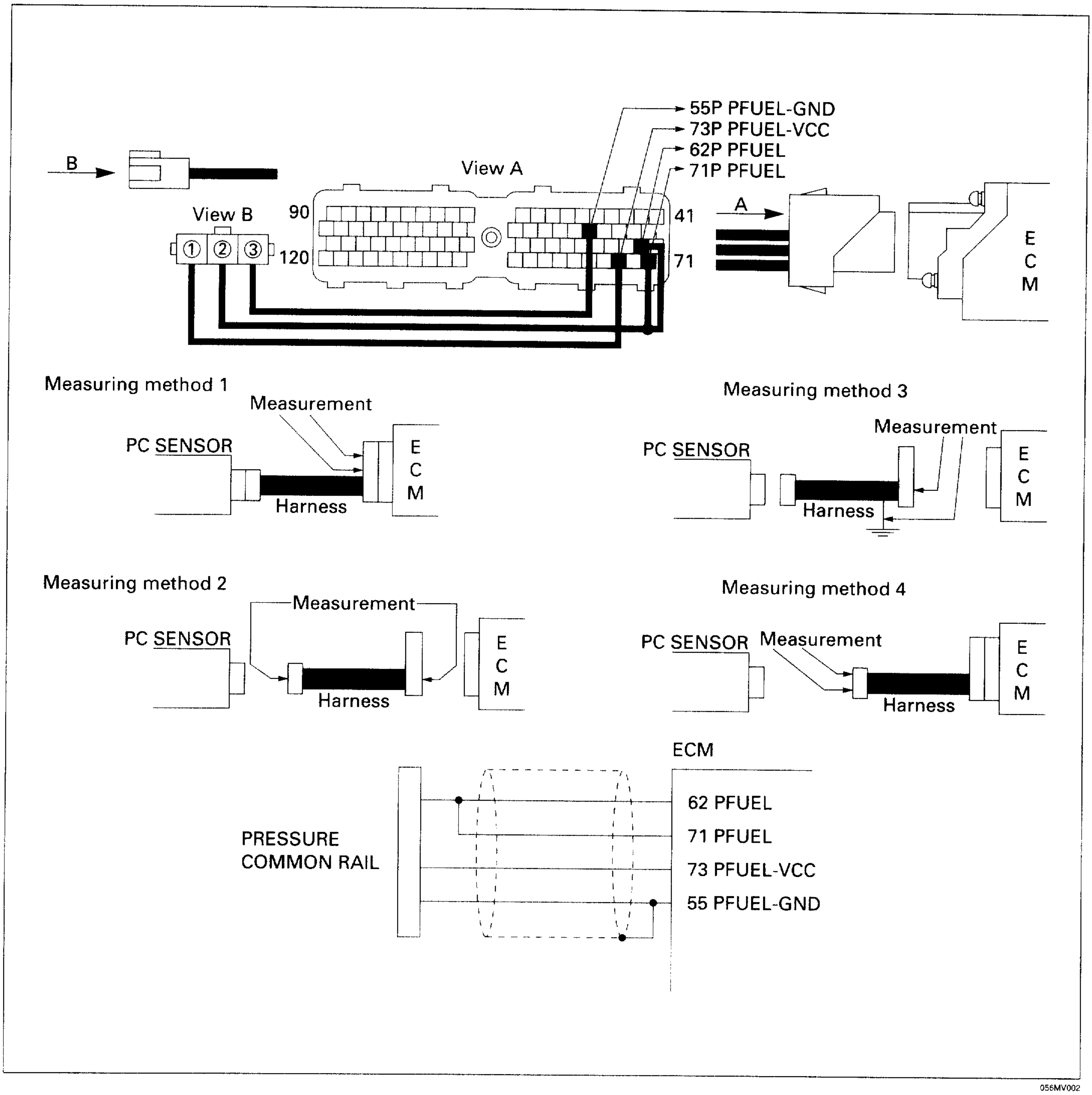
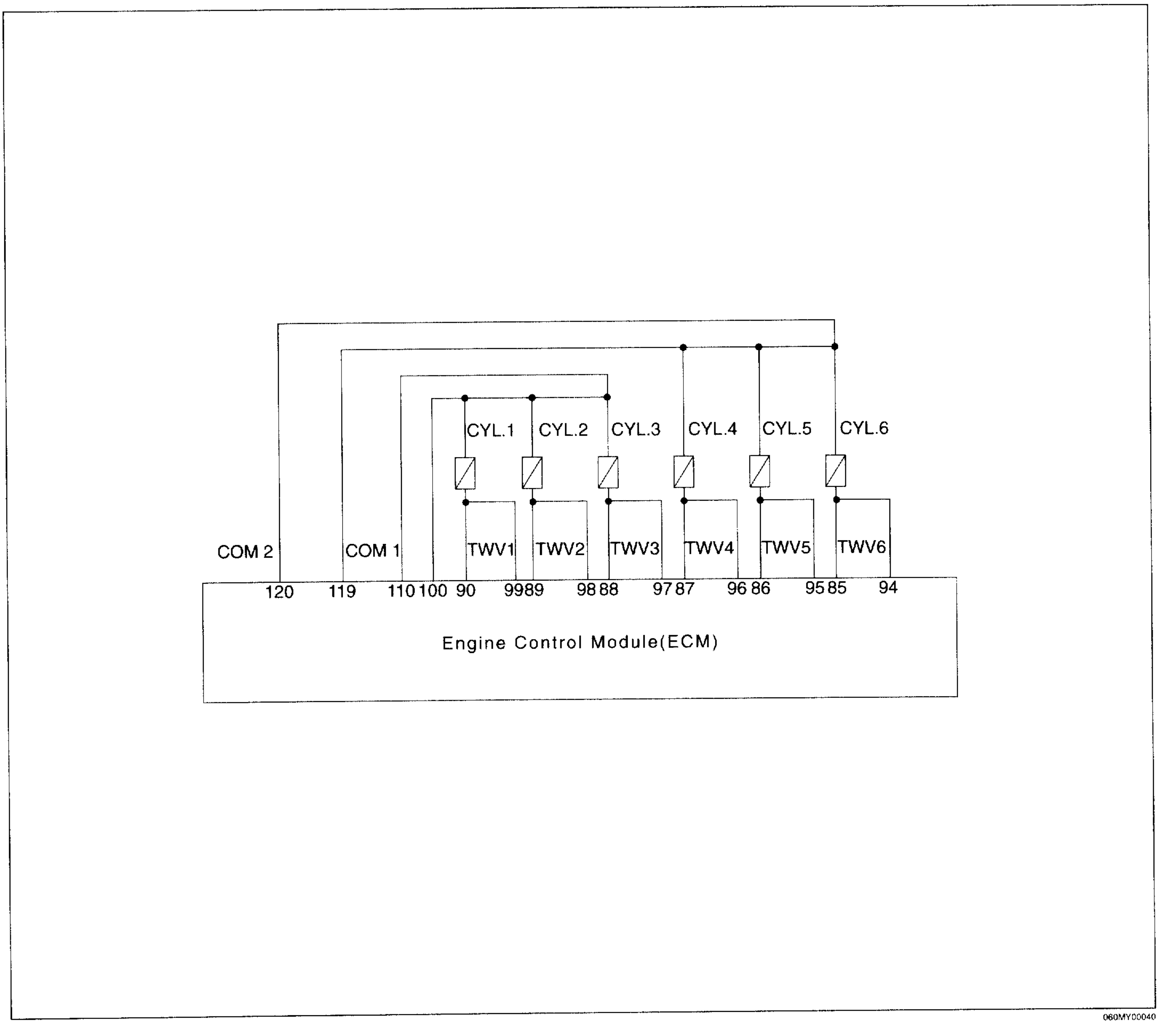
DTC 0151 Common Rail Pressure Abnormal (Pump over pressure supply)

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display DTC 0151 while engine is running or when key switch "ON"?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect PC sensor harness connector from PC sensor. 3. Start and idle the engine. 4. Measure the voltage between pin number 2 (PFUEL) and pin number 3 (PFUEL – GND) with ECT more than 60°C. (Measuring method 4) Is voltage within value?	More than 1.4V	Go to step 7	Go to step 4
4	Clear all DTCs. Is DTC 0151 display?	—	Go to step 6	Go to step 5
5	Check for an open circuit on the PC sensor harness connector. Is there a complete connection?	—	System OK	Reconnect or repair PC sensor harness, then Go to step 11
6	1. Check for any DTCs for CKP/CAM sensor. 2. Check complete installation of the supply pump. Was a problem found?	—	First,repair or replace for these problems.	Go to step 8
7	1. Key switch "OFF". 2. Disconnect PC sensor harness from the sensor and the ECM. 3. Measure the resistance at the following points. (Measuring method 2) • Between pin number 71 (PFUEL) at ECM side and pin number 2 at PC sensor side on the PC sensor harness. • Between pin number 62 (PFUEL) at ECM side and pin number 2 at PC sensor side on the PC sensor harness. • Between pin number 55 (PFUEL – GND) at ECM side and pin number 3 at PC sensor side on the PC sensor harness. Is resistance within value?	2Ω or less	Go to step 8	Repair/replace or correct connector contact for PC sensor harness. Then go to step 11
8	Measure the resistance at the following points. (Measuring method 3) • Between pin number 71 (PFUEL) at ECM side and GND on the PC sensor harness. • Between pin number 62 (PFUEL) at ECM side and GND on the PC sensor harness. • Between pin number 55 (PFUEL – GND) and GND on the PC sensor harness. Is resistance within value?	10MΩ or more	Go to step 9	Repair harness shortage or replace PC sensor harness. Then go to step 11
9	1. Reconnect PC sensor harness to both PC sensor and ECM. 2. Clear all DTCs, then start the engine. 3. Press and release the accelerator pedal several times. Is DTC 0151 display?	—	Replace PC sensor. Then go to step 11	Repair harness shortage or replace PC sensor harness. Then go to step 11
10	Clear all DTCs then engine start. Is DTC 0151 display?	—	Replace ECM assembly. Then go to step 11	System OK
11	Is DTC 0151 display?		Go back to step 3	System OK

Common Rail Pressure Abnormal (Pump over pressure supply)



DTC 0158 TWV Driving System Error (B+ Short Circuited)



Circuit Description

A hydraulic piston and TWV (solenoid valve) have been added to the conventional nozzle. Receiving signals from the ECM, the TWV opens and closes to change the pressure in the pressure adjustment chamber on top of the hydraulic piston so that the hydraulic piston operates, thereby to inject the fuel from the nozzle.

Conditions for Setting the DTC

Common 1

TWV Driving System B+ shorted.

- TWV harness B+ shorted and/or common harness B+ shorted and battery voltage is higher than 10V except when an overspeed condition occurs.

TWV Driving System Ground shorted.

- TWV harness ground shorted and/or common harness ground shorted and battery voltage is higher than 10V except when an overspeed condition occurs.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Constant current control by common 1 or common 2 circuit whichever normal (Abnormal system separated)
- Injection amount limited maximum 80 mm^3/st and boost becomes 0.

Conditions for Clearing the MIL/DTC

DTC 0158 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

DTC 0158 TWV Driving System Error (B+ Short Circuited)

Diagnostic Aids

Check for the following conditions:

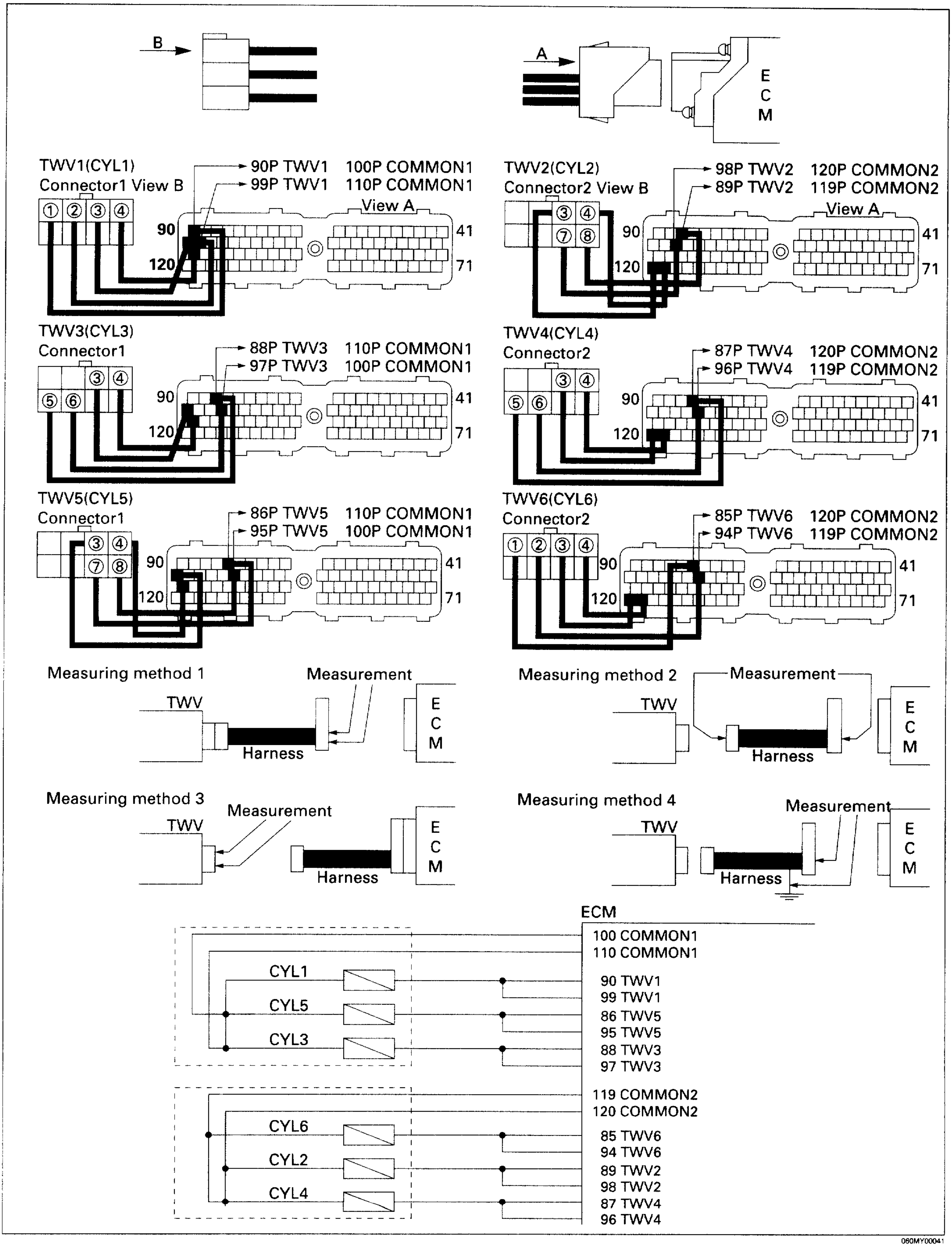
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- No smooth rotation.
- Lack of engine power etc.

DTC 0158 TWV Driving System Error (B+ Short Circuited)

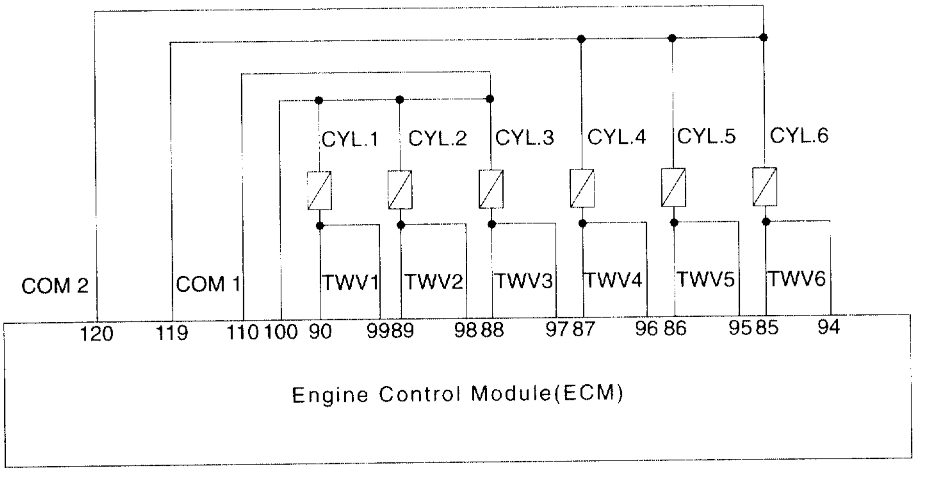
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display DTC 0158 or DTC 0159 while key switch "ON" or engine is running?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect TWV harness from both ECM and TWV connector at cylinder head. 3. Key switch "ON". 4. Measure voltage following points on the TWV harness. (Measuring method 4) • Between pin number 100, 110 (COMMON1) and GND at ECM side connector. • Between pin number 119, 120 (COMMON2) and GND at ECM side connector. In this case, assume there is a short circuit with an other B+ line. Is voltage within value?	1V or less	Go to step 4	Repair common1 and/or common2 of TWV harness. Then go to step 6
4	1. Key switch "ON". 2. Measure voltage at the following points at the ECM connector on the TWV harness. (Measuring method 4) • Between pin number 90, 99 (TWV1) and GND. • Between pin number 89, 98 (TWV2) and GND. • Between pin number 88, 97 (TWV3) and GND. • Between pin number 87, 96 (TWV4) and GND. • Between pin number 86, 95 (TWV5) and GND. • Between pin number 85, 94 (TWV6) and GND. In this case, assume there is a short circuit with other GND line. Is voltage within value?	1V or less	Go to step 5	Repair/replace TWV harness. Then go to step 8
5	1. Key switch "OFF". 2. Measure resistance at the following points at the ECM connector on the TWV harness. (Measuring method 4) • Between pin number 119, 120 (COMMON2) and GND. • Between pin number 100, 110 (COMMON1) and GND. Is resistance within value?	10MΩ or more	Go to step 6	Repair/replace TWV harness. Then go to step 8
6	Measure resistance following points at ECM side connector on the TWV harness. • Between pin number 90, 99 (TWV1) and ECM body GND. • Between pin number 89, 98 (TWV2) and ECM body GND. • Between pin number 88, 97 (TWV3) and ECM body GND. • Between pin number 87, 96 (TWV4) and ECM body GND. • Between pin number 86, 95 (TWV5) and ECM body GND. • Between pin number 85, 94 (TWV6) and ECM body GND. Is voltage within value?	10MΩ or more	Go to step 7	Repair/replace TWV harness. Then go to step 8
7	1. Clear DTC. 2. Start engine. Does DTC 0158 or DTC 0159 display?	—	Replace ECM assembly. Then go to step 8	System OK
8	1. Clear all DTCs. 2. Start engine. Does DTC 0158 or DTC 0159 display?	—	Go back to step 3	System OK

***IMPORTANT:** The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.*

TWV Driving System Error (B+ Short Circuited)



DTC 0159 TWV Driving System Error (Ground Line Shorted)



Circuit Description

A hydraulic piston and TWV (solenoid valve) have been added to the conventional nozzle. Receiving signals from ECM, the TWV opens and closes to change the pressure in the pressure adjustment chamber on top of the hydraulic piston so that the hydraulic piston operates, thereby to inject the fuel from the nozzle.

Conditions for Setting the DTC

Common 2

TWV Driving System B+ shorted.

- TWV harness B+ shorted and/or common harness B+ shorted and battery voltage is higher than 10V except when an over speed condition occurs.

TWV Driving System Ground shorted.

- TWV harness ground shorted and/or common harness ground shorted and battery voltage is higher than 10V except when an over speed condition occurs.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Constant current control by common 1 or common 2 circuits whichever normal (Abnormal system separated)
- Injection amount limited maximum 80 mm^3/st and boost becomes 0.

Conditions for Clearing the MIL/DTC

DTC 0159 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

DTC 0159 TWV Driving System Error (Ground Line Shorted)

Diagnostic Aids

Check for the following conditions:

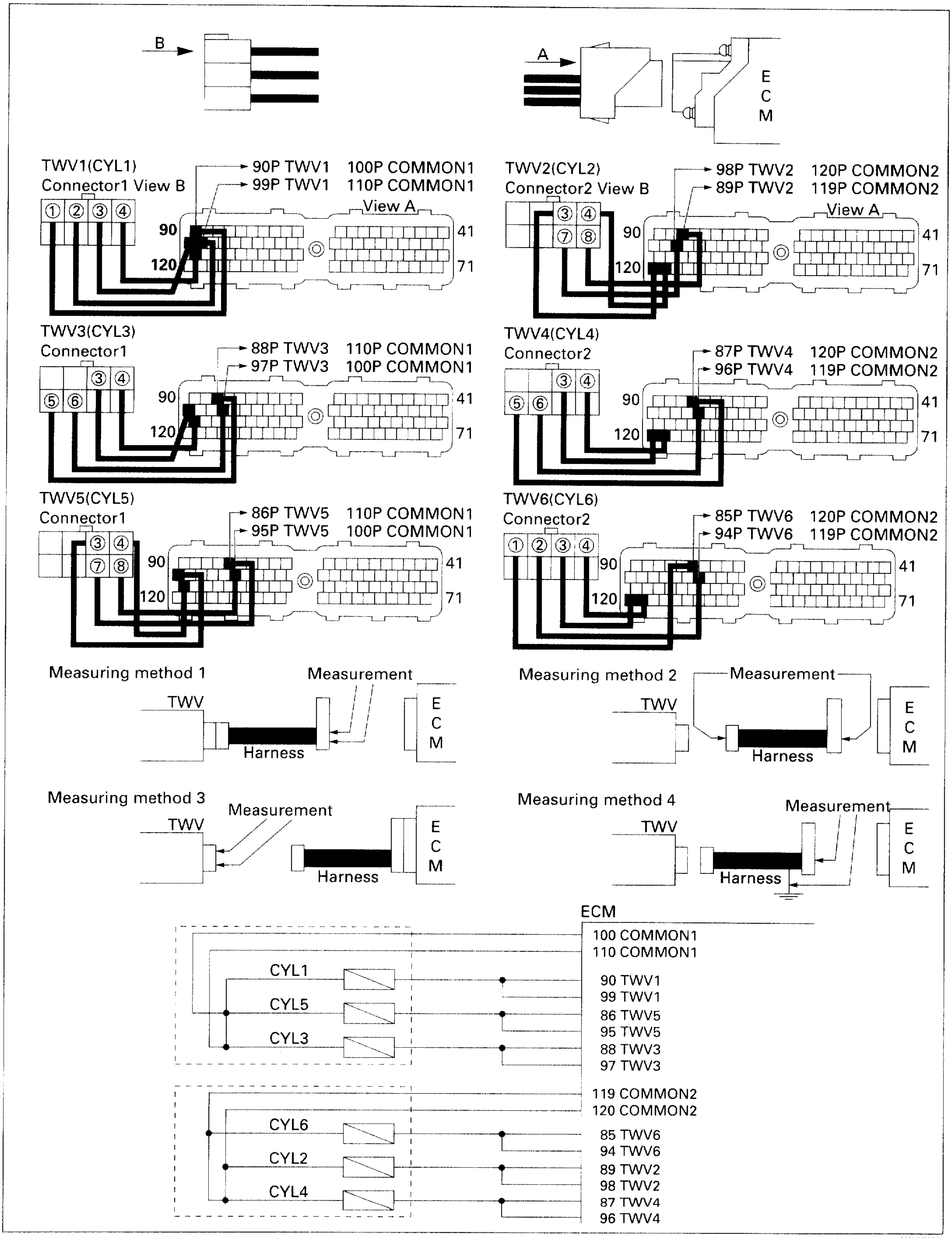
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- No smooth rotation.
- Lack of engine power etc.

DTC 0159 TWV Driving System Error (Ground Line Shorted)

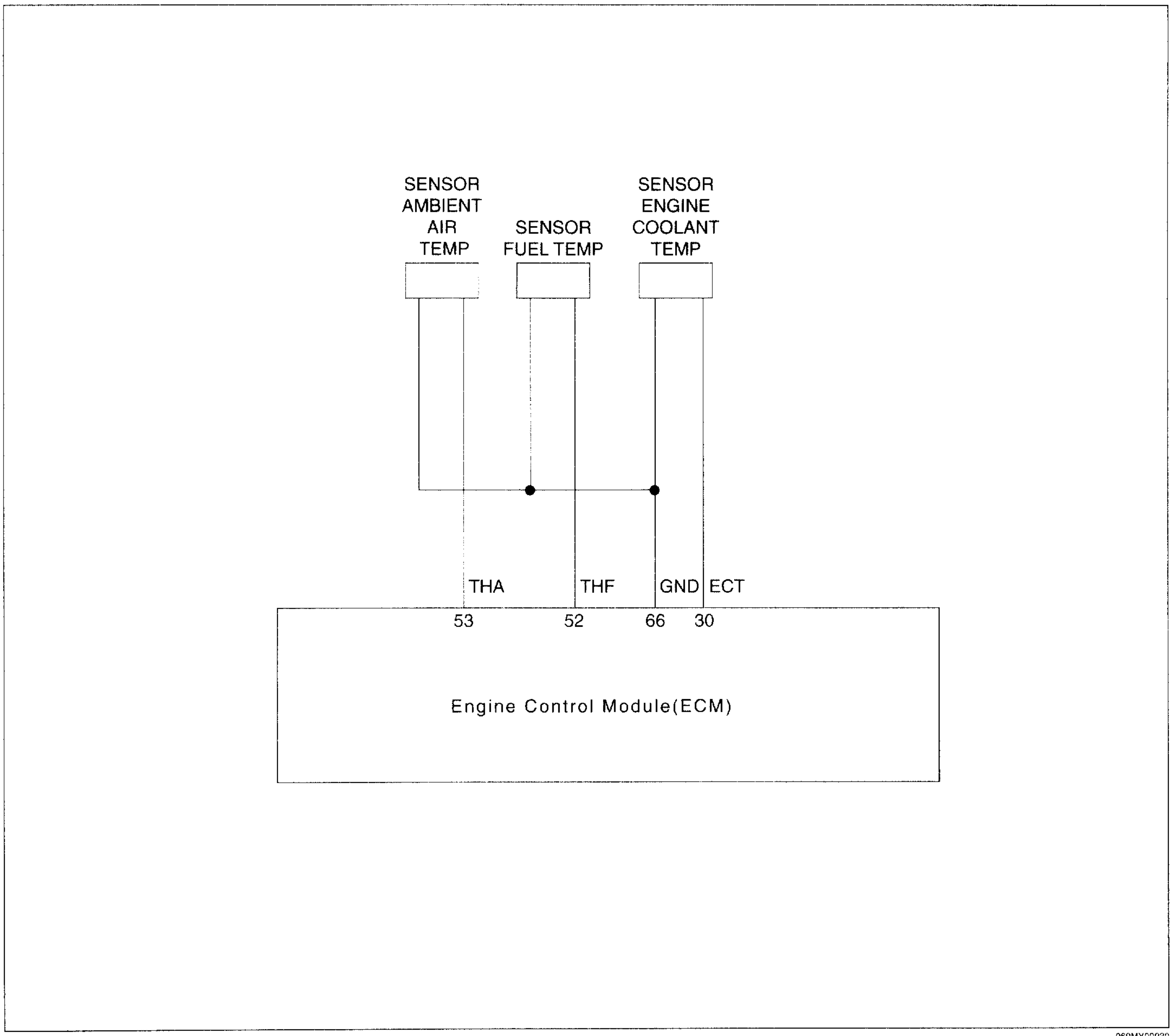
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display DTC 0158 or DTC 0159 while key switch "ON" or engine is running?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect TWV harness from both ECM and TWV connector at cylinder head. 3. Key switch "ON". 4. Measure voltage following points on the TWV harness. (Measuring method 4) • Between pin number 100, 110 (COMMON1) and GND at ECM side connector. • Between pin number 119, 120 (COMMON2) and GND at ECM side connector. In this case, assume there is a short circuit with an other B+ line. Is voltage within value?	1V or less	Go to step 4	Repair common1 and/or common2 of TWV harness. Then go to step 8
4	1. Key switch "ON". 2. Measure voltage at the following points at the ECM connector on the TWV harness. (Measuring method 4) • Between pin number 90, 99 (TWV1) and GND. • Between pin number 89, 98 (TWV2) and GND. • Between pin number 88, 97 (TWV3) and GND. • Between pin number 87, 96 (TWV4) and GND. • Between pin number 86, 95 (TWV5) and GND. • Between pin number 85, 94 (TWV6) and GND. In this case, assume there is a short circuit with other GND line. Is voltage within value?	1V or less	Go to step 5	Repair/replace TWV harness. Then go to step 8
5	1. Key switch "OFF". 2. Measure resistance at the following points at the ECM connector on the TWV harness. (Measuring method 4) • Between pin number 119, 120 (COMMON2) and GND. • Between pin number 100, 110 (COMMON1) and GND. Is resistance within value?	10MΩ or more	Go to step 6	Repair/replace TWV harness. Then go to step 8
6	Measure resistance following points at ECM side connector on the TWV harness. • Between pin number 90, 99 (TWV1) and ECM body GND. • Between pin number 89, 98 (TWV2) and ECM body GND. • Between pin number 88, 97 (TWV3) and ECM body GND. • Between pin number 87, 96 (TWV4) and ECM body GND. • Between pin number 86, 95 (TWV5) and ECM body GND. • Between pin number 85, 94 (TWV6) and ECM body GND. Is voltage within value?	10MΩ or more	Go to step 7	Repair/replace TWV harness. Then go to step 8
7	1. Clear DTC. 2. Start engine. Does DTC 0158 or DTC 0159 display?	—	Replace ECM assembly. Then go to step 8	System OK
8	1. Clear all DTCs. 2. Start engine. Does DTC 0158 or DTC 0159 display?	—	Go back to step 3	System OK

IMPORTANT:* *The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

TWV Driving System Error (Ground Line Shorted)



DTC 0211 Fuel Temperature Sensor Error



Circuit Description

The Fuel Temp. sensor (THF) is a thermister type sensor installed in the casing of the fuel return (from the injector) circuit.

Change in fuel temperature is converted into a resistance signal and sent to ECM for optimization of fuel injection control.

Diagnostic Trouble Code 0211 will set when the ECM detects an excessively high or low signal voltage on the THF sensor signal circuit.

Conditions for Setting the DTC

- A fuel temperature sensor voltage exceeding 4.8V or lower than 0.1V detected for 1 sec. or more.
  (4.8V = –50°C, 0.1V = 130°C)

Action Taken When the DTC Sets

- Backup control by ECT
  starting at a fuel temperature of –20°C
  Other = 80°C

Conditions for Clearing the MIL/DTC

DTC 0211 can be cleared by using the “Clear Info” by scan tool or using by the Diag Clear Switch.

DTC 0211 Fuel Temperature Sensor Error

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 Fuel Temperature display on the scan tool while moving connectors and wiring harnesses related to the Fuel Temperature sensor. A change in the Fuel Temperature display will indicate the location of the fault.

F2; ENGINE DATA 3

Engine Speed	610~620	RPM
Actual Rail Pressure	25.0	Kpa
Basic Fuel Rate	1.1	mm^3
Final Fuel Rate	5.0	mm^3
Fuel Rate at Start	0	mm^3
Fuel Rate at Maximum Speed	249.6	mm^3
Fuel Rate Correction	3	mm^3
ISC Fuel Rate Correction	7	mm^3
ISC Fuel Rate Proportion	0	mm^3
ISC Fuel Rate Intergral	4	mm^3
Sprit Fuel Rate	20	mm^3
Balancing Rate Cylinder 1	0	mm^3
Balancing Rate Cylinder 2	0	mm^3
Balancing Rate Cylinder 3	0	mm^3
Balancing Rate Cylinder 4	0.	mm^3
Balancing Rate Cylinder 5	0	mm^3
Balancing Rate Cylinder 6	0	mm^3
Injection Control Mode		Normal Control

Select Items | DTC | Quick Snapshot | More

060MY00055

- No symptom in particular

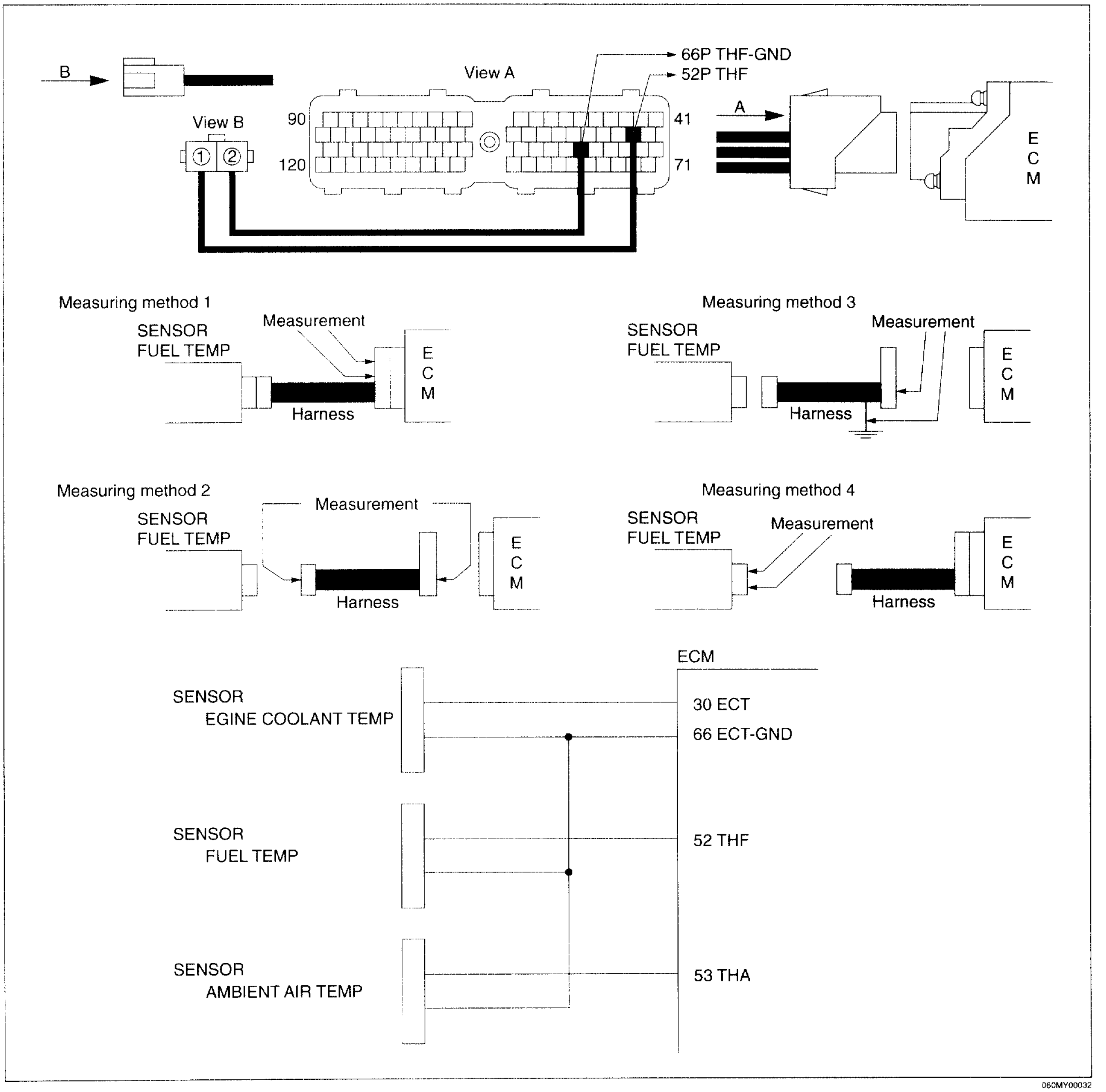
DTC 0211 Fuel Temperature Sensor Error

<table>
<tr><th>STEP</th><th>ACTION</th><th>VALUE</th><th>YES</th><th>NO</th></tr>
<tr><td>1</td><td>Was the "On-Board Diagnostic (OBD) System Check" performed?</td><td>—</td><td>Go to step 2</td><td>Go to OBD System Check</td></tr>
<tr><td>2</td><td>Does the scan tool display DTC 0211 while key switch "ON" or engine running?</td><td>—</td><td>Go to step 3</td><td>—</td></tr>
<tr><td>3</td><td>Measure the voltage between pin number 52 (THF) and pin number 66 (sensor – GND) at the ECM while key switch "ON" and engine is running. (Measuring method 1)
Is the voltage outside the specifical value?
(1.5V when fuel temp. about 60°C)</td><td>0.1V
to
4.8V</td><td>Go to step 5</td><td>Go to step 4</td></tr>
<tr><td>4</td><td>Check for poor connection at connector.
Is there incomplete connection?</td><td>—</td><td>Correct to complete connection.</td><td>Go to step 5</td></tr>
<tr><td>5</td><td>Is there abnormally high fuel temperature?</td><td>More than 212°F (100°C)</td><td>Repair fuel system</td><td>Go to step 6</td></tr>
<tr><td>6</td><td>1. Key switch "OFF".
2. Disconnect fuel temp sensor harness from both ECM and fuel temp sensor.
3. Measure resistance following points.
• Between pin number 52 (THF) at ECM side and pin number 1 at fuel temp sensor side on the THF sensor harness.
• Between pin number 66 (THF–GND) at ECM side and pin number 2 at THF sensor side on the THF sensor harness. (Measuring method 2)
Is resistance within value?</td><td>2Ω or less</td><td>Go to step 7</td><td>Repair/replace THF sensor harness.</td></tr>
<tr><td>7</td><td>Measure resistance between pin number 52 and GND. (Measuring method 3)
Is resistance within value?</td><td>10MΩ or more</td><td>Go to step 8</td><td>Repair/replace THF sensor harness</td></tr>
<tr><td>8</td><td>Measure the resistance of THF sensor unit. (Measuring method 4)
Is resistance within value?

Resistance for THF sensor unit
<table><tr><th>Fuel temperature (°C)</th><th>Resistance (kΩ)</th></tr><tr><td>20</td><td>About 2.7 (3V)</td></tr><tr><td>40</td><td>1.3 (2.2V)</td></tr><tr><td>60</td><td>0.6 (1.5V)</td></tr><tr><td>80</td><td>0.4 (1V)</td></tr></table></td><td>See table on left</td><td>Go to step 9</td><td>Replace THF sensor</td></tr>
<tr><td>9</td><td>1. Reconnect THF sensor harness to ECM and THF sensor.
2. Clear all DTCs.
Is DTC 0211 displayed?</td><td>—</td><td>Replace ECM assembly then Go to step 10</td><td>System OK</td></tr>
<tr><td>10</td><td>Clear all DTCs.
Is DTC 0211 displayed?</td><td>—</td><td>Go back to step 3</td><td>System OK</td></tr>
<tr><td></td><td>Note: The temperature sensor GND is common. If disconnected or short circuited, all sensors become erroneous. (Water, atmospheric and fuel temperature.)</td><td></td><td></td><td></td></tr>
</table>

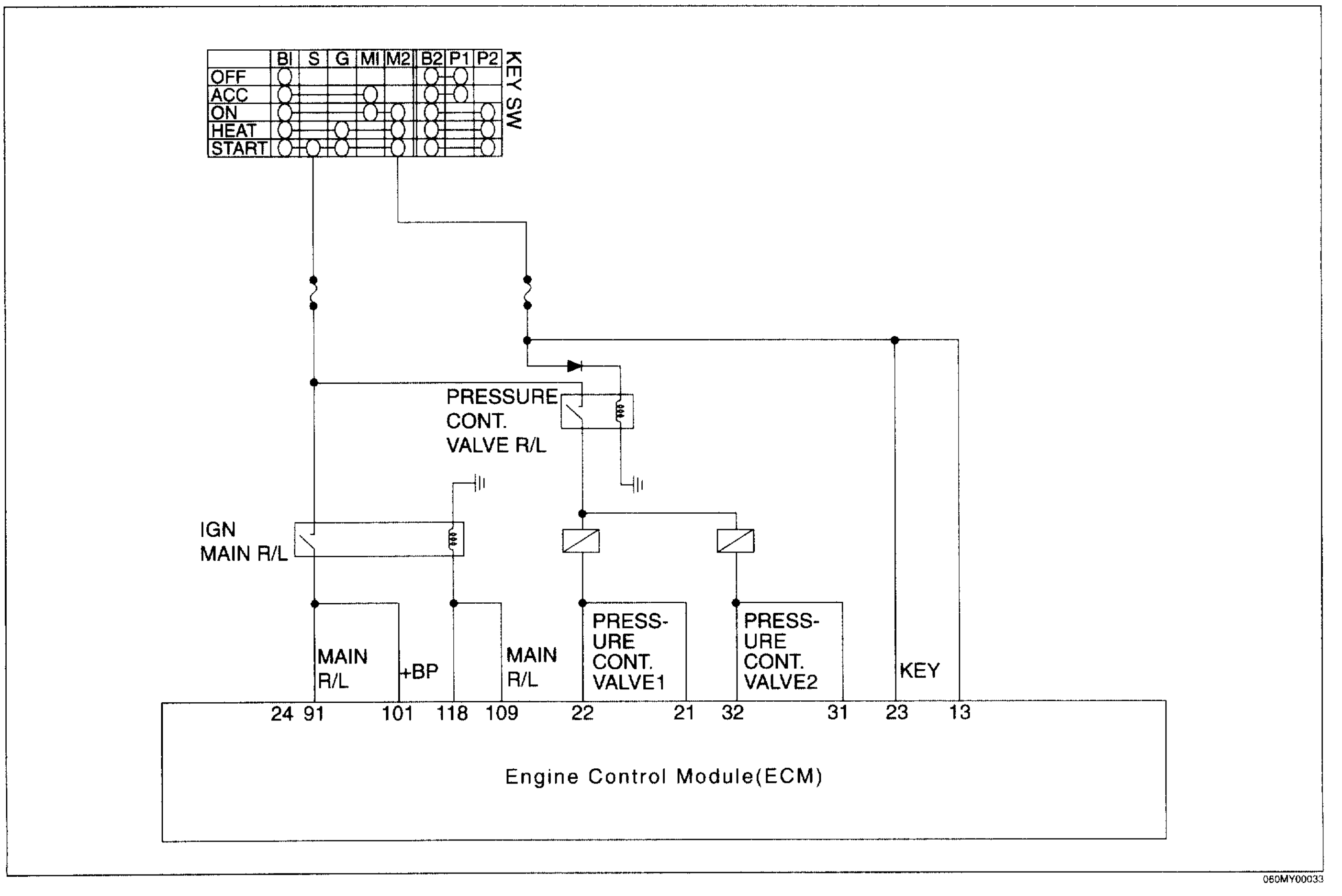
IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Fuel Temperature Sensor Error



060MY00032

DTC 0217 PCV1 (Coil or Harness) B+ Shortage



Circuit Description

The PCV is used to adjust supply pump discharge amount so as to adjust common rail pressure. Discharge amount from the supply pump to the common rail is determined by PCV current timing.

Diagnostic Trouble Code 0217 will set when the ECM detects an excessively high signal voltage on the PCV1 sensor signal circuit.

Conditions for Setting the DTC

PCV1;

- Abnormally high driving voltage with PCV on, Pump normal mode and battery voltage higher than 10V when key switch ON.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- If abnormally high driving voltage is generated, the PCV will be off. The default pressure is limited to 60 MPa or less.

Conditions for Clearing the MIL/DTC

DTC 0217 can be cleared by using the “Clear Info” by scan tool or using by the Diag Clear Switch.

Diagnostic Aids

Check for the following conditions:

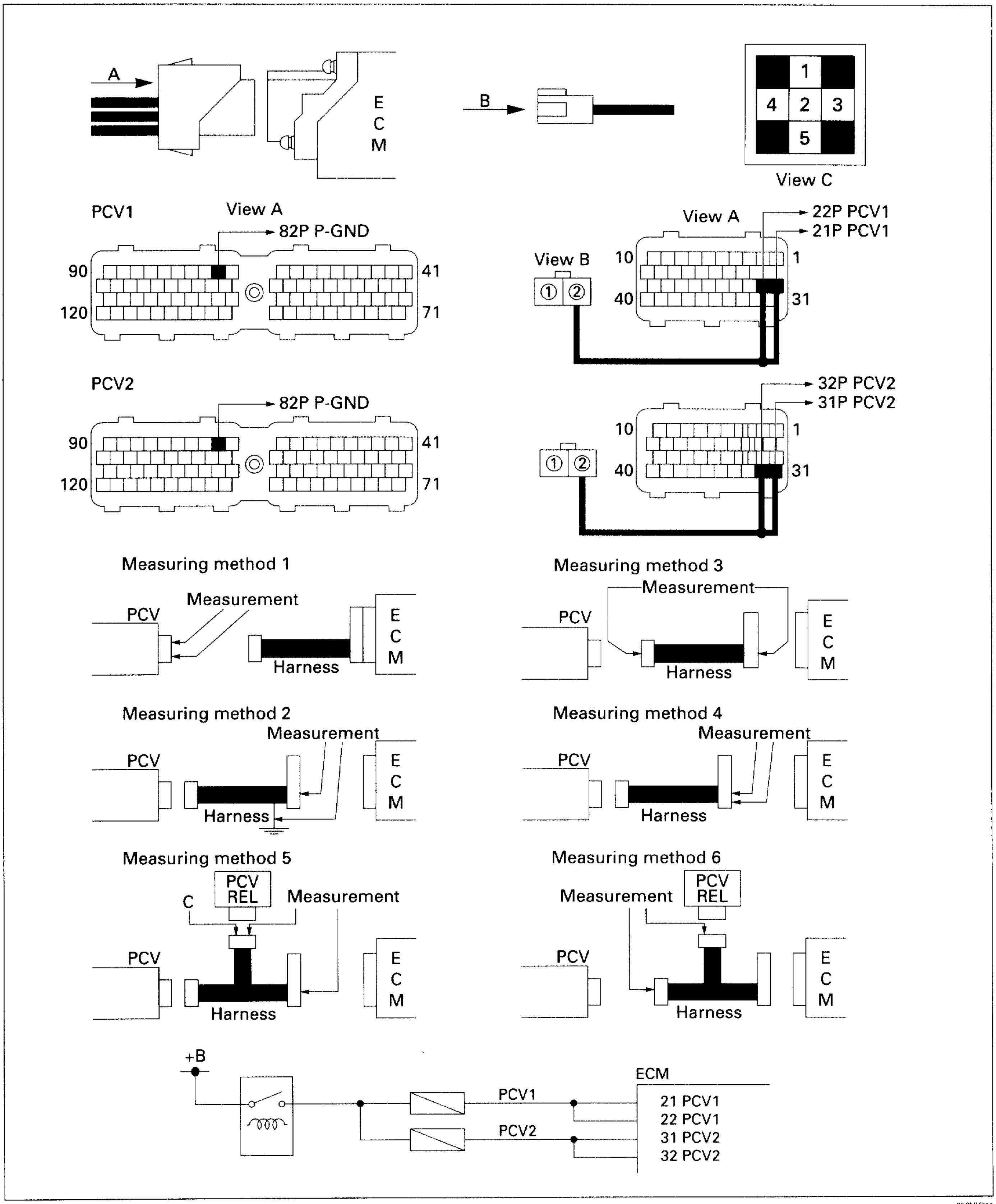
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness – Inspect the wiring harness for damage, shorts to ground, shorts to battery and open circuits. If the harness appears to be OK, observe the PCV display on the scan tool while moving connectors and wiring harnesses related to the PCV sensor A change in the PCV display will indicate the location of the fault.

DTC 0217 PCV1 (Coil or Harness) B+ Shortage

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does DTC 0217 display while key switch "ON" or engine is running?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect PCV1 and PCV2 connector. 3. Measure resistance following points. (Measuring method 1) • Between pin number 1 and 2 on the PCV1. Is resistance within value?	0.9Ω to 1.3Ω	Go to step 4	Replace PCV assembly. Then go to step 8
4	1. Key switch "OFF". 2. Disconnect ECM connector. (PCV connector remains connected) 3. Key switch "ON". 4. Measure voltage at the following points. (Measuring method 4) • Between pin number 21, 22 PCV1 side and pin number 82 (P–GND) ECM side on the PCV1 harness. Is voltage within value?	1V or less	Go to step 6	Go to step 5
5	Repair the short to battery positive (B+) on the PCV input circuit to ECM on the PCV harness Did you repair them?	—	Go to step 8	Repair them. Then go to step 8
6	1. Key switch "OFF". 2. Reconnect all connector to ECM and PCV harness. 3. Key switch "ON". Is DTC 0217 displayed?	—	Replace ECM. Then go to step 8	Go to step 7
7	1. Key switch "OFF". 2. Disconnect PCV harness from PCV, PCV relay and ECM. 3. Measure voltage between pin number 1 at PCV relay side of PCV harness and pin number 82 (P–GND) at ECM side of PCV harness. (Measuring method 5) Is voltage within value?	Less than 1V	Go to step 8	Repair/replace PCV harness. Then go to step 8
8	Clear all DTCs. Does DTC 0217 display while key "ON" or engine is running?	—	Go back to step 3	System OK

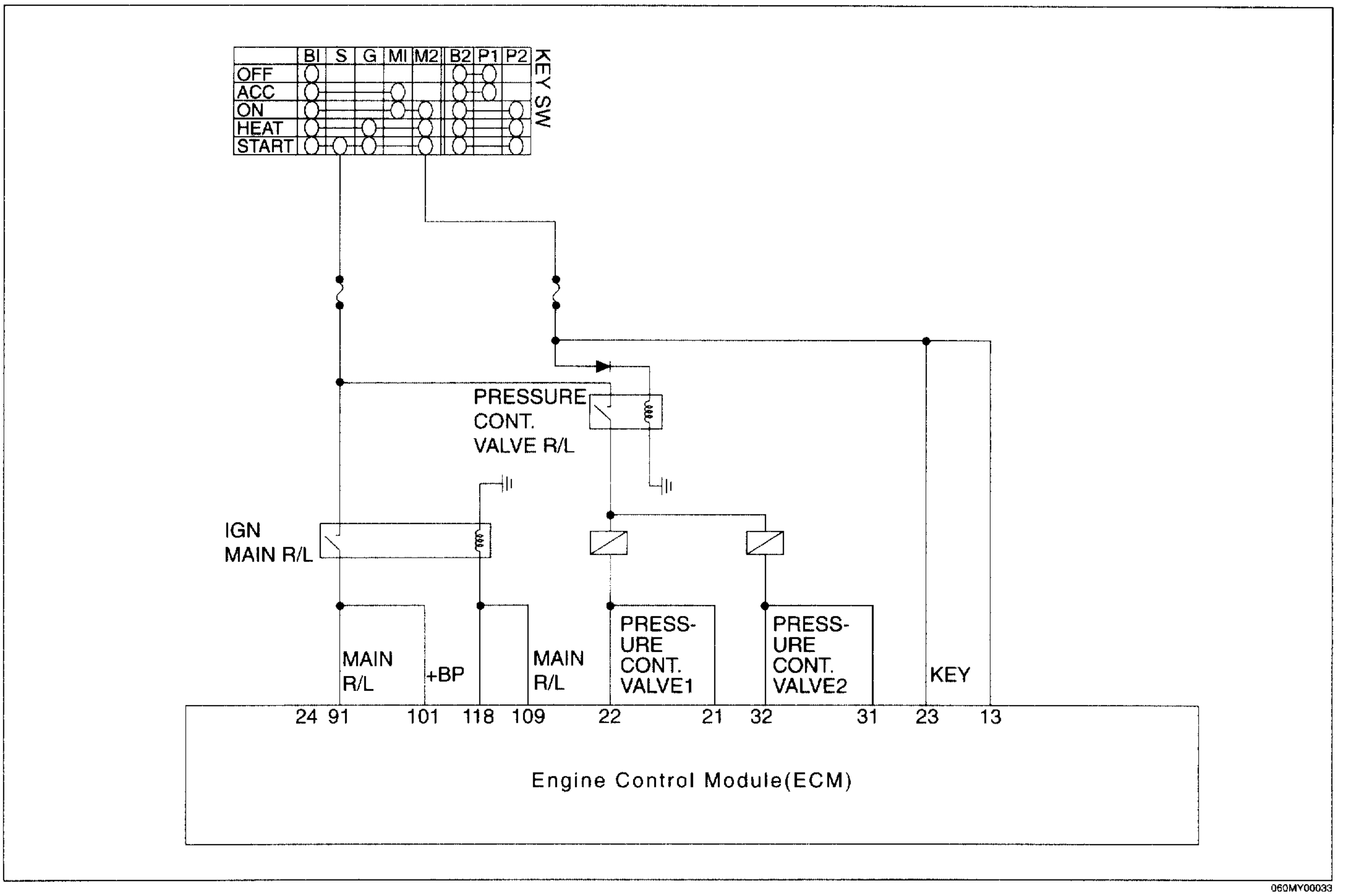
IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

PCV1, 2 (Coil or Harness) B+ Shortage



056MV011

DTC 0218 PCV2 (Coil or Harness) B+ Shortage



060MY00033

Circuit Description

PCV is used to adjust supply pump discharge amount so as to adjust common rail pressure. Discharge amount from the supply pump to the common rail is determined by PCV current timing.

Diagnostic Trouble Code 0218 will set when the ECM detects an excessively high signal voltage on the PCV2 sensor signal circuit.

Conditions for Setting the DTC

PCV2;

- Abnormally high driving voltage with PCV on, Pump normal mode and battery voltage higher than 10V when key switch ON.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- If abnormally high driving voltage is generated, the PCV will be off. The target pressure is limited to 60 MPa or less.

Conditions for Clearing the MIL/DTC

DTC 0218 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

Diagnostic Aids

Check for the following conditions:

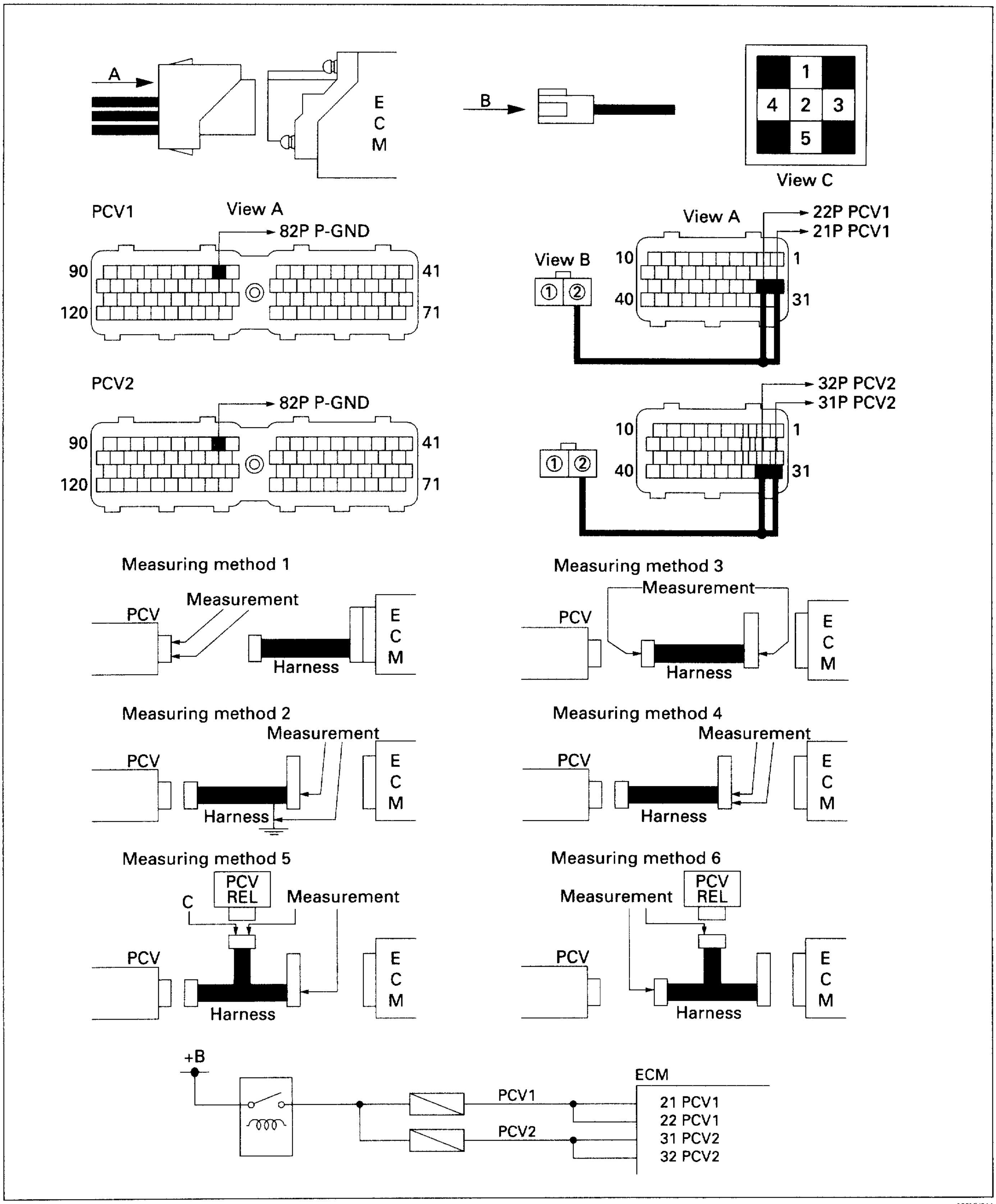
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness – Inspect the wiring harness for damage, shorts to ground, shorts to battery and open circuits. If the harness appears to be OK, observe the PCV display on the scan tool while moving connectors and wiring harnesses related to the PCV sensor A change in the PCV display will indicate the location of the fault.

DTC 0218 PCV2 (Coil or Harness) B+ Shortage

STEP	ACTION	VALUE	YES	NO
1	Was the “On-Board Diagnostic (OBD) System Check” performed?	—	Go to step 2	Go to OBD System Check
2	Does DTC 0218 display while key switch “ON” or engine is running?	—	Go to step 3	—
3	1. Key switch “OFF”. 2. Disconnect PCV1 and PCV2 connector. 3. Measure resistance following points. (Measuring method 1) • Between pin number 1 and 2 on the PCV2. Is resistance within value?	0.9Ω to 1.3Ω	Go to step 4	Replace PCV assembly. Then go to step 8
4	1. Key switch “OFF”. 2. Disconnect ECM connector. (PCV connector remains connection) 3. Key switch “ON”. 4. Measure voltage at the following points. (Measuring method 4) • Between pin number 31, 32 PCV2 side and pin number 82 (P–GND) ECM side on the PCV2 harness. Is voltage within value?	1V or less	Go to step 6	Go to step 5
5	Repair the short to battery positive (B+) on the PCV input circuit to ECM on the PCV harness Did you repair them?	—	Go to step 8	Repair them. Then go to step 8
6	1. Key switch “OFF”. 2. Reconnect all connector to ECM and PCV harness. 3. Key switch “ON”. Is DTC 0218 displayed?	—	Replace ECM. Then go to step 8	Go to step 7
7	1. Key switch “OFF”. 2. Disconnect PCV harness from PCV, PCV relay and ECM. 3. Measure voltage between pin number 1 at PCV relay side of PCV harness and pin number 82 (P–GND) at ECM side of PCV harness. (Measuring method 5) Is voltage within value?	Less than 1V	Go to step 8	Repair/replace PCV harness. Then go to step 8
8	Clear all DTCs. Does DTC 0218 display while key “ON” or engine is running?	—	Go back to step 3	System OK

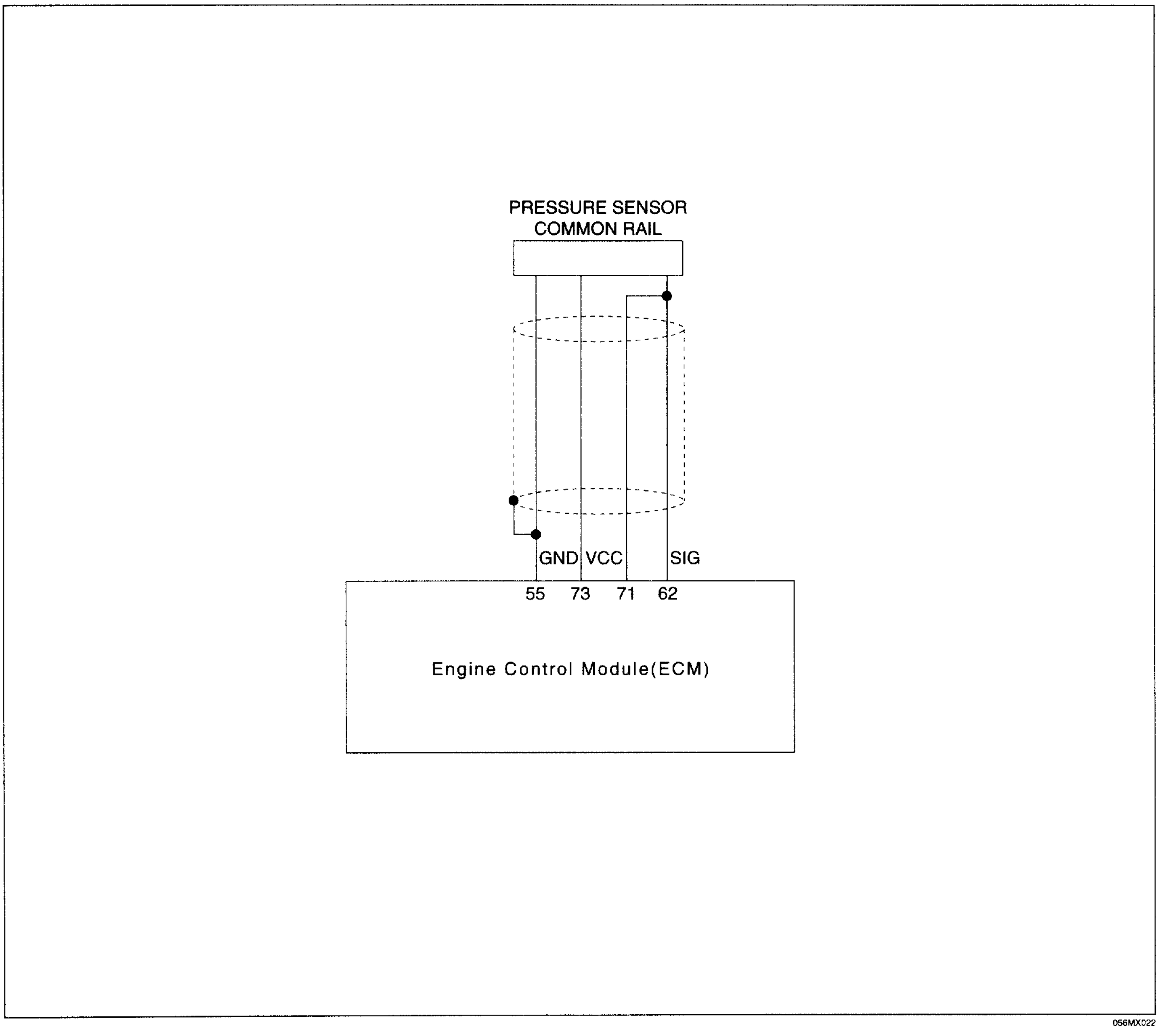
***IMPORTANT:** The replacement ECM must be restored the capture fuel rate data by Tech 2.*
Refer to “Capture and Restore Fuel Rate Data” of “Tech 2 Scan Tool” in this manual.

PCV1, 2 (Coil or Harness) B+ Shortage



056MV011

DTC 0226 Supply Pump Non Pressure Supply or Pressure Limiter Activation



Circuit Description

The pressure limiter opens when abnormally high pressure is generated, releasing the pressure. When the common rail pressure reaches approx. 140 MPa (1,420 kg/cm^2), the pressure limiter is actuated (opens), and when the pressure drops to approx. 30 MPa (310 kg/cm^2) later, it works to maintain the pressure, thereby enabling continuous running.

The common rail pressure sensor, installed at left end of the common rail, is used to detect fuel pressure. It is a semiconductor type pressure sensor utilizing silicon's property that the electric resistance of pressurized silicone is varied.

Further, a special gasket is used at the connection part with the common rail body so as to seal high pressure fuel.

Conditions for Setting the DTC

- Desired ISC speed as detected by scan tool and common rail pressure not controlled.
- DTC 0245, 0217, 218, 0247 and 0248 are not set.
- CKP sensor normal condition.
- Pump normal mode, battery voltage is higher than 8V.
- Pump speed is higher than 450 rpm.
- ECT is higher than 60°C.
- PCV opening timing reached the limited value or feedback value reaches –60CA deg.
- When above condition continues for 60 times.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Injection amount is limited for 60 mm^3/st.
- Target common rail pressure is lower than 25 MPa.

DTC 0226 Supply Pump Non Pressure Supply or Pressure Limiter Activation

Conditions for Clearing the MIL/DTC

DTC 0226 can be cleared by using the “Clear Info” by scan tool or using by the Diag Clear Switch.

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.
- Smoke, power shortage etc., due to lack of common rail pressure (Pressure limiter activated)
- Check Fuel Filter.

STEP	ACTION	VALUE	YES	NO
1	Was the “On-Board Diagnostic (OBD) System Check” performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display DTC 226 while Ignition “ON”, or engine at idle?	—	Go to step 3	—
3	1. After warming up the engine (at 60°C or more), turn engine “OFF”, clear the DTC. 2. Restart the engine and let idle for 60 seconds. Does the DTC reset?	—	Go to step 4	See Note on Intermittent
4	Check the fuel lines from supply pump to common rail for broken, loose, or restriction. Also check fuel filter for restriction. Was a problem found?	—	Repair or replace Go back to step 3	Go to step 5
5	Check the ECM and common rail fuel pressure sensor connectors, ECM ground, and wiring harness for looseness, bent terminals, or chafed wires. Was a problem found?	—	Repair or replace Go back to step 3	Go to step 6
6	1. Ignition“ON”, engine “ON”. 2. Record actual common rail fuel pressure at idle. Is the pressure lower than the specified value?	25 MPa	Go to step 7	See Note on Intermittent
7	Disconnect PCV#1 connector while engine is idling. Does engine shut down?	—	Replace supply pump. Go back to step 3	Go to step 8
8	1. Reconnect the PCV#1 connector. 2. Disconnect PCV#2 connector while engine is idling. Does engine shut down?	—	Replace supply pump. Go back to step 3	Go to step 9
9	1. Reconnect the PCV#2 connector. 2. Operate on acceleration pedal at 2,500 to 3,000 rpm on engine speed, and observe the actual common rail fuel pressure. Did the actual common rail fuel pressure have a pressure reading above the specified value?	120 MPa	Go to step 10	Replace common rail. Go back to step 3
10	1. Ignition “OFF”, engine “OFF” 2. Remove the fuel return line at pressure limiter. 3. Block off fuel return line. 4. Restart engine. Is a fuel leak present at the pressure limiter?	—	Replace common rail Go back to step 3	Go to step 11

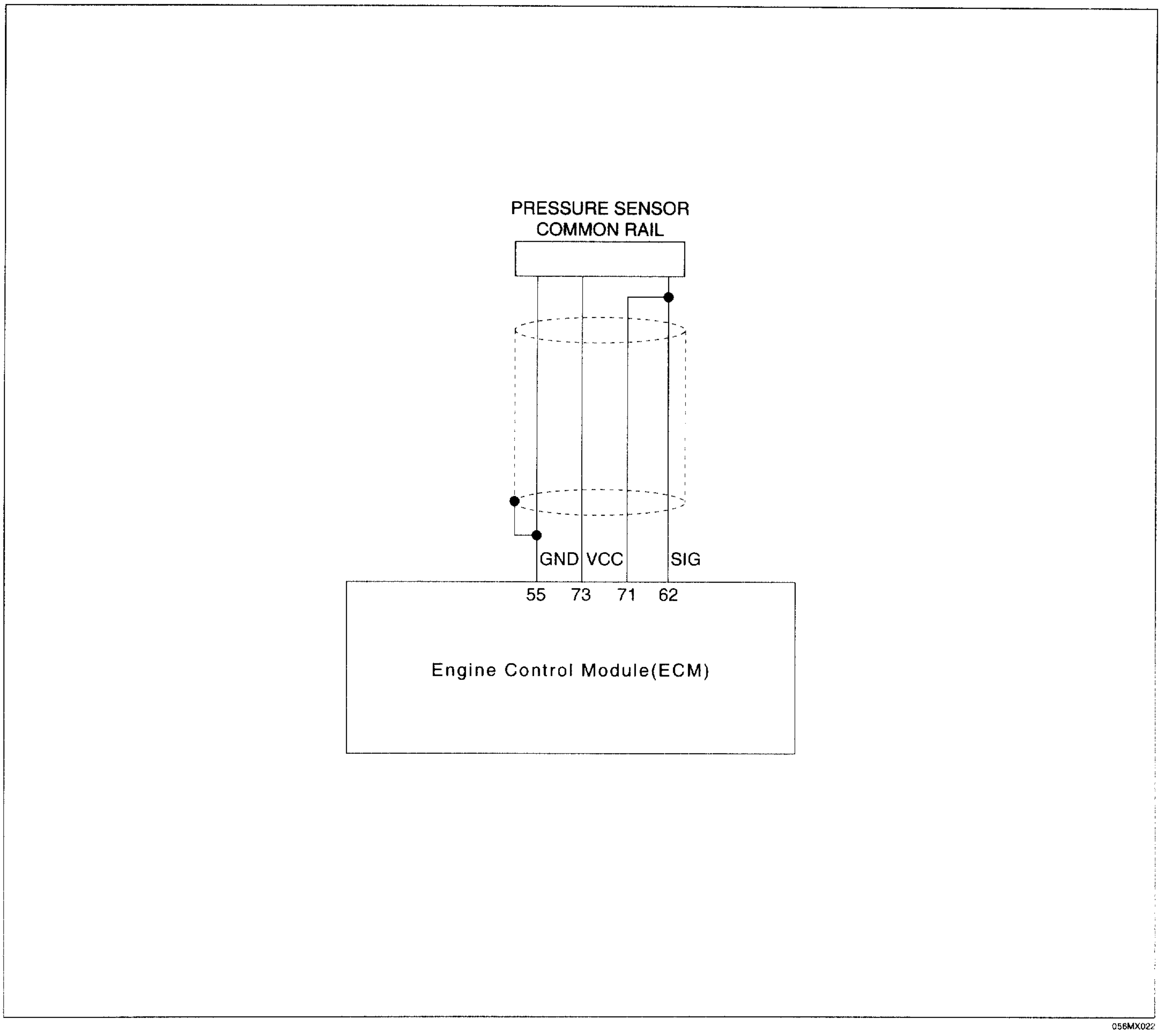
STEP	ACTION	VALUE	YES	NO
11	Is ECM properly grounded?	—	Replace ECM Go back to step 3	Replace ground Go back to step 3

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2.
Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

NOTE: This system operates at extremely high fuel pressure.
Take caution when loosening or removing fuel lines during service.
Intermittents can be caused by the following:

- **Air in the fuel system**
- **Fuel leaks**
- **Restricted fuel lines or filter**
- **Faults in wiring connector and harness**

DTC 0227 Supply Pump Non Pressure Supply



Circuit Description

The common rail pressure sensor, installed at left end of the common rail, is used to detect fuel pressure. It is a semiconductor type pressure sensor utilizing silicon's property that the electric resistance of pressurized silicone is varied.

Further, a special gasket is used at the connection part with the common rail body so as to seal high pressure fuel.

Conditions for Setting the DTC

- ISC target speed, common rail pressure not controlled.
- DTC 0245, 0217, 0218, 0247 and 0248 are not appear.
- CKP sensor normal condition.
- Pump normal mode, battery voltage is higher than 8V.
- Pump speed higher than 450 rpm.
- Water temperature higher than 60°C.
- DTC 0226 detected, common rail pressure higher than target pressure plus 5 MPa.
- PCV opening timing reaches the limit or feedback value –60CA.
- When above condition continues 255 times.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Fuel injection value lower than 60 mm^3/st.
- Common rail pressure lower than 25 MPa.
- Time required for running into backup is varied with the difference in common rail pressure against target pressure.

Conditions for Clearing the MIL/DTC

DTC 0227 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

DTC 0227 Supply Pump Non Pressure Supply

Check leakage injection line. When PC sensor output fixed at engine idling, does it occur? (DTC 0115)

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.
- Lack of power due to fuel leakage, fuel pressure and injection amount limited.
- Check Fuel Filter.

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display DTC 227 while Ignition "ON", or engine at idle?	—	Go to step 3	—
3	1. After warming up the engine (at 60°C or more), turn engine "OFF", clear the DTC. 2. Restart the engine and let idle for 60 seconds. Does the DTC reset?	—	Go to step 4	See Note on Intermittent
4	Check the fuel lines from supply pump to common rail for broken, loose, or restriction. Also check fuel filter for restriction. Was a problem found?	—	Repair or replace Go back to step 3	Go to step 5
5	Check the ECM and common rail fuel pressure sensor connectors, ECM ground, and wiring harness for looseness, bent terminals, or chafed wires. Was a problem found?	—	Repair or replace Go back to step 3	Go to step 6
6	1. Ignition"ON", engine "ON". 2. Record actual common rail fuel pressure at idle. Is the pressure lower than the specified value?	25 MPa	Go to step 7	See Note on Intermittent
7	Disconnect PCV#1 connector while engine is idling. Does engine shut down?	—	Replace supply pump. Go back to step 3	Go to step 8
8	1. Reconnect the PCV#1 connector. 2. Disconnect PCV#2 connector while engine is idling. Does engine shut down?	—	Replace supply pump. Go back to step 3	Go to step 9
9	1. Reconnect the PCV#2 connector. 2. Operate on acceleration pedal at 2,500 to 3,000 rpm on engine speed, and observe the actual common rail fuel pressure. Did the actual common rail fuel pressure have a pressure reading above the specified value?	120 MPa	Go to step 10	Replace common rail. Go back to step 3
10	1. Ignition "OFF", engine "OFF" 2. Remove the fuel return line at pressure limiter. 3. Block off fuel return line. 4. Restart engine. Is a fuel leak present at the pressure limiter?	—	Replace common rail Go back to step 3	Go to step 11

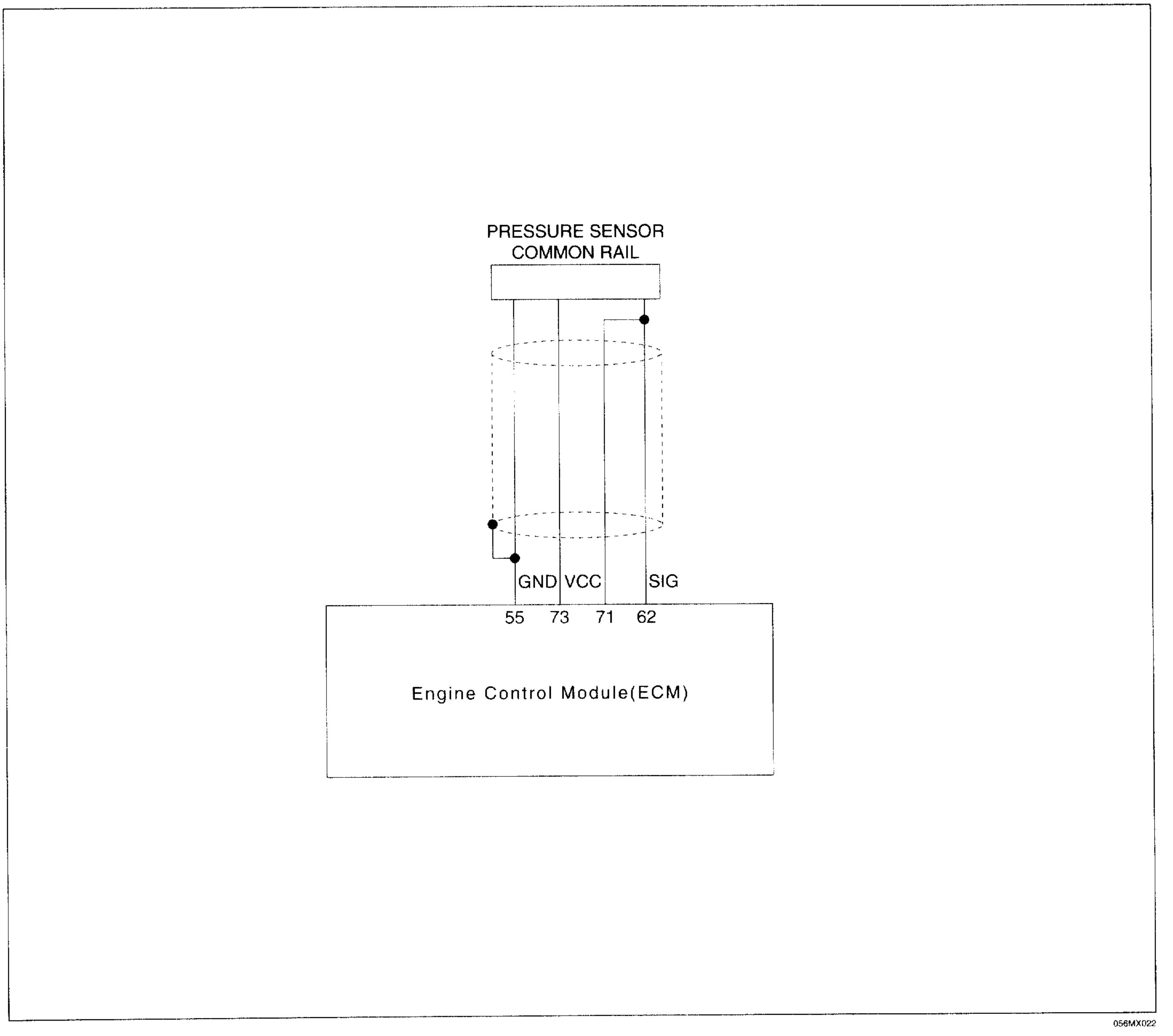
STEP	ACTION	VALUE	YES	NO
11	Is ECM properly grounded?	—	Replace ECM Go back to step 3	Replace ground Go back to step 3

***IMPORTANT:** The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.*

NOTE: **This system operates at extremely high fuel pressure.**
Take caution when loosening or removing fuel lines during service.
Intermittents can be caused by the following:

- **Air in the fuel system**
- **Fuel leaks**
- **Restricted fuel lines or filter**
- **Faults in wiring connector and harness**

DTC 0245 Abnormal Common Rail Pressure (PC sensor system)



Circuit Description

The common rail pressure sensor, installed at left end of the common rail, is used to the detect fuel pressure. It is a semiconductor type pressure sensor utilizing silicon's property that the electric resistance of pressurized silicone is varied.

Further, a special gasket is used at the connection part with the common rail body so as to seal high pressure fuel.

If the ECM detects a rail pressure signal voltage that is excessively low or high, Diagnostic Trouble Code 0245 will be set.

Conditions for Setting the DTC

- When sensor voltage is lower than 0.7V.
- When sensor voltage is over than 4.7V.
  (The pressure is 0 MPa = 0.93V · 160 MPa = 4.02V)

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Limits are set to common rail pressure open loop control, common rail pressure and injection amount.
- Common rail pressure; 60 MPa maximum Injection amount is limited for 50 mm^3/st.

Conditions for Clearing the MIL/DTC

DTC 0245 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

DTC 0245 Abnormal Common Rail Pressure (PC sensor system)

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 rail pressure display on the scan tool while moving connectors and wiring harnesses related to the rail pressure sensor. A change in the rail pressure display will indicate the location of the fault.

F1; ENGINE DATA 2

Engine Speed	610~620	RPM
Desired Idle Speed	614	RPM
APP Angle	0	%
ECT	176	°F
Fuel Temperature	113	°F
Actual Rail Pressure	25.0	Mpa
Desired Rail Pressure	25.0	Mpa
Main Injection Timing	–1.5	°
Basic Fuel Rate	1.1	mm^3
Final Fuel Rate	5.0	mm^3
PCV Close Intrerval	178	°
Battery Voltage	14.5	Volts
Exhaust Brake Switch		OFF
Engine Stop Switch		OFF
Diagnostic Switch		OFF
Clutch Switch		OFF
Starter Switch		OFF

Select Items | DTC | Quick Snapshot | More

060MY00054

- No powerfulness felt.
- Hard to start on a steep slope.
- Hard to get maximum speed on the flat road.

DTC 0245 Abnormal Common Rail Pressure (PC sensor system)

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	When key switch on, does DTC 0245 display?	—	Go to step 3	—
3	Measure voltage between pin number 62 and 71 (PFUEL) and pin number 55 (PFUEL – GND) at ECM side (Measuring method 1) Is voltage within specified value? (The voltage is about 1.4V more or less at idling with pressure 25 MPa)	0.7V to 4.7V	Go to step 4	Go to step 5
4	Clear all DTCs. Is DTC 0045 display?	—	Go to step 5	System OK
5	1. Key switch "ON". 2. Measure voltage between pin number 73 (PFUEL – VCC) and pin number 55 (PFUEL – GND) (Measuring method 1) Is voltage within value?	4.75V to 5.25V	Go to step 9	Go to step 6
6	1. Key switch "ON". 2. Disconnect harness connector from ECM. 3. Measure resistance as below. • Between pin number 73 (PFUEL – VCC) of ECM side and pin number 1 sensor side on PC sensor harness. (Measuring method 2) • Between pin number 55 (PFUEL – GND) ECM side and pin number 3 sensor side on PC sensor harness. (Measuring method 2) Is resistance within value?	2Ω or less	Go to step 7	Repair or replace the PC sensor harness then Go to step 15
7	Measure resistance as below. • Between pin number 73 (PFUEL – VCC) and GND on the PC sensor harness. • Between pin number 55 (PFUEL – GND) and GND on the PC sensor harness. (Measuring method 3) Is resistance within value?	10MΩ or more	Go to step 8	Repair or replace PC sensor harness then Go to step 15
8	1. Reconnect harness connector to ECM. 2. Measure the voltage between pin number 1 and pin number 3 at sensor side on the PC sensor harness. (Measuring method 4) Is voltage within value?	5 ± 1V	Replace ECM assembly then Go to step 15	Check, Repair harness and/or connector for poor connections then Go to step 15
9	1. Key switch "OFF". 2. Disconnect PC sensor harness connector from ECM. 3. Measure resistance as below. • Between pin number 62 (PFUEL – VCC) of ECM side and pin number 2 sensor side on PC sensor harness. (Measuring method 2) • Between pin number 71 (PFUEL) of ECM side and pin number 2 sensor side on PC sensor harness. (Measuring method 2) • Between pin number 55 (PFUEL – GND) of ECM side and pin number 3 sensor side on PC sensor harness. (Measuring method 2) Is resistance within value?	2Ω or less	Go to step 10	Repair/ or replace the PC sensor harness then go to step 16

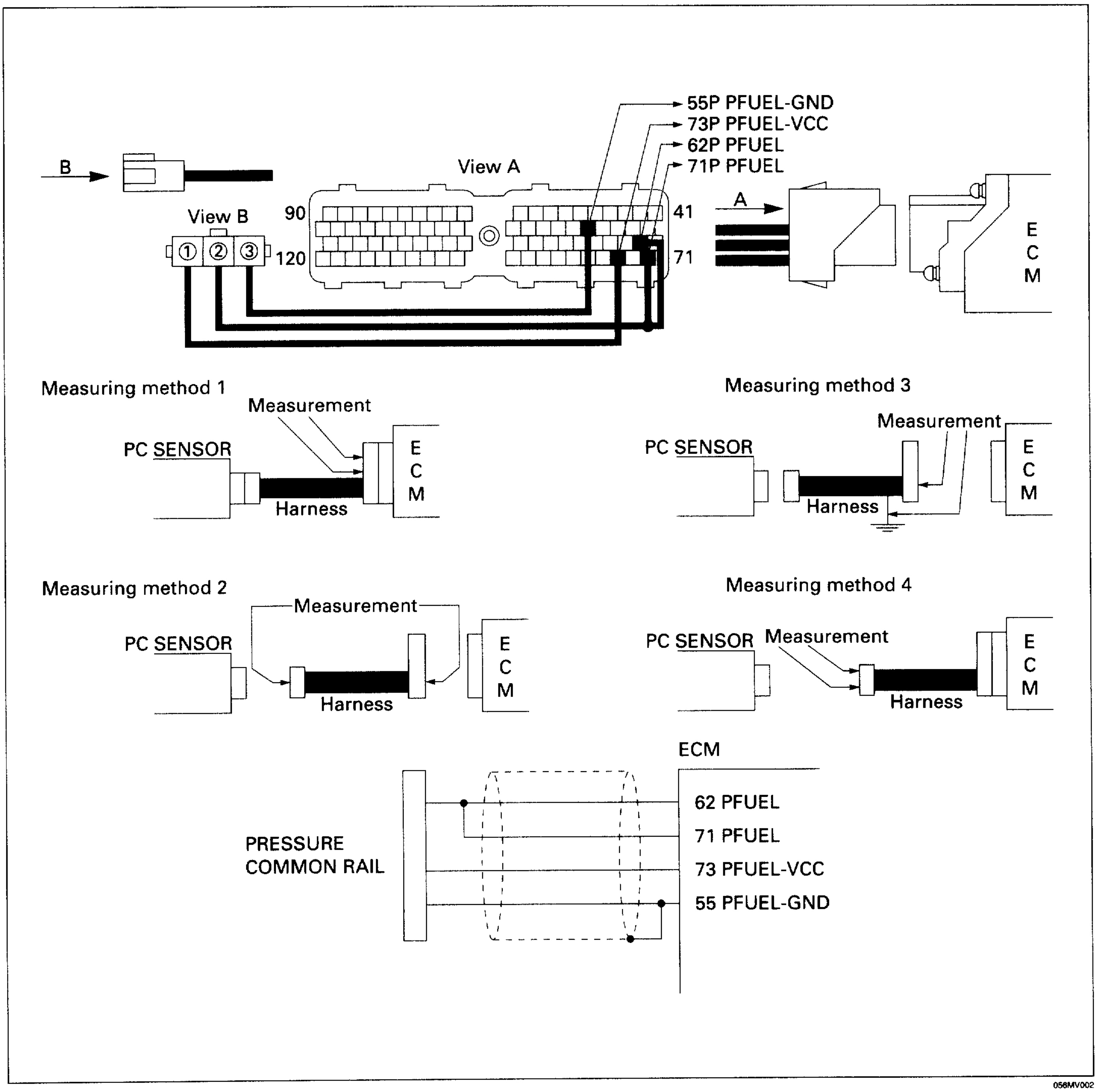
***IMPORTANT:** The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.*

DTC 0245 Abnormal Common Rail Pressure (PC sensor system)

STEP	ACTION	VALUE	YES	NO
10	Measure the resistance between pin number 71 (PFUEL) and GND. Is resistance within value?	10MΩ or more	Go to step 11	Repair or replace PC sensor harness then Go to step 13
11	1. Reconnect both ECM and PC sensor connector to PC sensor harness connector. 2. Observe PC sensor output waveform using oscilloscope. 3. Check for floating PC sensor output waveform by noise etc. Is result OK?	—	Go to step 13	Go to step 12
12	Clear DTCs and recheck DTC. Is DTC 0245 displayed?	—	Replace PC sensor then Go to step 15	Go to step 13
13	Check PC sensor harness connector for a poor connection? Was there a problem?	—	Make complete contact then Go to step 14	System OK
14	Clear all DTCs. Is DTC 0245 displayed?	—	Replace ECM assembly then Go to step 15	System OK
15	Clear all DTCs. Is DTC 0245 displayed?	—	Go back to step 3	System OK
	Note: Sometimes DTCs 0261 through DTC 0266 will set when PC sensor fails.			

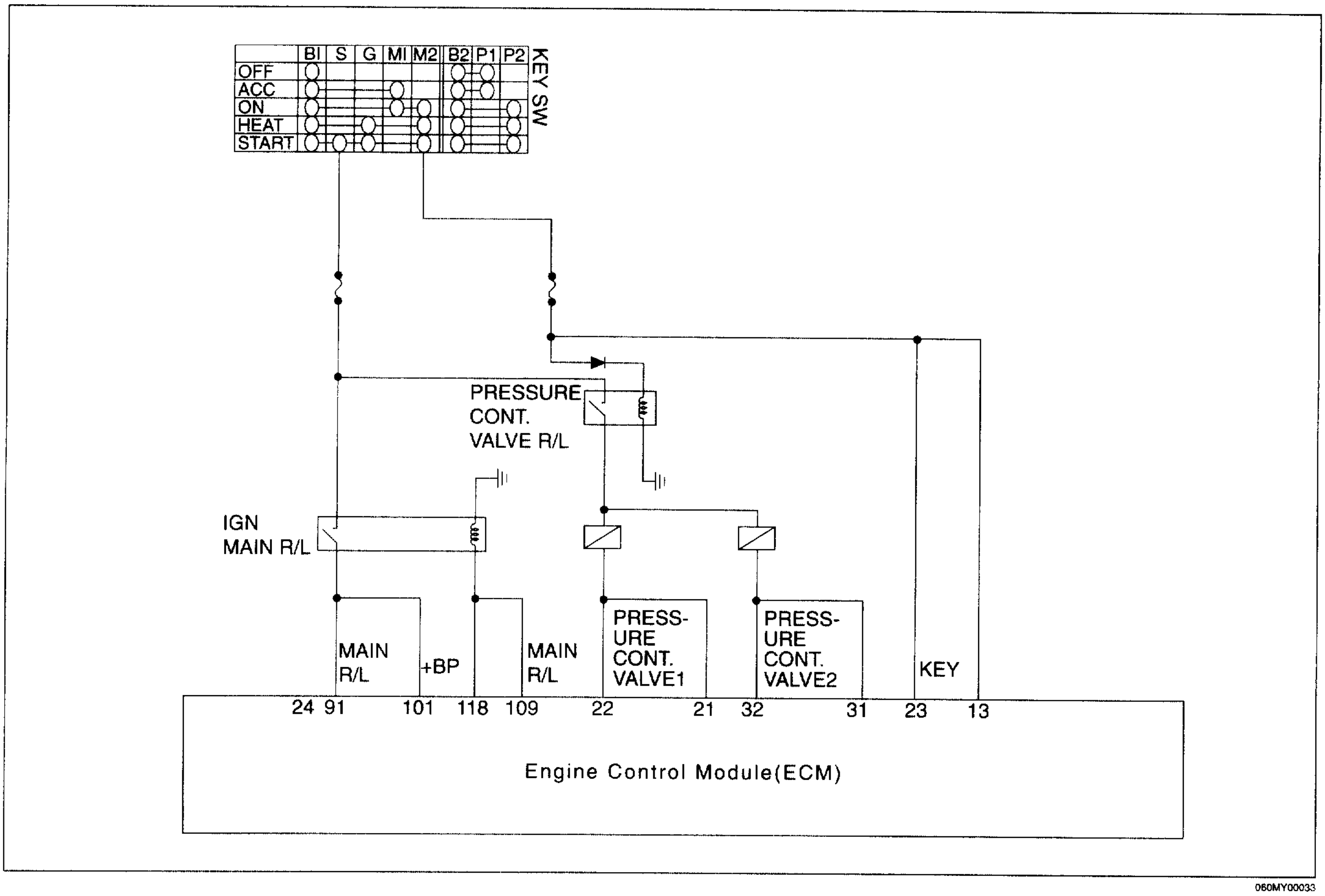
IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Abnormal Common Rail Pressure



056MV002

DTC 0247 PCV1 (Coil or Harness) Disconnect or GND Shorted



Circuit Description

The PCV is used to adjust supply pump discharge amount so as to adjust common rail pressure. Discharge amount from the supply pump to the common rail is determined by PCV current timing.

If the ECM detects a PCV1 signal voltage that is excessively high, Diagnostic Trouble Code 0247 will be set.

Conditions for Setting the DTC

- Abnormally low driving voltage with PCV off, pump normal mode, battery voltage higher than 10V and no CKP sensor faults with key switch ON.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Common rail pressure is limited to 60 MPa or less.

Conditions for Clearing the MIL/DTC

DTC 0247 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

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 PCV display on the scan tool while moving connectors and wiring harnesses related to the PCV sensor. A change in the PCV sensor display will indicate the location of the fault.

DTC 0247 PCV1 (Coil or Harness) Disconnect or GND Shorted

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does DTC 0247 display while key switch "ON" or engine is running?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect PCV harness connector from ECM. 3. Key switch "ON". 4. Measure voltage at the ECM side of the PCV harness at the following points. (Measuring method 4) • Between pin number 21, 22 for PCV1 and pin number 82 (P–GND). Is voltage within value?	10V to 14V	Go to step 9	Go to step 4
4	If DTC 0421 is also present, inspect voltage before measuring the resistance. 1. Key switch "OFF". 2. Disconnect PCV connector. 3. Measure resistance at the following points. (Measuring method 2). • Between pin number 21, 22 for PCV1 and pin number 82 (P–GND). Is resistance within value?	10MΩ or more	Go to step 6	Repair PCV harness Go to step 5
5	1. Key switch "OFF". 2. Disconnect PCV harness from PCV 1, 2, PCV relay and ECM. 3. Measure resistance from pin number 1 at PCV relay side of PCV harness and pin number 82 (P–GND) at ECM. (Measuring method 5) Is resistance within value?	Less than 10MΩ	Repair/replace PCV harness. Then go to step 13	Go to step 6
6	Measure resistance on PCV harness as following points. (Measuring method 3) • Between pin number 21, 22 for PCV1 and pin number 2. Is resistance within value?	2Ω or less	Go to step 7	Repair PCV harness. Then go to step 13
7	1. Key switch "OFF". 2. Disconnect PCV harness from PCV 1, 2, PCV relay and ECM. 3. Measure resistance from pin number 1 at PCV relay side of PCV harness and pin number 82 (P–GND) at ECM. (Measuring method 5) Is resistance within value?	More than 10MΩ	Go to step 8	Go to step 13
8	1. Key switch "OFF". 2. Disconnect PCV harness from PCV 1, 2, PCV relay and ECM. 3. Measure resistance following points. • Between pin number 1 at PCV 1 side of PCV harness and pin number 1 at PCV relay of PCV harness. (Measuring method 6) Is resistance within value?	Less than 2Ω	Go to step 9	Repair/replace PCV harness. Then go to step 13

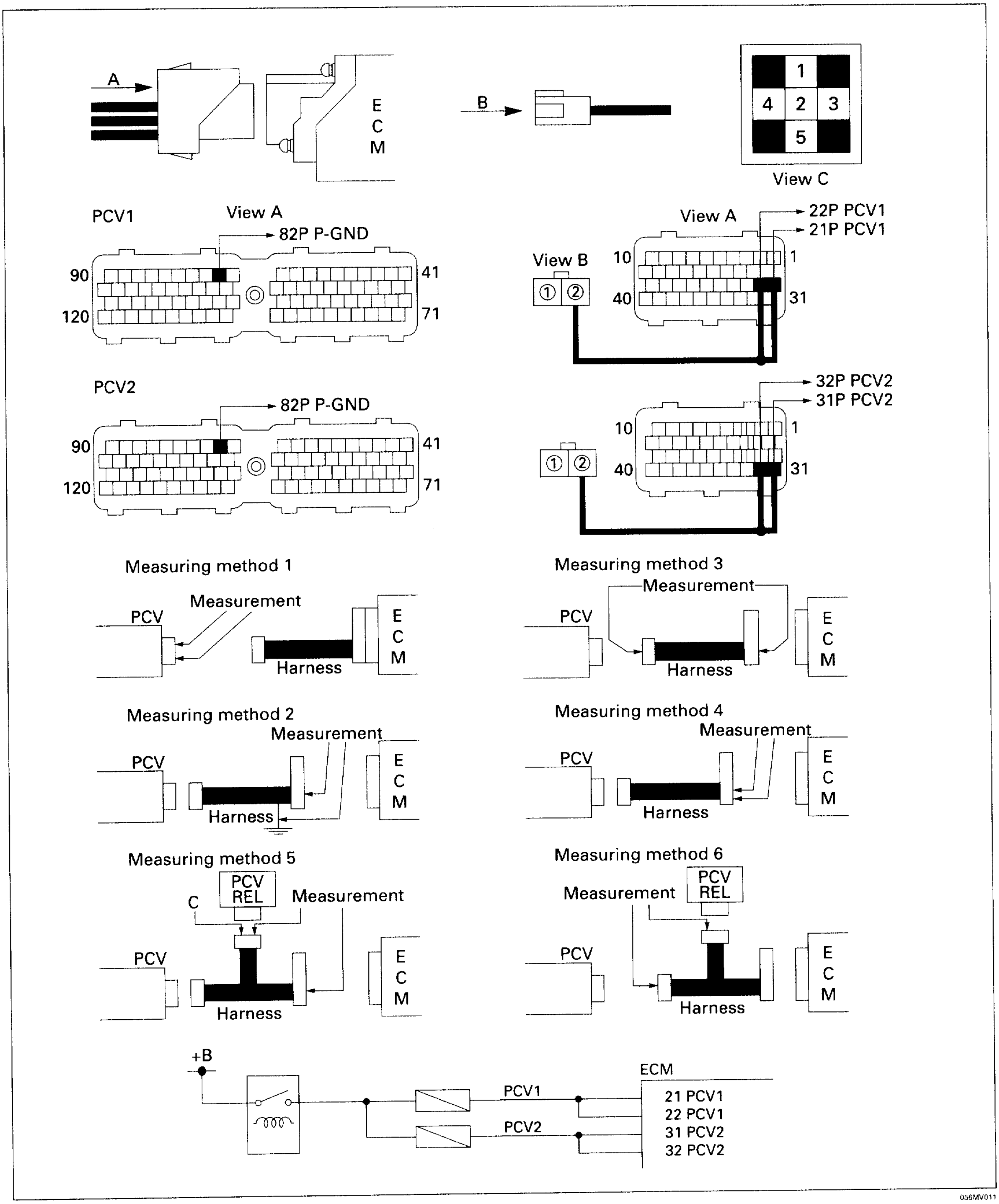
DTC 0247 PCV1 (Coil or Harness) Disconnect or GND Shorted

STEP	ACTION	VALUE	YES	NO
9	Measure PCV coil resistance. (Measuring method 1) Is resistance within value?	0.9Ω to 1.3Ω	Go to step 10	Replace PCV and/or supply pump. Then go to step 13
10	1. Key switch "ON". 2. Measure voltage at the following points. (Measuring method 2) • Between pin number 1 for PCV1 and GND. Is voltage within value?	10V to 14V	Go to step 12	Repair wire harness in between power supply and relay. Then go to step 13
11	Inspect for poor connection at the connector on PCV harness. Was a problem found?	—	Repair it. Go to step 13	System OK
12	Clear all DTCs. Does DTC 0247 display?	—	Replace ECM assembly. Go to step 13	System OK
13	Clear DTCs. Does DTC 0247 display?	—	Go back to step 3	System OK

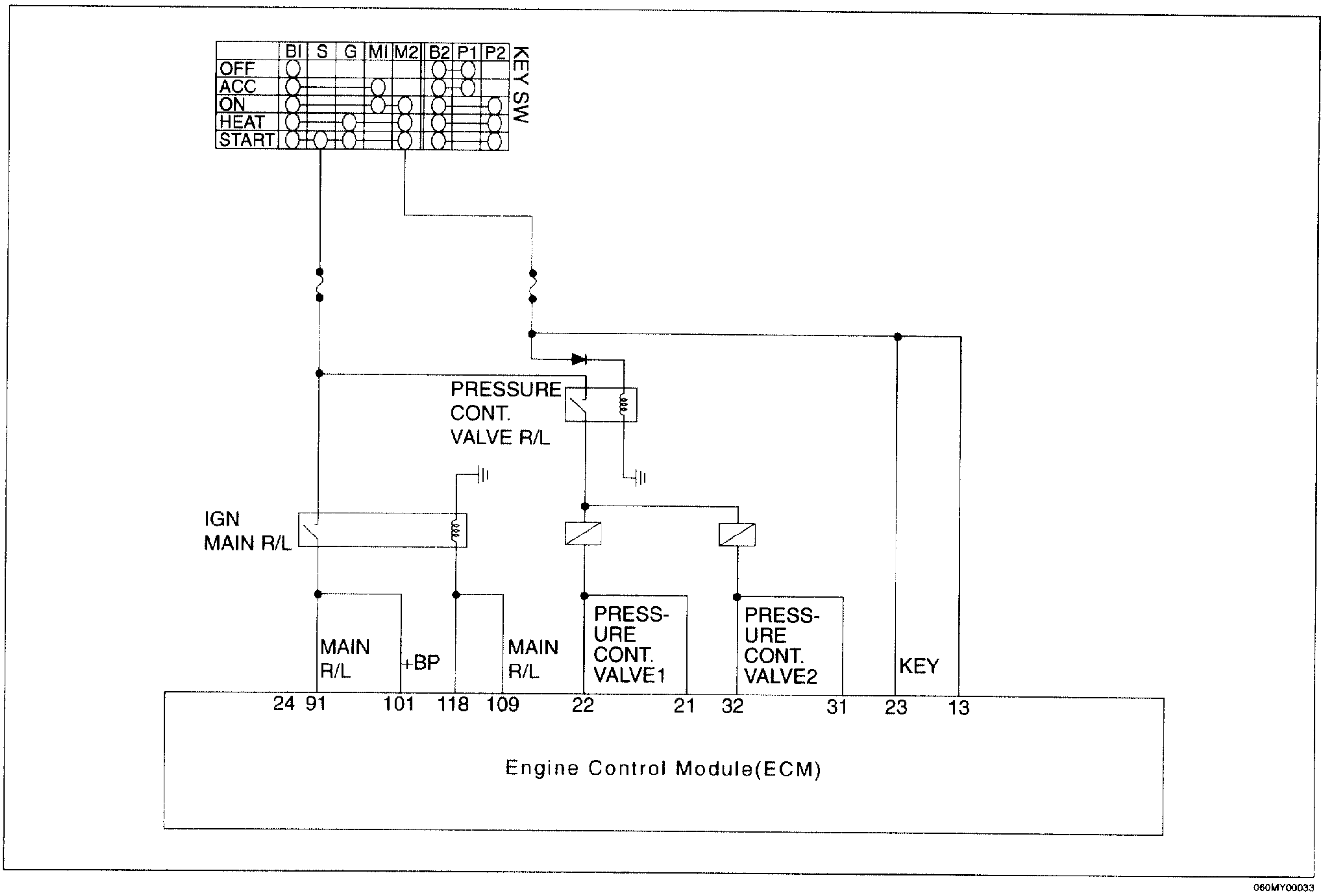
IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

NOTE: If PCV1 and PCV2 connectors are switched, engine will not start.

PCV1, 2 (Coil or Harness) Disconnect or GND Shorted



DTC 0248 PCV2 (Coil or Harness) Disconnect or GND Shorted



Circuit Description

The PCV is used to adjust supply pump discharge amount so as to adjust common rail pressure. Discharge amount from the supply pump to the common rail is determined by PCV current timing.

If the ECM detects a PCV2 signal voltage that is excessively high, Diagnostic Trouble Code 0248 will be set.

Conditions for Setting the DTC

- Abnormally low driving voltage with PCV off, pump normal mode, battery voltage higher than 10V and no CKP sensor faults with key switch ON.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Common rail pressure is limited to 60 MPa or less.

Conditions for Clearing the MIL/DTC

DTC 0248 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

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 PCV display on the scan tool while moving connectors and wiring harnesses related to the PCV sensor. A change in the PCV sensor display will indicate the location of the fault.

DTC 0248 PCV2 (Coil or Harness) Disconnect or GND Shorted

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does DTC 0248 display while key switch "ON" or engine is running?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect PCV harness connector from ECM. 3. Key switch "ON". 4. Measure voltage at the ECM side of the PCV harness at the following points. (Measuring method 4) • Between pin number 31, 32 for PCV2 and pin number 82 (P–GND). Is voltage within value?	10V to 14V	Go to step 9	Go to step 4
4	If DTC 421 is also present, inspect voltage before measuring the resistance. 1. Key switch "OFF". 2. Disconnect PCV connector. 3. Measure resistance at the following points. (Measuring method 2). • Between pin number 31, 32 for PCV2 and pin number 82 (P–GND). Is resistance within value?	10MΩ or more	Go to step 6	Repair PCV harness Go to step 5
5	1. Key switch "OFF". 2. Disconnect PCV harness from PCV 1, 2, PCV relay and ECM. 3. Measure resistance from pin number 1 at PCV relay side of PCV harness and pin number 82 (P–GND) at ECM. (Measuring method 5) Is resistance within value?	Less than 10MΩ	Repair/replace PCV harness. Then go to step 13	Go to step 6
6	Measure resistance on PCV harness as following points. (Measuring method 3) • Between pin number 31, 32 for PCV2 and pin number 2. Is resistance within value?	2Ω or less	Go to step 7	Repair PCV harness. Then go to step 13
7	1. Key switch "OFF". 2. Disconnect PCV harness from PCV 1, 2, PCV relay and ECM. 3. Measure resistance from pin number 1 at PCV relay side of PCV harness and pin number 82 (P–GND) at ECM side of PCV harness. (Measuring method 5) Is resistance within value?	More than 10MΩ	Go to step 7	Go to step 13
8	1. Key switch "OFF". 2. Disconnect PCV harness from PCV 1, 2, PCV relay and ECM. 3. Measure resistance following points. • Between pin number 1 at PCV 2 side of PCV harness and pin number 1 at PCV relay of PCV harness. (Measuring method 6) Is resistance within value?	Less than 2Ω	Go to step 8	Repair/replace PCV harness. Then go to step 13

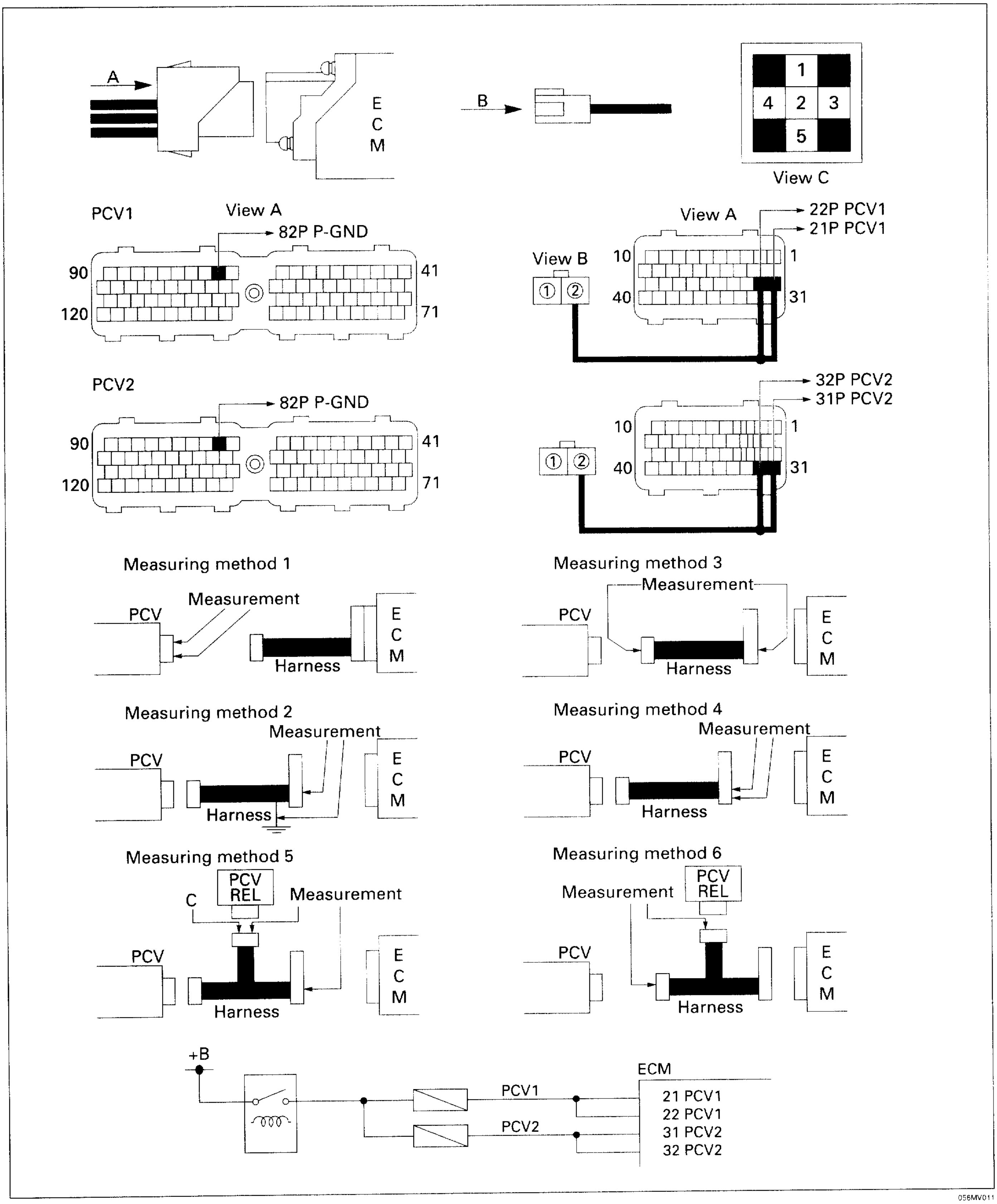
DTC 0248 PCV2 (Coil or Harness) Disconnect or GND Shorted

STEP	ACTION	VALUE	YES	NO
9	Measure PCV coil resistance. (Measuring method 1) Is resistance within value?	0.9Ω to 1.3Ω	Go to step 10	Replace PCV and/or supply pump. Then go to step 13
10	1. Key switch "ON". 2. Measure voltage at the following points. (Measuring method 2) • Between pin number 1 for PCV2 and GND. Is voltage within value?	10V to 14V —	Go to step 12	Repair wire harness in between power supply and relay. Then go to step 13
11	Inspect for poor connection at the connector on PCV harness. Was a problem found?	—	Repair it. Go to step 13	System OK
12	Clear all DTCs. Does DTC 0248 display?		Replace ECM assembly. Go to step 13	System OK
13	Clear all DTCs. Does DTC 0248 display?	—	Go back to step 3	System OK

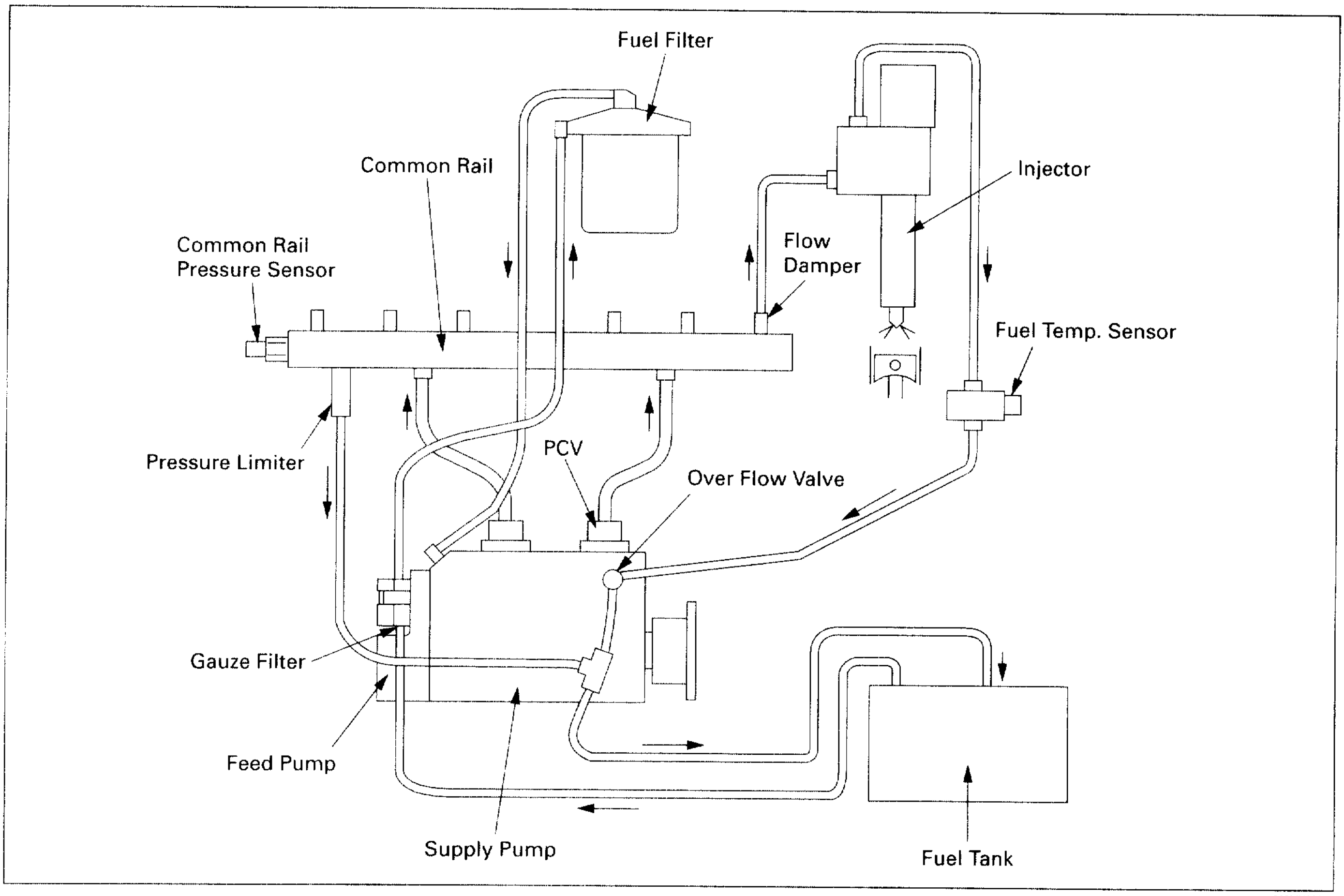
IMPORTANT:* *The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

NOTE: If PCV1 and PCV2 connectors are switched, engine will not starts.

PCV1, 2 (Coil or Harness) Disconnect or GND Shorted



DTC 0261 (Cylinder No. 1) Flow Damper Activated



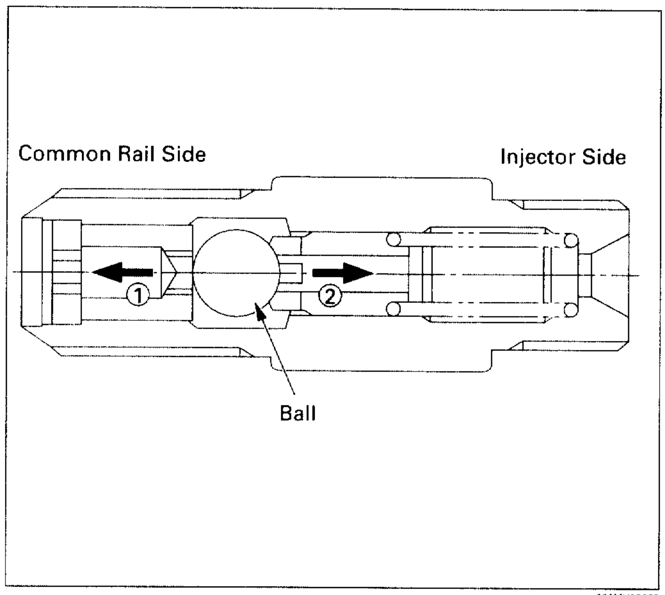
Operation Description

The flow damper comprises a piston, ball, spring seat, and spring.

The flow damper is used to damp the pressure pulsating in the common rail and the injection pipe.

During driving the flow of fuel makes the piston, ball, and spring seat move a little to the injector side and float.

Should too much fuel pass the flow damper, the ball moves further toward the injector until the ball comes into contact with the seat surface of the flow damper unit, thereby shutting the fuel passages.



① Common Rail Side < Fuel Pressure < Injector Side
② Common Rail Side > Fuel Pressure > Injector Side

DTC 0261 (Cylinder No. 1) Flow Damper Activated

Conditions for Setting the DTC

Cylinder No. 1

- No DTC 0271, DTC 0158 and DTC 0159.
- ECT higher than 60°C.
- Correction of uneven injection amount exceeding 4 mm^3/st and continues for 20 times.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Cylinder injection stops

Conditions for Clearing the MIL/DTC

DTC 0261 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

Diagnostic Aids

Check for the following conditions:

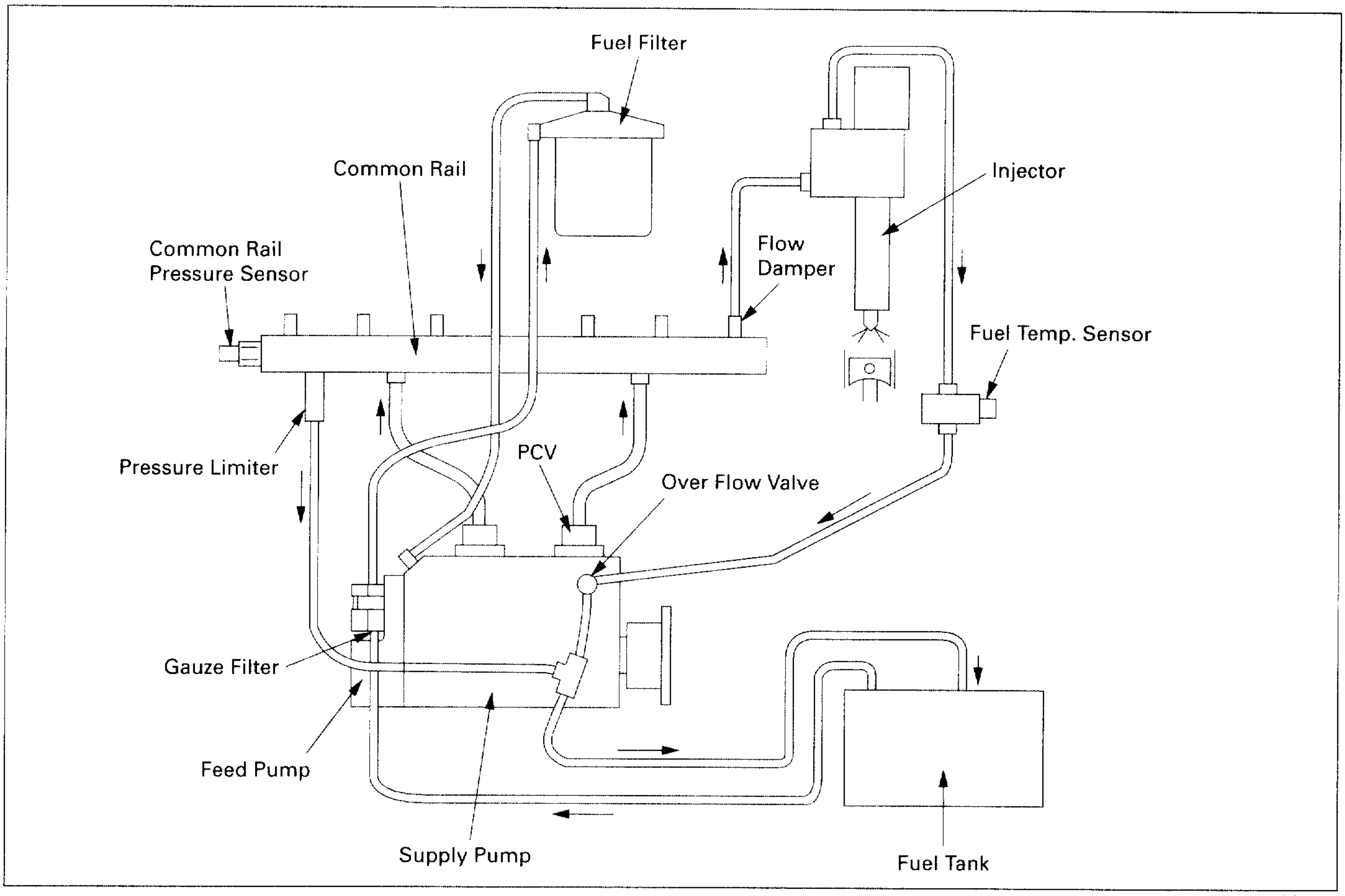
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Check Fuel Filter.

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display DTC 261 while Ignition "ON", or engine at idle?	—	Go to step 3	—
3	1. After warming up engine (at 60°C or more), turn engine "OFF", clear DTC. 2. Restart the engine and let idle for 60 seconds Does the DTC reset?		Go to step 4	See Note on Intermittent
4	Perform Tech2 cylinder power balance test to confirm cylinder #1 is misfiring? Is the action completed?	—	Go to step 5	Go to step 4
5	Ignition "OFF", engine "OFF" and listen for flow damper to reset ("click" sound). This may take 120 seconds. Was "click" sound heard?	—	Go to step 6	Go to step 7
6	Check for fuel leak in line between flow damper and fuel injector. Was fuel leak found?	—	Repair or replace Go back to step 3	Go to step 7
7	Replace #1 injector with known good injector. Does #1 injector misfire?	—	Go to step 9	Replace injector Go back to step 3
8	Check for restriction in fuel line between flow damper and injector. Was restriction found:	— —	Repair or replace Go back to step 3	Go to step 7
9	1. Replace common rail assembly. 2. Clear the DTC and start engine. Does scan tool display any DTC codes?		Go to step 2	System OK

NOTE: Use scan tool Common rail pressure control to check for fuel leakage, etc.
Sometimes DTC 261 will be displayed due to engine hunting when the PC sensor fails.
Intermittents codes are activated by:

- **Clutch shudder**
- **Clutch shock Disengagement**

DTC 0262 (Cylinder No. 2) Flow Damper Activated



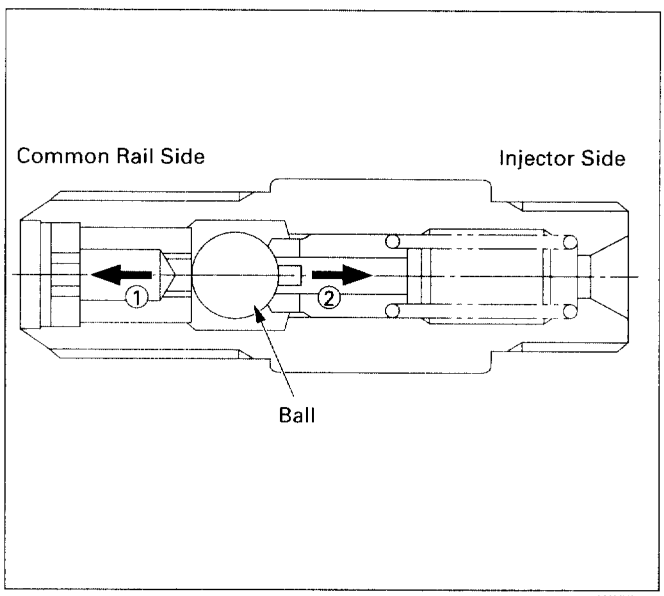
Operation Description

The flow damper comprises a piston, ball, spring seat, and spring.

The flow damper is used to damp the pressure pulsating in the common rail and the injection pipe.

During driving the flow of fuel makes the piston, ball, and spring seat move a little to the injector side and float.

Should too much fuel pass the flow damper, the ball moves further toward the injector until the ball comes into contact with the seat surface of the flow damper unit, thereby shutting the fuel passages.



① Common Rail Side < Fuel Pressure < Injector Side
② Common Rail Side > Fuel Pressure > Injector Side

DTC 0262 (Cylinder No. 2) Flow Damper Activated

Conditions for Setting the DTC

Cylinder No. 2

- No DTC 0271, DTC 0158 and DTC 0159.
- ECT higher than 60°C.
- Correction of uneven injection amount exceeding 4 mm^3/st and continues for 20 times.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Cylinder injection stops

Conditions for Clearing the MIL/DTC

DTC 0262 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

Diagnostic Aids

Check for the following conditions:

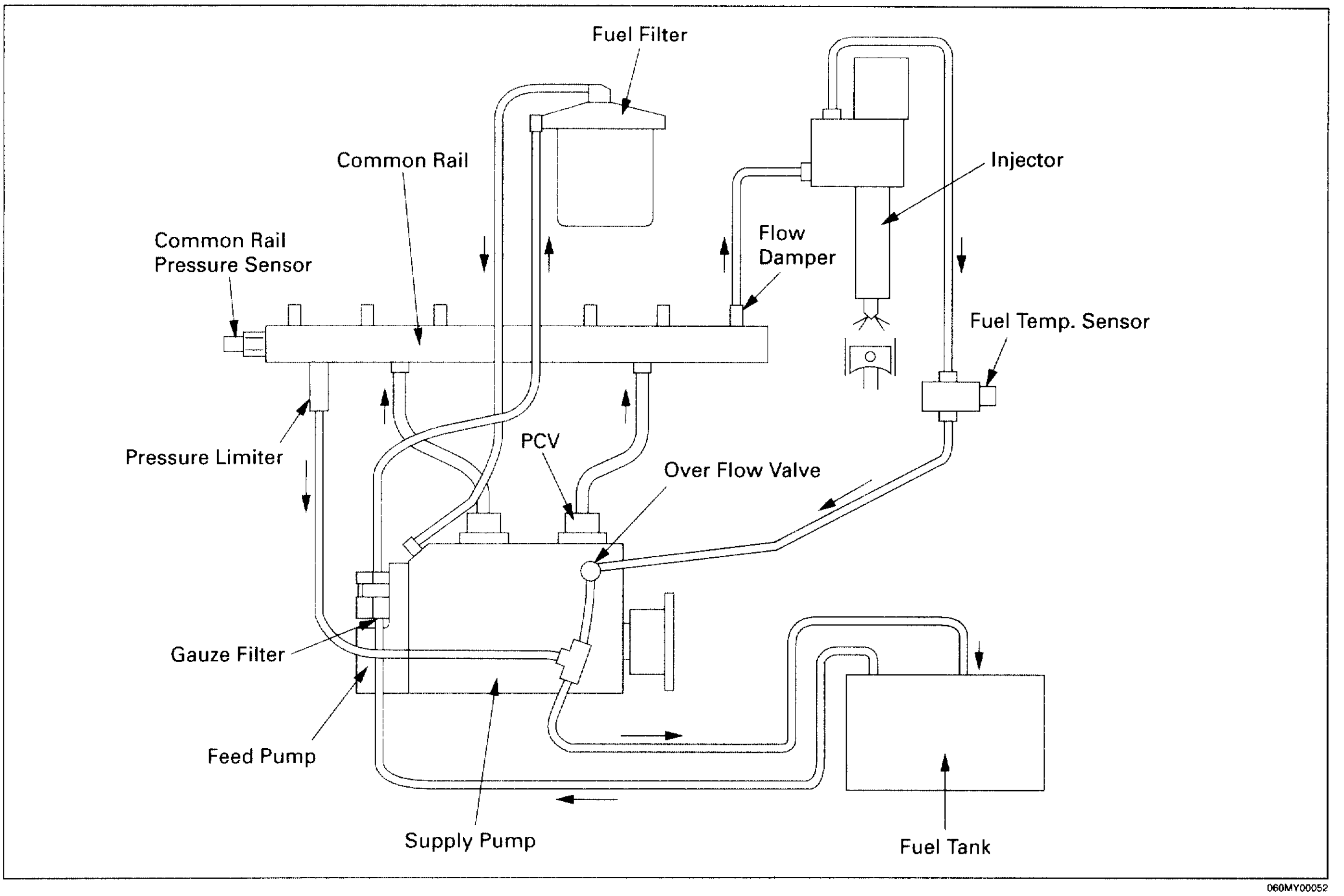
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Check Fuel Filter.

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display DTC 262 while Ignition "ON", or engine at idle?	—	Go to step 3	—
3	1. After warming up engine (at 60°C or more), turn engine "OFF", clear DTC. 2. Restart the engine and let idle for 60 seconds Does the DTC reset?		Go to step 4	See Note on Intermittent
4	Perform Tech2 cylinder power balance test to confirm cylinder #2 is misfiring? Is the action completed?	—	Go to step 5	Go to step 4
5	Ignition "OFF", engine "OFF" and listen for flow damper to reset ("click" sound). This may take 120 seconds. Was "click" sound heard?	—	Go to step 6	Go to step 7
6	Check for fuel leak in line between flow damper and fuel injector. Was fuel leak found?	—	Repair or replace Go back to step 3	Go to step 7
7	Replace #2 injector with known good injector. Does #2 injector misfire?	—	Go to step 9	Replace injector Go back to step 3
8	Check for restriction in fuel line between flow damper and injector. Was restriction found:	— —	Repair or replace Go back to step 3	Go to step 7
9	1. Replace common rail assembly. 2. Clear the DTC and start engine. Does scan tool display any DTC codes?		Go to step 2	System OK

NOTE: Use scan tool Common rail pressure control to check for fuel leakage, etc.
Sometimes DTC 262 will be displayed due to engine hunting when the PC sensor fails.
Intermittents codes are activated by:

- **Clutch shudder**
- **Clutch shock Disengagement**

DTC 0263 (Cylinder No. 3) Flow Damper Activated



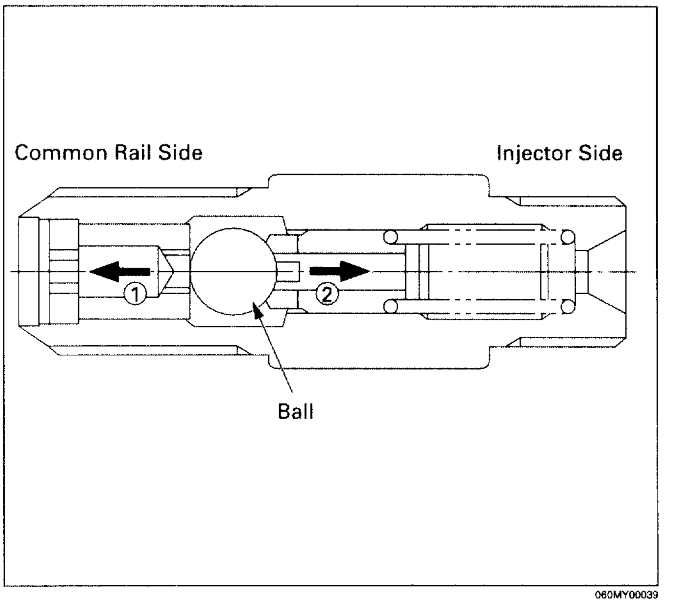
Operation Description

The flow damper comprises a piston, ball, spring seat, and spring.

The flow damper is used to damp the pressure pulsating in the common rail and the injection pipe.

During driving the flow of fuel makes the piston, ball, and spring seat move a little to the injector side and float.

Should too much fuel pass the flow damper, the ball moves further toward the injector until the ball comes into contact with the seat surface of the flow damper unit, thereby shutting the fuel passages.



① Common Rail Side < Fuel Pressure < Injector Side
② Common Rail Side > Fuel Pressure > Injector Side

DTC 0263 (Cylinder No. 3) Flow Damper Activated

Conditions for Setting the DTC

Cylinder No. 3

- No DTC 0271, DTC 0158 and DTC 0159.
- ECT higher than 60°C.
- Correction of uneven injection amount exceeding 4 mm^3/st and continues for 20 times.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Cylinder injection stops

Conditions for Clearing the MIL/DTC

DTC 0263 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

Diagnostic Aids

Check for the following conditions:

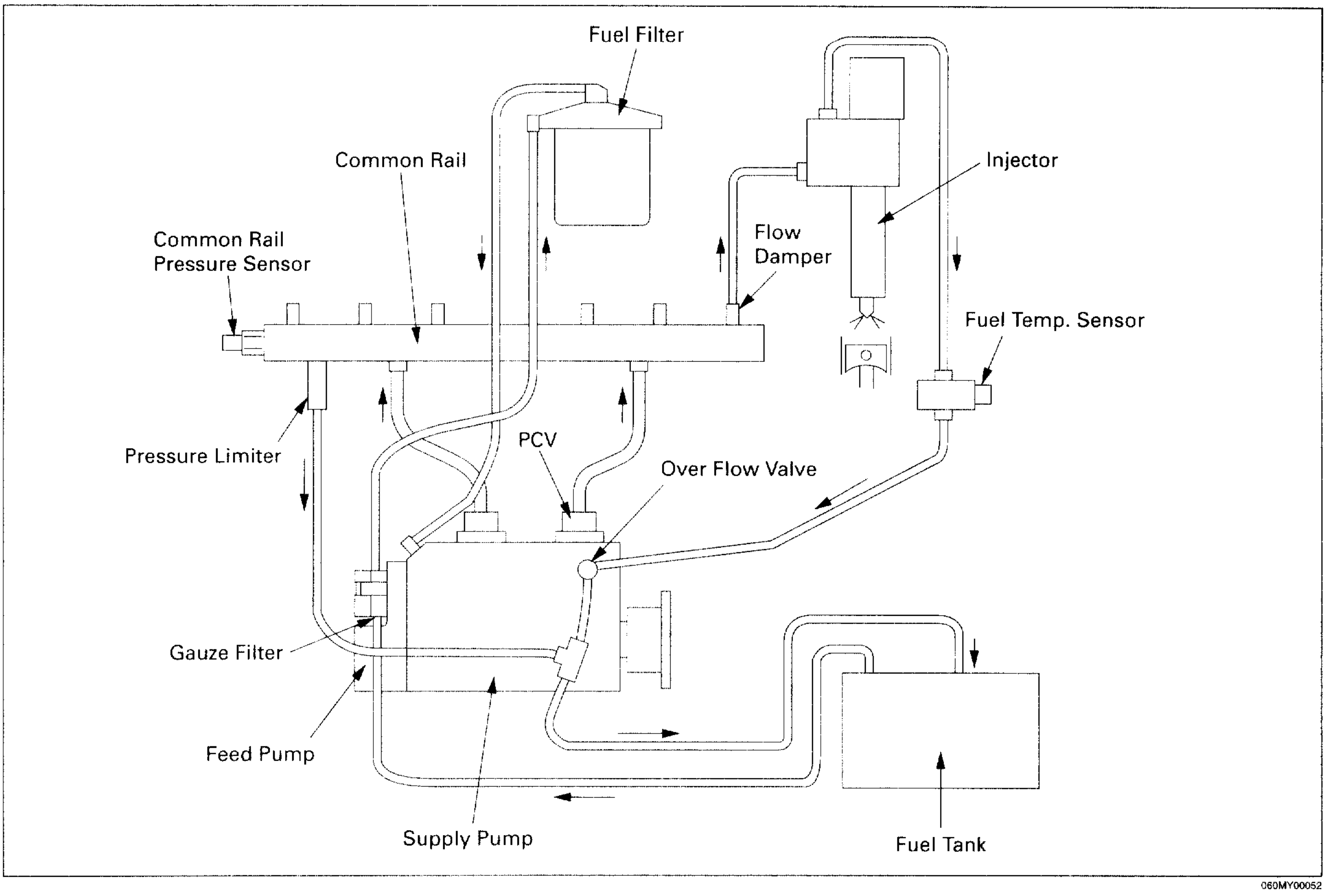
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Check Fuel Filter.

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display DTC 263 while Ignition "ON", or engine at idle?	—	Go to step 3	—
3	1. After warming up engine (at 60°C or more), turn engine "OFF", clear DTC. 2. Restart the engine and let idle for 60 seconds Does the DTC reset?		Go to step 4	See Note on Intermittent
4	Perform Tech2 cylinder power balance test to confirm cylinder #3 is misfiring? Is the action completed?	—	Go to step 5	Go to step 4
5	Ignition "OFF", engine "OFF" and listen for flow damper to reset ("click" sound). This may take 120 seconds. Was "click" sound heard?	—	Go to step 6	Go to step 7
6	Check for fuel leak in line between flow damper and fuel injector. Was fuel leak found?	—	Repair or replace Go back to step 3	Go to step 7
7	Replace #3 injector with known good injector. Does #3 injector misfire?	—	Go to step 9	Replace injector Go back to step 3
8	Check for restriction in fuel line between flow damper and injector. Was restriction found:	— —	Repair or replace Go back to step 3	Go to step 7
9	1. Replace common rail assembly. 2. Clear the DTC and start engine. Does scan tool display any DTC codes?		Go to step 2	System OK

NOTE: Use scan tool Common rail pressure control to check for fuel leakage, etc.
Sometimes DTC 263 will be displayed due to engine hunting when the PC sensor fails.
Intermittents codes are activated by:

- **Clutch shudder**
- **Clutch shock Disengagement**

DTC 0264 (Cylinder No. 4) Flow Damper Activated



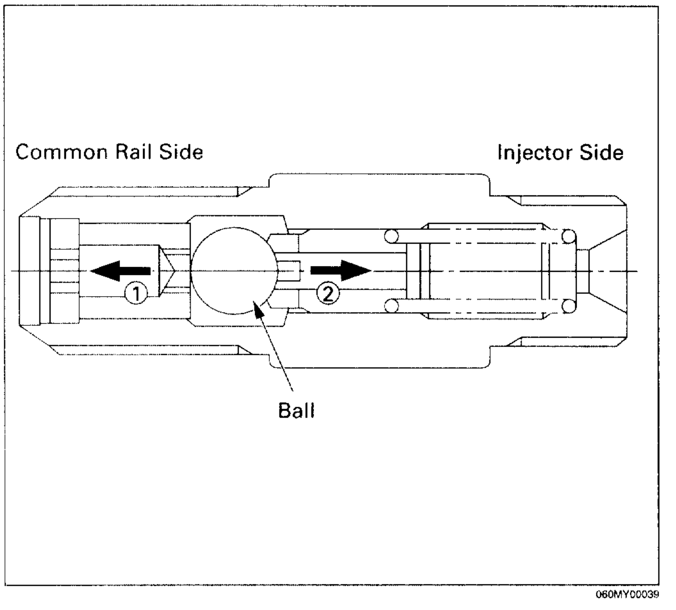
Operation Description

The flow damper comprises a piston, ball, spring seat, and spring.

The flow damper is used to damp the pressure pulsating in the common rail and the injection pipe.

During driving the flow of fuel makes the piston, ball, and spring seat move a little to the injector side and float.

Should too much fuel pass the flow damper, the ball moves further toward the injector until the ball comes into contact with the seat surface of the flow damper unit, thereby shutting the fuel passages.



① Common Rail Side < Fuel Pressure < Injector Side

② Common Rail Side > Fuel Pressure > Injector Side

DTC 0264 (Cylinder No. 4) Flow Damper Activated

Conditions for Setting the DTC

Cylinder No. 4

- No DTC 0271, DTC 0158 and DTC 0159.
- ECT higher than 60°C.
- Correction of uneven injection amount exceeding 4 mm^3/st and continues for 20 times.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Cylinder injection stops

Conditions for Clearing the MIL/DTC

DTC 0264 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

Diagnostic Aids

Check for the following conditions:

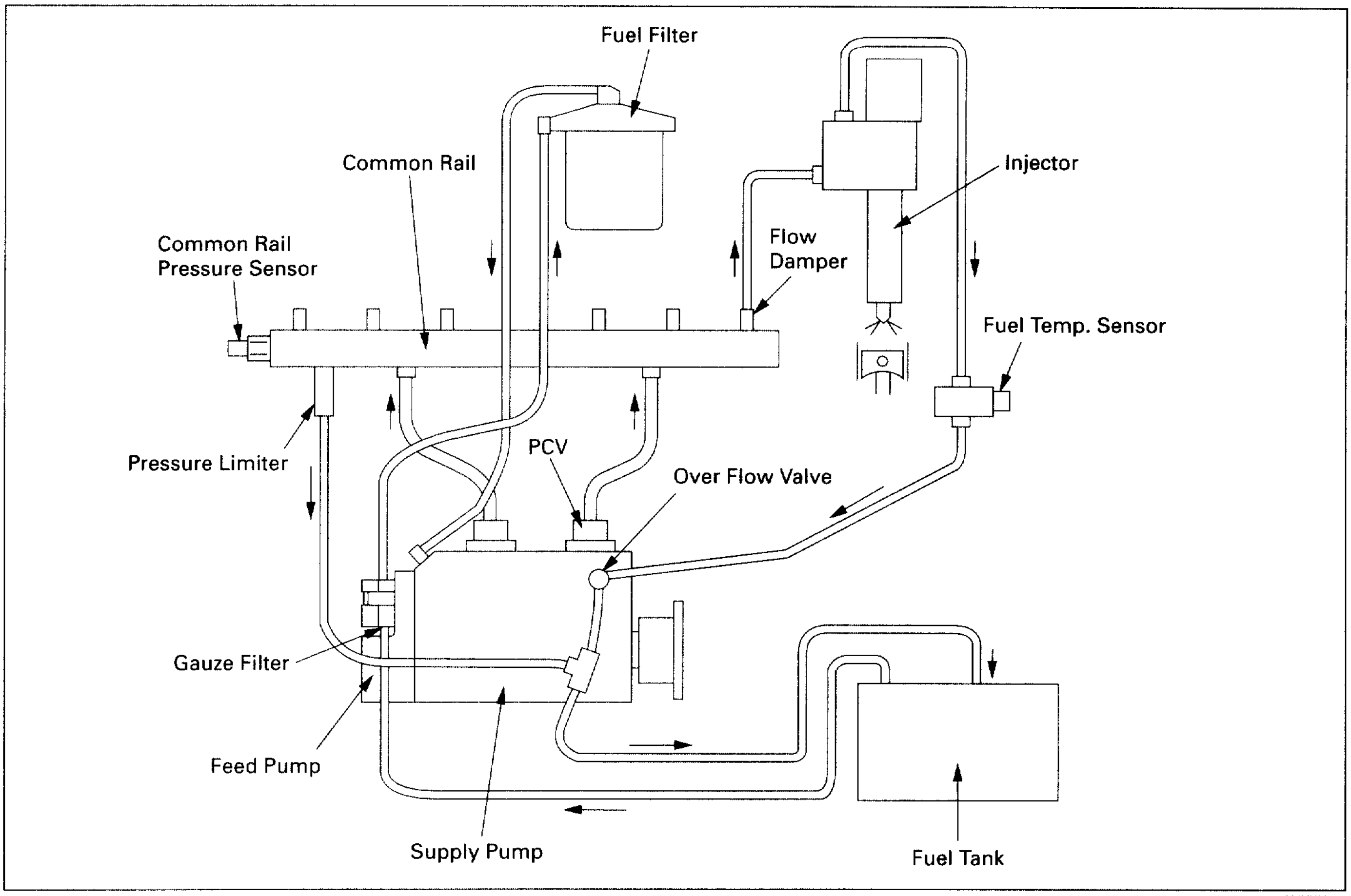
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Check Fuel Filter.

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display DTC 264 while Ignition "ON", or engine at idle?	—	Go to step 3	—
3	1. After warming up engine (at 60°C or more), turn engine "OFF", clear DTC. 2. Restart the engine and let idle for 60 seconds Does the DTC reset?		Go to step 4	See Note on Intermittent
4	Perform Tech2 cylinder power balance test to confirm cylinder #4 is misfiring? Is the action completed?	—	Go to step 5	Go to step 4
5	Ignition "OFF", engine "OFF" and listen for flow damper to reset ("click" sound). This may take 120 seconds. Was "click" sound heard?	—	Go to step 6	Go to step 7
6	Check for fuel leak in line between flow damper and fuel injector. Was fuel leak found?	—	Repair or replace Go back to step 3	Go to step 7
7	Replace #4 injector with known good injector. Does #4 injector misfire?	—	Go to step 9	Replace injector Go back to step 3
8	Check for restriction in fuel line between flow damper and injector. Was restriction found:	— —	Repair or replace Go back to step 3	Go to step 7
9	1. Replace common rail assembly. 2. Clear the DTC and start engine. Does scan tool display any DTC codes?		Go to step 2	System OK

NOTE: Use scan tool Common rail pressure control to check for fuel leakage, etc.
Sometimes DTC 264 will be displayed due to engine hunting when the PC sensor fails.
Intermittents codes are activated by:

- **Clutch shudder**
- **Clutch shock Disengagement**

DTC 0265 (Cylinder No. 5) Flow Damper Activated



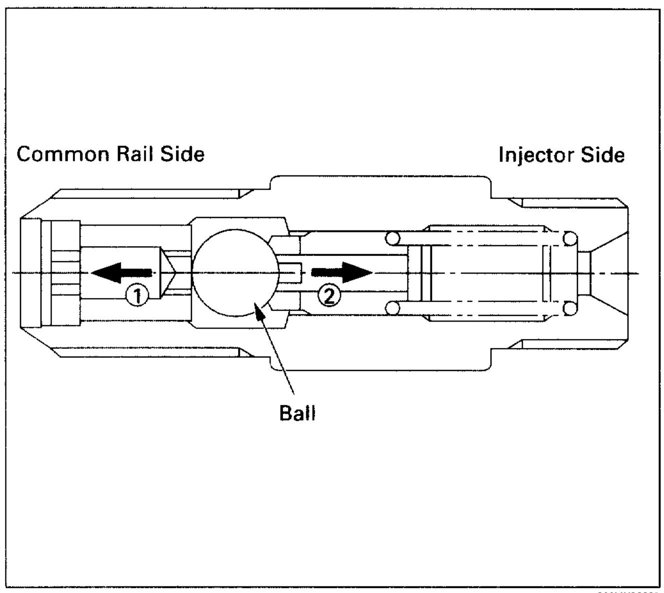
Operation Description

The flow damper comprises a piston, ball, spring seat, and spring.

The flow damper is used to damp the pressure pulsating in the common rail and the injection pipe.

During driving the flow of fuel makes the piston, ball, and spring seat move a little to the injector side and float.

Should too much fuel pass the flow damper, the ball moves further toward the injector until the ball comes into contact with the seat surface of the flow damper unit, thereby shutting the fuel passages.



① Common Rail Side < Fuel Pressure < Injector Side
② Common Rail Side > Fuel Pressure > Injector Side

DTC 0265 (Cylinder No. 5) Flow Damper Activated

Conditions for Setting the DTC

Cylinder No. 5

- No DTC 0271, DTC 0158 and DTC 0159.
- ECT higher than 60°C.
- Correction of uneven injection amount exceeding 4 mm^3/st and continues for 20 times.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Cylinder injection stops

Conditions for Clearing the MIL/DTC

DTC 0265 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

Diagnostic Aids

Check for the following conditions:

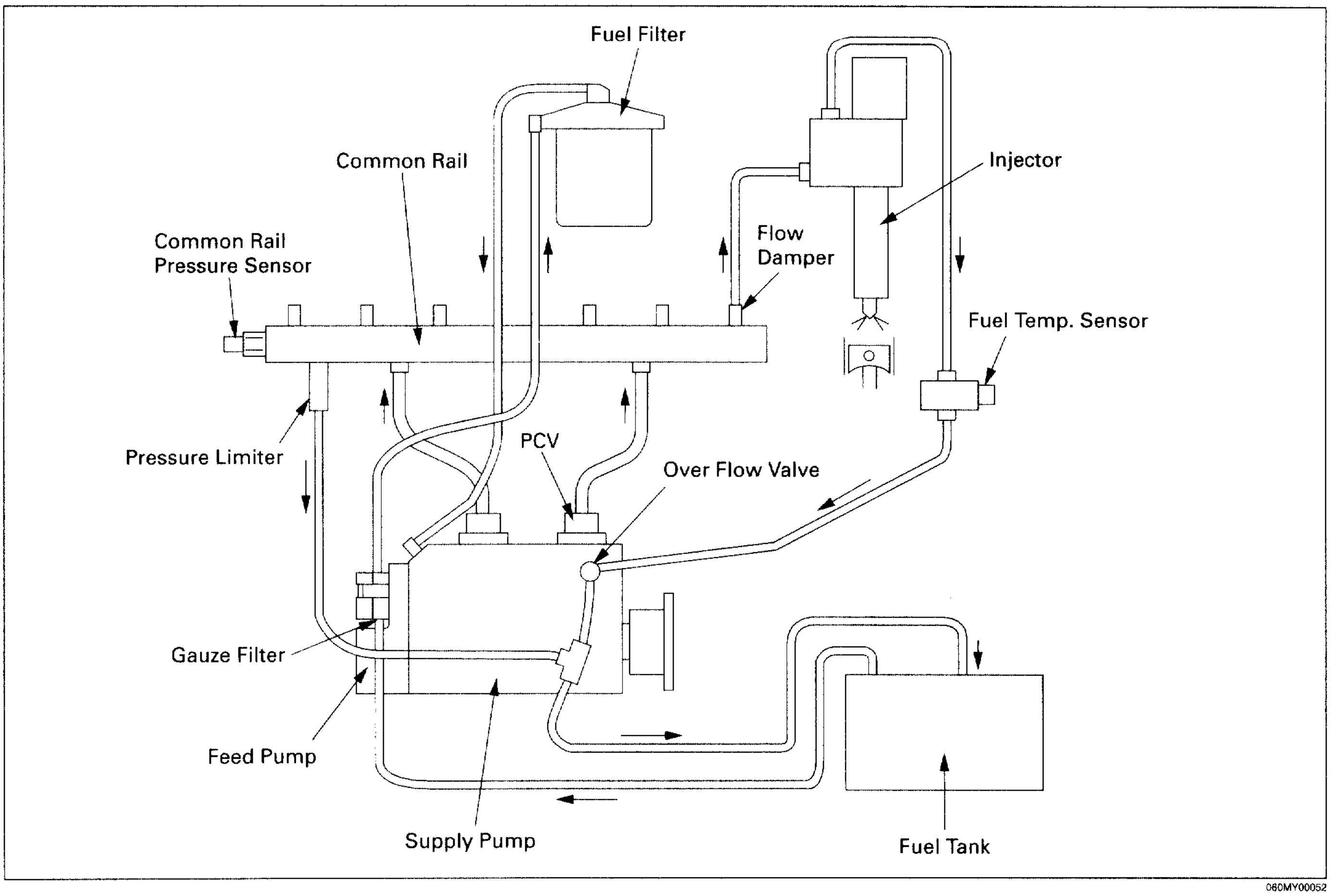
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Check Fuel Filter.

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display DTC 265 while Ignition "ON", or engine at idle?	—	Go to step 3	—
3	1. After warming up engine (at 60°C or more), turn engine "OFF", clear DTC. 2. Restart the engine and let idle for 60 seconds Does the DTC reset?		Go to step 4	See Note on Intermittent
4	Perform Tech2 cylinder power balance test to confirm cylinder #5 is misfiring? Is the action completed?	—	Go to step 5	Go to step 4
5	Ignition "OFF", engine "OFF" and listen for flow damper to reset ("click" sound). This may take 120 seconds. Was "click" sound heard?	—	Go to step 6	Go to step 7
6	Check for fuel leak in line between flow damper and fuel injector. Was fuel leak found?	—	Repair or replace Go back to step 3	Go to step 7
7	Replace #5 injector with known good injector. Does #5 injector misfire?	—	Go to step 9	Replace injector Go back to step 3
8	Check for restriction in fuel line between flow damper and injector. Was restriction found:	— —	Repair or replace Go back to step 3	Go to step 7
9	1. Replace common rail assembly. 2. Clear the DTC and start engine. Does scan tool display any DTC codes?		Go to step 2	System OK

NOTE: Use scan tool Common rail pressure control to check for fuel leakage, etc.
Sometimes DTC 265 will be displayed due to engine hunting when the PC sensor fails.
Intermittents codes are activated by:

- **Clutch shudder**
- **Clutch shock Disengagement**

DTC 0266 (Cylinder No. 6) Flow Damper Activated



060MY00052

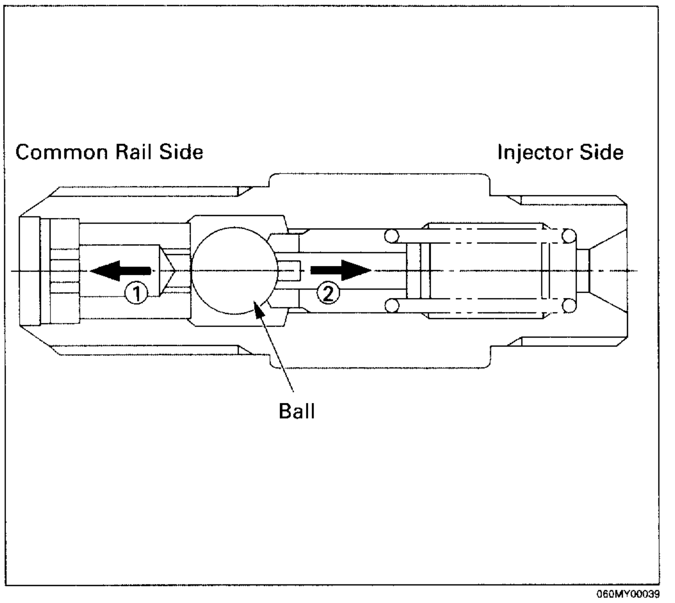
Operation Description

The flow damper comprises a piston, ball, spring seat, and spring.

The flow damper is used to damp the pressure pulsating in the common rail and the injection pipe.

During driving the flow of fuel makes the piston, ball, and spring seat move a little to the injector side and float.

Should too much fuel pass the flow damper, the ball moves further toward the injector until the ball comes into contact with the seat surface of the flow damper unit, thereby shutting the fuel passages.



060MY00039

① Common Rail Side < Fuel Pressure < Injector Side
② Common Rail Side > Fuel Pressure > Injector Side

DTC 0266 (Cylinder No. 6) Flow Damper Activated

Conditions for Setting the DTC

Cylinder No. 6

- No DTC 0271, DTC 0158 and DTC 0159.
- ECT higher than 60°C.
- Correction of uneven injection amount exceeding 4 mm^3/st and continues for 20 times.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Cylinder injection stops

Conditions for Clearing the MIL/DTC

DTC 0266 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

Diagnostic Aids

Check for the following conditions:

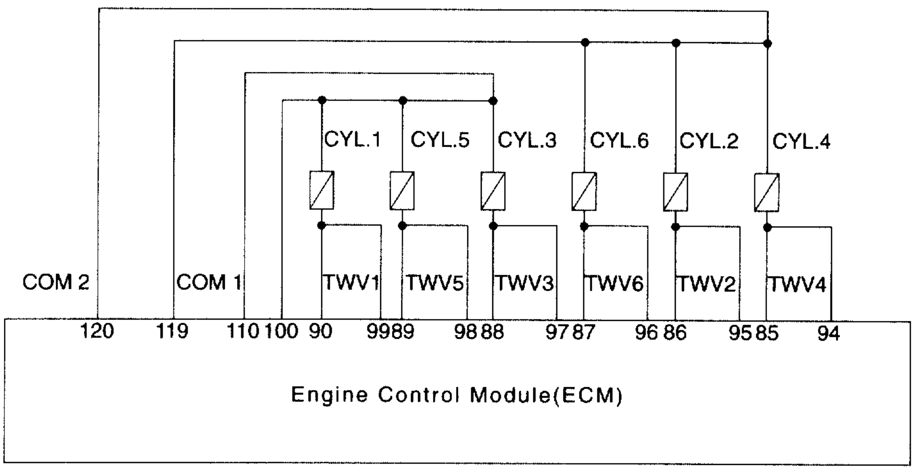
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Check Fuel Filter.

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display DTC 266 while Ignition "ON", or engine at idle?	—	Go to step 3	—
3	1. After warming up engine (at 60°C or more), turn engine "OFF", clear DTC. 2. Restart the engine and let idle for 60 seconds Does the DTC reset?		Go to step 4	See Note on Intermittent
4	Perform Tech2 cylinder power balance test to confirm cylinder #6 is misfiring? Is the action completed?	—	Go to step 5	Go to step 4
5	Ignition "OFF", engine "OFF" and listen for flow damper to reset ("click" sound). This may take 120 seconds. Was "click" sound heard?	—	Go to step 6	Go to step 7
6	Check for fuel leak in line between flow damper and fuel injector. Was fuel leak found?	—	Repair or replace Go back to step 3	Go to step 7
7	Replace #6 injector with known good injector. Does #6 injector misfire?	—	Go to step 9	Replace injector Go back to step 3
8	Check for restriction in fuel line between flow damper and injector. Was restriction found:	— —	Repair or replace Go back to step 3	Go to step 7
9	1. Replace common rail assembly. 2. Clear the DTC and start engine. Does scan tool display any DTC codes?		Go to step 2	System OK

NOTE: Use scan tool Common rail pressure control to check for fuel leakage, etc.
Sometimes DTC 266 will be displayed due to engine hunting when the PC sensor fails.
Intermittents codes are activated by:

- **Clutch shudder**
- **Clutch shock Disengagement**

DTC 0271 (Cylinder No. 1) TWV Side Disconnected



060MY00068

Circuit Description

A hydraulic piston and TWV (solenoid valve) have been added to the conventional nozzle. Receiving signals from ECM, the TWV opens and closes to change the pressure in the pressure adjustment chamber on top of the hydraulic piston so that the hydraulic piston works thereby to inject the fuel from the nozzle.

If No. 1 Cylinder TWV coil or harness is disconnected and battery voltage is over 10V except when in over speed condition, DTC 0271 will be set.

Conditions for Setting the DTC

Cylinder No. 1;

- TWV coil or harness disconnected and battery voltage is over 10V except when judged on overrun.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Injection amount is limited to maximum 80 mm^3/st and boost becomes 0.

Conditions for Clearing the MIL/DTC

DTC 0271 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

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.
- No smooth rotation.
- Lack of engine power.

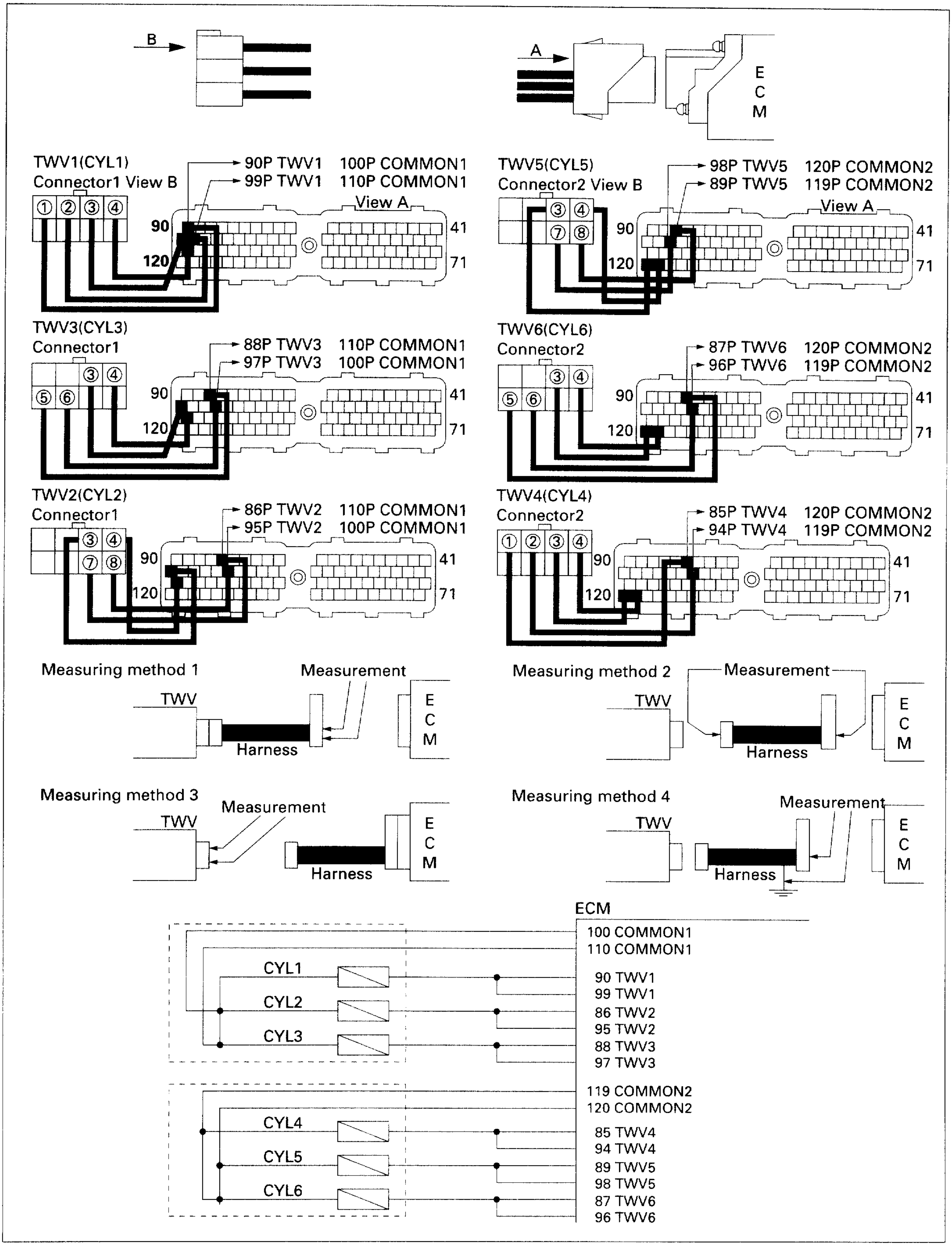
DTC 0271 (Cylinder No. 1) TWV Side Disconnected

Note: If diagnosed simultaneous with flow damper, inspect TWV trouble first.

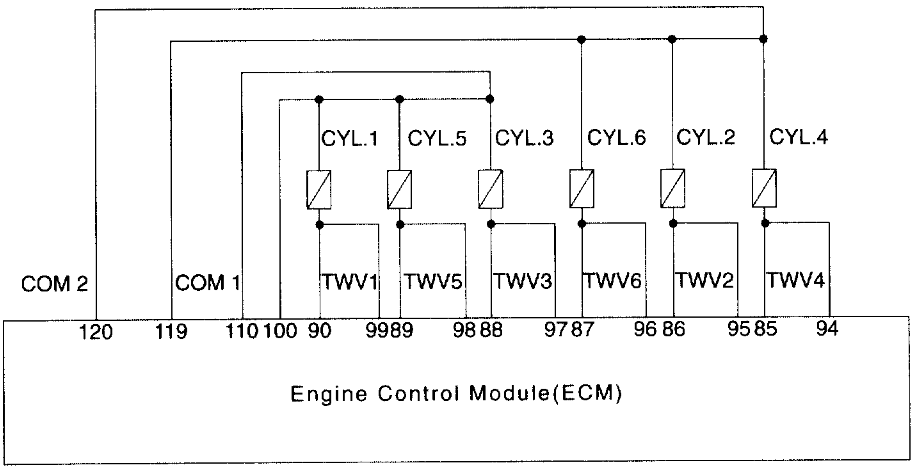
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display any TDC from DTC 0271 while key switch is "ON" or engine is running?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect TWV harness connector from ECM side. 3. Measure resistance at the following points at the ECM connector of TWV harness. (Measuring method 1). • Between pin number 90, 99 (TWV1) and pin number 100 (COMMON1). Is resistance within value?	2.0Ω or less for TWV harness resistance. 0.9Ω to 1.3Ω for TWV coil resistance. Thus minimum resistance is 0.9Ω to 1.3Ω. (If harness resistance 0)	Go to step 8 Before going to step 8, recheck incomplete connection on harness connector.	Go to step 4
4	1. Key switch "OFF". 2. Disconnect TWV harness connector from both ECM and TWV (cyl. head side). 3. Measure resistance following points on the TWV harness. (Measuring method 2) • Between pin number 90, 99 (TWV1) at ECM side and pin number 1, 2 (Connector 1) at TWV side. Is resistance within value?	2Ω or less	Go to step 5	Repair/replace TWV harness.
5	Measure resistance at the following points at the TWV side connector. (TWV COIL unit resistance) (Measuring method 3) • Between pin number 1, 2 and 3, 4 at connector 1 for TWV1. Is resistance within value?	0.4Ω to 0.8Ω	Go to step 7	Go to step 6
6	1. Remove cylinder head cover. 2. Inspect upper portion of cylinder head. Is there any problem? (Example. disconnected harness or broken wire etc.)	—	Repair problem portion. Then go to step 7	Repair problem portion. Then go to step 7
7	1. Reconnect all connector and terminal of TWV harness. 2. Install cylinder head cover. 3. Key switch "ON". Does the scan tool display any DTCs?	—	Replace ECM assembly. Then go to step 8	Replace ECM assembly. Then go to step8
8	1. Clear all DTCs. 2. Key switch "ON". Does the scan tool display any DTCs?	—	Go back to step 3	Go back to step 3

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Cylinder No. 1 to No. 6 TWV Side Disconnected



DTC 0272 (Cylinder No. 2) TWV Side Disconnected



Circuit Description

A hydraulic piston and TWV (solenoid valve) have been added to the conventional nozzle. Receiving signals from ECM, the TWV opens and closes to change the pressure in the pressure adjustment chamber on top of the hydraulic piston so that the hydraulic piston works thereby to inject the fuel from the nozzle.

If No. 2 Cylinder TWV coil or harness is disconnected and battery voltage is over 10V except when in over speed condition, DTC 0272 will be set.

Conditions for Setting the DTC

Cylinder No. 2;

- TWV coil or harness disconnected and battery voltage is over 10V except when judged on overrun.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Injection amount is limited to maximum 80 mm^3/st and boost becomes 0.

Conditions for Clearing the MIL/DTC

DTC 0272 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

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.
- No smooth rotation.
- Lack of engine power.

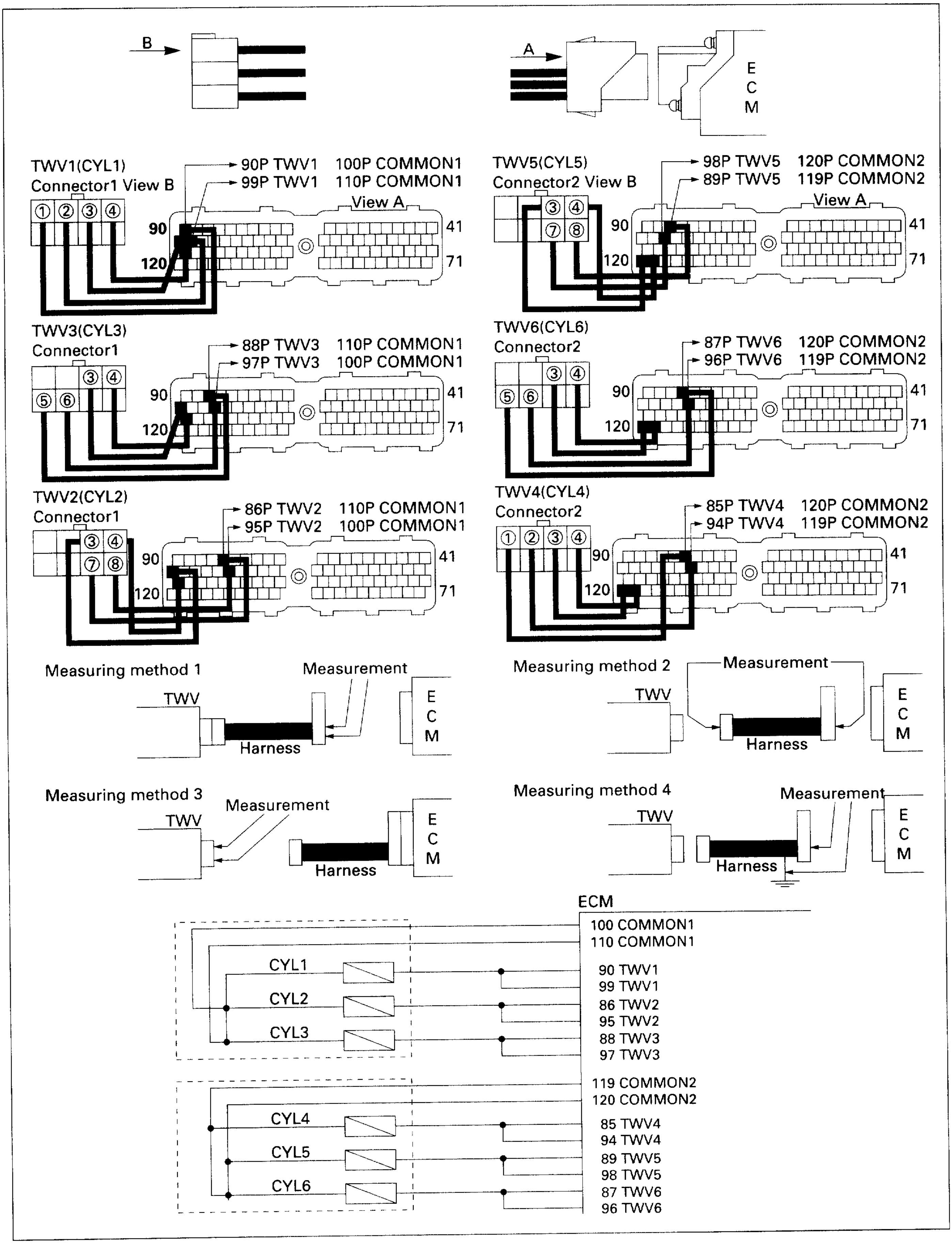
DTC 0272 (Cylinder No. 2) TWV Side Disconnected

Note: If diagnosed simultaneous with flow damper, inspect TWV trouble first.

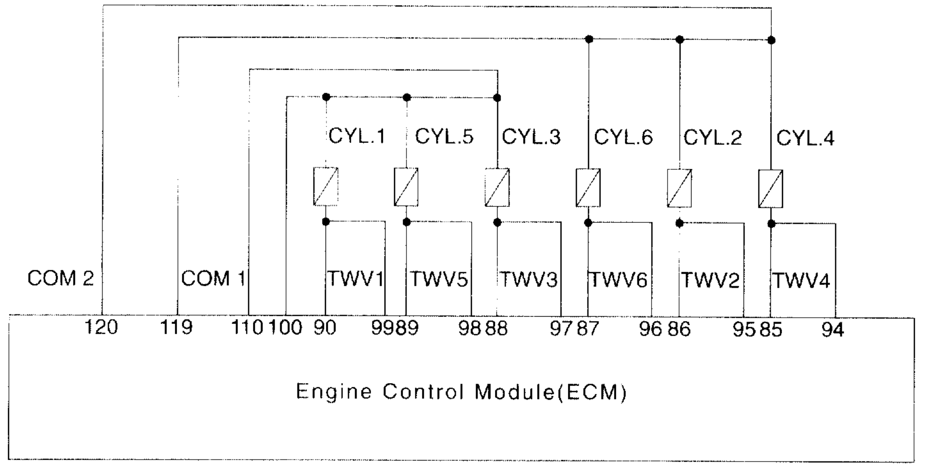
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display any TDC from DTC 0272 while key switch is "ON" or engine is running?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect TWV harness connector from ECM side. 3. Measure resistance at the following points at the ECM connector of TWV harness. (Measuring method 1). • Between pin number 86, 95 (TWV2) and pin number 100 (COMMON1). Is resistance within value?	2.0Ω or less for TWV harness resistance. 0.9Ω to 1.3Ω for TWV coil resistance. Thus minimum resistance is 0.9Ω to 1.3Ω. (If harness resistance 0)	Go to step 8 Before going to step 8, recheck incomplete connection on harness connector.	Go to step 4
4	1. Key switch "OFF". 2. Disconnect TWV harness connector from both ECM and TWV (cyl. head side). 3. Measure resistance following points on the TWV harness. (Measuring method 2) • Between pin number 86, 95 (TWV2) at ECM side and pin number 7, 8 (Connector 2) at TWV side. Is resistance within value?	2Ω or less	Go to step 5	Repair/replace TWV harness.
5	Measure resistance at the. following points at the TWV side connector. (TWV COIL unit resistance) (Measuring method 3) • Between pin number 7, 8 and 3, 4 at connector 2 for TWV2. Is resistance within value?	0.4Ω to 0.8Ω	Go to step 7	Go to step 6
6	1. Remove cylinder head cover. 2. Inspect upper portion of cylinder head. Is there any problem? (Example. disconnected harness or broken wire etc.)	—	Repair problem portion. Then go to step 7	Repair problem portion. Then go to step 7
7	1. Reconnect all connector and terminal of TWV harness. 2. Install cylinder head cover. 3. Key switch "ON". Does the scan tool display any DTCs?	—	Replace ECM assembly. Then go to step 8	Replace ECM assembly. Then go to step 8
8	1. Clear all DTCs. 2. Key switch "ON". Does the scan tool display any DTCs?	—	Go back to step 3	Go back to step 3

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2.
Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Cylinder No. 1 to No. 6 TWV Side Disconnected



DTC 0273 (Cylinder No. 3) TWV Side Disconnected



Circuit Description

A hydraulic piston and TWV (solenoid valve) have been added to the conventional nozzle. Receiving signals from ECM, the TWV opens and closes to change the pressure in the pressure adjustment chamber on top of the hydraulic piston so that the hydraulic piston works thereby to inject the fuel from the nozzle.

If No. 3 Cylinder TWV coil or harness is disconnected and battery voltage is over 10V except when in over speed condition, DTC 0273 will be set.

Conditions for Setting the DTC

Cylinder No. 3

- TWV coil or harness disconnected and battery voltage is over 10V except when judged on overrun.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Injection amount is limited to maximum 80 mm^3/st and boost becomes 0.

Conditions for Clearing the MIL/DTC

DTC 0273 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

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.
- No smooth rotation.
- Lack of engine power.

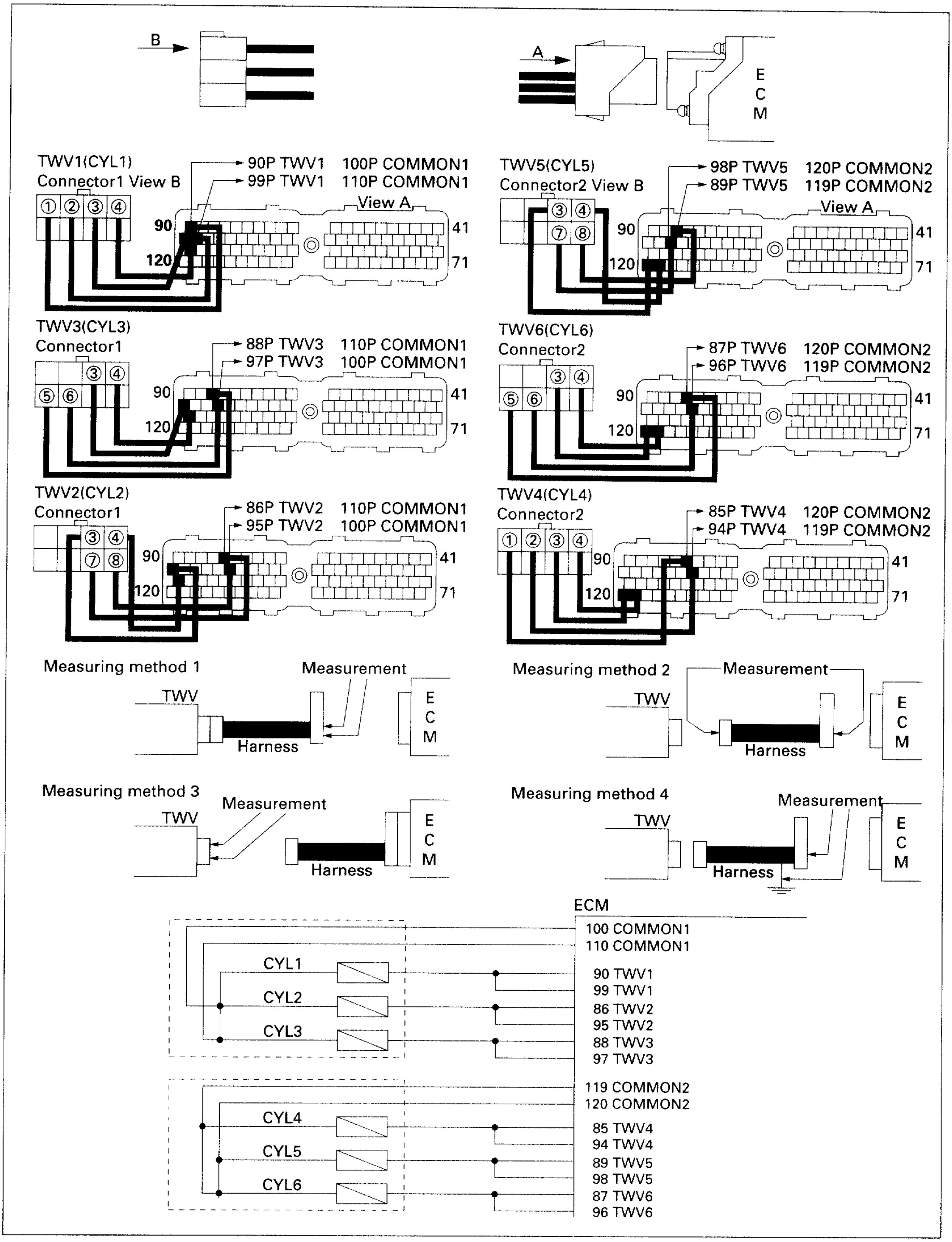
DTC 0273 (Cylinder No. 3) TWV Side Disconnected

Note: If diagnosed simultaneous with flow damper, inspect TWV trouble first.

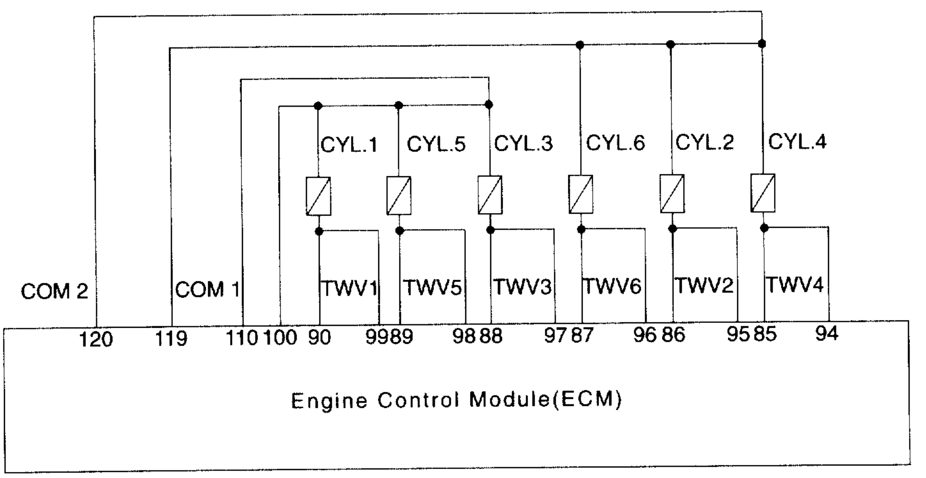
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display any TDC from DTC 0273 while key switch is "ON" or engine is running?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect TWV harness connector from ECM side. 3. Measure resistance at the following points at the ECM connector of TWV harness. (Measuring method 1). • Between pin number 88, 97 (TWV3) and pin number 110 (COMMON1). Is resistance within value?	2.0Ω or less for TWV harness resistance. 0.9Ω to 1.3Ω for TWV coil resistance. Thus minimum resistance is 0.9Ω to 1.3Ω. (If harness resistance 0)	Go to step 8 Before going to step 8, recheck incomplete connection on harness connector.	Go to step 4
4	1. Key switch "OFF". 2. Disconnect TWV harness connector from both ECM and TWV (cyl. head side). 3. Measure resistance following points on the TWV harness. (Measuring method 2) • Between pin number 88, 97 (TWV3) at ECM side and pin number 5, 6 (Connector 1) at TWV side. Is resistance within value?	2Ω or less	Go to step 5	Repair/replace TWV harness.
5	Measure resistance at the following points at the TWV side connector. (TWV COIL unit resistance) (Measuring method 3) • Between pin number 5, 6 and 3, 4 at connector 1 for TWV3. Is resistance within value?	0.4Ω to 0.8Ω	Go to step 7	Go to step 6
6	1. Remove cylinder head cover. 2. Inspect upper portion of cylinder head. Is there any problem? (Example. disconnected harness or broken wire etc.)	—	Repair problem portion. Then go to step 7	Repair problem portion. Then go to step 7
7	1. Reconnect all connector and terminal of TWV harness. 2. Install cylinder head cover. 3. Key switch "ON". Does the scan tool display any DTCs?	—	Replace ECM assembly. Then go to step 8	Replace ECM assembly. Then go to step 8
8	1. Clear all DTCs. 2. Key switch "ON". Does the scan tool display any DTCs?	—	Go back to step 3	Go back to step 3

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Cylinder No. 1 to No. 6 TWV Side Disconnected



DTC 0274 (Cylinder No. 4) TWV Side Disconnected



060MY00068

Circuit Description

A hydraulic piston and TWV (solenoid valve) have been added to the conventional nozzle. Receiving signals from ECM, the TWV opens and closes to change the pressure in the pressure adjustment chamber on top of the hydraulic piston so that the hydraulic piston works thereby to inject the fuel from the nozzle.

If No. 4 Cylinder TWV coil or harness is disconnected and battery voltage is over 10V except when in over speed condition, DTC 0274 will be set.

Conditions for Setting the DTC

Cylinder No. 4;

- TWV coil or harness disconnected and battery voltage is over 10V except when judged on overrun.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Injection amount is limited to maximum 80 mm^3/st and boost becomes 0.

Conditions for Clearing the MIL/DTC

DTC 0274 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

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.
- No smooth rotation.
- Lack of engine power.

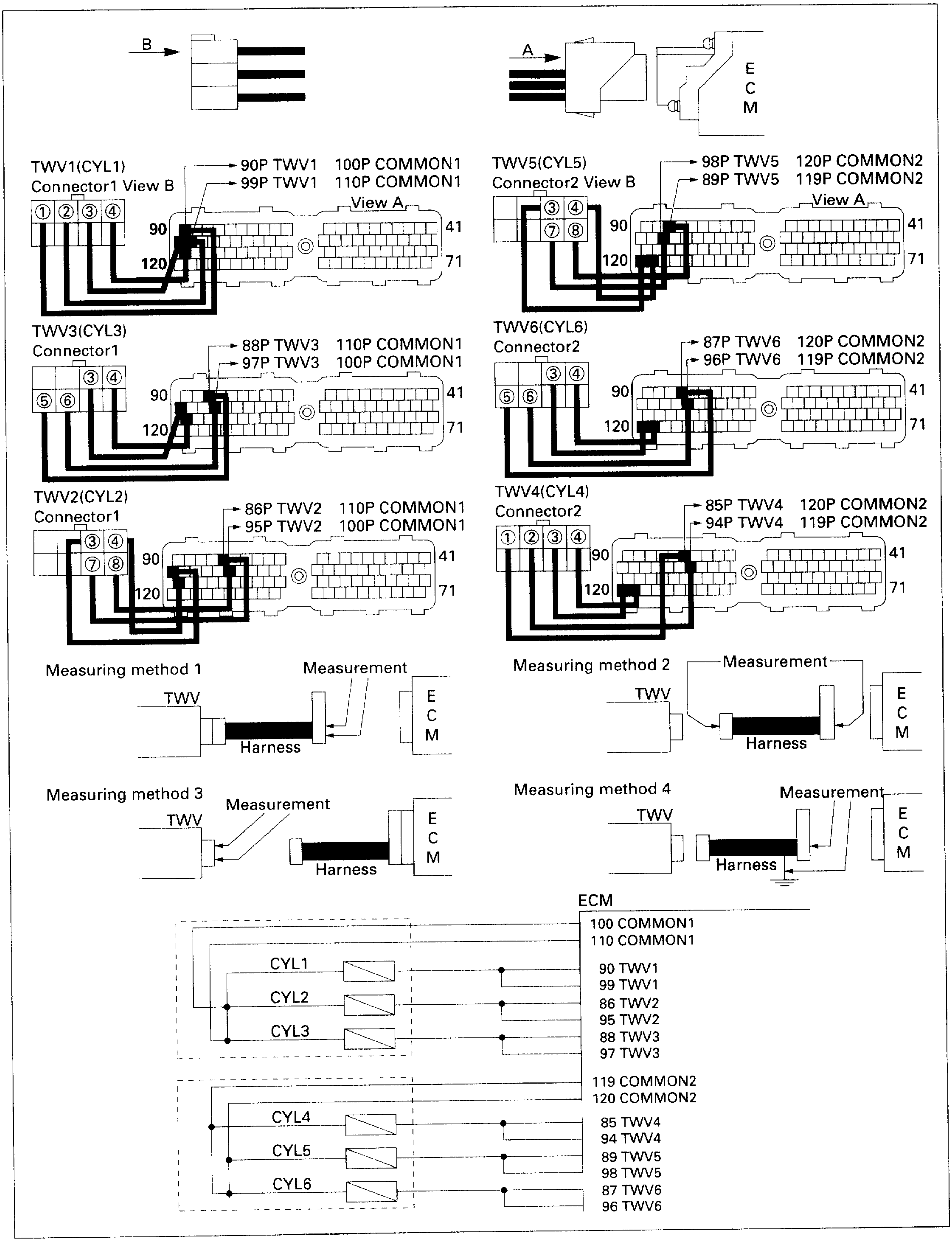
DTC 0274 (Cylinder No. 4) TWV Side Disconnected

Note: If diagnosed simultaneous with flow damper, inspect TWV trouble first.

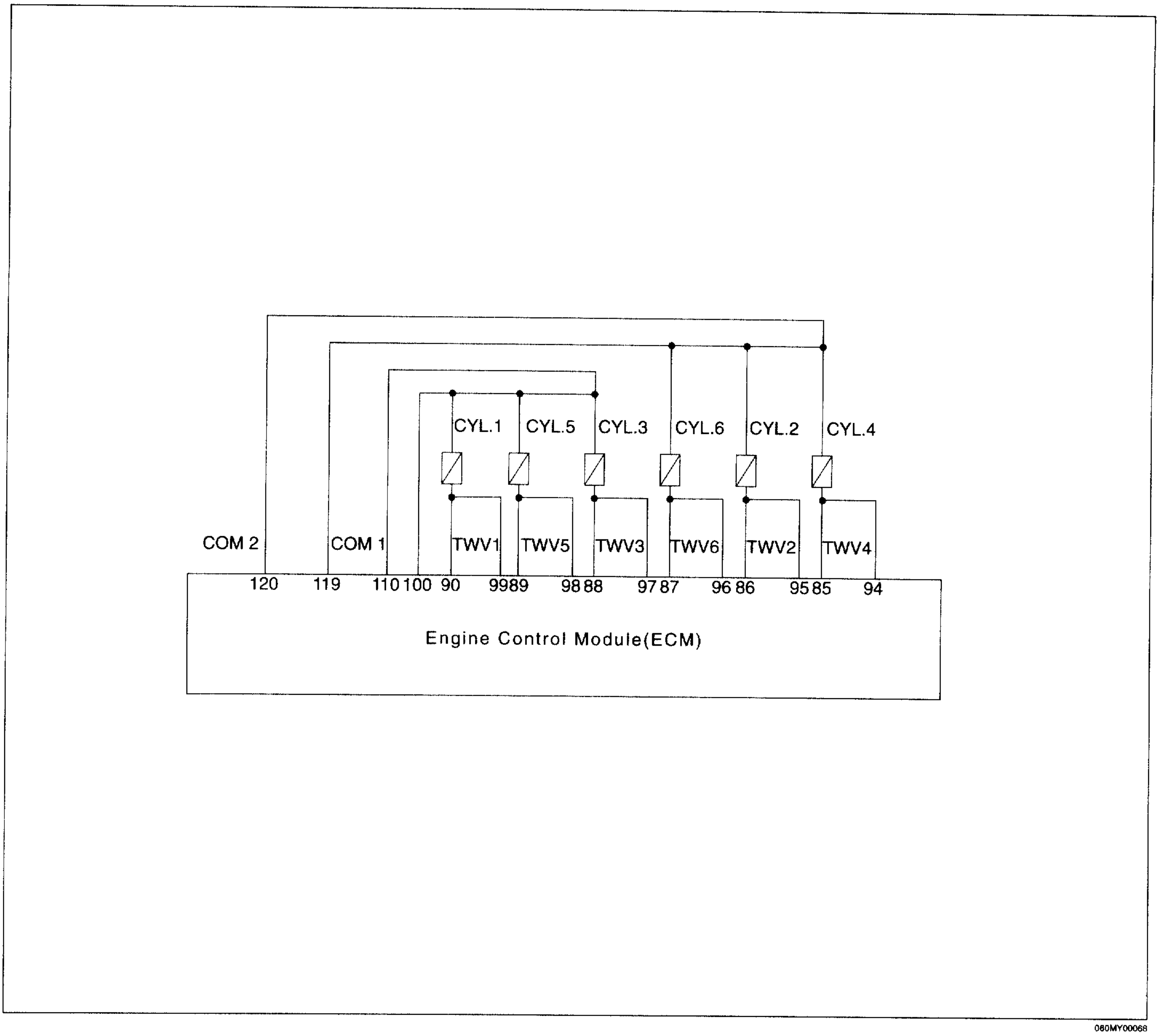
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does the scan tool display any TDC from DTC 0274 while key switch is "ON" or engine is running?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect TWV harness connector from ECM side. 3. Measure resistance at the following points at the ECM connector of TWV harness. (Measuring method 1). • Between pin number 85, 94 (TWV4) and pin number 119 (COMMON2). Is resistance within value?	2.0Ω or less for TWV harness resistance. 0.9Ω to 1.3Ω for TWV coil resistance. Thus minimum resistance is 0.9Ω to 1.3Ω. (If harness resistance 0)	Go to step 8 Before going to step 8, recheck incomplete connection on harness connector.	Go to step 4
4	1. Key switch "OFF". 2. Disconnect TWV harness connector from both ECM and TWV (cyl. head side). 3. Measure resistance following points on the TWV harness. (Measuring method 2) • Between pin number 85, 94 (TWV4) at ECM side and pin number 1, 2 (Connector 2) at TWV side. Is resistance within value?	2Ω or less	Go to step 5	Repair/replace TWV harness.
5	Measure resistance at the following points at the TWV side connector. (TWV COIL unit resistance) (Measuring method 3) • Between pin number 1, 2 and 3, 4 at connector 2 for TWV4. Is resistance within value?	0.4Ω to 0.8Ω	Go to step 7	Go to step 6
6	1. Remove cylinder head cover. 2. Inspect upper portion of cylinder head. Is there any problem? (Example. disconnected harness or broken wire etc.)	—	Repair problem portion. Then go to step 7	Repair problem portion. Then go to step 7
7	1. Reconnect all connector and terminal of TWV harness. 2. Install cylinder head cover. 3. Key switch "ON".	—	Replace ECM assembly. Then go to step 8	Replace ECM assembly. Then go to step 8
8	1. Clear all DTCs. 2. Key switch "ON". Does the scan tool display any DTCs?	—	Go back to step 3	Go back to step 3

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Cylinder No. 1 to No. 6 TWV Side Disconnected



DTC 0275 (Cylinder No. 5) TWV Side Disconnected



Circuit Description

A hydraulic piston and TWV (solenoid valve) have been added to the conventional nozzle. Receiving signals from ECM, the TWV opens and closes to change the pressure in the pressure adjustment chamber on top of the hydraulic piston so that the hydraulic piston works thereby to inject the fuel from the nozzle.

If No. 5 Cylinder TWV coil or harness is disconnected and battery voltage is over 10V except when in over speed condition, DTC 0275 will be set.

Conditions for Setting the DTC

Cylinder No. 5;

- TWV coil or harness disconnected and battery voltage is over 10V except when judged on overrun.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Injection amount is limited to maximum 80 mm^3/st and boost becomes 0.

Conditions for Clearing the MIL/DTC

DTC 0275 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

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.
- No smooth rotation.
- Lack of engine power.

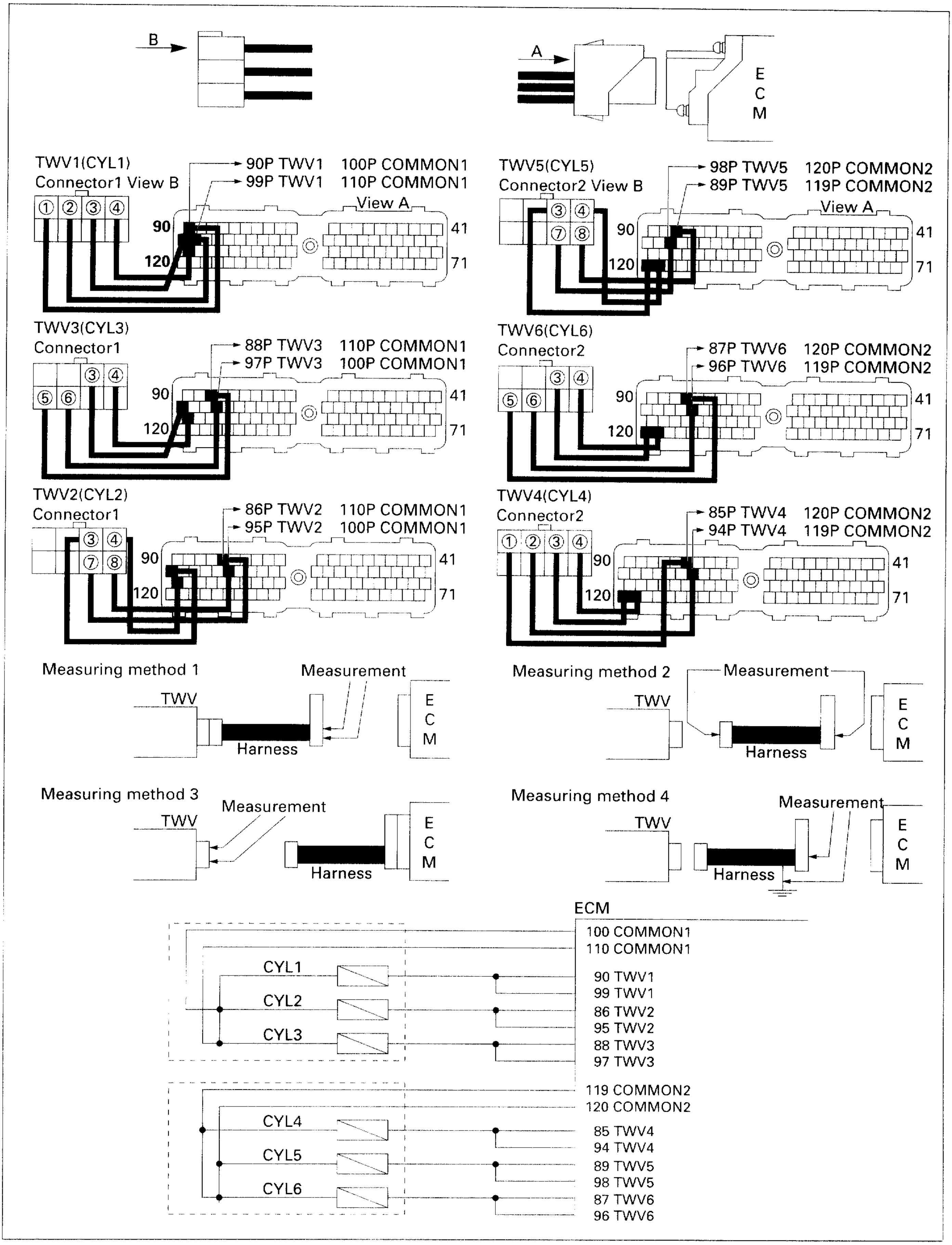
DTC 0275 (Cylinder No. 5) TWV Side Disconnected

Note: If diagnosed simultaneous with flow damper, inspect TWV trouble first.

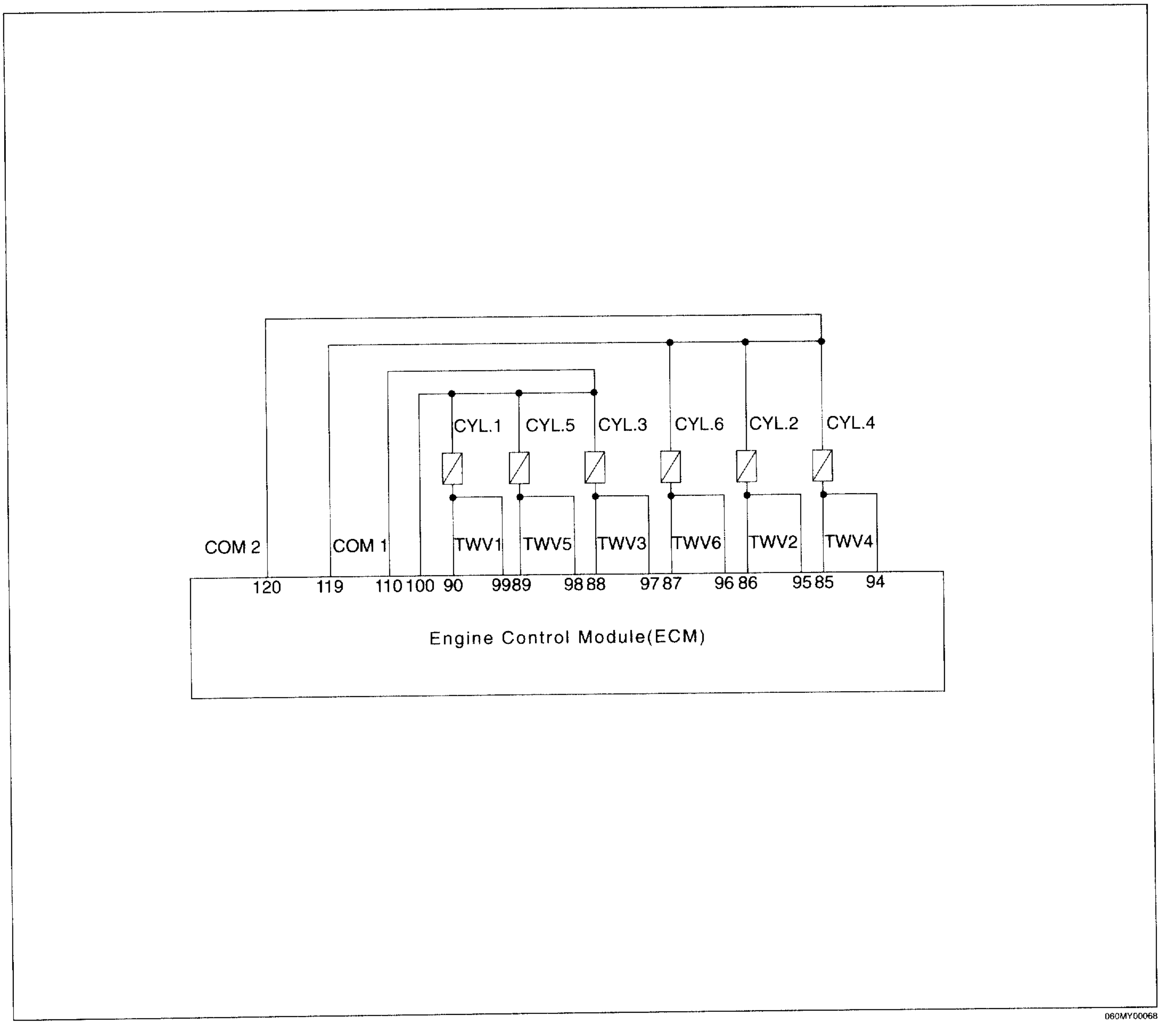
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD Ssytem Check
2	Does the scan tool display any TDC from DTC 0275 while key switch is "ON" or engine is running?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect TWV harness connector from ECM side. 3. Measure resistance at the following points at the ECM connector of TWV harness. (Measuring method 1). • Between pin number 89, 98 (TWV5) and pin number 119 (COMMON2). Is resistance within value?	2.0Ω or less for TWV harness resistance. 0.9Ω to 1.3Ω for TWV coil resistance. Thus minimum resistance is 0.9Ω to 1.3Ω. (If harness resistance 0)	Go to step 8 Before going to step 8, recheck incomplete connection on harness connector.	Go to step 4
4	1. Key switch "OFF". 2. Disconnect TWV harness connector from both ECM and TWV (cyl. head side). 3. Measure resistance following points on the TWV harness. (Measuring method 2) • Between pin number 89, 98 (TWV5) at ECM side and pin number 7, 8 (Connector 2) at TWV side. Is resistance within value?	2Ω or less	Go to step 5	Repair/replace TWV harness.
5	Measure resistance at the following points at the TWV side connector. (TWV COIL unit resistance) (Measuring method 3) • Between pin number 7, 8 and 3, 4 at connector 2 for TWV5. Is resistance within value?	0.4Ω to 0.8Ω	Go to step 7	Go to step 6
6	1. Remove cylinder head cover. 2. Inspect upper portion of cylinder head. Is there any problem? (Example. disconnected harness or broken wire etc.)	—	Repair problem portion. Then go to step 7	Repair problem portion. Then go to step 7
7	1. Reconnect all connector and terminal of TWV harness. 2. Install cylinder head cover. 3. Key switch "ON". Does the scan tool display any DTCs?	—	Replace ECM assembly. Then go to step 8	Replace ECM assembly. Then go to step 8
8	1. Clear all DTCs. 2. Key switch "ON". Does the scan tool display any DTCs?	—	Go back to step 3	Go back to step 3

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

Cylinder No. 1 to No. 6 TWV Side Disconnected



DTC 0276 (Cylinder No. 6) TWV Side Disconnected



Circuit Description

A hydraulic piston and TWV (solenoid valve) have been added to the conventional nozzle. Receiving signals from ECM, the TWV opens and closes to change the pressure in the pressure adjustment chamber on top of the hydraulic piston so that the hydraulic piston works thereby to inject the fuel from the nozzle.

If No. 6 Cylinder TWV coil or harness is disconnected and battery voltage is over 10V except when in over speed condition, DTC 0276 will be set.

Conditions for Setting the DTC

Cylinder No. 6;

- TWV coil or harness disconnected and battery voltage is over 10V except when judged on overrun.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL) the first time the fault is detected.
- Injection amount is limited to maximum 80 mm^3/st and boost becomes 0.

Conditions for Clearing the MIL/DTC

DTC 0276 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

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.
- No smooth rotation.
- Lack of engine power.

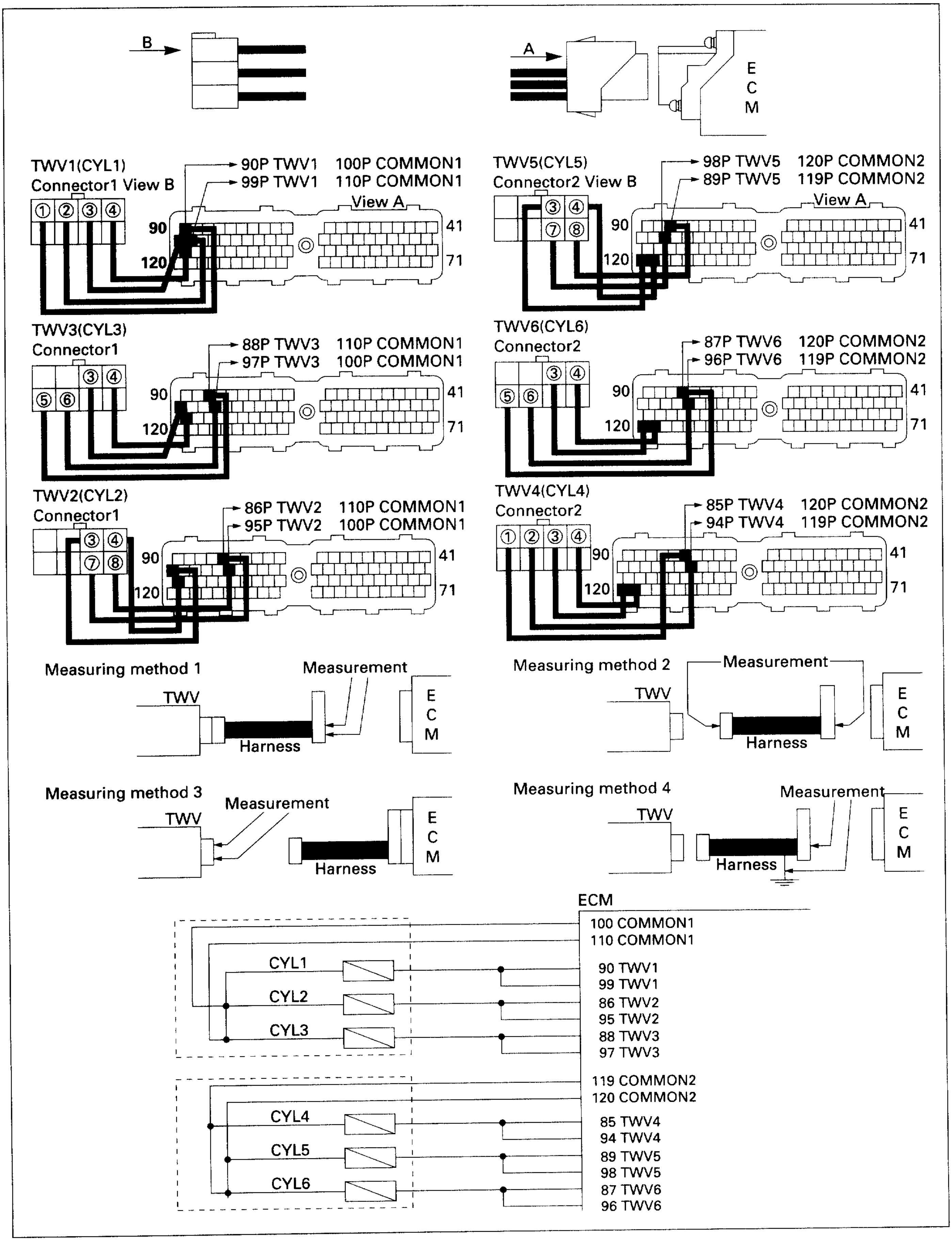
DTC 0276 (Cylinder No. 6) TWV Side Disconnected

Note: If diagnosed simultaneous with flow damper, inspect TWV trouble first.

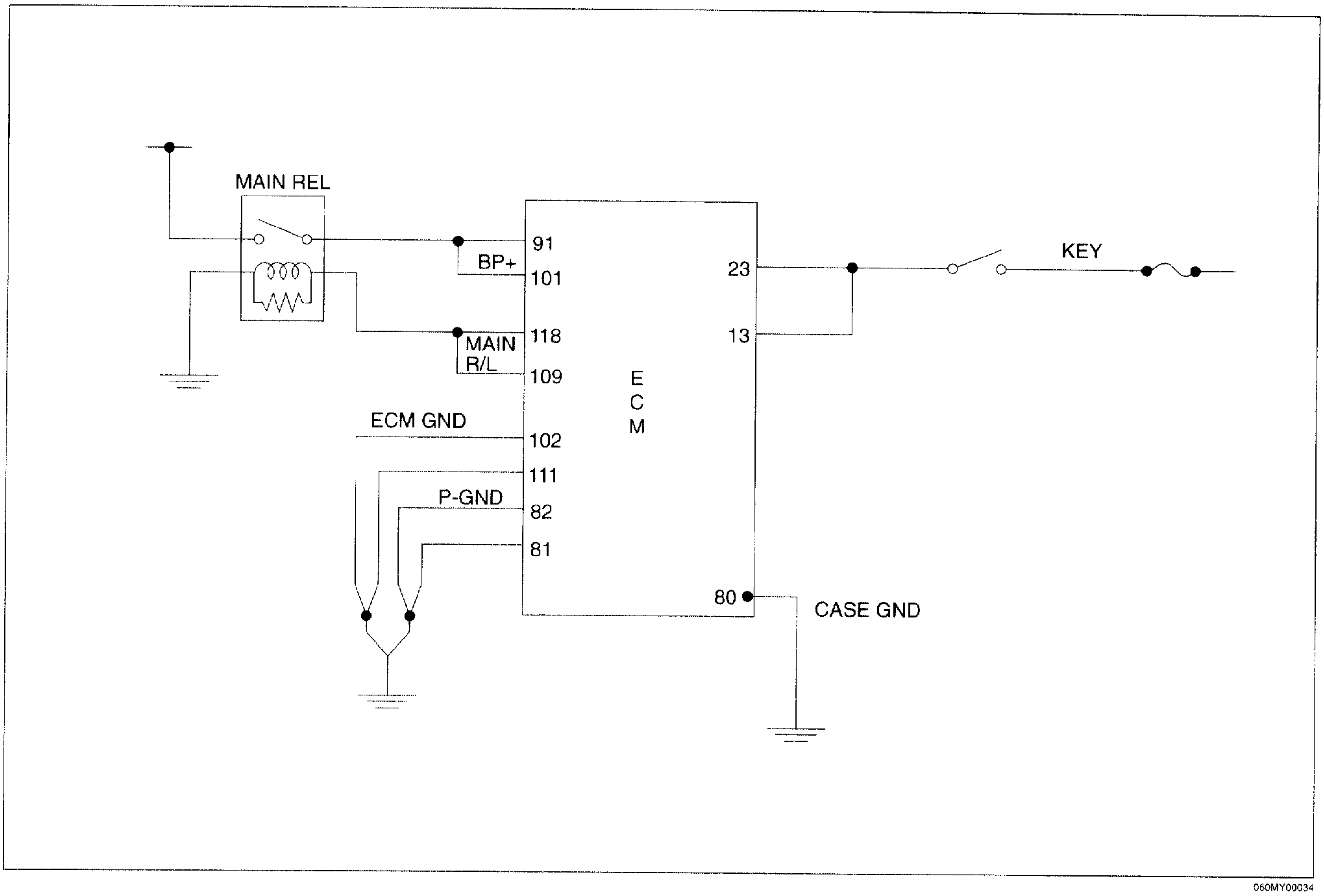
STEP	ACTION	VALUE	YES	NO
1	Was the “On-Board Diagnostic (OBD) System Check” performed?	—	Go to step 2	Go to OBD System Chekc
2	Does the scan tool display any TDC from DTC 0276 while key switch is “ON” or engine is running?	—	Go to step 3	—
3	1. Key switch “OFF”. 2. Disconnect TWV harness connector from ECM side. 3. Measure resistance at the following points at the ECM connector of TWV harness. (Measuring method 1). • Between pin number 87, 96 (TWV6) and pin number 120 (COMMON2). Is resistance within value?	2.0Ω or less for TWV harness resistance. 0.9Ω to 1.3Ω for TWV coil resistance. Thus minimum resistance is 0.9Ω to 1.3Ω. (If harness resistance 0)	Go to step 8 Before going to step 8, recheck incomplete connection on harness connector.	Go to step 4
4	1. Key switch “OFF”. 2. Disconnect TWV harness connector from both ECM and TWV (cyl. head side). 3. Measure resistance following points on the TWV harness. (Measuring method 2) • Between pin number 87, 96 (TWV6) at ECM side and pin number 5, 6 (Connector 2) at TWV side. Is resistance within value?	2Ω or less	Go to step 5	Repair/replace TWV harness.
5	Measure resistance at the following points at the TWV side connector. (TWV COIL unit resistance) (Measuring method 3) • Between pin number 5, 6 and 3, 4 at connector 2 for TWV6. Is resistance within value?	0.4Ω to 0.8Ω	Go to step 7	Go to step 6
6	1. Remove cylinder head cover. 2. Inspect upper portion of cylinder head. Is there any problem? (Example. disconnected harness or broken wire etc.)	—	Repair problem portion. Then go to step 7	Repair problem portion. Then go to step 7
7	1. Reconnect all connector and terminal of TWV harness. 2. Install cylinder head cover. 3. Key switch “ON”. Does the scan tool display any DTCs?	—	Replace ECM assembly. Then go to step 8	Replace ECM assembly. Then go to step 8
8	1. Clear all DTCs. 2. Key switch “ON”. Does the scan tool display any DTCs?	—	Go back to step 3	Go back to step 3

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2.
Refer to “Capture and Restore Fuel Rate Data” of “Tech 2 Scan Tool” in this manual.

Cylinder No. 1 to No. 6 TWV Side Disconnected



DTC 0416 Main Relay System Error (No history records)



Circuit Description

The ECM is supplied 12 volts through the main relay system.

If main relay is off for 5 sec. or more, DTC 0416 will be set.

Conditions for Setting the DTC

- Main relay is off for 5 sec. or more.

Action Taken When the DTC Sets

- Only MIL (Flashing lamp) can be lighted by key on current.

Conditions for Clearing the MIL/DTC

DTC 0416 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

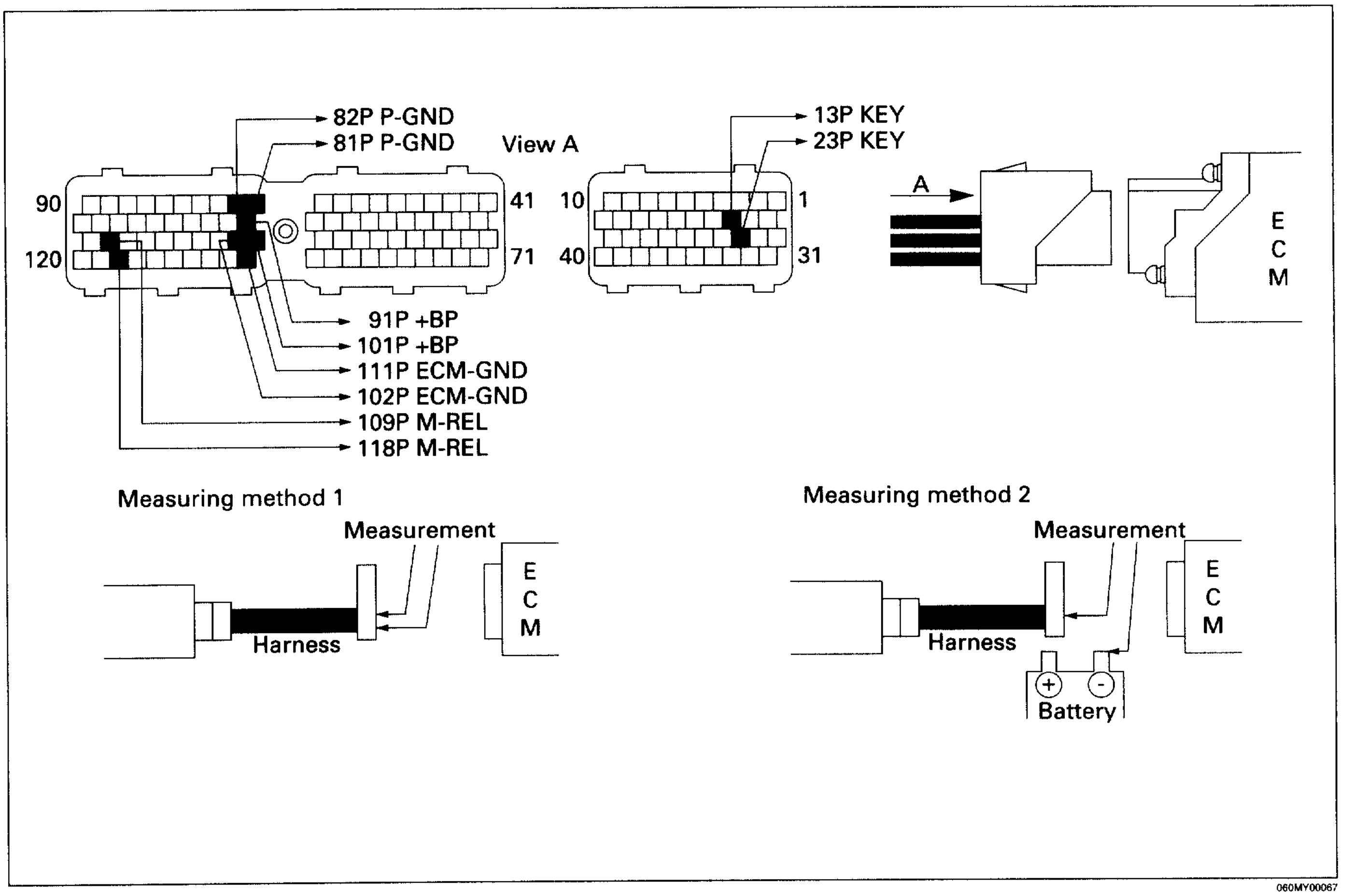
Diagnostic Aids

Check for the following conditions:

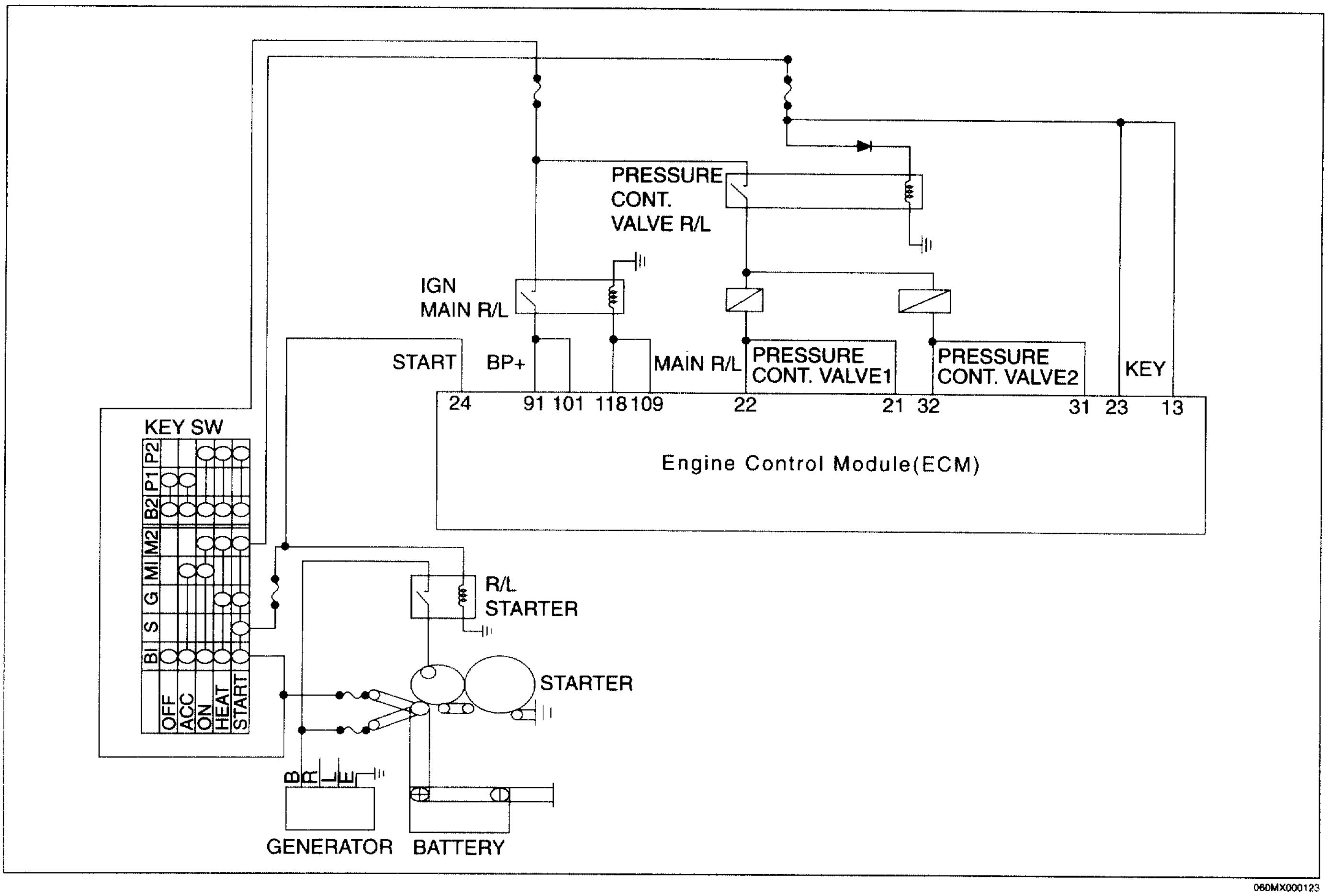
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.

STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Lamp: Light at 700 rpm or less for continuously 20 sec. (Lighted at hard circuit). **Note:** • **If this injection electrical control system and main relay malfunction, the system does not work (either ECM or driving system will not function). It is required to recheck.** • **See item regarding power supply inspection.**	—	—	—

DTC 0416 Main Relay System Error (No history records)



DTC 0417 Starter Switch Abnormal



060MX000123

Conditions for Setting the DTC

- Starter switch on and idle speed higher than 1000 rpm.
- When these conditions continue for 1.6 sec.

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

DTC 0417 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

Diagnostic Aids

Check for the following conditions:

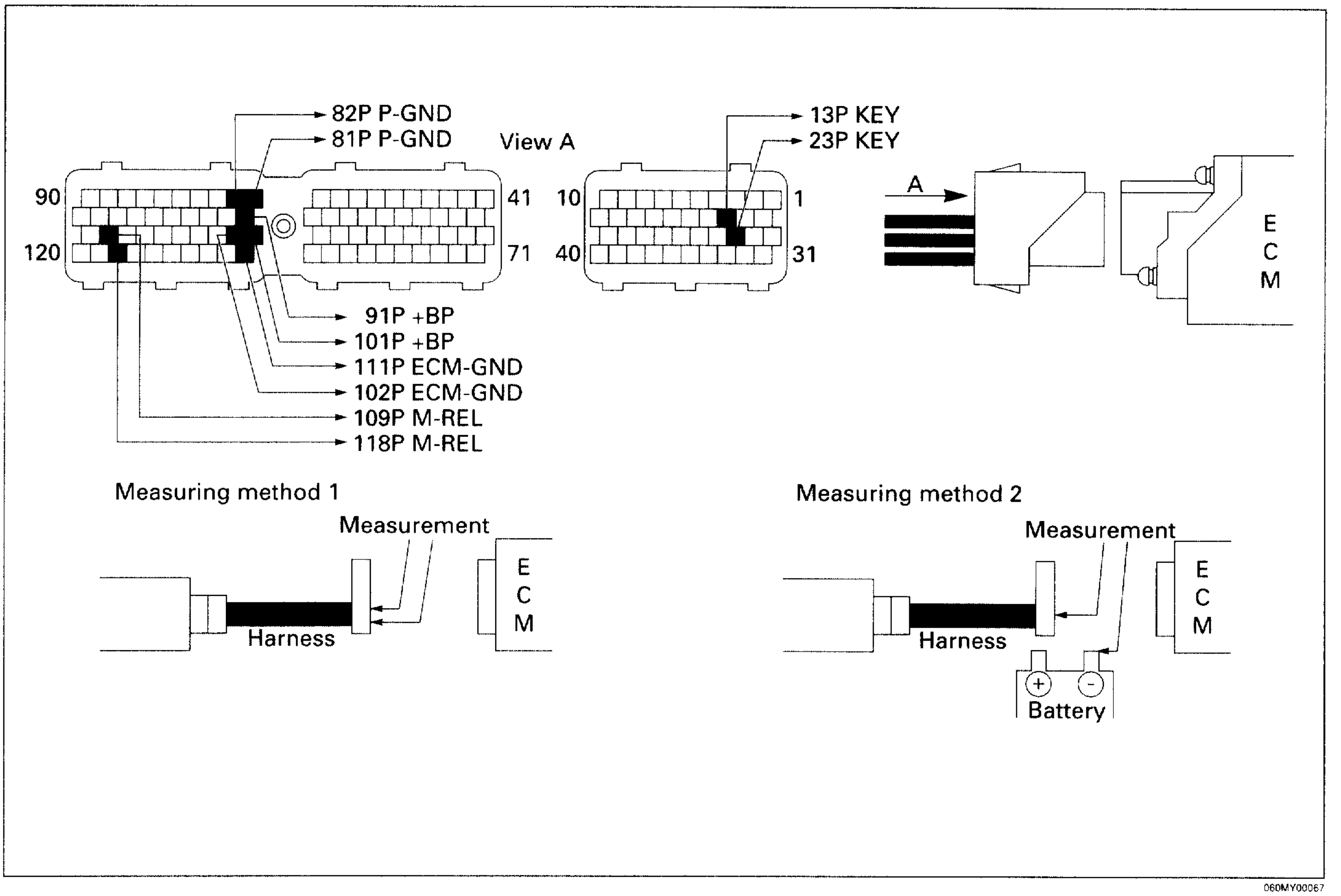
- Poor connection at ECM – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Increase to remains applies on idling when cold start engine.

DTC 0417 Starter Switch Abnormal

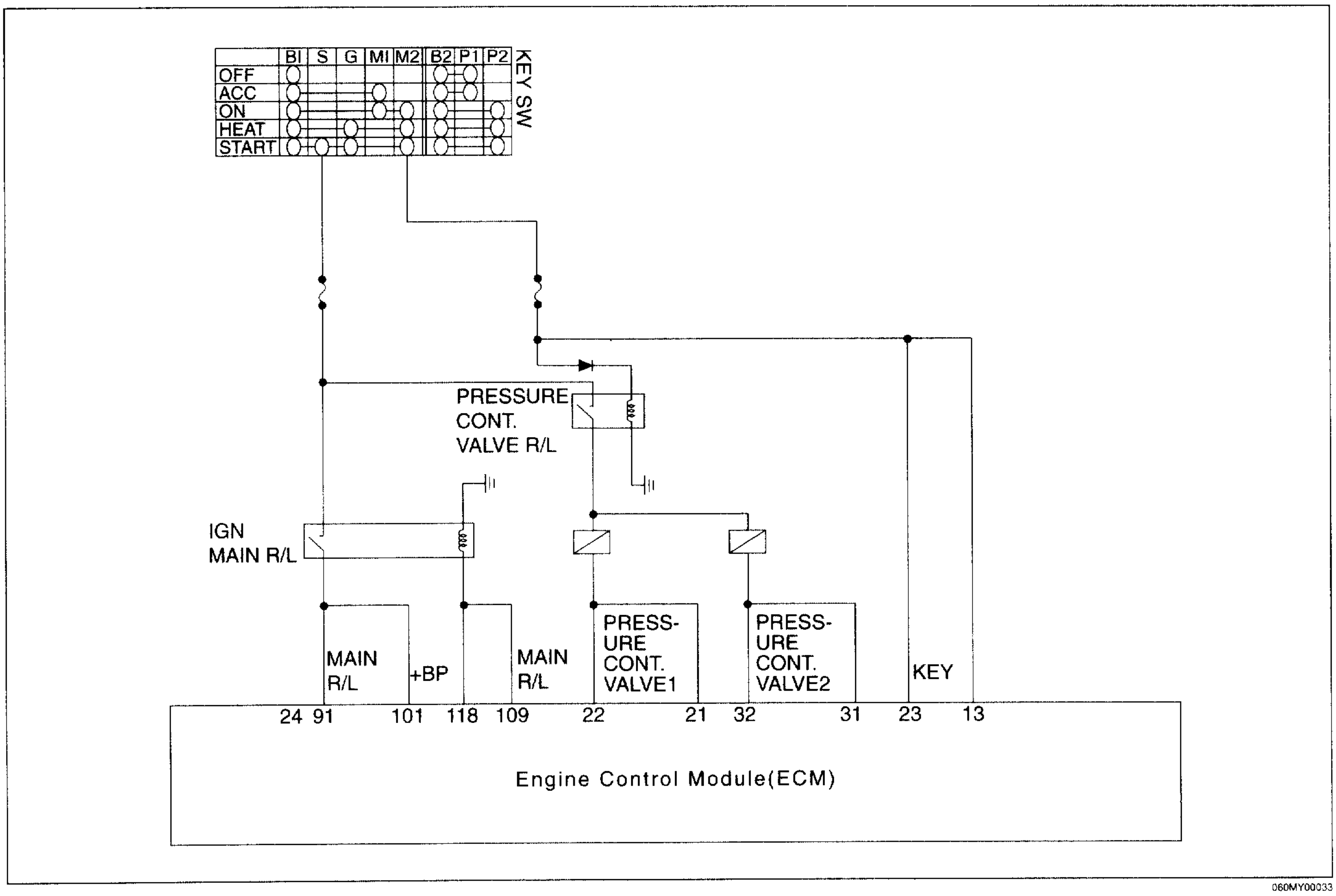
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to OBD System Check
2	Does DTC 0417 display while key switch "ON" and engine is running?	—	Go to step 3	—
3	Measure voltage between pin number 24 (STA) and GND while key switch "ON" and engine running. Does voltage indicate 12V.	12V always applied	Go to step 5	Go to step 4
4	Check wire harness and/or starter switch for shortage or starter switch melting (welding). Is any problem found?	—	Repair/replace wire harness starter switch Then go to step 5	Go to step 5
5	Clear all DTCs. Does DTC 0417 display?	—	Replace ECM assembly. Then go to step 6	System OK
6	Does DTC 0417 display?	—	Go back to step 3	System OK

***IMPORTANT:** The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.*

Starter Switch Abnormal



DTC 0421 PCV Relay (R/L) System Error



Circuit Description

PCV is used to adjust supply pump discharge amount so as to adjust common rail pressure. Discharge amount from the supply pump to the common rail is determined by PCV current timing.

PCV Relay is used for supply an electric current to the PCV.

Conditions for Setting the DTC

- If PCV driving voltage is present when the key is off it the circuit has a short to voltage condition.

Action Taken When the DTC Sets

- Only diagnostic code memory.

Conditions for Clearing the MIL/DTC

DTC 0421 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

Diagnostic Aids

Check for the following conditions:

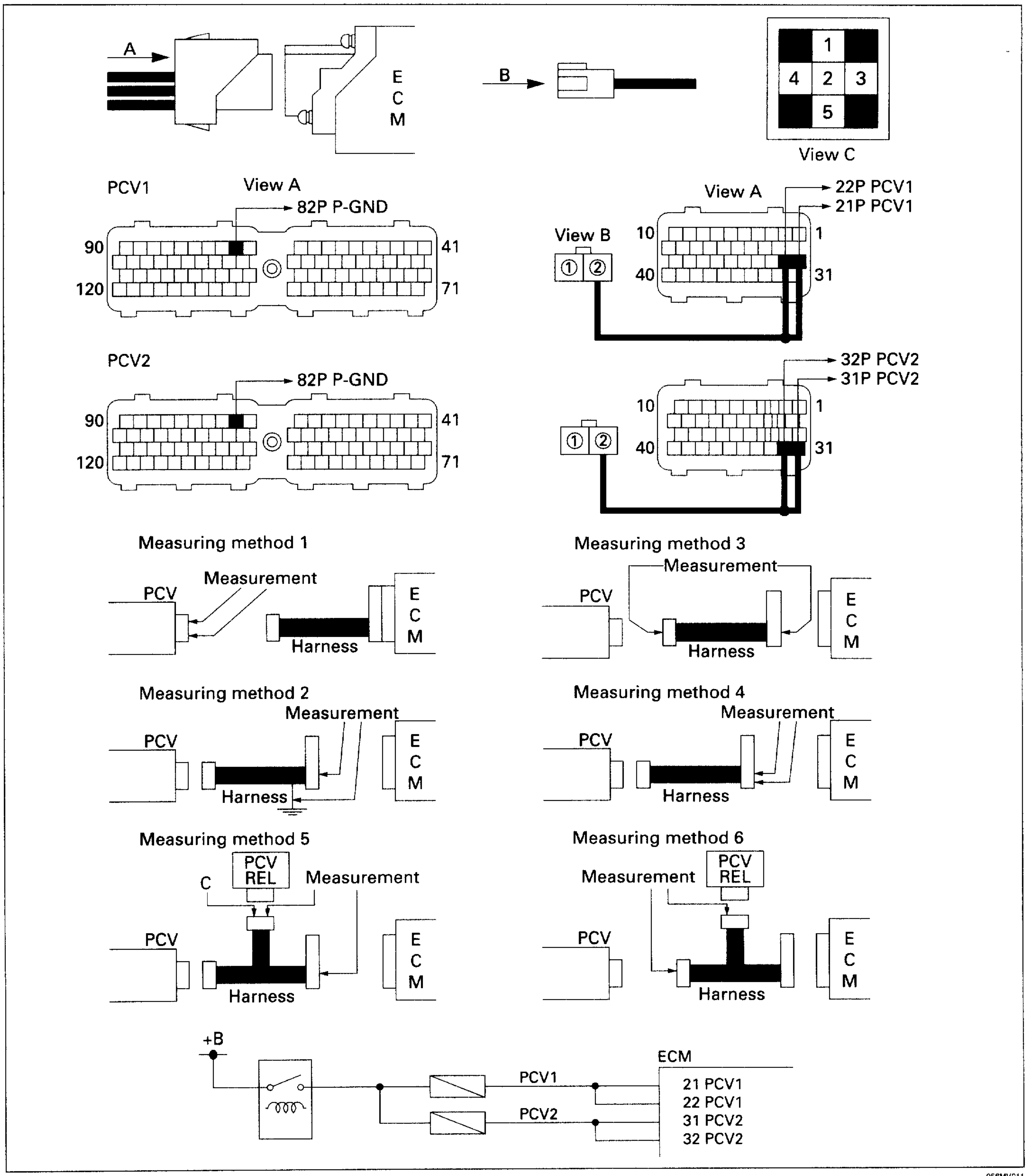
- Poor connection at PCV Relay – Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.

DTC 0421 PCV Relay (R/L) System Error

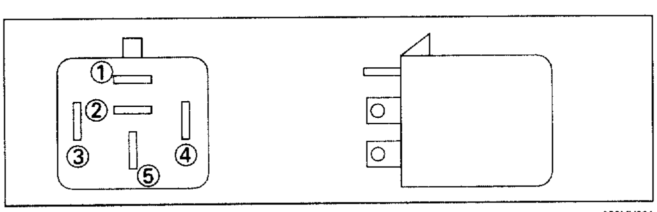
STEP	ACTION	VALUE	YES	NO
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2	Go to OBD System Check
2	Does DTC 0421 display while key switch is "ON" or engine is running?	—	Go to step 3	—
3	1. Key switch "OFF". 2. Disconnect PCV harness. 3. Measure voltage following points at the ECM connector. • Between pin number 21, 22 for PCV1 and pin number 82 for P–GND. • Between pin number 31, 32 for PCV2 and pin number 82 for P–GND. Is voltage at battery voltage?	Battery voltage	Go to step 6	Go to step 4
4	Contact point on relay is sticking intermittently. After DTC is cleared does the MIL indication code reads DTC 0421 display?	—	Go to step 5	Repair/replace PCV harness or PCV relay.
5	Does DTC 0421 display even if no change from LO (0V)?	—	Replace ECM.	System OK
6	1. Remove PCV relay. 2. Measure resistance between contact point 5 and 1. Is resistance within value?	100MΩ or more	Go to step 7	Replace PCV relay
7	Possible cause that the cable (Battery → R/L → PCV) on the side of PCV power supply short circuit to B+. 1. Key switch "OFF". 2. Disconnect PCV harness from PCV, PCV relay and ECM. 3. Measure voltage between pin number 1 at PCV relay side of PCV harness and pin number 82 (P–GND) at ECM side of PCV harness. (Measuring method 5) Is voltage within value?	Less than 1V	Go to step 8	Repair/replace PCV harness. Then go to step 8
8	Clear all DTCs. Does DTC 0421 display?	—	Go back to step 3	System OK

IMPORTANT: The replacement ECM must be restored the capture fuel rate data by Tech 2. Refer to "Capture and Restore Fuel Rate Data" of "Tech 2 Scan Tool" in this manual.

PCV1, 2 Relay (R/L) System Error

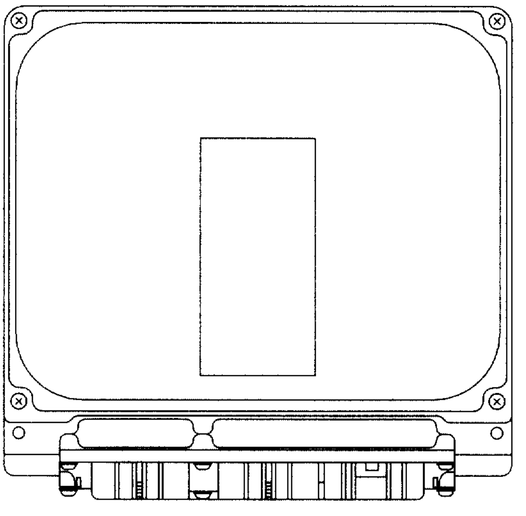


056MV011



056MV001

DTC 0543 Over Speed Condition (Not turn on MIL)



060MX113

Circuit Description

If the ECM detects over speed condition, then fuel injection stop.

Conditions for Setting the DTC

- At 4000 rpm or higher
- Fuel injection stops.
- Fuel pressure feed stops.

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

DTC 0543 can be cleared by using the "Clear Info" by scan tool or using by the Diag Clear Switch.

STEP	ACTION	VALUE	YES	NO
1	Does DTC 0543 display while key switch is "ON" or engine in operation?	—	Go to step 2	—
2	Ask driver if over speed condition was caused by gear slip-out, shift error, etc.	—	Misusage by owner or operator.	See Intermittent chart

ENGINE CONTROL MODULE (ECM) DESCRIPTION

The engine control module (ECM) is located in the compartment below the right seat. The ECM controls the following:

- Fuel system.
- Ignition timing.
- On-board diagnostics for powertrain 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 MIL (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 resistances 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. Too J 39200 meets this requirement. The ECM controls output circuits such as the injectors, ISC, 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 Voltage Description

The ECM supplies a buffered voltage to various switches and sensor. It can do this because resistance in the ECM is 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 J 39200) 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 and 7, called either a surface-mounted quad driver module (QDM), which can independently control up to 4 output terminals, or QDMs which can independently control up to 7 outputs. Not all outputs are always used.

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 J 39200. The ECM should remain connected to the ECM or to a recommended breakout box.

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.

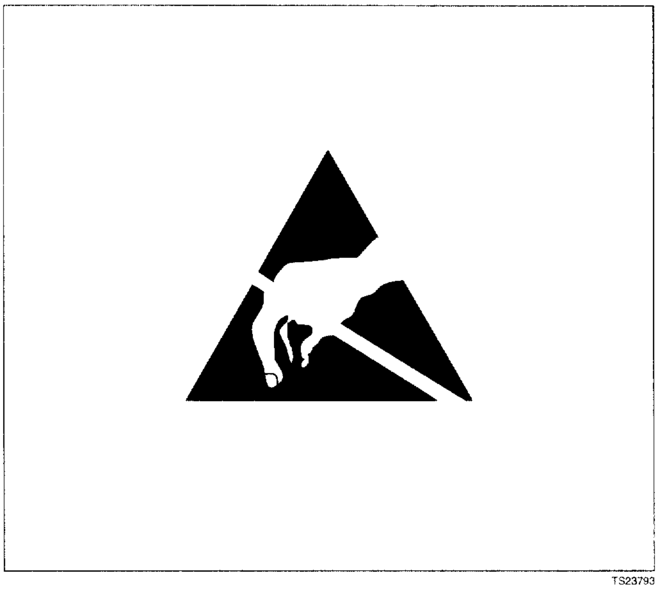
NOTE: No add-on vacuum equipment should be added to this vehicle.

Note: 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 powertrain 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 powertrain 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 mush as 4000 volts for a person to feel even the zap of a static discharge.



TS23793

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 momentary 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.

NOTE: To prevent possible electrostatic discharge damage, follow these guidelines:

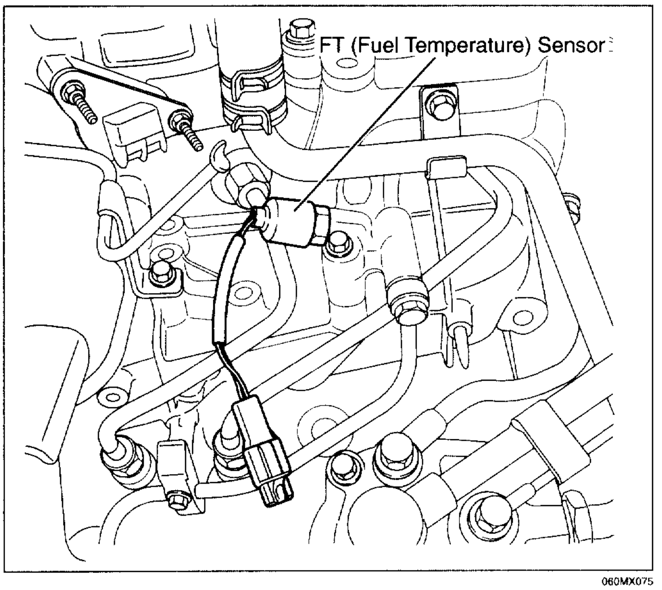
- Do not touch the ECM connector pins or soldered components on the ECM circuit board.
- Do not touch the knock sensor module component leads.
- Do not open the replacement part package until the part is ready to be installed.
- Before removing the part from the package, ground the package to a known 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.

ON-VEHICLE SERVICE

Fuel Temperature (THF) Sensor

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the clip from resonator.
3. Remove the resonator.
4. Disconnect the electrical connector to the Fuel Temp. Sensor.



060MX075

5. Loosen the Fuel Temp. retaining bolt.
6. Remove the Fuel Temp. sensor.

Inspection Procedure

1. Inspect the sensor for worn or damage.
2. Replace the sensor if it is worn or damaged.
3. Inspect the packing for cracks or leaks.
4. Replace the packing if it is worn or damaged.

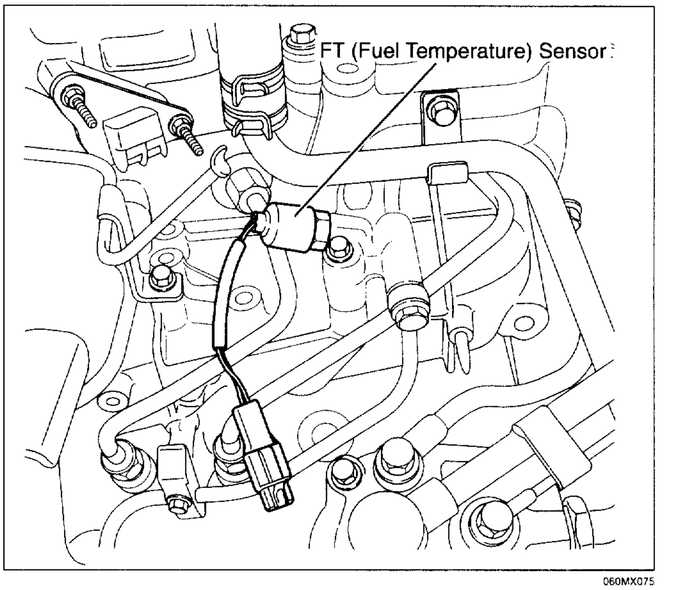
Installation Procedure

1. Install the Fuel Temp. sensor.
2. Install the Fuel Temp. sensor retaining bolt.

Tighten

- Tighten the retaining bolt to 19.6 N·m (173 lb·in)

3. Connect the electrical connector to the Fuel Temp. sensor.



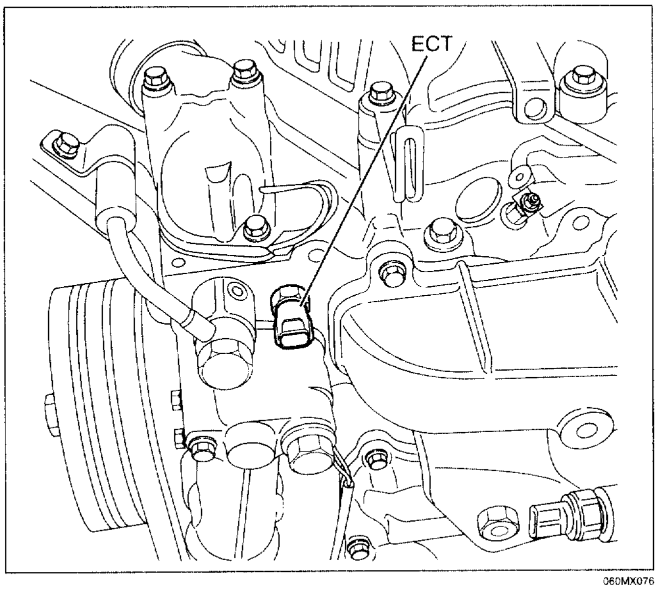
060MX075

4. Install the resonator.
5. Install the clip to the resonator.
6. Connect the negative battery cable.

ECT Sensor

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the electrical connector to the ECT sensor.

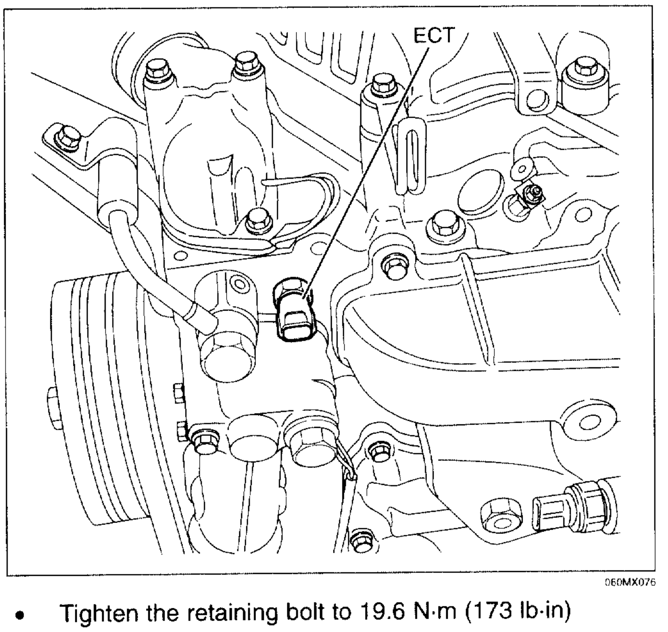


3. Loosen the ECT retaining bolt.
4. Remove the ECT sensor.

Installation Procedure

1. Install the ECT sensor.
2. Install the ECT sensor retaining bolt.

Tighten



- Tighten the retaining bolt to 19.6 N·m (173 lb·in)

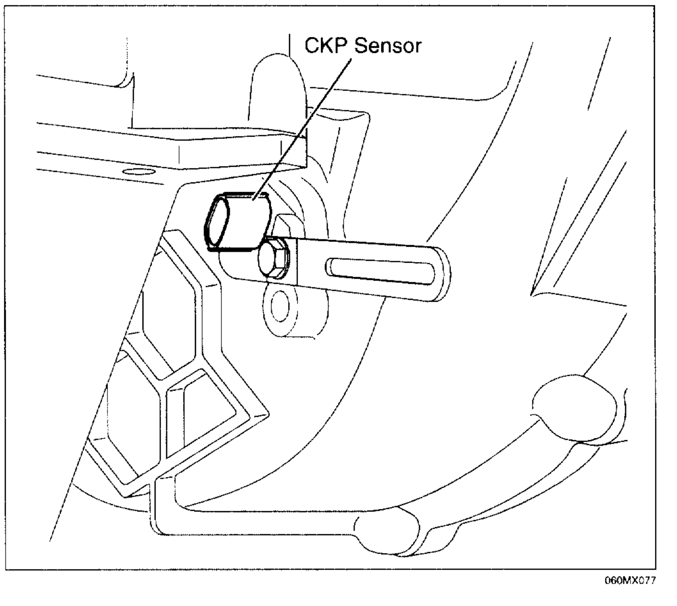
3. Connect the electrical connector to the ECT sensor.
4. Connect the negative battery cable.

CKP (Crank Position) Sensor

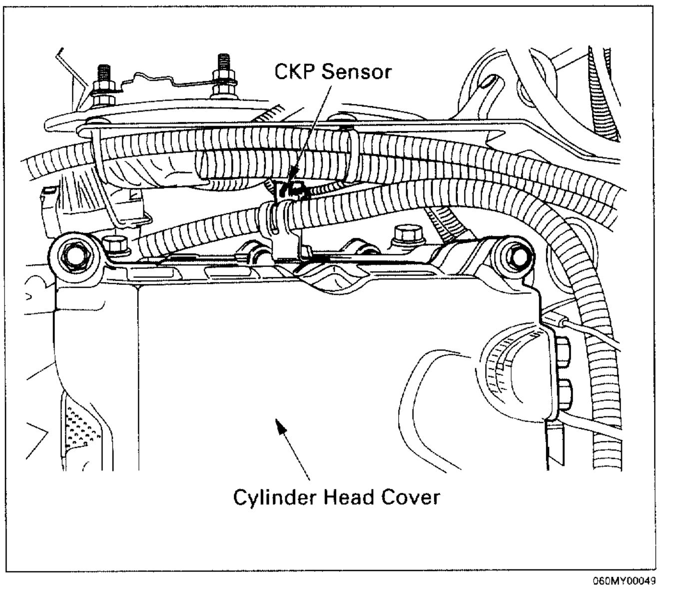
Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the electrical connector to the CKP sensor.
3. Loosen the CKP retaining bolt.

Transmission Type : M/T



Transmission Type : A/T



4. Remove the CKP sensor with clip.

Inspection Procedure

1. Inspect the sensor for worn or damage.
2. Replace the sensor if it is worn or damaged.

Installation Procedure

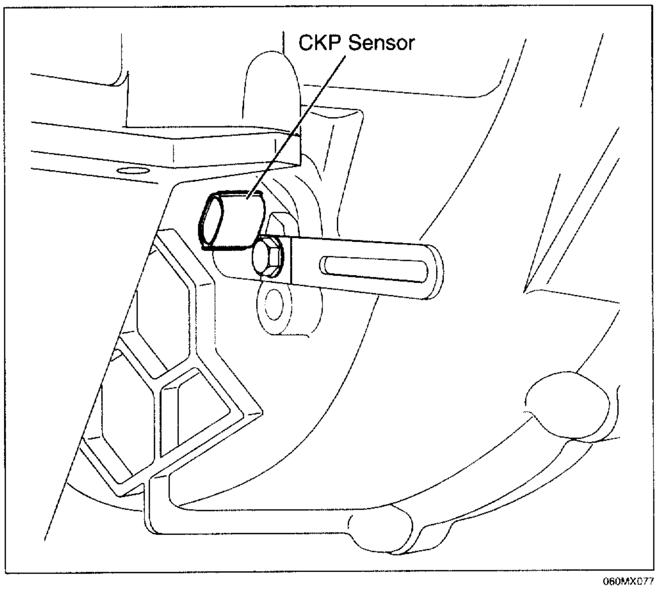
1. Install the CKP sensor.
2. Install the CKP sensor retaining bolt.

Tighten

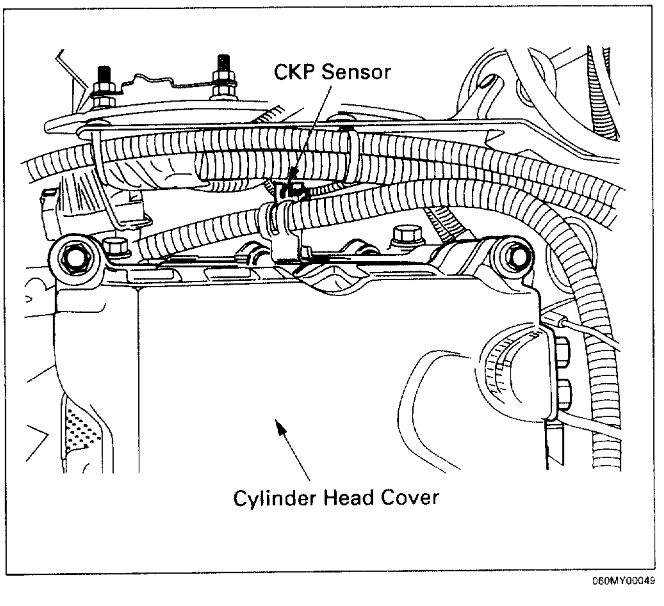
- Tighten the retaining bolt to 5.9 N·m (52 lb·in)

3. Connect the electrical connector to the CKP sensor.

Transmission Type : M/T



Transmission Type : A/T



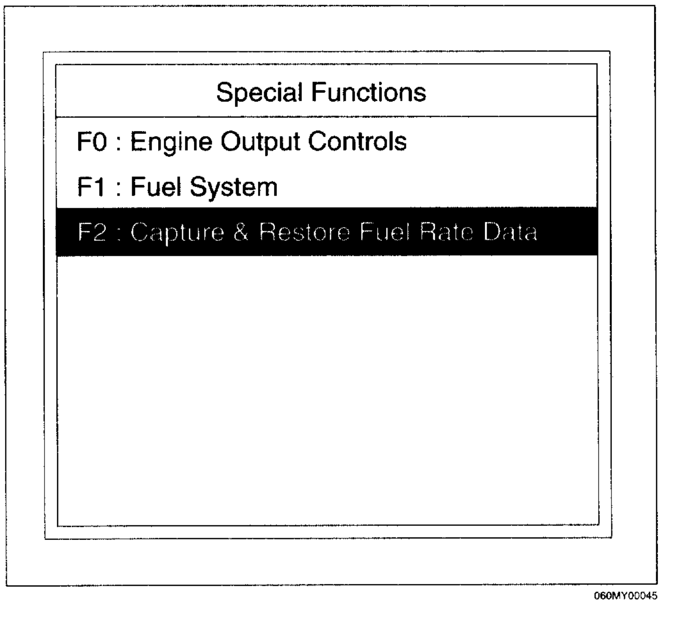
4. Connect the negative battery cable.

ECM

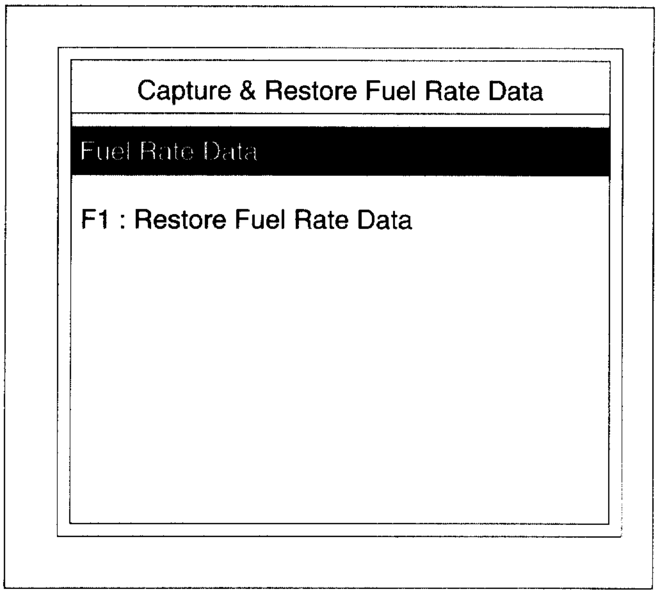
IMPORTANT; The replacement ECM must be stored the capture fuel rate data by scan tool.

FRR ECM Replace procedure

1. Ignition "ON", Engine "OFF".
2. Tech2 "ON".
3. Push "ENTER" key, when the "Tech2" appeared display screen.
4. Operate "△" or "▽" key, put on the hi-light bar to the "F0: Diagnostic".
5. Operate "△" or "▽" key, put on the hi-light bar to the "(Y)2000", and push "ENTER" key.
6. Select "ISUZU", and push "ENTER".
7. Select "F0: Power Train" and push "ENTER".
8. Select "7.6L L6 LG4" by operating "△" or "▽" key.
9. Select "Automatic".
10. Select "F2: Special Functions" by operating "△" or "▽" key, and push "ENTER" key.
11. Select "F2: Capture & Restore . . . . ." by operating "△" or "▽" key, and push "ENTER" key.

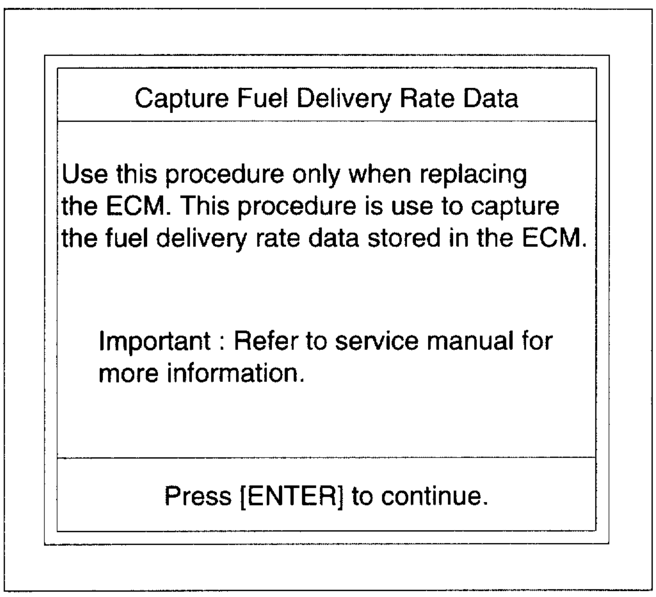


12. Select "F0: Capture Fuel Rate . . . . ." by operating "△" or "▽" key, and push "ENTER" key.



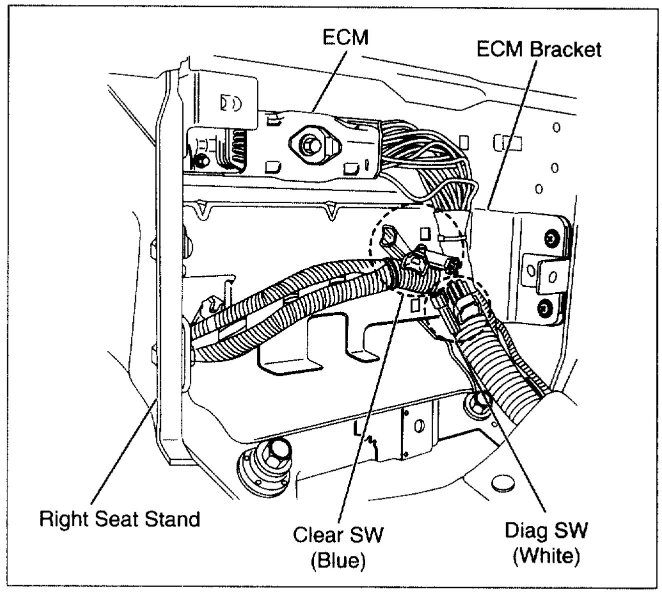
050MY00045

13. The message will be appeared on the Display Screen, and push "ENTER" key few times.
    When the Up Load was successfully, the message "Fuel Delivery rate data capture complete.



060MY00045

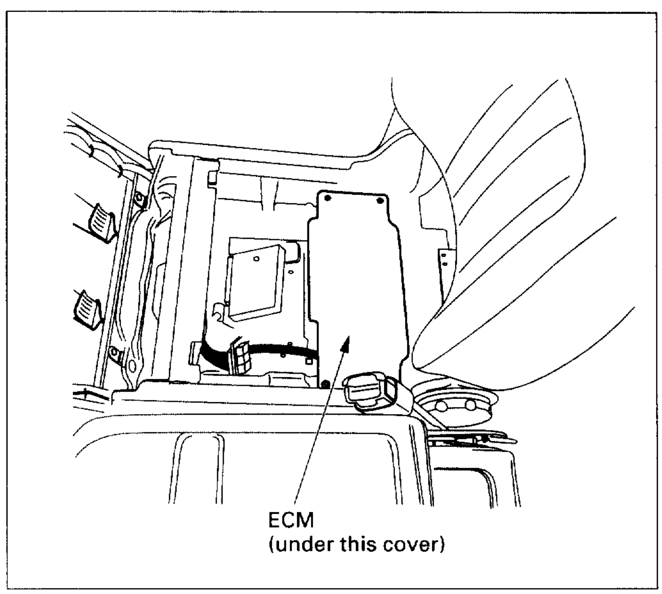
14. Tech2 "OFF" after this message appeared.
15. Ignition "OFF".
16. It replace ECM to a new on. (Vehicle Type: FRR)
    - Push the seat to behind.
    - Remove the four screws from Right seat stand.
    - Pull the ECM straight out with bracket.
    - Loosen the bracket retaining screws at the ECM.
    - Remove the bracket from ECM.
    - Loosen the electrical connector retaining bolt.
    - Disconnect the electrical connector from the ECM.



060MX033

- Connect the electrical connector at the new ECM.
- Tighten the electrical connector retaining bolt to 2 N·m (17 lb in)
- Install the bracket at the new ECM.
- Install the new ECM.

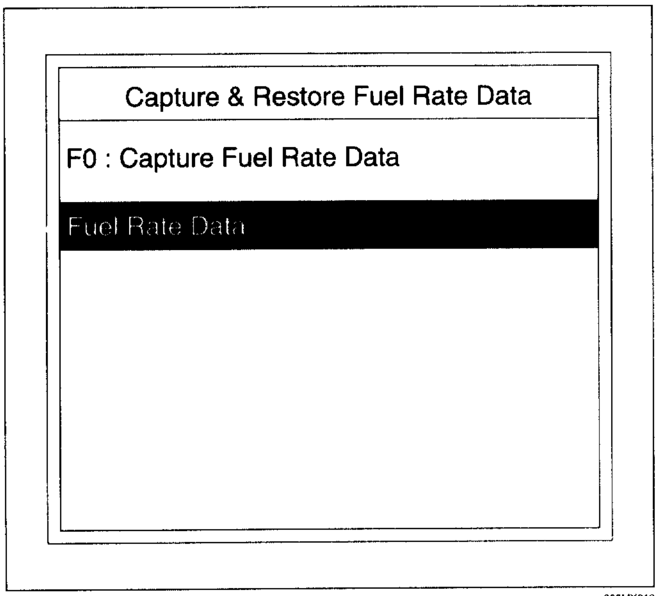
17. It replace ECM to a new on. (Vehicle Type: FSR, FTR, FVR)
    - Pull up the cushion of passenger seat.
    - Remove the four screws from the ECM panel.
    - Loosen the ECM panel retaining screws at the ECM.
    - Remove the ECM panel from the ECM.
    - Loosen the electrical connector retaining bolt.
    - Disconnect the electrical connector from the ECM.



060MY00021

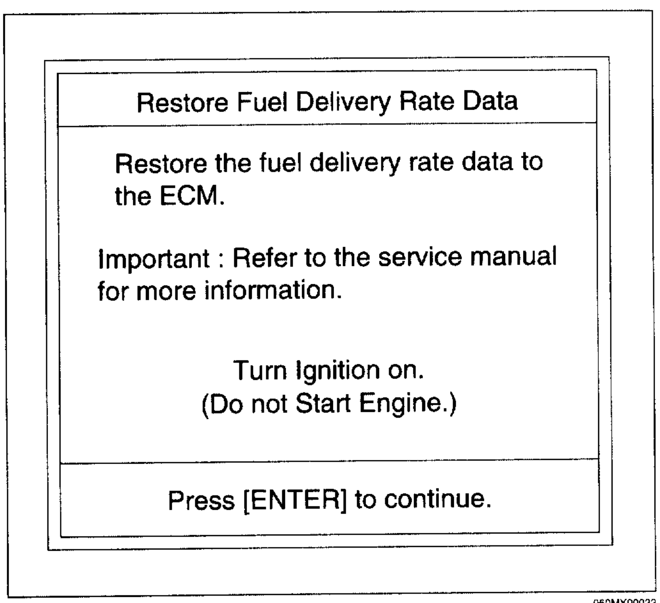
- Reconnect the electrical connector at the new ECM.
- Tighten the electrical connector retaining bolt to 2 N·m (17 lb in)
- Install the ECM panel the new ECM.
- Install the new ECM.
  Down the cushion of the passenger seat.

18. Ignition "ON", Tech2 "ON".
19. Repeat from Item 3 to 11 (This procedure).
20. Select "F1: Restore Fuel Rate . . . . ." by operating "△" or "▽" key, and push "ENTER" key, and push "ENTER" key.



060MX013

21. Push "ENTER" key following message few times, when some message will be appeared.



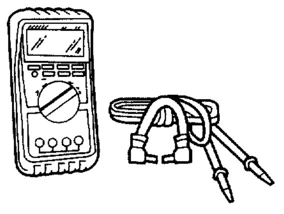
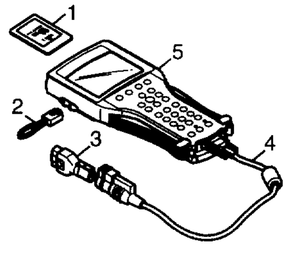
060MY00022

When the "Fuel delivery rate data storage complete" was appeared, the procedure was successfully completed".

At this moment the "Self Diagnosis Lamp" will be turned off.

NOTE: Unfortunately if you have failed, return to the initial menu screen by operating the "ENTER" key and repeat again.
There is a possibility to be appeared some information in relation to failure.
Also in this case, by operating "EXIT" key, return to the initial menu screen and then repeat from first step.

SPECIAL TOOLS

ILLUSTRATION	**TOOL NO.** TOOL NAME
 TS22900	**J 39200** High Impedance Multimeter (Digital Voltmeter – DVM)
 901RW181	(1) PCMCIA Card (2) RS232 Loop Back Connector (3) SAE 16/19 Adapter (4) DLC Cable (5) TECH-2

SECTION 6J

TURBOCHARGER

NOTICE: *Always use the correct fastener in the correct 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.*

CAUTION: *Turbochargers operate at high speeds and temperature. Do not operate the engine and/or turbocharger without all normally installed inlet piping and filters, along with all exhaust piping. Failure to install the above components could result in personal injury and damage to the vehicle.*

CONTENTS

GENERAL DESCRIPTION

The turbocharger is used to increase the amount of air that enters the engines cylinders. This allows a proportional increase of fuel to be injected into the cylinders, resulting in increased power output, more complete combustion of fuel and increased cooling of the cylinder heads, pistons, valves, and exhaust gas. This cooling effect helps extend engine life.

Heat energy and pressures in the engine exhaust gas are utilized to drive the turbine. Exhaust gas is directed to the turbine housing. The turbine housing acts as a nozzle to direct the exhaust gas flow to the turbine wheel blades which drive the shaft wheel assembly. Since the compressor wheel is attached directly to the shaft, it rotates at the same speed as the turbine wheel. Clean air from the air cleaner and crankcase vapors are drawn into the compressor housing and wheel where it is compressed and delivered through a crossover pipe to the engine air intake manifold and then into the cylinders. The inside of the turbocharger compressor housing, compressor wheel, and the inside of the intake manifold can be quite oily due to the ingestion of the crankcase vapors. The amount of air pressure rise and air volume delivered to the engine from the compressor outlet is regulated by a waste gate valve in the exhaust housing.

The position of the waste gate valve is controlled by the amount of pressure built up on the intake side of the turbocharger. The diaphragm on the inside of the waste gate is pressure sensitive, and controls the position of the valve inside the turbocharger. The position of the valve will increase or decrease the amount of boost to the turbocharger.

The Charger Air Cooler also helps the performance of the ISUZU diesel. Intake air is drawn through the air cleaner and into the turbocharger compressor housing. Pressurized air from the turbocharger then flows forward through the charge air cooler (intercooler) located in the front of the radiator. From the charge air cooler (intercooler), the air flows back into the intake manifold.

The charger air cooler (intercooler) is a heat exchanger that uses air flow to dissipate heat from the intake air. As the turbocharger increases air pressure, the air temperature increases. Lowering the intake air temperature increases the engine efficiency and power.

ON-VEHICLE SERVICE

CHARGE AIR COOLER

Remove or Disconnect (Figure 1)

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Clamps from the charge air intake hose.
4. Hose from the intake manifold inlet pipe and the charge air cooler.
5. Clamps from the air inlet hose.
6. Hose from the charge air cooler and the turbocharger inlet.
7. Mounting bolts from the charger air cooler to the radiator.
8. Charger air cooler from the radiator.

Install or Connect (Figure 1)

1. Charge air cooler to the radiator.
2. Mounting bolts to the radiator.

Tighten

- Bolts to 45 N·m (33 lb·ft.).

3. Hose to the charge air cooler and the turbocharger inlet.
4. Hose to the charge air cooler and the intake manifold inlet pipe.
5. Tighten the hose clamps.

Tighten

- Hose clamps to 6 N·m (53 lb.·in.).

6. Negative battery cables.
7. Lower the cab.

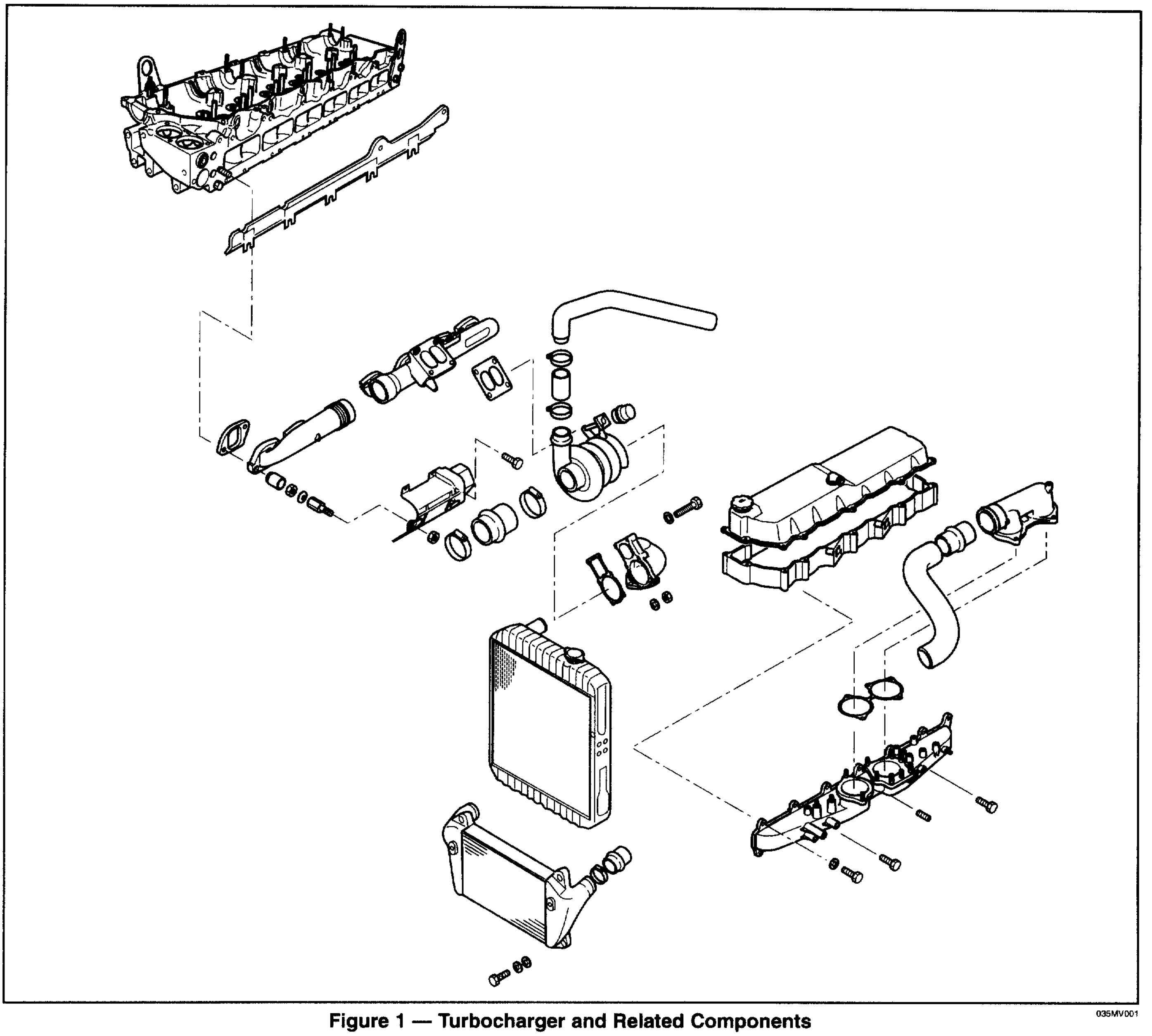
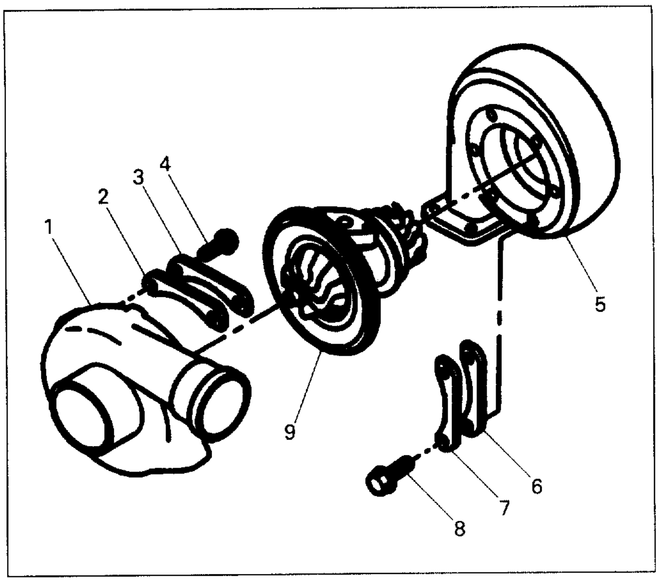


Figure 1 — Turbocharger and Related Components



Legend
(1) Compressor Housing
(2) Clamp
(3) Lock Plate
(4) Bolt
(5) Turbine Housing
(6) Clamp
(7) Lock Plate
(8) Bolt
(9) Center Section Assembly

Figure 2 – Turbocharger Internal Components

TURBOCHARGER

The turbocharger assembly consists of the turbocharger housing, internal components, the waste-gate actuator, exhaust elbow, and heat shield.

Remove or Disconnect (Figures 1 and 3)

1. Tilt the cab. Refer to SECTION 0A.
2. Negative battery cables. Refer to SECTION 6D1.
3. Air inlet hose from the air intake duct.
4. Air inlet hose from the turbocharger.
5. Air inlet from the charge air cooler.
6. Exhaust from the turbocharger. Refer to SECTION 6F.
7. Heat shield at the starter.
8. Coolant feed line.
9. Coolant return line.
10. Oil feed line.
11. Oil return line.
12. Exhaust manifold. Refer to SECTION 6A6.
13. Exhaust manifold with the turbocharger.
14. Turbocharger from the exhaust manifold.

Inspect

- Turbocharger for any cracks at the gasket mating surfaces.
- Compressor blades for damage or carbon build up.

Measure

- Bearing radial clearance: Use a dial indicator with an offset plunger and a magnetic base.
  Adjust the plunger so that it touches the turbocharger main shaft and readjust the gauge to zero.
- Hold the turbocharger, and move the compressor wheel up and down and read the radial clearance. Clearance should be 0.076 to 0.152 mm (0.0030 to 0.0060 in.).
- Compressor end plug: Use a dial indicator with a magnetic base. Adjust the plunger so that it touches the turbocharger main shaft and readjust the gauge to zero.
- Move the turbocharger mainshaft back and forth and read the end play. Clearance should be 0.025 to 0.076 mm (0.0010 to 0.0030 in.).
- If the bearing radial clearance, or the compressor end play is out of specifications, replace the turbocharger center section assembly, item (9).

Important

- Scribe an alignment mark across the compressor housing, center assembly and the turbine housing. These parts must be reassembled in the original location.

Disassemble

1. Bolts, lock plates and clamps from the turbocharger.
2. Compressor housing.
3. Turbine housing.

Important

- Handle to center assembly with care. The assemble is precisely balanced. Even minor scratches or distortion can cause a malfunction.
- Do not attempt to disassemble the center assembly. Replace as a unit if faulty.

Assemble

1. Turbine housing to the center assembly.
   Align the marks made at disassembly.
2. Compressor housing to the center assembly.
3. Clamps, plates and bolts.

Tighten

- Bolts to the compressor housing to 23 N·m (17 lb·ft.).
- Bolts to the turbine housing to 23 N·m (17 lb·ft.).

Inspect

- Assembly for proper operation. Turn the compressor wheel by hand. The wheels must rotate freely, without binding or noise.

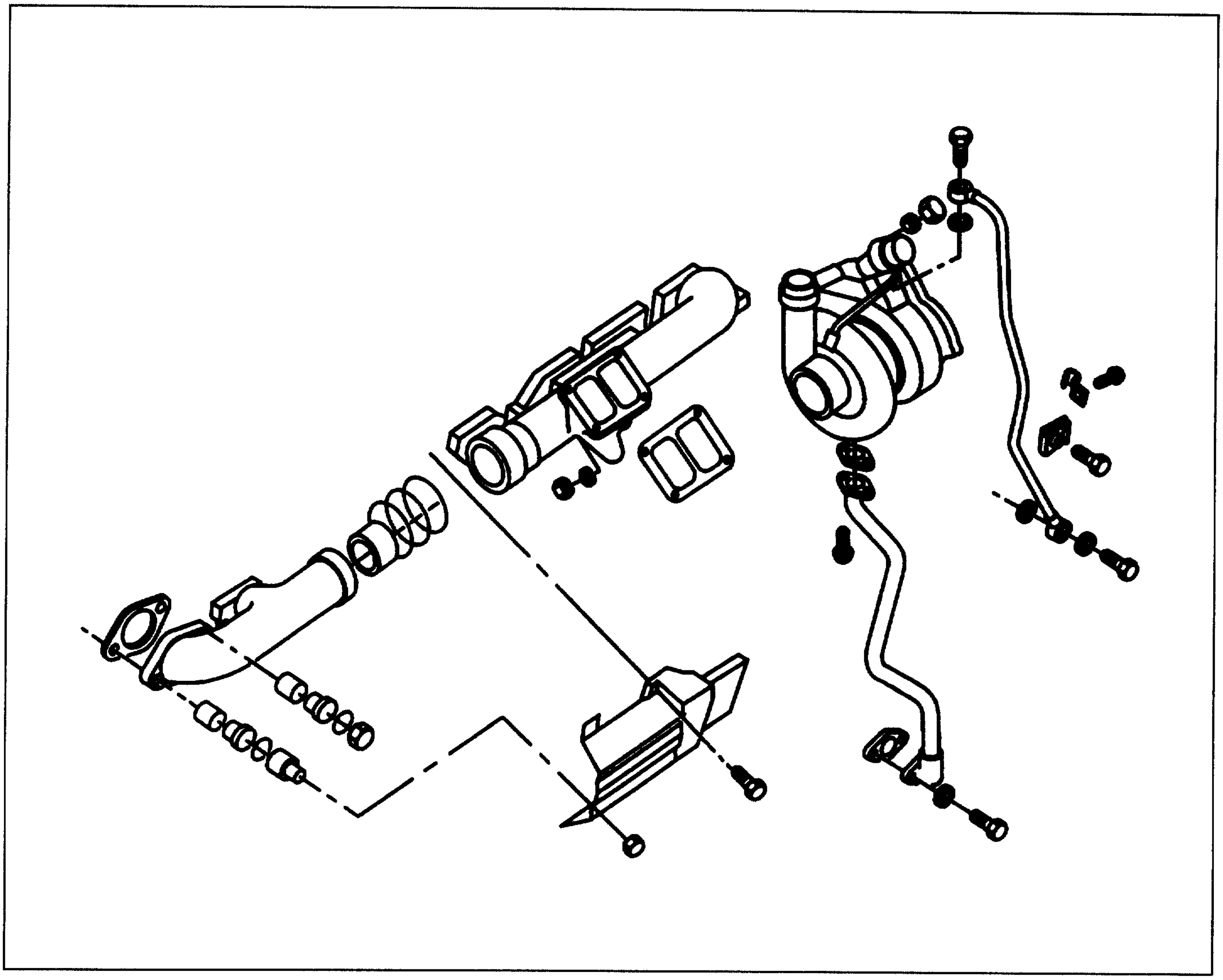


Figure 3 — Turbocharger Mounting

Install or Connect (Figures 1 and 3)

1. Gasket with the plain side towards the exhaust manifold.
2. Turbocharger to the exhaust manifold.
3. Washer and nuts to the exhaust manifold studs.

Tighten

- Nuts to 52 N·m (38 lb·ft.)

4. Oil drain tube and the gaskets to the turbocharger and the oil pan.

Tighten

- Bolts to 27 N·m (20 lb·ft.)

Tighten

- Prelubricate the turbocharger bearings with 4 fluid ounces of clean engine oil. Pour the clean engine oil into the oil feed port.
- Turn the compressor wheel by hand to distribute the oil in the turbocharger. Failure to do so could cause damage to the turbocharger.

5. Oil feed line to the turbocharger.
6. Joint bolt to the oil feed line.

Tighten

- Joint bolt to 18 N·m (13 lb·ft.)

7. Gasket to the exhaust pipe adapter.
8. Exhaust pipe adapter to the turbocharger.
9. Bolts and washers.

Tighten

- Bolts to 26 N·m (19 lb·ft.)

10. Heat shield to the starter.
11. Coolant feed lines.
12. Coolant return lines.
13. Air inlet hose to the charge air cooler.
14. Air inlet hose to the turbocharger.
15. Air inlet hose to air intake duct.
16. Negative battery cables.
17. Lower the cab.

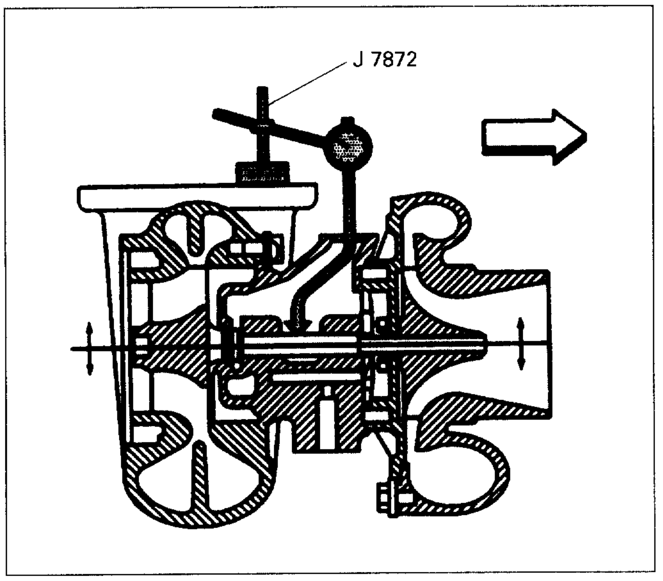


Figure 4 – Measuring Bearing Radial Clearance

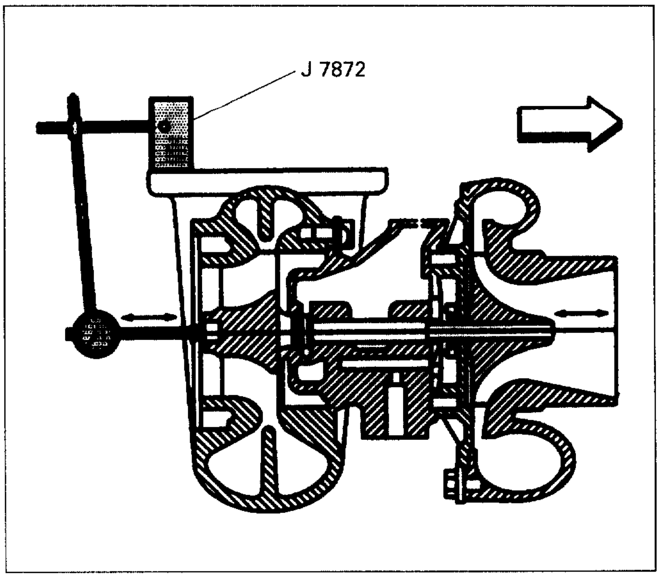


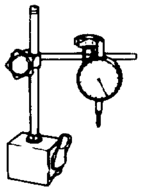
Figure 5 – Measuring Compressor End Play

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N·m	lb·ft	lb·in
Charge Air Cooler Hose Clamp	6	–	53
Charge Air Cooler Mounting Bolt	45	33	–
Charge Air Tube Bolt	37	27	–
Compressor Housing Bolt	23	17	–
Exhaust Manifold	34	25	–
Exhaust Pipe Adapter to the Exhaust Manifold Bolt	26	19	–
Turbine Housing Bolt	23	17	
Turbocharger Drain Line Bolt (to the Turbocharger)	27	20	–
Turbocharger Drain Line Bolt (to the Cylinder Block)	18	13	–
Turbocharger Feed Lines Bolt (to the Turbocharger)	18	13	–
Turbocharger Feed Lines Bolt (to the Cylinder Block)	18	13	–
Turbocharger to the Exhaust Manifold Nut	52	38	–

SPECIAL TOOLS

ILLUSTRATION	TOOL NO. TOOL NAME
 J7872	**J7872** Magnetic Base Indicator Set

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