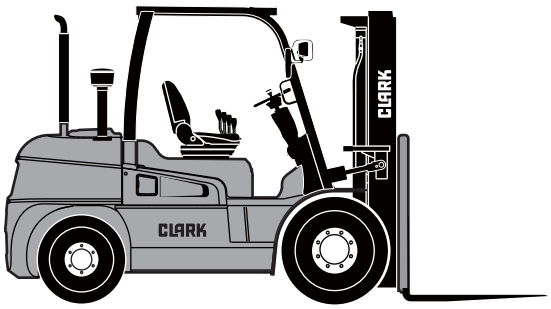
SERVICE MANUAL

C 40/45/50s/55s D
C 40/45/50s/55s L

Capacity : 4000-5500 kg



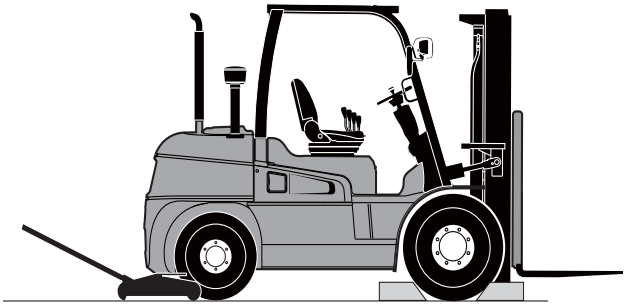
Part No. 8112926
Book No. SM 942 (Rev 1.6)
Nov. 2019

CLARK THE FORKLIFT 100 Years EST. 1917

CLARK
THE FORKLIFT

CLARK MATERIAL HANDLING INTERNATIONAL
215, Ojeong-ro, Bucheon-Si, Gyeonggi-do, Korea
Tel: 82-32-680-6300 [www.clarkmhc.co.kr]

2. Put a floor jack under the steer axle mounting frame member, centered between the two wheels.



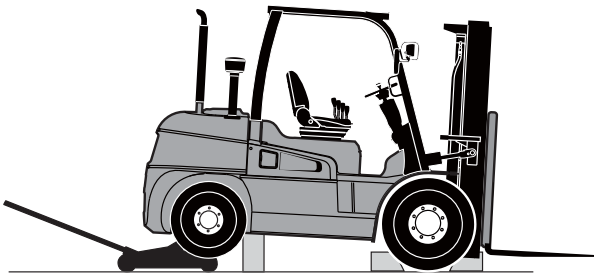
WARNING

Never lift the truck by the counterweight.

NOTE

If there is insufficient clearance under frame for your jack, the truck may first be driven onto shims, such as 25 x 150 x 300 mm (1 x 6 x 12 in) pieces of board, to increase the truck frame underclearance.

3. Raise the truck only as high as necessary to perform the maintenance work.
4. Put blocks at both sides of the truck, fully under the frame main side structure. Put the blocks in front of but close to the counterweight and steer wheels for best truck stability.



Put an equal amount of blocks under each side of the truck to provide a level working position.

5. Lower the truck onto the blocks and remove the jack.

CAUTION

Before performing any maintenance work, check the truck for stable condition on the blocking.

6. When maintenance work is completed, lower the rear of truck to the floor by reversing the above procedure and lowering each side of the truck 50 mm (2 in) at a time:
   - Put jack under frame and raise truck.
   - Carefully remove blocks and lower truck.
   - Remove jack and blocks from drive wheels.

Raising Entire Truck

Refer to truck data plate for truck weights.

1. Park truck safely as described in “Safe Parking.” Lower upright fully.
2. If necessary, drive truck onto boards to increase underclearance.

WARNING

SIDE-TO-SIDE TIPOVER. When jacking side of truck, be sure upright is lowered fully and do not raise one side of the truck more than about 50 mm (2 in) higher than the other, to avoid tipping truck over laterally.

END-TO-END TIPOVER. If the upright and transaxle are removed while the truck is blocked up, the truck will tip backwards due to the heavy counterweight. Both upright and counterweight must be removed before attempting to raise the truck for transaxle removal. The back of the truck must be supported by blocking under the steer axle to prevent movement.

The reverse is also true. If the counterweight is removed while the truck is up on blocks, the weight of the upright and transaxle will cause the truck to tip on the front blocks and fall forward.

Section 2

The Planned Maintenance Program

This Section defines a set of basic service procedures, known as the “Planned Maintenance Program”, and describes systematic approach for performing them.

GROUP 00 (D-KUBOTA)

ENGINE

(KUBOTA - TIER 3)

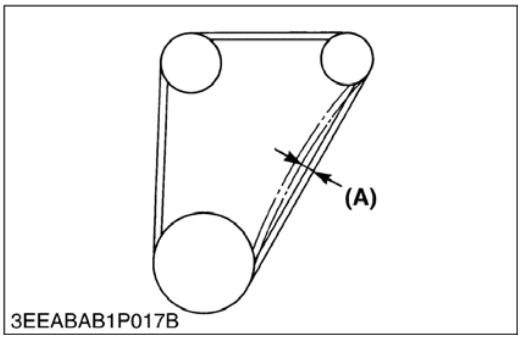
[4] CHECK POINTS OF EVERY 250 HOURS

Fan Belt Tension

1. Measure the deflection (A), depressing the belt halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbs).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

Deflection (A)	Factory spec.	10 ~ 12 mm 0.394 ~ 0.472 in.

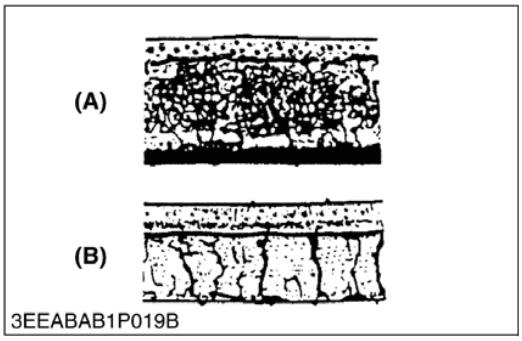
(A) Deflection

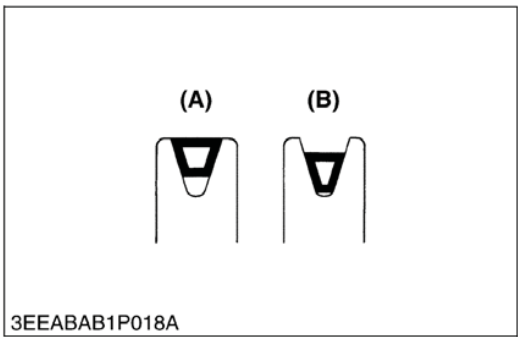


Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

(A) Good (B) Bad



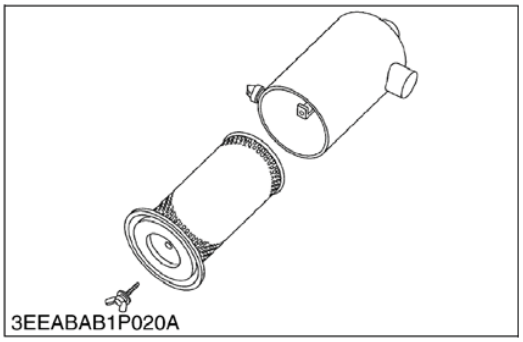


Cleaning Air Cleaner Element

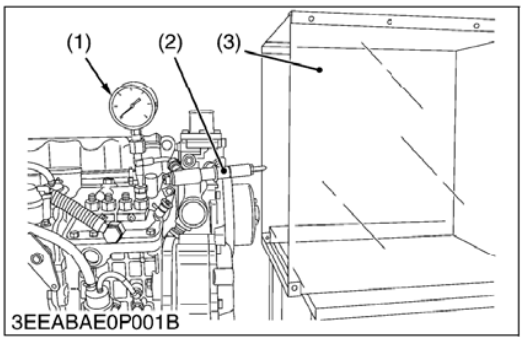
1. Remove the air cleaner element.
2. Use clean dry compressed air on the inside of the element.
   Pressure of compressed air must be under 205 kPa (2.1 kgf/cm2, 30 psi).
   Maintain reasonable distance between the nozzle and the filter.

NOTE

- **The air cleaner uses a dry element. Never apply oil to it.**
- **Do not run the engine with filter element removed.**
- **Change the element once a year or every 6th cleaning.**



Checking Injection Pump



(Fuel Tightness of Pump Element)

1. Remove the engine stop solenoid.
2. Remove the injection pipes.
3. Install the injection pump pressure tester to the injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Run the starter to increase the pressure.
7. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

(Fuel Tightness of Delivery Valve)

1. Remove the engine stop solenoid.
2. Remove the injection pipes.
3. Set a pressure tester to the fuel injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1).
5. Run the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. After that, turn the flywheel by the hand and raise the pressure to approx. 18.63 MPa (190 kgf/cm2, 2702 psi).
7. Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop from 18.63 to 17.65 MPa (from 190 to 180 kgf/cm2, from 2702 to 2560 psi).
8. Measure the time needed to decrease the pressure from 18.63 to 17.65 MPa (from 190 to 180 kgf/cm2, from 2702 to 2560 psi).
9. If the measurement is less than allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Fuel tightness of pump element	Allowable limit	18.63 MPa 190 kgf/cm² 2702 psi
Fuel tightness of delivery valve	Factory spec.	10 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm² 2702 → 2560 psi
	Allowable limit	5 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm² 2702 → 2560 psi

NOTE

Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubotaauthorized pump service shop.

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

[2] BOTTOM BYPASS SYSTEM

Bottom bypass system is introduced in V3 series for improving the cooling performance of the radiator.

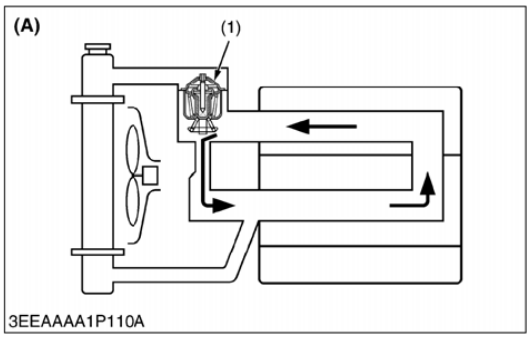
While the temperature of coolant in the engine is low, the thermostat is held closed and the coolant is allowed to flow through the bypass pipe and to circulate in the engine.

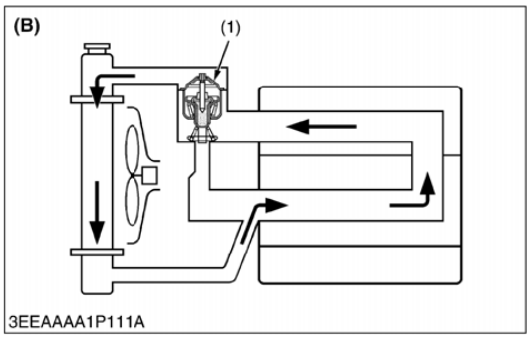
When the temperature exceeds the thermostat valve opening level, the thermostat fully opens itself to prevent the hot coolant from flowing through the bypass into the engine.

In this way, the radiator can increase its cooling performance.

(1) Thermostat

(A) Bypass Opened
(B) Bypass Close





Section 4

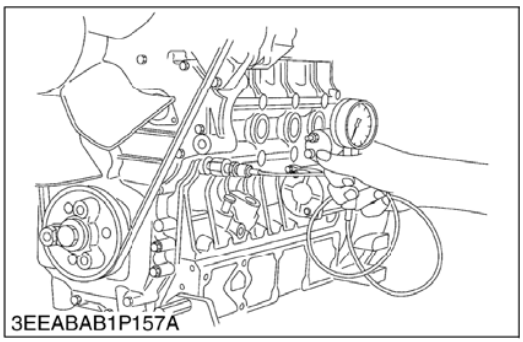
Servicing

1. TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	No fuel	Replenish fuel	
	Air in the fuel system	Vent air	
	Water in the fuel system	Change fuel and repair or replace fuel system	-
	Fuel hose clogged	Clean or replace	
	Fuel filter clogged	Replace	
	Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	
	Fuel with low cetane number	Use specified fuel	
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	
	Incorrect injection timing	Adjust	
	Fuel camshaft worn	Replace	
	Injection nozzle clogged	Repair or replace	
	Injection pump malfunctioning	Repair or replace	
	Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	-
	Compression leak from cylinder	Replace head gasket, tighten cylinder head screw and nozzle holder	
	Improper valve timing	Correct or replace timing gear	
	Piston ring and cylinder worn	Replace	
	Excessive valve clearance	Adjust	
	Stop solenoid malfunctioning	Replace	
Starter Does Not Run	Battery discharged	Charge	
	Starter malfunctioning	Repair or replace	
	Key switch malfunctioning	Replace	-
	Wiring disconnected	Connect	-

(2) Lubricating System

Engine Oil Pressure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1. Remove the oil switch and set a pressure tester (Code No. 07916-32032).
2. Start the engine. After warming up, measure the oil pressure of both idling and rated speeds.
3. If the oil pressure is less than the allowable limit, check the following.
   - Engine oil insufficient
   - Oil pump defective
   - Oil strainer clogged
   - Oil filter cartridge clogged
   - Oil gallery clogged
   - Excessive oil clearance
   - Foreign matter in the relief valve

(When reassembling)

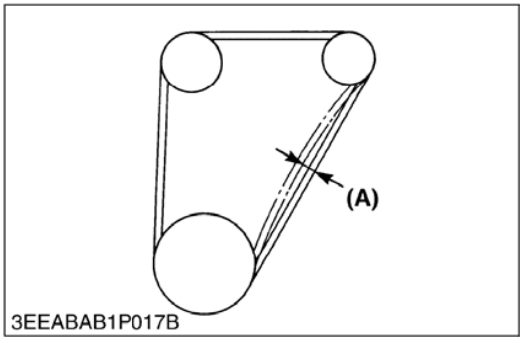
After checking the engine oil pressure, tighten the engine oil pressure switch to the specified torque.

Engine oil pressure	At idle speed	Allowable limit	49 kPa 0.5 kgf/cm² 7 psi
	At rated speed	Factory spec.	196 ~ 392 kPa 2.0~ 4.0 kgf/cm² 28 ~ 57 psi
		Allowable limit	147.1 kPa 1.5 kgf/cm² 21.3 psi

Tightening torque	Oil switch taper screw	14.7 ~ 19.6 N·m 1.5 ~ 2.0 kgf·m 10.8 ~ 14.5 ft-lbs

(3) Cooling System

Fan Belt Tension



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1. Measure the deflection (A), depressing the belt halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbs).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

Deflection (A)	Factory spec.	10 ~ 12 mm 0.394 ~ 0.472 in.

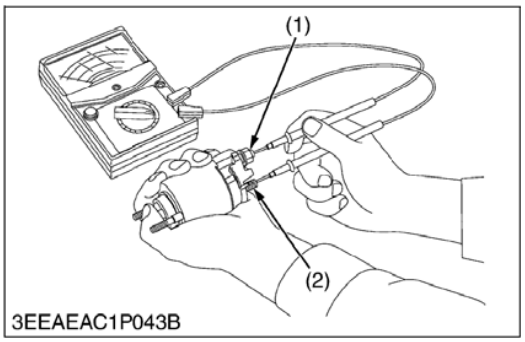
(A) Deflection

Magnet Switch Continuity Test

Check the continuity across the C terminal (1) and the B terminal (2) with a circuit tester, pushing in the plunger.

If not continuous or if a certain value is indicated, replace the magnet switch.

(1) C Terminal (2) B Terminal



Alternator on Unit Test

(Before testing)

- Before alternator on unit test, check the battery terminal connections, circuit connection, fan belt tension, charging indicator lamp, fuses on the circuit, and abnormal noise from the alternator.
- Prepare full charged battery for the test.

NOTE

- **Be careful not to touch the rotating engine parts while engine is running.**
- **Keep safety distance from the engine rotating parts.**

1. Start the engine.
2. When the engine is operating measure the voltage between two battery terminals. If the voltage is between 13.8 V and 14.8 V, the alternator is operating normally.
3. If the results of alternator on unit test are not within the specifications, disassemble the alternator and check the each component part for finding out the failure. See the “DISASSEMBLING AND ASSEMBLING” and “SERVICING” for alternator.

Regulating voltage at no load	Factory spec.	13.8 to 14.8 V at 25 °C (77 °F)

Intake Air Heater

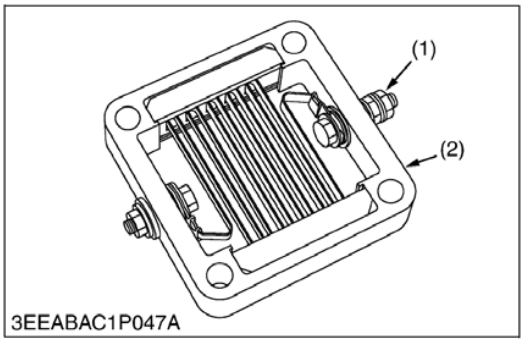
Disconnect the lead.

Measure the resistance between + terminal (1) and intake air heater body (2).

If the resistance is infinity, the intake air heater is faulty.

Intake air heater resistance	Factory spec.	Approx. 0.3 Ω (At cold occasion)

(1) + Terminal (2) Intake Air Heater Body



Rocker Arm and Push Rod

1. Remove the rocker arm (3) as a unit.
2. Remove the push rods (1).
3. Remove the bridge arm (4).

(When reassembling)

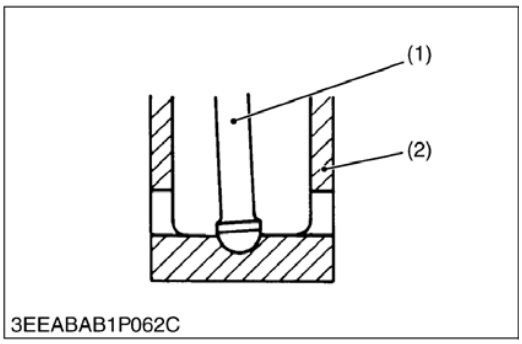
- When putting the push rods onto the tappets (2), check to see if their ends are properly engaged with the grooves.

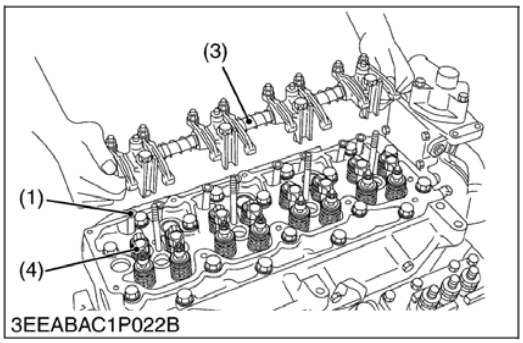
IMPORTANT

After reassembling the rocker arm, be sure to adjust the valve clearance.

Tightening torque	Rocker arm bracket screw	49.0 ~ 55.9 N·m 5.0 ~ 5.7 kgf·m 36.2 ~ 41.2 ft-lbs

(1) Push Rod
(2) Tappet
(4) Rocker Arm
(5) Bridge Arm





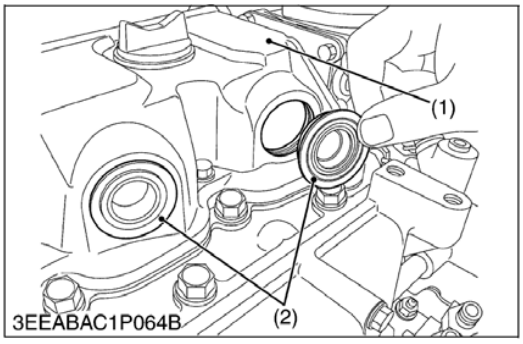
Injection Nozzle Oil Seal (if necessary)

1. Remove the injection nozzle oil seal (2) from cylinder head cover (1).

(When reassembling)

- When installing the injection nozzle oil seal, use new one.

(1) Cylinder Head Cover
(4) Injection Nozzle Oil Seal



Fuel Camshaft and Governor Weight

1. Remove the governor sleeve (1).
2. Remove the injection pump assembly (2).
3. Remove the fuel camshaft lock screws.
4. Fix the fuel camshaft with open end wrench (3), and remove the governor weight mounting nut and the governor weight (4).
5. Loosen the fuel camshaft stopper mounting screws and remove the fuel camshaft stopper (5).
6. Pull out the fuel camshaft (8) and bearings (6) together.
7. Remove the spacer (V3800DI-T-E3B Engine)
8. After removing the bearing's cir-clip (7), press out the bearings.

NOTE

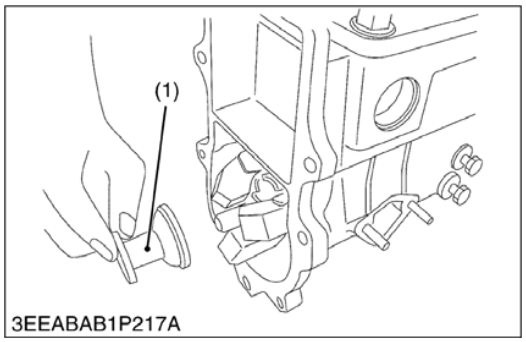
Do not use the fuel camshaft lock bolts, when removing the governor weight mounting nut. Otherwise, the lock bolts or injection pump housing might get damage.

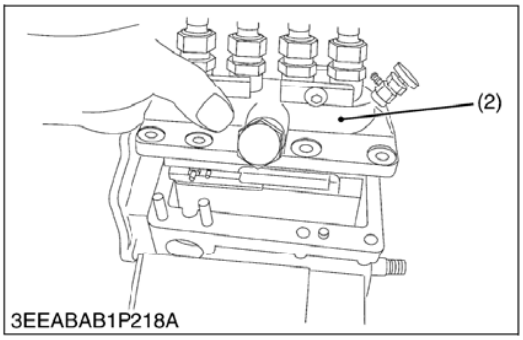
(When reassembling)

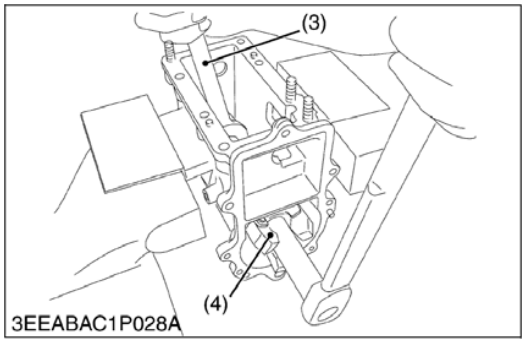
- Press the bearings into the fuel camshaft.
- Set the cir-clip at the gear side's bearing.
- Install the fuel camshaft and bearings to the injection pump housing.
- Attach the fuel camshaft stopper and tighten the fuel camshaft stopper mounting screws with the specified torque.
- Attach the governor weight to the fuel camshaft and tighten the governor weight mounting nut with specified torque.

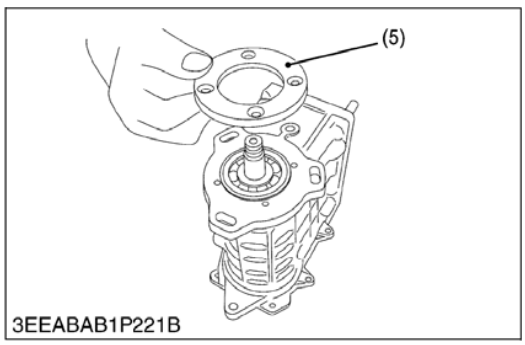
Tightening torque	Injection pump mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
	Injection pump mounting nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs

(1) Governor Sleeve
(2) Injection Pump Assembly
(3) Open End Wrench (22 mm)
(4) Governor Weight
(5) Fuel Camshaft Stopper
(6) Bearing
(7) Cir-clip
(8) Fuel Camshaft
(9) Key Way of Fuel Camshaft









Piston

1. Completely clean carbon in the cylinders.
2. Turn the flywheel and set a piston to the top dead center.
3. Pull out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.

(When reassembling)

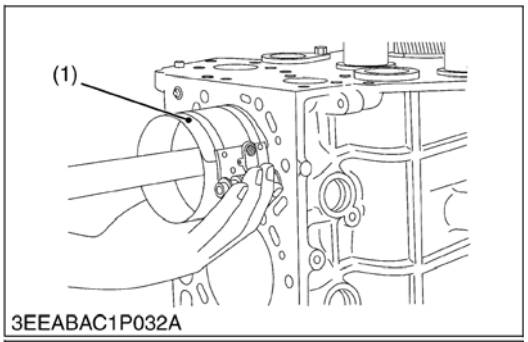
- Before inserting the piston into the cylinder, apply enough engine oil to the cylinder.
- When inserting the piston into the cylinder, face the mark (3) on the connecting rod to the injection pump.

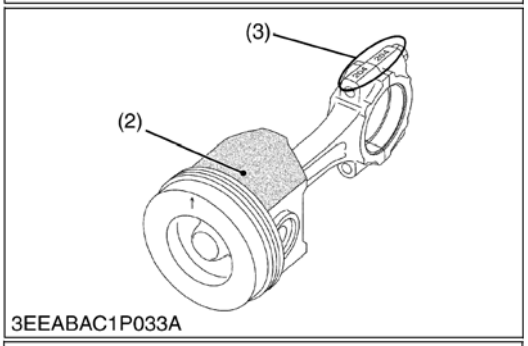
IMPORTANT

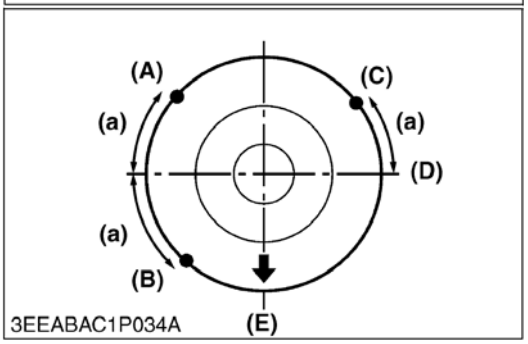
- **Do not change the combination of cylinder and piston.**
- **Make sure of the position of each piston by marking. For example, mark "1" on the No. 1 position.**
- **When inserting the piston into the cylinder, place the gap of each pison ring like the figure.**
- **Carefully insert the pistons using a piston ring compressor (1). Otherwise, their chrome-plated section of piston rings may be scratched, causing trouble inside the liner.**
- **When inserting the piston in place, be careful not to get the molybdenum disulfide coating torn off its skirt. This coating is useful in minimizing the clearance with the cylinder liner. Just after the piston pin has been press-fitted, in particular, the piston is still hot and the coating is easy to peel off. Wait until the piston cools down.**

(1) Piston Ring Compressor
(2) Molybdenum Disulfide Coating in piston skirt
(3) Mark
(a) 0.79 rad (45˚)

(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap
(D) Piston Pin Hole
(E) Injection Pump Side



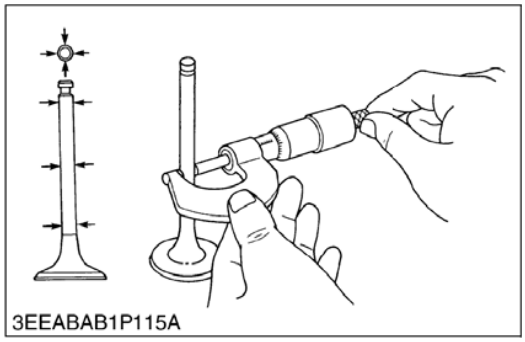




Clearance between Valve Stem and Valve Guide

1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with an outside micrometer.
3. Measure the valve guide I.D. of the cylinder head at the most wear part as shown in the figure below with a small hole gauge. And calculate the clearance.
4. If the clearance exceeds the allowable limit, replace the valves. If it still exceeds the allowable limit, replace the valve guide.

Clearance between valve stem and guide	Factory spec.	Intake valve	0.055 to 0.085 mm 0.0022 to 0.0033 in.
		Exhaust valve	0.055 to 0.085 mm 0.0022 to 0.0033 in.
	Allowable limit		0.1 mm 0.0039 in.
Valve stem O.D.	Factory spec.	Intake valve	6.960 to 6.975 mm 0.2740 to 0.2746 in.
		Exhaust valve	6.960 to 6.975 mm 0.2740 to 0.2746 in.
Valve guide I.D.	Factory spec.	Intake valve	7.030 to 7.045 mm 0.2768 to 0.2774 in.
		Exhaust valve	7.030 to 7.045 mm 0.2768 to 0.2774 in.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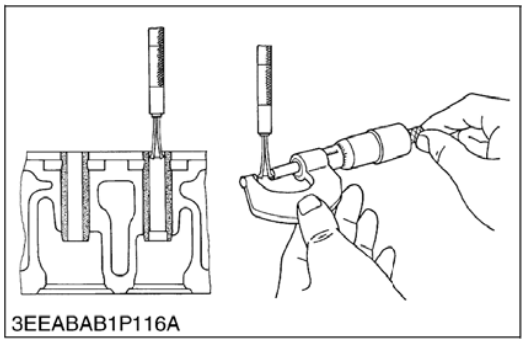
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Replacing Valve Guide

(When removing)

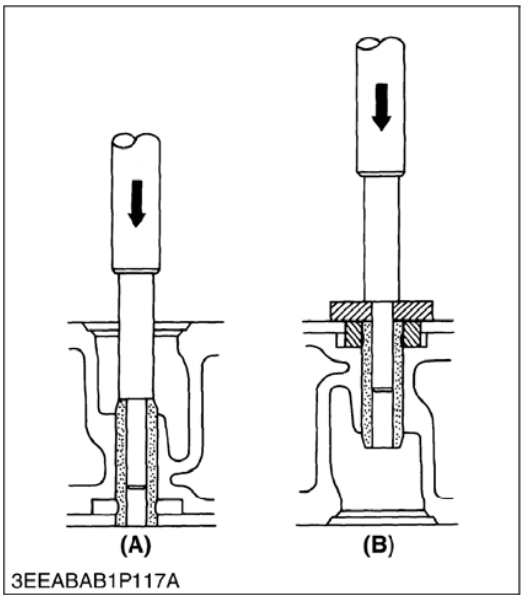
1. Using a valve guide replacing tool, press out the used valve guide.

(When installing)

1. Clean a new valve guide, and apply engine oil to it.
2. Using a valve guide replacing tool, press in a new valve guide until it is flush with the cylinder head as shown in the figure.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

IMPORTANT

Do not hit the valve guide with a hammer, etc. during replacement.



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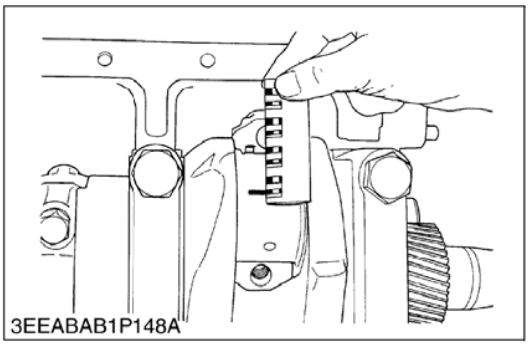
(A) When Removing **(B) When Installing**

Oil Clearance between Crankpin and Crankpin Bearing



1. Clean the crankpin and crankpin bearing.
2. Put a strip of plastigage on the center of the crankpin.
3. Install the connecting rod cap and tighten the connecting rod screws to the specified torque, and remove the cap again.
4. Measure the amount of the flattening with the scale, and get the oil clearance.
5. If the oil clearance exceeds the allowable limit, replace the crankpin bearing.
6. If the same size bearing is out of specifications because of the crankpin wear, replace it with an undersize one referring to the table and figure.

NOTE

- **Never insert the plastigage into the crankpin oil hole.**
- **Be sure not to move the crankshaft while the connecting rod screws are tightened.**

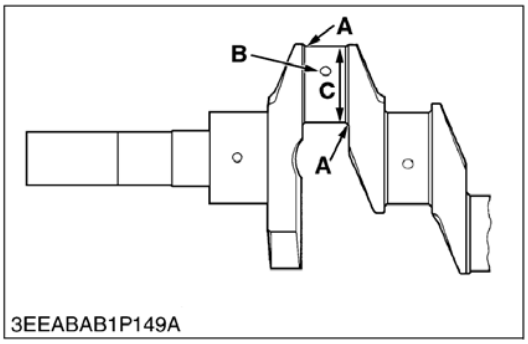
Crankpin O.D.	Factory spec.	52.977 to 52.990 mm 2.0857 to 2.0862 in.

Oil clearance between crankpin and crankpin bearing	Factory spec.	0.018 to 0.051 mm 0.0007 to 0.0020 in.
	Allowable limit	0.20 mm 0.0079 in.

IMPORTANT

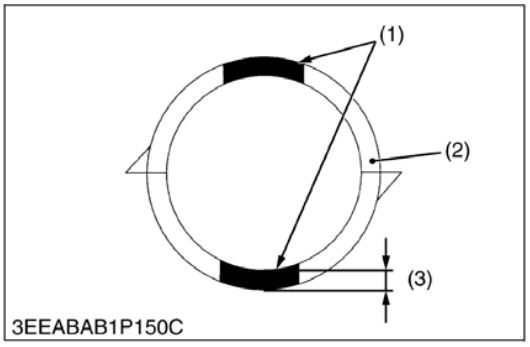
STD size crankpin bearing.
To replace it with a specific STD service part, make sure the crankpin bearing has the same ID color as the connecting rod.

ID Color	Connecting rod	Crankpin bearing		
	Large-end in. dia.	Class	Part code	Center wall thick
Blue	56.01 to 56.02 mm 2.2051 to 2.2055 in.	L	1C020-22311	1.496 to 1.501 mm 0.0589 to 0.0591 in.
Without color	56.00 to 56.01 mm 2.2047 to 2.2051 in.	S	1C020-22331	1.491 to 1.496 mm 0.0587 to 0.0589 in.



(Reference)

- Undersize dimensions of crankpin



Undersize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **A**	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
Dimension **C**	52.777 to 52.790 mm dia. 2.0778 to 2.0783 in. dia.	52.577 to 52.590 mm dia. 2.0700 to 2.0705 in. dia.
(0.8S) The crankpin must be fine-finished to higher than ▽▽▽▽. * Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.0394 to 0.0591 in.) relief.		

(1) ID Color
(2) Crankpin Bearing
(3) Center Wall Thick.

Engine description

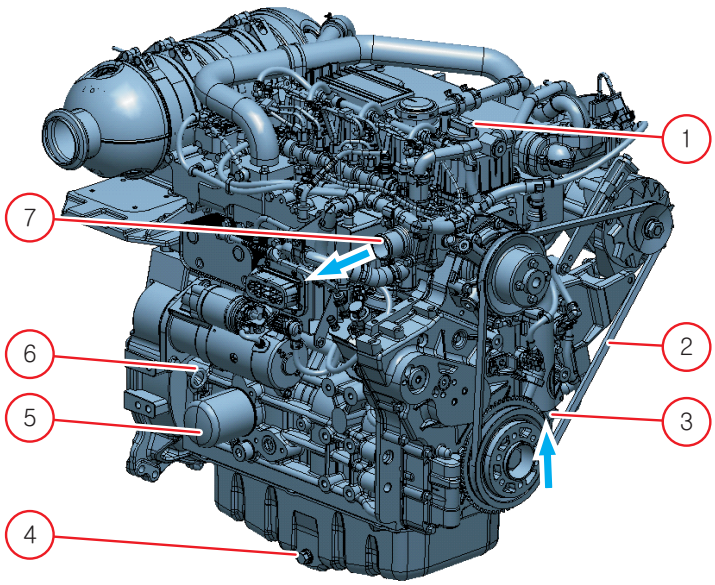
Engine illustrations

TD 3.6 L4

Industrial engine

View from right (example)

1. Lubricating oil filling
2. V-belts
3. Coolant inlet
4. Lubricating oil drain plug
5. Lube oil replacement filter
6. Lubricating oil dipstick
7. Coolant outlet

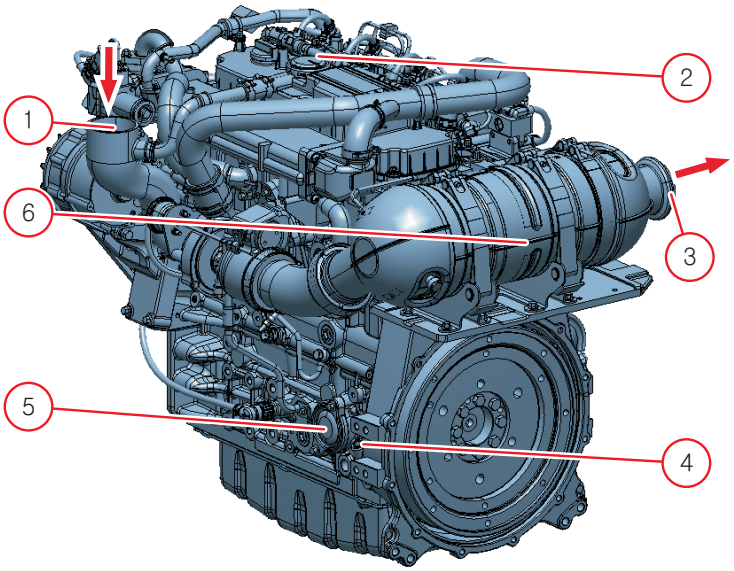


TD 3.6 L4

Industrial engine

View from left (example)

1. Combustion air inlet
2. Crankcase breather
3. Exhaust outlet
4. Lubricating oil dipstick (Optional)
5. Lube oil replacement filter (Optional)
6. Diesel oxidation catalytic converter



Fuel system

Specifications when working on the fuel system

DANGER

Engine must be switched off!
Smoking and naked lights prohibited!
No injection/high pressure pipes may be disconnected while the engine is running.
Caution when handling hot fuel!
Pay attention to utmost cleanliness when refuelling and working on the fuel system. Clean the respective affected parts carefully. Blow damp areas dry with compressed air.
Observe the safety regulations and national specifications for handling fuels.
Dispose of leaking fuel and filter elements properly. Do not allow fuel to seep away into the ground.
After all work on the fuel system, the system should be vented, a trial run performed and the tightness checked.
It will be necessary to vent the fuel system when commissioning for the first time, after maintenance work or if the tank has been run dry.

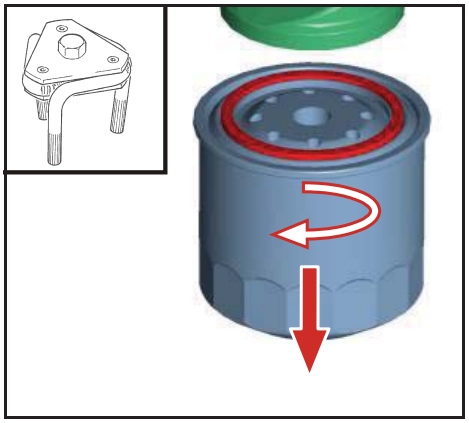
CAUTION

Additional venting of the fuel system by a 5 minute trial run at idle speed or on low load is absolutely essential.
Pay attention to utmost cleanliness due to the high production accuracy of the system!
The fuel system must be tight and closed.
Make a visual inspection for leaks/damage in the system.

CAUTION

Clean and dry the engine and engine compartment thoroughly before beginning work.
Areas of the engine compartment from which dirt could be loosened must be covered with a fresh, clean foil.
Work on the fuel system may only be carried out in an absolutely clean environment.
Contamination of the air such as dirt, dust, moisture etc. must be avoided.

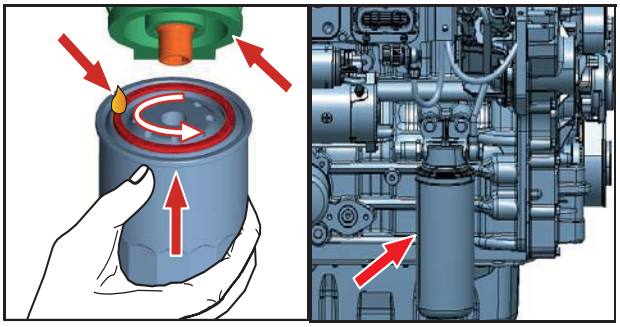
Change the fuel filter cartridge



NOTE

The filter cartridge should never be prefilled.
There is a danger of dirt contamination!

- Remove clamps when twist protection mounted (optional).
- Loosen and unscrew filter cartridge with tool (order number: 170050).
- Catch any escaping fuel.
- Clean the sealing surface of the filter support with a lint-free, clean cloth.



- Oil the gasket of the new DEUTZ original filter cartridge lightly.
- Screw on new filter by hand until the gasket is touching and tighten with a torque of: 10-12 Nm
- Fasten clamps of the twist protection (optional).
- Vent the fuel system.

Belt drive

- Remove V-belts and V-rib belts and store packed.
- Spray V-belt pulleys and tension rollers with corrosion protection agent.

Engine openings

- All engine openings must be fitted with air-tight, water-tight covers to delay the vapourisation process of the corrosion protection agents.
- With installed air compressor, the suction and pressure connection must be sealed by a cap.
- Air should be excluded to avoid ventilation of the engine (chimney effect) for the suction from an air supply pipe.

Storage and packaging

- After being protected against corrosion, the engine must be stored in a dry, ventilated hall and suitably covered.
- The cover must be placed loosely over the engine so that the air can circulate around it to prevent condensation from forming. Use a desiccant if necessary.

Removal of corrosion protection

- The corrosion protection must be removed from the corrosion protected engine before starting.
- The packaging and all covers over the closed openings must be removed.
- Any corrosion deposits and paint damage should be remedied.

Fuel system

- If there is a mixture of diesel fuel/corrosion protection oil in the fuel tank, drain it.
- Connect fuel/tank/supply line to the engine. Pay attention to cleanliness.
- Fill the fuel tank and fuel system with the proper fuel.

Lubricating oil system

- Unscrew the lube oil drain screw, drain oil.
- Fill the engine with lubricating oil via the lubricating oil filler neck.

Coolant system

- If the implemented corrosion protection agent is compatible with the intended cooling system protection agent, this can be filled directly into the coolant system as specified.
- If it is uncertain whether the implemented corrosion protection agent is compatible with the cooling system protection agent, the cooling system should be purged with fresh water for about 15 minutes before filling.

Removal of exterior corrosion protection

- All areas and components coated with corrosion protection agent must be washed off with distilled fuel or a suitable cleaning agent.
- Wash out grooves of V-belt pulleys if necessary.
- Mount V-belts or V-rib belts as specified.
- Fill with coolant.

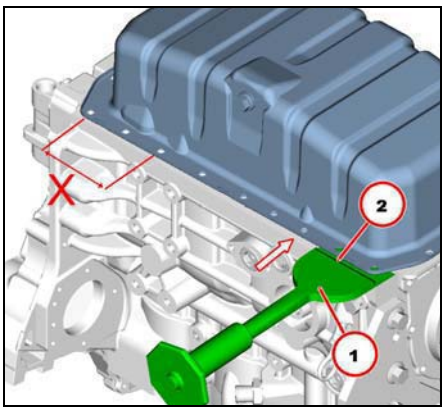
Corrosion protection agent / cleaning agent

Please ask CLARK dealer for reference products for the corrosion protection agents/cleaning agents to be used which meet DEUTZ requirements.

or see www.deutz.com

http://www.deutz.com
\SERVICE\Operating Liquids and Additives\ **Engine Corrosion Protection**

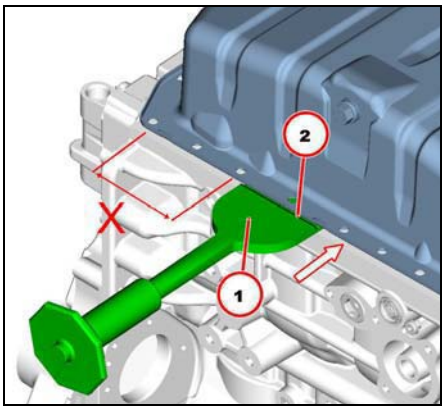
- Drive in separating tool (1) to the stop (2).



⚠CAUTION

The tool can only be driven in in the area of the crankcase.
Separation in the area of aluminium parts is not allowed.
!Do not damage the sealing surfaces.

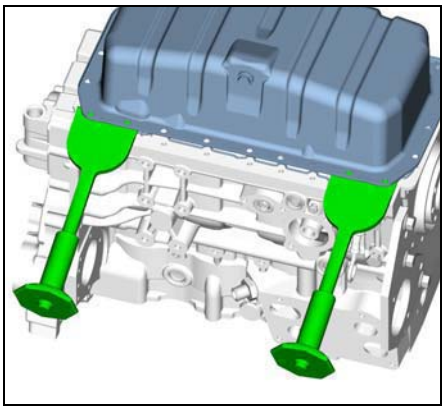
- Drive in second separating tool (1) to the stop (2).



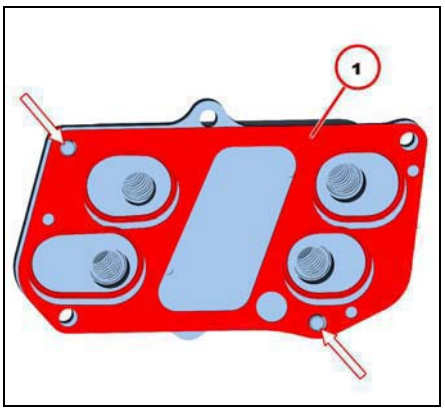
⚠CAUTION

The tool can only be driven in in the area of the crankcase.
Separation in the area of aluminium parts is not allowed.
!Do not damage the sealing surfaces.

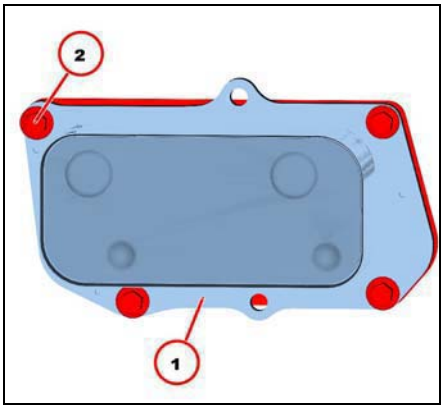
- Lever out lubricating oil pan.
- Remove lubricating oil pan.



Installing the lubricating oil cooler



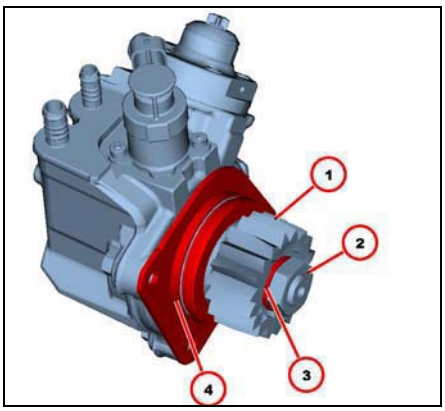
- Visually inspect the components.
- Clean sealing surfaces.
- Turn in screws (arrows).
  M8x20-10.9
- Fasten new seal (1) on lubricant oil cooler housing with screws.



- Mount lubricating oil cooler (1).
- Tighten screws (2).
- Tighten all screws (2) alternately.
  (Torque : **30 Nm**)

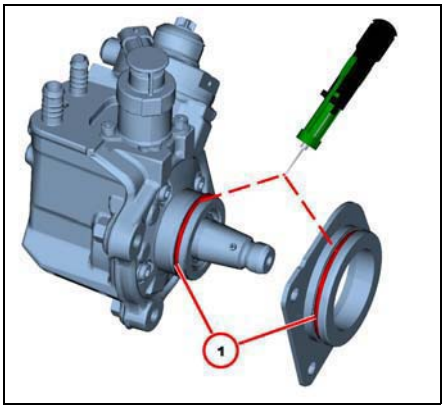
⚠CAUTION
Do not damage the high-pressure pump gear wheel.

NOTE
Use a suitable tool.



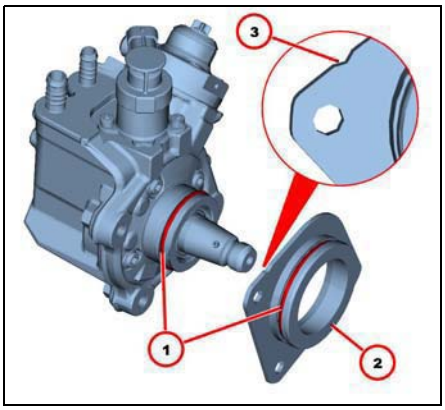
- Hold high-pressure pump gear wheel (1).
- Unscrew nut (2).
- Remove washer (3).
- Pull off high-pressure pump gear wheel (1) with separating tool.
- Remove spacer (4).
- Visually inspect the components.

- Remove the O-rings (1) with the disassembly tool.



⚠CAUTION
All the help markings must be transferred when renewing/changing a part.
Do not turn the crankshaft any more!

Installing the high-pressure pump



- Clean sealing surfaces.
- Mount new O-rings (1).
- Push on spacer (2).

⚠CAUTION
Ensure that the installation location is free from faults.
Recess (3) is on the fuel supply side.

21. Supply pump (Fuel)

Tool

Standard tools

Special tools:
– Plugs/caps

⚠ DANGER

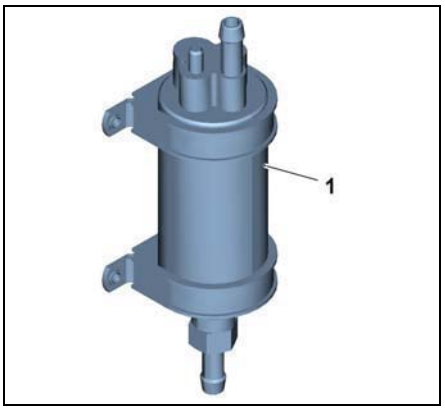
Do not carry out work on the fuel system when the engine is running.
The fuel system is under high pressure - Danger of death.
The fuel pressure can continuously remain up to several 100 bar even after stopping the engine.
Here the fuel pressure is only reduced if the fuel system is opened and the fuel can escape outside.

⚠ CAUTION

Ensure utmost cleanliness for all work.
Remove any paint residue and dirt particles before disassembly.
Clean the area around the components concerned carefully. Blow wet parts dry with compressed air.
Observe the safety regulations and national specifications for handling fuels.
Close all connections immediately after opening with new, clean plugs/caps.
Do not remove plugs/caps until immediately before assembling.
Collect leaking operating substances in suitable vessels and dispose of according to regulations.

1 Supply pump

– Fastening
Screws : 4 x M5-8.8
Torque : **7.5 Nm**

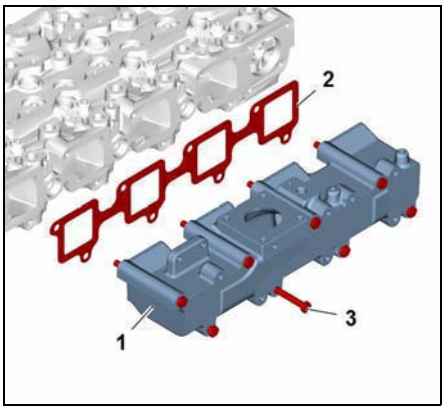


24. Removing and install the charge air line

Tool

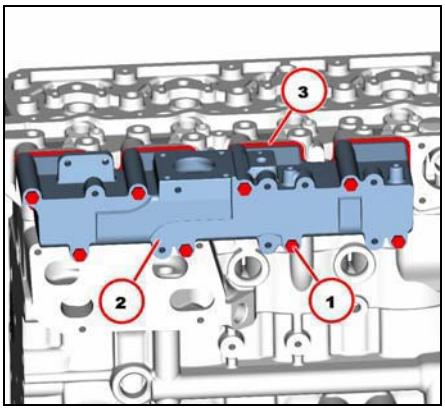
Standard tools

Remove charge air line



1 Charge air line
2 Seal
3 Hexagon head screw

- Remove fuel return line.
- Unlock cable plug and disconnect.
- Unscrew screws (1).
- Remove charge air line (2).
- Remove gasket (3).
- Visually inspect the components.

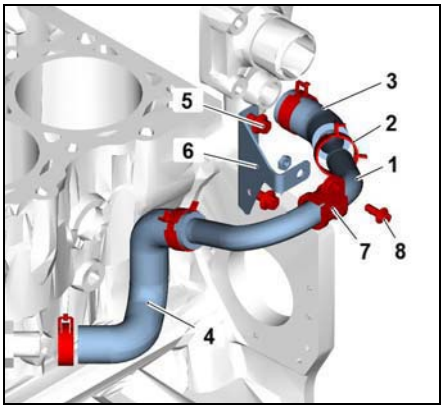


32. Line (Coolant)

Tool

Standard tools:
– Spring band pliers 01899112

Special tools:
– Plugs/caps 01899144

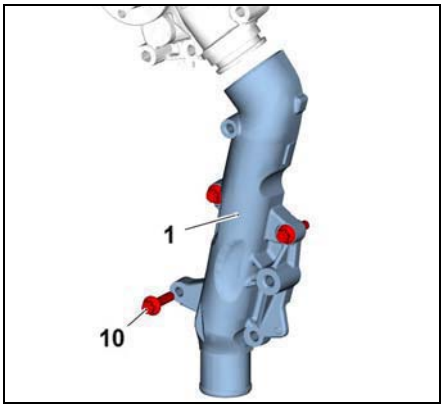


1	Pipe	
2	Spring band clip	
3	Elbow	
4	Hose pipe	
5	Hexagon head screw	13 Nm
6	Support plate	
7	Pipe clip	
8	Hexagon head screw	8 Nm

33. Line (Coolant)

Tool

Standard tools



1	Coolant line	
10	Hexagon head screw	14 Nm

43. Removing and installing the generator (Fastening parts)

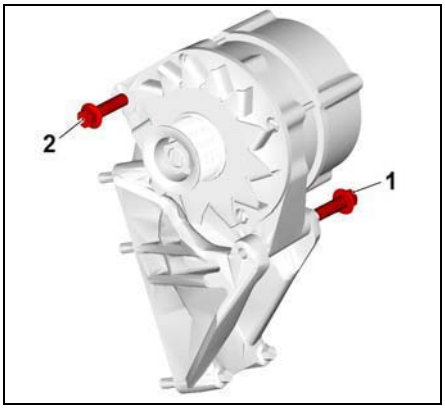
Tool

Standard tools

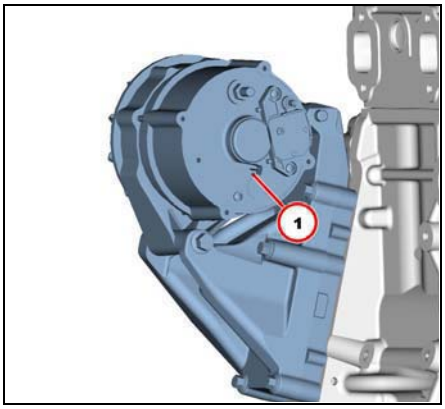
Removing the generator

1 Hexagon head screw

2 Hexagon head screw



- Remove V-rib belt.
- Disconnect the battery's negative terminal.
- Remove plus cable.
- Unlock cable plug (1) and disconnect.



50. Removing and installing hydraulic pump drive

Tool

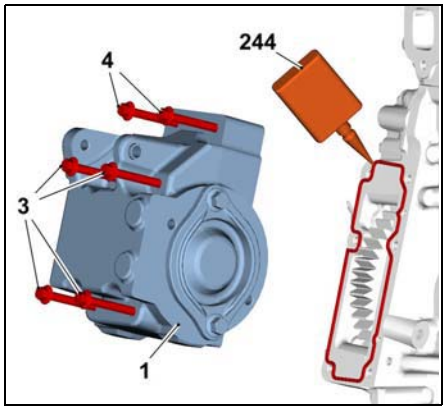
Standard tools

Auxiliary materials

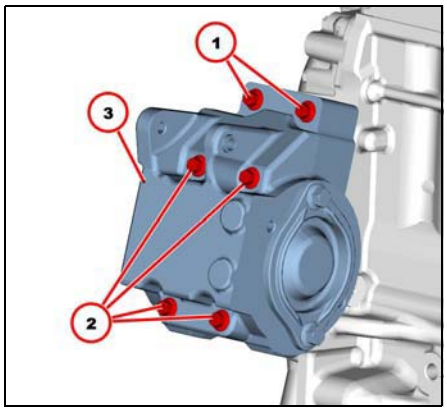
– Packing compound
DEUTZ DW 73

Removing hydraulic pump drive

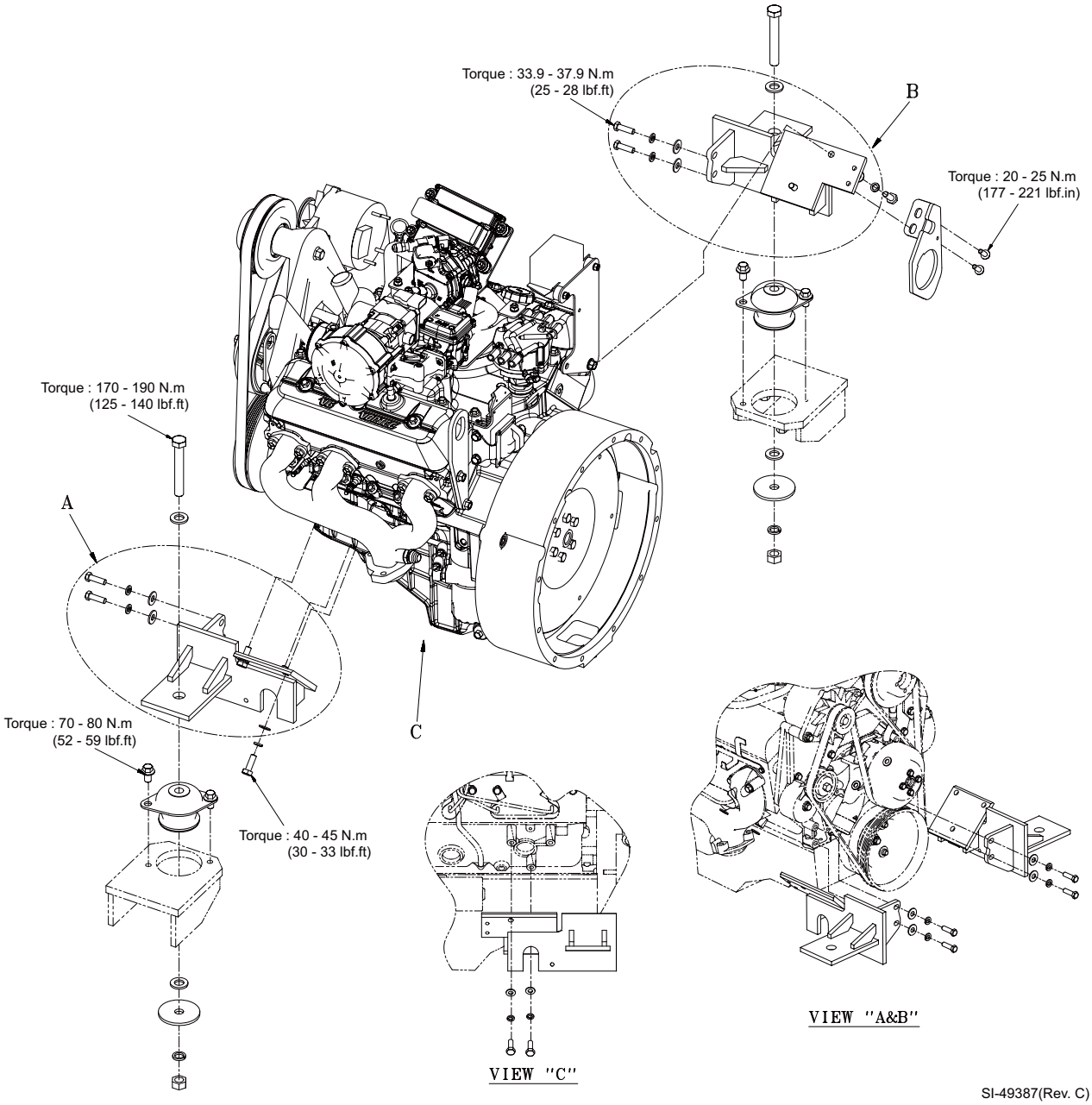
1 Hydraulic pump drive
3 Hexagon head screw
4 Hexagon head screw
244 Packing compound



- Unscrew screws (1).
- Unscrew screws (2).
- Remove hydraulic pump drive (3).

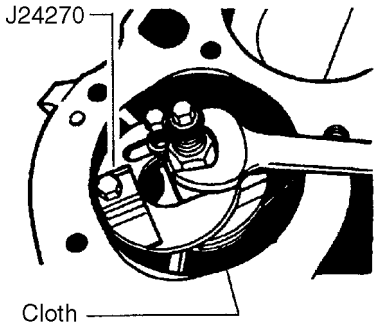


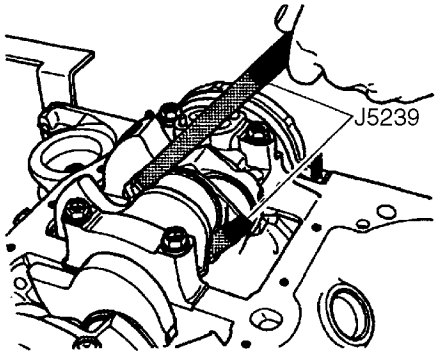
Engine mounting (Tier4)



20. Valve Stem Key
21. nlet Valve Spring Cap
22. Valve Stem Oil Shield
23. Valve Stem Oil Seal (O-Ring)
24. Inlet Valve Stem Seal
26. Valve Spring with Damper
27. Inlet Valve
28. Exhaust Valve Rotator
29. Exhaust Valve
40. Lifter Restrictor Retainer Bolt
41. Lifter Restrictor Retainer
42. Rocker Arm Nut
43. Rocker Arm Ball
44. Rocker Arm
45. Push Rod
46. VaIve Lifter Guide (Restrictor)
47. Lifter
48. Flat Washer
50. Cylinder Head Bolt
51. Spark Plug
52. Coolant Temperature Sensor
53. Drain Plug
54. Cylinder Head Gasket
60. Heat Shield
61. Washer
62. Exhaust ManifoId Lock
63. Bolt/Stud
162. Stud
163. Bolt
164. Coolant Outlet
165. Coolant Outlet Gasket
166. Thermostat
167. Vacuum Fitting
168. Engine Coolant Temperature, sensor
169. Bolt
170. Intake Manifold
171. Oil Pressure Sensor
172. Oil Pressure Fitting
173. E.G.R. Valve Gasket
174. E.G.R. Valve
175. Bolt
176. Intake Manifold Gasket
177. Nut
178. Power Booster Vacuum Pipe
179. Exhaust Manifold
180. Fower Booster Vacuum Pipe Fitting
181. Plug
182. Coolant Temperature Sensor
183. Crankcase Ventilation Valve
184. Oil Filler Cap
185. Oil Filler Tube
186. Bolt
700. Rocker Arm Cover Bolt
701. Rocker Arm Cover
702. Rocker Arm Cover Gasket
704. Crankcase Vent Tube Grommet
705. Crankcase Vent Valve Grommet

PISTON AND CONNECTING ROD REMOVAL





Tools Required :
5239 Guide Set
24270 Ridge Reamer

Remove or Disconnect

- Ridge or deposits from the upper end of the cylinder bores as follows:
  a. Rotate the crankshaft until the piston is at BDC.
  b. Place a cloth on top of the piston.
  c. Perform the cutting operation with 24270.
  d. Rotate the crankshaft until the piston is at TDC.
  e. Remove the cloth and cuttings.
  f. Repeat this procedure for each piston.
- Mark the cylinder numbers on the tops of each piston.

IMPORTANT

Marking them from the front to the rear, with the engine in an upright position and viewed from the front :
– The right bank is numbered l-3-5.
– The left bank is numbered 2-4-6.

- Check the connecting rod and cap for identification marks.

IMPORTANT

Mark the parts if required.
Marking them from the front to the rear, with the engine in an upright position and viewed from the front:
– The right bank is numbered l-3-5.
– The left bank is numbered 2-4-6.
Store the connecting rod, bearings and cap together as mating parts, so they may be reassembled in the same position from which they were removed.

- Connecting rod cap.
- Connecting rod and piston.

IMPORTANT

Attach 5239 to the connecting rod bolts (figure 20 page below and right).
Use the long guide rod of 5239 to push the connecting rod and piston out of the bore through the top of the engine.

- Connecting rod beatings.

CAMSHAFT BEARINGS

CAMSHAFT BEARING REPLACEMENT

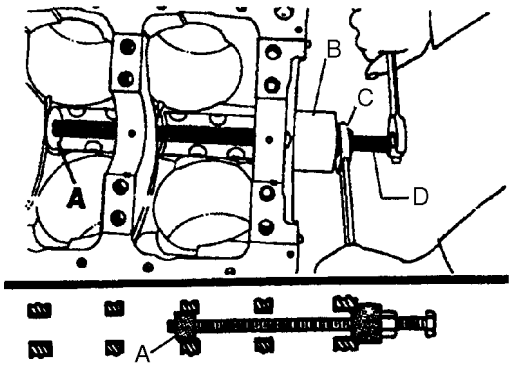
Inspect

- Camshaft bearings for scratches, pits, or loose fit in their bores. Replace the camshaft bearings if necessaty.

Remove or Disconnect

Tool Required
J 6098-01 Camshaft Bearing Remover and Installer

1. Rear camshaft plug.
2. Inner camshaft bearings. Use J 6098-01.
   - Insert the pilot into the front camshaft bearing bore.
   - Slide the puller screw, with the nut and washer, through the pilot.
   - Insert the bearing tool into the inner camshaft bearing bore with the shoulder of the tool against the bearing.
   - Hold the puller screw with a wrench.Turn the nut with a second wrench to pull the camshaft bearing from its bore.
   - Repeat this procedure to remove the remaining inner camshaft bearings. Note that the rear inner bearing must be removed with the pilot fitted into the rear camshaft bearing.
3. Outer camshaft bearing. Use J 6098-01.
   - Assemble the bearing tool and driver handle.
   - Drive the outer camshaft bearings out of the block.

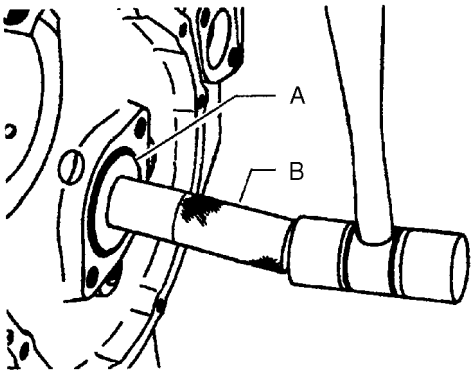


A. Bearing Tool
B. Pilot
C. Nut
D. Puller Screw

Clean

- Camshaft bearing bores in the block Install or Connect

Tool Required
J 6098-01 Camshaft Bearing Remover and Installer



A. Bearing Tool B. Driver Handle

NOTICE

The outer camshaft bearings must be installed first. These bearings serve as guides for the pilot, and help center the inner bearings during the installation process.

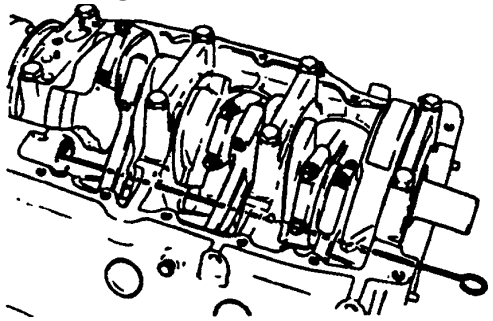
NOTICE

Besure to fit the correct cam bearing into the bore. The cam bearing bores vary in size.

1. Outer camshaft bearings. Drive the bearings into place using J 6098–01.

IMPORTANT

Make sure the camshaft bearing hole (or holes) align with the oil hole (or holes) in the block. On some engines, the oil holes may be difficult to see. If so, use a piece of 2 mm rod to check alignment.



Check camshaft bearing oil hole alignment

INSPECTING CRANKSHAFT END PLAY

Install or Connect

NOTICE

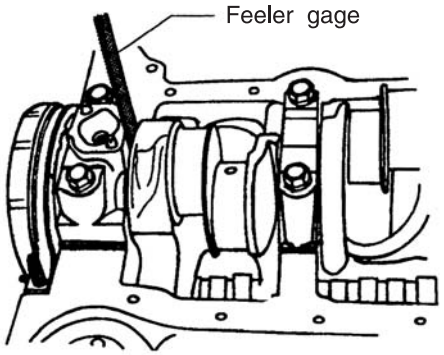
For steps 4 and 6, refer to "Notice" on page 00(L)-2-1.

1. Upper main bearing inserts to the block.

IMPORTANT

If any undersized bearings are used, they must be fitted to the proper journals.

2. Crankshaft
3. Lower main bearing inserts to the main bearing caps.



Measuring crankshaft end play

MEASURING MAIN BEARING CLEARANCE

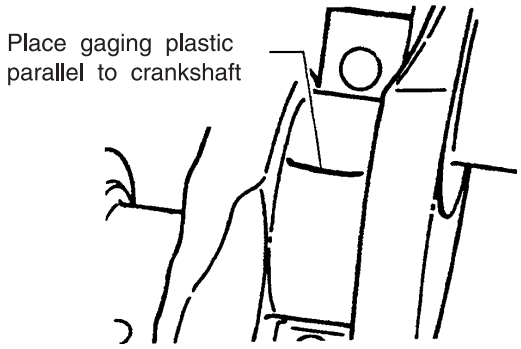
The simplest, most accurate way to measure main bearing clearance is with the use of gaging plastic. This wax-like material compresses evenly between the bearing and journal surfaces without damaging them. proceed as follows :

Clean

- All oil from the crankshaft journal and main bearing inserts.

Install or connect

1. Main bearing insert sand crankshaft.
2. Gaging plastic.
   - Begin with the rear main bearing.
   - Wipe the oil from the crankshaft journal and the lower main bearing insert.
   - Place a piece of gaging plastic the full width of the lower bearing insert (parallel to the crankshaft) on the journal. Do not rotate the crankshaft while the gaging plastic is between the bearing and journal.



Placing the gaging plastic on the bearing journal

3. Main bearing cap and bolts.

NOTICE

Refer to "Notice" on page 00(L)-2-1

Tighten

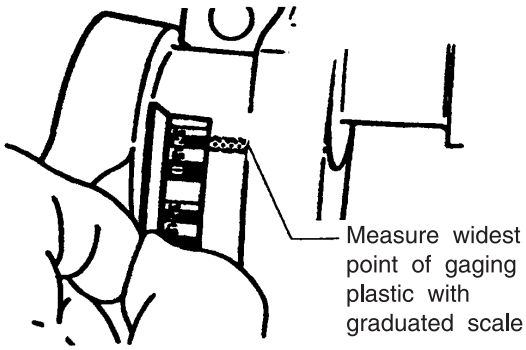
- Bolts to Specification.

Remove or Disconnect

- Main bearing cap. DO NOT REMOVE THE GAGING PLASTIC FROM THE JOURNAL OR LOWER MAIN BEARING INSERT.

Measure

- Gaging plastic as follows:
  - The flattened gaging plastic will be found adhering to either the lower bearing insert or journal.
  - On the edge of the gaging plastic envelope there is a graduated scale. Without removing the gaging plastic, measure its compressed width (at the widest point) with the graduations on the gaging plastic envelope.



Measuring the gaging plastic

INTAKE MANIFOLD INSTALLATION

INSTALL OR CONNECT

1. Gaskets to the cylinder head with the port blocking plates facing the rear of the engine.
2. RTV to the front and rear sealing surfaces on the block.
   Apply a 4.76250 mm (0.1875 in) bead of RTV or equivalent to the front and rear of the block as shown in figure. Extend the bead 12.7000 mm (0.500 in) up each cylinder head to seal and retain the gaskets.
3. Intake manifold to the engine.

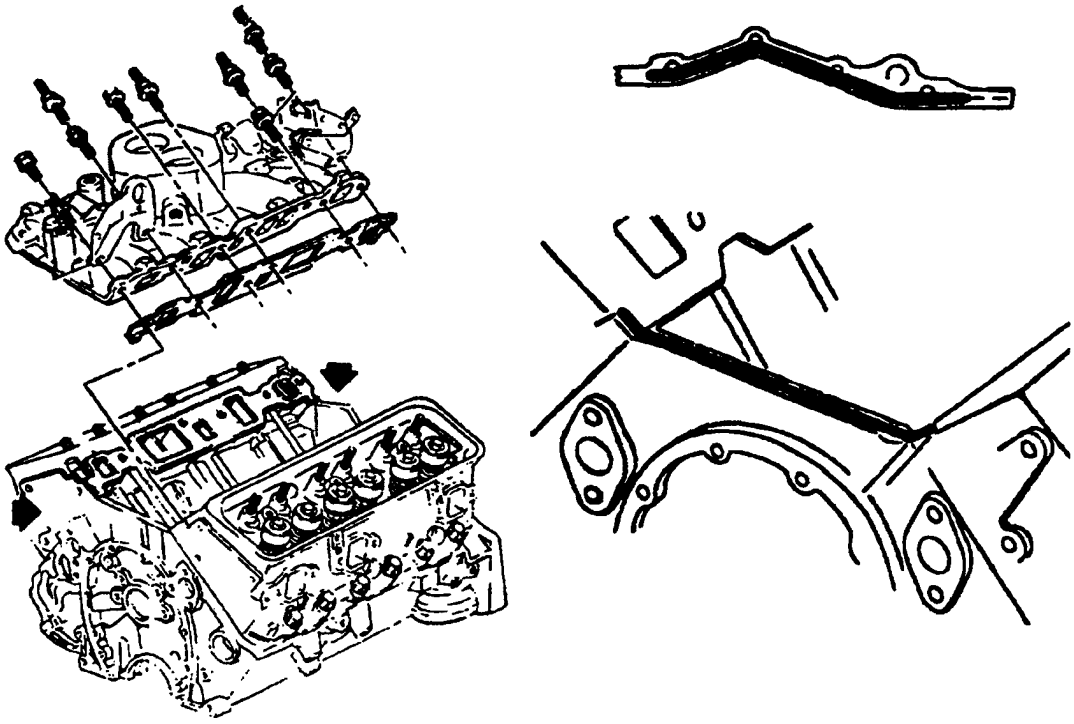
NOTICE

Refer to "Notice" on page 00(L)-2-1

4. Intake manifold bolts.

Tighten

- Intake manifold bolts to 47 N·m (35 lbs·ft) using the tightening sequence shown in next page.
- Retorque, intake manifold bolts using the tightening sequence shown in next page.



Intake Mainfold and components

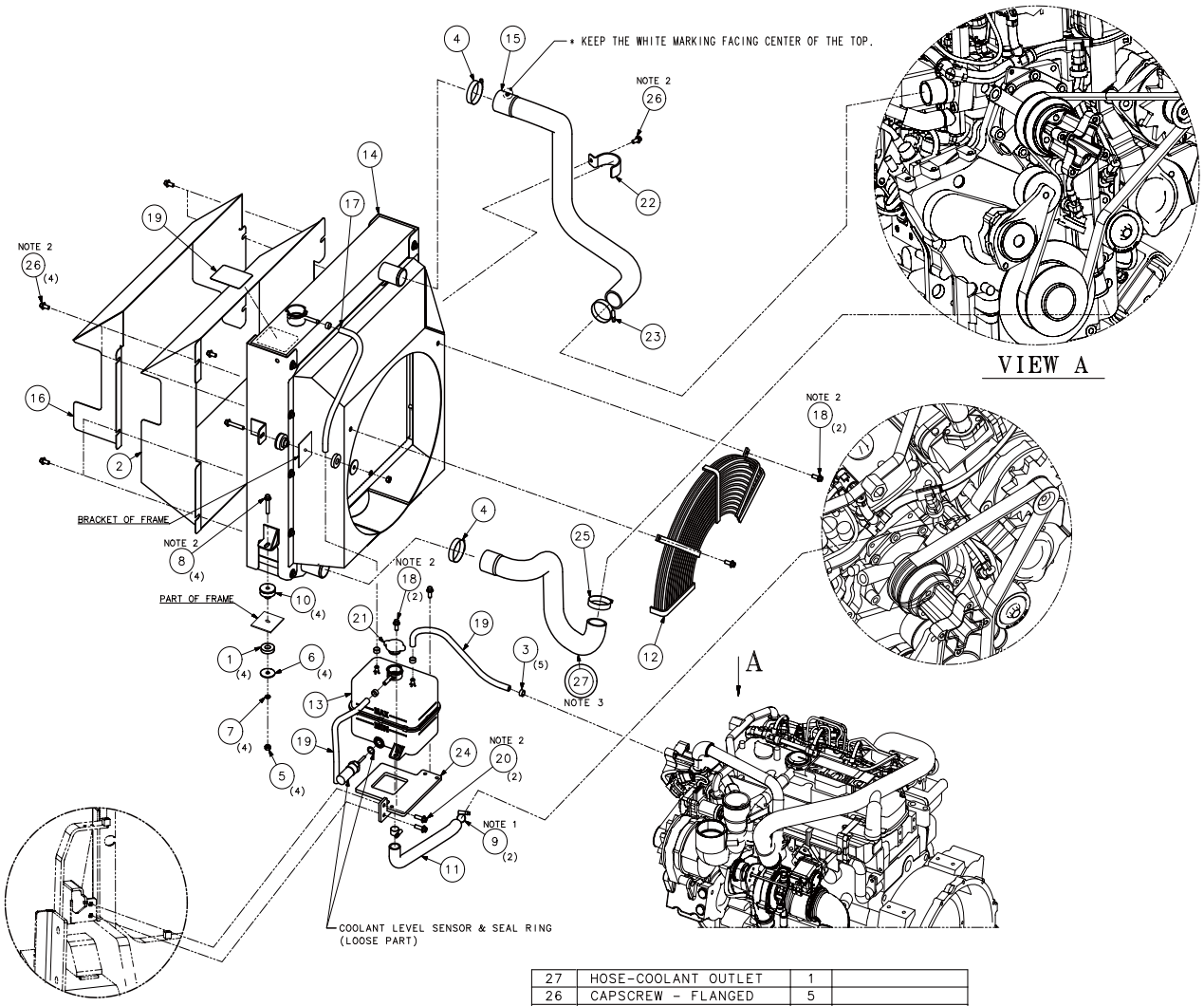
GROUP 01

ENGINE COOLING SYSTEM

NOTE

Removal and replacement procedures for the water pump and thermostat are covered in the Overhaul section of Group 00, "Engines".

Cooling System (Deutz, Diesel)



1. TORQUE : 3 - 4 N.m
2. TORQUE : 20 - 25 N.m
3. TO BE ASSEMBLED WITH ADEQUATE SPACE BETWEEN EXHAUST PIPE AND CRANK PULLEY.

[SI-51647H]

NO	PART NAME	QTY	REMARK
27	HOSE-COOLANT OUTLET	1	
26	CAPSCREW - FLANGED	5	
25	T-BOLT BAND CLAMP	1	
24	BRACKET-EXPANSION TANK	1	
23	T-BOLT BAND CLAMP	1	
22	CLAMP-HOSE	1	
21	CAP	1	
20	CAPSCREW - FLANGED	2	
19	DECAL	1	
18	CAPSCREW - FLANGED	4	OPTION : 2EA
17	HOSE	3	400mm
16	SHROUD-REAR	1	3.5/4 TON
15	HOSE-COOLANT INLET	1	
14	RADIATOR ASS'Y	1	
13	EXPANSION TANK ASS'Y	1	
12	FAN-GUARD	1	OPTION
11	HOSE-COMPENSATION	1	
10	ISOLATOR	4	
9	CLAMP - HOSE WORM	2	
8	CAPSCREW - FLANGED	4	
7	WASHER_SPRING	4	
6	WASHER_PLAIN	4	
5	NUT - HEX	4	
4	T-BOLT BAND CLAMP	2	
3	CLIP	5	
2	REAR SHROUD	1	4.5/5 TON
1	ISOLATOR	4	

MI-07 Fuel Lock-Off (Electric)

The fuel lock-off is a safety shutoff valve, normally held closed by spring pressure, which is operated by an electric solenoid and prevents fuel flow to the regulator/ converter when the engine is not in operation. This is the first of three safety locks in the MI-07 system.

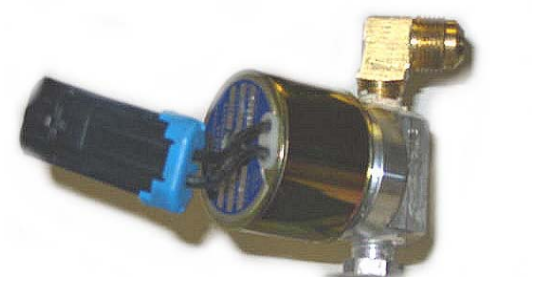


Figure 4. Electric Fuel Lock Assembly

In the MI-07 design, power is supplied to the fuel lock-off via the main power relay with the SECM controlling the lock-off ground (earth) connection. The lock-off remains in a normally closed (NC) position until the key switch is activated. This supplies power to the lock-off and the SECM, but will not open the lock-off via the main power relay until the SECM provides the lock-off ground connection. This design gives the SECM full control of the lock-off while providing additional safety by closing the fuel lock-off in the unlikely event of a power failure, wiring failure or module failure.

When the liquid service valve in the fuel container is opened, liquid propane flows through the LP filter and through the service line to the fuel lock-off. Liquid propane enters the lock-off through the 1/4" NPT liquid inlet port and stops with the lock-off in the normally closed position. When the engine is cranked over, the main power relay applies power to the lock-off and the SECM provides the lock-off ground, causing current to flow through the windings of the solenoid and create a magnetic field. The strength of this magnetic field is sufficient to lift the lock-off valve off of its seat against spring pressure. When the valve is open liquid propane, at tank pressure, flows through the lock-off outlet to the pressure regulator/converter. A stall safety shutoff feature is built into the SECM to close the lock-off in case of a stall condition. The SECM monitors three engine states: Crank, when the crankshaft position sensor detects any engine revolutions; Stall, when the key is in the ON position but the crankshaft position sensor detects no engine revolutions; and the Run state, when the engine reaches pre-idle rpm. When an operator turns on the key switch the lock-off is opened, but if the operator fails to crank the engine the SECM will close the lock-off after 5 seconds.

N-2007 Pressure Regulator/Vaporizer

The pressure regulator/vaporizer receives liquid LPG from the fuel storage tank, drops the pressure, changes the LPG phase from liquid to vapor, and provides vapor phase LPG at a regulated outlet pressure to the mixer. To offset the refrigeration effect of the vaporization process, the regulator will be supplied with engine coolant flow sufficient to offset the latent heat of vaporization of the LPG. A thermostat provided in the coolant supply line to maintain regulator outlet coolant temperature at or below 60°C (140°F) will minimize the deposit of fuel contaminants and heavy ends in the regulator and assure a more controlled vaporization process with reduced pressure pulsations.

A higher flow pressure regulator is required on larger engines.

Figure 5. N-2007 Regulator

The regulator is normally closed, requiring a vacuum signal (negative pressure) to allow fuel to flow. This is the second of three safety locks in the MI-07 system. If the engine stops, vacuum signal stops and fuel flow will automatically stop when both the secondary (2^{nd} stage) valve and the primary (1^{st} stage) valve closes. Unlike most other regulator/converters, the N-2007 primary valve closes with fuel pressure rather than against pressure, extending primary seat life and adding additional safety.

Liquid propane must be converted into a gaseous form in order to be used as a fuel for the engine. When the regulator receives the desired vacuum signal it allows propane to flow to the mixer. As the propane flows through the regulator the pressure is reduced in two stages from tank pressure to slightly less than atmospheric pressure. As the pressure of the propane is reduced, the liquid propane vaporizes and refrigeration occurs inside the regulator due

Engine Speed Governing

The MI-07 system also performs minimum (min) and maximum (max) speed governing through the SECM and DBW throttle. For min governing, or idle speed control, the idle speed is fixed by the SECM. Unlike a mechanical system, the idle speed is not adjustable by the end user. The idle speed is adjusted by the SECM based on engine coolant temperature. At these low engine speeds, the SECM uses spark and throttle to maintain a constant speed regardless of load.

The MI-07 system eliminates the need for air velocity governors. This substantially increases the peak torque and power available for a given system as shown in **Figure 19.** When the engine speed reaches the max governing point the speed is controlled by closing the DBW throttle. Using the DBW throttle as the primary engine speed control allows for a smooth transition into and out of the governor. If excessive over speed is detected, the engine is shut down.

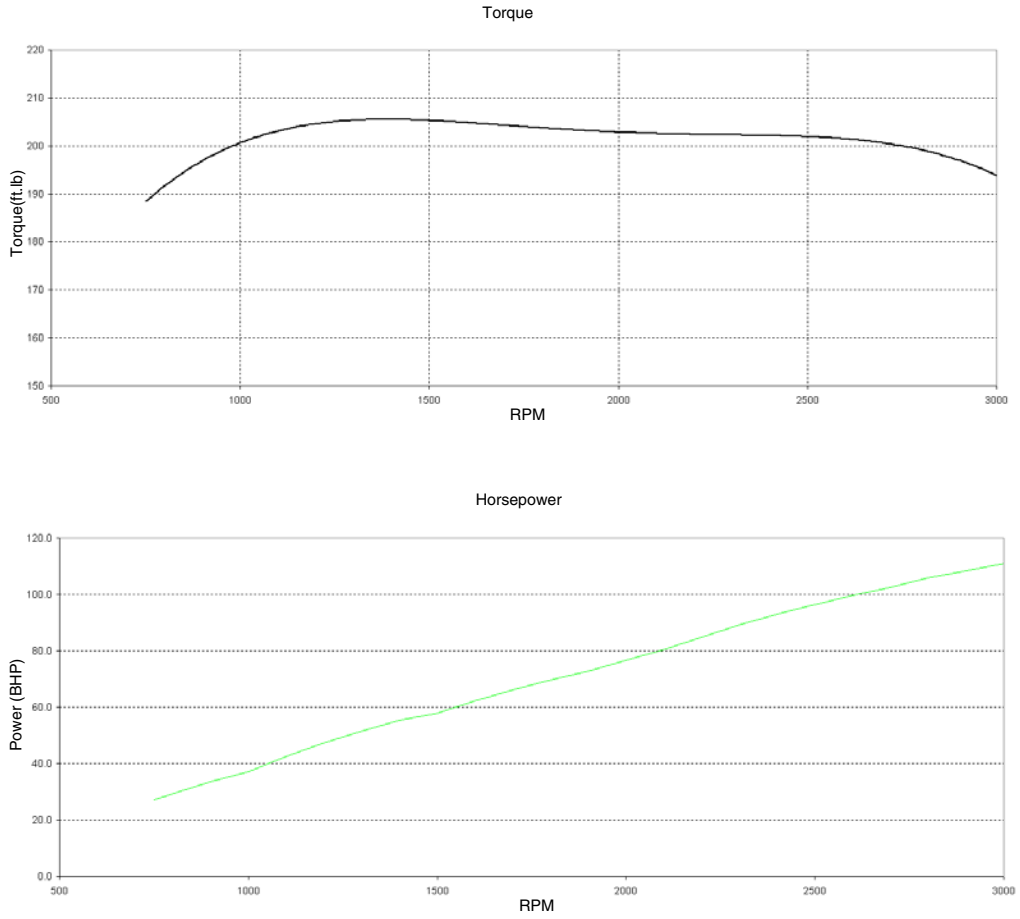


Figure 19. Peak Torque and Power Available with MI-07 System

Checking the TMAP Sensor

- Verify that the TMAP sensor (F) is mounted tightly into the manifold or manifold adapter (E), with no leakage.
- If the TMAP is found to be loose, remove the TMAP retaining screw and the TMAP sensor from the manifold adapter.
- Visually inspect the TMAP O-ring seal for damage. Replace as necessary.
- Apply a thin coat of an approved silicon lubricant to the TMAP O-ring seal.
- Re-install the TMAP sensor into the manifold or manifold adapter and securely tighten the retaining screw.

Inspect Engine for Exhaust Leaks

- Start the engine and allow it to reach operating temperatures.
- Perform visual inspection of exhaust system from the engine all the way to the tailpipe. Any leaks, even after the post-catalyst oxygen sensor, can cause the sensor output to be effected (due to exhaust pulsation entraining air upstream). Repair any/all leaks found. Ensure the length from the postcatalyst sensor to tailpipe is the same as original factory.
- Ensure that wire routing for the oxygen sensors is still keeping wires away from the exhaust system. Visually inspect the oxygen sensors to detect any damage.

Factory Adjustment Procedure:

NOTE

Be sure engine is fully warm (ECT>167°F [75°C]) before performing the idle mixture adjustment.

1. Operating the engine on LPG fuel, start the engine and permit it to warm up until the coolant temperature (ECT on Mototune display) is approximately 167°F (75°C).
2. Set APP input to minimum.
3. Adjust the load until engine speed reaches 750 rpm.
4. Mototune display parameter LP Fuel Control must display "Closed Loop."
5. Use the Mototune Service Tool to monitor Duty Cycle % on the Mototune display.
6. To adjust the idle mixture screw, use a 5mm hex or Allen-type wrench. Turning the screw in (clockwise) should increase the duty cycle; turning the screw out (counter-clockwise) should decrease the duty cycle.
7. Adjust the idle mixture screw on the mixer until a reading of 40-45% is reached for the FTV Duty Cycle in Closed Loop Idle (Figure 35).

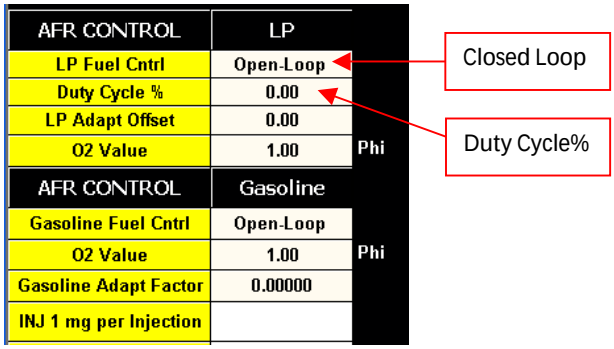


Figure 35. FTV Duty Cycle Percentage Displayed on Service Tool

8. Use the accelerator pedal to increase RPM above idle momentarily (rev the engine) then release the pedal to return to idle RPM. The duty cycle setting should remain within the adjustment range (40-45%). Place your thumb over the adjustment port for a more accurate reading by preventing air from leaking past the mixture adjustment screw, which may cause the duty cycle to decrease.
9. Use the Mototune Service Tool to lock the FTV duty cycle. Set display parameter DitherValveDC_ovr = locked (displayed in screen tab Manual Override 1 under AFR Trim Vales, select "locked" under box labeled Lock DC%).
10. Use the Mototune Service Tool to monitor throttle position (TPS1) and Exhaust gas oxygen equivalence ratio ("O2 Value" in Figure 1). While monitoring O2, slowly increase the pedal input (APP) to achieve a TPS1 value of 15%.
11. Use the Mototune Service Tool to unlock the FTV duty cycle. Set display parameter DitherValveDC_ovr = unlocked (displayed in screen tab Manual Override 1 under AFR Trim Vales, select "unlocked" under box labeled Lock DC%).
12. If at any time in step 10, O2 was greater than 1.2 go to step 13. If 02 remained below 1.2, proceed to Step 15.
13. Adjust the idle mixture screw on the mixer until a reading of 50-55% is reached for the FTV Duty Cycle in Closed Loop Idle (Figure 35).
14. Use the accelerator pedal to increase RPM above idle momentarily (rev the engine) then release the pedal to return to idle RPM. The duty cycle setting should remain within the adjustment range (50-55%). Place your thumb over the adjustment port for a more accurate reading by preventing air from leaking past the mixture adjustment screw, which may cause the duty cycle to decrease.

NOTE

If the FTV Duty Cycle reading is NOT between 25-60%, check for possible vacuum leaks, manifold leaks, or a faulty mixer.

15. Turn the ignition key to the OFF position to shut down the engine.

Rough, Unstable, Incorrect Idle, or Stalling

Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS
Perform the visual checks as described at start of "Basic Troubleshooting" chapter. Check for vacuum leaks. Check that SECM grounds are clean and tight. See SECM wiring diagram.

PROBABLE CAUSE	CORRECTIVE ACTION
Fuel system malfunction	Monitor oxygen feedback to help identify the cause of the problem. If the system is running lean or if the system is running rich evaluate further i.e. dither valve duty cycle and injector pulse width. Check for incorrect minimum idle speed that may be caused by foreign material accumulation in the throttle bore, on the throttle valve, or on the throttle shaft. Check that the injectors are clean and functioning. Check for liquid fuel in propane pressure regulator hose. If fuel is present, replace regulator assembly. The pre-catalyst oxygen (O2) sensor should respond quickly to different throttle positions. If it does not, then check the pre-catalyst O2 sensor for contamination. If the pre-catalyst O2 sensor is aged or contaminated, the SECM will not deliver correct amount of fuel, resulting in a drivability problem.
Fuel container empty	Check for LPG vapor from LPG liquid outlet valve on tank. Fill fuel container. Do not exceed 80% of liquid capacity.
Ignition system malfunction	Check ignition system; wires, plugs, rotor, etc.
LPG pressure regulator malfunction	Test regulator operation and pressure. See Chapter 6 Tests and Adjustments
Air/fuel mixer malfunction	Check mixer.
Component malfunction	Check throttle for sticking or binding. Check PCV valve for proper operation by placing finger over inlet hole in valve end several times. Valve should snap back. If not, replace valve. Check alternator output voltage. Repair if less than 9 or more than 16 volts.
Engine mechanical	Perform a cylinder compression check. See Engine Manufacturer's Service Manual.

(continued on next page)

Table 1. Fault List Definitions(cont'd)

FAULT	DESCRIPTION	CODE
ETC Spring Test	Electronic Throttle Control Spring Return Test has Failed. The SECM will perform a safety test of the throttle return spring following engine shutdown. If this spring has become weak the throttle will fail the test and set the fault. NOTE: Throttle assembly is not a serviceable item and can only be repaired by replacing the DV-EV throttle assembly.	481 (28)
ETC_Open_Fault	Electronic Throttle Control Driver has failed. Normally set if either of the ETC driver signals have opened or become disconnected, electronic throttle or SECM is defective.	471
ETC_Sticking	Electronic Throttle Control is Sticking. This can occur if the throttle plate (butterfly valve) inside the throttle bore is sticking. The plate sticking can be due to some type of obstruction; a loose throttle plate or worn components shaft bearings. NOTE: Throttle assembly is not a serviceable item and can only be repaired by replacing the DV-EV throttle assembly.	461 (26)
Fuel Select Conflict	Conflict in fuel select signals, normally set if one or both of the fuel select signals are shorted to ground	181
Fuel Temp Range High	Fuel Temperature Sensor Input is High. Normally set if the fuel temperature sensor wire has been disconnected or the circuit has opened to the SECM.	932
Fuel Temp Range Low	Fuel Temperature Sensor Input is Low. Normally set if the fuel temperature sensor wire has shorted to chassis ground or the sensor has failed.	931
Gas Fuel Adapt Range Hi	In LPG mode, system had to adapt lean more than expected	731 (73)
Gas Fuel Adapt Range Lo	In LPG mode, system had to adapt rich more than expected	721 (72)
Gas O2 Failed Lean	Pre-catalyst O2 sensor indicates extended lean operation on LPG	751
Gas O2 Failed Rich	Pre-catalyst O2 sensor indicates extended rich operation on LPG	771 (77)

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
531 (53)	**SysVoltRangeLow** System voltage too low	Turn On Mil	Check battery voltage • Perform maintenance check on electrical connections to the battery and chassis ground • Check battery voltage during starting and with the engine running to verify charging system and alternator function • Measure battery power at SECM with a multimeter (with key on) SECM Pin A23 (DRVP) to SECM Pin A16 (DRVG) SECM Pin A23 (DRVP) to SECM Pin B17 (DRVG)
541 (54)	**SysVoltRangeHigh** System voltage too high	Turn On Mil	Check battery and charging system voltage • Check battery voltage during starting and with the engine running • Check voltage regulator, alternator, and charging system • Check battery and wiring for overheating and damage • Measure battery power at SECM with a multimeter (with key on) SECM Pin A23 (DRVP) to SECM Pin A16 (DRVG) SECM Pin A23 (DRVP) to SECM Pin B17 (DRVG)
551 (55)	**SensVoltRangeLow** Sensor reference voltage XDRP too low	(1) Turn On Mil (2) Engine Shutdown	Measure transducer power at the TMAP connector with a multimeter TMAP Pin 3 XDRP +5 Vdc to TMAP Pin 1 XDRG GND Verify transducer power at the SECM with a multimeter SECM Pin B24 +5 Vdc to SECM Pin B1 XDRG GND Verify transducer power at ETC with a multimeter ETC Pin 3 XDRP PWR to ETC Pin 2 XDRG GND Verify transducer power to the foot pedal with a multimeter.

(*) Fault actions shown are default values specified by the OEM.

LPG Tank Pressure VS Temperature

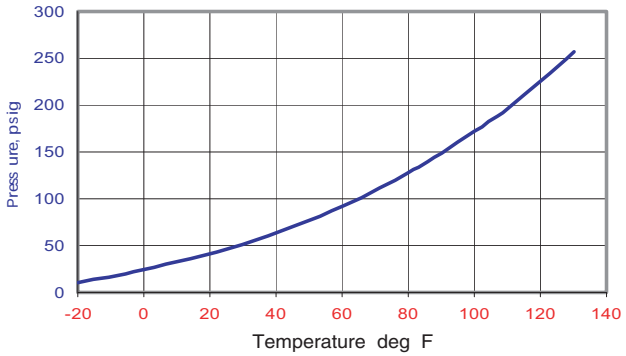
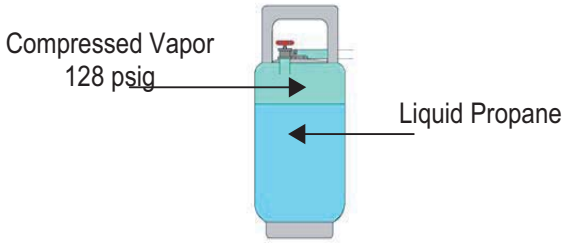


Figure A1. LPG Tank Pressure vs Temperature

With 128 psig vapor pressure acting against the liquid propane, the boiling point has been raised to slightly more than 80° F (27° C).



NOTE

Vapor pressure inside an LPG tank depends on the propane temperature, not the amount of liquid inside the tank. A tank that is 3/4 full of liquid propane at 80° F (27° C) will contain the same vapor pressure as a tank that is only 1/4 full of liquid propane.

LPG's relative ease of vaporization makes it an excellent fuel for low-rpm engines on start-and-stop operations. The more readily a fuel vaporizes, the more complete combustion will be. Because propane has a low boiling point (-44° F [-42° C]), and is a low carbon fuel, engine life can be extended due to less cylinder wall wash down and little, if any, carbon build up.

LPG Fuel Tanks

The two styles of LPG storage containers available for industrial use and lift truck applications are portable universal cylinders and permanently mounted tanks. Portable universal cylinders are used primarily for off-highway vehicles and are constructed in accordance with the DOT-TC (United States Department of Transport-Transport Canada). The cylinders are referred to as universal because they can be mounted in either a vertical or horizontal position (Figure A2).

Figure A2. Portable Universal Cylinder

NOTE

A 375-psig relief valve is used on a DOT forklift tank. The relief valve must be replaced with a new valve after the first 12 years and every 10 years thereafter.

The tank must be discarded if the collar is damaged to the point that it can no longer protect the valves. It must also be replaced if the foot ring is bent to the point where the tank will not stand or is easily knocked over.

Installing LPG Fuel Tanks

When installing a tank on a lift truck, the tank must be within the outline of the vehicle to prevent damage to the valves when maneuvering in tight spaces. Horizontal tanks must be installed on the saddle that contains an alignment pin, which matches the hole in the collar of the tank. When the pin is in the hole, the liquid withdrawal tube is positioned to the bottom of the tank. A common problem is that often these guide-pins are broken off, allowing the tank to be mounted in any position. This creates two problems: (1) Exposure of the liquid withdrawal tube to the vapor space may give a false indication that the

FUEL SYSTEM INSPECTION AND MAINTENANCE

LPG FUEL SYSTEM

The fuel system installed on this industrial engine has been designed to meet the mobile engine emission standard applicable for the 2010 and later model years. To ensure compliance to these standards, follow the recommended maintenance schedule contained in this section.

INSPECTION AND MAINTENANCE OF THE FUEL STORAGE CYLINDER

The fuel storage cylinder should be inspected daily or at the beginning of each operational shift for any leaks, external damage, adequate fuel supply and to ensure the manual service valve is open. Fuel storage cylinders should always be securely mounted, inspect the securing straps or retaining devices for damage ensure that all locking devices are closed and locked. Check to ensure that the fuel storage cylinder is positioned with the locating pin in the tank collar on all horizontally mounted cylinders this will ensure the proper function of the cylinder relief valve.

When refueling or exchanging the fuel cylinder, check the quick ll valve for thread damage. Also verify O-ring is in place and inspect for cracks, chunking or separation. If damage to the o-ring is found, replace prior to lling. Check the service line quick coupler for any thread damage.

IMPORTANT

When refueling the fuel cylinder, wipe both the female and male connection with a clean rag prior to lling to prevent dust, dirt and debris from being introduced to the fuel cylinder.

INSPECTION AND REPLACEMENT OF THE FUEL FILTER

The fuel system on this emission certi ed engine may utilize an in-line replaceable fuel lter element. This element should be replaced, at the intervals speci ed in the recommended maintenance schedule. When inspecting the fuel lter check the following:

- Check for leaks at the inlet and outlet ttings, using a soapy solution or an electronic leak detector and repair if necessary.
- Check to make sure lter is securely mounted.
- Check lter housing for external damage or distortion. If damaged replace fuel lter.

REPLACING THE FUEL FILTER:

1. Move the equipment to a well ventilated area and verify that sparks, ignition and any heat sources are not present.
2. Start the engine.
3. If the engine operates on a positive pressure fuel system, run the engine with the fuel supply closed to remove fuel from the system.

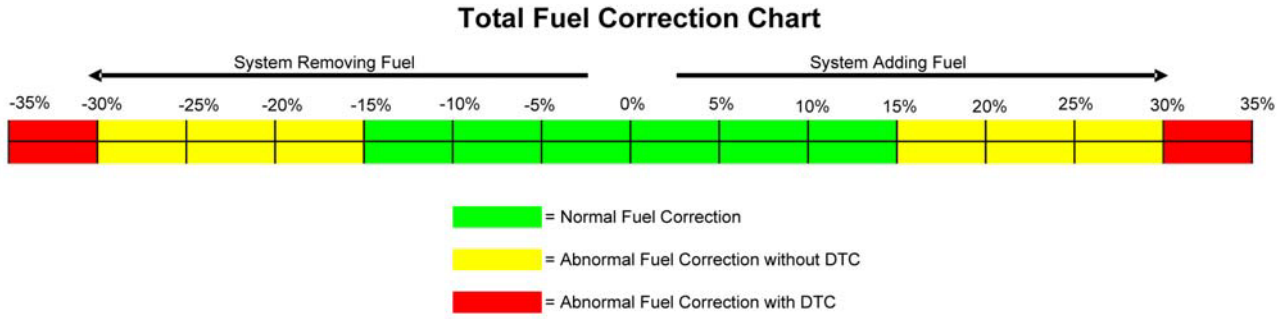
IMPORTANT

A small amount of fuel may still be present in the fuel line. Use gloves and proper eye protection to prevent burns. If liquid fuel continues to ow from the connections when removed, make sure the manual valve is fully closed.

4. Slowly loosen the inlet tting and disconnect.
5. Slowly loosen the outlet tting and disconnect.
6. Remove the lter housing form the equipment.
7. Check for contamination.
8. Tap the opening of the lter on a clean cloth.
9. Check for debris.
10. Check canister for proper mounting direction.
11. Reinstall the lter housing to the equipment.
12. Tighten the inlet and outlet ttings to specificaion.
13. Check for leaks at the inlet and outlet ttings, and the lter housing end connection using a soapy solution or an electronic leak detector, if leaks are detected make repairs

NORMAL & ABNORMAL FUEL CORRECTION

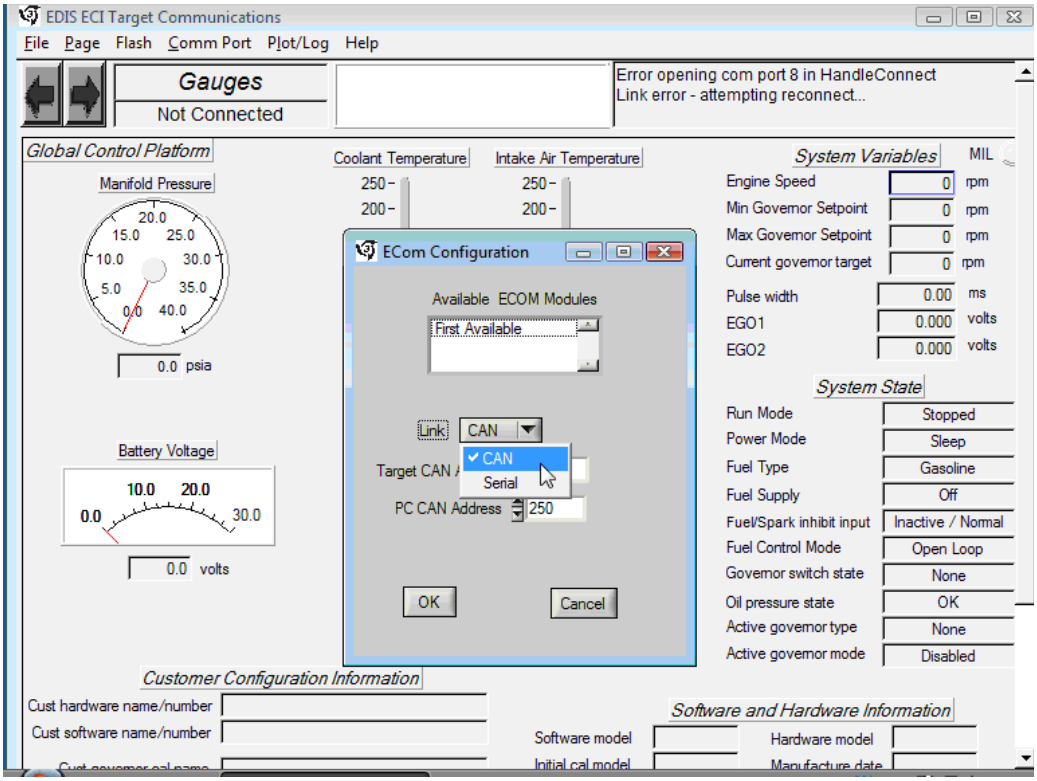
Generally, the system is operating within specification when total fuel correction falls between -15% and +15%. Operation outside of this range will require further diagnosis to determine the system level issue affecting fuel control. The system will set Diagnostic Trouble Codes (DTC's) for correction factors in the +/- 30%-35% range. If total fuel correction is found to be operating outside of the normal range additional diagnostic procedure will be required to determine the cause. Follow the appropriate Symptom Routine or DTC Chart for additional help.



ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

Checks	Action
DEFINITION: *The engine runs unevenly at idle. If severe enough, the engine may shake.*	
Preliminary Checks	None.
Sensor Checks	Check the Heated Exhaust Gas Oxygen Sensors (HEGO) performance: • Check for silicone contamination from fuel or improperly used sealant. If contaminated, the sensor may have a white powdery coating result in a high but false signal voltage (rich exhaust indication). The ECM will reduce the amount of fuel delivered to the engine causing a severe driveability problem. Check the Temperature Manifold Absolute Pressure (TMAP) sensor response and accuracy.
Fuel System Checks	• Check for rich or lean symptom that causes the condition. • Drive the vehicle at the speed of the complaint. • Monitoring the oxygen sensors will help identify the problem. • Check for a sticking mixer air valve. • Verify proper operation of the EPR. • Perform a cylinder compression test. Refer to *Engine Mechanical* in the Service Manual. • Check the EPR fuel pressure. Refer to the *LPG Fuel System Diagnosis*. • Check mixer assembly for proper installation and connection.
Ignition System Checks	• Check for the proper ignition output voltage using the spark tester *J26792* or the equivalent. • Verify that the spark plugs are the correct type and properly gapped. Remove the plugs and inspect them for the following conditions: • Wet plugs. • Cracks. • Wear. • Improper gap. • Burned electrodes. • Blistered insulators. • Heavy deposits. Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.
Additional Checks	**Important:** The LPG Fuel system is more sensitive to intake manifold leakage than the gasoline fuel supply system. • Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. • Check the ECM grounds for being clean, tight, and in their proper locations. Check the battery cables and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed resulting in poor idle quality.
Engine Mechanical Check	Check the engine for: • Broken motor mounts. • Improper valve timing. • Low compression. • Improper valve clearance. • Worn rocker arms. • Broken or weak valve springs. • Worn camshaft lobes.

- You will now need to configure the ECOM communication protocol.



- Select the CAN for systems with CAN enabled or serial for all others. Then select OK. You are now ready to connect using the ECOM USB DLC cable.

BLINK CODE FUNCTION

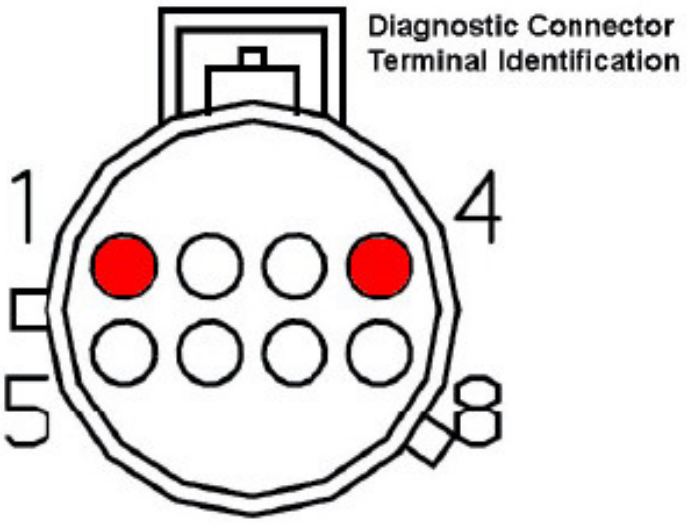
Although the DST is considered a required tool to access the DTC codes, codes may be retrieved without a laptop computer using the blink code function. To enable this function follow the steps below:

- Jump pins 1 and 4 at the DLC connector (see illustration below)
- Turn the ignition key to the on position
- The system will now enter the self diagnostic blink code mode. Be ready with pen and paper to write down any codes that may be stored.
- The ECM will flash the MIL indicator with a pause between represented numbers that represent DTC codes. The sequence starts with code 1654. Code 1654 confirms the system has entered the blink code mode. The ECM will flash code 1654 (3) times before displaying the actual DTC code that may be set.

  Example:

  One short blink (pause) six short blinks (pause) five short blinks (pause) four short blinks.

- If no DTC codes are found, the ECM will continue to flash 1654 only. This means no stored DTC codes were found.
- If one of the numbers in the DTC code is zero (0), no flash will occur to represent the zero value—it will be represented as a short pause.

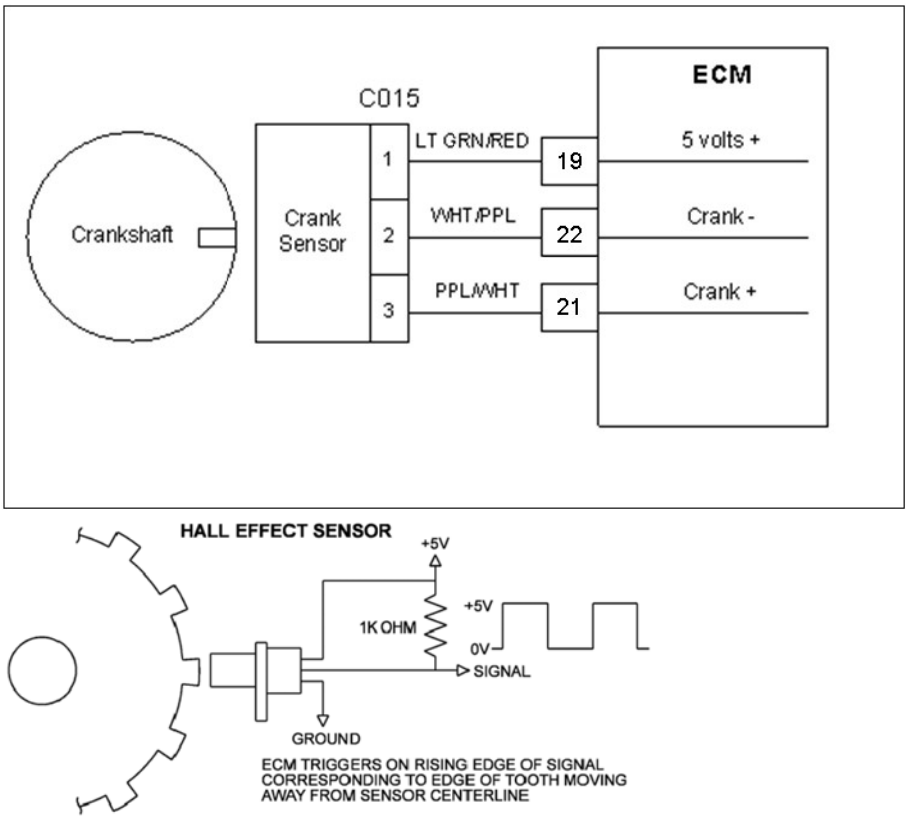


DIAGNOSTIC TROUBLE CODE (DTC) CHART – SORTED BY DTC # (4 of 4)

Description	DTC Set 2 SPN-2	DTC Set 2 FMI-2
DTC 2618: Tach output ground short	645	4
DTC 2619: Tach output short to power	645	3
DTC 8901: UEGO microprocessor internal fault	3221	31
DTC 8902: UEGO heater supply high voltage	3222	3
DTC 8903: UEGO heater supply low voltage	3222	4
DTC 8904: UEGO cal resistor voltage high	3221	3
DTC 8905: UEGO cal resistor voltage low	3221	4
DTC 8906: UEGO return voltage shorted high	3056	3
DTC 8907: UEGO return voltage shorted low	3056	4
DTC 8908: UEGO pump voltage shorted high	3218	3
DTC 8909: UEGO pump voltage shorted low	3218	4
DTC 8910: UEGO sense cell voltage high	3217	3
DTC 8911: UEGO sense cell voltage low	3217	4
DTC 8912: UEGO pump voltage at high drive limit	3225	3
DTC 8913: UEGO pump voltage at low drive limit	3225	4
DTC 8914: UEGO sense cell slow to warm up	3222	10
DTC 8915: UEGO pump cell slow to warm up	3225	10
DTC 8916: UEGO sense cell impedance high	3222	0
DTC 8917: UEGO pump cell impedance high	3225	0
DTC 8918: UEGO pump cell impedance low	3225	1

DTC 16-Never Crank Synchronized at Start (SPN 636:FMI 8)

4.3L, 5.0 & 5.7L - SHOWN BELOW



Conditions for setting the DTC

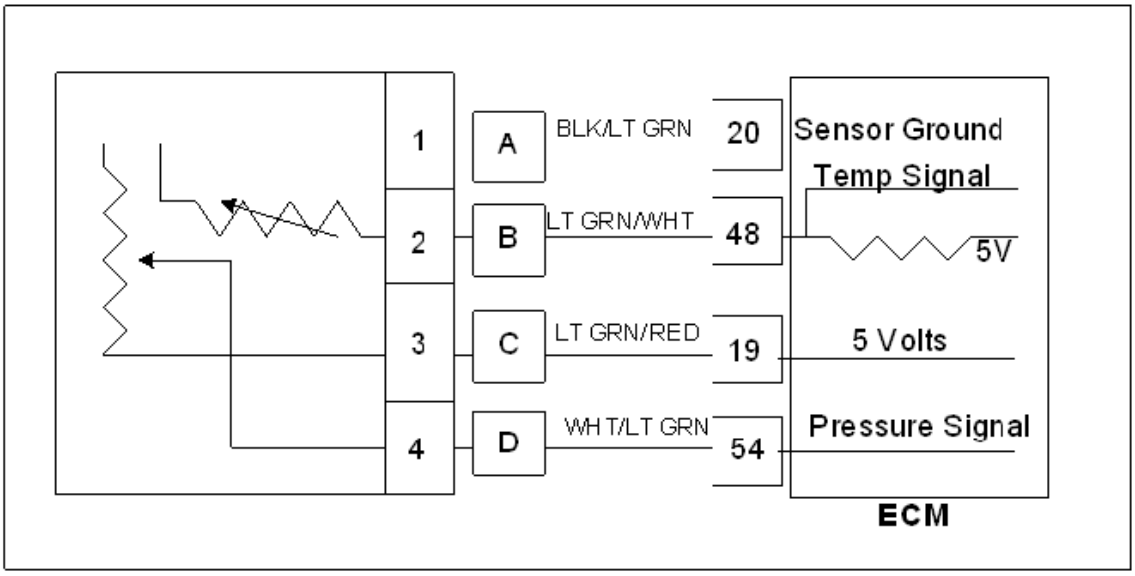
- Crankshaft Position sensor
- Check Condition- Engine cranking
- Fault Condition- Cranking rpm above 90 and more than 4 cranking revolutions without synchronization Adaptive Disabled
- MIL Command-ON

Circuit Description

The Crankshaft position sensor is a 5 volt powered sensor mounted to the lower front engine block. A pulse wheel located on the crankshaft is used to measure engine rpm and its signal is used to synchronize the ignition and fuel systems. This fault will set if the ECM detects cranking revolutions without synchronization of the CMP and CKP sensors.

Reversed sensor wires, poor wire connections or a faulty system ground are most frequently the cause of this code set.

DTC 91-Gasoline Fuel Pressure Sensor High Voltage (SPN 94: FMI 3)



Conditions for setting the DTC

- Gasoline fuel temperature sensor voltage
- Fuel pressure sensor voltage greater than 4.8v for greater than 1 second
- MIL-On for active fault and for 2 seconds after active fault
- Adaptive Learn is disabled during fault condition
- Forced Idle is enabled

Circuit Description

Note: The fuel pressure and temperature sensor is wired via Equipment Manufacturer supplied harness jumper. The terminals A, B, C, D & 19, 20, 48, 54 are engine wiring harness terminals at the fuel sensor interface connector C002 and the ECM header connector C001. You may need to consult additional wiring information supplied by the OEM. The gasoline fuel pressure sensor voltage is reading greater than 4.8v. This indicates a high voltage fault from the sensor or circuit.

DTC 113-IAT Voltage High

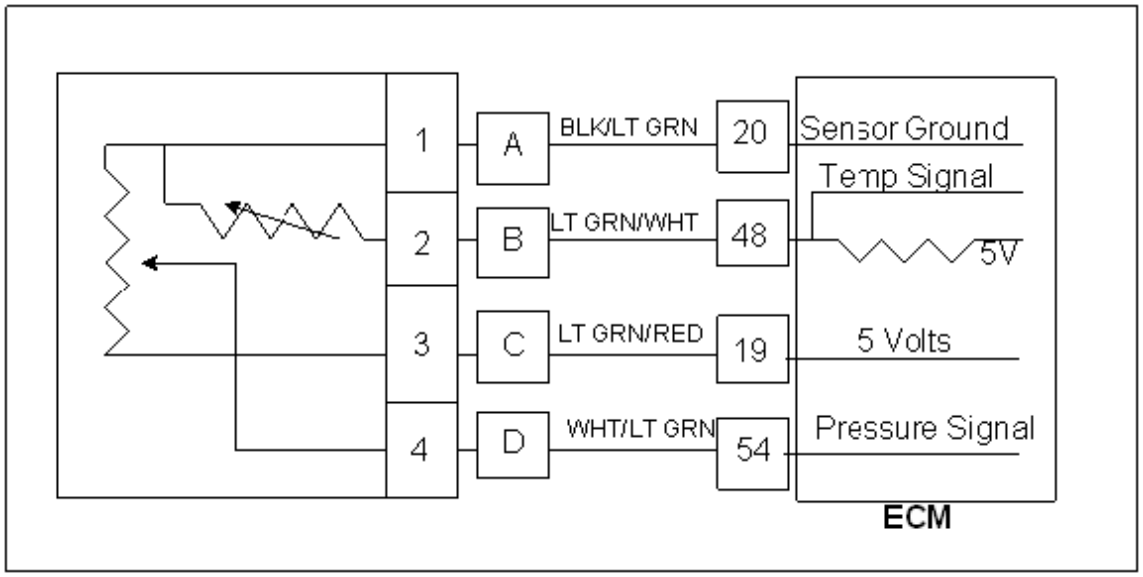
Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display IAT voltage of 4.950 or greater?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect the TMAP sensor connector C006 and jump pins 1 and 2 together • Key ON Does the DST display IAT voltage of 0.1 volts or less?		Go to Step (9)	Go to Step (4)
4	• Key OFF • Jump TMAP sensor connector signal pin 2 to engine ground • Key ON Does DST display IAT voltage of 0.1 volts or less?		Go to Step (7)	Go to Step (6)
5	• Replace TMAP sensor. Is the replacement complete?	-	Go to Step (11)	-
6	• Key OFF • Disconnect the ECM wire harness connector C001. • Check for continuity between TMAP sensor connector signal pin 2 and ECM IAT signal pin 39 Do you have continuity between them?	-	Go to Step (10)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
7	• Check for continuity between TMAP sensor connector ground circuit pin 1 and ECM sensor ground circuit pin 20 Do you have continuity between them?	-	Go to Step (10)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
8	• Replace the ECM. Is the replacement complete?		Go to Step (11)	-
9	• Re-check wire harness and TMAP sensor connector for damage corrosion or contamination Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (5)
10	• Re-check wire harness and TMAP sensor connectors for damage corrosion or contamination Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (8)

Step	Action	Value(s)	Yes	No
11	• Replace ECM Is the replacement complete?		Go to Step (12)	-
12	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-121 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 134-EGO 1 Pre Cat Open/Lazy

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Run engine to full operating temperature and then idle for a minimum of 2 minutes Does DST display EGO 1 voltage fixed between 0.4 and 0.5 volts after at least 2 minutes of idle run time?		Go to Step (3)	Intermittent problem. See Electrical Section Intermittent Electrical Diagnosis
3	• Key OFF • Disconnect EGO 1 connector C005 • Key ON • Using a DVOM check for voltage between EGO 1 connector pins C and D (Check must be made within 30 seconds or before power relay shuts down) Do you have voltage?		Go to Step (8)	Go to Step (4)
4	• Key OFF • Using a DVOM check for voltage between EGO 1 connector pin C and engine ground • Key ON (Check must be made within 30 seconds or before power relay shuts down) Do you have voltage?	System Voltage	Go to Step (5)	Repair system power relay open circuit
5	• Key OFF • Disconnect ECM wire harness connector C001 • Key ON • Using a DVOM check for voltage between TPS 1 signal at the ECM connector pin 5 and engine ground Do you have voltage?		Go to Step (6)	Repair open heater ground circuit
6	• Inspect wire harness connector C005 pins B and D and C001 pins 1 and 72 for damage, corrosion or contamination Did You find a problem?		Correct the problem as required see Electrical Section wire harness repair	Go to Step (7)
7	• Replace ECM Is the replacement complete?		Go to Step (11)	-
8	• Key OFF • Disconnect ECM wire harness connector C001 • Using a DVOM check for continuity between EGO 1 pin B and ECM connector pin 1 Do you have continuity?		Go to Step (9)	Repair open EGO 1 circuit

DTC 183-Gasoline Fuel Temperature High (SPN 174:FMI 3)



Conditions for Setting the DTC

- Gasoline fuel temperature low
- Faulty fuel temp sensor
- Fuel temperature sensor voltage greater than 4.95v for 5 seconds or greater
- Fuel temperature is 130F or higher for 5 seconds or greater
- MIL-On for active fault and for 2 seconds after active fault
- Adaptive Learn is disabled while this fault is active.

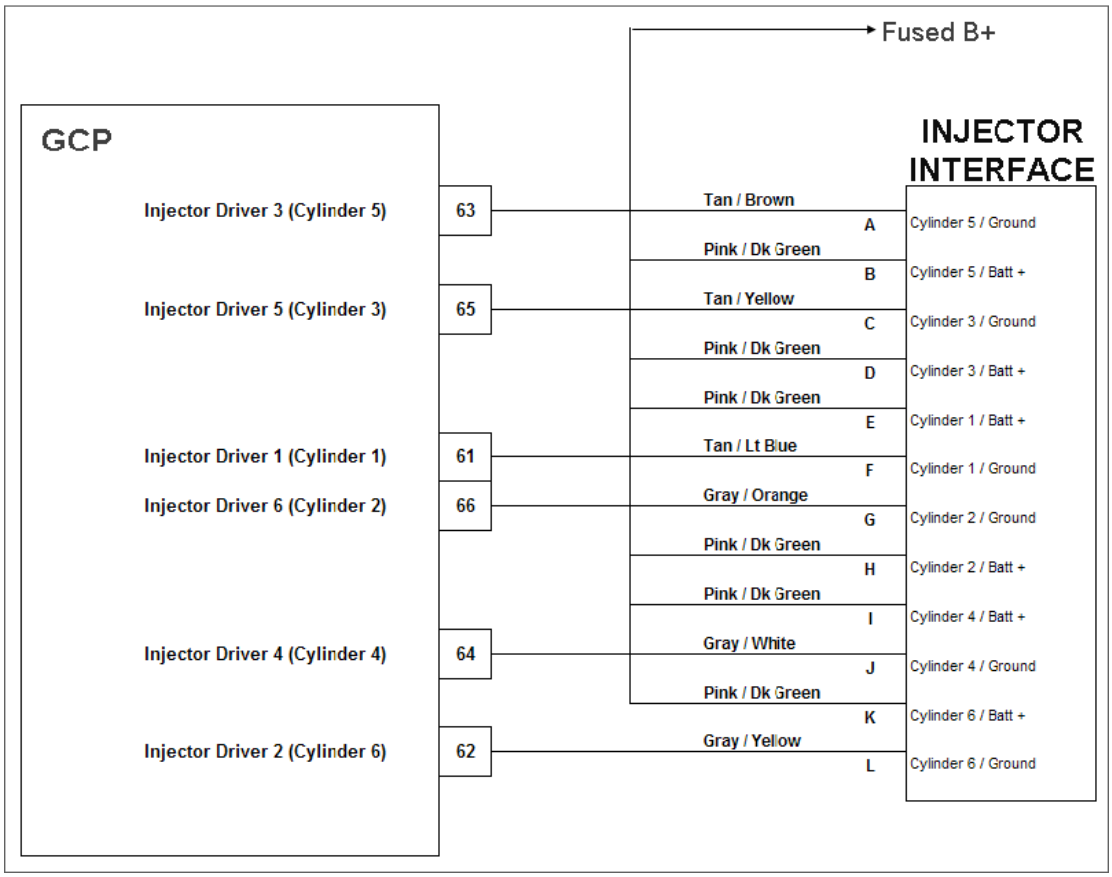
Circuit Description

Note: The fuel pressure and temperature sensor is wired via Equipment Manufacturer supplied harness jumper. The terminals A, B, C, D & 19, 20, 48, 54 are engine wiring harness terminals at the fuel sensor interface connector C002 and the ECM header connector C001. You may need to consult additional wiring information supplied by the OEM. The gasoline fuel temperature sensor voltage is read at less than 0.05v. This indicates a high voltage fault from the sensor or circuit. This could also indicate a high fuel temperature reading. Inspect the fuel temperature for extreme hot temperatures.

DTC 223-TPS 2 Signal Voltage High

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in DBW (Drive by Wire) throttle test mode Does the DST display TPS 2 voltage of 4.800 volts or greater with the throttle closed?		Go to Step (4)	Go to Step (3)
3	• Slowly depress Foot Pedal while observing TPS 2 voltage Does TPS 2 voltage ever exceed 4.800 volts?		Go to Step (4)	Intermittent problem. Go to Intermittent section
4	• Key OFF • Disconnect electronic throttle connector C017 • Key ON Does DST display TPS 2 voltage less than 0.2 volts?		Go to Step (7)	Go to Step (5)
5	• Key OFF • Disconnect ECM wire harness connector C001 • Key ON • Using a DVOM check for voltage between electronic throttle connector TPS 2 signal pin 5 and engine ground Do you have voltage?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Replace ECM Is the replacement complete?		Go to Step (11)	-
7	• Probe sensor ground circuit at the ECM side of the wire harness pin 3 with a test light connected to battery voltage Does the test light come on?		Go to Step (8)	Go to Step (10)
8	• Inspect the electronic throttle wire harness connector and terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (9)
9	• Replace electronic throttle Is the replacement complete?		Go to Step (11)	-
10	• Key OFF • Disconnect ECM connector C001 • Using a DVOM check for continuity between throttle connector C017 sensor ground pin 2 and ECM connector sensor ground pin 20 Do have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.

DTC 271: Injector driver 4 (Cyl 4) Coil Shorted (SPN 654:FMI 6)



Conditions for Setting the DTC

- Injector is in the On State
- Low side voltage is greater than 4.0 volts
- Battery voltage is less than 16.0 volts
- MIL Light turned on
- Closed Loop is disabled while this fault is active
- Adaptive Learn is disabled while this fault is active.

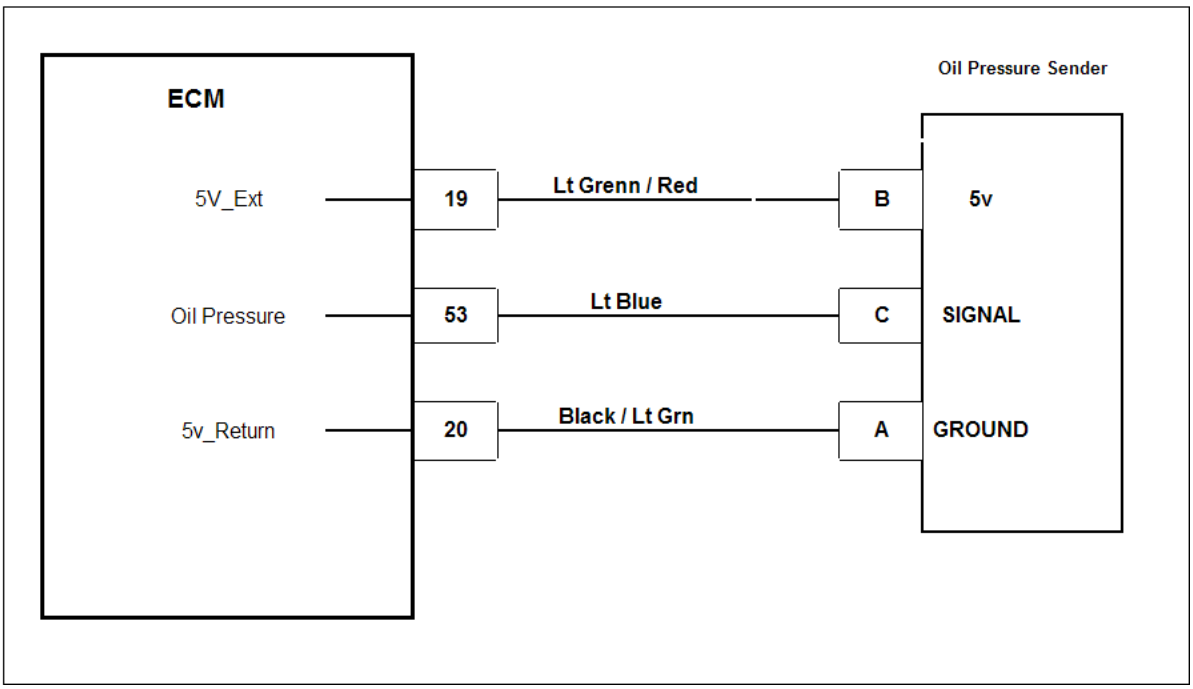
Circuit Description

The fuel injectors turn on when the GCP provides a ground circuit to the injector. Battery positive is constantly provided through the ignition fuse and the Pink / DK Green wire. Each Injector has a ground side driver assigned to it inside the GCP. The driver number does not match up with the mating cylinder number in each case. The driver is assigned in numerical order according to the engine firing order (4.3L = 1, 6, 5, 4, 3, 2). The ECM is monitoring the low side voltage internally in the ECM. This code will set if it sees a high voltage on the low side during an “injector on” state. This indicates the injector likely has a short circuit internal to the injector. It could also be a result of a short from power to the ground circuit.

The technician should check the wiring and the injector resistance. If the resistance is out of specification on the DVOM you should replace the injector. If there is a short from a power circuit to the ground circuit you should repair the faulty circuit in accordance with the recommended wire repair instructions provided in this manual.

Step	Action	Value(s)	Yes	No
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-341 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (9)
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-341 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 521- Oil Pressure High

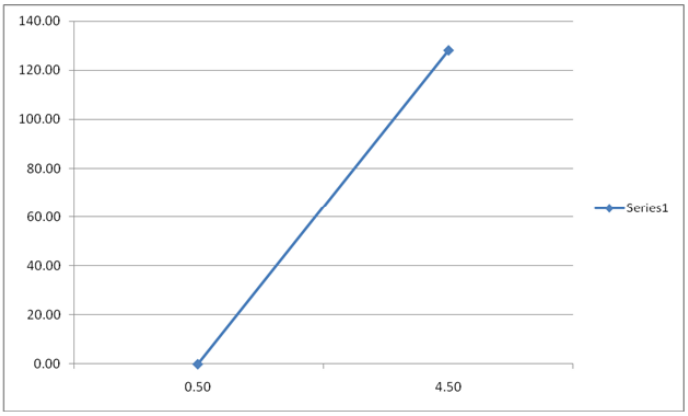


Conditions for Setting the DTC

- Engine Oil Pressure low.
- Check Condition-Engine running for 5 seconds.
- Fault Condition- Oil pressure greater than 95 psi for 5 or more seconds
- Forced idle is active

Circuit Description

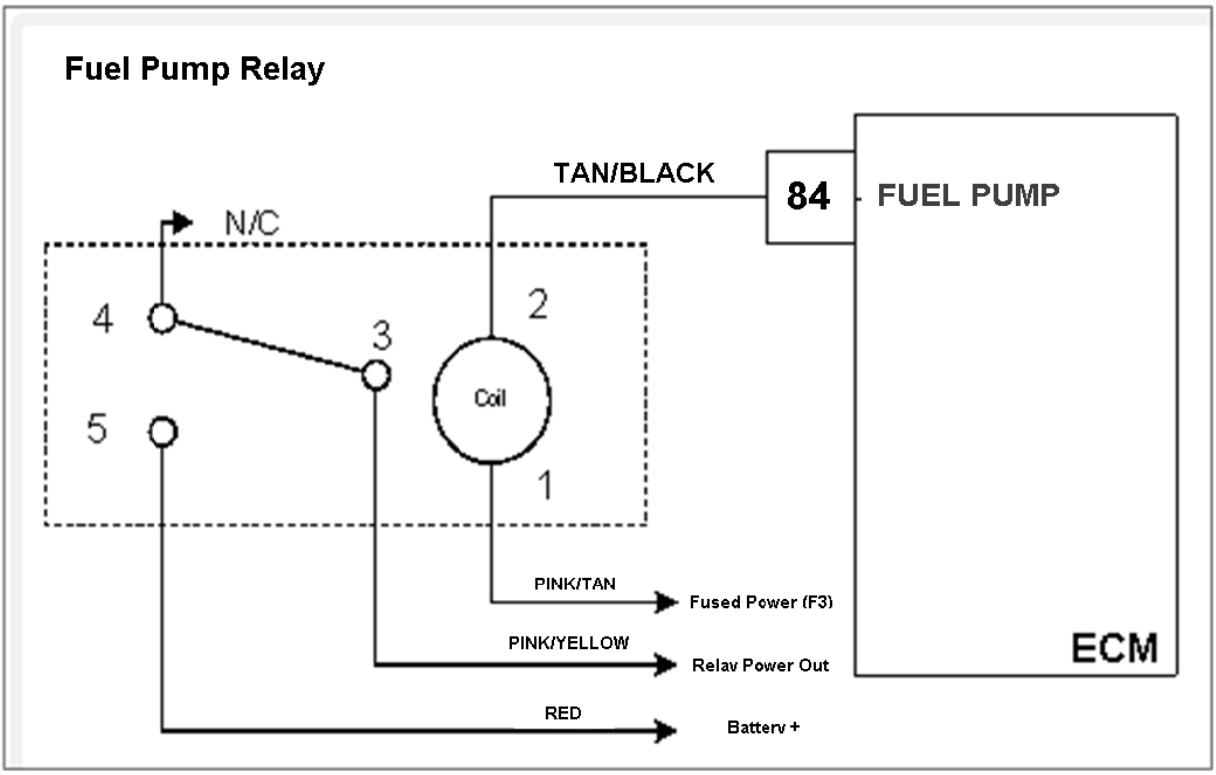
The Oil Pressure Sender is used to communicate the oil pressure condition to the ECM. Engine damage can occur if the engine is operated with low oil pressure. The ECM sends a 5v signal to the oil pressure sender. The sender will report a signal back to the ECM on the signal wire depending on the pressure that is applied on its diaphragm. The voltage is linear in comparison to the pressure applied (see chart below). The MIL command is ON and the engine will go into a forced idle condition in the event of this fault to help prevent possible engine damage.



DTC 563-System Voltage High

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display system voltage greater than 18 volts?	-	Go to Step (3)	Intermittent problem Go to Engine Electrical Intermittent section
3	• Check voltage at battery terminals with DVOM with engine speed greater than 1500 rpm Is it greater than 18 volts?	-	Go to Step (4)	Go to Step (5)
4	• Repair the charging system Has the charging system been repaired?	-	Go to Step (6)	-
5	• Replace ECM Is the replacement complete?	-	Go to Step (6)	-
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-563 check for any stored codes. Does the engine operate normally with no stored codes?	-	System OK	Go to OBD System Check

DTC 629- Fuel Pump Relay Coil Short to Power (SPN 1347:FMI 3)



Conditions for Setting the DTC

- Fuel Pump relay check
- Check Condition-Key ON
- Fault Condition-Relay coil open

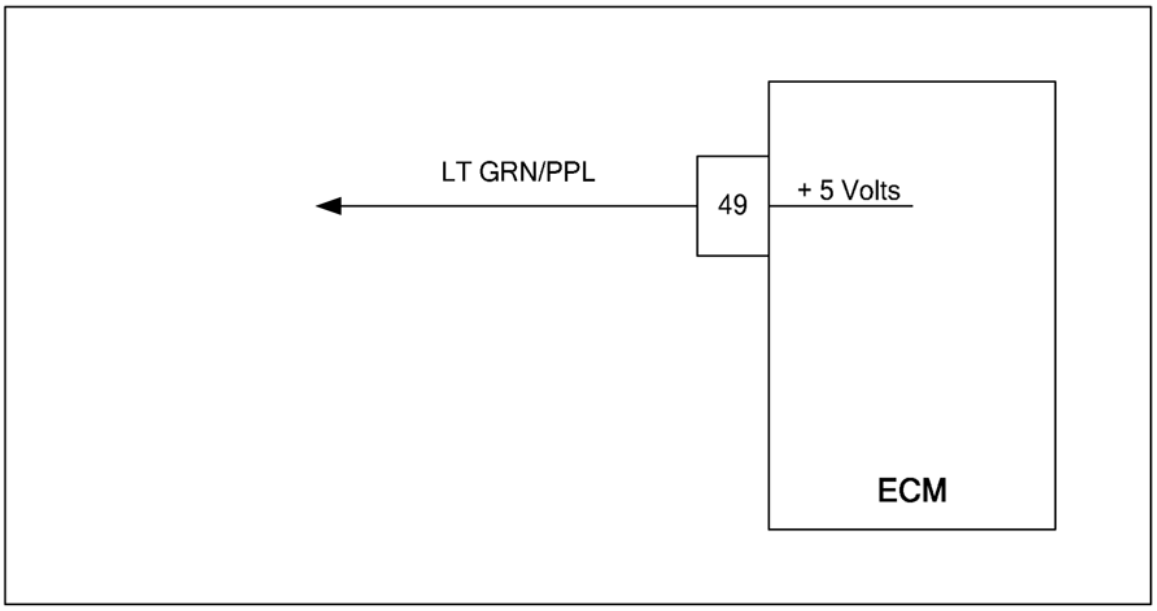
Circuit Description

The fuel pump relay switches power out to the gasoline fuel pump. This fault will set if the ECM detects an open circuit on the relay control output.

Diagnostic Aid

Relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values be sure the relay is at a reasonable temperature, between +20 and +100 degrees F.

DTC 653-External 5 Volt 2 Reference High (SPN 1080:FMI 3)



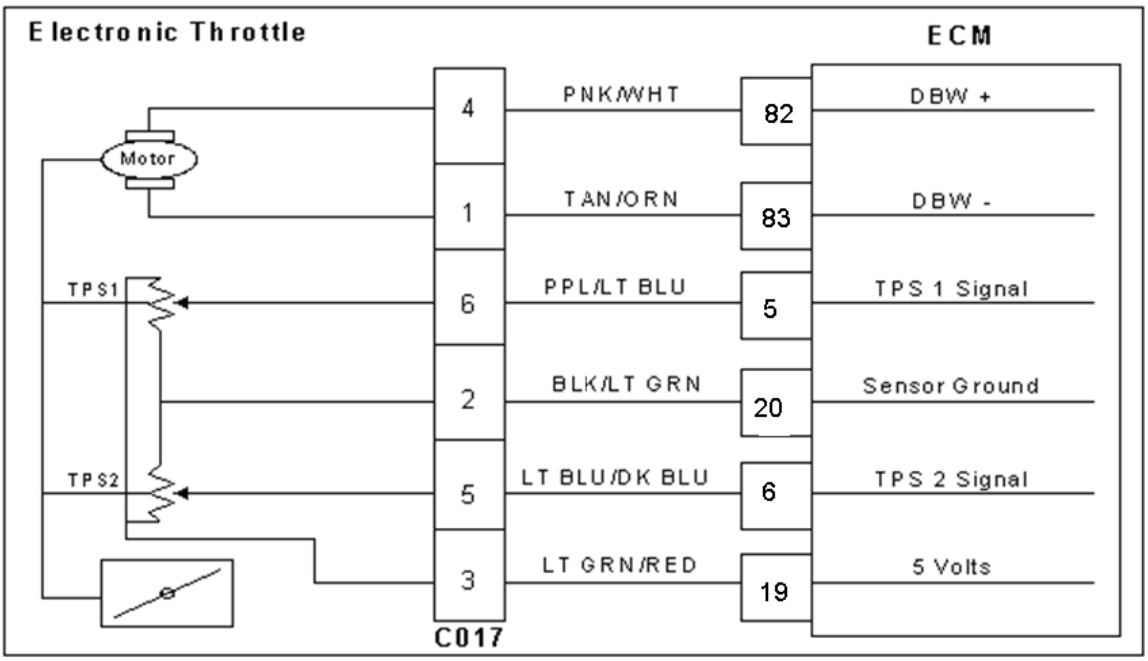
Conditions for Setting the DTC

- External 5 volt reference
- Check Condition-Engine cranking or running
- Fault Condition-5 volt reference higher than 5.40 volts
- MIL-On during active fault
- Adaptive-Disabled during active fault

Circuit Description

The External 5 volt supply is normally dedicated to the FPP sensor 5 volt supply circuit. The accuracy of the 5 volt supply is very important to the accuracy of the FPP sensor circuit. The ECM is able to determine if the circuit is open, shorted, or otherwise out of specification by monitoring this 5 volt supply. This fault will set if the 5 volt reference is above 5.40 volts. Adaptive Learn will be disabled during this fault.

DTC 1112-Spark Rev Limit (SPN 515: FMI 0)



Conditions for Setting the DTC

- Spark Rev Limit
- Check Condition-Engine running
- Fault Condition-Engine rpm greater than set limit
- MIL-ON during active fault
- Engine Shut Down

Circuit Description

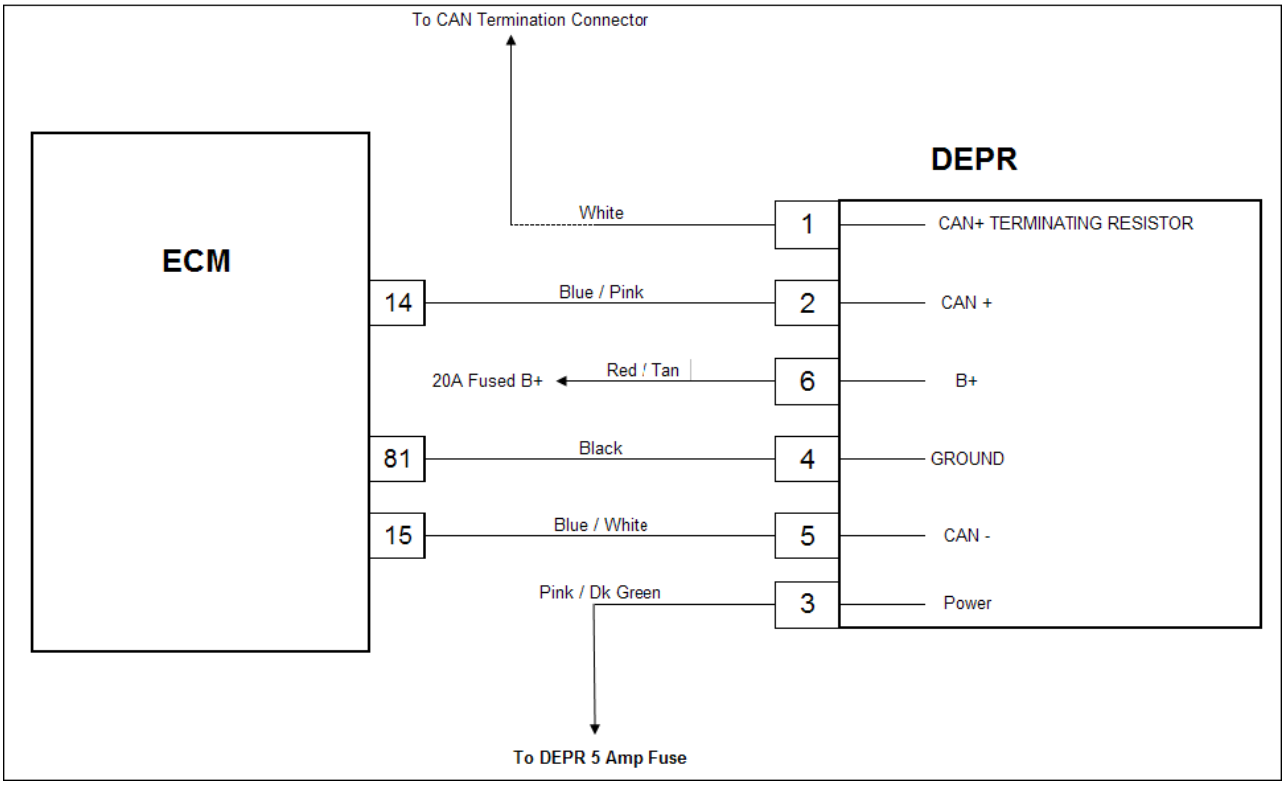
This fault will set anytime the engine rpm exceeds the specified speed settings installed in the calibration. This is generally set at 3200 rpms. The MIL command is ON during this active fault and the engine will shut down.

Diagnostic Aid

Always check for other stored DTC codes before using the following DTC chart for this code set. Repair any existing codes starting with the lowest numerical code first.

Step	Action	Value(s)	Yes	No
7	• Using a high impedance DVOM check for continuity between EGO 1 heater ground pin D and ECM pin 72 Do you have continuity?		Go to Step (8)	Repair the open EGO heater ground
8	• Replace EGO 1 sensor Is the replacement complete?		Go to Step (9)	-
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1155 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1172-EPR Pressure Lower Than Expected (SPN 520260:FMI 1)



Conditions for Setting the DTC

- EPR delivery pressure
- Check condition-Engine running or cranking
- MIL-ON during active fault
- Fault condition-EPR actual pressure less than 1.5 inches below commanded pressure
- Adaptive disabled
- Closed loop disabled

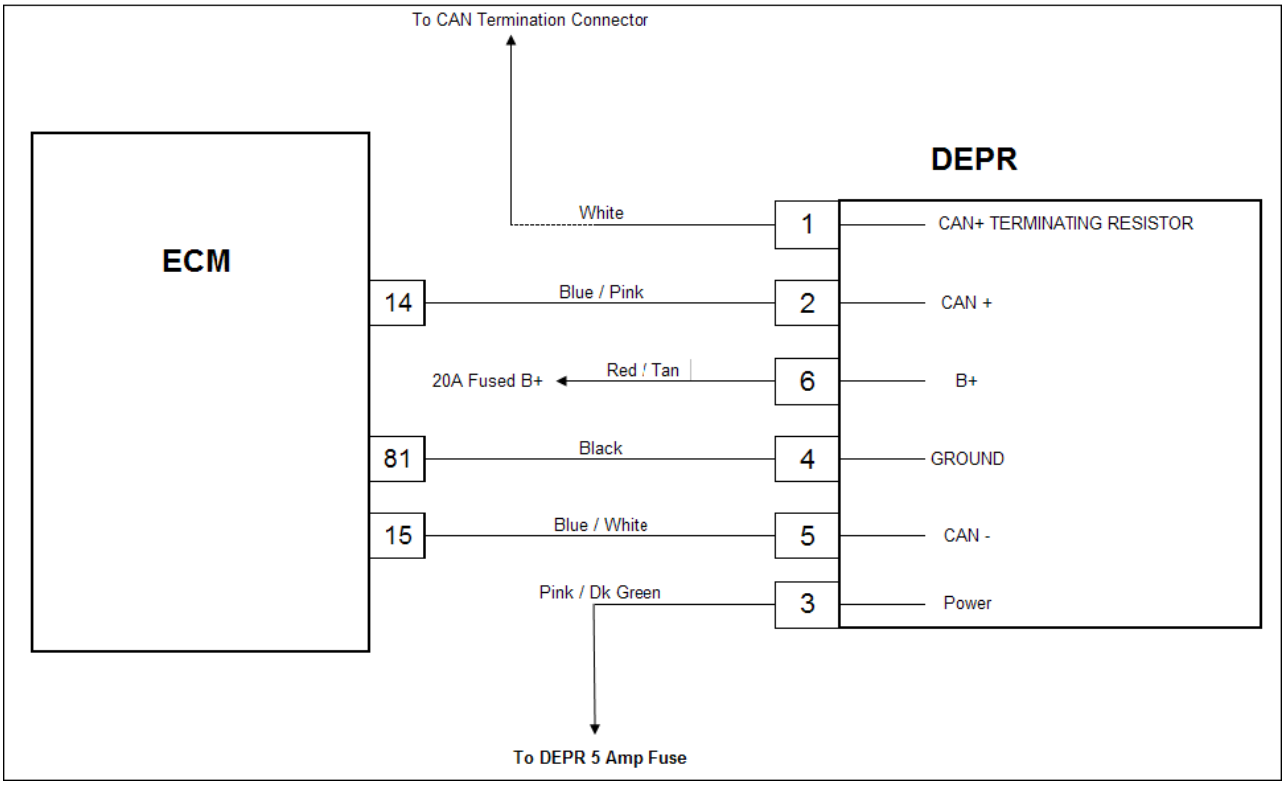
Circuit Description

The EPR (Electronic Pressure Regulator) unit measures and controls the amount of fuel that is able to pass to the fuel mixer. This code will set in the event the actual pressure is 1.0 inches water pressure lower than the actual commanded pressure. Adaptive is disabled and the MIL command is ON during this fault. Engine will shutdown if this fault occurs.

Diagnostic Aid

Always run the fuel system diagnostic pressure check before proceeding with the following diagnostic chart. Low secondary fuel pressure due to a fuel restriction or faulty regulator may cause this fault.

DTC 1176-EPR Internal Actuator Fault (SPN 520260:FMI 12)



Conditions for Setting the DTC

- EPR internal actuator test
- Check condition-Engine running or cranking
- MIL-ON during active fault
- Fault condition-Failed actuator
- Adaptive disabled

Circuit Description

The EPR (Electronic Pressure Regulator) unit measures and controls the amount of fuel that is able to pass to the fuel mixer. Pressure readings are sent over the CAN to the ECM and in return the ECM sends back a control signal to the EPR to increase or decrease pressure for precise mixture control. This code will set if the ECM detects an internal actuator fault with the EPR. In the event of multiple code sets, always start the diagnostic repair with the lowest numerical value DTC first. In most instances the EPR will need to be replaced in the event of this code set.

DTC 1613-RTI 2 Loss

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC 1613 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Check ECM power and ground circuits Did the power and ground circuits check OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Replace ECM Is the replacement complete?		Go to Step (5)	-
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1613 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1627-CAN Rx Failure

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC 1627 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Check that the ECM power connection C019 is clean, tight and in the proper location. • Check that the ECM ground connection C010 is clean, tight and in the proper location. Are the power and ground circuits OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Using a DVOM check for continuity between ECM pins 14 and 15 Do you have continuity between them?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (5)
5	• Using a DVOM check for continuity to engine ground on pin 14. • Do have continuity to engine ground?		Repair the shorted to ground circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Using a DVOM check for continuity to battery positive on pin 14. Do have continuity between them?		Repair the shorted to ground circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Replace ECM Is the replacement complete?		Go to Step (8)	-
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1627 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

Step	Action	Value(s)	Yes	No
12	• Replace throttle Is the replacement complete?		Go to Step (13)	-
13	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2111 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

Step	Action	Value(s)	Yes	No
12	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2123 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

Step	Action	Value(s)	Yes	No
11	• Replace ECM Is the replacement complete?		Go to Step (12)	-
12	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2135 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

Section 3

Intake System Service

Use the illustrations on the following pages to service the intake system, including changing the air filter element.

NOTE

The air restriction indicator gauges vacuum present in the system. For diesel engines, the filter should be replaced every 900-1000 hours. Regularly check the system components, however, to check for leaks, holes, or other damage that could affect the air restriction indicator.

⚠ CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

Air Filter Replacement

1. The air cleaner is located to the right of the driver's seat.
2. Inspect the components and look for fan-shaped dust accumulation at all hose connections. Clean components of dust, dirt, and other contaminants that might enter the system on disassembly.
3. Loosen the air cleaner, and remove the hose from the engine.
4. Clean the inside of the air cleaner.
5. Install the new filter element. Be sure that the filter element is fully seated in the air cleaner.

NOTE

Do not try to air clean and blow out the filter. Filter is further clogged by air cleaning. Always replace with a new filter element.

6. Reseat the air cleaner cover, making sure that it fits tightly around the air cleaner.
7. Close and latch the air cleaner cover clamps.

Air Cleaner Removal

1. Remove the two bolts that mount the air cleaner to the frame.
2. Loosen the clamp and remove the hose from the engine.
3. Remove the hose from the intake pipe.
4. Remove the air cleaner and hosing from the truck.

Air Cleaner Replacement

Installation is the reverse order of removal.

- Torque the hose clamp bolts to 2.9-3.9 N•m (2.1-2.9 ft-lb).
- Torque air cleaner bracket mounting bolts to 20-25 N•m (14.8-18.5 ft-lb).

Section 2

Testing and Adjusting

Troubleshooting

Perform various test operations to detect any trouble in the transmission.
Record any abnormal noise on the check sheet. If any abnormal operation is identified, refer to the “Troubles” and “Possible Cause” columns in the Troubleshooting Reference Sheet.

1) Visual Inspection

(1) With the transmission in neutral position, start the engine and check the oil level in the transmission.
(2) Inspect all the oil line, hoses, connections and fittings for damage or leaks.
(3) Shift the lever to forward and reverse positions.
(4) Inspect the strainer and oil filter in the transmission for any foreign material or clogging.
  a. If metal particles appear on the filter paper, the clutch may be failing.
  b. If metal particles appear in the filter, metalic wear is indicated or there are other defects.
  c. If rubber particles are visible, a seal or rubber hose may be damaged.
  d. If aluminum particles appear, the converter may be damaged.
(5) If metal or rubber scrap is seen, wash all the hydraulic parts of the transmission.
(6) If any part is damaged, replace it with a new one.

2) Caution in Operation

[CAUTION]
Check the oil level in the transmission before starting the engine. Refill if necessary.
Inappropriate oil level may cause damage to transmission parts.
(1) Start the engine. Depress the brake pedal and move the forward-reverse shift lever to all positions.
(2) If the lever can be shifted to each position, check that the vehicle moves in the direction and speed according to the lever position. If any abnormal noise is heard, find out the source and record it. If any problem is identified in this procedure, correct the problem referring to the sheet below.

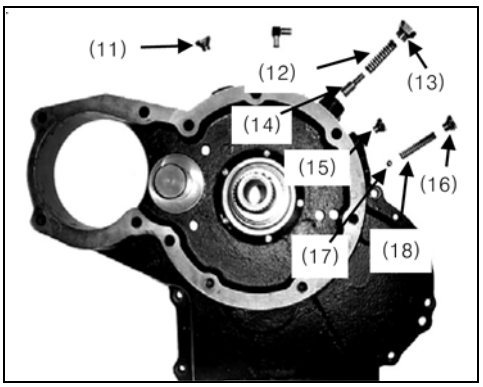
3) Checklist during Operation

No.	Problem	Possible Cause	Corrective Action
1	Transmission cannot be operated in all speed levels.	(1) Low or zero oil pressure. a. No or insufficient oil. Or oil viscosity is too high. b. Loose connection with inching control valve. Inaccurate adjustment or damaged. c. Inching valve spool is seized or open d. Charging pump defect or damaged e. Converter pump gear bolt damaged, or not engaged with pump f. Main regulator valve is seized or open g. Oil circuit is clogged or strainer is dirty	(1) Check oil level. a. Check if incompatible kinds of oil are mixed. b. Check/replace control valve joint bolts. c. Check/replace control valve spool. d. Check/replace Charging pump. e. Check tightening torque of converter pump gear bolts. f. Check control valve. g. Check the suction filter for clogging.

4) Remove the plug (16), spring (18) and ball (17) from the bearing plate.

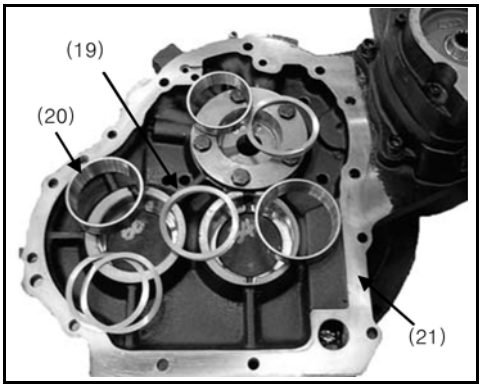
5) Remove the plug (13), spring (12) and valve (14).

6) Remove the plug (11).

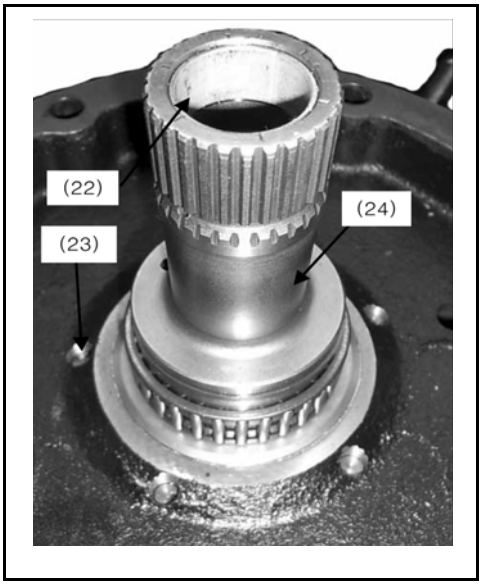


[CAUTION]

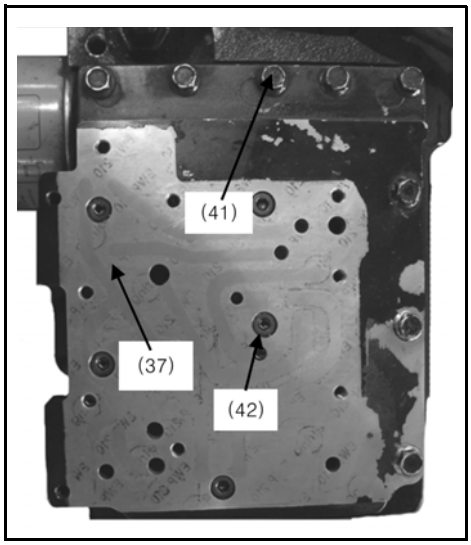
The bearing cups (20) and shims (19) are within the bearing plate (21) or on the shaft in the transmission case. Mark their positions on the transmission cover or transmission case before disassembly.



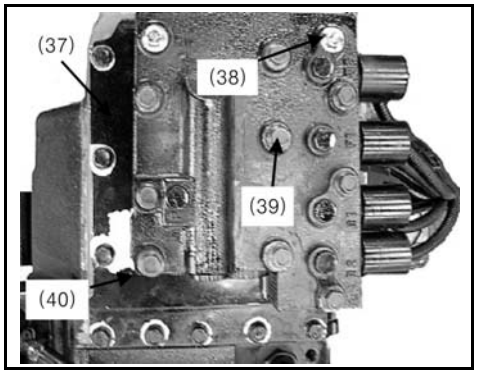
7) Remove the 5 bolts (23) from the stator hub (24) assembled with the bearing plate (21), and disassemble the stator hub (24) from the bearing plate (21). Use a rubber hammer not to damage the stator hub.



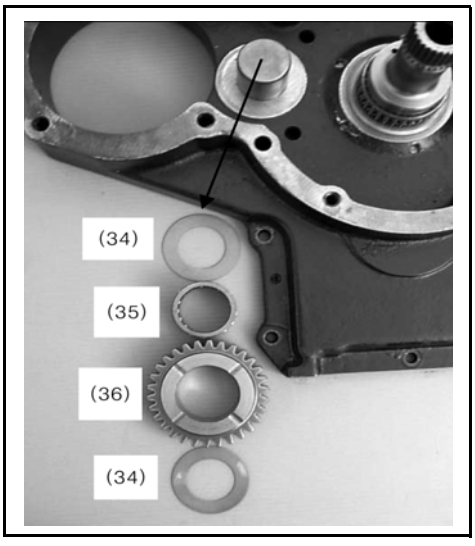
28) Apply Loctite #5127 on the gasket contact surface of the case. Install the valve plate (37) with 8 bolts (41) and 5 socket bolts (42).



29) Install the gasket (40) and install the control valve with 2 bolts (38) and 9 bolts (39).



30) On the bearing plate (21), install 2 thrust washers (34), needle bearing (35) and P.T.O idle gear (36).



Section 1

Cautions for working on the electrical system

As checking the electrical components

When working or checking electrical components make sure to study the features and specifications of the relevant components in advance so that the possibility of accident will be avoided.

Cautions for welding

Electrical components on the machine may be damaged by the high-voltage currents occurred during welding. If welding shall be performed on the machine, disconnect the (-) cables from the battery in advance.

Start-up with jumper cables

When the machine cannot be started due to the battery has being discharged, make use of jumper cables for starting. Proceed as follows:

Connecting the jumper cables

- Connect one end of jumper (+) cable to the battery (+) terminal of the discharged machine.
- Connect the other end of jumper (+) cable to the battery (+) terminal of the running engine.
- Connect one end of jumper (-) cable to the battery (-) terminal of the running engine.
- Connect the other end of jumper (-) cable to the engine block of the discharged machine.

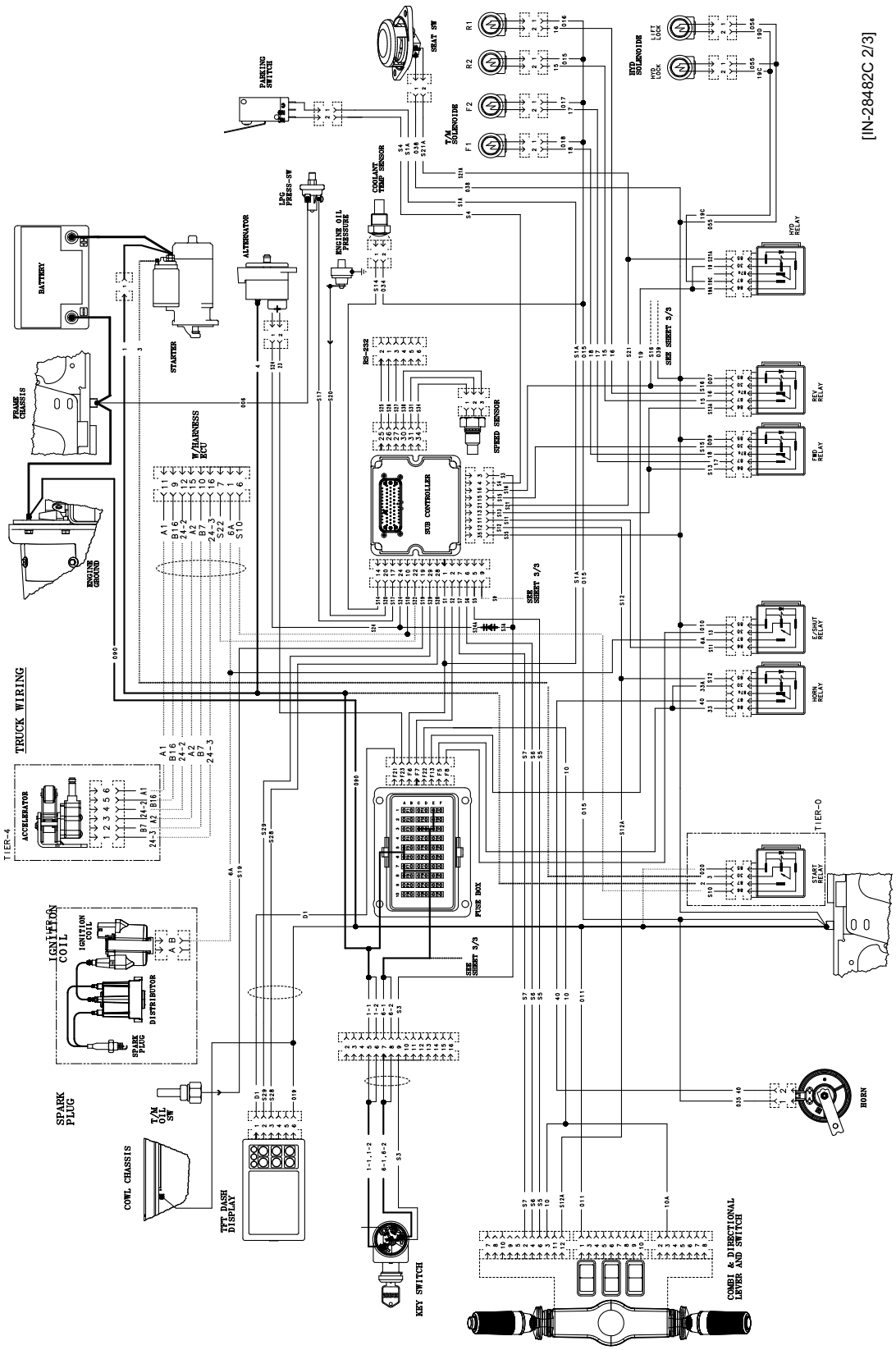
CAUTION

Confirm the clips of the jumper cable are secured on the terminals.
Try to start up only when there is no problem with the connection of the jumper cables.
Never make the jumper (+) cable and the jumper (-) cable contact each other.

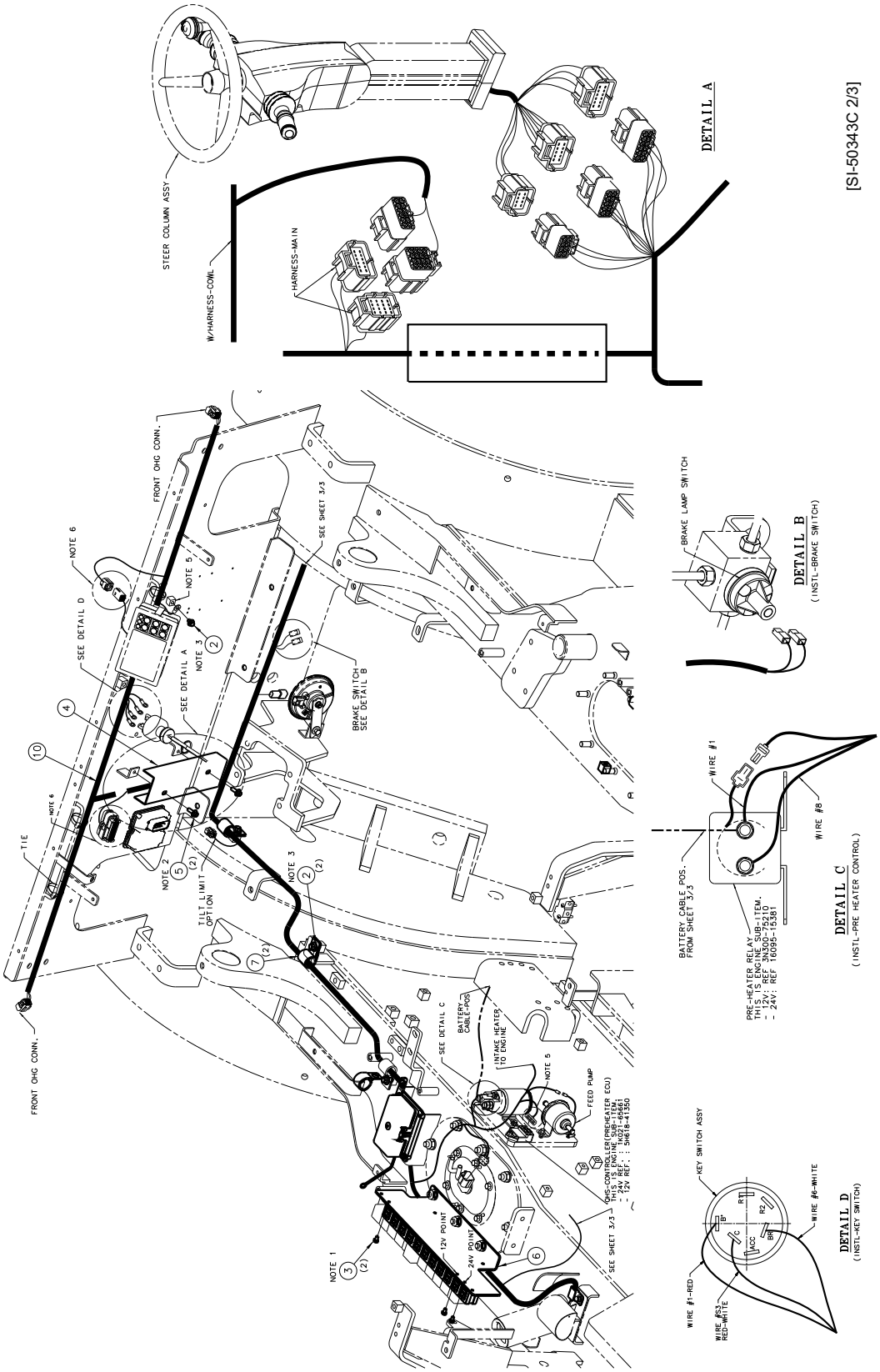
Removing the jumper cables

- When removing the jumper cables, reverse the order used for connecting.
- Remove the jumper (-) cable from the engine block of the discharged machine.
- Remove the other end of jumper (-) cable from the battery (-) terminal of the running engine.
- Remove the jumper (+) cable from the battery (+) terminal of the running engine.
- Remove the other end of jumper (+) cable from the battery (+) terminal of the discharged machine.

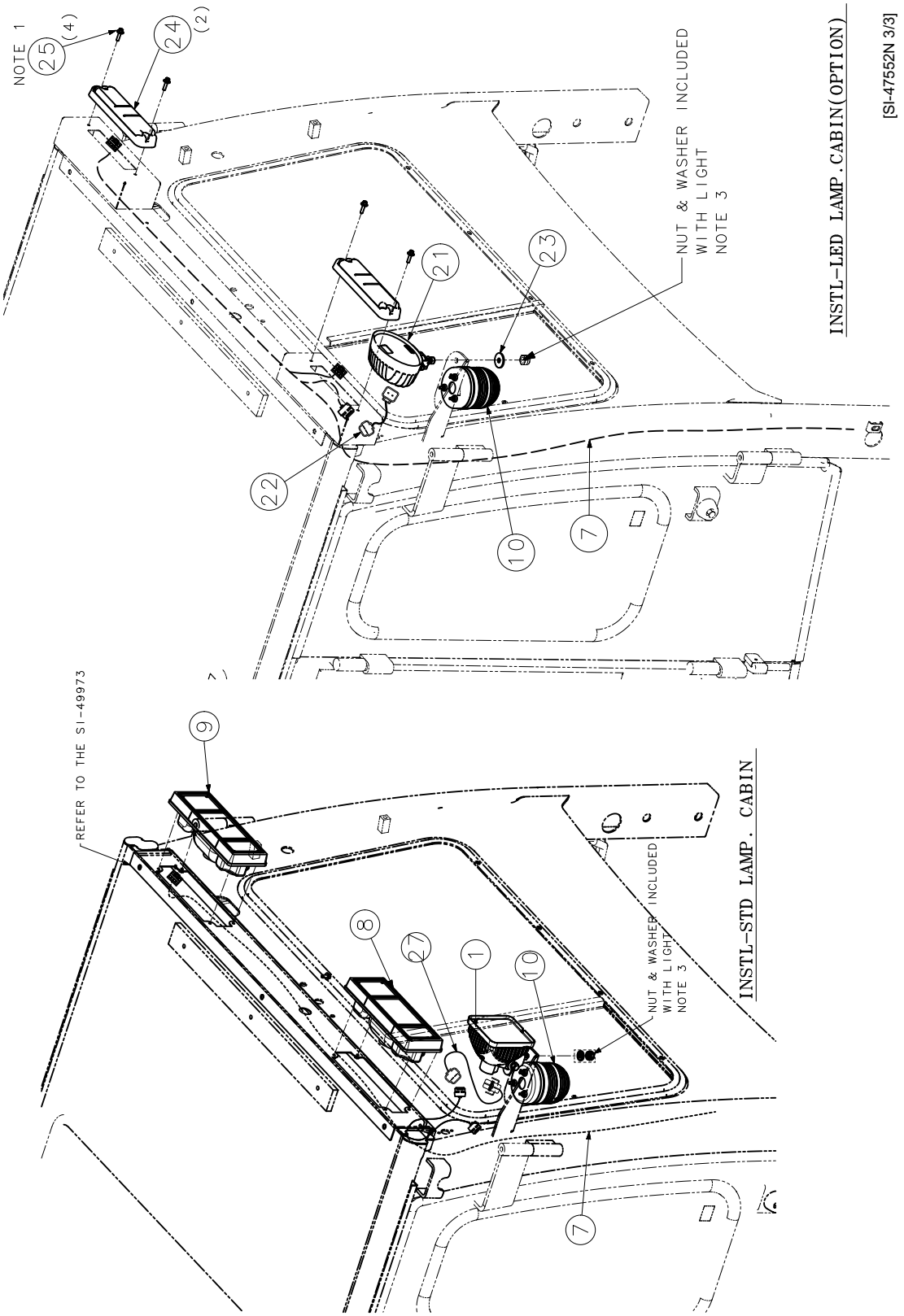
- Wiring Diagram (GM, LPG) - (2/3)



- Assembly of Wiring Harness (Kubota, Diesel) - (2/3)



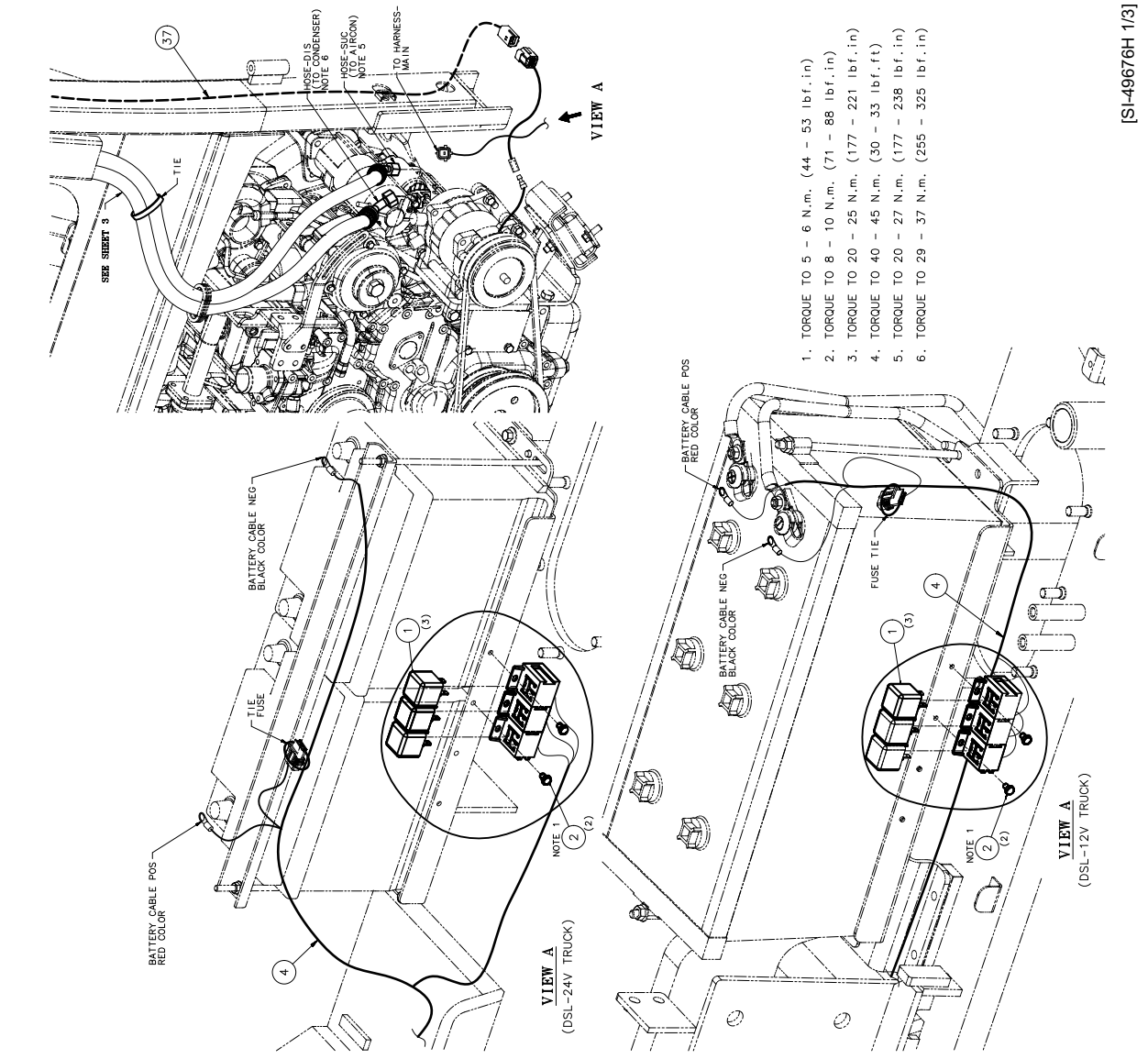
- Install Accessory (Diesel, LPG) - (3/3)



- Air Conditioner System (Kubota, Diesel) - 1/3

NO	PART NAME	QT'Y	REMARK
45	GROMMET	1	
44	WEATHER STRIP	1	260mm
43	CLAMP	1	
42	CAPSCREW-FLANGE	2	CABIN ITEM
41	WASHER-LOCK	1	
40	BOLT-HEX	1	
39	SLEEVE-HOSE	2	
38	COVER-CONDENSOR ASSY	1	
37	W/HARNESS-AIRCON W/CONDENSER	1	CABIN ITEM
36	CONDENSER ASSY-12V	1	- CABIN ITEM
	CONDENSER ASSY-24V	-	1 CABIN ITEM
35	BRKT-CONDENSER ASSY	1	1 CABIN ITEM
34	BRKT-COMPRESSOR	1	1
33	BRACKET-COMPRESSOR	1	1
32	COMPRESSOR-SD5H14,12V	1	-
	COMPRESSOR-SD5H14,24V	-	1
31	CAPSCREW-FLANGED	2	2
30	NUT-FLANGED	4	4
29	BOLT-HEX(SA 9011-20813)	2	2
28	WASHER-SPRING	2	2
27	BOLT-HEX(SA 9011-21022)	1	1
26	BOLT-HEX(SA 9011-21019)	1	1
25	BUSHING	1	1
24	CAPSCREW-FLANGED	1	1
23	BELT-AIRCON(42inch)	1	1
22	PULLY-AIRCON	1	1
21	AIRCON.0330 0182-SIROCO.12V	1	-
	AIRCON.0330 0183-SIROCO.24V	-	1
20	AIRCON GAS-R134a	0.8	0.8 Kg
19	COVER-AIRCON MTG	1	1
18	BRKT-AIRCON MTG.LH	1	1
17	BRKT-AIRCON MTG.RH	1	1
16	SPACER-RUBBER	4	4
15	CAPSCREW-FLANGED	4	4
13	CAPSCREW-FLANGED	4	4
12	HOSE-SUCTION	1	1
11	HOSE-DISCHARGE	1	1
10	HOSE-LIQUID	1	1
9	COVER-AIRCON HOSE.S40D-KBD	1	1
8	CAPSCREW-FLANGED	9	9 CABIN(7EA)
7	RUBBER(SA:6021-10040)	3	3
6	CABLE CLAMP	3	3
5	CAPSCREW-FLANGED	9	9
4	W/HARNESS-AC CABIN-12V	1	-
	W/HARNESS-AC CABIN-24V	-	1
2	CAPSCREW-HEX	2	2
1	RELAY-12V	3	-
	RELAY-24V	-	3

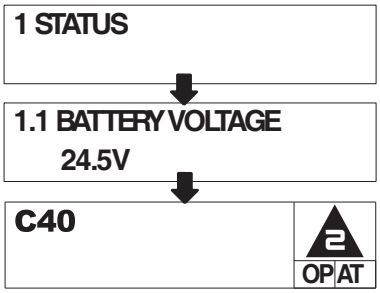
12V 1 1 24V



[SI-49676H 1/3]

Up arrow button (Enter button)

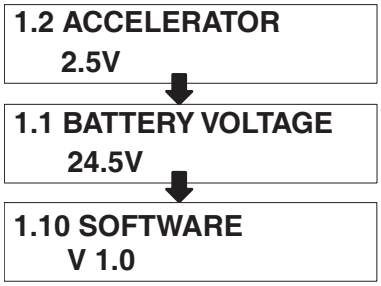
In Menu mode, move to upper menu by pressing this button.



Perform as "Enter" key function when confirming after the Password and important variables are changed.

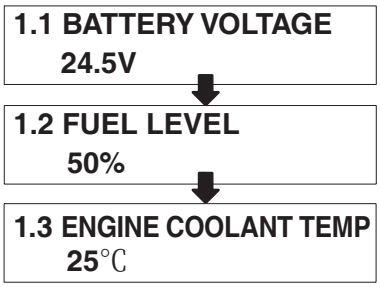
Left arrow button

In Menu mode, move to left menu by pressing this button.



Right arrow button (Power selection button)

In Menu mode, move to right menu by pressing this button.



Plus(+) button

It performs DR/OP selection function at normal mode.
It selects DR → OP in turns, whenever pressing the button.
The data for the selected mode will be transferred to T/M controller.
Under S/L mode, DR/OP does not change.

Minus(-) button

It performs ML/A1/A2 selection function at normal mode.
It selects ML → A1 → A2 in turns, whenever pressing the button.
The data for the selected mode will be transferred to T/M controller.
Under S/L mode, ML/A1/A2 does not change.

KWP Code	SPN	FMI	Blink code	Error Identification	Short Text Detail
2	132	11	2-2-6	Air flow sensor; sensor error	Air flow sensor load correction factor exceeding drift limit; plausibility error
3	132	11	2-2-6	Air flow sensor; sensor error	Air flow sensor low idle correction factor exceeding the maximum drift limit
4	132	11	2-2-6	Air flow sensor; sensor error	Air flow sensor load correction factor exceeding the maximum drift limit
877	157	3	1-4-7	Sesnor error rail pressure; signal range check high	Sesnor error rail pressure; signal range check high
878	157	4	1-4-7	Sensor error rail pressure; signal range check low	Sensor error rail pressure; signal range check low
1381	164	2	8-3-9	Rail pressure safety function is not executed correctly	Rail pressure safety function is not executed correctly
1180	168	0	3-1-8	Physical range check high for battery voltage	Physical range check high for battery voltage
1181	168	1	3-1-8	Physical range check low for battery voltage	Physical range check low for battery voltage
47	168	2	3-1-8	Battery voltage; system reaction initiated	High battery voltage; warning threshold exceeded
48	168	2	3-1-8	Battery voltage; system reaction initiated	Low battery voltage; warning threshold exceeded
45	168	3	3-1-8	Sensor error battery voltage; signal range check high	Sensor error battery voltage; signal range check high
46	168	4	3-1-8	Sensor error battery voltage; signal range check low	Sensor error battery voltage; signal range check low
417	171	3	3-1-2	Sensor error environment temperature; signal range check high	Sensor error environment temperature; signal range check high
418	171	4	3-1-2	Sensor error environment temperature; signal range check low	Sensor error environment temperature; signal range check low
1182	172	0	2-2-6	Physical range check high for intake air temperature	Physical range check high for intake air temperature
1183	172	1	2-2-6	Physical range check low for intake air temperature	Physical range check low for intake air temperature
9	172	2	2-2-6	Sensor ambient air temperature; plausibility error	Sensor ambient air temperature; plausibility error
983	172	2	2-2-6	lntake air sensor; plausibility error	lntake air sensor; plausibility error
981	172	3	2-2-6	Sensor error intake air; signal range check high	Sensor error intake air; signal range check high
982	172	4	2-2-6	Sensor error intake air sensor; signal range check low	Sensor error intake air sensor; signal range check low
481	174	0	2-3-7	High low fuel temperature; warning threshold exceeded	High low fuel temperature; warning threshold exceeded
482	174	0	2-3-7	High Low fuel temperature; shut off threshold exceeded	High Low fuel temperature; shut off threshold exceeded
740	175	0	1-4-4	Oil temperature; out of range, system reaction initiated	Physical range check high for oil temperature

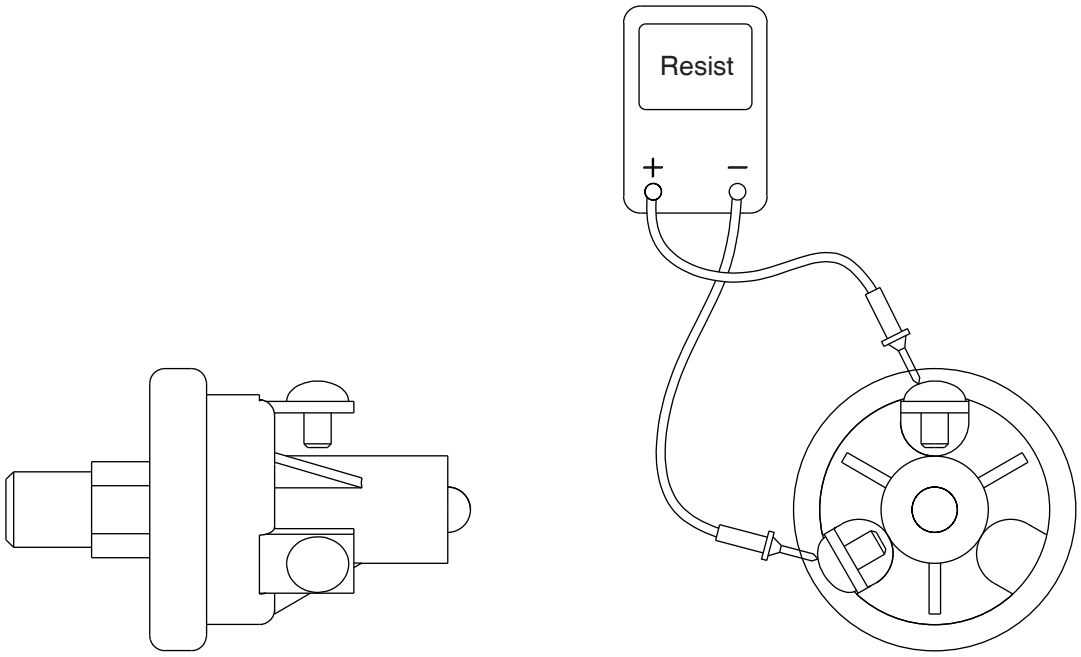
KWP Code	SPN	FMI	Blink code	Error Identification	Short Text Detail
1036	4768	2	6-8-3	Sensor exhaust gas temperature upstream (DOC); plausibility error	Sensor exhaust gas temperature upstream (DOC); plausibility error
1044	4768	3	6-8-3	Sensor error exhaust gas temperature upstream (DOC); signal range check high	Sensor error exhaust gas temperature upstream (DOC); signal range check high
1045	4768	4	6-8-3	Sensor error exhaust gas temperature upstream (DOC); signal range check low	Sensor error exhaust gas temperature upstream (DOC); signal range check low
1026	4769	2	6-8-4	Sensor exhaust gas temperature downstream (DOC); plausibility error	Sensor exhaust gas temperature downstream (DOC); plausibility error
1402	4769	2	6-8-4	Sensor exhaust gas temperature (DOC) downstream; plausibility error	Sensor exhaust gas temperature OxiCat downstream (normal operation); plausibility error
1403	4769	2	6-8-4	Sensor exhaust gas temperature (DOC) downstream; plausibility error	Sensor exhaust gas temperature OxiCat downstream (regeneration); plausibility error
1034	4769	3	6-8-4	Sensor error exhaust gas temperature downstream (DOC); signal range check high	Sensor error exhaust gas temperature downstream (DOC); signal range check high
1035	4769	4	6-8-4	Sensor error exhaust gas temperature downstream (DOC); signal range check low	Sensor error exhaust gas temperature downstream (DOC); signal range check low
34	523006	3	2-4-2	Controller mode switch; short circuit to battery	Controller mode switch; short circuit to battery
35	523006	4	2-4-2	Controller mode switch; short circuit to ground	Controller mode switch; short circuit to ground
648	523008	1	4-2-4	Manipulation control was triggered	Manipulation control was triggered
649	523008	2	4-2-4	Timeout error in Manipulation control	Timeout error in Manipulation control
825	523009	9	2-5-3	Pressure Relief Valve (PRV) reached maximun allowed opening count	Pressure Relief Valve (PRV) reached maximun allowed opening count
833	523009	10	2-5-3	Pressure relief valve (PRV) reached maximun allowed open time	Pressure relief valve (PRV) reached maximun allowed open time
171	523212	9	3-3-3	Timeout Error of CAN-Receive-Frame ComEngPrt; Engine Protection	Timeout Error of CAN-Receive-Frame ComEngPrt; Engine Protection
198	523216	9	3-3-7	Timeout Error of CAN-Receive-Frame PrHtEnCmd; pre-heat command, engine command	Timeout Error of CAN-Receive-Frame PrHtEnCmd; pre-heat command, engine command
179	523240	9	5-2-7	Timeout CAN-message FunModCtl; Function Mode Control	Timeout CAN-message FunModCtl; Function Mode Control
919	523330	14	1-3-1	Immobilizer status; fuel blocked	Immobilizer status; fuel blocked
565	523350	4	1-5-1	Injector cylinder-bank 1; short circuit	Injector cylinder-bank 1; short circuit
566	523352	4	1-5-2	Injector cylinder-bank 2; short circuit	Injector cylinder-bank 2; short circuit
567	523354	12	1-5-3	Injector powerstage output defect	Injector powerstage output defect
840	523450	2	1-4-3	Multiple Stage Switch constant speed; plausibility error	Multiple Stage Switch constant speed; plausibility error

KWP Code	SPN	FMI	Blink code	Error Identification	Short Text Detail
133	523938	9	7-6-6	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1lGCVol1 information; factors & Sensor calibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1lGCVol1 information; factors & Sensor calibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)
134	523939	9	7-6-6	Timeout Error (BAM to BAM) for CAN-Receive-Frame AT1lGCVol1 information; factors & Sensor calibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)	Timeout Error (BAM to BAM) for CAN-Receive-Frame AT1lGCVol1 information; factors & Sensor calibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)
135	523940	9	7-6-6	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1lGCVol1 information; factors & Sensor calibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1lGCVol1 information; factors & Sensor calibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)
140	523941	9	7-6-7	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensor calibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensor calibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)
141	523942	9	7-6-7	Timeout Error (BAM to BAM) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensor calibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)	Timeout Error (BAM to BAM) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensor calibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)
142	523943	9	7-6-7	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensor calibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensor calibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)
1158	523946	0	7-7-2	Zero fuel calibration injector 1 (in firing order); maximum value	Zero fuel calibration injector 1 (in firing order); maximum value
1164	523946	1	7-7-2	Zero fuel calibration injector 1 (in firing order); minimum value exceeded	Zero fuel calibration injector 1 (in firing order); minimum value exceeded
1159	523947	0	7-7-2	Zero fuel calibration injector 2 (in firing order); maximum value	Zero fuel calibration injector 2 (in firing order); maximum value
1165	523947	1	7-7-2	Zero fuel calibration injector 2 (in firing order); minimum value exceeded	Zero fuel calibration injector 2 (in firing order); minimum value exceeded

LPG Pressure Switch

Function

This switch will be ON/OFF depending upon the LPG pressure in LPG tank. This switch is on when the LPG pressure drops down as fuel is consumed.



Specification

Item	Spec
Switch operating pressure	40±4 psi (open)

Pressure	Resist (Ω)
more than 40 psi	Open (more than 1MΩ)
less than 40 psi	0

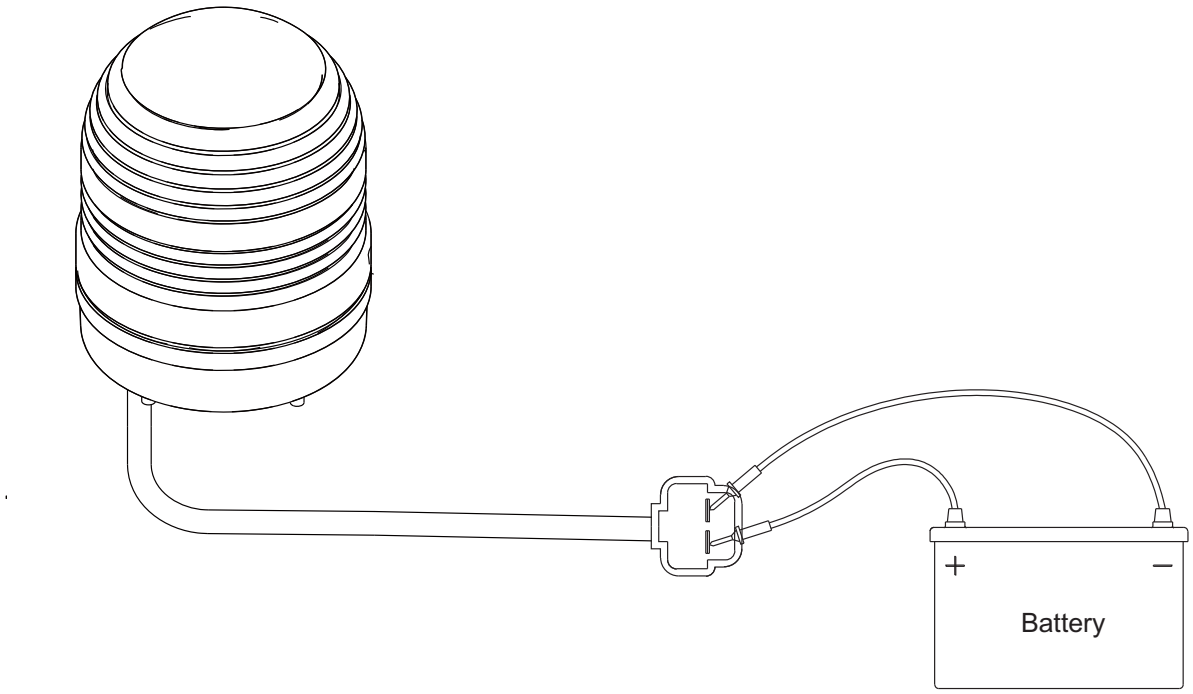
Testing

Measure resistance with a multi-meter as shown in the figure above, and inspect if open or closed. It will be closed when the pressure is at lower specification and open when the pressure is higher. (Open in case the LPG tank is full and closed when the tank is empty)

Lamp-Beacon

Function

This part uses a strobe lamp and functions as a visual warning to the area around the truck when operating.



Specification

Item	Spec.
Rated voltage	DC 12V
Bulb spec.	200mA < Max
Frequency	60 / Min ± 3

Testing

Check the beacon lamp for proper operation by applying 12V as shown in the figure above.

(When applying voltage, it's irrelevant that battery +/- terminals has cross connecting.)

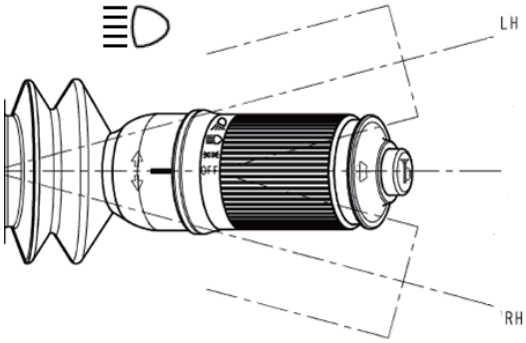
3. Auxiliary Electrical Circuit (various lamps)

Head lamp does not function.

↓

Start key S/W and headlamp S/W cannot turn the headlamp on

← - Head lamp Switch -



↓

Isolate headlamp connector(in OHG), measure the voltage.

↓

Is the battery voltage OK? (12V)

→ NO

Check the headlamp fuse in the fuse box.

↓

Replace the fuse if failed.

↓

YES

Is the battery voltage OK? 24V(DSL), 12V(LPG)

↓

Replace the headlamp relay.

← NO

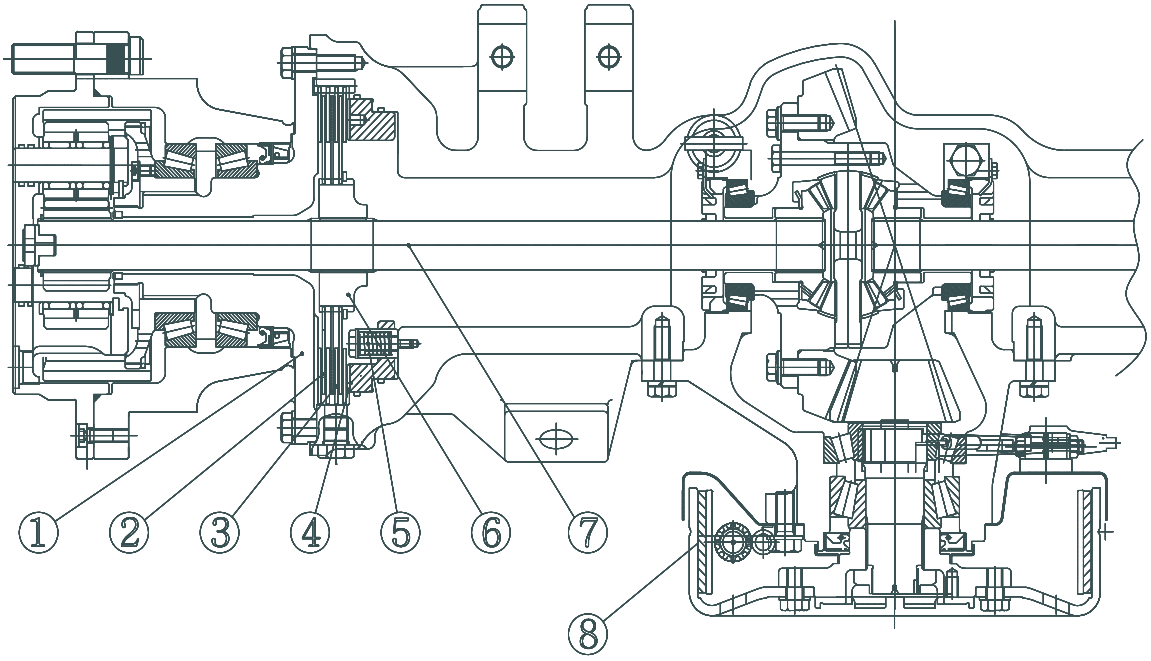
If fuse is OK, check the headlamp relay.

↓

YES

Problem in electrical wiring. Check for short circuited or open wire.

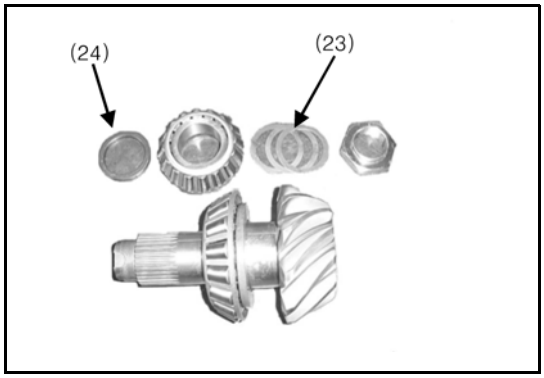
3. Disc Brake



1. Spindle
2. Steel Plate
3. Disc Plate
4. Brake Piston
5. Auto Clerance Adjust Bolt
6. Spline Collar
7. Drive Axle Shaft
8. Parking brake

The service brake is a hydraulic disc braking system which is a sealed type to guarantee braking performance in humid, corrosive, and dusty environments.
The brake system ensures a semi-permanent service life, without the necessity of lining replacement, different from a drum brake. In addition, a self-adjusting feature is included to prevent a low pedal situation.
Major parts are 3 disc plates (3), 4 steel plates (2), brake piston (4), and 4 gap control bolts. The power transmitted via the drive axle shaft (7) and brake piston (4) pushes the discs (3) and plates (2) to apply braking force.

14) Remove the shim (23) and ring (24) from the pinion shaft. Using a bearing puller, disassemble the inner race of the taper roller bearing from the pinion shaft.

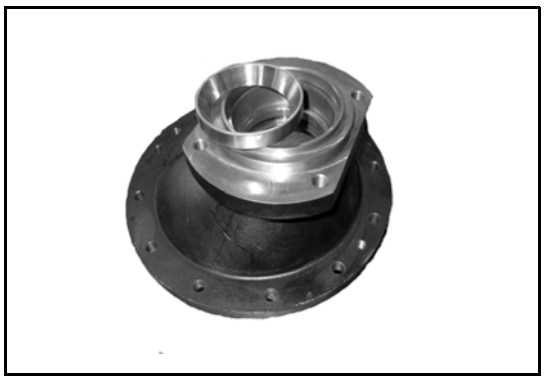


15) Using a jig and hammer, disassemble the outer race of the taper roller bearing and shim from the housing.

[Caution]

Do not reuse damaged shim.

16) Disassemble the outer race of the taper roller bearing on the opposite side.



Drive Axle Removal

CAUTION

SAFE PARKING: Before starting work

1. Be sure to park your forklift on horizontal surface that is rigid and has no cracks or broken areas, e.g. concrete floor.
2. Place the upright assembly in a vertical position and then slowly lower the attachment to the lowermost level.
3. Neutralize the controls.
   Turn off the ignition and then remove the key.

WARNING

Comply with all safe lifting practices whenever attempting to mount or remove drive Axle to or from the forklift.

Lifting is permitted only in the case where an appropriate size of eyebolt on the top of drive Axle is used.

Make sure to use lifting equipment having a safe load capacity exceeding the weight of the drive Axle.

1. Remove the upright as described in Group 34.
2. Set the block beneath to remove the drive wheel at the front bottom of the frame. (Fig. 1)
3. Remove the drive wheel as described in Group 22.
4. Remove the drain plug and drain the drive axle oil.
5. Remove the parking brake cable. (Fig. 2)
6. Remove the brake line. (Fig. 3)
7. Connect the crane hooks with the wheel bolts on both sides of the axle, and remove drive axle mounting bolts. (Fig. 4)

CAUTION

When connecting the crane hooks with the wheel bolts, take care not to damage the threads.

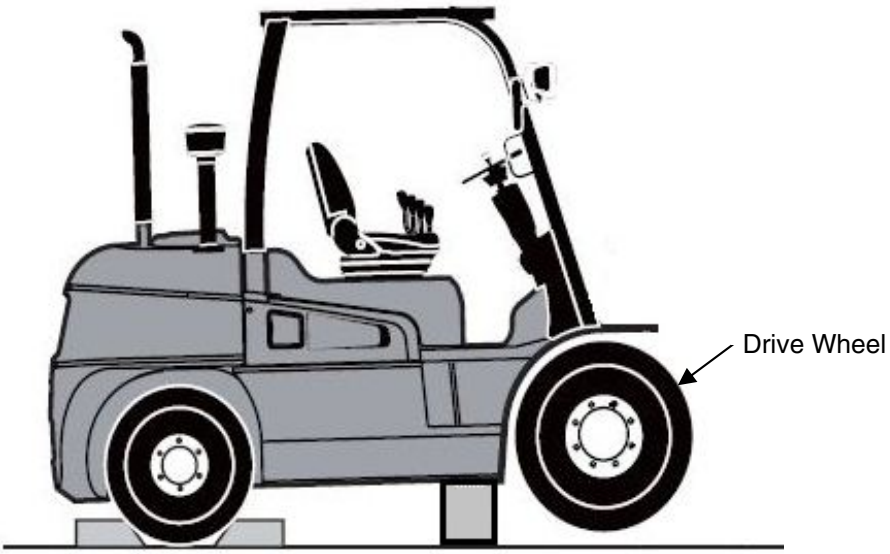
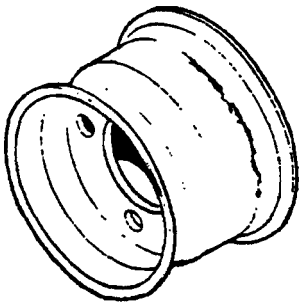


Fig. 1. Put the blocks beneath the vehicle.

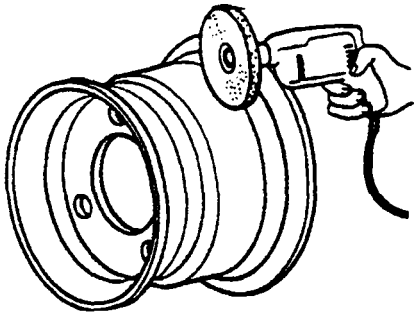
7. Check for cracks in the wheel.



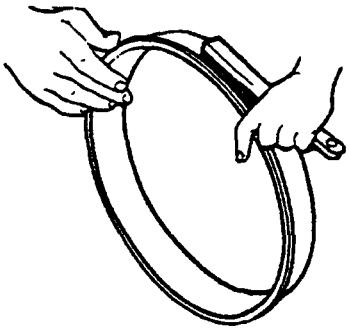
Cracks in the wheel are caused by :

- Deep rim tool marks.
- Overload on wheels.
- Too much air pressure in the tires.
- Using the wrong size tires.

8. Check for cracks in the lock ring.
9. Check for cracks between the stud holes in the wheel. Cracks are caused by :
   - Loose wheel nuts.
   - Wheel not installed correctly.
   - Wrong size or type of parts used.
   - Too much torque on the wheel fasteners. If the wheel mounting parts are too tight, the studs or bolts can break, causing cracks in the wheel between the stud holes.
   - Too little torque on the wheel fasteners. If the wheel mounting parts are too loose, damage to parts and tire wear will result.
10. Check wedge ring for wear or damage. Corrosion buildup will cause wear and damage to the wheel wedge ring.
11. Clean the wheels. Remove rust and dirt.
12. Clean the tire bead seat area. Remove all rust and rubber with a wire brush or wheel.



13. Clean wedge and lock rings. Make sure the seating surface and bead seat areas are clean.



14. Apply paint to the tire rim with a brush. Or, use an aerosol can of metal primer.
    The parts must be clean and dry before you apply the paint. Make sure to apply paint to the outside or tire side of the rim. This is important because air is on the metal surface of the tire side of the rim
15. Apply lubricant on the tire side of the rim base. Do not use a lubricant that has water or solvent which will cause damage to the rubber.

NOTE

Clark dealers can supply the correct lubricant, which contains a rust inhibitor.

Section 3

Brake / Inching Pedals and Linkages Adjustments

Introduction

Figures 1 show :

- The service brake linkage, which links the brake pedal to the brake valve.
- The inching pedal linkage, which links the inching pedal to the inching spool.
- The inching pedal overlap, which allows the inching pedal to operate the brake pedal.

The illustrations and accompanying text serve as guide to disassembly/assembly and adjustment.

Pedal Height Adjustment

See Figure 1. The brake pedal must be at the same height as the inching pedal. To adjust brake pedal height :

1. Loose the pedal stop bolt of brake and adjust pedal height to be 110 ± 2mm(4.3 ± 0.08in) from floor mat.
2. Rotate the eccentric stop in the hex hole until it stops the brake pedal at the same height as the inching pedal.

Freeplay Adjustment

When the brake pedal linkage is properly adjusted, braking should begin only after the pedal is depressed a certain distance, This is “Freeplay” is Adjusted as follows :

1. Loosen the jam nut on the rod brake valve (Figure 1).
2. Depress the brake pedal 3~5mm (0.12~0.19 in).
3. Adjust the rod until you feel the push rod make clearance with the valve piston.

Overlap Adjustment

See Figure 1. When the inching pedal is depressed, the **strike bolt** threaded into the inching pedal pushes against the **strike lever** on the brake pedal, applying the brake.

The clearance between the top of the **strike bolt** and the **strike lever** should be 0 to 2.5 mm (0~0.10in), depending on operator preference.

1. Measure clearance.

If necessary, adjust as follows:

2. Loosen jam nut.
3. Turn strike bolt to obtain desired clearance.
4. Tighten jam nut.

Constant noise from steering axle

- Loose or worn hub bearing cones. Adjust or replace hub bearing cones. Replace bearing cones and bearing cups as a set.

Noise when axle pivots

- Lack of lubricant in steering axle mounting.
- Steering axle mountings worn; replace mountings.
- Steering axle mounting cap(s) loose ; tighten mounting cap(s).

Fluctuating pressure

- Faulty operation of relief valve. Fluctuating pressure or loss of pressure in the system is usually caused by scales, chips, sludge, or filings that have lodged between the relief valve and seat. A damaged spring or worn valve may also be the cause of the trouble. Flush and refill the system and replace the hydraulic return line filter element. If condition still exists, replace the relief valve.

Low pressure at the pump

- Refer to the pump troubleshooting and overhaul procedures in Group 29.

Low pressure at the steering gear

- Refer to Section 5, “Steering Gear Overhaul.”

Low pressure at the steer cylinder

- Seals worn out at piston rod end of steer cylinder; replace seals.

Steer cylinder rod binding or sticking

- Binding of linkage. With hydraulic flow shut off from the cylinder and the rod end uncoupled, the rod should slide freely in or out by hand. If the piston is binding, overhaul or replace the cylinder.

Parts Inspection

Inspect all parts for damage, cracks, broken parts, damaged threads, corrosion or erosion of surfaces, worn spots, nicks or scratches.

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Discard all old seals and replace with new ones.

Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get into the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind these parts.

If parts are left exposed, cover them with a clean cover to prevent airborne dust from collecting on them.

Reassembly

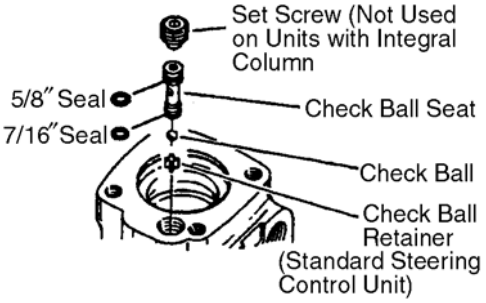
Refer to Service Parts Book when ordering replacement parts. A good service policy is to replace all old seals with new seals at overhaul.

NOTE

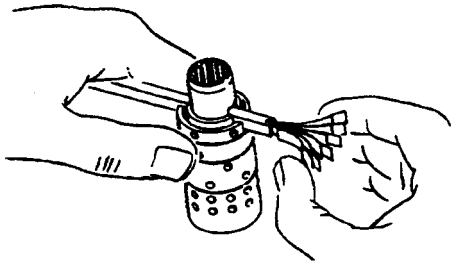
Lubricate all seals (with exception of new quad ring seal) with clean petroleum jelly such as Vaseline.
Do not use excessive lubricant on seals for meter (gerotor) section.
Make sure all parts are clean and free of dust. Before assembly, lightly coat all internal metal parts with oil.

Control End

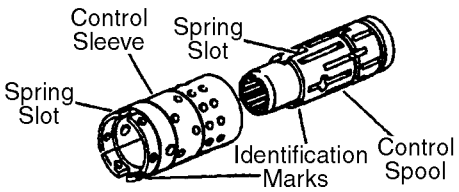
1. Use a needle-nosed pliers to lower check ball retainer into check valve hole of housing. Make sure retainer is straight (not tilted on edge) in housing.



2. Install check ball in housing.
3. Lubricate 5/8-inch diameter seal and 7/16-inch diameter seal. Install seals on check ball seat, as above.
4. Lubricate check ball seat and seals thoroughly before installing seat in housing. When installing seat do not twist or damage seals. Install check ball seat in housing; insert open end of seat first. Push check ball seat to bottom of hole.
5. Install set screw. Use a 5/16-inch Allen wrench to torque set screw to 11 N·m (100 in-lb; 8.3 ft·lb). To prevent interference of parts, make sure top of set screw is slightly below housing mounting surface.
6. Assemble spool and sleeve carefully so that the spring slots line up at the same end. Rotate spool while sliding parts together. Some spool and sleeve sets have identification marks ; align these marks. Test for free rotation. Spool should rotate smoothly in sleeve with finger tip force applied at splined end.



7. Bring spring slots of both parts in line and stand parts on end of bench. Insert spring installation tool (available as Part No. 6000057) through spring slots of both parts. Position three pairs of centering springs (or two sets of 3 each) on bench so that extended edge is down and arched center section is together. In this position, insert one end of entire spring set into spring installation tool, as shown.



On those units which use the low torque centering springs, there are two pairs of centering springs (or two sets of each) and one pair (two) spring spacers. The spring spacers are installed together between the two sets of centering springs. The installation procedure is the same as that used on the standard (three pairs of centering springs) units.

6. Rotate hub or wheel counter clockwise and torque wheel nut to 67-69 N·m (49-51 ft·lb).
7. Back wheel nut up until it is loose.
8. While turning the hub or wheel counter clockwise, torque the wheel nut to 12-15 N·m (9-11 ft·lb).
9. Back up wheel nut to nearest castellation slot and install new cotter pin.
10. Recheck for correct bearing adjustment by rotating the wheel by hand. Wheel should rotate freely or with only slight “drag”. Readjust bearings by adjusting wheel nut as necessary to avoid binding in bearings.
11. Bend cotter pin tabs over.
12. Pack the area around wheel nut with grease.
13. Refit O-ring on hubcap if removed or replaced and install hubcap by tapping into place with a rubber or plastic-faced hammer.

Preparation for Steer Cylinder Disassembly and Overhaul

Refer to Section 5 for removal of steer cylinder from the steer axle body.

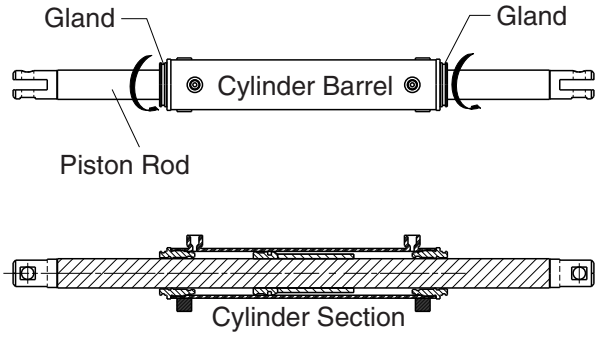
IMPORTANT

Cleanliness is of extreme importance in the repair and overhaul of this assembly.

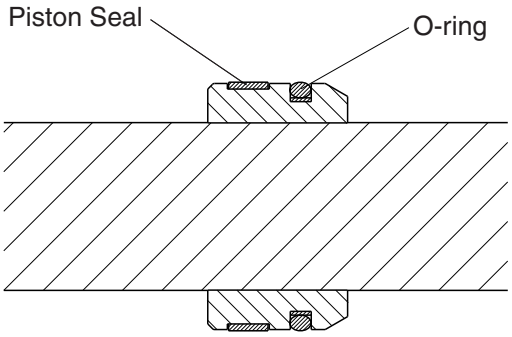
1. Overhaul steer cylinder only in a clean, dust-free location, using clean tools and equipment. Dirt or grit will damage the highly-machined surfaces and will result in leakage or premature failure of components. Cleanliness of the hydraulic circuit is extremely important to the proper operation and maintenance of the system. Be sure the work area is clean.
2. Before disassembly, the exterior of the steer cylinder should be carefully cleaned to remove all dirt and grease accumulation.
3. Be sure all hydraulic fluid has been removed from the cylinder. Stroking the piston rod will help force the fluid out.
4. Before starting disassembly, the steer cylinder should be carefully examined to determine if there is any external damage.

Steer Cylinder Disassembly

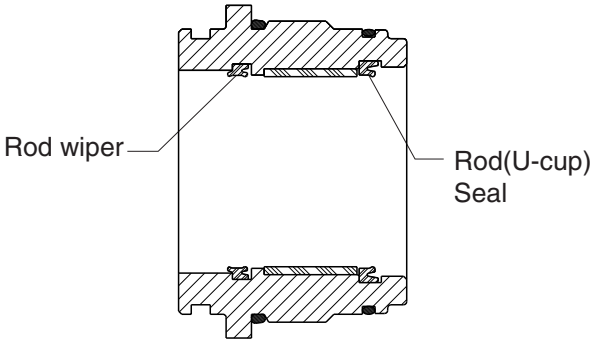
1. Clamp the steer cylinder assembly in a vise. Wrap the cylinder in a course cloth to prevent slipping and scratching. Use extreme caution when tightening vise and do not overtighten ; cylinder can be bent, distorted, and potentially destroyed.
2. Remove one gland by pulling it from cylinder barrel and pulling it off the piston rod.



3. Remove the piston and rod assembly from the cylinder.
4. Remove gland from opposite end of steer cylinder.
5. Remove the seal and O-ring set from the piston. Discard seals. Replace with new seal set at assembly.



6. Remove (inner) gland packing (O-ring) seal. Replace with new seals at assembly.



7. Remove the rod (U-cup) seal and rod wiper from gland and discard. Note direction of seal and wiper seating for correct reassembly. Replace with new seals and wipers at assembly.

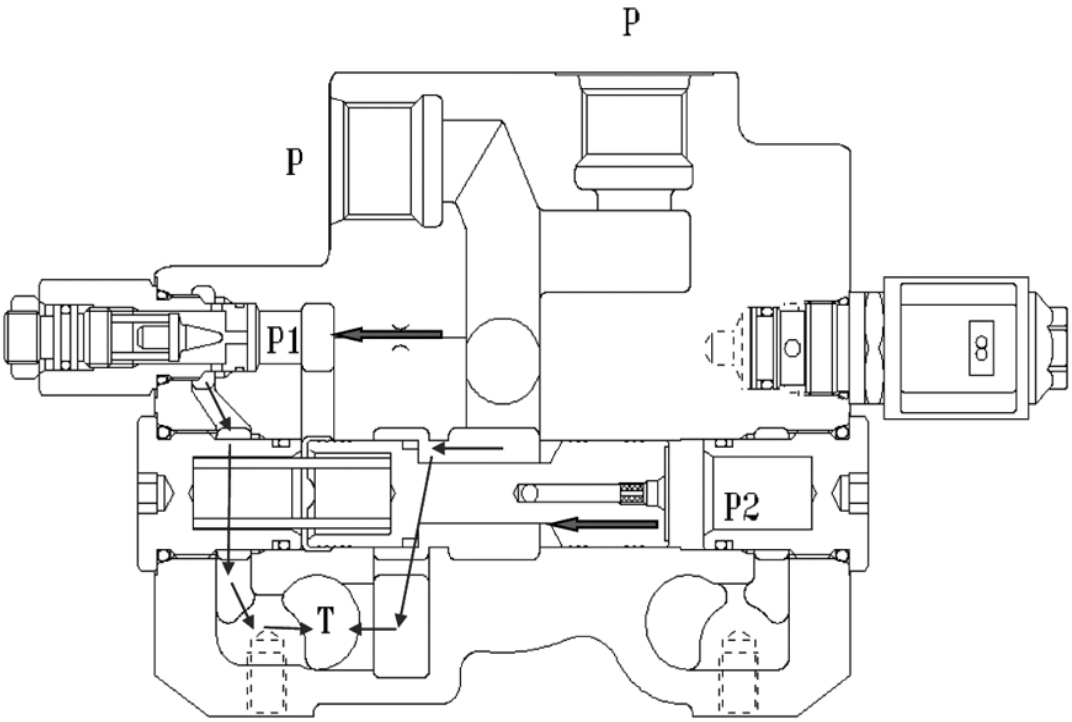
Parts Inspection

1. Carefully clean all parts in an approved solvent and place on a clean surface.
2. Check the piston for chips, cracks, and looseness on the rod. If loose, replace rod and piston assembly.
3. Be sure the piston-seal groove in the piston is smooth, true, and undamaged.
4. Check the piston rod for damage. Look for scratches, grooves, gouges, pitting, corrosion or other evidence of unusual wear. Minor surface damage may be repaired by use of fine abrasion cloth or stoning. Deeper damage will require replacement of piston rod assembly.

External Leakage

- Excessive system pressure; replace pressure control valve on main hydraulic valve.
- Faulty or distorted pump seal gasket; replace seal gasket.
- Damaged surfaces on pump body or cover; correct and replace as required.

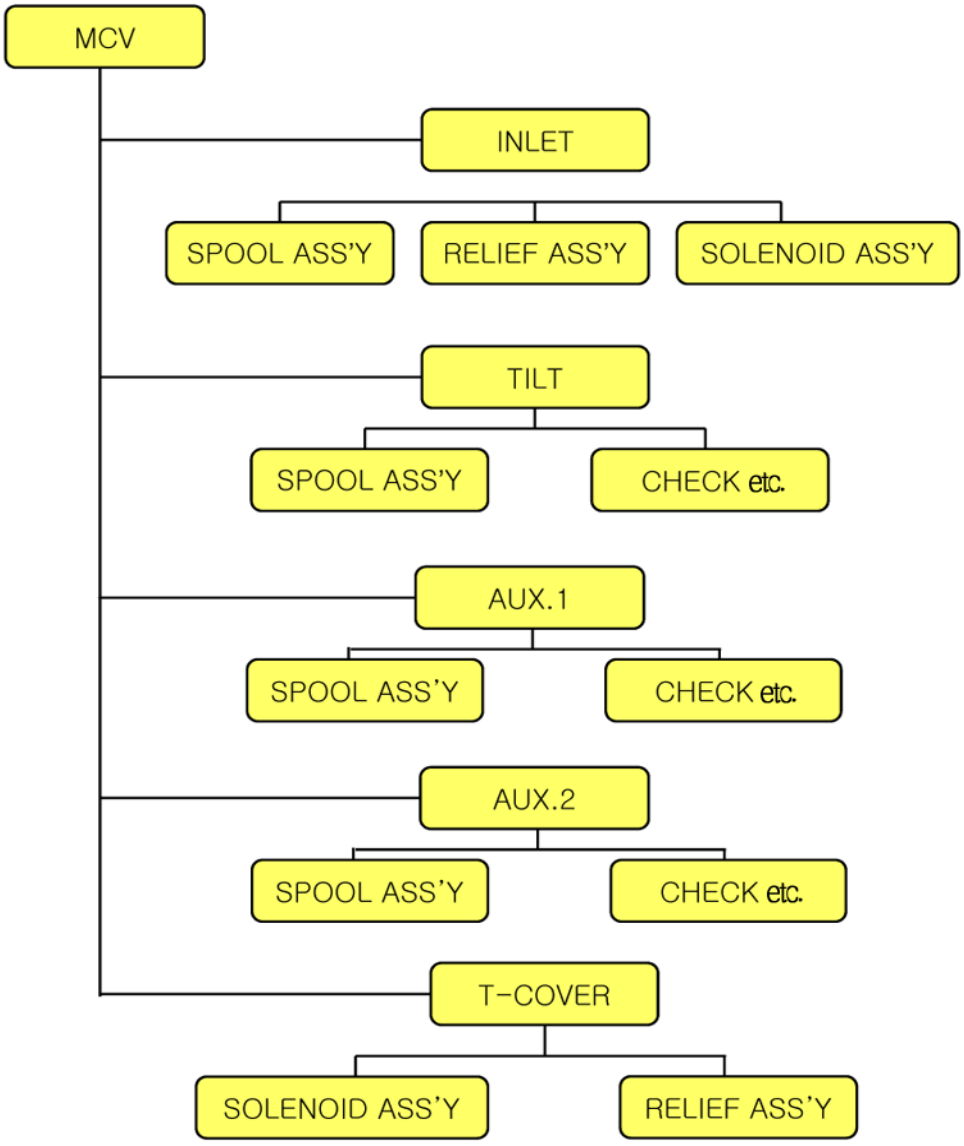
3) When the pressure in the P1 is released, the pressures in the P1 and P2 become imbalanced. When the pressure in P2 becomes higher than that in the P1, the unload spool is pushed to the left, allowing a large flow of oil to the T-line directly.



Section 4

Assembling Hydraulic Control Valve

* The hydraulic control valve assembly consists of following subassemblies and parts. Assembly shall be limited to the subassemblies and parts.



The above block diagram is of a 4-way valve.

- In a 3, 5-way valve, one auxiliary assembly is removed. (or added)
- A 2-way valve consists of INLET ASS'Y, Tilt ASS'Y and T-Cover ASS'Y, and the relief valve of the T-cover is substituted with a stopping-up plug.

Drift Causes and Remedies

Tilt cylinder drift indicates the following possible problems :

- Tilt cylinder hydraulic circuit hoses or fittings are leaking. Check the circuit components and repair as necessary.
- Cylinder piston seals are worn, damaged, or defective allowing fluid past the piston and causing the rod to drift. Consider rebuilding the cylinders if the other remedies in this list are not successful. See Section 3 for cylinder removal and replacement and Section 4 for cylinder repair, if necessary.
- The main hydraulic tilt valve is misadjusted, worn, or defective. Fluid is leaking past the valve and causing the tilt cylinders to drift. See Group 30 for hydraulic valve troubleshooting.

Tilt Cylinder Racking Check

Upright racking occurs when tilt cylinder strokes are unequal. Cylinders should be checked regularly during operation to determine if cylinder strokes are the same. To check for racking :

- Make sure truck is parked on level surface with parking brake applied and wheels chocked.
- Check condition of the tilt cylinder, rod-end yoke, mounting pins, piston rod, rod wiper, cylinder gland, etc., for excessive wear or damage. Make repairs before making twisting adjustment.
- Use a capacity load (see truck nameplate) centered on the forks.

CAUTION

Be sure to secure the load to the fork carriage to keep it from falling off when tilted forward. Raise the upright only to the height that will allow the fork tips to clear the floor when tilted fully forward.

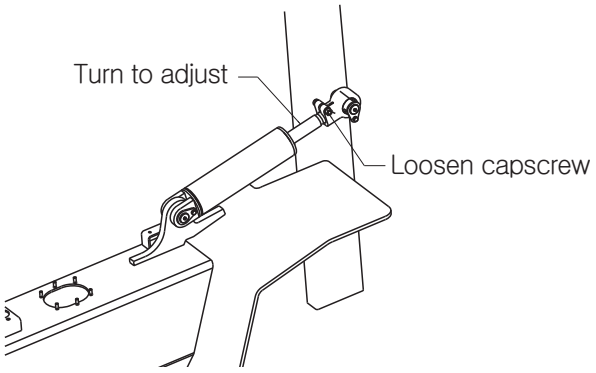
Forward Adjustment

1. Slowly tilt upright fully forward to the end of the tilt cylinder stroke.
2. As the cylinders approach the end of the stroke, watch both piston rods for equal movement and upright for twisting. Note if upright “racks” (is twisted at the end of its movement by unequal stroke of tilt cylinders).

NOTE

Correct the twisting effect by shortening the cylinder that is the longest length. Forward twisting must be adjusted before backward twisting. If forward adjustment is not needed, continue with backward adjustment.

3. To adjust, loosen rod-end yoke capscrew on the tilt cylinder that extends the farthest, and turn piston rod into rod-end yoke to shorten.



Forward Adjustment : Pneumatic-tire truck rod-end yoke orientation shown.

NOTE

Use wrench flat on rod under spacer (if installed). Move spacer for access.

Service Intervals

- All upright components should be visually checked every day during the Operator's Daily Inspection.
- A thorough visual inspection should be performed by a trained service professional every 50-250 hours.
- Lift chains should be inspected and lubricated every 50-250 hours or monthly.
- Lift chain tension should be checked every 50-250 hours or monthly.
- Upright and carriage roller checks should be performed every 50-250 hours or monthly.
- Roller patterns should be checked every 6 months or after 1000 hours of service.
- Racking and drift tests should be performed every 50~250 hours or monthly.
- The complete extended inspection should be performed at least every year or 2000 hours of operation.

Description

The upright assembly includes the lift chains, lift cylinders, carriage, forks, and mast or rail sets. Each of the components can be serviced using the tests, checks, adjustments, and removal and replacement procedures in the following Sections.

The upright uses the hydraulic cylinders and chain sets to lift the carriage and rail sets. On standard, two-stage uprights, the lift cylinders lift the carriage with chains and directly lift the inner rail set. On triple-stage uprights, the primary (free-lift) cylinder lifts the carriage by chains. When the primary cylinder reaches its maximum extension, fluid is diverted to the secondary lift cylinders, which lift the inner rails using a second set of chains and lift the intermediate rails by direct lift cylinder.

FFL uprights, the primary (free-lift) cylinder lifts the carriage by chains. When the primary cylinder reaches its maximum extension, fluid is diverted to the secondary lift cylinders. The secondary cylinders lift the inner rail set by directly.

Friction and play between the nesting rails is controlled by roller sets mounted on the rails and carriage. When rails or rollers become worn, the gap between the rollers and rails becomes larger, creating more play in lifting and lowering operations. The rail web to roller side clearances can be reduced by shimming the rollers to close the gap between the roller and rails. The gap between the rail flange and roller bearing surface can be reduced by the use of oversize rollers on a one-time basis.

Forks use a hanger design for mounting on the carriage. Auxiliary attachments may be added to the upright for specialized handling operations. The hydraulic circuit is modified with a hose adapter kit and an auxiliary section is added to the main hydraulic valve to operate the attachment.

The lift and secondary cylinders on standard uprights and triple-stage uprights (TSU) are piston type cylinders. The primary cylinder on TSU is piston-type cylinder. Secondary cylinders used on FFL upright are Ram type cylinders. See the chart under "Specifications" to determine the type of cylinder used on the upright you are servicing.

Piston-type cylinders contain a by-pass check valve in the piston that allows air and fluid that have accumulated in the rod end of the cylinder to return to the system. The check valve can be removed and cleaned if indicated by troubleshooting. A non-serviceable check-ball-type cushioning function is built into ram and piston cylinders for smooth staging during the lowering cycle. The primary cylinder on TSU incorporates cushioning on the lift cycle. A velocity fuse in the hydraulic port of the lift cylinders (secondary cylinders on TSU) prevents the mast from falling rapidly in case of sudden fluid pressure loss due to line breaks or other malfunction of the hydraulic circuit.

As the cushion system is added to lift cylinder of standard upright and the primary cylinder of TSU and FFL, the speed will get slow for a moment before the fork touches the ground. It is helpful to protect the ground.

As explained in more detail in Group 30, the main pump sends fluid to the main hydraulic control valve, which contains spools that route fluid to the lift cylinders and tilt cylinders. The valve assembly also contains a counterbalance valve that prevents upright tilt when the truck is not operating.

Fluid flow rates for lift functions are factory set and not adjustable. Flow rates for tilt and auxiliary functions are controlled by adjustments on the main hydraulic valve. A non-adjustable "load-lowering" flow valve mounted on the upright limits upright lowering speed.

Groups 29 and 30 contain general hydraulic information including upright hydraulic functions. Other hydraulic checks for the upright appear in "Troubleshooting," Section 2.