MITSUBISHI FORKLIFT TRUCKS

Service Manual

Chassis & Mast

LC/FC

FD100N1	AF15E-00011-up
FD120N1	AF15E-00011-up
FD135N1	AF15E-00011-up
FD150AN1	AF24C-00011-up
FD160AN1	AF39A-00011-up

For use with 1204E Diesel Engine Service Manual

99799-50100

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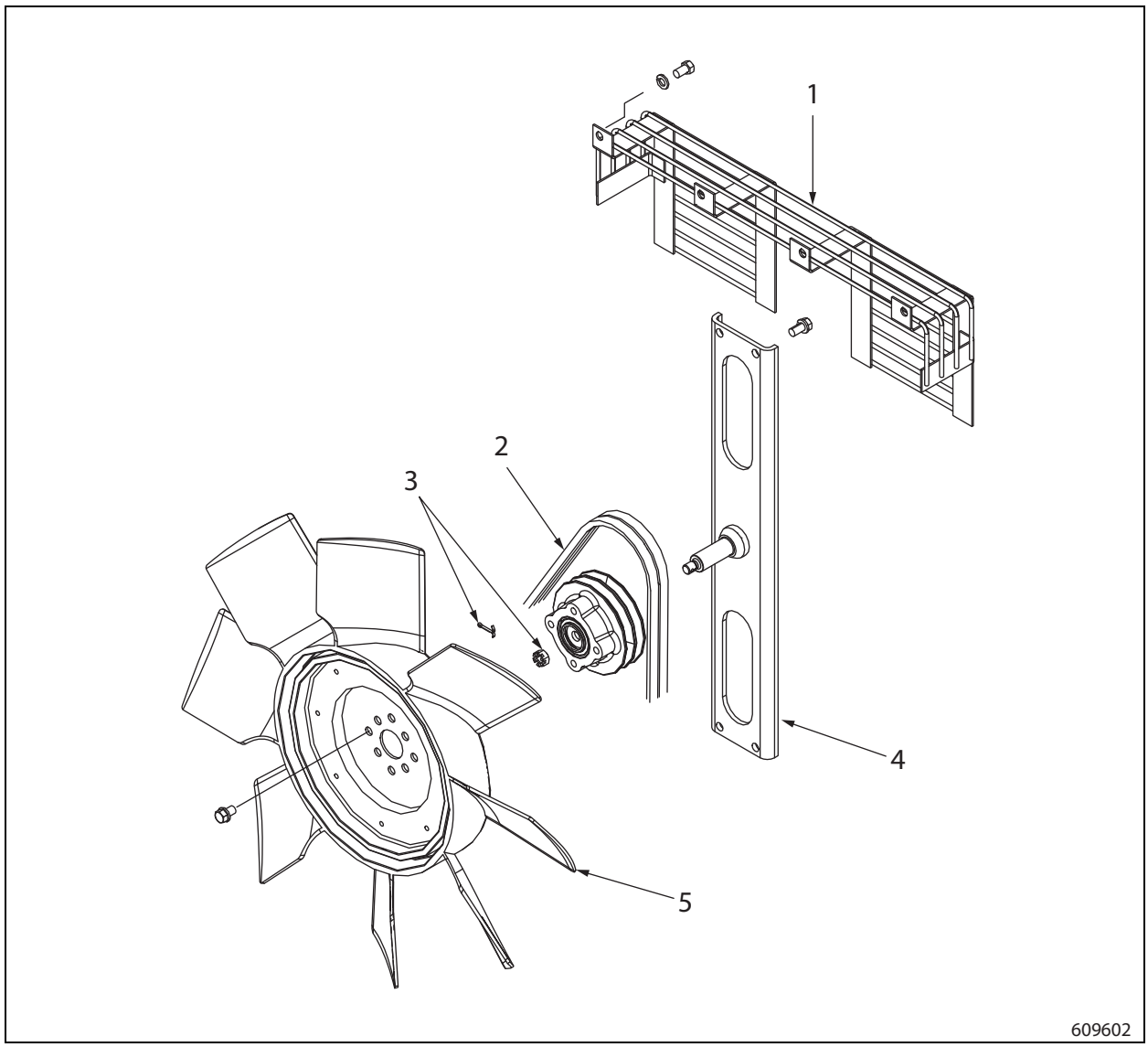
Chapter 10 STEERING SYSTEM

Chapter 11 HYDRAULIC SYSTEM

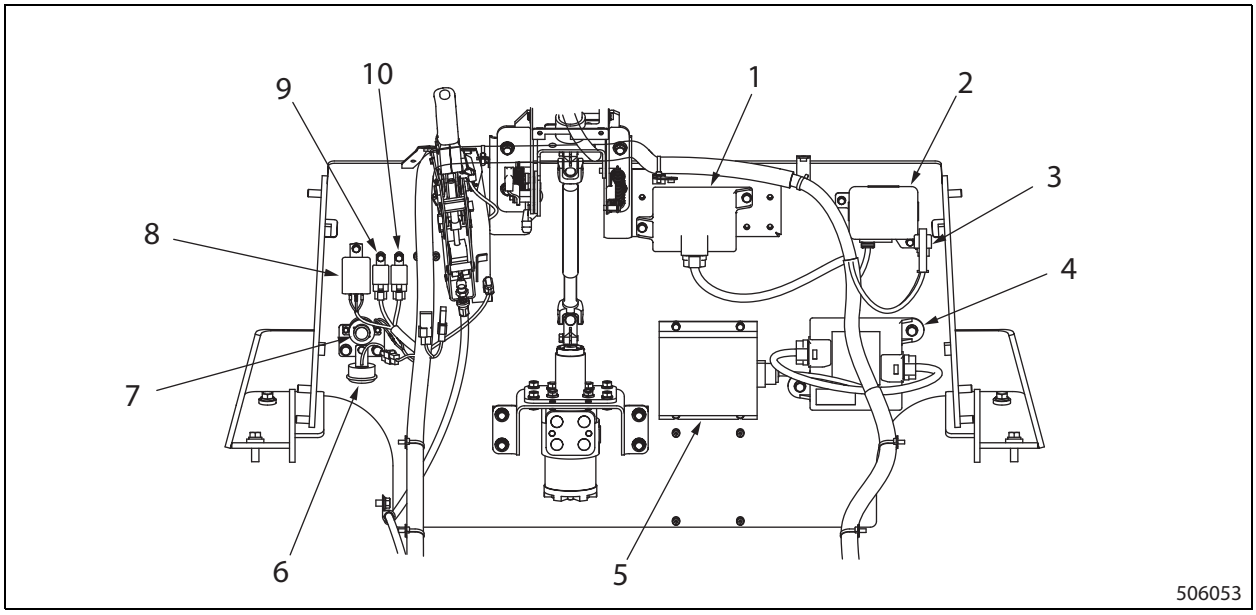
3.4 Removal Sequence of Cooling Fan



1. Fan cover
2. Fan belt
3. Slotted nut, Pin
4. Plate
5. Cooling fan

1.1 Electrical Components and Wiring Diagram of Each System

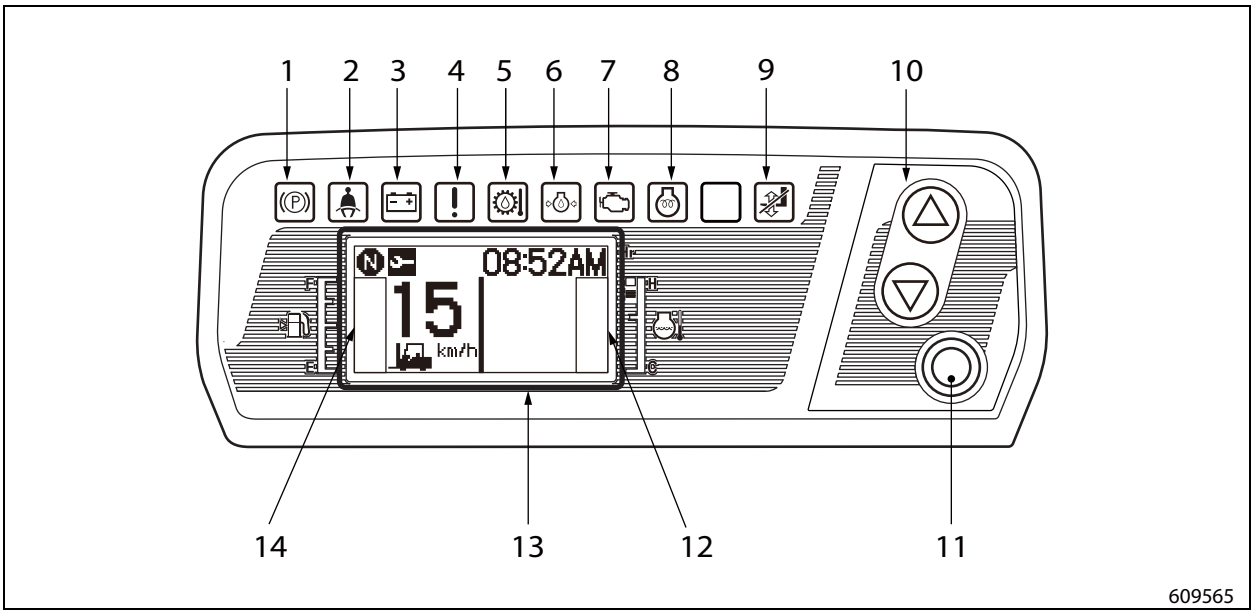
Console box



1. Output unit
2. Gateway
3. GSE Connector
4. VCM7
5. DC/DC converter
6. Buzzer
7. Buzzer
8. Flasher relay
9. Turn signal relay (L.H.)
10. Turn signal relay (R.H.)

3. Main Electrical Components

3.1 Meter Panel



Ref.	Names of indicators/ warning lights	When Light is OFF	When Light is ON or BLINK	Remarks
1	Parking brake warning icon	Parking brake is released Normal	Parking brake is activated (ON) Parking interlock is activated (BLINK)	-
2	Seat belt warning icon	Seat belt is fastened properly	The seat belt is not fastened (ON)	-
3	Battery charge warning icon	Battery properly charged	Charge is not working properly (ON) The engine is not running (ON)	-
4	Multi-purpose warning icon	Truck in normal conditions	Presence of a minor warning or operating caution (ON)	-
5	Torque converter oil temperature warning icon	Temperature is normal	Torque converter oil temperature is abnormal (ON)	-
6	Engine oil pressure warning icon	Engine oil level is normal	Engine oil pressure is low (ON) The engine is not running (ON)	-
7	Engine check icon	Normal	Engine check (ON)	-
8	Glow plug warning icon	Preheating completed	Glow plug heating is ON (ON)	-
9	Mast interlock indicator icon	-	Mast interlock is activated (ON)	-
10	Cursor buttons	-		-
11	Enter/select button	-	-	-
12	Coolant temperature gauge	Indicates coolant temperature when the key switch is turned to the ON position		-
13	LCD screen	-	-	-
14	Fuel gauge	Indicates the remaining amount in the tank when the key switch is turned to ON position		-

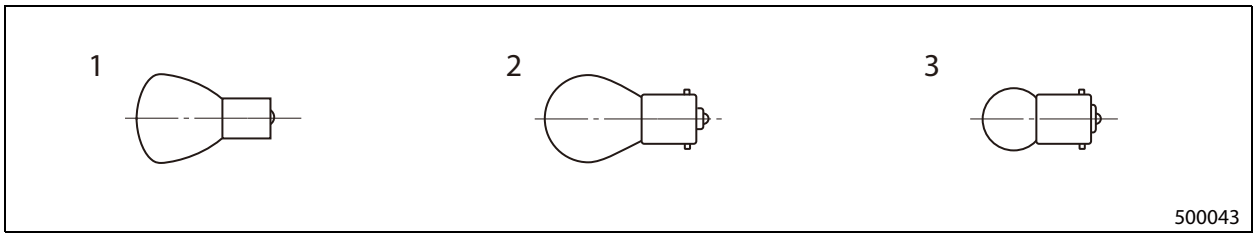
Description of function

How to check blown out bulbs in the meter panel

A warning or indicator icon glows when the key switch is turned to the ON position. If not, the bulb is blown out.

3.16 List of Lights

Light types		Qty	Glass color	valve	Figure	Remarks
Head light		2	Transparent	60W	1	
		2	Transparent	62/62W	1	Option
Rear working light		2	Transparent	60W	1	Option
Front combination light	Turn signal light	2	Orange	25W	2	
	Clearance light	2	Orange	5W	3	
Rear combination light	Tail light / Stop light	2	Red	21/5W	2	
	Turn signal light	2	Orange	21W	2	
	Backup light	2	Transparent	21W	2	
Rotary light		1	Red or amber	40W	1	Option
License plate light		1	Transparent	12W	3	Option



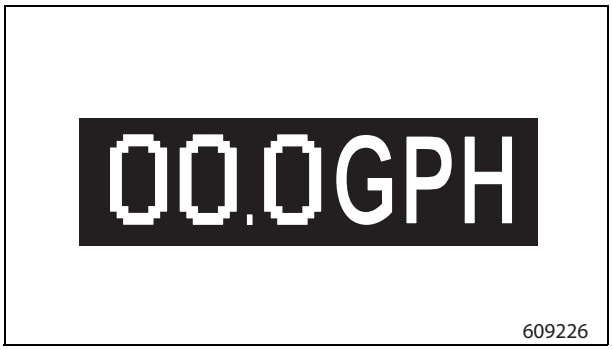
How to change unit of display

(1) Turn the key switch to the ON position to display fuel consumption.
(2) Long press of the ▽ button (2 seconds) will change the display from "GPH" to "L/H".

Button	Press	Display
▽	Long press	GPH ⇔ L/H

How to reset

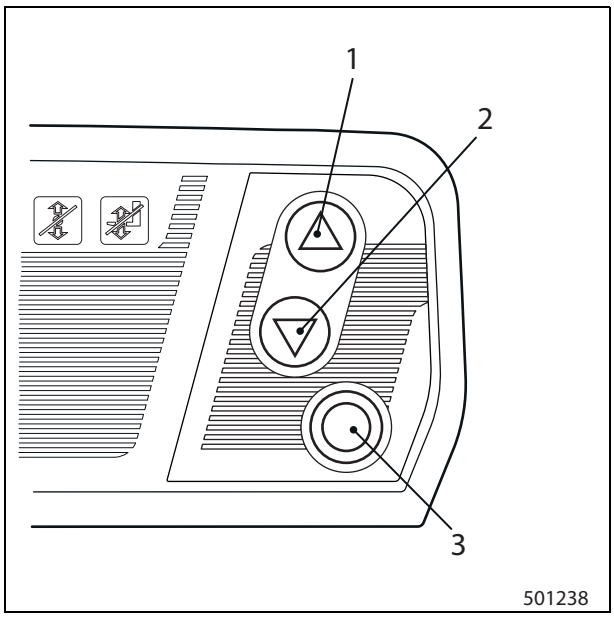
(1) Turn the key switch to the ON position to display fuel consumption.
(2) Long press of the ○ button (2 seconds) will reset the fuel consumption display. Note that "00.0 GPH(L/H)" will be displayed in white when resetting (1 second).



Button	Press	Display
○	Long press	00.0 GPH or 00.0 L/H

Displaying truck history screen

To adjust, turn the key switch to the ON position. A long press on all the buttons at the same time brings up the truck history screen.



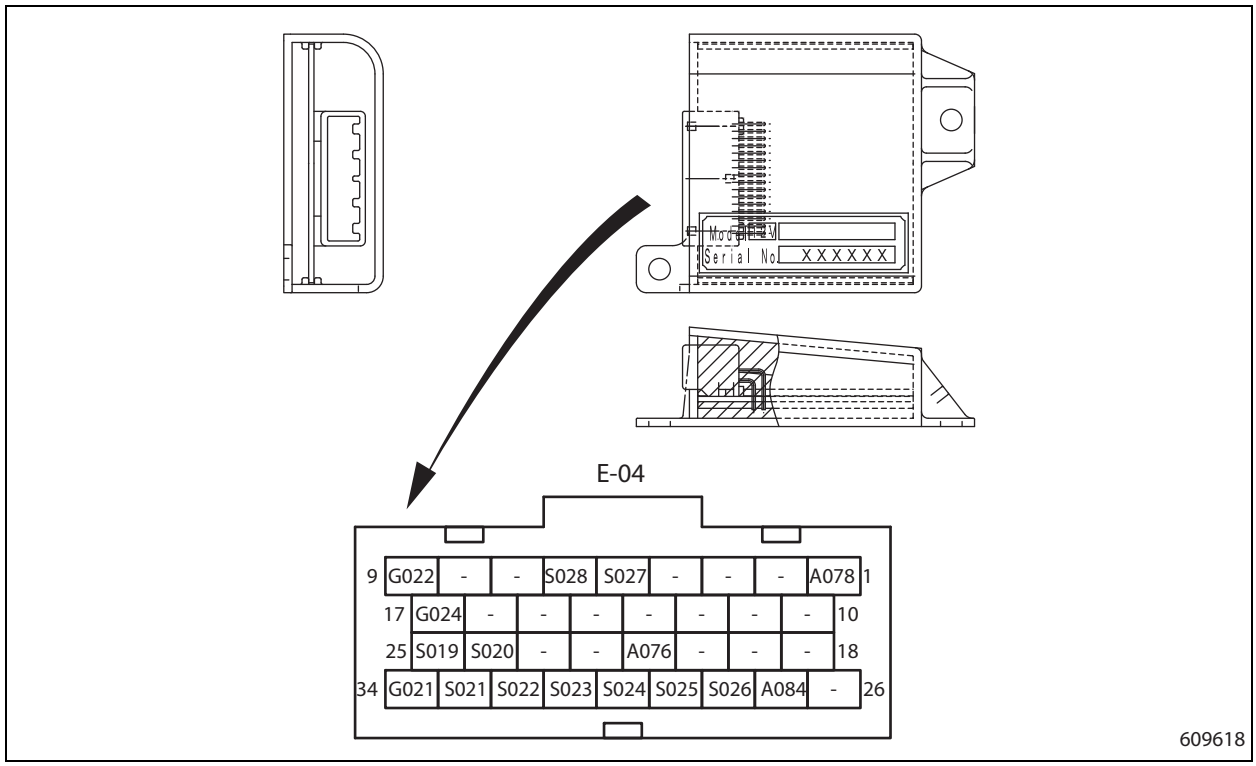
1. △ button
2. ▽ button
3. ○ button

Button	Press	Display
△▽○	Long press at same time	Truck history

7.3 Light-Related Problems

Condition		Possible cause	Action
All lights	Will not glow (blink) with the switch turned ON	Battery is discharged	Charge or replace battery
		Burned-out fuse	Check and correct the cause, then replace
		Disconnection or poor connection	Repair or replace
		The ground wire is faulty	Remove corrosion from the terminal or retighten
		Blown-out bulb	Replace
	Light glows (blinks) dimly	Battery is weak	Check and charge
		Switch contact is faulty	Repair or replace
		Terminal contact is poor	Repair
		Lens are dirty	Clean
		Water drops on the inside of the lenses	Dry and replace the packing
		Bulb life has expired	Replace
Headlight	Light will not turn ON	Defective light switch conductivity	Replace
		Blown-out bulb	Replace
Turn signal light	Does not blink	Turn signal switch continuity is faulty	Replace
		Turn signal relay is faulty	Replace
	Light will not go off	Turn signal relay is faulty	Replace
	Blinks too slowly	Bulb wattage is smaller than the specification	Replace it with a specified wattage bulb
		Turn signal relay is faulty	Replace
	Blinks too fast	Bulb wattage is larger than the specification	Replace it with a specified wattage bulb
		Blown-out bulb	Replace
		Turn signal relay is faulty	Replace
Other lights	Backup light does not glow	Backup light switch is faulty	Correct if incorrectly installed, or replace if internally defective
		Blown-out bulb	Replace
	License plate light does not glow (If equipped)	Defective light switch conductivity	Replace
		Blown-out bulb	Replace

Input unit



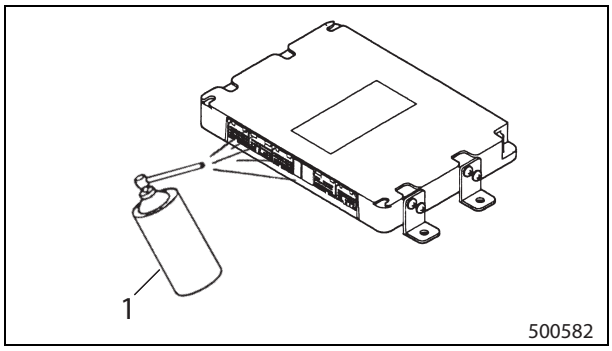
Pin No.	Circuit No.	Signal name	Wire diameter/ color
1	A078	12V power supply	1.25 Y/B
2	-	-	-
3	-	-	-
4	-	-	-
5	S027	CAN_H	0.5 W/B
6	S028	CAN_L	0.5 L/R
7	-	-	-
8	-	-	-
9	G022	GND	0.85 B
10	-	-	-
11	-	-	-
12	-	-	-
13	-	-	-
14	-	-	-
15	-	-	-
16	-	-	-
17	G024	Select SW GND	0.5 B/Y

Pin No.	Circuit No.	Signal name	Wire diameter/ color
18	-	-	-
19	-	-	-
20	-	-	-
21	A076	Select SW input 3	0.5 L/R
22	-	-	-
23	-	-	-
24	S020	ATT 2-1	0.5 G/L
25	S019	ATT 2-2	0.5 G/B
26	-	-	-
27	A084	Lift 5V	0.5 L/R
28	S026	Lift 1	0.5 W/Y
29	S025	Lift 2	0.5 W/R
30	S024	Tilt 1	0.5 Y/B
31	S023	Tilt 2	0.5 Y/L
32	S022	ATT 1-1	0.5 L/Y
33	S021	ATT 1-2	0.5 L/B
34	G021	Analogue input GND	0.5 B/L

How to clean harness connectors and system components

(1) Open-circuits are often caused by dirty harness connectors and components. Dust, together with greasy matter, forms grime, which, in time, penetrates electrical connections, results in loose metal-to-metal contactor, for worse, electrical separation of surfaces in contact.
For this reason, it is essential that the connectors and components be cleaned at every periodic inspection and when servicing the forklift truck.
Use the electronic parts cleaner (ThreeBond 29D).

Note: The electronic parts cleaner is volatile. All you have to do is just spray the area to be cleaned. There is no need to wipe the sprayed area.

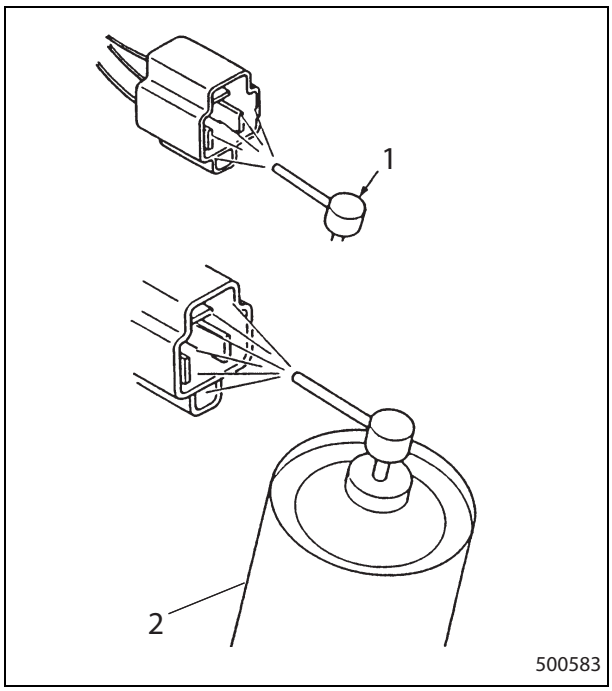


1. Electronic parts cleaner

(2) After cleaning the connector, remove the connector and spray the activator (ThreeBond 2501S (aerosol)) to the contacts.
Attach and then detach the connector several times to wet the contacts thoroughly with the activator.
After coupling up the connector, make sure that the connector is in locked state.

Note:

- Do not spray too much activator.
- Activators may adversely affect some plastics.



1. Electronic parts cleaner
2. Activator (ThreeBond 2501S (aerosol))

4.10 Attachment 3 Lever Neutral Warning (F14)

Diagnostic code: F14	
Situation	"F14" blinks. All load handling operations disabled.
Possible cause	Load handling lever operated when turning ON key switch. Faulty attachment 3 lever, faulty input unit, or faulty harness.
How the code is triggered	Attachment 3 lever is not in NEUTRAL when turning ON key switch.
Recovery	Auto recovery when the attachment 3 lever is placed in NEUTRAL.
Action	Turns OFF all solenoid outputs of operating functions.

Checks

(1) Shift attachment 3 lever to NEUTRAL, then turn ON key switch again.

Normal → Fail-safe operation

Warning remains →

(2) Check continuity between attachment 3 lever and input unit.

Between S020 (Input unit: E-04-24) and S020 (ATT2/3 lever: H-06-2)
Between S019 (Input unit: E-04-25) and S019 (ATT2/3 lever: H-06-4)
Between A084 (Input unit: E-04-27) and A074 (ATT2/3 lever: H-06-5)
Between G021 (Input unit: E-04-34) and G018 (ATT2/3 lever: H-06-1)

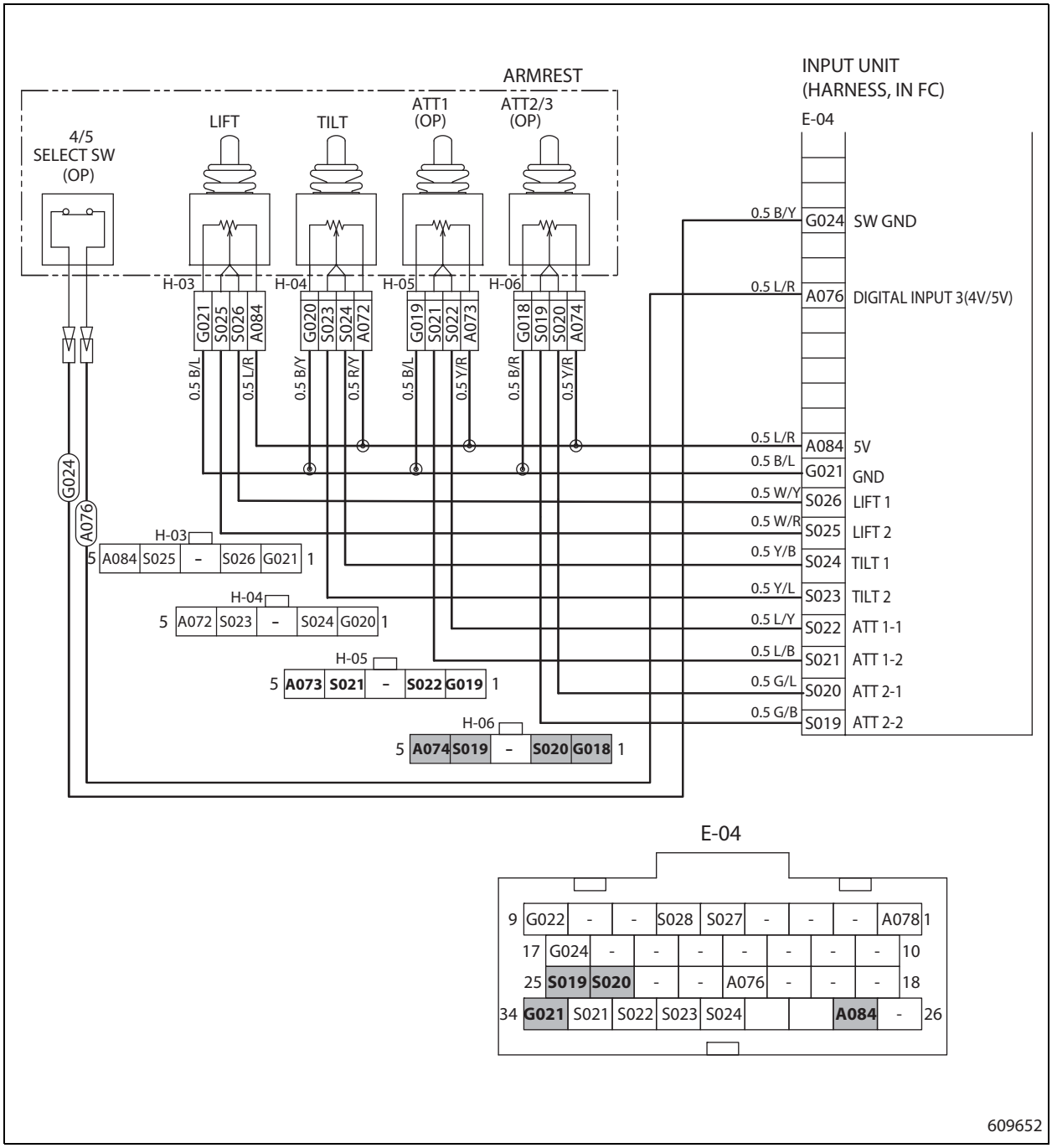
Continuity →

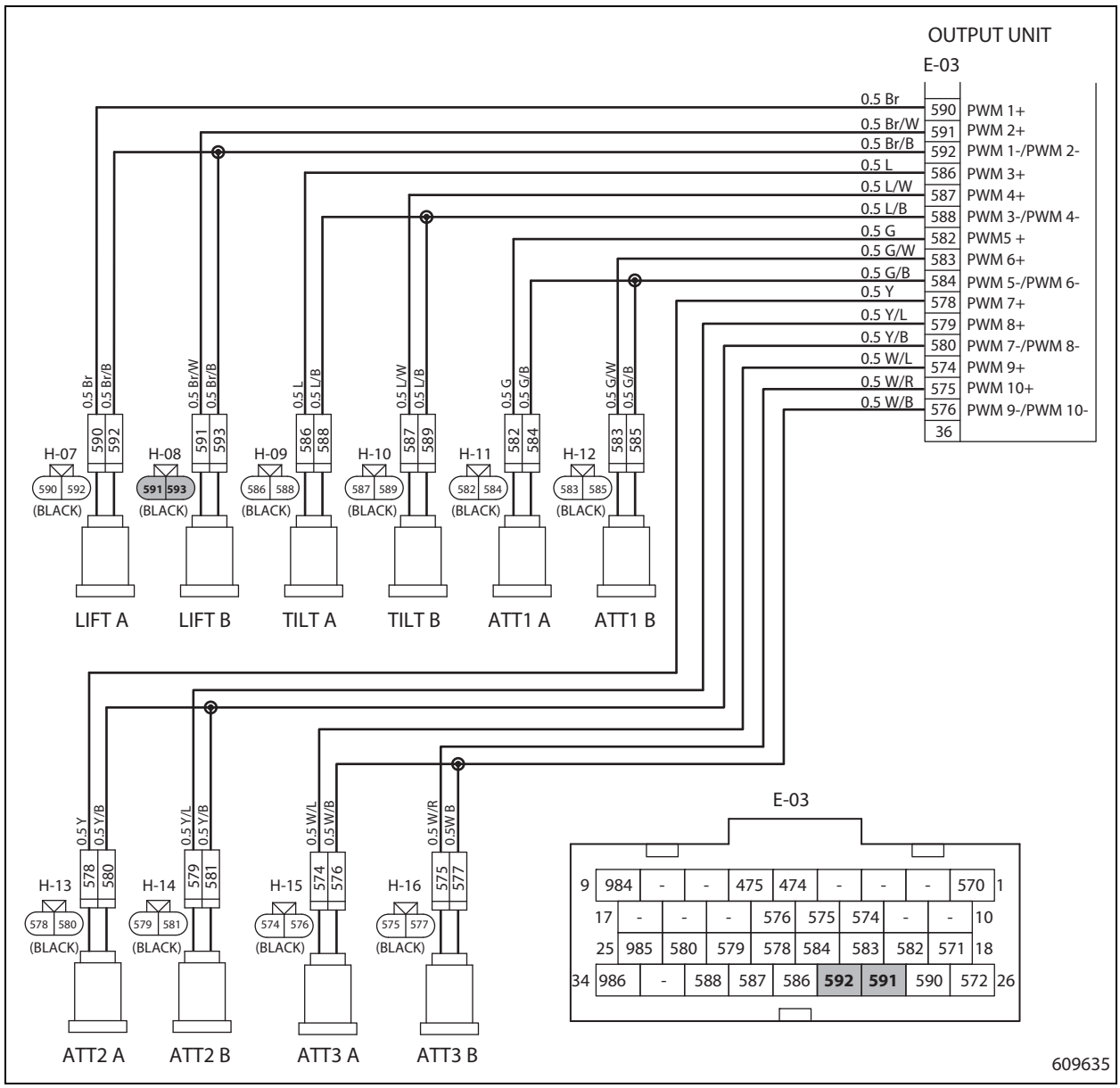
No continuity → (3) Replace harness.

(4) Replace attachment 3 lever with another section lever.

Warning transition → (5) Replace attachment 3 lever.

Warning remains → (6) Replace input unit.


ARMREST
INPUT UNIT
(HARNESS, IN FC)
E-04
4/5
SELECT SW
(OP)
LIFT
TILT
ATT1
(OP)
ATT2/3
(OP)
H-03
H-04
H-05
H-06
G021 S025 S026 A084
G020 S023 S024 A072
G019 S021 S022 A073
G018 S019 S020 A074
0.5 B/L
0.5 L/R
0.5 B/Y
0.5 R/Y
0.5 B/L
0.5 Y/R
0.5 B/R
0.5 Y/R
G024
A076
0.5 B/Y G024 SW GND
0.5 L/R A076 DIGITAL INPUT 3(4V/5V)
0.5 L/R A084 5V
0.5 B/L G021 GND
0.5 W/Y S026 LIFT 1
0.5 W/R S025 LIFT 2
0.5 Y/B S024 TILT 1
0.5 Y/L S023 TILT 2
0.5 L/Y S022 ATT 1-1
0.5 L/B S021 ATT 1-2
0.5 G/L S020 ATT 2-1
0.5 G/B S019 ATT 2-2
H-03
5 A084 S025 – S026 G021 1
H-04
5 A072 S023 – S024 G020 1
H-05
5 A073 S021 – S022 G019 1
H-06
5 A074 S019 – S020 G018 1
E-04
9 G022 - - S028 S027 - - - A078 1
17 G024 - - - - - - - 10
25 S019 S020 - - A076 - - - 18
34 G021 S021 S022 S023 S024 A084 - 26
609652


OUTPUT UNIT
E-03
0.5 Br 590 PWM 1+
0.5 Br/W 591 PWM 2+
0.5 Br/B 592 PWM 1-/PWM 2-
0.5 L 586 PWM 3+
0.5 L/W 587 PWM 4+
0.5 L/B 588 PWM 3-/PWM 4-
0.5 G 582 PWM5 +
0.5 G/W 583 PWM 6+
0.5 G/B 584 PWM 5-/PWM 6-
0.5 Y 578 PWM 7+
0.5 Y/L 579 PWM 8+
0.5 Y/B 580 PWM 7-/PWM 8-
0.5 W/L 574 PWM 9+
0.5 W/R 575 PWM 10+
0.5 W/B 576 PWM 9-/PWM 10-
36
H-07 (590 592) (BLACK) LIFT A
H-08 (591 593) (BLACK) LIFT B
H-09 (586 588) (BLACK) TILT A
H-10 (587 589) (BLACK) TILT B
H-11 (582 584) (BLACK) ATT1 A
H-12 (583 585) (BLACK) ATT1 B
H-13 (578 580) (BLACK) ATT2 A
H-14 (579 581) (BLACK) ATT2 B
H-15 (574 576) (BLACK) ATT3 A
H-16 (575 577) (BLACK) ATT3 B
E-03
9 984 - - 475 474 - - - 570 1
17 - - - 576 575 574 - - 10
25 985 580 579 578 584 583 582 571 18
34 986 - 588 587 586 592 591 590 572 26
609635

4.34 Attachment 1 Solenoid Leak (F64)

Diagnostic code: F64	
Situation	"F64" blinks. All load handling operations disabled.
Possible cause	Faulty output unit, faulty operating function solenoid, or faulty harness.
How the code is triggered	Current is 0.18A or more when attachment 1 lever is not operated.
Recovery	Key OFF/ON.
Action	Turns OFF solenoid output of all models. Turns OFF unload solenoid.

Checks

(1) Check hydraulic operations when a diagnostic code occurs.

- (2) No operation
- (3) Lift operation — **Ascent** / **Descent**
  - To (10)
  - To (13)
- (4) Attachment 1 operation — **Forward tilt** / **Backward tilt**
  - To (16)
  - To (19)
- (5) Attachment 1 operation — **A** / **B**
  - To (22)
  - To (25)
- (6) Attachment 3 operation — **A** / **B**
  - To (28)
  - To (31)

(7) Check resistance of the operating function solenoid causing the diagnostic code.

- **Normal (6.6 to 9.8 at 25°C (77°F)** → (8) Replace output unit.
- **Abnormal** → (9) Replace corresponding operating function solenoid.

(10) Check continuity of attachment 1 section harness and lift section harness.

Between 590 (Output unit: 27) and 584 (Output unit: 21)

- **Continuity (Several 10 or less)** → (11) Isolate harnesses or replace harness.
- **No continuity (Several M)** → (12) Replace output unit.

(13) Check continuity of attachment 1 section harness and lift section harness.

Between 591 (Output unit: 28) and 584 (Output unit: 21)

- **Continuity (Several 10 or less)** → (14) Isolate harnesses or replace harness.
- **No continuity (Several M)** → (15) Replace output unit.

(16) Check continuity of attachment 3 section harness and tilt section harness.

Between 586 (Output unit: 30) and 576 (Output unit: 14)

Continuity (Several 10 or less) — (17) Isolate harnesses or replace harness.

No continuity (Several M) — (18) Replace output unit.

(19) Check continuity of attachment 3 section harness and tilt section harness.

Between 587 (Output unit: 31) and 576 (Output unit: 14)

Continuity (Several 10 or less) — (20) Isolate harnesses or replace harness.

No continuity (Several M) — (21) Replace output unit.

(22) Check continuity of attachment 3 section harness and attachment 1 section harness.

Between 582 (Output unit: 19) and 576 (Output unit: 14)

Continuity (Several 10 or less) — (23) Isolate harnesses or replace harness.

No continuity (Several M) — (24) Replace output unit.

(25) Check continuity of attachment 3 section harness and attachment 1 section harness.

Between 583 (Output unit: 20) and 576 (Output unit: 14)

Continuity (Several 10 or less) — (26) Isolate harnesses or replace harness.

No continuity (Several M) — (27) Replace output unit.

(28) Check continuity of attachment 3 section harness and attachment 2 section harness.

Between 578 (Output unit: 22) and 576 (Output unit: 14)

Continuity (Several 10 or less) — (29) Isolate harnesses or replace harness.

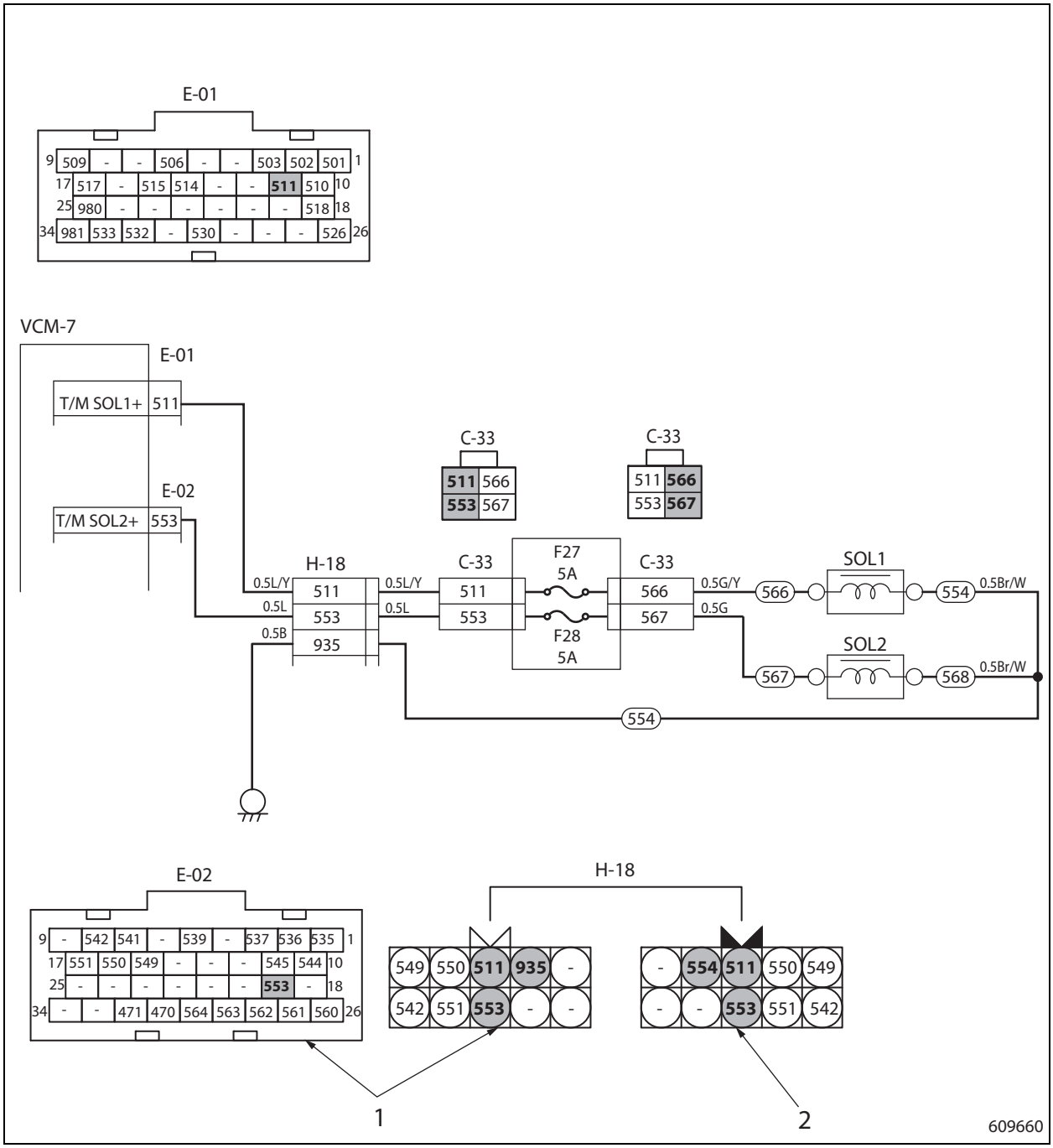
No continuity (Several M) — (30) Replace output unit.

(31) Check continuity of attachment 3 section harness and attachment 2 section harness.

Between 579 (Output unit: 23) and 576 (Output unit: 14)

Continuity (Several 10 or less) — (32) Isolate harnesses or replace harness.

No continuity (Several M) — (33) Replace output unit.



1. Connector at harness B side
2. Connector at T/M harness side

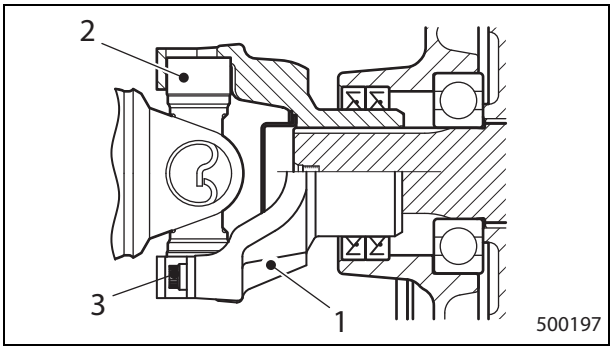
5. Installing Engine and Transmission Unit

Follow the removal sequence in reverse to install.

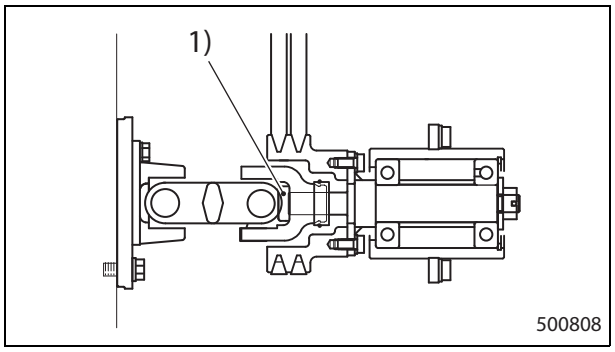
5.1 Suggestions for Installation

(1) Inspect the rubber cushion on engine and transmission mountings. If defect such as peeling or fatigue is found, replace with a new one.

(2) When installing the engine and transmission unit on the frame, position it on the mounting brackets while aligning the universal joint (front side) and the transmission output flange.



1. Yoke
2. Spider mounting bolt
3. Strap



1) Fill the universal joint with grease when assembling.

4. Installing Transmission

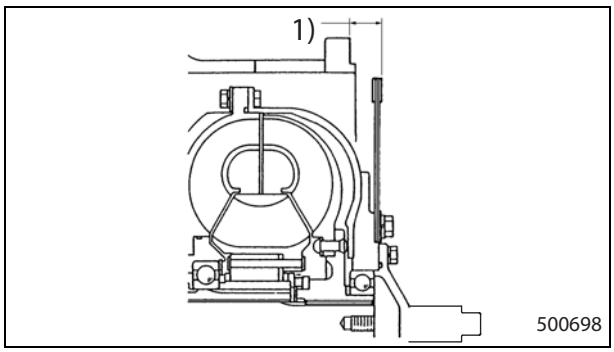
(1) Install the torque converter into transmission.
Make sure that the distance from the mounting face of flexible plate to the torque converter housing end is 14.5 mm (0.571 in.). If the distance is more than 14.5 mm (0.571 in.), it indicates an incorrect engagement of the transmission stator shaft or the input shaft splines with the torque converter splines. Dismount and install the torque converter.

(2) Lift the transmission and couple it to the engine.

(3) Check that the clearance between the flywheel and the flexible plate is somewhere from 0 to 2 mm (0.00 to 0.08 in.).

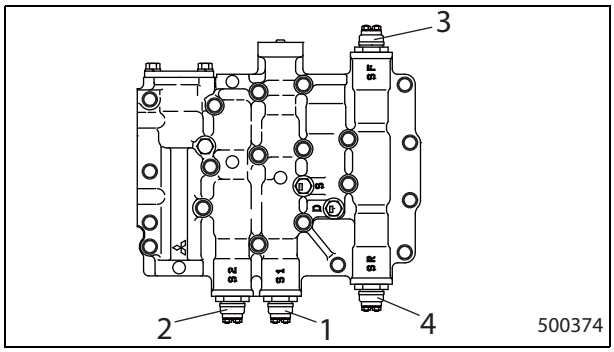
(4) Tighten the flexible plate bolts to the flywheel through the access hole in the torque converter housing. Tighten the bolts evenly and progressively.
To turn the torque converter, use a heavy-duty screwdriver through the access hole in the side face of the torque converter housing and apply it on the bolt.

(5) Install the hydraulic gear pump on the transmission.



1) Distance between the flexible plate mounting face and the torque converter housing end.

(6) Install the transmission harness.
Connect the travel speed sensor at the connector side, and connect the torque converter thermo unit at the terminal.
Connect the following wire color harnesses to each solenoid.



Ref.	Solenoid		Harness wiring color
1	Travel speed solenoid	S1	G/Y
			Br/W
2		S2	G
			Br/W
3	Direction change solenoid	SF	G/Y
			Br/Y
4		SR	G/L
			Br/Y

(7) Fill the transmission with oil.

8.7 Suggestions for Disassembling Forward Clutch Shaft Assembly

Removing ball bearing

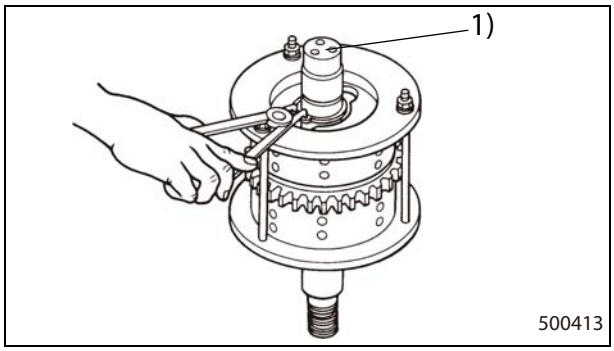
Install a gear puller to the 2nd speed gear, and pull out the gear together with the ball bearing and thrust washer.

Removing roller bearing

Install a gear puller to the forward drive gear, and pull out the gear together with the roller bearing and thrust washer.

Disassembling forward clutch shaft

Using the piston tool or a press, compress the clutch spring and retainer, and remove the snapring.



1) Oil pressure port

Special tool name	Part number
Piston tool	92267-00300

Removing clutch piston

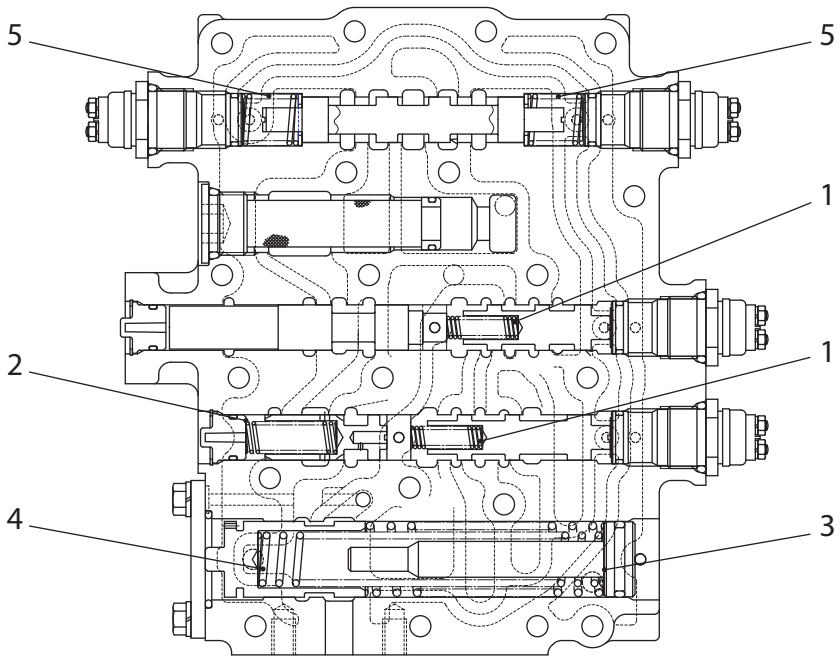
Apply compressed air through the oil pressure port of the forward clutch shaft on its servo case side to remove the clutch pin.

Note: Hold the clutch piston with a hand to prevent it from popping out.

12. Inspecting and Repairing Control Valve

- Check oil holes of valve housing for clogging.
- Check the valves for wear or damage. Make sure the valve moves smoothly.
- Replace the oil seals with new ones.
- Replace the filters with new ones.

Ref.	Item	Standard	Limit
1	1st speed, 2nd/3rd speed valves Free length of inner spring (k: Spring constant N/mm)	36.5 mm (1.437 in.) k = 5.658 N/mm (0.5769 kgf/mm) [32.3082 lbf/in.]	35.5 mm (1.398 in.)
2	Differential valve spring free length (k: Spring constant N/mm)	60 mm (2.36 in.) k = 1.677 N/mm (0.1710 kgf/mm) [9.5760 lbf/in.]	58 mm (2.28 in.)
3	Accumulator valve Outer spring free length (k: Spring constant N/mm)	142.5 mm (5.610 in.) k = 3.747 N/mm (0.3821 kgf/mm) [21.3960 lbf/in.]	140 mm (5.51 in.)
4	Accumulator valve Free length of inner spring (k: Spring constant N/mm)	184.5 mm (7.264 in.) k = 3.941 N/mm (0.4019 kgf/mm) [22.5038 lbf/in.]	182 mm (7.17 in.)
5	Free length of directional spring (k: Spring constant N/mm)	32.5 mm (1.280 in.) k = 4.23 N/mm (0.431 kgf/mm) [24.154 lbf/in.]	31.5 mm (1.240 in.)



500432

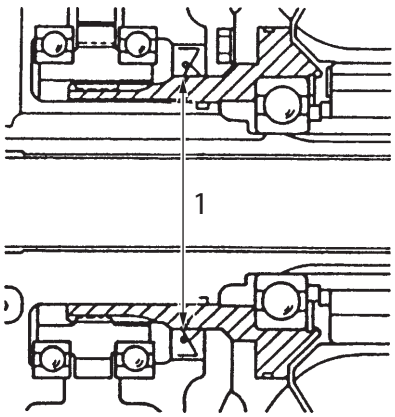
19. Service Data

19.1 Stall Speed and Oil Pressure

Item		Value
Stall speed	Standard	2110 ± 100 min^{-1}
Main oil pressure, Speed clutch oil pressure (Engine speed at 1500 ± 100 min^{-1})	Standard	1.06 to 1.22 MPa (10.81 to 12.44 kgf/cm^2) [153.74 to 176.95 psi]
Direction clutch oil pressure (Engine speed at 1500 ± 100 min^{-1})	Standard	0.91 to 1.07 MPa (9.28 to 10.91 kgf/cm^2) [131.98 to 155.19 psi]
Torque converter inlet oil pressure (Engine speed at 1500 ± 100 min^{-1})	Standard	0.54 to 0.70 MPa (5.51 to 7.14 kgf/cm^2) [78.32 to 101.53 psi]
Lubrication oil pressure (Engine speed at 1500 ± 100 min^{-1})	Standard	0.12 to 0.19 MPa (1.22 to 1.94 kgf/cm^2) [17.40 to 27.56 psi]
10 m (10.9 yd) acceleration (empty load)	Standard	5 seconds or less

19.2 Pump Boss

Ref.	Item		Value
1	Oil seal contact surface	Standard	$100\ ^{0}_{-0.035}$ mm ($3.94\ ^{0}_{-0.0014}$ in.)
		limit	99.85 mm (3.9311 in.)



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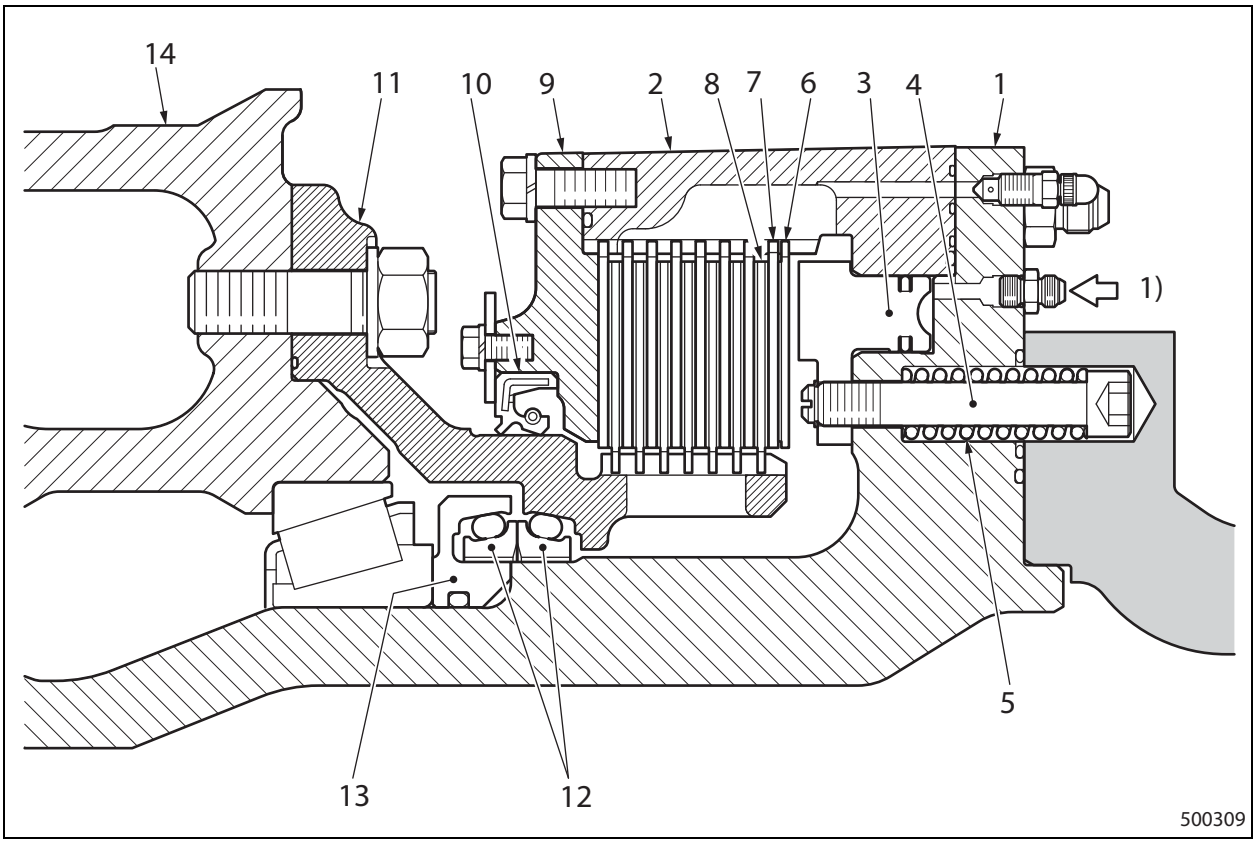
Wet type wheel brake



1. Spindle
2. Brake housing
3. Brake piston
4. Return spring guide
5. Return spring
6. End plate
7. Mating plate
8. Friction plate
9. Brake cover
10. Oil seal
11. Brake hub
12. Floating seal
13. Seal retainer
14. Wheel hub

1) Brake oil

The wet type wheel brake consists of a brake housing, brake piston, plate, and brake hub.

The brake housing is bolted to the spindle that is mounted on the axle housing.
In the circular grooves provided on the brake housing and spindle, a piston is assembled and supported in position by the return spring.

The brake hub is bolted to the wheel hub so that it can rotate together with the wheel hub.

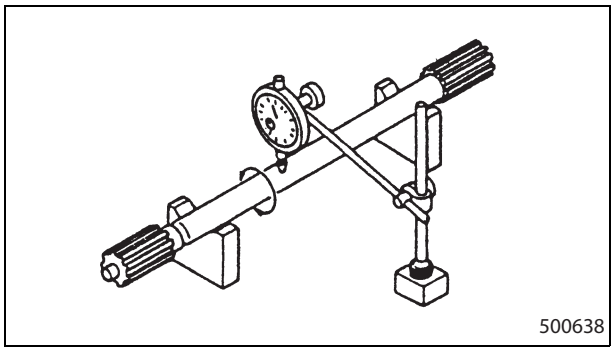
The mating plate with outer teeth is supported by the housing as it engages with the inner teeth of the brake housing, while the friction plate with inner teeth engages with the outer teeth of the brake hub and rotates together with the wheel hub.

A brake oil port is provided on the flange part of the spindle with connectors and bleeder screws. Also, piston seals and O-rings are installed on each part of sliding surfaces and mounting surfaces to seal the break oil.

10. Inspecting and Repairing Hub Reduction (FD100N1 to FD150AN1)

Axle shaft

Measure deflection (1/2 TIR) with a dial gauge positioned on the center of the axle shaft while rotating the shaft.



Item	limit
Axle shaft deflection (1/2 TIR)	0.2 mm (0.008 in.)

Axle housing

Check the axle housing for the following defects:

- Check the mast bearing rolling surfaces for damage.
- Check the end-face oil seal for wear or damage.
- Check the axle housing for distortion, dents, or other defects. Also check the welds for cracks.

Front wheel hub

Check the front wheel hub for the following defects:

- Check the oil seals for wear or damage.
- Check the tapered roller bearing (outer race) for wear or damage.

Brake drum

Check the inner surface of drum for wear or damage.

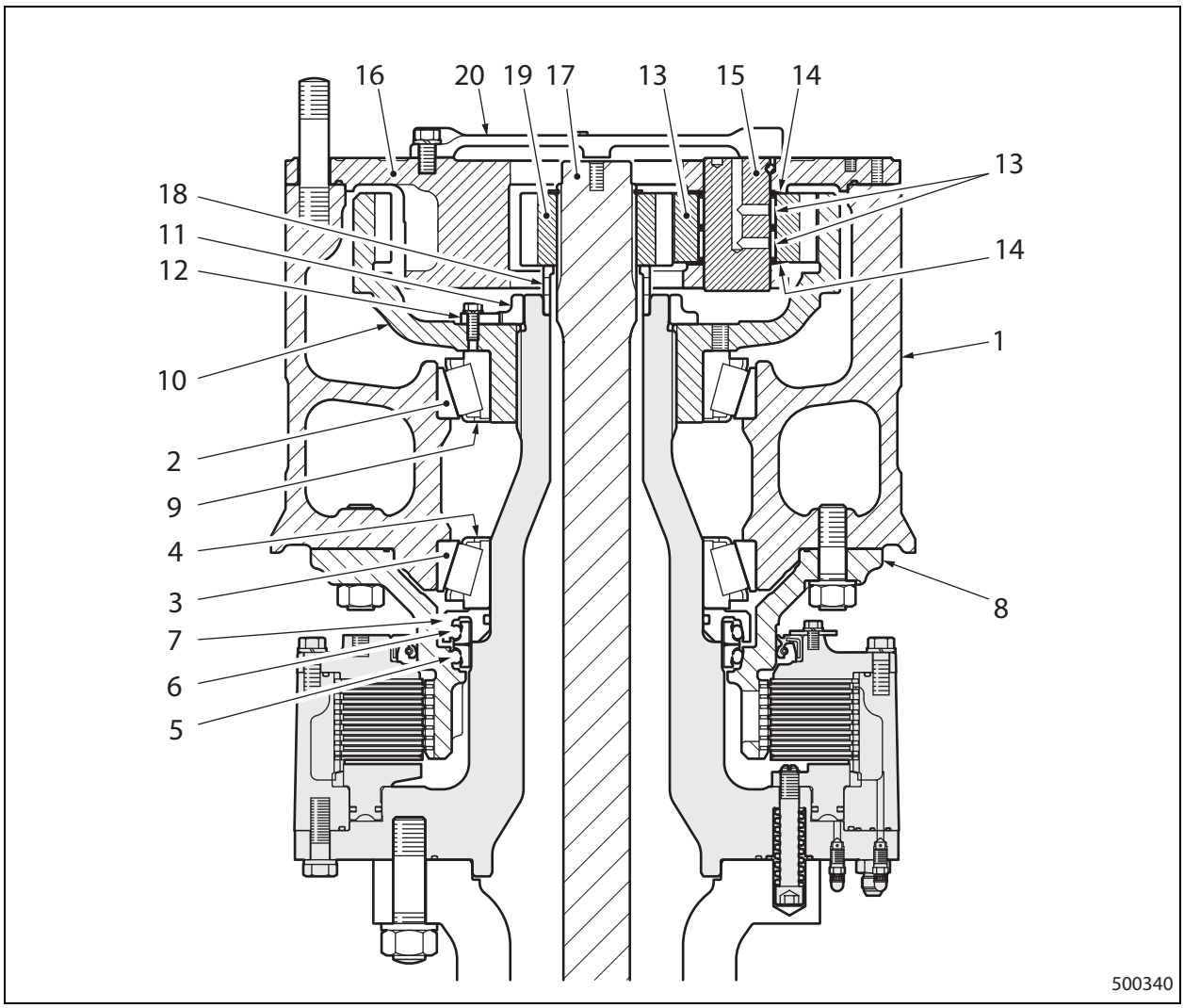
Item	Standard	limit
Inner diameter of brake drum	$420\ ^{+0.2}_{0}$ mm ($16.54\ ^{+0.01}_{0}$ in.)	424 mm (16.69 in.)

Planetary carrier

- Check the inner surface of needle bearing and the outer surface of planetary pin for wear or damage.

Item	Standard	limit
Planetary gear (bearing) inside diameter	$58\ ^{+0.029}_{+0.010}$ mm ($2.28\ ^{+0.0011}_{+0.0004}$ in.)	57.96 mm (2.2819 in.)
Planetary pin outside diameter	$58\ ^{0}_{+0.011}$ mm ($2.28\ ^{0}_{+0.0004}$ in.)	49.96 mm (1.9669 in.)

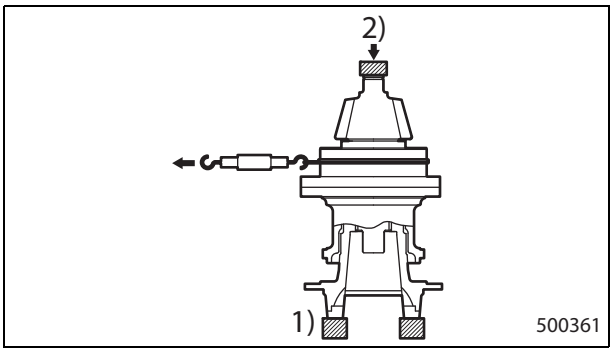
12.5 Assembly Sequence of Hub Reduction



1. Wheel hub
2. Tapered roller bearing (Outer race)
3. Tapered roller bearing (Outer race)
4. Tapered roller bearing (Inner race)
5. Floating seal
6. Floating seal
7. Seal retainer
8. Brake hub
9. Tapered roller bearing (Inner race)
10. Ring gear
11. Axle nut
12. Lockplate
13. Planetary gear, Needle roller bearing
14. Thrust washer
15. Planetary pin, Steel ball
16. Planetary carrier, O-ring
17. Axle shaft
18. Sleeve
19. Sun gear, Snapring
20. Wheel hub cover, Gasket

(3) Secure the input flange and apply a rated load on the top of the pinion.

(4) Attach a thread around the outer circumference of the bearing retainer, and pull the thread attached on the spring scale, and read the force just as the bearing retainer begins to rotate.



1) Hold 2) 5 ton

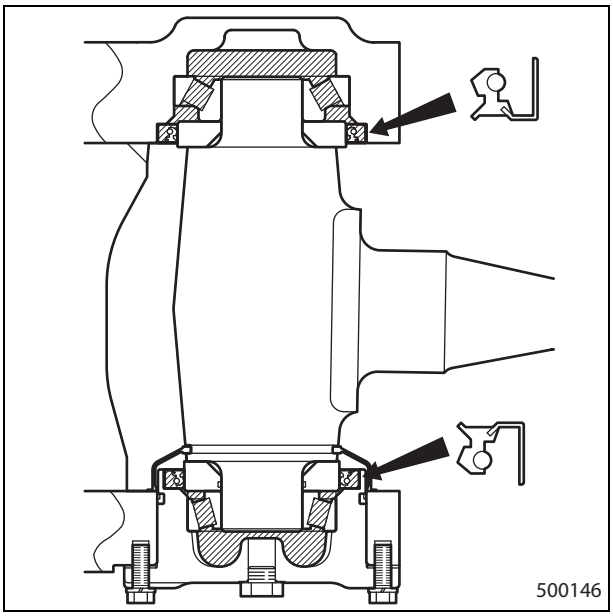
Tangential force at the circumference of bearing-retainer
30.4 to 43.1 N (3.10 to 4.39 kgf) [6.834 to 9.689 lbf]

(5) If the force applied in the tangential direction is within the specified range above, the preload also must be the specified value.

(6) If the tangential force does not meet the specified value, adjust it by means of varying the thickness of collar(s). There are 25 different varieties of collar in thickness.

Upper and lower steering knuckle supports

(1) Apply the grease specified below on each part before assembly so that the shaded area (illustration on the right) is filled with grease at the completion of assembly.



Item	Name
Grease	Idemitsu Autolex A

⚠ CAUTION

Fill the roller retainer of the tapered roller bearing with grease.

(2) Before installing upper and lower oil seals of the steering knuckle, apply grease specified below on lips.

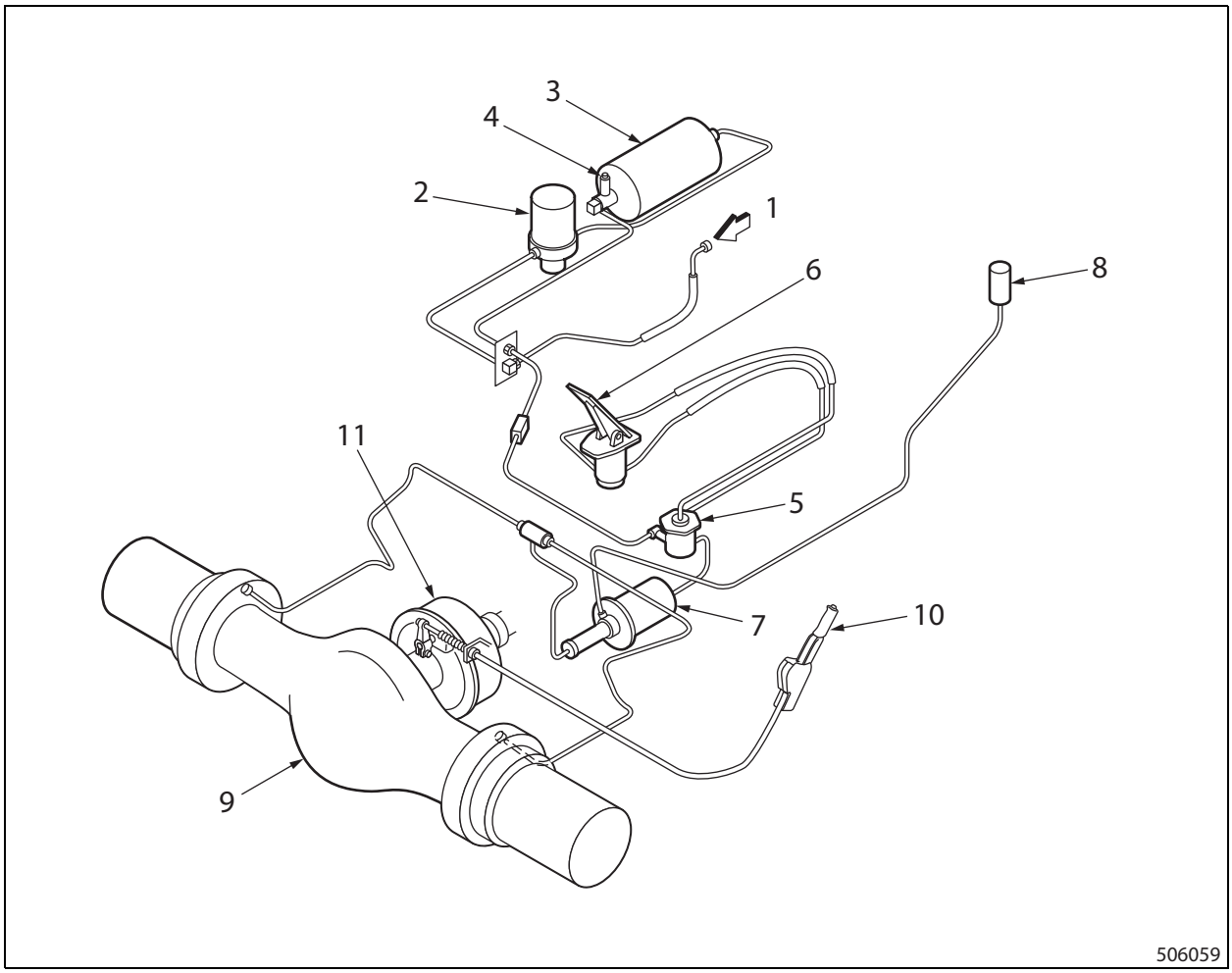
Item	Name
Grease	Idemitsu Autolex A

⚠ CAUTION

Pay attention to the orientation of oil seal for assembly. (See the above illustration in the right)

2. Structure

2.1 Outline of Wheel Brake System (Dry Brake System)

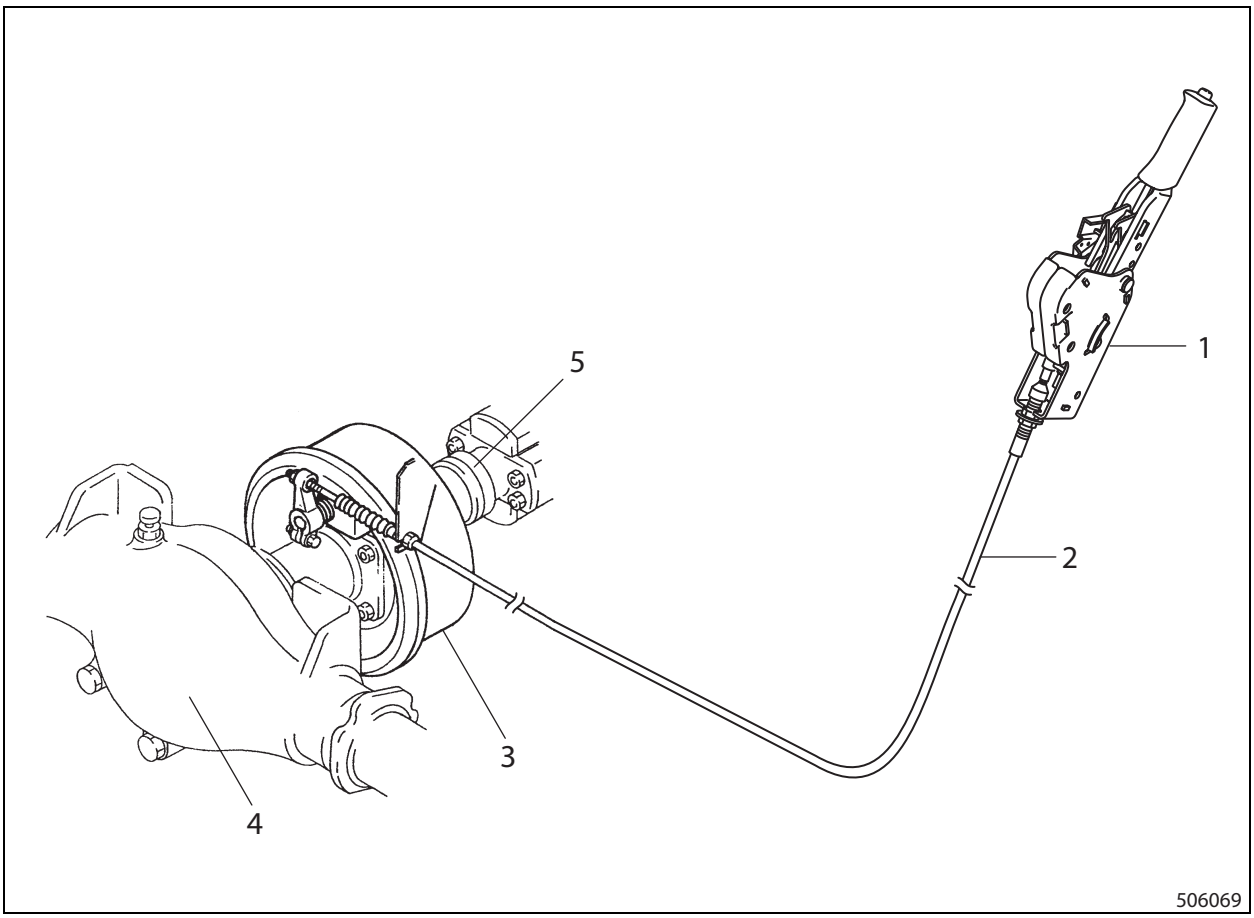


1. Air compressor
2. Air dryer
3. Air tank
4. Safety valve
5. Relay valve
6. Brake control valve
7. Air Master
8. Reserve tank
9. Front axle
10. Parking brake lever
11. Parking brake

Air compressed by the compressor is dehumidified with the air dryer, and filled in the air tank. The compressed air is open/closed and regulated with the brake control valve, and sent to the Air Master. The Air Master pressurizing brake fluid with this compressed air, and activate the wheel brakes directly connected to the front axle to bring the forklift truck to stop.

The parking brake is an internal shoe expanding drum type, controlling the drum mounted on the reduction pinion using the parking brake lever and flexible wire.

2.10 Parking Brake System

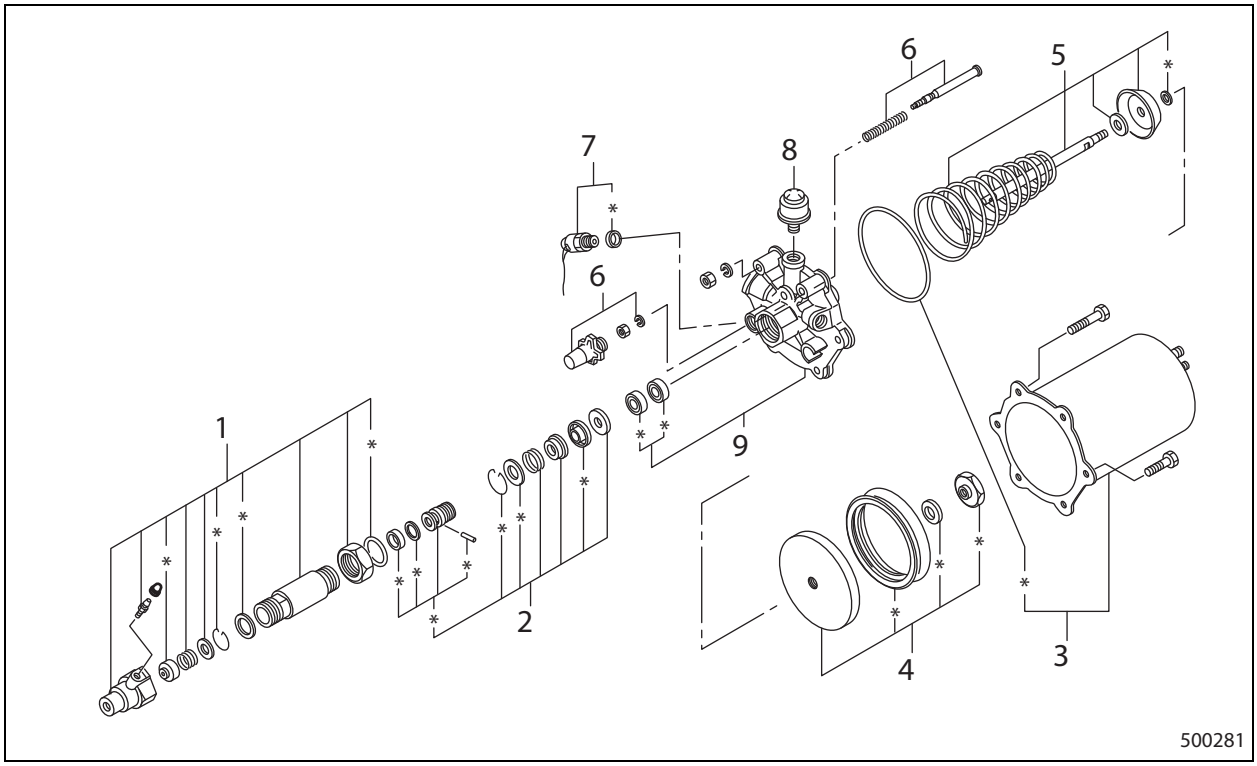


1. Parking brake lever
2. Parking brake wire
3. Parking brake drum assembly
4. Front axle
5. Universal joint

This parking brake is an internal expanding type, and the brake drum is mounted on the input flange on the front axle. The brake is applied with the parking brake lever and the flexible wire.
The main purpose of the parking brake system is preventing the forklift truck from moving at the time of parking, and it is also used as an auxiliary brake in case of brake system failure.

11. Disassembling Air Master (Dry Brake System)

11.1 Disassembly Sequence



1. Hydraulic cylinder, Outlet valve*, Cylinder cap, Plug, Spring, O-ring*, Washer, Ring*, Gasket*, Nut
2. Hydraulic piston*, Washer*, Spring, Cup packing*, Backup ring*, Straight pin*, Ring*
3. Cylinder shell, O-ring*
4. Piston plate, Rubber packing*, Washer*, Nut*
5. Push rod, Spring, Plate, Spring retainer, Gasket*
6. Rod and plate assy, Retainer, Spring
7. Switch, Shims*
8. Exhaust cover
9. End plate, Oil seal*

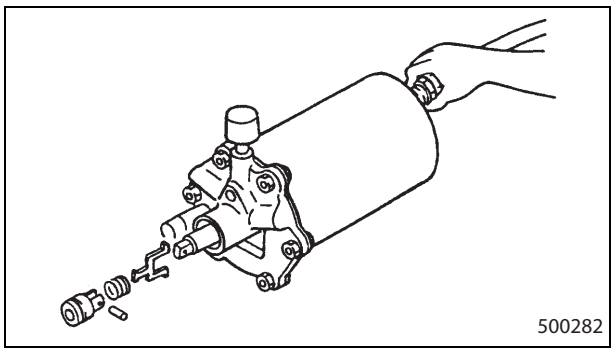
Note: Parts marked with * are contained in repair kit.

11.2 Suggestions for Disassembly

Removing hydraulic piston

(1) Apply compressed air of 558 kPa (6.0 kgf/cm2) [81.0 psi] or lower to the inlet port at the cylinder shell rear face, and protrude the push rod from the end plate.

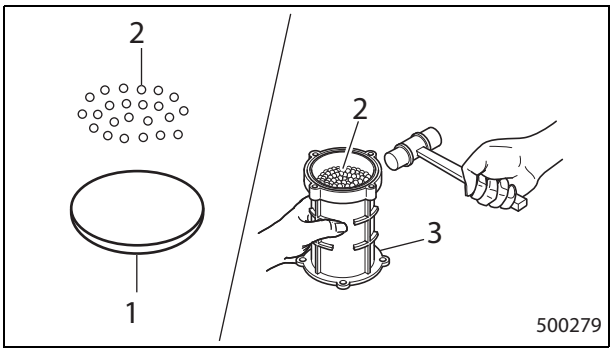
(2) Remove the pin and remove the hydraulic piston.



Cartridge assembly

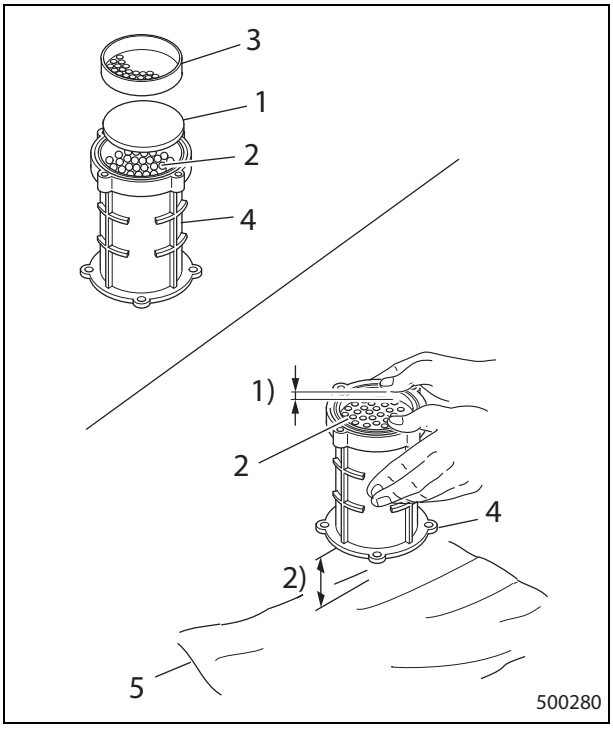
The standard weight of the desiccating agent is 200 g (7.055 oz.). Use the whole bag in the repair kit.

(1) Install the filter placing its soft side to the desiccating agent.
(2) After placing the agent in the case, tap the whole circle of the case periphery with a plastic hammer to settle the agent.



1. Filter
2. Desiccating agent
3. Case

(3) Place the soft side of filter to the desiccating agent, and place the filter plate on the case.
(4) Tap the filter as below:
- Wrap the case bottom with rag winding 2 to 3 rounds.
- Hold the filter plate and raise the case approx 100 mm (3.94 in.) from the table and let the case fall to the table.
- Repeat the tapping approx 30 times, and check the filter plate position lowered by 4 to 6 mm (0.16 to 0.24 in.) before the tapping.



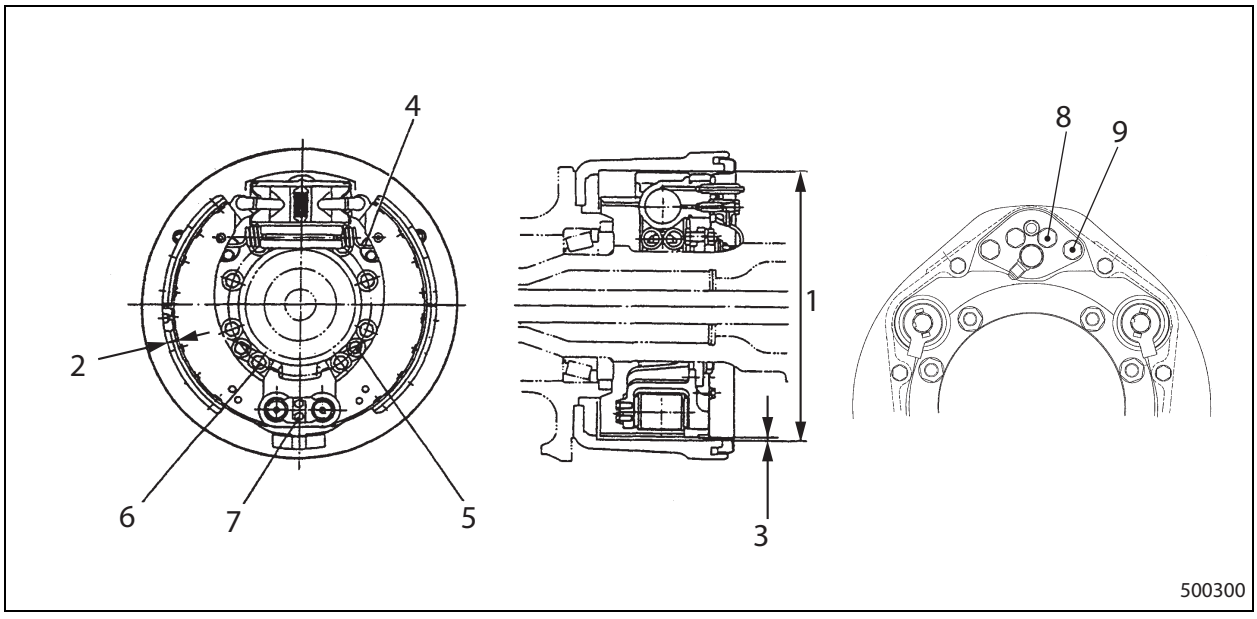
1. Filter
2. Desiccating agent
3. Filter plate
4. Case
5. Rag
1) 4 to 6 mm (0.16 to 0.24 in.)
2) 100 mm (3.94 in.)

⚠ CAUTION

Perform the tapping without fail, or the desiccating agent may flow out as powder and cause clogging in the brake system pipes, and result in malfunction of the braking system.

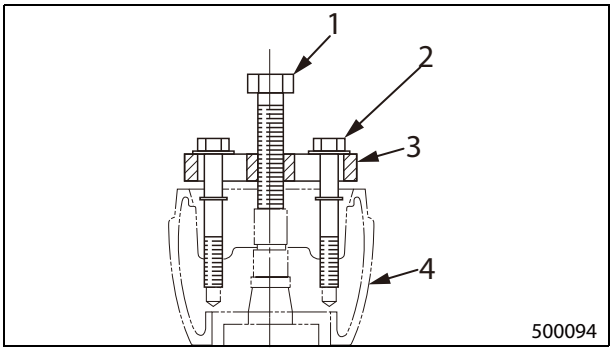
25.5 Wheel Brake (Dry Brake System)

Ref.	Item			Truck model			
				FD100N1	FD120N1	FD135N1	FD150AN1
1	Inner diameter of brake drum		Standard	420 mm (16.54 in.)			
			Limit	424 mm (16.69 in.)			
2	Lining thickness		Standard	16 mm (0.63 in.)			
			Limit	10 mm (0.39 in.)			
3	Clearance between lining and drum		Standard	0.2 mm (0.008 in.)			
4	Return spring	Free length	Standard	203.5 mm (8.012 in.)			
		Set load	Standard	423 N (43.1 kgf) [95.09 lbf]			
		Length under set load	Standard	251 mm (9.88 in.)			
5	Anchor bracket bolt (M14)		Tightening torque	155.9 N·m (15.90 kgf·m) [114.986 lbf·ft]			
6	Anchor bracket bolt (M16)		Tightening torque	233.3 N·m (23.79 kgf·m) [172.073 lbf·ft]			
7	Lockplate bolt		Tightening torque	15.7 to 23.6 N·m (1.60 to 2.41 kgf·m) [11.580 to 17.406 lbf·ft]			
8	Cylinder bolt		Tightening torque	45 to 69 N·m (4.6 to 7.0 kgf·m) [33.19 to 50.89 lbf·ft]			
9	Cylinder plate		Tightening torque	45 to 69 N·m (4.6 to 7.0 kgf·m) [33.19 to 50.89 lbf·ft]			



4.1 Removing Steering Wheel

(1) Remove the horn button.
(2) Remove the steering wheel nut and remove the steering wheel using the wheel puller.



1. M12 bolt
2. M8 bolt
3. Wheel puller
4. Steering wheel

Special tool name	Part number
Wheel puller	91268-10600

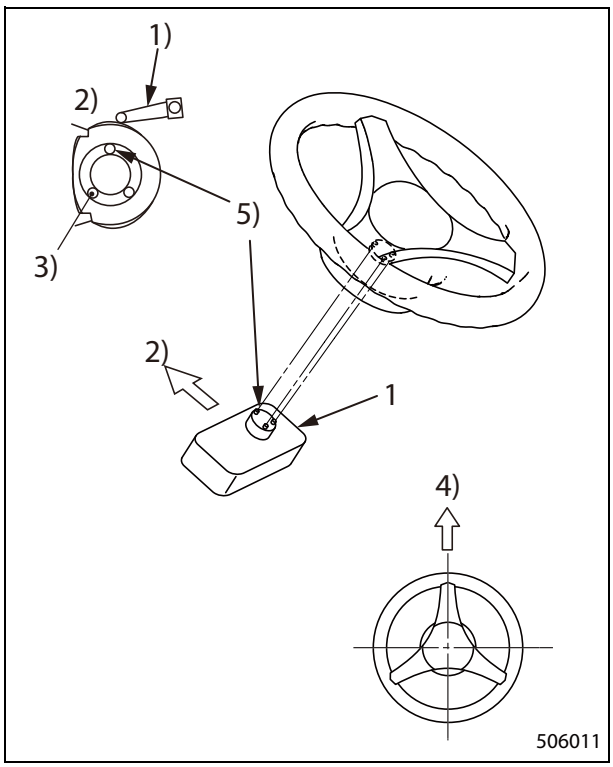
⚠ CAUTION

When removing steering wheels, DO NOT tap the top end of the steering shaft.

4.2 Installing Steering Wheel

Without knob type

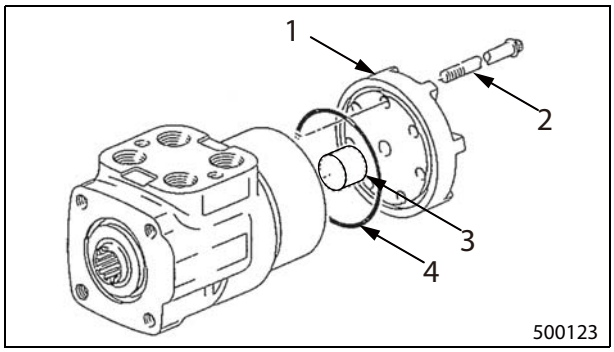
(1) Turn the protrusion on the steering wheel angle sensor of combination switch by hand to orient the direction as shown in the illustration.
(2) Apply a thin coat of grease on the sliding portion of the horn contact under the steering wheel boss.
(3) Install the steering wheel by orienting it in the straight forward traveling position. (The protrusions on the combination switch must be engaged with the notches on the steering wheel.)
Rotate the steering wheel to both directions several times to make sure the complete fit.
(4) Before tightening the steering wheel nut, make sure the automatic return of the combination switch works properly.
(5) If the automatic return does not work, repeat steps (3) and (4) above.
(6) Tighten the steering wheel nut to the specified torque.



1. Combination switch
1) Horn switch contact
2) Front
3) Protrusions form an isosceles triangle
4) Front of forklift truck
5) Protrusion

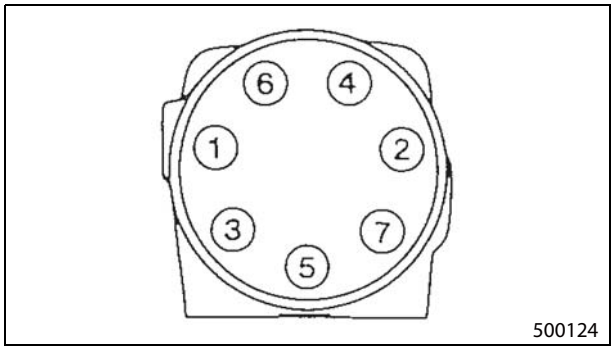
Installing end cap

Install the drive spacer **3** in the spline of rotor. Install the O-ring **4** on the end cap **1**. Place the end cap on the gerotor set and align the bolt holes.



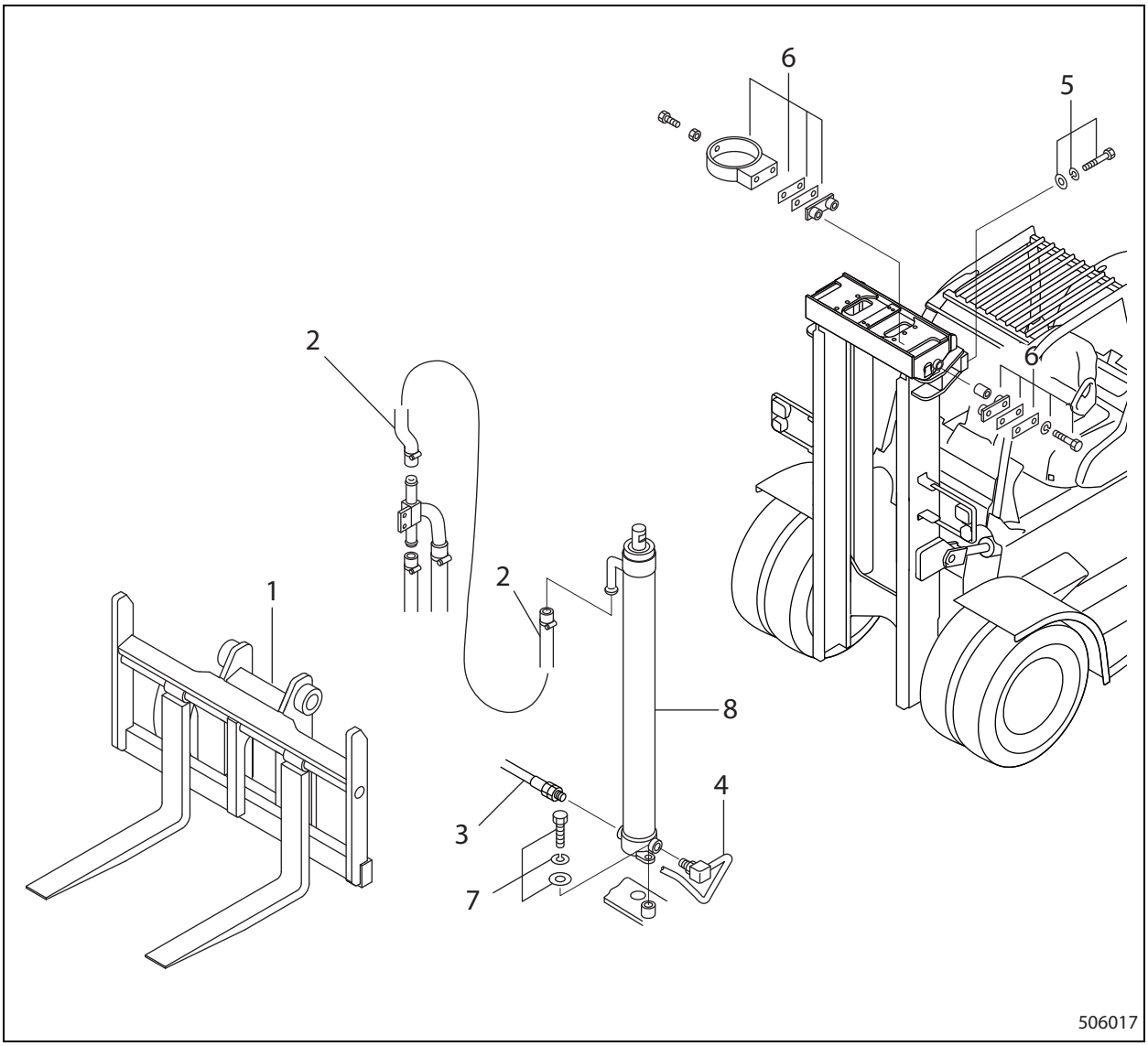
1. End cap
2. End cap screw
3. Drive spacer
4. O-ring

Apply oil on the threads of end cap screw **2**, and tighten the bolts evenly in the sequence shown in the illustration. The tightening torque is given in the table below.
Install the steering shaft in the spool and check that the spool turns smoothly.



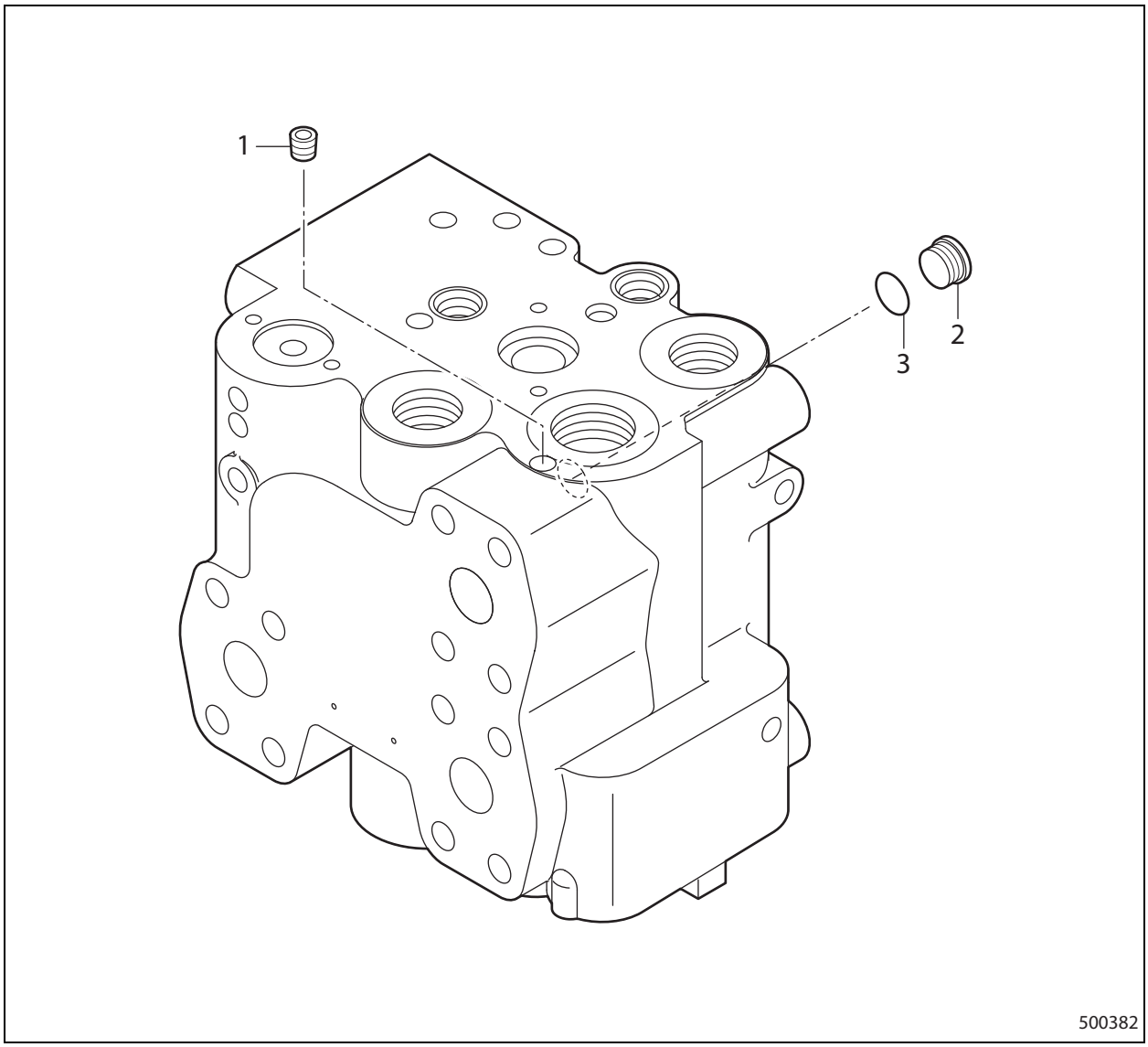
Item	Tightening torque
End cap screw	28 N·m (2.9 kgf·m) [20.65 lbf·ft]

4. Removing Lift Cylinders



1. Lift bracket
2. Return hose, Hose clamp
3. High-pressure hose
4. Synchronized pipe
5. Stopper bolt
6. Cylinder clamp, Cushion, Collar, Shims
7. Stopper bolt, Washers
8. Lift cylinder

Disassembly sequence of inlet valve assembly (part 5)



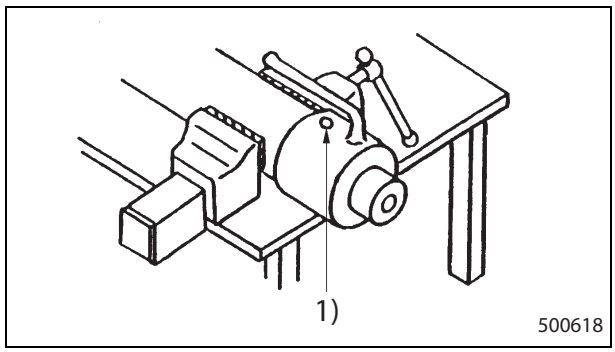
1. Tapered plug
2. Plug
3. O-ring

18.2 Suggestions for Disassembly

(1) Place the cylinder horizontally.

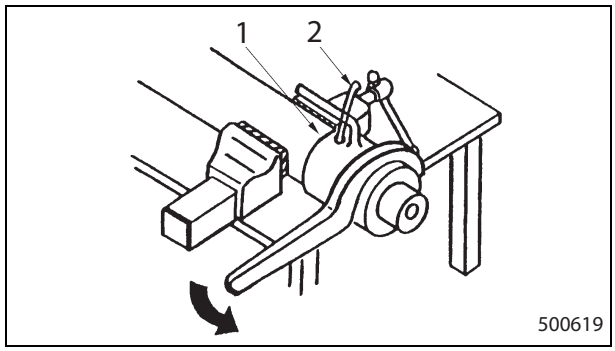
(2) Apply air pressure of 0.39 to 0.59 MPa (3.98 to 6.02 kgf/cm^2) [56.56 to 85.57 psi] to the extend port, and extend the rod to the stroke end. Then open the port to release the pressure in the cylinder.

(3) Remove the sealing compound from the rod cover stopper hole with tweezers.

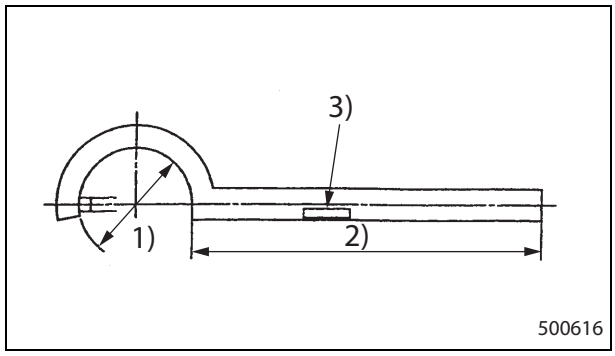


1) Stopper hole

(4) Turn the rod cover in the direction shown by arrow with the hook wrench (special tool), and remove the wire.



1. O-ring (inside) 2. Wire

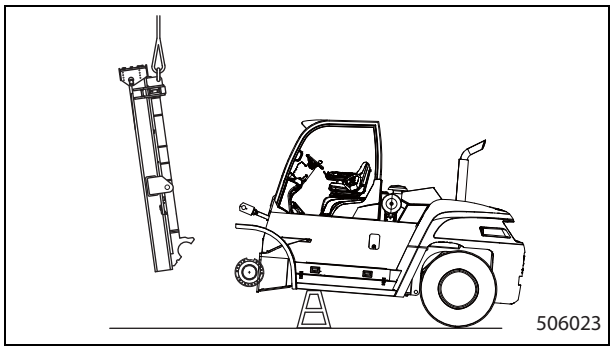


26. Troubleshooting

Condition		Possible cause	Action
Hydraulic tank	Hydraulic tank heats excessively	Not enough oil	Add
		Oil viscosity is improper	See "14. SERVICE DATA" and replace
		Overloaded due to harsh operating conditions	Check the working conditions, and if overloaded, urge the operator to stay within the load limit
		Line clogged, which generates a restriction to oil line flow and causes local overheating	Clean oil line
		Relief valve is improperly adjusted	Adjust set pressure
		Gear pump is worn	Replace pump
		Clog due to flattened outlet pipe or tube, etc.	Repair or replace
		Clogged oil cooler	Clean
	Cylinders move too slow	Shortage of oil due to a natural loss	See "14. SERVICE DATA" and refill oil
		Oil leaks due to damaged oil line, seals, etc.	Repair or replace
		Oil viscosity is too high	See "14. SERVICE DATA" and replace
Gear pump	Cylinders move too slow	Gear pump does not suck oil	Inspect pump and piping, repair or replace
		Oil leaks from part of the hydraulic line	Check the oil level and contamination. Add or change oil if necessary
		Oil level rises to an abnormal high level	Check control valve spools for misalignment. Repair or replace
		Oil leaks inside of gear pump	Replace pump
	Pump is too noisy	Poor pumping of oil	See "14. SERVICE DATA" and refill oil
		Cavitation	Check suction pipe for any flat portion or loose connection. Retighten or replace if necessary
			Check shaft oil seal for air-tightness. Replace Pump
			Check pump body for any outside interference, repair
	Pump case, drive gear or pump port flange is damaged	Pressure exceeds the rating	Replace pump (check if pressure control valve had been working at rated valve)
		Distortion or damage due to external strain or stress	Replace pump
			Check if return line has been blocked or excessively restricted
			Check if pipe connection has been externally strained or stressed
	Oil leaks from pump	Oil leaks from oil seal	Replace seal
		Oil leaks through sliding surfaces of drive shaft	Replace pump assembly
		Bolts that secure the pump are loosened	Retighten. Replace parts if required
		Seal inside pump is deteriorated	Replace O-ring

Separating tilt cylinders

(1) Attach lifting jigs and wire ropes to the right and left lifting holes at the top of crossmember and lift with hoist.

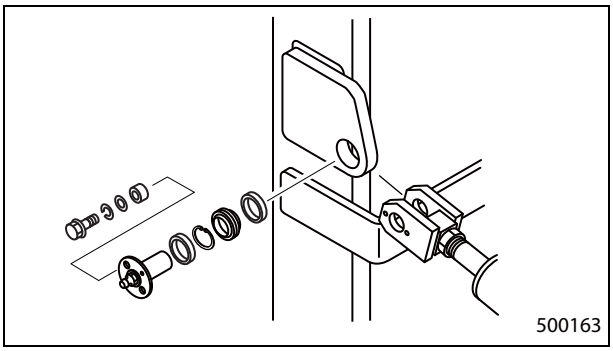


⚠ WARNING

When removing and installing the mast assembly with a hoist, be sure to use a hoist with enough capacity.

Truck model	Mast weight
FD100N1	1995 kg (4398.2 lb.)
FD120N1	1995 kg (4398.2 lb.)
FD135N1	2100 kg (4629.7 lb.)
FD150AN1	2320 kg (5114.7 lb.)
FD160AN1	2515 kg (5544.6 lb.)

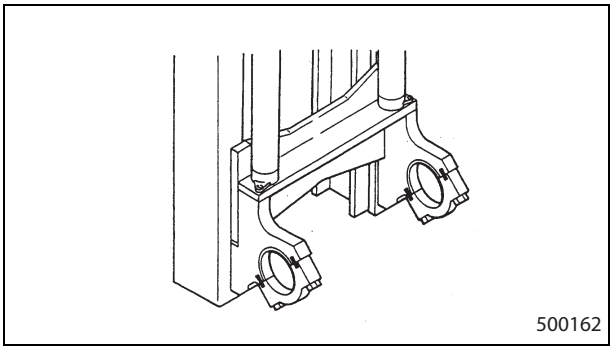
(2) Remove the tilt pin and separate the tilt cylinder from the mast.



Removing mast support bearing cap

(1) Make a matchmark on each cap.
(2) Remove the cap mounting bolts and separate the whole mast assembly by lifting it up from the forklift truck.
(3) Place the mast on level ground with the lift bracket side facing upward.

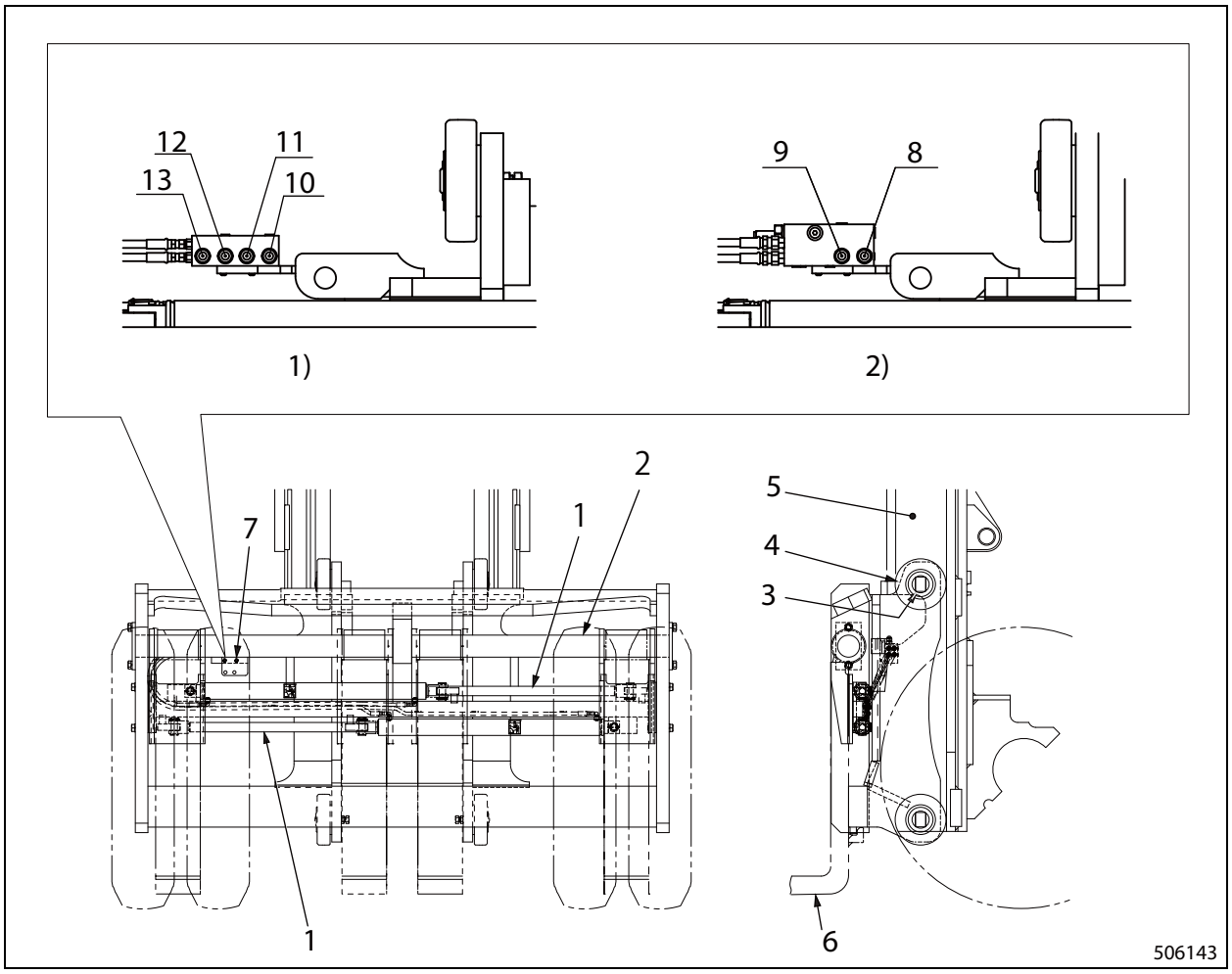
Note: Lay the mast on level ground spacious enough to slide the mast for the disassembly work.



9. Service Data

Item				FD100N1	FD120N1	FD135N1	FD150AN1	FD160AN1
Fork and chain	Difference of height at blade tips		Standard value	5 mm (0.20 in.) or less				
	Chain elongation (mm/20 links)		Standard value	889 mm (35.00 in.)			1016 mm (40.00 in.)	
			Limit value	915 mm (36.02 in.)			1046 mm (41.18 in.)	
	Nut of chain anchor bolt		Tightening torque	393 ± 39.3 N·m (40.1 ± 4.01 kgf·m) [289.86 ± 28.986 lbf·ft]			441 ± 44.1 N·m (45.0 ± 4.50 kgf·m) [325.26 ± 32.526 lbf·ft]	
Rollers	Main roller outside diameter	S	Standard value	203 mm (7.99 in.)				
		M	Standard value	205 mm (8.07 in.)				
		L	Standard value	207 mm (8.15 in.)				
	Side roller outside diameter		Standard value	$58\ ^{0}_{-0.1}$ mm ($2.28\ ^{0}_{-0.004}$ in.)				
Outer mast and inner mast	Smallest inner width of outer mast	1)	Standard value	$890\ ^{+0.5}_{-1.0}$ mm ($35.04\ ^{+0.02}_{-0.04}$ in.)			$884\ ^{+0.5}_{-1.0}$ mm ($34.80\ ^{+0.02}_{-0.04}$ in.)	
		2)	Standard value	$890\ ^{+1.0}_{-0.5}$ mm ($35.04\ ^{+0.039}_{-0.020}$ in.)			$884\ ^{+1.0}_{-0.5}$ mm ($34.80\ ^{+0.039}_{-0.020}$ in.)	
	Smallest inner width of inner mast	3)	Standard value	$704\ ^{+0.5}_{-1.0}$ mm ($27.72\ ^{+0.02}_{-0.04}$ in.)			$692\ ^{+0.5}_{-1.0}$ mm ($27.24\ ^{+0.02}_{-0.04}$ in.)	
		4)	Standard value	$704\ ^{+1.0}_{-0.5}$ mm ($27.72\ ^{+0.039}_{-0.020}$ in.)			$692\ ^{+1.0}_{-0.5}$ mm ($27.24\ ^{+0.039}_{-0.020}$ in.)	
	Clearance between main roller and rolling face (whole lifting stroke)	5)	Standard value	0.5 to 2.8 mm (0.020 to 0.110 in.)				
	Clearances between side roller and rolling surfaces K (at the maximum height)	6)	Standard value	0.5 to 1.5 mm (0.020 to 0.059 in.)				
	Clearance between mast strap and sliding face	7)	Standard value	0.5 to 1.5 mm (0.020 to 0.059 in.)				
	Thickness of mast strip		Standard value	9 mm (0.35 in.)				
			Limit value	7 mm (0.28 in.)				
Tilt cylinder	Locknut		Tightening torque	1334 to 1468 N·m (136.0 to 149.7 kgf·m) [983.91 to 1082.74 lbf·ft]				1618 to 1780 N·m (165.0 to 181.5 kgf·m) [1193.38 to 1312.86 lbf·ft]

3. Structure



1. Fork positioner cylinders
2. Fork guide bar
3. Side roller
4. Main roller
5. Mast
6. Forks
7. Piping
8. Forks outward
9. Forks inward
10. Left fork outward
11. Left fork inward
1. Right fork outward
12. Right fork inward

1) Piping for simultaneous fork positioner
2) Piping for individual fork positioner

- The fork positioner is an attachment that enables the outside fork spread to be adjusted stepless from the minimum position to the maximum position.
- The spread of the forks must be changed depending on the sizes of loads to ensure the stability of load.
- The hydraulic fork positioner can smoothly adjust the fork position using hydraulic cylinders.
- The fork positioner must be adjusted before picking up a load, as it cannot be adjusted while carrying the load on the fork.
- The fork positioner cylinder is mounted between the fork bracket and the lift bracket, and the extending and retracting movements of the cylinder slide the fork blades sideways.
- The right and left blades are independently adjustable.
  In the case of the simultaneous move type, one attachment lever operates the right and left blades simultaneously. In the case of the independent move type, two attachment levers operate the right and left blades independently.

3. Periodic Replacement Parts

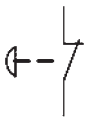
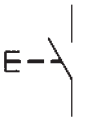
The safety critical parts (marked with *) and elements for safe operation listed below must be replaced at every designated replacement period.

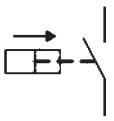
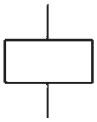
If a malfunction is found on these parts, correct or replace immediately, regardless of scheduled replacement period.

No.	Periodic Replacement Parts	Replacement period			Remarks
		Year	Month	Service hours	
1	* Rubber parts for brake master cylinder	1		2000	
2	* Rubber parts for brake wheel cylinder	1		2000	
3	* Brake booster repair kit	1		2000	
4	* Brake valve repair kit	1		2000	
5	* Rubber parts for wet type disk brake	1		2000	
6	* Brake hose	2		2000	
7	* Rubber parts for spring chamber	1		2000	
8	* Stop light switch (air type)	2		4000	
9	* Tubes for brake reservoir tank	2		2000	
10	* High pressure hoses for loading/unloading operation	2		2000	
11	* Rubber parts for power steering cylinder	2		4000	
12	* Power steering hose	2		4000	
13	* Lift chain	2		4000	
14	* Fuel hoses	2		4000	
15	Engine oil filter element		3	500	Also 1 month after delivery
16	Primary fuel filter element		3	500	Also 1 month after delivery
17	Secondary fuel filter element		3	500	Also 1 month after delivery
18	Torque converter oil filter		6	1000	Also 1 month after delivery
19	Transmission suction strainer		6	1000	Also 1 month after delivery
20	Hydraulic suction strainer	1		2000	
21	Hydraulic tank return filter		6	1000	Also 1 month after delivery
22	Air cleaner element	1		500	Clean every 2 weeks.
23	Engine cooling water	2		3000	
24	Air dryer desiccant	1		2000	
25	Crankcase breather element			1500	

Note: Replace the parts every specified period: year, month, or service hour, whichever comes first. Time units are enclosed in parentheses.

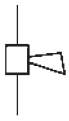
(6) Switches, control, and protective devices

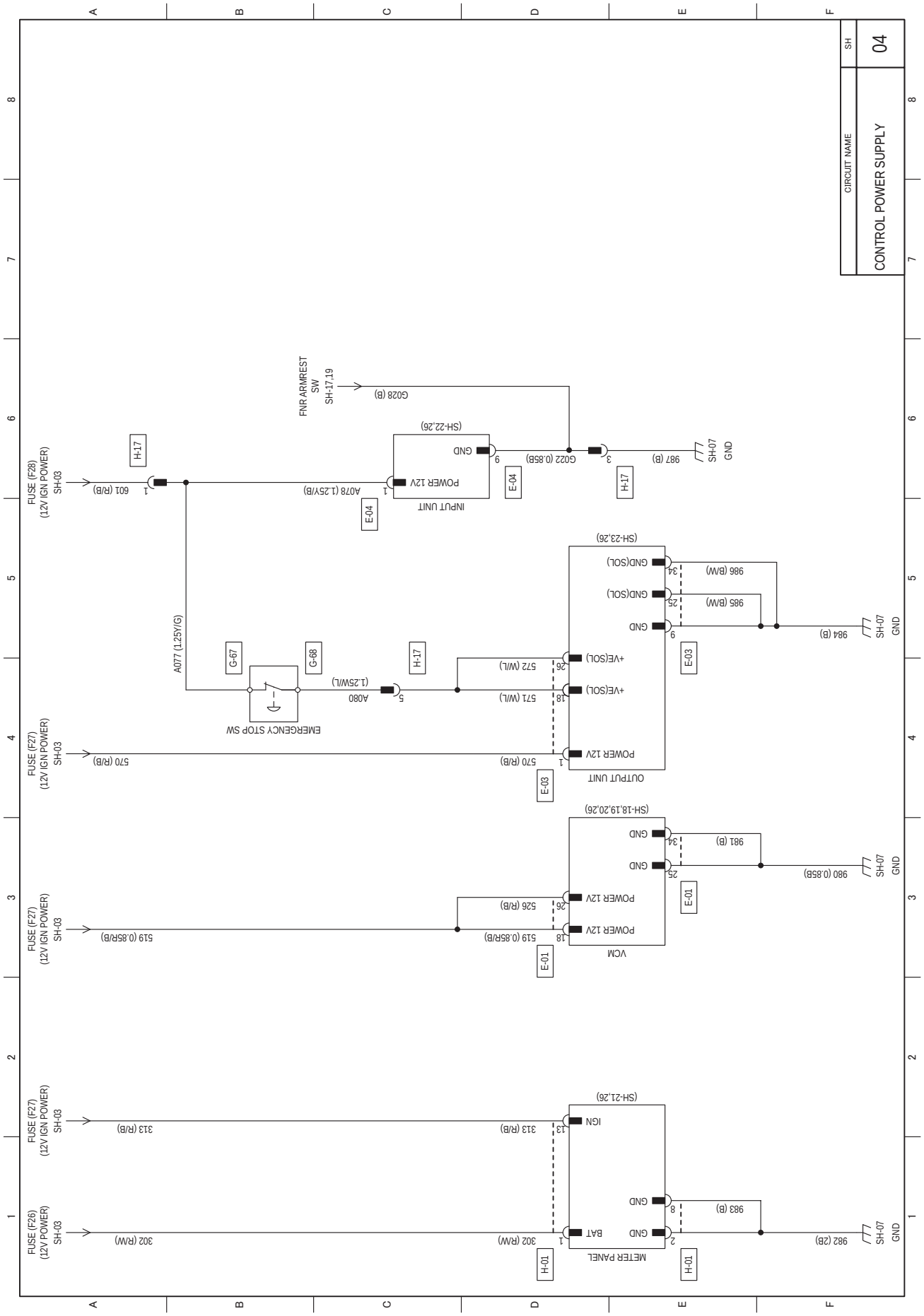
Symbol	Name
	Switch (N.O)
	Switch (N.C)
	Two position switch
	Emergency switch
	Push button switch
	Switch (Auto return)

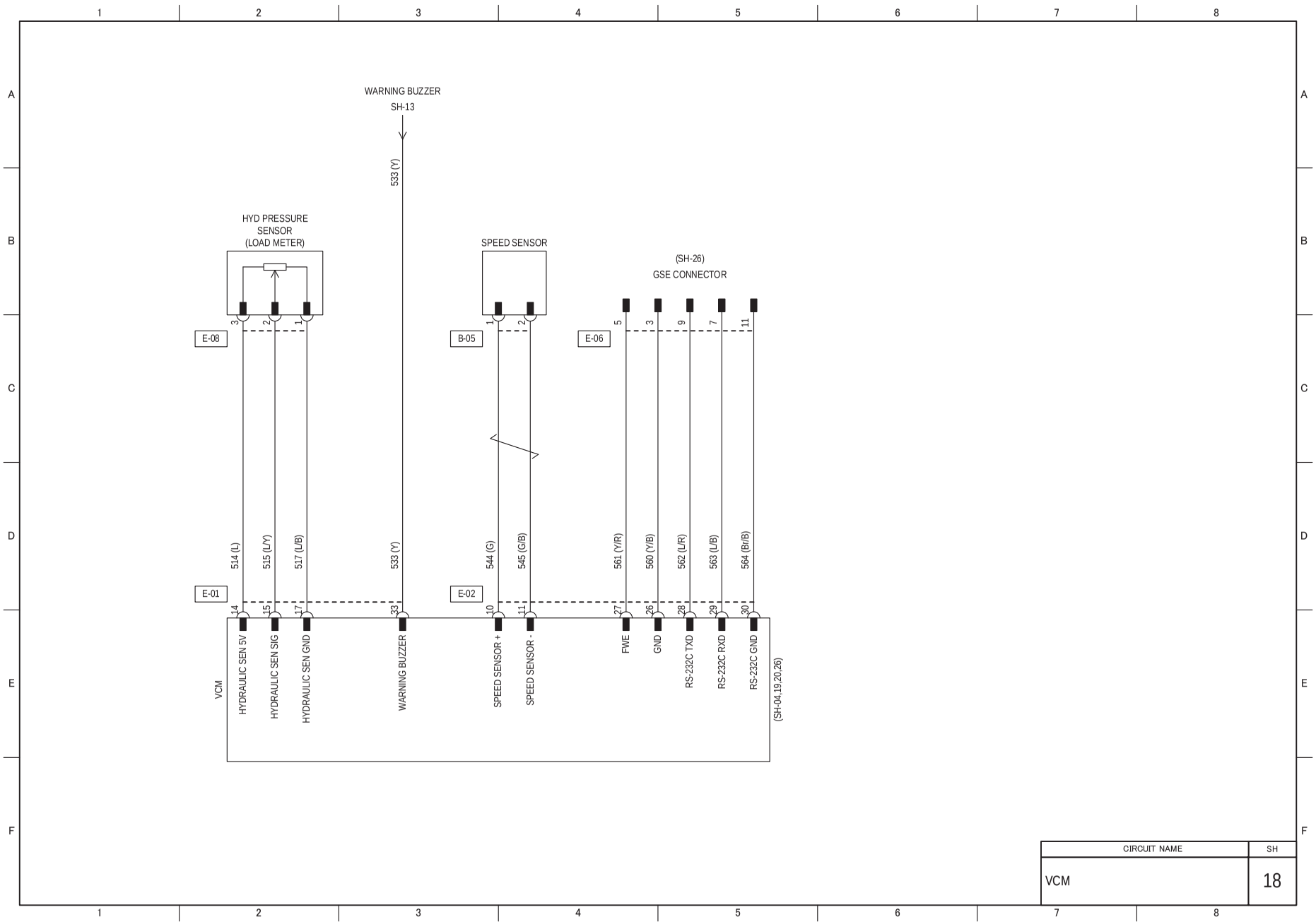
Symbol	Name
	Oil pressure switch
	Magnetic contactor
	Fuse
	Thermistor
	Magnetic coil
	Proximity sensor

(7) Indicators, lamps, and signal devices

Symbol	Name
	Lamp
	Buzzer

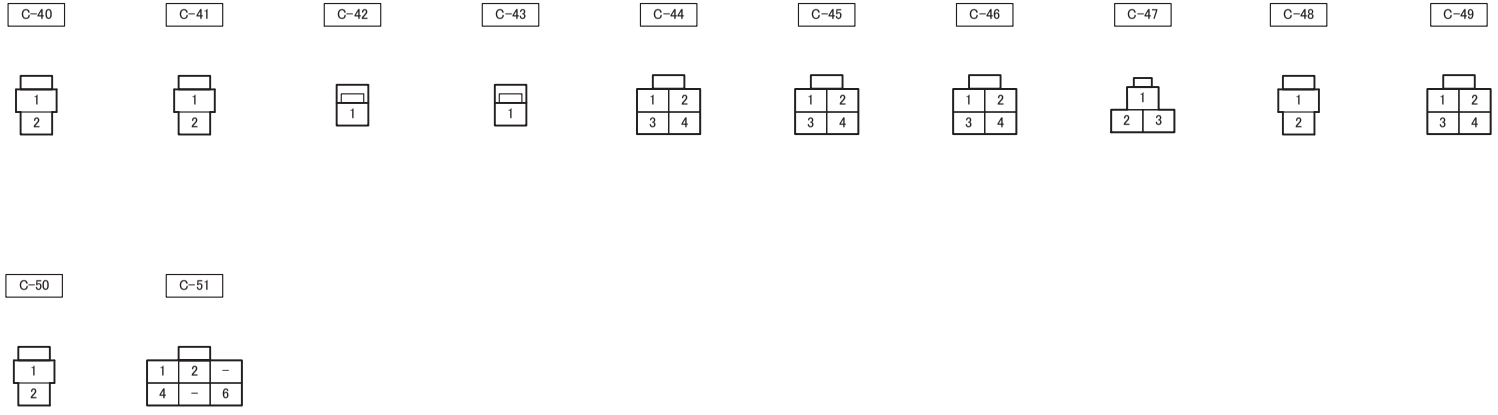
Symbol	Name
	Horn


CIRCUIT NAME
CONTROL POWER SUPPLY
SH
04
FUSE (F28)
(12V IGN POWER)
SH-03
601 (R/B)
A078 (1.25Y/B)
INPUT UNIT
(SH-22,26)
GND
POWER 12V
G022 (0.85B)
987 (B)
SH-07
GND
FNR ARMREST
SW
SH-17,19
G028 (B)
H-17
E-04
FUSE (F27)
(12V IGN POWER)
SH-03
570 (R/B)
OUTPUT UNIT
(SH-23,26)
+VE(SOL)
GND(SOL)
571 (W/L)
572 (W/L)
A080 (1.25W/L)
A077 (1.25Y/G)
EMERGENCY STOP SW
G-67
G-68
E-03
984 (B)
985 (B/W)
986 (B/W)
FUSE (F27)
(12V IGN POWER)
SH-03
519 (0.85R/B)
VCM
(SH-18,19,20,26)
526 (R/B)
980 (0.85B)
981 (B)
E-01
FUSE (F27)
(12V IGN POWER)
SH-03
313 (R/B)
IGN
FUSE (F26)
(12V POWER)
SH-03
302 (R/W)
BAT
METER PANEL
(SH-21,26)
982 (2B)
983 (B)
H-01

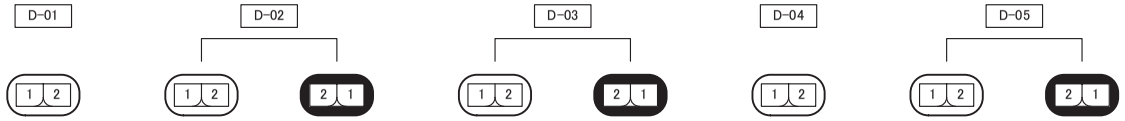


CIRCUIT NAME	SH
VCM	18

GROUP C



GROUP D

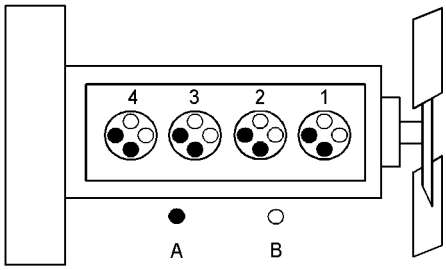


CIRCUIT NAME	SH
CONNECTOR	33

Specifications Section

i03907589

Engine Design



g01335181

Illustration 1

Cylinder and valve location

(A) Exhaust valve
(B) Inlet valve

Bore ..... 105 mm (4.133 inch)

Stroke ..... 127 mm (5.000 inch)

Displacement ..... 4.4 L (269 in^3)

Cylinder arrangement ..... In-line

Type of combustion ..... Direct injection

Compression ratio

Turbocharged engines and turbocharged charge cooled engines 16.2:1

Number of cylinders 4

Valves per cylinder 4

Firing order 1, 3, 4, 2

When the crankshaft is viewed from the front of the engine, the crankshaft rotates in the following direction: ..... Clockwise

The front of the engine is opposite the flywheel end. The left side and the right side of the engine are viewed from the flywheel end. The No. 1 cylinder is the front cylinder.

i04136796

Fuel Injection Lines

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

Refer to Operation and Maintenance Manual, “General Hazard Information and High Pressure Fuel Lines” before adjustments and repairs are performed.

NOTICE

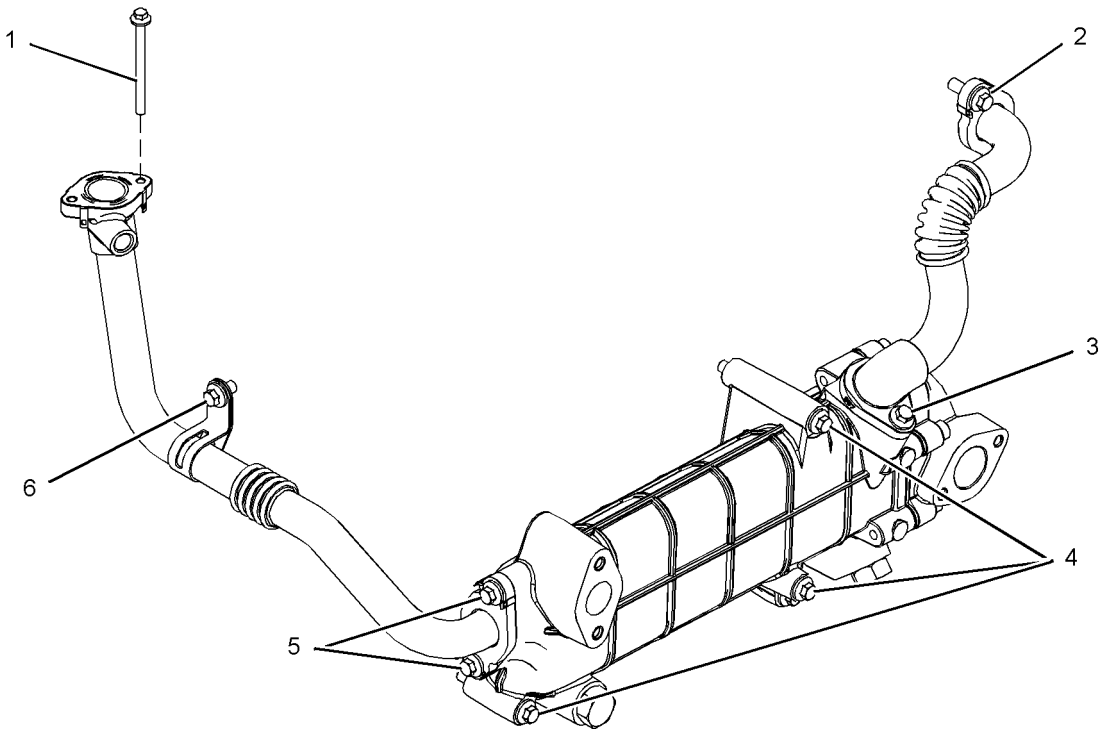
Refer to Systems Operation, Testing, and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Ensure that all adjustments and repairs are performed by authorized personnel that have had the correct training.

i04138514

Exhaust Cooler (NRS)

Note: When the pipes for the exhaust cooler are removed or installed, care must be taken so that the pipes are not bent or the pipes are not damaged.



g02337136

Illustration 40

Typical example

(1) Tighten the bolts to the following torque. ... 9 N·m (80 lb in)

(2) Tighten the bolts to the following torque. .. 22 N·m (16 lb ft)

(3) Tighten the bolts to the following torque. .. 22 N·m (16 lb ft)

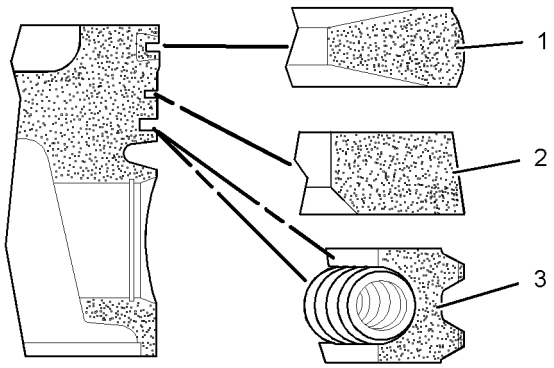
(4) Tighten the bolts to the following torque. .. 22 N·m (16 lb ft)

(5) Tighten the bolts to the following torque. .. 22 N·m (16 lb ft)

(6) Tighten the bolt to the following torque. ... 22 N·m (16 lb ft)

i04041471

Piston and Rings



g01155119

Illustration 71

Typical example

(1) Top compression ring

The shape of the top compression ring ..... Keystone

Ring gap ..... 0.30 to 0.40 mm (0.01181 to 0.01575 inch)

Note: When you install a new top compression ring, make sure that the word “TOP” is facing the top of the piston. New top piston rings have a black identification mark. The identification mark must be on the left of the ring end gap when the top piston ring is installed on an upright piston.

(2) Intermediate compression ring

The shape of the intermediate compression ring ..... Internal bevel in the bottom edge with a tapered face

Width of intermediate compression ring .... 2.47 to 2.495 mm (0.0972 to 0.0982 inch)

The clearance between a new intermediate compression ring and the piston groove in a new piston ..... 0.065 to 0.110 mm (0.00256 to 0.00433 inch)

Ring gap ..... 0.65 to 0.85 mm (0.0256 to 0.0335 inch)

Note: When you install a new intermediate compression ring, make sure that the word “TOP” is facing the top of the piston. New intermediate rings have a blue identification mark. The identification mark must be on the left of the ring end gap when the top piston ring is installed on an upright piston.

(3) The oil control ring

Width of oil control ring ..... 2.97 to 2.99 mm (0.1169 to 0.1177 inch)

The clearance between a new oil control ring and the groove in a new piston ..... 0.03 to 0.07 mm (0.0011 to 0.0027 inch)

Ring gap ..... 0.30 to 0.55 mm (0.0118 to 0.0216 inch)

Note: When you install a new oil control ring, make sure that the word “TOP” is facing the top of the piston. New oil control rings have a red identification mark. The identification mark must be on the left of the ring end gap when the top piston ring is installed on an upright piston. The oil control ring is a two-piece ring that is spring loaded. A pin is used in order to hold both ends of the spring of the oil control ring in position. The ends of the spring of the oil control ring must be installed opposite the end gap of the oil control ring.

Note: Ensure that the ring end gaps of the piston rings are spaced 120 degrees from each other.

Piston

Note: An arrow which is marked on the piston crown must be toward the front of the engine.

Piston height above cylinder block .. 0.55 to 0.20 mm (0.02165 to 0.00787 inch)

Width of top groove in the piston ..... Tapered

Width of second groove in new piston ..... 2.56 to 2.58 mm (0.1008 to 0.1016 inch)

Width of third groove in new piston .. 3.02 to 3.04 mm (0.1189 to 0.1197 inch)

Piston pin

Diameter of a new piston pin ..... 39.694 to 39.700 mm (1.5628 to 1.5630 inch)

i03907009

Air Compressor (Twin Cylinder Compressor)

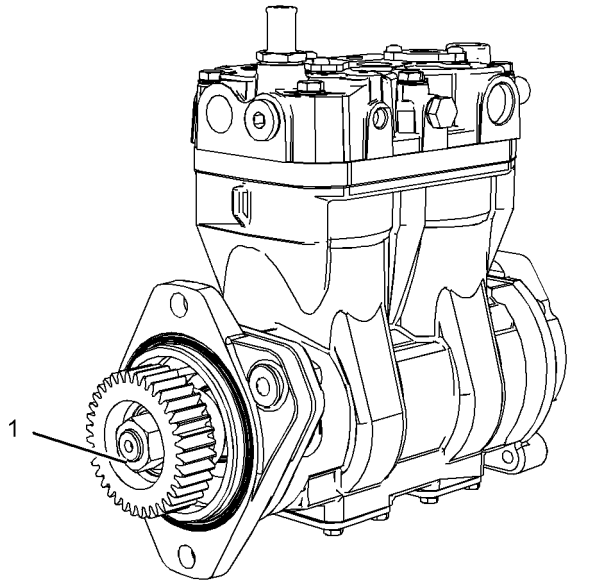


Illustration 105 g02148379
Typical example

(1) Tighten the nut to the following torque. .. 120 N·m (89 lb ft)

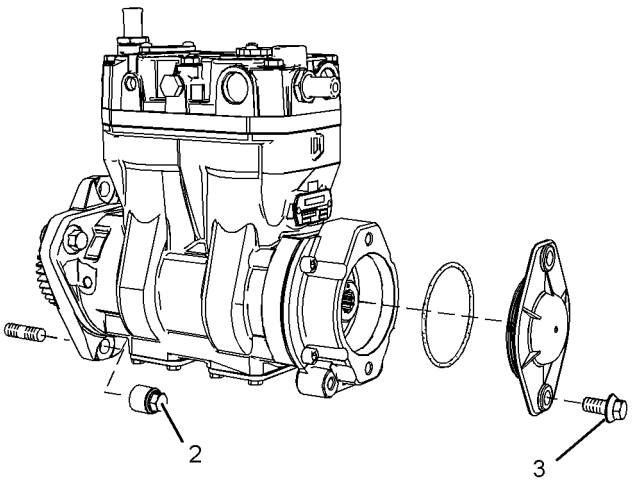


Illustration 106 g02148380
Typical example

(2) Tighten the nuts to the following torque. .. 78 N·m (58 lb ft)

(3) Tighten the bolts to the following torque. .. 16 N·m (12 lb ft)

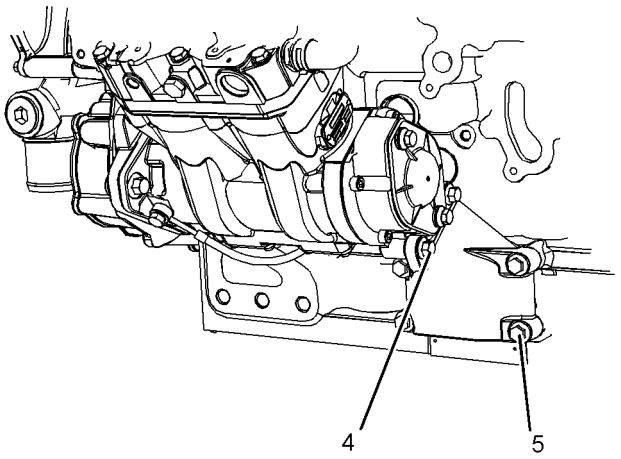


Illustration 107 g02148381
Typical example

(4) Tighten the bolts to the following torque. .. 22 N·m (16 lb ft)

(5) Tighten the bolts to the following torque. .. 44 N·m (32 lb ft)

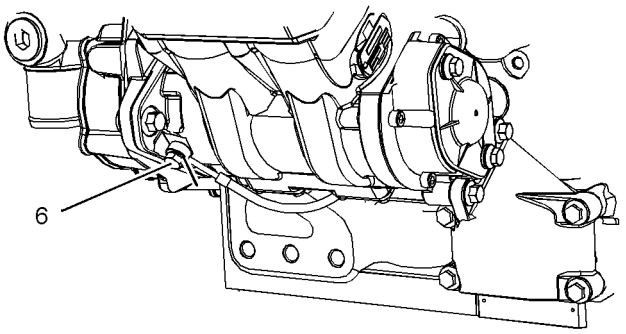


Illustration 108 g02148408
Typical example

(6) Tighten the banjo bolt to the following torque. ..... 9 N·m (80 lb in)

For the correct procedure to install the air compressor, refer to Disassembly and Assembly, “Air Compressor - Remove and Install - Twin Cylinder Compressor”.

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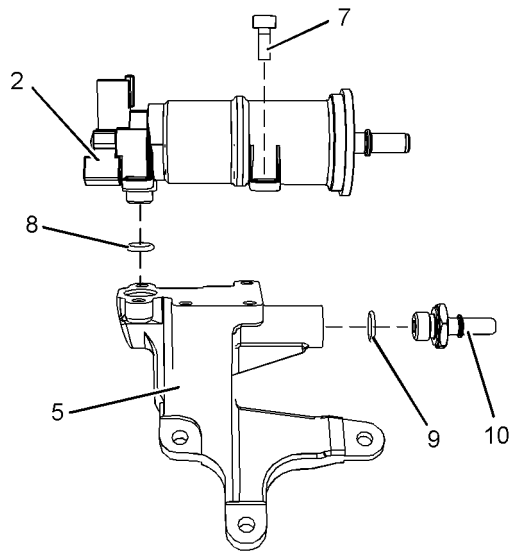


Illustration 2 g02485838

9. If necessary, follow Step 9.a through Step 9.d in order to remove fuel priming pump (2) from bracket (5).

a. Remove allen head screws (7) from fuel priming pump (2).

b. Remove fuel priming pump (2) from bracket (5).

c. Remove O-ring seal (8).

d. If necessary, remove connection (10) from bracket (5). Remove O-ring seal (9) from connection (10).

Installation Procedure

NOTICE

Ensure that all adjustments and repairs that are carried out to the fuel system are performed by authorized personnel that have the correct training.

Before beginning ANY work on the fuel system, refer to Operation and Maintenance Manual, "General Hazard Information and High Pressure Fuel Lines" for safety information.

Refer to System Operation, Testing and Adjusting, "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

1. Ensure that the fuel priming pump is clean and free from wear and damage. If necessary, replace the fuel priming pump.

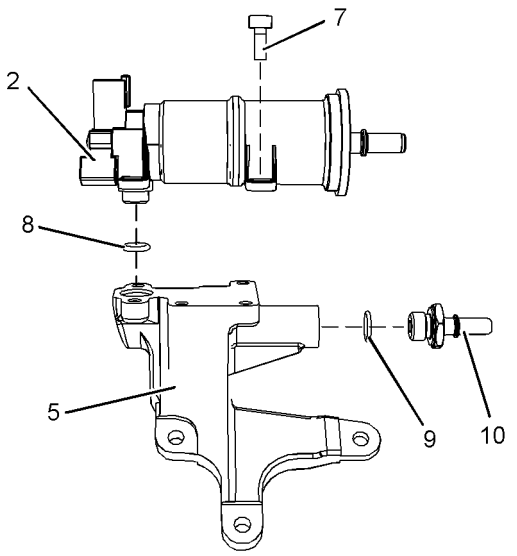


Illustration 3 g02485838

2. If necessary, follow Step 2.a through Step 2.d in order to install fuel priming pump (2) from bracket (5).

a. If necessary, install a new O-ring seal (9) to connection (10). Install connection (10) to bracket (5). Tighten the connection to a torque of 20 N·m (177 lb in).

b. Install a new O-ring seal (8) to fuel priming pump (2).

c. Position fuel priming pump (2) onto bracket (5).

Note: Ensure that the fuel priming pump is correctly located onto the bracket.

d. Install new allen head screws (7). Tighten the allen head screws to a torque of 9 N·m (80 lb in).

i04494469

Relief Valve (Fuel) - Remove and Install

Removal Procedure

Table 6

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	92G67-01100	Cap Kit	1

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

NOTICE

Ensure that all adjustments and repairs that are carried out to the fuel system are performed by authorized personnel that have the correct training.

Before beginning ANY work on the fuel system, refer to Operation and Maintenance Manual, "General Hazard Information and High Pressure Fuel Lines" for safety information.

Refer to System Operation, Testing and Adjusting, "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

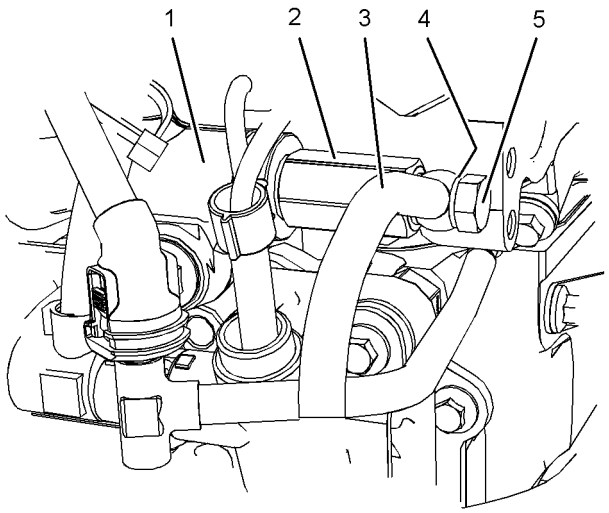


Illustration 30 g02673936

Typical example

1. Thoroughly clean the area around fuel manifold (1) and fuel pressure relief valve (2).
2. Remove banjo bolt (5) and remove sealing washers (4) (not shown).
3. Position plastic tube assembly (3) away from fuel pressure relief valve (2). Use Tooling (A) in order to immediately cap the open port in fuel pressure relief valve (2) with a new cap. Tooling (A) in order to immediately plug the open end of plastic tube assembly (3) with a new plug.
4. Follow Step 4.a through Step 4.c in order to remove the fuel pressure relief valve from the fuel manifold.
   a. Ensure that the area around the fuel pressure relief valve (2) and fuel manifold (1) is still thoroughly clean.
   b. Use a deep socket in order to remove the fuel pressure relief valve (2) from fuel manifold (1).
   c. Use Tooling (A) in order to immediately plug the open port in fuel manifold (1). Use Tooling (A) in order to immediately cap the fuel pressure relief valve (2).

Installation Procedure

Table 7

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	92G67-01200	Degree Wheel	1

5. Position a new gasket (22) (not shown) and a new gasket (26) (not shown) onto tube assembly (23).

6. Position tube assembly (23) onto the exhaust cooler and the inlet air control. Install bolts (20) and bolts (25) to tube assembly (23).

7. Install bolt (24) to clamp on tube assembly (23).

8. Tighten bolts (20) to a torque of 9 N·m (80 lb in).

Tighten bolts (25) to a torque of 18 N·m (159 lb in).

Tighten bolt (24) to a torque of 22 N·m (195 lb in).

9. Connect wiring harness assembly (17) to engine wiring harness assembly (19). Slide locking tab (18) into the locked position.

10. Install new cable straps (21) to wiring harness assembly (17).

Note: Ensure that the cable straps meet the specification of Truck's Service Manual.

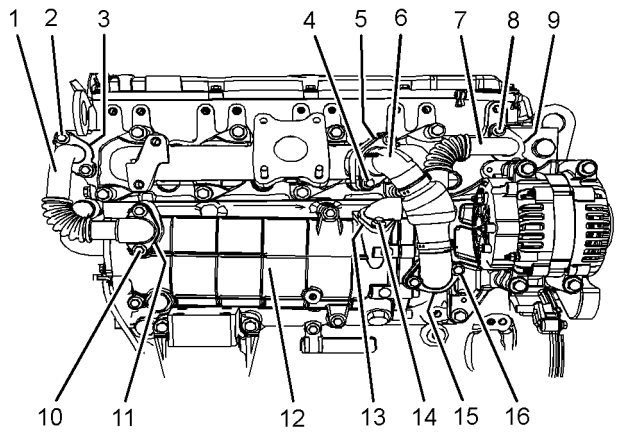


Illustration 59 g02477077

11. Position a new gasket (3) (not shown) and a new gasket (11) (not shown) onto tube assembly (1).

12. Install tube assembly (1) to exhaust cooler (12) and the cylinder head.

13. Install bolts (2) and bolts (10) to tube assembly (1).

14. Tighten bolts (10) to a torque of 18 N·m (159 lb in).

Tighten bolt (2) to a torque of 22 N·m (195 lb in).

15. Position a new gasket (9) (not shown) and install a new O-ring seal (13) (not shown) onto tube assembly (7).

Note: Do not lubricate the O-ring seal.

16. Position tube assembly (7) onto exhaust cooler (12) and the cylinder head. Install bolts (8) and bolt (14) to tube assembly (7). Ensure that the tube assembly is correctly positioned into the exhaust cooler.

17. Tighten bolt (14) to a torque of 18 N·m (159 lb in).

Tighten bolts (8) to a torque of 22 N·m (195 lb in).

18. Position a new gasket (5) (not shown) and a new gasket (15) (not shown) onto tube assembly (6).

19. Position tube assembly (6) onto exhaust cooler (12) and the exhaust manifold.

20. Install new bolts (4) and new bolts (16) to tube assembly (6).

21. Tighten bolts (4) and bolts (16) to a torque of 22 N·m (195 lb in).

22. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change” for the correct procedure.

End By:

a. Install the first stage turbocharger for twin turbocharged engine. Refer to Disassembly and Assembly, “Turbocharger (First Stage Turbocharger) - Install” for the correct procedure.

b. Install the second stage turbocharger for twin turbocharged engine. Refer to Disassembly and Assembly, “Turbocharger (Second Stage Turbocharger) - Install” for the correct procedure.

Note: Ensure that the ends of the fuel injection line are seated in the electronic unit injector and the fuel manifold. Tighten the nuts finger tight.

13. Use Tooling (A) to tighten Torx screw (12) to a torque of 27 N·m (239 lb in).

14. Use Tooling (E) to tighten the fuel injection line to a torque of 40 N·m (30 lb ft). Refer to Disassembly and Assembly, “Fuel Injection Lines - Install” for the correct procedure.

15. Use a deep socket to install harness assembly (6) to electronic unit injector (8). Use Tooling (F) to tighten connections (7) to a torque of 2.0 N·m (18 lb in).

16. If necessary, repeat Step 1 through Step 15 in order to install the remaining electronic unit injector.

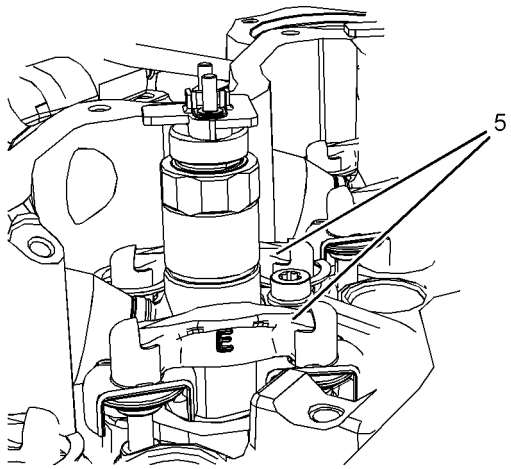


Illustration 85 g01973093

The correct location of valve bridges

NOTICE
Failure to ensure that ALL valve bridges are correctly seated onto the valve stems will cause interference between the pistons and the valves, resulting in damage to the engine.

17. Install valve bridges (5) to the cylinder head.

Note: Ensure that used valve bridges are reinstalled in the original location and the original orientation. Do not interchange the location or the orientation of used valve bridges.

18. Install the rocker shaft assembly. Refer to Disassembly and Assembly, “Rocker Shaft - Install” for the correct procedure.

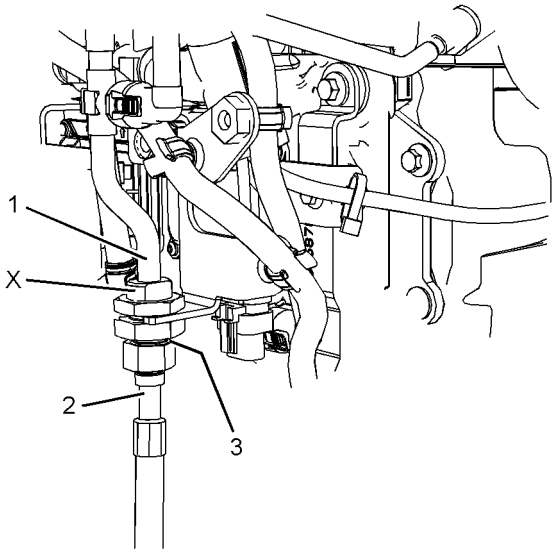


Illustration 86 g02475251

19. Remove cap from tube assembly (1). Install a new O-ring seal (3) (not shown) to tube assembly (1).

20. Remove cap from hose assembly (2). Install hose assembly (2) to tube assembly (1).

21. Use a suitable tool in order to hold tube assembly (1) in Position (X). Tighten nut for hose assembly(2) to a torque of 43 N·m (32 lb ft).

22. Turn the fuel supply to the ON position.

23. Turn the battery disconnect switch to the ON position.

24. Remove the air from the fuel system. Refer to Operation and Maintenance Manual, “Fuel System - Prime” for the correct procedure.

i04485906

Turbocharger - Remove (First Stage Turbocharger)

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

End By:

a. Install the exhaust elbow from the second stage turbocharger. Refer to Disassembly and Assembly, “Exhaust Elbow - Remove and Install” for the correct procedure.

i04485915

Wastegate Solenoid - Remove and Install

Removal Procedure

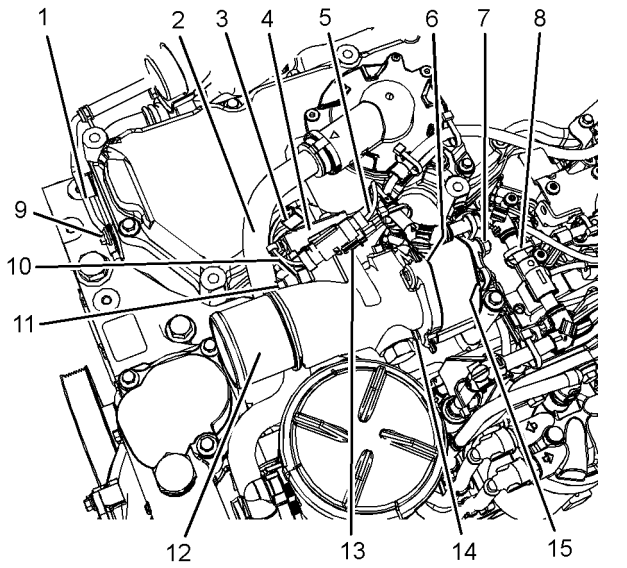


Illustration 116 g02522557

1. If the Diesel Particulate Filter (DPF) assembly is mounted on the valve mechanism cover, removal of the DPF assembly will be necessary in order to access the wastegate solenoid. Refer to Disassembly and Assembly, “Diesel Particulate Filter - Remove” for the correct procedure.

2. Loosen hose clamps and remove hose assembly from connection (12).

3. Remove plastic tube assembly (2) from the valve mechanism cover and the crankcase breather canister.

4. Slide locking tab (13) into the unlocked position. Disconnect harness assembly (5) from the harness assembly for wastegate solenoid (3).

5. Slide the harness assembly for wastegate solenoid (3) from bracket (4).

6. Remove bolts (9) from tube assembly (1).

7. Remove banjo bolt (11) and remove sealing washers (10) (not shown).

8. Cut cable straps (8) from harness assembly (5). Position harness assembly (5) away from NRS induction mixer.

9. Remove nut (7) and bolts (14).

10. Remove the assembly of inlet connection (12) from the NRS induction mixer assembly.

11. Remove gasket (6) (not shown) and gasket (15) (not shown).

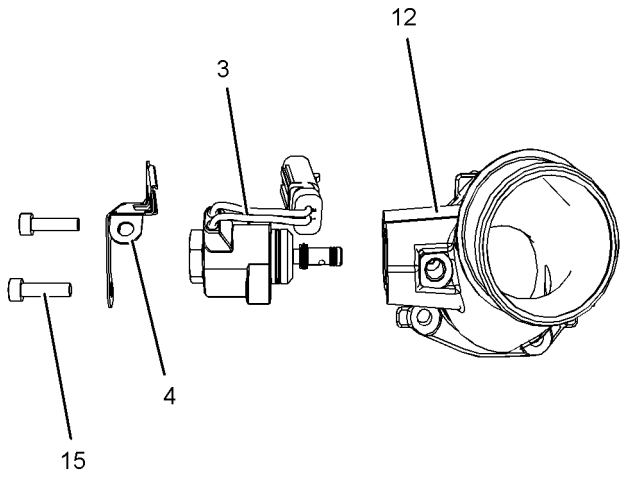


Illustration 117 g02522558

12. Remove allen head bolts (15) from wastegate solenoid (3). Remove bracket (4).

13. Remove wastegate solenoid (3) from inlet connection (12).

14. Plug inlet connection (12) and cap wastegate solenoid (3) with new plugs and caps.

Installation Procedure

Table 17

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Delphi Lockheed Rubber Grease	1

NOTICE
Ensure that the wiring harness assembly is correctly routed and the cable straps are not over tightened. Over tightening of the cable straps will damage the wiring harness and the convoluting.

Note: If the V-band clamp (4) remain tight on the flanges, apply releasing fluid on the V-band clamps in order to assist removal. Lightly tap the bolts on the V-band clamps with a soft faced hammer in order to assist removal. **Do not use a prybar in order to remove V-band clamps.**

2. Remove V-band clamp (4) from turbocharger (5) and exhaust elbow (2).

3. Remove bolts (3) and spacers. Remove exhaust elbow (2) from turbocharger (5).

Note: Support the weight of the exhaust elbow as the bolts are removed.

Installation Procedure

Table 22

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Anti-Seize Compound	1

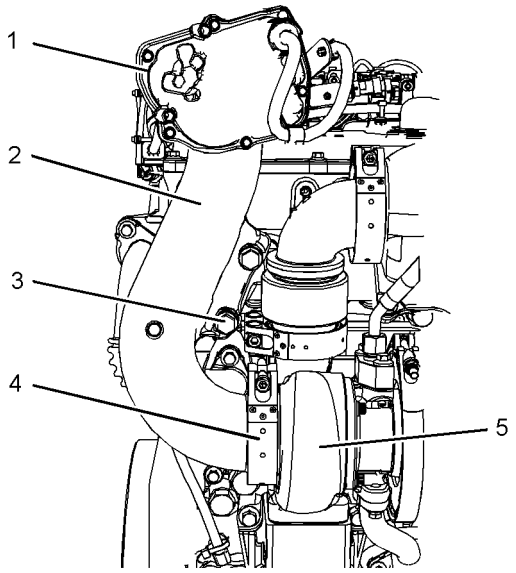


Illustration 146 g02476565

1. Ensure that the exhaust elbow and the outlet of the turbocharger are free from damage. Replace any components that are damaged.

2. Use Tooling (A) to lubricate the threads of the allen head bolt for V-band clamp (4).

3. Loosely position V-band clamp (4) onto turbocharger (5).

4. Position exhaust elbow (2) onto turbocharger (5). Install V-band clamp (4) onto exhaust elbow (2) and hand tighten the allen head bolt on the V-band clamp.

Note: Support the weight of the exhaust elbow as the V-band clamp is installed.

5. Install the spacers and bolts (3) hand tight. Ensure that exhaust elbow (2) is correctly positioned onto turbocharger (5) and is correctly aligned.

6. Tighten the allen head bolt for V-band clamp (4) to a torque of 12 N·m (106 lb in).

7. Tighten bolts (3) to a torque of 44 N·m (32 lb ft).

End By:

a. Install the exhaust back pressure valve to the exhaust elbow. Refer to Disassembly and Assembly, “Exhaust Back Pressure Valve - Remove and Install” for the correct procedure.

i04485849

Exhaust Elbow - Remove and Install (Top Mounted and Side Mounted Turbocharger Exhaust Elbow)

Removal Procedure

Start By:

a. Remove the exhaust back pressure valve from the exhaust elbow. Refer to Disassembly and Assembly, “Exhaust Back Pressure Valve - Remove and Install” for the correct procedure.

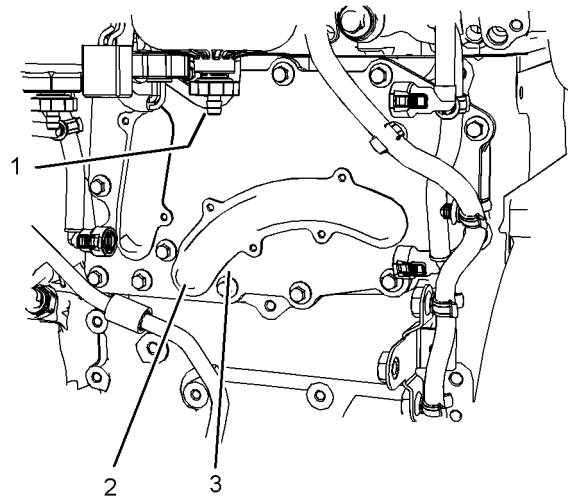


Illustration 173 g02475489

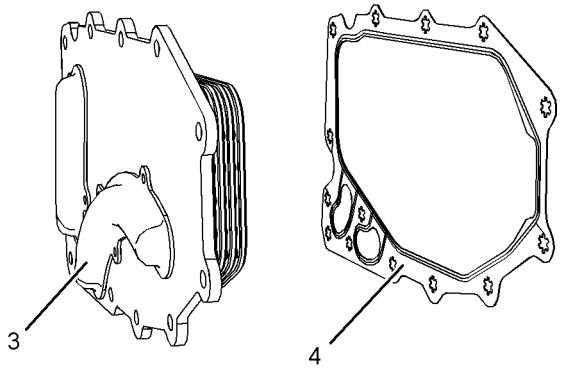


Illustration 174 g02475493

2. Remove spacer (1) (not shown) from the cylinder block.

3. Remove bolt (2) from the assembly of engine oil cooler (3).

Note: Support the engine oil cooler as the bolts are removed.

4. Remove the assembly of engine oil cooler (3) from the cylinder block.

5. Remove gasket (4) from engine oil cooler (3).

i04485836

Engine Oil Cooler - Install

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

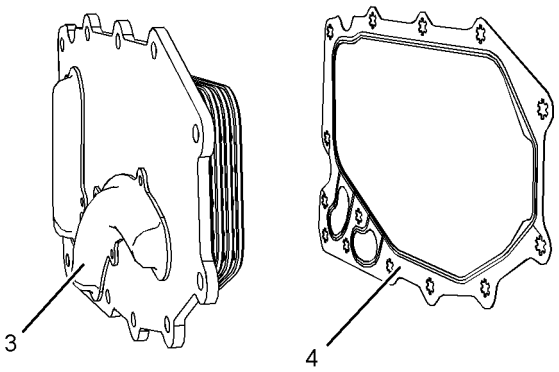


Illustration 175 g02475493

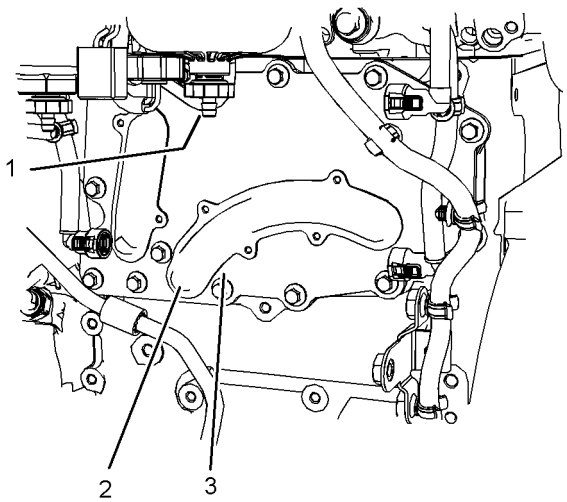


Illustration 176 g02475489

1. Ensure that engine cooler (3) is clean and free from damage. Ensure that the engine oil cooler is free from restriction.

2. Position a new gasket (3) onto engine oil cooler (2).

3. Push bolts (1) through the holes in the gasket.

2. Install Tooling (A) into Position (X) on flywheel housing (1).

3. Install a suitable lifting device to the flywheel housing in order to support the flywheel housing. The flywheel housing can weigh 40 kg (88 lb).

4. Remove bolts (2) and remaining bolts (3) from flywheel housing (1).

5. Use a suitable lifting device in order to remove flywheel housing (1) from the cylinder block.

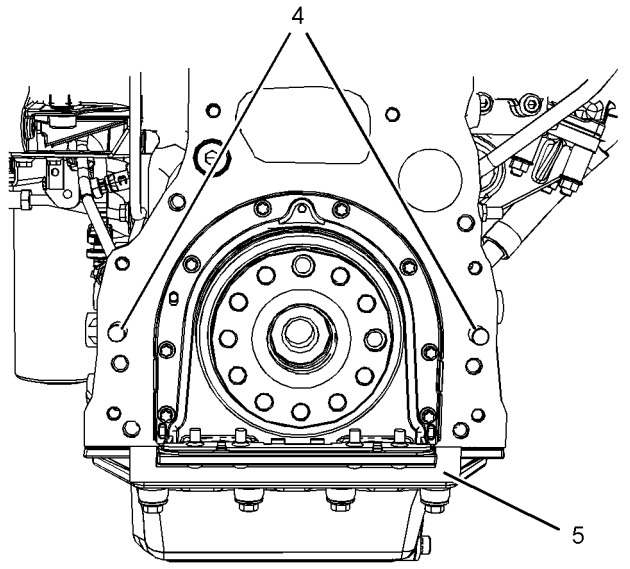


Illustration 207 g01983533

Typical example

6. Remove dust seal (5).

7. If necessary, remove dowels (4) from the cylinder block.

Installation Procedure (Standard Housing)

Table 36

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud M10 by 100 mm	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the flywheel housing is clean and free from damage. If necessary, replace the flywheel housing.

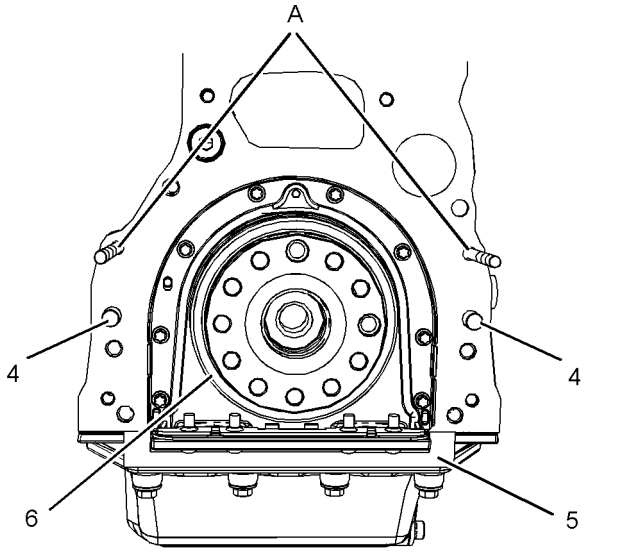


Illustration 208 g01983535

Typical example

2. Inspect crankshaft rear seal (6) for leaks. If there are any oil leaks, replace the crankshaft rear seal. Refer to Disassembly and Assembly, “Crankshaft Rear Seal - Remove” and refer to Disassembly and Assembly, “Crankshaft Rear Seal - Install” for the correct procedure.

3. Clean the rear face of the cylinder block. If necessary, install dowels (4) to the cylinder block.

4. Install Tooling (A) to the cylinder block.

5. Install dust seal (5).

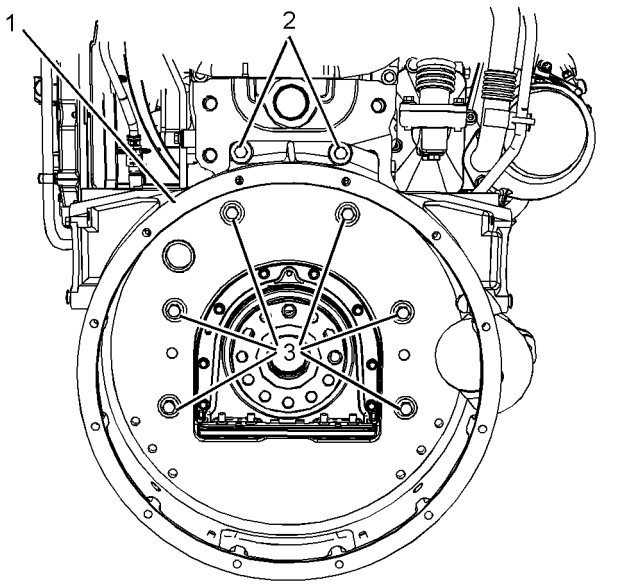


Illustration 209 g01981253

Typical example

14. If necessary, remove bolts (7) from plate (8). Remove plate (8) and remove O-ring seal (9).

15. Remove circlip (10) and remove gear assembly (11) from front housing (12).

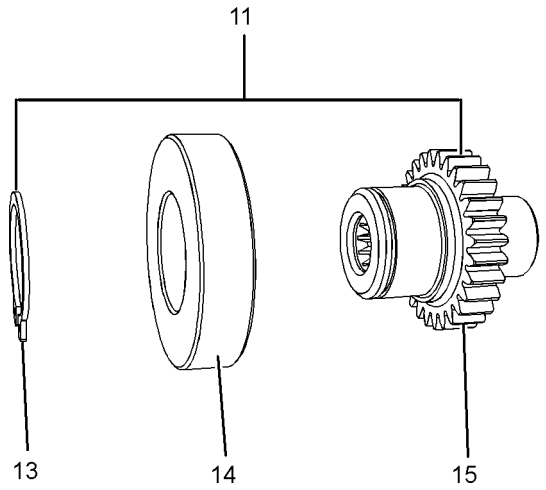


Illustration 239 g02053673

16. If necessary, follow Step 16.a through Step 16.b in order to disassemble gear assembly (11).

a. Remove circlip (13) from gear assembly (11).

b. Place gear assembly (11) on a suitable support. Press bearing (14) from gear (15).

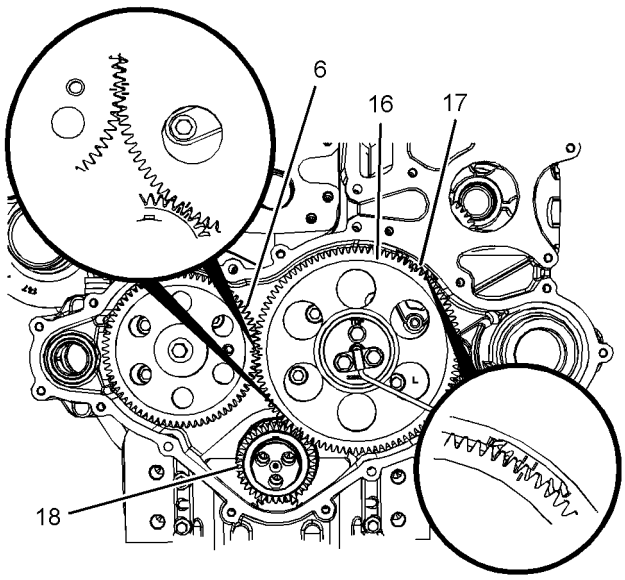


Illustration 240 g02048714

17. Mark gear (6), gear (16), gear (17) and gear (18) in order to show alignment. Refer to Illustration 240.

Note: Identification will ensure that the gears can be installed in the original alignment.

18. Remove camshaft gear (6). Refer to Disassembly and Assembly, “Camshaft Gear - Remove and Install” for the correct procedure.

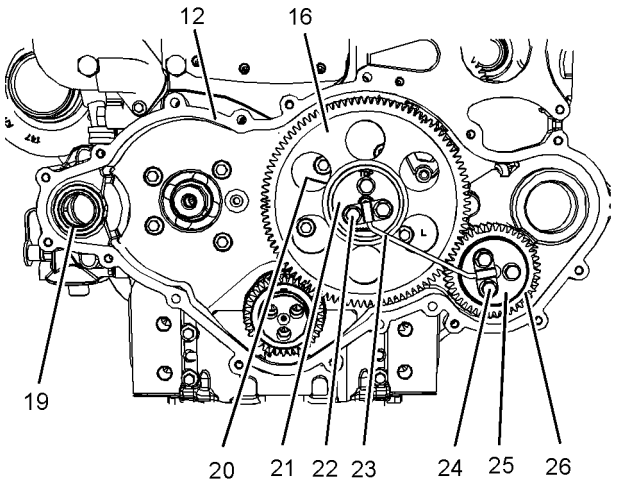


Illustration 241 g02053984

19. Remove bolts (22) and bolts (24).

20. Remove tube assembly (23) from idler gear (16) and idler gear (26).

21. Remove plate (21).

22. Remove idler gear (16) from hub (20) (not shown).

23. Remove idler gear (26) and idler gear hub (25) from front housing (12).

24. Remove hub (20) (not shown) from front housing (12).

25. If necessary, remove bearing (19) from front housing (12). Refer to Disassembly and Assembly, “Housing (Front) - Remove” for the correct procedure.

i04485878

Housing (Front) - Install (Heavy Duty Housing (Front))

Installation Procedure

Table 51

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 575 Sealant	1
B	-	Guide Studs M8 by 80 mm	2
C	92G67-04100	Alignment Tool	1
	-	Bolts M10 by 50 mm	3
D	-	Delphi Lockheed Rubber Grease	1
E	-	Loctite 609 Bearing Mount Compound	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Ensure that the wiring harness assembly is correctly routed and the cable straps are not over tightened. Over tightening of the cable straps will damage the wiring harness and the convoluting.

1. Ensure that the front housing is clean and free from damage. If necessary, replace the front housing.

   If necessary, install blanking plugs to a new front housing. Use Tooling (A) in order to seal all D-plugs.

2. Clean all the gasket surfaces of the cylinder block.

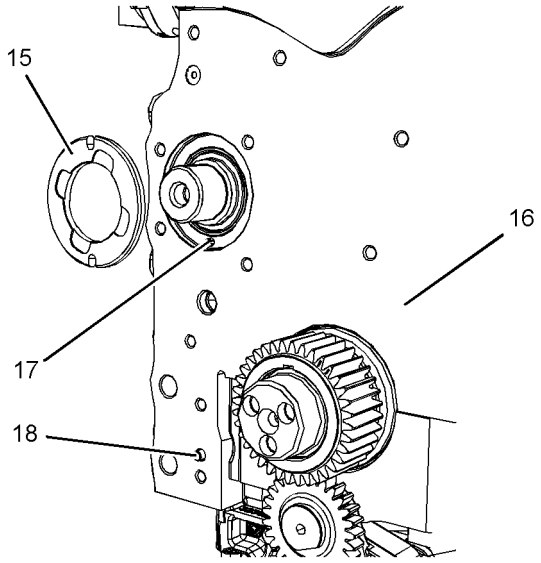


Illustration 274 g02490396

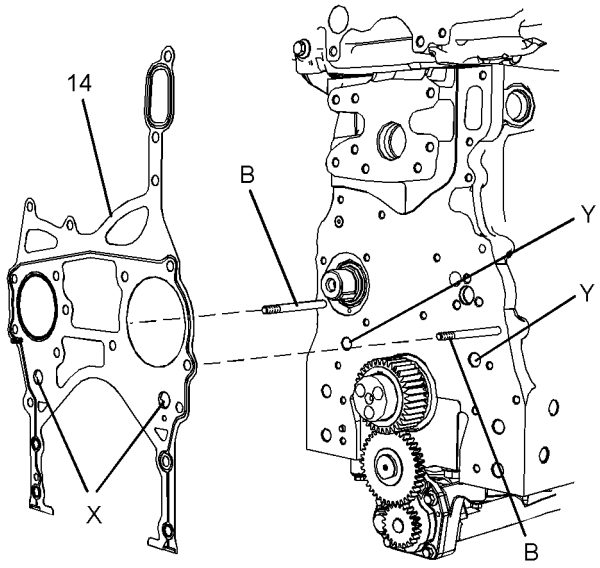


Illustration 275 g02490397

3. Inspect dowel (17) and dowel (18) for damage. If necessary, replace the dowels in the cylinder block.

4. Install thrust washer (15) into the recess in cylinder block (16). Refer to Disassembly and Assembly, “Camshaft - Install” for more information.

5. Install Tooling (B) to cylinder block (16). Refer to Illustration 275.

6. Align a new gasket (10) with Tooling (B). Install the gasket to (16) cylinder block.

1. Make an identification mark on each rocker arm assembly in order to show the location.

Note: The components must be reinstalled in the original location. Do not interchange components.

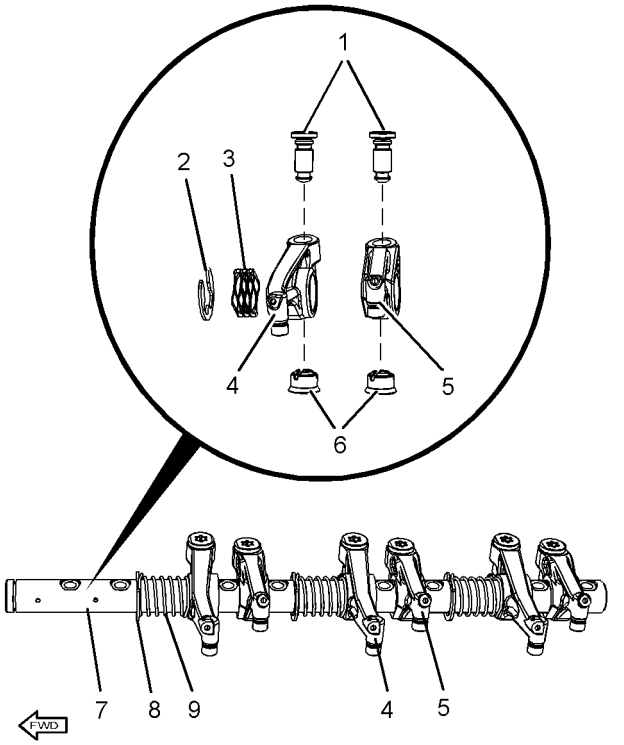


Illustration 308 g02520576

2. Remove the Torx screws from the rocker shaft assembly. Note position of different length Torx screws for assembly purposes.

3. Remove retaining clip (2) from rocker shaft (7). Remove spring (3) from the rocker shaft.

4. Remove rocker arm assembly (4) for the inlet valve from rocker shaft (7). Remove rocker arm assembly (5) for the exhaust valve from rocker shaft (7).

Note: The rocker arm assembly for the inlet valve is longer than the rocker arm assembly for the exhaust valve.

5. Remove retaining clip (8) from rocker shaft (7). Remove spring (9) from the rocker shaft.

6. Remove rocker arm assembly (4) for the exhaust valve from rocker shaft (7). Remove rocker arm assembly (5) for the inlet valve from rocker shaft (7).

7. Repeat Step 5 through Step 6 in order to remove the remaining rocker arms from rocker shaft (7).

8. If necessary, follow Step 8.a through Step 8.c in order to remove threaded inserts (1) from the rocker arms.

   a. Make a temporary identification mark on each threaded inserts (1) in order to show the location.

Note: The components must be reinstalled in the original location. Do not interchange components.

   b. Remove guide (6) from threaded inserts (1).

   c. Remove threaded inserts (1) from the rocker arms.

i04485898

Rocker Shaft - Assemble

Assembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that all components are clean and free from wear and damage. Refer to Specifications, “Rocker Shaft” for more information. If necessary, replace any components that are worn or damaged.

3. Inspect the lifters for wear and for damage. Refer to Specifications, “Lifter Group” for more information. Replace any worn lifters or any damaged lifters. Refer to Disassembly and Assembly, “Lifter Group - Remove and install” for the correct procedure.

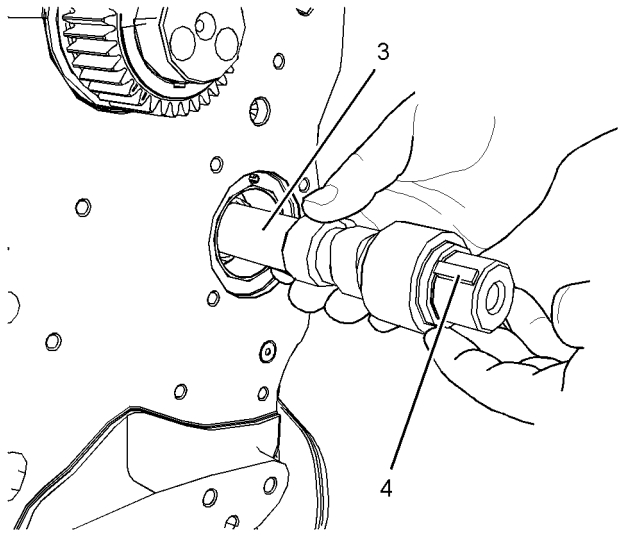


Illustration 339 g02009035

4. If necessary, install a new key (4) into camshaft (3).

5. Lubricate the bearing surfaces of camshaft (3) and lubricate the lobes of the camshaft with clean engine oil.

NOTICE
Do not damage the lobes or the bearings when the camshaft is removed or installed.

6. Carefully install camshaft (3) into the cylinder block.

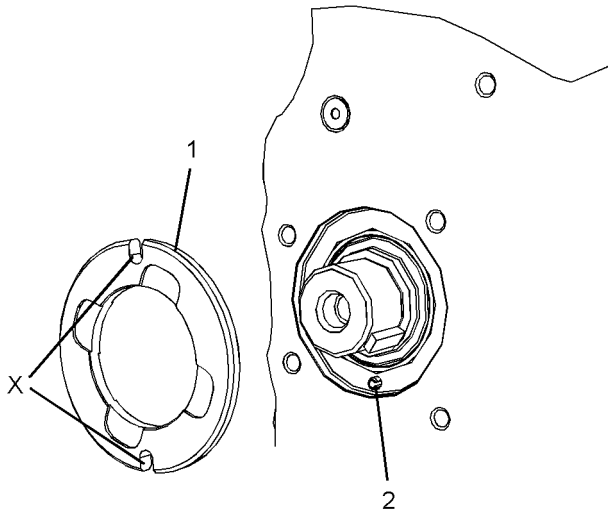


Illustration 340 g02009034

7. Lubricate the thrust washer with clean engine oil. Align Slot (X) in thrust washer (1) with dowel (2) in the cylinder block. Install thrust washer (1) into the recess in the cylinder block.

Note: The thrust washer can have one or two Slots (X).

End By:

a. Install the front housing. Refer to Disassembly and Assembly, “Housing (Front) - Install” for the correct procedure.

b. Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, “Rocker shaft and Pushrod - Install” for the correct procedure.

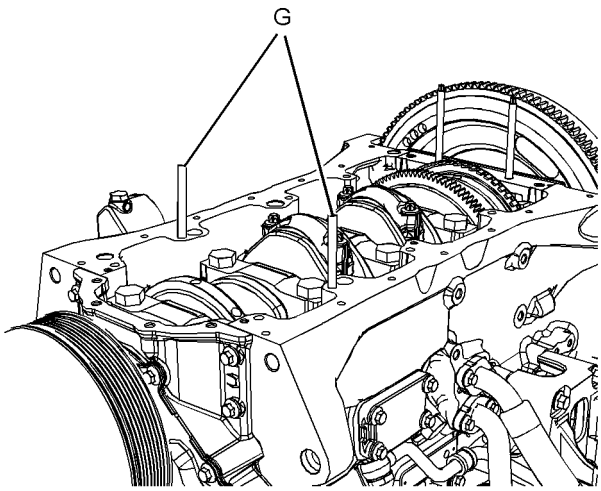


Illustration 376 g02435516

3. Install Tooling (G) to the cylinder block.

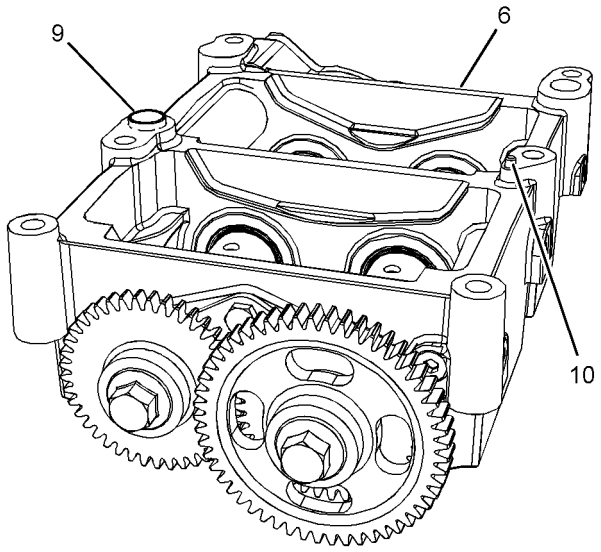


Illustration 377 g02435366

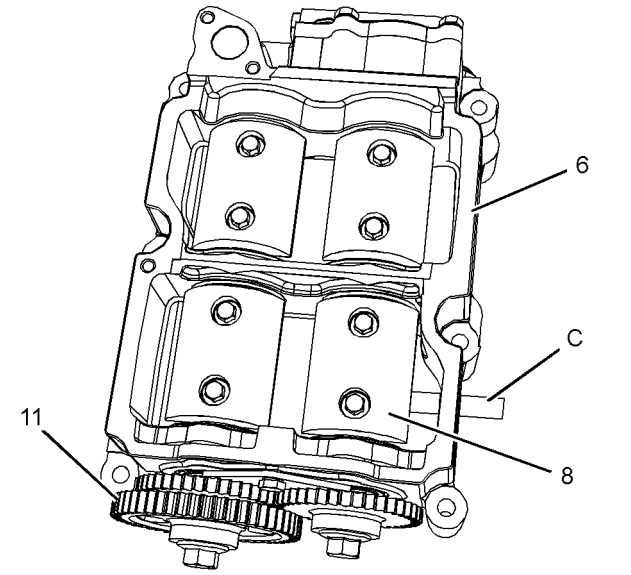


Illustration 378 g02435776

4. Ensure that dowel (9) and dowel (10) are seated in the housing of balancer (6).

5. Install Tooling (C) to balancer (6). Ensure that Tooling (C) is correctly engaged into shaft (8).

6. Attach a suitable lifting device to the balancer. The balancer weighs approximately 23 kg (51 lb).

7. Use the lifting device to align balancer (6) with Tooling (G). Install the balancer to the cylinder block. Ensure that dowel (9) and dowel (10) are aligned with the holes in the cylinder block. Ensure that gear (11) and the crankshaft gear mesh. Remove the lifting device.

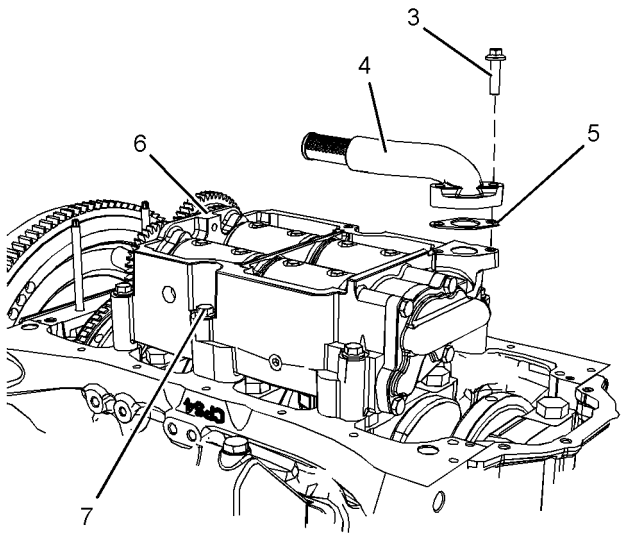


Illustration 379 g02435356

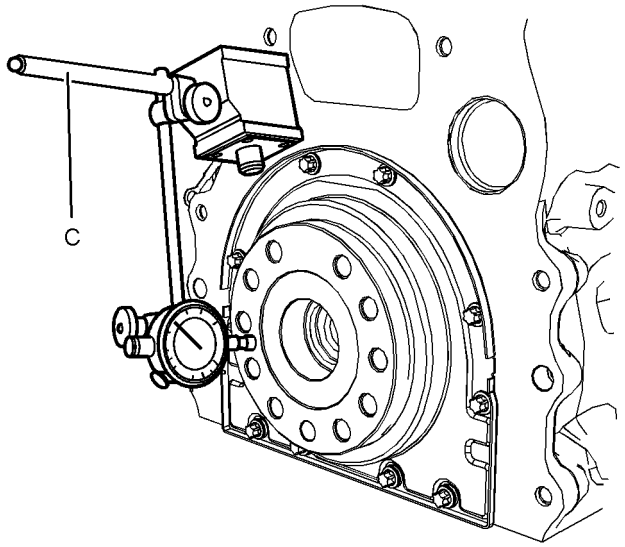


Illustration 408 g02447421

10. Check the crankshaft end play. Push the crankshaft toward the front of the engine. Install Tooling (C) to the cylinder block and the rear face of the crankshaft. Push the crankshaft toward the rear of the engine. Use Tooling (C) to measure the crankshaft end play. The permissible crankshaft end play is 0.10 mm (0.004 inch) to 0.41 mm (0.016 inch).

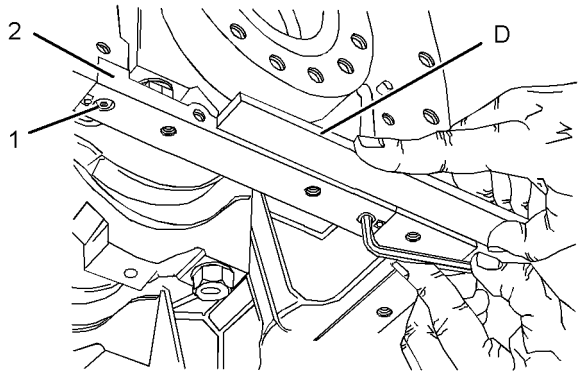


Illustration 409 g02447422

11. Follow Steps 11.a through Step 11.d in order to install the bridge piece.

a. Ensure that the cylinder block and the bridge piece are clean, dry, and free from old sealant.

b. Install bridge piece (2) and allen head screws (1). Tighten the allen head screws finger tight.

c. Use Tooling (D) in order to align the rear face of the bridge piece with the rear face of the cylinder block.

d. Use Tooling (B) in order to tighten the allen head screws to a torque of 16 N·m (142 lb in).

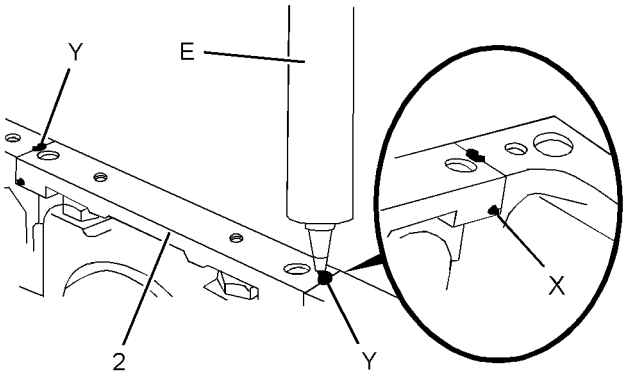


Illustration 410 g02442239

12. Apply Tooling (E) to cavities (Y) in the bridge piece (2). Continue to apply Tooling (E) until sealant extrudes from cavities (X).

Note: If the oil pan will not be installed immediately, ensure that the joint face of the bridge piece and the cylinder block are left free of sealant.

End By:

a. Install the crankshaft rear seal. Refer to Disassembly and Assembly, “Crankshaft Rear Seal - Install” for the correct procedure.

b. If the engine is equipped with a balancer, install the balancer. Refer to Disassembly and Assembly, “Balancer - Install” for the correct procedure.

c. If the engine is not equipped with a balancer, install the engine oil pump. Refer to Disassembly and Assembly, “Engine Oil Pump - Install” for the correct procedure.

i04485813

Crankshaft - Remove

Removal Procedure

Table 81

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Lifting Sling	2
B	-	5mm Allen Socket	1

Start By:

a. If the engine is equipped with a balancer, remove the balancer. Refer to Disassembly and Assembly, “Balancer - Remove” for the correct procedure.

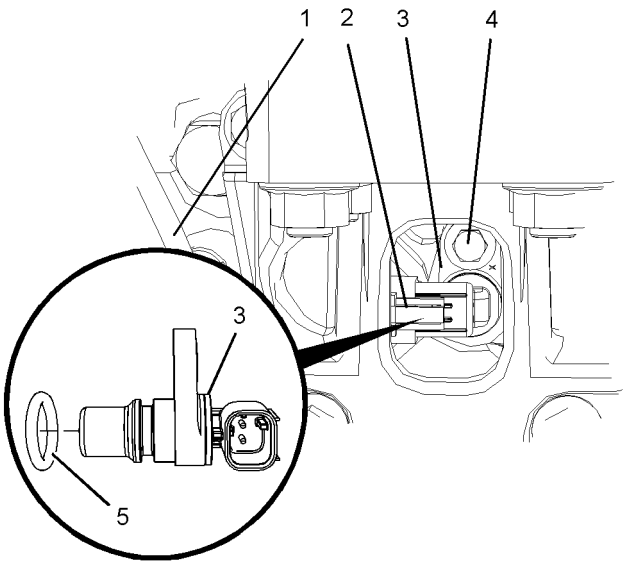


Illustration 443 g02437917

1. Install a new O-ring seal (5) to camshaft position sensor (3).

Note: Do not lubricate the O-ring seal.

2. Install camshaft position sensor (3) to the cylinder block. Install bolt (4) and tighten the bolt to a torque of 14 N·m (124 lb in).

3. Connect harness assembly (1) to camshaft position sensor (3). Slide locking tab (2) into the locked position.

i04485819

Crankshaft Position Sensor - Remove and Install

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

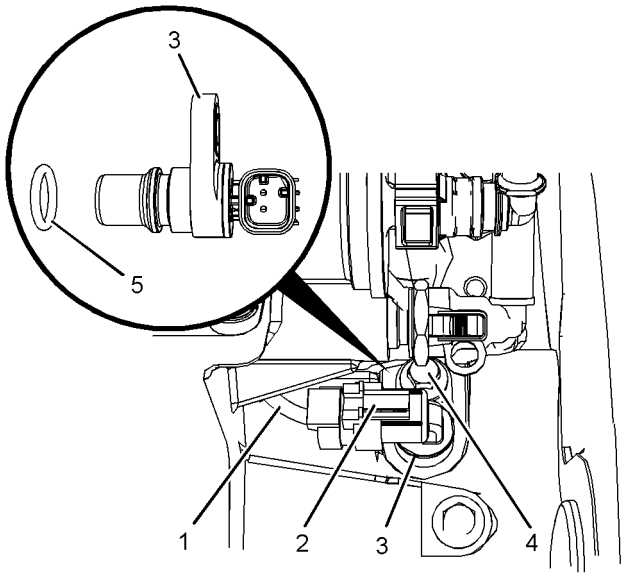


Illustration 444 g02449496

1. Slide locking tab (2) into the unlocked position. Disconnect harness assembly (1) from crankshaft position sensor (3).

2. Remove bolt (4) from the cylinder block.

3. Carefully remove crankshaft position sensor (3) from the cylinder block.

Note: Do not use a lever to remove the crankshaft position sensor from the cylinder block.

4. Remove O-ring seal (5) from crankshaft position sensor (3).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

6. If the engine has guards, install the guards. Refer to the Truck's Service Manual for the correct procedure.

i04485885

Idler Pulley - Remove and Install (Grooved Idler Pulley)

Removal Procedure

Start By:

a. Remove the alternator belt. Refer to Disassembly and Assembly, “Alternator Belt - Remove and Install” for the correct procedure.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

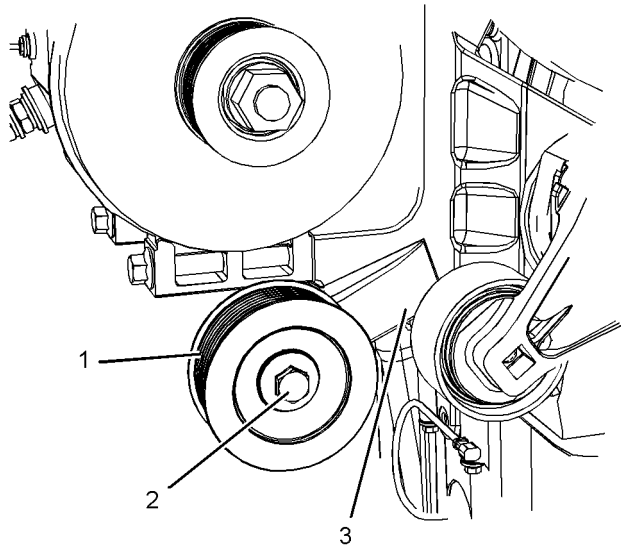


Illustration 472 g02501039
Typical example

1. Remove bolt (2).
2. Remove grooved idler pulley (4) from bracket (3).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

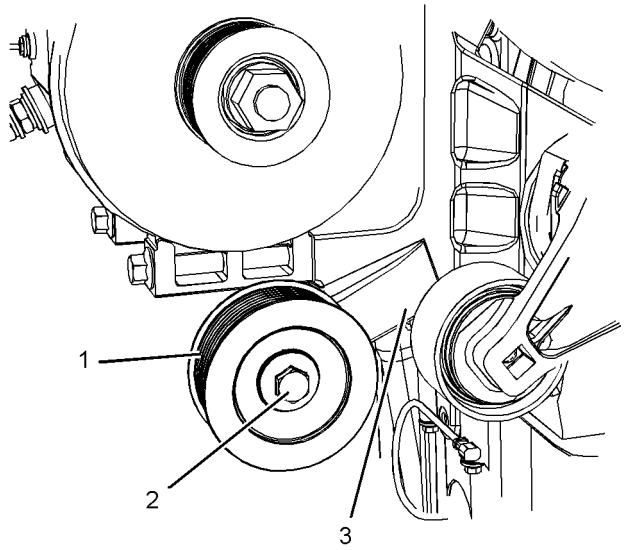


Illustration 473 g02501039
Typical example

1. Position grooved idler pulley (1) onto bracket (3). Loosely tighten bolt (2).
2. Tighten bolt (2) to a torque of 44 N·m (32 lb ft).

End By:

a. Install the alternator belt. Refer to Disassembly and Assembly, “Alternator Belt - Remove and Install” for the correct procedure.

i04485884

Idler Pulley - Remove and Install (Flat Idler Pulley)

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

4. Connect the harness assembly to the electric starting motor and the solenoid.

5. Turn the battery disconnect switch to the ON position.

i04485794

Alternator - Install

Installation Procedure for the Alternator Bracket for Hydraulic Excavator

Table 94

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A(1)	-	1/2 Inch Drive T50 Torx Bit	1
	-	1/2 Inch Drive x 8 mm Hex Drive	1

(1) Either tool may be necessary in order to install the alternator pulley.

1. If necessary, follow Step 1.a through Step 1.j in order to install the alternator bracket to the cylinder block of the hydraulic excavator.

   a. Ensure that all of the components of the alternator bracket are clean and free from wear and damage. If necessary, replace any components that are worn or damaged.

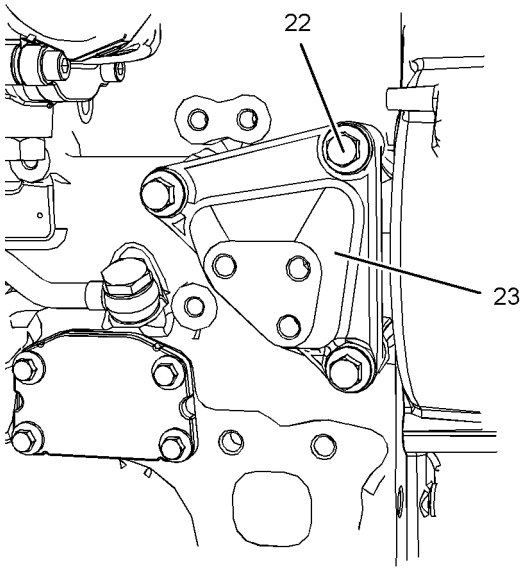


Illustration 507 g02422757

   b. Position bracket (23) onto the cylinder block. Ensure that the bracket is correctly oriented.

   c. Install bolts (22) and tighten the bolts to a torque of 44 N·m (32 lb ft).

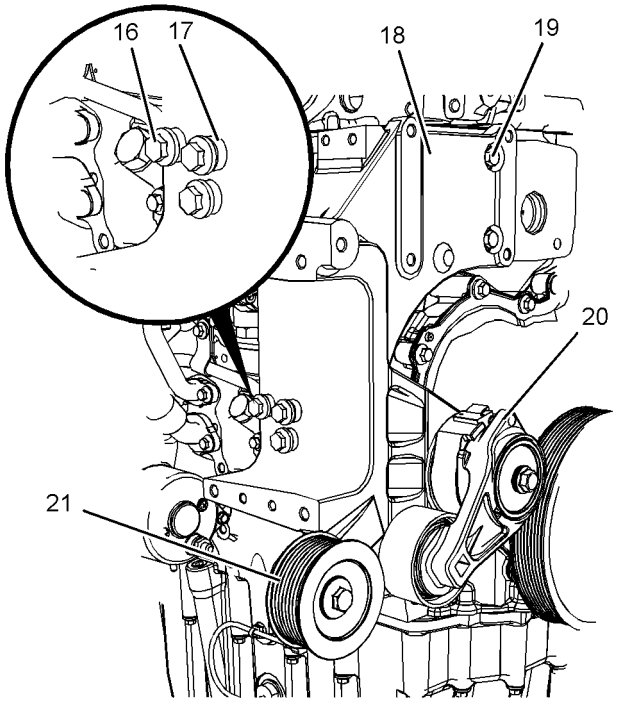


Illustration 508 g02422756

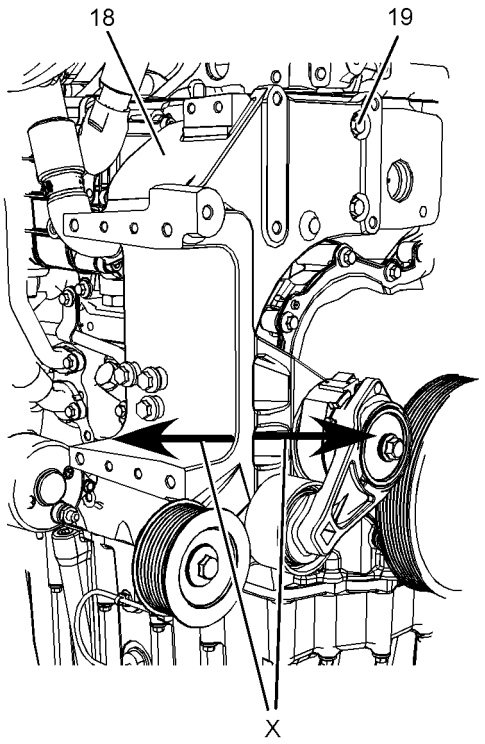
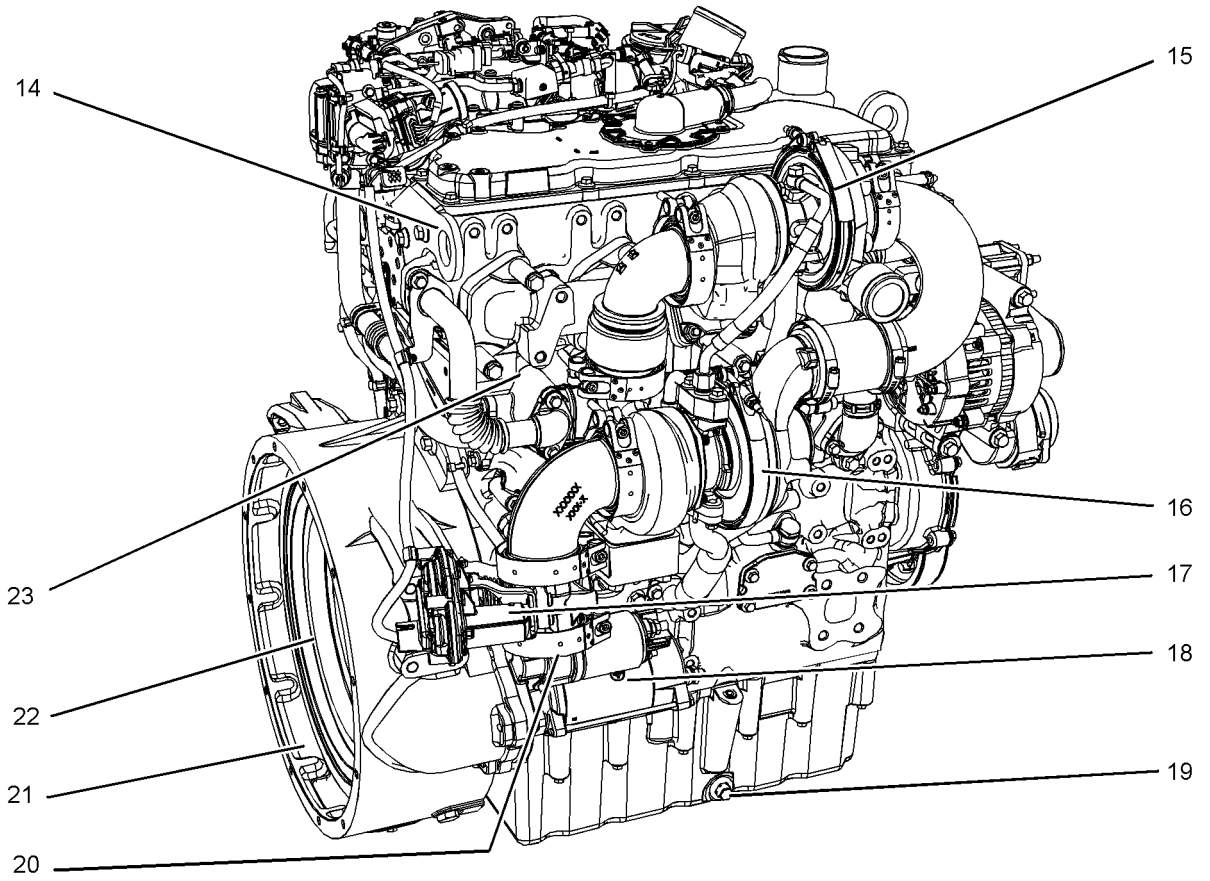


Illustration 509 g02425358

Index



g02409512

Illustration 2

Typical example

(14) Rear lifting eye
(15) High-pressure turbocharger
(16) Low-pressure turbocharger
(17) Back pressure valve
(18) Starting motor
(19) Oil drain plug
(20) Exhaust outlet
(21) Flywheel housing
(22) Flywheel
(23) Exhaust gas cooler (NRS)

Air is drawn in through the air cleaner into the air inlet of the low-pressure turbocharger by the low-pressure turbocharger compressor wheel. The air is compressed to a pressure of about 75 kPa (11 psi) and heated to about 120° C (248° F). From the low-pressure turbocharger, the air passes to the high-pressure turbocharger. The air is compressed to a pressure of about 220 kPa (32 psi) and heated to about 240° C (464° F) before the air is forced to the aftercooler. The air flows through the aftercooler. The temperature of the compressed air lowers to about 55° C (131° F). Cooling of the inlet air assists the combustion efficiency of the engine. Increased combustion efficiency helps achieve the following benefits:

- Lower fuel consumption
- Increased power output
- Reduced NOx emission
- Reduced particulate emission

From the aftercooler, the air flows to the exhaust gas valve (NRS). A mixture of air and exhaust gas is then forced into the inlet manifold. Air flow from the inlet manifold to the cylinders is controlled by inlet valves. There are two inlet valves and two exhaust valves for each cylinder. The inlet valves open when the piston moves down on the intake stroke. When the inlet valves open, cooled compressed air from the inlet port is forced into the cylinder. The complete cycle consists of four strokes:

- Inlet
- Compression
- Power
- Exhaust

On the compression stroke, the piston moves back up the cylinder and the inlet valves close. The cool compressed air is compressed further. This additional compression generates more heat.

Note: If the cold starting system is operating, the glow plugs will also heat the air in the cylinder.

Just before the piston reaches the top center (TC) position, the ECM operates the electronic unit injector. Fuel is injected into the cylinder. The air/fuel mixture ignites. The ignition of the gases initiates the power stroke. Both the inlet and the exhaust valves are closed and the expanding gases force the piston downward toward the bottom center (BC) position.

From the BC position, the piston moves upward. The piston moving upward initiates the exhaust stroke. The exhaust valves open. The exhaust gases are forced through the open exhaust valves into the exhaust manifold.

The fuel pump assembly consists of a low-pressure transfer pump and a high-pressure fuel injection pump. The pump assembly is driven from a gear in the front timing case at engine speed. The fuel injection pump (1) has two plungers that are driven by a camshaft. The fuel injection pump (1) delivers a volume of fuel two times for each revolution. The stroke of the plungers are fixed.

The injector will use only part of the fuel that is delivered by each stroke of the pistons in the pump. The suction control valve (3) for the fuel injection pump (1) is controlled by the ECM. This maintains the fuel pressure in the fuel manifold (rail) at the correct level. A feature of the fuel injection pump (1) allows fuel to return to the tank continuously.

The fuel temperature sensor (2) measures the temperature of the fuel. The ECM receives the signal from the fuel temperature sensor (2). The ECM calculates the volume of fuel.

The fuel injection pump has the following operation:

- Generation of high-pressure fuel

The fuel output of the fuel injection pump is controlled by the ECM in response to changes in the demand of fuel pressure.

Shutoff

The engine shuts off by preventing the electronic unit injectors from injecting. The ECM then closes the suction control valve to prevent the pressure in the fuel manifold (rail) from increasing.

The operating range of the boost pressure sensors is 39 to 400 kPa (6 to 58 psi).

The engine oil pressure sensor provides the ECM with a measurement of engine oil pressure. The ECM can warn the operator of possible conditions that can damage the engine. This includes the detection of an oil filter that is blocked.

The operating range for the engine oil pressure sensor ..... 13 to 1200 kPa (2 to 174 psi)

Temperature Sensors

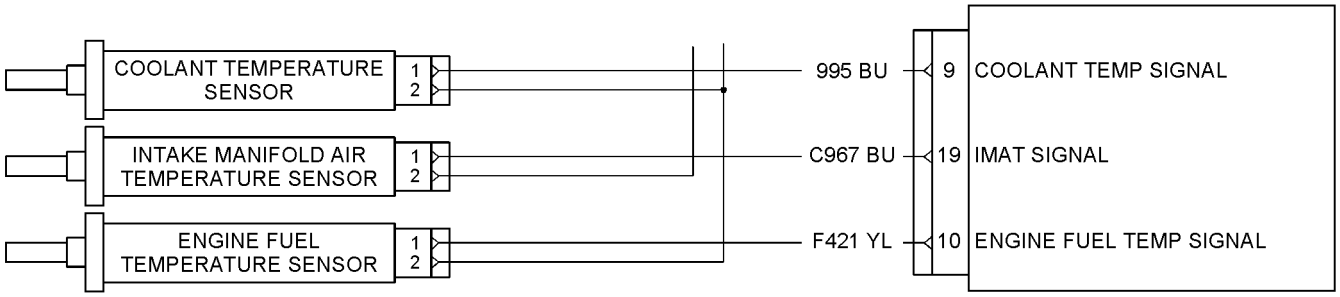


Illustration 52 g02139713

Schematic for the engine temperature sensors

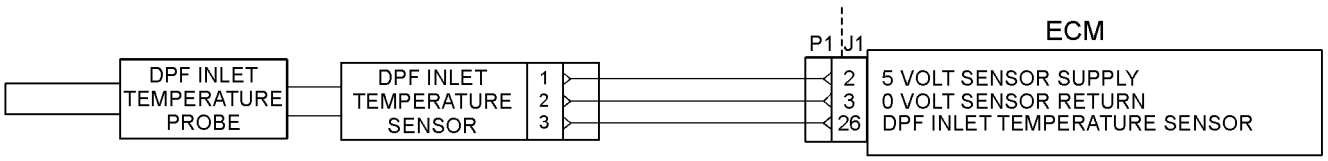


Illustration 53 g02139706

Schematic for the temperature sensors for the engine aftertreatment system

The air inlet temperature sensor and the coolant temperature sensor are passive sensors. Each sensor provides a temperature input to the ECM. The ECM controls following operations:

- Fuel delivery
- Injection timing

The operating range for the sensors ... −40° to 125°C (−40° to 257°F)

The operating range for the fuel temperature sensor ..... −40° to 120°C (−40° to 248°F)

The sensors are also used for engine monitoring.

1. Ensure that the fuel system is in working order. Check that the fuel supply valve (if equipped) is in the “ON” position.

2. Turn the keyswitch to the “RUN” position.

3. The keyswitch will allow the electric priming pump to operate. Operate the electric priming pump for 2 minutes.

4. Turn the keyswitch to the “OFF” position. The fuel system should now be primed and the engine should be able to start.

5. Operate the engine starting motor and crank the engine. After the engine has started, operate the engine at low idle for a minimum of 5 minutes. Ensure that the fuel system is free from leaks.

Note: Operating the engine for this period will help ensure that the fuel system is free of air. **DO NOT loosen the high-pressure fuel lines in order to purge air from the fuel system. This procedure is not required.**

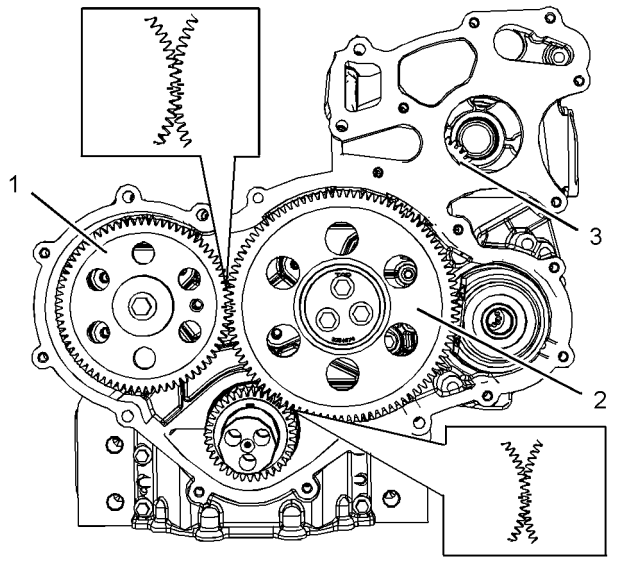
After the engine has stopped, you must wait for 10 minutes in order to allow the fuel pressure to be purged from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low-pressure fuel system and from the cooling, lubrication, or air systems. Replace any high-pressure fuel line that has leaked. Refer to Disassembly and Assembly, “Fuel Injection Lines - Install”.

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, “General hazard Information”.

If the engine will not start, refer to Troubleshooting, “Engine Cranks but will not Start”.

i03578027

Gear Group (Front) - Time



g01907773

Illustration 65

Typical example

(1) Camshaft gear
(2) Idler gear
(3) Fuel Injection Pump gear

1. Install the camshaft gear (1) onto the camshaft. Refer to Disassembly and Assembly, “Camshaft Gear - Remove and Install” for the correct procedure.

2. Ensure that the crankshaft and the camshaft are locked in the correct position. Refer to Systems Operation, Testing and Adjusting, “Finding Top Center Position for No. 1 Piston” for the correct procedure. Ensure that the fuel injection pump is locked in the correct position. Refer to Disassembly and Assembly, “Fuel Injection Pump - Remove” for the correct procedure.

3. Install the idler gear (2). Refer to Disassembly and Assembly, “Idler Gear - Remove and Install” for the correct procedure.

4. Install the fuel injection pump and gear assembly (3). Refer to Disassembly and Assembly, “Fuel Injection Pump - Install” for the correct procedure.

5. Make sure that the timing marks on the gears (1), (2) and (3) are in alignment. If the timing marks are not aligned, refer to Disassembly and Assembly, “Gear Group (Front) - Remove and Install”.

i03577881

Increased Engine Oil Temperature - Inspect

Look for a restriction in the oil passages of the oil cooler. The oil temperature may be higher than normal when the engine is operating. In such a case, the oil cooler may have a restriction.

f. The current is above 0.015 amperes. There is an internal fault with the alternator. Replace the alternator. Refer to Disassembly and Assembly, “Alternator - Remove and Install” for the correct procedure.

8. Turn off all electrical accessories. Turn the keyswitch to the OFF position.

a. Connect a current probe or an ammeter to a digital multimeter. Ensure that the probe is zeroed. Clamp the current probe or an ammeter to the main ground cable. Clamp the tool with the positive side away from the battery.

b. Monitor the current and remove the fuses and circuit breakers one at a time. Check the current after each fuses or each of the circuit breakers are removed. After removing a fuse and checking the current, replace the fuse. Start with the main fuses and proceed to the smaller circuits.

c. If removing a fuse causes a current drop, then the problem is within that circuit.

d. Check if any components on the circuit are on.

e. If all components are switched off, disconnect electrical components on that circuit one at a time and monitor the current.

f. After all components on the circuit have been disconnected, check the current. If the problem still exists, check the wiring for corrosion. Check if there is a short to ground.

Note: The standard current is 0.05 amperes. A current value above this figure usually indicates a problem. However, some large machines with multiple control modules have a higher acceptable limit.

i01899136

Battery - Test

Most of the tests of the electrical system can be done on the engine. The wiring insulation must be in good condition. The wire and cable connections must be clean, and both components must be tight.

⚠ WARNING

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel can be the result.

The battery circuit is an electrical load on the charging unit. The load is variable because of the condition of the charge in the battery.

NOTICE
The charging unit will be damaged if the connections between the battery and the charging unit are broken while the battery is being charged. Damage occurs because the load from the battery is lost and because there is an increase in charging voltage. High voltage will damage the charging unit, the regulator, and other electrical components.

The correct procedures to test the battery can be found in the Truck's Service Manual.

i03631789

Charging System - Test

The condition of charge in the battery at each regular inspection will show if the charging system is operating correctly. An adjustment is necessary when the battery is constantly in a low condition of charge or a large amount of water is needed. A large amount of water would be more than one ounce of water 28 ml per cell per week or per every 100 service hours. There are no adjustments on maintenance free batteries.

When it is possible, make a test of the charging unit and voltage regulator on the engine, and use wiring and components that are a permanent part of the system. Off-engine testing or bench testing will give a test of the charging unit and voltage regulator operation. This testing will give an indication of needed repair. After repairs are made, perform a test in order to prove that the units have been repaired to the original condition of operation.

Alternator

The charging rate of the alternator should be checked when an alternator is charging the battery too much or not charging the battery enough.

Troubleshooting

1204E-E44TA, 1204E-E44TTA and 1206E-E66TA Industrial Engines

BK1 (Engine)
MK1 (Engine)
ML1 (Engine)

Signal – The signal is a voltage or a waveform that is used in order to transmit information typically from a sensor to the ECM.

Suction Control Valve (SCV) – The SCV is a control device in the high-pressure fuel pump. The valve controls the pressure in the fuel rail by varying the amount of fuel that enters the chambers in the pump.

Supply Voltage – The supply voltage is a continuous voltage that is supplied to a component. The power may be generated by the ECM or the power may be battery voltage that is supplied by the engine wiring.

Suspect Parameter Number (SPN) – The SPN is a J1939 number that identifies the specific component of the electronic control system that has experienced a diagnostic code.

System Configuration Parameters – System configuration parameters are parameters that affect emissions and/or operating characteristics of the engine.

Tattletale – Certain parameters that affect the operation of the engine are stored in the ECM. These parameters can be changed by use of the electronic service tool. The tattletale logs the number of changes that have been made to the parameter. The tattletale is stored in the ECM.

Throttle Position – The throttle position is the interpretation by the ECM of the signal from the throttle position sensor or the throttle switch.

Throttle Position Sensor – The throttle position sensor is a sensor that is normally connected to an accelerator pedal or a hand lever. This sensor sends a signal to the ECM that is used to calculate desired engine speed.

Throttle Switch – The throttle switch sends a signal to the ECM that is used to calculate desired engine speed.

Top Center Position – The top center position refers to the crankshaft position when the engine piston position is at the highest point of travel. The engine must be turned in the normal direction of rotation in order to reach this point.

Total Tattletale – The total tattletale is the total number of changes to all the parameters that are stored in the ECM.

Wait To Start Lamp – This lamp is included in the cold starting aid circuit in order to indicate when the wait to start period is active. The lamp will go off when the engine is ready to be started. The glow plugs may not have deactivated.

Wastegate – The wastegate is a device in a turbocharged engine that controls the maximum boost pressure that is provided to the inlet manifold.

Wastegate Regulator – The wastegate regulator controls the pressure in the intake manifold to a value that is determined by the ECM. The wastegate regulator provides the interface between the ECM and the mechanical system. The wastegate regulates intake manifold pressure to the desired value that is determined by the software.

i04084033

Electronic Service Tools

Electronic service tools are designed to help the service technician:

- Retrieve diagnostic codes.
- Diagnose electrical problems.
- Read parameters.
- Program parameters.
- Install injector trim codes.

Required Service Tools

Table 1

Required Service Tools	
Part Number	**Description**
92G67-04600	Crimp Tool (12−AWG TO 18−AWG)
92G67-04700	Wire Removal Tool
92G67-04800	Removal Tool
-	Suitable Digital Multimeter

Two short jumper wires are needed to check the continuity of some wiring harness circuits by shorting two adjacent terminals together in a connector. A long extension wire may also be needed to check the continuity of some wiring harness circuits.

Optional Service Tools

Table 2 lists the optional service tools that can be used when the engine is serviced.

Clean Emissions Module (CEM)

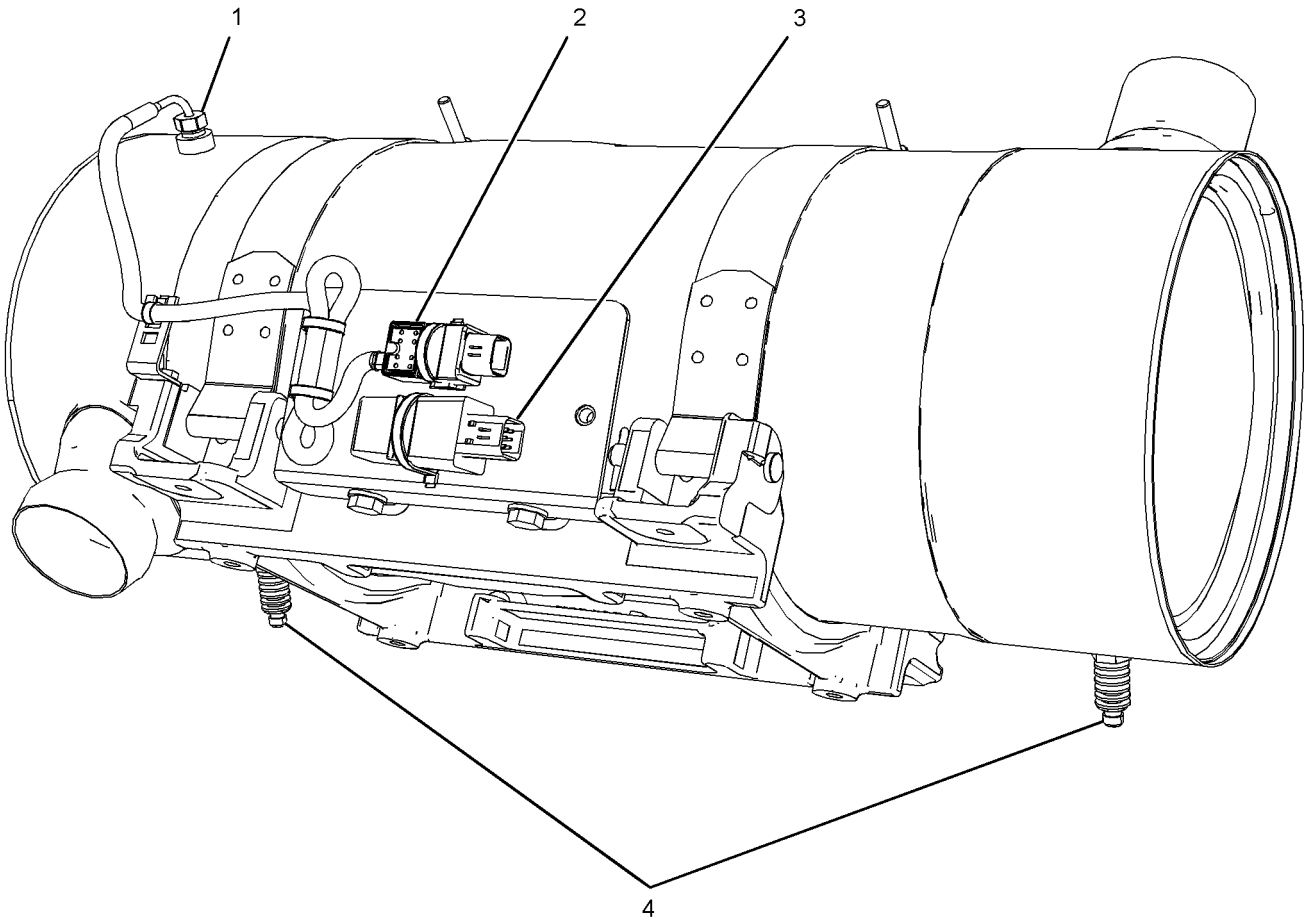


Illustration 18 g02095035

Sensors and components on a typical CEM

(1) Temperature probe for the inlet to the DPF
(2) Inlet temperature sensor
(3) Aftertreatment identification module
(4) Soot antennas

i04319697

Engine Wiring Information

Harness Wire Identification

Mitsubishi Forklift Trucks identifies all wires with 11 solid colors. The circuit number is stamped on the wire at a 25 mm (1 inch) spacing. Table 5 lists the wire colors and the color codes.

Table 5

Color Codes for the Harness Wire			
Color Code	**Color**	**Color Code**	**Color**
BK	Black	BU	Blue
BR	Brown	PU	Purple
RD	Red	GY	Gray
OR	Orange	WH	White
YL	Yellow	PK	Pink
GN	Green		

For example, a wire identification of F730-OR on the schematic would signify an orange wire with the circuit number F730. F730-OR identifies the power supply for the oil pressure sensor.

Note: Always replace a harness wire with the same gauge of wire and with the same color code.

Shutdown Delay Time

Table 41

Value	Default
1 to 60 minutes	5 minutes

Ambient Temperature Override Enable Status

Table 42

Value	Default
Enabled Disabled	Disabled

Air Shutoff

Air Shutoff

The Air Shutoff parameter defines whether an air shutoff valve is installed in the air inlet for the engine.

Table 43

Value	Default
Enabled Disabled	Disabled

Multiple Engines on J1939

Engine Location

In a situation where multiple engines communicate on one J1939 channel, the Engine Location parameter defines the identity of each engine in the set.

Table 44

Value	Default
Engine #1 Engine #2 Engine #3 Engine #4 Engine #5	Engine #1

PTO and Throttle Lock Parameters

Throttle Lock Feature Installation Status

Note: PTO and a multi-position throttle switch cannot be installed at the same time.

The “Throttle Lock Feature Installation Status” is used to turn on the throttle lock features. When this parameter is changed to “Installed”, the following parameters are active and the parameters can be programmed.

- “PTO engine Speed Setting”
- “Throttle Lock Increment Speed Ramp Rate”
- “Throttle Lock Engine Set Speed Increment”

Table 45

Value	Default
Not Installed Installed	Not Installed

PTO Mode

PTO mode can be configured to operate in either Set/Resume mode or Ramp up/Ramp down mode. Set/Resume mode allows the engine speed to be controlled by the operator through switch inputs. This mode allows two specific speeds to be set and stored in the ECM. A speed can be selected or the previously selected speed can be resumed. Adjustments in engine speed can then be made via the raise and lower switch inputs. Ramp up/Ramp down mode only allows the engine speed to be raised or lowered via switch inputs at a desired ramp rate. The “Set” and “Resume” functions are disabled.

Table 46

Value	Default
Ramp Up/Ramp Down Set/Resume	Set/Resume

Throttle Lock Engine Set Speed 1

The “Throttle Lock Engine Set Speed 1” parameter is one of the engine speeds that can be selected in the PTO Set/Resume mode.

Table 47

Minimum	Maximum	Default
Low idle speed	Rated speed	700

Throttle Lock Engine Set Speed 2

The “Throttle Lock Engine Set Speed 1” parameter is one of the engine speeds that can be selected in the PTO Set/Resume mode.

Table 48

Minimum	Maximum	Default
Low idle speed	Rated speed	700

Throttle Lock Increment Speed Ramp Rate

The “Throttle Lock Increment Speed Ramp Rate” parameter is the rate of engine acceleration when the PTO switch is held in the ACCELERATE position. If this parameter is set to “0”, the feature is turned off.

3. Use the electronic service tool to verify the throttle position status.

4. Run the engine until the speed is equal to the maximum no-load speed.

5. Use the electronic service tool to make sure that the throttle is set to reach the maximum no-load speed.

6. If the maximum no-load speed cannot be obtained refer to Troubleshooting, “Throttle Switch Circuit - Test” and Troubleshooting, “Mode Selection Circuit - Test”.

7. If the engine speed is erratic refer to Troubleshooting, “Analog Throttle Position Sensor Circuit - Test” or Troubleshooting, “Digital Throttle Position Sensor Circuit - Test”.

8. If the fault has not been eliminated, proceed to “Air Intake and Exhaust System”.

Air Intake and Exhaust System

1. Check the air filter restriction indicator, if equipped.

2. Ensure that the air filter is clean and serviceable.

3. Check the air intake and the exhaust system for the following defects:

   - Blockages
   - Restrictions
   - Damage to the air intake and exhaust lines and hoses

4. Make all necessary repairs to the engine.

5. If the fault has not been eliminated, proceed to “Valve Lash”.

Valve Lash

1. Check the valve lash. Refer to Systems Operation, Testing and Adjusting, “Engine Valve Lash - Inspect”.

2. If any repair does not eliminate the fault, proceed to “Turbochargers”.

Turbocharger or Turbochargers

Turbocharger

This procedure is applicable only to engines that have a single turbocharger.

Note: The turbocharger that is installed on the engine is a nonserviceable item. If any mechanical fault exists, then the turbocharger must be replaced.

1. Ensure that the mounting bolts for the turbocharger are tight.

2. Check that the oil feed for the turbocharger is not blocked or restricted.

3. Check that the oil drain for the turbocharger is not blocked or restricted.

4. Check that the compressor housing for the turbocharger is free of dirt, debris, and damage.

5. Check that the turbine housing for the turbocharger is free of dirt, debris, damage, and oil deposits.

6. Check that the turbine wheel rotates freely in the turbocharger. Make sure that the compressor wheel rotates with the turbine wheel.

7. Ensure that the wastegate on the turbocharger is operating correctly. Refer to Systems Operation, Testing and Adjusting, “Turbocharger - Inspect”. If the wastegate actuator is faulty, replace the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”.

8. If necessary, replace the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”.

9. Check that the repairs have eliminated the faults.

10. If the fault has not been eliminated, proceed to “Fuel Supply”.

Turbochargers

This procedure is applicable only to engines that have two turbochargers.

Note: The turbochargers that are installed on the engine are nonserviceable items. If any mechanical fault exists, then the faulty turbocharger must be replaced.

1. Ensure that the mounting bolts for the turbochargers are tight.

2. Check that the oil feeds for the turbochargers are not blocked or restricted.

3. Check that the oil drains for the turbochargers are not blocked or restricted.

4. Check that the compressor housings for the turbochargers are free of dirt, debris, and damage.

Table 82

Diagnostic Trouble Code		
J1939 Code	**Code Description**	**Comments**
3242-17	Particulate Trap Intake Gas Temperature : Low - least severe (1)	The temperature at the intake of the DPF is below the trip point that is calculated by the ECM. The trip point varies depending on engine operating conditions. The code is logged. The code remains active until electrical power to the ECM is cycled.
3242-18	Particulate Trap Intake Gas Temperature : Low - moderate severity (2)	The temperature at the intake of the DPF is below the trip point that is calculated by the ECM. The trip point varies depending on engine operating conditions. Engine power is derated 30%. The code is logged. The code remains active until electrical power to the ECM is cycled.

Probable Causes

- Insulation on the exhaust duct (if equipped)
- Exhaust back pressure valve

Recommended Actions

Insulation on the Exhaust Duct (if equipped)

Check the insulation on the exhaust duct between the engine and the Clean Emissions Module (CEM). Make sure that insulation is not missing or damaged.

Exhaust Back Pressure Valve

1. Use the electronic service tool to check for any active diagnostic trouble codes that are associated with the exhaust back pressure valve.
2. Investigate any faults that are associated with the exhaust back pressure valve. Refer to Troubleshooting, “Motorized Valve - Test”.

i04079197

ECM Does Not Communicate with Other Modules

Probable Causes

- Electrical connectors
- Data Link
- Electronic Control Module (ECM)
- CAN data link

Recommended Actions

1. Connect the electronic service tool to the diagnostic connector. If the ECM does not communicate with the electronic service tool, refer to Troubleshooting, “Electronic Service Tool Does Not Communicate”.
2. Ensure that the following items are correctly installed and undamaged. Refer to Troubleshooting, “Electrical Connectors - Inspect”.
   - P1 and P2 connectors on the ECM
   - Wiring to display modules
   - Wiring to other control modules
3. Troubleshoot the data link for possible faults. Refer to Troubleshooting, “Data Link Circuit - Test”.
4. Verify that the CAN data link does not have an open or short circuit. Refer to Troubleshooting, “CAN Data Link Circuit - Test”.

i03937795

ECM Will Not Accept Factory Passwords

Probable Causes

One of the following items may not be recorded correctly on the electronic service tool:

- Passwords
- Serial numbers

2. Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”.

3. Install a new electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”.

4. Repeat the test in 1. If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”.

5. If all injectors have been checked and no faults are detected, proceed to “Individual Malfunctioning Cylinders”.

Individual Malfunctioning Cylinders

1. With the engine speed at a fast idle, use the electronic service tool to perform the manual “Cylinder Cut Out Test”. As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine. If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change that is less noticeable, the isolated cylinder may be operating below normal performance. Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance.

2. If the fault is not eliminated, repeat this test procedure from Test Step 1.

i03948949

Engine Overspeeds

This procedure covers the following diagnostic trouble code:

Table 83

Diagnostic Trouble Code for Engine Overspeed		
J1939 Code	**Description**	**Information About the Code**
190-15	Engine Overspeed Warning - Level 1	The engine has exceeded the value that is programmed into the ECM for 0.6 seconds. There are no diagnostic trouble codes for the speed/timing sensors. The engine has been running for at least 3 seconds.

Low Compression (cylinder pressure)

1. Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, “Compression - Test ”.
2. If low compression is noted on any cylinders, investigate the cause and rectify the cause.

   Possible causes of low compression are shown in the following list:

   - Loose glow plugs
   - Faulty piston
   - Faulty piston rings
   - Worn cylinder bores
   - Worn valves
   - Faulty cylinder head gasket
   - Damaged cylinder head
3. Perform all necessary repairs.
4. Ensure that the repair has eliminated the fault.
5. If the repair does not eliminate the fault, refer to “Individual Malfunctioning Cylinder”.

Individual Malfunctioning Cylinder

1. With the engine speed at a fast idle, use the electronic service tool to perform the manual “Cylinder Cut Out Test”. As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine. If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If a change in the sound of the engine is less noticeable, the cylinder may be operating below normal performance. Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance.
2. Rectify any faults.
3. If the fault has not been eliminated, contact your authorized Mitsubishi forklift truck dealer.

i04147995

Fuel Consumption Is Excessive

Probable Causes

- Diagnostic codes
- Misreading of fuel level
- Fuel leakage
- Fuel quality
- Quality of oil
- Low engine temperature
- Prolonged operation at idle speed
- Engine operating speed
- Air intake and exhaust system
- Cooling fan
- Reduced pressure of intake air
- Excessive valve lash
- Failure of the primary speed/timing sensor

Recommended Actions

Diagnostic Codes

Use one of the following methods to check for active diagnostic codes:

- The electronic service tool
- The display on the control panel
- Flash Codes

Electronic Service Tool

1. Connect the electronic service tool to the diagnostic connector.
2. Check for active diagnostic codes on the electronic service tool.
3. Investigate any active codes before continuing with this procedure. Refer to Troubleshooting, “Troubleshooting with a Diagnostic Code”.

Display on the Control Panel

Intake Air from a Heated Area

1. Ensure that the air inlet system is not receiving air from a heated area.
2. If necessary, relocate the air intake to the outside of the engine enclosure.
3. Check for air leaks in the pipe between the air inlet and the inlet to the turbocharger compressor.

i03900074

Intake Manifold Air Pressure Is High

Use this procedure in order to troubleshoot high intake manifold air pressure or use this procedure if one of the following event codes are active.

Table 88

Event Code		
J1939 Code	**Description**	**Information**
102-16	Engine Intake Manifold Pressure : High - moderate severity	Engine speed must be at least 650 rpm. The warning lamp will illuminate and the code is logged. The engine power is derated 20 percent.

Probable Causes

- Diagnostic codes
- Air inlet and exhaust restrictions
- Wastegate regulator
- Wastegate
- Full Load Setting (FLS)

Recommended Actions

Diagnostic Codes

Use one of the following methods to check for active diagnostic codes:

- The electronic service tool
- The display on the control panel
- Flash Codes

Electronic Service Tool

1. Connect the electronic service tool to the diagnostic connector.
2. Check for active diagnostic codes on the electronic service tool.
3. Investigate any active codes before continuing with this procedure. Refer to Troubleshooting, “Troubleshooting with a Diagnostic Code”.

Display on the Control Panel

Note: The following procedure is only applicable if the application is equipped with a display on the control panel.

1. Check the display on the control panel for active diagnostic codes.
2. Troubleshoot any active codes before continuing with this procedure. Refer to Troubleshooting, “Troubleshooting with a Diagnostic Code”.

Flash Codes

Note: The following procedure is only applicable if the machine is equipped with the appropriate warning lamps.

Engine Oil Cooler

1. If oil flow or coolant flow through the oil cooler is suspected of being low, replace the oil cooler. Refer to Disassembly and Assembly, “Engine Oil Cooler - Remove” and Disassembly and Assembly, “Engine Oil Cooler - Install”.

2. If the fault is still apparent, proceed to “Fuel in the Engine Oil”.

Fuel in the Engine Oil

1. If contamination of the engine oil with fuel is suspected, refer to Troubleshooting, “Oil Contains Fuel”.

2. If the fault is still apparent, proceed to “Piston Cooling Jets”.

Piston Cooling Jets

1. Inspect the piston cooling jets for damage. Replace any piston cooling jet that appears to be cracked, broken, or missing. Refer to Disassembly and Assembly, “Piston Cooling Jets - Remove and Install”.

2. If no damage is found, proceed to “Engine Oil Suction Tube”.

Engine Oil Suction Tube

1. Check the inlet screen on the oil suction tube and remove any material that may be restricting oil flow.

2. Check the joints of the oil suction tube for cracks or a damaged joint. Cracks or damage may allow air leakage into the supply to the oil pump.

3. If no faults are found, proceed to “Engine Oil Pump”.

Engine Oil Pump

1. Inspect the components of the engine oil pump for excessive wear. Repair the oil pump or replace the oil pump, if necessary. Refer to Disassembly and Assembly, “Engine Oil Pump - Remove”, Disassembly and Assembly, “Engine Oil Pump - Install” and Disassembly and Assembly, “Engine Oil Relief Valve - Remove and Install”.

2. If no faults are found, proceed to “Bearing Clearance”.

Bearing Clearance

Inspect the engine components for excessive bearing clearance or damaged bearings. If necessary, replace the bearings and/or the components. Inspect the following components for excessive bearing clearance:

- Crankshaft main bearings
- Connecting rod bearings
- Camshaft front bearing
- Idler gear bearing

If the fault is still present, contact your authorized Mitsubishi forklift truck dealer.

i04154092

Power Is Intermittently Low or Power Cutout Is Intermittent

Note: Use this procedure only if the engine does not shut down completely.

Probable Causes

- Diagnostic codes
- Electrical connectors
- ECM connection
- Fuel supply
- Intake manifold pressure

Recommended Actions

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

Diagnostic Codes

Use one of the following methods to check for active diagnostic codes:

- The electronic service tool
- The display on the control panel
- Flash Codes

Electronic Service Tool

(Table 97, contd)

CDL Code	Description	J1939 Code	Flash Code
E396-1	High Fuel Rail Pressure - Warning	157-15	159
E398-1	Low Fuel Rail Pressure - Warning	157-17	159
E499-3	Fuel Rail #1 Pressure Leak - Shutdown	1239-0	-
E539-1	High Intake Manifold Air Temperature - Warning	105-15	133
E539-2	High Intake Manifold Air Temperature - Derate	105-16	133
E583-1	High Air Inlet #1 Differential Pressure - Warning	107-15	151
E995-2	High DPF #1 Soot Loading - Derate	3719-16	-
E995-3	High DPF #1 Soot Loading - Shutdown	3719-0	-
E1014-1	Low DPF #1 Intake Temperature - Warning	3242-17	224
E1014-2	Low DPF #1 Intake Temperature - Derate	3242-18	224
E1044-2	High Intake Manifold Pressure - Derate	102-16	197
E1045-2	Low Intake Manifold Pressure - Derate	102-18	197
E1092-1	High Engine Exhaust Gas Recirculation Temperature - Warning	412-15	227
E1092-2	High Engine Exhaust Gas Recirculation Temperature - Derate	412-16	227
E1095-2	Low Engine Exhaust Gas Recirculation Mass Flow Rate - Derate	2659-18	-
E1096-1	High Engine Exhaust Gas Recirculation Mass Flow Rate - Warning	2659-15	-
E1096-2	High Engine Exhaust Gas Recirculation Mass Flow Rate - Derate	2659-16	-
E1121-2	Engine Exhaust Gas Recirculation Valve Control Not Responding to Command - Derate	2791-7	-
E1264-2	High Pressure Common Rail Fuel pressure relief valve active - Derate	5571-0	-
E1265-1	Particulate Trap Active Regeneration Inhibited Due to Low Exhaust Gas Pressure - Warning	5629-31	-
E2143-3	Low Engine Coolant Level - Shutdown	111-01	169

i03942012

No Diagnostic Codes Detected

Conditions Which Generate This Code:

A flash code 0551 indicates that there are no detected faults in the system since the previous powering up.

System Response:

This code will not appear on the electronic service tool. The indicator lamps will flash the diagnostic code. For more information on flash codes, refer to Troubleshooting, “Indicator Lamps”.

Possible Performance Effect:

None

There are no faults that require troubleshooting.

Results:

- OK – STOP.

Expected Result:

One or more of the diagnostic codes that are listed in Table 100 is active or recently logged.

Results:

- One or more of the preceding diagnostic codes is active or recently logged. **–** Proceed to Test Step 3.
- There are no active or recently logged diagnostic codes for the analog throttle position sensors. **–** Proceed to Test Step 5.

Test Step 3. Check the Throttle Position with the Electronic Service Tool

A. Connect the electronic service tool to the diagnostic connector.

B. Turn the keyswitch to the ON position. Do not start the engine.

C. Observe the throttle position reading on the electronic service tool.

D. Operate the throttle over the full range of movement.

Expected Result:

The output should increase when the throttle is increased.

The output should be between “20 percent” and “27 percent” at the low idle position. The output should be between “80 percent” and “87 percent” at the high idle position.

Results:

- OK **–** The sensor is operating correctly. Proceed to Test Step 4.
- Not OK – The ECM is not receiving a correct signal from the sensor. Proceed to Test Step 5.

Test Step 4. Check the Throttle Selection Status with the Electronic Service Tool

A. Check the status of the throttle selection switch (if equipped). Use the electronic service tool in order to check the status of the throttle selection switch.

Expected Result:

If the status of the throttle selection switch is shown in the OFF position, then the throttle 1 has control of the engine speed.

If the throttle selection switch status is shown in the ON position, then the throttle 2 has control of the engine speed.

The throttle may be overridden by using the SAE J1939 (CAN) data link or a PTO control.

Results:

- OK – The throttle selection switch is operating correctly.

  Repair: There may be an intermittent fault. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – The wrong throttle is selected. Change to the other throttle. There may be a fault with the selector switch input.

  Repair: Check the connections between the throttle selection switch and P1:70 and P1:64. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

Test Step 5. Check the Voltage at the Sensor

A. Turn the keyswitch to the OFF position.

B. Install a breakout “T” with three terminals to the sensor.

C. Turn the keyswitch to the ON position.

D. Measure the voltage between terminal “A” and terminal “B” on the breakout “T”.

Expected Result:

The supply voltage should be between 4.84 VDC and 5.16 VDC.

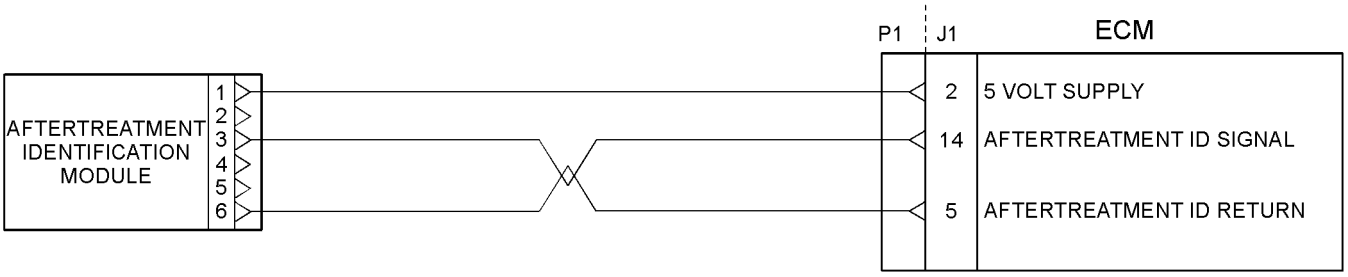
Results:

- The supply voltage is reaching the sensor. **–** Proceed to Test Step 6.
- The supply voltage is not reaching the sensor. – The fault is in the 5 VDC supply wire or the sensor ground wire between the suspect throttle position sensor and the ECM.

  Repair: Repair the faulty harness or replace the faulty harness.

  Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

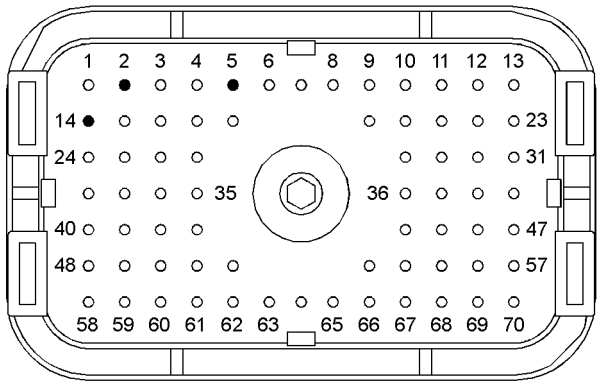
  STOP.



g02094894

Illustration 122

Schematic for the aftertreatment identification module

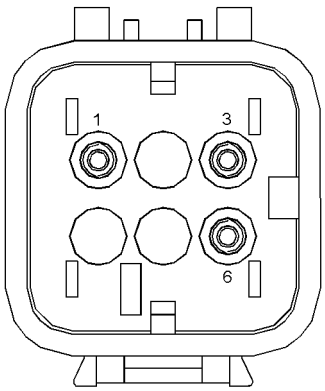


g02094913

Illustration 123

View of the pin locations on the P2 connector for the aftertreatment identification module

(2) 5 VDC supply
(5) The return for the aftertreatment identification module
(14) The signal for the aftertreatment identification module



g02084579

Illustration 124

Typical example of the connector for the aftertreatment identification module

(1) 5 VDC Supply
(3) Signal
(6) Ground

Test Step 1. Check for Diagnostic Trouble Codes

A. Establish communication between the electronic service tool and the ECM.

B. Download the “Product Summary Report” from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes.

Results:

- A 5576-2 diagnostic code is active. **–** Proceed to Test Step 5.
- A 5576-8 diagnostic code is active **–** Proceed to Test Step 2.
- A 5576-14 diagnostic code is active **–** Proceed to Test Step 5.

Test Step 2. Inspect Electrical Connectors and Wiring

A. Inspect the connector for the aftertreatment identification module. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the aftertreatment identification module.

C. Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).

D. Check the harness for abrasion and pinch points from the aftertreatment identification module back to the ECM.

A. Ensure that the locking wedge for the connector is installed correctly. Terminals cannot be retained inside the connector if the locking wedge is not installed correctly.

B. Perform the 45 N (10 lb) pull test on each wire. Each terminal and each connector should easily withstand 45 N (10 lb) of tension and each wire should remain in the connector body. This test checks whether the wire was correctly crimped in the terminal and whether the terminal was correctly inserted into the connector.

Results:

- Each terminal and each connector easily withstand 45 N (10 lb) of pull and each wire remains in the connector body. – All terminals pass the pull test. Proceed to Test Step 5.
- A wire has been pulled from a terminal or a terminal has been pulled from the connector.

  Repair: Use the 2900A033 Crimp Tool to replace the terminal. Replace damaged connectors, as required.

  Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

  STOP.

Test Step 5. Check Individual Pin Retention into the Socket

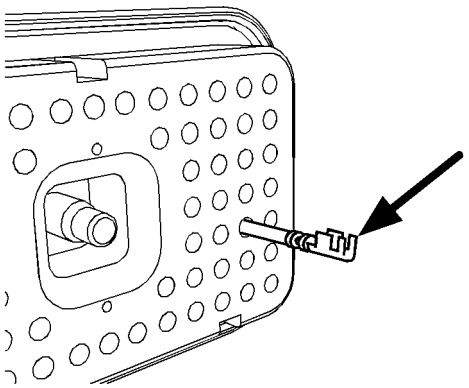


Illustration 135 g02022414

A. Verify that the sockets provide good retention for the pins. Insert a new pin into each socket one at a time in order to check for a good grip on the pin by the socket.

Results:

- The sockets provide good retention for the new pin – The terminals are OK. Proceed to Test Step 6.
- Terminals are damaged.

  Repair: Use the 2900A033 Crimp Tool to replace the damaged terminals. Verify that the repair eliminates the problem.

  Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

  STOP.

Test Step 6. Check the Locking Mechanism of the Connectors

A. Ensure that the connectors lock correctly. After locking the connectors, ensure that the two halves cannot be pulled apart.

B. Verify that the latch tab of the connector is correctly latched. Also verify that the latch tab of the connector returns to the locked position.

Results:

- The connector is securely locked. The connector and the locking mechanism are without cracks or breaks. – The connectors are in good repair. Proceed to Test Step 7.
- The locking mechanism for the connector is damaged or missing. –

  Repair: Repair the connector or replace the connector, as required.

  Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

  STOP.

Test Step 7. Check the Screws on the ECM Connectors (70 way)

Visually inspect the screws for the ECM connectors. Ensure that the threads on each screw are not damaged.

A. Connect the ECM connectors.

a. Use a 7 mm screw in order to retain each of the ECM connectors.

b. Tighten the two screws for the ECM connector to the correct torque of 6 N·m (53 lb in).

Expected Result:

The ECM connectors are secure and the screws are correctly torqued.

B. Exchange the primary speed/timing sensor with the secondary speed/timing sensor. Refer to Disassembly and Assembly, “Crankshaft Position Sensor - Remove and Install” and refer to Disassembly and Assembly, “Camshaft Position Sensor - Remove and Install”.

C. Turn the keyswitch to the ON position.

D. Start the engine.

E. Use the electronic service tool to check for active diagnostic codes. Wait for 30 seconds in order for diagnostic codes to become active.

Expected Result:

One of the following conditions exists:

- A 190-8 diagnostic code was previously active. A 723-8 diagnostic code is now active.
- A 723-8 diagnostic code was previously active. A 190-8 diagnostic code is now active.

Results:

- OK – The active diagnostic code is now for the other speed/timing sensor.

  Repair: Perform the following repair:

  1. Turn the keyswitch to the OFF position.
  2. Disconnect the suspect sensor and remove the suspect sensor from the engine.
  3. Install a replacement sensor. Refer to Disassembly and Assembly, “Crankshaft Position Sensor - Remove and Install” or refer to Disassembly and Assembly, “Camshaft Position Sensor - Remove and Install”.
  4. Turn the keyswitch to the ON position.
  5. Start the engine.
  6. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.

  STOP.

- Not OK – The diagnostic code that was previously active is still active. Proceed to Test Step 7.

Test Step 7. Bypass the Signal Wire for the Speed/Timing Sensor

A. Turn the keyswitch to the OFF position.

B. Disconnect the P2 connector. Disconnect the connector for the suspect speed/timing sensor.

C. For a 190-8 diagnostic code, remove the wire from P2:38. For a 723-8 diagnostic code, remove the wire from P2:39.

D. Remove the wire from terminal 2 of the connector for the speed/timing sensor.

E. Fabricate a jumper wire that is long enough to reach from the connector for the speed/timing sensor to the P2 connector.

F. Insert one end of the jumper wire into terminal 2 on the connector for the speed/timing sensor. Insert the other end of the jumper wire into the terminal for the signal of the speed/timing sensor on the P2 connector.

G. Reconnect the P2 connector and the connector for the speed/timing sensor.

H. Turn the keyswitch to the ON position.

I. Start the engine.

J. Use the electronic service tool to check for active diagnostic codes. Wait for 30 seconds in order for diagnostic codes to become active.

Expected Result:

There are no active diagnostic codes.

Results:

- OK – The fault is in the harness.

  Repair: Repair the faulty connectors or replace the faulty connectors. Repair the faulty harness or replace the faulty harness. Reconnect all sensor and ECM connectors. Ensure that all of the seals are correctly in place. Ensure that all connectors are correctly coupled.

  Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

  STOP.

- Not OK – The XXX-8 diagnostic code for the speed/timing sensor is still active. Remove all jumper wires and replace all wires to the original configuration. Proceed to Test Step 8.

Test Step 8. Check if the Replacement of the ECM Eliminates the Fault

A. Make sure that the latest flash file for the application is installed in the ECM. Refer to Troubleshooting, “Flash Programming”.

B. Contact the your authorized Mitsubishi forklift truck dealer.

⚠ WARNING

Breathing ether vapors or repeated contact of ether with skin can cause personal injury. Personal injury may occur from failure to adhere to the following procedures.

Use ether only in well ventilated areas.

Do not smoke while changing ether cylinders.

Use ether with care to avoid fires.

Do not store replacement ether cylinders in living areas or in the operator's compartment.

Do not store ether cylinders in direct sunlight or at temperatures above 49 °C (120 °F).

Discard cylinders in a safe place. Do not puncture or burn cylinders.

Keep ether cylinders out of the reach of unauthorized personnel.

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

B. Inspect the connector for the ether injection solenoid. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the ether injection system.

D. Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).

E. Check the harness and the wiring for abrasion and for pinch points from the ether injection solenoid to the ECM.

Expected Result:

All connectors, pins, and sockets are correctly connected, and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The connectors and the wiring appear to be OK. Proceed to Test Step 2.
- Not OK – The connectors and/or the wiring are not OK.

  Repair: Repair the connectors and/or the wiring. Replace parts, if necessary.

  If necessary, use the electronic service tool to perform a “Wiggle Test”.

  Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

  STOP.

Test Step 2. Check for Active Diagnostic Codes

Note: Remove the ether canister before you perform this procedure.

A. Connect the electronic service tool to the diagnostic connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Restore electrical power to the engine ECM.

C. Proceed to the “Diagnostic Overrides” screen on the electronic service tool.

D. Activate the ether injection system. The system will activate for 10 seconds.

E. Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

F. Check for a 626-5 diagnostic code or a 626-6 diagnostic code.

Results:

- Neither diagnostic code is active.

  Repair: The fault may have been caused by a poor electrical connection. Carefully inspect the connectors and the wiring. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- A 626-6 code is active at this time – Proceed to Test Step 3.
- A 626-5 code is active at this time – Proceed to Test Step 4.

Test Step 3. Create an Open at the Harness Connector for the Ether Injection Solenoid

A. Remove electrical power from the engine ECM.

B. Disconnect the connector for the solenoid.

C. Restore electrical power to the engine ECM.

Results:

- The fuse is blown. – There is a short circuit in the wiring between the fuse and the glow plug start aid relay.

  Repair: Perform the following repair:

  1. Repair the faulty wiring or replace the faulty wiring. Replace the fuse. Reconnect the relay.
  2. Turn the battery disconnect switch to the ON position. Turn the keyswitch to the ON position.
  3. Use the electronic service tool to perform the “Glow Plug Start Aid Override Test”.
  4. Confirm that the fault has been eliminated.

  STOP.

- The fuse is not blown. – The wiring between the fuse and the relay is OK. Proceed to Test Step 13.

Test Step 13. Check the Wiring between the Relay and the Bus Bar for a Short Circuit

A. Disconnect the power supply wire from the bus bar.

B. Measure the resistance between Test Point B on the harness connector for the relay to a suitable ground.

Expected Result:

The resistance should be more than 10,000 Ohms.

Results:

- OK – The resistance is more than 10,000 Ohms. The wiring between the relay and the bus bar is not shorted. The fault is in the relay.

  Repair: Perform the following repair:

  1. Install a replacement relay. Reconnect the power supply wire to the bus bar.
  2. Turn the battery disconnect switch to the ON position. Turn the keyswitch to the ON position. Reconnect the relay.
  3. Use the electronic service tool to perform the “Glow Plug Start Aid Override Test”.
  4. Confirm that the fault has been eliminated.

  STOP.

- Not OK – The resistance is less than 10,000 Ohms. The wiring between the relay and the bus bar is shorted.

  Repair: Perform the following repair:

  1. Repair the faulty wiring or replace the faulty wiring. Reconnect the relay.
  2. Turn the battery disconnect switch to the ON position. Turn the keyswitch to the ON position.
  3. Use the electronic service tool to perform the “Glow Plug Start Aid Override Test”.
  4. Confirm that the fault has been eliminated.

  STOP.

Test Step 14. Check the Input Voltage to the Relay

A. Disconnect the connector for the glow plug start aid relay.

B. Turn the battery disconnect switch to the ON position.

C. Measure the voltage at Test Point A on the harness connector for the relay to a suitable ground.

Expected Result:

For 12 V systems, the measured voltage should be a constant 11.0 to 13.5 VDC.

For 24 V systems, the measured voltage should be a constant 22.0 to 27.0 VDC.

Results:

- OK – The voltage is within the expected range. The wiring between the battery and the relay is OK. Leave the relay connector disconnected. Proceed to Test Step 15.

- Not OK – The voltage is not within the expected range. The fault is in the wiring between the battery and the relay.

  Repair: Perform the following repair:

  1. Repair the faulty wiring or replace the faulty wiring.
  2. Turn the keyswitch to the ON position. Reconnect the relay.
  3. Use the electronic service tool to perform the “Glow Plug Start Aid Override Test”.

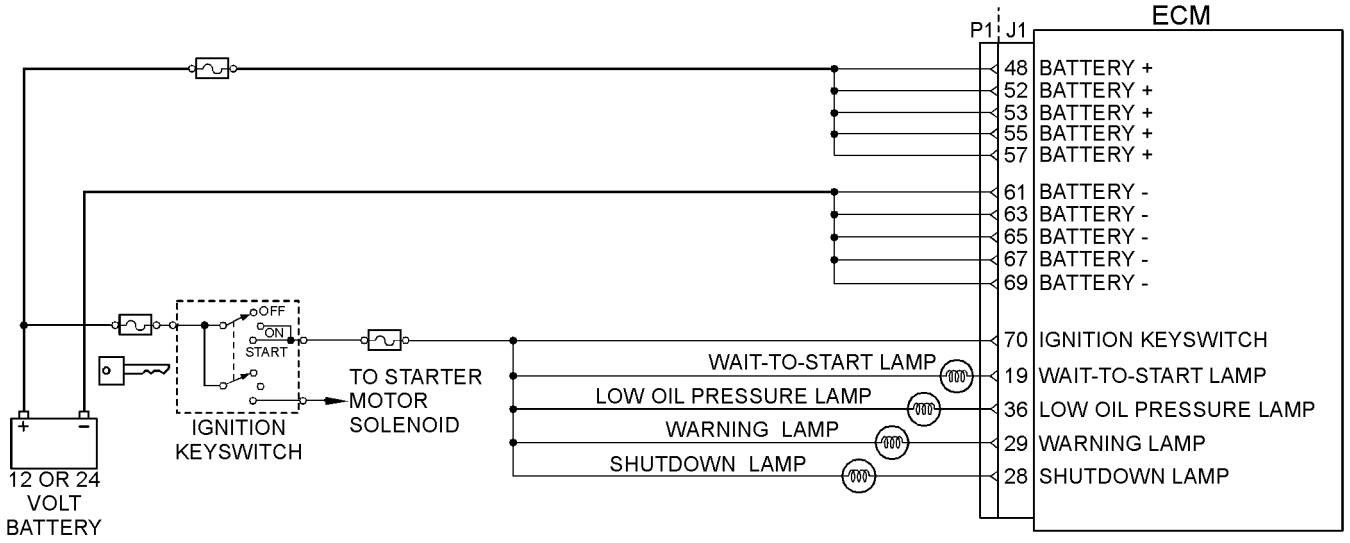


Illustration 165 g02490517

Typical schematic of the circuit for the indicator lamps

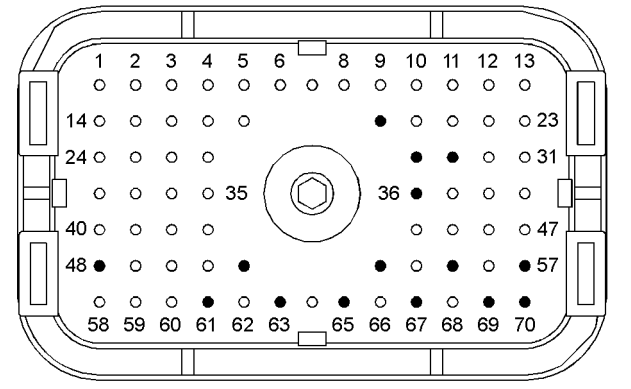


Illustration 166 g02118994

Typical example of the pin locations on the P1 connector for the indicator lamps

(19) Wait-to-Start lamp
(28) Shutdown lamp
(29) Warning lamp
(36) Low oil pressure lamp
(48) Battery (+)
(52) Battery (+)
(53) Battery (+)
(55) Battery (+)
(57) Battery (+)
(61) Ground
(63) Ground
(65) Ground
(67) Ground
(69) Ground
(70) Ignition keyswitch

Test Step 1. Inspect Electrical Connectors and Wiring

A. Turn the keyswitch to the OFF position.

B. Thoroughly inspect the lamp connections. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

C. Perform a 45 N (10 lb) pull test on each of the wires in the P1 connector that are associated with the indicator lamps.

D. Check the screw for the P1 connector for the correct torque of 6 N·m (53 lb in).

E. Check the harness for abrasions and for pinch points from the battery to the ECM.

Results:

- OK – Proceed to Test Step 2.
- Not OK

  Repair: Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all of the seals are correctly in place and ensure that the connectors are correctly coupled.

  Verify that the repair eliminates the fault.

  STOP.

Test Step 2. Inspect the Lamp, the Fuse, and the Power Supply

A. Disconnect the lamp from the harness. Inspect the lamp in order to determine if the lamp has failed.

B. Measure the resistance across the two terminals of the lamp. If the resistance is more than 2000 Ohms, the bulb has failed.

Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair has eliminated the fault.

STOP.

i04156734

Motorized Valve - Test

System Operation Description:

This procedure covers the following codes:

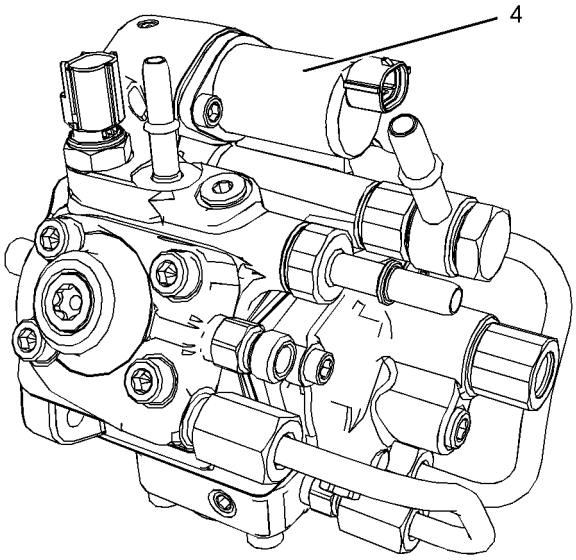


Illustration 189 g02126869

High-pressure fuel pump for the 1206E-E66 engine

(4) Solenoid for the Suction Control Valve (SCV)

Test Step 1. Inspect Electrical Connectors and Wiring

A. Thoroughly inspect the connectors for the solenoid valves. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

B. Perform a 45 N (10 lb) pull test on each wire that is associated with the solenoid valves.

C. Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).

Expected Result:

Results:

- All connectors, pins, and sockets are correctly connected and the harness is free of corrosion, abrasion, and pinch points **–** Proceed to Test Step 2.
- There is a fault in the connectors and/or the harness.

  Repair: Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all of the seals are correctly in place and ensure that the connectors are correctly connected.

  Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

  STOP.

Test Step 2. Check for Diagnostic Codes

A. Turn the keyswitch to the OFF position.

B. Connect the electronic service tool to the diagnostic connector.

C. Turn the keyswitch to the ON position.

D. Monitor the electronic service tool for active diagnostic codes and/or logged diagnostic codes.

Results:

- An XXXX-5 diagnostic code is active or recently logged **–** Proceed to Test Step 3.
- An XXXX-6 diagnostic code is active or recently logged **–** Proceed to Test Step 4.
- No Codes – The fault seems to be resolved.

  Repair: For intermittent faults, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

Test Step 3. Create a Short Circuit at the Solenoid Connector

A. Turn the keyswitch to the OFF position.

B. Disconnect the connector for the suspect solenoid.

C. Fabricate a jumper wire. Install the wire between the two pins on the connector for the suspect solenoid in order to create a short circuit.

D. Turn the keyswitch to the ON position. Check for active diagnostic codes on the electronic service tool.

E. Remove the jumper wire from the connector for the solenoid valve.

Results:

- Diagnostic code XXXX-6 is active when the jumper wire is installed – There is a fault in the solenoid.

  Repair: Perform the following procedure:

  1. Temporarily connect a replacement for the suspect component to the harness.
  2. Turn the keyswitch to the ON position. Use the electronic service tool in order to check for active diagnostic codes. Wait at least 30 seconds in order for the codes to be displayed.

5. If the fault is resolved with the test ECM, reconnect the suspect ECM.

6. If the fault returns with the suspect ECM, replace the ECM.

7. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

STOP.

i04025951

Water In Fuel Sensor - Test

System Operation Description:

For a 97-15 diagnostic code, refer to Troubleshooting, “Fuel Contains Water” before returning to this procedure.

This procedure covers the following diagnostic code:

Table 126

Diagnostic Trouble Code for the Water-in-Fuel Sensor		
J1939 Code	**Description**	**Notes**
97-3	Water In Fuel Indicator : Voltage Above Normal	The ECM detects the following conditions: An open circuit in the Water-In-Fuel (WIF) sensor circuit. The ECM has been powered for less than 5 seconds. The warning lamp will stay on when the “indicator lamp self check” has been completed. The ECM will disable the function to detect water in fuel while the code is active.

Water-in-Fuel Sensor Operation

The WIF sensor is a normally open sensor. During normal operation, there will be no signal sent from the WIF sensor to the ECM. If water is detected in the fuel, the sensor will send a signal to the ECM. If the signal remains constant for 45 seconds, a 97-15 diagnostic code will become active. This diagnostic code can also be caused by a short in the WIF sensor circuit.

Water-in-Fuel Sensor Self Check

When the ignition keyswitch is turned to the ON position, the switch in the WIF sensor will close for 5 seconds. If the ECM does not detect a signal from the WIF sensor during this period, a 97-3 diagnostic code will become active.

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Mitsubishi Forklift Trucks cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Mitsubishi Forklift Trucks is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Mitsubishi forklift truck dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Mitsubishi Forklift Trucks recommends using Mitsubishi replacement parts.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

Uncontrolled electrical circuit paths can result in damage to the crankshaft bearing journal surfaces and to aluminum components.

Engines that are installed without engine-to-frame ground straps can be damaged by electrical discharge.

To ensure that the engine and the engine electrical systems function correctly, an engine-to-frame ground strap with a direct path to the battery must be used. This path may be provided by way of a direct engine ground to the frame.

The connections for the grounds should be tight and free of corrosion. The engine alternator must be grounded to the negative “-” battery terminal with a wire that is adequate to handle the full charging current of the alternator.

The power supply connections and the ground connections for the engine electronics should always be from the isolator to the battery.

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Engine Electronics

⚠ WARNING

Tampering with the electronic system installation or the truck wiring installation can be dangerous and could result in personal injury or death and/or engine damage.

⚠ WARNING

Electrical Shock Hazard. The electronic unit injectors use DC voltage. The ECM sends this voltage to the electronic unit injectors. Do not come in contact with the harness connector for the electronic unit injectors while the engine is operating. Failure to follow this instruction could result in personal injury or death.

This engine has a comprehensive, programmable Engine Monitoring System. The Electronic Control Module (ECM) has the ability to monitor the engine operating conditions. If any of the engine parameters extend outside an allowable range, the ECM will initiate an immediate action.

The following actions are available for engine monitoring control:

- Warning
- Derate
- Shutdown

The following monitored engine operating conditions have the ability to limit engine speed and/or the engine power:

- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Speed
- Intake Manifold Air Temperature
- Engine Intake Throttle Valve Fault
- Wastegate Regulator
- Supply Voltage to Sensors
- Fuel Pressure in Manifold (Rail)
- NOx Reduction System
- Engine Aftertreatment System

The Engine Monitoring package can vary for different engine models and different engine applications. However, the monitoring system and the engine monitoring control will be similar for all engines.

Note: Many of the engine control systems and display modules that are available for Mitsubishi Engines will work in unison with the Engine Monitoring System. Together, the two controls will provide the engine monitoring function for the specific engine application. Refer to Troubleshooting for more information on the Engine Monitoring System.

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Product Lifting (Clean Emission Module)

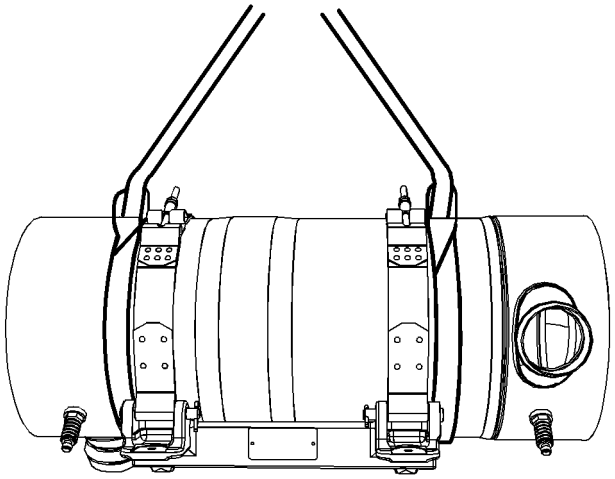

Illustration 32 g02385036

Ensure that the correct clothing is worn, refer to this Operation and Maintenance Manual, “General Hazard Information”.

The weight of the clean emission module (CEM) when laden is approximately 50 kg (110 lb). Two suitable double looped slings are required in order to lift the CEM. Also a suitable hoist will be required in order to remove and install the assembly.

The slings must be attached to the CEM in the positions as shown in illustration 32.

Ensure that the slings only contact the body of the CEM. A test lift may be required in order to achieve the correct balance of the assembly.

Some applications may require a frame or jig in order to lift the CEM. A frame or jig must only be connected to the cradle of the CEM. Refer to the truck manual for more information.

i04084189

Product Storage (Engine and Aftertreatment)

Mitsubishi Forklift Trucks are not responsible for damage which may occur when an engine is in storage after a period in service.

Your authorized Mitsubishi forklift truck dealer can assist in preparing the engine for extended storage periods.

Condition for Storage

The engine must be stored in a water proof building. The building must be kept at a constant temperature. Engines that are filled with Mitsubishi ELC will have coolant protectionto anambient temperature of −36° C (−32.8° F). The engine must not be subjected to extreme variations in temperature and humidity.

Storage Period

An engine can be stored for up to 6 months provided all the recommendation are adhered to.

Storage Procedure

Keep a record of the procedure that has been completed on the engine.

Note: Do not store an engine that has biodiesel in the fuel system.

1. Ensure that the engine is clean and dry.
   a. If the engine has been operated using biodiesel, the system must be drained and new filters installed. The fuel tank will require flushing.
   b. Fill the fuel system with an ultra low sulfur fuel. For more information on acceptable fuels refer to this Operation and Maintenance Manual, “Fluid recommendations”. Operate the engine for 15 minutes in order to remove all biodiesel from the system.
2. Drain any water from the primary filter water separator. Ensure that the fuel tank is full.
3. The engine oil will not need to be drained in order to store the engine. Provided the correct specification of engine oil is used the engine can be stored for up to 6 months. For the correct specification of engine oil refer to this Operation and Maintenance Manual, “Fluid recommendations”.

(Table 3, contd)

Fuel rail pressure sensor out of range	159
Fuel temperature sensor out of range	165
Engine coolant temperature sensor out of range	168
Low Engine Coolant Level - Shutdown	169
Turbo wastegate drive out of range	177
Intake manifold pressure sensor out of range	197
Glow plug start aid relay current above normal	199
Diesel Particulate Filter DPF Intake temperature sensor out of range	224
DPF Soot sensors out of range	226
Exhaust gas recirculation temperature/pressure out of range	227
Exhaust gas recirculation valve control current out of range	228
Exhaust gas recirculation valve control voltage out of range	229
Exhaust gas recirculation pressure sensor out of range	231
Air inlet temperature sensor voltage out of range	232
Ether injection control solenoid out of range	233
Idle validation switch #1 erratic, intermittent, or incorrect	245
Idle validation switch #2 erratic, intermittent, or incorrect	246
Exhaust Gas Recirculation Outlet Pressure Sensor out of range	247
Exhaust back pressure regulator position voltage out of range	249
Engine Fuel Supply Lift Pump Relay out of range	253
Personality module erratic, intermittent, or incorrect	415
Machine security system module abnormal update rate	426
Ignition key switch loss of signal	429
Electrical System Voltage fault	511
SAE J1939 Data Link abnormal update rate	514
5 Volt sensor DC power supply voltage out of range	516

(continued)

(Table 3, contd)

8 V DC Supply voltage out of range	517
Programmed parameter fault erratic, intermittent, or incorrect	527
5 Volt Sensor DC Power Supply #2 out of range	528
No diagnostic code detected	551

Refer to Troubleshooting, “Diagnostic Flash Code Cross Reference” for more information.

i01902949

Fault Logging

The system provides the capability of Fault Logging. When the Electronic Control Module (ECM) generates an active diagnostic code, the code will be logged in the memory of the ECM. The codes that have been logged by the ECM can be identified by the electronic service tool. The active codes that have been logged will be cleared when the fault has been rectified or the fault is no longer active. The following logged faults can not be cleared from the memory of the ECM without using a factory password: Overspeed, low engine oil pressure, and high engine coolant temperature.

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