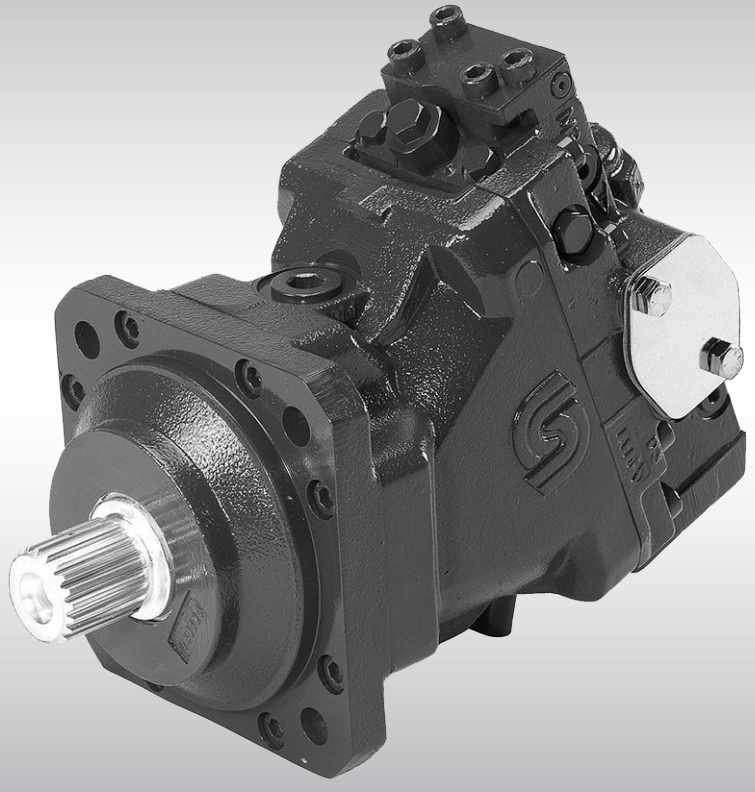
MAKING MODERN LIVING POSSIBLE

Service Manual

Series 51 - HZ, HA, HB, HE, HS, H1, H2, K1, K2, HP, HC, J1, J2, J3, J4, JA

Hydraulic Proportional Controls



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Revision history

Table of revisions

Date	Changed	Rev
July 2014	Danfoss layout	BA
November 2010	new last page	AC
February 2010	Fix Osaka address	AB
July 2009	First edition	AA

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Introduction

Safety Precautions

Always consider safety precautions before beginning a service procedure. Protect yourself and others from injury. Take the following general precautions whenever servicing a hydraulic system.

Unintended Machine Movement

Warning

Unintended movement of the machine or mechanism may cause injury to the technician or bystanders. To protect against unintended movement, secure the machine or disable/disconnect the mechanism while servicing.

Flammable Cleaning Solvents

Warning

Some cleaning solvents are flammable. To avoid possible fire, do not use cleaning solvents in an area where a source of ignition may be present.

Fluid Under Pressure

Warning

Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury and/or infection. This fluid may also be hot enough to cause burns. Use caution when dealing with hydraulic fluid under pressure. Relieve pressure in the system before removing hoses, fittings, gauges, or components. Never use your hand or any other body part to check for leaks in a pressurized line. Seek medical attention immediately if you are cut by hydraulic fluid.

Personal Safety

Warning

Protect yourself from injury. Use proper safety equipment, including safety glasses, at all times.

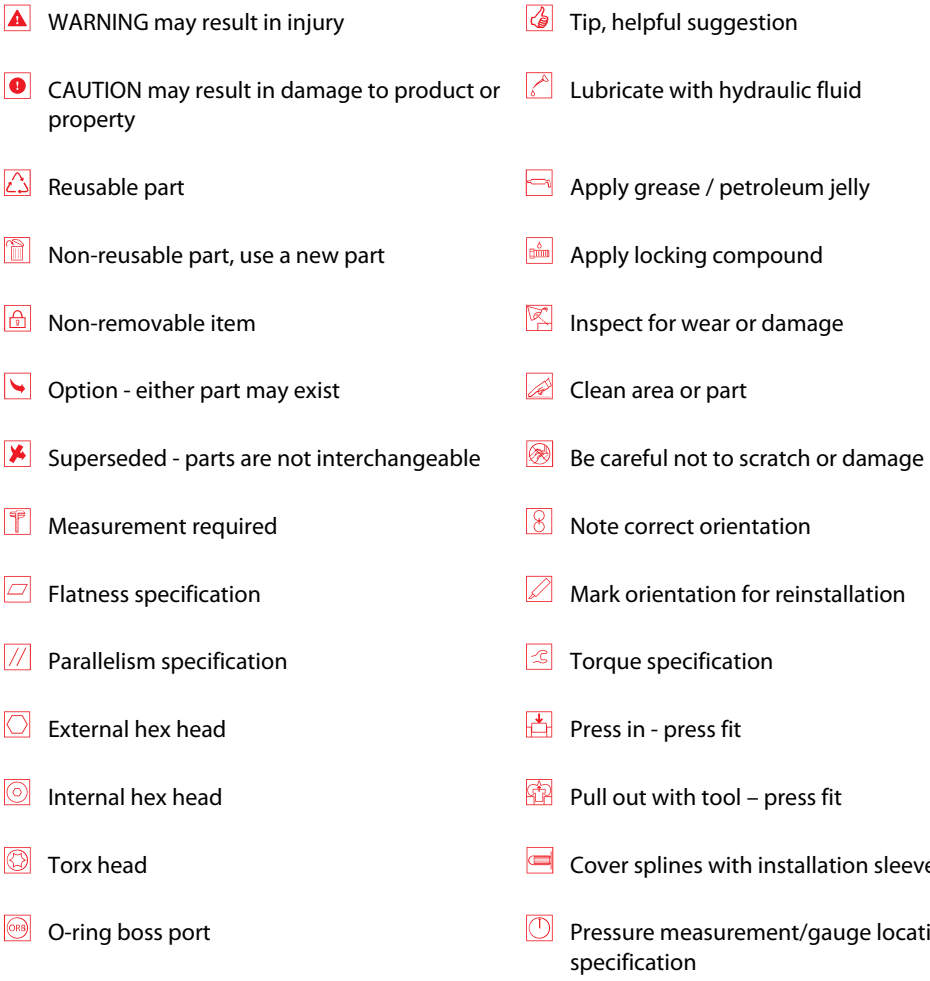
Hazardous Material

Warning

Hydraulic fluid contains hazardous material. Avoid prolonged contact with hydraulic fluid. Always dispose of used hydraulic fluid according to state, and federal environmental regulations.

Introduction

Symbols used in Danfoss literature



The symbols above appear in the illustrations and text of this manual. They are intended to communicate helpful information at the point where it is most useful to the reader. In most instances, the appearance of the symbol itself denotes its meaning. The legend above defines each symbol and explains its purpose.

Overview

This manual includes information for the installation, maintenance, and minor repair of Series 51 hydraulic proportional controls. It includes a description of the unit and its individual components, and minor repair procedures.

Performing minor repairs may require removal of the unit from the vehicle/machine. Thoroughly clean the unit before beginning maintenance, or repair activities. Since dirt and contamination are the greatest enemies of any type of hydraulic equipment, follow cleanliness requirements strictly. This is especially important when changing the system filter and when removing hoses or plumbing.

A worldwide network of Danfoss Global Service Partners is available for major repairs. Danfoss Global Service Partners are trained by the factory and certified on a regular basis. You can locate your nearest Global Service Partner using the distributor locator at www.powersolutions.danfoss.com. Click on the *Sales and Service* link.

Introduction

General Instructions

Keep it Clean

You can complete many repairs or adjustments without removing the unit from the machine, *if* the unit is accessible and you can thoroughly clean it before beginning any procedures.

Cleanliness is a primary means of assuring satisfactory motor life on either new or repaired units. *Clean the outside of the motor thoroughly before disassembly*. Take care to avoid contamination of the system ports. Cleaning parts with a clean solvent wash and air drying is usually adequate.

As with any precision equipment, keep all parts free of foreign materials and chemicals. Protect all exposed sealing surfaces and open cavities from damage and foreign material. Cap all hoses after removal, and plug all open ports. Cover any unattended parts with a protective layer of plastic.

Inspect for System Contamination

Inspect the motor for signs of system contamination. If you find contamination, fully disassemble, clean and inspect all components of the motor.

Replace the O-rings and Gaskets

Replace all O-rings and gaskets. Discard them only after you make certain that you have the correct replacement parts. Lightly lubricate all O-rings with clean petroleum jelly before assembly.

Lubricate all Moving Parts

During reassembly, coat all moving parts with a film of clean hydraulic oil. This helps lubricate the surfaces during start-up.

For fluid quality requirements, refer to **520L0463** *Hydraulic Fluids and Lubricants, Technical Information*.

Torque Procedure

During reassembly, cross torque all retaining screws to the given value. Do not overtorque.

General Description

Overview

Hydraulic proportional controls infinitely vary the motor displacement between maximum and minimum by feeding a variable hydraulic signal pressure to the end of the 4-way valve directly, or to a piston that moves the 4-way valve As signal-pressure shifts the 4-way valve, it ports pressure to the ends of the servo piston, changing motor displacement. A threshold spring and a ramp spring act on the opposite end of the 4-way valve.

Threshold and Ramp Springs

The threshold adjustment screw varies the threshold spring force required to move the 4-way valve and start the change in displacement. The ramp spring(s)—2 used in 160cc and 250cc motors, and one used in the 80 cc and 110cc motors—increase the force on the 4-way valve as the servo piston moves toward minimum displacement. This provides a motor displacement proportional to the input signal pressure.

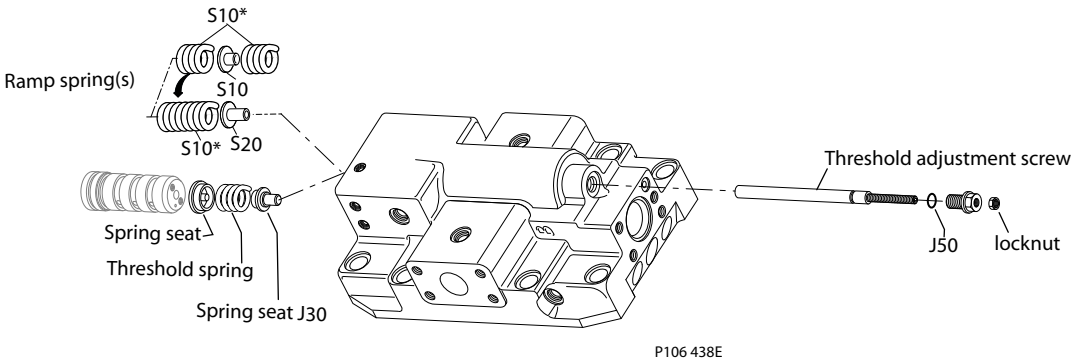
The control operating threshold (the signal pressure when the motor starts to shift) is adjustable. Adjust it using the adjusting screw in the end cap.

Changing ramp spring force requires replacing the springs. There are several spring rates available.

Optional orifices may be installed at several locations to regulate shift speed. Refer to the Model Code for your motor for details.

Introduction

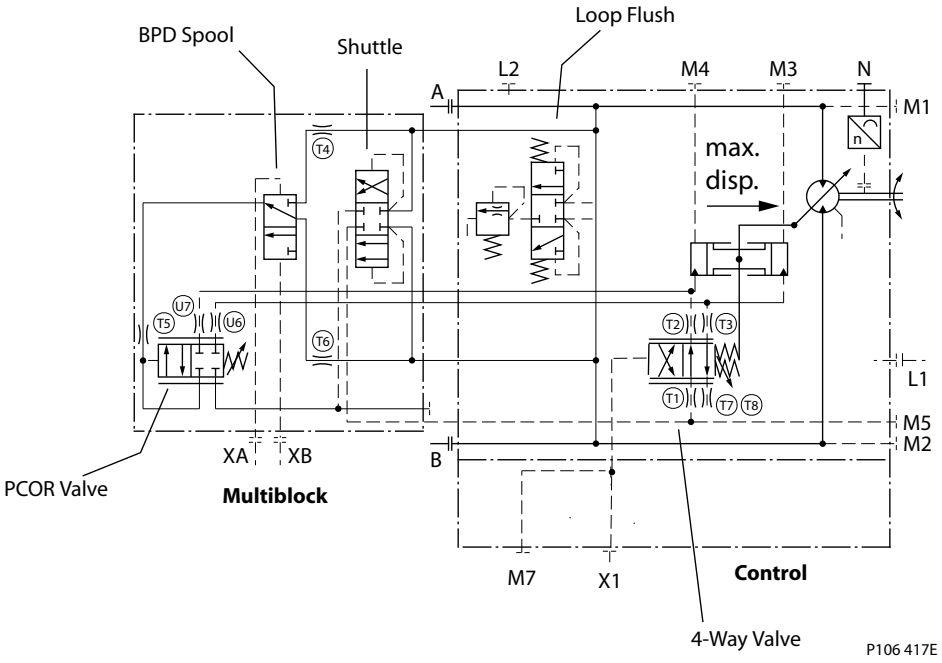
Threshold and Ramp Springs



Multiblock

Some hydraulic proportional controls are used in conjunction with the multiblock. The multiblock is a manifold with a shuttle-valve that routes high loop (system pressure) from port A or port B to the 4-way valve to serve as servo supply and to the PCOR function. The shuttle valve also routes the low pressure side of the loop to the PCOR function.

Multifunction Schematic



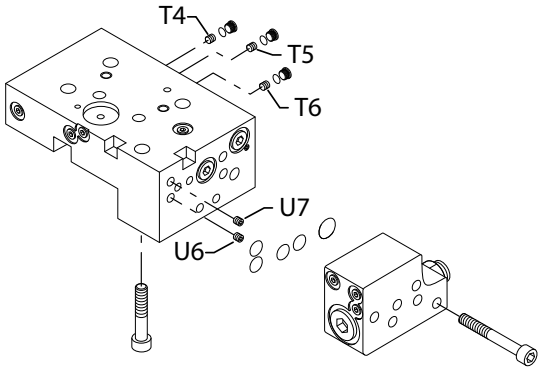
Pressure Compensator OverRide (PCOR) Function

The Pressure Compensator OverRide (PCOR) function allows the motor to match its displacement to the system load. The PCOR overrides the control command allowing the motor to increase displacement when system pressure reaches a set level due to load. This permits the motor to regulate system pressure by modulating the displacement of the rotating group. As displacement increases, available torque increases. Output speed decreases and system pressure remains nearly constant at the PCOR setting.

The PCOR setting is adjustable from 110 to 370 bar [1595 to 5365 psi]. Optional orifices at locations T4, T5, T6, U6, and U7 regulate the PCOR operation speed.

Introduction

Optional Orifices: T4, T5, T6, U6, U7



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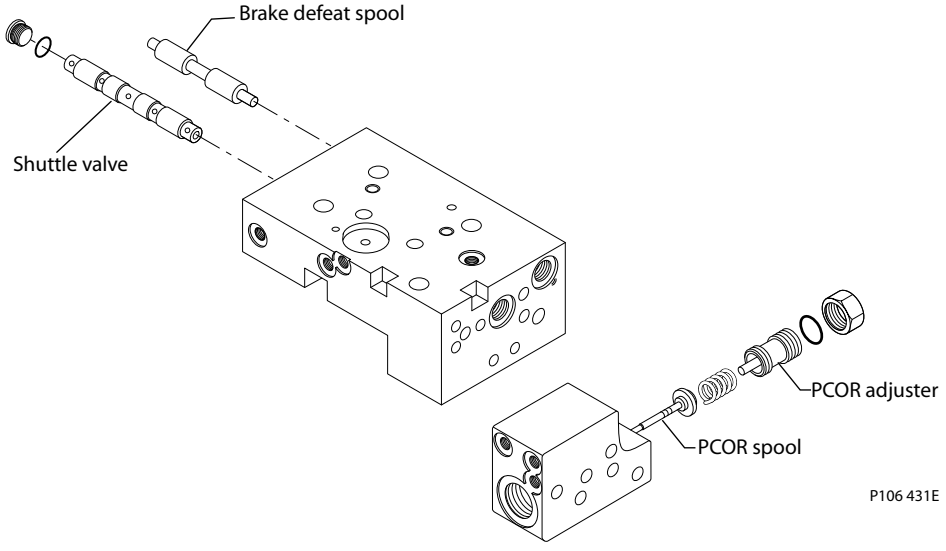
Brake Pressure Defeat (BPD) Option

The PCOR function can be equipped with an optional brake pressure defeat (BPD) option that defeats the PCOR operation during dynamic braking. A shuttle spool ahead of the PCOR valve directs only acceleration system pressure to the PCOR. During deceleration the dynamic braking pressure is blocked from the PCOR limiting rapid deceleration, uncontrolled pressures or engine over-speeding while the vehicle/machine is slowing down. An external hydraulic signal pressure fed to ports XA or XB are required to operate the BPD spool. PCOR operation on one system pressure side is also an option.

BPD Option



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Pressure measurements

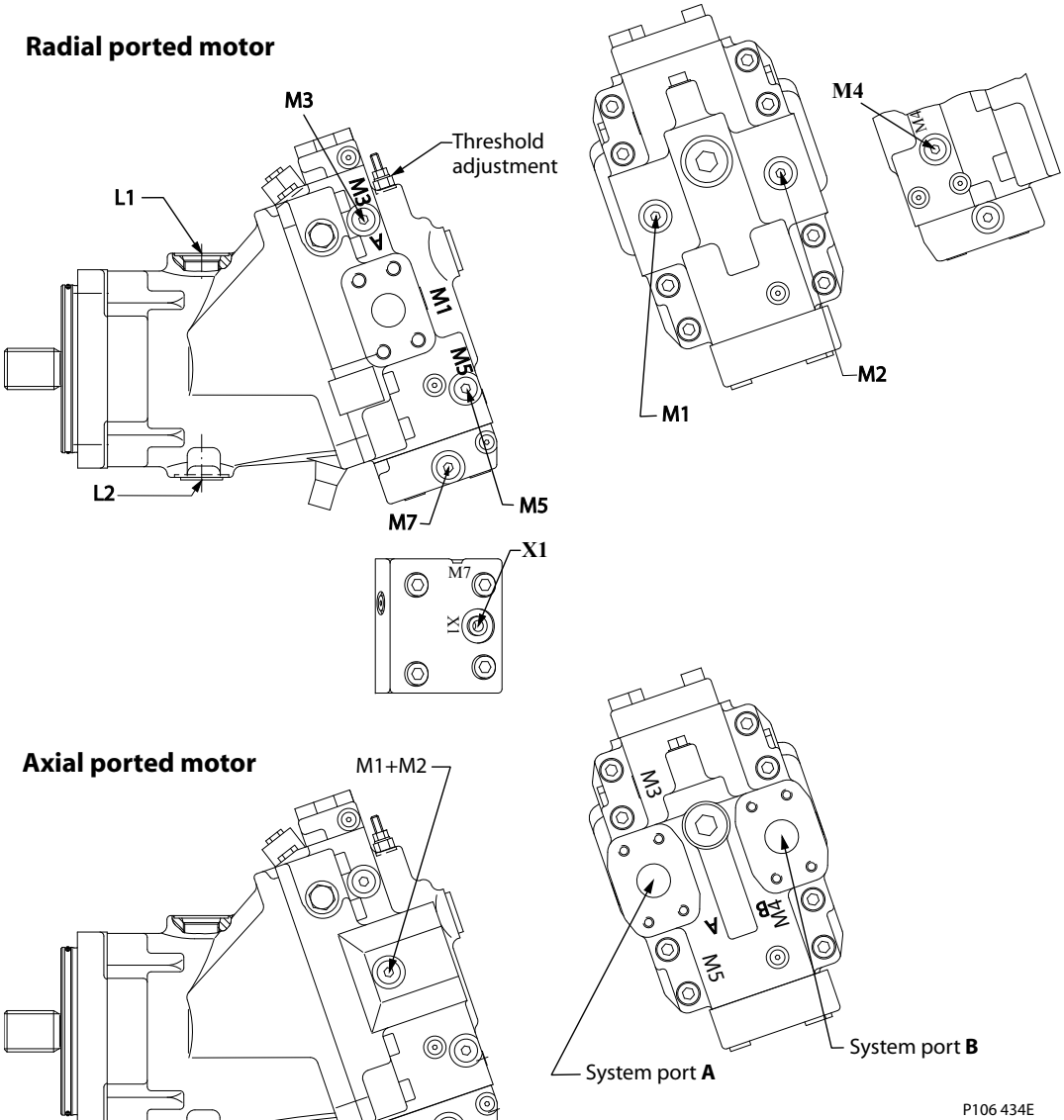
Port locations and Gauge Installation

The following table and drawings show the port locations and gauge sizes needed. When testing system pressures, calibrate pressure gauges frequently to ensure accuracy. Use snubbers to protect gauges.

Port Information

Port identifier	Port size	Wrench size	Reading	Gauge size, bar [psi]
L1, L2	1 1/16-12 UNF	9/16 internal hex	Case drain	10 bar [100 psi]
M1, M2	9/16-18 UNF	1/4 internal hex	System pressure	600 bar [10,000 psi]
M3, M4, M5	9/16-18 UNF	1/4 internal hex	Servo pressure	50 bar [1000 psi]
X1, M7	9/16-18 UNF	1/4 internal hex	Control pressure	50 bar [1000 psi]

Port Locations



Adjustments

Threshold Setting

Checking Threshold Setting

1. Install a 50 bar [600 psi] gauge at port M3 to read minimum servo pressure.
2. Install a 50 bar [600 psi] gauge at port M4 to read maximum servo pressure.
3. Install meter to read signal current.
4. Increase the signal current to the proper setting.

The pressure at port M3 should rise to about 100 psi [6.89 bar] higher than the pressure at port M4. This causes the servo piston to move toward minimum position. Signal current at this point is the threshold setting.

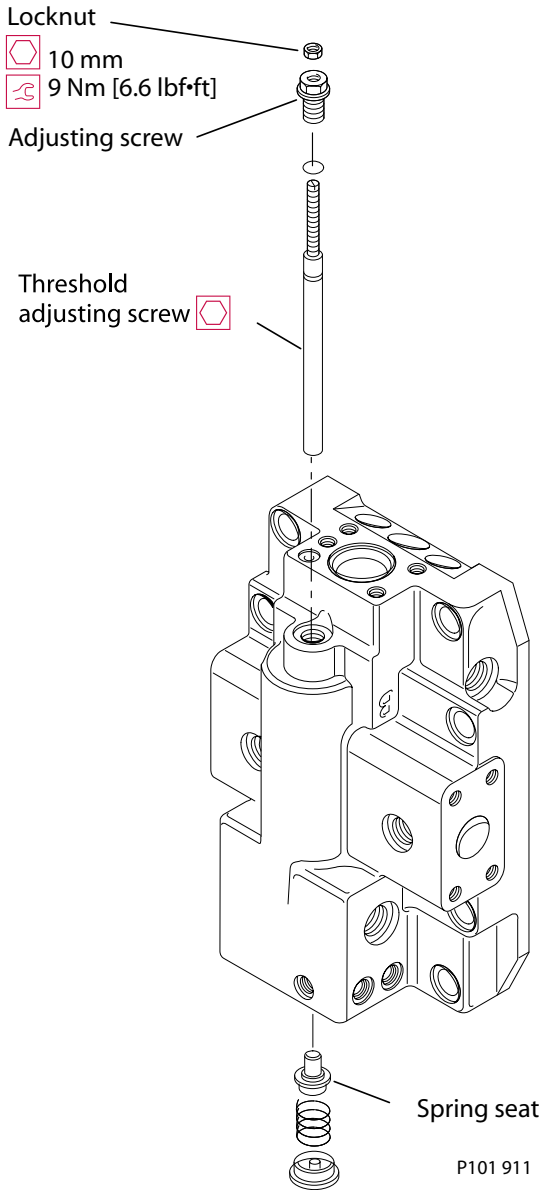
On a test stand, increase signal current until the flow from the motor begins to decrease. The signal current at this point is the threshold setting.

Adjusting Threshold Setting

1. Using a 10 mm wrench, loosen the locknut on the adjustment screw.
2. Using a 3 mm internal hex wrench turn the adjusting screw:
   - Clockwise (cw) to increase the setting
   - Counterclockwise (ccw) to decrease the setting.
3. While holding the position of the adjustment screw:
   - tighten the locknut
   - using a 10 mm wrench torque the locknut to 9 N•m [6.6 lbf•ft].

Adjustments

Locknut and Threshold



Pressure Compensator OverRide (PCOR) Setting

PCOR Adjustment

In order to measure and adjust the start pressure setting for the PCOR function:

1. Install a 600 bar [10000 psi] gauge at port M1 or M2 or M5 to read high system pressure.
2. Install a 600 bar [10000 psi] gauge at port M3 to read minimum servo pressure.
3. Lock the motor shaft from moving by:
   - Applying the park brake, apply an extreme load, or
   - Position the machine against an immovable object, or
   - Other means to hold the machine.
4. Start the prime mover. Operate at medium RPM.

Adjustments

5. Stroke the pump very slowly to gradually increase the system pressure.

   An alternate method to slowly increase the system pressure is to use the pump's pressure limiter (PL) valve. Lower the PL setting below the PCOR setting. Stroke the pump to about one-fourth displacement. Raise the PL setting slowly to increase system pressure until pressure at the M3 port drops down. System pressure at this point is the PCOR setting. Adjust the PL back to its proper setting after checking the PCOR setting.

6. Increase system pressure until pressure at port M3 drops down, system pressure at this point is the PCOR setting.

Checking PCOR Setting on a Test Stand

Increase system pressure until the system flow begins to increase. System pressure at this point is the PCOR setting.

Warning

System pressure may increase rapidly when flow increases.

Adjusting the PCOR Setting

- For PCOR valves mounted on a Multiblock; use a 1-1/16 inch wrench to loosen the lock nut on the adjusting screw. Using a large screw driver or a 13 mm wrench, turn the adjusting screw clockwise to increase pressure setting or counter clockwise to lower pressure setting. One turn of the adjusting screw changes the setting approximately 69 bar [1000 psi].
- For controls using the threshold adjusting screw for PCOR adjustment; use a 10 mm wrench to loosen the locknut. Using a 3 mm wrench, turn the adjusting screw clockwise to increase pressure or counter clockwise to lower pressure setting. One turn of the adjusting screw changes the setting approximately 55 bar [800 psi].

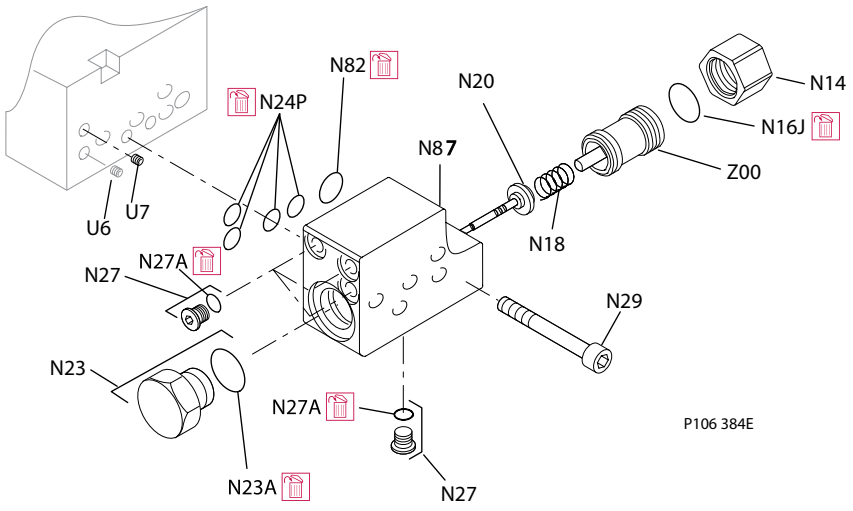
PCOR

Optional PCOR Housing

Disassembly

1. Remove plugs (N27). Remove and discard O-rings (N27A).
2. Using a 1 inch wrench, remove plug (N23). Remove and discard O-ring (N23A).
3. Remove locknut (N14).
4. Remove adjustment plug (Z00). Remove and discard O-ring (N16J).
5. Remove spring (N18).
6. Remove spool and spring guide assembly (N20).
7. Remove screws (N29).
8. Remove and discard O-rings (N24P, N82).
9. If present, remove orifices (U6, U7).

PCOR



Legend

Item	Wrench size	Torque
N27	1/8 inch internal hex	7 Nm [4 lbf•ft]
N23	1 inch	40 Nm [30 lbf•ft]
U6, U7	3 mm internal hex	6 Nm [4 lbf•ft]
N29	5 mm internal hex	16 Nm [12 lbf•ft]
N14	1-5/16 inch	N/A

Inspection

Clean and inspect components for damage or foreign material. Replace damaged parts.

Assembly

1. If previously removed, use a 3mm internal hex wrench to install orifices (U6, U7). Torque to 6 N•m [4 lbf•ft].
2. Using petroleum jelly to retain them, install new interface O-rings (N24P, N82).
3. Position PCOR on multiblock. Install screws (N29). Torque using a 5 mm internal hex wrench to 16 N•m [12 lbf•ft].

PCOR

4. Lubricate and install spool and spring guide assembly (N20).
5. Install spring (N18) to cavity.
6. Lubricate and install new O-ring (N16J). Install adjustment plug (Z00).
7. Using a 1-1/16 inch hex wrench, install locknut (N14). Do not torque until after PCOR adjustment. Refer to page 13 for instructions.
8. Lubricate and install a new O-ring (N23A). Using a 1 inch hex wrench, install plug (N23). Torque to 40 N•m [30 lbf•ft].
9. Lubricate and install new O-rings (N27A). Using a 1/8 inch internal hex wrench, install and torque plugs (N27) to 7 N•m [4 lbf•ft].

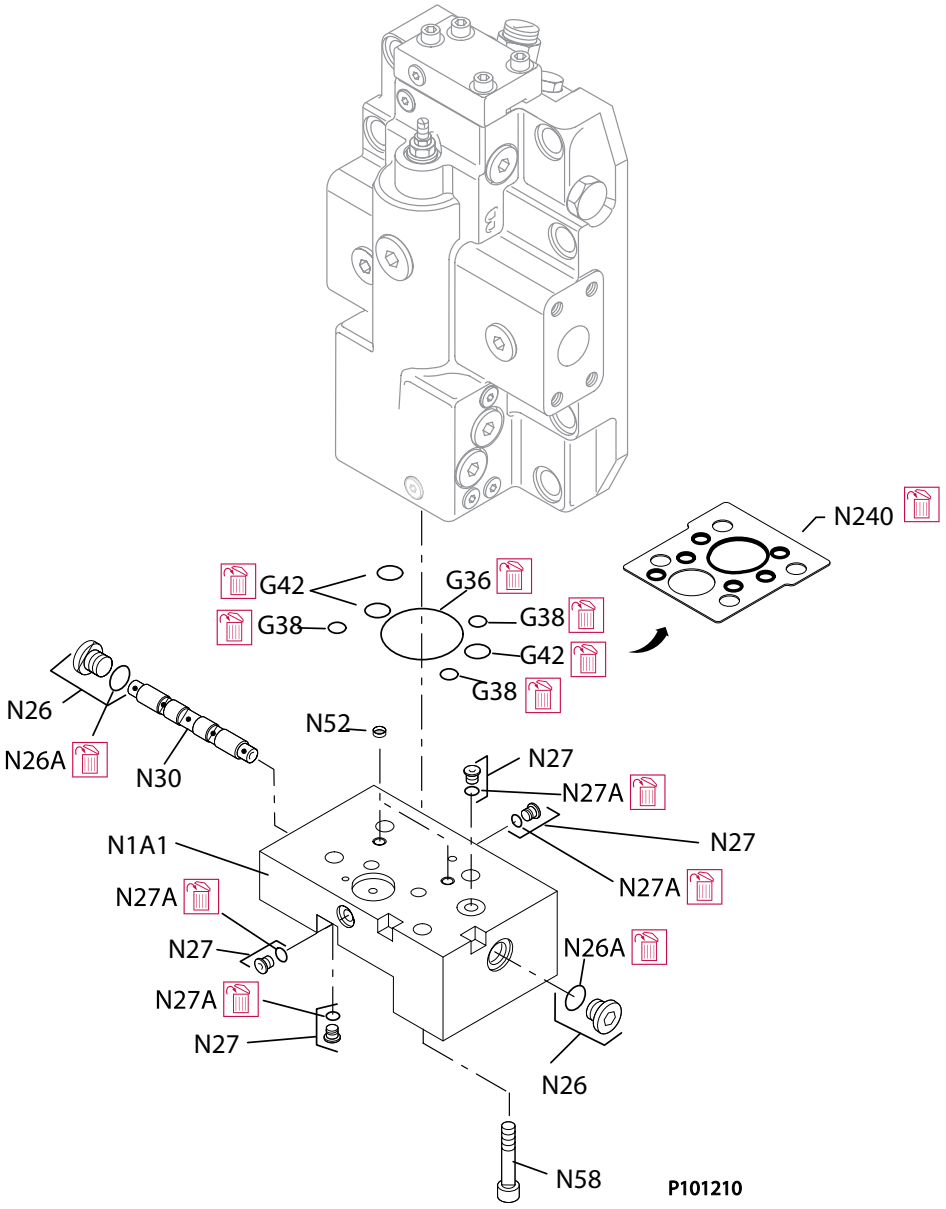
Multifunction block

Optional Multifunction block

Disassembly

1. Using a ¼ inch internal hex wrench, remove plugs (N26). Remove and discard O-rings (N26A).
2. Remove the spool (N30).
3. Using a 1/8 inch internal hex wrench, remove plugs (N27). Remove and discard O-rings (N27A).
4. Remove screws (N58).
5. Remove the multifunction block (N1A1).
6. Remove and discard O-rings (G36, G38, and G42) or gasket (N240).
7. If present, remove and discard screens (N52). They are no longer used.

E, F* Control*



Multifunction block

Legend

Item	Wrench size	Torque
N27	1/8 inch internal hex	7 Nm [4 lbf•ft]
N26	1/4 inch internal hex	37 Nm [28 lbf•ft]
N58 80cc, 110cc	8 mm internal hex	78 Nm [58 lbf•ft]
N58 160cc, 250cc	10 mm internal hex	110 Nm [81 lbf•ft]

Inspection

Clean and inspect components for damage or foreign material. Replace damaged parts.

Assembly

1. Lubricate and install new O-rings (N27A). Install plugs (N27) using a 1/8 inch internal hex wrench. Torque to 7 N•m [4 lbf•ft].
2. Using petroleum jelly to retain them, install new interface O-rings (G36, G38, G42) or gasket (N240).
3. Position the multifunction block on the endcap. Install screws (N58). Torque screws as shown in the table.
4. Lubricate and install the double-resolver spool (N30). The spool is symetrical, either end in first.
5. Lubricate and install new O-rings (N26A). Using a 1/4 inch internal hex wrench, install plugs (N26). Torque to 37 N•m [28 lbf•ft].

HZ, HA, HB, HE Controls

Operation

Functional Description

The HZ, HA, HB, and HE controls consist of a ported housing mounted directly to the end cap. Variable signal pressure fed to port X1 is routed to the end of the 4-way valve. A threshold spring and ramp spring(s) act on the opposite end of the 4-way valve.

HZ Control

The HZ control has a check valve to resolve which port (system A or B) is higher pressure. It routes this high pressure to the 4-way valve to power the servo piston.

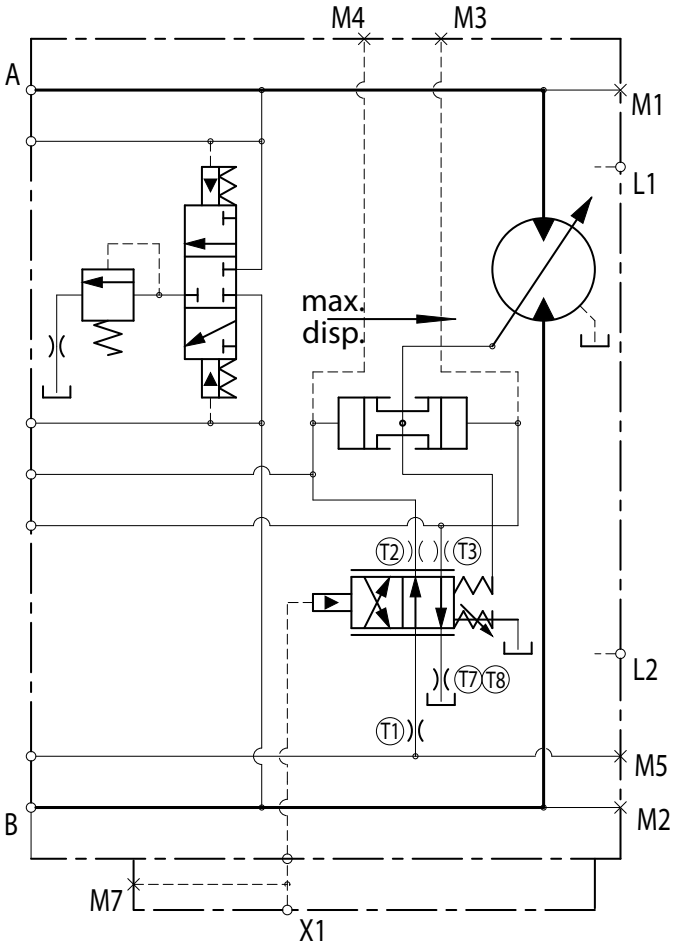
HA and HB Controls

The HA and HB controls have internal porting to feed system A or B pressures, respectively, to the 4-way valve to power the servo piston.

HE Control

The HE control has no internal porting for servo supply pressure. An external servo supply pressure fed to port M5 is required.

HZ Schematic Diagram



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HZ, HA, HB, HE Controls

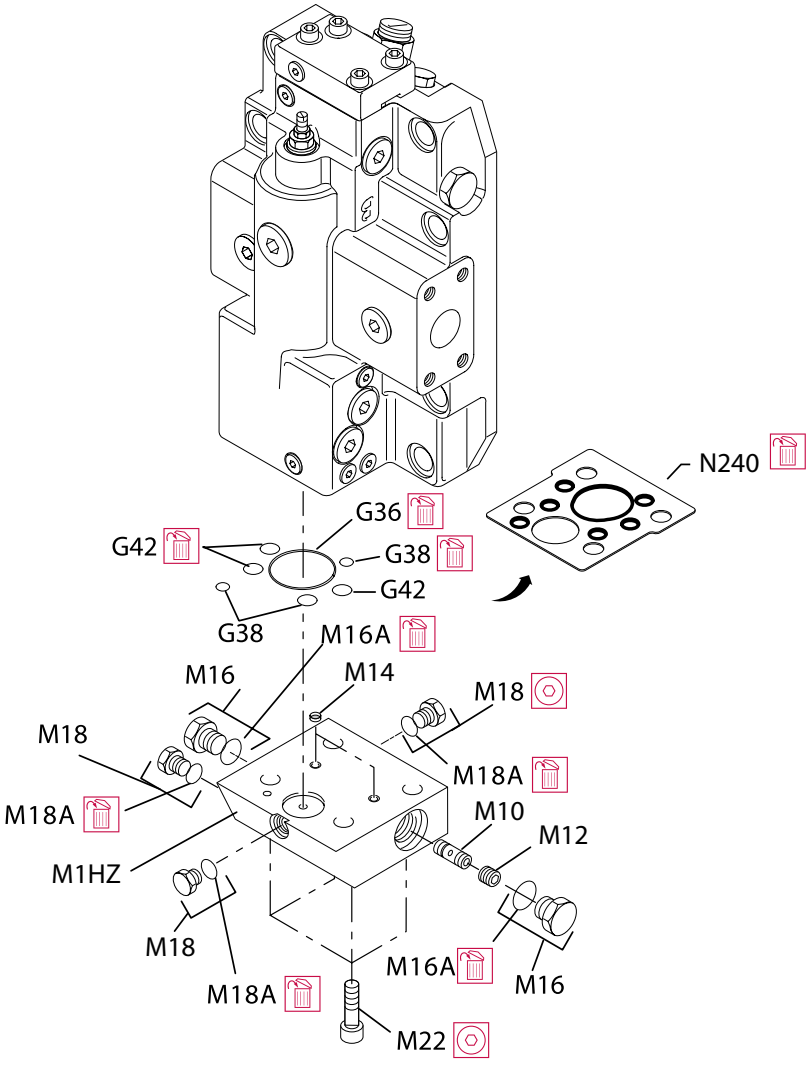
Repair

Disassembly

1. Remove screws (M22) using a:
   - 8 mm internal hex wrench for 80 cc and 110cc motors
   - 10 mm internal hex wrench for 160 cc and 250 cc motors.
2. Remove control block (M1HZ).
3. Remove and discard O-rings (G38, G42, and G36) or gasket (G420).
4. If present, remove plugs (M16) using a ¼ inch internal hex wrench (HZ controls only).
5. Remove and discard O-rings (M16A).
6. If present, remove orifice (M12) using a 5mm internal hex wrench (HZ controls only).
7. If present, remove shuttle valve (M10) (HZ controls only).

   If necessary, tap the housing on a solid surface to remove the shuttle valve.
8. Remove plugs (M18) using a 1/8 inch internal hex wrench.
9. Remove and discard O-rings (M18A).

Disassembly



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HZ, HA, HB, HE Controls

Legend

Item	Wrench size	Torque
M18	1/8 internal hex	6 Nm [4 lbf•ft]
M12	5 mm internal hex	12 Nm [6 lbf•ft]
M16	1/4 internal hex	31 Nm [27 lbf•ft]
M22 (80, 110)	8 mm internal hex	78 Nm [58 lbf•ft]
M22 (160, 1250)	10 mm internal hex	110 Nm [81 lbf•ft]

Inspection

1. Inspect the housing and shuttle valve for damage or foreign material.
2. Check internal passages for contamination and clean them if necessary. If present, discard the 2 screens (M14) (they are no longer necessary).

Assembly

1. If used, install the shuttle valve assembly (M10) (HZ controls only).
2. If used, install orifice (M12) using a 5 mm internal hex wrench (HZ controls only). Torque to 8 N•m [6 lbf•ft].

Caution

Overtorquing orifice (M12) may crush shuttle valve (M10).

3. Lubricate and Install new O-rings to all plugs.
4. Using a 1/4 inch internal hex wrench, install plugs (M16). Torque to 37 N•m [27 lbf•ft].
5. Using a 1/8 inch internal hex wrench, install plugs (M18). Torque to 6 N•m [4 lbf•ft].
6. Using petroleum jelly to retain them, install new O-rings (G36, G38, G42) or install gasket (G420).
7. Install the control housing onto the end cap.
8. Install screws (M22). Torque screws to:
   - 78 N•m [58 lbf•ft] for 80 cc, and 110cc motors using an 8mm internal hex wrench.
   - 110 N•m [81 lbf•ft] for 160cc and 250cc motors using a 10 mm internal hex wrench.

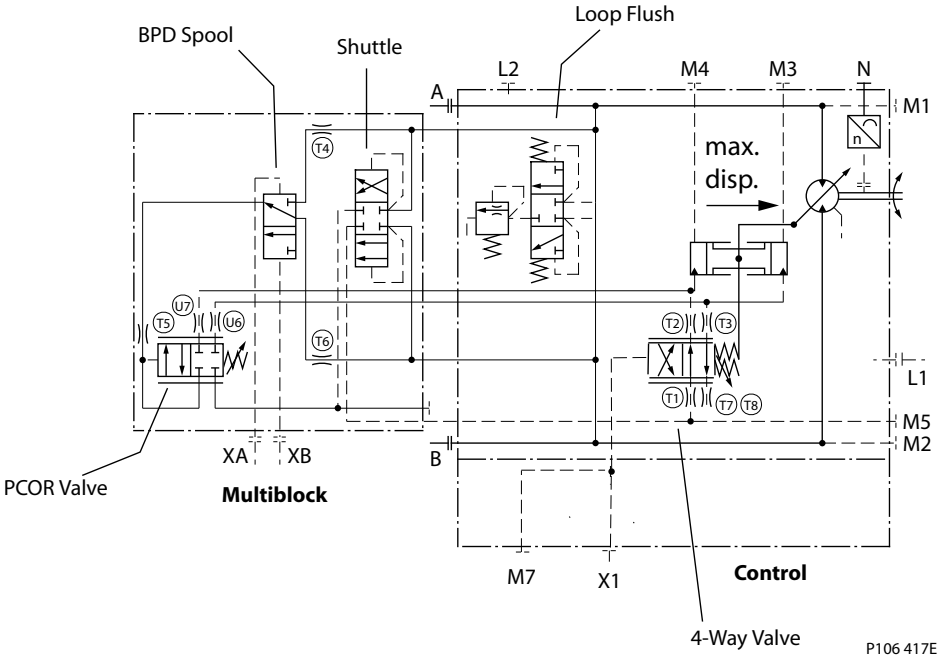
HS Control

Operation

Functional Description

The HS control consists of a ported housing mounted on a multiblock. External variable signal pressure fed to port X1 is routed to the 4-way valve. As signal pressure shifts the 4-way valve it ports pressure to the ends of the servo piston changing motor displacement. A threshold spring and ramp spring(s) act on the opposite end of the 4-way valve.

HS Schematic



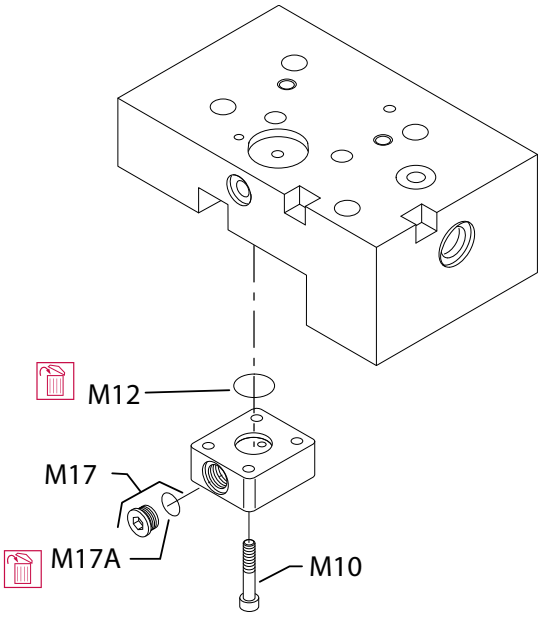
Repair

Disassembly

1. Using a 4 mm internal hex wrench, remove screws (M10).
2. Remove the HS valve housing from the multifunction block.
3. Remove and discard O-ring (M12).

HS Control

Disassembly



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4. Remove plug (M17) using a 1/4 internal hex wrench.
5. Remove and discard O-ring (M17A).

Inspection

1. Inspect the housings for damage or foreign material.
2. Check internal passages for contamination. Clean passages if necessary.

Assembly

1. Using petroleum jelly to retain it, install a new O-ring (M12).
2. Install the HS valve housing on to the multifunction block.
3. Using a 4 mm internal hex, install screws (M10). Torque to 6.4 Nm [4.7 lbf•ft].
4. Lubricate and install a new O-ring (M17A).
5. Using a 1/4 internal hex wrench install plug (M17). Torque to 37 N•m [28 lbf•ft].
   Refer to *Optional Multifunction block* on page 16 for multiblock repair.

H1, H2, K1, K2 Controls

Operation

Functional Description

The H1, H2, K1, and K2 controls consist of a ported housing mounted on the multiblock. It contains a solenoid valve and internal porting to direct the external variable signal pressure through the solenoid valve to the end of the 4-way valve. A threshold spring and ramp spring(s) act on the opposite end of the 4-way valve.

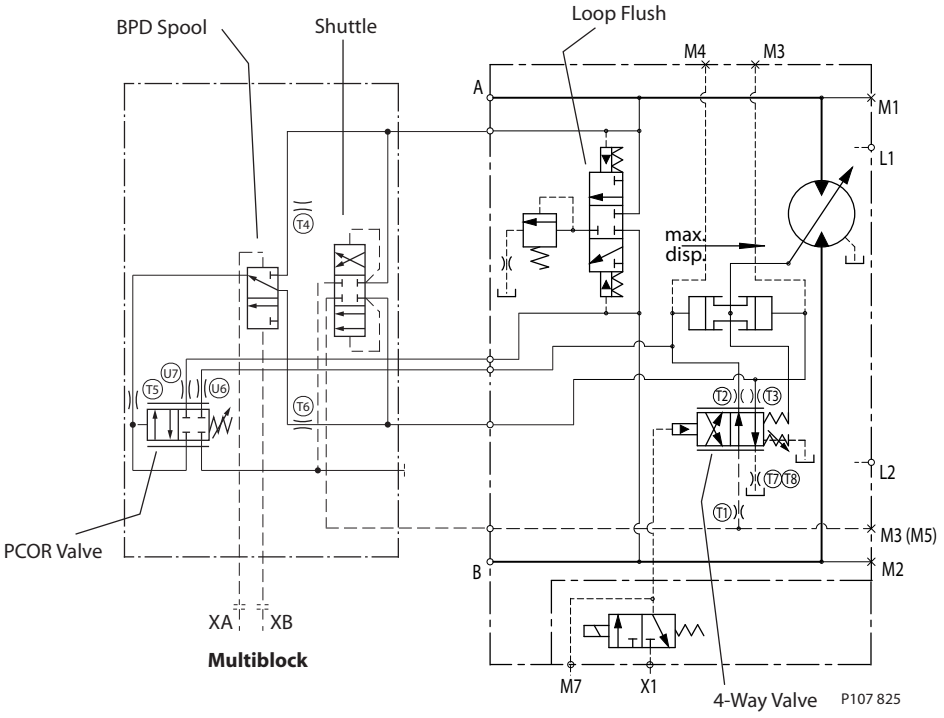
Solenoid Valve

The solenoid valve (M1) is a 2-position 3-way valve that passes the external signal pressure to the end of the 4-way valve, or blocks the external signal and drains the end of the 4-way valve to the motor case. The H1 and K1 solenoid valves have a 12-volt coil with DIN connector. The H2 and K2 solenoid valves have a 24-volt coil with DIN connector. The 4-way valve and the solenoid valve are the same for H1, H2, K1, and K2 controls. The control housings are different between the H1, H2, and the K1, K2 controls. The logic for the control is:

- If H1 or H2 are energized operation is proportional; if de-energized output is maximum displacement.
- If K1 or K2 are energized, output is maximum displacement; if de-energized, operation is proportional.

Refer to *Multiblock* on page 8 *Pressure Compensator OverRide (PCOR) Function* on page 8 and *Brake Pressure Defeat (BPD) Option* on page 9 for multiblock, PCOR and brake pressure defeat information.

H1, H2 Schematic



Repair

The solenoid valve (M1) is available as a complete assembly only. Do not remove unless it is being replaced.

H1, H2, K1, K2 Controls

Removing Solenoid Valve

1. Using a 3/4 wrench, remove the coil nut from the solenoid cartridge valve (M1).
2. Remove the coil from the solenoid cartridge valve (M1). Using a 7/8 wrench, remove the solenoid cartridge valve (M1) from the control housing.

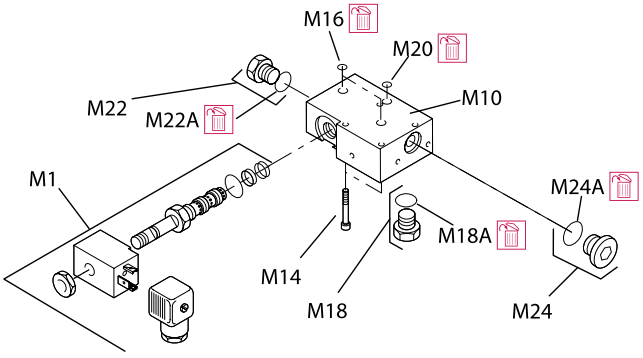
Disassembly

1. Using a 1/4 internal hex wrench, remove plugs (M22, M18) (and M24 if present).
2. Remove and discard O-rings (M22A, M18A, and M24A).
3. Using a 4 mm internal hex wrench, remove screws (M14). Remove control (M10).
4. Remove and discard O-rings (M16 and M20).

Inspection

Inspect all components for damage or foreign material. Clean all parts and replace damaged components as necessary.

Control Block



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Legend

Item	Wrench size	Torque
M1 coil nut	3/4 inch	6 Nm [4 lbf•ft]
M1 solenoid valve	7/8 inch	12 Nm [6 lbf•ft]
M22, M18, M24	1/4 internal hex	31 Nm [27 lbf•ft]
M14	4 mm internal hex	6.4 Nm [4.7 lbf•ft]

Assembly

1. Using petroleum jelly to retain them, install O-rings (M16, M20).
2. Install the control housing to the multifunction block.
3. Install mounting screws (M14) to the multifunction block. Using a 4 mm internal hex wrench. Torque to 6.4 N•m [4.7 lbf•in].
4. Lubricate and install new O-rings (M18A, M22A, and M24A).
5. Install plugs (M18A, M22A, and M24A). Using a 1/4 internal hex wrench, torque to 37 N•m [28 lbf•ft].

Installing Solenoid

1. Lubricate O-rings and install solenoid valve. Using a 7/8 wrench, torque to 78 Nm [58 lbf•ft].
2. Install coil and nut. Using a 3/4 wrench, torque to 1.2 Nm [0.9 lbf•ft].

HP Controls

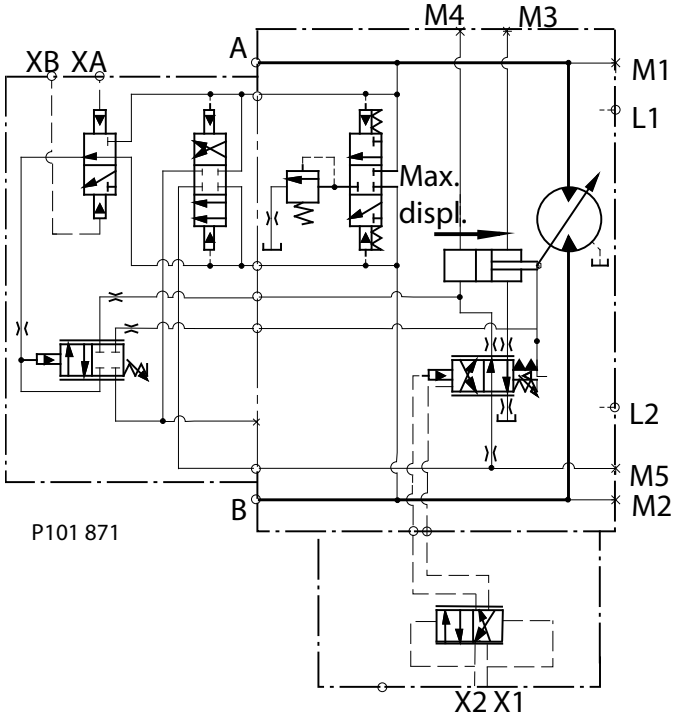
Operation

Functional Description

The HP and HC two-line hydraulic proportional controls vary the motor displacement between maximum and minimum by feeding hydraulic signal pressure to both ends of a piston. A pin connects the piston to the 4-way valve. A threshold spring and ramp spring(s) act on the opposite end of the 4-way valve.

As deferential pressure moves the piston, it shifts the 4-way valve that ports servo supply pressure to the ends of the servo piston. A threshold spring and ramp spring(s) act on the opposite end of the 4-way valve. The threshold adjustment screw varies the threshold spring force and the signal pressure required to move the 4-way valve and start the change in displacement. The ramp spring(s)—two used in 160 cc and 250 cc motors, one in 80 cc and 110 cc motors—increases the force on the 4-way valve as the servo piston moves toward minimum displacement. This provides a motor displacement proportional to the input signal delta pressure. Optional orifices at locations T1, T2, T3, T7, and T8 regulate shift speed.

HP Schematic Diagram



HP Control

The HP control consists of a ported housing that mounts onto the multifunction block. The ported housing contains a shuttle valve, a piston, a connecting pin, and a bias spring.

Shuttle Valve

The shuttle valve ports higher signal pressure to the top of the piston. It ports lower signal pressure to the bottom of the piston.

Connecting Pin

The connecting pin links the piston to the 4-way valve. The bias spring holds the piston and pin against the 4-way valve.

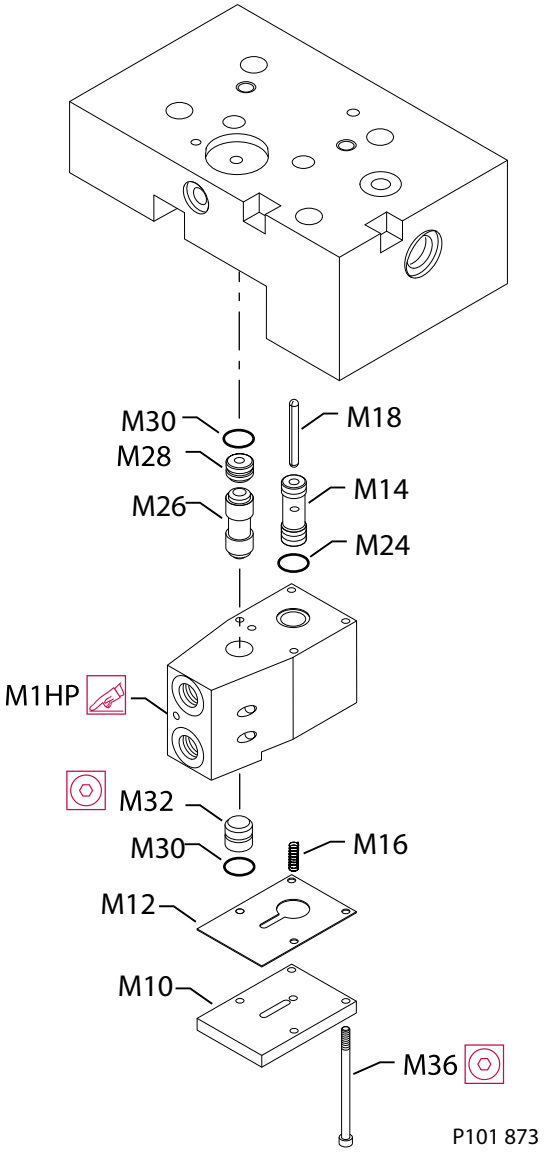
HP Controls

Repair

Disassembly

1. Using a 4 mm internal hex wrench remove screws (M36).
2. Remove the housing cover (M10). Remove gasket (M12).
3. Remove spring (M16).
4. Remove housing (M1HP) with the shuttle valve assembly.
5. Remove the pilot piston (M14). Remove and discard O-ring (M24).
6. Remove pin (M18) from the multifunction block.
7. Use screw (M36) as a threaded puller to remove plug (M28). Remove O-ring (M30).
8. Remove shuttle spool (M26).
9. Remove plug (M32). Remove O-ring (M30).

HP Control



HP Controls

Legend

Item	Wrench size	Torque
M36	4 mm internal hex	6.4 Nm [4.7 lbf•ft]

Inspection

1. Clean and inspect all parts.
2. Discard any parts that are worn or damaged.

Assembly

1. Install new O-rings (M30).
2. Install new O-ring (M24).
3. Install plug (M32) with the large chamfer toward the inside of the block.
4. Install shuttle spool (M26).
5. Install plug (M28) with the large chamfer toward the inside of the block.
6. Install pin (M18) in the multiblock.
7. Position the control valve housing on the multifunction block.
8. Install the pilot piston (M14) into the control valve housing over pin (M18).
9. Install spring (M16).
10. Install new gasket (M12).
11. Install control cover (M10).
12. Position control assembly (M1HP) on multifunction block to align the screw holes.
13. Using a 4 mm internal hex wrench, install screws (M36). Torque to 6.4 Nm [4.7 lbf•ft].

HC Controls

Operation

Functional Description

The HC control consists of a ported housing, mounted directly on the end cap. It contains a check valve, a shuttle valve, a piston, a connecting pin, and a bias spring. The HC control does not have pressure compensating override (PCOR) function.

Check Valve

The check valve resolves which port (system A or B) is at higher pressure. It routes that higher pressure to the 4-way valve to power the servo piston.

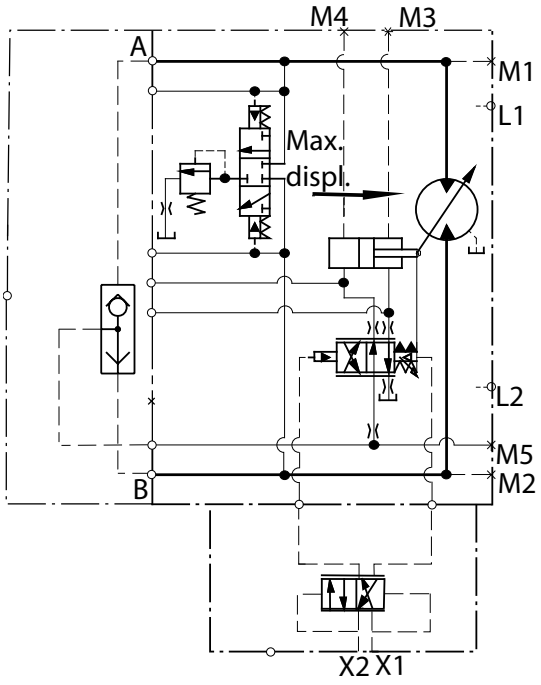
Shuttle Valve

The shuttle valve ports higher signal pressure to the top of the servo piston. It ports lower signal pressure to the bottom of the servo piston.

Connecting Pin

The connecting pin links the piston to the 4-way valve. The bias spring holds the piston and pin against the 4-way valve. A threshold spring and ramp spring(s) act on the opposite end of the 4-way valve.

HC Schematic Diagram



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Repair

Diassembly

1. Using a 10 mm wrench, loosen locknut (M40).
2. Using a 4 mm internal hex, remove bleed valve (M38).
3. Using a 1/4-inch internal hex, remove plug (M48)

HC Controls

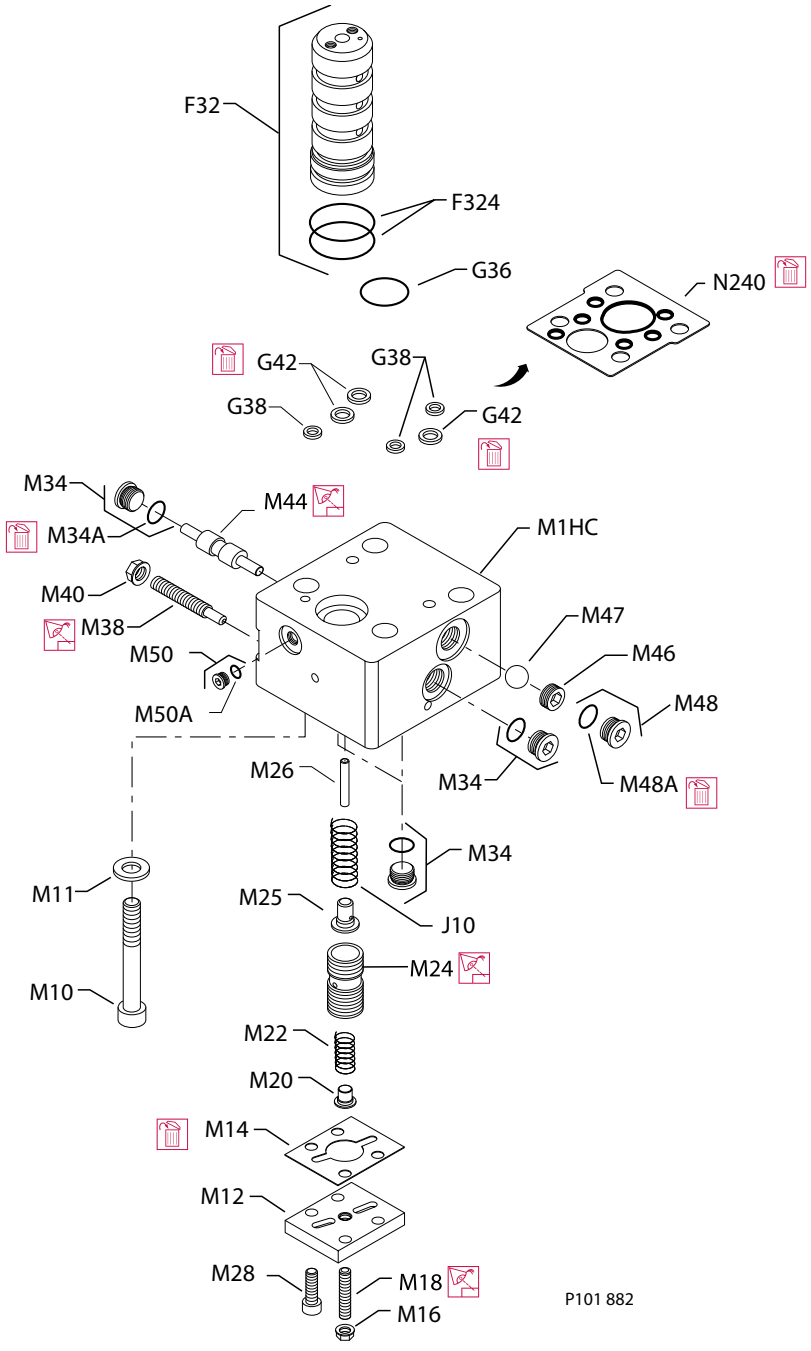
4. Remove and discard O-ring (M48A).
5. Remove check ball seat (M46) using a 5 mm internal hex.
6. Remove check ball (M47) using a pencil magnet.
7. Using a 1/4-inch internal hex, remove plugs (M34).
8. Remove and discard O-rings (M34A).
9. Slide shuttle spool (M44) out of block.
10. Using a 10 mm wrench, loosen locknut (M16). Using a 4 mm internal hex, remove adjustment screw (M18).
11. Remove screws (M28).
12. Remove cover (M12). Remove gasket (M14).
13. Remove spring seat (M20). Remove spring (M22).
14. Remove the pilot piston (M24).
15. Remove spring seat (M25). Remove pin (M26).
16. Remove spring (J10).
17. Remove screws (M10) and washers (M11).
18. Remove block (M1HC).
19. Remove and discard O-rings (G38), (G36) and (G42) or gasket (N240).
20. Remove 4-way valve (F32).
21. Remove and discard O-rings (F324).

Inspection

1. Inspect the control block for signs of corrosion or damage.
2. Discard any damaged or worn parts.

HC Controls

HC Control Disassembly



Legend

Item	Wrench size	Torque
M48	1/4 internal hex	37 Nm [27 lbf•ft]
M40	10 mm	18 N•m [13.3 lbf•ft]
M34	1/4 internal hex	37 Nm [27 lbf•ft]
M28	4 mm internal hex	6.4 Nm [4.7 lbf•ft]
M16	10 mm	9 Nm [6.6 lbf•ft]

HC Controls

Legend (continued)

Item	Wrench size	Torque
M18	4 mm internal hex	N/A
M10 (060, 080, 110)	8 mm internal hex	78 Nm [58 lbf•ft]
M10 (160, 250)	10 mm internal hex	110 Nm [81 lbf•ft]

Assembly

1. Lubricate and install O-rings (F324).
2. Install 4-way valve (F32).
3. Using petroleum jelly, lubricate and install O-rings (G38), (G36) and (G42) or install gasket (N240).
4. Install block (M1HC).
5. Install screws (M10) and washers (M11), if present.
6. Install spring (J10).
7. Install pin (M26). Install spring seat (M25).
8. Install the pilot piston (M24).
9. Install spring (M22). Install spring seat (M20)
10. Install gasket (M14). Install cover (M12).
11. Using a 4 mm internal hex wrench, install screws (M28). Torque to 6.4 Nm [4.7 lbf•ft].
12. Install adjustment screw (M18). Install locknut (M16).
13. Hold adjustment screw in place and torque locknut (M16) to 9 Nm [6.6 lbf•ft].
14. Slide shuttle spool (M44) into block.
15. Lubricate and install O-rings (M34A).
16. Using a 1/4-inch internal hex, install plugs (M34).
17. Install check ball (M47)
18. Install check ball seat (M46)
19. Lubricate and install O-ring (M48A).
20. Using a 1/4-inch internal hex, install plug (M48)
21. Using a 4 mm internal hex, install bleed valve (M38).
22. Using a 10 mm wrench, install locknut (M40).
23. Hold bleed valve in place and torque lock nut per table.

J1, J2, J3, J4 Controls

Operation

Functional Description

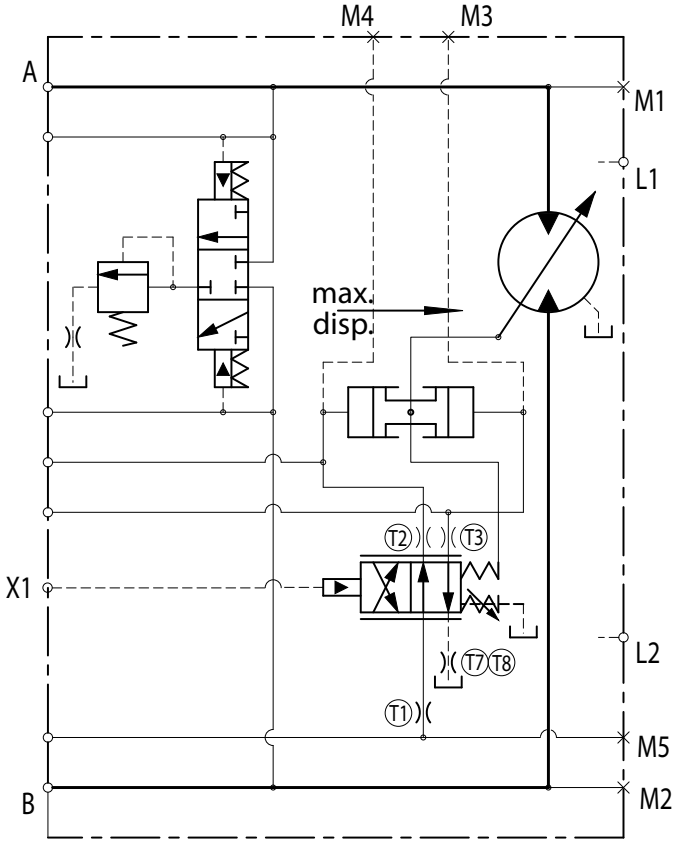
J1, J2, J3, and J4 controls are one-line hydraulic proportional with a solenoid valve that overrides the hydraulic signal to hold the motor at maximum displacement. The control housing contains a solenoid valve, a pressure compensating override (PCOR) valve, optional brake pressure defeat (BPD) valve, and passages to route oil to the 4-way valve and to the servo piston ends. As signal pressure shifts the 4-way valve, it ports pressures to the ends of the servo piston changing motor displacement. A threshold spring and ramp spring(s) act on the opposite end of the 4-way. Variable signal pressure is fed to port X1.

Solenoid Valve

The solenoid valve (item M1) is a 2-position 3-way valve that passes the external signal pressure to the end of the 4-way valve, or blocks the external signal and drains the end of the 4-way valve to the motor case. The J1 and J3 solenoid coils are 12 volt. The J2 and J4 are 24 volt. The J1 and J2 solenoids have DIN connectors. The J3 and J4 solenoids have Jet Jr. Timer connectors. The logic for the control is

- If J3 or J4 are energized operation is proportional; if de-energized output is maximum displacement.
- If J1 or J2 are energized output is maximum displacement; if de-energized operation is proportional.

J1, J2 Schematic Diagram



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J1, J2, J3, J4 Controls

Repair

Removing the Solenoid Valve

It is not necessary to remove the valve unless it is being replaced.

Individual parts are not available. Replace entire valve.

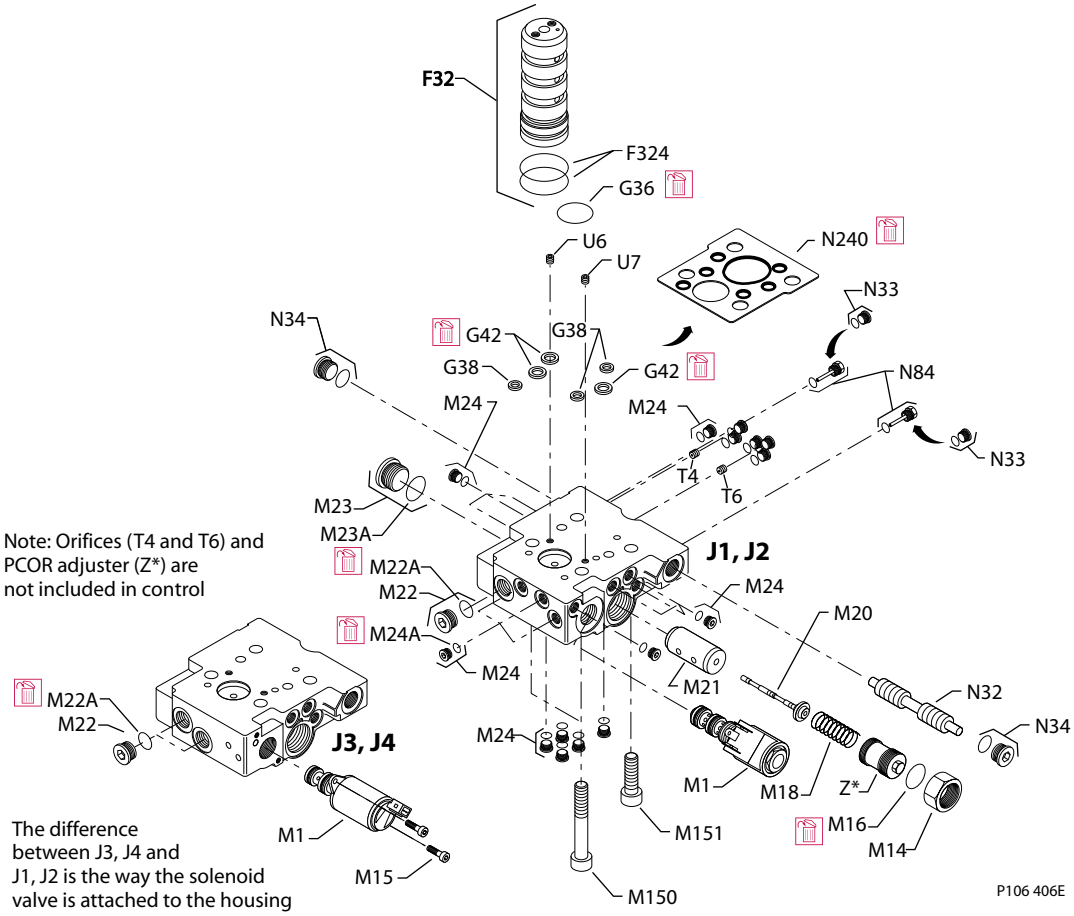
Solenoid for J1, J2

If replacing the valve, use a 7/8 wrench to remove the valve from the housing.

Solenoid for J3, J4

If replacing the valve, use a 3 mm internal hex wrench to remove screws (M15). Remove the valve.

Control Disassembly



Legend

Item	Wrench size	Torque
M15	3 mm internal hex	2.8 Nm [1 lbf•ft]
M1 (J1, J2)	7/8	20 Nm [15 lbf•ft]
M150, M151 (80, 110)	8 mm internal hex	78 Nm [58 lbf•ft]

J1, J2, J3, J4 Controls

Legend (continued)

Item	Wrench size	Torque
M150, M151 (160, 1250)	10 mm internal hex	110 Nm [81 lbf•ft]

Item	Wrench size	Torque
M14	1 1/16	54 Nm [40 lbf•ft]
T4, T5, U6, U7	3 mm internal hex	3.7 Nm [2.7 lbf•ft]
N34, M22	1/4 internal hex	37 Nm [27 lbf•ft]
M23	3/8 internal hex	95 Nm [70 lbf•ft]
M24	1/8 internal hex	6 Nm [4.5 lbf•ft]
N84, N33	7/16 internal hex	12 Nm [9 lbf•ft]

Disassembly

1. Remove PCOR lock nut (M14).
2. Remove and discard O-ring (M16).
3. Remove the adjuster (Z*).
4. Remove the spring (M18).
5. Remove the PCOR spool assembly (M20).

Caution

Do not remove the PCOR valve bushing (M21).

6. Using a 7/16 wrench, remove the pin/plugs (N84) or (N33).
7. Remove and discard the O-rings (N84A) or (N33A).
8. Using a 1/8 internal hex wrench, remove 15 plugs (M24).
9. Remove and discard O-rings (M24A).
10. Using a 1/4 internal hex wrench, remove plugs (M22, N34).
11. Remove and discard O-rings (M22A, N34A).
12. Remove spool (N32).
13. Using a 3/8 internal hex, remove plug (M23). Discard O-rings (M23A).
14. Remove screws (M150 and M151) using a:
    - 8mm internal hex wrench for 80 cc and 110cc motors
    - 10 mm internal hex wrench for 160cc and 250cc motors
15. Remove the control assembly from the end cap.
16. Remove the 4-way valve assembly (F32).

Caution

Read *Series 51 and 51-1 Bent Axis Motors Service Manual* **11008567** for minor repair instructions for the 4-way valve, threshold spring, and ramp spring components, if repair is necessary.

17. Remove and discard O-rings (F324).
18. Remove and discard O-rings (G38), (G36) and (G42) or the gasket (N240).
19. Using a 3 mm internal hex, remove orifices (T4, T6, U6, U7).

Inspection

1. Inspect the housing for signs of corrosion or damage.
2. Discard any damaged parts.

J1, J2, J3, J4 Controls

Assembly

1. Using a 3mm internal hex, install orifices (T4, T5, U6, U7). Torque to 3.7 Nm [2.7 lbf•ft].
2. Lubricate and install O-rings (F324).
3. Install the 4-way valve assembly (F32).
4. Using petroleum jelly, lubricate and install a new O-rings (G38, G36 and G42) or install gasket (N240).
5. Install the control assembly to the end cap.
6. Install screws (M150 and M151).
7. Torque screws (M150 and M151) to:
   - 78 N•m [58 lbf•ft]. Use an 8mm internal hex wrench for 80 cc and 110cc motors.
   - 110 N•m [81 lbf•ft]. Use a 10 mm internal hex for 160cc and 250ccmotors.
8. Install spool (N32).
9. Lubricate and install O-rings (N34A and M22). Using a 1/4 internal hex wrench, install plugs (M22 and N34). Torque to 25 Nm [18 lbf•in].
10. Lubricate O-ring (M23A). Using a 3/8 internal hex wrench, install plug (M23). Torque to 95 Nm [70 lbf•in].
11. Lubricate and install 15 O-rings (M24A). Using an 1/8 internal hex wrench, install 15 plugs M24). Torque to 6 Nm [4 lbf•in].
12. Lubricate and install O-rings (N84A) or (N33A). Using a 7/16 wrench, install plugs (N84) or (N33). Torque to 12 Nm [9 lbf•in].
13. Install the PCOR spool assembly (M20).
14. Install spring (M18). Install adjuster (Z*).
15. Lubricate and install O-ring (M16).
16. Install lock nut (M14). Torque to 54 Nm [40 lbf•in].

Caution

Readjust the PCOR to its proper setting

Installing the Solenoid Valve

Solenoid for J1, J2

Lubricate O-rings. Use a 7/8 wrench to install the valve. Torque to 20 Nm [15 lbf•ft].

Solenoid for J3, J4

Use a 3 mm internal hex wrench to install screws (M15). Torque to 2.8 Nm [2.1 lbf•ft].

JA Control

Operation

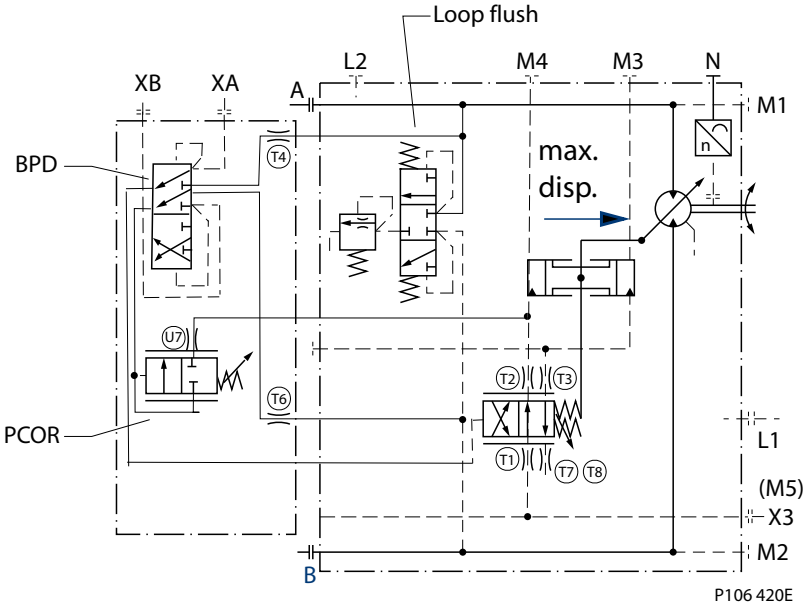
Functional Description

JA control is a stand-alone, dual signal hydraulic proportional control. The control housing contains a pressure compensating override (PCOR) valve, a brake pressure defeat (BPD) valve, and passages to route oil to the 4-way valve and to the servo piston ends. An external servo supply pressure fed to port M5 is required. A threshold spring and ramp spring(s) act on the opposite end of the 4-way valve.

Signal Pressure

Separate external variable signal pressures are fed into ports XA or XB. The BPD spool resolves which signal pressure is higher and routes this signal pressure to the end of the 4-way valve. The signal pressure shifts the 4-way valve and it ports servo supply pressure to the ends of the servo piston, changing motor displacement in proportion to the signal pressure.

JA Control Schematic Diagram



Repair

Disassembly

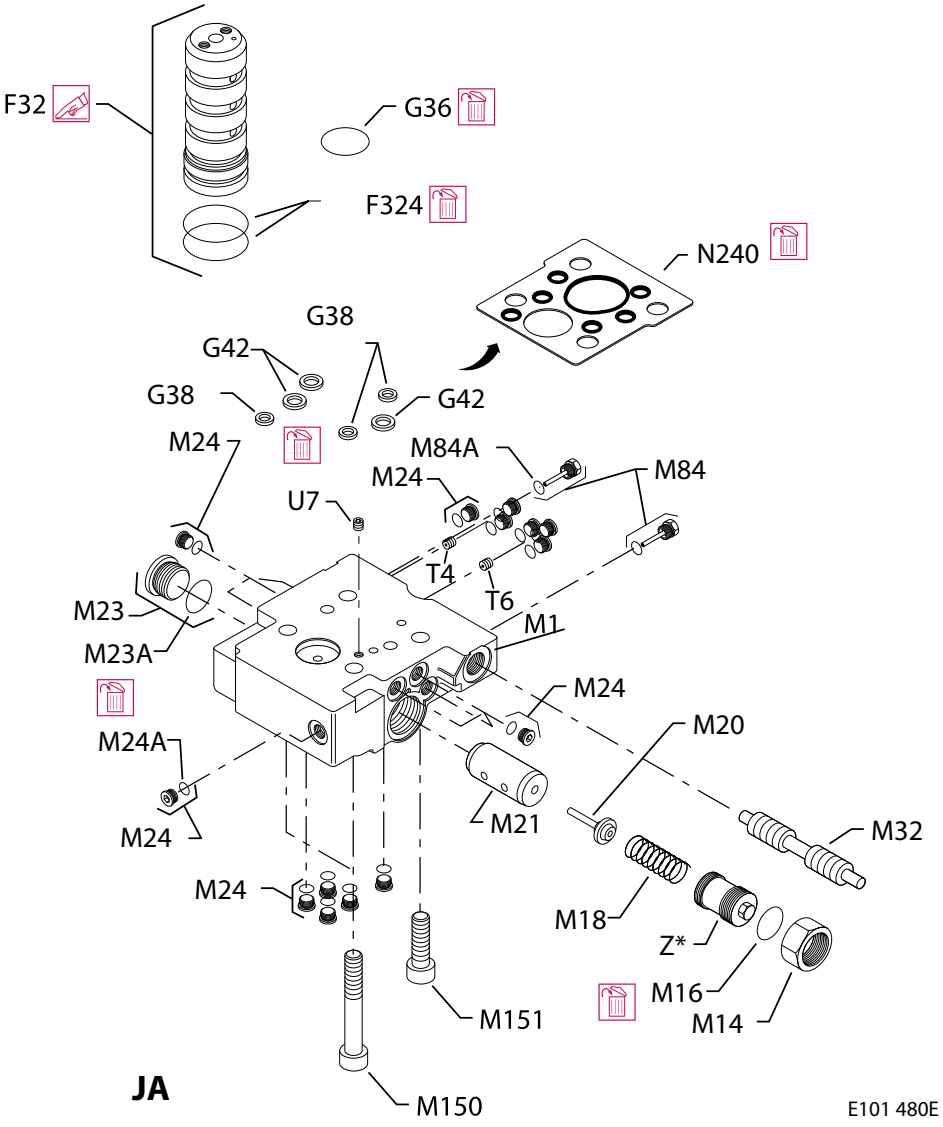
1. Remove PCOR lock nut (M14).
2. Remove and discard O-ring (M16).
3. Remove adjuster (Z*).
4. Remove spring (M18).
5. Remove spool assembly (M20).

Caution

Do not remove PCOR valve bushing (M21).

JA Control

Control Disassembly



Legend

Item	Wrench size	Torque
M150, M151 (80, 110)	8 mm internal hex	78 Nm [58 lbf•ft]
M150, M151 (160, 1250)	10 mm internal hex	110 Nm [81 lbf•ft]
M14	1 1/16	54 Nm [40 lbf•ft]

Item	Wrench size	Torque
T4, T6, U7	3 mm internal hex	3.7 Nm [2.7 lbf•ft]
M23	3/8 internal hex	25 Nm [18 lbf•ft]
M24	1/8 internal hex	6 Nm [4.5 lbf•ft]
M84	7/16 internal hex	12 Nm [9 lbf•ft]

JA Control

6. Using a 7/16 wrench remove pin/plugs (M84).
7. Remove and discard O-rings (M84A).
8. Remove spool (M32).
9. Using a 1/8 internal hex wrench remove 13 plugs (M24).
10. Remove and discard O-rings (M24A).
11. Using a 3/8 internal hex wrench remove plug (M23).
12. Remove and discard O-ring (M23A).
13. Remove screws (M150 and M151) using a:
    - 8mm internal hex wrench for the 80 cc and 110cc motors
    - 10 mm internal hex wrench for the 160cc and 250cc motors.
14. Remove the control from the endcap.
15. Remove 4-way valve assembly (F32).

Caution

If repair is necessary to the 4-way valve, threshold spring, and ramp spring components, refer to *Series 51 and Series 51-1 Motors Service Manual* **11008567**.

16. Remove and discard O-rings (F324).
17. Remove O-rings (G38), (G36) and (G42) or gasket (N240).
18. Using a 3 mm internal hex, remove orifices (T4, T6, U7).

Inspection

1. Inspect the housing (M1) for signs of corrosion or damage.
2. Replace any damaged parts.

Assembly

1. Using a 3 mm internal hex, install orifices (T4, T6, U7). Torque to 3.7 Nm [2.7 lbf•ft].
2. Lubricate and install O-rings (F324).
3. Install the 4-way valve assembly (F32).
4. Using petroleum jelly, lubricate and install a new O-rings (G38, G36 and G42) or install gasket (N240).
5. Install the control assembly to the end cap.
6. Install screws (M150 and M151).
7. Torque screws (M150 and M151) to:
    - 78 N•m [58 lbf•ft]. Use an 8mm internal hex wrench for 80 cc and 110cc motors.
    - 110 N•m [81 lbf•ft]. Use a 10 mm internal hex for 160cc and 250ccmotors.
8. Install spool (M32).
9. Lubricate O-ring (M23A). Using a 3/8 internal hex wrench, install plug (M23). Torque to 25 Nm [18 lbf•in].
10. Lubricate and install 13 O-rings (M24A). Using an 1/8 internal hex wrench, install 13 plugs M24). Torque to 6 Nm [4 lbf•in].
11. Lubricate and install O-rings (M84A). Using a 7/16 wrench, install plugs (M84). Torque to 12 Nm [9 lbf•in].
12. Install the PCOR spool assembly (M20).
13. Install spring (M18). Install adjuster (Z*).
14. Lubricate and install O-ring (M16).
15. Install lock nut (M14). Torque to 54 Nm [40 lbf•in].

JA Control

Caution

Readjust the PCOR to its proper setting

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