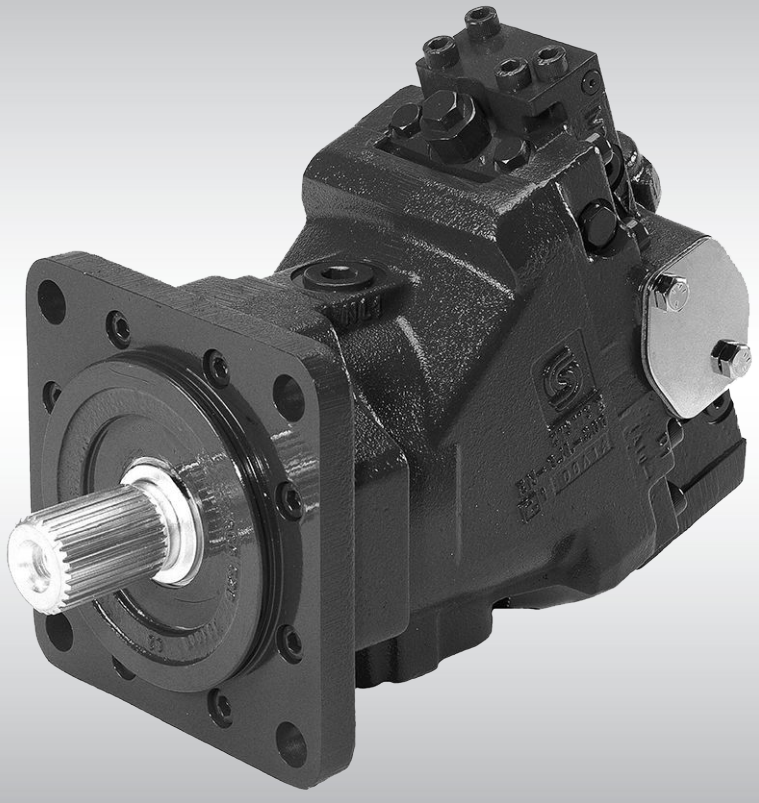
MAKING MODERN LIVING POSSIBLE

Service Manual

Electrohydraulic Controls Series 51

A7, D7, D8, DA, DC, EE, EP, EQ, ER, ES, L1, L2, L7



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Revision history

Table of revisions

Date	Changed	Rev
July 2014	Danfoss layout	BA
July 2009	First edition	AA

Contents

Contents

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.

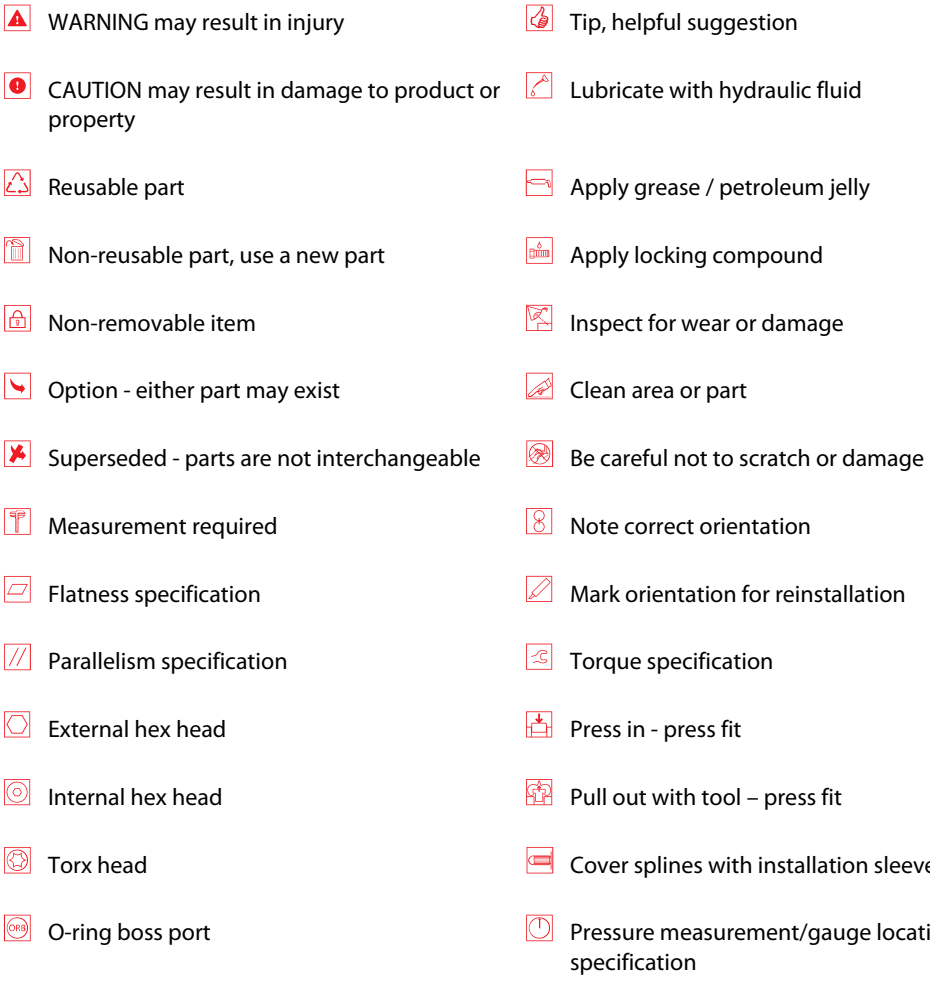
Hazardous Material

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 electrohydraulic 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, strictly follow cleanliness requirements. 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.powersolutionsdanfoss.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 *Hydraulic Fluids and Lubricants, Technical Information* **520L0463**.

Torque Procedure

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

General Description

Overview

Electrohydraulic proportional controls infinitely vary motor displacement between maximum and minimum. They do this by shifting the 4-way valve. The spool position shifts with an

- electric pressure-reducing valve. It varies signal pressure on the end of the 4-way valve (D7, D8 controls), or
- electrically varied differential pressure on the ends of a piston connected to the 4-way valve (EP, EQ, ER, ES, ED, EE controls), or
- electric proportional solenoid acting directly on the 4-way valve (A7, L1, L2, L7 controls).

Multifunction Block

Some of the electrohydraulic proportional controls are used in conjunction with the multifunction block. The multifunction block is a manifold with a shuttle valve that routes high loop (system pressure) from port A or B to the 4-way valve while routing the low loop (stystem pressure) to the PCOR valve. The 4-way valve directs this pressure to the ends of the servo piston to change displacement. The multifunction block may also provides the pressure compensating override (PCOR) option that regulates system pressure.

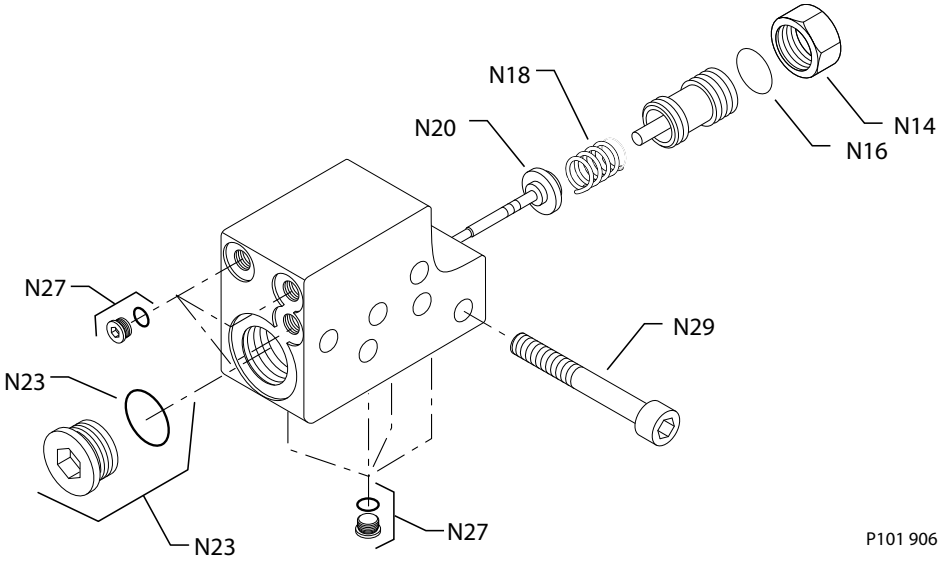
Introduction

Pressure Compensating OverRide (PCOR) Option

The 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, so does available torque while output speed decreases and system pressure remains nearly constant at the PCOR setting.

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

PCOR



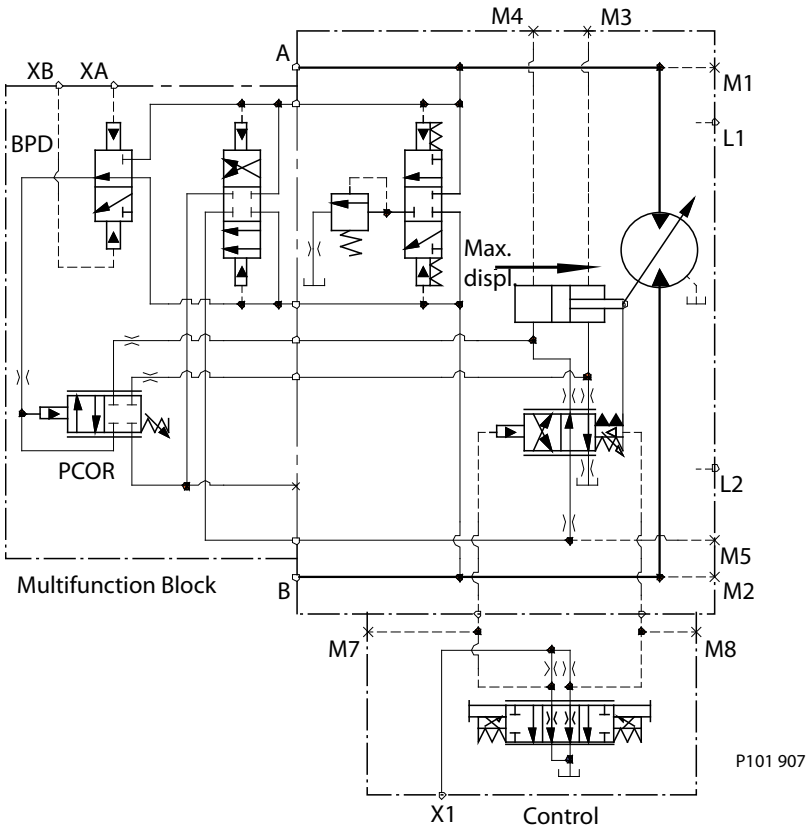
Brake Pressure Defeat (BPD) option

The PCOR function can be equipped with a brake pressure defeat (BPD) option that defeats the PCOR operation during dynamic braking. A shuttle spool in the multifunction block in front of the PCOR valve directs only acceleration system pressure to the PCOR. During deceleration, the high dynamic braking pressure is blocked from the PCOR. This limits rapid and uncontrolled pressures or engine over-speeding while the vehicle/machine is slowing down. External hydraulic signal pressures fed to ports XA or XB are essential to operate the BPD spool. PCOR operation on one-system pressure side is also an option.

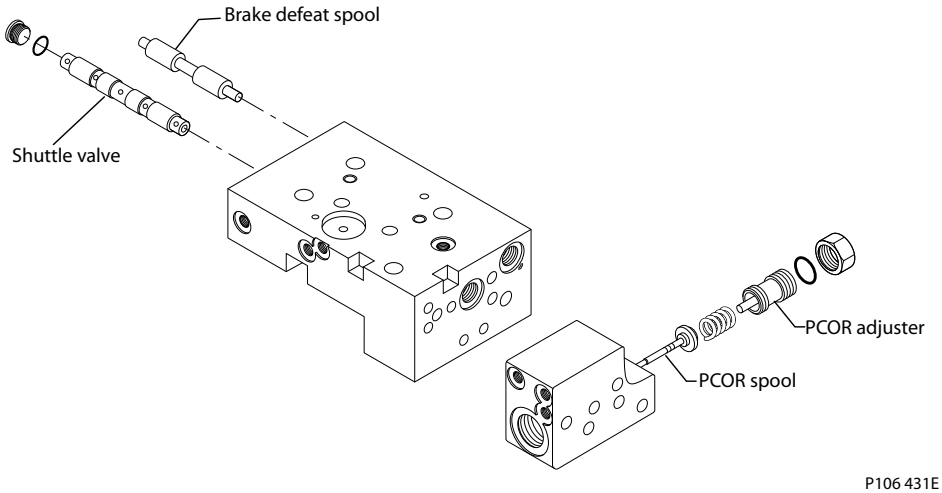
EP, EQ Electrohydraulic Proportional Control with Pressure Compensator and Hydraulic Brake Pressure Defeat.

Introduction

BPD



BPD option



Introduction

Threshold and Ramp Springs

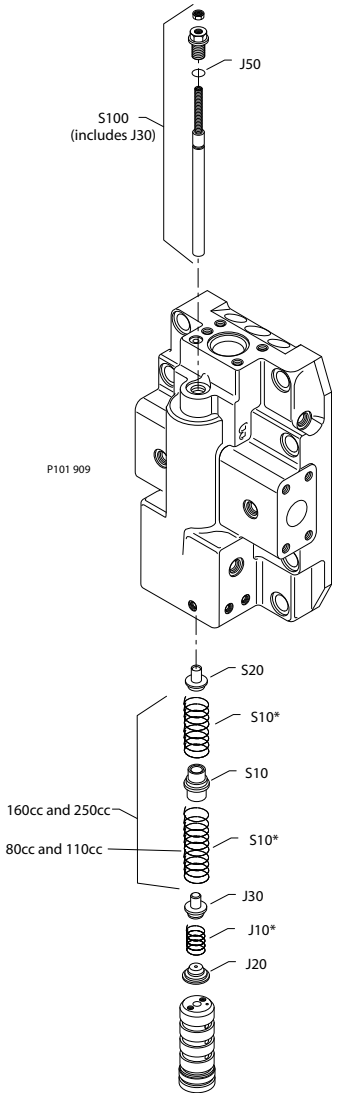
A threshold spring and ramp spring(s) act on the opposite end of the 4-way valve. The threshold adjustment screw (S100) varies the threshold spring force. This changes the signal current required to move the 4-way valve and start the change in displacement. The S10* ramp spring(s)—two used in 160 cc and 250 cc motors and one used in 80 cc and 110 cc 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 variable input signal current.

The control-operating threshold (the signal current or force when the motor starts to shift) is adjustable. Adjust it using the S100 adjusting screw in the motor's 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.

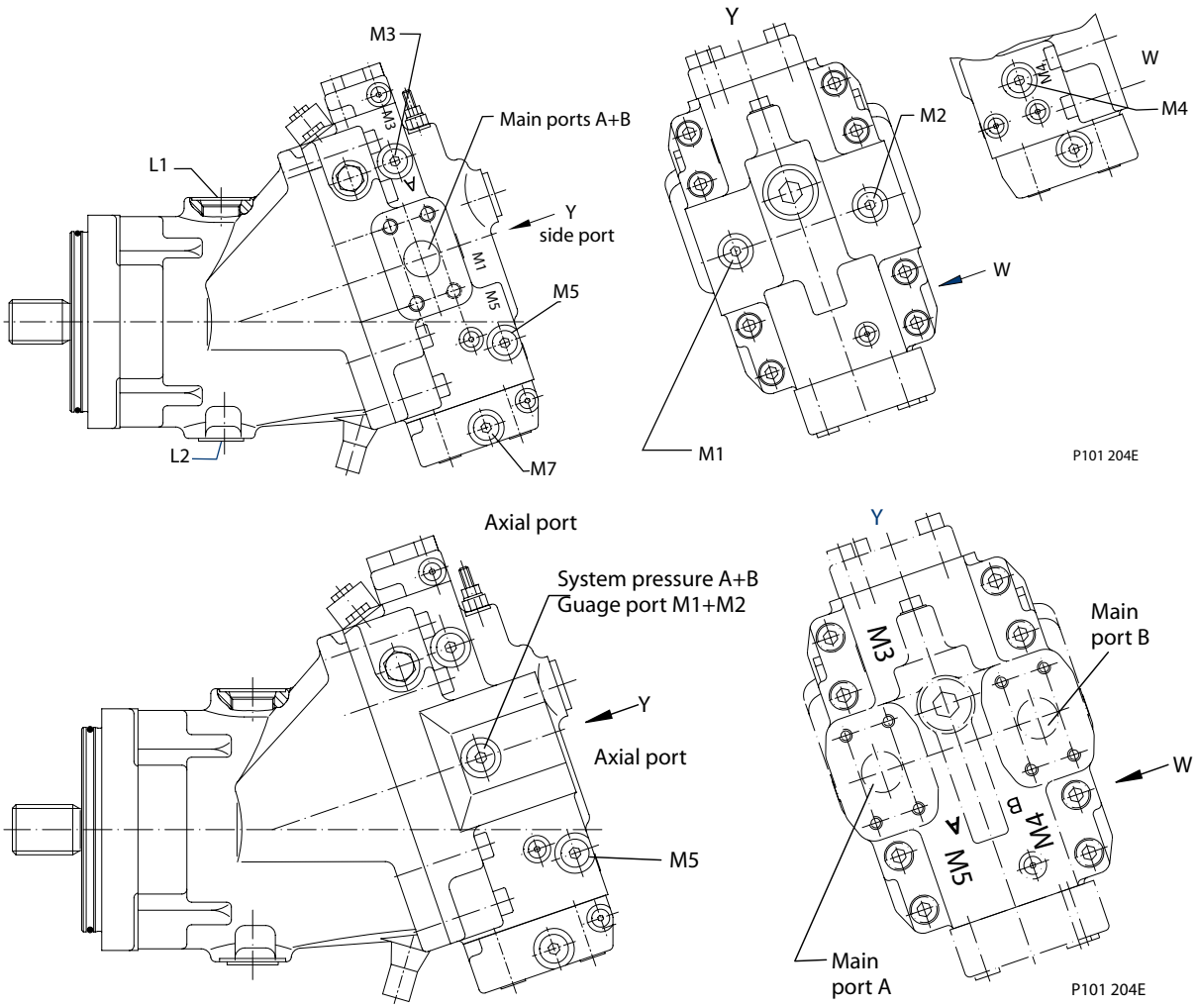
Ramp Springs



Pressure measurements

Port Locations and Gauge Installation

Series 51 Motors



Legend

Abbreviation	Definition
L1	Case drain; (1-5/16-12UNF)
L2	Alternate case drain: (1-5/16-12UNF)
M1	Gauge port: system pressure A (9/16-18UNF)
M2	Gauge port: system pressure B (9/16-18UNF)
M3	Gauge port: servo pressure min. angle (9/16-18UNF)
M4,	Gauge port: servo pressure max. angle (9/16-18UNF)
M5	Gauge port: servo supply pressure (9/16-18UNF)
M7	Control pressure port (9/16-18UNF)

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 start to move toward minimum position. Signal current at this point is the threshold setting.

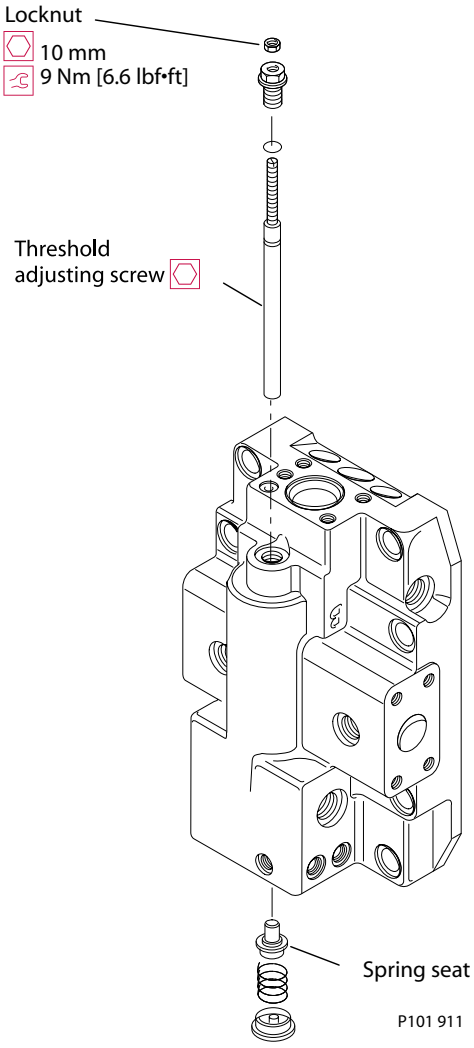
On a test stand, increase signal current until the flow from the motor begins to decrease. The signal current at this point is the threshold setting.

Adjusting Threshold Setting

1. Using a 10 mm wrench, loosen the locknut on the adjusting 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.
5. Stroke the pump very slowly to gradually increase the system pressure.

Adjustments

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 in. 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].

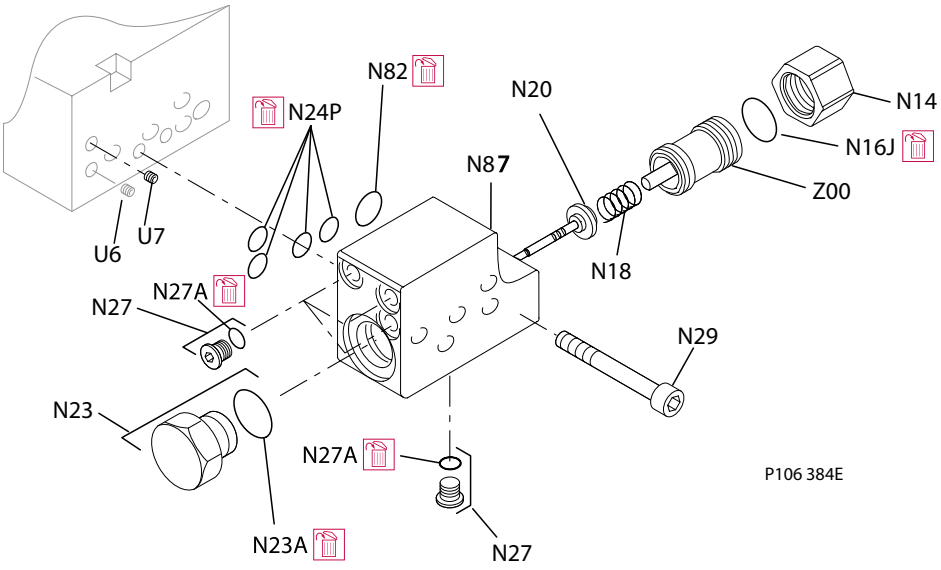
PCOR

Optional PCOR Housing Repair

Disassembly

1. Remove plugs (N27). Remove and discard O-rings (N27A).
2. Using a 1 inch hex 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).

PCOR

3. Position PCOR on multiblock. Install screws (N29). Torque using a 5 mm internal hex wrench to 16 N•m [12 lbf•ft].
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 *PCOR Adjustment* on 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].

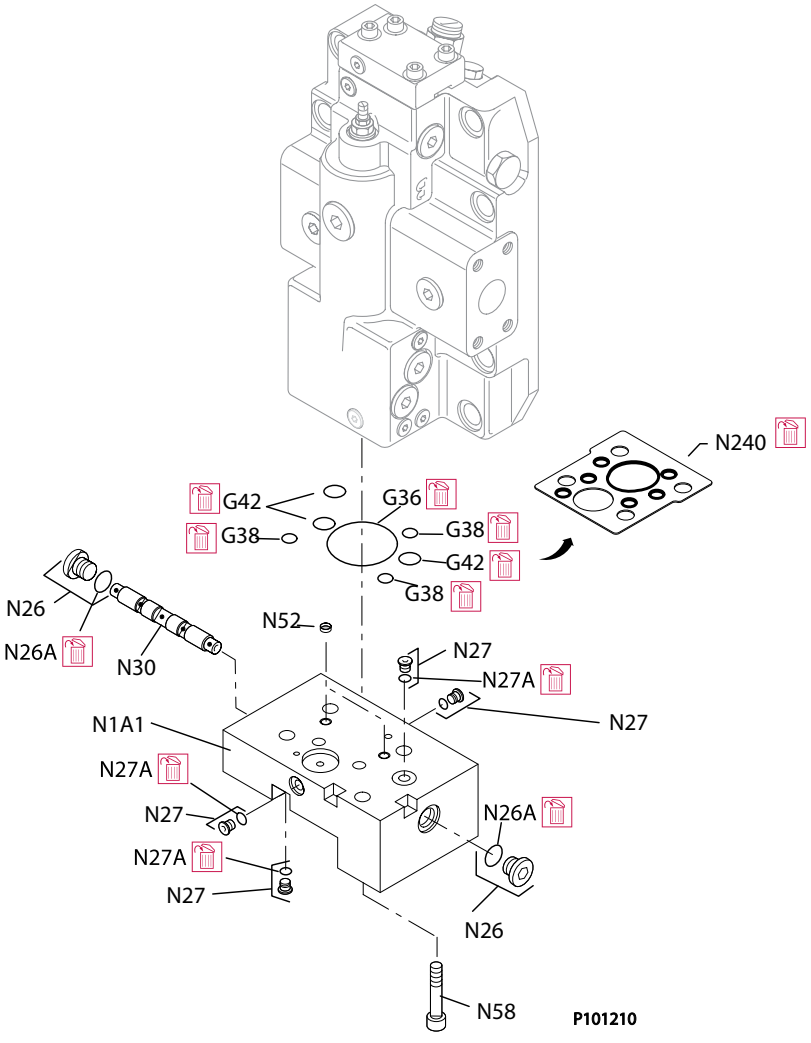
Multifunction block

Optional Multifunction Block Repair

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 the O-rings (G36, G38, G42) or gasket (N240).
7. If present, remove and discard screens (N52).

E, F* Control*



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]

Multifunction block

Legend (continued)

Item	Wrench size	Torque
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). Spool is symetrical, either end 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].

A7, L1, L2, L7 Controls

Operation

General Description

The A7, L1, L2, L7 controls consist of a ported housing mounted directly on the end cap. It contains a check valve. A direct acting proportional solenoid, with a pushpin, is mounted onto the housing. This solenoid is high-current. It has an input range of 440 to 1290 mA (12V) or 220 to 645 mA (24v). These controls are not available with pressure compensator override.

Proportional Solenoid

The proportional solenoid, through the pushpin, presses directly against the 4-way valve. With signal current below the threshold setting, the motor defaults to maximum displacement. An increase in signal current above the threshold setting, shifts motor displacement steplessly from maximum to minimum.

Connector Oder Code

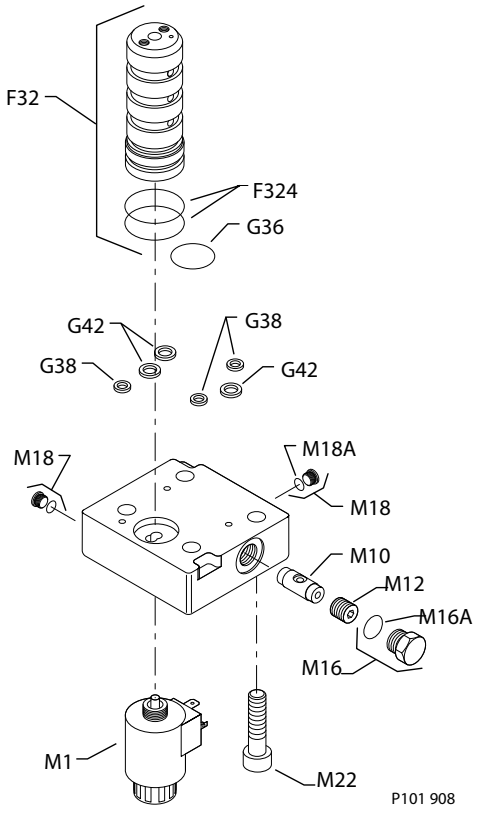
Order code	Volts	Connector
A7	12v	AMP Junior Timer
L1	12v	DIN
L2	24v	DIN
L7	12v	AMP Junior Timer

Check Valve

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

A7, L1, L2, L7 Controls

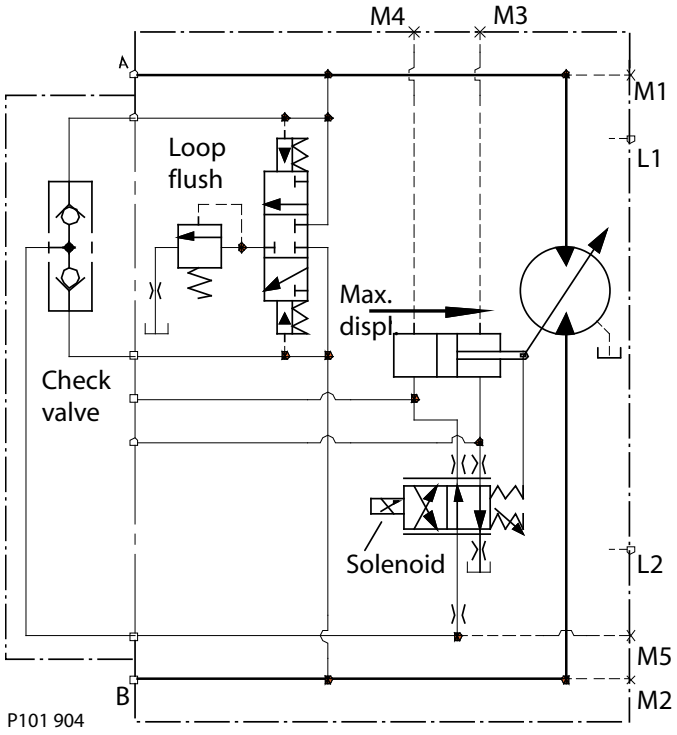
A7, L1, L2, L7 controls



A7, L1, L2, L7 Controls

Schematic

A7, L1, L2, L7 Schematic



Repair

Removing Solenoid

Solenoid (M1) is available as complete assembly only. Do not remove the solenoid unless it is being replaced.

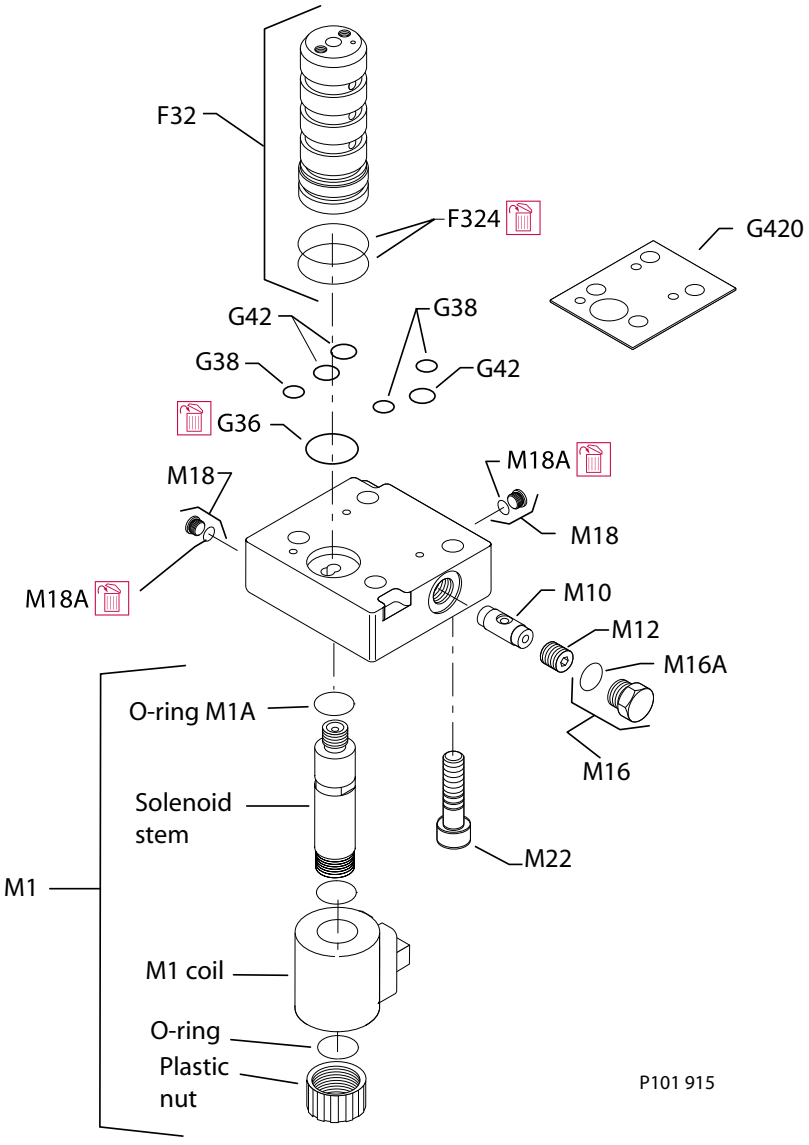
If replacing the solenoid (M1); remove plastic nut, remove coil, and use a 3/4 inch thin wrench to remove solenoid.

Disassembly

1. Using a 1/8-inch internal hex wrench, remove plugs (M18).
2. Remove and discard O-rings (M18A).

A7, L1, L2, L7 Controls

Controls



Legend

Item	Wrench size	Torque
M22 (80, 110)	8 mm internal hex	78 Nm [58 lbf•ft]
M22 (160, 1250)	10 mm internal hex	110 Nm [81 lbf•ft]

Item	Wrench size	Torque
M16	1/4 internal hex	37 Nm [27 lbf•ft]
M18	1/8 internal hex	6 Nm [4 lbf•ft]
M12	5 mm internal hex	11 Nm [8 lbf•ft]

3. Using a 1/4-inch internal hex wrench, remove the plug assembly (M16).
4. Remove and discard O-ring (M16A).

A7, L1, L2, L7 Controls

5. Using a 5mm internal hex wrench remove orifice (M12)
6. Remove check-valve assembly (M10).

   If necessary, tap the housing on a hard surface to remove the check valve assembly.
7. Remove screws (M22)
8. Remove control housing. Remove and discard O rings (G36, G38, and G42) or gasket (G420).
9. Remove spool (F32).

   Caution

   Read *BLN-10181* for repair instructions for the F32 4-way valve, threshold spring, and ramp spring components, if their repair is necessary
10. Remove and discard O-rings (F324).

Inspection

1. Inspect the housing and spools for wear, damage or foreign material.
2. Check internal passages for contamination and clean them if necessary.

Assembly

1. Lubricate and install O-rings (F324).
2. Install valve (F32).
3. Using petroleum jelly, lubricate and install new O-rings (G38, G42, G36), or install gasket (N240).
4. Position control on end cap.
5. Install screws (M22). Torque per listing in table.
6. Lubricate and install new O-rings (M18A).
7. Install plugs (M18). Using a 1/8-inch internal hex wrench torque plugs to 6 N•m [4 lbf•ft].
8. Install the check valve assembly (M10).
9. Install orifice (M12). Using a 5mm internal hex, torque orifice to 11 N•m [8 lbf•ft].
10. Install new O-ring (M16A).
11. Install the plug (M16). Using a 1/4-inch internal hex wrench torque the plug to 37 N•m [27 lbf•ft].

Solenoid Assembly

1. Lubricate and install O-ring (M1A). Install solenoid.
2. Using a 3/4 inch thin wrench, torque solenoid to 47 Nm [35 lbf•ft].
3. Install coil with O-rings.
4. Install plastic nut. Tighten by hand.

D7, D8, DA, DC Controls

Operation

General Description

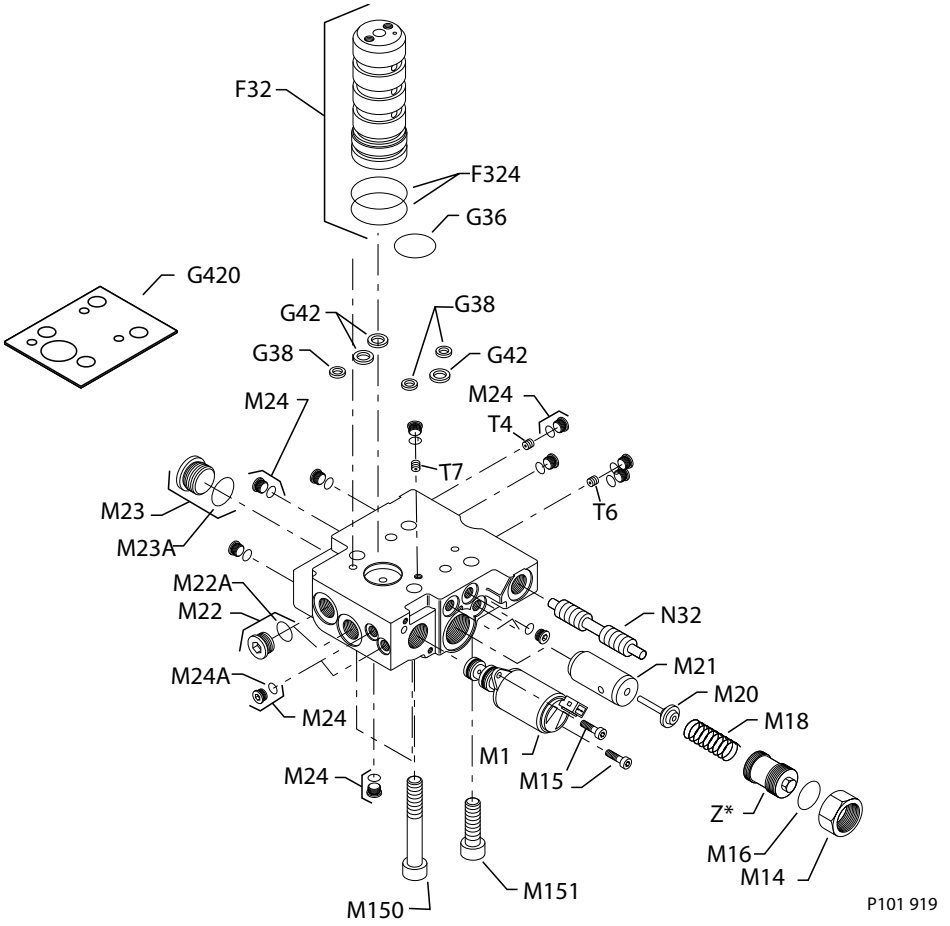
The D7 and D8 controls consist of a ported housing with an electric pressure-reducing valve, a pressure compensator override valve (PCOR), and an optional hydraulic brake pressure defeat (BPD) spool. For these controls, there must be external servo supply pressure fed to the M5 port (25 bar [363 psi] minimum, 50 bar [725 psi] maximum).

DA and DC controls include an electric brake pressure defeat option.

Pressure-Reducing Valve

The pressure-reducing valve uses servo supply pressure for signal pressure. It varies this pressure electrically and feeds it to the end of the F32 4-way valve. With signal current below the threshold setting, the motor defaults to maximum displacement. An increase in signal current shifts the motor displacement from maximum to minimum.

D7, D8 Control



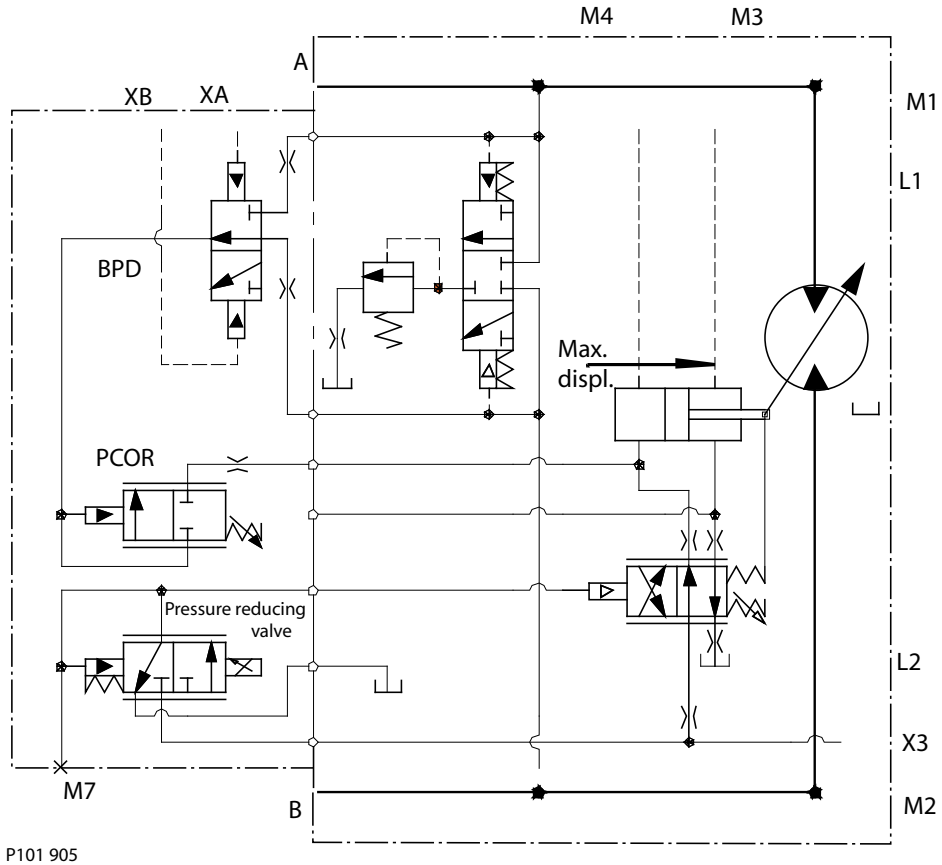
This pressure-reducing valve coil is high current. It has an input range of 640 mA to 1188 mA (12v) or 320 mA to 594 mA (24v).

The D7 solenoid is 12 volt. The D8 solenoid is 24 volt. Both are fitted with AMP Junior Timer connectors.

D7, D8, DA, DC Controls

Schematic

D7, D8 Schematic



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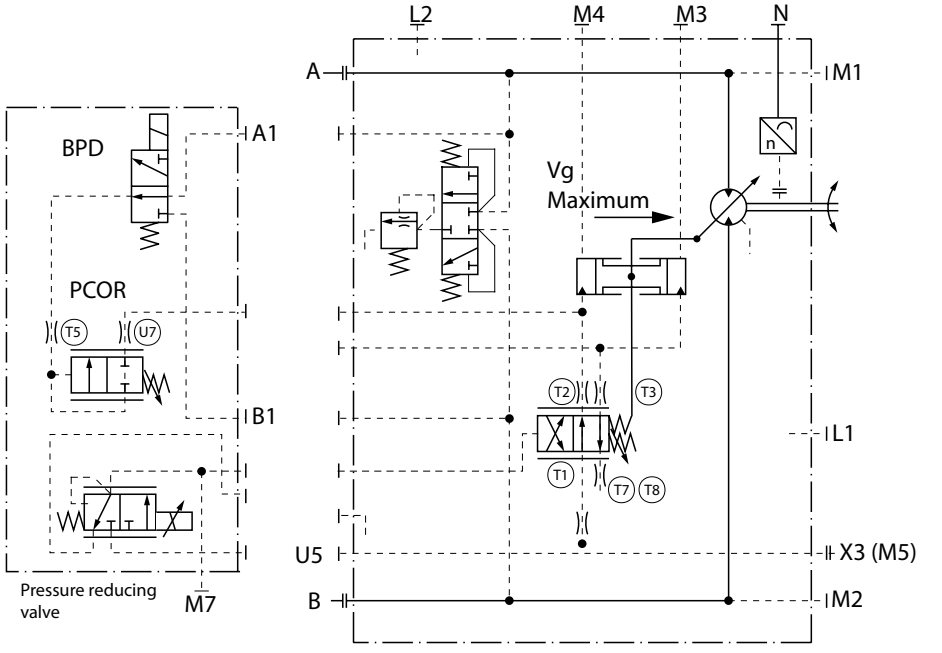
DA, DC Schematic



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D7, D8, DA, DC Controls

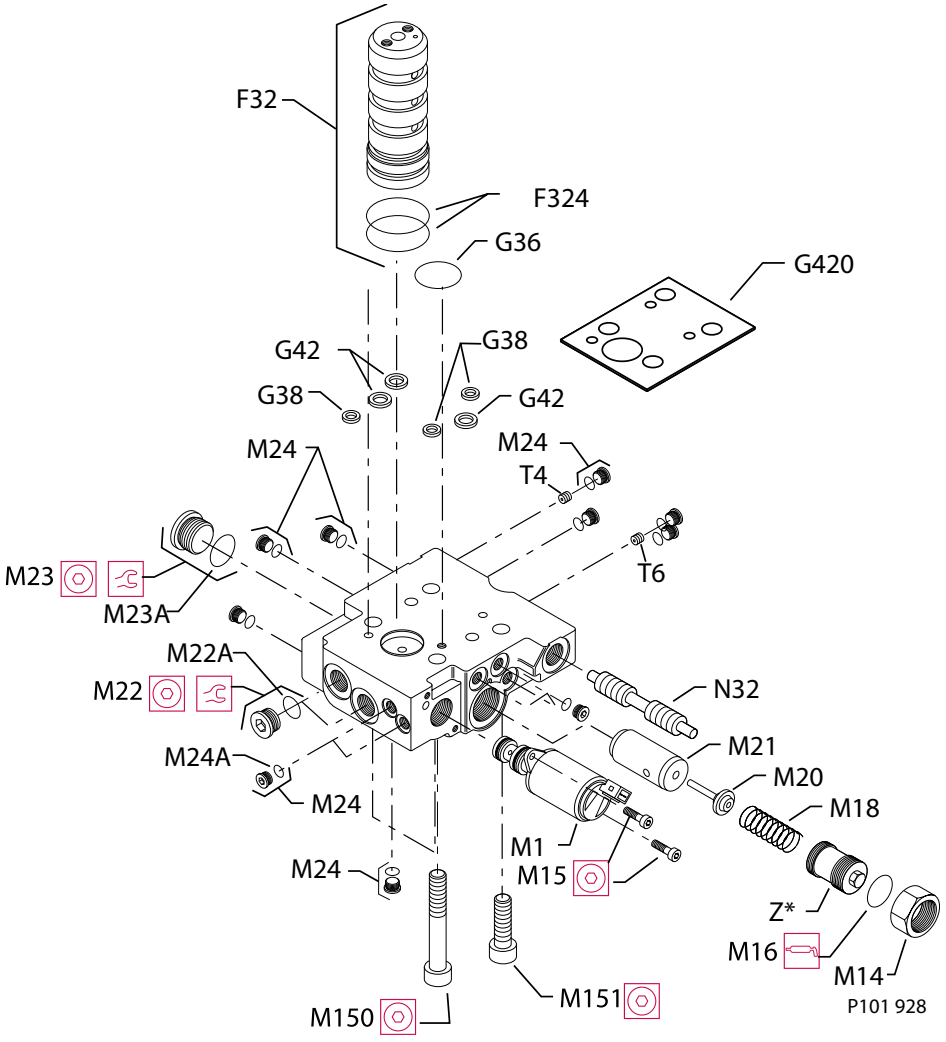
Repair

Disassembly

Solenoid (M1) is available as complete assembly only. Do not remove the solenoid unless it is being replaced.

1. Using a 3 mm internal hex wrench remove screws (M15).
2. Remove solenoid M1.
3. Using a 1 1/16-inch wrench remove nut (M14).
4. Remove and discard O-ring (M16).

D7, D8 Control



Legend

Item	Wrench size	Torque
M151 (80, 110 cc)	8 mm internal hex	78 Nm [58 lbf•ft]
M150 (160, 250 cc)	10 mm internal hex	110 Nm [81 lbf•ft]
U7	3 mm internal hex	6 Nm [4 lbf•ft]

D7, D8, DA, DC Controls

Legend (continued)

Item	Wrench size	Torque
M24, N84	1/8 internal hex	6 Nm [4 lbf•ft]

Item	Wrench size	Torque
M22	1/4 internal hex	37 Nm [28 lbf•ft]
M15	3 mm internal hex	3.7 Nm [2.7 lbf•ft]
M18	1/8 internal hex	6 Nm [4.5 lbf•ft]
M14	1-1/16 inch	52 Nm [38 lbf•ft]
M23	1 inch	40Nm [30 lbf•ft]
Z*	13 mm	N/A

5. Using a 13 mm wrench remove the Z* adjuster.
6. Remove spring (M18). Remove the PCOR spool (M20).
7. Don't remove PCOR valve bushing (M21).
8. Using a 1/8-inch internal hex wrench, remove plugs (M24).
9. Remove and discard O-rings (M24A).
10. If necessary, use a 3 mm internal hex wrench to remove and clean orifices T4, and T6.
11. Using a 1-inch wrench remove plug (M23). Remove and discard O-ring (M23A).
12. Using a 1/4-inch internal hex wrench remove plug (M22). Remove and discard O-ring (M22A).
13. Remove spool (N32).
14. Remove screws (M150 and M151). Refer to table for wrench sizes.
15. Remove control assembly from end cap.
16. Remove and discard O-rings (G36, G38, and G42) or gasket (G420).
17. Remove the 4-way valve assembly (F32). Discard O-rings (F324).

Caution

Read *BLN-10181* for minor repair instructions for the F32 4-way valve, threshold spring, and ramp spring components, if their repair is necessary

Inspection

1. Inspect the housing and spools for wear, damage or foreign material.
2. Check internal passages for contamination and clean them if necessary.

Assembly

1. Lubricate and install new O-rings (F324). Install 4-way valve assembly (F32)
2. Using a 3 mm internal hex wrench, install and torque orifices (T4, and T6) to 2.8 N•m [2.1 lbf•ft].
3. Using petroleum jelly to retain them, install the new O-rings (G36, G38, and G42) or gasket (G420).
4. Position control housing on endcap.
5. Install screws (M150 and M151). Refer to table for wrench sizes and torques.
6. Install spool (N32).
7. Lubricate and install new O-rings (M22A). Install plug (M22).
8. Using a 1/4-inch internal hex wrench, torque plug (M22) to 37 N•m [27 lbf•ft].
9. Lubricate and install a new O-ring (M23A). Install plug (M23).
10. Using a 1-inch wrench, torque plug (M23) to 40 N•m [30 lbf•ft].
11. Lubricate and install new O-rings (M24A). Install plugs (M24).

D7, D8, DA, DC Controls

12. Using a 1/8-inch internal hex wrench, torque plugs (M24) to 6 N•m [4 lbf•ft].
13. Install PCOR spool (M20). Install spring (M18).
14. Using a 13 mm wrench, install the Z* adjuster.
15. Lubricate and install O-ring (M16). Install nut (M14). Do not torque nut (M14).
16. Before returning to normal operation, readjust the PC setting (see p. 15).
17. Install solenoid M1. Install screws (M15).
18. Using a 3 mm internal hex wrench torque screws (M15) to 2.8 N•m [2.1 lbf•ft].

EE Control

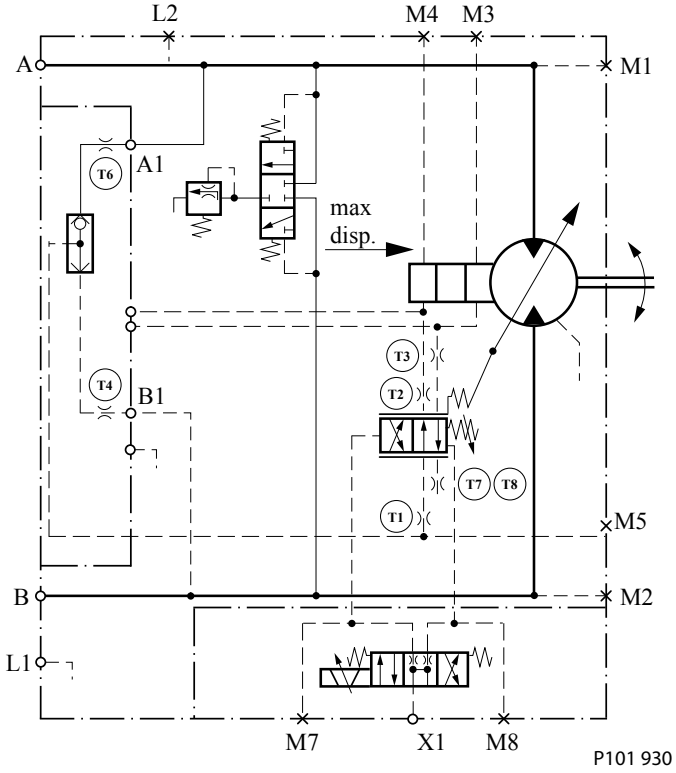
Operation

General Description

The EE controls consist of a ported housing mounted directly on the end cap. The ported housing has a piston and a pushpin that contact the 4-way valve (F32), and a ball-check valve. A pressure control pilot (PCP) is mounted on the control housing.

The PCP produces a differential output pressure. It's proportional to the applied electrical input signal. Differential pressure is fed to the piston ends. When differential pressure reaches the preset threshold force on the piston it causes the 4-way valve (F32) to move. The 4-way valve ports servo supply pressure to the servo piston. This changes the motor's displacement.

Circuit Diagram for Motor with EE Control



Ports:

A, B = Main pressure lines

L1, L2 = Drain lines

M1, M2 = Gauge port for A and B

M3, M4 = Gauge port servo pressure

X3 (M5) = Servo pressure supply

M7 = Gauge port control pressure

XA, XB = Control pressure ports hydraulic brake pressure defeat

T1, T2, T3, T4, T6, T7, T8, U7= Optional orifices

N = Speed sensor

EE controls have a metri-pack connector.

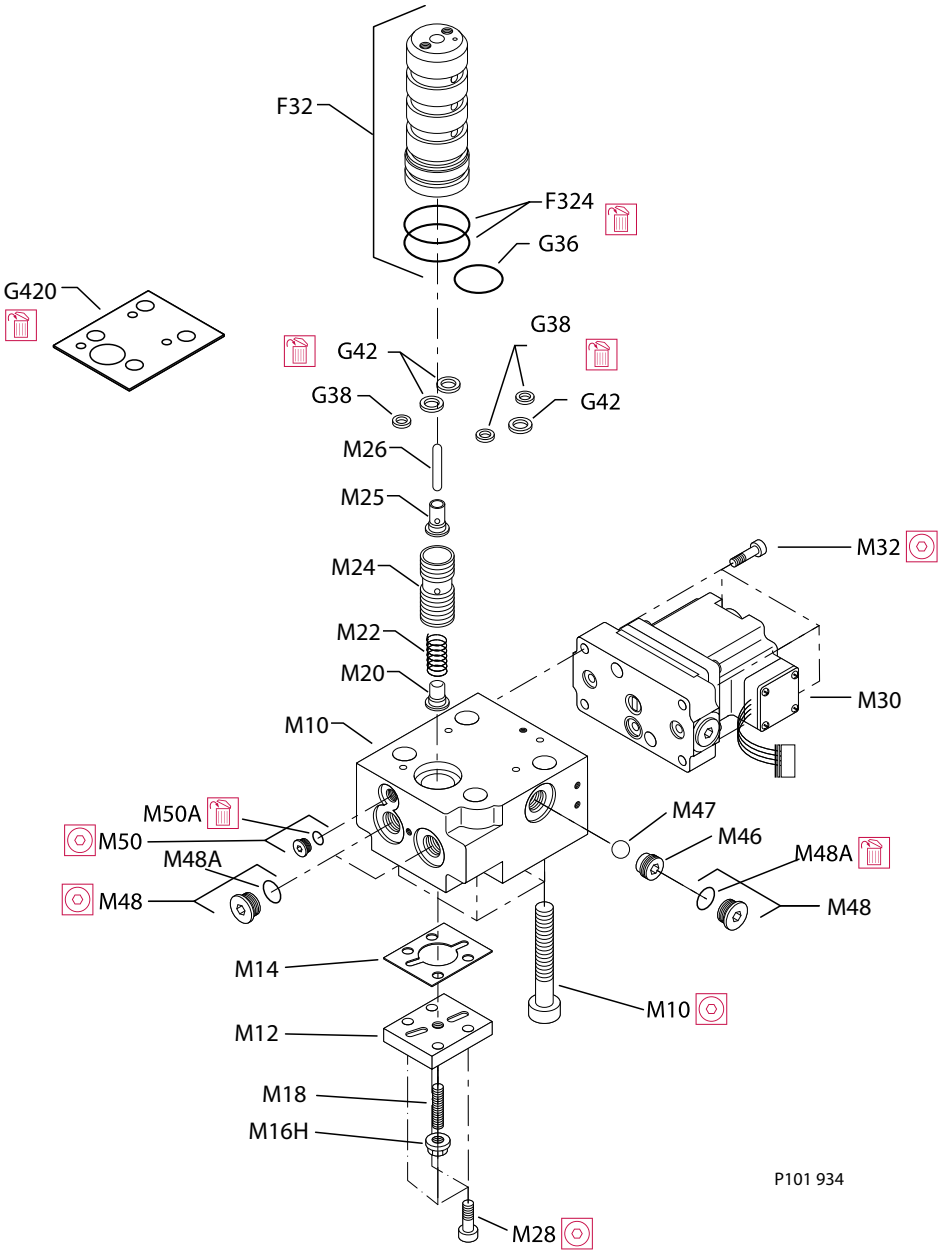
EE Control

Repair

Disassembly

1. Using a 5/32 inch internal hex wrench remove screws (M32).
2. Remove the PCP (M30). The PCP has no repairable parts.

EE Controls



Legend

Item	Wrench size	Torque
M10 (80, 110 cc)	8 mm internal hex	78 Nm [58 lbf•ft]

EE Control

Legend (continued)

Item	Wrench size	Torque
M10 (160, 250 cc)	10 mm internal hex	110 Nm [81 lbf•ft]
M32	5/32 internal hex	6 Nm [4 lbf•ft]
M28	4 mm internal hex	7 Nm [5 lbf•ft]

Item	Wrench size	Torque
M48	1/4 internal hex	37 Nm [28 lbf•ft]
M18	3 mm internal hex	N/A
M46	5 mm internal hex	8 Nm [6 lbf•ft]
M50	1/8 internal hex	6 Nm [4 lbf•ft]
M16H	10 mm	15 Nm [11 lbf•ft]

3. Mark position of adjuster screw (M18).
4. Using a 10 mm wrench, remove locknut (M16H).
5. Using a 3 mm internal hex, remove adjuster screw (M18).
6. Using a 4 mm internal hex wrench remove screws (M28).
7. Remove cover block (M12). Remove and discard gasket (M14).
8. Using a 1/4-inch internal hex wrench remove plugs (M48).
9. Remove and discard O-rings (M48A).
10. Using a 5mm internal hex wrench remove check ball seat (M46).

Newer units have a check valve assembly at M46.

11. Remove check ball (M47).
12. Using a 1/8-inch internal hex wrench remove plug (M50).
13. Remove and discard O-ring (M50A).
14. Remove screws (M10). Refer to table for wrench size.
15. Remove the control assembly from the end cap.
16. Remove O-rings (G36, G38, G42) or gasket (G420).
17. Remove the pin (M26).
18. Remove piston (M24). Remove spring seat (M25).
19. Remove spring guide (M20). Remove spring (M22).
20. Remove valve (F32). Remove and discard O-rings (F324).

Caution

Read *BLN-10181* for minor repair instructions for the F32 4-way valve, threshold spring, and ramp spring components, if their repair is necessary

Inspection

1. Inspect the housing and spools for wear, damage or foreign material.
2. Check internal passages for contamination and clean them if necessary.

Assembly

1. Lubricate and install O-rings (F324). Install 4-way valve (F32).
2. Install spring seat (M25) in piston (M24).
3. Install the spring (M22) into the piston (M24).

EE Control

4. Install the spring guide (M20).
5. Install pin (M26). and Install piston (M24).
6. Make sure pin (M26) fits into 4-way valve (F32).

Caution

Read *BLN-10181* for minor repair instructions for the F32 4-way valve, threshold spring, and ramp spring components, if their repair is necessary

7. Using petroleum jelly to hold them in place, install new O-rings (G36, G38, G42) or gasket (G420).
8. Install screws (M10). Refer to table for wrench size and torque.
9. Lubricate and install new O-ring (M50A).
10. Install plug (M50). Using a 1/8-inch internal hex wrench, torque to 6 N•m [4 lbf•ft].
11. Install check ball (M47).
12. Install the check ball seat (M46). Using a 5mm internal hex wrench, torque to 8 N•m [6 lbf•ft].

Newer units have a check valve assembly at M46.

13. Lubricate and install the new O-ring (M48A).
14. Install plug (M48). Using a 1/4-inch internal hex wrench torque to 37 N•m [27 lbf•ft].
15. Install gasket (M14). Install cover block (M12).
16. Install screws (M28). Using a 4 mm internal hex wrench torque to 6.4 N•m [4.7 lbf•ft].
17. Install adjuster screw (M18). Adjust to previously marked position.
18. Using a 3 mm internal hex to hold screw (M18) in place, install locknut (M16). Torque to 15 N•m [11 lbf•ft].
19. Install the PCP (M30).
20. Using a 5/32-inch internal hex wrench install screws (M32) and torque to 6 N•m [4 lbf•ft].

EP, EQ, ER, ES Controls

Operation

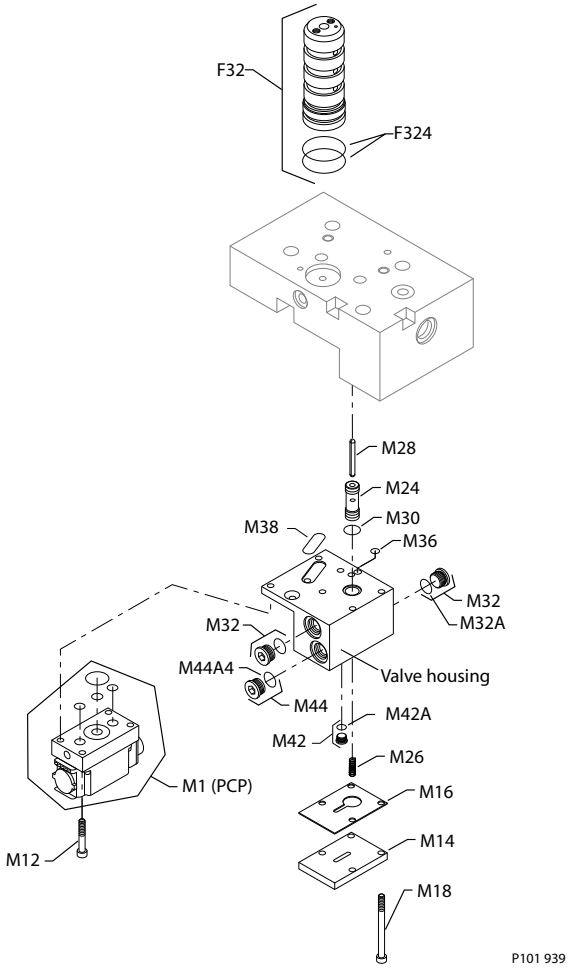
General Description

The EP, EQ, ER, ES controls consist of a ported housing mounted on the multifunction block. The ported housing has a piston and a pushpin that contact the 4-way valve. A pressure control pilot (PCP) is mounted on the control housing.

The PCP produces a differential output pressure. It's proportional to the applied electrical input signal. Differential pressure is fed to the piston ends. When differential pressure reaches the preset threshold force on the piston it causes the 4-way valve to move and port servo supply pressure to the servo piston. This changes the motor's displacement.

The EP and ER controls have Packard connectors. The EQ and ES controls have MS connectors.The EP and EQ controls have external supply pressure to X1 port.The ER and ES controls have internal supply pressure from the multiblock.

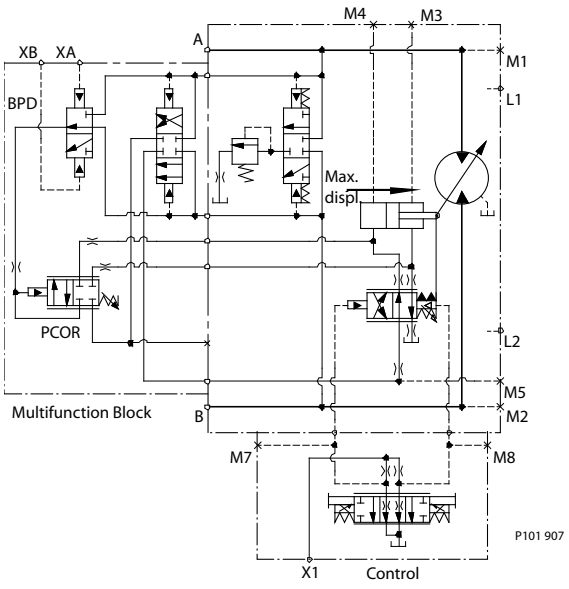
EP, EQ, ER, ES



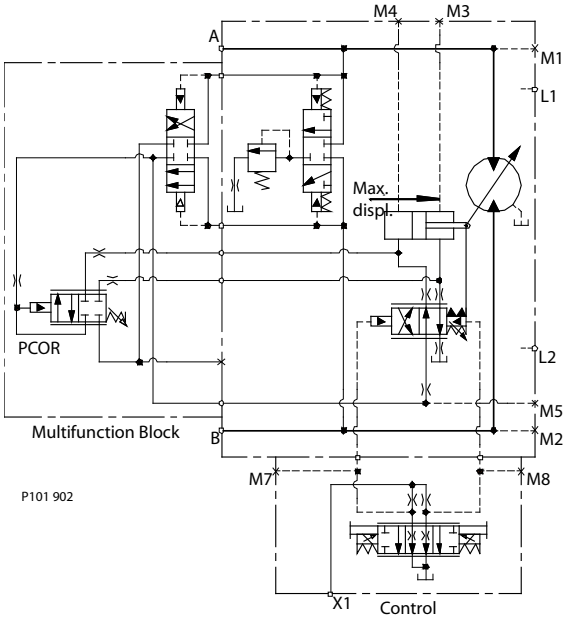
EP, EQ, ER, ES Controls

Schematics

E-A1 Schematic*

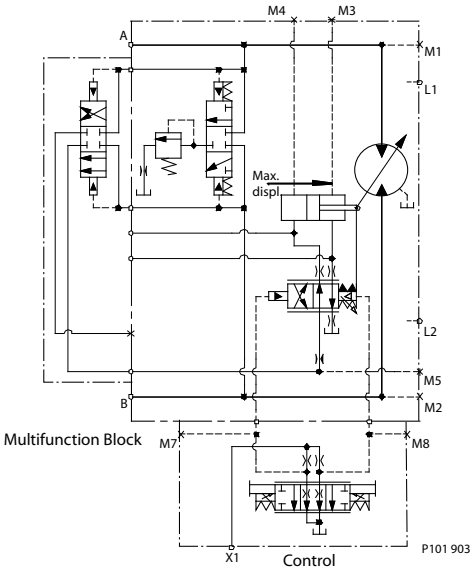


E-A2 Schematic*



EP, EQ, ER, ES Controls

E-A5 Schematic*



Definitions

E*-A1 is the electrohydraulic proportional with PCOR and BPD.

E*-A2 is the electrohydraulic proportional with PCOR.

E*-A5 is the electrohydraulic proportional without PCOR.

* = P, Q, R, or S

Repair

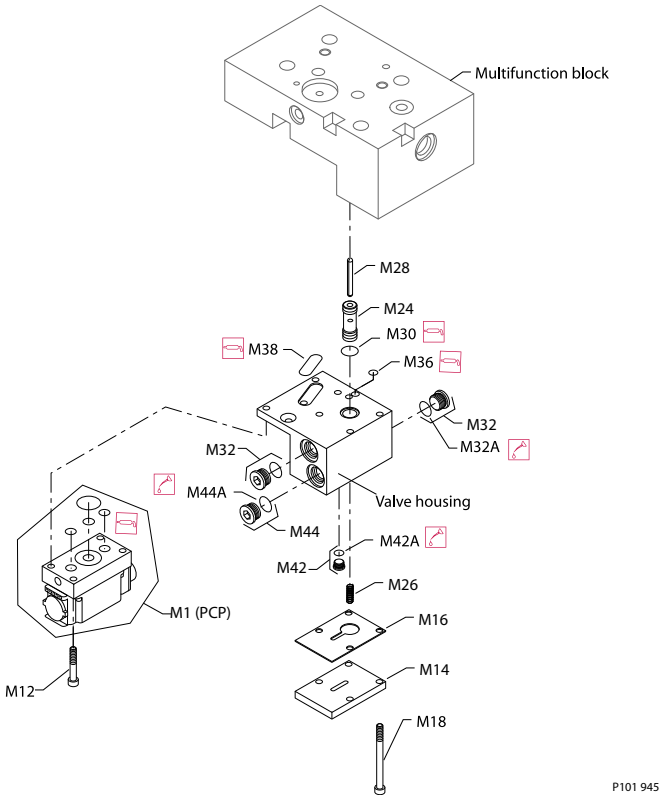
Control Housing Disassembly

Do not remove PCP valve (M1) unless replacing it. PCP valve is sold as a complete unit. O-rings are not available separately.

1. Using a 5/32-inch internal hex wrench, remove screws (M12).
2. Remove the pressure control pilot (PCP) valve (M1) from the control valve housing. (There are no repairable parts in the PCP.)
3. Using a 1/4-inch in internal hex wrench remove plug (M44), if present.
4. Remove and discard O-ring (M44A).
5. Using a 1/4-inch internal hex wrench remove plugs (M32).
6. Remove and discard O-rings (M32A).
7. Using a 4 mm internal hex wrench remove the screws (M18).
8. Remove valve housing.
9. Remove and discard O-rings (M30, M36, and M38).
10. Remove cover plate (M14). Remove and discard gasket (M16).
11. Remove bias spring (M26). Remove pilot piston (M24).
12. Remove pin (M28).
13. Using a 1/8-inch internal hex wrench remove plug (M42).
14. Remove and discard the O-ring (M42A).

EP, EQ, ER, ES Controls

EP, EQ, ER, ES Control



Legend

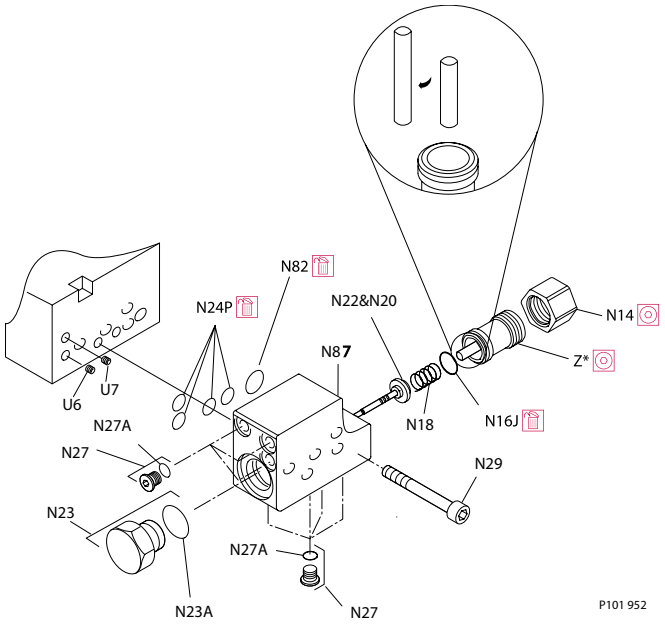
Item	Wrench size	Torque
M18	4 mm internal hex	7 Nm [5 lbf•ft]
M44, M32	1/4 internal hex	30 Nm [22 lbf•ft]
M12	5/32 internal hex	20 Nm [15 lbf•ft]
M44	4 mm internal hex	7 Nm [5 lbf•ft]

PCOR Disassembly

1. Using a 4 mm internal hex, remove screws (N29). Remove the PCOR valve housing (N87).
2. Remove and discard O-rings (N82 and N24P).
3. Using a 1 1/16-inch hex wrench remove locknut (N14).
4. Using a large flat screwdriver or a 13 mm hex wrench remove adjustment assembly (Z).
5. Remove and discard O-ring (N16J). Remove spring (N18). Remove spool assembly (N22 and N20).
6. Using a 1 inch wrench remove plug (N23). Remove and discard O-ring (N23A).
7. Using a 1/8 inch internal hex remove plugs (N27). Remove and discard O-rings (N27A).
8. Using a 3 mm internal hex, remove orifices (U6 and U7).

EP, EQ, ER, ES Controls

PCOR



Legend

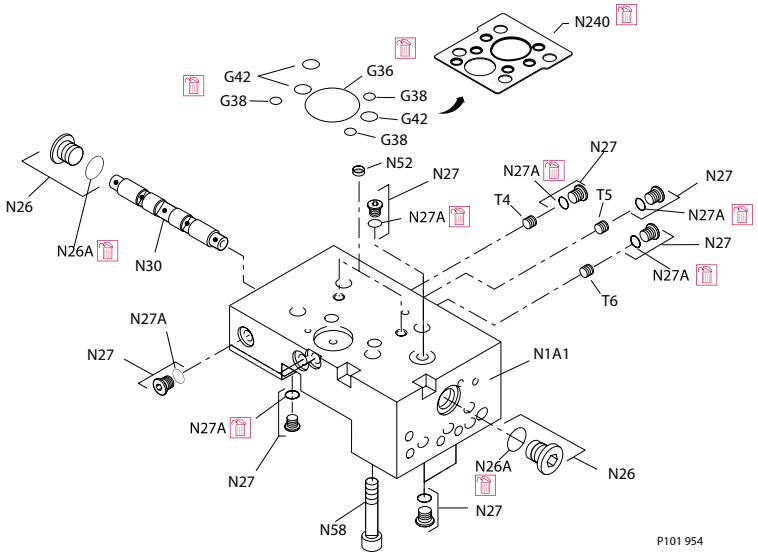
Item	Wrench size	Torque
N27	1/8 inch internal hex	7 Nm [4 lbf•ft]
N23	1 inch	40 Nm [30 lbf•ft]
U6, U7	3 mm internal hex	6 Nm [4 lbf•ft]
N29	5 mm internal hex	16 Nm [12 lbf•ft]
N14	1-5/16 inch	N/A

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. Remove screws (N58). Remove the multifunction block (N1A1).
4. Remove and discard the O-rings (G36, G38, G42) or gasket (N240).
5. Using a 1/8 inch internal hex wrench, remove plugs (N27). Remove and discard O-rings (N27A).
6. If present, remove and discard screens (N52).
7. Using a 3 mm internal hex, remove orifices T4, T5, and T6 , if present.

EP, EQ, ER, ES Controls

Multifunction Block



Legend

Item	Wrench size	Torque
N58 80cc, 110cc	8 mm internal hex	78 Nm [58 lbf•ft]
N58 160cc, 250cc	10 mm internal hex	110 Nm [81 lbf•ft]

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]
T4, T5, T6	3 mm internal hex	6 Nm [4 lbf•ft]

Control Orifices

1. Remove plugs (N27) covering orifices (T4, T5, T6) using a 1/8-inch internal hex wrench or a 1/4-inch wrench.
2. Remove and discard O-rings.
3. Using a 3 mm internal hex wrench, remove all orifices.
4. Clean the orifices thoroughly.
5. Install the orifices. Using a 3 mm internal hex, torque to 4 N•m [3 lbf•ft].

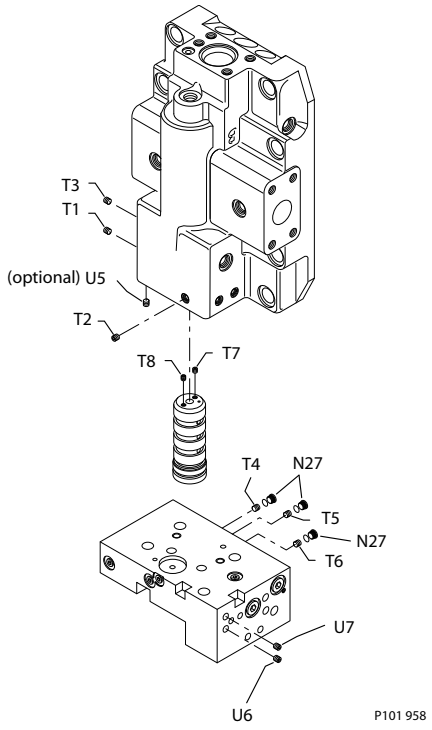
Caution

Do not over-torque the orifices.

6. Install plugs (N27). Torque plugs to 9 N•m [7 lbf•ft].

EP, EQ, ER, ES Controls

Control Orifices



Inspection

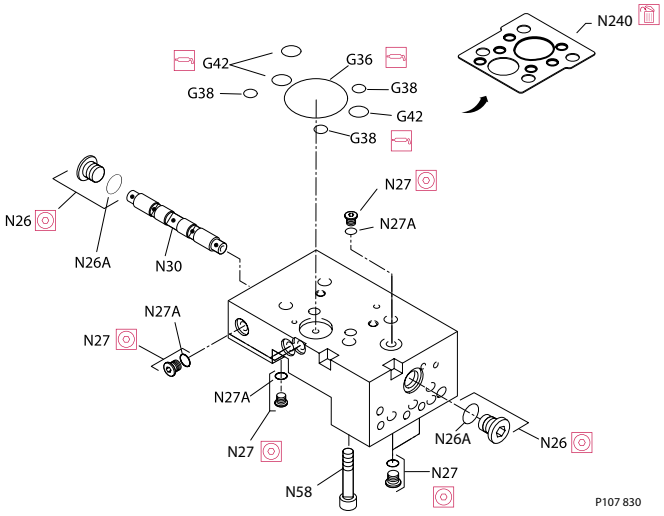
1. Inspect the multifunction block, shuttle spool, PCOR spool, and PCOR valve housing for damage or foreign material.
2. Clean all internal passages thoroughly. Replace worn or damaged components as necessary.

Multifunction Block Assembly

1. Lubricate and install new O-rings (N27A).
2. Install plugs (N27). Using a 1/8-inch internal hex wrench torque to 6 N•m [4 lbf•ft].
3. Using petroleum jelly to retain them, install new interface O-rings (G36, G38, and G42), or install gasket (N240).
4. Position multifunction block on endcap.
5. Install screws (N58). Refer to table for wrench size and torques.
6. Lubricate and install shuttle spool (N30).
7. Lubricate and Install new O-rings (N26A).
8. Install plugs (N26). Using a 1/4-inch internal hex wrench torque to 37 N•m [28 lbf•ft].

EP, EQ, ER, ES Controls

Install Multifunction Block



Legend

Item	Wrench size	Torque
N58 80cc, 110cc	8 mm internal hex	78 Nm [58 lbf•ft]
N58 160cc, 250cc	10 mm internal hex	110 Nm [81 lbf•ft]

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]
T4, T5, T6	3 mm internal hex	6 Nm [4 lbf•ft]

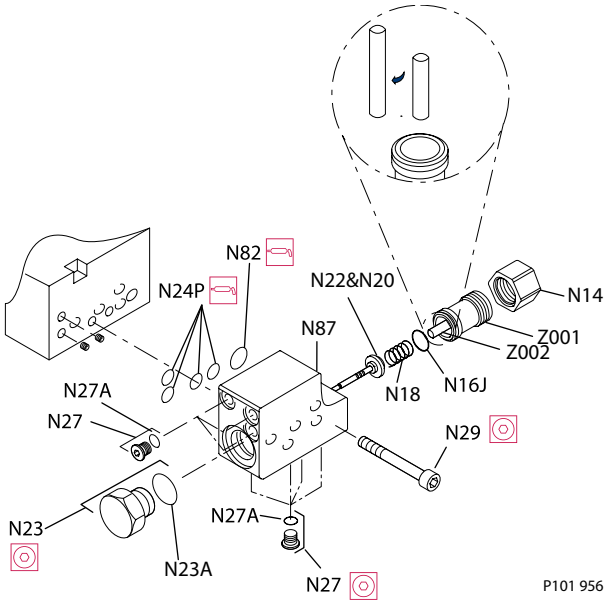
Inspection

PCOR Assembly

1. Using petroleum jelly to retain them, install new interface O-rings (N24P and N82) to the PCOR valve housing.
2. Install the PCOR valve housing (N87).
3. Install screws (N29). Using a 5 mm internal hex wrench torque to 9 Nm [7 lbf•ft].
4. Install the PCOR valve spool (N22, and N20) to the cavity in the PCOR valve housing.
5. Install the PCOR spring (N18).
6. Install a new O-ring(N16J). Install the PCOR adjustment screw (Z).
7. Install the PCOR valve locknut (N14). Torque locknut after adjusment.
8. Before returning to normal operation, reset the PC threshold setting. See *Adjusting the PCOR Setting* on page 14.
9. Install new O-ring (N23A).
10. Install plug (N23). Using a 1 inch wrench torque to 40 N•m [30 lbf•ft].
11. Lubricate and install O-rings (N27A).
12. Install plugs (N27). Using a 1/8 internal hex, torque to 6 Nm [4 lbf•ft].

EP, EQ, ER, ES Controls

PCOR Valve Assembly



Legend

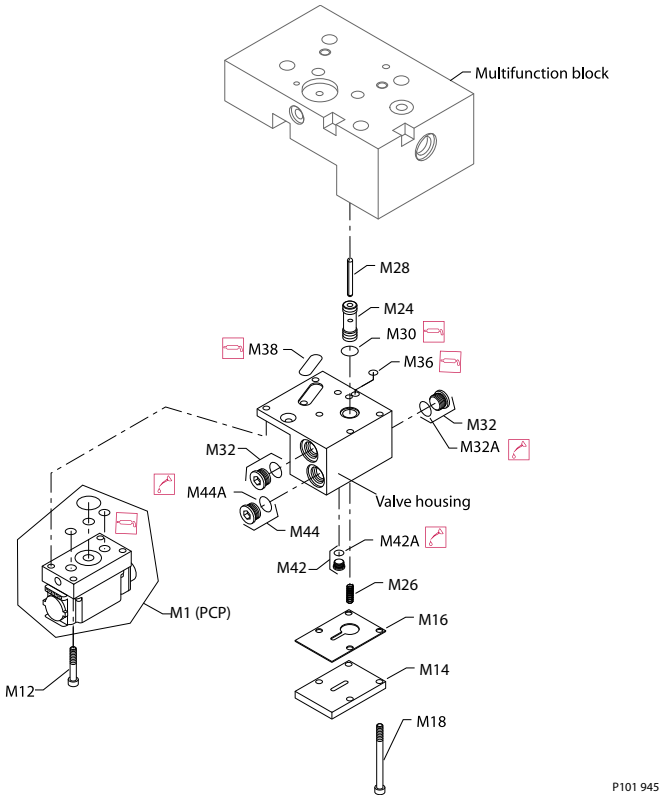
Item	Wrench size	Torque
N27	1/8 inch internal hex	7 Nm [4 lbf•ft]
N23	1 inch	40 Nm [30 lbf•ft]
U6, U7	3 mm internal hex	6 Nm [4 lbf•ft]
N29	5 mm internal hex	16 Nm [12 lbf•ft]
N14	1-1/16 inch	N/A

Control Housing Assembly

1. Lubricate and install new O-ring (M42A).
2. Install plug (M42). Using a 1/8 internal hex, torque to 6Nm [4 lbf•ft].
3. Install pin (M28). Install pilot piston (M24).
4. Install bias spring (M26). Install gasket (M16).
5. Install cover (M14).
6. Using petroleum jelly to hold them in place, install O-rings (M30, M36, and M38).
7. Install valve housing.
8. Install screws (M18). Using a 4 mm internal hex wrench, torque to 7 Nm [5 lbf•ft].
9. Lubricate and install O-rings (M32A).
10. Install plugs (M32). Using a 1/4 internal hex, torque to 30 Nm [22 lbf•ft].
11. Lubricate and install new O-ring (M44A).
12. If used, install plug (M44). Using a 1/4 intarnal hex, torque to 30 Nm [22 lbf•ft].
13. Using petroleum jelly to hold them in place, install PCP O-rings.
14. Install PCP valve (M1). Install screws (M12).
15. Using a 5/32-inch internal hex, torque to 20 Nm [15 lbf•ft].

EP, EQ, ER, ES Controls

EP, EQ, ER, ES Control



Legend

Item	Wrench size	Torque
M18	4 mm internal hex	7 Nm [5 lbf•ft]
M44, M32	1/4 internal hex	30 Nm [22 lbf•ft]
M12	5/32 internal hex	20 Nm [15 lbf•ft]
M42	4 mm internal hex	7 Nm [5 lbf•ft]

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