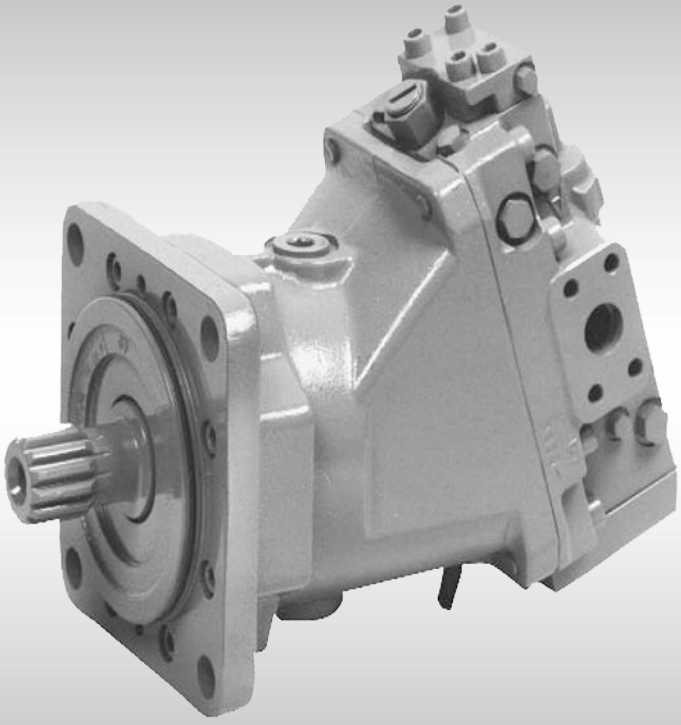
MAKING MODERN LIVING POSSIBLE

Service Manual

Series 51-1 Controls B1, B2, B7, E1, E2, E7, F1, F2, N1, T1, T2, T7, TA, TH, P7, P8



Revision history

Table of revisions

Date	Changed	Rev
February 2015	Danfoss layout	BA
January 2008	First edition	AA

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 acm^{3}ording to state, and federal environmental regulations.

Introduction

Symbols used in Danfoss literature


WARNING may result in injury


CAUTION may result in damage to product or property


Reusable part


Non-reusable part, use a new part


Non-removable item


Option - either part may exist


Superseded - parts are not interchangeable


Measurement required


Flatness specification


Parallelism specification


External hex head


Internal hex head


Torx head


O-ring boss port


Tip, helpful suggestion


Lubricate with hydraulic fluid


Apply grease / petroleum jelly


Apply locking compound


Inspect for wear or damage


Clean area or part


Be careful not to scratch or damage


Note correct orientation


Mark orientation for reinstallation


Torque specification


Press in - press fit


Pull out with tool – press fit


Cover splines with installation sleeve


Pressure measurement/gauge location or specification

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.

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.

Introduction

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.

Overview

Series 51-1 motor controls operate by routing the flow of oil to the servo piston in the motor's endcap. The servo piston has a differential area of 2:1.

- The *larger area* acts to *reduce* displacement.
- The *smaller area* works to *increase* displacement.

Due to the simplified design of the Series 51-1, only two-position and pressure compensator controls are available.

An external hydraulic or electric signal operates two-position controls. Pressure comes from the low side of the system loop and the control routes it to either the rod or piston end of the servo piston to set the motor's displacement.

Pressure compensator (PC) controls automatically set the displacement of the motor based on system pressure. PC controls allow the motor to increase available torque based on system demand by increasing the motor's displacement.

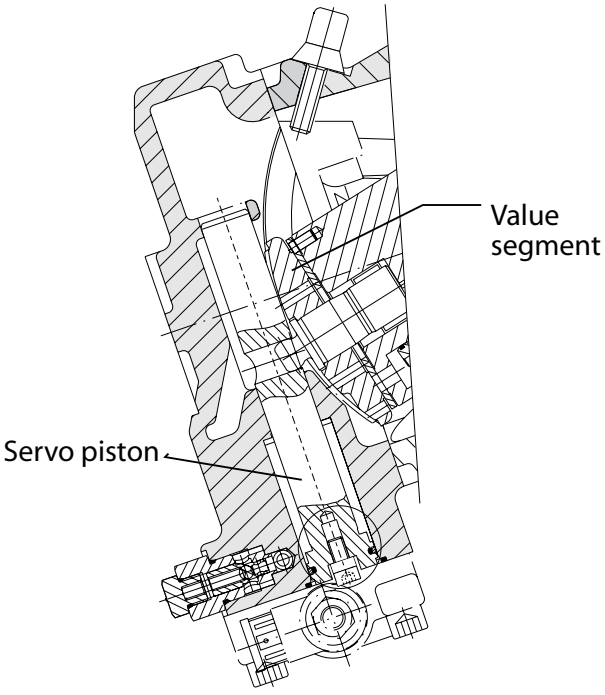
The motor defaults to minimum displacement until system pressure reaches the PC set pressure. The PC set pressure is adjustable in a range from 110 to 370 bar [1595 to 5365 psi]. Pressure is taken from the high side of the system loop to operate the servo piston.

PC controls:

Introduction

- can have a **maximum displacement lock** that holds the displacement at maximum when a hydraulic or electric signal is applied.
- can be equipped with a **brake pressure defeat option** that holds the motor at minimum displacement during dynamic braking. A hydraulic or electric signal operates the brake pressure defeat feature.

Differential area servo piston



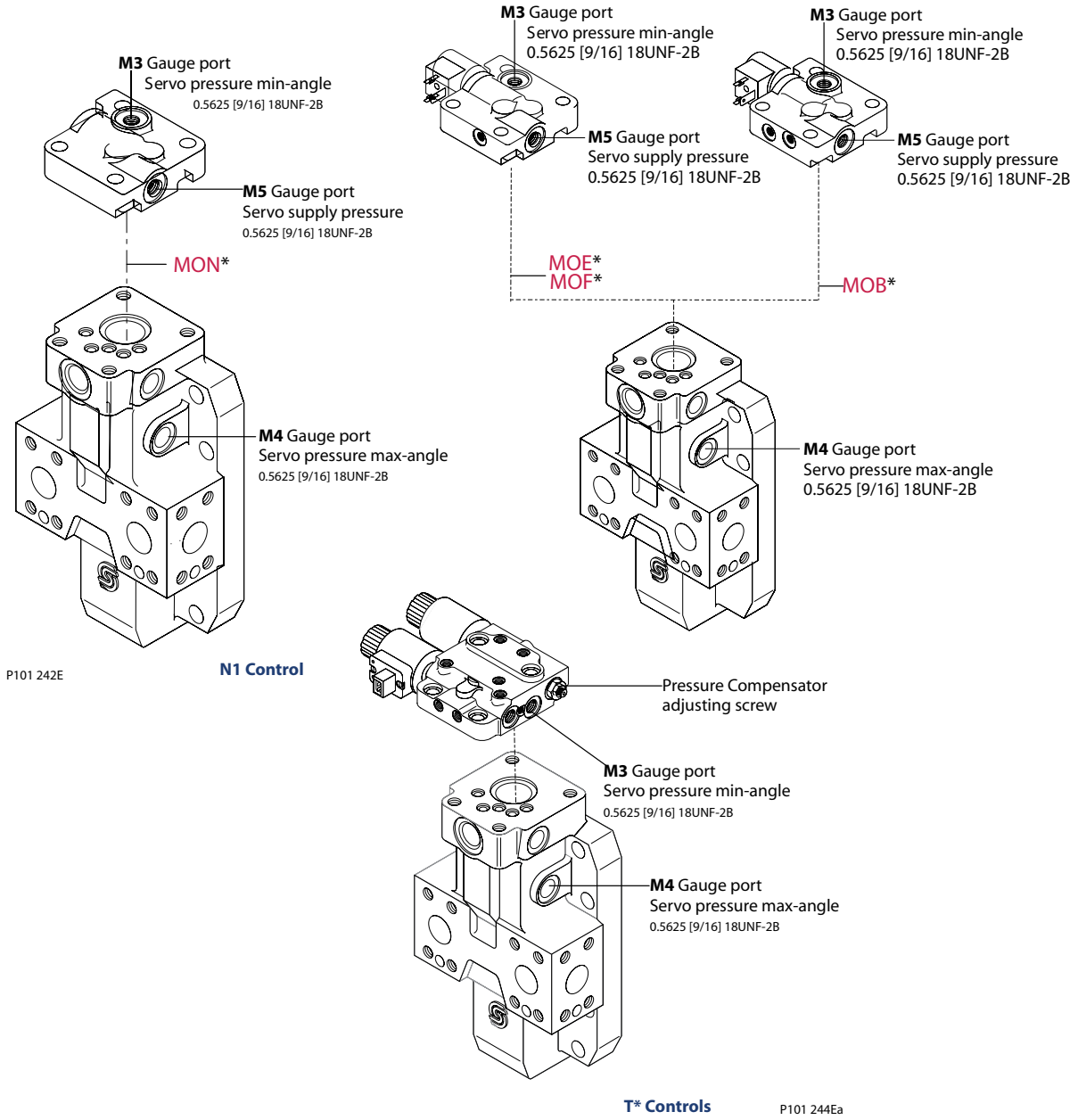
Required tools, gauge port and orifice locations

Required tools

You can perform the service procedures in this manual using common mechanic's hand tools. Special tools, if required, are shown. Calibrate pressure gauges frequently to ensure accuracy. Use snubbers to protect pressure gauges. For controls **N***, **E***, **F***, and **B*** use a 600 psi [45 bar] gauge for **M3**, **M4**, **and M5** gauge (pressure) ports. For **T*** controls use a 10,000 psi [600 bar] gauge for **M3 and M4** gauge (pressure) ports..

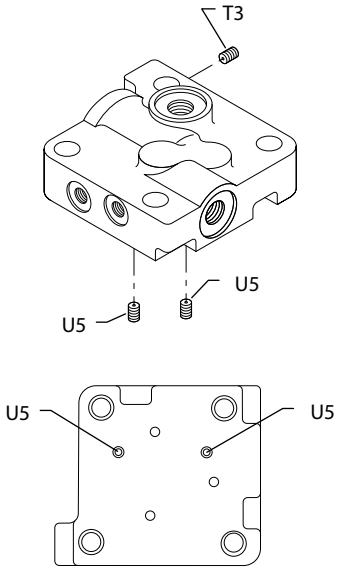
Port locations and gauge installation

Two-position controls

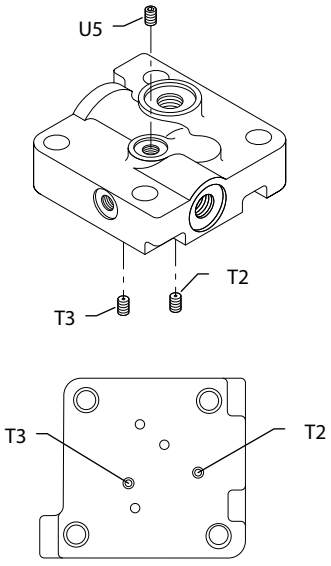


Required tools, gauge port and orifice locations

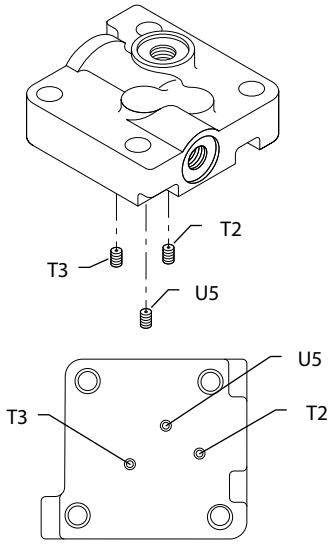
Orifice locations



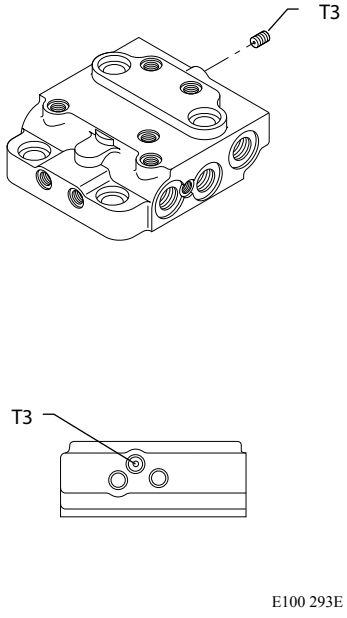
B* control codes



E* and F* control codes



N* control codes



E100 293E

T* control codes

N1 two-position control

Functional Description

The **N1** control consists of a ported housing that is mounted on the endcap over the piston end of the servo piston.

The housing contains two external ports, designated **M3** and **M5**. These ports serve as the control inputs. There are three interface ports[1] that connect to the rod and piston ends of the servo, and to the servo supply port in the endcap. The servo supply connects to the output of the loop flushing spool so it dispenses low loop pressure to the control regardless of motor direction.

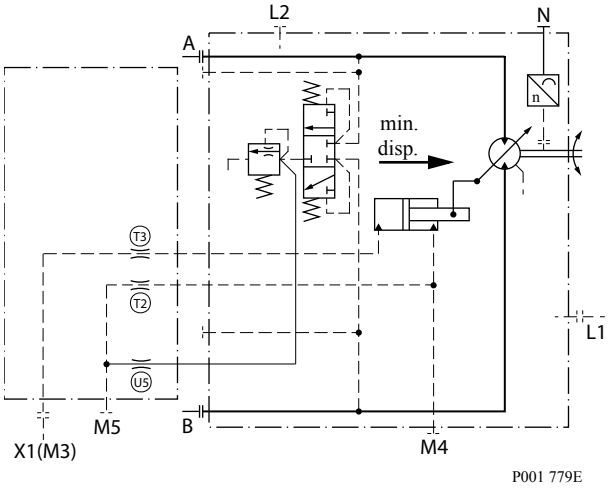
The control routes servo supply pressure through orifices **U5** and **T2** to the rod end of the servo piston. This holds the motor at maximum displacement until pressure from an external source is applied at port **M3**. This signal pressure then routes through orifice **T3** to the piston end of the servo, shifting the motor to minimum displacement. Typically 20 to 25 bar [290 to 360 psi] is necessary to shift the motor.

You may also install a plug in place of orifice **U5**, blocking the connection to servo supply. You can then apply pressure from an external source at port **M5** to shift the motor to maximum displacement.

Orifices **T2** and **T3** set the control response by limiting the flow to either end of the servo piston.

Schematic diagram

N1 control schematic diagram



Adjustments

This control requires no adjustments.

Minor repair

Disassembly

1. Thoroughly clean all external surfaces before disassembly. Mark components as necessary to ensure you reassemble the unit correctly.
2. Remove the 4 screws (M16). Use an 8mm internal hex wrench.
3. Remove the control housing (M1N*) from the endcap.

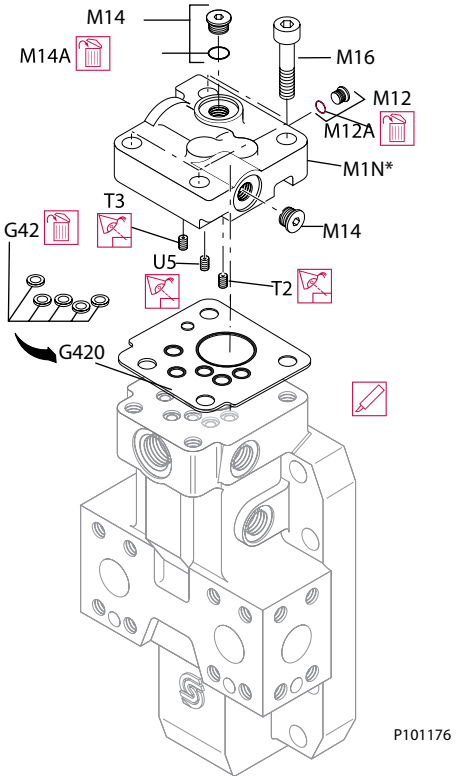
[1] Interface ports are those between the control and the endcap.

N1 two-position control

4. After ensuring you have the correct replacement parts, remove and discard the interface O-rings (G42), or remove the control gasket (G420) from the endcap.
5. Using a 1/4-inch internal hex wrench remove plugs (M14) from the housing.

   Fasteners are metric. Porting plugs are SAE.
6. Using a 1/8-inch internal hex wrench remove plug (M12) from the housing.
7. After ensuring you have the correct replacement parts, remove and discard O-rings (M12A and M14A) from the plugs (M12 and M14).
8. If necessary, remove T2, T3, and U5 control orifices. Use a 3mm internal hex wrench. Tag the orifices for reassembly.

N1 control exploded



Inspection

Clean and inspect all parts for damage. Check orifices and passages in control housing for foreign material.

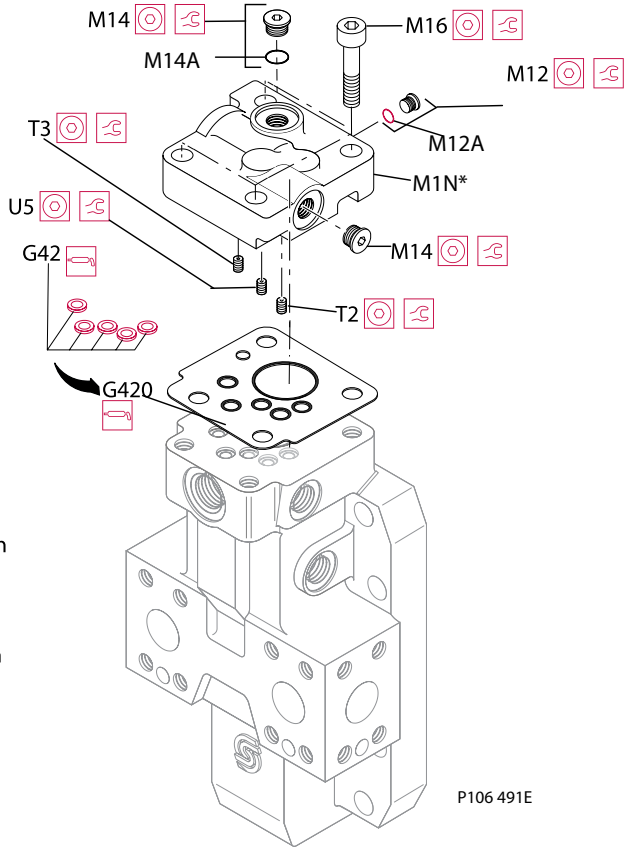
Assembly

1. If removed, install control orifices T2, T3, and U5 to their proper location. Using a 3mm internal hex wrench, torque the orifices to 6 N•m [4 lbf•ft].
2. Lubricate and install new O-rings on the housing plugs (M12). Using a 1/8-inch internal hex wrench, torque them to 9 N•m [7 lbf•ft]
3. Lubricate and install new O-rings on the housing plugs (M14). Using a 1/4-inch internal hex wrench, torque them to 37 N•m [28 lbf•ft].
4. Using clean petroleum jelly to retain them, install new interface O-rings (G42) or a new control gasket (G420) on the endcap.

N1 two-position control

5. Install the control housing and retaining screws (M16) on the endcap. Using an 8mm internal hex wrench torque the retaining screws to 78 N•m [58 lbf•ft].

N1 control assembly



Legend

T2, T3, U5
- 3mm internal hex wrench
- 6 Nm [4 lbf•ft]

M12
- 1/8-inch internal hex wrench
- 9 Nm [7 lbf•ft]

M14
- 1/4-inch internal hex wrench
- 37 Nm [28 lbf•ft]

M16
- 8mm internal hex wrench
- 78 Nm [58 lbf•ft]

E1, E2, E7, F1, F2 two-position controls

Functional description

The E* and F* controls consist of a ported housing that is mounted onto the endcap over the piston end of the servo piston. The housing contains a solenoid operated four-way, two-position cartridge valve that routes servo supply pressure to either the rod or piston end of the servo piston while draining the opposite end. The coil and valve are common, but the housing changes between the E and F controls. Orifices U5, T2, and T3 set the control response.

The housing contains two external ports, designated M3 and M5. These ports, along with port M4 in the endcap, serve as diagnostic ports for troubleshooting control performance. Port M4 connects to the rod end of the servo piston (maximum angle), port M3 connects to the piston end of the servo piston (minimum angle), and port M5 connects to servo supply pressure (downstream of orifice U5).

You may also install a plug in place of orifice U5 if you desire to use pressure from an external source at port M5 to serve as supply to the solenoid valve.

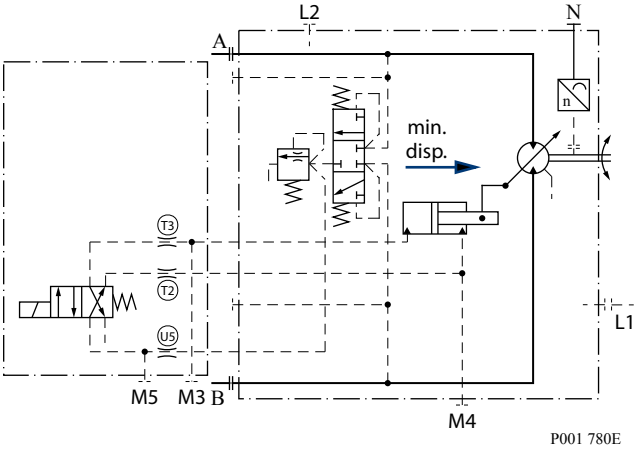
This table shows control logic, input voltage, and connector type for each control type.

Control requirements

Type		Sol. on	Sol. off	Volts	Connector
E	1	min.	max.	12v	DIN 46350
	2	min.	max.	24v	DIN 46350
	7	min.	max.	12v	Jet Jr. Timer
F	1	max.	min.	12v	DIN 46350
	2	max.	min.	24v	DIN 46350

Schematic diagrams

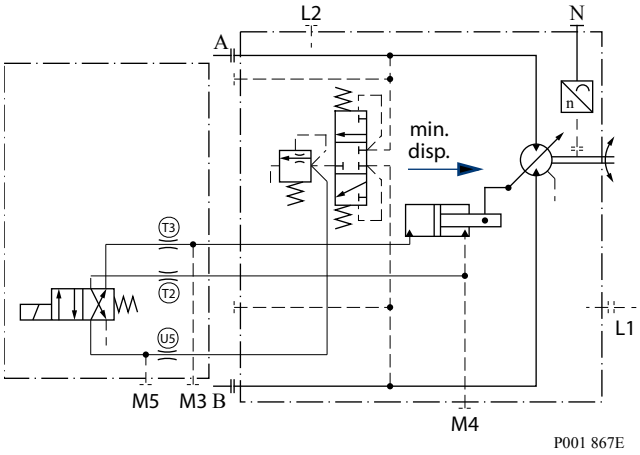
Schematic diagram of E controls*



- With **E*** controls, the motor defaults to maximum displacement, shifting to minimum when the solenoid is energized.

E1, E2, E7, F1, F2 two-position controls

Schematic diagram of F controls*



- With **F*** controls, the motor defaults to minimum displacement, shifting to maximum when the solenoid is energized.

Adjustments

These controls require no adjustments.

Minor repair

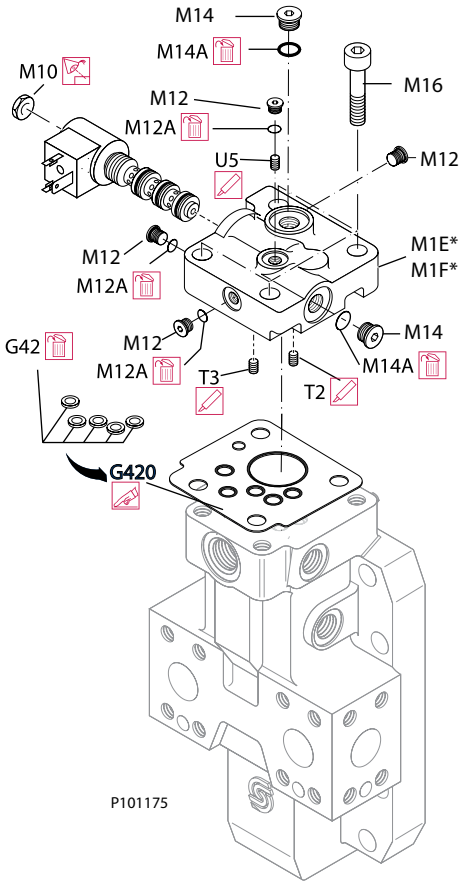
Disassembly

1. Thoroughly clean all external surfaces before disassembly.
2. Using a 3/4-inch wrench remove the coil nut from the solenoid valve stem (M10).
3. Slide the coil off of the solenoid valve stem (M10).
4. Using a 7/8-inch wrench remove the solenoid valve (M10) from the control housing.
5. Remove and discard the O-rings and backup rings from the cartridge.

   Always ensure you have the correct replacement parts (O-rings/seals) before discarding the used ones.
6. Using a 8mm internal hex wrench remove the 4 screws (M16) .
7. Remove the control housing (M1E* / M1F*) from the endcap.
8. Remove and discard the O-rings (G42) or the control gasket (G420) from the endcap.
9. Using a 1/8-inch internal hex wrench remove all plugs (M12) from the control housing.
10. Using a 1/4-inch internal hex wrench remove all plugs (M14) from the control housing.
11. Remove and discard the O-rings (M12A, M14A) from the plugs.
12. If necessary, remove orifices (T2, T3, and U5) using a 3mm internal hex wrench. Tag each orifice for reassembly.

E1, E2, E7, F1, F2 two-position controls

E, F* control disassembly*



Inspection

Clean and inspect all parts for damage. Check orifices and passages in control housing for foreign material.

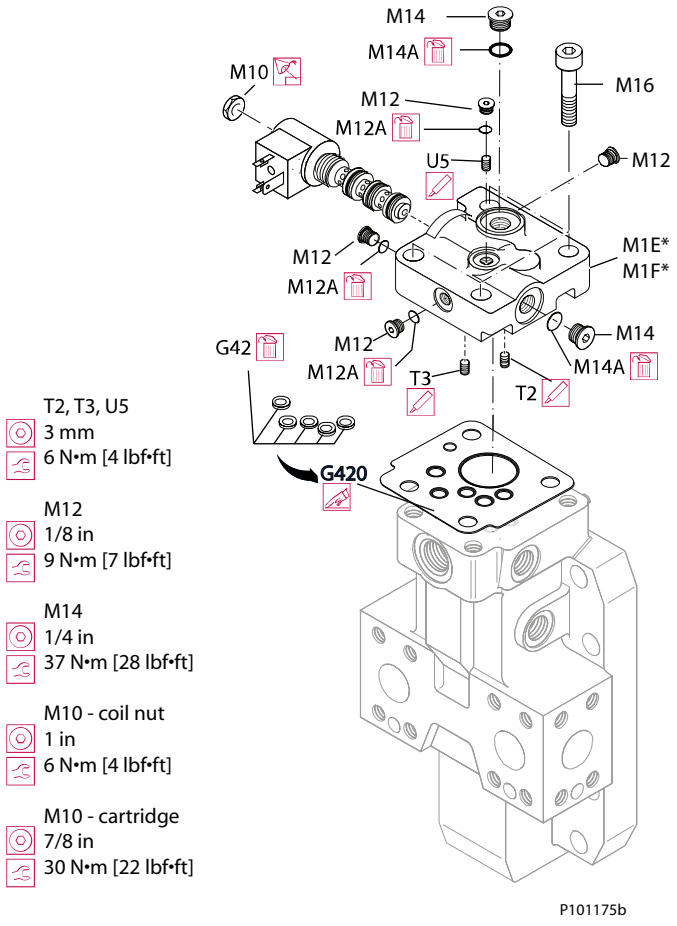
Assembly

1. If removed, install orifices (T2, T3, and U5) in to their proper location using a 3mm internal hex wrench. Torque the orifices to 6 N•m [4 lbf•ft]
2. Lubricate and install new O-rings (M14A) on to the plugs (M14). Using a 1/4-inch internal hex wrench torque the plugs (M14) to 37 N•m [28 lbf•ft]
3. Lubricate and install new O-rings (M12A) on to the plugs (M12). Using a 1/8-inch internal hex wrench torque the plugs to 9 N•m [7 lbf•ft].
4. Using clean petroleum jelly to retain them, install new interface O-rings (G42) or new control gasket (G420) on the endcap.
5. Install the control housing (M1E*/ M1F*) to the endcap.
6. Install the retaining screws (M16). Using an 8mm internal hex wrench, torque the screws to 78 N•m [58 lbf•ft].
7. Lubricate and install new O-rings and backup rings onto the solenoid cartridge.
8. Using a 7/8-inch wrench install the solenoid cartridge into the control housing. Torque the cartridge to 30 N•m [22 lbf•ft]. Do not overtorque.
9. Slide the solenoid coil over the valve stem.

E1, E2, E7, F1, F2 two-position controls

10. Install the solenoid coil nut. Using a 1 inch wrench, torque the coil nut to 6 N•m [4 lbf•ft]. Do not overtorque.

E/F* control assembly*



B1, B2, B7 two-position controls

Functional description

The B* controls consist of a ported housing mounted on the endcap over the piston end of the servo piston. The housing contains a four-way, two-position, solenoid-operated cartridge valve. The table shows control logic, input voltage, and connector for each control:

Control requirements

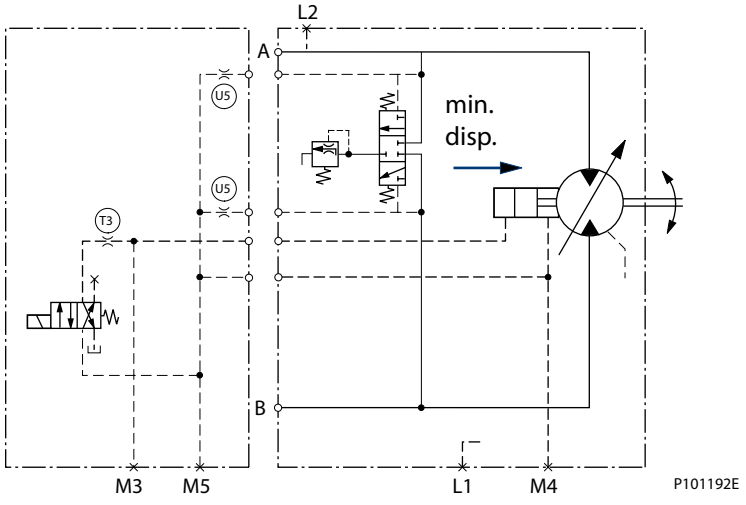
Type		SOL on	SOL off	Volts	Connector
B	1	min.	max.	12v	DIN 46350
	2	min.	max.	24v	DIN 46350
	7	min.	max.	12v	Jet Jr. Timer

Internal porting in the control housing connects system A and system B ports together through two orifices (U5). This connection creates a minimal cross port flow. It provides a source of servo supply pressure that is about one-half of system pressure. The housing is ported internally to route this servo supply pressure continually to the rod end of the servo.

The cartridge valve routes servo supply pressure to the piston end of the servo piston through an orifice (T3) when operated by an electrical signal. This allows the motor to shift to minimum displacement. When the valve is not operating, the piston end of the servo piston is drained to motor case. This permits the motor to default to maximum displacement.

Schematic diagram

four-way, 2-position, solenoid operated cartridge valve



Adjustments

These controls require no adjustments.

Minor repair

Disassembly

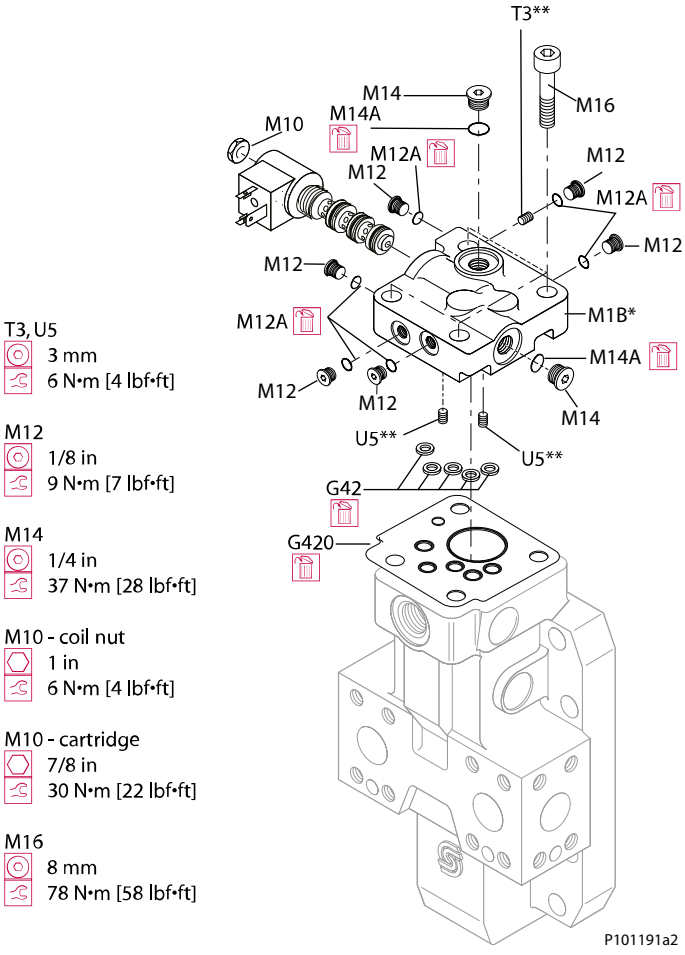
1. Thoroughly clean all external surfaces before disassembly.
2. Using a 1 inch wrench remove the coil nut from the solenoid valve (M10).

B1, B2, B7 two-position controls

3. Slide the coil from the solenoid valve stem (M10).
4. Using a 7/8-inch wrench remove the valve cartridge from the control housing.
5. Remove and discard the O-rings and back-up rings from the cartridge.

   Always ensure you have the correct replacement parts (O-rings/seals) before discarding the used ones.
6. Remove the 4 screws (M16) retaining the control housing to the endcap.
7. Lift the control housing (M1B*) off of the endcap.
8. Remove and discard the O-rings (G42) or the control gasket (G420) from the endcap.
9. Using a 1/8-inch internal hex wrench remove plugs (M12) from the control housing.
10. Remove and discard the O-rings (M12A).
11. Using a 1/4-inch internal hex wrench remove plugs (M14) from the control housing.
12. Remove and discard the O-rings (M14A).
13. Using a 3mm internal hex wrench remove orifices (T3 and U5). Tag the orifices for reassembly.

B control disassembly*



Inspection

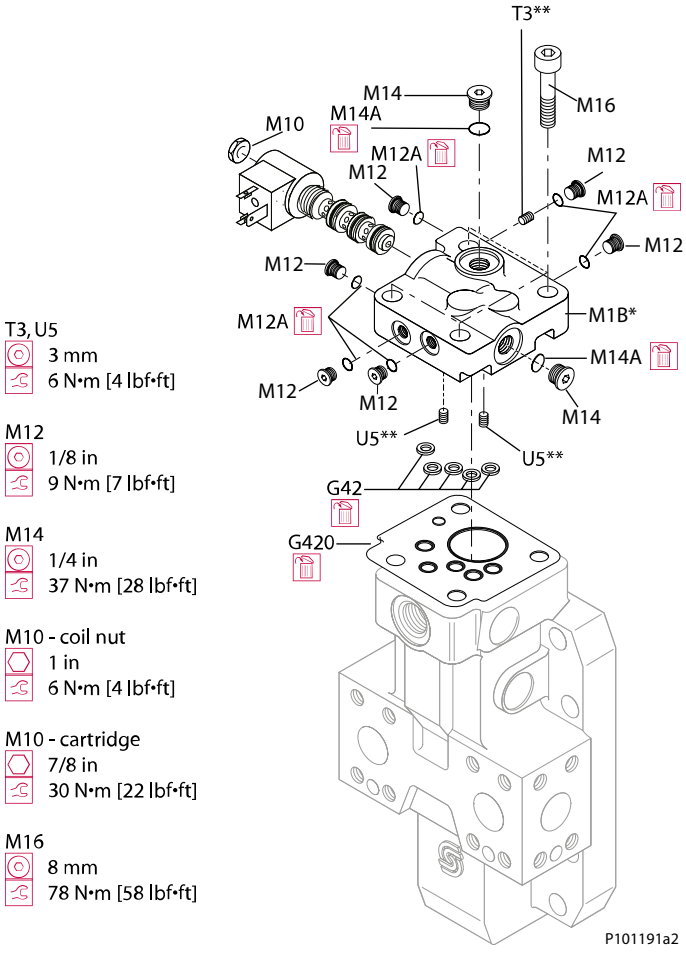
Clean and inspect all parts for damage. Check orifices and passages in control housing for foreign material.

B1, B2, B7 two-position controls

Assembly

1. Install orifices (T3 and U5) in to their proper location. Using a 3mm internal hex wrench torque the orifices to 6 N•m [4 lbf•ft].
2. Install new O-rings (M12A) on the plugs (M12). Install the plugs using a 1/8-inch internal hex wrench. Torque to 9 N•m [7 lbf•ft].
3. Install new O-rings (M14A) on the plugs (M14). Install the plugs using a 1/4-inch internal hex wrench. Torque to 37 N•m [28 lbf•ft].
4. Using clean petroleum jelly to retain them, install new interface O-rings (G42) or new control gasket (G420) on the endcap.
5. Install the control housing on the endcap.
6. Using an 8mm internal hex wrench, install the retaining screws (M16). Torque to 78 N•m [58 lbf•ft].
7. Lubricate the solenoid valve cartridge (M10) with clean hydraulic oil.
8. Lubricate and install new O-rings and backup rings on the solenoid cartridge (M10).
9. Install the cartridge into the control housing. Using a 7/8-inch wrench, torque the cartridge to 35 N•m [35 lbf•ft]. Do not overtorque.
10. Slide the solenoid coil over the valve stem.
11. Install the solenoid coil nut. Using a 3/4-inch, torque, to 6 N•m [22 lbf•in]. Do not overtorque.

B control sassembly*



T3, U5
3 mm
6 N•m [4 lbf•ft]

M12
1/8 in
9 N•m [7 lbf•ft]

M14
1/4 in
37 N•m [28 lbf•ft]

M10 - coil nut
1 in
6 N•m [4 lbf•ft]

M10 - cartridge
7/8 in
30 N•m [22 lbf•ft]

M16
8 mm
78 N•m [58 lbf•ft]

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

Functional Description

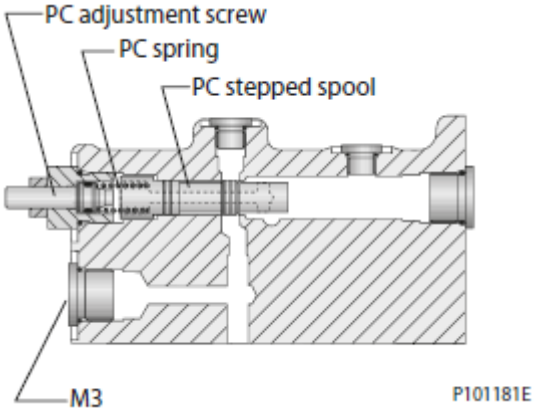
Overview

Pressure Compensator (PC) controls operate by routing system (high) pressure to both ends of the servo piston. Because the piston end of the servo piston has greater area, this causes the motor to shift to minimum displacement by default. When system pressure reaches the PC setpoint, the control drains the piston end of the servo piston allowing the motor to shift toward maximum displacement. The control modulates the displacement position of the motor, keeping system pressure at or below the PC set point. When the motor reaches maximum displacement, system pressure may rise above the PC set point until the pump pressure limiter or system relief valve begins to operate

Option TA

TA option PC controls operate strictly as described above, with the option of several brake pressure defeat configurations that we explain later.

TA control cross section

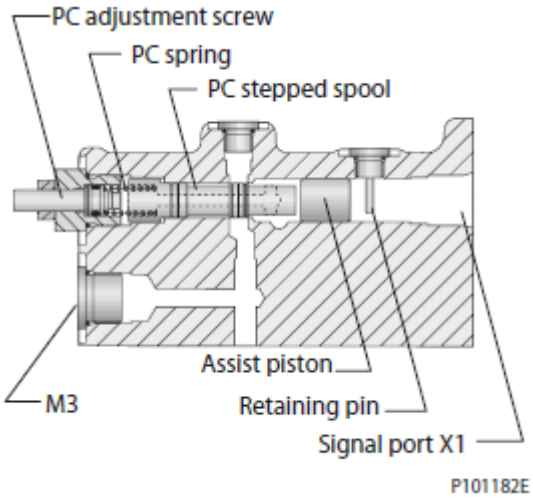


Option TH

TH option PC controls operate as described above except a piston is installed to operate the PC control spool and shift the motor to maximum displacement when a hydraulic-pressure signal is applied. 10 to 35 bar [145 to 507 psi] applied at port X1 overrides the PC function and shifts the motor to maximum displacement. There is a second option of several brake pressure defeat configurations. We explain this option later.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

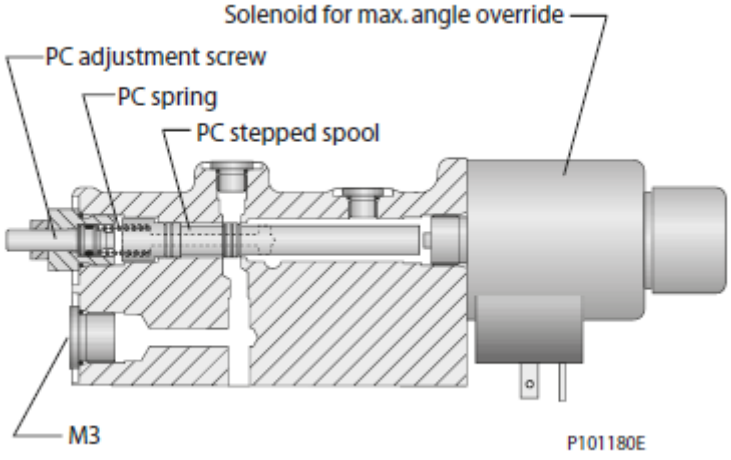
TH control cross section



Option T1T2/T7

T1/T2/T7 option PC controls operate as described above with an additional feature. A solenoid is installed to operate the PC control spool and shift the motor to maximum displacement when an electric signal is applied. The solenoid is available in three configurations: 12V (T1) or 24V (T2) with DIN 43650 connector, and 12V with Jet Jr.™ timer connector (T7) with integral zener diode transient voltage suppressor. There is a second option of several brake pressure defeat configurations. We explain this option later.

T1/T2/T7 cross section



Brake pressure defeat

Brake Pressure Defeat (BPD) options are available that abort the PC control operation during dynamic breaking.

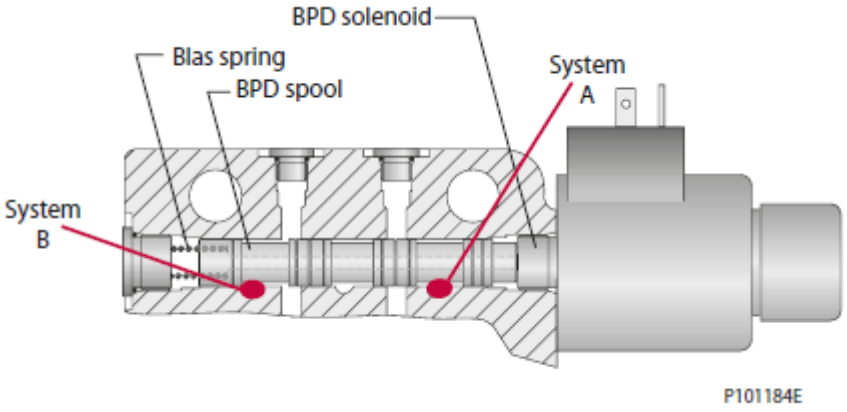
Option D1/D2/D7

The BPD feature is electrically operated by a solenoid. The electric signal applied to the solenoid allows PC functions to operate only when system port **A** has high pressure. This defeats PC operation when

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

system port **B** is high. When no signal is applied to the solenoid, PC functions operate only when system port **B** has high pressure. This defeats PC operation when system port **A** is high.

BPD option D1/D2/D7 cross section

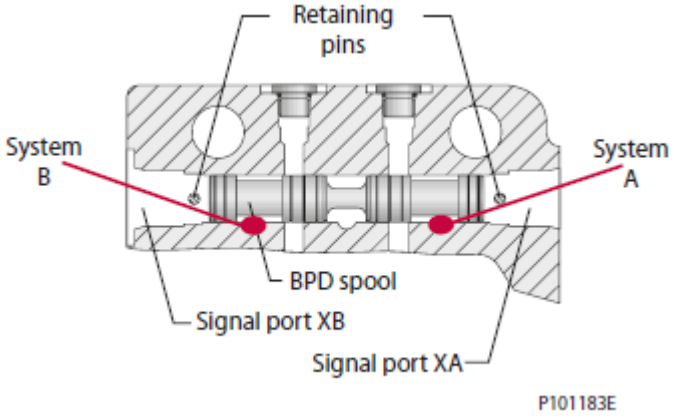


The solenoid is available in three configurations. The configurations are: 12V (**D1**) or 24V (**D2**) with DIN 43650 connector, and 12V with Jet Jr.™ timer connector (**D7**) with integral zener diode transient voltage suppressor.

Option CA

An external hydraulic signal at ports **XA** or **XB** operates the BPD feature. Pressure applied at port **XA** allows PC functions to operate only when system port **A** has high pressure, defeating PC operation when system port **B** is high. Pressure applied at port **XB** allows PC functions to operate only when system port **B** has high pressure, defeating PC operation when system port **A** is high.

BPD option CA cross section

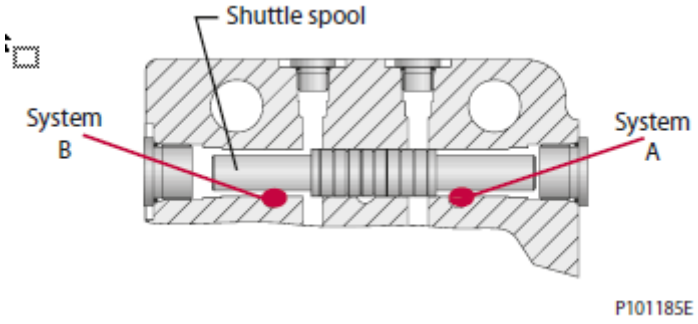


Option C2

No BPD features are used. PC operation is allowed in either direction. The BPD spool resolves high pressure and routes it to the PC spool.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

BPD option C2cross section



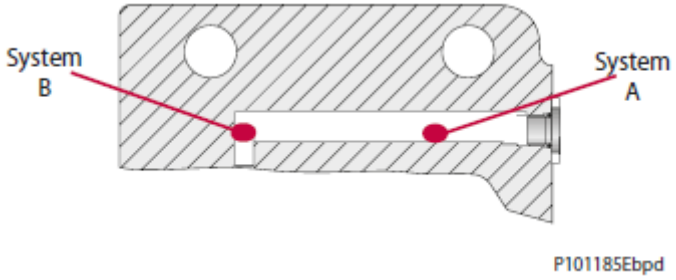
Option R5

No BPD features are used. PC operation is allowed only when system port **A** has high pressure. No BPD spool is used. System **B** interface port is plugged.

Option L5

No BPD features are used. PC operation is allowed only when system port **B** has high pressure. No BPD spool is used. System **A** interface port is plugged.

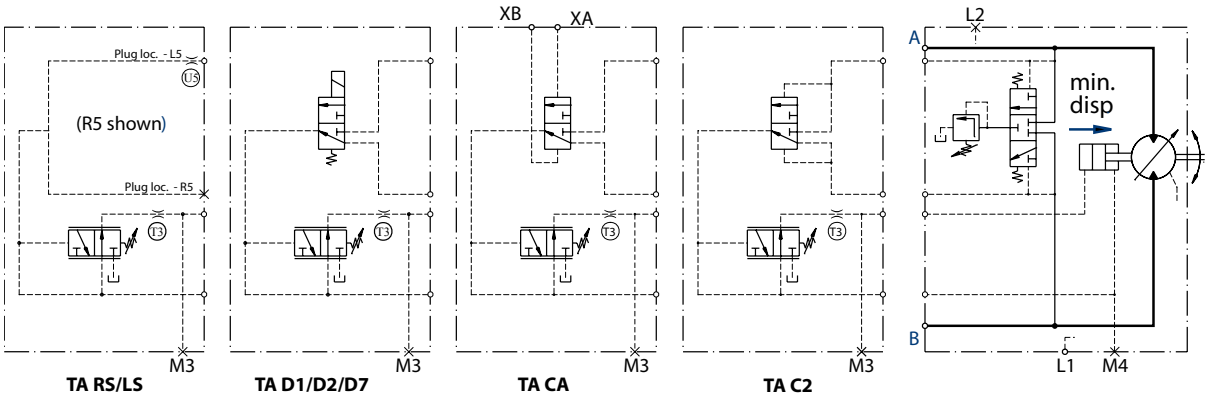
BPD option R5/L5 cross section



Schematics

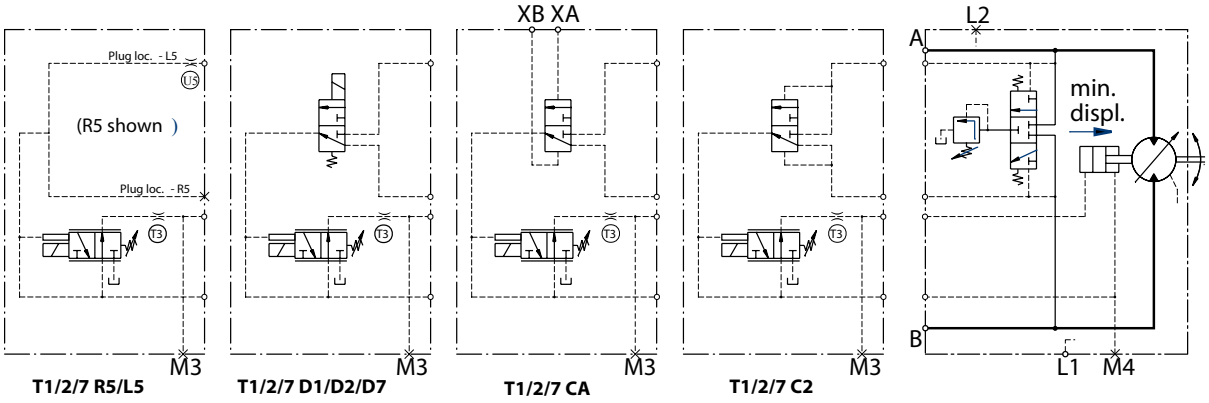
These schematic diagrams illustrate the **T1, T2, T7, TA,** and **TH** pressure compensator (PC) controls.

Schematic diagrams - TA

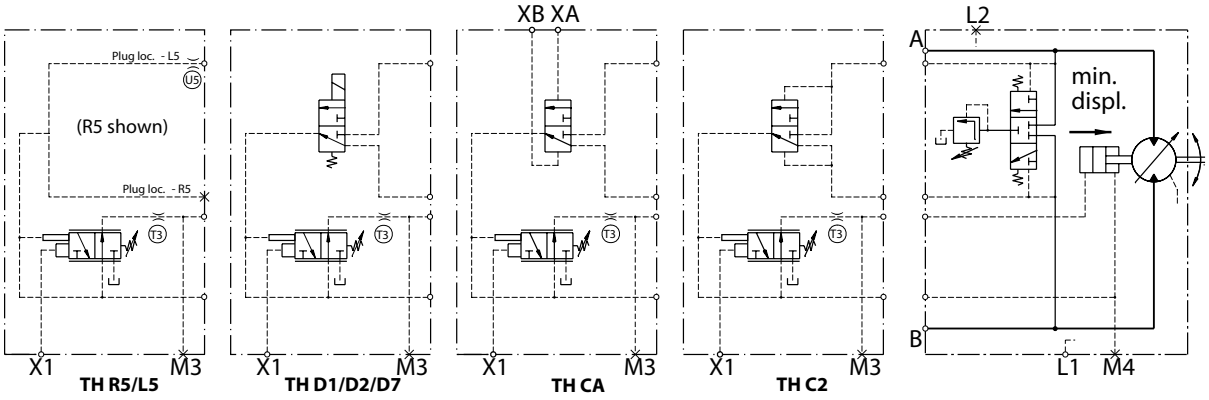


T1, T2, T7, TA, TH Pressure Compensator (PC) controls

Schematic diagrams - T1/T2/T7



Schematic diagrams - TH



Adjustment

Warning

Do not perform this procedure unless the machine can be safely operated while loading the motor shaft as described. If necessary, remove the motor from the application and perform this procedure in an appropriate test stand.

PC start pressure

The pressure compensator start pressure setting is adjustable in a range from 110 to 370 bar [1595 to 5366 psi]. To measure the start pressure setting:

- apply the vehicle's brakes to lock the motor shaft from turning

or

- add an extreme load to the work function of the machine.

To check or reset the pressure compensator setting on a vehicle:

1. Install a 600 bar [10,000 psi] gauge at port M4 to monitor pressure at the rod end (maximum displacement) of the servo piston.

   Due to the control's configuration the pressure at M4 will equal the system pressure.

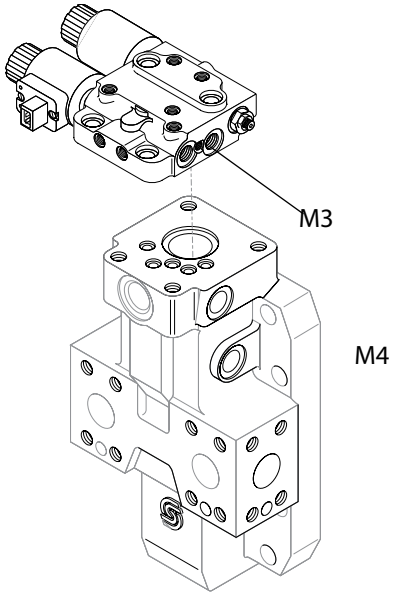
2. Install a 600 bar [10,000 psi] gauge at port M3 to monitor pressure at the piston end (minimum displacement) of the servo piston.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

3. Start the prime mover and operate at normal speed.
4. Stroke pump very slowly to gradually increase system pressure to the PC setting pressure, or:
   a) lower the pump's multifunction valve (Series 90) or HPRV (H1) below the PC setting
   b) stroke the pump to approximately 1/4 displacement
   c) adjust the multifunction valve (Series 90) or HPRV (H1) to slowly increase system pressure to the PC setting pressure.
5. Watch the gauge at port M3. When pressure in M3 begins to decrease, note the pressure at port M4. This is the PC setting.

   If you don't get the correct pressure setting, repeat step 4 using a different option. The result depends on the application.

PC setting



To check or reset the pressure compensator setting on a test stand:

1. Monitor system flow.
2. Increase the system pressure until flow begins to increase. System gauge pressure at this point is the PC setting.

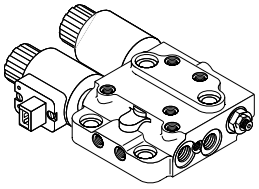
To adjust the pressure compensator setting:

1. Use a 10mm hex wrench to loosen the seal locknut.
2. Using a 3mm internal hex wrench, turn the PC adjusting screw clockwise to increase the pressure setting, counter-clockwise to decrease the setting.

   The pressure compensator setting changes at a rate of approximately 70 bar [800 psi] per turn.
3. Using a 10mm hex wrench to hold the adjustment screw in place torque the seal locknut to 52 N•m [38 lbf•ft].
4. Recheck the pressure compensator setting and readjust the as necessary.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

PC adjusting screw



Pressure Compensator adjusting screw P101244a2

After testing and adjustment:

1. Readjust the pump multifunction valve (Series 90) or HPRV (H1) to its proper setting if it was changed.
2. Shut down the prime mover.
3. Remove the gauges.
4. Return the system to its normal operating configuration.

Minor repair

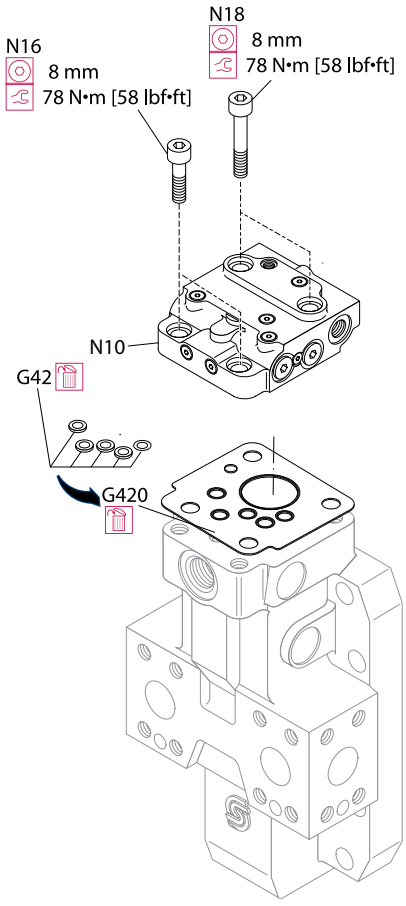
Control housing

1. Thoroughly clean all external surfaces before disassembly.
2. Using an 8mm internal hex wrench remove the 4 screws (N16 and N18) retaining the control housing to the endcap.
3. Lift the control housing (N10) from the endcap.
4. Remove the interface O-rings (G42) or the gasket (G420). Remove and discard the O-rings or gasket.

   Always ensure you have the correct replacement parts (O-rings/seals) before discarding the used ones.
5. Make necessary repairs., see pages 28-46 for options.
6. Using clean petroleum jelly to retain them during assembly, install the new interface O-rings (G42) or the gasket (G420) to the endcap, .
7. Install the control housing (N10) to the endcap.
8. Align the holes and install the four retaining screws (N16 and N18).
9. Using an 8mm internal hex wrench torque the four retaining screws (N16 and N18) to 78 N•m [58 lbf•ft].

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

*Control housing T**



P101186_a

TA option components

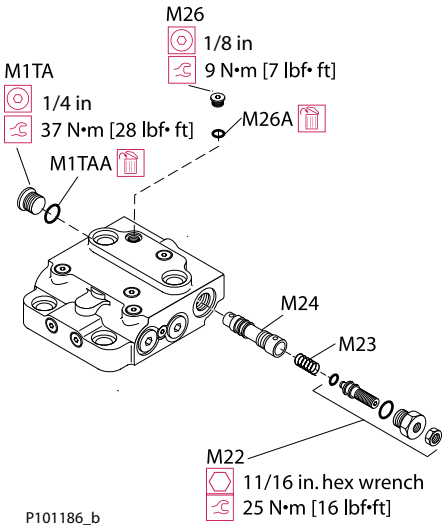
Disassembly

1. Thoroughly clean all external surfaces before disassembly.
2. Using an 11/16 inch wrench remove, the pressure compensator adjustment assembly (M22).
3. Remove the pressure compensator spring (M23).
4. Remove the stepped spool (M24).

   Always ensure you have the correct replacement parts (O-rings/seals) before discarding the used ones.
5. Remove the stepped spool (M24).
6. Using a 1/4 inch internal hex wrench, remove plug (M1TA). Remove and discard O-ring (M1TAA).
7. Refer to *Servo-supply options* for procedures pertaining to your particular servo-supply option.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

TA components



Inspection

Clean and inspect all components for damage. Replace as necessary

Assembly

1. Lubricate and install new O-ring (M1TAA) on plug (M1TA). Install plug using a 1/4 inch internal hex wrench. Torque to 9 N•m [7 lbf•ft].
2. Lubricate and install new O-ring (M26A) on plug (M26). Install plug using a 1/8 inch internal hex wrench. Torque to 37 N•m [28 lbf•ft].
3. Lubricate and install the stepped spool (M24) into the control housing bore.
4. Install the spring (M23) into the control housing bore.
5. Lubricate and install new O-rings on the pressure compensator adjustment assembly (M22). Using an 11/16 inch hex wrench, install and torque the pressure compensator adjustment assembly to 25 N•m [16 lbf•ft].

TH option components

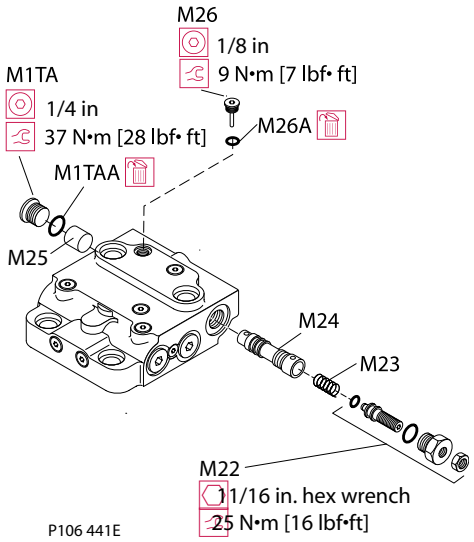
Disassembly

1. Thoroughly clean all external surfaces before disassembly.
2. Using an 11/16 inch wrench remove, the pressure compensator adjustment assembly (M22).
3. Remove the pressure compensator spring (M23).
4. Remove the stepped spool (M24).
5. Using a 1/4 inch internal hex wrench, remove plug (M1TA). Remove and discard O-ring (M1TAA).

   Always ensure you have the correct replacement parts (O-rings/seals) before discarding the used ones.
6. Using a 1/8 inch internal hex wrench, remove plug (M26). Remove and discard O-ring (M26A).
7. Remove the assist piston (M25) from the housing bore.
8. Refer to *Servo-supply options* for procedures pertaining to your particular servo-supply option.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

TA components



Inspection

Clean and inspect all components for damage. Replace as necessary

Assembly

1. Install assist piston (M25) to the housing bore.
2. Lubricate and install new O-ring (M1TAA) on plug (M1TA). Install plug using a 1/4 inch internal hex wrench. Torque to 9 N•m [7 lbf•ft].
3. Lubricate and install new O-ring (M26A) on plug (M26). Install plug with retaining pin using a 1/8 inch internal hex wrench. Ensure pin retains assist piston in bore. Torque to 37 N•m [28 lbf•ft].
4. Lubricate and install the stepped spool (M24) into the control housing bore.
5. Install the spring (M23) into the control housing bore.
6. Lubricate and install new O-rings on the pressure compensator adjustment assembly (M22). Using an 11/16 inch hex wrench, install and torque the pressure compensator adjustment assembly to 25 N•m [16 lbf•ft].

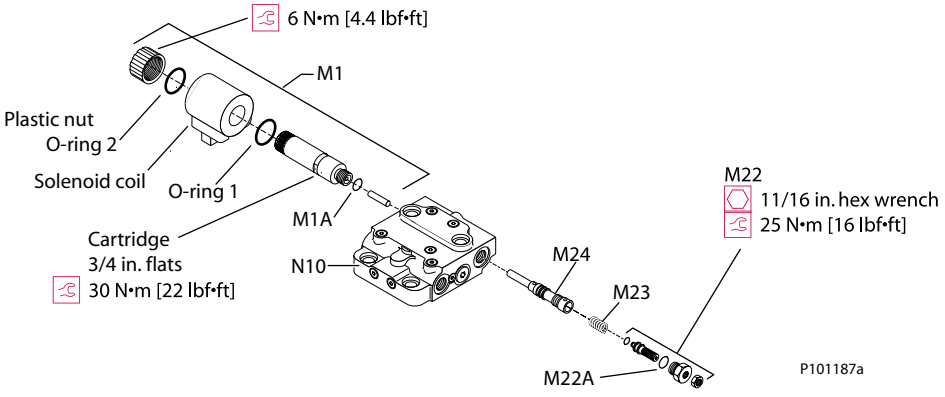
T1, T2, T7 option components

Disassembly

1. Thoroughly clean all external surfaces before disassembly.
2. Using an 11/16 inch wrench remove the PC adjustment assembly (M22). Remove and discard the O-rings.
3. Remove the pressure compensator spring (M23).
4. Remove the stepped spool (M24).
5. Remove the plastic coil nut from the solenoid valve (M1) **by hand**.
6. Remove the first O-ring. Slide the coil off the cartridge. Remove the second O-ring. Remove and discard the O-rings.
7. Using a thin 3/4-inch wrench remove the cartridge from the control housing (N10). Remove and discard the O-ring (M1T*A).
8. If it remains in the housing, remove the pushrod.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

T1/2/7 components



Inspection

Thoroughly clean and inspect all components for damage or foreign material. Replace damaged parts as necessary.

Assembly

1. Install the stepped spool (M24) to the housing bore.
2. Install the spring (M23).
3. Lubricate and install new O-rings on the PC adjustment assembly (M22). Using an 11/16 inch hex wrench, install the PC adjustment assembly to the housing. Torque to 25 N•m [16 lbf•ft].
4. Slide the pushrod into the cartridge. Install the cartridge to the housing. Using a 3/4 inch hex wrench on the flats, torque the cartridge to 30 N•m [22 lbf•ft].
5. Lubricate and install a new O-ring onto the cartridge. Install the solenoid coil. Install the second O-ring. Install the plastic nut and torque by hand to 6 N•m [4.4 lbf•ft].

Servo/PC supply option CA (with hydraulic signal)

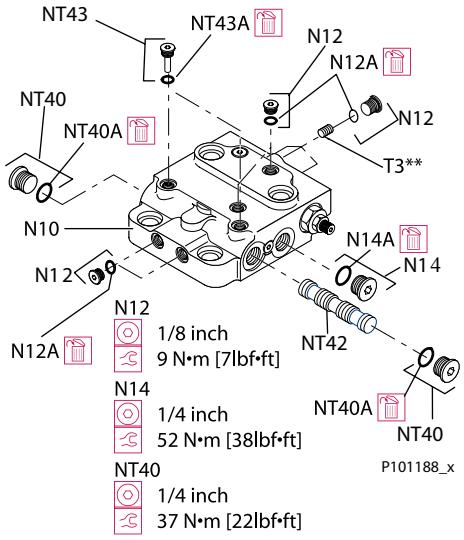
Disassembly

1. Thoroughly clean all external surfaces before disassembly.
2. Using a 1/8 inch internal hex wrench, remove seven plugs (N12) from the control housing (N10). Remove and discard the O-rings (N12A).
3. Using a 1/4 inch internal hex wrench remove the plug (N14) from the control housing. Remove and discard the O-ring (N14A).

   Always ensure you have the correct replacement parts (O-rings/seals) before discarding the used ones.
4. Using a 3mm internal hex wrench, remove the orifice (T3). Note the location for reassembly.
5. Using a 1/4 inch internal hex wrench or 11/16 inch hex wrench, remove the plugs/fittings (NT40) from ports XA and XB in the control housing. Remove and discard the O-rings (NT40A).
6. Using a 1/8 inch internal hex wrench, remove the two pin-plugs (NT43) from the control housing. Remove and discard the O-rings (NT43A).
7. Slide the BPD spool (NT42) from the housing bore.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

CA servo supply option components



Inspection

Thoroughly clean and inspect all components for damage or foreign material. Replace damaged parts as necessary.

Assembly

1. Using clean hydraulic oil, lubricate the BPD shuttle spool (NT42) and slide into the housing bore.
2. Lubricate and install new O-rings (NT43A) on to pin-plugs (NT43). Using a 1/8-inch internal hex wrench, install the pin-plugs into the housing. Torque to 9 N•m [7 lbf• ft].
3. Using a 3mm internal hex wrench, install the T3 orifice. Torque to 6 N•m [4 lbf•ft].
4. Lubricate and install new O-rings to plugs/fittings (NT40). Install plugs/fittings to ports XA and XB. Using a 1/4 inch internal hex wrench or 11/16 inch hex wrench, torque the plugs/fittings 37 N•m [28 lbf•ft].
5. Lubricate and install new O-rings to seven plugs (N12). Using a 1/8 inch internal hex wrench, install and torque the plugs to 9 N•m [7 lbf•ft].
6. Lubricate and install new O-ring to plug (N14). Using a 1/4 inch internal hex wrench, install and torque the plugs to 52 N•m [38 lbf•ft].

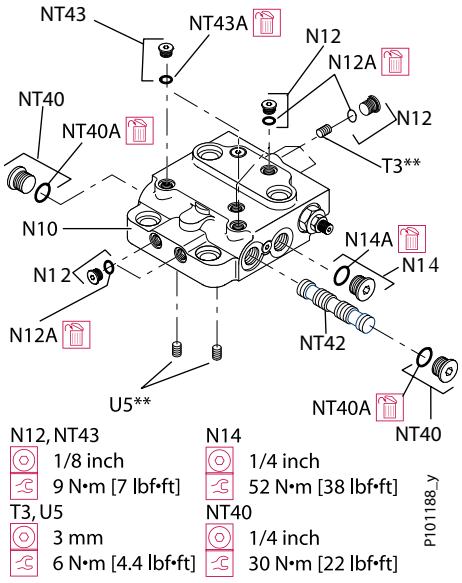
Servo/PC supply option C2 (without external signal)

1. Thoroughly clean all external surfaces before disassembly.
2. Using a 1/8 inch internal hex wrench, remove seven plugs (N12). Remove and discard the O-rings (N12A).
3. Using a 1/4 inch internal hex wrench, remove the plug (N14). Remove and discard the O-ring (N14A).

   Always ensure you have the correct replacement parts (O-rings/seals) before discarding the used ones.
4. Using a 1/4 inch internal hex wrench, remove two plugs (NT40) from ports XA and XB. Remove and discard the O-rings (NT40A).
5. Using a 1/8 inch internal hex wrench, remove two plugs (NT43). Remove and discard the O-rings (NT43A).
6. Using a 3mm internal hex wrench, remove orifice (T3). Note the location for reassembly.
7. Using a 3mm internal hex wrench, remove two orifices (U5). Note the location for reassembly.
8. Remove the BPD spool (NT42) from the housing bore.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

C2 Option components



Inspection

Thoroughly clean and inspect all components for damage or foreign material. Replace damaged parts as necessary.

Assembly

1. Lubricate and install the BPD shuttle spool (NT42) into the housing bore.
2. Lubricate and install new O-rings (NT43A) on plugs (NT43). Using a 1/8 inch internal hex wrench, install and torque the plugs to 9 N•m [7 lbf• ft].
3. Lubricate and install new O-rings (NT40A) on plugs (NT40). Using a 1/4 inch internal hex wrench, install and torque the plugs to 37 N•m [22 lbf• ft].
4. Using a 3mm internal hex wrench, install orifice (T3). Torque to 6 N•m [4 lbf•ft].
5. Using a 3mm internal hex wrench, install two orifices (U5). Torque to 6 N•m [4 lbf•ft].
6. Lubricate and install new O-rings(N12A) on seven plugs (N12). Using a 1/8-inch internal hex wrench, install and torque the plugs to 9 N•m [7 lbf• ft].
7. Lubricate and install new O-ring (N14A) on plug (N14). Using a 1/4 inch internal hex wrench, install and torque the plug to 52 N•m [38 lbf• ft].

Servo/PC supply options D1/D2/D7

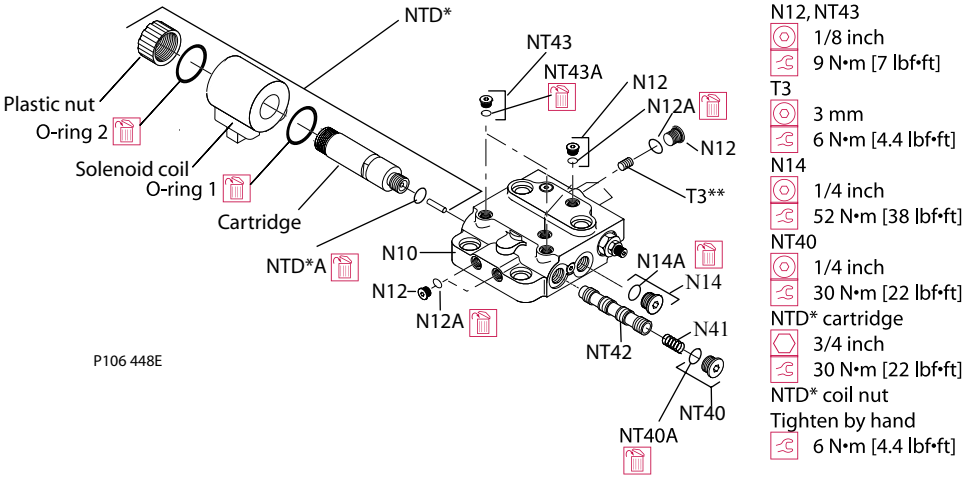
Disassembly

1. Thoroughly clean all external surfaces before disassembly.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

2. Using a 1/8 inch internal hex wrench, remove seven plugs (N12). Remove and discard the O-rings (N12A).

D1/D2/D7 components



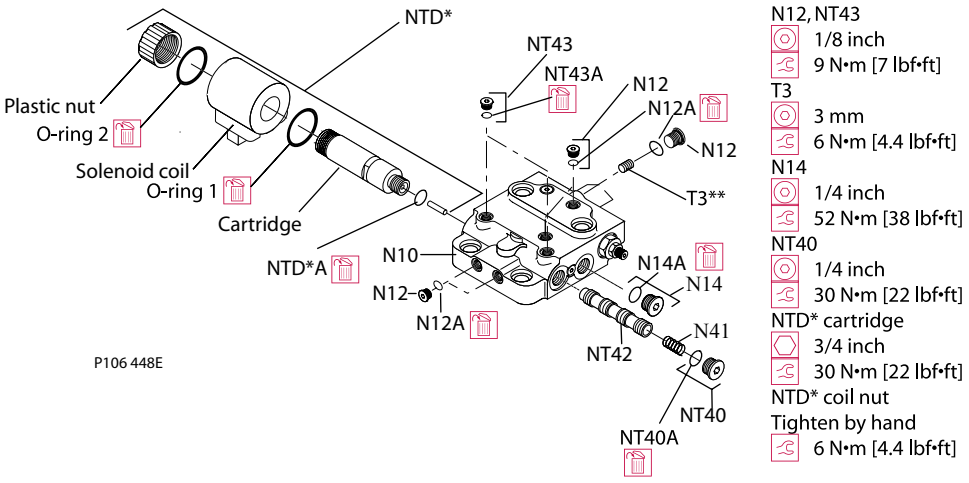
3. Using a 1/4 inch internal hex wrench, remove the plug (N14). Remove and discard the O-ring (N14A).
4. Using a 1/4 inch internal hex wrench, remove plug (NT40) from port XB. Remove and discard the O-ring (NT40A).
5. Using a 1/8 inch internal hex wrench, remove two plugs (NT43). Remove and discard the O-rings (NT43A).
6. Using a 3mm internal hex wrench, remove orifice (T3). Note the location for reassembly.
7. Remove the spring (NT41) and BPD spool (NT42) from the housing bore.
8. Remove the plastic coil nut from the solenoid (NTD*). Remove the coil and two O-rings. Discard the O-rings.
9. Remove the coil.
10. Remove the second O-ring.
11. Remove the cartridge from the control housing using a thin 3/4 inch hex wrench on the flats provided.
12. Remove the pushrod from the cartridge.

Inspection

Thoroughly clean and inspect all components for damage or foreign material. Replace damaged parts as necessary.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

D1/D2/D7 components



Assembly

1. Install the pushrod to the cartridge.
2. Lubricate and install a new O-ring (NTD*A) on the cartridge (NTD*). Install the cartridge to the control housing (N10) using a 3/4 inch hex wrench on the flats provided. Torque the cartridge to 30 N•m [22 lbf•ft].
3. Install the coil with new O-rings on the cartridge.
4. Install the plastic coil nut. Torque by hand to 6 N•m [4.4 lbf•ft].
5. Lubricate and install the BPD spool (NT42) to the housing bore.
6. Install the spring (NT41).
7. Lubricate and install new O-ring (NT40A) on plug (NT40). Using a 1/4 inch internal hex wrench, install and torque the plug to 30 N•m [22 lbf•ft].
8. Lubricate and install new O-rings (NT43A) on two plugs (NT43). Using a 1/8 inch internal hex wrench, install and torque the plugs to 9 N•m [7 lbf• ft].
9. Using a 3mm internal hex wrench, install orifice (T3). Torque to 6 N•m [4 lbf•ft].
10. Lubricate and install new O-rings (N12A) on seven plugs (N12). Using a 1/8-inch internal hex wrench, install and torque the plugs to 9 N•m [7 lbf• ft].
11. Lubricate and install new O-ring (N14A) on plug (N14). Using a 1/4 inch internal hex wrench, install and torque the plug to 52 N•m [38 lbf• ft].

Servo/PC supply options L5/R5

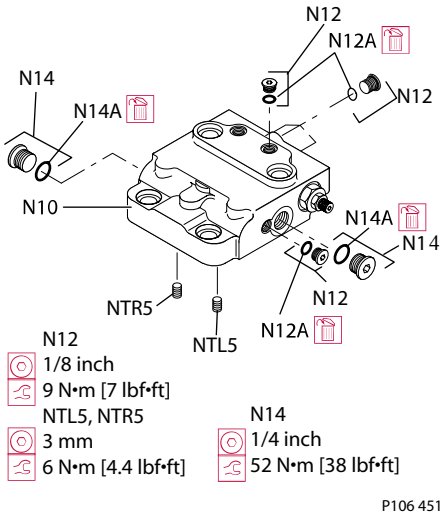
Disassembly

1. Thoroughly clean all external surfaces before disassembly.
2. Using a 1/8 inch internal hex wrench, remove five plugs (N12). Remove and discard the O-rings (N12A).

   Always ensure you have the correct replacement parts (O-rings/seals) before discarding the used ones.
3. Using a 1/4 inch internal hex wrench, remove two plugs (N14). Remove and discard the O-ring (N14A).
4. Using a 3mm internal hex wrench, remove orifices (NTL5, NTR5). Note the location for reassembly.

T1, T2, T7, TA, TH Pressure Compensator (PC) controls

L5/R5 components



Inspection

Thoroughly clean and inspect all components for damage or foreign material. Replace damaged parts as necessary.

Assembly

1. Using a 3mm internal hex wrench, install orifices (NTL5, NTR5). Torque to 6 N•m [4 lbf•ft].
2. Lubricate and install new O-rings (N12A) on five plugs (N12). Using a 1/8-inch internal hex wrench, install and torque the plugs to 9 N•m [7 lbf• ft].
3. Lubricate and install new O-rings (N14A) on two plugs (N14). Using a 1/4 inch internal hex wrench, install and torque the plugs to 52 N•m [38 lbf• ft].

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