

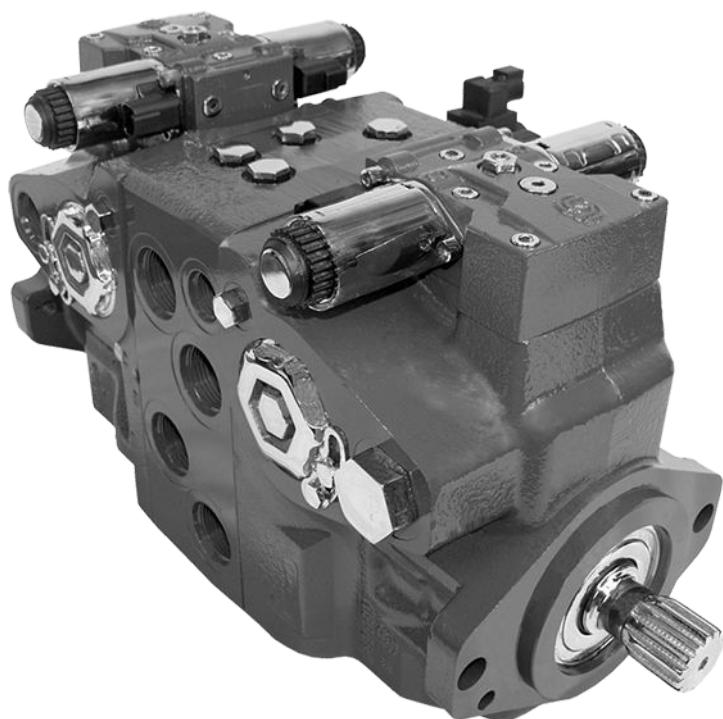
ENGINEERING  
TOMORROW



Service Manual

# Closed Circuit Axial Piston Pumps

## H1 45/53/60/68 Tandem



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**Revision history***Table of revisions*

Date	Changed	Rev
August 2017	minor edits	0302
May 2017	add 60-68	0301
March 2015	fix geroter orientation	BD
September 2014	add MDC	BC
June 2014	Torque correction, page 37, K350 is 56 lbf-ft	BB
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March 2010	add Control Cutoff (CCO)	AI
March 2010	Fix Osaka address	AH
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November 2008	correction to running cover bolt torque	AF
September 2008	correction to charge pressure relief valve torque	AE
May 2008	Added model code option and pressure setting for charge pressure relief valves	AD
October 2007	Pressure limiter valves removed from this manual	AB
Jun 2007	First edition	AA

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## Introduction

### Overview

This manual includes information for the installation, maintenance, and minor repair of H1 tandem pumps. It includes a description of the unit and its individual components, troubleshooting information, and minor repair procedures.

Performing minor repairs requires the unit to be removed 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 trains and certifies Global Service Partners on a regular basis. You can locate your nearest Global Service Partner using the distributor locator at <http://www.powersolutions.danfoss.com>.

### Warranty

Performing adjustments and minor repairs according to the procedures in this manual will not affect your warranty. Major repairs requiring the removal of a unit's center section, servo sleeves, or front flange voids the warranty unless a Danfoss Authorized Service Center performs them.

### General instructions

Follow these general procedures when repairing H1 tandem variable displacement closed circuit pumps.

#### Remove the unit



If necessary, remove the unit from the vehicle/machine. Chock the wheels on the vehicle or lock the mechanism to inhibit movement. Be aware that hydraulic fluid may be under high pressure and/or hot. Inspect the outside of the pump and fittings for damage. Cap hoses after removal to prevent contamination.

#### Keep it clean



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

As with any precision equipment, you must keep all parts free of foreign material and chemicals. Protect all exposed sealing surfaces and open cavities from damage and foreign material. If left unattended, cover the pump with a protective layer of plastic.

#### Replace all O-rings and gaskets



We recommend you replace all O-rings and seals removed during service. Lightly lubricate O-rings with clean petroleum jelly prior to assembly.

#### Secure the unit



If removed from machine, place the unit in a stable position with the shaft pointing downward. It will be necessary to secure the pump while removing and torquing fasteners and components.

## 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.

## Symbols used in Danfoss literature

	WARNING may result in injury		Tip, helpful suggestion
	CAUTION may result in damage to product or property		Lubricate with hydraulic fluid
	Reusable part		Apply grease / petroleum jelly
	Non-reusable part, use a new part		Apply locking compound
	Non-removable item		Inspect for wear or damage
	Option - either part may exist		Clean area or part
	Superseded - parts are not interchangeable		Be careful not to scratch or damage
	Measurement required		Note correct orientation

## Introduction

	Flatness specification		Mark orientation for reinstallation
	Parallelism specification		Torque specification
	External hex head		Press in - press fit
	Internal hex head		Pull out with tool - press fit
	Torx head		Cover splines with installation sleeve
	O-ring boss port		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.

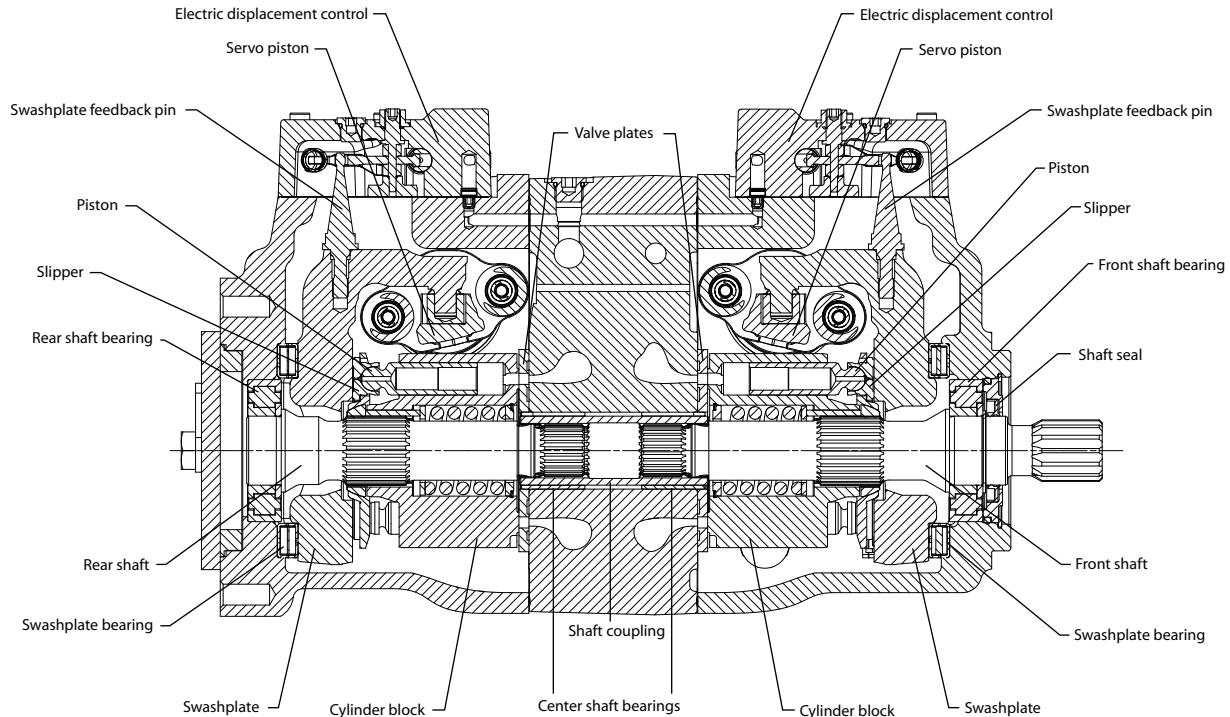
## Design

Danfoss H1 tandem closed circuit piston pumps convert input torque to hydraulic power. The tandem design powers two independent drive trains for dual-path propel applications. The two-piece input shaft transmits rotational force to the cylinder block. A splined coupling connects the front and rear shafts. Bearings at the front, rear, and center of the pump support the shaft. Splines connect each shaft to a cylinder block. A lip-seal at the front end of the pump prevents leakage where the shaft exits the pump housing. The spinning cylinder block contains nine reciprocating pistons. Each piston has a brass slipper connected at one end by a ball joint. The block spring, ball guide, and slipper retainer hold the slippers to the swashplate. The reciprocating movement of the pistons occurs as the slippers slide against the inclined swashplates during rotation. Via the valve plates, one half of each cylinder block is connected to port A or C and the other half to port B or D. Front and rear sections have independent porting in the center section. As each piston cycles in and out of its bore, fluid is drawn from one port and displaced to the other thereby imparting hydraulic power into the system. A small amount of fluid is allowed to flow from the cylinder block/valve plate and slipper/swashplate interfaces for lubrication and cooling. Case drain ports return this fluid to the reservoir. An external charge pump (not shown) provides clean, cool fluid to makeup this lubricating flow and to maintain minimum loop pressure.

The angle of each swashplate controls the volume and direction of fluid displaced into the system. The servo pistons control the angle of the swashplates. Each pump control, by varying the pressure at the servo pistons, controls each piston's position. An electric signal to the control coils transmits the command from the operator to the pump. Mechanical feedback of the swashplate position to the control through the feedback pins allows for very precise displacement control and increases overall system stability. Non-feedback control options do not use the mechanical feedback link.

## Introduction

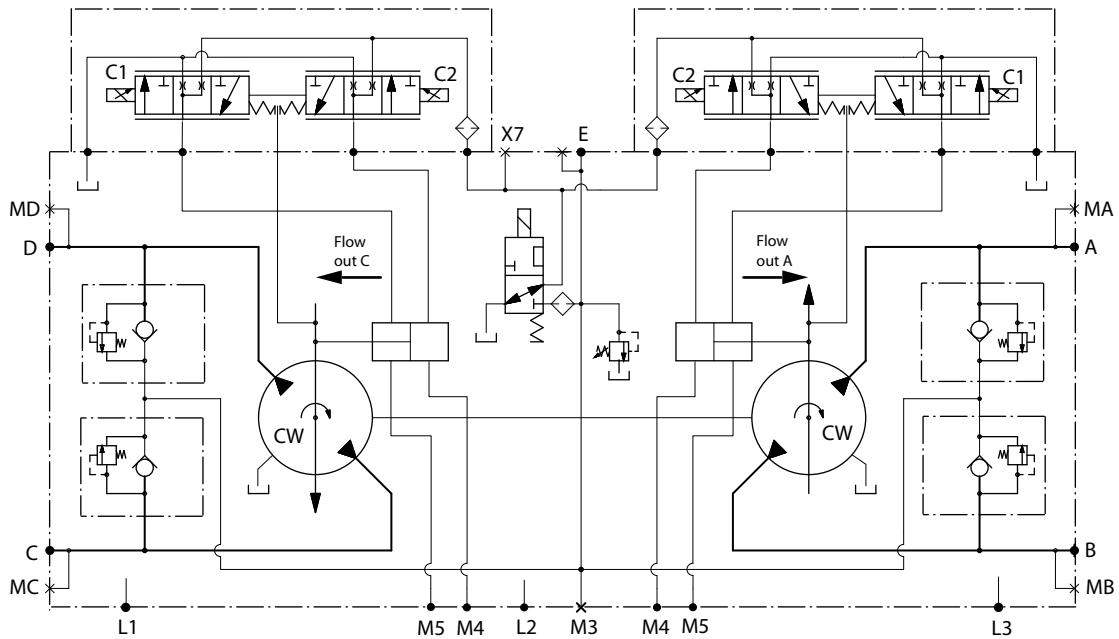
### Cross section view



P106 146E

### Pump schematic

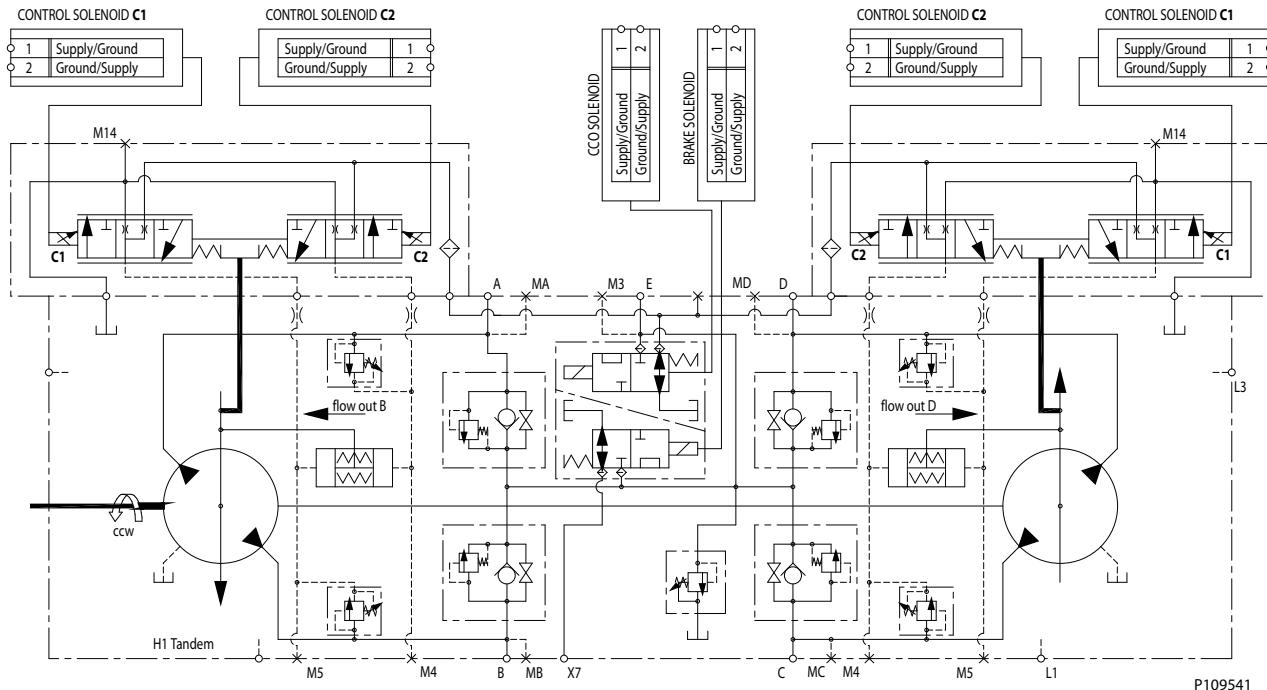
045/053 Tandem



P106 148E

## Introduction

### 060/068 Tandem



Above schematics show the function of an H1 tandem axial piston variable displacement pump with electric displacement control (EDC) and optional control cutoff valve.

## The system circuit

### The basic closed circuit

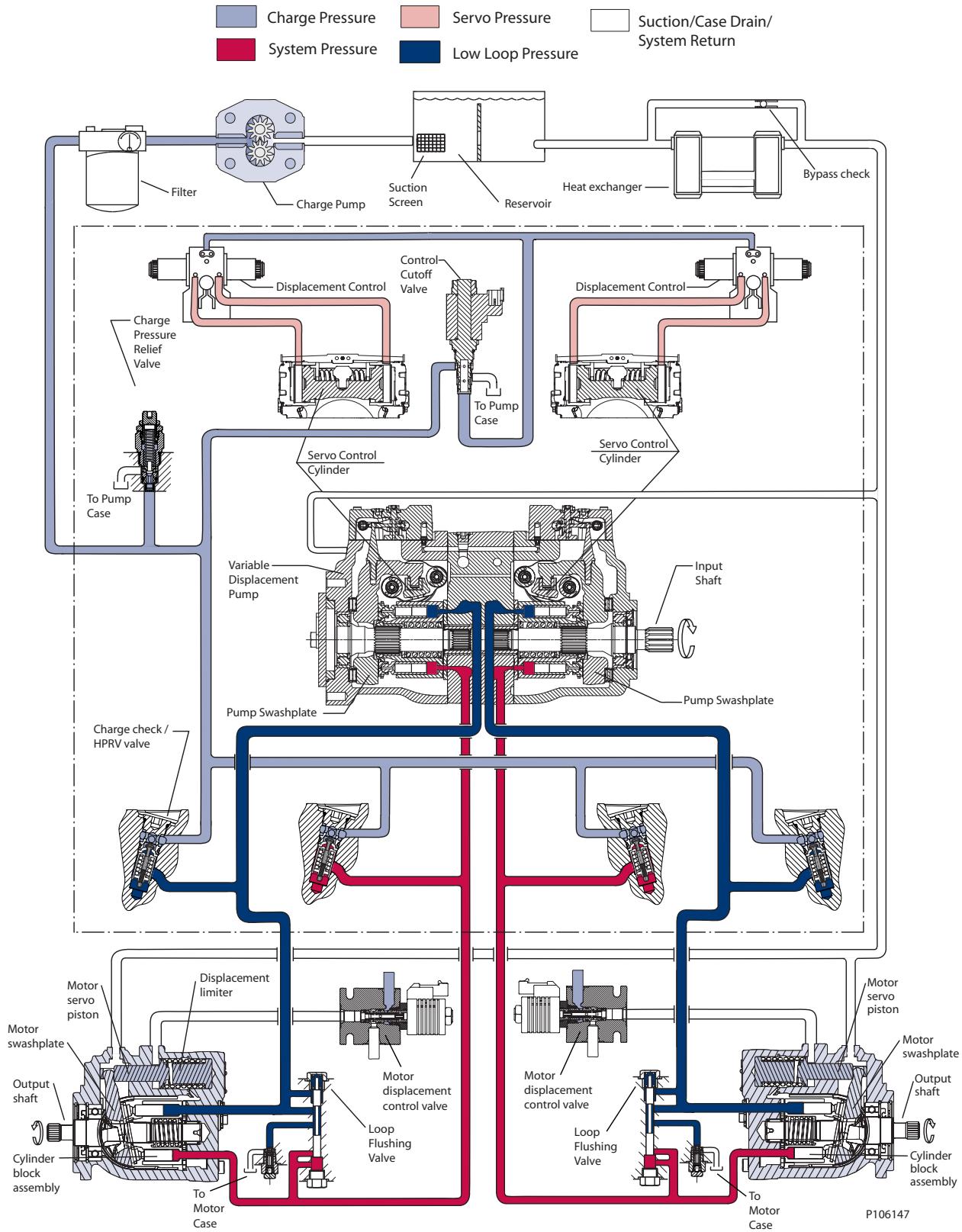
Hydraulic lines connect the main ports of the pump to the main ports of the motor. Fluid flows in either direction from the pump to the motor and back. Either of the hydraulic lines can be under high pressure. In pumping mode the position of the pump swashplate determines which line is high pressure as well as the direction of fluid flow.

### Case drain and heat exchanger

The pump and motor require case drain lines to remove hot fluid from the system. The pump and motor drain from the topmost port to ensure the cases remain full of fluid. The motor case drain can connect to the lower drain port on the pump housing or it can tee into the case drain line upstream of the heat exchanger. A heat exchanger with bypass valve cools the case drain fluid before it returns to the reservoir.

## Introduction

## System circuit diagram



## Operation

### Pressure Limiter Valves (060/068 only)

Pressure limiter valves provide system pressure protection by compensating the pump swashplate position when the set pressure of the valve is reached. A pressure limiter is a non-dissipative (non heat generating) pressure regulating system.

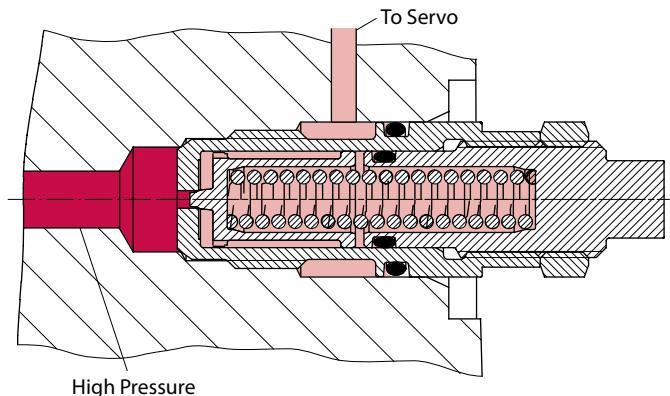
Each side of the transmission loop has a dedicated pressure limiter valve that is set independently. Each system port may have a different pressure limiter setting.

The pressure limiter setting is the maximum differential pressure between the high and low loops. When the pressure limiter setting is reached, the valve ports oil to the low-pressure side of the servo piston. The change in pressure across the servo rapidly reduces pump displacement. Fluid flow from the valve continues until the resulting drop in pump displacement causes system pressure to fall below the pressure limiter setting.

An active pressure limiter strokes the pump to near neutral when the load is in a stalled condition. The pump swashplate moves in either direction necessary to regulate the system pressure, including increasing stroke when overrunning or over-center.

The pressure limiter is optional on H1 pumps.

#### *Pressure limiter valve*



### High pressure relief valve (HPRV) and charge check

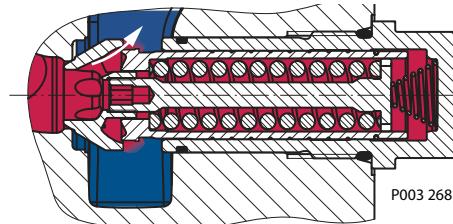
All H1 pumps have a combination high pressure relief and charge check valve. The high-pressure relief function is a dissipative (heat generating) pressure control valve for the purpose of limiting excessive system pressures. The charge check function replenishes the low-pressure side of the working loop with charge oil. Each side of the transmission loop has a dedicated non-adjustable, factory-set HPRV. When system pressure exceeds the factory setting, oil is passed from the high pressure system loop into the charge gallery, and into the low pressure system loop via the charge check.

The pump may have different pressure settings at each system port. When an HPRV is used in conjunction with a pressure limiter, the HPRV is always factory set above the setting of the pressure limiter. The system pressure shown in the order code for pumps with only HPRV is the HPRV setting. The system pressure shown in the order code for pumps with both pressure limiter and HPRV, is the pressure limiter setting.

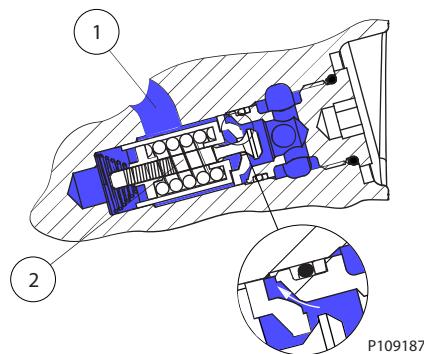
**HPRVs are set at low flow condition. Any application or operating condition which leads to elevated HPRV flow will cause a pressure rise with flow above the valve setting.**

## Operation

*High Pressure Relief and Charge Check Valve with Bypass Valve in relief mode (060/068)*

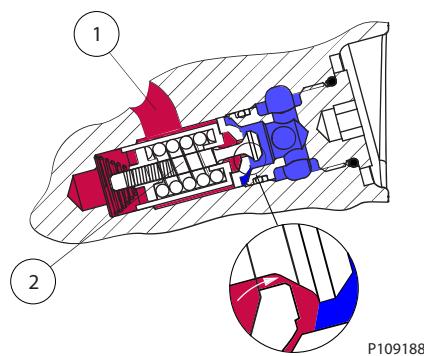


*High pressure relief and charge check valve in charging mode*



1. High pressure side of working loop
2. Charge check and high pressure relief valve

*High pressure relief and charge check valve in relief mode*



1. High pressure side of working loop
2. Charge check and high pressure relief valve

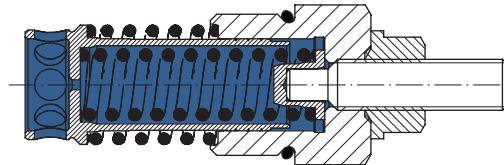
## Charge Pressure Relief Valve

The charge pressure relief valve maintains charge pressure at a designated level above case pressure. The charge pressure relief valve is a direct acting poppet valve that opens and discharges fluid to the pump case when pressure exceeds a designated level. This level is set with the pump running at 1800  $\text{min}^{-1}$ (rpm). For external charge flow, the CPRV is set with 30 l/min [8 US gal/min]. In forward or reverse, charge pressure will be slightly lower than in neutral position. The model code of the pump specifies the charge pressure relief valve setting.

Typical charge pressure increase from 1.2-1.5 bar per 10 l/min [17.4-21.8 psi per 2.64 US gal/min].

## Operation

### Charge pressure relief valve



## Electrical displacement control (EDC)

### EDC Principle

The Electrical Displacement Control (EDC) consists of proportional solenoids on each side of a three-position, four-way porting spool. The proportional solenoid applies a force to the spool, which ports hydraulic fluid to either side of the servo piston. Differential pressure across the servo piston rotates the swashplate, changing the pump's displacement from full displacement in one direction to full displacement in the opposite direction.

### EDC Operation

H1 EDC's are current driven controls requiring a Pulse Width Modulated (PWM) signal. Pulse width modulation allows more precise control of current to the solenoids. The PWM signal causes the solenoid pin to push against the porting spool, which pressurizes one end of the servo piston, while draining the other. Pressure differential across the servo piston moves the swashplate. A swashplate feedback link, opposing control links, and a linear spring provide swashplate position force feedback to the solenoid. The control system reaches equilibrium when the position of the swashplate spring feedback force exactly balances the input command solenoid force from the operator. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position of the swashplate.

The EDC incorporates a positive neutral dead-band as a result of the control spool porting, spring preload from the servo piston assembly, and the linear control spring. Once the neutral threshold current is reached, the swashplate position becomes directly proportional to the control current. To minimize the effect of the control neutral deadband, we recommended the transmission controller or operator input device incorporate a jump up current.

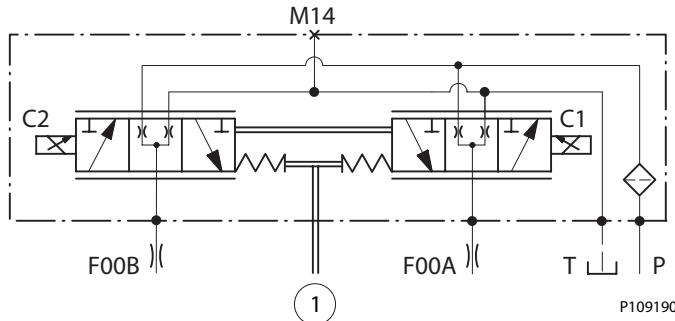
**The neutral position of the control spool does provide a positive preload pressure to each end of the servo piston assembly.**

When the control input signal is either lost or removed, or if there is a loss of charge pressure, the spring-loaded servo piston automatically returns the pump to neutral position.

The EDC is a displacement (flow) control. Pump swashplate position is proportional to the input command and therefore vehicle or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

## Operation

*EDC schematic diagram*



1. Feedback from Swash plate

### Manual OverRide (MOR)

All controls are available with a Manual OverRide (MOR) for temporary actuation of the control to aid in diagnosis. FNR controls always include MOR functionality.

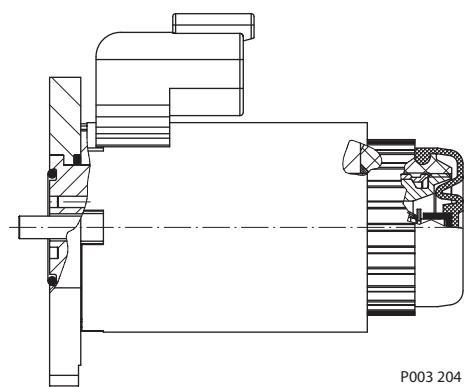
 **Warning**

Depressing the plunger causes the pump to go into stroke which will move the machine or mechanism. Ensure the vehicle or machine is in a safe condition (wheels off the ground or mechanism disconnected) before attempting to use the MOR feature.

An O-ring seals the MOR plunger. Initial actuation of the function requires additional force to overcome the O-ring resistance. A threshold force of 45 N is typically required at first actuation. Additional actuations typically require a threshold force of 12 N to move the MOR plunger. Force required to keep the pump at full stroke is typically 51 N. Do not expect proportional control of the pump using the MOR.

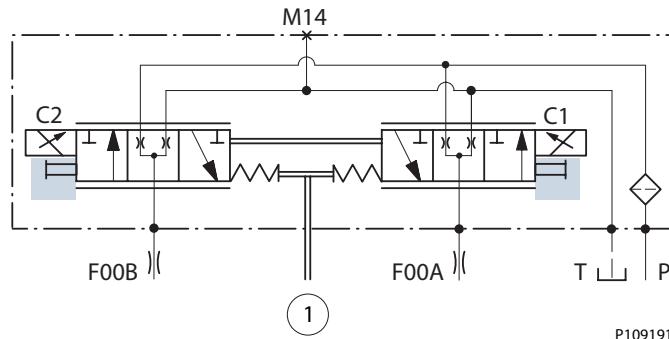
Refer to control flow table for the relationship of solenoid to direction of flow.

*Control solenoid*



## Operation

*EDC schematic diagram showing MOR*



### 1. Feedback from Swash plate

#### Manual Displacement Control (MDC)

A Manual proportional Displacement Control (**MDC**) consists of a handle on top of a rotary input shaft. The shaft provides an eccentric connection to a feedback link. This link is connected on its one end with a porting spool. On its other end the link is connected to the pumps swashplate.

This design provides a travel feedback without spring. When turning the shaft the spool moves thus providing hydraulic pressure to either side of a double acting servo piston of the pump.

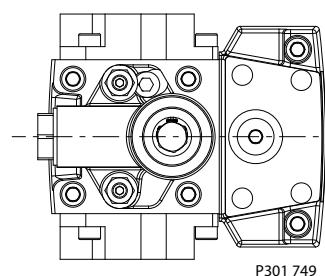
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swashplate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swashplate rotation.

The MDC changes the pump displacement between no flow and full flow into opposite directions. Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

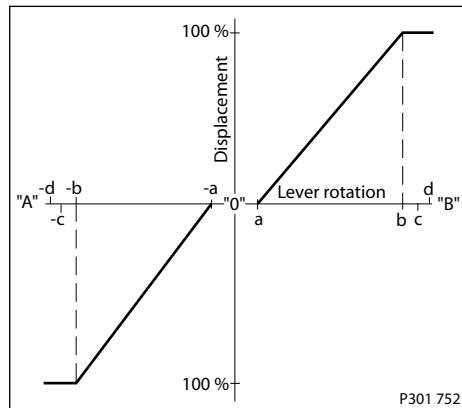
The MDC is sealed by means of a static O-ring between the actuation system and the control block. Its shaft is sealed by means of a special O-ring which is applied for low friction. The special O-ring is protected from dust, water and aggressive liquids or gases by means of a special lip seal.

#### Manual Displacement Control



## Operation

Pump displacement vs. control lever rotation



*Legend:*

Deadband on **B** side – **a** =  $3^\circ \pm 1^\circ$

Maximum pump stroke – **b** =  $30^\circ +2/-1^\circ$

Required customer end stop – **c** =  $36^\circ \pm 3^\circ$

Internal end stop – **d** =  $40^\circ$

### MDC Torque

Description	Value
Torque required to move handle to maximum displacement	1.4 N·m [12.39 lbf·in]
Torque required to hold handle at given displacement	0.6 N·m [5.31 lbf·in]
Maximum allowable input torque	20 N·m [177 lbf·in]

 **Caution**

Volumetric efficiencies of the system will have impacts on the start and end input commands.

### MDC General Information

In difference to other controls the MDC provides a mechanical deadband. This is required to overcome the tolerances in the mechanical actuation.

The MDC contains an internal end stop to prevent over travel. The restoring moment is appropriate for turning the MDC input shaft back to neutral only. Any linkages or cables may prevent the MDC from returning to neutral.

The MDC is designed for a maximum case pressure of 5 bar and a rated case pressure of 3 bar. If the case pressure exceeds 5 bar there is a risk of an insufficient restoring moment. In addition a high case pressure can cause the NSS to indicate that the control is not in neutral. High case pressure may cause excessive wear.

Customers can apply their own handle design but they must care about a robust clamping connection between their handle and the control shaft and avoid overload of the shaft.

Customers can connect two MDC's on a tandem unit in such a way that the actuation force will be transferred from the pilot control to the second control but the kinematic of the linkages must ensure that either control shaft is protected from torque overload. To avoid an overload of the MDC, customers must install any support to limit the setting range of the Bowden cable.

 **Caution**

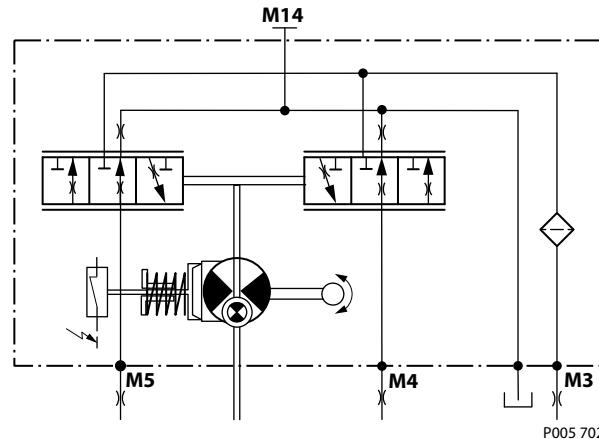
Using the internal spring force on the input shaft is not an appropriate way to return the customer connection linkage to neutral.

## Operation

### Neutral Start Switch (NSS)

The Neutral Start Switch (**NSS**) contains an electrical switch that provides a signal of whether the control is in neutral. The signal in neutral is Normally Closed (**NC**).

*Neutral Start Switch schematic*



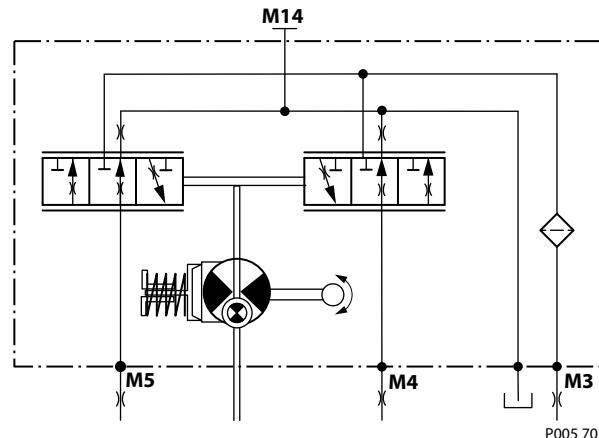
*Neutral Start Switch data*

<b>Max. continuous current with switching</b>	8.4 A
<b>Max. continuous current without switching</b>	20 A
<b>Max. voltage</b>	36 V <sub>DC</sub>
<b>Electrical protection class</b>	IP67 / IP69K with mating connector

### Case Gauge Port M14

The drain port should be used when the control is mounted on the unit's bottom side to flush residual contamination out of the control.

*MDC schematic diagram*



### Control-Cut-Off (CCO) valve and brake valve

The H1 tandem pumps offer an optional control cutoff valve integrated into the pump center section.

This valve shunts charge pressure from the pump controls allowing the servo springs to de-stroke both pumps. The valve is normally open for fail-safe operation. The solenoid must be energized for the pump

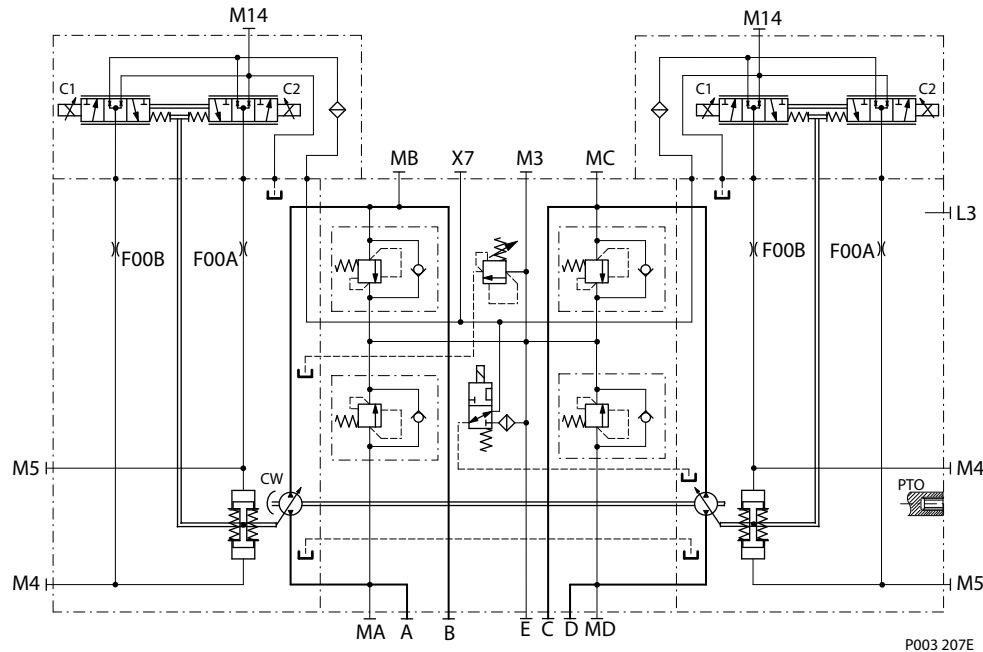
## Operation

to operate. When the machine control circuits energize the CCO solenoid, it connects charge supply from the charge gallery to the pump controls.

The 45/53cc tandem also supplies charge pressure to the port X7 for auxiliary operation of devices such as spring applied/pressure released brakes. The control cutoff valve also shunts pressure away from port X7.

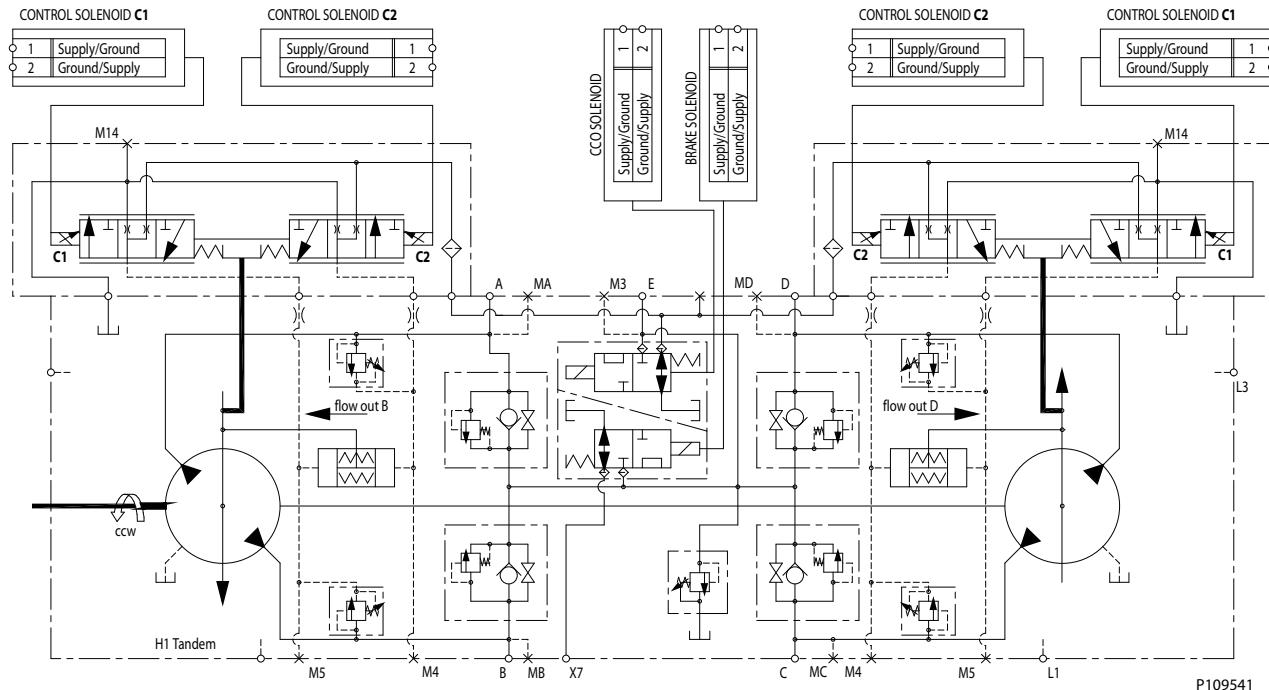
The 60/68 tandem offers a separate brake release valve that operates independent of the CCO valve allowing the controls to be activated before activating any auxiliary functions. When the 60/68 brake valve is deactivated the X7 port shunts to case."

045/053 schematic



## Operation

### 060/068 schematic

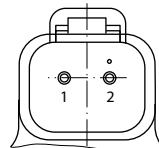


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### Solenoid data

Description		12 V	24 V
<b>Minimum supply voltage</b>		9 V <sub>DC</sub>	18 V <sub>DC</sub>
<b>Maximum supply voltage (continuous)</b>		16 V <sub>DC</sub>	32 V <sub>DC</sub>
<b>IP Rating</b>	IEC 60 529	IP 67	
	DIN 40 050, part 9	IP 69K with mating connector	
<b>Pin connector</b>		any order	

For additional information, please contact Danfoss.



P003 480

### Connector ordering data

Description	Quantity	Ordering data
Mating connector	1	DEUTSCH DT06-2S
Wedge lock	1	DEUTSCH W2S
Socket contact (16 and 18 AWG)	2	DEUTSCH 0462-201-16141
Danfoss mating connector kit	1	K29657

## Operating parameters

### Overview

This section defines input speed and pressure operating parameters and limitations for H1 pumps. For actual parameters, refer to the technical specifications for each displacement.

### Input speed

**Minimum speed** is the lowest input speed recommended during engine idle condition. Operating below minimum speed limits the pump's ability to maintain adequate flow for lubrication and power transmission.

**Rated speed** is the highest input speed recommended at full power. Operating at or below this speed generally yields satisfactory product life.

**Maximum speed** is the highest operating speed permitted. Exceeding maximum speed reduces product life and can cause loss of hydrostatic power and braking capacity. Never exceed the maximum speed limit under any operating conditions.

When determining speed limits for a particular application see Danfoss publication **BLN-9884 Pressure and speed limits**.

#### **Warning**

#### **Unintended vehicle or machine movement hazard**

Exceeding maximum speed may cause a loss of hydrostatic drive line power and braking capacity. You must provide a braking system, redundant to the hydrostatic transmission, sufficient to stop and hold the vehicle or machine in the event of hydrostatic drive power loss.

### System pressure

**System pressure** is the differential pressure between system ports A & B and/or C & D. It is the dominant operating variable affecting hydraulic unit life. High system pressure, which results from high load, reduces expected life. Hydraulic unit life depends on speed and normal operating—or weighted average—pressure that you can only determine from a duty cycle analysis.

**Applied pressure** is the chosen application pressure in the order code for the pump. This is the pressure at which the drive line generates maximum pull or torque in the application.

**Rated pressure** is the design pressure for the pump. Applications with applied pressures at or below this pressure should yield satisfactory unit life given proper component selection.

**Maximum pressure** (peak) is the highest intermittent pressure allowed under any circumstances. Applications with applied pressures between rated and maximum require factory approval with complete application, duty cycle, and life expectancy analysis.

All pressure limits are differential pressures referenced to low loop (charge) pressure. Subtract low loop pressure from gauge readings to compute the differential.

### Charge pressure

The external charge pump supplies the control with pressure to operate the servo piston and to maintain a minimum pressure in the low side of the transmission loop. An internal charge relief valve regulates pressure in the charge circuit.

**Minimum charge pressure** is the lowest pressure safe working conditions allow in the system loop. Minimum control pressure requirements are a function of speed, pressure, and swashplate angle, and may be higher than the minimum charge pressure shown in the technical specifications.

**Maximum charge pressure** is the highest charge pressure the charge relief adjustment allows, and which provides normal component life. You can use elevated charge pressure as a secondary means to reduce swashplate response time.

## Operating parameters

The charge pressure setting listed in the order code is the set pressure of the charge relief valve with the pump in neutral, operating at 1800 min<sup>-1</sup> (rpm), and with a fluid viscosity of 32 mm<sup>2</sup>/sec [150 SUS]. The charge pressure setting is referenced to case pressure (the differential pressure above case pressure).

**Charge flow to pump must be sufficient to provide adequate charge pressure.**

### Charge inlet pressure

At normal operating temperature charge inlet pressure must not fall below **rated charge inlet pressure**.

**Minimum charge inlet pressure** is only allowed at cold start conditions. In some applications you may need to warm up the fluid (start the prime mover without using the vehicle/machine functions) before moving the vehicle or operating the machine.

### Case pressure

Do not exceed rated case pressure under normal operating conditions. During cold start, keep case pressure below maximum intermittent case pressure. Size drain plumbing accordingly.

 **Caution**

#### Possible component damage or leakage

Operation with case pressure in excess of stated limits may damage seals, gaskets, and/or housings, causing external leakage. This condition may also affect performance since charge and system pressure are referenced to case pressure.

## Temperature and viscosity

### Temperature

High temperature limits apply at the hottest point in the transmission loop, which is normally the motor case drain. Ensure the system generally runs at or below the rated temperature. The maximum intermittent temperature is based on material properties: Never exceed it.

Cold oil will generally not affect the durability of the transmission components, but it may affect the ability of oil to flow and transmit power: therefore ensure temperatures remain 16 °C [30 °F] above the pour point of the hydraulic fluid. Minimum temperature relates to the physical properties of component materials.

Size heat exchangers to keep the fluid within these limits. Danfoss recommends testing to verify that these temperature limits are not exceeded.

### Viscosity

For maximum efficiency and bearing life, ensure the fluid viscosity remains in the recommended range. Minimum viscosity should be encountered only during brief occasions of maximum ambient temperature and severe duty cycle operation. Maximum viscosity should be encountered only at cold start.

## Technical Specifications

For definitions of the following specifications, see *H1 Axial Piston Pumps, Basic Information 11062168*, chapter *Operating parameters*.

### H1T general specifications

<b>Design</b>	Axial piston pump of cradle swashplate design with variable displacement
<b>Direction of rotation</b>	Clockwise, counterclockwise
<b>Pipe connections</b>	<i>Main pressure ports 045/053:</i> SAE straight thread O-ring boss <i>Main pressure ports 060/068:</i> ISO split flange boss <i>Remaining ports:</i> SAE straight thread O-ring boss
<b>Recommended installation position</b>	Pump installation position is discretionary, however the recommended control position is on the top or at the side, with the top position preferred. If the pump is installed with the control at the bottom, flushing flow must be provided through port M14 located on the EDC and FNR control. Vertical input shaft installation is acceptable. The housing must always be filled with hydraulic fluid. Recommended mounting for a multiple pump stack is to arrange the highest power flow towards the input source. Consult Danfoss for nonconformance to these guidelines.
<b>Auxiliary cavity pressure</b>	Will be inlet pressure with the charge pump option. For reference see operating parameters on next page. Will be case pressure with external charge supply. Please verify mating pump shaft seal capability.

### Technical data H1 Tandem

Feature	Size 045	Size 053	Size 060	Size 068
<b>Displacement</b>	45.0 cm <sup>3</sup> [2.75 in <sup>3</sup> ]	53.8 cm <sup>3</sup> [3.28 in <sup>3</sup> ]	60.4 cm <sup>3</sup> [3.69 in <sup>3</sup> ]	68.0 cm <sup>3</sup> [4.15 in <sup>3</sup> ]
<b>Flow at rated (continuous) speed*</b>	153 l/min [40 US gal/min]	183 l/min [48 US gal/min]	210 l/min [55.5 US gal/min]	238 l/min [62.8 US gal/min]
<b>Torque at maximum displacement (theoretical)</b>	0.8 N·m/bar [488 lbf·in/1000 psi]	0.9 N·m/bar [549 lbf·in/1000 psi]	0.96 N·m/bar [590 lbf·in/1000 psi]	1.08 N·m/bar [610 lbf·in/1000 psi]
<b>Mass moment of inertia of rotating components</b>	0.0078 kg·m <sup>2</sup> [0.00575 slug·ft <sup>2</sup> ]	0.0077 kg·m <sup>2</sup> [0.00568 slug·ft <sup>2</sup> ]	0.01431 kg·m <sup>2</sup> [0.01055 slug·ft <sup>2</sup> ]	0.01427 kg·m <sup>2</sup> [0.01052 slug·ft <sup>2</sup> ]
<b>Mass (weight) dry</b>	65 kg [143 lb] (without charge pump or auxiliary flange)	96.2 kg [212 lb]		
<b>Oil volume</b>	2.3 l [0.61 US gal]	4.2 l [1.1 US gal]		
<b>Mounting flange</b>	ISO 3019-1 flange 101-2 (SAE B), Special bolt diameter	ISO 3019-1 flange 127-4 (SAE C)		
<b>Input shaft outer diameter, splines and tapered shafts</b>	ISO 3019-1, outer Ø25 mm - 4 (SAE B-B, 15 teeth) ISO 3019-1, outer Ø32 mm - 4 (SAE-B, 14 teeth) Conical keyed shaft end similar to ISO 3019-1 code 25-3, taper 1:8	ISO 3019-1, outer Ø32 mm - 4 (SAE C, 14 teeth) ISO 3019-1, outer Ø35 mm - 4 (SAE-C, 21 teeth)		
<b>Auxiliary mounting flange with metric fasteners, Shaft outer diameter and splines</b>	ISO 3019-1, flange 82 - 2, outer Ø16 mm - 4 (SAE A, 9 teeth) ISO 3019-1, flange 82 - 2, outer Ø19 mm - 4 (SAE A, 11 teeth) ISO 3019-1, flange 101 - 2, outer Ø22 mm - 4 (SAE B, 13 teeth) ISO 3019-1, flange 101 - 2, outer Ø25 mm - 4 (SAE B-B, 15 teeth)	ISO 3019-1, flange 101 - 2, outer Ø22 mm - 4 (SAE B, 13 teeth) ISO 3019-1, flange 101 - 2, outer Ø25 mm - 4 (SAE B-B, 15 teeth)		
<b>Charge inlet port</b>	Port ISO 11926-1 - 7/8 -14 (SAE O-ring boss)	Port ISO 11926-1 - 1 1/16 -14 (SAE O-ring boss)		
<b>Main port configuration</b>	ISO 11926-1 - 1 5/16 -12 (SAE O-ring boss)	ISO 6162 M12 x 1.75 (split flange)		
<b>Case drain port L3 (use for cooling purposes)</b>	Port ISO 11926-1 - 1 1/16 -12 (SAE O-ring boss)	Port ISO 11926-1 - 1 5/16 -12 (SAE O-ring boss)		

## Technical Specifications

Feature	Size 045	Size 053	Size 060	Size 068
Other ports		SAE O-ring boss		
Customer interface threads		Metric fasteners		

\* Applies for each rotating group

## Operating parameters H1 Tandem

Feature	Size 045	Size 053	Size 060	Size 068
Input speed (at minimum charge/control pressure)	Minimum for external charge supply <sup>2)</sup>			500 min <sup>-1</sup> (rpm)
	Rated		3400 min <sup>-1</sup> (rpm)	3500 min <sup>-1</sup> (rpm)
	Maximum		3500 min <sup>-1</sup> (rpm)	4000 min <sup>-1</sup> (rpm)
System pressure	Maximum working pressure	420 bar [6090 psi]	380 bar [5510 psi]	420 bar [6090 psi]
	Maximum pressure	450 bar [6527 psi]	400 bar [5800 psi]	450 bar [6527 psi]
	Maximum low loop	45 bar [650 psi]		
	Minimum low loop pressure	10 bar [145 psi]		
Charge pressure	Minimum without CCO (Control Cut Off) valve	16 bar [232 psi]		
	Minimum with CCO (Control Cut Off) valve	18 bar [265 psi]		
	Maximum	34 bar [435 psi]		
Control pressure	Minimum (at corner power for EDC, MDC, FNR)	21.5 bar [312 psi]		18.5 bar [268 psi]
	Maximum	40 bar [580 psi]		
Case pressure	Rated	3 bar [44 psi]		
	Maximum	5 bar [73 psi]		
Lip seal external maximum pressure		0.4 [5.8 psi]		

<sup>2)</sup> Full performance (pressure and displacement) possible at minimum charge and control pressure supply.

## Fluid Specifications

## Viscosity and Temperature range

Feature	Unit	Data
Viscosity	mm <sup>2</sup> /s [SUS]	5 [42]
		7 [49]
		12 – 80 [66 – 370]
		1600 [7500]
Temperature range <sup>2)</sup>	°C [°F]	-40 [-40]
		60 – 85 [140 – 185]
		104 [220]
		115 [240]

<sup>1)</sup> Intermittent = Short term t < 1 min per incident and not exceeding 2 % of duty cycle based load-life

<sup>2)</sup> At the hottest point, normally case drain port

<sup>3)</sup> Cold start = Short term t < 3min, p ≤ 50 bar [725 psi], n ≤ 1000 min-1(rpm)

## Technical Specifications

<b>per</b>	22/18/13
<b><math>\beta_x</math> (charge pressure filtration)</b>	$\beta_{15-20} = 75$ ( $\beta_{10} \geq 10$ )
<b><math>\beta_x</math> (suction and return line )</b>	$\beta_{35-45} = 75$ ( $\beta_{10} \geq 2$ )
<b>inlet screen mesh size</b>	100 – 125 $\mu\text{m}$

## Fluid and filter maintenance

### Fluid and filter recommendations

To ensure optimum life, perform regular maintenance of the fluid and filter. Contaminated fluid is the main cause of unit failure. Take care to maintain fluid cleanliness when servicing.

Check the reservoir daily for proper fluid level, the presence of water, and rancid fluid odor. Fluid contaminated by water may appear cloudy or milky or free water may settle in the bottom of the reservoir. Rancid odor indicates the fluid has been exposed to excessive heat. Change the fluid and correct the problem immediately if these conditions occur.

Inspect vehicle for leaks daily. Change the fluid and filter per the vehicle/machine manufacturer's recommendations or at intervals shown in the table. We recommend first fluid change at 500 hours.

---

High temperatures and pressures will result in accelerated fluid aging. More frequent fluid changes may be required.

---

Change the fluid more frequently if it becomes contaminated with foreign matter (dirt, water, grease, etc.) or if the fluid is subjected to temperature levels greater than the recommended maximum. Dispose of used hydraulic fluid properly. Never reuse hydraulic fluid.

Change filters with the fluid or when the filter indicator shows it's necessary. Replace all fluid lost during filter change.

For detailed filtration information, see Danfoss publication **520L0463 Fluids and Filtration**. For information on biodegradable fluids see Danfoss publication **520L0465 Biodegradable Hydraulic Fluids**.

### Hazardous material

#### **Warning**

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

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### Fluid and filter change interval

Reservoir type	Max oil change interval
Sealed	2000 hours
Breather	500 hours

## Pressure measurements

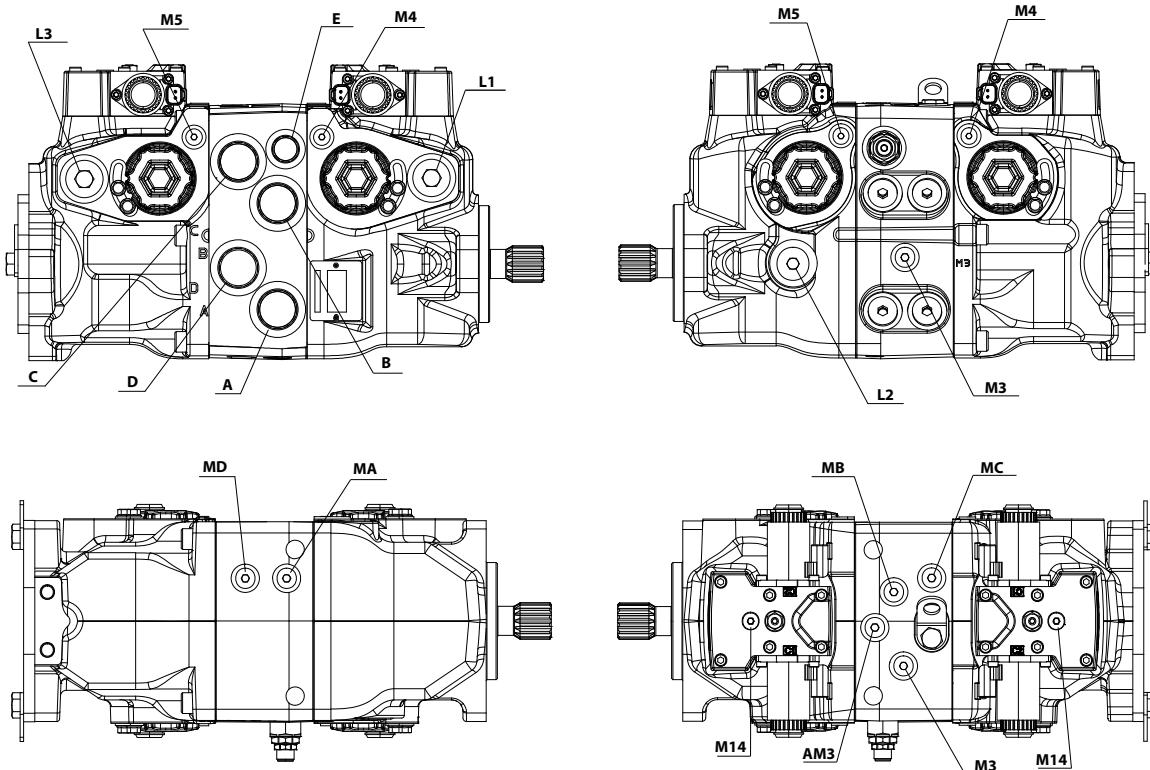
## Port locations and gauge installation - 045/053

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, L3	1 1/16-12 UNF 2B	9/16 internal hex	Case drain	10 bar [100 psi]
MA, MB, MC, MD	9/16-18 UNF	1/4 internal hex	System pressure	600 bar [10,000 psi]
M3	9/16-18 UNF 2B	1/4 internal hex	Charge pressure	50 bar [1000 psi]
M4, M5	7/16-20 UNF 2B	3/16 internal hex	Servo pressure	50 bar [1000 psi]
AM3	9/16-18 UNF 2B	1/4 internal hex	Alternate Charge pressure	50 bar [1000 psi]
A, B, C, D	1 5/16-12	-	System ports	-
E	7/8-14	-	Charge filtration	-
M14	7/16-20	1/4 internal hex	Case gauge port	10 bar [100 psi]

## Port locations



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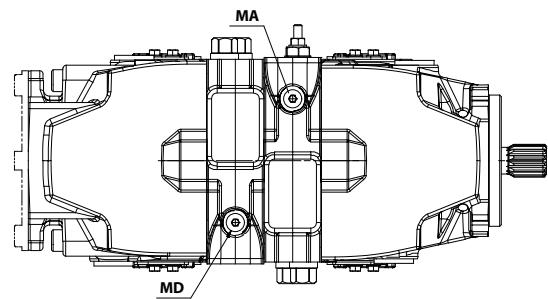
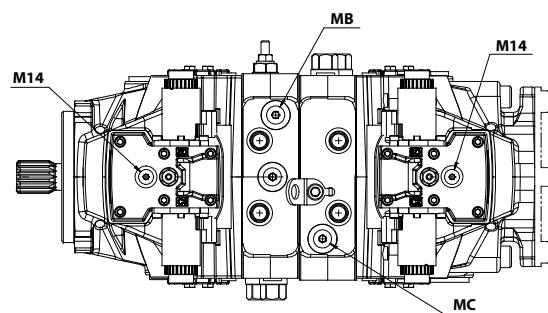
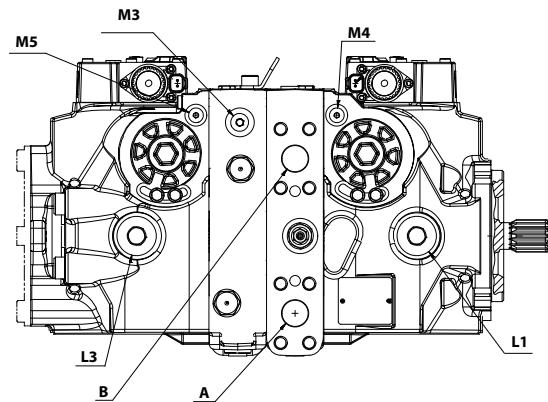
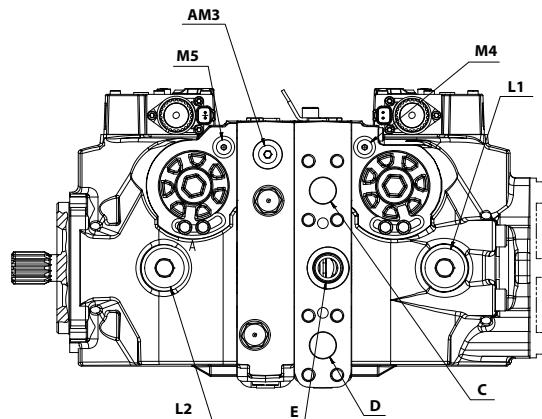
## Pressure measurements

## Port locations and gauge installation - 060/068

## Port information

Port identifier	Port size	Wrench size	Reading	Gauge size, bar [psi]
L1, L2, L3	1 1/16-12 UNF 2B	9/16 internal hex	Case drain	10 bar [100 psi]
MA, MB, MC, MD	9/16-18 UNF	1/4 internal hex	System pressure	600 bar [10,000 psi]
M3, AM3	9/16-18 UNF 2B	1/4 internal hex	Charge pressure	50 bar [1000 psi]
M4, M5	7/16-20 UNF 2B	3/16 internal hex	Servo pressure	50 bar [1000 psi]
M14	7/16-20	3/16 internal hex	Case gauge port	10 bar [100 psi]
A, B, C, D	1 5/16-12	-	System ports	-
E	7/8-14	-	Charge filtration	-

## Port locations



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## Initial startup procedures

### General

Follow this procedure when starting-up a new pump or when restarting a pump that has been removed. Ensure the pump is thoroughly tested on a test stand before installing.

#### **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.

---

### Start-up procedure

Prior to installing the pump, inspect for damage that may have occurred during shipping.

1. Ensure that the machine hydraulic oil and system components (reservoir, hoses, valves, fittings, and heat exchanger) are clean and free of any foreign material.
2. Install new system filter element(s) if necessary. Check that inlet line fittings are properly tightened and free of air leaks.
3. Install the pump. Install a 50 bar [1000 psi] gauge in the charge pressure gauge port M
4. Fill the housing by adding filtered hydraulic fluid to the upper case drain port. If the controls are installed on top, open the construction plugs in the top of the controls to assist in air bleed.
5. Fill the reservoir with hydraulic fluid of the recommended type and viscosity. Use a 10-micron filter filter. Ensure construction plug is closed after filling is complete.
6. Disconnect the pump from all control input signals.

#### **Caution**

After start-up the fluid level in the reservoir may drop due to system components filling. Damage to hydraulic components may occur if the fluid supply runs out. Ensure reservoir remains full of fluid during start-up.

Air entrapment in oil under high pressure may damage hydraulic components. Check carefully for inlet line leaks.

**Do not run at maximum pressure until system is free of air and fluid has been thoroughly filtered.**

7. Use a common method to disable the engine to prevent it from starting. Crank the starter for several seconds. Do not exceed the engine manufacturer's recommendation. Wait 30 seconds and then crank the engine a second time as stated above. This operation helps remove air from the system lines. Refill the reservoir to recommended full oil level.
8. When the gauge begins to register charge pressure, enable and start engine. Let the engine run for a minimum of 30 seconds at low idle to allow the air to work itself out of the system. Check for leaks at all line connections and listen for cavitation. Check for proper fluid level in reservoir.
9. When adequate charge pressure is established (as shown in model code), increase engine speed to normal operating rpm to further purge residual air from the system.
10. Shut the off engine. Connect the pump control signal. Start the engine, checking to be certain the pump remains in neutral. Run the engine at normal operating speed and carefully check for forward and reverse control operation.
11. Continue to cycle between forward and reverse for at least five minutes to bleed all air and flush system contaminants out of the system loop.

**Normal charge pressure fluctuation may occur during forward and reverse operation.**

12. Check that the reservoir is full. Remove charge pressure gauge and cap port. The pump is now ready for operation.

## Troubleshooting

### Overview

This section provides general steps to follow if you observe undesirable system conditions. Follow the steps listed until you solve the problem. Some of the items are system specific. We reference the section in this manual of more information is available. Always observe the safety precautions listed in *Safety precautions* on page 6 and precautions related to your specific equipment.

### Safety precautions

 **Caution**

High inlet vacuum causes cavitation which can damage internal pump components.

 **Warning**

Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury and/or infection and may be hot enough to cause burns. Relieve pressure in the system before removing hoses, fittings, gauges, or components. Seek immediate medical attention if you are cut or burned by hydraulic fluid.

 **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.

 **Caution**

Contamination can damage internal components and void the manufacturer's warranty. Take precautions to ensure system cleanliness when removing and reinstalling system components and lines

### Electrical troubleshooting

Item	Description	Action
Control operates pump in one direction only	Control coil failure.	Measure resistance at coil pins. Resistance should be 14.2W (24V) or 3.66W (12V) at 20° C [70° F]. Replace coil.
No pump function	No power to controller.	Restore power to controller.
Erratic pump function	Electrical connection to pump is bad.	Disconnect connection, check wires, reconnect wires.
Erratic or no machine function	External controller malfunction or hydraulic system problem.	Verify external controller problem using spare controller. Replace controller. Check hydraulic system fluid level/pressures/filters/etc. Fix hydraulic system problems.

If available, use a manual override to check proper pump operation and verify electrical problem.

## Troubleshooting

### Neutral difficult or impossible to find

Item	Description	Action
Input to pump control	Input to control module is operating improperly.	Disconnect input and check to see if pump comes back to neutral. If Yes, input fault, replace/repair external controller. If No, go to next step.
Pump control neutral	Neutral set improperly.	Shunt servo gauge ports M4 and M5 together with external hose and see if pump comes back to neutral. If Yes: control neutral improperly set (see <a href="#">Control Neutral Adjustment</a> on page 40). If no: balance swashplate (see <a href="#">Mechanical neutral adjustment</a> on page 42). If you still cannot set neutral, replace control.

### System operating hot

Item	Description	Action
Oil level in reservoir	Insufficient hydraulic fluid will not meet cooling demands of system.	Fill reservoir to proper level.
Heat exchanger	Heat exchanger not sufficiently cooling the system.	Check air flow and input air temperature for heat exchanger. Clean, repair or replace heat exchanger.
Charge pressure	Low charge pressure will overwork system.	Measure charge pressure. Inspect and adjust or replace charge relief valve. Inspect charge pump. Repair or replace charge pump.
Charge pump inlet vacuum	High inlet vacuum will overwork system. A dirty filter will increase the inlet vacuum. Inadequate line size will restrict flow.	Check charge inlet vacuum. If high, inspect inlet filter and replace as necessary. Check for adequate line size, length or other restrictions.
System relief pressure settings	If the system relief valves are worn, contaminated, or valve settings are too low, the relief valves will be overworked.	Verify settings of high pressure relief valves and replace valves as necessary.
System pressure	Frequent or long term operation over system relief setting will create heat in system.	Measure system pressure. If pressure is too high, reduce loads.

### Transmission operates normally in one direction only

Item	Description	Action
Input to pump control	Input to control module is operating improperly.	Check control input and repair or replace as necessary.
Control orifices	Control orifice(s) are blocked.	Clean control orifices.
Control screens	Control screen(s) are blocked.	Clean or replace control screens.
Interchange charge check / HPRVs	Interchanging the charge check / HPRVs will show if the problem is related to the valve function.	If the problem changes direction, replace the valve that does not operate correctly.
Servo pressure	Servo pressure low or decaying.	Check for damaged servo seals. Replace and retest. Refer to <a href="#">520L0928 H1 45/53 Tandem Repair Instructions</a> for seal locations. Only a Danfoss Global Service Partner may remove the servo piston without voiding the warranty.

### System will not operate in either direction

Item	Description	Action
Oil level in reservoir	Insufficient hydraulic fluid to supply system loop.	Fill reservoir to proper level.
Control orifices	Control orifices are blocked.	Clean control orifices.
Control screens	Control screens are blocked.	Clean or replace control screens.

## Troubleshooting

Item	Description	Action
Charge pressure with pump in neutral	Low charge pressure insufficient to recharge system loop.	Measure charge pressure with the pump in neutral. If pressure is low, go to next step.
Pump charge relief valve	A pump charge relief valve that is leaky, contaminated, or set too low will depressurize the system.	Adjust or replace pump charge relief valve as necessary.
Charge pump inlet filter	A clogged filter will under supply system loop.	Inspect filter and replace if necessary.
Charge pump	A malfunctioning charge pump will provide insufficient charge flow.	Repair or replace the charge pump.
System pressure	Low system pressure does not provide enough power to move load.	Measure system pressure. Continue to next step.
Charge check / HPRVs	Defective charge check / HPRVs cause system pressure to be low.	Repair or replace charge check / HPRVs.
Input to control	Input to control module is operating improperly.	Repair or replace control.
Optional control cutoff valve	Control cutoff valve coil not energized.	Ensure charge pressure to control via port X7. If none, confirm control cutoff valve coil is energized. If still no pressure, repair or replace control cutoff valve.

## System noise or vibration

Item	Description	Action
Reservoir oil level	Low oil level leads to cavitation.	Fill reservoir.
Aeration of the oil/pump inlet vacuum	Air in system decreases efficiency of units and controls. Air in system is indicated by excessive noise in pump, foaming in oil, and hot oil.	Find location where air is entering into the system and repair. Check that inlet line is not restricted and is proper size.
Cold oil	If oil is cold, it may be too viscous for proper function and pump cavitates.	Allow the oil to warm up to its normal operating temperature with engine at idle speed.
Pump inlet vacuum	High inlet vacuum causes noise/cavitation.	Check that inlet line is not restricted and is proper size. Check filter and bypass switch.
Shaft couplings	A loose input shaft to prime mover coupling will cause excessive noise.	Replace loose shaft coupling.
Shaft alignment	Misaligned input and prime mover shafts create noise.	Correct misalignment.
Charge/system relief valves	Unusual noise may indicate sticking valves. Possible contamination.	Clean/replace valves and test pump. May be a normal condition.

## Sluggish system response

Item	Description	Action
Oil level in reservoir	Low oil level will cause sluggish response.	Fill reservoir.
Charge check / HPRVs	Incorrect pressure settings will affect system reaction time.	Replace charge check / HPRVs.
Low prime mover speed	Low engine speed will reduce system performance.	Adjust engine speed.
Charge and control pressures	Incorrect pressures will affect system performance.	Measure and adjust charge and control pressures.
Air in system	Air in system will produce sluggish system response.	Fill tank to proper level. Cycle system slowly for several minutes to remove air from system.
Contaminated control orifices	Control orifices are plugged.	Clean control orifices.
Contaminated control screens	Control screens are plugged.	Clean or replace control screens.
Pump inlet vacuum	Inlet vacuum is too high resulting in reduced system pressure.	Measure charge inlet vacuum. Inspect line for proper sizing. Replace filter. Confirm proper bypass operation.

## Adjustments

### Pump adjustment

This section offers instruction on inspection and adjustment of pump components. Read through the entire topic before beginning a service activity. Refer to [Pressure measurements](#) on page 26, for location of gauge ports and suggested gauge size.

### Standard procedures

#### **Warning**

Contamination can damage internal components and void your warranty. Take precautions to ensure system cleanliness when removing and reinstalling system lines

1. With the prime mover off, thoroughly clean the outside of the pump.
2. If removing the pump, tag each hydraulic line. When you disconnect hydraulic lines, cap them and plug each open port to prevent contamination.
3. Ensure the surrounding area is clean and free of contaminants like dirt and grime.
4. Inspect the system for contamination.
5. Check the hydraulic fluid for signs of contamination: oil discoloration, foam in the oil, sludge, or metal particles.
6. If there are signs of contamination in the hydraulic fluid, replace all filters and drain the hydraulic system. Flush the lines and refill the reservoir with the correct filtered hydraulic fluid.
7. Before reinstalling the pump, test for leaks.

### Charge pressure relief valve adjustment

This procedure explains how to check and adjust the charge pressure relief valve.

See [Fastener size and torque chart](#) on page 63 for torques and wrench sizes on other charge pressure relief valves.

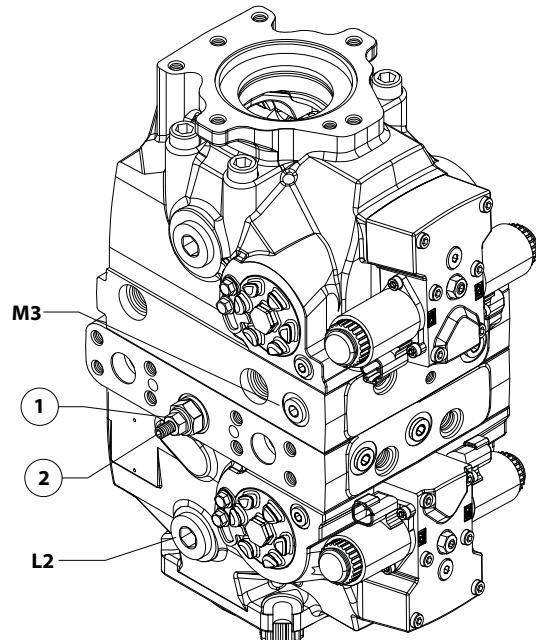
1. Install a 50 bar [1000 psi] pressure gauge in charge pressure gauge port M3. Install a 10 bar [100 psi] gauge at case pressure port L1, L2, or L3. Operate the system with the pump in neutral (zero displacement) when measuring charge pressure.
2. The table below shows the acceptable pump charge pressure range for some nominal charge relief valve settings (refer to model code located on serial number plate). These pressures assume 1800

## Adjustments

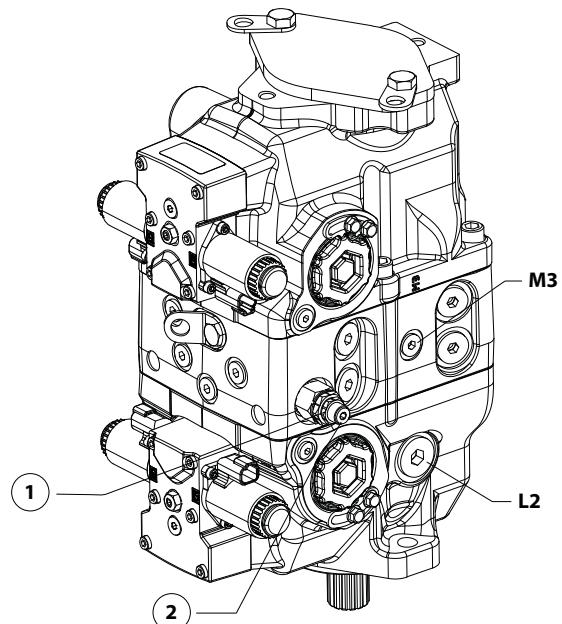
$\text{min}^{-1}$  (rpm) pump speed and a reservoir temperature of 50°C [120°F], and are referenced to case pressure.

### Charge pressure adjustment

060/068



045/053



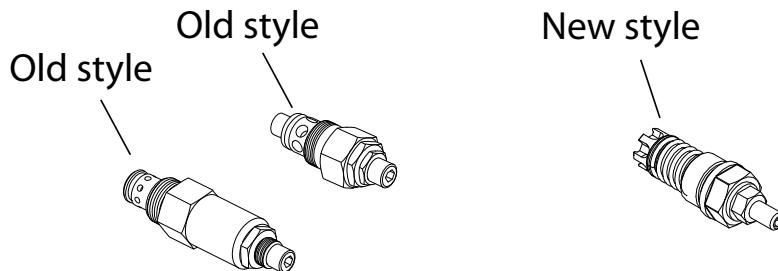
P109550

### Legend

Item	Description	Wrench size	Torque	Gauge size
1	Lock nut	19 mm	40 Nm [29.5 lb·ft]	-
2	Adjusting screw	6 mm	-	-
M3	Charge pressure gauge port	1/4 inch	24 Nm [17 lb·ft]	0 - 50 bar [0 - 1000 psi]
L2 (045/053)	Case drain port	9/16 inch	48.5 Nm [35.8 lb·ft]	0 - 10 bar [0 - 100 psi]
L2 (060/068)	Case drain port	5/8 inch	148 Nm [109 lb·ft]	0 - 10 bar [0 - 100 psi]

Listed pressures assume a pump speed of 1800  $\text{min}^{-1}$  (rpm) and charge flow of 30 l/min [7.9 US gal/min]. At higher pump speeds or higher charge flows the charge pressure will rise over the rated setting.

## Adjustments



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3. Loosen the locknut and rotate the adjusting screw clockwise to increase the setting; counterclockwise to decrease it. Subtract the case pressure reading to compute the actual charge pressure.

**Pressure change per turn is dependent on charge flow entering pump.**

4. While holding the adjusting screw, torque locknut to 40 N·m [30 lbf·ft].  
 5. When you achieve the desired charge pressure setting, remove the gauges and plug the ports.

*Charge pressure ranges\**

Current style - option code	Old style - option code	Pressure setting
20	BK	20 bar [290 psi] ± 1.5 bar[21.8 psi]
22	BB	22 bar [319 psi] ± 1.5 bar[21.8 psi]
24	BD	24 bar [348 psi] ± 1.5 bar[21.8 psi]
26	BF	26 bar [377 psi] ± 1.5 bar[21.8 psi]
28	BH	28 bar [406 psi] ± 1.5 bar[21.8 psi]
30	CK	30 bar [435 psi] ± 1.5 bar[21.8 psi]
32	CB	32 bar [464 psi] ± 1.5 bar[21.8 psi]
34	N/A	34 bar [493 psi] ± 1.5 bar[21.8 psi]
N/A	CD	36 bar [522 psi] ± 1.5 bar[21.8 psi]

\* This is the actual charge pressure (gauge reading minus case pressure) factory set at 1800 min<sup>-1</sup> (rpm) with a reservoir temperature of 50° C [120° F].

## Charge check / HPRV adjustment

The charge check/HPRV combines the charge check and high pressure relief functions. Whenever you replace a charge check/HPRV, operate the vehicle/machine through its full range of functions to ensure proper pump operation. The charge check/HPRVs are preset at the factory, no adjustment is possible.

## Checking for proper charge check / HPRV operation

If you suspect charge check/HPRV malfunction, swap valves and test operation. If the symptoms switch direction, replace the faulty valve.

## Pressure Limiter Adjustment (060/068 only)

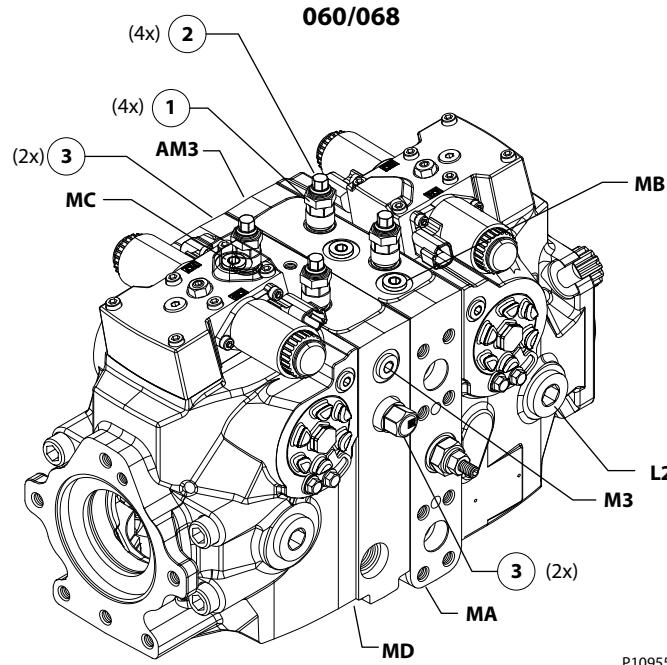
Lock motor output shaft to adjust the pressure limiter setting. Lock the vehicle's brakes or rigidly fix the work function so it cannot rotate.

1. Install 600 bar [10,000 psi] pressure gauges in the high pressure gauge ports (MA, MB, MC and MD). Install a 50 bar [1000 psi] pressure gauge in the charge pressure gauge ports (M3 or AM3).

**Ensure charge pressure is properly set before checking pressure limiter.**

## Adjustments

## Pressure limiter adjustment



P109551

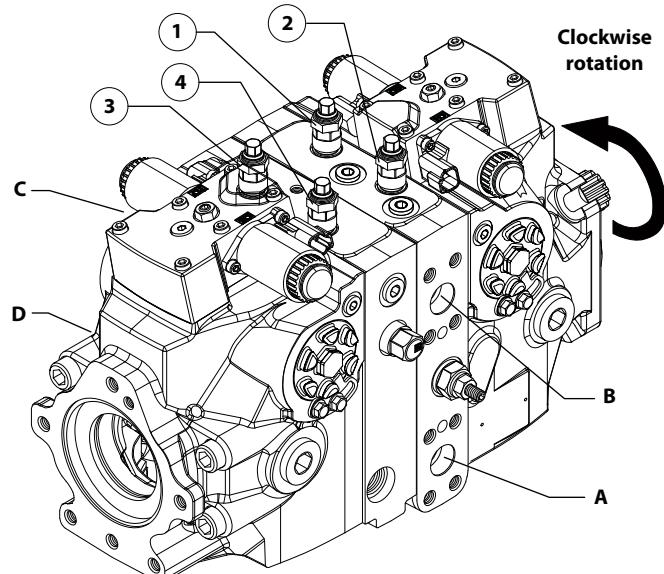
## Legend

Item	Description	Wrench size	Torque	Gauge size
1	Lock nut	14 mm	20 Nm [15 lb·ft]	-
2	Adjusting screw	6 mm	-	-
3	HPRV Valve	22 mm	70 Nm [52 lb·ft]	-
M3, AM3	Charge pressure gauge port	1/4 inch	43 Nm [32 lb·ft]	0 - 50 bar [0 - 1000 psi]
L2	Case drain port	5/8 inch	148 Nm [109 lb·ft]	0 - 10 bar [0 - 100 psi]
MA, MB, MC, MD	System pressure gauge ports	1/4 inch	43 Nm [32 lb·ft]	0 - 600 bar [0 - 10,000 psi]

## Adjustments

*Pressure limiter valve adjustment - Clockwise*

**060/068**



P109552

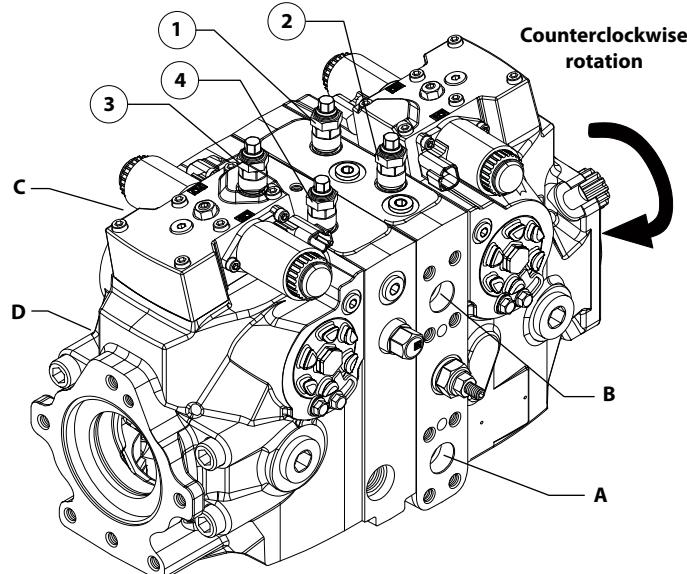
### Legend

Item	Description	Lock nut torque	Controls port
1	Pressure limiter adjusting valve	20 Nm [15 lb·ft]	<b>B</b>
2	Pressure limiter adjusting valve	20 Nm [15 lb·ft]	<b>A</b>
3	Pressure limiter adjusting valve	20 Nm [15 lb·ft]	<b>C</b>
4	Pressure limiter adjusting valve	20 Nm [15 lb·ft]	<b>D</b>
A, B, C, D	Pressure port	-	-

## Adjustments

Pressure limiter valve adjustment - Counterclockwise

060/068



P109553

## Legend

Item	Description	Torque	Controls port
1	Pressure limiter adjusting valve	20 Nm [15 lb·ft]	<b>A</b>
2	Pressure limiter adjusting valve	20 Nm [15 lb·ft]	<b>B</b>
3	Pressure limiter adjusting valve	20 Nm [15 lb·ft]	<b>D</b>
4	Pressure limiter adjusting valve	20 Nm [15 lb·ft]	<b>C</b>
A, B, C, D	Pressure port	-	-

If you change pressure limiter settings, you must also change the HPRV valve to maintain proper PL function. Refer to table on next page for corresponding settings.

2. Start the prime mover and operate at normal speed.
3. Use a 14 mm wrench to loosen the locking nut (L024).
4. Activate the control input until pressure in the high side of the system loop stops rising. This pressure is the PL setting.
5. Return the pump to neutral and adjust the PL setting using an internal hex wrench. Wrench size is in the diagram on the previous page. Turn the adjusting screw clockwise to increase the PL setting, counter clockwise to decrease it. The adjustment is very sensitive. Change per turn is approximately 150 bar [2176 psi].

Change per turn is 150 bar/rev [2176 psi/rev].

## Adjustments

The model code on the serial plate gives the factory setting of the PL (Pressure Limiter). The PL setting is referenced to charge pressure. Subtract charge pressure from system pressure gauge readings to compute the effective PL setting.

6. Repeat steps four and five until you reach the desired PL setting. After adjustment, torque the locknut (L024). Do not over torque.
7. Shut down the prime mover. Remove gauges and replace plugs.

### *Pressure limiter settings*

Pressure limiter setting	HPRV setting
150	200
180	230
200	250
230	280
250	300
280	330
300	350
330	380
350	400
380	420

Pressure limiter setting	HPRV setting
400	450
410	
420	
430	480
440	
450	
460	510
470	
480	

### **Engaging the Bypass Function (060/068 only)**

Use this procedure to bypass the pump to allow moving the vehicle/machine short distances when you cannot start the prime mover.

#### **Caution**

It is possible to damage the drive motor(s) by operating in bypass mode without charge pressure. Move the vehicle/machine at a speed not more than 20% of maximum for a duration not exceeding 3 minutes.

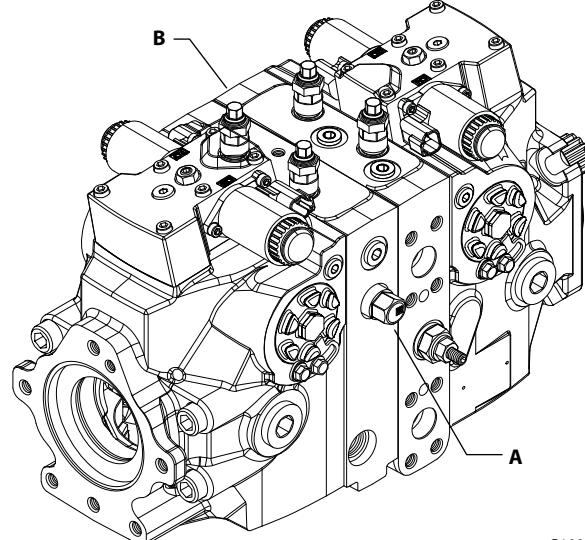
1. To open the HPRVs (A and B), rotate three revolutions counter clockwise using a 22mm hex wrench. Do not rotate more than 3 revolutions, leakage will result.
2. To close the HPRVs, rotate them clockwise until seated. Torque to 70 N·m [52 lbf·lb].

## Adjustments

3. If machine is towable with HPRVs opened three turns and if wheels are locked (not towable) with HPRV valves closed, bypass function is working correctly.

*Engaging the bypass function*

**060/068**



P109554

### Legend

Item	Description	Wrench size	Torque
A	HPRV valve for rear pump	22 mm	70 N·m [52 lbf·lb]
B	HPRV valve for front pump	22 mm	70 N·m [52 lbf·lb]

### Displacement limiter adjustment

An optional displacement limiter is located on each side of the pump housing. The maximum displacement can be limited in either direction.

**Displacement limiters are not pre-set by the factory but are installed to minimize the extension of the adjustment screw while not limiting the maximum displacement of the pump. A small amount of clockwise screw adjustment is required before the 100% displacement condition is reached.**

1. Mark servo cylinder location in case it rotates during displacement limiter adjustment.
2. Loosen the locknut (E550).
3. Rotate the adjusting screw (E450) based on the following table. Rotating the adjusting screw clockwise decreases the maximum displacement of the pump while rotating the adjusting screw counterclockwise increases the maximum displacement.
4. After establishing the desired maximum displacement setting, hold adjusting screw in place and tighten the locknut. Torque to 23 N·m [17 lbf·ft].

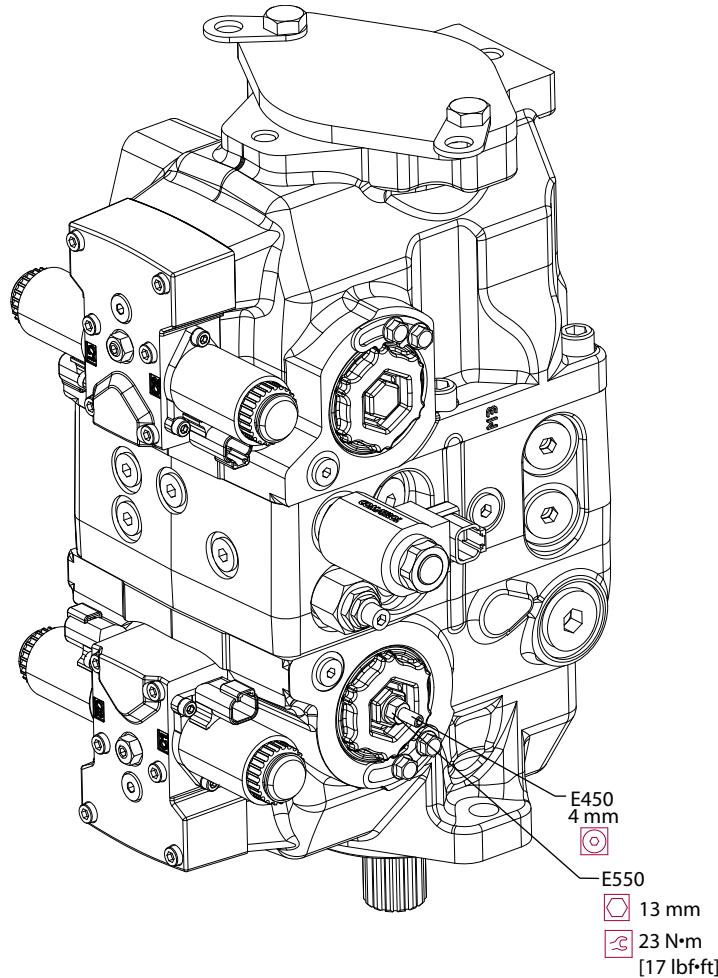
#### **Caution**

Be sure servo cylinder does not rotate when displacement limiter locknut (E550) is torqued.

## Adjustments

5. One turn of the adjusting screw will change the maximum displacement approximately as follows.

*Displacement limiter adjustment*



P106 144E

*Displacement limiter adjustment data*

Displacement	Locknut wrench size and torque	Adjusting screw size	Approximate displacement change per revolution of adjusting screw
45	13 mm 23 N·m [17 lbf·ft]	4 mm internal hex	5.1 cc / turn
53	13 mm 23 N·m [17 lbf·ft]	4 mm internal hex	6.0 cc / turn
60	13 mm 23 N·m [17 lbf·ft]	4 mm internal hex	5.9 cc / turn
68	13 mm 23 N·m [17 lbf·ft]	4 mm internal hex	6.6 cc / turn

## Control Neutral Adjustment

All functions of the Electric Displacement Control (EDC) are preset at the factory. Adjust the pump to neutral with the pump running on a test stand or on the vehicle/machine with the prime mover operating. If adjustment fails to give satisfactory results, you may need to replace the control or coils. See [Electric control module](#) on page 47 for details.

## Adjustments

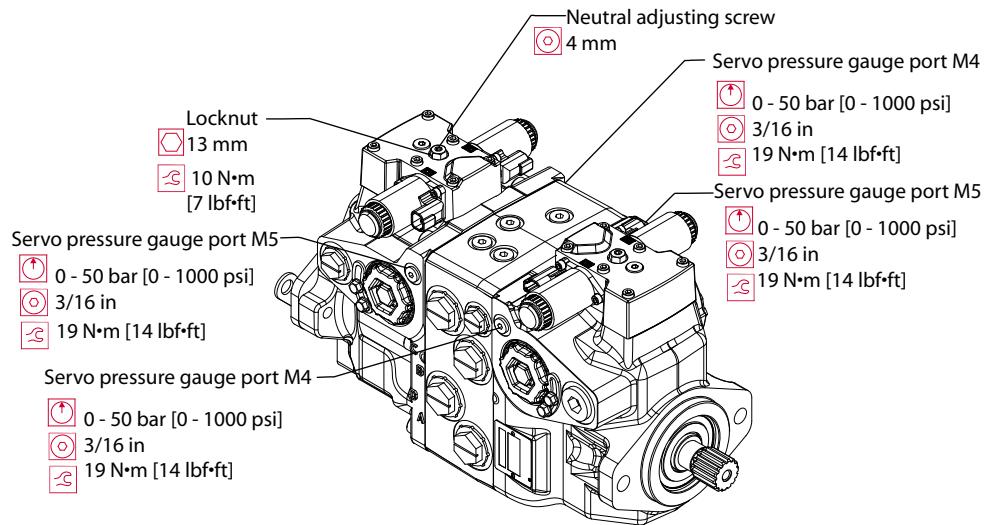
### ⚠ Warning

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.

1. Install a 50 bar [1000 psi] gauge in each of the two servo gauge ports (M4 and M5). Disconnect the external control input (electrical connections) from the control. Start the prime mover and operate at normal speed.
2. Use a 4mm internal hex wrench to hold the neutral adjusting screw stationary while loosening the locknut with a 13mm wrench.
3. Observe pressure gauges. If necessary, turn adjusting screw to reduce any pressure differential.

Adjustment of the EDC is very sensitive. Be sure to hold the hex wrench steady while loosening the locknut. Total adjustment is less than 120 degrees.

#### Control adjustment



P106 145E

4. Rotate the neutral adjusting screw clockwise until the pressure increases on the gauge. Note the angular position of the wrench. Then rotate the neutral adjusting screw counterclockwise until the pressure increases by an equal amount on the other gauge. Again note the angular position of the wrench.
5. Rotate the neutral adjusting screw clockwise half the distance between the wrench positions noted above. The gauges should read the same pressure, indicating that the control is in its neutral position.
6. Hold the neutral adjusting screw stationary and tighten the lock nut. Torque to 10 N·m [7 lbf·ft]. Do not over torque the nut.
7. When the neutral position is set, stop the prime mover, remove the gauges, and install the gauge port plugs. Reconnect the external control input.

A small pressure differential of 2.5 bar [36 psi] or less is acceptable. Zero differential is usually not possible.

## Adjustments

*Neutral adjustment (EDC) (bottom view)*

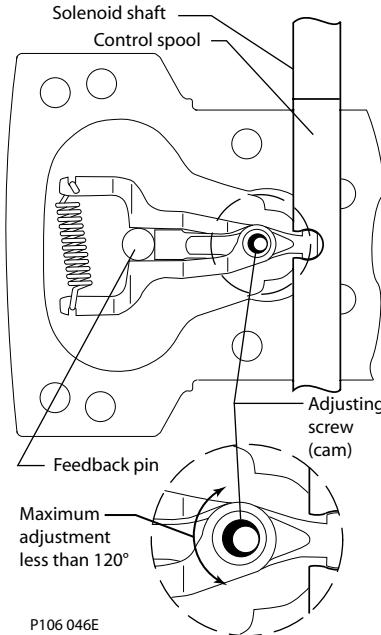


Illustration shows how eccentric cam on adjusting screw rotates to adjust neutral.

### Mechanical neutral adjustment

#### ⚠ **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.**

Mechanical neutral is set with the pump running at 1800 min<sup>-1</sup>(rpm). To set neutral, you must stroke the pump in each direction. You can do this with a small movement of the eccentric screw on EDC controls, however non-feedback controls (NFPE/FNR) lack this mechanism. To stroke a pump with non-feedback control, you must provide a 100 Hz PWM signal to the control solenoids. If you perform this adjustment with the pump installed in a vehicle or machine, safely elevate the wheels or disconnect the mechanism to allow safe operation during adjustment.

This procedure details setting neutral for the entire pump, one side at a time. The procedure is the same for each side of each pump so you will need to repeat it four times to set mechanical neutral for both the front and rear sections. Alternate M4/M5 and MA/MB to zero out forward and reverse directions of the front unit, then move the gauges to M4/M5 of the rear unit and MC/MD (system gauge ports for the rear unit). Refer to the drawing on the next page to identify all ports. The front and rear sections are basically mirror images of each other. The control solenoids C1 and C2 are marked on each control.

While performing this adjustment, you monitor the following pressures.:

- Servo pressure at M4 and M5
- System pressure at MA and MB or MC and MD
- Pressure differential between M4 and M5 (optional)
- Pressure differential between A and B or C and D (optional)

Refer to [Pressure measurements](#) on page 26 and the illustration on the next page for gauge port locations and information.

## Adjustments

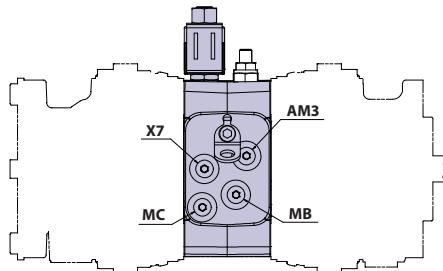
### Pump setup

1. Attach a 50 bar [1000 psi] gauge to each servo pressure port M4 and M5.
2. Attach a 600 bar [10 000 psi] gauge to each system pressure port (MA and MB for front pump, MC and MD for rear pump).
3. Remove servo cylinder locking screws (E350) and plates (E300) from both sides of the pump.
4. Disconnect the control solenoids from the vehicle wiring harness.
5. If using a PWM signal to set mechanical neutral, connect the control solenoids C1 and C2 to the signal source. Ensure the source supplies no current to the solenoids until required in the following procedure.

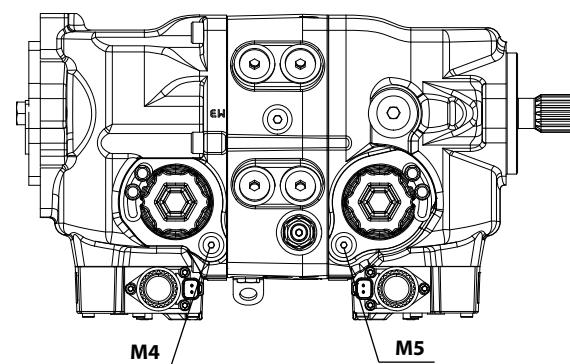
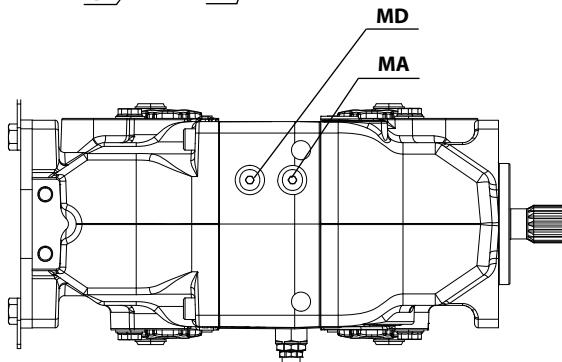
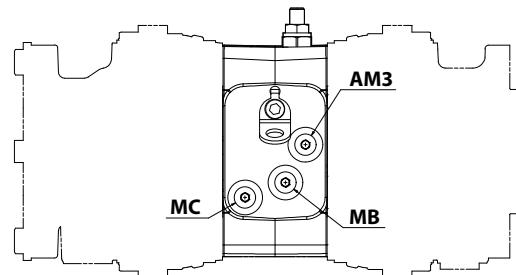
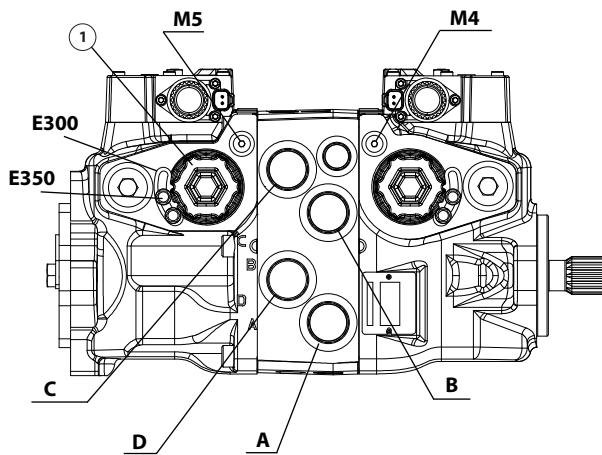
## Adjustments

## Servo adjustment

Servo and system pressure gauge port locations (45/53)



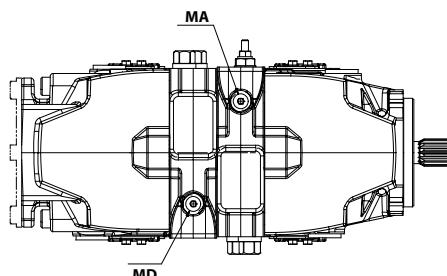
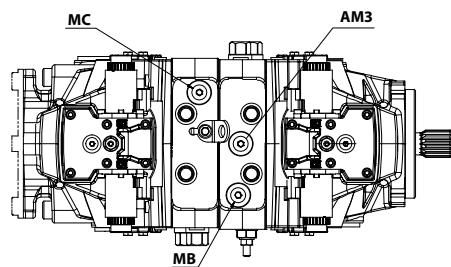
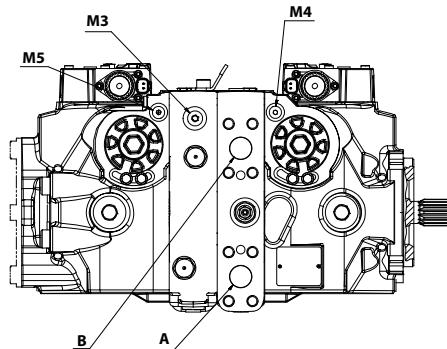
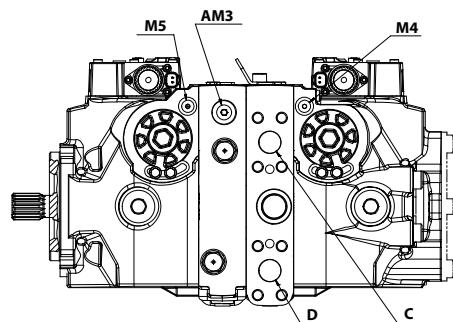
Control Cutoff (CCO)



P109257

## Adjustments

*Servo and system pressure gauge port locations (60/68)*



P109555

Item	Description	Port
1	Servo Cylinder	-
M3, AM3	Charge port	ISO 11926-1 9/16-18
A, B, C, D	System port	ISO 11926-1 1-5/16-12 (045/053) Split flange M12 x 1.5 (060/068)
X7 (045/053)	Brake gauge port	ISO 11926-1 9/16-18
X7 (060/068)	Brake gauge port	ISO 11926-1 3/4-16
MA, MB, MC, MD	System gauge port	ISO 11926-1 9/16-18
M4, M5	Servo gauge port	ISO 11926-1 7/16-20
E300	Servo cylinder clamp	-
E350	Servo cylinder clamp bolt	-

1. Run prime mover at 1800 min<sup>-1</sup>(rpm).
2. If using a PWM signal, ensure the signal is off. Check the servo pressure gauges. Ensure the differential between M4 and M5 is less than 2.5 bar [36 psi].
3. Using a 3/4 in deep socket, unthread both servo cylinders 2-3 turns. This step ensures the servo cylinders have no contact with the servo piston.
4. Stroke the pump by turning the control eccentric screw (or supplying current to solenoid C1) until the servo pressure at port M4 is 1 to 2 bar [14– 29 psi] greater than at port M5 and the system pressure gauges indicate displacement. Pressure should be greater at port MA for clockwise rotation, or MB for counterclockwise rotation. This also indicates the servo piston is in contact with the servo cylinder on side M5.

## Adjustments

5. Maintain servo pressure differential between 1-2 bar [14-29 psi] during this step. Slowly thread the servo cylinder on the M5 side in until the system pressure differential starts to decrease. Continue turning the servo cylinder in until the system delta pressure results in no machine movement.

**System delta pressure (ports MA to MB or MC to MD) between 3-4 bar typically does not cause machine movement. If service of a pump is not performed on the machine, validation of machine movement must be checked upon machine start up.**

---

6. To complete setting neutral, repeat steps 1-5 but stroke the pump in the opposite direction by turning the eccentric screw in the opposite direction, or by supplying current to solenoid C2. Reverse gauge locations (M4 for M5, MB for MA etc.) from those stated above since the pump is now stroking the other direction.
7. Set neutral for the rear pump by repeating steps 1-6 on the rear pump. Remember that the rear pump is a mirror image of the front pump and therefore the locations of the servo gauge ports (M4/M5) and the control solenoids (C1/C2) are opposite.
8. Remove all gauges and replace gauge port plugs. You can find wrench sizes and plug torques in [Plug size and torque chart](#) on page 63

## Minor repair

### Standard procedures, removing the pump

Before working on the pump, thoroughly clean the outside. If the pump has an auxiliary pump attached, remove both pumps as a single unit. Tag and cap all hydraulic lines as you disconnect them, and plug all open ports to ensure that dirt and contamination do not get into the system.

#### Caution

Contamination can damage internal components and void the manufacturer's warranty. Take precautions to ensure system cleanliness when removing and installing system lines.

#### Removal

1. With the prime mover off, thoroughly clean all dirt and grime from the outside of the pump.
2. Tag, disconnect, and cap each hydraulic line connected to the pump. As hydraulic lines are disconnected, plug each open port, to ensure that dirt and contamination do not get into the pump.
3. Remove the pump and its auxiliary pump (if applicable) as a single unit.

Be careful, do not damage solenoids and electrical connections when using straps or chains to support the pump.

#### Inspection

1. Ensure the work surface and surrounding area are clean and free of contaminants such as dirt and grime.
2. Inspect the system for contamination.
3. Look at the hydraulic fluid for signs of system contamination, oil discoloration, foam in the oil, sludge, or metal particles.

#### Replacement

1. Before replacing the pump, replace all filters and drain the hydraulic system. Flush the system lines and fill the reservoir with the correct, filtered hydraulic fluid.
2. Fill the pump with clean, filtered hydraulic fluid.
3. Attach the pump to the prime mover. Torque mounting screws according to the manufacturers recommendation.
4. Replace all hydraulic lines. Ensure the charge inlet line is filled with fluid.

## Electric control module

#### Removal

Refer to the exploded diagram.

1. Using a 5 mm internal hex wrench, remove the six cap screws (D250).
2. Remove the control module and gasket (D150). Discard the gasket.
3. If necessary, remove orifices (F100) using a 3 mm internal hex wrench. Tag and number them for reinstallation.

#### Inspection

Inspect the machined surfaces on the control and top of the pump. If you find any nicks or scratches, replace the component.

#### Reassembly

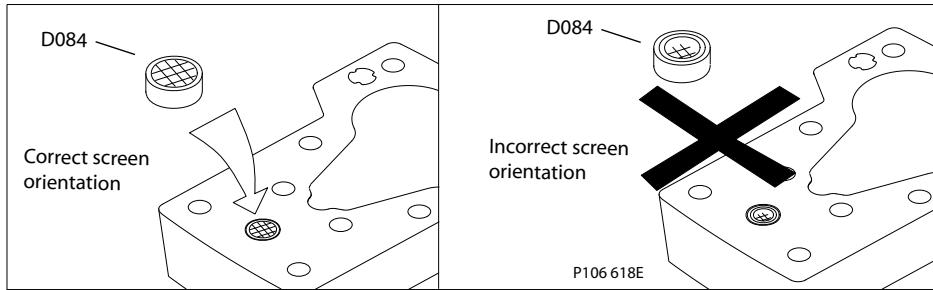
Ensure you install dowel pins (D300) in housing before installing control.

## Minor repair

Remove plug on top of control to ensure the swashplate feedback pin is properly positioned in the center of the control module when installing control.

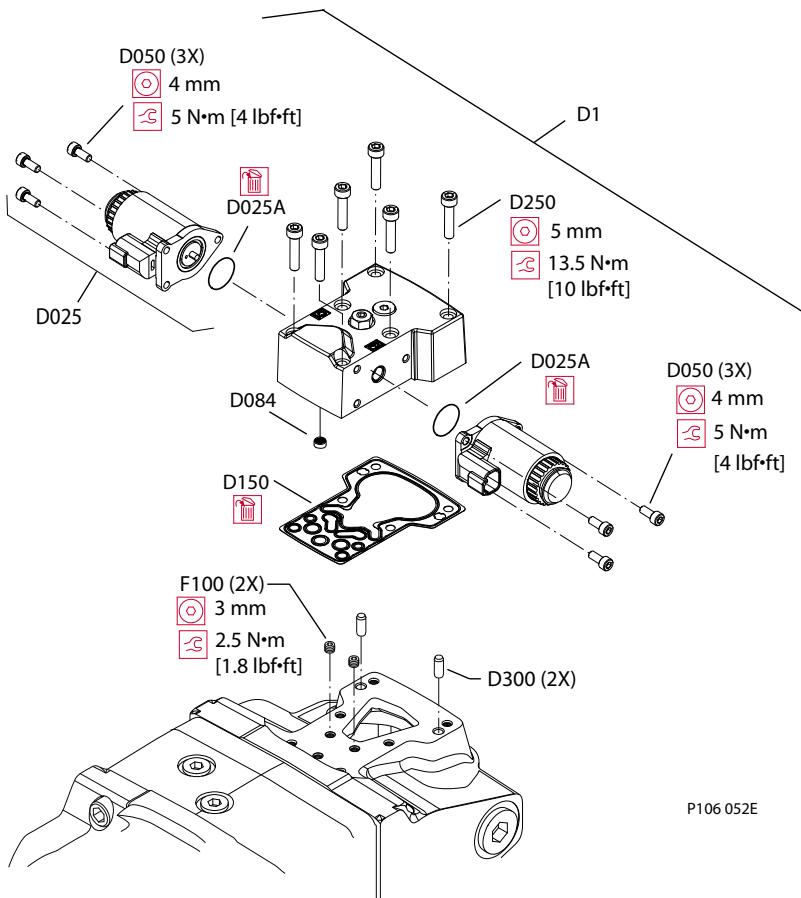
1. Install a new gasket (D150).
2. If you removed screen (D084), install a new one. Install with the mesh facing outward (see drawing).

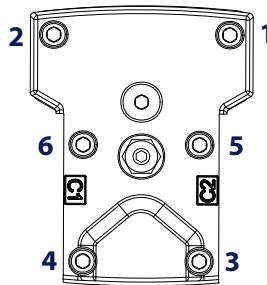
*Proper screen orientation*



3. If previously removed, install orifices (F100) using a 3 mm internal hex wrench. Torque to 2.5 N·m [1.8 lbf·ft].
4. Install the control module and six cap screws (D250).
5. Using a 5 mm internal hex wrench, torque the cap screws (D250) to 13.5 N·m [10 lbf·ft].

*Control module and solenoid removal/installation*



**Minor repair***Torque sequence***Control solenoids****Removal**

1. Disconnect electrical connection and remove the three cap screws (D050) using a 4 mm internal hex wrench.
2. Remove the solenoid (D025) and O-ring (D025A). Discard the O-ring.
3. If necessary, remove the coil using a 12 point 26 mm socket.

**Inspection**

Inspect the machined surface on the control. If you find any nicks or scratches, replace the component.

**Reassembly**

1. Lubricate new O-ring (D025A) using petroleum jelly and install.
2. Install solenoid with three cap screws (D050) using a 4 mm internal hex wrench. Torque screws to 5 N·m [4 lbf·ft].
3. Install coil using a 12 point 27 mm socket. Torque coil nut to 5 N·m [3.7 lbf·ft].
4. Reconnect electrical connections and test the pump for proper operation.

**MDC Control****Removal**

Refer to exploded diagram, below.

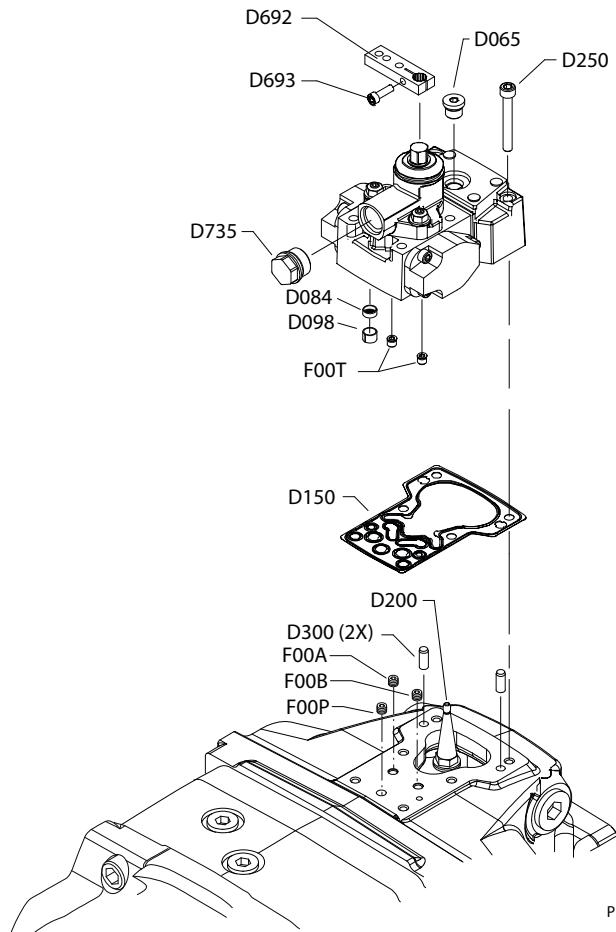
1. Using a 5 mm internal hex wrench, remove the six cap screws (D250).
2. Remove the control module and gasket (D150). Discard the gasket.
3. If necessary, remove servo orifices (F00A, F00B), supply orifice (F00P), and tank orifices (F00T) using a 3 mm internal hex wrench. Tag and number them for reinstallation.
4. If screen (D084) is clogged, use a hook to remove the retaining ring (D098) and the screen. Discard the screen and replace with a new screen.
5. Before removing the control, note the position of the control lever for reassembly.

**!** **Caution**

**Do not disassemble the control, otherwise the functionality of the control and the neutral position of the pump can be lost!**

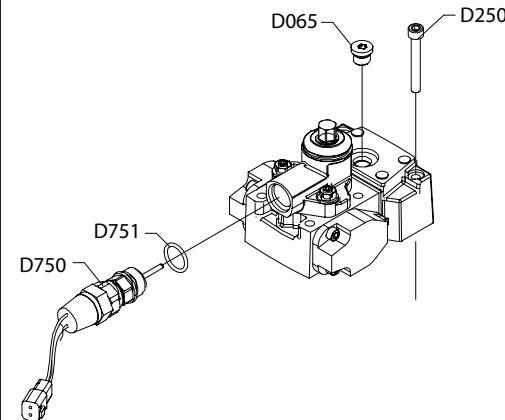
## Minor repair

## MDC illustration - tandems



P108792

## MDC with neutral start switch



## MDC Legend - tandems

## Wrench size and torque

Item	Description	Wrench size	Torque
D065	O-ring plug	3/16 internal hex	12 N·m [9 lbf·ft]
D084	screen	-	-
D098	ring	-	-
D200	feedback pin	13 mm deep well socket	22.5-27.5 Nm [16.6-20.3 lbf·ft]
D250	cap screw	5 mm internal hex	13.3 Nm [9.8 lbf·ft]
D750	neutral start switch	-	-
D751	Oring	-	-
D735	plug	3/4 inch	30 Nm [22 lbf·ft]
F00A	servo orifice	3 mm internal hex	2.5 Nm [1.8 lbf·ft]
F00B	servo orifice	3 mm internal hex	2.5 Nm [1.8 lbf·ft]
F00P	supply orifice	3 mm internal hex	2.5 Nm [1.8 lbf·ft]
F00T	tank orifice	3 mm internal hex	2.5 Nm [1.8 lbf·ft]

**Minor repair****Inspection**

Inspect the machined surfaces on the control and top of the pump. If you find any nicks or scratches, replace the component.

**Reassembly**

Ensure you install dowel pins (D300) in the housing before installing the control.

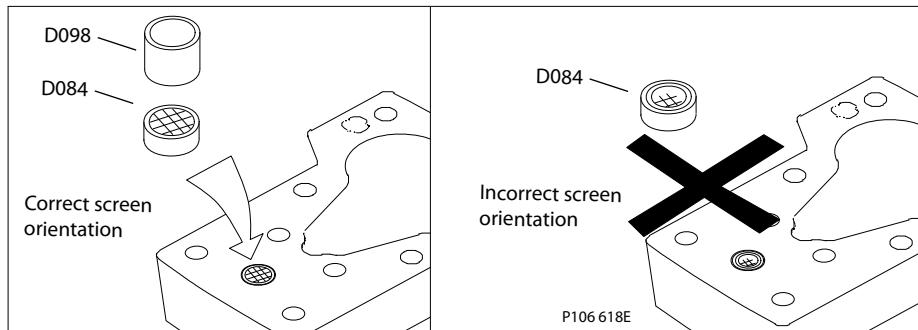
1. Install a new gasket (D150).
2. Install dowel pins (D300) in the housing.

 **Warning**

If the feedback pin comes off during operation, the pump will lose controllability causing a potentially hazardous situation. Insure feedback pin is properly torqued before continuing with reassembly.

3. If you removed screen (D084), install a new one. Install it with the mesh facing outward (see drawing). Install retaining ring (D098).

*MDC - Proper screen orientation*

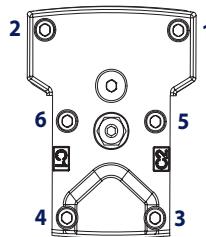


4. If previously removed, install orifices using a 3 mm internal hex wrench. Torque to 2.5 Nm [1.8 lbf ft].

Remove the plug on top of the control to ensure the swashplate feedback pin is properly positioned in the center of the control module when installing control.

5. Install the control module and six cap screws (D250).

*Torque sequence*



6. Using a 5 mm internal hex wrench, torque the cap screws (D250) to 13.3 Nm [9.8 lbf ft].

**Front Shaft, seal, and bearing**

The front pump input shaft assembly is serviceable without disassembling the pump, the rear shaft is not. Orient the pump on the work surface so the shaft is pointing to the side.

## Minor repair

## Removal

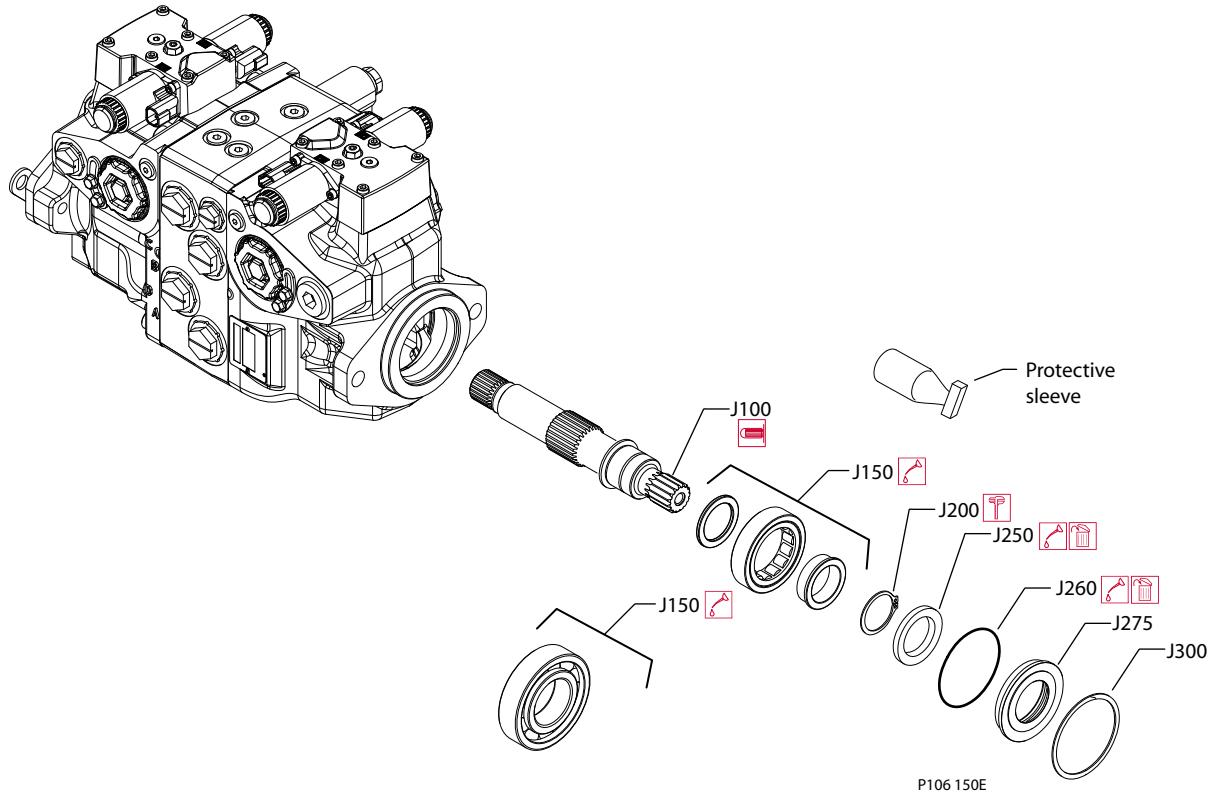
1. Remove the retaining ring (J300) from the housing to release the shaft/seal/bearing subassembly.
2. Pry on the lip of the seal carrier (J275) to remove it from the pump. Remove the seal carrier. Remove and discard O-ring (J260). Press the seal (J250) out of the carrier and discard.
3. Pull the shaft (J100) with bearing (J150) out of the pump. If necessary, tap lightly on the shaft to dislodge it from the cylinder block.

! **Caution**

**Do not damage the housing bore, shaft or bearing when removing the shaft and bearing.**

4. Remove the retaining ring (J200) using retaining ring pliers. Press the bearing off the shaft.

Shaft assembly (45/53 shown)



## Inspection

Inspect the shaft journals for wear, scratching, and pits. Check the splines for fretting; replace if damaged. Rotate the bearing, if it does not rotate smoothly, replace it.

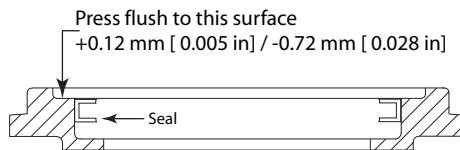
## Reassembly

1. Press the bearing (J150) onto the shaft (J100) and replace the retaining ring (J200). Ensure the retaining ring diameter is less than 38.84 mm [1.53 in] when installed on the shaft.
2. Install the shaft/bearing assembly into the pump.

## Minor repair

3. Lubricate and install a new O-ring (J260) onto seal carrier (J275). Press a new seal (J250) into the seal carrier. Press the seal until it is flush within +0.12mm [0.005 in] or -0.72 mm [0.0028 in] of the inside lip of the carrier: see illustration.
4. Cover the shaft with a protective sleeve while installing the seal carrier. Hand press the seal carrier into the housing. Ensure the seal carrier clears the retaining ring groove in the housing. Remove the protective sleeve.
5. Install the retaining ring (J300). Ensure the inside diameter of the retaining ring is greater than 68mm [2.68 in] after installation.

### *Positioning seal in seal carrier*



P106 498E

## Charge Pump (045/053 only)

Position pump with front shaft pointing downward. Attach securely to a proper work stand. If an auxiliary pump is attached, remove auxiliary pump before servicing charge pump.

### Removal

1. Remove screws (K351), and hangers (K975).
2. Remove running cover (K301). Remove and discard seal ring (K250).
3. Using a 10 mm internal hex, remove screws (K400). Remove cover (K101).
4. Remove and discard seal (S300).
5. Remove geroter cover (S200).

**Note the position of the alignment pin (S500) in the housing. The alignment pin position is different for clockwise or counterclockwise rotation.**

6. Remove and disassemble charge pump assembly, [shaft (K201), pin (S500), geroter (S100), two clips (K205)].
7. Remove and discard gasket (K151). Remove alignment pins (K450).
8. If it is necessary to remove housing (K300), use a 10 mm internal hex to remove screws (K350).
9. Remove housing (K300).
10. Remove and discard seal (K150).

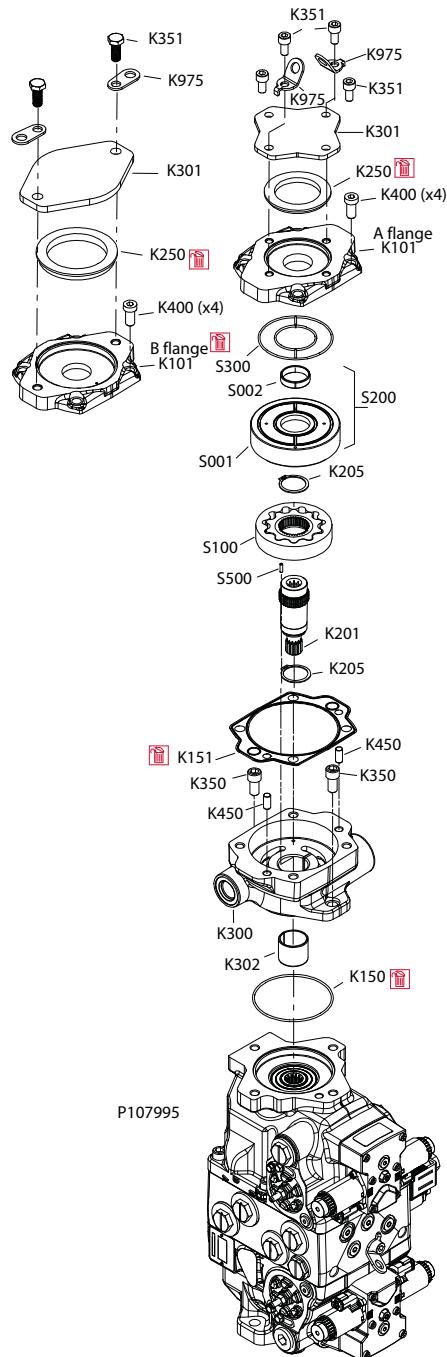
### Inspection

1. Inspect all machined surfaces. If you find any nicks or scratches, replace the component.
2. Inspect geroter and cover for wear or damage. If wear or damage is found, replace geroter kit.
3. Inspect shaft for wear or damage. If found, replace shaft.
4. Inspect journal bearings in aux pad and housing. If worn or damaged, replace journal bearings or aux pad or housing assembly.

**Refer to *Replacing charge pump journal bearings* on page 55 for journal installation dimensions.**

## Minor repair

Charge pump

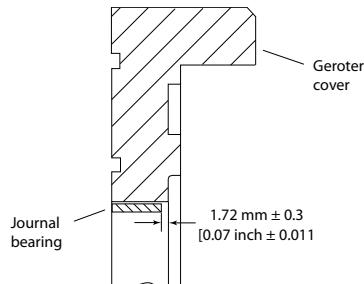


Legend

Item	Wrench size	Torque
K351 (A flange)	8 mm internal hex	64 N·m [47 lbf·ft]
K351 (B flange)	18 mm	76 N·m [56 lbf·ft]
K400	10 mm internal hex	92 N·m [68 lbf·ft]
K350	10 mm internal hex	76 N·m [56 lbf·ft]

**Minor repair****Replacing charge pump journal bearings**

Use a suitable press to remove and replace the journal bearings. Refer to the drawings below for installation dimensions.

*Replacing the journal bearings*

P107 999E

**Assembly**

1. Lubricate and install new seal (K150).
2. Install housing (K300). Install screws (K350). Using a 10 mm internal hex, torque screws per listing in table.
3. Install alignment pins (K450). Install new gasket (K151).
4. Lubricate and reassemble the charge pump assembly, [shaft (K201), pin (S500), geroter (S100), two clips (K205)].

**Install the alignment pin (S500) in its original position. The alignment pin position is different for clockwise or counterclockwise rotation.**

5. Install the charge pump assembly into the housing.
6. Install the geroter cover (S200).
7. Lubricate and install the seal (S300).
8. Install the aux pad (K101).
9. Using a 10 mm internal hex, install screws (K400). Torque screws per listing in table.
10. Lubricate and install seal (K250). Install running cover (K301).
11. Install screws (K351) and brackets (K975). Torque screws per listing in the table.

**Charge check / HPRV (45/53)**

The high pressure relief and charge check valve assembly may be removed for cleaning and replacement of the O-rings. These valves are factory set and are not field adjustable. Refer to the pump model code for the factory setting when ordering replacements.

**Removal**

1. Using an 8 mm internal hex wrench, remove the valve seat plugs (K007).
2. Carefully lift the valve (H002) and spring (H003) assemblies from the center section using a magnet.

**Inspection**

Inspect the valves and mating seats in the valve seat plugs (K007) for damage or foreign material.

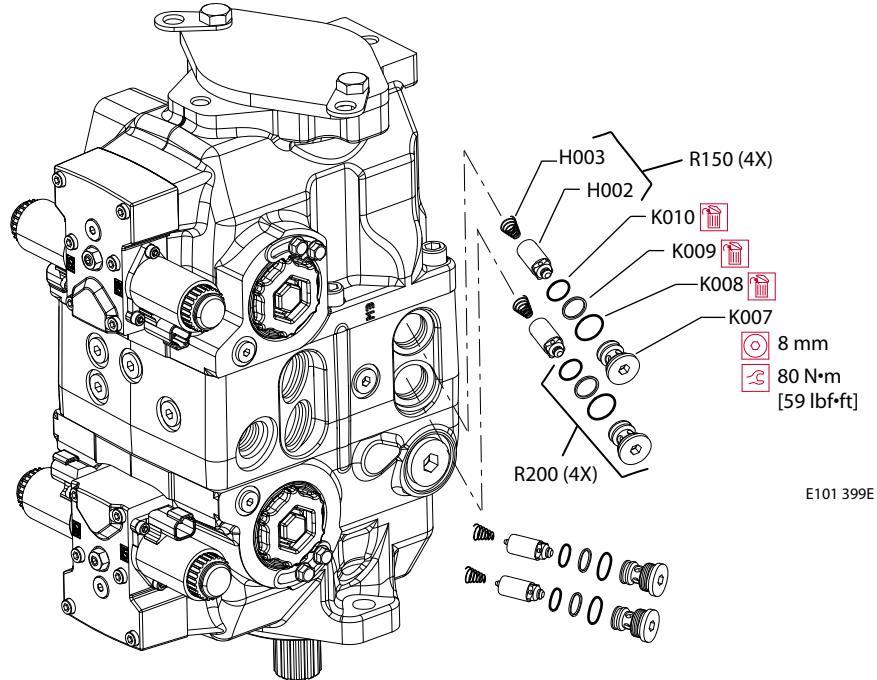
**Reassembly**

1. Lubricate and install new O-rings (K008, K010) and backup ring (K009) on valve seat plug (K007).

## Minor repair

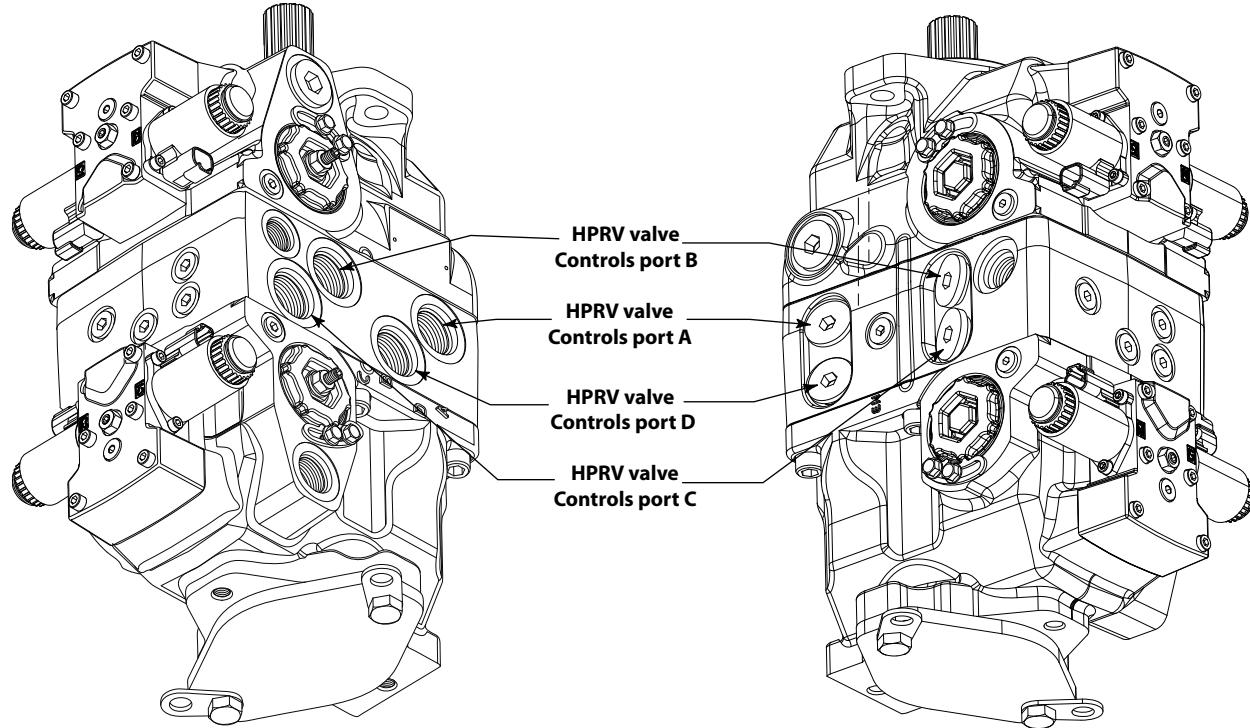
2. Verify that the conical springs (H003) are properly retained on the check relief valves (H002). Install the valve assemblies into the center section. Ensure each valve assembly moves freely in its bore.
3. Install the valve seat plugs into the center section and torque to 80 N·m [59 lbf·ft].
4. Operate vehicle/machine through full range of controls to ensure proper operation. Check for leaks.

Charge check / HPRV\*



\*Rear pump location shown. There are four valve assemblies total.

The illustration below illustrates the relationship between the HPRVs and the ports controlled by those valves.

**Minor repair***HPRV/port relationships*

P106 499E

**HPRV (60/68)**

The high pressure relief and pressure limiter valve assemblies may be removed for cleaning and replacement of the O-rings. HPRV valves are factory set and are not field adjustable. Refer to the pump model code for the factory setting of each valve when ordering replacements.

**Removal**

1. Mark the location of each valve prior to removal.
2. Using a 22mm wrench remove the HPRVs.
3. Remove and discard the Orings (L060) and backup rings (L068).

**Inspection**

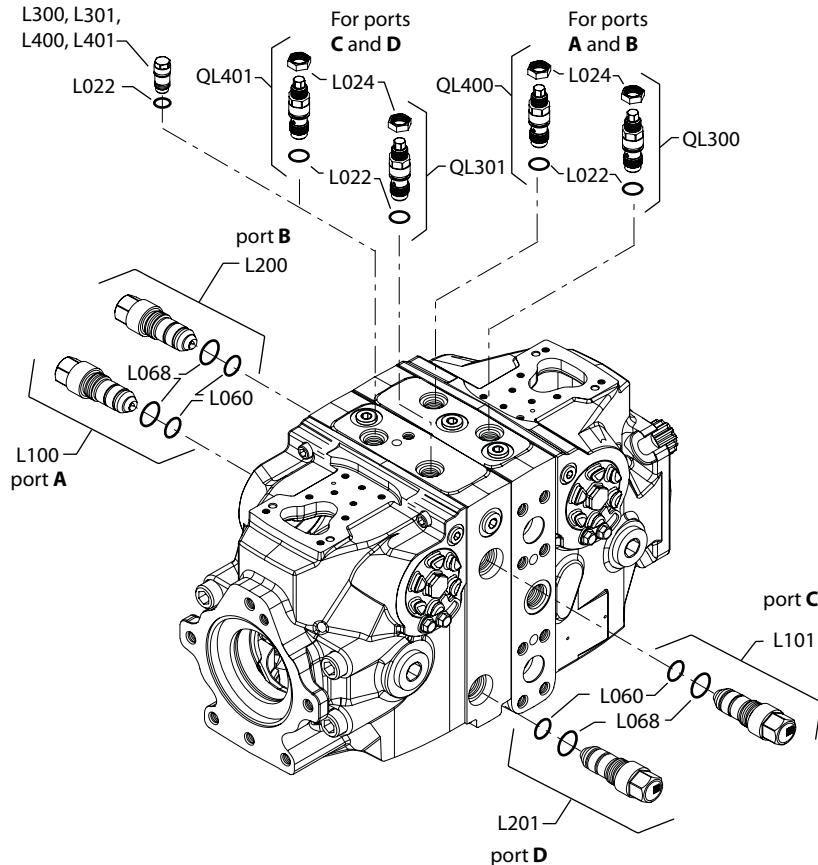
Clean oil off the sealing surfaces and inspect the sealing surfaces for nicks or scratches. Check the valves for damage. Replace any damaged components.

**Reassembly**

1. Lubricate and install new backup rings (L068) and O-rings (L060).
2. Install HPRV and pressure limiter valves in their original locations.

## Minor repair

3. Operate the vehicle/machine through its full range of control to ensure proper operation. Check for leaks.



P109251

Item	Description	Wrench size	Torque
L300, L301 L400, L401	Pressure limiter plug assembly	14 mm	30 N·m [22 lbf·ft]
QL300, 301, 400, 401	Pressure limiter valve assembly	17 mm	30 N·m [22 lbf·ft]
L100, L101, L200, L201	High Pressure Relief Valve	22 mm	70Nm [51.6 lbf·ft]

## Charge pressure relief valve

Replace the charge pressure relief valve (V10-1) or (V10-2) as a complete unit. Do not attempt to repair the internal components of the valve. See [Charge pressure relief valve adjustment](#) on page 32 for adjustment instructions.

## Minor repair

### Removal

Using a 27 mm (V10-1) or a 1 in (V10-2) wrench, remove the charge pressure relief valve. Discard the O-rings (V10A).

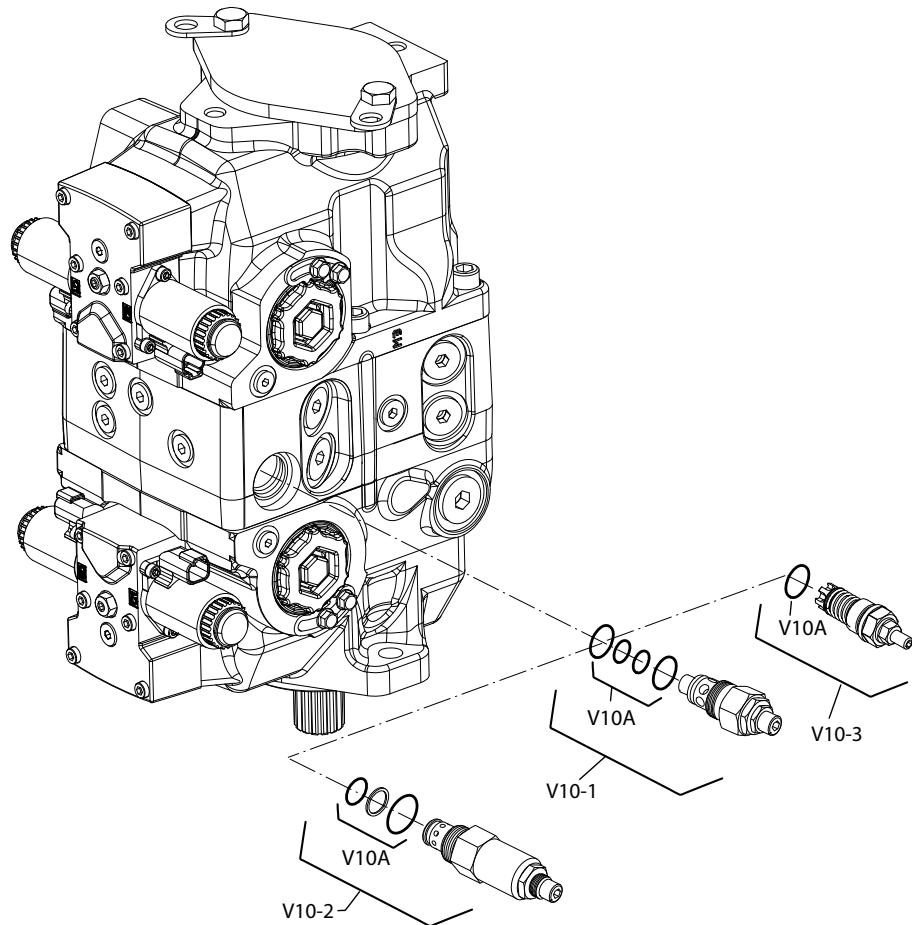
### Inspection

Inspect the sealing surfaces of the pump and charge pressure relief valve for nicks or scratches, replace components as necessary.

### Reassembly

1. Lubricate and install new O-rings (V10A).
2. Install the charge pressure relief valve (V10). Torque to 52 Nm [38 lbf·ft].
3. Operate vehicle/machine through full range of controls to ensure proper operation.

#### Charge pressure relief valve



P109568

## Minor repair

### *Legend*

Item	Wrench size	Torque
V10-1	27 mm	52 Nm [38 lb·ft]
V10-2	1 Inch	52 Nm [38 lb·ft]
V10-3	27 mm	52 Nm [38 lb·ft]

### Control cutoff valve and brake valve

Replace the control cutoff valve as a complete unit. Do not attempt to repair the internal components of the valve.

#### Removal

1. Disconnect the coil from the vehicle/machine wire harness.
2. Using a 24 mm hex wrench, remove the control cutoff valve coil nut (G30). Remove the coil (G20).
3. Use a 1 1/16 in hex wrench to remove the control cutoff valve (G10). Remove and discard the O-rings and backup rings (G10A).

#### Inspection

Inspect the sealing surfaces of the pump and control valve for nicks or scratches. Replace components as necessary.

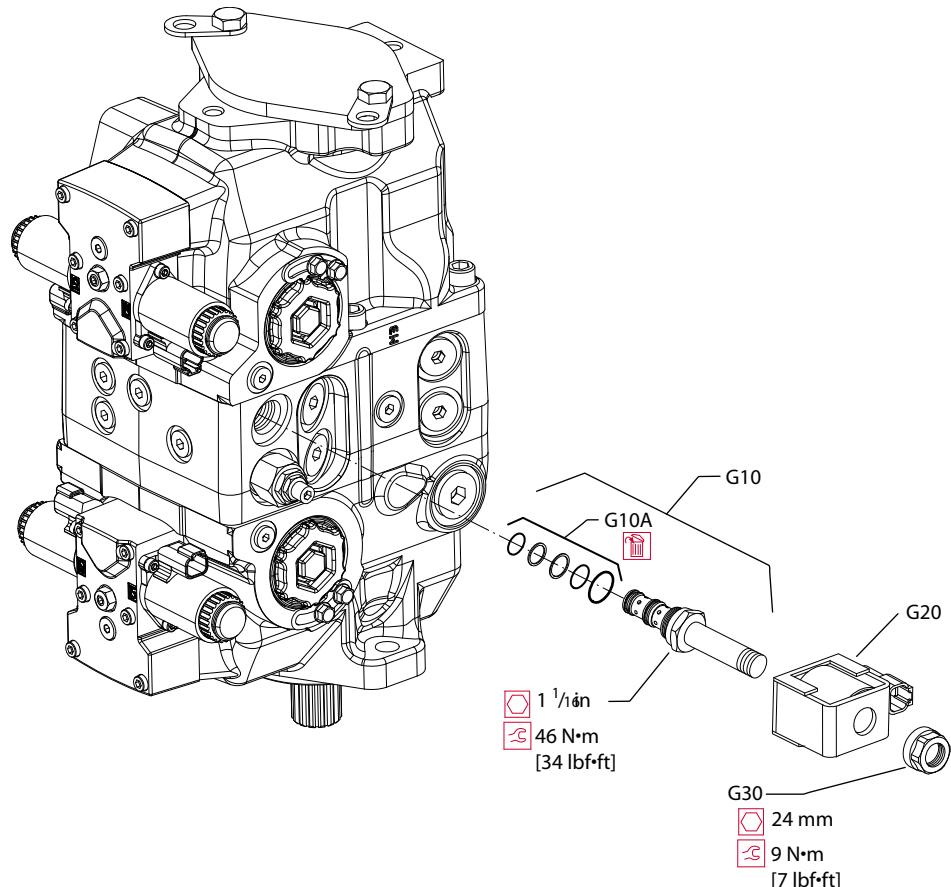
#### Reassembly

1. Lubricate and install new O-rings (G10A) onto the valve.
2. Install the control valve (G10). Torque to 46 N·m [34 lbf·ft]. Slide the coil (G20) onto the valve.
3. Install the coil nut (G30). Torque to 9 N·m [7 lbf·ft]. Do not overtorque.

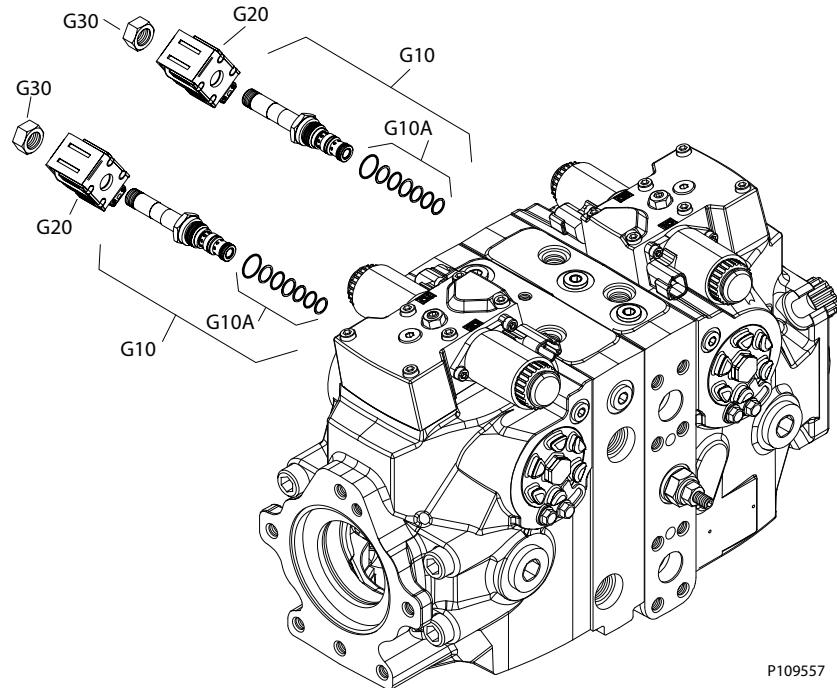
## Minor repair

4. Operate vehicle/machine through full range of controls to ensure proper operation

*Control cutoff valve (045/053)*



E101 401E

**Minor repair***Control cutoff valve (060/068)*

**Torque chart****Fastener size and torque chart**

Item	Fastener	Wrench size	Torque
D015	Neutral adjust screw	4 mm internal hex	NA
D050	Control coil mounting screw	4 mm internal hex	8 N·m [5.9 lbf·ft]
D060	Neutral adjust locking nut	13 mm hex	10 N·m [7 lbf·ft]
D200	Swash plate feedback pin (not shown)	13 mm hex	25 N·m [18.4 lbf·ft]
D250	Electric control mounting screw	5 mm internal hex	13 N·m [9.5 lbf·ft]
E350	Servo cylinder locking screw	10 mm hex	14.5 N·m [11 lbf·ft]
G10	Control cutoff valve	1 1/16 in hex	45 N·m [33 lbf·ft]
G10B	Control cutoff valve coil nut	24 mm hex	10 N·m [7.5 lbf·ft]
K007	Charge check / HPRV	8 mm internal hex	80 N·m [60 lbf·ft]
K350	A pad cover mounting screw	17 mm hex	64 N·m [47 lbf·ft]
	B pad cover mounting screw	18 mm hex	76 N·m [56 lbf·ft]
L010	Pressure limiter adjust screw	8 mm internal hex	NA
L300/L400/ L101/L201	Pressure limiter cartridge	14 mm hex	30 N·m [22 lbf·ft]
L024	Pressure limiter locking nut	14 mm hex	20 N·m [15 lbf·ft]
L100/L200/ L101/L201	High pressure relief valve	22 mm hex	70 N·m [52 lbf·ft]
V10-1	Charge relief valve	27 mm hex	52 N·m [38 lbf·ft]
V10-2	Charge relief valve	1 in hex	52 N·m [38 lbf·ft]
V10-3	Charge relief valve	24 mm hex	52 N·m [38 lbf·ft]
V020	Charge pressure adjusting screw	6 mm internal hex	NA
V022	Charge pressure locking nut	19 mm hex	40 N·m [30 lbf·ft]

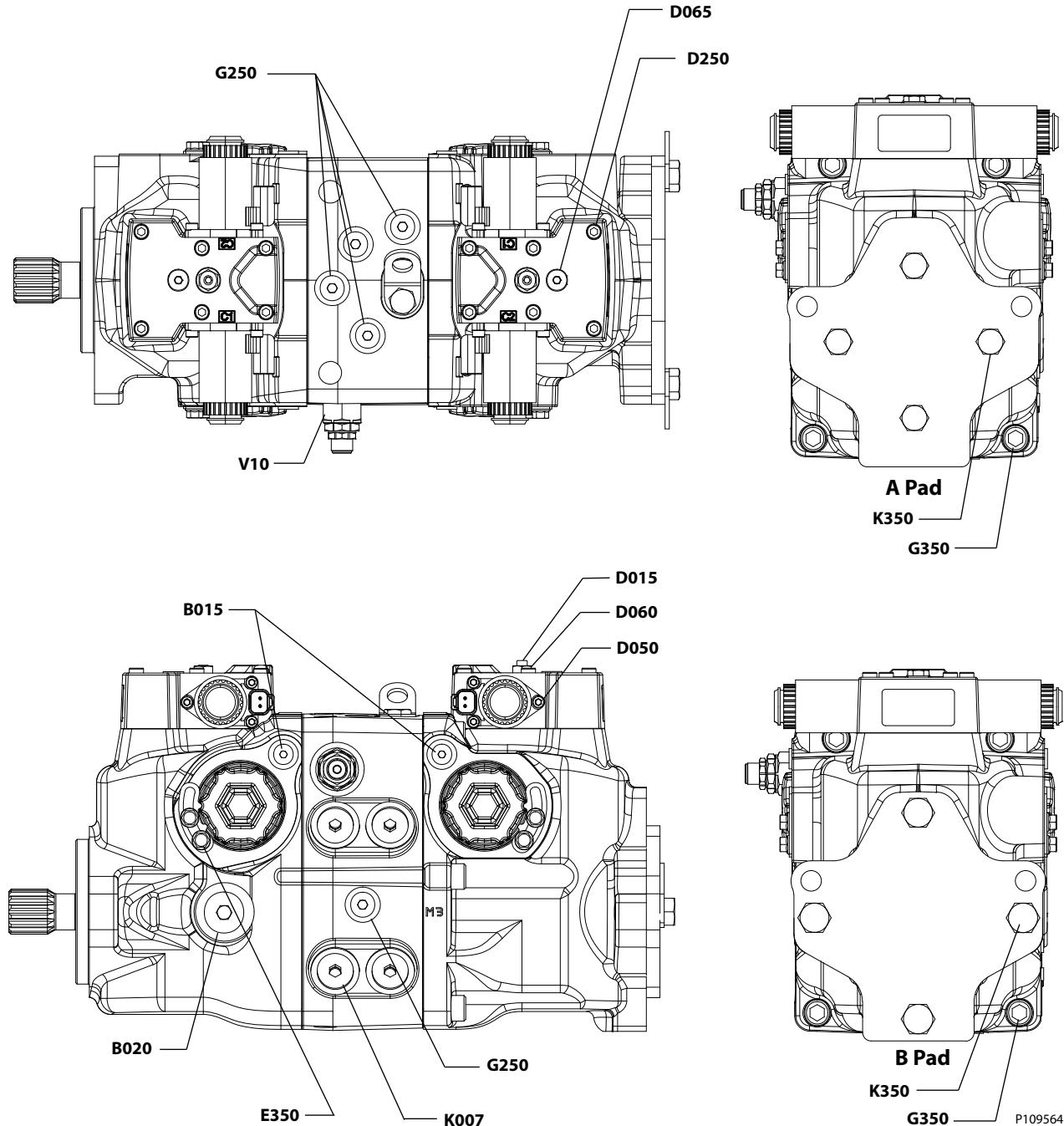
**Plug size and torque chart**

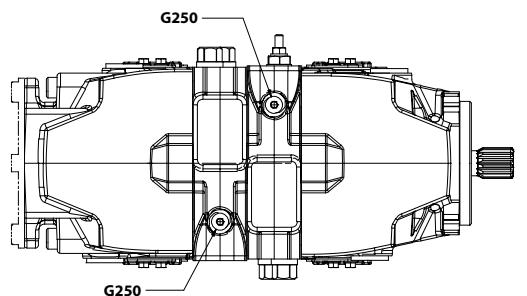
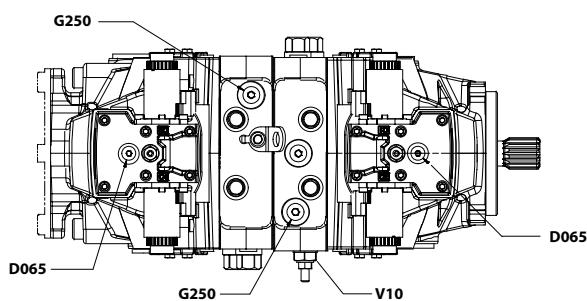
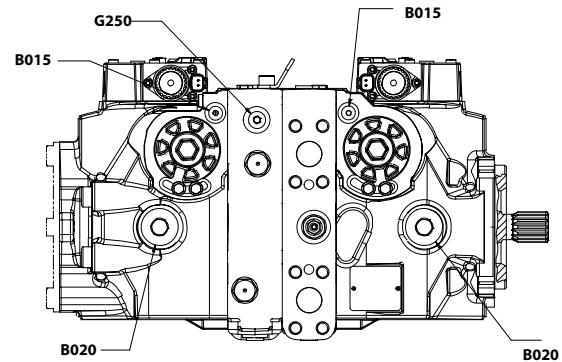
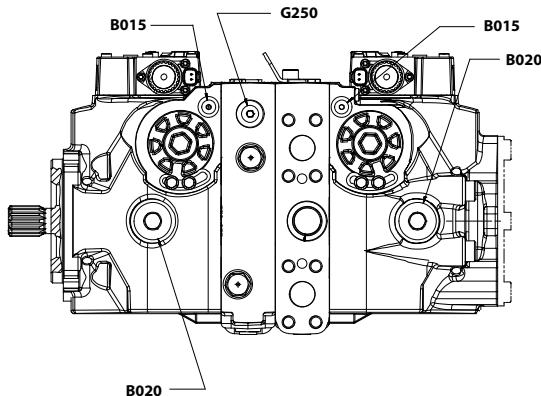
Item	O-ring plug	Wrench size	Torque
B015	7/16 - 20	3/16 internal hex	20 N·m [15 lbf·ft]
B020 (45/53)	1-1/16 - 12	9/16 internal hex	48 N·m [35 lbf·ft]
B020 (60/68)	1-3/8 - 12	5/8 internal hex	148 N·m [109 lbf·ft]
D065	7/16 - 20	3/16 internal hex	12 N·m [9 lbf·ft]
G250	9/16 - 18	1/4 internal hex (hardened plug)	45 N·m [33 lbf·ft]

## Torque chart

## Fasteners and plugs

Fastener and plug locations (045/053)



**Torque chart***Fastener and plug locations (060/068)*





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