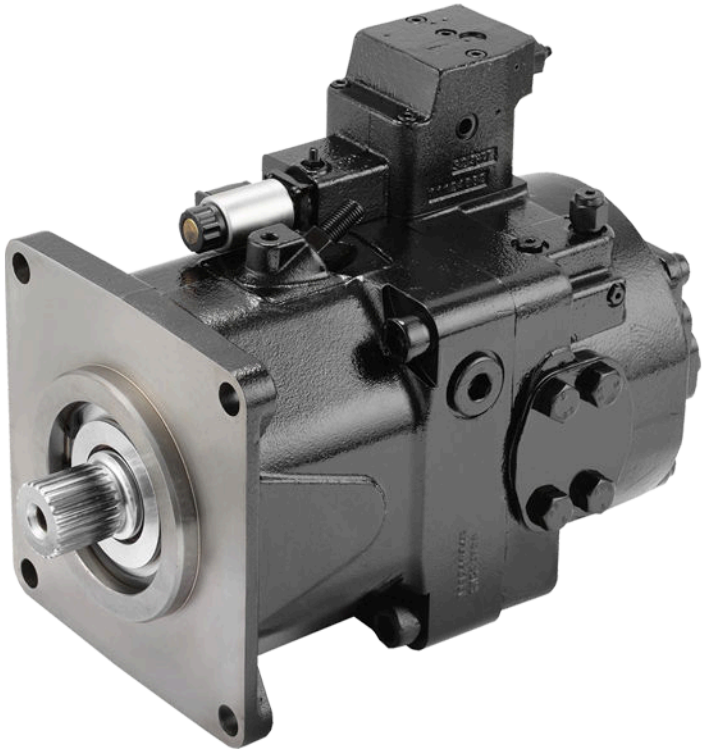
ENGINEERING
TOMORROW

Service Manual

D1 High Power Open Circuit Pumps
Size 130/145/193/260



Revision history

Table of revisions

Date	Changed	Rev
October 2017	Added Size 130	0103
June 2016	Added Size 260	0102
April 2016	Converted to Danfoss layout - DITA CMS	0101
July 2015	Added 145 cc information	AB
January 2014	First edition	AA

Contents

Contents

Introduction

Overview

This manual includes information for the installation, maintenance, and minor repair of the D1 pumps. It includes a description of the unit and its individual components, troubleshooting information, and minor repair procedures.

Performing minor repairs may require removal 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 Authorized Service Centers (ASCs) is available for major repairs. Major repairs require the removal of the unit's endcap, which voids the warranty unless done by an ASC.Danfoss ASCs are trained by the factory and certified on a regular basis. You can locate your nearest ASC using the distributor locator at **www.powersolutions.danfoss.com**

General Instructions

Follow these general procedures when repairing D1 variable displacement open circuit pump.

Remove the Unit

Prior to performing repairs, 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 during service. Lightly lubricate O-rings with clean petroleum jelly prior to assembly.

Secure the Unit

For repair, 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.

Hazardous Material

Warning

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

Introduction

Symbols used in Danfoss literature


WARNING may result in injury


CAUTION may result in damage to product or property


Reusable part


Non-reusable part, use a new part


Non-removable item


Option - either part may exist


Superseded - parts are not interchangeable


Measurement required


Flatness specification


Parallelism specification


External hex head


Internal hex head


Torx head


O-ring boss port


Tip, helpful suggestion


Lubricate with hydraulic fluid


Apply grease / petroleum jelly


Apply locking compound


Inspect for wear or damage


Clean area or part


Be careful not to scratch or damage


Note correct orientation


Mark orientation for reinstallation


Torque specification


Press in - press fit


Pull out with tool – press fit


Cover splines with installation sleeve


Pressure measurement/gauge location or specification

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

Introduction

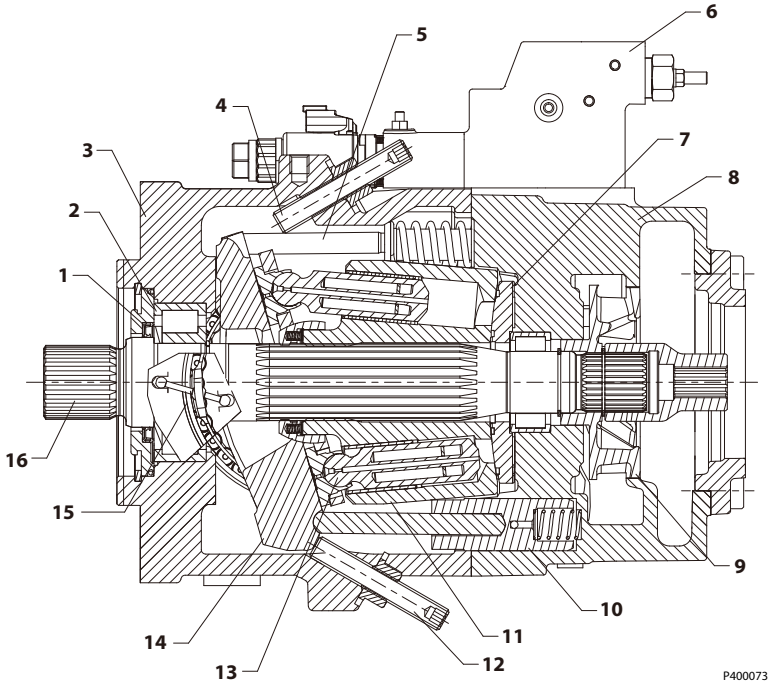
Design

Danfoss D1 high power open circuit piston pumps convert input torque into hydraulic power. Rotational force is transmitted through the input shaft to the cylinder block. The input shaft is supported by roller bearings at the front and rear of the pump and is splined into the 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 slippers are held to the swashplate by the retainer. The block spring holds the cylinder block to the valve plate. The reciprocating movement of the pistons occurs as the slippers slide against the inclined swashplate during rotation. Via the valve plate, one half of the cylinder block is connected to pump inlet and the other half to pump outlet. As each piston cycles in and out of its bore, fluid is drawn from the inlet and displaced to the outlet thereby imparting power into the system circuit. A small amount of fluid is allowed to "leak" from the cylinder block / valve plate and slipper / swashplate interfaces for lubrication and cooling. Case drain ports are provided to return this fluid to the reservoir.

The volume of fluid displaced into the system circuit is controlled by the angle of the swashplate. The swashplate is forced into an inclined position (into stroke) by the bias piston and spring. The servo piston opposes the action of the bias piston and spring forcing the swashplate out of stroke.

The pump control, by varying the pressure at the servo piston, controls the displacement of fluid in the system circuit.

*Series D1 Pump Cross-Section View**

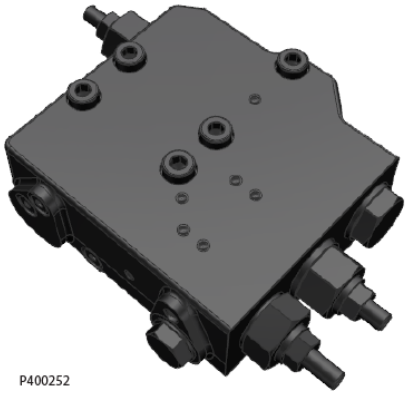


1. Shaft Seal
2. Roller Bearing
3. Housing
4. Minimum Displacement Limiter
5. Bias Piston
6. Control
7. Valve Plate
8. Endcap
9. Charge Pump
10. Servo Piston
11. Cylinder Block
12. Maximum Displacement Limite
13. Piston
14. Swashplate
15. Swashplate Bearing
16. Input Shaft

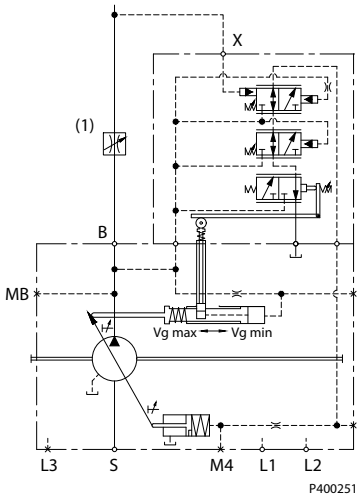
*Some internal parts may be different depend on different pump size.

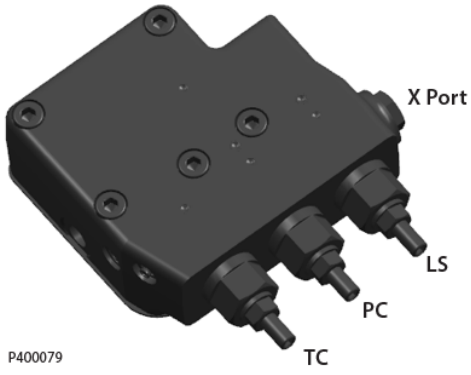
Operation

TPSN (Power Control + Pressure Compensated Control + Load Sensing Control)



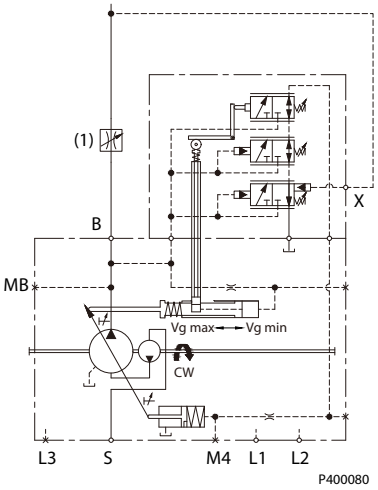
D1P 130/145+TPSN



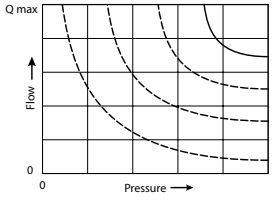


D1P193/260+TPSN

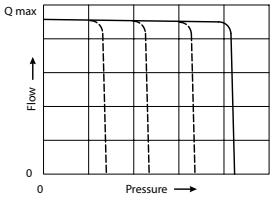
*Control oil filter is optional



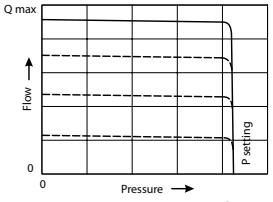
T Characteristic



P Characteristic



S Characteristic



Operation

Power Control (T) Principle

The power control regulates the displacement of the pump depending on the working pressure so that a given drive power is not exceeded at constant drive speed, this function can prevent engine stall or protect electric generator.

$P_B \cdot V_g = C$

P_B = working pressure
V_g = displacement
C = constant

The precise control with a hyperbolic control characteristic, provides an optimum utilization of available power.

Power Control (T) Operation

The working pressure acts on a rack-pivot via a roller jack which produce a rotate torque, an externally adjustable spring force counteracts this which determines the power setting.

If the moment generated by working pressure exceeds the moment generated by spring force, the control valve is actuated by the rack-pivot, pump reduces displacement. The lever length at the rack-pivot is shortened and the working pressure can increase at the same rate as the displacement decreases without the drive powers being exceeded.

($P_B \cdot V_g = C$).

The hydraulic output power (characteristic T) is influenced by the efficiency of the pump.

Pressure Compensated Control (P) Principle

The P control design maintains a constant pressure in the hydraulic circuit as flow varies. The P control modulates pump flow accordingly to maintain system pressure at the P setting as the P adjusting screw and spring defines.

Pressure Compensated Control (P) Operation

When system pressure, acting on the non-spring end of the P spool ,overcomes the force of the P spring, the spool shifts porting system pressure to the servo piston and the swashplate angle decreases. When system pressure drops below the P setting, the P spring shifts the spool in the opposite direction connecting the servo piston to pump case and the swashplate angle increases. The swashplate is maintained at whatever angle is required to keep system pressure at the P setting.

Load Sensing Control (S) Principle

The S control design matches pump flow with system demand. The S control senses the flow demand of the system as a pressure drop across the external control valve (1).

As the (1) opens and closes, the pressure delta across the valve changes. When opening, the delta decreases. When closing, the delta increases. The S control then increases or decreases pump flow to the system until the pressure delta becomes equal to the S setting as defined by the S adjusting screw and spring .

Load Sensing Control (S) Operation

Through internal porting, system pressure [upstream of (1)] is applied to the non-spring end of the S spool, and through hydraulic line connected at port X, load pressure [downstream of (1)] is applied to the spring end. This arrangement allows the S spool to act on the delta between system pressure and load pressure. The S spring sets the threshold of operation (S setting).

Because the swashplate is biased to maximum angle, the pump attempts to deliver full flow to the hydraulic system. When the flow being delivered exceeds demand, the pressure delta across the (1) is

Operation

great enough to overcome spring force and shift the S spool porting system pressure to the servo piston. The pump de-strokes reducing flow until the delta across the (1) becomes equal to the S setting.

When flow being delivered is less than demand, the delta across the (1) drops below the S setting and the S spring shifts the spool connecting the servo piston to pump case. The pump strokes increasing flow until the delta across the (1) becomes equal to the S setting.

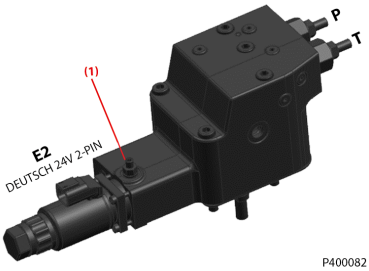
When the external control valve (1) is placed in neutral, it connects the LS signal line to drain. With no LS pressure acting on the non-spring end of the LS spool, the pump adjusts stroke to whatever position necessary to maintain system pressure at the LS setting. The pump is now in low pressure standby mode. (1) is not in the scope of supply.

TPSN Priority

The Pressure Compensated Control (P) has priority over the Power Control (T), and the Power Control (T) has priority over the Load Sensing (S).

Operation

TPE2/TPE5 (Power Control + Pressure Compensated Control + Electric Displacement Control)



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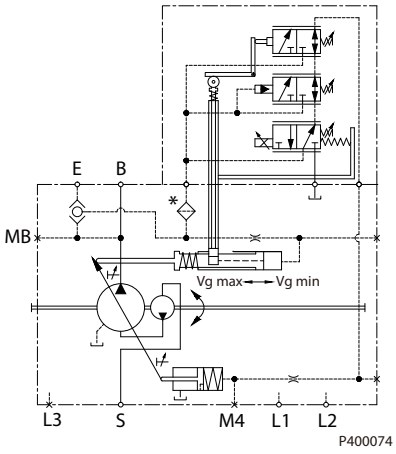
Warning

(1) Adjustment is not permissible

D1P 193/260+TPE2

*Control oil filter is optional



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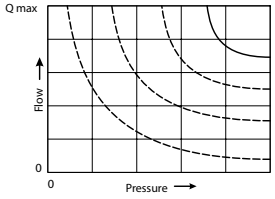
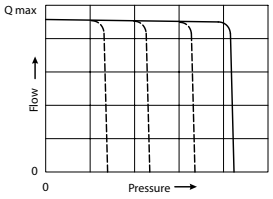
Characteristics

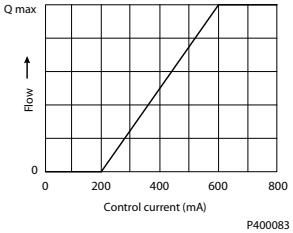
T Characteristic



P Characteristic



E2/E5 characteristics



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Displacement Principle and Operation

Power Control (T) Principle and Operation

Please refer *TPSN (Power Control + Pressure Compensated Control + Load Sensing Control)* on page 9

Pressure Compensated Control (P) Principle and Operation

Please refer *TPSN (Power Control + Pressure Compensated Control + Load Sensing Control)* on page 9

Electric Displacement Control (E2/E5) Principle

The electric displacement control uses an electric proportional solenoid valve to vary the pump's displacement from minimum displacement to maximum displacement or from maximum displacement to minimum displacement. The swashplate angle (pump displacement) is proportional to the electrical input signal (control current).

Electric Displacement Control (E2/E5) Operation

E2/E5 is current driven control requiring a Pulse Width Modulated (PWM) signal. Pulse width modulation allows more precise control of current to the solenoid. The PWM signal causes the solenoid pin to push against the E2/E5 spool, which depressurizes the end of servo piston, the swashplate angle increases under the force of bias piston .

Operation

A swashplate feedback link provides swashplate position force to the solenoid through E2/E5 spool linear spring. The control reaches equilibrium when the position of the swashplate spring feedback force exactly balances the input command solenoid force from the operator. As working pressure changes with load, the control and servo/swashplate system work constantly to maintain the commanded position of the swashplate.

Electric Displacement Control (E2/E5) Operating Instruction

To make sure the electric displacement control works properly, a minimum control pressure of 30 bar is required. The required control pressure is taken either from the working pressure, or from the externally applied control pressure at the E port.

If you can't make sure that the working pressure is above 30 bar all the time, then 30bar pressure at the E port is mandatory.

If E port is not connected , remove the shuttle valve.

MOR

The electric displacement control with Manual Over Ride (MOR) fuction for temporary actuation of the control to aid in diagnostics.

Warning

Do not actuate MOR unless the machine is in a "SAFE" mode.

Solenoid Specifications

Technical data - Solenoid

Voltage	24V (±20%)
Start current at Vg min	200 mA
End Current at Vg max	600 mA
Maximum current	770 mA
Coil resistance @ 20 °C [70 °F]	22.7 Ω
PWM Range	70~200 Hz
PWM Frequency (preferred)*	100 Hz
IP Rating (IEC 60 529) + DIN 40 050, part 9	IP 67
IP Rating (IEC 60 529) + DIN 40 050, part 9 with mating connector	IP 69K

* PWM signal required for optimum control performance

Mating connector for Solenoid

Description	Ordering Number	Quantity
Danfoss mating connector kit	K29657	1
The mating connector is not included in the delivery contents, this can be delivered by Danfoss on request.		

Below compatible PLUS+1® controllers are available:

MC012	L1301095
MC024	L1315302
MC038	11051653

Operation

Below compatible PLUS+1® controllers are available: (continued)

MC050	L1301752
MC088	11006645

For further information:

You can see *http://www.danfoss.com/Products/MobileElectronics/index.htm*

Standard EDC Valve

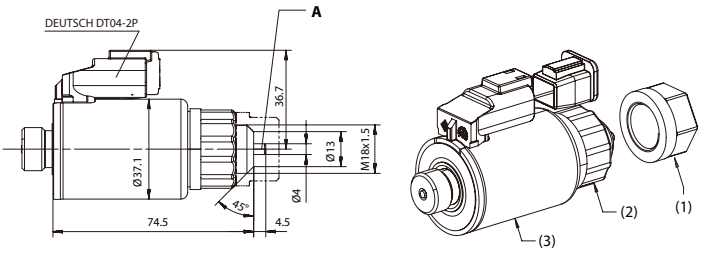
The position of the connector can be changed by turning the solenoid body. Proceed as follows:

1. Loosen protect cap (1).
2. Loosen lock nut (2).
3. Turn the solenoid body (3) to the desired position.
4. Tighten the lock nut (2).
5. Tighten the protect cap (1).

Tightening torque of lock nut: 5±1 N•m.

The Pressure Compensated Control (P) has priority over the Power Control (T), and the Power Control (T) has priority over Electric Dispalcement Control (EDC) .

Standard EDC Valve



A At first actuation breakaway force max.45N; Repeat of actuation max.25N.

Operating Parameters

Pressure

Maximum working pressure is the highest recommended outlet (application) pressure. Maximum working pressure is not intended to be a continuous pressure. For all applications, the load should move below this pressure. This corresponds to the maximum allowable pressure compensated control setting.

Maximum (peak) pressure is the highest intermittent (t<1s) outlet pressure allowed. Maximum machine load should never exceed this pressure, and pressure overshoots should not exceed this pressure.

Inlet pressure is the absolute pressure in the pump suction port, it is related to pump speed. Make sure it is in the allowable range, see *Pump Specifications* on page 17.

Case pressure : The case pressure at the ports L1 and L2 may be a maximum of 1.2 bar higher than the inlet pressure at the port S but not higher than 2bar. Size drain plumbing accordingly and connect it to tank directly .The housing must always be filled with hydraulic fluid.

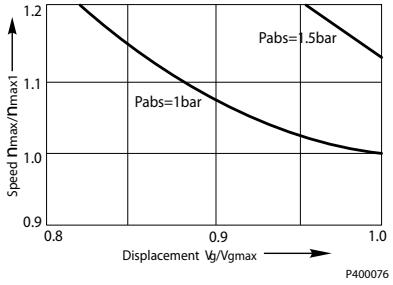
Speed

Rated speed is the fastest recommended operating speed at full displacement and at least 0.8 bar abs with charge pump (1 bar abs without charge pump) inlet pressure. Operating at or below this speed should yield satisfactory product life.

Maximum speed is the highest recommended operating speed at full power conditions. Operating at or beyond maximum speed requires positive inlet pressure and/or a reduction of pump outlet flow. Refer to *Inlet pressure vs. speed* on page 15 chart below.

Minimum speed is the lowest operating speed allowed. Operating below this speed will not yield satisfactory performance.

Inlet pressure vs. speed



Caution

Duty cycle and pump life

Knowing the operating conditions of your application is the best way to ensure proper pump selection. With accurate duty cycle information, your Danfoss Power Solutions representatives can assist in calculating expected pump life.

Fluid

Ratings and performance data for D1 pump are based on operating with premium hydraulic fluids containing oxidation, rust, and foam inhibitors. These include premium turbine oils, API CD engine oils per SAE J183, M2C33F or G automatic transmission fluids (ATF), Dexron II (ATF) meeting Allison C-3 or Caterpillar T0-2 requirements, and certain specialty agricultural tractor fluids. For more information on hydraulic fluid selection, see Danfoss Power Solutions publications **520L0463** *Hydraulic Fluids and Lubricants*, Technical Information, and **520L0465** *Experience with Biodegradable Hydraulic Fluids*, Technical Information.

Operating Parameters

Viscosity

Minimum Viscosity: This should only occur during brief occasions of maximum ambient temperature and severe duty cycle operation.

Maximum Viscosity: This should only occur at cold start. Pump performance will be reduced. Limit speeds until the system warms up.

Maintain fluid viscosity within the recommended range for maximum efficiency and pump life.

Temperature

Minimum temperature relates to the physical properties of the component materials. Cold oil will not affect the durability of the pump components. However, it may affect the ability of the pump to provide flow and transmit power.

Maximum temperature is based on material properties. Don't exceed it. Measure maximum temperature at the hottest point in the system. This is usually the case drain.

Fluid Velocity

Choose piping sizes and configurations sufficient to maintain optimum fluid velocity, and minimize pressure drops. This reduces noise, pressure drops, and overheating. It maximizes system life and performance.

Recommended fluid velocities

System lines	6 to 9 m/sec
Suction line	1 to 2 m/sec
Case drain	3 to 5 m/sec

Typical guidelines; obey all pressure ratings.

Velocity equations

SI units

Q = flow (l/min)

A = area (mm^2)

Velocity = (16.67•Q)/A (m/sec)

Technical Specifications

Pump Specifications

(theoretical values, without efficiency and tolerances; values rounded)

Features		Unit	Size			
			Without Charge Pump	With Charge Pump	With Charge Pump	With Charge Pump
			130/145	130/145	193	260
Displacement	Maximum	cm^3	130/145	130/145	193	260
	Minimum		0	0	0	0
Working input speed	Maximum at Vg max	min^{-1} (rpm)	2200[1)]	2500[2)]	2500[2)]	2300[2)]
	Maximum at Vg ≤ Vg max[3)]		2500	2500	2500	2300
Flow at n max and Vg max		l/min	273/319	325/363	483	598
Working pressure	Maximum	bar	350	350	350	350
	Peak		400	400	400	400
Inlet pressure (Absolute)	Minimum	bar	0.8	0.6	0.6	0.6
	Maximum		30[4)]	2	2	2
Case pressure (Absolute)	Maximum above inlet	bar	1.2	1.2	1.2	1.2
	Maximum		2	2	2	2
Filling capacity		L	2.9	2.9	3.8	4.6
Torque at Vg max and Δp = 350 bar		N•m	724/808	724/808	1075	1448
Power at Q max and Δp = 350 bar		kw	159/186	190/211	281	349
Mass moment of inertia of internal rotating components		$kg•m^2$	0.0299	0.0306	0.0576	0.2080
Mass (approx.)		kg	68	74	106	141
External shaft loads	Me	N•m	476	476	822	1081
	Thrust in (Tin), out (Tout)	N	-2340/5073	-2340/5073	-3990/5570	-3570/7180
Mounting flange load moments	Vibratory (continuous)	N•m	4553	4553	6286	8477
	Shock (maximum)		8692	8692	13782	16338

[1)] The values apply at absolute pressure (Pabs) of at least 1 bar at the suction port S and mineral hydraulic fluid.

[2)] The values apply at absolute pressure (Pabs) of at least 0.8 bar at the suction port S and mineral hydraulic fluid.

[3)] The values apply at Vg ≤ Vg max or in case of an increase in the inlet pressure (Pabs) at the suction port S.

[4)] If the application requires the higher inlet pressure than 5 bar (up to 30 bar), please contact Danfoss Power Solutions.

Caution

Exceeding the permissible values could cause a loss of function, reduced life or the destruction of the pump.

Fluid Specifications

Features		Units	
Viscosity	intermittent[1)]	$mm^2/sec.$	5
	Minimum		7
	Recommended range		16 - 36
	Maximum (cold start)[2)]		1600
Temperature range	Minimum (cold start)[2)]	°C	-40
	Maximum intermittent[1)]		115[3)]

Technical Specifications

Features		Units	
Filtration (minimum) Cleanliness per ISO 4406	-40 - 90 °C		20/18/15
	90 - 115 °C		19/17/14

[1] Intermittent = Short term t < 3min per incident.

[2] Cold start = Short term t < 3min, p ≤ 30 bar, n ≤ 1000 min-1(rpm) , please contact Danfoss Power Solutions especially when the temperature is below -25 °C.

[3] Must not be exceeded locally either (e.g. in the bearing area) . The temperature in the bearing area is (depending on pressure and speed) up to 5 °C higher than the average case drain temperature.

Fluid and Filter Maintenance

Recommendations of fluid and filter maintenance

To ensure optimum life of D1 pumps, 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. Water in the fluid may be noted by a cloudy or milky appearance or free water in the bottom of the reservoir. Rancid odor indicates the fluid has been exposed to excessive heat. Change the fluid immediately if these conditions occur. Correct the problem immediately.

Change the fluid and filter per the vehicle / machine manufacturer's recommendations or at these intervals: 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 that the recommended maximum.

Fluid and filter change interval

Reservoir type	Maximum change interval
Sealed	2000 hours
Breather	500 hours

Dispose of used hydraulic fluid properly. Never reuse hydraulic fluid.

Change filters whenever the fluid is changed or when the filter indicator shows that it is necessary to change the filter. Replace all fluid lost during filter change.

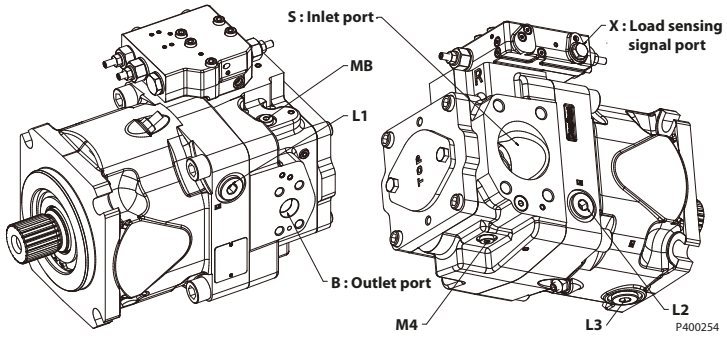
Pressure Measurements

Port Locations and Gauge Installation (130/145)

The following table and drawing 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	Purpose	Port size	Wrench size	Range of gauge
L1, L2, L3	Case drain	M26x1.5	12 mm	0-60 bar
M_B	Outlet	M12x1.5	6 mm	0-600 bar
M_4	Servo piston chamber	M12x1.5	6 mm	0-600 bar

130/145 Port locations, Control type: TPSN

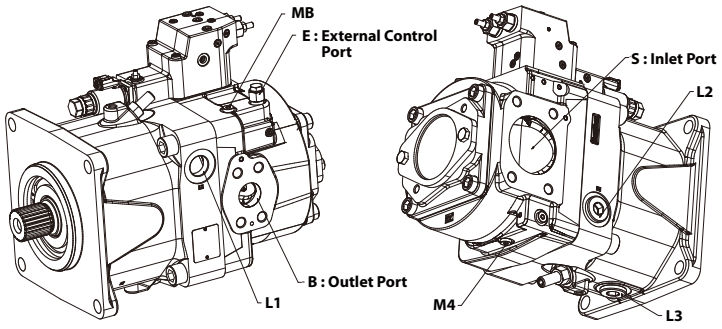


Pressure Measurements

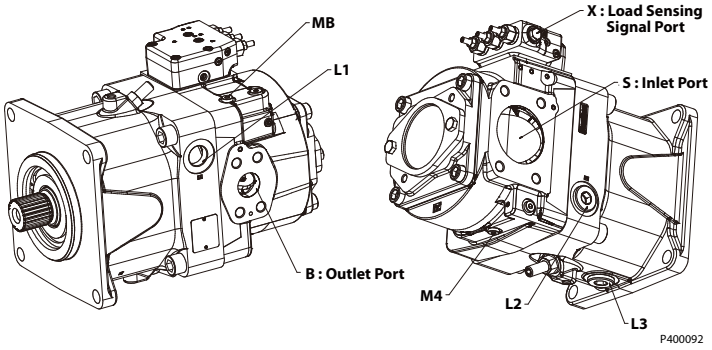
Port Locations and Gauge Instalation (193/260)

Port	Purpose	Port size	Wrench size	Range of gauge
L1, L2, L3	Case drain	M33x2	17 mm	0-60 bar
M_B	Outlet	M12x1.5	6 mm	0-600 bar
M_4	Servo piston chamber	M12x1.5	6 mm	0-600 bar

193/260 Port location, Control type: TPE2



193/260 Port location, Control type: TPSN



Initial Start-up Procedures

General

Follow this procedure when starting-up a new D1 installation or when restarting an installation in which the pump has been removed.

Prior to installing the pump, inspect for damage incurred during shipping. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Start-up Procedure

1. Connect the pump to the prime mover.

   Ensure that pump shaft is properly aligned with the shaft of the prime mover. Alignment should be within 0.25 mm and the angle must not exceed 0.2°.

   Caution

   Incorrect shaft alignment may result in damage to drive shaft, bearings, or seal which can cause external oil leakage.

2. Fill the reservoir with recommended hydraulic fluid.

   Always filter fluid through a 10 micron filter pouring into the reservoir. Never reuse hydraulic fluid.

3. Fill the main pump housing with clean hydraulic fluid. Pour filtered oil directly into the upper most case drain port.
4. Fill the inlet line leading from the pump to the reservoir. Check the inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.
5. To ensure the pump stays filled with oil, install the case drain line in the upper most case drain port.
6. Install a gauge at port **MB** to monitor system pressure during start up.

   Follow recommendations in the vehicle / machine operator's manual for prime mover start up procedures.

7. Switch system to free circulation or to lowest pressure, jog the prime mover or run at the lowest possible speed until pump and all pipes are filled and free from air bubbles. Raise pressure setting only when all air is removed.

   Let the pump work at reduced pressure for 5 - 10 min, check if all pipes and connections are leak free and tight.

8. Check the suction pressure at port **S** of the axial piston pump at nominal speed and maximum flow, make sure it is in allowable range.
9. Check the case drain pressure at the connected port **L1** or **L2** at maximum pressure, make sure it is in allowable range.
10. Shut down the prime mover and remove the pressure gauge. Replace plug at port **MB**.
11. Check the fluid level in the reservoir; add clean filtered fluid if necessary.

The pump is now ready for operation.

Troubleshooting

Excessive Noise and /or Vibration

Item	Description	Action
Check fluid level in reservoir.	Insufficient hydraulic fluid causes cavitation.	Fill the reservoir to proper level.
Check for air in system.	Air in system causes noisy, erratic control.	Purge air and tighten fittings. Check inlet for leaks.
Check pump inlet pressure / vacuum.	Improper inlet conditions cause erratic behavior and low output flow.	Correct pump inlet pressure / vacuum conditions.
Inspect shaft couplings.	A loose or incorrect shaft coupling causes excessive noise and / or vibration.	Repair or replace coupling and ensure that correct coupling is used.
Check shaft alignment.	Misaligned shafts create excessive noise and / or vibration.	Correct shaft misalignment.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operating, or use fluid with the appropriate viscosity grade for expected operating temperatures.

Low Pump Output Flow

Item	Description	Action
Check fluid level in reservoir.	Insufficient hydraulic fluid will limit output flow and cause internal damage to pump.	Fill the reservoir to proper level.
Hydraulic fluid viscosity above acceptable limits.	Fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operating, or use fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system relief valve setting.	Eternal relief valve set below PC setting causes low output flow.	Adjust external relief valve following manufacturer's recommendation. External relief valve setting must be above PC setting to operate properly.
Check pressure compensate (PC), load sensing (LS) and power (T) control setting.	Low PC setting prevents the pump from achieving full stroke. Low LS setting limits output flow. Low T setting limits output flow.	Contact Danfoss Service.
Check LS control signal pressures.	Incorrect LS signal will not allow pump to operate correctly.	Inspect system to ensure that proper LS signal transmit to pump.
Check Pilot pressure for hydraulics displacement control and input current for electric displacement control.	Incorrect input signal causes low output flow.	Adjust input hydraulic or electric signal to right value.
Check pump inlet pressure / vacuum.	High inlet vacuum causes low output flow.	Correct inlet pressure conditions.
Check input speed.	Low input speeds decrease flow.	Adjust input speed.
Check pump rotation.	Incorrect rotational configuration causes low flow.	Use pump with appropriate rotational configuration.

Troubleshooting

No or Low System Pressure

Item	Description	Action
Check pressure compensate (PC) and power (T) control setting.	Low PC and T setting leads to low system pressure.	Contact Danfoss Service.
Check external relief valve.	External relief valve setting below PC setting.	Adjust external relief valve according to manufacturer's recommendations. External relief valve must be set above PC setting to operate properly.
Check pilot pressure or control pressure.	Insufficient pilot pressure or control pressure.	Increase them to appropriate value.
Internal system leaks.	Worn internal parts don't allow the pump to operate properly.	Refer to Authorized Service Center for required repair.

Actuator Response is Sluggish

Item	Description	Action
Check external system relief valve setting.	Low external relief valve setting slows down system.	Adjust external relief valve setting following manufacturer's recommendations. External relief setting must be above PC setting to operate properly.
Check pressure compensate (PC), load sensing (LS) and power (T) control setting.	Low PC setting prevents the pump from achieving full stroke. Low LS setting limits output flow. Low T setting limits output Torque.	Contact Danfoss Service.
Check LS control signal pressures.	Incorrect LS signal will not allow pump to operate correctly.	Inspect system to ensure that proper LS signal transmit to pump.
Check Pilot pressure for hydraulics displacement control and input current for electric displacement control.	Incorrect input signal causes low output flow.	Adjust input hydraulic or electric signal to right value.
Internal system leaks.	Worn internal parts don't allow the pump to operate properly.	Refer to Authorized Service Center for required repair.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or sue fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system valving.	Malfunctioning valving may not allow system to respond properly.	Repair or replace system valving as required.
Check pump case pressure.	High case pressure causes the system to be sluggish.	Correct case drain line restrictions.
Check pump inlet pressure / vacuum.	High inlet vacuum causes low output flow.	Correct inlet pressure conditions.

Pressure or Flow Instability

Item	Description	Action
Check for air in system.	Air in system causes erratic operation.	Activate PC allowing system to bleed air. Check inlet line for leaks and eliminate source of air ingression.
Check LS setting.	Low LS setting may cause instability.	Contact Danfoss Service.
Check LS signal line.	Blocked LS signal line interferes with proper LS operation.	Remove blockage.

Troubleshooting

Item	Description	Action
Check external relief valve and PC setting.	Insufficient pressure differential between PC setting and external relief valve.	Adjust external relief valve or PC control settings to appropriate level. Relief valve setting must be above PC setting to operate properly.
Check external relief valve.	Chattering external relief valve may cause unstable feedback to pump control.	Adjust or replace relief valve.

System Operating Hot

Item	Descriptin	Action
Check fluid level in reservoir.	Insufficient volume of hydraulic fluid will not meet cooling demands of system.	Fill reservoir to proper level. Verify proper size of reservoir.
Inspect heat exchanger. Check air flow and input air temperature for the heat exchanger.	Insufficient air flow, high input air temperature, or undersized heat exchanges will not meet cooling demands of the system.	Clean, repair, or replace heat exchanger as required. Verify proper size of heat exchanger.
Check external system relief valve setting.	Fluid passing through relief valve adds heat to system.	Adjust external system relief valve setting following manufacturer's recommendations. External relief valve setting must be above PC setting for proper operation.
Check pump inlet pressure / vacuum.	High inlet vacuum adds heat to system.	Correct inlet pressure / vacuum conditions.

High Inlet Vacuum

Item	Description	Action
Check fluid temperature.	Low temperature increases viscosity. High fluid viscosity causes high inlet vacuum.	Allow system to warm up before operating.
Inspect inlet screen.	Blocked or restricted inlet screen causes high inlet vacuum.	Clean screen / remove blockage.
Check inlet piping.	Too many fittings, bends, or long piping causes high inlet vacuum.	Eliminate fittings to make path more direct.
Hydraulic fluid viscosity above acceptable limits.	High fluid viscosity causes high inlet vacuum.	Select fluid with appropriate viscosity for expected operating temperature.

Caution

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

Adjustments

TPE2 Control (193/260)

TPE2+TPSN setting value is indicated in the pump model code, refer to *the D1 High Power Open Circuit Pump Technical Information Manual*, L1426007 for more information.

Before performing adjustments, read *Pressure Measurements* on page 20.

Calculate Power Control Start Point Pressure and Corresponding Flow in Advance

1. Calculate the power control start point pressure according to the formula : Power=P*n*Vg*10-3/(600 • η),(P: power control start point pressure, n : pump input speed, Vg : Pump theoretical displacement, η : total efficiency, set as 91.2%),
   the desired power setting is 90 kW, the pump input speed is 1500 rpm and the Pump theoretical displacement is 193 cc, then $90=P*1500*193*10^{-3}/(600 • \eta)$, so the power control start point pressure P=170 bar.
2. Choose the average pressure between power control start point pressure and Pressure compensated control setting, then calculate the corresponding flow.
   now the power control start point pressure is 170 bar, and Pressure compensated control setting is 320 bar, then the average pressure is （170+320）/2=245 bar, then calculate the flow according to the formula Power = P*Q/(600 • η), for example : 90=245*Q/(600 • η), the Q=201 l/min.

Electric Displacement Control Adjustment

3. Install a pressure gauge in port **MB** to measure outlet pressure, Install a flow meter in outlet line to measure pump flow.

Warning

Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury and/or infection. Relieve pressure in the system before removing hoses, fittings, gauges, or components.

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 lines.

4. Start the prime mover and input 700 mA to electric displacement control solenoid valve, then allow fluid to reach normal operating temperature.
5. Totally lock the power control which means firstly loosen the power control lock nut and turn the power control adjusting screw clockwise to the end, while holding the power control adjusting screw, torque the the power control lock nut to 21.6~24.6 N•m.
6. Totally lock the pressure compensated control which means firstly loosen the power control lock nut and turn the pressure compensated control adjusting screw clockwise to the end, while holding the pressure compensated control adjusting screw, torque the the power control lock nut to 21.6~24.6N.m.
7. Input 400mA to electric displacement control and load the pump outlet pressure to 50 bar, then loosen the electric displacement control lock nut and turn its adjusting screw until the pump displacement achive (see Table 1) which can calculated by monitoring pump outlet flow and pump speed. Clockwise turning adjusting screw decrease pump displacement, counterclockwise truning increase pump displacement, the displacement - current curve will offset (see Table 2) per turn.
8. While holding the position of the electric displacement control adjusting screw, torque the lock nut to 9.5 N•m.

Adjustments

9. Input 500 mA to electric displacement control, check if the displacement is aroud (see Table 1) at this moment, if it is, the electric displacement control adjustment complete, if it is not, please re-adjust.

Table 1

Input Current	Size 193	Size 260
400 mA	92.5 cc	140.5 cc
500 mA	115.5 cc	172.5 cc

Table 2

Per Turn	Size 193	Size 260
Offset	263 mA	263 mA

Pressure Compensated Control Adjustment

10. Input 700 mA to electric displacement contol to make sure the pump is at maximum displacement.

11. Load the pump outlet prssure to at least 30 bar higher than expected pressure conpensated control setting.

12. Loosen the Pressure compensated control lock nut and turn the Pressure compensated control adjusting screw until the desired setting is indicated on the pressure gauge at port **MB**. Clockwise rotation increases pressure, counterclockwise rotation decreases; approximate gain (see Table 3) per turn, while holding the Pressure compensated control adjusting screw, torque the the Pressure compensated control lock nut to 21.6~24.6 N•m.

Table 3

	Size 193	Size 260
Change per turn	163.2 bar	163.2 bar

If the pressure does not increase, an external system relief valve may require adjustment. External system relief valve must be set above the Pressure compensated control setting for proper operation.

Power Control Adjustment

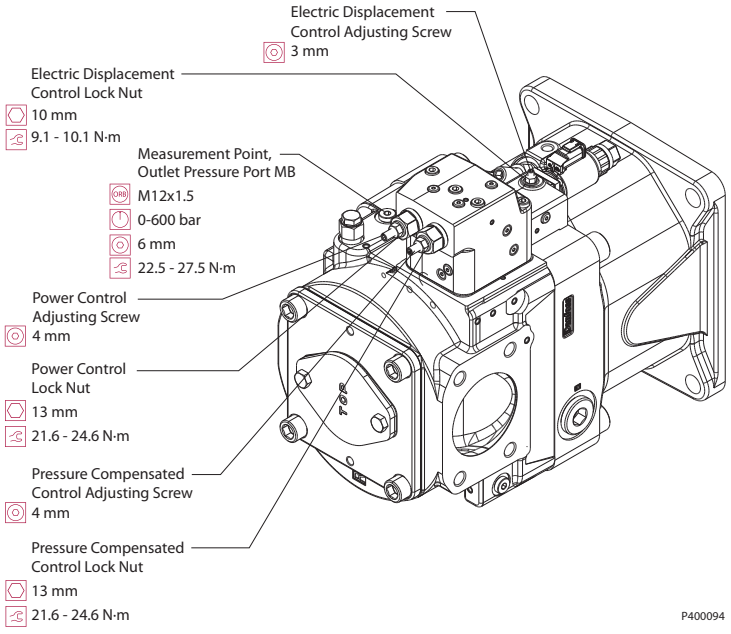
13. Load the pump outlet pressure to 253 bar, loosen the power control lock nut and turn power control adjusting screw and monitor the flow meter, when the flow meter shows the flow is 201 l/min, stop turning, while holding the position of power control adjusting screw, torque the power control lock nut to 21.6~24.6 N•m. Clockwise rotation increases power, counterclockwise rotation decreases approxiate gain per turn (See Table 4).

Table 4

	Size 193	Size 260
Chnage per turn	73.5 kW	99 kW

Adjustments

14. Stop the prime mover, remove the pressure gauge and flow meter, and return the system to its normal operating configuration.



Adjustments

TPSN Control (193/260)

Power Control and Pressure Compensated Control Adjustments

1. Calculate power control start point pressure and corresponding flow in advance, see step 1, 2 in *Calculate Power Control Start Point Pressure and Corresponding Flow in Advance* of TPE2 control adjustments.
2. Install a pressure gauge in port **MB** to measure outlet pressure, Tee-in a pressure gauge to the LS signal line (port **X**) to measure LS signal pressure, Install a flow meter in outlet line to measure pump flow.
3. Start the prime mover and allow fluid to reach normal operating temperature.
4. Totally lock the LS control which means firstly loosen the LS control lock nut and turn the LS control adjusting screw clockwise to the end, while holding the LS control adjusting screw, torque the LS control lock nut to 21.6~24.6 N•m.
5. Then adjust power control and pressure compensated control according to the steps 5, 6, 11, 12, 13 of TPE2 control.

Load Sensing Control Adjustment

6. After step 5, Slowly operate a hydraulic function that will demand approximately half flow from the pump, but keep outlet pressure below the power control pressure turning point.

Warning

Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury and/or infection. Relieve pressure in the system before removing hoses, fittings, gauges, or components.

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 lines.

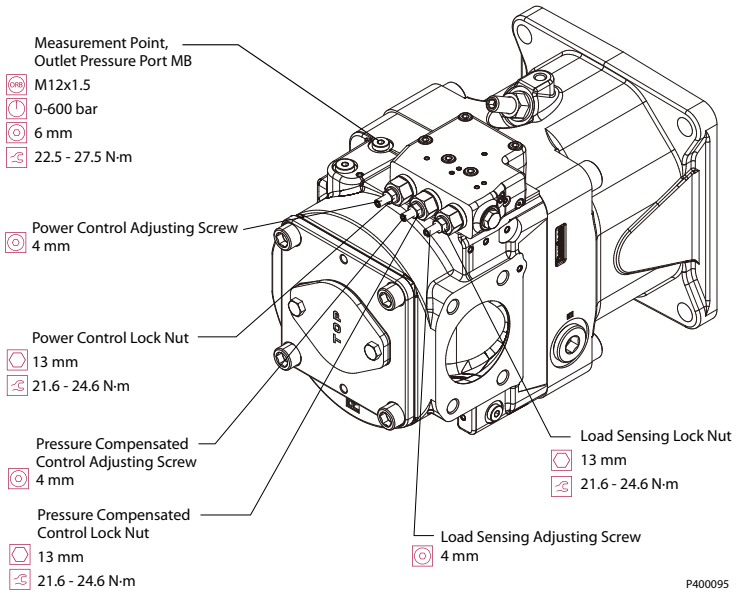
7. Loosen the LS control lock nut. While watching the pressure gauges, turn the LS control adjusting screw counterclockwise until the desired pressure differential between port **MB** and port **X** is achieved. Clockwise rotation increases the setting, counterclockwise rotation will decrease it; approximate gain (see Table 5) per turn. While holding the position of the LS adjusting screw, torque the LS lock nut to 21.6~24.6 N•m.

Table 5

	Size 193	Size 260
Change per turn	26.4 bar	26.4 bar

Adjustments

8. Stop the prime mover, remove the pressure gauge and flow meter, and return the system to its normal operating configuration.



Adjustments

TPSN Control (130/145)

The specific adjustment steps please refer to *193 TPSN* adjustment steps.

Warning

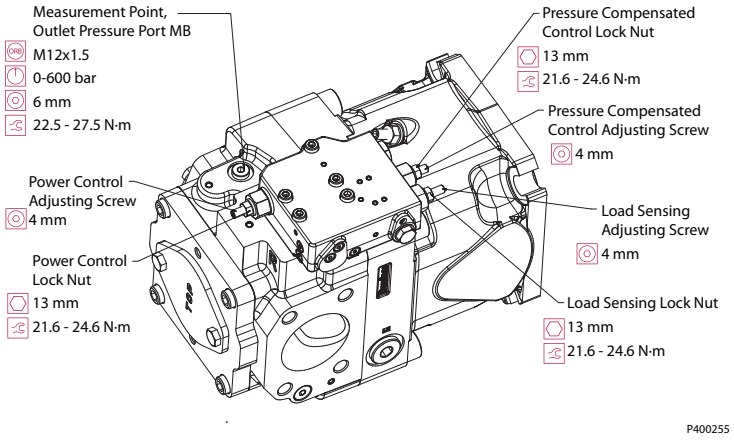
Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury and/or infection. Relieve pressure in the system before removing hoses, fittings, gauges, or components.

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 lines.

The wrench sizes and torques please check below drawing



Change per turn of each adjustment bolt

Control Type	Change per Turn
T	39KW@1500rpm, (50.8kw@1500rpm for TPE5)
P	271bar, (163.2bar for TPE5)
S	50 bar
N	-

Adjustments

Displacement Limiters Adjustment

Adjust Displacement Limiters

Warning

Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury and/or infection. Relieve pressure in the system before removing hoses, fittings, gauges, or components.

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 lines.

1. Install a flow meter in outlet line to measure pump flow.
2. Start the prime mover and allow fluid to reach normal operating temperature.
3. Adjust the control properly to make sure the pump at maximum displacement.
4. Loosen the maximum or minimum displacement limiter lock nut with an external hex wrench and turn the adjusting screw with an internal hex wrench until the desired flow is achieved.

Option	Description
Maximum displacement	• Clockwise turn decreases displacement • Counter-clockwise turn increases displacement
Minimum displacement	• Clockwise turn increases displacement • Counter-clockwise turn decreases displacement

Displacement change per turn

	130/145	193	260
Max. displacement change per turn	11 cm^3/rev	15 cm^3/rev	19 cm^3/rev
Min. displacement change per turn	9 cm^3/rev	14 cm^3/rev	18 cm^3/rev

5. While holding the position of the adjusting screw, torque the lock nut to required torque.

Wrench sizes and Torque

	130/145	193	260
Screws	5 mm	8 mm	8 mm
Nuts	17 mm	24 mm	24 mm
	43~48 N·m	180~206 N·m	180~206 N·m

Minor Repair

Shaft Seal Replacement

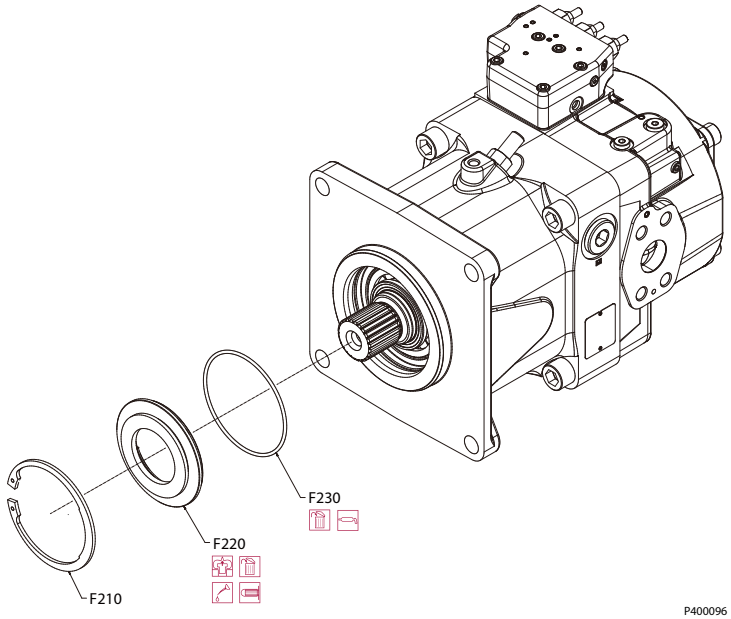
D1 pump uses a lip-type shaft seal. You can replace this seal without major disassembly of the unit. Replacing the shaft seal requires removing the pump from the machine.

Removal

1. Using the appropriate snap-ring pliers, remove the retaining ring (F210) from the housing.
2. Remove the shaft seal and its carrier (F220) with appropriate tool (like 2 straight screwdriver) from the bore in the pump housing and discard.
3. Remove the O-ring (F230) and discard.

Installation

1. Inspect the pump housing and new seals for damage. Inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.
2. Lubricate new O-ring (F230) with petroleum jelly and fit in the housing groove.
3. Lubricate the lip of the new shaft seal with clean hydraulic fluid. Place a protective sleeve over the shaft end to prevent damage to the seal during installation.
4. Keeping the new seal and its carrier perpendicular to the shaft, press them into the housing just far enough to clear the retaining ring groove. Install seal with the cupped side toward the shaft bearing. Do not damage the seal during installation.
5. Using the appropriate snap ring pliers, install the seal retaining ring.
6. Remove the installation sleeve.



Minor Repair

Auxiliary Flange and Charge Pump Replacement

Follow these steps to either remove, replace, or exchange auxiliary mounting pads and charge pump.

Removal

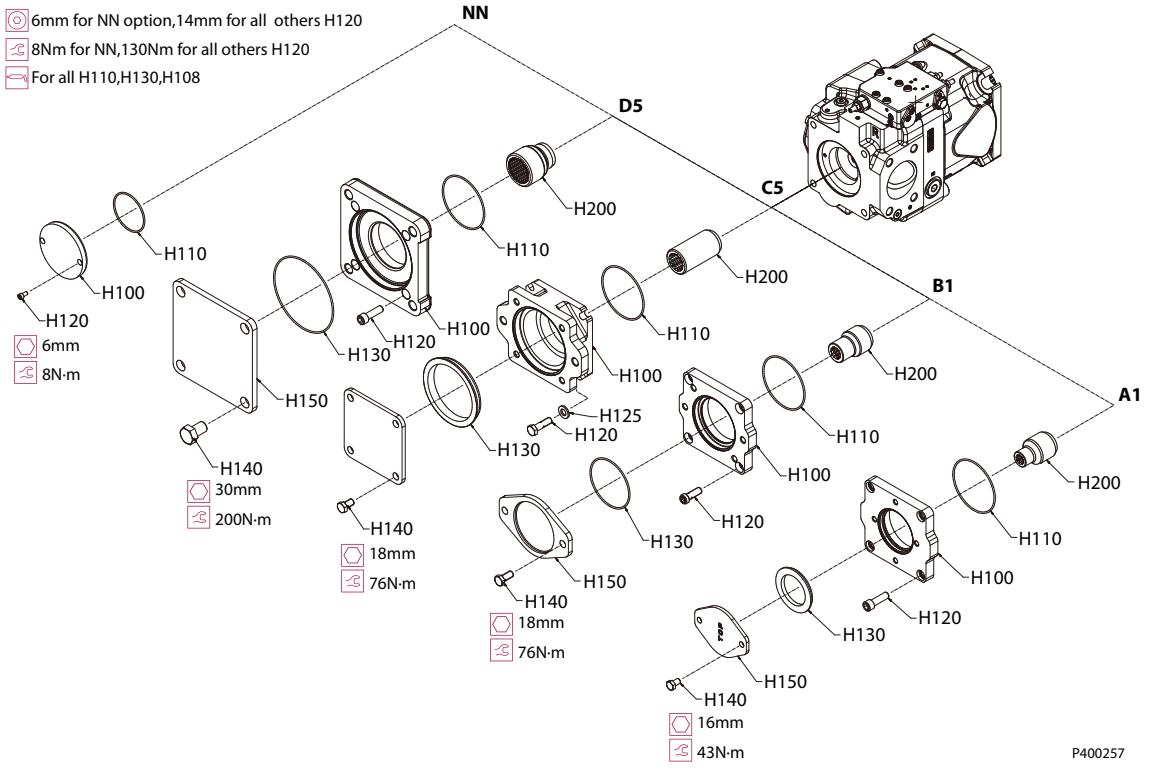
1. Remove the screws (H140), retaining the cover plate (H150). Remove the seal (H130).
2. Remove the drive coupling (H200) if present.
3. Remove the 4 screws (H120), retaining the pad adapter (H100) to the endcap. Discard the pad adapter O-ring (H110).
4. Use the appropriate snap-ring pliers, remove the retaining ring (G610) from the shaft.
5. Pull out the charge pump, if it is damaged, discard it.

Installation

1. Push in the new charge pump far enough to clear the retaining ring groove.
2. Use the appropriate snap-ring pliers to install retaining ring (G610) onto the shat.
3. Lubricate new O-ring (H110) with petroleum jelly. Install the pad adapter to the endcap.
4. Install the 4 screws (H120) and torque to required torques.
5. Install the drive coupling (H200) if present.
6. Install the cover (H150) with seal (H130), lubricate the seal with petroleum jelly.
7. Install the screws (H140) and torque to required torques.

130/145

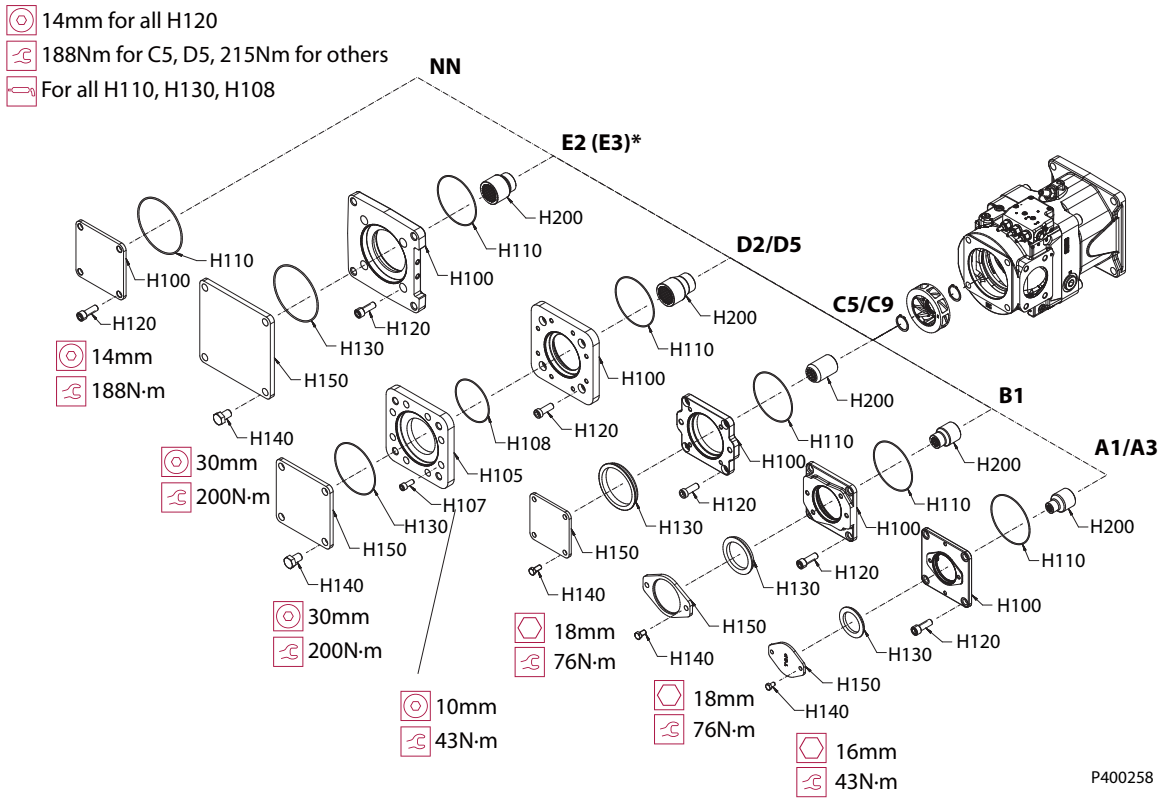
All torques tolerance ±10%



Minor Repair

193/260

All torques tolerance ±10%



* **E3** option is only for 260.

Minor Repair

Control (193/260)

Removal

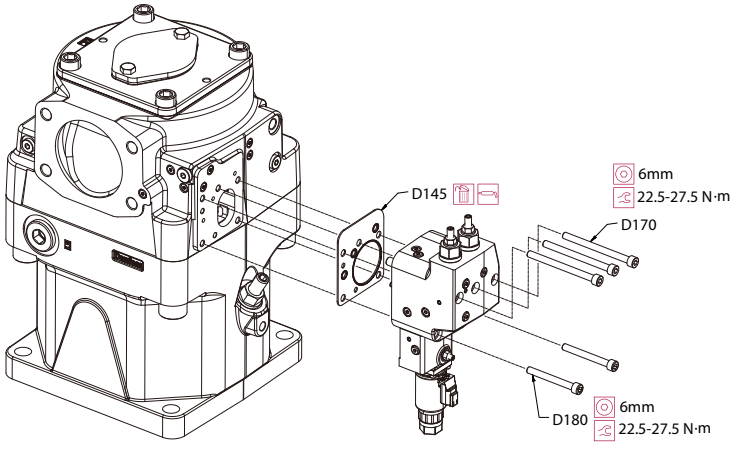
1. Remove the TPE2 control from the endcap by removing the 3 long control bolts (D170) and 2 short bolts (D180), TPSN control are 5 short bolts (D175).

   The sleeve-tc Jack (D640) might stay on the hole of bias piston in endcap, remove and place it with control.
2. Remove and discard the Seals, 193: O-ring (D140) and 3 other O-ring (D150), 260: gasket (D145).

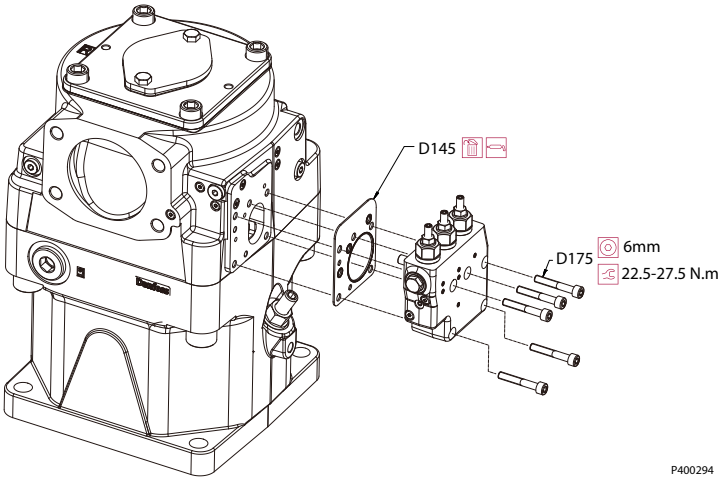
Installation

1. Lubricate new Seals, 193: O-ring (D140) and 3 small O-ring (D130), 260: gasket (D145) with petroleum jelly and fit in the control housing grooves.
2. Make sure TC jack sleeve (D640) is set in bias piston hole, then install the control housing assembly onto the endcap using the 3 long screws (D170) and 2 short screws (D180). TPSN control use 5 short screws (D175).

193/260 TPE Control



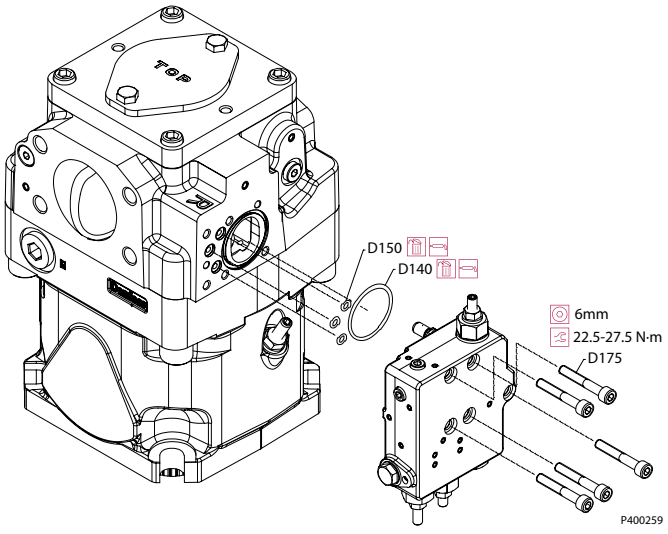
193/260 TPSN Control



Minor Repair

Control (130/145)

TPSN Control



Minor Repair

Shuttle Valve or Plug

Removal

1. For TPE2 control, first remove the plug assy-HEX(D900).
2. Then pull out shuttle vale seat(D920) with a M6 screw.
3. At last remove the spool(D910) with an appropriate tool.
4. For TPSN control, here is only a plug, normally no need to remove.

Installation

1. For TPE2 control, coat the shuttle valve spool (D910) with cleaning hydraulic oil and install to E port in the endcap.
2. Install shuttle valve seat(D920) according to the direction showing in the picture.
3. Install E port plug assembly(D900).
4. If the shuttle valve is not used, replace it with the plug (D900).

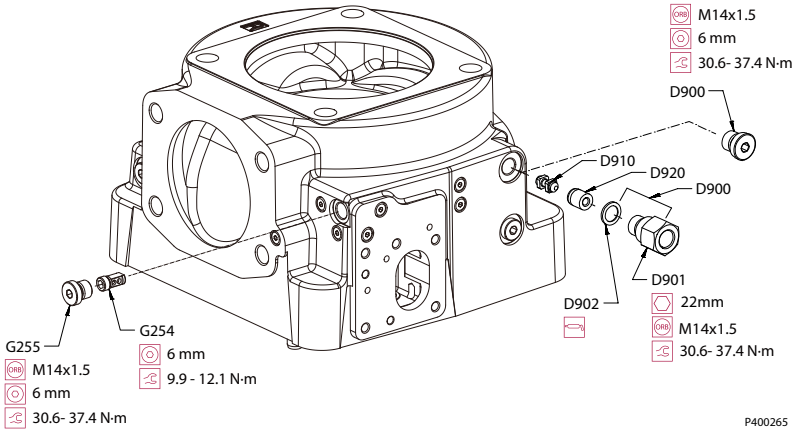
Edge Filter (260)

Removal

1. Remove the plug G255.
2. Then, remove the filter G254.

Installation

1. First, install the filter G254, torque to required torque.
2. Then, install the plug G255, torque to required torque.



Minor Repair

Displacement Limiters

Removal

The removal steps of the maximum (bottom of the pump) and minimum (top of the pump) are the same.

1. Loosen the lock nut (F120) with an extenal hex wrench.
2. Counter clockwise turn the adjusting screw (F110) with 8mm internal hex wrench until it totally out.
3. Inspect the lock nut seal and adjusting screw, if they are damaged , discard them.

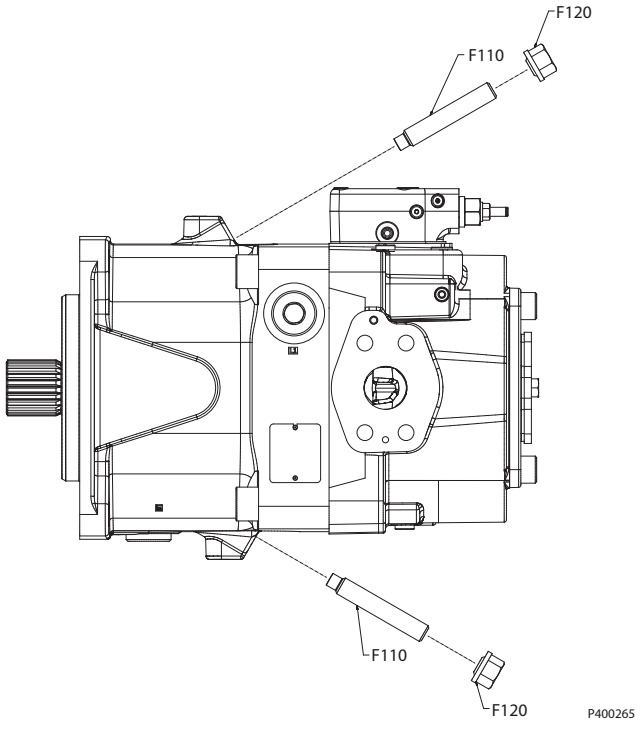
Installation

The installation steps of the maximum (bottom of the pump) and minimum (top of the pump) are the same.

1. Clockwise turn the adjusting screw (F110) with 8mm internal hex wrench until you feel it start against the swashplate.
2. Install the lock nut (F120), while holding the adjusting screw position, torque the lock nut to required torque.

Table 1 : Wrench sizes and Torque

	130/145	193	260
Screws	5 mm	8 mm	8 mm
Nuts	17 mm	24 mm	24 mm
	43~48 N·m	180~206 N·m	180~206 N·m

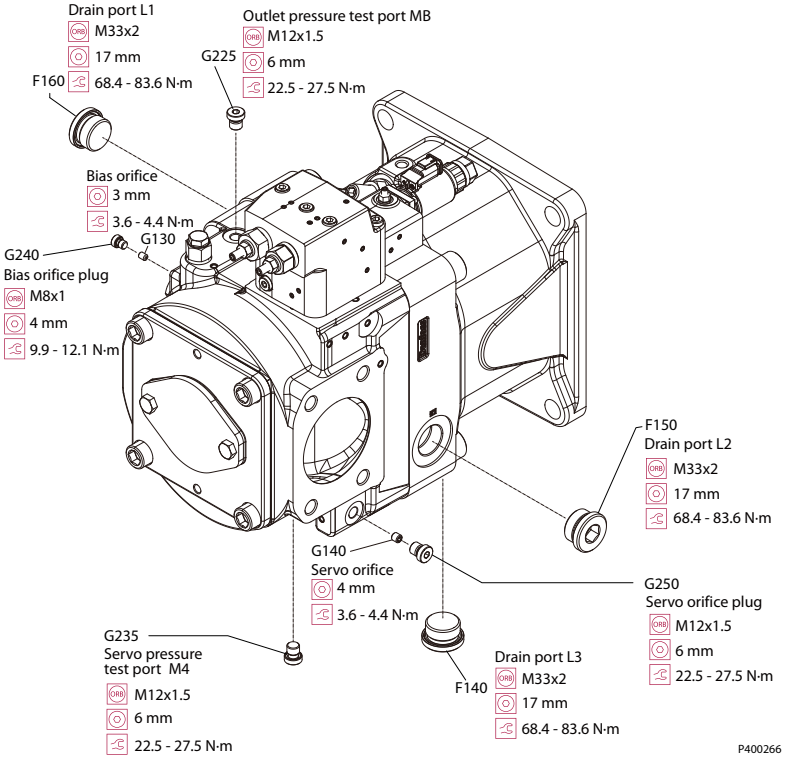


Minor Repair

Plug and Fitting Sizes and Torques

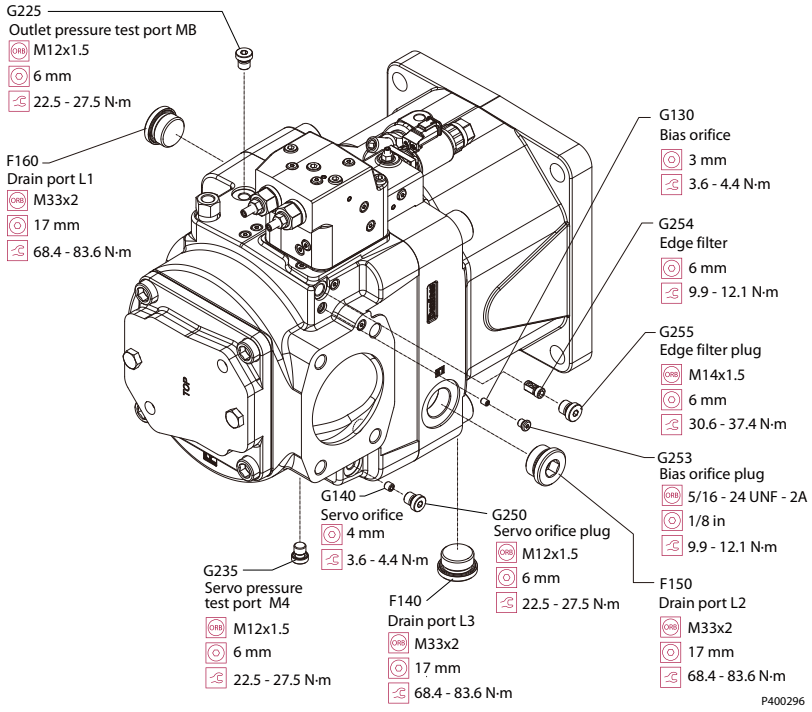
If any plugs or fittings are removed from the unit during service, install and torque as indicated here. This drawing is a composite. Your configuration may differ but here is the appropriate wrench size and torque:

193 TPE2 Control

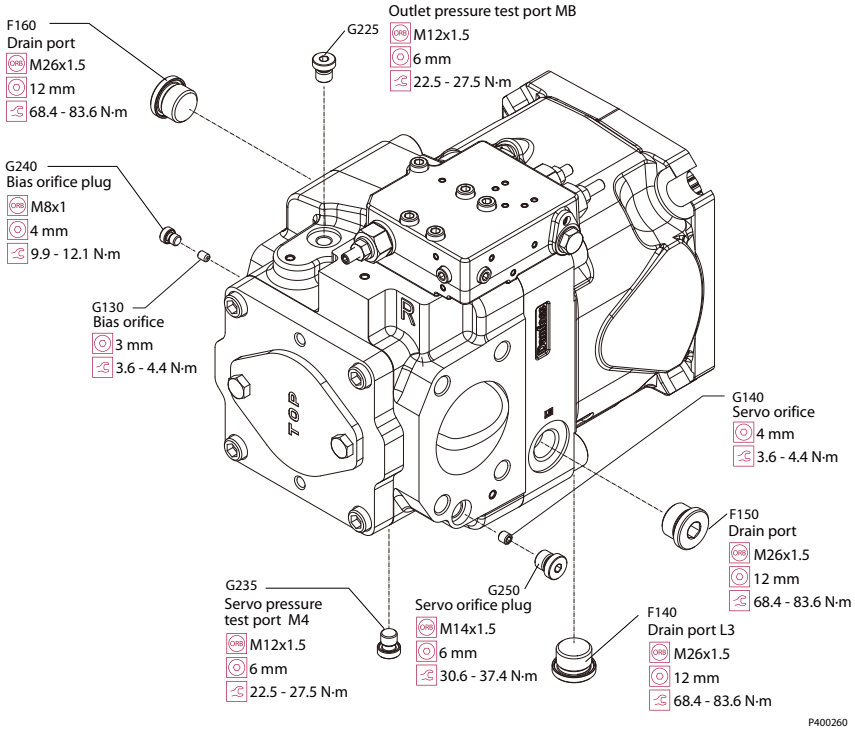


Minor Repair

260 TPE2 Control



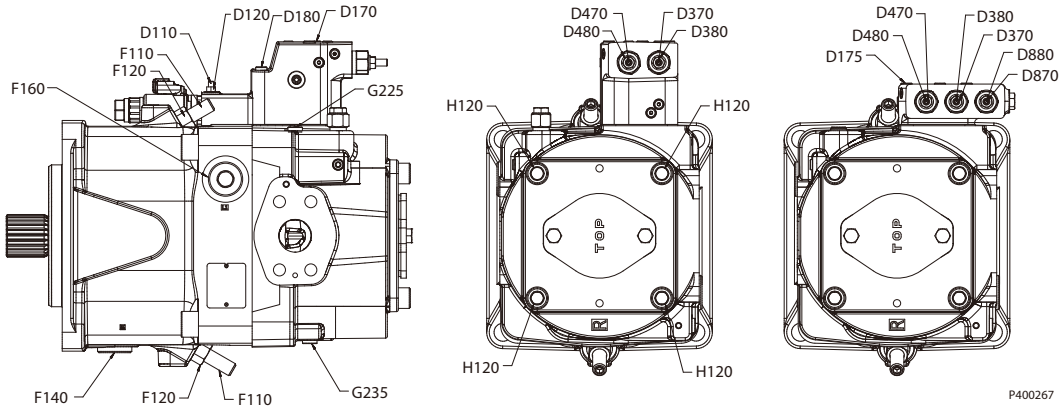
130/145 TPSN Control



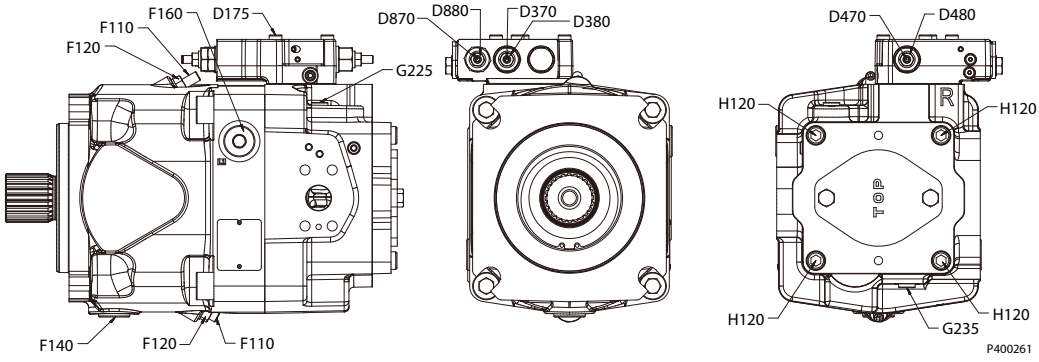
Minor Repair

Torque Chart

Size 193/260



Size 130/145



Fastener Size and Torque Chart

All torques tolerance (except already given range) : ±10%

Item	Fastner	130/145		193		260	
		Wrench size	Torque	Wrench size	Torque	Wrench size	Torque
D170 D180	Control assembly screws	N/A	N/A	6 mm internal hex	25 N·m	6 mm internal hex	25 N·m
D175	Control assembly screws	6 mm internal hex	25 N·m	6 mm internal hex	25 N·m	6 mm internal hex	25 N·m
H120	Adapter screws	10 mm internal hex	130 N·m	14 mm internal hex	215 N·m	14 mm internal hex	215 N·m
F110	Displacement limiter screws	5 mm internal hex	N/A	8 mm internal hex	N/A	8 mm internal hex	N/A
D370	P adjusting screw	4 mm internal hex	N/A	4 mm internal hex	N/A	4 mm internal hex	N/A
D470	T adjusting screw	4 mm internal hex	N/A	4 mm internal hex	N/A	4 mm internal hex	N/A
D870	S adjusting screw	4 mm internal hex	N/A	4 mm internal hex	N/A	4 mm internal hex	N/A
D110	E2 adjusting screw	N/A	N/A	3 mm internal hex	N/A	3 mm internal hex	N/A
F120	Displacement limiter lock nuts	17 mm external hex	43 -48 N·m	24 mm external hex	180 - 206 N·m	24 mm external hex	180 - 206 N·m

Minor Repair

All torques tolerance (except already given range) : ±10% (continued)

Item	Fastner	130/145		193		260	
		Wrench size	Torque	Wrench size	Torque	Wrench size	Torque
D380	P locknut	13 mm external hex	21.6-24.6 N·m	13 mm external hex	21.6-24.6 N·m	13 mm external hex	21.6-24.6 N·m
D480	T locknut	13 mm external hex	21.6-24.6 N·m	13 mm external hex	21.6-24.6 N·m	13 mm external hex	21.6-24.6 N·m
D880	S locknut	13 mm external hex	21.6-24.6 N·m	13mm external hex	21.6-24.6 N·m	13mm external hex	21.6-24.6 N·m
D120	E2 locknut	N/A	N/A	10 mm external hex	9.5 N·m	10 mm external hex	9.5 N·m

Plug Size and Torque Chart

All torques tolerance (except already given range) : ±10%

Item	130/145			193			260		
	ED-ring plug	Wrench size	Torque	ED-ring plug	Wrench size	Torque	ED-ring plug	Wrench size	Torque
F140 F150	M26X1.5	12 mm internal hex	76 N·m	M33X2	17 mm internal hex	225 N·m	M33X2	17 mm internal hex	225 N·m
G225 G235	M12X1.5	6 mm internal hex	25 N·m	M12X1.5	6 mm internal hex	25 N·m	M12X1.5	6 mm internal hex	25 N·m

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