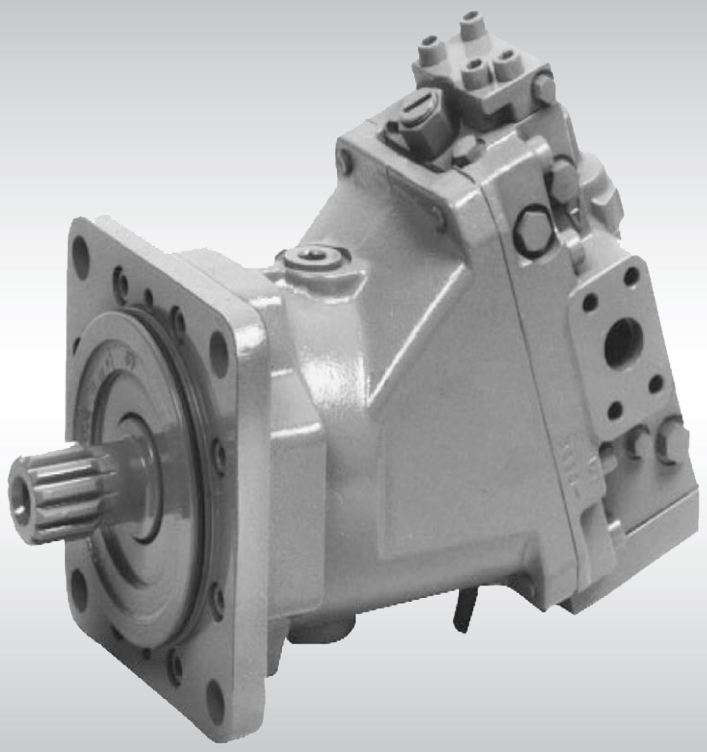
MAKING MODERN LIVING POSSIBLE

Repair Instructions

Bent Axis Motors

Series 51 and 51-1 Repair Instructions



Revision history

Table of revisions

Date	Changed	Rev
December 2014	Danfoss layout	BA
Jan 2008	First edition	AA

Contents

Introduction

Overview

This manual details repair procedures for Series 51 bent axis motors. These include the complete disassembly, inspection, and reassembly of the unit. Where rework of worn or damaged components is possible, specifications are given to ensure these parts meet factory tolerances. Only Danfoss Global Service Partners may perform major repairs. Danfoss trains Global Service Partners to perform major repairs and certifies their facilities on a regular basis.

Warning

Use of components that do not comply with rework specifications may result in loss of performance, which may constitute a safety hazard. Do not reuse components that don't comply to given specifications: replace with genuine Danfoss service parts.

Minor repair procedures, adjustments, and troubleshooting information are given in the Series 51 and 51-1 Service Manual, 11008567. Minor repairs include service operations you can perform without removing the unit's endcap. Removal of the endcap voids your warranty.

General instructions

Follow these general procedures when repairing Series 51 bent axis variable displacement closed circuit motors.

Remove the unit

Prior to performing major 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 with a clean solvent wash and air drying is usually adequate.

As with any precision equipment, you must keep all parts free of foreign materials 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.

Lubricate moving parts

During assembly, coat all moving parts with clean hydraulic oil. This assures that these parts are lubricated during start-up.

Replace all O-rings and gaskets

Danfoss recommends you replace all O-rings, gaskets, and seals. Lubricate O-rings with clean petroleum jelly prior to assembly. Grease must be soluble in hydraulic fluid.

Introduction

Secure the unit

For major repair, place the unit in a stable position with the shaft pointing downward. Secure the pump while removing and torquing the endcap bolts.

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.

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

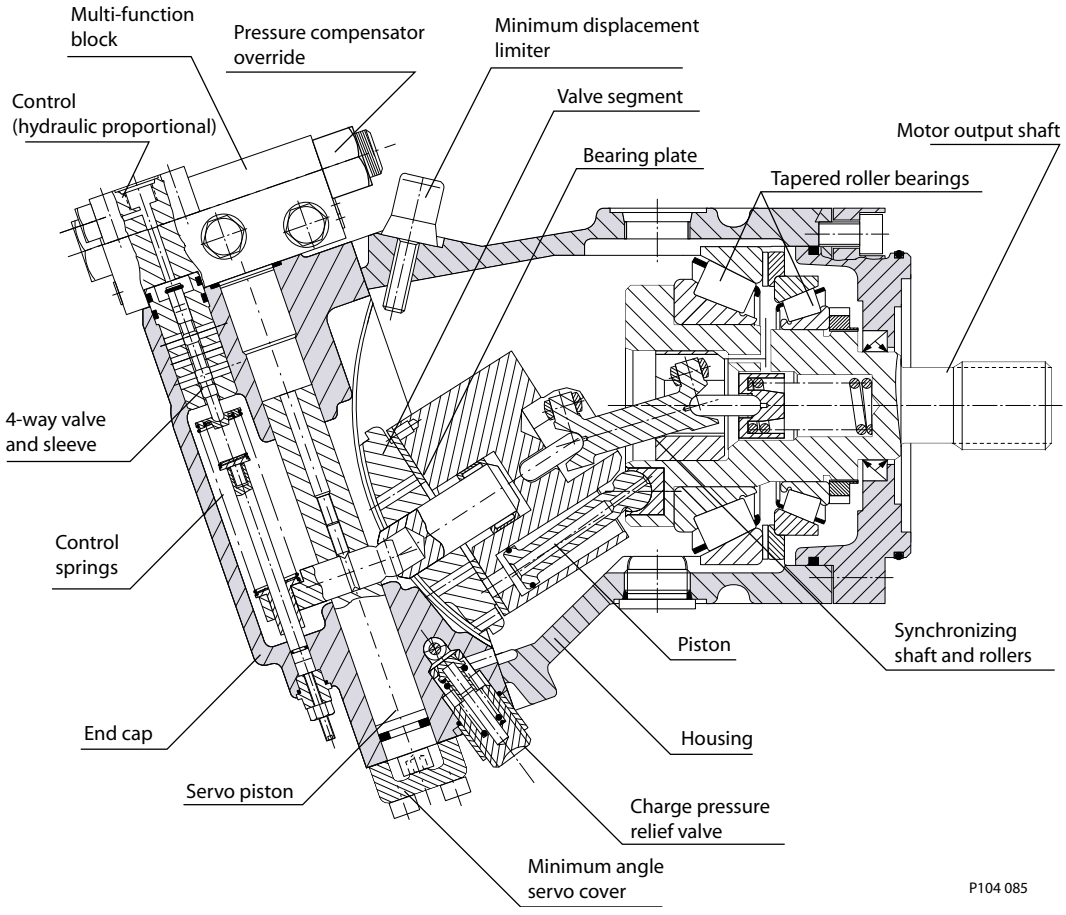

Pressure measurement/gauge location or specification

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

Section diagram

Series 51 bent axis variable motor



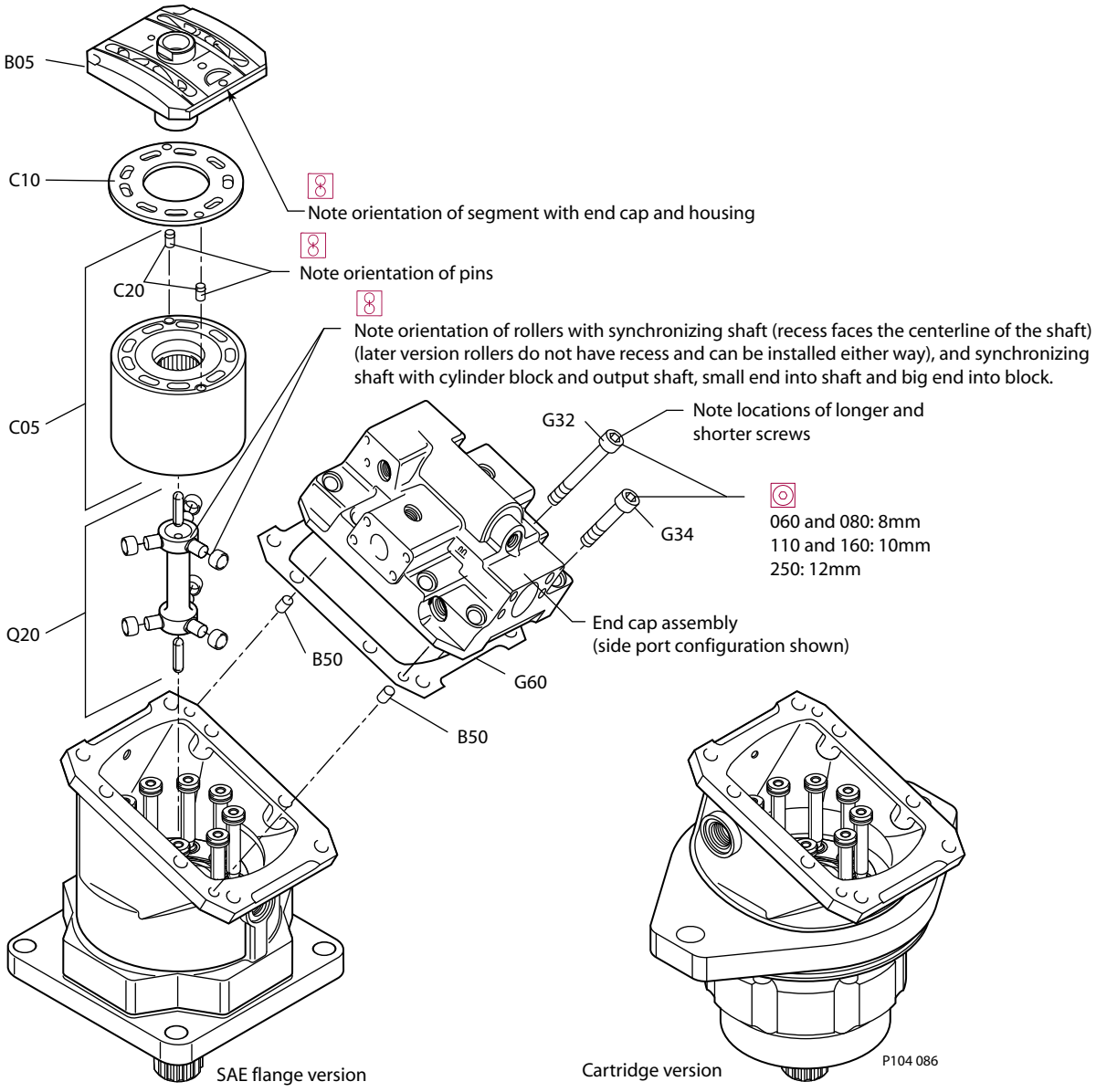
Disassembly

Endcap

Following procedures in the Series 51 and 51-1 Service Manual, 11008567: Remove the control and multi-function block (if installed). Remove the 4-way valve spool and sleeve (if installed). Remove the threshold springs and guides. Remove the control springs (if installed). Remove the ramp springs and guides (if installed). Remove the minimum angle servo cover from the motor. Remove the loop-flushing valve and charge relief valve.

1. Remove the screws (G32 and G34) retaining the end cap assembly to the motor housing.
2. Remove the end cap assembly.
3. Remove the gasket (G60); discard.
4. Remove the alignment pins (B50).

Endcap and rotating components

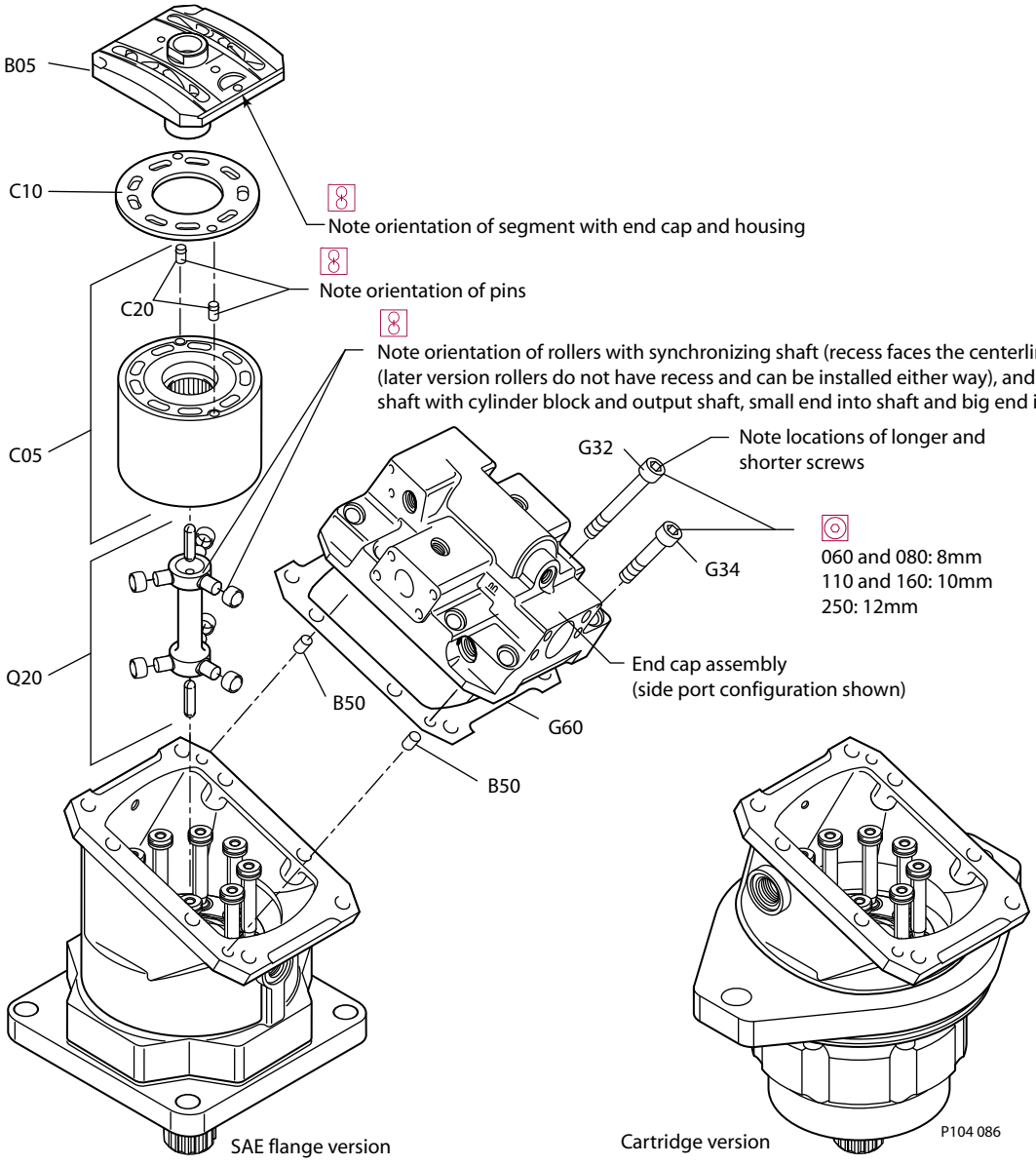


Disassembly

Rotating components

1. Remove the valve segment (B05) and set aside.
2. Remove the bearing plate (C10) and alignment pins (C20).
3. Remove the cylinder block (C05) and set aside. Be careful not to scratch the running surface of the block.
4. Remove the synchronizing shaft assembly (C20) with rollers and pins.

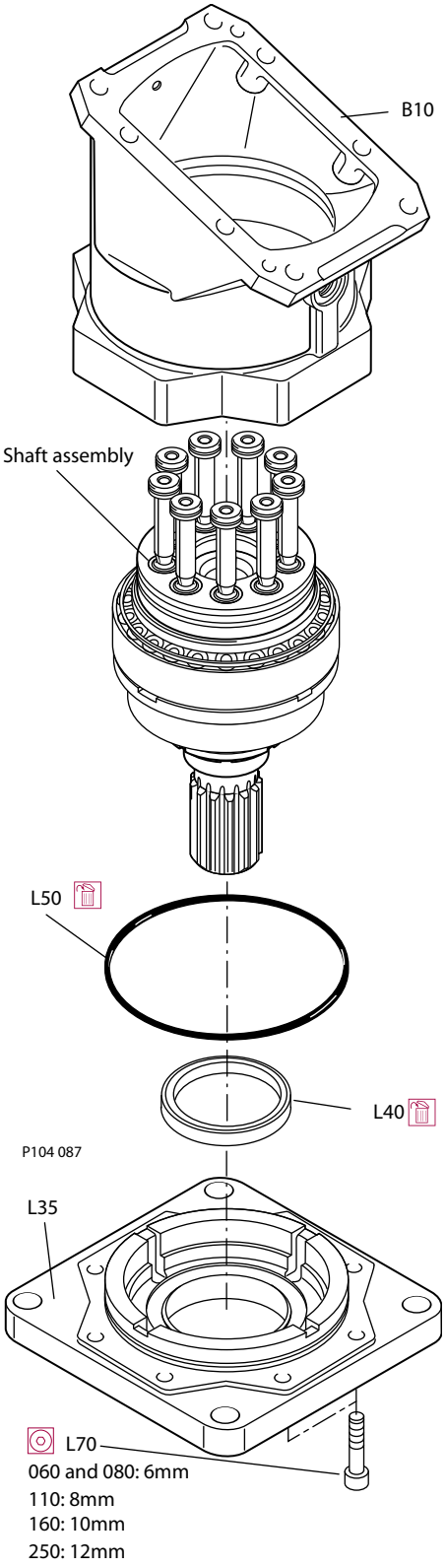
Endcap and rotating components



Disassembly

Shaft removal (SAE or DIN)

Shaft assembly SAE or DIN flange version



Disassembly

1. Remove screws (L70) retaining the mounting flange (L35) to the main housing (B10).
2. Remove the mounting flange using a suitable puller.
3. Remove the O-ring (L50); discard.
4. Remove the shaft seal (L40) from the flange; discard.
5. Press shaft assembly out of main housing, taking care not to damage the shaft and speed sensor ring (if installed).

Caution

Do not damage piston sockets.

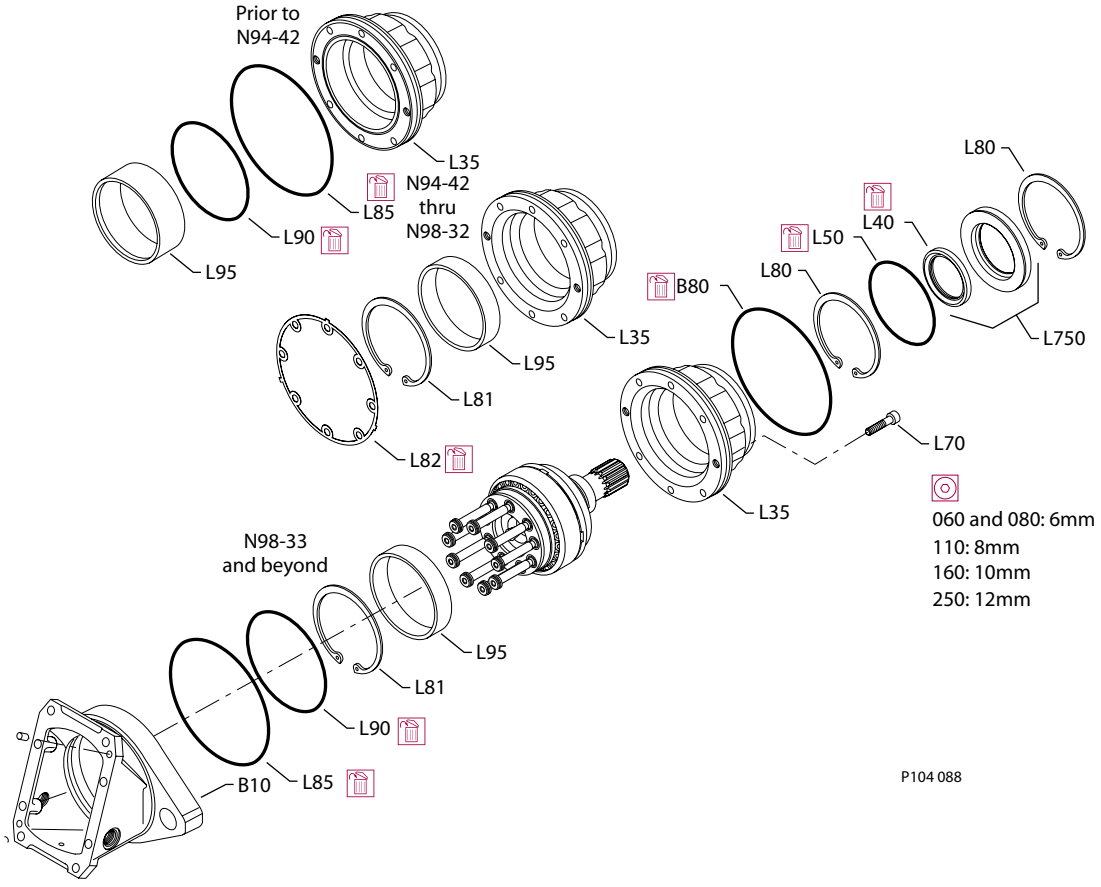
Shaft removal (Cartridge)

1. Remove retaining ring (L80).
2. Remove seal carrier (L750).
3. Remove shaft seal (L40); discard.
4. Remove retaining ring (L80) for the shaft seal carrier (L750) from the bearing housing (L35).
5. Remove the screws (L70) retaining the bearing housing (L35) to the main housing (B10).
6. Separate the bearing housing from the main housing (B10).
7. Remove the retaining ring (L81) if present.
8. Remove spacer ring (L95).
9. Remove O-rings (L85 and L90, or gasket L82); discard.

Disassembly

10. Press shaft assembly out of bearing housing, taking care to not damage the shaft, piston sockets, and speed sensor ring (if installed).

Shaft assembly, cartridge version



Endcap disassembly

060 frame

1. Remove end cap plug (G80). Remove O-ring (G80A) from plug; discard.

2. Remove lock screws (F28) from servo piston (F12).

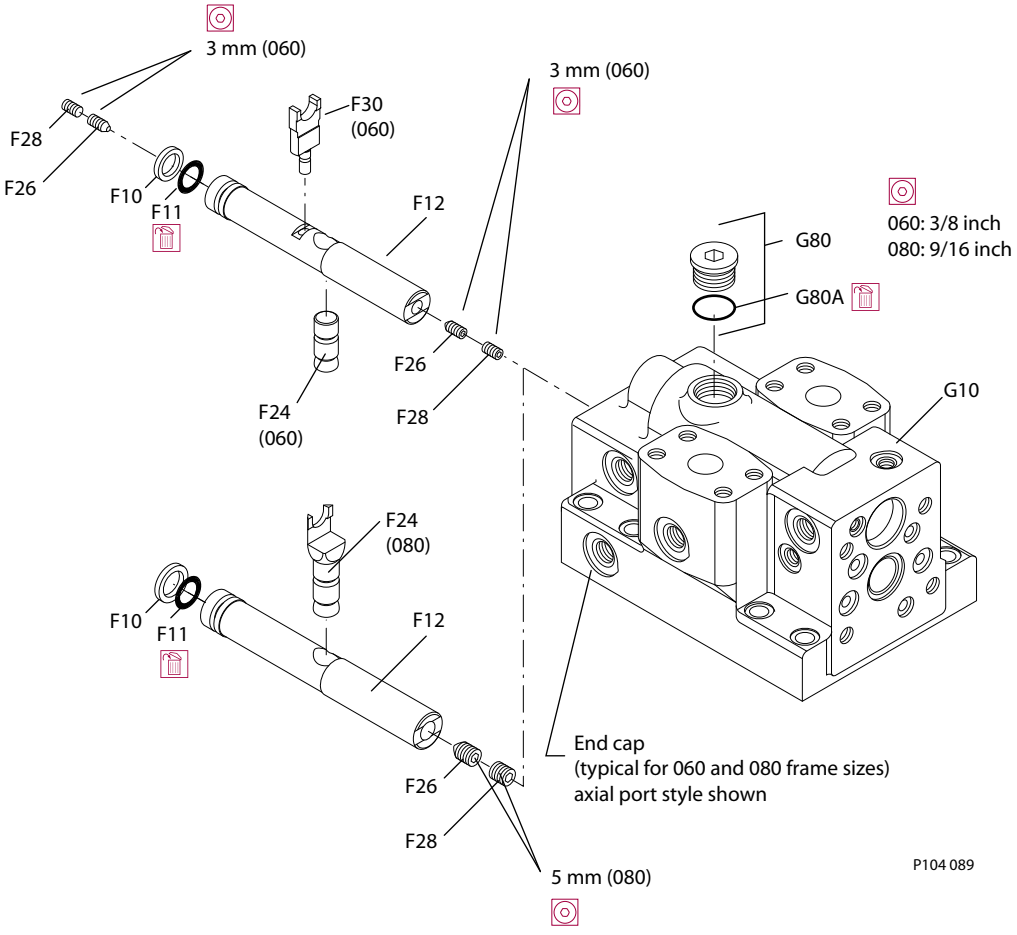
3. Remove cone-point set screws (F26) from servo piston.

4. Remove feedback fork (F30) through the hole in the end cap.

Disassembly

5. Remove the setting lug (F24) from inside of end cap.

End cap components



080 frame

1. Remove end cap plug (G80).
2. Remove lock screw (F28).
3. Remove cone-point set screw (F26).
4. Remove feedback fork / setting lug (F24) through hole in end cap.

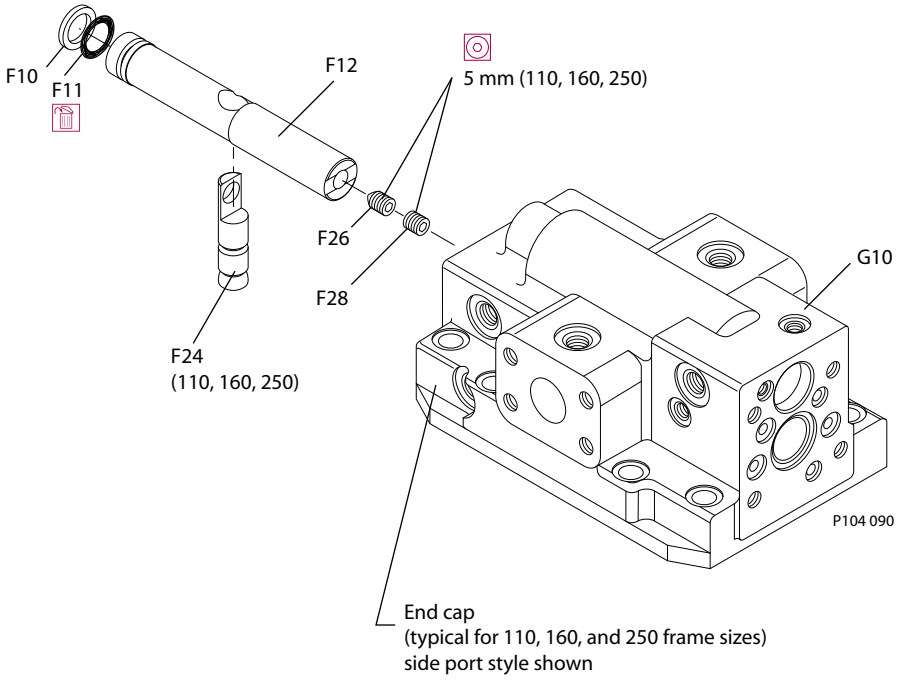
110 - 250 frame

1. Remove lock screw (F28).
2. Remove cone-point set screw (F26).

Disassembly

3. Remove feedback fork / setting lug (F24) from inside of end cap.

Disassembling the end cap



All frame sizes

1. Remove servo piston (F12) from end cap (F10) glide ring end first.
2. Inspect glide ring (F10) for damage or wear.
3. Remove glide ring (F10) from servo piston if you need to replace it.
4. Remove O-ring (F11) from servo piston; discard.
5. Inspect servo piston bore in end cap for damage or wear.

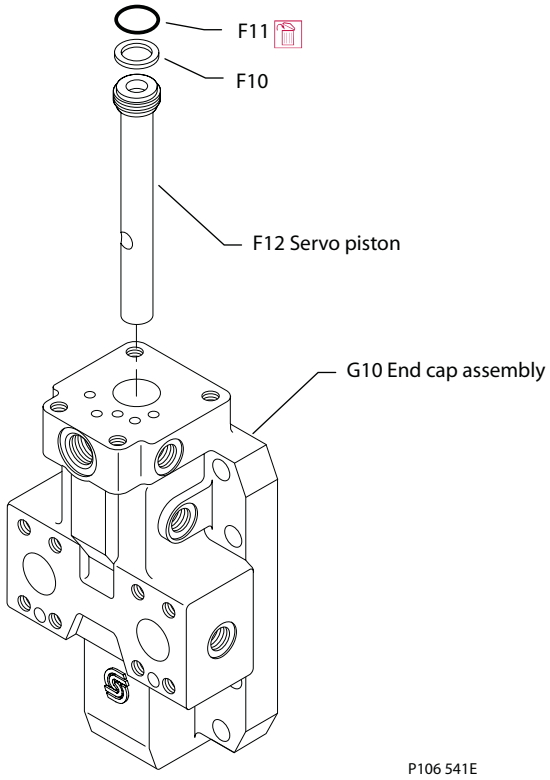
51-1 Endcap

1. Remove servo piston (F12) from end cap (G10) glide ring end first.
2. Inspect glide ring (F10) for damage or wear.
3. Remove glide ring (F10) from servo piston if you need to replace it.
4. Remove O-ring (F11) from servo piston; discard.

Disassembly

5. Inspect servo piston bore in end cap for damage or wear.

Disassembling the end cap



Inspection

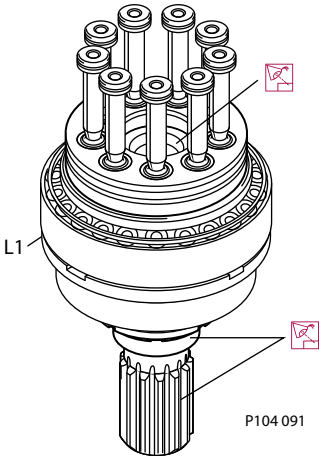
Shaft assembly

Caution

The optional magnetic speed sensor ring is pressed onto a machined surface of the shaft. Take care not to damage the sensor ring.

1. Check the seal area of the shaft (L1) for damage or wear.
2. Check the output splines for damage or wear.
3. Inspect synchronizing shaft raceways for wear.
4. Inspect shaft bearings for wear and roughness.
5. Check that the bearing retaining nut is firmly staked to the output shaft, and that no noticeable looseness is present in the bearings.
6. Check the piston assemblies (L84) for damage or wear.

Shaft assembly



Bearings and pistons are not individually serviceable. Replace the entire shaft assembly if any components are damaged or worn.

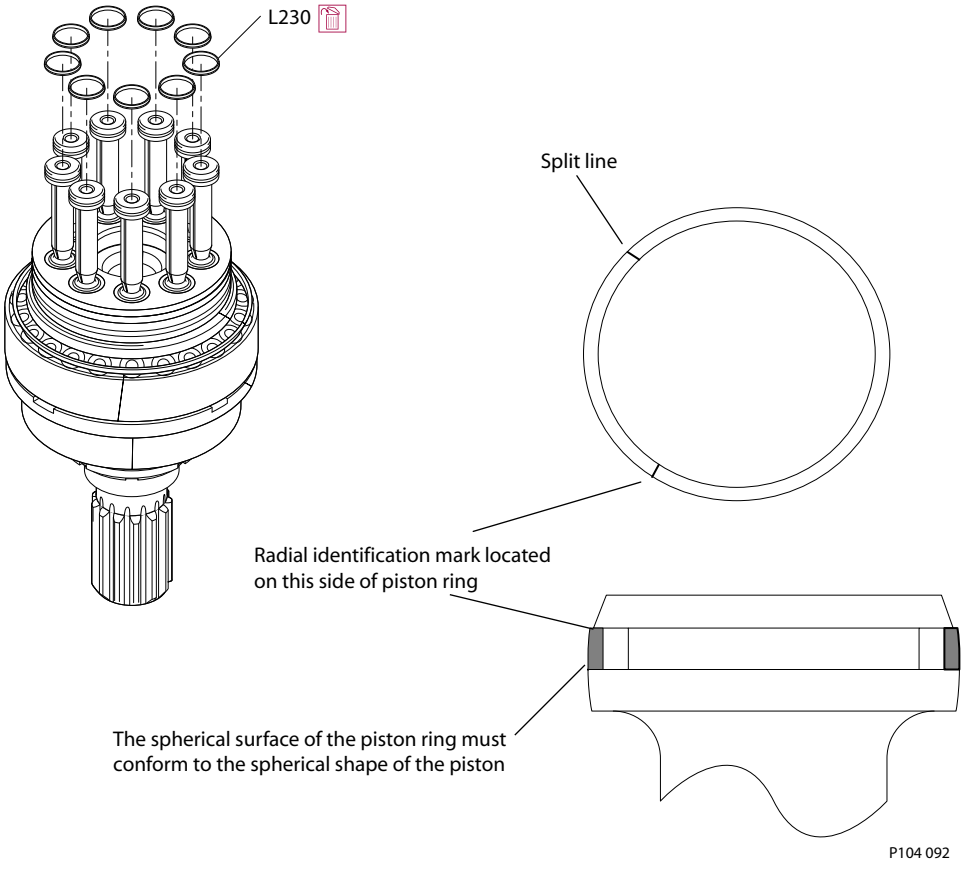
Piston rings

1. Use a small pair of retaining ring pliers to spread and remove the piston rings (L230) from the pistons. Discard the rings.

Inspection

2. Install new piston rings (L230). Ensure the spherical surface conforms to the shape of the piston. A radial identification mark appears on the outer side of the piston rings. Do not let the ends of each piston ring overlap each other.

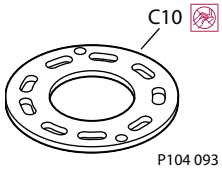
Spherical piston rings



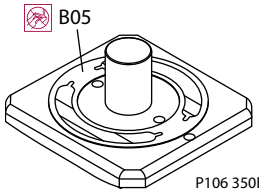
Bearing plate, valve segment, and cylinder block

1. Inspect the bronze surface of the bearing plate (C10) for damage and excessive wear. Sealing surface must be free from scratches and nicks. The locating pin holes must not be worn. Replace if necessary.

Bearing plate



Valve segment

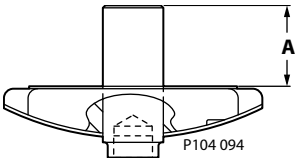


2. Inspect the valve segment (B05) for damage or wear on the sealing surfaces.

Inspection

3. Inspect the spindle for wear.
4. Ensure the spindle is located correctly in the valve segment by measuring distance **A**. If this dimension is not within the range shown in the table, it indicates that the spindle has moved in the valve segment. Replace it.

Valve segment



Spindle location distance

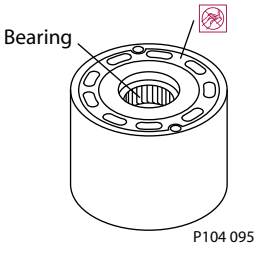
Frame size	Distance A mm [in]
060	27.5 ± .4 [1.08 ± 0.02]
080	32 ± .4 [1.25 ± 0.02]
110	34 ± .4 [1.34 ± 0.02]
160	38.9 ± .4 [1.49 ± 0.02]
250	44.2 ± .4 [1.74 ± 0.02]

Do not lap the valve segment to remove scratches. The hard treated surface is thin and lapping may remove this surface. Removing the spindle loosens its tight press fit and allows it to move.

5. Inspect cylinder block assembly for wear or damage. If bearing is worn or damaged, replace the complete block assembly. The bearing is not available as a separate part.

   The piston bores must be smooth. The bearing plate surface must be free from scratches or nicks. The holes for the bearing plate locating pins must be free from wear. The races for the synchronizing shaft rollers must also be free from wear.

Cylinder block bearing



Assembly

Endcap assembly

All frame sizes

1. Carefully install a new O-ring (F11) and glide ring (F10) on the servo piston (F12).
2. Lubricate the glide ring.
3. Install the servo piston into the end cap (G10).

   The end of the servo piston with the glide ring is opposite the multi-function block/control mounting surface of the end cap.

060 frame

1. Install the setting lug (F24) into the servo piston (F12) from inside of end cap.
2. Using a 3 mm internal hex wrench, install the cone-point set screw (F26) so that its point enters the groove in the setting lug and torque to 5 N•m [44 lbf•in].
3. Install the lock screw (F28).
4. Using a 3 mm hex wrench torque the lock screw (F28) to 7 N•m [62 lbf•in].
5. Install the feedback fork (F30) into the servo piston through the hole in the end cap.

   The contact pads on the fork must face toward the multi-function block/control end of the end cap.

6. Using a 3mm internal hex wrench, install the other cone-point set screw (F26) so that its point enters the groove in the feedback fork (F30). Do not tighten the set screw yet. See page 21 for final assembly instructions.
7. Lubricate and install a new O-ring (G80A) on the end cap plug (G80). Install the plug.
8. Using a 3/8 in. internal hex wrench, torque the end cap plug to 40 N•m [29.5 lbf•ft].

080 frame

1. Install feedback fork / setting lug (F24) into the servo piston through the hole in the end cap.

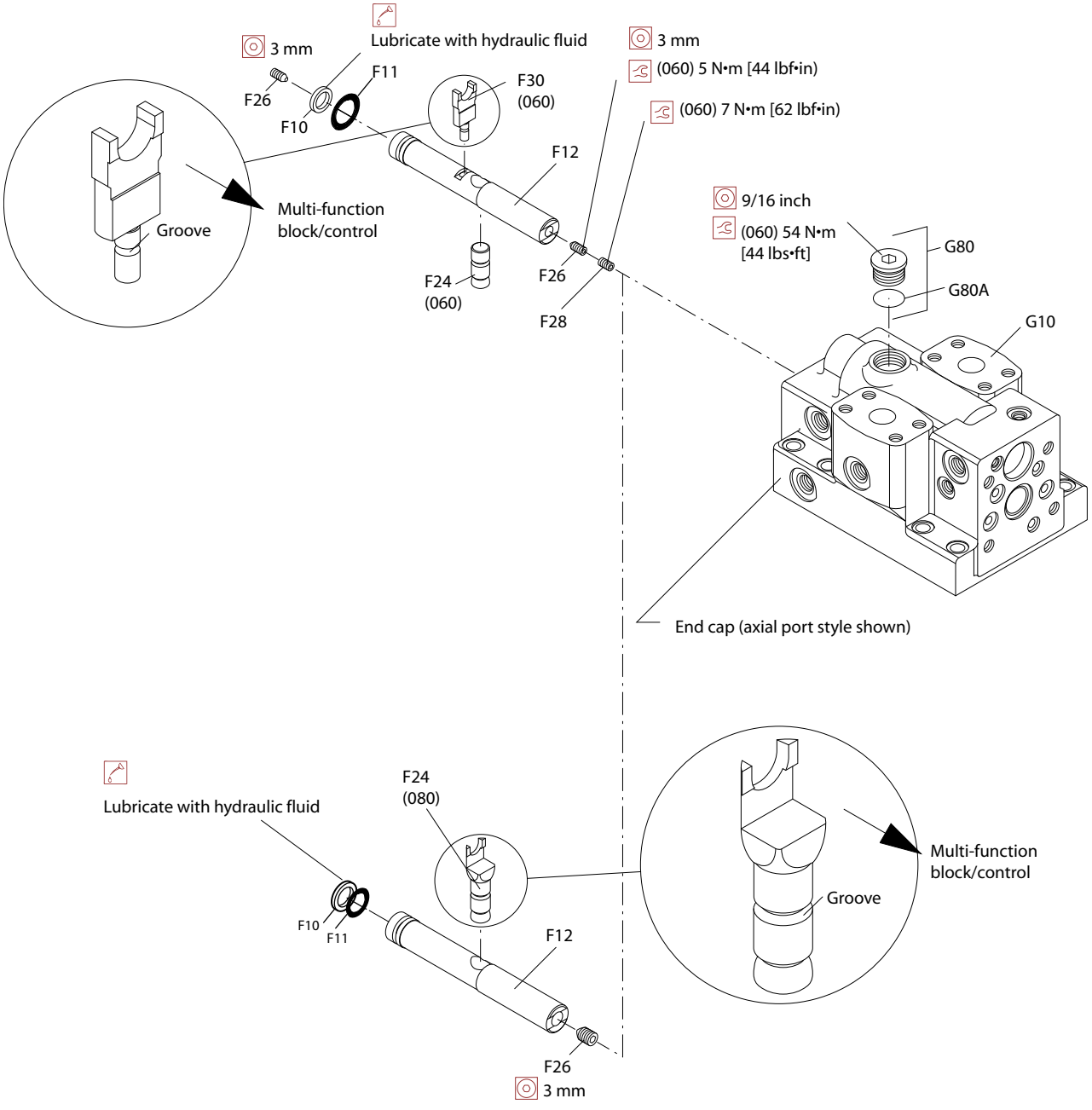
   The offset of the fork must be facing away from the multi-function block / control end of the end cap.

2. Install the cone-point set screw (F26) so that its point enters the groove in the feedback fork (F30) / setting lug (F24). Do not tighten the set screw yet. See page 21 for final assembly instructions.
3. Install the end cap plug (G80).

Assembly

4. Using a 9/16 in. internal hex wrench torque the end cap plug (G80) to 40 N•m [29.5 lbf•ft].

Setting lugs



P104 096

110-250 frames

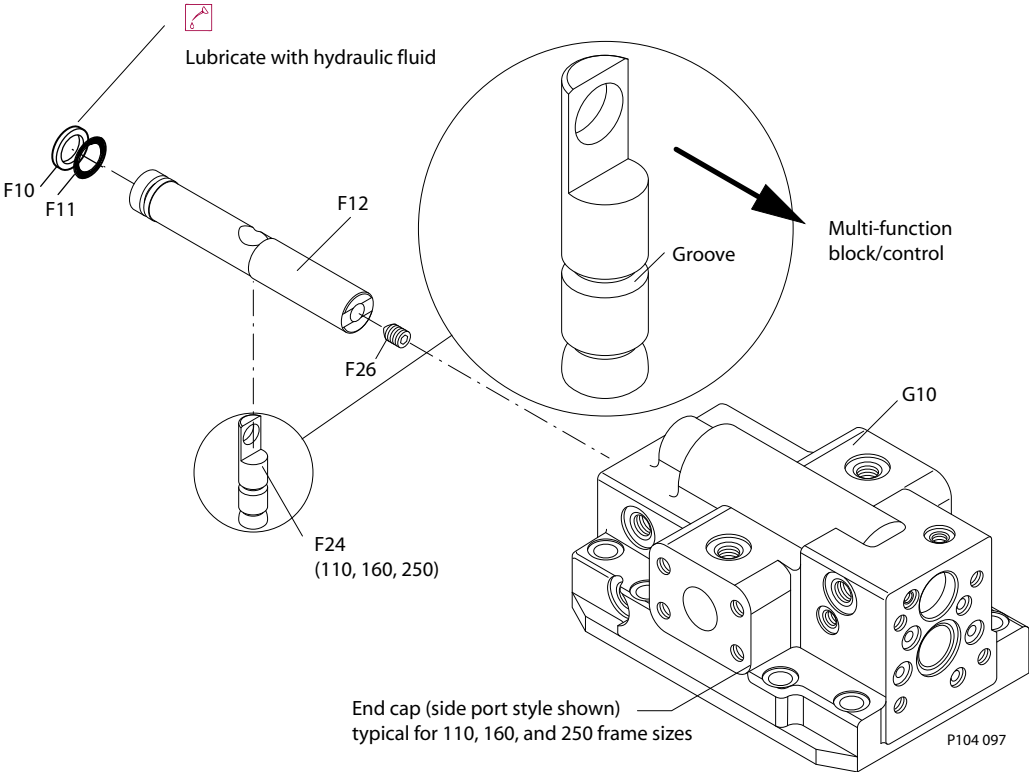
1. Install feedback fork (F24) / setting lug into the servo piston from inside of the endcap.

The offset of the fork must be away from the multi-function block / control end of the end cap.

Assembly

2. Install the cone-point set screw (F26) so that its point enters the groove in the feedback fork (F24) / setting lug. Do not tighten the set screw yet. See page 21 for final assembly instructions.

Cone-point screw and feedback fork

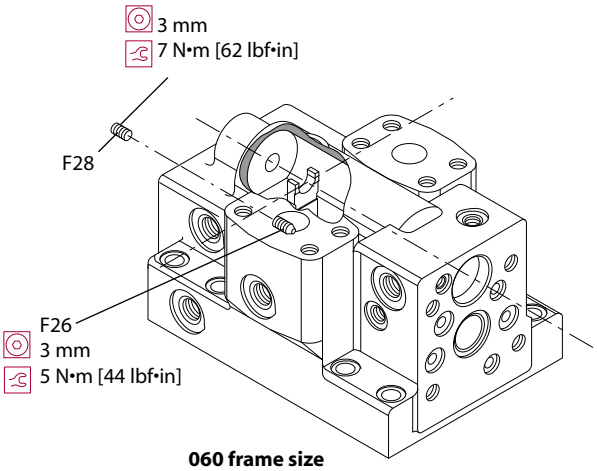


All frame sizes

1. Position feedback fork (F30) (060 cc) or feedback fork/setting lug (080 cc - 250 cc) perpendicular to the setting piston for proper control spring operation.
2. Insert a 26.9 mm [1.06 in] diameter rod, with the end machined perpendicular to its axis, into the valve sleeve bore in the end cap. Align the fork while tightening the cone-point set screw (F26).
3. Using a 3 or 5 mm internal hex wrench, torque the cone-point set screw to 5 N•m [44 lbf•in].
4. Install and torque the lock screw (F28) to
   - 7 N•m [62 lbf•in] using a 3 mm internal hex wrench for a 60 cc motor
   - 34 N•m [25 lbf•ft] using a 5 mm internal hex wrench for the 80 cc through 250 cc motors

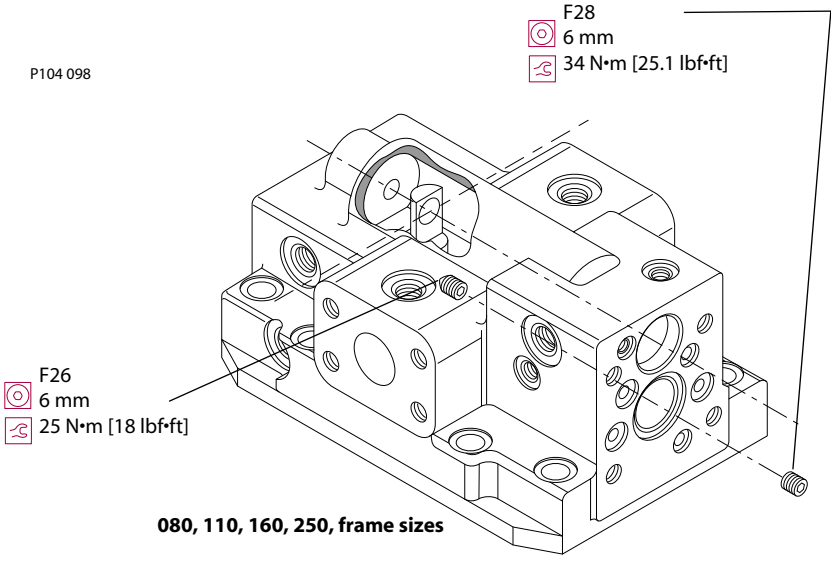
Assembly

Cone-point set screws



060 frame size

P104 098



080, 110, 160, 250, frame sizes

Shaft and mounting flange assembly

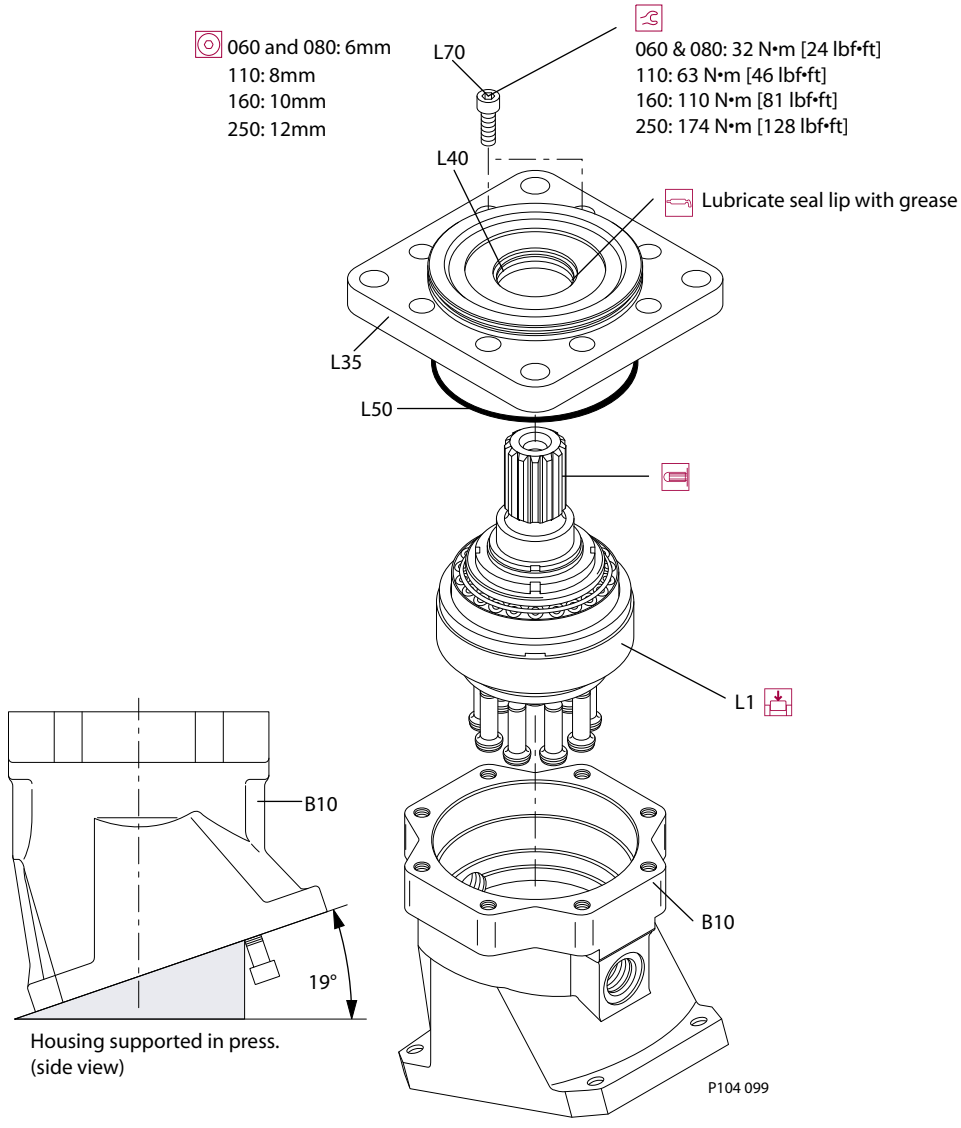
SAE/DIN flange

1. Support the main housing (B10) so the bearing bore is vertical.
2. Press shaft assembly (L1) into main housing.
3. Install new O-ring (L50) on mounting flange (L35).
4. Install new seal (L40) in flange.
5. Cover the shaft splines with an installation sleeve to protect the seal during assembly. Install flange assembly (L35).
6. Install screws (L70).

Assembly

7. Torque screws (L70) to value shown in the diagram.

SAE/DIN Flange version bearing bore and housing



Cartridge flange

1. Install the inner retaining ring (L80) for the shaft seal carrier in the bearing housing.
2. Press shaft assembly into bearing housing (L35).
3. Install spacer ring (L95). C

Caution

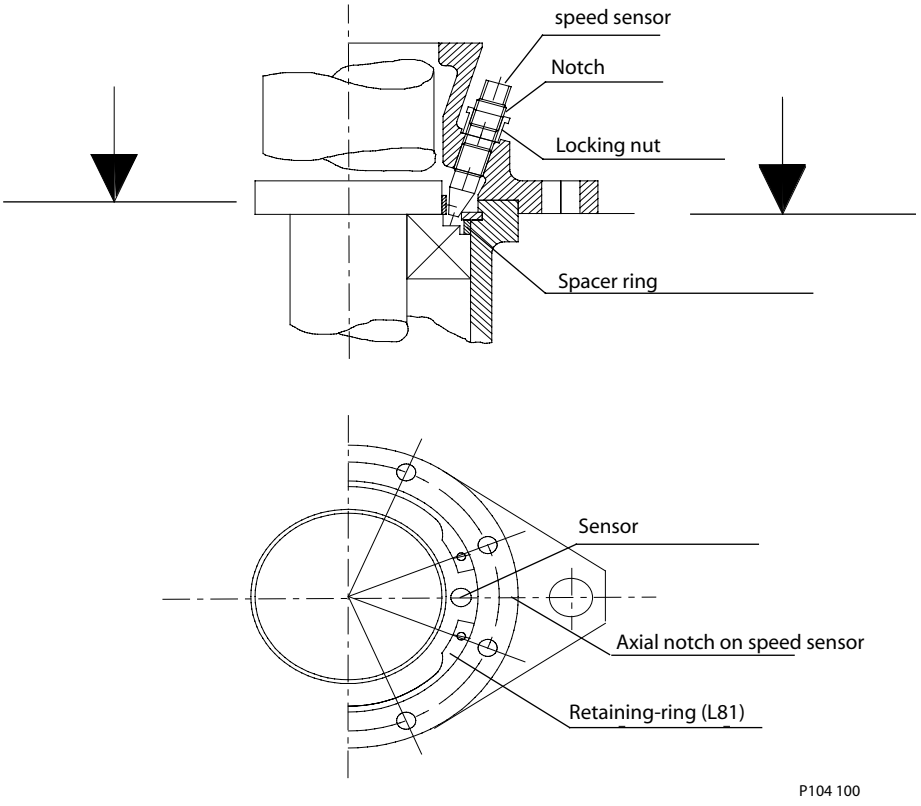
Do not damage the piston sockets or shaft seal surface.

4. Install the end of the spacer with the larger inside diameter next to the inner shaft bearing cup.
5. Install retaining ring (L81).

Assembly

6. Align ends of the retaining ring between the two bolt holes to allow clearance for speed sensor.

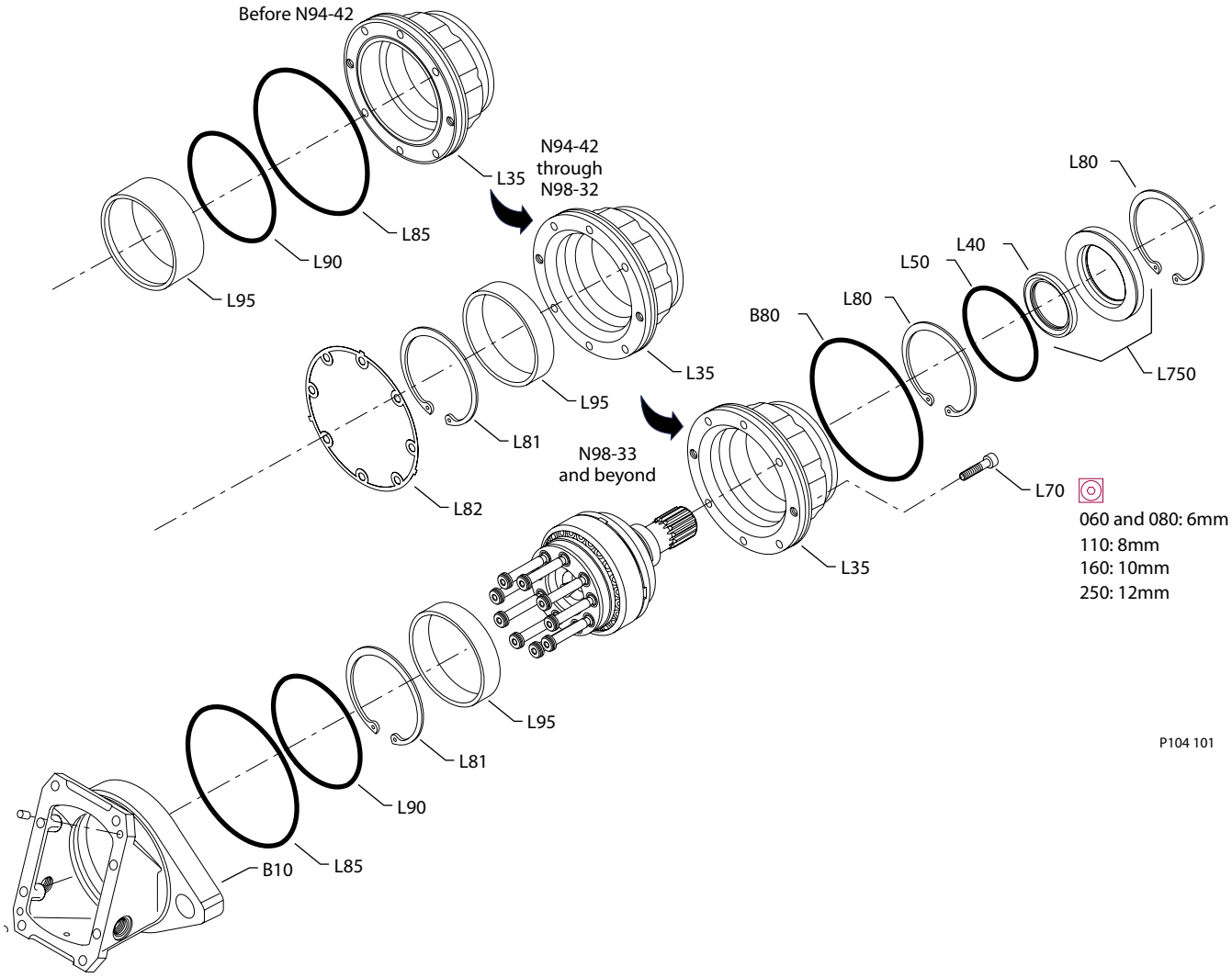
Speed sensors



7. Install O-rings (L85) and (L90) or gasket (L82).
8. Install main housing (B10). Ensure snap ring (L81) ends align with speed sensor port.
9. Install screws (L70).
10. Torque screws:
    - 32 N•m [24 lbf•ft] for 60 cc and 80 cc
    - 63 N•m [46 lbf•ft] for 110 cc
    - 110 N•m [81 lbf•ft] for 160 cc

Assembly

Cartridge version bearing bore and housing



Cylinder block and synchronizing shaft

Synchronizing shaft and rollers

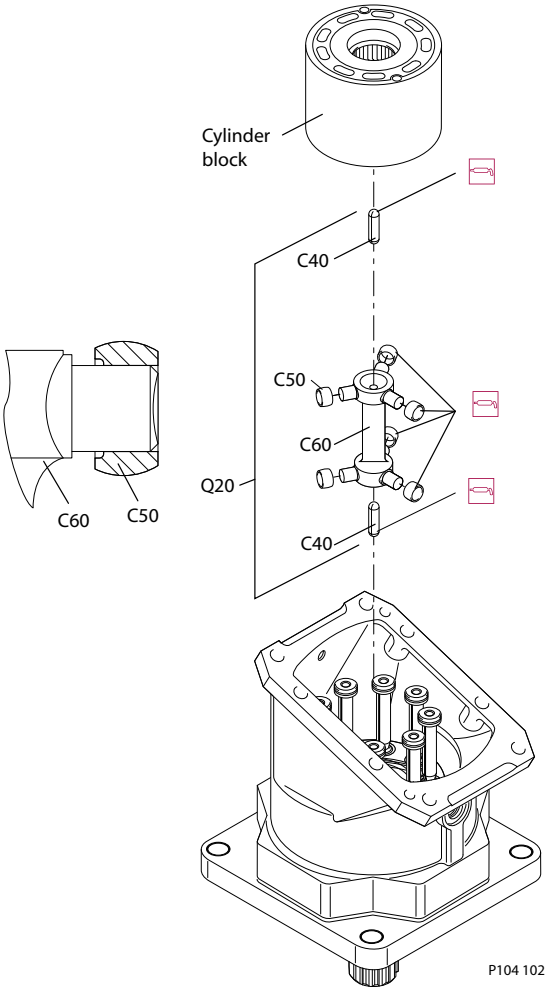
1. Using petroleum jelly to retain it, install the first synchronizing shaft support pin (C40) into the recess in the cylinder block.
2. Using petroleum jelly to retain them, install the synchronizing shaft rollers (C50) on the journals of the synchronizing shaft (C60).
3. Position the recess on each roller to face the center line of the synchronizing shaft.

Motors built after serial number N01-39-XXXXX have symmetrical rollers.
See service bulletin SB-2001-015.

Assembly

4. Position each roller with its outside edge flush with the end of the synchronizing shaft journal.

Cylinder block and sync-shaft



5. Install the second C40 synchronizing shaft support pin into the motor shaft assembly.

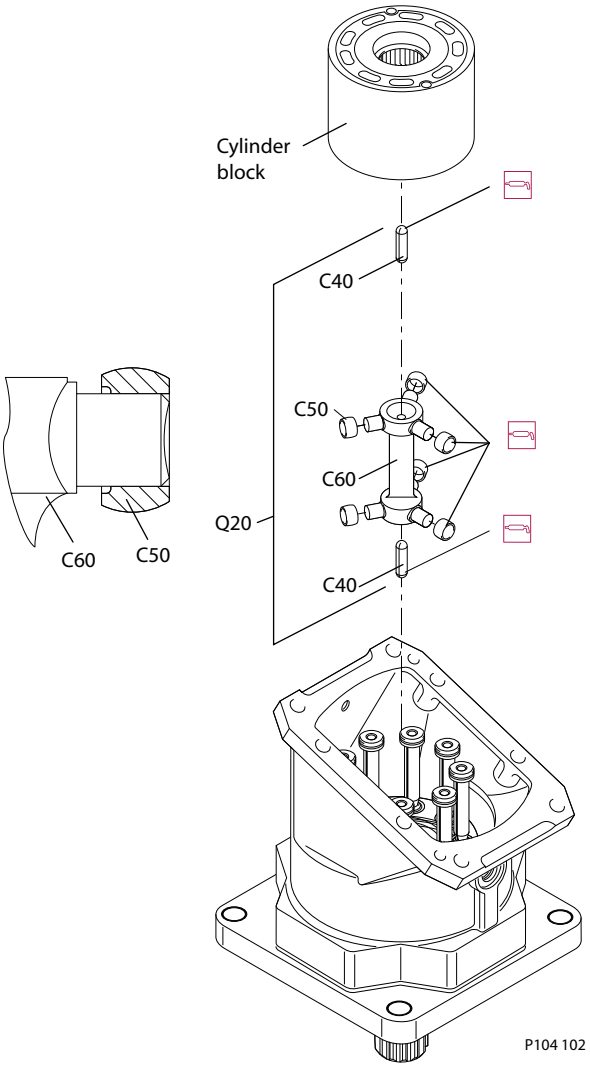
6. Install the synchronizing shaft and rollers into the motor shaft.

The cylinder block end of the shaft is a larger diameter than the motor shaft end on all frame sizes. The rollers must enter the races in the motor shaft and the recess in the end of the synchronizing shaft must engage the support pin.

Assembly

7. Tip and rotate the synchronizing shaft in all directions to check for binding. The synchronizing shaft rollers must move freely in the races in the motor shaft.

Cylinder block and sync-shaft



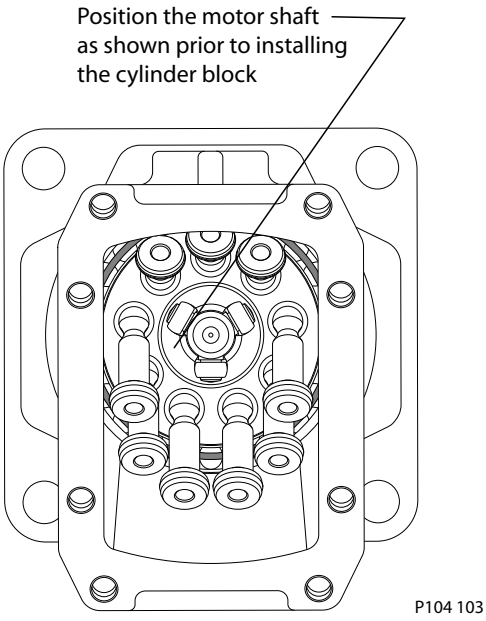
Cylinder block

1. Lubricate the pistons and sync-shaft and rollers with clean hydraulic oil and rotate the shaft to the position shown in the illustration.
2. Tip the 3 pistons closest to the minimum angle stop out, toward the housing.
3. Tip the 6 remaining pistons forward toward the lowest part of the end cap mounting surface.
4. Tip the synchronizing shaft forward toward the lowest part of the end cap mounting surface.
5. Position the cylinder block so one synchronizing shaft roller raceway is aligned between two pistons.

Assembly

6. Install the cylinder block and its support pin (C40) on to the pistons and synchronizing shaft.

Pistons



(Cylinder block not installed)

The synchronizing shaft rollers (C50) enter their races in the block, while each piston enters its corresponding bore in the block.

7. Insert a brass rod through the cylinder block kidneys to guide the pistons into position.
8. Start with the four (4) pistons closest to the lowest part of the end cap mounting surface.
9. After the 4 pistons enter their bores, tilt the cylinder block so the synchronizing shaft rollers (C50) enter their races in the cylinder block and the next two pistons enter their bore.

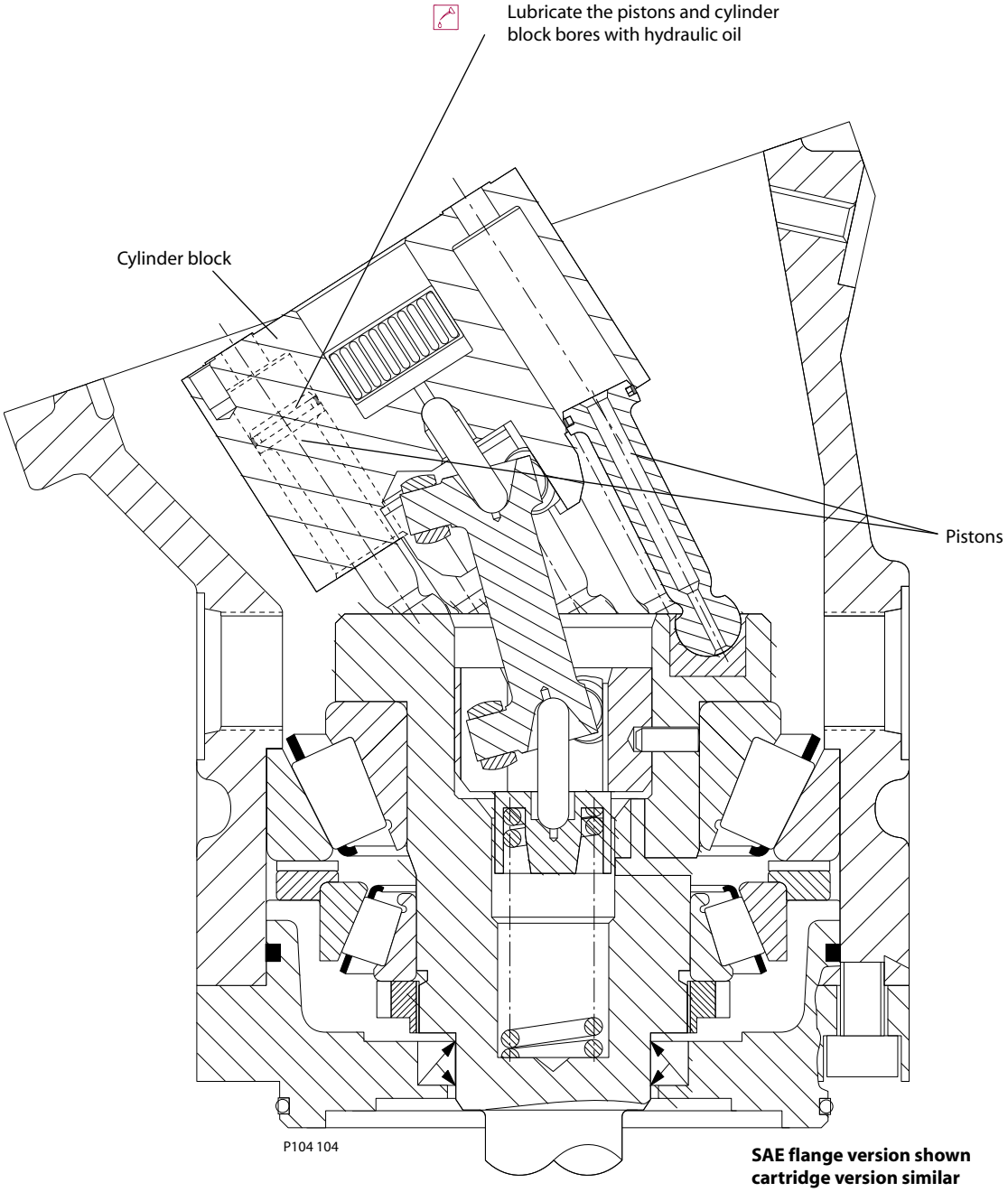
The support pin (C40) enters its recess in the synchronizing shaft (C60).

10. Lift the cylinder block slightly.
11. Guide the remaining 3 pistons into their bores.
12. After the last piston is in position, check the position of the rollers closest to the minimum angle stop.
13. Maintain an inward force on the cylinder block.
14. Carefully push it toward the highest part of the end cap mounting surface.
15. Check that all of the synchronizing shaft rollers are in position.

If the cylinder block is properly installed, there will be very little rotational free-play between the cylinder block and the motor shaft.

Assembly

Cylinder block



SAE flange version shown cartridge version similar

Bearing plate and valve segment

Bearing plate

1. Install the bearing plate locating pins (C20) into the cylinder block.
2. Install the longer end of each shouldered pin into the block.
3. Install the bearing plate (C10) on the cylinder block, with steel side facing the block.
4. Lubricate the bronze side of the plate with hydraulic oil.
5. Install the end cap alignment pins (B50). Install a new gasket (G60).

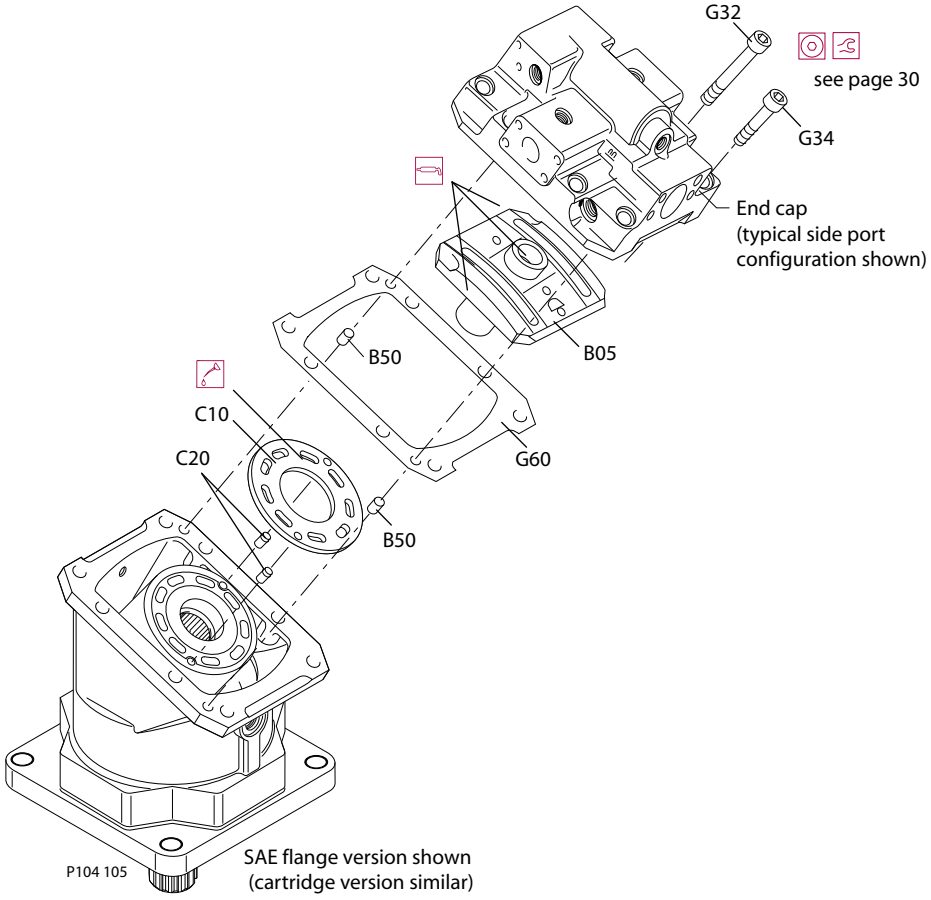
Assembly

6. Locate the cylinder block in the approximate center of the housing opening.

   Tip the housing until the endcap mounting surface is level to help keep the block centered. Do not allow pistons or synchronizing shaft rollers to fall out of position

7. Using petroleum jelly, install the valve segment (B05) into the end cap so the segment spindle engages the setting lug in the servo piston.
8. Orient the valve segment so the hole at the edge is aligned with the loop-flushing valve drain hole in the end cap.
9. Locate the valve segment and servo piston in the approximate center of their travel.

Bearing plate and valve segment



Endcap installation

1. Rotate the motor shaft and check for play between the shaft and cylinder block. Any play indicates that the synchronizing shaft rollers are not installed correctly.
2. Install the end cap assembly and valve segment so the spindle engages the bearing in the cylinder block.

   Caution

   Do not allow the pistons or synchronizing shaft rollers to fall out of position.

3. Install screws (G32) and (G34) to retain the end cap assembly to the motor.

   Install the screws in their proper locations to ensure adequate thread engagement. The internal spring (in the motor shaft) will hold the end cap away from the housing a short distance.

Assembly

4. Tighten the screws by hand in a double-X pattern while rotating the motor shaft to ensure proper positioning of the synchronizing shaft rollers.
5. When the end cap is in position, torque the screws in a double-X pattern as shown in the table:

Endcap screw torque

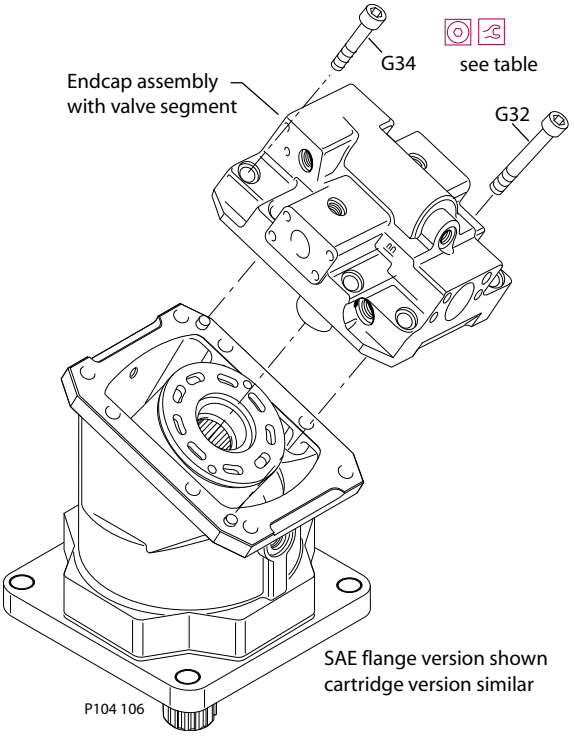
Frame size	Wrench size	Torque N•m [lbf•ft]
060	8 mm	66 [49]
080	8 mm	78 [58]
110	10 mm	115 [85]
160	10 mm	135 [100
250	12 mm	213 [157]

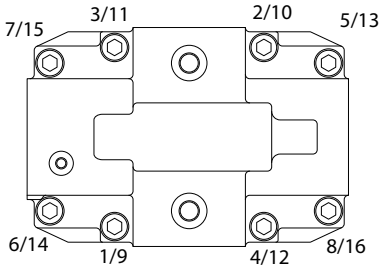
Caution

Do not force the end cap into position on the housing. If necessary, reassemble the components to ensure proper alignment.

6. Recheck the end cap screw torque.
7. Reinstall the minimum angle servo cover, control springs (if used), 4-way valve spool and sleeve (if used), and control and multifunction block (if used). Refer to Series 51 and 51-1 Service Manual, 11008567 for instructions.

Torquing pattern





Double-X pattern torquing sequence
(110 frame size with side port end cap shown)

Following procedures in the Series 51 and 51-1 Service Manual, 11008567: Install the control and multi-function block (if installed). Install the 4-way valve spool and sleeve (if installed). Install the threshold springs and guides. Install the control springs (if installed). Install the ramp springs and guides (if installed). Install the minimum angle servo cover from the motor. Install the loop-flushing valve and charge relief valve.

Assembly

After assembly, test and adjust the motor as necessary before placing the unit back in service. Refer to Series 51 and 51-1 Service Manual, 11008567 for adjustment procedures.

Products we offer:

- Bent Axis Motors
- Closed Circuit Axial Piston Pumps and Motors
- Displays
- Electrohydraulic Power Steering
- Electrohydraulics
- Hydraulic Power Steering
- Integrated Systems
- Joysticks and Control Handles
- Microcontrollers and Software
- Open Circuit Axial Piston Pumps
- Orbital Motors
- PLUS+1® GUIDE
- Proportional Valves
- Sensors
- Steering
- Transit Mixer Drives

Danfoss Power Solutions is a global manufacturer and supplier of high-quality hydraulic and electronic components. We specialize in providing state-of-the-art technology and solutions that excel in the harsh operating conditions of the mobile off-highway market. Building on our extensive applications expertise, we work closely with our customers to ensure exceptional performance for a broad range of off-highway vehicles.

We help OEMs around the world speed up system development, reduce costs and bring vehicles to market faster.

Danfoss – Your Strongest Partner in Mobile Hydraulics.

Go to www.powersolutions.danfoss.com for further product information.

Wherever off-highway vehicles are at work, so is Danfoss. We offer expert worldwide support for our customers, ensuring the best possible solutions for outstanding performance. And with an extensive network of Global Service Partners, we also provide comprehensive global service for all of our components.

Please contact the Danfoss Power Solution representative nearest you.

Comatrol
www.comatrol.com

Schwarzmüller-Inverter
www.schwarzmueller-inverter.com

Turolla
www.turollaocg.com

Valmova
www.valmova.com

Hydro-Gear
www.hydro-gear.com

Daikin-Sauer-Danfoss
www.daikin-sauer-danfoss.com

Local address:

Danfoss
Power Solutions (US) Company
2800 East 13th Street
Ames, IA 50010, USA
Phone: +1 515 239 6000

Danfoss
Power Solutions GmbH & Co. OHG
Krokamp 35
D-24539 Neumünster, Germany
Phone: +49 4321 871 0

Danfoss
Power Solutions ApS
Nordborgvej 81
DK-6430 Nordborg, Denmark
Phone: +45 7488 2222

Danfoss
Power Solutions
(Shanghai) Co., Ltd.
Building #22, No. 1000 Jin Hai Rd
Jin Qiao, Pudong New District
Shanghai, China 201206
Phone: +86 21 3418 5200