

INDUSTRIAL EQUIPMENT MANUFACTURING LTD.

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OPERATING, INSTALLATION & MAINTENANCE MANUAL

APRON FEEDERS & DRIBBLE CONVEYORS

ITEM ADMIN JOB V977

CUSTOMER INFORMATION

Name _____ MEGATECH ENGINEERING

Project _____

Purchase Order _____ 110557

Reference _____ Apron Feeder

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A. GENERAL

CONTACT PERSONNEL

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GENERAL DESCRIPTION

The Apron Feeders comprise of:

- 1) D8N Series, 215.9mm Pitch for 2134mm Wide Inclined Apron Feeder
- 2) Cast manganese apron pans bolted to the chain using hi-strength track bolts.
- 3) Two segmental sprockets, 21 teeth, three segments bolted to steel hubs mounted on head shaft.
- 4) Two segmental traction wheels bolted to steel hubs mounted on tail shaft.
- 5) Heavy duty support rollers to support chain on the working part of the feeder (Same indication sizes as chain. eg: D8).
- 6) Return rollers to support pans/chain. Pan ends run on the outside surface of rollers on return. (Part number S638B).
- 7) Drive system comprising of Electric motor and SEW Eurodrive Right Angle Planetary Reducer
- 8) Apron Feeder operates in one direction only as shown on GA drawings.

SAFETY PRECAUTIONS

Do not operate Apron Feeder with guardrails removed, except as may be required for maintenance.

During maintenance, Apron Feeder is to be fenced off and electrical supply and control are to be locked out in accordance with plant safety procedures.

Apron Feeder may require operation during maintenance for inspection and/or for momentary advancement when replacing pans or chains.

When the feeder is to be run it must be verified that no one is in contact or near the feeder posing any danger prior to starting it.

During the actual work on the feeder, the feeder must be locked out at all times.

It is recommended that a minimum of two workers be in attendance at all times during maintenance.

Plant safety procedures should be reviewed for additional precautions and procedures.

B. OPERATING INSTRUCTIONS

The Apron Feeder is controlled from a remote location using plant PLC.

On initial startup, it is recommended to have the feeder running at 20% speed prior to initial load of ore being handled.

As ore is loaded, speed unit up during a five minute period to the maximum speed.

It is recommended that a bed of ore be maintained on the pans to soften the direct impact of ore on the apron pans. This will tend to extend the life of the pans.

The feeder has a “Zero Speed” switch equipped to monitor the speed of the tail shaft. The PLC will need to be programmed to allow for little rotation during slow startups of the feeder. During normal operation the PLC should be programmed to trip the drive if the head or tail shaft falls speed falls too low

In the event of a jamming / stall condition, the Apron Feeder drive must be shut down automatically. Feeder must be checked and problem resolved before operating again.

DO NOT REVERSE THE DRIVE DIRECTION. The Apron Feeder is designed to operate in one direction only.

C. INSTALLATION INSTRUCTIONS

STORAGE

If the equipment and materials will not be needed for installation upon arrival at the site, we recommend the following minimum storage instructions:

- Leave small equipment in its shipping packaging and store instrumentation and field bolts in a protected area.
- If equipment is to be exposed to rain/sun for a long period of time, the following procedures are required:
 - Rotate shafts once a month, where possible. A few turns is enough to spread lubricant in bearings. If chains and pans are already installed and drive is not connected, a come-along can be used to move chain thereby rotating shafts.
 - Re-lubricate pillow blocks and labyrinth seals prior to operation. See FAG bearing lubrication instructions.

LIFTING POINTS & WEIGHTS

The Apron Feeder is supplied with four (4) lifting lugs. Load is fairly evenly distributed on the four lugs when the drive is not already mounted.

Drive to be mounted when Apron Feeder has been positioned and fastened in place.

For lifting the drive assembly use lifting points according to SEW Installation and Maintenance Manual.

It is recommended that spreader bars be used when lifting feeder.

The weight of the feeder/drive is listed on arrangement drawings and shipping lists.

APRON FEEDER LEVELING & ALIGNMENT

Leveling

Apron Feeder will need to be leveled at time of installation.

Extreme ends of main beams are reference points for leveling (4 points). These are used to level unit in shop during fabrication and assembly.

Positioning

Apron feeder needs to be positioned accurately with centerline of feeder as reference point.

Skirtboard centerline should coincide with feeder/apron pans centerline.

Head shaft centerline is reference point to be used to position the feeder longitudinally.

Squaring Shafts

Although shafts were squared and aligned at time of shop assembly, there is a possibility that transport and/or installation of feeder may have caused some movement.

Refer to Industrial Equipment Manufacturing Ltd. Fabricating & Machine Shop Procedures for Apron Feeder Alignment EP-055-00 Oct. 31, 2003.

Clearance

Ensure adequate operating clearance:

- between apron pan sides and outside of skirtboard (minimum 1" per side)
- underside of skirtboard and top of apron pans
- slot through end of skirtboards to clear apron pan lifting lug/pan sides

Grouting

If grouting is used, mount and fasten Apron Feeder to supports ensuring level is maintained and finish grout.

HEAD & TAILSHAFT BEARINGS

Apron Feeder Shipped Assembled

Although the head and tailshaft bearings have been aligned and adjusted during shop assembly, the integrity of alignment should be checked to ensure no movement has taken place during transport or installation.

Apron Feeder Shipped Disassembled

Shaft assemblies are supplied with sprockets/idler wheels mounted on head and tailshafts.

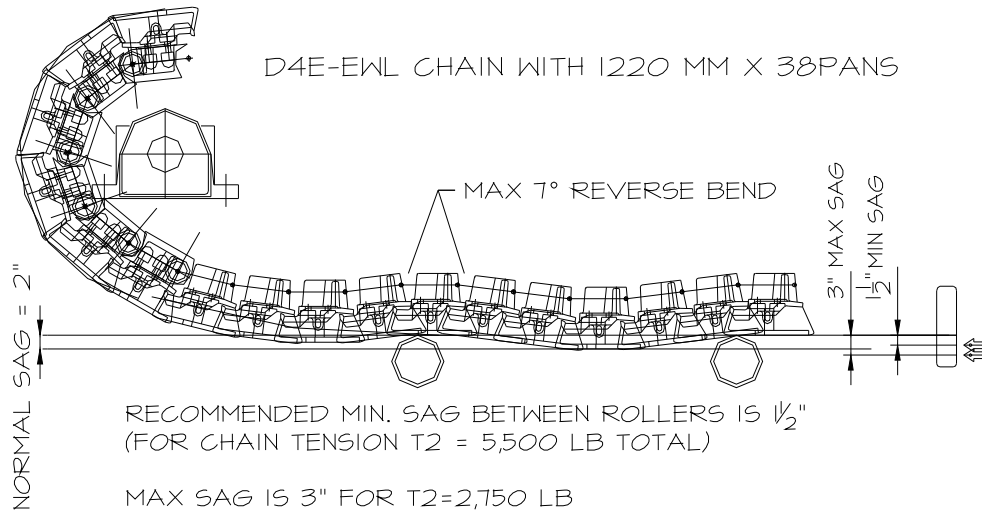
Pillow blocks are mounted on shafts. If bearings have taconite seals, seal assemblies have been backed off to ensure they are not damaged by pillow block movement beyond allowable angles during transit and re-installation.

Shaft assemblies are fit onto Apron Feeder and aligned prior to disassembly for shipment.

Refer to *“Apron Feeder Leveling & Alignment”* for installation and alignment procedure for shaft assemblies.

TAKE - UP ADJUSTMENT / HYDRAULIC ASSIST

Return chain catenary should be checked regularly. Apron pans will accept limited 'back bending'. It is important that chain tension be adjusted as wear occurs to ensure back bending of pans is minimized on the return (maximum 7 degrees)



If the optional integral hydraulic assist system has not been ordered, a portable jack, such as Enerpac, could be used to assist in making chain take-up adjustment.

Note: Make sure both sides are adjusted equally so taconite seals will not be damaged. (Advance each side max 1/8" at a time)

FIELD ASSEMBLED / INSTALLED ITEMS

Feeder & Dribble Conveyor

The Apron Feeders and Dribble conveyors have been shipped individually and will need to be installed in the field. The Apron feeder is mounted on top of the dribble conveyor in eight places. The Dribble conveyor feet are mounted to the floor through the same support beams that are securing the Apron Feeder above. Reference the appropriate arrangement drawing for the field bolt arrangements.

Drive Assembly

The drive assembly has been pre-assembled and shipped separate from the feeder to prevent damage during transportation and installation. The drive shaft and the hollow shaft of the reducer needs to be thoroughly cleaned as per instructions in the SEW Operation and Maintenance manual. The location of the drive on the drive shaft needs to be positioned according to the dimensions given on the general arrangement drawings.

Hydraulic Power Unit

This is also shipped loose to keep safe during transportation. The fluid capacity of the system depends on the size of the Feeder. Please reference dwg: V977-11 and the General Arr't to assemble the Hydraulic Power Assist to the feeder.

Lincoln Lube System

The Lincoln Lubrication system has been shipped separate from the feeder to prevent damage during transportation. The Hydraulic lines and fitting have however been secured to the frame and connected to the head/tail shaft bearings. This also includes the Lincoln injectors. As for the Lincoln Electric Pump, it will need to be mounted to the frame as indicated by the General Arrangement drawings and then connected to the system according to the Lincoln Installation Manual included.

Zero Speed Switch

The Zero Speed Switch has not been supplied by IEM. Please contact Megatech or Rotech for any technical questions regarding installation and operation.

Guard Panels

The guard panels for all the feeders and the dribble conveyors have been shipped separate for ease of shipment. The guards are installed by simply dropping them into the pipe slots fabricated to the frames. The arrangement drawings for each feeder and dribble conveyor show the location of these panels.

(See "MAINTENANCE" section for manuals referred to above)

D. MAINTENANCE OF COMPONENTS

PROCEDURE TO REPLACE APRON PANS AND/OR CHAINS

SAFETY

Do not operate Apron Feeder with guardrails removed, except as may be required for maintenance.

During maintenance, Apron Feeder is to be fenced off and electrical supply and control are to be locked out in accordance with plant safety procedures.

Apron Feeder may require operation during maintenance for inspection and/or momentary advancement when replacing pans or chains.

When the feeder is to be run it must be verified that no one is in contact or near the feeder posing any danger prior to starting it.

During the actual work on the feeder, the feeder must be locked out at all times.

It is recommended that a minimum of two workers be in attendance at all times during maintenance.

Plant safety procedures should be reviewed for additional precautions and procedures.

VERIFY WEAR ON COMPONENTS

Sprockets

Check the amount of wear on the sprocket face. If the wear is more than 1/8" deep, the sprocket should be reversed. If both sides of the teeth are worn, the sprockets should be replaced.

Chains

Check the pitch length of the chains by measuring the length over 10 pitches and divide it by 10. If the pitch is more than 2% longer than the new chain pitch, the chains should be replaced. Also verify the integrity of the chain barrels, seals etc. If unusual damage or wear shows on some or all links consult supplier to remedy problem.

Pans

Verify the base thickness of the pans and compare with the original thickness. If more than 1/4" of material has worn off the face of the pans, replace the pans. If some or all pans have local damage or excessive wear, consult supplier to remedy problem and or replace pans.

Carry and Return Rollers

Verify that rollers are turning during operation. If roller does not turn under load it should be replaced. If roller has excessive wear (more than 1/8" deep) on the running face it should be replaced.

REPLACING PANS ONLY

1. If one or more damaged pans are to be replaced, run the feeder to bring those pans to the back of the feeder just on top of the tail traction wheel where it will be easiest to work.
2. If one or more pans are missing completely, do not run this gap through the return, where it will hang up on the return rollers. Either replace the pan on the top run or in the head chute or carefully guide the gap over each return roller.
3. Remove the damaged pans and replace them with new pans.
4. Verify that the pan fits properly on the chains and does not interfere with the adjacent pans.
5. Do not re-use the old bolts, always use new high strength "track" bolts with square nuts and hardened steel flat washers. (see separate page "*Mounting Apron Pan To Chain*").
6. Please note that the pan on the master link may have a different bolt pattern from the rest.
7. Make sure there is a hardened flat washer under all the bolt heads and that the bolts are torqued correctly to prevent bolts coming loose later on.
8. Make sure all guards are back in place before operating feeder again.

REPLACING CHAINS AND PANS

1. If the pans and chains are to be replaced, run the feeder until one of the split master links sits just forward of the tail traction wheel.
2. Loosen the take ups on the tail shaft forward approx 2"-3" so the chains are slack.
3. Take the pan off the split master link, which also will separate the chains. Remove the adjacent 5 or 6 pans on the tail traction wheel and fold the chains back from the traction wheel.
4. Lay the new chains behind the feeder in the correct orientation, connect them to the forward chains and mount a new pan on the master links (which for some chains has a different bolt pattern than the rest) and should be marked as "master link pan". Only use the bolts that come with the master link as they are special and different from the rest.
5. Mount 2 or 3 more new pans on the new chains and snug the bolts, but do not tighten them until all the pans are on.
6. Now, advance the feeder a little while at the same time pulling the return chains and pans back out of the feeder with a come-along or winch.
7. Remove some more pans from the old chain and put more pans on the new chains and keep repeating this procedure until all the pans and chains are replaced and the new chains can be connected in full circle.

8. Make sure that the pans are sitting correctly on the return rollers and that there is not one pan missing which will cause a hang up on the return.
9. Now run the feeder until the chain has gone around at least one more time. If everything looks okay, the pan bolts can be tightened to specified torque.
10. Make sure there is a hardened flat washer under all the bolt heads and that the bolts are torqued correctly to prevent bolts coming loose later on.
11. Make sure all guards are back in place before operating feeder again.

CONVEYOR COMPONENTS

CHAIN

Chain is TREK sealed and lubricated track chain (SALT) for the Apron Feeders.

Disassembly / Assembly of Master Links

Each chain is supplied with split master links for ease of chain connection and disassembly.

Fasteners supplied with chain only are to be used – do not substitute with standard fasteners.

If chain is to be broken outside of split master link:

Removal (if master pin press is not available)

1. Drive chain pin out with minimum 20 lb sledge hammer.
Do not drive directly on pin. Use a drive pin with diameter smaller than pin O.D. Pin can be removed from either side of chain.

Install (if master pin press not available)

1. Clean pin boss in link.
2. Install seal washers and trust rings in link counter bore. Make sure pin boss and bushing bore are in a direct line.
3. Drive pin with 20 lb sledge hammer. Do not drive directly on pin. Use same drift pin as used in dismantling chain.

Note: Do not heat chain links to make pin installation / removal easier. This will reduce chain strength.



Quality Parts



Since 1957 Trek has been a trusted leader in the marketplace, offering Quality and Reliable Undercarriage parts at a Competitive Price. Our line of Excavator and Tractor parts are manufactured with strict quality control measures to assure 100% interchangeable with those of the original equipment manufacturer. Trek offers a written warranty unmatched by any other undercarriage distribution network in the after market. Knowledgeable sales and product support staff are available throughout the United States and Canada. Call one of our 10 Trek locations or log on to our web site www.trekdirect.com for your parts requirements.

CHAINS

Trek Chain is manufactured from the finest quality steel, using the latest world technology to ensure long life and resistance to wear. Track links are forged from high quality boron steel, having greater mass in key areas for reinforcement. Track pins and bushings receive special heat treatment to provide exceptional strength and shock resistance, combined with a focused hardness, which ensures a longer wear life.

Trek design Seals prolong pin and bushing life by sealing lubricants in and by preventing joint contamination.

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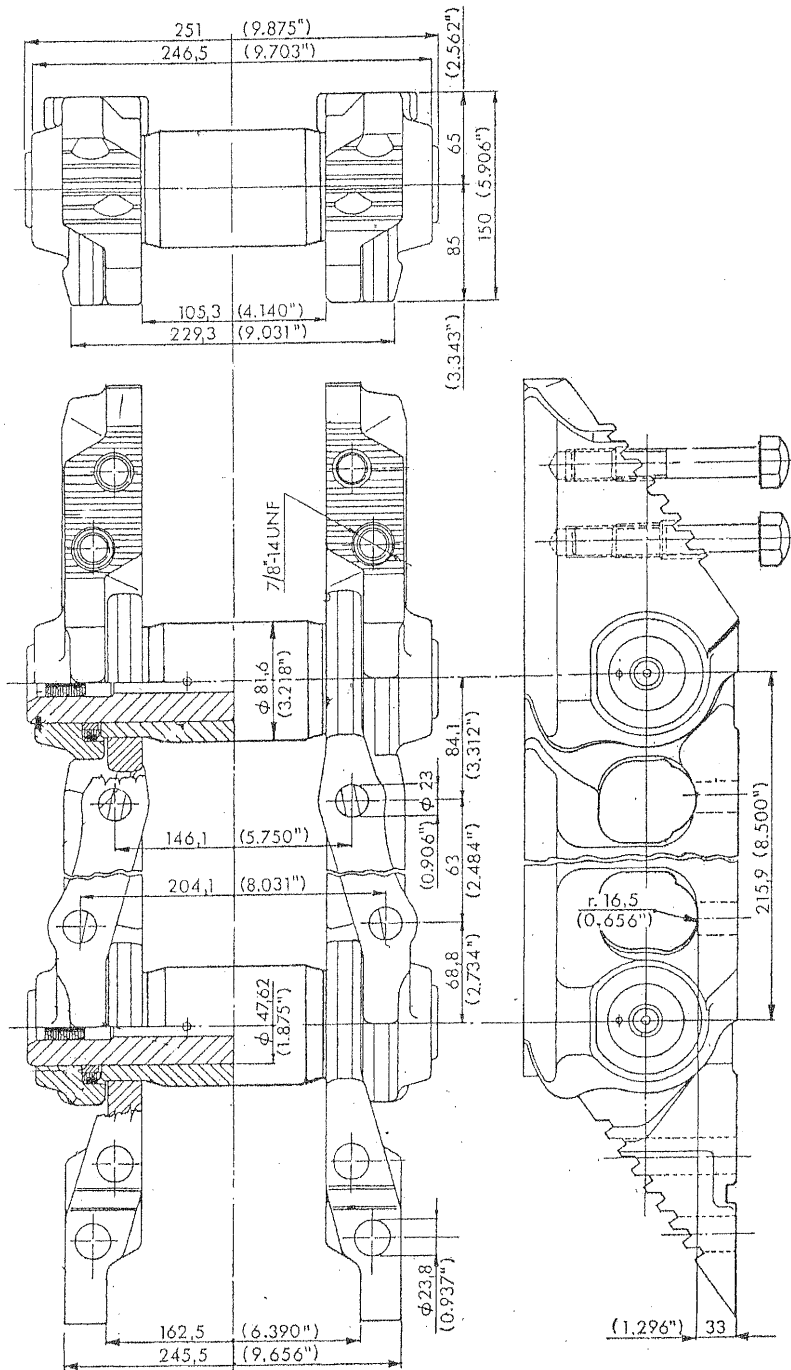
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D8N SALT Track Chain 215.9mm (8.5") Pitch



December 2003

ROLLERS

Rollers used are “lubricated for life” and have lifetime seals. Rollers are normally replaced when worn or seized.

However, if the need arises to re-lubricate, this can be done.

To replace lubrication in rollers:

Carrying Roller

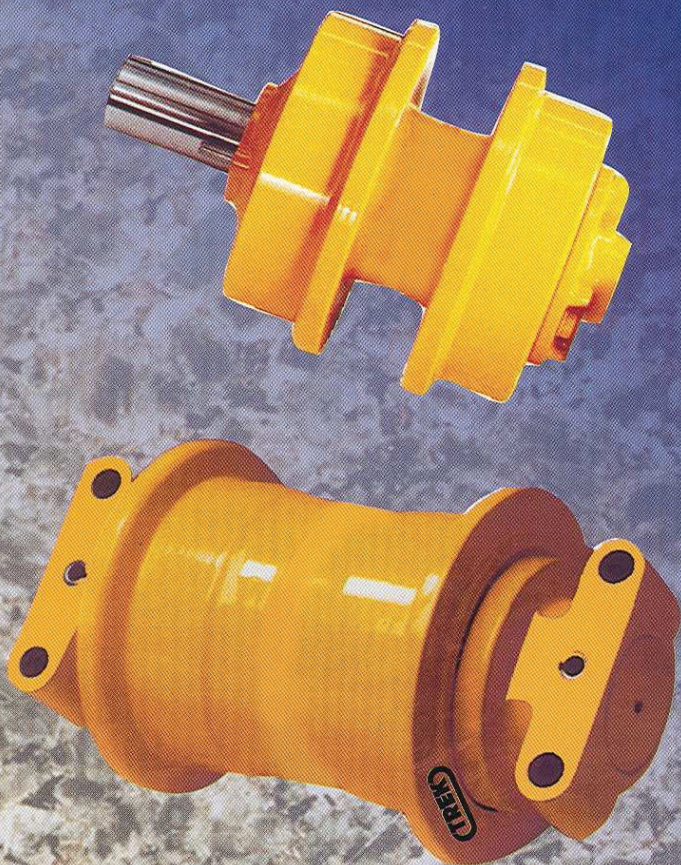
1. Remove carry roller from feeder.
2. Remove plug in middle of carrying roller and drain out old oil as much as possible.
3. Turn roller so that plug is on top of roller.
4. Pump/pour 30W oil into roller until new oil overflows freely.
5. Use new gasket with plug and tighten.
6. Put roller back on feeder and align with chain before tightening down.

Return Roller

1. Remove roller from feeder
2. Roller has plug in end of cap; remove plug.
3. Drain out old oil as much as possible.
4. Stand Roller on end (shaft down) and insert nozzle.
5. Pump/pour 30W oil through nozzle until new oil flows freely.
6. Use Teflon tape or pipe sealant on plug and tighten.
7. Re-install return roller in feeder.



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ROLLERS

Trek provides the finest top quality Upper and Lower Rollers, which are guaranteed to be interchangeable for the replacement market. Trek demands the best materials be used in the manufacturing of their rollers, to provide extended wear life. Trek is working to complete the full line of "R" Series High Drive Symmetrical Seal Rollers. This design retro fits older models and is the trouble free extended wear Roller for today's bigger and faster Tractors.

Trek continues to earn customer satisfaction and trust by our constant effort to provide an exceptional trouble free product.

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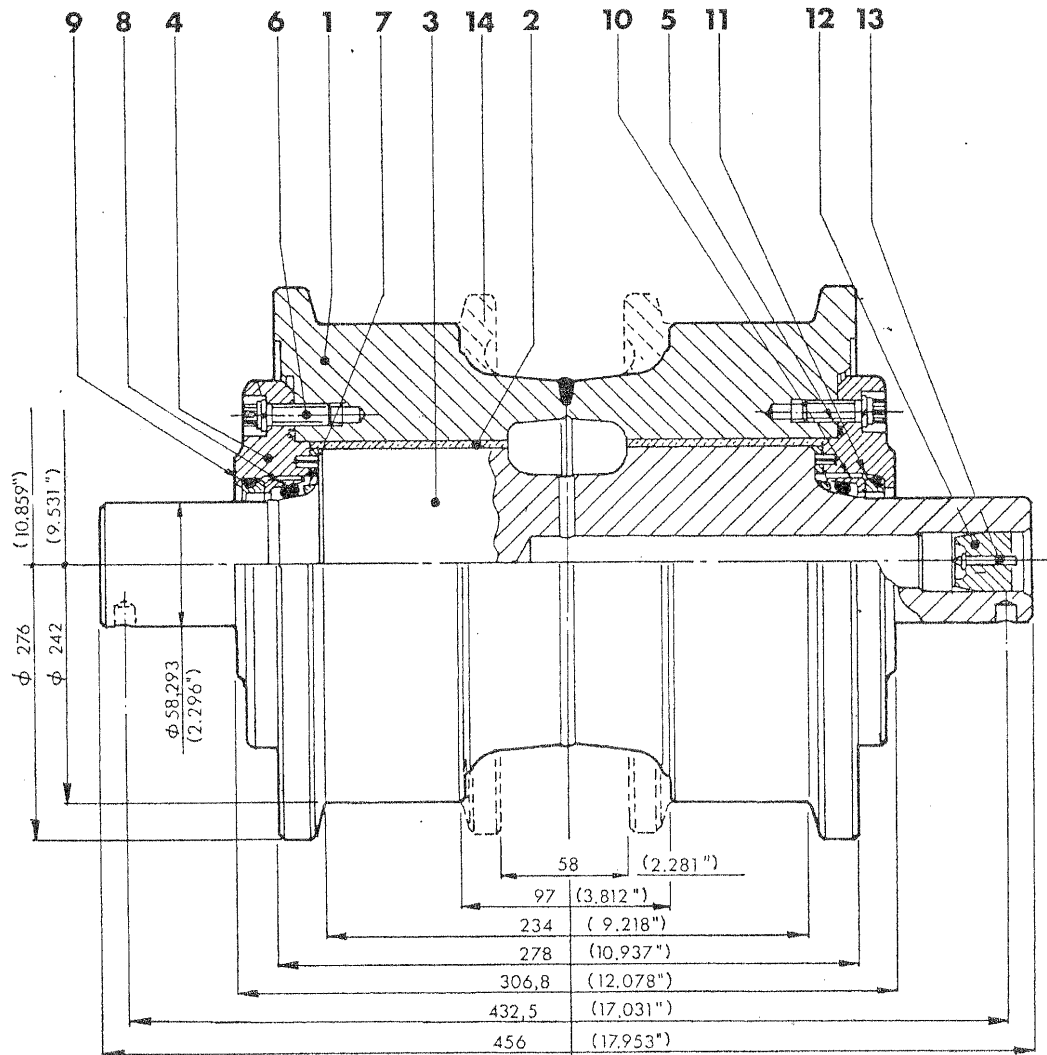
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D8N CARRY ROLLER PART #01070586



CHAIN CARRY ROLLERS

REMOVAL/INSTALLATION

IEM apron feeders allow for removal/installation of chain carry rollers without need for:

- dismantling apron pans
- dismantling chain
- dismantling skirtboards
- emptying charge area



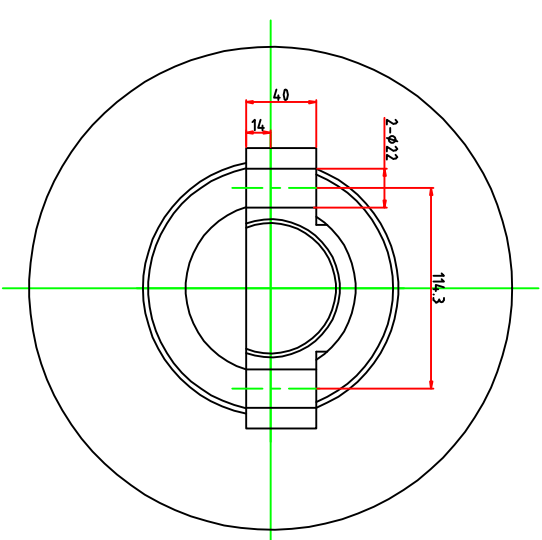
Remove Roller

- 1) Remove bolts on inside support "B".
- 2) Loosen lower bolts on outside support "A".
- 3) Remove spacer from inside support "B"
- 4) Undo lower bolts on outside spacer "A" allowing roller to rest on top of inside support "B".
- 5) Remove lower bolts of outside support "A".
- 6) Remove roller with attached support "A".

Install Roller

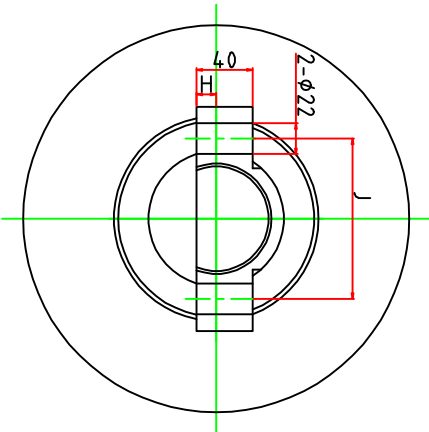
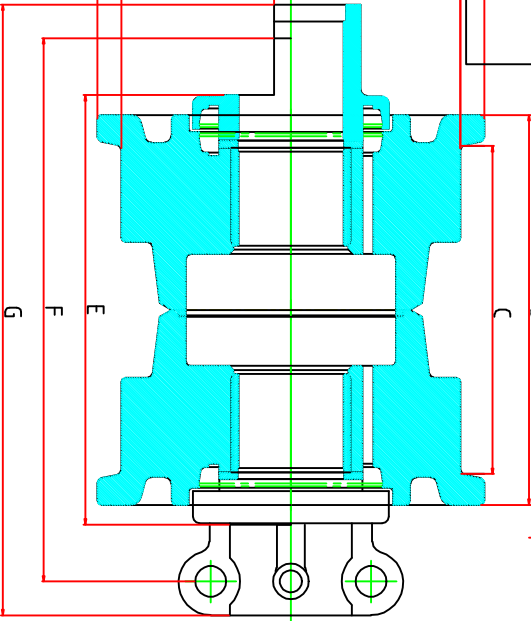
- 1) Position roller end on top of inside support "B".
- 2) Position outside support "A" under roller end.
- 3) Install bolts (loosely) in top and bottom flanges of outside support "A".
- 4) Raise roller upwards to allow spacer to be inserted on top of support "B".
- 5) Install bolts loosely in top of inside support "B".
- 6) Do final positioning of roller to give equal clearance, both sides, between outside of chain link and inside of roller end flanges.
- 7) Tighten bolts as required.

D8N-S/F-00



										Assembly Drawing	EB		
标记	处数	分区	更改文件号	签字	年、月、日								
设计	Zhang	2012-2-8	标准化	Zhang									
审核													
工艺				批准									
						阶段标记 重量 比例				D8N-S/F-Carry-Roller			
						共 张 第 张				D8N-S/F-00			

UTR160207-00



SIZE NO.	A	B	C	D	E	F	G	H	J	Remarks
1	276	242	234.2	278.2	306.7	387.4	436	14	114.3	OK
2	276	242	234.1	278.1	306.8	387.4	436	14	114.3	OK
3	276	242	234	278	306.8	387.45	436	14	114.3	OK
4	276	242	234.1	278.1	306.7	387.3	436	14	114.3	OK
5	276	242	234.2	278.3	306.6	387.4	436	14	114.3	OK

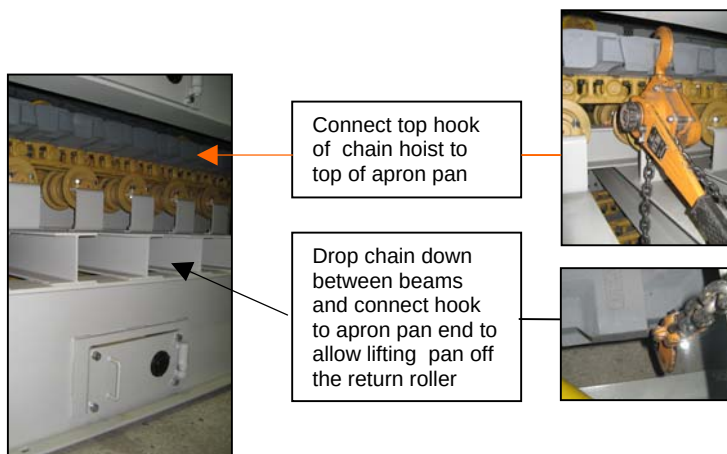
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REPLACING RETURN ROLLER ASSEMBLIES

ITEM Return Rollers are designed and mounted for ease of replacement.

Steps are as follows:

- 1) The apron pan on the return side must be lifted clear of the return roller outside hardened sleeve and held in the clear position until the roller has been replaced. This allows the roller to be easily removed and replaced by taking the pan and chain weight off the roller. Typically, a chain hoist can be used to do this...see below.



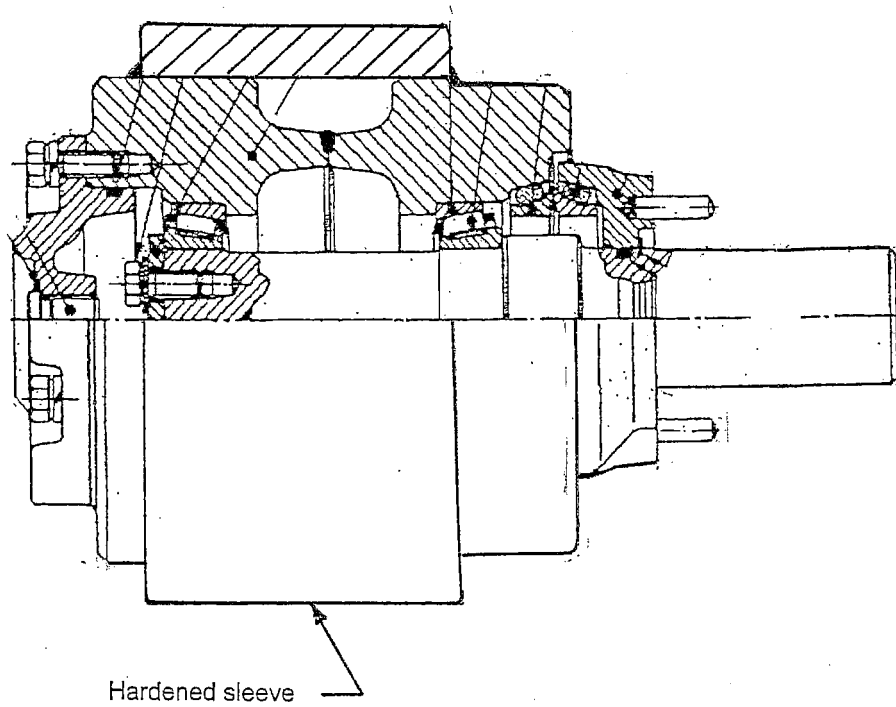
- 2) Loosen the four bolts anchoring the door assembly to the main frame and pull the door open. The return roller is now accessible for removal.
- 3) Loosen the three holding bolts on outside of the tapered bushing holding the roller shaft. Remove the bolts and re-install them into the threaded holes on the bushing. Tighten the bolts which now push the bushing out of the tapered bushing.
CAUTION: Place some blocking under the roller while the roller shaft is being pushed out to support the roller from falling. When the roller has been pushed out from the bushing, the new roller can be installed by reversing the process.
- 4) Once the new roller has been installed into the bushing assembly, check the clearance between the inside wall of the door and roller body before tightening the bushing.
- 5) Close the door and re-install the four door bolts.
- 6) Lower the pan back on to the roller and remove the chain hoist.



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#S638 Return Roller



June 6, 2001

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REPLACING CHAIN RETURN ROLLER



1. Remove locking bolts.



2. Pull door out (may require a strong pull).



3. Replace roller:

Loosen two bolts and slide roller out from clamp. Install new roller making sure that positioning dowels are inserted into mating holes in clamp.



4. Close door until end of roller touches side of apron pans. Install pry bar through hole and raise apron pans above top of roller. Close door and release pry bar and tighten bolts.

APRON PANS

Each cast manganese apron pan has been test fit to a jig to ensure proper fit prior to installing them on the chain.

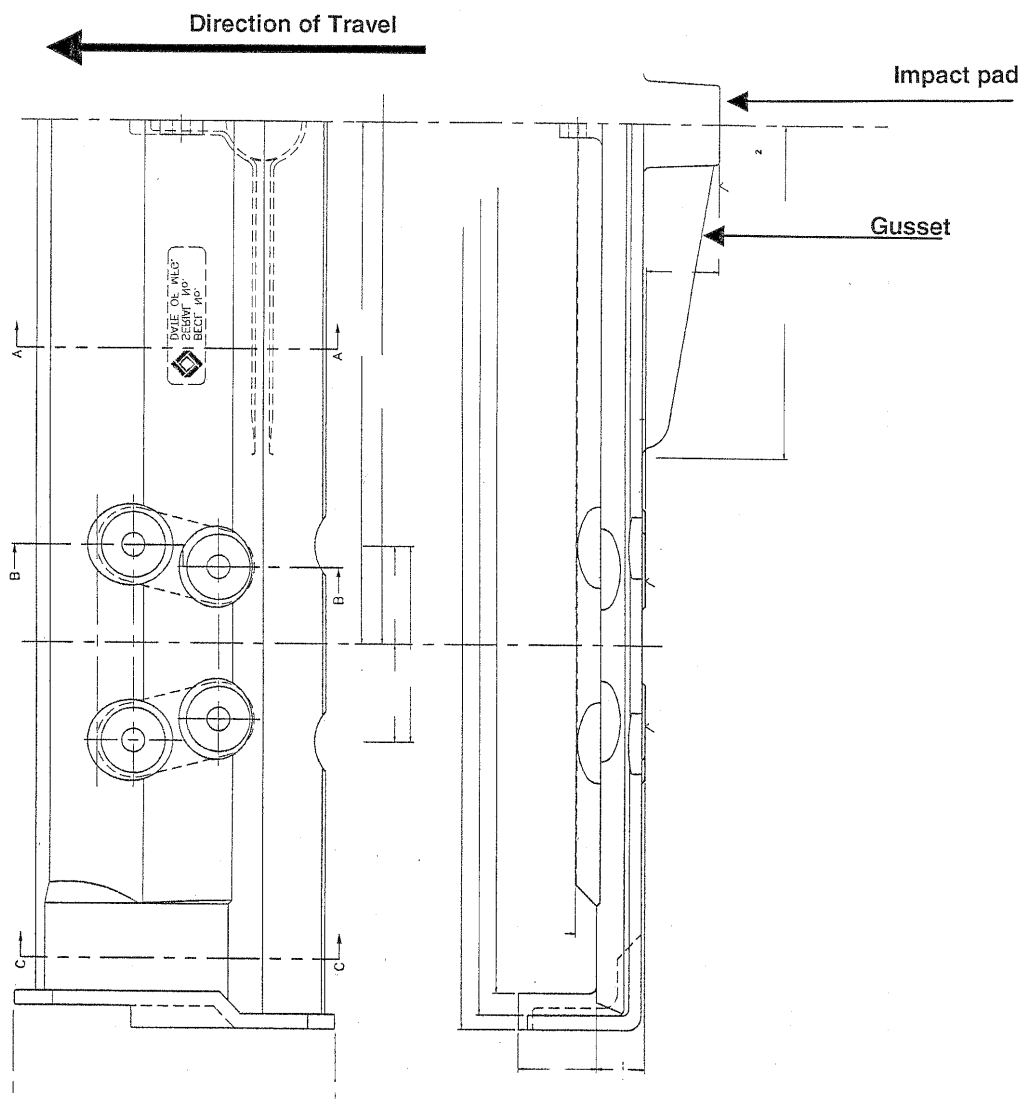
Pans are supplied with top lifting lugs to assist in positioning or removing pans using a winch, come-along, etc.

If pans are replaced, always check clearances before applying full torque to bolts. Check front & rear overlap clearances of mating pans and side clearance.

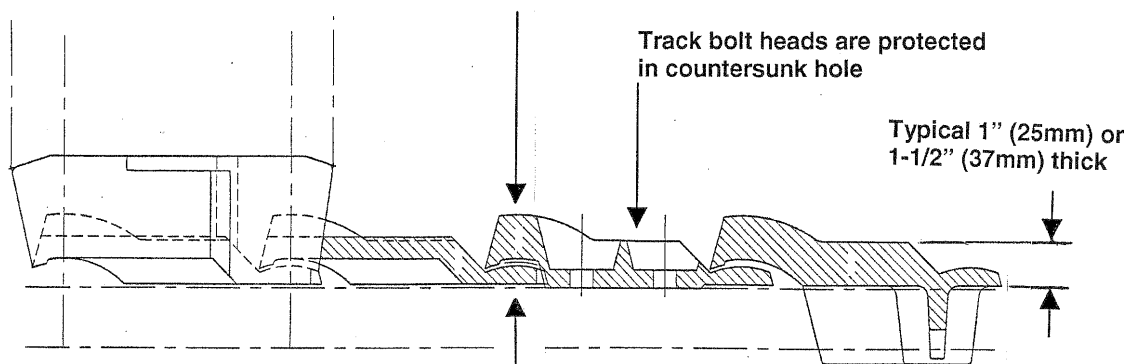
Always use hardened flat washer under bolt head.

109 -19433 96th Avenue
Surrey, BC V4N 4C4 Canada
Tel: 604-513-9930 Fax: 604-513-9905
Web: www.iem.ca

ISO 9001 Certified for Quality Assurance



Nose is above flat portion of pan and assists in moving material (unlike a flat pan)



January/2008

SECTION C-C

SECTION B-B

SECTION A-A

Close tolerance at articulation point minimizes leakage of fine ore between pans

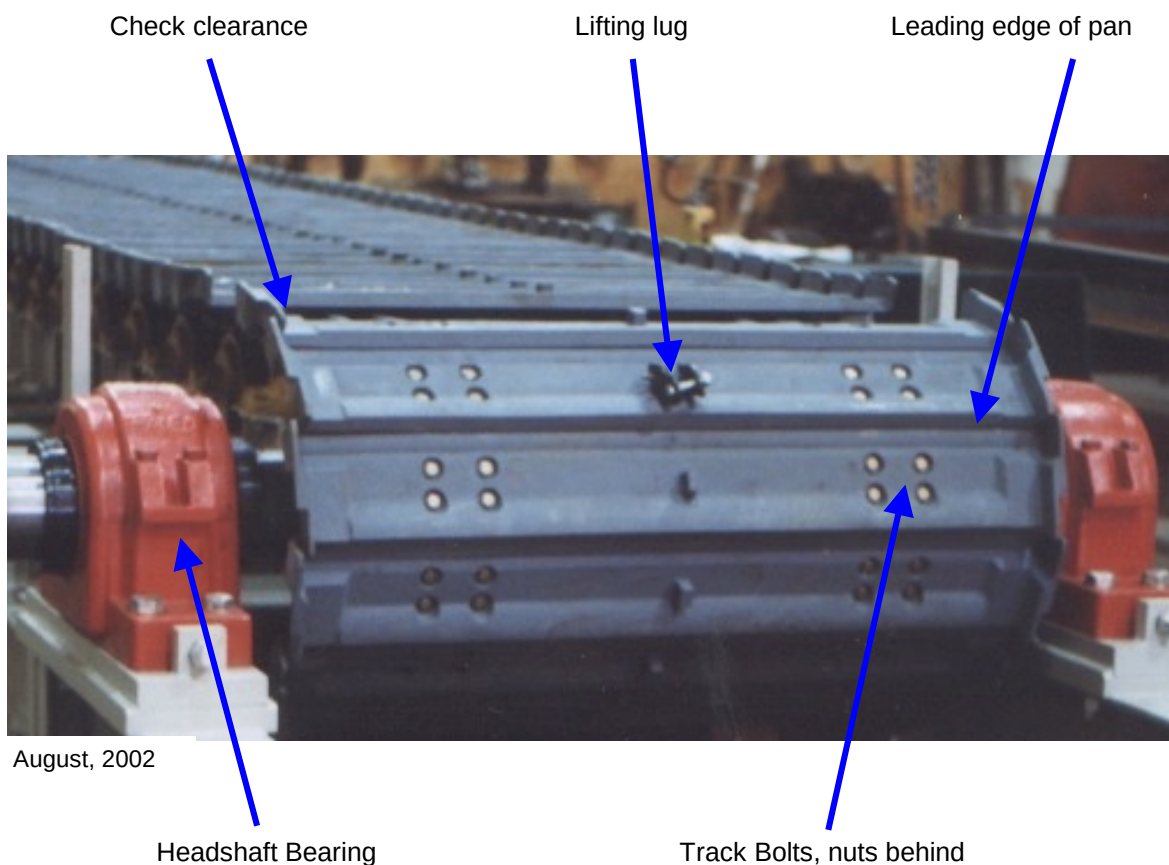
Industrial Equipment Manufacturing Ltd.

#109 – 19433 96th Ave, Surrey, BC, Canada V4N 4C4 Phone (604) 513-9930 Fax (604) 513-9905

CAST MANGANESE APRON PANS

Cast manganese apron pans are test fit to jig prior to installation on feeder (or prior to shipping as spares).

When installing new pans, place pan in position, install track bolts but do not torque down until proper fit and clearances have been confirmed.



Industrial Equipment Manufacturing Ltd.

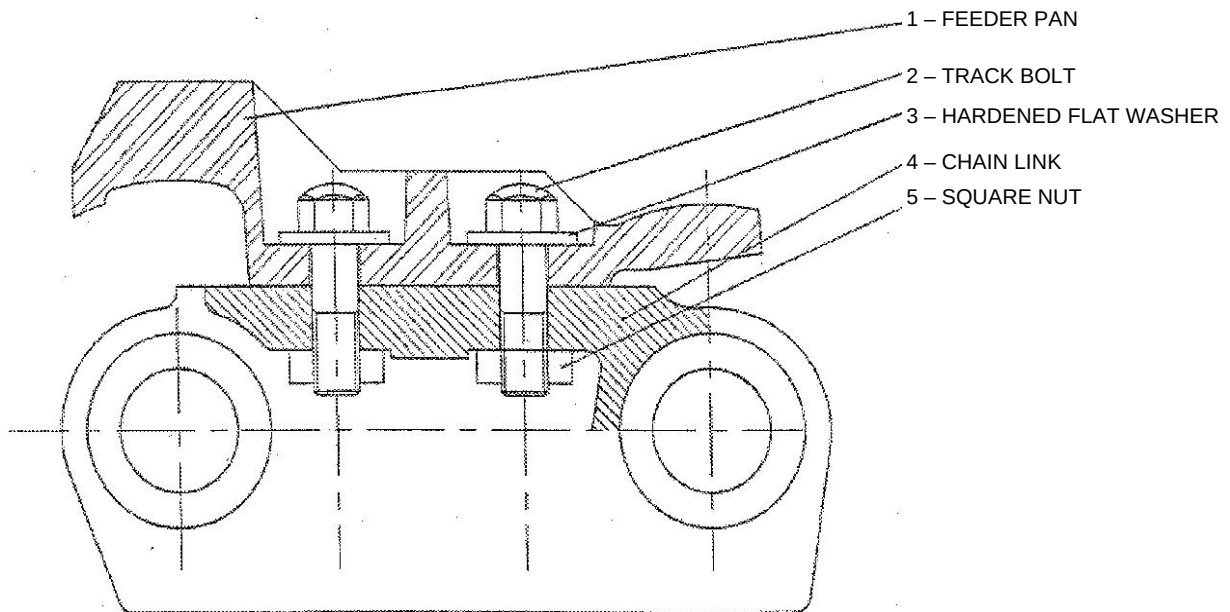
#109 – 19433 96th Ave, Surrey, BC, Canada V4N 4C4 Phone (604) 513-9930 Fax (604) 513-9905

MOUNTING APRON PAN TO CHAIN

Use High Tensile strength track bolts and square nuts from chain manufacturer. SAE flat hardened washers can be purchased from local fastener suppliers.

The square track nut is held in place by the recess in the chain link. The hardened flat washer is used under the head of the track bolt. This assists in the torquing of the bolt by providing a flat, smooth surface for the bolt head to turn when torquing bolt in place. Track bolts are to be torqued to the dry torque values shown below for the different size of chain.

Prior to installing the pan onto the chain, any excessive paint on the top of the chain link should be removed.



Track Bolt Dry Torque Settings

<u>Chain Size</u>	<u>Track Bolt</u>	<u>Torque Setting</u>
CS450	1/2"	50 lb.ft plus 1/3 turn
D4E-EWL	5/8"	130 lb.ft plus 1/3 turn
D6D	3/4"	250 lb.ft plus 1/3 turn
D7G	3/4"	250 lb.ft plus 1/3 turn
D8N	7/8"	375 lb.ft plus 1/3 turn

SPROCKETS

Sprockets are segmented (3 segments each with 7 teeth bolt-on type).

Segments are jig drilled. When worn, sprockets can be reversed.

Ensure sprocket split locations are in the same location on both sprockets / hubs.

SEGMENTAL SPROCKETS

D7-21 Tooth (10 1/2 Effective Teeth)

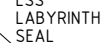
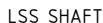


Sprocket segments are jig-drilled so they can be mounted in any position on the hub.

When sprockets are worn on one side, all segments can be reversed to present the new tooth face to the chain.

It is recommended that splits between segments be positioned in the same location on both sprockets





AIR INLET;
KEEP FREE!

SEW_S0W	870193569.12	Date	Name	DIN ISO 5456	Material:
Customer	SEW Canada	Drawn	05/19/2012	Melaragno	Material No.:
Customer P0#	4.7626.28	Drawn	05/19/2012	Melaragno	made from:
n1 (rpm)	1780	Check			Weight (kg)
n2 (rpm)	5.4	Stand.			-3210
P1 (kw)	156.9				
M2 (kNm)	2.15				
Δ Ambient [°C]	-10 to +20				
Oil type	SYN ISO VG220-SEP				
Oil Temp. [°C]	-10				
IE ex	325/2				
Mount Position	M10/03	Mod.-No.	Type:-FAN		
		LAB			
		Quant.			
Certified by:	S.Melaragno				
Certified date:	5/19/12	Date:	SP03		
Approval / date:		Name:			



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Planetary gear unit

PHF082MC3RLSF06/FAN/LAB

Part number Status Rev Format Validity

1877 134 3.3 0.1 00

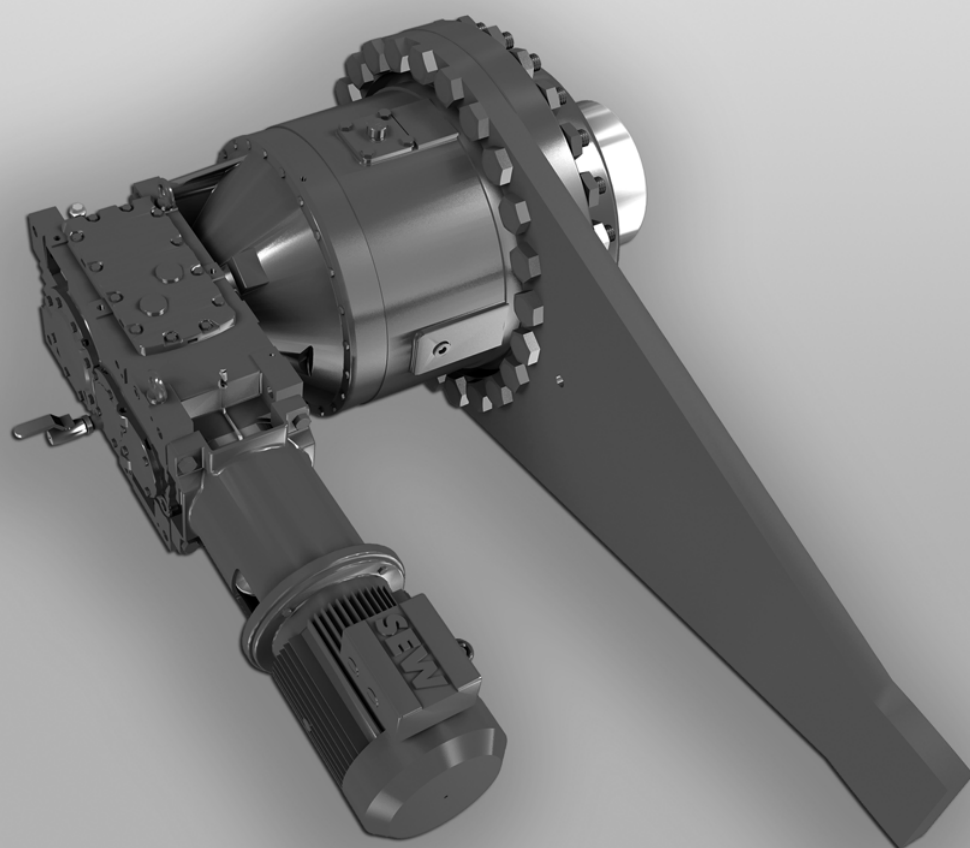
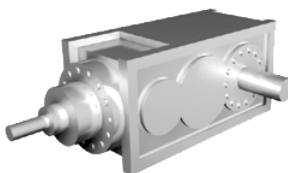
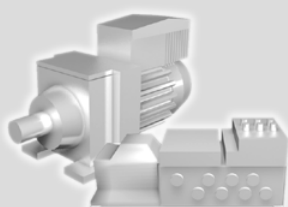
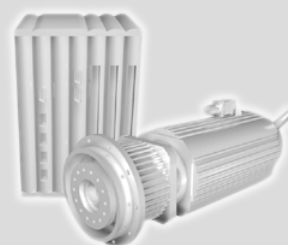
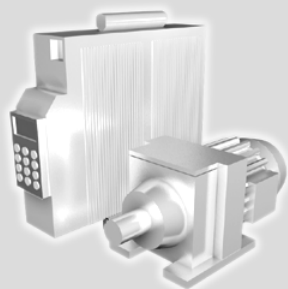
Dimension drawing | LN: 870193569.12

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CAD-PlotInfo: /S/19.05.2012/15.23.24



SEW
EURODRIVE



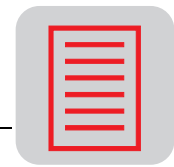
Industrial Gear Units P.MC.. Series

Edition 12/2006

11572604 / EN

Operating Instructions





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1 Important Notes

Introduction

A requirement of fault-free operation and fulfillment of any rights to claim under limited warranty is that you adhere to the information in the operating instructions. Read the operating instructions before you start working with the unit.

Make sure that the operating instructions are available to persons responsible for the plant and its operation, as well as to person who work independently on the unit.

Also observe other technical documents, contracts for delivery or other agreements.

General information

P.MC.. industrial gear units are a combination of

1. P.. planetary gear units output stage
2. MC.R.. or MC.P.. primary gear unit
3. Motor, coupling, adapter and backstop, if required.

Designated use

The designated use refers to the procedure specified in the operating instructions.

The P.MC.. industrial gear units are units run by motors for industrial and commercial systems. Gear unit utilizations other than those specified and areas of application other than industrial and commercial systems can only be used after consultation with SEW-EURODRIVE.

In compliance with the EG Machinery Directive 98/37/EG, the P.MC.. industrial gear units are components for installation in machinery and systems. In the scope of the EG directive, you must not take the machinery into operation in the designated fashion until you have established that the end product complies with the Machinery Directive 98/37/EG.

Qualified personnel

P.MC.. series industrial gear units represent a potential hazard for persons and material. Consequently, assembly, installation, startup and service work may only be performed by trained personnel who are aware of the potential hazards.

The personnel must be appropriately qualified for the task in hand and must be familiar with the

- Assembly
- Installation
- Startup
- Operation
- Inspection
- Maintenance

of the product.

The personnel must read the operating instructions, in particular the safety notes section, carefully and ensure that they understand and comply with them.

***Exclusion of liability***

You must comply with the information contained in these operating instructions to ensure safe operation of the P.MC.. series gear units and to achieve the specified product characteristics and performance requirements.

SEW-EURODRIVE GmbH & CoKG assumes no liability for injury to persons or damage to equipment or property resulting from non-observance of these operating instructions. In such cases, any liability for defects is excluded.

Product names and trademarks

The brands and product names contained within these operating instructions are trademarks or registered trademarks of the titleholders.

Disposal**(Please follow the latest instructions):**

- Housing parts, gears, shafts and roller bearings of the gear units must be disposed of as steel scrap. This also applies to gray-cast iron parts if there is no special collection.
- Collect waste oil and dispose of it according to the regulations in force.



1.1 Explanation of symbols

Important instructions concerning the safety and industrial safety are marked by the following symbols.

	Electrical hazard Possible consequences: Severe or fatal injuries.
	Hazard Possible consequences: Severe or fatal injuries.
	Hazardous situation Possible consequences: Slight or minor injuries.
	Harmful situation Possible consequences: Damage to the drive and the environment.
	Tips and useful information.

1.2 Operating notes



- The industrial gear units of the P.MC.. series are delivered without oil fill.
- The nameplate of the gear unit contains the most important technical data!
- The two gear units have a common oil compartment!
- The mounting position may only be changed after consultation with SEW-EURODRIVE. The warranty will become void without prior consultation. When changing to a vertical mounting position of the MC.. gear unit (M2, M4), oil compensator or oil riser pipe are required. Adjust the lubricant fill volume and position of the breather valve accordingly.
- Follow the instructions in Sec. "Mechanical installation" / "Installing the gear unit"!



2 Safety Notes

2.1 Introduction



- The following safety notes are concerned with the use of industrial gear units of the P.MC.. series.
- Please also consider the supplementary safety notes in the individual sections of these operating instructions.

2.2 General information



Burns hazard!

Touching the gear unit when it has not been cooled will result in burns. The gear unit can have a surface temperature of more than 100 °C.

Never touch the gear unit during operation or in the cool down phase once the unit has been switched off.



Never install damaged products or take them into operation.

Submit a complaint to the shipping company immediately in the event of damage.

During or after operation, industrial gear units and motors have:

- Live parts
- Moving parts
- Hot surfaces (may be the case)

Only qualified personnel may carry out the following work:

- Installation / assembly
- Connection
- Startup
- Maintenance
- Servicing

The following information and documents must be observed during these processes:

- Relevant operating instructions and wiring diagrams
- Warning and safety signs on the gear unit
- System-specific regulations and requirements
- National/regional regulations governing safety and the prevention of accidents



Serious injuries and property damage may result from:

- Improper use
- Incorrect installation or operation
- Unauthorized removal of necessary protection covers or housing



Startup / operation



- **Check that the direction of rotation is correct in decoupled status. Listen out for unusual grinding noises as the shaft rotates.**
- Secure the keys for test mode without output elements.
- Do not deactivate monitoring and protection equipment even in test mode.
- Switch off the main motor if in doubt whenever changes occur in relation to normal operation (e.g. increased temperatures, noise, oscillation). Determine the cause of the fault and consult SEW-EURODRIVE.
- Work carefully and keep safety in mind.
- Work on the gear unit only when the machine is not in use. Prevent the drive unit from being unintentionally switched on, for example by locking the keyswitch or removing the fuses from the power supply. Attach an information sign near the on-switch to warn that the gear unit is being worked on.
- Observe the notes attached to the gear unit such as the nameplate and direction arrow. They must be free of paint and dirt. Replace missing signs.
- When installing the gear unit in devices or systems, the manufacturers of the device or system are obliged to include the regulations, notes, and descriptions from these operating instructions in their own operating instructions.
- Purchase spare parts from SEW-EURODRIVE.

Inspection / maintenance

Refer to the instructions in Sec. "Inspection and Maintenance."

Operational environment



- **The gear unit is not suited for operation in potentially explosive atmospheres!**
- **Observe the information of the order-specific ambient temperature and ambient conditions. Modifications require prior approval by SEW-EURODRIVE.**

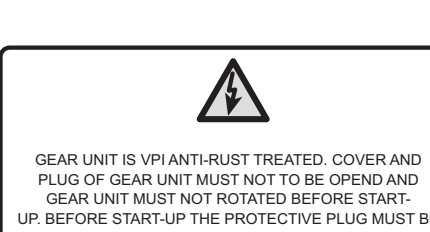


Safety Notes

Symbols on the gear unit

2.3 Symbols on the gear unit

The symbols on the gear unit must be observed. They have the following meaning:

Symbol	Meaning
	Breather valve
	Oil filling plug
	Oil drain plug
	Lubrication point
	Oil sight glass
	Direction of rotation
	Delivery status
	Hot surfaces
 GEAR UNIT IS VPI ANTI-RUST TREATED. COVER AND PLUG OF GEAR UNIT MUST NOT TO BE OPENED AND GEAR UNIT MUST NOT ROTATED BEFORE START-UP. BEFORE START-UP THE PROTECTIVE PLUG MUST BE REMOVED AND REPLACED BY ENCLOSED AIR VALVE.	Extended storage



2.4 Transportation

General notes

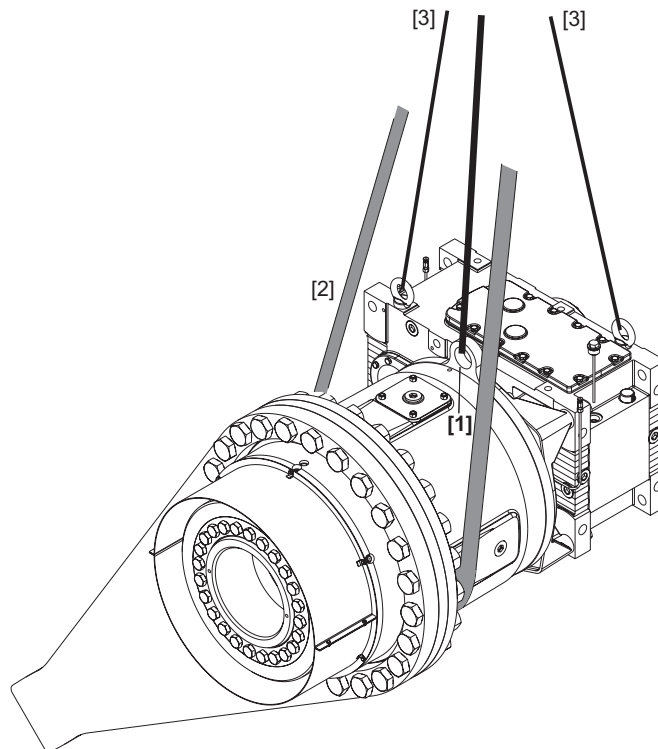


- Inspect the shipment for any damage in transit as soon as you receive the delivery. Inform the shipping company immediately. It may be necessary to preclude startup.
- Do not stay under the gear unit during transportation.
- Secure the danger zone.
- During transport, use only hoists and load-bearing equipment with sufficient load-bearing capacity.
- The weight of the gear unit is indicated on the nameplate or the dimension sheet. Observe the loads and regulations specified on the nameplate.
- The gear unit must be transported in a manner that prevents injuries and damage to the gear unit. For example, impacts against exposed shaft ends can damage the gear unit.
- Do not use the eyebolts on motors, auxiliary gear units or primary gear units for transport of the mounted drive unit (see next page).
- Use suitable, sufficiently rated handling equipment if necessary. Before start-up, remove securing devices used for transport.

Transporting the gear unit without motor



The gear unit may only be transported using lifting belts and ropes or chains. Take the load distribution of the gear unit into account. The main load has to be carried by the transport eye [1] and the lift belt [2] at the P.. gear unit. The lift chain [3] at the lifting eyebolts of the MC gear unit is only for balancing during transport.



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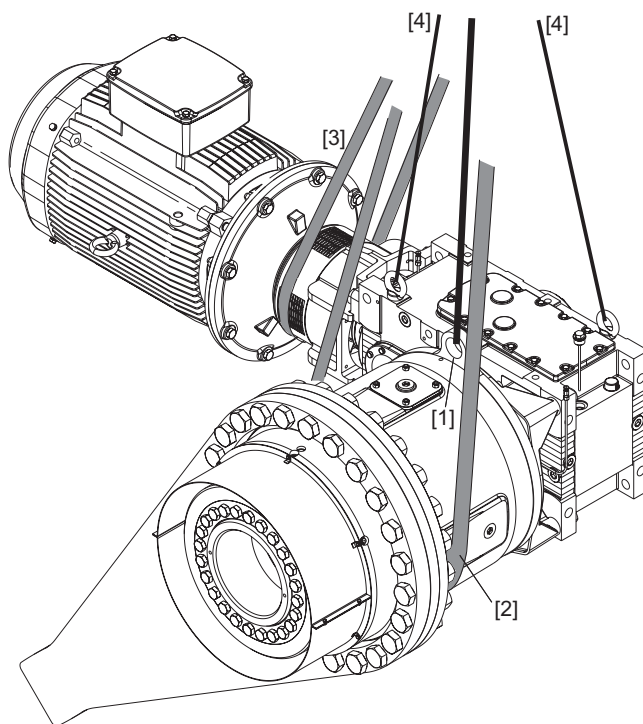
Safety Notes

Transportation

Transporting the gear unit with motor adapter



The gear unit may only be transported using lifting belts and ropes or chains. Take the load distribution of the gear unit and motor into account. The main load has to be carried by the transport eye [1] and the lifting belt [2] at the P.. gear unit. The lifting belt [3] at the motor adapter and the lifting chain [4] at the lifting eyebolts of the MC gear unit are only for balancing during transport.



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2.5 Corrosion and surface protection



The information in this section apply only to P.MC.. series industrial gear units assembled in Europe. Other paint systems might be used in other regions. Please consult the SEW-EURODRIVE assembly plant for P.MC.. industrial gear units at your location.

Introduction

The corrosion and surface protection of gear units comprises the following three basic features:

1. Painting system
 - Standard painting system K7 E160/2
 - High-resistant painting system K7 E260/3 as option
2. Gear unit corrosion protection with
 - interior protection and
 - exterior protection
3. Gear unit packing
 - Standard packing (pallet)
 - Wooden box
 - Seaworthy packaging

Standard painting system K7 E160/2

Painting is performed according to TEKNOS EPOXY SYSTEM K7 based on the high-solid epoxy paint TEKNOPLAST HS 150.

Two layer system K7 E 160/2	Thickness
• Epoxy primer	60 µm
• Teknoplant HS 150	100 µm
Total thickness	160 µm

Color shade: RAL 7031, blue gray

Protective covers

Powder coating, epoxy-based coat paint (EP) is used for guards and shields.

Layer thickness: 65 µm

Color shade: TM 1310 PK, warning in yellow color

High-resistant painting system K7 E 260/3

Painting is performed according to TEKNOS EPOXY SYSTEM K7 based on the high-solid epoxy paint TEKNOPLAST HS 150.

Three-layer system, E 260/3	Thickness
• Epoxy primer	60 µm
• Teknoplant HS 150	2x100 µm
Total thickness	260 µm

Optional color shade

Other color shades are available on request.



Safety Notes

Corrosion and surface protection

Usage of painting system

Environmental pollution	No	Low	medium	High	Very high
Typical environmental conditions		Unheated buildings where condensation can build up. Atmospheres with low pollution. Mostly rural areas.	Production halls with high humidity levels and low air contamination. City and industrial atmospheres, moderate contamination with sulphur dioxide. Coastal areas with low salt load.	Industrial areas and coastal areas with moderate salt load. Chemical plants	Buildings or areas with almost permanent condensation and high levels of contamination. Industrial areas with very high levels of moisture and aggressive atmospheres.
Mounting	Indoors	Indoors	Indoors or outdoors	Indoors or outdoors	Indoors or outdoors
Relative humidity	< 90 %	Up to 95 %	Up to 100 %	Up to 100 %	Up to 100 %
Recommended painting system	Standard painting system K7 E160/2	Standard painting system K7 E160/2	Standard painting system K7 E160/2	High resistant painting system K7 E260/3	Consult SEW-EURODRIVE

Storage and transport conditions

Industrial gear units of the P.MC.. series are delivered without oil fill. Different protection systems are required depending on storage period and ambient conditions:

Storage period: Up to ... months	Storage conditions Gear unit corrosion protection				Transport conditions Gear unit packing	
	OUTDOORS, roofed	INDOORS, heated (0°C...+20°C)	Storage OUTDOORS close to the sea, roofed	Storage close to the sea INDOORS	Land transport	Sea transport
6	Standard protection	Standard protection	Consult SEW-EURODRIVE	Long-term protection	Standard packaging	Seaworthy packaging
12	Consult SEW-EURODRIVE	Standard protection	Consult SEW-EURODRIVE	Long-term protection	Standard packaging	Seaworthy packaging
24	Long-term protection	Consult SEW-EURODRIVE	Consult SEW-EURODRIVE	Long-term protection	Standard packaging	Seaworthy packaging
36	Consult SEW-EURODRIVE	Long-term protection	Consult SEW-EURODRIVE	Long-term protection	Standard packaging	Seaworthy packaging

Standard protection / interior

- Gear units undergo a test run with protection oil. The protection oil is drained by SEW-EURODRIVE before dispatch. The remaining layer of protection oil on the inner parts serves as basic protection.

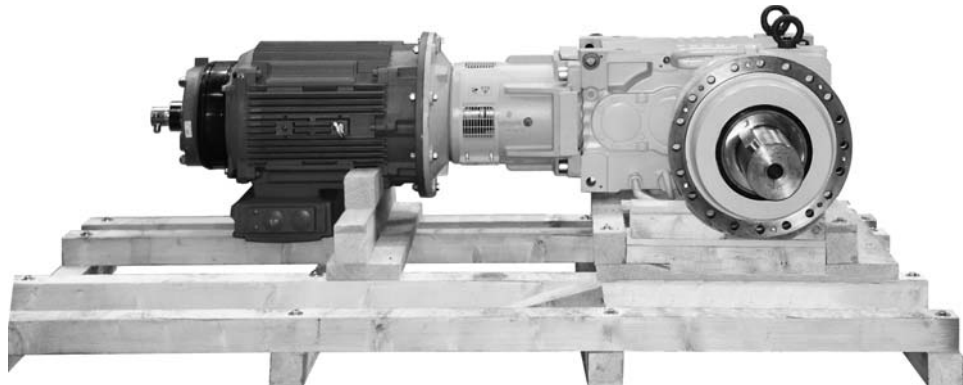
Standard protection / exterior

- Oil seals and seal surfaces are protected by suitable bearing grease.
- Unpainted surfaces (including spare parts) are covered with a protective coating. Remove the coating using a solvent before mounting other equipment onto the surface.
- Small spare parts and loose pieces, such as screws, nuts, etc., are supplied in corrosion protection plastic bags (VCI corrosion protection bag).
- Threaded holes and blind holes are covered by plastic plugs.
- The breather plug (position → see order documents) is already installed at the factory.



Standard protection / packing

Standard packaging is used: The gear unit is delivered on a pallet without cover.



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Long-term protection / interior



Internal gear unit protection in addition to the "standard protection":

- A VPI solvent is sprayed through the oil filling hole.
- **Never open the gear unit near open flames, sparks and hot objects because the solvent vapors might be ignited.**
- **Take preventive measures to protect people from the solvent vapors. Make sure that open flames are avoided when the solvent is applied and when it evaporates.**
- **The output shaft must be rotated at least one turn in such a way that the position of the roller elements in the bearings of LSS and HSS changes. This procedure has to be repeated every 6 months until startup.**
- **Long-term protection of the gear unit interior with VPI solvent has to be repeated every 24 / 36 months until startup (according to the table "Storage and transport conditions").**



Safety Notes

Corrosion and surface protection

Long-term protection / exterior



- If the gear unit is stored longer than 6 months, it is recommended to regularly check the protective coating of unpainted areas as well as the paint coat. Areas with removed protection coating or paint have to be repainted, if necessary.
- Oil seals and sealing surfaces are protected by suitable grease.
- Unpainted surfaces (including spare parts) are covered with a protective coating. Remove the coating using a solvent before mounting other equipment onto the surface.
- Small spare parts and loose pieces, such as screws, nuts, etc., are supplied in corrosion protection plastic bags (VCI corrosion protection bag).
- Threaded holes and blind holes are covered by plastic plugs.
- The breather plug (position → see order documents) is already installed at the factory.
- The breather plug is replaced by a screw plug. You find the position of the breather plug in the order documents. Prior to startup, the screw plug must be replaced again by the breather plug. The breather plug is attached to the gear unit separately.

Long-term protection / packaging

- Seaworthy packaging is used: The gear unit is packaged in a seaworthy plywood box and is delivered on a pallet.



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Alternative packaging

Optionally, the gear unit can be supplied in a wooden box with standard gear unit protection.

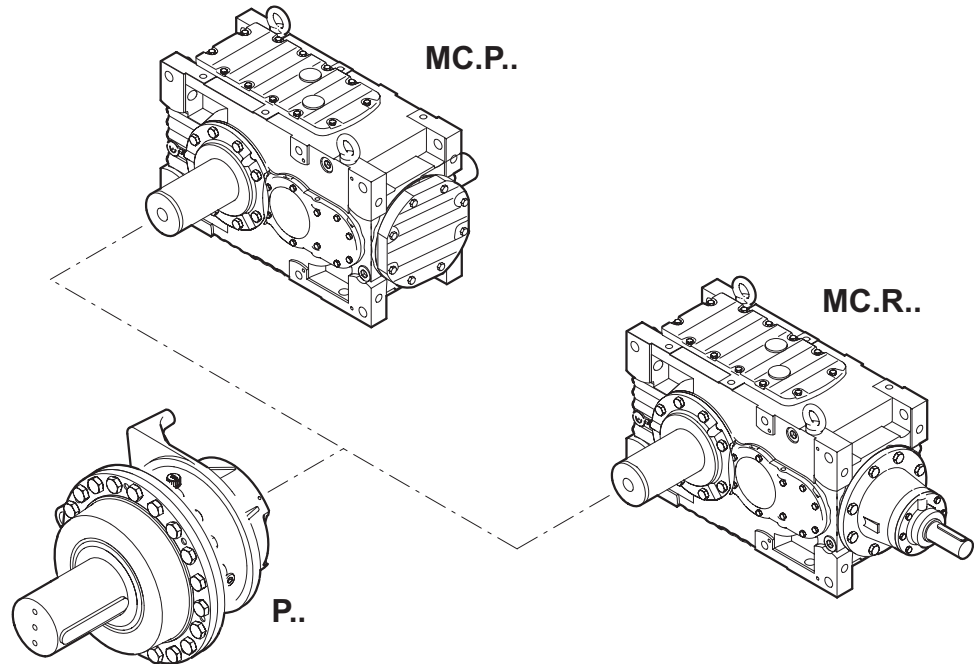


3 Gear Unit Design

3.1 Combination of P.. planetary gear unit with MC.. primary gear unit

The following figure shows the design of P.MC.. gear units .

The gear unit comprises a P.. planetary gear unit and an MC.P../MC.R.. primary gear unit.



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P.. = Planetary gear unit

MC.P.. = Helical gear unit (primary gear unit)

MC.R.. = Bevel-helical gear unit (primary gear unit)

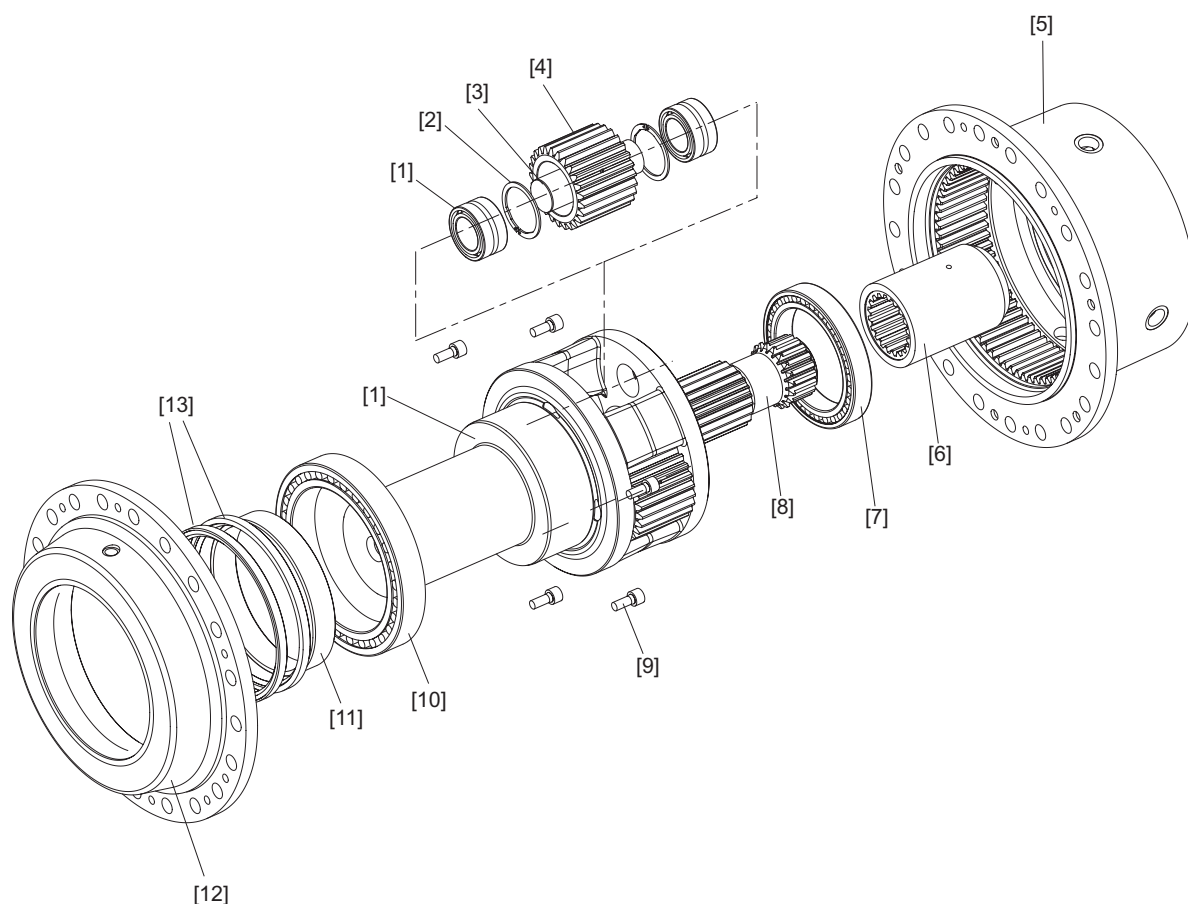


3.2 Structure of the planetary gear unit



The following illustrations allow to easily assign components to the spare parts lists. Discrepancies are possible depending on the gear unit size and version.

P1..MC..



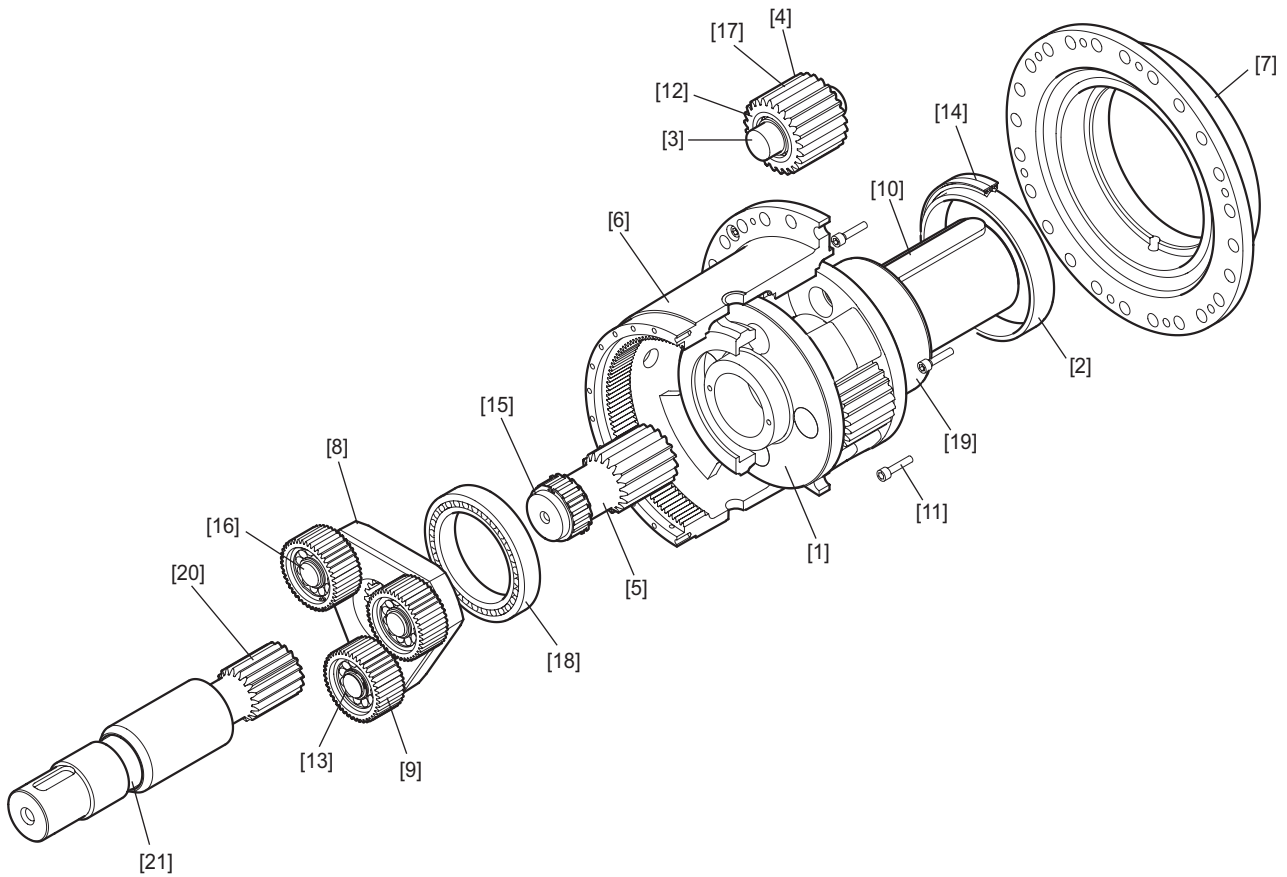
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[1] Planetary bearing
[2] Circlip
[3] Planet bolt
[4] Planet wheel
[5] Housing gear rim

[6] Gear coupling
[7] Bearing
[8] Sun pinion
[9] Retaining screw
[10] Bearing

[11] Bearing race
[12] Flange cover
[13] Sealing ring
[14] Planet carrier output shaft

P2..MC..



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- [1] Planet carrier
- [2] Bearing race
- [3] Planetary gear axle
- [4] Planet wheel
- [5] Sun pinion
- [6] Housing gear rim
- [7] Output flange

- [8] Planet carrier
- [9] Planet wheel
- [10] Key (not in hollow shaft)
- [11] Machine screw
- [12] Cylindrical roller bearings
- [13] Self-aligning roller bearing
- [14] Oil seal

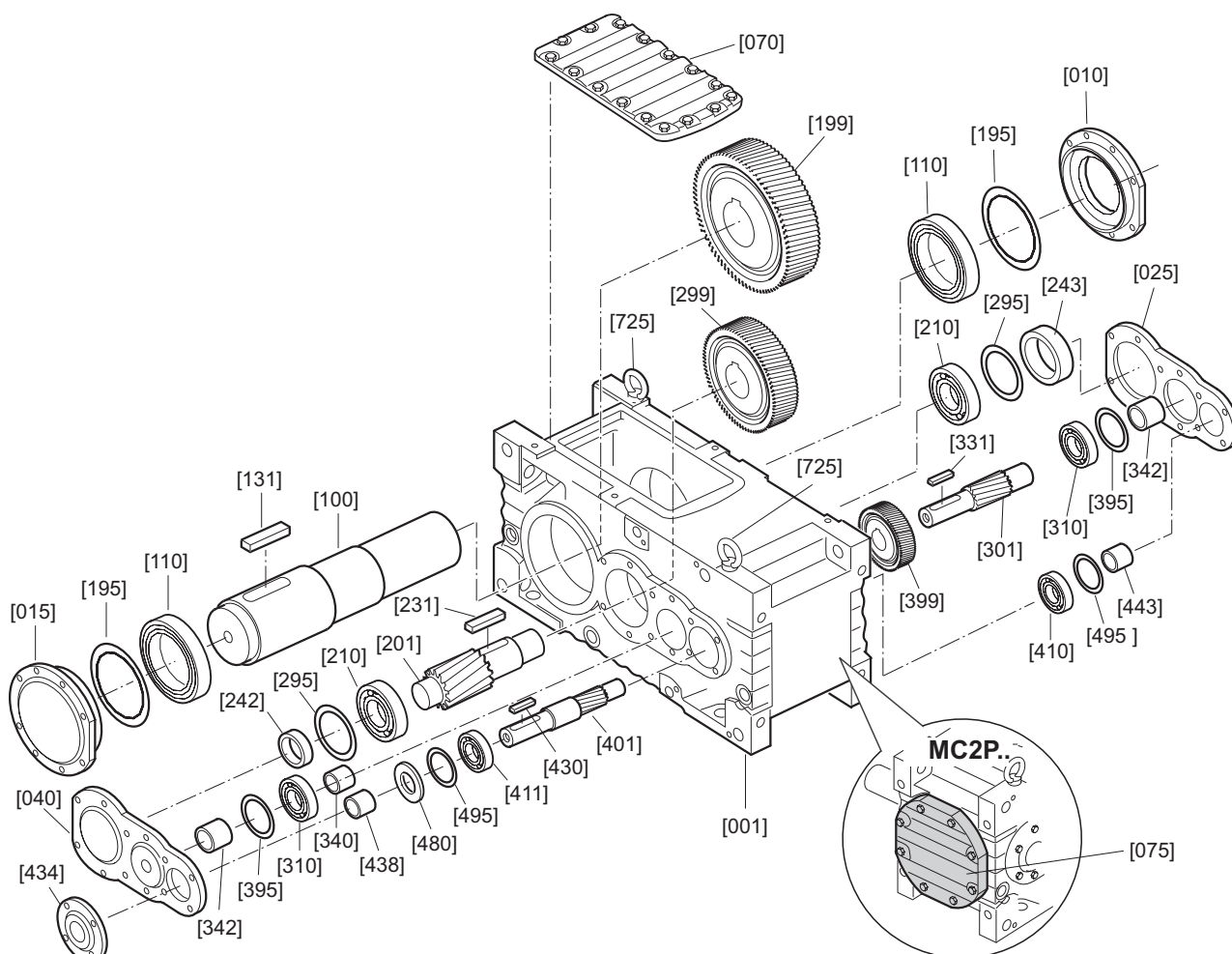
- [15] Circlip
- [16] Circlip
- [17] Circlip
- [18] Cylindrical roller bearings
- [19] Cylindrical roller bearings
- [20] Sun pinion
- [21] Intermediate shaft



3.3 Design of the MC.P.. series primary gear unit



The following illustrations allow to easily assign components to the spare parts lists. Discrepancies are possible depending on the gear unit size and version.



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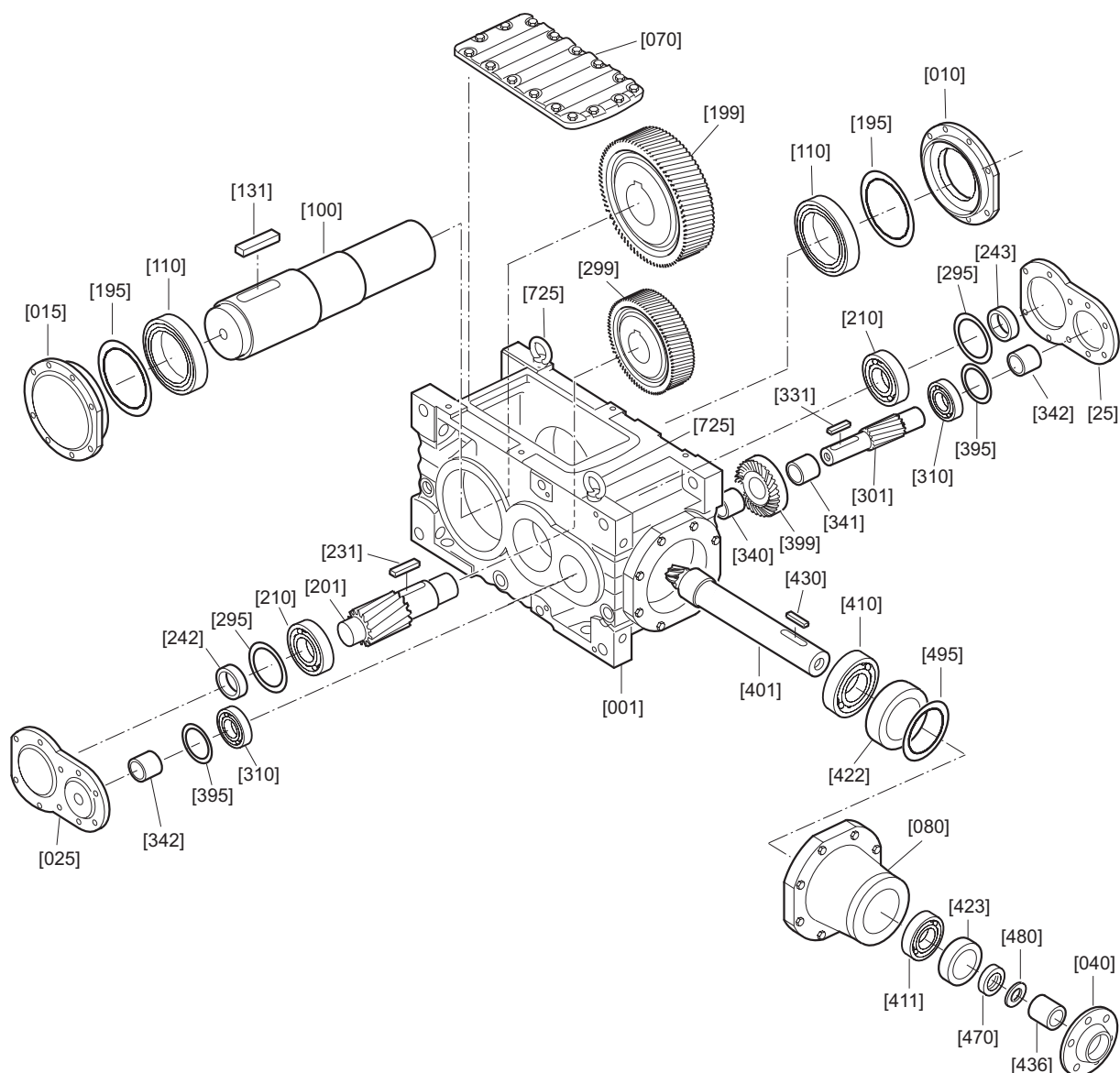
[001] Gear unit housing	[195] Shim	[301] Pinion shaft	[411] Rolling element bearing
[010] Bearing cover	[199] End gear	[310] Bearing	[430] Key
[015] Bearing cover	[201] Pinion shaft	[331] Key	[434] Cover
[025] Bearing cover	[210] Bearing	[340] Spacer	[438] Socket
[040] Bearing cover	[231] Key	[342] Spacer	[443] Distance bushing
[070] Gearcase cover	[242] Spacer	[395] Shim	[480] Oil seal
[075] Cover plate	[243] Spacer	[399] Gearwheel	[495] Shim
[100] Output shaft	[295] Shim	[401] Input shaft	[725] Lifting eyebolt
[110] Bearing	[299] Gearwheel	[410] Bearing	



3.4 Design of the MC.R.. series primary gear unit



The following illustrations allow to easily assign components to the spare parts lists. Discrepancies are possible depending on the gear unit size and version.



58516AXX

[001] Gearcase	[199] End gear	[310] Bearing	[411] Bearing
[010] Bearing cover	[201] Pinion shaft	[331] Key	[422] Bearing bushing
[015] Bearing cover	[210] Bearing	[340] Spacer	[423] Bearing bushing
[025] Bearing cover	[231] Key	[341] Spacer	[430] Key
[040] Cover	[242] Spacer	[342] Spacer	[436] Sleeve
[070] Gearcase cover	[243] Spacer	[395] Shim	[470] Clamping nut
[080] Bearing cover	[295] Shim	[399] Bevel	[480] Oil seal
[100] Output shaft	[299] Gearwheel	[401] Bevel pinion shaft	[495] Shim
[110] Bearing	[301] Pinion shaft	[410] Bearing	[725] Lifting eyebolt
[195] Shim			

Sample unit designation

P 1 H F 031 /... MC 2 R L S T 05

- **Size:** 02 ... 09

Gear unit mounting:

T = Torque arm

Low speed shaft type (LSS):

- S = Solid shaft

Mounting position:

- L = horizontal

V = vertical

E = upright

Gear unit design:

R = Bevel-helical gear unit

P = Helical gear unit

Number of gear unit stages of the primary gear unit

- 2 = two stages

3 = three stages

-MC.. series primary gear unit

Gear unit mounting

- T = Torque arm

S = Swing base

-Size: 001...081

Planetary gear unit mounting

... = Foot mounted

F = Flange mounted

Planetary gear unit type

- S = Solid shaft

R = Solid shaft with key

L = Splined solid shaft

V = Splined hollow shaft

H = Hollow shaft with shrink disc

Number of gear unit stages of the planetary gear unit

1 = single stage

2 = two stages

- Planetary gear units



Example nameplate

☐ SEW-EURODRIVE		Bruchsal / Germany		☐
Type	P061			
Nr. 1	01.1119651601.0001.05		Nr. 2	W10527
	norm.	min.	max.	i 1 :
PK1 [kW]	12.7	2.3	15.8	FS 2.5
MK2 [kNm]	75.4	75.4	75.4	FR1 [kN] 0
n1 [1/min]	62	11.7	78.5	FR2 [kN] 0
n2 [1/min]	1.6	0.3	2.0	FA1 [kN] 0
Operation instruction have to be observed!				FA2 [kN] 0
Made by	SEW		Mass [kg]	1770
Qty of greasing points	0	Fans	0	
Lubricant	Synthetic ISO VG 460 EPPAO - 25 ltr.		Year	2006
☐ FSA GmbH EUCode0588 // IM: M1-F1 // Tu=0 ... 40 °C ☐				

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Type		Unit designation
Nr. 1		Serial number 1
Nr. 2		Serial number 2
P _{K1}	[KW]	Driving force gear unit
M _{K2}	[kNm]	Gear unit output torque
n ₁	[1/min]	Input speed (HSS)
n ₂	[1/min]	Output speed (LSS)
norm.		Standard operating point
min.		Operating point at minimum speed
max		Operating point at maximum speed
i		Exact gear unit reduction ratio
F _S		Service factor
F _{R1}	[kN]	Actual overhung load acting on the input shaft
F _{R2}	[kN]	Actual overhung load acting on the output shaft
F _{A1}	[kN]	Actual axial load acting on the input shaft
F _{A2}	[kN]	Actual axial load acting on the output shaft
Mass	[kg]	Weight of the gear unit
Qty of greasing points:		Number of points that require regreasing
Fan		Number of installed fans
Lubricant		Oil grade and viscosity class / oil capacity
Year		Year of construction
IM		Mounting position: Housing orientation and mounting surface variants
TU		Permitted ambient temperature



3.6 Mounting positions

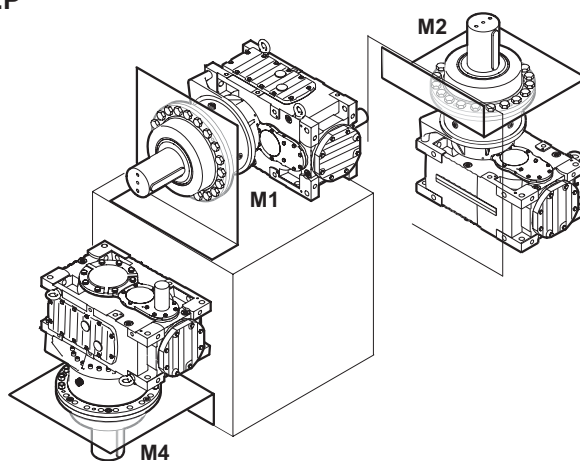
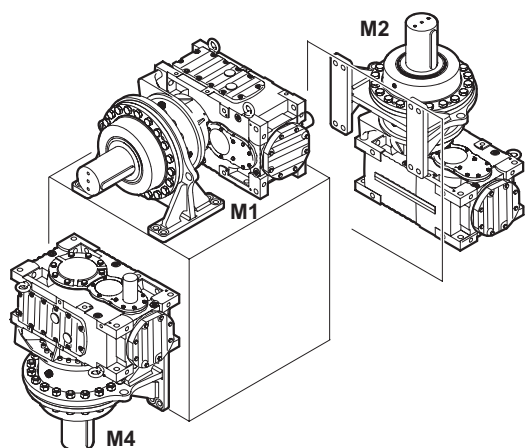
Mounting position designations

SEW-EURODRIVE differentiates between mounting positions M1, M2 and M4 for planetary gearmotors. The following figure shows the spatial orientation of the gear unit. The mounting positions apply to planetary gear units with solid shafts and hollow shafts.

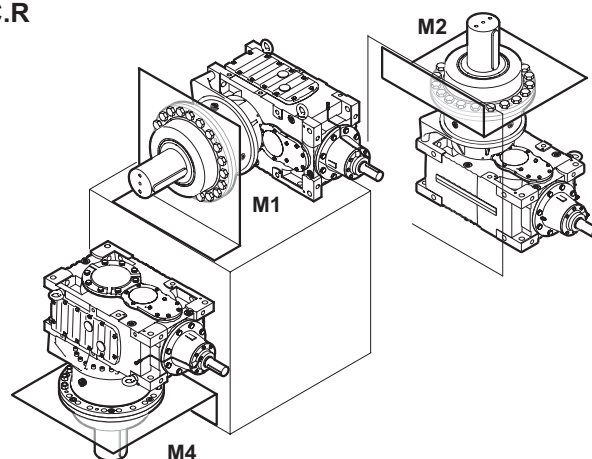
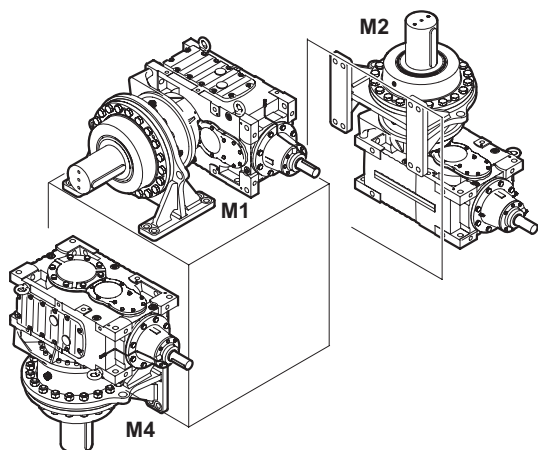


Refer to your order documents if the position of the primary gear unit differs.

P..MC.P



P..MC.R

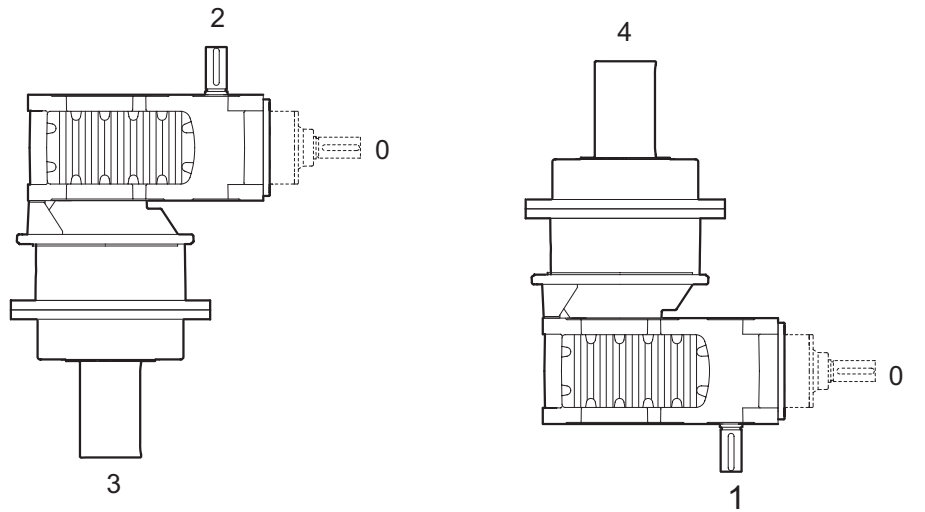


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3.7 Shaft position

The following figure shows the shaft position (0, 1, 2, 3, 4).

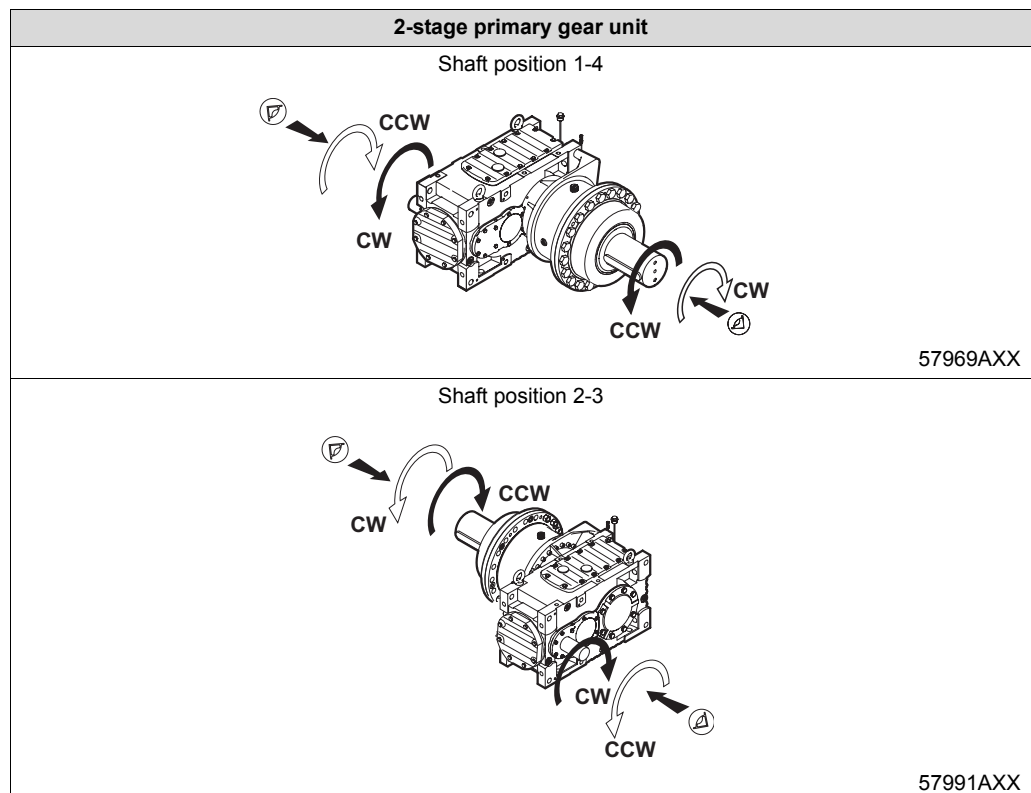


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3.8 Direction of rotation

**Shaft positions
and corresponding
directions of
rotation of
P.MC2P..**

The following figures show shaft positions and corresponding directions of rotation for P.MC2P.. series industrial gear units.



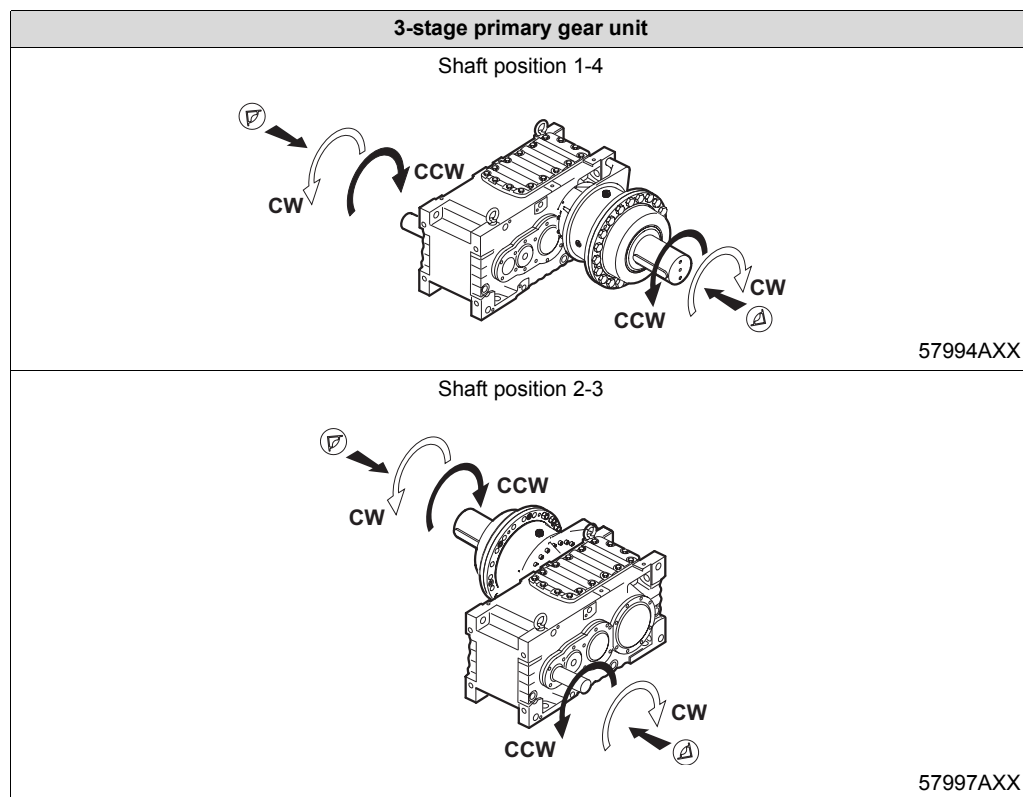


Gear Unit Design

Direction of rotation

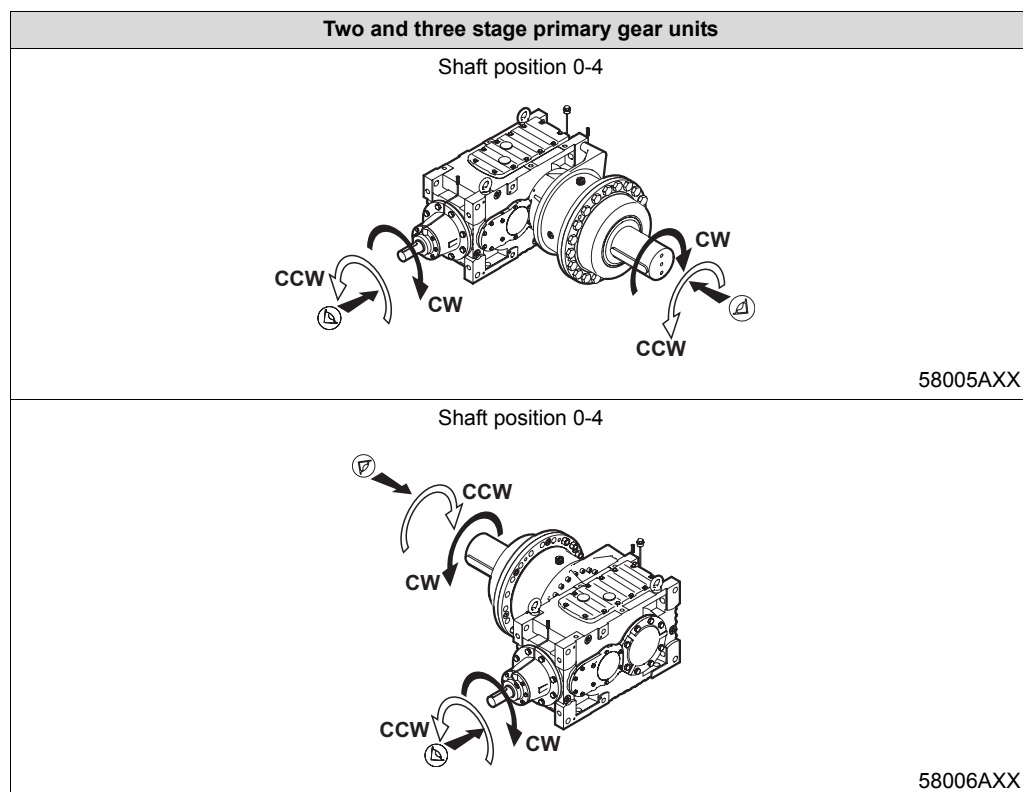
Shaft positions and corresponding directions of rotation of P.MC3P..

The following figures show shaft positions and corresponding directions of rotation for P.MC3P.. series industrial gear units.



Shaft positions and corresponding directions of rotation of P.MC.R.. without backstop

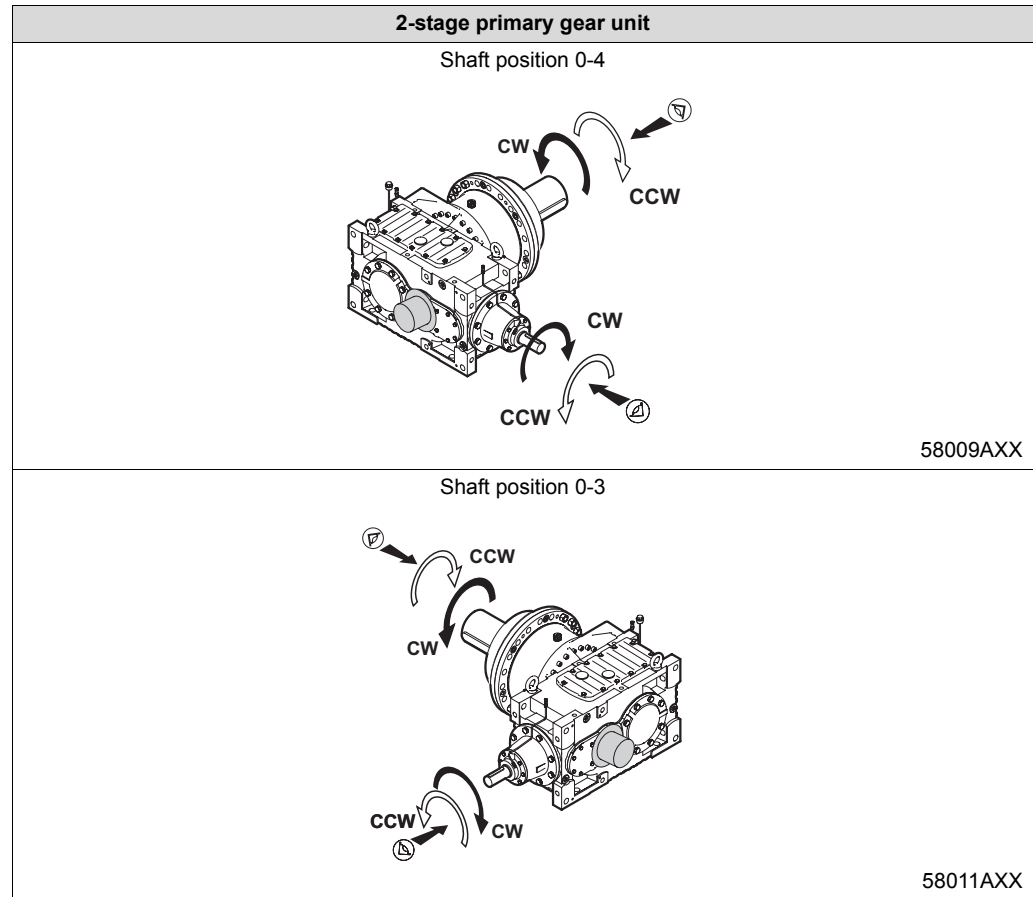
The following figures show shaft positions and corresponding directions of rotation for two and three stage P.MC.R.. series industrial gear units without backstop.





**Shaft positions
and correspond-
ing directions of
rotation of
P.MC2RS.. /
P.MC2RH..
keyway with
backstop**

The following figures show shaft positions and directions of rotation for two-stage gear units with backstop of the types P.MC.RS..und P.MC.RH.. with keyway.



Only one direction of rotation is possible, which has to be specified in the order. The permitted direction of rotation is indicated on the housing.

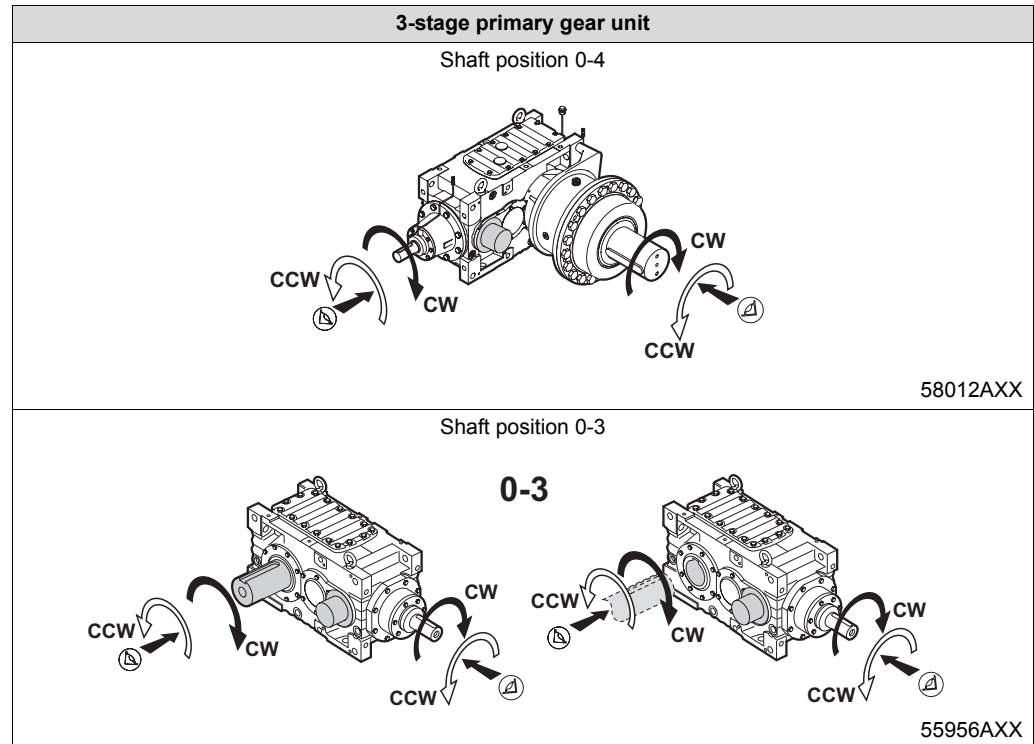


Gear Unit Design

Direction of rotation

Shaft positions and corresponding direction of rotation for P.MC3R.. with backstop on driven machine end

The following figures show the shaft positions and corresponding directions of rotation for 3-stage gear units with backstop P.MC.3R..

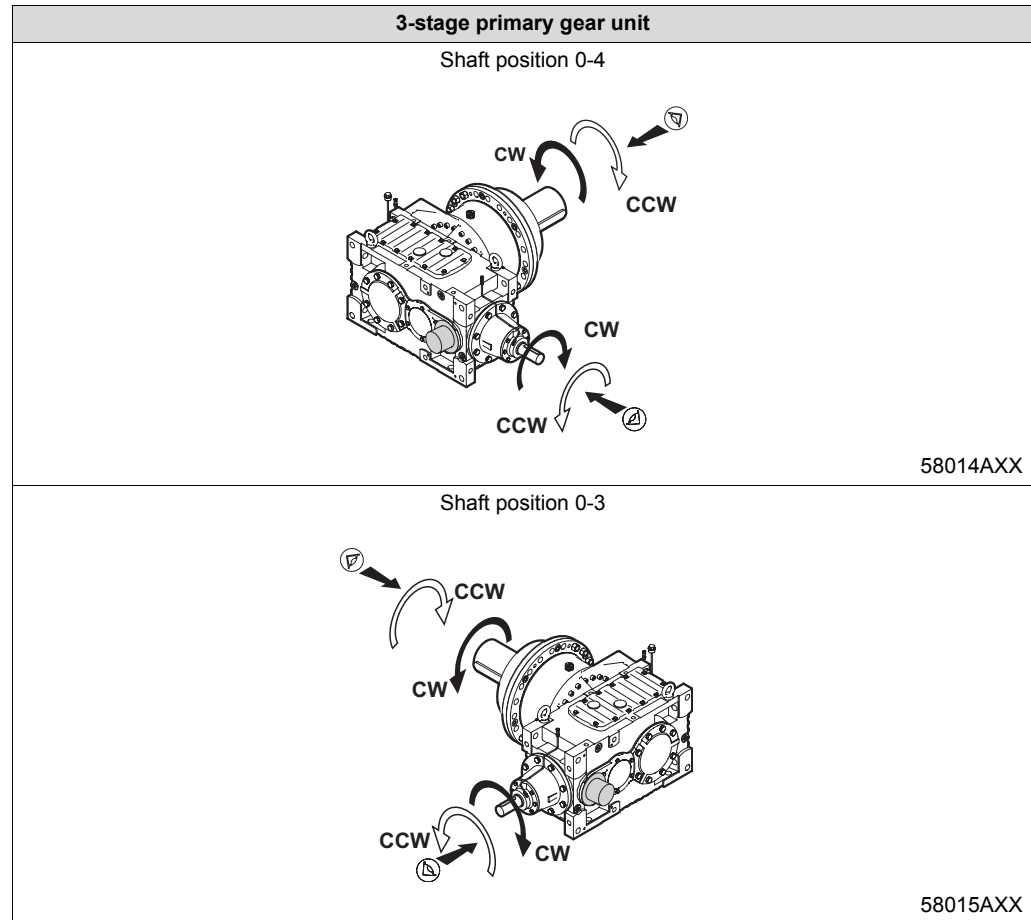


Only one direction of rotation is possible, which has to be specified in the order. The permitted direction of rotation is indicated on the housing.



**Shaft positions
and corresponding
directions of
rotation of
P.MC3R.. Back-
stop opposite
driven machine**

The following figures show the shaft positions and corresponding directions of rotation for gear units with backstop P.MC3R.



Only one direction of rotation is possible, which has to be specified in the order. The permitted direction of rotation is indicated on the housing.



Splash lubrication

With splash lubrication, the oil level is low. With this lubrication method, oil is splashed onto the bearings and gearing components.

Oil bath lubrication

With oil bath lubrication, the oil level is so high that the bearings and gearing components are completely immersed in the lubricant.

Oil expansion tanks are **always used with bath lubrication**. Oil expansion tanks allow the lubricant to expand when the gear unit heats up during operation.

Symbols used

The following table shows the symbols used in the following figures that appear in the order documents. Refer to the order documents for the mounting positions of the gear units.

Symbol	Meaning
	Breather plug
	Air outlet screw
	Inspection opening
	Oil filling plug
	Oil drain plug
	Oil dipstick
	Oil sight glass



4 Installation / Assembly

4.1 Required tools / resources

Not included in the scope of delivery:

- Set of wrenches
- Torque wrench (for shrink disks)
- Motor mount on motor adapter
- Mounting device
- Compensation elements (shims, spacing rings)
- Fasteners for input and output elements
- Mount the components according to the gear unit illustrations shown in Sec. "Gear unit foundation".

4.2 Installation tolerances

	Shaft end	Flange
Primary gear unit MC..	Diameter tolerance > 50 mm -> ISO m6 Center hole in accordance with DIN 332, shape D.. d, d1 > 85..130 mm -> M24 > 130..180 mm -> M30 > 180 mm -> -	Centering shoulder tolerance -> ISO m8
P.. planetary gear units	Shaft end ISO m6	Centering shoulder ISO f8

4.3 Prerequisites for assembly

Check that the following conditions have been met:

- The entries on the nameplate of the gearmotor match the voltage supply system.
- The drive has not been damaged during transportation or storage.
- Ambient temperature according to the nameplate.
- The drive must not be assembled in the following ambient conditions:
 - Potentially explosive area
 - Oils
 - Acids
 - Gases
 - Vapors
 - Radiation



4.4 Preliminary work

Cleaning the shaft



Ensure sufficient ventilation when using solvents. There is a risk of explosion. No open flames.



Risk of material damage.

Do not let the solvent come into contact with the sealing lips of the oil seals.

- You must clean the output shafts and flange surfaces thoroughly to ensure they are free of anti-corrosion agents, contamination or similar. Use a commercially available solvent.
- Protect all oil seals against direct contact with abrasive substances (such as sand, dust, shavings).

Extended storage

Please note: The service life of the bearing lubricant in the bearing is reduced if the unit is stored for ≥ 1 year.

P.MC.. gear units designed for "extended storage" usually have a higher oil level (CLP PG). Adjust the oil level before startup (see Sec. "Inspection / Maintenance").

Oil check



Fill the P.MC.. gear unit with the oil grade and quantity specified on the nameplate (see Sec. 'Startup' and 'Inspection and Maintenance'):

- Fill to volume suitable for the mounting position (see nameplate)
- Check oil level through oil sight glass or with oil dipstick

→ see Sec. "Inspection and Maintenance" and "Design and Operating Notes".



4.5 Notes on installing the gear unit



- You must strictly adhere to the safety instructions in the previous sections.
- The nameplate indicates the most important technical data. Additional data relevant for operation is available in drawings, order confirmation or any order-specific documentation.
- The gear unit must be installed with great care by qualified personnel. Damage caused by improper handling leads to exclusion of liability.
- Install/mount the gear unit only in the specified mounting position on a level, vibration-damping, and torsionally rigid support structure. Do not tighten housing legs and mounting flanges against each other.
- Work on the gear unit only when the machine is not in use. Prevent the drive unit from being unintentionally switched on (for example by locking the key-switch or removing the fuses from the power supply). Attach an information sign near the on-switch to warn that the gear unit is being worked on.
- The oil level and drain plugs as well as the breather valves must be easily accessible.
- Use plastic inserts (2 to 3 mm thick) if there is a risk of electrochemical corrosion between the gear unit and the driven machine (connection between different metals such as cast iron and high-grade steel). Also fit the plugs with plastic washers. Ground the housing additionally - use the grounding screws on the motor.
- Before startup, check whether the oil fill corresponds to the specified mounting position (→ information on the nameplate).
- The mounting position may only be changed after consultation with SEW-EURODRIVE. Warranty will become void without prior consultation.
- Only authorized personnel may assemble gear head units with motors and adapters. Please contact SEW-EURODRIVE.
- Do not weld anywhere on the drive. Do not use the drive as a ground point for welding work. Welding may destroy gearing parts and bearings.
- Protect rotating drive parts, such as couplings, gears, or belt drives using suitable devices that protect from contact.
- Units installed outdoors must be protected from the sun. Suitable protective devices are required, such as covers or roofs. When using these, avoid heat accumulation. The operator must ensure that foreign objects do not impair the function of the gear unit (e.g. by falling objects, or coverings).
- Gear units are supplied with suitable coating for use in damp areas or in the open air. Any damage to the coating (e.g. on the breather valve) must be repaired.
- For the standard mounting positions, the breather valve on the gear unit is mounted at the factory and activated if the gear unit is supplied without oil fill. Check the functionality of the breather valve and that it is seated correctly.
- Only mount couplings using a mounting device.

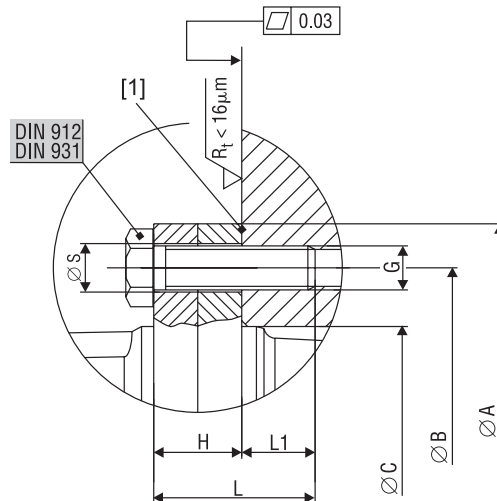


4.6 Flange mounting



During gear unit mounting on the torque arm and/or machine frame, note the following.

- Only use screws of strength class 8.8 in accordance with the table below.
- Tighten the screws with the specified tightening torque.
- In addition, apply Loctite 640 to the screw contact surface [1].



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Gear unit type P	Screws DIN	Thread	Quan- tity	Strength classes	Tightening torque [Nm] ± 20 %	Dimensions in [mm]						
						Ø S	H	L	L1	Ø A	Ø B	Ø C
P..001MC..	912/931	M20	20	8.8	310	22	36	70	34	410	370	330 f8
P..011.MC..	912/931	M20	20	8.8	310	22	38	70	32	450	410	370 f8
P..021MC..	912/931	M20	24	8.8	310	22	44	80	36	500	460	410 f8
P..031MC..	912/931	M24	20	8.8	540	26	46	80	34	560	510	460 f8
P..041MC..	912/931	M30	20	8.8	1100	33	60	110	50	620	560	480 f8
P..051MC..	912/931	M30	24	8.8	1100	33	60	110	50	650	590	530 f8
P..061MC..	912/931	M36	24	8.8	1830	39	70	130	60	760	690	610 f8
P..071MC..	912/931	M36	24	8.8	1830	39	80	140	60	840	770	690 f8
P..081MC..	912/931	M42	24	8.8	3200	45	80	150	70	920	840	750 f8



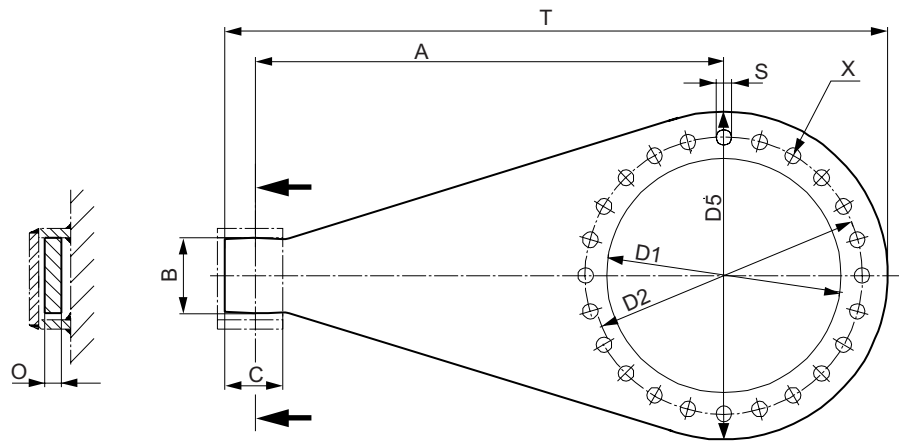
4.7 Installing torque arms for hollow shaft gear units

Single-sided torque arm



Do not place torque arms under strain during installation.

The reactive force due to the gear unit torque is absorbed via the torque arm with lever arm A. The illustration shows an example for absorption in a welded construction with design dimensions. Two supporting plates are welded with the suggested dimensions on the machine design. Once the gear unit has been mounted, a connecting cover plate is welded onto the two supporting plates. The force of the gear unit torque acts on the support, divided by the length of the lever arm A. The reaction force also acts on the gear unit and machine shafts.



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Installation / Assembly

Installing torque arms for hollow shaft gear units

Dimensions

Gear unit type	Dimensions in [mm]									Quantity	Weight
	A	B	C	D1	D2	D5	O	S	T	X	[Kg]
P001	650	60	50	335	370	410	25	22	880	16	31
P011	700	70	60	375	410	450	30	22	955	20	36
P021	750	90	70	415	460	500	35	22	1035	24	58
P031	800	110	90	465	510	560	35	26	1125	20	70
P041	900	150	120	485	560	620	40	33	1270	20	117
P051	1000	160	130	535	590	650	40	33	1390	24	147
P061	1200	180	150	615	690	760	50	39	1655	24	183
P071	1500	230	200	695	770	840	60	39	2020	24	315
P081	1600	230	200	755	840	920	70	45	2160	24	360

Tightening torques



- Only use class 8.8 screws in accordance with the table below.
- Tighten the screws with the specified tightening torque.

Gear unit type	Screws	Thread	Quantity	Strength classes	Tightening torque
	DIN				[Nm] ± 20 %
P001	912/931	M20	20	8.8	310
P011	912/931	M20	20	8.8	310
P021	912/931	M20	24	8.8	310
P031	912/931	M24	20	8.8	540
P041	912/931	M30	20	8.8	1100
P051	912/931	M30	24	8.8	1100
P061	912/931	M36	24	8.8	1830
P071	912/931	M36	24	8.8	1830
P081	912/931	M42	24	8.8	3200

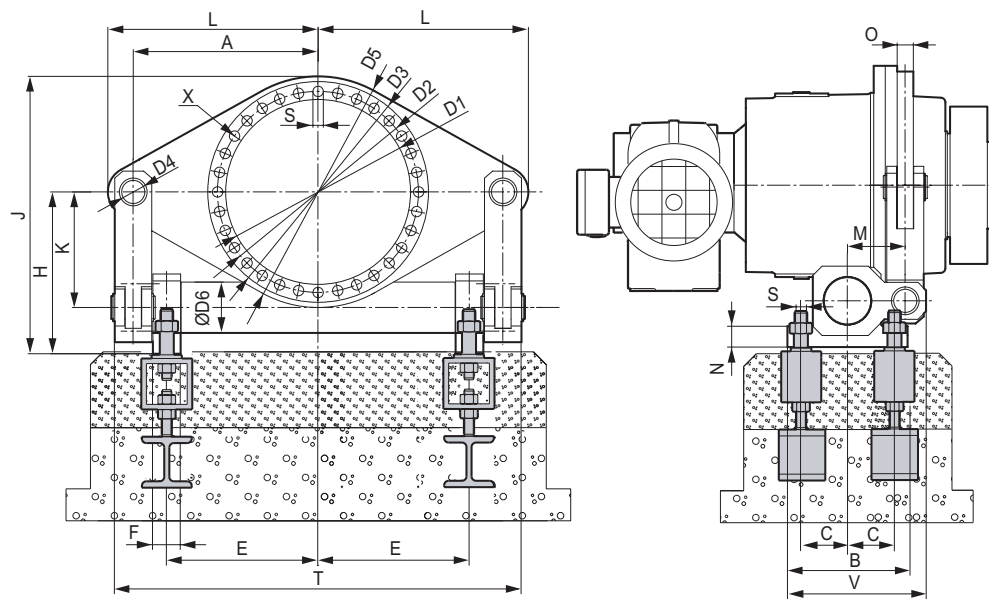


Double-sided torque arms



Do not place torque arms under strain during installation.

The reaction torque from the gear unit output torque is absorbed via the lever arms A. The resulting reactive force is absorbed in the foundation. No reaction forces act on the gear unit and machine bearings. The torque arm must be screwed onto a structure or foundation provided by the customer using the foot screws.



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Installation / Assembly

Installing torque arms for hollow shaft gear units

Dimensions

Gear unit type	Dimensions in [mm]											
	A	B	C	D1	D2	D3	D4	D5	D6	E	F	H
P061	500	500	190	610	690	770	90	810	200	370	110	640
P071	600	500	190	690	770	850	90	890	200	470	110	640
P081	700	520	200	750	840	930	100	970	220	555	120	710

Gear unit type	Dimensions in [mm]										Quantity	Weight
	J	K	L	M	N	O	S	T	V	X		[Kg]
P061	1045	460	595	240	70	60	39	1140	560	24		780
P071	1085	460	695	240	70	60	39	1340	560	24		895
P081	1195	520	810	260	80	70	45	1560	600	24		1292

Tightening torques



- Only use class 8.8 screws in accordance with the table below.
- Tighten the screws with the specified tightening torque.

Gear unit type	DIN screws	Thread	Quantity	Strength class	Tightening torque [Nm] $\pm 20\%$
P061	912/931	M36	8	8.8	1830
P071	912/931	M36	8	8.8	1800
P081	912/931	M42	8	8.8	3200



4.8 Assembly / disassembly of hollow shaft gear units and shrink discs

Assembly instructions

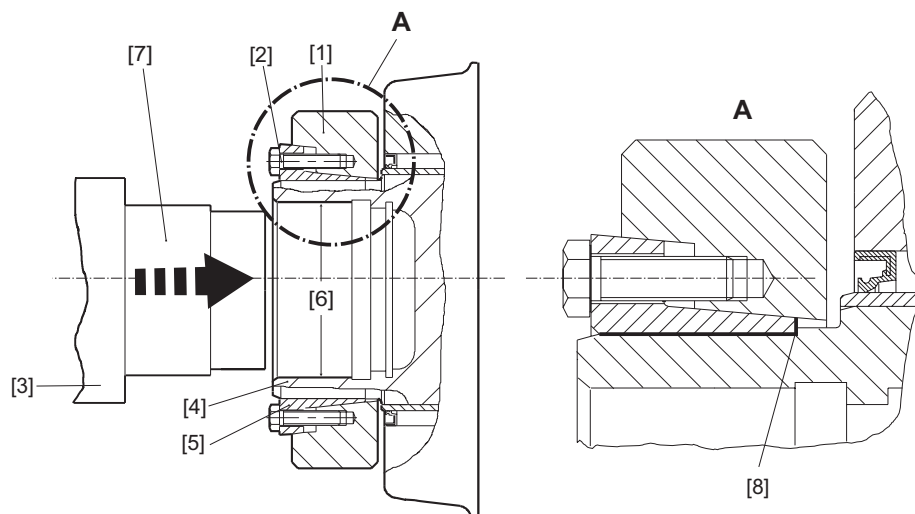


- Do not disassemble the shrink disc before the first installation.
- Never tighten the locking screws until the machine shaft has been installed.
- Do not tighten the locking screws in diametrically opposite sequence.
- On the outside surface of the shrink disc, the bore of the hollow shaft and the machine shaft must be absolutely free from any grease. This is an important factor for the reliability of torque transmission. Contaminated solvents and cleaning rags are not suitable for degreasing.



The shrink discs are delivered preassembled and ready for installation.

Assembly



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- | | |
|-------------------|---|
| [1] Outer ring | [5] Inner ring |
| [2] Locking screw | [6] Free from grease |
| [3] Machine shaft | [7] Free from grease |
| [4] Hub | [8] Correct position of the shrink disc |

1. Before installing the shrink disc, clean and degrease the hub [4] and the machine shaft [3]. This is a very important factor for the reliability of torque transmission.
2. Ensure that the dimensions of the machine shafts correspond to SEW specifications.



Installation / Assembly

Assembly / disassembly of hollow shaft gear units and shrink discs

3. Slide the loose shrink disc onto the hub [4].
4. Check the correct position of the shrink disc [8]. The shrink disc is positioned correctly when it is in contact with the shaft shoulder.
 - Never tighten the locking screws [2] until the machine shaft [3] has been installed.
5. Install the machine shaft [3] or slide the hub [4] to a stop on the machine shaft [3]. Perform the mounting sequence slowly to allow the compressed air to escape around the outside of the shaft.
6. Tighten the locking screws [2] manually first. Tighten all locking screws by working round equally (not in diametrically opposite sequence) in 1/4 turn increments.
7. **Observe the tightening torque** → see the table below. Tighten the locking screws [2] by continuing to work round in 1/4 turns until you reach the tightening torque. Additionally, you can visually check to see that the front lateral surfaces are aligned to the outer [1] and inner rings [5].



Verify the type details on your shrink disc and choose the tightening torque.

Shrink disc type	Gear unit type	Screws	Rated torque [Nm]	Tightening torque [Nm] ± 20 %
3191	P001	M16	41000	250
3181	P011	M16	75500	290
	P021	M16	95500	290
	P031	M20	134000	570
	P041	M20	194000	570
	P051	M20	255000	570
	P061	M24	405000	980
	P071	M24	525000	980
	P081	M24	720000	980



Disassembly



Danger of injury if disassembly is not performed correctly.

1. Loosen the locking screws [2], working around in 1/4 turns for each screws.
If the rings [1] [5] do not loosen from each other, unscrew as many screws as there are forcing threads and screw these equally into the forcing threads until the tapered bushing is pushed out of the tapered ring.
Under no circumstances should more locking screws be unscrewed than there are forcing threads present, else there is a potential risk of injury.
2. Remove the machine shaft [3] or pull the hub [4] off the customer shaft (first, remove any corrosion, which may have formed between the hub and the shaft end).
3. Remove the shrink disc from the hub [4].

Cleaning and lubrication

Do not disassemble and regrease the removed shrink disc before installing it again. Only clean the shrink disc if it is contaminated.

Next, regrease only the inner sliding surfaces of the shrink disc.

Use a solid lubricant with a friction factor of $\mu = 0.04$.

Lubricant	Sold as
Molykote 321 R (lube coat)	Spray
Molykote spray (powder spray)	Spray
Molykote G Rapid	Spray or paste
Aemasol MO 19R	Spray or paste
Molykombin UMFT 1	Spray
Unimoly P5	Powder



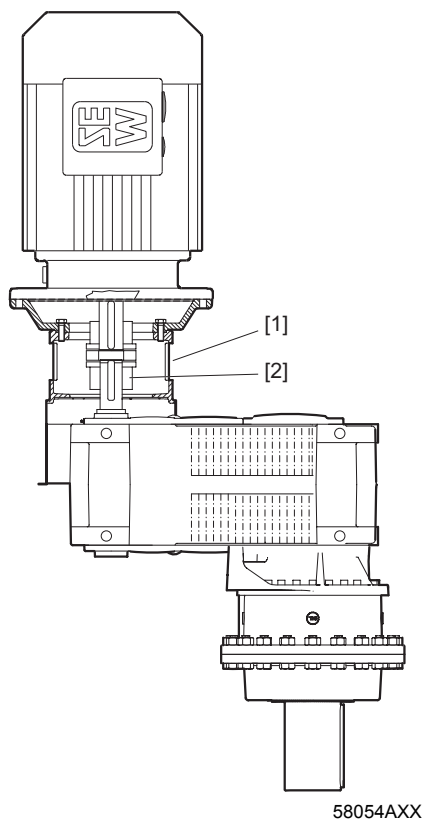
4.9 Mounting a motor with motor adapter

Motor adapters [1] are available for mounting IEC / NEMA motors to P.MC series industrial gear units.



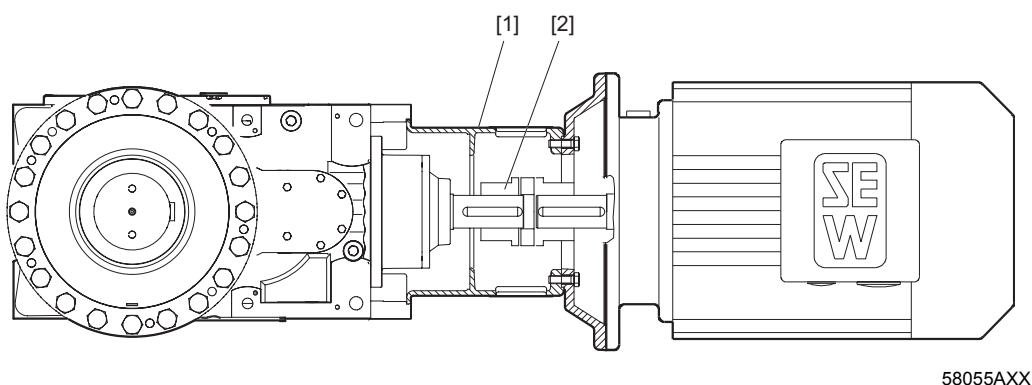
For mounting the coupling [2], refer to the notes in Sec. "Mounting couplings".

The figures below show the basic structure of the motor adapter.



[1] Motor adapter

[2] Coupling



[1] Motor adapter

[2] Coupling



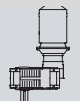
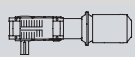
When selecting a motor, **take into account the permitted motor weight**, the **gear unit design** and the **type of gear unit mounting** according to the following tables.

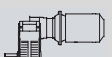
The following applies to all tables:

G_M = Motor weight

G_G = Gear unit weight

Mounting type	Series / industrial gear unit design	
	 MC.PL..	 MC.RL..
Foot-mounted	$G_M \leq G_G$	$G_M \leq G_G$
Shaft-mounted	$G_M \leq 0.5G_G$	$G_M \leq G_G$
Flange-mounted	$G_M \leq 0.5G_G$	$G_M \leq G_G$

Mounting type	Series / industrial gear unit design	
	 MC.PV..	 MC.RV..
Foot-mounted	$G_M \leq 1.5G_G$	$G_M \leq G_G$
Shaft-mounted	$G_M \leq G_G$	$G_M \leq G_G$
Flange-mounted	$G_M \leq G_G$	$G_M \leq 0.75G_G$

Mounting type	Series / industrial gear unit design	
	 MC.PE..	 MC.RE..
Foot-mounted	$G_M \leq G_G$	$G_M \leq 1.5G_G$
Shaft-mounted	$G_M \leq G_G$	$G_M \leq G_G$
Flange-mounted	$G_M \leq G_G$	$G_M \leq G_G$



These tables are only valid for stationary operation. If gear unit is moving during (e.g. travel drives) please contact SEW-EURODRIVE.



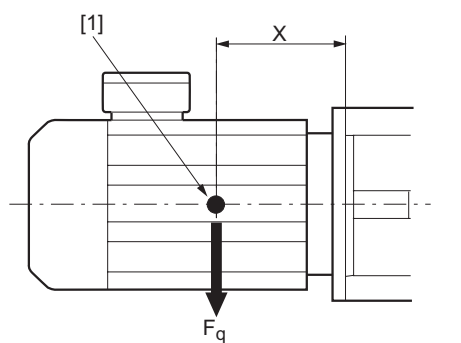
Installation / Assembly

Mounting a motor with motor adapter

Permitted motors for connection



When mounting motors, observe the center of gravity of the motor and the weight of the motor.



58517AXX

[1] Center of gravity of the motor



These tables only apply to the following correlation of motor size / weight F_q and dimension "x".

Motor size		$F_{q \max}$	x
IEC	NEMA	[N]	[mm]
132S	213/215	579	189
132M	213/215	677	208
160M	254/286	1059	235
160L	254/286	1275	281
180M	254/286	1619	305
180L	254/286	1766	305
200L	324	2354	333
225S	365	2943	348
225M	365	3237	348
250M	405	4267	395
280S	444	5984	433
280M	445	6475	433
315S	505	8142	485
315M	505	8927	485
315L		11772	555

The maximum approved weight of the attached motor F_q has to be reduced in a linear manner if the center of gravity distance x is increased. $F_{q \max}$ cannot be increased if the center of gravity distance is reduced.

Please contact SEW-EURODRIVE in the following cases.



- When retrofitting motor adapters with a cooling air fan (not for motors of sizes 132S and 132M).
- If a motor adapter is removed, re-alignment is necessary.



5 Mechanical Installation Options

5.1 Important installation instructions



- You must strictly adhere to the safety instructions in the individual sections.
- Disconnect the motor from the power supply before starting work on couplings and secure it against unintentional restart.
- Work on the gear unit only when the machine is not in use.
- Never drive couplings, pinions, etc. onto the shaft end by hitting them with a hammer (damage to bearings, housing and the shaft!).
- In the case of belt pulleys, make sure the belt is tensioned correctly in accordance with the manufacturer's instructions.
- Input and output elements such as couplings must be equipped with a touch guard!
- Power transmission elements should be balanced after installation and must not give rise to excessive radial or axial forces.
- Only use a mounting device for installing input and output elements. Use the center bore and the thread on the shaft end for positioning.

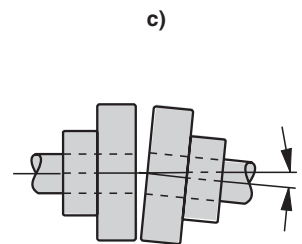
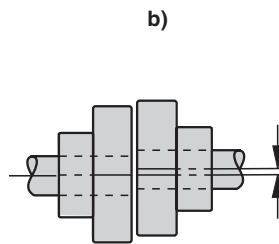
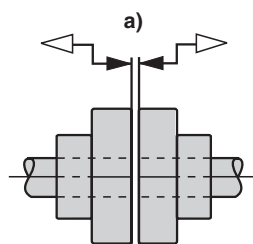


Mounting is easier if you first apply lubricant to the output element or heat it up briefly (to 80-100 °C).

Installation note for couplings

Adjust the following misalignments when mounting couplings:

- a) Axial misalignment (maximum and minimum clearance)
- b) Offset misalignment (concentric running fault)
- c) Angular misalignment



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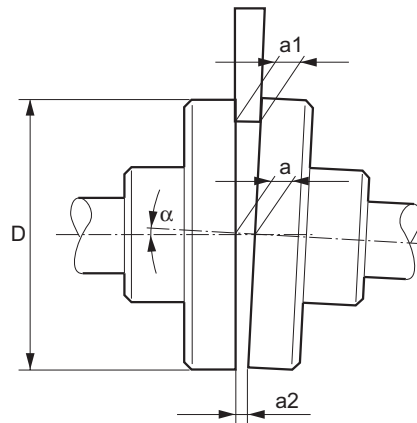


Note:

The following methods for measuring angular and axial misalignment are important for complying with the mounting tolerances specified in Sec. "Mounting of couplings"!

Measuring of angular misalignment with a feeler gauge

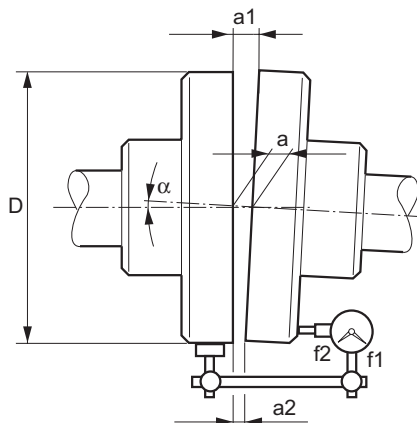
The following figure shows the measurement for angular misalignment (α) using a feeler gauge. When using this method, an accurate result is only achieved when the deviation of the coupling faces is eliminated by turning both coupling halves by 180° and the average value is then calculated from the difference ($a_1 - a_2$).



52063AXX

Measuring of angular misalignment using a micrometer dial

The following figure shows the measurement for angular misalignment using a micrometer dial. This measuring method provides the same result as described under "Measuring angular offset with a feeler gauge" if the **coupling halves are rotated together**, for instance with one coupling pin, so that the needle of the micrometer dial does not move noticeably on the measuring surface.



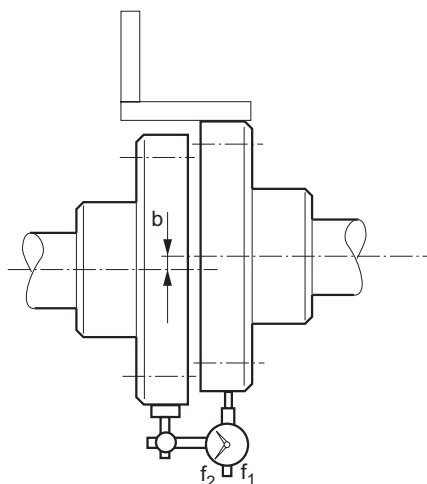
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A prerequisite for this measuring method is that there is no axial play in the shaft bearings when the shafts rotate. If this condition is not fulfilled, the axial play between the faces of the coupling halves must be eliminated. As an alternative, you can use two micrometer dials positioned on the opposite sides of the coupling (to calculate the difference of the two micrometer dials when rotating the coupling).



Measuring of offset misalignment using straight-edge and micrometer dial

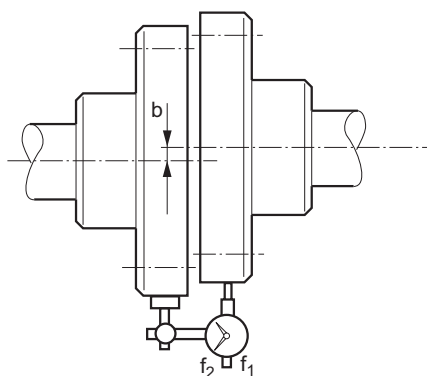
The following figure shows the measurement for offset misalignment using a straight-edge. Permissible values for eccentricity are usually so small that the best measurement results can be achieved with a micrometer dial. If you **rotate one coupling half** together with the micrometer dial and divide the deviation by two, the micrometer dial will indicate the deviation and as a result the misalignment (dimension "b"), which includes the offset misalignment of the other coupling half.



52065AXX

Measuring of offset misalignment using a micrometer dial

The following figure shows the measurement for offset misalignment using a **more accurate measuring method**. The **coupling halves are rotated together** without the tip of the micrometer dial moving on the measuring surface. The offset misalignment is obtained by dividing the deviation indicated on the micrometer dial (dimension "b").

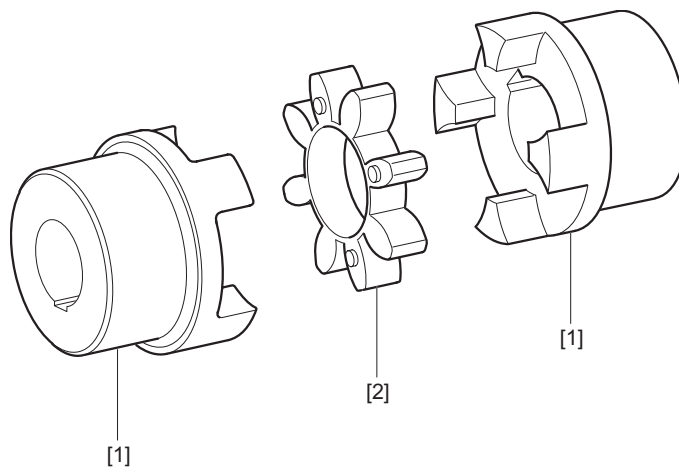


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5.2 Installing couplings

ROTEX coupling



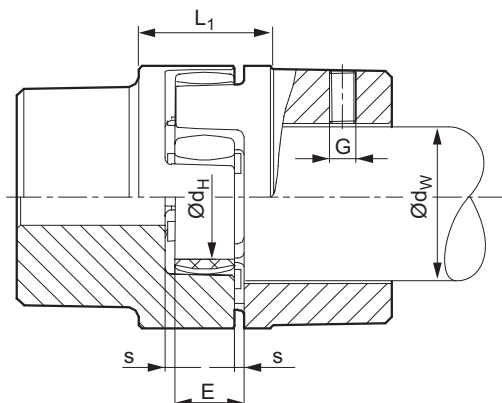
[1] Coupling hub

[2] Ring gear

The low-maintenance, elastic ROTEX coupling is capable of compensating radial and angular misalignment. Careful and exact alignment of the shaft ensures long service life of the coupling.



Mounting the
coupling halves
onto the shaft



51689AXX



The shaft distance must be strictly observed (dimension E) to ensure axial play of the coupling.

Coupling size	Mounting dimensions						Locking screw	
	E [mm]	s [mm]	d _H [mm]	d _W [mm]	L ₁ (Alu / GG / GGG) [mm]	L ₁ (steel) [mm]	G	Tightening torque [Nm]
14	13	1.5	10	7	-	-	M4	2.4
19	16	2	18	12	26	-	M5	4.8
24	18	2	27	20	30	-	M5	4.8
28	20	2.5	30	22	34	-	M6	8.3
38	24	3	38	28	40	60	M8	20
42	26	3	46	36	46	70	M8	20
48	28	3.5	51	40	50	76	M8	20
55	30	4	60	48	56	86	M10	40
65	35	4.5	68	55	63	91	M10	40
75	40	5	80	65	72	104	M10	40
90	45	5.5	100	80	83	121	M12	69
100	50	6	113	95	92	-	M12	69
110	55	6.5	127	100	103	-	M16	195
125	60	7	147	120	116	-	M16	195
140	65	7.5	165	135	127	-	M20	201
160	75	9	190	160	145	-	M20	201
180	85	10.5	220	185	163	-	M20	201

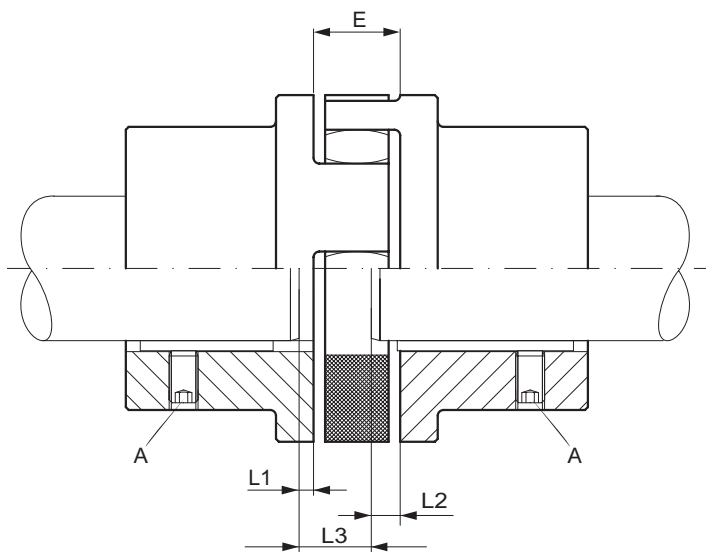


Mechanical Installation Options

Installing couplings

Mounting dimensions of ROTEX coupling in motor adapter

Tighten the set screws (A) to avoid axial play of the coupling.



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The mounting dimensions specified in the following table only apply to mounting a ROTEX coupling in a motor adapter. They apply to all gear unit versions and gear ratios.



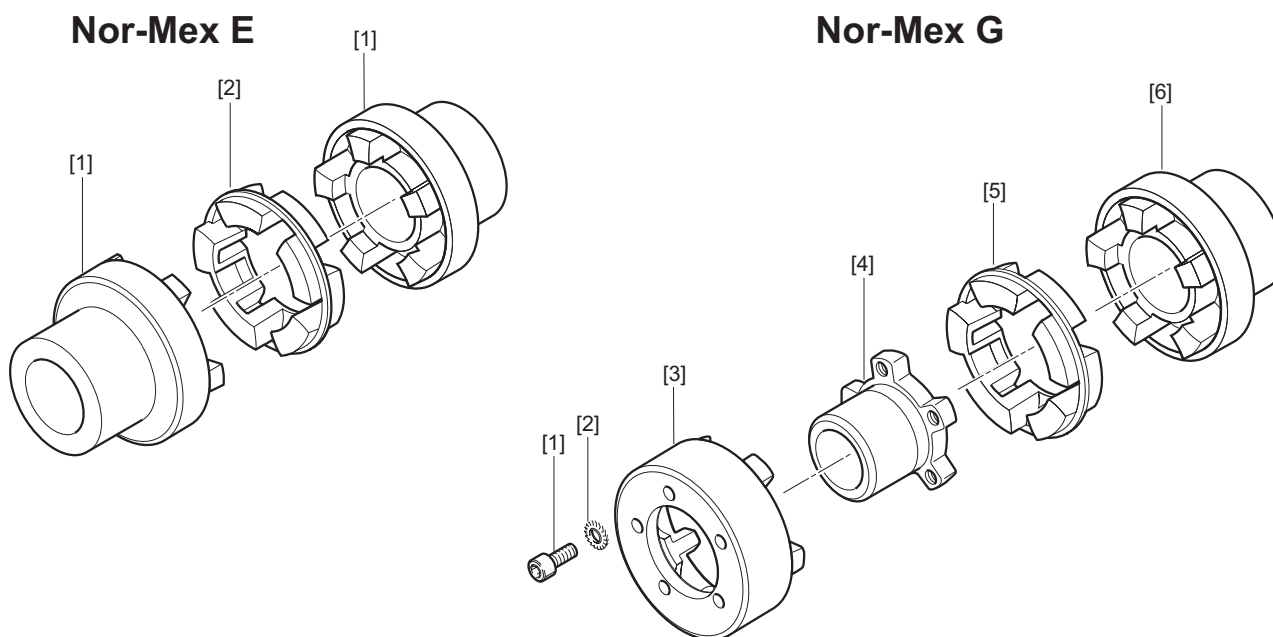
The shaft distance must be strictly observed (dimension E) to ensure axial play of the coupling.

ROTEX coupling size	IEC motor size	Mounting dimensions			
		E [mm]	L ₁ [mm]	L ₂ [mm]	L ₃ [mm]
R28 / 38	132	20	0	-17	3
R38 / 45	160	24	1	0	25
R42 / 55	180/200	26	-1	0	25
R48 / 60	225	28	0	-3	25
R55 / 70	225	30	0	-5	25
R65 / 75	250/280	35	0	-10	25
R75 / 90	315	40	0	-15	25
R90 / 100	315	45	-20	0	25



Nor-Mex coupling, types G and E

The low-maintenance Nor-Mex couplings types G and E are torsionally flexible couplings capable of compensating axial, angular, and radial misalignments. Torque is transmitted via an elastic element with high damping properties, which is also oil and heat resistant. The couplings can be used for either direction of rotation and can be mounted in any position. The design of the Nor-Mex coupling type G allows to replace the elastic element [5] without movement of the shafts.



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- [1] Coupling hub
- [2] Elastic element

- [1] Socket head screw
- [2] Tooth lock washer
- [3] Claw ring
- [4] Flange hub
- [5] Elastic element
- [6] Coupling hub

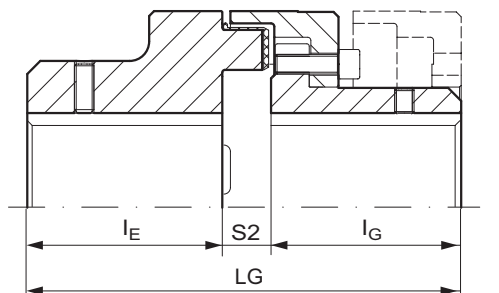


Mechanical Installation Options

Installing couplings

Mounting instructions, mounting dimensions for Nor-Mex G coupling

After having mounted the coupling halves, ensure that the recommended play (dimension S_2 for type G, dimension S_1 for type E) and the overall length (dimension L_G for type G and dimension L_E for type E) corresponds with the dimensions given in the following tables. Accurate alignment of the coupling (→ Sec. 'Mounting tolerances') ensures long service life.

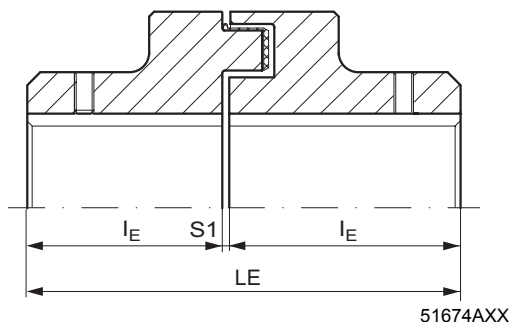


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Nor-Mex G Coupling size	Mounting dimensions				Weight [kg]
	l_E [mm]	l_G [mm]	L_G [mm]	Permitted deviation S_2 [mm]	
82	40	40	92	12 ± 1	1.85
97	50	49	113	14 ± 1	3.8
112	60	58	133	15 ± 1	5
128	70	68	154	16 ± 1	7.9
148	80	78	176	18 ± 1	12.3
168	90	87	198	21 ± 1.5	18.3
194	100	97	221	24 ± 1.5	26.7
214	110	107	243	26 ± 2	35.5
240	120	117	267	30 ± 2	45.6
265	140	137	310	33 ± 2.5	65.7
295	150	147	334	37 ± 2.5	83.9
330	160	156	356	40 ± 2.5	125.5
370	180	176	399	43 ± 2.5	177.2
415	200	196	441	45 ± 2.5	249.2
480	220	220	485	45 ± 2.5	352.9
575	240	240	525	45 ± 2.5	517.2



Mounting dimensions of the Nor-Mex E coupling



Nor-Mex E Coupling size	Mounting dimensions			
	l_E [mm]	L_E [mm]	Permitted deviation S_1 [mm]	Weight [kg]
67	30	62.5	2.5 ± 0.5	0.93
82	40	83	3 ± 1	1.76
97	50	103	3 ± 1	3.46
112	60	123.5	3.5 ± 1	5
128	70	143.5	3.5 ± 1	7.9
148	80	163.5	3.5 ± 1.5	12.3
168	90	183.5	3.5 ± 1.5	18.4
194	100	203.5	3.5 ± 1.5	26.3
214	110	224	4 ± 2	35.7
240	120	244	4 ± 2	46.7
265	140	285.5	5.5 ± 2.5	66.3
295	150	308	8 ± 2.5	84.8
330	160	328	8 ± 2.5	121.3
370	180	368	8 ± 2.5	169.5
415	200	408	8 ± 2.5	237
480	220	448	8 ± 2.5	320
575	240	488	8 ± 2.5	457

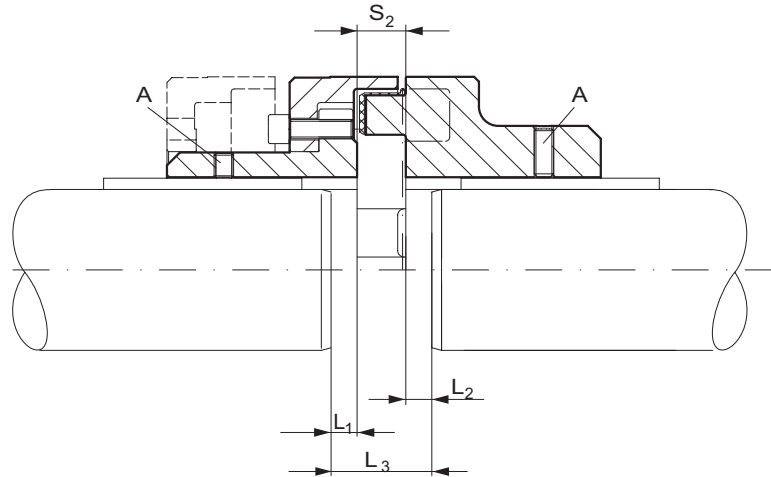


Mechanical Installation Options

Installing couplings

Mounting dimensions of the Nor-Mex G coupling in the motor adapter

Tighten the set screws (A) to avoid axial play of the coupling.



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The mounting dimensions specified in the following table only apply to mounting a Nor-Mex coupling in a motor adapter.

NOR-MEX G. Coupling size		97	97	112	128	148	168	194	214
IEC motor size		132	160	160/180	200	225	250/280	280/315	315
Gear unit size Gear ratio i	Mounting dimensions	[mm]							
All All	S ₂	14	14	15	16	18	21	24	26
	L ₃	3	25	25	25	25	25	25	25
MC3R02 i = 14 ... 63	L ₂	-	5	5	5	10	2	1	0
	L ₁	-	6	5	4	-3	2	0	-1
MC3R05 i = 14 ... 63	L ₂	-	5	5	5	4	2	5	0
	L ₁	-	6	5	4	3	2	-4	-1
MC3R08 i = 14 ... 63	L ₂	-	5	5	5	4	2	1	5
	L ₁	-	6	5	4	3	2	1	-6
Other P.MC.. i = 7.1 ... 112	L ₂	-5	5	5	5	4	2	1	0
	L ₁	-6	6	5	4	3	2	0	-1



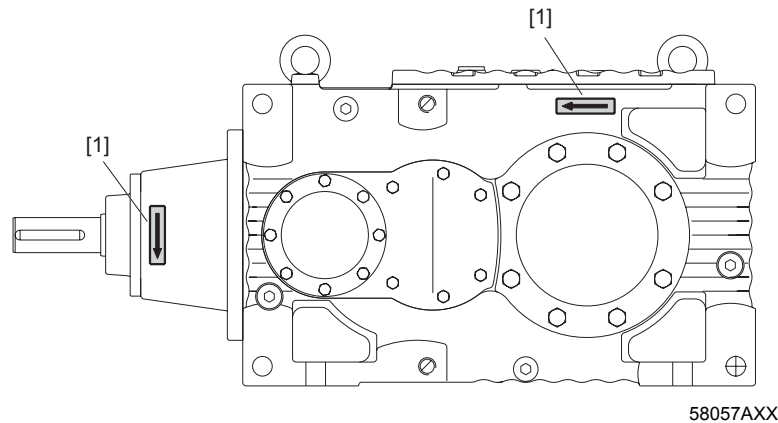
5.3 Backstop FXM

The purpose of a backstop is to prevent undesirable reverse rotation. During operation, the backstop permits rotation in one specified direction of rotation only.



- **Do not start up the motor in the blocking direction. Note the correct power supply of the motor to achieve the required direction of rotation. Running the motor in blocking direction might destroy the backstop!**
- **Consult SEW-EURODRIVE if you want to change the blocking direction.**

The maintenance-free FXM type backstop is a centrifugally operated backstop with sprags that lift off. Once the lift-off speed is reached, the sprags completely lift off from the contact surface of the outer ring. The backstop is lubricated with gear oil. An arrow on the gearcase indicates the permitted direction of rotation [1] (→ following figure).

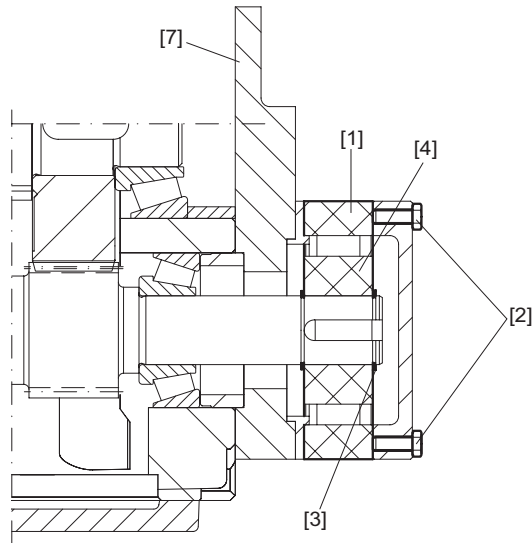


Changing the direction of rotation

To change the direction of rotation, turn the inner ring with the sprags by 180°. Pull out the inner ring with the sprags using a pulling-off device (not included in the scope of delivery) and replace turned by 180° (see next page).



... Backstop
mounted outside
the gear unit



51640AXX

- [1] Outer ring [2] Retaining screws
[3] Circlip [4] Inner ring with cage and sprags

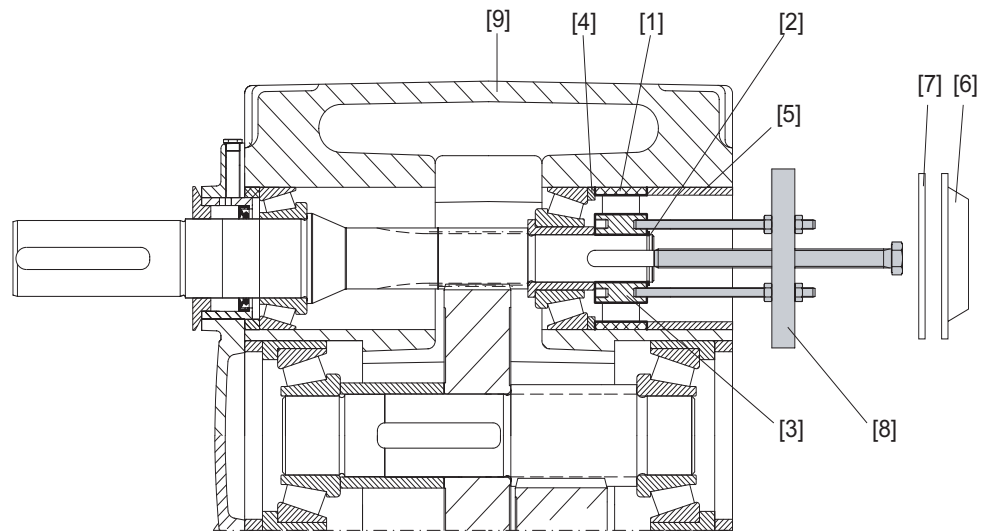
1. Drain the gear unit oil (→ Sec. "Inspection and Maintenance").
2. Loosen the retaining screws [2] of the backstop.
3. Remove the outer ring [1]. To facilitate dismounting, slightly turn the outer ring [1] in freewheeling direction.
4. Remove circlip [3], and inner ring with cage and sprags [4].
5. Turn the inner ring [4] with the sprags by 180° and replace the parts in reverse order. When mounting the backstop, do not apply pressure to the cage with the sprags but to the inner ring [4] only. Use the threaded holes on the inner ring [4] for mounting.
6. Fix the inner ring [4] with the circlip [3] in axial direction. Mount the outer ring [1] using the retaining screws [2]. Observe the tightening torques specified in the following table:

Screw size	Tightening torque [Nm]
M5	6
M6	10
M8	25
M10	48
M12	84
M16	206
M20	402
M24	696
M30	1420

7. Alter the direction arrow on the gearcase.
8. Refill the gear oil (→ Sec. Lubricants). Check the oil level.
9. After mounting, check that the backstop runs smoothly.



... with backstop
mounted inside the
gear unit



51645AXX

- | | |
|-------------------------------------|-------------------|
| [1] Outer ring | [5] Sleeve |
| [2] Circlip | [6] Bearing cover |
| [3] Inner ring with cage and sprags | [7] Shims |
| [4] Supporting ring | [8] Extractor |

1. Drain the gear unit oil (→ Sec. "Inspection and Maintenance").
2. Remove bearing cover [6], shims [7] and sleeve [5]. It is important that shims [7] and sleeve [5] between bearing cover [6] and outer ring [1] are not mixed up because they must be assembled in the correct order.
3. Remove the circlip [2] from the input shaft.
4. Remove the inner ring with cage and sprags [3] using a suitable extractor [8]. Use the threaded holes on the inner ring [3] for mounting.
5. Turn the inner ring [3] with the sprags by 180° and replace the parts in reverse order. When mounting the backstop, do not apply pressure to the cage with the sprags but to the inner ring [3] only.
6. When mounting the backstop, turn it in freewheeling direction so that the sprags move into the outer ring.
7. Fix the inner ring [3] with the circlip [2] in axial direction.
8. Mount sleeve [5], shims [7] and bearing cover [6] in reverse order.
9. Alter the direction arrow on the gearcase.
10. Refill the gear oil (→ Sec. Lubricants). Check the oil level.
11. After mounting, check that the backstop runs smoothly.



5.4 Shaft end pump SHP

Usage

The maintenance-free shaft end pump SHP.. can be used to lubricate gear unit parts of gear unit sizes MC04 to MC09 that are not submerged in the oil bath. The shaft end pump can be operated in both directions of rotation.



A minimum input speed is necessary for correct working of the shaft end pump. Therefore, always consult SEW-EURODRIVE in the event of variable input speeds (e.g. with inverter controlled drives) or when changing the input speed range of an already delivered gear unit with shaft end pump.

Pump position

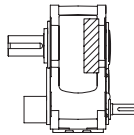
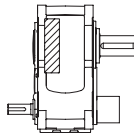
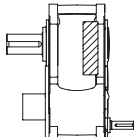
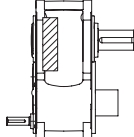
The pump is mounted externally to the gear unit and is directly driven by the input shaft or intermediate shaft of the gear unit. A high reliability of the pump function is ensured in this way. The pump position depends on the following factors:

- Number of gear unit stages
- Gear unit type (helical or bevel-helical)
- Shaft position of the gear unit
- Output shaft type

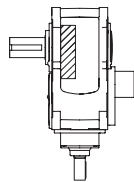
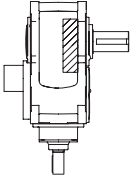
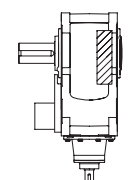
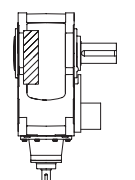
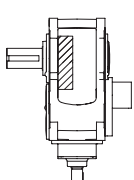
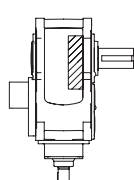


Check for interference of the shaft end pump with other surrounding structures.



	Shaft positions			
	23	13 ¹⁾	24 ¹⁾	14
MC2PS • Solid shaft				
MC3PS • Solid shaft				

1) The maximum permitted external loads on the output shaft are lower.

	Shaft positions			
	03	04	03 ¹⁾	04 ¹⁾
MC2R • Solid shaft				
MC3RS • Solid shaft				

1) The maximum permitted external loads on the output shaft are lower.



Mechanical Installation Options

Shaft end pump SHP

Pump suction

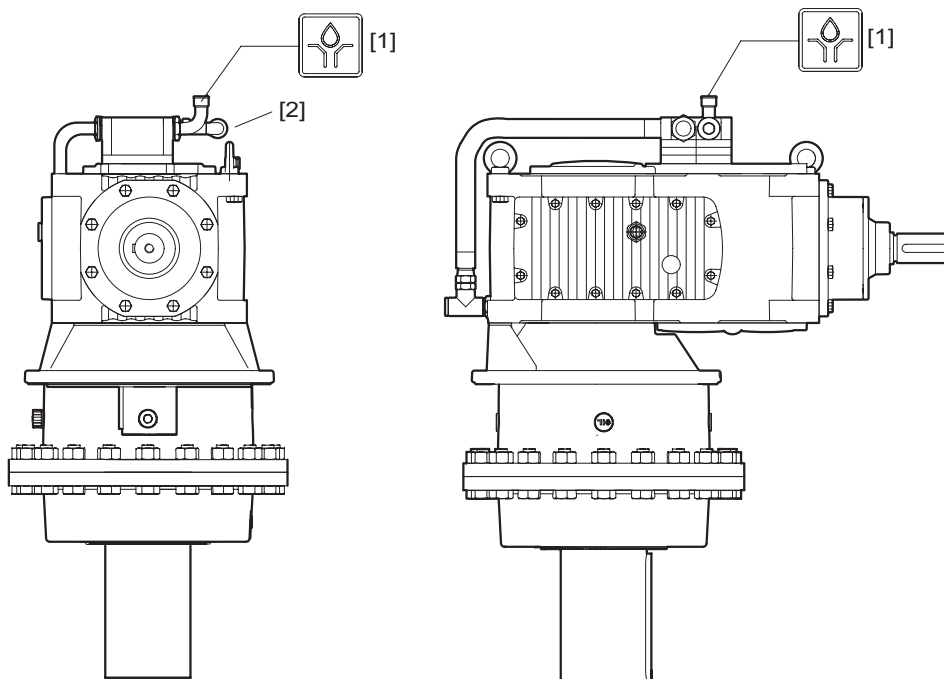


- It is essential that the gear unit is sufficiently lubricated from the very beginning!
- Do not change the diameter of the tube / pipe connection!
- Do not open the pressure line [PRE]!
- If the shaft end pump does not build up pressure within 10 seconds after the gear unit has been started, please contact SEW-EURODRIVE.

Shaft end pump mounted on top of the P.MC.V.. gear unit



Danger of dry-start with shaft end pump mounted on top of gear unit.



58058AXX

[1] Separate suction oil filling plug

[2] Flow switch or visual flow indicator (not visible in the drawing)

It is essential that the oil pump begins to pump oil as soon as the main motor begins to rotate. If the pump does not begin to pump oil immediately, open the separate oil filling plug [1] and pour in oil (1-4 liters). Once the oil begins to circulate (check with flow switch or visual flow indicator [2]), close the separate oil filling plug.

This procedure is particularly important if the gear unit has been standing for a long period of time and there is air in the suction pipe and oil pump.



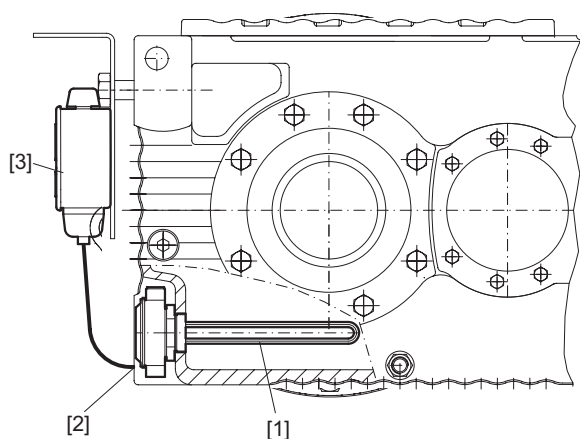
5.5 Oil heater

Oil heating is required to ensure lubrication at startup when the ambient temperature is low (e.g. cold start of the gear unit).

Purpose and basic design

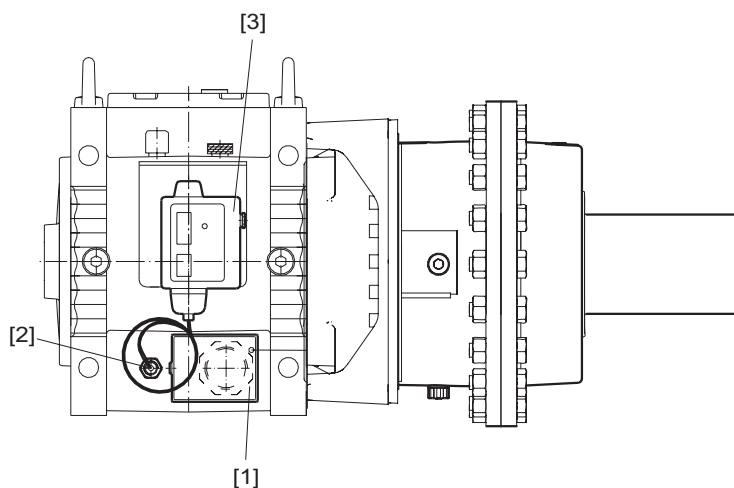
The oil heater consists of three basic parts:

1. Resistor element in the oil bath ("Oil heater") with terminal box
2. Temperature sensor
3. Thermostat



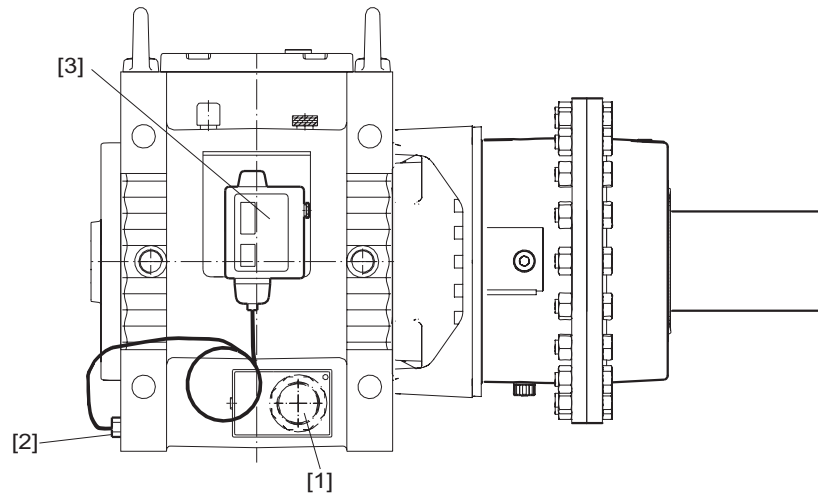
58062AXX

- [1] Oil heater
[2] Temperature sensor
[3] Thermostat



58059AXX

- [1] Oil heater
[2] Temperature sensor
[3] Thermostat



58060AXX

- [1] Oil heater
[2] Temperature sensor
[3] Thermostat

Activation / deactivation behaviour

- The oil heater is activated when the factory set temperature is reached. This temperature setpoint depends on the following factors:
 - For splash/bath lubrication: on the pourpoint of the used oil
 - For pressure lubricated units: on the temperature at which the oil viscosity reaches a maximum of 2000 cSt

ISO VG	Trip point for splash/bath lubrication [°C]					
	680	460	320	220	150	100
Mineral oil	-7	-10	-15	-20	-25	-28
Synthetic oil		-30	-35	-40	-40	-45

ISO VG	Trip point for pressure lubrication [°C]					
	680	460	320	220	150	100
Mineral oil	+25	+20	+15	+10	+5	
Synthetic oil		+15	+10	+5	0	-5

- The oil heater is deactivated when the set temperature is exceeded by 8 to 10°C.

Thermostat and oil heater are usually installed on the gear unit and are ready for operation but without electrical connections. Therefore, do the following before startup:

1. Connect the resistor element ("Oil heater") to the power supply
2. Connect the thermostat to the power supply



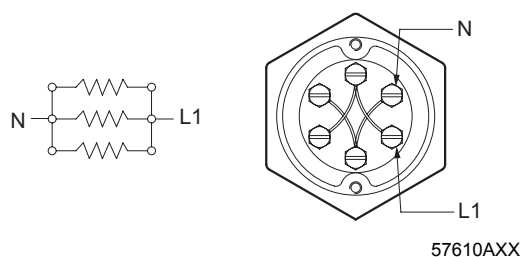
Technical data

Gear unit size	Current consumption oil heater [W]	Voltage supply [V _{AC}]
04 - 06	600	See separate data sheet ¹⁾
07 - 09	1200	

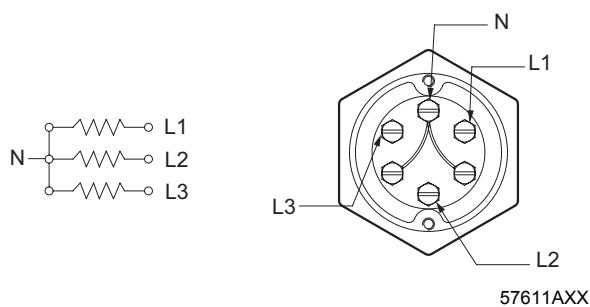
1) Only use voltage specified in separate data sheet.

Electrical connection resistor element

Wiring examples with 230/400 V supply voltage



1-phase	
Voltage	230 V
Phase voltage	230 V
Mains voltage	400 V
Resistor element voltage	230 V

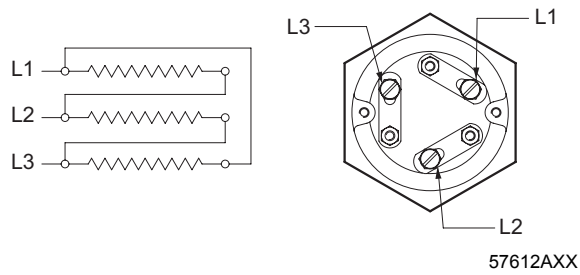


3-phase / star connection	
Voltage	230/400 V
Phase voltage	230 V
Mains voltage	400 V
Resistor element voltage	230 V



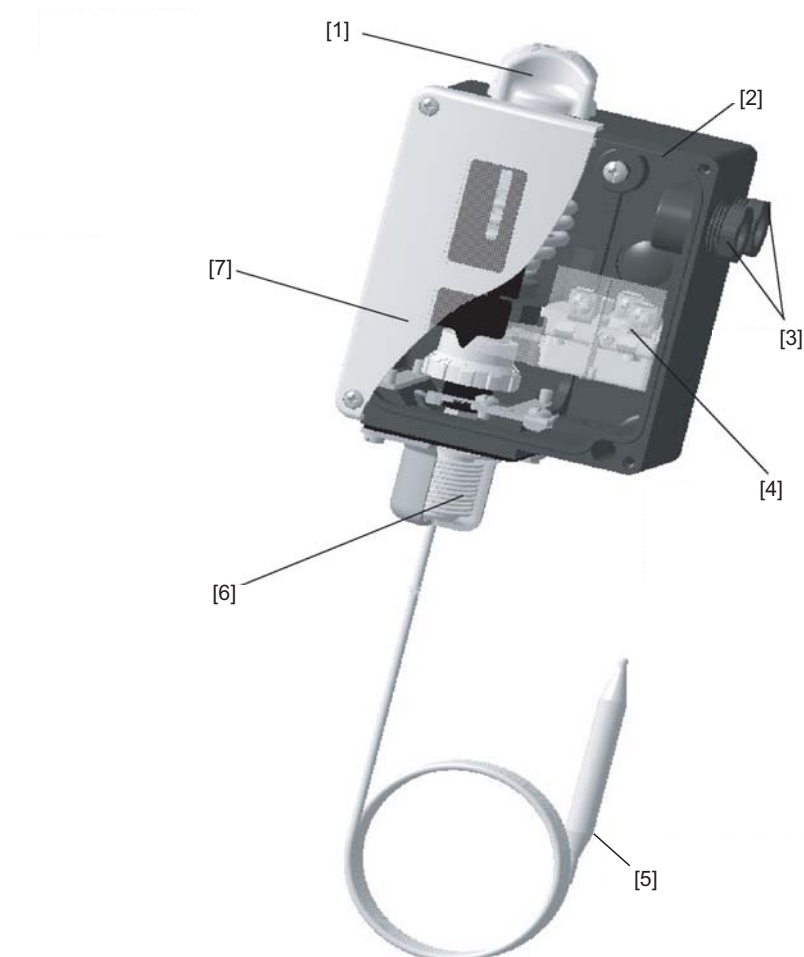
Mechanical Installation Options

Oil heater



3-phase / delta connection	
Voltage	400 V
Mains voltage	400 V
Resistor element voltage	400 V

Basic structure of thermostat

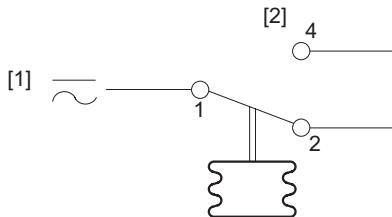
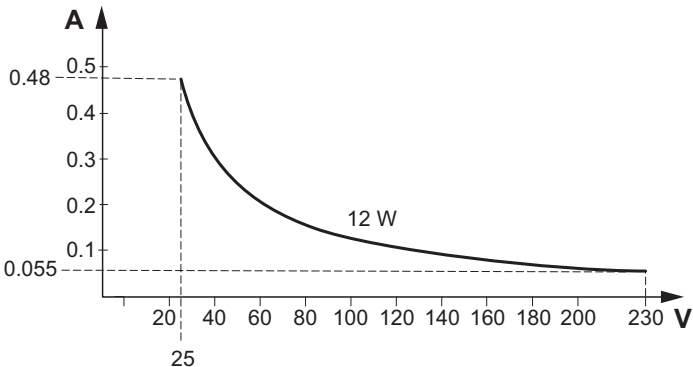


53993AXX

- [1] Setting range knob
- [2] Degree of protection IP66 (IP54 in units with external reset)
- [3] 2 x PG 13.5 for cable diameter 6 mm → 14 mm
- [4] SPDT contact system. Exchangeable
- [5] Capillary tube length up to 10 m
- [6] Stainless steel bellows
- [7] Polyamid housing



Basic structure of thermostat

	Thermostat RT
Ambient temperature	–50 °C to +70 °C
Connection diagram	 [1] Line [2] SPDT
Connection data	Alternating current: AC-1: 10 A, 400 V AC-3: 4 A, 400 V AC-15: 3 A, 400 V
Contact material: AgCdO	Direct current: DC-13: 12 W, 230 V 
Cable entry	2 PG 13.5 for cable diameter of 6 -14 mm
Degree of protection	IP66 acc. to IEC 529 and EN 60529, IP54 for units with external reset. The thermostat housing is made of bakelite according to DIN 53470, the cover is made of polyamid.

A contactor must be used in the following cases:

- 3-phase voltage supply
- 2 heating rods
- current ratings exceed nominal values of thermostat.



Mechanical Installation Options

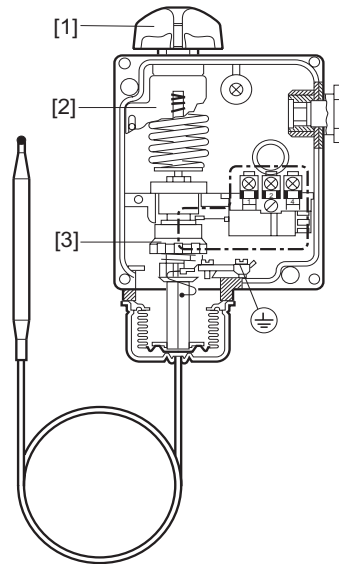
Oil heater

Adjusting the setpoint

The setpoint is usually set at the factory. Proceed as follows for adjustment:

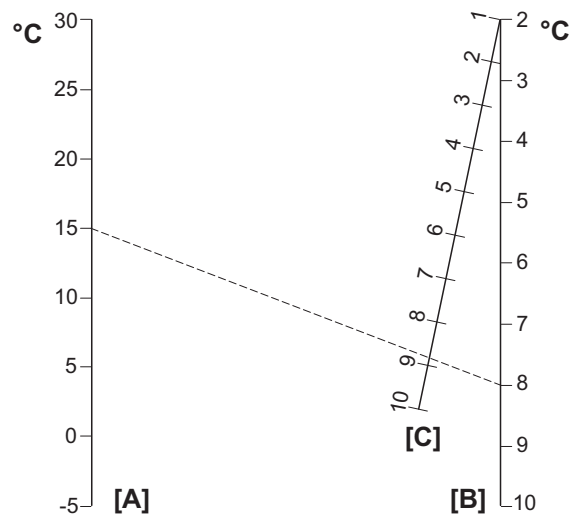
The range is set by using the setting knob [1] while at the same time reading the main scale [2]. Use a tool if the thermostat is equipped with a cap. The differential is set using the differential disk [3].

The size of the differential obtained for the relevant thermostat can be established by comparing the set main scale value and the scale value on the differential disk with the help of a nomogram.



53994AXX

- [1] Setting range knob
- [2] Main scale
- [3] Differential setting disk



53992AXX

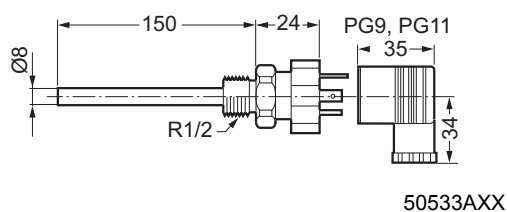
- [A] Setting range
- [B] Obtained differential
- [C] Differential setting



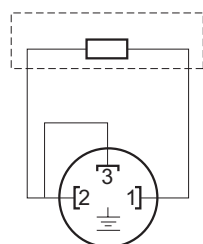
5.6 Temperature sensor PT100

The temperature sensor PT100 can be used to measure the temperature of the oil in the gear unit.

Dimensions



Electrical connection



50534AXX

Technical data

- Sensor tolerance $\pm (0.3 + 0.005 \times t)$, (corresponds to DIN IEC 751 class B), t = oil temperature
- Plug connector DIN 43650 PG9 (IP65)
- The tightening torque for the retaining screw in the back of the plug connector for electrical connection is 25 Nm.

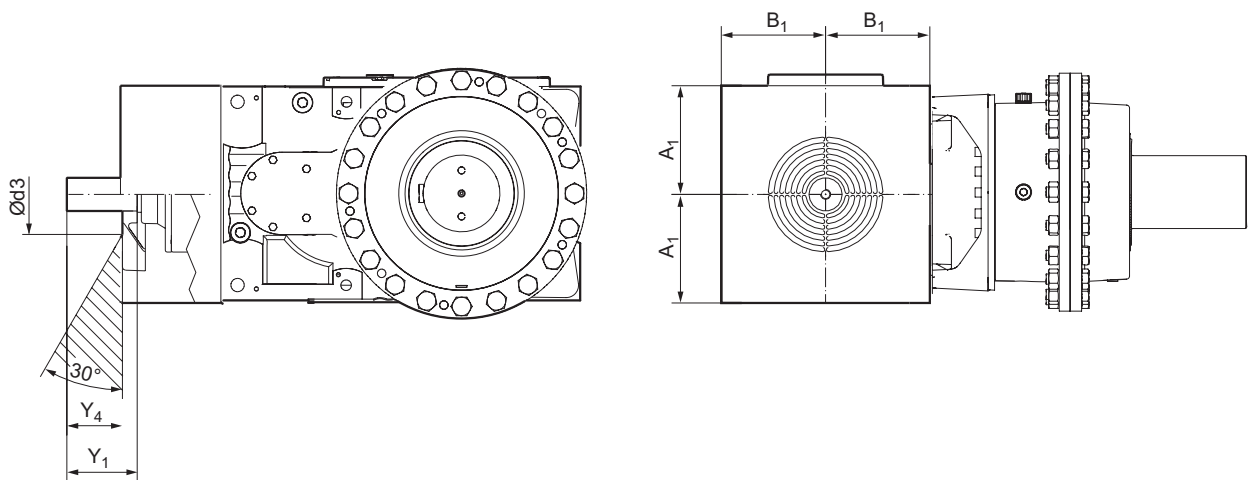


5.7 Fan



Make sure air intake vents are not blocked or covered!

A fan can be mounted if the projected thermal power of the gear unit is exceeded. A fan can be retrofitted if the ambient conditions change after having installed the gear unit. The direction of rotation of the gear unit does not influence the operation of the fan.



58061AXX

Gear unit type	A ₁	B ₁	Y ₄	Y ₁	Air intake	
					Ø d ₃ [mm]	Angle
PMC3RL..02	158	160	70	100	109	30°
PMC3RL..03	178	165	82	112	131	
PMC3RL..04	198	185	90	120	131	
PMC3RL..05	213	195	95	125	156	
PMC3RL..06	232	220	100	130	156	
PMC3RL..07	262	230	105	135	156	
PMC3RL..08	297	255	105	135	198	
PMC3RL..09	332	265	110	140	226	



5.8 Flow switch

Usage

The flow switch is an electrical switch used for controlling the correct functioning of a pressure lubrication system (→ shaft end pump; → motor pump) by checking the oil flow.

In deliveries since March 1, 2005, the flow switch is a standard feature for all gear units supplied with

- a motor pump
- a shaft end pump with a flow rate of 8.5 l/min or higher.

Shaft end pumps with a flow rate below 8.5 l/min are equipped only with a visual flow indicator (→ Visual flow indicator) as standard (as of 2006).

If the flow rate exceeds 8.5 l/min, the gear unit is delivered with a visual flow indicator and flow switch (as of 2006).

Selection

SEW-EURODRIVE selects the flow switch. As standard, a flow switch of the type DW-R-20 is used. All the following technical data refer to this type.

Function

The oil flow pushes against a circular plate attached to a pendulum. The pendulum, which is regulated by a spring, moves on its pivot. A magnet attached to the end of the pendulum operates a movable reed contact. The switch unit itself is separated from the oil.

The flow switch has two switching points:

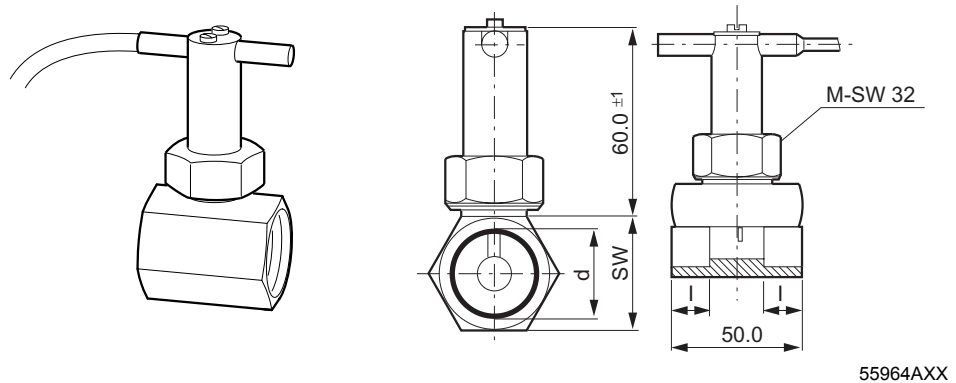
1. Switching point HIGH (lower limit of flow rate) → contact closed - ON
2. Switching point LOW (upper limit of flow rate) → contact closed - OFF



Mechanical Installation Options

Flow switch

Dimensions



	d (inner thread)	NW (rated width)	I	SW	Z	Z	L	H	Z
	[mm]								
Material				A+B+C	A+B	C	D	D	D
Dimension	R 3/4"	20	11	30	50	50	19	109	66

Material abbreviations:

A = Brass

B = Nickel-plated brass

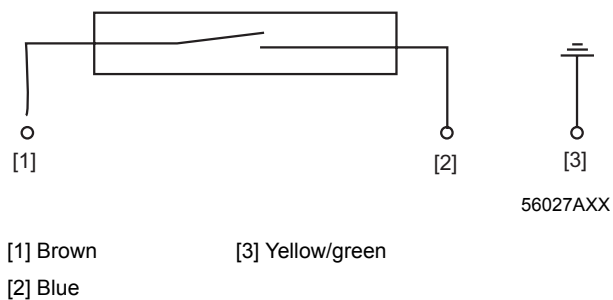
C = Stainless steel

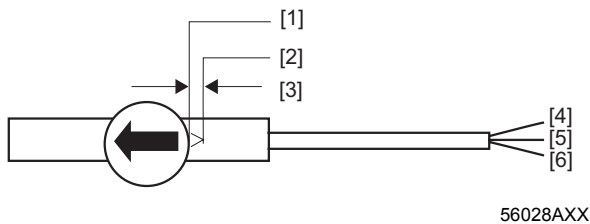
D = Stainless steel / PVC



For determining the exact position of the flow switch, refer to the order-specific dimension drawing.

Electrical connection





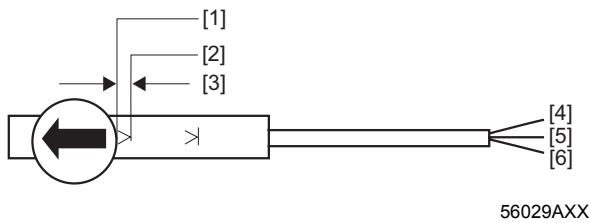
- [1] Switching point HIGH

[2] Switching point LOW

[3] Setting range
- [4] Blue

[5] Brown

[6] Yellow/green



- [1] Switching point HIGH

[2] Switching point LOW

[3] Setting range
- [4] Blue

[5] Brown

[6] Yellow/green

- Connection data:

Degree of protection:

Maximum temperature of medium:

Maximum ambient temperature:

Maximum working pressure:

Length of connecting cable:

Switch:

Switch hysteresis:
- 230 V; 1,5 A; 80 W, 90 V_A max

IP 65

110 °C

70 °C

25 bar

1.5 m

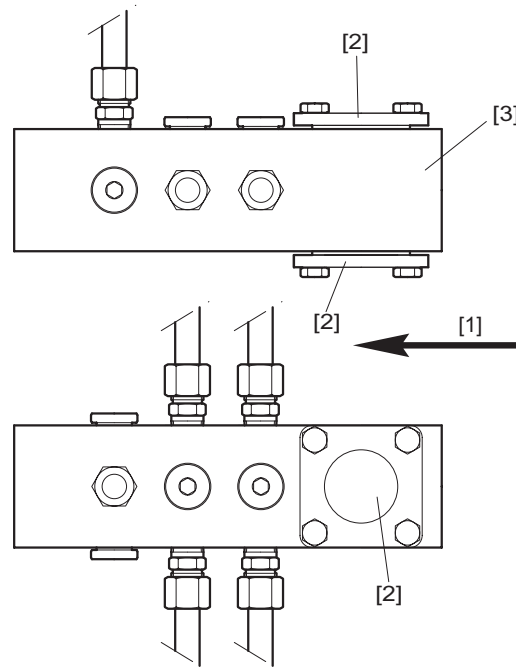
Switch can be used as normally closed or normally open contact; SPDT switch available on request

ca. 5 %

Type	Switching point range ON	Switching point range OFF [l/min]	Maximum flow rate
DW-R-20	8.5 - 12.0	6.6 - 11.0	80



5.9 Visual flow indicator



57682AXX

[1] Direction of oil flow

[2] Glass

[3] Oil distribution block

Usage

The visual flow indicator is a simple method of checking the functioning of a pressure lubrication system by visually checking the oil flow. The visual flow indicator is a standard feature in all gear units with oil pump (as of 2006).

Gear units with oil pump and a flow rate above 8.5 l/min are equipped with an electrical flow switch and visual flow indicator (as of 2006).

Function

The oil flow can be seen behind the glass [2]. If no oil flows and/or if there are air bubbles in the oil, check the function of the pump and suction pipes with connections.



It is easier to see the oil flow when the glasses [2] are clean and bright light is used on the other side of the oil distribution block.



5.10 Oil expansion tank and oil riser pipe



An oil expansion tank or an oil riser pipe may be necessary for vertical output shaft positions. Please refer to the order documents for information.

5.11 Connecting the oil/water cooling system



Follow the instructions in the separate manufacturer's documentation when connecting the oil/water cooling system.

5.12 Connecting the oil/air cooling system



Follow the instructions in the separate manufacturer's documentation when connecting the oil/water cooling system.

5.13 Connecting the motor pump



Follow the instructions in the separate manufacturer's documentation when connecting the motor pump.



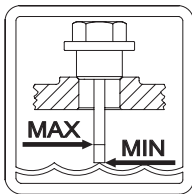
6 Startup

6.1 Startup of gear units



- It is essential to adhere to the safety notes in Sec. "Safety Notes."
- It is absolutely necessary to avoid open flames or sparking when working with the gear unit!
- Take preventive measures to protect people from the solvent vapors generated by the vapor phase inhibitor!
- Before startup, check for correct oil level! For lubricant fill quantities, refer to Sec. "Lubricants."
- For gear units with long-term protection: Replace the screw plug on the location indicated by the breather plug (Position → Sec. "Mounting Positions").
- If doing maintenance or/and oil-filling activities on the gear unit check the surface temperature in advance. Danger of burns (hot oil inside inside gear unit!)

Before startup



- Remove dust and dirt completely from gear unit surface.
- **For gear units with long-term protection:** Remove the gear unit from the sea-worthy protection box.
- Remove the corrosion protection agent from the gear unit parts. Make sure gaskets, sealing surfaces and sealing lips are not damaged by mechanical abrasion, etc.
- Before filling the gear unit with the correct oil grade and volume, drain the remaining amount of protection oil. To do so, unscrew the oil drain plug and drain the remaining protection oil. Thread the oil drain plug back in place.
- Remove the oil filling plug (Position → Sec. "Mounting Positions"). Use a funnel to fill the oil (filter mesh max. 25 µm). Fill the gear unit with the correct oil grade and volume (→ Sec. "Nameplate"). The oil volume specified on the nameplate of the gear unit is a reference value. **The mark on the dipstick is the decisive indicator of the correct oil level.** Check for correct oil level (= below the "max" mark on the dipstick) using the oil dipstick. After having filled the oil, replace the oil filling plug.
- For gear units with steel oil expansion tank (→ 6.3 Startup of MC gear units with steel expansion tank).



- **For gear units with oil sight glass (chapter 7.3): Visually check for correct oil level (= oil is visible in the oil sight glass).**
- Make sure that rotating shafts as well as couplings are equipped with suitable protective covers.
- If the gear unit has a motor pump, check for proper functioning of the pressure lubricating system. Make sure that monitoring devices are connected properly.
- After an extended period of storage (max. two years), have the gear unit operate without load with the correct oil fill (→ Sec. "Nameplate"). This way, the correct functioning of the lubricating system and particularly the oil pump is ensured.
- If the gear unit is equipped with a fan on the input shaft, check for free air intake within the specified angle (→ Sec. "Fan").



**Running-in
period**

SEW-EURODRIVE recommends running-in the gear unit as first startup phase. Increase load and revolutions in two to three steps up to maximum level. The running-in phase takes about 10 hours.

Check the following points during the running-in phase:

- Verify the power values specified on the nameplate because their frequency may be a decisive factor for the service life of the gear unit.
- Does the gear unit run smoothly?
- Are there vibrations or unusual running noise?
- Are there signs of oil leakages on the gear unit?



For further information and troubleshooting, refer to Sec. "Malfunctions."

6.2 Startup of gear units with long-term protection

Adhere to the following points for gear units with long-term protection:

Anti-corrosion agent:



Ensure sufficient ventilation when using solvents. There is a risk of explosion. No open flames.



Risk of material damage.

Do not let the solvent come into contact with the sealing lips of the oil seals.

Remove the corrosion protection agent from the gear unit parts. Make sure gaskets, sealing surfaces and sealing lips are not damaged by mechanical abrasion, etc.

Oil level

Since the gear units under "long-term protection" are delivered complete with oil, the correct oil volume and oil level should be checked before startup.

→ Correct the oil level to the appropriate fill level.

Breather plug:

Replace the screw plug by the enclosed breather filter.



Startup

Starting up gear units with backstop

6.3 Starting up gear units with backstop



Ensure that the direction of rotation of the motor is correct for gear units with backstop.

6.4 Shutting down gear units



Turn off the drive unit. Prevent the drive unit from unintentionally starting up. Put an information sign near the ON switch.

If the gear unit will not operated for an extended period of time, you must activate it regularly at intervals of approx. 2-3 weeks.

If the gear unit will not operated for a period **longer than nine months**, additional corrosion protection is required:

- **Corrosion protection for the interior of gear units with splash or oil bath lubrication:**
 - Fill the gear unit up to the breather plug with the oil grade specified on the nameplate.
 - Set the planetary gear unit in no-load running operation for a short period of time.
- **Exterior corrosion protection:**
 - Clean the surfaces
 - Grease the shaft around the sealing lip to separate the sealing lip of the oil seal and the corrosion protection
 - Apply a wax-based protective coating to shaft ends and unpainted surfaces as corrosion protection.



Refer to the "Startup" section before restarting the gear unit.



7 Inspection and Maintenance



- Strictly observe the safety notes in the individual sections.
- All maintenance work must be carried out carefully by qualified personnel.
- Work on the gear unit and additional equipment only when the machine is not in use. Prevent the drive unit from starting up unintentionally (for example by locking the keyswitch or removing the fuses from the power supply). Attach an information sign near the on-switch to warn that the gear unit is being worked on.
- Use only OEM spare parts according to the delivered spare parts lists.
- If you remove the gearcase cover, you must apply new sealing compound to the sealing surface. Else the sealing properties of the gear unit might be impaired. Contact SEW-EURODRIVE in this case.
- During subsequent work, protect the gear unit from ingress of foreign objects.



Danger of burns

Touching the gear unit when it has not been cooled will result in burns.

Never touch the gear unit during operation or in the cool down phase once the unit has been switched off.



7.1 Inspection and Maintenance intervals

Maintenance interval	What to do?
Daily	- Check the housing temperature: - with mineral oil: max 90 °C - with synthetic oil: max. 100 °C - Check gear unit noise - Check gear unit for signs of leakage
Every 3000 hours of operation, at least every 6 months:	- Check the oil and oil level. - Check the oil: If the gear unit is operated outdoors or in humid conditions, check the water content of the oil. The water content must not exceed 0.05 % (500 ppm). - Fill labyrinth seals with grease. Use about 30 g grease per grease nipple. - Clean breather plug
Depending on the operating conditions, at the latest every 12 months	- Change the mineral oil (→ Sec. "Inspection and Maintenance") - Check whether retaining screws are tightly secured - Check contamination and condition of the oil/air cooling system - Check the condition of the oil/water cooling system - Clean oil filter, replace filter element if necessary
Depending on the operating conditions, at the latest every 3 years	Change the synthetic oil (→ Sec. "Inspection and Maintenance")
Varying (depending on external factors)	- Repair or renew the surface/anticorrosion coating - Clean the gearcase surface and fan - Check the oil heater: - Are all connection cables and terminals tightened securely and free from corrosion? - Clean incrustated elements (e.g. heating element) and replace, if required (→ Sec. "Inspection and Maintenance")

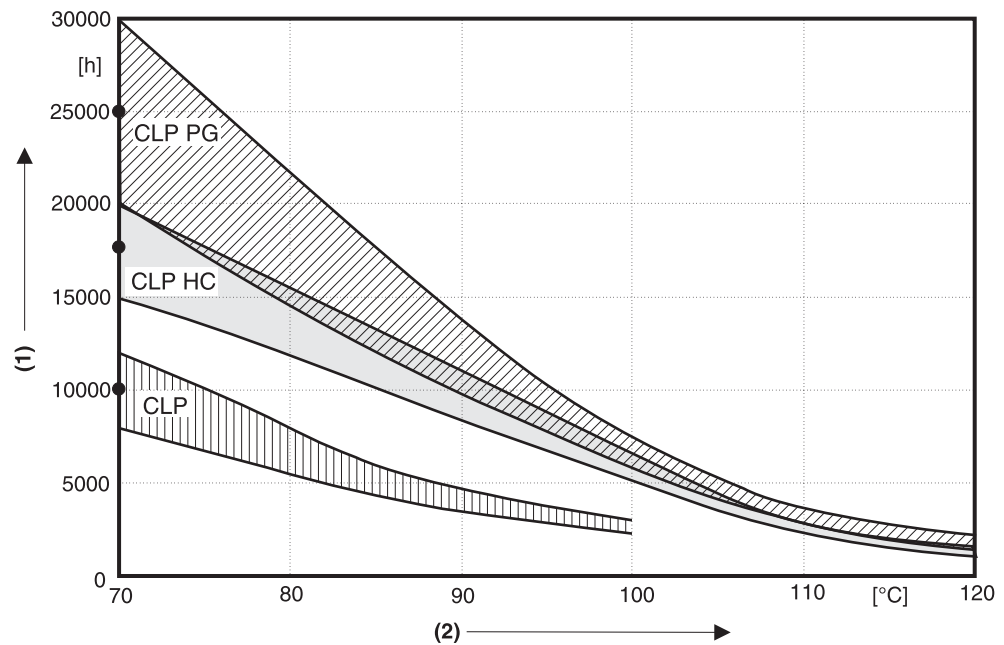


7.2 Lubricant change intervals

Change the oil more frequently when using special versions subject to more severe/aggressive environmental conditions!



Mineral CLP lubricants and synthetic polyalphaolefin-based (PAO) lubricants are used for lubrication. The synthetic lubricant CLP HC (according to DIN 51502) shown in the following figure corresponds to the PAO oils.



04640AXX

- (1) Hours of operation
(2) Sustained oil bath temperature
• Average value per oil type at 70 °C



Inspection and Maintenance

Checking the oil level

7.3 Checking the oil level



- Do not mix different synthetic lubricants and do not mix synthetic with mineral lubricants!
- The positions of the oil level plug, drain plug, and breather valve depends on the mounting position. Refer to the mounting position diagrams.
- Mineral oil is used as standard lubricant.

1. Work on the gear unit only when the machine is not in use.
2. Secure the drive unit against unintentional power-up.



Wait until the gear unit has cooled off – Danger of burns!

3. For gear units with oil dipstick:
 - Unscrew the oil dipstick and remove it.
 - Clean the oil dipstick and re-insert it into the gear unit (do **not** screw in tightly).
 - Remove dipstick again and check oil level. Correct, if necessary: the oil level is correct when it is between the oil level mark (= maximum oil level) and the end of the dipstick (= minimum oil level)
4. For gear units with oil sight glass:
 - Visually check for correct oil level (= middle of oil sight glass).

7.4 Checking the oil consistency

1. Work on the gear unit only when the machine is not in use.
2. Secure the drive unit against unintentional power-up.



Wait until the gear unit has cooled off – Danger of burns!

3. Remove a little oil from the oil drain plug.
4. Check the oil consistency:
 - For more detailed information on checking the oil for water content and viscosity, contact your lubricant manufacturer.
 - Contact SEW-EURODRIVE if the oil is heavily contaminated.



7.5 Changing the oil



- When changing the oil, always refill the gear unit with the grade of oil that was used before. Mixing oil of different grade or manufacturer is not permitted. Especially synthetic oils may not be mixed with mineral oils or other synthetic oils. If you switch from mineral oil to synthetic oil, or from synthetic oil on a certain basis to synthetic oil with a different basis, you will have to flush the gear unit thoroughly with the new oil.
- Refer to the lubrication table in section 9 to determine which oils from the various lubricant manufacturers can be used.
- Information such as the oil grade, oil viscosity and required oil volume is listed on the nameplate of the gear unit.
- The oil volume specified on the nameplate is an approximate quantity. The mark on the oil sight glass or dipstick is the decisive indicator of the correct oil level.
- Only change the oil when the gear unit is at operating temperature.
- When changing the oil, flush the housing thoroughly with oil to remove oil sludge, oil residue, and abrasion. Use the same grade of oil that is used to operate the gear unit. Viscous oil must be heated up first. Fill with fresh oil only after all residues have been removed.
- The position of the oil level plug, oil drain plug and the breather valve depends on the mounting position. Refer to the diagrams of the mounting positions.

Procedure

1. Work on the gear unit only when the machine is not in use.
2. Secure the drive unit against unintentional power-up.



Wait until the gear unit has cooled off – Danger of burns!



The gear unit must still be warm otherwise the high viscosity of excessively cold oil will make it more difficult to drain the oil correctly.



When changing the oil, clean the gearcase thoroughly to remove oil residues and abrasion. Use the same oil grade as for the operation of the gear unit.



If your gear unit is equipped with an oil expansion tank, let the gear unit cool off until it reaches ambient temperature. The reason is that there might still be oil in the oil expansion tank which might leak through the oil filling hole!



Any dripping oil must be removed immediately with an oil binding agent.

3. Place a container underneath the oil drain plug.



Inspection and Maintenance

Checking and cleaning the breather plug

4. Remove the oil filling plug, breather plug and oil drain plugs. When using a steel oil expansion tank, also remove the air outlet screw on the air expansion tank. To drain all the oil, blow air through the breather into the oil expansion tank. As a result, the rubber membrane lowers and forces the remaining oil out. The lowering membrane compensates the pressure, which facilitates filling the new oil.
5. Drain all the oil.
6. Screw in the oil drain plug.
7. Use a funnel to fill the oil (filter mesh max. 25 mm). Fill new oil of the same type as the old oil via the oil filling plug (if you want to change the oil type, contact our customer service first).
 - Fill the oil according to the volume specified on the nameplate ((→ Sec. "Nameplate"). The oil volume specified on the nameplate is an approximate value. **The marks on the oil dipstick indicate the correct oil level.**
 - Check whether the oil level is correct using the oil dipstick
8. Screw the oil level plug back in. If your gear unit is equipped with a steel oil expansion tank, also screw in the air outlet screw.
9. Screw in the breather plug.
10. Clean the oil filter, replace the filter element if necessary (when using an external oil/air or oil/water cooling system).

7.6 Checking and cleaning the breather plug

The breather plug must be cleaned if there is a layer of dust and also before the expiration of a minimum period of three months.

To do so, remove the breather plug, clean it with benzine or a similar cleaning agent, and dry or blow the breather plug with compressed air. Prevent foreign objects from entering into the gear unit.



8 Malfunctions



- **Strictly observe the safety notes in the individual sections.**
- **For eliminating malfunctions, the gear unit and additional equipment must be deactivated. Prevent the drive unit from starting up unintentionally (for example by locking the keyswitch or removing the fuses from the power supply). Attach an information sign near the ON switch to warn that the gear unit is being worked on.**



Danger of burns

Touching the gear unit when it has not been cooled will result in burns.

Never touch the gear unit during operation or in the cool down phase once the unit has been switched off.



Malfunctions that occur during the warranty period that require repair to the gear unit may only be resolved by SEW-EURODRIVE.

After expiration of the warranty period, we recommend that our customers contact our customer service in the event of malfunctions whose cause is not clear.

8.1 Customer service

Please have the following information to hand if you require the assistance of our customer service:

- Complete nameplate data
- Type and extent of the problem
- Time the problem occurred and any accompanying circumstances
- Assumed cause



8.2 Gear unit malfunctions

Malfunction	Possible cause	Remedy
Unusual, regular running noise	A Meshing/grinding noise: Bearing damage B Knocking noise: Irregularity in the gearing	A Check the oil (→ Sec. "Inspection and Maintenance"), replace bearings B Contact customer service
Unusual, irregular running noise	Foreign bodies in the oil	- Check the oil (see Sec. "Inspection and Maintenance") - Stop the drive, contact customer service
Unusual noise in the area of the gear unit mounting	Gear unit mounting has loosened	- Tighten retaining screws and nuts to the specified torque - Replace the damaged / defective retaining screws or nuts
Operating temperature too high	A Too much oil B Oil too old C The oil is heavily contaminated D Gear units with fan: air intake opening / gearcase contaminated E Shaft end pump defective F Malfunctions of oil/air or oil/water cooling system	A Check the oil level, correct if necessary (→ Sec. "Inspection and Maintenance") B Check when the oil was changed last time; change oil if necessary (→ Sec. "Inspection and Maintenance") C Change the oil (→ Sec. "Inspection and Maintenance") D Check the air intake opening and clean if necessary, clean gearcase E Check shaft end pump; replace if necessary F Observe the separate operating instructions of the oil/water and oil/air cooling system.
Bearing point temperatures too high	A Oil not enough B Oil too old C Shaft end pump defective D Bearing damaged	A Check the oil level, correct if necessary (→ Sec. "Inspection and Maintenance") B Check when the oil was changed last time; change oil if necessary (→ Sec. "Inspection and Maintenance") C Check shaft end pump; replace if necessary D Check bearing and replace if necessary, contact customer service
Oil leaking¹⁾ - from cover plate - From the gear cover plate - from bearing cover - from mounting flange - from output/input end oil seal	A Gasket on cover plate / gearcase cover / bearing cover / mounting flange leaking B Sealing lip of the oil seal turned up C Oil seal damaged/worn	A Tighten the bolts on the respective cover plate and observe the gear unit. If oil still leaks: Contact customer service B Vent the gear unit (→ Sec. "Mounting Positions") Observe the gear unit. If oil still leaks: Contact customer service C Contact customer service
Oil leaking from - oil drain plug - breather plug	A Too much oil B Drive operated in incorrect mounting position C Frequent cold starts (oil foams) and/or high oil level	A Correct the oil volume (see Sec. "Inspection and Maintenance") B Mount the breather plug correctly (see order documents) and correct the oil level (see nameplate)
Malfunctions of oil/air or oil/water cooling system		Observe the separate operating instructions for the oil/water and oil/air cooling system.
Operating temperature at backstop too high	Damaged / defective backstop	- Check backstop; replace if necessary - Contact customer service

1) It is normal for small amounts of oil/grease to emerge from the oil seal during the running-in phase - (24 hour running time, see also DIN 3761).



9 Lubricants

9.1 Guidelines for lubricant selection

**General
information**

Unless a special arrangement is made, SEW-EURODRIVE delivers the P.MC.. gear units without an oil fill.



Before startup, ensure that the gear unit is filled with the correct oil grade and volume. You find the corresponding information on the gear unit nameplate and the lubricant table in the following section.



The most important factors for selecting the lubricant are the oil grade and viscosity specified on the nameplate. The specified viscosity / oil grade are chosen for the operating conditions agreed upon in the contract. Any deviation from these conditions requires consultation with SEW-EURODRIVE.



This lubricant recommendation does not represent a guarantee as to the quality of the lubricant delivered by each respective supplier. The lubricant manufacturers are responsible for the quality of their products.



Do not mix different synthetic lubricants and do not mix synthetic with mineral lubricants.

If you have selected synthetic oil because of the operating temperature or oil change intervals, SEW-EURODRIVE recommends that you use polyalphaolefin-based oil (PAO).



9.2 Lubricant table

General information

The lubricant table on the following page shows the permitted lubricants for SEW-EURODRIVE gear units. Please refer to the following legend for the lubricant table.

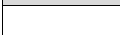
Legend for the lubricant table

Abbreviations used, meaning of shading, and notes:

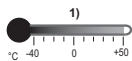
CLP = Mineral oil

CLP PAO = Synthetic polyalphaolefin

 = Synthetic lubricant (= synthetic-based anti-friction bearing grease)

 = Mineral lubricant (= mineral-based anti-friction bearing grease)

 = Contact SEW-EURODRIVE

 Ambient temperature

Notes on the lubricant table



- The temperature ranges are to be considered as guide values. The decisive factor is the viscosity information on the nameplate.
- Contact SEW-EURODRIVE if you operate the unit under extreme conditions, such as cold, heat, or if the operating conditions differ from those based on the project planning.

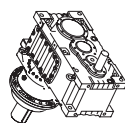


Lubricant table

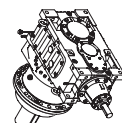
01763198_3

 1) °C -40 0 +20	 DIN (ISO)	ISO VG class	 Mobil®	 Shell	 KLÜBER	 ARAL	 bp	 TESACO	 FUCHS	 Q8	 Castrol	 TOTAL
 -10 +25	CLP	VG 150			KLÜBER GEM 1-150N	Degol BG Plus 150	BP Energol GX-XF 150		Renolin CLP150Plus	Q8 Goya NT 150		
	CLP PAO	VG 150			Klübersynth GEM4-150N	Degol PAS 150 Degol GS 150	Energol EP-XF 150 Energol SG-XP 150		Renolin Unisyn CLP 150	Q8 ELGRECO 150		Carter SH 150
 -35 +30	CLP	VG 220	Mobilgear XMP220	Omala Oil F220	KLÜBER GEM 1-220N	Degol BG Plus 220	BP Energol GX-XF 220	Meropa 220	Renolin CLP220Plus	Q8 Goya NT 220	Alphamax 220 Tribol 1710/ 220 Optigear BM 220	
	CLP PAO	VG 220	Mobilgear SHC XMP220	Omala Oil HD 220	Klübersynth GEM4-220N	Degol PAS 220 Degol GS220	Energol EP-XF 220 Energol SG-XP 220	Pinnacle EP 220	Renolin Unisyn CLP 220	Q8 ELGRECO 220	Optigear Synthetic X 220	Carter SH 220
 0 +40	CLP	VG 320	Mobilgear XMP320	Omala Oil F320	KLÜBER GEM 1-320N	Degol BG Plus 320	BP Energol GX-XF 320	Meropa 320	Renolin CLP320Plus	Q8 Goya NT 320	Alphamax 320 Tribol Optigear 1100/ 320 BM 320	
	CLP PAO	VG 320	Mobilgear SHC XMP320 Mobil SHC 632	Omala Oil HD 320	Klübersynth GEM4-320N	Degol PAS 320 Degol GS 320	Energol EP-XF 320 Energol SG-XP 320	Pinnacle EP 320	Renolin Unisyn CLP 320	Q8 ELGRECO 320	Tribol 1510/ 320 Tribol 1710/ 320 Optigear Synthetic A320 Optigear Synthetic X 320	Carter SH 320
 -5 +40	CLP	VG 460	Mobilgear XMP460	Omala Oil F460	KLÜBER GEM 1-460N	Degol BG Plus 460	BP Energol GX-XF 460	Meropa 460	Renolin CLP460Plus	Q8 Goya NT 460	Alphamax 460 Tribol 1100/ 460 Optigear BM 460	
	CLP PAO	VG 460	Mobilgear SHC XMP460 Mobil SHC 634	Omala Oil HD 460	Klübersynth GEM4-460N	Degol PAS 460 Degol GS 460	Energol EP-XF 460 Energol SG-XP 460	Pinnacle EP 460	Renolin Unisyn CLP 460	Q8 ELGRECO 460	Tribol 1510/ 460 Tribol 1710/ 460 Optigear Synthetic A460 Optigear Synthetic X 460	Carter SH 460
 -20 +50	CLP	VG 680	Mobilgear XMP680		KLÜBER GEM 1-680N	Degol BG Plus 680	BP Energol GX-XF 680	Meropa 680		Q8 Goya NT 680	Tribol 1100/ 680 BM 680 Optigear Synthetic X 680	Renolin CLP680

P.MC..P..



P.MC..R..





9.3 Lubricant fill quantities



The lubricant fill quantity is specified in your order document or on the nameplate.



The two gear units have a common oil chamber.



In case of a pivoted mounting position, refer to the oil fill quantity specified on the nameplate.

9.4 Sealing grease

The below mentioned greases can be used as

- Sealing grease
- Bearing grease for the lower LSS bearings for gear units with Drywell sealing system

SEW-EURODRIVE recommends the grease types listed in below table for operating temperatures from – 30 °C to +100 °C.

Lubricating grease properties:

- Contains EP additives
- Hardness class NLGI2

Supplier	Oil
Aral	Aralub HLP2
BP	Energrease LS-EPS
Castrol	Spheerol EPL2
Chevron	Dura-Lith EP2
Elf	Epexa EP2
Esso	Beacon EP2
Exxon	Beacon EP2
Gulf	Gulf crown Grease 2
Klüber	Centoplex EP2
Kuwait	Q8 Rembrandt EP2
Mobil	Mobilux EP2
Molub	Alloy BRB-572
Optimol	Olista Longtime 2
Shell	Alvania EP2
Texaco	Multifak EP2
Total	Multis EP2
Tribol	Tribol 3030-2



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Service Competence Center	Mitte Getriebe / Motoren	SEW-EURODRIVE GmbH & Co KG Ernst-Blickle-Straße 1 D-76676 Graben-Neudorf	Tel. +49 7251 75-1710 Fax +49 7251 75-1711 sc-mitte-gm@sew-eurodrive.de
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Montagewerke Vertrieb Service	Bordeaux	SEW-USOCOME Parc d'activités de Magellan 62, avenue de Magellan - B. P. 182 F-33607 Pessac Cedex	Tel. +33 5 57 26 39 00 Fax +33 5 57 26 39 09
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Gabun			
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Korea			
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Vertrieb Service	Zagreb	KOMPEKS d. o. o. PIT Erdödy 4 II HR 10 000 Zagreb	Tel. +385 1 4613-158 Fax +385 1 4613-158 kompeks@net.hr
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Libanon			
Vertrieb	Beirut	Gabriel Acar & Fils sarl B. P. 80484 Bourj Hammoud, Beirut	Tel. +961 1 4947-86 +961 1 4982-72 +961 3 2745-39 Fax +961 1 4949-71 gacar@beirut.com
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Serbien und Montenegro			
Vertrieb	Beograd	DIPAR d.o.o. Ustanicka 128a PC Košum, IV floor SCG-11000 Beograd	Tel. +381 11 347 3244 / +381 11 288 0393 Fax +381 11 347 1337 dipar@yubc.net
Singapur			
Montagewerk Vertrieb Service	Singapore	SEW-EURODRIVE PTE. LTD. No 9, Tuas Drive 2 Jurong Industrial Estate Singapore 638644	Tel. +65 68621701 Fax +65 68612827 http://www.sew-eurodrive.com.sg sewsingapore@sew-eurodrive.com
Slowakei			
Vertrieb	Bratislava	SEW-Eurodrive SK s.r.o. Rybnicna 40 SK-83107 Bratislava	Tel. +421 2 49595201 Fax +421 2 49595200 http://www.sew.sk sew@sew-eurodrive.sk
	Zilina	SEW-Eurodrive SK s.r.o. ul. Vojtecha Spanyola 33 SK-010 01 Zilina	Tel. +421 41 700 2513 Fax +421 41 700 2514 sew@sew-eurodrive.sk
	Banská Bystrica	SEW-Eurodrive SK s.r.o. Rudlovska cesta 85 SK-97411 Banská Bystrica	Tel. +421 48 414 6564 Fax +421 48 414 6566 sew@sew-eurodrive.sk
Slowenien			
Vertrieb Service	Celje	Pakman - Pogonska Tehnika d.o.o. Ul. XIV. divizije 14 SLO - 3000 Celje	Tel. +386 3 490 83-20 Fax +386 3 490 83-21 pakman@siol.net
Spanien			
Montagewerk Vertrieb Service	Bilbao	SEW-EURODRIVE ESPAÑA, S.L. Parque Tecnológico, Edificio, 302 E-48170 Zamudio (Vizcaya)	Tel. +34 94 43184-70 Fax +34 94 43184-71 http://www.sew-eurodrive.es sew.spain@sew-eurodrive.es

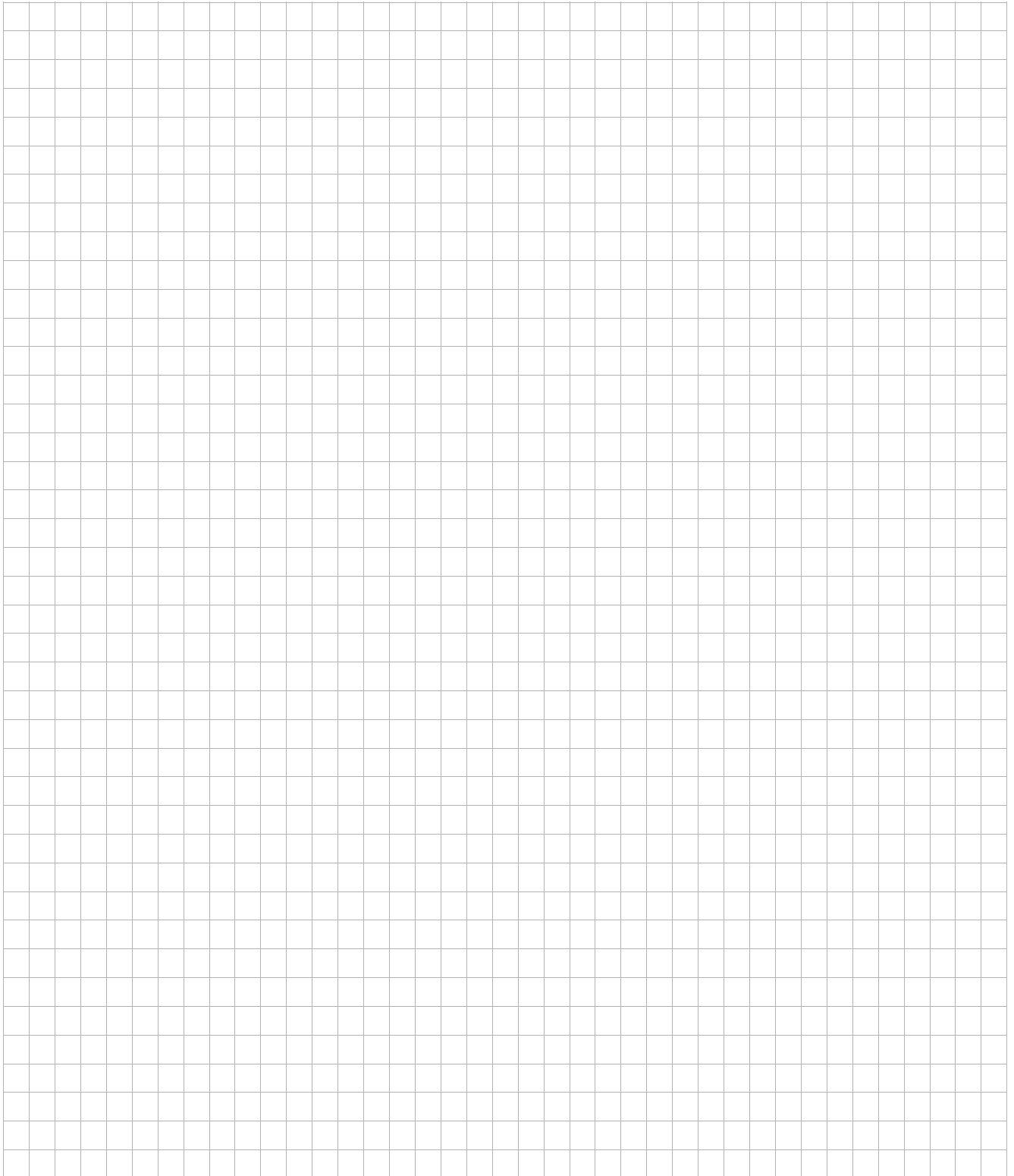


Südafrika			
Montagewerke Vertrieb Service	Johannesburg	SEW-EURODRIVE (PROPRIETARY) LIMITED Eurodrive House Cnr. Adcock Ingram and Aerodrome Roads Aeroton Ext. 2 Johannesburg 2013 P.O.Box 90004 Bertsham 2013	Tel. +27 11 248-7000 Fax +27 11 494-3104 http://www.sew.co.za dross@sew.co.za
	Capetown	SEW-EURODRIVE (PROPRIETARY) LIMITED Rainbow Park Cnr. Racecourse & Omuramba Road Montague Gardens Cape Town P.O.Box 36556 Chempet 7442 Cape Town	Tel. +27 21 552-9820 Fax +27 21 552-9830 Telex 576 062 dswanepoel@sew.co.za
	Durban	SEW-EURODRIVE (PROPRIETARY) LIMITED 2 Monaceo Place Pinetown Durban P.O. Box 10433, Ashwood 3605	Tel. +27 31 700-3451 Fax +27 31 700-3847 dtait@sew.co.za
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Montagewerk Vertrieb Service	Chonburi	SEW-EURODRIVE (Thailand) Ltd. 700/456, Moo.7, Donhuaroh Muang Chonburi 20000	Tel. +66 38 454281 Fax +66 38 454288 sewthailand@sew-eurodrive.com
Tschechische Republik			
Vertrieb	Praha	SEW-EURODRIVE CZ S.R.O. Business Centrum Praha Lužná 591 CZ-16000 Praha 6 - Vokovice	Tel. +420 220121234 Fax +420 220121237 http://www.sew-eurodrive.cz sew@sew-eurodrive.cz
Tunesien			
Vertrieb	Tunis	T. M.S. Technic Marketing Service 5, Rue El Houdaibiah 1000 Tunis	Tel. +216 71 4340-64 + 71 4320-29 Fax +216 71 4329-76 tms@tms.com.tn
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Adressenliste

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	Philadelphia/PA	SEW-EURODRIVE INC. Pureland Ind. Complex 2107 High Hill Road, P.O. Box 481 Bridgeport, New Jersey 08014	Tel. +1 856 467-2277 Fax +1 856 845-3179 csbridgeport@seweurodrive.com
	Dayton	SEW-EURODRIVE INC. 2001 West Main Street Troy, Ohio 45373	Tel. +1 937 335-0036 Fax +1 937 440-3799 cstroy@seweurodrive.com
	Dallas	SEW-EURODRIVE INC. 3950 Platinum Way Dallas, Texas 75237	Tel. +1 214 330-4824 Fax +1 214 330-4724 csdallas@seweurodrive.com
	Weitere Anschriften über Service-Stationen in den USA auf Anfrage.		
Venezuela			
Montagewerk Vertrieb Service	Valencia	SEW-EURODRIVE Venezuela S.A. Av. Norte Sur No. 3, Galpon 84-319 Zona Industrial Municipal Norte Valencia, Estado Carabobo	Tel. +58 241 832-9804 Fax +58 241 838-6275 http://www.sew-eurodrive.com.ve sewventas@cantv.net sewfinanzas@cantv.net



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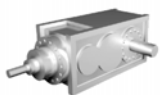
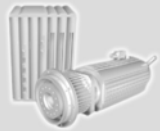
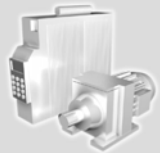


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Benennung

ES2/1500/B/F

Kunde

R+W America

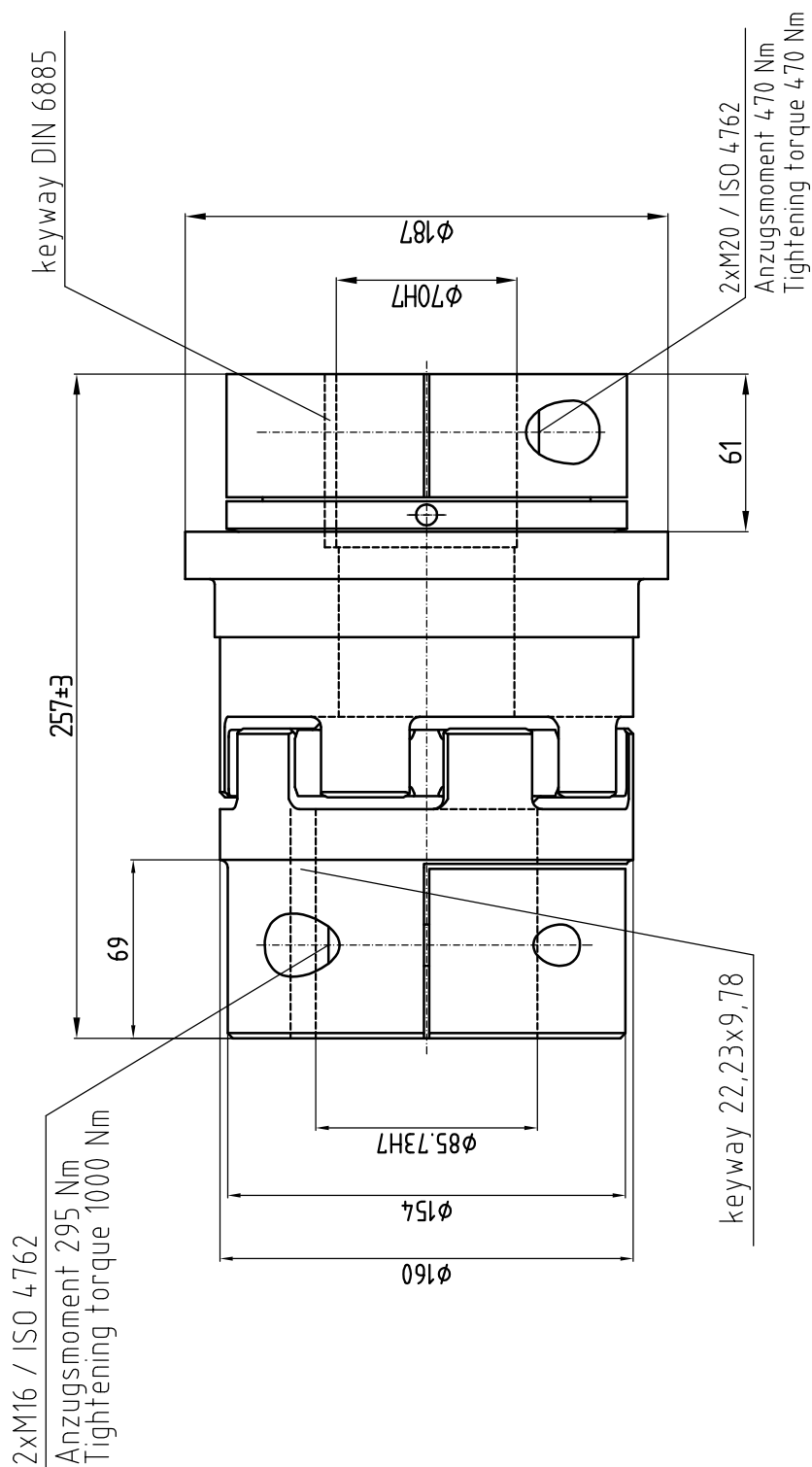
Angeb.-Zchg.-Nr.

A 11.12.15 1

Maßstab (ISO 5455):

Blatt

von



Adjustment range: 1000-1250 Nm
 Disengagement torque: 1250 Nm
 Elastomer insert: Type B (64Sh D)

Schutzvermerk nach DIN 34 beachten

CAD-Zeichnungen dürfen nicht
manuell geändert werden.Der Maßstab einer Kopie
kann sich von dem des
Originals unterscheidenAllgemein-
toleranzen
DIN ISO 2768-1-mOber-
flächen
ISO 1302

R+W
 COUPLING TECHNOLOGY

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 63911 Klingenberg
 Telefon (09372) 9864-0
 Telefax (09372) 986420

	Datum	Name
Bearb.	14.12.11	Börger
Gepr.		

Index	Änderung	Datum	Name

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Installation and operating instructions for R+W Torque Limiting couplings: Series SK



Please carefully and completely read the following installation, operation and maintenance procedures for the R+W torque limiting couplings. Failure to comply with these procedures may result in poor performance and/or the failure of the coupling.

Installation of the couplings should be performed by a qualified technician.

General functioning



Function:

R+W torque limiting couplings are ball detent style overload couplings. They protect drive and driven mechanical components from damage associated with torque overloads. Backlash free torque transmission is accomplished by a series of steel balls (4) nested in hardened detents (5). See figure 1. Disc springs push against an actuation ring (3) keeping the balls nested. The disengagement torque is adjustable by means of an adjustment ring (1). In the event of an overload, the actuation ring moves axially allowing the balls to come out of the detents separating the drive and driven elements. The movement of the actuation ring can be sensed by means of a mechanical switch or proximity sensor triggering the drive to shut down.

Single-position / Multi-position

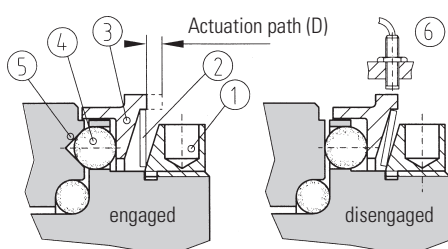


Figure 1

In a torque overload, for the single-position design (standard) and multi-position design, the spring disengages to allow the balls to come out of their detents separating the drive and driven elements. Very low residual spring pressure remains so that the coupling will re-engage once the torque is reduced below the overload setting. See diagram 1 too.



CAUTION: Re-engagement may only be effected at low speed.

Re-engagement: Full disengagement

The R+W Torque Limiter can be re-engaged with a low engagement force E (Table 2) on six positions within a 360° circle. The markings of the re-engagement positions had to be lined up. Starting on series 200, the re-engagement can be done with 2 levers, which must be strutted on the adjustment nut. Also two screwdrivers can be used as levers. (see Pic. 3b)



IMPORTANT: Re-engagement must happen on shutdown only.

Full-disengage

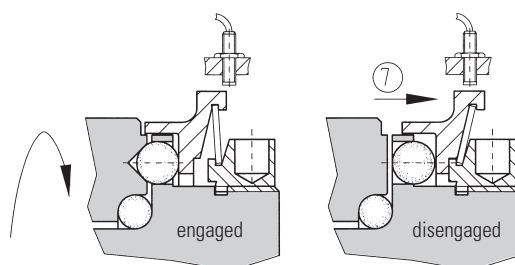


Figure 2

With this design, when a torque overload is detected, the disc spring completely flips over and places no residual spring pressure on the actuation ring. The drive and driven elements are completely separated.



Note:

Re-engagement of the coupling is not automatic and must be performed manually (Figure 3).

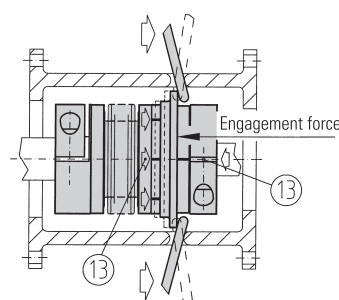


Figure 3a

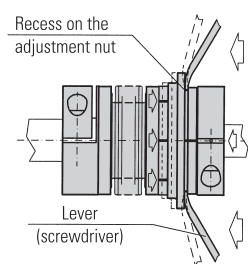


Figure 3b

Transport

R+W couplings are delivered ready for installation. After incoming inspection the coupling should be stored in its original packaging until it is ready for installation. A copy of this installation, operation, and maintenance manual should be kept with the coupling.

Safety alert



Safety alert

Rotating couplings can be very dangerous. Proper guarding should be in place at all times and is the responsibility of the machine builder, user or operator. Do not approach or touch a coupling while it is rotating. Make sure that the machine is "locked out" and cannot be accidentally started during installation or maintenance of the coupling.

Manufacturer's declaration

According to EG guidelines for machinery 89/392 EWG Appendix 11B

In the sense of machine guidelines (MR) shaft couplings are no machines, but components for the installation in machines. Their putting into operation is subject to the fulfillment of all requirements of machine guidelines by or after integration in the final product.

Mounting preparation

All mounting surfaces including shafts, bores, keys, and key ways, must be clean and free of burrs, nicks, or dents. Inspect shaft diameters; coupling bore diameters, key and key-way dimensions and tolerances. All R+W coupling bores are machined to ISO tolerance H7. Clearances between shaft and hub bores are maintained to 0.01 and 0.05 mm. A light coating of oil is recommended to ease the mounting process and will not affect the clamping force of the hub.



CAUTION:

Do not use sliding grease, or oils and grease with molybdenum disulfide or other high-pressure additives.

Mounting drive elements to SK 1 couplings

Series	A	B	Belt pre-tensioning force max. (N)	Distance from - to (mm)	Fastening screws	Tightening torque (Nm)	ISO 4762	Fastening screws	Tightening torque (Nm)	ISO 4762	Fastening screws	Tightening torque (Nm)	ISO 4762
Series	A	B	conical sleeve	Clamping hub									
1,5	50	3-6	M2,5	1	x	x							
2	100	5-8	M3	2	x	x							
4,5	200	6-10	M4	4	x	x							
10	500	6-12	M4	4,5	x	x							
15	1400	7-14	M5	8	M4	4							
30	1800	8-18	M6	15	M5	6							
60	2300	8-18	M8	40	M5	8							
80/150	3000	12-20	M10	70	M6	12							
200	3500	12-22	M12	120	M6	14							
300	4500	12-23	M12	130	M8	18							
500	5600	12-25	M16	200	M8	25							
800	8000	14-34	2xM16	250	M10	40							
1500	12000	20-42	2xM20	470	M12	70							
2500	20000	32-60	x	x	M16	120							

Table 1

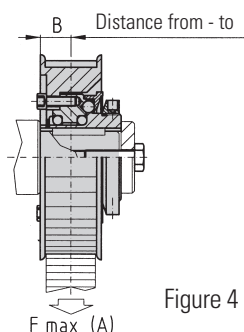


Figure 4

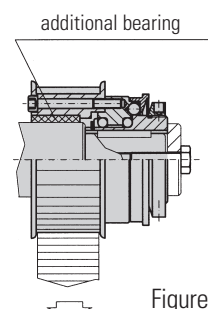


Figure 5

Mounting of the drive element

Center the drive element (i.e. timing belt pulley or gear) onto the connecting flange of the coupling and fasten with screws. If the center of the radial load falls over the middle of the coupling an additional support bearing is not required (figure 4). If the radial load is not centered over the coupling an additional support bearing is required (figure 5). Please observe the maximum allowable radial load for each coupling size as indicated (Table 1). Excess radial load will affect the performance of the coupling.

Mounting and dismounting: Models SK 1 and SKP

SKP with key

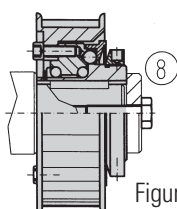


Figure 6

Mounting:

Slide the coupling onto the shaft. Lock it in position, with an end plate (8) for example. Figure 6.

Dismounting:

Remove the end plate and slide the coupling off the shaft using an appropriate tool.

SK 1 with clamping hub

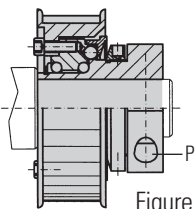


Figure 7

Mounting:

Slide the coupling onto the shaft to the proper axial position. Using a torque wrench tighten the clamp screw to the proper tightening torque as indicated in Table 1.

Dismounting:

Simply loosen the clamp screw (P) and remove the coupling.

SK 1 with tapered bushing

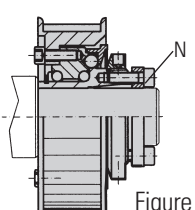


Figure 8

Mounting:

Slide the coupling onto the shaft to the proper axial position. Using a torque wrench, uniformly tighten the clamping screws using a cross-wise tightening pattern until all the clamping screws are evenly tightened to the correct tightening torque as given in Table 1. While tightening the coupling may move slightly towards the tapered bushing.



CAUTION: Further tightening of the clamping screws may destroy the tapered bushing connection.

NOTE: Prior to reassembly make sure that the jack-screws are raised to their original position.

Dismounting:

Loosen the clamping screw (N). Insert the three jack screws into the taped holes on the tapered segment apply even pressure to remove the tapered segment. Remove the coupling.

Mounting and dismounting: Models SK 2 / 3 / 5

SK 2 with clamping hub

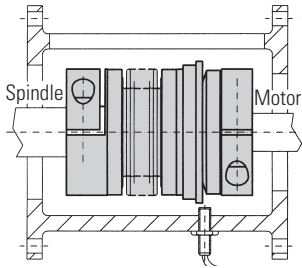


Figure 9

SK 3 with tapered bushing

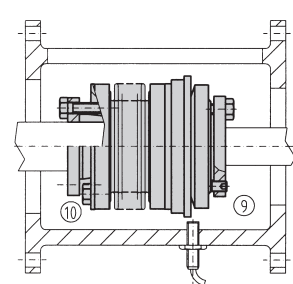


Figure 10

SK 5 with press-fit tapered bushings

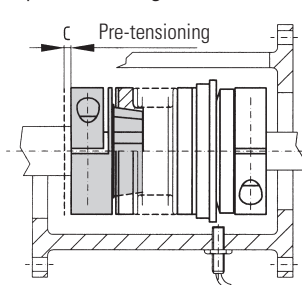


Figure 11

Mounting:

Prior to mounting make sure that the shaft to be connected do not exceed the angular or lateral misalignment limits for the coupling size to be used. This data can be found in the catalog. Slide the coupling on the first shaft end to the proper axial position. Using a torque wrench, tighten the clamp screw to the correct tightening torque as indicated in Table 1. Insert the second shaft into the other end of the coupling to the proper axial position. Make sure that the coupling is free of any axial forces before tightening. Tighten the clamp screw as above using a torque wrench.

Mounting:

Prior to mounting make sure that the shaft to be connected do not exceed the angular or lateral misalignment limits for the coupling size to be used. This data can be found in the catalog. Slide the coupling onto the first shaft to the proper axial position. Using a torque wrench, uniformly tighten the clamping screws using a cross-wise tightening pattern until all the clamping screws are evenly tightened to the correct tightening torque as given in Table 1.



CAUTION: Further tightening of the clamp screws may destroy the tapered bushing connection.

Mounting:

Prior to mounting it is necessary to consider the overall length of the assembled coupling. The press-fit coupling requires a specific pre-tensioning (C) between the two coupling halves to ensure backlash free operation. Mount the "female" coupling half containing the bellows onto the first shaft end to the proper axial position. Using a torque wrench tighten the clamp screw to the proper tightening torque. Mount the "male" coupling segment onto the second shaft end. The proper axial position is when the two couplings come together and coupling is compressed by the proper pre-tension distance (C). See Table 2. When the coupling segment is properly positioned tighten the clamp screw to the proper torque.

Dismounting:

Simply loosen the clamp screw and remove the coupling.

Dismounting:

Loosen the clamping screws. Use the three jackscrews conveniently mounted in the taper segment to evenly back out the tapered segment. Remove the coupling.



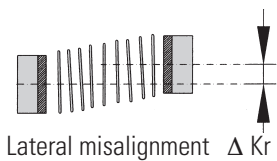
CAUTION:

Prior to reassembly make sure that the jackscrews are raised to their original position.

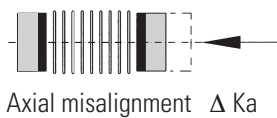
Dismounting:

Pull the coupling apart. Simply loosen the clamp screws and remove the coupling from the shaft.

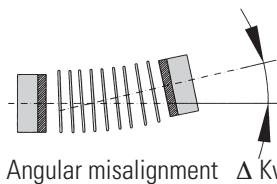
Axial misalignment



Lateral misalignment ΔK_r



Axial misalignment ΔK_a



Angular misalignment ΔK_w

Figure 12

Maximum shaft misalignment

In addition to torque overload protection R+W torque limiters combined with a metal bellows compensate for lateral, axial and angular misalignment. Table 2 contains the maximum allowable values for each axis of misalignment for the different size couplings. It is important to remain within these limits to ensure maximum life and proper operation of the coupling.

Series	Lateral misalignment ΔK_r (mm)	Axial misalignment ΔK_a (mm)	Angular ΔK_w (mm)	Pre-tensioning (SK 5) (mm)	Actuation path (mm)	Engagement force approx. (N)
1.5	0.15/0.20	1/1.5	1/1.5	0.1-0.5	0.7	5-10
2	0.15/0.20	1/2	1/1.5	0.2-0.7	0.8	8-15
4.5	0.20/0.25	1/2	1/1.5	0.2-0.7	0.8	10-20
10	0.20/0.30	1/2	1/1.5	0.2-1.0	1.2	15-30
15	0.15/0.20	1/2	1/1.5	0.2-1.0	1.5	20-40
30	0.20/0.25	1/2	1/1.5	0.3-1.5	1.5	25-50
60	0.20/0.25	1.5/2	1/1.5	0.5-1.5	1.7	30-60
80/150	0.20/0.25	2/3	1/1.5	0.5-1.0	1.9	35-70
200	0.25/0.30	2/3	1.5/2	x	2.2	50-100
300	0.25/0.30	2.5/3.5	1.5/2	0.5-1.5	2.2	80-200
500	0.30/0.35	2.5/3.5	2/2.5	0.5-2.0	2.2	200-500
800	0.35	3.5	2.5	0.8-2.0	2.2	500-1000
1500	0.35	3.5	2.5	0.8-2.2	3	2000-3000
2500	0.4	4	2.5	1-2.5	3	3000-4000

Table 2

x/x First values are for bellows with 4-5 corrugations.
Second values are for bellows with 6-8 corrugations.



CAUTION: Exact alignment of the R+W metal bellows coupling considerably increases the service life of the coupling. Reducing or eliminating lateral misalignment eliminates the radial loading of the adjacent bearings, increasing service life and reducing heat. For drives running at high speed it is recommended to align the coupling with a dial indicator.

Emergency switch function

Mechanical switch (PART No. 618.6740.425)

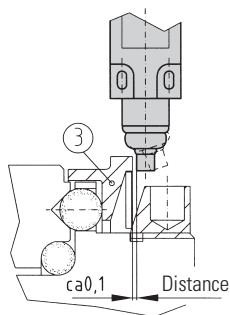
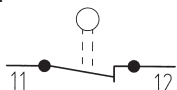


Figure 13

Technical Data

Max. Voltage:	500 V AC
Max. Permanent current:	10 A
Protection type:	IP 65
Type of contact:	Opener
Ambient temperature:	-30°C to +80°C
Confirmation:	(metal)

Switch symbol



Proximity switch (PART No. 650.2703.1)

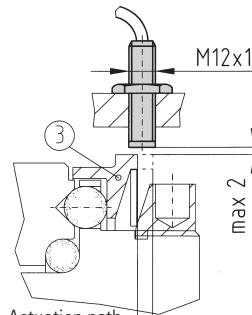
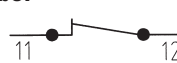


Figure 14

Technical Data

Voltage range:	10 to 30 V DC
Initial current max.:	200 mA
Switch frequency:	800 Hz
Temperature range:	-25°C to +70°C
Protection type:	IP 67
Switching type:	PNP opener
Switch distance:	max. 2 mm

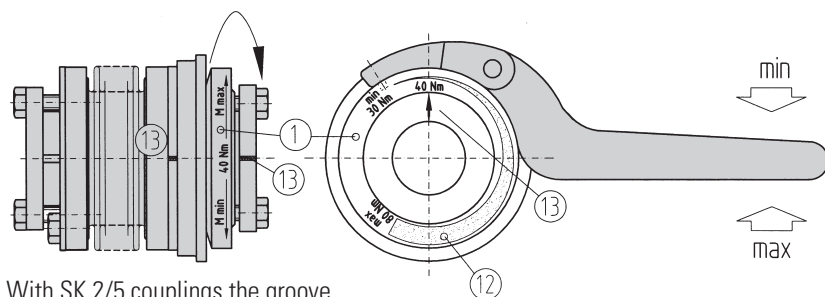
Switch symbol



The axial movement of the actuation ring (3) can be sensed by either a mechanical switch or a proximity sensor. The distance the actuation ring moves is given in Table 2 and is important for the selection of the appropriate sensing device. Mount the sensing device on a solid support keeping the distance shown in figure 13+14. Without prior agreement it is not allowed to operate R+W torque limiters of the series SK and ES without end switch. In case of an electronic circuit collapse, the coupling had to be checked visually right after the first disengagement for the preassigned disengagement torque. Here fore the marks on the adjustment nut are the reference value.



Disengagement torque setting



With SK 2/5 couplings the groove of the clamping hub serves as a marking (3)

Figure 15

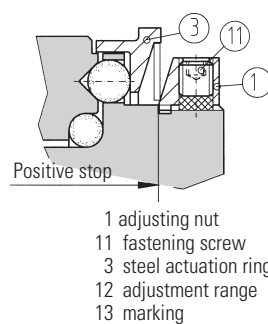


Figure 16

R+W torque limiters are factory set to the customer specified disengagement torque, which is marked onto the coupling. The adjustment range (min/max) is also marked on the adjustment ring. The customer can adjust the disengagement torque as long as it falls into the range indicated on the adjustment ring.



The adjustment range may not be left during setting.

To adjust the disengagement torque, loosen the locking screws (11) and rotate the adjustment ring using a spanner wrench to the desired new setting. Tighten the locking screws and test the coupling.



CAUTION: R+W torque limiters incorporate disc springs that exhibit a special spring characteristic. It is important to stay in the max-min range of the coupling.

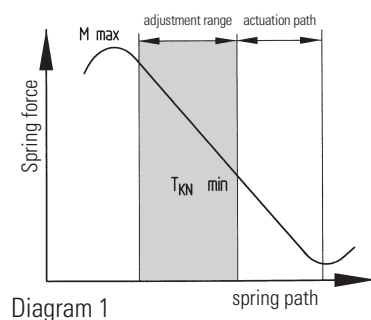


Diagram 1

Maintenance



R+W torque limiters are maintenance free as long as they are properly mounted and the maximum misalignment and radial load values are not exceeded. The internal components are permanently greased for lifetime lubrication.

CAUTION: Disassembly of the coupling will void the warranty.

R+W
COUPLING TECHNOLOGY

R+W Antriebselemente GmbH
Alexander-Wiegand-Str. 8 · 63911 Klingenberg
Tel. +49-(0)93 72 – 98 64-0 · Fax +49-(0)93 72 – 98 64 20
info@rw-kupplungen.de · <http://www.rw-couplings.com>

The above-mentioned information is based on our present knowledge and experiences and does not free the user of his own regular checks. A legally binding guarantee is not given even in regard to protection rights of Third parties.

BEARINGS/PULLEYS

Since all bearings have taconite seals, there is very little misalignment allowance on the bearing housings. See assembly instructions for taconite seals.

All shafts mounted on frames are aligned and will have free running seals. If any adjustment is made during final alignment, care must be taken to make sure that the seals will run free after the adjustment.

Shafts mounted on screw take-ups need to be adjusted evenly ± 3 mm in both sides when moving them back or forth on the take-ups. (Refer to take-up section)

LUBRICATION

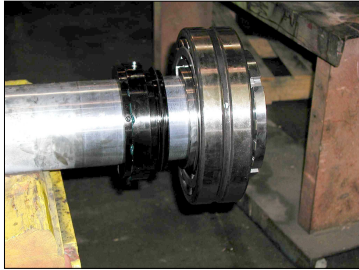
An automatic lubrication system is provided. Bearings have been shop lubricated with TEXACO STARPLEX NLGI grease. Please refer to the Lincoln Operation and Maintenance Manual for operating instructions

SPLIT PILLOW BLOCKS

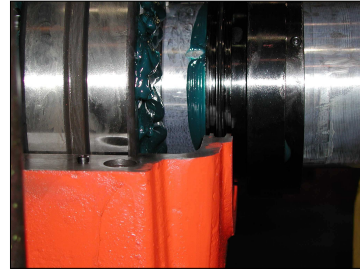
For Pillow Block Housings / Bearings assembly see **FAG** bearing manual

Grease used to pre-fill housings: EP1 - TEXACO STARPLEX 1

INSTALLING BEARINGS AND SEALS ONTO SHAFT



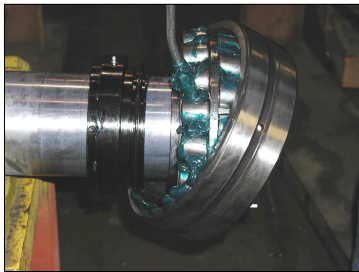
1. Mount seal & bearing



4. Fit seal/bearing into grooves



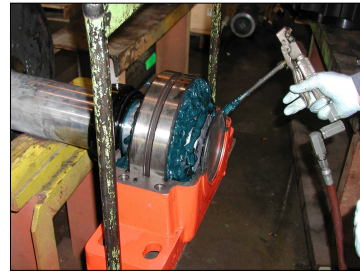
2. Grease rollers all around



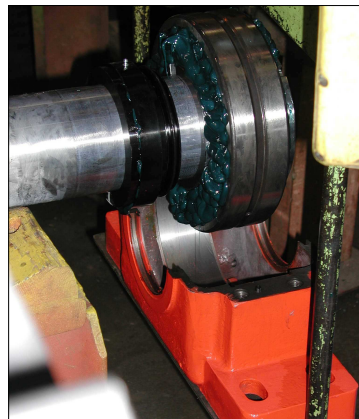
3. Bring bottom housing up



5. Bring housing fully up



6. Fill with grease



7. Carefully install top housing



FAG



Ductile Iron Pillow Block Housings General and Heavy Duty

SCHAEFFLER GROUP
INDUSTRIAL

Ductile Iron Housings

Selecting the most appropriate housing material should be the result of careful analysis of the operating and environmental conditions of the application. When the demands placed upon the pillow block do not allow for compromises, the material choice becomes increasingly obvious: ductile iron.

Optimum Material, Maximum Performance

FAG utilizes ductile iron as a high grade material for standard housing production. This remarkably versatile material possesses a number of engineering advantages, including:

- the fluid casting properties of cast iron
- superb material consistency comparable to carbon cast steel, with the inherent high tensile and yield strengths (see chart)
- tremendous resistance to corrosion
- the strength to withstand substantial mechanical shock
- resilient to brittle fracture at low temperatures
- extended service life in severe operating conditions

Series Availability

FAG offers an extensive standard selection of ductile iron pillow blocks for general duty and heavy duty applications. Series SAF...D and AFD general duty housings are designed for shafts ranging from 1 $\frac{1}{16}$ " to 7 $\frac{1}{16}$ ", whereas heavy duty series SDD accommodate shaft diameters as great as 43 inches.

In addition to standard series production, FAG also utilizes ductile iron for special design housings unique to their specific industrial applications.



Comparison: Housing Material Properties

Material	A.S.T.M. Designation	Grade	Tensile Strength psi	Yield Strength psi	Elongation (% in 2 in.)
Cast Iron	A48-64	30	30,000	—	—
Ductile Iron	A-536	65-45-12	65,000	45,000	12
Cast Steel	A27	65-35	65,000	35,000	24

General Duty Series SAF...D

- series SAF...D housings are designed to accept a full range of shaft diameters from $1\frac{1}{16}$ " to $7\frac{1}{16}$ "
- housing sizes within this standard production program are machined to accommodate inch or metric shaft dimensions
- housings are supplied with a central grease inlet and nipple for relubrication of the bearing, and an outlet hole on each side of the block for drainage
- housings are equipped with a 2-bolt base for shaft sizes up to and including $3\frac{7}{16}$ " (SAF520D), and with a 4-bolt base thereafter; 4-bolt bases are also available by specifying FSAF...D for shafts ranging from $2\frac{3}{16}$ " to $3\frac{7}{16}$ " (FSAF513D to FSAF520D)
- series SAF...D housings can be supplied with triple seal rings for normal service conditions, or SuperTac II taconite seals for severe service conditions
- bearings can be installed as floating bearings, or located with fixing rings

For detailed SAF...D assembly components and dimensions, see pages 6 & 7



SAF...D housing assembly featuring FAG SuperTac II taconite seals

General Duty Series AFD

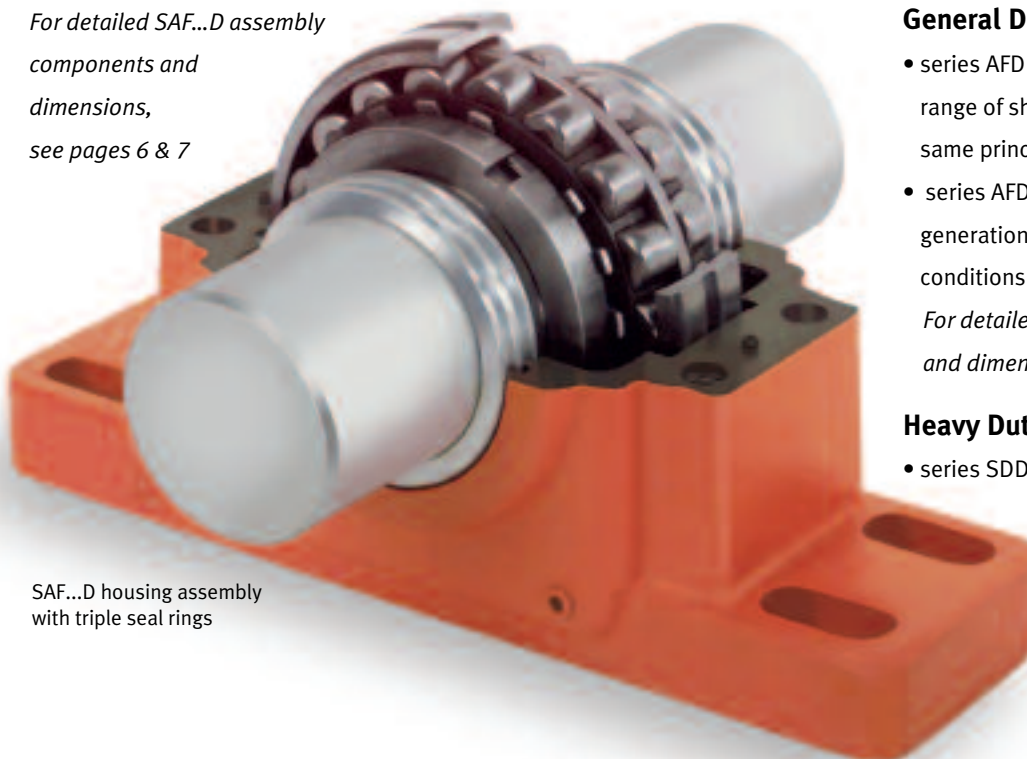
- series AFD housings are available for the same range of shaft sizes as series SAFD, and with the same principle design features
- series AFD housings are equipped with 1st generation taconite seals for severe service conditions without substitution

For detailed AFD assembly components and dimensions, see pages 8 & 9

Heavy Duty Series SDD

- series SDD housings are available for larger shaft diameters as great as 43 inches

For SDD housing dimensions and bearing selection, see pages 10 & 11

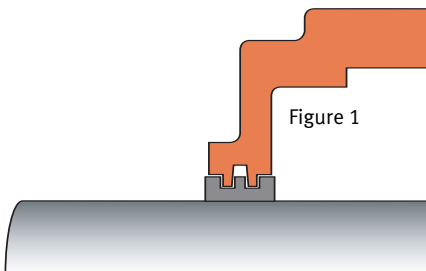


SAF...D housing assembly with triple seal rings

Seals and Endcovers

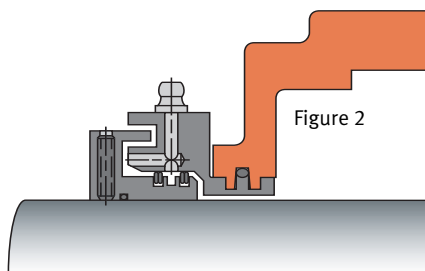
Triple Seal Rings

- series SAF...D and SDD housings are generally equipped with an efficient non-contact radial labyrinth seal commonly referred to as a triple seal ring (series LER for SAF...D and TSG for SDD housings)
- this rotating ring automatically locates itself relative to the labyrinth groove of the housing (Figure 1)



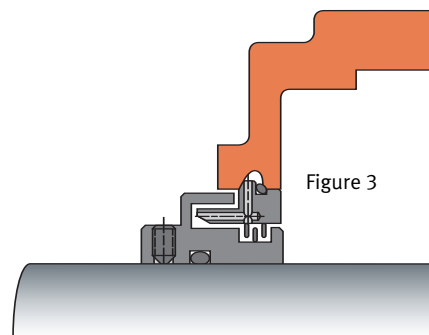
Taconite Seals

- for severe service conditions, SAF...D housings can be equipped with SuperTac II taconite seals (Figure 2) without any modification to the housing (see additional information below and opposite)
- series AFD housings are standardly equipped with 1st generation FAG taconite seals (Figure 3) without substitution



- taconite seals are also available for series SDD housings, and in special designs

If any housing is to be closed on one side, an endcover is installed in the annular groove of the housing.

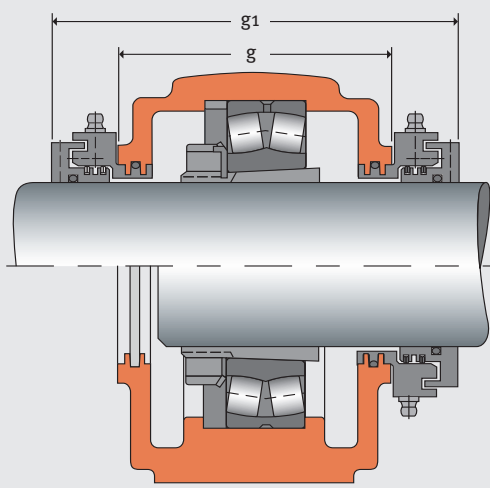


At the Sign of Contamination, the Seal that Delivers: SuperTac II

Design Features

- FAG SuperTac II seals are manufactured from high grade steel with black oxide coating as standard; special design option of nickel plating is available upon request
- the internal design features a radial / axial web barrier to external contaminants
- a grease packed radial labyrinth is formed by high grade spring steel laminar rings that align into two close running barriers, separated by a lubricant distribution channel
- working together with the grease purged axial labyrinth, the result is a web that stands virtually impenetrable
- the seal flinger is equipped with 2 set screws spaced at a 65° interval for maximum holding power to the shaft
- an o-ring in the flinger bore prevents the ingress of fluids between the seal and shaft





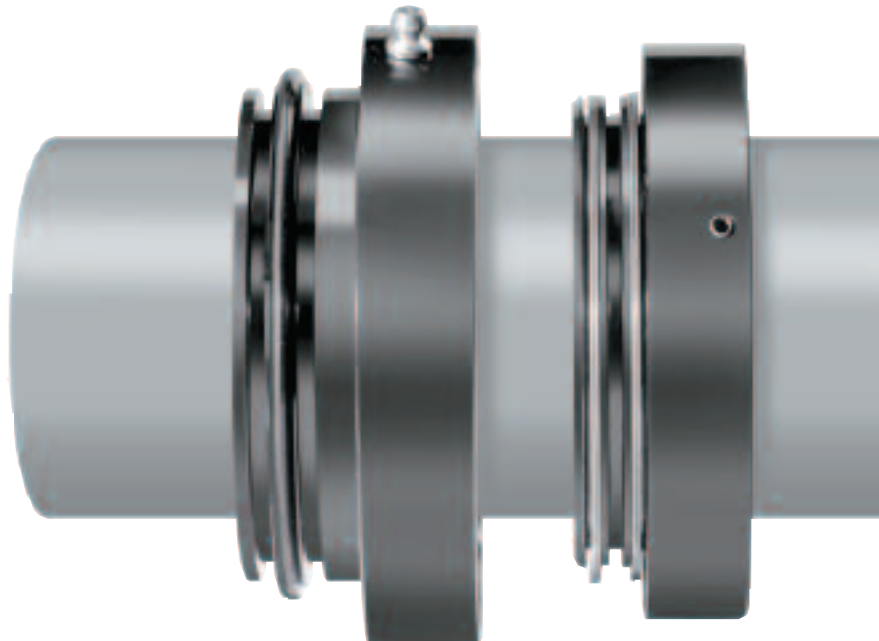
Dimensions “g” and “g1” apply to SuperTac II seals installed with FAG series SAF5..D pillow blocks. Dimensions may vary when using SuperTac II seals with non-ductile iron FAG SAF series pillow blocks, or with a non-FAG pillow block. SuperTac II seals are unavailable for some metric shaft sizes due to inadequate space between the shaft and housing seal grooves to accommodate the seal design.

FAG Super Tac II Taconite Seals

Shaft in./mm	Pillow Block	FAG Seal No.	Dimensions g in./mm	g1 in./mm	Shaft in./mm	Pillow Block	FAG Seal No.	Dimensions g in./mm	g1 in./mm
1 ¹ / ₁₆	SAF509	TA17A	3.420 87	5.910 150	4 ³ / ₁₆	SAF524	TA113A	7.125 181	10.314 262
1 ¹ / ₁₆	SAF510	TA20A	3.420 87	5.910 150	4 ⁷ / ₁₆	SAF526	TA117A TA117A.M	7.750 197	11.214 285
1 ¹⁵ / ₁₆ 50	SAF511	TA24A TA24A.M	3.750 95	6.269 159	4 ¹⁵ / ₁₆ 125	SAF528	TA122A TA122A.M	7.375 187	10.818 275
2 ³ / ₁₆	SAF513	TA29A	4.250 108	6.782 172	5 ³ / ₁₆ 135	SAF530	TA125A TA125A.M	8.125 206	11.890 302
2 ⁷ / ₁₆	SAF515	TA37A	4.625 117	7.367 187	5 ⁷ / ₁₆ 140	SAF532	TA130A TA130A.M	8.500 216	12.215 310
2 ¹¹ / ₁₆ 70	SAF516	TA44A TA44A.M	4.750 121	7.520 191	5 ¹⁵ / ₁₆ 150	SAF534	TA140A TA140A.M	9.250 235	13.150 334
2 ¹⁵ / ₁₆ 75	SAF517	TA53A TA53A.M	4.813 122	7.740 197	6 ⁷ / ₁₆ 160	SAF536	TA148A TA148A.M	9.625 244	13.720 348
3 ³ / ₁₆ 80	SAF518	TA188A TA188A.M	5.500 140	8.138 207	6 ¹⁵ / ₁₆ 170	SAF538	TA155A TA155A.M	10.500 267	14.671 373
3 ⁷ / ₁₆ 90	SAF520	TA102A TA102A.M	5.813 148	9.025 229	7 ³ / ₁₆ 180	SAF540	TA159A TA159A.M	11.000 279	15.417 392
3 ¹⁵ / ₁₆ 100	SAF522	TA109A TA109A.M	6.438 164	9.682 246	7 ¹⁵ / ₁₆ 200	SAF544	TA167A TA167A.M	11.750 298	16.265 413

Operating Benefits

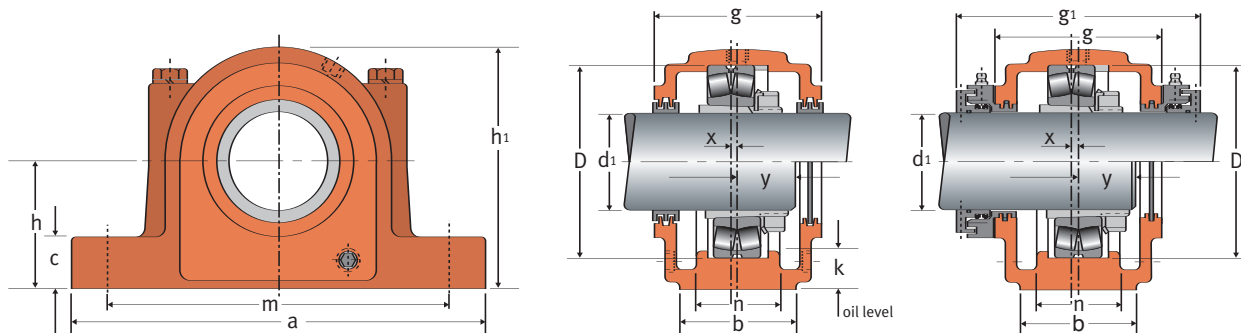
- FAG SuperTac II is designed as a drop-in fit to the seal grooves of FAG series SAF pillow blocks, as well as many competitive designs, eliminating the need for special housing features
- the non-contact seal design eliminates shaft wear common to competitive designs
- SuperTac II seals accept greater misalignments than lip seals
- exceptional speed characteristics: equivalent to bearing speed limits



Series SAF...D Housings

SAF...D Assembly Components and Dimensions

Shaft Diameter mm/in.	Pillow Block No.	Basic Bearing No.	Split Bearing No.	Adapter Sleeve No.	Triple Seal Ring No.	Super Tac II Seal No.	End Cover No.	Fixing Ring No.	pcs.	Complete Weight (approx) lbs. kgs.	
40 1 ⁷ / ₁₆	SAF509-D	22209-E1-K		H309 H309X107	LER20.M40 LER17.0107	TA17A	EC509.D2	FRM85/6	1	10.5	4.8
45 1 ¹¹ / ₁₆	SAF510-D	22210-E1-K		H310 H310X111	LER20.M45 LER20.0111	TA20A	EC510.D2	FRM90/7	1	11.5	5.2
50 1 ¹⁵ / ₁₆	SAF511-D	22211-E1-K		H311 H311X115	LER24.M50 LER24.0115	TA24A.M TA24A	EC511.D2	FRM100/6	1	13.5	6.1
60 2 ³ / ₁₆	SAF513-D	22213-E1-K		H313 H313X203	LER35.M60 LER29.0203	TA29A	EC513.D2	FRM120/8	1	21	9.5
65 2 ⁷ / ₁₆	SAF515-D	22215-E1-K	222SM.65 222S.207	H315 H315X207	LER38.M65 LER37.0207	TA37A	EC515.D2	FRM130/6	1	24	10.9
70 2 ¹¹ / ₁₆	SAF516-D	22216-E1-K	222SM.70 222S.211	H316 H316X211	LER44.M70 LER44.0211	TA44A.M TA44A	EC516.D2	FRM140/10	1	32	14.5
75 2 ¹⁵ / ₁₆	SAF517-D	22217-E1-K	222SM.75 222S.215	H317 H317X215	LER53.M75 LER53.0215	TA53A.M TA53A	EC517.D2	FRM150/10	1	35	15.9
80 3 ¹ / ₁₆	SAF518-D	22218-E1-K	222SM.80 222S.303	H318 H318X303	LER188.M80 LER188.0303	TA188A.M TA188A	EC518.D2	FRM160/10	1	44	20.0
90 3 ⁵ / ₁₆	SAF520-D	22220-E1-K	222SM.90 222S.307	H320 H320X307	LER102.M90 LER102.0307	TA102A.M TA102A	EC520.D2	FRM180/10	1	74	33.6
100 3 ¹⁵ / ₁₆	SAF522-D	22222-E1-K	222SM.100 222S.315	H322 H322X315	LER109.M100 LER109.0315	TA109A.M TA109A	EC522.D2	FRM200/10	1	97	44.0
110 4 ¹ / ₁₆	SAF524-D	22224-E1-K	222SM.110 222S.403	H3124 H3124X403	LER113.M110 LER113.0403	TA113A	EC524.D2	FRM215/10	1	121	54.9
115 4 ⁵ / ₁₆	SAF526-D	22226-E1-K	222SM.115 222S.407	H3126 H3126X407	LER117.M115 LER117.0407	TA117A.M TA117A	EC526.D2	FRM230/10	1	161	73.1
125 4 ¹⁵ / ₁₆	SAF528-D	22228-E1-K	222SM.125 222S.415	H3128 H3128X415	LER122.M125 LER122.0415	TA122A.M TA122A	EC528.D2	FRM250/10	1	174	79.0
135 5 ¹ / ₁₆	SAF530-D	22230-E1-K	222SM.135 222S.503	H3130 H3130X503	LER125.M135 LER125.0503	TA125A.M TA125A	EC530.D2	FRM270/10	1	221	100.3
140 5 ⁵ / ₁₆	SAF532-D	22232-E1-K	222SM.140 222S.507	H3132 H3132X507	LER130.M140 LER130.0507	TA130A.M TA130A	EC532.D2	FRM290/10	1	246	111.7
150 5 ¹⁵ / ₁₆	SAF534-D	22234-E1-K	222SM.150 222S.515	H3134 H3134X515	LER140.M150 LER140.0515	TA140A.M TA140A	EC534.D2	FRM310/10	1	310	140.7
160 6 ¹ / ₁₆	SAF536-D	22236-E1-K	222SM.160 222S.607	H3136 H3136X607	LER148.M160 LER148.0607	TA148A.M TA148A	EC536.D2	FRM320/10	1	345	156.6
170 6 ¹⁵ / ₁₆	SAF538-D	22238-K	222SM.170 222S.615	H3138 H3138X615	LER155.M170 LER155.0615	TA155A.M TA155A	EC538.D2	FRM340/10	1	400	181.6
180 7 ¹ / ₁₆	SAF540-D	22240-K	222SM.180 222S.703	H3140 H3140X703	LER159.M180 LER159.0703	TA159A.M TA159A	EC540.D2	FRM360/10	1	492	223.4
200 7 ¹⁵ / ₁₆	SAF544-D	22244-K	222SM.200 222S.715	H3144 H3144X715	LER167.M200 LER167.0715	TA167A.M TA167A	EC544.D2	FRM400/10	1	672	305.1



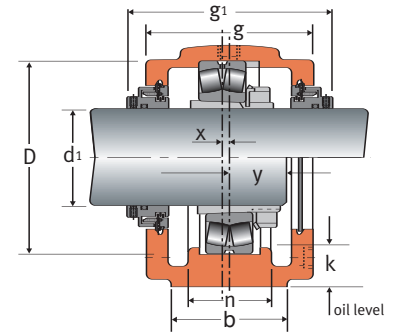
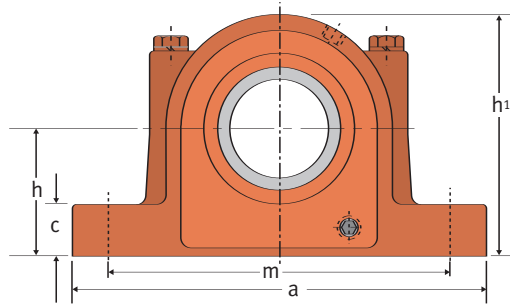
D	h mm/in.	a mm/in.	b mm/in.	c mm/in.	m Max. mm/in.	Min. mm/in.	n mm/in.	h1 mm/in.	g mm/in.	g1 mm/in.	x mm/in.	k (Static) mm/in.	y mm/in.	Mounting Bolts 2 pcs. mm/in.	4 pcs. mm/in.
85	57.15 2 1/4	210 8 3/4	60 2 3/8	21 1 3/16	178 7	159 6 1/4		111 4 3/8	87 3 3/16	150 5 15/16	3.0 .118	25 3 1/32	30 1 1/16	M12 1/2	
90	63.50 2 1/2	210 8 3/4	60 2 3/8	24 1 5/16	178 7	165 6 1/2		121 4 3/4	87 3 3/16	150 5 15/16	3.5 .138	28 1 1/32	30 1 1/16	M12 1/2	
100	69.85 2 3/4	244 9 7/8	70 2 3/4	24 1 5/16	200 7 7/8	187 7 3/8		133 5 1/4	95 3 3/4	159 6 1/4	3.0 .118	32 1 1/16	32 1 1/4	M16 5/8	
120	76.20 3	279 11	79 3 1/8	25 1	241 9 1/2	206 8 1/8	51 2	151 5 15/16	108 4 1/4	172 6 13/16	4.0 .157	32 1 1/32	37 1 1/16	M16 5/8	M12 1/2
130	82.55 3 1/4	286 11 1/4	79 3 1/8	29 1 1/8	244 9 7/8	219 8 5/8	48 1 7/8	162 6 3/8	117 4 5/8	187 7 7/8	3.0 .118	32 1 1/8	38 1 1/2	M16 5/8	M12 1/2
140	88.90 3 1/2	330 13	89 3 1/2	30 1 3/16	279 11	244 9 7/8	54 2 1/8	175 6 5/8	121 4 3/4	191 7 1/2	5.0 .197	35 1 1/4	41 1 5/8	M20 3/4	M16 5/8
150	95.25 3 3/4	330 13	89 3 1/2	32 1 1/4	279 11	251 9 7/8	54 2 1/8	186 7 5/16	122 4 13/16	197 7 3/4	5.0 .197	37 1 3/8	43 1 11/16	M20 3/4	M16 5/8
160	101.60 4	349 13 3/4	98 3 7/8	33 1 5/16	295 11 7/8	264 10 7/8	54 2 1/8	197 7 3/4	140 5 1/2	207 8 1/8	5.0 .197	40 1 1/2	44 1 3/4	M20 3/4	M16 5/8
180	114.30 4 1/2	387 15 1/4	111 4 3/8	44 1 3/4	333 13 3/8	295 11 7/8	60 2 3/8	213 8 3/8	148 5 13/16	229 9	5.0 .197	45 1 21/32	51 2	M24 3/4	M20 3/4
200	125.41 4 15/16	419 16 1/2	121 4 3/4	51 2	368 14 1/2	321 12 5/8	70 2 3/4	244 9 5/8	164 6 1/16	246 9 11/16	5.0 .197	48 1 29/32	54 2 1/8		M20 3/4
215	133.35 5 1/4	419 16 1/2	121 4 3/4	54 2 1/8	368 14 1/2	337 13 3/4	70 2 3/4	260 10 1/4	181 7 1/8	262 10 5/16	5.0 .197	51 1 27/32	59 2 5/16		M20 3/4
230	152.40 6	467 18 3/8	130 5 1/8	60 2 3/8	406 16	371 14 7/8	83 3 1/4	292 11 1/2	197 7 3/4	285 11 3/16	5.0 .197	63 2 11/32	62 2 1/16		M24 7/8
250	152.40 6	511 20 1/8	149 5 7/8	60 2 3/8	435 17 7/8	406 16	86 3 3/8	298 11 3/4	187 7 3/8	275 10 13/16	5.0 .197	56 2 1/32	65 2 9/16		M24 1
270	160.34 6 1/16	540 21 1/4	159 6 1/4	64 2 1/2	464 18 1/4	432 17	95 3 3/4	318 12 1/2	206 8 1/8	302 11 7/8	5.0 .197	56 2	70 2 3/4		M24 1
290	169.86 6 11/16	559 22	159 6 1/4	67 2 5/8	489 19 1/4	441 17 3/8	95 3 3/4	338 13 3/16	216 8 1/2	310 12 3/16	5.0 .197	57 2 1/16	75 2 15/16		M24 1
310	179.39 7 1/16	630 24 3/4	171 6 3/4	70 2 3/4	549 21 7/8	492 19 3/8	108 4 1/4	360 14 3/16	235 9 1/4	334 13 3/8	5.0 .197	61 2 5/32	79 3 1/8		M24 1
320	190.50 7 1/2	679 26 3/4	181 7 1/8	76 3	600 23 3/8	530 20 7/8	117 4 7/8	378 14 7/8	244 9 5/8	348 13 3/4	5.0 .197	67 2 3/8	79 3 1/8		M24 1
340	200.03 7 7/8	711 28	191 7 1/2	79 3 1/8	619 24 7/8	549 21 7/8	114 4 1/2	398 15 11/16	267 10 1/2	373 14 11/16	5.0 .197	69 2 1/16	84 3 1/16		M30 1 1/4
360	209.55 8 1/4	749 29 1/2	203 8	86 3 3/8	635 25	572 22 1/2	127 5	419 16 1/2	279 11	392 15 1/16	5.0 .197	71 2 15/32	89 3 1/2		M30 1 1/4
400	241.30 9 1/2	832 32 3/4	222 8 3/4	95 3 3/4	708 27 7/8	629 24 3/4	133 5 1/4	473 18 3/8	298 11 3/4	413 16 1/4	5.0 .197	88 3 1/8	97 3 13/16		M36 1 1/2

- Dimensions "g1" specific to SAF...D housings with SuperTac II seals
- Specify FSAF...D when ordering 4-bolt bases for pillow block sizes 513 to 520

Series AFD Housings

AFD Assembly Components and Dimensions

Shaft Diameter mm/in.	Pillow Block No.	Basic Bearing No.	Split Bearing No.	Adapter Sleeve No.	Taconite Seal No.	End Cover No.	Fixing Ring No.	pcs.	Complete Weight (approx)		D	h mm/in.
40 1 ⁷ / ₁₆	AFD509.D2	22209-E1-K		H309 H309X107	TA509.M40 TA509.107	AC509S	FRM85/8	1	12	5.4	85	57.15 2 ¹ / ₄
45 1 ¹¹ / ₁₆	AFD510.D2	22210-E1-K		H310 H310X111	TA510.M45 TA510.111	AC510S	FRM90/10	1	13	5.9	90	63.5 2 ¹ / ₂
50 1 ¹⁵ / ₁₆	AFD511.D2	22211-E1-K		H311 H311X115	TA511.M50 TA511.115	AC511S	FRM100/10	1	18	8.2	100	69.85 2 ³ / ₄
60 2 ³ / ₁₆	AFD513.D2	22213-E1-K		H313 H313X203	TA513.M60 TA513.203	AC513S	FRM120/10	1	26	11.8	120	76.2 3
65 2 ⁷ / ₁₆	AFD515.D2	22215-E1-K	222SM.65 222S.207	H315 H315X207	TA515.M65 TA515.207	AC515S	FRM130/10	1	31	14.1	130	82.55 3 ¹ / ₄
70 2 ¹¹ / ₁₆	AFD516.D2	22216-E1-K	222SM.70 222S.211	H316 H316X211	TA516.M70 TA516.211	AC516S	FRM140/10	1	38	17.2	140	88.9 3 ¹ / ₂
75 2 ¹⁵ / ₁₆	AFD517.D2	22217-E1-K	222SM.75 222S.215	H317 H317X215	TA517.M75 TA517.215	AC517S	FRM150/10	1	45	20.4	150	95.25 3 ³ / ₄
80 3 ¹ / ₁₆	AFD518.D2	22218-E1-K	222SM.80 222S.303	H318 H318X303	TA518.M80 TA518.303	AC518S	FRM160/10	1	51	23.1	160	101.6 4
90 3 ⁷ / ₁₆	AFD520.D2	22220-E1-K	222SM.90 222S.307	H320 H320X307	TA520.M90 TA520.307	AC520S	FRM180/10	1	72	32.7	180	114.3 4 ¹ / ₂
100 3 ¹⁵ / ₁₆	AFD522.D2	22222-E1-K	222SM.100 222S.315	H322 H322X315	TA522.M100 TA522.315	AC522S	FRM200/10	1	100	45.4	200	125.41 4 ¹⁵ / ₁₆
110 4 ³ / ₁₆	AFD524.D2	22224-E1-K	222SM.110 222S.403	H3124 H3124X403	TA524.M110 TA524.403	AC524S	FRM215/10	1	126	57.2	215	133.35 5 ¹ / ₄
115 4 ⁷ / ₁₆	AFD526.D2	22226-E1-K	222SM.115 222S.407	H3126 H3126X407	TA526.M115 TA526.407	AC526S	FRM230/10	1	151	68.5	230	152.4 6
125 4 ¹⁵ / ₁₆	AFD528.D2	22228-E1-K	222SM.125 222S.415	H3128 H3128X415	TA528.M125 TA528.415	AC528S	FRM250/10	1	184	83.5	250	152.4 6
135 5 ³ / ₁₆	AFD530.D2	22230-E1-K	222SM.135 222S.503	H3130 H3130X503	TA530.M135 TA530.503	AC530S	FRM270/10	1	234	106.1	270	160.34 6 ⁵ / ₁₆
140 5 ⁷ / ₁₆	AFD532.D2	22232-E1-K	222SM.140 222S.507	H3132 H3132X507	TA532.M140 TA532.507	AC532S	FRM290/10	1	283	128.4	290	169.86 6 ¹¹ / ₁₆
150 5 ¹⁵ / ₁₆	AFD534.D2	22234-E1-K	222SM.150 222S.515	H3134 H3134X515	TA534.M150 TA534.515	AC534S	FRM310/10	1	347	157.4	310	179.39 7 ¹ / ₁₆
160 6 ¹ / ₁₆	AFD536.D2	22236-E1-K	222SM.160 222S.607	H3136 H3136X607	TA536.M160 TA536.607	AC536S	FRM320/10	1	382	173.3	320	190.5 7 ¹ / ₂
170 6 ¹⁵ / ₁₆	AFD538.D2	22238-K	222SM.170 222S.615	H3138 H3138X615	TA538.M170 TA538.615	AC538S	FRM340/10	1	464	210.5	340	200.03 7 ⁷ / ₈
180 7 ³ / ₁₆	AFD540.D2	22240-K	222SM.180 222S.703	H3140 H3140X703	TA540.M180 TA540.703	AC540S	FRM360/10	1	536	243.1	360	209.55 8 ¹ / ₄
200 7 ¹⁵ / ₁₆	AFD544.D2	22244-K	222SM.200 222S.715	H3144 H3144X715	TA544.M200 TA544.715	AC544S	FRM400/10	1	730	331.1	400	241.3 9 ¹ / ₂



a mm/in.	b mm/in.	c mm/in.	m Max. mm/in.	Min. mm/in.	n mm/in.	h1 mm/in.	g mm/in.	g1 mm/in.	x mm/in.	k (Static) mm/in.	y mm/in.	Mounting Bolts 2 pcs. mm/in. 4 pcs. mm/in.	
210 8¼	60 2⅜	21 1⅜	178 7	159 6¼		110 4⅞	89 3½	113 4⅞	4 0.157	25 1	30 1⅜	M12 ½	
210 8¼	60 2⅜	29 1⅞	178 7	165 6½		121 4¾	92 3⅝	120 4¾	5 0.197	28 1⅞	30 1⅜	M12 ½	
251 9⅞	70 2¾	29 1⅞	200 7⅞	187 7⅞		133 5¼	98 3⅞	127 5	5 0.197	32 1¼	32 1¼	M16 ⅝	
279 11	79 3⅞	30 1⅞	241 9½	206 8⅞		151 5⅞	114 4½	146 5¾	5 0.197	32 1¼	37 1⅞	M16 ⅝	
286 11¼	79 3⅞	30 1⅞	244 9⅞	219 8⅞	48 1⅞	160 6⅞	114 4½	148 5⅞	5 0.197	32 1¼	38 1½	M16 ⅝	M12 ½
330 13	89 3½	32 1¼	279 11	244 9⅞	54 2⅞	171 6¾	127 5	159 6¾	5 0.197	35 1⅜	41 1⅞	M20 ¾	M16 ⅝
324 12¾	89 3½	32 1¼	279 11	251 9⅞	54 2⅞	186 7⅞	132 5⅞	171 6¾	5 0.197	37 1⅞	43 1⅞	M20 ¾	M16 ⅝
349 13¾	98 3⅞	35 1⅞	295 11⅞	264 10⅞	54 2⅞	197 7¾	152 6	185 7¾	5 0.197	40 1⅞	44 1¼	M20 ¾	M16 ⅝
387 15¼	111 4⅞	40 1⅞	333 13⅞	295 11⅞	60 2⅞	219 8⅞	159 6¾	198 7⅞	5 0.197	45 1¾	51 2	M24 ⅞	M20 ¾
419 16½	121 4¾	44 1¾	368 14½	321 12⅞	70 2¾	243 9⅞	176 6⅞	216 8½	5 0.197	48 1⅞	54 2⅞		M20 ¾
419 16½	121 4¾	44 1¾	368 14½	337 13¾	70 2¾	260 10¼	187 7⅞	229 9	5 0.197	51 2	59 2⅞		M20 ¾
467 18⅞	130 5⅞	52 2⅞	406 16	371 14⅞	83 3¼	289 11⅞	192 7⅞	232 9⅞	5 0.197	63 2½	62 2⅞		M24 ⅞
511 20⅞	149 5⅞	52 2⅞	435 17⅞	406 16	86 3⅞	302 11⅞	205 8⅞	248 9¾	5 0.197	56 2⅞	65 2⅞		M24 1
540 21¼	159 6¼	60 2⅞	464 18¾	432 17	95 3¾	322 12⅞	219 8⅞	267 10½	5 0.197	55 2⅞	70 2¾		M24 1
559 22	159 6¼	60 2⅞	489 19¾	441 17⅞	95 3¾	344 13⅞	235 9¼	283 11⅞	5 0.197	57 2¼	75 2⅞		M24 1
629 24¾	171 6¾	70 2¾	549 21⅞	492 19⅞	108 4¼	368 14½	241 9½	295 11⅞	5 0.197	61 2⅞	79 3⅞		M24 1
679 26¾	181 7⅞	76 3	600 23⅞	530 20⅞	117 4⅞	381 15	254 10	306 12⅞	5 0.197	67 2⅞	79 3⅞		M24 1
711 28	191 7½	70 2¾	619 24⅞	549 21⅞	114 4½	412 16¼	270 10⅞	321 12⅞	5 0.197	69 2⅞	84 3⅞		M30 1¼
749 29½	205 8⅞	76 3	635 25	572 22½	127 5	435 17⅞	279 11	337 13¾	5 0.197	71 2¾	89 3½		M30 1¼
832 32¾	222 8¾	95 3¾	708 27⅞	629 24¾	133 5¼	484 19⅞	298 11¾	356 14	5 0.197	88 3⅞	97 3⅞		M36 1½

Series SDD Housings

Heavy Duty Series SDD

Servicing requirements for large size pillow blocks has become a standard practice for FAG, as demonstrated with a complete standard series of extra large ductile iron housings.

Substantiating that size does not prohibit flexibility, series SDD housings are designed to:

- accept shaft diameters as large as 43"
- accommodate a wide variety of spherical roller bearing options
- provide the optional seal designs and other engineered features relative to FAG general duty housings

SDD Housing Selection

Essentially, SDD housing size is determined by the outside diameter of the bearing. Each housing size can be machined to accept a range of outside diameters and therefore a variety of bearings as illustrated in the table opposite.

This table allows basic housing dimensions to be established when bearing selection has already been made from one of the eight common bearing series.

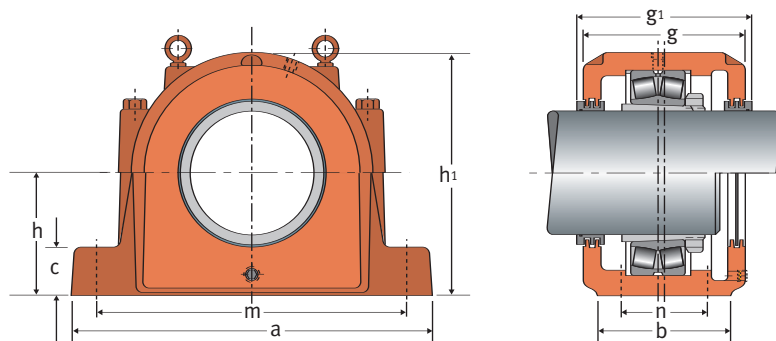
For final details, such as seal design, float requirement, or any optional feature, please consult an FAG engineering representative.

Housing Dimensions by Bearing Selection

Bearing O.D. mm From To		Basic Bearing Number			
		Series 239..	*Series 230..	Series 240..	*Series 231..
270	280	23940	23036	24036	23132 23134
290	300	23944	23038	24038	23136
310	320	23948	23040	24040	23138
340			23044	24044	23140
360	370	23952	23048	24048	23144
400	420	23960	23052 23056	24052 24056	23148
440		23964			23152
460	480	23968 23972	23060 23064	24060 24064	23156
480	520	23976	23068	24068	23160
540	560	23980 23984	23072 23076	24072 24076	23164
580	600	23988	23080	24080	23168 23172
620	650	23992 23996	23084 23088	24084 24088	23176 23180
680	720	239/530	23092 23096 230/500	24092 24096 240/500	23184 23188
760	800	239/600	230/530	240/530	23192 23196
820	870	239/630	230/560 230/600	240/560 240/600	231/500 231/530
920	980	239/710	230/630 230/670	240/630 240/670	231/560 231/600
1030	1090	239/800	230/710 230/750	240/710 240/750	231/630 231/670

* Preferred bearing series





				Housing Dimensions										Mounting Bolts mm/in.
Series 241..	Series 222..	*Series 232..	Series 223..	h mm/in.	a mm/in.	b mm/in.	c mm/in.	Max. mm/in.	Min. mm/in.	n mm/in.	h1 mm/in.	g mm/in.	g1 mm/in.	
	22230	23230	22326	170 6.693	510 20 ¹ / ₁₆	180 7 ¹ / ₈	70 2 ³ / ₄	436 17 ³ / ₁₆	424 16 ¹¹ / ₁₆	100 3 ¹⁵ / ₁₆	335 13 ³ / ₁₆	230 9 ¹ / ₁₆	240 9 ⁷ / ₁₆	M24 1
	22232	23232	22328	180 7.087	530 20 ⁷ / ₈	190 7 ¹ / ₂	75 3	456 18	444 17 ¹ / ₂	110 4 ¹¹ / ₃₂	355 14	240 9 ⁷ / ₁₆	250 9 ²⁷ / ₃₂	M24 1
24138	22234 22236	23234 23236	22330	190 7.480	560 22 ¹ / ₁₆	210 8 ¹ / ₄	80 3 ⁵ / ₃₂	486 19 ¹ / ₈	474 18 ²¹ / ₃₂	120 4 ²³ / ₃₂	375 14 ³ / ₄	260 10 ¹ / ₄	270 10 ⁵ / ₈	M24 1
24140	22238	23238	22332	210 8.268	610 24	230 9 ¹ / ₁₆	85 3 ¹¹ / ₃₂	517 20 ¹¹ / ₃₂	503 19 ¹³ / ₁₆	130 5 ¹ / ₈	410 16 ⁵ / ₃₂	280 11 ¹ / ₃₂	290 11 ¹³ / ₃₂	M30 1 ¹ / ₄
24144	22240	23240	22334	220 8.661	640 25 ³ / ₁₆	240 9 ⁷ / ₁₆	90 3 ¹⁷ / ₃₂	547 21 ¹⁷ / ₃₂	533 21	140 5 ¹ / ₂	435 17 ⁷ / ₈	290 11 ¹³ / ₃₂	300 11 ¹³ / ₁₆	M30 1 ¹ / ₄
	22244	23244	22338 22340	240 9.449	700 27 ⁹ / ₁₆	260 10 ¹ / ₄	95 3 ³ / ₄	607 23 ²⁹ / ₃₂	593 23 ¹¹ / ₃₂	150 5 ²⁹ / ₃₂	475 18 ²³ / ₃₂	310 12 ⁷ / ₃₂	326 12 ²⁷ / ₃₂	M30 1 ¹ / ₄
	22248	23248		260 10.236	775 30 ¹ / ₂	280 11 ¹ / ₃₂	100 3 ¹⁵ / ₁₆	658 25 ²⁹ / ₃₂	642 25 ⁹ / ₃₂	160 6 ⁵ / ₁₆	515 20 ⁹ / ₃₂	320 12 ¹⁹ / ₃₂	337 13 ³ / ₄	M36 1 ¹ / ₂
	22252		22344	280 11.024	790 31 ¹ / ₈	280 11 ¹ / ₃₂	105 4 ¹ / ₈	678 26 ¹¹ / ₁₆	662 26 ¹ / ₁₆	160 6 ⁵ / ₁₆	550 21 ⁵ / ₈	335 13 ³ / ₁₆	354 13 ¹⁵ / ₁₆	M36 1 ¹ / ₂
24160	22256	23252 23256	22348	300 11.811	830 32 ¹¹ / ₁₆	310 12 ⁷ / ₃₂	110 4 ¹¹ / ₃₂	718 28 ¹ / ₄	702 27 ⁵ / ₈	190 7 ¹ / ₂	590 23 ³ / ₄	350 13 ²⁵ / ₃₂	360 14 ³ / ₁₆	M36 1 ¹ / ₂
	22260	23260	22352	320 12.598	885 34 ²⁷ / ₃₂	330 13	115 4 ¹⁷ / ₃₂	758 29 ²⁷ / ₃₂	742 29 ⁷ / ₃₂	200 7 ⁷ / ₈	630 24 ¹³ / ₁₆	370 14 ⁹ / ₁₆	380 14 ³¹ / ₃₂	M36 1 ¹ / ₂
24168 24172	22264	23264	22356	360 14.173	1000 39 ³ / ₈	370 14 ⁹ / ₁₆	120 4 ²³ / ₃₂	872 34 ¹¹ / ₃₂	848 33 ³ / ₈	230 9 ¹ / ₁₆	705 27 ³ / ₄	410 16 ¹ / ₈	418 16 ⁷ / ₁₆	M45 1 ³ / ₄
	22268 22272	23268 23272	22360	390 15.354	1118 44	394 15 ¹ / ₂	127 5	978 38 ¹ / ₂	952 37 ¹ / ₂	235 9 ¹ / ₄	762 30	457 18	468 18 ⁷ / ₁₆	M50 2
24184	22276 22280	23276 23280		425 16.732	1200 47 ¹ / ₄	420 16 ¹⁷ / ₃₂	127 5	1048 41 ¹ / ₄	1022 40 ¹ / ₄	251 9 ⁷ / ₈	841 33 ³ / ₈	500 19 ¹¹ / ₁₆	510 20 ¹ / ₁₆	M50 2
24192 24196	22284 22288	23284 23288	22376	470 18.504	1454 57 ¹ / ₄	470 18 ¹ / ₂	146 5 ³ / ₄	1257 49 ³ / ₂	1232 48 ¹ / ₂	260 10 ¹ / ₄	940 37	562 22 ¹ / ₈	574 22 ¹⁹ / ₃₂	M56 2 ¹ / ₄
241/500	22292 22296	23292 23296	22380	520 20.472	1530 60 ³ / ₄	520 20 ¹ / ₂	160 6 ⁵ / ₁₆	1314 51 ³ / ₄	1286 50 ⁵ / ₈	270 10 ⁷ / ₈	1030 40 ⁹ / ₁₆	620 24 ¹ / ₁₆	626 24 ⁵ / ₈	M56 2 ¹ / ₄
241/560 241/600	222/500 222/530	232/500 232/530	22392 22396	575 22.638	1676 66	565 22 ¹ / ₄	175 6 ⁷ / ₈	1455 57 ¹ / ₄	1430 56 ⁵ / ₁₆	292 11 ¹ / ₂	1140 44 ³ / ₈	673 26 ¹ / ₂	704 27 ²³ / ₃₂	M64 2 ¹ / ₂
241/630 241/670	222/560 222/600	232/560 232/600	223/500 223/530	625 24.606	1830 72	610 24	185 7 ¹ / ₄	1632 64 ¹ / ₄	1600 63	314 12 ³ / ₈	1245 49	730 28 ³ / ₄	740 29 ⁵ / ₈	M64 2 ¹ / ₂

- This table applies only to SDD series housings
- Bearing series 241.. can be used for direct shaft mount only, without locknut

Special Designs

When the size or application requirements of a bearing housing lie outside the parameter of standard series production, the design concept, the material selection and the manufacturing process require specialized insight and experience. Venturing into new technical territory to solve complex applications is a unique area of expertise for the FAG engineering group.

From meeting special sealing and lubrication requirements to accommodating unique bearing arrangements and mountings, FAG lends its engineering versatility towards functional design innovations that improve long term serviceability and operating costs.



Pillow block housing for wood grinding machinery

Vertically mounted pillow blocks for dryer rolls

Split pillow block for dryer rolls

Schaeffler Canada Inc.

2871 Plymouth Drive
Oakville, ON Canada L6H 5S5
Tel.: (905) 829-2750
Fax: (905) 829-2563

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WL 90 122/3 EC



SuperTac II



The Drop-In Taconite Sealing Solution

FAG



At the Sign of Contamination

The Seal that Delivers

Given the severe service conditions to which FAG pillow blocks are so ideally suited, it is common for the rolling bearings and integral components of the pillow block assembly to be at risk of being adversely affected by environmental contamination. In order to prevent bearing failure due to localized pollutants, FAG has added a new solution to our line of seal design options: the drop-in SuperTac II.

Features

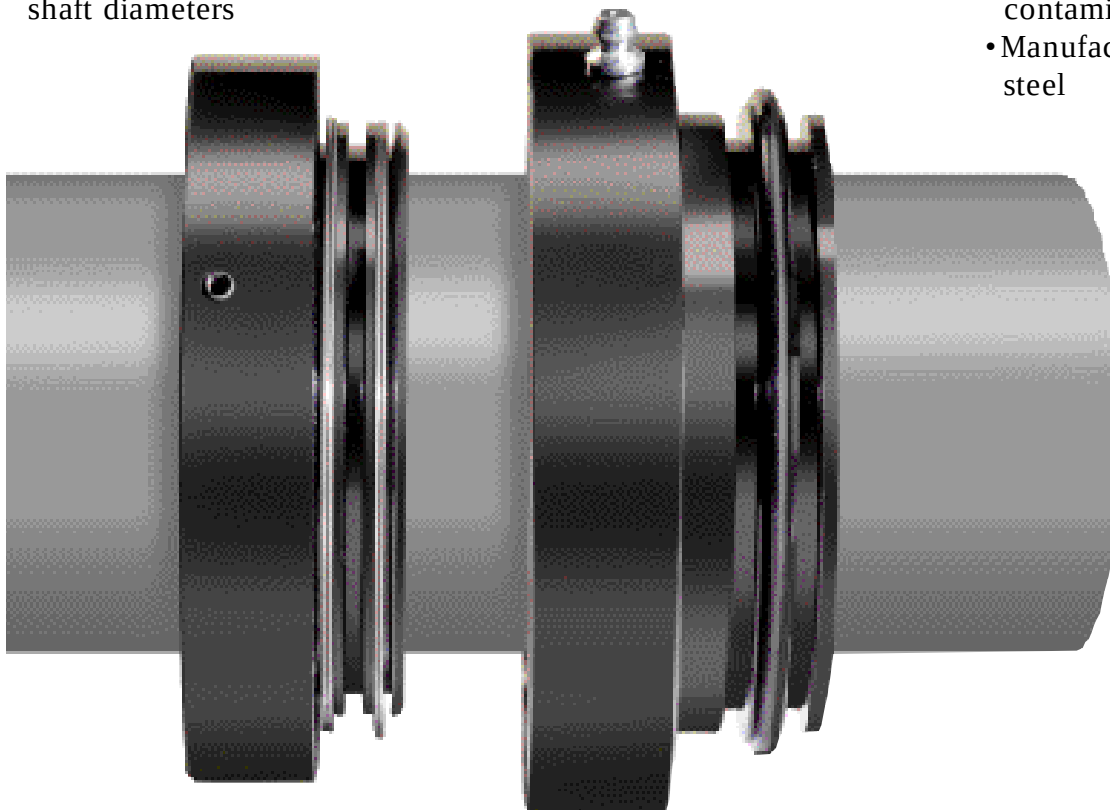
- SuperTac II drops in to fit the seal grooves of FAG series SAF housings, as well as many competitive designs
- Non-contact seal
- Seal flinger equipped with 2 set screws, spaced at 65° interval, for optimum holding power to the shaft
- An O-ring in the flinger bore prevents the ingress of fluids between the seal and the shaft
- Available in a wide range of standard inch and/or metric shaft diameters

Benefits

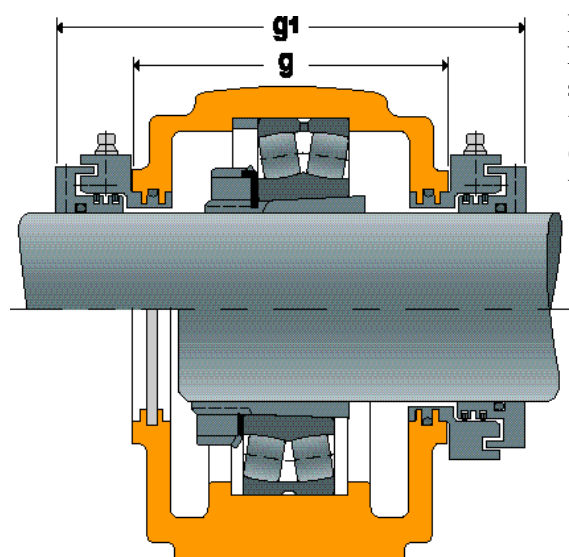
- Promotes extended bearing life
- Drop-in design eliminates the need for special housing features
- Non-contact design eliminates shaft wear common to competitive designs
- Accepts greater misalignments than lip seals
- Exceptional speed characteristics; equivalent to bearing speed limits

Design

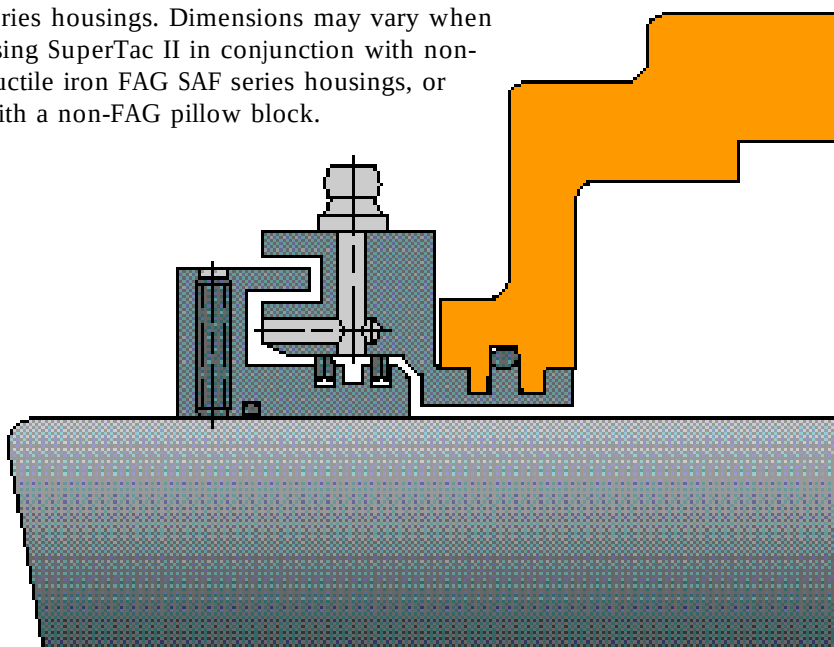
- New and exclusive FAG design for severe service conditions
- Features a grease packed labyrinth formed by high grade spring steel laminar rings
- Rings align into two close running barriers, separated by a lubricant distribution channel
- Complemented by the grease purged axial labyrinth, the result is a seal arrangement that stands virtually impenetrable to external contaminants
- Manufactured from high grade steel
- Supplied with black oxide coating as standard
- Special design option of nickel plating, with chromium nickel steel laminar rings also available



SHAFT DIAMETER INCH/MM	BASIC PILLOW BLOCK NO.	SUPERTAC II SEAL NO.	g INCH/MM	g ₁ INCH/MM	SHAFT DIAMETER INCH/MM	BASIC PILLOW BLOCK NO.	SUPERTAC II SEAL NO.	g INCH/MM	g ₁ INCH/MM
1 ⁷ / ₁₆ 50	SAF509..	TA17 N/A	3.420 87	5.91 150	4 ³ / ₁₆ 110	SAF524..	TA113 N/A	7.125 181	10.314 262
1 ¹¹ / ₁₆ 50	SAF510..	TA20 N/A	3.420 87	5.91 150	4 ⁷ / ₁₆ 115	SAF526..	TA117 TA117M	7.750 197	11.214 285
1 ¹⁵ / ₁₆ 50	SAF511..	TA24 TA24M	3.750 95	6.269 159	4 ¹⁵ / ₁₆ 125	SAF528..	TA122 TA122M	7.375 187	10.818 275
2 ³ / ₁₆ 60	SAF513..	TA29 N/A	4.250 108	6.782 172	5 ³ / ₁₆ 135	SAF530..	TA125 TA125M	8.125 206	11.890 302
2 ⁷ / ₁₆ 65	SAF515..	TA37 N/A	4.625 117	7.367 187	5 ⁷ / ₁₆ 140	SAF532..	TA130 TA130M	8.500 216	12.215 310
2 ¹¹ / ₁₆ 70	SAF516..	TA44 TA44M	4.750 121	7.520 191	5 ¹⁵ / ₁₆ 150	SAF534..	TA140 TA140M	9.250 235	13.150 334
2 ¹⁵ / ₁₆ 75	SAF517..	TA53 TA53M	4.813 122	7.740 197	6 ⁷ / ₁₆ 160	SAF536..	TA148 TA148M	9.625 244	13.720 348
3 ³ / ₁₆ 80	SAF518..	TA188 TA188M	5.500 140	8.138 207	6 ¹⁵ / ₁₆ 170	SAF538..	TA155 TA155M	10.500 267	14.671 373
3 ⁷ / ₁₆ 90	SAF520..	TA102 N/A	5.813 148	9.025 229	7 ³ / ₁₆ 180	SAF540..	TA159 TA159M	11.000 279	15.417 392
3 ¹⁵ / ₁₆ 100	SAF522..	TA109 TA109	6.438 164	9.682 246	7 ¹⁵ / ₁₆ 200	SAF544..	TA167 TA167M	11.750 298	16.265 413



Dimensions “g” and “g₁” as noted apply to FAG SuperTac II seals used in FAG SAF...D series housings. Dimensions may vary when using SuperTac II in conjunction with non-ductile iron FAG SAF series housings, or with a non-FAG pillow block.



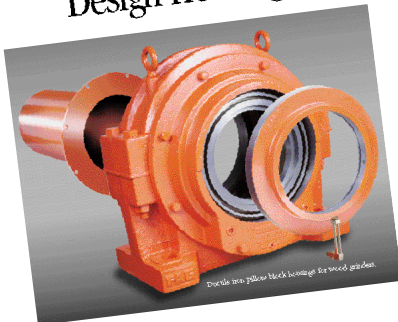
When operating conditions do not allow for compromises, demand the most from your housing selection with FAG ductile iron pillow blocks. FAG offers a full line of general duty housings designed to accept shaft diameters ranging from 1 $\frac{1}{16}$ " to 7 $\frac{15}{16}$ ", machined to fit inch or metric shaft dimensions.

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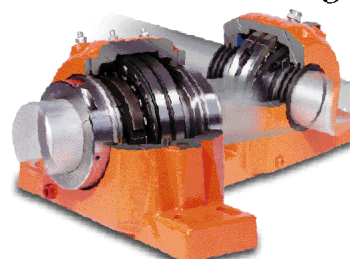
When the size or application requirements of a bearing housing lies beyond standard production, FAG lends its engineering versatility towards functional design innovations that improve long term serviceability and operating costs. Amid a receding list of competitors, FAG is continually breaking new ground with large size and special design housings.

WL 90 123 EC/ED

Large Size and Special Design Housings



Ductile Iron Pillow Block Housings



featuring
SuperTac Seals for Contaminated Environments

FAG

FAG Bearings Corporation

200 Park Avenue

Danbury CT USA 06813-1933

Tel.: (800) 243-2532

Fax: (203) 830-8171

FAG National Sales Division

6255 Cantay Road

Mississauga ON Canada L5R 3Z4

Tel.: (905) 890-9770

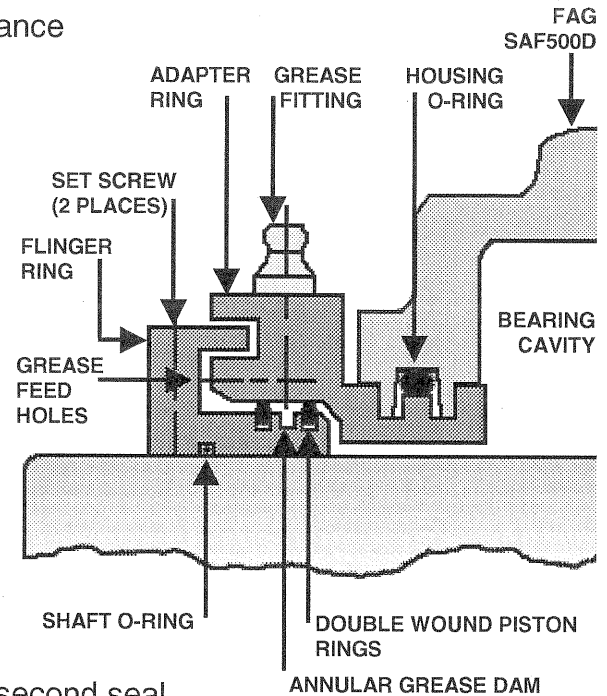
Fax: (905) 890-9779

FAG SUPERTAC II for "SAF" Series Housings

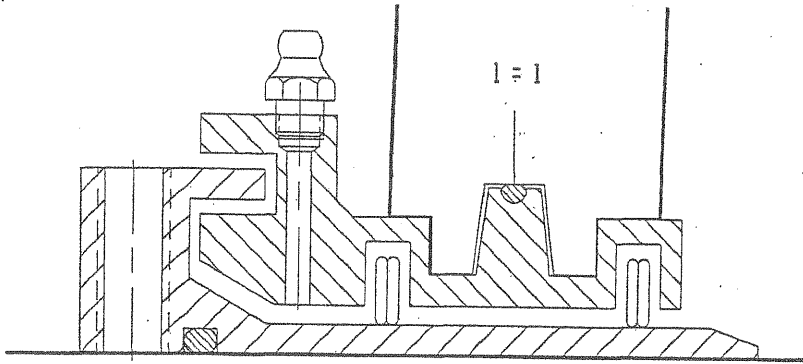
SEAL PREPARATION AND INSTALLATION INSTRUCTIONS

NOTE: Leave all parts in protective wrapping until ready to assemble

1. Separate the flinger from the adapter. Slight resistance is expected due to the inherent spring tension of the piston rings.
2. Pack the groove between the piston ring with the same grease as used for the bearing. It is not necessary to pack the piston-rings themselves with grease.
3. Pack the labyrinth area of the flinger with grease.
4. Place the flinger on the bench with piston rings upward and centred in their grooves. Set the chamfered end of the adapter over the piston rings. With even pressure applied to the adapter ring, the unit will slide together.
5. Repeat packing and assembly instructions for the second seal.
6. Check that the set screws do not protrude into the flinger bore, then slide the inboard seal unit onto the shaft.
NOTE: A lead in chamfer is recommended on the shaft to avoid O-Ring damage.
A small amount of lubricant will also be helpful.
7. Follow installation instructions for the bearing, sleeve and locknut as outlined in the FAG pillow block catalogue.
8. Install the outboard seal onto the shaft and locate both seals in the groove of the housing base. If one end of housing is closed, insert the endcover.
9. Before installing housing cap, adjust the flingers to provide 1/16" axial running clearance and tighten the two set screws in each flinger, then install housing cap. In the case of a floating unit the axial clearance may have to be adjusted.
10. If the grease fitting can be safely accessed during operation, the seal should be purged soon after start-up. Pump grease until purging around the flinger is visible and re-grease as the application schedule requires with the same grease used for the bearing. If the grease fitting cannot be safely reached, purge the seal at the next equipment shutdown.



Head Shaft Bearing Seals



HOUSING C

SDTAR60
SDF60.M280

11.02 [280] DIA

8.27 [210]

FAG BEARINGS LTD NATIONAL SALES DIVISION	UNIT						
	PART				rev	description	date
					PART NO.		
UG11	date	18-NOV-03	checked	approved	SCALE 1:2	DWG. NO. SDTA60.M280	
	name	D. MUNDY					

FAG Supertac II Axial Clearance Setting

"SAF" Housing	Shaft Dia. (ref)	Complete Seal No.	* Flinger Protrusion (mm)
509	1 7/16	TA17	9.5
	40 mm	NA	
510	1 11/16	TA20	9.5
	45 mm	NA	
511	1 15/16	TA24	9.5
	50 mm	TA24M	
513	2 3/16	TA29	9.5
	60 mm	NA	
515	2 7/16	TA37	9.5
	65 mm	NA	
516	2 11/16	TA44	9.5
	70 mm	TA44M	
517	2 15/16	TA53	11.5
	75 mm	TA53M	
518	3 3/16	TA188	11.5
	80 mm	TA188M	
520	3 7/16	TA102	11.5
	90 mm	TA102M	
522	3 15/16	TA109	11.3
	100 mm	TA109	
524	4 3/16	TA113	10.7
	110 mm	NA	
526	4 7/16	TA117	13.5
	115 mm	TA117M	
528	4 15/16	TA122	12.5
	125 mm	TA122M	
530	5 3/16	TA125	13.0
	135 mm	TA125M	
532	5 7/16	TA130	11.6
	140 mm	TA130M	
534	5 15/16	TA140	12.5
	150 mm	TA140M	
536	6 7/16	TA148	13.5
	160 mm	TA148M	
538	6 15/16	TA155	13.0
	170 mm	TA155M	
540	7 3/16	TA159	13.5
	180 mm	TA159M	
544	7 15/16	TA167	13.5
	200 mm	TA167M	

* This is the distance from the adaptor side face to the outboard face of the flinger and may be helpful when positioning the flinger axially.

Mounting and Dismounting of Rolling Bearings

FAG

Rolling Bearings

FAG Industrial Bearings AG

WL 80 100/3 EA



Mounting and Dismounting of Rolling Bearings

Publ. No. WL 80 100/3 EA

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Rolling bearings are heavy-duty machine elements with high-precision components. In order to fully utilize their capacity, the design engineer must select the right bearing type and design and match the bearing properties to those of the mating components. Mounting and dismounting, lubrication, sealing and maintenance must also be given special attention.

Appropriate means for mounting and dismounting of rolling bearings as well as utmost cleanliness and care at the assembly site are necessary in order to enable the bearings to reach a long service life.

This publication is intended to inform bearing servicemen and maintenance men on handling, mounting and dismounting, lubrication and maintenance of rolling bearings. A special chapter deals with bearing failures and their causes. The tables in the annex specify bearing numbers, tolerances of bearings and their mating components, bearing clearance and FAG rolling bearing greases Arcanol.

For information on special mounting and dismounting tools and methods and on measuring instruments, further publications are available. Bearing mounting problems beyond the scope of this publication should be referred to our Engineering Service.

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Chart: Tools and Methods for Mounting and Dismounting

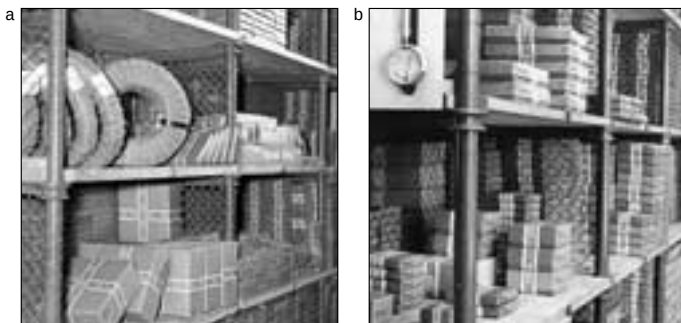
Bearing type			Bearing bore	Bearing size	Mounting				without heating
					with heating				
	Deep groove ball bearing		cylindrical	small					
	Angular contact ball bearing			medium					
	Spindle bearing								
	Four-point bearing			large					
	Self-aligning ball bearing								
	Cylindrical roller bearing		cylindrical	small					
	Needle roller bearing			medium					
				large					
	Thrust ball bearing		cylindrical	small					
	Angular contact thrust ball bearing			medium					
	Cylindrical roller thrust bearing								
	Spherical roller thrust bearing			large					
	Self-aligning ball bearing with adapter sleeve		tapered	small					
	Barrel roller bearing with adapter sleeve			medium					
	Spherical roller bearing with adapter sleeve								
	Spherical roller bearing with withdrawal sleeve			large					
	Adapter sleeve								
	Cylindrical roller bearing, double row		tapered	small					
				medium					
				large					

	Dismounting					Hydraulic method	Symbols
	Hydraulic method	with heating	without heating				
							 Oil bath  Heating plate  Hot air cabinet
		 					 Induction heating device  Induction coil  Heating ring
							 Hammer and mounting sleeve  Mechanical and hydraulic presses  Double hook wrench  Nut and hook wrench
 							 Nut and thrust bolts  Axle cap  Hydraulic nut
				 			 Hammer and metal drift  Extractor  Hydraulic method

1. Rolling Bearing Storage

1: Rolling bearing storage

- a: Large bearings especially should not be stored upright.
- b: They should be stored flat and supported over their entire circumference.



Leave bearings in their original package

Store bearings in their original package in order to protect them against contamination and corrosion. Open package only at the assembly site immediately prior to mounting.

Store larger bearings flat

Larger bearings with relatively thin-walled rings should not be stored upright (Figure 1a) but flat and supported over their whole circumference (Figure 1b).

Prior to packing, FAG rolling bearings are dipped in anticorrosive oil. This oil does not gum and harden and is compatible with all commercial rolling bearing greases. In their original package rolling bearings are safely protected against external influences.

Store bearings in dry rooms

During storage, the bearings must not be exposed to the effects of aggressive media such as gases, mists or aerosols of acids, alkaline solutions or salts. Direct sunlight should be avoided. The formation of condensation water is avoided under the following conditions:

- Temperatures + 6 to + 25 °C,
for a short time 30 °C
- temperature difference day/night ≤ 8 K,
relative air humidity ≤ 65 %.

With standard preservation, bearings can be stored up to 5 years if the said conditions are met.

If the permissible storage period is exceeded, it is recommended to check the bearings for its preservation state and corrosion prior to use. On request, FAG will help to judge the risk of longer storage or use of older bearings.

Bearings with shields or seals on both sides should not be kept to their very limit of storage time. The lubricating greases contained in the bearings may change their chemico-physical behaviour due to aging (see FAG catalogue WL 41 520).

2. How to Prepare Rolling Bearings for Mounting and Dismounting

2.1 Work Planning

Prior to mounting and dismounting of rolling bearings, several preparatory steps should be taken.

Study the shop drawing to familiarize yourself with the design details of the application and the assembly sequence. Phase the individual operations and get reliable information on heating temperatures, mounting and dismounting forces and the amount of grease to be packed into the bearing.

Study shop drawing and phase individual operations

Whenever rolling bearing mounting and dismounting require special measures, the bearing serviceman should be provided with comprehensive instructions on mounting details, including means of transport for the bearing, mounting and dismounting equipment, measuring devices, heating facilities, type and quantity of lubricant.

2.2 The „Right“ Bearing

Prior to mounting, the bearing serviceman must make sure that the bearing number stamped on the package agrees with the designation given on the drawing and in the parts list. He should therefore be familiar with the bearing numbering and identification system (see tables 7.1 and 7.2, pp. 83 to 85).

Compare inscription on package with data on drawing

Standard bearings are identified by the bearing number listed in the pertinent standards and rolling bearing catalogues. Its structure is a system of numerals and letters. The first group in the system identifies the bearing type and diameter series, also the width series for some bearings. The second group constitutes the bore reference number; for bearings of 20 to 480 mm bore, the actual bore diameter in millimetres is five times the bore reference number.

If operating conditions call for a bearing with special design features, the required bearing characteristics are indicated by suffixes added to the bearing number (see table 7.1, p. 83).

Non-standardized FAG bearings are identified by code numbers from the 500 000 or 800 000 series.

Preparations

2.3 Handling of Rolling Bearings before Mounting

FAG rolling bearings are preserved in their original package, with an anticorrosive oil. The oil need not be washed out, when mounting the bearing. In service, the oil combines with the bearing lubricant and provides for sufficient lubrication in the run-in period.

The seats and mating surfaces must be wiped clean of anticorrosive oil before mounting.

Wash out anticorrosive oil with cold-cleaning agent from tapered bearing bores prior to mounting in order to ensure a safe and tight fit on the shaft or sleeve. Then thinly coat the bore with a machine oil of medium viscosity.

Prior to mounting, wash used and contaminated bearings carefully with kerosene or cold-cleaning agent and oil or grease them immediately afterwards.

Do not perform any rework on the bearing. Subsequent drilling of lubrication holes, machining of grooves, flats and the like will disturb the stress distribution in the ring resulting in premature bearing failure. There is also the risk of chips or grit entering the bearing.

Wipe clean seats and mating surfaces of anticorrosive oil

Wash out used and contaminated bearings

Do not rework rings

2.4 Cleanliness in Mounting

Absolute cleanliness is essential! Dirt and humidity are dangerous offenders, since even the smallest particles penetrating into the bearing will damage the rolling surfaces. The work area must, therefore, be dust-free, dry and well removed from machining operations. Avoid cleaning with compressed air.

Ensure cleanliness of shaft, housing and any other mating parts. Castings must be free from sand. Bearing seats on shaft and in housing should be carefully cleaned from anti-rust compounds and residual paint. Turned parts must be free from burrs and sharp edges. After cleaning, the housing bore should receive a protective coating.

Keep work area dust-free and dry

Wipe clean seats and mating surfaces of anticorrosive oil

2.5 Surrounding Parts

All surrounding parts should be carefully checked for dimensional and form accuracy prior to assembly

Check mating parts for dimensional and form accuracy prior to bearing mounting

Non-observance of the tolerances for shaft and housing seat diameters, out-of-roundness of these parts, out-of-square of abutment shoulders etc. impair bearing performance and may lead to premature failure. The responsibility of such faults for bearing failure is not always easy to establish and much time can be lost in looking for the cause of failure.

2.6 Fits

Good bearing performance is largely dependent on adherence to the fits specified for the rings in the drawing (see table 7.3 and 7.4, pp. 86 to 100).

Observe ring fits specified on drawing

No one can give a straight answer to the question of the "right" fit; indeed the selection of fits is determined by the operating conditions of the machine and the design characteristics of the bearing assembly. Basically, both rings should be well supported over their seating areas and should therefore be tight fits. This is, however, not always possible, since it makes mounting and dismounting more difficult and is unfeasible with applications calling for easy axial displacement of one ring, for instance with floating bearings.

The interference produced by tight fits expands the inner ring and contracts the outer ring resulting in a reduction of radial clearance. Therefore, the radial clearance should be adapted to the fits.

The shaft and housing tolerances should be checked. Too loose a fit causes the ring to creep on the shaft which tends to damage both ring and shaft. It also affects the working accuracy of the machine or causes premature raceway fatigue from poor support. On the other hand, too tight a fit may result in detrimental preload and hot running of the bearing.

Check shaft and housing tolerances

As the walls of rolling bearing rings are relatively thin, possible poor geometry of the mating parts is transmitted to the raceways. The seats must therefore be checked for diameter and form tolerances. For cylindrical seats, cylindricity is checked (DIN ISO 1101). For tapered seats, roundness (DIN ISO 1101), taper angle and straightness (DIN 7178) are checked.

Check form tolerance of shaft and housing seats

The seating surfaces of shaft and housing smoothen, when joined, the bearing surfaces usually to a lesser degree. The rougher the surfaces, the more marked is the loss in interference. Therefore, the roughness of the bearing seats (DIN 4768) is also checked.

Check roughness of bearing seats

Preparations

2.7 Inspection of Bearing Seats

For all measurements ensure that the measuring instrument has approximately the same temperature as the parts to be measured.

2.7.1 Cylindrical Seats

Shafts are generally checked with external micrometers (Fig. 2); The measuring accuracy must be checked by calibration.

2: External micrometer for measuring shaft diameters



3: A snap gauge ensures safe positioning and perfect measurement of cylindrical seats. The diameter for setting the gauge is marked on the master ring.



Another useful instrument is the snap gauge shown in fig. 3. It functions as a comparator and its correct setting is checked with master rings. These master rings are supplied by FAG for each diameter.

Bores are checked with internal micrometers (Fig. 4).

Conventional comparative measuring instruments are also used (Figs. 5 to 7).



4: Internal micrometer for bore measurements



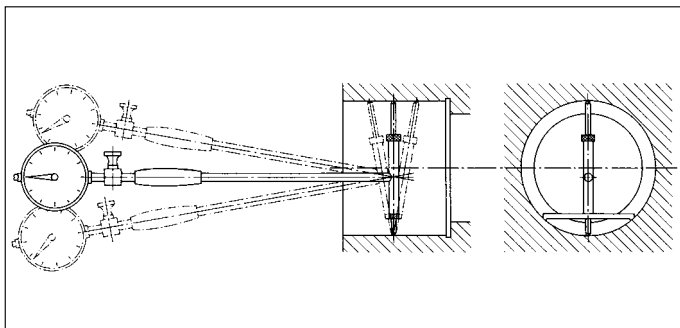
5: Comparative measuring instruments are especially suitable for bore measurements. The master ring is used for setting.

Preparations

6: A housing bore is measured with a bore measuring instrument.



7: Principle of the measurement with a bore measuring instrument (determination of the minimum dimension).

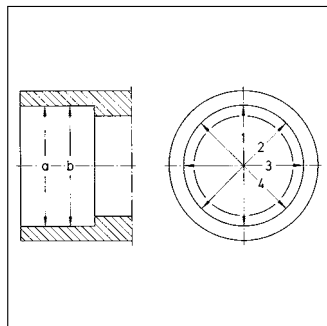
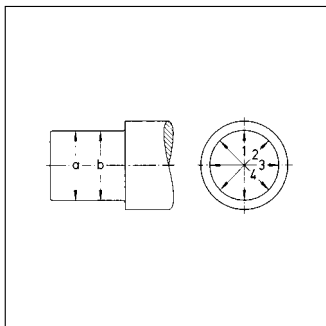


Check diameter and cylindricity of shaft and housing seats

Shaft and housing seats are checked for their diameter and their cylindricity.

Normally, the diameter is measured in two different cross sections and several planes (two-point measurement) (Figs. 8 and 9).

8, 9: Usually the cylindricity of shaft and housing seats is checked by measuring the diameter in two cross sections and several planes (two-point measurement).



Unless otherwise specified in the shop drawing, the cylindricity tolerance should not exceed half the diameter tolerance (two-point measurement).

According to DIN ISO 1101, the cylindricity tolerance refers to the radius. The tolerance values specified according to this standard must therefore be doubled for two-point measurements.

2.7.2 Tapered Seats

Full inner ring support on the shaft requires exact coincidence of shaft taper and inner ring bore taper.

The taper of rolling bearing rings is standardized. For most bearing series it is 1:12, for some large width series 1:30.

The master taper ring (Fig. 10) is the simplest measuring device.

Conformity of shaft and master taper is ascertained by blueing. An inadequate shaft taper must be improved, until the master ring shows full width support. FAG supply master tapers for taper diameters from 25 to 150 mm.

Bearing inner rings should not be used as master rings.

For the exact checking of tapered shaft seats FAG developed the taper measuring instruments MGK 133 and MGK 132. The use of a reference taper or segment enables exact measurement of the bearing seat taper and diameter. Both instruments are easy to handle; the workpiece to be measured need not be removed from the machine.

**Do not use bearing inner rings
as master taper rings
Use FAG taper measuring instru-
ments MGK 133 and MGK 132
for exact checking**



10: Master taper ring for checking small tapered bearing seats

Preparations

11: Taper measuring instrument FAG MGK 133 for tapers with outside diameters of 27 to 205 mm and lengths of less than 80 mm



The taper measuring instrument FAG MGK 133 is provided for tapers of less than 80 mm length (Fig. 11).

Measuring Ranges

Taper measuring instrument	MGK 133A	MGK 133B	MGK 133C	MGK 133D	MGK 133E	MGK 133F	MGK 133G
Taper dia. [mm]	27...47	47...67	67...87	87...115	115...145	145...175	175...205
Taper	Taper 1:12 and 1:30 (other angles on request)						
Min. taper length [mm]	17	21	28	34	42	52	65
Dist. betw. meas. planes [mm]	12	15	20	25	33	45	58



12: Taper measuring instrument FAG MGK 132 for tapers with outside diameters of 90 to 820 mm and lengths of more than 80 mm

The taper measuring instrument FAG MGK 132 is used for tapers of a minimum length of 80 mm and a minimum diameter of 90 mm (Fig. 12).

Measuring Ranges

Taper measuring instrument	MGK 132B	MGK 132C	MGK 132D	MGK 132E	MGK 132F
Taper dia. [mm]	90...210	190...310	290...410	390...510	490...820
Taper	Taper 1:12 and 1:30 (other angles on request)				
Min. taper length [mm]	80	80	110	125	140
Dist. betw. meas. planes [mm]	20	20	25	30	36

3. Rolling Bearing Mounting

The various bearing types and sizes require different mounting methods. Depending on the individual conditions these can be mechanical, hydraulic or thermal.

Do not subject bearing rings to hammer blows

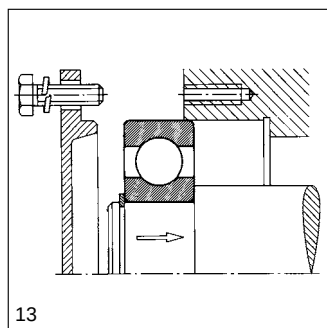
For non-separable bearings apply mounting force directly to the ring to be mounted

As the hardened bearing rings are sensitive to blows, these must never be applied directly to the rings.

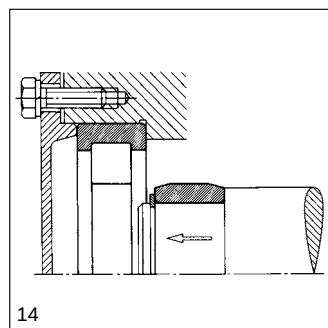
On mounting of non-separable bearings (Fig. 13), the mounting forces must always be applied to the ring which will have the tight fit and therefore is the first to be mounted. Forces applied to the ring with the loose fit would be transmitted by the rolling elements, thus damaging raceways and rolling elements.

Mounting of separable bearings (Fig. 14) is easier, since the two rings can be mounted separately. In order to avoid score marks during assembly, slightly rotate the parts.

13: If a tight fit is required for the inner ring of a non-separable bearing, the bearing will first be mounted on the shaft; then the shaft and bearing assembly is pushed into the housing.



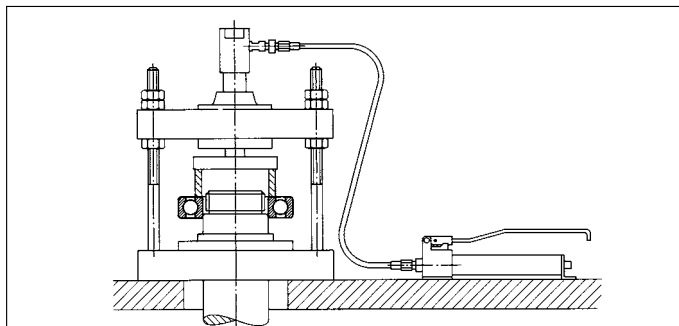
14: With separable bearings the rings can be mounted independently. This is especially advantageous when both rings get a tight fit. In order to avoid score marks, slightly rotate the parts when installing inner ring and shaft into outer ring and housing.



3.1 Mechanical Methods

3.1.1 Mounting of Cylindrical Bore Bearings

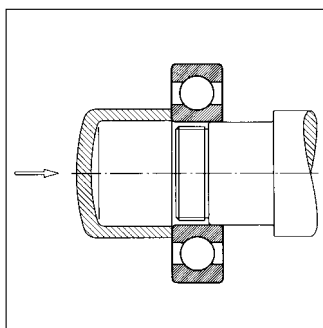
Bearings with a maximum bore of approximately 80 mm can be mounted cold. The use of a mechanical or hydraulic press is recommended (Fig. 15).



15: Bearings with a max. bore of 80 mm can be mounted on the shaft with a hydraulic press.

If no press is available, the bearing can be driven on the shaft by gentle taps with a hammer or mallet. However, a mounting sleeve with a flat face must be used in order to distribute the mounting force evenly over the entire ring circumference and to avoid damage to the bearing (Fig. 16).

The FAG mounting tool sets EINBAU.SET.ALU and EINBAU.SET.ST with perfectly matched precision components are suitable for correct mounting, see TI No. WL 80-49.



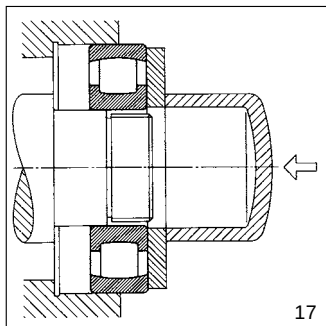
16: If necessary, small bearings can be driven on the shaft with gentle hammer taps, using an appropriate mounting sleeve.

The inside diameter of the sleeve should just be little larger than the bearing bore and, to avoid damage to the cage, its outside diameter should not exceed the inner ring shoulder height.

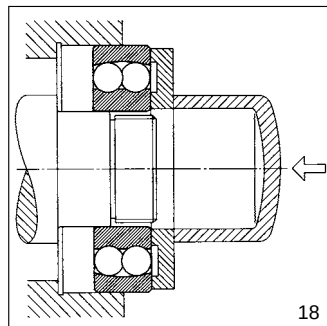
If a self-aligning bearing has to be pressed on the shaft and pushed into the housing at the same time, a disk should be used which bears against both bearing rings, thus avoiding misalignment of the outer ring in the housing (Fig. 17).

Mounting

17: Simultaneous shaft and housing assembly of a bearing with the aid of a mounting disk.



18: For some self-aligning ball bearings, the mounting disk must be relieved.



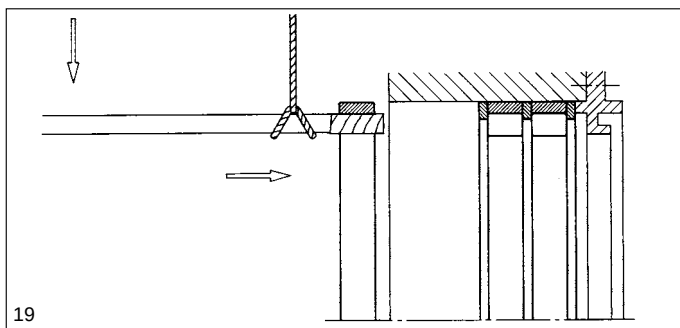
Heat also small bearings to achieve heavy interference fits

In some self-aligning ball bearings, the balls protrude beyond the rings. In such cases, the disk must be relieved (Fig. 18).

If very tight fits are required, even small bearings should be heated for mounting, chapter 3.2.

With light metal housings the seating areas might be damaged by press-fitting the outer ring in the housing bore. In such cases, the housing should be heated or the bearing cooled.

19: The outer rings of large cylindrical roller bearings are positioned by means of a mounting lever.



Heavy bearing outer rings with sliding fit can be mounted with a mounting lever (Fig. 19).

In order to avoid damage to the raceway and roller surfaces the end of the mounting lever should be wrapped with cloths (do not use cotton waste).

Mounting of Needle Roller Bearings

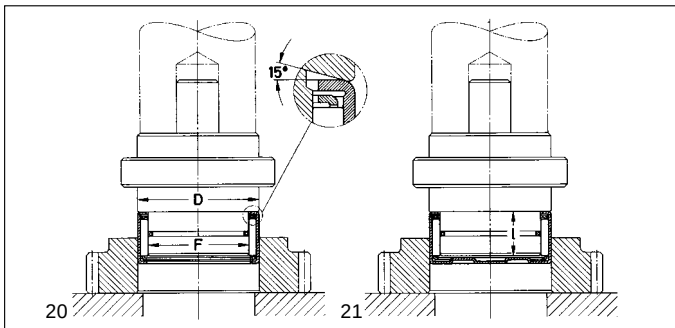
Needle Roller Bearings with Machined Rings

The same mounting principles apply to needle roller bearings as to cylindrical roller bearings. Bearings mounted in groups must have the same radial clearance to ensure uniform load distribution.

Drawn Cup Needle Roller Bearings

Due to their thin outer rings the form accuracy for the drawn cup needle roller bearings is achieved by means of tight fits in the housing, making a lateral location unnecessary.

For mounting drawn cup needle roller bearings, special mounting mandrels are used. Usually the mandrel abuts the stamped bearing face which is hardened with smaller sizes. If the mounting mandrel is accurately dimensioned, it can be applied to an unhardened lip without deforming or jamming the needle roller and cage assembly (Figs. 20 and 21).



Drawn cup needle roller bearings are pressed into the housing with a mounting mandrel.

20: Drawn cup needle roller bearing, open ends

21: Drawn cup needle roller bearing, closed end

Needle Roller and Cage Assemblies

Needle roller and cage assemblies are mounted between shaft and housing. In order to avoid score marks on the raceways and needle rollers, the needle roller and cage assemblies should be slightly turned and remain unloaded on mounting.

Needle roller and cage assemblies can be axially guided in the housing or on the shaft (Fig. 22).

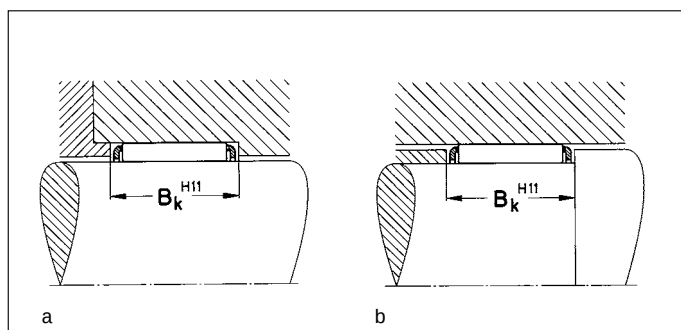
The distance between the lateral cage guiding surfaces must be large enough (tolerance H11) to prevent the needle roller and cage assembly from jamming.

The radial clearance of needle roller and cage assemblies depends on the machining tolerances of the hardened and ground raceways on the shaft and in the housing. Needle roller and cage assemblies mounted in groups must be fitted with needle rollers of the same tolerance group.

22: Needle roller and cage assemblies can be guided in the housing or on the shaft.

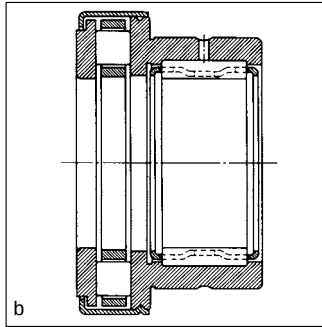
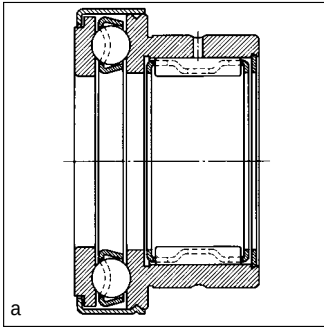
a: Guidance in the housing

b: Guidance on the shaft



Combined Needle Roller Bearings

The tight fits for the combined needle roller bearings require relatively high mounting forces. This must be borne in mind especially for needle roller-thrust ball bearings and needle roller-cylindrical roller thrust bearings with dust shield, where the ball or roller assembly of the thrust bearing is non-separable. It is advantageous to heat the housings for pressing-in these bearings.



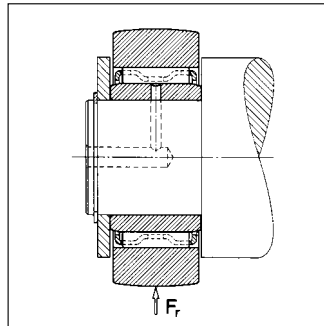
23: Combined needle roller - thrust ball bearings and needle roller - cylindrical roller thrust bearings with dust shield must be pressed into the housing.

a: Needle roller - thrust ball bearing

b: Needle roller - cylindrical roller thrust bearing

Yoke Type Track Rollers

Since, in most cases, the inner ring of yoke type track rollers is subjected to point load, a tight fit on the shaft is not required. On mounting, ensure that the lubricating hole is located in the unloaded zone of the raceway. The outer ring of yoke type track rollers without axial guidance must be guided by lateral backing surfaces.



24: On mounting yoke type track rollers, the lubricating hole must be located in the unloaded zone of the raceway. The outer rings of yoke type track rollers without axial guidance must be guided by lateral backing surfaces.

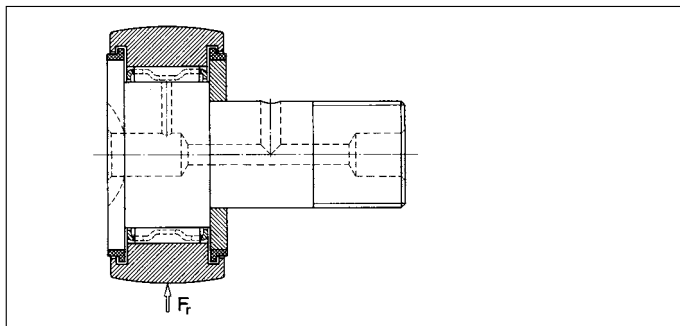
Stud Type Track Rollers

On mounting stud type track rollers, the radial lubricating hole should be located in the unloaded zone of the raceway.

On mounting a stud type track roller in the through-hole of a machine frame, the stud must usually be secured against rotating when tightening the nut. This is enabled by a slot at the flanged end of the stud (Fig. 25).

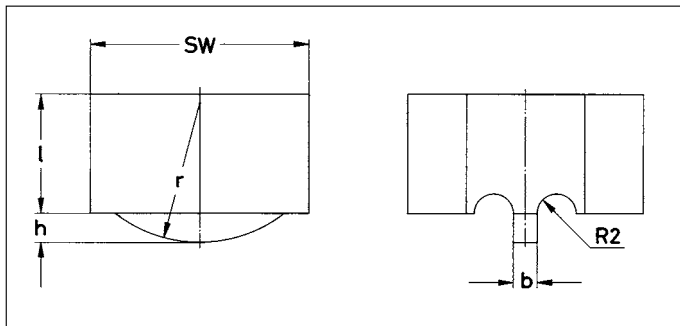
Mounting

25: Rotation of the stud during tightening of a stud type track roller is prevented by the slot at the flanged end of the stud.



When a stud type track roller is screwed into a blind hole, the tightening torque must be applied through the slot. For this purpose, an appropriate tool is required (Fig. 26). About 75% of the tightening torques listed in the catalogues can be safely applied with these tools.

26: The stud of a stud type track roller can be screwed into a blind hole with special tools.



3.1.2 Mounting of Tapered Bore Bearings

Bearings with tapered bore are either fitted directly on the tapered shaft journal or, if the shaft is cylindrical, on an adapter sleeve or a withdrawal sleeve.

Apply just a thin oil film to washed out bearing bore and seats on shaft and sleeve

The oil film applied to the washed out bearing bore, shaft and sleeve should be very thin. A heavier coating would reduce friction and thus ease mounting; however, in operation the lubricant would be gradually forced out from the joint with a slackening effect on the tight fit, causing the ring or sleeve to creep and corrosion to develop on the surfaces.

Forcing the bearing onto the tapered seat expands the inner ring and reduces radial clearance. Therefore the reduction in radial clearance can be used as a measure of the seating condition of the inner ring.

The reduction in radial clearance is the difference between the radial clearance prior to mounting and the radial clearance after bearing mounting. It is necessary to determine the initial radial clearance before mounting and then to check the clearance repeatedly during mounting until the proper amount of reduction and thus the required tight fit are obtained.

Instead of measuring the reduction in radial clearance the distance the bearing is forced onto the tapered seat can be measured. For the standard inner ring bore taper of 1:12 the ratio of axial drive-up to radial clearance reduction is approximately 15:1. This ratio considers the fact that the expansion of the inner ring is more than 75 to 80% of the amount of interference existing between the fitted parts.

If, with small bearings, the exact axial drive-up cannot be measured, the bearing should be mounted outside the housing. The bearing should be driven up the tapered seat just enough to still turn smoothly and to allow the outer ring to be easily swivelled by hand. The serviceman must have a "touch" for the smooth running feature.

The radial clearance reduction, the axial drive-up distance or the expansion should also be measured, when a bearing is being refitted.

Special attention should be given to the locknut, the position of which may have changed due to the broaching effect in the seating areas and the settling of the threads. The values for the recommended reduction of radial clearance are listed in the appendix (tables 7.21 and 7.22, pp. 111 and 112).

The radial clearance is measured with feeler gauges (Fig. 27).

In case of spherical roller bearings, the clearance must be measured simultaneously over both rows of rollers (Fig. 28). Identity of clearance values, such as measured over both rows of rollers, ensures that there is no lateral offset of the inner ring relative to the outer ring. Aligning of the ring faces alone is, because of the width tolerances of the rings, no guarantee against such an offset position.

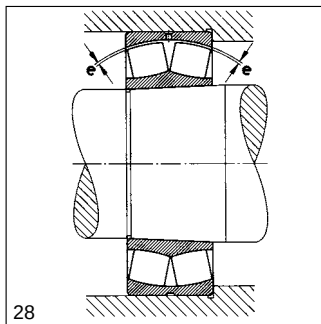
Check radial clearance reduction, drive-up distance or expansion

Check radial clearance reduction, drive-up distance or expansion also during reassembly

Check radial clearance with feeler gauges



27



28

27: measuring radial clearance with feeler gauges before mounting

28: For spherical roller bearings, the radial clearance must be measured simultaneously over both rows of rollers.

Mounting

Check inner ring expansion of separable bearings

Cylindrical roller bearings offer the advantage of separate installation of inner and outer rings; the inner ring expansion can be measured - by means of an external micrometer - instead of the reduction of radial clearance (Fig. 29).

29: Measuring the expansion of a cylindrical roller bearing inner ring with an external micrometer



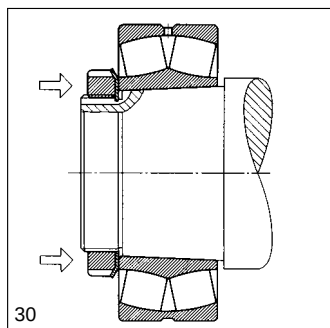
Mechanical and hydraulic equipment is available to pressfit the bearing on its tapered seat or to press a sleeve in place. Which method is the best to a given application depends on the mounting conditions.

Mount small bearings with shaft nut and hook spanner

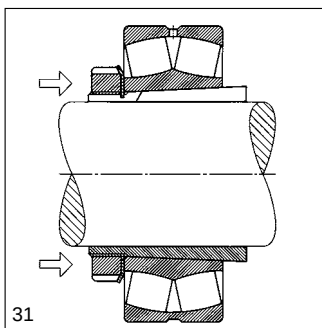
Press fit small and medium-size bearings with shaft nut on the tapered seat (Fig. 30). Tighten nut with hook spanner.

The adapter sleeve nut and hook spanner are used for driving small bearings onto the tapered seat of the sleeve (Fig. 31).

Shaft nuts are also used to press small withdrawal sleeves into the space between shaft and bearing inner ring (Fig. 32).



30: Press-fitting a spherical roller bearing with a shaft nut

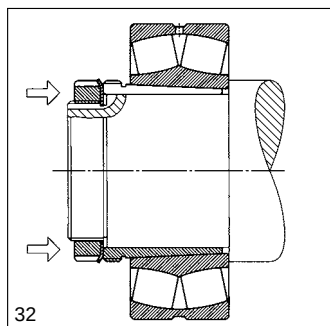


31: Press-fitting an adapter sleeve mounted spherical roller bearing with the adapter sleeve nut

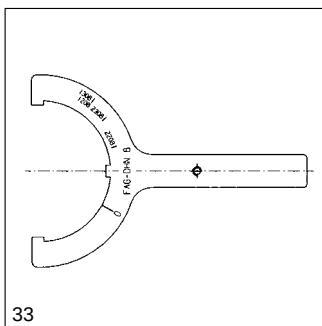
Double hook spanners

The double hook spanner sets FAG 173556 and 173557 are used for mounting self-aligning ball bearings onto adapter sleeves. Both sets include torque wrenches for more exactly determining the starting position before the bearing is driven onto the shaft.

On every double hook spanner there are rotation angles engraved for the self-aligning ball bearings that have to be mounted by means of these spanners so that the drive-up distance and radial clearance reduction can be adjusted accurately (Fig. 33).



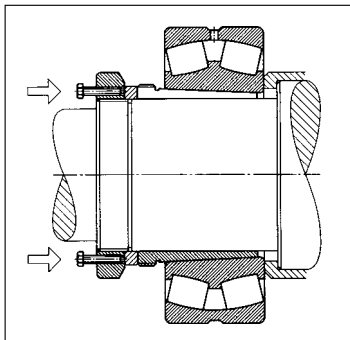
32: Press-fitting a withdrawal sleeve with the shaft nut



33: Double hook spanner with engraved rotation angles for fitting self-aligning ball bearings

Mounting

34: Mounting nuts with thrust bolts facilitate mounting of large withdrawal sleeves. Between nut and sleeve a ring is inserted.



For larger bearings, considerable forces are required to tighten the nut. In such cases, the mounting nut with thrust bolts shown in Fig. 34 facilitates mounting.

To avoid tilting of the bearing or sleeve, the mounting nut should just be tightened enough to make nut and ring bear flush against their mating part. Then the thrust bolts of hardened steel, evenly spaced around the circumference of the nut, - their number depending on the forces required - are diagonally tightened, until the required reduction in radial clearance is obtained.

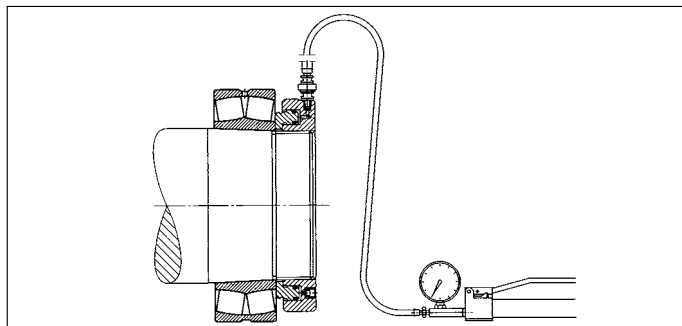
As the taper connection is self-locking, the mounting nut can then be removed and be replaced by the locknut. The procedure can also be applied to bearings mounted on an adapter sleeve or directly on the tapered journal.

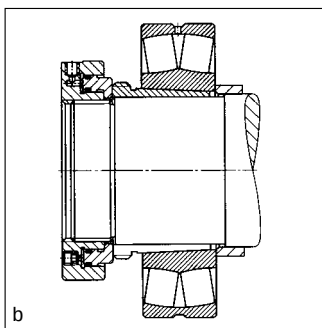
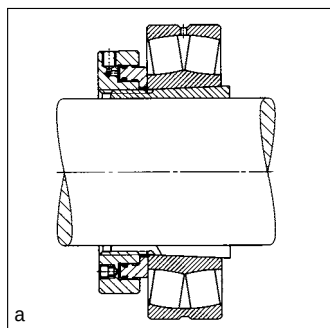
Use FAG hydraulic nuts for mounting of larger bearings

When mounting larger bearings, it may be advisable to use a hydraulic press. Figs. 35 and 36 show how a spherical roller bearing is being press-fitted with the aid of a hydraulic nut ¹⁾. Hydraulic nuts are available for all regular sleeve and shaft threads. The hydraulic pro-

¹⁾ See „FAG Hydraulic Nuts“, Publ. No. WL 80 103 for nomenclature and dimensions.

35: Hydraulic nut for mounting tapered bore bearings on a tapered shaft





36: Mounting of a spherical roller bearing with an annular piston press.

a: Mounting on an adapter sleeve

b: Press fitting of a withdrawal sleeve

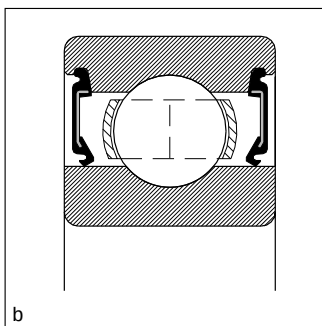
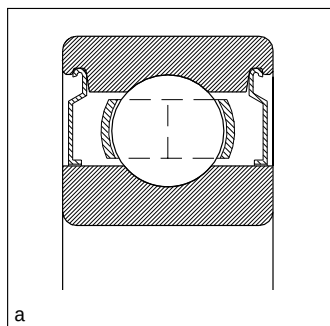
cedure described in chapters 3.3 and 4.3 is another valuable mounting and particularly dismantling aid.

3.2 Thermal Methods

If tight fits are specified for the inner rings on cylindrical shaft seats, the bearings are heated for mounting. Sufficient expansion is obtained when heated between 80 and 100°C. Accurate temperature control is essential in heating the bearings. If the temperature exceeds 120°C there is the risk of alteration of bearing grain structure resulting in a drop of hardness and dimensional instability.

For bearings with moulded cages of glass fibre reinforced polyamide the same temperature limits are valid as for the other rolling bearings.

Bearings with shields (Fig. 37a) and with seals (Fig. 37b) are packed with grease during manufacture. They can be heated up to 80°C maximum, but never in an oil bath.



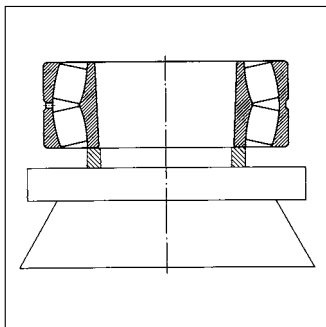
37: Never heat bearings with shields or seals in an oil bath. The maximum heating temperature is 80°C.

a: Bearing with shields

b: Bearing with seals

Mounting

38: A ring is inserted between a heating plate without thermostatic control and the inner ring of an E spherical roller bearing with polyamide cage.



3.2.1 Heating Plate

Provisionally, rolling bearings can be heated on a heating plate which should be thermostatically controlled. Turn the bearing over several times in order to ensure uniform heating.

If the temperature of a heating plate without thermostatic control exceeds 120°C, polyamide cages must not contact the heating plate. This can be avoided by inserting a ring between the plate and the bearing inner ring (Fig. 38).

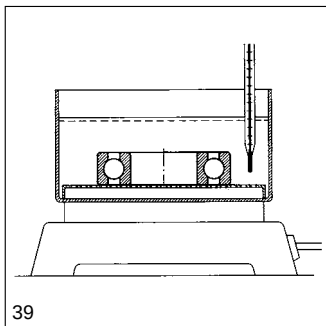
3.2.2 Oil Bath

For uniform heating, rolling bearings are generally immersed in an oil bath which is thermostatically controlled to a temperature of 80 to 100°C. The bearing should not be in direct contact with the heat source. The best arrangement is to have a screen several inches off the bottom of the oil tank which will prevent uneven heating of the bearing and protect it from contaminants settling on the tank bottom (Fig. 39).

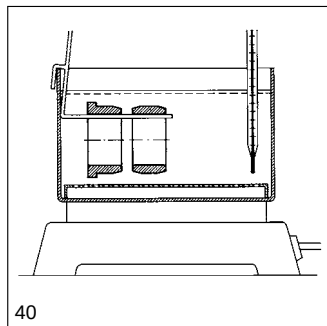
The bearings may also be suspended in the oil bath (Fig. 40). After heating, any oil adhering to the bearing should be well drained off and the fitting surfaces should be carefully wiped clean.

39, 40: Heating in an oil bath ensures uniform heating of the bearings: A temperature of 80 to 100°C can be easily controlled. Disadvantage: Risk of contamination.

39: Heating a deep groove ball bearing in an oil bath



40: Heating cylindrical roller bearing inner rings in oil bath



Mounting of heated rings or bearings requires some skill (Fig. 41). The parts should be rapidly pushed on the shaft and positioned squarely against the shoulder. A slight twisting motion during fitting facilitates the work. It is advisable to use heat-protective gloves or non-fraying cloths, but never cotton waste.

Larger bearings are generally transported with a crane. In this case the bearing is suspended in mounting grippers (Fig. 42) or in a rope sling. Working with the rope sling is not easy. Ensure alignment of ring and shaft in order to prevent tilting.

Heat larger bearings for mounting

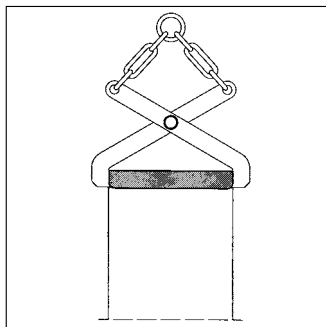
Do not use cotton waste in mounting work



41: Heated bearing parts are rapidly pushed on the shaft and positioned squarely against the shoulder. This is facilitated by a slight twisting motion.

Mounting

42: Mounting grippers



Provide for immediate axial location of mounted ring

When positioning, the inner ring should be immediately held tight against the shaft shoulder, until it has cooled down to avoid any clearance between ring face and shoulder after cooling. This also applies to a pair of rings mounted side by side.

3.2.3 Hot Air Cabinet

A safe and clean method of heating rolling bearings is by use of a hot air cabinet. Thermostat regulation enables accurate temperature control. Careful operation excludes contamination of the bearings. However, heating the bearings in hot air takes considerable time, therefore adequately dimensioned hot air cabinets should be provided for batch mounting.

3.2.4 Induction Heating Device

Rolling bearings are brought up to mounting temperature in a fast, secure and clean manner with induction heating devices, which operate on the transformer principle. The devices are used above all for batch mounting.

With the six FAG induction heating devices any rolling bearing types including greased and sealed bearings are heated. The smallest device AWG.MINI is used for bearings with 20 mm bores upwards. The maximum bearing mass is about 20 kg. The field of application of the largest device AWG40 starts at 85 mm bores. The maximum bearing mass may amount to approximately 800 kg.

See FAG TI No. WL 80-47 for description.



43,44: The induction heating devices ensure fast, clean and secure heating up to mounting temperature.

43: FAG AWG3,5



44: FAG AWG13

45: Induction coil for 380 V with bearing inner ring



3.2.5 Induction Coil*)

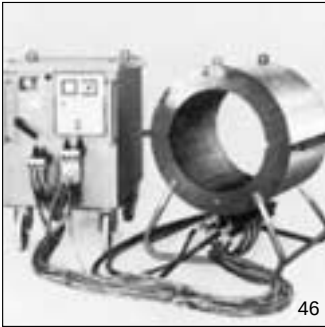
Induction coils heat the inner rings of cylindrical roller and needle roller bearings of 100 mm bore onward.

The induction coils shown in this chapter can be used for both mounting and dismounting. They are, however, mainly used for ring withdrawal (chapter 4.2.2). Since heating for dismounting tight-fitted inner rings is very fast, the amount of heat transferred to the shaft is minimized so that the rings such as axle box roller bearings in rail vehicles, or for frequent dismounting and remounting of large-size bearings, as is the case for roll exchange in rolling mills.

FAG induction coils can be connected between two phases to the common three-phase current mains (50 or 60 Hz). For heating inner rings of a bore up to approximately 200 mm, coils are used which are connected directly to the 380 V mains (Fig. 45). For larger bearings the harmless low voltage equipment with 20 to 40 V at 50 Hz (60 Hz) should be used.

Low voltage induction coils are connected to the mains (380 V) via transformer (Fig. 46). The water-cooled winding provides for a better efficiency, easier handling and lower weight of the device.

*) For details see Publ. No. WL 80107 EA "FAG Induction Heating Equipment".



46: Low-voltage induction coil with transformer EFB 125/1, for cylindrical roller bearing inner rings of 635 mm bore
Ring weight: 390 kg
Approx. coil weight: 70 kg



47: Demagnetization of the inner ring of a cylindrical roller bearing by means of the induction coil

When the induction coils are used for mounting work, ensure that the rings are not overheated. The heatup times are indicated in the operating instructions.

The operating instructions also describe the use of the coil for demagnetization of the bearing rings upon completion of induction heating (Fig. 47).

See operating instructions for heatup times

3.2.6 Cooling

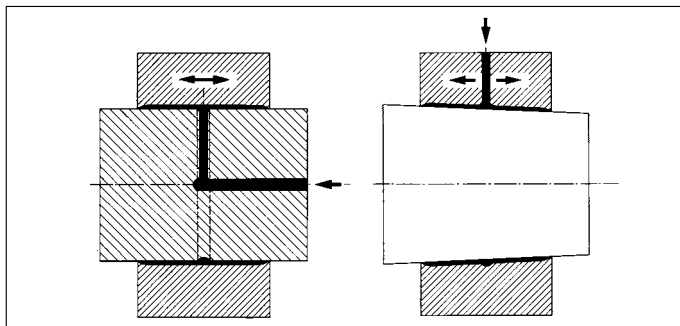
For a tight fit of the outer ring, the housing is heated in most cases to mounting temperature. With large and bulky housings, this may cause problems. In this case, the rolling bearing is cooled in a mixture of dry ice and alcohol. The temperature should not drop below -50°C .

The condensation water resulting from temperature equalization must be completely rinsed out of the bearing with oil in order to prevent corrosion.

Never cool bearings below -50°C

Mounting

48: Principle of hydraulic mounting; fluid film buildup between the mating surfaces.



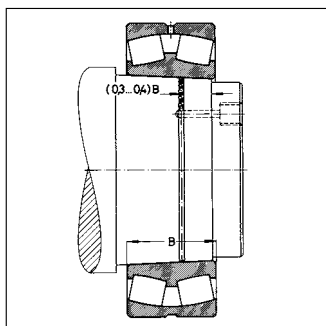
3.3 Hydraulic Method

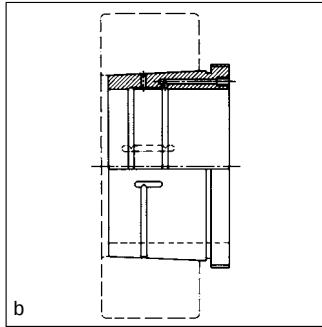
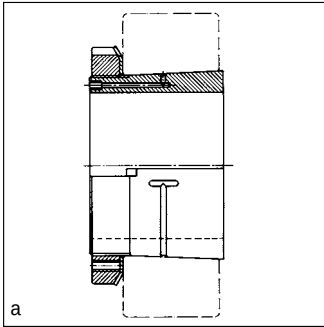
With the hydraulic method, oil is injected between the mating surfaces. This may be machine oil, or oil containing rust dissolving additives. The oil film greatly reduces the friction between the mating parts which can then be easily displaced in relation to one another without the risk of surface damage. Fretting corrosion can be dissolved by means of kerosene or rust-dissolving additives to the oil.

Tapered bore bearings can be mounted on, and dismantled from, their tapered counterpart by the hydraulic method. Cylindrical bore bearings or sleeves are heated for mounting, whilst dismantling is performed hydraulically. For oil injection, oil grooves, feed channels and threaded connections for the pump are machined into shaft or the sleeve (Figs. 49, 50). See FAG publication WL 80 102 EA "How to Mount and Dismount Rolling Bearings Hydraulically" for technical details.

Hydraulic mounting of tapered bore bearings which are directly fitted on the tapered shaft end, requires but a small amount of oil. Simple, low feed injectors are therefore satisfactory (Fig. 51). FAG supply two sizes of oil injectors with connecting threads G 3/8 and G 3/4. The smaller oil injector is good for shaft diameters up to 80 mm, the larger for diameter up to 150 mm.

49: Position of the oil groove for a tapered bore bearing

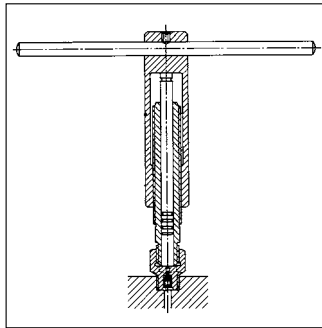




50: Larger adapter and withdrawal sleeves feature oil grooves and oil collecting grooves.

a: Adapter sleeve, design HG

b: Withdrawal sleeve, design H



51: Oil injector and valve nipple for connecting thread G 3/8:

Injector: FAG No. 107640

Nipple: FAG No. 107642

for connecting thread G 3/4:

Injector: FAG No. 107641

Nipple: FAG No. 107643

It is different with cylindrical bore bearings and with adapter and withdrawal sleeves. Here, the oil loss occurring at the edges of the mating surfaces must be compensated by a higher rate of oil feed. This is achieved by an oil pump (Figs. 52 to 54), see FAG TI No. WL 80-46.

The fluid used is a machine oil of medium viscosity. Mounting work should be performed with an oil having a viscosity of about $75 \text{ mm}^2/\text{s}$ at 20°C (nominal viscosity $32 \text{ mm}^2/\text{s}$ at 40°C).



52: FAG Hand pump set PUMPE1000.4L, consisting of a two-step piston pump (1000 bar) with 4-litre oil container, manometer, 1 HP tube, plug-in joint (connecting thread G 1/4), metal box

Mounting

53: FAG Hand pump set PUMPE1600.4L, consisting of a two-step piston pump (1600 bar) with 4-litre oil container, manometer, 1 HP tube, plug-in joint (connecting thread G 1/4), metal box



54: FAG Hand pump set PUMPE2500.8L.V, consisting of a two-step piston pump (2500 bar) with 8-litre oil container, two-way-valve, manometer, 2 HP tubes, 2 closing nipples G 1/4, 2 adapters and 6 reduction adapters, metal box

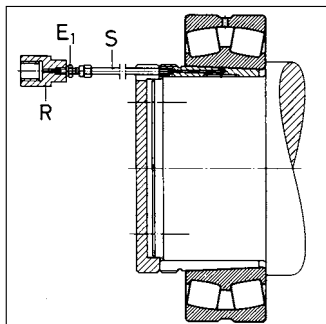


Use shaft nut, thrust bolts or FAG hydraulic nut for mounting

Mounting of Tapered Bore Bearings

The bearing is pressed into position by a shaft nut, thrust bolts or the FAG hydraulic nut (see Fig. 35). Hydraulic withdrawal sleeves and adapter sleeves are provided with threaded oil bore connections M6, M8, G 1/8, G 1/4, depending on sleeve size (see FAG catalogue WL 41 520). The pumps shown in Figs. 52 to 54 feature an extreme pressure hose and are connected to the sleeve by reducing socket R, ERMETO tube E1 and steel pipe S (Fig. 55).

55: Hydraulic connection of a withdrawal sleeve





56: Mounting of a tapered bore spherical roller bearing by the hydraulic method

For mounting, oil is pumped between the mating surfaces. The axial forces required for mounting are applied through six or eight bolts located in the shaft nut or the adapter sleeve nut (Figs. 56 to 59).

A spacer between the bolts and the sleeve or bearing ring prevents damage to the latter. When pressing in a withdrawal sleeve as shown in Fig. 58, the pipe for the hydraulic fluid passes through the shaft nut. The amount of axial drive-up of the bearing or the withdrawal sleeve depends on the required reduction of radial clearance (tables 7.21 and 7.22, pages 111 and 112). The bearing must not, of course, be under oil pressure, when the radial clearance is being measured.

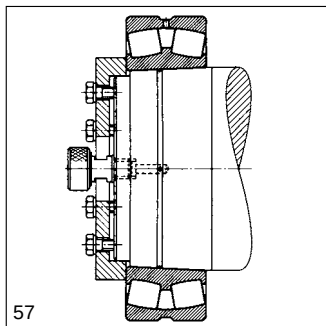
After relieving the oil pressure, the bearing is still kept under axial preload. Wait for 10 to 30 minutes, until oil has completely drained off from the fitting surfaces. As a final step, the mounting device (nut with thrust bolts or hydraulic nut) is removed and the shaft or sleeve nut put in place and locked.

Relieve bearing of oil pressure prior to measuring radial clearance

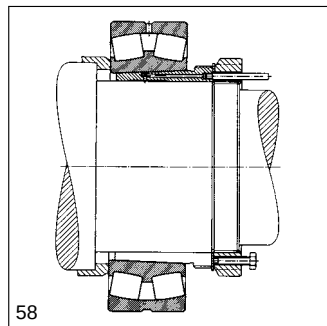
Keep bearing under axial preload for 10 to 30 minutes after relief of the oil pressure

Mounting

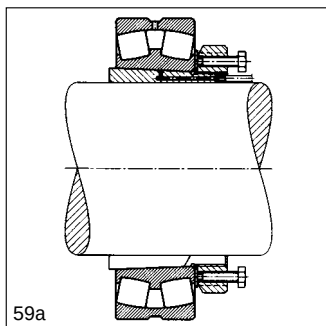
57: Bearing seated on shaft: The oil is pumped between the mating surfaces; at the same time pressure from bolts or a nut drives the bearing up the tapered journal. The reduction in radial clearance or the axial drive-up distance is measured.



58: Bearing seated on withdrawal sleeve: The oil is pumped between the mating surfaces. The sleeve is pressed into the bearing bore with bolts and the reduction in radial clearance is measured.

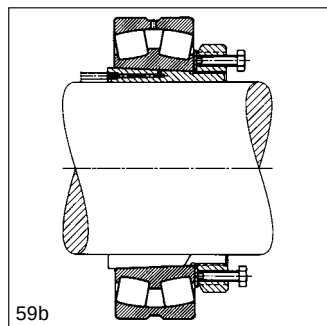


59: Bearing seated on adapter sleeve: The oil is pumped between the mating surfaces. Bolts drive the bearing up the sleeve and the radial clearance reduction is measured.



a: Oil bore in small end of sleeve

b: Oil bore in large end of sleeve



3.4 Clearance Adjustment on Mounting

3.4.1 Angular Contact Ball Bearings and Tapered Roller Bearings

Angular contact ball bearings and tapered roller bearings are always mounted in pairs. The axial and radial clearance of two bearings mounted in opposition is adjusted on mounting, the clearance or preload depending on the operating conditions. Angular contact ball bearings of universal design can be mounted in pairs or groups in any arrangement.

High loads and high speeds cause a temperature rise at the bearing location. This leads to thermal expansion and clearance variation. The type of clearance variation, i. e. an increase or a decrease, depends on arrangement and size of the bearings, the shaft and housing material and on bearing centre distance.

If close shaft guidance is required, the clearance is adjusted by stages. Each adjustment should be followed by a trial run and a temperature check. Thus, it is ensured that the clearance does not become too small, resulting in a higher running temperature.

A welcome effect of trial runs is that the whole bearing mounting "settles" and that, afterwards, the clearance practically remains stable (see also page 51).

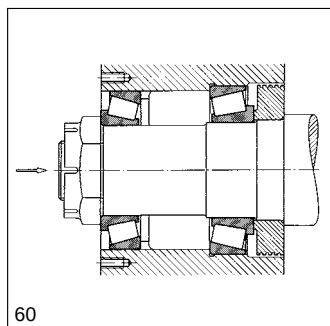
A high speeds, adjust axial clearance by stages

The right temperature for a bearing, operating in the medium to high speed range under medium load, can, indicatively, be defined as follows: In the absence of extraneous heat, a correctly adjusted bearing is allowed to attain, during the trial runs, a temperature of about 60 to 70°C. After 2 or 3 hours running, this temperature should, however, drop, especially when in the case of grease lubrication, the churning action diminishes, after the excess grease is expelled from the bearing interior.

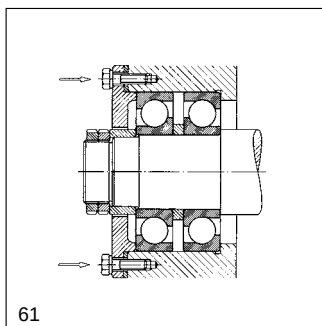
Bearings exposed to vibration at low speeds are mounted with zero clearance or even preloaded to avoid the risk of the balls or rollers brinnelling the raceways. Angular contact ball bearings and tapered roller bearings are adjusted against one another by nuts on the shaft (Fig. 60), by shims (Fig. 61) or threaded rings in the housing.

Provide for zero-clearance or preload of a bearing exposed to vibration at low speeds

Axial clearance or preload of adjustable bearings is established by loosening or tightening the adjusting nut or by the insertion of calibrated shims. From the thread pitch, axial clearance and preload can be converted into turns of the adjusting nut.



60



61

60: Adjustment of tapered roller bearings of a loose wheel with the shaft nut

61: Axial location of paired angular contact ball bearings; clearance adjustment with shim

Mounting

The changeover from clearance to preload during adjustment is found by constant manual rotation of the shaft. Simultaneously, a dial gauge is applied to check the axial freedom of the shaft.

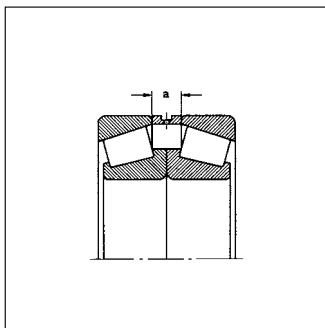
Adjust with torque wrench

A simpler method for correct bearing adjustment is the use of a torque wrench. The adjusting nut is tightened to the appropriate torque (e. g. for passenger car front wheel bearings 30 or 50 Nm. The right torque is determined in tests; the values are specified in the repair instructions).

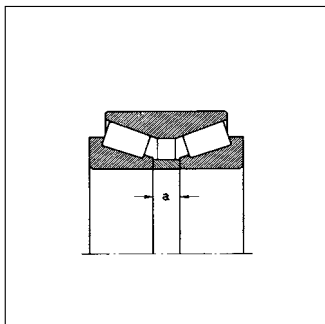
Loosening of the nut by approximately 1/12th of a turn provides for the required clearance. In tapered roller bearings, the rollers should bear against the cone back face rib during assembly. If the rollers were to contact the rib only after mounting is completed, i. e. when the bearing should therefore be alternatively turned in both directions during mounting.

In matched, multi row tapered roller bearings (Figs. 62 and 63), the axial clearance is a function of the spacer width. To determine distance "a" FAG developed the measuring devices of series MGS 155. Details are gladly supplied on request.

62: Matched tapered roller bearings in X arrangement (suffix N11CA)

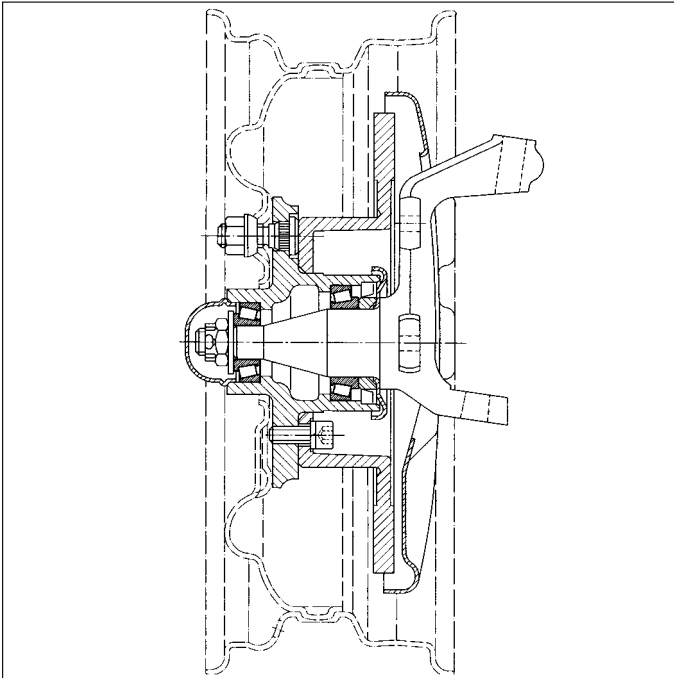


63: Double row tapered roller bearing in O arrangement



Example:

Installation and adjustment of tapered roller bearings in the wheel hubs of motor vehicles (Fig. 64).



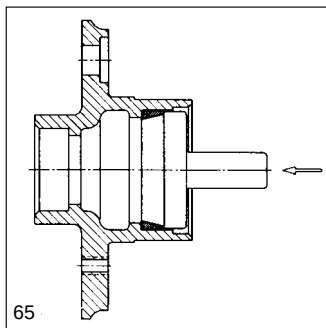
64: Passenger car front wheel with adjusted tapered roller bearings

Mounting

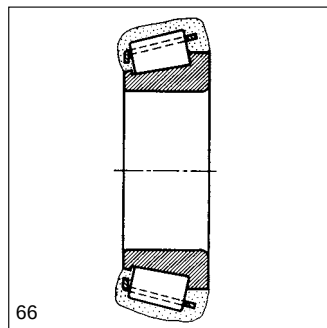
Proceed as follows:

1. Clean hub and carefully remove any chips and burrs.
2. Apply thin oil film to bearing seats. Press the two cups in place with a die. Make sure the die contacts only the cup face. Take care that the cup faces fit well against the hub shoulders (Fig. 65).
3. Grease cone of inner bearing.
Pack grease also in the spaces between cage, cone, and rollers (Fig. 66).
4. Insert cone into hub.
5. Press shaft seal ring into hub with sealing lip pointing towards bearing.
6. Mount protective cap and spacer on the shaft. Make sure spacer face has full support against shaft shoulder (Fig. 67).
7. Mount hub on shaft; make sure seal is not damaged.

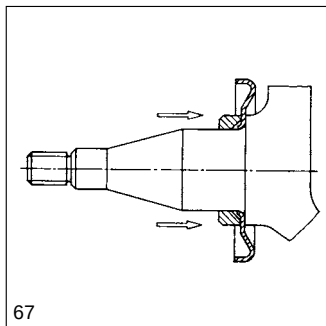
65: Fitting of the bearing cup with a die.



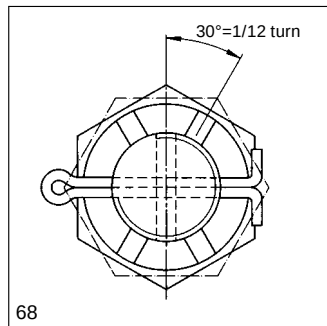
66: Pack roller/cage assembly of tapered roller bearing with grease



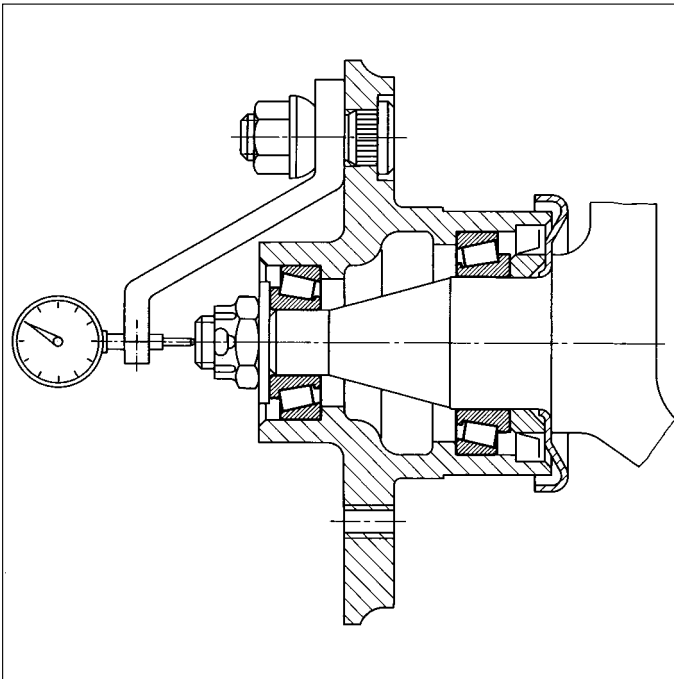
67: After the protective cap, the spacer is mounted on the shaft.



68: Tighten castle nut while rotating the wheel, until drag is felt. Back off castle nut by 1/12 turn at the most, until alignment with next cotter pin hole is obtained and fit cotter pin



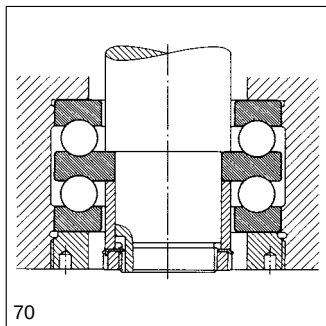
8. Apply grease well to cone of outside bearing and mount on shaft.
9. Mount safety plate.
10. Fit castle nut.
11. Tighten castle nut while the wheel is being rotated until drag is felt (use torque wrench, if possible; follow repair instructions).
12. Back off castle nut approximately $1/12$ turn, until alignment with the next cotter pin hole is obtained and fit cotter pin (Fig. 68).
13. Check bearing for running smoothness and wobble. The wheel must not drag, but rotate freely. Be sure the wheel does not wobble. If necessary, change safety plate or nut. If the illustrated dial gauge (Fig. 69) is available, check axial clearance. 0 to 0.05 mm are optimum values.
14. Mount cover.
15. Perform test run to check for change of bearing clearance. Re-adjust, if necessary.



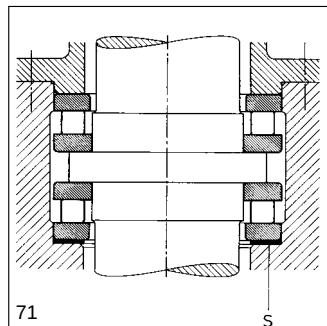
69: Measurement of axial clearance

Mounting

70: Zero clearance double direction thrust ball bearing



71: Cylindrical roller thrust bearing preloaded with shim S



This is a field-proven method of adjusting wheel bearings requiring no special tools. There are other methods which, however, necessitate mounting tools and measuring instruments. They are primarily intended for batch mounting.

3.4.2 Thrust Bearings

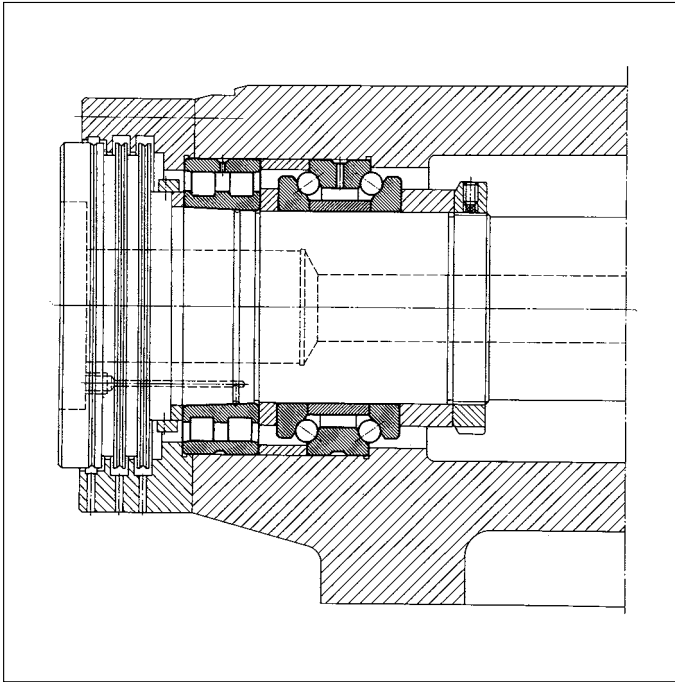
With thrust bearings, the shaft washers are generally transition fits, tight fits being the exception. The housing washers are always loose fits. The shaft washer of double direction thrust bearings should always be positively locked axially (Fig. 70). The mounting and dismounting of thrust bearings offers no difficulties.

3.4.3 Machine Tool Bearings

For machine tool spindles, the correct adjustment of bearing clearance is of paramount importance because it controls the quality of the machined workpieces. For correct adjustment, on mounting, of the operating clearance or preload specified by the designer, FAG developed special measuring devices. These are used for today's widely employed spindle bearing arrangements with double row cylindrical roller bearings (Fig. 72). The correct preload of double direction angular contact thrust ball bearings is automatically adjusted during mounting.

The radial clearance of a mounted cylindrical roller bearing is equal to the difference between the boundary circle diameter of the rollers, and the raceway diameter of the lipless ring. For gauging the boundary circle, FAG supply the boundary circle measuring instruments MGI 21 and MGA 31.

The raceway diameter of cylindrical roller bearings NNU49SK is measured with a snap gauge, the raceway diameter of series NN30ASK with a plug gauge.



72: Bearing assembly of a fineboring spindle (work end). The radial clearance of the double row cylindrical roller bearing is adjusted on mounting.

FAG boundary circle measuring instruments are comparators allowing to measure the radial clearance within a measuring accuracy of ± 1 micron.

For precise adjustment of the radial clearance, the form accuracy of the bearing seats, i. e. their roundness, cylindricity or taper, is important (also see p. 12 "Inspection of bearing seats").

Boundary Circle Measuring Instrument MGI 21

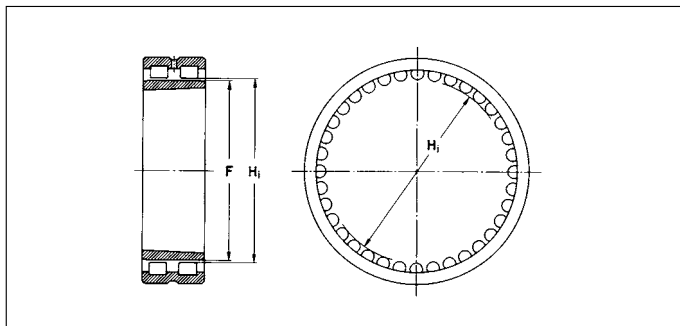
The radial clearance or preload of cylindrical roller bearings with separable inner ring (NNU49SK) is the difference between the diameter of the circle under the rollers H_i and the raceway diameter F . The circle under the rollers is the circle which contacts all rollers from inside, when they are in contact with the outer ring raceway (Fig. 73).

The circle under the rollers is measured with the aid of the instrument MGI21; the radial clearance of the mounted bearing can be determined together with a snap gauge (Fig. 74).

The two opposed steel segments of the boundary circle measuring instrument form the measuring surfaces. The lower segment is stationary, the upper can be displaced; the movement being read from the dial gauge.

Mounting

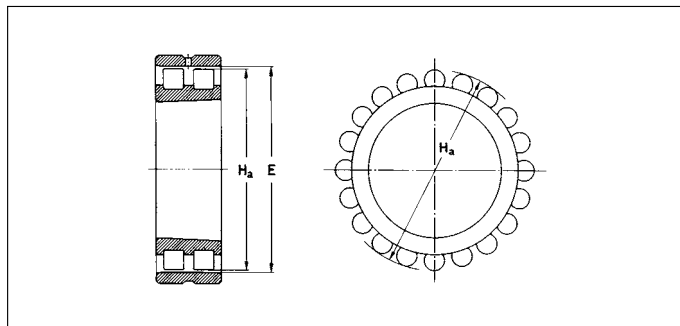
73: Diameter under rollers H_i of cylindrical roller bearings NNU49SK (separable inner ring)



After having determined the boundary circle of the mounted outer ring roller assembly, this value is transmitted to the snap gauge. During inner ring mounting on the tapered shaft seat, the expansion of its raceway diameter is constantly checked with the aid of the snap gauge. Positive values on the dial gauge indicate preload, negative values indicate radial clearance; a zero value indicates a clearance-free bearing.

74: The measured diameter under rollers is transmitted to the dial indicator snap gauge. The boundary circle measuring instrument FAG MGI 21 is used for cylindrical roller bearings with separable inner ring, such as FAG NNU49SK.

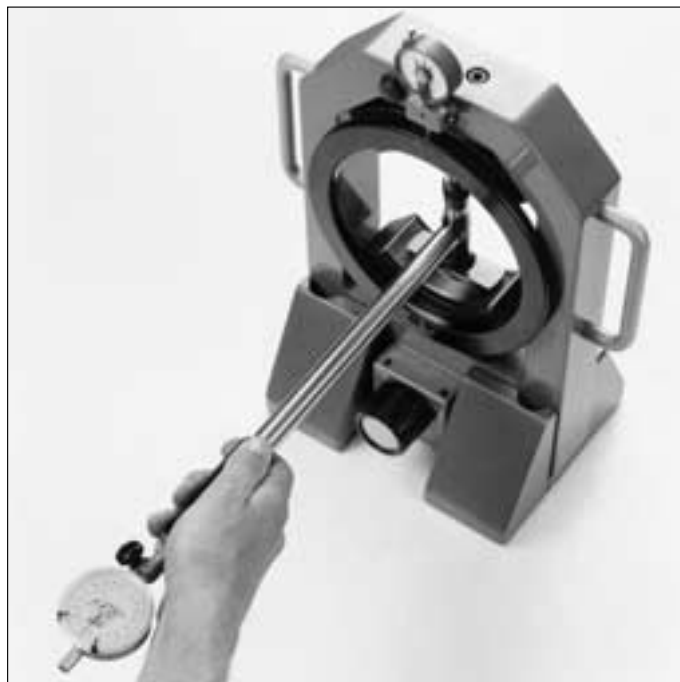




75: Diameter over rollers H_a of cylindrical roller bearings NN30ASK (separable outer ring)

Boundary Circle Measuring Instrument MGA 31

The radial clearance or preload of cylindrical roller bearings with separable outer ring (NN30ASK) is the difference between the diameters of the raceway E and the circle over the rollers H_a . The circle over the rollers is the circle which circumscribes all rollers when they are in contact with the inner ring raceway (Fig. 75).



76: The measured raceway diameter is transmitted to the boundary circle measuring instrument with the aid of an internal dial gauge. The boundary circle measuring instrument FAG MGA 31 is used for cylindrical roller bearings with separable outer ring, such as FAG NN30ASK.

Mounting

The circle over the rollers is measured with the instrument MGA 31; the radial clearance of the mounted bearing can thus be determined together with an internal dial gauge (Fig. 76).

The two opposed steel segments of the boundary circle measuring instrument form the measuring surfaces. One segment is stationary; the other can be displaced. The movement can be read from the dial gauge.

During measuring, the bearing outer ring has to be mounted in the housing. After having determined the outer ring raceway diameter with the aid of an internal dial gauge, this value is transmitted to the boundary circle measuring instrument.

During mounting, the inner ring with cage and roller assembly is pushed onto the tapered shaft seat until positive contact is established. The boundary circle measuring instrument is applied and the inner ring driven onto the taper seat, until the dial gauge indicates the required value.

Positive values indicate preload, negative values indicate radial clearance; a zero value indicates a clearance-free bearing.

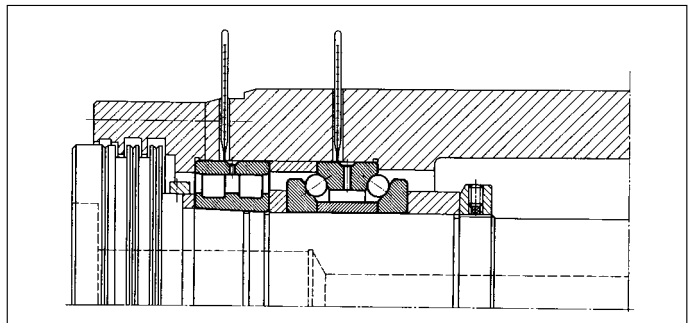
The Steady-State Temperature as a Means of Clearance Control

In the case of high-speed spindles, the operating clearance or preload can be verified from the bearing temperature registered during trial runs.

For temperature control, the bearing housing must be provided with bores for the insertion of temperature sensors (Fig. 77). These bores should be drilled prior to bearing installation. To obtain the true bearing temperature, the sensors must be in direct contact with the bearing rings. Controlling merely the temperature of the cylindrical roller bearing will not do; the temperature of the preloaded angular contact thrust ball bearing should also be measured.

Sensors should contact
bearing rings

77: Arrangement of heat sensors



4. Rolling Bearing Dismounting

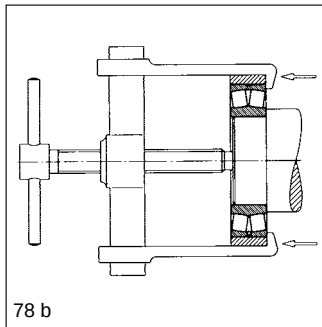
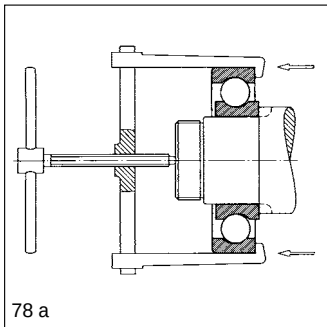
The trial run should be long enough to allow the operating temperature to come to a steady state; this will happen after half an hour to three hours depending on machine size. Steady-state temperatures from 50 to 60°C are acceptable, when the spindle operates at its top speed; experience has shown that at this temperature bearing clearance is optimum.

4. Rolling Bearing Dismounting

If the bearings are intended for re-use, dismounting must be performed most carefully; it is imperative that the extracting tool be applied to the ring to be extracted to prevent the rolling elements from brinelling the raceways (Fig. 78a). In addition, thin-walled outer rings involve the risk of ring fracture (Fig. 78b).

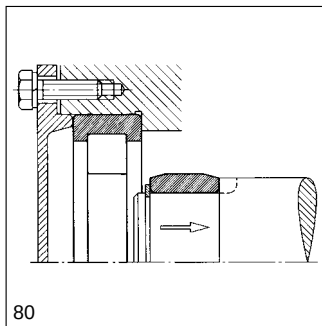
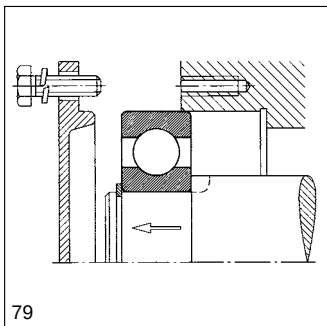
With non-separable bearings, first withdraw the ring with sliding fit from its seat and then dismount the tight-fitted ring. The force required for dismounting is generally higher than the mounting force, since, as time passes, the ring becomes embedded on its seat. Even with loose-fitted rings, fretting corrosion may make dismounting work difficult.

Apply tool to the ring to be extracted



78a: Wrong! Do not apply dismounting force through the rolling elements, if you want to re-use the bearing.

78b: If dismounting through the rolling elements is unavoidable, put a collar of unhardened steel round the outer ring (thickness 1/4 greater than bearing cross section height). This applies especially to bearings with small cross section height and small contact angle (such as tapered roller and spherical roller bearings). The bearings shall not be reused.



79: Start dismounting of nonseparable bearings with the loose-fitted ring.

80: The ring of separable bearings can be dismounted separately.

Dismounting

4.1 Mechanical Methods

4.1.1 Dismounting of Cylindrical Bore Bearings

Small bearings are usually dismantled with the aid of mechanical extracting devices (Figs. 81, 82) or hydraulic presses (Fig. 83). These are applied either directly to the tight-fitted ring or to the mating parts, such as the labyrinth ring.

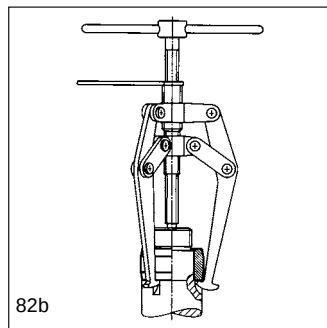
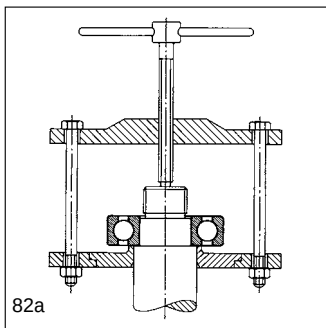
81: Dismounting of a barrel roller bearing with an extractor



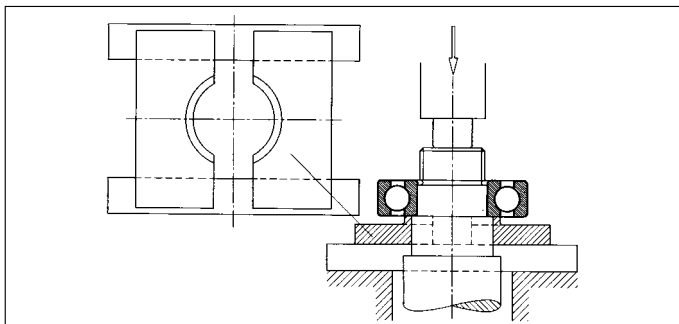
82: Extracting devices for rolling bearings

a: Extractor with puller arms for split ring

b: Extractor with three adjustable arms



83: Dismounting is facilitated by use of a press.



Provisionally, small bearings can be driven off their seat with a hammer and a metal drift (Fig. 84, right). The light hammer blows should be applied evenly round the whole circumference of the tight-fitted ring.

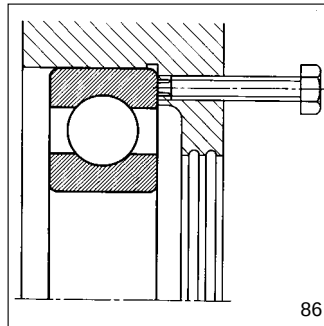
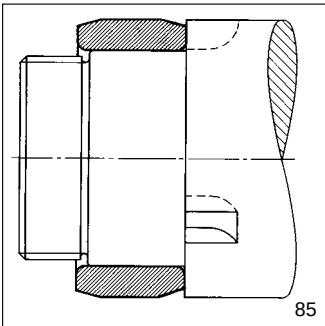
Dismounting is greatly facilitated, if extracting slots are provided so that the extractor can be directly applied to the tight-fitted bearing ring (Figs. 85, 86 and 87).

Provide extracting slots



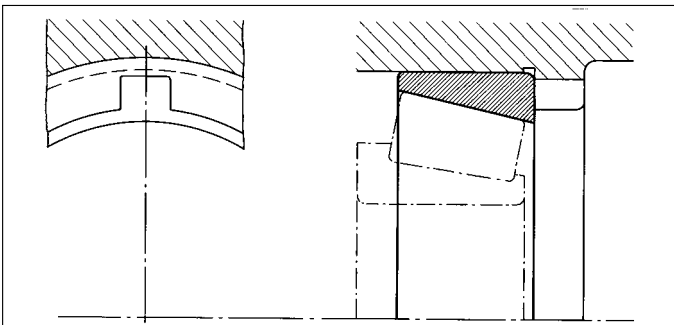
84: Provisional bearing dismounting by hammering
left: wrong
right: correct
(use soft metal drift)

Do not subject the bearing rings to hammer blows



85: Slots in the shaft shoulder to apply bearing extractor

86: Bores for extraction nuts



87: Slots for bearing outer ring removal

Dismounting

When the inner ring abuts the shaft shoulder and when no extracting slots are provided, ball bearings, tapered roller bearings and cylindrical roller bearings can be dismantled with a special extractor. With the ball bearing extractor (Figs. 88, 89c), the clamping piece inserted in the extractor engages with finger-shaped extensions between the balls at the inner ring raceway edge; with extractors for cylindrical and tapered roller bearings the clamping piece engages behind the rollers (Fig. 89a).

88: Ball bearing extractor with clamping piece



89a: Collet for tapered roller bearings and cylindrical roller bearings with separable outer rings/cups

89b: Collet for tapered roller bearings and N-type cylindrical roller bearings with unseparable outer rings (cups).

89c: Collet for deep groove ball bearings



The clamping piece forms part of a collet and is clamped against the inner ring with a tapered clamping ring. The extraction force is generated by a spindle. This extractor enables bearings mounted in the housing to be withdrawn from the shaft.

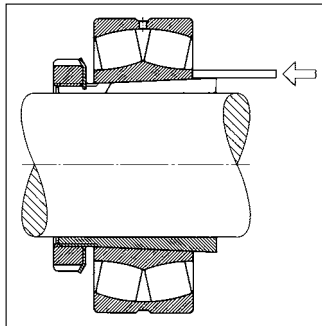
Mechanical FAG extractors see TI No. WL 80-48.

4.1.2 Dismounting of Tapered Bore Bearings

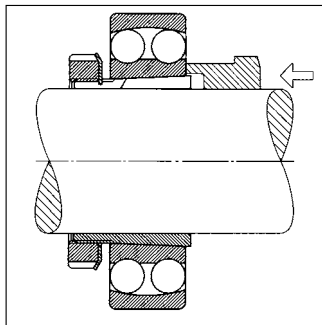
4.1.2.1 Dismounting of Adapter Sleeve Mounted Bearings

For dismounting bearings directly seated on the tapered shaft or an adapter sleeve, loosen the locking device of the shaft or sleeve nut. Loosen nut by an amount corresponding to the drive-up distance. Drive inner ring off the adapter sleeve or tapered shaft seat by gentle hammer taps, using a soft metal drift (Fig. 90) or, even better, a piece of tubing (Fig. 91).

When a press is used, support the adapter sleeve or the loosened adapter sleeve nut and withdraw the bearing from the sleeve.



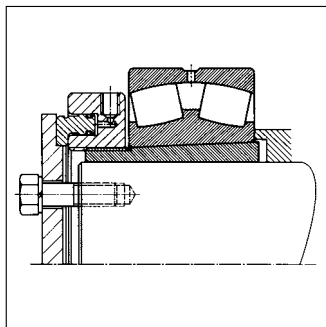
90: Dismounting of a small, adapter sleeve mounted spherical roller bearing. The inner ring is driven off the sleeve by means of a metal drift.



91: Dismounting of an adapter sleeve mounted self-aligning ball bearing. The use of a piece of tubing prevents damage to the bearing.

Dismounting

92: Hydraulic nut for dismounting an adapter sleeve mounted spherical roller bearing



Adapter sleeves can be released with a hydraulic nut provided the bearing rests against an angular support ring. The nut should take support on a plate or the like (Fig. 92).

4.1.2.2 Dismounting of Withdrawal Sleeve Mounted Bearings

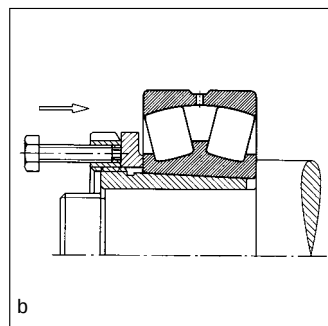
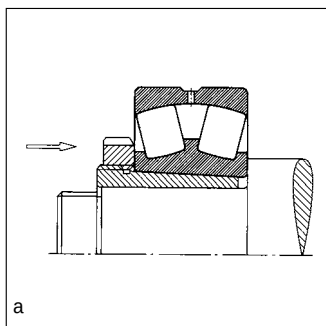
Withdrawal sleeve mounted bearings are removed by means of the extraction nut (Fig. 93a). For this purpose, the shaft nut must be removed. In difficult cases (for large-size bearings), extraction nuts with additional thrust bolts can be used (Fig. 93b). A washer is inserted between inner ring and thrust bolts.

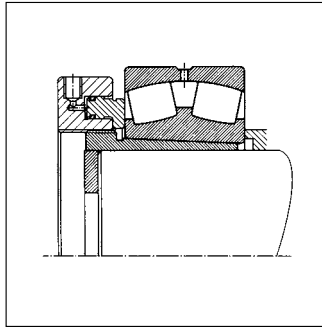
Dismounting of withdrawal sleeves is much easier and less costly with hydraulic nuts (Fig. 94). Withdrawal sleeves projecting beyond the shaft end, should be backed up by a thick-walled support ring.

93: Dismounting of a withdrawal sleeve

a: with extraction nut

b: with nut and thrust bolts applied to the inner ring through a washer





94: Hydraulic nut for dismounting a withdrawal sleeve mounted spherical roller bearing. The projecting portion of the sleeve is backed up by a thick-walled support ring.

4.2 Thermal Methods

4.2.1 Heating Ring *)

Heating rings are used for dismounting cylindrical roller bearing and needle roller bearing inner rings without lip or with one lip only. The heating rings of light alloy are radially slotted. Their insulated handles provide for easy handling (Fig. 95).

With an electric heating plate, the heating rings are heated to a temperature of 200 to 300 °C, placed around the inner ring to be extracted and clamped by means of the handles. The heat is rapidly transferred from the heating ring to the inner ring. When the tight inner ring fit on the shaft is loosened, withdraw both rings simultaneously. After extraction, remove the inner ring immediately from the heating ring to avoid overheating. Heating rings are of great advantage for occasional withdrawal of small or medium-size bearing rings, each bearing size requiring its own heating ring.

*) For details see TI No. WL 80-9 „FAG Aluminium Heating Ring“.



95: Heating rings are used for dismounting cylindrical roller and needle roller bearing inner rings.

Dismounting

4.2.2 Induction Coil*)

Induction coils (also see chapter 3.2.5) are used for withdrawing shrunk-on cylindrical roller and needle roller bearing inner rings of 100 mm bore onward from the shaft. Since the coil heats up at a very fast rate, the amount of heat transferred to the shaft is minimized so that the rings can be easily withdrawn.

Induction coils can be connected between two phases to the common three-phase mains (50 Hz or 60 Hz). For dismounting rolling bearings with a maximum bore of 200 mm, coils are used which are connected directly to the 380 V mains. For larger bearings, the harmless low voltage equipment - 20 to 40 V/50 Hz (60 Hz) - should be used.

Low voltage induction coils are connected to the mains (380 V) via a transformer (Fig. 96). The water-cooled winding provides for a better efficiency, easier handling and lower weight of the coil.

For extraction, the induction coil is pushed over the inner ring and the fingers provided on the coil grip the ring at its back face. The labyrinth ring features milled recesses to allow positioning of the fingers. The current is switched on and, as soon as the ring is heated to 80 to 100°C, the current is disconnected and the ring together with the appliance removed from the shaft.

*) For details see publ. no. WL 80107 EA "FAG Induction Heating Equipment".



96: Low-voltage induction coil with transformer EFB 125/1, for cylindrical roller bearing inner rings of 635 mm bore:

Ring weight	390 kg
Approx. coil weight	70 kg

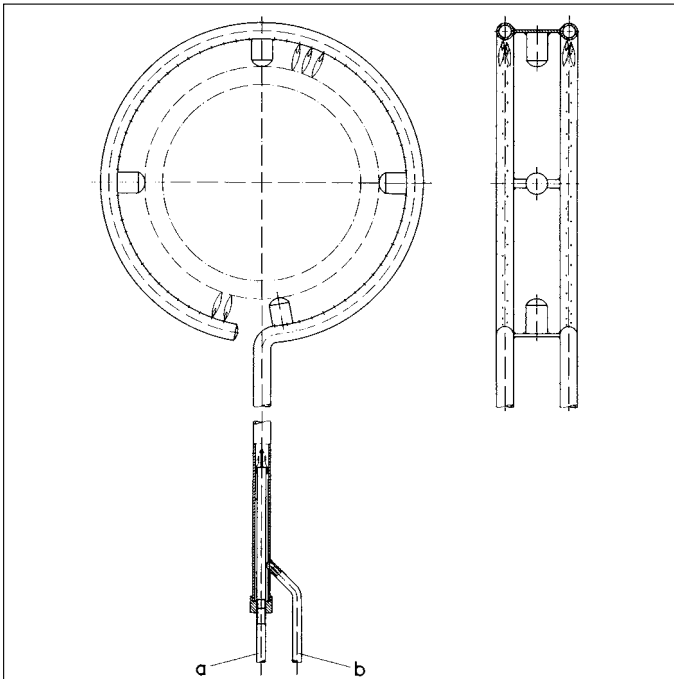
4.2.3 Ring Burner

If no oil grooves are provided in the shaft for hydraulic mounting, and if electric devices are not economical, inner rings of larger separable bearings can also be dismantled by heating them with a flame.

Never should a welding torch be used because of the danger of overheating or unequal heating of the ring. The uniform, high hardness and dimensional stability of the bearing ring could be affected.

Ring burners (fig. 97) have proven to be an acceptable solution. The burner should clear the ring surface by 40 to 50 mm. At the usual gas pressure, the diameter of the burner jet is 2 mm. Flame temperature and flame length are adjusted by the addition of air. The burner jets should be bored in staggered arrangement and be spaced 20 to 45 mm apart. For small rings and heavy interference fits, the burner should be operated for maximum heat output. Air should only be added after burner ignition. There must be provisions for the air pressure to be delicately adjustable, since excessive pressure may force the gas back into the mains.

Use ring burner



97: Ring burner for dismantling inner rings
a = gas, b = air

Dismounting

The surfaces of the hardened bearing rings are susceptible to overheating which reduces hardness and changes the dimensions. The burner should, therefore, always be held concentric to the bearing ring. The burner should be moved slowly and evenly across the bearing ring in the axial direction. This will avoid a tempering effect and additional stressing in the ring.

Sometimes heavy fretting corrosion or cold welding can make the regular removal of bearing rings impossible. In such cases which, of course, only apply to unserviceable rings, these are heated by a welding torch to 350°C and hosed with cold water. The heavy internal stresses thus produced in the ring will make it crack. Since the ring is likely to burst, the area of dismounting must be well screened or covered to avoid accidents.

Crack unserviceable rings for a removal

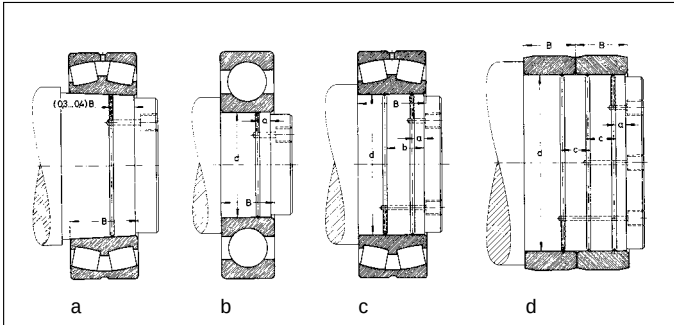
Safety information

If - for example when a bearing is dismounted by means of a welding torch - a temperature of approx. 300°C and above is reached, fluorinated materials can release gases and vapours that are detrimental to human health. FAG uses fluorinated materials for seals made of fluoroelastomer (FKM, FPM, e. g. Viton®) or for fluorinated lubricating greases such as the rolling bearing grease Arcanol L79V. If high temperatures cannot be avoided, the safety data sheet valid for the fluorinated material in question has to be observed that can be obtained on request.

4.3 Hydraulic Method

With the hydraulic method, oil is injected between the mating surfaces. The oil film greatly reduces the friction between the mating parts which can then be conveniently displaced in relation to one another without the risk of damaging the mating surfaces (see chapter 3.3).

The hydraulic method is suitable for dismounting bearings with tapered and cylindrical bore. In both cases, oil grooves, ducts and threaded connections for the pump must be provided (Fig. 98). Larger adapter and withdrawal sleeves feature the corresponding grooves and holes (Figs. 101, 102).



98: Position of oil grooves for dismounting by the hydraulic method.

- a: Tapered shaft seat;
- b: Cylindrical shaft seat, bearing width $B \leq 80 \text{ mm}$, $a \approx \sqrt{d}$;
- c: Cylindrical shaft seat, bearing width $B > 80 \text{ mm}$, $a \approx \sqrt{d}$, $b \approx (0.5 \text{ to } 0.6) B$;
- d: Cylindrical shaft seat, two inner rings mounted side by side; bearing width $B > 80 \text{ mm}$; $a \approx \sqrt{d}$, $c \approx B - (1.5 \text{ to } 2) \sqrt{d}$

For dismounting tapered bore bearings directly seated on the shaft, injectors will do for pressure generation (Fig. 51). Cylindrical bore bearings and adapter and withdrawal sleeve mounted bearings require a pump (Fig. 52, chapter 3.3).

For dismounting, a thicker oil with a viscosity of about $150 \text{ mm}^2/\text{s}$ (cSt) at 20°C (nominal viscosity $46 \text{ mm}^2/\text{s}$ at 40°C) can be used. If the contact surfaces are damaged, a high-viscosity oil of about $1,150 \text{ mm}^2/\text{s}$ (cSt) at 20°C (nominal viscosity $320 \text{ mm}^2/\text{s}$ at 40°C) should be used. Fretting corrosion can be dissolved by anti-corrosive additives in the oil.

4.3.1 Dismounting of Tapered Bore Bearings

For hydraulic dismounting of bearings, mounted on a tapered journal, a withdrawal sleeve or an adapter sleeve, oil is pumped between the surfaces in contact. This releases the press fit instantly. The release being rather abrupt, a stop should be provided to control the movement. This may be a shaft or sleeve nut or any other convenient means (Figs. 99 to 102).

Restrict axial movement!



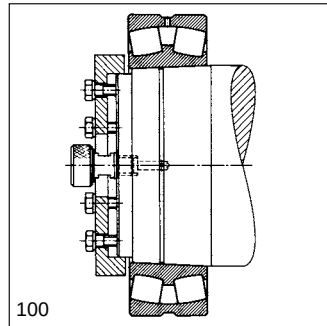
99: Dismounting a withdrawal sleeve mounted spherical roller bearing by the hydraulic method.

Dismounting

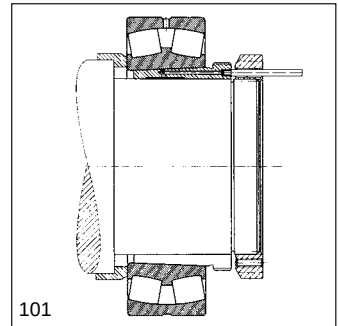
Dissolve fretting corrosion by the addition of rust solvents

The incidence of fretting corrosion may render dismounting more difficult. In this case, a rust-dissolving hydraulic oil should be used, especially for bearings of long service. For a seized withdrawal sleeve, the extra force required to set it moving can be applied through the withdrawal nut. If the withdrawal nut features thrust bolts (Fig. 103), a plate or washer should be inserted between the bolts and the bearing, to avoid damaging the lips of the bearing ring.

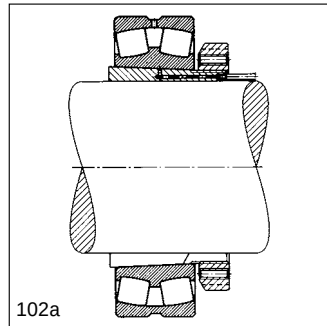
100: Bearing seated on shaft; the oil is pumped between the surfaces in contact; bearing disengages spontaneously. Stop to be left on shaft to restrict bearing movement.



101: Bearing seated on withdrawal sleeve: Oil is pumped into withdrawal sleeve bore and O. D.; withdrawal sleeve disengages spontaneously. Nut to be left on shaft.

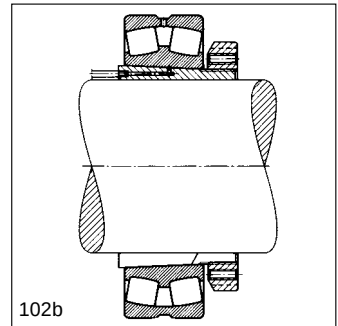


102 a-b: Adapter sleeve mounted bearing: Oil is pumped between adapter sleeve O. D. and bearing bore; Bearing disengages spontaneously. Stop to be left on sleeve.

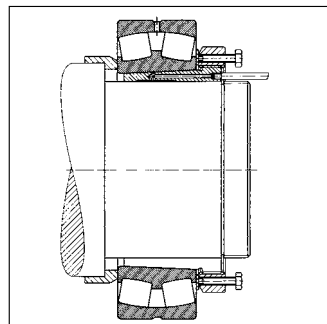


a: Oil connection in small end of sleeve

b: Oil connection in large end of sleeve



103: Dismounting in difficult cases: Oil containing rust solvents is pumped between the mating surfaces. Higher-viscosity oils should be used. Sleeve extraction is facilitated by applying nut provided with thrust bolts.

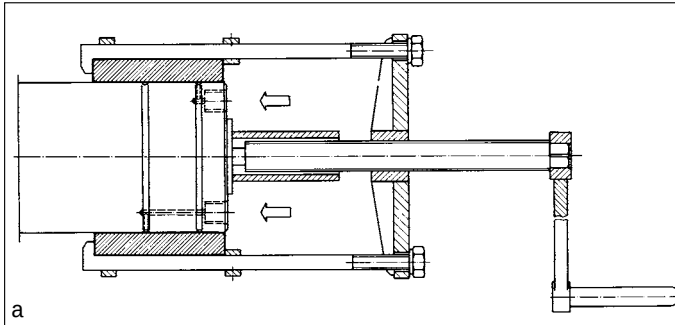


4.3.2 Dismounting of Cylindrical Bore Bearings

For cylindrical bore bearings, the use of the hydraulic technique is generally limited to dismounting.

The first step is to apply a bearing extractor to the bearing ring (Figs. 104 a-c). Then, hydraulic oil is pumped into the oil grooves.

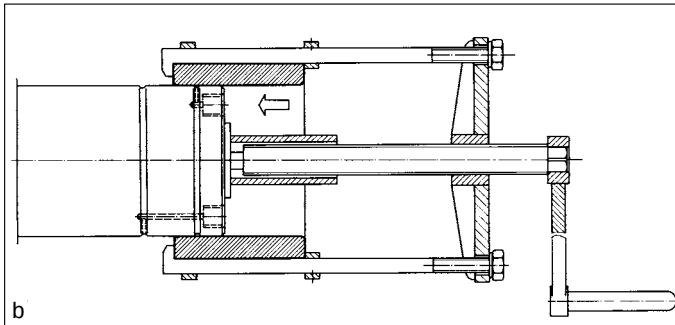
When the bearing ring moves easily, it should be displaced far enough to expose the rear oil groove; the oil feed to this groove is stopped.



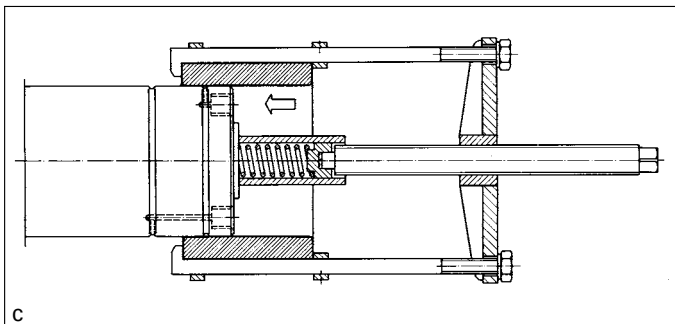
104: dismounting of a cylindrical bore inner ring with the hydraulic method

a: Apply extractor to the inner ring and pump oil into the two oil grooves.

b: Pull ring far enough to expose the rear oil groove and stop oil feed to this groove. The ring is given a further pull, until it covers the forward oil groove at either side by an identical length. The oil feed is stopped so that the ring will freeze.



c: The extracting device is preloaded with a spring. Rebuilding the oil film enables the ring to slide off the shaft.



Dismounting

Then the ring is given a further pull, until the ring covers the forward oil groove at either side by an identical length (Fig. 104 b).

The oil feed to the forward groove is stopped which means that the ring will freeze again. A spring is inserted into the guide sleeve of the extractor and preloaded (Fig. 104 c).

The travel stroke of the extractor spring should be a little greater than the length occupied by the ring on the shaft. Rebuilding the oil film by vigorous pumping enables the extractor to slide the ring off the shaft. It is recommended to catch the ring on its way off.

Catch ring on its way off the shaft

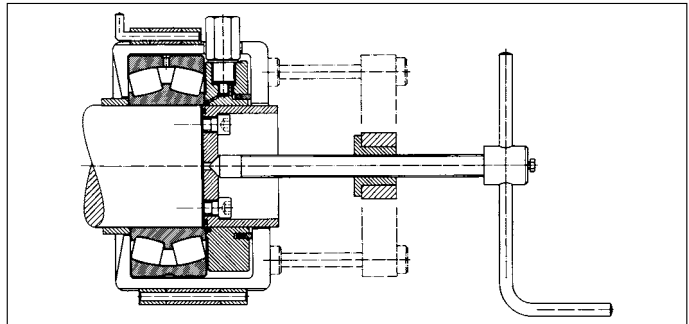
The spring preload should be approximately $F = 20 \cdot d$ (F in N and d in mm). Whenever several rings are mounted on the shaft side by side, they are dismantled separately.

The displacement of the ring up to the point where the forward oil groove is still covered evenly, can generally be done by hand, since upon injection of the hydraulic oil, the rings are easily displaceable. The better the ring "floats" in the extraction phase, when the spring pressure pulls it from the shaft, the less the probability of its getting caught at the shaft end.

Use oil injection ring for the removal of bearing from plain shafts

In the absence of oil grooves and ducts in the shaft, the oil can be injected between the mating surfaces from the inner ring front face (Fig. 105). To this effect, a sealed oil injection ring is placed in front of the bearing feeding pressurized oil into the fitting joint. Mounting a sleeve to the shaft end allows oil to be pumped between the mating surfaces all the time the dismantling operation lasts. If the use of such a sleeve is not possible, a high-viscosity oil of 320 mm²/s (cSt) at 40°C must be used. An oil of this viscosity maintains an adequate oil film for approximately 5 minutes which is sufficient for bearing removal.

105: Special device for extracting a cylindrical bore spherical roller bearing from a shaft without oil grooves. The oil is fed into the fitting joint from the inner ring front face.



These special extracting devices are relatively complicated. They are, for example, used for applications where no oil grooves are provided in the shafts or axles for strength reasons, but which require frequent dismounting (e. g. for rail vehicles).

5. Lubrication

The primary purpose of the lubricant is to build a load-carrying film separating the bearing components in rolling and sliding contact in order to minimize friction and wear. The lubricant should also protect the bearing against corrosion. If required, it should also act as a sealant, and in case of circulating oil lubrication, as a coolant.

Due to deterioration and mechanical stressing, the lubricants become unuseable. Change of oil or grease or replenishment, i. e. bearing maintenance, has a favorable influence on the bearing service life. Under certain sealing and environmental conditions, appropriate lubricant selection allows for a lubrication for life. For detailed information see also FAG Publ. No. WL 81115 "Rolling Bearing Lubrication".

5.1 Greases

Only high-grade greases - generally on a metal soap basis - should be used. Rolling bearing greases for extreme temperatures contain different thickeners and a synthetic oil instead of the mineral oil.

Only use time-tested greases

Greases containing extreme pressure (EP) additives are used in high-load and low-speed applications. High-speed bearings and bearings which ask for low friction, are lubricated with greases containing a thin synthetic base oil.

The operating temperatures specified by the grease supplier should be kept in mind. Rolling bearing greases should be stable against deterioration and must not change their structure, even after long periods of operation.

Consider grease application range

The table 7.23 on p. 113 lists the FAG rolling bearing greases Arcanol and their properties.

5.2 Oils

Only use time-tested oils

For rolling bearing lubrication, mineral oils are generally used. They should have the following properties:

Utmost cleanliness, stability against deterioration, good viscosity-temperature behaviour and good water repellency. In addition, the lubricating oil must ensure satisfactory protection of the bearing against corrosion. Very high and very low operating temperatures require the use of synthetic oils. Oils for highly loaded and low-speed bearings should contain EP-additives.

5.3 Selection of Lubricant

Greases are generally preferred to oils because they simplify maintenance and can be used as sealants. The asset of oil is that it readily feeds into all areas of contact and carries off heat. Its disadvantage is that it involves a more complex design of the bearing location and especially of the sealing system.

The following factors determine the selection of lubricant:

Operating Temperature

Depending on the speed, the temperature of a bearing location is a function of bearing friction, lubricant friction, heat dissipation to the outside, and, as the case may be, heat supply from the outside.

Watch steady-state temperature

A bearing mounting is reliable, if the steady-state temperature settles at a level acceptable for the application. A continuous temperature increase, on the other hand, necessitates special measures (extra cooling, change-over to a different lubricant etc.). A short-term temperature rise occurs with grease relubrication.

The viscosity of lubricating oils decreases with increasing temperature and increases when the temperature drops. Preference should be given to oils the viscosity of which varies little with temperature (good V-T behaviour).

Watch viscosity at operating temperature

The higher the expected operating temperature, the higher should be the nominal viscosity of the oil. The nominal or mid-point viscosity is the viscosity for oils at 40°C. The oils are classified in viscosity grades (ISO VG) (DIN 51519).

The permissible temperature range of greases varies with the saponification bases. As a rule, the upper limits are:

Calcium soap base: + 50°C (120°F)

Sodium soap base: + 70°C (160°F) to 120°C (250°F)

Lithium soap base: + 110°C (230°F) to 130°C (265°F)

Diverse complex soap greases, gels, and greases containing entirely synthetic thickeners feature temperature limits beyond 130°C (265°F). Greases with thin synthetic base oils are especially applicable for low temperatures.

Exact values for the commercial greases are available from manufacturers' catalogues.

In selecting oils and greases, it should be borne in mind that a high temperature speeds up deterioration and decreases the lubricant service life.

Exact values of greases with different saponification bases are available from manufacturers' catalogues

Loads and speed

Under the given operating conditions, the lubricant must form a load carrying lubricating film. With oil, the load carrying capacity of the film is primarily a function of viscosity. The lower the bearing speed, the higher the oil viscosity in operating condition. Information on viscosity v_1 can be seen in the FAG catalogue WL 41520. Consideration must be given to the fact that bearing temperatures depend on load and speed. The operating temperature required for determination of the nominal viscosity must be estimated.

Increases in speed are associated with increasing lubricant friction and accordingly, increasing bearing temperature. The friction will be higher, the more viscous the lubricant is. On the other hand, higher temperatures lower viscosity which decreases the load carrying capacity of the lubricant film.

The permissible speeds for the various types and sizes of rolling bearings for grease and oil lubrication are listed in the FAG catalogues.

The use of solid lubricants as e. g. graphite and MoS_2 is limited to ultralow speeds and creeping motions only.

High-load applications call for oils containing EP additives. Greases for high-load applications are characterized by base oils of high viscosity and EP additives.

High-viscosity oils for low speeds

Observe relationship between speed, lubricant friction, temperature and viscosity

Permissible speeds for oil and grease lubrication see FAG Rolling Bearing Catalogues

Solid lubricants only for creeping speeds

Lubrication

Bearing Size

Small bearings are generally lubricated with a low-viscosity oil or with a very soft grease to minimize lubricant friction in the bearing. In large bearings, the lubricant friction plays a minor role, and the choice between oil or grease is, in this respect, of secondary importance.

Moisture

Consider lubricant behaviour with moisture

The reaction of rolling bearing greases against moisture is different from one grease to the other. Only the water-repellent calcium base greases (Ca-greases) possess a safe sealing action against water. They are used, therefore, in labyrinths for operating temperatures not exceeding 50°C, acting as sealing agents.

The sodium base greases feature a higher limiting temperature than the calcium greases. They emulsify with water and are indicated for applications with a limited amount of moisture (e. g. condensation water). Since the sodium base greases are water-absorbing, there is the risk that so much water will be absorbed that they will wash out of the bearing.

Lithium base greases do not absorb as much water as sodium base greases. Because of their reasonable resistance to water and their wide temperature range they have become the greases of preference for rolling bearings.

Also with oils, their moisture and water resisting properties must be considered. Oils that separate water well should be preferred, because they allow the water to settle in the oil sump or reservoir when the machine is at rest.

The protection against corrosion is improved by anti-corrosive additives in the oils or greases.

Contamination

Maintain cleanliness of lubricant reservoir, lubricators and grease nipples.

Relubrication involves the risk of bearing contamination. High standards of cleanliness should, therefore, be maintained for the lubricant reservoir and the lubricators and also when handling the lubricant. Grease nipples should be cleaned before relubrication.

Mixing of Lubricants

Never mix different lubricants

Lubricants of different saponification bases should not be mixed to avoid impairment of temperature stability and lubricating properties. The same applies to oils.

Lubricant Quantity

With grease lubrication, the bearing cavities should be packed to capacity. Only partly fill (20 to 35% of free space) extremely fast running bearings. The amount of grease to be filled into both lateral housing cavities depends on $n \cdot d_m$.

(n = maximum operating speed

$$d_m = \frac{D+d}{2} \text{ mean bearing diameter)}$$

Speed index	Amount of grease filled in the housing space
$n \cdot d_m < 50000 \text{ min}^{-1} \cdot \text{mm}$	full
$n \cdot d_m = 50000 \text{ up to } 500000 \text{ min}^{-1} \cdot \text{mm}$	60%

Overgreasing at medium and higher speeds causes churning resulting in an undesirable temperature rise which may harm both bearing and lubricant.

Rolling bearings with seals or shields are packed with grease to approx. 35% only during manufacture.

With oil lubrication, too much oil in the housing has similarly detrimental effects: the churning action overheats the oil and exposes it to air oxygen, causing oxidation and foaming.

With sump lubrication, the oil level in the housing should be no higher than the centre point of the lowest ball or roller when the bearing is at rest.

6. Rolling Bearing Damage

6. Rolling Bearing Damage

The life of a rolling bearing depends on the total number of stress cycles and the loads incurred by rolling elements and raceways.

The standardized calculation method for dynamically stressed bearings is based on material fatigue (pitting) causing the damage.

Normal fatigue manifests itself by flaking or spalling of the rolling surfaces (Fig. 106). An increasing local stress may result in fracture of the ring (Fig. 107).

If the bearing fails earlier than predicted by the life calculation, it should be checked for overloading. With this failure cause excluded, faulty mounting or poor maintenance or wear might be the cause for the damage. The following pages describe some of the more common forms of bearing damage and their causes.

106: Flaked inner ring of a deep groove ball bearing



107: Fracture of the inner ring of a deep groove ball bearing as final stage of fatigue



6.1 Why Does a Bearing Fail?

6.1.1 Faulty Mounting

Local damage to the raceways, such as nicks, score marks or indentations suggest faulty mounting. This type of damage occurs, if, for instance, the inner ring of a cylindrical roller bearing is inserted out-of-square into the outer ring, or if the mounting force is applied through the rolling elements (Figs. 108 to 111).

Surface damage is also caused, when foreign particles enter the bearing and are cycled (see chapter 6.1.2).

The damage can be recognized for instance by a louder running noise; in the long run, it may lead to premature fatigue of the functional surfaces.

The typical sign for surface damage are the raised edges of the indentations.



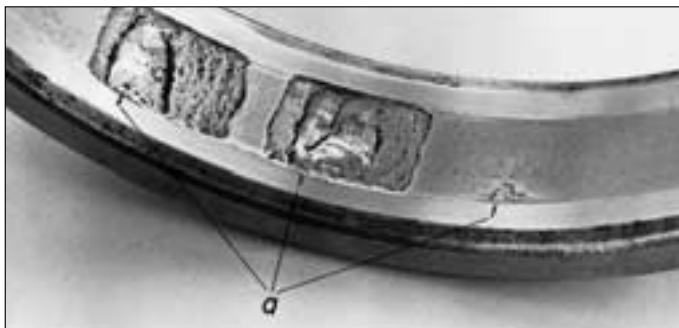
108: Ball indentations in the raceway of a deep groove ball bearing resulting from faulty mounting

Rolling Bearing Damage

109: Scored raceway of a cylindrical roller bearing inner ring



110: Premature fatigue of a cylindrical roller bearing outer ring caused by score marks visible at "a"



111: Fractured lip of a barrel roller bearing inner ring driven up its seat by hammer blows

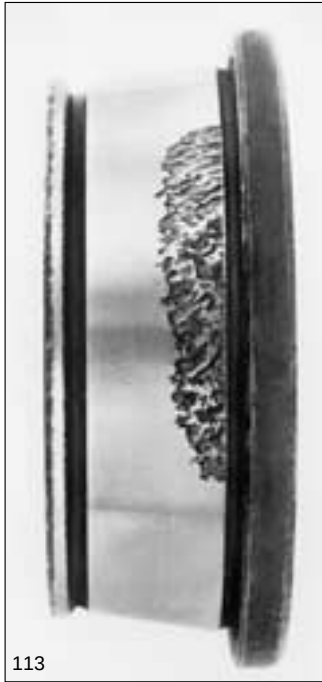


The location of the load zone in a bearing ring results from the direction of the externally applied loads and from the conditions of rotation. The load zone can soon be recognized by slight frosting on the raceways indicating whether the bearing was loaded as specified.

Rolling Bearing Damage



112: Running tracks caused by off-square mounting of a stationary deep groove ball bearing inner ring



113: One-sided flaking caused by off-square mounting of a stationary tapered roller bearing cone

Unusual running tracks suggest detrimental preloading which may be caused by too tight fits, excessive axial adjustment, form inaccuracies of shaft or housing, misalignment or by a tight fit of the floating bearing (Figs. 112 and 113).

6.1.2 Contamination

Foreign particle indentations in the functional surfaces may lead to premature fatigue (see chapter 6.1.1). Foreign particles with abrasive effect, however, accelerate bearing failure due to wear. The surfaces are roughened and look dull. Progressive wear causes excessive clearance.

Possible causes:

- Contaminated parts
- Moulding sand in housings
- Inadequate seals
- Contaminated lubricants
- Metallic abrasion from gears brought into the bearing by the lubricant.

Rolling Bearing Damage

6.1.3 Corrosion

Corrosion in rolling bearings may occur in various forms and have different causes. The damage shows in an uneven and loud running noise. The rust abraded by the rolling elements causes wear.

Figures 114 and 115 show corrosion damage due to moisture or other corrosive media.

Possible causes:

Inadequate sealing against moisture,
acid fumes,
lubricants containing acids,
condensation,
unsuitable storage of the rolling bearings in the warehouse.

False brinelling is identified by marks in the raceways at rolling element spacing. In contrast to the rolling element indentations caused by incorrect mounting, they have no raised edges (Fig. 116). The increased number of indentations shown in Fig. 117 is a result of occasional turning of the bearing.

False brinelling is caused by vibrations in the contact areas of parts while these are stationary, resulting in wear. Susceptible to such damage are machines which are subjected to vibrations while stationary or during transportation. Possible remedy: Securing by wedges

114: Corrosion of tapered roller bearing cone



115: Corrosion marks in the raceway of a self-aligning ball bearing outer ring



or similar means for transportation or keeping the bearing in rotation (e. g. on ships).

Fretting corrosion, however, occurs at the fitting surfaces, i. e. in the bearing bore or at the bearing outside diameter. It is caused by relatively loose fits or too soft mating components. Minute motions (micro-slipping) in the fitting joint may cause heavy wear resulting in an impeded floating bearing function or fracture of the shaft due to notch stresses. Possible remedy: Tight bearing fits or reinforcement of mating structure.

6.1.4 Passage of Electric Current

Continuous passage of electric current causes brownish flutes parallel to the axis over the entire circumference of one or both raceways as well as on the rolling elements (Fig. 118 and 119).

6.1.5 Imperfect Lubrication

Starved lubrication is caused by an insufficient lubricant supply or by use of an improper lubricant. If the lubricating film does not sufficiently separate the parts in rolling contact, sliding motion and wear result. Since maximum material stressing occurs at the raceway surfaces, micro pits and consequently large-area superficial flaking is produced (Fig. 120).



116



117

116: Indents caused by false brinelling of the raceway of a self-aligning ball bearing outer ring

117: False brinelling in the raceway of a cylindrical roller bearing inner ring - due to vibrations

Rolling Bearing Damage

118: Fluted rollers of a spherical roller bearing due to the passage of electric current



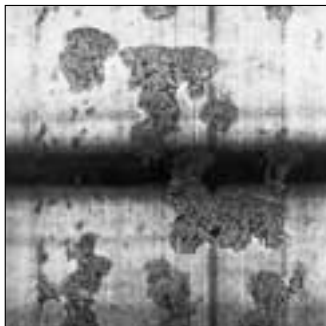
119: Fluted raceway of a spherical roller bearing outer ring due to the passage of electric current



In the case of overlubrication, the lubricant heats up due to the churning action and loses its lubricity. Overheating, i. a. catastrophic failure of the bearing, may be the result. Prevent lubricant retention without the bearing, especially for high-speed bearings.

The possible consequences of contaminated lubricants are described in chapter 6.1.2.

120: A non load-carrying lubricating film causes large-area superficial flaking on cylindrical rollers.



6.2 How to Recognize Bearing Damage in Operation?

Symtoms	Source of Trouble	Examples
Uneven running	Damaged rings or rolling elements Contamination Excessive clearance	Motor vehicles: Increased wheel wobble and vibration of steering system Fans: Increasing vibration Sawmills: Increasing knocking in connection rods Combustion engines: Increased vibration in crankshaft
Reduced working accuracy	Wear due to contaminants or insufficient lubrication Damaged rings or rolling elements	Lathe: Gradual development of chatter marks on workpiece Grinders: Waviness of ground surface Cold Rolling Mill: Period surface defects on rolled material such as stretcher strains, ghost lines etc.
Unusual running noise: Whining or high pitched noise	Insufficient operating clearance	Electric motors, gears; with gearboxes, the bearing noise is hard to identify, since it is generally drowned in the running noise of the gears
Low pitched rumbling or irregular noise	Excessive operating clearance Damaged running surfaces Contamination Inadequate lubricant	
Gradual change in running noise	Changes in operating clearance caused by temperature. Damaged raceway (from contamination or fatigue)	

Rolling Bearing Damage

6.3 How to Pinpoint Bearing Damage?

The examples shown in Figs. 106 to 120 are striking damage cases. They can be clearly defined and diagnosed. A detailed discussion of all imaginable combinations of bearing damage would certainly go beyond the scope of this manual.

In the field, the diagnosis of the primary cause of failure is not always easy. In many cases an examination of, for instance, the running tracks, allows certain conclusions to be drawn. Advice for the avoidance of future trouble can, however, hardly be given without knowing operating conditions, lubrication and overall design of the machine. Information should, moreover, be available on the damage symptoms in evidence and on relevant secondary phenomena.

Keep track of operating
behaviour and record
observations

6.3.1 Observations prior to Dismounting

Prior to dismounting, the following four conditions should be surveyed and the survey result be made a matter of record. The importance of this procedure cannot be overemphasized, since, after bearing dismounting and cleaning of bearing and housing, this evidence is irretrievably lost.

Contamination

What are the overall conditions of the machine, particularly near the bearing location? Are there deposits of dirt or residues of the machined or processed material? Could water, caustics, cutting fluids, vapours and fumes have entered the bearing housing?

Loss of Lubricant

Was there any chance of lubricant escape? To find out, check the oil gauge level and the sealing gaps at the shaft outlet, all joints between housing and cover, and the seals of the oil pipes, drain plug and oil gauge.

Running Noise

Bearing damage can frequently be recognized by changes in the running noise. The nature of the noise should be specified as exactly as possible by indicating whether it is even or pulsating, recurrent or nonrecurrent, rumbling, whining, singing, or knocking. If the noise is recurrent, its frequency should be recorded. For higher speeds, this may require complicated recording equipment; for low speeds,

however, it has been found practical to tap with a pencil on a piece of paper at the rate of noise recurrency, and to count the dots after a given number of seconds. The result should give a clue as to whether the trouble occurs, for instance, at inner ring or cage frequency. An attempt should also be made to assess the noise level.

Keep track of behaviour and record observations

Before disassembly, the bearing should once more be turned by hand. Often this allows easy identification and accurate characterization of running irregularities.

Case History and Secondary Evidence

The damage should be recorded, while still fresh in mind. It is important that all details be listed, i. e. the time the malfunction was first noticed, the initial symptoms and the alterations in noise or temperature occurring with time. If the trouble starts suddenly, the position of the control handles and the operating position of the machine should be noted. Any former modifications made on the machine, for instance clearance adjustment, installation of new shafts, sleeves, or spacers, increases in capacity and speed should be included in the analysis. When these modifications and the onset of the bearing trouble coincide, the expert will certainly be able to draw significant conclusions.

6.3.2 Observations during Dismounting

The following four conditions should be watched:

Lubrication

In order to examine the cause of failure of the dismounted bearing, the lubricant must not be removed. Even an expert cannot define the cause of failure of a damaged, but cleaned bearing. Avoid additional contamination of the damaged bearing.

Do not wash out lubricant, but take samples

Oil Lubrication

With oil-lubricated bearings, the oil and, as the case may be, the coolant, are drained. The oil should be collected in a clean container, especially, if there is suspicion of dirt, metal chips or an unusual amount of grit from nearby gears. If the suspicion proves true, enough oil will thus be available for a thorough investigation.

Rolling Bearing Damage

Grease Lubrication

Dismounting of grease-lubricated bearings starts with the removal of covers, caps or shields. These parts should not be immediately washed out, but stored in a clean place, until the nature of bearing failure is clarified. The same applies to felt and rubber seals and to any other seals and shields. Even if maintenance instructions call for the installation of new seals at each overhaul, the old ones should be kept for some time, as their condition may be indicative of the efficiency of the sealing system.

Two grease samples should be taken, one from the bearing interior and another from the housing. Dirty grease nipples may contaminate grease used for relubrication; in this case a sample should be taken from the grease duct.

A generous quantity should always be sampled. The sampled grease should be kept in clean containers or spread on clean oil-paper and identified such that its origin can be traced back any time.

Looseness of Locating Devices

Check tightness of
locating nuts

As dismounting progresses, check tightness of the nuts which provide for axial location of the bearing inner ring. This is of particular importance with double row angular contact ball bearings with split inner ring, and with four-point bearings. Any loosening of axial location entails a change in bearing kinematics and clearance. This also applies to tapered roller bearings and angular contact ball bearings mounted in opposition. In the case of adapter and withdrawal sleeves and tapered seats, the tightness of the clamping or locknuts should be checked.

Position of Bearing Rings

Upon removal of the nuts, the ring faces should be cleaned to check the position of the rings relative to the housing and the shaft.

Prepare sketch of bearing
arrangement

Generally, the running tracks on the raceways give sufficient evidence of the direction of load; this evidence is, however, of little value, if the running tracks are unusual and nothing is known on how the outer ring was mounted in the housing and the inner ring on the shaft. For this purpose, a sketch should be made showing the position of the bearing number stamping relative to a reference point in the housing or on the shaft. The sketch should also show the direction into which the stamped face of the bearing ring points, i. e. towards the shaft center or the shaft end. For separable bearings, such as cylindrical roller bearings, magneto bearings and four-point bearings, this applies to both rings. If, upon disassembly, the running tracks are found to be unusual, conclusions can be drawn as to the type and direction of load, perhaps also on detrimental preload, furnishing a clue to the cause of damage.

Examination of Bearing Seats

When extracting the bearing, a note should be made of any unusually easy or difficult removal of the rings from their seats. The bearing components of separable bearings must be kept together and not be mixed up with parts of other bearings.

An inspection of the adjacent machine parts should be made at the same time, especially when the machine has to be quickly reassembled with the new bearings to avoid a prolonged close-down. The shaft and housing seat diameters should always be measured. Special care should be given to the roundness of the seats. The condition of the driving and the driven machine elements, especially of gears and other moving parts, should also be inspected. Sliding marks and the contact pattern will frequently furnish evidence on the shaft misalignment.

Measure shaft and housing diameter, check roundness of seat

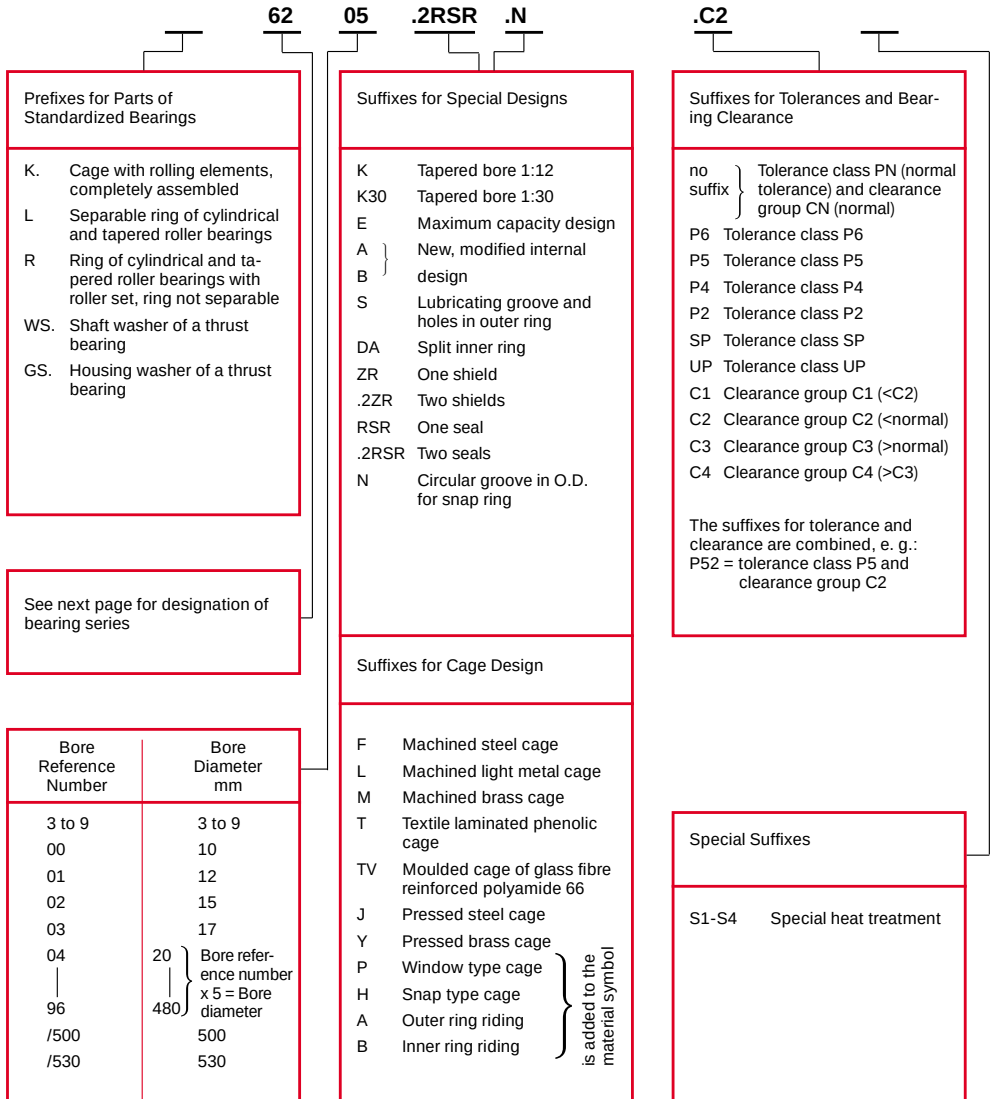
6.3.3 Bearing Inspection

Upon completion of dismounting, the damaged bearing itself should be examined. Check cleanliness, condition of the mating surfaces (dimensional stability) and function (bearing clearance, smooth running) of the complete bearing. The damage in evidence on the bearing and the recorded secondary phenomena are, in most cases, sufficient to obtain a clear picture of the damage history. Doubtful cases should be reported to the nearest FAG Engineering Office.

In case of doubt, contact the nearest FAG Engineering Office

There are, of course, many applications where no necessity exists for going into such detail. This is the case with machines built in large numbers, where the "weak points" are known. Neither will one go to great lengths with low-cost bearings. However, in customer built or special purpose machines where a seemingly unexplainable bearing damage occurs, the described secondary evidence should, in any case, be a valuable diagnostic aid.

7.1 Bearing Designation



Tables

7.2 Designation of Bearing Series: Ball Bearings

Bearing Series	Ball Bearings									Width or Height Series	Diameter Series
	Deep Groove Ball Bearings	Angular Contact Ball Bearings	Type Self-Aligning Ball Bearings	Thrust Ball Bearings	Angular Contact Thrust Ball Bearings	Single Row or Single Direction	Double Row or Double Direction	With Flat Housing Washer	With Spherical Housing Washer		
618	x					x				1	8
160	x					x				0	0
60	x					x				1	0
62	x					x				0	2
63	x					x				0	3
64	x					x				0	4
42	x						x			2	2
43	x						x			2	3
12			x				x			0	2
112			x				x			0	2
13			x				x			0	3
113			x				x			0	3
22			x				x			2	2
23			x				x			2	3
B 719		x				x				1	9
B 70		x				x				1	0
B 72		x				x				0	2
72		x				x				0	2
73		x				x				0	3
QJ 2		x				x				0	2
QJ 3		x				x				0	3
32		x					x			3	2
33		x					x			3	3
511				x		x		x		1	1
512				x		x		x		1	2
513				x		x		x		1	3
514				x		x		x		1	4
532				x		x			x		2
533				x		x			x		3
534				x		x			x		4
522				x			x	x		2	2
523				x			x	x		2	3
524				x			x	x		2	4
542				x			x		x		2
543				x			x		x		3
544				x			x		x		4
2344					x		x				
2347					x		x				
7602					x	x					
7603					x	x					

7.2 Designation of Bearing Series: Roller Bearings

Bearing Series	Roller Bearings						Single Row	Double Row	Width or Height Series	Diameter Series
	Cylindrical Roller Bearings	Tapered Roller Bearings	Barrel Roller Bearings	Type Spherical Roller Bearings	Cylindrical Roller Thrust Bearings	Spherical Roller Thrust Bearings				
N 2; NU 2; NJ 2; NUP 2	x						x		0	2
N 3; NU 3; NJ 3; NUP 3	x						x		0	3
N 4; NU 4; NJ 4; NUP 4	x						x		0	4
NU 10	x						x		1	0
NU 22; NJ 22; NUP 22	x						x		2	2
NU 23; NJ 23; NUP 23	x						x		2	3
NN 30	x							x	3	0
NNU 49	x							x	4	9
302		x					x		0	2
303		x					x		0	3
313		x					x		1	3
320		x					x		2	0
322		x					x		2	2
323		x					x		2	3
329		x					x		2	9
330		x					x		3	0
331		x					x		3	1
332		x					x		3	2
202			x				x		0	2
203			x				x		0	3
204			x				x		0	4
213				x				x	0	3
222				x				x	2	2
223				x				x	2	3
230				x				x	3	0
231				x				x	3	1
232				x				x	3	2
233				x				x	3	3
239				x				x	3	9
240				x				x	4	0
241				x				x	4	1
292						x	x		9	2
293						x	x		9	3
294						x	x		9	4
811					x		x		1	1
812					x		x		1	2

Tables

7.3 Shaft Tolerances

Dimensions in mm

Nominal shaft diameter	over to	3 6	6 10	10 18	18 30	30 50	50 65	65 80	80 100	100 120	120 140	140 160	160 180	180 200
Tolerance in microns (normal tolerance)														
Bearing bore diameter		0	0	0	0	0	0	0	0	0	0	0	0	0
Deviation Δ_{dmp}		-8	-8	-8	-10	-12	-15	-15	-20	-20	-25	-25	-25	-30
Diagram of fit														
Shaft	Bearing	Shaft tolerance in microns												
e 7		-20 -32	-25 -40	-32 -50	-40 -61	-50 -75	-60 -90	-60 -90	-72 -107	-72 -107	-85 -125	-83 -125	-85 -125	-100 -146
e 8		-20 -38	-25 -47	-32 -59	-40 -73	-50 -89	-60 -106	-60 -106	-72 -126	-72 -126	-85 -148	-85 -148	-85 -148	-100 -172
f 6		-10 -18	-13 -22	-16 -27	-20 -33	-25 -41	-30 -49	-30 -49	-36 -58	-36 -58	-43 -68	-43 -68	-43 -68	-50 -79
f 7		-10 -22	-13 -28	-16 -34	-20 -41	-25 -50	-30 -60	-30 -60	-36 -71	-36 -71	-43 -83	-43 -83	-43 -83	-50 -96
g 5		-4 -9	-5 -11	-6 -14	-7 -16	-9 -20	-10 -23	-10 -23	-12 -27	-12 -27	-14 -32	-14 -32	-14 -32	-15 -35
g 6		-4 -12	-5 -14	-6 -17	-7 -20	-9 -25	-10 -29	-10 -29	-12 -34	-12 -34	-14 -39	-14 -39	-14 -39	-15 -44
h 5		0 -5	0 -6	0 -8	0 -9	0 -11	0 -13	0 -13	0 -15	0 -15	0 -18	0 -18	0 -18	0 -20
h 6		0 -8	0 -9	0 -11	0 -13	0 -16	0 -19	0 -19	0 -22	0 -22	0 -25	0 -25	0 -25	0 -29
j 5		+3 -2	+4 -2	+5 -3	+5 -4	+6 -5	+6 -7	+6 -7	+6 -9	+6 -9	+7 -11	+7 -11	+7 -11	+7 -13
j 6		+6 -2	+7 -2	+8 -3	+9 -4	+11 -5	+12 -7	+12 -7	+13 -9	+13 -9	+14 -11	+14 -11	+14 -11	+16 -13
js 3		+1,25 -1,25	+1,25 -1,25	+1,5 -1,5	+2 -2	+2 -2	+2,5 -2,5	+2,5 -2,5	+3 -3	+3 -3	+4 -4	+4 -4	+4 -4	+5 -5
js 4		+2 -2	+2 -2	+2,5 -2,5	+3 -3	+3,5 -3,5	+4 -4	+4 -4	+5 -5	+5 -5	+6 -6	+6 -6	+6 -6	+7 -7
js 5		+2,5 -2,5	+3 -3	+4 -4	+4,5 -4,5	+5,5 -5,5	+6,5 -6,5	+6,5 -6,5	+7,5 -7,5	+7,5 -7,5	+9 -9	+9 -9	+9 -9	+10 -10
js 6		+4 -4	+4,5 -4,5	+5,5 -5,5	+6,5 -6,5	+8 -8	+9,5 -9,5	+9,5 -9,5	+11 -11	+11 -11	+12,5 -12,5	+12,5 -12,5	+12,5 -12,5	+14,5 -14,5
k 3		+2,5 0	+2,5 0	+3 0	+4 0	+4 0	+5 0	+5 0	+6 0	+6 0	+8 0	+8 0	+8 0	+10 0
k 4		+5 +1	+5 +1	+6 +1	+8 +2	+9 +2	+10 +2	+10 +2	+13 +3	+13 +3	+15 +3	+15 +3	+15 +3	+18 +4
k 5		+6 +1	+7 +1	+9 +1	+11 +2	+13 +2	+15 +2	+15 +2	+18 +3	+18 +3	+21 +3	+21 +3	+21 +3	+24 +4
k 6		+9 +1	+10 +1	+12 +1	+15 +2	+18 +2	+21 +2	+21 +2	+25 +3	+25 +3	+28 +3	+28 +3	+28 +3	+33 +4

200 225	225 250	250 280	280 315	315 355	355 400	400 450	450 500	500 560	560 630	630 710	710 800	800 900	900 1000	1000 1120	1120 1250
0 -30	0 -30	0 -35	0 -35	0 -40	0 -40	0 -45	0 -45	0 -50	0 -50	0 -75	0 -75	0 -100	0 -100	0 -125	0 -125
-100 -146	-100 -146	-110 -162	-110 -162	-125 -182	-125 -182	-135 -198	-135 -198	-145 -215	-145 -215	-160 -240	-160 -240	-170 -260	-170 -260	-195 -300	-195 -300
-100 -172	-100 -172	-110 -191	-110 -191	-125 -214	-125 -214	-135 -232	-135 -232	-145 -255	-145 -255	-160 -285	-160 -285	-170 -310	-170 -310	-195 -360	-195 -360
-50 -79	-50 -79	-56 -88	-56 -88	-62 -98	-62 -98	-68 -108	-68 -108	-76 -120	-76 -120	-80 -130	-80 -130	-86 -142	-86 -142	-98 -164	-98 -164
-50 -96	-50 -96	-56 -108	-56 -108	-62 -119	-62 -119	-68 -131	-68 -131	-76 -146	-76 -146	-80 -160	-80 -160	-86 -176	-86 -176	-98 -203	-98 -203
-15 -35	-15 -35	-17 -40	-17 -40	-18 -43	-18 -43	-20 -47	-20 -47	-22 -51	-22 -51	-24 -56	-24 -56	-26 -62	-26 -62	-28 -70	-28 -70
-15 -44	-15 -44	-17 -49	-17 -49	-18 -54	-18 -54	-20 -60	-20 -60	-22 -66	-22 -66	-24 -74	-24 -74	-26 -82	-26 -82	-28 -94	-28 -94
0 -20	0 -20	0 -23	0 -23	0 -25	0 -25	0 -27	0 -27	0 -29	0 -29	0 -32	0 -32	0 -36	0 -36	0 -42	0 -42
0 -29	0 -29	0 -32	0 -32	0 -36	0 -36	0 -40	0 -40	0 -44	0 -44	0 -50	0 -50	0 -56	0 -56	0 -66	0 -66
+7 -13	+7 -13	+7 -16	+7 -16	+7 -18	+7 -18	+7 -20	+7 -20								
+16 -13	+16 -13	+16 -16	+16 -16	+18 -18	+18 -18	+20 -20	+20 -20	+22 -22	+22 -22	+25 -25	+25 -25	+28 -28	+28 -28	+33 -33	+33 -33
+5 -5	+5 -5	+6 -6	+6 -6	+6,5 -6,5	+6,5 -6,5	+7,5 -7,5	+7,5 -7,5								
+7 -7	+7 -7	+8 -8	+8 -8	+9 -9	+9 -9	+10 -10	+10 -10								
+10 -10	+10 -10	+11,5 -11,5	+11,5 -11,5	+12,5 -12,5	+12,5 -12,5	+13,5 -13,5	+13,5 -13,5	+14,5 -14,5	+14,5 -14,5	+16 -16	+16 -16	+18 -18	+18 -18	+21 -21	+21 -21
+14,5 -14,5	+14,5 -14,5	+16 -16	+16 -16	+18 -18	+18 -18	+20 -20	+20 -20	+22 -22	+22 -22	+25 -25	+25 -25	+28 -28	+28 -28	+33 -33	+33 -33
+10 0	+10 0	+12 0	+12 0	+13 0	+13 0	+15 0	+15 0								
+18 +4	+18 +4	+20 +4	+20 +4	+22 +4	+22 +4	+25 +5	+25 +5								
+24 +4	+24 +4	+27 +4	+27 +4	+29 +4	+29 +4	+32 +5	+32 +5	+29 0	+29 0	+32 0	+32 0	+36 0	+36 0	+42 0	+42 0
+33 +4	+33 +4	+36 +4	+36 +4	+40 +4	+40 +4	+45 +5	+45 +5	+44 +0	+44 +0	+50 +0	+50 +0	+56 +0	+56 +0	+66 +0	+66 +0

Tables

7.3 Shaft Tolerances (continuation)

Dimensions in mm

Nominal shaft diameter	over to	3 6	6 10	10 18	18 30	30 50	50 65	65 80	80 100	100 120	120 140	140 160	160 180	180 200
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Tolerance in microns (normal tolerance)

Bearing bore diameter	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deviation Δ_{dmp}	-8	-8	-8	-10	-12	-15	-15	-20	-20	-25	-25	-25	-25	-30

Diagram of fit Shaft	Bearing	Shaft tolerance in microns												
m 5		+9 +4	+12 +6	+15 +7	+17 +8	+20 +9	+24 +11	+24 +11	+28 +13	+28 +13	+33 +15	+33 +15	+33 +15	+37 +17
m 6		+12 +4	+15 +6	+18 +7	+21 +8	+25 +9	+30 +11	+30 +11	+35 +13	+35 +13	+40 +15	+40 +15	+40 +15	+46 +17
n 5		+13 +8	+16 +10	+20 +12	+24 +15	+28 +17	+33 +20	+33 +20	+38 +23	+38 +23	+45 +27	+45 +27	+45 +27	+51 +31
n 6		+16 +8	+19 +10	+23 +12	+28 +15	+33 +17	+39 +20	+39 +20	+45 +23	+45 +23	+52 +27	+52 +27	+52 +27	+60 +31
p 6		+20 +12	+24 +15	+29 +18	+35 +22	+42 +26	+51 +32	+51 +32	+59 +37	+59 +37	+68 +43	+68 +43	+68 +43	+79 +50
p 7		+24 +12	+30 +15	+36 +18	+43 +22	+51 +26	+62 +32	+62 +32	+72 +37	+72 +37	+83 +43	+83 +43	+83 +43	+96 +50
r 6		+23 +15	+28 +19	+34 +23	+41 +28	+50 +34	+60 +41	+62 +43	+73 +51	+76 +54	+88 +63	+90 +65	+93 +68	+106 +77
r 7		+27 +15	+34 +19	+41 +23	+49 +28	+59 +34	+71 +41	+73 +43	+86 +51	+89 +54	+103 +63	+105 +65	+108 +68	+123 +77
s 6		+27 +19	+32 +23	+39 +28	+48 +35	+59 +43	+72 +53	+78 +59	+93 +71	+101 +79	+117 +92	+125 +100	+133 +108	+151 +122
s 7		+31 +19	+38 +23	+46 +28	+56 +35	+68 +43	+83 +53	+89 +59	+106 +71	+114 +79	+132 +92	+140 +100	+148 +108	+168 +122

Shaft tolerance for withdrawal sleeves and adapter sleeves (microns)

$h7/IT5$		0 -12 2,5	0 -15 3	0 -18 4	0 -21 4,5	0 -25 5,5	0 -30 6,5	0 -30 6,5	0 -35 7,5	0 -35 7,5	0 -40 9	0 -40 9	0 -40 9	0 -46 10
$h8/IT5$		0 -18 2,5	0 -22 3	0 -27 4	0 -33 4,5	0 -39 5,5	0 -46 6,5	0 -46 6,5	0 -54 7,5	0 -54 7,5	0 -63 9	0 -63 9	0 -63 9	0 -72 10
$h9/IT6$		0 -30 4	0 -36 4,5	0 -43 5,5	0 -52 6,5	0 -62 8	0 -74 9,5	0 -74 9,5	0 -87 11	0 -87 11	0 -100 12,5	0 -100 12,5	0 -100 12,5	0 -115 14,5
$h10/IT7$		0 -48 6	0 -58 7,5	0 -70 9	0 -84 10,5	0 -100 12,5	0 -120 15	0 -120 15	0 -140 17,5	0 -140 17,5	0 -160 20	0 -160 20	0 -160 20	0 -185 23

The cylindricity tolerance (blue numbers) refers to the radius (DIN ISO 1101).
Double the tolerance values for measuring the shaft diameter.
For general mechanical engineering, h7 and h8 values are preferable.

200 225	225 250	250 280	280 315	315 355	355 400	400 450	450 500	500 560	560 630	630 710	710 800	800 900	900 1000	1000 1120	1120 1250
0 -30	0 -30	0 -35	0 -35	0 -40	0 -40	0 -45	0 -45	0 -50	0 -50	0 -75	0 -75	0 -100	0 -100	0 -125	0 -125
+37 +17	+37 +17	+43 +20	+43 +20	+46 +21	+46 +21	+50 +23	+50 +23	+55 +26	+55 +26	+62 +30	+62 +30	+70 +34	+70 +34	+82 +40	+82 +40
+46 +17	+46 +17	+52 +20	+52 +20	+57 +21	+57 +21	+63 +23	+63 +23	+70 +26	+70 +26	+80 +30	+80 +30	+90 +34	+90 +34	+106 +40	+106 +40
+51 +31	+51 +31	+57 +34	+57 +34	+62 +37	+62 +37	+67 +40	+67 +40	+73 +44	+73 +44	+82 +50	+82 +50	+92 +56	+92 +56	+108 +66	+108 +66
+60 +31	+60 +31	+66 +34	+66 +34	+73 +37	+73 +37	+80 +40	+80 +40	+88 +44	+88 +44	+100 +50	+100 +50	+112 +56	+112 +56	+132 +66	+132 +66
+79 +50	+79 +50	+88 +56	+88 +56	+98 +62	+98 +62	+108 +68	+108 +68	+122 +78	+122 +78	+138 +88	+138 +88	+156 +100	+156 +100	+186 +120	+186 +120
+96 +50	+96 +50	+108 +56	+108 +56	+119 +62	+119 +62	+131 +68	+131 +68	+148 +78	+148 +78	+168 +88	+168 +88	+190 +100	+190 +100	+225 +120	+225 +120
+109 +80	+113 +84	+126 +94	+130 +98	+144 +108	+150 +114	+166 +126	+172 +132	+194 +150	+199 +155	+225 +175	+235 +185	+266 +210	+276 +220	+316 +250	+326 +260
+126 +80	+130 +84	+146 +94	+150 +98	+165 +108	+171 +114	+189 +126	+195 +132	+220 +150	+225 +155	+255 +175	+265 +185	+300 +210	+310 +220	+355 +250	+365 +260
+159 +130	+169 +140	+190 +158	+202 +170	+226 +190	+244 +208	+272 +232	+292 +252	+324 +280	+354 +310	+390 +340	+430 +380	+486 +430	+526 +470	+586 +520	+646 +580
+176 +130	+186 +140	+210 +158	+222 +170	+247 +190	+265 +208	+295 +232	+315 +252	+350 +280	+380 +310	+420 +340	+460 +380	+520 +430	+560 +470	+625 +520	+685 +580
0 -46 10	0 -46 10	0 -52 11,5	0 -52 11,5	0 -57 12,5	0 -57 12,5	0 -63 13,5	0 -63 13,5	0 -70 14,5	0 -70 14,5	0 -80 16	0 -80 16	0 -90 18	0 -90 18	0 -105 21	0 -105 21
0 -72 10	0 -72 10	0 -81 11,5	0 -81 11,5	0 -89 12,5	0 -89 12,5	0 -97 13,5	0 -97 13,5	0 -110 14,5	0 -110 14,5	0 -125 16	0 -125 16	0 -140 18	0 -140 18	0 -165 21	0 -165 21
0 -115 14,5	0 -115 14,5	0 -130 16	0 -130 16	0 -140 18	0 -140 18	0 -155 20	0 -155 20	0 -175 22	0 -175 22	0 -200 25	0 -200 25	0 -230 28	0 -230 28	0 -260 33	0 -260 33
0 -185 23	0 -185 23	0 -210 26	0 -210 26	0 -230 28,5	0 -230 28,5	0 -250 31,5	0 -250 31,5	0 -280 35	0 -280 35	0 -320 40	0 -320 40	0 -360 45	0 -360 45	0 -420 52,5	0 -420 52,5

Tables

7.4 Housing Tolerances

Dimensions in mm													
Nomin. housing over bore diameter to	6 10	10 18	18 30	30 50	50 65	65 80	80 100	100 120	120 140	140 160	160 180	180 200	200 225
Tolerance in microns (normal tolerance)													
Bearing outside dia. Deviation Δ_{Dmp}	0 -8	0 -8	0 -9	0 -11	0 -13	0 -13	0 -15	0 -15	0 -18	0 -18	0 -25	0 -30	0 -30
Diagram of fit Housing Bearing	Housing tolerance in microns												
D 10		+98 +40	+120 +50	+149 +65	+180 +80	+220 +100	+220 +100	+260 +120	+260 +120	+305 +145	+305 +145	+355 +170	+355 +170
E 8		+47 +25	+59 +32	+73 +40	+89 +50	+106 +60	+106 +60	+126 +72	+126 +72	+148 +85	+148 +85	+172 +100	+172 +100
F 7		+28 +13	+34 +16	+41 +20	+50 +25	+60 +30	+60 +30	+71 +36	+71 +36	+83 +43	+83 +43	+96 +50	+96 +50
G 6		+14 +5	+17 +6	+20 +7	+25 +9	+29 +10	+29 +10	+34 +12	+34 +12	+39 +14	+39 +14	+44 +15	+44 +15
G 7		+20 +5	+24 +6	+28 +7	+34 +9	+40 +10	+40 +10	+47 +12	+47 +12	+54 +14	+54 +14	+61 +15	+61 +15
H 5		+6 0	+8 0	+9 0	+11 0	+13 0	+13 0	+15 0	+15 0	+18 0	+18 0	+20 0	+20 0
H 6		+9 0	+11 0	+13 0	+16 0	+19 0	+19 0	+22 0	+22 0	+25 0	+25 0	+29 0	+29 0
H 7		+15 0	+18 0	+21 0	+25 0	+30 0	+30 0	+35 0	+35 0	+40 0	+40 0	+46 0	+46 0
H 8		+22 0	+27 0	+33 0	+39 0	+46 0	+46 0	+54 0	+54 0	+63 0	+63 0	+72 0	+72 0
J 6		+5 -4	+6 -5	+8 -5	+10 -6	+13 -6	+13 -6	+16 -6	+16 -6	+18 -7	+18 -7	+22 -7	+22 -7
J 7		+8 -7	+10 -8	+12 -9	+14 -11	+18 -12	+18 -12	+22 -13	+22 -13	+26 -14	+26 -14	+30 -16	+30 -16
JS 4		+2 -2	+2,5 -2,5	+3 -3	+3,5 -3,5	+4 -4	+4 -4	+5 -5	+5 -5	+6 -6	+6 -6	+7 -7	+7 -7
JS 5		+3 -3	+4 -4	+4,5 -4,5	+5,5 -5,5	+6,5 -6,5	+6,5 -6,5	+7,5 -7,5	+7,5 -7,5	+9 -9	+9 -9	+10 -10	+10 -10
JS 6		+4,5 -4,5	+5,5 -5,5	+6,5 -6,5	+8 -8	+9,5 -9,5	+9,5 -9,5	+11 -11	+11 -11	+12,5 -12,5	+12,5 -12,5	+14,5 -14,5	+14,5 -14,5
JS 7		+7,5 -7,5	+9 -9	+10,5 -10,5	+12,5 -12,5	+15 -15	+15 -15	+17,5 -17,5	+17,5 -17,5	+20 -20	+20 -20	+23 -23	+23 -23
K 4		+0,5 -3,5	+1 -4	0 -6	+1 -6	+1 -7	+1 -7	+1 -9	+1 -9	+1 -11	+1 -11	0 -14	0 -14
K 5		+1 -5	+2 -6	+1 -8	+2 -9	+3 -10	+3 -10	+2 -13	+2 -13	+3 -15	+3 -15	+2 -18	+2 -18
K 6		+2 -7	+2 -9	+2 -11	+3 -13	+4 -15	+4 -15	+4 -18	+4 -18	+4 -21	+4 -21	+5 -24	+5 -24

Tables

225 250	250 280	280 315	315 355	355 400	400 450	450 500	500 560	560 630	630 710	710 800	800 900	900 1000	1000 1120	1120 1250	1250 1400
0 -30	0 -35	0 -35	0 -40	0 -40	0 -45	0 -45	0 -50	0 -50	0 -75	0 -75	0 -100	0 -100	0 -125	0 -125	0 -160
+355 +170	+400 +190	+400 +190	+440 +210	+440 +210	+480 +230	+480 +230	+540 +260	+540 +260	+610 +290	+610 +290	+680 +320	+680 +320	+770 +350	+770 +350	+890 +390
+172 +100	+191 +110	+191 +110	+214 +125	+214 +125	+232 +135	+232 +135	+255 +145	+255 +145	+285 +160	+285 +160	+310 +170	+310 +170	+360 +195	+360 +195	+415 +220
+96 +50	+108 +56	+108 +56	+119 +62	+119 +62	+131 +68	+131 +68	+144 +76	+144 +76	+160 +80	+160 +80	+176 +86	+176 +86	+203 +98	+203 +98	+235 +110
+44 +15	+49 +17	+49 +17	+54 +18	+54 +18	+60 +20	+60 +20	+66 +22	+66 +22	+74 +24	+74 +24	+82 +26	+82 +26	+94 +28	+94 +28	+108 +30
+61 +15	+69 +17	+69 +17	+75 +18	+75 +18	+83 +20	+83 +20	+92 +22	+92 +22	+104 +24	+104 +24	+116 +26	+116 +26	+133 +28	+133 +28	+155 +30
+20 0	+23 0	+23 0	+25 0	+25 0	+27 0	+27 0									
+29 0	+32 0	+32 0	+36 0	+36 0	+40 0	+40 0	+44 0	+44 0	+50 0	+50 0	+56 0	+56 0	+66 0	+66 0	+78 0
+46 0	+52 0	+52 0	+57 0	+57 0	+63 0	+63 0	+70 0	+70 0	+80 0	+80 0	+90 0	+90 0	+105 0	+105 0	+125 0
+72 0	+81 0	+81 0	+89 0	+89 0	+97 0	+97 0	+110 0	+110 0	+125 0	+125 0	+140 0	+140 0	+165 0	+165 0	+195 0
+22 -7	+25 -7	+25 -7	+29 -7	+29 -7	+33 -7	+33 -7									
+30 -16	+36 -16	+36 -16	+39 -18	+39 -18	+43 -20	+43 -20									
+7 -7	+8 -8	+8 -8	+9 -9	+9 -9	+10 -10	+10 -10									
+10 -10	+11,5 -11,5	+11,5 -11,5	+12,5 -12,5	+12,5 -12,5	+13,5 -13,5	+13,5 -13,5									
+14,5 -14,5	+16 -16	+16 -16	+18 -18	+18 -18	+20 -20	+20 -20	+22 -22	+22 -22	+25 -25	+25 -25	+28 -28	+28 -28	+33 -33	+33 -33	+39 -39
+23 -23	+26 -26	+26 -26	+28,5 -28,5	+28,5 -28,5	+31,5 -31,5	+31,5 -31,5	+35 -35	+35 -35	+40 -40	+40 -40	+45 -45	+45 -45	+52 -52	+52 -52	+62 -62
0 -14	0 -16	0 -16	0 -17	0 -17	0 -20	0 -20									
+2 -18	+3 -20	+3 -20	+3 -22	+3 -22	+2 -25	+2 -25									
+5 -24	+5 -27	+5 -27	+7 -29	+7 -29	+8 -32	+8 -32	0 -44	0 -44	0 -50	0 -50	0 -56	0 -56	0 -66	0 -66	0 -78

Tables

7.4 Housing Tolerances (continuation)

Dimensions in mm													
Nomin. housing over bore diameter to	6 10	10 18	18 30	30 50	50 65	65 80	80 100	100 120	120 140	140 160	160 180	180 200	200 225
Tolerance in microns (normal tolerance)													
Bearing outside dia. Deviation Δ_{Dmp}	0 -8	0 -8	0 -9	0 -11	0 -13	0 -13	0 -15	0 -15	0 -18	0 -18	0 -25	0 -30	0 -30
Diagram of fit													
Housing	Bearing												
K 7		Housing tolerance in microns											
		+5 -10	+6 -12	+6 -15	+7 -18	+9 -21	+9 -21	+10 -25	+10 -25	+12 -28	+12 -28	+12 -28	+13 -33
M 6		Housing tolerance in microns											
		-3 -12	-4 -15	-4 -17	-4 -20	-5 -24	-5 -24	-6 -28	-6 -28	-8 -33	-8 -33	-8 -33	-8 -37
M 7		Housing tolerance in microns											
		0 -15	0 -18	0 -21	0 -25	0 -30	0 -30	0 -35	0 -35	0 -40	0 -40	0 -40	0 -46
N 6		Housing tolerance in microns											
		-7 -16	-9 -20	-11 -24	-12 -28	-14 -33	-14 -33	-16 -38	-16 -38	-20 -45	-20 -45	-20 -45	-22 -51
N 7		Housing tolerance in microns											
		-4 -19	-5 -23	-7 -28	-8 -33	-9 -39	-9 -39	-10 -45	-10 -45	-12 -52	-12 -52	-12 -52	-14 -60
P 6		Housing tolerance in microns											
		-12 -21	-15 -26	-18 -31	-21 -37	-26 -45	-26 -45	-30 -52	-30 -52	-36 -61	-36 -61	-36 -61	-41 -70
P 7		Housing tolerance in microns											
		-9 -24	-11 -29	-14 -35	-17 -42	-21 -51	-21 -51	-24 -59	-24 -59	-28 -68	-28 -68	-28 -68	-33 -79
R 6		Housing tolerance in microns											
		-16 -25	-20 -31	-24 -37	-29 -45	-35 -54	-37 -56	-44 -66	-47 -69	-56 -81	-58 -83	-61 -86	-68 -100
S 6		Housing tolerance in microns											
		-20 -29	-25 -36	-31 -44	-38 -54	-47 -66	-53 -72	-64 -86	-72 -94	-85 -110	-93 -118	-101 -126	-113 -150

225 250	250 280	280 315	315 355	355 400	400 450	450 500	500 560	560 630	630 710	710 800	800 900	900 1000	1000 1120	1120 1250	1250 1400
0 -30	0 -35	0 -35	0 -40	0 -40	0 -45	0 -45	0 -50	0 -50	0 -75	0 -75	0 -100	0 -100	0 -125	0 -125	0 -160
+13 -33	+16 -36	+16 -36	+17 -40	+17 -40	+18 -45	+18 -45	0 -70	0 -70	0 -80	0 -80	0 -90	0 -90	0 -105	0 -105	0 -125
-8 -37	-9 -41	-9 -41	-10 -46	-10 -46	-10 -50	-10 -50	-26 -70	-26 -70	-30 -80	-30 -80	-34 -90	-34 -90	-40 -106	-40 -106	-48 -126
0 -46	0 -52	0 -52	0 -57	0 -57	0 -63	0 -63									
-22 -51	-25 -57	-25 -57	-26 -62	-26 -62	-27 -67	-27 -67	-44 -88	-44 -88	-50 -100	-50 -100	-56 -112	-56 -112	-66 -132	-66 -132	-78 -156
-14 -60	-14 -66	-14 -66	-16 -73	-16 -73	-17 -80	-17 -80									
-41 -70	-47 -79	-47 -79	-51 -87	-51 -87	-55 -95	-55 -95	-78 -122	-78 -122	-88 -138	-88 -138	-100 -156	-100 -156	-120 -186	-120 -186	-140 -218
-33 -79	-36 -88	-36 -88	-41 -98	-41 -98	-45 -108	-45 -108	-78 -148	-78 -148	-88 -168	-88 -168	-100 -190	-100 -190	-120 -225	-120 -225	-140 -265
-75 -104	-85 -117	-89 -121	-97 -133	-103 -139	-113 -153	-119 -159	-150 -194	-155 -199	-175 -225	-185 -235	-210 -266	-220 -276	-250 -316	-260 -326	-300 -378
-131 -160	-149 -181	-161 -193	-179 -215	-197 -233	-219 -259	-239 -279									

Tables

7.5 Normal Tolerances of FAG Radial Bearings (Except Tapered Roller Bearings)

Inner ring

Dimensions in mm																
Nominal bore diameter d	over to	2,5 10	10 18	18 30	30 50	50 80	80 120	120 180	180 250	250 315	315 400	400 500	500 630	630 800	800 1000	1000 1250
Tolerance class PN (normal tolerance)																
Tolerance in microns																
Bore, cylindrical		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deviation	Δ_{dmp}	-8	-8	-10	-12	-15	-20	-25	-30	-35	-40	-45	-50	-75	-100	-125
Variation	diameter series 7 · 8 · 9	10	10	13	15	19	25	31	38	44	50	56	63			
V_{dp}	0 · 1	8	8	10	12	19	25	31	38	44	50	56	63			
	2 · 3 · 4	6	6	8	9	11	15	19	23	26	30	34	38			
Variation	V_{dmp}	6	6	8	9	11	15	19	23	26	30	34	38			
Bore, taper	1:12	+15	+18	+21	+25	+30	+35	+40	+46	+52	+57	+63	+70	+80	+90	+105
Deviation	Δ_{dmp}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deviation	$\Delta_{d1mp} - \Delta_{dmp}$	+15	+18	+21	+25	+30	+35	+40	+46	+52	+57	+63	+70	+80	+90	+105
Variation	V_{dp}	10	10	13	15	19	25	31	38	44	50	56				
Bore, taper	1:30					+15	+20	+25	+30	+35	+40	+45	+50	+75	+100	+125
Deviation	Δ_{dmp}					0	0	0	0	0	0	0	0	0	0	0
Deviation	$\Delta_{d1mp} - \Delta_{dmp}$					+35	+40	+50	+55	+60	+65	+75	+85	+100	+100	+115
Variation	V_{dp}					19	25	31	38	44	50	56	63			
Width deviation	Δ_{Bs}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		-120	-120	-120	-120	-150	-200	-250	-300	-350	-400	-450	-500	-750	-1000	-1250
Width variation	V_{Bs}	15	20	20	20	25	25	30	30	35	40	50	60	70	80	100
Radial runout	K_{ia}	10	10	13	15	20	25	30	40	50	60	65	70	80	90	100

Bore diameter

- Δ_{dmp} Single plane mean bore diameter deviation
- Δ_{d1mp} Deviation of mean large diameter from nominal dimension (tapered bore)
- V_{dp} Bore diameter variation in a single radial plane
- V_{dmp} Mean bore diameter variation; difference between maximum and minimum mean bore diameter

Outside diameter

- Δ_{Dmp} Single plane mean outside diameter deviation
- V_{Dp} Outside diameter variation in a single radial plane
- V_{Dmp} Mean outside diameter variation; difference between maximum and minimum mean outside diameter

Outer ring

Nominal outside diameter D	Dimensions in mm															
	over to	6 18	18 30	30 50	50 80	80 120	120 150	150 180	180 250	250 315	315 400	400 500	500 630	630 800	800 1000	1000 1250

Tolerance class PN (normal tolerance)

		Tolerance in microns															
Deviation	Δ_{Dmp}	0 -8	0 -9	0 -11	0 -13	0 -15	0 -18	0 -25	0 -30	0 -35	0 -40	0 -45	0 -50	0 -75	0 -100	0 -125	0 -160
Variation V_{Dp}	diameter series 7-8-9	10	12	14	16	19	23	31	38	44	50	56	63	94	125		
	0-1	8	9	11	13	19	23	31	38	44	50	56	63	94	125		
	2-3-4	6	7	8	10	11	14	19	23	26	30	34	38	55	75		
	sealed bear- ings 2-3-4	10	12	16	20	26	30	38									
Variation	V_{Dmp}	6	7	8	10	11	14	19	23	26	30	34	38	55	75		
Radial runout	K_{ea}	15	15	20	25	35	40	45	50	60	70	80	100	120	140	160	190

The width tolerances Δ_{Cs} and V_{Cs} are identical to Δ_{Bs} and V_{Bs} for the pertinent inner ring.

Width

Δ_B, Δ_{Cs} Deviation of a single ring width (inner and outer ring) from nominal dimension
 V_{Bs}, V_{Cs} Variation of inner ring width and outer ring width

Running accuracy

K_{ia} Radial runout of assembled bearing inner ring
 K_{ea} Radial runout of assembled bearing outer ring

Tables

7.6 Normal Tolerances of FAG Tapered Roller Bearings in Metric Dimensions

Cone

		Dimensions in mm										
Nominal bore diameter d	over to	10 18	18 30	30 50	50 80	80 120	120 180	180 250	250 315	315 400	400 500	500 630

Tolerance class PN (normal tolerance)

		Tolerance in microns										
Deviation	Δ_{dmp}	0 -12	0 -12	0 -12	0 -15	0 -20	0 -25	0 -30	0 -35	0 -40	0 -45	0 -50
Variation	V_{dp}	12	12	12	15	20	25	30	35	40	45	50
	V_{dmp}	9	9	9	11	15	19	23	26	30		
Width deviation	Δ_{Bs}	0 -120	0 -120	0 -120	0 -150	0 -200	0 -250	0 -300	0 -350	0 -400	0 -450	0 -500
Radial runout	K_{ia}	15	18	20	25	30	35	50	60	70	70	85
Width deviation	Δ_{Ts}	+200 0	+200 0	+200 0	+200 0	+200 -200	+350 -250	+350 -250	+350 -250	+400 -400	+400 -400	+500 -500
	Δ_{T1s}	+100 0	+100 0	+100 0	+100 0	+100 -100	+150 -150	+150 -150	+150 -150	+200 -200		
	Δ_{T2s}	+100 0	+100 0	+100 0	+100 0	+100 -100	+200 -100	+200 -100	+200 -100	+200 -200		

Cup

		Dimensions in mm												
Nominal outside diameter D	over to	18	30	50	80	120	150	180	250	315	400	500	630	800
		30	50	80	120	150	180	250	315	400	500	630	800	1000

Tolerance class PN (normal tolerance)

		Tolerance in microns												
Deviation	Δ_{Dmp}	0 -12	0 -14	0 -16	0 -18	0 -20	0 -25	0 -30	0 -35	0 -40	0 -45	0 -50	0 -75	0 -100
Variation	V_{Dp}	12	14	16	18	20	25	30	35	40	45	50	75	100
	V_{Dmp}	9	11	12	14	15	19	23	26	30	34	38		
Radial runout	K_{ea}	18	20	25	35	40	45	50	60	70	80	100	120	120

The width tolerance Δ_{Cs} is identical with Δ_{Bs} for the pertinent inner ring.

- T_s
 T_{1s}
 T_{2s}
 $\Delta_{Ts} = T_s - T$
 $H_s, H_{1s}, H_{2s}, H_{3s}, H_{4s}$
 $\Delta_{Hs} = H_s - H$
 H
 H_1
 H_2
 H_3
 H_4

Overall width of a tapered roller bearing, measured at a single position
Overall width of a tapered roller bearing, measured at a single position by cone and master cup
Overall width of a tapered roller bearing, measured at a single position by cup and master cone
Deviation of a single tapered roller bearing overall width from nominal dimension
Overall thrust bearing height measured at a single position
Deviation of a single overall thrust bearing height from nominal dimension
Overall height of a single direction thrust bearing
Overall height of a single direction thrust bearing with seating ring
Overall height of a double direction thrust bearing
Overall height of a double direction thrust bearing with seating rings
Overall height of a spherical roller thrust bearing

7.7 Normal Tolerances of FAG Thrust Bearings

Shaft washer

Dimensions in mm

Nominal bore diameter d_w	over to	18	30	50	80	120	180	250	315	400	500	630	800	1000	1250
-----------------------------	---------	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	------	------

Tolerance class PN (normal tolerance)

Tolerance in microns

Deviation Δ_{amp}	0 -8	0 -10	0 -12	0 -15	0 -20	0 -25	0 -30	0 -35	0 -40	0 -45	0 -50	0 -75	0 -100	0 -125
Variation V_{dp}	6	8	9	11	15	19	23	26	30	34	38			
Wall thickness variation S_{17}	10	10	10	10	15	15	20	25	30	30	35	40	45	50
Seating ring deviation Δ_{du}	+70 0	+70 0	+85 0	+100 0	+120 0	+140 0	+140 0	+160 0	+180 0	+180 0				

Housing washer

Dimensions in mm

Nominal outside diameter D_g	over to	18	30	50	80	120	180	250	315	400	500	630	800	1000	1250	1600
--------------------------------	---------	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------

Tolerance class PN (normal tolerance)

Tolerance in microns

Deviation Δ_{Dmp}	0 -13	0 -16	0 -19	0 -22	0 -25	0 -30	0 -35	0 -40	0 -45	0 -50	0 -75	0 -100	0 -125	0 -160
Variation V_{Dp}	10	12	14	17	19	23	26	30	34	38	55	75		
Seating ring deviation Δ_{Du}	0 -30	0 -35	0 -45	0 -60	0 -75	0 -90	0 -105	0 -120	0 -135	0 -180				

*) The values of the wall thickness variation apply to shaft and housing washers

Construction Heights of Thrust Bearings

Dimensions in mm

Nominal bore diameter d_w	over to	30	50	80	120	180	250	315	400	500	630	800	1000	1250
-----------------------------	---------	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	------	------

Tolerance classes PN ... P4

Tolerance in microns

Deviation Δ_{Hs}	+20 -250	+20 -250	+20 -300	+25 -300	+25 -400	+30 -400	+40 -400	+40 -500	+50 -500	+60 -600	+70 -750	+80 -1000	+100 -1400
Δ_{H1s}	+100 -250	+100 -250	+100 -300	+150 -300	+150 -400	+150 -400	+200 -400	+200 -500	+300 -500	+350 -600	+400 -750	+450 -1000	+500 -1400
Δ_{H2s}	+150 -400	+150 -400	+150 -500	+200 -500	+200 -600	+250 -600	+350 -700	+350 -700	+400 -900	+500 -1100	+600 -1300	+700 -1500	+900 -1800
Δ_{H3s}	+300 -400	+300 -400	+300 -500	+400 -500	+400 -600	+500 -600	+600 -700	+600 -700	+750 -900	+900 -1100	+1100 -1300	+1300 -1500	+1600 -1800
Δ_{H4s}	+20 -300	+20 -300	+20 -400	+25 -400	+25 -500	+30 -500	+40 -700	+40 -700	+50 -900	+60 -1200	+70 -1400	+80 -1800	+100 -2400

Tables

7.8 Limit Dimensions of Chamfer

Symbols

r_{1s}, r_{3s}	chamfer in radial direction
r_{2s}, r_{4s}	chamfer in axial direction
r_{smin}	general symbol for the minimum chamfer $r_{1smin}, r_{2smin}, r_{3smin}, r_{4smin}$
r_{1smax}, r_{3smax}	maximum chamfer in radial direction
r_{2smax}, r_{4smax}	maximum chamfer in axial direction

Chamfer of radial bearings (except tapered roller bearings)

Dimensions in mm													
r_{smin}	0,1	0,15	0,2	0,3	0,6		1		1,1		1,5		
Nominal bore diameter d	over to			40	40	40	40	50	50	120	120	120	120
r_{1smax}	0,2	0,3	0,5	0,6	0,8	1	1,3	1,5	1,9	2	2,5	2,3	3
r_{2smax}	0,4	0,6	0,8	1	1	2	2	3	3	3,5	4	4	5

Chamfer of tapered roller bearings in metric dimensions Cone

Dimensions in mm												
r_{smin}	0,3	0,6		1		1,5			2			
Nominal bore diameter d	over to	40	40	40	40	50	50	120	120	250	250	250
r_{1smax}	0,7	0,9	1,1	1,3	1,6	1,9	2,3	2,8	3,5	2,8	3,5	4
r_{2smax}	1,4	1,6	1,7	2	2,5	3	3	3,5	4	4	4,5	5

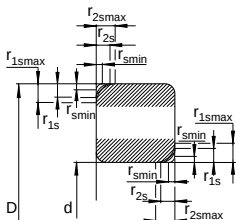
Cup

Dimensions in mm												
r_{smin}	0,3	0,6		1		1,5			2			
Nominal outside diameter D	over to	40	40	40	40	50	50	120	120	250	250	250
r_{3smax}	0,7	0,9	1,1	1,3	1,6	1,9	2,3	2,8	3,5	2,8	3,5	4
r_{4smax}	1,4	1,6	1,7	2	2,5	3	3	3,5	4	4	4,5	5

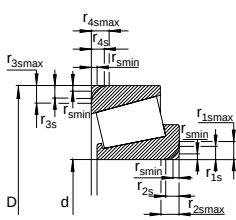
Chamfer of thrust bearings

Dimensions in mm																		
r_{smin}	0,1	0,15	0,2	0,3	0,6	1	1,1	1,5	2	2,1	3	4	5	6	7,5	9,5	12	15
r_{1smax}, r_{2smax}	0,2	0,3	0,5	0,8	1,5	2,2	2,7	3,5	4	4,5	5,5	6,5	8	10	12,5	15	18	21

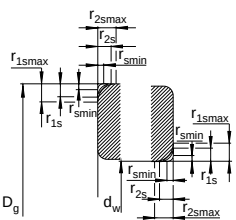
Radial bearings



Tapered roller bearings



Thrust bearings



	2			2,1		2,5		3		4	5	6	7,5	9,5	12	15	19
	80	80 220	220	280	280	100	100 280	280	280								
	3	3,5	3,8	4	4,5	3,8	4,5	5	5	5,5	6,5	8	10	12,5	15	18	21
	4,5	5	6	6,5	7	6	6	7	8	8	9	10	13	17	19	24	30

	2,5			3				4				5		6			
	120	120 250	250	120	120 250	250 400	400	120	120 250	250 400	400	180	180	180	180	180	180
	3,5	4	4,5	4	4,5	5	5,5	5	5,5	6	6,5	6,5	7,5	7,5	9		
	5	5,5	6	5,5	6,5	7	7,5	7	7,5	8	8,5	8	9	10	11		

	2,5			3				4				5		6			
	120	120 250	250	120	120 250	250 400	400	120	120 250	250 400	400	180	180	180	180	180	180
	3,5	4	4,5	4	4,5	5	5,5	5	5,5	6	6,5	6,5	7,5	7,5	9		
	5	5,5	6	5,5	6,5	7	7,5	7	7,5	8	8,5	8	9	10	11		

Tables

7.9 Radial Clearance of FAG Deep Groove Ball Bearings

Dimensions in mm																
Nominal bore diameter	over to	2,5 6	6 10	10 18	18 24	24 30	30 40	40 50	50 65	65 80	80 100	100 120	120 140	140 160	160 180	180 200

Bearing clearance in microns																
Clearance group C2	min	0	0	0	0	1	1	1	1	1	2	2	2	2	2	
	max	7	7	9	10	11	11	11	15	15	18	20	23	23	25	30
Clearance group CN (norm.)	min	2	2	3	5	5	6	6	8	10	12	15	18	18	20	25
	max	13	13	18	20	20	20	23	28	30	36	41	48	53	61	71
Clearance group C3	min	8	8	11	13	13	15	18	23	25	30	36	41	46	53	63
	max	23	23	25	28	28	33	36	43	51	58	66	81	91	102	117
Clearance group C4	min		14	18	20	23	28	30	38	46	53	61	71	81	91	107
	max		29	33	36	41	46	51	61	71	84	97	114	130	147	163

Dimensions in mm																	
Nominal bore diameter	over to	200	225	250	280	315	355	400	450	500	560	630	710	800	900	1000	1120
		225	250	280	315	355	400	450	500	560	630	710	800	900	1000	1120	1250

Bearing clearance in microns																	
Clearance group C2	min	4	4	4	8	8	8	10	10	20	20	30	30	30	40	40	40
	max	32	36	39	45	50	60	70	80	90	100	120	130	150	160	170	180
Clearance group CN (norm.)	min	28	31	36	42	50	60	70	80	90	100	120	130	150	160	170	180
	max	82	92	97	110	120	140	160	180	200	220	250	280	310	340	370	400
Clearance group C3	min	73	87	97	110	120	140	160	180	200	220	250	280	310	340	370	400
	max	132	152	162	180	200	230	260	290	320	350	390	440	490	540	590	640
Clearance group C4	min	120	140	152	175	200	230	260	290	320	350	390	440	490	540	590	640
	max	187	217	237	260	290	330	370	410	460	510	560	620	690	760	840	910

7.10 Radial Clearance of FAG Self-Aligning Ball Bearings

Dimensions in mm															
Nominal bore diameter	over to	2,5 6	6 10	10 14	14 18	18 24	24 30	30 40	40 50	50 65	65 80	80 100	100 120	120 140	140 160

with cylindrical bore

Bearing clearance in microns															
Clearance group C2	min	1	2	2	3	4	5	6	6	7	8	9	10	10	15
	max	8	9	10	12	14	16	18	19	21	24	27	31	38	44
Clearance group CN (norm.)	min	5	6	6	8	19	11	13	14	16	18	22	25	30	35
	max	15	17	19	21	23	24	29	31	36	40	48	56	68	80
Clearance group C3	min	10	12	13	15	17	19	23	25	30	35	42	50	60	70
	max	20	25	26	28	30	35	40	44	50	60	70	83	100	120
Clearance group C4	min	15	19	21	23	25	29	34	37	45	54	64	75	90	110
	max	25	33	35	37	39	46	53	57	69	83	96	114	135	161

with tapered bore

Bearing clearance in microns															
Clearance group C2	min max					7 17	9 20	12 24	14 27	18 32	23 39	29 47	35 56	40 68	45 74
Clearance group CN (norm.)	min max					13 26	15 28	19 35	22 39	27 47	35 57	42 68	50 81	60 98	65 110
Clearance group C3	min max					20 33	23 39	29 46	33 52	41 61	50 75	62 90	75 108	90 130	100 150
Clearance group C4	min max					28 42	33 50	40 59	45 65	56 80	69 98	84 116	100 139	120 165	140 191

Tables

7.11 Radial Clearance of FAG Cylindrical Roller Bearings

Dimensions in mm															
Nominal bore diameter	over to	24	24 30	30 40	40 50	50 65	65 80	80 100	100 120	120 140	140 160	160 180	180 200	200 225	225 250

with cylindrical bore

Bearing clearance in microns															
Clearance group C1NA ¹⁾	min max	5 15	5 15	5 15	5 18	5 20	10 25	10 30	10 30	10 35	10 35	10 40	15 45	15 50	15 50
Clearance group C2	min max	0 25	0 25	5 30	5 35	10 40	10 45	15 50	15 55	15 60	20 70	25 75	35 90	45 105	45 110
Clearance group CN (norm.)	min max	20 45	20 45	25 50	30 60	40 70	40 75	50 85	50 90	60 105	70 120	75 125	90 145	105 165	110 175
Clearance group C3	min max	35 60	35 60	45 70	50 80	60 90	65 100	75 110	85 125	100 145	115 165	120 170	140 195	160 220	170 235
Clearance group C4	min max	50 75	50 75	60 85	70 100	80 110	90 125	105 140	125 165	145 190	165 215	170 220	195 250	220 280	235 300

with tapered bore

Bearing clearance in microns															
Clearance group C1NA ¹⁾	min max	10 20	15 25	15 25	17 30	20 35	25 40	35 55	40 60	45 70	50 75	55 85	60 90	60 95	65 100
Clearance group C2	min max	15 40	20 45	20 45	25 55	30 60	35 70	40 75	50 90	55 100	60 110	75 125	85 140	95 155	105 170
Clearance group CN (norm.)	min max	30 55	35 60	40 65	45 75	50 80	60 95	70 105	90 130	100 145	110 160	125 175	140 195	155 215	170 235
Clearance group C3	min max	40 65	45 70	55 80	60 90	70 100	85 120	95 130	115 155	130 175	145 195	160 210	180 235	200 260	220 285
Clearance group C4	min max	50 75	55 80	70 95	75 105	90 120	110 145	120 155	140 180	160 205	180 230	195 245	220 275	245 305	270 335

250 280	280 315	315 355	355 400	400 450	450 500	500 560	560 630	630 710	710 800	800 900	900 1000	1000 1120	1120 1250	1250 1400	1400 1600	1600 1800	1800 2000
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20 55	20 60	20 65	25 75	25 85	25 95	25 100	30 110	30 130	35 140	35 160	35 180	50 200	60 220	60 240	70 270	80 300	100 320
55 125	55 130	65 145	100 190	110 210	110 220	120 240	140 260	145 285	150 310	180 350	200 390	220 430	230 470	270 530	330 610	380 700	400 760
125 195	130 205	145 225	190 280	210 310	220 330	240 360	260 380	285 425	310 470	350 520	390 580	430 640	470 710	530 790	610 890	700 1020	760 1120
190 260	200 275	225 305	280 370	310 410	330 440	360 480	380 500	425 565	470 630	520 690	580 770	640 850	710 950	790 1050	890 1170	1020 1340	1120 1480
260 330	275 350	305 385	370 460	410 510	440 550	480 600	500 620	565 705	630 790	690 860	770 960	850 1060	950 1190	1050 1310	1170 1450	1340 1660	1480 1840

75 110	80 120	90 135	100 150	110 170	120 190	130 210	140 230	160 260	170 290	190 330	210 360	230 400	250 440	270 460	300 500	320 530	340 560
115 185	130 205	145 225	165 255	185 285	205 315	230 350	260 380	295 435	325 485	370 540	410 600	455 665	490 730	550 810	640 920	700 1020	760 1120
185 255	205 280	225 305	255 345	285 385	315 425	350 470	380 500	435 575	485 645	540 710	600 790	665 875	730 970	810 1070	920 1200	1020 1340	1120 1480
240 310	265 340	290 370	330 420	370 470	410 520	455 575	500 620	565 705	630 790	700 870	780 970	865 1075	960 1200	1070 1330	1200 1480	1340 1660	1480 1840
295 365	325 400	355 435	405 495	455 555	505 615	560 680	620 740	695 835	775 935	860 1030	960 1150	1065 1275	1200 1440	1330 1590	1480 1760	1660 1980	1840 2200

1) Clearance group C1NA applies to single and double row cylindrical roller bearings of tolerance classes SP and UP.

Tables

7.12 Radial Clearance of FAG Spherical Roller Bearings

Dimensions in mm															
Nominal bore diameter	over to	24	24 30	30 40	40 50	50 65	65 80	80 100	100 120	120 140	140 160	160 180	180 200	200 225	225 250

with cylindrical bore

Bearing clearance in microns															
Clearance group C2	min max	10 20	15 25	15 30	20 35	20 40	30 50	35 60	40 75	50 95	60 110	65 120	70 130	80 140	90 150
Clearance group CN (norm.)	min max	20 35	25 40	30 45	35 55	40 65	50 80	60 100	75 120	95 145	110 170	120 180	130 200	140 220	150 240
Clearance group C3	min max	35 45	40 55	45 60	55 75	65 90	80 110	100 135	120 160	145 190	170 220	180 240	200 260	220 290	240 320
Clearance group C4	min max	45 60	55 75	60 80	75 100	90 120	110 145	135 180	160 210	190 240	220 280	240 310	260 340	290 380	320 420

with tapered bore

Bearing clearance in microns															
Clearance group C2	min max	15 25	20 30	25 35	30 45	40 55	50 70	55 80	65 100	80 120	90 130	100 140	110 160	120 180	140 200
Clearance group CN (norm.)	min max	25 35	30 40	35 50	45 60	55 75	70 95	80 110	100 130	120 160	130 180	140 200	160 220	180 250	200 270
Clearance group C3	min max	35 45	40 55	50 65	60 80	75 95	95 120	110 140	135 170	160 200	180 230	200 260	220 290	250 320	270 350
Clearance group C4	min max	45 60	55 75	65 85	80 100	95 120	120 150	140 180	170 220	200 260	230 300	260 340	290 370	320 410	350 450

250	280	315	355	400	450	500	560	630	710	800	900	1000	1120	1250	1400
280	315	355	400	450	500	560	630	710	800	900	1000	1120	1250	1400	1600

100	110	120	130	140	140	150	170	190	210	230	260	290	320	350	380
170	190	200	220	240	260	180	310	350	390	430	480	530	580	630	700
170	190	200	220	240	260	180	310	350	390	430	480	530	580	630	700
260	280	310	340	370	410	440	480	530	580	650	710	770	840	910	1020
350	370	410	450	500	550	600	650	700	770	860	930	1050	1140	1240	1390
350	370	410	450	500	550	600	650	700	770	860	930	1050	1140	1240	1390
460	500	550	600	660	720	780	850	920	1010	1120	1220	1430	1560	1700	1890

150	170	190	210	230	260	290	320	350	390	440	490	540	600	660	740
220	240	270	300	330	370	410	460	510	570	640	710	780	860	940	1060
220	240	270	300	330	370	410	460	510	570	640	710	780	860	940	1060
300	330	360	400	440	490	540	600	670	750	840	930	1020	1120	1220	1380
390	430	470	520	570	630	680	760	850	960	1070	1190	1300	1420	1550	1750
390	430	470	520	570	630	680	760	850	960	1070	1190	1300	1420	1550	1750
490	540	590	650	720	790	870	980	1090	1220	1370	1520	1650	1800	1960	2200

Tables

7.13 Radial Clearance of FAG Barrel Roller Bearings

Dimensions in mm																
Nominal bore diameter	over to	30	30 40	40 50	50 65	65 80	80 100	100 120	120 140	140 160	160 180	180 225	225 250	250 280	280 315	315 355

with cylindrical bore

Bearing clearance in microns																
Clearance group C2	min	2	3	3	4	5	7	10	15	20	25	30	35	40	40	45
	max	9	10	13	15	20	25	30	35	40	45	50	55	60	70	75
Clearance group CN (norm.)	min	9	10	13	15	20	25	30	35	40	45	50	55	60	70	75
	max	17	20	23	27	35	45	50	55	65	70	75	80	85	100	105
Clearance group C3	min	17	20	23	27	35	45	50	55	65	70	75	80	85	100	105
	max	28	30	35	40	55	65	70	80	95	100	105	110	115	135	140
Clearance group C4	min	28	30	35	40	55	65	70	80	95	100	105	110	115	135	140
	max	40	45	50	55	75	90	95	110	125	130	135	140	145	170	175

with tapered bore

Bearing clearance in microns																
Clearance group C2	min	9	10	13	15	20	25	30	35	40	45	50	55	60	70	75
	max	17	20	23	27	35	45	50	55	65	70	75	80	85	100	105
Clearance group CN (norm.)	min	17	20	23	27	35	45	50	55	65	70	75	80	85	100	105
	max	28	30	35	40	55	65	70	80	95	100	105	110	115	135	140
Clearance group C3	min	28	30	35	40	55	65	70	80	95	100	105	110	115	135	140
	max	40	45	50	55	75	90	95	110	125	130	135	140	145	170	175
Clearance group C4	min	40	45	50	55	75	90	95	110	125	130	135	140	145	170	175
	max	55	60	65	75	95	120	125	140	155	160	165	170	175	205	210

7.14 Axial Clearance of FAG Double Row Angular Contact Ball Bearings

Series 32, 32B, 33 and 33B

Dimensions in mm												
Nominal bore diameter	over to	6	10	18	24	30	40	50	65	80	100	120
		10	18	24	30	40	50	65	80	100	120	140

Bearing clearance in microns												
Clearance group C2	min	1	1	2	2	2	2	3	3	3	4	4
	max	11	12	14	15	16	18	22	24	26	30	34
Clearance group CN (norm.)	min	5	6	7	8	9	11	13	15	18	22	25
	max	21	23	25	27	29	33	36	40	46	53	59
Clearance group C3	min	12	13	16	18	21	23	26	30	35	42	48
	max	28	31	34	37	40	44	48	54	63	73	82
Clearance group C4	min	25	27	28	30	33	36	40	46	55	65	74
	max	45	47	48	50	54	58	63	71	83	96	108

Series 32DA and 33 DA

Bearing clearance in microns												
Clearance group C2	min	5	6	7	8	9	11	13	15	18	22	25
	max	22	24	25	27	29	33	36	40	46	53	59
Clearance group CN (norm.)	min	11	13	14	16	18	22	25	29	35	42	48
	max	28	31	32	35	38	44	48	54	63	73	82
Clearance group C3	min	20	23	24	27	30	36	40	46	55	65	74
	max	37	41	42	46	50	58	63	71	83	96	108

Tables

7.15 Axial Clearance of FAG Four-Point Bearings

Dimensions in mm															
Nominal bore diameter	over to	18	18 40	40 60	60 80	80 100	100 140	140 180	180 220	220 260	260 300	300 355	355 400	400 450	450 500

Bearing clearance in microns															
Clearance group C2	min	20	30	40	50	60	70	80	100	120	140	160	180	200	220
	max	60	70	90	100	120	140	160	180	200	220	240	270	290	310
Clearance group CN (norm.)	min	50	60	80	90	100	120	140	160	180	200	220	250	270	290
	max	90	110	130	140	160	180	200	220	240	280	300	330	360	390
Clearance group C3	min	80	100	120	130	140	160	180	200	220	260	280	310	340	370
	max	120	150	170	180	200	220	240	260	300	340	360	390	430	470

Dimensions in mm						
Nominal bore diameter	over to	500 560	560 630	630 710	710 800	800 900 900 1000

Bearing clearance in microns						
Clearance group C2	min max	240 330	260 360	280 390	300 420	330 460 360 500
Clearance group CN (norm.)	min max	310 420	340 450	370 490	400 540	440 590 480 630
Clearance group C3	min max	400 510	430 550	470 590	520 660	570 730 620 780

7.16 Radial Clearance Reduction of FAG Cylindrical Roller Bearings with Tapered Bore

Nominal bore diameter		Radial clearance prior to mounting						Reduction in radial clearance ¹⁾		Axial displacement on 1:12 taper ¹⁾				Smallest radial clearance after mounting		
d	to	Clearance group CN (normal)		C3		C4		min	max	Shaft		Sleeve		CN	C3	C4
over mm	mm	min	max	min	max	min	max	min	max	min	max	min	max	min	min	min
24	30	0,035	0,06	0,045	0,07	0,055	0,08	0,015	0,02	0,3	0,35	0,3	0,4	0,02	0,025	0,035
30	40	0,04	0,065	0,055	0,08	0,07	0,095	0,02	0,025	0,35	0,4	0,35	0,45	0,02	0,025	0,04
40	50	0,045	0,075	0,06	0,09	0,075	0,105	0,025	0,03	0,4	0,45	0,45	0,5	0,02	0,03	0,045
50	65	0,05	0,08	0,07	0,1	0,09	0,12	0,03	0,035	0,45	0,55	0,5	0,65	0,02	0,035	0,05
65	80	0,06	0,095	0,085	0,12	0,11	0,145	0,035	0,04	0,55	0,6	0,65	0,7	0,025	0,04	0,07
80	100	0,07	0,105	0,095	0,13	0,12	0,155	0,04	0,045	0,6	0,7	0,65	0,8	0,03	0,05	0,075
100	120	0,09	0,13	0,115	0,155	0,14	0,18	0,045	0,055	0,7	0,85	0,8	0,95	0,045	0,065	0,085
120	140	0,1	0,145	0,13	0,175	0,16	0,205	0,055	0,065	0,85	1	0,95	1,1	0,045	0,07	0,095
140	160	0,11	0,16	0,145	0,195	0,18	0,23	0,06	0,075	0,9	1,2	1	1,3	0,05	0,075	0,105
160	180	0,125	0,175	0,16	0,21	0,195	0,245	0,065	0,085	1	1,3	1,1	1,5	0,06	0,08	0,11
180	200	0,14	0,195	0,18	0,235	0,22	0,275	0,075	0,095	1,2	1,5	1,3	1,7	0,065	0,09	0,125
200	225	0,155	0,215	0,2	0,26	0,245	0,305	0,085	0,105	1,3	1,6	1,4	1,8	0,07	0,1	0,14
225	250	0,17	0,235	0,22	0,285	0,27	0,335	0,095	0,115	1,5	1,8	1,6	2	0,075	0,105	0,155
250	280	0,185	0,255	0,24	0,31	0,295	0,365	0,105	0,125	1,6	2	1,7	2,3	0,08	0,125	0,17
280	315	0,205	0,28	0,265	0,34	0,325	0,4	0,115	0,14	1,8	2,2	1,9	2,4	0,09	0,13	0,185
315	355	0,225	0,305	0,29	0,37	0,355	0,435	0,13	0,16	2	2,5	2,2	2,7	0,095	0,14	0,195
355	400	0,255	0,345	0,33	0,42	0,405	0,495	0,14	0,17	2,2	2,6	2,5	2,9	0,115	0,165	0,235
400	450	0,285	0,385	0,37	0,47	0,455	0,555	0,15	0,185	2,3	2,8	2,6	3,1	0,135	0,19	0,27
450	500	0,315	0,425	0,41	0,52	0,505	0,615	0,16	0,195	2,5	3	2,8	3,4	0,155	0,215	0,31
500	560	0,35	0,47	0,455	0,575	0,56	0,68	0,17	0,215	2,7	3,4	3,1	3,8	0,18	0,24	0,345
560	630	0,38	0,5	0,5	0,62	0,62	0,74	0,185	0,24	2,9	3,7	3,5	4,2	0,195	0,26	0,38
630	710	0,435	0,575	0,565	0,705	0,695	0,835	0,2	0,26	3,1	4,1	3,6	4,7	0,235	0,305	0,435
710	800	0,485	0,645	0,63	0,79	0,775	0,935	0,22	0,28	3,4	4,4	3,9	5,3	0,26	0,35	0,495
800	900	0,54	0,71	0,7	0,87	0,86	1,03	0,24	0,31	3,7	4,8	4,3	5,5	0,3	0,39	0,55
900	1000	0,6	0,79	0,78	0,97	0,96	1,15	0,26	0,34	4,1	5,3	4,8	6,2	0,34	0,44	0,62
1000	1120	0,665	0,875	0,865	1,075	1,065	1,275	0,28	0,37	4,4	5,8	5,2	7	0,385	0,5	0,7
1120	1250	0,73	0,97	0,96	1,2	1,2	1,44	0,31	0,41	4,8	6,4	5,7	7,6	0,42	0,55	0,79
1250	1400	0,81	1,07	1,07	1,33	1,33	1,59	0,34	0,45	5,3	7	6,3	8,3	0,47	0,62	0,85

¹⁾ Valid only for solid steel shafts and hollow shafts whose bore diameter does not exceed half the shaft diameter.

Note: Bearings whose radial clearance is in the upper half of the tolerance range are mounted with the greater value of radial clearance reduction/axial drive-up distance. Bearings whose radial clearance is in the lower half of the tolerance range are mounted with the smaller value of radial clearance reduction/axial drive-up distance.

7.17 Radial Clearance Reduction of FAG Spherical Roller Bearings with Tapered Bore

Nominal bore diameter d over to mm		Radial clearance prior to mounting Clearance group CN (normal) C3 C4 min max min max min max						Reduction in radial clearance ¹⁾		Axial displacement on 1:12 taper ¹⁾				Axial displacement on 1:30 taper ²⁾				Smallest radial clearance after mounting		
		min		max		min		max		min		max		min		max		CN	C3	C4
		mm		mm		mm		mm		mm		mm		mm		mm		min	min	min
24	30	0,03	0,04	0,04	0,055	0,055	0,075	0,015	0,02	0,3	0,35	0,3	0,4	-	-	-	-	0,015	0,02	0,035
30	40	0,035	0,05	0,05	0,065	0,065	0,085	0,02	0,025	0,35	0,4	0,35	0,45	-	-	-	-	0,015	0,025	0,04
40	50	0,045	0,06	0,06	0,08	0,08	0,1	0,025	0,03	0,4	0,45	0,45	0,5	-	-	-	-	0,02	0,03	0,05
50	65	0,055	0,075	0,075	0,095	0,095	0,12	0,03	0,04	0,45	0,6	0,5	0,7	-	-	-	-	0,025	0,035	0,055
65	80	0,07	0,095	0,095	0,12	0,12	0,15	0,04	0,05	0,6	0,75	0,7	0,85	-	-	-	-	0,025	0,04	0,07
80	100	0,08	0,11	0,11	0,14	0,14	0,18	0,045	0,06	0,7	0,9	0,75	1	1,7	2,2	1,8	2,4	0,035	0,05	0,08
100	120	0,1	0,135	0,135	0,17	0,17	0,22	0,05	0,07	0,7	1,1	0,8	1,2	1,9	2,7	2	2,8	0,05	0,065	0,1
120	140	0,12	0,16	0,16	0,2	0,2	0,26	0,065	0,09	1,1	1,4	1,2	1,5	2,7	3,5	2,8	3,6	0,055	0,08	0,11
140	160	0,13	0,18	0,18	0,23	0,23	0,3	0,075	0,1	1,2	1,6	1,3	1,7	3	4	3,1	4,2	0,055	0,09	0,13
160	180	0,14	0,2	0,2	0,26	0,26	0,34	0,08	0,11	1,3	1,7	1,4	1,9	3,2	4,2	3,3	4,6	0,06	0,1	0,15
180	200	0,16	0,22	0,22	0,29	0,29	0,37	0,09	0,13	1,4	2	1,5	2,2	3,5	4,5	3,6	5	0,07	0,1	0,16
200	225	0,18	0,25	0,25	0,32	0,32	0,41	0,1	0,14	1,6	2,2	1,7	2,4	4	5,5	4,2	5,7	0,08	0,12	0,18
225	250	0,2	0,27	0,27	0,35	0,35	0,45	0,11	0,15	1,7	2,4	1,8	2,6	4,2	6	4,6	6,2	0,09	0,13	0,2
250	280	0,22	0,3	0,3	0,39	0,39	0,49	0,12	0,17	1,9	2,6	2	2,9	4,7	6,7	4,8	6,9	0,1	0,14	0,22
280	315	0,24	0,33	0,33	0,43	0,43	0,54	0,13	0,19	2	3	2,2	3,2	5	7,5	5,2	7,7	0,11	0,15	0,24
315	355	0,27	0,36	0,36	0,47	0,47	0,59	0,15	0,21	2,4	3,4	2,6	3,6	6	8,2	6,2	8,4	0,12	0,17	0,26
355	400	0,3	0,4	0,4	0,52	0,52	0,65	0,17	0,23	2,6	3,6	2,9	3,9	6,5	9	5,8	9,2	0,13	0,19	0,29
400	450	0,33	0,44	0,44	0,57	0,57	0,72	0,2	0,26	3,1	4,1	3,4	4,4	7,7	10	8	10,4	0,13	0,2	0,31
450	500	0,37	0,49	0,49	0,63	0,63	0,79	0,21	0,28	3,3	4,4	3,6	4,8	8,2	11	8,4	11,2	0,16	0,23	0,35
500	560	0,41	0,54	0,54	0,68	0,68	0,87	0,24	0,32	3,7	5	4,1	5,4	9,2	12,5	9,6	12,8	0,17	0,25	0,36
560	630	0,46	0,6	0,6	0,76	0,76	0,98	0,26	0,35	4	5,4	4,4	5,9	10	13,5	10,4	14	0,2	0,29	0,41
630	710	0,51	0,67	0,67	0,85	0,85	1,09	0,3	0,4	4,6	6,2	5,1	6,8	11,5	15,5	12	16	0,21	0,31	0,45
710	800	0,57	0,75	0,75	0,96	0,96	1,22	0,34	0,45	5,3	7	5,8	7,6	13,3	17,5	13,6	18	0,23	0,35	0,51
800	900	0,64	0,84	0,84	1,07	1,07	1,37	0,37	0,5	5,7	7,8	6,3	8,5	14,3	19,5	14,8	20	0,27	0,39	0,57
900	1000	0,71	0,93	0,93	1,19	1,19	1,52	0,41	0,55	6,3	8,5	7	9,4	15,8	21	16,4	22	0,3	0,43	0,64
1000	1120	0,78	1,02	1,02	1,3	1,3	1,65	0,45	0,6	6,8	9	7,6	10,2	17	23	18	24	0,32	0,48	0,7
1120	1250	0,86	1,12	1,12	1,42	1,42	1,8	0,49	0,65	7,4	9,8	8,3	11	18,5	25	19,6	26	0,34	0,54	0,77
1250	1400	0,94	1,22	1,22	1,55	1,55	1,96	0,55	0,72	8,3	10,8	9,3	12,1	21	27	22,2	28,3	0,36	0,59	0,84

¹⁾ Valid only for solid steel shafts and hollow shafts whose bore diameter does not exceed half the shaft diameter.

Note: Bearings whose radial clearance is in the upper half of the tolerance range are mounted with the greater value of radial clearance reduction/axial drive-up distance. Bearings whose radial clearance is in the lower half of the tolerance range are mounted with the smaller value of radial clearance reduction/axial drive-up distance.

7.18 FAG Rolling Bearing Greases Arcanol – Chemico-physical data and directions for use

Grease	Thickener	Base oil viscosity at 40°C mm²/s	Consistency NLGI Class	Operating temperature °C	Main characteristics	Typical applications
MULTITOP (so far L135V)	Lithium soap with EP additives	85	2	-40...+150	Universal grease for bearings at increased speeds, high loads, low and high temperatures	Rolling mills, construction machines, cars, spinning and grinding spindles
MULTI2 (so far L78V)	Lithium soap	ISO VG 100	2	-30...+140	Universal grease for ball bearings with Ø D ≤ 62 mm	small electric motors, agricultural and construction machines, household appliances
MULTI3 (so far L71V)	Lithium soap	80	3	-30...+140	Universal grease for ball bearings with Ø D > 62 mm	large electric motors, agricultural and construction machines, blowers
LOAD220 (so far L215V)	Lithium/ calcium soap with EP additives	ISO VG 220	2	-20...+140	Special grease for bearings at high loads, large speed range, high degree of humidity	Rolling mills, rail vehicles
LOAD400 (so far L186V)	Lithium/ calcium soap with EP additives	400	2	-25...+140	Special grease for bearings at extreme loads, medium speeds, medium temperatures	Mining machines, construction machines
LOAD1000 (so far L223V)	Lithium/ calcium soap with EP additives	ISO VG 1000	2	-20...+140	Special grease for bearings at extreme loads, medium temperatures, low speeds	Mining machines, construction machines, preferably for shock loads and large bearings
TEMP90 (so far L12V)	Calcium polyurea with EP additives	130	2	-40...+160	Special grease for bearings at high temperatures, high loads	Couplings, electric motors, cars
TEMP110 (so far L30V)	Lithium complex soap	ISO VG 150	2	-40...+160	Special grease for bearings at high temperatures, high speeds	Electric machines, cars
TEMP120 (so far L195V)	Polyurea with EP additives	ISO VG 460	2	-35...+180	Special grease for bearings at high temperatures, high loads	Continuous casting plants
TEMP200 (so far L79V)	PTFE	400	2	-40...+260	Special grease for bearings at extremely high temperatures (safety advice page 60), chemically aggressive environment	Support rollers in baking machines, piston pins in compressors, kiln trucks, chemical plants
SPEED2,6 (so far L75)	Polyurea	ISO VG 22	2-3	-50...+120	Special grease for ball bearings at extremely high speeds, low temperatures	Machine tools, instruments
VIB3 (so far L166V)	Lithium complex soap with EP additives	170	3	-30...+150	Special grease for bearings at high temperatures, high loads, oscillating motion	Blade adjusters in rotors of wind power plants, packing machines
BIO2	Lithium/ calcium soap	58	2	-30...+140	Special grease for bearings in environmentally hazardous applications	
FOOD2	Aluminium complex soap	192	2	-30...+120	Special grease for bearings in applications with food contact; USDA H1	

Fundamental Course

Mounting Cabinet and Mounting Sets – Fundamental Course for Vocational Training

Plenty of literature is available on the correct mounting of rolling bearings. In most cases, however, the apprentices lack means and components for practical training. Therefore, the instructors of the FAG apprentice shops have prepared a fundamental course.

The target of this fundamental course is to impart the knowledge of the selection of the suitable bearing, appropriate mounting and dismounting, and maintenance. Therefore, the course has two parts.

The theoretical part deals with rolling bearing fundamentals, the practical part with the basic skill required for mounting and dismounting.

For the theoretical part, great store has been set by reasonably combining technical drawing, arithmetic, and instruction in mechanical engineering. For the practical part, simplified models of the mating parts of rolling bearings (shafts and housings) are available by means of which the mounting and dismounting of the current bearing types can be practised with mechanical and hydraulic equipment.

The subjects taught are based on instruction records and do not exceed the degree of difficulty required today in vocational training.

Based on this fundamental course, other units such as transmissions, pumps, spindles, motor car wheels etc. can be prepared for practical training.

Technical Data

Mounting cabinet:

Dimensions 1135x710x380 mm

Weight (with contents) 94 kg

Suitable for 10 mounting exercises:

5 with shafts, 2 with housings,

3 with shafts and housings

Smallest shaft diameter 15 mm

Largest shaft diameter 55 mm

Angle plate: Dimensions 500x300x300 mm

Weight 40 kg

Manual 1 (Theoretical Part)

Instructions in mechanical engineering

Technical arithmetic

Technical drawing

Manual 2 (Practical Part)

Mounting of bearings with cylindrical bore

Mounting of bearings with tapered bore

Hydraulic technique

Mounting of heated bearings

Practical training with shafts and housings

In addition to the mounting cabinet with contents and the mounting angle also single mounting sets can be ordered, see Publ. No. WL 80 111.

Please direct enquiries and orders to

FAG Industrial Services

P.O. Box 12 60 · D-97419 Schweinfurt

Phone +49 97 21/91 36 91 · Telefax +49 97 21/91 38 09

<http://www.fag.com>



Selection of FAG Publications

The following publications are selected from the numerous FAG publications available. Further information on request.

Catalogue WL 41520	FAG Rolling Bearings
Publ. No. WL 00106	W.L.S. Rolling Bearing Learning System
Publ. No. WL 80102	How to Mount and Dismount Rolling Bearings Hydraulically
Publ. No. WL 80103	FAG Hydraulic Nuts
Publ. No. WL 80107	FAG Induction Heating Equipment
Publ. No. WL 80111	Rolling Bearing Mounting Cabinet and Mounting Sets – A fundamental course for vocational training
Publ. No. WL 80123	All about the Rolling Bearing – FAG Training Courses on Rolling Bearings Theory and Practice
Publ. No. WL 80134	FAG Video: Mounting and Dismounting of Rolling Bearings
Publ. No. WL 80135	FAG Video: Hydraulic Methods for the Mounting and Dismounting of Rolling Bearings
Publ. No. WL 80250	FAG Mounting and Maintenance Equipment and Services for Rolling Bearings – Greater operational reliability for rolling bearings
Publ. No. WL 81115	Rolling Bearing Lubrication
Publ. No. WL 81116	Arcanol · Rolling bearing-tested grease
Publ. No. WL 82102	Rolling Bearing Damage
TI No. WL 00-11	FAG Videos on Rolling Bearings
TI No. WL 80-9	Aluminium Heating Ring for Cylindrical Roller Bearing Inner Rings
TI No. WL 80-14	Mounting and Dismounting of Spherical Roller Bearings with Tapered Bore
TI No. WL 80-38	Mounting of Self-aligning Ball Bearings on Adapter Sleeves
TI No. WL 80-46	FAG Hand Pump Sets
TI No. WL 80-47	FAG Induction Heating Devices
TI No. WL 80-48	FAG Mechanical Extractors
TI No. WL 80-49	FAG sets of mounting tools EINBAU.SET.ALU and EINBAU.SET.ST
TI No. WL 80-51	FAG Temperature measuring instrument TEMP. MG175830
TI No. WL 80-60	Rolling Bearing Diagnosis with FAG Devices and Services



Rolling Bearings

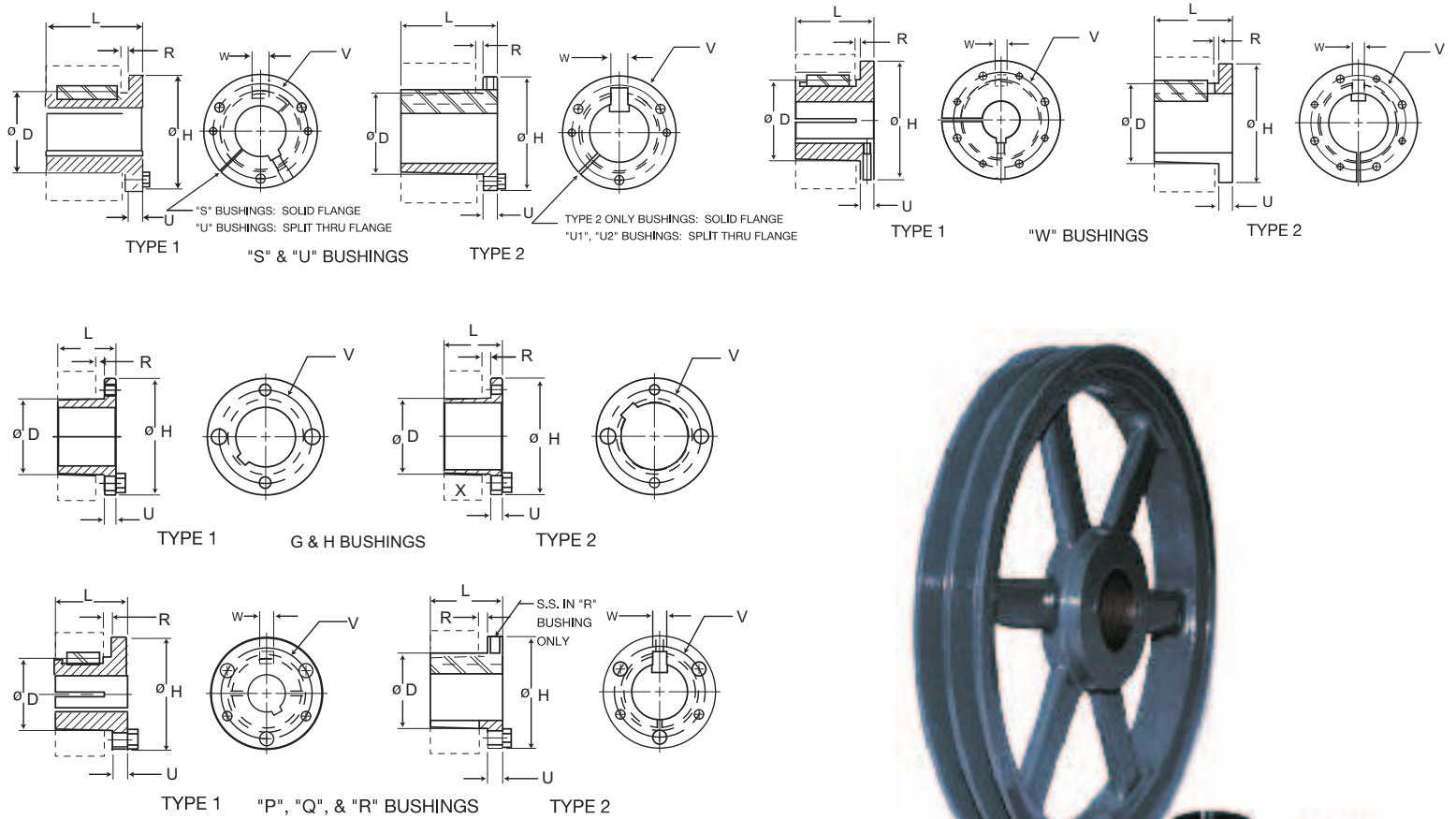
Mounting and Dismounting of Rolling Bearings

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Split Taper Bushings

PART NO.	Dimensions												Bore Range		Cap Screws			AV.Wt. Lbs	Wrench Torque Ln-Lbs.	
	L	U	T	D		H	V	W	X	Y	R	S	Type 1	Type 2	No.	Size				
				Large End	Small End															
G	1"	1/4"	3/4"	1.172"	1.133	2"	1 9/16"	-	5/8"	3/16"	1/8"	3/16"	3/8"-15/16"	1"	2	1/4"	x	5/8"	.5	95
H	1 1/4	1/4	1	1.625	1.570	2 1/2	2	-	7/8	3/16	1/8	3/16	3/8-1 3/8	1 7/16-1 1/2	2	1/4	x	3/4	.8	95
P1	1 15/16	13/32	1 17/32	1.9375	1.8555	3	2 7/16	3/8	1 5/16	7/32	7/32	1/4	1/2 - 1 7/16	1 1/2-1 3/4	3	5/16	x	1	1.3	192
P2	2 15/16	13/32	2 17/32	1.9375	1.7930	3	2 7/16	3/8	2 5/16	7/32	7/32	1/4	3/4-1 7/16	1 1/2-1 3/4	3	5/16	x	1	1.5	192
P3	4 7/16	13/32	4 1/32	1.9375	1.6993	3	2 7/16	3/8	3 13/16	7/32	7/32	1/4	1 1/8-1 3/8	1 5/8	3	5/16	x	1	2	192
B	1 15/16	1/2	1 7/16	2.625	2.5567	3 11/16	3 1/8	1/2	1 3/16	7/32	1/4	1/4	1/2-1 15/16	2-2 7/16	3	5/16	x	1 1/4	1.8	192
Q1	2 1/2	17/32	1 31/32	2.875	2.7657	4 1/8	3 3/8	1/2	1 3/4	7/32	7/32	9/32	3/4-2 1/16	2 1/8-2 11/16	3	3/8	x	1 1/4	3.5	348
Q2	3 1/2	17/32	2 31/32	2.875	2.7032	4 1/8	3 3/8	1/2	2 3/4	7/32	7/32	9/32	1-2 1/16	2 1/8-2 5/8	3	3/8	x	1 1/4	4.5	348
Q3	5	17/32	4 15/32	2.875	2.6094	4 1/8	3 3/8	1/2	4 1/4	7/32	7/32	9/32	1 3/8-2 1/16	2 1/8-2 1/2	3	3/8	x	1 1/4	5.5	348
R1	2 7/8	5/8	2 1/4	4.000	3.8750	5 3/8	4 5/8	3/4	2	1/4	1/4	9/32	1 1/8-2 13/16	2 7/8-3 3/4	3	3/8	x	1 3/4	7.5	348
R2	4 7/8	5/8	4 1/4	4.000	3.7500	5 3/8	4 5/8	3/4	4	1/4	1/4	9/32	1 3/8-2 13/16	2 7/8-3 5/8	3	3/8	x	1 3/4	11	348
S1	4 3/8	3/4	3 5/8	4.625	4.4180	6 3/8	5 3/8	3/4	3 5/16	5/16	5/16	3/8	1 11/16-3 -3/16	3 1/4-4 1/4	3	1/2	x	2 1/4	13.5	840
S2	6 3/4	3/4	6	4.625	4.2696	6 3/8	5 3/8	3/4	5 1/16	5/16	5/16	3/8	1 7/8-3 3/16	3 1/4-4 3/16	3	1/2	x	2 1/4	19	840
U0	5 1/4	1 1/16	4 3/16	6.000	5.7656	8 3/8	7	1 1/4	3 3/4	7/16	7/16	15/32	2 3/8-3 1/16	-	3	5/8	x	2 3/4	30	1680
U0	4 15/16	3/4	4 3/16	6.000	5.7656	8 3/8	7	1 1/4	3 3/4	7/16	7/16	15/32	3 1/4-4 1/4	4 3/8-5 1/2	3	5/8	x	2 3/4	27	1680
U1	7 1/8	1 1/16	6 1/16	6.000	5.6485	8 3/8	7	1 1/4	5 5/8	7/16	7/16	15/32	2 3/8-4 1/4	4 3/8-5 1/2	3	5/8	x	2 3/4	40	1680
U2	10 1/8	1 1/16	9 1/16	6.000	5.4610	8 3/8	7	1 1/4	8 5/8	7/16	7/16	15/32	2 7/16-4 1/4	4 3/8-5	3	5/8	x	2 3/4	50	1680
W1	8 1/4	1 7/16	6 13/16	8.500	8.1016	12 1/2	10	1 1/4	6 3/8	7/16	7/16	9/16	3 3/8-6 3/16	6 1/4-7 7/16	4	3/4	x	3	104	3000
W2	11 1/4	1 7/16	9 13/16	8.500	7.9141	12 1/2	10	1 1/4	9 3/8	7/16	7/16	9/16	3 3/8-6 3/16	6 1/4-7 7/16	4	3/4	x	3	133	3000
Y0	11 1/8	2	9 1/8	12.000	11.4688	16 1/2	14 1/2	2	8 1/2	5/8	5/8	5/8	6-7 15/16	8-10	4	1	x	5	270	7200

Note: Taper on all Bushings is 3/4" Per Foot on Diameter.

Split Taper Bushings

COMPLETE ROUND SHAFT COVERAGE Plus MILLIMETER AND SPLINE BORES

Table No.1

Stock Inch Bore Bushings

Stock Bores	Keyseat	G	H	P1	P2	P3	B	Q1	Q2	Q3	R1	R2	S1
3/8"	None	x	x	-	-	-	-	-	-	-	-	-	-
7/16	None	x	x	-	-	-	-	-	-	-	-	-	-
1/2	1/8x1/16	x	x	x	-	-	x	-	-	-	-	-	-
9/16	1/8x1/16	x	x	x	-	-	x	-	-	-	-	-	-
19/32	3/16x3/32	-	x	-	-	-	-	-	-	-	-	-	-
5/8	3/16x3/32	x	x	x	-	-	x	-	-	-	-	-	-
21/32	3/16x3/32	-	x	x	-	-	-	-	-	-	-	-	-
11/16	3/16x3/32	x	x	x	-	-	x	-	-	-	-	-	-
3/4	3/16x3/32	x	x	x	-	-	x	x	-	-	-	-	-
25/32	3/16x3/32	-	x	x	-	-	-	-	-	-	-	-	-
13/16	3/16x3/32	x	x	x	x	-	x	x	-	-	-	-	-
7/8	3/16x3/32	x	x	x	x	-	x	x	-	-	-	-	-
15/16	1/4x1/8	x*	x	x	x	-	x	x	-	-	-	-	-
31/32	1/4x1/8	-	x	x	-	-	-	-	-	-	-	-	-
1	1/4x1/8	x*	x	x	x	-	x	x	x	-	-	-	-
1 1/16	1/4x1/8	-	x	x	x	-	x	x	x	-	-	-	-
1 1/8	1/4x1/8	-	x	x	x	x	x	x	x	-	x	-	-
1 3/16	1/4x1/8	-	x	x	x	-	x	x	x	-	x	-	-
1 1/4	1/4x1/8	-	x*	x	x	-	x	x	x	-	x	-	-
1 5/16	5/16x5/32	-	x*	x	x	-	x	x	x	-	x	-	-
1 3/8 **	5/16x5/32	-	x*	x	x	x*	x	x	x	x	x	x	-
1 3/8 **	3/8x3/16	-	x*	x	x	-	x	x	x	-	x	-	-
1 7/16	3/8x3/16	-	x*	x	x*	-	x	x	x	x	x	x	-
1 1/2	3/8x3/16	-	x*	x	x	-	x	x	x	x	x	x	-
1 9/16	3/8x3/16	-	-	x	x	-	x	x	x	x	x	x	-
1 5/8	3/8x3/16	-	-	x	x	x	x	x	x	x	x	x	-
1 11/16	3/8x3/16	-	-	x	x	-	x	x	x	x	x	x	x
1 3/4	3/8x3/16	-	-	x	x	-	x	x	x	x	x	x	x

		B	Q1	Q2	Q3	R1	R2	S1	S2	U0	U1	U2
1 13/16	1/2x1/4	x	x	x	x	x	x	-	-	-	-	-
1 7/8	1/2x1/4	x	x	x	x	x	x	x	-	-	-	-
1 15/16	1/2x1/4	x	x	x	x	x	x	x	-	-	-	-
2	1/2x1/4	x	x	x	x	x	x	x	-	-	-	-
2 1/16	1/2x1/4	x	x	x	x	x	x	-	-	-	-	-
2 1/8	1/2x1/4	x	x	x	x	x	x	x	-	-	-	-
2 3/16	1/2x1/4	x	x	x	x	x	x	x	-	-	-	-
2 1/4	1/2x1/4	x	x	x	x	x	x	x	-	-	-	-
2 5/16	5/8x5/16	x	x	x	x	x	x	x	-	-	-	-
2 3/8	5/8x5/16	x	x	x	x	x	x	x	x	-	-	-
2 7/16	5/8x5/16	x	x	x	x	x	x	x	x	x	-	-
2 1/2	5/8x5/16	-	x	x	x	x	x	x	x	x	x	-
2 9/16	5/8x5/16	-	x	x	-	x	x	x	x	x	x	-
2 5/8	5/8x5/16	-	x	x	-	x	x	x	x	x	x	-
2 11/16	5/8x5/16	-	x	-	-	x	x	x	x	x	x	-
2 3/4	5/8x5/16	-	-	-	-	x	x	x	x	x	x	-
2 13/16	3/4x3/8	-	-	-	-	x	x	-	-	-	-	-
2 7/8	3/4x3/8	-	-	-	-	x	x	x	x	x	x	-
2 15/16	3/4x3/8	-	-	-	-	x	x	x	x	x	x	-
3	3/4x3/8	-	-	-	-	x	x	x	x	x	x	-
3 1/8	3/4x3/8	-	-	-	-	x	x	x	x	x	x	-
3 3/16	3/4x3/8	-	-	-	-	x	x	x	x	x	x	-
3 1/4	3/4x3/8	-	-	-	-	x	x	x	x	x	x	-

Stock Spline Bore Bushings

Table No.4

Spline	H	P1	Q1	Q2
.978-10 Inv.	x	x	-	-
1 1/8-6B	x	x	x	-
1 1/4-10B	-	x	-	-
1 3/8-6B	x	x	x	x
1 3/8-10B	-	x	x	-
1 3/8-21Inv.	x	x	x	-

*These sizes have a Shallow Keyseat. Special Keys are furnished to fit standard depth keyseats in shafts.

** 1 3/8 Bore Bushings with 5/16x5/32 Keyway will be supplied unless the 3/8x3/16 Keyway is specified on the order.

Stock bore tolerances: up to and incl. 1" **-.000/ +.001"**, 1" up to and incl. 3" **-.000/ +.002"**, over 3" **-.000/ +.003"**

Table No.2

Stock Bores	Keyseat	W1	W2
5 5/8	1 1/2x3/4	x	x
5 3/4	1 1/2x3/4	x	x
5 7/8	1 1/2x3/4	x	x
5 15/16	1 1/2x3/4	x	x
6	1 1/2x3/4	x	x
6 1/8	1 1/2x3/4	x	x
6 3/16	1 1/2x3/4	x	x
6 1/4	1 1/2x3/4	x	x
6 3/8	1 1/2x3/4	x	x
6 7/16	1 1/2x3/4	x	x
6 1/2	1 1/2x3/4	x	x
6 5/8	1 3/4x3/4	x	x
6 3/4	1 3/4x3/4	x	x
6 7/8	1 3/4x3/4	x	x
6 15/16	1 3/4x3/4	x	x
7	1 3/4x3/4	x	x
7 1/8	1 3/4x3/4	x	x
7 3/16	1 3/4x3/4	x	x
7 1/4	1 3/4x3/4	x	x
7 3/8	1 3/4x3/4	x	x
7 7/16	1 3/4x3/4	x	x

Stock Millimeter Bore Bushings

Table No.3

Stock Bores	Keyseat (Millimeters)	G	H	P1	B	Q1	R1	R2
10 mm.	None	x	x	-	-	-	-	-
11 mm.	None	x	x	-	-	-	-	-
12 mm.	None	x	x	-	-	-	-	-
14 mm.	5x2.5	x	x	x	-	-	-	-
15 mm.	5x2.5	-	-	x	x	-	-	-
16 mm.	5x2.5	x	x	x	x	-	-	-
18 mm.	6x3	x	x	x	x	x	-	-
19 mm.	6x3	x	x	x	x	x	-	-
20 mm.	6x3	x	x	x	x	x	-	-
22 mm.	6x3	x	x	x	x	x	-	-
24 mm.	8x3.5	x	x	x	x	x	-	-
25 mm.	8x3.5	x	x	x	x	x	-	-
28 mm.	8x3.5	-	x	x	x	x	x	-
30 mm.	8x3.5	-	x	x	x	x	x	-
32 mm.	10x4	-	x	x	x	x	x	-
35 mm.	10x4	-	x	x	x	x	x	x
36 mm.	10x4	-	x	x	x	x	x	x
38 mm.	10x4	-	x	x	x	x	x	x
39 mm.	12x4	-	-	x	x	-	x	x
40 mm.	12x4	-	-	x	x	x	x	x
42 mm.	12x4	-	-	x	x	x	x	x
45 mm.	14x4.5	-	-	-	x	x	x	x
48 mm.	14x4.5	-	-	-	x	x	x	x
50 mm.	14x4.5	-	-	-	x	x	x	x
55 mm.	16x5	-	-	-	x	x	x	x
60 mm.	18x5.5	-	-	-	x	x	x	x
65 mm.	18x5.5	-	-	-	-	x	x	x
70 mm.	20x6	-	-	-	-	-	x	x
75 mm.	20x6	-	-	-	-	-	x	x
80 mm.	22x7	-	-	-	-	-	x	x
85 mm.	22x7	-	-	-	-	-	x	x
90 mm.	25x7	-	-	-	-	-	x	x
95 mm.	25x7	-	-	-	-	-	x	-

Split Taper Bushings

COMPLETE ROUND SHAFT COVERAGE Plus MILLIMETER AND SPLINE BORES

Table No.1 Stock Inch Bore Bushings

Stock Bores	Keyseat	R1	R2	S1	S2	U0	U1	U2	W1	W2
3 3/8	7/8×7/16	x	x	x	x	x	x	x	x	x
3 7/16	7/8×7/16	x	x	x	x	x	x	x	x	x
3 1/2	7/8×7/16	x	x	x	x	x	x	x	x	x
3 5/8	7/8×7/16	x	x	x	x	x	x	x	x	x
3 11/16	7/8×7/16	x	-	x	x	x	x	x	x	x
3 3/4	7/8×7/16	x	-	x	x	x	x	x	x	x
3 7/8	1×1/2	-	-	x	x	x	x	x	x	x
3 15/16	1×1/2	-	-	x	x	x	x	x	x	x
4	1×1/2	-	-	x	x	x	x	x	x	x
4 1/8	1×1/2	-	-	x	x	x	x	x	x	x
4 3/16	1×1/2	-	-	x	x	x	x	x	x	x
4 1/4	1×1/2	-	-	x	-	x	x	x	x	x
4 3/8	1×1/2	-	-	-	-	x	x	x	x	x
4 7/16	1×1/2	-	-	-	-	x	x	x	x	x
4 1/2	1×1/2	-	-	-	-	x	x	x	x	x
4 5/8	1 1/4×5/8	-	-	-	-	x	x	x	x	x
4 11/16	1 1/4×5/8	-	-	-	-	x	x	x	-	-
4 3/4	1 1/4×5/8	-	-	-	-	x	x	x	x	x
4 7/8	1 1/4×5/8	-	-	-	-	x	x	x	x	x
4 15/16	1 1/4×5/8	-	-	-	-	x	x	x	x	x
5	1 1/4×5/8	-	-	-	-	x	x	x	x	x
		U0	U1	W1	W2					
5 1/8"	1 1/4×5/8	x	x	x	x					
5 3/16	1 1/4×5/8	x	x	x	x					
5 1/4	1 1/4×5/8	x	x	x	x					
5 3/8	1 1/4×5/8	x	x	x	x					
5 7/16	1 1/4×5/8	x	x	x	x					
5 1/2	1 1/4×5/8	x	x	x	x					

Table No.2

Stock Bore	Keyseat	W1	W2
5 5/8	1 1/2×3/4	x	x
5 3/4	1 1/2×3/4	x	x
5 7/8	1 1/2×3/4	x	x
5 15/16	1 1/2×3/4	x	x
6	1 1/2×3/4	x	x
6 1/8	1 1/2×3/4	x	x
6 3/16	1 1/2×3/4	x	x
6 1/4	1 1/2×3/4	x	x
6 3/8	1 1/2×3/4	x	x
6 7/16	1 1/2×3/4	x	x
6 1/2	1 1/2×3/4	x	x
6 5/8	1 3/4×3/4	x	x
6 3/4	1 3/4×3/4	x	x
6 7/8	1 3/4×3/4	x	x
6 15/16	1 3/4×3/4	x	x
7	1 3/4×3/4	x	x
7 1/8	1 3/4×3/4	x	x
7 3/16	1 3/4×3/4	x	x
7 1/4	1 3/4×3/4	x	x
7 3/8	1 3/4×3/4	x	x
7 7/16	1 3/4×3/4	x	x

Stock Millimeter Bore Bushings

Table No.3

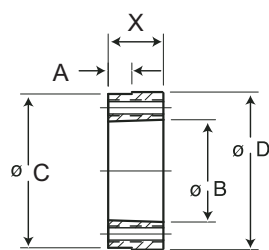
Stock Bores	Keyseat (Millimeters)	G	H	P1	B	Q1	R1	R2
10 mm.	None	x	x	-	-	-	-	-
11 mm.	None	x	x	-	-	-	-	-
12 mm.	None	x	x	-	-	-	-	-
14 mm.	5×2.5	x	x	x	-	-	-	-
15 mm.	5×2.5	-	-	x	x	-	-	-
16 mm.	5×2.5	x	x	x	x	-	-	-
18 mm.	6×3	x	x	x	x	x	-	-
19 mm.	6×3	x	x	x	x	x	-	-
20 mm.	6×3	x	x	x	x	x	-	-
22 mm.	6×3	x	x	x	x	x	-	-
24 mm.	8×3.5	x	x	x	x	x	-	-
25 mm.	8×3.5	x	x	x	x	x	-	-
28 mm.	8×3.5	-	x	x	x	x	x	-
30 mm.	8×3.5	-	x	x	x	x	x	-
32 mm.	10×4	-	x	x	x	x	x	-
35 mm.	10×4	-	x	x	x	x	x	x
36 mm.	10×4	-	x	x	x	x	x	x
38 mm.	10×4	-	x	x	x	x	x	x
39 mm.	12×4	-	-	x	x	-	x	x
40 mm.	12×4	-	-	x	x	x	x	x
42 mm.	12×4	-	-	x	x	x	x	x
45 mm.	14×4.5	-	-	-	x	x	x	x
48 mm.	14×4.5	-	-	-	x	x	x	x
50 mm.	14×4.5	-	-	-	x	x	x	x
55 mm.	16×5	-	-	-	x	x	x	x
60 mm.	18×5.5	-	-	-	x	x	x	x
65 mm.	18×5.5	-	-	-	-	x	x	x
70 mm.	20×6	-	-	-	-	-	x	x
75 mm.	20×6	-	-	-	-	-	x	x
80 mm.	22×7	-	-	-	-	-	x	x
85 mm.	22×7	-	-	-	-	-	x	x
90 mm.	25×7	-	-	-	-	-	x	x
95 mm.	25×7	-	-	-	-	-	x	-

Stock Spline Bore Bushings

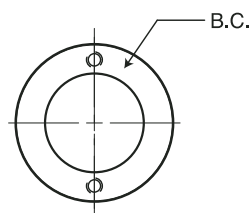
Table No.4

Spline	H	P1	Q1	Q2
.978-10 Inv.	x	x	-	-
1 1/8-6B	x	x	x	-
1 1/4-10B	-	x	-	-
1 3/8-6B	x	x	x	x
1 3/8-10B	-	x	x	-
1 3/8-21Inv.	x	x	x	-

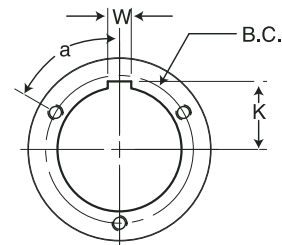
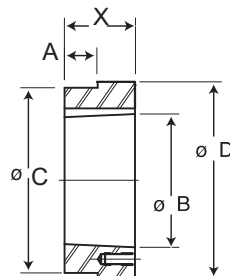
Stock bore tolerances: up to and incl. 1" **-.000/ +.001"**, 1" up to and incl. 3" **-.000/ +.002"**, over 3" **-.000/ +.003"**



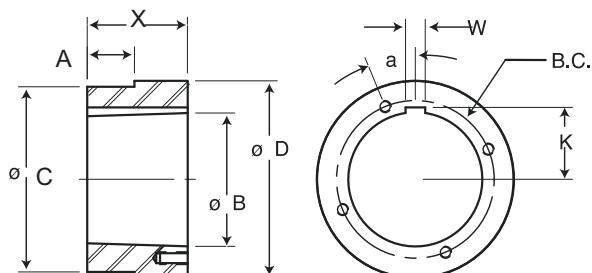
ALL TAPERS 3/4" PER FT.
ON DIAMETER



G & "H" HUBS



"P", "Q", "R", "S", & "U" HUBS



"W" HUBS

Steel Hubs for Split Taper Bushings

Part No.	For Bushing	Dimensions									Tapped Holes			Wt. Lbs.
		O.D.	A	B	C	K	Bolt circle	W	X	a	d	No.	Size	
HG1	G	2"	0.174"	1.168	1.875"	—	1 9/16"	—	5/8"	—	5/8"	2	1/4-20	0.4
HH1	H	2 1/2	0.174	1.621	2.375	—	2	—	7/8	—	7/8	2	1/4-20	0.6
HCH1	H	2 1/2	0.625	1.621	2.375	—	2	—	7/8	—	7/8	2	1/4-20	0.7
HP1	P1	3	0.292	1.9375	2.875	1 3/32"	2 7/16	3/8"	1 5/16	60°	5/8	3	5/16-18	1.4
HCP1	P1	3	1.000	1.9375	2.875	1 3/32	2 7/16	3/8	1 5/16	60	5/8	3	5/16-18	1.1
HP2	P2	3	1.100	1.9375	2.875	1 3/32	2 7/16	3/8	2 5/16	60	5/8	3	5/16-18	2.5
HB1	B	3 7/8	0.292	2.623	3.750	1 7/16	3 1/8	1/2	1 5/16	60	13/16	3	5/16-18	2.3
HB2	B	4 1/2	0.709	2.623	4.375	1 7/16	3 1/8	1/2	1 3/4	60	13/16	3	5/16-18	4.7
HQ1	Q1	4 1/2	0.709	2.875	4.375	1 9/16	3 3/8	1/2	1 3/4	60	7/8	3	3/8-16	4.4
HQ1	Q1	4 1/2	1.250	2.875	4.375	1 9/16	3 3/8	1/2	1 3/4	60	7/8	3	3/8-16	4.4
HQ2	Q2	4 1/2	1.606	2.875	4.375	1 9/16	3 3/8	1/2	2 3/4	60	7/8	3	3/8-16	6.9
HR1	R1	5 3/4	0.709	4.000	5.625	2 3/16	4 5/8	3/4	2	60	1 1/8	3	3/8-16	7.3
HR2	R2	5 3/4	1.606	4.000	5.625	2 3/16	4 5/8	3/4	4	60	1 1/8	3	3/8-16	15.4
HS1	S1	6 3/4	0.946	4.625	6.500	2 9/16	5 3/8	3/4	3 5/16	60	1 5/8	3	1/2-13	17.3
HS2	S2	6 3/4	2.963	4.625	6.500	2 9/16	5 3/8	3/4	5 11/16	60	1 5/8	3	1/2-13	30.4
HU0	U0	8 1/2	2.000	6.000	8.250	3 1/4	7	1 1/4	3 3/4	60	2	3	5/8-11	32.0
HU1	U1	8 1/2	2.963	6.000	8.250	3 1/4	7	1 1/4	5 5/8	60	1 3/4	3	5/8-11	44.6
HU2	U2	8 1/2	6.016	6.000	8.250	3 1/4	7	1 1/4	8 5/8	60	1 3/4	3	5/8-11	69.0
HW1	W1	12 1/2	2.963	8.500	12.250	4 9/16	10	1 1/4	6 3/8	22 1/2	1 3/4	4	3/4-10	130.0

Type "B" Steel Hubs

Part No.	Dimensions					Bore		Wt. Lbs.
	O.D.	A	C	P	X	Stock	Max.	
HB40	3"	0.281"	2.875"	27/32"	1 1/8"	1/2"	1 7/8"	2.3
HB50	3 1/4	0.344	3.125	1 1/32	1 3/8	5/8	2 1/4	3.0
HB60	4	0.469	3.875	1 1/32	1 1/2	5/8	2 3/8	5.0
HB80	5	0.563	4.875	1 1/2	2 1/16	3/4	3	11.1
HB100	5 1/4	0.688	5.125	2 1/16	2 3/4	1	3 1/4	16.3

NOTE—"A" dimension is plate thickness of sprocket for chain indicated in part number. Other plates can be used by remachining "A" dimension.

HYDRAULIC ASSIST TAKE-UP – TECHNICAL OPERATION

The hydraulic assist take-up system comprises:

- Screw type take-up unit for hydraulic cylinder assist
- Two single-acting hydraulic cylinders
- Hydraulic power unit

The hydraulic assist is to be used to tension the belt (or chain) after installation and periodically during operation as required. The screws on the take-up units are used to hold the take-ups in position against belt/chain tension. *The system is not designed to be a constant tension device by constantly holding cylinders in a pressurized state.*

Single acting cylinders are used and can only be reversed by manually pushing the rods in or by driving the take-ups back using the screws. Always move take-ups simultaneously or 2-3 mm each side at a time to prevent damage to the bearings and seals in the pillow blocks.

Calculate the required cylinder pressure to achieve the design belt/chain tension if this has not been provided for your specific application. During initial installation, the initial tensioning should be to 80% of the set pressure. Final tensioning would be to 100% of the pressure required (i.e., 100% of required tension).

The relief valve on the pump must be set to the required pressure. This will ensure that the belt/chain will not be over-tensioned, which could cause damage to the belt, bearings, pulleys, shafts or frame.

Operation

Power Unit for Hydraulic Take-Up Assist

1. Ensure that there is sufficient volume in the reservoir to fully extend both hydraulic cylinders and still leave 20% capacity in the tank.
2. Fill reservoir with clean new hydraulic oil, with suitable viscosity, to meet the ambient and operating temperatures. Check with your oil supplier for the correct oil.
3. Ensure hoses are properly connected.
4. If the relief valve has not been set to required pressure, refer to relief adjustment section for instructions.
5. Ball valves should be opened to allow flow to both cylinders for the initial cylinder fill. Close release valve and manually stroke the pump to provide flow to the cylinders.
6. Once the cylinders meet with resistance, there will be an increase of pressure. This will be seen on the pressure gauge. Always move the cylinders simultaneously or 2-3 mm each side at a time to prevent damage to the bearings or seals in the pillow blocks.
7. As the pressure approaches the desired pressure, you may choose to leave both valves open (flow going to both cylinders) or you may choose to pump to one

cylinder only by closing one ball valve.
Caution: Refer to 6. above.

8. Once you have positioned the take-up and locked it mechanically into position, both ball valves should be left in the open position *as well as the release valve*. This releases the pressure in the hydraulic system.

Relief Valve Adjustment

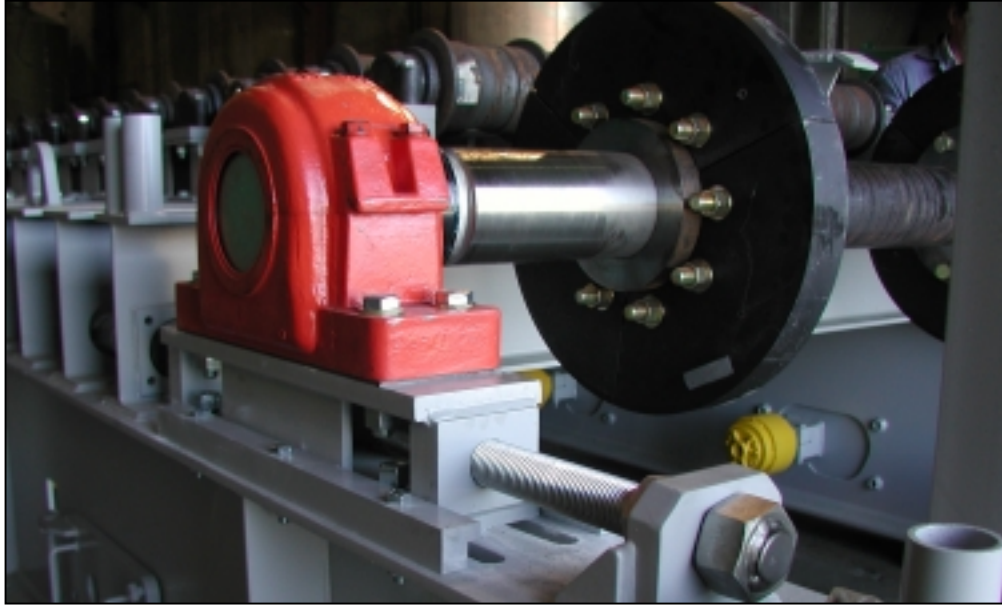
Refer to Brand Hydraulics technical and parts information sheets attached to find location of the relief valve adjusting screw.

To make adjustments:

- Loosen the nut locking the adjustment setscrew.
- Using an allen wrench, turn the setscrew counter-clockwise two turns.
- Close both ball valves.
- Close release valve (clockwise).
- Start pumping and check pressure. When pressure remains constant when pumping, the gauge will indicate the relief setting.
- If the pressure reading is below that required, gradually increase the relief valve setting by turning the setscrew clockwise until the required pressure setting has been achieved. Continue pumping to check if reading is constant. If so, lock setscrew using locknut.
 Open release valve.

Industrial Equipment Manufacturing Ltd.

#109 – 19433 96th Ave, Surrey, BC, Canada V4N 4C4 Phone (604) 513-9930 Fax (604) 513-9905



Tailshaft Take-Up Showing Dovetail Guide



Hydraulic Assist Take-Up Cylinder (optional)

Industrial Equipment Manufacturing Ltd.

#109 – 19433 96th Ave, Surrey, BC, Canada V4N 4C4 Phone (604) 513-9930 Fax (604) 513-9905

Typical Hydraulic Assist for Feeder Take-Up

Arrangement varies depending on type of feeder and size.

The hydraulic cylinder is single-acting, pressurized to extend. Cylinder is retracted using the screw take-up and opening the release valve in the hand pump (refer to operating manual for instructions). The cylinder is only used for assisting tensioning of chain (or conveyor belt)--***not to be used as a holding cylinder.***

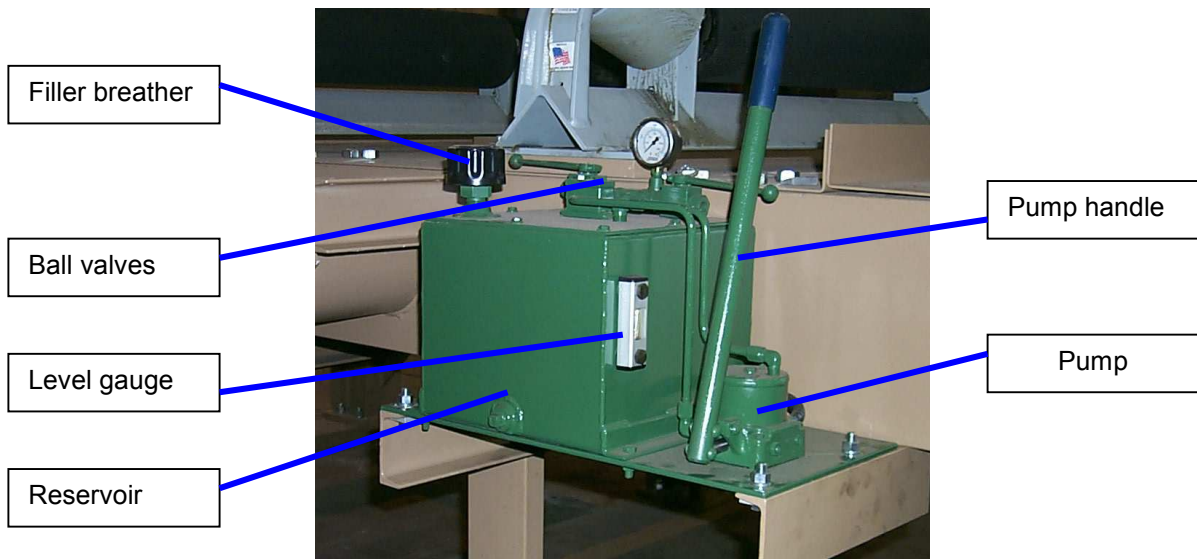
Hydraulic Assist
Cylinder



Typical Hydraulic Power Unit, Manual Operation

Mounting arrangement varies depending type of feeder and orientation.

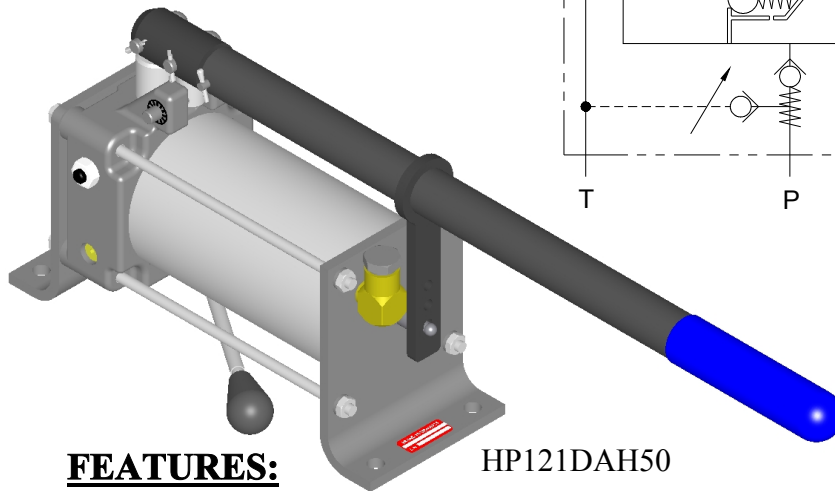
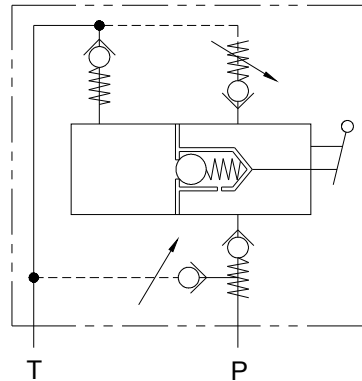
The hand-operated pump is used to provide the flow for the assist cylinders. The valves on the power unit can be used to direct flow to either of the two cylinders individually or both at the same time.



HAND OPERATED HYDRAULIC PUMPS

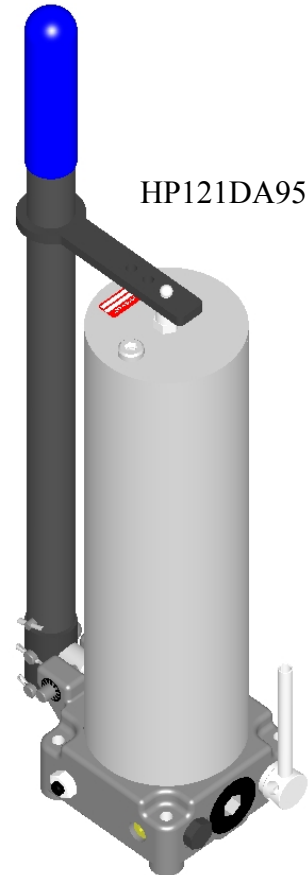
“HP”

HP121 OR HP61



HP121DAH50

HP121DA95



FEATURES:

- **O’RING PORT** to eliminate leakage.
- **DELTRIN SEAT** to seal between tank inlet and piston reservoir.
- **O’RING OUTLET CHECK** for zero leakage.
- **O’RING SEAL** between tank and casting.
- **STEEL BALL RELEASE VALVE** allows oil to travel to tank and relieves pressure on the outlet line.
- **EVERY HP IS TESTED** for outlet check leakage, double or single pump action and relief setting.
- **OPTIONAL HORIZONTAL MOUNTING BRACKETS** allows for horizontal handle actuation.

SPECIFICATIONS:

- **Volume Displacement**
HP22SA – 0.20 in³ (3.3 cm³) (When handle is pulled).
HP61DA – 0.60 in³ (9.8 cm³) per full cycle.
HP121DA – 1.20 in³ (19.7 cm³) per full cycle.
- **Tank sizes**
95 in³ (1557 cm³), 80 in³ (1311 cm³), 65 in³ (1065 cm³), and 50 in³ (819 cm³).
TL – 2 in. (50.8 mm) tank used with remote reservoir.
- **Pressure rating and (Standard relief setting).**
HP22SA – 6000 psi, 414 bar (4000 psi, 276 bar).
HP61DA – 3000 psi (3000 psi, 207 bar).
HP121DA – 2000 psi (2000 psi, 138 bar).

- **Outlet Port Size #6 SAE (9/16-18).**
- **Filler Port Size 1/4” NPT.**

MATERIALS:

- **Cast Iron Body**
- **Buna N O’Rings**
- **Delrin Inlet Seat**
- **Stainless Steel Piston**

HP – GENERAL INFORMATION

The Brand, hand operated hydraulic pump comes in three basic models HP121DA, HP61DA and HP22SA. Each one of these models comes with a relief that can be adjusted manually to suit the customer's requirements. Brand has also redesigned the outlet check seat for zero leakage. The zero leak seat was created by utilizing an o'ring seal to replace the steel ball seal. The NT (no tank) option does not have a tank, pressure relief and release valve. To use the NT option the customer must connect the inlet of the hand pump to an external reservoir (external reservoir is not supplied by Brand). The TL (2 in. tank) option has a small tank, pressure relief and release valve. To use the TL option the customer must connect the fill port on the tank to an external reservoir (external reservoir is not supplied by Brand). When mounting the NT or TL option, the pump should be placed below the fluid level of the external reservoir. All standard tanks have a 1/4" NPT filler plug at the top of the tank.

HP22SA – has a single-acting piston that can pump 0.20 in³ (3.3 cm³) per full cycle. The term single-acting means that the piston only pumps fluid when the handle is pulled away from the pump. The piston does not displace fluid when the handle is pushed towards the pump. The pressure rating is higher than the HP121DA because it takes less force to displace the smaller surface area of the piston. This pump is typically used in applications that require low volume displacement and high pressure.

HP61DA – has a double-acting piston that can pump 0.60 in³ (9.8 cm³) per full cycle. The term double-acting means that the piston pumps fluid when the handle is pushed and pulled. The pressure rating is higher than the HP121DA because it takes less force to displace the piston. This pump is typically used in applications that require medium volume displacement and medium pressure.

HP121DA – has a large double-acting piston that can pump 1.20 in³ (19.7 cm³) per full cycle. The term double-acting means that the piston pumps fluid when the handle is pushed and pulled. The pressure rating is lower than the HP22SA and HP61DA because it takes a greater amount of force to displace a piston that has a large surface area. This pump is typically used in applications that require high volume displacement and lower pressure.

HP – EXAMPLES OF COMMON MODEL CODES:

HP22SA50 0.20 in³ (3.3 cm³) displacement, single acting and 50 in³ (819 cm³) tank.

HP61DA95 0.60 in³ (9.8 cm³) displacement, double acting and 95 in³ (1557 cm³) tank.

HP121DA65 1.20 in³ (19.7 cm³) displacement, double acting and 65 in³ (1065 cm³) tank.

HP – CREATING A COMMON MODEL CODE FOR HP'S:

H P	
DISPLACEMENT PER CYCLE AND PUMP ACTION:	TANK:
22SA – 0.20 in ³ (3.3 cm ³) and single acting	95 – 95 in ³ 1.55 Liters) (12 in. (30.5 cm) height)
61DA – 0.60 in ³ (9.8 cm ³) and double acting	80 – 80 in ³ (1.31 Liters) (10 in. 25.4 cm) height)
121DA – 1.20 in ³ (19.7 cm ³) and double acting	65 – 65 in ³ (1.06 Liters) (8 in. (20.3 cm) height)
	50 – 50 in ³ (0.82 Liters) (6 in. (15.2 cm) height)
	TL – 2 in. tank used in conjunction with customer's external reservoir (1/4" NPT filler port).
	NT – Does not come with tank, adjustable relief and release valve. (61DA and 121DA only)
	RP – Return port (1/4" NPT return port, cannot be used with the NT option.).
HAND PUMP MOUNTING:	
Omit – Standard vertical mounting	
H – Horizontal-mounting brackets (must use 50, 65, 80, or 95 tank option)	

HP – COMPLETE LIST OF OPTIONS AND ACCESSORIES:

HP22-K Seal kit for HP22SA.

HP22-K-EPR Ethylene propylene rubber (EPR) seal kit for HP22SA.

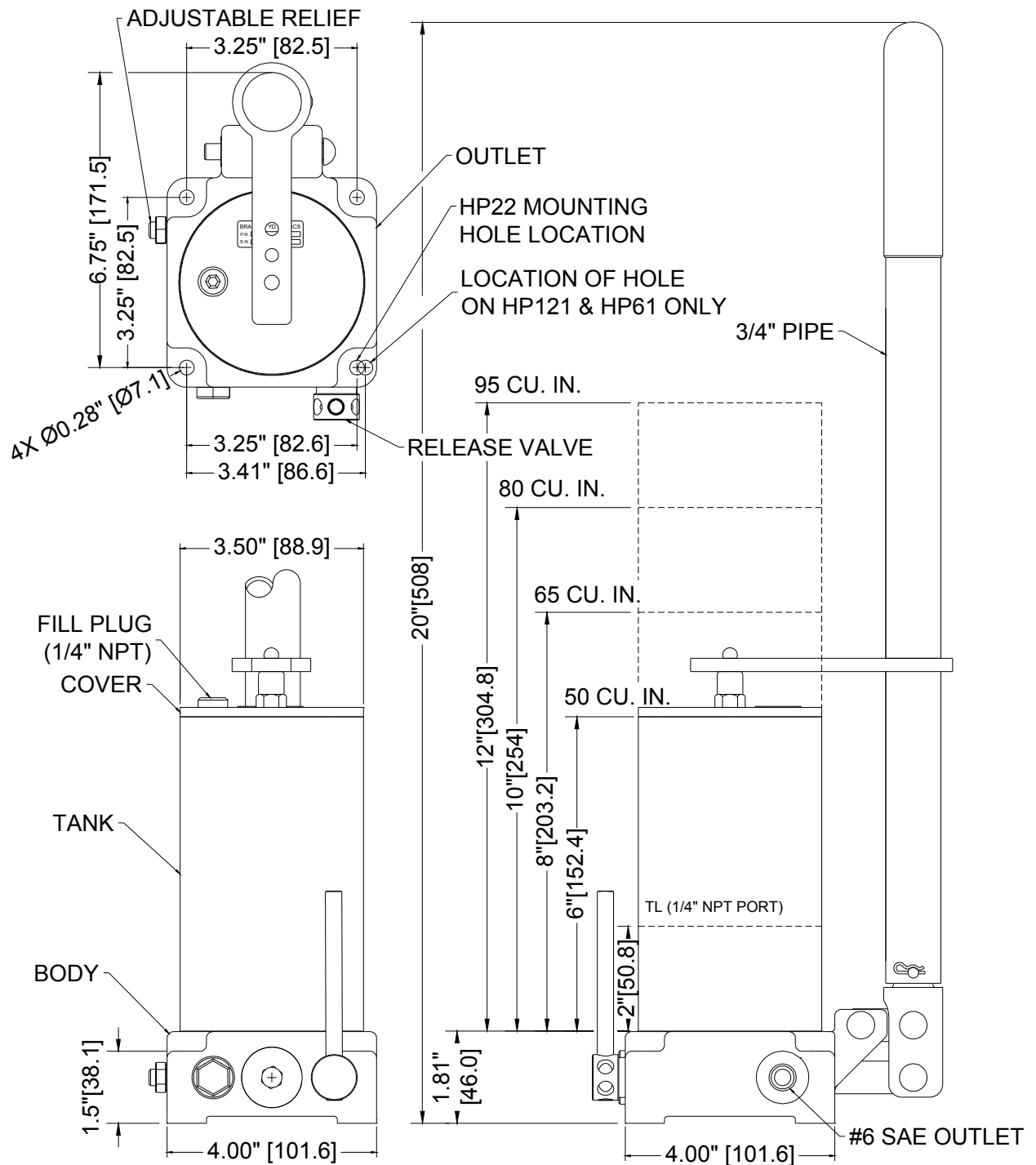
HP61-K Seal kit for HP61DA.

HP121-K Seal kit for HP121DA.

DIMENSIONAL DATA: inches & [millimeters]

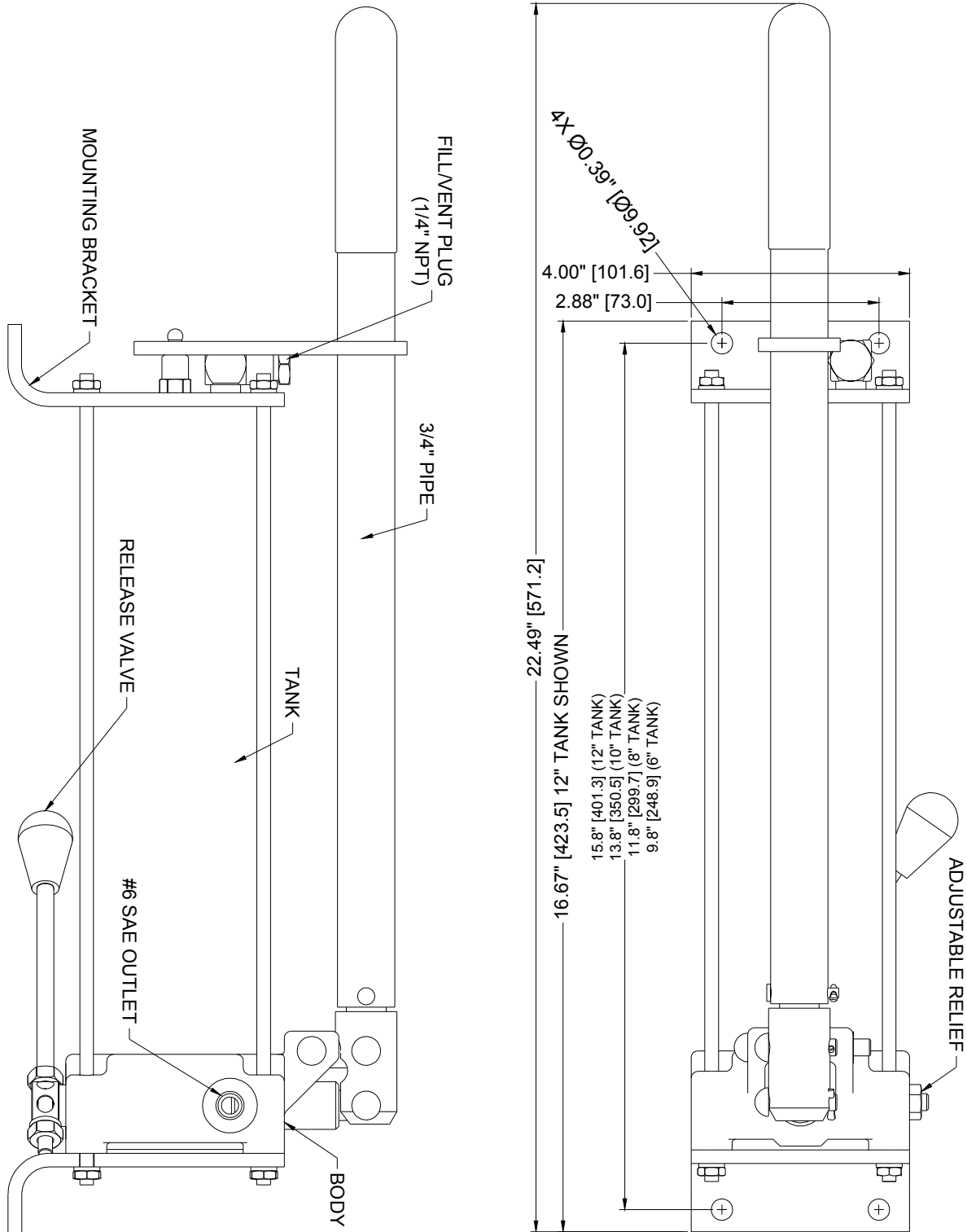
DIMENSIONS LISTED ARE THE SAME FOR ALL THREE PUMP SERIES

NOTE: HP121 & HP61 MOUNTING HOLE (NEXT TO PRESSURE RELEASE LEVER) IS NOT IN THE SAME LOCATION AS THE MOUNTING HOLE ON THE HP22.
(HP61DA SHOWN)

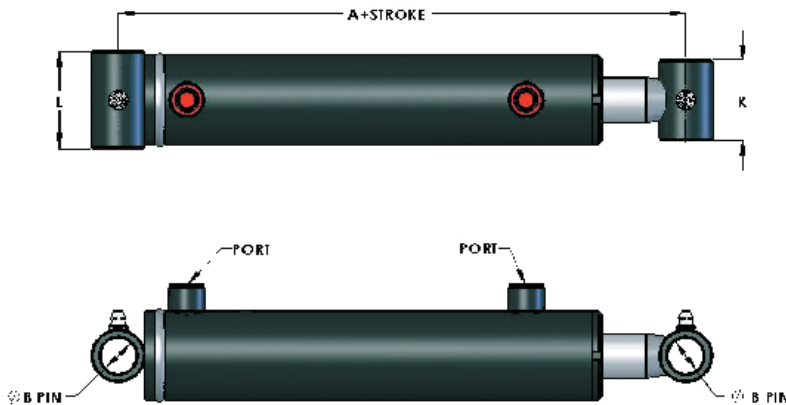


DIMENSIONAL DATA CONTINUED: inches & [millimeters]

DIMENSIONS LISTED ARE THE SAME FOR ALL THREE PUMP SERIES
(HP61DA AND HP121DA SHOWN)



MAL MODEL - SPECIFICATIONS

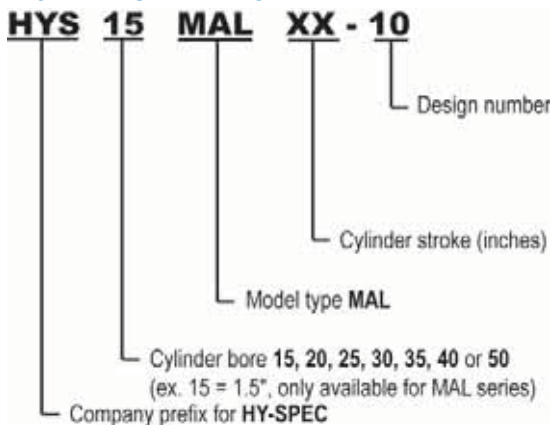


Pressure (PSI)	
Operating	Testing
3000	5600

MAL CYLINDER DIMENSIONS

	TUBE DIA.	A	Ø B PIN	K	L	PORTS (SAE)
in.	1.500	8.000	0.750	2.000	2.250	6
mm	38.10	203.20	19.05	50.80	57.15	
in.	2.000	8.000	1.000	2.250	2.750	6
mm	50.80	203.20	25.40	57.15	69.85	
in.	2.500	8.000	1.000	2.250	3.250	8
mm	63.50	203.20	25.40	57.15	82.55	
in.	3.000	8.000	1.000	2.250	3.750	8
mm	76.20	203.20	25.40	57.15	95.25	
in.	3.500	10.000	1.250	2.250	4.250	8
mm	88.90	254.00	31.750	57.15	107.95	
in.	4.000	10.000	1.500	2.500	4.750	8
mm	101.60	254.00	38.10	63.50	120.65	
in.	5.000	12.000	1.750 / 2.000	3.250	6.000	12
mm	127.00	304.80	44.45	82.55	152.40	

MODEL NUMBER FOR MAL



WARNING / ATTENTION

PLEASE NOTE THAT THE MAXIMUM CAPACITY OF CLEVIS PINS ARE:

VEUILLEZ NOTER QUE LA CAPACITÉ MAXIMUM DES GOUPILLES D'ATTACHEMENT EST DE :

1" Ø = 26 000 Lbs	1-1/2" Ø = 56 000 Lbs
1-1/4" Ø = 39 000 Lbs	2" Ø = 96 000 Lbs

LIMITED LIFETIME WARRANTY ON OUR CYLINDERS AGAINST ALL MANUFACTURING DEFECTS

ASK FOR HY-SPEC QUALITY

Product availability, specifications and prices are subject to change without notice. Taxes extra.

MAL MODELS

MODEL	BORE X STROKE (in.)	ROD DIA. (in.)	PIN DIA. (in.)	CENTER TO CENTER OF PIN (in.)		PORTS	WEIGHT (lb)	LIST PRICE	SEAL KIT		
				Retracted	Extended				PART #	PRICE	
HYS 15MAL04-10	1 1/2 X 4	1	3/4	12	16	SAE-6	8		HYS MF 151000-10		
HYS 15MAL06-10	1 1/2 X 6			14	20		9				
HYS 15MAL08-10	1 1/2 X 8			16	24		10				
HYS 15MAL10-10	1 1/2 X 10			18	28		12				
HYS 15MAL12-10	1 1/2 X 12			20	32		13				
HYS 15MAL14-10	1 1/2 X 14			22	36		14				
HYS 15MAL16-10	1 1/2 X 16			24	40		15				
HYS 20MAL04-10	2 X 4	1-1/4	1	12	16		11		HYS MF 201250-10		
HYS 20MAL06-10	2 X 6			14	20		13				
HYS 20MAL08-10	2 X 8			16	24		15				
HYS 20MAL10-10	2 X 10			18	28		16				
HYS 20MAL12-10	2 X 12			20	32		18				
HYS 20MAL14-10	2 X 14			22	36		20				
HYS 20MAL16-10	2 X 16			24	40		21				
HYS 20MAL18-10	2 X 18			26	44		23				
HYS 20MAL20-10	2 X 20			28	48		25				
HYS 20MAL24-10	2 X 24			32	56		28				
HYS 20MAL28-10	2 X 28			36	64		31				
HYS 20MAL30-10	2 X 30			38	68		33				
HYS 20MAL32-10	2 X 32			40	72		35				
HYS 20MAL36-10	2 X 36			44	80		39				
HYS 20MAL40-10	2 X 40			48	88		42				
HYS 20MAL48-10	2 X 48			56	104		49				
HYS 25MAL04-10	2 1/2 X 4	1-1/2		1	12	16	SAE-8	15		HYS MF 251500-10	
HYS 25MAL06-10	2 1/2 X 6				14	20		17			
HYS 25MAL08-10	2 1/2 X 8				16	24		20			
HYS 25MAL10-10	2 1/2 X 10				18	28		22			
HYS 25MAL12-10	2 1/2 X 12				20	32		24			
HYS 25MAL14-10	2 1/2 X 14				22	36		26			
HYS 25MAL16-10	2 1/2 X 16				24	40		28			
HYS 25MAL18-10	2 1/2 X 18				26	44		31			
HYS 25MAL20-10	2 1/2 X 20				28	48		33			
HYS 25MAL24-10	2 1/2 X 24				32	56		37			
HYS 25MAL28-10	2 1/2 X 28				36	64		42			
HYS 25MAL30-10	2 1/2 X 30				38	68		44			
HYS 25MAL32-10	2 1/2 X 32				40	72		46			
HYS 25MAL36-10	2 1/2 X 36				44	80		51			
HYS 25MAL40-10	2 1/2 X 40				48	88		55			
HYS 25MAL48-10	2 1/2 X 48				56	104		64			
HYS 30MAL06-10	3 X 6	1-1/2			14	20		21		HYS MF 301500-10	
HYS 30MAL08-10	3 X 8				16	24		24			
HYS 30MAL10-10	3 X 10				18	28		26			

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MAL MODELS

MODEL	BORE X STROKE (in.)	ROD DIA. (in.)	PIN DIA. (in.)	CENTER TO CENTER OF PIN (in.)		PORTS	WEIGHT (lb)	LIST PRICE	SEAL KIT	
				Retracted	Extended				PART #	PRICE
HYS 30MAL12-10	3 X 12	1-1/2	1	20	32	SAE-8	29		HYS MF 301500-10	
HYS 30MAL14-10	3 X 14			22	36		31			
HYS 30MAL16-10	3 X 16			24	40		33			
HYS 30MAL18-10	3 X 18			26	44		36			
HYS 30MAL20-10	3 X 20			28	48		38			
HYS 30MAL24-10	3 X 24			32	56		43			
HYS 30MAL28-10	3 X 28			36	64		48			
HYS 30MAL30-10	3 X 30			38	68		50			
HYS 30MAL32-10	3 X 32			40	72		53			
HYS 30MAL36-10	3 X 36			44	80		58			
HYS 30MAL40-10	3 X 40			48	88		63			
HYS 30MAL48-10	3 X 48			56	104		73			
HYS 35MAL06-10	3 1/2 X 6	1-3/4	1-1/4	16	22	SAE-8	30		HYS MF 351750-10	
HYS 35MAL08-10	3 1/2 X 8			18	26		33			
HYS 35MAL10-10	3 1/2 X 10			20	30		36			
HYS 35MAL12-10	3 1/2 X 12			22	34		39			
HYS 35MAL14-10	3 1/2 X 14			24	38		42			
HYS 35MAL16-10	3 1/2 X 16			26	42		45			
HYS 35MAL18-10	3 1/2 X 18			28	46		48			
HYS 35MAL20-10	3 1/2 X 20			30	50		51			
HYS 35MAL24-10	3 1/2 X 24			34	58		57			
HYS 35MAL28-10	3 1/2 X 28			38	66		63			
HYS 35MAL30-10	3 1/2 X 30			40	70		66			
HYS 35MAL32-10	3 1/2 X 32			42	74		69			
HYS 35MAL36-10	3 1/2 X 36			46	82		75			
HYS 35MAL40-10	3 1/2 X 40			50	90		81			
HYS 35MAL48-10	3 1/2 X 48			58	106		93			
HYS 40MAL08-10	4 X 8	2	1-1/2	18	26	SAE-8	46		HYS MF 402000-10	
HYS 40MAL10-10	4 X 10			20	30		50			
HYS 40MAL12-10	4 X 12			22	34		55			
HYS 40MAL14-10	4 X 14			24	38		59			
HYS 40MAL16-10	4 X 16			26	42		63			
HYS 40MAL18-10	4 X 18			28	46		67			
HYS 40MAL20-10	4 X 20			30	50		71			
HYS 40MAL24-10	4 X 24			34	58		80			
HYS 40MAL28-10	4 X 28			38	66		88			
HYS 40MAL30-10	4 X 30			40	70		92			
HYS 40MAL32-10	4 X 32			42	74		96			
HYS 40MAL36-10	4 X 36			46	82		105			
HYS 40MAL40-10	4 X 40			50	90		113			
HYS 40MAL48-10	4 X 48			58	106		130			

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MAL MODELS

MODEL	BORE X STROKE (in.)	ROD DIA. (in.)	PIN DIA. (in.)	CENTER TO CENTER OF PIN (in.)		PORTS	WEIGHT (lb)	LIST PRICE	SEAL KIT	
				Retracted	Extended				PART #	PRICE
HYS 50MAL08-10	5 X 8	2-1/2	1-3/4 & 2	20	28	SAE-12	82		HYS MF 502500-10	
HYS 50MAL10-10	5 X 10			22	32		89			
HYS 50MAL12-10	5 X 12			24	36		95			
HYS 50MAL14-10	5 X 14			26	40		101			
HYS 50MAL16-10	5 X 16			28	44		108			
HYS 50MAL18-10	5 X 18			30	48		114			
HYS 50MAL20-10	5 X 20			32	52		121			
HYS 50MAL24-10	5 X 24			36	60		133			
HYS 50MAL28-10	5 X 28			40	68		146			
HYS 50MAL30-10	5 X 30			42	72		152			
HYS 50MAL32-10	5 X 32			44	76		159			
HYS 50MAL36-10	5 X 36			48	84		172			
HYS 50MAL40-10	5 X 40			52	92		184			
HYS 50MAL48-10	5 X 48			60	108		210			

CYLINDER PARTS & ACCESSORIES



PIN ONLY



PIN & BUSHING KIT



FEMALE CLEVIS



STROKE LIMITERS

Dimensions in inches

PIN ONLY					
MODEL	Ø PIN	USABLE LENGTH	FOR CYLINDER MODEL		
HYSPIN1X2750	1	2.750	20AGU-10	25AGU-10	30AGU-10
HYSPIN1X2250	1	2.250	20FEM-10	25FEM-10	30FEM-10
HYSPIN125X2500	1-1/4	2.500	35FEM-10		
HYSPIN150X3250	1-1/2	3.250	40FEM-10		
HYSPIN2X4250	2	4.250	50FEM-10		

PIN & BUSHING KIT (includes 2 pins & 4 bushings)			
MODEL	Ø PIN	FOR CYLINDER MODEL	LIST PRICE
HYSHYF-35-075-K	1-1/4 to 1	35FEM-10	
HYSHYF-40-075-ASAE-K	1-1/2 to 1	40FEM-ASAE-10	
HYSHYF-40-075-K	1-1/2 to 1	40FEM-10	
HYSHYF-50-075-K	2 to 1-1/2	50FEM-10	
HYSHYM-50-075	2 to 1 3/4	50MAL-10 (2 bushings only)	
HYSITC12-18-001	1 1/2 to 1	12ITC-10 (1 bushing only)	

FEMALE CLEVIS			
MODEL	THREAD	FOR CYLINDER MODEL	LIST PRICE
HYSAGU-20-070	1-1/8 12UNF	20AGU-10 25AGU-10	
HYSAGU-30-070	1-1/4 12UNF	30AGU-10 35AGU-10	
HYSAGU-40-070	1-1/4 12UNF	40AGU-10	

STROKE LIMITER ADJUSTABLE FROM 2 1/8" TO 5 3/16"			
MODEL	Ø ROD	FOR CYLINDER MODEL	LIST PRICE
HYSSL-1125-3000-001	1-1/8	20AGU-10 25AGU-10	
HYSSL-1250-3000-001	1-1/4	30AGU-10 35AGU-10 40AGU-10	
HYSSL-1250-3000-002	1-1/2 1-3/4 2	35AGU-10 40AGU-10	

ASK FOR HY-SPEC QUALITY

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HIGH PRESSURE BALL VALVES - 2 WAY

SPECIFICATIONS

BODY:	STEEL
BALL:	STEEL
TEMPERATURE RANGE:	-25° C to 100° C
BALL SEAL:	DELTRIN
SHAFT SEAL:	BUNA-N



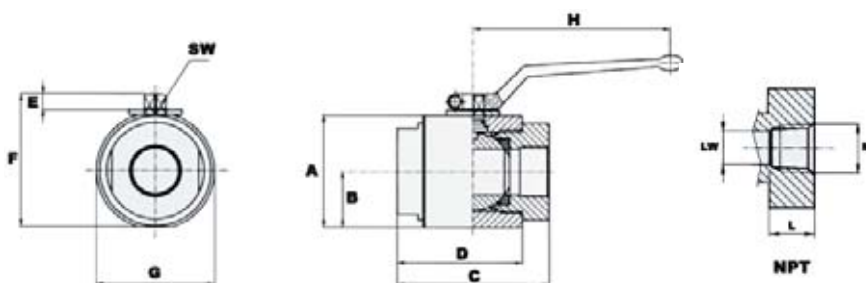
HYSGE2



HYSGB2

DIMENSIONS

**5000 PSI
to
7250 PSI**



Dimensions in inches

DIMENSIONS		A	B	C	D	E	F	G	H	L	M	SW	LW
FULL BORE	1/4	1.38	0.55	2.80	1.65	0.43	1.93	1.18	4.33	0.63	1/4	0.35	0.24
	3/8	1.57	0.67	2.87	1.73	0.43	2.13	1.38	4.33	0.63	3/8	0.35	0.39
	1/2	1.69	0.71	3.27	1.89	0.43	2.24	1.46	4.33	0.67	1/2	0.35	0.51
	3/4	2.17	0.91	3.74	2.44	0.51	2.87	1.77	7.09	0.87	3/4	0.55	0.79
	1	2.56	1.42	4.45	2.60	0.51	3.27	2.17	7.09	0.98	1	0.55	0.98
REDUCED BORE	1-1/4	2.56	1.42	4.76	2.60	0.51	3.27	2.17	7.09	0.98	1-1/4	0.55	0.98
	1-1/2	2.56	1.42	4.76	2.60	0.51	3.27	2.17	7.09	0.98	1-1/2	0.55	0.98
	1-1/4	3.31	1.65	4.53	3.74	0.53	3.98	3.31	13.27	0.94	1-1/4	0.55	1.26
FULL BORE	1-1/2	3.86	1.89	5.16	4.25	0.53	4.53	4.01	13.27	1.06	1-1/2	0.55	1.58
	2	4.06	2.03	5.51	4.53	0.53	4.72	4.25	13.27	1.10	2	0.55	1.97

NPT MODEL		PORTS	LIST PRICE	SAE MODEL	PORTS	LIST PRICE	WORKING PRESSURE (PSI)	WEIGHT (lb)	HANDLE PART #	LOCKING KIT PART #
FULL BORE	HYS GE2-N $\frac{1}{8}$ -DN4-PSI7250	1/8 NPT		-	-	-	-	-	HYS C1010ZB	HYS BALLK6-U
	HYS GE2-N $\frac{1}{4}$ -DN6-PSI7250	1/4 NPT		HYS GE2-SAE4-DN6-PSI7250	SAE-4		7250	1.00		
	HYS GE2-N $\frac{3}{8}$ -DN10-PSI7250	3/8 NPT		HYS GE2-SAE6-DN10-PSI7250	SAE-6		7250	1.25		
	HYS GE2-N $\frac{1}{2}$ -DN13-PSI7250	1/2 NPT		HYS GE2-SAE8-DN13-PSI7250	SAE-8		7250	1.61		
	HYS GE2-N $\frac{3}{4}$ -DN20-PSI5800	3/4 NPT		HYS GE2-SAE12-DN20-PSI5800	SAE-12		5800	3.00		
	HYS GE2-N1-DN25-PSI5075	1 NPT		HYS GE2-SAE16-DN25-PSI5075	SAE-16		5075	4.80	HYS C1200ZB	HYS BALLK20-U
REDUCED BORE	HYS GE2-N1 $\frac{1}{4}$ -DN25-PSI5075	1-1/4 NPT		HYS GE2-SAE20-DN25-PSI5075	SAE-20		5075	5.25		
	HYS GE2-N1 $\frac{1}{2}$ -DN25-PSI5075	1-1/2 NPT		HYS GE2-SAE24-DN25-PSI5075	SAE-24		5075	5.25		
FULL BORE	HYS GB2-N1 $\frac{1}{4}$ -DN32-PSI5075	1-1/4 NPT		HYS GB2-SAE20-DN32-PSI5075	SAE-20		5075	8.25	HYS C2890AV	HYS BALLK20-F
	HYS GB2-N1 $\frac{1}{2}$ -DN40-PSI5075	1-1/2 NPT		HYS GB2-SAE24-DN40-PSI5075	SAE-24		5075	12.75		
	HYS GB2-N2-DN50-PSI5075	2 NPT		HYS GB2-SAE32-DN50-PSI5075	SAE-32		5075	14.25		

OTHER MODELS AVAILABLE ON REQUEST

ASK FOR HY-SPEC QUALITY

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GAUGES

LIQUID FILLED PRESSURE GAUGES

STEM MOUNT

MODEL	DESCRIPTION	WEIGHT (lb)	LIST PRICE
HYS 25KL4V-15-0 PSI	0-30 in Hg STAINLESS STEEL CASE VACUUM	0.44	
HYS 25KL4P 0-30PSI	0-30 PSI STAINLESS STEEL CASE		
HYS 25KL4P 0-100PSI	0-100 PSI STAINLESS STEEL CASE		
HYS 25KL4P 0-600PSI	0-600 PSI STAINLESS STEEL CASE		
HYS 25KL4P 0-1000PSI	0-1000 PSI STAINLESS STEEL CASE		
HYS 25KL4P 0-1500PSI	0-1500 PSI STAINLESS STEEL CASE		
HYS 25KL4P 0-3000PSI	0-3000 PSI STAINLESS STEEL CASE		
HYS 25KL4P 0-5000PSI	0-5000 PSI STAINLESS STEEL CASE		

PANEL MOUNT

MODEL	DESCRIPTION	WEIGHT (lb)	LIST PRICE
HYS 25KV4V -15- 0 PSI	0-30 in Hg STAINLESS STEEL CASE VACUUM	0.51	
HYS 25KV4P 0-500PSI	0-500 PSI STAINLESS STEEL CASE		
HYS 25KV4P 0-3000PSI	0-3000 PSI STAINLESS STEEL CASE		
HYS 25KV4P 0-5000PSI	0-5000 PSI STAINLESS STEEL CASE		

STEM MOUNT

MODEL	DESCRIPTION	WEIGHT (lb)	LIST PRICE
HYS 4KL4V -15-0PSI-1/2 NPT	0-30 in Hg STAINLESS STEEL CASE VACUUM	1.3	
HYS 4KL4P 0-30PSI-1/2 NPT	0-30 PSI STAINLESS STEEL CASE		
HYS 4KL4P 0-100PSI-1/2 NPT	0-100 PSI STAINLESS STEEL CASE		
HYS 4KL4P 0-600PSI-1/2 NPT	0-600 PSI STAINLESS STEEL CASE		
HYS 4KL4P 0-1000PSI-1/2 NPT	0-1000 PSI STAINLESS STEEL CASE		
HYS 4KL4P 0-1500PSI-1/2 NPT	0-1500 PSI STAINLESS STEEL CASE		
HYS 4KL4P 0-3000PSI-1/2 NPT	0-3000 PSI STAINLESS STEEL CASE		
HYS 4KL4P 0-5000PSI-1/2 NPT	0-5000 PSI STAINLESS STEEL CASE		

PANEL MOUNT

MODEL	DESCRIPTION	WEIGHT (lb)	LIST PRICE
HYS 4KV4V -15-0PSI-1/2 NPT	0-30 in Hg STAINLESS STEEL CASE VACUUM	1.4	
HYS 4KV4P 0-30PSI-1/2 NPT	0-30 PSI STAINLESS STEEL CASE		
HYS 4KV4P 0-100PSI-1/2 NPT	0-100 PSI STAINLESS STEEL CASE		
HYS 4KV4P 0-600PSI-1/2 NPT	0-600 PSI STAINLESS STEEL CASE		
HYS 4KV4P 0-1500PSI-1/2 NPT	0-1500 PSI STAINLESS STEEL CASE		
HYS 4KV4P 0-3000PSI-1/2 NPT	0-3000 PSI STAINLESS STEEL CASE		
HYS 4KV4P 0-5000PSI-1/2 NPT	0-5000 PSI STAINLESS STEEL CASE		

N.B. Our Pressure Gauges must be mounted upright and the rubber tip must be cut after installation. Performance : accuracy +/- 3.33%

2 1/2"



DESCRIPTION

Body Case: Stainless Steel 304
Case Diameter: 2.5"
Window: Polycarbonate
Connection: Brass 1/2 NPT
Pressure scale: Red: PSI
Blue: BAR

4"



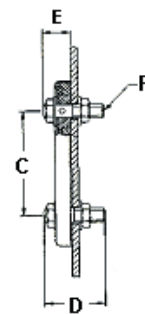
DESCRIPTION

Body Case: Stainless Steel 304
Case Diameter: 4"
Window: Polycarbonate
Connection: Brass 1/2 NPT
Pressure scale: Red: PSI
Blue: BAR

SIGHT LEVEL AND TEMPERATURE GAUGES

MODEL	A	B	C	D	E	F	WEIGHT (lb)	LIST PRICE
	mm in.	mm in.	mm in.	mm in.	mm in.			
HYS LS3	120 4.72	44 1.73	76 3.00	49 1.93	20 0.80	M10 X 1.5	0.4	
HYS LS5	175 6.89	48 1.89	127 5.00	45 5.71	21 4.76	M12 X 1.75	0.6	

MODELS WITH THERMOMETER



ASK FOR HY-SPEC QUALITY

Product availability, specifications and prices are subject to change without notice. Taxes extra.



Metal Filler Breathers SMBB / SMTB / SMBP

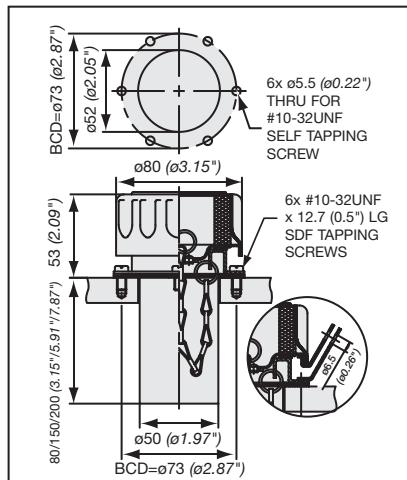
Group size 80 – Breather cap diameter 80 mm

SMBB-80

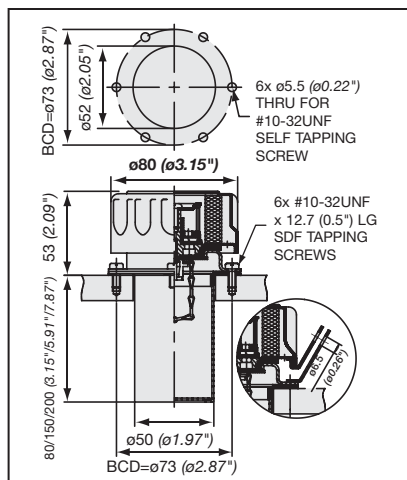
Metal Filler Breather
Bayonet style, 3" metal basket standard

Options:

- Metal Dipstick – non-pressurized
- Plastic Dipstick – pressurized
- Locking version
- Pressurized, opening pressure 5 PSI (0.35 bar) and 10 PSI (0.7 bar)
- Seal material: cork – non-pressurized
Buna-N – pressurized
- 6" (150 mm) and 8" (200 mm) metal and 4" (100 mm) plastic baskets available
- 3μ, 10μ or 40 micron breather element
- Chrome plated or epoxy coated
- Extended Bayonet options available



Non-pressurized version



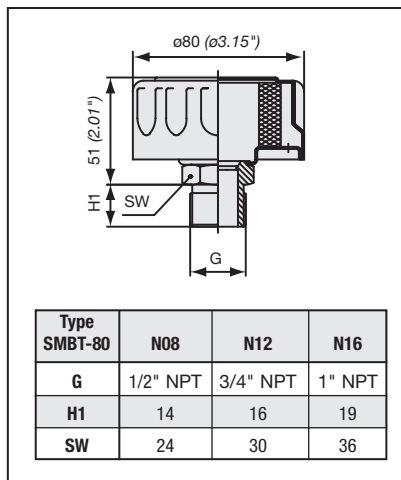
Pressurized version

SMTB-80

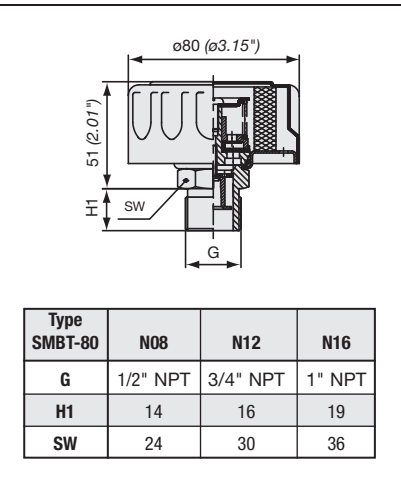
Metal Breather
Screw-in style

Options:

- Metal Dipstick non-pressurized
- Plastic Dipstick – pressurized
- NPT thread standard, BSP available on request
- Pressurized, opening pressure 5 PSI (0.35 bar) or 10 PSI (0.7 bar)
- 3μ, 10μ or 40 micron breather element
- Chrome plated or epoxy coated



Non-pressurized version



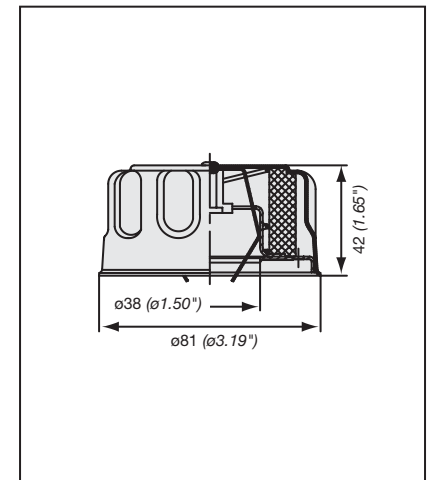
Pressurized version

SMBP-80

Metal Breather, epoxy coated standard
Push-on style

Options:

- Plastic Dipstick



The SMBP is only available without pressurization

Bayonet Flange Options

Standard Bayonet - "B"

Part No. EBF-1 - "B1"
38 mm (1.5 in) high
(See A13 for details)

Part No. EBF-2 - "B2"
69 mm (2.7 in) high
(See A13 for details)

Part No.	Micron Rating	Air Flow Capacity		Oil Displacement		Screws
		cfm	m ³ /min	gpm	lpm	
SMBB/SMTB 80	3	10	0.28	72	272	10-32x1/2
SMBB/SMTB 80	10	16	0.45	110	416	10-32x1/2
SMBB/SMTB 80	40	26	0.75	190	720	10-32x1/2

Ordering Code (bayonet style, cap ø80)

SMBB - 80E - N - L - 10 - 05 - B - S080 - O

Type	
SMBB	Metal Filler Breather (bayonet style)

Cap Size	
80	ø80, steel cap, chrome-plated (standard)
80E	ø80, steel cap, black epoxy
Note: other versions on request	

Version	
S	with STAUFF-logo (standard)
N	neutral (without logo)

Locking Option	
O	not lockable (standard)
L	lockable

Filter Material and Micron Rating	
00	without filter insert
03	3 µm filter paper
10	10 µm foam (PUR, standard)
40	40 µm foam (PUR)

Dipstick	
O	without dipstick (standard)
D300	plastic dipstick 300 mm
Note: The plastic dipstick can be shortened by the customer to requested lengths.	

Baskets	
O	without baskets
S080	80 mm metal basket (standard)
P100	100 mm plastic basket
S150	150 mm metal basket
S200	200 mm metal basket

Seal Material	
C	cork (for non-pressurised version)
B	NBR (for pressurised version)

Pressurisation (Opening Pressure)	
O	without pressurisation (standard)
05	0,35 bar (5 PSI)
10	0,70 bar (10 PSI)

Note: Screws are supplied with the SMBB as standard

Ordering Code (screw-in style, cap ø80)

SMBT - 80E - N - 10 - 05 - N12 - O

Type	
SMBT	Metal Filler Breather (screw-in style)

Cap Size	
80	ø80, steel cap, chrome-plated (standard)
80E	ø80, steel cap, black epoxy
Note: other versions on request	

Version	
S	with STAUFF-logo (standard)
N	neutral (without logo)

Filter Material and Micron Rating	
00	without filter insert
03	3 µm filter paper
10	10 µm foam (PUR, standard)
40	40 µm foam (PUR)

Dipstick	
O	without dipstick (standard)
D300	plastic dipstick 300 mm
Note: The plastic dipstick can be shortened by the customer to requested lengths.	

Connection Thread	
N08	1/2 NPT
N12	3/4 NPT
N16	1 NPT upon request
B08	G 1/2 BSP upon request
B12	G 3/4 BSP upon request
B16	G 1 BSP upon request

Pressurisation (Opening Pressure)	
O	without pressurisation (standard)
05	0,35 bar (5 PSI)
10	0,70 bar (10 PSI)

Ordering Code (push-on style, cap ø80)

SMBP - 80E - N - 10 - D300

Type	
SMBP	Metal Filler Breather (push-on style)

Cap Size	
80	ø80, steel cap, chrome-plated
80E	ø80, steel cap, black epoxy (standard)
Note: other versions on request	

Version	
S	with STAUFF-logo (standard)
N	neutral (without logo)

Dipstick	
O	without dipstick (standard)
D300	plastic dipstick 300 mm
Note: The plastic dipstick can be shortened by the customer to requested lengths.	

Filter Material and Micron Rating	
00	without filter insert
10	10 µm foam (PUR, standard)
40	40 µm foam (PUR)



Pressure Gauges Type SPG, WPG Series

Specifications

- Glycerine Filled for Accuracy
- Copper Alloy Bourden Tube
- Dual Scales
- Built in Relief Valve
- Operating Temperatures
Ambient -4°F to 140°F (-20°C to 60°C)
Media 140°F (+60°C)
- Acrylic Lens
- Accuracy + 1.5% of Full Scale
- Built in Snubber

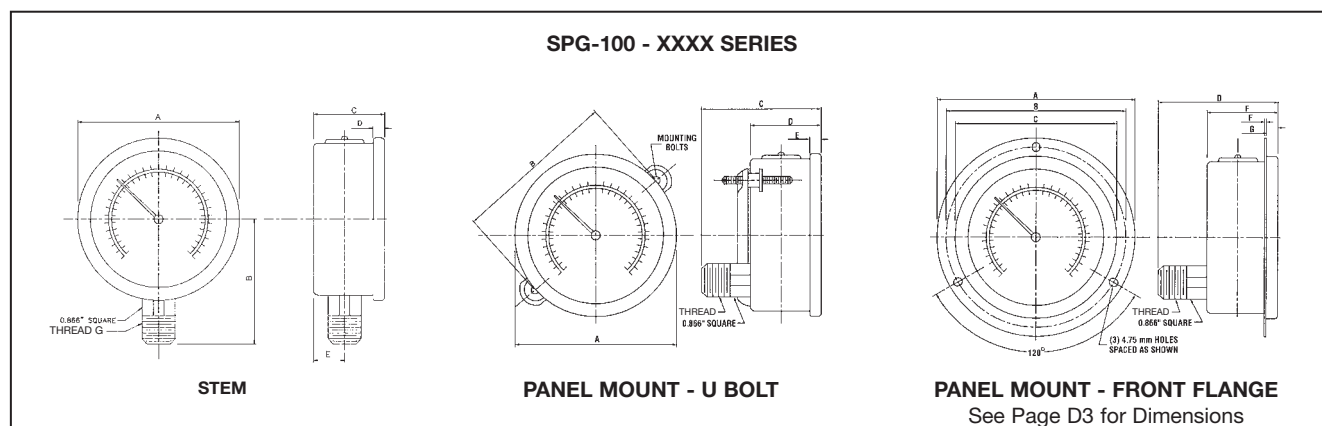
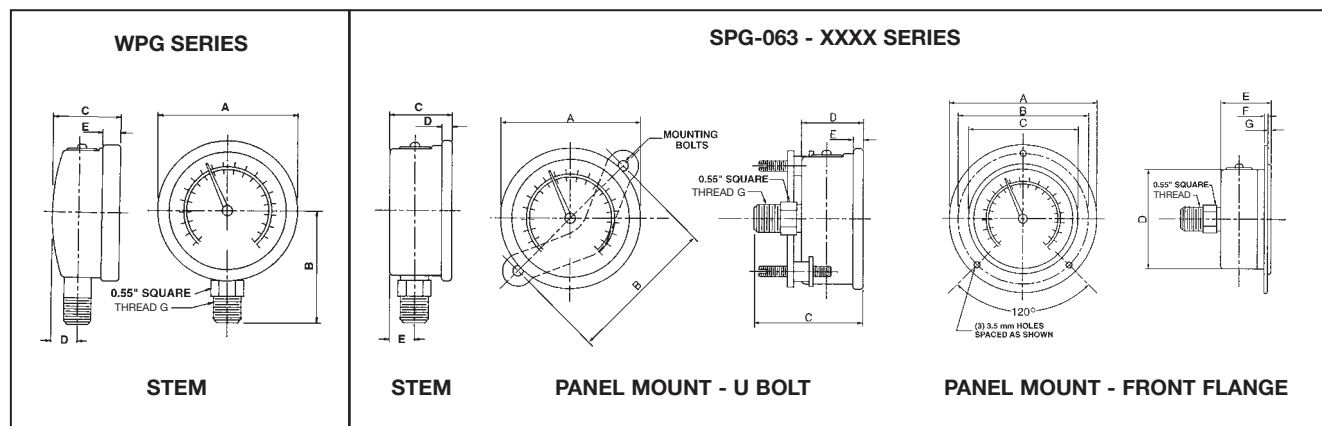
Options

- 2 1/2" or 4" Diameter Available
- Forged Brass Case Available in 2 1/2" Version.
- Stainless Steel Case Available in 2 1/2" and 4" Version.
- Front Flange
- Rubber Protective Cover Available for SPG-063 Series Only
- Custom Dials & Pressure Gauges Available on Special Request.
- 7/16"-20 SAE Thread Available on Popular Ranges of SPG-063 Series

Dimensions



Protective Gauge Cover - SPG63 Series



Standard Stock Pressure Ranges

	SPG 063 Series STEM		SPG 063 Series PANEL		SPG 100 Series STEM	SPG 100 Series PANEL	WPG 063 Series STEM
	NPT	SAE	NPT	SAE			
-30" Hg - 0 PSI	•						
-30" Hg - 30 PSI	•		•				•
0 - 30 PSI	•	•					•
0 - 60 PSI	•		•				•
0 - 100 PSI	•						
0 - 160 PSI	•	•	•				•
0 - 200 PSI	•						
0 - 300 PSI	•		•	•	•	•	•
0 - 500 PSI	•						
0 - 600 PSI	•	•	•		•	•	•
0 - 1000 PSI	•	•	•		•	•	•
0 - 1500 PSI	•	•	•		•	•	•
0 - 2000 PSI	•	•	•		•	•	
0 - 3000 PSI	•	•	•	•	•	•	•
0 - 4000 PSI	•		•				
0 - 5000 PSI	•	•	•	•	•	•	•
0 - 6000 PSI	•		•				•
0 - 7500 PSI							•
0 - 10000 PSI	•	•	•		•	•	

Series	Style	Size		A	B	C	D	E	F	G
SPG	STEM MOUNT	2 1/2"	in mm	2.5 63	2.1 53	1.2 31	0.51 13	0.26 6,5	-	1/4 NPT 7/16 - 20 UNF
	PANEL MOUNT U-BOLT	2 1/2"	in mm	2.5 63	2.8 72	2.4 62	1.2 31	0.26 6,5	-	1/4 NPT 7/16 - 20 UNF
	PANEL MOUNT FRONT FLANGE	2 1/2"	in mm	3.3 85	2.9 75	2.5 63	2.44 62	1.2 31	0.08 2	1/4 NPT 7/16 - 20 UNF
	STEM MOUNT	4"	in mm	4.2 107	3.4 86	1.85 47	0.3 7.5	0.64 16,3	-	1/2 NPT
	PANEL MOUNT U-BOLT	4"	in mm	4.2 107	4.25 108	3.15 80	1.85 47	0.3 7,5	-	1/2 NPT
	PANEL MOUNT FRONT FLANGE	4"	in mm	5.2 132	4.7 118	4.2 107	3.15 80	1.85 47	0.05 1,25	1/2 NPT
WPG	STEM MOUNT	2 1/2"	in mm	2.5 63,5	2.13 54	1.5 38	0.44 11	0.50 12,2	-	1/4 NPT

Ordering Code

Ordering Code

SPG 063 03000 5 S N04 O

Case Type

SPG	Stainless Steel
WPG	Forged Bronze

Dial Size

063	63 mm Face
100	100 mm Face

Pressure Range

-30" HG-0 psi	30HG30
-30" HG-30 psi	03030
0-30 psi	00030
0-60 psi	00060
0-100 psi	00100
0-160 psi	00160
0-200 psi	00200
0-300 psi	00300
0-500 psi	00500
0-600 psi	00600
0-1000 psi	01000
0-1500 psi	01500
0-2000 psi	02000
0-3000 psi	03000
0-4000 psi	04000
0-5000 psi	05000
0-6000 psi	06000
0-7500 psi	07500
0-10,000 psi	10000

Order Code

Scale

5	PSI/BAR
---	---------

Accessories

O	None
U	U-Bracket
F	Front Flange
R	Rear Flange
UF	U-Bracket & Front Flange

Thread

N04	1/4" NPT *
N08	1/2" NPT **
U04	7/16 - 20 UNF

Connection

S	Stem
P	Panel

* N04 - Standard on SPG-063 Series
WPG-063 Series

** N08 - Standard on SPG-100 Series

Adjustable Gauge Fitting EMV

	G ₁	G ₂	H	SW	Order No.	
					BURA-N	VITON
	G' _{1/4}	G' _{1/4}	42	19	EMV-G' _{1/4} -P-OR-PC	EMV-G' _{1/4} -V-OR-VC
	G' _{1/4}	G' _{1/2}	47	19	EMV-G' _{1/4} /G' _{1/2} -P-OR-PC	EMV-G' _{1/4} /G' _{1/2} -V-OR-VC
	G' _{1/2}	G' _{1/4}	51	27	EMV-G' _{1/2} /G' _{1/4} -P-OR-PC	EMV-G' _{1/2} /G' _{1/4} -V-OR-VC
	G' _{1/2}	G' _{1/2}	55,5	27	EMV-G' _{1/2} -P-OR-PC	EMV-G' _{1/2} -V-OR-VC



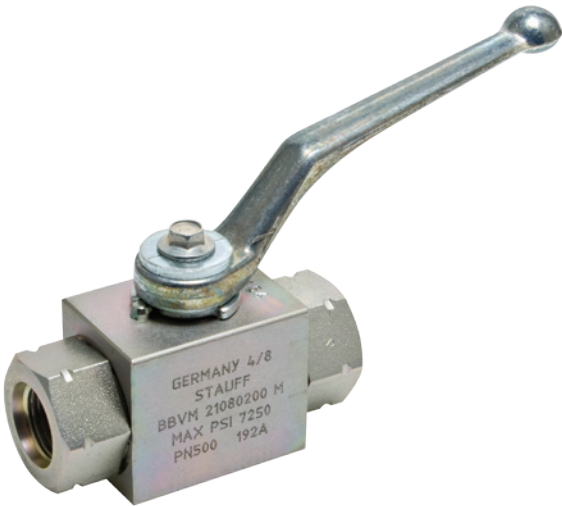
Two-Way Valves - BBVM Series Medium Duty

Specifications

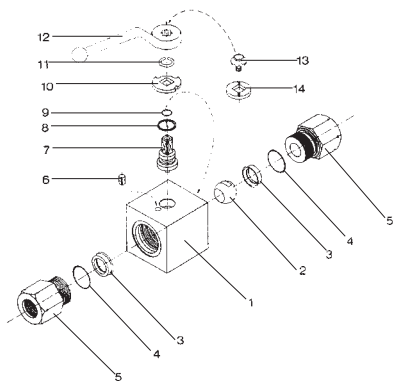
- Block Body, Medium Duty High Pressure Shut-off Valves
- 1/8"-1" Fully Ported-(1 1/4" & 1 1/2" with reduced bore)
- NPT SAE O-Ring Connectors
- Delrin +MoS2 Ball Seats
- Buna O-Ring
- Pressure Range: Up to 7250 PSI (500 bar) (depending on material combination and size)
- Standard Carbon Steel Construction
- Standard Temperature Range: -20°F to 212°F (-17°C to 100°C)
- Zinc Plated Body
- Brass Ball

Options

- Locking Kits
- Limit Switch
- Straight Handles



Technical Information

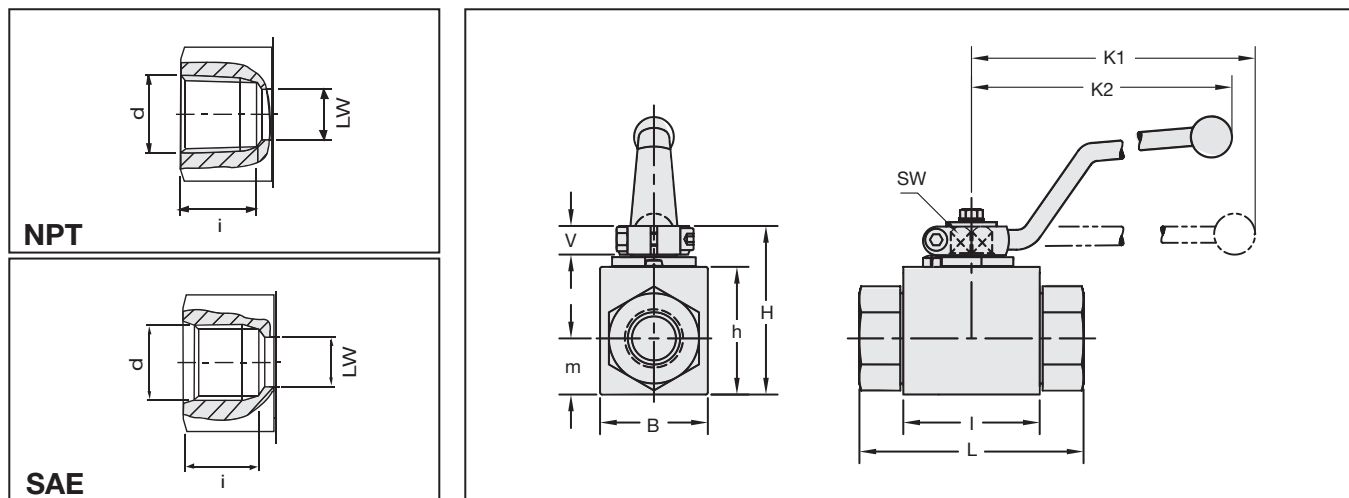


Item Number	Quantity	Description
1	1	Housing
2	1	Brass Ball
3*	2	Seat
4*	2	Connector O-Ring
5	2	Connector
6	1	Stop Pin
7	1	Stem
8*	1	Thrust Ring
9*	1	Stem O-Ring
10	1	Cam Plate
11	1	Snap Ring
12	1	Handle
13	1	Stem Screw
14	1	Flow Indicator

*Included in Seal Kit

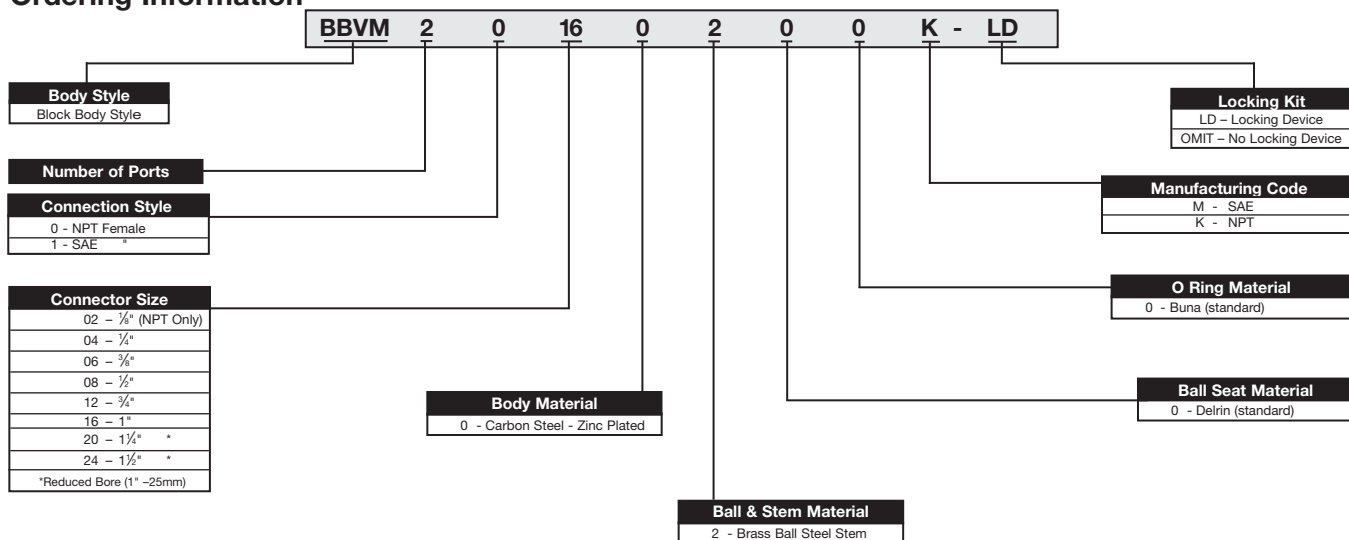
Size		Part Number	Maximum Working Pressure		Size		Part Number	Maximum Working Pressure	
			PSI	Bar				PSI	Bar
1/8"	NPT	BBVM20020200K	7250 PSI	500	3/4"	NPT	BBVM20120200K	6000 PSI	420
	SAE	BBVM21020200M	7250 PSI	500		SAE	BBVM21120200M	6000 PSI	420
1/4"	NPT	BBVM20040200K	7250 PSI	500	1"	NPT	BBVM20160200K	5000 PSI	345
	SAE	BBVM21040200M	7250 PSI	500		SAE	BBVM21160200M	5000 PSI	345
3/8"	NPT	BBVM20060200K	7250 PSI	500	1 1/4"	NPT	BBVM20200200K	5000 PSI	345
	SAE	BBVM21060200M	7250 PSI	500		SAE	BBVM21200200M	5000 PSI	345
1/2"	NPT	BBVM20080200K	7250 PSI	500	1 1/2"	NPT	BBVM20240200K	3600 PSI	250
	SAE	BBVM21080001M	7250 PSI	500		SAE	BBVM21240001M	3600 PSI	250

Dimensional Information



Size	d NPT	d SAE	i NPT	i SAE	L NPT	L SAE	LW NPT	LW SAE	I	B	H	h	m	V	SW	K ₁	K ₂	Weight
			in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm	lbs kg
1/8"	1/8-27	0.51 12.95	2.72 69.09	2.72 69.09	0.24 6.10	1.57 39.88	1.02 25.91	1.85 46.99	1.30 33.02	0.53 13.46	0.43 10.92	0.35 9	5.91 150.11	4.53 115.06	0.50 0.23			
1/4"	1/4-18	0.67 17.02	3.07 77.98	3.07 77.98	0.24 6.10	1.57 39.88	1.02 25.91	1.85 46.99	1.30 33.02	0.53 13.46	0.43 10.92	0.35 9	5.91 150.11	4.53 115.06	0.66 0.30			
3/8"	3/8-18	0.69 17.53	3.07 77.98	3.07 77.98	0.39 10	1.69 42.93	1.26 32.00	2.05 52.07	1.50 38.10	0.69 17.53	0.43 10.92	0.35 9	5.91 150.11	4.53 115.06	1.10 0.50			
1/2"	1/2-14	0.98 24.89	4.09 103.89	4.09 103.89	0.51 13	1.89 48.01	1.38 35.05	2.13 54.10	1.57 39.88	0.75 19.05	0.43 10.92	0.35 9	5.91 150.11	4.53 115.06	0.75 0.34			
3/4"	3/4-14	1.09 27.69	4.09 103.89	4.09 103.89	0.79 20	2.44 61.98	1.93 49.02	2.95 74.93	2.24 56.90	1.16 29.46	0.55 13.97	0.55 14	7.87 199.90	6.30 160.02	3.65 1.66			
1"	1-11 1/2	1.10 27.94	5.10 129.54	5.10 129.54	0.98 25	2.60 66.04	2.28 57.91	3.27 83.06	2.56 65.02	1.16 29.46	0.55 13.97	0.55 14	7.87 199.90	6.30 160.02	5.06 2.30			
1 1/4"	1 1/4-11 1/2	1.19 30.28	5.20 132.08	5.20 132.08	0.98 25	2.60 66.04	2.28 57.91	3.27 83.06	2.56 65.02	1.16 29.46	0.55 13.97	0.55 14	7.87 199.90	6.30 160.02	5.50 2.50			
1 1/2"	1 1/2-11 1/2	1.19 30.28	5.20 132.08	5.20 132.08	0.98 25	2.60 66.04	2.28 57.91	3.27 83.06	2.56 65.02	1.16 29.46	0.55 13.97	0.55 14	7.87 199.90	6.30 160.02	5.75 2.61			

Ordering Information



AFU SAFETY SWITCH

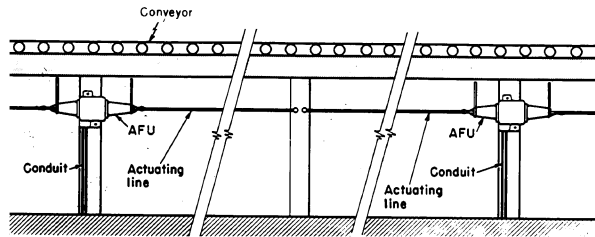


Figure 1

WARNING

Make certain power is OFF
before starting installation.

MOUNTING BODY

1. Fasten AFU body to mounting surface using screws or bolts through mounting holes provided. Each body has three 1" conduit hubs — two for horizontal through-feed and one at bottom. Cast mounting lugs permit attachment to web of standard 3" angle iron.
2. Remove access cover and gasket.
3. Thread conduit into body and pull wires.

BODY AND SWITCH ASSEMBLY

1. Strip insulation from ends of individual conductors (3/4" recommended).

2. Slip gasket(s) over snap switch(es).
3. Using wire nuts connect leads from snap switch(es) to line leads.

AFU switch assemblies are furnished with one or two end units, each unit containing one or two normally closed (N.C.) snap switches having single circuit contacts. Second switch provides auxiliary circuit for audible or visual alarm signal.

Contacts are momentary motor control push buttons, with contact maintained by spring loaded shaft rotation.

4. Switches are to be positioned as indicated on drawing. Right switch assembly is marked R1 on indicating arm; left switch assembly is marked L1.
5. Replace access cover and gasket, making sure gasket is properly seated.
6. Connect pull rope or cable to ring on switch assembly housing.

Depending on size and length of line, supports at properly spaced intervals may be necessary to insure that line or cable weight will not actuate switch. See Table I for pull requirements.

OPERATION

In installation, actuating line or cable is connected from a fixed point to loop on the switch unit. Pulling line moves shaft 1/4" which opens switch and trips red indicating arm, locking shaft into switch open position. Mechanism is reset by returning indicating arm to its normal position.

Table I

Description	Max. Lbs. Wgt. for Line or Cable so Switch is not Actuated	Operating Lbs. Force Required	Snap Switch Heavy Duty 600 Volts A.C. Maximum	
			Catalog #	Catalog #
Single End Left	15	25	AFU0333-10	AFU0333-50
	25	50	AFU0333-20	AFU0333-60
Single End Right	15	25	AFU0333-01	AFU0333-05
	25	50	AFU0333-02	AFU0333-06
Double End	15	25	AFU0333-11	AFU0333-55
	25	50	AFU0333-22	AFU0333-66



Electric Operated Centro-Matic® Pump P653S
24 VDC or 120/230 VAC, 50-60Hz



With Follower



Without Follower

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Introduction

Explanation of Symbols Used

The following description standards are used in this manual:

Safety Instructions

Structure of safety instructions:

- Pictogram
- Signal words
- Danger text
- Danger notes
- How to avoid danger

The following pictograms are used in this manual and are combined with corresponding signal words:



- ATTENTION
- CAUTION
- WARNING



- ATTENTION
- CAUTION
- WARNING



- NOTE
- IMPORTANT

The signal words give the seriousness of danger if the following text is not observed:

ATTENTION refers to faults or damages on machines.

CAUTION refers to bad damages and possible injuries.

WARNING refers to possible dangerous injuries.

NOTE indicates improved operation of the device.

IMPORTANT indicates special operating features of the device.

Example:



ATTENTION!

When making use of other than the tested spare parts, serious damage may affect your device.

Therefore, for the operation of your device always use original parts made by Lincoln Industrial.

Furthermore, you will find the following text symbols in this manual:

- Listing of applicable statements
 - Sub point of applicable statements
- 1. Determination of the number or sequence of contents
 - Procedural instruction

User's Responsibility

To ensure the safe operation of the unit, the user is responsible for the following:

1. The pump/system shall be operated only for the intended use (see next chapter "Safety Instructions") and its design shall neither be modified nor transformed.
2. The pump/system shall be operated only if it is in a proper functioning condition and if it is operated in accordance with the maintenance requirements.
3. The operating personnel must be familiar with this Owner Manual and the safety instructions mentioned within, and observe these carefully.

The correct installation and connection of tubes and hoses, if not specified by Lincoln Industrial, is the user's responsibility. Lincoln Industrial Technical Services will gladly assist you with any questions pertaining to the installation.

Environmental Protection

Waste (e.g. used oil, detergents, lubricants) must be disposed of in accordance with relevant environmental regulations.

Service

The personnel responsible for the handling of the pump/system must be suitably qualified. If required, Lincoln Industrial offers you full service in the form of advice, on-site installation assistance, training, etc. Please contact the Technical Service department for assistance.

In the event of inquiries pertaining to maintenance, repairs and spare parts, we require model specific data to enable Technical Services to clearly identify the components of your pump/system.

Therefore, always indicate the part, model and series number.

Safety Instructions

Appropriate Use

The electric Centro-Matic pump P653S has been designed for the automatic lubrication of commercial vehicles, industrial, construction and agricultural machines and wind power plants. The P653S pump has been designed for intermittent operation and is not suitable for continuous operation. The pump is capable of supplying lubricants up to NLGI # 2 grades. (see page 28 for list of recommended greases).

Misuse

Any use of the P653S pump that is not expressly mentioned in this User Manual will be regarded as misuse. If the P653S pump is used or operated in a manner other than specified, any claim for warranty or liability will be null and void.



CAUTION !

If personal injury or material damage occurs as a result of inappropriate operation, (e.g. if the safety instructions are ignored or resulting from an incorrect installation of the P653S pump), no claims or legal actions may be taken against Lincoln Industrial

Exclusion of Liability

The manufacturer of the P653S pump will not accept any liability for damages caused by:

- a lack of lubricant due to an irregular refilling of the pump
- the use of contaminated lubricants
- the use of greases which are not or only conditionally pumpable by P653S pump
- inadequate disposal of used or contaminated lubricants as well as of components that have been in touch with lubricant
- unauthorized modification of the system components
- the use of unapproved parts
- operation without adhering to the minimum pause time and respectively the maximum lubrication time (see chapter "Technical Data")

Regulations for Prevention of Accidents

To prevent accidents, observe all city, state and federal safety regulation of the country in which the product will be used.

General Safety Instructions

- Pump P653S is designed for safe operation.
- Incorrect use may result in bearing damage caused by poor or excessive lubrication.
- P653S pump with follower can be mounted vertically, horizontally or upside down.
- Pump without the follower should be mounted vertically upright only.
- Unauthorized modifications or changes to an installed system are not admissible. Any modification of the pump must be subject to prior authorization by manufacturer.
- Install the components of the P653S pump in such way that operator can always see the low-level position of the pump reservoir.
- Each time the reservoir has been refilled, make sure that no air has been trapped under the follower and pump is pumping lubricant.

Operation, Maintenance and Repair



WARNING!

Before carrying out any maintenance or repair on the P653S pump, make sure that all lubrication lines of the carrier unit are depressurized.

Repair

Repair should only be performed by authorized and instructed personnel who are familiar with the instructions.

Operation/Maintenance

Pumps P653S:

- must be refilled at regular intervals with clean lubricant recommended by the manufacturer without air entrapments under follower plate.
- operate automatically. However, a regular check (approx. every 2 days) should be made to ensure that lubricant is pumped to all lubrication points.

Disposal

Dispose of used or contaminated lubricants as well as of parts that were in touch with lubricant according to the legal regulations pertaining to environmental protection. Make sure to observe the safety data sheets of the lubricants used.

Operation, Maintenance, and Repair (continued)



WARNING!

Pump P653S must be installed by qualified personnel. The connection of the 120 VAC must be done according to the National Electrical code. **Before installing or working on the pump, disconnect and lock out the incoming power.**



WARNING!

Failure to observe the safety instructions, (e. g. touching electrically charged parts when the pump is opened, or improper handling of the pump P653S) may cause serious injury or death. If the values specified in the Technical Data are exceeded, the device may overheat. It may damage the pump P653S and thus impair the electric safety.

- Repairs should only be performed by authorized personnel who are familiar with the instructions.
- Defective printed circuit boards should be appropriately packed and returned to the factory.



CAUTION!

Electric Voltage!

In the case of pumps where grease is filled from top, the power supply must be switched off before the lubricant is filled in.



CAUTION!

Danger of injury in case of pumps being filled from the reservoir top: Never put your hand into the open reservoir while pump is running!



ATTENTION!

Risk of bursting if the reservoir is over-filled! When filling the reservoir by means of pumps with a large delivery volume do not exceed the max. filling mark.



CAUTION!

Do not use the pump in potentially explosive applications.

Installation

- Any safety equipment already installed on the vehicle:
 - should not be modified or made ineffective;
 - should only be removed for the purpose of installing the system and must be replaced afterwards.
- Use only original Lincoln spare parts or parts approved by Lincoln.



IMPORTANT

Adhere to:

- the installation instructions of the vehicle manufacturer with regard to all drilling and welding procedures.
- the specified minimum distances between the holes and the upper/lower rim of the frame or between two holes.



IMPORTANT

Route supply lines professionally. Firmly bolt together any components that are subject to pressure.

Installation and Maintenance of Hydraulic Hoses



ATTENTION!

Operational safety of the P653S pump can only be ensured in the case of a professional installation and maintenance of the hose lines. Make sure to observe the following recommendations!

Lubrication hose lines

- must never be subjected to torsion
- must be installed twist-free
- must not rub against metal components or edges
- are to undergo regular visual checks and must be exchanged in the case of wear (at the latest 2 years after installation)

Pay attention to non-linear installations to allow for a larger bending radius as possible. Avoid kinks. In constricted installation conditions use pipe elbow unions to avoid the danger of kinking behind the hose socket. Use high pressure hydraulic hose for lubrication lines.

Description

Pump with Follower Plate



Fig. 1 Components of the P653S pump with follower

- | | |
|---------------------------|-----------------------|
| 1 - Reservoir | 2 - Mounting plate |
| 3 - Pump elements | 4 - Pump housing |
| 5 - Pump outlet | 6 - Relief valve |
| 7 - Keypad | 8 - Low-level control |
| 9 - Refill Grease Fitting | connection |
| 10 - Top Lid | 11 - Vent Hole |

Pump without Follower Plate



Fig. 2 Single-line pump P653S, No follower
(Note: Low-level control see Fig. 15 & 16)

- | | |
|---------------------------|------------------------|
| 1 - Reservoir | 2 - Mounting plate |
| 3 - Pump elements | 4 - Pump housing |
| 5 - Pump outlet | 6 - Relief valve |
| 7 - Keypad | 8 - Stirring paddle |
| 9 - Refill Grease Fitting | 10 - Stationary paddle |
| 11 - Top Lid | |

P653S pump is designed for single line (S) parallel Centro-Matic type lubrication systems. The pumps integrated design includes all necessary components to support Centro-Matic lubrication systems:

- controller to program and monitor lubrication cycle
- choice of internal pressure switch or internal pressure transducer
- internal vent valve
- three pumping elements connected together
- external pressure relief valve
- reservoir low-level control
- end of lubrication line pressure switch or pressure transducer choice
- contacts for remote monitoring
- 24 VDC or 120/230 VAC power supply option, etc.

Pump for 24 VDC power supply is ready for installation on medium and small mobile construction equipment. Pump can supply adequate lubrication for up to 35 bearings using SL-V, SL-V XL, SL-1, SL-33 or SL-32* Lincoln injectors. Can support up to 9 SL-V XL injectors.

Pump for 120/230 VAC power supply can be installed in any stationary industrial type of applications requiring lubrication for the same number of medium size bearings.

Pump basic model can be supplied with follower plate or without follower plate. Follower plate is recommended in stationary industrial type applications with heavy consistency greases (NLGI #1 and #2) and for pumps used at low temperatures applications in all installations.

*Note: Installations using SL-32 and SL-33 Lincoln injectors can lubricate more than 35 bearings.

Typical Centro-Matic system schematic is shown on page 31.



CAUTION! Use only supply line hose and fittings that are appropriate for the programmed/set system pressure.

Pump P653S

- pumps greases up to NLGI 2 (per approved list) at temperatures from -40° F to 158°F (-40°C to 70°C)
- develop maximum pressure up to 3,500 psig (240 bar) with pressure switch and up 4,600 psig (317 bar) with pressure transducer.

Reservoir sizes

- 4-l transparent plastic reservoir
- 8-l transparent plastic reservoir
- 15-l transparent plastic reservoir
- 20-l transparent plastic reservoir

Electrical connection

- For industrial 120/230 VAC applications P653S pumps are provided with 4-pole square type connector. Electric cable is provided by installer.
- For mobile applications P653S pumps are equipped with an electric cable 32 ft. (10.0 m) and 7-pole bayonet type connector.



Electric Operated Centro-Matic Pump P653S

Code example

Pump model, basic

Reservoir size and configuration

- 4 = 4L, transparent plastic
- 8 = 8L, transparent plastic
- 15 = 15L, transparent plastic
- 20 = 20L, transparent plastic

X = Grease pump

L = Low-level control

BO = Without follower

F = With follower

Power supply

- 24 = 24 VDC
- AC = 110 - 240 V ; 50 - 60 Hz

Electrical cord and connections

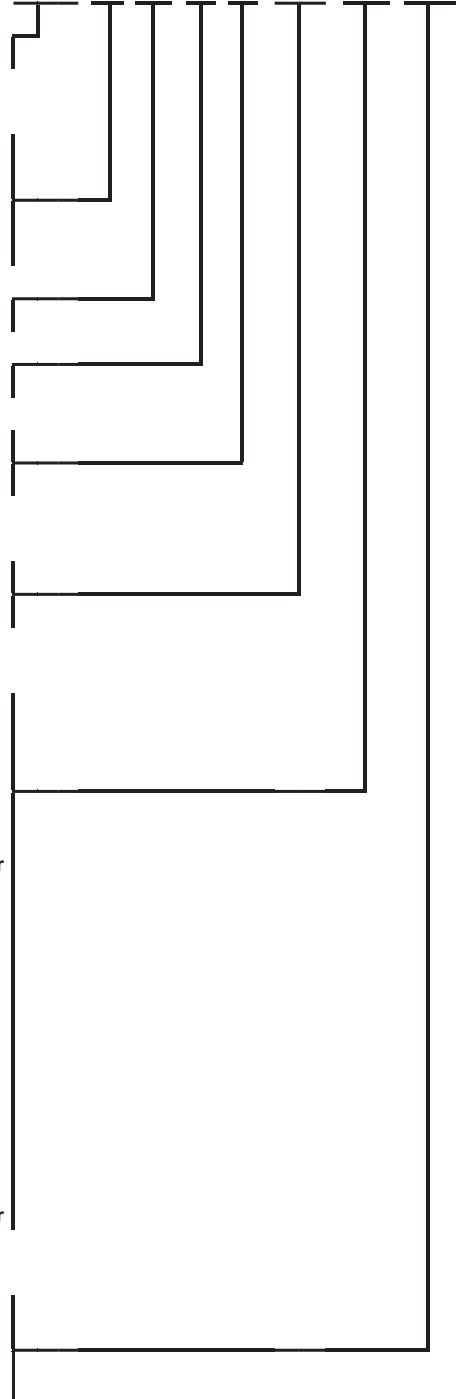
- 1A DC;
 - 33 ft. (10 m) cord, 7 conductors
- 2A DC;
 - 33 ft. (10 m) cord, 7 conductors
 - 33 ft. (10 m) cord, 4 conductors with bayonet plugs for external pressure switch or transducer
- 2A = AC;
 - 33 ft. (10 m) cord, 7 conductors
 - 4-pole square plug
- 2A1 = AC;
 - 7 poles bayonet plug
 - 4-pole square plug
- 3A = AC;
 - 33 ft. (10 m) cord, 7 conductors
 - 4-pole square plug,
 - 33 ft. (10 m) cord, 4 conductors with bayonet plugs for external pressure switch or transducer

Pressure control, PCB setting

- AS01 - AS08 = Pressure switch (see jumper setting table)
- AS09 - AS16 = Pressure transducer (see jumper setting table)
- Example: P653S-4XLF-24-2A-AS06:
Pump consists of the following:
 - 24 VDC grease pump with follower
 - Four liter reservoir
 - Low-level control
 - Internal pressure switch
 - 33 ft (10 m) power cord
 - External pressure switch with 33 ft (10m) cord

Identificaton code P653S pump

P653S - 4 X L F - 24 - 2A - AS06





Jumper setting combinations - Centro-Matic pumps

Pump combinations			Application: Industrial (S) -o; Mobil (M) - x	Time (TC) or count control (CC); TC -o; CC - x	Number of pressure switches or transducers. o - one; x - two	Low-level control; NO- o; NC - x	F1 fault relay; (31) switch to ground - x	F2 fault relay; (31) switch to ground - x
			Jumper setting (plugged - x; unplugged - o)					
Pressure switch	AS01	Industrial (AC) (S)	o	o	o	x	x	x
	AS02		o	o	x	x	x	x
	AS03		o	o	o	o	x	x
	AS04		o	o	x	o	x	x
	AS05	Mobile (DC) (M)	x	o	o	x	x	x
	AS06		x	o	x	x	x	x
	AS07		x	o	o	o	x	x
	AS08		x	o	x	o	x	x
Pressure transducer	AS09	Industrial (AC) (S)	o	o	o	x	x	x
	AS10		o	o	x	x	x	x
	AS11		o	o	o	o	x	x
	AS12		o	o	x	o	x	x
	AS13	Mobile (DC) (M)	x	o	o	x	x	x
	AS14		x	o	x	x	x	x
	AS15		x	o	o	o	x	x
	AS16		x	o	x	o	x	x

An external pressure switch or external pressure transducer is included with the pumps that have the feature of external pressure monitoring. Also included is a 33 ft (10m) cord to connect the external monitoring device to the pump.

Description of Operation

Pump Operation

Drive

- The pump housing consists of the following components: gear motor, final gear drive, three pumping elements connected together by internal passages and vent valve. Pump can be configured with internal pressure switch or transducer.
- The gear motor shaft is connected to the final stage gear drive. The final gear has incorporated eccentric and cam to drive the pumping elements and to control the internal vent valve (Fig. 4).
- Vent valve is a two way normally closed spring biased valve.
- Pressure switch is not adjustable and preset to 3,500 psig (240 bar).
- Pressure transducer is adjustable. Factory setting is 3,500 psig (240 bar). Pressure setting of the pressure transducer can be adjusted from 1,400 to 4,600 psig (96 to 317 bar) in 100 psig (6.9 bar) increments.

Lube Cycle/Pressurization

- The motor turns the cam (7) clockwise to start lubrication cycle. As soon as pump starts to operate, the display rotating segment is turning clockwise also (Fig. 20). Maximum time to build the preset pressure is 12 minutes. If pump does not build preset pressure, fault signal E1 or E2 will appear on the display.
- Vent valve (1) is normally closed and stays closed during lubrication cycle, preventing lubricant flow back to the reservoir (see Fig. 4).
- The output of three pump elements (4) (Fig. 3) is combined by internal passages.
- The eccentric drives the pump elements to pump the lubricant from the reservoir and build the line pressure.
- The cam (7) will keep the vent valve (1) closed.
- Supply line can be connected to any one of the pump element outlets. The remaining two pump elements outlets should be plugged.

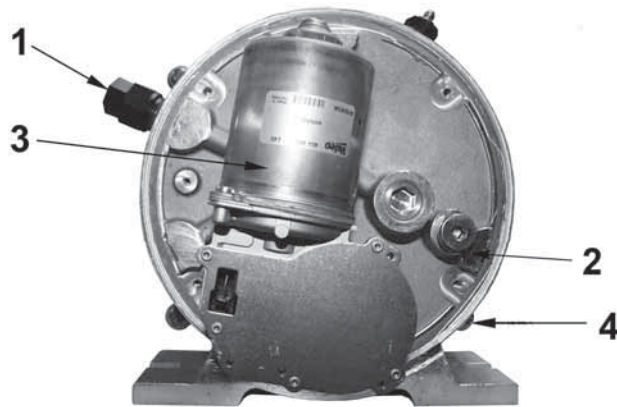


Fig. 3 Disassembled pump housing - view from the bottom

- | | |
|---------------------|---|
| 1 - Venting element | 2 - Integrated pressure switch |
| 3 - Motor | 4 - Pump elements with integrated lubrication lines |

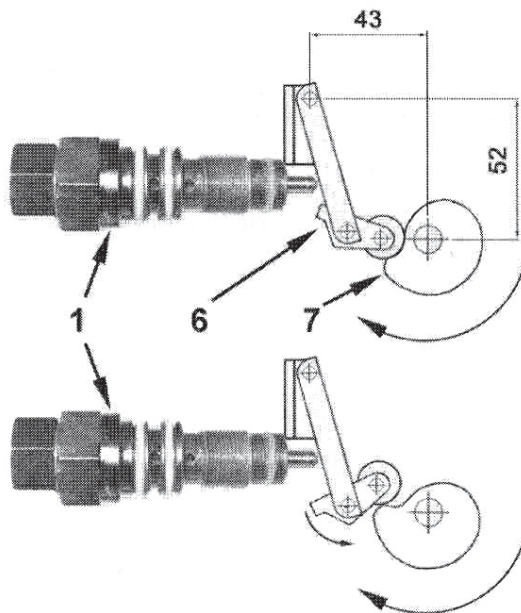


Fig. 4 Idle run of the switch joint on the venting element

- | |
|---|
| 1 - Inactive venting element |
| 6 - Switch joint |
| 7 - Cam (driven clockwise by the motor) |

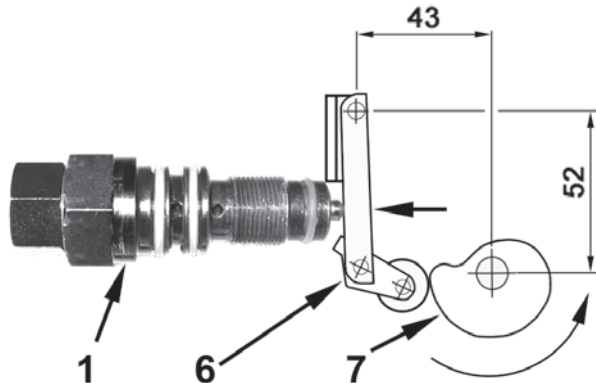


Fig. 6 Activated vent cycle diagram

- 1 - activated venting element
- 6 - activated vent lever
- 7 - cam (driven by the motor counterclockwise)



Fig. 7 Display during braking application of pump motor.



Fig. 8 Display during change of moving direction of pump motor.

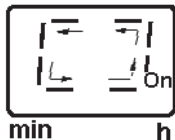


Fig. 9 Rotating segmented display during venting (counterclockwise)

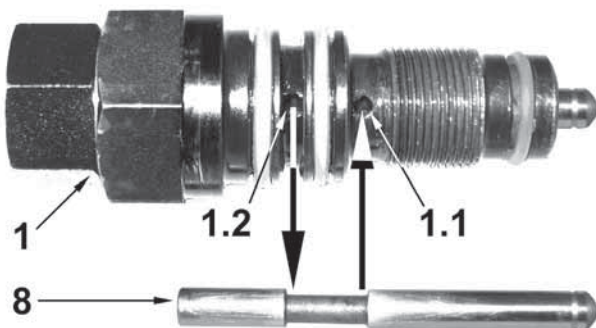


Fig. 10 Venting in the vent valve1 - Venting element

- 1.1 - inlet hole
- 1.2 - outlet hole
- 8 - plunger, venting

Pump Element operation

The pump element (Fig. 13 and 14) is a single stroke spring biased pump. Motor drives the eccentric (1). Eccentric is in constant contact with the plunger (2).

Compression spring (3) is pushing plunger (2) to open lubricant passage to create vacuum to prime the pump with lubricant from the reservoir. Check valve (4) is closed to isolate the supply lines of the system.

Eccentric (1) is pushing the plunger (2) in opposite direction to pump lubricant, developing the operating pressure. Check valve (4) is open to pass the lubricant to supply lines.

The body of the pump element has a lateral outlet (5) (Fig. 12) for lubricant crossporting to the internal material passages to combine the outlet of all three pump elements.

Any one of the three elements can be used as a pump outlet. The remaining two elements should be closed with plug (A) (Fig. 12).

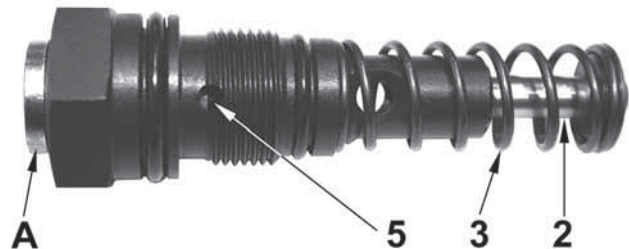


Fig. 12 Pump element Z7 for internal lubricant crossporting

A - Closure plug (connection G 1/4" for main line)

2 - Piston

3 - Spring

5 - Lateral outlet for lubricant crossporting

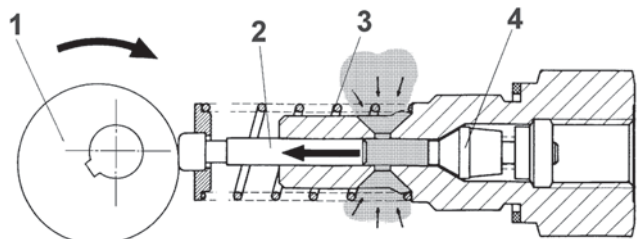


Fig. 13

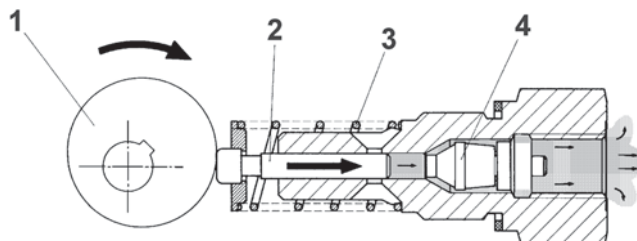


Fig. 14

NOTE: Use only pump elements designed for operation in the P653S and P603S pumps. No other pump elements should be used. See the parts listing for the correct pump element part number.



Pressure Control/Hold Time/Vent Cycle

Pump with internal pressure switch only:

Internal pressure switch will close at 3500 psig and open at 2600 psig.

After pump starts a lubrication cycle, motor stops when pressure at pump reaches preset pressure of 3,500 psig (240 bar). Pump will go through two holding periods, H1 and H2.

Holding Time (H1)

- Internal pressure switch must stay closed for 15 consecutive seconds before going to H2. If internal pressure switch opens during the 15 seconds, pump will restart and run until internal pressure switch closes.

Holding Time (H2) - Will last for 30 seconds

- At the end of 30 seconds, if the internal pressure switch is closed, the pump will begin a vent cycle.
- If at the end of the 30 seconds the internal pressure switch is open, the pump will restart and run until the internal pressure switch closes. When it closes a vent cycle will take place.
- If at the end of 30 seconds the internal pressure switch is closed, but during the H1 hold time the internal pressure switch did open, the pump will restart and pump for 2 seconds before a vent cycle begins.

Possible Faults

- E1 Fault – A failure to build pressure at the pump within the allotted 12 minutes of pumping time.
- E3 Fault – A failure to vent at the pump. The internal pressure switch has 10 seconds to open when the motor reverses to locate the vent position

Pump with internal and external pressure switch:

Internal pressure switch will close at 3500 psig and open at 2600 psig. The external pressure switch will close at 2500 psig and open at 1900 psig

After pump starts a lubrication cycle, motor stops when pressure at pump reaches preset pressure of 3,500 psig (240 bar). Pump can go through three holding periods, H1, H2 and H3.

Holding Time (H1)

- Internal pressure switch must stay closed for 15 consecutive seconds before going to H2. If the internal pressure switch opens during the 15 seconds, the pump will restart and run until the internal pressure switch closes.

Holding Time (H2) - Will last for 30 seconds

- At the end of H2, if the internal pressure switch is closed and the external pressure switch is closed, pump will begin a vent cycle.
- At the end of H2, if the internal pressure switch is open or both the internal and external pressure switches are open an H3 will appear on the display. Pump will turn on again and pump until the internal pressure switch is closed. When both the internal and external pressure switches are closed a vent cycle will take place.
- If at the end of H2 the internal pressure switch is closed but the external pressure switch is open, the pump will turn on for 2 seconds and then stop and wait until the external pressure switch closes. An H3 will appear on the display. When both the internal and external pressure switches are closed a vent cycle will take place.

Holding Time (H3)

- Holding time H3 will remain until both the internal and external pressure switches are closed and then a vent cycle will take place. If both pressure switches do not close within the allotted pumping time of 12 minutes, an alarm will occur. If the internal pressure switch opens during H3, it will repump until the internal pressure switch closes.

Possible Faults

- E1 Fault – A failure to build pressure at the pump within the allotted 12 minutes of pumping time.
- E2 Fault – A failure to build pressure at the end of the supply line.
- E3 Fault – A failure to vent at the pump. The internal pressure switch has 10 seconds to open when the motor reverses to locate the vent position.
- E4 Fault – A failure to vent at the end of the supply line. The external pressure switch must be open before the next lube cycle takes place.

Pump with internal pressure transducer only:

The internal pressure transducer is factory set to close at 3500 psig (241 bar). The internal transducer can be adjusted from 1,400 psig to 4,600 psig (96 to 317 bar) using the key pad on the pump. The adjustment is in 100 psig (6.9 bar) increments. The internal pressure transducer is set to open at 900 psig (62 bar) below the point where it closed at.

After the pump starts a lubrication cycle, the motor stops when pressure at pump reaches the preset pressure. The pump will go through two holding periods, H1 and H2. The following will use the factory setting of 3500 psig (241 bar) and the opening pressure of 2600 psig (179 bar).

Holding Time (H1)

- Internal pressure transducer must reach 3500 psig and stay above 2600 psig (179 bar) for 15 consecutive seconds before going to H2. If the internal pressure transducer drops below 2600 psig during the 15 seconds, the pump will restart and run until internal pressure transducer reaches 3500 psig (241 bar).

Holding Time (H2) - Will last for 30 seconds

- At the end of 30 seconds, if the internal pressure transducer is above 2600 psig. (179 bar) the pump will begin a vent cycle.
- If at the end of the 30 seconds the internal pressure transducer is below 2600 psig (179 bar), the pump will restart and run until the internal pressure transducer reaches 3500 psig (241 bar). When this happens a vent cycle will take place.
- If at the end of 30 seconds the internal pressure transducer is above 2600 psig (179 bar), but during the H1 hold time the internal pressure transducer dropped below 2600 psi (179 bar), the pump will restart and pump for 2 seconds before a vent cycle begins.

Possible Faults

- E1 Fault – A failure to build pressure at the pump within the allotted 12 minutes of pumping time.
- E3 Fault – A failure to vent at the pump. The internal pressure switch has 10 seconds to open when the motor reverses to locate the vent position.
- E3 Fault – A failure to vent at the pump. If at the end of the pause time the pressure of the internal pressure transducer has not dropped below 900 psig (62 bar) an E3 fault will occur.

Pump with internal and external pressure transducer:

The internal pressure transducer is factory set to close at 3500 psig (240 bar). The internal transducer can be adjusted from 1,400 psig to 4,600 psig (96 to 317 bar) using the key pad on the controller. The adjustment is in 100 psig (6.9 bar) increments. The internal pressure transducer is set to open at 900 psig (62 bar) below the point where it closed at.

The external pressure transducer is set to close at 2500 psig (172 bar). The opening point of the external pressure transducer is adjustable from 200 psig to 1000 psig (14 to 69 bar). It is factory set to open at 900 psig.

After the pump starts a lubrication cycle, the motor stops when pressure at the pump reaches preset pressure of 3,500 psig (240 bar). The pump can go through three holding periods, H1, H2 and H3.

The following will use the factory settings for P7 and P8.

Holding Time (H1)

- Internal pressure transducer must reach 3500 psig and stay above 2600 psig for 15 consecutive seconds before going to H2. If the internal pressure transducer drops below 2600 psig during the 15 seconds, the pump will restart and run until the internal pressure transducer reaches 3500 psig.

Holding Time (H2) - Will last for 30 seconds

- At the end of H2, if the internal pressure transducer is above 2600 psig and the external pressure transducer has reached 2500 psig, the pump will begin a vent cycle.
- At the end of H2, if the internal pressure transducer is below 2600 psig, or both the internal pressure transducer is below 2600 psig and the external pressure transducer has not reached 2500 psig, an H3 will appear on the display. The pump will turn on again and pump until the internal pressure transducer has reached 3500 psig. When the internal pressure transducer is above 2600 psig and external pressure transducer has reached 2500 psig, a vent cycle will take place.
- If at the end of H2 the internal pressure transducer is above 2600 psi but the external pressure transducer has not reached 2500 psig, the pump will turn on for 2 seconds and then stop and wait until the external pressure transducer reaches 2500 psig. An H3 will appear on the display. When the internal pressure transducer is above 2600 psig and external pressure transducer has reached 2500 psig a vent cycle will take place.

Holding Time (H3)

- Holding time H3 will remain until the internal pressure transducer is above 2600 psig and the external pressure transducer has reached 2500 psig, and then a vent cycle will take place. If both pressure transducers do not reach their preset settings within the allotted pumping time of 12 minutes an alarm will occur. If the internal pressure transducer drops below 2600 psig during H3 it will repump until the internal pressure transducer reaches 3500 psig.

Possible Faults

- E1 Fault – A failure to build pressure at the pump within the allotted 12 minutes of pumping time.
- E2 Fault – A failure to build pressure at the end of the supply line.
- E3 Fault – A failure to vent at the pump. The internal pressure transducer has 10 seconds to drop below 2600 psig when the motor reverses to locate the vent position.
- E4 Fault – A failure to vent at the end of the supply line. The external pressure transducer has to drop below 900 psig before the next lube cycle takes place.

Venting Cycle/Depressurization

- After pump completes preset pressure hold time and pump maintains specified pressure, controller will initiate vent cycle. "Hr" will be displayed momentarily.
- The motor will turn counterclockwise to engage and open the vent valve. Motor will stop in a position to hold vent valve open.
- The display rotating segment is turning counter clockwise as well.
- The cam (7) (Fig. 6) engages the vent lever (6) depressing the vent valve plunger (8) (Fig 10). This opens the valve passage of the supply line to the reservoir.
- Lubricant is flowing back to the reservoir venting pressure from the system. The valve stays open during pause time.

Filling reservoir with grease

Use grease fitting (9) (Fig 1) to fill the reservoir. Filling reservoir for the first time is critical to the proper pump operation. Make sure no air is trapped under the follower plate. Grease should be in full contact with the surface of the follower. It's recommended to run the motor by initiating the lubrication cycle during the first reservoir fill. The stirring paddle of the running motor will help to evenly spread the grease under follower minimizing air pockets.

Air Expelling Procedures for Pumps with Follower

Disconnect the low-level square type bayonet plug 8 (Fig. 1) and unscrew the top lid (1)0 (Fig. 1) of the reservoir. Remove lid and spring from the pump. Start filling the pump. As soon as the grease level starts lifting the follower, stop filling and check for air trapped under the follower. Use a plastic wire tie to expel the air: push plastic tie between the follower seal and wall of the reservoir and push the follower with hand until it completely contacts the grease. Replace the lid and connect the low-level electric plug. Finish the filling of the reservoir.

Stirring paddle

The stirring paddle (3) (Fig. 2) is attached to the motor and rotates during the lubrication cycle. The paddle is working grease in the reservoir to make it more pumpable and at the same time pushing the grease down into the housing and pumping elements to prevent cavitation.

Low-level control

The pump model P653S is equipped with a low-level grease control as a standard feature.

Pump with Follower Plate

Low-level control electromagnetic reed switch is located in the central rod of the reservoir. The switch is sealed and does not have any contact with grease.

The follower plate bushing has a magnet. As soon as the follower reaches the preset position at the bottom of the reservoir, a magnetic field will close the switch to indicate the low-level of the grease. The control panel display "LL" will be on. The pump can be operational for some time since there is a small amount of grease left under follower in the reservoir and pump housing. The pump should be refilled as soon as possible. Always refill the pump to the maximum of the reservoir capacity. The "LL" display should be "off" as soon as pump is refilled.



Caution!

Make sure there is no air trapped under follower plate. Grease should be in full contact with surface of the follower. Use "Air Expelling Procedures" if necessary.

WARNING

The follower spring is completely compressed if reservoir is full of grease. Exercise extreme caution removing the top of the pump.

Pump Without Follower Plate

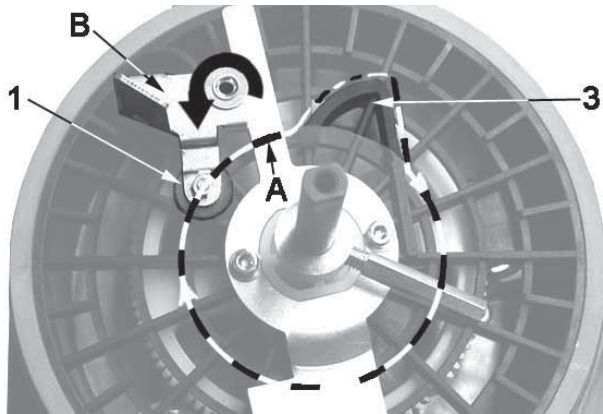


Figure 15 Switching parts of the low-level control for grease (when reservoir is filled).

- 1. Pivot bracket with round magnet
- 3. Control Cam
- A. Inner orbit of the round magnet
- B. Position of the pivot bracket (LL not activated)

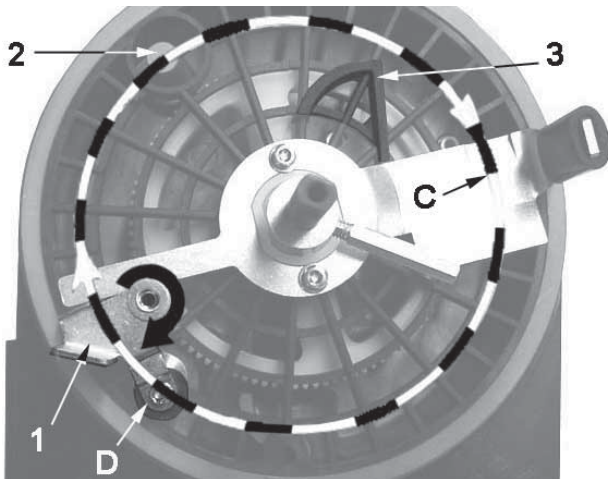


Figure 16 Switching parts of the low-level control for grease (when the reservoir is empty).

- 1. Pivot Bracket with round magnet.
- 2. Low-level Switch
- 3. Control Cam
- C. Outer orbit of the round magnet
- D. Position of the Pivot bracket (LL activated)

Grease Reservoir Full of Grease - Fig. 15

- The stirring paddle rotates clockwise during the lubrication cycle.
- The pivot bracket of the stirring paddle (B) (Fig. 15) is completely submerged into grease and grease resistance to paddle rotation guides the bracket with round magnet 1 inward to orbit (A).
- Control Cam (3) (Fig. 15) guides the pivot bracket with magnet and outwards, in the direction of the reservoir wall. Since reservoir is full, grease resistance guides pivot bracket inward to orbit (A) as soon as bracket passes the cam (3).
- Magnet and low-level switch (2) (fig. 16) are not aligned and switch can not be activated.

NOTE: The above mentioned switching parts (1 to 3) (Fig. 15 & 16) must not be used with fluid grease or oil. In this case, use a float magnetic switch.

Grease Reservoir Empty - Fig. 16

- Control cam (3) guides the pivot bracket with magnet (1) outward. Since there is no grease resistance, the bracket with magnet (1) will stay outward in the Orbit C.
- Magnet (1) will align with Low-level Switch and activate LL indicator on a pump display.

Keypad and Display

Membrane Key Pad

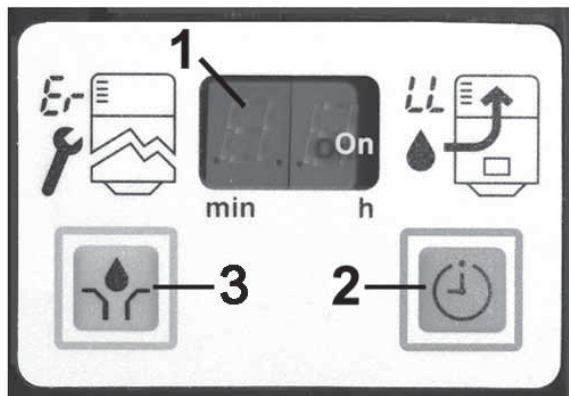
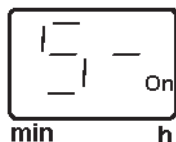
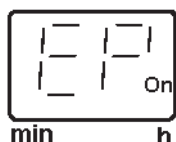


Fig. 17 P653S membrane key pad

- 1 - Display
- 2 - Key for acknowledgment of fault indications and changing programming screens.
- 3 - Key for triggering an additional lubrication cycle and for changing programming values.

Test Display of the Membrane Key Pad



- A test display is made when voltage is applied: all segments and decimal points are illuminated for 2 seconds.



NOTE

If *EP* is displayed after the display test, this indicates that the button or the keypad is defective.

When power is applied to the pump the display will indicate if a pressure switch or pressure transducer is connected to the pump. The example indicates an internal pressure switch.

There are four possibilities:

- S- Internal pressure switch
- T- Internal pressure transducer
- TT Internal and external pressure transducer (must be connected)
- SS Internal and external pressure switch (must be connected)

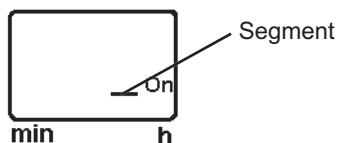


Fig. 18 Green segment right, power supply "on", ignition switch open ("off").

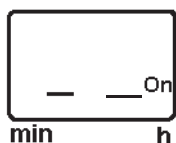


Fig. 19 Green segment left & right are "On"/ Ignition switch closed ("on").

Operating mode

- As soon as voltage is applied (On), the lower right-hand segment in the display window flashes (Fig. 18). If there is only one segment at the bottom this indicates that the ignition switch is open.
- When switching on the ignition switch, the left-hand segment in the display window lights up (Fig. 19).
- During the lubricating time of the pump, a circulating illuminated segment appears in the display window of the membrane key pad (Fig. 20).
- If the power supply is interrupted during the pause time, the pause time continues at the point of interruption after switching power on again.
- If the power supply is interrupted during the lubricating time the operating time will start at the beginning after switching power on again.

Keypad and Display

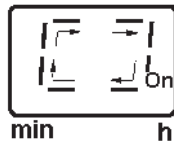


Fig. 20 Green circulating illuminated segment, lubricating time, pump is running.



Fig. 21 Display of a low-level indication

Low-level control

In the event of a low-level signal the display will flash LL.



IMPORTANT

If a low-level signal occurs during the lubricating time, the current operating cycle will still be completed. However the pump does not switch on automatically any more. It can only be switched on again by a manual lube cycle. Furthermore, it is not possible to change to the programming mode while there is a low-level signal.

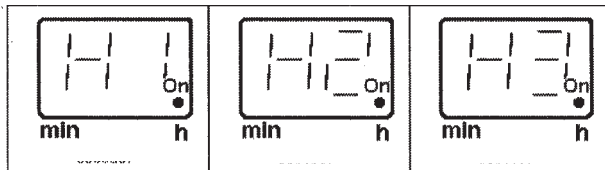


Fig. 22 Display of Holding Time

Display is indicating holding times when pump reaches preset pressure.

Malfunctions

- If there is no feedback from the pressure switch or pressure transducer within 12 minutes of pumping time, the pump switches off immediately. One of the fault signals E1 to E4 (Error, Fig. 23 to 26) will be shown flashing in the display of the membrane key pad.



IMPORTANT

If a malfunction is present, E1, E2, E3 or E4 will be flashing. The pump does not switch on automatically any longer. It can only be triggered via an additional lubrication cycle. Furthermore, a change to the programming mode is not possible while in alarm.

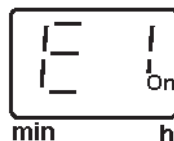


Fig. 23 Display of the malfunction E1, failure to build pressure at the pump.

E1 fault is a failure to build pressure at the pump.

- If either the pressure switch or pressure transducer fails to actuate within 12 minutes of pumping this fault will occur.

Keypad and Display



Fig. 24 Display of the malfunction E2, failure to build pressure at the end of the line.

E2 fault is a failure to build pressure at the end of the supply line. You must use an external pressure switch or pressure transducer to detect this.

- If either the external pressure switch or pressure transducer fails to reach 2500 psi within 12 minutes of pumping this fault will occur.

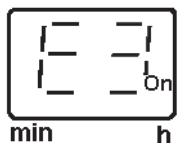


Fig. 25 Display of the malfunction E3, failure to vent at the pump.

E3 fault is a failure to vent at the pump.

- Failure of the internal pressure switch to open during the 10 seconds that the pump motor reverses to locate the vent position.
- Failure of the internal pressure transducer to drop 900 psi below the P7 parameter (P7 minus 900 psi) during the 10 seconds that the pump motor reverses to locate the vent position.
- If at the end of the pause time the internal pressure transducer has not dropped below 900 psi an E3 fault will occur.

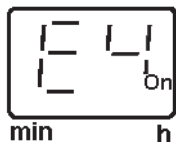


Fig. 26 Display of the malfunction E4, failure to vent at the end of the line.

E4 fault is a failure to vent at the end of the supply line. You must use an external pressure switch or pressure transducer to detect this.

- If at the end of the pause time the external pressure switch has not opened an E4 fault will occur.
- If at the end of the pause time the external pressure transducer has not dropped below the P8 parameter an E4 fault will occur.

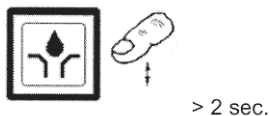


Fig. 27 Operator key to trigger an additional lubrication cycle

To trigger an additional lubrication cycle via the pushbutton, press the button for 2 seconds.



Fig. 28 Operator key to acknowledge a fault.



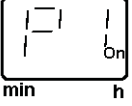
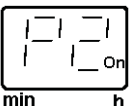
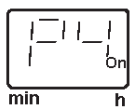
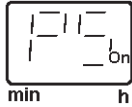
NOTE

Existing fault signals (Fig. 21 to 26) must be acknowledged before triggering an additional lubrication cycle.

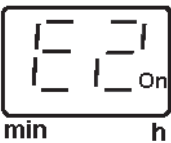
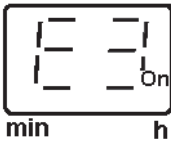
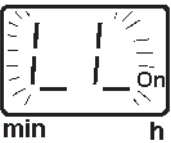
To trigger additional lubrication cycles externally

- **Press the pushbutton to trigger additional lubrication cycles externally. Press the pushbutton for 2 seconds.**
 - Mobile pump w/ignition switch open.....up to two times
 - Industrial pump w/machine switch open...unlimited

Factory Settings For Parameters

Programming steps	Factory Setting	Description
	01	Pause time 0 to 59 hours
	00	Pause time 0 to 59 minutes
	NO	Output of both fault relays no (normally open) nc (normally closed)
	o2	Two options for signaling a fault o1 (Option 1) F1 relay contact a) Low-level fault will cause F1 contact to repeatedly open and close. b) Pressure fault will cause F1 contact to close and stay closed. F2 relay contact A low-level fault or a pressure fault will cause the F2 contact to close and stay closed. o2 (Option 2) F1 fault relay's contact will close on a low-level fault F2 fault relay's contact will close on a pressure fault Both of these contacts can be used for remote signaling.
	SP	Option to have the pump start with a pause time or a lube cycle. SP – Pump starts with a pause time SO – Pump starts with a lube cycle
	35	The P7 programming step will only appear if you have a pump that uses an internal pressure transducer. (Reading x 100) 35 x 100 = 3500 psi. 3500 psi is the maximum pressure that the pump will build. Adjustable from 1400 psi to 4600 psi in 100 psi increments.
	09	The P8 programming step will only appear if you have a pump that uses an external pressure transducer. (Reading x 100) 09 x 100 = 900 psi. 900 psi is where the external pressure transducer will open (VENT) adjustable from 200 psi to 1000 psi in 100 psi increments.

Acknowledging a Fault

Display	Press
	 < 2 sec.
	 < 2 sec.
	 < 2 sec.
	 < 2 sec.
	 < 2 sec.

To acknowledge a malfunction:

- The flashing display changes into continuous light by pressing the button (acknowledging). By acknowledging the fault signal, the flashing E1, E2, E3, E4 or LL changes into permanent light.
- Messages which have been acknowledged but have not yet been remedied will flash again after the pump is switched off and on again.
- After fault has been acknowledged no more lube cycles will take place until a successful manual lube cycle has taken place.



Programming the Pump

Programming Mode: Pump with Pressure Switch

Key	Function
	Key for modifying the parameters in the programming step

Key	Function
	Key for switching to the next programming step



IMPORTANT! Pump Power must be on to start programming.

Step 1

Display

Press

> 4 sec.

Setting of Pause Time P1 (hours) and P2 (minutes).
To access the programming mode, press both buttons at the same time > 4 seconds, so that "P1" appears in the display.

<u>Programming options:</u>	<u>Pause time:</u>
P1	0 - 59 hours
P2	0 - 59 minutes
Min. pause time	4 minutes
Max. pause time	59 hours 59 minutes

Step 2

Press button.

P1: Setting of hours
When releasing the two buttons, the currently set value appears.
Example.: factory-set value: 1 hour
"Hour" is indicated by a **dot** on the **right-hand side**.

Settings are made in one direction:..... 0, 1, 2, 3,...59 hours
Button pressed once increase by 1 hour
Button pressed continuously quick sequence
Example:..... 12 hours

Step 3

Press button.

P2: Setting minutes
Press button, so that "P2" appears in the display.

When releasing the button, the currently set value appears (here the factory-set value: 0 minutes).
"Minute" is indicated by a **dot** on the **left-hand side**.

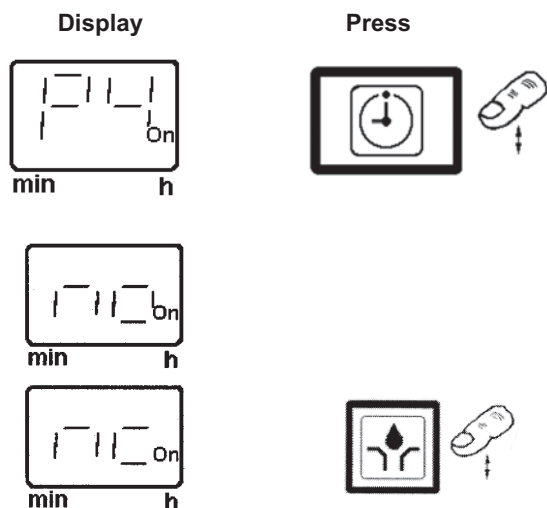
Settings are made in one direction:.... 0, 1, 2, 3, 4, 5, 59 min
Button pressed once increase by 1 minute
Button pressed continuously quick sequence
Example:..... 30 minutes



IMPORTANT
If "Hours" are set to "00", the display will show minimum pause time of 4 minutes.

Programming Mode, continued

Step 4

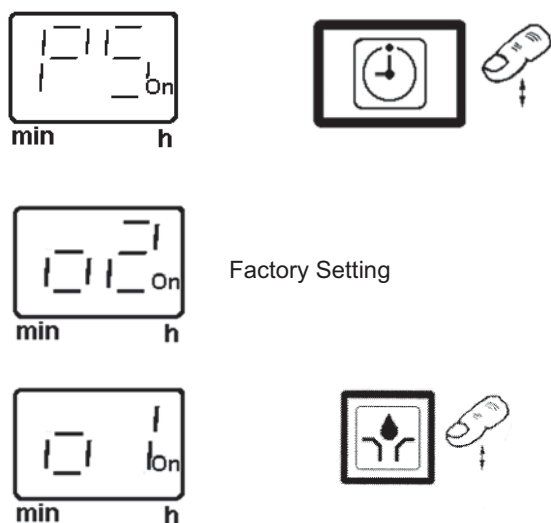


P4: Programming of the output signal for both alarm relays. The default setting on the printed circuit board for the alarm contacts is switching to battery minus.
Press button so that "P4" appears in the display.

When releasing the button, the currently set value appears in the display (here the factory-set value NO, normally open contact). On a fault condition the alarm contact will close.

Press button.
The external fault contact is modified by programming it as NC normally closed contact. On a fault condition the alarm contact will open.

Step 5



P5: Two options for signaling a fault condition with alarm relays F1 and F2.

Press button so that "P5" appears in the display.

o1 (Option 1) *P4 is set to the default of Normally Open.*

F1 relay contact

a) A low-level fault will cause the F1 contact to repeatedly open and close.

b) A pressure fault will cause the F1 contact to close and stay closed.

F2 relay contact

A low-level fault or a pressure fault will cause the F2 contact to close and stay closed.

o2 (Option 2) *P4 is set to the default of Normally Open.*

F1 fault relay's contact will close on a low-level fault and stay closed.

F2 fault relay's contact will close on a pressure fault and stay closed.

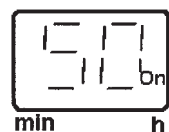
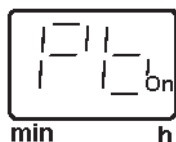
Both of these contacts can be used for remote signaling.

Press pushbutton to change to Option 1.

Programming Mode, continued

Step 6

Display



Press



P6: Upon applying power to the pump you can program whether it starts with a pause time SP or starts with a lube cycle SO.

Press button, so that "P6" appears in the display.

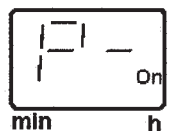
The currently set values appear as to whether the cycle is to start with the pause time or the lubricating time.

The default setting for the pump is set to start with a pause time **SP (Start Pause time)**.

Press button.

Each time the pump is switched on, it will start with the lubricating time **SO (Start Operation)**. After the first lubricating time the preset pause time will be valid.

Step 7



Completing the programming

Press button. "P -" is displayed.



IMPORTANT

Always carry out the programming completely in order to save the new values.

- Press this key (additional lubrication) to complete the programming and to save the entered parameters.



NOTE

If the button "additional lubrication" is not pressed within 30 seconds, the changed parameters will not be saved and the previous programming remains valid.

IMPORTANT

After completion of the programming, check the parameter settings in the operating mode once again.

Programming of the pump with pressure switch is complete.

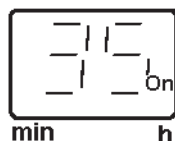
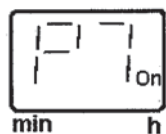
Programming Mode: Pump with Pressure Transducer

Complete Steps 1 through 6 of Pump with Pressure switch

Display

Press

Step 7



IMPORTANT

The P7 programming will only appear if you have a pump that has an internal pressure transducer.

P7: Programs the setting of where the internal pressure transducer will close. This is the maximum pressure that the pump can reach. Factory setting is 3,500 psi.

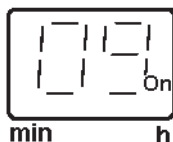
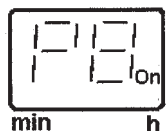
Press button to change value.

Reading x 100 = Transducer setting in psi

35 x 100 = 3500 psi.

This setting is adjustable from 1400 psi to 4600 psi in 100 psi increments.

Step 8



IMPORTANT

The P8 programming parameter will only appear if you have a pump that has an external pressure transducer connected.

P8: Programs the setting of where the external pressure transducer will open. The opening point (vent pressure) is adjustable from 200 psi to 1,000 psi in 100 psi increments. Factory set opening point (vent pressure) is 900 psi. The closing point of the external pressure transducer is fixed in software at 2500 psi.

Press button to change value.

Reading x 100 = Transducer setting in psi

9 x 100 = 900 psi.

Programming Mode, continued

Step 9



Completing the programming

Press button. "P -" is displayed.



IMPORTANT

Always carry out the programming completely in order to save the new values.

- Press this key (additional lubrication) to complete the programming and to save the entered parameters.



NOTE

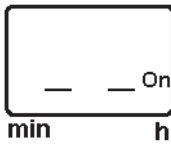
If the button "additional lubrication" is not pressed within 30 seconds, the changed parameters will not be saved and the previous programming remains valid.

IMPORTANT

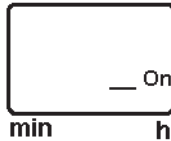
After completion of the programming, check the parameter settings in the review mode.

Programming of the pump with pressure transducer is complete.

Review of the Pump Parameters



or



Press the button > 2 seconds.

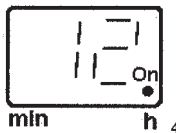


NOTE

The following display sequence is shown **once**. The change of display occurs every two seconds. Example of the pump set to lubricate each 12 hours 30 minutes and remaining pause time (rP) is 5 hours 10 minutes.



Pause Time



after one sec.

12 . (hours)



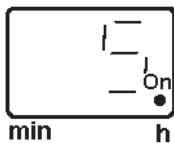
after one sec.

. 30 (minutes)



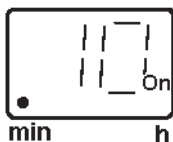
after one sec.

rP (remaining pause time)



after one sec.

5 . (hours)



after one sec.

. 10 (minutes)



Review of the Pump Parameters

Operating Mode

	after one sec.	NO	Both relay contacts are normally open
	after one sec.	o2	Option 2 - How F1 and F2 will signal a fault.
	after one sec.	SP	Pump starts with a pause time
	after one sec.		Will only appear if pump has an internal pressure transducer. Maximum pressure the pump will build.
	after one sec.		Indicates that the internal pressure transducer will close at 3500 psi.
	after one sec.		Will only appear if pump has an internal and external pressure transducer. Setting where external transducer will open.
	after one sec.		External pressure transducer will open at 900 psi.
			Indicates software version. The next two displays will indicate software version.
	or		Termination of the Reviewing of Parameters.



Technical Data

Electrical data for DC pump

Incoming voltage.....24 vdc -20%/+30%
Maximum current..... 10 amps
External Fuse..... 10 amps (time delay)
Reverse polarity protection..... Yes

Electrical data for AC pump

Incoming voltage..... 100 to 240 vac
Maximum current.....1.7 amps
Frequency.....47 to 63 hz
Output from power supply..... 24 vdc @ 5 amps
External Fuse..... 3 amps (time delay)

Common electrical data for DC and AC pumps

Minimum pause time..... 4 min.
Maximum pause time..... 59 hrs 59 min.
Pause time increments..... 1 min. or 1 hour
Maximum pumping time..... 12 min.
Enclosure rating..... IP 6K9K (NEMA 4X)
Rating for fault relay contact:
Switching voltage..... max. 230 vac/120 vac/24 vdc
Switching current..... max. 1 amp inductive
Minimum switching current..... .1 ma

Pump P653S

Operating pressure with:
-pressure switch3,500 psig (240 bar)
-pressure transducer.....3,500 psig (240 bar)
(transducer can be adjusted
from 1,400 to 4,600 psig
(96 to 317 bar)
End of line pressure switch
setting..... 2,500 psig (172 bar)
(not adjustable)
End of line pressure transducer
setting.....2,500 psig (172 bar)
not adjustable.
End of the line transducer vent pressure is factory preset at 900
psi (62 bar). Pressure can be adjusted from 200 to 1,000 psig
(14 to 70 bar) in 100 psig (7 bar) increments.
Operating temperature
range for DC pumps..... - 40 °F to + 158°F ¹⁾
(- 40 °C to +70 °C) ¹⁾
Operating temperature
range for AC pumps.....32°F to 122° F¹⁾
(0° C to 50° C)¹⁾
Number of outlets
(see instructions)..... 1
Lubricant up to NLGI grade 2 ¹⁾
Output 1.5 in³/min ²⁾
(24.6 cm³/min)
Reservoir sizes, L..... 4, 8, 15 and 20
Lubricant line connection size...G 1/4"

Pump elements K7

Piston diameter 7 mm
Number of Pumping Elements..... 3
(connected together)

Tightening torques

Install pump..... 13.3 ft-lb (18 Nm)
Electric motor on housing 8.8 ft-lb (12 Nm)
Pump element in housing 14.57 ft-lb (20 Nm)
Closure plug in housing8.8 ft-lb (12 Nm)
Return line connector on housing8.8 ft-lb (10-12 Nm)
Tie rods for 15 and 20 l reservoir7.4 ft-lb (10 Nm)

Weights

15-l reservoir with 3 pump elements K7, without pressure relief
valve, empty

Pump P653S without connecting cable..... 21.1 lb (9.6 kg)
Pump P653S version 1A 23.3 lb(10.6kg)
Pump P653S version 3A 24.6 lb (11.2 kg)

8-l reservoir, standard

Pump P653S without connecting cable..... 19.8 lb (9.0 kg)
Pump P653S version 1A..... 21.1 lb (9.6 kg)
Pump P653S version 3A..... 24.6 lb (10.6 kg)

4-l reservoir, standard

Pump P653S without connecting cable..... 19.1 lb (8.7 kg)
Pump P653S version 1A..... 21.3 lb (9.7 kg)
Pump P653S version 3A..... 23.1 lb (10.5 kg)

The weights above include the following equipment:

Pump kit with three pump elements, pressure relief valve,
grease filling (1.5 kg)

Packing (cardboard box)

Attaching parts

Operating Instructions

Installation

- Use only high pressure 5,000 psig minimum hydraulic
hose for supply lines.
- Use only hose connection fittings that are appropriate for
the programmed/pre-set system pressure.

Note #1: See the list of the approved and recommended lubricants.
Contact Lincoln if lubricant is not in the list.

Note #2: The lubricant output is measured at + 70 °F (+ 21 °C) and
backpressure 1,450 psig (100 bar). Different pressures, temperature
and grease can change the output results.

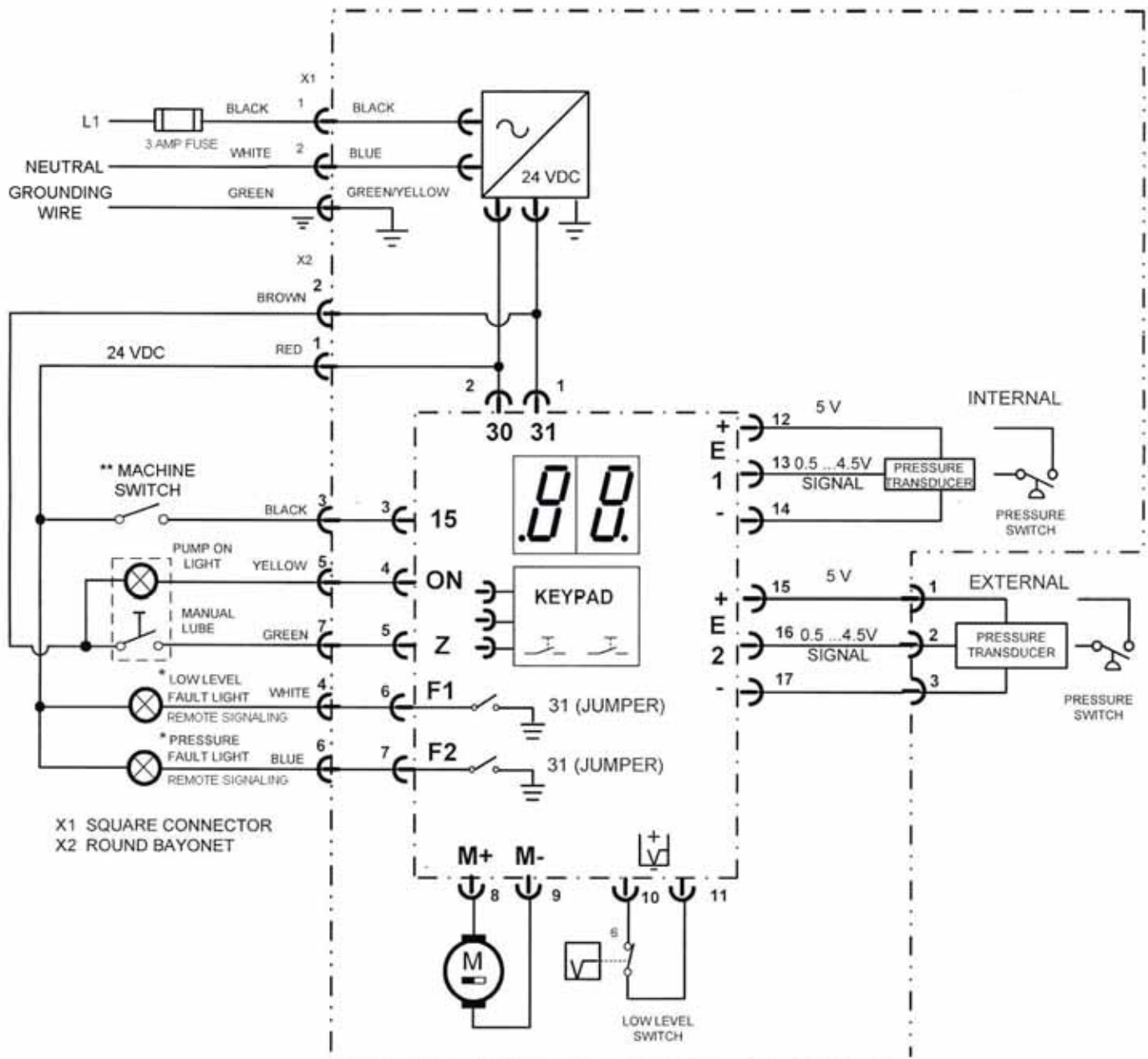
LINCOLN

[illegible]

* P4 PROGRAMMING PARAMETER SET TO N.O.
P5 PROGRAMMING PARAMETER SET TO OPTION 2

24 VDC BATTERY

CONNECTIONS FOR 110-230 VAC 50/60 Hz 653 PUMP

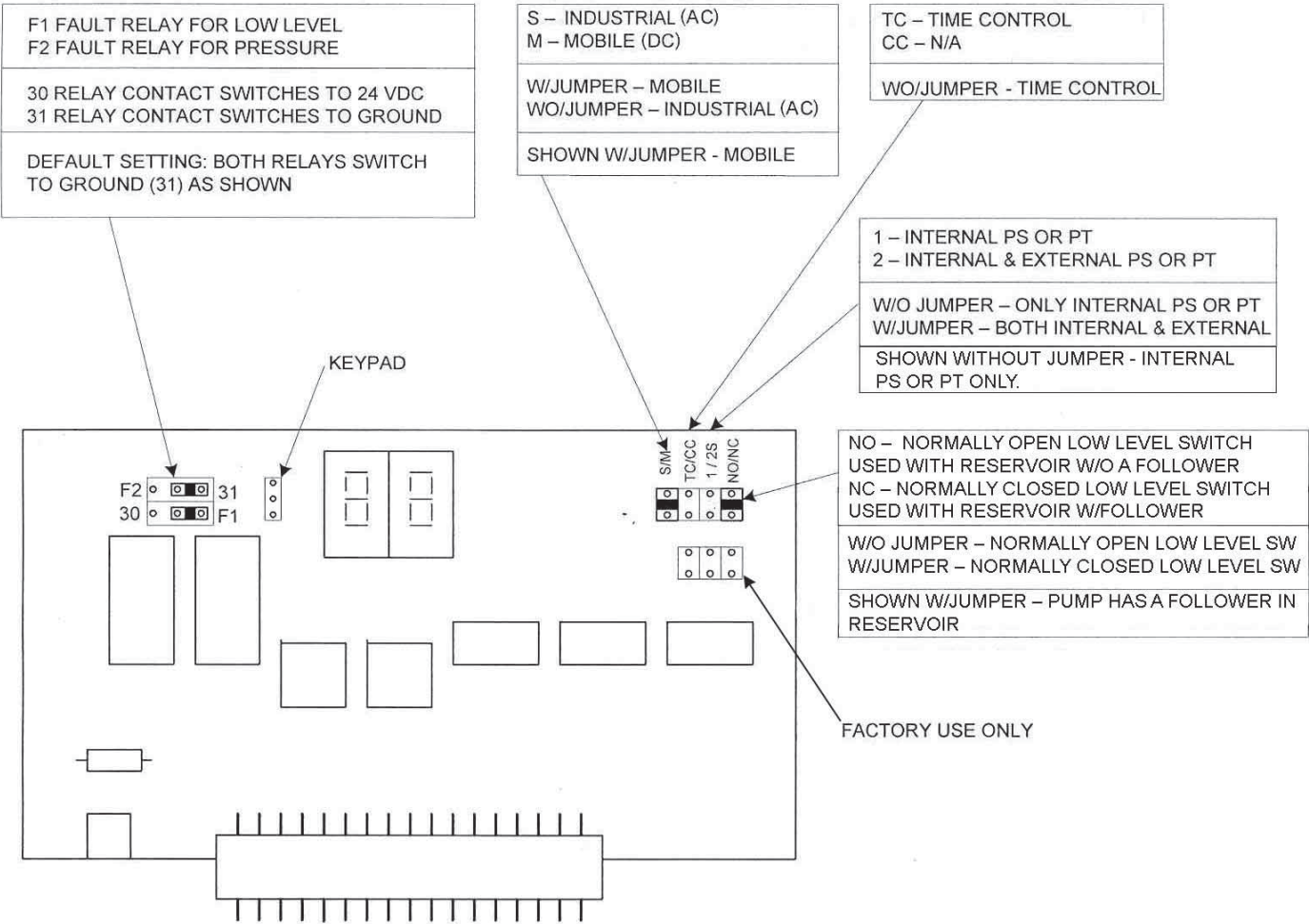


* P4 PROGRAMMING PARAMETER SET TO N.O.
P5 PROGRAMMING PARAMETER SET TO OPTION 2

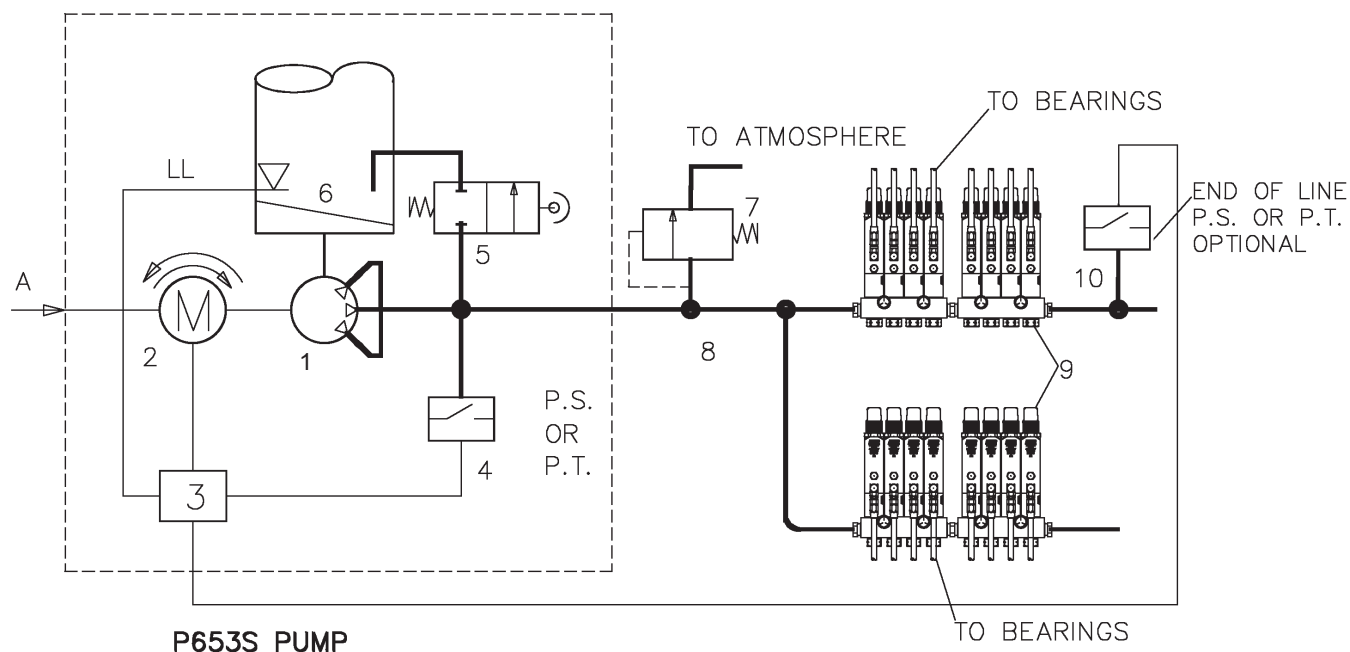
** Must connect red and black wires together if no machine switch is used.
You can also use a special 7 conductor bayonet plug (P/N 664-34550-1).



JUMPER SETTINGS FOR 653 PUMP PCB



Centro-Matic System Schematic with P653S Pump



- 1 - PUMPING HOUSING (3 PUMP ELEMENTS)
- 2 - MOTOR
- 3 - CONTROLLER, KEY BOARD WITH DISPLAY
- 4 - INTERNAL PRESSURE SWITCH (P.S.) OR PRESSURE TRANSDUCER (P.T.)
- 5 - INTERNAL VENT VALVE
- 6 - RESERVOIR WITH Low-level CONTROL
- 7 - PRESSURE RELIEF, 5,000 PSI (350 BAR) EXTERNAL
- 8 - HIGH PRESSURE SUPPLY LINE
- 9 - INJECTORS, SL-V, SL-1, OR SL-32, SL-33, and SL-V XL INJECTORS
- 10 - PRESSURE SWITCH (P.S.) OR PRESSURE TRANSDUCER (P.T.), EXTERNAL, OPTIONAL.
- A - POWER SUPPLY (24 VDC OR 120 VAC, OPTIONAL)

Note: For proper operation of the Centro-Matic systems, vent pressure before next lubrication cycle at the end of line should be:

- below 900 psig (62 bar) for SL-V and SL-V XL type of injectors
- below 600 psig (41 bar) for SL-1 type of injectors
- below 200 psig (13.8 bar) for SL-32/33 type of injectors.

Lincoln List of Lubricants



IMPORTANT

Absolute cleanliness is essential when handling lubricants. Impurities will remain suspended in the lubricant and cannot settle. This will result in damage to the lubrication system and thus to the bearing.

The Centro-Matic pump can dispense commercial greases up to NLGI grade 2 at specified operating temperature range.

The **proven lubricants** (see following tables) have been tested by Lincoln with regard to their pumpability and venting behavior. Lincoln can recommend them for an application up to the indicated **minimum delivery temperature** in Centro-Matic lubrication systems. During the tests these lubricants did not cause any damage due to incompatibility with the material used by Lincoln.

The lubricants Lincoln recommends on the basis of the manufacturer's data sheet (see following tables) can be used in Lincoln's lubrication systems up to the indicated **minimum delivery temperature**.

Grease pumpability and venting behavior depend on ambient temperature range of the application, and may be different for the same NLGI grade of grease. This refers in particular to greases with more than 3% graphite. Lincoln can test the grease and develop recommendations for specific applications.



IMPORTANT

The manufacturer of the centralized lubrication system can accept no liability for:

- damages due to the use of greases that are not or only conditionally pumpable in centralized lubrication systems.
- damages on parts of the centralized lubrication system caused by chemical or biological changes of the lubricant used.
- damages due to the incompatibility with other materials.

The liability is limited to pumpable lubricants in centralized lubrication systems.



IMPORTANT

Consult Lincoln or Lincoln Distributor/Representative before using lubricants with solid additives.

Proven Lubricants

Manufacturer	Designation	Thickener	Min. Operating Temp.
CATERPILLAR	Moly Ultra 5 NLGI #1	CA-Complex	10° F (-12° C)
CATERPILLAR	Arctic Platinum NLGI #0	CA-Complex Synthetic Base Oil	-40° F (-40° C)
CATERPILLAR	Auto-Lube NLGI #1	Ca-Complex	10° F (-12° C)
FUCHS-LUBRITECH	Stabil Eco EP2	Li/Ca	-13° F (-25° C)
FUCHS	Gleitmo 585	Li	-40° F (-40° C)
FUCHS	Renocal FN 745	Ca-12-OH-stearat	-13° F (-25° C)
FUCHS	Renoral FN3	Ca	-4° F (-20° C)
FUCI-IS	Renolit LZR 2 t I	Li	-4° F (-20° C)
FUCHS	Renolit HLT 2	Li	-13° F (-25° C)
MOBIL	Mobilith SHC 100	Li-complex	-13° F (-25° C)
SHELL	Retinax EPL 2	Li-12-OH-stearat	14° F (-10° C)
SHELL	Retinax CSZ	Li/Ca	-31° F (-35° C)

Lincoln List of Lubricants, continued



IMPORTANT

Consult Lincoln or Lincoln Distributor/Representative before using lubricants with solid additives.

Lubricant recommendations based on the manufacturer's data sheet

Manufacturer	Designation	Thickener	Min. delivery temperature
AGIP	F1 Grease 24	Ca	-15 °C
ARAL	Multipurpose grease	Li-12-OH-stearat	-15 °C
ARAL	Multipurpose grease ZS 1/2	Li/Ca	-20 °C
AVIA	Avialith 2 EP	Li-12-OH-stearat	-15 °C
BP	Energrease LC 2	Li-complex	-15 to -10 °C
BP	Energrease MP-MG 2	Ca-complex	-5 °C
CASTROL / TRIBOL	Molub Alloy 6780	Li-12-OH-stearat	-30 to -25 °C
CASTROL	CLS - Grease	Li/Ca	-25 °C
CASTROL	Olista Longtime 2	Li	-20 °C
CASTROL	Optimol Olit 2 EP	Li	-20 °C
DEA	Glissando 20	Li-12-OH-stearat	-15 to -10 °C
ESSO	Ronex Extra Duty 2	Li-complex	5 °C
ESSO	Ronex MP2	Li-complex	-5 °C
ESSO	Beacon EP2	Li	-5 °C
ESSO	Cazar K2	Ca	-15 °C
FIAT LUBRIFICANTI	Comar 2	Li	-25 °C
KLÜBER	Centoplex 1 DL	Li/Ca	-20 °C
KLÜBER	Isoflex NBU 15	Ba	-25 °C
KLÜBER	Klüberplex BEM 34-132	Ca-complex	-20 °C
KLUEBER	Klüberplex BEM 41-141	Li-complex	-25 °C
KLÜBER	Petamo GHY 133 N	Polycarbamide	-15 °C
MOBIL	Mobilgrease XHP 221	Li-complex	-10 °C
MOBIL	Mobilgrease XHP 461	Li-complex	-10 °C
MOBIL	Mobilgrease XHP 222	Li-complex	-5 °C
MOBIL	Mobilith SHC 220	Li-complex	-20 °C
SHELL	Alvania EP(LF) 1	Li-12-OH-stearat	-15°C +/- 5°C
SHELL	Alvania EP(LF) 2	Li-12-OH-stearat	-10°C +/- 5°C
SHELL	Alvania RL2	Li-12-OH-stearat	-15°C +/- 5°C
SHELL	Malleus GL	Gel	GL205 -20 °C, GL300 -10 °C GL400 0 °C, GL500 +5 °C
SHELL	Retinax CS	Li	-20 °C
SHELL	Retinax LX 2	Li	-5°C +/- 5°C
SHELL	Retinax HDX 2	Li/Ca	-10°C +/- 5°C
TEXACO	Premium RB	Li	-20 °C
TOTAL	Ceran AD	Ca-complex	-15 °C
TOTAL	Ceran LT	Ca-complex	-20 °C
TOTAL	Ceran WR2	Ca-complex	-10 °C
ZELLER & GMELIN	Divinol Lithogrease G 421	Li-complex	-15 °C

Lincoln List of Lubricants, continued



IMPORTANT

Consult Lincoln or Lincoln Distributor/Representative before using lubricants with solid additives.

Biodegradable lubricants

Proven lubricants:

Manufacturer	Designation	Thickener	min. delivery temperature
ARAL	Aralub BAB EP 2	Li/Ca	-25 °C
BP	Biogrease EP 2	Li/Ca	-25 °C
FUCHS-LUBRITECH	Stabyl ECO EP 2	Li/Ca	-25 °C

Lubricant recommendations based on the manufacturer's data sheet:

Manufacturer	Designation	Thickener	min. delivery temperature
AUTOL	Top Bio 2000	Ca	-25 °C
AVIA	Biogrease 1	Li	up to 0 °C
DEA	Dolon E 2	Li	-15 °C
FUCHS	Plantogel 2 S	Li/Ca	-15 °C
KLÜBER	Klüberbio M72-82	Polycarbamide	-20 °C

Lubricants for the food & beverage industry

Lubricant recommendations based on the manufacturer's data sheet:

Manufacturer	Designation	Thickener	min. delivery temperature
ARAL EURAL	Grease EPF 2	Al-complex	-5°C
BREMER & LEGUIL	Rivolta F.L.G 4 – 2	Al-complex	-20 °C
ELKALUB	GLS 364	organic thickener	-10 °C
ELKALUB	GLS 367/N2	inorganic thickener	-5°C
ELKALUB	GLS 380/N1	Al-complex	-10 °C
ELKALUB	GLS 380/N2	Al-complex	-5°C
FUCHS	Renolit G 7 FG 1	Bentonite	-5°C
FUCHS-LUBRITECH	Gleitmo 585 M (KTM-drinking water release)	Li	-10 °C
INTERFLON	Fin Food Grease EP	Al-complex	-5°C
KLUEBER	Paraliq GA 343	Al-complex	-10 °C
KLUEBER	Kluebersynth UH1 14-151	Al-complex	-20 °C
MOBIL	Mobilgrease FM 462	Al-complex	-15 °C
Nordischer Maschinenbau BAADER	Special grease GLS 380/N3	Al-complex	-5°C
OKS	470	Li-12-OH-stearat	-15 °C
OPTIMOL	Obeen UF 1	Al-complex	-15 °C
OPTIMOL	Obeen UF 2	Al-complex	-10 °C
RHENUS NORPLEX	AFD 2	Al-complex	-5°C
RHENUS NORPLEX	AFP 2	Al-complex	-5°C
RHENUS NORPLEX	AFS 2	Al-complex	-25 °C
RHENUS NORPLEX	AFW 2	Al-complex	-5°C
SHELL	Cassida Grease EPS 1	Al-complex	-15 °C
SHELL	Cassida Grease EPS 2	Al-complex	-10 °C
TOTAL	Lubriplate FGL 2	Al-complex	-5°C
TRIBOL MOLUB-ALLOY	FoodProof 823-2 FM	Al-complex	-15 °C
TRIBOL MOLUB-ALLOY	9830 high-temperature grease	PTFE	0°C

Dimensions: 4-liter reservoir

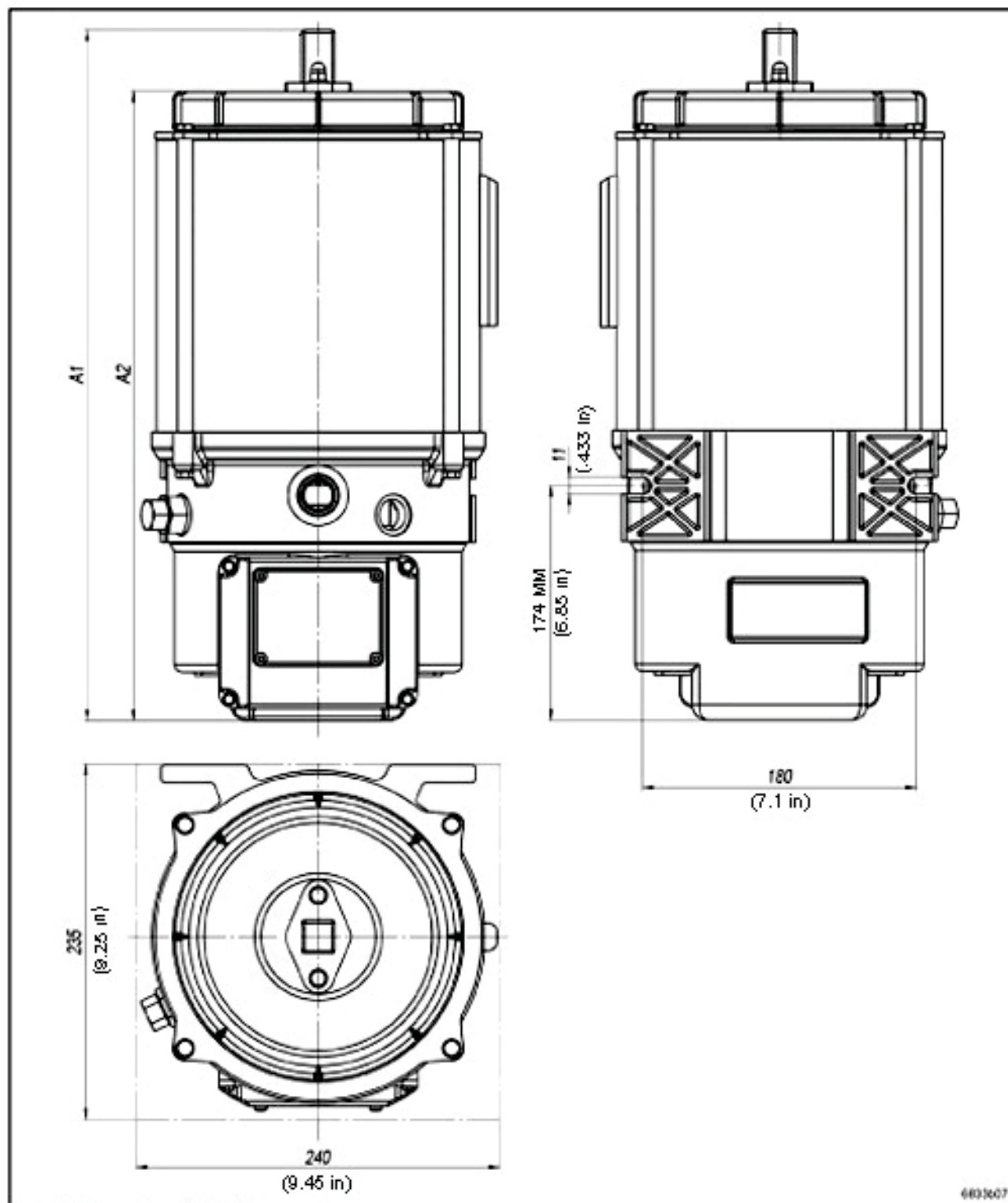


Fig. 45 Dimensions P 653S, 4-liter reservoir

Reservoir with follower plate:
Reservoir with stirring paddle:

A1 = 509 mm (20 in)
A2 = 467 mm (18.4 in)



Dimensions: 8-liter reservoir

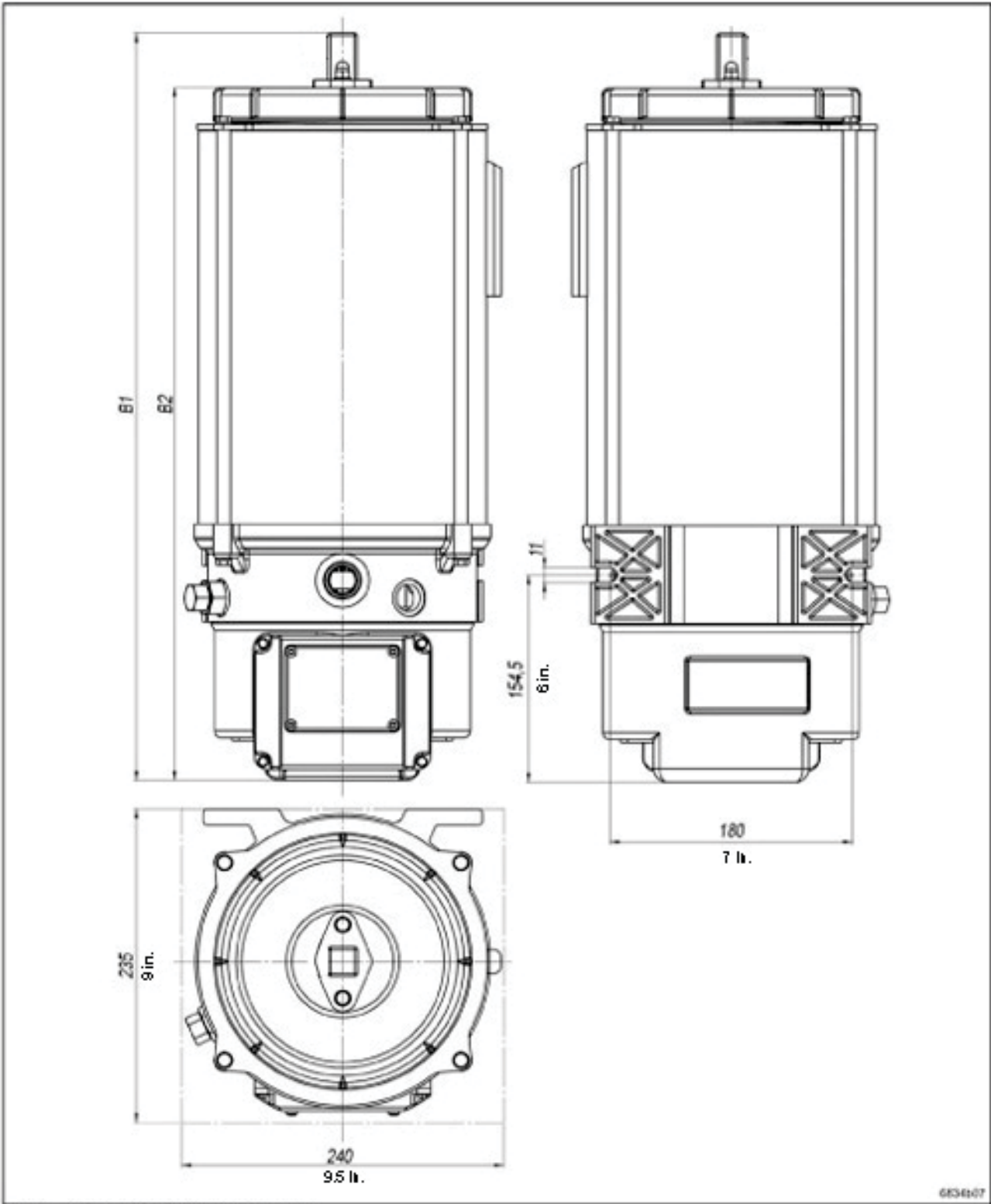


Fig. 48 Dimensions P 653, 8-liter reservoir

Reservoir with follower plate: B1 = 557 mm (22 in.)
Reservoir with stirring paddle: B2 = 515 mm (20 in.)

Dimensions: 15-liter reservoir

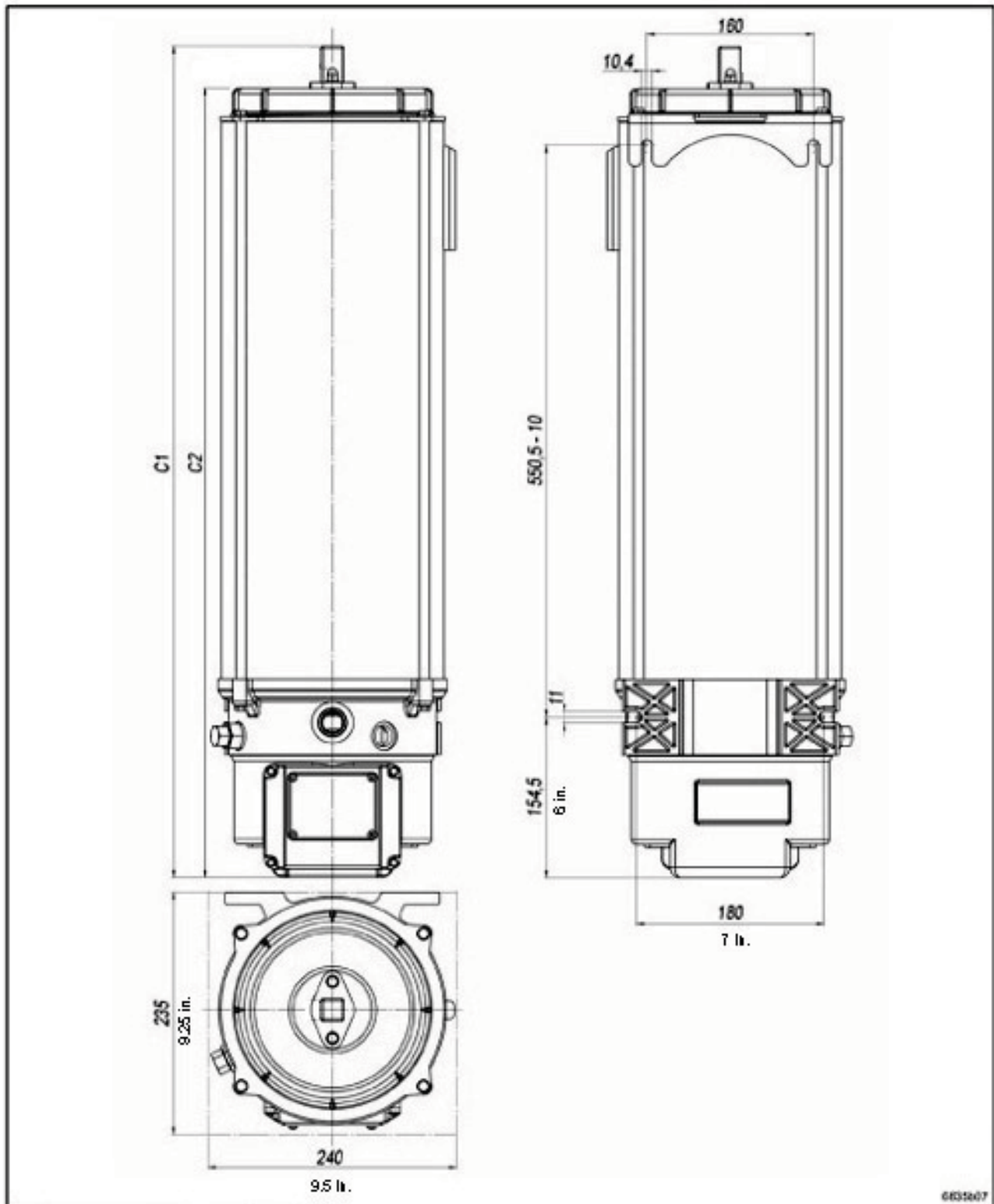


Fig. 47 Dimensions P 653, 15-liter reservoir

Reservoir with follower plate:
Reservoir with stirring paddle:

C1 = 800 mm (31 in.)
C2 = 758 mm (30 in.)



Dimensions: 20 Liter Reservoir

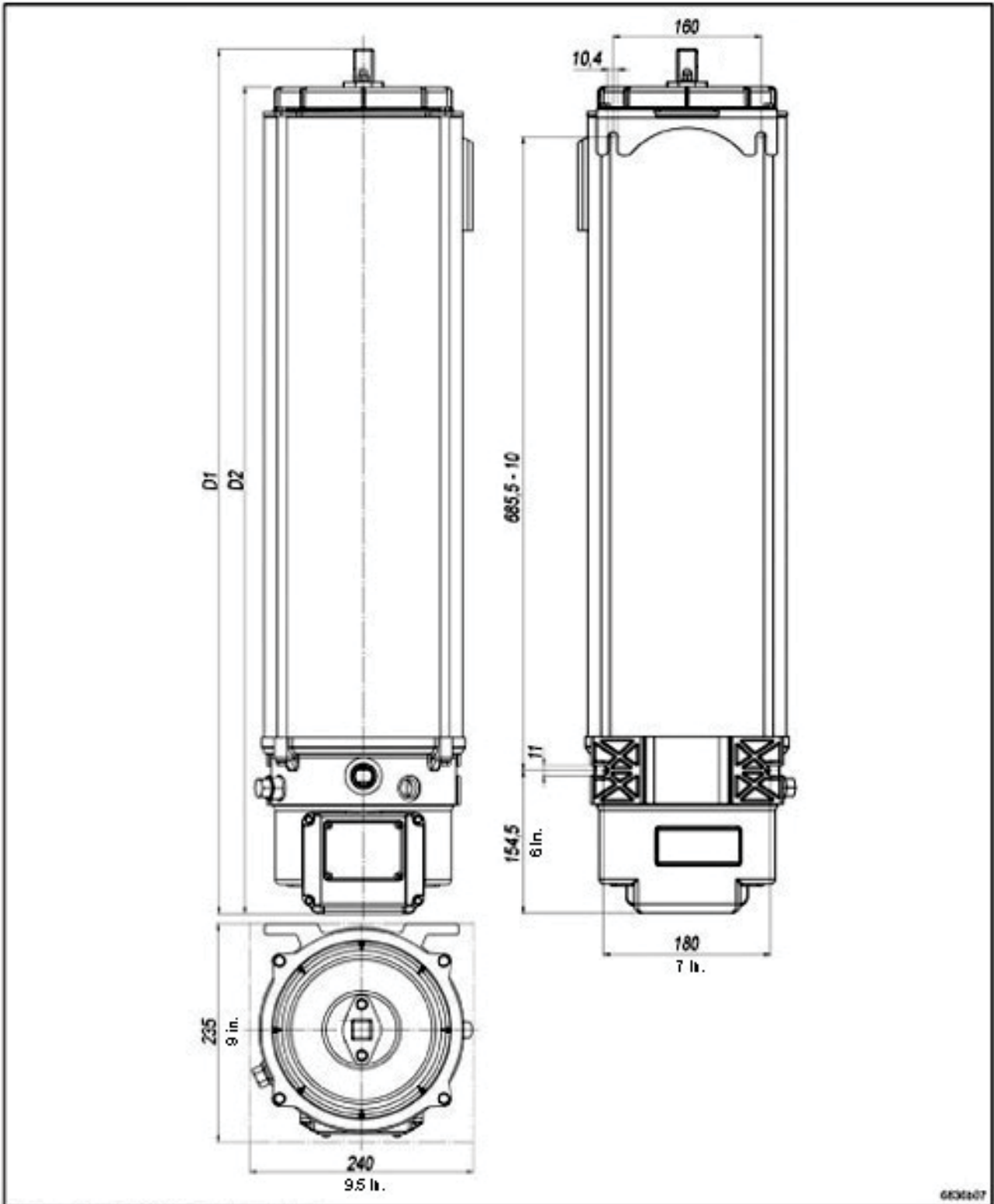


Fig. 48 Dimensions P 653, 20-liter reservoir

Reservoir with Follower Plate: D1 = 935 mm (37 in.)
Reservoir with Stirring Paddle: D2 = 893 mm (35 in.)

Refill and Maintenance

Caution! First time filling of the reservoir with grease is very critical for proper pump operation. The pump may be shipped with a small amount of Fuchs Renocal FN 745/LINCOLN grease used for final testing and inspection. The grease thickener is Ca-12-OH-stearat. Check compatibility of the Renocal FN 745/LINCOLN with the grease you are going to use and remove the test grease if necessary.

Pump with follower plate:

Use grease fitting (9) (Fig. 1) to fill or refill reservoir. Make sure no air is trapped under the follower plate. Grease should be in full contact with the surface of the follower. It's recommended to run the motor by initiating the lube cycle during the first fill of the reservoir. The stirring paddle of the running motor will help to evenly distribute grease under follower minimizing air pockets. The reservoir has a vent hole (11) (Fig.1). Fill grease to the maximum follower position until follower seal will slightly cross the vent hole. If air is still trapped under the follower, add some more grease to expel air through the vent hole.

Pump without follower plate:

Use the same grease fitting (9) (Fig. 1) to fill or refill reservoir. It's recommended to run the motor by initiating the lube cycle during the first fill of the reservoir. The stirring paddle of the running motor will help to evenly distribute grease in the reservoir minimizing air pockets.

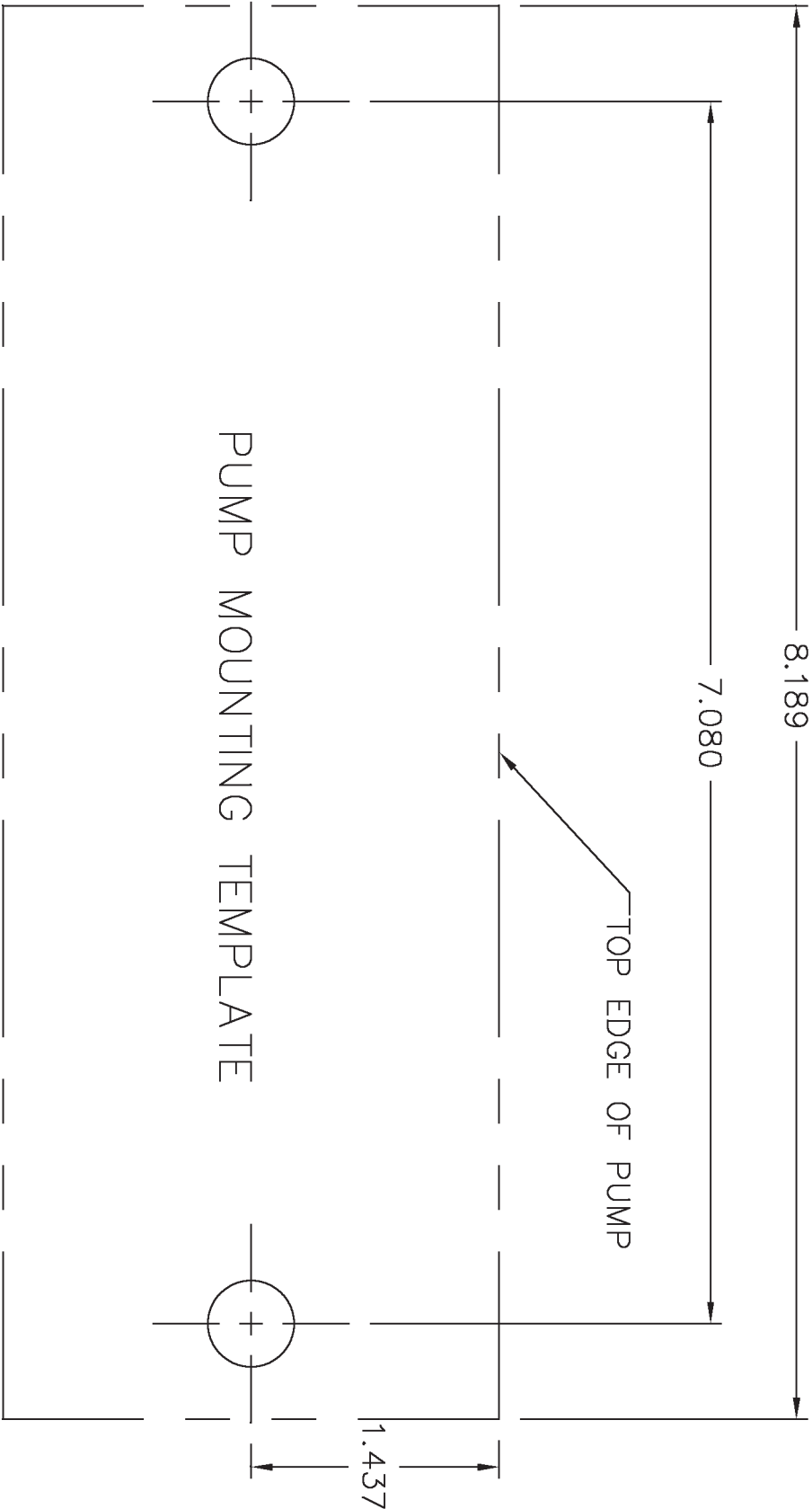
To speed up filling or refilling of the pump, grease fitting can be replaced with 1/8" swivel connection to attach a hose from a larger output filling pump.



Caution! There is a risk of reservoir bursting if overfilled. When filling the reservoir with large output fill or refill pump, do not exceed the maximum fill mark.

Pump cleaning:

Use petroleum or benzene based cleaning solutions. Do not use tri-, perchloroethylene or similar solvents. Do not use polar organics such as alcohol, methyl alcohol, acetone or similar solvents.





Troubleshooting

Mode of failure

Pump motor does not run. No green right corner segment lit on display (Fig. 18 page 15).

Pump does not deliver lubricant but runs if manual lube switch 3 (Fig. 17 page 15) is pushed. No green left corner segment lit on display (Fig. 19 page 15).

"LL" display is flashing. Reservoir is almost empty.

"E1" display is flashing. Pump failed to develop internal pressure in 12 minutes.

"E2" display is flashing. Pump failed to develop pressure at the end of the line (pump with external pressure switch or pressure transducer)

"E3" display is flashing. Pump failed to vent at the pump.

"E4" display is flashing. Pump failed to vent at the end of the line (pump with external pressure switch or pressure transducer).

Grease is coming out of the pressure relief valve (6) (Fig.1).

Solution

Check power supply and fuses.

Connect "ignition" or "machine" switch per electrical schematic on pages 28 and 29.

Pump with follower - refill reservoir. Pump without follower – refill reservoir and push switch (3) (Fig 17) to initiate manual lube cycle.

Push switch (2) (Fig 17) to acknowledge the fault. Initiate manual lube cycle. Investigate and correct possible causes – air pockets, broken line, connections leakage, worn pumping element, failed internal pressure switch or pressure transducer. Initiate manual lube cycle.

Push switch (2) (Fig 17) to acknowledge the fault. Initiate manual lube cycle. Investigate and correct possible causes – air pockets in lubrication line, connections leakage, grease consistency changed with low temperatures, failed end of line pressure switch or pressure transducer.

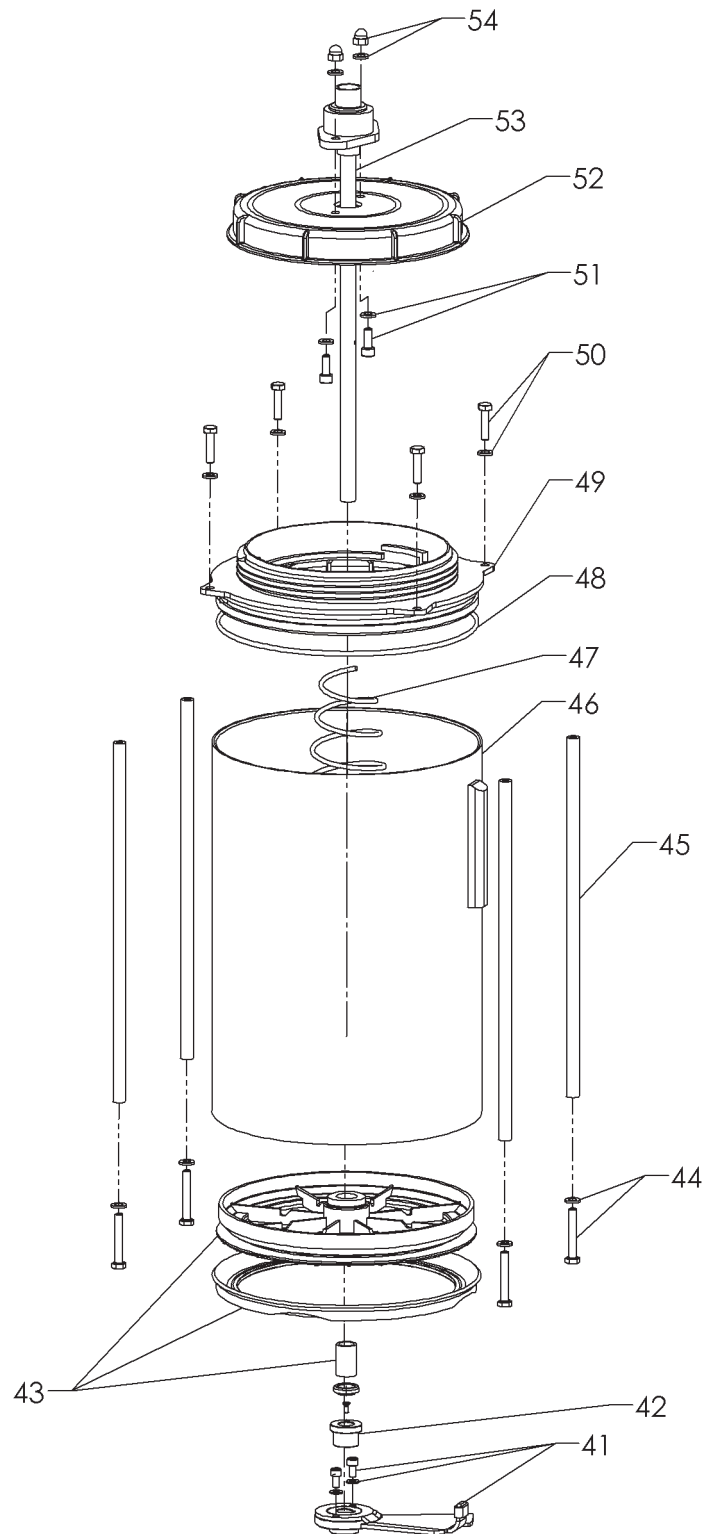
Push switch (2) (Fig 17) to acknowledge the fault. Initiate manual lube cycle. Investigate and correct possible causes – pump eccentric did not stop in a proper position, vent valve failed

Push switch (2) (Fig 17) to acknowledge the fault. Initiate manual lube cycle. Investigate and correct possible causes – restriction in lubrication line, grease consistency changed with low temperature, failed end of line pressure transducer or pressure switch.

Check and adjust setting of the pressure transducer or failed pressure switch.

LINCOLN



**Pump with Follower**

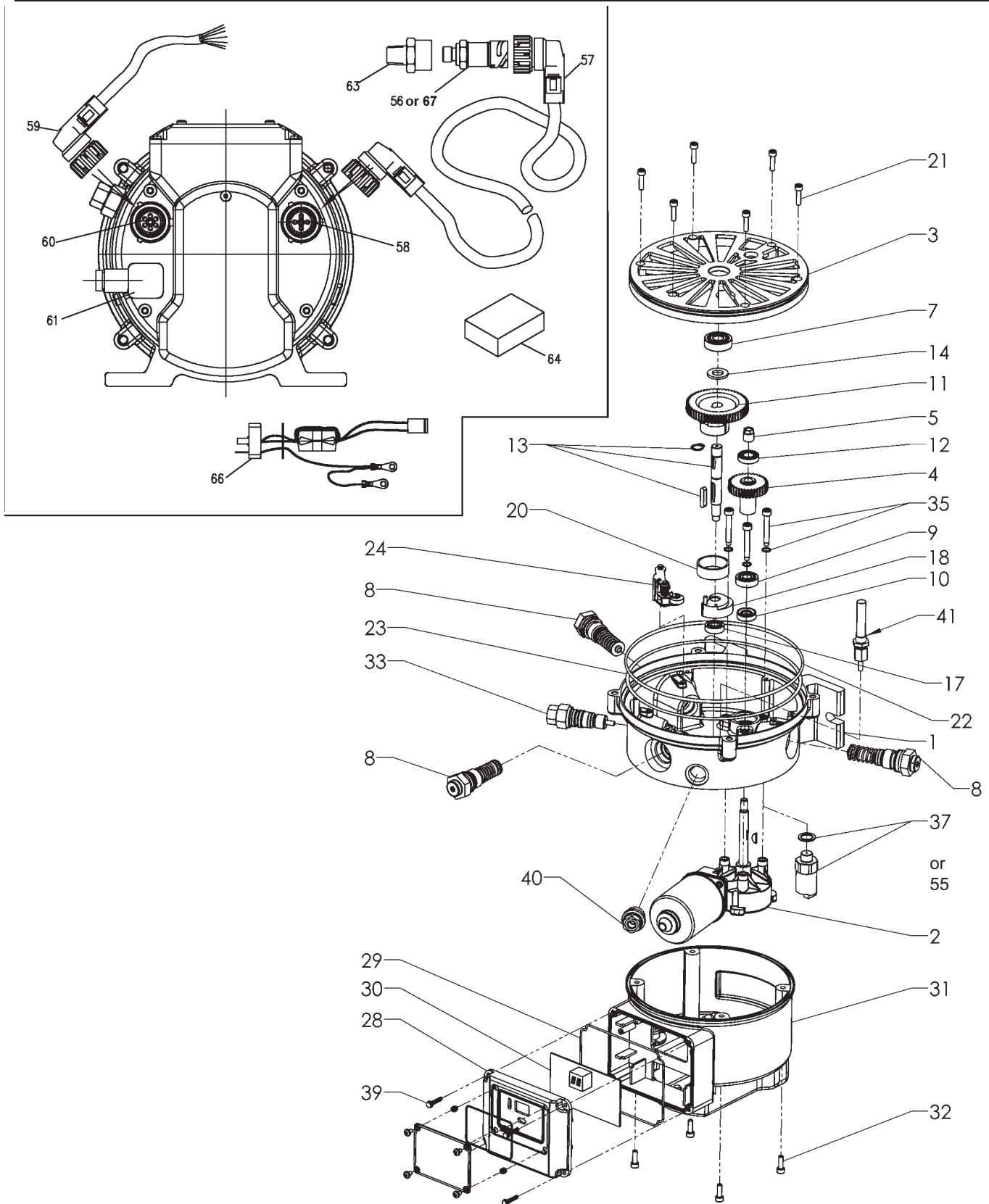
Electric Operated Centro-Matic Pump P653S



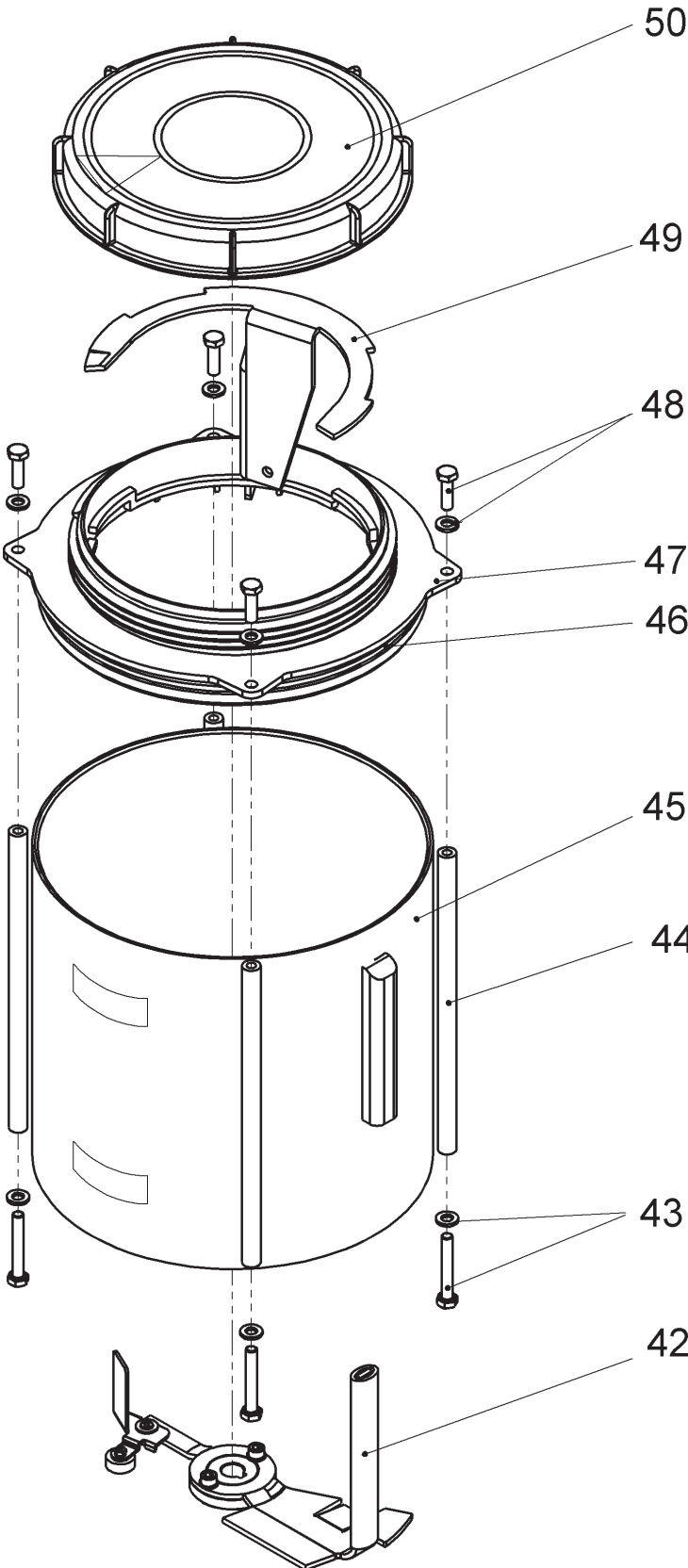
P653S PUMP with follower (housing and reservoir)

Item #	Part Number	Description	QTY	Item #	Part Number	Description	QTY
1	316-16444-1©	HOUSING	1	45	445-71543-1	SUPPORT SLEEVE, 4L RESERVOIR	4
2	275702	MOTOR, DRIVE 24VDC	1		445-71542-1	SUPPORT SLEEVE, 8L RESERVOIR	4
3	445-71524-1	INTERMEDIATE BOTTOM	1		445-71528-1	SUPPORT SLEEVE, 15L RESERVOIR	4
4	275557	PINION GEAR, DRIVE	1		445-71536-1	SUPPORT SLEEVE, 20L RESERVOIR	4
5	445-71527-1	THREADED SLEEVE	1	46	545-33045-1	RESERVOIR, 4L W/VENT TUBE AND LABELS	1
7	250-10683-1	BEARING D12/24X 6	1		545-33044-1	RESERVOIR, 8L W/VENT TUBE AND LABELS	1
8	645-29818-1	PUMP ELEMENT, Z7	3		545-33041-1	RESERVOIR, 15L W/VENT TUBE AND LABELS	1
9	250-14009-7	BEARING D10/26X 8	1		545-33043-1	RESERVOIR, 20L W/VENT TUBE AND LABELS	1
10	220-12231-3	SEAL, RADIAL BA 75FKM 10X22X 7	1	47	300-19860-1	SPRING, FOLLOWER, FOR 4L AND 8L RESERVOIR	1
11	275558	GEAR, ECCENTRIC	1		300-16288-1	SPRING, FOLLOWER, FOR 15L AND 20L RESERVOIR	1
12	250-14064-6	BEARING d12/32x10	1	48	219-10684-6	O-RING 72NBR 180.000 X 4.00	1
13	445-71266-1	SHAFT F.DRIVE with RETAINING RING AND KEY	1	49	445-71532-1	INSERT, RESERVOIR	1
14	209-13011-9	WASHER ST 12 C -200HV	1	50	200-13022-7	SCREW, HEX, 8.8 M6x20C	4
17	250-14064-7	BEARING D 8/22X 7	1	51	201-12019-9	SCREW, SOCKET HEX, 8.8 M6x16C	2
18	445-71253-1	CAM, RELIEF UNIT	1	52	444-70113-1	COVER, RESERVOIR	1
20	444-24439-1	PRESS RING	1	53	234-10693-6	CONTACT ROD, 4L RESERVOIR	1
21	201-12016-8	SCREW, SOCK,HEX. 8.8 M 5X 20C	6		234-10693-7	CONTACT ROD, 8L RESERVOIR	1
22	219-10684-6	O-RING 72NBR 180,00X4,00	1		234-10693-8	CONTACT ROD, 15L RESERVOIR	1
23	219-10390-3	O-RING 72NBR 195,00x3,00	1		234-10693-9	CONTACT ROD, 20L RESERVOIR	1
24	545-32906-1	ROCKER ARM, ASS'Y, RELIEF UNIT	1	54	207-12247-2	NUT, CAP WITH WASHER 209-13011-5	2
25		NOT USED©	1	55	234-10663-6	PRESSURE TRANSDUCER WITH SEAL RING 209-12158-6	1
26		NOT USED©	1	56	234-10825-3	EXTERNAL PRESSURE TRANSDUCER	1
27		NOT USED©	4	57	664-34456-9	CABLE ASSY,10M.4/4 POLE	1
28	445-71441-1	FRONT COVER W/KEYBOARD 236-14340-7	1	58	644-34550-6	CONNECTOR FOR EXTERNAL PRESSURE SWITCH/ TRANSDUCER	1
29	445-72277-1©	PROFILE PACKING	1	59	664-34428-3©	CABLE ASSY,10M,7/7 POLE	1
30	236-10655-1	PRINTED CIRCUIT BOARD*	1	60	664-34569-1	CONECTOR FOR SIGNAL CABLE 7 POLES (AC PUMP)	1
31	275666	COVER, HOUSING	1		664-34303-7	CONECTOR FOR SIGNAL CABLE 7 POLES (DC PUMP)	1
32	201-12016-6	SCREW, SOCK, HEX. 8.8 M 5X 16C	4	61	236-13277-9	AC POWER CABLE PLUG	1
33	545-33042-1	RELIEF ELEMENT	1	62	664-34517-6	LOW LEVEL CONTROL SWITCH CABLE (4L RESERVOIR)	1
35	206-13710-6	SCREW,6.0x40Z WITH SEAL 220-14101-1	3		664-34517-7	LOW LEVEL CONTROL SWITCH CABLE (8L RESERVOIR)	1
37	234-10723-8	PRESSURE SWITCH WITH SEAL RING 209-12158-6	1		664-34517-5	LOW LEVEL CONTROL SWITCH CABLE (15L RESERVOIR)	1
39	206-13796-9	SCREW W/WASHER	4		664-34517-8	LOW LEVEL CONTROL SWITCH CABLE (20L RESERVOIR)	1
40	304-19619-1	ADAPTER M22x1.5 W/GREASE FITTING 251-14045-9	1	63	644-34550-11©	PLUG, 7 POLE JUMPER	1
41	545-33031-1	STIRING PADDLE ASSE'Y	1	64	275906	POWER SUPPLY	1
42	445-71267-1	BUSHING	1	65	664-34428-1	MOTOR CONNECTOR	1
43	544-33307-1©	FOLLOWER PLATE ASS'Y	1	66	664-34569-2	INTERNAL CABLE FOR AC PUMP	1
44	200-12000-3	SCREW, HEX, 8.8 M6x40C	4	67	234-10825-4	EXTERNAL PRESSURE SWITCH	1
				-	624-77144-1©	VLAVE SVTE - 400 - R 1/4-1/4 NPT	1
				-	271249	HORIZONTAL MOUNTING BRACKET	1
				-	226-14105-5	ADAPTER S2520-1/4-1/4-25	1

* When replacing Printed Circuit Board 236-10655-1, special attention must be given to the jumper settings. The replacement Printed Circuit Boards are shipped with a standard factory setting. For your pump to work properly, the replacement Printed Circuit Board jumper settings must duplicate the original Printed Circuit Board.



PUMP WITHOUT FOLLOWER



PUMP WITHOUT FOLLOWER



Electric Operated Centro-Matic Pump P653S

P653S Pump without Follower (Housing and Reservoir)

Item #	Part Number	Description	QTY	Item #	Part Number	Description	QTY
1	316-16445-1©	HOUSING	1	40	304-19619-1	ADAPTER M22x1.5 W/GREASE FITTING 251-14045-9	1
2	275702	MOTOR, DRIVE 24VDC	1	41	234-10423-6	PROXIMITY SWITCH	1
3	445-71524-1	INTERMEDIATE BOTTOM	1	42	545-33093-1	STIRING PADDLE ASSE'Y	1
4	275557	PINION GEAR, DRIVE	1	43	200-12000-3	SCREW, HEX, 8.8 M6x40C	4
5	445-71527-1	THREADED SLEEVE	1	44	445-71543-1	SUPPORT SLEEVE, 4L RESERVOIR	4
7	250-10683-1	BEARING D12/24X 6	1		445-71542-1	SUPPORT SLEEVE, 8L RESERVOIR	4
8	645-29818-1	PUMP ELEMENT, Z7	3		445-71528-1	SUPPORT SLEEVE, 15L RESERVOIR**	4
9	250-14009-7	BEARING D10/26X 8	1		445-71536-1	SUPPORT SLEEVE, 20L RESERVOIR**	4
10	220-12231-3	SEAL, RADIAL BA 75FKM 10X22X 7	1	45	545-33045-1	RESERVOIR, 4L W/VENT TUBE AND LABELS	1
11	275558	GEAR, ECCENTRIC	1		545-33044-1	RESERVOIR, 8L W/VENT TUBE AND LABELS	1
12	250-14064-6	BEARING d12/32x10	1		545-33041-1	RESERVOIR, 15L W/VENT TUBE AND LABELS***	1
13	445-71266-1	SHAFT F.DRIVE with RETAINING RING AND KEY	1		545-33043-1	RESERVOIR, 20L W/VENT TUBE AND LABELS***	1
14	209-13011-9	WASHER ST 12 C -200HV	1	46	219-10684-6	O-RING 72NBR 180.000 X 4.00	1
17	250-14064-7	BEARING D 8/22X 7	1	47	445-71532-1	INSERT, RESERVOIR	1
18	445-71253-1	CAM, RELIEF UNIT	1	48	200-13022-7	SCREW, HEX, 8.8 M6x20C	4
20	444-24439-1	PRESS RING	1	49	444-70490-1	FIXED PADDLE	1
21	201-12016-8	SCREW, SOCK,HEX. 8.8 M 5X 20C	6	50	444-70641-1	COVER, RESERVOIR	1
22	219-10684-6	O-RING 72NBR 180,00X4,00	1	55	234-10663-6	PRESSURE TRANSDUCER WITH SEAL RING 209-12158-6	1
23	219-10390-3	O-RING 72NBR 195,00x3,00	1	56	234-10825-3	EXTERNAL PRESSURE TRANSDUCER	1
24	545-32906-1	ROCKER ARM, ASS'Y, RELIEF UNIT	1	57	664-34456-9	CABLE ASSY,10M.4/4 POLE	1
25		NOT USED©	1	58	644-34550-6	CONNECTOR FOR EXTERNAL PRESSURE SWITCH/TRANSDUCER	1
26		NOT USED©	1				
27		NOT USED©	4	59	664-34428-3©	CABLE ASSY,10M,7/7 POLE	1
28	445-71441-1	FRONT COVER W/KEYBOARD 236-14340-7	1	60	664-34569-1	CONECTOR FOR SIGNAL CABLE 7 POLES (AC PUMP)	1
29	445-72277-1©	PROFILE PACKING	1		664-34303-7	CONECTOR FOR SIGNAL CABLE 7 POLES (DC PUMP)	1
30	236-10655-1	PRINTED CIRCUIT BOARD 24 V*	1	61	236-13277-9	AC POWER CABLE PLUG	1
31	275666	COVER, HOUSING	1	63	664-34550-11©	PLUG, 7 POLE JUMPER	1
32	201-12016-6	SCREW, SOCK, HEX. 8.8 M 5X 16C	4	64	275906	POWER SUPPLY	1
33	545-33042-1	RELIEF ELEMENT	1	66	664-34569-2	INTERNAL CABLE FOR AC PUMP	1
35	206-13710-6	SCREW,6.0x40Z WITH SEAL 220-14101-1	3	67	234-10825-4	EXTERNAL PRESSURE SWITCH	1
37	234-10723-8	PRESSURE SWITCH WITH SEAL RING 209-12158-6	1	-	624-77144-1©	VALVE SVTE - 400 - R1/4 - 1/4 NPT	1
39	206-13796-9	SCREW W/WASHER	4	-	271249	HORIZONTAL MOUNTING BRACKET	1
				-	226-14105-5	ADAPTER S2520-1/4-1/4-25	1

* When replacing Printed Circuit Board 236-10655-1, special attention must be given to the jumper settings. The replacement Printed Circuit Boards are shipped with a standard factory setting. For your pump to work properly, the replacement Printed Circuit Board jumper settings must duplicate the original Printed Circuit Board.

** Components available in kit to convert 4 and 8 liter to 15 liter - part # 276764.

*** Components available in kit to convert 4 and 8 liter to 20 liter - part # 276765.



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Model No. 85770-1, -2, -3, -4, -5, -6 85771, 85772
85780-1, -2, -3, -4, -5, -6 85781 and 85782
SL-V INJECTOR
Series "A"

SINGLE AND MANIFOLD TYPE INJECTORS

for dispensing fluid lubricants and greases not
exceeding Lincoln ventmeter viscosity of 600 psi.

SPECIFICATIONS

Minimum operating pressure – 1850 psi [128 bar]

Maximum operating pressure – 6000 psi [413 bar]

Recommended operating pressure – 2500 psi [172 bar]

Maximum vent (recharge) pressure – 1000 psi [69 bar]

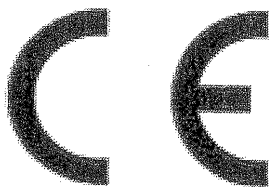
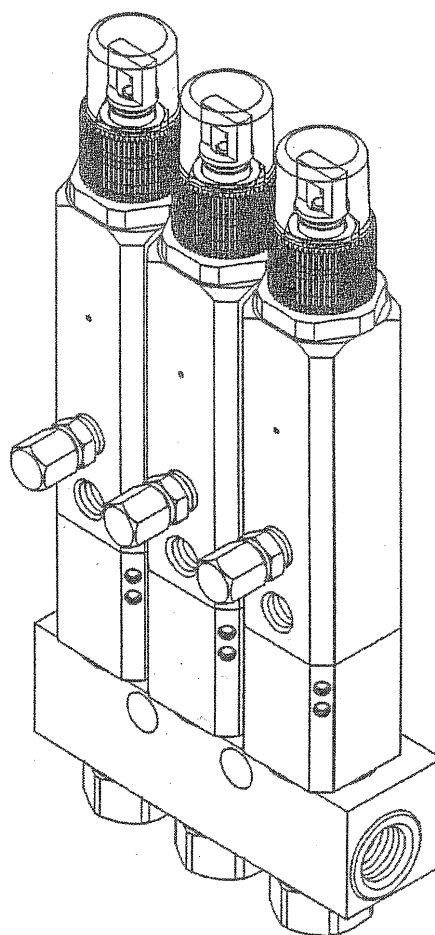
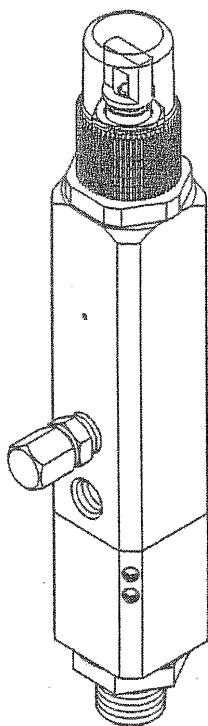
Temperature Range - -40°F to 180°F [-40°C - 80°C]

Lubricant output (adjustable):

SL-V - 0.015 to 0.080 cu. in. [0.25 to 1.31 ccm]

SL-V HO - 0.015 to 0.305 cu. in. [0.25 to 5.00 ccm]

Injectors can be mounted in any position and can be used
in circuits with SL-1, SL-11, SL-32 and/or SL33 injectors.



U.S Patent Number 6,705,432
Foreign Patents Pending



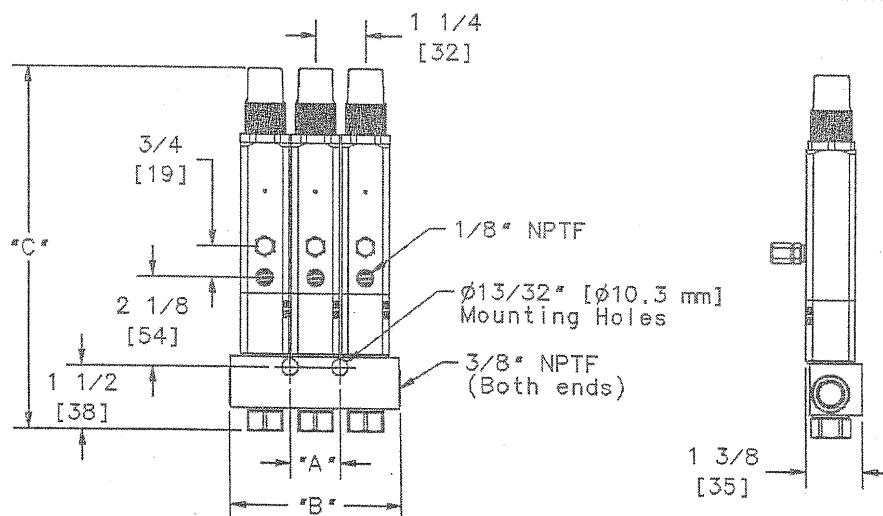
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Section - **C8**

Page - **301**

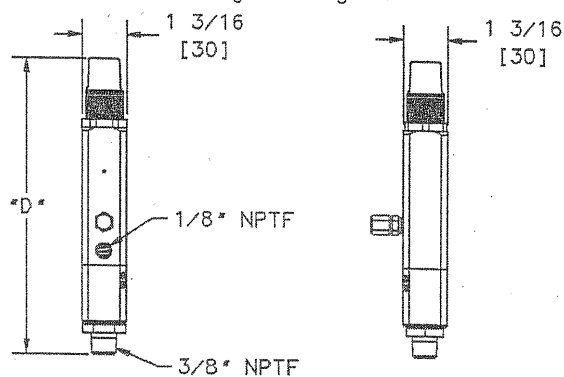
Model No. 85770-1, -2, -3, -4, -5, -6
 85771, 85772
 85780-1, -2, -3, -4, -5, -6
 85781, 85782
SL-V INJECTOR



MANIFOLD TYPE INJECTORS

Injector	Model	Type	Dimension "A"		Dimension "B"		Dimension "C"	
			in.	[mm.]	in.	[mm.]	in.	[mm.]
SL-V	85770-1	Single injector manifold	*	*	2-1/2	[63.5]	8-3/4	[222]
	85770-2	Two injector manifold	*	*	3	[76.2]		
	85770-3	Three injector manifold	1-1/4	[31.8]	4-1/4	[108]		
	85770-4	Four injector manifold	2-1/2	[63.5]	5-1/2	[140]		
	85770-5	Five injector manifold	3-3/4	[95.3]	6-3/4	[171]		
	85770-6	Six injector manifold	5	[127]	8	[203]		
	85771	Replacement injector	N/A		N/A			
SL-V HO	85780-1	Single injector manifold	*	*	2-1/2	[63.5]	11-3/16	[284]
	85780-2	Two injector manifold	*	*	3	[76.2]		
	85780-3	Three injector manifold	1-1/4	[31.8]	4-1/4	[108]		
	85780-4	Four injector manifold	2-1/2	[63.5]	5-1/2	[140]		
	85780-5	Five injector manifold	3-3/4	[95.3]	6-3/4	[171]		
	85780-6	Six injector manifold	5	[127]	8	[203]		
	85781	Replacement injector	N/A		N/A			

* Single mounting hole

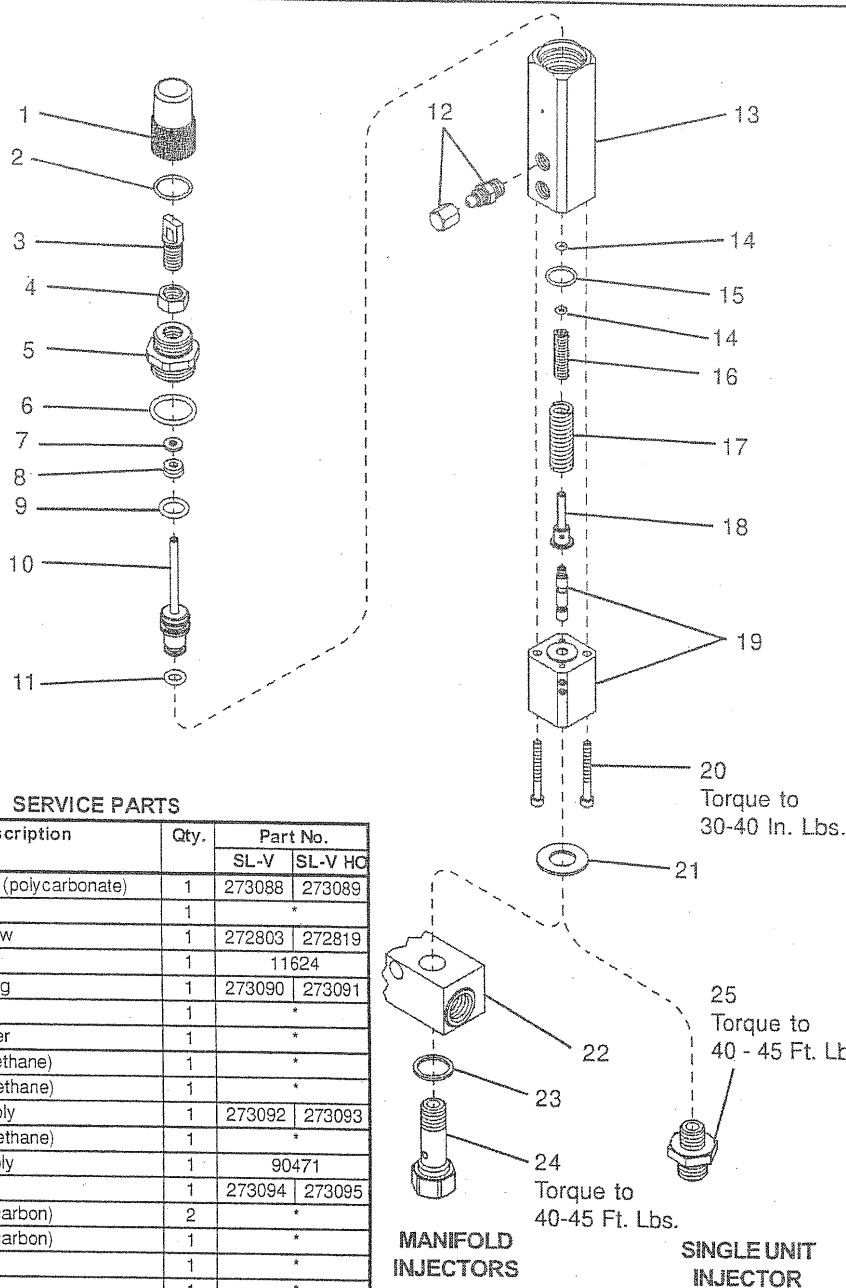


SINGLE UNIT INJECTORS

Injector	Model	Type	Dimension "D"	
			in.	[mm.]
SL-V	85772	Single unit injector	7-3/4	[191]
SL-V HO	85782	Single unit injector	10-3/16	[248]



Model No. 85770-1, -2, -3, -4, -5, -6
 85771, 85772
 85780-1, -2, -3, -4, -5, -6
 85781, 85782
SL-V INJECTOR



SERVICE PARTS

Item No.	Description	Qty.	Part No.	
			SL-V	SL-V HC
1	Protective Cap (polycarbonate)	1	273088	273089
2	O-ring (nitrile)	1	*	*
3	Adjusting Screw	1	272803	272819
4	Lock Nut	1	11624	
5	Piston Stop Plug	1	273090	273091
6	O-ring	1	*	*
7	Backup Washer	1	*	*
8	U-cup (polyurethane)	1	*	*
9	O-ring (polyurethane)	1	*	*
10	Piston Assembly	1	273092	273093
11	O-ring (polyurethane)	1	*	*
12	Fitting Assembly	1	90471	
13	Injector Body	1	273094	273095
14	O-ring (fluorocarbon)	2	*	*
15	O-ring (fluorocarbon)	1	*	*
16	Spring	1	*	*
17	Spring	1	*	*
18	Spring Seat	1	272798	
19	Body and Plunger Assy.	1	273096	
20	Socket Head Screw (8-32 x 1-1/2)	2	272796	
21	Gasket	1	*	*
22	Single Injector Manifold	1	12658	
	Two Injector Manifold	1	11962	
	Three Injector Manifold	1	11963	
	Four Injector Manifold	1	11964	
	Five Injector Manifold	1	11965	
	Six Injector Manifold	1	246965	
23	Gasket	1	*	*
24	Adapter Bolt	1	273097	
25	Adapter	1	273098	

* Included in 272970 Repair Kit

MANIFOLD INJECTORS

SINGLE UNIT INJECTOR

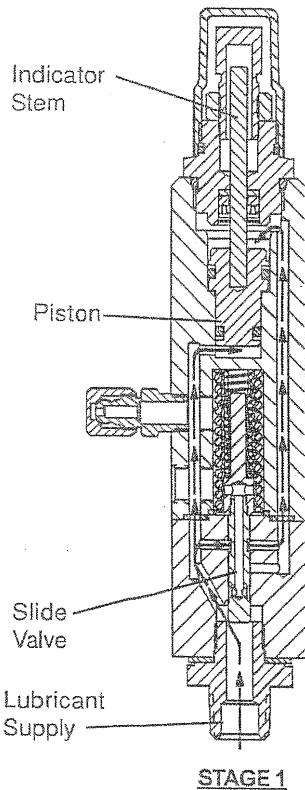
SPECTRUM ADJUSTMENT SLEEVES

Part #	Output in3 (cc)	Ratio from Minimum Output	Ratio from Maximum Output	Sleeve Color
NA	0.015 (0.25)	1	0.2	N/A
85785-1	0.03 (0.50)	2	0.4	red
85785-2	0.045 (0.75)	3	0.6	silver
85785-3	0.06 (1.00)	4	0.8	gold
85785-4	0.075 (1.25)	5	1.0	green

NOTE: Remove and discard Lock Nut (Item 4) before installing Spectrum Adjustment Sleeve onto Adjusting Screw (Item 3).



SL-V Injector Operation

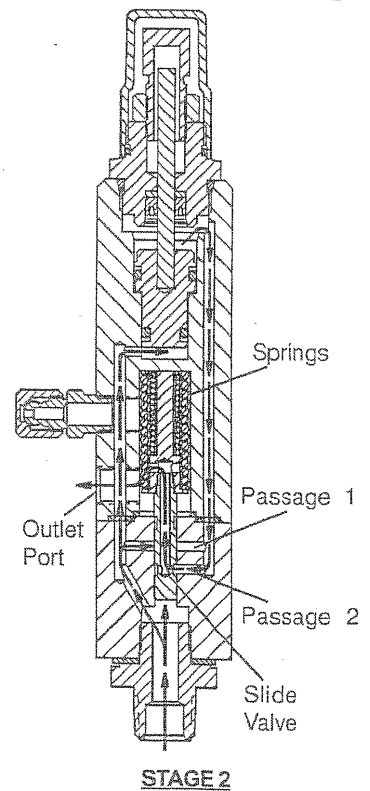


Stage 1

The injector starts in its normal or rest position. Incoming lubricant is directed through the slide valve to both sides of the piston. The pressure of the incoming lubricant acting on both sides of the piston causes the piston to move downward against the shoulder and fills the measuring chamber. The indicator stem is fully retracted away from the stop of the adjusting screw.

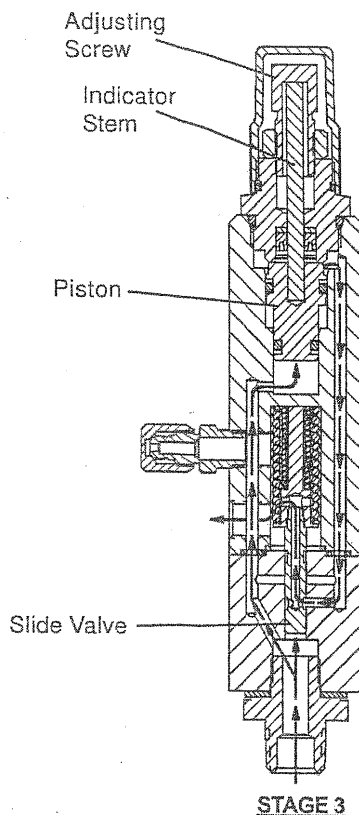
Stage 2

Further increase in pressure causes the slide valve to move against the force of the springs. As the slide valve moves, it closes passage 1 and opens passage 2 to the outlet port. The pressure of the incoming lubricant is now acting only upon the bottom of the piston. The incoming lubricant displaces the piston which forces the lubricant in the measuring chamber to be dispensed through passage 2, through the slide valve and through the outlet port to the lube point.



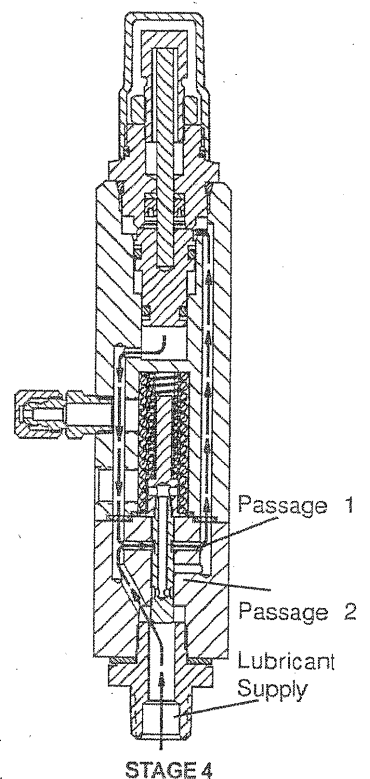
Stage 3

The piston will dispense lubricant until the indicator stem hits the stop of the adjusting screw. The volume of lubricant dispensed can be adjusted by limiting the travel of the piston. The piston and slide valve remain in this position until the lubricant pressure in the supply line is vented.



Stage 4

As the pressure in the supply line vents to 1000 psig [69 bar], the slide valve moves downward and closes passage 2 and opens passage 1. The lubricant pressure in the supply line is now acting upon both sides of the piston causing it to move downward. As the piston moves downward, a volume of lubricant flows from the underside of the piston, past the slide valve, through passage 1 and to the upper side of the piston. Since the volume on top of the piston is greater than the volume under the piston, an additional volume of lubricant flows from the supply line to the upper side of the piston. This volume of lubricant leaving the supply line causes the pressure to drop very quickly. The piston may or may not fully return to the shoulder, depending upon the volume of lubricant in the supply line. The injector is now ready for the next cycle.





Model No. 85770-1, -2, -3, -4, -5, -6

85771, 85772

85780-1, -2, -3, -4, -5, -6

85781, 85782

SL-V INJECTOR

Lincoln Industrial Standard Warranty

LIMITED WARRANTY

Lincoln warrants the equipment manufactured and supplied by Lincoln to be free from defects in material and workmanship for a period of one (1) year following the date of purchase, excluding therefrom any special, extended, or limited warranty published by Lincoln. If equipment is determined to be defective during this warranty period, it will be repaired or replaced, within Lincoln's sole discretion, without charge.

This warranty is conditioned upon the determination of a Lincoln authorized representative that the equipment is defective. To obtain repair or replacement, you must ship the equipment, transportation charges prepaid, with proof of purchase to a Lincoln Authorized Warranty and Service Center within the warranty period.

This warranty is extended to the original retail purchaser only. This warranty does not apply to equipment damaged from accident, overload, abuse, misuse, negligence, faulty installation or abrasive or corrosive material, equipment that has been altered, or equipment repaired by anyone not authorized by Lincoln. This warranty applies only to equipment installed, operated and maintained in strict accordance with the written specifications and recommendations provided by Lincoln or its authorized field personnel.

THIS WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE WARRANTY OF MERCHANTABILITY OR WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.

In no event shall Lincoln be liable for incidental or consequential damages. Lincoln's liability for any claim for loss or damages arising out of the sale, resale or use of any Lincoln equipment shall in no event exceed the purchase price. Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, therefore the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights. You may also have other rights that vary by jurisdiction.

Customers not located in the Western Hemisphere or East Asia: Please contact Lincoln GmbH & Co. KG, Walldorf, Germany, for your warranty rights.

Lincoln Industrial Special Limited Warranty

SPECIAL LIMITED 2 YEAR WARRANTY

SL-V Series, Single Injectors-85772, 85782, and Replacement Injectors-85771, 85781

Lincoln warrants the SL-V Injector series to be free from defects in material and workmanship for two (2) years following the date of purchase. If an injector model (single or replacement) is determined to be defective by Lincoln, in its sole discretion, during this warranty period, it will be repaired or replaced, at Lincoln's discretion, without charge.

Lincoln Industrial Contact Information

To find Lincoln Industrial's Nearest Service Center

Call one of the following numbers, you may also use our website

Customer Service - 314-679-4200

Website - www.lincolnindustrial.com

Model No. 85770-1, -2, -3, -4, -5, -6
85771, 85772
85780-1, -2, -3, -4, -5, -6
85781, 85782
SL-V INJECTOR



**Declaration by the manufacturer as defined by
machinery directive 89/392/EEC Annex IIB**

Herewith we declare that the supplied model of

SL-V

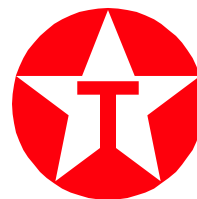
is intended to be incorporated into machinery covered by
this directive and must not be put into service until the
machinery into which it is to be incorporated has been
declared in conformity with the provisions of the directive.

Applied harmonized standards in particular:

**EN292 T1/T2
prEN 809**

Paul A. Conley

Paul Conley,
Chief Engineer



TEXACO STARPLEX[®]

1, 2

CUSTOMER BENEFITS

Texaco Starplex greases deliver value through:

- **Good water resistance** — Strong resistance to wash out of bearings.
- **Good rust and corrosion protection**, even in wet conditions.
- **Extreme pressure protection**
- **Protection against shock loading**, thus extending bearing life.
- **Outstanding film strength** and adhesive properties.
- **Good low temperature pumpability** — Better handling in the container and grease dispensing equipment.

FEATURES

Texaco Starplex greases are water resistant, extreme pressure, heavy duty chassis, wheel bearing and general purpose lubricating greases.

They are manufactured using highly refined, select high viscosity index base oils, and a lithium complex soap.

Texaco Starplex greases are available in two grades:

- **NLGI 1** for better pumpability at low ambient temperatures
- **NLGI 2** for use in normal ambient temperatures

FUNCTIONS

Texaco Starplex greases are formulated to:

- Protect bearings and other metal surfaces from corrosion when exposed to wet conditions.
- Resist water. These greases strongly resist being washed out of bearings.
- Retain their consistency under adverse service conditions.
- Provide outstanding film strength and adhesive properties. As a result, Texaco Starplex greases are particularly effective in providing low wear in shock load service.
- Operate effectively over a wide temperature range.

APPLICATIONS

Texaco Starplex greases are recommended for:

- general use in the lubrication of trucks, tractors, and passenger cars. This includes ball joints, universal joints, and all other chassis points, wheel bearings, water pumps, and fifth wheels.
- boat trailer wheel bearings
- high temperature disc brake bearing applications

Texaco Starplex greases are approved for the NLGI Certification Mark GC-LB.

TYPICAL TEST DATA

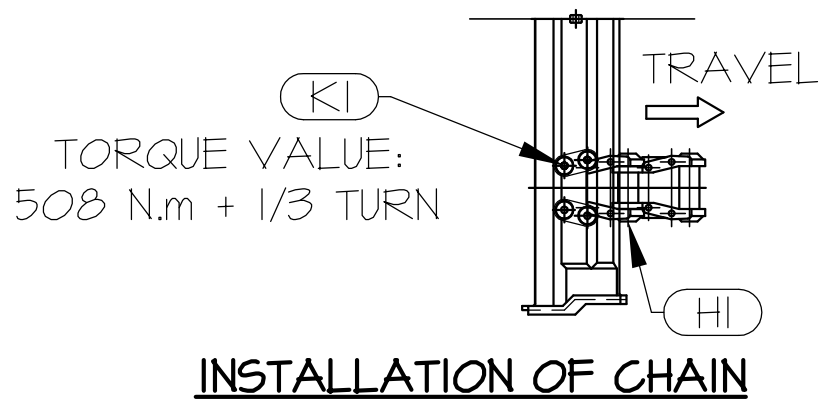
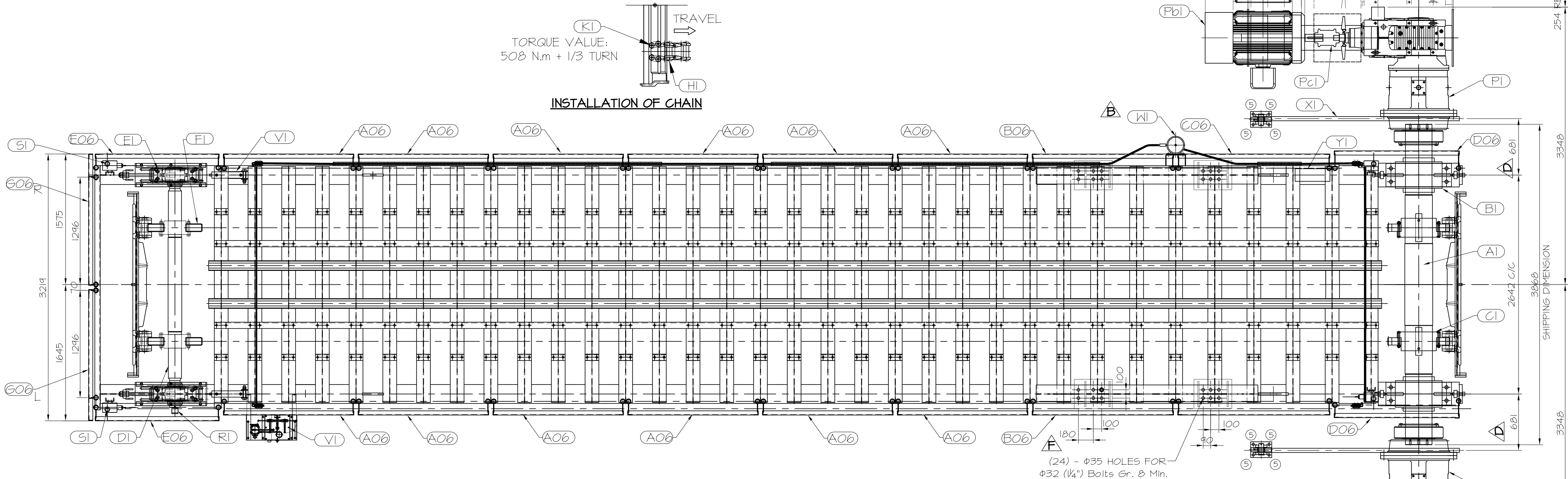
NLGI Grade	1	2
CPS Number	221927	221935
MSDS Number	8807	8807
Operating Temperature, °C(°F) Minimum ¹ Maximum ²	-40(-40) 177(350)	-40(-40) 177(350)
Penetration, at 25°C(77°F) Unworked Worked	310 325	267 280
Dropping Point, °C(°F)	270(518)	270(518)
Four-Ball Weld Point, kg Wear Scar Diameter, mm	315 0.4	315 0.4
Timken OK Load, lb	40	40
Thickener, % Type	9 Lithium Complex	12 Lithium Complex
Viscosity, Kinematic* cSt at 40°C cSt at 100°C	188 19.4	188 19.4
Viscosity, Saybolt* SUS at 100°F SUS at 210°F	987 92	987 92
Viscosity Index*	104	104
Flash Point, °C(°F)*	198(388)	198(388)
Pour Point, °C(°F)*	-12(+10)	-12(+10)
Texture	Smooth, Stringy	Smooth, Strigy
Color	Red	Red

Typical test data are average values only. Minor variations which do not affect product performance are to be expected in normal manufacturing.

¹ Minimum operating temperature is the lowest temperature at which a grease, already in place, could be expected to provide lubrication. Most greases cannot be pumped at these minimum temperatures.

² Maximum operating temperature is the highest temperature at which the grease could be used with frequent (daily) relubrication.

* Determined on mineral oil extracted by vacuum filtration.



Industrial Equipment Manufacturing Ltd.
PORT KELLS, SURREY, B.C.
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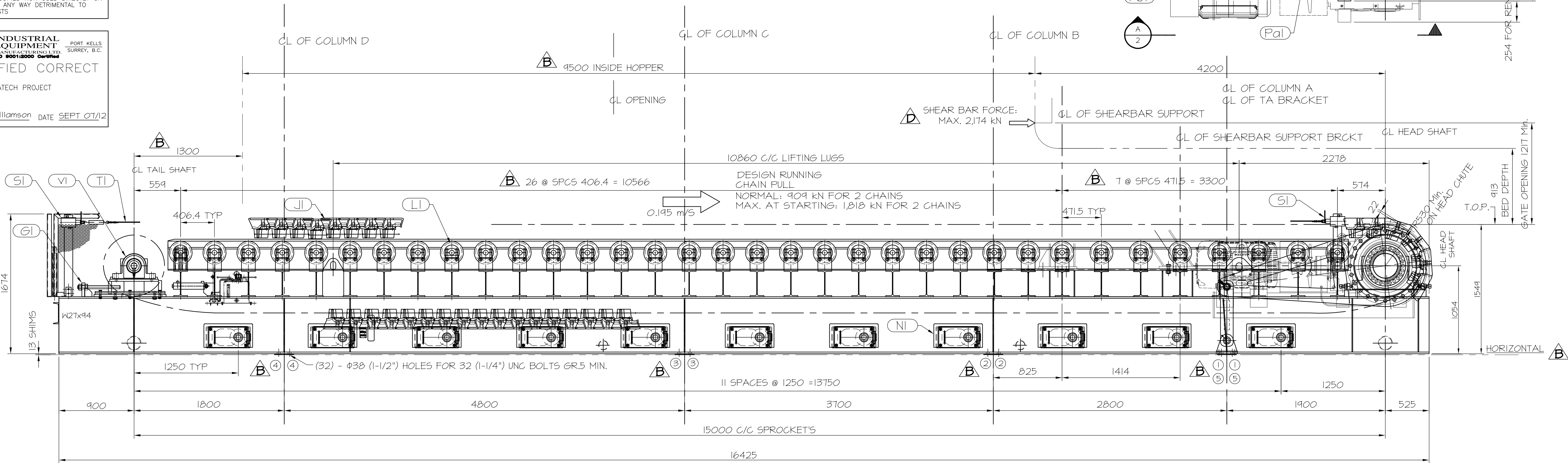
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FOR MEGATECH PROJECT
CUSTOMER

PER: G. Williamson DATE: SEPT 07/12
P. eng

NOTES:
1. PAN HEIGHT IS BASED ON EXPECTED STEEL DIMENSIONS AND MAY VARY +/- 3 mm - CONFIRMED PRIOR TO SHIPMENT.



ONE- REQ'D - 2134 mm WIDE APRON FEEDER D&N - MK. 'A01' EQPT #:

TO HANDLE NORMAL 1800 MTPH (MAX. 2000 MTPH) OF OVERBURDEN WITH SAND, CLAY, ETC.
APPROXIMATELY 1.76 PER CUBE METER
BED DEPTH: 913 mm / 0.75 VOID FACTOR = 1217 mm Min. SHEARBAR HT
SPEED: 0.195 m/s MAX. (VARIABLE) DRIVE: 2 x 93.2 kW

SEE DWG NO: V971-01-02 FOR BOM, SECTION A-A AND A-BOLT LOADS

PAINT SPECIFICATIONS:
SP6 COMMERCIAL BLAST FOLLOWED BY:
2 COATS CARBOLINE 840 EPOXY 3.0 MILS DFT PER COAT
FINAL COLOR GREY
GUARDS: POWDER COATED SAFETY YELLOW

REV.	DATE	DESCRIPTION	CHKD.	REV.	DATE	DESCRIPTION	CHKD.
				D	APR 20/12	CORRECTED THE INFO OF THE MAX SHEARBAR FORCE	OZH
				C	MAR 14/12	ADDED MTG HOLES AND STIFFENERS AS CLIENT REQ'D	OZH
				B	MAR 02/12	UPDATED AS CLIENT'S COMMENTS AND ISSUED CERTIFIED	OZH
				A	JAN 12/12	ISSUED FOR APPROVAL	OZH

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			DRAWN BY: OZH
			CHKD. BY: G.J.K.
			DATE: JAN 12/12
			REV.
			V971-01-01

8 ANCHOR BOLTS ON COLUMN A	①	NORMAL	MAX
VERTICAL DEAD LOAD		39.5 kN	39.5 kN
VERTICAL MATERIAL LIVE LOAD		11.0 kN	11.0 kN
VERTICAL DRIVE LIVE LOADS		7.4 kN	11.3 kN
VERTICAL SHEAR LIVE LOADS		79.0 kN	197.5 kN
HORIZONTAL LONGIT. LIVE LOAD		5.1 kN	5.1 kN
HORIZONTAL PERPEND. LIVE LOAD		0.5 kN	0.5 kN

8 ANCHOR BOLTS ON COLUMN B		(2)
VERTICAL DEAD LOAD	15.9 kN	15.9 kN
VERTICAL MATERIAL LIVE LOAD	27.9 kN	34.9 kN
VERTICAL SHEAR LIVE LOADS	-79.0 kN	-197.5 kN
HORIZONTAL LONGIT. LIVE LOAD	4.4 kN	5.6 kN
HORIZONTAL PERPEND. LIVE LOAD	0.4 kN	0.6 kN

8 ANCHOR BOLTS ON COLUMN C		(3)
VERTICAL DEAD LOAD	20.8 kN	20.8 kN
VERTICAL MATERIAL LIVE LOAD	34.7 kN	54.5 kN
HORIZONTAL LONGIT. LIVE LOAD	6.1 kN	8.0 kN
HORIZONTAL PERPEND. LIVE LOAD	0.6 kN	0.8 kN

8 ANCHOR BOLTS ON COLUMN D		(4)
VERTICAL DEAD LOAD	26.9 kN	26.9 kN
VERTICAL MATERIAL LIVE LOAD	37.4 kN	56.0 kN
HORIZONTAL LONGIT. LIVE LOAD	6.4 kN	8.3 kN
HORIZONTAL PERPEND. LIVE LOAD	0.6 kN	0.8 kN

4 TORQUE ARM ANCHOR BOLTS PER SIDE	(5)	
VERTICAL DEAD LOAD ON TORQUE ARM	0.6 kN	0.6 kN
VERTICAL LIVE LOADS ON TORQUE ARM	20.2 kN	51.7 kN
HORIZONTAL LONGIT. LIVE LOAD	0 kN	0 kN
HORIZONTAL PERPEND. LIVE LOAD	0 kN	0 kN

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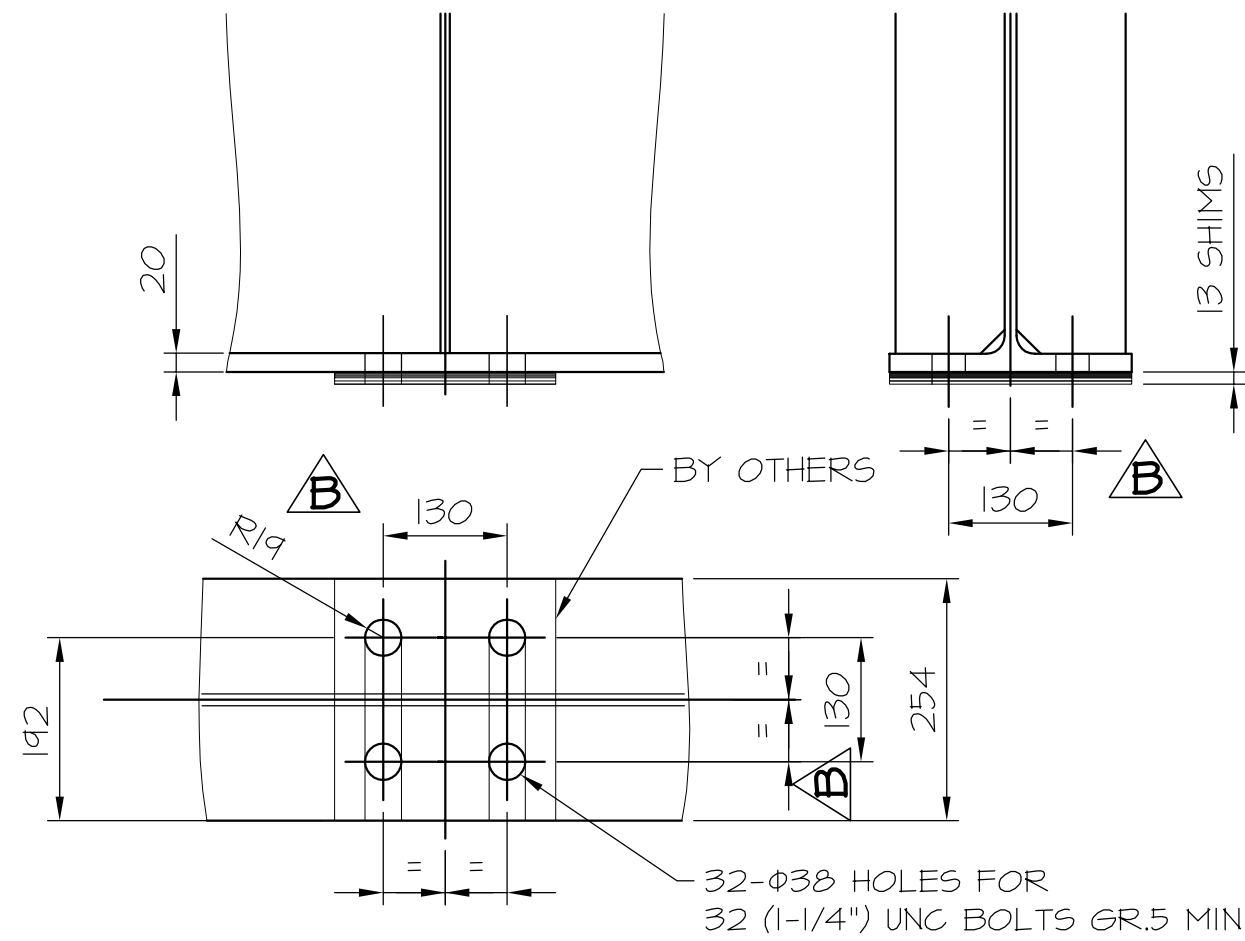
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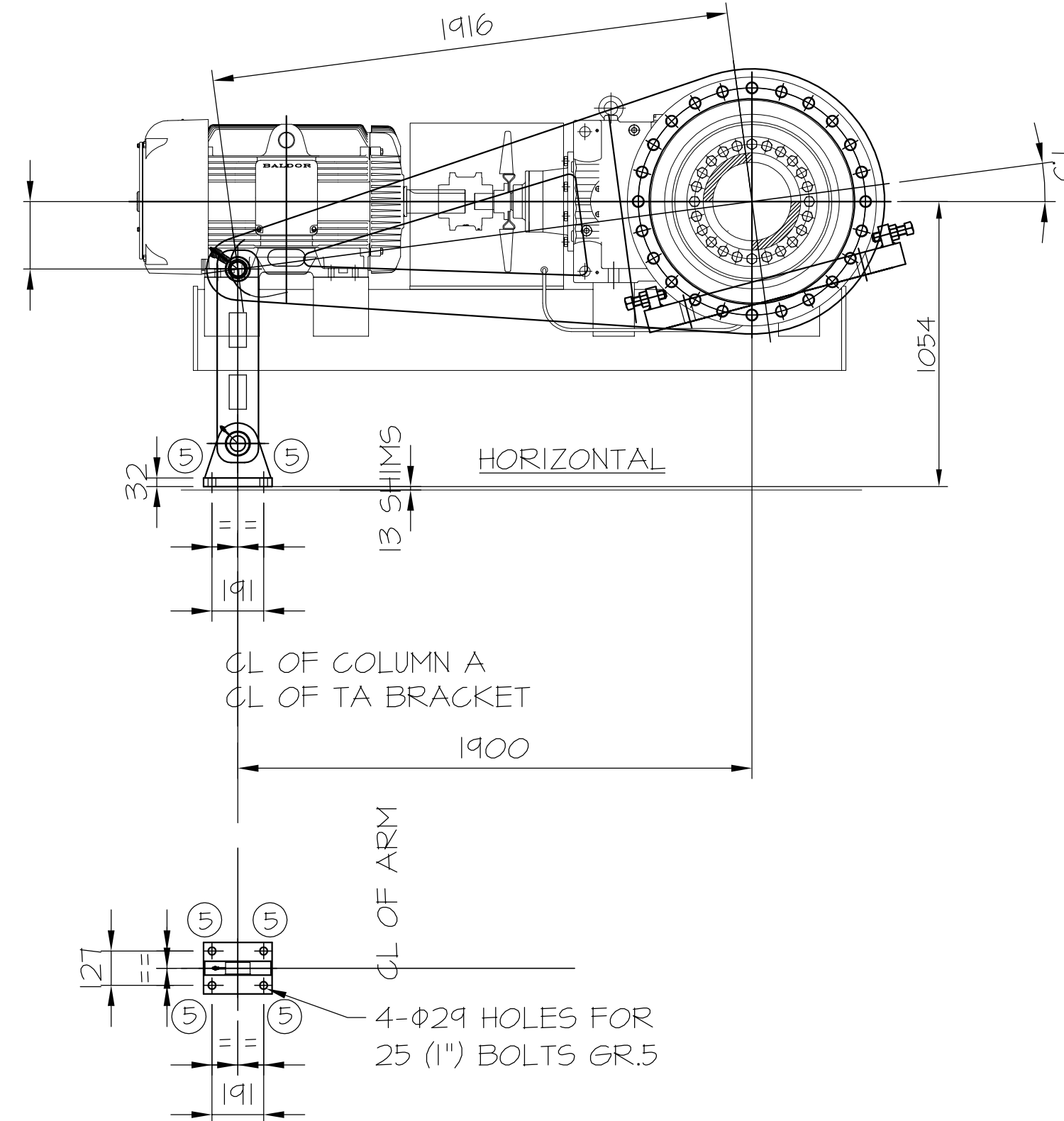
CERTIFIED CORRECT

FOR MEGATECH PROJECT
CUSTOMER

PER G.J.Williamson DATE SPET 13/12
Peng

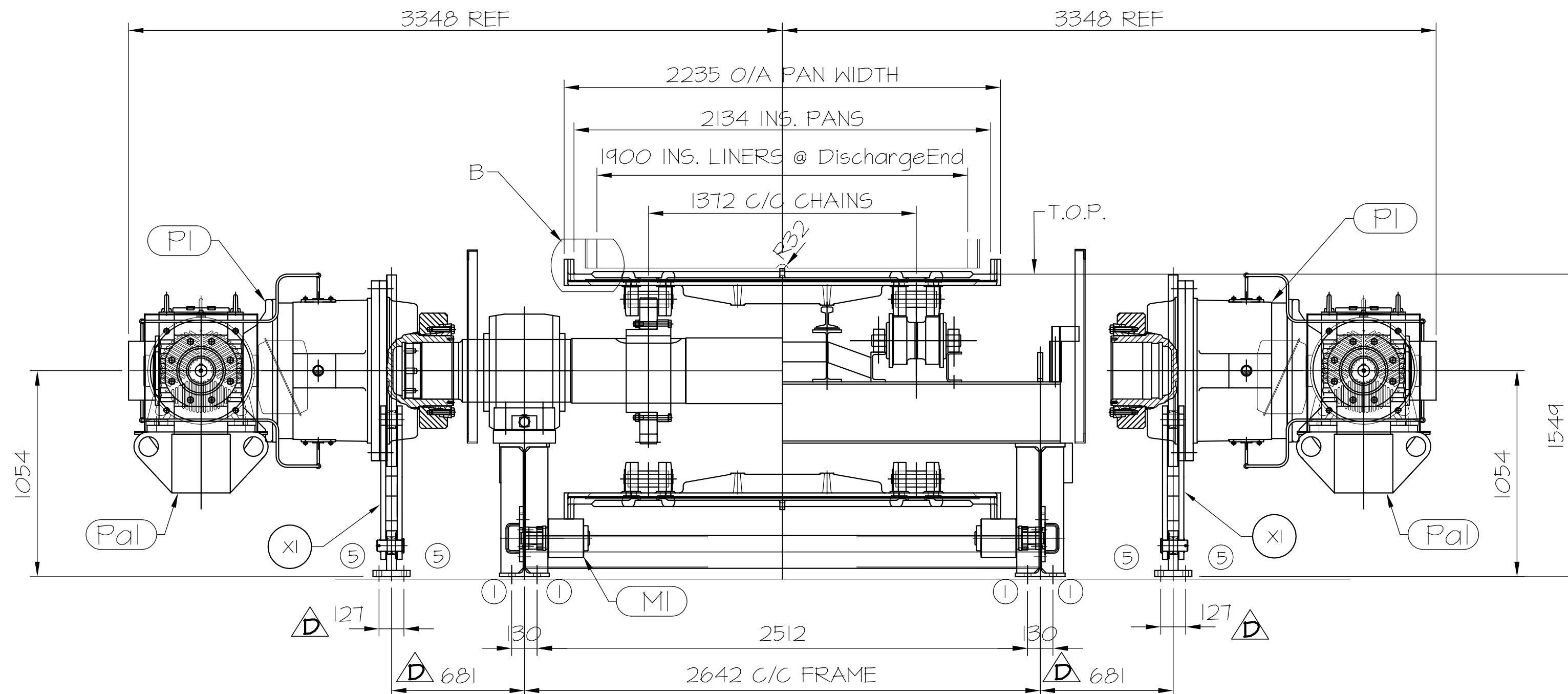


DETAIL 1 - TYPICAL
DETAIL 1 - TYPICAL
SCALE: 1:8

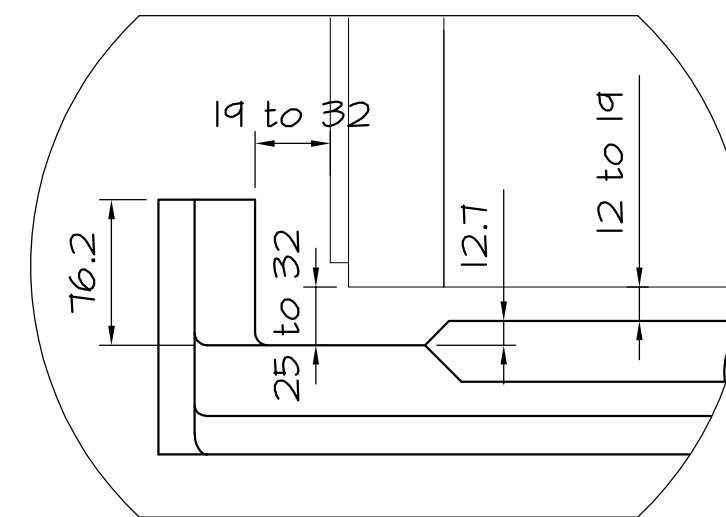


SECTION A-A

NOTES:
1. PAN HEIGHT IS BASED ON EXPECTED STEEL DIMENSIONS AND MAY VARY +/- 3 mm - CONFIRMED PRIOR TO SHIPMENT.



RIGHT SIDEVIEW

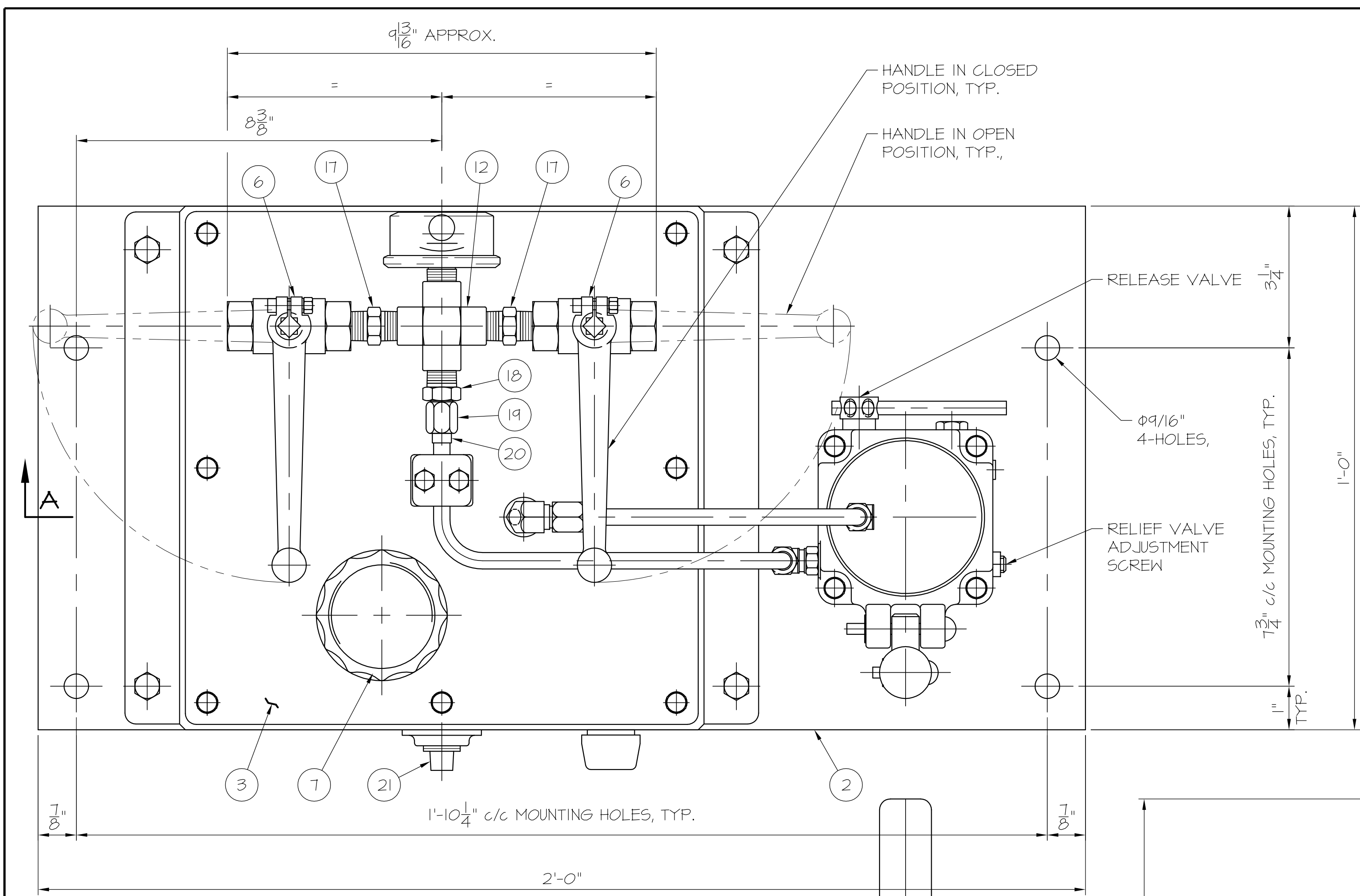


DETAIL B
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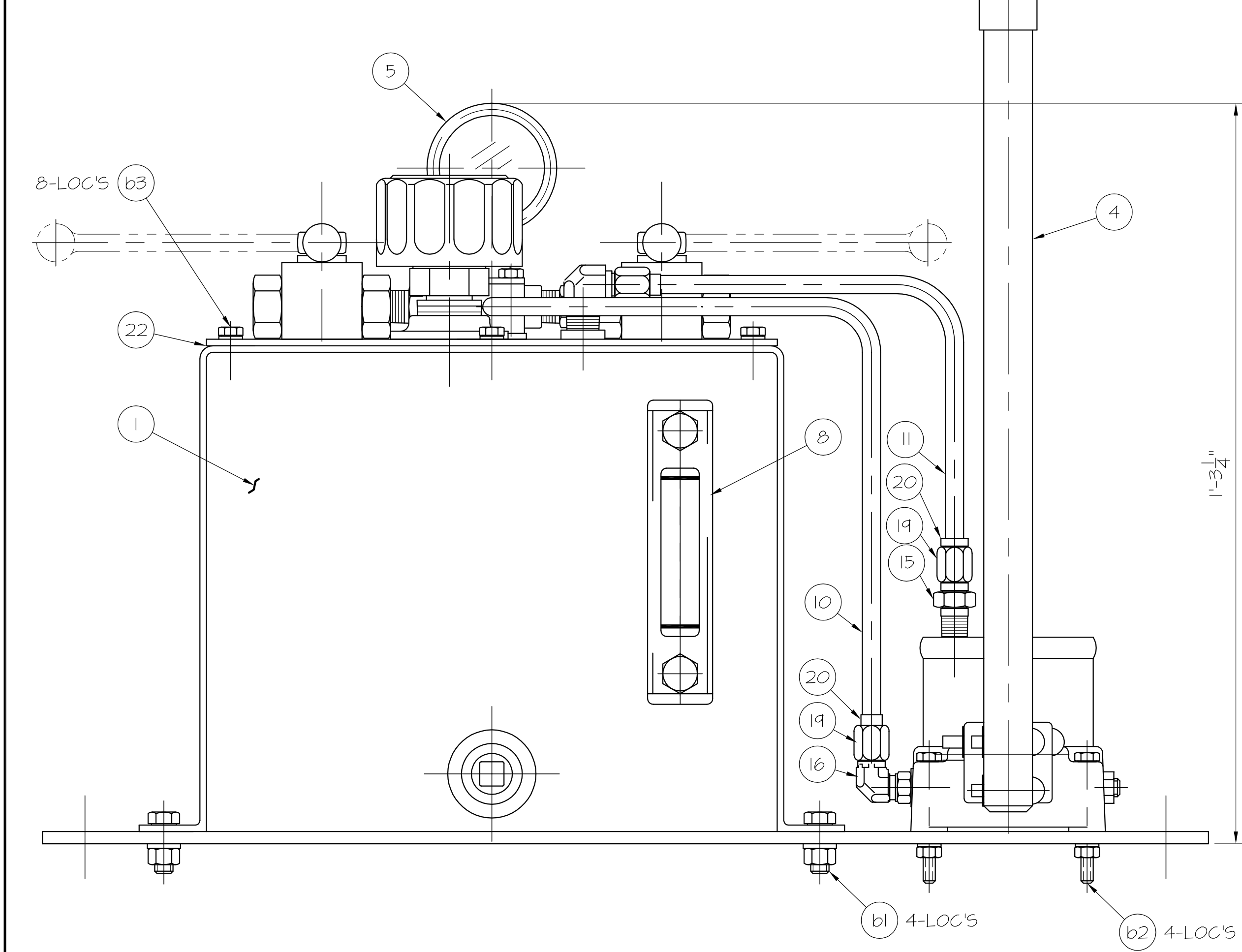
QTY.	DESCRIPTION	WEIGHT kg
ONE	2134 mm WIDE INCLINED APRON FEEDER D8N	
AI	336 mm DIA. 4340 HTSR x 3868mm LG HEADSHAFT NECKED TO 330 DIA. @ 5PKTS, 300 @ BRGS, AND 300 @ REDUCER	2580
BI	FAG #5DD23064K.M300TA P. BLOCKS, TACONITE SEALS AND OIL RELEASE ADAPTOR, 1 OPEN AND FIXED, 1 OPEN AND FREE	850
CI	D8N x 21 TOOTH SPROCKET-3 SEGMENTS BOLTED TO HUB, K5 FN-2 FIT, SPROCKETS P.D.: 732mm	680
DI	171.8 mm DIA C1045 TAIL SHAFT, NECKED TO 125.4 mm DIA. @ BRGS	560
EI	FAG SAFD 22528.415 PILLOW BLOCKS, TACONITE SEALS 1 OPEN AND FIXED, 1 CLOSED AND FREE	131
FI	HARDENED RIM TRACTION WHEEL- 3 SEGMENTS PER WHEEL	910
GI	1EM WELDED STL. SCREW TAKE-UP x 254 mm ADJUSTMENT C/W HYDRAULIC TAKEUP ASSIST ITEM VI	200
HI	D8N SALT TRACK CHAIN 215.9mm P. x (14+15) LINKS/CHAIN C/W 2 SPLIT MASTER LINKS / CHAIN	8,073
JI	DUAL IMPACT SKID CAST MANGANESE STEEL APRON PAN 2134 WIDE x 215.9 PIT, 38mm THICK, C/W LIFTING EYE AT CENTER	30,750
KI	22 DIA. (1/8") x 84 (3 1/2") LG HIGH-TENSILE TRACK BOLTS C/W TRACK NUTS & HW	256
LI	D8R CARRYING TRACK ROLLER #2-1986 (5F)	1,050
MI	1EM RETURN ROLLER S638B	1,108
NI	FABRICATED STL. DOORS/BRAKETS FOR RETURN ROLLER	998
PI	SEW EURODRIVE PHF082MC3RLSF06 RIGHT ANGLE PLANETARY REDUCER WITH HOLLOW SHAFT AND SHRINK DISC MOUNT WITH SOLID SHAFT INPUT AND FOOT MOUNT	6,450
Pal	2 WELD'D STL. MACHINED SWING-BASE MOTOR/REDUCER MOUNT 93.2 kW (125 HP) EL. MOTOR 1760 RPM, 575V/3/60,	1,800
Pbl	TEFC FOR INVERTER DUTY, ADVANTAGE PLUS IEEE 841 SEVERE DUTY NEMA 444T FRAME WITH FOOT MOUNT (THE ABOVE INFO IS PROVIDED FOR REFERENCE ONLY & THE MOTORS WILL BE SUPPLIED BY OTHERS)	
Pcl	2 R+W SERVOMAX TORQUE LIMITER ES2/1500BF, DI 85.73HT, D2 50HT DISENGAGEMENT TORQUE: 1250 Nm	90
RI	ROTECH 4B ZERO SPEED SWITCH (SUPPLIED BY MEGATECH)	2
SI	4 CROUSE HINDS' SINGLE END PULLCORD SWITCH 2-AFU0333-05 RIGHT AND 2-AFU0333-50 LEFT	10
TI	2 GALV. VINYL COVERED WIRE ROPE PULL CORD ASSY. C/W TENSION SPRING, TURNBUCKLE, THIMBLES, & CLAMPS	25
UI	1 REINFORCED WELDED STEEL FEEDER FRAME, C/W MOUNTING AND ANCHOR BOLT HOLES, BRG. SHIM PLATES, ABOVE MECHANICAL ITEMS TO BE SHOP ASSEMBLED TO FRAME	16,000
VI	1 HYDRAULIC ASSIST TAKE-UP C/W 2 HYDRAULIC CYLINDERS & 1 HYDRAULIC HANDPUMP POWER UNIT C/W MOUNTING BRKT	65
WI	1 LINCOLN AUTO LUBE SYSTEM C/W INJECTORS & EL PUMP P6535 #80091 24VDC 8L RESERVOIR W INTERNAL PRESS. TRANSDUCER	80
XI	2 TORQUE ARM ASSEMBLY WITH FLOOR MOUNTING BRACKET	1,000
YI	1 10" x 8" x 6" NEMA 4X JUNCTION BOX	50
A6~G6	22 REMOVABLE ANGLE FRAME EXPANDED METAL GUARDS ITEM OF INSTALLATION & MAINTENANCE MANUAL	1,000
I SET	ITEM OF SHOP & FILED BOLTS	
I SET	13mm THK INSTALLATION SHIM PACKAGE (BY OTHERS)	

WEIGHT OF FEEDER LESS DRIVE: 67,451 kg.
 TOTAL WEIGHT OF DUAL DRIVES & TORQUE ARMS (WITHOUT EL. MOTOR): 9,420 kg.
 TOTAL WEIGHT PER FEEDER WITHOUT EL. MOTOR: 76,871 kg.

SEE DWG NO: V97T-01-01 FOR ELEVATION VIEW AND TOP VIEW									
PAINT SPECIFICATIONS:				CODE		 INDUSTRIAL EQUIPMENT PORT KELLS SURREY, B.C. MANUFACTURING LTD. ISO 9001:2000 Certified		SCALE: 1:25 U.N.O.	
2 COATS CARBOLINE 840 EPOXY 3.0 MILS DFT PER COAT								DRAWN BY: OZH	
FINAL COLOR GREY								CHKD. BY: G.W.J	
GUARDS: POWDER COATED SAFETY YELLOW								DATE: JAN 12/12	
				C	APR 24/12	UPDATED INFO OF TORQUE ARM AND BRACKET AS BUILT	OZH	GENERAL ARRANGEMENT OF 2134 mm WIDE APRON FEEDER D8N EQPT #: SHT 2 OF 2	
G	SEPT 13/12	CORRECTED THE BORE SIZES OF R+W TORQUE LIMITER	OZH	D	APR 19/12	UPDATED LOADS OF ANCHOR BOLTS	OZH		
F	JUN 18/12	UPDATED ANCHOR BOLT'S LOADS FOR COLUMN A & B	OZH	B	MAR 02/12	UPDATED AS CLIENT'S COMMENTS AND ISSUED CERTIFIED	OZH		
E	JOY 05/12	UPDATED INFO OF JUNCTION BOX AND WEIGHTS	OZH	A	JAN 12/12	ISSUED FOR APPROVAL	OZH	FOR: MEGATECH ENGINEERING LTD.	
REV.	DATE	DESCRIPTION	CHKD.	REV.	DATE	DESCRIPTION	CHKD.	DRAWING No.: V97T-01-02	

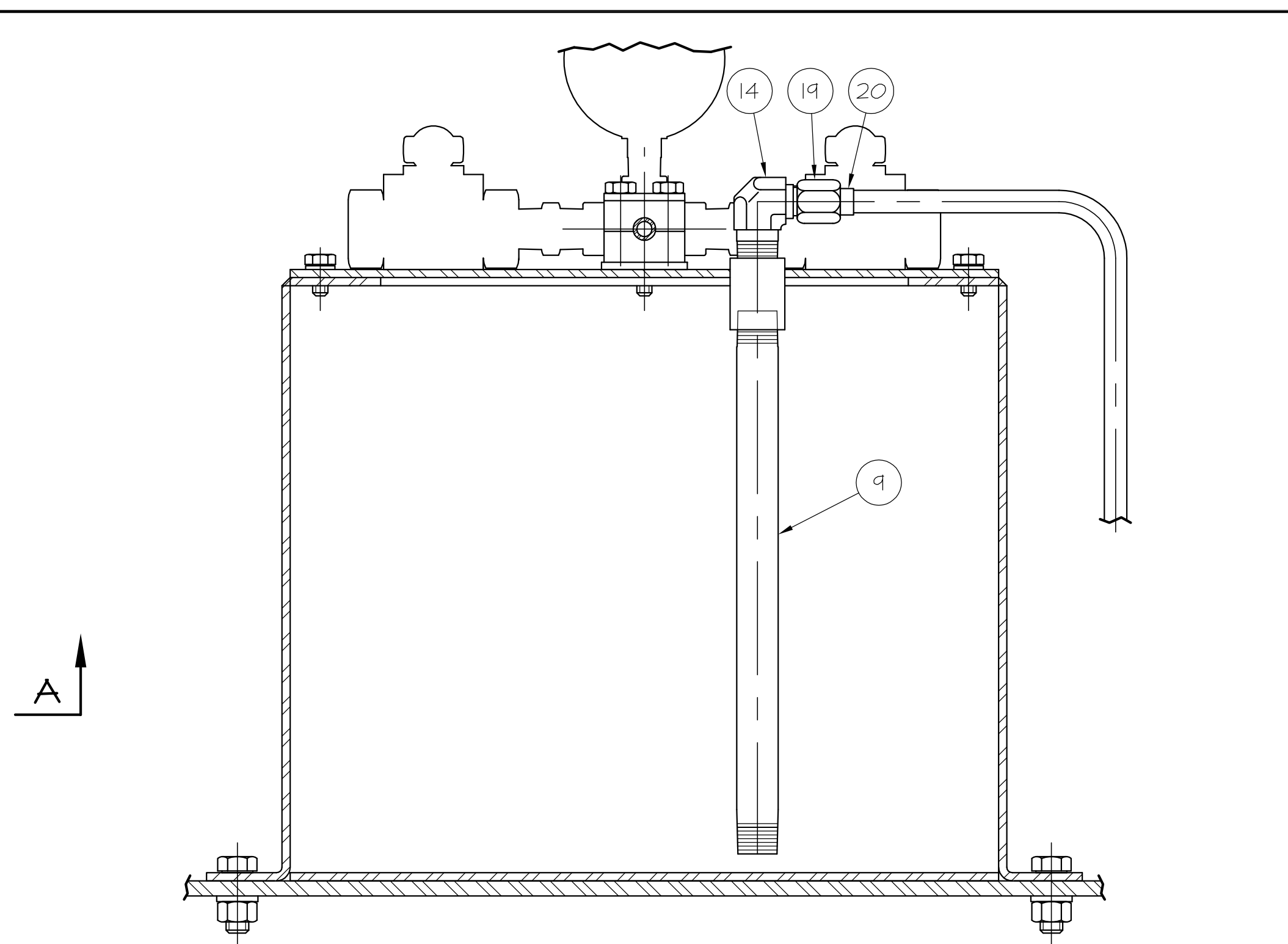


PLAN VIEW

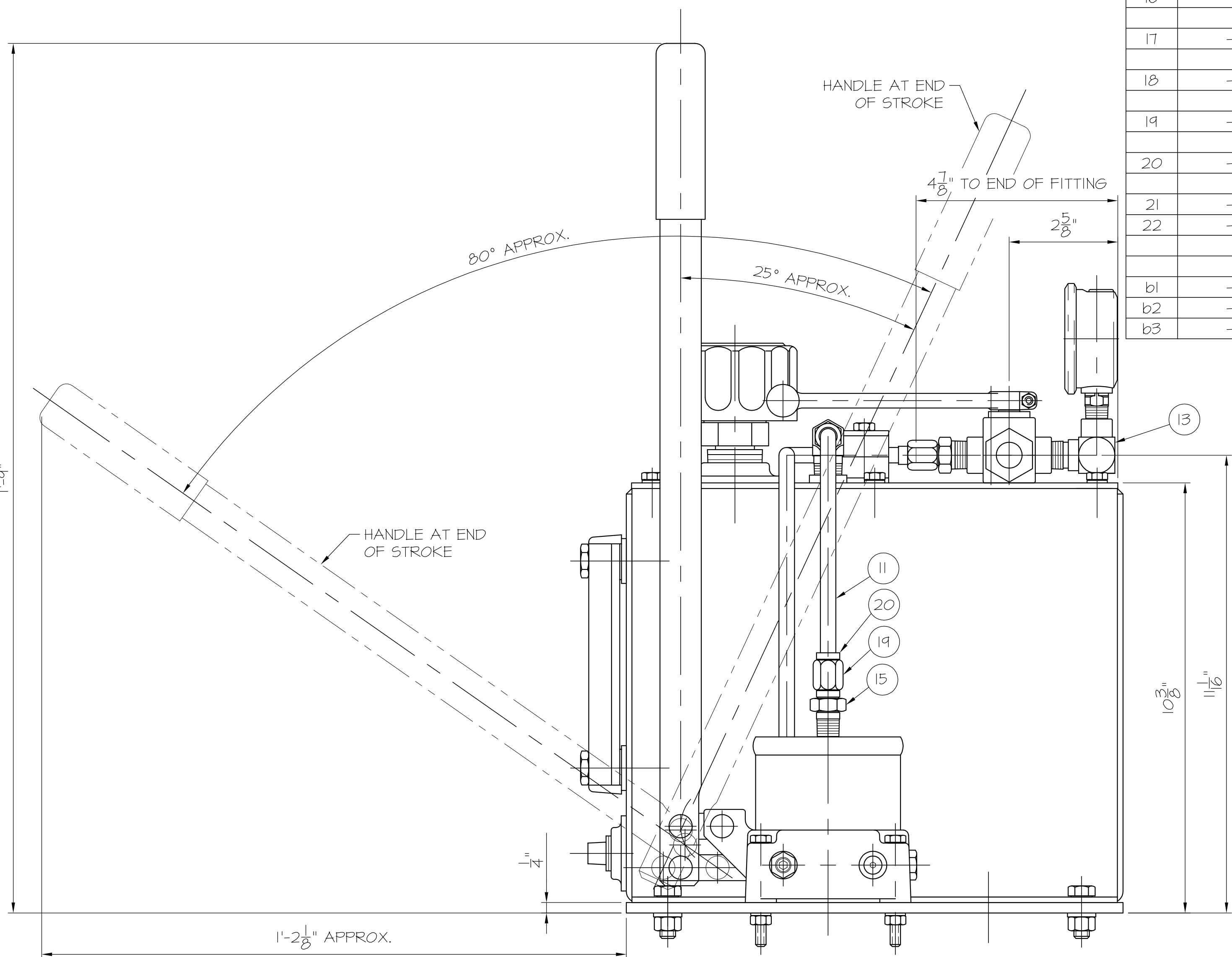


FRONT ELEVATION

ONE REQ'D - HYDRAULIC POWER-UNIT - MK'All'



SECTION A-A



SIDE ELEVATION

SEE V977-505 FOR HYDRAULIC TAKE-UP UNIT

BILL OF MATERIAL			
ITEM	PART/DWG. No.	QTY.	DESCRIPTION
'All'	M1145	ONE	HYDRAULIC ASSIST POWER UNIT
MATERIALS FOR ONE HYDRAULIC ASSIST POWER UNIT			
1	S-622	1	RESERVOIR WELDMENT, 5 GALLON-U.S., 12" x 12" x 10" x 10 GA.
2	S-624	1	MOUNTING PLATE, 24" x 12" x 1/4"
3	S-625	1	RESERVOIR LID, II 3/4" x II 3/4" x 10 GA., c/w WELDED FITTINGS & TUBE CLAMP
4	V894-507	1	HAND PUMP, TANKLESS, 3000 psi, 0.6 cu. in., BRAND HYDRAULICS HP6IDATL (PAINT AS PER NOTES)
5	V894-507	1	PRESSURE GAUGE, 2 1/2" SERIES, STEM MOUNT, 0-3000 psi, 1/4"NPT, FOSTER 9317644
6	V894-507	2	BALL VALVE, 2-WAY, 3/8"NPT, c/w HANDLE HYDAC KHB-10NPT-1-1-1-4-11X
7	V894-507	1	FILLER-BREATHER, 3/4"NPT, 10um, HYDAC BFP3G10W1.0
8	V894-507	1	FLUID-LEVEL INDICATOR, 5", c/w THERMOMETER HYDAC FSA-12T-1.1-T-12
9	-	1	PIPE NIPPLE, BLACK, 3/8" SCH-40, 9"Lg.
10	-	1	TUBING, HYDRAULIC, STEEL, 3/8", BEND TO SUIT (PAINT AS PER NOTES)
11	-	1	TUBING, HYDRAULIC, STEEL, 3/8", BEND TO SUIT (PAINT AS PER NOTES)
12	-	1	FITTING, CROSS, FEM PIPE/FEM PIPE, 3/8", AEROQUIP 2080-6-6
13	-	1	FITTING, 90° ELBOW, MALE PIPE/FEM PIPE, 3/8"-1/4", AEROQUIP 2089-6-4
14	-	1	FITTING, 90° ELBOW, MALE PIPE/3T° FLARE, 3/8"-3/8"O.D., AEROQUIP 2024-6-6
15	-	1	FITTING, MALE PIPE/3T° FLARE, 1/4"-3/8"O.D., AEROQUIP 2021-4-6
16	-	1	FITTING, 90° ELBOW, SAE O-RING BOSS/3T° FLARE, 9/16"THD-3/8"O.D., AEROQUIP 2062-6-6
17	-	2	FITTING, NIPPLE, MALE PIPE/MALE PIPE, 3/8", AEROQUIP 2083-6-6
18	-	1	FITTING, ADAPTER, MALE PIPE/3T° FLARE, 3/8"-3/8"O.D., AEROQUIP 2021-6-6
19	-	4	NUT, 3T° FLARE, 3/8"O.D., AEROQUIP 1290-6
20	-	4	FITTING, FLARED SLEEVE, SAE 3T°, 3/8"O.D., AEROQUIP 900605-6
21	-	1	PLUG, MALE PIPE THD, 1/2"NPT
22	-	1	WEATHER STRIP 'TUCK TAPE' 4-LENGTHS AS REQ'D
b1	-	4	HEX CAPSCREW, GR-5, 3/8"UNC x 1 1/2" c/w L.W. & H.N.
b2	-	4	HEX CAPSCREW, GR-5, 1/4"UNC x 2 1/2" c/w L.W. & H.N.
b3	-	8	HEX CAPSCREW, GR-5, 1/4"UNC x 1/2" c/w L.W.

- NOTES:**
- 'GLYPTOL' TO BE APPLIED TO INSIDE OF RESERVOIR BODY INCLUDING INSIDE OF LID AND OUTSIDE OF SUCTION PIPE
 - ONE SHOP COAT I.E.CO.-GREY ENAMEL TO BE APPLIED TO 'BLACK' HAND PUMP AND 'BLACK' TUBING (PLATED AND ANODIZED COMPONENTS DO NOT REQUIRE PAINT)
 - WEATHER STRIPPING TO BE ADDED BETWEEN RESERVOIR BODY AND LID
 - PIPE SEALANT TO BE APPLIED TO ALL THREADED CONNECTIONS
 - TUBING ENDS TO BE FLARED TO SUIT FITTINGS

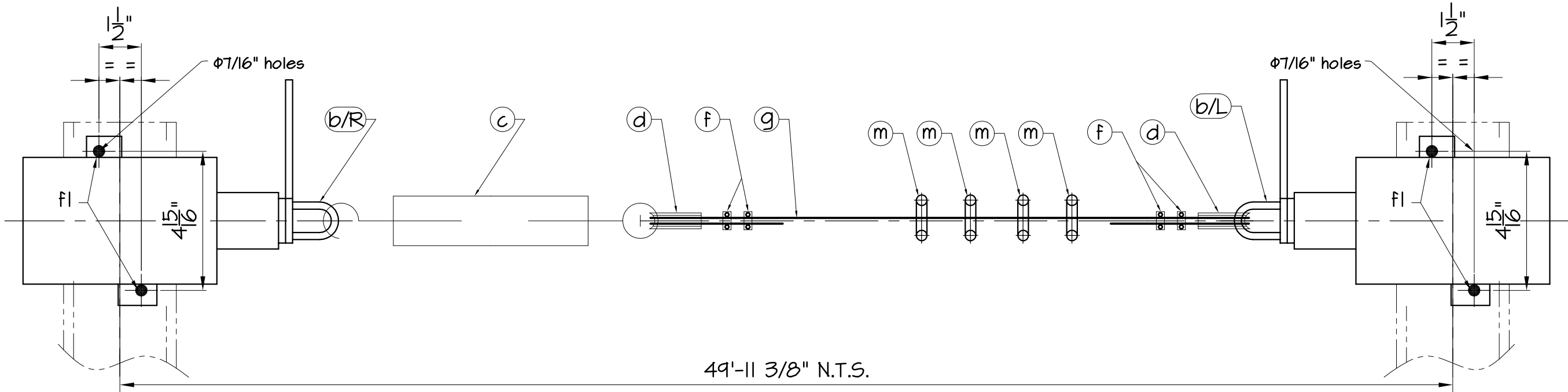
TOLERANCES FOR DIMENSIONS SHOWN			
unless otherwise noted			
Fabrication		Machining	
Fractional	+/- 1/16"	Overall length	+/- 1/16"
		Fractional	+/- 1/64"
		Decimal	+/- 0.010"
In addition to mill rolling		Decimal	+/- 0.005"
tolerances		xxx	+/- 0.005"
Deburr and Break Sharp Edges			

ALL HOLES
UNLESS NOTED

PAINT SPECIFICATIONS: - JOB SPECS. FOR WHICH THIS UNIT IS TO BE SUPPLIED, FOR TANK BODY INCLUDING LID AND MOUNTING PLATE - NOTES FOR COMPONENTS			CODE	 INDUSTRIAL EQUIPMENT MANUFACTURING LTD. ISO 9001:2000 Certified	PORT KELLS SURREY, B.C.	SCALE: 6" = 1'-0"	
						DRAWN BY: OZH	
				HYDRAULIC ASSIST HAND POWER-UNIT WITH 5 U.S.-GALLON RESERVOIR FOR APRON FEEDER		CHKD. BY OZH	
						DATE: OCT. 17, 11	
A	OCT. 20, 11	ISSUED FOR FABRICATION	OZH	FOR:	IEM STD. no.:	DRAWING No.:	REV.
REV.	DATE	DESCRIPTION	CHKD.		M-1145	V977-11	A

FIELD TO INSTALL ASSEMBLIES

MK.	QTY.	DESCRIPTION	
'A502R'	ONE	EMERGENCY PULL-CORD SWITCH ASSY RH	
'A502L'	ONE	EMERGENCY PULL-CORD SWITCH ASSY LH	
b/R	2	CROUSE-HINDS SINGLE END SWITCH AFU0333-05 RIGHT	
b/L	2	CROUSE-HINDS SINGLE END SWITCH AFU0333-50 LEFT	
c	2	3/8" x 6" GALV'D TURNBUCKLE HOOK AND EYE	
d	4	3/16" GALV'D OR SS THIMBLE	
f	8	3/16" W.R. CABLE CLAMPS	
g	2	1/8" DIA. 7 x 19 - GALV'D WIRE ROPE, 3/16" DIA. PVC YELLOW JACKET x 60'-0 LG.	
m	8	3/8" x 4" LG. EYEBOLT W 2HN & 2FW	
f ₁	8	HEX CAP SCREW, GR-5, 3/8 UNC x 1 1/2"Lg. W HN & LW	



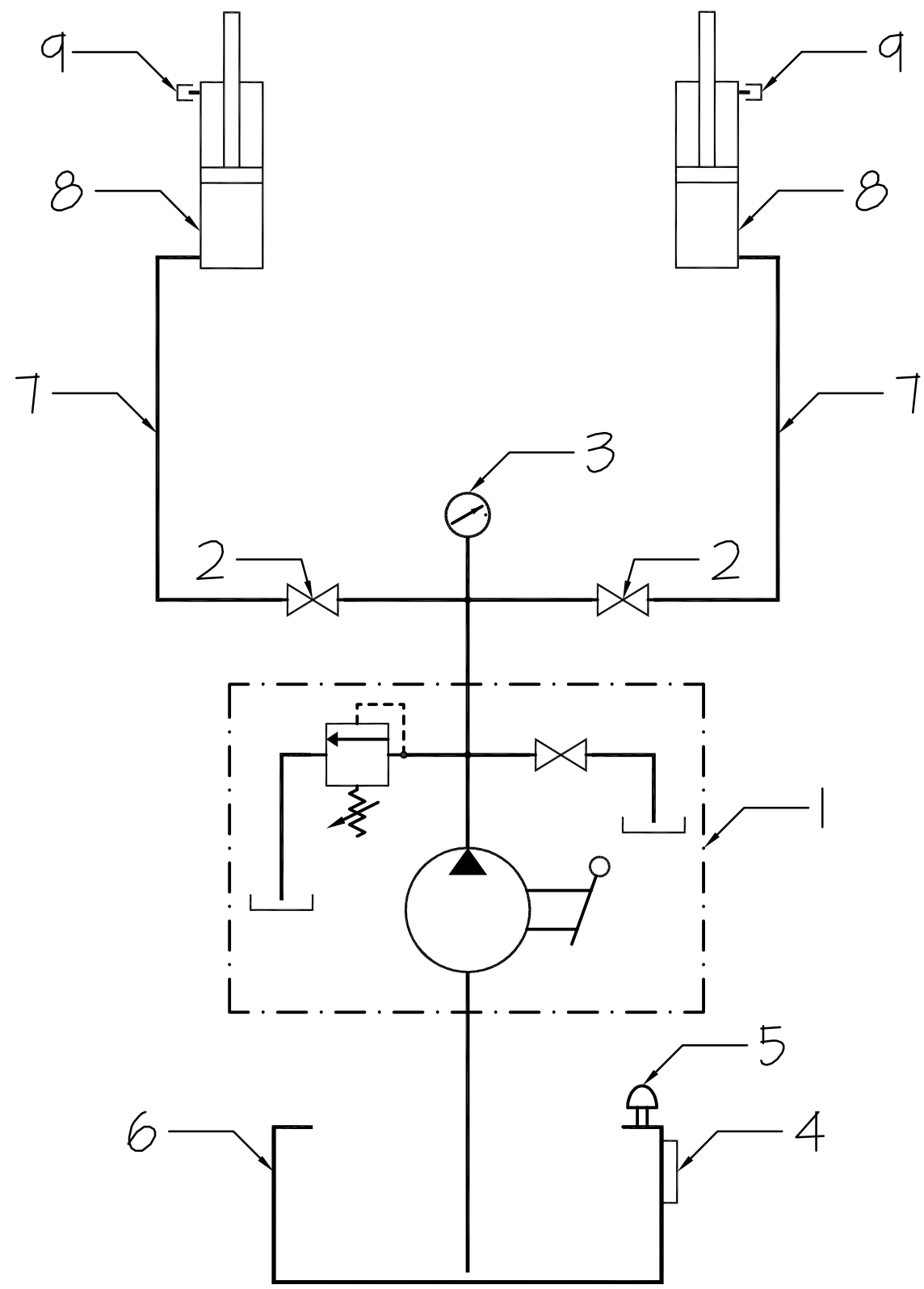
1-REQ'D - EMERGENCY PULL-CORD, R.H. - MK.'A502R' AS SHOWN
1-REQ'D - EMERGENCY PULL-CORD, L.H. - MK.'A502L' OPPOSITE

A	APR 09/12	ISSUED FOR FABRICATION	OZH
REV.	DATE	DESCRIPTION	CHKD.

 INDUSTRIAL EQUIPMENT MANUFACTURING LTD. ISO 9001:2000 Certified	PORT KELLS		SCALE: N.T.S.
	SURREY, B.C.		DRAWN BY: OZH
	PULLCORD SWITCH ASSY FOR 2143 WIDE APRON FDR D8 EQPT #		CHKD. BY
			DATE: APR 09/12
FOR: MEGATECH ENGINEERING LTD.		DRAWING No.:	REV.
		V977-502	



				HYDRAULIC TAKE-UP ASSIST		DATE: MAR 14/12
A	MAR 14/12	ISSUED FOR FABRICATION	OZH	FOR: CONDUMEX, INC	DRAWING No.:	REV.
REV.	DATE	DESCRIPTION	CHKD.		V977-505	

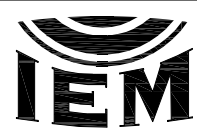


ONE - HYDRAULIC TAKE-UP ASSIST

MK.	QTY.	DESCRIPTION	
	ONE	HYDRAULIC TAKE-UP ASSIST SYSTEM	
		PARTS FOR ONE	
1	1	HAND PUMP, TANKLESS, 3000 psi, 0.6 cu. in., BRAND HYDRAULICS HP61DATL (PAINT AS PER NOTES)	
2	2	BALL VALVE, 2-WAY, 3/8"NPT, c/w HANDLE HYDAC KHB-10NPT-1-1-1-4-11X	
3	1	PRESSURE GAUGE, 2 1/2" SERIES, STEM MOUNT, 0-3000 psi, 1/4"NPT, FOSTER 9317644	
4	1	FLUID-LEVEL INDICATOR, 5", c/w THERMOMETER HYDAC FSA-127-1.1-T-12	
5	1	FILLER-BREATHER, 3/4"NPT, 10um, HYDAC BFP3GI0W1.0	
6	1	5 GALLON RESERVOIR	
7		3/8" HOSE ASSYS c/w JIC SWIVEL FEMALE ENDS	
8		Φ2 1/2" x 10" STROKE HYS 25MAL10-10, Φ1 1/2" ROD HY-SPEC MAL CYLINDER	
9		#ASP - 4BV BREATHER PLUG, 1/2" NPT	

SEE DWG: V977-505 FOR Q'ty OF ITEM '7', '8' & '9'

- NOTES:**
- 1. PRE-SET HYDRAULIC PUMP RELIEF VALVE TO 2,260 PSI FOR MAX FORCE OF 11,100 lbs/CYLINDER
 - 2. ITEM 7 HOSE ASSYS - LENGTH TO SUIT.



**INDUSTRIAL
EQUIPMENT**
MANUFACTURING LTD.
ISO 9001:2000 Certified

PORT KELLS
SURREY, B.C.

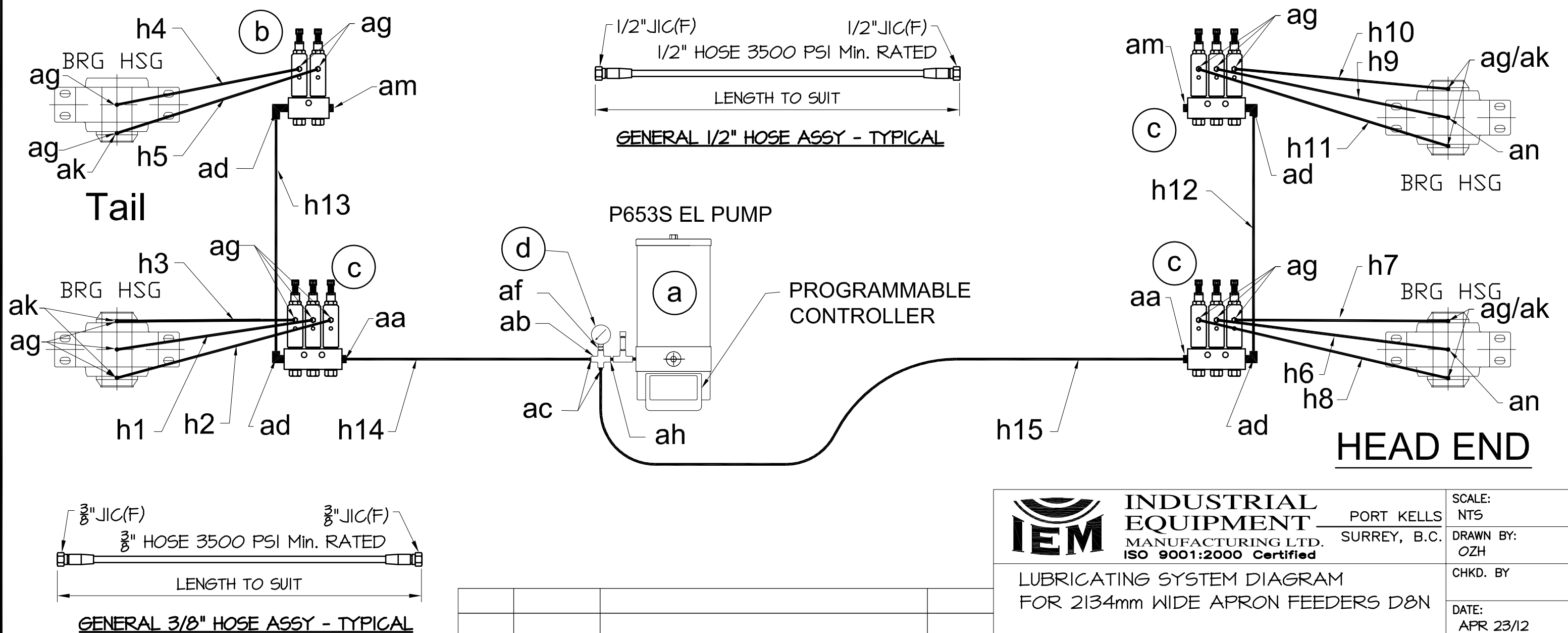
HYDRAULIC TAKE-UP ASSIST DIAGRAM
FOR APRON FEEDER

SCALE:
-
DRAWN BY:
OZH
CHKD. BY
GJW
DATE:
mar 14/12

DRAWING No.:
V977-507

REV.
A

MK.	QTY.	DESCRIPTION	MK.	QTY.	DESCRIPTION
af	1	ADAPTER 1/2" NPT (M) x 1/4" NPT (F) #2081-8-45	'A513'	ONE	CENTROMATIC LUBRICATING SYSTEMS FOR APRON FEEDER
ag	20	90° ADAPTER 1/8" NPT(M) x 3/8" JIC (M) #2024-2-65	a	1	MODEL #80091 P653S LINCOLN 24VDC EL PUMP C/W
ah	1	ADAPTER 1/2" NPT(M) x 1/4" NPT (M)			8L RESERVIOR, INTERNAL PRESSURE TRANSDUCER &
ak	7	Φ1/4"-28NF MALE x 1/8" NPT(F) ADAPTER			PROGRAMMABLE CONTROL
am	2	3/8" NPT HEX PLUG	b	1	SL-I INJECTORS (DOUBLE) #85770-2
an	2	90° ADAPTER 1/4" NPT(M) x 3/8" JIC (M) #2024-4-65	c	3	SL-I INJECTORS (TRIPLE) #85770-3
			d	1	PRESSURE GAUGE NOSHOK # 25.901-5000 PSI/350 kPA
			aa	2	ADAPTER 1/2" JIC (M) x 3/8" NPT(M)
h1~h13	1 Set	3/8" HOSE C/W 3/8" JIC (F) FITTINGS BOTH ENDS (LENGTH TO SUIT)	ab	1	CROSS 1/2" NPT (FFFF) #2080-8-85
h14~h15	1 Set	1/2" HOSE C/W 1/2" JIC (F) FITTINGS BOTH ENDS (LENGTH TO SUIT)	ac	2	ADAPTER 1/2" JIC (M) x 1/2" NPT(M) #2021-8-85
			ad	4	90° ADAPTER 3/8" NPT(M) x 3/8" JIC (M) #2024-6-65



 INDUSTRIAL EQUIPMENT MANUFACTURING LTD. ISO 9001:2000 Certified PORT KELLS SURREY, B.C. SCALE: NTS DRAWN BY: OZH CHKD. BY DATE: APR 23/12			
LUBRICATING SYSTEM DIAGRAM FOR 2134mm WIDE APRON FEEDERS D8N			
FOR: MEGATECH ENGINEERING LTD.			
DRAWING No.:		REV.	
V977-513		A	

[illegible]

MEGATECH PROJECT				IEM WO NO. V977		SHIPPING LIST			SEPT 13/12
2134 Wide D8N Apron Feeder				GA DWG	V977-01	V977-522	Rev B		
Item NO.	Q'ty	Description		Mark No	Weight	Dimensions, m			
		qty	components		in kg	length	height	width	Ship date
1	1	Feeder Assembly		V977-01	66,228	16.60	1.65	3.90	
		1	Bottom Frame	'a03'	5,928				
		1	Top Frame	'a04'	8,425				
		2	21-tooth Sprockets	'A05'	708				
		2	Traction Wheels	'a502'	579				
		11L/11R	Return roller assy	'A07L/R'	1,928				
		2	T-up assembly	'a08R/L'	254				
		1	Head shaft assy & FAG SDD23064K	'a09'	3,333				
		1	Tail shaft assy& FAG SAFD22528.415	'b09'	1,607				
		68	D8N Carry rollers	'L1'	6,020				
		2	D8N Chain 8.5" P.x 149 Links including	'H1'	7,325				
			2 Split Master links/chain						
		149	2134mm Wide Apron pans D8N	'J1'	29,800				
		2	2 1/2x10 HYS 25Mal10-10 Hydr Cylinder	'm505'	20	(TO TIE UP BEFORE SHIPPING)			
		1	Misc and bolts	A520	300				
2	12	Side guard panel - Type A		'A06'	305	1.62	0.22	1.00	
3	2	Side guard panel - Type B		'B06'	55	1.75	0.22	1.00	
4	2	Side guard panel - Type C		'C06'	57	1.88	0.22	1.00	
5	1R/1L	Side guard panel - Type D		'D06'	58	1.55	0.24	1.00	
6	2	Side guard panel - Type E		'E06'	50	1.52	0.22	1.00	
7	1R/1L	Tail guard panel - Type G		'G06L/R'	54	1.61	0.20	1.00	
8	1R/1L	SEW PHF082MC3RLSF06 REDUCER W SWING		'P1, Pa1,					
		Base, Guards and TA		'X1'	9,330	2.75	1.20	1.70	
9	2	R+W Torque Limiter ES1/1500BF, D1: 85.73H7,							
		D2: 50H7		'Pc01'	90				
10	2	Pullcord sw 1-AFU0333-05 Right		'b502R'	3				
11	2	Pullcord sw 1-AFU0333-50 Left		'b502L'	3				
12	2	C4 x 5.4 x 3'-2 1/4" LG		'f02'	16	1.00	0.10	0.04	
13	2	C4 x 5.4 x 2'-1 15/16" LG		'g02'	12	0.66	0.10	0.04	
14	6	L2 1/2 x 2 1/2 x 1/4" x 2'-11 3/4" LG		'h02'	33	0.91	0.07	0.06	
15	1	5 Gal. Hydraulic Power-unit & mtg brckts		'A11,A506'	100	0.61	0.53	0.34	
16	1	#80091 P653s EL Pump c/w Bkt		'A513'	90				

MEGATECH PROJECT				IEM WO NO. V977		SHIPPING LIST			SEPT 13/12
2134 Wide D8N Apron Feeder				GA DWG	V977-01	V977-522		Rev B	
Item NO.	Q'ty	Description		Mark No	Weight	Dimensions, m			
		qty	components		in kg	length	height	width	Ship date
17	1	NEMA 4X JUNCTION BOX		'Y1'	50				
18	1	FIELD BOLTS		'A521'	10				
				Total Weight/Feeder Less Drive=		67,214	kg		
				Total Weight=		76,544	kg		